# FROM DENSITY TO DIALOGUE

## UNFOLDING LABORATORY BUILDINGS

DIPLOMA THESIS – CLARA J. PFAFFINGER

# From Density to Dialogue

## Unfolding Laboratory Buildings

**Diplomarbeit**
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# ABSTRACT



**From Density to Dialogue: Unfolding Laboratory Buildings**

In the field of laboratory construction, there is a significant research deficit concerning open-plan laboratories and the working atmosphere for researchers. Laboratory buildings present a complex challenge for planners due to their requirements for hygiene, safety, and room connection. The tight corset of specifications and standards often leaves little room for aesthetics. Targeted transparency, a high density of use and information, flexibility, a wide range of rooms, and mobility are decisive parameters for an efficient research building.

An often neglected approach to sustainability lies in saving space. The resulting reduction in the use of materials positively affects the $CO_2$ balance of the energy-demanding laboratory building, both in production and during operation. The sophisticated uses and networks provide a generous basis for optimizing spatial connections. The in-depth analysis of 18 international reference projects provides an initial approach to the topic: How are the proportions of the uses distributed? What architectural parameters does an efficient laboratory building require? Which room groupings and typologies can create more efficient structures? Which concepts can save space?

The architectural competition "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestrasse in Berlin" allows the results of the research work to be optimally applied in a design. From February to May 2023, more than 20 high-ranking architectural firms from across Europe developed their concepts. How can corridor situations be reduced without losing their logistics and meeting function? How can the space saved be used to promote communication?

Therefore, the work aims to provide a well-founded introduction to laboratory construction and a strategy for more sustainability by optimizing the spatial connections of an individual proposal, which offers optimal conditions for exchanging knowledge. The constructive separation of the open-plan laboratory and flexible office area is a sustainable approach.

**Von der Dichte zum Dialog: Entfaltung von Laborgebäuden**

Im Bereich des Laborbaus herrscht ein erhebliches Forschungsdefizit bezüglich Großraumlaboren und der Arbeitsatmosphäre für Forscher*innen. Laborgebäude stellen durch ihre Anforderungen an Hygiene, Sicherheit und die Raumverknüpfungen eine komplexe Herausforderung für Planer*innen dar. Durch das enge Korsett an Vorgaben und Normen bleibt oft wenig Spielraum für Ästhetik. Gezielte Transparenz, eine hohe Nutzungs- und Informationsdichte, Flexibilität, ein breites Spektrum an Raumangeboten sowie Mobilität sind entscheidende Parameter für ein effizientes Forschungsgebäude.

Ein oft vernachlässigter Ansatz zum Thema Nachhaltigkeit liegt in der Einsparung von Fläche. Der dadurch reduzierte Materialeinsatz wirkt sich sowohl bei der Herstellung als auch im laufenden Betrieb positiv auf $CO_2$-Bilanz energetisch anspruchsvoller Laborgebäude aus. Durch die vielschichtigen Nutzungen und Vernetzungen wird eine großzügige Basis geboten, um Raumbeziehungen zu optimieren. Die tiefgehende Analyse von 18 internationalen Referenzprojekten bietet hierbei einen ersten Zugang zur Thematik: Wie sind die Proportionen der Nutzungen verteilt? Welche architektonischen Parameter benötigt ein effizienter Laborbau? Durch welche Raumgruppierungen und Typologien können effizientere Strukturen entstehen? Welche Konzepte können den Flächenverbrauch reduzieren?

Anhand des Architekturwettbewerbs „Neubau des Laborgebäudes Haus 7 für das Robert Koch-Institut (RKI) an der Seestraße in Berlin" lassen sich die Ergebnisse der Forschungsarbeit optimal in einem Entwurf anwenden. Über 20 europaweit hochrangige Architekturbüros haben von Februar bis Mai 2023 ihre Konzepte entwickelt. Im Entwurf stellen sich folgende Fragen: Inwieweit können Flursituationen reduziert werden, ohne ihre Logistik- und Begegnungsfunktion zu verlieren? Wie kann die eingesparte Fläche kommunikationsfördernd genutzt werden?

Ziel der Arbeit ist es somit nicht nur einen fundierten Einstieg in das Thema Laborbau zu bieten, sondern auch durch optimierte Raumverknüpfungen eines eigenen Entwurfes, einen Ansatz für mehr Nachhaltigkeit zu leisten, der optimale Bedingungen für Wissensaustausch bietet. Die konstruktive Trennung von Großraumlabor und flexiblem Bürobereich erweist sich dabei als nachhaltiger Ansatz.

# Introduction

***"Cathedrals of Science"***

– Kaji-O'Grady & Smith, 2019, Chapter 1

Laboratory buildings: In which research work takes place, describing our world and future. The position of knowledge mediators that the church occupied 600 years ago is now occupied by scientific institutes (Kaji-O'Grady & Smith, 2019, Chapter 1).
Research is an essential part of our development as humanity. The curiosity that lies within each of us finds professional application in laboratories. Therefore, it is essential to support this activity to better understand the future and, above all, our world.

**Motivation**

The topic of sustainability is becoming increasingly present in everyday life through construction with resource-saving materials and the thoughtful use of existing buildings. The aspect that particularly appeals to me is the additional level created by optimizing space. On the one hand, less space is built on, or more use is accommodated within a defined area, and on the other, less material is required.
This approach is supported by open-plan spaces that can be densified using flexible areas. In addition, upgrading the use of circulation areas can also make a decisive contribution to space efficiency by reducing typical corridor situations as far as possible.
One typology in particular lends itself to this, offering a basis for this investigation due to the complex requirements in numerous rooms, such as laboratory buildings. Research buildings are not an everyday topic for most architects. The complexity and the tight corset of specifications and standards usually seem daunting at first glance.
However, laboratory buildings are not only architecturally interesting because of their spatial density but also need to provide an enjoyable and communicative environment for researchers. Laboratories are not just architectural machines but offer the potential to motivate researchers to conduct creative and efficient research.
In my practical work in architectural offices, I came across the competition for the "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestrasse in Berlin" with the focus on laboratory research and diagnostics. This opportunity presents itself as the perfect basis for conceptually implementing the optimizations in an example with a realistic room program.

**Problem definition**

The architectural challenge in laboratory construction is maintaining hygiene and safety within the optimization process. For reasons of cost and high requirements, there is often little scope for aesthetics and pleasant working environments.
In contrast to office construction, where intensive research into innovative and flexible solutions has been carried out for decades, there is a considerable research deficit in the area of open-plan labs and the arrangement and sorting of room groups (Marguin et al., 2022, p. 139). Furthermore, the approach of saving space should be given more consideration in the discussion about sustainable approaches in architecture.
In order to increase space efficiency, this thesis examines whether circulation areas can be upgraded through additional uses. The aim here is not to reduce the communicative and logistical function of corridors (Grömling, 2005, p. 47), but to integrate the mobility of employees more strongly into an overall network throughout the building.

**Research questions**

Every laboratory is different in terms of its research area and its requirements. An intensive dialog with the users and specialist planners is required. In order to be able to develop optimizations, however, the structure of a laboratory building must first be understood. *How are the proportions of the uses distributed? What architectural parameters does an efficient laboratory building require? Which room groupings and typologies can create more efficient structures?*
The next step is to consider whether the optimization measures can be implemented in a design based on the architectural competition. *Does this save space? How can corridor situations be reduced without losing their logistics and meeting function?*
The final step is to examine how the optimized space can not only be reduced but also provided with attractive added value. *How can the space saved be used to promote communication?*

**Goals**

The main focus is optimizing the space ratios to maximize the percentage of laboratory rooms, office areas, teaching rooms, and essential communication areas. Optimized room linkages are intended to promote mobility and interaction between employees.
A variety of measures, such as large-area usage options and the targeted reduction of traditional corridor situations, are in-

tended to reduce space consumption, thereby contributing to sustainability. However, space should be decreased concretely and replaced by attractive offers to promote communication.
In addition, this work is intended to provide a catalogue of the unusual field of laboratory construction. An overview of the complex topic provides a quick orientation of the most important parameters that need to be considered when designing and planning.

**State of research**

As already mentioned, there is a massive research deficit in the area of open-plan laboratories or room groupings in laboratory construction. To counteract this deficit, an instructive experiment was conducted at Humboldt University in Berlin from 2015 to 2018: Experimental Zone - An Interdisciplinary Investigation on the Spaces and Practices of Collaborative Research describes how the spatial environment affects research in interdisciplinary teams. Over a period of three years, the room layout and furnishings in the 350 $m^2$ space were changed every two months in order to be able to adapt flexibly to project work. The researchers worked in the fields of engineering, design, natural sciences and humanities (Marguin et al., 2019, pp. 9, 10, 87).

**Methodology and structure**

The first step in understanding how laboratory buildings work is to present the basic planning parameters using a catalog with *Zoom-In* in Chapter 01 Typology. The most essential aspects for a basic understanding are conveyed from the rough typology to the various security levels. An interview with two employees of the international architecture firm HENN also serves as a source of information.
Since the findings of the thesis are to be applied conceptually and fictitiously on the basis of an architectural competition for the Robert Koch Institute (RKI) at the Berlin Seestraße site, an overview of the history, current developments, research work and public confidence is given in Chapter 02 RKI as an introduction.
In order to get a practical idea of laboratory buildings after the theoretical presentation, eighteen international projects from the last 75 years are analyzed in Chapter 03 References. A rough area analysis of the standard floors is carried out in accordance with DIN 277-1 | 2016 in order to understand the area ratios and distributions. Innovative concept points, the respective research areas, the materials used, and the floor organization are highlighted in text form. A comparison of dimensions, floor area ratios, and spatial connections follows a detailed explanation of all references.
The analysis findings obtained up to this point are used in Chapter 04 Optimization to develop tools for an efficient floor plan arrangement. The results are aimed at optimizing room groupings with regard to technical and social aspects, the most important layers for modern laboratory planning, the appropriate floor plan structure for flexible use, and the upgrading of corridor situations.
Chapters 05 Site and 06 Proposal transition to the practical application of the results. Based on the architectural competition "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestrasse in Berlin" from 2023, which has already been mentioned, the participating projects are analyzed, and a proposal is developed.
The thesis concludes with a comparison of the analyzed reference projects, competition participants, and the proposed design.
Throughout the work, intensive literature research in specialist books, magazines, and websites served as a source of information. Furthermore, site visits and the vernissage of the exhibition of the competition results also provided exciting insights.

**Notice**

The area analyses and drawings presented in this master's thesis are based on my own estimates. These are derived from an evaluation of plan drawings, photographs, and text sources on the concept and structure of the buildings.
Due to differences in quality in the existing planning documents, minor deviations in dimensions and floor space ratios cannot be ruled out. As detailed information is not available for all rooms, assumptions had to be made regarding placement and use in some cases.
In connection with the "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestraße in Berlin" competition, the existing buildings and the feasibility study were intensively analyzed. For safety reasons and in coordination with the BBR, House 5 and House 6 are only shown to the minimum extent necessary - solely to make the conceptual decisions for my own design for House 7 comprehensible. The feasibility study is not shown.

# DEFINITIONS

**Laboratory building**
What is a laboratory building? According to the Assessment System for Sustainable Building New laboratory building, in German Bewertungssystem Nachhaltiges Bauen (BNB) Neubau Laborgebäude, it is "all buildings that are used for laboratory activities" (Bewertungssystem Nachhaltiges Bauen (BNB) Neubau Laborgebäude, 2013, p. 1, translated from German). The uses are often divided into laboratories and office or administrative areas. The laboratory share must be at least 10 % of the total use to be included in this typology. These buildings deal with the so-called "small series" (Bewertungssystem Nachhaltiges Bauen (BNB) Neubau Laborgebäude, 2013, p. 1) — an aspect different from production facilities. Two decisive parameters in planning, which must be taken into account more than in most building types, are the required technical areas and the safety factor regarding the working areas. Substances to be tested must not be allowed to leave the premises in an uncontrolled manner (Bewertungssystem Nachhaltiges Bauen (BNB) Neubau Laborgebäude, 2013, p. 1).
*Biosafety* and *Biosecurity* are important terminology distinctions, especially in microbiological laboratories like the RKI. The former describes the avoidance of incidents through well-thought-out working methods; the latter protects against external influences in laboratory operations or against the possibility of investigative materials being unintentionally released into the outside world. Nevertheless, there are, of course, areas in everyday laboratory work that relate to both concepts (Mertsching, 2022, p. 1).

**Laboratory**
"Laboratories [...] are workrooms in which specialists or trained persons carry out experiments to investigate or utilize scientific processes. [...]. These include, for example, chemical, physical, medical, microbiological, and genetic engineering laboratories." (Bewertungssystem Nachhaltiges Bauen (BNB) Neubau Laborgebäude, 2013, p. 1, translated from German).
Numerous definitions are used to describe a laboratory. Presumably, everyone has their own perspective on research work. However, one impression that is often repeated is that many people are not directly aware of what goes on behind the walls of laboratory buildings. The high complexity of research activities and the essential safety measures are aspects that reinforce this image.
The adjacent quote comes from the historian of science Robert E. Kohler. His idea alludes to the fact that people generally as-

## "It is precisely the stripped-down simplicity and invariability of labs – their placelessness – that gives them their credibility"

- Robert E. Kohler (Landbrecht & Straub, 2016, p. 30)

sume that the results obtained in a laboratory are automatically true. He also places the research work on a social pedestal. This train of thought has since been examined and further developed several times. Anthony Giddens and David Harvey, both sociologists, developed the "theory of placelessness" (Landbrecht & Straub, 2016, p. 30) in the 1990s (Landbrecht & Straub, 2016, pp. 29, 30).
To name a few more descriptions of laboratories and laboratory buildings: in 1892, the Englishman Thomas X. Huxley described university laboratories as "factories for new knowledge" (Landbrecht & Straub, 2016, p. 38). The famous chemist Louis Pasteur called them "temple[s] to the future" (Landbrecht & Straub, 2016, p. 38). As described at the beginning of the thesis, they can also be seen as "cathedrals of science" (Kaji-O'Grady & Smith, 2019, Chapter 1). It thus becomes apparent that curiosity and reverence for research work have been widespread over time.

**Experiment**

Experiments are one of the first terms that come to mind when considering laboratories. But what is a scientific experiment?

> ***"a test done in order to learn something or to discover if something works or is true"***
>
> - Cambridge University Press & Assessment 2024, 2024

The guiding principle when conducting an experiment is to make a valid declaration verifiable or recognizable in a planned and organized manner. This is an attempt to find answers to specific questions. Various characteristics can be described that give this process its validity and credibility. The following explanations refer to scientific experiments (Kelterborn, 1994). Even if the source is understood in an archaeological context, the procedures and definitions are helpful for understanding scientific experiments and their implementation.
First of all, the framework conditions and objectives of the experiment should be defined. In addition, the handling of future test results should be clarified. The next step is to develop a clear concept. It requires implementation, monitoring, and evaluation of the results. A further characteristic is that the person carrying out the experiment must have sufficient specialist knowledge and, if necessary, work together with experts (Kelterborn, 1994).

This aspect speaks for interdisciplinarity in research practice, which is nowadays standard in global terms.
An experiment is based on a question, the answer to which is the goal. This means that it must be possible to answer a query using an experiment. Objectivity is essential. Convincing methods and rules must be used. A final characteristic is the optional repeatability of the experiment so that results can be checked again. This is also one of the criteria for being able to recognize the results. The variance of the findings can also provide new information (Kelterborn, 1994).
In addition, especially for experiments in the microbiological field, the issue is how a sterile working environment can be created to keep foreign bacteria or microorganisms away from the experiment. 100% avoidance is not possible. However, the aim should be to recognize this as quickly as possible and implement countermeasures.

# BERLIN

As Germany's capital city, Berlin not only offers a diverse and densely populated environment but is also the seat of numerous internationally renowned companies, institutes, and organizations. Berlin offers a rich basis for possible synergy effects for the laboratory for the RKI to be planned in the district Berlin-Mitte and the neighbourhood Wedding (see Figure 00.01 →).

**History**

1237 is the date on which the city was founded. It emerged from the two settlements of Berlin and Cölln, located next to the river Spree in what is now the district of Berlin-Mitte. In the 18th and 19th centuries, it became the Prussian capital. Massive destruction occurred during the Second World War, and large parts had to be rebuilt. During the Cold War, Berlin was divided: the West was under Western control, while the East was the capital of the DDR - the Wall became a symbol of this division. Since January 11, 1991, Berlin has once again been the capital of Germany. (BerlinOnline GmbH, n.d.)

**Urban landscape**

The Brandenburg Gate, the Reichstag building, the Red City Hall, the Berlin Dome, the museums on Museum Island, and the Humboldt Forum are just a few examples of the city's multifaceted architecture. Architects have the opportunity to view reference projects and current, highly acclaimed buildings on site. Several renowned international architecture firms are located close to each other.
Since the end of the war, the capital city has taken a contradictory stance. On the one hand, remaining buildings are to be preserved, on the other hand, reminders of terrible times are to be removed. In addition, the division of the city during the DDR era still shapes the cityscape. The West was dominated by impressive, functionalist buildings, while the former East was characterized by socialist, neoclassical architecture. The Berlin eaves height has been 22 m for around 37 years until today. The upper edge of the roof should also not exceed 30 m (Golubka, 2022). After the fall of the Wall, architecture was primarily realized with regard to private interests. This is a topic that has been insufficiently researched to date. The capitalist approach to current construction projects is also viewed critically by the publicists of ARCH+ (ARCH+, 2020). Numerous construction sites characterize the cityscape. Rental costs have risen rapidly in recent years, with the result that a rent cap was decided in 2020 (Malterre-Barthes, 2020).

| Numbers: | |
|---|---|
| Population (2022) | 3.6 Mio. |
| Total area | 892 km² |
| River length (Spree) | 45 km |
| Districts | 12 |
| Laboratories (2022) | 105 |

(Berlin Tourismus & Kongress GmbH, 2024)
(Datamego GmbH, 2022)

**Figure 00.01 |** Berlin | Map | Scale 1:500,000

**Cultural diversity and economy**

Numerous tourists flow through the city every day. Techno clubs, to name just one example, have become one of Berlin's characteristics since 1989. Berlin stands for creative people, freedom, and innovative ideas. However, the growing success of recent years has caused property prices to rise to such an extent that this scene is now under threat (Santacana López & Ritts, 2020).
For years, Berlin's economy has been expanding at a pace that surpasses the national average in Germany. New jobs are created every year. The economic output amounted to 193 billion euros in 2023 (Wirtschaftliche Entwicklung, 2024).
In view of the dynamic development of the city, the planned laboratory of the Robert Koch-Institute (RKI) in the Berlin-Mitte district in Wedding represents a great opportunity to further expand cutting-edge research in this vibrant urban fabric.

# WEDDING


Figure 00.02 | Wedding | Aerial view | Scale 1:10,000

**01** | Charité Campus - Virchow Clinic
**02** | Social Pediatric Center
**03** | Research and Teaching Institute for Brewery
**04** | Research Brewery TU Berlin
**05** | Goethepark
**06** | Plötzensee
**07** | Robert Koch Institute Headquarter
**08** | Vattenfall Cogeneration Plant
**09** | Logistics Center Health
**10** | Prison
**11** | Berlin Wholesale Market
**12** | Berlin University of Applied Sciences
**13** | Jobcenter Berlin Mitte
**14** | Leopoldplatz

# 01

# Typology

# OVERVIEW

Humans are curious by nature. We explore, want to understand connections, and develop new ideas - we research. This instinct will always be one of the reasons why humankind makes progress.

**Ancient times |** It becomes obvious here that research has been around for longer than there have been adapted spaces for it - the laboratories. In ancient times, several fundamental discoveries were made that are still part of our everyday lives. Number systems and surgical tools were created. Questions were asked about where we are on the planet and where our earth is in the universe. Educational institutions also began to play an important role (Braun, 2005, p. 32).

**10th and 11th centuries |** If we look back to the beginning of the second millennium, we see that despite the continuing lack of laboratories, students from different countries gathered and worked together. In the 10th and 11th centuries, this was the Fez´s Kairouine University in middle of the city. This already shows that communication is an essential part of the process (Braun, 2005, p. 32).

**12th century |** A milestone in the history of research was that, with the rising emergence of European universities at the end of the 12th century, the methodology of experimentation became increasingly popular. The following decades also saw the emergence of pharmacy and medicine as separate fields of research. (Braun, 2005, p. 32).

**13th century |** The first differentiation of research activities in the field of medicine took place. From then on, a distinction was made between pharmacy and practicing medicine. Pharmacy work took place in hygienic rooms, so-called "pharmacy offices" (Braun, 2005, p. 32) (Braun, 2005, p. 32).

**15th and 16th centuries |** Equipment and aids, some of which are still used in a similar form in chemical research today, were first used in hygienic rooms for pharmaceutical work in the late Middle Ages (Braun, 2005, p. 32).

**17th century |** A significant example is *Uraniborg* by Tycho Brahe, an astronomer from Denmark from 1598. It is striking that this castle-like laboratory building was built in isolation on the island of Ven in Denmark. Just eight years later, Andreas Libavius presented a concept for an optimized *domus chemiae*, which, on the contrary, was to be centrally located in the city and provided living space for employees, among other things. Both examples were highlighted by Owen Hannaway in 1989. He pointed out that the architecture of both projects was intended to be expressive of the research work taking place there. In addition, the first laboratories were built in private homes in England (Landbrecht & Straub, 2016, pp. 31–34).
The decisive factor for the emergence of special laboratory rooms was that research and craftsmanship were no longer seen as a single entity. It is worth noting, however, that geniuses of their time, such as Isaac Newton or Galileo Galilei, did not need special rooms to make their discoveries. Parallel to the very practical view of physical research areas, laboratories, and cool storage rooms became increasingly important in pharmacies and were always separate from the pharmacy rooms used by customers. Chemical research into mining also led to the first laboratories. The first official chemistry laboratory was established in Sweden in 1686. The first distinction was between areas for concentrated work and zones for collegial exchange. (Braun, 2005, pp. 32, 33)

**18th century |** At the beginning of the century, the importance of and desire for research among the population became ever stronger. In 1750, Giovanni Battista Pironesi developed an important architectural approach with his optimized design for a university. It was intended to house all the necessary uses in one place. Industrialization promoted the benefits of high-quality research by placing greater emphasis on the hygiene of the rooms and linking the results to production. New methods of acquiring knowledge were developed, especially in the field of chemistry, which led to fundamental discoveries, such as that of oxygen. (Braun, 2005, p. 33)

**19th century |** In contrast to today, progress in laboratory construction was still very much focused on Europe. Researchers were in contact with each other, which led to the development of a certain unity (Braun, 2005, p. 33). However, the majority of laboratories were still hidden away in the basements of museums (Landbrecht & Straub, 2016, p. 37). In 1870, "in contrast to these isolated laboratories founded at the personal initiative of individual scientists, the first ever 'state-funded laboratory system'" (Landbrecht & Straub, 2016, p. 35) was established in

Imperial Germany, which also promoted academic architecture (Landbrecht & Straub, 2016, p. 35). Thus began the so-called "laboratory revolution" (Landbrecht & Straub, 2016, p. 33), which brought standardization and optimization and increased global exchange between researchers. The first standards and specifications for research work and architecture were the result, for example, by the architect Edward Cookworthy Robins in 1887. (Landbrecht & Straub, 2016, pp. 35, 36) (Straub, 2016, p. 56). In 1878, the Berlin University, with its physics institute, was the trigger for "functional architecture for science" (Interview with Jürgen P. Rabe, 2016, p. 169).

**20th century |** As more and more laboratory buildings had been built by renowned companies at this time, the working atmosphere within the laboratory also came to the fore, which was strongly influenced by the parameters of light incidence and air supply (Braun, 2005, p. 33).
According to Peter Galison, a historian, the 20th century can be divided into different phases: In the beginning, scientists saw themselves isolated in gaining knowledge about our world. This

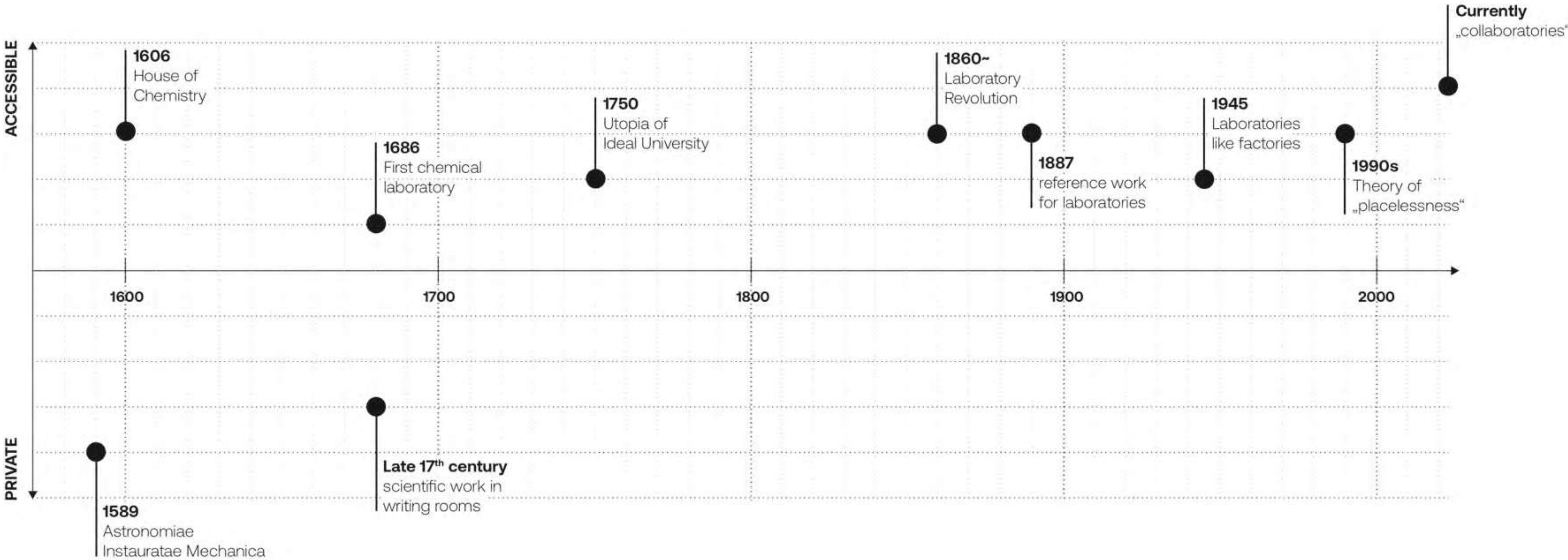
**Figure 01.01 |** Robert Koch-Institute (RKI) Laboratory at the Nordufer | Photograph | Beginning of 20th century | © Robert Koch-Institut

self-image changed as a result of the trend away from small laboratories towards factory-like halls (Klonk, 2016, p. 10) (Galison 1999, 18).
From the 1970s onwards, the workflow changed in such a way that computers were now also considered an essential part of research work. The first ethnographies for laboratory construction by Latour, Woolgar, Karin Knorr Cetina, and Michael Lynch were also produced at this time (Klonk, et. al., 2016, pp. 10, 24). In the 1990s, Robert E. Kohler introduced the concept of "placelessness" (Landbrecht & Straub, 2016, p. 30). He claims that the universality, social elevation of researchers, and isolation from the outside world increase the credibility of research. This theory was affirmed and further developed by other experts (Landbrecht & Straub, 2016, pp. 29, 30). The idea of a communicative building, which is entered through an inviting foyer and can be flexibly designed, became increasingly present (Braun, 2005, p. 35).

**Current |** At the beginning of the new millennium, the state *Excellence Initiative* was developed in Germany. This increased the attractiveness of high-quality research through financial support (Interview with Jürgen P. Rabe, 2016, p. 168). Currently, the global trend is moving towards so-called "collaboratories" (Landbrecht & Straub, 2016, p. 31).
Networking and global exchange are now becoming increasingly important. Technology, software, sustainability, interdisciplinarity, and the combination of biology and electronics are becoming relevant today. Society's constant desire for optimization also plays a decisive role in research work. Digital support in the laboratory is now considered a given and commonplace. Nowadays, there is also a greater focus on the meaning behind findings and how they fit into our worldview (Braun, 2005, p. 35).

**Future |** In the future, the individual design possibilities of a laboratory building will increase. Users will perform a broader range of tasks. One of the most significant differences will be that humans and technology will share the research. The first robots are already being used. Research area managers will design their area according to their wishes. The frequency of work at the lab bench will be reduced. Will employees be able to work from home? How can we deal with robots being used in high-security areas and dealing with dangerous situations? Will science fiction films become more and more of a reality? (Traube et al., 2022, pp. 240–247) All these questions will be answered

# MILESTONES




| | |
|---|---|
| **Ancient times** | No laboratories even if there was research |
| **10th \| 11th century** | Keruin University of Féz in the city center \| communication important for research |
| **12th century** | Increasing emergence of European universities |
| **13th century** | Differentiation between pharmacy and practicing medicine |
| **15th \| 16th century** | First equipments |
| **1589** | *Uraniborg* by Tycho Brahe |
| **1606** | *domus chemiae* by Andreas Libavius |
| **17th century** | Separation of craftmanship and science \| scientific work in writing rooms |
| **Late 17th century** | Simple laboratories in mining science |
| **1686** | First specific chemical laboratory |

| | |
|---|---|
| **1700~** | Increasing interest in society for the importance of research |
| **1750** | Utopia of Ideal-University by Giovanni Battista Pironesi |
| **1860~** | "laboratory revolution" |
| **1870** | First ever 'state-funded laboratory system' |
| **1887** | Reference work for laboratories by Edward Cookworthy Robin |
| **1940s – 1960s** | Laboratories similar to factories |
| **1970s** | Ethnographies of laboratories |
| **1990s** | theory of "placelessness" |
| **21st century** | *Excellence Initiative* in Germany |
| **Current** | global connection in "collaboratories" |

**Figure 01.02 |** Milestones | Diagram

# RESEARCHERS

Research demands a lot from employees. At the beginning of this century, there has been an increase in this demanding work, which now accounts for around 50 percent of all occupational fields. About 100 years ago, the figure was around 15 percent (Henn, 2005, p. 3).

**Motivation & pressure**

The laboratory is not just a workplace. It is where researchers spend a large part of their time, put a lot of energy into the search for new findings, and are in contact and under competitive pressure with their colleagues. They are motivated by the idea of being the first to gain new insights and thereby gain prestige. There is often a respectful interaction among the specialist staff that offers mutual support and advice despite the pressure. This is despite the fact that it is standard these days to change jobs frequently in the course of a career. This means changing research institutions and moving to other countries (Pääbo, 2005, p. 10). Researchers most often have their most significant discoveries at the beginning of their career (Nickl et al., 2022c, p. 122).

***“Laboratory spaces are as individual as the people who work in them”***

- Nickl et al., 2022b, p. 148

**Needs**

Two of the most important aspects of research work are communication and the ability to retreat to quiet zones for concentration. This balancing act is one of the architectural difficulties (Pääbo, 2005, p. 10).
The planners should create attractive architecture to make the numerous working hours as pleasant as possible and also, on the one hand, offer the opportunity to exchange ideas with colleagues from the same department and, on the other hand, enable interdisciplinary communication (Behnisch, 2022, p. 110).
The characteristics of the building strongly influence the quality of research work. Employees develop a particular pride and pleasure in working in this institute through functional, aesthetic, and varied architecture. The more activities and uses the working environment offers, the easier it is to recruit talented young graduates and experienced researchers to the respective location (Behnisch, 2022, p. 110). This aspect is also addressed in Chapter 01.04 Interview.
The team spirit among the researchers is strengthened by promoting joint activities and highlighting the characteristics of the institute and the building. External transparency through guided tours inside the institute or opportunities for passers-by to gain insights is also an important aspect here. The feeling of being presented as a representative of the institute or company takes employees out of their concentration at times, but creates a sense of community through a teased smile among each other (Marguin et al., 2019, pp. 149-153).

**Efficiency**

Efficient researchers provide quick results because of implementing creative approaches (Pääbo, 2005, p. 10).
The employees have completed intensive training and now apply their skills daily. Rationalization and structuring of work processes make this less stressful for them. Architecturally, the aim should be to offer the highest possible density of uses and exchanges. Short distances between functional areas also increase efficiency. As mentioned above, the need for places of retreat for concentration provides a decisive contrast to this. Transparency to the outside world promotes the opportunity to encourage communication through international colleagues. Furthermore, to be able to respond to unforeseeable changes in working methods or individual preferences of researchers, maximum flexibility should be made possible. Most researchers like to organize themselves in their workflow and benefit greatly from spontaneous communication. As a further aspect, an overview of all activities and progress in the workplace should be established for the entire collegium in order to increase the frequency of new research results and thus increase efficiency in international comparison. Economic gains in this field are closely tied to these aspects and are crucial for funding and research investment today (Henn, 2005, pp. 3, 5).

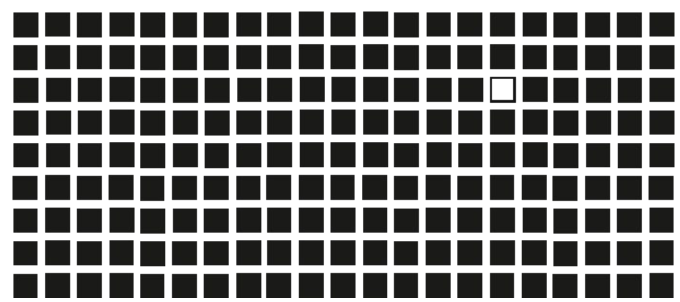


**Figure 01.03 |** High pressure & the drive to pioneer uncharted territories

**Attraction**

As already mentioned, an attractive working environment offers the opportunity to draw talented researchers, whether young or experienced, to the research institution. A well-planned working environment promotes creativity and, thus, the efficiency of employees. It is, therefore, important that positive associations are generated in the building. One aspect that makes the workplace more attractive is the possibility of offering a view, provided the building is in a central urban location. It increases the pride and enjoyment of employees and provides a change from desk work (Nickl et al., 2022c, p. 122).

**Communication**

Communication is one of the most important aspects of research work. It must, therefore, also be implemented architecturally. The interaction between researchers offers many interesting facets, but these are only presented here in abbreviated form so as not to go beyond the scope of this paper.

After all, it is not only the motivation to make great discoveries as quickly as possible as an individual that plays a role here but also to recognize that colleagues have the same incentive. As research is only efficient through the creative exchange and development of ideas, a basis of respect and familiarity is established. This means both successes are shared, and emotional space is given for mistakes (Henn, 2005, pp. 3-5).

According to the *Experimental Zone* study, three tasks of the daily work process can be distinguished in the researcher's everyday work: “knowledge production, knowledge distribution, and knowledge storage” (Marguin et al., 2019, p. 89).

This means that collecting new knowledge involves, among other things, reading, thinking, and writing. This information is then published for colleagues and the general public and archived as a final step (Marguin et al., 2019, p. 23).

In addition, four phases of the processes were evaluated, consisting of “researching-investigating”, “reading-receiving”, “conceptualizing-developing”, and “formalizing-evaluating” (Marguin et al., 2019, p. 89).

These areas are also linked by smaller intermediate tasks, which are not discussed in detail in this thesis. The phases mentioned include, for instance, collecting information and sources, acquiring new knowledge, noting down ideas, and presenting, evaluating, and recording the work in writing (Marguin et al., 2019, p. 89).

Another aspect is the distinction between different ways of working together. On the one hand, within a project team, and on the other hand, with colleagues with specialist knowledge on a particular topic. The former, which consists of at least two people, manifests itself, for instance, in the arrangement of desks, the joint coordination of work processes, and a hierarchy of task distribution with regard to student assistants through to managerial positions. The exchange with colleagues outside the project team relates to problem-solving specific topics for which specialist knowledge is required (Marguin et al., 2019, pp. 155, 156).

According to the book *New Laboratories*, the room groupings in the laboratory building can be divided into “space of theory, spaces of experiment and informal spaces” (Rabe, 2016, pp. 122).Communication-promoting spaces are the so-called “informal spaces” or “in-between spaces” (Rabe, 2016, p. 121), which have become increasingly prominent as a percentage of total space since the 1990s. They are not assigned to any specific function but are used for spontaneous exchange or relaxation between work (Rabe, 2016, pp. 121-127).

Independent parameters to change the workspace:
- size of spatial areas
- distance betw. workstations
- connectivity of spatial areas
- visibility
- noise level
- readability of the space
- communication in the space
- spatial arrangement of working methods
- temporal regulations

(Marguin et al., 2019, p. 38)



**Clichés**

How do you picture a researcher in a laboratory? Presumably, a person in a white coat between numerous measuring devices in a calm, hygienic working environment.

***“Remember: not all scientists are ´nerds´ for whom everything around them is irrelevant.”***

- Stefan Hell, 2022, p. 125

It doesn't matter where this building is located because the laboratories meet a uniform standard anyway. Nowadays, this image is outdated. Scientists present themselves in open-plan laboratories with a view of the countryside through glass facades. Screens and table tennis tables surround the communicative researcher in everyday clothes (Straub, 2016, pp. 63-65).

This impression was not always intended. In the late 19th century, it was often only about the equipment in the photographs. The researcher was almost completely disregarded or staged only incidentally. In the 20th century, the depiction of the genius, which forms a unit with the harmoniously staged laboratory room and is almost indistinguishable from the surroundings, intensified and also inspired numerous movies. The first depictions of this kind also appeared in the 17th century (Straub, 2016 , pp. 49–63). It looks like an unchangeable, complex system.

# COLOUR CONCEPT


**DIN 277-1 | 2016**
This standard defines the calculation for the spaces and volumes of a building. The area calculation, according to this guideline, represents the standard in approval planning in German architectural offices. This DIN-standard is used as a basis to provide a comprehensible introduction to the following reference analyses.

**Optimization**
This work aims to maximize the areas within a laboratory building that are essential for efficient work in proportion to the floor area, thereby optimizing the overall proportion of space. Communication zones, spaces for knowledge exchange, and work in office rooms, write-up spaces, and laboratories are seen here as the basis for productive work processes.

**Constancy**
Technical rooms, storage rooms, and secondary rooms such as sanitary areas or changing rooms are considered neutral here. They are, of course, part of a laboratory building out of necessity. Concerning space optimization, the existing proportion of this space is taken as given and remains untouched.

**Reduction**
The aim is also to avoid the *classic corridor situation*. However, under no circumstances should the logistical and communicative function of circulation zones be reduced or bypassed (Grömling, 2005, p. 47).

In deviation from the DIN-standard, shafts with an area of less than 1 $m^2$ are counted as *infrastructure* or *circulation* areas in this analysis instead of *construction areas*.

## 01.04 CATALOGUE

# ZOOM-IN

Laboratory buildings are outside the everyday tasks of most architects. This chapter has an introduction and overview of this type of building; a catalog is presented below.
A so-called *zoom-in* is used to work from the rough to the fine. It starts with the types of research, and continues with the main parameters in architectural planning. Then, the most frequently used building forms or typologies will be presented. The next step shows the different area categories. A significant topic in laboratory construction (see Chapter 01.05 Interview) is the ratio of dark zones to work areas with natural daylight. The focus of this work (see Chapter 03.03 Comparison) is on the core typology, which is analyzed accordingly. The technical infrastructure in the laboratory building is just as critical as the architecture.
The next level of detail is a brief introduction to different room types and their layout and equipment. In addition to the density of use and technically demanding requirements, another unique feature is the classification into different safety levels. Two regulations applicable to the competition "New construction of the laboratory building House 7 for the Robert Koch-Institute (RKI) on Seestraße Berlin" are highlighted here. Safety in laboratory construction is concerned not only with hygienic measures and differences in the materials used but also with the visual relationships between employees.

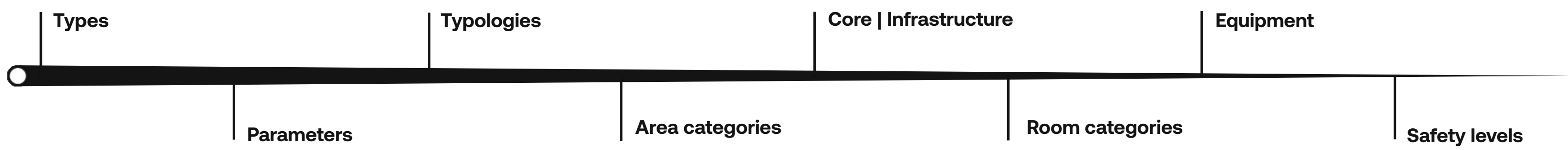



**Figure 01.04 |** Zoom-In

# TYPES

The following is an overview of the types that describe both the kind of use (Development type) and the field of research (Research type). The classification is based on a summary of different sources with own additions. These have emerged as valid from the research for this thesis.

**DEVELOPMENT TYPE**
**Research And Development Laboratories (R&D)**
This most common type of laboratory is usually run privately, i.e., as part of a company. From research to product testing, all steps are carried out for the interests of the company and represent an essential role in the workflow. Nevertheless, this type of laboratory can also be used for university or other purposes (Copenspace, 2023).

**Clinical laboratories**
This type is usually closely networked with hospitals in terms of space, personnel, and research areas. Here, the range of research areas is very broad (Copenspace, 2023).
Related to this are clinical trial laboratories. It is possible to conduct research directly on patients, which can be compared to medical examinations. As toxic substances are not usually used, the hygiene requirements are lower than in other types of laboratories (Pohl & Kliemt, 2022, p. 213).

**Educational Laboratories**
These laboratory rooms are used specifically in universities and other educational institutions. Numerous scientific and technical courses, such as physics and biology, require laboratories to impart practical knowledge. Therefore, a separate category is deemed appropriate for this purpose.

**Production Laboratories**
This type also predominantly belongs to a company. It is a mixture of the Test, Analysis and Quality Control Laboratories and the R&D Labs. (FDM - Environment Makers, 2022). The aim is to generate the relevant preparations for future approvals and sales.

**Test-, Analysis- and Quality-Control-Laboratories**
As the name suggests, this stage of development is about testing goods. It examines whether they are ready for sale in accordance with the applicable specifications (FDM - Environment Makers, 2022).

Other laboratory types:
- Cleanrooms
- IT laboratories
- Filling laboratories
- Aquaristic laboratory
- Food labs
- Labs for specific fields

(Pohl & Kliemt, 2022, p. 194)

**RESEARCH TYPE**
**Wet chemistry laboratories**
As liquids are often used here, specially adapted furniture and materials are required. So-called fume cupboards are an essential part (Pohl & Kliemt, 2022, p. 196).

**Biology | Biosafety | Genetic laboratories**
This work is primarily concerned with this area of research. It is essential that bacteria and viruses are prevented from unintentionally passing through the hygiene area barrier (FDM - Environment Makers, 2022). It should be possible to clean furniture surfaces efficiently and hygienically (Pohl & Kliemt, 2022, p. 198).

**Physics laboratories | Optics laboratory**
In addition to high technical requirements, the lowest possible vibration for sensitive measurements must be ensured. This type of laboratory partially breaks away from typical laboratory setups (Pohl & Kliemt, 2022, p. 201).

**Technical laboraotires | Scale-up | Testing Halls**
Equipment is tested in these mostly large laboratory buildings. Explosions can occur here (Pohl & Kliemt, 2022, p. 202).

**GMP laboratories**
GMP, or "Good Manufacturing Practices," ensures high laboratory standards for medicine production, with separate access for materials and personnel (Pohl & Kliemt, 2022, p. 205).

**Isotope laboratories | Hotlabs**
This type of laboratory is used for research into radioactivity. Therefore, cooling systems, compressed air, monitoring systems, and massively dimensioned components are required (Pohl & Kliemt, 2022, p. 208).

**Fab labs | Workshops**
Here, practical activities such as welding are carried out on work benches. This means that they are on the borderline between a laboratory and a workshop (Pohl & Kliemt, 2022, p. 210).

**Laboratories in animal experiment facilities**
Hygiene guidelines are essential for animal research. High protective measures for tests and operations include one-way lanes, access restrictions, compressed air systems, and metallic surfaces. (Pohl & Kliemt, 2022, p. 214).

# PARAMETERS

The following is an overview of general parameters in laboratory planning. Communication between the client, the user, if already known, the architect, the climate designer, the structural engineer, and the facility manager is essential and should begin as early as possible in the planning process (Hausladen & Meindl, 2005, p. 56). The location, integration into the neighborhood, use, and building-specific requirements must also be considered from the outset (Grömling, 2005, p. 36). Laboratory planners with specialist knowledge should be closely integrated throughout the entire planning process.

**Dimensions**
In principle, laboratories count as permanent workplaces. This indicates that sufficient natural daylight must be available.
Laboratory buildings often have a depth of 20 to 25 meters. Surrounded by lab and office zones, the dark zone with ancillary rooms, infrastructure, and circulation area is centrally located (see Area Categories). However, this arrangement reduces the increasingly important flexibility within the stories. The aim would be to generate depths of 13.50 to 17.00 meters. This would reduce extended cable routes and numerous supports. In addition, a future change of use is more straightforward to plan, increasing sustainability (Hegger, 2005, p. 30).
Laboratory zones that take up to 400 m² are permitted to ensure fire safety. A lab area basically consists of the laboratory, an upstream write-up space, and a service zone. The former usually has a depth of 6.00 m to 10.80 m. The evaluation area and the service zone each require an additional 2.40 m to 4.80 m. Laboratories require the highest possible story height due to the numerous ceiling installations. The story height should, therefore, be 4.00 m to 4.50 m. The current trend is to generate as much height as possible. Nowadays, the floor plan grid is often based on distances of 1.20 m (see Room Categories) (Nickl et al., 2022a, p. 65).

Dimensions:
Building depth: 13.50 – 17.00m
Lab depth: 6.00 – 10.80 m
Max. area per zone: 400 m²
Level height: 4.00 – 4.50 m
Floor plan grid: 1.15 – 1.20 m
Number of stories: 3 – 4

**Zone hierarchies**
The allocation of areas within the laboratory building is crucial. A well-planned arrangement can promote communication between employees (Hegger, 2005, p. 30). Even if it may seem tempting at first glance to mix different functions such as office, communication, and laboratory in one open space, this results in a very inefficient approach. Laboratories require a very high level of technical infrastructure and, therefore, have requirements different from office space. This is also reflected in different dimensioning requirements. As lighting plays a significant role in the placement of zones, a distinction should be made between three groups. Firstly, there are rooms with sufficient daylight for concentrated work, then areas with sufficient daylight and high technical requirements, such as laboratories, and secondly, the dark zone without daylight. The latter includes, for example, storage rooms, technical rooms, or sanitary areas. Thus, two methods of structuring a laboratory building are allocating mainly one function per floor or distributing several uses within many similar floors. Laboratory buildings with three to four floors are the most economical (Grömling, 2005, pp. 40-42).
In principle, four main room groups can be defined. The groups are office, laboratory, infrastructure, and special areas. Communication areas and storage rooms count as infrastructure. Learning rooms or so-called clean room areas are part of the special zones (Weber & Ulrich, 2023, p. 139).
The last important aspect of the zones is the three hierarchies. Areas for experiments and research are the primary zones. Secondly, there are places for exchange, organization, storage, and technical areas. The third group is the additional offer for employees, such as living areas or *Attraction Points* (see Chapter 04 Optimization) (Grömling, 2005, p. 43). As can be seen, there are different systems for allocating space in laboratory buildings. A new concept for this is developed in Chapter 04.

**Costs**
The construction and materials of a laboratory building account for around 40 to 60% of the total costs. In contrast to other building types, technical infrastructure accounts for around 20 to 30 % of the total. Furniture accounts for 8 to 15 % and equipment and machinery for around 8 to 10 % (Söhngen, 2015, p. 3). The higher the safety level, the more expensive the running costs for energy supply. In an S1 and S2 laboratory (see Safety levels), this is around 30 to 35 % of the total running costs. For S3 and S4, the two higher safety levels, this figure is 40%. The use of a laboratory building usually accounts for 80% of the total costs, while construction only accounts for 15% (Weber & Ulrich, 2023, p. 143).

# TYPOLOGIES

The different arrangements can be found in a wide range of variations. The definition of each arrangement in the book *Raumpilot Basics* are described below. The illustration (see Figure 01.05 →) is based on the book *Research and Technology Buildings: A Design Manual* illustration. It refers to the most frequently used arrangements in laboratory construction.
Urban planning factors, user requirements, such as the number of employees and safety requirements, the technical infrastructure, and economic efficiency are decisive parameters when deciding on a typology (Grömling, 2005, p. 46, 47).

**Linear**
A linear arrangement is defined by circulation paths that run in a single direction, often through one or several parallel corridors. Depending on the row-system, this can lead to excellent exposure – 1-Row – or a lack of natural light – 2-/3-Row (Jocher et al., 2012, p. 352).

**Comb**
The advantage is that the area is subdivided immensely. This typology is therefore favorable for arranging different departments. The rooms have a strong orientation towards the outside. The resulting areas between the protruding parts of the building can be used with roofing for energy benefits (Jocher et al., 2012, p. 353). With a large number of safety levels within the laboratory, this typology offers a structure that is relatively easy to divide up (Grömling, 2005, p. 47).

**Core**
The core can take different forms: As a patio, an internal core or as a separate part of the building. This typology has the advantage of condensing uses. Both open-plan arrangements and individual rooms can be positioned economically. The core for circulation is usually located centrally or at the side. If the core is an open space | patio, there are particularly clear differences between the room arrangements. The inward orientation of the rooms offers protection from the impact of the surrounding space. Area-saving floor plans can also be created here (Jocher et al., 2012, p. 352).

Special forms and mixed forms are possible. Expansions in the floor plan that go beyond the standard dimensions can provide space for communication rooms (Jocher et al., 2012, p. 353).



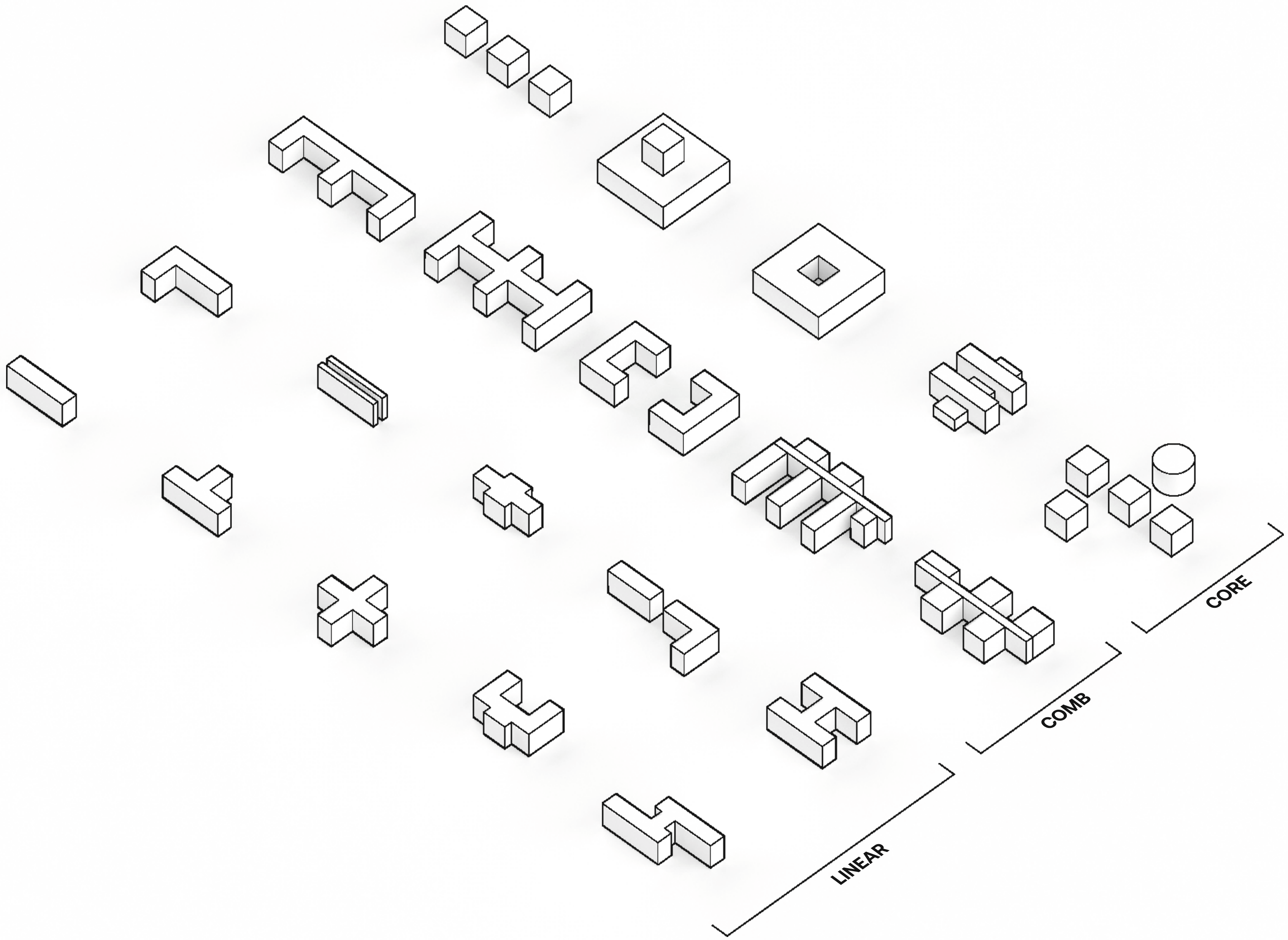



**Figure 01.05 |** Overview Typologies

# AREA CATEGORIES

- **NUF 1** I Living | Stay
- **NUF 2** I Office work
- **NUF 3** I Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

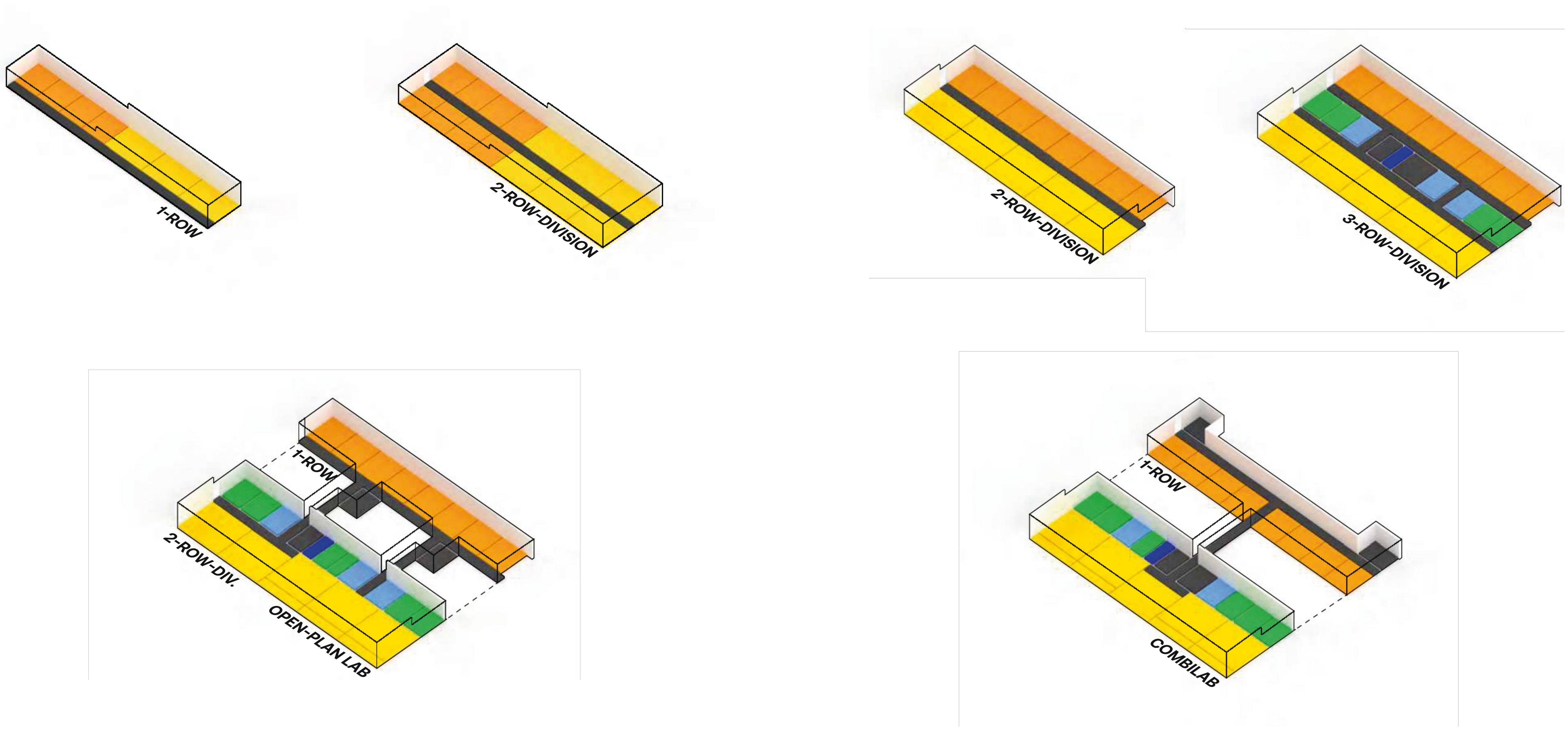





**Figure 01.06 |** Overview Area Categories | Axonometry

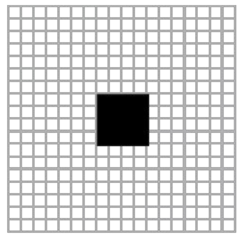
# CORE I INFRASTRUCT.

## CORE

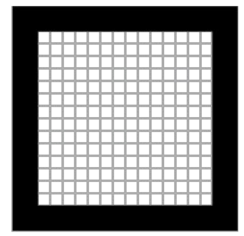
Criteria | View axes, Flexibility, Hierarchies, Mobility, Facade access, Fire safety
Core = (escape) stairway, (escape) elevator, sanitary rooms, learning room + here: dark zone

— **Opposite**
■ **Core**

**01 | Central**
The centrally arranged core offers shorter distances, a democratic floor plan layout, high flexibility, high daylight utilization, and a flexible fire protection layout. However, visual relationships between employees are minimized. It also corresponds to the typical structure with a central dark zone.



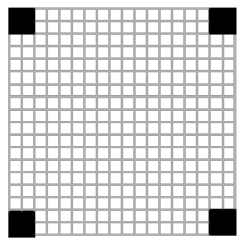
**01 |** Central



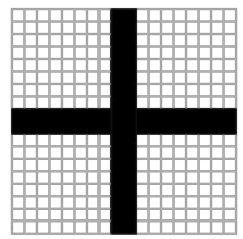
**05 |** Surrounding

**05 | Surrounding**
In this abstract representation, the core zone runs all the way around the story. This severely restricts the amount of daylight through the façade. However, maximum visual axes and flexibility are generated. There are hardly any hierarchies, and the distances for the employees are short. However, the division into fire protection zones proves to be difficult.

**02 | Corner**
If the central core is divided up and placed at the corners of the stories, the visual connections are maximized. There are no hierarchies and a high degree of flexibility. In addition, the cores can be reached quickly from any position. The fire protection walls are extended compared to 01, and daylight penetration is minimally reduced.



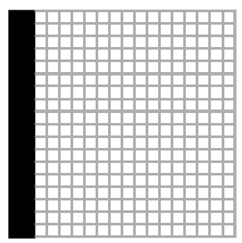
**02 |** Corner



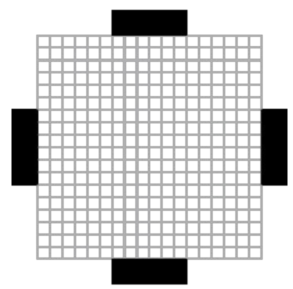
**06 |** Partial

**06 | Partial**
The advantage lies in the non-hierarchical division into four zones. This means that fire protection units are optimally possible. There is a high degree of flexibility and sufficient daylight within the zones. The amount of light varies depending on the direction of the sky. The distances to the core zone are short. The disadvantages are that the visual relationships between employees are severely restricted, and the floor layout has an extroverted effect.

**03 | Edge**
The core arrangement along one side of the façade also offers a high degree of flexibility. The north side is recommended in terms of daylight incidence. The visual connections are high, as is the quick accessibility of the core. However, a slight hierarchy is created here, which can result in longer distances. The fire protection division is made more difficult.



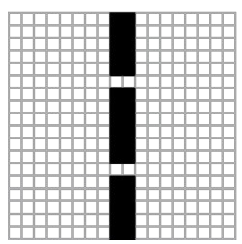
**03 |** Edge



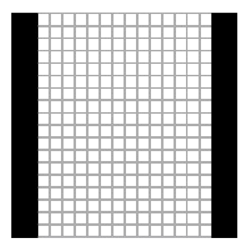
**07 |** Docked

**07 | Docked**
This arrangement creates maximum visual relationships between employees. It offers a coherent, flexible space that has no hierarchies. The distances to the external core zone are short. The disadvantages are the difficulty of implementing fire protection walls and the reduction of the transparent façade area.

**04 | Halving**
This arrangement shows a frequently found elongated central dark zone. This allows quick connections to the core, sufficient access to the façade, and the division into fire protection zones, which can be planned very flexibly. The disadvantage is the clear, non-hierarchical division of the story into two parts. The visual connections between these two halves are largely non-existent. The fixed central zone limits the flexibility of the floor plan.



**04 |** Halving



**08 |** Double-sided

**08 | Double-sided**
This variant is very similar to 03. However, it has the advantage that distances and hierarchies are reduced. There is still a high degree of flexibility and numerous visual relationships. The distances to the core zone are shorter compared to 03, and the division into fire protection zones can also be implemented flexibly. One disadvantage is the significant reduction in the proportion of daylight.

**Figure 01.07 |** Overview Core | Top view

# INFRASTRUCTURE

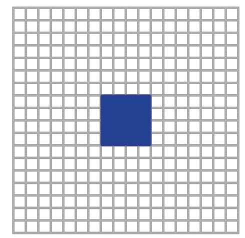
Well-thought-out planning of the technical building equipment is essential in research buildings. Three different approaches can be identified, and their advantages and disadvantages are described below.
The choice of this basic arrangement influences various building parameters, such as the height of the stories, the sizes of the cables and pipes, and the approach to fire hazards (Grömling, 2005, p. 43).

**A | Central technical shaft**
In principle, they can be freely positioned in the floor plan. The advantages are that flexible cable routing can be guaranteed, fire protection measures can be reduced, and the technical floors can be smaller. A problem is the routing of cables through several rooms, which can have an effect on the heights of the floors (Grömling, 2005, p. 43).

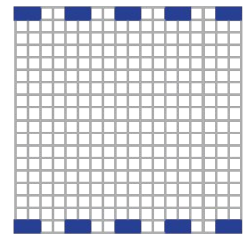
**B | Single technical shafts**
This arrangement allows more freedom in the supply of individual rooms. The floor height can be reduced due to the differentiation, and the supply can occur more directly without crossing other rooms. A negative aspect, however, is the increased technical area. The maximum vertical supply is limited. The number of recesses in the floor slabs can also be increased (Grömling, 2005, pp. 43, 44).

**C | Combination**
The third option is to combine these two shaft types. In this way, different cable routing can be guaranteed for different safety requirements of the laboratory rooms. This variant is very often used (Grömling, 2005, p. 44).
In the design of this work (see Chapter 06 Unfold Density), this arrangement is chosen to meet the trend of so-called automated technology highways to a certain extent.

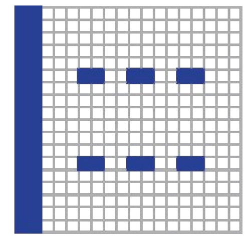
■ **Infrastructure**



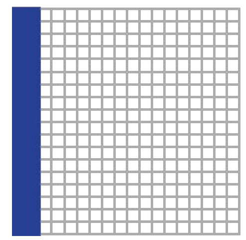
**A |** Central shaft



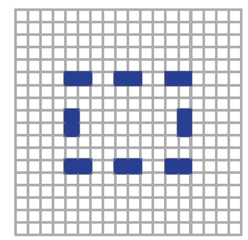
**B |** Single shafts



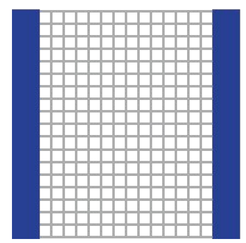
**C |** Combination



**A |** Central shaft



**B |** Single shafts



**A |** Central shaft

**Figure 01.08 |** Overview Infrastructure | Top view

# CORE + INFRASTRUCTURE

An important point to note about the infrastructure of a laboratory building is the difference between the highly installed labs and the remaining areas, such as offices or communication areas and other additional rooms with no special requirements. This difference also plays a decisive role in the conceptual design of this work (see Chapter 06 Unfold Density).

> ***"The installation of a research building, like the skeleton of a human being, is the support for all "movement sequences"."***
>
> \- Grömling, 2005, p. 45 (Translated from German)

An efficient laboratory building aims to organize the technical infrastructure as simply as possible. Intersections should be avoided as far as possible. The clients should be involved in the planning at an early stage with their needs assessments, as the buildings technical infrastucture account for around half of the total costs of a research building. In turn, 50 % of these costs relate to the electronic building supply. Ducts for supply and exhaust air, pipes for water, gas or cooling, heating, and electrical cables require much larger dimensions than other building typologies. Both the vertical and horizontal installation routes must be taken into account. The requirements for cooling will become ever more significant in the future, as an increase in the number of appliances is expected to produce more heat (Grömling, 2005, pp. 45-47).
Depending on the safety level, there are also hygiene requirements for air purification or a ban on openable windows in the laboratory.
The supply usually occurs via technical floors arranged in the basement and top floor. Alternatives to this are considered uneconomical. In addition, these large areas offer potential for redensification. A rough figure for the percentage of technical space for a laboratory building is around 40 to 60 % of the total area (Pfab, 2022, p. 70).
In principle, planning for reserve space is essential to respond flexibly to future densification. One trend that is becoming increasingly popular is a technology highway. These elongated technical areas are predominantly separated from the usage areas and function as automatically as possible without human interaction (see Chapter 01.05 Interview).

| Examples from references (see Chapter 03): |
|---|
| 01 \| A = SCJ |
| 01 \| B = BSM |
| 02 \| A ≈ FSN |
| 05 \| A = SAI |
| 05 \| A = BAS |
| 07 \| A ≈ RMR |

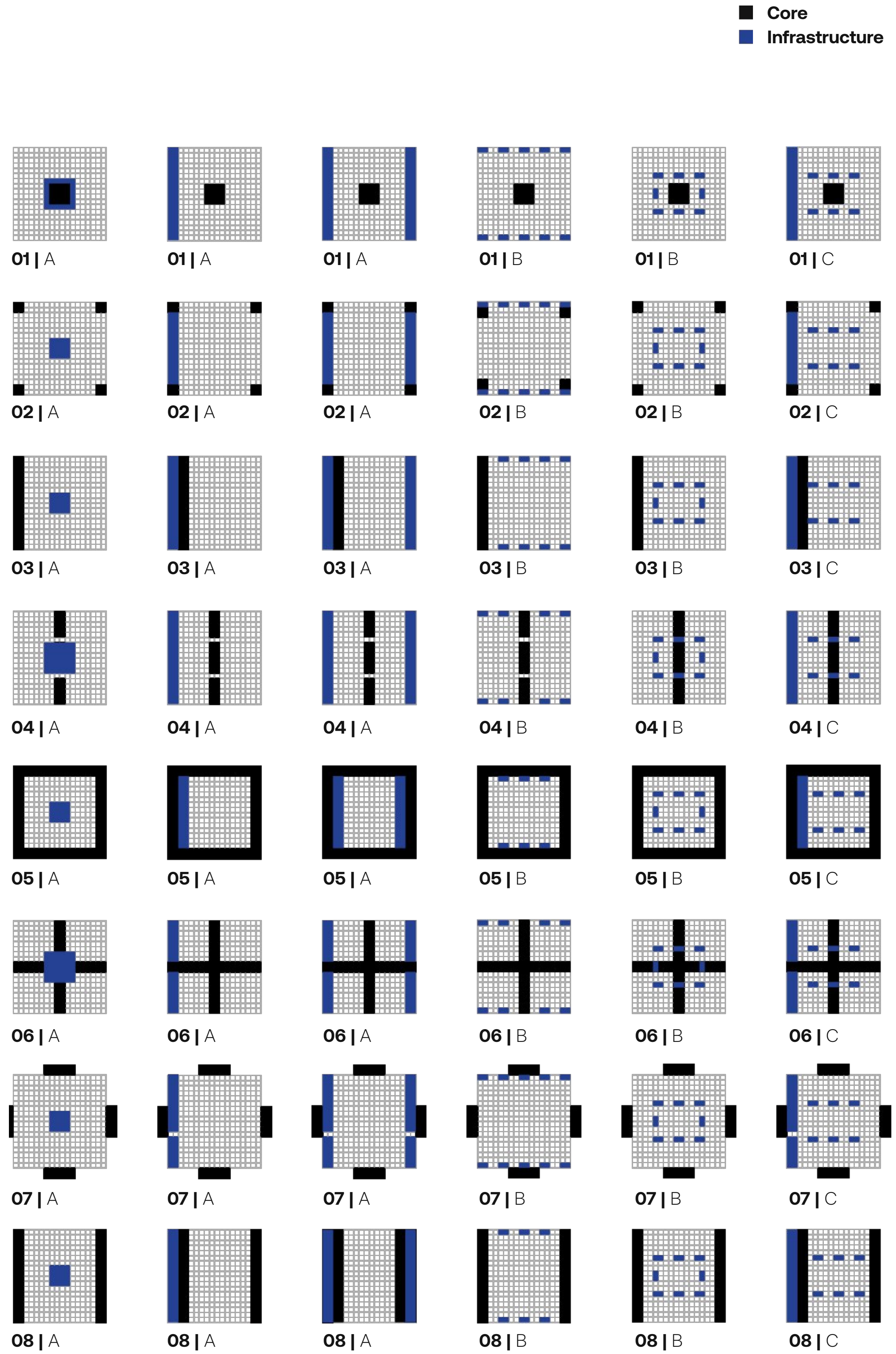



**Figure 01.09 |** Overview Core + Infrastructure | Top view

# ROOM CATEGORIES

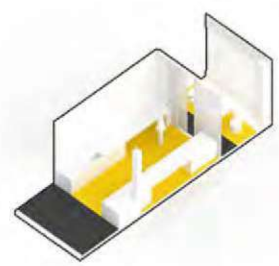
- **NUF 1** I Living | Stay
- **NUF 2** I Office work
- **NUF 3** I Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

If you take a look at the individual rooms in a laboratory building, it quickly becomes clear that the spectrum is broader than one might think. Offices, laboratories, or technical rooms are essential, as well as places for communication and presentation. As already mentioned, the focus of the work is, among other things, on the concept of *Growth - Constancy - Reduction*. The following pages present individual rooms, most of which belong to the *Growth* category. In addition, the airlock system, which is used for hygienic safety in biological laboratories and thus belongs to the *Constancy* category, is also explained.

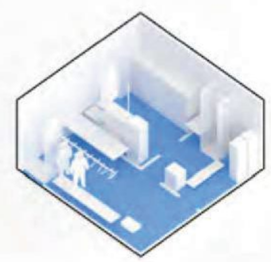
**Communication zone**

**Office**

**Molecular biological lab**



**Competition lab**



**Airlock**

**Presentation | Learning**



**Figure 01.10 |** Overview Room Categories | Axonometry

# COMMUNICATION ZONE

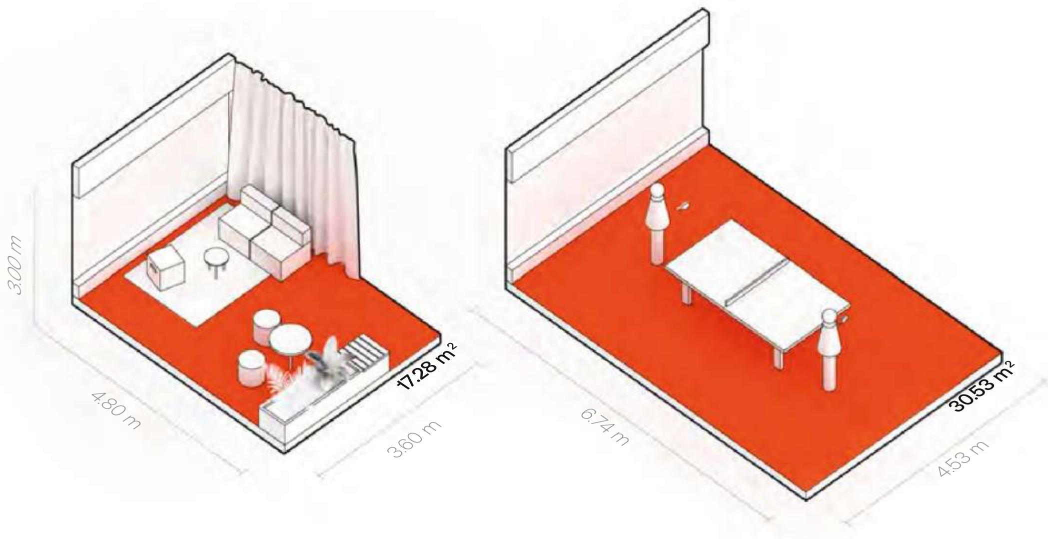



**Figure 01.11 |** Communication Zone | Axonometry

As already explained, efficient communication is one of the most important components of research work. In principle, communication takes place everywhere in the building, whether spontaneous or planned. So-called *Attraction Points* (see Chapter 04 Optimization) are the main points for communication in this thesis. These places can be arranged in a wide variety of dimensions. They are multifunctional and enhance the working atmosphere. The reference analysis (see Chapter 03 References) shows an increasing proportion of these areas in laboratory construction in recent years. Communication is multifaceted, and the architecture should reflect this.

# OFFICE

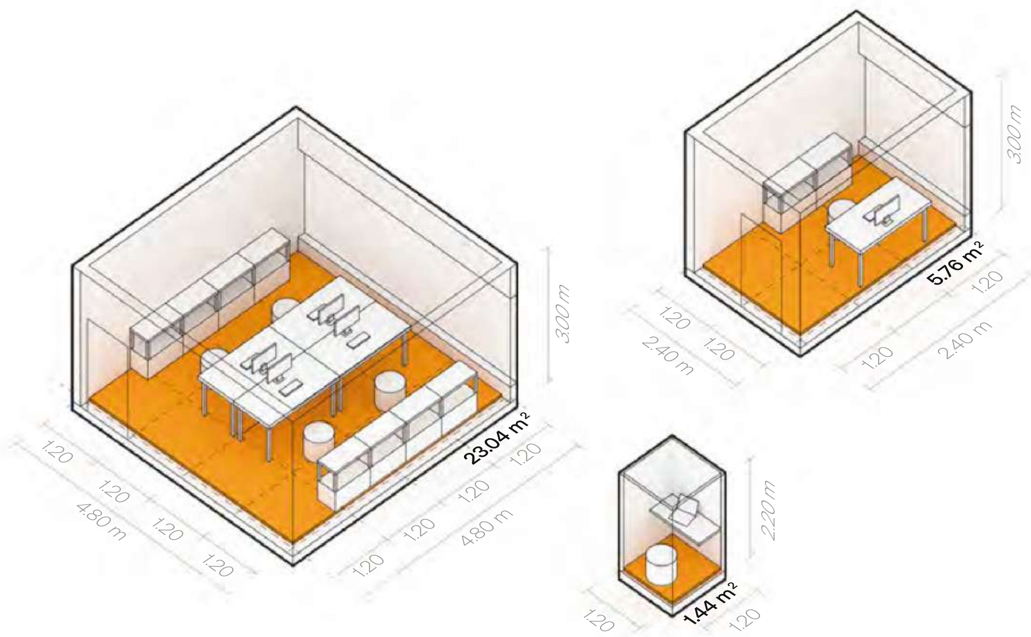



**Figure 01.12 |** Office | Axonometry

In order to comply with the frequently used 1.20 m "Euro grid" (Grömling, 2005, p. 44) in laboratory buildings, the above illustrations have been adapted accordingly. It is essential for efficient research work that there are places for communication and concentrated individual work in different shapes and dimensions. To support the trend towards open-plan structures and office landscapes, room-in-room systems such as telephone boxes or smaller meeting rooms are ideal. Thanks to the uniform grid, both cellular offices and open-plan offices can be realized. Trolley systems and multi-purpose furniture increase flexibility and support individual adaptability by the researchers (see Chapter 04.02 Sorting).

# MOLECULAR BIOLOGICAL LAB

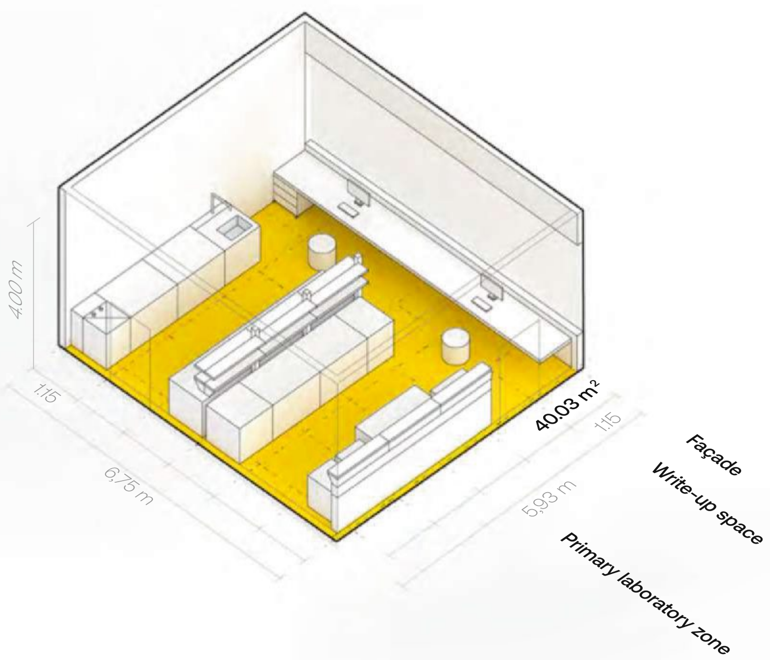



**Figure 01.13 |** Molecular Biological Laboratory | Axonometry

The lab is the heart of the laboratory building. Laboratory rooms are possible in different formats depending on the field of research. The room shown is an exemplary laboratory for molecular biology research. The floor plan is based on the frequently used distance of 1.15 m. Laboratory tables, a sink, equipment, storage areas, and spatially integrated write-up spaces can be seen. In principle, a laboratory room should be differentiated between wet and dry areas. In this case, the dry area is intended for smaller machines and the write-up spaces. Wet areas can be considered for larger devices and methods that handle hazardous substances. Sufficient daylight should also be available (Grömling, 2005, pp. 39, 40).



# COMPETITION LAB

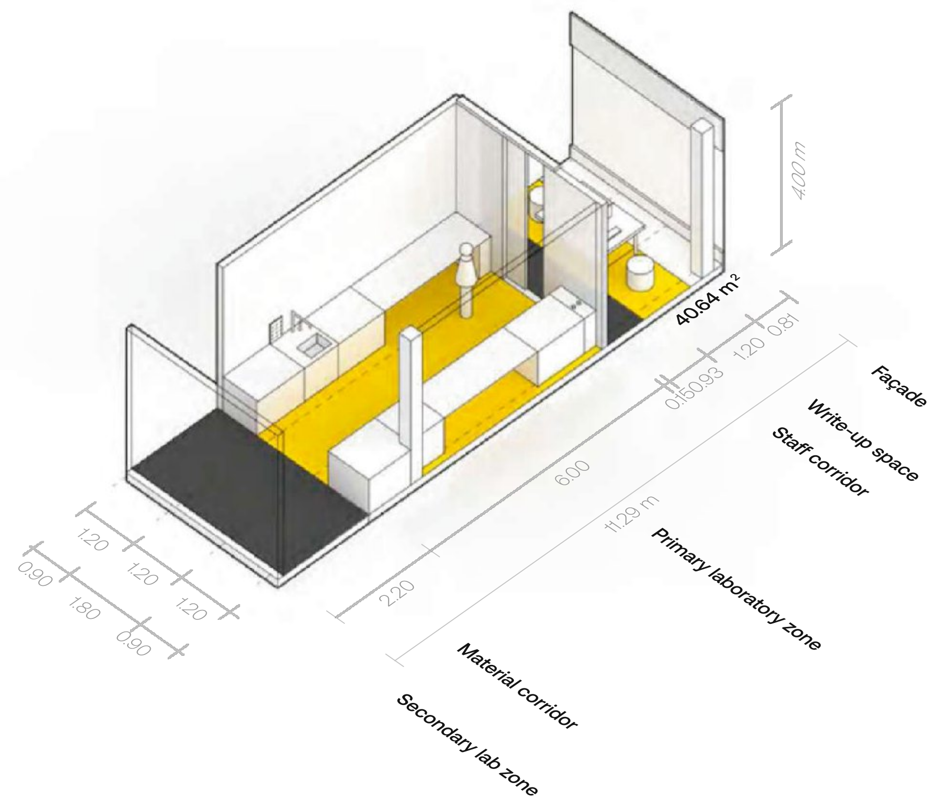



**Figure 01.14 |** Competition Laboratory | Axonometry

This lab serves as a rough guideline for the competition planning of House 7 for the RKI. The floor plan is based on axes spaced 1.20 m apart. The evaluation areas are arranged directly next to the laboratory rooms, which is intended to increase flexibility.
The grid dimensions account for future trends, anticipating larger space needs for laboratory equipment due to development advances. To ensure that there is still sufficient space for employees to move around, this is calculated as at least 1.45 m between the laboratory benches. Also, up to the fume cupboards, at least 1.50 m must be allowed above the laboratory benches. Sufficient daylight must be available due to the classification as a permanent workstation (BBR, 2023).

# AIRLOCK

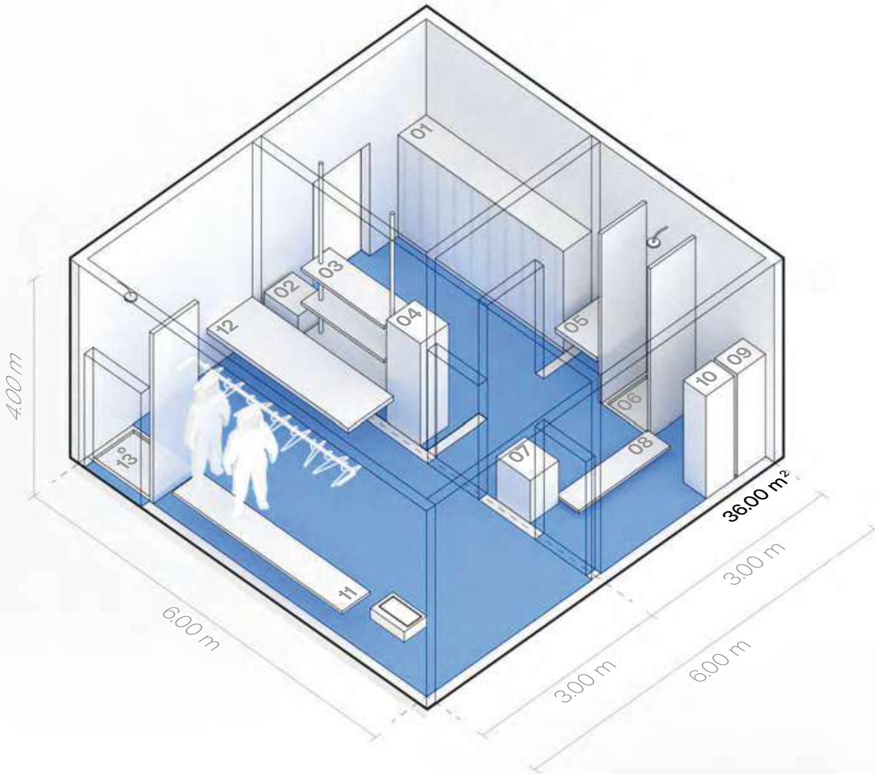



**Figure 01.15 |** Airlock | Axonometry

An airlock system is required, depending on the security level of the laboratory. For microbiological research areas, this applies from level S3. On levels S3 and S4, the airlock systems differ depending on the number and implementation of the safety measures. The aim of generating hygiene zones is achieved through disinfection showers and changing areas, among other things. It is also important to provide visibility in the form of doors with windows or cameras so that employees can be helped as quickly as possible in case of an accident. Other factors that play a decisive role in the planning of safety areas include air pressure conditions, wastewater, and filter system (Mertsching et al., 2023, pp. 100–110).

**01** | Lockers
**02** | Charging station
**03** | Shelf
**04** | Cupboard
**05** | Hygiene articles
**06** | Hygiene shower
**07** | Functional underwear
**08** | Shoe bench
**09** | Waste box
**10** | Autoclave container
**11** | Protective suits
**12** | Test table
**13** | Decontamination shower
(Mertsching et al., 2023, p. 107)



# PRESENTATION I LEARNING

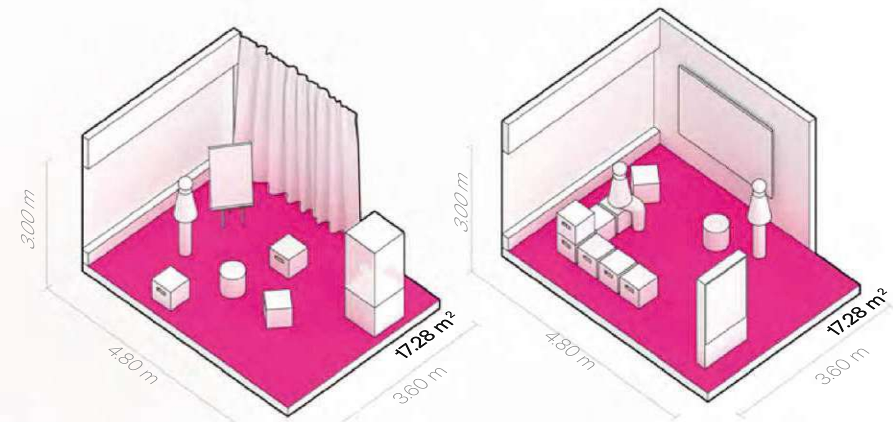



**Figure 01.16 |** Presentation | Learning | Axonometry

It is essential to provide an overview of the research status of colleagues in the form of displays or information walls, both digital and analog. These areas should be placed as prominently as possible (Marguin et al., 2019, p. 160). Integrating different presentation formats, such as posters, digital presentations, or interactive models, promotes the transfer of knowledge. These areas represent an intermediate zone between the concentrated work of an individual and the central communication zone. They support both presentation and learning, and enable transparent exchange of current issues, goals, and results with external guests. The room size can vary from small retreats between team colleagues to large lecture halls.

# EQUIPMENT

Each type of laboratory has its own individual equipment requirements. Regardless of this, the focus is on flexibility and cost-effectiveness. The furniture shown here can be found in laboratories specializing in biology, chemistry, or medicine. The elements can either be positioned freely in the room or placed against walls. When planning, the positioning of the technical shafts and the cable routing must always be taken into account (Eichler, 2005, pp. 53-55).

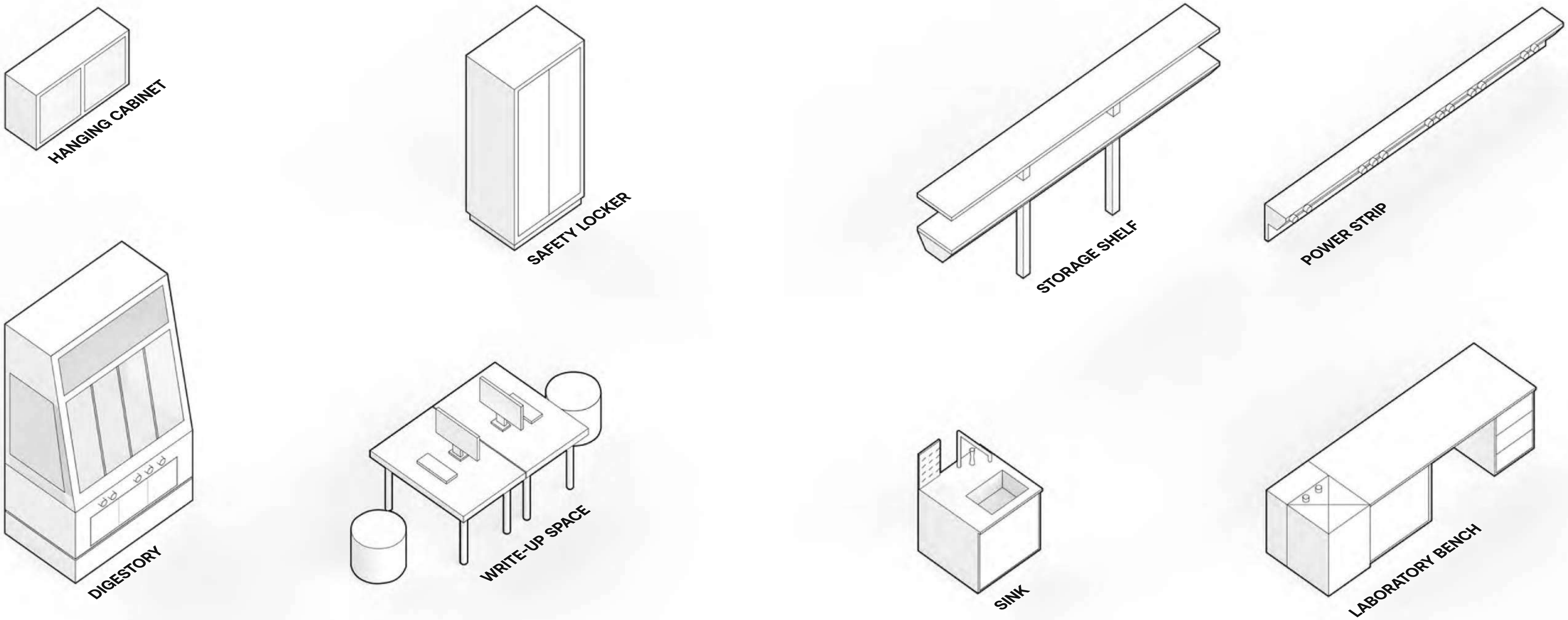



**Figure 01.17 |** Overview Equipment | Axonometry

# SAFETY LEVELS

Safety and hygiene are among the first words that come to mind when considering laboratories. However, it is challenging to categorize them. As explained, laboratories span a wide range of research areas with varying specifications and safety levels.

**How can safety be increased?**
An important factor, which also plays an essential role in the design (see Chapter 06 Unfold Density), is to enable visual contact between employees. It should be avoided that people work alone in laboratories as much as possible (Hegger, 2005, pp. 28–30). In case of hazardous gas leaks or accidents, it is crucial to intervene quickly from outside. Further measures can be found on the following pages: ventilation measures, access requirements to hygienic areas, or the choice of easy-to-clean materials.

**What do the security levels mean?**
Generally speaking, the higher the security classification, the more and stricter the measures that need to be taken in planning and operation. In terms of architecture, this affects, for example, room connections, technical systems, floor space ratios, and furnishings. In category S2, there are centrifuges, autoclaves, and disinfection areas, as well as mandatory distancing between certain rooms (Pohl & Kliemt, 2022, p. 198).

**Where can the specifications be found?**
For the proposal that follows later, two texts, the *Biological Agents Ordinance* and the *Act on the Regulation of Genetic Engineering*, provide optimal orientation (BBR, 2023).
These two ordinances and the *GenTSV Ordinance on the Restructuring of the Law on the Safety Levels and Safety Measures for Genetic Engineering Operations in Genetic Engineering Installations* are among the standards for laboratories dealing with biology and genetic engineering (Pohl & Kliemt, 2022, p. 198).

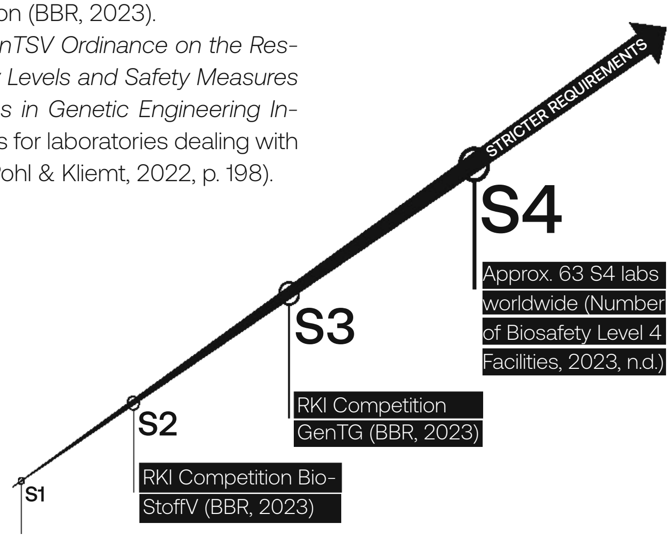



**Figure 01.18 |** Safety Levels S1 to S4

## GENTG

The *GenTG* is the abbreviation for *Act on the Regulation of Genetic Engineering*. It describes protective measures against damage caused by genetic engineering work. The law, which was developed by the Federal Council in 1990, was last renewed on September 27, 2021. The term genetic engineering refers to "genetically modified organisms" (Bundesministerium der Justiz, 1993, p.4 (Translated from German)) and their handling, such as storage or destruction. (Bundesministerium der Justiz, 1993, pp. 1-3).

**Commission**
The "Central Commission for Biological Safety" (Bundesministerium der Justiz, 1993, p. 6 (Translated from German)) is an association of experts with highly advanced experience. The areas from which the members come in terms of knowledge are, for example, virology, hygiene, safety engineering or microbiology. According to § 4, this is defined more precisely in the GenTG. There are a total of 12 members plus their respective representatives. They are selected by federal authorities and advise the government on safety requirements (Bundesministerium der Justiz, 1993, p. 6).

**Protection levels**
Similar to the BioStoffV, there is also a classification of four different safety levels.
*Safety level 1* | Here, there is no danger to humans or the environment
*Safety level 2* | Here, there is a low risk of human illness or damage to the environment
*Safety level 3* | There is a risk of human illness or damage to the environment
*Safety level 4* | There is a high risk of human illness or damage to the environment
(Bundesministerium der Justiz, 1993, pp. 7, 8).

**Authorizations**
Genetic engineering research may only take place in rooms designated for this purpose. From safety level 3 on, a permit must be obtained for commissioning and modifications. In some cases, decisions must be made in consultation with various authorities and institutions such as the Robert Koch Institute. The Federal Register serves as a further safeguard and source of information (Bundesministerium der Justiz, 1993, pp. 8, 15, 16).

# BIOSTOFFV

The *BioStoffV - Biological Agents Ordinance (Biostoffverordnung)* - describes protective measures for handling biological agents. It was last amended on July 21, 2021. The Federal Ministry of Labour and Social Affairs provides it. Some of these laboratory safety measures are listed below. BioStoffV is the abbreviation for V*erordnung über Sicherheit und Gesundheitsschutz bei Tätigkeiten mit Biologischen Arbeitsstoffen* (Bundesministerium der Justiz, 2021, p. 1).

**Protection levels and risk groups**
Four protection levels from S1 to S4 exist. They are based on four different so-called *risk groups*. They indicate how high the risk of infection of a work task with so-called biological substances is. If several substances from different risk groups are used, the highest group is used for classification. Other parameters, such as the function of activity, can also be used for assessment.
*Risk Group 1* | Low risk of humans becoming ill as a result
*Risk Group 2* | Possible risk of illness for humans and employees in particular. Low risk of the biological agent spreading to the general public. Treatment options are usually available.
*Risk Group 3* | A high risk of illness for people, and especially employees. There is a risk that the biological agent will spread to the general public. Treatment options are usually available.
*Risk Group 4* | A high risk of illness for people, and especially employees. There is a high risk that the biological agent will spread to the general public. There are usually no treatment options (Bundesministerium der Justiz, 2021, pp. 3, 4).

**Documentation**
The employer's documentation obligation is to create a list of the bio-substances processed. In the case of S3 and S4, the people who have worked with them must also be recorded. It is only possible to work with biological substances at home if they belong to risk group 1 (Bundesministerium der Justiz, 2021, pp. 6, 7).

**Hygiene**
There are certain hygiene regulations that must be guaranteed regardless of the respective protection level. The following rules apply in particular:

**01** Workstations and necessary objects must remain clean and must be cleaned regularly
**02** The floor and surfaces of objects must be easy to clean







**Figure 01.19 |** Symbol "Biohazard"

**03** There must be a washbasin

**04** There must be changing rooms for required work clothes. They must be changed and cleaned regularly

The safe storage of biological substances in appropriate boxes must be ensured (Bundesministerium der Justiz, 2021, pp. 7, 8).

**Working with high-risk groups**
When working in risk groups higher than level 1, additional measures must be taken. Some of these are listed below and on the following page.

**01** Objects and processes must be designed in such a way that the risk of injury to employees is minimized
**02** Formation of dust and aerosols should be minimized at all times. This also applies to cleaning.
**03** The number of employees involved in an activity should be kept as low as possible
**04** Special procedures must be followed when cleaning and disposing of work items
**05** Protective clothing must be used, maintained and cleaned accordingly
**06** It must be possible to remove protective clothing separately from other items of clothing
**07** Eating is not permitted in rooms with organic materials. Separate rooms must be provided for this purpose

(Bundesministerium der Justiz, 2021, p. 8)

**Labeling**
The laboratory rooms must be marked with the *Biohazard* symbol. Sharp objects can cause injuries and must, therefore, be avoided. Access to risk groups 3 and 4 is additionally restricted by the supervision of authorized persons. Prior to first use, changes, or accidents when handling certain risk groups, the authorities must give their approval in advance. Additional behavioral requirements must also be communicated in advance. In an emergency, it must be possible to contact emergency services from the laboratory. A signal warns all those potentially affected by the accident (Bundesministerium der Justiz, 2021, pp. 9, 10, 20).

The following list is a direct quotation from the Biological Agents Ordinance for reasons of precise specification. (Bundesministerium der Justiz, 2021, pp. 18-21), Annex II and Annex III.

| | |
|---|---|
| dashed square | Recommended |
| empty square | Mandatory under certain conditions |
| filled square | Mandatory |
| square with diagonal | Minimised |
| square with horizontal line | Prevented |
| (blank) | No |

# BIOSTOFFV

**Annex II - Additional protective measures for activities in laboratories and comparable facilities and in the husbandry of laboratory animals**

| No. | Measure | S2 | S3 | S4 |
|---|---|---|---|---|
| 01 | The area with an assigned protection level shall be separated from other areas with an assigned protection level or working areas in the same building. | Recommended | Mandatory | Mandatory |
| 02 | The access to the area with an assigned protection level must be equipped with an airlock with interlocking doors. | | Mandatory under certain conditions | Mandatory |
| 03 | The access to the area with an assigned protection level shall be limited to designated employees. | Mandatory | Mandatory | Mandatory |
| 04 | Permanent negative pressure shall be maintained in the area with an assigned protection level. | | Mandatory | Mandatory |
| 05 | Supply air and exhaust air must be conducted through a high-efficiency particle filter or a similar installation. | | Mandatory under certain conditions | Mandatory |
| 06 | It must be possible to seal the area with an assigned protection level for fumigation. | | Mandatory under certain conditions | Mandatory |
| 07 | A microbiological safety cabinet or a technical facility providing a similar level of protection shall be used. | Mandatory under certain conditions | Mandatory | Mandatory |
| 08 | Any area with an assigned protection level shall have dedicated equipment. | Recommended | Mandatory | Mandatory |
| 09 | Any area with an assigned protection level shall be equipped with an autoclave or an equivalent sterilisation unit. | Recommended | Mandatory under certain conditions | Mandatory |
| 10 | Contaminated process exhaust air must not be released into the working area. | Mandatory | Mandatory | Mandatory |
| 11 | Effective disinfection and inactivation processes shall be defined. | Mandatory | Mandatory | Mandatory |
| 12 | The surfaces in question shall be impervious to water and easy to clean. | Mandatory | Mandatory | Mandatory |
| 13 | Surfaces shall be resistant to the chemicals and disinfectants used. | Mandatory | Mandatory | Mandatory |
| 14 | Decontamination and washing facilities for employees shall be provided. | Mandatory | Mandatory | Mandatory |
| 15 | Employees shall take a shower prior to leaving the area with an assigned protection level. | | Recommended | Mandatory |
| 16 | Contaminated solid and liquid waste shall be inactivated prior to its final disposal using established physical or chemical methods. | Mandatory under certain conditions | Mandatory under certain conditions | Mandatory |
| 17 | Waste water shall be inactivated prior to its final disposal using established physical or chemical methods. | | Recommended | Mandatory |
| 18 | An observation window, or similar equipment, shall be present so that working area can be seen. | Mandatory | Mandatory | Mandatory |
| 19 | An emergency call facility shall be provided when employees work alone. | Recommended | Mandatory | Mandatory |
| 20 | It must be impossible to open windows. | | Mandatory | Mandatory |
| 21 | Emergency power supply shall be provided for safety-critical installations. | Recommended | Mandatory | Mandatory |
| 22 | Biological agents shall be kept under lock and key. | Mandatory under certain conditions | Mandatory under certain conditions | Mandatory |
| 23 | An effective control of vectors (such as rodents and insects) shall be implemented. | Recommended | Mandatory | Mandatory |
| 24 | Safe disposal of infected animal carcasses for instance by thermal inactivation, in incinerators or animal carcasses or other suitable sterilisation/inactivation facilities. | Mandatory | Mandatory | Mandatory |

**Annex III - Additional protective measures for biotechnological activities**

| No. | Measure | S2 | S3 | S4 |
|---|---|---|---|---|
| 01 | The apparatus shall physically separate the process from the environment. | Mandatory | Mandatory | Mandatory |
| 02 | The apparatus or a similar facility must be located in an appropriate area with an assigned protection level. | Mandatory | Mandatory | Mandatory |
| 03 | The process exhaust air from the apparatus shall be treated so that a release of biological agents | Minimised | Prevented | Prevented |
| 04 | Opening the apparatus for sampling, adding substances or transferring biological agents, for example must be performed so that a release of biological agents | Minimised | Prevented | Prevented |
| 05 | Culture fluids may only be taken from the apparatus for further processing when their removal is handled in a closed system or when the biological agents have been inactivated by effective physical or chemical processes. | Mandatory | Mandatory | Mandatory |
| 06 | The seals of the apparatus must be designed so that an inadvertent release of biological agents | Minimised | Prevented | Prevented |
| 07 | It must be possible to collect the entire content of the apparatus. | Mandatory | Mandatory | Mandatory |

# HOW LABS WORK





**HENN**
With over 400 employees at 5 locations, the international architecture office HENN is one of the most renowned in Europe. Over the last 75 years, the firm has established itself through innovation and precision, particularly in office, industrial, and laboratory buildings. The office is now in its third generation. HENN was also responsible for the new construction and conversion of both existing buildings on the competition site of the Robert-Koch-Institute in Berlin - House 5 and House 6.
In the following interview, Thomas Polster and Michael Reininger, two experienced employees, talk about their expertise in laboratory construction and future developments.
The interview via videocall was translated from German and took place on February 7, 2024.

**Thomas Polster**
Senior Associate
Project Studio

**Michael Reininger**
Associate
Project Studio

**Figure 01.20 |** Interview Partners | Photograph | © Henn GmbH


**Figure 01.21 |** Novartis | Floor plan | Scale 1:1,000

Typologies depend on the respective daylight requirements

**Open-plan laboratory**
*Thomas Polster* | The open-plan laboratory is often about circulation areas, core areas and write-up areas. Where are they located, and how are they accessed? In the building for Novartis by Rafael Moneo (see Figure 01.21 ↙) in collaboration with HENN, there are six cores for vertical access to the open-plan laboratory. The basic idea was sketched by Rafael Moneo, and our office executed it. The write-up spaces are located in a ring around the cores, and the circulation is in the form of corridors next to the façade. This is a rather unusual typology that is very flexible.

**Daylight and dark zones**
*Thomas Polster* | The ratio of daylight in accordance with workplace guidelines and the need for dark zones are significant. Cold storage rooms that have to cool down to -80°C, for instance, do not need any light. Typologies often develop from this factor. This is where the 3-row-division system comes in. Together with Heikkinen & Komonen, HENN designed a very functional laboratory building in Dresden. It has a pretty good floor plan with a wide dark zone in the middle and laboratory areas along the façades. This is the Max Planck Institute of Molecular Cell Biology and Genetics.
To summarize: The daylight requirements for workplaces on the one hand and the great need for dark areas on the other often shape the floor plan.

**Laboratory bench and write-up space**
*Thomas Polster* | In addition, the relationship between the write-up space and the laboratory bench is always questioned. Those who carry out research in the laboratory work at laboratory benches and evaluate their results at small touch-down write-up

stations. This space is very similar to the write-up areas in office buildings. It can be located directly on the windowsill so that people can sit down spontaneously. We tried to implement this idea in the Necker building in Paris (see Figure 01.22 ↓). However, we learned that it was not possible to apply it due to regulations in France or other issues. Instead, we had to plan extra corridors for the so-called "offices". This meant that the write-up spaces could not be accessed via the laboratories. In Switzerland, this is permitted. In our project, there were stub corridors that radiate from the main corridor within our 3-row-division structure towards small offices next to the façade.
However, this took up quite a lot of space. These stub corridors were "squeezed" into the floor area.
*Michael Reininger* | In one of our current projects the write-up spaces are integrated into the laboratory area. There are no explicit write-up areas in this design. Nevertheless, at the Roche Laboratory and Office in Penzberg, which we planned, they are also located along the façade and directly accessible from the laboratories.
*Thomas Polster* | In the Paris project, these areas are accessible through a glazed partition wall. A door has to be opened to get from the laboratory to the write-up space. There, it was the case that all write-up spaces could not only be accessed via the laboratory but also required access to the primary circulation.
*Michael Reininger* | This option is also available in the Roche Laboratory and Office.
*Thomas Polster* | Furthermore, the reorganization in Paris was challenging because much more dark space was required than the 1967 design actually provided.
Important issues are: Who works where, and how close is the relationship between the write-up spaces and the laboratory? How to deal with the areas that need daylight because they are workplaces?

Connection of laboratory and write-up space to enable coherent work steps


**Figure 01.22 |** Necker | Floor plan | Scale 1:1,000

**Circulation as a place of communication**
*Thomas Polster* | The important thing about circulation is that people can encounter there. This is also Gunter Henn's credo, as he describes in his book. Innovation happens by bringing together lots of creative people, resulting in informal communication and exchange. Most innovative ideas come about through dialog between people who don't even necessarily work together. That is why circulation areas are not just corridors in the traditional sense but also meeting places. This is also the reason why we plan stairs that are wide enough for people to stand or sit down.
When Neckar was renovated, the greatest need at the time was not the laboratory areas or the dark zones but the small tea kitchens on each floor, meeting rooms, and informal communication zones.

***"Someone once said that a good 100 years ago, aspirin was discovered by a single pharmacist alone in a quiet room. Nowadays, in contrast, innovation happens through dialog between different creative people. Space must be provided for this."***

This idea comes from Gunter Henn. Different creative people are creating something innovative together. Therefore, the circulation should perhaps not only be seen as a corridor but also as a meeting area and as part of today's research in contrast to 100 years ago.
*Michael Reininger* | We need to differentiate between communicative situations and the classic development of potential laboratory areas. We agree with you that you should work with open-plan laboratories and not always with small cells and individual areas.
*Thomas Polster* | The two corridor functions, namely access as a meeting place and the logistics corridor, can also be separated. This is comparable to the service corridor in Louis I. Kahn's Salk Institute  (see Chapter 03 References) or the old French aristocratic castle with service corridors behind the scenes so that the service does not have to go through a noble entrée.

**The term “laboratory”**

*Thomas Polster* | Laboratory is a broad term. For example, building areas for the police for ballistics or firearms testing also come under the heading of “laboratory”. Here, attention must be paid to the comparability of uses. Nowadays, many workshops are referred to as a “lab” in designs without actually being one. Depending on the type, there are corresponding requirements for the architecture.

Similar to office buildings, the flexibility of the arrangement of workstations is very easy in some workshop laboratories. In my experience, medical research laboratories are often built on fixed, raised plinths. In these cases, the term “flexibility” corresponds more to how many of these sections and units are made available to each team.

*Michael Reininger* | The circulation areas probably differ depending on the type of “lab” or these workshops and their differences in use.

*Thomas Polster* | The typologies must be differentiated precisely. Trends can only become visible if the same typologies are clustered. On the other hand, the results of the analysis must not be generalized without considering the reasons behind architectural decisions.

**Retrofittability**

*Thomas Polster* | What definitely creates a sustainable building is to keep a certain amount of space in reserve for subsequent installations in the vertical connections. For example, 20 % reserve area can be provided in the shafts that is not currently required for use. Additions can somehow be accommodated in the horizontal area, but it becomes more difficult to retrofit vertically. This aspect should, therefore, be taken into account when planning cores.

Infrastructure reserve areas
enable vertical densification

**Attractiveness through additional offers**

*Thomas Polster* | It is also crucial that an attractive building draws good researchers. At the moment, they often go to England, Germany or the USA. The building was upgraded during the renovation of the Paris project. Despite the attractive city, it was difficult to find good postdocs for this institute before the renovation. If you look at Harvard, for example, you can see that many promising young researchers choose to go there. There, they can simply go to reception in the morning, hand in their dirty laundry and pick it up cleaned and ironed in the evening. Such offers are strongly linked to the number of researchers working there, who later receive Nobel prizes and enhance the value of the institute. Employees choose their workplace according to what makes their work more pleasant.

**What are the current trends in laboratory construction?**

Current trends:
open-plan laboratory
reduction of circulation areas
lab-boxes
infrastructure highways
automation
modular ceiling systems

*Michael Reininger* | The open-plan laboratory. Ultimately, the direction you want to take. Reduction of circulation areas in the open-plan laboratory and not in the communication areas. Interconnected areas. In certain cases, areas must be partitioned off for hygiene reasons. If you need these in a large laboratory area, you often work with laboratory boxes.

These boxes are explicitly connected to the technical infrastructure. This creates large infrastructure highways that “drive” through the building.

*Thomas Polster* | This prevents odors from being transferred from the box to the large room.

*Michael Reininger* | Exactly! If they need an explicit supply, then they get their own connection. The boxes are reasonably flexible and can be dismantled. Of course, element partitions, which have to be placed on a normal prefabricated floor, are used again. This reduces our flexibility. There is also a trend towards automation. This can be seen, for instance, in fully automated laboratory lines that can be over 50 m long. Samples are analyzed, almost completely without the help of humans, automatically transported through the lines, and stored in a biobank - large refrigerators, so to speak.

There is also a trend towards modular laboratory ceiling systems.

*Thomas Polster* | Modular laboratory ceiling installation systems provide intersection-free horizons for encounters between different media. Care is taken to ensure that the electricity or gases, for example, are routed at their own levels without collision. These ceiling systems or suspended scaffolding are initially rather oversized but can be retrofitted at a later date. If areas are already provided in the core, additional areas can be distributed later in these modular ceiling systems for the infrastructure.

# 02

# Robert Koch Institute

# ROBERT KOCH





In 1905, the doctor and former director of the "Königlich Preußisches Institut für Infektionskrankheiten", the name of the Robert Koch Institute (RKI) at the time, was awarded the Nobel Prize for Medicine. He and Louis Pasteur are regarded as the founders of the field of microbiology. Prof. Dr. Robert Koch was born in 1843 and grew up with his twelve siblings in Germany, in Clausthal in the Harz Mountains (Robert Koch-Institut, 2018a).

**Studies and first career steps**

He initially studied natural sciences in Göttingen, specifically mathematics, physics, and botany, and then switched to medicine, which was common at the time for children from middle-class or poorer families. His talents quickly became apparent. His career began as a country doctor in Poznan, Poland, after his excellent doctoral thesis. A solid job provided enough money for him and his wife Emmy. Due to the low workload, he had the opportunity to investigate his own research interests in his laboratory, such as anthrax, a disease that was particularly prevalent in animals. He soon came across findings that others had sought in vain in this field, which led to him being celebrated by experts after he published them in 1876. He began working at the Imperial Health Department in Berlin four years later. He was awarded the Nobel Prize for his research on tuberculosis, one of the deadliest diseases at the time, which he carried out at this department. From then on, he was highly praised not only for his discovery of the causative agent but also for providing methods, tools, and a structured approach (Berndt, 2020).

***"I wish that in the war against the smallest but most dangerous enemies of the human race, one nation may always outstrip the other!"***

– Robert Koch (*Translated from German)*

**Motivation**

This statement shows that his research motivation consisted of hostility towards deadly diseases and that he, therefore, acted almost belligerently. Confidence in his ability was strong, both on his part and on the part of society and supporters (Blawat, 2010). In 1916, a marble statue was erected by Louis Tuaillon on Robert-Koch-Platz in Berlin Mitte, which honors this very phrase, Robert Koch (Robert-Koch-Denkmal, 2009).

Examples of his research:
- Anthrax
- Tuberculosis
- Cholera
- Typhoid
- Sleeping Sickness

**Pioneering work**

Koch was not only a pioneer in microbiology due to his discoveries in tuberculosis. He developed the technique of coloring microbes, which is still used today to make them visible. He understood how to make a personal profit from his scientific success. When Koch announced he had discovered a tuberculosis cure, he negotiated a share of the profits and, six years later, sought to establish his own institute. However, support dwindled as experts grew skeptical of his lack of evidence. Rudolf Virchow, notably tied to the nearby Virchow Clinic, exposed the era's biggest pharmaceutical scandal, proving the treatment ineffective. Although his reputation was severely tarnished as a result, his knowledge of topics such as cholera and typhoid had a counteracting effect. He was offered the opportunity to travel to Africa to carry out intensive research. There, he also dealt with sleeping sickness, the treatment of which again proved to be of little help (Blawat, 2010). Despite the controversies, his theoretical contributions and the rise of bacteriology earned him the Nobel Prize and his own institute (Robert Koch Institute, 2018a). Throughout his life, he dismissed criticism of his work, died wealthy, and divorced from Emmy of heart disease at 67 (Blawat, 2010) in 1910 in Baden-Baden.



**Figure 02.01 |** Robert Koch | Photograph | © Robert Koch-Institut

# THE INSTITUTE

The following is a historical overview. Due to the importance and long history of the Robert Koch Institute, a more detailed description would go beyond the scope of this thesis.

**The starting point**

The leading cause of death in the twentieth century was infectious diseases. Hundreds of thousands of deaths were recorded in Germany at that time. In honor of Robert Koch's outstanding research findings, the Prussian government provided him with his own institute (Robert Koch Institute, 2018a). Today's Robert Koch Institute was founded in Berlin-Mitte in 1891 under the name *Königlich Preußisches Institut für Infektionskrankheiten*. For the first nine years, research was conducted in a former residential building under the direction of Robert Koch. Today's main building in Berlin-Wedding, which is only about 600 meters away from the competition site as the crow flies, was occupied in 1900. Robert Koch remained the director for another four years. 1912, two years after his death, the research facility was renamed *Königlich Preußisches Institut für Infektionskrankheiten, Robert Koch'* (Robert Koch-Institut, 2024c).

**National Socialism**

The reappraisal of the role of the RKI from 1933 to 1945 was put on the back burner for a long time. From 2006 to 2008, experts from the Charité in Berlin analyzed the role of the RKI as a state institute under National Socialism with the help of historical studies commissioned by the RKI (Robert Koch-Institut, 2024b).
Today, the Robert Koch Institute takes the reappraisal of its own history under National Socialism seriously. A topic that has not yet been addressed by many institutions. Artistic, visual projects and written publications are being used to deal with the past (Baumann, 2013, p. 27).
National Socialist ideas strongly influenced the RKI. This was evident both in the mindset of the staff and in the choice of research topics. Atrocious human experiments were carried out under a massive silence on the part of the employees. Jewish staff were expelled from the institution (Burger, 2013, pp. 9-12).
One of the main aims of the research was to use vaccines to make soldiers fit to fight in the Second World War. An example of many human experiments can be seen in the investigation of typhus vaccines on concentration camp inmates in Buchenwald. Those selected were given the disease in order to study its progression. A cure was not intended. After not all participants in the group had died, the others were killed by injection using syringes. Employees of the RKI were witnesses and accomplices in these human experiments. Even Vice President Gerhard Rose was responsible for testing one of the vaccines. When this series of experiments was decided in 1941, the president of the RKI at the time, Eugen Gildemeister, sat on the committee. He also felt it was appropriate to personally visit the site to gain an impression of these outrages. Other research, such as blood tests for alleged human races and testing treatments on concentration camp inmates and psychiatric patients, were also part of the research at the time. As can be seen, National Socialists reached the highest positions. There were only a few employees who resisted this ideology. Moreover, dismissed Jewish employees who had previously worked successfully on pioneering projects had no prospect of further employment. This led to a forced organizational change at the institute (Hinz-Wessels, 2013, pp. 13–16). From 1942, the name *Robert Koch-Institut* applies (Robert Koch-Institut, 2024c).

**Second half of the 20th century**

The RKI was not spared the heavy destruction of the Second World War. After the end of the war, the Allies helped to make research possible again. In 1952, the Federal Health Office was put into operation, which immediately took over the RKI as part of its activities. A decisive breakthrough was achieved in 1960. The institute produced the only approved vaccine against yellow fever (Robert Koch-Institut, 2024c).
After the institute on the Nordufer in Wedding had been expanded in the previous years and space had been created for an in-house museum, the decision was made in 1967 to build a new building - House 4. The building was planned by the Federal Building Directorate and was one of the most modern laboratory buildings in Europe. A high-security laboratory S3 with sufficient gas, water, and electrical connections impressed the researchers. Due to concerns about vibrations from the nearby subway, vibration-sensitive equipment was located in the basement, which is placed on special foundations. In addition, a metallic façade cladding was chosen to give concerned residents a reassuring feeling that no bacteria are escaping from the laboratories. Houses 1 to 4 were thus located on the Nordufer in Wedding. Nowadays, however, the laboratories from House 4 have been relocated to House 6 (Robert Koch-Institut, 2017).
In 1982, a register for the number of cases was established at the RKI due to the then-new disease AIDS. In 1990, shortly after the fall of the Berlin Wall, additional functions were integrated

Buildings in Wedding:
House 1 – Main building
House 2 – Medium-sized animals
House 3 – former flood protection building
House 4 – virology, cytology, biophysics, radiobiology, S3
House 5 – S2
House 6 – S4
House 7 – S2/S3
(Robert Koch-Institut, 2017)

into the existing institute. This meant that tasks such as hygiene, epidemiology, and microbiology were transferred from the former DDR. The former location in Wernigerode still exists today. The aforementioned health department was discontinued in 1994, resulting in the establishment of the RKI's Berlin-Tempelhof site. Research on non-infectious diseases is carried out there together with two other former institutions. Four years later, the first comprehensive public health surveys were conducted (Robert Koch-Institut, 2024c).

**21st century**
In 2001, new laws on infectious diseases gave the institute additional tasks, and in the same year, it was appointed the "central point in Germany for recognizing and addressing bioterrorist risk situations" (Robert Koch-Institut, 2024c). One year later, the institute's extension is built on Seestraße in Wedding, which will be discussed in more detail later in this thesis. Since 2006, the RKI has been responsible for the dissemination of information on the German health status together with the Federal Statistical Office. In 2007, this task was expanded to include regular analyses of society and current disease progression. One year later, it officially became the "public health institute ('RKI 2010')" (Robert Koch-Institut, 2024c) by the government, as a result of which numerous employees were hired. (Robert Koch-Institut, 2024c) In February 2015, the opening of House 6 on the Seestraße site took place with the then Federal Chancellor, Dr. Angela Merkel (Robert Koch-Institut, 2017). In 2016, 450 researchers were working at the RKI. Three years later, in 2019, a separate "Center for International Health Protection" (Robert Koch-Institut, 2024c) was opened. The RKI has been involved in the containment of major diseases, such as the Ebola crisis in 2015 and the COVID-19 pandemic in 2019. In 2021, the "Centre for Artificial Intelligence in Public Health Research located in Wildau" (Robert Koch-Institut, 2024c) was opened (Robert Koch-Institut, 2024c).

**Figure 02.02 |** 1960 Opening of the new driveway on the Nordufer | Photograph | © Robert Koch-Institut

**Future**
In the near future, the institute intends to focus on working more with digital networking, among other things. In concrete terms, this means making it easier for experts in Germany to share specialist knowledge. The "one health approach" (Smolinski, 2017) aims to create interdisciplinary links. In addition, not only experts but also the general public should be informed in greater detail during crises (Smolinski, 2017). Architecturally, the RKI wants to develop in such a way that the different locations are concentrated in the two areas in Berlin-Wedding (Große Baumaßnahme: Erster Bauabschnitt, 2023c). As the architectural competition, which is dealt with within this thesis, shows, House 7 is to be built next to House 5 and House 6 in a forward-looking way.

## 02.02 CURRENT STATE

“The Robert Koch Institute (RKI) is the government's central scientific institution in the field of biomedicine” (Robert Koch-Institut, 2024f). The majority of the funds invested come from the German federal budget and additionally from specific funds from the Federal Ministry of Health. Donations and other funds for research interests can also contribute to the financing. All information on this is public (Robert Koch-Institut, 2024f).

**Locations**
The current locations are in Berlin, Wildau near Berlin, and Wernigerode in the Harz Mountains. In Berlin, the institute is located in the Wedding district and Tempelhof. The RKI headquarters are on the Nordufer in Wedding, just a few minutes walk from the competition site House 7, which is analyzed later in this thesis (Robert Koch-Institut, 2023c).
There is a museum of the research and history of the institute, and a mausoleum for Robert Koch, which is next to the main building ensemble. Themes like art in architecture, artistic exhibitions, and references to the institute's National Socialist history are also present at the Wedding sites (Robert Koch-Institut, n.d.).

**Guiding principles**
The two basic tasks are to research and publish the knowledge gained and to advise the public health service and German politicians. In doing so, it is important not to be biased and to be trustworthy. Cooperation with partner countries provides additional protection against disease outbreaks (Robert Koch-Institut, 2024d).

***“Promoting research and evidence, sharing knowledge, protecting and improving health”***

- Mission statement (Robert Koch-Institut, 2023a)

The RKI strives to provide an efficient work environment with flexible, up-to-date methods. Due to evolving research demands, it is crucial to adapt quickly. Artificial intelligence and digitalization are integrated into operations. The RKI undergoes regular internal and external evaluations. Interdisciplinary collaboration is encouraged internationally, with knowledge shared through publications, talks, and teaching. The RKI recognizes its global responsibility, cooperating with organizations like the WHO. It aims to comply with laws as well as regulations while considering potential risks (Robert Koch-Institut, 2024d).


**Figure 02.03 |** House 6 | Photograph | © Henn GmbH

**Importance of efficiency**

As the official Public-Health-Institute in Germany, the RKI is responsible for recognizing changing health conditions in the population as quickly as possible. The processes are not only observed over long periods, but information and warnings are issued as early as possible in the event of conspicuous changes (Robert Koch-Institut, 2024h). The Institute's task is to assist in political decision-making and provide advice to society (Eitze et al., 2021, p. 8). Therefore, an efficient flow of research activities and communication is of enormous importance.
The guidelines that employees should adhere to include, for instance, the following points. Firstly, self-criticism and modern scientific standards are highly valued. This means regularly exchanging ideas with colleagues and integrating innovative research practices into one's own work. The careful preparation of findings in the form of precise evidence and descriptions is fundamental here. It must also always be possible to verify the results. The methodology of the research should be handled in such a way that it is comprehensible to other colleagues and experts. The various research areas have a leader, who must not have any overall influence on which topics are researched and which findings are published. In addition, the RKI offers training courses for employees (Robert Koch-Institut, 2023b).

**Management**

The head of the RKI is the medical doctor, Prof. Dr. Lars Schaade. He has been in this position since October 4, 2023. Dr. Anke Engelbert heads the administration. The Centre for International Health Protection is headed by Prof. Dr. Johanna Hanefeld (Robert Koch-Institut, 2023d).

**Departments**

The Institute is organized into departments, each of which is assigned to a specific research area. Each unit has a director, who is also part of the institute's management. The respective areas are, in turn, divided into sub-areas, each of which is also headed by a research supervisor (Robert Koch-Institut, 2024g). In addition, since 1997, project groups have been working on freer and interdisciplinary research topics. The administration is also comprised of various sub-areas, such as topics relating to buildings, personnel, or the institute's organization. Other areas, to name just a few examples, include press issues, the library, the institute's management, quality management, advice, and coordination (Robert Koch-Institut, 2024h).

| Numbers: | |
|---|---|
| Employees | 1,500 |
| Researchers | 750 |
| Employees´ Nations | 50 |
| Professions | 90 |
| Locations | 5 |

Status October 2024
(Robert Koch-Institut, 2024c)

The following research departments structure the institute and are taken directly from the RKI website (Robert Koch-Institut, 2024h). Corresponding subgroups will be identified later in the competitive analysis and in the design proposal (see Chapters 05 and 06):

- Department 1 | Infectious Diseases
- Department 2 | Epidemiology & Health Monitoring
- Department 3 | Infectious Disease Epidemiology
- ZBS | Center for Biological Threats and Special Pathogens
- MFI | Method Development, Research Infrastructure and Information Technology
- ZIG | Centre for International Health Protection
- ZKI-PH | Centre for Artificial Intelligence in Public Health Research

**Safety measures**

An S4 laboratory has the highest safety requirements and is a suitable example to explain the Institute’s hygienic working methods. The RKI has one of the few laboratories of this kind in the world.



**Figure 02.04 |** Putting on the protective suit in the S4-laboratory | Photograph | © Robert Koch-Institut

In order to protect the specially trained staff, work is carried out in a safety suit. Research usually takes place under time pressure in order to analyse dangerous pathogens as quickly as possible. In this way, measures are taken promptly to contain risks to public health. The viruses and pathogens come from external samples. The frequently tested suits have an individual air supply from outside via a pipe and are waterproof. For critical work, it is necessary to ensure that there are at least two researchers in the room. Computers and measuring devices can be used despite the suit and three layers of gloves. Any waste products produced are cleaned in so-called autoclaves using a specific steam and pressure process. Employees can also only leave the laboratory via an airlock. They are cleaned by a disinfectant shower for six minutes while still wearing their protective suit (Robert Koch-Institut, 2024a).

**Figure 02.05 |** Airlock in the S4-laboratory | Photograph | © Robert Koch-Institut

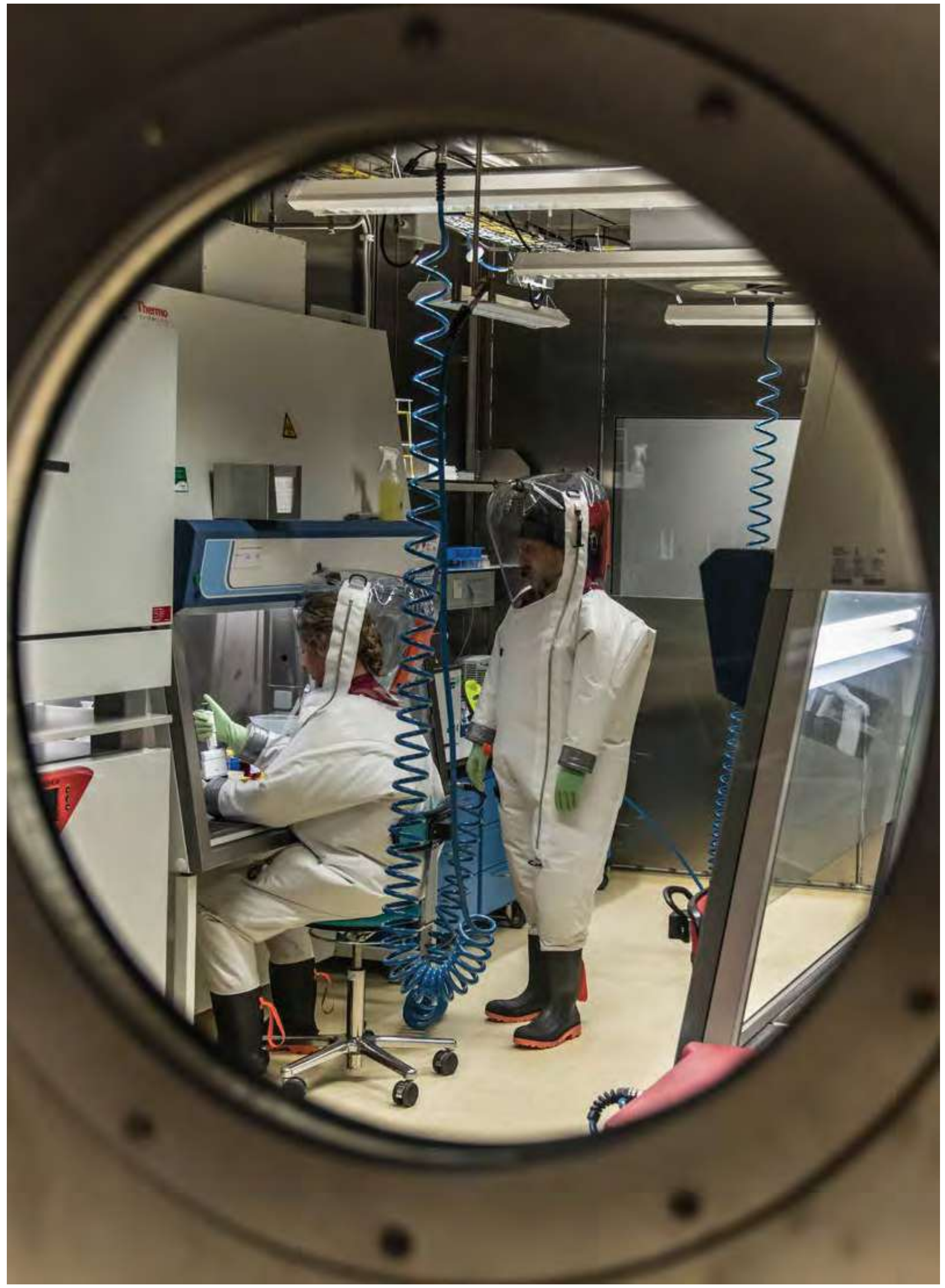


**Figure 02.06 |** Working in the S4-laboratory | Photograph | © Robert Koch-Institut

During the COVID-19 pandemic the RKI became very present in the everyday life of many people. Due to the Institute's information function in Germany, it quickly became the focus of anti-establishment thinkers and conspiracy theories.

**The importance of trust**
At the beginning of the pandemic, the Institute informed the population about the current situation every day in live broadcasts. To build trust, the Federal Center for Health Education, also known as the BZgA, quickly took additional measures. Recommendations and information were communicated clearly and addressed to as broad a section of the population as possible. The RKI and BZgA saw the importance of taking effective action against the virus by educating society (Eitze et al., 2021, p. 1).

***"An expectation in the sincerity and truthfulness of the institutions [...] as well as the perception of the institution as benevolent [...], morally and legally committed to the citizens [...] determines the trust."***
– Eitze et al., 2021, p. 1 (*Translated from German)*

The population's reliance on the Institute's work is crucial because it reduces fears and panic in crisis situations, makes generally applicable guidelines and measures more acceptable, and increases the seriousness of situational awareness (Eitze et al., 2021, pp. 1, 8).

**What does the population think about the German healthcare system and the RKI?**
In general, there has been a noticeable loss of trust in the German healthcare system in recent years. Before the pandemic, around 66 percent of respondents were confident in the work of the healthcare system. One striking finding here was that trust is generally higher among those with a higher level of education than among those with a lower level. (Eitze et al., 2021, pp. 1-2).
In order to test trust in the RKI, online surveys were conducted over several months at the beginning of 2020. The result shows a strong essential trust in the institute before the crisis, which only diminished slightly. Men clearly show more skepticism, but more women lose trust over time. People who have chronic illnesses, live in cities, have a high level of education, or are older have a very high level of trust. (Eitze et al., 2021, pp. 3, 6)

Particularly high level of trust
in the RKI among people with:
- Advanced age
- Chronic diseases
- High education
- Many residents in the town

**Strong contrasts**
Reading through the Google reviews of the RKI Seestraße or Instagram comments on the Institute's posts, for instance, one quickly notices that two opposite opinions are predominant: the supporters of the research work and the massively critical opposition to the information clash in the comment columns.

**Attacks and fake news**
One night in October 2020, there was an alleged attack with incendiary devices on the institute building in Berlin-Tempelhof. Unknown persons threw burning objects at the building, destroying a window in the process. A fire was caused, but it was extinguished without causing injuries or severe damage (Husmann, 2020). This clearly shows that hatred is directed at people who do not cause facts such as pandemics but who discover, research, and try to communicate them.
In March, a blog published over 1,000 pages of RKI protocols from 2020, in which the coronavirus classification was raised. One of the reasons for the considerable public attention was the suspicion that the conclusion was not made by researchers working there but by politicians. According to ZDF, this has even been described as a potential political explosive (Siggelkow, 2024). However, experts clarify that the decision to upgrade the Covid-19 risk status had already been made internally at the RKI but that it was still waiting for the approval of another person before it was made public. The rapid dissemination and sometimes erroneous interpretation of the protocols, especially by conspiracy theorists, led to misunderstandings. Here, it becomes clear that a thoughtful way of dealing with suspicious critics must be found as quickly as possible (Siggelkow, 2024) to gain citizens' trust in crisis situations and thus make future essential research easier.

**What confidence-building measures does the RKI take?**
As already mentioned, it is essential to make information as accessible as possible. One possibility is to communicate research results in an easily understandable way to as large a proportion of the population as possible via the media or the website. Consideration should be given to whether people with a critical attitude can be better informed, especially in social media. (Eitze et al., 2021, p. 8)

The so-called "rki_fuer_euch" Instagram account shares information on current research, institute history, health promotion, key facts, and its working methods. Looking at the institute's website gives a comprehensive overview and insight into its work and history. Categories such as research, structure, disease developments in Germany and protective measures, future relevant topics, cooperations, institute structures, and contact details can be explored in detail (see www.rki.de).

**How can architecture build trust?**

One conceptual point for the design of House 7 is, therefore, to signal transparency. Passers-by should be able to become curious and gain insight without violating hygiene measures. (see Chapter 06 Unfold Density). In addition, a rational and technical-looking architecture is intended to create a basic sense of trust. This is based, among other things, on Kohler's "theory of placelessness," (Landbrecht & Straub, 2016, p. 30) as discussed in Chapter 01.01 History.

Increased trust leads to greater public acceptance and financial benefits for research institutions. A resolution in modern research construction is: "to eliminate boundaries; to communicate the potential benefits and interests of its research programs; and to foster collaboration among its scientists." (Kaji-O´Grady & Smith, 2019, Chapters 1; A Common Rhetoric) Prevention of corruption is also actively enforced (Robert Koch-Institut, 2018).

***"Replacing ignorance and fear of science with desire and understanding"***

– Kaji-O´Grady & Smith, 2019, Chapters 1; A Common Rhetoric

Entrance areas and public spaces within a laboratory building have a particular function. They should arouse curiosity and provide information about current research. They are referred to as "scientific displays" (Kaji-O'Grady & Smith, 2019, Chapters 1; A Common Rhetoric), " (Kaji-O'Grady & Smith, 2019, Chapters 1; A Common Rhetoric) which are also implemented in the concept (see Chapter 06 Unfold Density).

Transparency is enforced architecturally through the use of glass. It should be noted that glass is not the same as transparency. The building material will never be completely transparent due to its materiality, dirt or imprints, and reflection (Kaji-O'Grady & Smith, 2019, Chapter 4).




**Figure 02.07 |** Opening of House 6 | Dr. Angela Merkel (middle) and Prof. Dr. Henn (front left) | © Henn GmbH

03

# References

# TIMELINE

Sorted by year of opening

······· New decade


**Helio Lab SC Johnson | 1950**


**Salk Institute | 1960**


**Richards Medical Res. | 1964**


**Kline Biology Tower | 1965**


**Max-Planck-Institute | 1972**


**Burroughs-Wellcome | 1972**


**Mäusebunker | 1982**


**BASE | 1992**

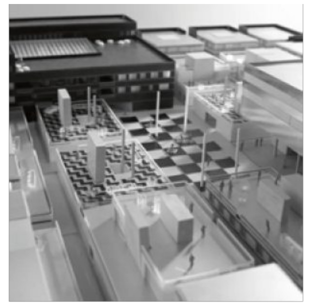

**Lise-Meitner-Haus | 2002**


**James H. Clark Center | 2003**


**Terrence Donnelly Centre | 2005**


**MIT Media Lab | 2009**


**Fabrikstraße 22 | 2010**


**CentraleSupélec | 2017**


**Maersk Tower | 2017**


**GUZ | 2020**


**Biocentre Schällemätteli| 2021**


**BSS Reseaerch Building | 2023**

**Why have these references been selected?**

The term “laboratory” encompasses a wide variety of building types with diverse dimensions, uses, structures, and design concepts.

To gain a basic understanding of the great variety and how they function, 18 reference projects from the past 73 years are examined in the following. The focus is on the distribution of uses and the spatial connections within their standard floors. The selection criteria included floor plan structure, country of origin, year of completion, use, and innovative design approaches, aiming to capture a broad spectrum of insights.

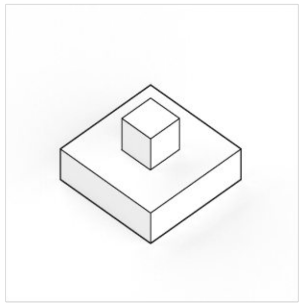
The projects are grouped according to their respective typology (see Chapter 01.04 Catalogue). This results in five categories: linear, core, and comb, which are already known from previous explanations. Due to the large number of core typologies, these were subdivided into core, core-patio, and mixed forms were considered separately.

Noticeably, the location distribution in the reference search relates to the northern hemisphere.

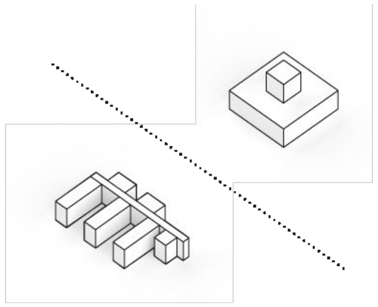
**Figure 03.01 |** Overview References | Photographs

# TYPOLOGIES

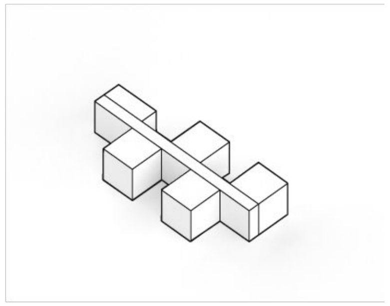
see Chapter 01.03 Catalogue | Typologies



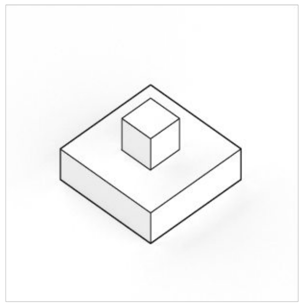
**01 |** Helio Lab SC Johnson



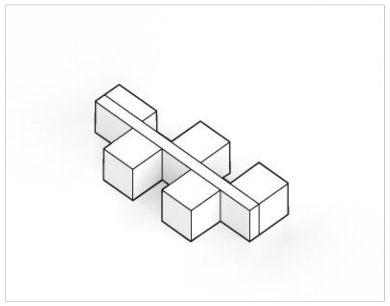
**02 |** Salk Institute



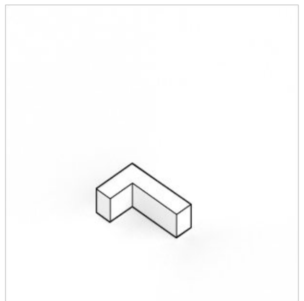
**03 |** Richards Medical Research



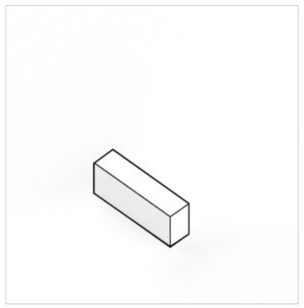
**04 |** Kline Biology Tower



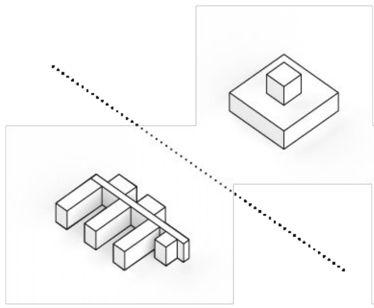
**05 |** Max-Planck-Institute



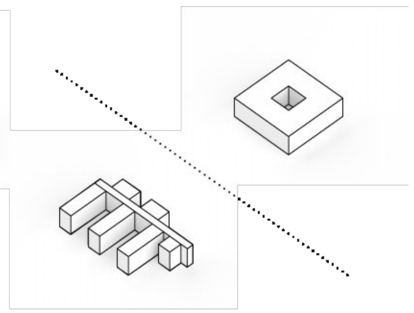
**06 |** Burroughs-Wellcome



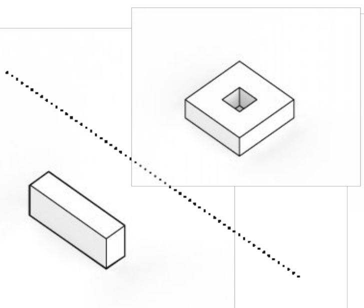
**07 |** Mäusebunker



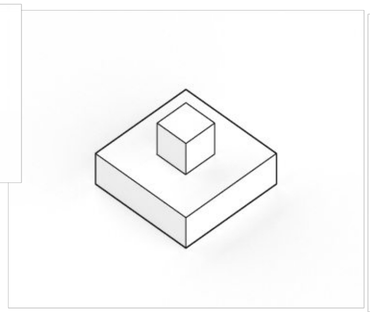
**08 |** BASE



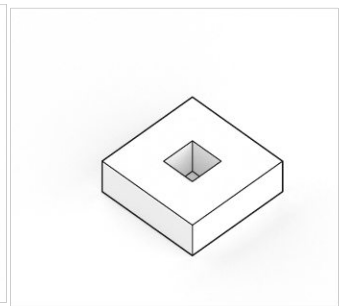
**09 |** Lise-Meitner-Haus



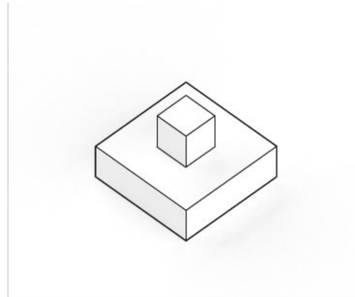
**10 |** James H. Clark Center



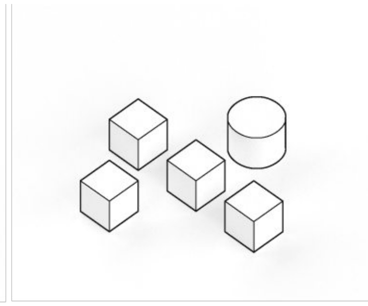
**11 |** Terrence Donnelly Centre



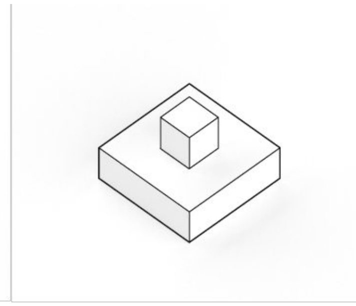
**12 |** MIT Media Lab



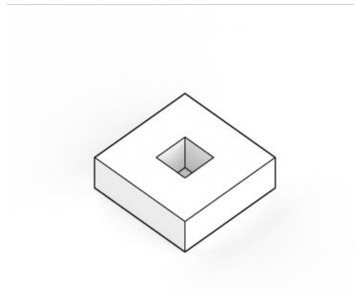
**13** | Fabrikstraße 22



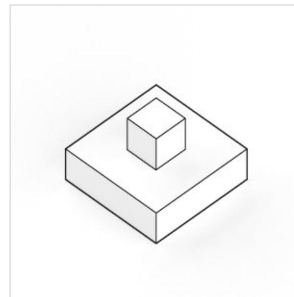
**14 |** CentraleSupélec



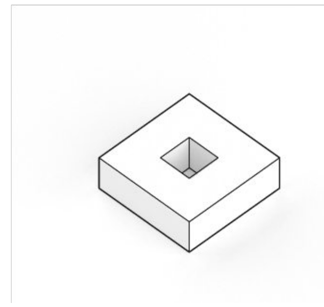
**15 |** Maersk Tower



**16 |** GUZ



**17 |** Biocentre Schällemätteli



**18 |** BSS Reseaerch Building

**Figure 03.02 |** Overview Reference Typologies | Axonometry

# LOCATION


| Project | City | Country |
|---|---|---|
| **01** \| Helio Lab | Racine, | USA |
| **02** \| Salk Institute | La Jolla, California | USA |
| **03** \| Richards Medical Research | Philadelphia, Pennsylvania | USA |
| **04** \| Kline Biology Tower | New Haven, Connecticut | USA |
| **05** \| Max-Planck-Institute | Göttingen | Germany |
| **06** \| Burroughs-Wellcome | Durham, North Carolina | USA |
| **07** \| Mäusebunker | Berlin | Germany |
| **08** \| BASE | Nagoya | Japan |
| **09** \| Lise-Meitner-Haus | Berlin | Germany |

| Project | City | Country |
|---|---|---|
| **10** \| James H. Clark Center | Stanford, California | USA |
| **11** \| Terrence Donnelly Centre | Toronto, Ontario | Canada |
| **12** \| MIT Media Lab | Cambridge, Massachusetts | USA |
| **13** \| Fabrikstraße 22 | Basel | Switzerland |
| **14** \| CentraleSupélec | Paris | France |
| **15** \| Maersk Tower | Copenhagen | Denmark |
| **16** \| GUZ | Tübingen | Germany |
| **17** \| Biocentre Schällemätteli | Basel | Switzerland |
| **18** \| BSS Research Building | Basel | Switzerland |

**Figure 03.03 |** Worldmap

# LINEAR

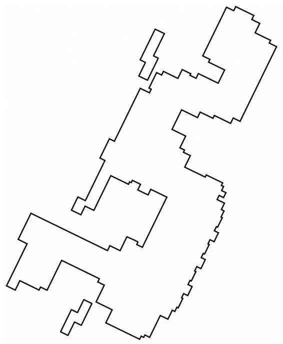
The following reference projects exemplify a linear layout, emphasizing circulation as a key organizational element. Both buildings have striking façades and unique internal floor plan organizations.
These two projects demonstrate how diverse design strategies can be effectively employed in the planning and design of laboratory buildings. In addition, both buildings have been used as part of films due to their appearance and have also been tried to be protected from demolition plans by enthusiastic initiatives.




**Figure 03.04 |** Overview Linear | Axonometry

# BUW

## BURROUGHS-WELLCOME HQ



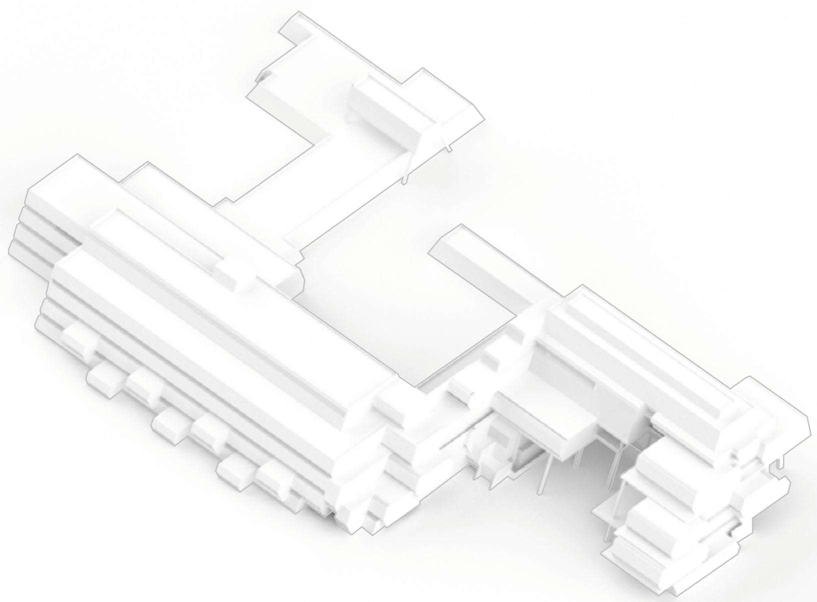


Figure 03.05 | Axonometry

**Context**
The American HQ of the global pharmaceutical company Burroughs Wellcome was built on the 66-hectare Research Triangle Park in North Carolina. The unusually S-shaped building tilts 22.5 degrees to fit the site. After decades of use, resale, and renaming, permission was granted in 2014 for its demolition, which was attempted to be prevented by a petition from enthusiasts. (Paul Rudolph Institute for Modern Architecture, n.d.)

**Use**
Three main spaces are accommodated in an area of more than 29,000 m² for around 400 users. These are divided into laboratory use, administration, and support areas. The building has a total of 140 labs, which, together with the associated offices and the animal testing, surround the so-called "service yard". The entrance courtyard is surrounded by a foyer, library, dining area, lecture hall, and administration (Paul Rudolph Institute for Modern Architecture, n.d.).

**Innovation**
The main purposes were flexibility and communication, with inclined outer edges designed for extension in one direction. Over time, parts of the building with different uses were added, and its impressive atmosphere attracted fiction filming (Paul Rudolph Institute for Modern Architecture, n.d.). Paul Rudolph stated, "The functions of the building are celebrated architecturally" (Paul Rudolph Institute for Modern Architecture, n.d.).

**Material**
The façade and fixed sections were finished on site with limestone aggregate, while flexible parts were built with drywall (Paul Rudolph Institute for Modern Architecture, n.d.).

| | |
|---|---|
| **Architect** | Paul Rudolph |
| **Client** | Burrough Wellcome & Company, Inc. |
| **Location** | Durham, North Carolina USA |
| **Type** | Pharmaceutical |
| **Opening** | 1972 |
| **Area** | ≈29,000 m² |

(Paul Rudolph Institute for Modern Architecture, n.d.)

Figure 03.06 | Aerial View | Scale 1:10,000

Figure 03.07 | Photograph | © Columbia Univ., Avery Architect. (...), Joseph W. M. Photog. Coll.

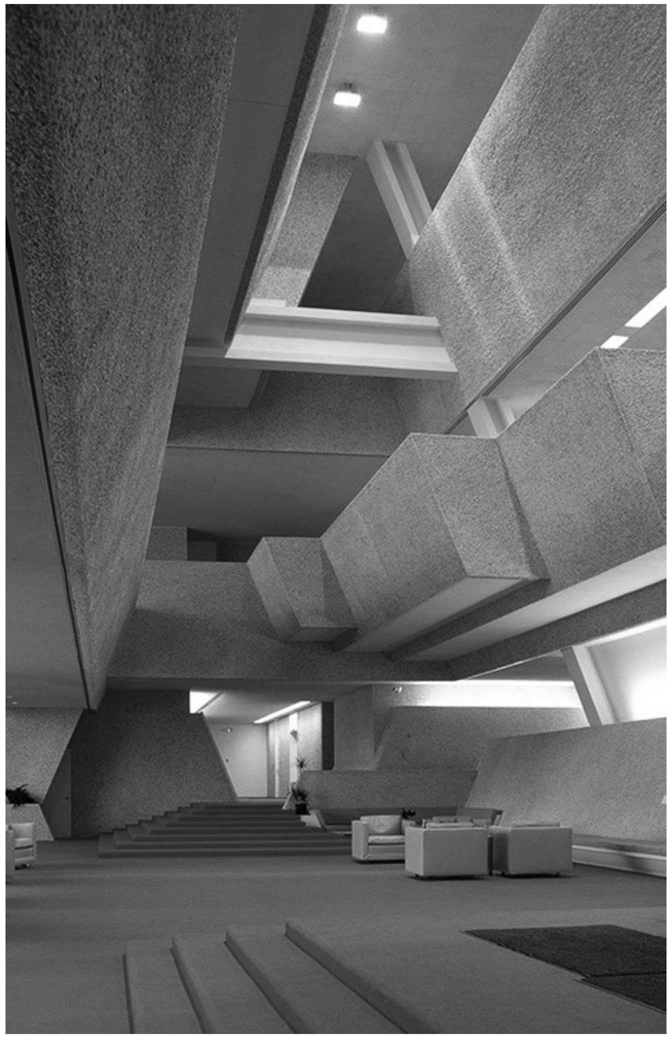


**Figure 03.08 |** Foyer | Photograph | © Massachusetts Institute of Technology, photograph by G. E. Kidder Smith

### Floor plan organization

Towards the top, each story becomes smaller in terms of its footprint. This leads to numerous visual axes in the three-story foyer (see Figure 03.08 ↑). The area shown serves as the social center, supported by 75 percent of nearby offices. Despite its frequent use, the generous space lowers the corridor area. It is interesting to acknowledge the design of fixed parts, such as infrastructure and columns, in contrast to flexible areas (Paul Rudolph Institute for Modern Architecture, n.d.).

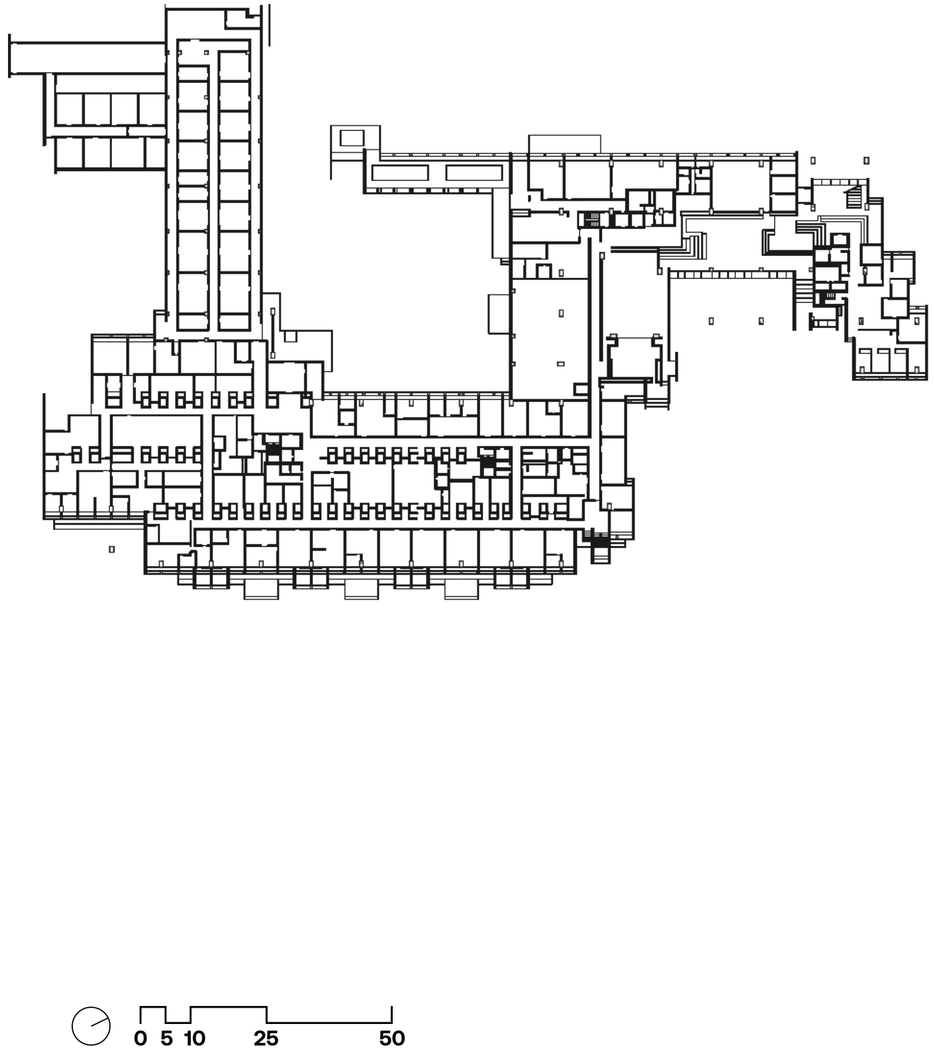



**Figure 03.09 |** Ground Floor | Floor plan | Scale 1:1,500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

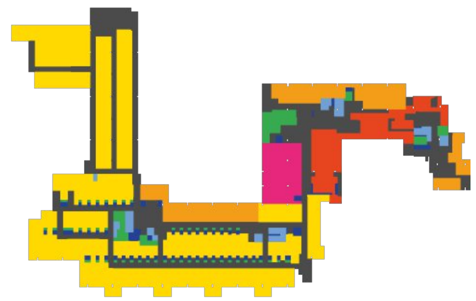
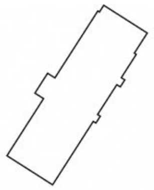


**Figure 03.10 |** Ground Floor | Space analysis | Scale 1:3,000

# MBB
MÄUSEBUNKER



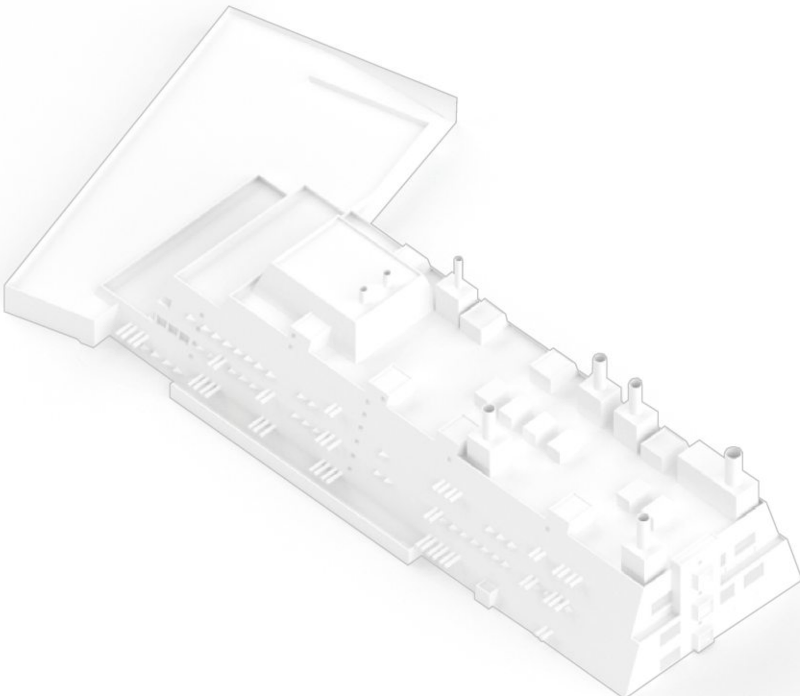


**Figure 03.11 |** Axonometry

**Context**
The original Central Animal Laboratories (ZTL) of the Faculty of Medicine with the Chair of Laboratory Animal Science is a brutalist masterpiece. It was built as an extension for various research areas of health sciences of the Steglitz Clinic (Wiese & Janik GbR, 2020, pp. 7–11). Later, the building was operated by the Charité for the field of experimental medicine. After demolition plans were drawn up for 2020, successful protests led to a dialogue with international experts for future use. (Landesdenkmalamt Berlin, n.d.).

**Use**
The nine-story building has three underground levels. There is a remarkable horizontal division between alternating technical and usage spaces. Sculpturally highlighted technical facilities are placed on top. The ground floor contains, e.g., organizational and storage areas. (Wiese & Janik GbR, 2020, pp. 3, 23, 42, 43).

**Innovation**
At its time of construction, the building featured an unprecedented level of technological innovation. Offices and teaching areas are located within the Mäusebunker as well as lab areas (Rauhut & Lassnig, 2023, p. 8). The building's industrial aesthetic reflects its complex infrastructure, with functional spaces and color-coded lab hygiene levels. (Wiese & Janik GbR, 2020, p. 33).

**Material**
The building predominantly utilizes reinforced concrete, a hallmark of brutalist design. External walls taper at an angle of 18.5°. Ninety-four ventilation pipes protrude from the technical levels to prevent excessive heat build-up on the façade. The usage areas have pointed windows (Wiese & Janik GbR, 2020, pp. 3, 23, 40).

| | |
|---|---|
| **Architect** | Gerd Hänska, Magdalena Hänska |
| **Client** | Senator für Bau- und Wohnungswesen für Freie Universität |
| **Location** | Berlin, Germany |
| **Type** | Animallaboratory |
| **Opening** | 1982 |
| **Area** | 8,500 m² (use area) |

(Wiese & Janik GbR, 2020)

**Figure 03.12 |** Aerial View | Scale 1:10,000

**Figure 03.13 |** Photograph | © Kay Fingerle

**Figure 03.14 |** Photograph | © Kay Fingerle

**Floor plan organization**

There are terraces in the front area. A tunnel connects the building to the neighboring Institute for Hygiene and Microbiology. There are forty-six axes in five sections with a 2.60 m grid. The interior also has a modular structure. The technical floors are each responsible for the utility floor below, creating independent units. The design includes several airlock systems to meet diverse hygiene requirements, ensuring efficient and controlled access (Wiese & Janik GbR, 2020, pp. 23, 37, 42–46).

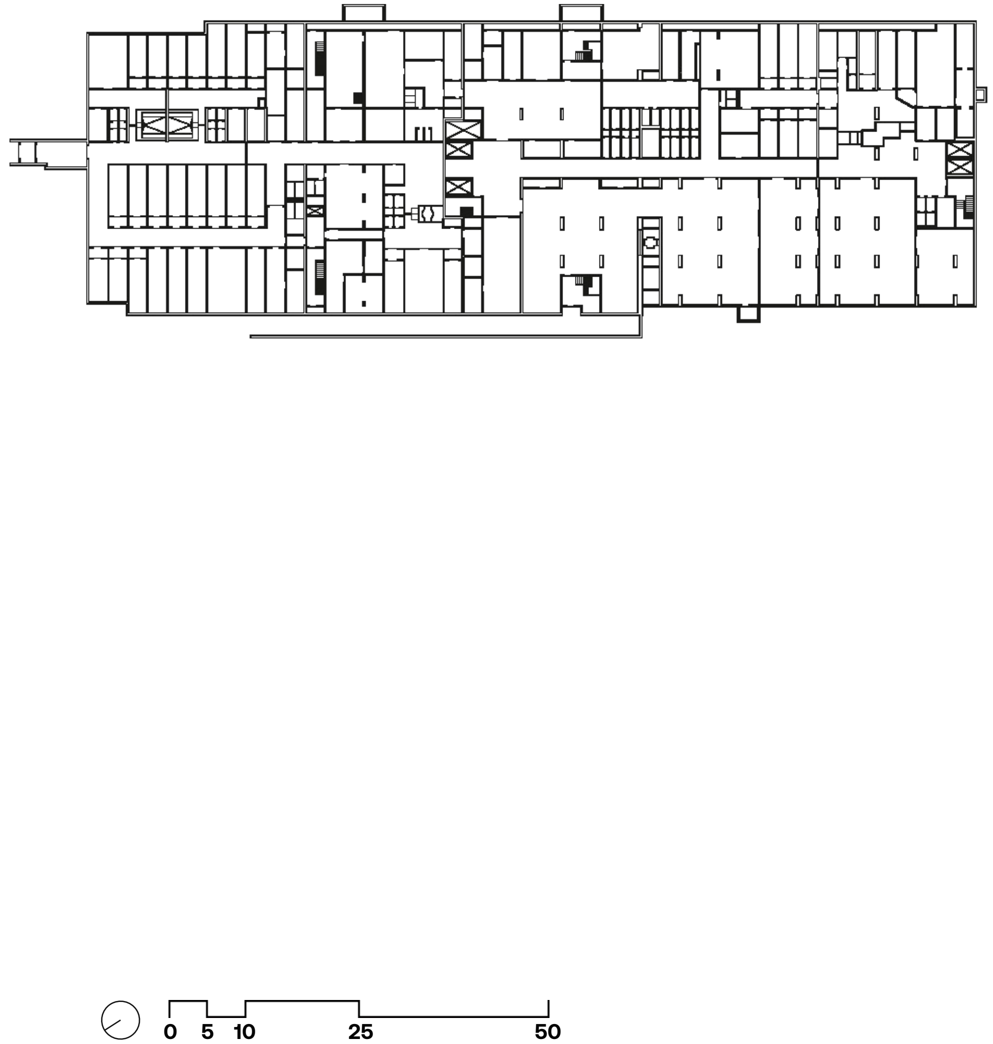



**Figure 03.15 |** Basement | Level II | Floor plan | Scale 1:1,000


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

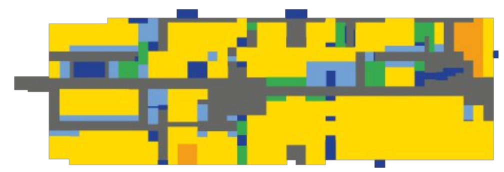


**Figure 03.16 |** Basement | Level II | Space analysis | Scale 1:2,000

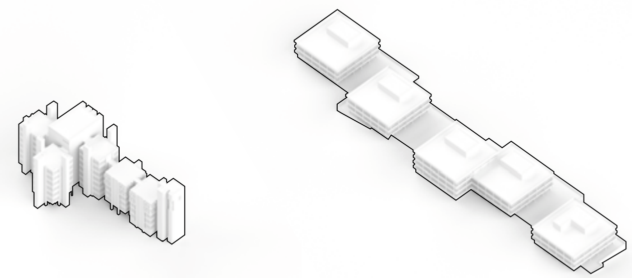
# COMB

With the comb arrangement, it is essential to emphasize that subdivisions into different usage areas are easy to implement (Grömling, 2005, p. 47).
These two reference projects are pioneering buildings in their respective fields. The Alfred Newton Richards Medical Research Laboratories can be understood as a horizontal comb structure, while the Max Planck Institute is a vertical comb structure. Both projects demonstrate a clear conceptual division of spaces tailored to their specific functions, emphasizing the adaptability of this typology.









**Alfred Newton Richards Medical Research Laboratories**
Louis I. Kahn
Philadelphia, USA
1964

**Max-Planck-Institute**
HENN GmbH
Göttingen, Germany
1972

**Figure 03.17 |** Overview Comb | Axonometry

# RMR

## RICHARDS MEDICAL RESEARCH LABORATORIES

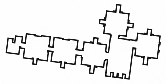


**Figure 03.18 |** Axonometry

**Context**

The Alfred Newton Richards Medical Research Laboratories by Louis I. Kahn is the best-known building on the campus of the University of Pennsylvania. Its four towers directly adjoin the three towers of the David Goddard Building (see the three towers on the right in the axonometry ←). Together, they are known as a National Landmark. It is considered one of Louis I. Kahn's flagship projects (ArchEyes, 2022).

**Use**

Three laboratory towers are arranged around a supply core in the Richards section. It is important to note that the uses were clearly divided into "served and servant spaces" (ArchEyes, 2022), the laboratory areas on the one hand and technical areas and vertical access in the form of external shafts and two service parts on the other (ArchEyes, 2022). This clear separation of spaces laid the foundation for innovative design solutions.

**Innovation**

The linear arrangement of the connected towers on each floor allows a very flexible solution for organizing rooms and furniture (Nickl et al., 2022a, pp. 76–81). In addition, the 14 x 14 m tower stories are column-free. The technical area and vertical access happen through shafts, and eight columns surround the laboratory area along the façade. It was unusual to present the construction structure so clearly to the outside at the time, as the ground floor reveals (ArchEyes, 2022).

**Material**

The combination of red bricks and prefabricated concrete beams was unusual for modern architecture then. The spaces between the façades were filled with glass (ArchEyes, 2022).

| | |
|---|---|
| **Architect** | Louis I. Kahn |
| **Client** | University of Pennsylvania |
| **Location** | Philadelphia, Pennsylvania, USA |
| **Type** | Medical |
| **Opening** | 1962 |
| **Area** | 9,692 m² |

(University of Pennsylvania Facilities & Real Estate Services, n.d.)

**Figure 03.19 |** Aerial View | Scale 1:10,000

**Figure 03.20 |** Photograph | © Xavier de Jaureguiberry

**Figure 03.21 |** Entrance | Photograph | © Xavier de Jaureguiberry

**Floor plan organization**

The internal layout of the towers is highly structured, with technology and access areas docked externally, resulting in flexible, open interiors. The open ground floor serves as an entrance. Cables are easily routed through the recesses in the beams. There are a further four shafts for ventilation on the service tower (ArchEyes, 2022). The horizontal, connecting infrastructure runs linearly through the towers. The usable areas dock onto the development like a comb.

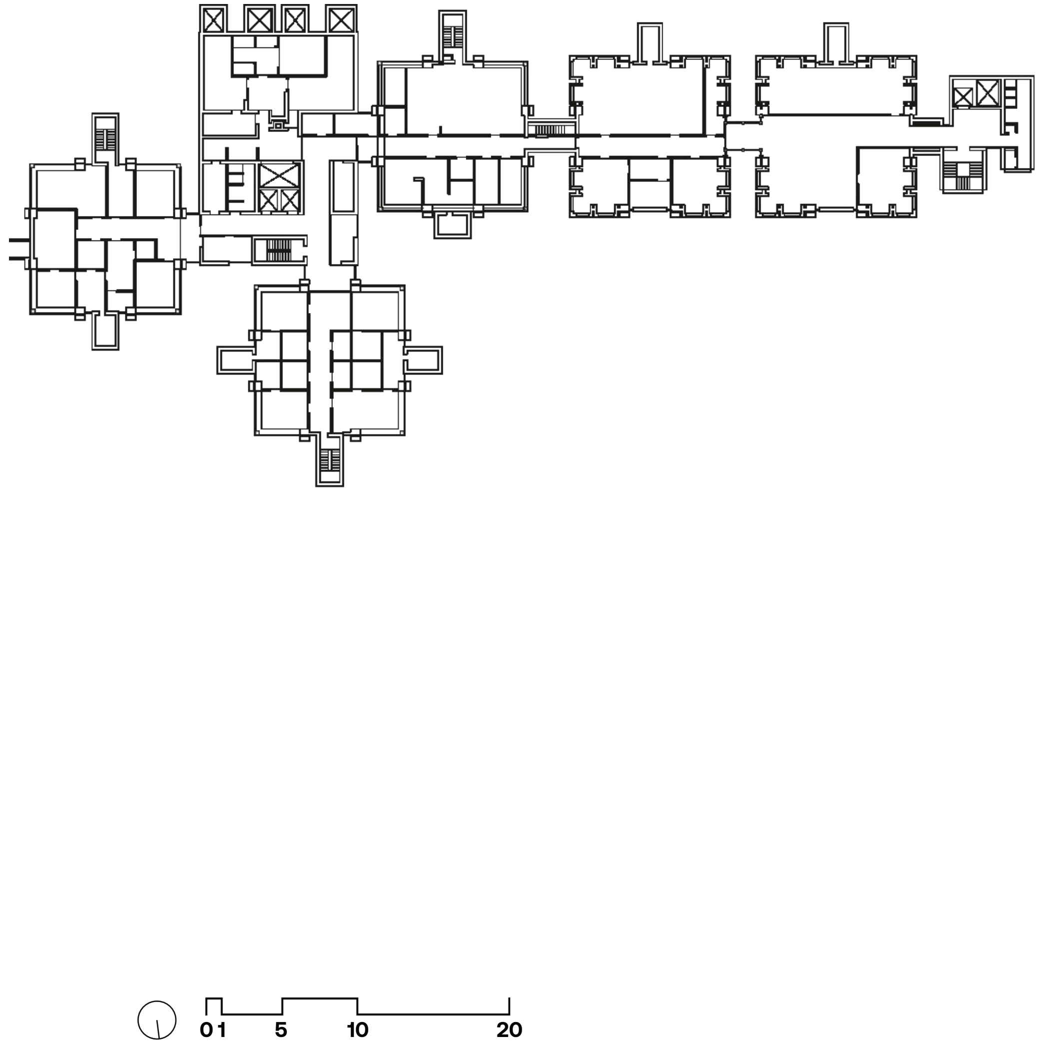
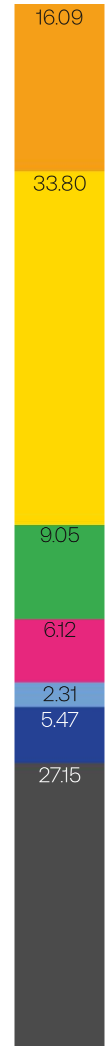



**Figure 03.22 |** Standard Floor | Floor plan | Scale 1:500




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

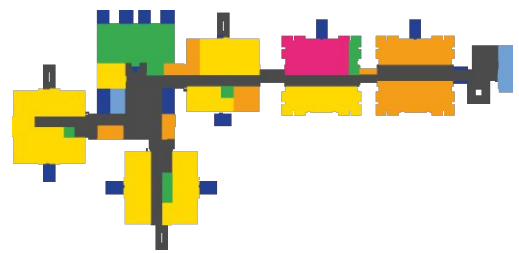


**Figure 03.23 |** Standard Floor | Space analysis | Scale 1:1,500

# MPI

## MAX-PLANCK-INSTITUTE

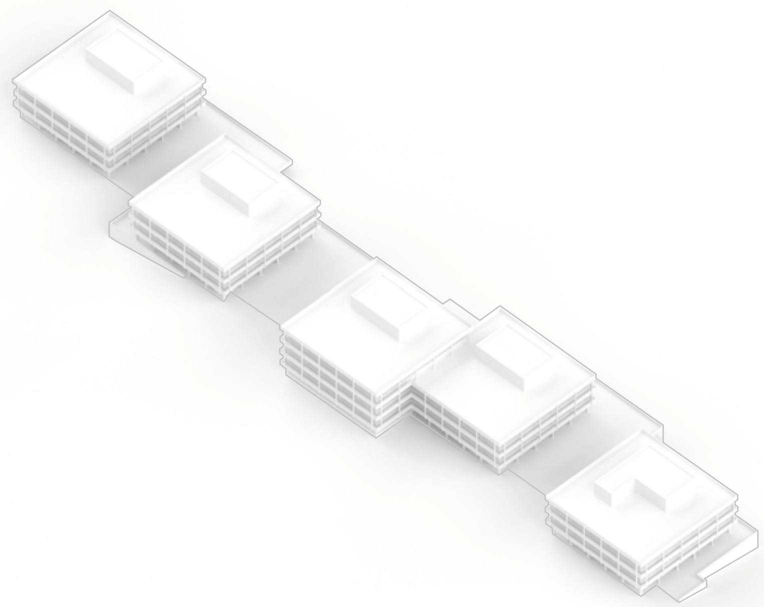


Figure 03.24 | Axonometry

**Context**

The Max-Planck-Institute (MPI) is one of the most renowned research centers. The individual institutes are part of the Max-Planck-Gesellschaft, which conducts interdisciplinary research primarily in life or natural sciences, as well as humanities (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V., 2024a). This reference is the Institute for Biophysical Chemistry in Göttingen. In 2022, the Institute for Multidisciplinary Natural Sciences was formed on this campus from the previous institute and the Institute for Experimental Medicine (Hendel, n.d.).

**Use**

The building was, at times, unique to the MPI, combining three different research areas: basic physical, chemical, and biological research. Over the years, further research areas were added. By 2019, 700 employees worked in 12 departments and independent groups. The building contains labs and workshops, while an adjoining edifice includes teaching rooms, a library, a cafeteria, administrative offices, and accommodations (Hendel, n.d.).

**Innovation**

One main conceptual goal of the collaboration between Walter Henn and the then-director Manfred Eigen was to provide researchers with individual configuration options for the labs (Henn GmbH, 2024). Today, there is also a focus on transparency toward the public (Hendel, n.d.).

**Material**

The building has a strong horizontality, which is reinforced by the surrounding windows and balconies. The construction was made of in-situ concrete, reinforced concrete, precast elements, and light metal profiles on the façade (Henn GmbH, 2024).

| | |
|---|---|
| **Architect** | HENN GmbH |
| **Client** | Max-Planck-Gesellschaft |
| **Location** | Göttingen, Germany |
| **Type** | Biophysical Chemistry |
| **Opening** | 1972 |
| **Area** | – |

(Henn GmbH, 2024)

Figure 03.25 | Aerial View | Scale 1:10,000

Figure 03.26 | Photograph | © Insitut Heidersberger

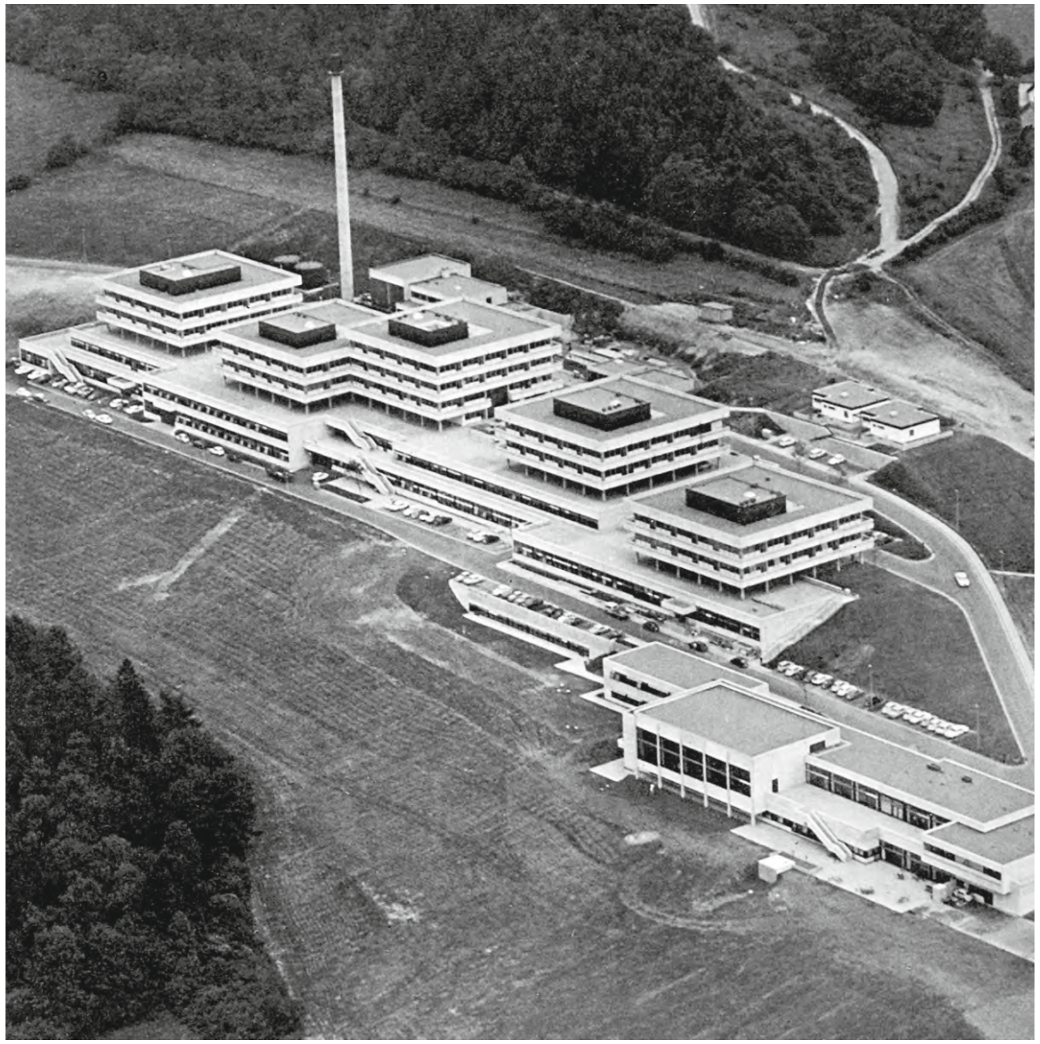


**Figure 03.27 |** Photograph | © Insitut Heidersberger

**Floor plan organization**

Five lab towers are situated on a terraced base connected to the workshops below by stairs and elevators. The building's design follows the slope, with a clear and rational arrangement of spaces (Henn GmbH, 2024). High demands are placed on special areas for sensitive measuring equipment, which will be located in a future new building, among others (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V., 2024b). Its scheme is reminiscent of a vertical comb structure.

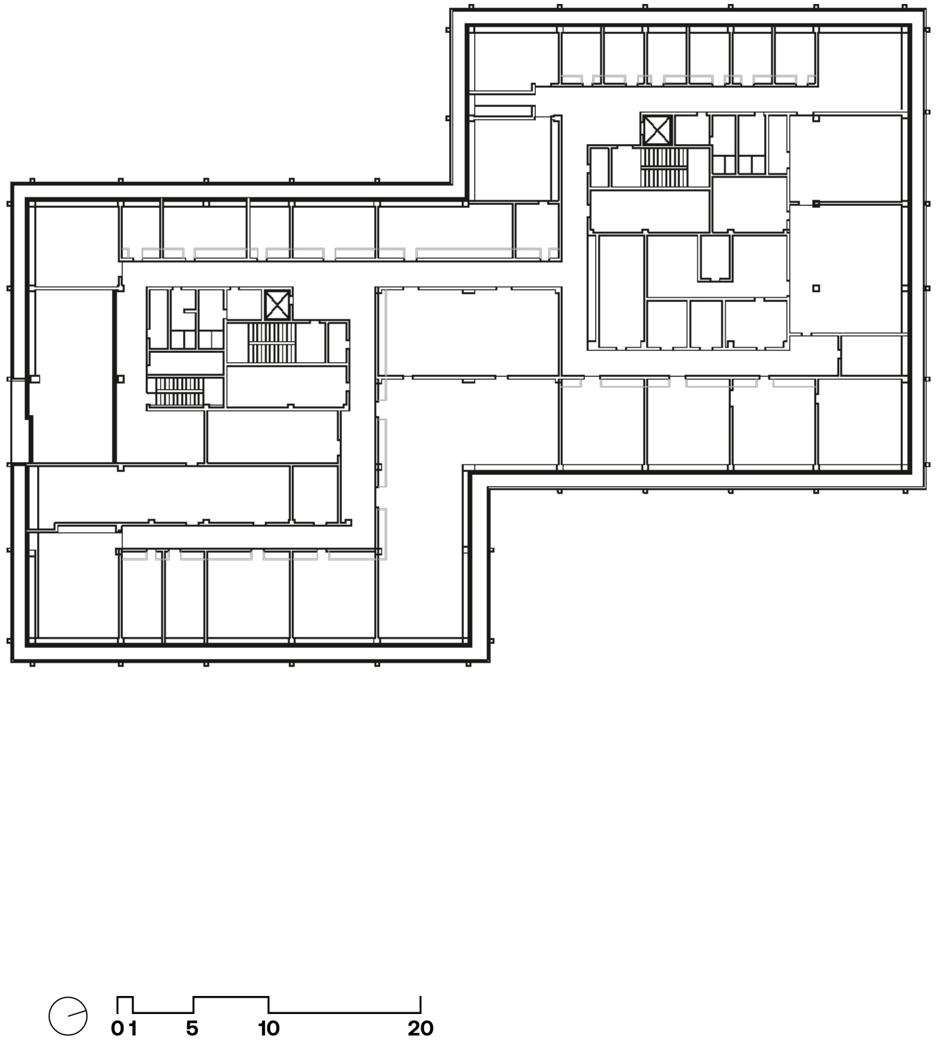



**Figure 03.28 |** Standard Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

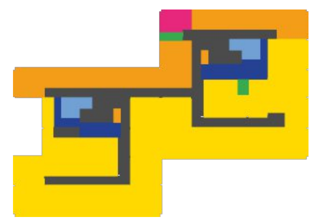


**Figure 03.29 |** Standard Floor | Space analysis | Scale 1:1,500

# CORE

The core arrangement is characterized by providing an optimal basis for flexible large-scale structures (Jocher et al., 2012, p. 352).
This typology has frequently appeared throughout the history of laboratory architecture. The arrangement has proven particularly suitable for towers and high-rise buildings, with notable examples demonstrating its adaptability and efficiency. Enormous structures, such as LAB City | CentraleSupélec, are a combination of several core arrangements. Despite the compact design of the service functions, such as circulation and infrastructure, the variety of possibilities in the floor plan organization is not restricted but, on the contrary, enhanced. The following reference projects do not have any conceptually important atriums. Corresponding examples can be found in the following list - Core | Patio.



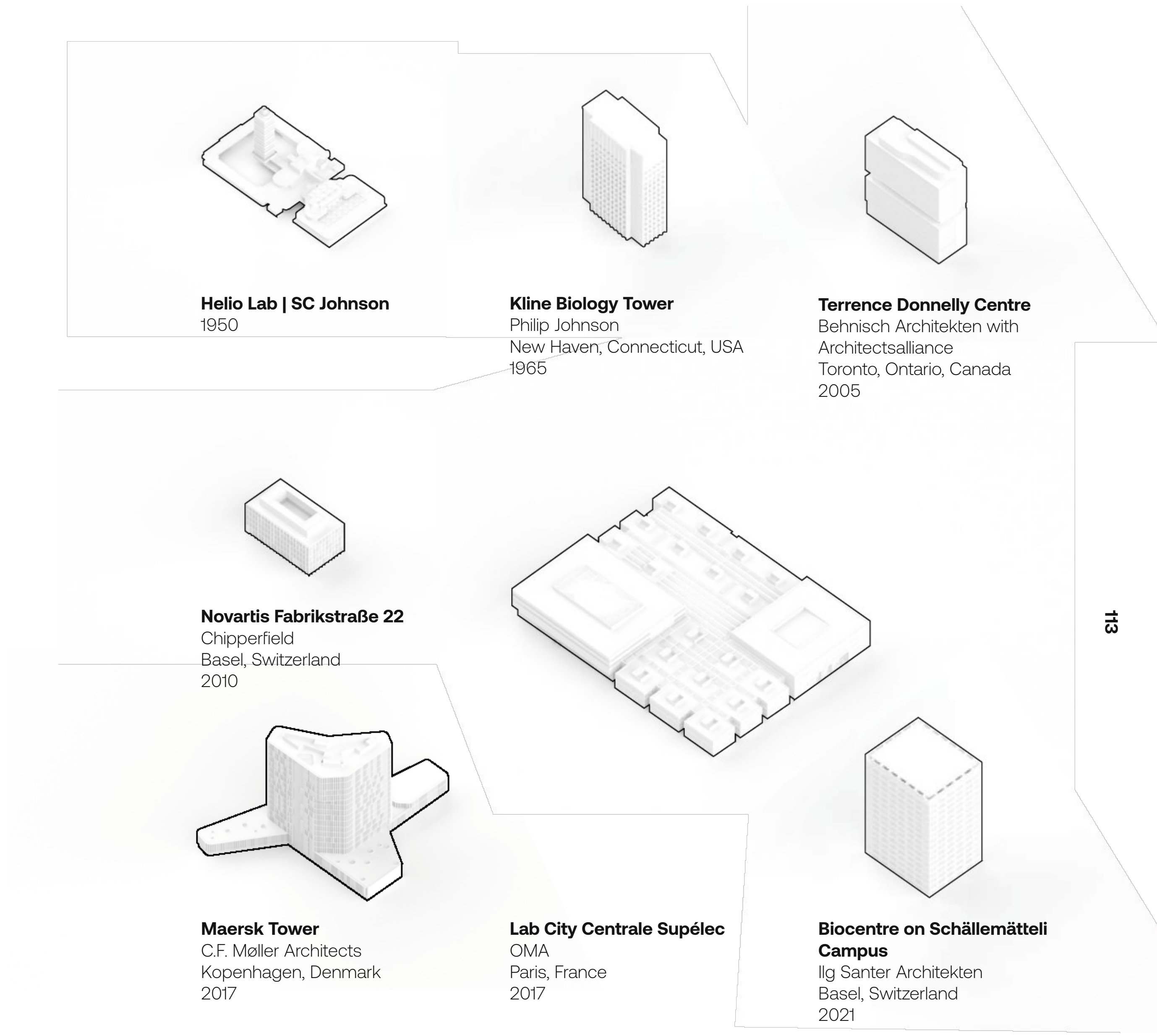
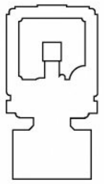



**Figure 03.30 |** Overview Core

# SCJ

HELIO LAB I SC JOHNSON



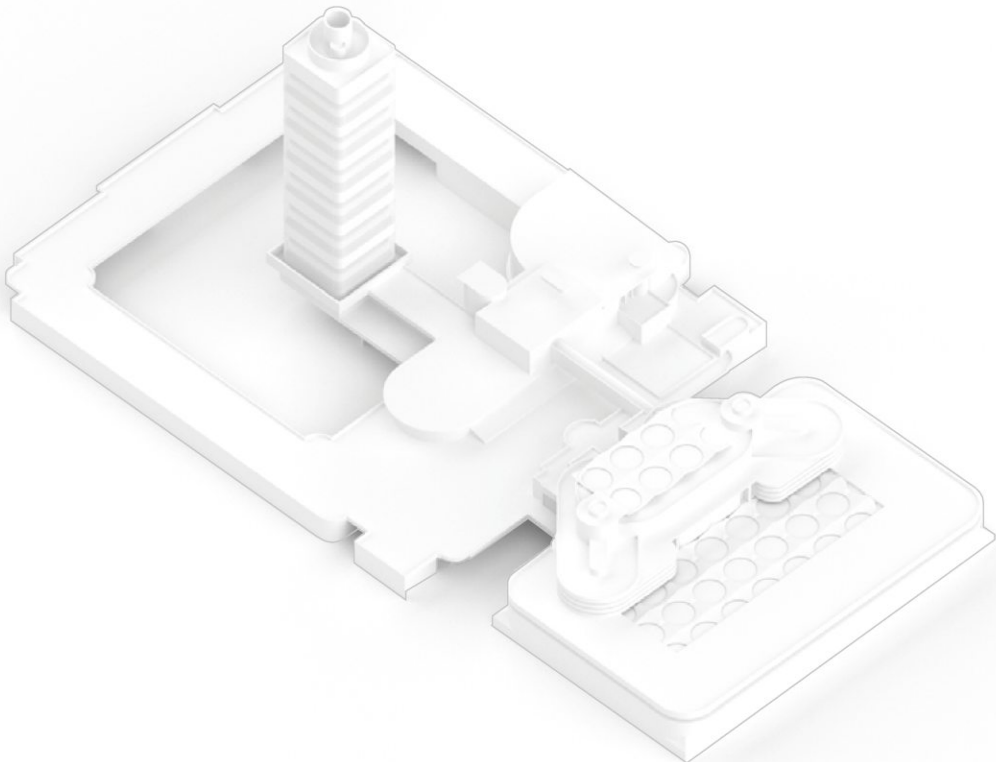


**Figure 03.31 |** Axonometry

**Context**

After designing the administration building for SC Johnson, Frank Lloyd Wright was commissioned by the managing director to create additional lab space. In their collaboration, they developed an almost floating 50 m high tower, which is still exceptional in its kind today (S.C. Johnson & Son Inc., n.d.). The project far exceeded the planned costs. Wright's vision was that the "helio-lab" (S.C. Johnson & Son Inc., n.d.), as he called it, would give rise to ideas in the uppermost area and sink down to the flat administrative building and production area (Sisson, 2015).

**Use**

Although the building has not been used as a lab since the 1980s due to stricter demands and regulations (Nickl et al., 2022a, pp. 74–76), it now serves as an attraction and exhibition space (S.C. Johnson & Son Inc., n.d.). SC Johnson is known for hygiene products, cleaning agents, and skin care products (SC Johnson Professional USA, Inc., n.d.).

**Innovation**

The tower has a strong symbolic effect (Nickl et al., 2022a, pp. 74–76). It was considered innovative and unique in its day, and to some extent, this is still true today. One employee noted excellent space distribution, technical infrastructure, work, and storage space (S.C. Johnson & Son Inc., n.d.).

**Material**

The façade consists of 7,000 Pyrex tubes, which were also used in the administration section. These create a unique play of light at night, though they block the view from the inside (Sisson, 2015). Until a curtain system was installed, users were dazzled by the light without sunglasses (Nickl et al., 2022a, pp. 74–76).

| | |
|---|---|
| **Architect** | Frank L. Wright |
| **Client** | SC Johnson |
| **Location** | Racine, Wisconsin, USA |
| **Type** | R&D |
| **Opening** | 1950 |
| **Area** | – |

(Sisson, 2015)

**Figure 03.32 |** Aerial View | Scale 1:10,000

**Figure 03.33 |** Photograph | © SC Johnson

**Figure 03.34 |** Photograph | © SC Johnson

**Floor plan organization**

The structural concept is reminiscent of a tree with its roots reaching deep into the earth. The trunk is the core, which contains sanitary facilities, circulation, and infrastructure. Two stories each are visually framed by the horizontal façade. This corresponds to a square laboratory level with a mezzanine level (Nickl et al., 2022a, pp. 74–76). Despite being a small section, the area analysis reveals an efficient division that can be scaled for further consideration.

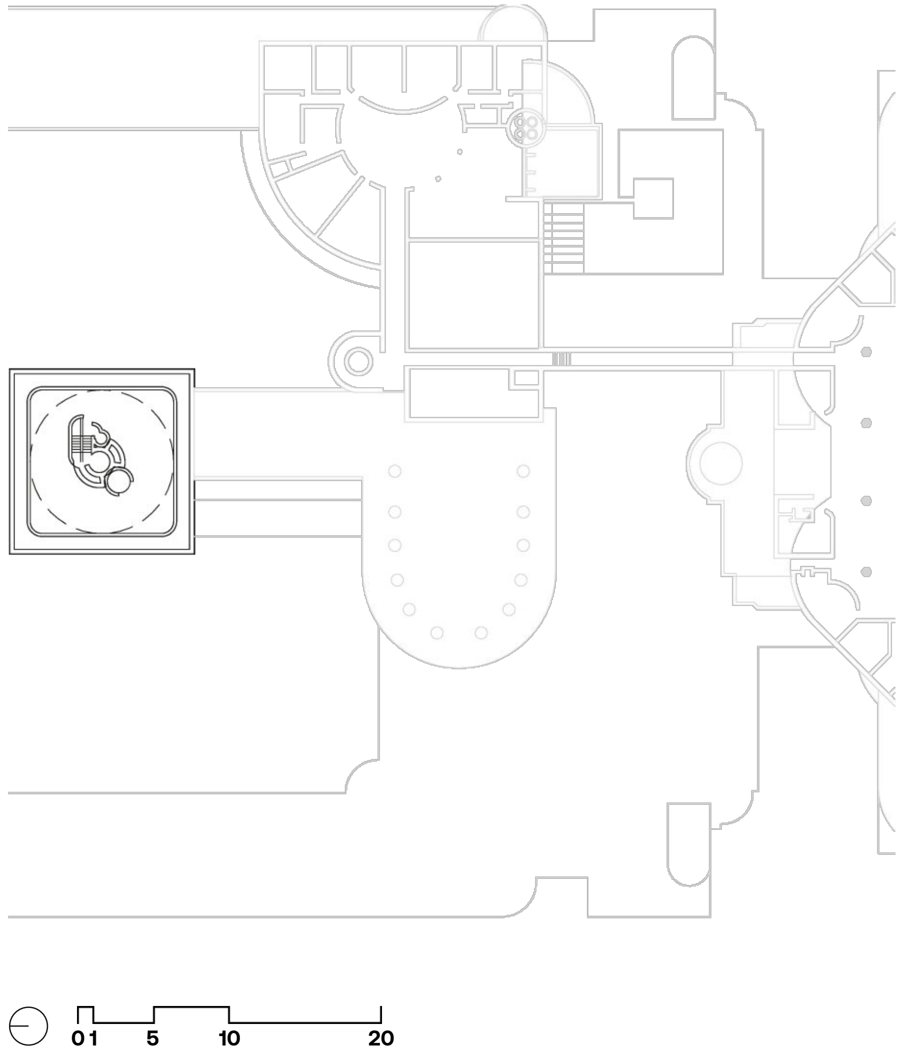



**Figure 03.35 |** Third Floor | Floor plan | Scale 1:500

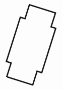

Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

**Figure 03.36 |** Third Floor | Space Analysis | Scale 1:500

# KBT

## KLINE BIOLOGY TOWER



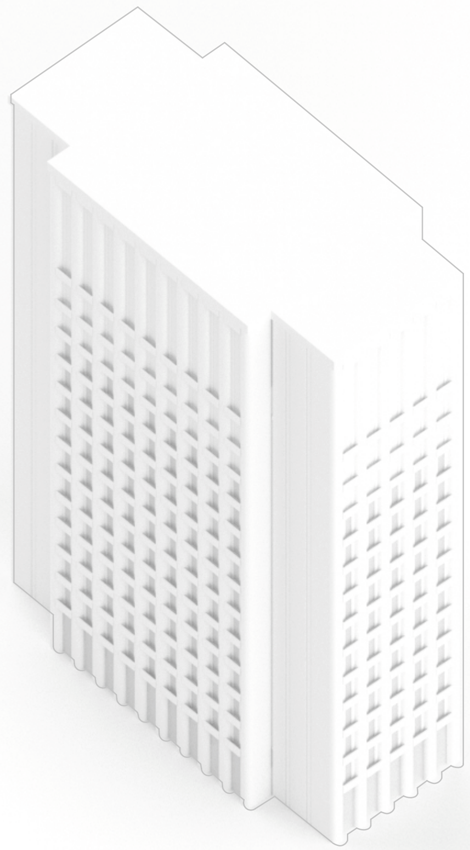


**Figure 03.37 |** Axonometry

### Context

The Kline Biology Tower was designed as a visual high point on Yale University's campus hill. The classicist and functionalist character of the tower is (Zonda Media, 2013) oriented towards the typical Gothic buildings on the campus and attracts visitors due to its predestined location (Fellman, 1993).
After years of use, the department of molecular, cellular, and developmental biology was relocated to another building. The tower was then renovated in recent years and reopened in 2023 with a new use and restructuring (Seth & Gorelick, 2022).

### Use

The tower initially housed, among others, classrooms, laboratories, offices, a cafeteria, and a library (Ryan, 1981). It shows that laboratory structures can also be repurposed. The new focus in the 16-story tower is on communication, vertical links, and new teaching rooms (Locklear, 2023). Critics argued that the increased number of offices would undersize them and hinder communication in vertically oriented buildings (Seth & Gorelick, 2022).

### Innovation

The tower's prominence on the hill and its height are key elements of its attraction (Fellman, 1993). Another topic is that short connections between different faculties and offices were desired for the conversion (Seth & Gorelick, 2022). In terms of materials, the design reflects both its functional intent and its integration with the surrounding architecture.

### Materials

The façade is based on the surrounding neo-Gothic buildings (Zonda Media, 2013). It consists of reinforced concrete, brick, and brownstone (Ryan, 1981).

| | |
|---|---|
| **Architect** | Philip Johnson & Associates |
| **Client** | Yale University |
| **Location** | New Haven, Connecticut, USA |
| **Type** | Education \| Biology |
| **Opening** | 1965 |
| **Area** | ≈17,200 m² |

(Seth & Gorelick, 2022)
(Zonda Media, 2013)

**Figure 03.38 |** Aerial View | Scale 1:10,000

**Figure 03.39 |** Photograph | © Yale University

**Figure 03.40 |** Photograph | © L. Flippo

**Floor plan organization**

The floor plan follows a strong symmetrical axis. Round columns on the first floor become semi-circular columns on the upper floors. There is a technical area in the attic, which is used to supply several neighboring buildings (Zonda Media, 2013).
After the renovation, two levels were created on the top floor as a communication zone (Locklear, 2023). On the standard floors is a ring-shaped circulation with workrooms mainly facing the façade. Figure 03.31 shows an interior view of the converted building.



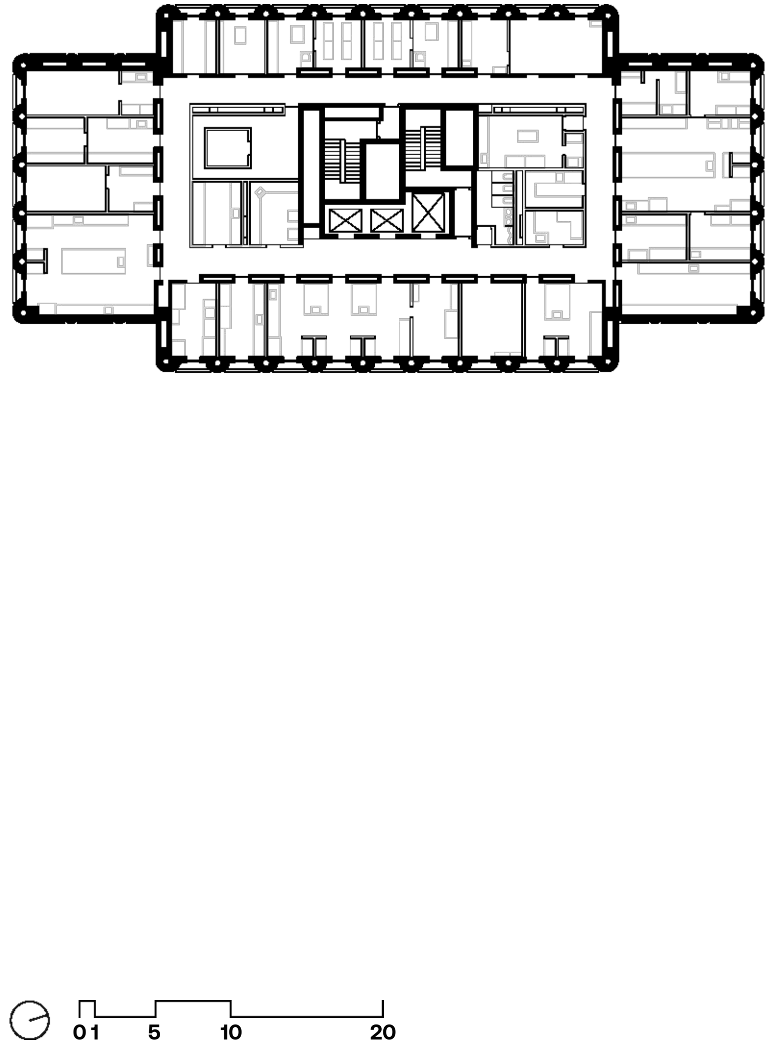



**Figure 03.41 |** Standard Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

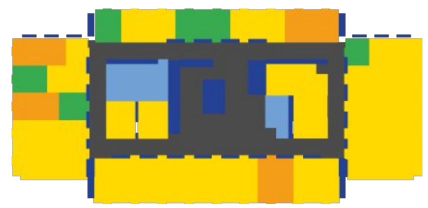


**Figure 03.42 |** Standard floor | Space analysis | Scale 1:1,000

# TDC

## TERRENCE DONNELLY CENTRE

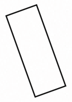


Figure 03.43 | Axonometry

**Context**
The Terrence Donnelly Centre for Cellular & Biomedical Research is a central part of the University of Toronto. It's directly connected to the neighboring Rosebrugh building from 1921. The building is located in one of the most important places for research in the field of gene studies (Canadian Consulting Engineer, 2008).

**Use**
It contains a public entry on the ground floor next to a garden area. Also, the building encourages public engagement. On the upper floors, laboratories are located close to meeting rooms with colored glass walls and break rooms with greenery. Each floor has space for 44 principals and associated researchers (OAA, 2023). The internal green areas are expanding to a multi-level height (Behnisch Architekten Partnerschaft mbB, n.d.).

**Innovation**
A key design concept was to create multidisciplinary communication spaces for employees. Staircases near these green zones connect the levels vertically. The goal was to design adaptable spaces that can accommodate future changes (OAA, 2023). Every research story has the same design to enable as much flexibility and re-usability as possible (Behnisch Architekten Partnerschaft mbB, n.d.).

**Material**
The façade is a double-layer glass curtain wall. Between these layers, the users can control glare protection (Canadian Consulting Engineer, 2008). The façade allows colorful walls to be visible, creating a unique visual impression (Behnisch Architekten Partnerschaft mbB, n.d.).

| | |
|---|---|
| **Architect** | Behnisch Architekten & Architects alliance |
| **Client** | University of Toronto |
| **Location** | Toronto, Ontario, Canada |
| **Type** | Education \| Cellular & Biomolecular Research |
| **Opening** | 2005 |
| **Area** | 20,750 m² |

(Behnisch Architekten Partnerschaft mbB, n.d.)

**Figure 03.44 |** Aerial View | Scale 1:10,000

**Figure 03.45 |** Photograph | © T. Arban

**Figure 03.46 |** Photograph | © D. Cook

**Floor plan organization**

The building has a total of 12 stories. The central technical shaft allows flexibility for future lab changes (OAA, 2023). Also, the furniture in the lab can be freely rearranged (Canadian Consulting Engineer, 2008). The open-plan laboratory layout is notably efficient, with a clear spatial arrangement. The offices are located to the south. The areas requiring less natural light are strategically placed away from the façade. The circulation is oriented to the western part.

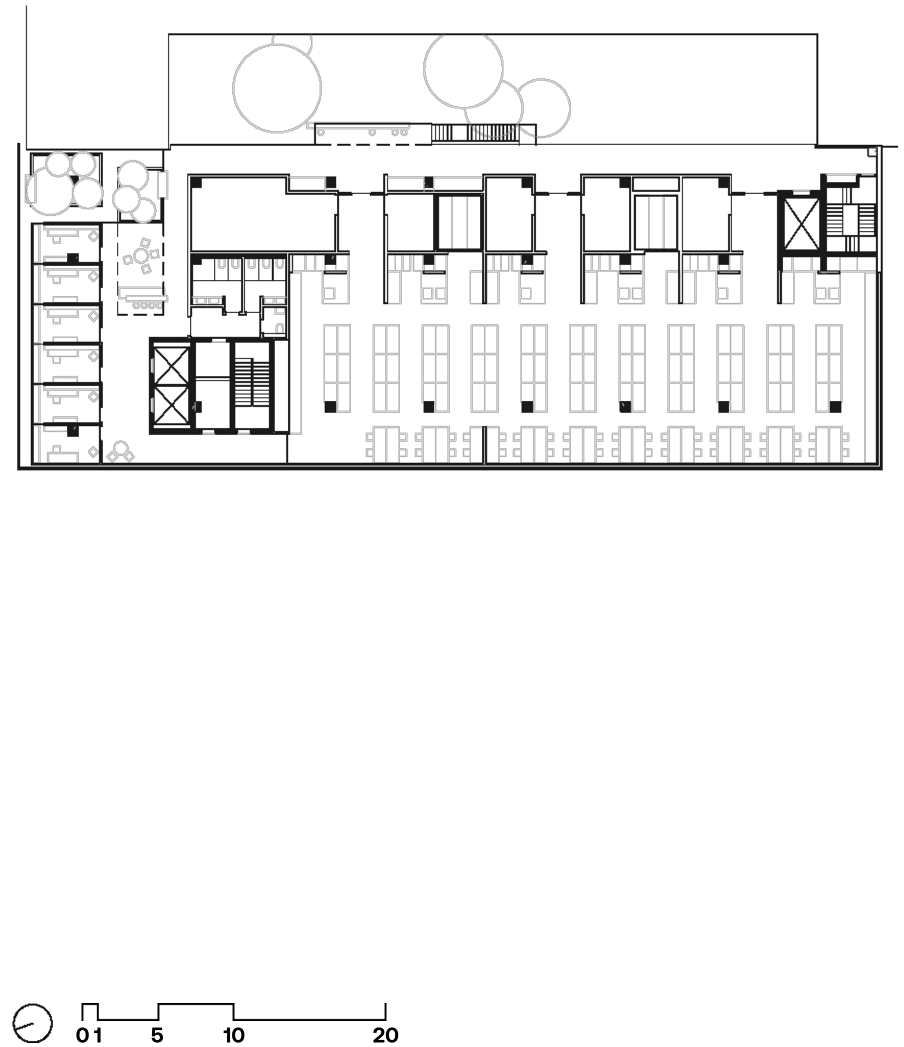



**Figure 03.47 |** Second Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

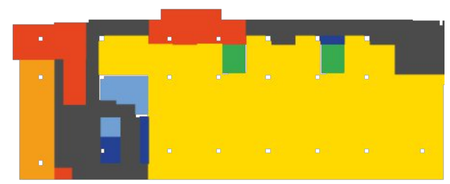


**Figure 03.48 |** Second Floor | Space analysis | Scale 1:1,000

# FSN

FABRIKSTRASSE 22 I NOVARTIS

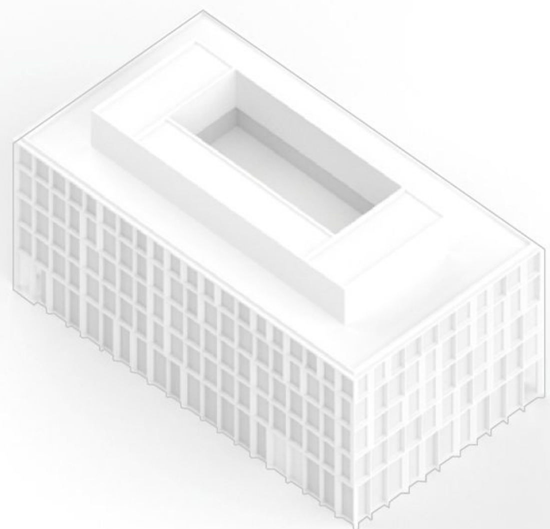


Figure 03.49 | Axonometry

**Context**
The Novartis Campus in Basel is currently one of the most innovative research-building clusters in the world.
Although the building's height, number of stories, floor area, and construction methods were predetermined, David Chipperfield Architects created an outstanding reference project. The basic concept is based on a floor-by-floor arrangement of different uses (Space for Science, n.d.).

**Use**
Communication zones and a café are located on the ground floor. Following the vertical circulation, one first reaches the three open-lab floors above. The office and meeting area are located on the top floor around a central roof garden. The two basement levels house storage areas and infrastructure, which are also located on the roof (Space for Science, n.d.).

**Innovation**
It is not only the open-lab concept or the strict floor-by-floor location of use that is remarkable, but also the flexible lab furnishings planned in collaboration with Novartis. There are no designated write-up spaces; instead, computer workstations are at the free-form laboratory tables. Each of them has a vertical infrastructure connection to the ceiling (Space for Science, n.d.).

**Material**
The differently twisted exterior concrete columns on the façade are prefabricated and fit in with the intended campus's character (David Chipperfield Architects Ltd., n.d.). Natural light is ensured by floor-to-ceiling windows and column-free floor plans. A height of 1.25 m is provided under the clad concrete ceiling for technical installations (Space for Science, n.d.).

| | |
|---|---|
| **Architect** | David Chipperfield Architects Berlin |
| **Client** | Novartis Pharma AG |
| **Location** | Basel, Switzerland |
| **Type** | Pharmaceutical Research |
| **Opening** | 2010 |
| **Area** | 11,600 m$^2$ |

(David Chipperfield Architects Ltd., n.d.)

**Figure 03.50 |** Aerial View | Scale 1:10,000

**Figure 03.51 |** Photograph | © Studio Kaspar Schmid

**Figure 03.52 |** Photograph | © P. Rosselli

**Floor plan organization**

The spacious floor areas are visually interrupted by only two cores containing the circulation and dark zones. A prominent staircase connects each of the laboratory floors in the open-plan area. This organization strongly promotes communication between the researchers. It offers particular advantages among large groups working in very similar subject areas. Different laboratory requirements could be better served here. There are also strong heat flows within the story (Space for Science, n.d.).

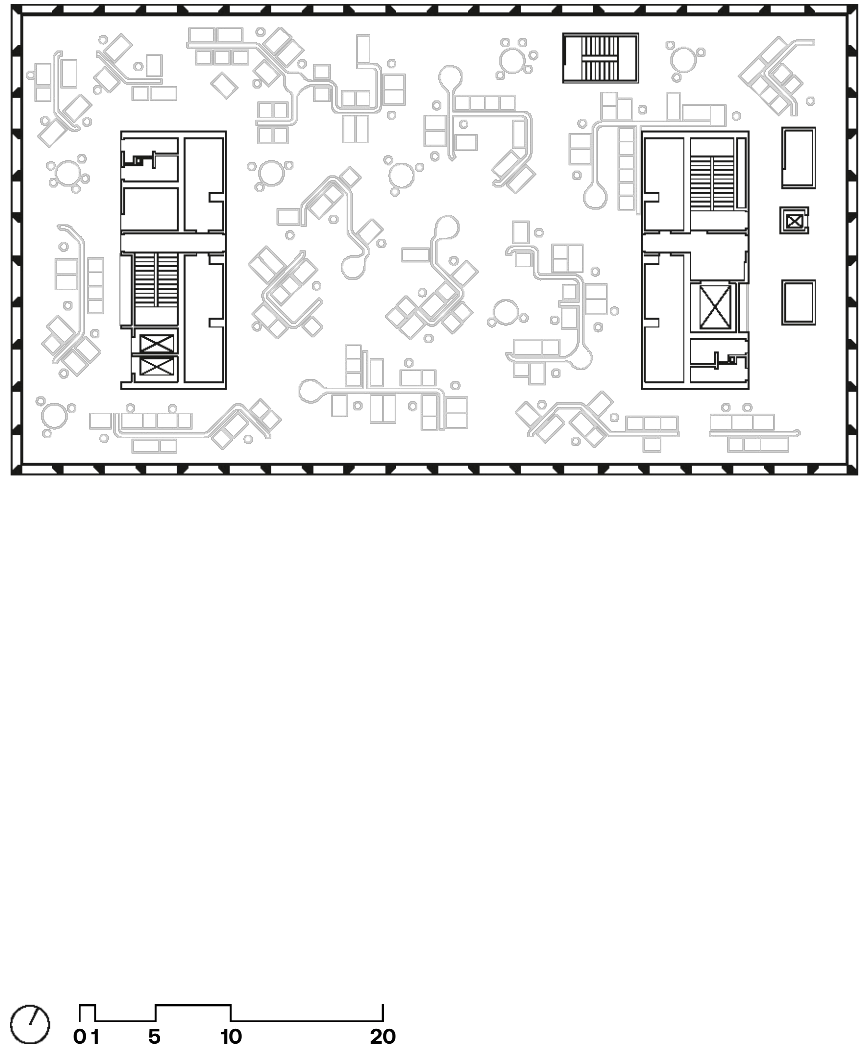



**Figure 03.53 |** Second Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

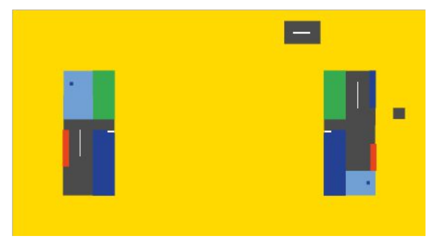


**Figure 03.54 |** Second Floor | Space analysis | Scale 1:1,000

# MAT

## MAERSK TOWER

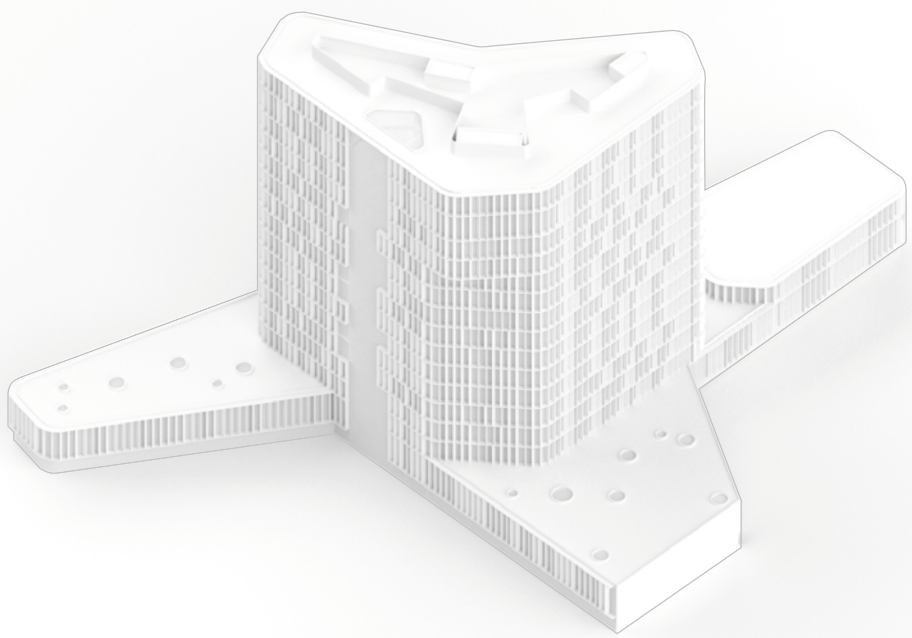


**Figure 03.55 |** Axonometry



**Context**

The Panum complex at the University of Copenhagen was originally built in the 1970s. It has the Faculty of Health and Medical Sciences. The high-rise building represents a modern concept for research architecture. It complements the existing neighboring buildings and is located in the middle of a public park (C.F. Møller Architects, n.d.).

**Use**

Research rooms and public university spaces are located within the tower. The base houses teaching rooms, conference areas, dining space, and the entrance. Research occurs on the upper floors, each featuring a communication zone. The so-called "Science Plaza" (C.F. Møller Architects, n.d.), located on an inviting staircase, offers city views. Interaction between researchers and students is encouraged on the underground floor (C.F. Møller Architects, n.d.).

**Innovation**

The Maersk Tower is widely regarded as one of Denmark's most advanced research buildings, not only because of its extraordinary façade but also because of the use of energy inside. The façade panels are movable and serve as sun protection. Only around half of the usual kWh/$m^2$ is achieved inside. Further advantages include the short distances inside, as well as flexibility and increased visual connections, thanks to the use of glass partitions (C.F. Møller Architects, n.d.).

**Material**

The façade panels are clad in copper. They soften the massive impression of the 15-story building. Inside, warm tones such as wood create an inviting atmosphere (C.F. Møller Architects, n.d.).

| | |
|---|---|
| **Architect** | C.F. Møller Architects |
| **Client** | The Danish Property Agency for the University of Copenhagen & A.P. Møller Foundation |
| **Location** | Copenhagen, Denmark |
| **Type** | Education, Health & Medical Sciences |
| **Opening** | 2017 |
| **Area** | 42,700 $m^2$ |

(C.F. Møller Architects, n.d.)

**Figure 03.56 |** Aerial View | Scale 1:10,000

**Figure 03.57 |** Photograph | © A. Moerk

**Figure 03.58 |** Photograph | © A. Moerk

**Floor plan organization**

The free-form floor plan includes a ring that functionally connects the uses on one floor. The focus was also placed on the vertical connections and the view to the outside. The spiral staircase leads to the “Science Plaza” (C.F. Møller Architects, n.d.). There, the focus is increasingly on the view and transparency (C.F. Møller Architects, n.d.).
The dark zones are located inside despite the free form. NUF 3 and NUF 2 are mainly located on the façade.



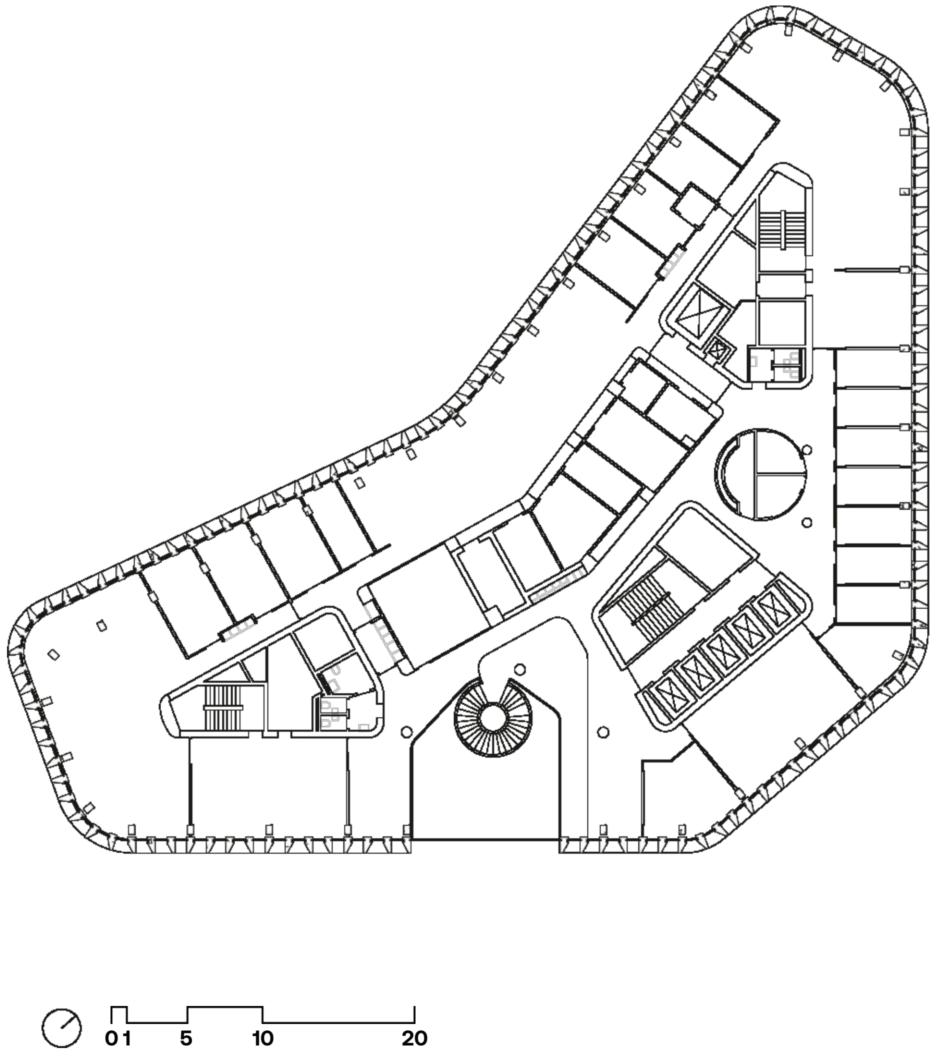



**Figure 03.59 |** Standard Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

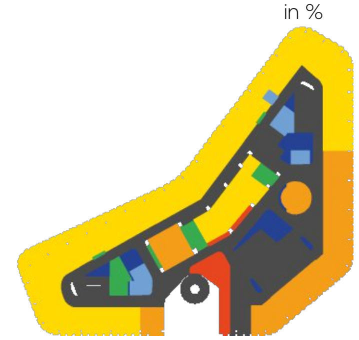
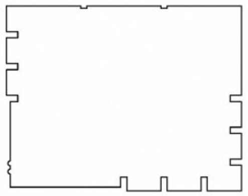


**Figure 03.60 |** Standard Floor | Space analysis | 1:1,500

# LAC

## LAB CITY I CENTRALESUPÉLEC



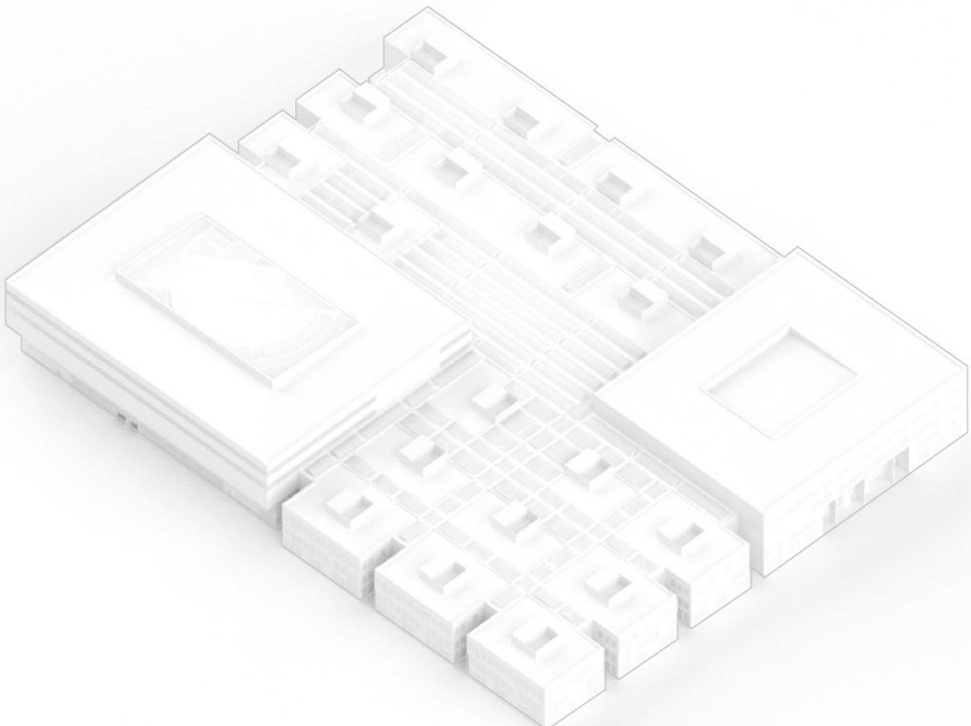


**Figure 03.61 |** Axonometry

**Context**

One of the most important French research campuses, CentraleSupélec, was built around 30 km from the capital. OMA won the planning competition for Lab City, which serves as the central hub of the campus, as well as the master planning for the entire educational structure. The engineering university is a merger of two of the most influential French universities of its kind (Schürkamp, 2017).

**Use**

Inside, laboratories can be used both privately and publicly. It houses educational rooms and laboratories, as well as communication areas. The central core is the cafeteria, which cuts into the main axis that runs through the campus. The library and the lecture hall for up to 970 people are also centrally located. The reception can be reached via an inviting staircase to the upper floor. The classic, rather inaccessible laboratories are in the basement (Schürkamp, 2017).

**Innovation**

OMA's approach here is to see laboratories and teaching spaces as "discrete packages" (OMA, n.d.) with constantly changing requirements. Therefore, there was a need for a basic structure that could be flexibly filled (OMA, n.d.). Stacking different rooms creates numerous platforms and vantage points united under one roof (Schürkamp, 2017).

**Material**

There is a high contrast between the aluminum façade and the dark concrete façade. Inside, the predominant materials are white drywall and exposed concrete. A translucent ETFE cushion roof spans the structure (Schürkamp, 2017).

| | |
|---|---|
| **Architect** | OMA |
| **Client** | CentraleSupélec |
| **Location** | Plateau de Saclay - Gif-sur Yvette, France |
| **Type** | Education |
| **Opening** | 2017 |
| **Area** | 48,700 m$^2$ |

(OMA, n.d.)

**Figure 03.62 |** *Aerial View | Scale 1:10,000*

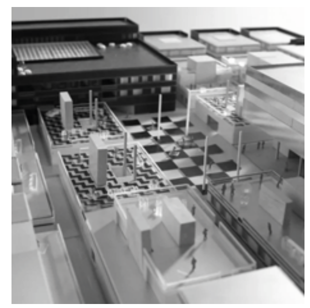
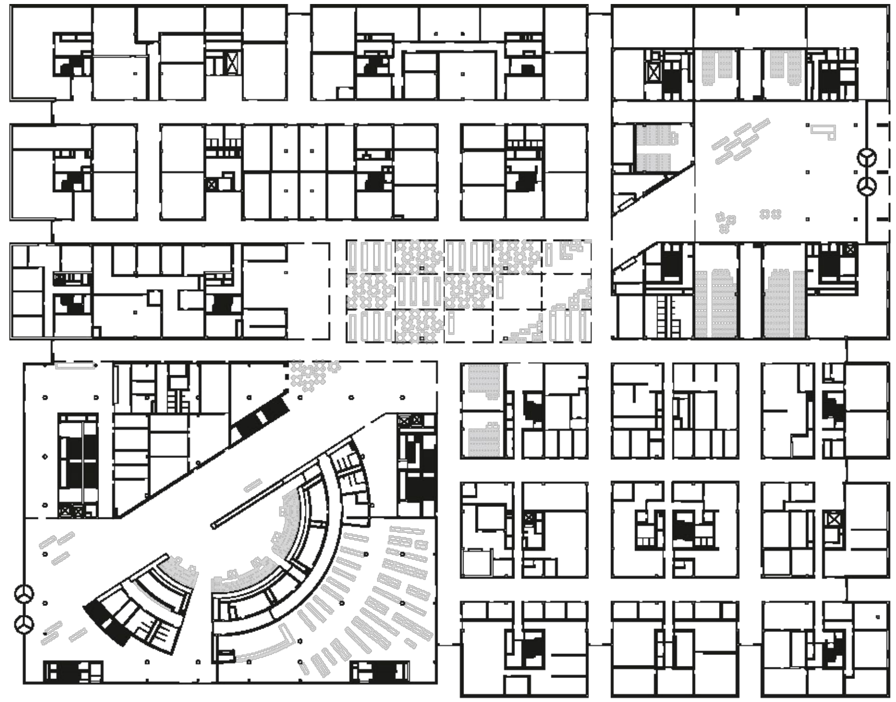


**Figure 03.63 |** Photograph | © F. Parthesius

**Figure 03.64 |** Photograph | © P. Ruault

**Floor plan organization**

The floor plan is clearly divided into four different grids or module arrangements. The village-like arrangement maximizes circulation space, creating open areas that foster communication and interaction between the building's occupants.
Vertical circulation is centered within the modules. Four themed areas were also located in the building, which are divided along the campus's so-called "Center Langues" axis (Schürkamp, 2017). This axis leads to a train station (Schürkamp, 2017).



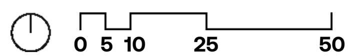
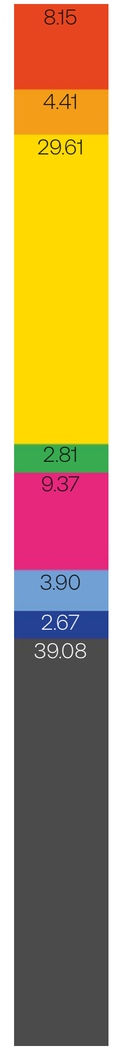



**Figure 03.65 |** Ground Floor | Floor plan | Scale 1:1,500




- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

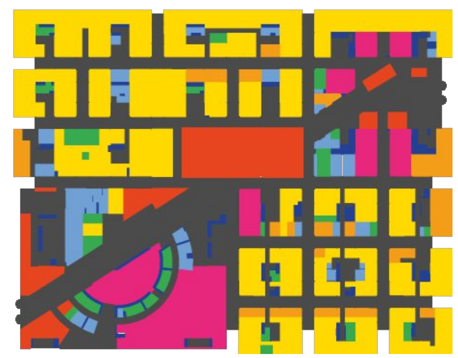


**Figure 03.66 |** Ground Floor | Space analysis | 1:3,000

# BSM

BIOCENTRE SCHÄLLENMÄTTELI

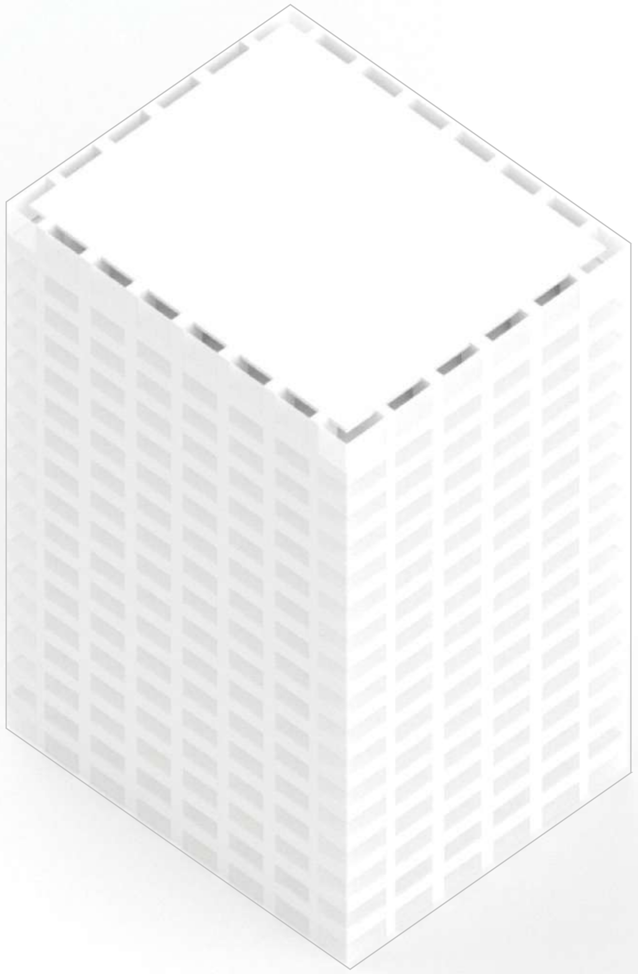


Figure 03.67 | Axonometry

**Context**

This is one of the buildings on the newly built educational campus of the University of Basel. As a high-rise typology, the result is not only a landmark for education but also a concept to meet the high space requirements of 23,400 m². The compressed footprint creates a public square intended to enliven the campus (Ilg Santer Architekten, n.d.). As with many research facilities, the new building aims to attract talented researchers by providing an attractive workplace (BauNetz, 2021).

**Use**

Upon entering the multi-story entrance hall, public uses open up on playfully integrated platforms into the vertical space. Teaching rooms, cafeteria, computer center, and research rooms are available for university use. The underground areas include parking facilities and infrastructure (Ilg Santer Architekten, n.d.).
Of a total of 16 floors, ten are available for basic molecular and biomedical research. The structure was designed for around 400 researchers and 900 students (BauNetz, 2021).

**Innovation**

A key concept is the focus on visual connections between users (Ilg Santer Architekten, n.d.). Flexibility is promoted not only by the column-free floors but also by creating a vertical link through recesses between every two floors in the floor slabs. Communication is one of the most important issues here, as it is in many research facilities (BauNetz, 2021).

**Material**

The non-transparent façade sections of chrome-nickel sheet metal give the building a calm, elegant look alongside its rectangular shape and large windows (BauNetz, 2021).

| | |
|---|---|
| **Architect** | Ilg Santer Architekten |
| **Client** | University Basel \| HBA BS |
| **Location** | Basel, Switzerland |
| **Type** | Education \| Molecular and Biomedical Research |
| **Opening** | 2021 |
| **Area** | 23,400 m² |

(Ilg Santer Architekten, n.d.)
(BauNetz, 2021)

Figure 03.68 | Aerial View | Scale 1:10,000

Figure 03.69 | Photograph | © D. Hirabayashi

**Figure 03.70 |** Photograph | © ilg santer architekten

**Floor plan organization**

The shafts used for media routing surround the floor plan (Ilg Santer Architekten, n.d.). This is a single-shaft arrangement, which is often planned in laboratory construction. In the center are four load-bearing core structures, which contain the circulation system, among other things. The strong geometric orientation on mirror axes is striking. A look at the area analysis reveals a sorted and grouped distribution of uses. The communication areas are centrally located.

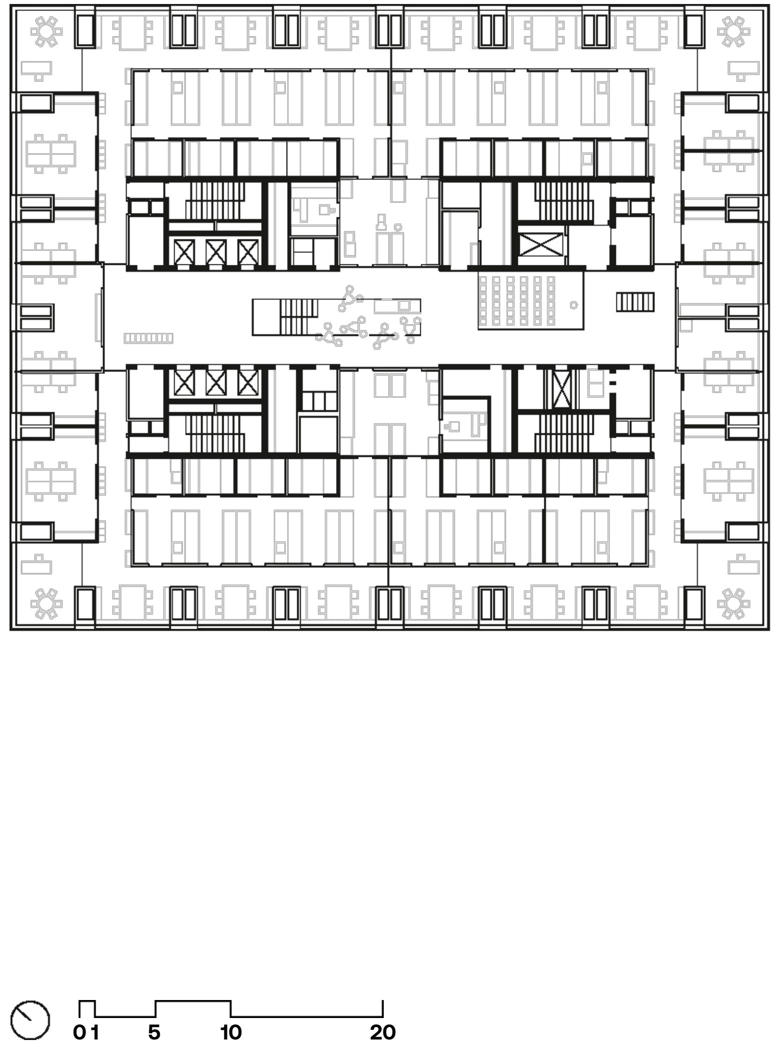



**Figure 03.71 |** Standard Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

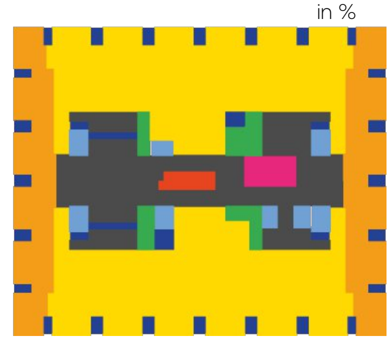


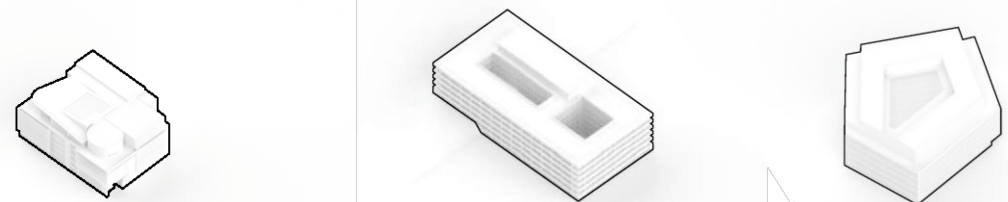
**Figure 03.72 |** Standard Floor | Space analysis | 1:1,000

# CORE I PATIO

The core arrangement can also be implemented with a conceptually important atrium or courtyard. The resulting protected space offers a certain degree of separation from the surroundings (Jocher et al., 2012, p. 352).
The following three examples have all been built in the last 15 years. They each have a similar number of stories - six above ground. The routing was an essential conceptual point in all three projects. The atrium creates three-dimensional visual connections and provides deep building depth, which is typical for laboratory buildings, with natural lighting.







**MIT Media Lab**
Maki and Associates, Leers Weinzapfel Associates
Cambridge, Massachusetts, USA
2009

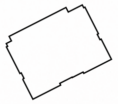
**Geo- and Environmental Centre (GUZ)**
KAAN ARCHITECTEN
Tübingen, Germany
2020

**BSS research building**
Nickl & Partner
Basel, Switzerland
2023

**Figure 03.73 |** Overview Core | Patio

# MML

## MIT MEDIA LAB



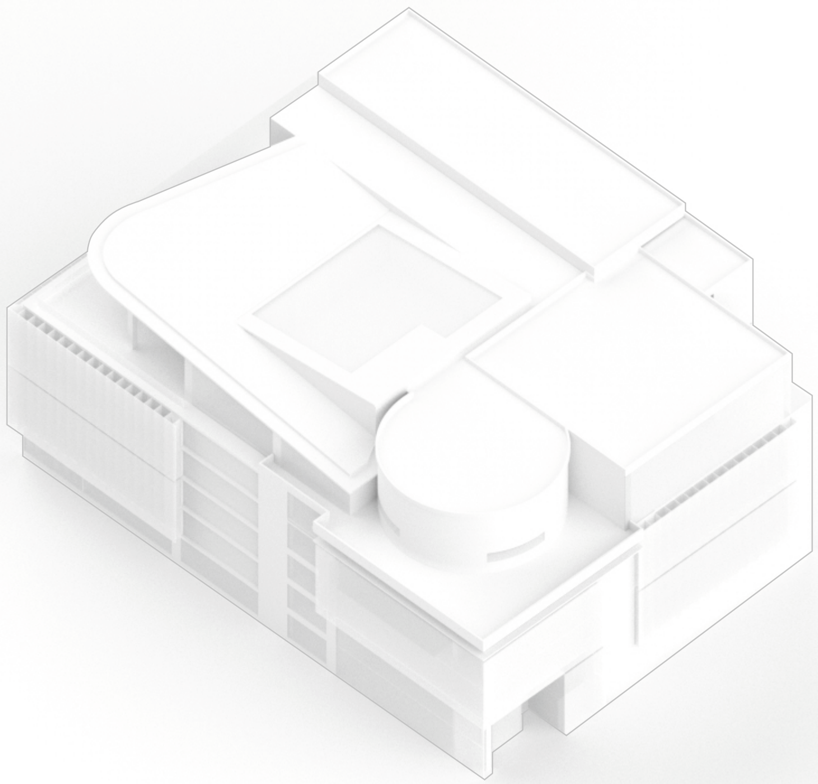


**Figure 03.74 |** Axonometry

### Context

Next to the Wiesner Building, MIT commissioned the Media Lab from Japanese architect Fumihiko Maki and the office Leers Weinzapfel. The original wish in the 1990s was for an institute building that could keep pace with the new digitalization of the time (Gonchar, 2010). This reference is a precursor project in terms of the opportunities for cooperation, communication, and interdisciplinarity between industry and education (Leers Weinzapfel Associates, n.d.). Even if laboratories are viewed as workshops, the concept is worth examining.

### Use

From prosthetics to vehicle technology, seven labs explore art and technology, with public spaces like presentation rooms and a café on the top floor (Gonchar, 2010). There is plenty of space, from research and meetings to exhibitions and performances (Leers Weinzapfel Associates, n.d.). The design features elements that enhance interaction.

### Innovation

Unusual is that visitors and users are guided into and through the building by a circulation system that runs along the communication areas and the visible laboratory spaces in the form of eye-catching staircases and elevators. The floor plan structure is comparable to a three-dimensional grid that is similar to a "tic-tac-toe board" (Gonchar, 2010). It is made of a steel frame (Gonchar, 2010).

### Material

The aluminum lattice glare protection over the non-public areas is remarkable. This not only complies with local regulations but also provides privacy from outside (Gonchar, 2010).

**Architect** Maki and Associates, Leers Weinzapfel Associates
**Client** MIT
**Location** Cambridge, Massachusetts, USA
**Type** Education
**Opening** 2009
**Area** ≈15.100 m$^2$
(Gonchar, 2010) (Leers Weinzapfel Associates, n.d.)



**Figure 03.75 |** *Aerial View | Scale 1:10,000*

**Figure 03.76 |** Photograph | © A. Grassl

**Figure 03.77 |** Photograph | © Maki and Associates

**Floor plan organization**

The two-story workshops intersect vertically in such a way that a multitude of visual axes are offered through the transparent partition walls. In addition, each workshop has at least one facade and access to office space for each faculty (Gonchar, 2010). The central interaction area runs through all floors (Leers Weinzapfel Associates, n.d.). Overall, the design features an efficient division of space. The size of the communication areas corresponds to the architects' guiding principle.

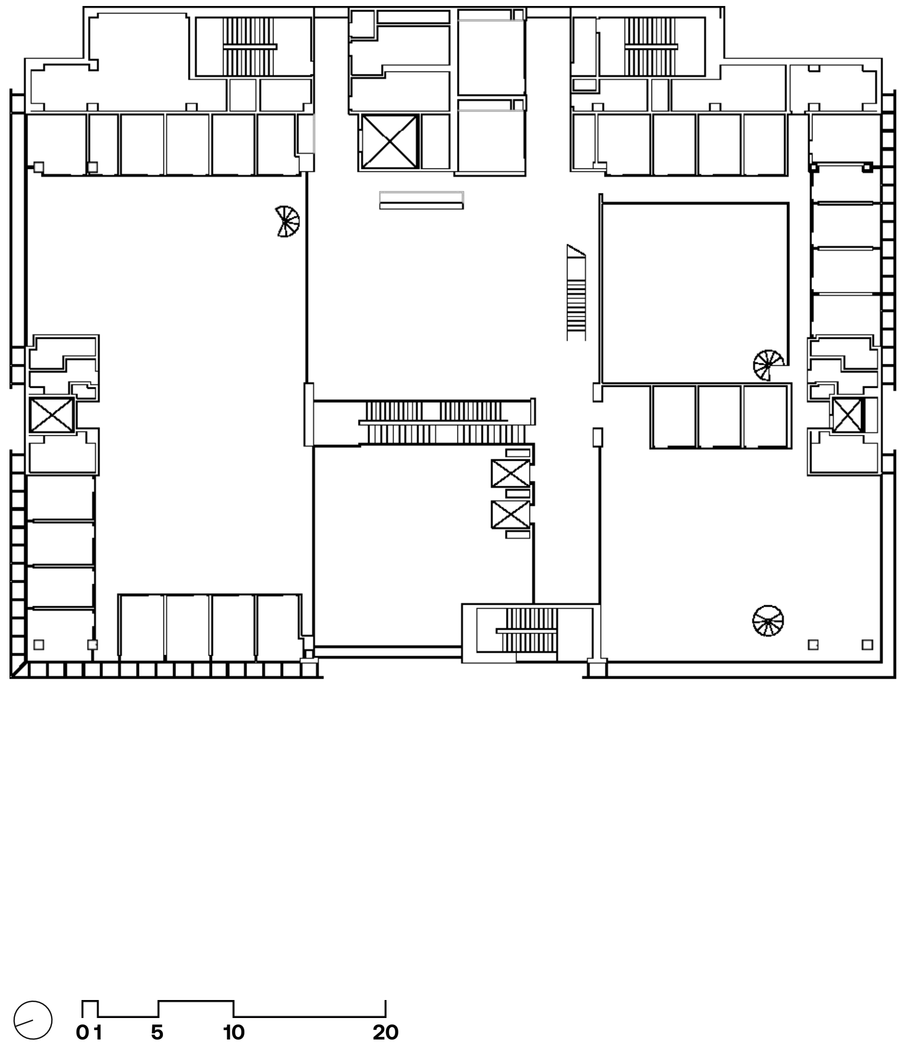



**Figure 03.78 |** Third Floor | Floor plan | Scale 1:500


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

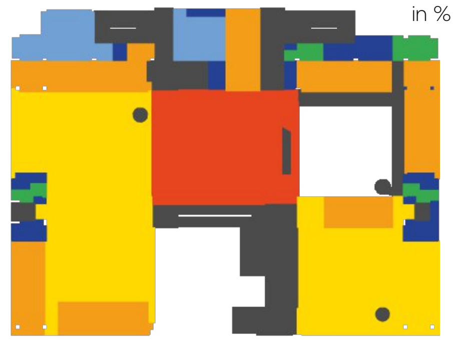
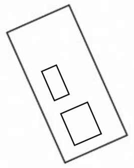


**Figure 03.79 |** Third Floor | Space analysis | Scale 1:1,000

# GUZ

GEO- AND ENVIRONMENTAL CENTRE



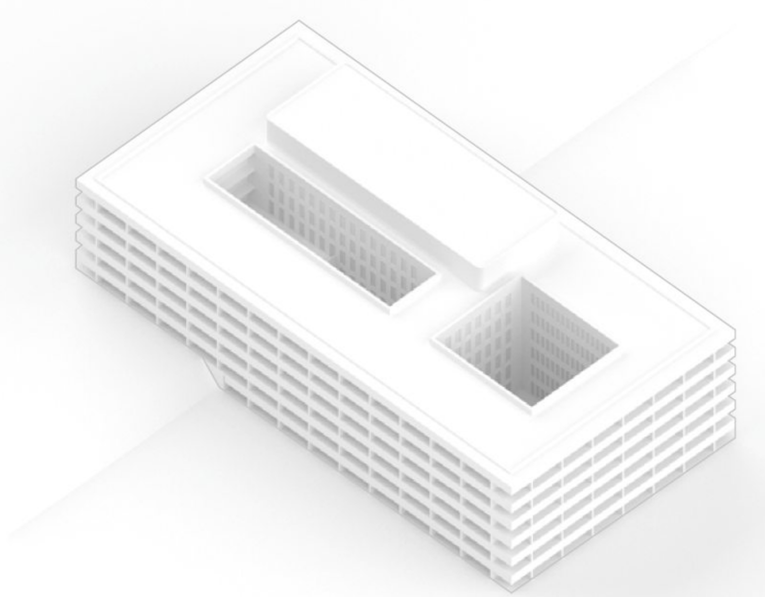


**Figure 03.80 |** Axonometry

**Context**

The Morgenstelle Campus of Eberhard Karls University was originally built in the 1960s. As an extension, the solid-looking Geo- and Environmental Centre was designed by KAAN Architecten to promote interdisciplinary exchange. Solutions to environmental problems are researched here. The focus of the research is on water, the soil, and our atmosphere. The campus buildings are oriented around a central space, which will be enlarged by further buildings in the future according to plans by Harris + Kurrle Architekten (Pintos, 2022).

**Use**

Upon entering the building, visitors first encounter public areas, including teaching rooms and communication spaces. Two courtyards have also been integrated, which serve both for social contact and orientation. An inviting staircase in the entrance area is intended to increase interaction. Other uses are arranged in clusters oriented towards the cardinal points (Pintos, 2022).

**Innovation**

One aim was to ensure a high degree of flexibility in the floor plan layout. This resulted in the grouped arrangement of the uses, particularly the laboratories in the east. The circulation area between the laboratory and office spaces facilitates networking. The overall principle of "from coarse to fine" (Pintos, 2022) applies in the laboratory groups (Pintos, 2022).

**Material**

The horizontal concrete façade strips are prefabricated and hollow for ventilation, while external concrete supports enhance interior flexibility. The glass façade offers a seemingly unrestricted view by dispensing with mullions (Pintos, 2022).

| | |
|---|---|
| **Architect** | KAAN Architecten |
| **Client** | Land Baden-Württemberg, Vermögen und Bau Baden Württemberg, Amt Tübingen |
| **Location** | Tübingen, Germany |
| **Type** | Education \| Geo - and Environmental research |
| **Opening** | 2020 |
| **Area** | 20,700 m$^2$ |

(KAAN Architecten, n.d.)



**Figure 03.81 |** Aerial View | Scale 1:10,000

**Figure 03.82 |** Photograph | © B. Gonzalez

**Figure 03.83 |** Photograph | © B. Gonzalez

**Floor plan organization**

The rooms are oriented towards the center of the campus and are intended to arouse viewers'curiosity from outside (Pintos, 2022). In this case, these are the teaching rooms. The offices face south and west. The laboratory areas are grouped north with the respective evaluation areas on the façade. In total, the structure extends over six stories (KAAN Architecten, n.d.). The space analysis reveals a clear division into thirds between the NUF 2 and NUF 3 areas and the circulation space.

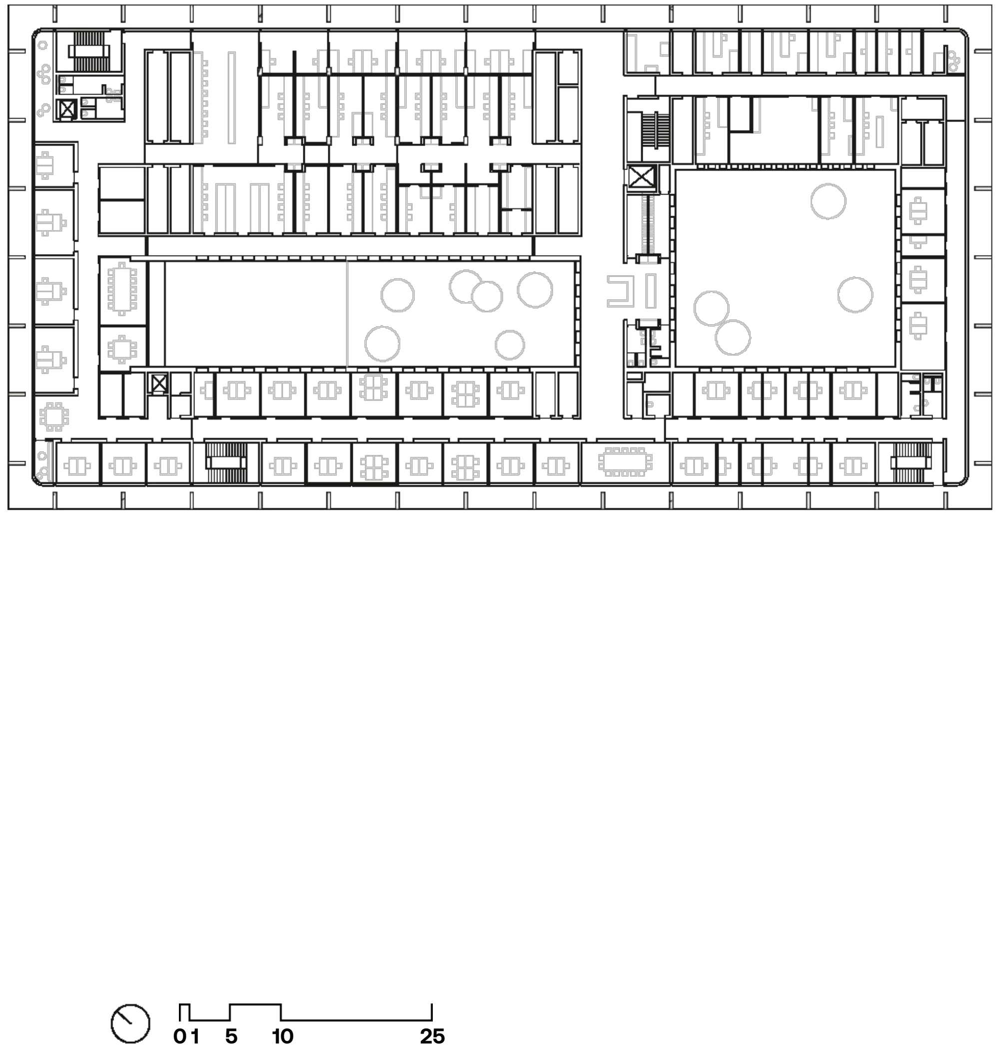



**Figure 03.84 |** Second Floor | Floor plan | Scale 1:750


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

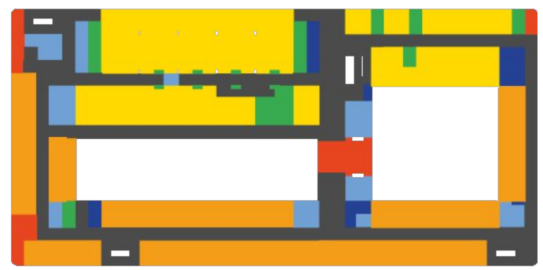
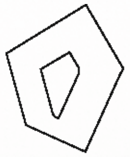


**Figure 03.85 |** Second Floor | Space analysis | 1:1,500

# BSS

## BSS RESEARCH BUILDING



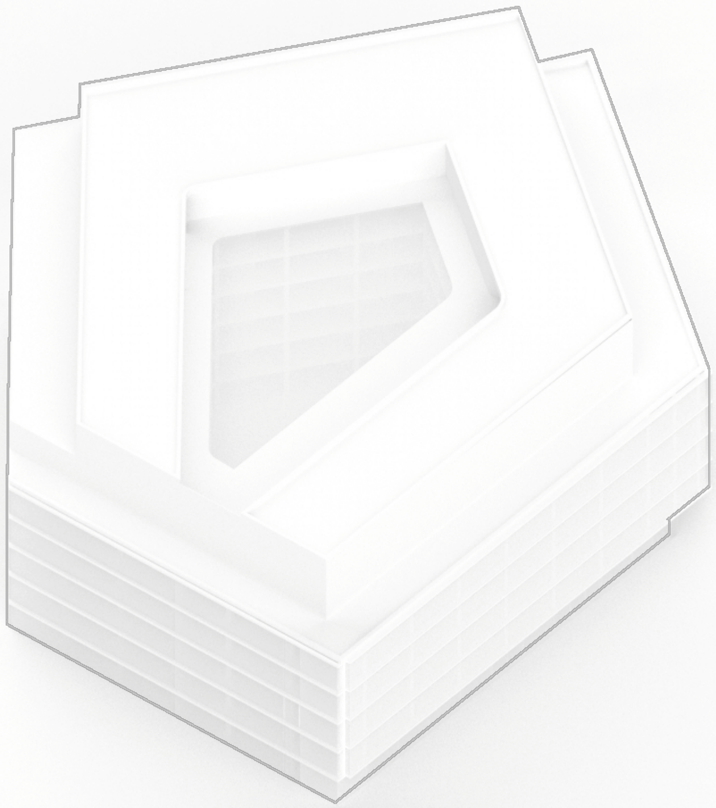


**Figure 03.86 |** Axonometry

### Context

Next to the Biocentre (see reference BSM) is the new ETH Zurich building, which houses the D-BSSE Department of Biosystems Science and Engineering (Implenia AG, n.d.).
Unlike its neighboring buildings, the design avoids a high-rise structure due to the site's previous development. Rather, it is a modern, flat-looking pentagonal building (Nickl & Partner Architekten AG, n.d.).
The sustainable building allows researchers to work close to important industry partners. These include hospitals, natural sciences, and medical faculties (ETH Zurich Department of Biosystems Science and Engineering, n.d.).

### Use

Laboratories, teaching rooms, communication zones, a canteen, and presentation rooms are arranged over almost 19,000 m$^2$ of main usable space. The technology of the six-story building is, among others, located on the roof. There are also two basement levels (Implenia AG, n.d.).

### Innovation

The goal is to create a highly networked, communicative environment to enhance researchers' efficiency. Flexibility for future needs is crucial, even within the building's compact design. The university's excellent reputation led to high demands for the installed technology, with the inviting foyer serving as a central feature (Nickl & Partner Architekten AG, n.d.).

### Material

Glass partitions were used to enable both the numerous visual connections and the flexibility. Sustainability was considered in their design and manufacturing (Lindner Group KG, n.d.).

| | |
|---|---|
| **Architect** | Nickl & Partner Architekten |
| **Client** | ETH Zurich |
| **Location** | Basel, Switzerland |
| **Type** | Life Sciences, Bio- and Pharmacenter |
| **Opening** | 2023 |
| **Area** | 36,000 m$^2$ |

(Implenia AG, n.d.)

**Figure 03.87 |** Aerial View | Scale 1:10,000

**Figure 03.88 |** Photograph | © A. Birnbaum

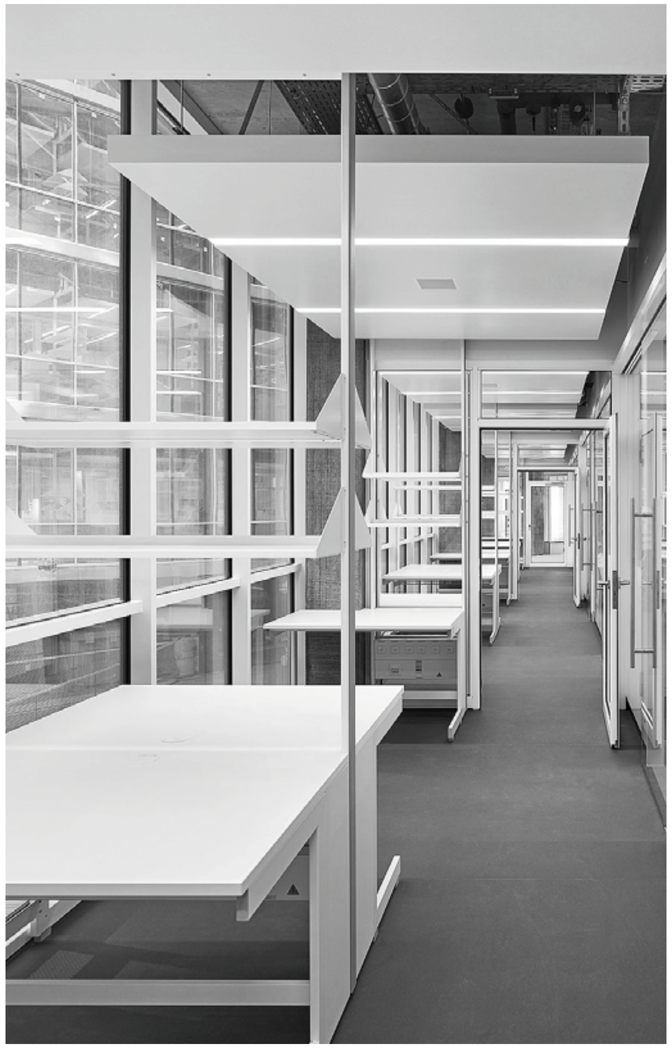


**Figure 03.89 |** Photograph | © Jansen AG

## Floor plan organization

The floor plan clearly features a ring with the core and dark zones around the atrium. The atrium is enclosed and networked with circulation, workspaces, and laboratories. However, the numerous circulation routes are visible in the space distribution. Write-up spaces, for instance, are arranged toward the foyer to enable visual connections. Flexible placement of future uses is possible around the core zone. The distances between rooms may be significant, as users are guided around the central part.

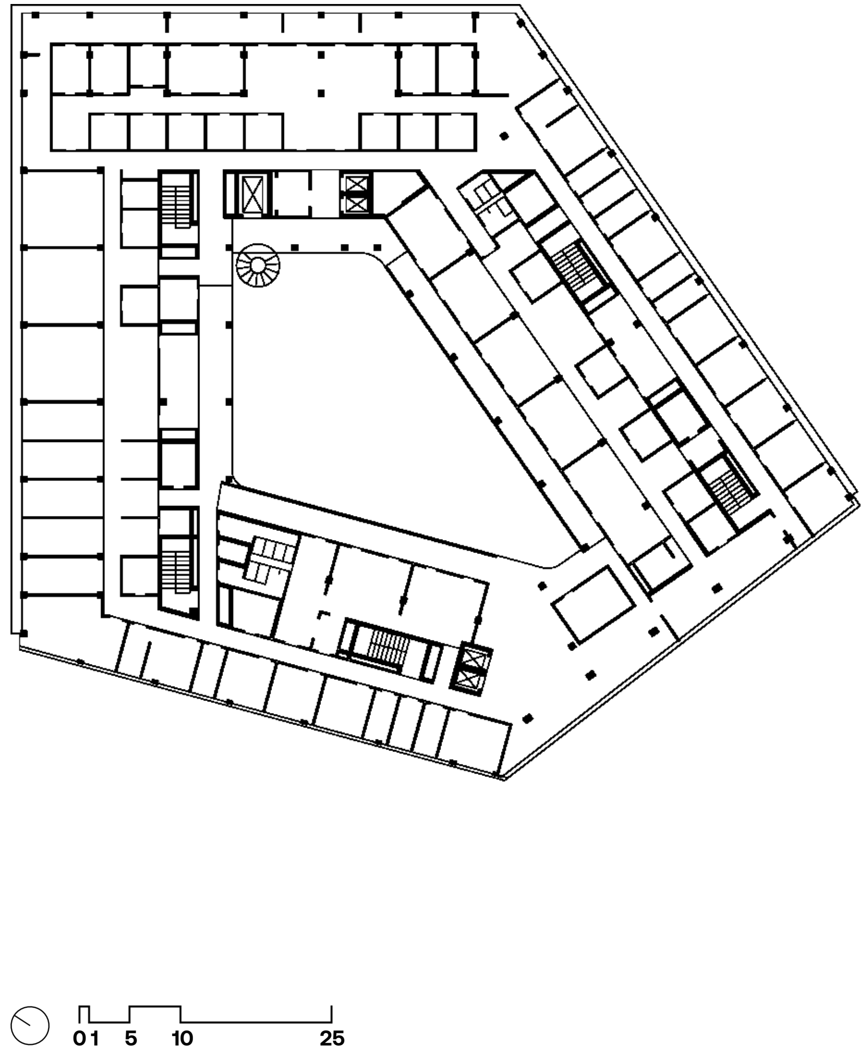



**Figure 03.90 |** Second floor | floor plan | Scale 1:750


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

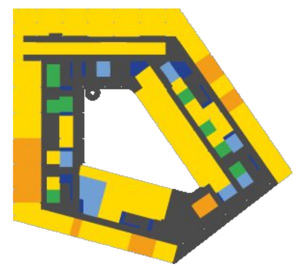


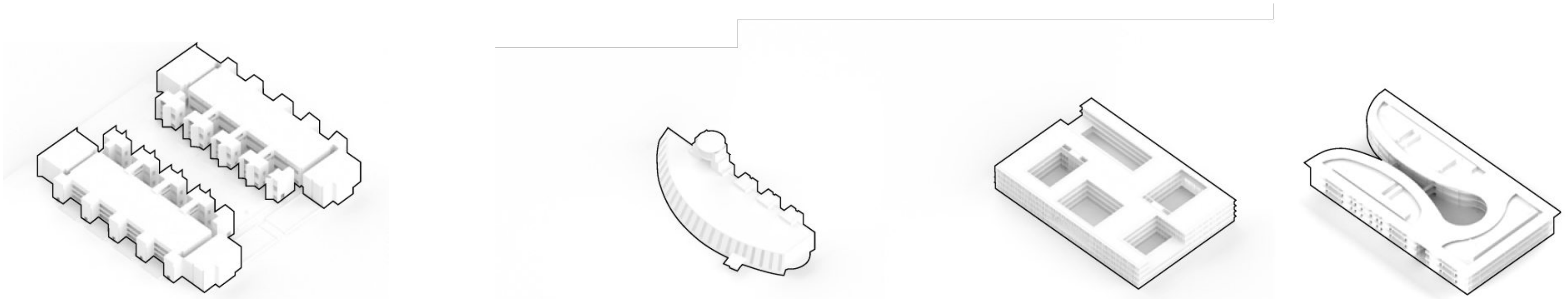
**Figure 03.91 |** Second floor | space analysis | Scale 1:2,000

# MIXED FORMS

The following reference projects demonstrate that there is a clearly structured spatial distribution within the stories. The Lise-Meitner-Haus is an exception here due to a more group-oriented use distribution. The other three examples aimed to guarantee a spacious central laboratory or production area that can be used flexibly. These four projects all cover large floor areas and have a similar building height or number of stories.







**Salk Institute**
Louis I. Kahn
La Jolla, California, USA
1960

**BASE**
Architect 5 Partnership
Nagoya, Japan
1992

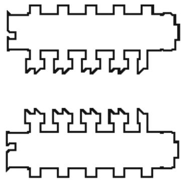
**Lise-Meitner-Haus**
**Humboldt-University**
Augustin und Frank
Berlin-Adlershof, Germany
2002

**James H. Clark Center**
Norman Foster
Stanford, California, USA
2003

**Figure 03.92 |** Overview Mixed Forms | Axonometry

# SAI

## SALK INSTITUTE



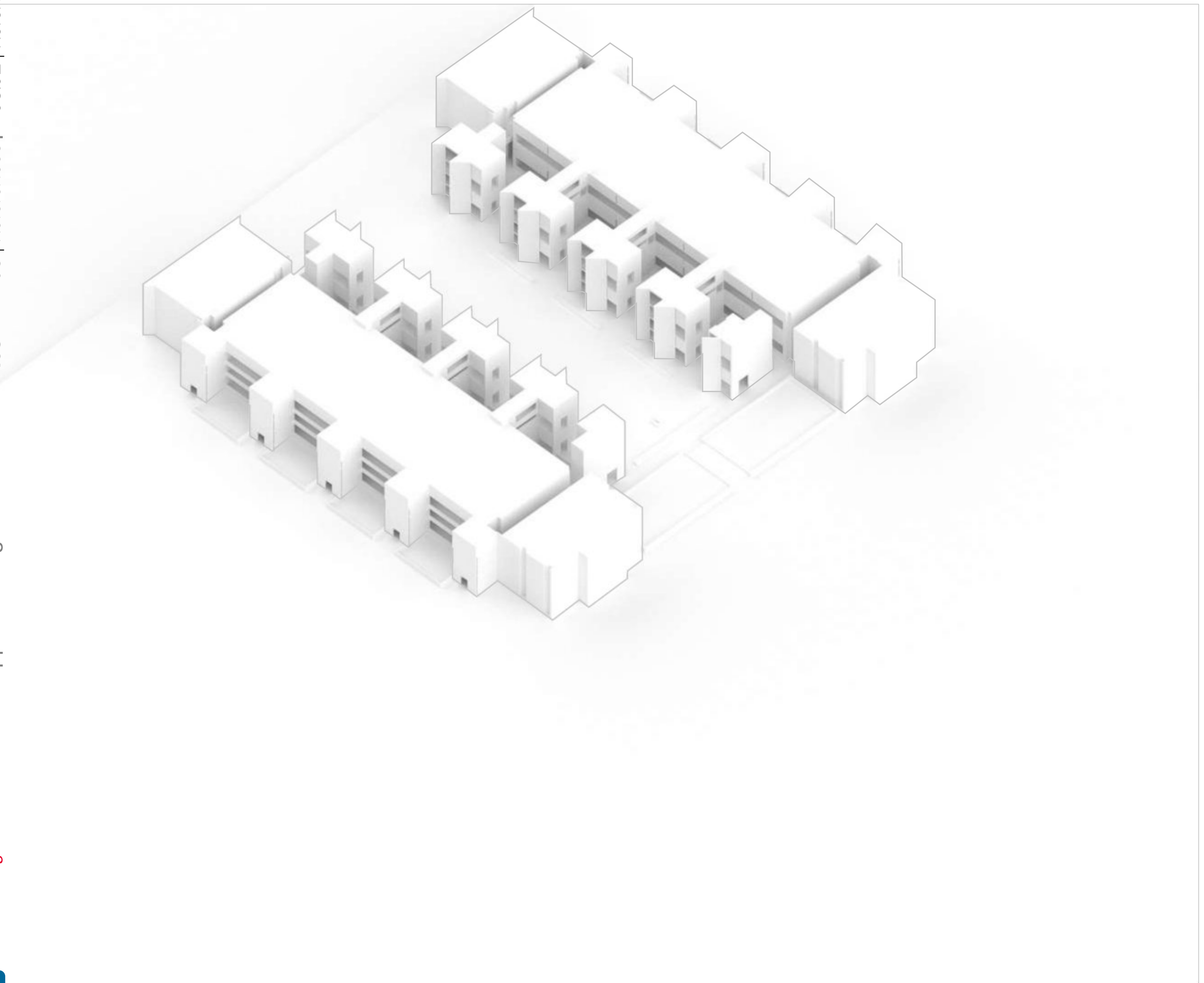


Figure 03.93 | Axonometry

**Context**

The Salk Institute, a collaboration between Louis I. Kahn and researcher Jonas Salk, is one of the world's most architecturally significant institutes. Annually, 400,000 visitors come to the Pacific Ocean campus, where 36 groups research contemporary issues (Salk Institute for Biological Studies, n.d.-b). The focus is on the topics of "molecular biology and genetics, neurosciences, and plant biology" (Inskip & et al., 2017, p. 12).

**Use**

The two opposing building structures each have six floors, two of which are underground. Laboratory areas are centered on three levels. Offices are arranged towards the west, and learning spaces for teaching staff are in the comb-like areas towards the central courtyard. There are 29 building sections on the entire campus (Salk Institute for Biological Studies, n.d.-a). The heads of the respective research groups divide the spacious laboratory into laboratory areas of up to 74 $m^2$ (Inskip & et al., 2017, p. 128).

**Innovation**

The flexible laboratory spaces can be adapted to suit the needs of the users. Jonas Salk's main focus here was on communication (Inskip & et al., 2017, pp. 62, 128). Special attention was given to utilizing natural daylight through light shafts to the basement levels (Salk Institute for Biological Studies, n.d.-a).

**Material**

Thanks to the outstandingly simple but robust choice of materials, only a few renovations have been needed. Following the example of ancient building materials, Louis I. Kahn chose water-resistant, so-called pozzolanic concrete. Glass, teak, and steel were also used (Salk Institute for Biological Studies, n.d.-a).

| | |
|---|---|
| **Architect** | Louis I. Kahn |
| **Client** | e.g. Jonas Salk |
| **Location** | La Jolla, California, USA |
| **Type** | Biology |
| **Opening** | 1964 |
| **Area** | 38,200 $m^2$ |

(Salk Institute for Biological Studies, n.d.-a)
(Inskip & et al., 2017, pp. 12, 177)

**Figure 03.94 |** Aerial View | Scale 1:10,000

**Figure 03.95 |** Photograph | © T. Nemeskeri

**Figure 03.96 |** Photograph | © A. Clotis

**Floor plan organization**

The overall concept is based on strict mirror axes. The area analysis also reveals a very clearly structured layout.
The courtyard has a connecting significance and is even described as a “façade to the sky” (Salk Institute for Biological Studies, n.d.-a). The lab areas are spanned by Vierendeel beams (Inskip & et al., 2017, p. 128), allowing column-free spaces (Salk Institute for Biological Studies, n.d.-a). Infrastructure is efficiently routed between the labs (Salk Institute for Biological Studies, n.d.-b).



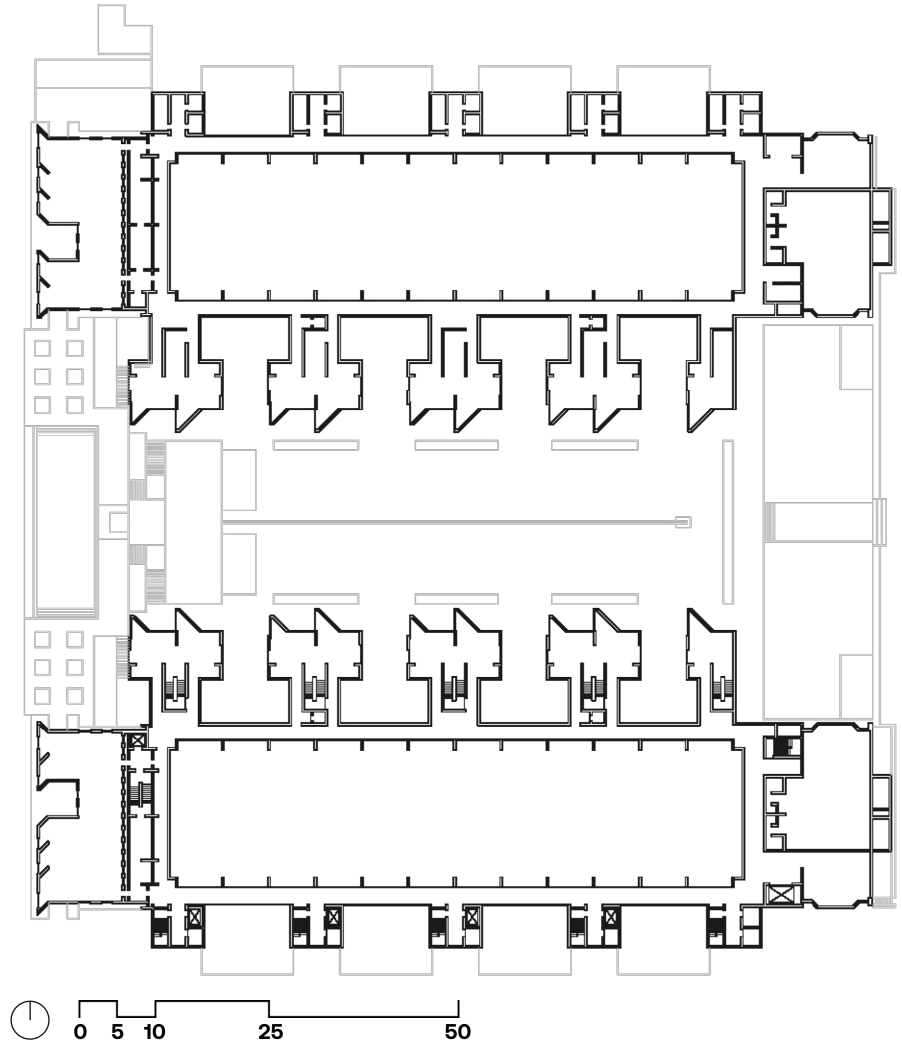
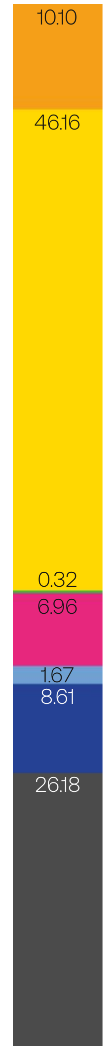



**Figure 03.97 |** Standard Floor | Floor plan | Scale 1:1,000




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

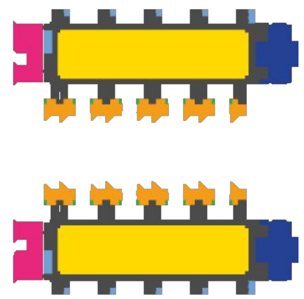
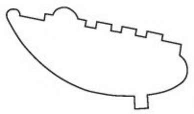


**Figure 03.98 |** Standard floor | Space analysis | Scale 1:3,000

# BAS

BASE



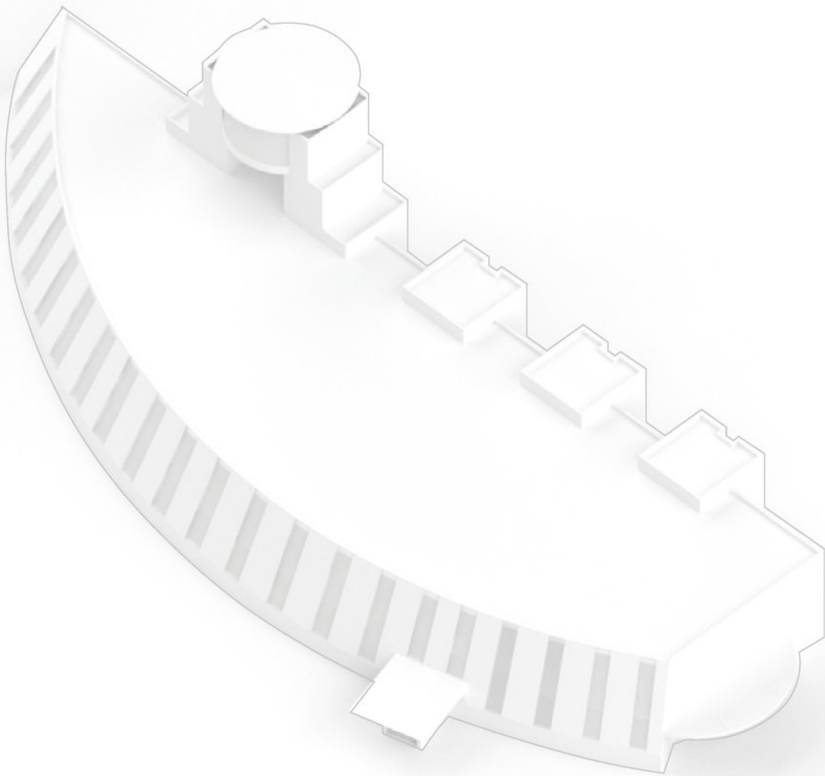


Figure 03.99 | Axonometry

**Context**
The BASE is an ideal example for expanding the references.
A total of two buildings were built, each dedicated to the production or research of dental tools. The design within the curved building is based on the principle of “Hoigaku” (Braun & Grömling, 2005, p. 218). This Japanese concept attempts to understand the character of a site in such a way that the optimum environment is created in harmony with nature and people (Braun & Grömling, 2005, pp. 218, 219).

**Use**
Offices, laboratories, production areas, and administration are located on the site. The production areas and workspaces are oriented towards the south. Quiet work areas such as the plant room, meeting rooms, and side rooms are located next to cherry trees in the north. This once again highlights a conceptual point of “Hoigaku”: the synergy of contrasting spaces within one building (Braun & Grömling, 2005, pp. 218, 219).

**Innovation**
The main hall is column-free, spanning 25 m by 90 m (UMEZAWA STRUCTURAL ENGINEERS, n.d.). It allows a very high degree of flexibility. The high amount of natural light is intended to promote employee productivity. The “Hoigaku” (Braun & Grömling, 2005, p. 218) approach aims to support this and create a unique work environment (Braun & Grömling, 2005, pp. 218, 219).

**Material**
BASE is enveloped by an aluminum façade. The curved roofs of the main labs and observatory (Braun & Grömling, 2005, pp. 218, 219) consist of triangular panels between a steel structure (UMEZAWA STRUCTURAL ENGINEERS, n.d.).

| | |
|---|---|
| **Architect** | Architect 5 Partnership |
| **Client** | Osada Electric Co. Ltd. |
| **Location** | Nagoya, Japan |
| **Type** | Science \| Medicine |
| **Opening** | 1992 |
| **Area** | 14,300 m² |

(Braun & Grömling, 2005, pp. 218, 219)

Figure 03.100 | Aerial View | Scale 1:10,000

Figure 03.101 | Photograph | © Birkhäuser Verlag GmbH

**Figure 03.102 |** Photograph | © 2013 ARCHITECTSHIP

**Floor plan organization**

The clear distribution of space within BASE shares similarities with Louis I. Kahn's Salk Institute. The large production area and the perimeter circulation increase NUF 3's efficiency. In addition, visual axes are available from nearly every point, potentially improving communication among employees. To the north, the uses are connected to the hall like a comb and offer a contrast. According to the photographs, the storage areas are presumably located south under the circulation next to the façade side.

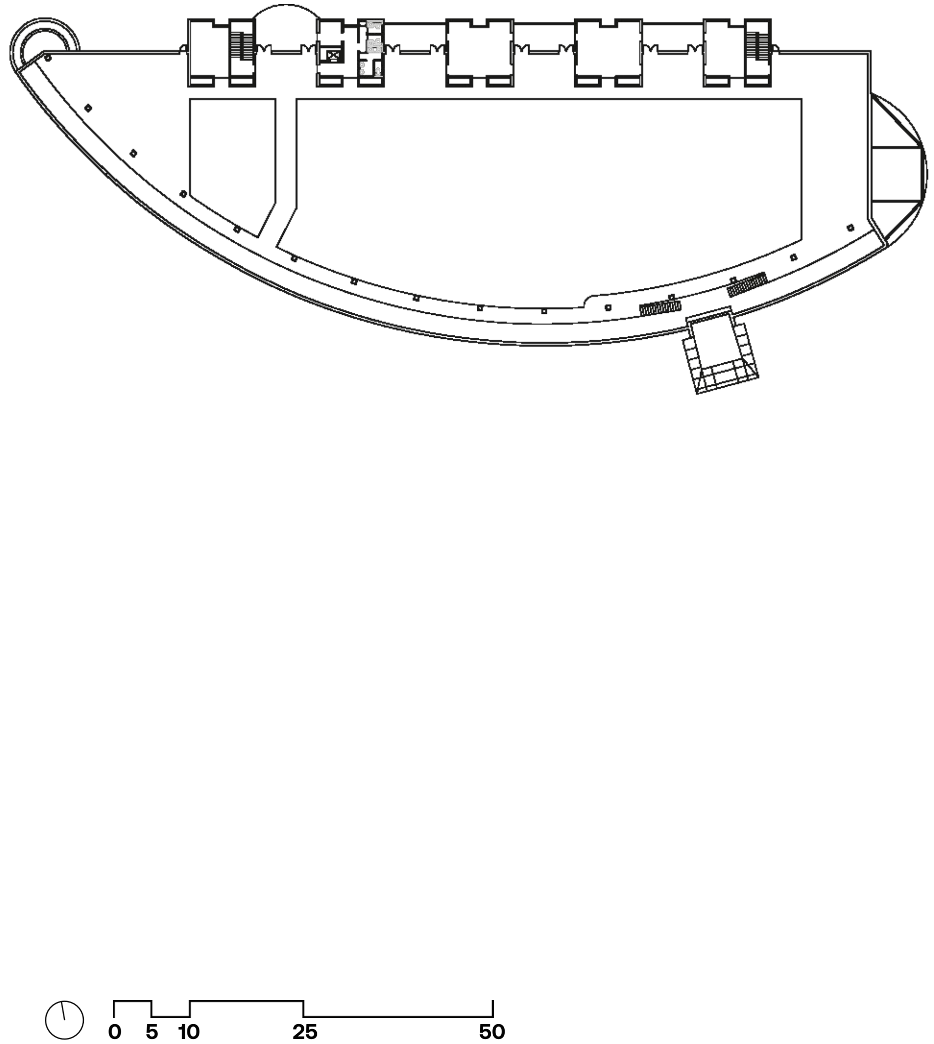



**Figure 03.103 |** First Floor | Floor plan | Scale 1:1,000


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

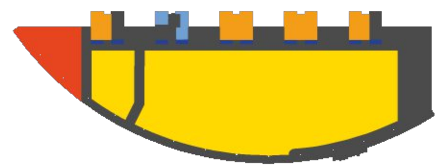
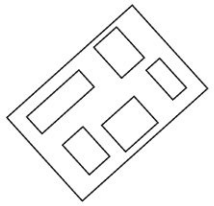


**Figure 03.104 |** First Floor | Space analysis | Scale 1:2,000

# LMH

LISE-MEITNER-HAUS



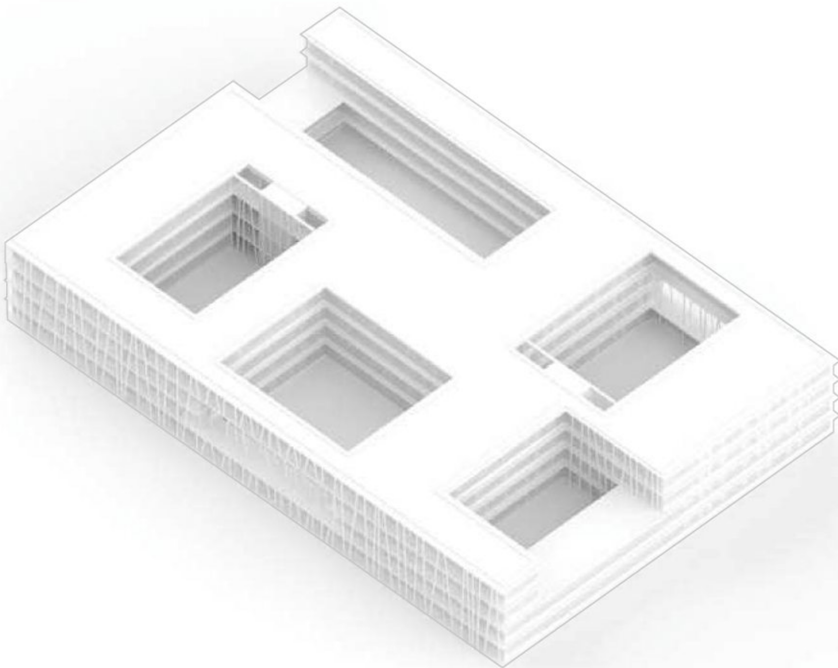


**Figure 03.105 |** Axonometry

**Context**

The institute of the Humboldt University Berlin, which was awarded the Berlin Architecture Prize in 2003, was built at the Adlershof research cluster (BauNetz, n.d.). The research focuses on experimental physics for materials (augustinundfrank/winkler ARCHITEKTEN, n.d.). The plans included a conversion and a new building, as well as relocating previous research areas to nearby buildings (Schneider & Kluge, n.d., p. 13).

**Use**

In addition to an entrance area with public uses such as lecture rooms, common areas, administration and library, labs with special requirements, workshops, and offices are located on the ground floor and the upper floors. The top houses research rooms with specialized requirements (augustinundfrank/winkler ARCHITEKTEN, n.d.).

**Innovation**

A "house-in-house" construction technique was employed to ensure the efficient operation of vibration-sensitive equipment. Despite the large floor area, orientation is easy due to the short distances (augustinundfrank/winkler ARCHITEKTEN, n.d.). A main corridor runs through all floors, with secondary corridors branching out to external paths, creating courtyards for clarity (BauNetz, n.d.).

**Material**

Exposed concrete ceilings optimize the internal climate by utilizing thermal storage (BauNetz, n.d.). The multi-layered façade incorporates glare protection and includes maintenance walkways. Horizontally, the media routing was implemented freely under the ceiling. The laboratories are supplied directly through vertical shafts (augustinundfrank/winkler ARCHITEKTEN, n.d.).

| | |
|---|---|
| **Architect** | augustinundfrank/ winkler Architekten PartG mbB |
| **Client** | Land Berlin \| Senatsverwaltung für Wissenschaft, Forschung und Kultur |
| **Location** | Berlin, Germany |
| **Type** | Education \| experimental physics, materials sciences |
| **Opening** | 2002 |
| **Area** | - |

(BauNetz, n.d.)



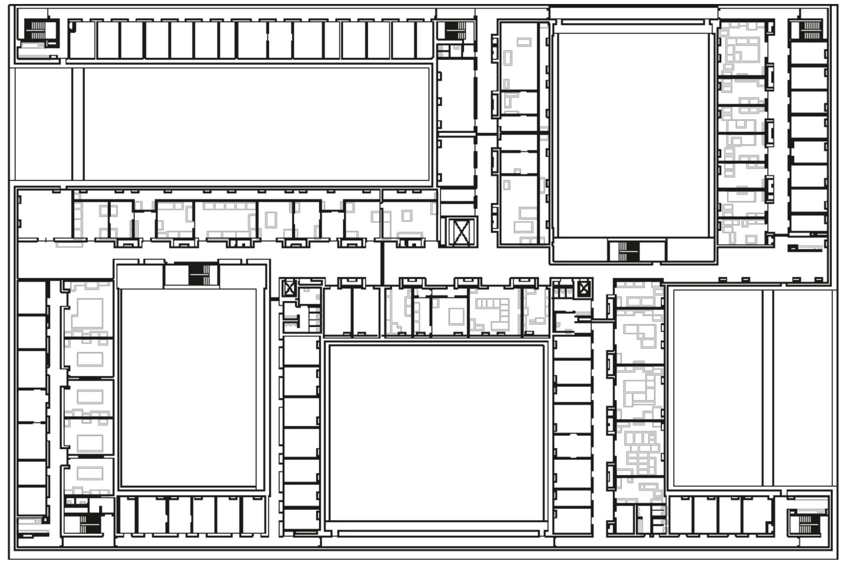
**Figure 03.106 |** Aerial View | Scale 1:10,000

**Figure 03.107 |** Photograph | © Humboldt-Universität zu Berlin

**Figure 03.108 |** Photograph | © Humboldt-Universität zu Berlin

**Floor plan organization**

The design prioritizes floor plan flexibility, allowing for the free grouping of various uses. The laboratories are generally assigned to the professors'offices. The floor plan was designed as a net (augustinundfrank/winkler ARCHITEKTEN, n.d.). Communication areas are arranged along the main circulation route (BauNetz, n.d.). The space distribution is clearly divided into thirds, with NUF 2, NUF 3, and circulation zones. The groups of professorships and their associated rooms are clearly delineated.



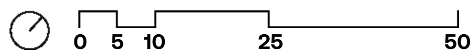



**Figure 03.109 |** Second Floor | Floor plan | Scale 1:1,000


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

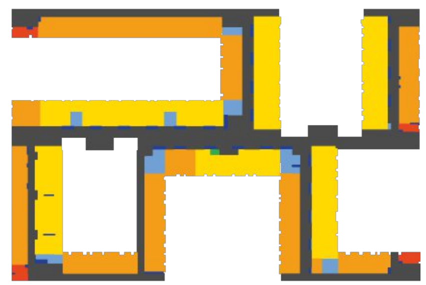
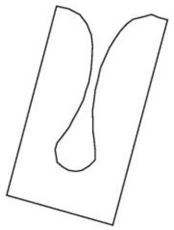


**Figure 03.110 |** Second Floor | Space analysis | Scale 1:1,000

# JCC

## JAMES H. CLARK CENTER



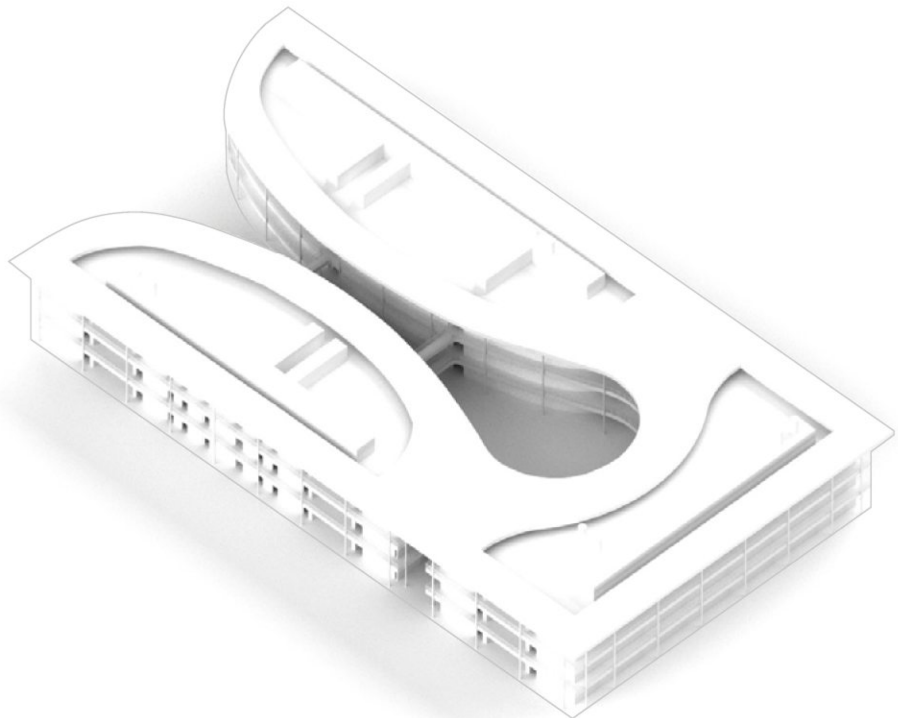


Figure 03.111 | Axonometry

**Context**
This building occupies a central location on the Stanford campus and is considered a key social hub. The basic idea of a communicative research environment, which was originally represented in the CCSR Center for Clinical Science Research at the university, is continued in this building (Foster and Partners, n.d.). It is known as “Bio-X”. Research is executed in the fields of medicine, engineering, and humanities & sciences (“The James H.Clark Center,” 2004).

**Use**
The facilities, including laboratories, offices, and communication areas, accommodate 700 users. The ground floor includes a canteen, while a stage in the central courtyard hosts events. To promote movement and communication among researchers, a café is situated on the upper floor. There is a large lecture hall in the basement under the central stage (Foster and Partners, n.d.).

**Innovation**
An essential concept point was the equal networking of different research fields (Stanford University & Wander, 2013). The open-plan laboratories are a key feature, encouraging interactions within the building through various work areas and views from the glass façade. Laboratory furniture on wheels and flexible ceiling infrastructure allow for the free use of the spaces (Foster and Partners, n.d.).

**Material**
Minimizing floor vibration was essential for the free structure. Each wing has an independent static system with its steel construction and concrete floor slabs (“The James H.Clark Center,” 2004).

| | |
|---|---|
| **Architect** | Foster and Partners \| MBT Architecture |
| **Client** | Stanford University |
| **Location** | Stanford, California, USA |
| **Type** | Education \| medicine, engineering, humanities & sciences |
| **Opening** | 2003 |
| **Area** | 22,760 m² |

(Foster and Partners, n.d.)

**Figure 03.112 |** Aerial View | Scale 1:10,000

**Figure 03.113 |** Photograph | © 2024 Foster + Partners

**Figure 03.114 |** Photograph | © 2024 Foster + Partners

**Floor plan organization**

The numerous bridges and external staircases reinforce communication ("The James H.Clark Center," 2004). A very efficient NUF 3 distribution can be seen. By moving the main circulation areas to the outside, they are not counted as usable space in accordance with DIN 277-1. The two laboratory wings are surrounded by a solid core structure, which mainly contains the dark zones. The work areas are based on visual relationships with each other. Most rooms in the southern part are offices.

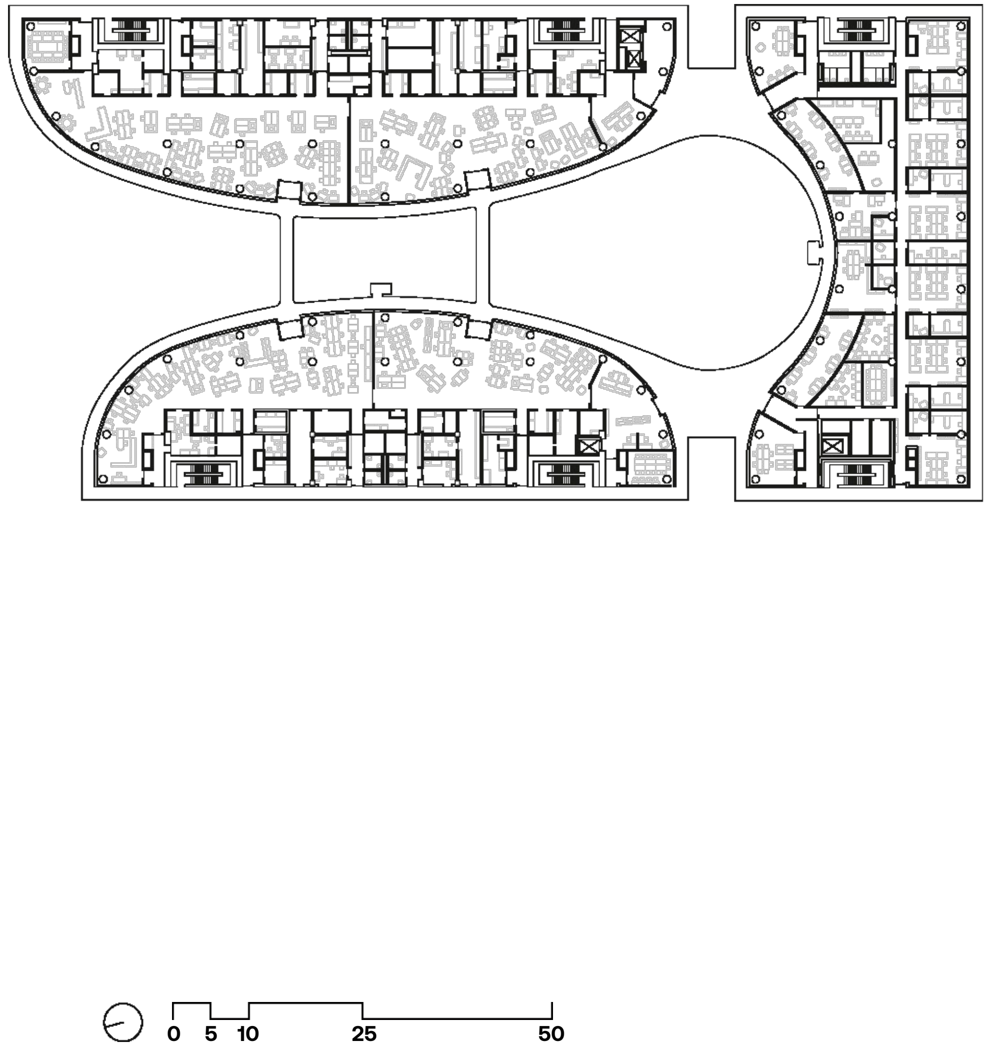



**Figure 03.115 |** Second Floor | Floor plan | Scale 1:1,000


Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

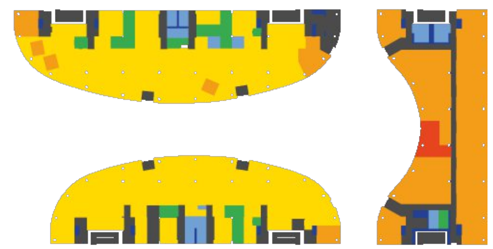


**Figure 03.116 |** Second Floor | Space analysis | Scale 1:2,000

# VOLUME

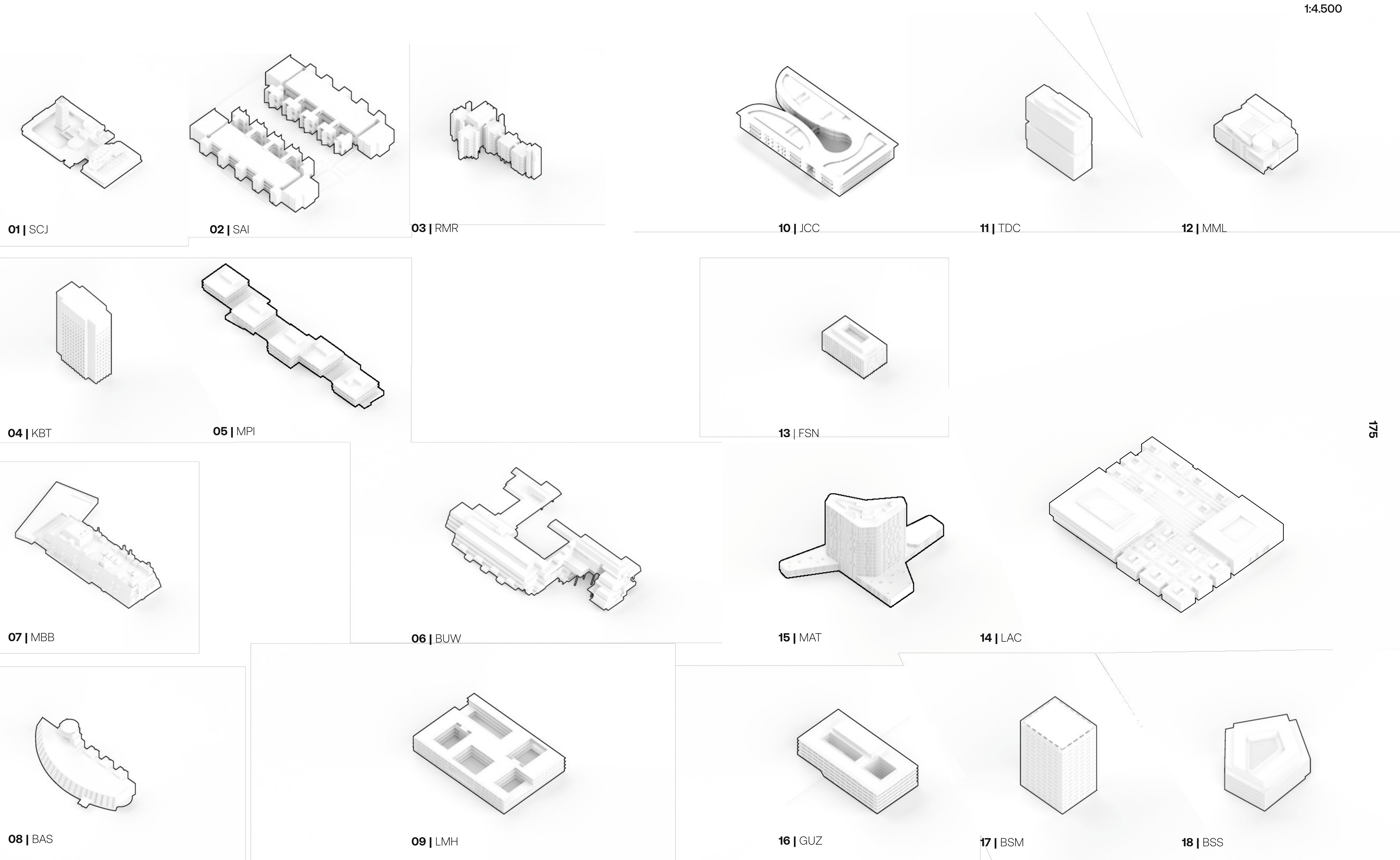



**Figure 03.117 |** Overview Axonometries

# FOOTPRINT

An overview of the footprints of the eighteen reference projects compared to the competition site with the existing Robert Koch Institute ensemble is shown.

**1:5.000**

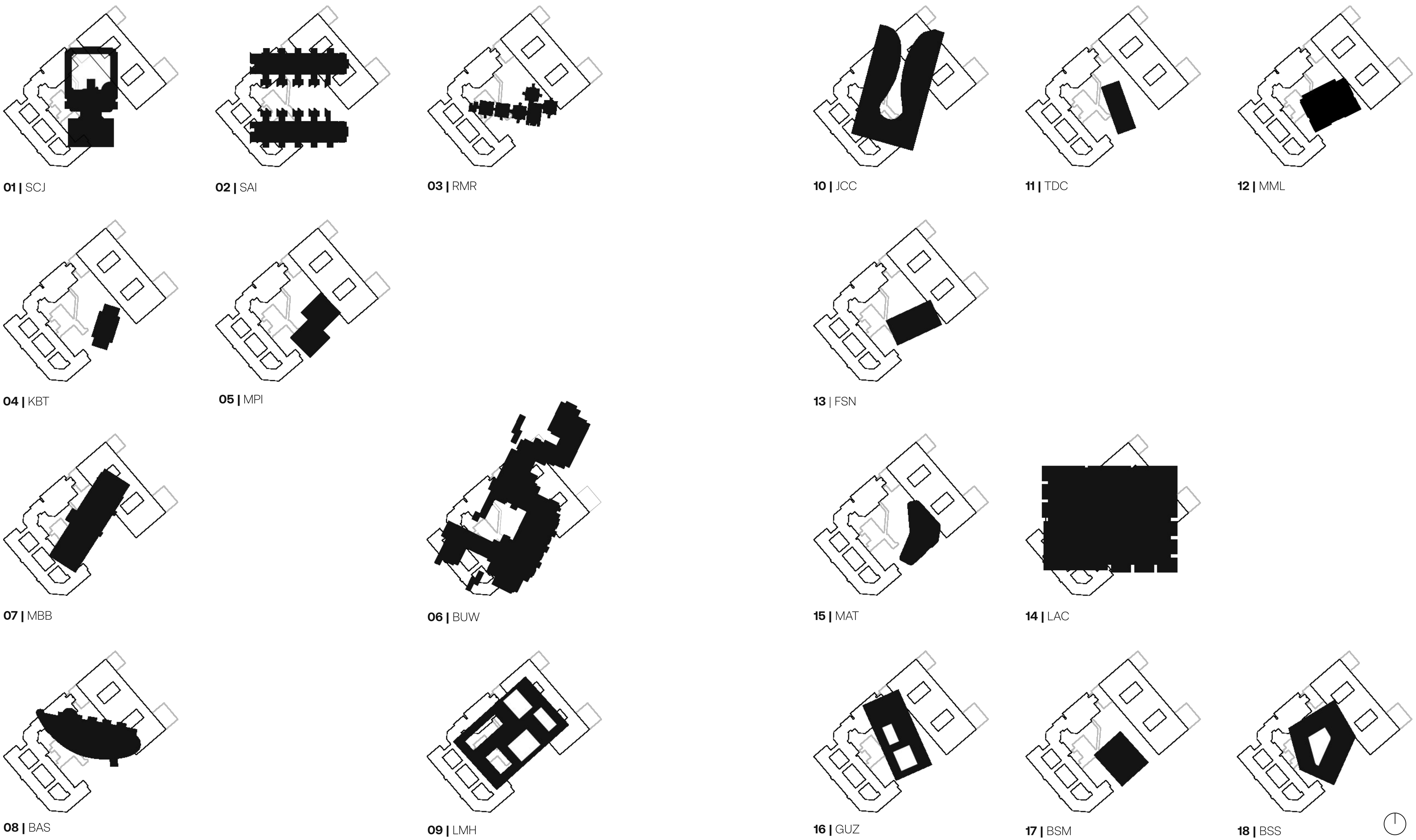



**Figure 03.118 |** Overview Footprints

# AREA RATIO

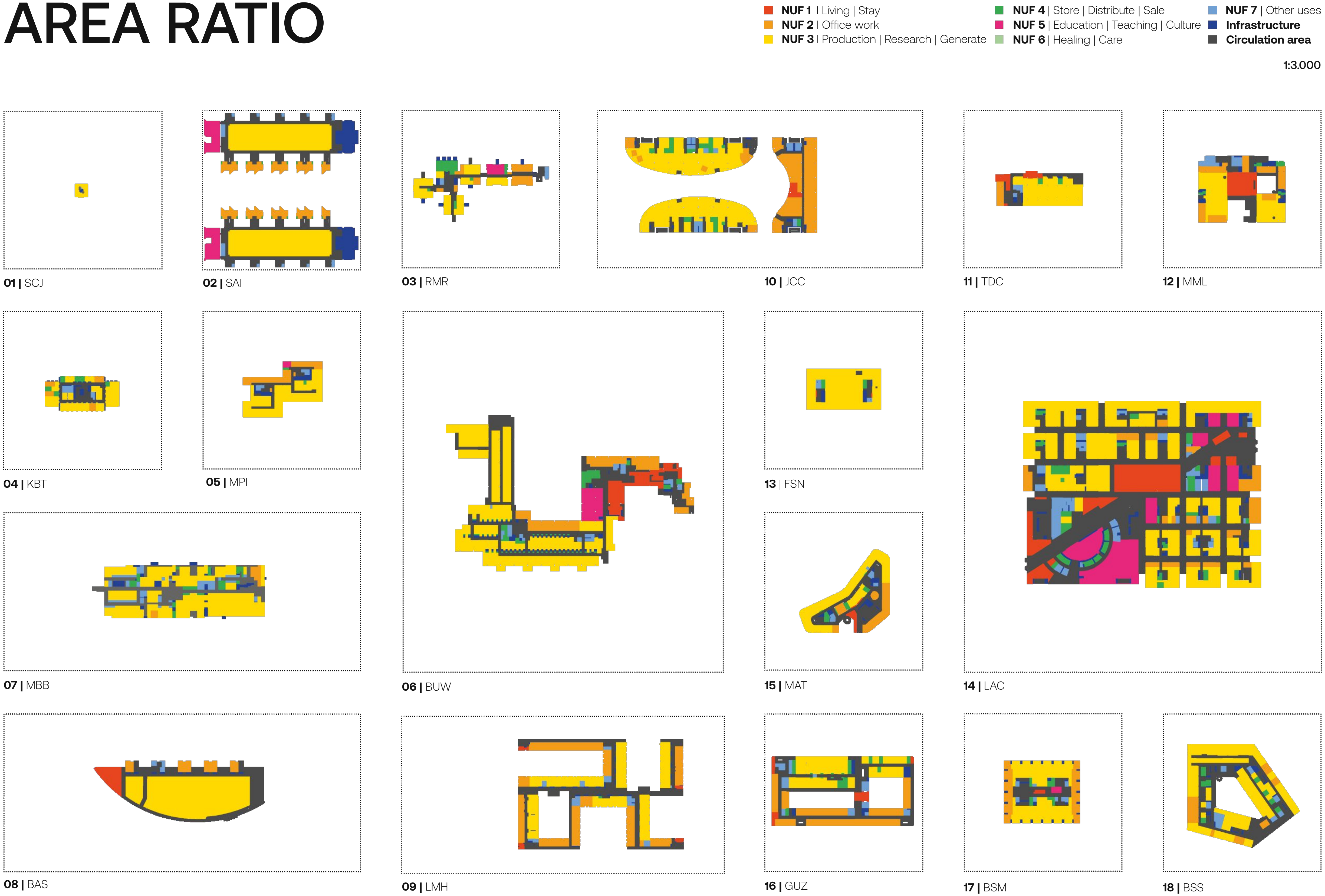



**Figure 03.119** | Overview Area Ratio

The chronological overview of the reference projects does not show any decisive trend. However, more subtle differences can be identified, which could be investigated through more in-depth research (see Chapter 04.03 Optimization - Evaluation). The most recent projects from 2017 have a higher percentage of circulation areas. On the one hand, compared to the first laboratory buildings, there is an increase in the area for explicitly designated communication zones. On the other hand, storage areas have been reduced, which could be due to increased digital use. The technical area and NUF 7 have instead remained the same.

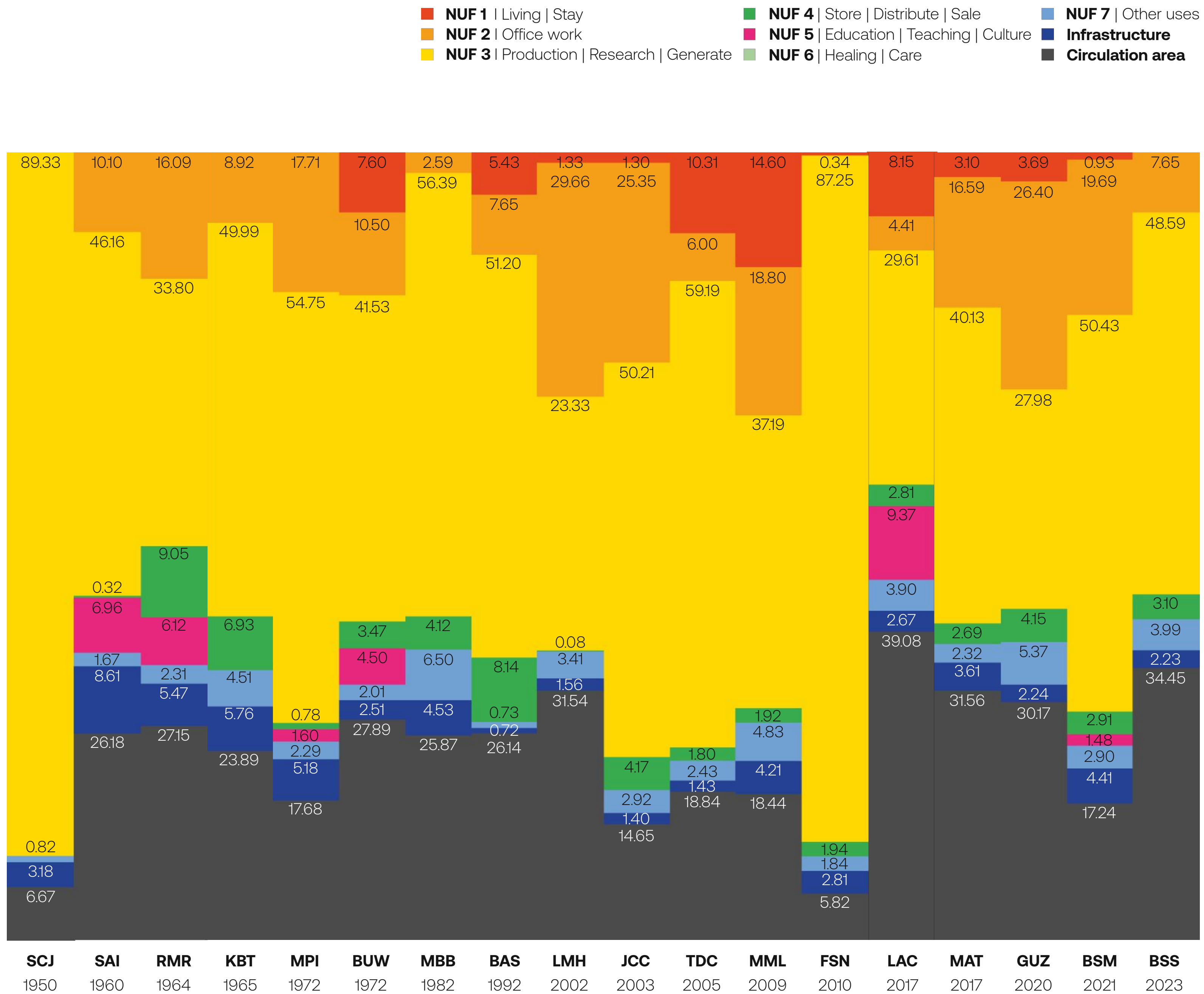



**Figure 03.120 |** Area Ratio Chronological | Chart | Numbers in %

The graphic on the right shows the area proportions of the 18 reference projects, sorted by the laboratory building types presented initially (see Chapter 01.04 Catalogue).
Within a group, the listing follows chronologically by year of construction.
Again there are no striking tendencies at first glance. The floor area ratios on the respective standard floors remain balanced despite the different disciplines. This facilitates a design that aims to promote interdisciplinary research work.
A higher proportion of office space is provided for educational institutions than for R&D or production.

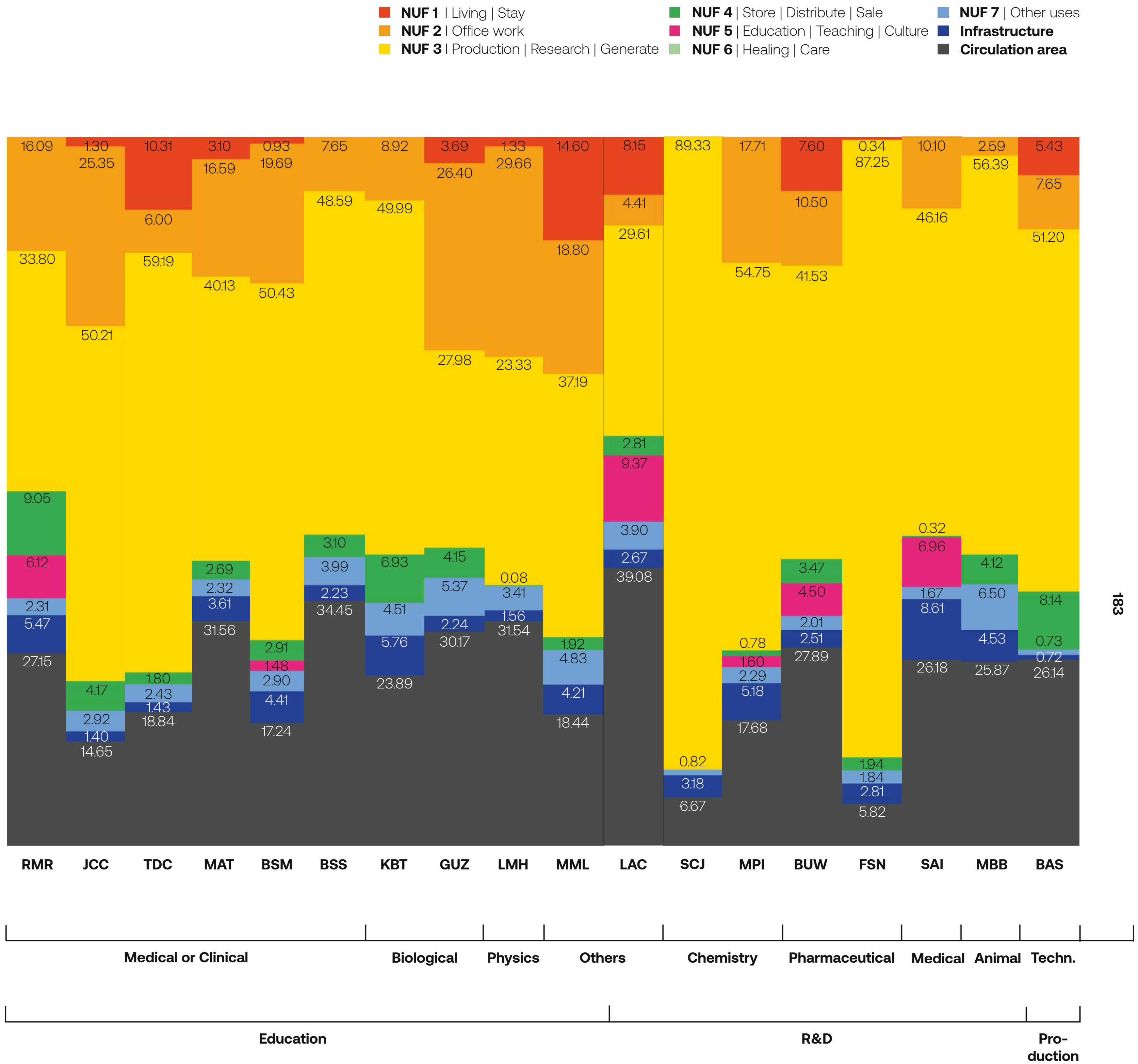
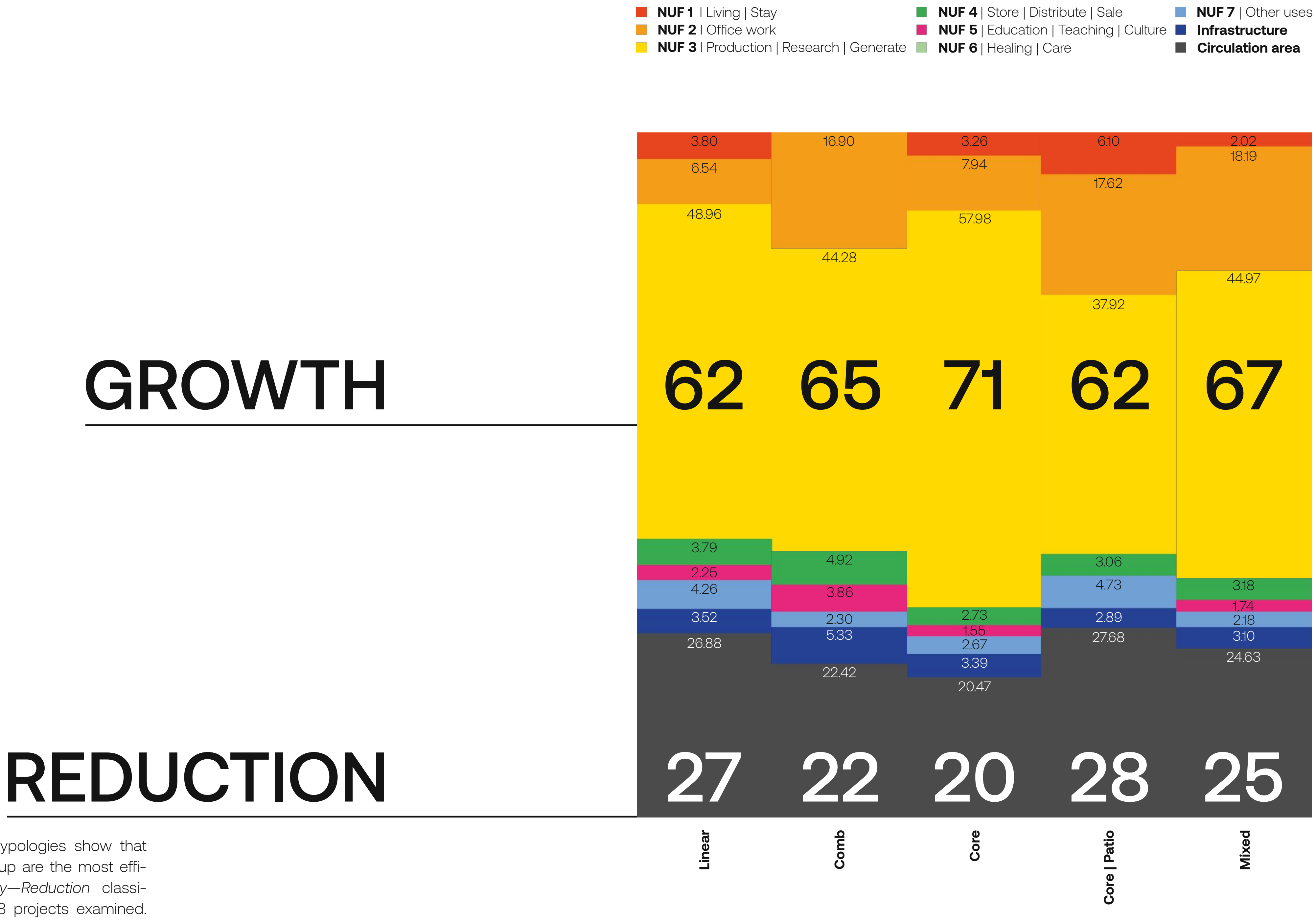



**Figure 03.121 |** Area Ratio Type | Chart | Numbers in %




The average shares of the respective typologies show that the references assigned to the Core group are the most efficient regarding the *Growth—Constancy—Reduction* classification. The results here relate to the 18 projects examined. As mentioned at the beginning of the thesis, the Core typology offers the optimum environment for open-plan laboratories and offices. The results of the analysis, therefore, confirm the current trend toward open-plan laboratories. Accordingly, it makes sense to use this typology for the following proposal in this thesis in order to allow maximum flexibility in arranging areas.

**Figure 03.122 |** Area Ratio Evaluation | Chart | Numbers in %

# ROOM CONNECTIONS

In order to obtain an analysis of the area ratios on the standard floors and to understand the correlations between the areas, the room connections are examined. The logic on which the analysis is based consists of the following five rules.

**Rules**

1. There is at least one connection
2. The path between two entrances to the rooms must be directly accessible without passing through other rooms - Circulation may be located in between as an exception.
3. A connection does not count in case of impression of spatial separation
4. Infrastructure is not taken into account
5. Fire doors and airlock systems count as boundaries

In the adjacent graphic, eleven frequently occurring types of rooms in laboratory buildings or reference projects are analyzed. Considering eleven types is sufficient to obtain an accurate overview. The figure shows the summary of all reference projects. The individual representations for each project can be found on the following two pages. The thicker a connecting line is shown, the more frequently the connection can be found in the buildings. If room connections exist multiple times within a project, they are only counted once for the sake of clarity and simplification.

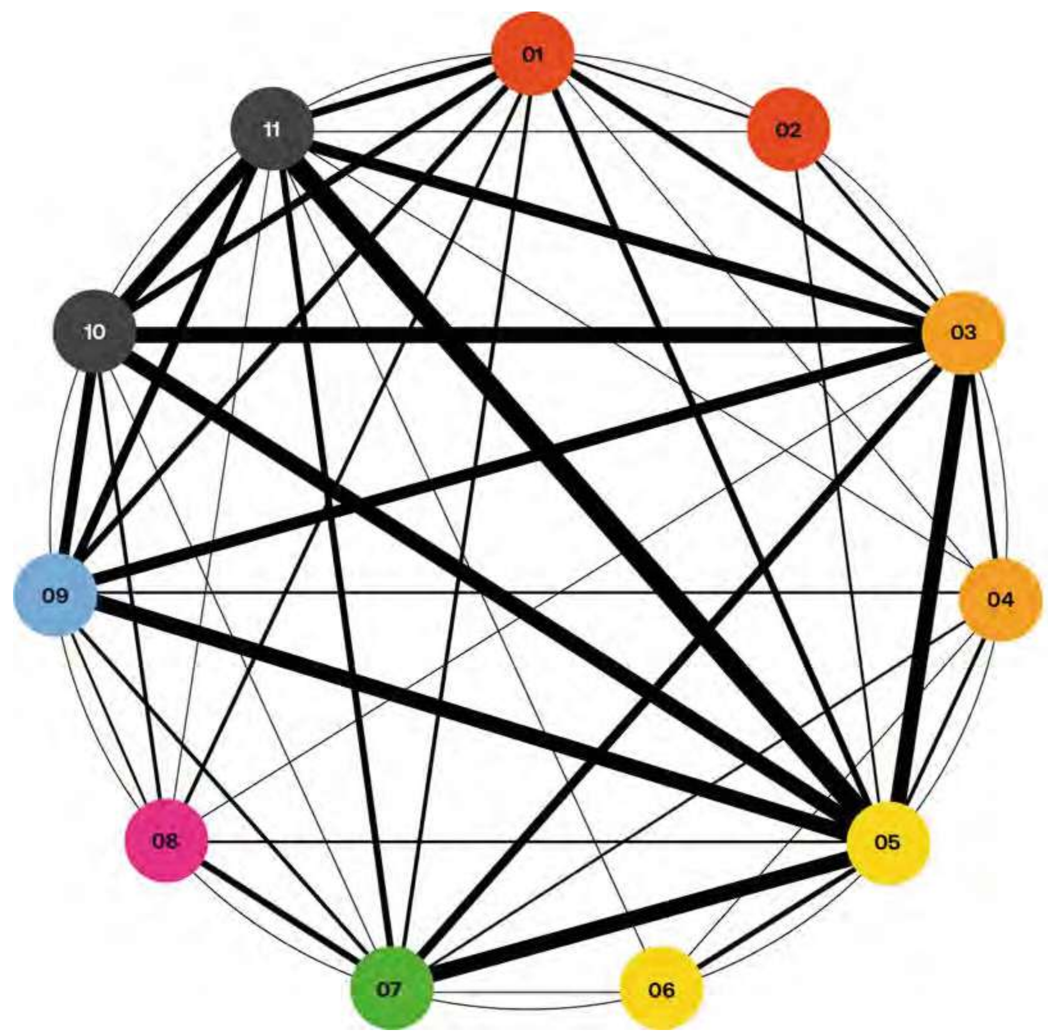
**Evaluation**

Four dense areas emerge. There is either a particular frequency of connections, which is shown by thick lines, or the accumulation of numerous connections to a space.

**Areas**

1. Communication zone | 01
   Broad-based connectivity. Frequently central communication area, but rarely present on the floors surveyed.
2. Office | 03
   Broad-based and frequent connectivity.
3. Laboratory | 05
   Broad-based and frequent connectivity.
4. Core | 09 – 10 – 11
   Strong and frequent linking of numerous rooms to the cluster: elevator, stairs, and sanitary area.

**01** Communication zone
**02** Tea kitchen
**03** Office
**04** Meeting room
**05** Laboratory
**06** Write-Up space
**07** Storeroom
**08** Presentation | Learning
**09** Sanitary room
**10** Elevator
**11** Stairway




| Strongest connections | | ↓ / 18 |
|---|---|---|
| **05 - 11** | Laboratory - Stairway | **16** |
| **03 - 05** | Office - Laboratory | **12** |
| **03 - 10** | Office - Elevator | **12** |
| **05 - 07** | Laboratory - Storeroom | **12** |
| **05 - 09** | Laboratory - Sanitary room | **12** |
| **05 - 10** | Laboratory - Elevator | **12** |
| **10 - 11** | Elevator - Stairway | **11** |
| **03 - 09** | Office - Sanitary room | **9** |
| **03 - 11** | Office - Stairway | **9** |

**Figure 03.123 |** Room Connections | Diagram

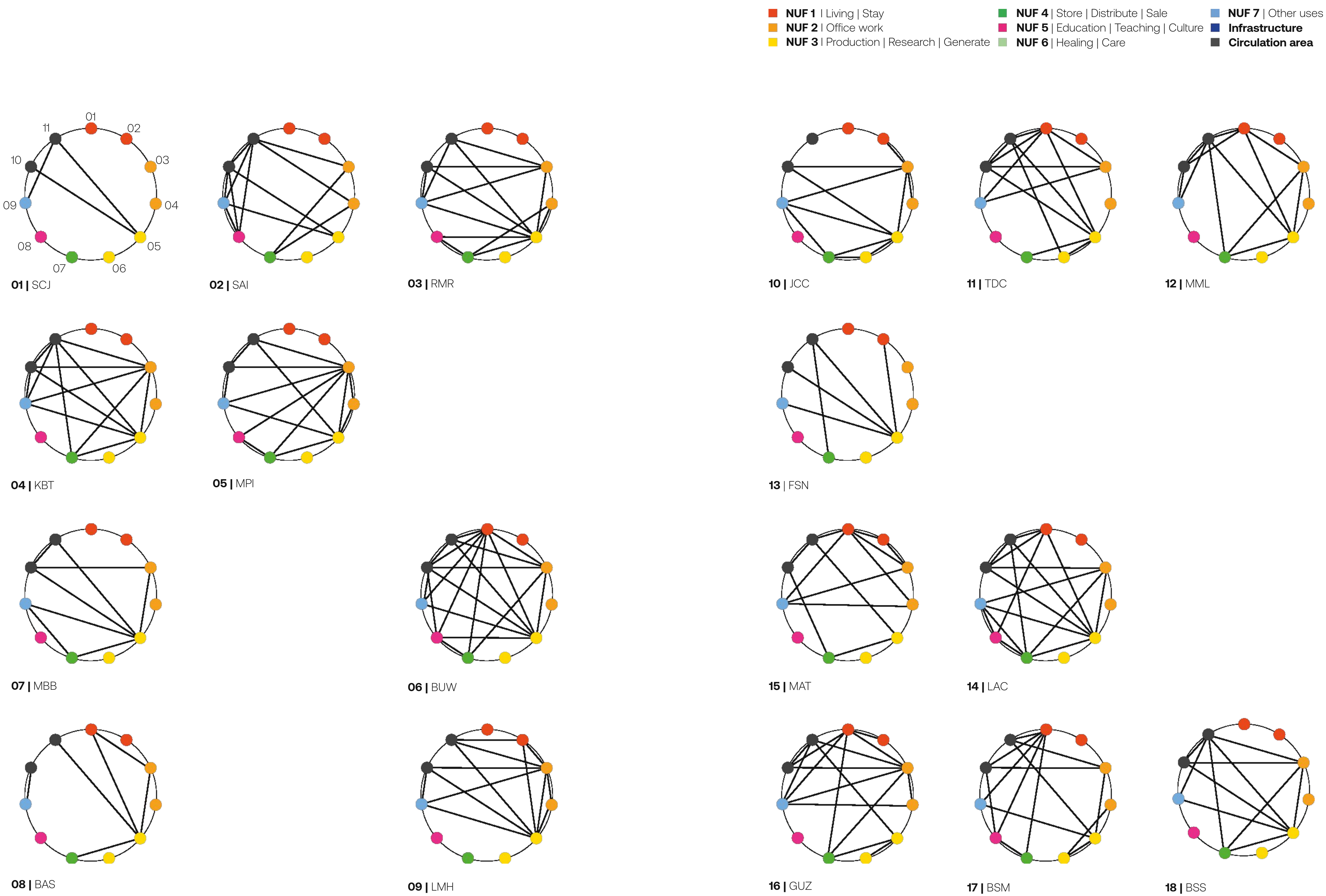



**Figure 03.124 |** Overview Room Connections | Diagrams

# 04 Optimization

The work aims to generate a sustainable approach to the planning of laboratory buildings. But what does sustainability mean? Most people probably associate it with the use of environmentally friendly materials such as wood or clay or the option of dismantling and recycling. The longevity, costs, and differentiated usability of a building are also important approaches to sustainability. However, an approach that is often underestimated but which should be highlighted in this thesis is the optimization of space in order to use as little material as possible in the first place. Saving space is often equated with a deterioration in room quality, aesthetics, or working atmosphere. This idea is crucial to the methods presented, aiming to balance theoretical optimization with the building's practical appeal.

**Space-efficiency in laboratory buildings**
Another aspect that speaks for the investigation of possible space optimizations in laboratory buildings is the aim of increasing the efficiency of research work. The more researchers operate in a smaller space, the more interaction takes place. In addition, the safety aspect is increased by the resulting visual connections. In general, people should not be alone in laboratories. In the future, more and more processes will take place without direct or constant supervision of employees, creating “people-free” zones with machines. A balance must be found between close employee contact and machine-operated areas (Hegger, 2005, p. 28). It can also be assumed that shorter transportation routes in a compact environment will lead to faster research results. It should always be borne in mind that there must be spaces for exchange as well as for concentrated work.
Optimizing space alone does not create a fully sustainable approach. The flexibility of the stories and adaptability to unforeseen developments must also be possible (Nickl et al., 2022a, p. 71).

**Rating system**
Firstly, the gross floor area (GFA) is divided by the main usable area (MUA). This means that all areas, except for cavities or unused roof areas, are divided by the total usable area, excluding ancillary rooms such as sanitary areas, technical areas, or circulation areas. On the other hand, the gross floor area (GFA) is usually divided by the main usable area (MUA). Alternatively, this can be divided by the total enclosed volume. Furthermore, the heights of the stories and the distribution of use play a decisive economic role (Grömling, 2005, p.47).

**Further sustainability parameters**
In the planning, tendering, and evaluation of laboratory buildings, sustainability is expressed in different values, as already mentioned. However, points such as materials, construction, durability, and space efficiency alone are not enough (Nickl et al., 2022a, p. 71).
Considered planning of the laboratory façades also offers important sustainability approaches. How much glass is installed, and what solar shading is used? What is the ratio between opaque and transparent façade elements? Furthermore, fixed building elements should be provided with a heat storage option. Finally, the assessment of the users is, of course, of enormous importance. Making them feel comfortable in an aesthetically pleasing building also promotes performance and, therefore, research efficiency. In addition, the longevity of an aesthetically pleasing building is enhanced by an increased willingness to maintain the building (Nickl et al., 2022a, p. 71).

**Structure of the chapter**
In the chapters so far, an introduction to the topic of laboratory construction with corresponding reference projects was provided. The transition is now made to the implementation of the knowledge gained. The following pages present the insights earned from the analysis to date and show ways in which each can contribute to space optimization.
On the following pages, five layers with parameters for a modern and innovative laboratory building are presented. The information is based on the findings of the research carried out for this thesis. Subsequently, 44 frequently occurring rooms within this typology are presented, classified, and hierarchized according to four categories. The four categories *Accessibility*, *Communication*, *Frequency of Users* and *Technical Infrastructure* are intended to enable the layers presented to be implemented in the planning as far as possible. This analysis results in 14 room groups, *New Categories*, that can be used as an alternative to the previously presented usable areas according to DIN 277-1 | 2016. The design of this work is based on this approach. A method is also demonstrated to minimize the typical corridor situation as far as possible without losing the communication or logistics function. Item 04.03 Evaluation provides an overview of the theoretical research findings up to this chapter.

# LAYERS

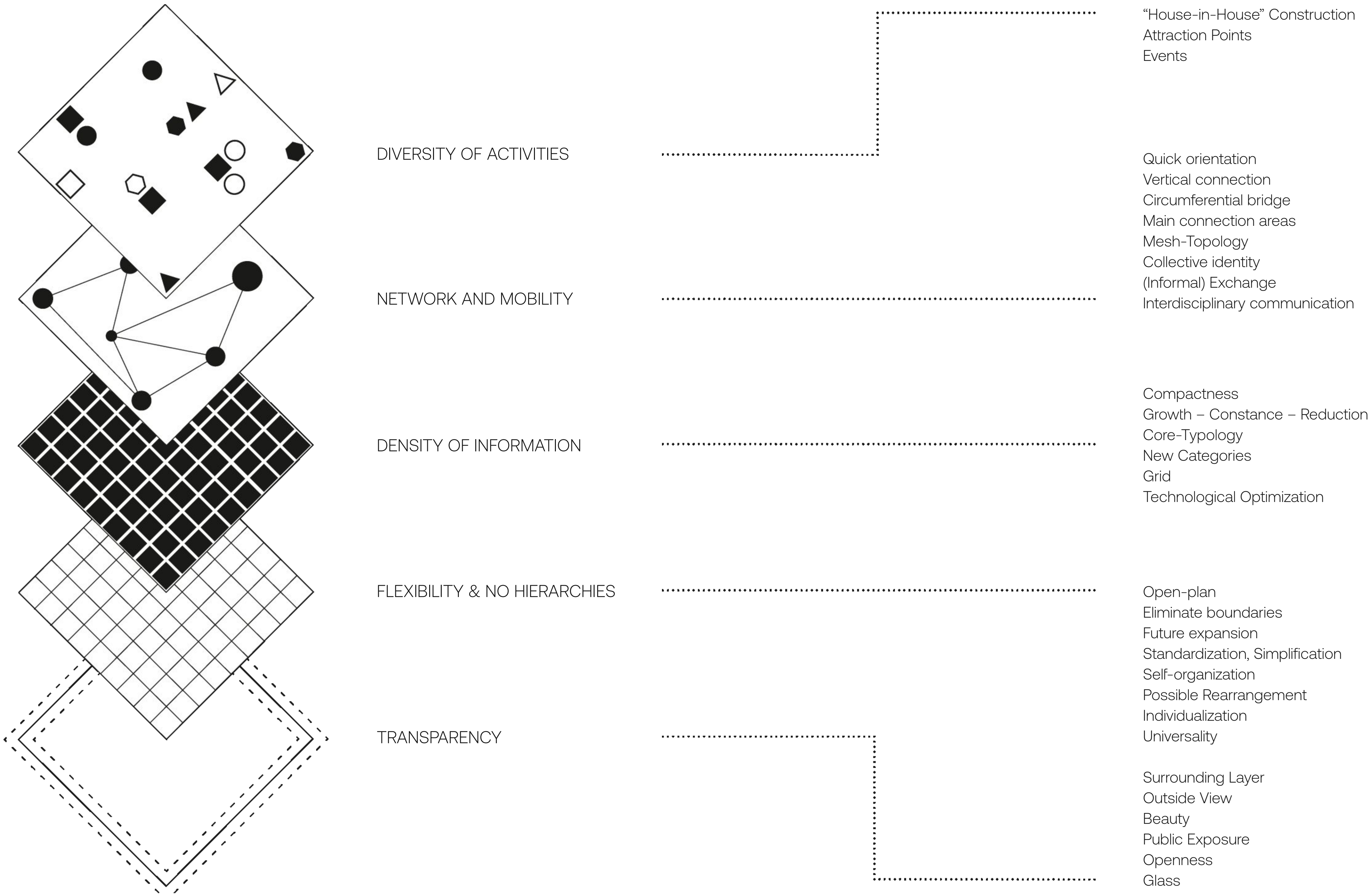
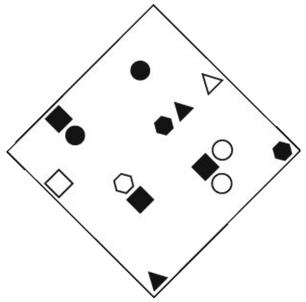



**Figure 04.01 |** Layers

# DIVERSITY OF ACTIVITIES



**“House-in-house” construction**

The “room-in-room system” or “house-in-house” construction enables the special architectural treatment of rooms that contain vibration-sensitive measuring devices or require individual ventilation systems. The first term refers to individual rooms, while the second refers to larger overall areas. In an S4 laboratory, for instance, negative pressure is generated throughout, as was implemented in RKI House 6. By statically separating the building elements, on the other hand, a separate zone can be efficiently created, as in the Lise-Meitner-Haus. In the design, this aspect will be shown later in this thesis by placing the laboratory zone within a reinforced concrete structure (Bundesamt für Bauwesen und Raumordnung, n.d.,) (augustinundfrank/winkler ARCHITEKTEN, n.d.).

**Attraction Points**

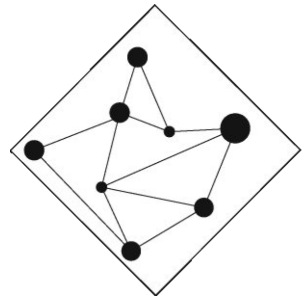
In the design of this thesis, the *Attraction Points* play a decisive role in increasing communication. These zones are offered both in a separate outdoor area and distributed on each floor. The size of the areas varies greatly.
Various uses also promote concentrated work and well-being (Marguin et al., 2019, p. 160). Examples of this include retreat and relaxation areas as well as communication areas. Concentration opportunities can consist of creative spaces, learning spaces, quiet boxes, vegetable beds, massage rooms, or innovation labs. Areas for table tennis, snack or coffee bars, brainstorming areas, feedback zones, or climbing walls are conceivable for employee exchanges. Additional services, such as a laundry service (see 01.05 Interview), increase the attractiveness of the institute.

**Events**

Events promote the so-called “collective identity” (→) among employees and the work dynamic. They encourage spontaneous communication and exchange with colleagues with little overlap in everyday working life (Marguin et al., 2019, pp. 149-151). The events can occur at different intervals, each with advantages. Examples include the following. Daily team meetings or joint lunches promote regular interaction. Weekly sports lessons, guided tours for visitors, lectures, or after-work celebrations can provide a change from the daily work routine. Monthly stress management seminars, table tennis tournaments, art exhibitions, hackathons, and orientation programs for new employees could take place. Inter-institute sports competitions, Christmas parties, and excursions could be offered annually.



# NETWORK AND MOBILITY



**Quick orientation**

Communication is enhanced via view axes. In addition, the frequent, global change of institutes by researchers in requires quick orientation options. Examples are spacious foyers, platforms, signage, color concepts, and room clusters.

**Vertical Connection**

It promotes communication, and is a crucial concept point in numerous references such as the Kline Biology Tower or the Maersk Tower. Visual axes and attractive stairwells increase spontaneous communication.

**Circumferential Bridge**

This element can provide an (emergency) exit to the outside and a direct view when walking along the surrounding walkway, thus increasing communication. House 5 on the RKI site is an example of this.

**Main connection areas**

As analyzed in Chapter 03.03, four main areas can be identified, closely linked to all uses. Therefore, the laboratory, office, cores, and central communication zone are essential in the planning.

**Mesh-Topology**

The zones are arranged to require crossing others, creating a complex layout. (Marguin et al., 2019, pp. 124-134). “[N]odes” for stay should be formed in the buildings (Henn, 2005, p. 3).

**Collective identity**

“[C]ollective identity” (Marguin et al., 2019, p. 149) is promoted among employees by planning joint activities and presenting them to the public together as representatives of the institute (Marguin et al., 2019, pp. 149-153).

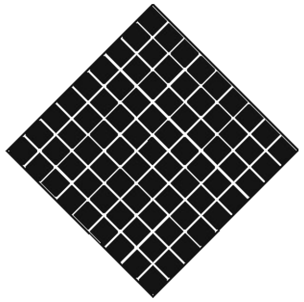
**(Informal) Exchange**

„Research takes place on the staircase, not in the laboratory.” (Nickl et al., 2022c, p. 126). Communication, both spontaneous and planned, is crucial in laboratory work (see Chapter 01.02).

**Interdisciplinary Communication**

Since the middle of the 20th century, interdisciplinary research has become increasingly commonplace (Landbrecht & Straub, 2016a, p. 40). Nowadays, the exchange with colleagues and experts is essential (Nickl et al., 2022c, p. 110).

# DENSITY OF INFORMATION



**Compactness**
One parameter for large areas such as the office is the density of workstations (Marguin et al., 2019, p. 110). In order to increase efficiency, there should be opportunities for employees to interact as frequently as possible. The length and duration of communication routes are crucial (Henn, 2005, p. 3).

**Growth - Constance - Reduction**
As described in chapter 01.02 Colour Concept, this thesis aims to increase the proportion of space in the Growth category. This means maximizing the percentage of laboratory, office, teaching, and communication zones. The classic corridor situation should be avoided as far as possible.

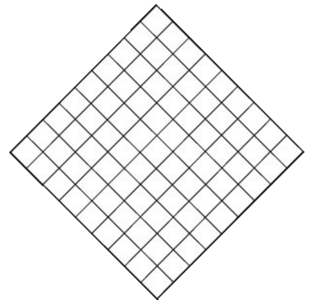
**Core-Typology**
As the analysis of the references has shown, the core typology is the most space-efficient. Based on the reference projects and additional research, a core contains a minimum of the following rooms: (escape) stairway, (escape) elevator, sanitary rooms, and an adjacent optional learning room.

**New Categories**
New room groupings are proposed as alternatives to the current NUF per DIN 277-1:2016 (see Classification). Fifty typical rooms in a laboratory building are categorized according to Accessibility, Communication, Frequency of users, and Technical Infrastructure.

**Grid**
Grids that are as large as possible increase the flexibility of the stories. It is helpful to distinguish between fixed components and areas that can be changed with little effort. An axis grid of 1.15 m or 1.20 m is often used (Nickl et al., 2022a/c, pp. 65, 92, 118). The strong grid characterizes the sense of space in the laboratory building (Marguin et al., 2019, p. 129).

**Technological Optimization**
As mentioned in the interview, there is a trend towards “highways” for technical infrastructure in the form of automated central shafts. Researchers will work on diverse tasks in the future, while machines will perform simple tasks (Traube et al., 2022, p. 241). Densifying the story usually results in a shorter distance and, therefore, greater proximity between employees, which is advantageous in terms of safety (Hegger, 2005, p. 28).

# FLEXIBILITY & NO HIERARCHIES



**Open-plan**
The aim is spaces in which the transition from privacy to communication is fluid, with short distances. (Marguin et al., 2019, p. 161). "Laboratory landscapes" with many modules must allow separate room layouts for safety. (Nickl et al., 2022a, pp. 92, 93).

**Eliminate boundaries**
Research efficiency depends on the speed of exchange, so an overview of all work areas should be provided. (Henn, 2005, p. 5). Above all, enabling spontaneous communication is essential (Nickl et al., 2022c, p. 126).

**Future expansion**
The option of expandability (see Interview) aligns with sustainable laboratories, covering technology, structure, story dimensions, and the building envelope. (Nickl et al., 2022a, p. 71).

**Standardization, Simplification**
The division of complex activities into simple, solvable sub-tasks promotes efficiency. (Henn, 2005, p. 3). It can be implemented using a 90° grid on the floor in which the furniture is placed (Nickl et al., 2022a, p. 95).

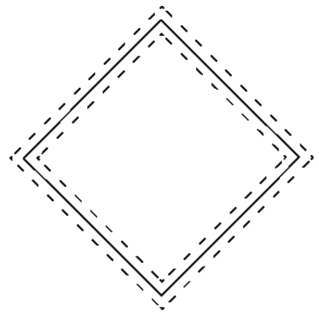
**Self-organization**
The way of working in the lab can be described as a “social system with its own cultural codes” (Klonk, 2016, p. 18). It should not be a fixed space that is difficult to adapt to current projects (Marguin et al., 2019, p. 89).

**Possible rearrangement**
The basic area should be highly flexible, with walls added as needed. (Nickl et al., 2022a, p. 93). A roller system for furnishings could be considered here (Landbrecht & Straub, 2016, p. 31).

**Individualization**
The user's customizability of spaces is becoming increasingly important (Semmler, 2022, p. 97). Researchers, as Experimental Zone shows, set up their worstations according to their wishes.

**Universality**
The “Theory of placelessness” (Landbrecht & Straub, 2016, p. 30) assumes that society's trust in research results is strong due to the universality of laboratory buildings. History shows that universality has increased with the “laboratory revolution”.

# TRANSPARENCY



**Surrounding layer**
Façades are increasingly being planned with greenery and as sustainably as possible. Sun protection, filter systems, and photovoltaic systems are just a few examples of common applications. The glass-to-solid façade ratio is key, often including walkable elements. (Nickl et al., 2022b, pp. 175, 191).

**Outside view**
Public exposure and outside view usually represent a certain contrast in the choice of desk. Accordingly, each employee has an individual preference (Marguin et al., 2019, p. 119). Also, an exciting external view can attract talented researchers (Nickl et al., 2022c, p. 124).

**Beauty**
"[B]eauty motivates people and it helps to recruit people in the competitive work situation of today" (Fishman & Reinhardt, 2009, p. 34). A building's sustainability is shown not only through its space and materials but also its aesthetic value, which justifies long-term maintenance.

**Public exposure**
The entrance and public insight are key, with displays making current research excitingly clear upon entry. (Kaji-O'Grady & Smith, 2019, Chapter 1). The team spirit among employees is strengthened by the exposure during visitor tours (Marguin et al., 2019, p. 152). In addition, an insight into the building conveys transparency, which can have a confidence-building effect on passers-by (see also "theory of placelessness" (Landbrecht & Straub, 2016, p. 30)).

**Openness**
Nowadays, openness and external representation are of great importance. A spacious laboratory building with numerous view axes promotes communication between employees. In addition, the employees' pride and connection to the institute increases (Landbrecht, 2016, p. 88).

**Glass**
"Glass façades allow [...] democratisation of knowledge" (Landbrecht, 2016, p. 76). Glass is not the same as transparency. It will never be completely transparent with its reflection and imprints (Kaji-O'Grady & Smith, 2019, Chapter 4). The façade can provide insight as a public display.



**NUF 1** | Living | Stay
**NUF 2** | Office work
**NUF 3** | Production | Research | Generate
**NUF 4** | Store | Distribute | Sale
**NUF 5** | Education | Teaching | Culture
**NUF 6** | Healing | Care
**NUF 7** | Other uses
**Infrastructure**
**Circulation area**

In summary, the layers are based on extensive literature research. Frequently mentioned terms in the literature were compared and grouped logically. The complexity and parameters to be considered when planning a research building are very extensive. However, this overview also shows the diversity of uses and the unexpected variance in planning options. The axonometry shows mainly possible *Attraction Points* that can contribute to the well-being of employees and increase efficiency.

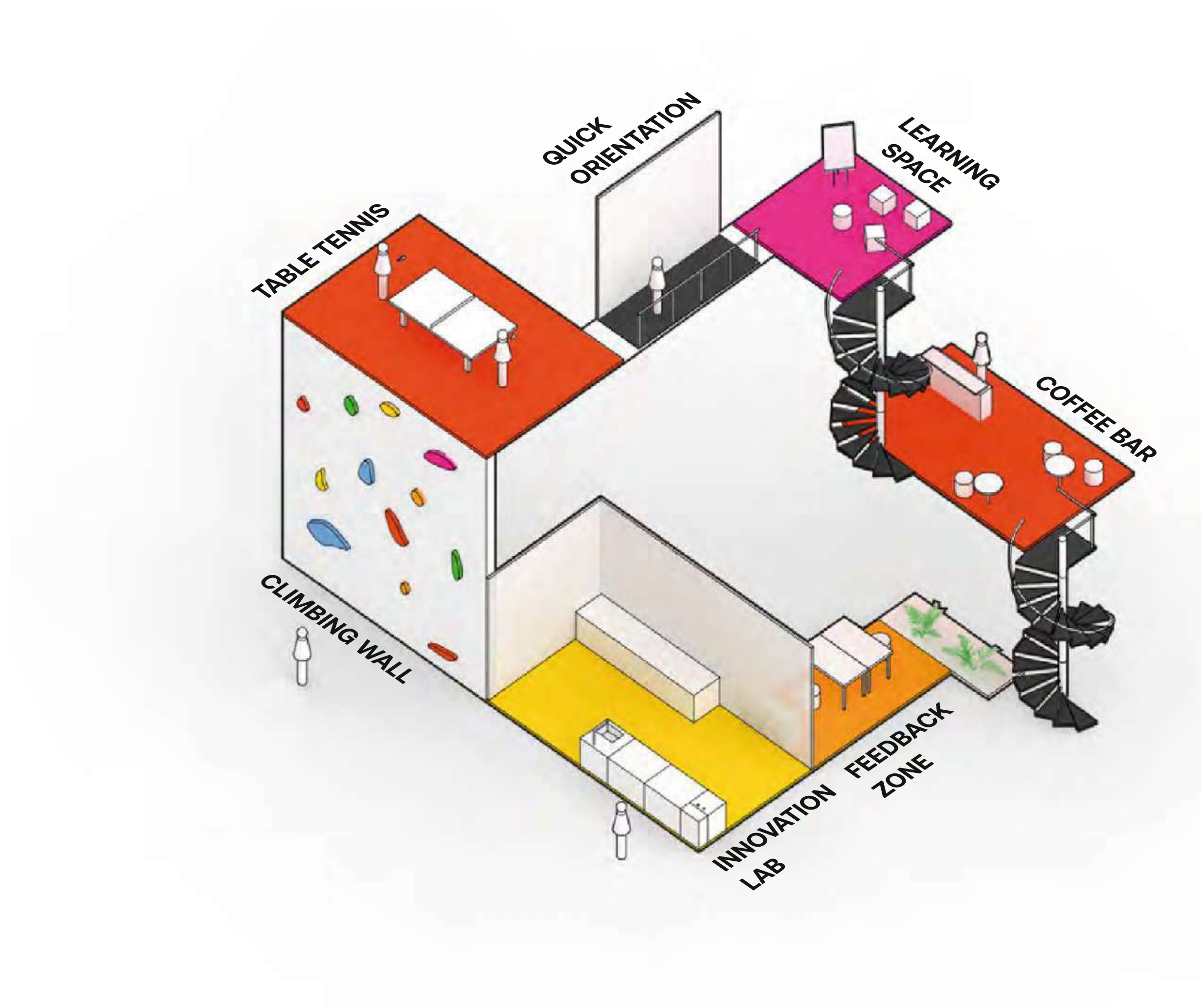
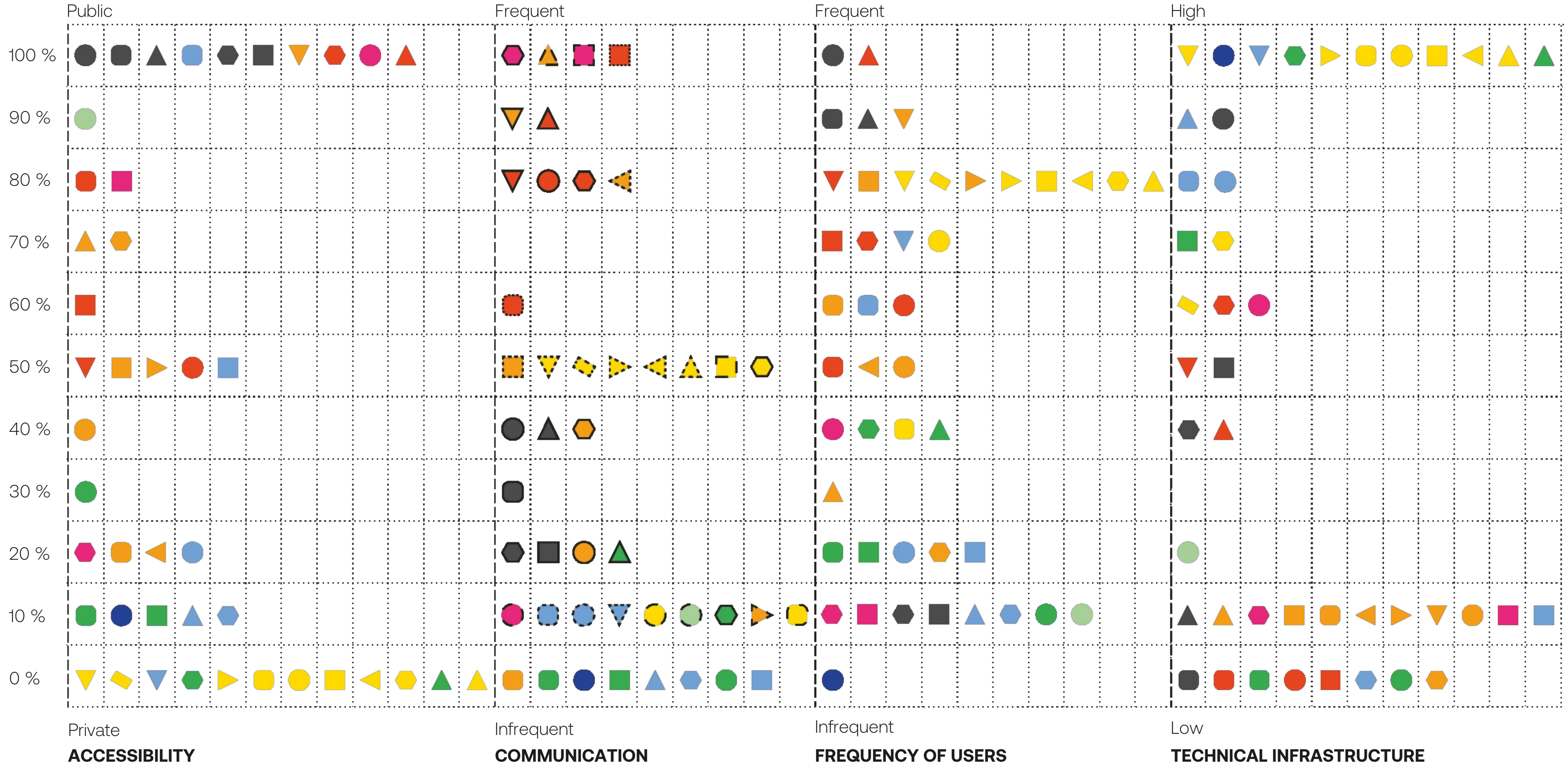



**Figure 04.02 |** Examples Attraction Points | Axonometry

# CLASSIFICATION

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**




Random
Spontaneous
Planned

**NUF 1 | Living and Stay**
Break room
Cafeteria
Central communication zone
Foyer
Seating areas
Tea kitchen

**NUF 2 | Office work**
Computerpool
Copy/Printer room
Group office
Meeting room
Phone booth
Secretary´s office
Single office
Workbox

**NUF 3 | Production**
Autoclave room
Dark room
Drainage machine and hazardous material
Electrophoresis
Incubator room
Laboratory
Microscopy room
PMCA
Write-up space

**NUF 4 | Store**
Archive
Cold storage
Equipment room
Liquid fuel filling
Storeroom

**NUF 5 | Education**
Learning space
Presentation areas
Training room

**NUF 6 | Healing**
First aid room

**NUF 7 | Other uses**
Changing room/Shower
Cleaning room
Garbage room
IT-Room
Sanitary room
Airlock

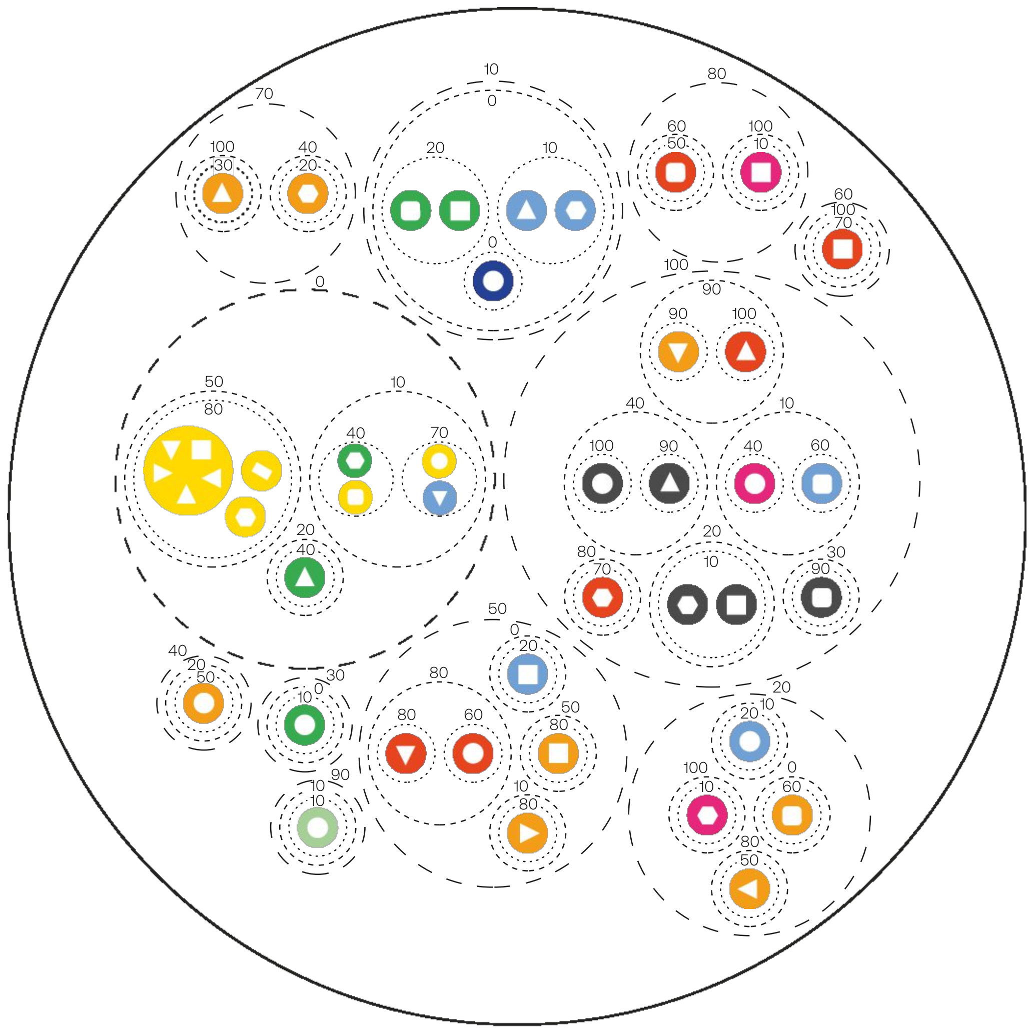
**Infrastructure**
Technical shaft

**Circulation area**
Elevator
Escape route
Escape stairway
Hallway
Stairway

**Figure 04.03 |** Classification | Diagram

# SORTING

1. Accessibility
2. Communication
3. Frequency of users
4. Technical infrastructure



The previous layers of a modern, complex laboratory building should be as easy to plan as possible. The aim is to use room categories that make as much sense as possible in terms of economic factors, efficiency, employee communication, and hygiene limits. This order should represent an alternative to the prior investigations according to the usable areas in accordance with DIN 277-1 | 2016.
On the previous page (see Figure 04.03), 44 rooms that are frequently found in laboratory buildings were initially assigned to four parameters according to my own assessment. These parameters are *Accessibility*, *Communication*, *Frequency of users* and *Technical infrastructure*. In the adjacent graphic (see Figure 04.04 ←), the second step, sorting, is carried out. In order to create room groups from the previous categorization, a hierarchy of parameters must be created. This corresponds to the enumeration just mentioned, starting with *Accessibility*. The line type corresponds to the parameter (see Legend ↑), and the specified number indicates my own assessment according to Figure 04.03. With this number of rooms, *Frequency of users* and *Technical infrastructure* are given little or no weight. This would only be relevant for a larger number of rooms. This sorting is followed by the summary and grouping shown on the following two pages, which are used in the draft of this paper.

**NUF 1 | Living and Stay**
Break room
Cafeteria
Central communication zone
Foyer
Seating areas
Tea kitchen

**NUF 2 | Office work**
Computerpool
Copy/Printer room
Group office
Meeting room
Phone booth
Secretary´s office
Single office
Workbox

**NUF 3 | Production**
Autoclave room
Dark room
Drainage machine and hazardous material
Electrophoresis
Incubator room
Laboratory
Microscopy room
PMCA
Write-up space

**NUF 4 | Store**
Archive
Cold storage
Equipment room
Liquid fuel filling
Storeroom

**NUF 5 | Education**
Learning space
Presentation areas
Training room

**NUF 6 | Healing**
First aid room

**NUF 7 | Other uses**
Changing room/Shower
Cleaning room
Garbage room
IT-Room
Sanitary room
Airlock

**Infrastructure**
Technical shaft

**Circulation area**
Elevator
Escape route
Escape stairway
Hallway
Stairway

**Figure 04.04 |** Sorting

# NEW CATEGORIES

A = Accessibility
C = Communication
F = Frequency of users
T = Technical infrastructure

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other Uses
- **Infrastructure**
- **Circulation area**

Once the rooms have been evaluated and hierarchized, 14 room groups can achieve an efficient and logical arrangement concerning the four criteria of *Accessibility*, *Communication*, *Frequency of users*, and *Technical infrastructure*. The two exceptions to this are groups 06 and 09 due to their tolerance of A = 10. Also, Group 08 is an exception with the max. tolerance of C = 30. The rooms can be arranged separately or located together due to their similar characteristics in A or C. Group 11 is considered a single room. If the number of investigated rooms is extended, the parameters F and T can also be included.

**01**
Autoclave room
Cold storage
Incubator room
Airlock
Liquid fuel filling
A = 0 | C = 10 – 20

**02**
Drainage
Electrophoresis
Laboratory
Microscopy room
PMCA
Dark room
Write-up space
A = 0 | C = 50

**03**
Equipment room
Storeroom
Cleaning room
IT-Room
Technical shaft
A = 10 | C = 0 – 20

**04**
Changing room/
Shower
Phone booth
A = 20 | C = 0 – 10

**05**
Presentation areas
Workbox
A = 20 | C = 80 – 100

**06**
Archive
Computerpool
A = 30 – 40 | C = 0 – 20

**07**
Garbage room
Single office
A = 50 | C = 0 – 10

**08**
Break room
Tea kitchen
Group office
A = 50 | C = 50 – 80

**09**
Central communication zone
Meeting
Copy/Printer room
A = 60 – 70 | C = 40, 100

**10**
Seating area
Training room
A = 80 | C = 60, 100

**11**
First-aid room
A = 90 | C = 10

**12**
Escape route
Escape stairway
Learning space
Sanitary room
A = 100 | C = 10 – 20

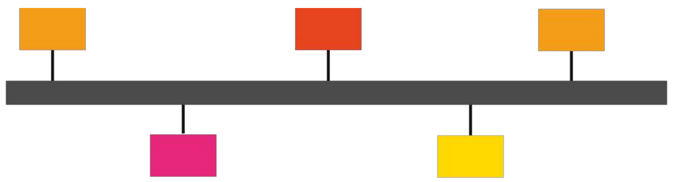
**13**
Elevator
Hallway
Stairway
A = 100 | C = 30 – 40

**14**
Foyer
Secretary´s office
A = 100 | C = 90

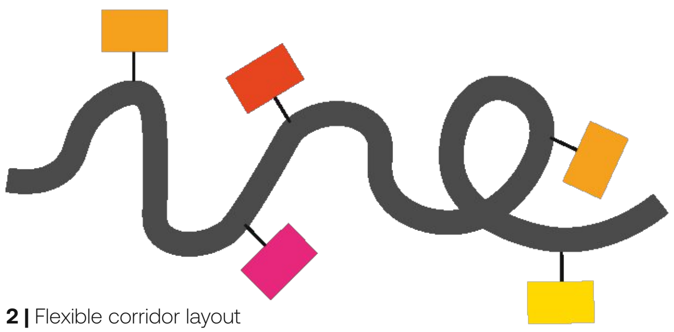
**Figure 04.05 |** New Categories

# CIRCULATION

**What steps generate space optimization?**
The reference analysis shows that the core typology without a patio is the most space-efficient and allows for open-plan structures, avoiding partition walls and long corridors. The aim is to minimize the classic corridor layout to enhance the working atmosphere and research efficiency.
However, the communication and logistics function of the access corridors should be retained. The spatial relationship between labs and offices significantly impacts the floor plan, with scientists preferring a short distance between the two. Economically, separating laboratory and office components is more favorable, but it is usually undesirable due to the longer distances (Grömling, 2005, p.47).



**1 |** Classic corridor



**2 |** Flexible corridor layout

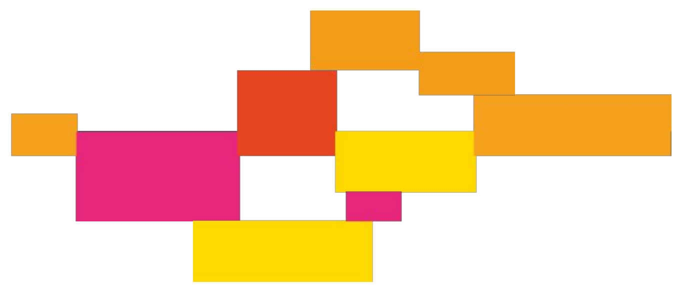
**3 |** Indentations along the corridor

- **NUF 1** I Living | Stay
- **NUF 2** I Office work
- **NUF 3** I Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

**4 |** "Islands" docked to the corridor

**5 |** Pushing the "islands" together

**6 |** Corridor as a communication space



**7 |** Adding alternative paths

**What kind of stations are these?**
*Attraction Points* or events
Platforms for the view
Vertical Connections
Circumferential Bridge
Printerroom
Presentation area
Meetingpoint
Telephonebooth
Tea kitchen
...

**↓ Connection between the cores**

**= INTUITIVE GUIDANCE**

**Figure 04.06 |** Circulation

# EVALUATION

The assumptions are based on the analysis of the 18 reference projects and the research carried out to date. A larger sample of reference projects would yield more precise results.





## 01

**Open-plan laboratory**
Open-plan laboratories are currently and will increasingly be used in laboratory construction. The advantages, which are not only flexibility and a high level of communication, also include very efficient use of space. The *Growth* areas can be seen very clearly in the Salk Institute (63.22 %), BASE (64.28 %), James H. Clark Center (76.86 %) Terrence Donnelly Center (75.50 %), MIT Media Lab (70.59 %) and Novartis (87.59 %).

## 02

**Growth in Circulation**
With a few exceptions, the circulation in the references has increased since 2017. The assumption as to why less space was built in the previous decades lies propably in the growing number of standards and requirements. Since 2017, the proportion has remained constant at over 30 %. The deviations are Novartis and the Biocentre Schällenmätteli in Basel.

## 03

**Core-typology most efficient**
The analysis of the utilization areas shows that the core arrangement is the most efficient. Around 70% is *Growth* and only 20 % *Reduction*. This result reinforces the trend towards open-plan laboratories, as this floor plan typology can be used very flexibly for this purpose.

## 04

**Core | Patio-typology least efficient**
If a patio is added to the efficient core-typology, the values deteriorate significantly to 62 % *Growth* and 28 % *Reduction*. Visibility is increased, but the circulation routes are usually longer. Examples are the GUZ with a circulation share of 30,17 % and the BSS Research Building with 34,45 %.

## 05

**Growth in communication areas**
The analysis of references shows that communication zones have become more common since the 1970s and are now a key factor for productive research work. The MIT Media Lab stands out with 14.60 %. In the past, these zones were probably more integrated into the office zone or not seen as separate areas.

## 06

**Reduction in storage and infrastructure area**
It is noticeable that the infrastructure area on the standard floor has shrunk since the 1980s. The varying requirements of different laboratory types must be considered. Today, technical floors are added, often on the top floor or in the basement. Digitalization has likely reduced storage space.

## 07

**Four spatial priorities**
A look at the room connections shows that there are four main areas (see Chapter 03.03 Comparison | Room connections). For instance, Novartis representents the open-plan-lab as a central point. Nevertheless, these main areas can also appear as combined focal points, as in the Burroughs-Wellcome HQ.

## 08

**Importance of vertical connections**
Horizontal communication within a single floor is undeniably crucial, but vertical connections also demand significant focus and attention. The references clearly show that 12 out of 18 have a connection between at least one staircase and/or one elevator to the laboratory area. This also applies to the office zones.

## 09

**Safety influences room linkages**
Safety requirements and safety levels play an essential role. This not only relates to ventilation systems or visual relationships between colleagues, but is also noticeable in the room connections. Possible limiting factors for the number of room connections can be high security requirements. Airlocks serve as transition areas between two zones.

## 10

**Importance of connecting lab and office**
The room linkage analysis shows that there is a connection between office and laboratory areas in 12 out of 18 references. Although very diverse space requirements apply here, both areas represent a fundamental part of the research work. Both zones can serve as a central starting point as described in point 08.

## 11

**Constant number of room linkages over time**
If the number of spatial connections of all references is considered, it becomes apparent that they have not undergone any significant changes. It seems that no decisive innovations have taken place in this area in the last 75 years. However, depending on the typology, field of research and safety requirements, these differ significantly.

## 12

**City-like module arrangement causes circulation area**
An interesting concept for dividing up laboratory space is to divide it into modules within a large flexible area. However, this can have disadvantages in terms of efficiency with regard to circulation. OMA has developed an impressive spatial structure in its Lab City CentraleSupélec. The circulation ratio here is 39.08 %. However, communication is architecturally maximized.

# 05

# Site

**Berlin**

Berlin offers a multifaceted architecture. The city combines numerous historical and modern buildings, which are regarded as architectural testimonies to a wide range of political and social developments. The competition site is located in former West Berlin, in the Wedding district.

The generally accepted planning parameters are an eaves height of 22 m and a maximum upper edge of 30 m for the roofs (Golubka, 2022).

**Wedding**

Wedding, a district of Berlin Mitte, which was founded around 1200 as a village by Rudolphus de Weddinge and has been part of Berlin since 1861, is today a socially and architecturally diverse area. It is a working-class neighborhood and has numerous social challenges, such as heavy drug use and a high unemployment rate (District Office Mitte of Berlin, n.d.). Violence often highlights Wedding in drug policy and security debates, with Leopoldplatz, 1.5 km from the competition site, as a focal point.

The RKI site is located in the so-called Parkviertel next to Wedding Zentrum. The average age of the residents is 41.8 years, according to 2018 statistics. However, there is an influx of younger people. 2018, the migration background of the population was 68.9 %. Structurally, the areas in which the RKI and the neighboring *Virchow Clinic* are located are of enormous importance even beyond the national borders. (District Office Mitte of Berlin, 2019).

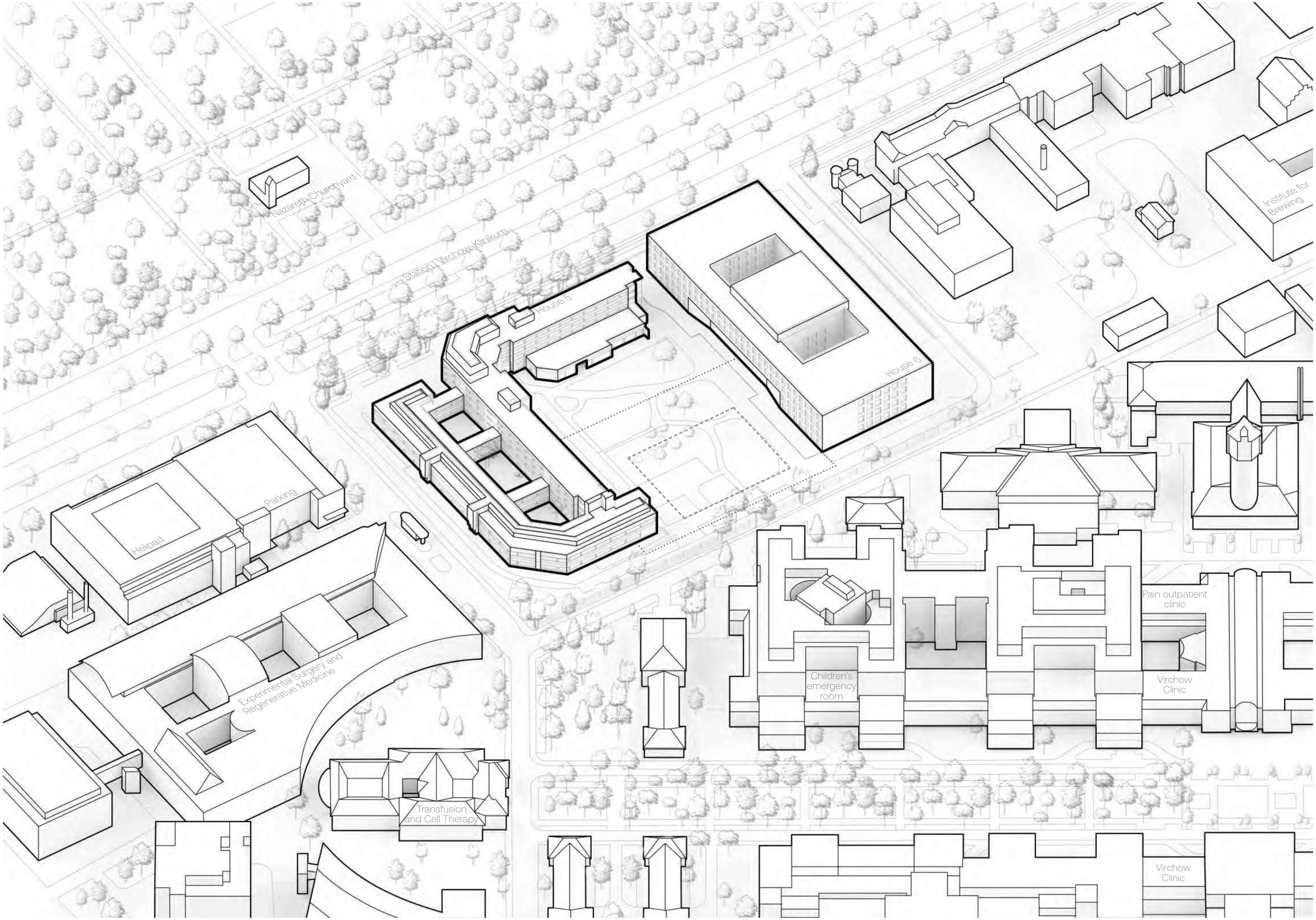
Architecturally, the area features diverse styles and standout highlights. The following photos confirm the strong contrast between the architecture to be found within Wedding. Worth mentioning are the *Alte Nazarethkirche* by Karl Friedrich Schinkel from 1835 on *Leopoldplatz* (Wedding Weiser, 2024) and the *Schillerpark Housing Estate*, which was declared a UNESCO World Heritage Site in 2008 (Mitte district of Berlin, n.d.).

The competition site's main entrance is on Seestraße, a three-kilometer traffic axis through Wedding. Since 1827, it has been named after the adjacent lake *Plötzensee*. A green median strip with streetcar routes lies between the busy street, which is part of the inner city ring road (Faust, 2017). The Berlin *Virchow-Klinikum* streetcar and bus stop, a cab rank, and a multi-story parking lot are located adjacent to the site. The subway stations *Amrumer Straße* and *Seestraße* are around a 10 – 15 minute walk away.


**Figure 05.01 |** Seestraße 122 | Photograph

**Figure 05.02 |** Water tower of the Virchow Clinic | Photograph

**Figure 05.03 |** Seestraße | Station Virchow-Klinikum | Photograph




----- **Desired cubature** ······· **Construction field**

**Figure 05.04 |** Axonometry Surrounding

**Virchow clinic**

Adjacent to the RKI site is the Virchow Clinic, planned in 1899 by Ludwig Hoffmann. The site was chosen at the time because it was a large undeveloped green area and was on the outskirts of the city. A quiet park runs through it for about half a kilometer and was surrounded by around 50 pavilions, as well as mostly small buildings. The green area and the baroque façades were richly decorated to make the stay as pleasant as possible for the patients. At the time, this area was an innovation. The aim of Rudolf Virchow was to create a forward-looking and hygienic health area that was highly regarded throughout Europe. Over two-thirds of the site was destroyed in the 2nd World War. In 1962, the eight-story surgical hospital, notable for its large scale, was constructed. In the last few decades, there have been repeated conversions and extensions, such as at the German Heart Center. To this day, this area is considered one of the most essential components of Berlin's healthcare system. It has been known since 2020 that major conversion measures, demolitions, and new buildings within a new masterplan will be carried out. To this day, the pavilions along the green axis and the water tower are original witnesses to the past (Faust, 2024).






**Figure 05.05 |** Southeastern Site Wall | Photographs

**Immediate vicinity**

A completely different atmosphere can be found on the northern side of Seestrasse. In the middle of an extensive green zone lies the Nazareth Churchyard with the St. Paul cemetery. Goethepark adjoins this further to the north. The RKI is located in the middle of this contrasting areas between the hustle and bustle of the city and the quiet wooded green zone. On the western side of the site is the entrance to the Virchow Areal, which is bordered by barriers. When exploring the area, it is noticeable that the sirens of the incoming ambulances can be heard every minute. You also become aware of the decreasing noise level the further you move into the area, away from the busy Seestraße. There is an adjacent parking garage, which is also designed as a landing pad for helicopters. The flight path runs across the competition area but just past the specified construction site for House 7. At the moment, there are still containers on the site, which serve as a temporary solution.

**Site wall**

The wall that separates the Robert Koch Institute from the *Virchow Clinic* along the southern boundary of the site is a listed building and must not be demolished (BBR, 2023).

Figure 05.06 | Aerial View | Scale 1:1,000

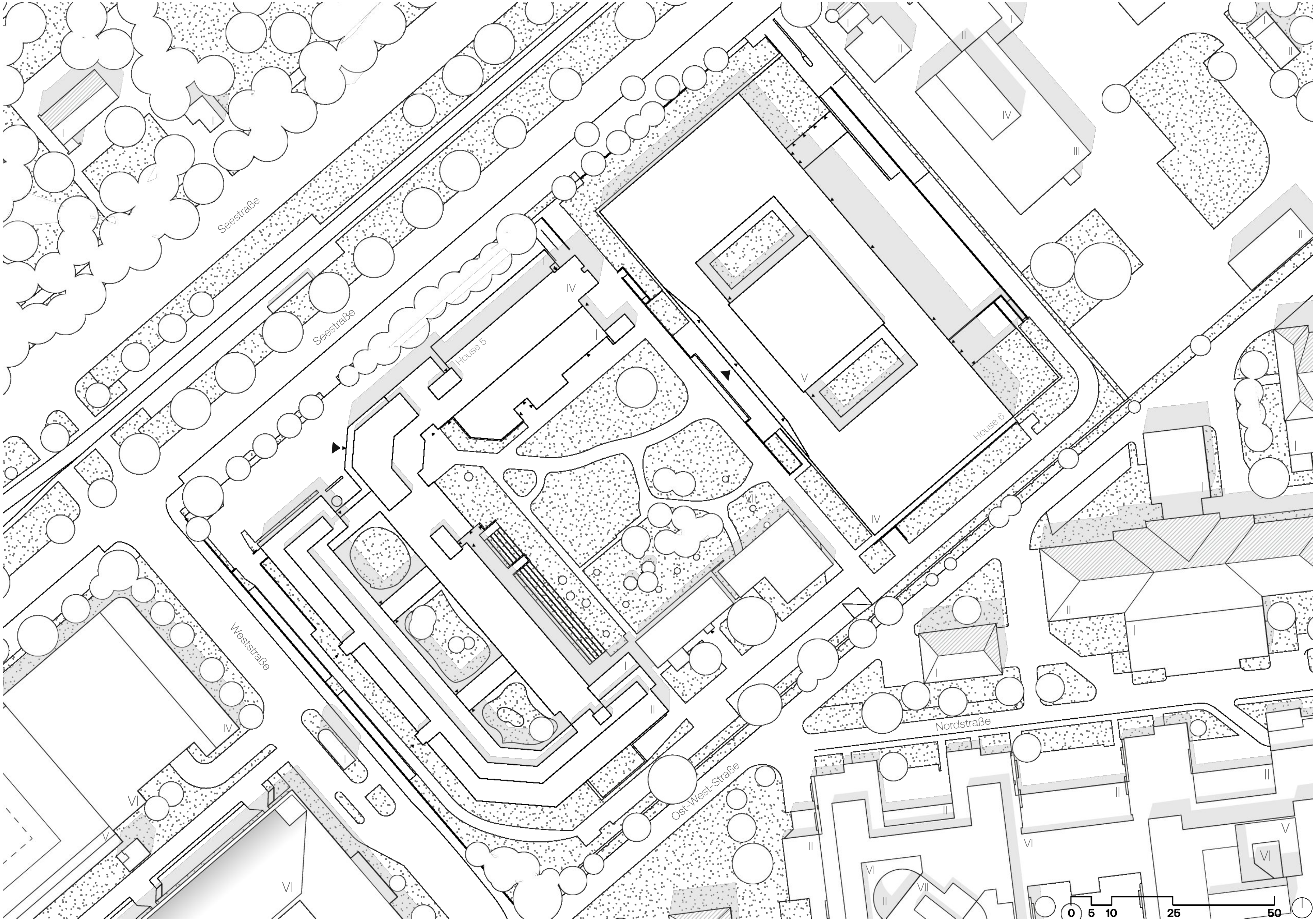
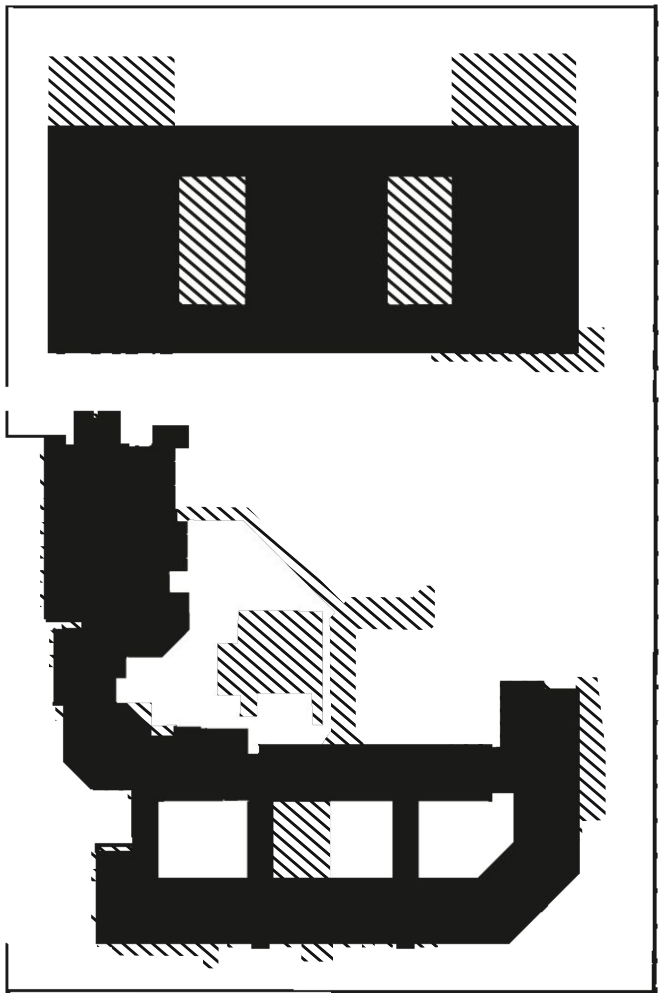
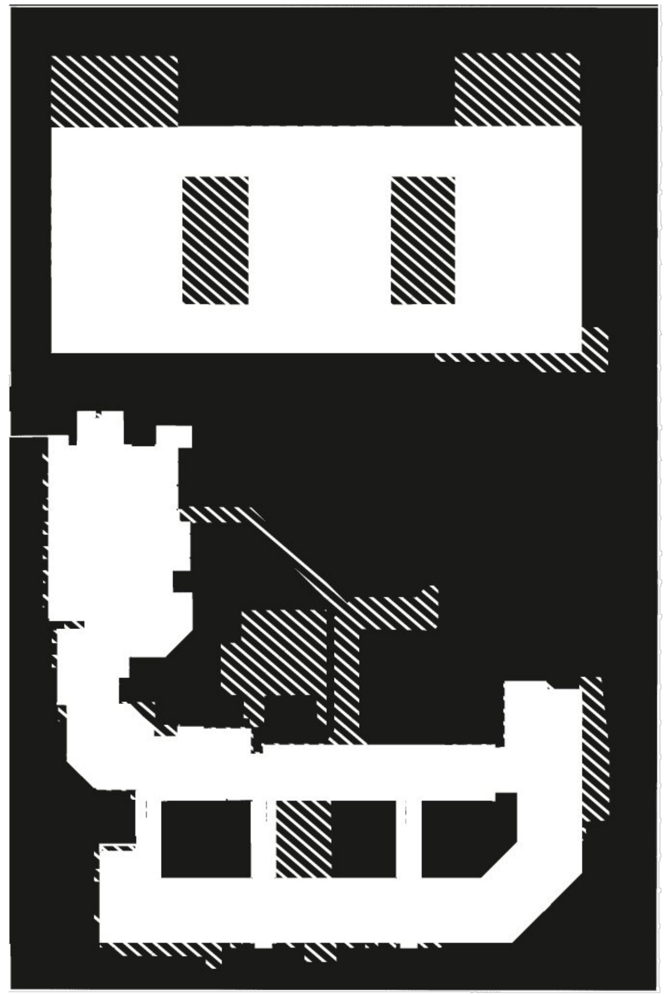



**Figure 05.07 |** Site Plan | Scale 1:1,000

# FOOTPRINT

Underground floor







0 1 5 10 20

**Figure 05.08 |** Footprint | Scale 1:1,500

# HOUSE 5

**Figure 05.09 |** House 5 | West view | Photograph

**Context**

The L-shaped building serves as an entrance point to the RKI site. House 5, House 6, and the future House 7 are accessed from the main entrance on Seestraße via the green park. The entrance situation stands out as it represents the previous high point of the ensemble. The administration, offices, canteen, lecture hall, laboratory areas, infrastructure, and service zones are located here. The original function of House 5 was to provide appropriate workspaces for the Institute for Drugs of the Federal Health Office (BBR, 2023).

The security level of the laboratories is S2. Renovations and technical upgrades took place in 2010 and 2013 (WUP Ingenieure, n.d.).

**Material**

The reinforced concrete construction is encased in a masonry façade. Horizontal ribbon windows provide sufficient daylight in the workspaces. Along the west and south façades, there is an external corridor that serves as sun protection (BBR, 2023).

**Floor plan organization**

Depending on its function, the building was divided into seven structurally different areas on four above-ground and two underground floors. The two largest groupings are the laboratory area in the wing on the western edge of the site and the offices and administration zone in the inner areas. On the first floor, next to the entrance zone, are the staff canteen and the lecture hall, which offer an interesting symbiosis with the new building of House 7. A staircase was built on the east side to allow natural light into the workrooms on the basement floor. An underground corridor provides barrier-free access to House 6 from the building, which has a full basement. (BBR, 2023).

| | |
|---|---|
| **Architect** | Fritz Bornemann, Mathias Boje, Friedrich Karl Borck |
| **Opening** | 1982 |
| **Renovati.** | 2010 \| 2013 Henn Architekten |
| **BGF** | ≈ 18,000 m$^2$ |
| **NF** | ≈ 8,500 m$^2$ |
| **Height** | 13.95 m = 50.85 m o. NHN |
| **Costs** | 40.1 Mio. € |

(BBR, 2023)
(WUP Ingenieure, n.d.)

**Figure 05.10 |** Aerial View | Scale 1:10,000

**Figure 05.11 |** Entrance | Photograph

# HOUSE 6

**Figure 05.012 |** Entrance House 6 | Photograph | © HENN

**Context**

The newest building on the site is used for research into viruses such as Ebola. One of the few existing high-security level S4 laboratories in the world is located here (see Chapter 01.04 Catalogue) (Henn GmbH, n.d.). It is Germany's third and largest high-security lab for human medicine. The elongated, rectangular building is based on a strong symmetry (BBR, 2023).

**Material**

The building was constructed in reinforced concrete (BBR, 2023). The façade made of fired bricks with a symmetrical window arrangement blends in calmly opposite House 5. The roof and the two inner courtyards are greened and serve as retention areas (Bundesamt für Bauwesen und Raumordnung, n.d.-b).

**Floor plan organization**

The floor plan divides the building into an office section facing the courtyard and adjoining laboratory areas. These parts are arranged along the façades with nearby service areas. A two-story, daylight-flooded foyer with an inviting multi-story staircase provides access to the site's park. The so-called "room-in-room" system (see Chapter 04.02 Sorting), which contains the S4 laboratories, is located between the two inner courtyards. This area is also separated from the foyer by a void and a solid reinforced concrete wall. Access via five airlocks and numerous complex technical installations provides a safe working environment (Bundesamt für Bauwesen und Raumordnung, n.d.-b). Located at the rear of the building, is the delivery area via Seestraße. Access from the parking garage is barrier-free, with a ramp and stairs.
The building has a full basement and a barrier-free connecting corridor to House 5 (BBR, 2023).

| | |
|---|---|
| **Architect** | Henn Architekten |
| **Opening** | 2015 |
| **BGF** | ≈ 22,000 m$^2$ |
| **NF** | ≈ 9,600 m$^2$ |
| **Height** | 19.63 m = 56.53 m o. NHN |
| **Costs** | 107 Mio. € |

(BBR, 2023)
(Bundesamt für Bauwesen und Raumordnung, n.d. b)

**Figure 05.13 |** Aerial View | Scale 1:10,000

**Figure 05.14 |** Façade East View | Photograph

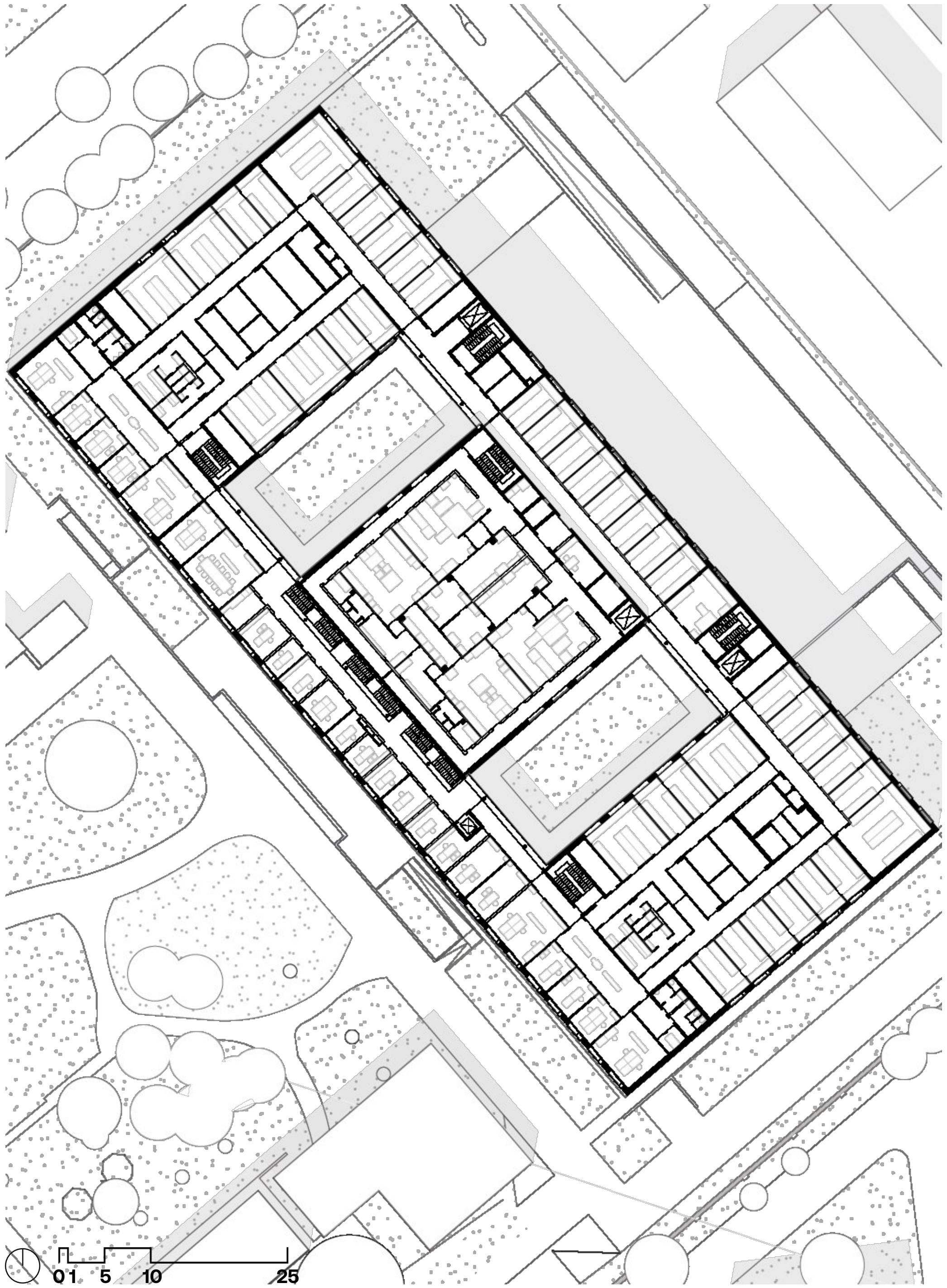
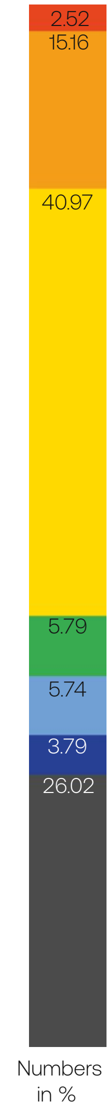



**Figure 05.15 |** House 6 | Upper Floor | Floor plan | Scale 1:750

- **NUF 1** I Living | Stay
- **NUF 2** I Office work
- **NUF 3** I Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

**Use**

The strong symmetry of the floor plan is evident in the distribution of use. Office and laboratory areas have sufficient daylight along the façade. The central zone with the high-security laboratories is surrounded by a perimeter circulation system. The dark zones are clearly visible between the office and laboratory areas in the north and south sections.



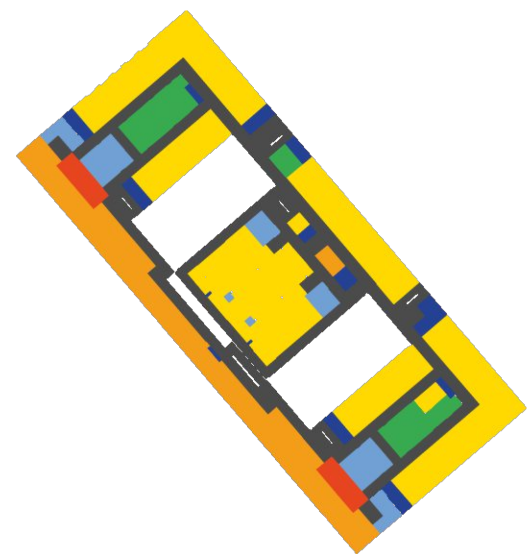




**Figure 05.16 |** Upper floor | Space Analysis | Floor plan | Scale 1:1,000

The non-open, single-phase, and anonymous planning competition "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestraße in Berlin" represents an optimal framework for applying the research results obtained in this work to a design proposal. The following outlines key specifications and competition results. Before the start, an open application procedure was carried out. The information was taken from the competition documents, which are not publicly accessible (BBR, 2023).

**Organization**
The competition is organized by the Federal Office for Building and Regional Planning (BBR), Division A2, with the head of the division Gesa Petersen and the project team Michael Kasiske and Ken Koch. The Federal Ministry of Health (BMG) is the overarching sponsor. The user is the Robert Koch Institute (RKI). Subsequent implementation will be supervised by Division IV 6 of the BBR. A colloquium for participants to ask questions and a site visit were possible. The tender documents are dated 08.02.2023. The submission of the plans and documents of the participants took place on 10.05.2023, seven days after the submission of the model (BBR, 2023).

**Goals**
In the future, the Robert Koch Institute wants to center all of its laboratories in the ensemble on Seestrasse. House 7 is intended to close the gap between House 5 and House 6 in terms of urban development. Due to its proximity to the existing buildings, the new building can benefit from existing structures for infrastructure and access. Laboratories, office zones, and corresponding service areas with a direct connection to House 5 are to be implemented using sustainable and innovative approaches. The flexibility to adapt to future user requirements, technical expansions, and an excellent working atmosphere are at the forefront. The building should also offer the possibility of realizing the most modern requirements for laboratories. In addition, efficiency in terms of workflow, space efficiency, and cost-effectiveness should be the guiding principles of the design concept (BBR, 2023).

**Location**
The property on which House 5 and House 6 are located (see Figure 05.17 →) has the address Seestraße 11, 13353 in Berlin-Wedding. The surrounding edifices are characterized by a soli-

**Figure 05.17 |** View onto the site for House 7 | Photograph | North view

tary appearance. The main entrance and the two delivery zones are oriented towards Seestraße, whereas House 7 is oriented along the listed wall on the south side. A spacious green area provides a central recreational area for employees (BBR, 2023).

**Room program**

The following two pages provide an overview of the room program, which is oriented towards different research groups. These areas mainly relate to diagnostics and laboratory research. The safety levels of some of the 88 laboratories - they are considered permanent workplaces - are classified as S2 according to BioStV and S3 according to GenTG (see Chapter 01.04 Catalogue | Safety levels). Due to the large number of laboratories required, departments have to be divided over several floors. As several experiments often take place in parallel within one room, increased documentation work is expected, and direct access to write-up spaces is required. The write-up spaces are proposed as upstream workstations, allowing additional air supply within the laboratories. It should also be borne in mind that equipment and furnishings will take up more and more space in the future, which means that there should be at least 1.45 m between the laboratory benches, and a grid of at least 1.20 m is favored by the user (see Chapter 01.04 Catalogue). Ancillary rooms, storage, and sanitary areas can be planned without daylight. With regard to office space, the requirement for 103 workstations can be specified. Of these, 20 are pool workstations, and four are without direct room allocation. Meeting rooms and communication zones are also to be integrated into the design. Glass partitions and lightweight walls promote the adaptability of the floor plan and is explicitly mentioned. Accessibility is also an essential component, which means that one laboratory and two offices, as well as the access routes to all rooms, should be planned accordingly. The fire protection units should not exceed the usual 400 $m^2$. The technical areas should be accessible and maintainable during operation with an additional calculated area of 30 %. A separate exhaust air system is required for safety level S3**. Technical areas are located in the basement and attic. House 7 is accessed via the main entrance in House 5. Deliveries are made either directly via minibuses or via House 6 (BBR, 2023).

**Specifications**

Construction will take place during ongoing operations, whereby increased safety measures and a small amount of free space must be ensured. The space efficiency is a decisive aspect in the evaluation of the proposals in the form of (NF+TF)/BGF with a target ratio of 0.67 and a minimum of 0.6 (BBR, 2023).

Requirements:
NUF | ≈ 5,075 $m^2$
≥ 35 % (NUF) Laboratory area
Max. costs | ≈ 53.7 mio. € (G)
Group 300 – 500
(Bundesamt für Bauwesen und Raumordnung, n.d.)

**Materials**

When selecting materials and construction, attention should be paid to durability, simplicity, reduction and environmental friendliness. A silver standard according to the Assessment System for Sustainable Building (BNB) and EGB 40 is desired (BBR, 2023).

**Feasibility study**

A feasibility study was carried out in advance by the architects Heinle Wischer und Partner with the support of Weber und Partner and Krebs und Kiefer. This was examined as part of this work with regard to the concept and area balance but was not presented for data protection reasons (BBR, 2023).

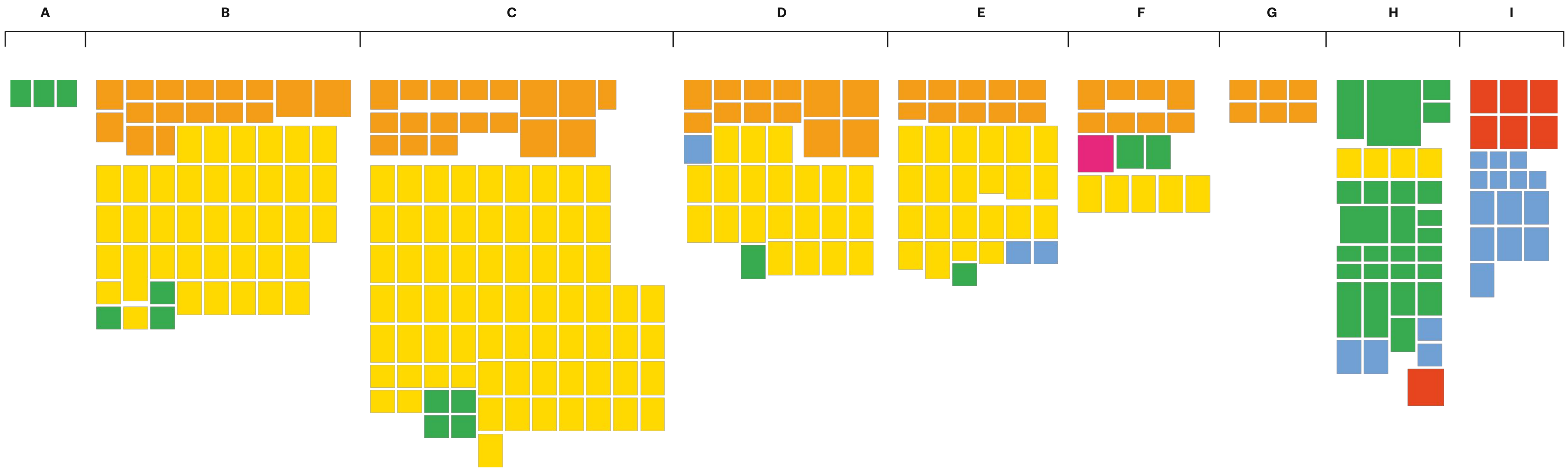
**Number of participants**

A total of 24 architectural firms were eligible to take part in the competition. The traditional submissions included plans, illustrations, explanations, proof of area, and a working model (BBR, 2023).

**Figure 05.18 |** View onto the site for House 7 | Photograph | South view

# ROOMS

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**




| **Function** | **Area** |
|---|---|
| | **4.927 m²** |
| **A \|** S Occupational safety specialist | 36 m² |
| **B \|** FG 14 Hospital Hygiene, Infection Prevention and Control | 1.032 m² |
| **C \|** FG 18 HIV and other retroviruses | 1.650 m² |
| **D \|** FG 22 Epidemiological Laboratory | 631 m² |
| **E \|** ZBS6 Proteomics and Spectroscopy | 514 m² |
| **F \|** ZIG4 Public Health Laboratory Support | 276 m² |
| **G \|** ZV4 Information technology | 72 m² |
| **H \|** ZV5 Internal service | 596 m² |
| **I \|** Central Funktions | +120 m² |

(BBR, 2023)

**Figure 05.019 |** House 7 Overview Rooms | Diagram | Scale 1:1,750

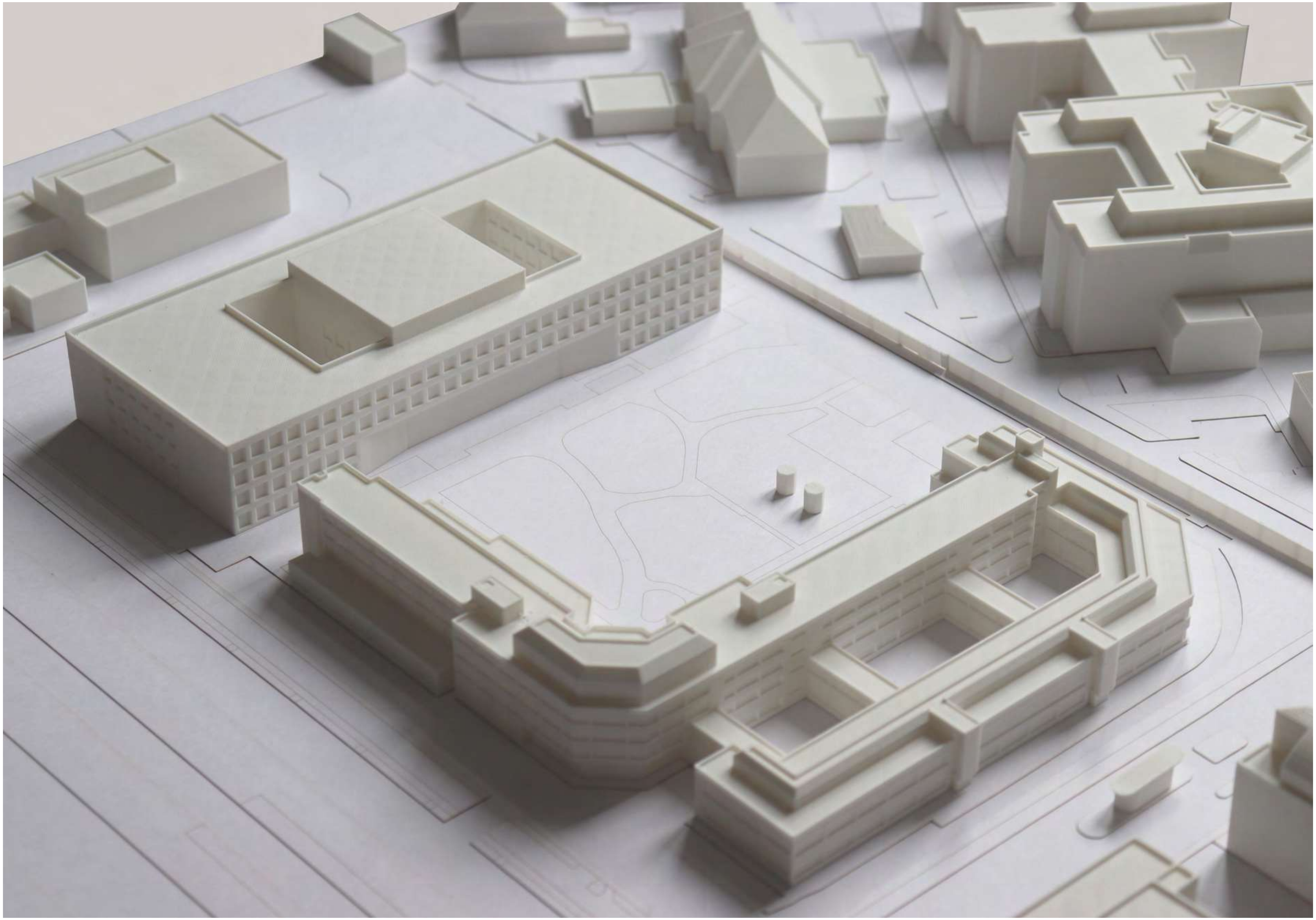


**Figure 05.20 |** Model photograph | Current Site | West view | Scale 1:500

# VERNISSAGE

The exhibition of the proposals took place from August 18 to September 1, 2023, in the foyer of the Bundesamt für Bauwesen und Raumordnung in Berlin (see Figure 05.21 →).

| **Name** | **Profession** | **Location** |
|---|---|---|
| **Expert judges** | | |
| Prof. Markus Allmann | Architect | Munich |
| Liza Heilmeyer | Architect | Stuttgart |
| Alexander Koblitz | Architect | Berlin |
| Elise Pischetsrieder | Architect | Zurich \| Berlin |
| **Judges** | | |
| Johannes Heyne | BMG, Ref. Z 33 | |
| Dr. Anke Engelbert | RKI, Central. Administration | |
| Philipp Dittrich | BBR, Ref. IV 6, project management RKI, Europa-, Deutschlandhaus | |
| **Deputy specialist judges** | | |
| Josef Hämmerl | Architect | Stuttgart |
| Birgit Rudacs | Architect | München |
| **Experts** | | |
| Marko Markovic | Hitzler Ingenieure Projektmanagement, Costs | |
| Achim Maier | Max-Delbrück-Centrum, Laborplanung | |
| Sabine Kleeberg | BBR, Ref. IV S 3 | |
| Eberhard Kurzke | BBR, Ref. IV S 2 | |
| René Wauer | BBR, Ref. IV S 2 | |
| Julia Zimmermann | BBR, Ref. A2 | |
| **Process consultant** | | |
| Antje Kotlan | Architektenkammer Berlin | |
| Susanne Scharabi | Committee for Awarding and Competitions of the Architektenkammer Berlin | |
| **Coordination and implementation of the competition, protocol** | | |
| Gesa Petersen | BBR, Ref. A 2 | |
| Michael Kasiske \| Ken Koch | BBR, Ref. A 2 | |
| **Preliminary examination** | | |
| Katja Pfeiffer | Architect | |
| Juliane Zach | Architect | |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

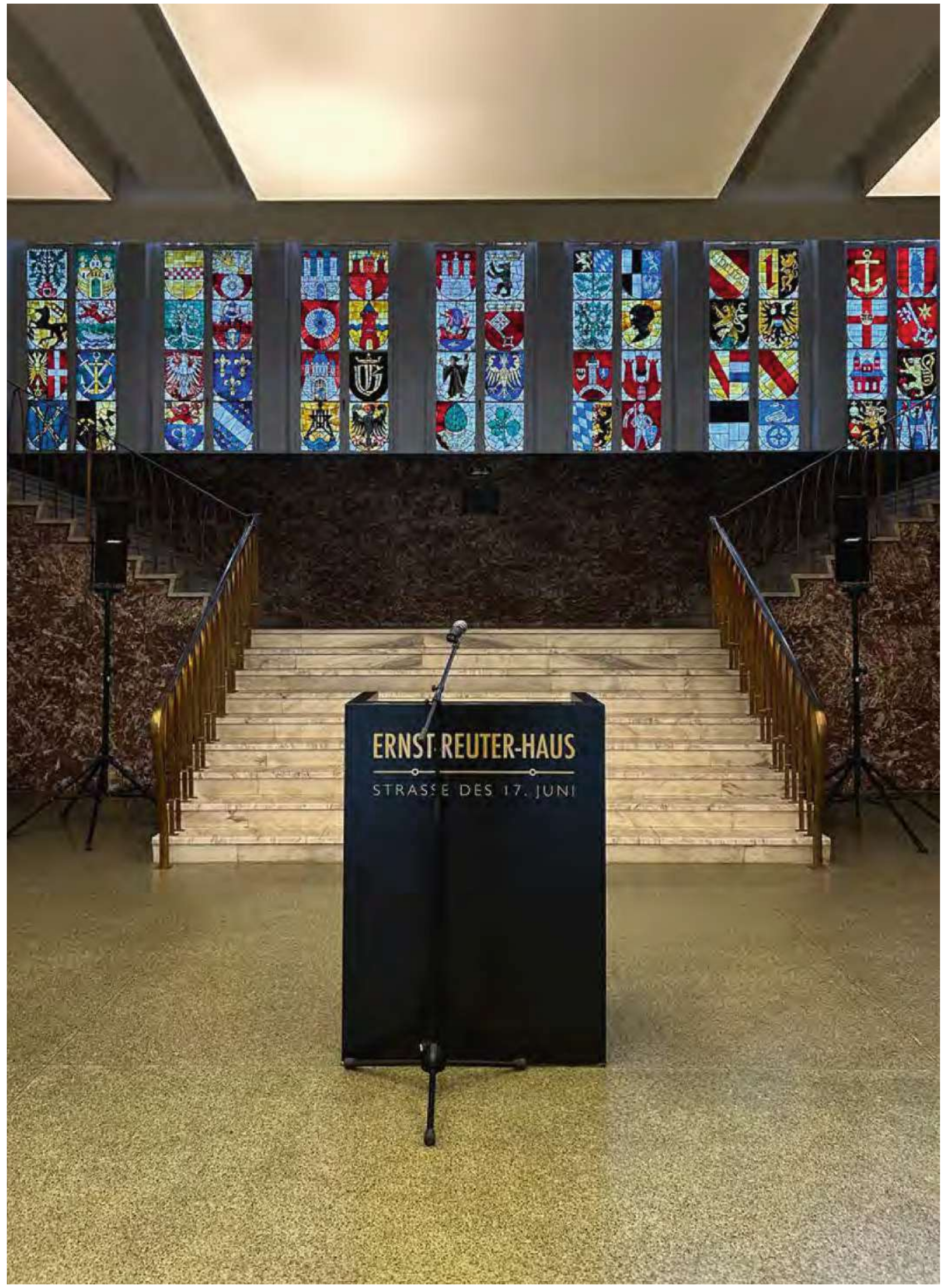



**Figure 05.21 |** Foyer Bundesamt für Bauordnung und Raumwesen | Photograph

# PROPOSALS

**1701 |** h4a Gessert + Randecker Architekten | Stuttgart

**1702 |** erchinger wurfbaum | Arnke Häntsch Mattmüller | Berlin

**1703 |** Ludloff Ludloff Architekten | Berlin

**1704 |** Schulz und Schulz Architekten | Leipzig

**1705 |** Kleihues+Kleihues | Berlin

**1706 |** hammeskrause architekten | Stuttgart

**1707 |** Heinle Wischer Partnerschaft | Berlin

**1708 |** wulf architekten | Stuttgart

**1709 |** Riegler Riewe Architekten | Berlin

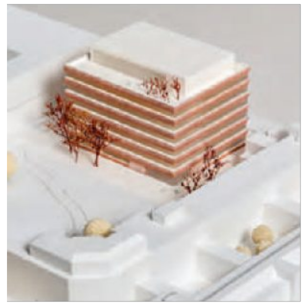
**1710 |** Burckhardt Architektur | Berlin

**1711 |** Gerber Architekten | Dortmund

**1712 |** Nickl Architekten Deutschland | Berlin



**1713 |** Ortner & Ortner Baukunst | Berlin



**1714 |** HENN | Berlin

**1715 |** Glass Kramer Löbert | Berlin

**1716 |** Behles & Jochimsen | Berlin

**1717 |** Baumschlager Eberle Architekten | Berlin

**1718 |** Rohdecan Architekten | Dresden

**1719 |** Osterwold°Schmidt EXP!ANDER Architekten | Weimar

**1720 |** BAYER & STROBEL ARCHITEKTEN | Kaiserslautern

**1721 |** SWAP Architekten ZT | Wien

**1722 |** RIEHLE KOETH | Stuttgart

**Figure 05.22 |** Model Photographs | © Michael Lindner

# RESULTS

On June 30, 2023, the jury evaluated the submissions at the Bundesamt für Bauwesen und Raumordnung in Berlin. The winning project was chosen unanimously as the most convincing (Bundesamt für Bauwesen und Raumordnung, n.d.).
The first three winning designs and the three Honorable Mention projects are analyzed in the following. It is noticeable that the individual entries are very similar in terms of cubature, floor plan layout, and story height. Some of the participants were strongly oriented toward the previously conducted feasibility study.

**1st prize**
SWAP Architekten ZT GmbH

**2nd prize**
Burckhardt Architektur

**3rd prize**
RIEHLE KOETH

**Honorable Mention**
Schulz und Schulz Architekten

**Honorable Mention**
wulf architekten

**Honorable Mention**
BAYER & STROBEL ARCHITEKTEN

**Figure 05.23 |** Overview Results | Photograph | © Michael Lindner

# 1ST PRIZE

**Figure 05.24 |** Model Photograph | West view | © Michael Lindner

**Concept**

The winning design is based on a square concept. This ensures maximum use of natural daylight by arranging the utility rooms around the façade and the centrally placed dark zone. It also emphasizes the distance to the neighboring buildings and the urban positioning. There is an external communication area for employees in the entrance zone, which is extended into the interior. The sealed area is small. The aim was to enable maximum flexibility and communication. A wood hybrid construction was planned for sustainability reasons (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Positive rating**

The placement of the building precisely in the middle between the two existing buildings and the central entrance appears unobtrusive and synergetic to the ensemble. It is also positively noted that barrier-free delivery access is planned at the side of the building, directly at the parking lots. A communicative routing leads convincingly via attractive stairwells through House 7. Teaching areas can be found immediately upon entering the building. The design, with its strong character, separates staff and material corridors from each other in a coherent manner and enables efficient technical routing. Prefabricated elements and the façade were used to develop a non-intrusive design that has an inner logic and can react flexibly to future change requests (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Negative rating**

The negative aspects here were the non-existent need for greenery on the façade, the longitudinal opening of the elevators, and the direct connection of the stairwells to the laboratory zone (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

| | |
|---|---|
| **Architect** | SWAP Architekten ZT |
| **Number** | 1721 |
| **Location** | Vienna, Austria |
| **Team** | Georg Unterhohenwarter, Rainer Maria Froehlich, Aleksandra Maričić, Georg Wilhelm, Gerfried Hinteregger |
| **Specialists** | Bollinger+Grohmann (statics & fire protection) |
| **Prize (€)** | 62,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

**Figure 05.25 |** Model Photograph | East view | © Michael Lindner

**Figure 05.26 |** Rendering | North view | © SWAP

**Figure 05.27 |** Section North-South | Scale 1:500 | © SWAP

**Floor plan organization**

The floors can be filled with any proportion of office or laboratory space. The dark zone, which contains the necessary material supply, technology, ancillary rooms, and secondary laboratory zone, is located in the center.

Attention was paid to short circulation and the rapid changeability of laboratory buildings. The technical areas offer sufficient space for future extensions (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

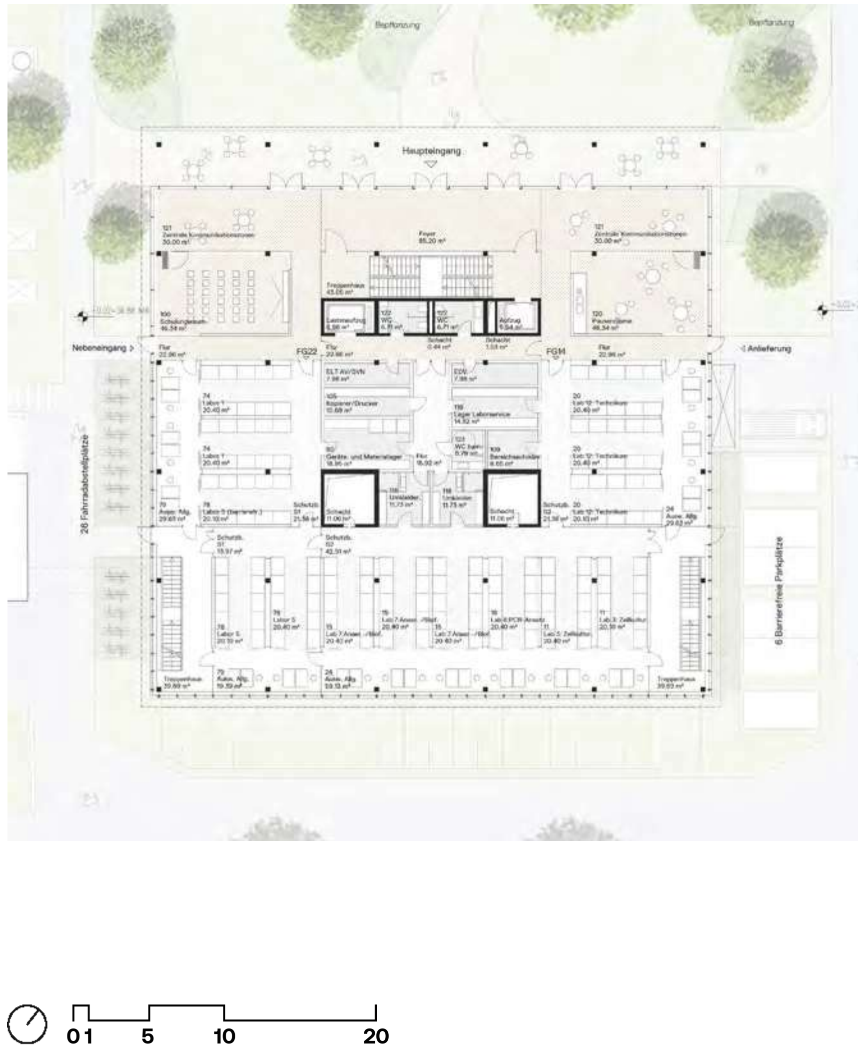
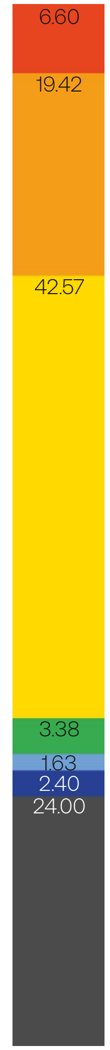



**Figure 05.28 |** Ground Floor | Floor plan | Scale 1:500 | © SWAP




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

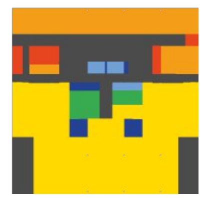


**Figure 05.29 |** First Floor | Space analysis | Scale 1:1,000

# 2ND PRIZE

**Figure 05.30 |** Model Photograph | West view | © Michael Lindner

**Concept**
Five above-ground stories are developed so as not to overshadow the site's green area too much and to integrate the building appropriately in terms of urban development. These are each slightly modified but, at the same time, follow a strict basic order. Inside, the two-story communication zones stand out in particular. A synergy with the park is created on the first floor, while on the upper floor, the building opens up to the surroundings. A high degree of modularity and prefabrication was taken into account in the skeleton construction made of prefabricated reinforced concrete elements from recycled concrete. The shell and extension are conceptually firmly separate from each other (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Positive rating**
The strong and independent character of the building, which also has a small footprint and creates a connection to House 5, was particularly praised. The reduced top floor emphasizes this aspect. The communication zones, the western entrance area, and the thoughtful use of the existing green zone were positively noted. The strict implementation of the 7.20 m grid and the grouping of office and lab areas offers flexibility. Meeting rooms are arranged to the east and west. The communication zones bring daylight deep inside. The construction costs are estimated to be low (Bundesamt für Bauwesen und Raumordnung, n.d.).

**Negative rating**
Maintenance is rated as costly. Despite its location, the entrance area is described as needing more character. The lack of open vertical connections and the absence of a pass-through autoclave in the technical zone were also noted (Bundesamt für Bauwesen und Raumordnung, n.d.).

| | |
|---|---|
| **Architect** | Burckhardt Architektur |
| **Number** | 1710 |
| **Location** | Berlin, Germany |
| **Team** | Carsten Krafft, Daria Grouhi, Luka Witalinkski, Kohli Dhruv |
| **Prize (€)** | 38,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

**Figure 05.31 |** Model Photograph | East view | © Michael Lindner

**Figure 05.32 |** Rendering | North view | © Burckhardt Architektur

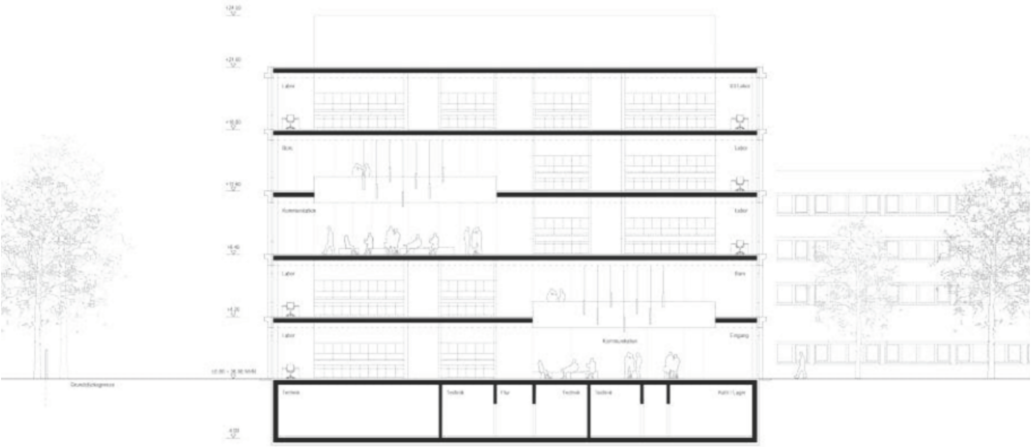


Figure 05.33 | Section South-North | Scale 1:500 | © Burckhardt Architektur

**Floor plan organization**

The lab areas are arranged to the north and south. Clustering the office and laboratory areas and planning them as open-space areas ensures a high degree of flexibility. The dark zone is located in the central part. Meeting rooms, break areas, and seminar rooms are placed next to the two-story communication zones. The S3 laboratories are on the top floor. Each floor can be used independently (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

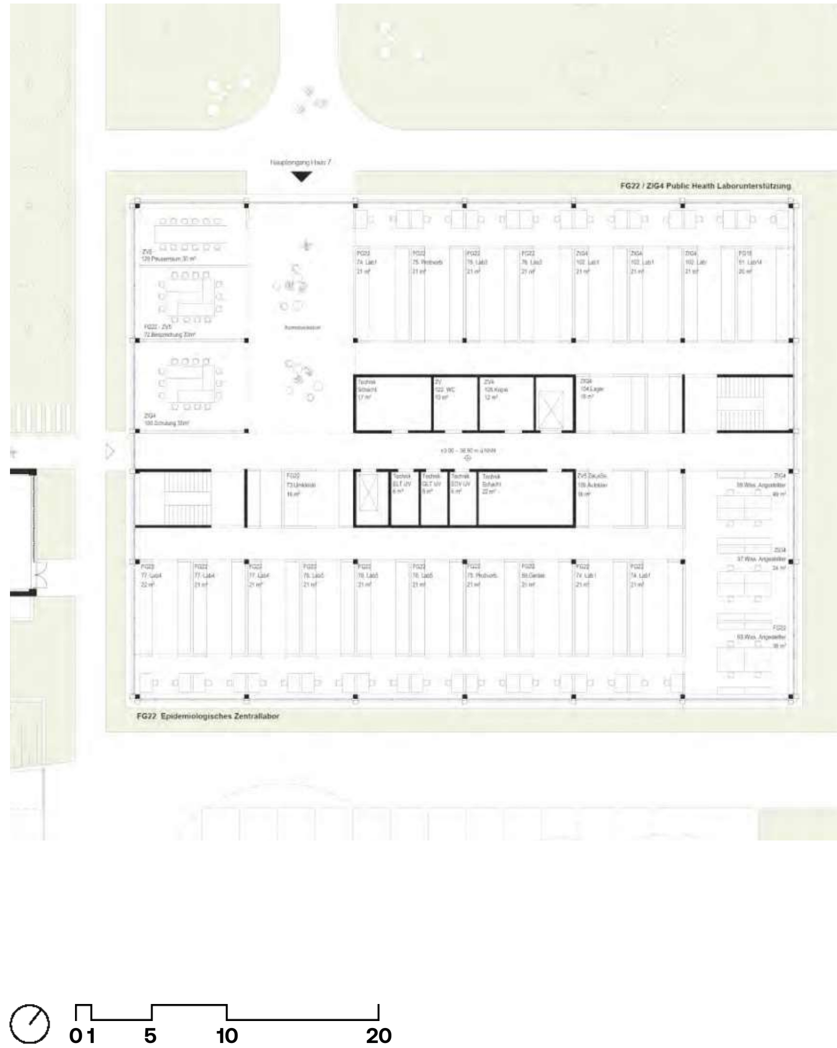
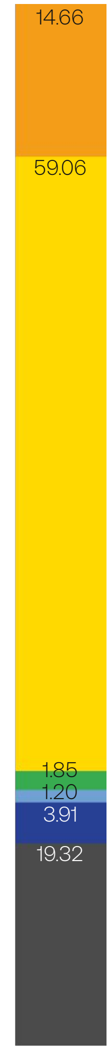



Figure 05.34 | Ground Floor | Floor plan | Scale 1:500 | © Burckhardt Architektur




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

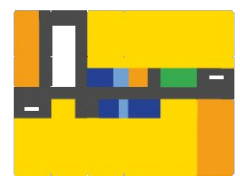


**Figure 05.35 |** First Floor | Space analysis | Scale 1:1,000

# 3RD PRIZE

**Figure 05.36 |** Model Photograph | West view | © Michael Lindner

**Concept**
This design aims for a sustainable approach by using natural materials and reducing technology to the bare minimum. The construction is divided into three areas. Between two column-free laboratory areas on the east and west sides made of pre-cast concrete elements lies the dark zone made of reinforced concrete cores. Beech columns and beams surround the floors along the façade. This consists of glass, wood, and aluminum. (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023). A courtyard forms an inviting transition from House 5 to House 7.

**Positive rating**
The jury praised the clear structuring of the stories through symmetry and the tripartite division, highlighting the flexibility provided by column-free laboratory zones. The two-story, protruding plinth provides a clear entrance situation. It was also mentioned that the work was highly detailed, with particular attention paid to the outdoor areas in the planning. The façade harmonizes with the ensemble's color, integrates photovoltaic panels positively, and includes a balcony zone above the second floor. (Bundesamt für Bauwesen und Raumordnung, n.d.).

**Negative rating**
While the design has many strengths, some areas could be improved. For instance, the choice of wooden floor for the laboratories was deemed unsuitable, and the dimensions of the timber-hybrid construction are 11.50 m. The footprint greatly reduces the size of the park, which was also shown in the site plan, and the model is smaller than the actual dimensions. The communication area and stairwells offer little quality of stay. The greening of the building is described as unnecessary (Bundesamt für Bauwesen und Raumordnung, n.d.).

| | |
|---|---|
| **Architect** | RIEHLE KOETH |
| **Number** | 1722 |
| **Location** | Stuttgart, Germany |
| **Team** | Hannes Riehle, Maximilian Koeth Shuhui Wang, Johannes Pojtinger, Mario Walker, Hao Liang |
| **Statics** | Konrad Merz - Merz Kley Partner |
| **TGE** | Leypoldt - ZWP |
| **Fire prot.** | Scherbening - Dekra |
| **Landsca.** | Luc Monsigny - Levin Monsigny |
| **Prize (€)** | 24,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

**Figure 05.37 |** Model Photograph | East view | © Michael Lindner

**Figure 05.38 |** Rendering | North view | © Riehle Koeth

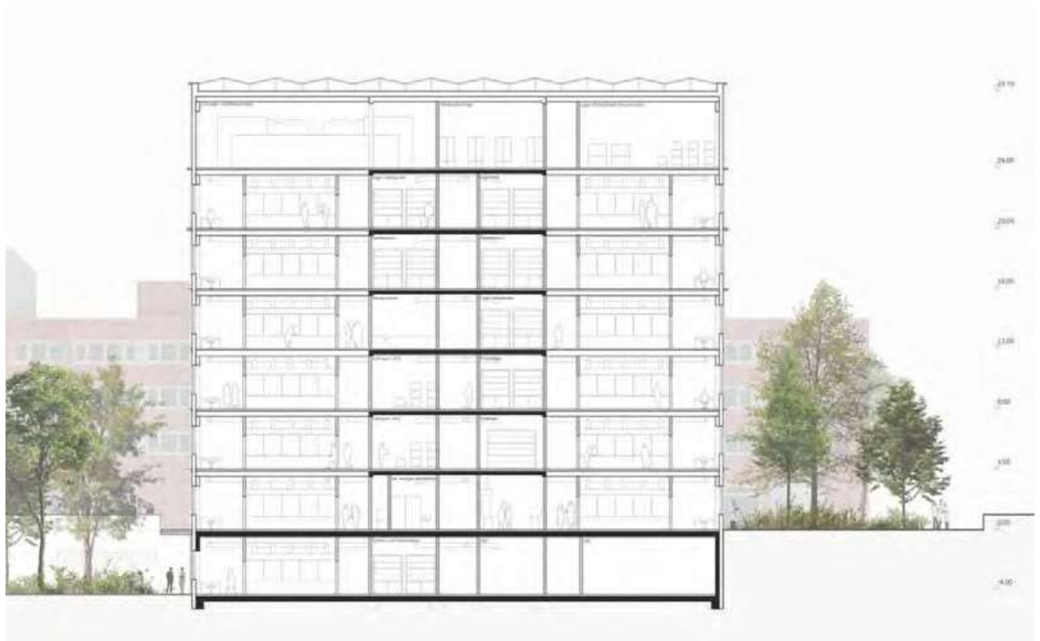
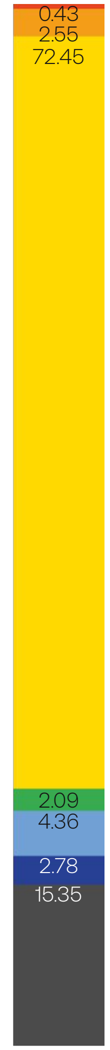


Figure 05.39 | Section West-East | Scale 1:500 | © Riehle Koeth

**Floor plan organization**

In comparison to the other five entries presented, the building features an east-west orientation of the laboratory rooms. The secondary laboratories, technology, and ancillary rooms are clearly located in the central dark zone. The entrance zone is also centrally positioned towards the courtyard. A flexible, column-free basic structure prevails, which makes it possible to divide the space into different departments. Even with a various number of labs on each floor, the floor plan looks coherent.


Figure 05.40 | Ground Floor | Floor plan | Scale 1:500 | © Riehle Koeth




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

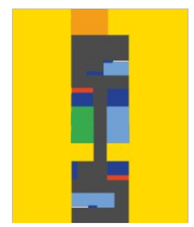


Figure 05.41 | First Floor | Space analysis | Scale 1:1,000

# HONORABLE MENTION

**Figure 05.42 |** Model Photograph | West view | © Michael Lindner

**Concept**

Particular attention was paid to integrating the park into the laboratory building. The atrium, which unfolds over the entire height of the building, is designed as an extension of the green space. The color of the wooden façade is similar to the surrounding existing buildings. The entrance is inviting and centrally located. A constructive tripartite division prevails. The solid, inner concrete cores are framed to the north and south by a timber hybrid skeleton construction. The focus here is on a high degree of flexibility thanks to prefabricated components that can be altered without compromising the sense of space in the event of future changes (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Positive rating**

The spacious atrium provides additional natural lighting for the laboratory rooms, which is seen as an innovative approach whose uniqueness and visual relationships promote communication. The clear floor plan layout and central entrance were praised, as were the well-chosen window proportions for natural lighting and the horizontal façade structure (Bundesamt für Bauwesen und Raumordnung, n.d.).

**Negative rating**

Implementing the green area by planting inside doesn´t seem easy. The numerous glass partitions also seem uneconomical. The resulting air space reduces the size of the park too much. The autoclave room specifically required for the S3* laboratories needs to be included. In general, the shaft area is considered to be too small. The round windows on the stairwells are viewed negatively for aesthetic reasons. According to the jury, the core areas that separate the laboratories from each other reduce flexibility (Bundesamt für Bauwesen und Raumordnung, n.d.).

| | |
|---|---|
| **Architect** | Schulz und Schulz Architekten |
| **Number** | 1704 |
| **Location** | Leipzig, Germany |
| **Team** | Prof. Ansgar Schulz, Prof. Benedikt Schulz, Dominik Schuermann Tobias Krautwig, Roman Stamborski, Felix Sonnenberg |
| **Prize (€)** | 10,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)



**Figure 05.43 |** Model Photograph | East view | © Michael Lindner

**Figure 05.44 |** Rendering | North view | © Schulz und Schulz Architekten

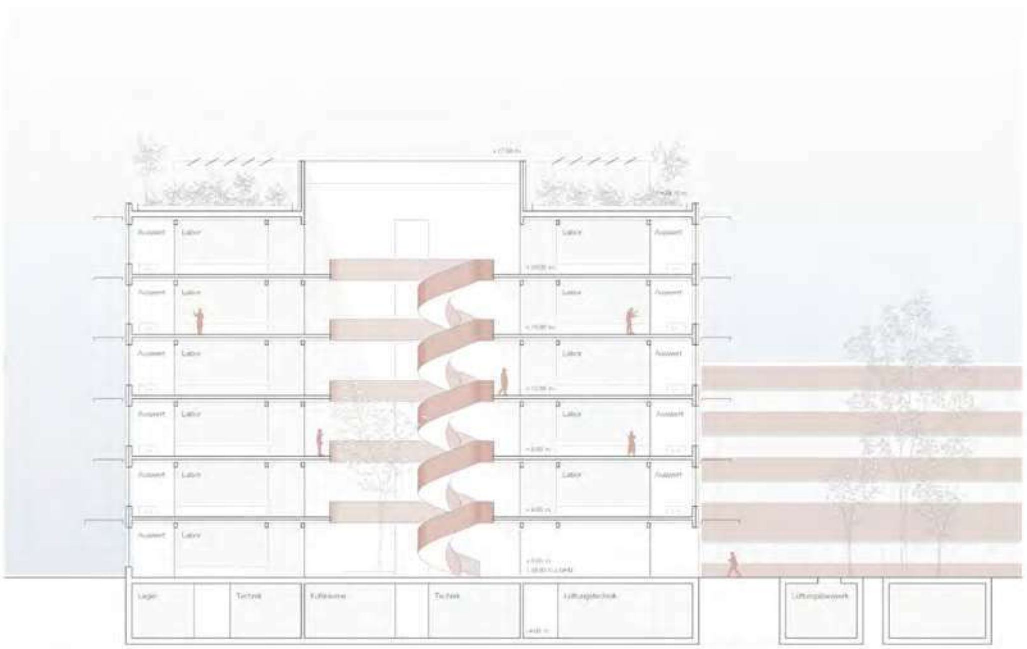


**Figure 05.45 |** Section South-North | Scale 1:500 |
© Schulz und Schulz Architekten

**Floor plan organization**
In order to guarantee flexibility, the laboratory areas were designed without any fixed components apart from columns. It is possible to add further laboratory space to the east and west. The secondary laboratory rooms, ancillary spaces, and circulation areas frame the central communication area. The cavity offers numerous visual connections. The chance encounters created by this area and the vertical circulation is increased (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

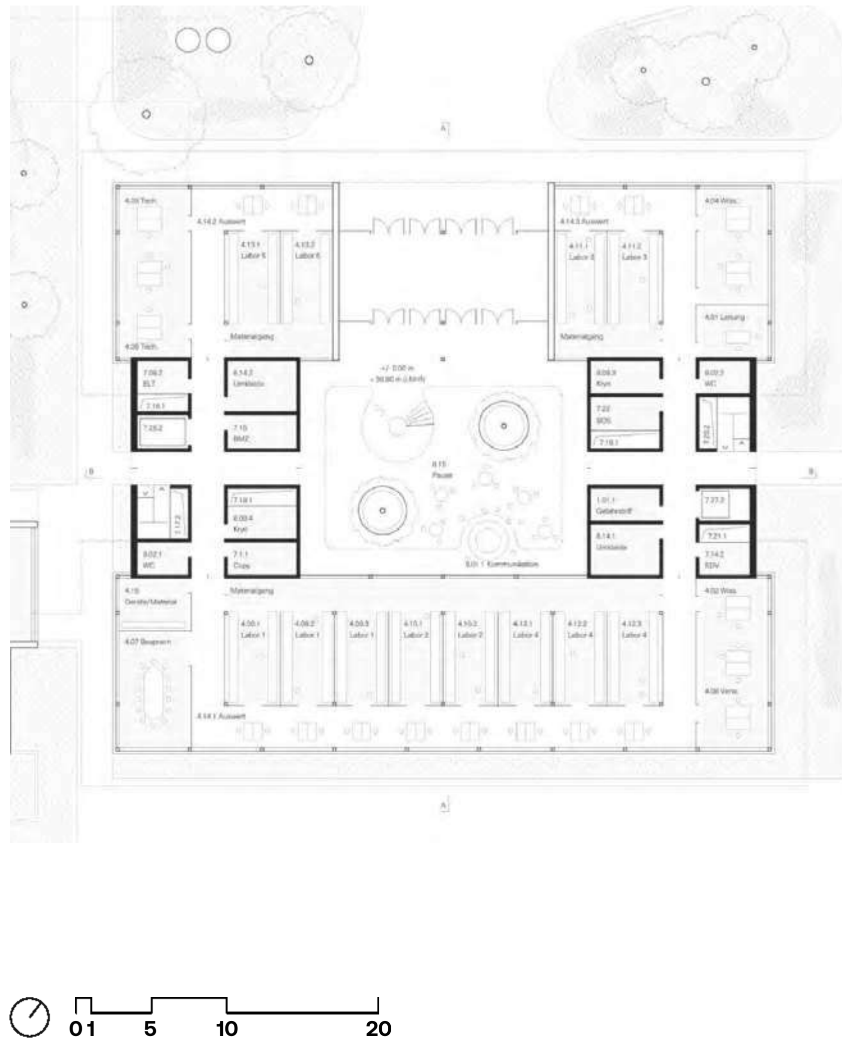
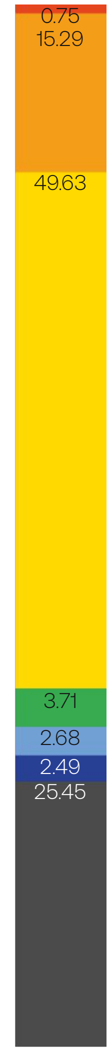



**Figure 05.46 |** Ground Floor | Floor plan | Scale 1:500 |
© Schulz und Schulz Architekten




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

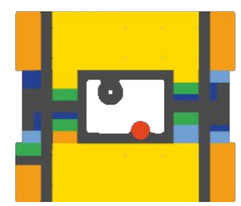


**Figure 05.47 |** First Floor | Space analysis | Scale 1:1,000

# HONORABLE MENTION

**Figure 05.48 |** Model Photograph | West view | © Michael Lindner

**Concept**
This design is one of the most discussed entries.
The striking character of the building is mainly represented by the base consisting of a brick façade and an almost floating cubature above. A circumferential joint frames the technical floor and serves as a break area for employees. The relationship to the neighboring buildings is clearly established by the visual separation of the base and the upper structure (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Positive rating**
The unique character of the building caught the jury's eye. It fits into the ensemble and preserves as much of the park as possible. The clinker brick façade with long-term usability in the base area and a glass and PV panel façade in the upper part of the building are also outstanding. The joint with planting provides a communication area for employees. The technical areas are arranged in such a way that short cable runs are possible. The costs over the entire service life are low. The flexible areas are logically interconnected and can also be used without barriers. The use of rainwater is a positive feature (Bundesamt für Bauwesen und Raumordnung, n.d.).

**Negative rating**
One central point of criticism is the high level of gray energy and the lack of sun protection in the upper part of the building. Sanitary areas and communication zones within the joint would be desirable. The east and west office depths are shallow, and a few rooms are missing. The windowless vertical access lacks quality. The escape route from the stairwell to the outside must be revised. The distance to House 6 should be explained in more detail (Bundesamt für Bauwesen und Raumordnung, n.d.).

| | |
|---|---|
| **Architect** | wulf architekten |
| **Number** | 1708 |
| **Location** | Stuttgart, Germany |
| **Team** | Tobias Wulf, Steffen Vogt, Gabriel Wulf Urta Halili, Sofia Odintsova |
| **Model** | Bela Berec - Architektur-Modellbau-Gestaltung |
| **Statics** | Mathias Lenz, Edgar Fink - Mayer Ludesche Partner |
| **Façade** | Kai Babetzki - Drees + Sommer |
| **Laboratory** | Christian Heinekamp, Hermann Zeltner - dr. heinekamp |
| **Prize (€)** | 10,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

**Figure 05.49 |** Model Photograph | East view | © Michael Lindner

**Figure 05.50 |** Rendering | North view | © wulf architekten

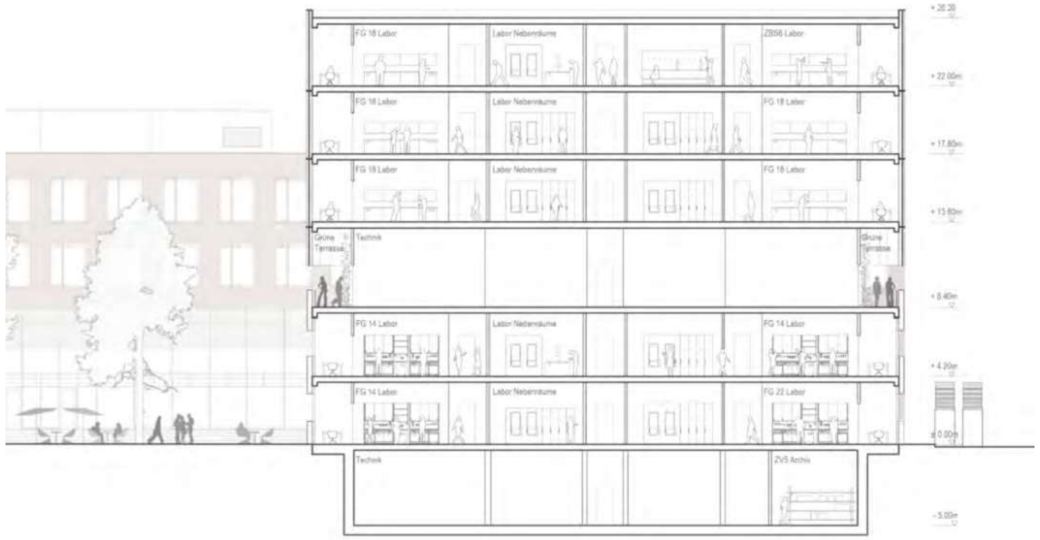
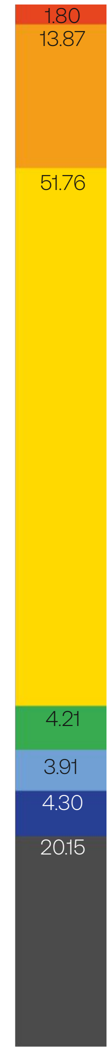


**Figure 05.51 |** Section North-South | Scale 1:500 | © wulf architekten

**Floor plan organization**

Compared to the feasibility study, the vertical circulation is not located next to the façade. This implies that office space can be placed on the east and west sides. As a result, this design requires one story less than the feasibility study, although the basic layout is closely based on it. Communication zones are next to green areas, the entrance, and building corners. A division into four uses per floor is possible. The laboratories are column-free spaces (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).


**Figure 05.52 |** Ground Floor | Floor plan | Scale 1:500 | © wulf architekten




Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

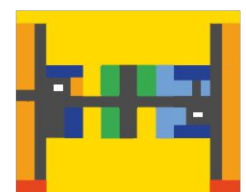


**Figure 05.53 |** First Floor | Space analysis | Scale 1:1,000

# HONORABLE MENTION

Figure 05.54 | Model Photograph | West view | © Michael Lindner

**Concept**

The proposal was widened to minimize the impact on the existing park. Inside, a void that extends over the entire height of the building provides an overview and view axes across all departments. In terms of circulation, the communication function of the corridors is emphasized. Flexibility is ensured by a uniform grid and numerous technical connections. However, the overall planning was strongly oriented towards the given feasibility study (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023).

**Positive rating**

The restrained positioning of the building is a positive aspect. The clearly gridded wooden façade is seen as a complementary and harmonious extension of the existing buildings. Here, the multi-story communication options and the laboratory and office areas, which are flooded with sufficient daylight, also impressed the jury. The costs are considered efficient, and the use of materials is classified as deconstructable (Bundesamt für Bauwesen und Raumordnung, n.d.).

**Negative rating**

The technical areas are assumed to be too small, while the circulation areas are proportionally too large. In particular, the designated communication areas within the circulation areas are seen as critical and confusing. The timber construction also appears to be generously dimensioned. The labs are partially offset from the column grid. This is an aspect that detracts from the clear aesthetics of the design. The vertical circulation does not lead to any specific common areas and is mainly realized via the emergency staircases. In addition, there is a lack of justification for the positioning of the foyer at the eastern corner (Bundesamt für Bauwesen und Raumordnung, n.d.).

| | |
|---|---|
| **Architect** | BAYER & STROBEL ARCHITEKTEN |
| **Number** | 1720 |
| **Location** | Kaiserlautern, Germany |
| **Team** | Gunther Bayer, Peter Strobel Lena Wagner, Janina Hüther, Jaqueline Gregorius, Joschua Deimling |
| **Laboratory** | Hans-Georg Averdunk - Hospitaltechnik Planungsgesellschaft mbH Krefeld |
| **TGE** | Alexander Oertel - S.I.G. Schroll Consult GmbH Saarbrücken |
| **Prize (€)** | 10,000 € |

(Bundesamt für Bauwesen und Raumordnung, n.d.)

Figure 05.56 | Model Photograph | East view | © Michael Lindner

Figure 05.55 | Rendering | North view | © Bayer & Strobel Architekten

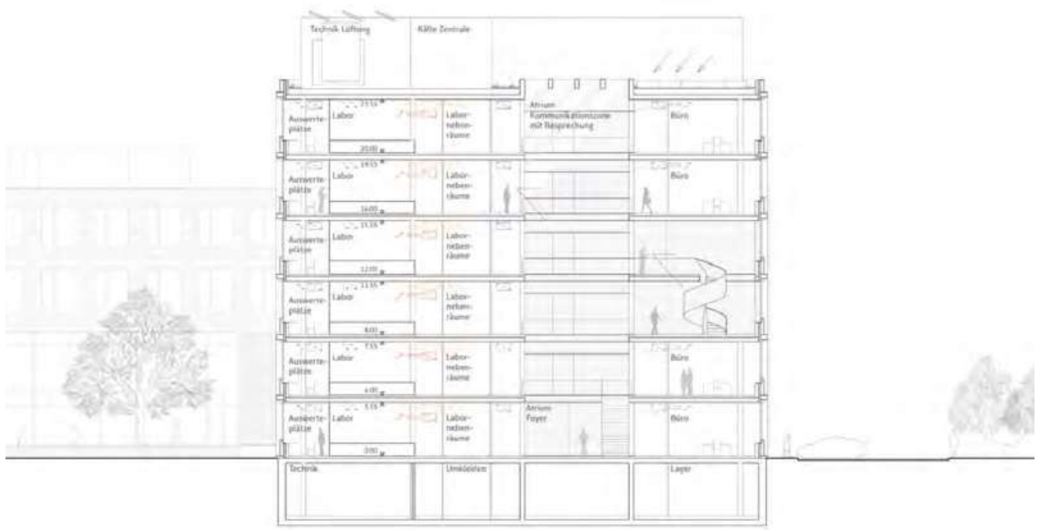



**Figure 05.57 |** Section North-South | Scale 1:500 |
© Bayer & Strobel Architekten

### Floor plan organization

The office and laboratory areas were strictly separated from each other in order to generate energy benefits and promote employee mobility. (wettbewerbe aktuell Verlagsgesellschaft mbH, 2023) There is a clear division into the primary lab zone and the secondary ancillary rooms, which are arranged linearly. The two cores include the escape staircase, elevator, shaft, and ancillary rooms surrounding the central communication zone on the first floor, while the office zone is located on the north.



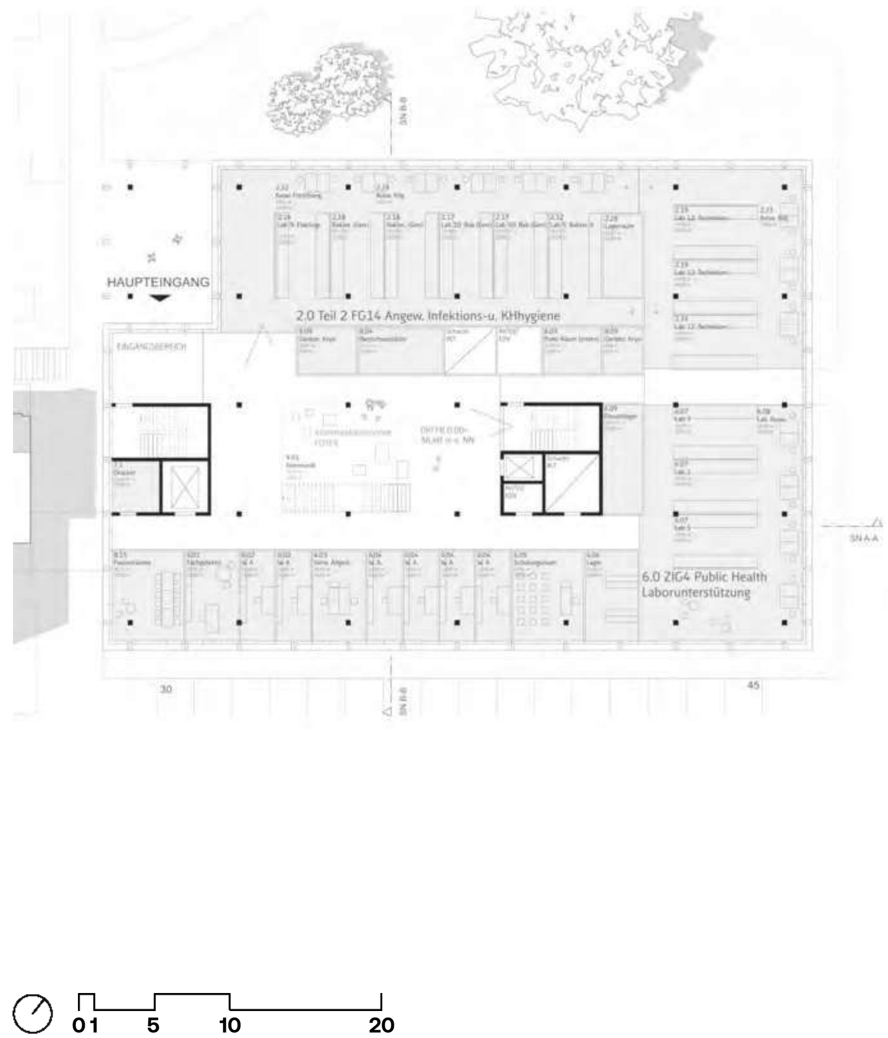
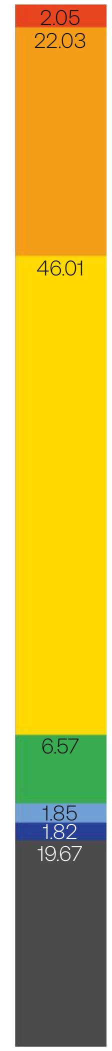



**Figure 05.58 |** Ground Floor | Floor plan | Scale 1:500 |
© Bayer & Strobel Architekten



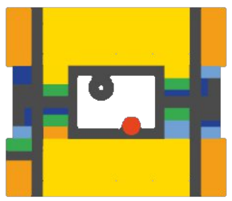

Numbers in %

- **NUF 1** | Living | Stay
- **NUF 2** | Office work
- **NUF 3** | Production | Research | Generate
- **NUF 4** | Store | Distribute | Sale
- **NUF 5** | Education | Teaching | Culture
- **NUF 6** | Healing | Care
- **NUF 7** | Other uses
- **Infrastructure**
- **Circulation area**

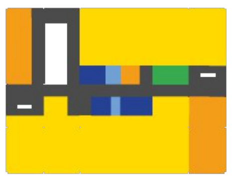
**Figure 05.59 |** First Floor | Space analysis | Scale 1:1,000

# AREA RATIO

The participations submitted correspond to a similar floor plan organization. Many of the participants followed the principles of the feasibility study. Others showed new approaches by rearranging the areas but did not show any drastic structural changes. It is clear that there is not much freedom in the participants' concepts in terms of space efficiency, flexibility, and hygiene requirements. Air voids mostly serve as communication areas with visual connections to the other floors, and the dark zone is arranged centrally. This allows maximum lighting of the laboratory and office areas along the façades.
But are there ways to find a different approach despite these narrow specifications? Can more visual axes and, thus, communication be strengthened? Can the laboratory areas be designed differently, allowing other layouts? Can the circulation area be reduced despite the room program remaining the same? These questions are examined in a separate concept in the following chapter.

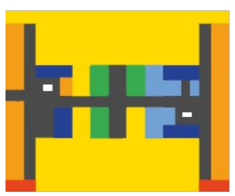


**1704 |** Schulz und Schulz Architekten | Leipzig | 1st floor

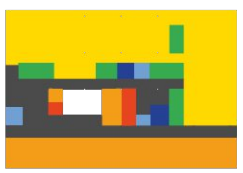


**1710 |** Burckhardt Architektur | Berlin | 1st floor

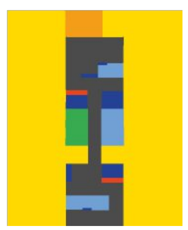
**1721 |** SWAP Architekten ZT | Vienna | 1st floor



**1708 |** wulf architekten | Stuttgart | 1st floor



**1720 |** BAYER & STROBEL ARCHITEKTEN | Kaiserslautern



**1722 |** RIEHLE KOETH | Stuttgart

**NUF 1** | Living | Stay
**NUF 2** | Office work
**NUF 3** | Production | Research | Generate
**NUF 4** | Store | Distribute | Sale
**NUF 5** | Education | Teaching | Culture
**NUF 6** | Healing | Care
**NUF 7** | Other uses
**Infrastructure**
**Circulation area**

1:1.500

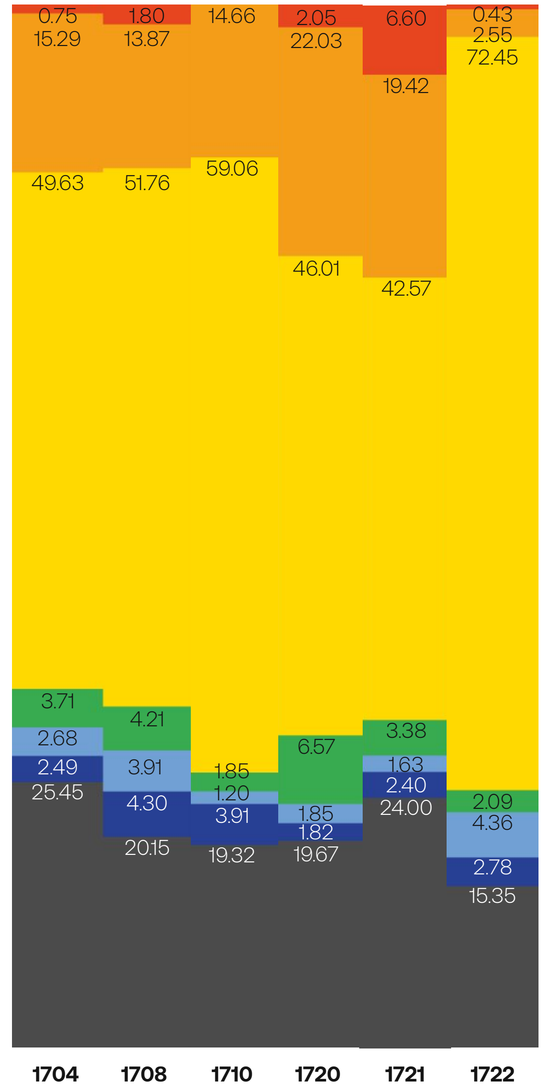



**Figure 05.60 |** Comparison Area Ratio | Diagram

# 06

# Unfold Density

# 06.01 CONCEPT





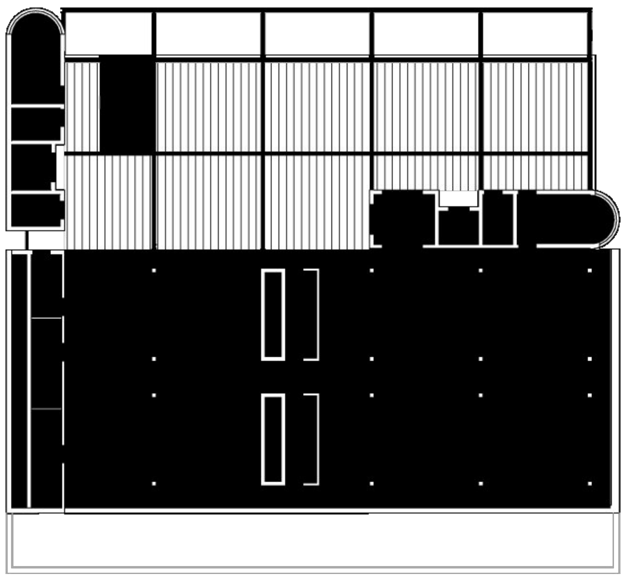


**Figure 06.01 |** Unfold Density | Floor plan | Concept | Scale 1:500

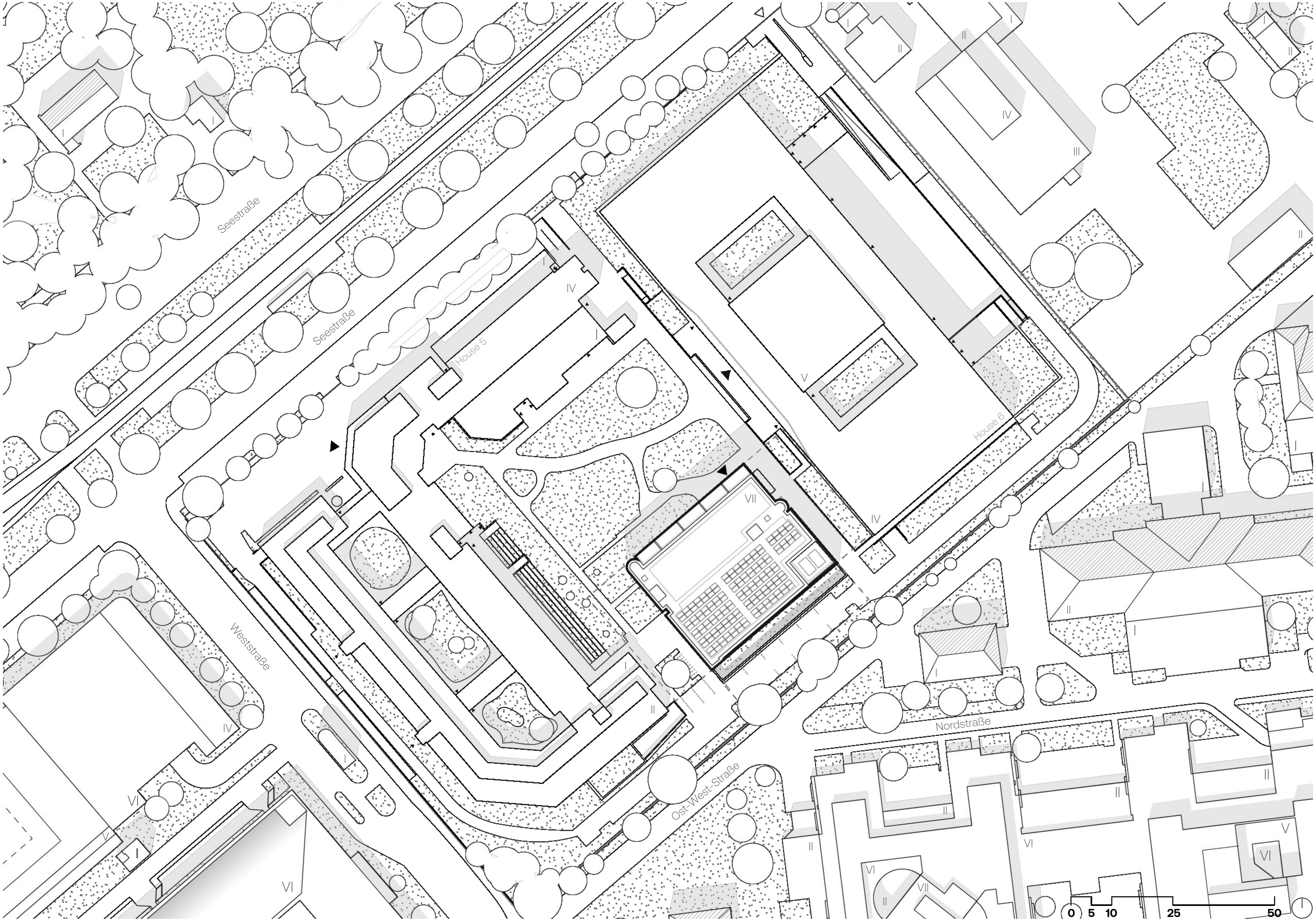
**Rhythm and order** - A glance around the room reveals a clear stringency. Every measuring device and every laboratory bench has its place. It looks like a large, finely tuned grid that conveys a *density of information*.

**Sterility and rationality** - A technical hum pervades the room - a gentle background noise. The clinking of glass and typing on the keyboard break the monotony. The view outside through the *transparency* of the walls emphasizes the contrast to the hectic outside world.

**Creativity and performance** - The machine-like atmosphere is interrupted. Two colleagues lean over the microscope. After a moment of concentrated silence, a lively conversation about the viruses on the slide begins. It is particularly remarkable that the head of research speaks to the new doctoral student as equals - with *no hierarchies*.

**Communication and efficiency** - The path is short, the response is fast. A colleague has heard the conversation and joins the team immediately. The quick reaction and *mobility* are rewarded with a smile. It becomes clear that an impromptu meeting in the presentation room makes sense. The technical hum returns to the foreground.

**Change of pace and regeneration** - After the intensive exchange of ideas, it's off to the balcony to enjoy a coffee. The view sweeps across the institute site. A table tennis tournament is about to take place this evening - one of a *diversity of activities* that enrich the working day.




- - - **Distance |** 0,4 H = 11.8 m

**Figure 06.02 |** Site Plan | Scale 1:1,000

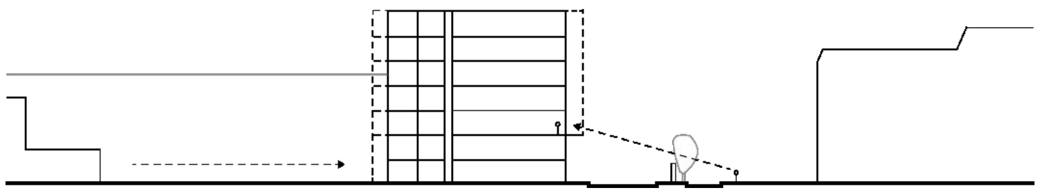



**Figure 06.03 |** Concept Section

**Display**

Transparency toward the public is a key element of modern laboratory architecture, fostering trust and enhancing acceptance. Generous street-facing windows embody this attitude, offering views above the approx. 2.5 m high wall from the second floor up. The lower stories remain intentionally introverted. The *Shelf* acts as a visual and atmospheric link, opposite the casino of House 5. Employees on balconies on the *Shelf* and behind the display lab façade become protagonists in a scene of communication and transparency.

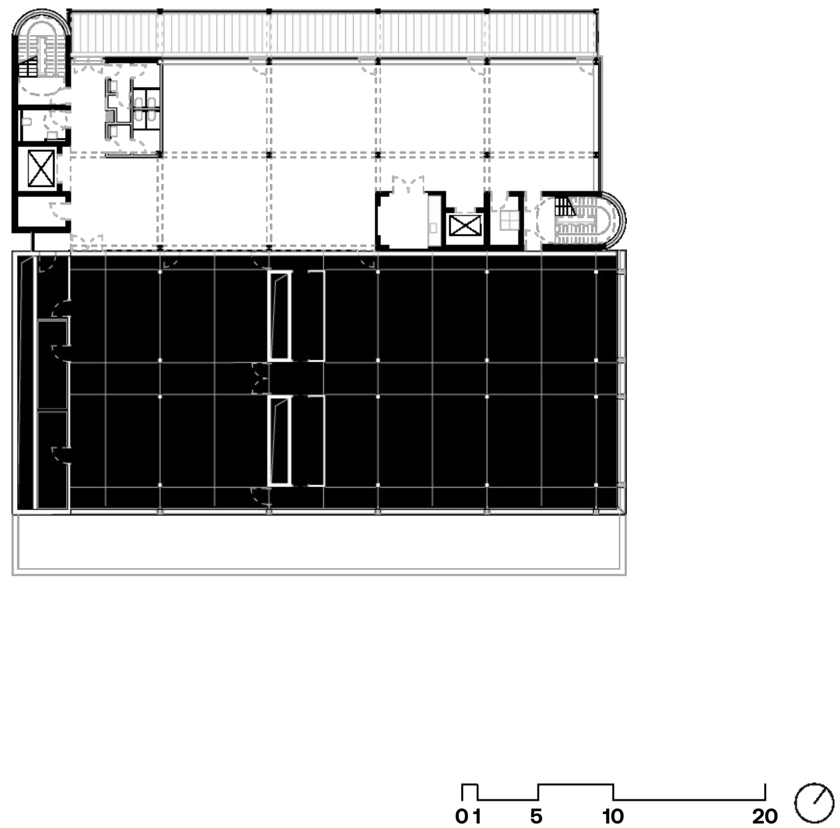



**Figure 06.04 |** Concept Structure | Floor plan | Scale 1:500

**Structure**

In order to pursue the most sustainable approach possible, attention is paid not only to space efficiency but also to the considered use of materials. As the ability to conduct experiments with vibration-sensitive measuring equipment is desirable for laboratories, a reinforced concrete flat slab is one of the most suitable solutions. However, to keep the use of concrete to a minimum, all other zones, such as offices and communication, are planned within a steel structure - the *Shelf*. It can be flexibly filled with wooden hybrid floor panels.

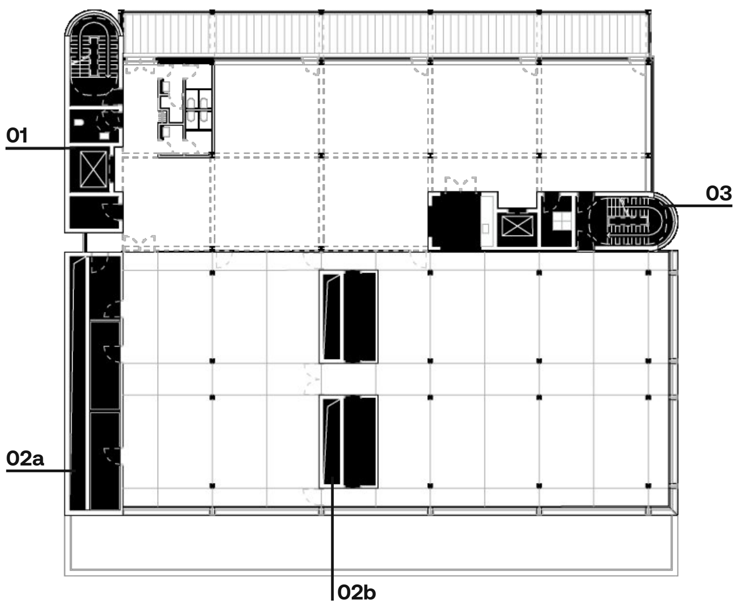



Figure 06.05 | Concept Cores | Floor plan | Scale 1:500

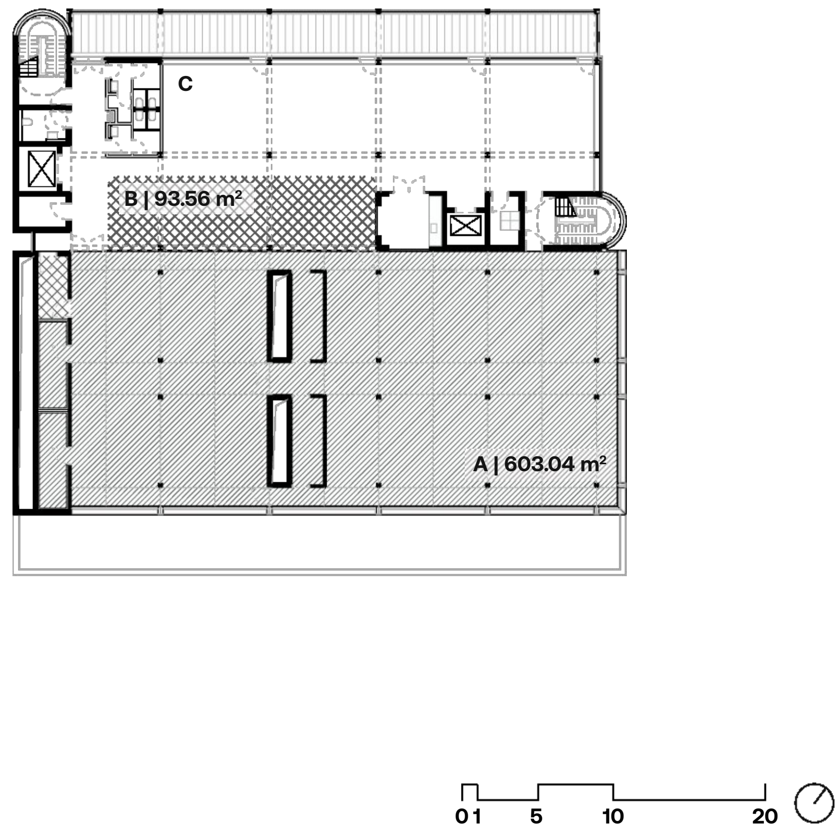



**Figure 06.06 |** Concept Hygiene | Floor plan | Scale 1:500

**Cores**

The space-efficient core typology unfolds into three types: 01 (*Shelf*) provides vertical access for employees and anchors the *Shelf area*. 02a | 02b (lab + transition) house ancillary lab spaces and technical shafts, with 02a bridging into the hygienic lab zone via airlocks or autoclave rooms, while 02b accommodates additional safety shafts for S2/S3 levels. 03 (intermediate zone) lies between the lab and *Shelf*, where visual connections through the tea kitchen meet hygiene standards. Together, 02a, optionally 02b, and 03 form the transition into the hygienic realm.

**Hygiene**

The division into hygienically safe areas is one of the main features of laboratory buildings. Area A is fully available for all safety-level labs. The open-plan space can be flexibly divided and combined. The façade of this area has no openable windows to prevent viruses and germs from entering or escaping.Area B accommodates the transition zone and the write-up spaces. Area C can be used for purposes such as offices, communication zones, further write-up spaces or for laboratories without vibration-sensitive equipment.

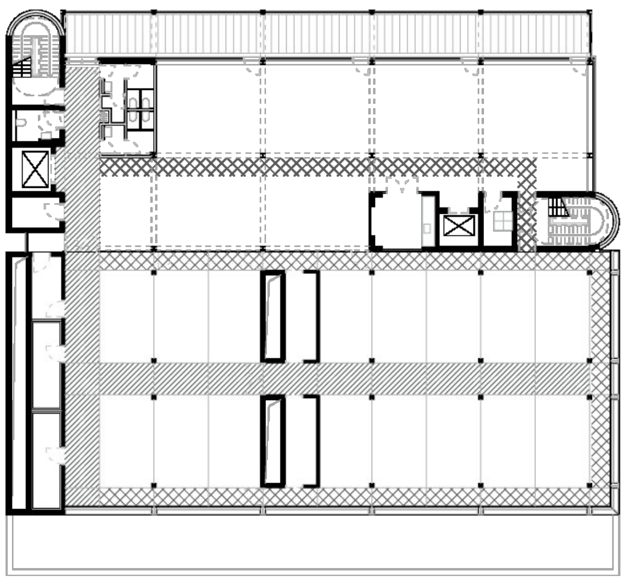


Figure 06.07 | Concept Circulation | Floor plan | Scale 1:500

### Circulation

As requested in the competition, a difference is made in the lab area between material and staff corridors (see Chapter 01.04 Catalogue). All laboratory rooms are connected to both types of corridors - material and staff -, with one elevator each. The overall result is a circular circulation system that leads through both the *Shelf* and the hygienic laboratory area in order to promote communication. The staff corridor was widened from 0.93 m to 1.20 m in order to be considered an escape route. The ≥ 2.10 m material corridor offers a delivery option to all laboratory rooms.

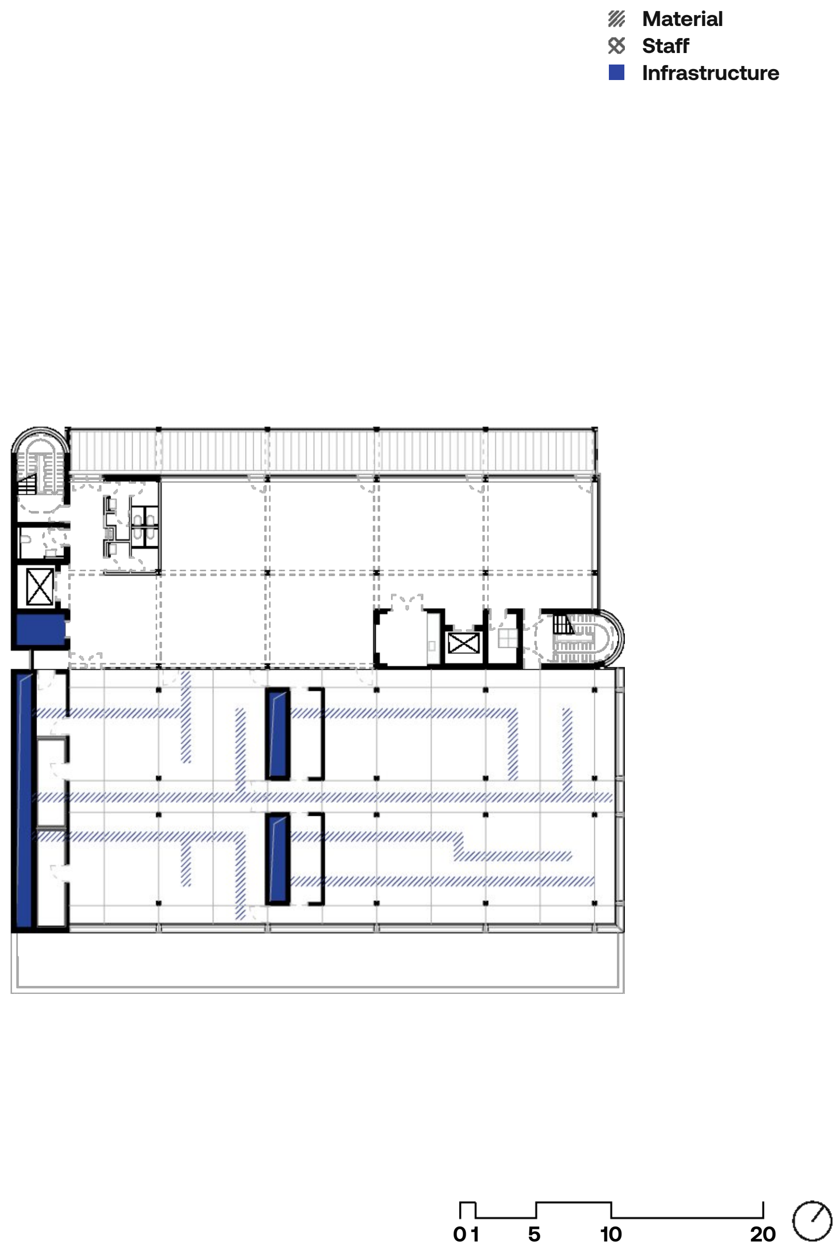



**Figure 06.08 |** Concept Infrastructure | Floor plan | Scale 1:500

### Infrastructure

A current trend in laboratory construction is automated “shaft highways” (see Chapter 01.05 Interview). This design was implemented in a scaled-down form as single shafts. One aim here is to generate the greatest possible flexibility and future expandability. The main shaft spans the outer wall across the lab's entire width. Due to special requirements for higher safety levels, in this case S2/S3, two optional additional shafts were placed within the open-plan lab. Maintenance work during operation and accessibility can be easily implemented.

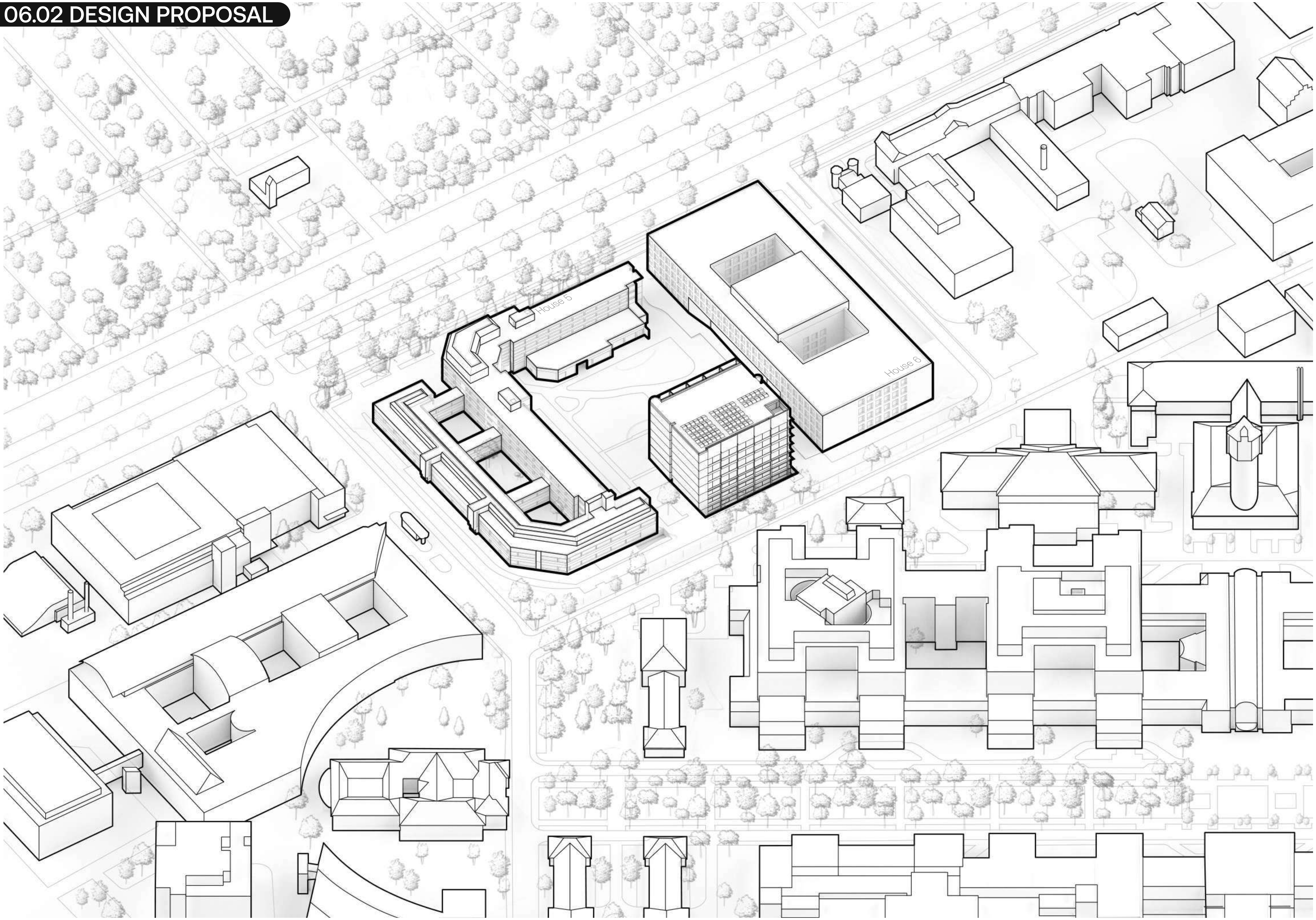



**Figure 06.09 |** Axonometry | South view

Laboratory buildings, resembling architectural machines, balance people and technology, creating a contrasting atmosphere. How can performance pressure on researchers be eased without losing efficiency? Sterility and communication pose diverse architectural challenges. As noted, “placelessness” (Landbrecht & Straub, 2016, p. 30) conveys professionalism, while the cool, technical monotony contrasts with individuality and human needs.

**Attraction Points**

The goal was to create a space-efficient building while preserving communication and aesthetics. Space reduction is achieved through open-plan layouts, a core typology, reduced circulation, double-linear lab arrangements with shared corridors, and grouped write-up spaces. Nevertheless, this goes one step further. Adding so-called *Attraction Points* brings additional significance to the reduced space. Communication and regeneration areas are created as zones on balconies, which have an attractive effect on the employees of the entire institute and promote productivity and creativity.

**Dimensions**

House 7’s design – *Unfold Density* – is based on feasibility study dimensions: 40.50 m width, 33.40 m depth, and 29.50 m height. After an analysis, the specified building site proves to be quite sensible due to the existing basement, the preservation of the central green space, and the closing of gaps in the urban development. A uniform grid of 1.20 m, the typical and sustainable laboratory grid, runs through the entire building. The seven-story building, with an additional basement, connects to House 5 and is accessible via House 5 or the institute courtyard. Each story is 4.10 m high, with technical areas in the basement and top floor.

**Layer**

As described in the introductory text (see Chapter 06.01 Concept), the design implements the findings from the previous analysis and the optimization approaches. Balancing theory and practice is a complex but promising process.



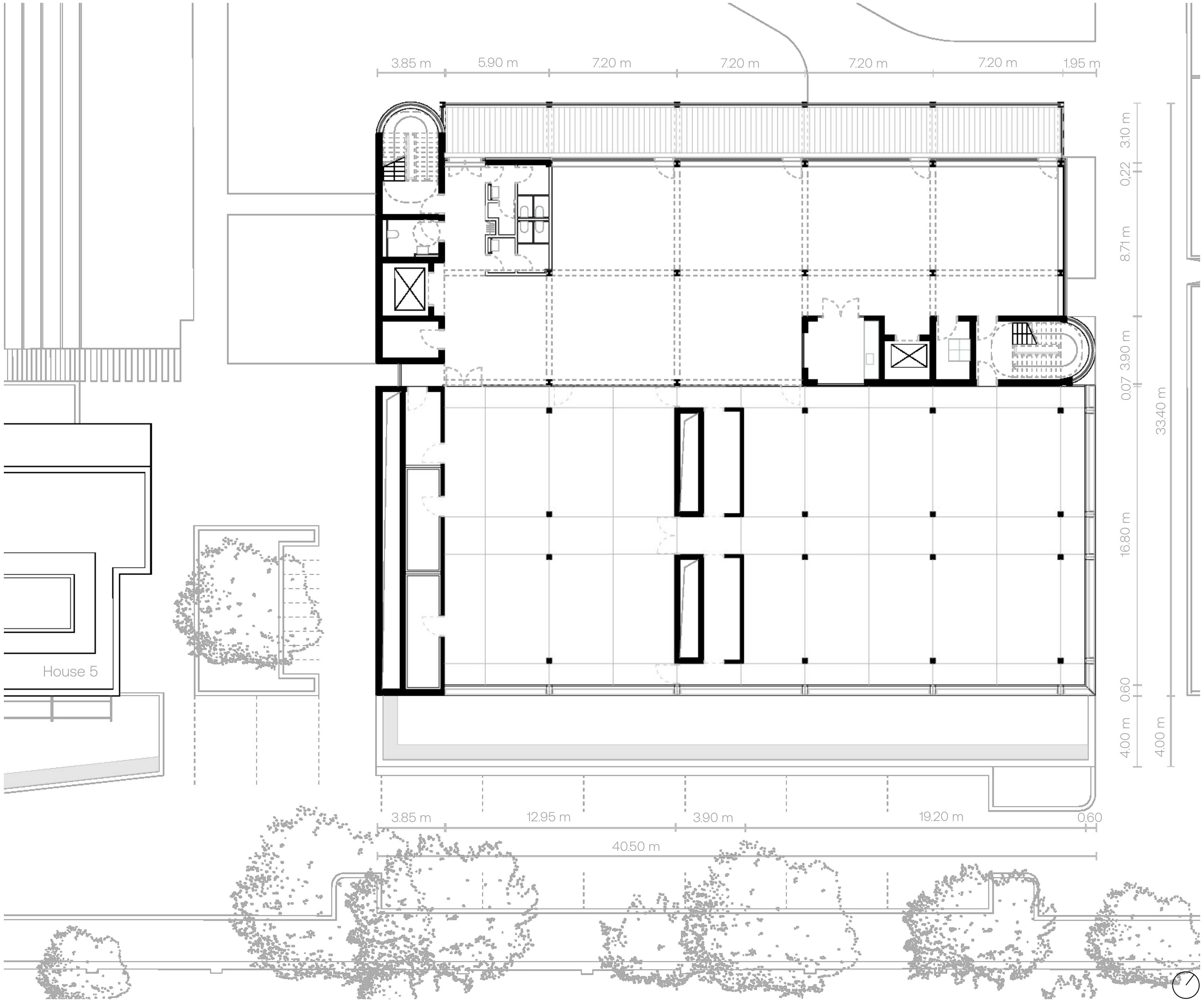



**Figure 06.10 |** Standard Floor | Floor plan | Scale 1:300

# DEPARTMENTS

**2nd floor**
- **FG14** Hospital Hygiene, Infection Prevention and Control
- **ZV4 | ZV5** Information technology | Internal service

**1st floor**
- **FG14** Hospital Hygiene, Infection Prevention and Control
- **FG22** Epidemiological Laboratory
- **ZIG4** Public Health Laboratory Support

**Ground floor**
- **FG22** Epidemiological Laboratory
- **ZBS6** Proteomics and Spectroscopy
- **ZIG4** Public Health Laboratory Support

**Underground floor**
- **ZBS6** Proteomics and Spectroscopy
- Storage
- Technical Infrastructure

**Top floor**
- **FG22** Epidemiological Laboratory
- **ZV4 | ZV5** Information technology | Internal service
- **S** Occupational safety specialist
- Technical Infrastructure

**5th floor**
- **FG18** HIV and other retroviruses
- **ZV4 | ZV5** Information technology | Internal service

**4th floor**
- **FG18** HIV and other retroviruses
- **FG22** Epidemiological Laboratory
- **ZV4 | ZV5** Information technology | Internal service

**3rd floor**
- **FG18** HIV and other retroviruses
- **FG14** Hospital Hygiene, Infection Prevention and Control
- **ZV4 | ZV5** Information technology | Internal service

**Figure 06.11 |** Axonometry Departments | North view

# SCENARIOS

Flexibility is one of the most important parameters in modern laboratory construction. It must be possible to integrate unforeseen future requirements without too much effort. In the design, the floor plan organization's flexibility was implemented so that the user could choose between different tools and spectrums.

**Scenario A**

Here, the space of the required room program is fully utilized. The open-plan arrangement of the office zones creates numerous opportunities to generate small meeting, break or communication zones. This corresponds to the intuitive route concept proposed as an alternative to the classic corridor situation (see Chapter 04 Optimization). A light well is proposed between the two structures to better use the building's depth. Its width, which affects the *Attraction Points*' depth and can be freely selected, also requires doubling partition walls and large dimensions for adequate light at workstations. However, the gap offers diverse sightlines to the floors above and below.

**Scenario B**

This scenario also accommodates all the required uses. The implementation of an open-plan space means that there are no excessive communication corners, the workstations are grouped more strongly, and air spaces are created on every second floor. Numerous additional visual axes are created in the *Shelf*. Compared to scenario A, the space efficiency is optimized, and the lighting of the evaluation stations is improved. The area for the *Attraction Points* is also increased. Disadvantages include the creation of a kind of corridor zone along the evaluation room and the void. Despite this, it offers a communicative, spacious atmosphere, though fewer communication islands can be implemented per floor.

**Divisibility**

The laboratory area can be seen as an open-plan space and can be used freely, thanks to the technical cable routing. In this case, the competition brief was adhered to as much as possible. Departments can be arranged over several floors and linked by stairs. Different departments and security levels are also possible within the story. Office zones are to be arranged across departments throughout the building for increased mobility.

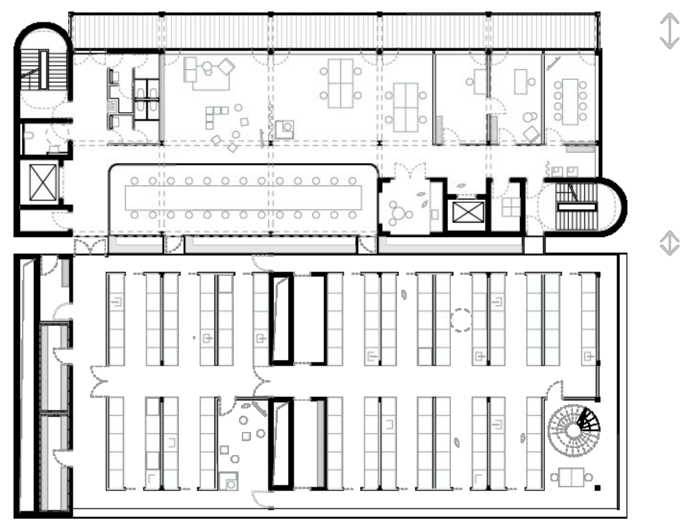


**Figure 06.12 |** Scenario A | Floor plan | Scale 1:500

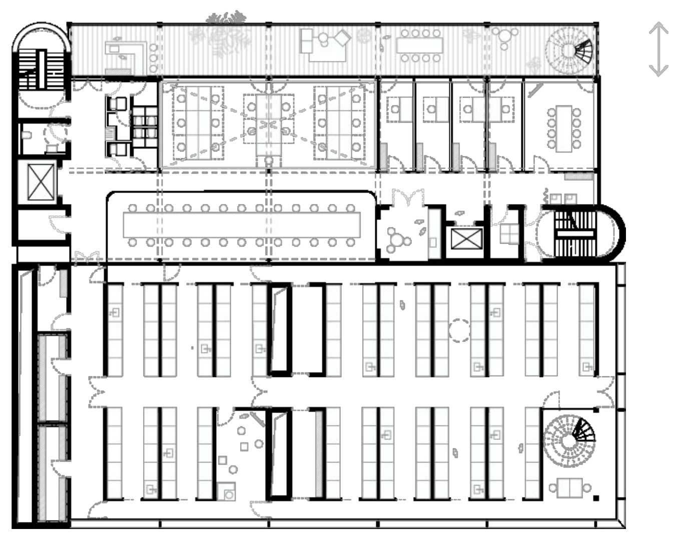
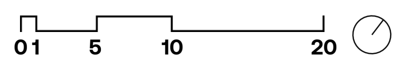


**Figure 06.13 |** Scenario B | Floor plan | Scale 1:500



**01** | Emergency Staircase
**02** | Barrier-free Sanitary room
**03** | Elevator | Material
**04** | ELT-Room
**05** | Side entrance to House 5
**06** | Technical shaft
**07** | ZBS 6 Airlock
**08** | ZV5 Cold storage +4 °C
**09** | ZV5 Cold storage -20 °C
**10** | Attraction Point
**11** | ZV4 Sanitary women
**12** | Fire alarm center
**13** | ZV4 Sanitary men
**14** | ZBS 6 Meeting Room
**15** | Lab
**16** | ZBS 6 | ZIG 4 Scie. empl.
**17** | Write-up space
**18** | ZBS 6 Autoclave
**19** | ZBS 6 Lab 1: Histology
**20** | ZBS 6 Wet chem./Elect.
**21** | ZBS 6 Lab 1: Histology
**22** | ZBS 6 Wet chem./Elect
**23** | ZBS 6 Wet chem./Elect
**24** | Technical shaft
**25** | Technical shaft
**26** | ZBS 6 Microscopy
**27** | Write-up space
**28** | ZBS 6 PMCA
**29** | FG 22 Lab. 1
**30** | FG 22 Lab. 1
**31** | FG 22 Lab. 1
**32** | FG 22 Lab. 2
**33** | FG 22 Lab. 2
**34** | FG 22 Lab. 4
**35** | FG 22 Lab. 4
**36** | FG 22 Lab. 4
**37** | Write-up space
**38** | ZIG 4 Training room
**39** | Storage room
**40** | Tea kitchen
**41** | Elevator | Staff
**42** | IT-Room
**43** | Emergency Staircase
**44** | Double-height foyer

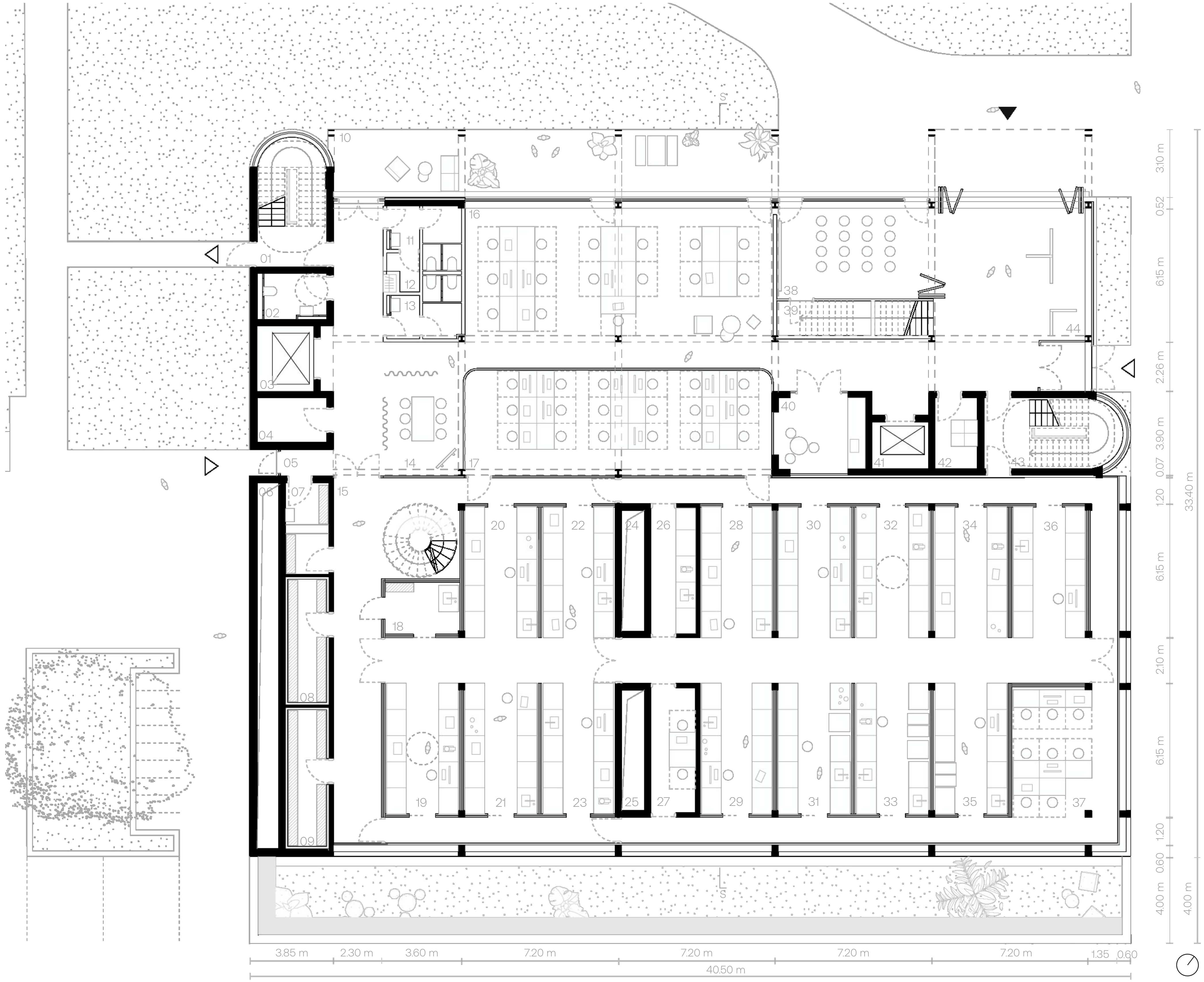



**Figure 06.14** | Ground Floor | Floor plan | Scale 1:200

**01** | Emergency Staircase
**02** | Barrier-free Sanitary room
**03** | Elevator | Material
**04** | ELT-Room
**05** | Technical shaft
**06** | ZV5 Area autoclave
**07** | FG 18 Cold storage +4 °C
**08** | FG 18 Cold storage -20 °C
**09** | Attraction Point
**10** | ZV4 Sanitary women
**11** | Cleaning room
**12** | ZV4 Sanitary room men
**13** | Write-up space
**14** | Lab | Material corridor
**15** | FG 18 Scient. employe.
**16** | FG 18 Lab 7: PCR-D. Pr-NGS
**17** | FG 18 Lab 7: PCR-D. Pr-NGS
**18** | FG 18 Lab 7: PCR-D. Pr-NGS
**19** | FG 18 Lab 8: PCR-D/F. Pr-A
**20** | FG 18 Lab 8: PCR-D/F. Pr-A
**21** | Presentation Area
**22** | Technical shaft
**23** | Technical shaft
**24** | FG 18 Lab 20: Cellc. 2
**25** | FG 18 Lab 20: Cellc. 2
**26** | FG 18 Lab 23: FACS
**27** | FG 18 Lab 23: FACS
**28** | FG 18 Lab 26: PAGE
**29** | FG 18 Lab 9: PCR-F Extr.
**30** | FG 18 Lab 12: PCR-F/D. Nst.
**31** | FG 18 Lab 5: PCR-D Ans.
**32** | FG 18 Lab 10: PCR-F Ans.
**33** | FG 18 Lab 6: PCR-D/F Cycl.
**34** | FG 18 Lab 11: PCR-F Mix
**35** | Write-up space|
**36** | FG 18 Scient. employe.
**37** | FG 18 Scient. employe.
**38** | FG 18 Scient. employe.
**39** | FG 18 Administration
**40** | Tea kitchen
**41** | Elevator | Staff
**42** | IT-Room
**43** | Emergency Staircase
**44** | FG 18 Meeting room

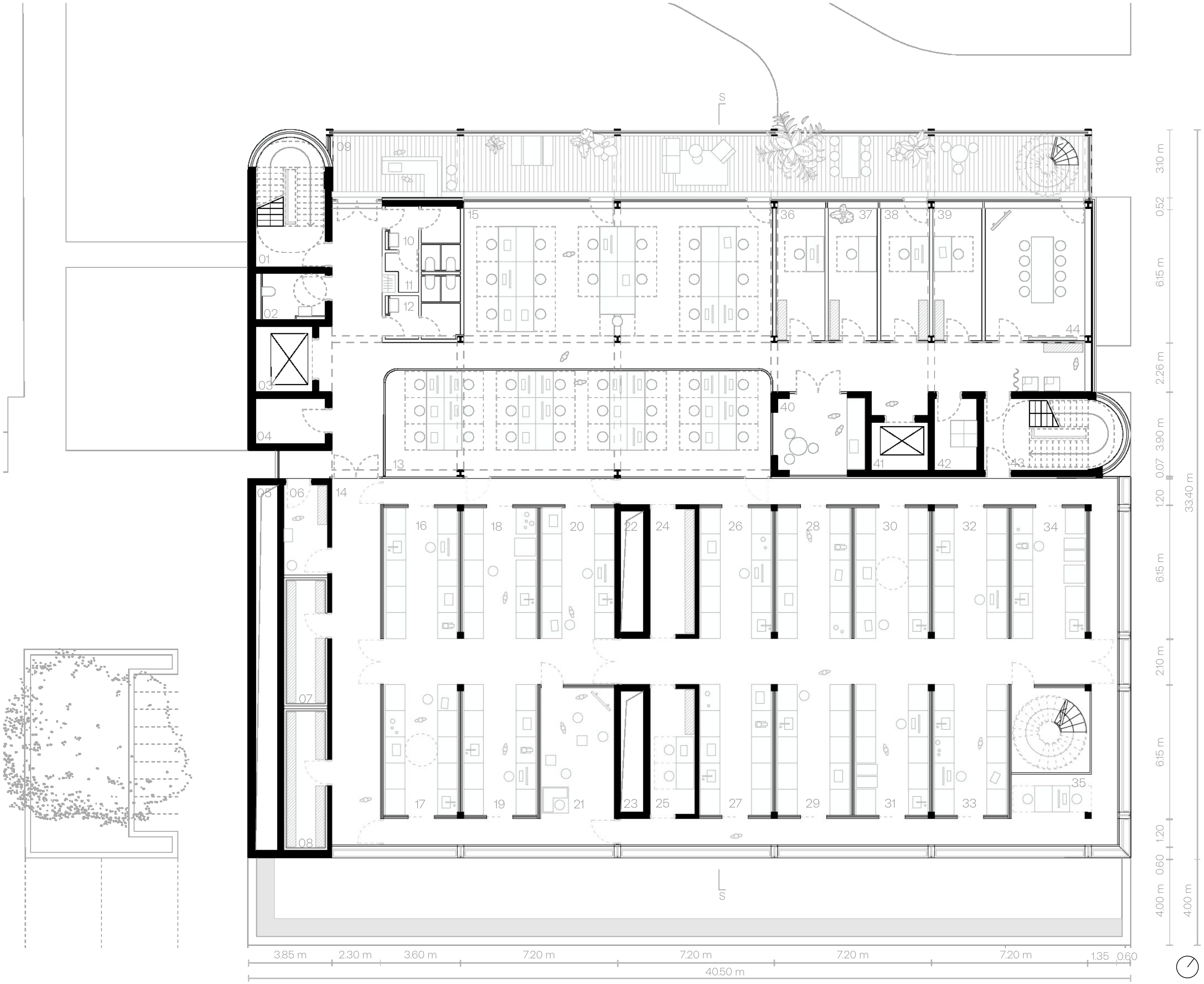



**Figure 06.15 |** Fourth Floor | Floor plan | Scale 1:200

**01** | Emergency Staircase
**02** | Barrier-free Sanitary room
**03** | Elevator | Material
**04** | ELT-Room
**05** | Technical shaft
**06** | ZV5 Area autoclave
**07** | FG 18 Cold storage +4 °C
**08** | FG 18 Cold storage -20 °C
**09** | Attraction Point
**10** | Sanitary room women
**11** | Cleaning room
**12** | Sanitary room men
**13** | Write-up space
**14** | Lab
**15** | Level below
**16** | FG 18 Lab 13: Proj. MolEpi.
**17** | FG 18 Lab 13: Proj. MolEpi.
**18** | FG 18 Lab 14: MB
**19** | FG 18 Lab 14: MB
**20** | FG 18 Lab 14: MB
**21** | FG 18 Lab 25: Agarosegele
**22** | Technical shaft
**23** | Technical shaft
**24** | FG 18 Lab 21: Cellc. 3 ...
**25** | FG 18 Lab 21: Cellc. 3 ...
**26** | FG 18 Lab 15: MB
**27** | FG 18 Lab 15: MB
**28** | FG 18 Lab 15: MB
**29** | FG 18 Lab 17: MB
**30** | FG 18 Lab 17: MB
**31** | FG 18 Lab 17: MB
**32** | FG 18 Lab 18: Doc./Stud.
**33** | FG 18 Lab 18: Doc./Stud.
**34** | FG 18 Lab 23 FACS
**35** | Write-up space
**36** | FG 18 Scient. employe.
**37** | FG 18 Scient. employe.
**38** | FG 18 Scient. employe.
**39** | FG 18 Secretary's office
**40** | FG 18 Head of department
**41** | Tea kitchen
**42** | Elevator | Staff
**43** | IT-Room
**44** | Emergency Staircase
**45** | ZV4 Printer

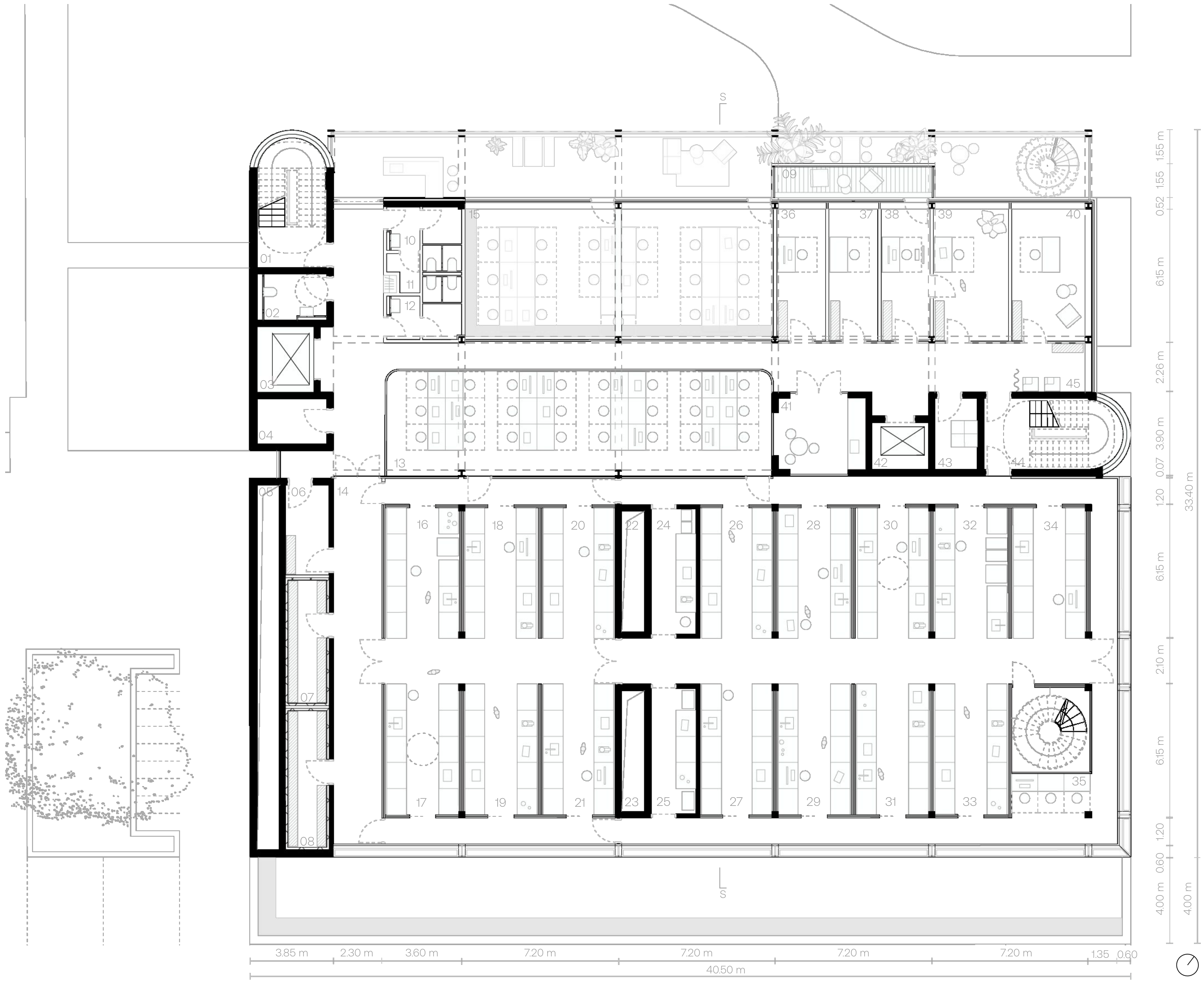
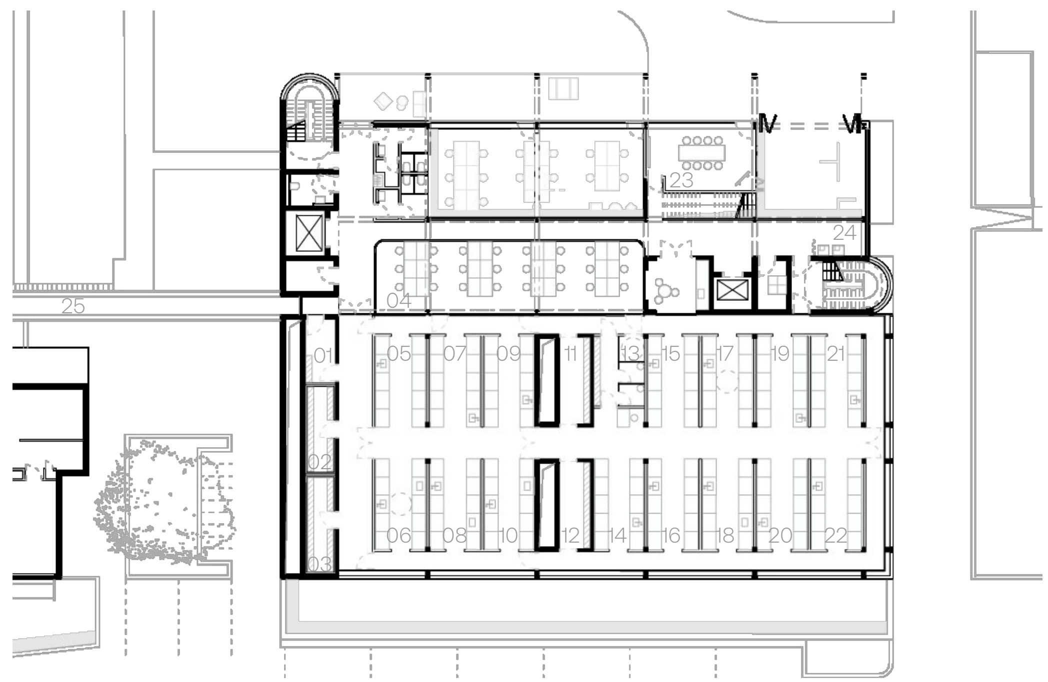



**Figure 06.16 |** Fifth Floor | Floor plan | Scale 1:200

# OVERVIEW

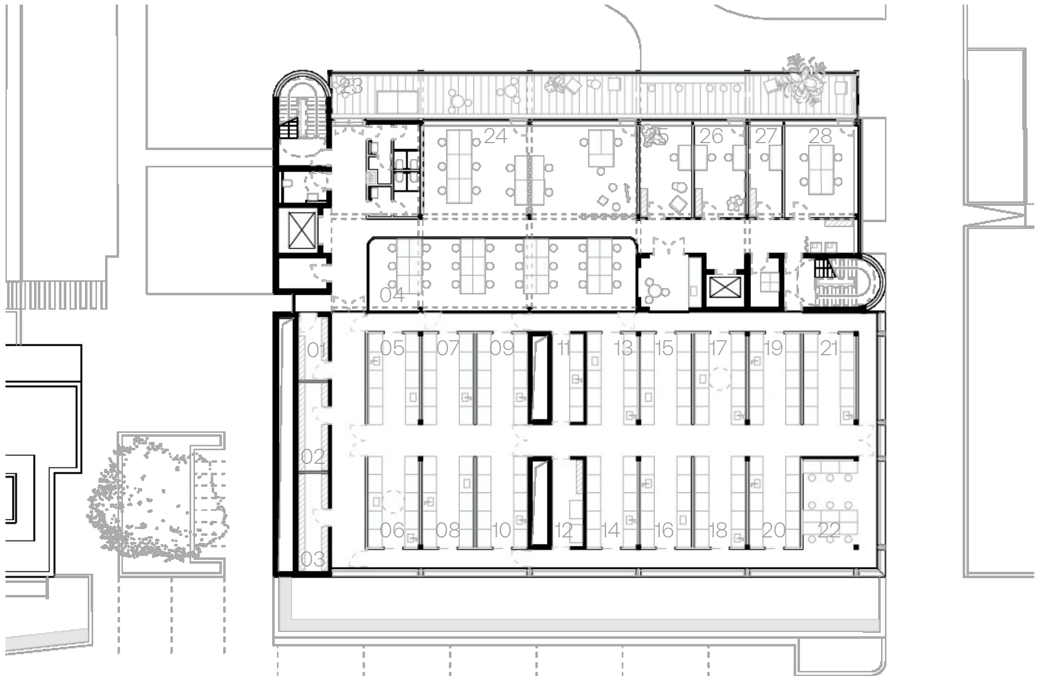
01 | Ventilation and media duct
02 | Steam center and central heating system
03 | Ventilation and media duct
04 | ELT
05 | ELT
06 | Sanitary infrastructure
07 | Break room
08 | Airlock
09 | Cold storage -4 °C
10 | Cold storage -20 °C
11 | Patio
12 | Write-up space
13 | ZBS 6 Lab 2: Purification
14 | ZBS 6 Lab 2: Purification
15 | ZBS 6 Lab 3: Cell culture
16 | ZBS 6 Lab 3: Cell culture
17 | Automatic drainage and hazardous substances
18 | ZBS 6 Dark room
19 | ZBS 6 Liquid nitrogen filling
20 | ZV5 Changing room women
21 | ZV5 Equipment room -20 °C | -4 °C
22 | ZV5 Changing room men
23 | ZV5 Equipment room Deep-freeze -80°C
24 | Hazardous materials storage
25 | GVT
26 | ZV5 Cryogenic garbage cans
27 | ZV5 Archive
28 | S Storage
29 | ZIG 4 Storage
30 | ZV5 Cleaning room (intern)
31 | ZV5 Storage laboratory equip.
32 | ZV5 Storage
33 | ZV5 Storage lab. service
34 | ZV5 Storage furniture | equip.

**Figure 06.17 |** Basement | Floor plan | Scale 1:500



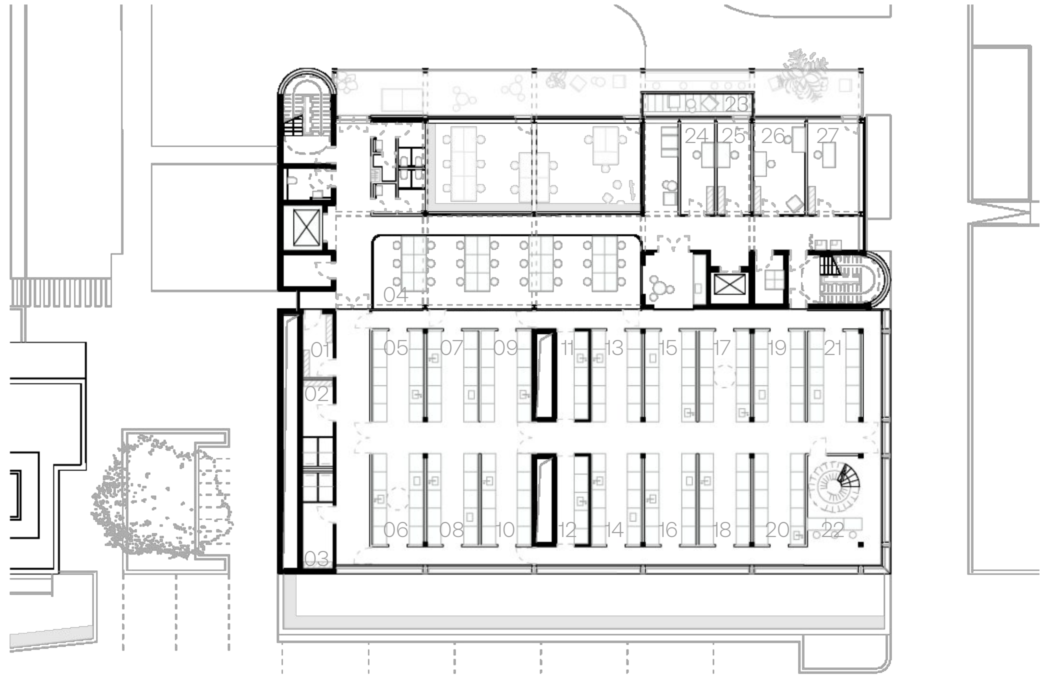
01 | ZV5 Area autoclave
02 | ZV5 Cold storage +4 °C
03 | ZV5 Cold storage -20 °C
04 | Write-up space
05 | FG 14 Lab 1: Virology I
06 | FG 14 Lab 1: Virology I
07 | FG 14 Lab 2: Virology II
08 | FG 14 Lab 2: Virology II
09 | FG 14 Lab 3: Cell culture
10 | FG 14 Lab 3: Cell culture
11 | Equipment and material
12 | Equipment and material
13 | FG 22 Changing room
14 | FG 14 Lab 9: Electrophoresis
15 | FG 22 Labor. 3
16 | FG 22 Labor. 3
17 | FG 22 Labor. 5
18 | FG 22 Labor. 5
19 | FG 22 Labor. 5
20 | ZIG 4 Labor. 1
21 | ZIG 4 Labor. 1
22 | ZIG 4 Labor. 1
23 | FG 14 Meeting room
24 | ZV4 Printer
25 | Optional Bridge to House 5

**Figure 06.18 |** First Floor | Floor plan | Scale 1:500



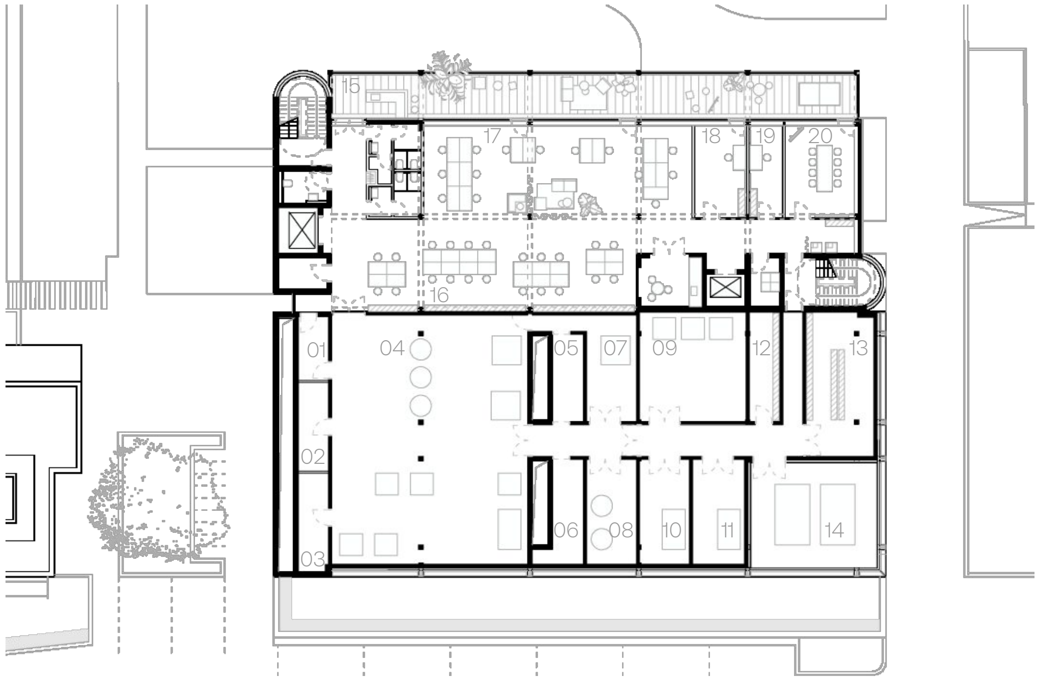
**01** | FG 14 Storage
**02** | FG 14 Equipment room I
**03** | FG 14 Equipment room II
**04** | Write-up space
**05** | FG 14 Lab 4: Bacteriol. I
**06** | FG 14 Lab 4: Bacteriol. I
**07** | FG 14 Lab 5: Bacteriol. II
**08** | FG 14 Lab 5: Bacteriol. II
**09** | FG 14 Lab 6: Bacteriol. III
**10** | FG 14 Lab 6: Bacteriol. III
**11** | FG 14 Microscopy
**12** | FG 14 Incubator
**13** | FG 14 Lab 8: PCR prep.
**14** | FG 14 Lab 7: Anaer. and biofilm
**15** | FG 14 Lab 7: Anaer. and biofilm
**16** | FG 14 Lab 7: Anaer. and biofilm
**17** | FG 14 Lab 10: Bacter. (Gen.)
**18** | FG 14 Lab 10: Bacter. (Gen.)
**19** | FG 14 Lab 12: Technikum
**20** | FG 14 Lab 12: Technikum
**21** | FG 14 Lab 12: Technikum
**22** | Write-up space
**23** | Attraction Point
**24** | FG 14 Scientific employ.
**25** | FG 14 Head of Department
**26** | FG 14 Administration
**27** | FG 14 Secretary´s office
**28** | FG 14 Administration

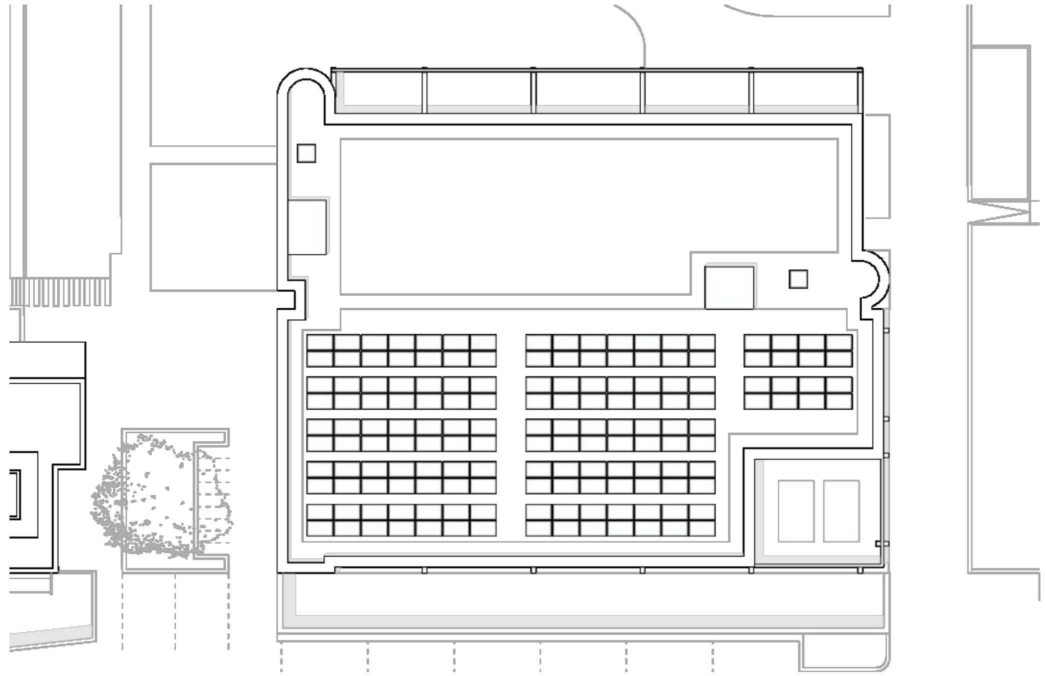
**Figure 06.19 |** Second Floor | Floor plan | Scale 1:500



**01** | ZV5 Area autoclave
**02** | ZV5 Changing room women
**03** | ZV5 Changing room men
**04** | Write-up space
**05** | FG 14 Lab 11: Bacteriology
**06** | FG 14 Lab 11: Bacteriology
**07** | FG 18 Lab 22: Bacteria | Ulz.
**08** | FG 18 Lab 22: Bacteria | Ulz.
**09** | FG 18 Lab 27: Equipm. lab.
**10** | FG 18 Lab 27: Equipm. lab.
**11** | FG 18 Lab 19: Cellc. 1
**12** | FG 18 Lab 19: Cellc. 1
**13** | FG 18 Lab 1: SK
**14** | FG 18 Lab 1: SK
**15** | FG 18 Lab 2: IMS/Inz.
**16** | FG 18 Lab 2: IMS/Inz.
**17** | FG 18 Lab 3: PCR-D. Extr.
**18** | FG 18 Lab 3: PCR-D. Extr.
**19** | FG 18 Lab 3: PCR-D. Extr.
**20** | FG 18 Lab 4: PCR-D. Mix.
**21** | FG 18 Lab 18: Doc./Stud.
**22** | Write-up space
**23** | Attraction Point
**24** | ZIG 4 Head of Department
**25** | ZIG 4 Scientific employee
**26** | ZIG 4 Administration
**27** | ZIG 4 Head of Department

**Figure 06.20 |** Third Floor | Floor plan | Scale 1:500



**01 – 08** | Ventilation and cooling center
**09** | Electrical operating room for emergency power system
**10** | GVT
**11** | BOS
**12** | ZV5 Cleaning room (intern)
**13** | Storage
**14** | Air-cooled cooling machines
**15** | Attraction Point
**16** | Pool Workspace
**17** | FG 22 Scientific empl.
**18** | FG 22 Head of Department
**19** | FG 22 Administration
**20** | FG 22 Meeting room

**Figure 06.21 |** Sixth Floor | Floor plan | Scale 1:500

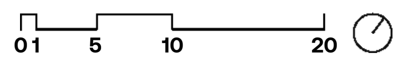



**Figure 06.22 |** Roof | Floor plan | Scale 1:500

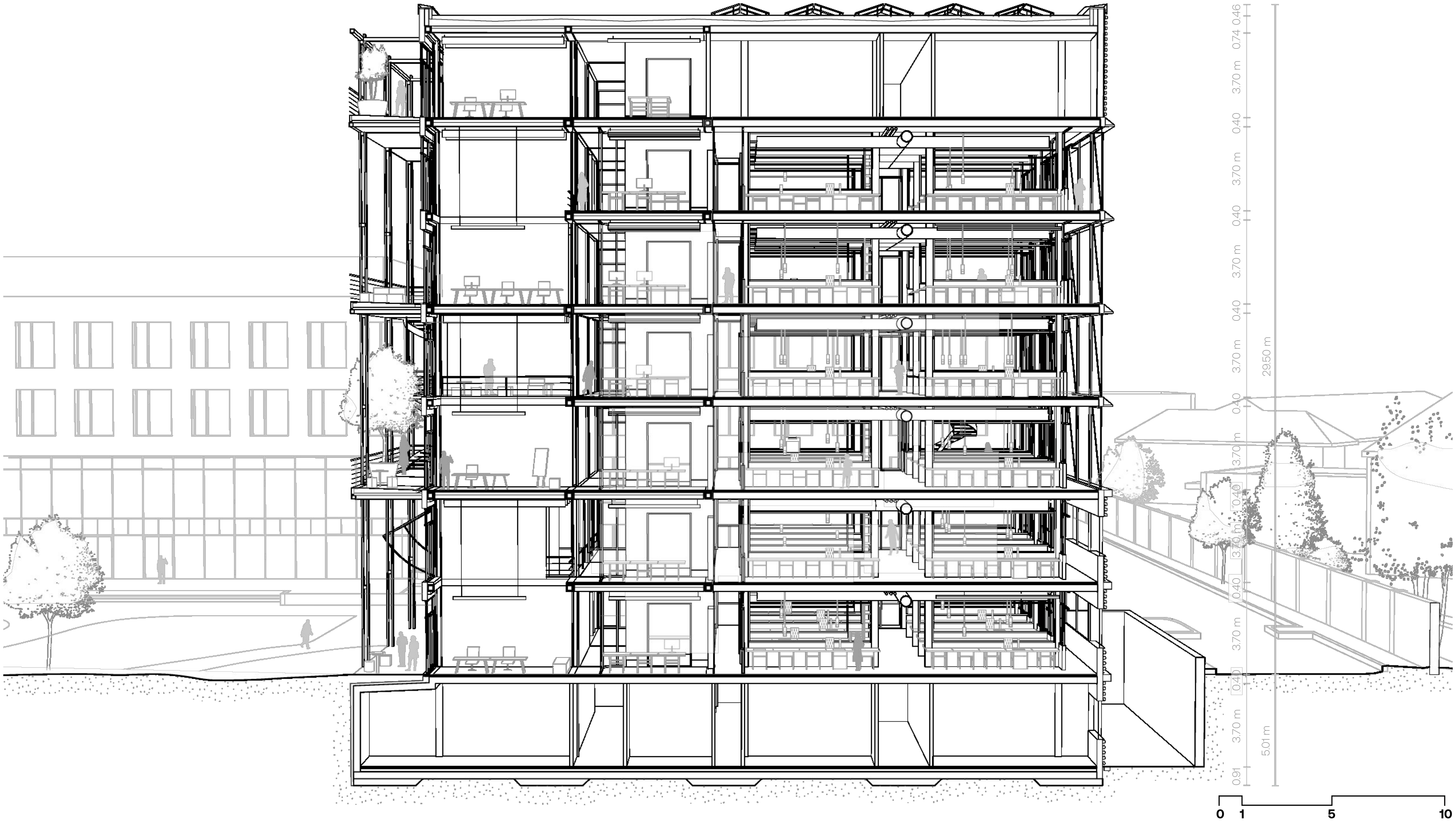



**Figure 06.23 |** S | Section North-South | Scale 1:200

# FURNITURE

Laboratory furnishing is a very complex subject and requires a high level of expertise. The furnishing concept presented here is merely a suggestion as to how rapid adaptation to project-specific or user-specific requirements can be implemented. Future-oriented (see 01.05 Interview) are laboratory boxes and roller systems.

**Parameters**
Based on a standard module (01), numerous extensions and combinations are possible. From write-up desk and cabinet system to washbasin. As described in Chapter 01, all standard elements of a laboratory can be built with this system. One option is a castor system that allows laboratory benches and chairs to be moved around with little effort. It is important to ensure that the individual elements do not weigh too much, which is why aluminum structures are planned. The dark table tops are made of HPL, High-Pressure Laminate, panels. All surfaces must be easy to clean. The uniform dimensions, which are based on the laboratory grid of 1.20 m, are also an advantage. The technical connections are made via suspended connections, which can be freely distributed throughout the open-plan space. Thanks to their transparency, the partition walls allow numerous lines of sight and provide space for cable routing at a height of 70 cm.

**Elements**
**01** | Standard laboratory bench with castors
**02** | Sink with eye wash and Draining rack
**03** | Hanging cabinet
**04** | Storage shelf
**05** | Chair with castors
**06** | Weighing table for vibration-free measurements
**07** | Hanging power connection
**08** | Cabinet
**09** | Storage shelf
**10** | Partition wall with glass and pipe routing option
**11** | Write-up desk

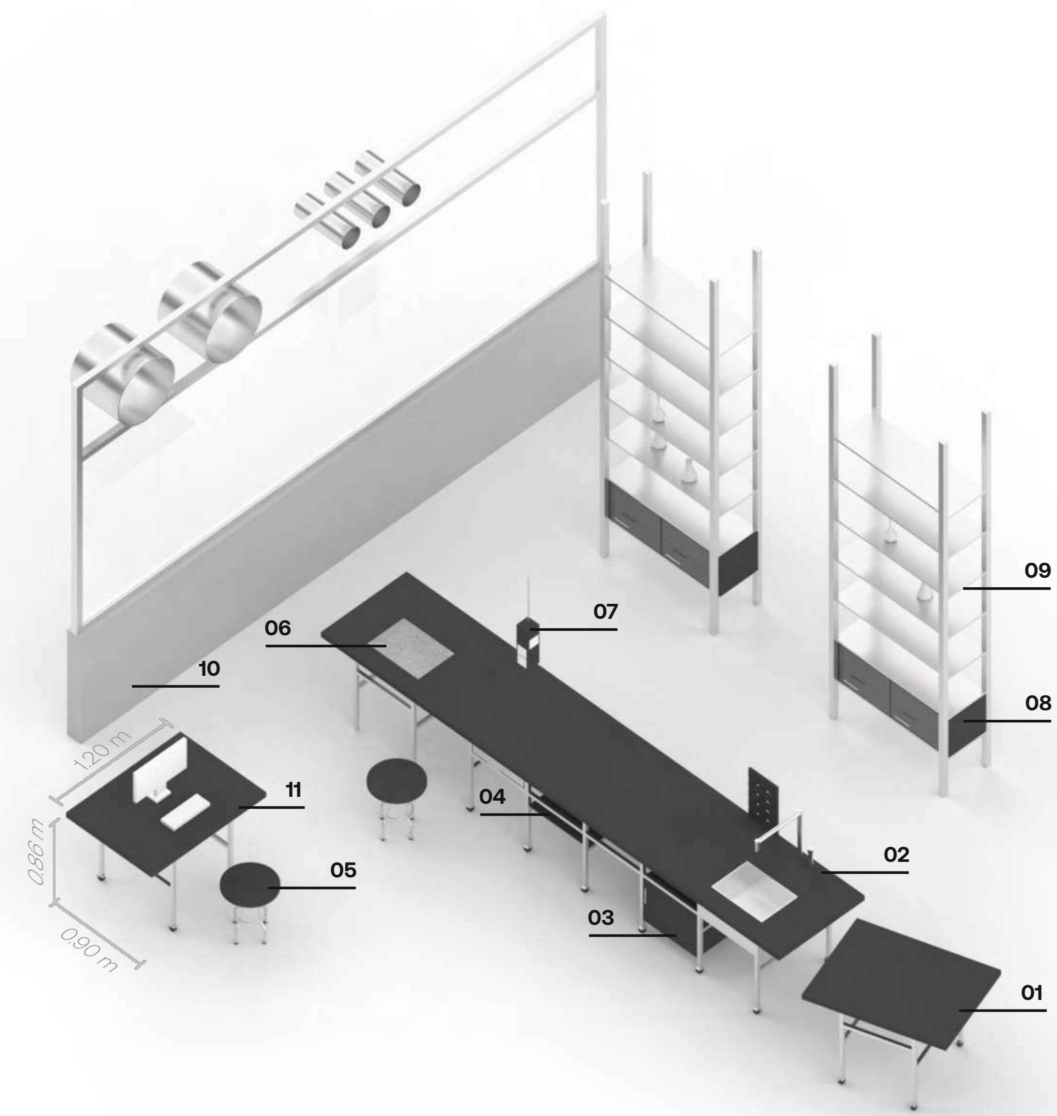
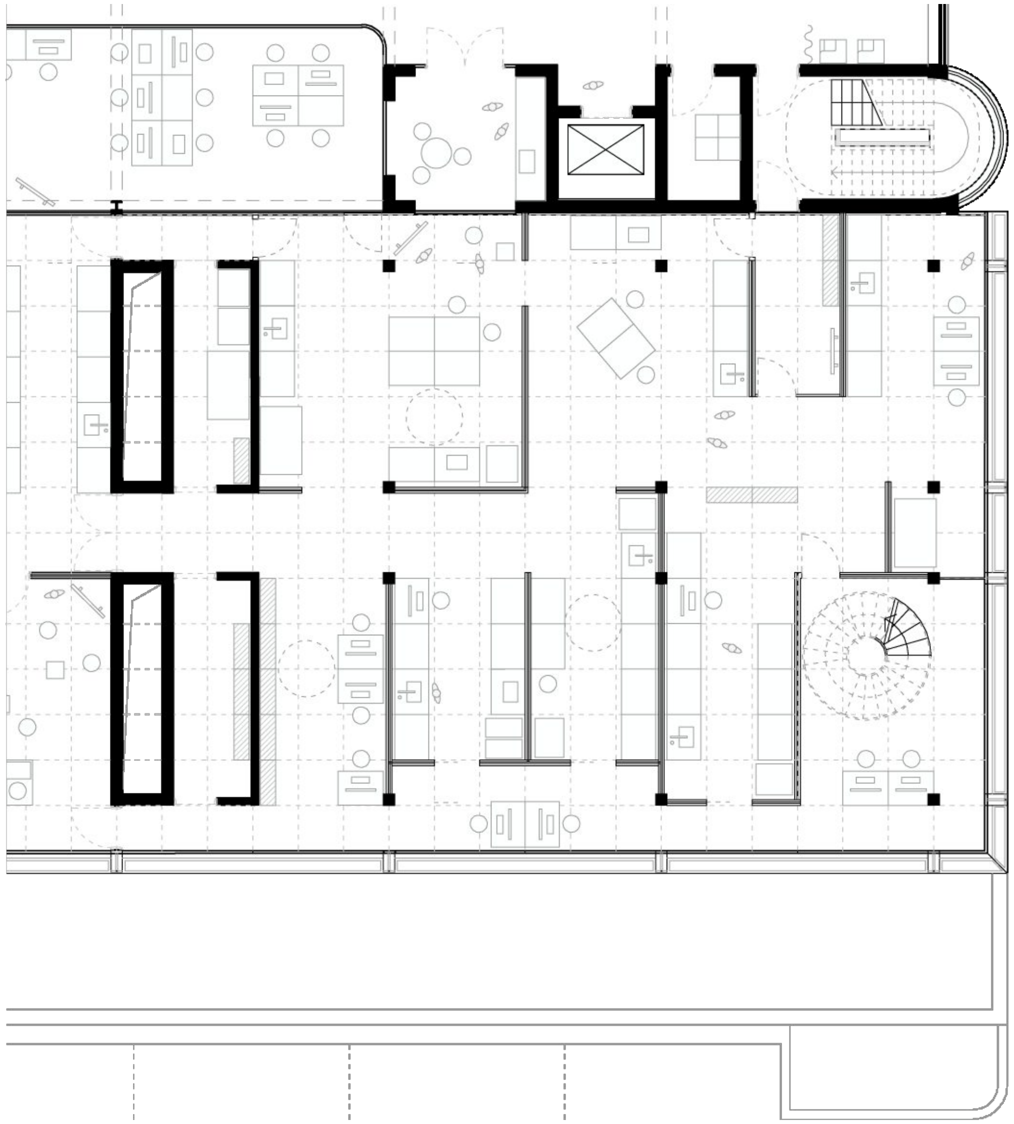
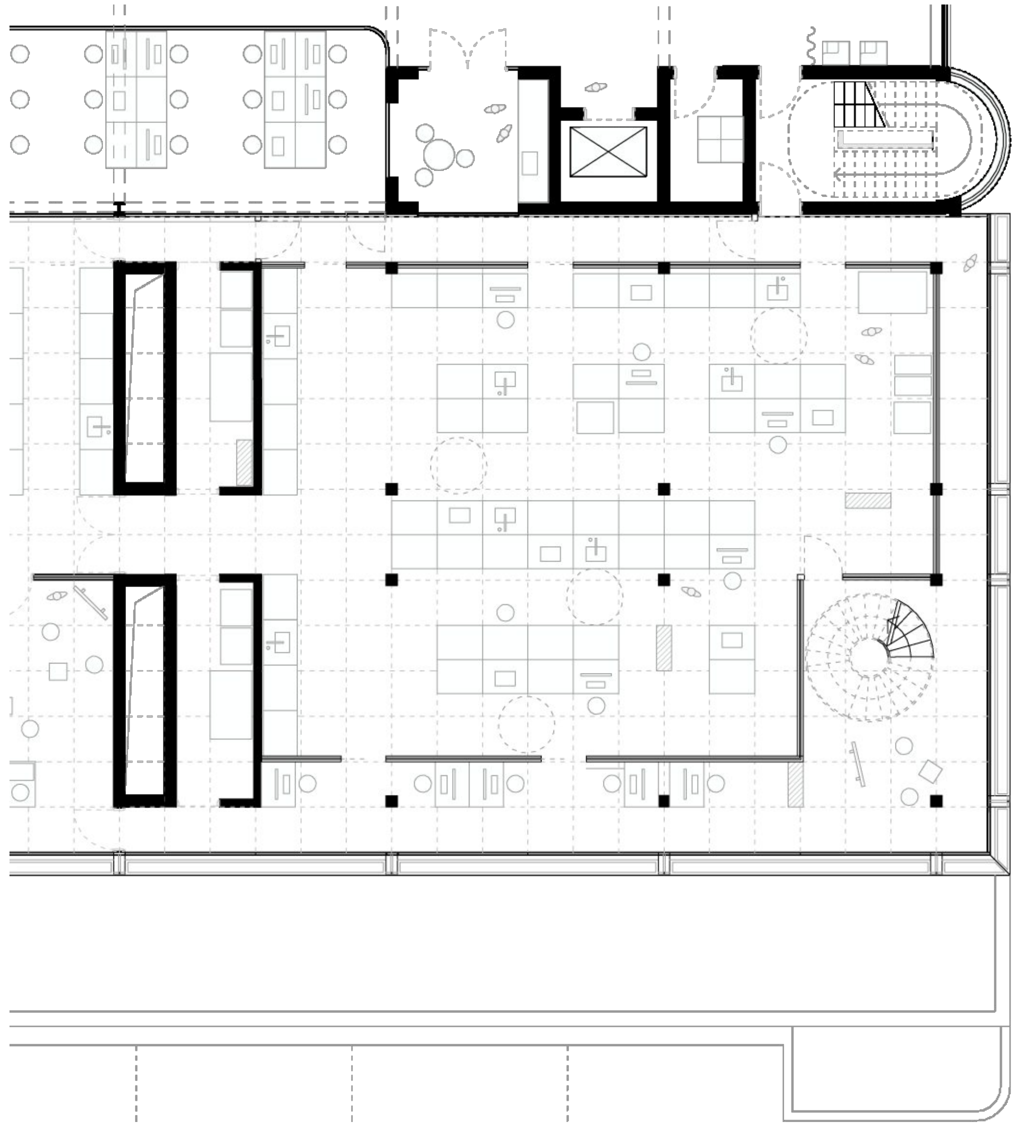



**Figure 06.24 |** Furniture | Axonometry

# FLEXIBILITY





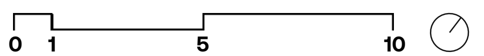



**Figure 06.25 |** Alternative A | Floor plan | Scale 1:200

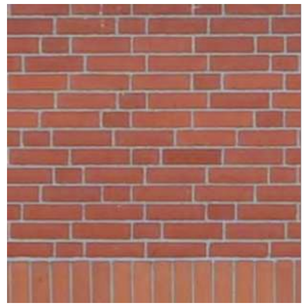
**Figure 06.26 |** Alternative B | Floor plan | Scale 1:200

# MATERIALITY

**Existing building**
The clinker brick façades of the two buildings, House 5 and House 6, have an impressively solid and calm effect. The window framing with dark grey painted aluminum supports this restraint.

**Construction**
One of the most decisive concept points for implementing a sustainable approach is the structural separation of functions. Only the laboratory areas are designed with reinforced concrete flat slabs. Thanks to the high stability, precise measurements can be carried out on vibration-sensitive equipment. The remaining functions, such as the office, evaluation areas, and communication, are housed in the *Shelf*. This steel skeleton structure can be flexibly equipped with wooden hybrid floor slabs. The support grid of 7.20 m is uniform for both constructions and forms a visual symbiosis. In both areas, the floor panels can be seen as modules that can be adapted as required. Both components are separated by a joint.

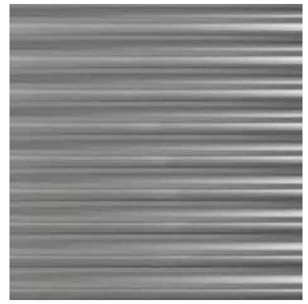
**Material**
The façades are also similar in terms of material and rhythm. The cool, metallic House 7 stands as a calm contrast to the two existing buildings. In addition, a metallic façade has a comforting effect on residents and passers-by, as was seen in House 4 on the Nordufer (see Chapter 02 RKI). It conveys a feeling of hygienic purity and safety. The *Shelf* windows are spaced 2.40 m apart, while those on the laboratory side are spaced 3.60 m apart for maximum transparency and display function. The fabric sun protection is adjustable along a rail system. Photovoltaic systems, which almost completely disappear visually, form an energy-generating sustainability aspect on the south façade. Linoleum flooring in the laboratory was also chosen for sustainability reasons and its low installation height. Its conductivity is extremely important in laboratories. Inside House 7, the *Shelf* with its warm atmosphere contrasts with the cool, technical laboratory section.


**Brick**
Façade (House 5)


**Brick**
Façade (House 6)


**Aluminum**
Windowframe (House 5 + 6)

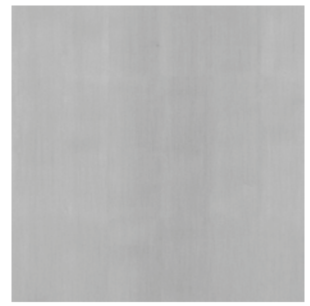

**Recycled concrete**
Walls | Façade | Structure


**Corrugated Iron**
Façade | Walls Lab


**Recycled 3D-printed concrete** | Façade Techn. Shaft


**Linoleum**
Conductive flooring | Lab


**Photovoltaic panel**
Solar protection | Façade Lab


**Aluminum**
Façade | Windowframe | Balcony


**Larch wood**
Flooring | Shelf


**Larch wood**
Partition wall | Shelf


**Larch wood**
Flooring balcony | Shelf

**Figure 06.27 |** Overview Material

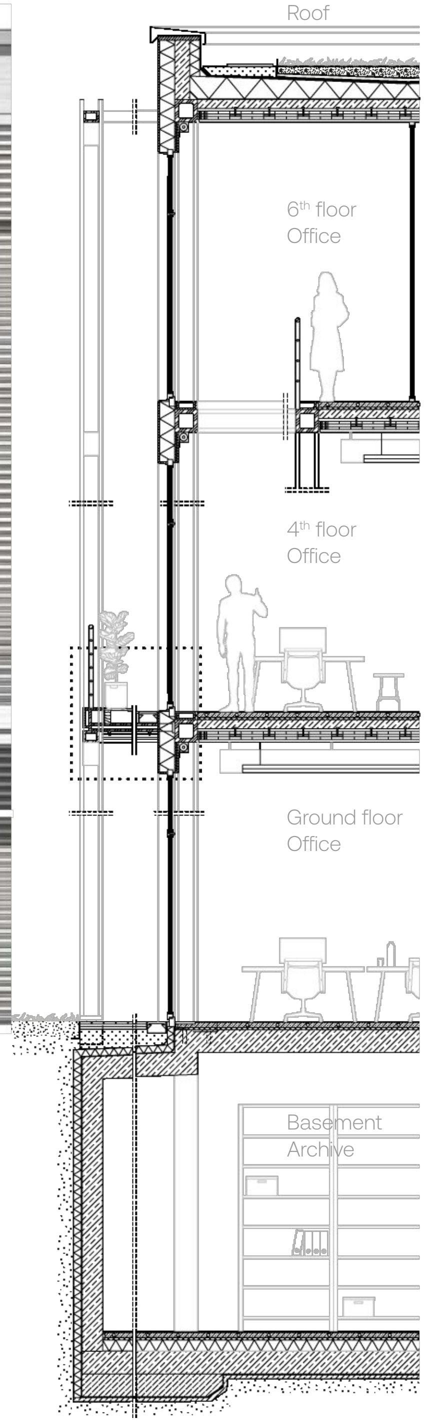



**Figure 06.28 |** Elevation North | Detail | Scale 1:100

**Figure 06.29 |** Section Façade North | Detail | Scale 1:100

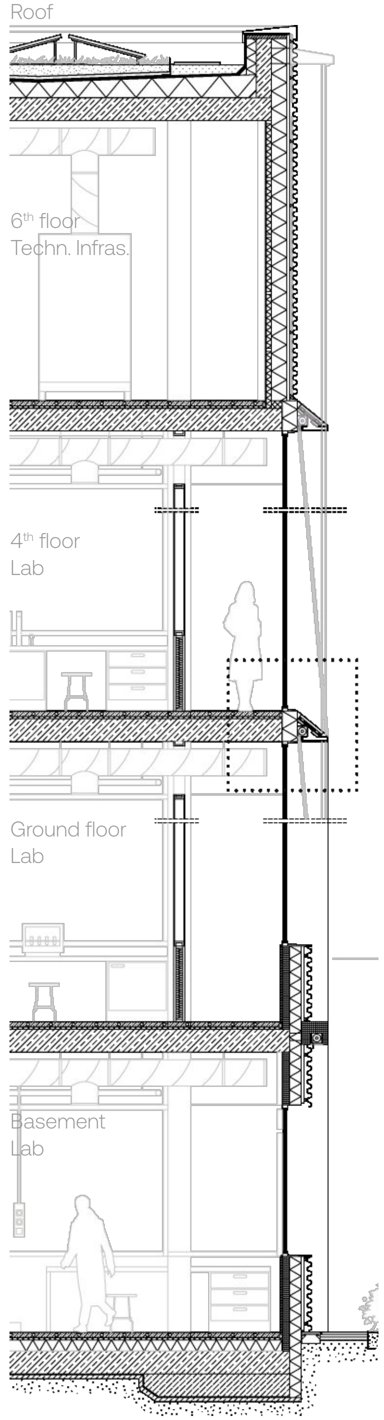
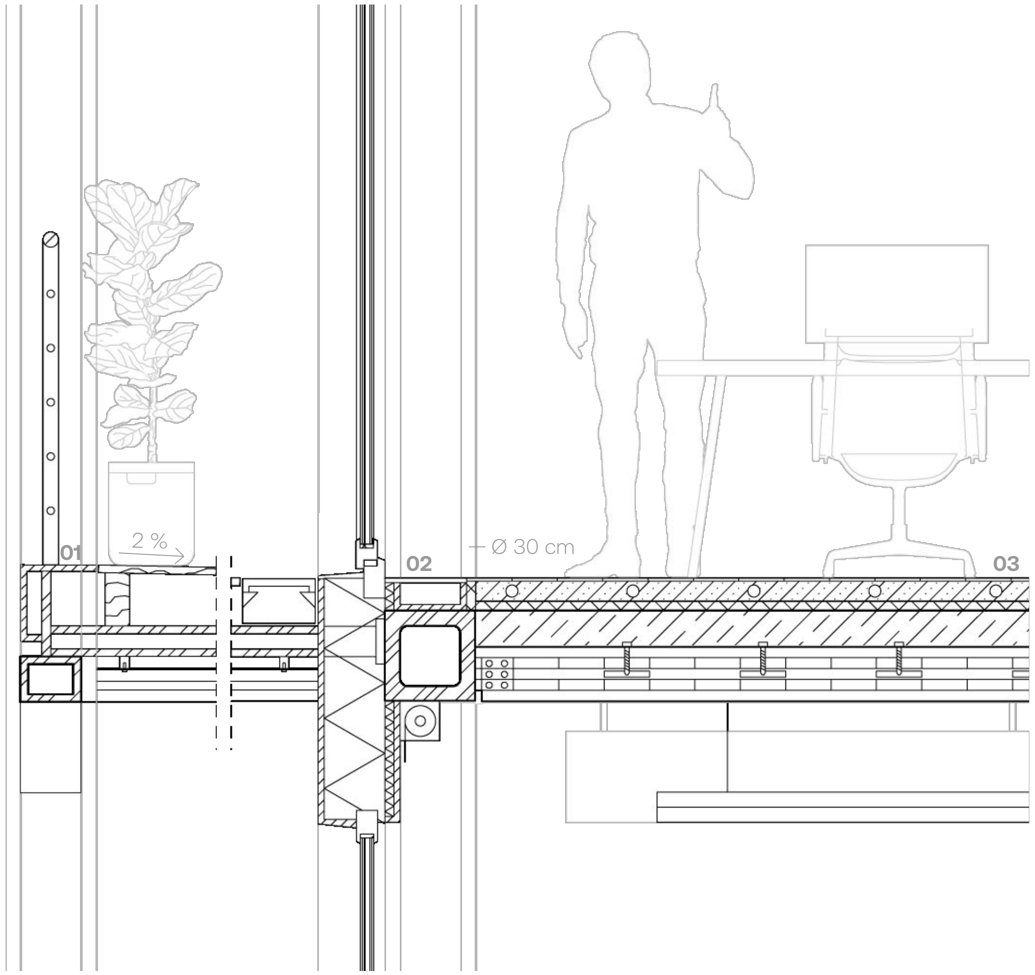



**Figure 06.31 |** Section Façade South | Detail | Scale 1:100

**Figure 06.30 |** Elevation South | Detail | Scale 1:100




**01 | Balcony**

| | | |
|---|---|---|
| Larchwood decking to falls 2% | 25 | mm |
| Wood beam | 239 | mm |
| Steel beam | 100 | mm |
| Wooden substructure | 40 | mm |
| Corrugated sheet metal | 42 | mm |

**02 | Façade Shelf**

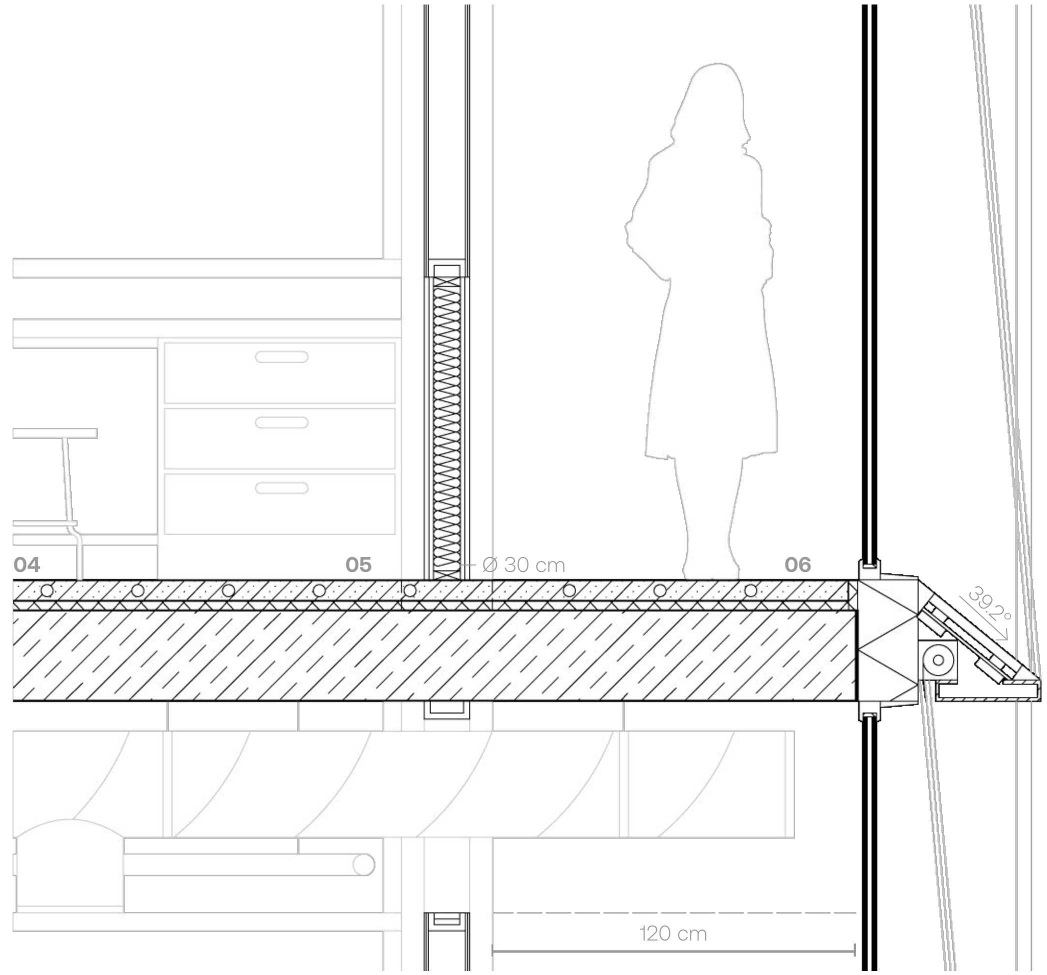
| | | |
|---|---|---|
| Aluminum panel | 20 | mm |
| Insulation \| XPS | 200 | mm |
| Triple glazing \| Alu. frame | 30 | mm |
| Steel \| Fire protec. coating | 300 | mm |

**03 | Ceiling Shelf**

| | | |
|---|---|---|
| Parquet Larch | 3 | mm |
| Heeting screed | 65 | mm |
| PE foil separation layer | | |
| Impact Soundproofing | 30 | mm |
| Recycled concrete | 120 | mm |
| Cross laminated timber | 180 | mm |
| | **400** | **mm** |
| Felt sound absorber | 400 | mm |
| LED lamp \| Aluminum | 100 | mm |

**Figure 06.32 |** Detail Shelf | Scale 1:25






**04 | Ceiling Lab**

| | | |
|---|---|---|
| Linoleum \| dissipative | 3 | mm |
| Heeting screed | 65 | mm |
| PE foil separation layer | | |
| Impact Soundproofing | 30 | mm |
| Recycled concrete | 300 | mm |
| | **400** | **mm** |
| Technical infrastructure | 700 | mm |

**05 | Partition wall**

| | | |
|---|---|---|
| Flush-fitting drywall | 125 | mm |
| Tiles on both sides | 25 | mm |

**06 | Façade Lab**

| | | |
|---|---|---|
| Triple glazing in aluminum frame | 70 | mm |
| PV-Panel | 15 | mm |
| Sun protec. \| Fabric layer \| White | 1 | mm |
| Horizon. aluminum panel | 70 | mm |
| Vertical rail \| Sun protec. \| stainless steel | 30 | mm |

**Figure 06.33 |** Detail Lab | Scale 1:25

Figure 06.34 | Sophie

**Sophie (30)**
Gives an insight into her everyday work

***“A workplace should inspire and connect people, not just function efficiently. In House 7, everything feels human-centered – functional, open, and welcoming. It’s a space that fosters both research and collaboration.“***

After the predominantly factual and theoretical discussion of the contents of this work, the following section opens up a *new perspective*. It describes the everyday life of a fictitious young researcher at the Robert Koch Institute and shows how the spatial and atmospheric conditions influence her work and her daily routine.

**Arrival**
May 12, Monday, 8:05 in the morning. The week begins.
It's always particularly stressful on the streetcar in Berlin at this time of day. Sophie gets off right outside the institute at Virchow-Klinikum station and walks to the main entrance. As she does every morning, she greets the porter and walks past the large staircase in the foyer straight into the green courtyard. There, she already sees some colleagues on their way to the various institute buildings. Today is going to be a stressful day for her. Tomorrow, she has to give a presentation to an international group of experts on her current research findings on infections with multi-resistant pathogens. Sophie is part of Department FG 18 HIV and other retroviruses.
As she approaches the entrance area of House 7, she sees a colleague from her team, drinking a cup of coffee on the balcony. He sees her and waves to her.

**Figure 06.35 |** Rendering North View | Façade Shelf

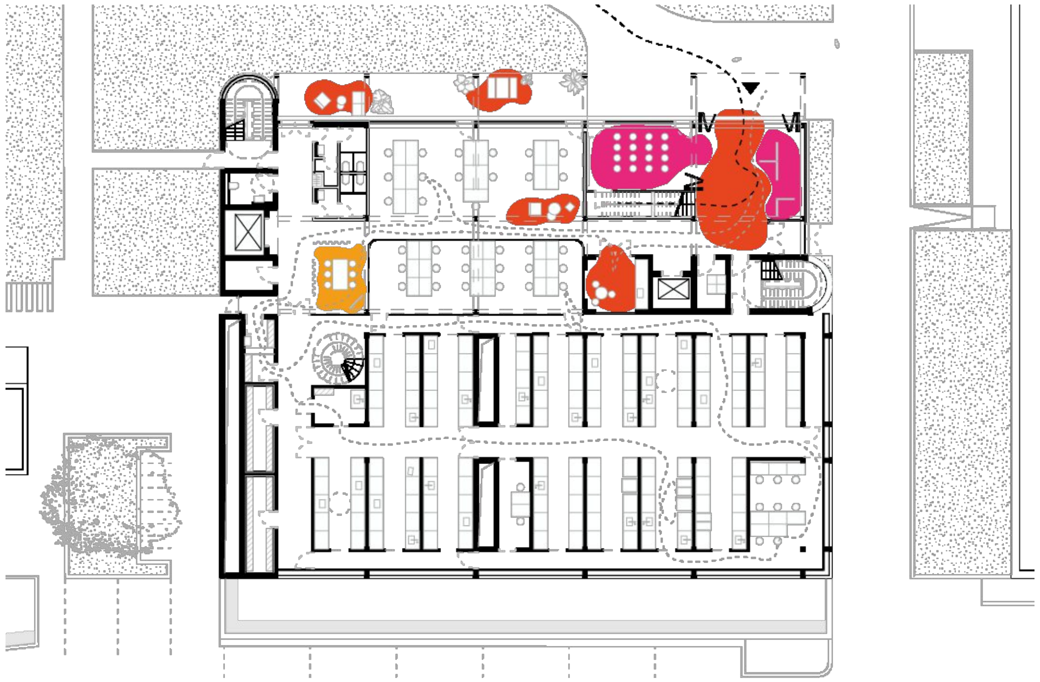


**Figure 06.36 |** Movement Ground Floor | Floor plan | Scale 1:500

**Figure 06.37 |** Movement Fourth Floor | Floor plan | Scale 1:500



**Foyer**

In the foyer, she sees the first preparations being made in the training room for the presentations the next day. Her nervousness rises for a moment. Sophie hears someone say her name. Two colleagues are looking at the presentation plans on display and tell her that they are already excited. Sophie goes over and has a quick chat with them. The results of the three other presenters are hanging next to her plans.
She looks up at the first floor and considers whether she should take the elevator today. Sophie decides to take the stairs and makes her way to her workplace on the fourth floor. Perhaps this will help her to get the excitement out of her head for a moment.

**Office**

On the way upstairs, she greets her colleagues as she does every day. There are still plenty of desks free, as most of them don't arrive until 8:30. The colleague is still standing outside enjoying his coffee. Perhaps she should join him for 10 minutes after she has put her things away. It's still quiet, so she takes a moment to look around her desk and enjoy the view. The warm atmosphere of the wood is unusual. There is a slightly woody smell in the air. Her last workplace was dominated by cool, white surfaces. After a moment, she goes outside to see her colleague and starts her working day shortly afterward.

Figure 06.38 | Rendering Office | Second Floor

**Figure 06.39 |** Rendering Lab | Second floor

**Laboratory**
She enters the laboratory area through the autoclave room. Before Sophie goes into Lab 5: PCR-D Ans., she puts on her lab coat, disinfects her hands and checks that her materials are ready. The atmosphere is different now. A dark floor and the pipes under the ceiling give a much more mechanical impression. A technical hum can be heard in the background. Every now and then, she looks out of the window and sees passers-by and visitors to the clinic. Some stop and look up with interest. Absolute precision prevails in the laboratory - every movement is dictated by the protocols and protective equipment is mandatory. In order to make final preparations for tomorrow, she has small discussions and conversations with colleagues. Today, she frequently switches between the computer at the write-up space and the microscope. Everything is now prepared.

**Attraction Point**
After an intensive day, she remembers that an after-work meet-up is planned on the second floor at the coffee bar. There, she can mentally relax before her big day.
She crosses the autoclave room again, goes back to her desk - a route she has already taken several times today - and picks up her bag. Her team leader, who has already seen her through the tea kitchen this afternoon, gives her some final tips for the presentation and wishes her good luck.

**Figure 06.40 |** Rendering South view | Façade Lab

# FOOTPRINT

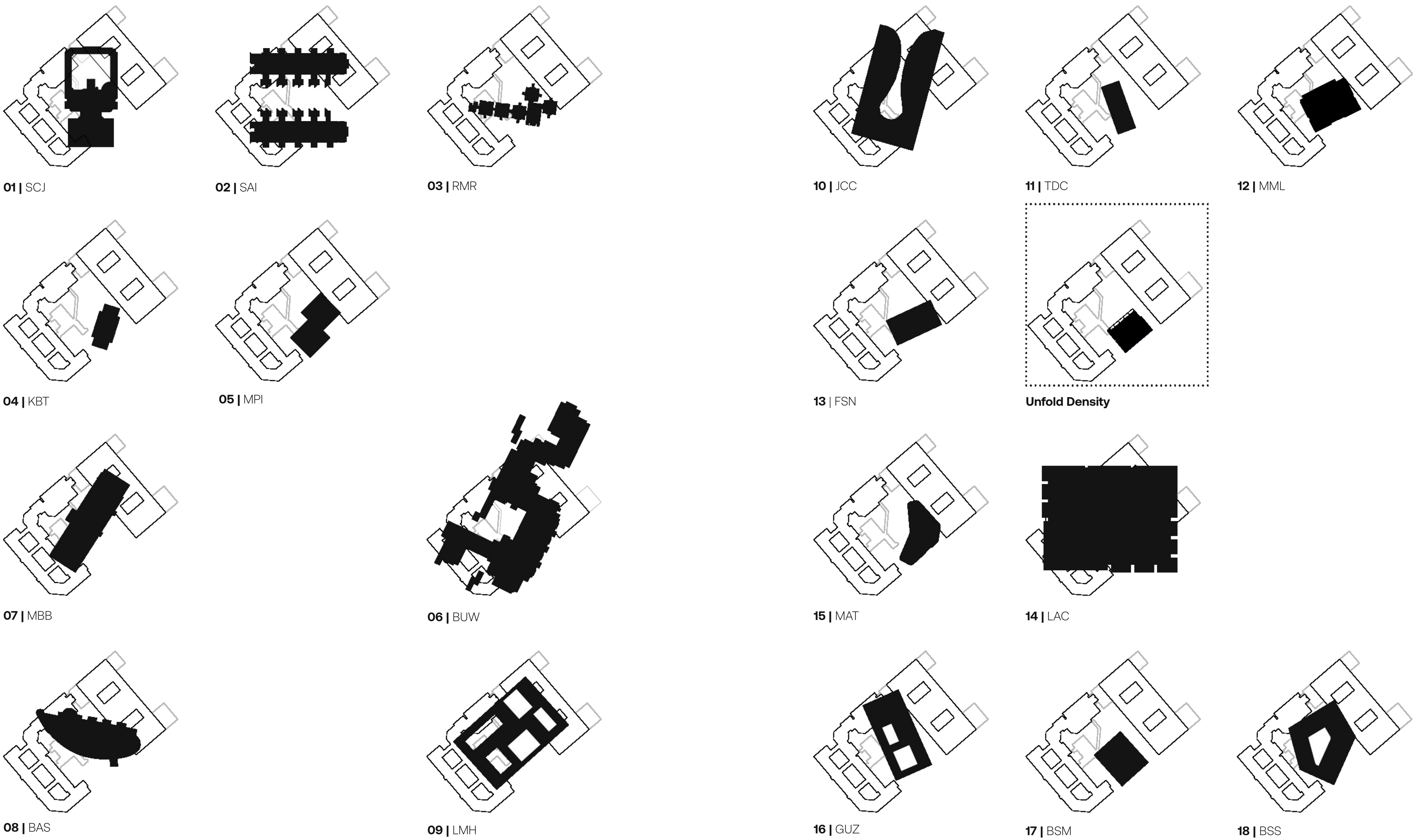



**Figure 06.41 |** Comparison Footprint Unfold Density & References | Scale 1:5,000

# AREA RATIO

When comparing the area of *Unfold Density* with the eighteen reference projects, it quickly becomes apparent that the goal of generating as little circulation area as possible is implemented successfully. The reduction is, therefore, achieved. Only the SCJ, FSN, and JCC references are more efficient in this aspect. However, it should be noted that in the case of SCJ, only the laboratory tower was included in the calculation without office and communication rooms.

It is also positive to note that *Unfold Density* has growth areas of 77 %. On average, these values are 62 - 71 % in the analysis. As intended, the proportion of the Constancy areas was not changed.

At 9 %, the communication areas account for the third-highest proportion of the comparison projects.

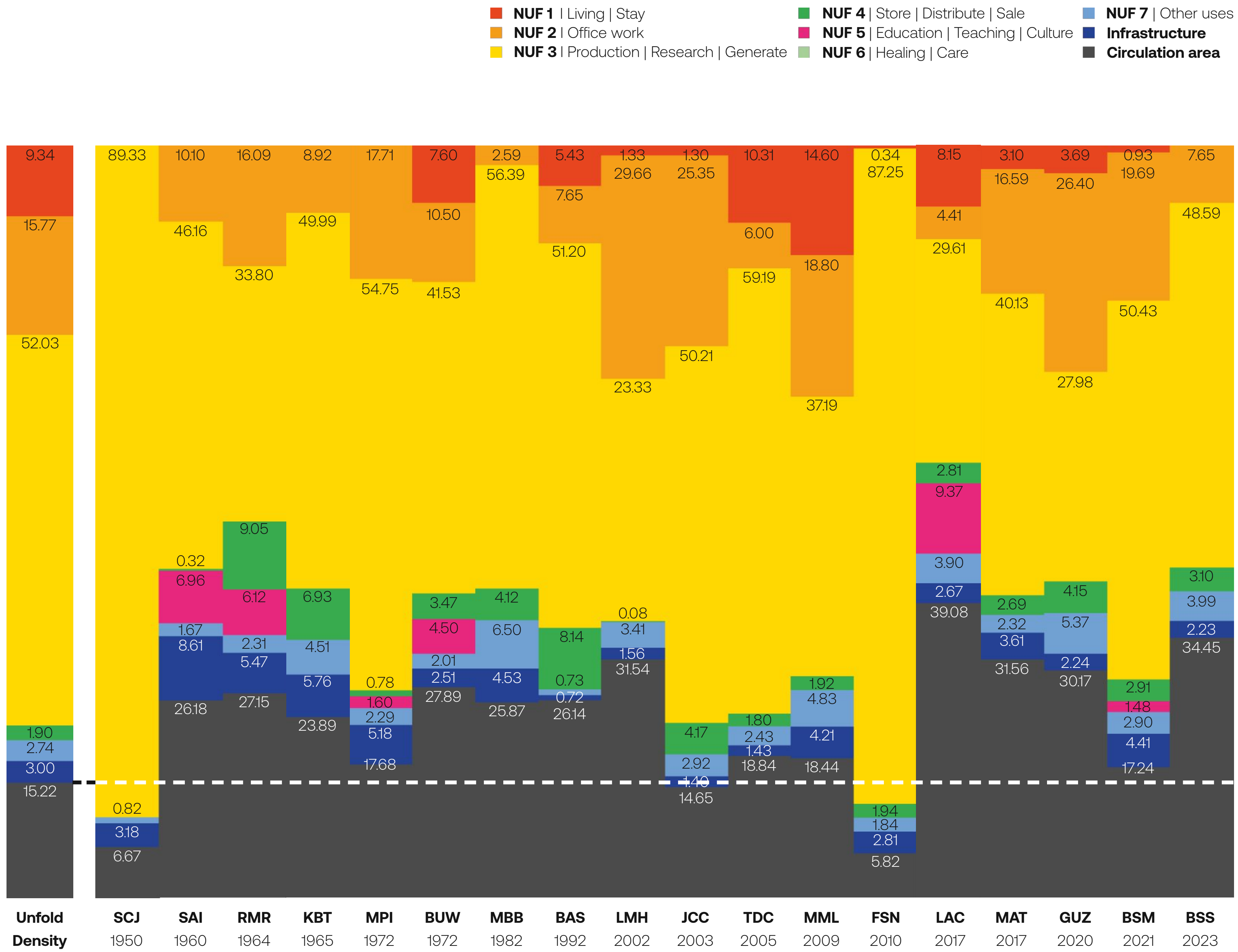
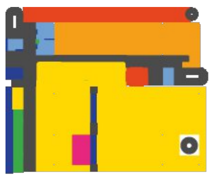
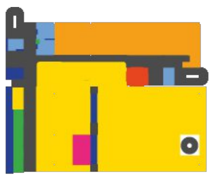



**Figure 06.42 |** Comparison Area Ratio Unfold Density & References | Numbers in %

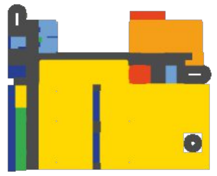
# PROPOSALS



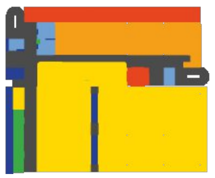
**Unfold Density |** 4th floor
with *Attraction Points* | A



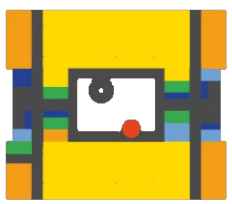
**Unfold Density |** 4th floor
without *Attraction Points* | B



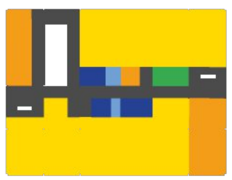
**Unfold Density |** 5th floor
with *Attraction Points* | C



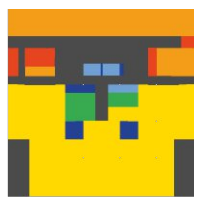
**Unfold Density** | Optimum



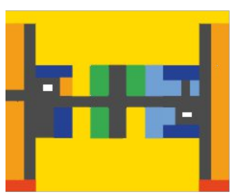
**1704 |** Schulz und Schulz
Architekten | Leipzig



**1710 |** Burckhardt Architektur |
Berlin

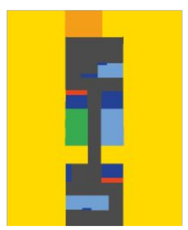


**1721 |** SWAP Architekten ZT |
Vienna | 1st floor



**1708 |** wulf architekten |
Stuttgart

**1720 |** BAYER & STROBEL
ARCHITEKTEN | Kaiserslautern



**1722 |** RIEHLE KOETH |
Stuttgart

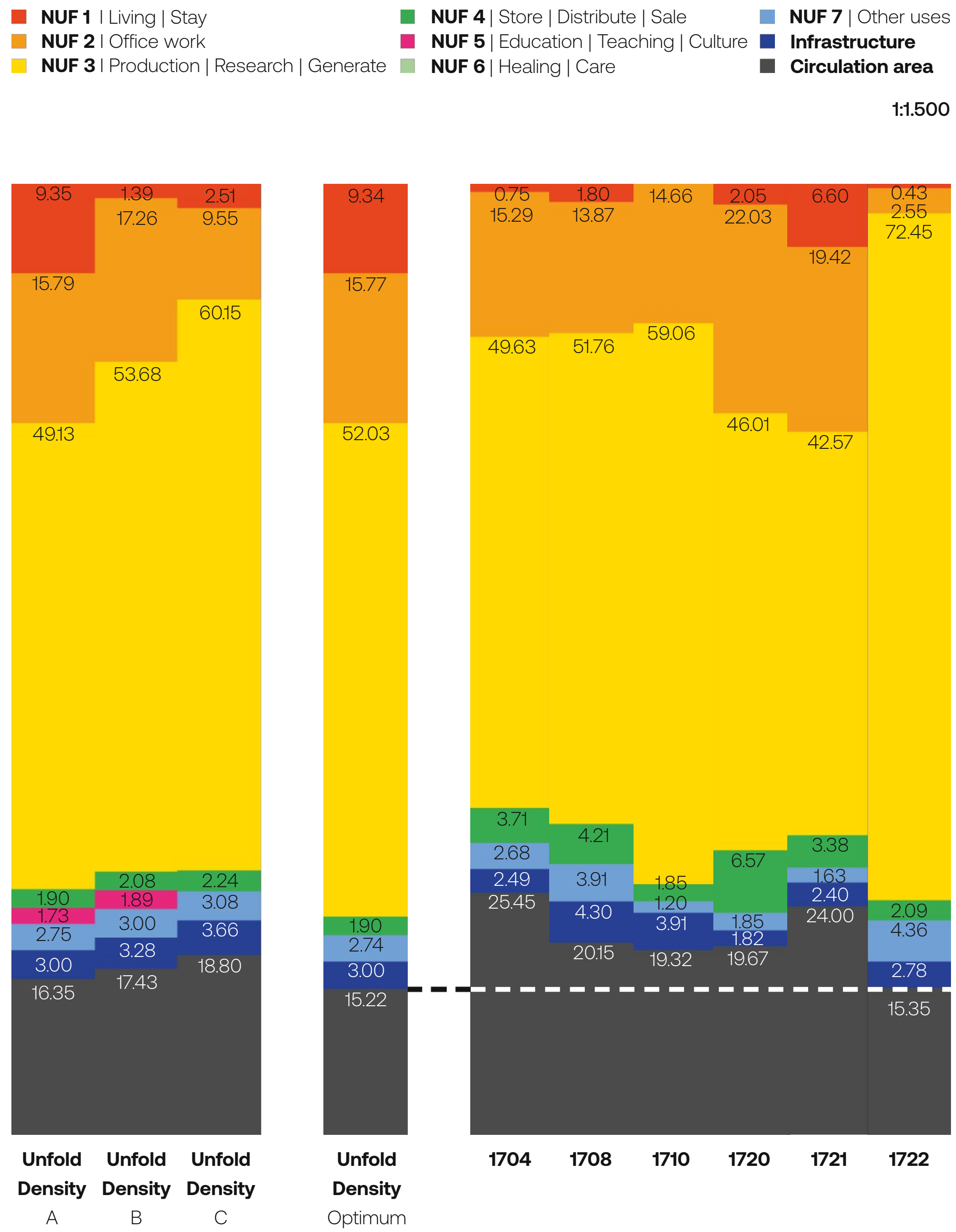



**Figure 06.43 |** Comparison Area Ratio Unfold Density & Competition Proposals | Numbers in %

# SAVING SPACE

■ *Unfold Density* is more efficient than the proposal
□ *Unfold Density* is less efficient than the proposal
▒ *Unfold Density* is same efficient than the proposal

The values given are based on own estimates and own evaluation of the competition entries, shown at the vernissage and online. The three winner projects and the three honorable mention entries are shown as comparative values. *Unfold Density* (with *Attraction Points*) shows that **145 – 327 m²** of NUF area DIN 277-1 per story could be reduced. Ancillary rooms are not included in the lab space calculation (C, D, E, G). Without *Attraction Points*, an additional 95 m² can be saved, resulting in an area of **240 – 422 m²**. By adding the void on the 1st, 3rd or 5th floor, an additional 90 m² can be saved on these floors, i.e. **330 – 512 m²**.
Factors that limit direct comparability are the different room distributions within the floors like small labs or storage rooms, as well as different numbers of write-up desks per lab. In contrast to the proposals, the top floor was extended with office space.

**A |** Footprint
**B |** NUF Area
**C |** Lab Area | Total
**D |** Lab Area (= C/E)
**E |** Labs / Floor
**F |** Circulation area (%)
**G |** Lab Area | Total (%)
(per story)

| | 1 | 2 | 3 | HM 1 | HM 2 | HM 3 |
|---|---|---|---|---|---|---|
| A | ■ | ■ | ■ | ■ | ■ | ■ |
| B | ■ | ■ | ■ | ■ | ■ | ■ |
| C | ■ | □ | □ | □ | □ | ■ |
| D | □ | ■ | ■ | ■ | ■ | □ |
| E | ■ | □ | □ | ▒ | □ | ■ |
| F | ■ | ■ | ■ | ■ | ■ | ■ |
| G | ■ | □ | □ | ■ | ■ | ■ |

**A |** 1.329 m² (with *Attraction Points*)
**B |** 1,171 m² (with *Attraction Points*) (Total ≈ 6,589 m²)
**C |** 609.33 m²
**D |** 40.62 m² (38.08 m²)
**E |** 15 (16)
**F |** 15.22 % (Total ≈ 1,668 m²)
**G |** 52.03 %

**Unfold Density |** Optimum

**A |** 1,468 m²
**B |** 1,316 m²
**C |** 560.09 m²
**D |** 40.00 m² (37.34 m²)
**E |** 14 (max. 15)
**F |** 24.00 %
**G |** 42.57 %

**1st prize**
SWAP Architekten ZT GmbH

**A |** 1,523 m²
**B |** 1,312 m²
**C |** 775.03 m²
**D |** 43.06 m²
**E |** 18
**F |** 19.32 %
**G |** 59.06 %

**2nd prize**
Burckhardt Architekten

**A |** 1,585 m²
**B |** 1,402 m²
**C |** 1,015.73 m²
**D |** 48.37 m² (46.17 m²)
**E |** 21 (max. 22)
**F |** 15.35 %
**G |** 72.45 %

**3rd prize**
RIEHLE KOETH

**A |** 1,656 m²
**B |** 1,373 m²
**C |** 681.48 m²
**D |** 42.59 m²
**E |** 16
**F |** 25.45 %
**G |** 49.63 %

**Honorable Mention (HM 1)**
Schulz und Schulz Architekten

**A |** 1,632 m²
**B |** 1,487 m²
**C |** 769.84 m²
**D |** 42.77 m²
**E |** 18
**F |** 20.15 %
**G |** 51.76 %

**Honorable Mention (HM 2)**
wulf architekten

**A |** 1,516 m²
**B |** 1,319 m²
**C |** 606.83 m²
**D |** 40.46 m²
**E |** 15
**F |** 19.67 %
**G |** 46,01 %

**Honorable Mention (HM 3)**
BAYER & STROBEL ARCHITEKTEN

When estimating the total circulation area of all stories, it is noticeable that *Unfold Density* performs better than the six projects analyzed at around 1,668 m². The average area there is 2,617.6 m². The values are in the range of approximately 2,135 m² and 3,155 m². This means that the savings amount to around **950 m²**, which represents a considerable proportion.
In total, *Unfold Density* has an approximate NUF area for 1-7 of **6,589 m²**. The competition specification expected ≈ 5.075 m².

**Figure 06.44 |** Comparison Unfold Density & Competition Proposals

# NEW CATEGORIES

In the following, the comparison of the room categories with regard to the areas of *DIN 277-1* and the *New Categories* (see Chapter 04 Optimization) is analyzed. The aim of introducing the New Categories is to investigate whether a more efficient and economical room arrangement can be found by grouping according to the parameters *Accessibility*, *Communication*, *Frequency of Users* and *Technical Infrastructre* a more efficient and economical room arrangement can be encountered.

**Advantages**
In principle, it is positive to note that the two representations align well, with the long-established *DIN* division complementing the *New Categories* and meeting the parameters. It is noticeable that the greater differentiation of the groups - from 9 to 14 - is also reflected in the floor plan. The laboratory area and evaluation stations are still considered to be one continuous flexible area. The office and communication zones are more closely interlinked in *New Categories*. The ancillary laboratory rooms are grouped next to the technical shafts, which confirms Category 01. Categories 02, 07, 09 and 12 also form spacious interconnected areas. Both variants appear orderly. 01 and 02 (laboratory area), 07 - 09 (office and communication), and 12 and 13 (access) are located close to each other.

**Disadvantages and potential**
It would be desirable to see greater differentiation between the two representations. The categories 03 and 13 are distributed in various positions on the floor plan. Further investigations based on other laboratory buildings with a larger room program would be potentially interesting.

**01** | Autoclave room
Cold storage
**02** | Laboratory
Write-up space
**03** | Cleaning room
IT-Room
Technical shaft
Storage
**04** | Phone booth
**05** | Presentation area
**07** | Single office
**08** | Break room
Tea kitchen
Group office
**09** | Central communication zone
Meeting
Copy/Printer room
**12** | Escape route
Escape stairway
Sanitary room
**13** | Elevator
Hallway
Stairway
**14** | Secretary´s office

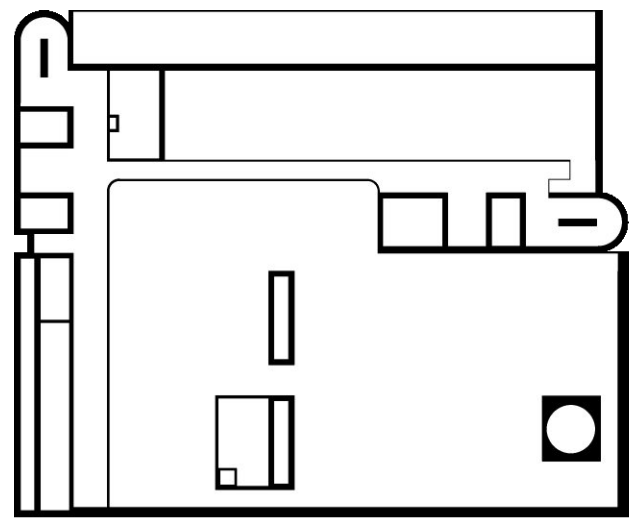


**Figure 06.45 |** Room groups | DIN 277-1 | Fourth floor | Scale 1:500

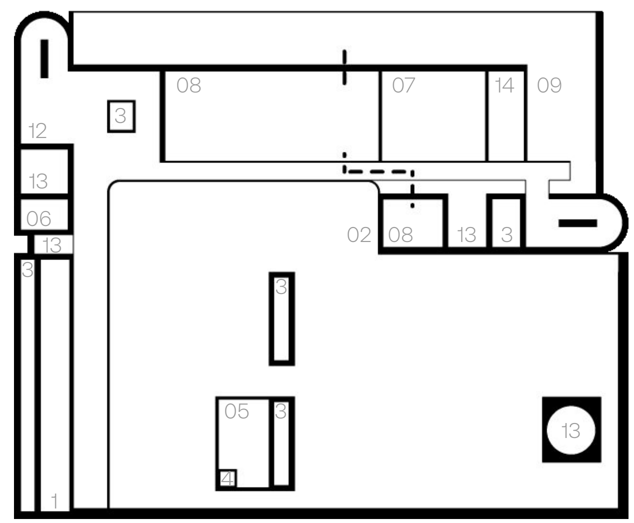
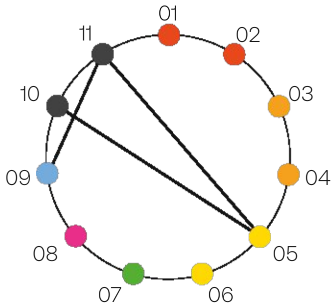


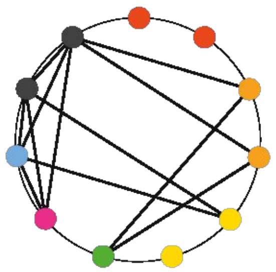

**Figure 06.46 |** Room Groups | New Categories | Fourth floor | Scale 1:500

# ROOM CONNECTIONS

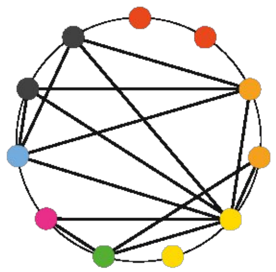
**01** Communication zone
**02** Tea kitchen
**03** Office
**04** Meeting room
**05** Laboratory
**06** Write-Up space
**07** Storeroom
**08** Presentation | Learning
**09** Sanitary room
**10** Elevator
**11** Stairway



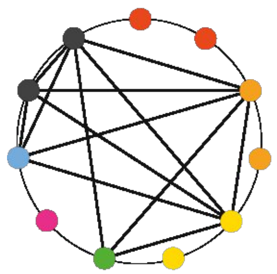

**01 |** SCJ



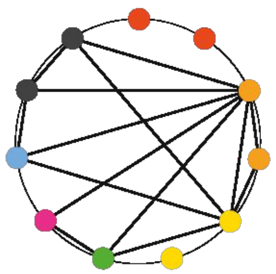
**02 |** SAI



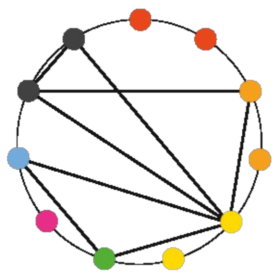
**03 |** RMR



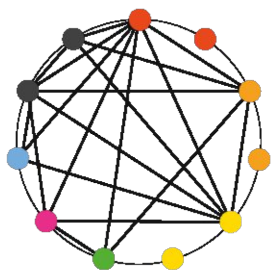
**04 |** KBT



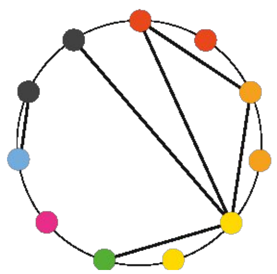
**05 |** MPI



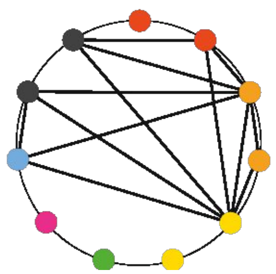
**07 |** MBB



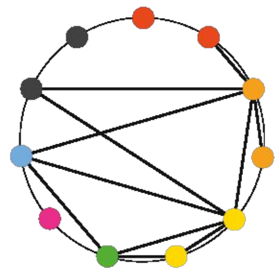
**06 |** BUW



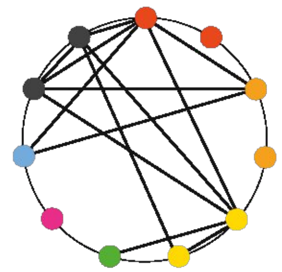
**08 |** BAS



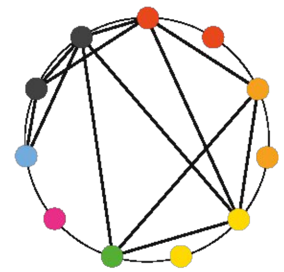
**09 |** LMH



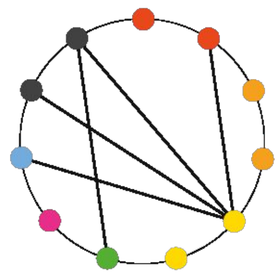
**10 |** JCC



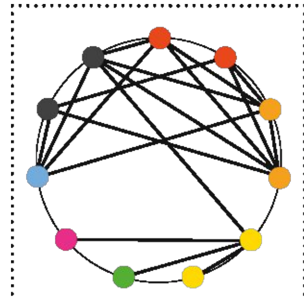
**11 |** TDC



**12 |** MML

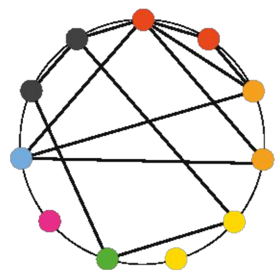


**13 |** FSN

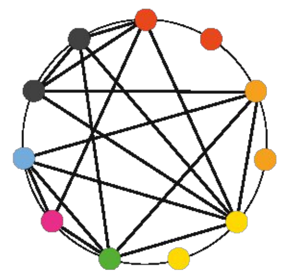


**Unfold Density**

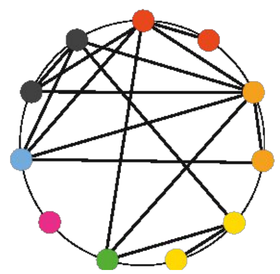
**Evaluation**
It is clear that the office zone, cores, and the *Attraction Points* as the central communication zone are closely linked. What also becomes clear is the strong hygienic separation of the laboratory area. The visual axes, which are not included here, offer users a very good communicative exchange without violating hygiene regulations.



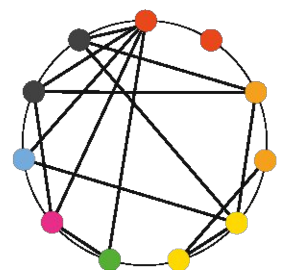
**15 |** MAT



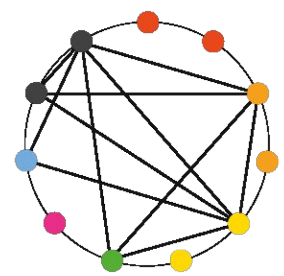
**14 |** LAC



**16 |** GUZ



**17 |** BSM



**18 |** BSS

**Figure 06.47 |** Comparison Room Connections Unfold Density & References

The work follows a structured approach that leads from a theoretical analysis of the modern laboratory building and its space efficiency to its practical implementation in a concrete design. In the beginning, the most important architectural parameters are cataloged (see Chapter 01 Typology), and the Robert Koch Institute (see Chapter 02 RKI) is introduced as a user. This is followed by a detailed analysis of eighteen international reference projects in order to gain insights into the design and distribution of space (see Chapter 03 References). In the transition to practical implementation (see Chapter 04 Optimization), new approaches to space optimization and room grouping are developed, which are then translated into an architectural concept as part of the competition "New construction of the laboratory building House 7 for the Robert Koch Institute (RKI) on Seestrasse in Berlin" (see Chapters 05 Site and 06 Unfold Density).
The original aim of the work was to provide an overview of the most important laboratory construction parameters and to generate maximum space efficiency for a sustainable approach by using less material and sealing less space. In the course of the comprehensive literature research, reference analysis, and the interview, it emerged that not only the reduction of space in modern laboratory construction must be convincing, but also the promotion of communication and recreation. This gave rise to the innovative approach of so-called *Attraction Points*. Here, the reduced, undeveloped building area is combined in a 1:1 ratio with communication and regeneration areas - the *Attraction Points*. The dimensions of the competition's feasibility study were used as the maximum initial area. The *Attraction Points* are integrated into the flexible *Shelf* concept in the form of balconies and offer not only functional benefits but also tangible added value for the building's users.
Another sustainable aspect is the structural separation of the laboratory (*Lab*) and office/communication area (*Shelf*), which proves to be very advantageous. This reduces the amount of reinforced concrete flat slabs required, which are suitable for vibration-sensitive equipment, to a minimum. This is in line with the concept of house-in-house construction. The flexible *Shelf* is equipped as a steel construction with insertable wood-hybrid floor panels.

01

**How are the proportions of the uses distributed?**
In order to consider which areas particularly strengthen efficiency and communication, a division into three categories was introduced right at the beginning of the work: *Growth - Constancy - Reduction*. All area analyses are carried out using a high-contrast, continuous color concept. In the reference analysis, it is noticeable that the *Growth* areas are usually 62 – 71 % of the total standard floor area. The *Reduction* areas, on the other hand, account for 20 – 28 %. Open-plan laboratories and offices are proving to be forward-looking. In the proposal *Unfold Density*, *Growth* is increased to **77 %** and *Reduction* is reduced to **15 %** in an optimal standard story.

02

**What architectural parameters does an efficienct laboratory building require?**
To simplify the complex laboratory building planning, dividing it into key parameters can help. When one immerses oneself in the subject, one realizes that certain features and arrangements are often repeated. However, there is no generally valid overview of these proven criteria without individual interpretations. These *Layers* prove to be suitable points of orientation due to their recurring relevance in the literature and the reference analysis. They provide a structured basis for planning efficient laboratory buildings and help to meet modern requirements in terms of functionality, sustainability, and user-friendliness.

*Diversity of Activities - Network and Mobility - Density of Information - Flexibility & No Hierarchies - Transparency*

03

**Which room groupings and typologies can create more efficient structures?**
As there are usually a large number of different functions and rooms available in a laboratory building, it is difficult to develop an economical and efficient room layout. According to the reference analysis, the core typology proves to be the most space-saving. On the basis of the sorting, hierarchization and grouping of 44 rooms, which frequently occur in laboratories, but especially in the room program of the competition, an alternative to the floor space arrangement according to DIN 277-1 is developed in this work. Due to the high degree of conformity of the 14 room groups with the proven DIN, this can be seen as a supplement to a differentiated structuring of the floor plan. The sorting is based on four hierarchical parameters: *Accessibility - Communication - Frequency of Users - Technical Infrastructure.*

04

**Which concepts can save space?**
The proposal *Unfold Density* shows that, compared to the three winning projects and the three Honorable Mentions, the application of the developed tools can save areas of **145 – 512 m²** on the standard floor. Open-plan arrangements, the core typology, the reduction in circulation areas, the double-linear arrangement of the laboratories with a shared material corridor, and the grouping of evaluation stations prove to be efficient. It should be noted that, in comparison to the competition participants, the top floor was developed entirely in *Unfold Density* as a technical and office floor. As shown in some projects, laboratories are possible in the basement.

05

**How can corridor situations be reduced without losing their logistics and meeting function?**
A fundamental aim of the work is to reduce the classic corridor situation without losing its logistical and communicative function. The method in this work is developing an intuitive system of possible routes that not only connects different rooms to the circulation but also goes one step further. The development is transformed into the passage through different zones, which consist, for example, of vertical links with visual connections, bridges, or *Attraction Points*. In concrete terms, this means passing through “islands” such as tea kitchens, printer rooms, meeting points, open-plan offices, or presentation zones, taking fire safety aspects into account. The cores are the starting and endpoints. In the *Unfold Density* proposal, a ring circulation is formed on each floor, which integrates the hygienic lab areas and also offers spontaneous meeting and presentation zones here, for instance. Depending on user requirements and department, the floor plan can also be equipped with additional vertical connections in the laboratory area and the *Attraction Points*.

06

**How can the space saved be used to promote communication?**
As already mentioned, the *Attraction Points* in the *Shelf* concept serve to implement this aspect. The employees become protagonists both for passers-by on the street and for the employees who are on the rest of the institute's site. The resulting balconies can be designed as open spaces or potential enclosed spaces. Within the building, numerous visual axes are possible through air spaces and transparent walls between the different zones so that communication is encouraged despite complex hygiene requirements. In addition, denser use leads to more inter-action.

**Reflection**
The intensive examination of the aforementioned questions has shown that only a small fraction of the possible research potential has been investigated. The cataloging of space requirements in open-plan laboratories, as mentioned in the book *Experimental Zone*, or the optimization of space efficiency are just two of the potential and promising topics that will become increasingly relevant in the future, and there is also great potential in analyzing a wider range of laboratory buildings using the methods applied in this work. To what extent would results change or remain the same?
One challenge that has emerged in dealing with these complex issues is the link between theory and design practice. It is clear that people remain the most important factor in research work and that theoretical approaches must be adapted to the human scale. Balancing space efficiency with a feel-good atmosphere is a challenging yet exciting task. The development of an optimized design for an already completed competition procedure is also a challenging hurdle, but one that offers interesting options for comparison with the final results at the end. In particular, topics such as lighting with the examination of light shafts, visual relationships despite hygiene limits, the avoidance of air spaces in favor of space efficiency, the vertical connections with regard to the desired few circulation areas, and the arrangement of the laboratory rooms in a flexible but dense structure in compliance with the hygiene rules had to be taken into consideration.
It is interesting to note that in the final comparison with the competition designs, some aspects appear to be different concepts as well. Be it the relocation of the dark zone to the façade, the lab double-layout or the construction separation. One of the most similar concepts is the design by HENN. The detailed examination and analysis of the submitted designs took place after the conceptualization of *Unfold Density*. It should not be forgotten that 100 % application of all the requirements of the spatial program and the competition brief for both *Unfold Density* and the competition designs cannot be fully implemented in this period.

**And as a final review...**
In summary, it can be said that the title and associated process, “From Density to Dialogue: Unfolding Laboratory Buildings,” can be felt in the structure of the work. From theory to practice. From individuality to placelessness. From flexibility to clarity. From space efficiency to communication.

# Appendix

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# FIGURES

All graphics, illustrations, collages, and plans if not otherwise indicated, are created by the author.

**Introduction**

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Figure 00.02 | *Wedding*
Modified (Lines&Numbers). Pallgen, M. (2023). [Aerial View]. Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen. ALKIS Berlin, DOP 2023. Retrieved January 10, 2024, from https://fbinter.stadt-berlin.de

**01 Typology**

Figure 01.01 | *Robert Koch Institute (RKI) Laboratory at the Nordufer*
© Robert Koch-Institut. (2024, March 21). *Laboratory at the Nordufer site, beginning of the 20th century* [Photograph]. Robert Koch-Institut. Retrieved November 06, 2024, from https://www.rki.de/DE/Content/Institut/Geschichte/geschichte_node.html

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**03 References**

All axonometric views of the reference projects are own figures based on floor plans, sections, elevations and photographs of the projects.

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Figure 03.105 | *Axonometry*

Figure 03.106 | *Aerial view*
Modified (Outline). © Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen. Pallgen, M. (n.d.). *ALKIS Berlin s/w (Amtliches Liegenschaftskatasterinformationssystem)* [Aerial View]. Retrieved November 14, 2023, from https://fbinter.stadt-berlin.de/

Figure 03.107 | *Photograph*
Modified (Colors). © Humboldt-Universität zu Berlin (n.d.). Institut für Physik, Ansicht von Nordwesten [Photograph]. Institut für Physik Humboldt-Universität zu Berlin. Retrieved February 13, 2025, from https://www.physik.hu-berlin.de/de/institut/ueber/lise-meitner-haus

Figure 03.108 | *Photograph*
Modified (Colors). © Humboldt-Universität zu Berlin (n.d.). Institut für Physik, Flur [Photograph]. Institut für Physik Humboldt-Universität zu Berlin. Retrieved February 13, 2025, from https://www.physik.hu-berlin.de/de/institut/ueber/lise-meitner-haus

Figure 03.109| *Second Floor | Floor plan*
a) Based on © LCI Labor Concept Ingenieurgesellschaft mbH (n.d.). [Floor plan]. LCI Labor Concept Ingenieurgesellschaft. Retrieved November 15, 2023, from https://www.labor-concept.de/de/referenzen/national/neubau-physikinstituts-humboldt-universitaet-berlin.html
b) Based on © Fundació Mies van der Rohe (n.d.). [Floor plan]. EU Mies Award. Retrieved March 31, 2024, from https://www.miesarch.com/work/832

Figure 03.110 | *Second Floor | Space analysis*

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Figure 03.111 | *Axonometry*

Figure 03.112 | *Aerial View*
Modified (Outline). © Google Ireland Limited. (2022). [Aerial view]. Google Earth. Retrieved October 11, 2023, from https://earth.google.com

Figure 03.113 | *Photograph*
Modified (Colors). © 2024 Foster + Partners. (n.d.). [Photograph]. Foster + Partners. Retrieved October 7, 2023, from https://www.fosterandpartners.com/projects/james-h-clark-center-stanford-university

Figure 03.114 | *Photograph*
Modified (Colors). © 2024 Foster + Partners. (n.d.). [Photograph]. Foster + Partners. Retrieved October 7, 2023, from https://www.fosterandpartners.com/projects/james-h-clark-center-stanford-university

Figure 03.115 | *Second Floor | Floor plan*
Based on © 2024 Editorial Arquitectura Viva SL (n.d.). *Centro Clark, Stanford* [Floor plan]. 2024 Editorial Arquitectura Viva SL. Retrieved August 14, 2023, from https://arquitecturaviva.com/works/centro-clark-0

Figure 03.116 | *Second Floor | Space analysis*

Figure 03.117 | *Overview Axonometries*

Figure 03.118 | *Overview Footprints*

Figure 03.119 | *Overview Area Ratio*

Figure 03.120| *Area Ratio Chronological*

Figure 03.121 | *Area Ratio Type*

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Figure 05.32 | *Rendering | North view*
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Figure 05.33 | *Section South-North*
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Figure 05.34 | *Ground Floor | Floor plan*
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Figure 05.35 | *First Floor | Space Analysis*

Figure 05.36 | *Model Photograph | West view*
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Figure 05.37 | *Model Photograph | East view*
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Figure 05.38 | *Rendering | North view*
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Figure 05.40 | *Ground Floor | Floor Plan*
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Figure 05.41 | *First Floor | Space Analysis*

Figure 05.42 | *Model Photograph | West view*
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Figure 05.43 | *Model Photograph | East view*
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Figure 05.44 | *Rendering | North view*
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Figure 05.45 | *Section South-North*
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Figure 05.46 | *Ground Floor | Floor plan*
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Figure 05.47 | *First Floor | Space Analysis*

Figure 05.48 | *Model Photograph | West view*
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Figure 05.49 | *Model Photograph | East view*
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Figure 05.50 | *Rendering | North view*
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Figure 05.51 | *Section North-South*
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Figure 05.52 | *Ground Floor | Floor plan*
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Figure 05.52 | *First Floor | Space Analysis*

Figure 05.54 | *Model Photograph | West view*
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