MASTER-/DIPLOMARBEIT

SUNVERSE

Astronomy Museum and Education Center in Canakkale, Turkey

Astronomie Museum und Ausbildungszentrum am Canakkale, Türkei

ausgeführt zum Zwecke der Erlangung des akademischen Grades
eines Diplom-Ingenieurs / Diplom-Ingenieurin
unter der Leitung von

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ABSTRAKT

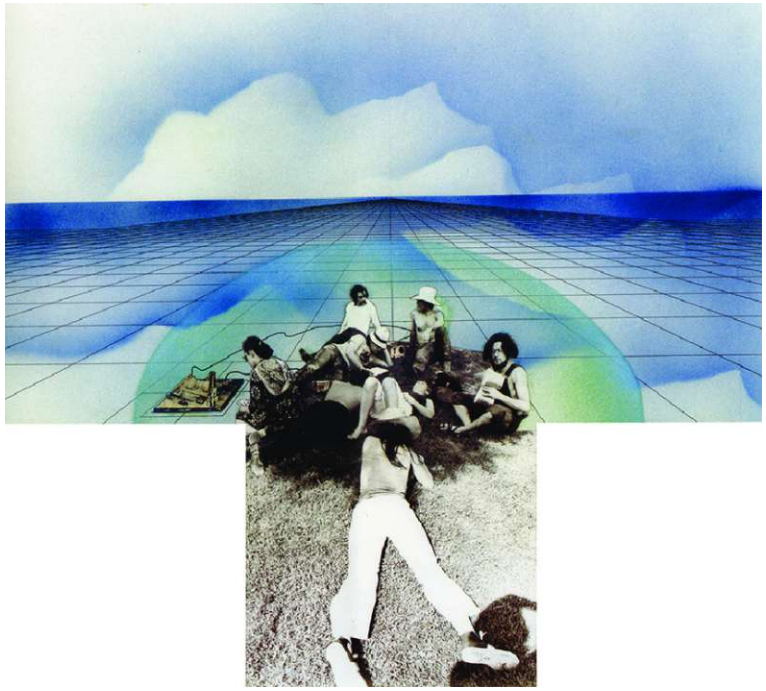
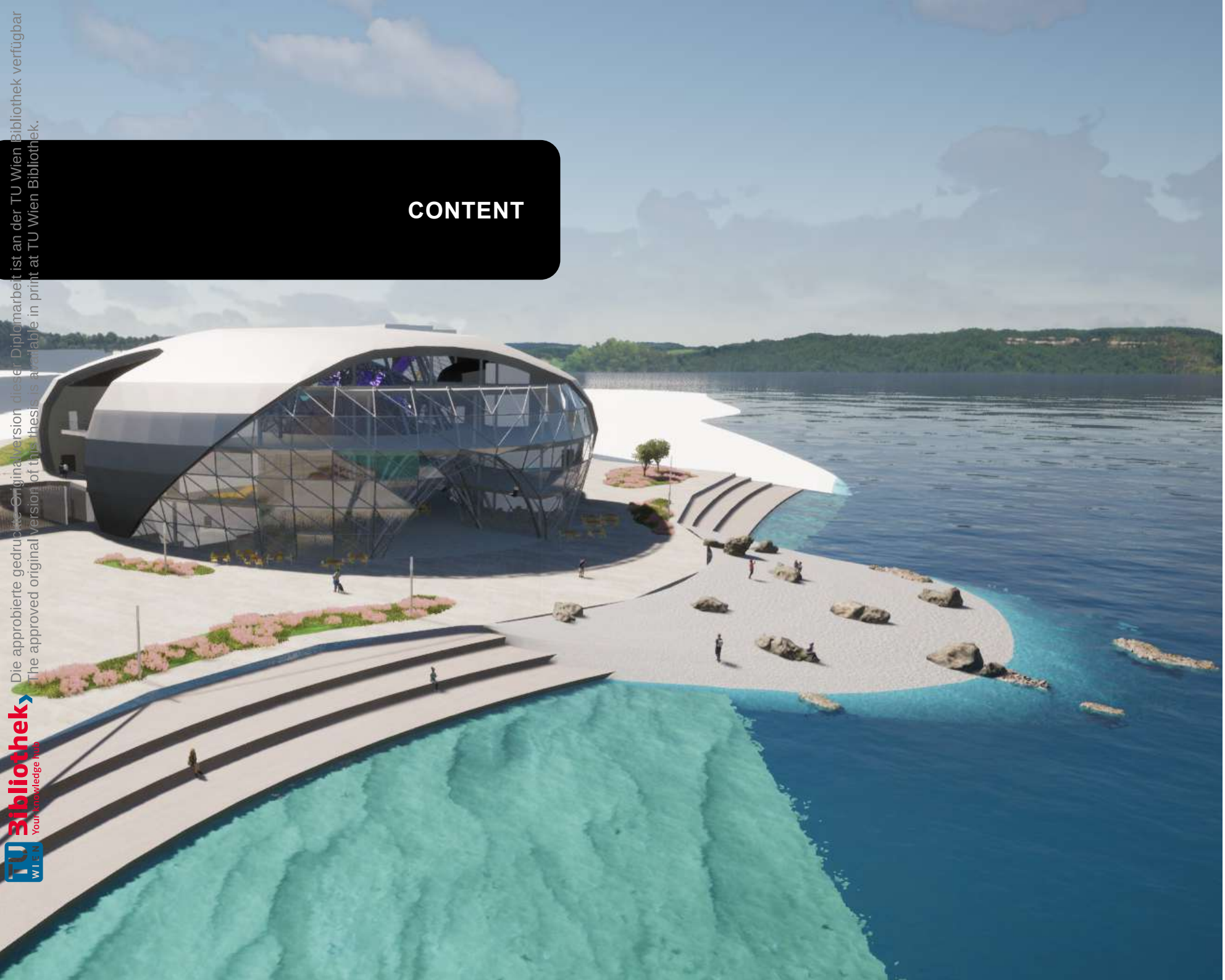


Fig. 1: Superstudio, Atti Fondamentali (Supersuperficies), San Martino alla Palma, 1971

Museum buildings are multifaceted and are powerful tools for addressing social, political, and educational issues. This work presents a design proposal for astronomy museum and education center including a planetarium in Çanakkale, northwest Türkiye. Çanakkale is home to Onsekiz Mart University. The city has a humble domestic tourism industry and visited also by school trips for its historic significance. The museum is planned to serve to these target groups as well as creating a new attraction point for the city. Main goal is to encourage the visitors to engage with science.
The design concept is centered around the idea of connecting visitors with astronomy through experiential learning and observation. Today astronomic research is done through, telescopes, radars, sophisticated machinery. We often forget, that our own senses are tools to observe and understand our environment. Drawing inspiration by the ancient time keeping device sundial, the design utilizes roof of the building as a reverse sundial. Enveloped by the galleries, the planetarium sits at the hearth of the building as a separate structure and series of cutouts on the roof projects sunlight on to the exterior facade of the planetarium. The facade of the planetarium works as a sun clock and is observed throughout the galleries as the main spectacle of the exhibition. The sun clock invites visitors to engage with the museum even before entering, stimulating curiosity and interest.

Museumsgebäude sind vielfältig und wirkungsvolle Instrumente zur Auseinandersetzung mit sozialen, politischen und pädagogischen Themen. Diese Arbeit stellt einen Entwurf für ein Astronomie Museum und Bildungszentrum einschließlich eines Planetariums in Canakkale im Nordwesten Türkei vor. Die Onsekiz-Mart-Universität befindet sich in Canakkale. Die Stadt verfügt über eine bescheidene inländische Tourismusbranche und wird aufgrund ihrer historischen Bedeutung auch von Schulausflügen besucht. Das Museum soll diese Zielgruppen bedienen und gleichzeitig einen neuen Anziehungspunkt für die Stadt schaffen. Hauptziel ist es, die Besucher zur Auseinandersetzung mit der Wissenschaft zu ermutigen.
Im Mittelpunkt des Designkonzepts steht die Idee, Besucher durch erfahrungsorientiertes Lernen und Beobachten mit der Astronomie zu verbinden. Heutzutage erfolgt die astronomische Forschung mithilfe von Teleskopen, Radargeräten und hochentwickelten Maschinen. Wir vergessen oft, dass unsere eigenen Sinne Werkzeuge sind, um unsere Umwelt zu beobachten und zu verstehen. Inspiriert von der antiken Zeitmessuhr Sonnenuhr fungiert das Dach des Gebäudes als umgekehrte Sonnenuhr. Das Planetarium befindet sich als separater Baukörper in der Mitte des Gebäudes. Eine Reihe von Öffnungen auf dem Dach projiziert Sonnenlicht auf die Außenfassade des zentral gelegenen Planetariums. Der Rest des Programms umhüllt das Planetarium wie eine Hülle. Die Fassade des Planetariums fungiert als Sonnenuhr und wird in allen Galerien als Hauptspektakel der Ausstellung beobachtet. Die Sonnenuhr lädt Besucher schon vor dem Betreten dazu ein, sich mit dem Museum auseinanderzusetzen und weckt Neugier

CONTENT



1. INTRODUCTION

Fig. 2: The School of Athens, Raphael, 1510-1511, Rome

Observation, a fundamental human instinct, lies at the heart of both architecture and astronomy. In astronomy observation is the cornerstone of discovery and architecture by its nature explores the physical possibilities of our world, then it shapes our environment. The relationship between the two disciplines run deep. Throughout the human history architecture has been built for astronomical observation or for the mere admiration of it. From the pyramids of Egypt, which are aligned with celestial bodies, to the precision instruments of the Jantar Mantar in India, architecture has served as the link between Earth and the cosmos.

This work is born out of admiration for this connection between architecture and the study of space. The design explores possibilities to create an immersive learning experience for the visitors of the museum and to push the viewer to question “how”. To reach this goal the building becomes part of the exhibitions and communicates its content by its geometry. Inspiration for the design is the ancient timekeeping device, the sundial. The concept puts a twist to the simple principle of a sundial, it casts light rather than a shadow. Several sun studies are done with the help of computational environmental analysis tools to create a reverse sun clock and through this exploration is the roof of the building is designed to cast light and keep time.

2. SITUATION ANALYSIS

2.1 EVOLUTION OF PLANETARIUMS

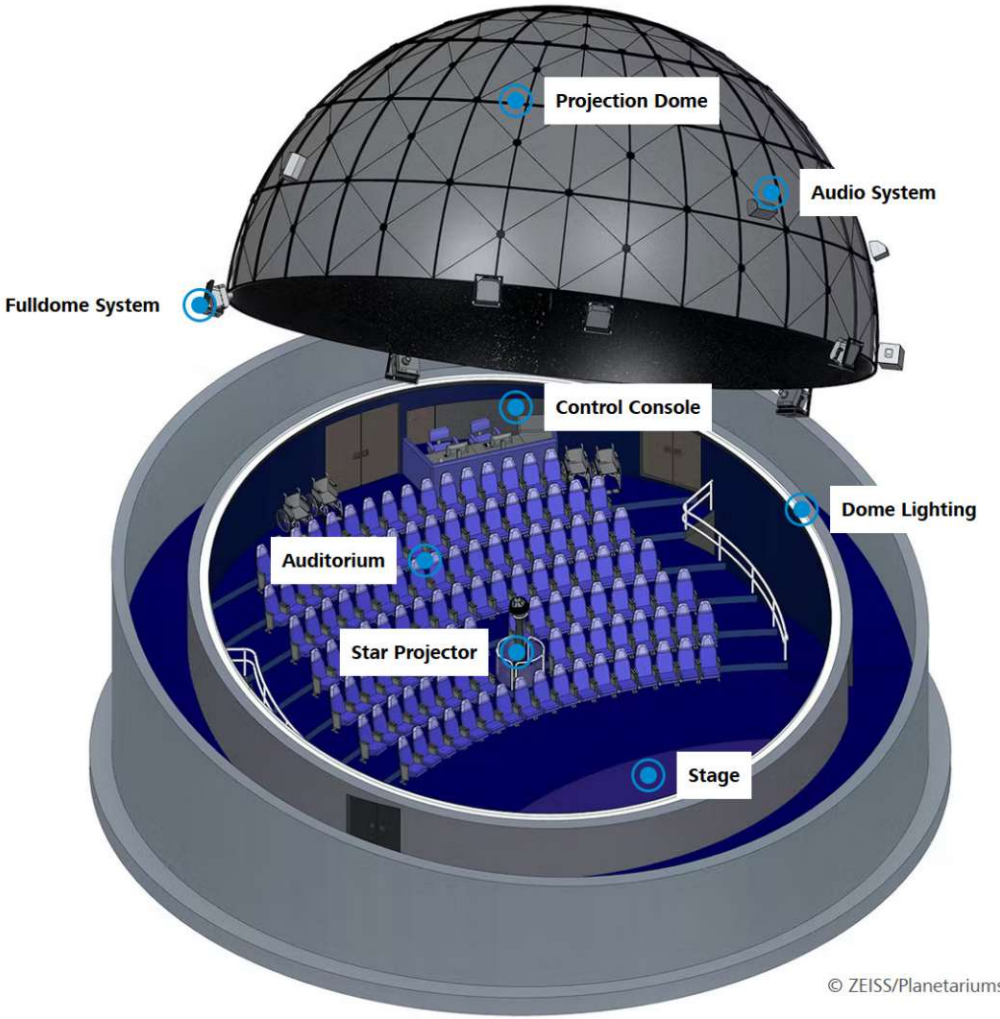


Fig. 3: Components of a planetarium, ZEISS

Planetariums are spherical theaters, that simulate the night sky. They are designed to educate and entertain people about astronomy. Modern planetariums typically consist of three main components. A domed ceiling is used as projection surface. Underneath the ceiling there is an auditorium with reclining seating and a star projector. Today planetarium shows range from traditional star field projections to animated simulations of space exploration, cosmic events and educational content about the universe.

The first device similar to a modern-day planetarium, which created an artificial sky within an enclosed space, was a tent with holes made by Arab craftsmen. This device reached Europe as a spoil of the crusades in 1229. The surface of the tent had small holes on it imitating stars, enabling the viewer to observe the night sky during the daylight. The tent could also rotate with a clockwork mechanism showing moving constellations. (BCIT, 2023) This concept evolved into various domes and globes for star viewing, while mechanical orreries, or solar system models, became increasingly precise and decorative.

In 17th Century, Adam Olearius designed the Gottorf Globe, an enormous sphere with a three-meter diameter. The globe could be entered and accommodate up to 12 people. The interior depicted the night sky from the 17th century and could also be rotated. (Landesmuseum SH)

In the 18th century, architects explored geometric designs linked to astronomy. Étienne-Louis Boullée's 1784 Cenotaph for Newton, was a notable example. It featured a large sphere simulating the night sky inside, symbolizing the connection between Earth and the cosmos. Jean-Jacques Lequeu, a cartographer, obscure artist, and astronomy enthusiast, designed the Temple to Earth in 1790, building on Boullée's Cenotaph. The Temple to Earth had the same starry sphere like the Cenotaph, but it also added an educational aspect to the concept, with a globe Earth at the center of it. (Faidit, 2013)

Wallace W. Atwood designed The Atwood Sphere in 1913, which is a stainless steel sphere with a diameter of 4.6 m. It has 692 punctured holes of different sizes that map the night sky. The rotating sphere offered an immersive show, The viewers could listen to stories, accompanied by glowing disks to represent planets and a moveable light providing solar illumination. It represents a significant step in the development of astronomical education tools. (Faidit, 2013)

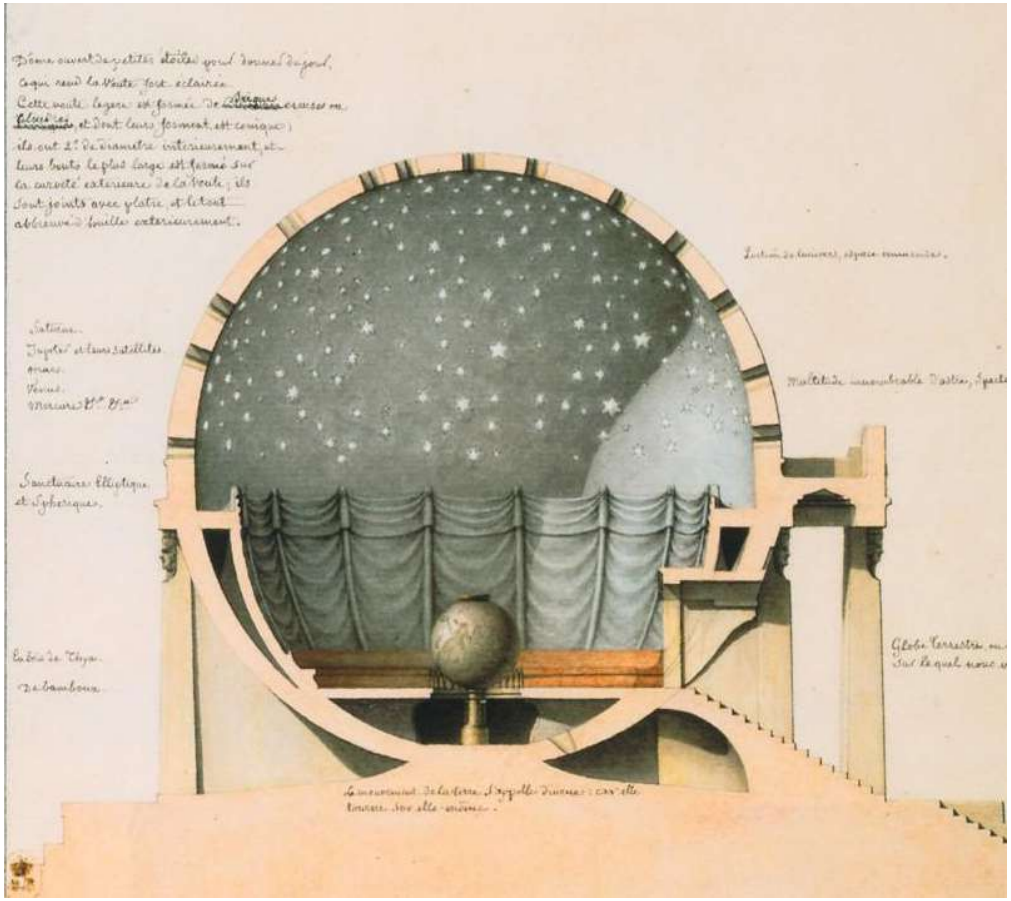


Fig. 4: T Design for a Temple of the Earth, Lequeu , 1794

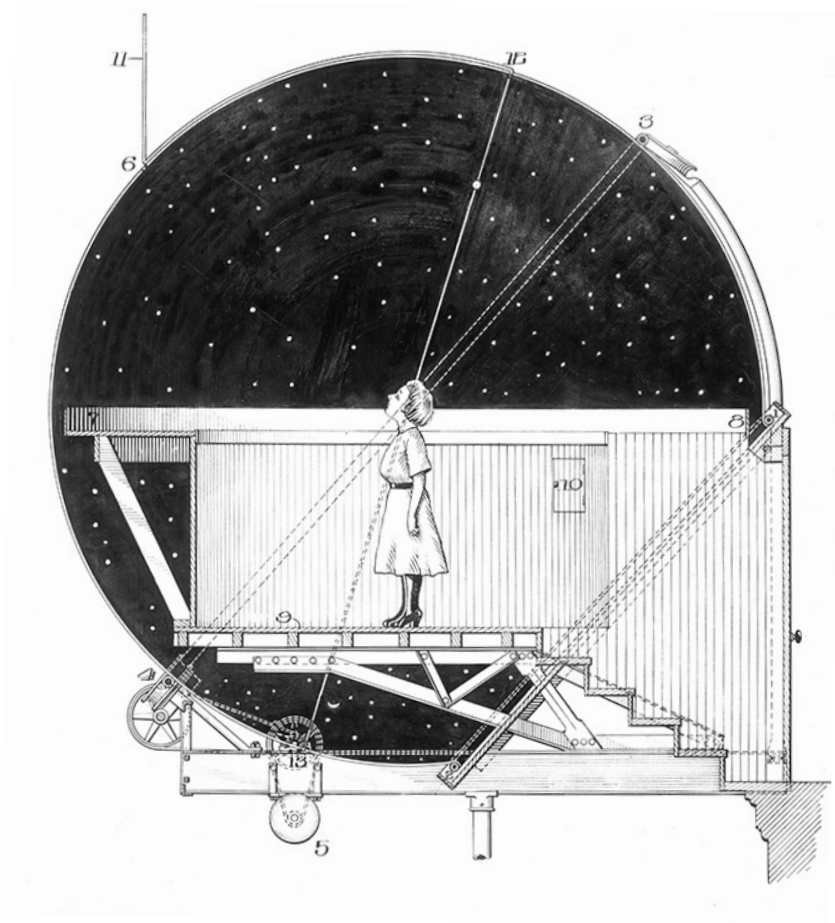


Fig. 5: Drawing of the Atwood Celestial Sphere, ca. 1903

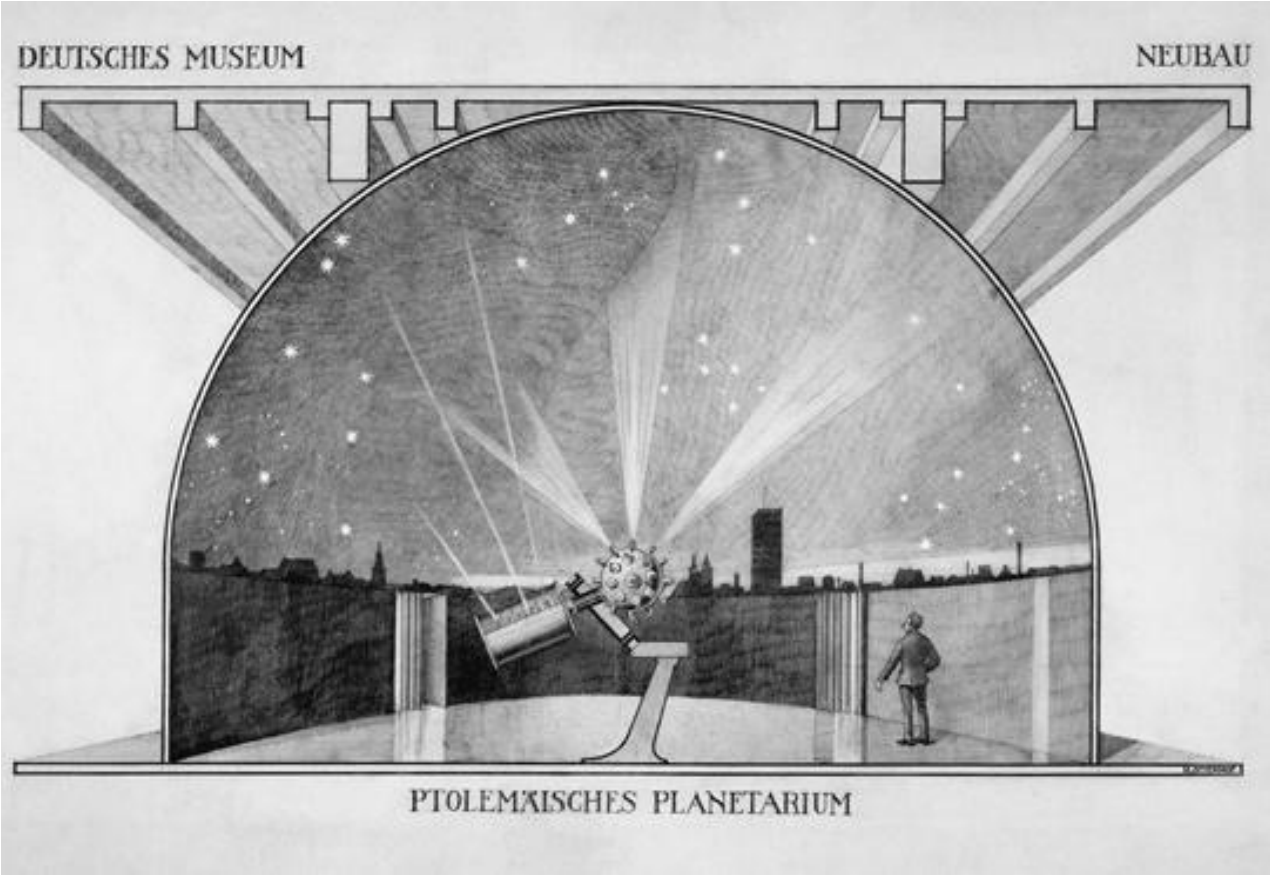


Fig. 6: Drawing of the projection planetarium in Munich, ca. 1923

The Deutsches Museum, founded in 1903 by engineer Oskar von Miller, aimed to celebrate the accomplishments of science and technology. The museum's original opening was delayed by World War I, but it finally opened in 1925 on an island in the Isar River in Munich.

Max Wolf, an astronomer, suggested to von Miller the creation of a device to showcase not just the stars, but also the planetary motions for the astronomy section of the Museum. Von Miller approached the Carl Zeiss optical company, which was founded in 1846 for the manufacturing of the device. (Chartrand, 1973)

Chief design engineer and later director of Carl Zeiss, hit upon the idea of projection of the celestial objects in a dark room. The original plan had been some sort of rotatilng globe similar to that of Gottorp. The new idea simplified things immensely. The mechanism could be on a small scale and easily controllable. Over five years, Bauersfeld and his team developed the modern projection planetarium, using star plates with images of 4500 stars and interconnecting motion drives to maintain accurate planetary positions. The first model was tested on the roof of the Carl Zeiss factory in Jena in August 1923 and later was permanently installed in Munich in May 1925. (Chartrand, 1973)

2.3 REFERENCES

‘Light is the expeller of darkness. Shadow is the suppression of light.’

Leonardo da Vinci (15th century CE), trans. MacCurdy, 1939.

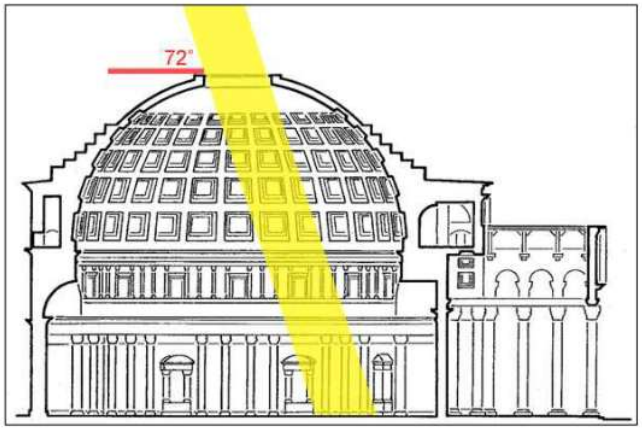


Fig. 7: Section through the Pantheon, showing the fall of the noon sunlight at the summer solstice, when the sun is at altitude 72°

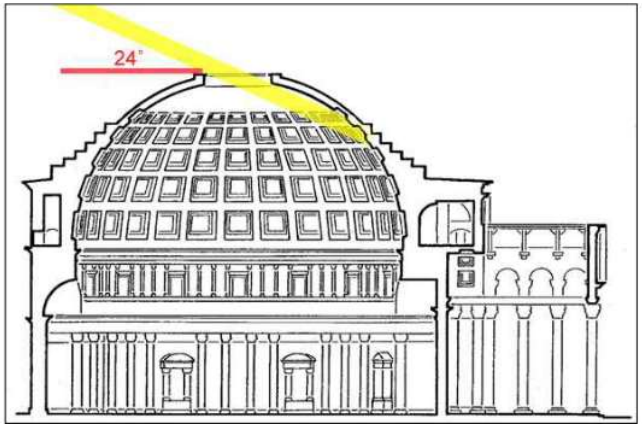


Fig. 9: Section through the Pantheon, showing the fall of the noon sunlight at the winter solstice, when the sun is at altitude 24°.

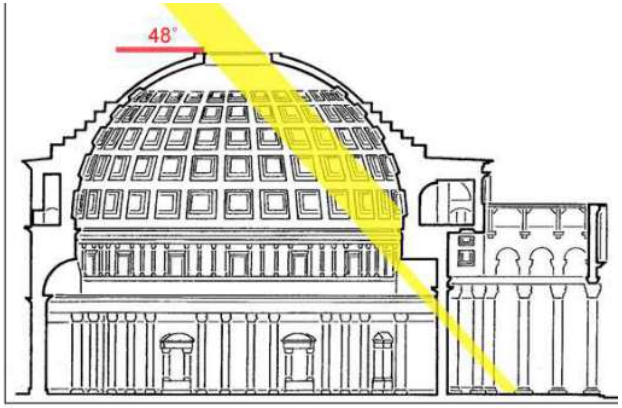


Fig. 8: Section through the Pantheon, showing the the fall of the noon sunlight, when the sun is at altitude 48°.

Pantheon, Rome

The Pantheon is the best-preserved building from ancient Rome, constructed between A.D. 118 and 128. It was dedicated to all Roman gods and continues to amaze visitors today with its huge dome and the 9-meter-wide hole “oculus” on top of it. The oculus is not covered, letting sun, rain and air in. The entrance is facing north, which makes the oculus the sole light source of the interior. Thus, turning the dome in to a sundial. In that frame of mind, if we concentrate on the passage of the midday sun inside the Pantheon, we find that the sun spends six months of the year, in spring and summer, falling below the level of the dome. In autum and winter, on the other hand, the sun spends six months lighting the surface of the dome. (Hannah, 2009)

Etienne-Louis Boullée, Cenotaph for Sir Isaac Newton, 1784

Étienne-Louis Boullée (1728–1799) was a visionary French architect, whose designs and theories had a profound influence on the development of neoclassical architecture and architectural theory. Very few of Boullée's designs for buildings reached construction. Boullee's uniqueness can best be seen in his drawings and the manuscript of his Architecture bequeathed by him to the nation. Both are preserved in the Bibliotheque Nationale in Paris. Boullée's architectural style is distinguished by monumentality combined with simplicity. (Kaufmann, 1952)

One of Boullée's most famous works is his design for the Cenotaph for Sir Isaac Newton, which could be seen as a predecessor to modern planetariums. The central element of Boullée's design was a colossal empty sphere, representing the universe. During the day, the dark interior walls of the sphere would have sparkled with natural light, entering through holes drilled on its curved exterior. The holes are visible in the architect's daytime section. The pattern of heavenly bodies would have replicated the appearance of the night sky. At night there would have been light produced by an astrolabe suspended in the center of the space. (Johnson, 2024)

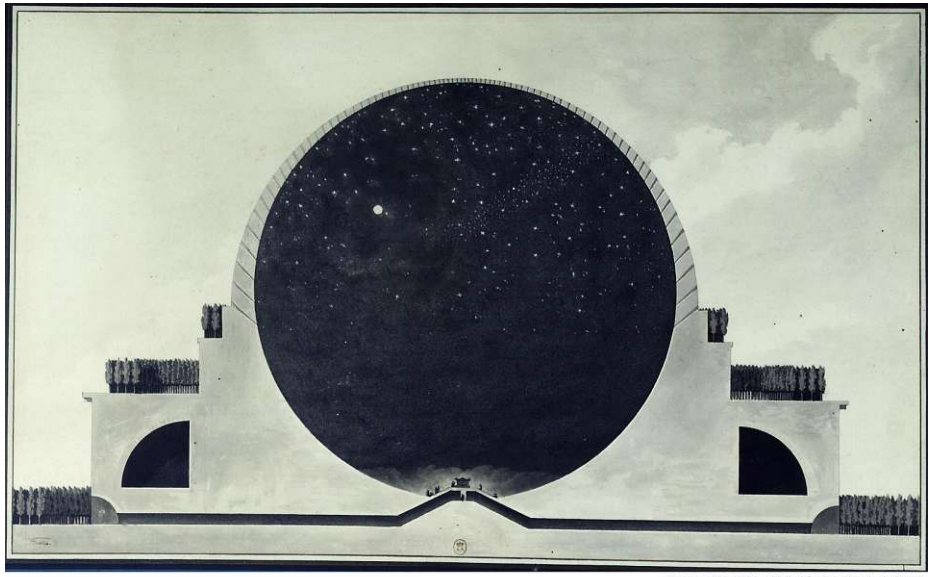


Fig. 10: Cenotaph for Isaac Newton- daytiime Section 1784

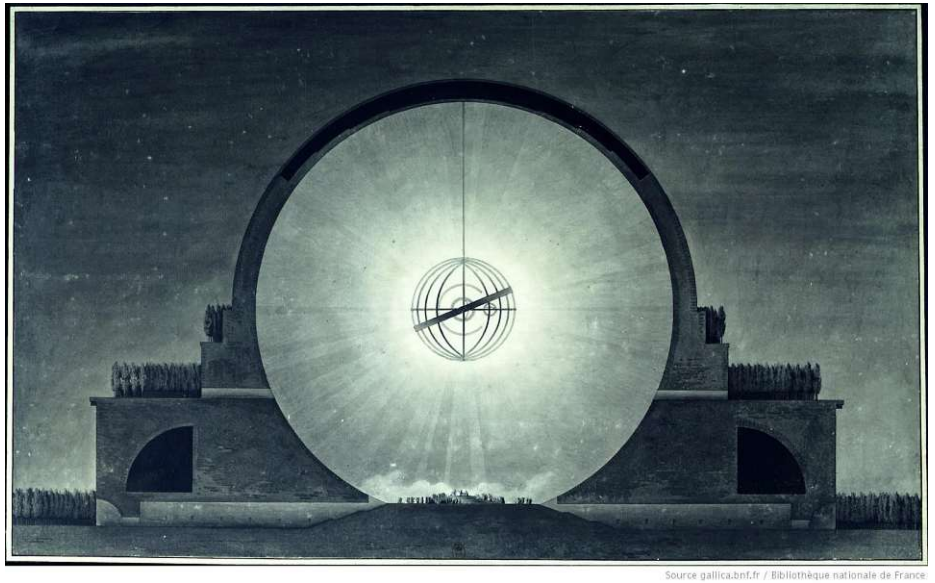


Fig. 11: Cenotaph for Isaac Newton- nighttime section 1784

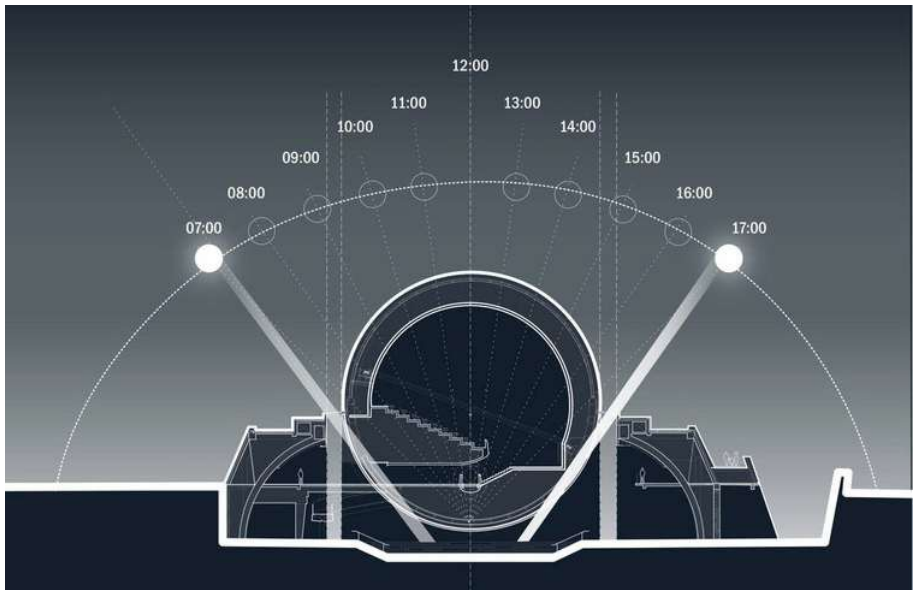


Fig. 12: Shangai astronomy museum section demonstrating the fall of the sunlight.

Shanghai Astronomy Museum by Ennead Architects

The monumental new museum creates an immersive experience that places visitors in direct engagement with real astronomical phenomena. Through scale, form, and the manipulation of light, the building heightens awareness of our fundamental relationship to the sun and the earth's orbital motion. The sphere houses the planetarium theater, which is half-submerged in the building. (Ennead Architects, 2021) The sunlight passes through the opening between the planetarium and the roof, creating different light shapes on the ground floor. Although the geometry is different, the building creates a sundial effect similar to the Pantheon.

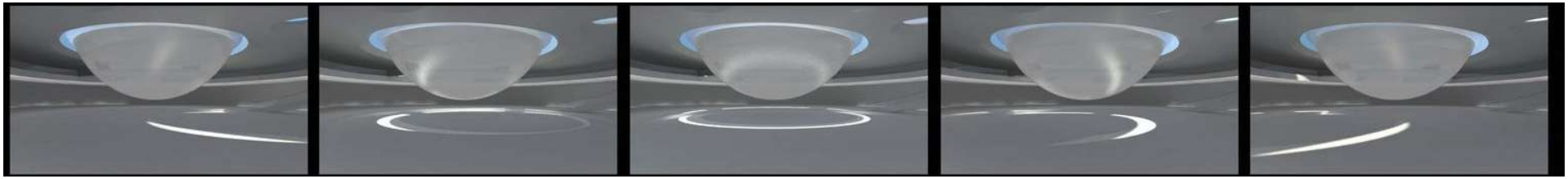


Fig. 13: Shangai astronomy museum simulation demonstrating the fall of the sunlight

PROJECT SPECTRUM

Salt Galata, December 13, 2023 – March 30, 2024

Salt's lighting design project, offers visitors a chance to explore the architectural features of Salt Galata from different perspectives with a play of light and shadow that represents the solar cycle. The atmospheric presence and spectrum of light emphasize the layers of the building, while the shadows make the viewer feel a part of the space. (Salt Galata, 2023)

Fig. 14: Project Spectrum photo

The Weather Project by Olafur Eliasson

Tate Modern, 16 October 2003 – 21 March 2004

The Weather Project featured a massive, glowing sun, which filled the museum's Turbine Hall with a warm, yellow light. A fine mist created an atmospheric effect, and a giant mirror on the ceiling reflected the scene, encouraging visitors to lie on the floor and observe their environment. This artwork was not created to create an illusion. It brought viewers to be a part of the place. It gave a sense of a close encounter. (Shulze, 2023)

Fig. 15: The Weather Project photo (2003).

2.3 LOCATION

Fig. 16: Çanak-kale on map of Turkey

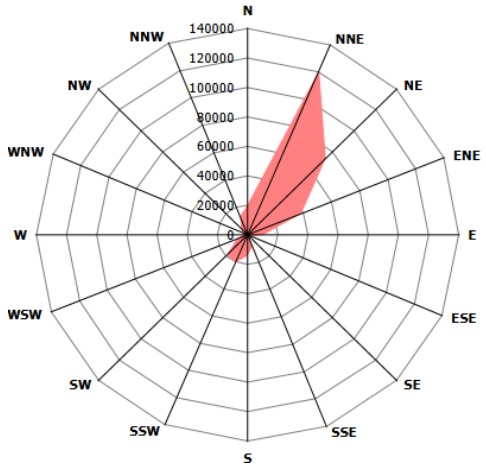
Fig. 17: Merkez district on map of Çanakkale

2.3.1 General Information on Canakkale

Çanakkale, located on the northwest coast of Turkey, holds a pivotal position both geographically and historically. The intercontinental city, which is situated in both shores of the Çanakkale Strait on the Biga and Gallipoli Peninsulas, is a transit point between Europe and Asia. Its strategic location at the entrance of the Dardanelles strait has made it significant throughout the history.

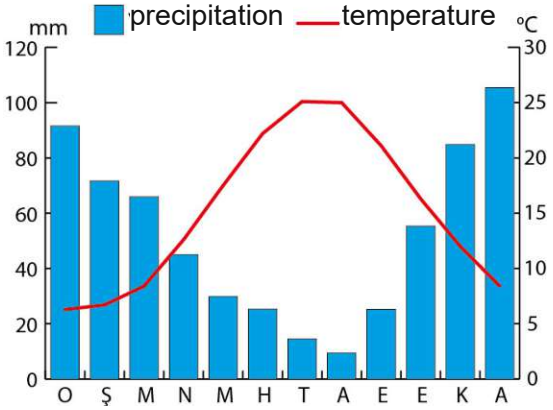
Canakkale covers an area of 9.933 km² and has an estimated population of 574.936. the population density is 56 / km2. (Çanakkale Nüfusu, 2024) The province has total of 12 districts. The Most populated district is MERKEZ. Merkez district covers an area of 928 km² (Cografya, 2024), 10% of the city total area, however it hosts 35% percent of the population. A total of 203.523 people live in the MERKEZ district, making the districts population density 219/ km2. (ÇANAKKALE, 2022)

Black Sea and Mediterranean climates are dominant in the city. In the Çanakkale region, summers are typically warm, humid, and mostly clear, while winters are long, cold, rainy, and occasionally windy with partial cloudiness. Temperatures typically fluctuate throughout the year between 3°C and 31°C. Extreme temperatures are rare. The long-term average temperature is 15.0°C. The predominant wind direction in Çanakkale is north-northeast, with the secondary predominant wind direction being northeast depending on seasonal variations. (Turkish State Meteorological Service)



ÇANAKKALE WINDROSE

Fig. 18: Çanakkale windrose

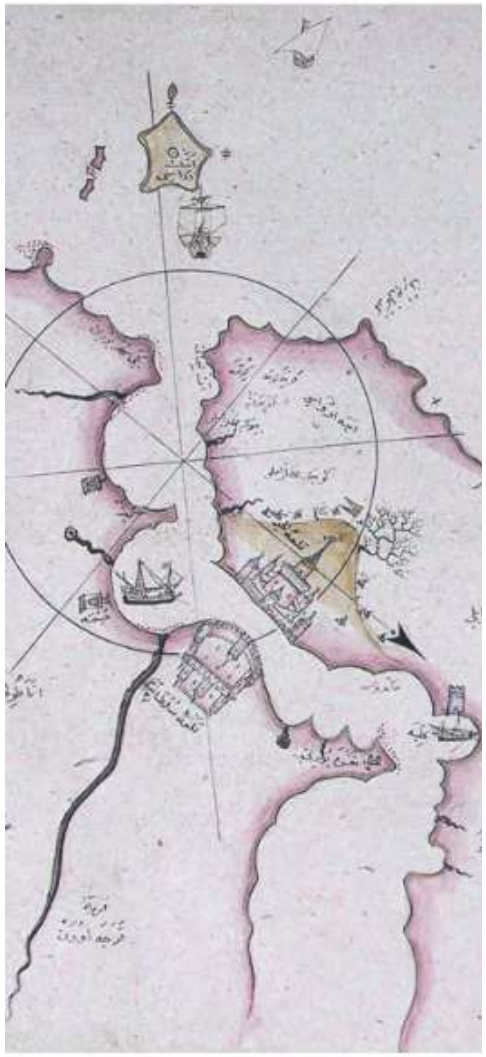


ÇANAKKALE ANUAL PERCIPITATION AND TEMPERATURE GRAPH

Fig. 19: Çanakkale temperature and precipitation graph

Fig. 20: Çanak-
kale 1920s

Fig. 21: Old map
of Dardanelles



2.3.2 City Development

Çannakkale Province is most famous for the wars, that have been fought on its soil, the Trojan Wars (12th-13th century BCE) and the Gallipoli campaign (1915) during the WWI. The strategic location of the city requisites always a military presence and today the city is still shaped by its defensive nature.

In 1462 two castles on both sides of the strait were built to protect the entrance of the Marmara Sea. The Center of the Town has developed around the Çimenlik Castle and the city was formed by the workers, soldiers, and administrative officials involved in the construction. (ÇAVUŞ, 2007) From the second half of the 1600s onwards, trade began to develop and various ethnic groups have settled in the city. Çanakkale maintained its identity as a trading city and its multicultural structure until the early 1900s, but the city was heavily affected by the Balkan Wars and World War I. During this process, minorities left the city, and Muslim Turks from the Balkans and Aegean Islands came in their place. (Çavuş & Basaran Uysal, 2018) After 1950s popular trend in Turkey was migration from rural to urban regions. On the contrary, during this trend Çanakkale experienced outward immigration towards other neighboring cities. During the Cold War, despite its location in the heavily industrialized Marmara Region, the city's primary role was seen as a defensive border city and the industrial sector did not flourish. (Çavuş & Basaran Uysal, 2018)

Between 1973 and 1980, Çanakkale was included in the „Priority Development Regions" program. During this period the Dardanel Tuna Fish Factory, Çan Thermal Power Plant, and Çanakkale Ceramic Factory were established, while in Biga, iron-steel and Doğtaş furniture factories were opened. (Tolga Kara, 2018) However, the city kept having outward immigration. Until the 1990s, the presence of the military remained as the most significant dynamic of the city's economy. (Çavuş & Basaran Uysal, 2018) In 1990s the city, with the opening of the 18 Mart University, won a new identity. The presence of the university triggered rapid urbanization. Today 18 Mart University has approximately 50.000 students and an academic staff, roughly 10 percent of the population. This shifted the direction of the city's development and caused southern Kepez area to develop rapidly, becoming a center on its own.

Fig. 22: Areal map of Çananakkale Merkez

Fig. 23: Map of Marmara Highway Ring

Today the city has long narrow shape, located on the coastlines of the Çanakkale Strait, as the shore is geologically suitable for settlement towards the Kepez region; however, the city is constrained between the airport, military facilities, and the Çanakkale Strait. (ILGAR, 2011) Furthermore the airport and the university campus cuts the city in the middle. Connection between Kepez and the Center is only possible through a narrow section at the shore. There are discusions on moving the airport to a different location, but there are no consequent plans for it yet. Another future prospect of the Çanakkale Municipality is introducing a tramline at the shore. However the population growth needs to reach the 200,000 mark for this project to be feasible.

The State is investing in the area to strengthen its connection with the rest of the Marmara Region. The 1915 Canakkale Bridge has been completed and was opened in 2022. The bridge has a length of 4,608 meters and reduces the strait crossing time to only 6 minutes. (Karayolları Genel Müdürlüğü, 2022) As part of the 101-kilometer Malkara-Çanakkale Highway, the 1915 Çanakkale Bridge provides passage over the Çanakkale Strait between Gelibolu and Lapseki. The bridge constitutes the most important crossing point of the Kınalı-Tekirdağ-Çanakkale-Savaştepe Highway, which completes the Marmara Highway Ring. As new alternative transportation network, the project aims to lower the Istanbul Strait crossings. Also provides a seamless travel route to İzmir. (Ünal, 2022)

2.3.3 ÇANAKKALE 18 MART UNIVERSITY

Çanakkale Onsekiz Mart University (ÇOMÜ) was established in 1922. In 2023, it continues its educational and research activities with the following faculties and units: 1 Graduate School, 21 Faculties, 2 Vocational Schools, 13 Vocational Schools of Higher Education, 45 Research and Application Centers. These units enable ÇOMÜ to provide a diverse range of undergraduate, graduate, and vocational education programs, as well as conduct extensive research across various fields. (ÇOMÜ)

University also has a department of Space Sciences and Technologies which has 1 professor, 3 associate professors, and 1 research assistant in its faculty. The faculty offers undergrad and graduate course on Space Sciences and Technologies. Students also have access to Ulupinar Observatory, which has been established in 2001 and formally opened on 19 May 2002. The Center and Observatory is located at 410 m altitude from the sea level on the southern hill of the “Radar Hill”, being 10 km from downtown Çanakkale near the village called Ulupınar. (Department of Space Sciences and Technologies) However the university lacks a planetarium.

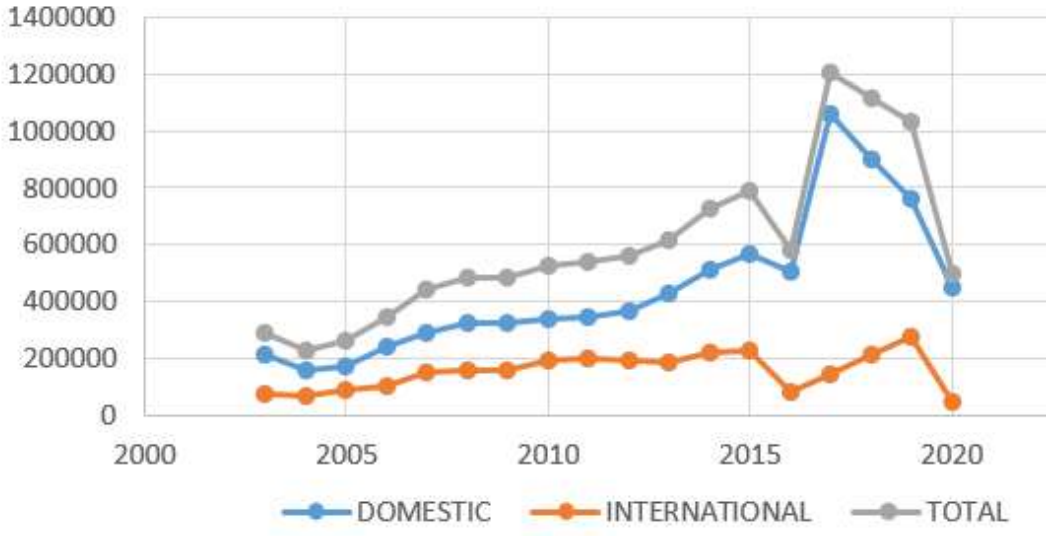
Fig. 24: ÇOMÜ campus photo

Administrative Personal:	**750**
Academic Personal:	**1921**
Student:	**41.370**
Space Sciences and Technologies Students:	**107**

2.3.4 Tourism in Çanakkale Province

Çanakkale Peninsula has yearlong tourism potential thanks to its multitude of cultural and natural attraction points. The coastal regions and the islands have vast beaches and clean shores, which are visited in summer months, especially by Istanbul Residents. The province is also a popular spot for summer retreat, doubling its population in summer months. Also, a new trend is camping or clamping on Mount Ida (Kazdağı). The Mountain has the potential to become a prime eco-tourism center due to its rich biodiversity, flora, and fauna. (Atay, Aksu, Yildirim, & Korkmaz, 2019)

There are two national parks within the borders of the province, both distinguished by their natural and cultural characteristics, Troy Archaeological Site and the Gallipoli Historical Area are the driving forces behind cultural tourism in Çanakkale. Other significant cultural sites include but not limited to ancient cities like Assos, Parian, Alexandria Troas. The Troy and Gallipoli national parks are popular for 2-day school trips. Schools in Marmara region organiize visits to these sites, mainly for middle schoolers. Also, intensives from different organizations offer funds to schools from different regions to visit the parks.



ÇANAKKALE DOMESTIC AND FOREIGN TOURISTS OVERNIGHT STAYS BETWEEN 2003 - 2020

Fig. 25: Çanakkale domestic and foreign tourists overnight stays between 2003 - 2020 graph

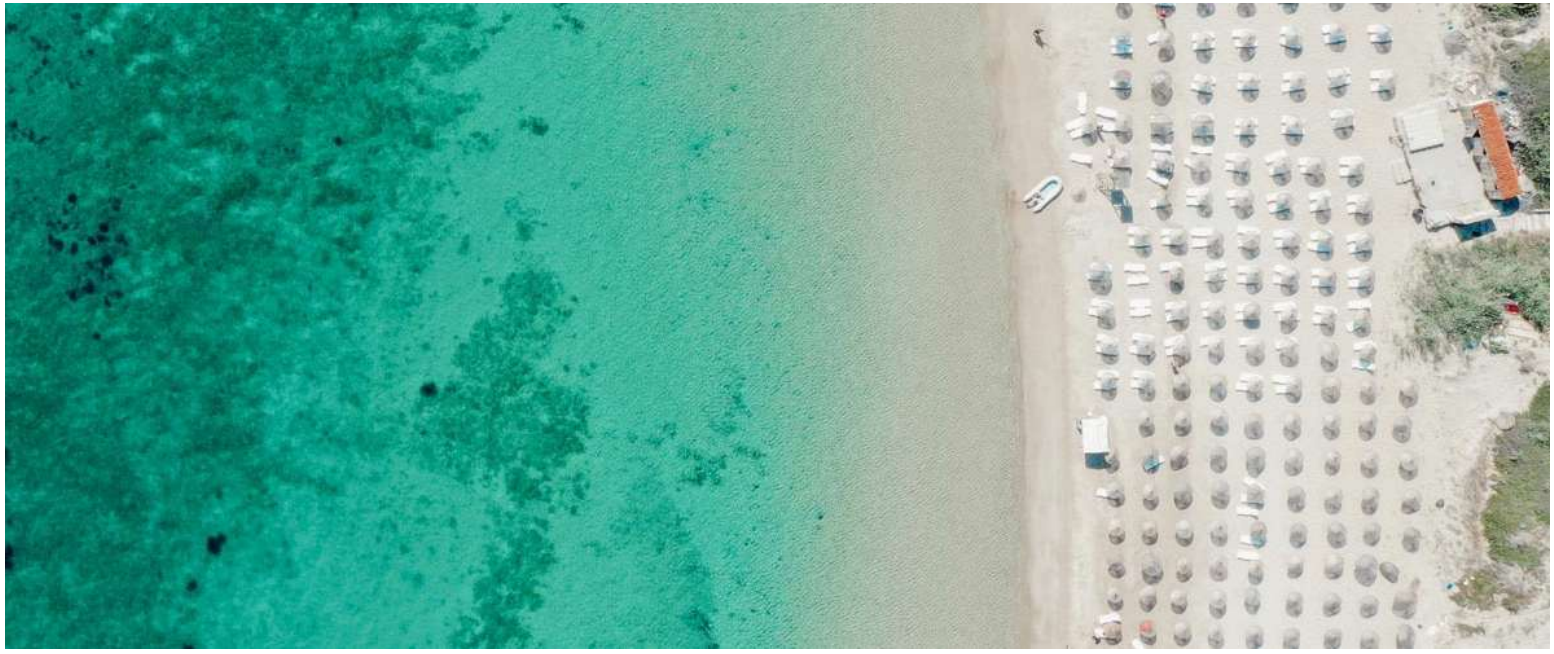


Fig. 26: Wooden horse used in the 2004 movie “Troy”

Fig. 28: Galipoli historical site

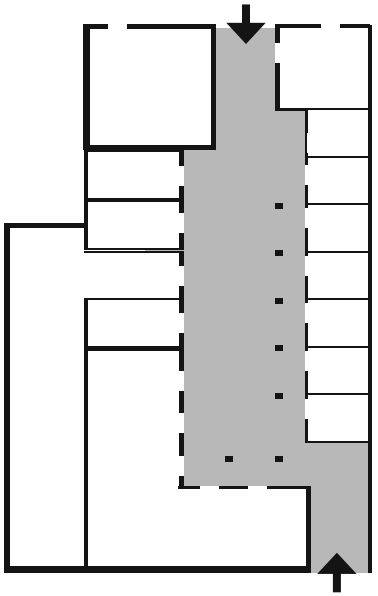
Fig. 29: Bozca Island, Ayazma Beach

2.3.5 Urban Fabric: In-between Spaces

The moderate climate allows year-round utilization of outdoor spaces. In commercial areas occur a deliberate blurring of boundaries between exterior and interior space. The architecture incorporates in-between spaces, that seamlessly integrate open-air plazas, arcades, and covered walkways into the built environment. To illustrate this concept, two historical buildings and one roofed street are chosen for detailed analysis and demonstration.

Yalı Han

Built in 1889, Yalı Han is located between Fetvane Street and Yalı Street and has an entrance to both streets and is frequently used by passerbys as a shortcut. Currently it houses bookshops, handicraft workshops, and cafés, is also like a crossing corridor which joins both streets together. (Yanmaz & Cengiz, 2019) It is approximately 800 m^2 in size and has a rectangular plan. The upper floor of this two story building, originally served as guesthouse and the ground floor as stables. (Kusku, 2020) The han's atrium has a long rectangle shape, that creates an intimate feeling. The balconies provide shelter when it rains, while a three in the middle offers cooling shade during summer. In the winter a portable coal heater is placed in the atrium.



Left to right

Fig. 30: Yali Han Photo

Fig. 31: Yali Han schematic plan

Fig. 32: Bar street photo

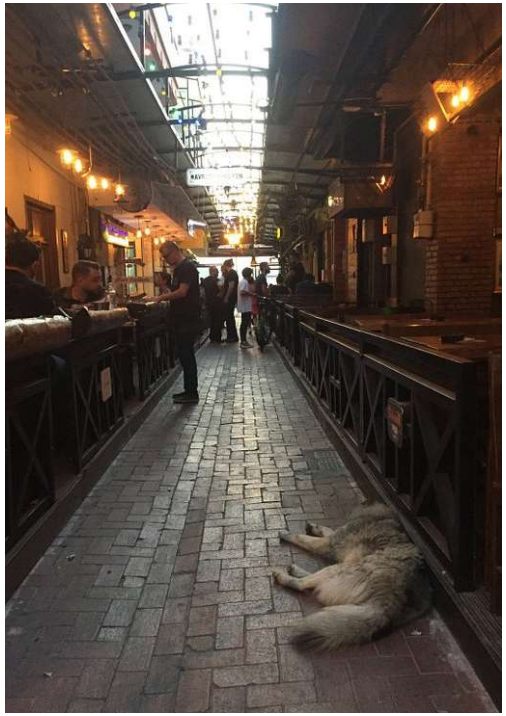
Fig. 33: Bar street schematic plan

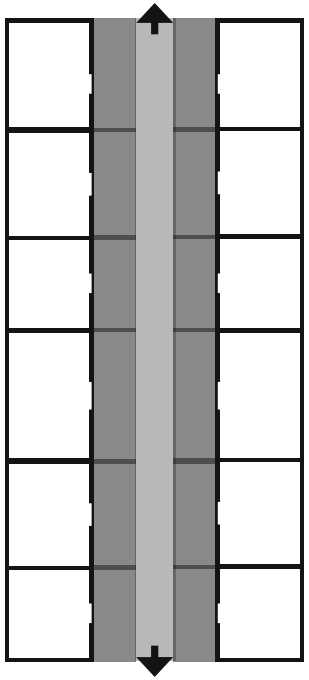
Fig. 34: Aynali Bazaar photo

Fig. 35: Aynali Bazaar schematic plan

Bar Street

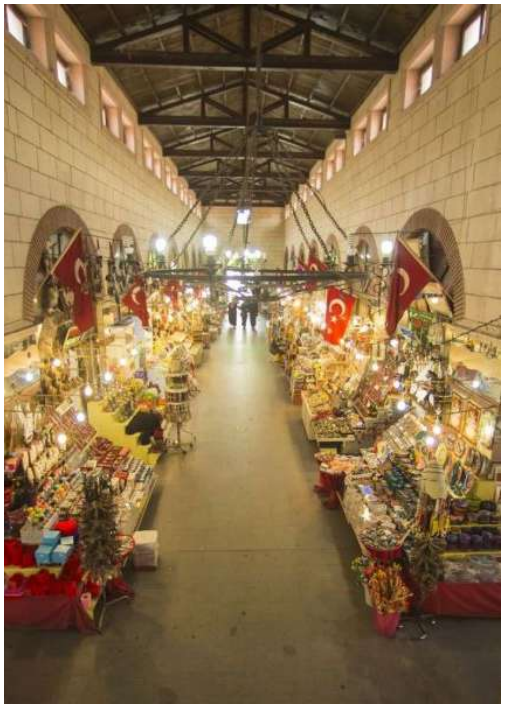
This is a roofed pedestrian street filled with very popular restaurants and bars. The street is formed by cellular spaces varying in shapes and sizes. However, the mutual activity and the cohesive design of shopfronts unites them. All of the restaurants and bars on the street have 2 rows of tables Infront of them. The railing along the both sides of the central walk path provides a room defining structure to the space. The space make people, feel like having a communal meal at dinner time and chit-chat between different tables are not uncommon. In late hours live music is blasting from the bars, which can be listened throughout the street.

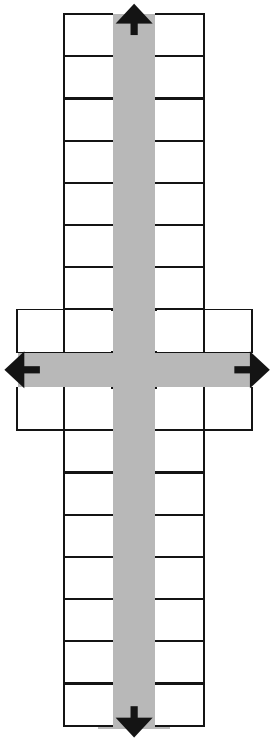




Aynali Bazaar

Aynalı (Mirrored) Bazaar has a significant importance in the urban memory of the city. It is located on the Çarşı (Bazaar) Avenue, which is a pedestrian commercial street of the Old Town. Eliyau Haliyo, one of Kent's prominent figures from the Jewish community, had it constructed in 1890 (Eren, 1990). The bazaar was burned and destroyed during the bombardment from the English battleship Queen Elizabeth during the 1915 Gallipoli Campaign and later was used as a stable by the British who occupied Çanakkale after the Armistice of Mudros. In 1967, the bazaar was restored by the Çanakkale Municipality. (GÜLERYÜZ, 2017) Today the Bazaar is open, has mostly souvenir shops. The Bazaar has a typical one row roofed "carsi" plan. The perpendicular alignment of the space lets user perceive the rows of the shops from distance. Rather than shop windows, the goods are presented on open displays seeping into the middle avenue.





3. PROJECT GOALS

The city of Çanakkale is currently divided by an airport, but the removal of the airport will transform the underused shoreline in front of the university campus into a vibrant new center, connecting the northern and southern parts of the city. The building should create a new attraction point here.

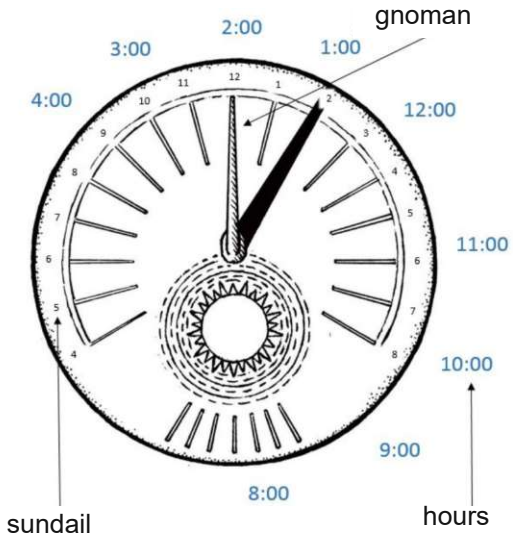
Throughout the city semi outdoor spaces are used frequently in the urban space and are cherished by the locals. The new Museum should implement, this concept and open up to its immediate surroundings, to create foot traffic and attract locals.

The 18 Mart University needs a planetarium for its space sciences students. This planetarium will cater to their academic needs and offer additional programs for other visitors. A library with study spaces will also be included. It is foreseen, that the museum will be visited by the numerous schools across the country, that plan trips to Çanakkale. Workshop and seminar spaces should be arranged to further the learning experience.

The exhibition galleries should all offer direct views of the reverse sun clock, integrating this unique feature into the visitor experience and reinforcing them to use their own senses to observe astronomy.

4. METHODOLOGY

4.1 CONCEPT DEVELOPMENT



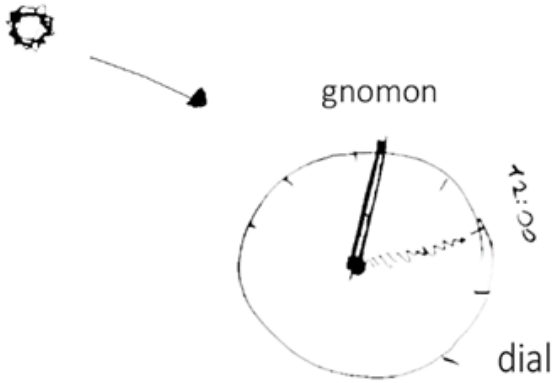
CONCEPT IDEA: REVERSE SUN CLOCK

Sun clocks are one of the earliest time keeping devices. A typical sun clock has a stick (the gnomon). The stick cast shadows on to a plate (the sundial). The sundial has the hours of the day marked on to it. As the sun moves across the sky, placement of the shadow changes on the sundial, determining the time.

The **reverse sun clock** plans to use light, instead of shadow to tell the time. The Idea is to have a dome and cut precise holes on to its surface. The holes must let the sun in, on different hours. Thus, a light beam would fall inside the dome, determining the time.

Fig. 36: sunclock explanation

Normal Sun Clock



Reverse Sun Clock

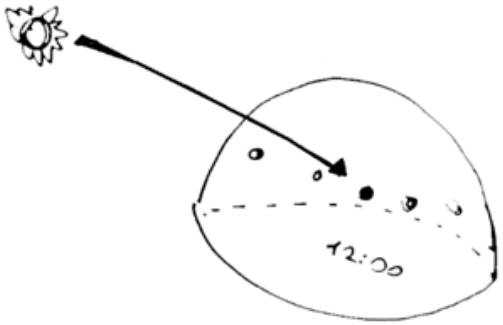


Fig. 37: Concept idea: reverse sunclock drawing

EXPERIMENT SETUP

To test the idea several experiments are done via Ladybug environmental analysis plugins for Grasshopper for Rhino. Ladybug allows you to visualize sun-path information for any location. Using the 3d sun-path graph, sun vectors and subsequent shadows for different scenarios are calculated. Then a mock-up is built to test the concept.

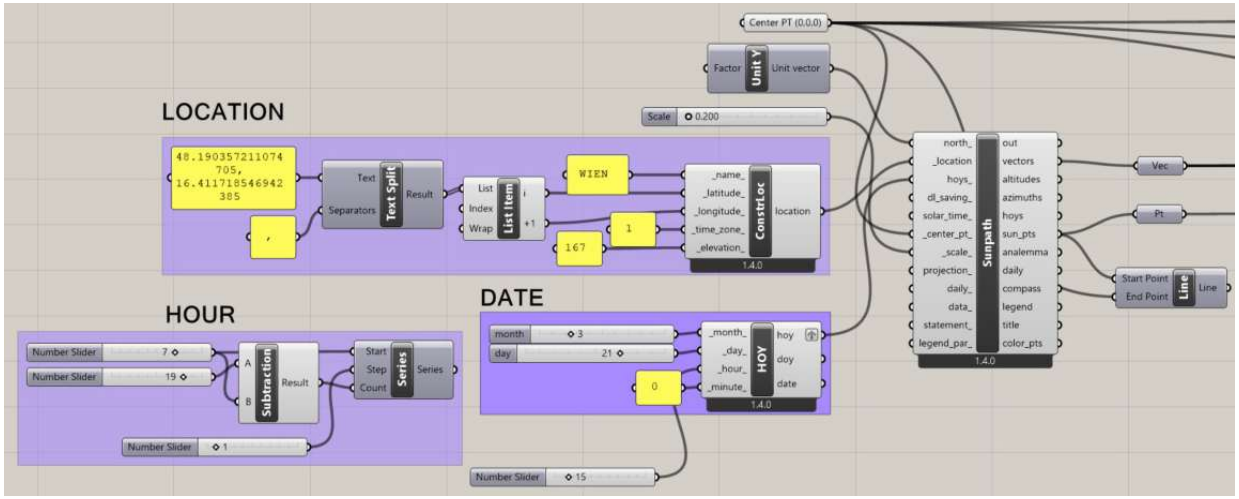
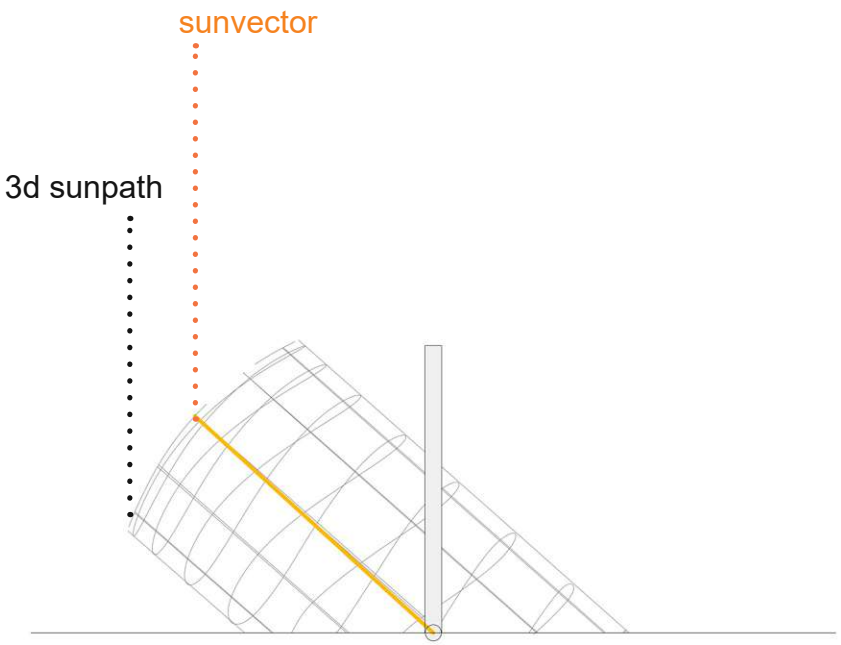


Fig. 38: grashopper nodes for the experiment



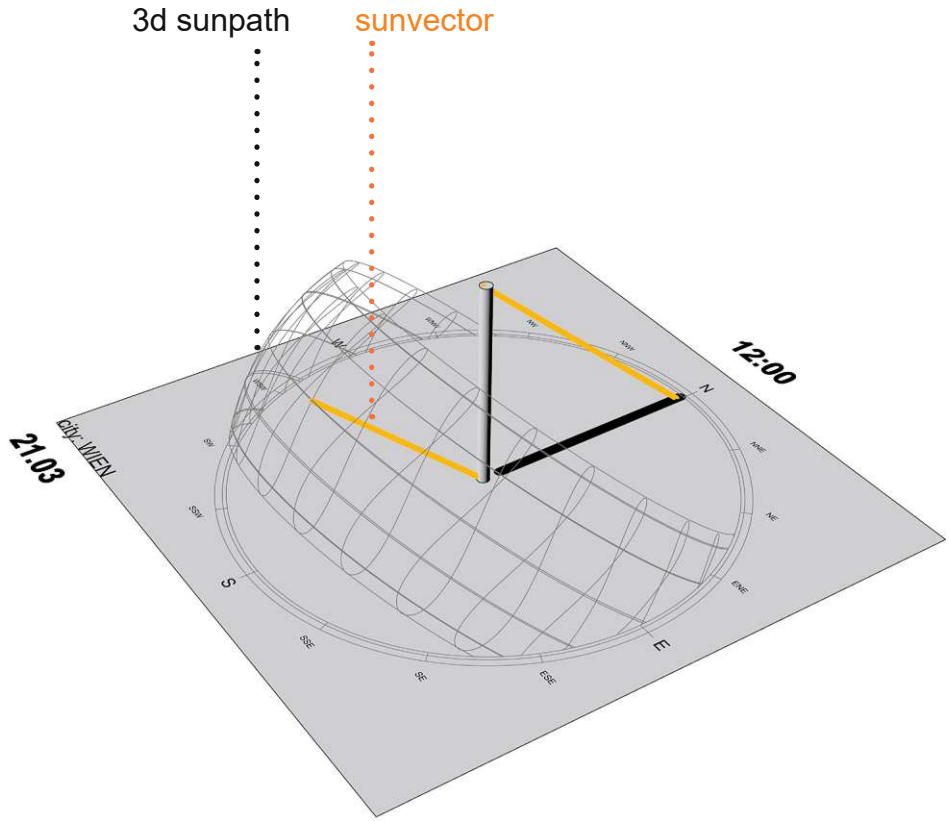
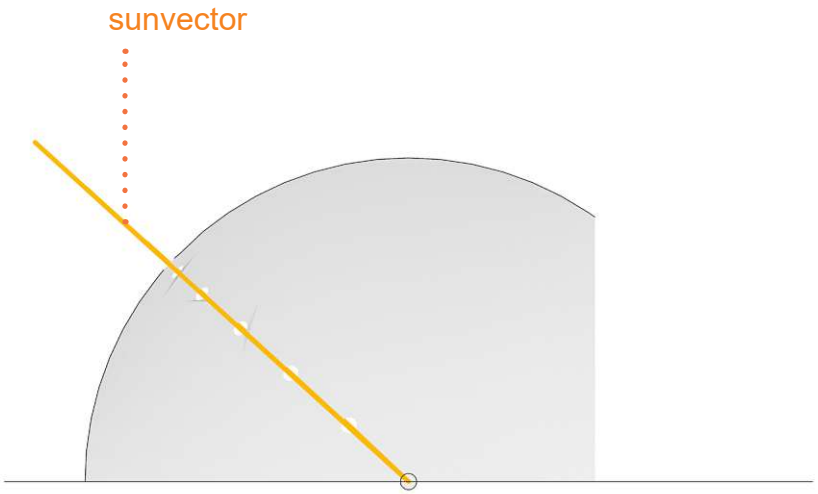
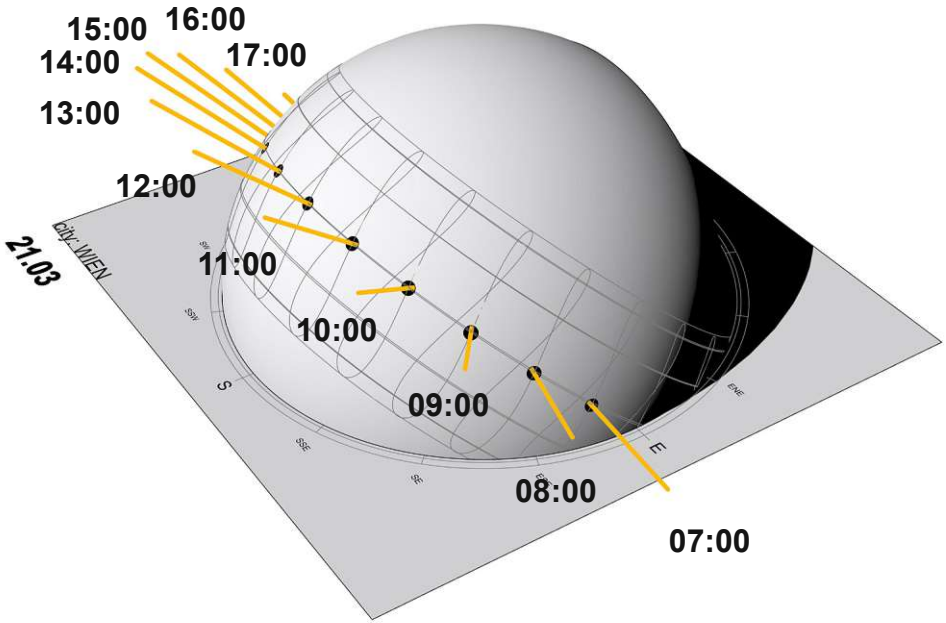


Fig. 39: experiment setup showcasing a typical sun clock





Experiment 1:

For the first experiment, sun vectors on the date of spring equinox in Vienna are calculated via Rhino Ladybug plugin. Every vector stands for a single hour and they meet at the center of the dome. At the intersection points between the dome and the vectors, the holes are cut out. Light passes through the holes and falls on to the inner plane of the dome.

Fig. 40: experiment 1 section

Fig. 41: experiment 1 ISO

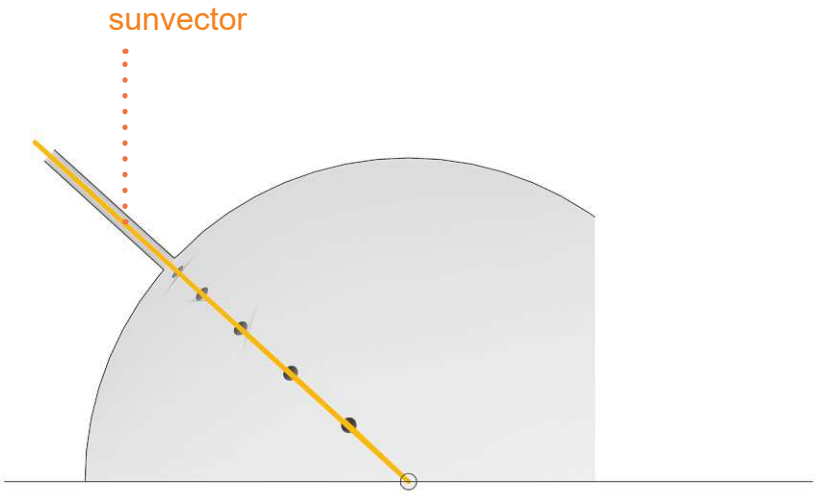
21. March 12:00

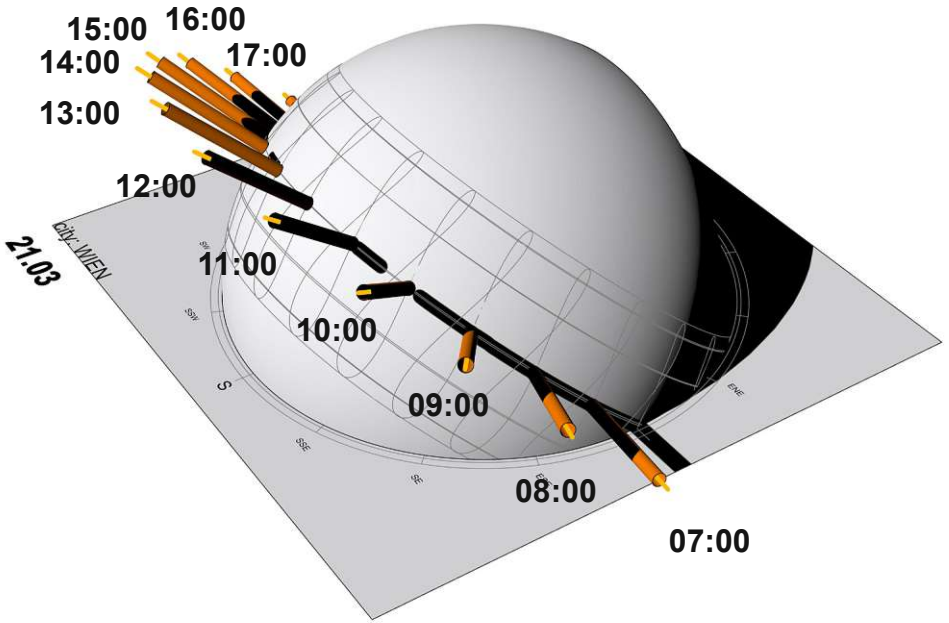
Fig. 42: experiment 1 interior

Results:

The light beam from the corresponding hole falls on to the inner-center of the dome. In this example, at 12 o'clock, light beam for the corresponding hour illuminates the center circle, passing through its dedicated hole. The center of the dome is marked with an orange circle on the figure above.

This version of this dome is hard to read because the planned cutouts have only one dimension, which makes light pass through every hole and mark many positions under the dome. Therefore it is hard to distinguish between light beams for a specific time of the day.



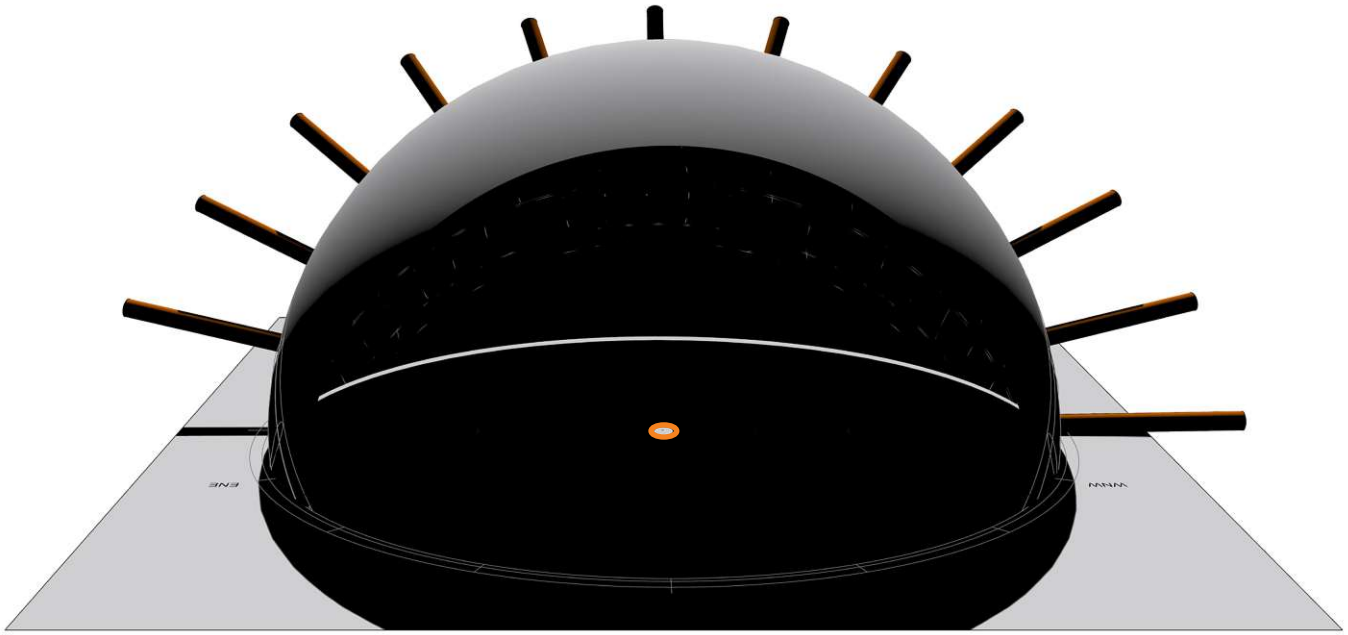


Experiment 2:

To restrict the light, pipes are introduced to the model. Pipes along the sun vectors are added on top of the holes. This way, light should only pass through one hole at the correct hour.

Fig. 43: experiment 2 section

Fig. 44: experiment 2 ISO



21. March 12:00

Results:

In this example above, only one light beam through the corresponding hole can pass and illuminate the center of the dome.

If there would have been a hole for every hour for each day throughout the year, this model should have worked.

Fig. 45: experiment 2 interior

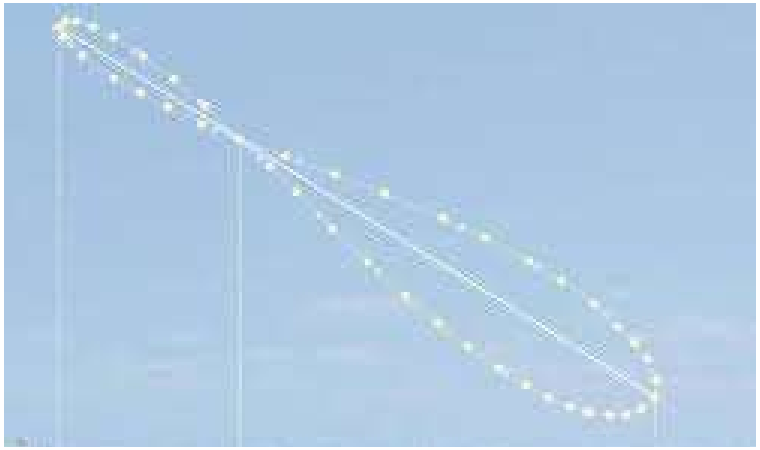


Fig. 46: anlemma photo

ANALEMMA

An analemma is a diagram that depicts the position of the Sun in the sky, observed from a fixed location on Earth at the same solar time each day over the course of a year. Due to the elliptical nature of Earth‘s orbit and the 23.5° tilt of its axis, the Sun‘s position varies throughout the year, creating a figure-eight pattern in the analemma.

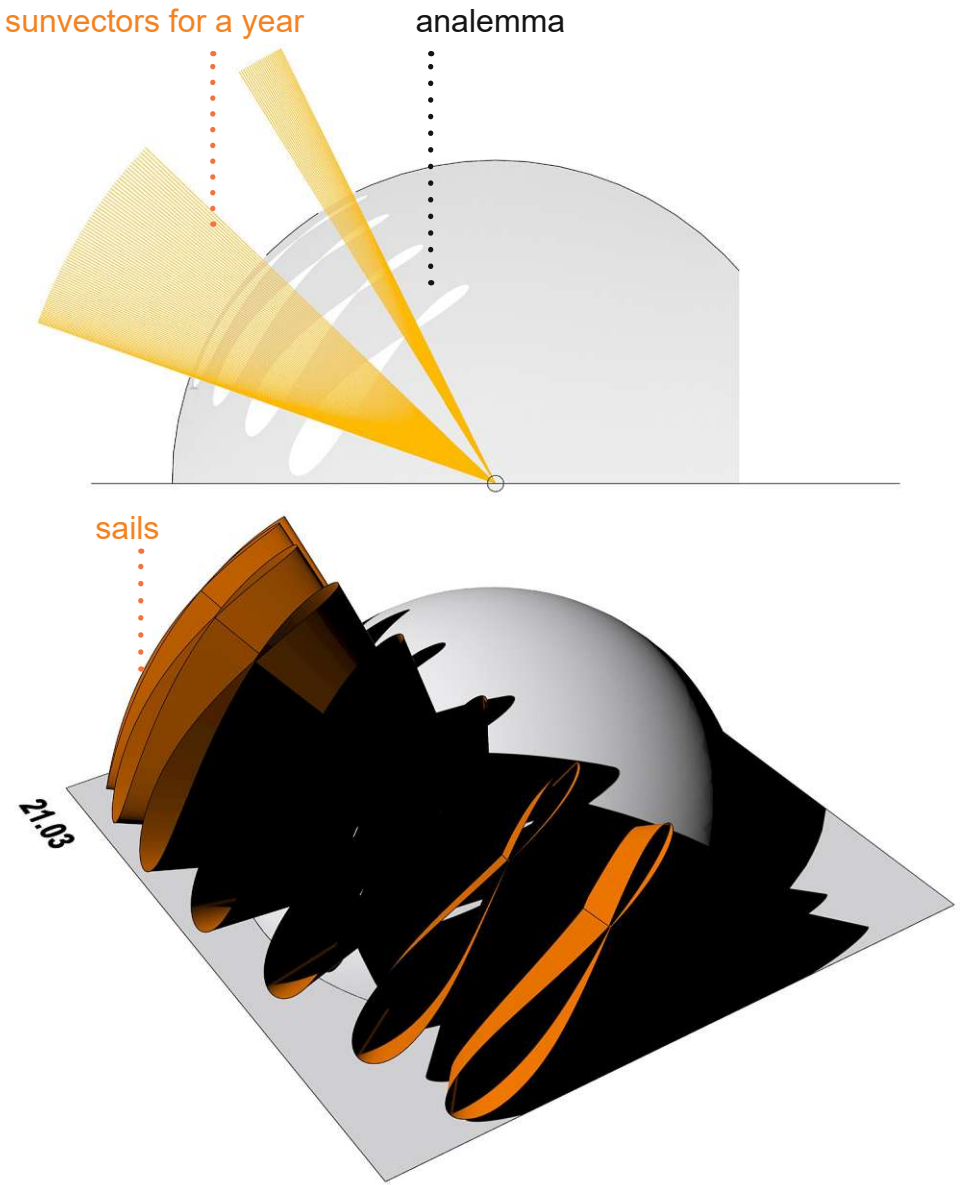
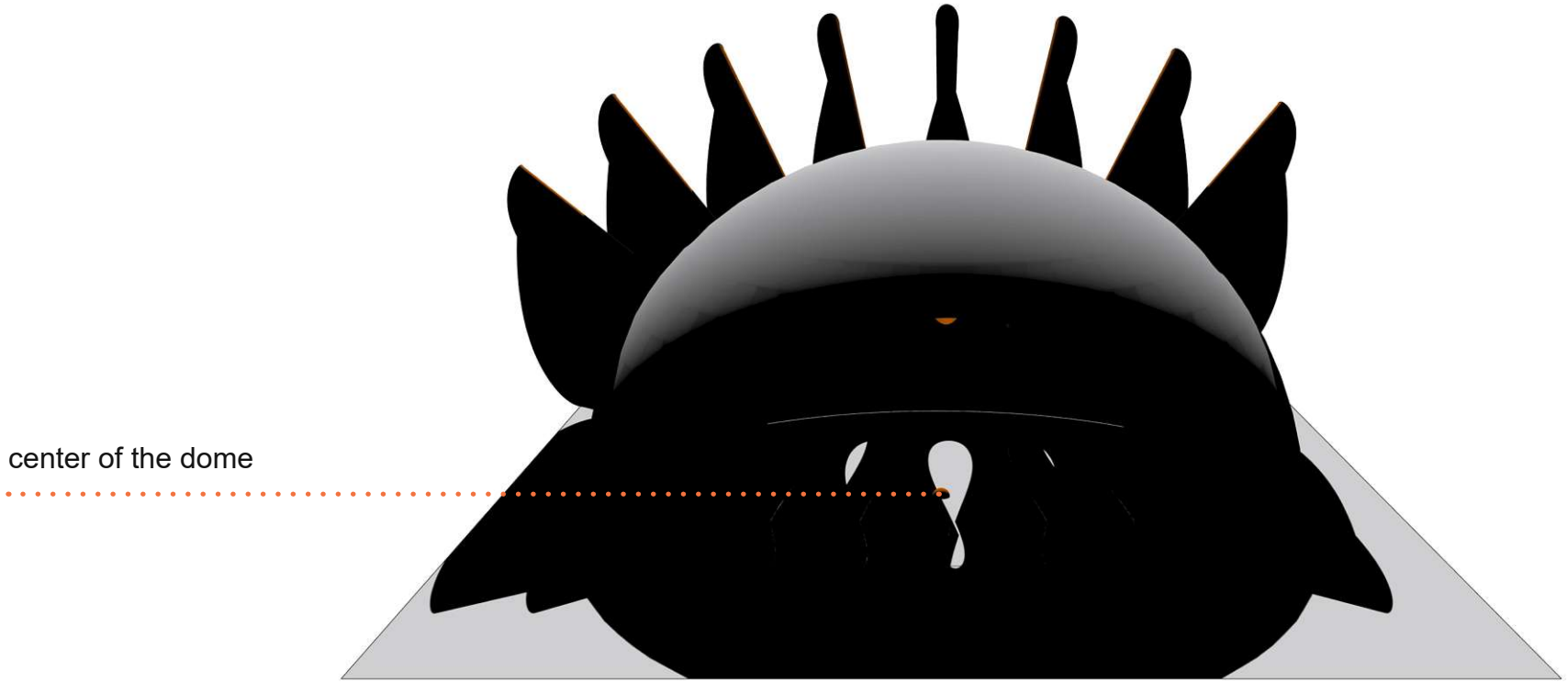


Fig. 47: experiment 3 section

Fig. 48: experiment 3 ISO sails

Experiment 3:

This time the analemmas for every hour are cut out from the half-sphere. To restrict the light, sails are added on to the cutouts.



21. March 12:00

Fig. 49: experiment 3 interior

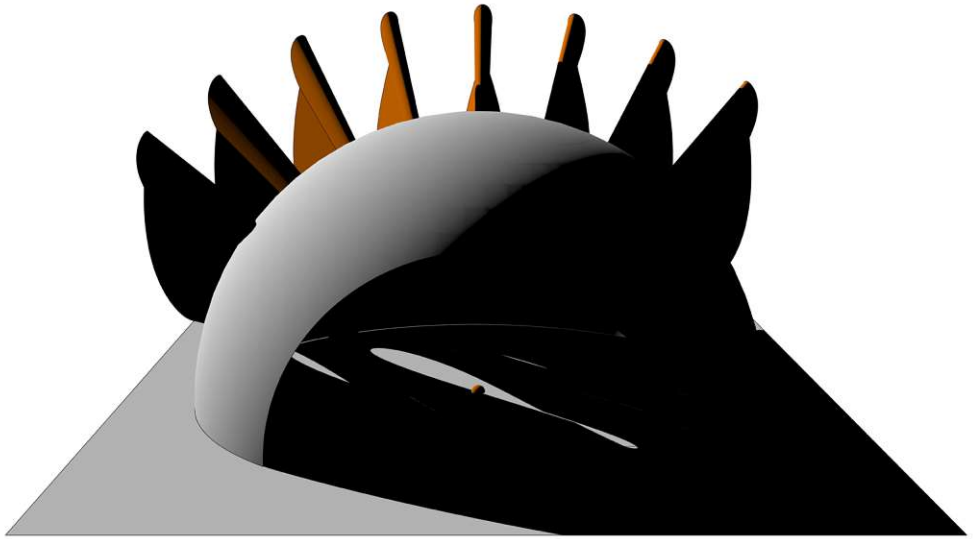
Results:

The anlaemma shape is projected in to the interior.

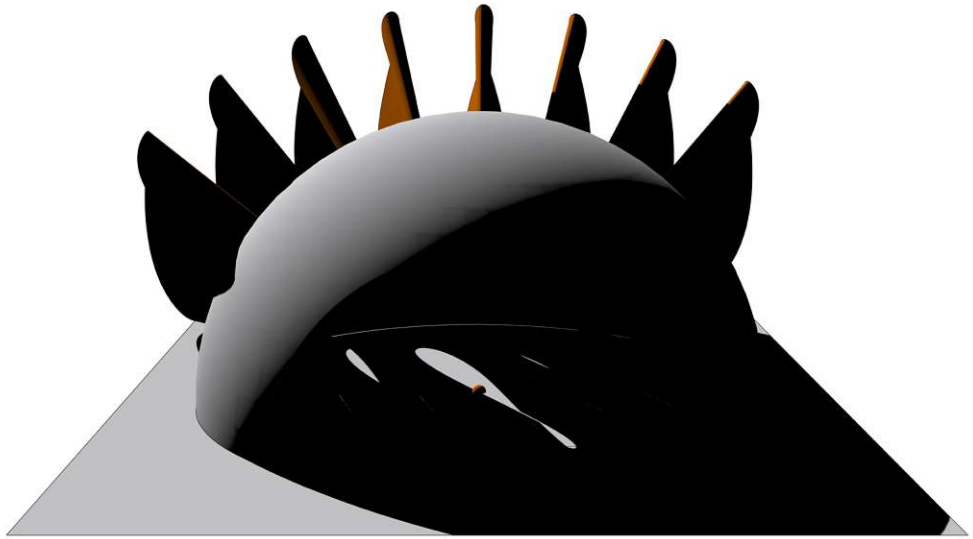
The results are tested with a mock-up.

Mock-up: 21. 12:00

Fig. 50: experiment 3 mock-up

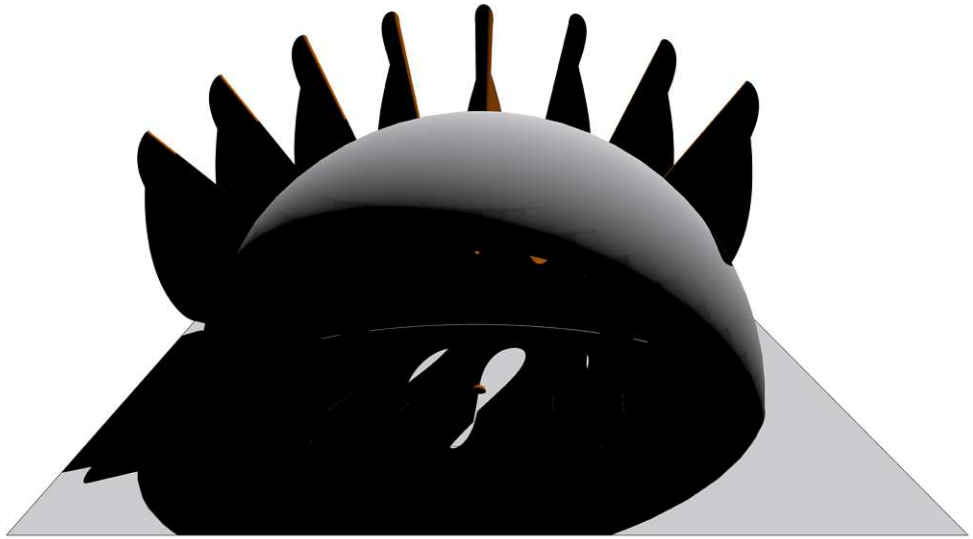


09:00



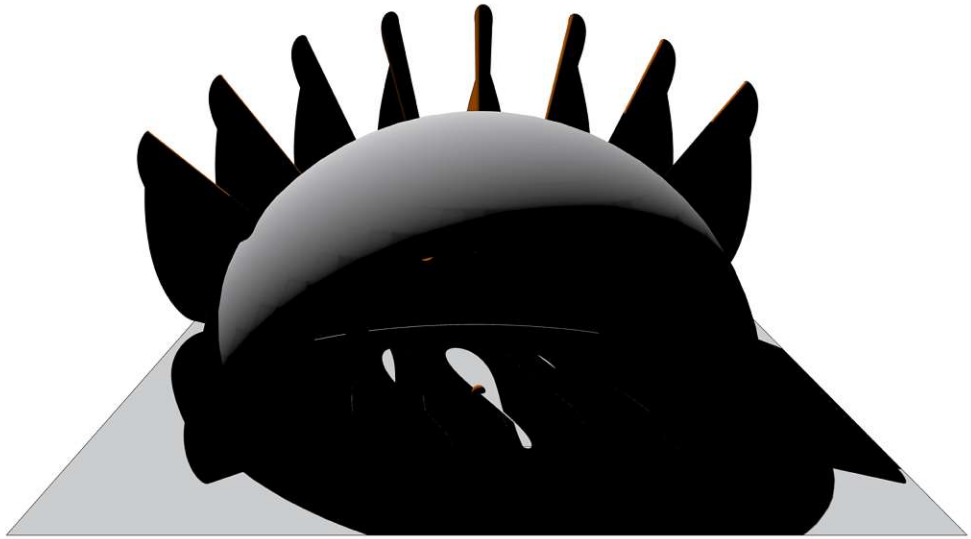
10:00

Spring equinox sequence, 21st of March

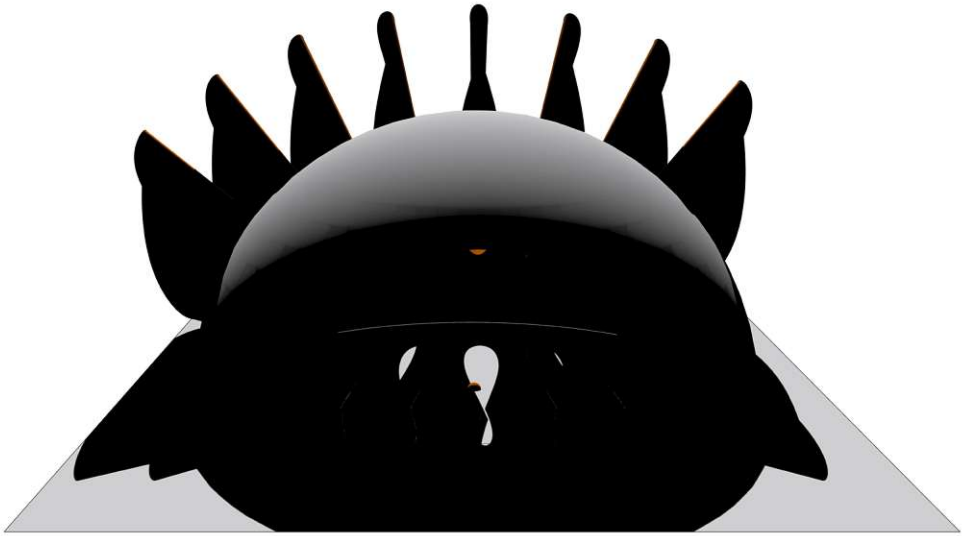


13:00

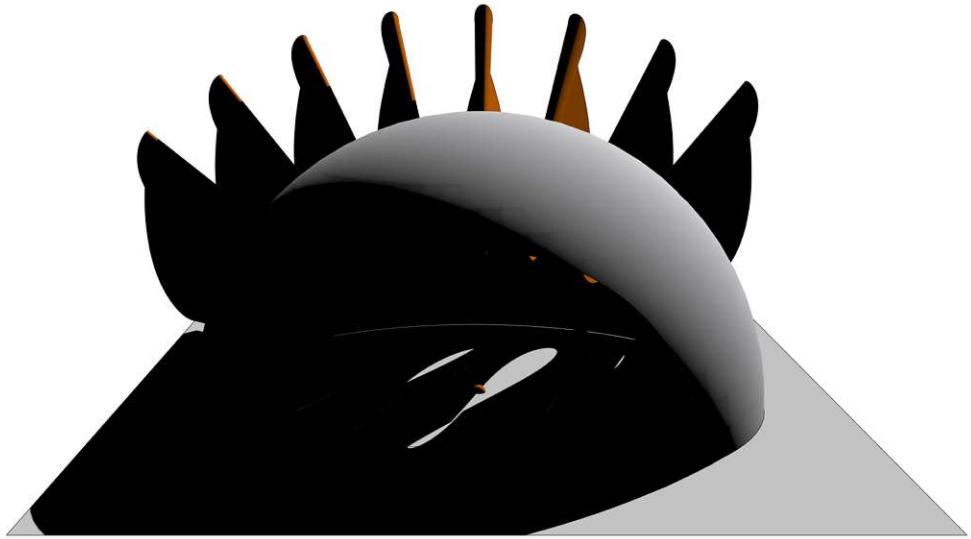
Fig. 51: experiment 3 interior, spring equinox sequence



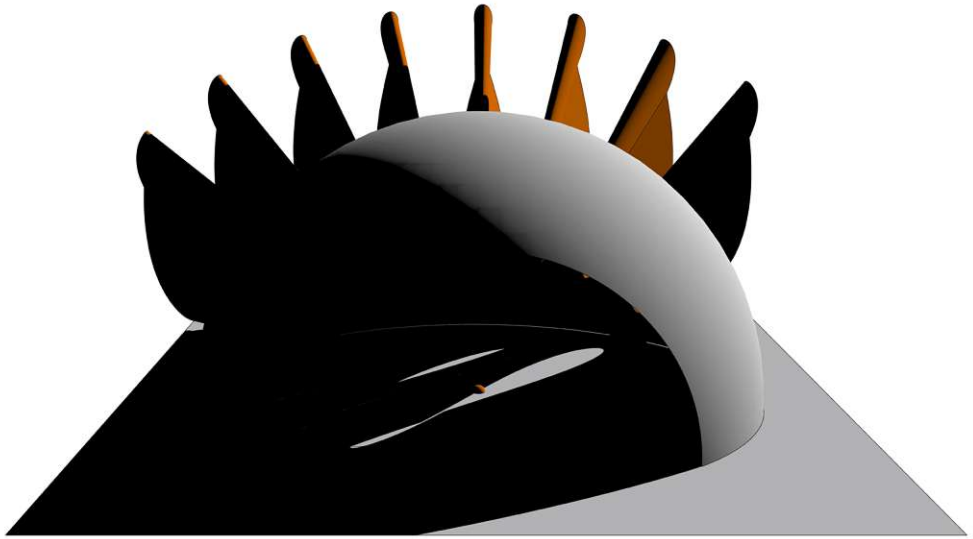
11:00



12:00



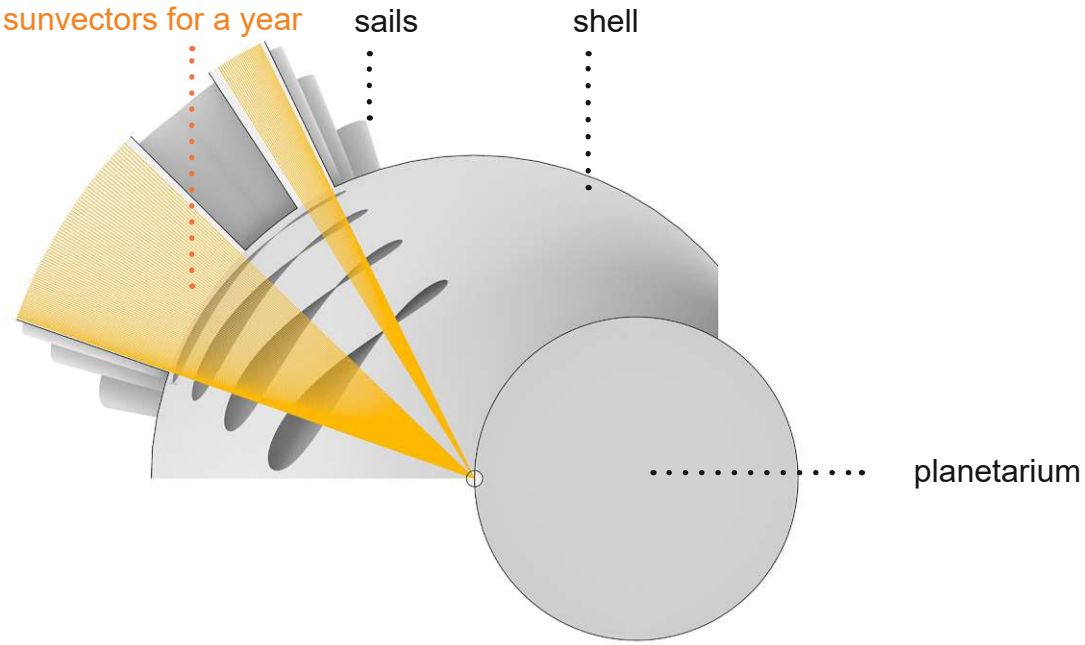
14:00



15:00

Final Version:

A sphere is added on to the inner center of the dome. Representing the planetarium. The exterior of the planetarium is used as the projection surface for the **Reverse Sun Clock**.

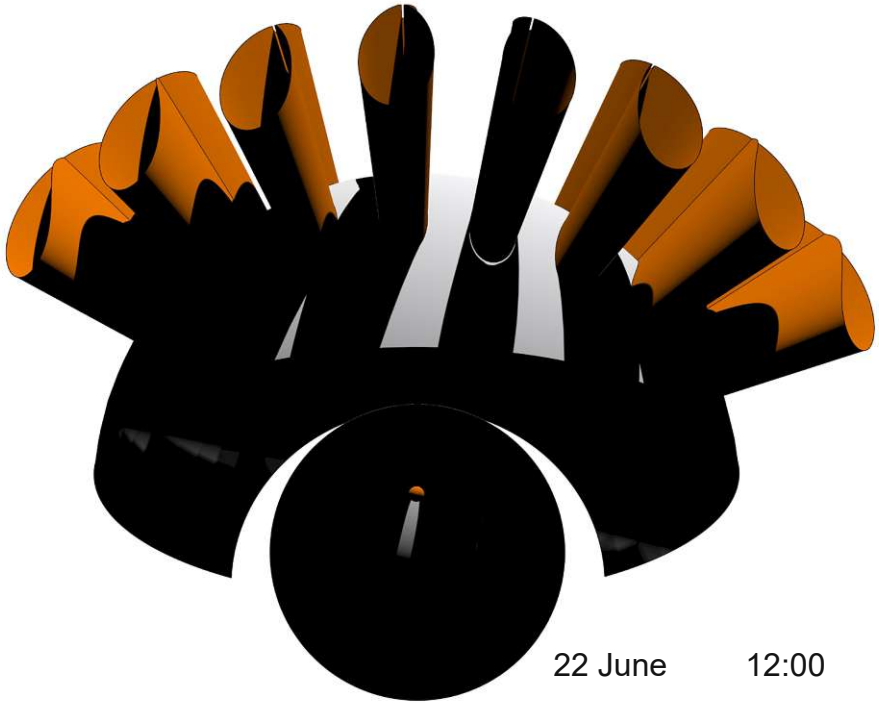


21 December 12:00

21 March 12:00

Results:

The sun clock can also be used to get a sense of the season. As the positioning of the projected analemma changes throughout the year.



22 June 12:00

22 September 12:00

4.2 LOCATION AND SURROUNDINGS

CHOOSING THE BUILDING SITE

Three empty plots were considered, all are selected for their proximity to the 18 Mart University campus.

Fig. 52: areal view of the considered building lots

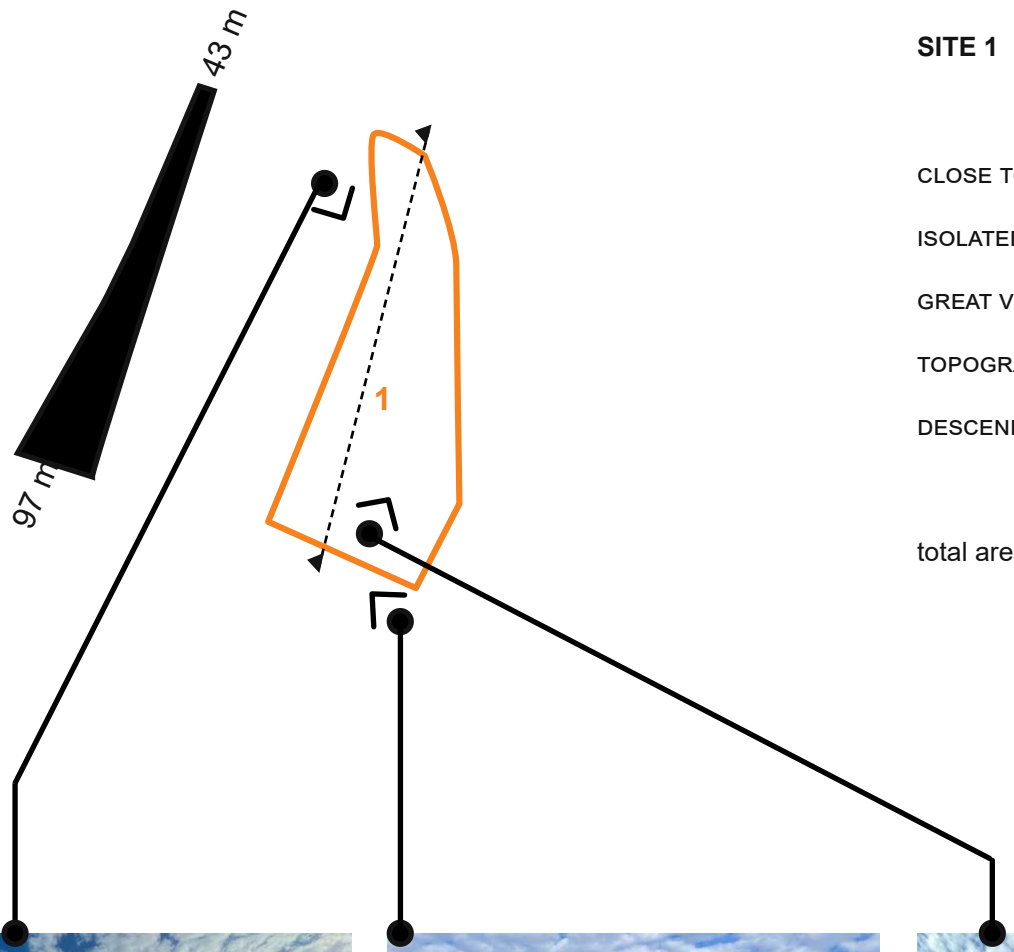


Fig. 53: site 1
schematic plan
and elevation

SITE 1

CLOSE TO UNIVERSITY CAMPUS

ISOLATED FROM THE CITY

GREAT VIEW TOWARDS THE STRAIT

TOPOGRAPHY ALLOWS THE CONCEPT

DESCENDING TOWARDS NORTH

total area: 60 000 m²

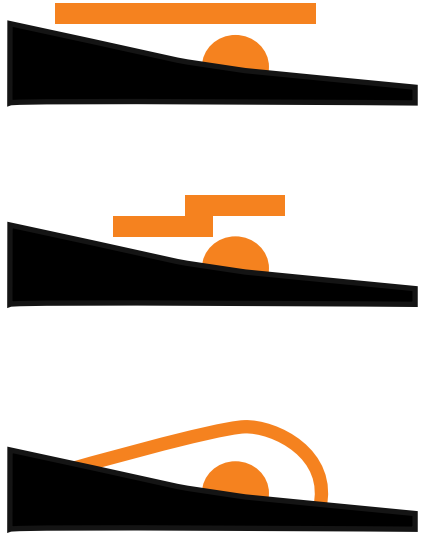


Fig. 54: site 1
first ideas

Fig. 55: site
1 photos

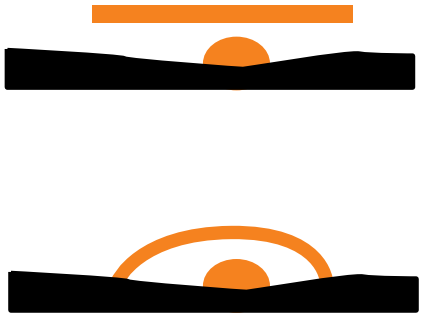


Fig. 56: site 2
first ideas

SITE 2

POTENTIAL FOR CREATING A SQUARE

NO SEA VIEW

FREEWAY BRIDGE VERY CLOSE

total area: 30 000 m²

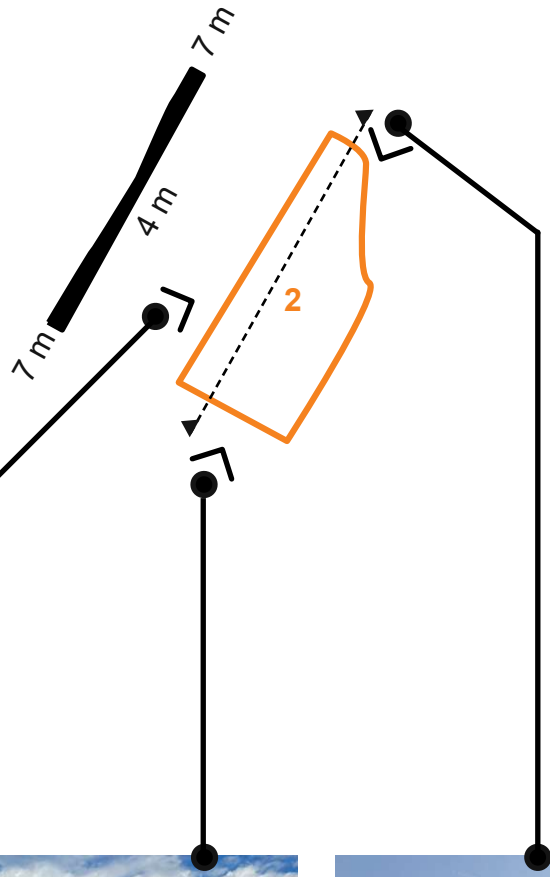
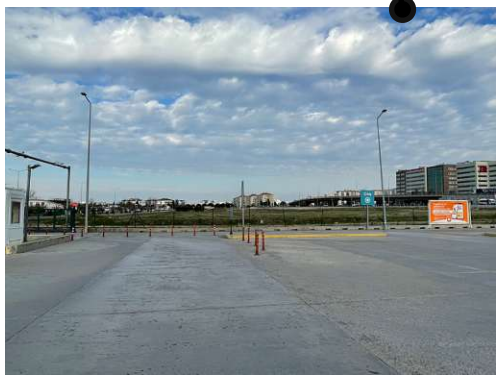


Fig. 58: site 2
schematic plan
and elevation



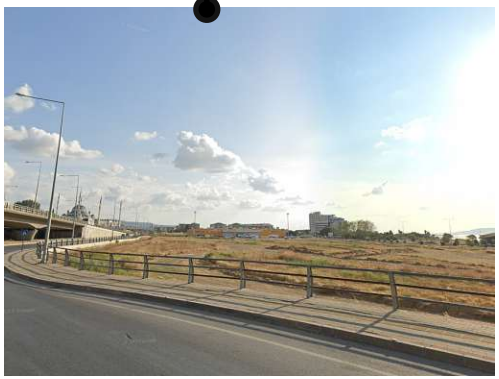


Fig. 57: site
2 photos

SITE 3 CHOOSEN

SEA VIEW

CONNECTION TO THE SHORE

SHOPPING MALL BEHIND

BUS LINE TO THE CENTER, CLOSE

total area: 18 000 m²

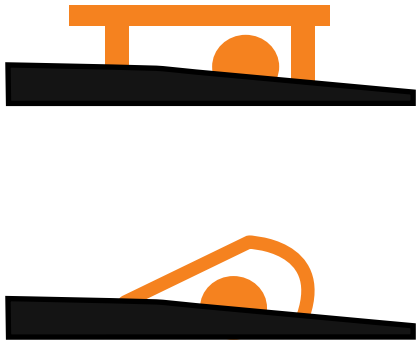


Fig. 59: site 3
first ideas

Fig. 60: site 3
schematic plan
and elevation

Fig. 61: site
3 photos

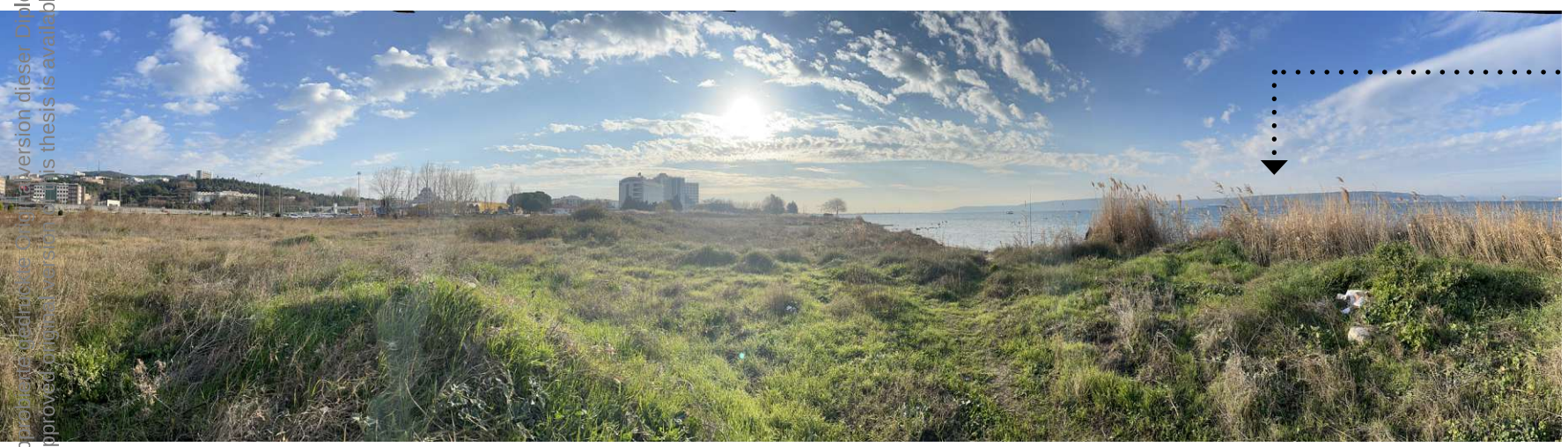


Fig. 62: Building site map

1. UNIVERSITY CAMPUS
2. UNIVERSITY HOSPITAL
3. MOSQUE
4. OPEN CAR MARKET
5. HOTEL
6. SHOPPINGMALL
7. RESTAURANTS

BUILDING LOT
UNIVERSITY BRIDGE
BUS STOP
SHORE PARK

Fig. 63: Building site and project environment

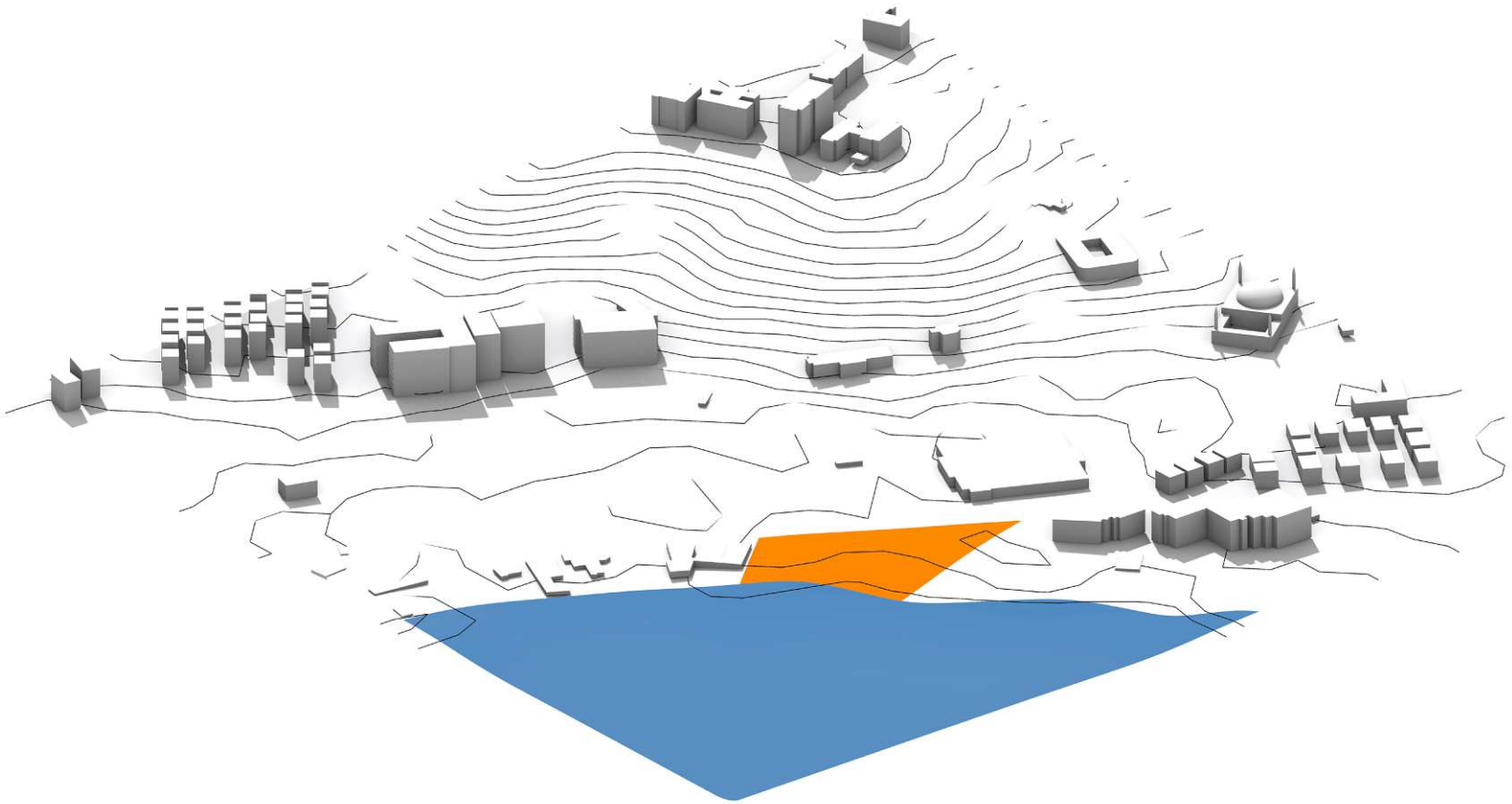


Fig. 64: topography

ACTION PLAN

EXTEND THE SHORE PARK

EXTEND THE RESTAURANT BELT

VIEW TOWARDS THE STRAIT

SUNCLOCK SHOULD BE VISIBLE FROM THE MAIN WALKING PATHS

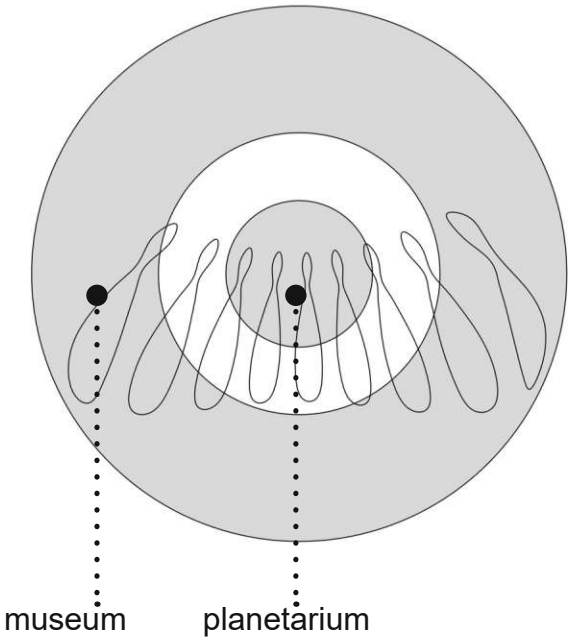
USE THE SHOPPING MALL PARKING LOT (500 PARKING SPOTS)

Fig. 65: action plan

4.3 SPATIAL CONCEPT

FORM FINDING: STEP 1

Planetarium sits in the middle. Rest of the program will be inside the building, surrounding the planetarium. The sun cutouts for the reverse sun clock are cut through the surrounding building.



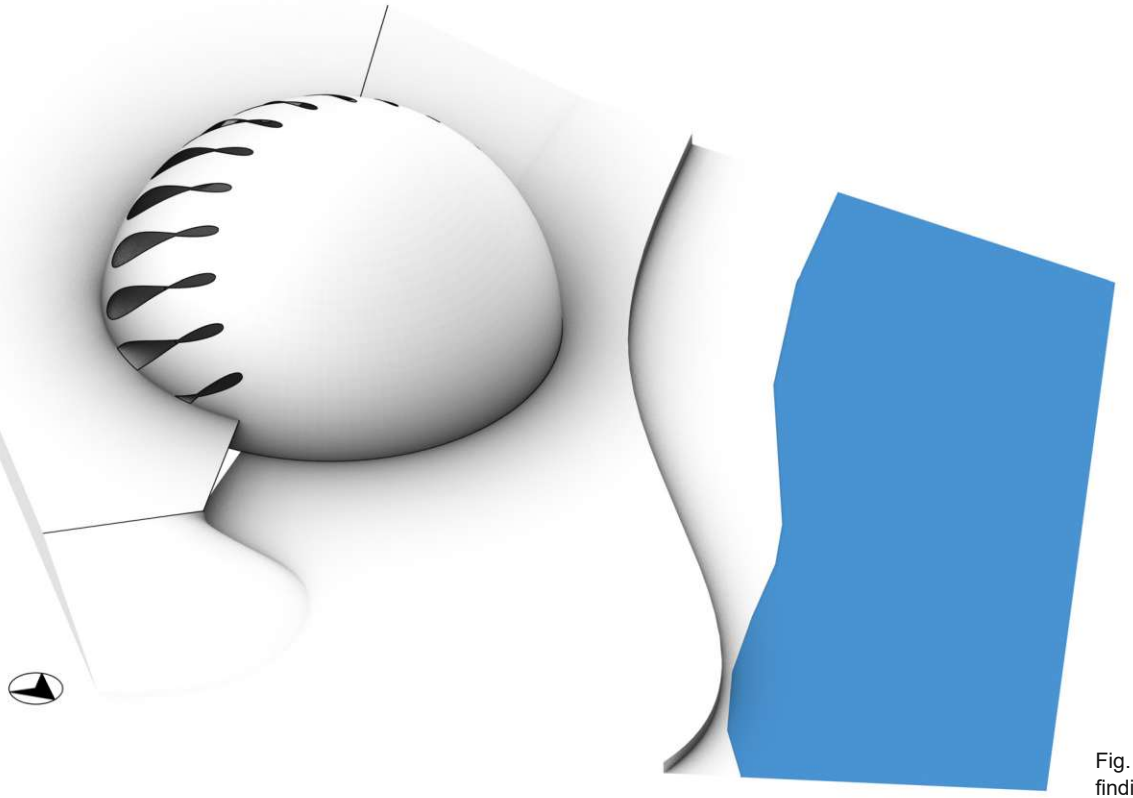


Fig. 66: form finding step 1, schematic pllan

Fig. 67: form finding step 1, Iso

FORM FINDING: STEP 2

The planetarium is moved towards north expanding the surrounding building. This creates a central plaza to the south of the planetarium, providing ample space for the sundial to be visible and offering a flexible area for various activities.

The northern part of the structure is opened up with a glass facade facing the Dardanelles Strait, accommodating building programs that require a direct outside view.

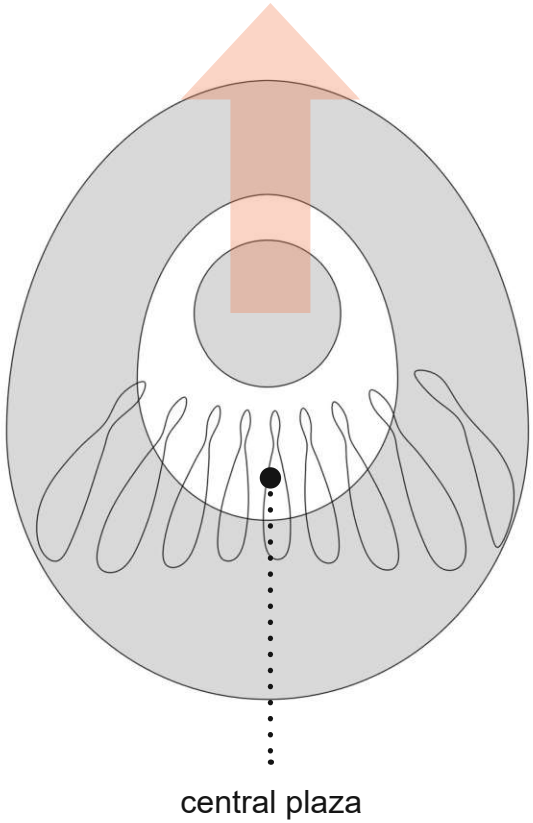


Fig. 68: form finding step 2, schematic pllan

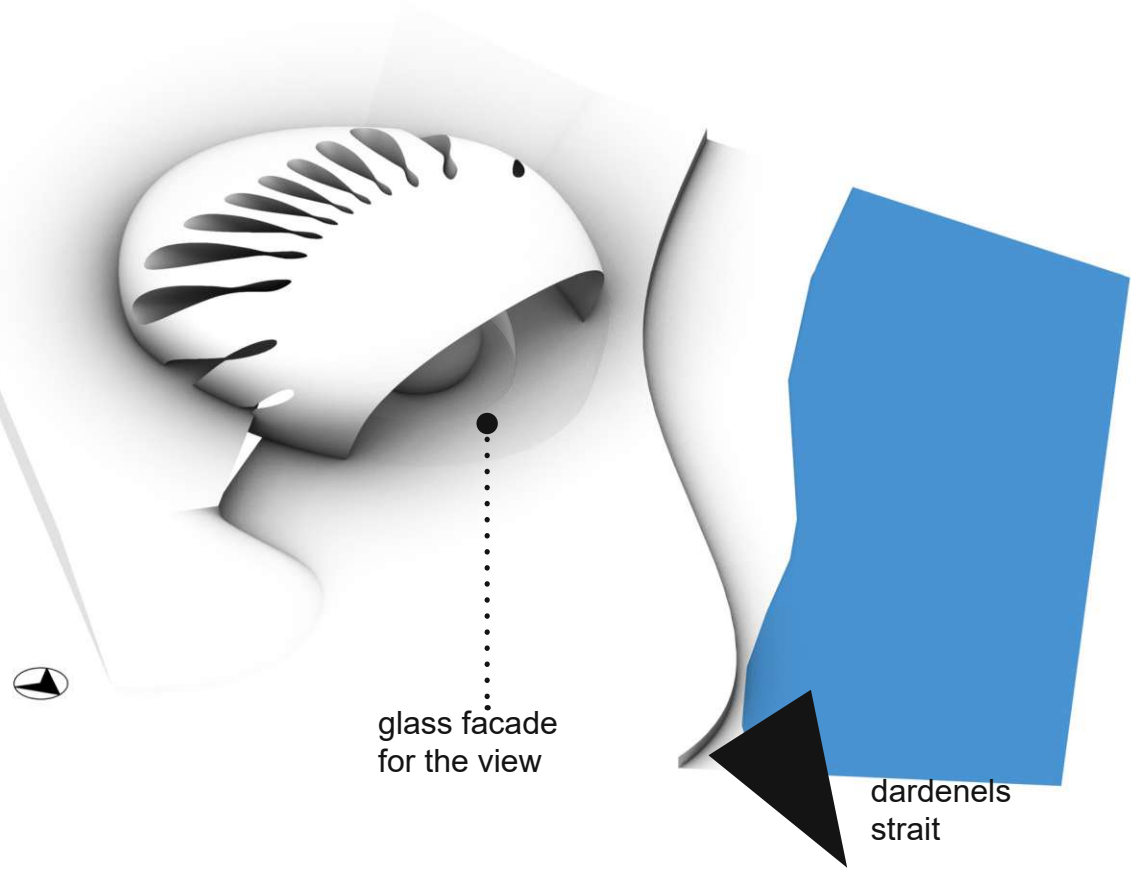


Fig. 69: form finding step 2, Iso

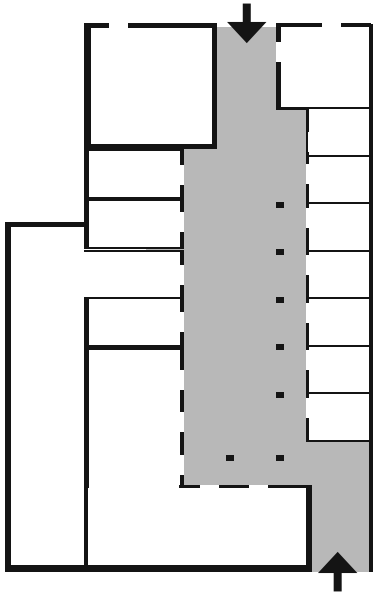


Fig. 70: Yali Han schematıc plan

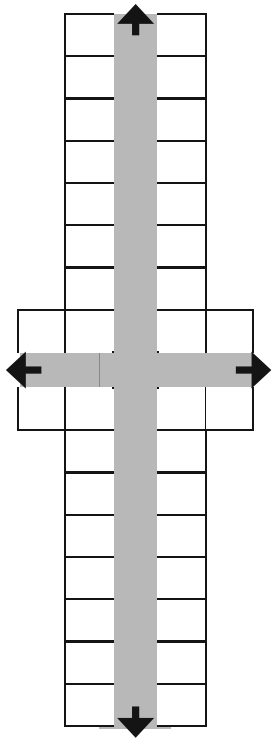


Fig. 71: Aynali Bazaar schematic plan

FORM FINDING: STEP 3

Drawing inspiration from the Han and Bazaar plans, four entrances are created, leading to the central plaza. These entrances connect the building with its immediate context. The space between the planetarium and the surrounding building becomes a roofed outdoor area. This intermediate zone will provide a circular path connecting different parts of the building. Additionally, the sea breeze will help cooling the building.

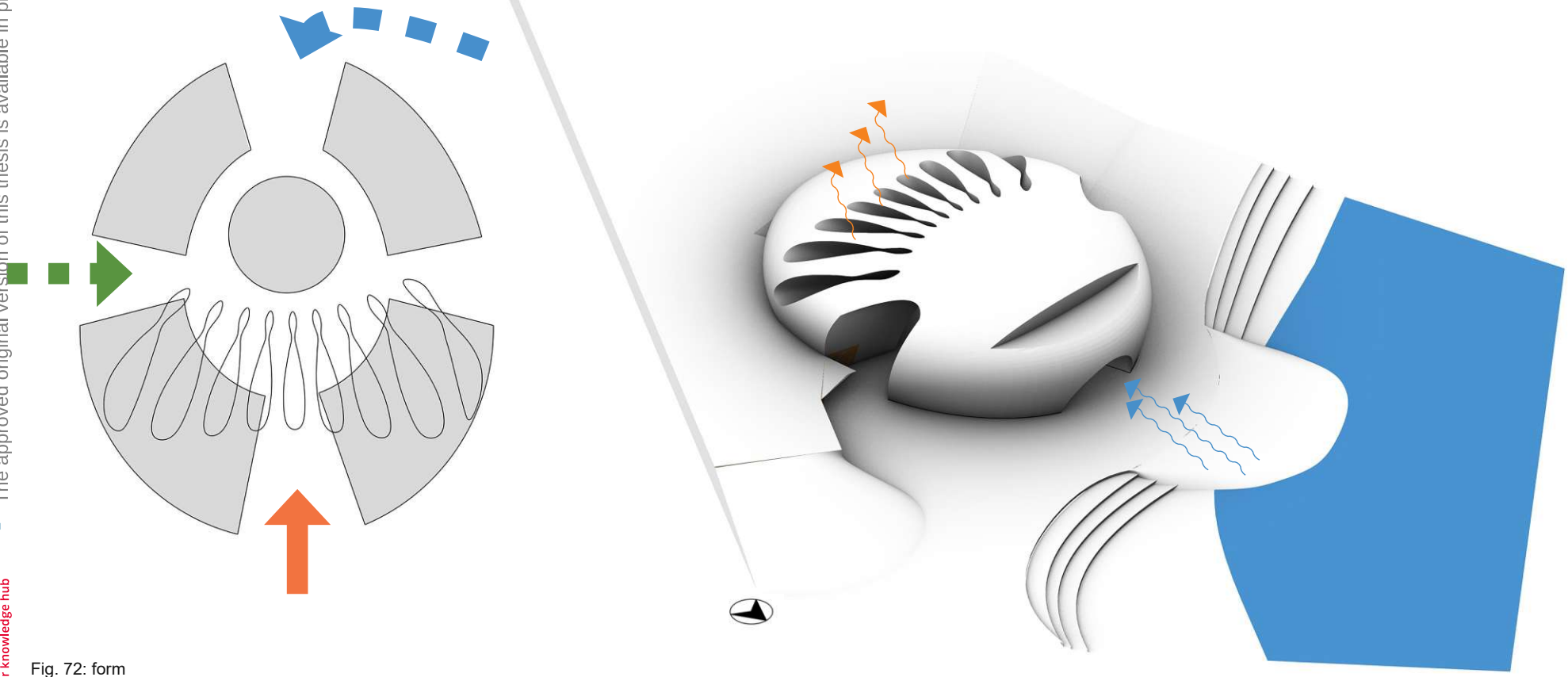
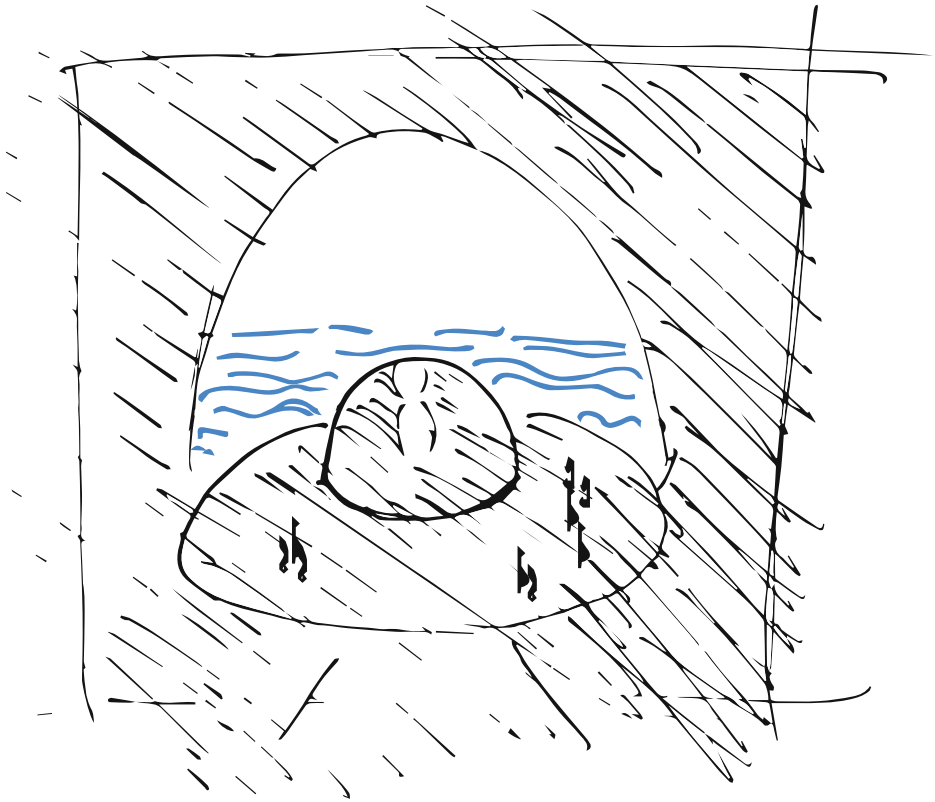


Fig. 72: form finding step 3, schematic plan

Fig. 73: form finding step 3, ISO



FORM FINDING: INTERIOR

a dark void opening to the waves

Fig. 74: form finding, interior, concept ilustration

Fig. 75: form finding, interior visualization

PROGRAM

MUSEUM
FRONT OF HOUSE 4662 m²

Temporary Galleries	600 m²
Permenant Galleries	2860 m²
Entrance Hall (including orientation space)	520 m²
Information Centre/Reception/Ticketing/ Foyer	200 m²
Cloakrooms	40 m²
WC	58 m²

Target Group : Local Residents
University Students
School Trips
Dommestic Tourist

BACK OF HOUSE 1811 m²

Office space	230 m²
Copy/Resource Room	10 m²
Coffee/Staff Room	25 m²
Staff WC	20 m²
Lunch Room	25 m²
Staff and service entrance	30 m²
Security	25 m²
Loading Bay	140 m²
Delivery, packing, crate storage	150 m²
Preparation	300 m²
Storage	300 m²
Archival storage	200 m²
Technical	200 m²
Furniture storage	33 m²
Cleaner's room(s)	25 m²
Refuse room and recycling room	50 m²
IT Room	30 m²
Nurse	18 m²

EDUCATION CENTER 1724 m²

Planetarium	150 m²
Flexible Space	500 m²
Workshops	180 m²
Library	800 m²
Furniture storage	94 m²
Foyer	70 m²
WC	32 m²

Target Group : Local Residents
University Students
School Trips

COMMERCIAL 660m²

Restaurant	525 m²
Kitchen	70 m²
Kitchen storage	45 m²
WC	20 m²

Target Group : Local Residents
University Students

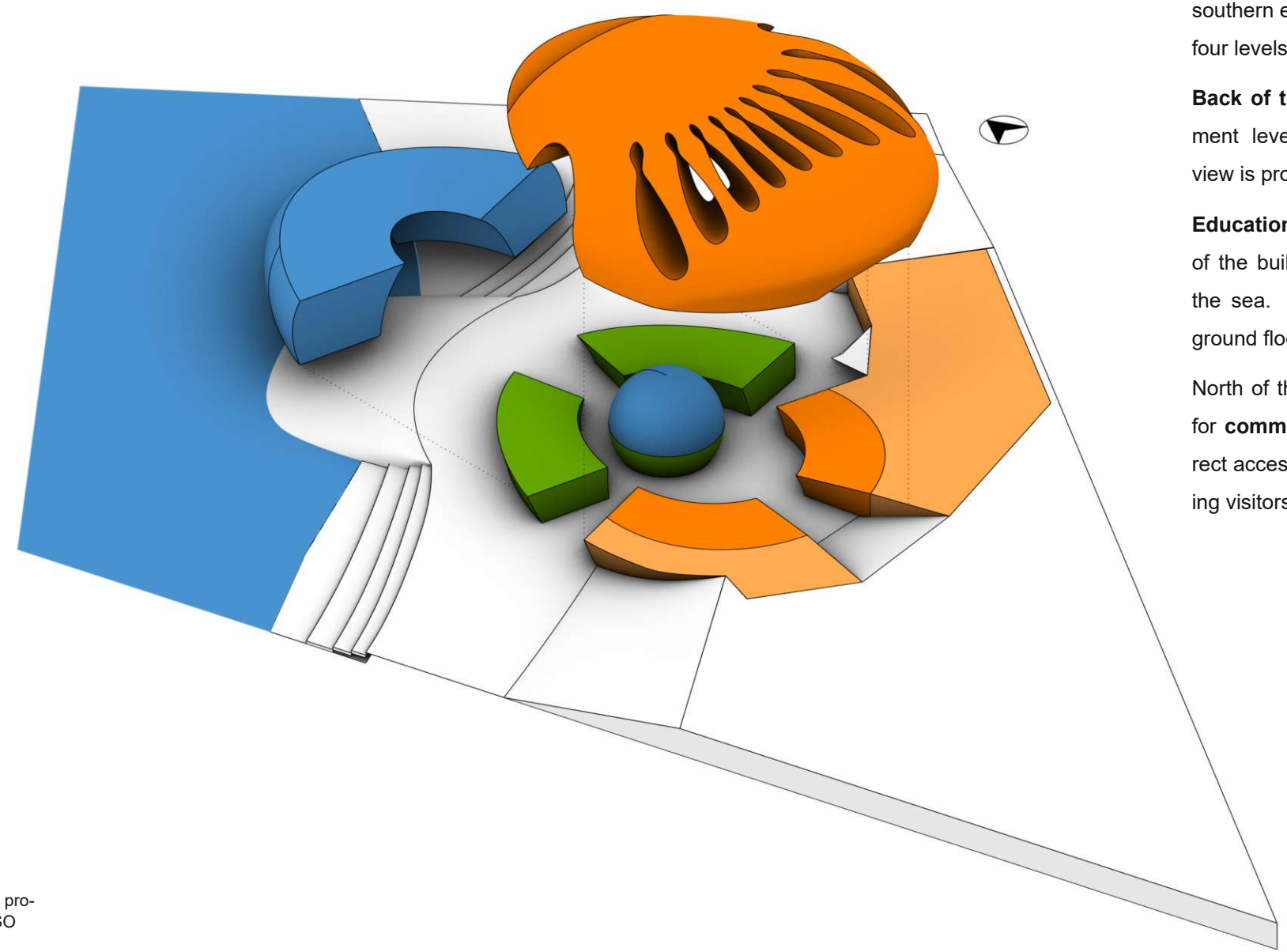


Fig. 78: program ISO

Museum occupies the dark side at the southern end of the building and it spans four levels.

Back of the House is located at basement level. For office spaces outside view is provided.

Education Center is located at the north of the building with direct view towards the sea. It can be accessed from the ground floor.

North of the basement floor is allocated for **commercial** use, benefiting from direct access to the shore, thereby attracting visitors.

VERTICAL CIRCULATION

The vertical circulation within the building is facilitated by staircases located inside the first two and last two cutouts.

The northern two staircases are open-air, effectively dividing the building in half and extending the courtyard to the upper levels. They both accommodate two pair of staircases. These open-air stairs provide access to all the different functions of the building through side entrances and they also function as escape routes.

The southern two staircases, which are covered, are exclusively dedicated to the museum. The museum spans four levels, and all of the museum galleries can be accessed internally without having to leave the museum, ensuring a seamless visitor experience.

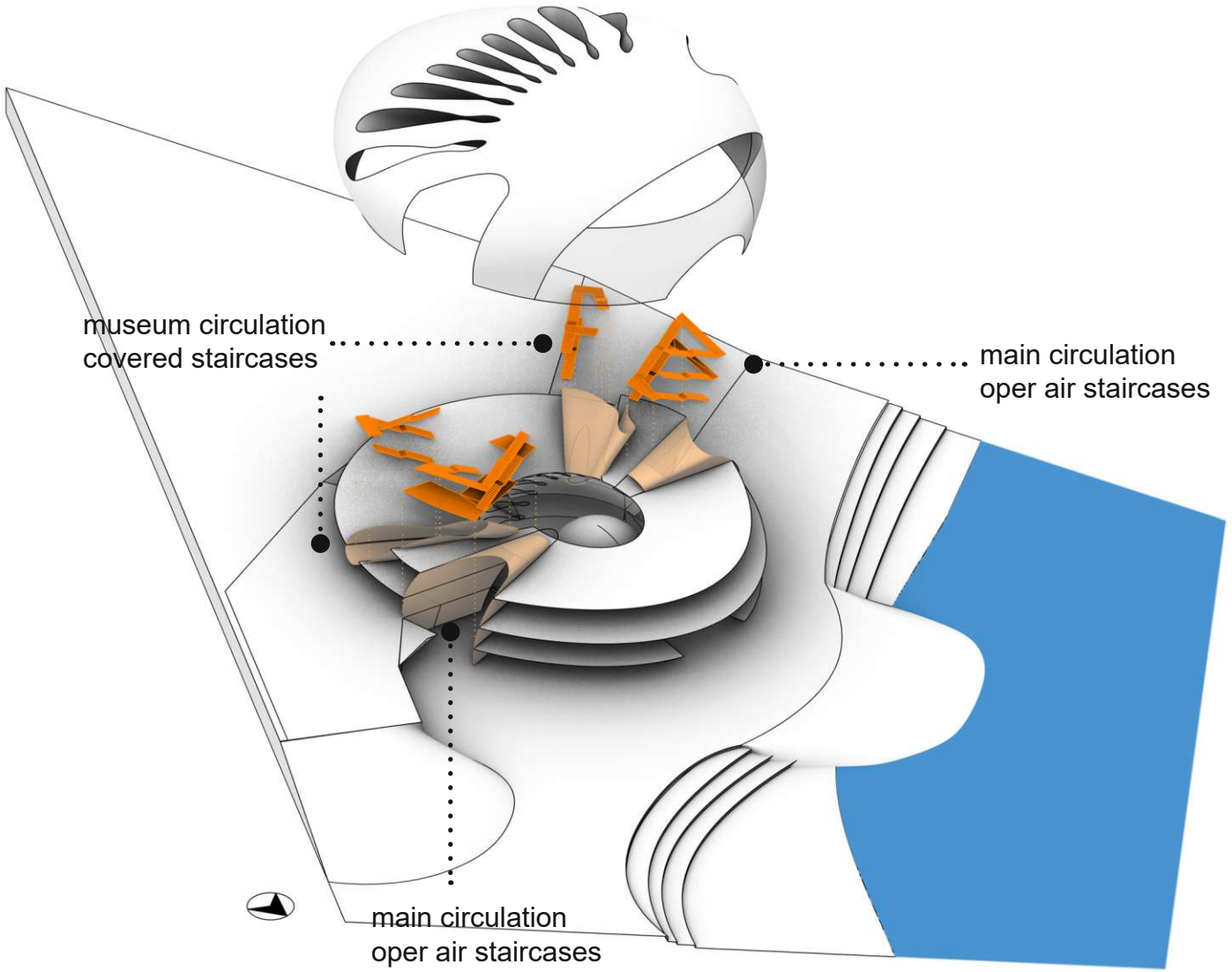


Fig. 79: vertical circulation, ISO NE

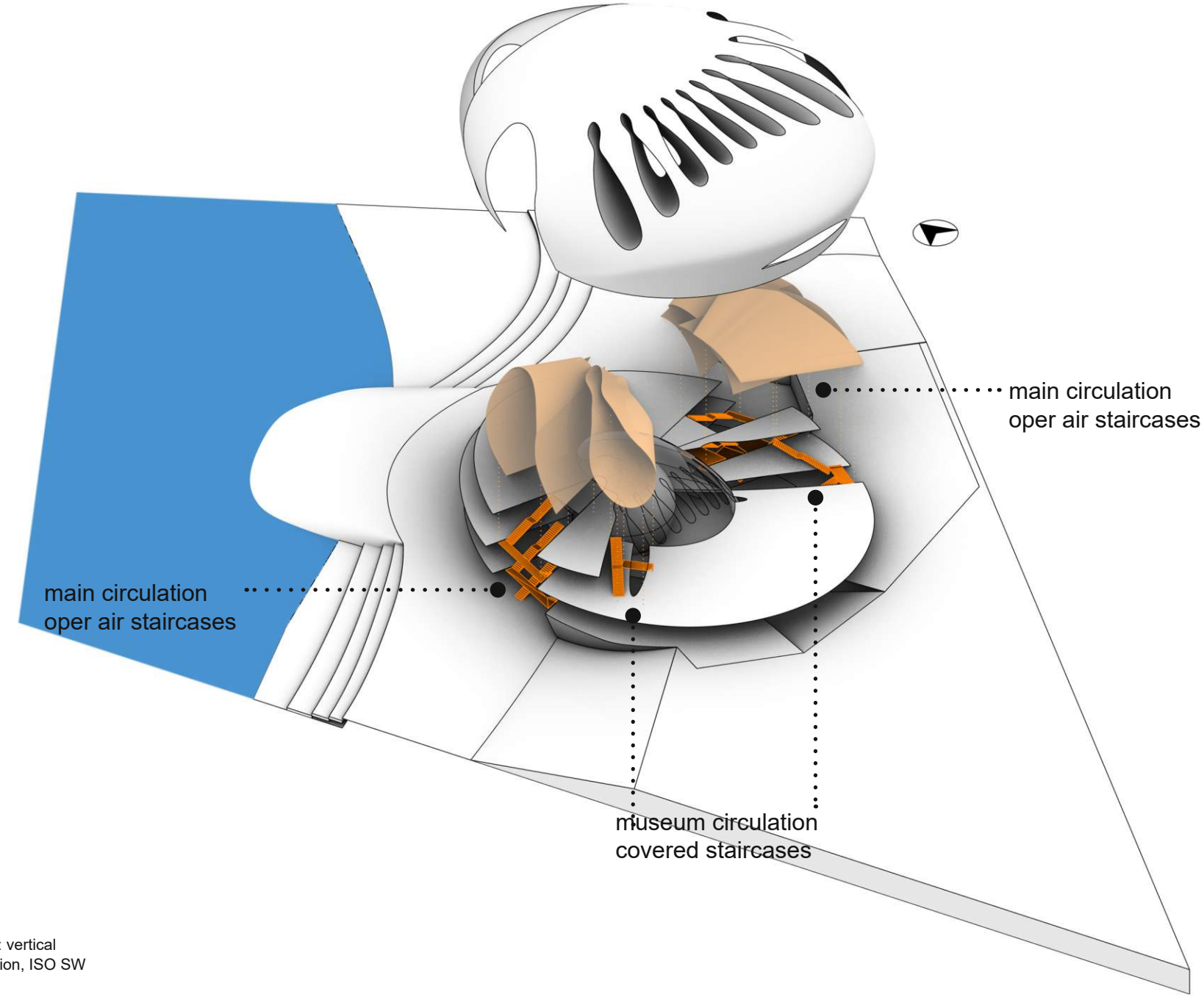


Fig. 80: vertical circulation, ISO SW

MUSEUM CIRCULATION

The gallery route within the museum is designed as a circular path. It begins at the basement level, allowing visitors to explore the exhibits as they move upward through all four levels. After passing through each level, the route ultimately returns to the basement, providing a continuous route without the need of backtracking.

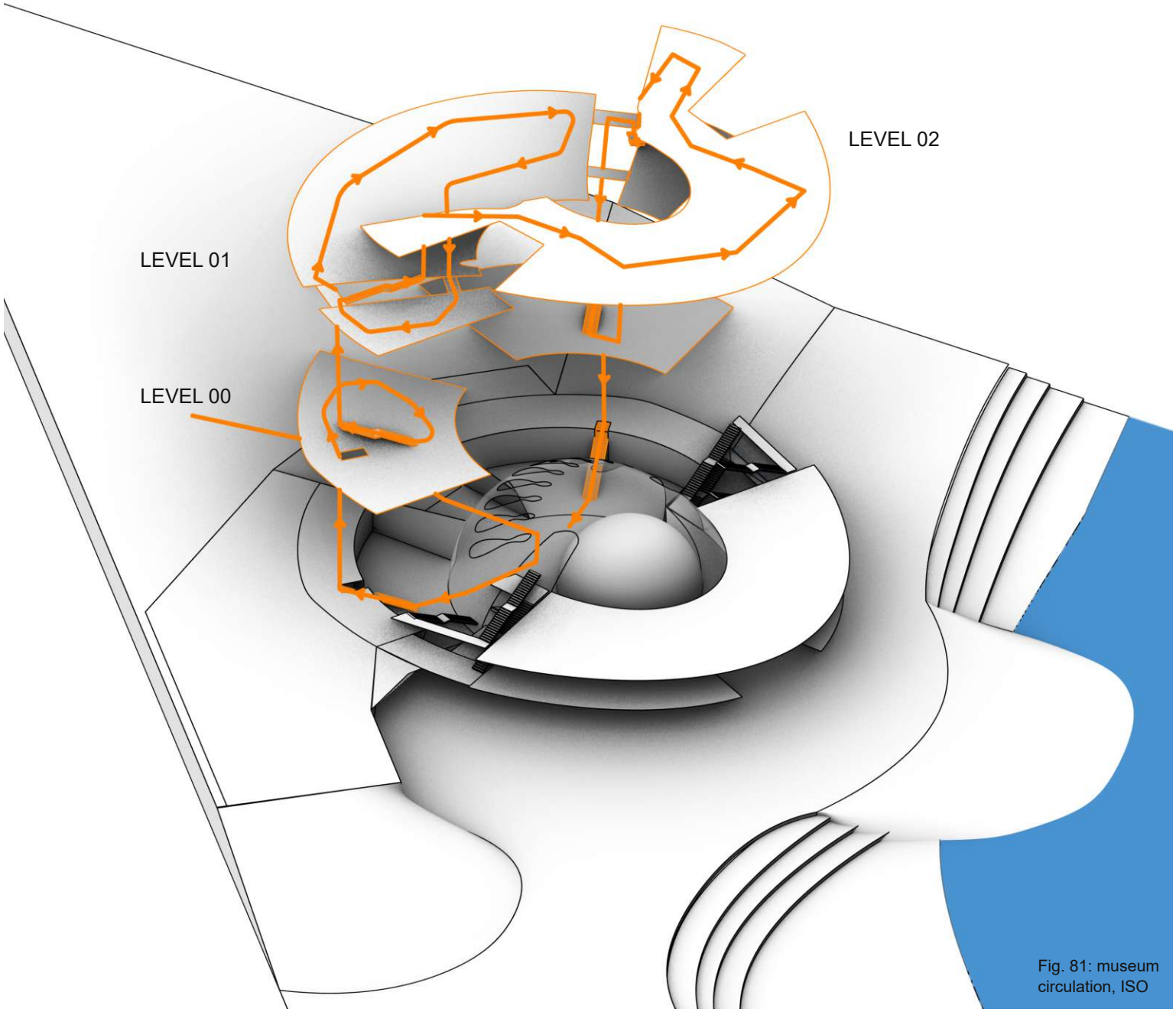


Fig. 81: museum circulation, ISO

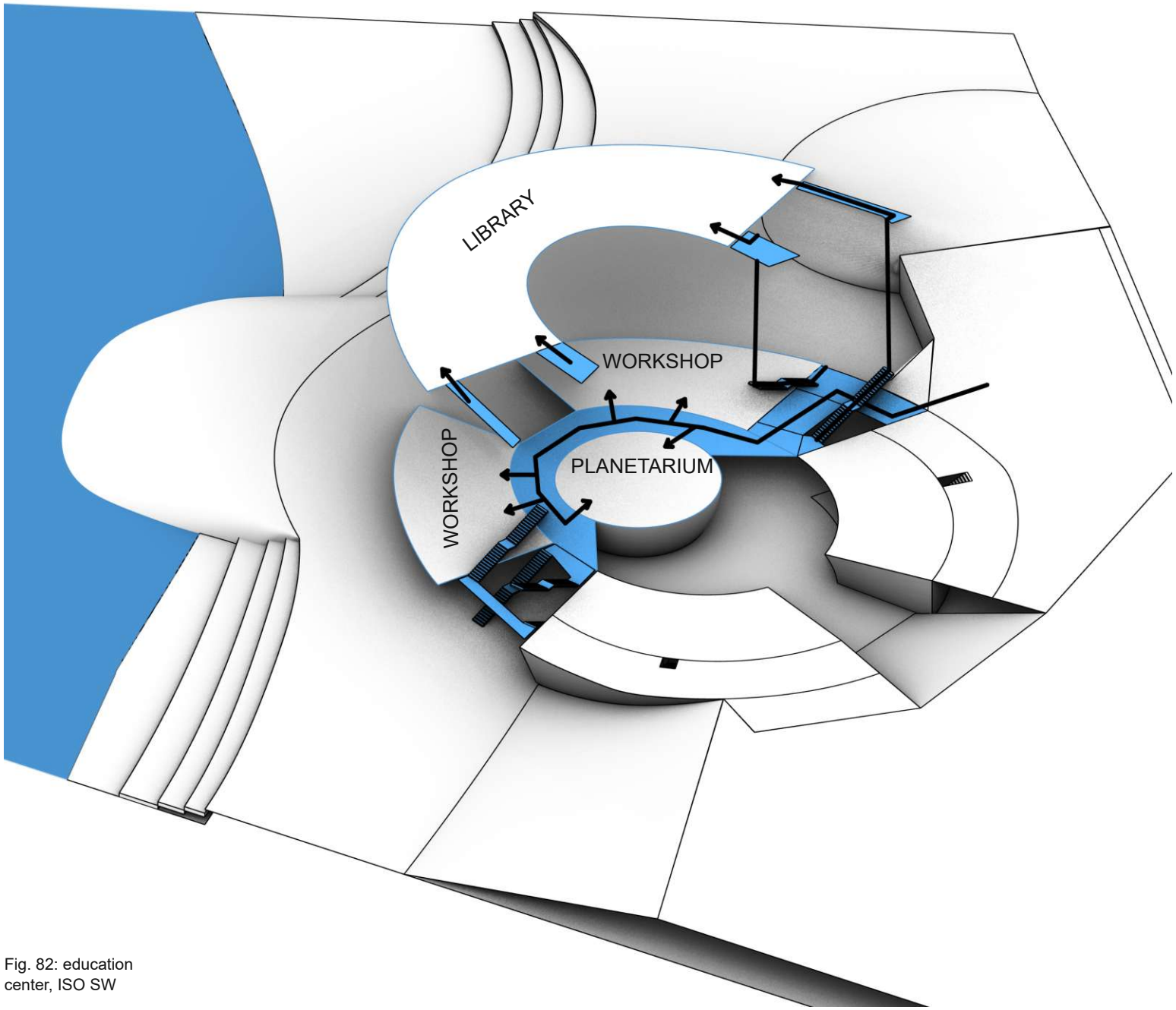


Fig. 82: education center, ISO SW

EDUCATION CENTER CIRCULATION

The education center consists of two levels. On the ground floor, there are a planetarium and flexible workshop spaces. The first floor houses a library. Each of these spaces is designed to function independently form each other and can be accessed separately, providing versatile usage for various educational activities and visitors.

4.4 CONSTRUCTION DEVELOPMENT

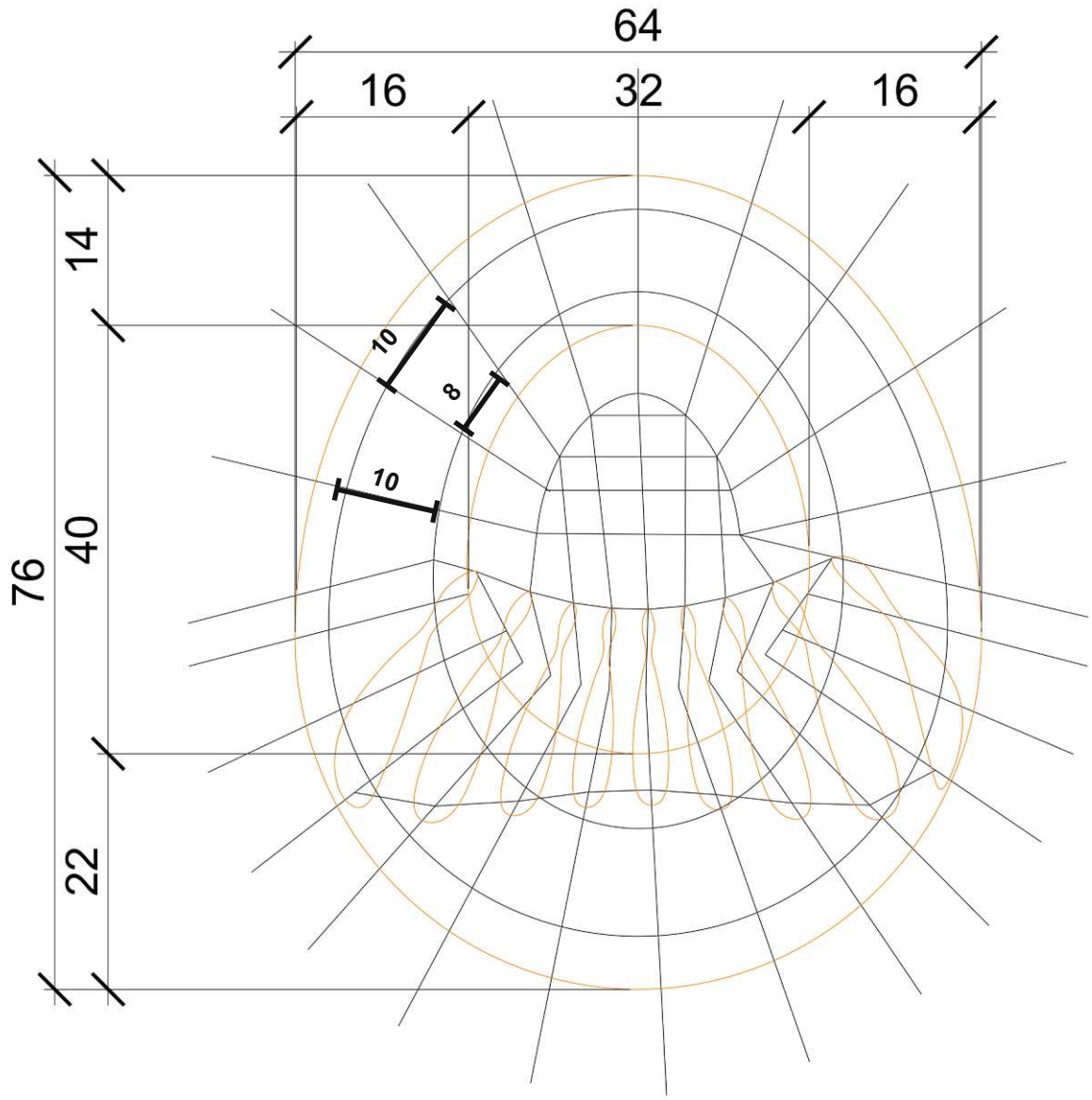


Fig. 83: structural grid

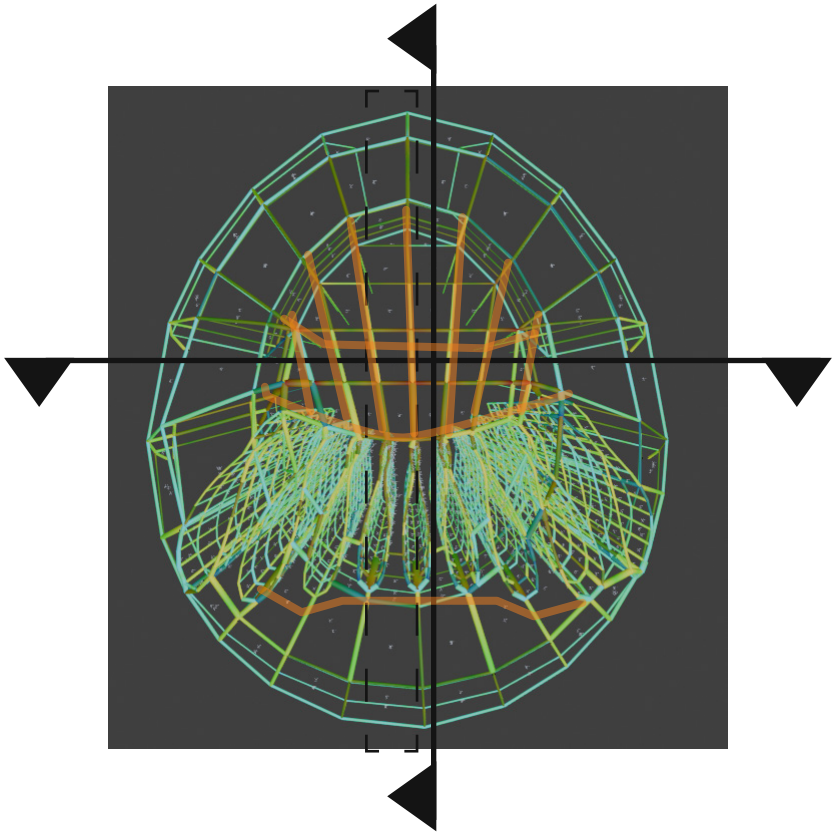
GRID

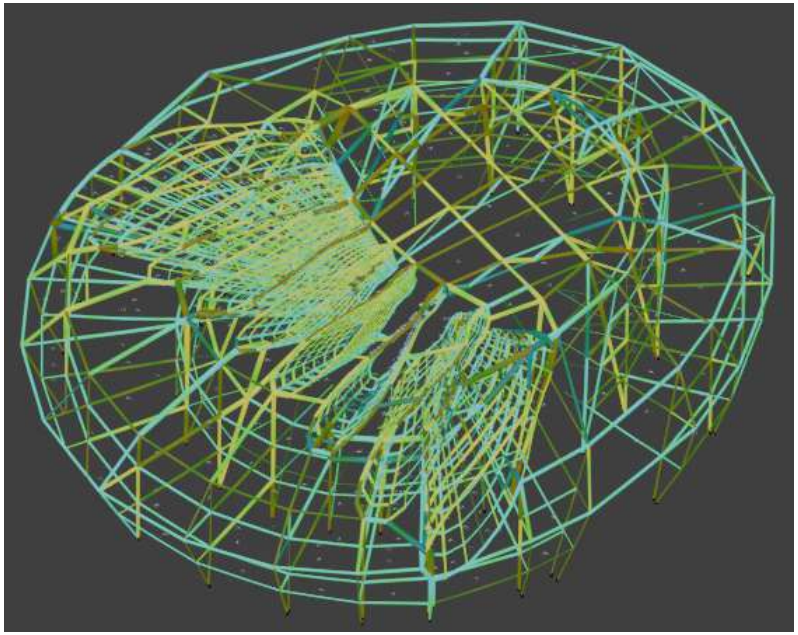
The main challenge was to set the grid to accommodate the suncuouts without having any beams crossing through them.

The grid is regular and concentric on the north side of the building. The distance between the concentric axis vary between 8-10 m.

On the south side, the grid lines become irregular, falling exactly underneath the holes to provide extra support for them.

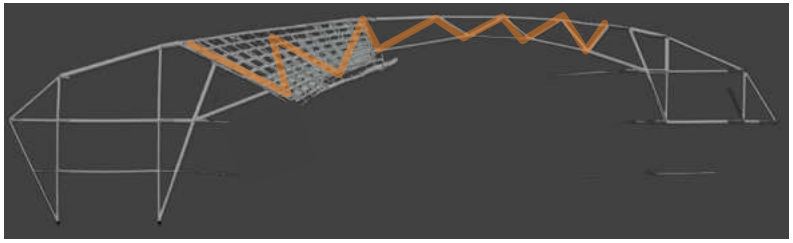
ROOF CONSTRUCTION Phänotyp Examination
VERSION 1 : THRUSS SYSTEM



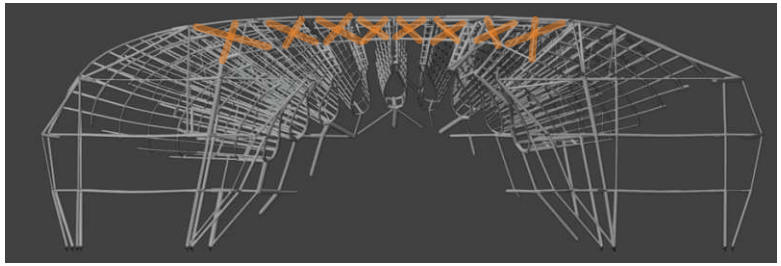


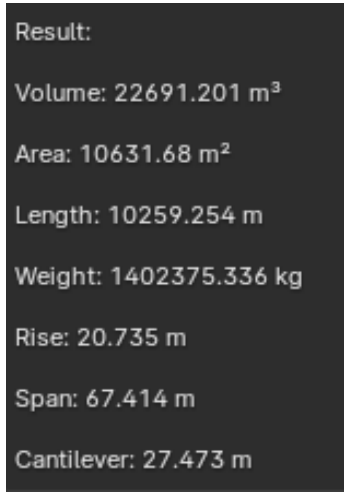
Middle part of the dome is connected via trusses.

Fig. 84: roof construction Phänoty examination visuals, version 1



The thruss continues around the sun cutouts, connecting the columns.





ROOF CONSTRUCTION Phänotyp Examination
VERSION 2 : Space Frame

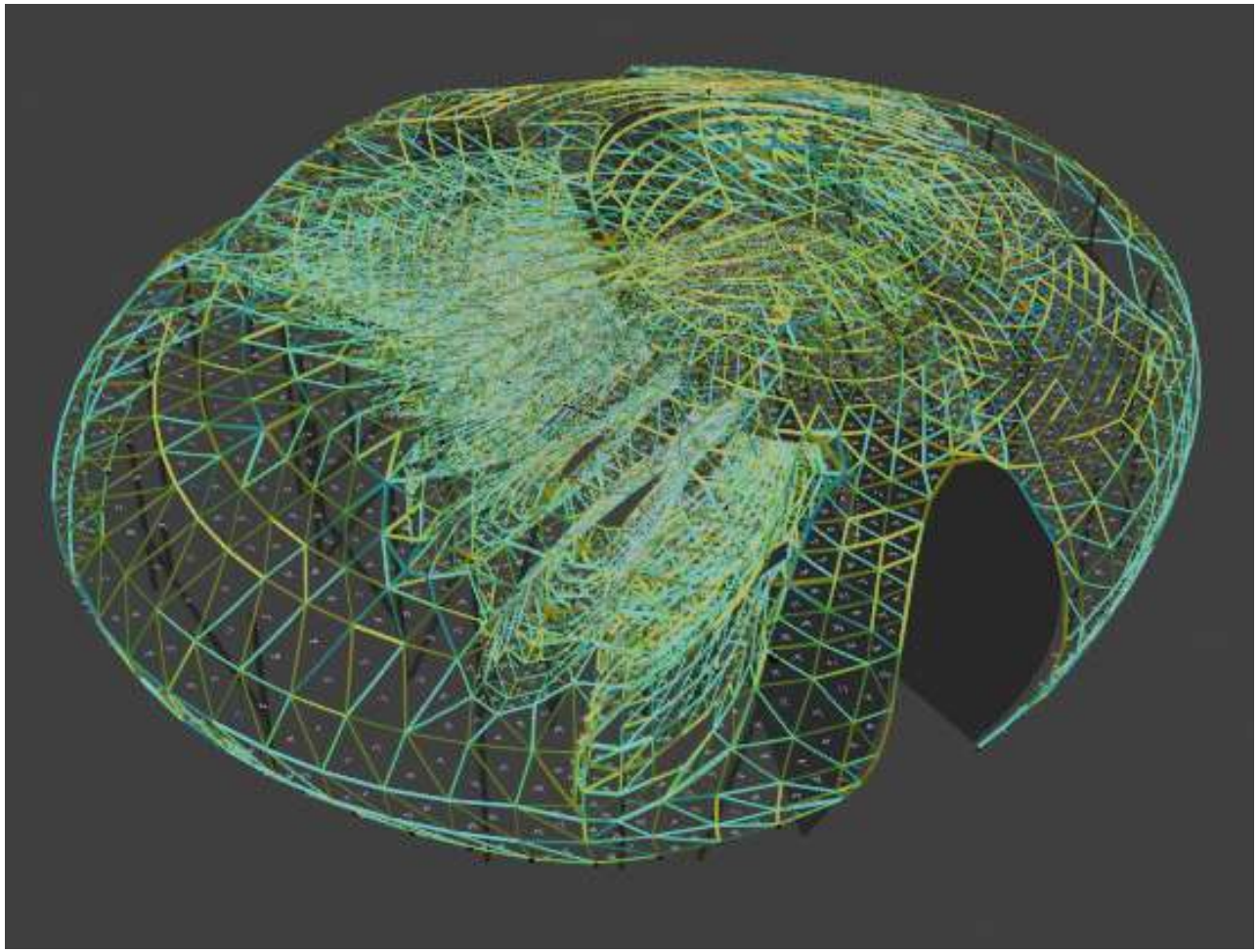


Fig. 85: roof construction Phänoty examination visuals, version 2

Space Frame is selected, because it is lighter overall.

Result:

Volume: 28110.485 m³

Area: 9373.722 m²

Length: 20290.994 m

Weight: 478562.769 kg

Rise: 21.152 m

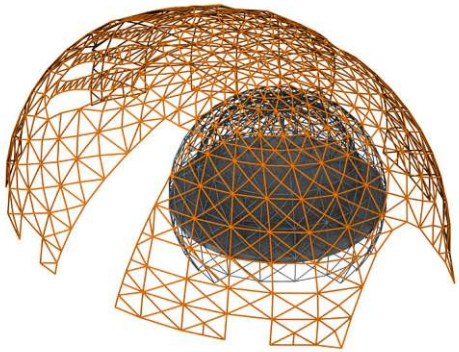
Span: 70.838 m

Cantilever: 17.885 m

Construction Explosion

PLANETARIUM : Singleframe

Fig. 86: Planetarium structure, ISO



INTERIOR DOME : Singleframe

Fig. 87: Interior dome structure, ISO

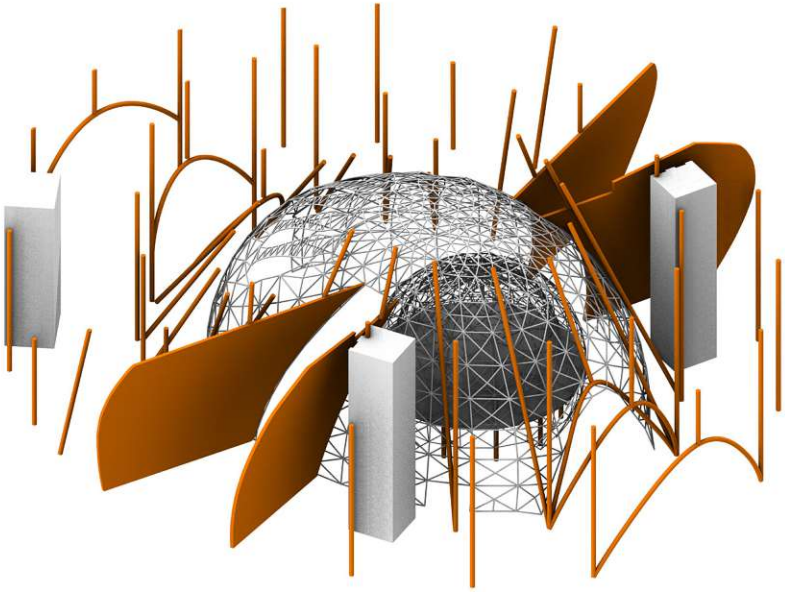
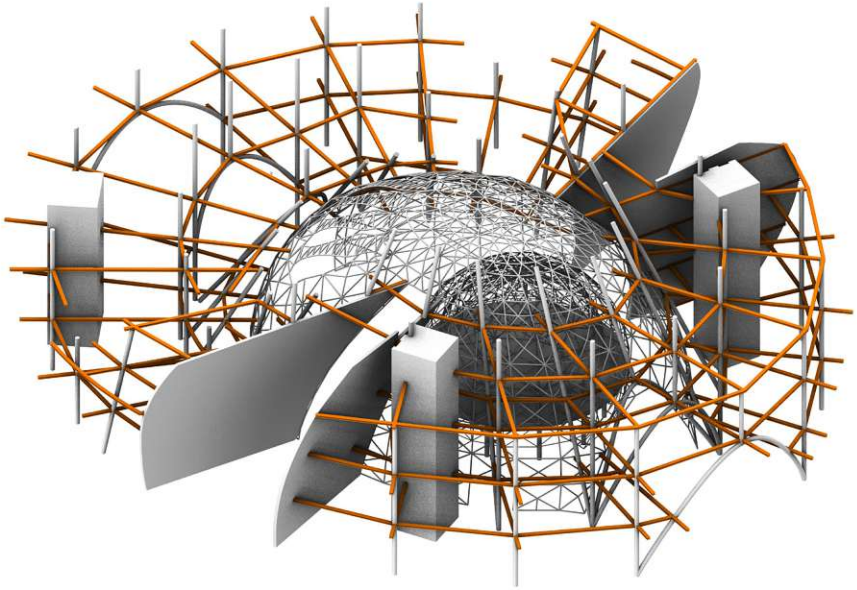


Fig. 89: geometrica single frame

VERTICAL ELEMENTS

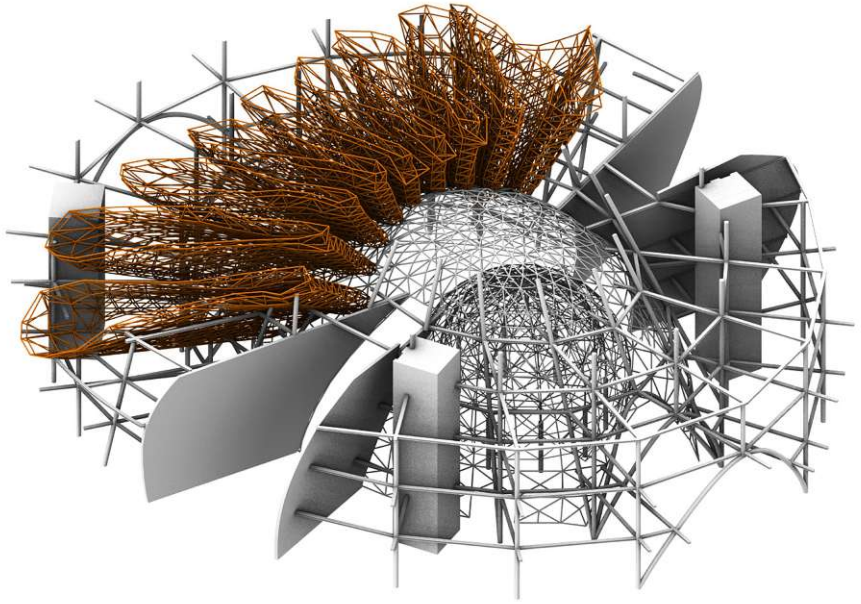
Columns - composite

Fig. 88: vertical elments, ISO



BEAMS: I-profile beams

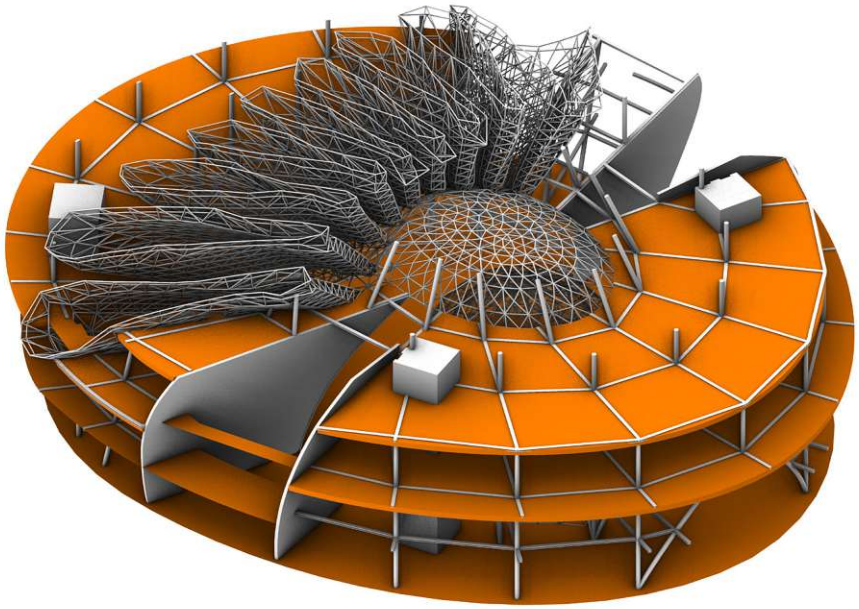
Fig. 90: beams, ISO



SUN SAILS - Space frame

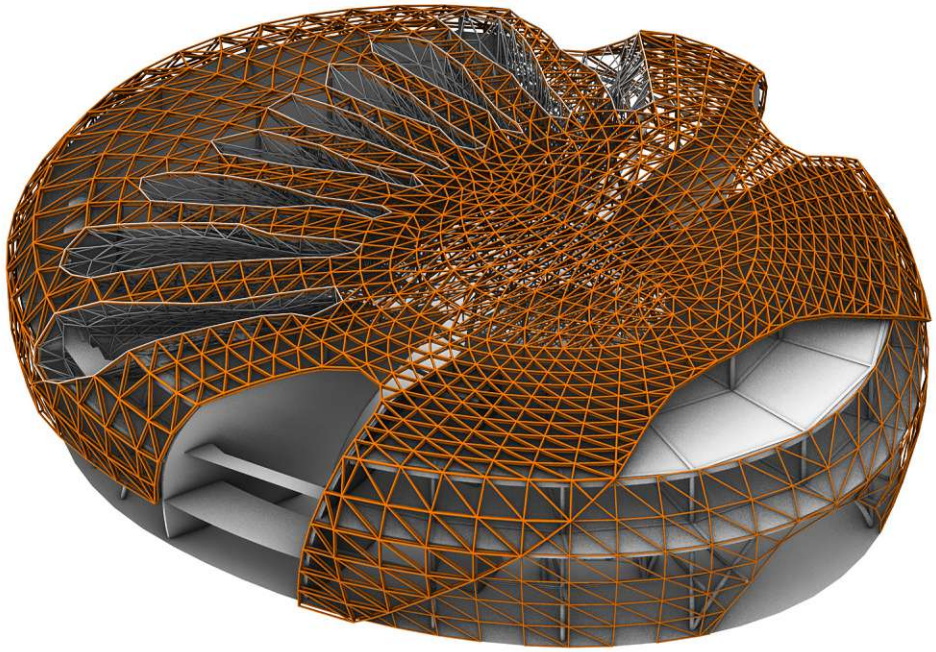
Fig. 91: sun-cutouts structure, ISO

Fig. 92: space-frame geometrica,



FLOOR SLABS - reinforced concrete

Fig. 93: floor slabs, ISO



FACADE: SPACE FRAME

Fig. 94: facade structure, ISO

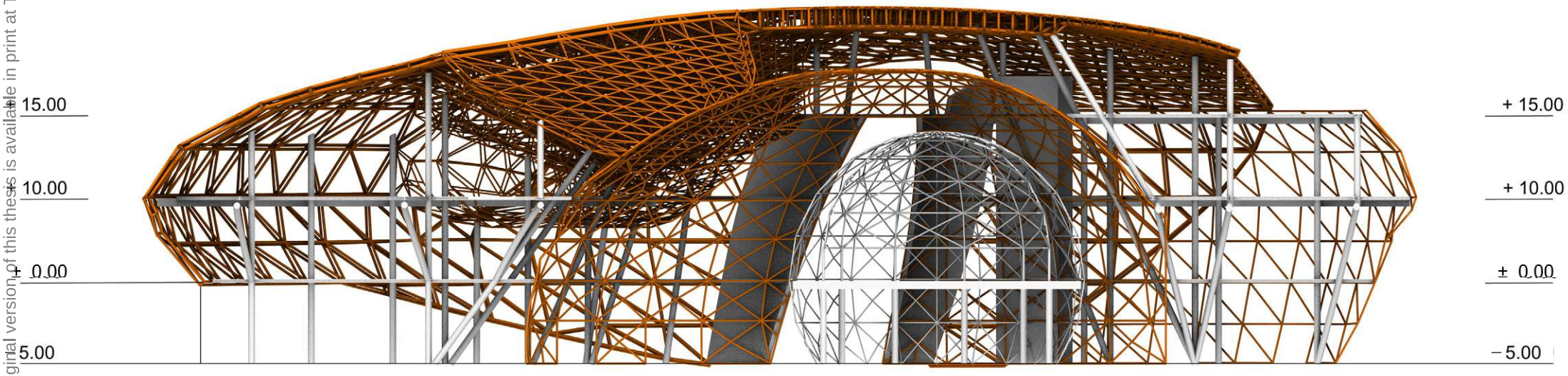
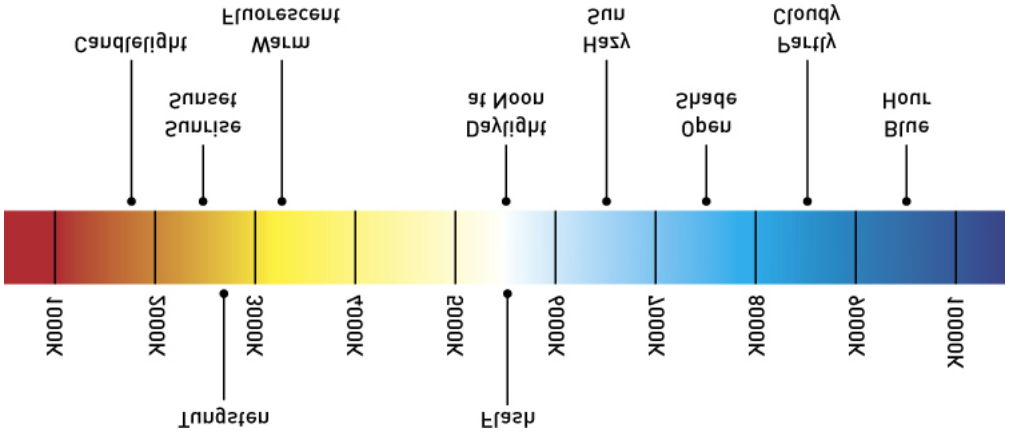


Fig. 95: Structural elevation

4.5 MATERIAL CONCEPT



Color temperature describes a spectrum of light frequency, which determines the warmth of a light source on the scale. The unit of measurement for color temperature is “Kelvin”.

To represent the hours of the sun, cut outs will be in different colors. The colors are chosen from the Kelvin Scala. Starting from the 8 clock sun cutout, first color is red. The midday is represented by white. The last cutout is navy blue like the afternoon sky. The panels will be ALUCOBOND, a composite sandwich material, which consists of two outer aluminium panels with a isolation material inbetween and offers a variety of color options.

Fig. 96: Kelvin Scala

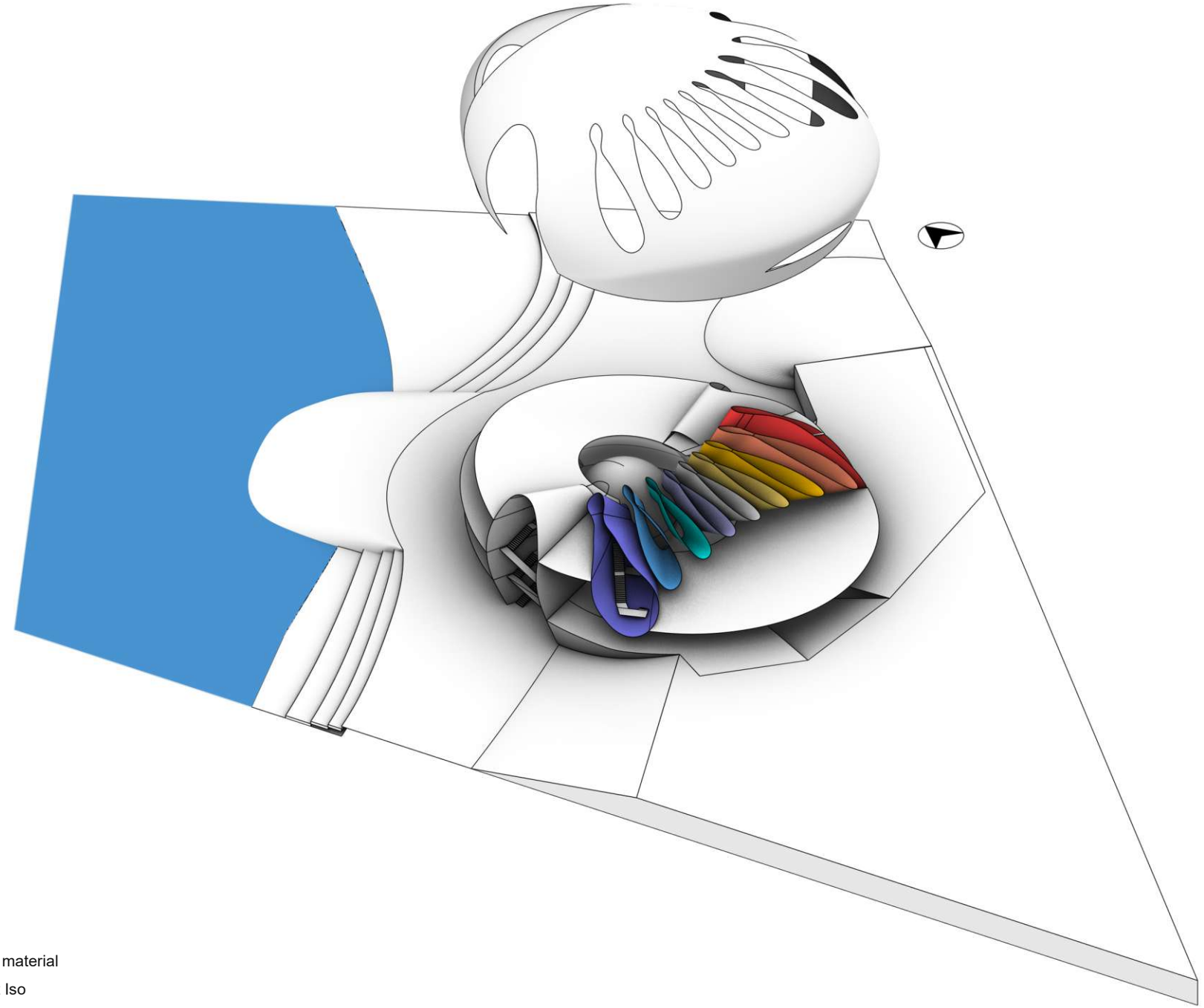


Fig. 97: material concept Iso

5. RESULTS

5.1 FIGURE-GROUND DIAGRAM

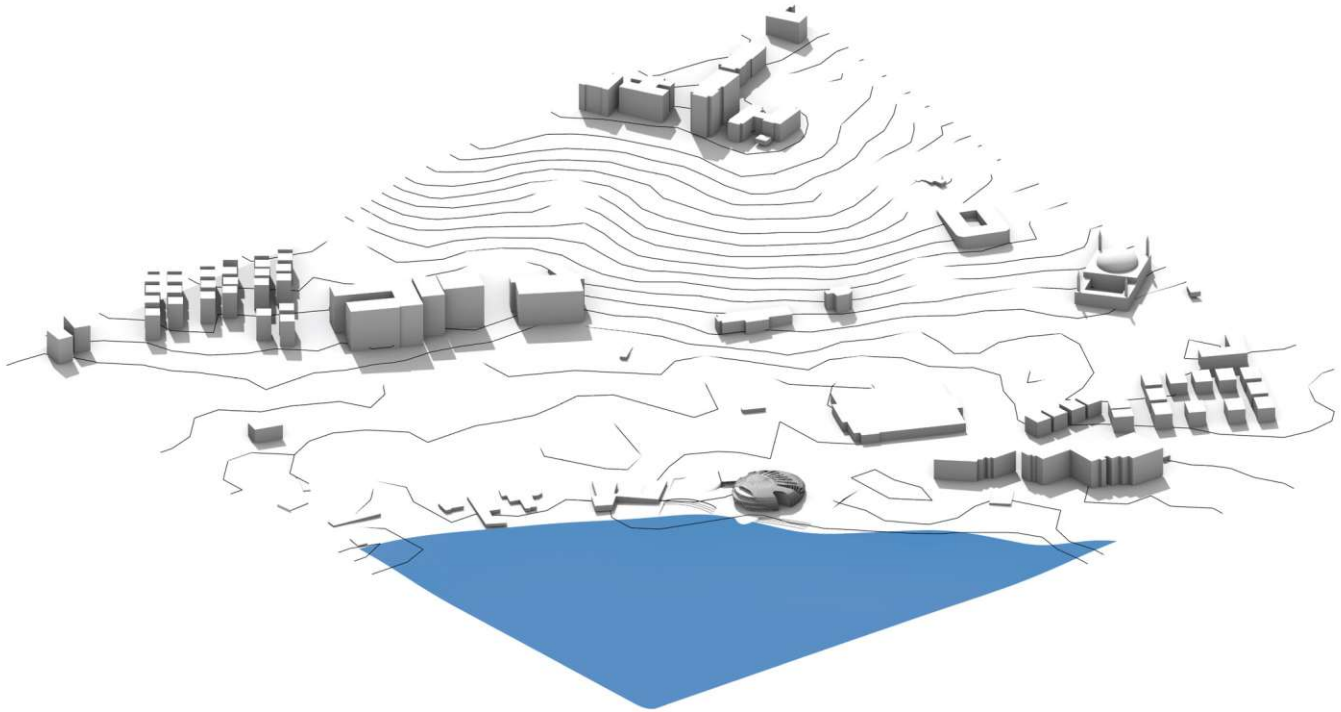
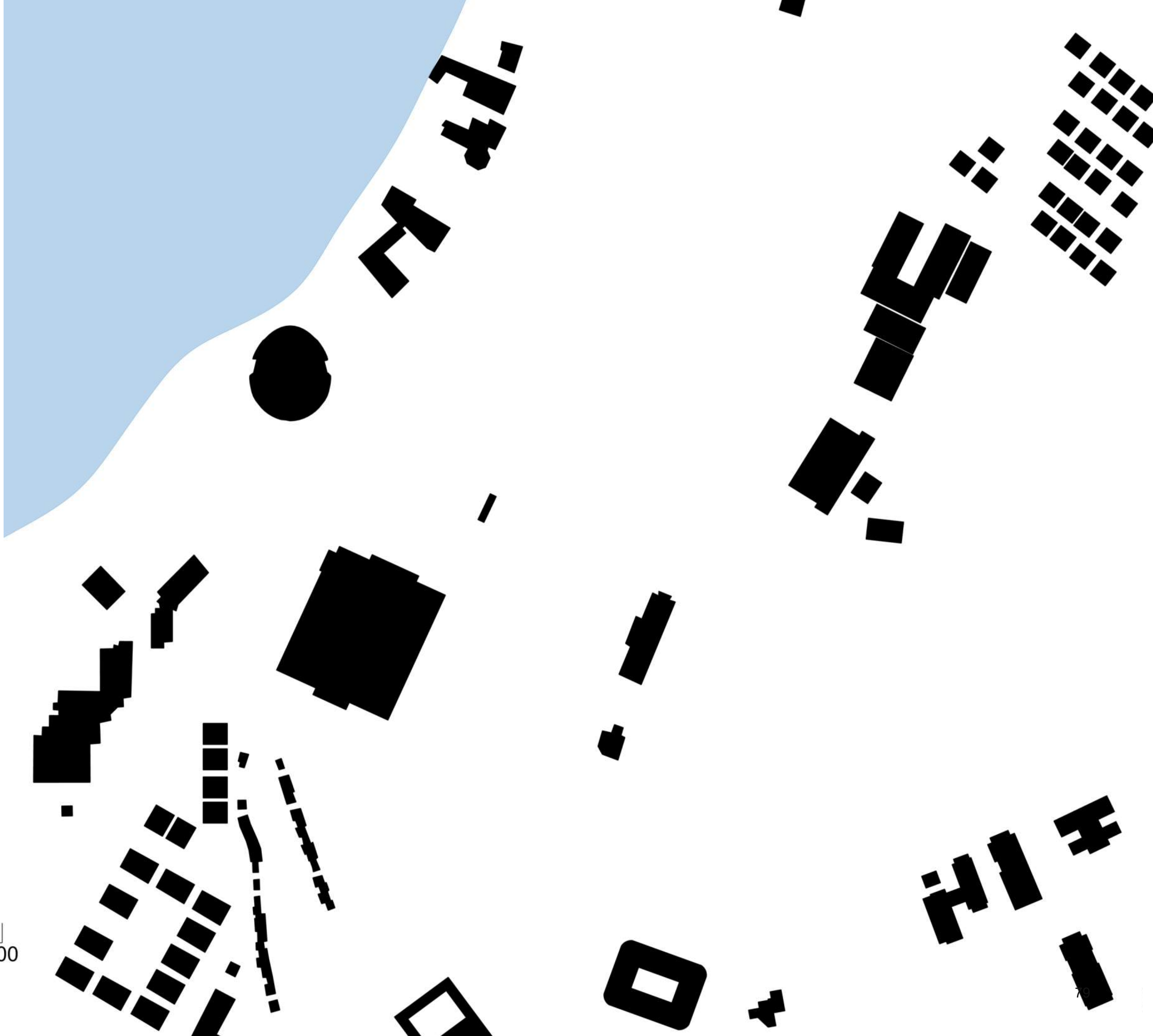
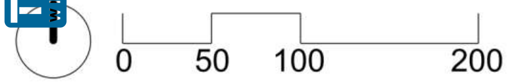


Fig. 98: topography ISO

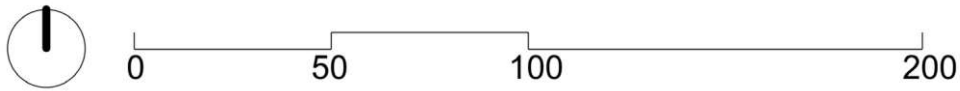


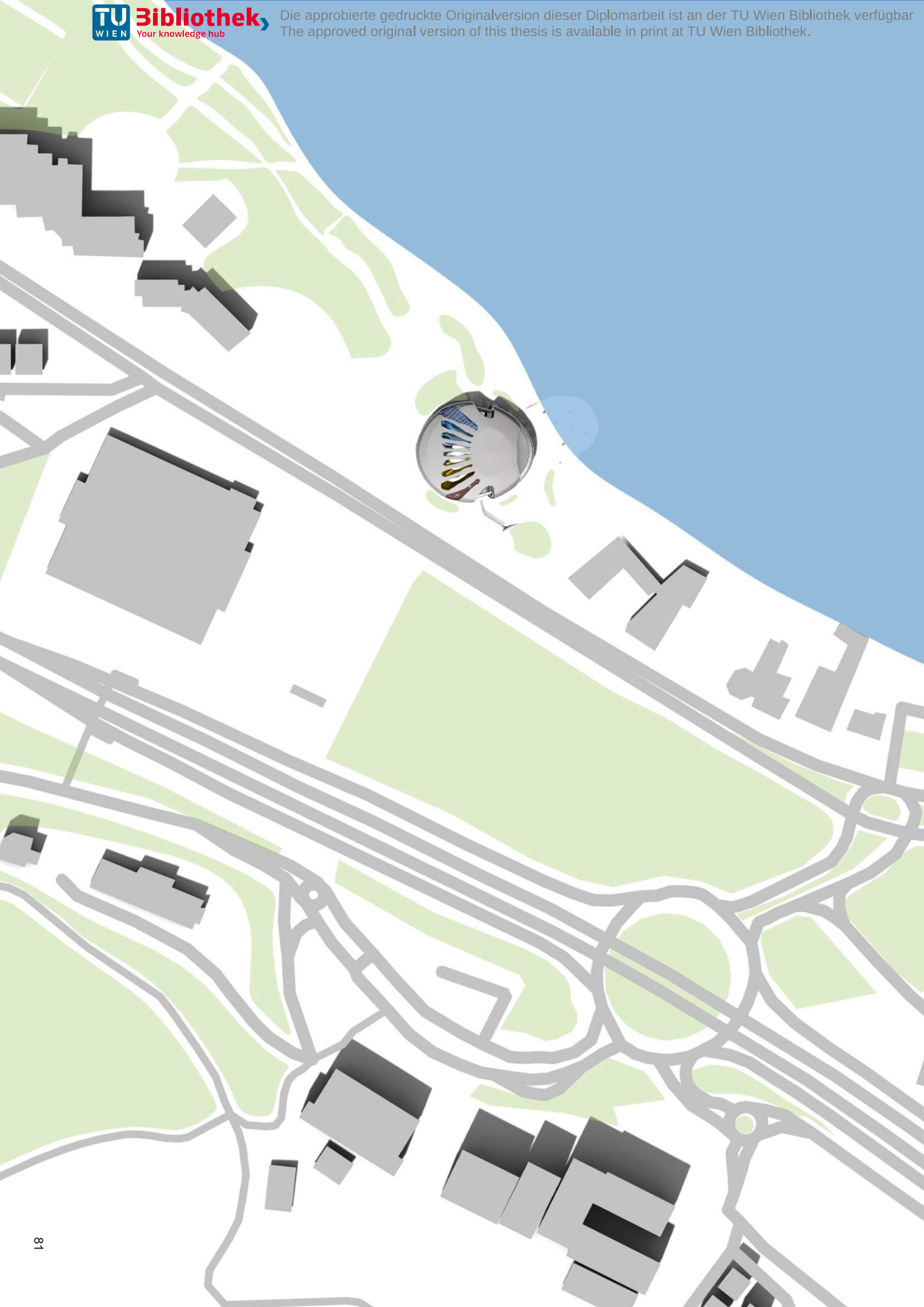
Plan 1: ground figure plan



5.1 SITE PLAN

Plan 2: site plan

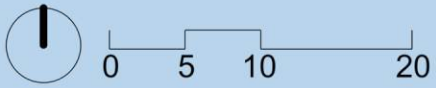




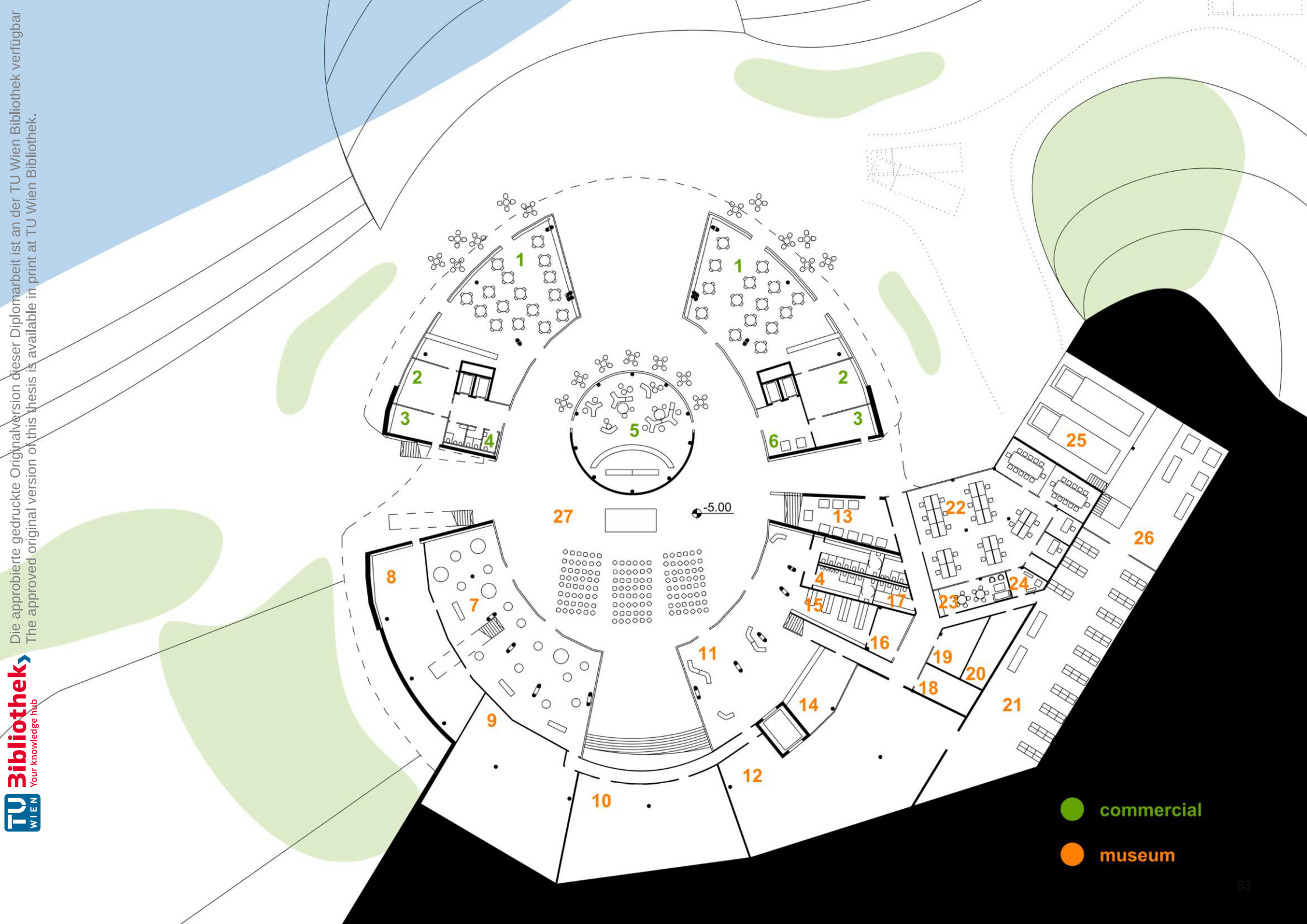
5.2 FLOOR PLANS

LEVEL -1

1	restaurant	377 m²
2	kitchen	67 m²
3	kitchen storage	45 m²
4	restrooms	65 m²
5	cafe	147 m²
6	automats	15 m²
7	shops	260 m²
8	shop storage	134 m²
9	technical	258 m²
10	archive	200 m²
11	museum foyer	200 m²
12	preparation	314 m²
13	refuse and recycling	49 m²
14	ticket office	44 m²
15	wardrobes	37 m²
16	nurse	18 m²
17	staff restrooms	18 m²
18	cleaners room	23 m²
19	security	25 m²
20	IT	30 m²
21	main storage	304 m²
22	office space	227 m²
23	break room	25 m²
24	copy room	10 m²
25	delivery	137 m²
26	crating	150 m²
27	central plaza	818 m²

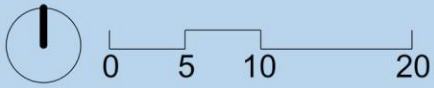


Plan 3: level -1 plan

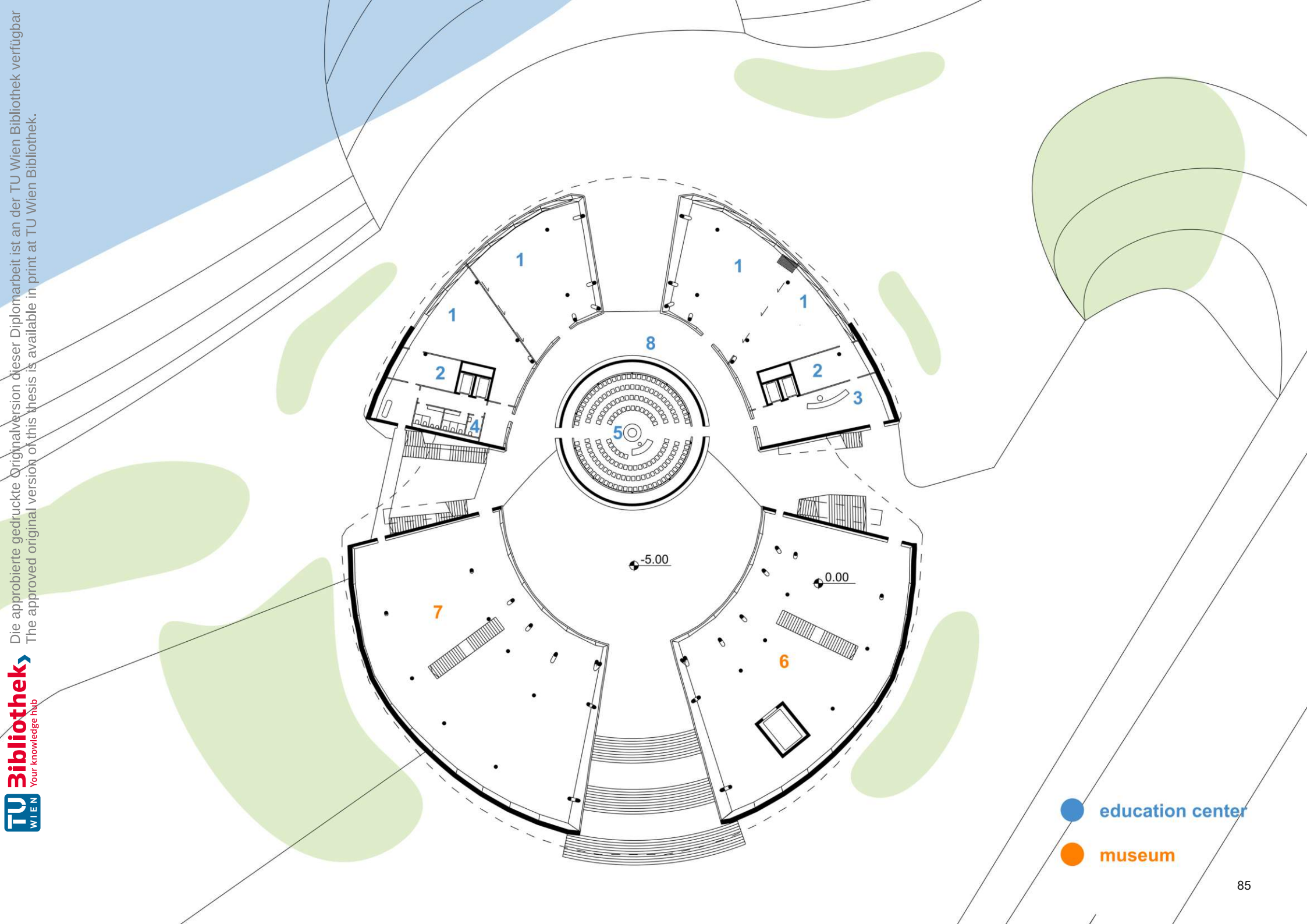


GROUND LEVEL

1	flexible workshop space	490 m²
2	furniture storage	24 m²
3	education center foyer	75 m²
4	restrooms	11 m²
5	planetarium	147 m²
6	gallery	510 m²
7	temporary gallery	596 m²
8	projection gallery	220 m²

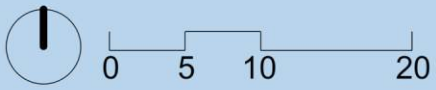


Plan 4: ground level plan

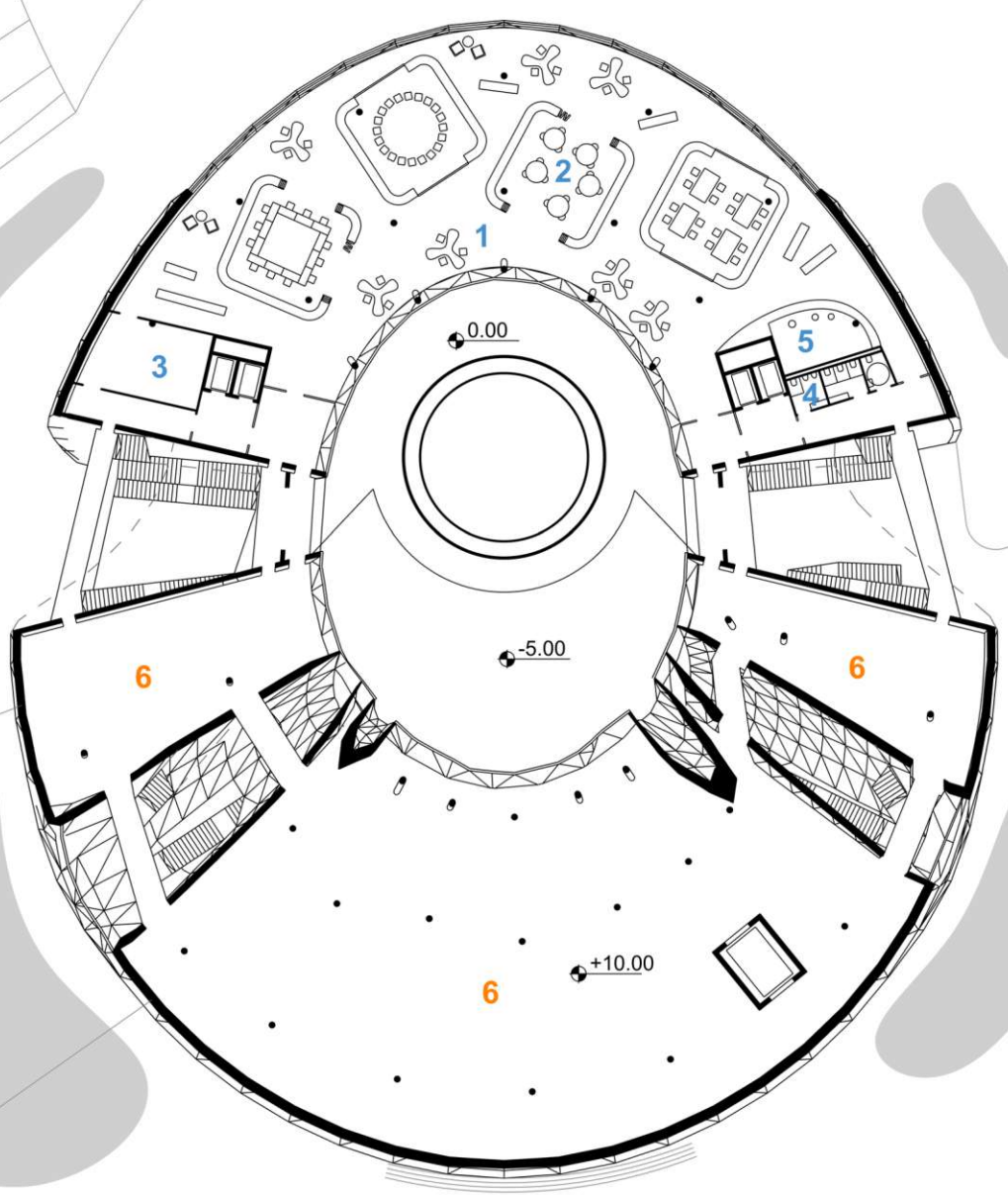


LEVEL 1

1	library	560 m²
2	seminar rooms	180 m²
3	furniture storage	39 m²
4	restrooms	15 m²
5	foyer	29 m²
6	gallery	1433 m²



Plan 5: level 1 plan

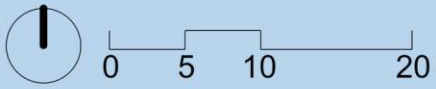


education center

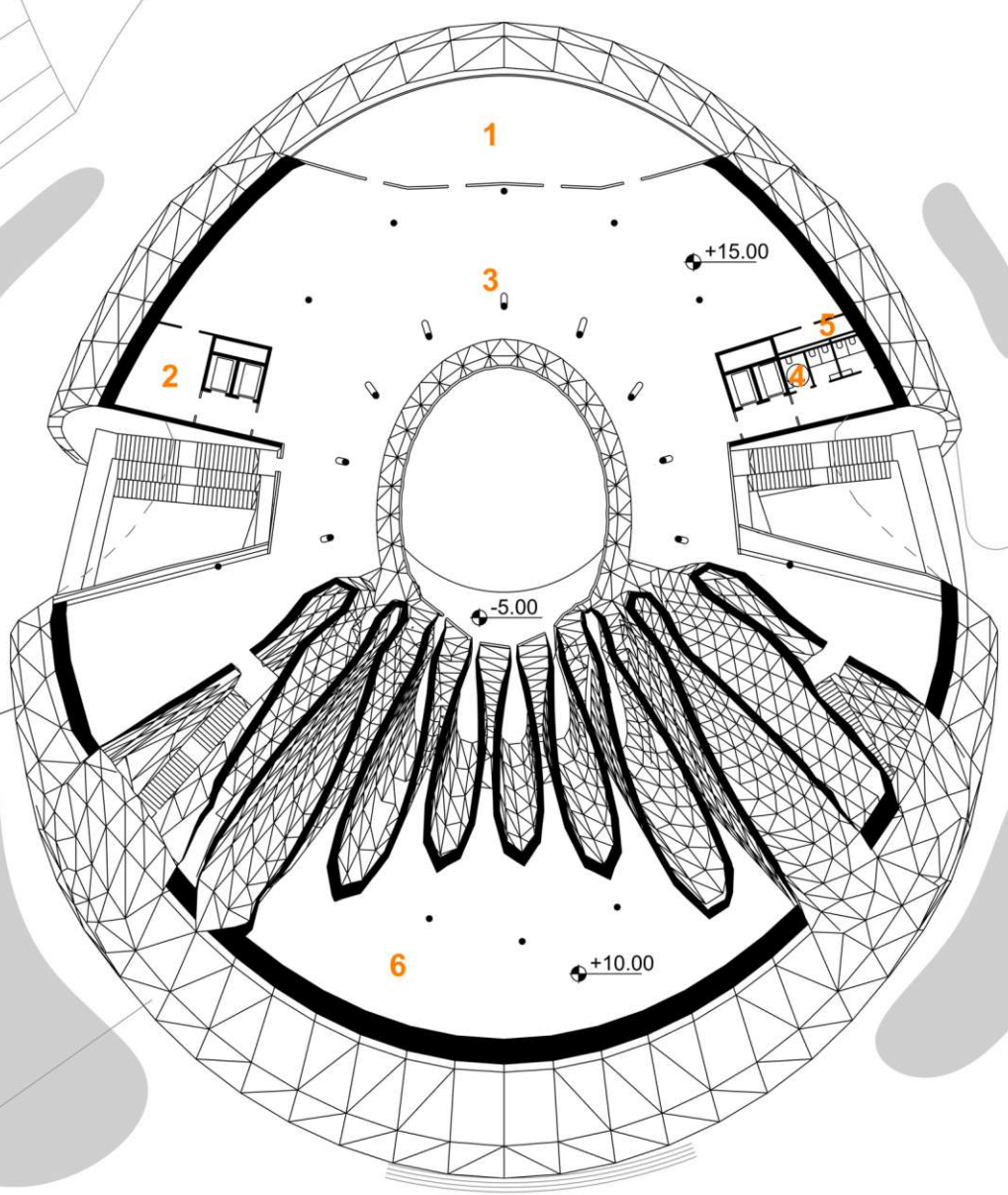
museum

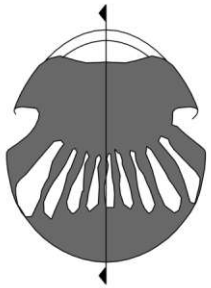
LEVEL 2

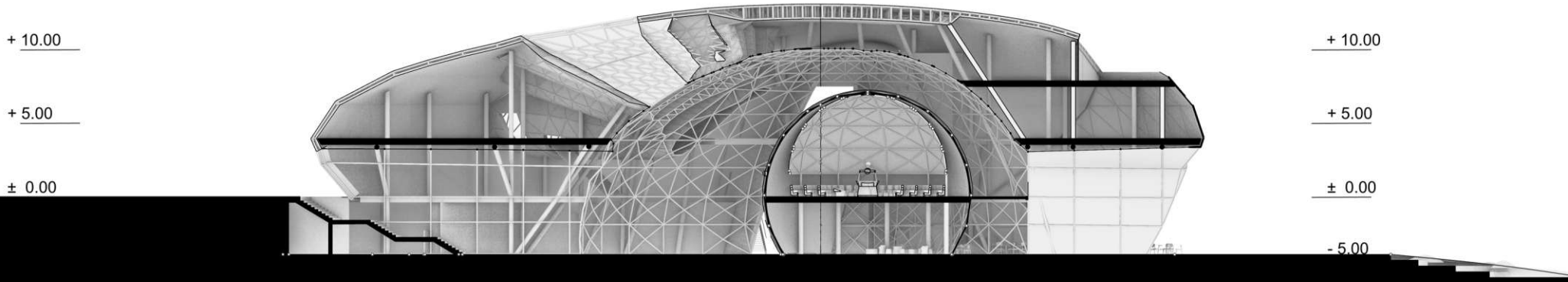
1	terrace	1069 m²
2	furniture storage	27 m²
3	interractive gallery	927 m²
4	restrooms	13 m²
5	storage	6 m²
6	void above gallery	

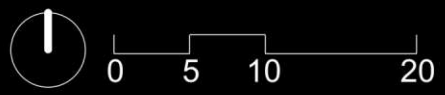


Plan 6: level 2 plan

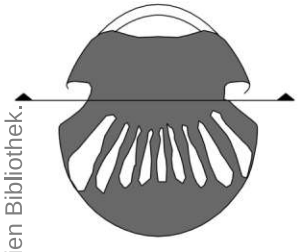


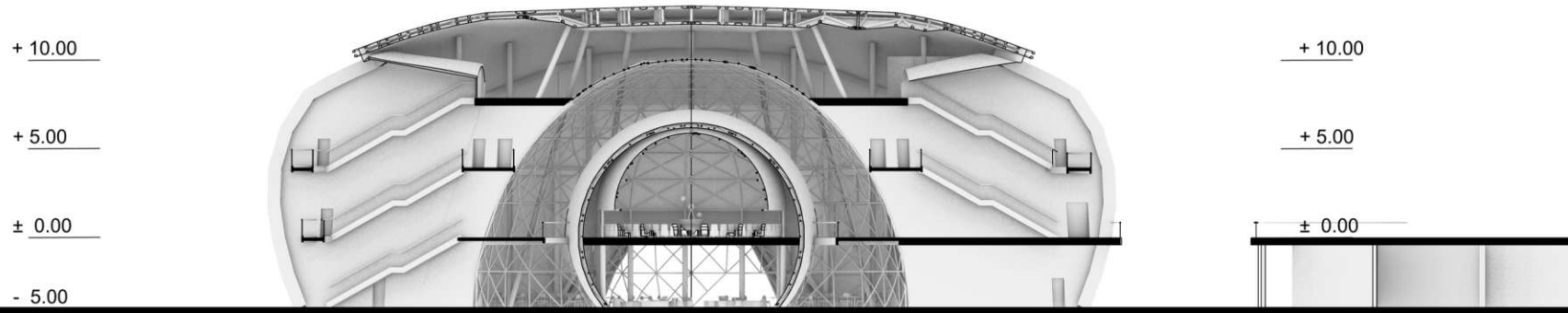




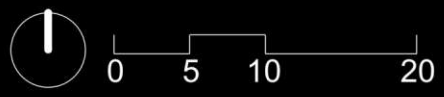


Plan 7: Longitudinal section

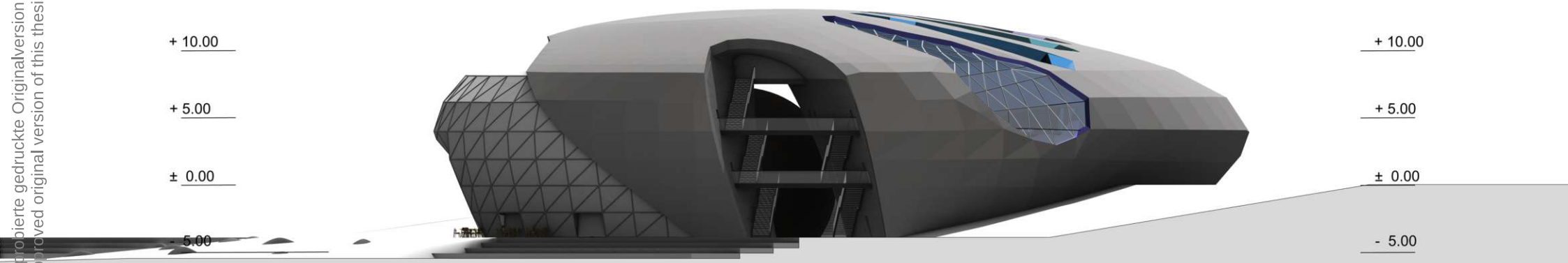




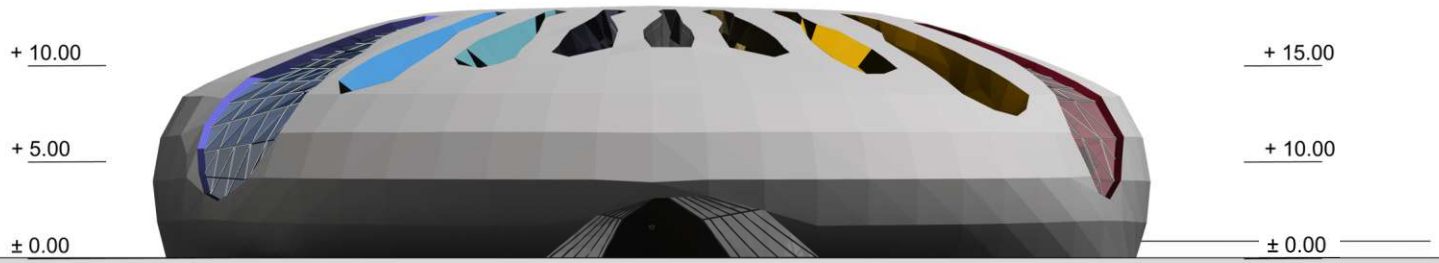
Plan 8: Cross section



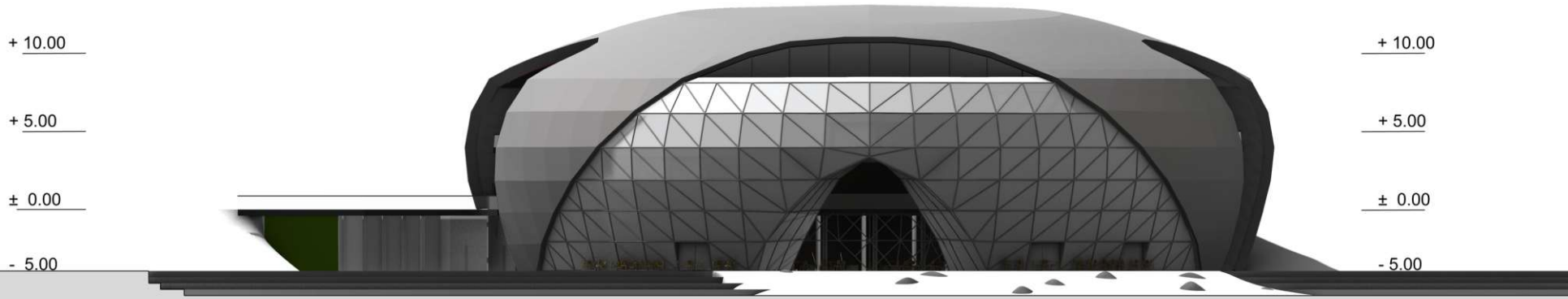
Plan 9: East Elevation



Plan 10: West Elevation



Plan 11: South Elevation



Plan 12: North Elevation

5.4 FACADE 3D SECTION

5.5 STRUCTURAL DETAILS

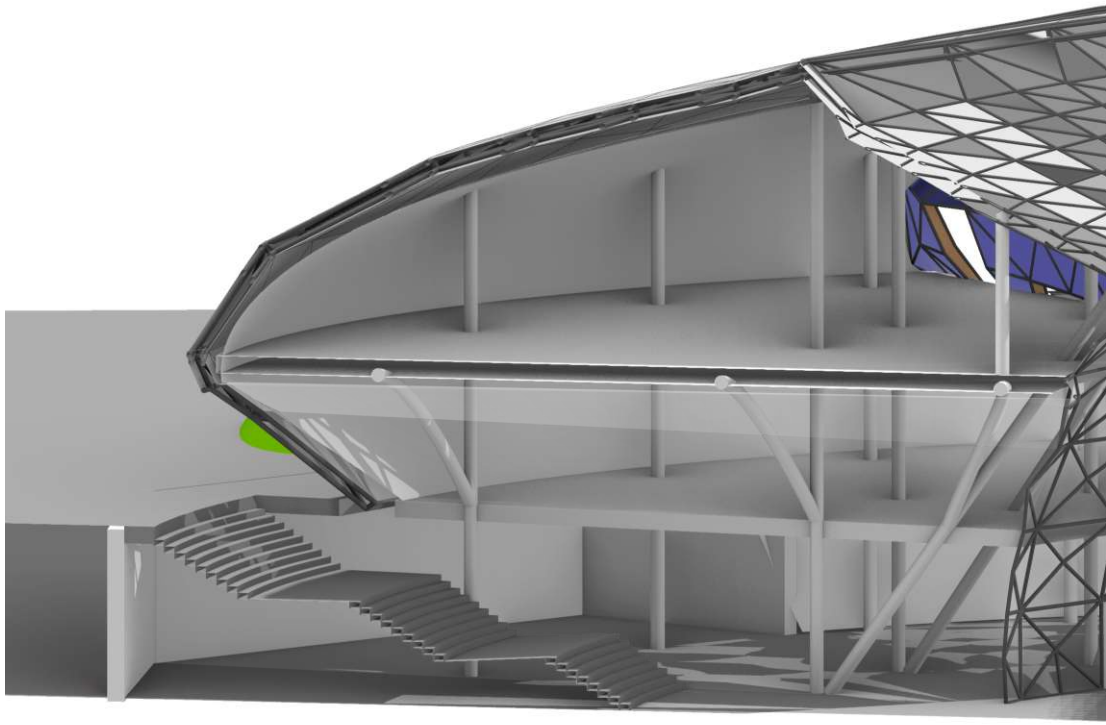
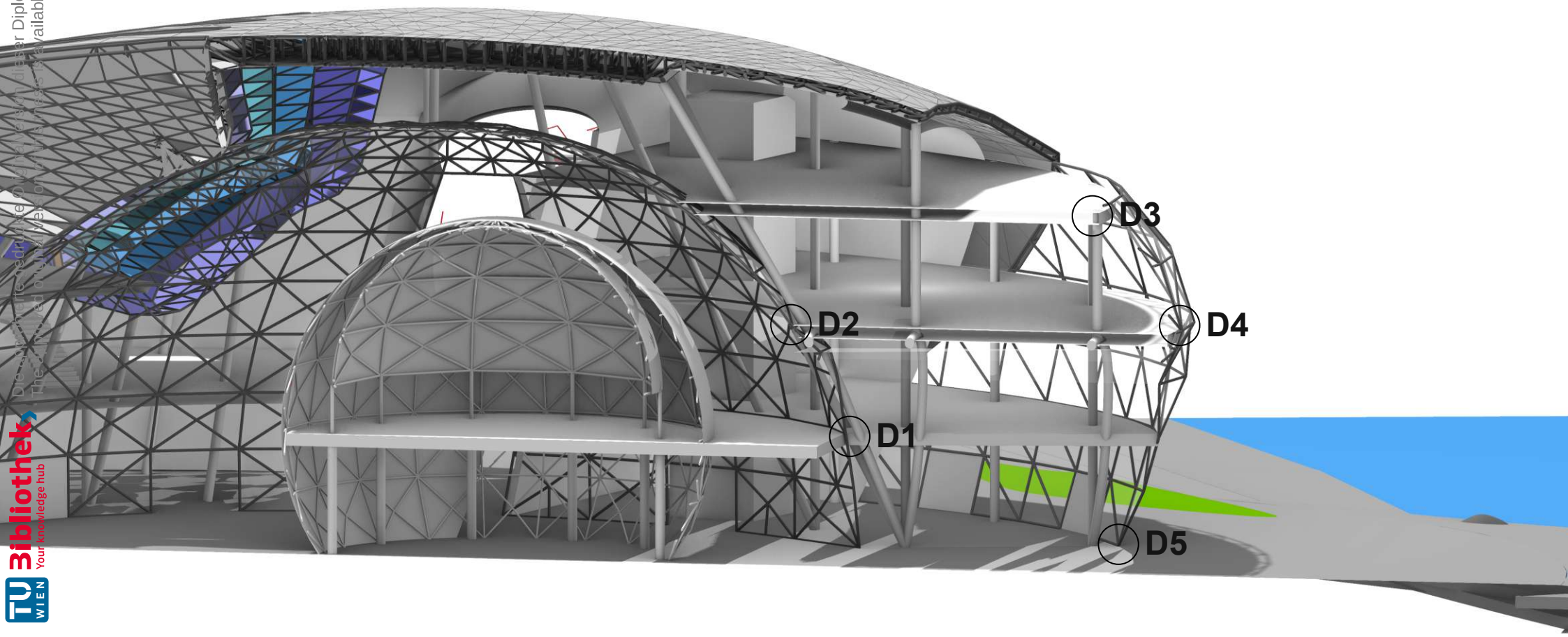


Fig. 99: 3D facade section



D1

1
1 cm Linoleum coating
5.5 cm Floating screed | Heated screed
0.5 cm Tack plate for underfloor heating
3 cm Impact sound insulation, EPS-T
PE Foil
3 cm Polystyrene concrete, levelling fill, for electro installation
20 cm Reinforced pre-cast concrete slab, half-prefabricated
20 cm Cavity for installations
5.5 cm Mineral wool stretched between KNAUF CW profiles
1.5 cm KNAUF Fireboard gypsum plasterboard suspended
1.5 cm KNAUF Fireboard gypsum plasterboard suspended

2 HEB 200, construction steel I-profile

3 RRO 160x80x0,6, steel hollow section,
support for spaceframe construction

4 RO 193x10, steel round profile,
Geometrica spaceframe construction

5 RRO 100x50x0,6, steel hollow section,
support for spaceframe construction

6 RRO 100x50x0,6, steel angle profile,
support for hollow sections
PE-Foil underneath for airtightness

7 Thermal decoupling for steel angle profile

8 QRO 60x5,0, steel hollow profile,
support for steel grating

9 Steel grating

10 Purenit, rigid foam insulation, pressure resistant

11 Triple glazing, laminated safety glass

12 ALUCOBOND aluminium panel

13 10 cm EPS insulation

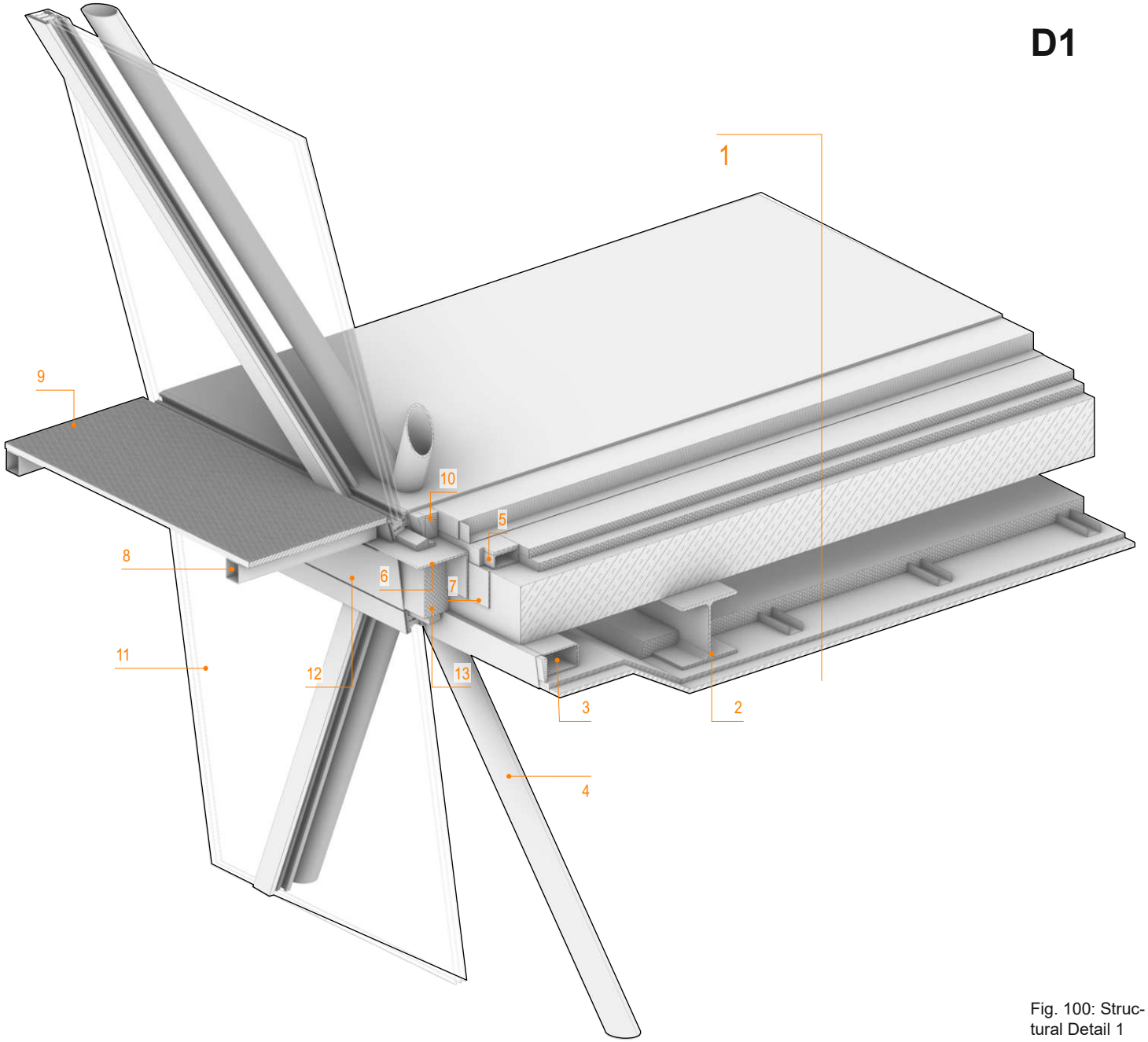
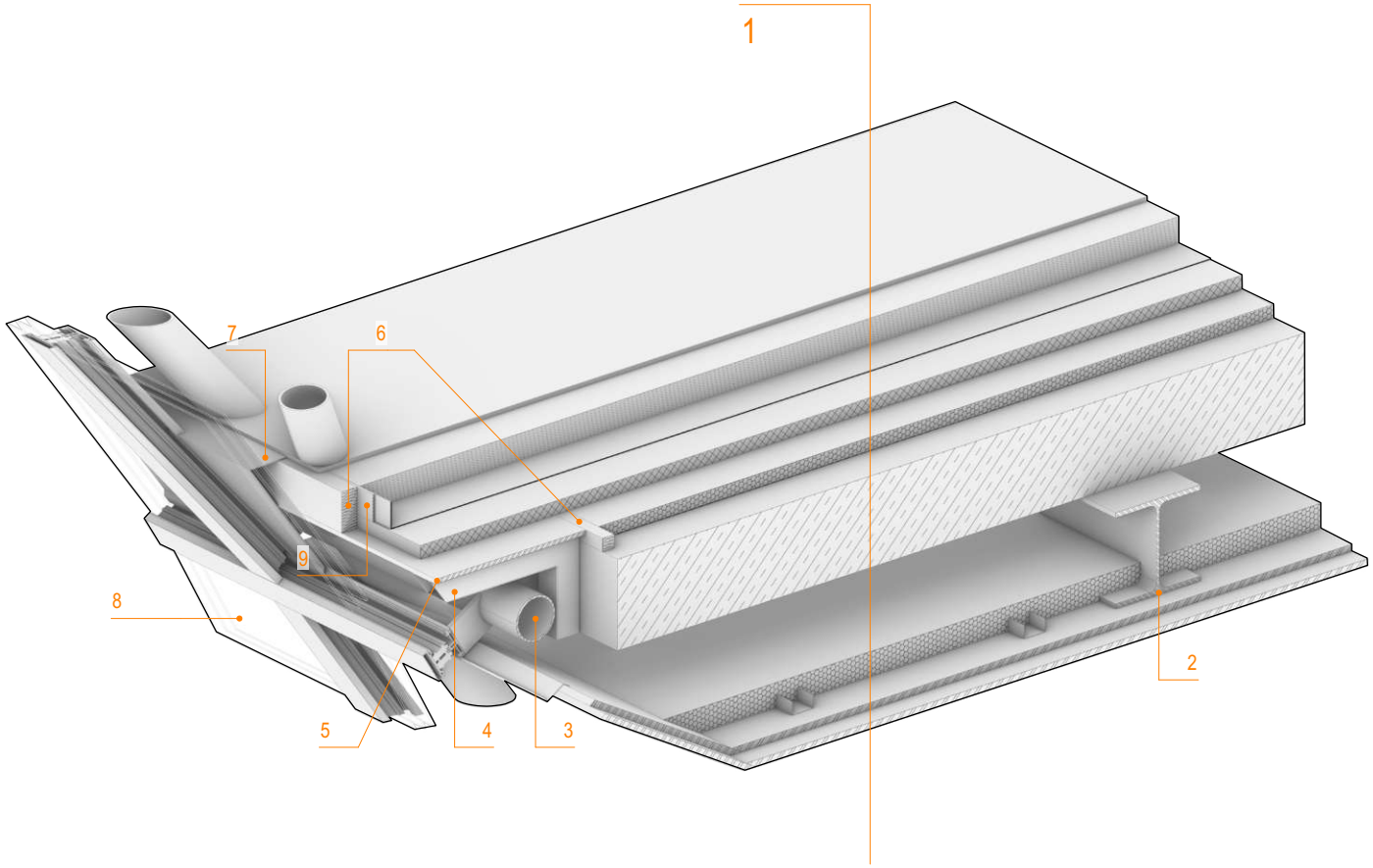


Fig. 100: Structural Detail 1

D2



Linoleum coating	1 cm	1
Floating screed | Heated screed	5.5 cm	
Tack plate for underfloor heating	0.5 cm	
Impact sound insulation, EPS-T	3 cm	
PE Foil		
Polystyrene concrete, levelling fill, for electro-intsallation	3 cm	
Reinforced concrete slab, half-prefabricated	20 cm	
Cavity for Installations	20 cm	
Mineral wool stretched between KNAUF CW profiles	5.5 cm	
KNAUF Fireboard gypsum plasterboard suspended	1.5 cm	
KNAUF Fireboard gypsum plasterboard suspended	1.5 cm	
HEB 200, construction steel I-profile		2
RO 193x10, steel round profile, Geometrica spaceframe construction		3
QRO 60x6,0, steel hollow profile, welded in L-shape console for flat steel		4
Flat Steel		5
Glued laminated timber		6
Powder-coated aluminium sheet		7
Triple glazing, laminated safety glass		8
Acoustic decoupling strip for floating screed		9

Fig. 101: Structural Detail 2

D3

1
4 cm Concrete paving on pedestal supports
5 cm Gravel filling 16/32 for fire protection
Fleece
20 cm XPS insulation
1 cm 2-layer waterproofing membrane, bituminous
9 cm Sloping concrete, %2 slope
20 cm Reinforced concrete slab
20 cm Cavity for Installation
5.5 cm Mineral wool stretched between KNAUF CW profiles
1.5 cm KNAUF Fireboard gypsum plasterboard suspended
1.5 cm KNAUF Fireboard gypsum plasterboard suspended

2
HEB 200, construction steel I-profile

3
RO 193x10, steel round profile,
Geometrica spaceframe construction

4
QRO 60x6,3, steel hollow profile as console,
Supports for railing construction
thermally decoupled from roof parapet

5
QRO 60x3, steel hollow profile,
Railing construction

6
10 cm XPS, parapet insulation

7
Perforated coated aluminium sheet
for roof ventilation

8
ALUCOBOND Aluminium Panel

9
Gravel Catcher Strip

10
Vapor Barrier (sD<10 m)
airtight adhered to concrete slab

11
0,5 cm ALUCOBOND aluminium panel
5 cm Ventilation cavity, battens, hollow profiles for paneling
3 cm Cross battens, hollow profiles
0,3 cm Roof underlay felt, breatheable
2,4 cm DWD boards, roof deck, breatheable
9 cm Mineral wool spreaded between space frame construction
20 cm Concrete roof parapet

12
Powder-coated aluminium sheet

13
Triple glazing, laminated safety glass

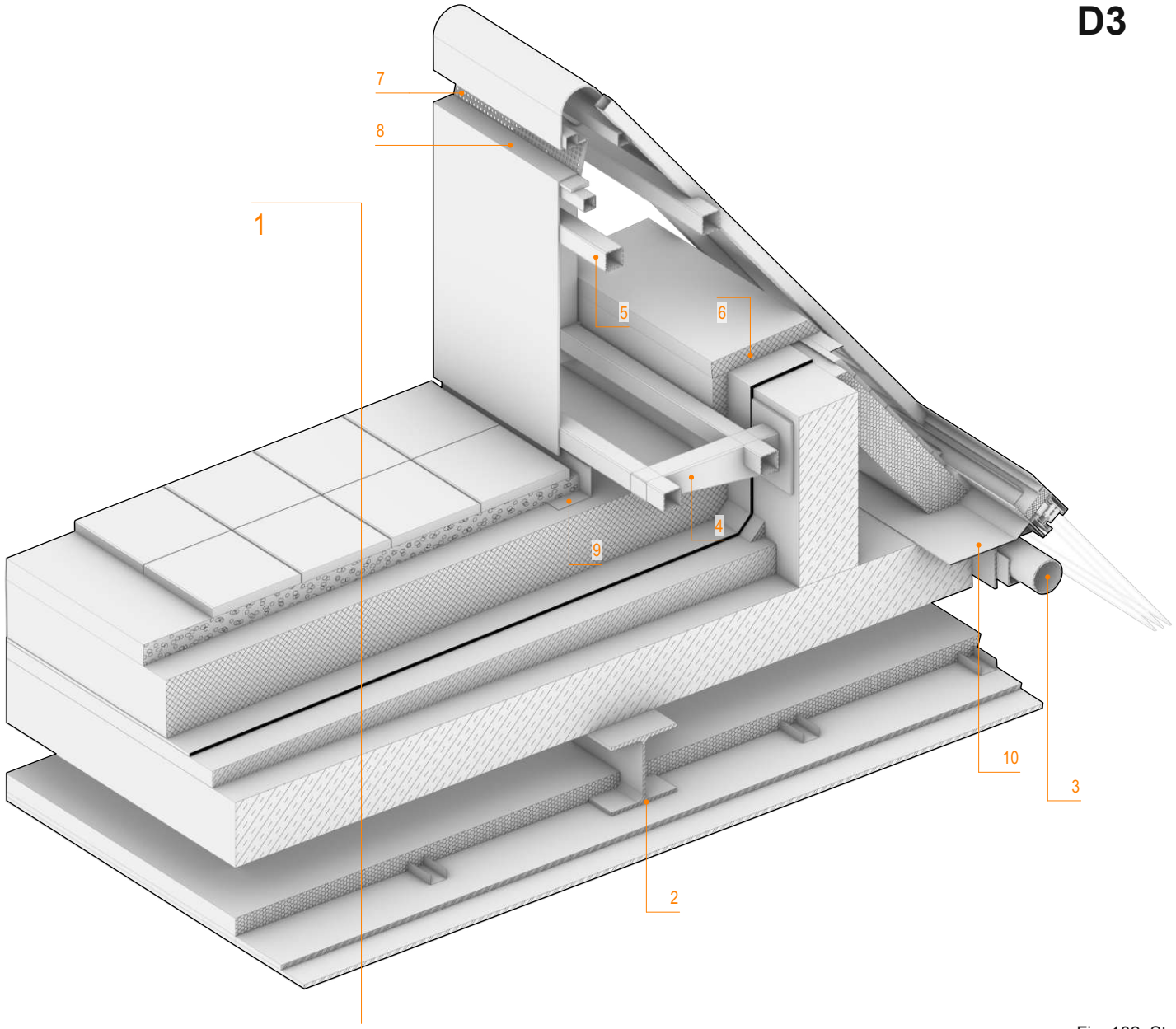
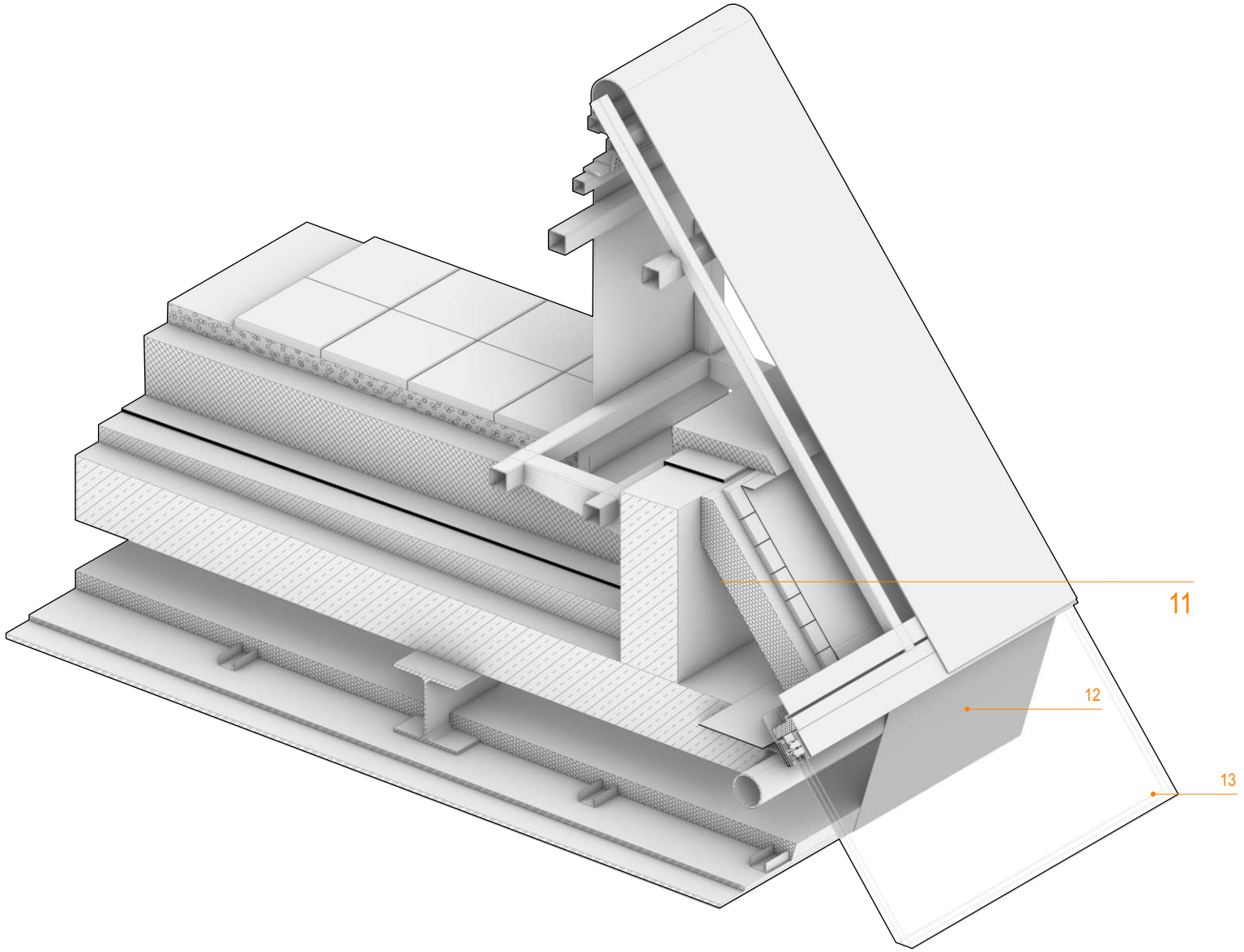


Fig. 102: Structural Detail 3



D4

1
1 cm Linoleum coating
5.5 cm Floating screed | Heated screed
0.5 cm Tack plate for underfloor heating
3 cm Impact sound insulation, EPS-T
PE Foil
3 cm Polystyrene concrete, levelling fill, for electro installation
20 cm Reinforced pre-cast concrete slab, half-prefabricated
20 cm Cavity for installations
5.5 cm Mineral wool stretched between KNAUF CW profiles
1.5 cm KNAUF Fireboard gypsum plasterboard suspended
1.5 cm KNAUF Fireboard gypsum plasterboard suspended

2 HEB 200, construction steel I-profile

3 RO 193x10, steel round profile,
Geometrica spaceframe construction

4 RRO 100x100x0.4, steel angle profile,
connecting piece for space-frame construction to concrete slab

5 Flat steel

6 Decoupling for steel angle profile

7 Acoustic decoupling strip for floating screed

8 Glued laminated timber

9 Powder-coated aluminium sheet

10 Triple glazing, laminated safety glass

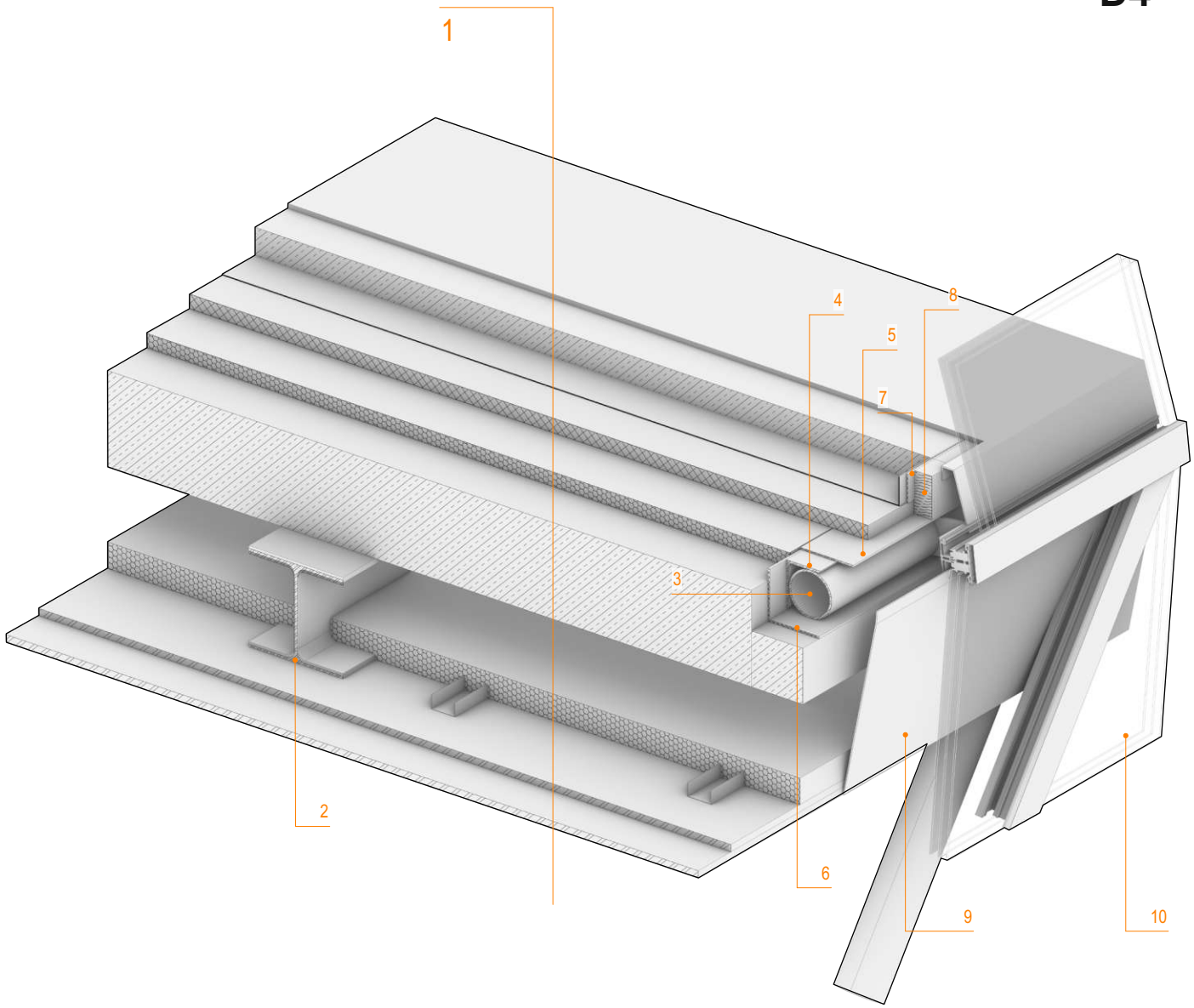
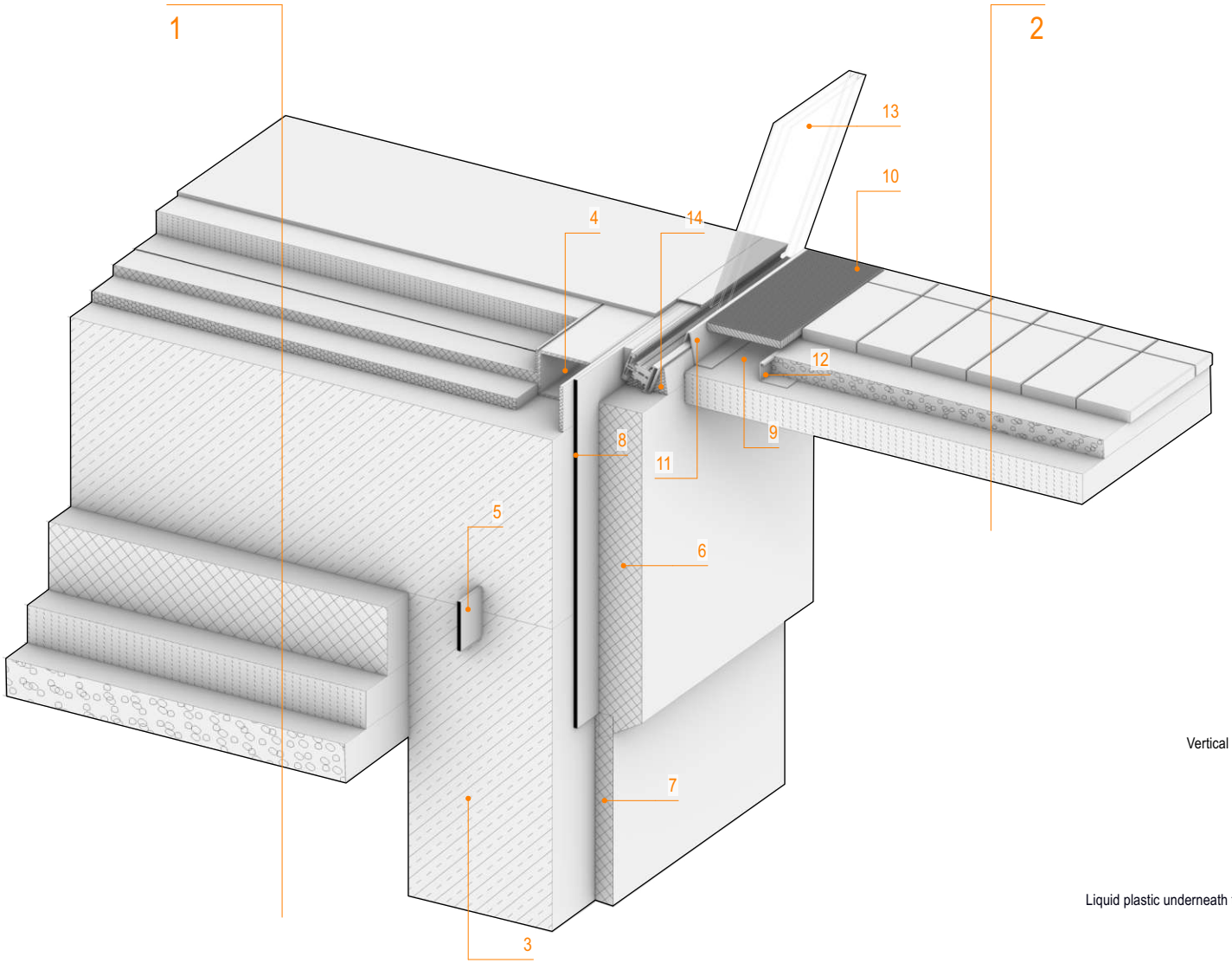


Fig. 103: Structural Detail 4

D5



Linoleum coating	1 cm	1
Floating screed | Heated screed	5.5 cm	
Tack plate for underfloor heating	0.5 cm	
Impact sound insulation, EPS-T	3 cm	
PE Foil		
Polystyrene concrete, levelling fill, for electro-intsallation	3 cm	
Waterproof(WU) reinforced concrete slab, ground slab	50 cm	
Austrotherm XPS TOP serie, high resistant XPS Insulation	20 cm	
Lean concrete, blinding layer	10 cm	
PE Foil		
Gravel 16/32, capillary-breaking layer	10 cm	
Concrete paving	3 cm	2
Gravel filling 16/32	5 cm	
Lean Concrete	8 cm	
Strip foundation (footing) spans 80 cm beneath the bottom edge of the ground slab		3
RRO 200x120x8,0, steel hollow section support for spaceframe construction		4
Gap sealing sheet (strip)		5
XPS Insulation	12 cm	6
XPS Insulation	5 cm	7
2-layer waterproofing membrane, bituminous Vertical depth (Tiefzug) of 20 cm below the gap between slabs Vertical height (Hochzug) of 15 cm from the bottom edge of the drainage channel		8
Drainage channel		9
Steel grating, 20 cm deep		10
Powder-coated aluminium sheet Liquid plastic underneath the sheet, waterproofing the area between purenit and the drainage base		11
Gravel Catcher Strip		12
Triple glazing, laminated safety glass		13
Purenit, rigid foam insulation, pressure resistant		14

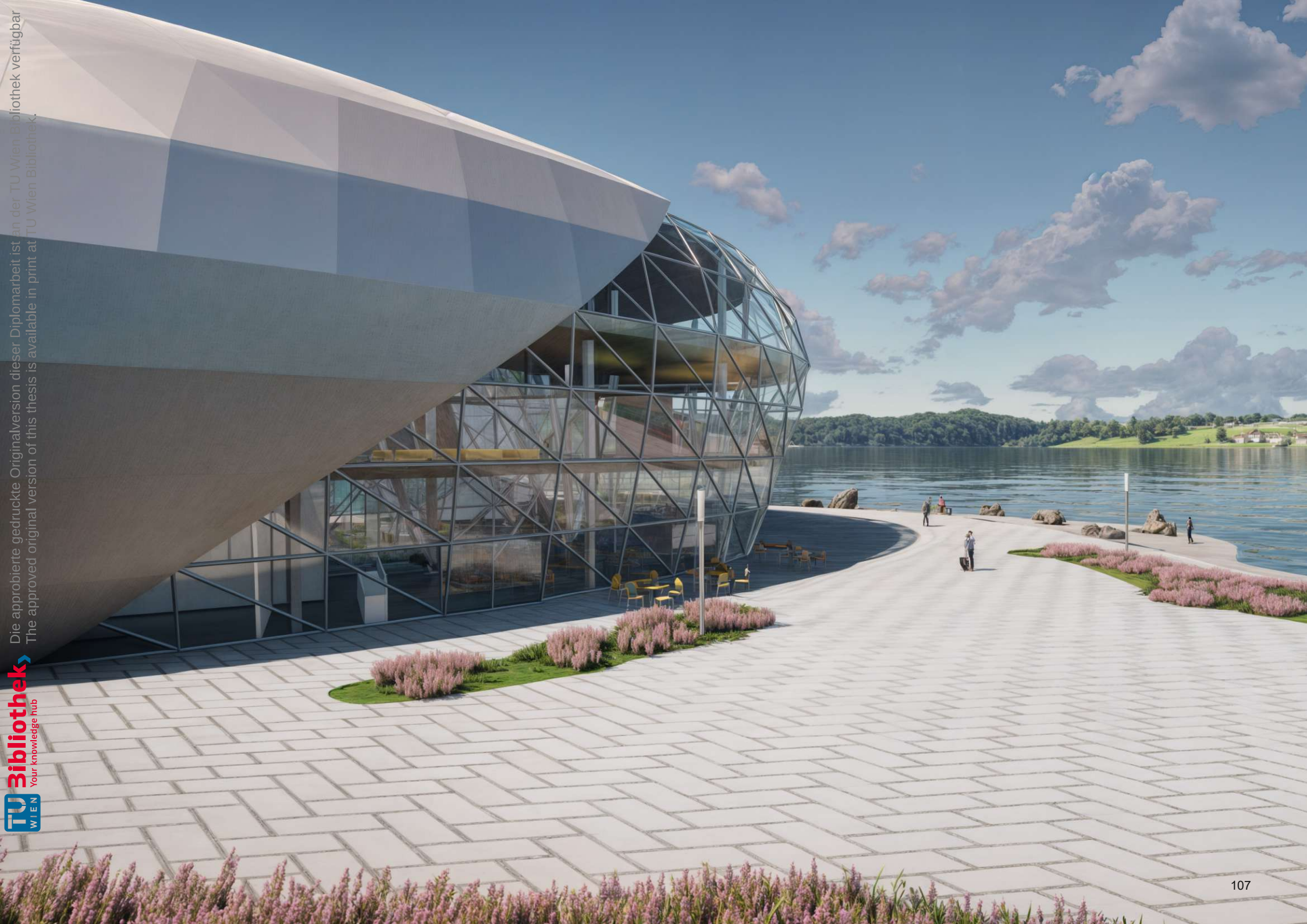
Fig. 104: Structural Detail 5

5.6 RENDERINGS

Fig. 105: Render southwiew

Fig. 106: Render outside view

Fig. 107: Render view from the side



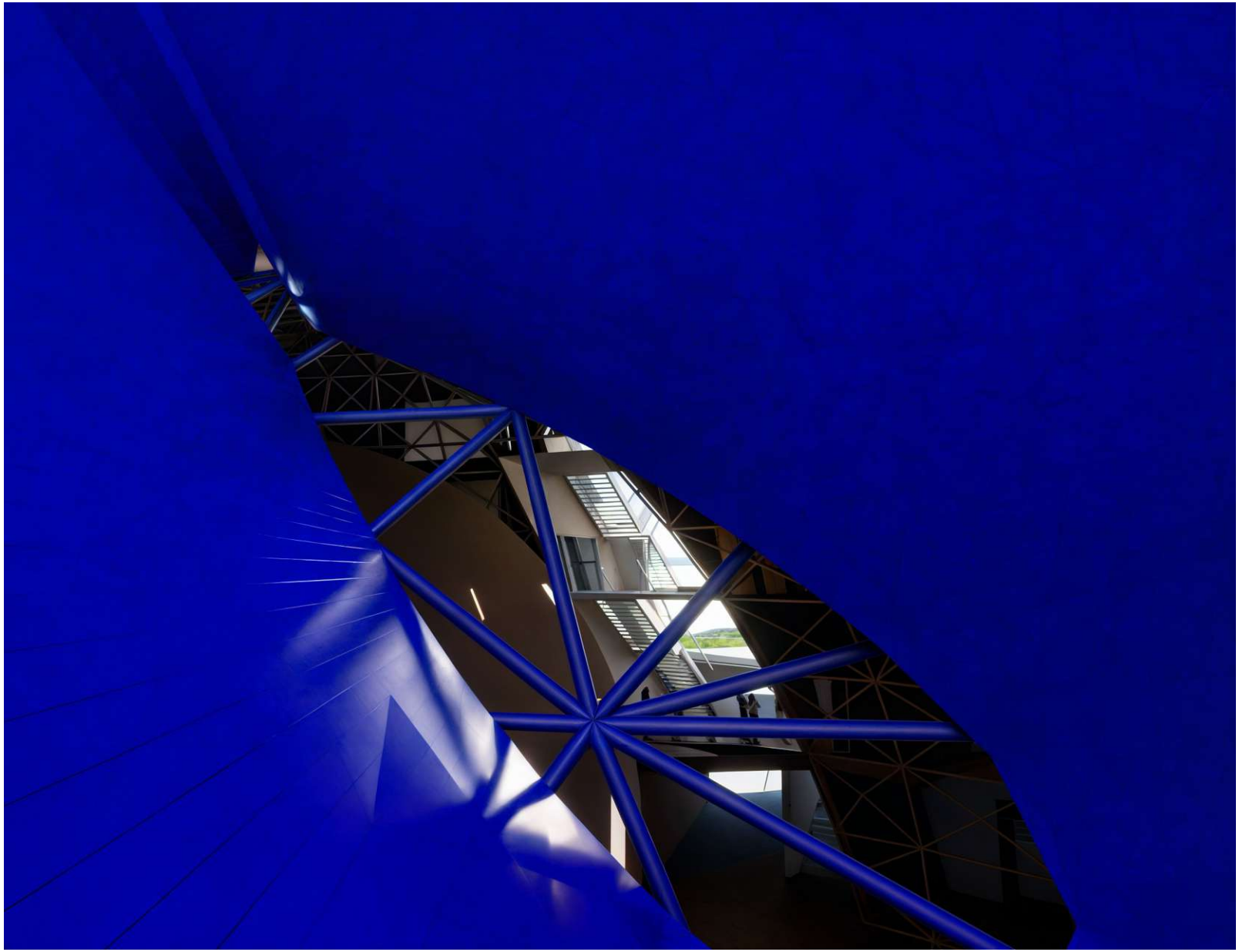
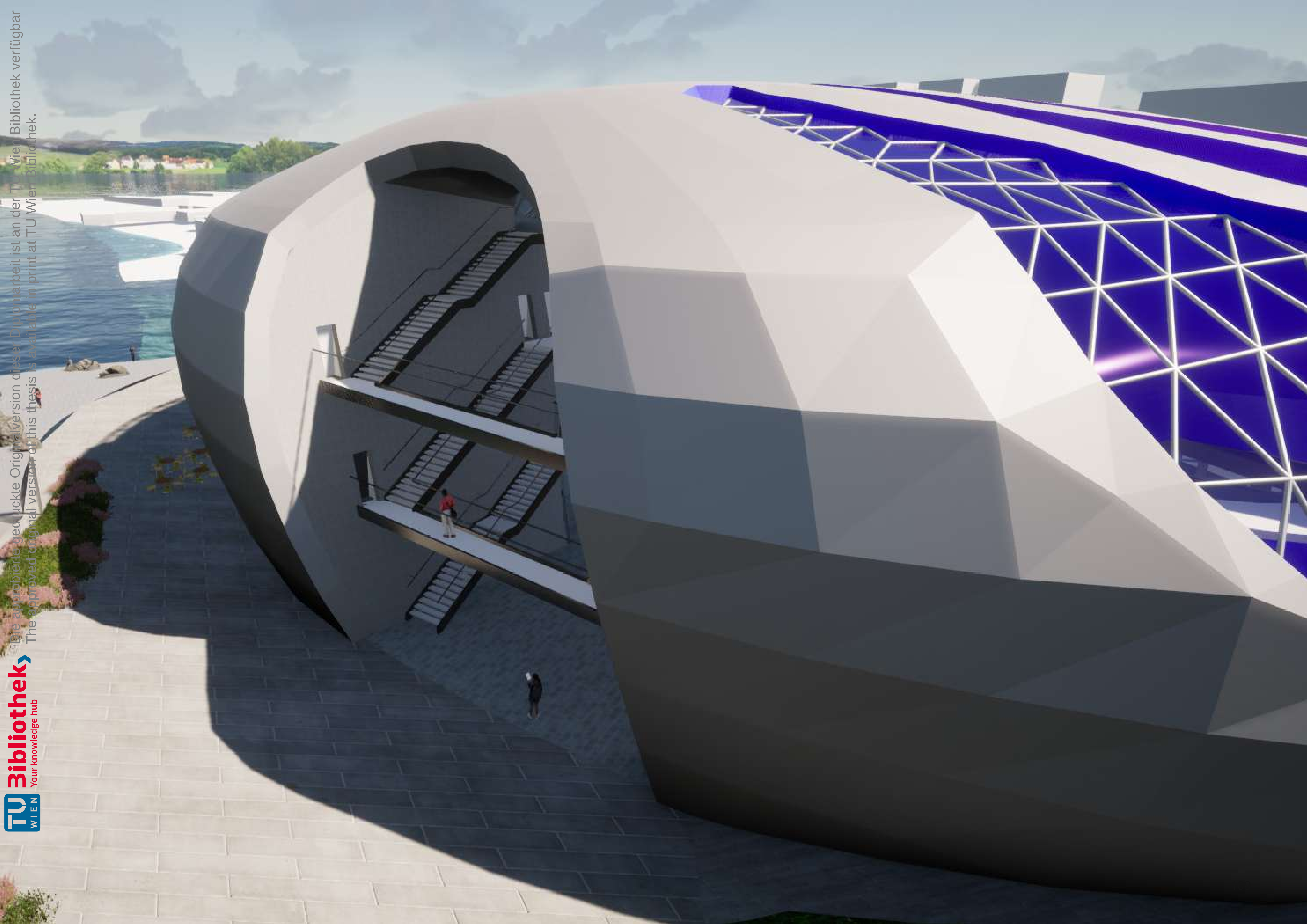


Fig. 108:
Render south-west entrance

Fig. 109: Render look from the stairs inside the suncutout



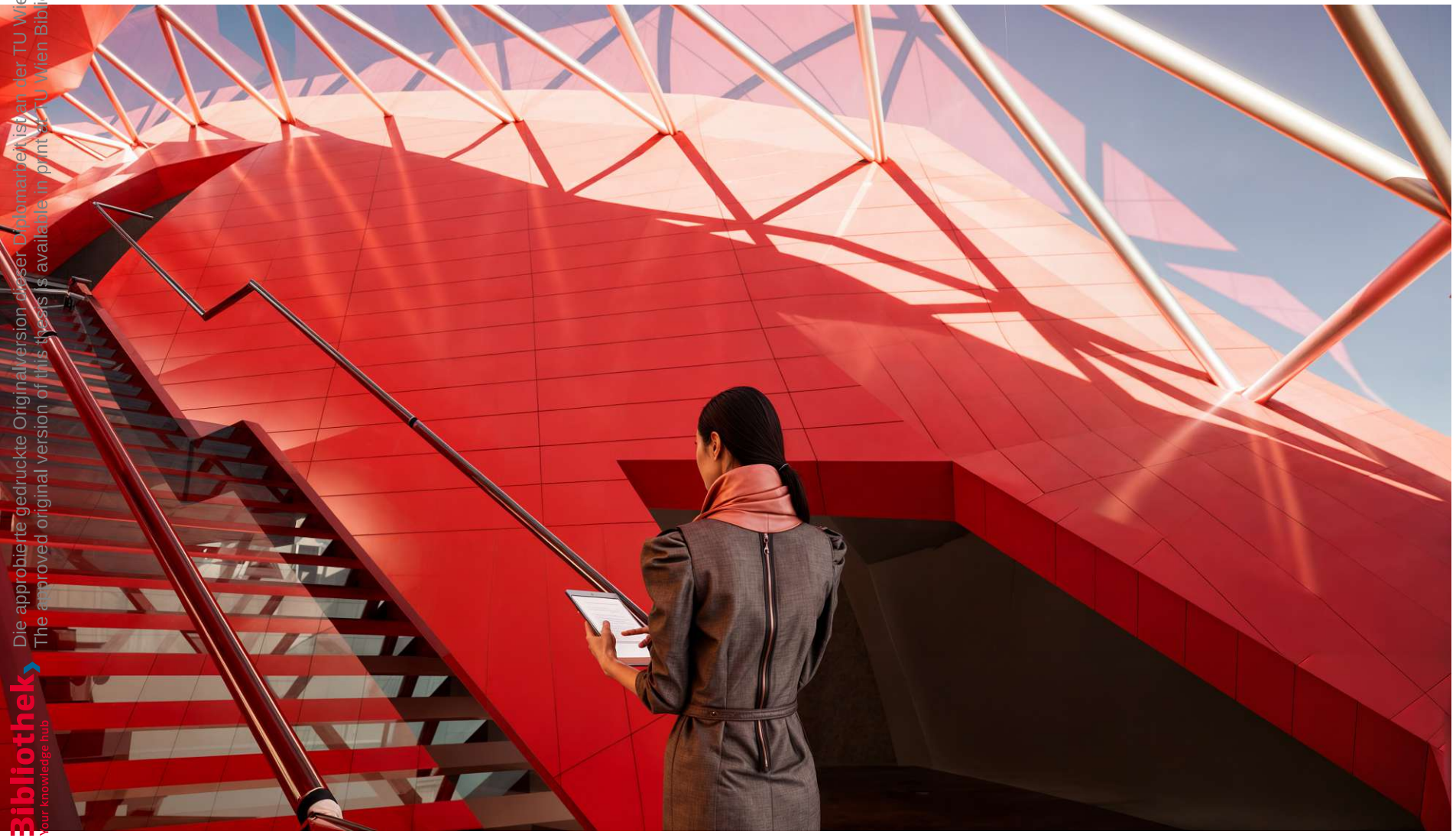


Fig. 110: Render stairs inside the sun cutout

Fig. 111: Render south-east entrance

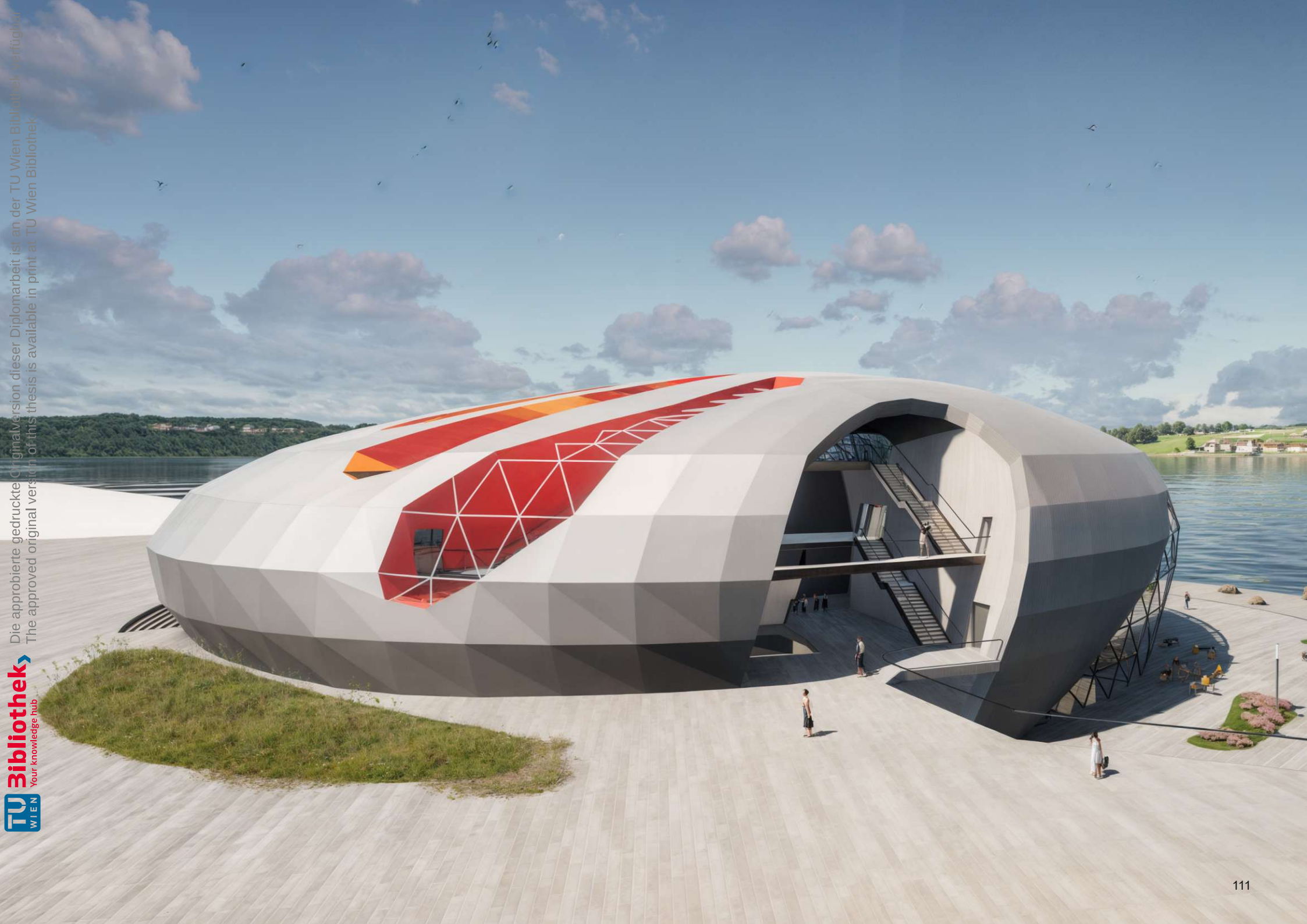


Fig. 112: Render
main gallery

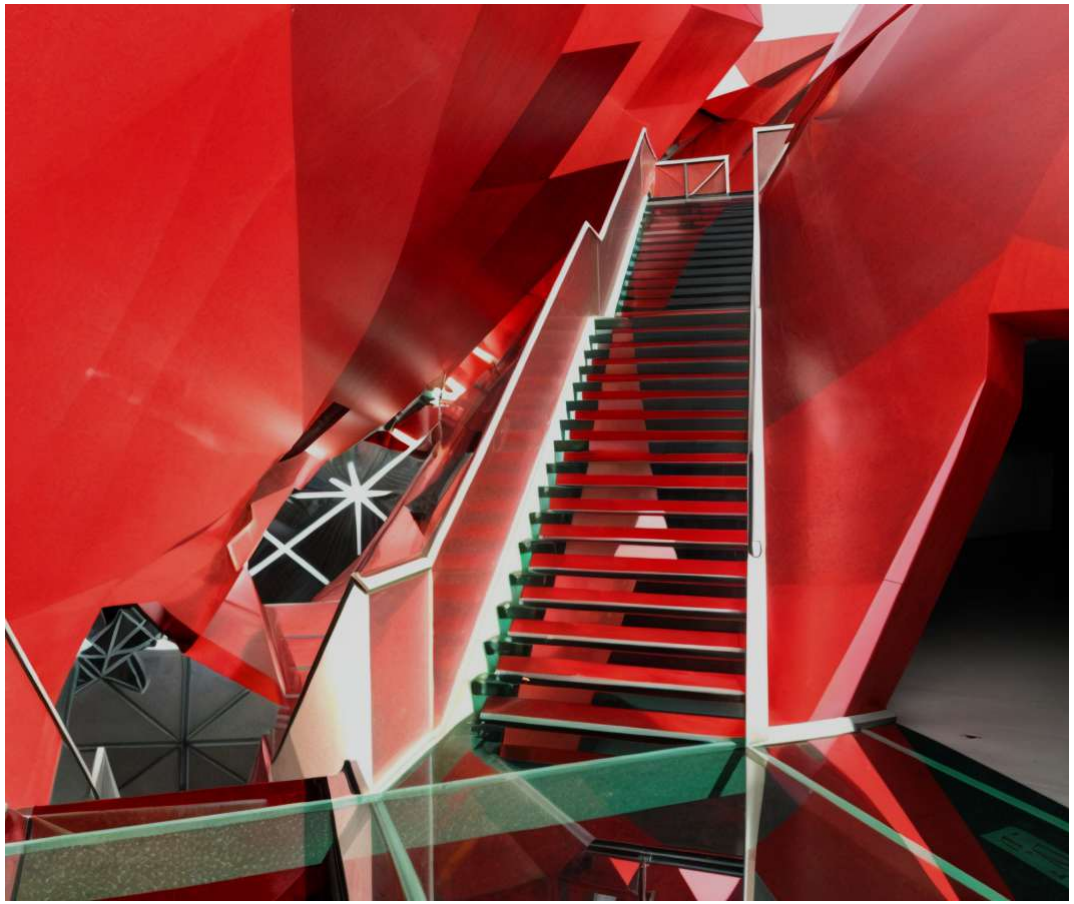


Fig. 113: Render satirs inside the sun cutout

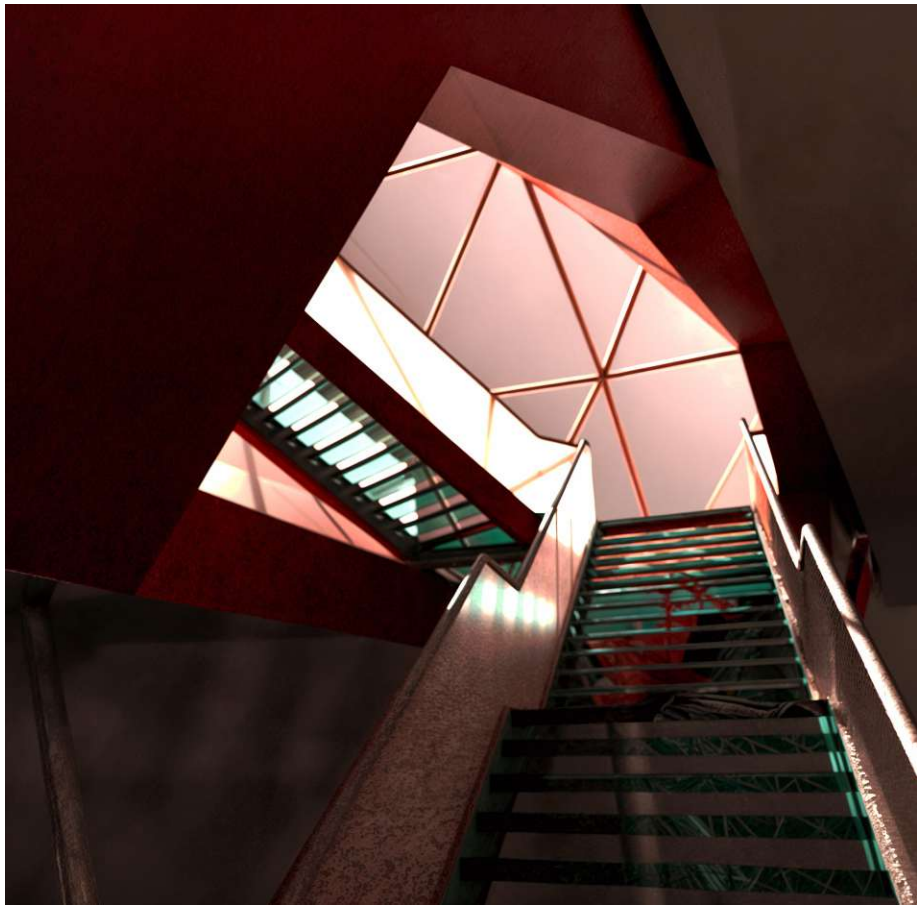
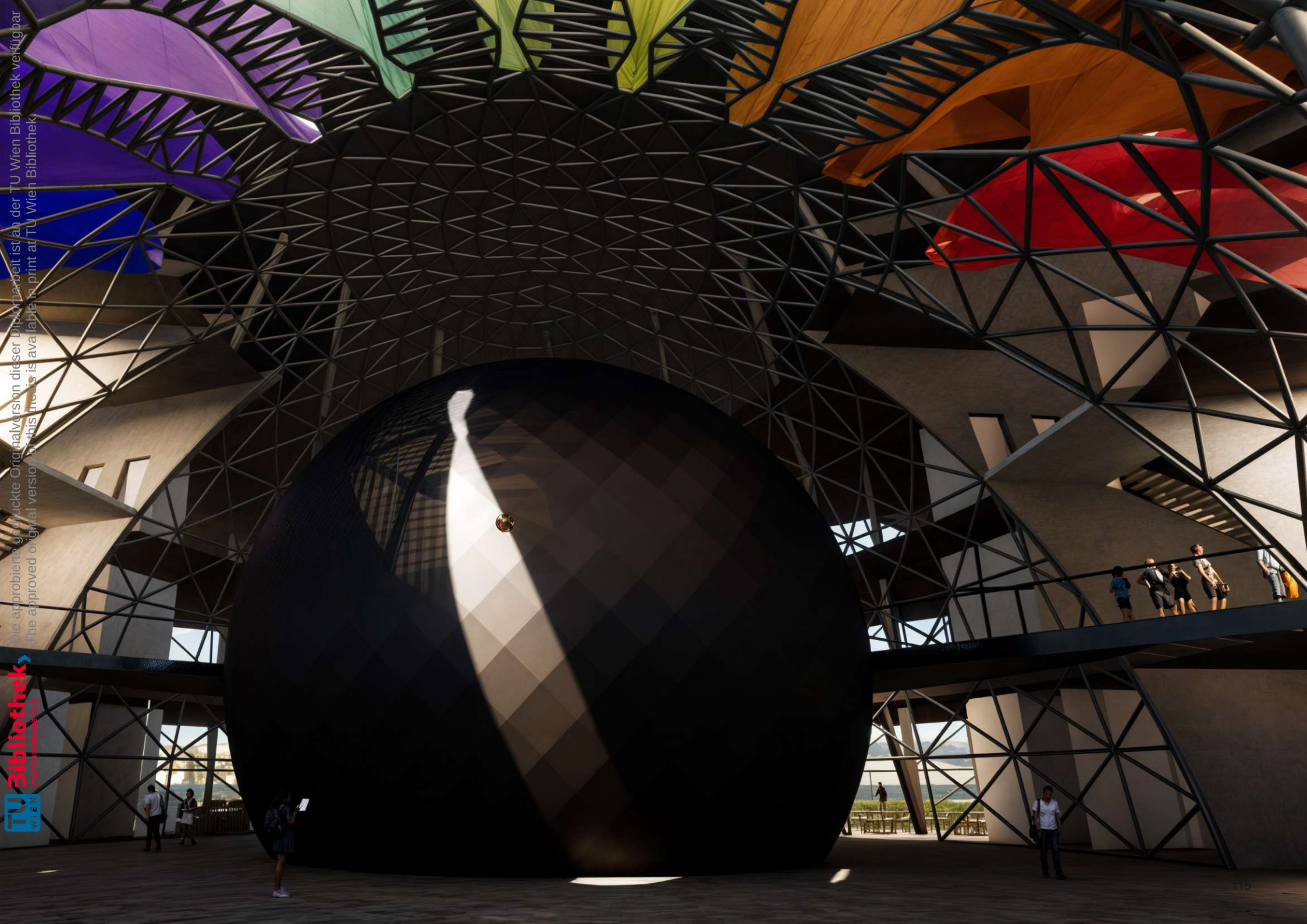


Fig. 114: Render stairs inside the sun cutout

Fig. 115: Render
central plaza



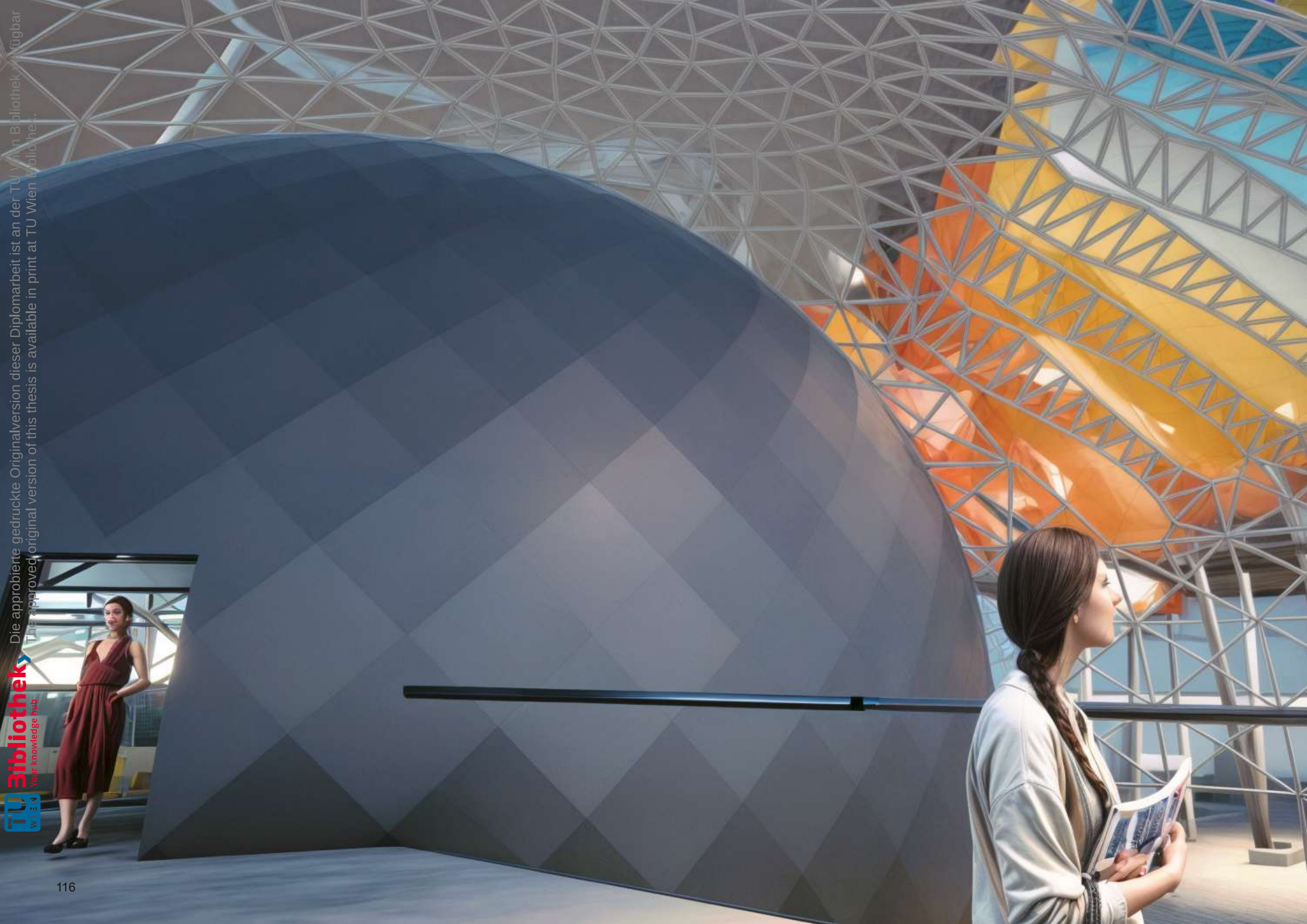


Fig. 116: Render entrance, the planetrarium

6. AREA EVALUATION

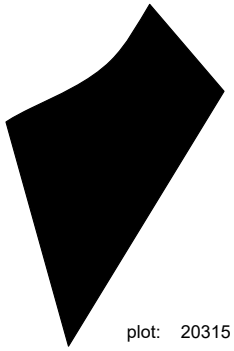
		-1	GF	1	2	TOTAL	Area/ UFA
UFA	usable floor area	4157	2015	2213	1077	9462	100%
TA	technical area	217	10	9	9	245	3%
TFA	traffic area	454	424	344	126	1348	14%
NFA	net floor area	4828	2449	2566	1212	11055	117%
CFA	construction floor area	270	146	177	323	916	10%
GFA	gross floor area	5762	2621	2952	2952	14287	151%
							GV/UFA
GV	gross volume 42109						4,45

8.1 Bibliotheken, Museen und Ausstellungen

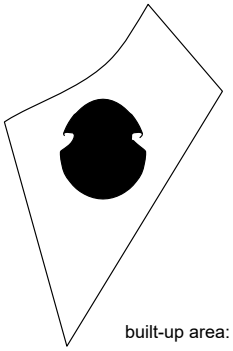
Grundflächen		>	Fläche/NUF (%)	<	>
NUF	Nutzungsfläche		100,0		64,6
TF	Technikfläche	5,4	7,7	15,6	3,5
VF	Verkehrsfläche	11,6	16,5	21,7	8,2
NRF	Netto-Raumfläche	114,7	122,1	133,0	81,4
KGF	Konstruktions-Grundfläche	18,6	23,2	30,6	12,8
BGF	Brutto-Grundfläche	133,8	145,2	160,9	

Brutto-Rauminhalte		>	BRI/NUF (m)	<	>
BRI	Brutto-Rauminhalt	5,68	6,48	7,53	4,10

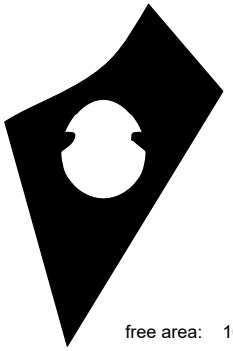
Fig. 117: BKI (Baukosteninformationszentrum) 2019



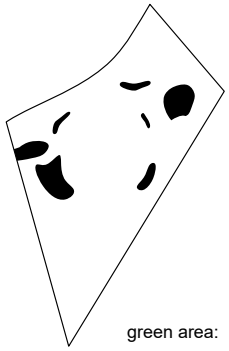
plot: 20315 m²



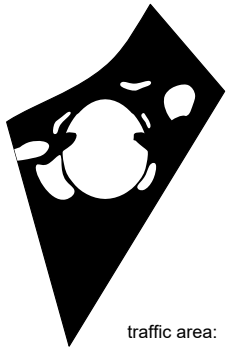
built-up area: 3751 m²



free area: 16564 m²



green area: 1706 m²



traffic area: 14815 m²

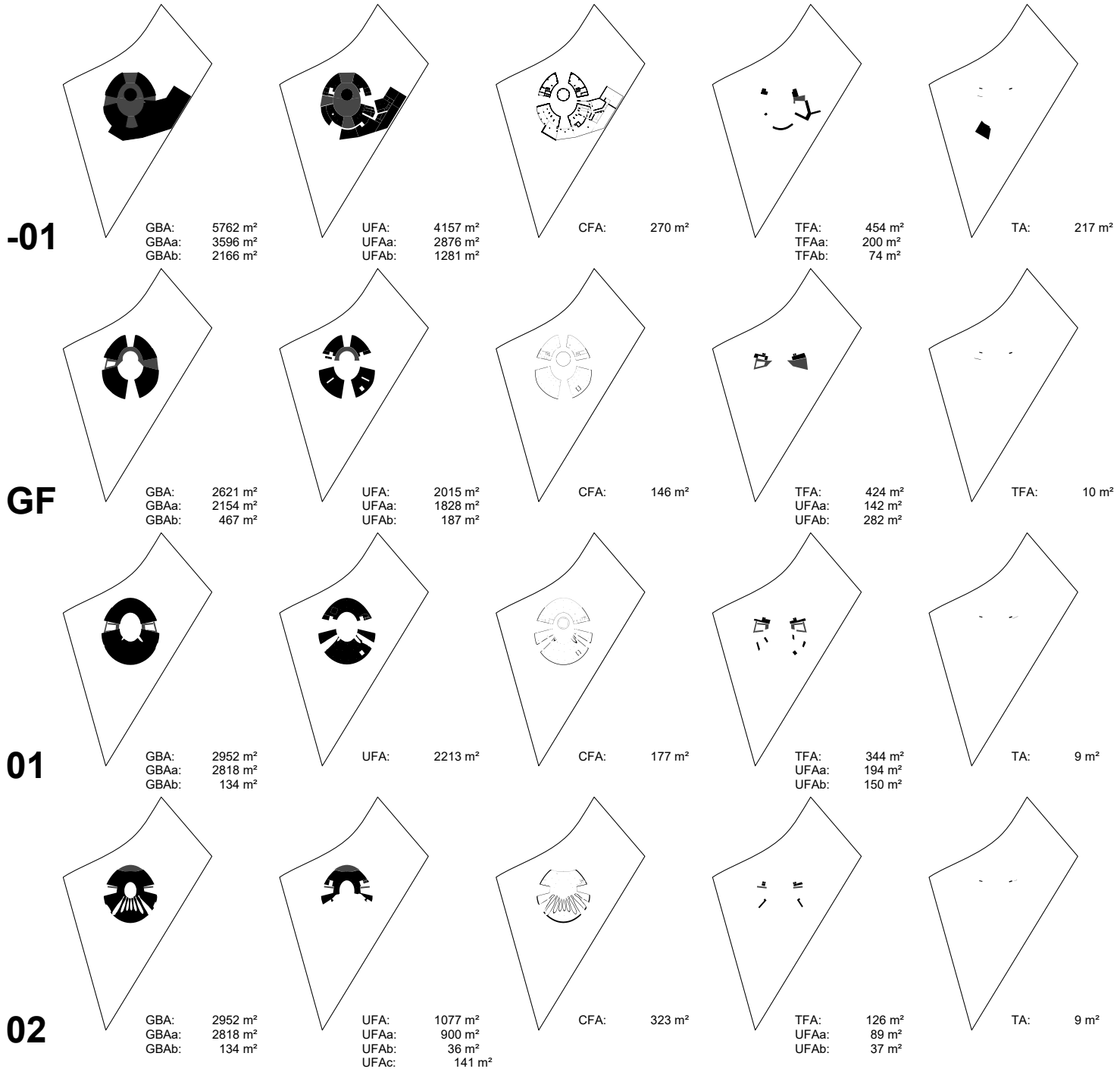


Fig. 118: Area evaluation

7. CONCLUSION

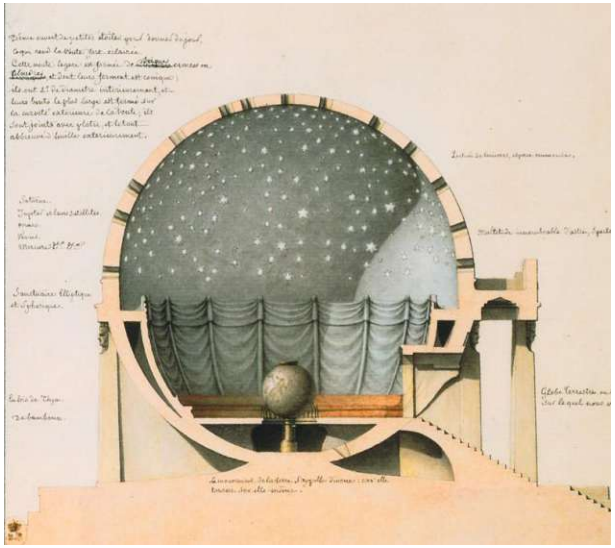


Fig. 120: Design for a Temple of the Earth, Lequeu , 1794

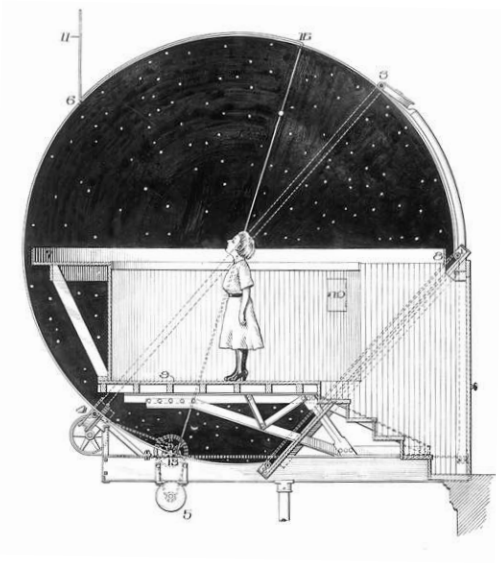


Fig. 121: Drawing of the Atwood Celestial Sphere., ca. 1903

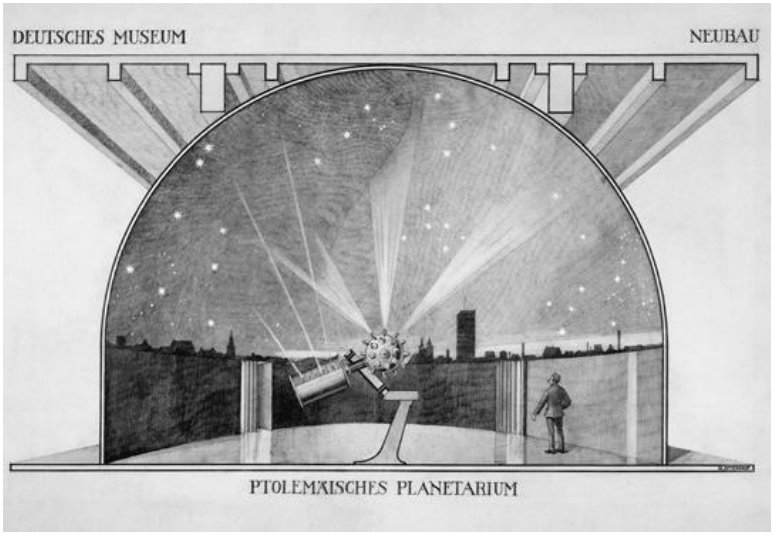


Fig. 119: Drawing of the projection planetarium in Munich, ca. 1923

Fig. 122: Render,
central plaza

My aim for starting this project was to explore the potentials of computational tools at our disposal today. I explored the ways to manipulate the sunlight through geometry. Through these experiments the reverse sun clock concept has emerged. The astronomy museum and education center “Sunverse” offers an immersive experience with its architectural features. The introverted building has a planetarium at its heart, an enormous sphere encapsulated by a shell, reminding the vastness of the cosmos. The planetarium represents the earth. Inside the planetarium the viewers are educated about the night sky, while the outside of the planetarium becomes a spectacle. The sunlight filtered through the roof, turns the planetarium in to an astronomical instrument, which tracks the sun. The building becomes part of the exhibition and aids to communicate astronomical principles.

8. DIRECTORIES

8.1 Figure Directory

8.2 Plan Directory

8.3 Literature Directory

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