D3.1 PRELIMINARY CONCEPTUAL DESIGN

WP3 – FACILITIES AND INFRASTRUCTURE

A. HUTZLER, L. FERRIÈRE, A. BENNETT AND THE OTHER MEMBERS OF THE WP3 TEAM.

Authors

This *Preliminary Conceptual Design* was prepared by Aurore Hutzler, Ludovic Ferrière, Allan Bennett, and the rest of the WP3 team: John Robert Brucato, Vinciane Debaille, Luigi Folco, Andrea Longobardo, Tom Pottage and Caroline Smith.

Section 2.4, in the form of a booklet, was prepared together with Sandra Häuplik-Meusburger, San-Hwan Lu and a group of students from the Vienna University of Technology, in the framework of a *Design Studio*.

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Table of contents

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1 Introduction

1.1 Aim

This report is part of the EURO-CARES project – a European Commission Horizon 2020 funded project to create a roadmap for the implementation of a European Extra-terrestrial Sample Curation Facility (ESCF).

It is one of the four reports to be prepared for the Work Package 3 (WP3) "Facilities and Infrastructures". One report (D3.2) is based on a meeting held in April 2016 at the Natural History Museum Vienna (Austria). The other three reports are "conceptual design" of an ESCF with increasing level of complexity and details, from Preliminary Conceptual Design (D3.1, this report) to Advanced Design and Technology Identification (D3.3), to Final Design (D3.4).

1.2 Approach

A workflow diagram describing the approach used to perform this work is shown in Figure 1.

The present *Preliminary Conceptual Design* of the ESCF has been produced by combining data gathered as part of Work Package 1 of the EURO-CARES project *Knowledge Capture and Requirements Review,* the knowledge that was acquired in the meantime by means of visits of divers facilities and meetings with experts from different fields and the results of an architecture Design Studio (in collaboration with the Vienna University of Technology).

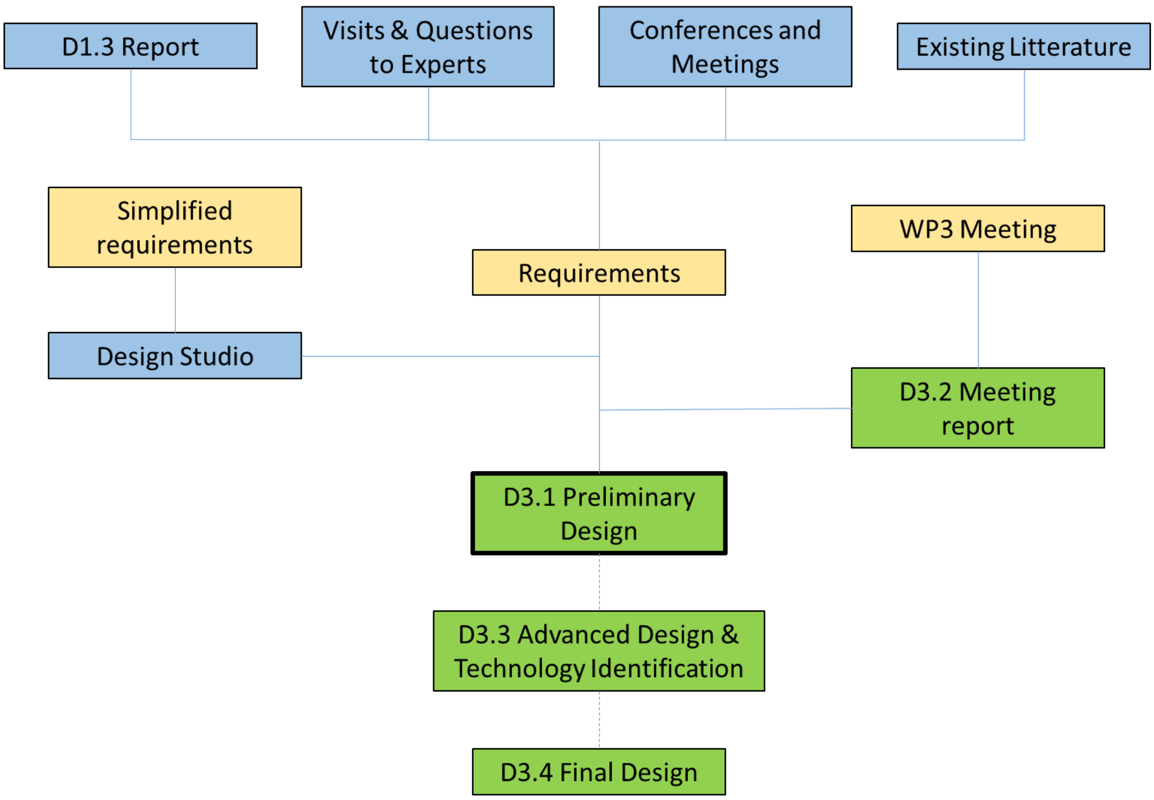

Figure 1 : Workflow for D3.1

(Inputs are in blue, actions in yellow and deliverables in green).

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List of visited facilities:

- Public Health England, Porton Down, UK. Biosafety Level 4 (BSL-4) laboratory.
- P4 Jean Mérieux, Lyon, France. BSL-4 laboratory.
- National Institute of Polar Research (NIPR), Tokyo, Japan. Antarctic meteorites curation laboratory.
- Japan Aerospace Exploration Agency (JAXA), Sagamihara, Japan. Hayabusa samples curation facility.
- Institute of Science and Technology (IST) Austria, Klosterneuburg, Austria. Cleanroom facility.
- Cleanroom Technology Austria (CTA), Wiener Neudorf, Austria. Cleanroom technology and innovative sterile air systems specialists.
- Johnson Space Center (JSC)/NASA, Houston, Texas, USA. Extraterrestrial samples curation facilities and laboratories.

This report summarizes what we have learnt from our main visits and meetings with experts. Reports of visits and meetings are available on demand.

Specific topics that did not evolve significantly since the completion of D1.3 and D3.2 are not further discussed in the present report.

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2 Architecture and Design

The ESCF is designed to be able to receive the return capsule after return to Earth, to access the containers and the samples, and to curate and store the samples, independently of the parent body and of the mission. Sample return missions from planetary bodies considered by the scientific community to be of significant interest to the process of chemical evolution and/or the origin of life (such as Mars, Europa, etc.) are classified as Restricted Category V, while other sample return missions (from asteroids, the Moon, etc.) are Unrestricted Category V (COSPAR, 2011). Receiving and curation areas are to be separated for restricted and unrestricted samples. The ESCF also includes working space for the curators, the guest researchers and staff. Public awareness and communication are part of the functions of the building, to manage in the best way the various stakeholders involve in the ESCF (Cohen, 2002).

The current project plan to propose an integrated design for all functions listed above. The design will be modular and flexible enough so that some parts of the building can be excluded, or added following a long-term building timeline.

We present first the initially identified different ESCF units. We then propose a non-exhaustive list of "building scenarios", to test the modularity of the facility. We finally present the results of an architectural *design studio* (Häuplik-Meusburger and Lu, 2016).

2.1 Different units, with subunits

- **Portable Receiving Facility (PRF)**: Assessing, cleaning and packaging of the return capsule on the landing site. Delivery of the spacecraft to the Sample Receiving Facility (SRF). Based on inputs from WP6 “Portable Receiving Technology”. It is important to note that the PRF, even not being part of the main facility (i.e. will be located close to the landing site), is taken into account for the entire concept of the ESCF.

- **Sample Receiving Facility (SRF) Unrestricted**: Receiving of the sample container, cleaning and opening of the outer layers and delivery of the unopened sample canisters to the curation facility. Clean environment.
- **SRF Restricted**: Receiving the sample container, cleaning and opening of the outer layers and delivery of the unopened sample canisters to the curation facility (same as above). Environment should be clean and contained.

- **Sample Curation Facility (SCF) Unrestricted**: Receiving of the sample canister and accessing the sample. Curation and dissemination to science laboratories. Clean environment.
- **SCF Restricted**: Receiving of the sample canister and accessing the sample (as above). Protocols for Life Detection (LD) (including Biohazard Assessment). Curation, without dissemination if risk of biohazard. Clean and high containment environment.

- **Work Space**: Offices, meeting rooms, social rooms, restaurant…
- **Public outreach**: Museum, exhibition area...

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- **Analogue Facility**: Semi-mirror facility for personnel training, instruments and protocols testing on analogue samples. For restricted samples mostly, since analogues have to be kept totally separated from samples. In the case of unrestricted samples, analogues can be kept in the same curation unit. Based on input from WP5 "Analogue Samples".

- **Remote Storage Unrestricted**: Storage under dead-mode of a TBD part of unrestricted samples. Clean conditions.
- **Remote Storage Restricted**: Storage under dead-mode of a TBD part of the potentially biohazardous samples. Clean and contained conditions.

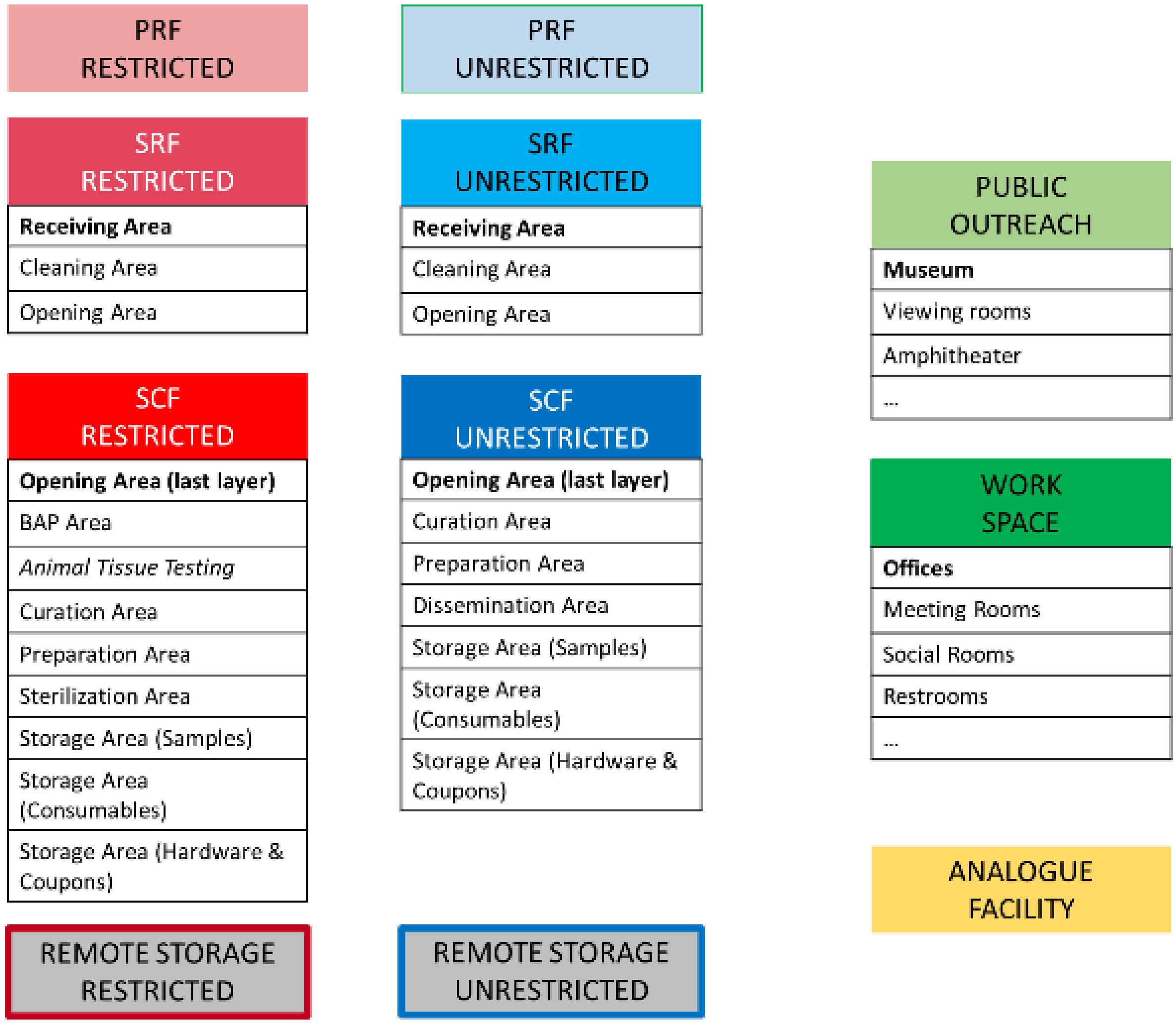

Figure 2 : Units and subunits of the ESCF. Red units are for restricted samples, blue units for unrestricted ones. Green units are non-scientific units. Analogue facility (orange) is still TBD.

The path and detail of the transfer systems for samples and workers between the different units or within a unit will be defined and described in the next deliverables.

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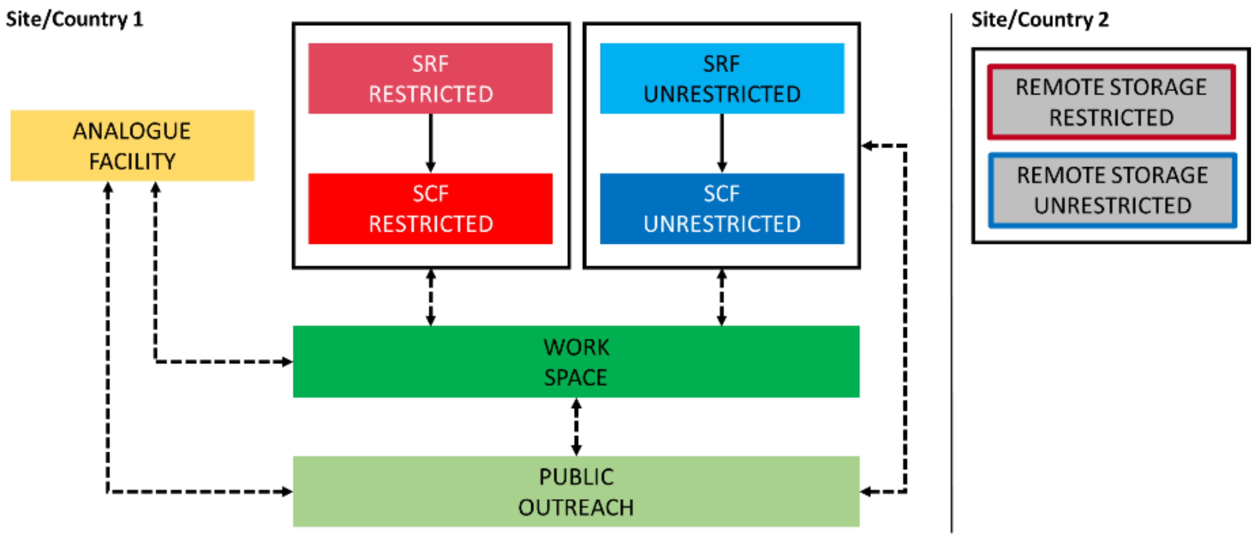
2.2 Possible scenarios for building the ESCF

As stated previously (see D3.2), it is not mandatory and even not recommended to build all units at the same time, knowing that they should be designed to be structurally independent, allowing building over a TBD timeline. We envision below several possible scenarios. This list is non exhaustive.

- Integrated approach

In this scenario, all units (except the remote storage) are built on the same site, but not necessarily at the same time.

Pros: One location and one team only. Less expensive.
Cons: "All eggs in the same basket"; If shut down because of a catastrophe or for any other reason, all activities are over. This option may also rise political issues because not sharing the samples. Need a site large enough from the very beginning to be able to accommodate future units.



- Restricted vs. Unrestricted

In this scenario, potentially biohazardous samples and non-biohazardous samples are treated separately, with SRF/SCF built on different sites.

Pros: More than one country involved. Redundancy. Smaller initial sites.
Cons: Training and skills of workers less easily transferable between "Restricted" and "Unrestricted". Cost.

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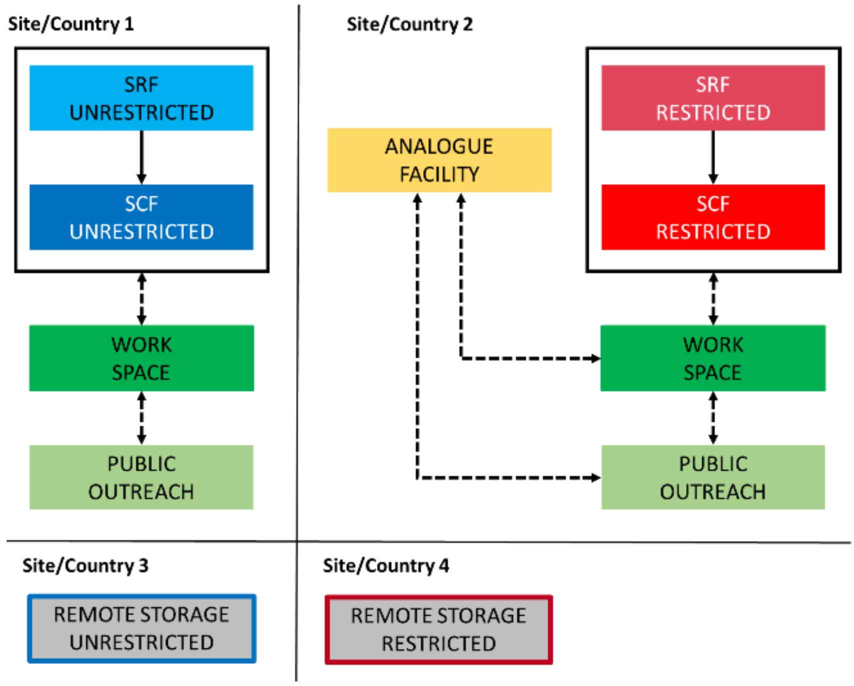
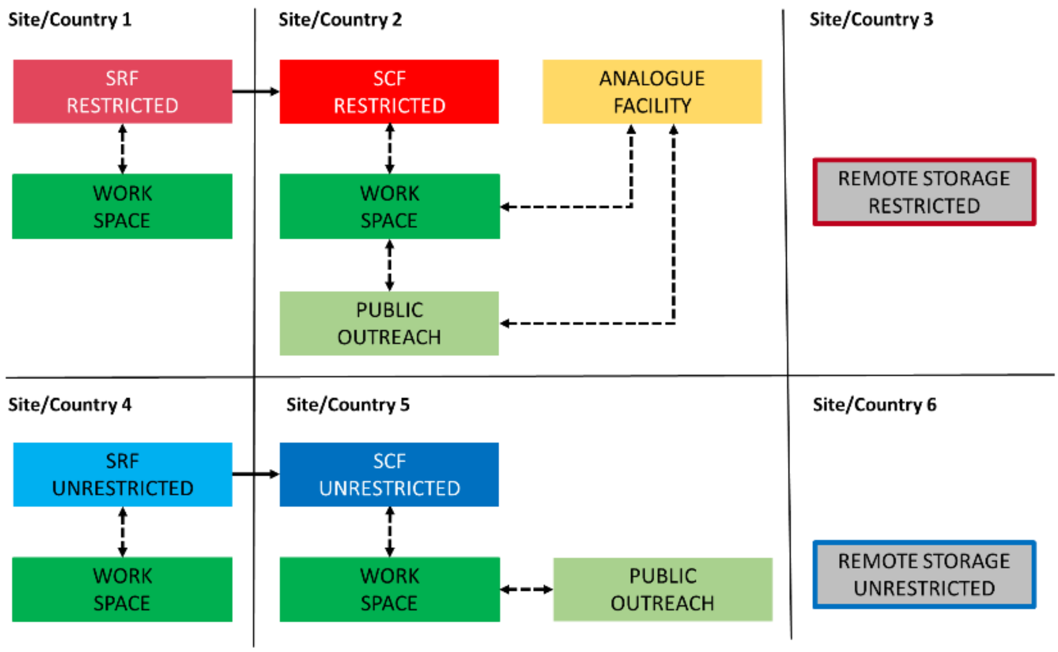


- <u>Common receiving facility – Separated curation facilities</u>

All missions are received in the same place, samples are then shipped to distinct curation facilities.

Pros: The receiving facility is used more often, to counterweight the transient function of it. More partners involved. Redundancy. Smaller initial sites.
Cons: High replication of workers and working space. Training and skills of workers less easily transferable between "Restricted" and "Unrestricted".



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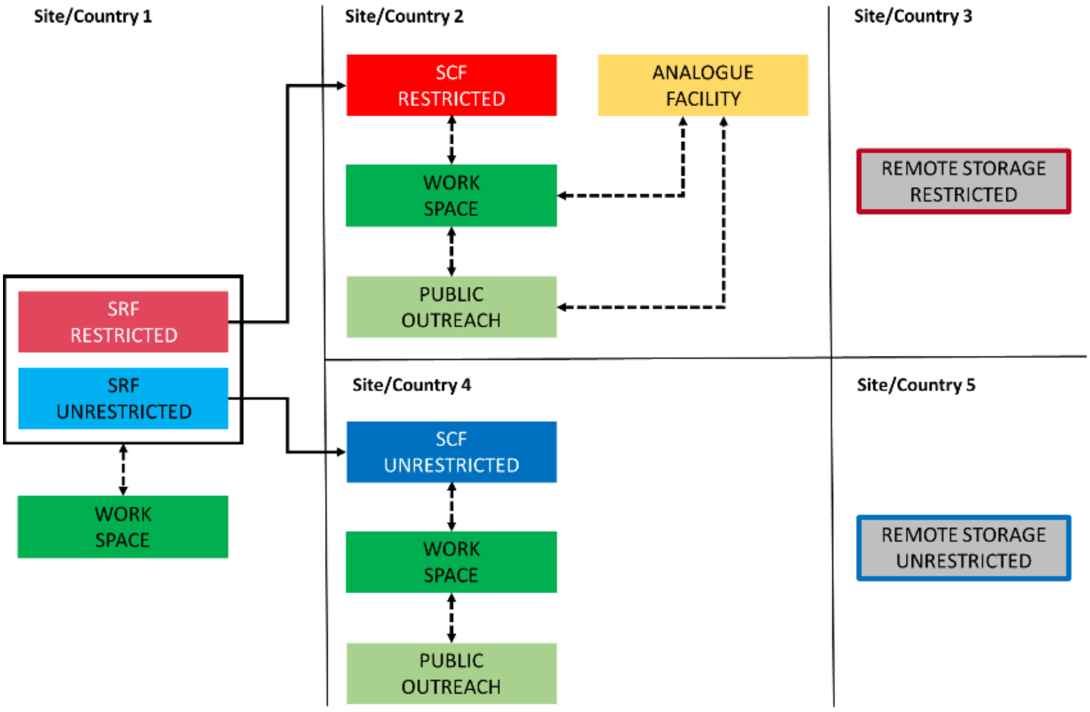
- <u>Distributed approach</u>

All functions (receiving and curation) are scattered in different locations.

Pros: More partners involved.
Cons: Very high replication of workers and working space. Cost. High risks and costs of transports between facilities.



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2.3 Planning and Management of building

The present work is part of the road mapping phase of such an ESCF. Conception and plans will have to be finalized with one or more very specific and trustworthy companies. The building phase itself can then be achieved by less specific companies. Ideally, all phases (road mapping, conception, planning and building) should be supervised and coordinated by a project manager. This is meant to guarantee a link between all the different parties involved and to have a complete overview over the project.

Planning and building require no less than two years to be completed, not including finance planning and acquisition of a physical location. When dealing with restricted samples, the qualification of a BSL-4-like laboratory can take as much as two years. Similarly, staff recruitment and staff training (especially for BSL-4 processors) can take up to two years. Consequently, it is vital to start planning for such an ESCF several years before the return to Earth of sample-return space mission (if not even before the launch of a sample return mission since the facility could also be used for spacecraft clean assembly; See D3.2.).

2.4 EURO-CARES Design Studio

L. Ferrière and A. Hutzler approached Sandra Häuplik-Meusburger and San-Hwan Lu from the Department of Building Construction and Design HB2 (Institute of Architecture and Design of the Vienna University of Technology) to obtain an external input on the EURO-CARES project in general and WP3 in particular. It was decided to collaborate through a *Design Studio*, in the first semester of 2016.

A *Design Studio* is a class in an architecture student program, where students receive instructions on an architectural project and then are asked to produce a whole concept in a limited amount of time.

The EURO-CARES Design Studio was launched in March 2016, for a duration of six weeks. Eighteen students (mostly bachelor students) attended the studio. The initial input was through a three-day intensive workshop during which the students were presented with the preliminary requirement of an ESCF, and were asked to reflect on existing scientific buildings. Scientific lectures were given by Aurore Hutzler, Ludovic Ferrière and Allan Bennett. Lecture presentations are in Appendix A to E.

The main requirements were the following:

- The ESCF includes scientific laboratories, as well as working space for curators, researchers and staff. A space for public outreach should be included.
- Depending on their origin (i.e. unrestricted vs. restricted), the samples are either hosted in a clean laboratory, or in a clean and contained laboratory. Both types of laboratory are independent from each other. There could be one or two receiving area for the samples.
- The building should be located somewhere in Vienna (Austria).
- No analysis of risks or costs were conducted, though the overall cost should be theoretically kept under 200 million euros.

Student's projects were assessed all along the semester, through desk critics and meetings with the teachers and the lecturers. Nine out of fourteen projects were presented during the international WP3 Meeting in the Natural History Museum Vienna (13-16 April, 2016). The finalized projects were then compiled in a published booklet, presented below, from pages 13 to 75. It is also available online: https://issuu.com/hochbau2/docs/book_institute_hb2

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This publication should be cited:

Häuplik-Meusburger S. and Lu S.-H.(Eds.) 2016. European Extra-terrestrial Sample Curation Facility - Design Studio SS2016. Vienna University of Technology, Department for Building Construction and Design – HB2, 121 pages.

New important and interesting ideas emerged from the *Design Studio* and interactions with the students, including:

- Involvement of architects from the very beginning of design operations can increase functionality and productivity.
- Cleanrooms can be of any shape (even if non-traditional configurations are more expensive and more difficult to plan and to construct).
- Public areas can be next to the scientific areas, with a high level of security between them. In previous studies, this aspect of the ESCF has seldom been studied.
- It is important to find a common language and to define clear requirements and specifications to avoid problems of miscomprehension between what the curators/scientists would like/want and what the architects can plan and design for the construction.
- Habitability is something very important for the architects and was not considered in our "scientific approach" so far. It is interesting to highlight the architecture contribution to the physical and psychological well-being of workers and visitors.

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HB2

European Extra-terrestrial Sample Curation Facility

Department for Building Construction and Design - HB2

Design Studio SS 2016

Vienna University of Technology

European Extra-terrestrial Sample Curation Facility
Design Studio SS2016

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European Commission

Content

EUROPEAN EXTRA-TERRESTRIAL SAMPLE CURATION FACILITY

Concept and planning for an European extra-terrestrial sample curation facility.
Design Studio SS 2016

Image: S5 payload preparation complex – spacecraft fuelling bay, CSG-Europe's Spaceport, Kourou, French Guiana, from the series The Poetic Impossibility to Manage the Infinite, 2014, © Edgar Martins (www.edgarmartins.com)

Design Studio Approach

Sandra Häuplik-Meusburger &
San-Hwan Lu

Theme

Space agencies worldwide are pursuing mission plans to asteroids, the Moon and Mars. Many of these missions include the collection and return of samples to Earth. However only a small number of facilities have been established - most of them for processing samples from the Apollo or deep space missions. No suitable facility exists that is capable to process samples from all possible space return missions likely for the next few decades.
The study and long-term curation (protection, preservation, documentation and distribution) of extra-terrestrial samples imply keeping the samples free from Earth contaminants, while - in case of biohazards - ensuring they remain contained. The requirements for a combined high containment and ultraclean facility will naturally lead to the development of a highly specialised and unique facility that will require the development of novel scientific and engineering techniques.
The topic of the design studio was the conceptualisation and planning for such a European extra-terrestrial sample curation facility.

Initiation and Goals

A few months prior to the design studio, the Vienna University of Technology was approached by representatives from the Natural History Museum Vienna regarding a cooperation between these two institutions. The NHM Vienna is involved in an ongoing EU research project with the goal of laying the foundations for a European sample curation facility. As there are currently no architects and designers involved, we were invited for a cooperation based on our specific expertise on extreme environment architecture. The topic of the joint design studio has therefore been strongly based on this project's objectives. Following a number of work meetings, basic guidelines for the project were set as follows:

The student's projects should not be restricted to a specific site, but new, single buildings (as opposed to an addition to or renovation of an existing building). In order to determine design relevant parameters, such as the climate zone, the juristic, transportation and social environment we agreed on placing the research facility in Vienna.

The research facility should include additional functions. It should include a laboratory for sample handling and storage, working spaces for researchers, each with their respective technical requirements, work space for scientists, but also public facilities for public outreach. A strong focus will be on the architectural design and the spatial layout, accommodating all functions.

Strategy and Structure of the Studio

This was a short but intense design studio. As a start, the students were asked to study existing research building facilities. The selected buildings included the MRT-Forschungsgebäude in the Max-Delbrück-Centrum for molecular medicine by Glass Kramer Löbbert Architekten and the Fraunhofer IAO Institute, Centre for Virtual Engineering (ZVE) in Stuttgart by UN Studio and ASPLAN Architects. In particular we asked the students to analyse important aspects that would be relevant for their own projects:

· Spatial Organisation: urban setting, layout, spatial sequences in plans and section, functional areas and sizes, etc.
· Materials and Structure: construction, materials used inside and outside, etc.
· Special Requirements: laboratory, work environment, dedicated areas, building equipment and appliances, etc.

The study and discussion of built examples of research facilities within the whole group as well as the identification of possible challenges for their own design served as a foundation for the design process.

An intensive workshop was held in the second week of the design studio. The goal for this one-week working session was to derive a preliminary functional design and architectural concept of the facility. Lectures by Aurore Hutzler, Ludovic Ferrière and Allan Bennett on the programmatic aspects on laboratories and scientific work processes were scheduled in the mornings. The afternoons were used for individual and group working activities as well as table critics. From our side, special care was given to the spatial programming combining the laboratory design with the work and public facilities.

After the intensive workshop with our external experts, students developed their design proposal further. Weekly meetings with the whole group and individual table critics assisted the design process.

All students were invited to join the Working Group Meeting for the EU research project at the Natural History Museum Vienna in mid-April 2016. We, as representatives of the department, were also invited for a talk with the theme 'Architecture as the Interface between Humans and Technologies'. The presentation introduced some work and research activities at our department Hochbau 2 of the University of Technology in Vienna. The main part of the presentation emphasized the role of architecture and building design as the intermediary between the human element and the built environment. Examples, drawn from 'Space and Extreme Environment Architecture' showed the importance of this element for creating a functional, healthy and creative environment.
As a discipline, architecture aims at creating an optimized design that is compatible with technological, scientific, design, and human factors requirements. The design process is usually multidisciplinary and interrelates with the involvement of different disciplines.
The diverse topics of lectures and discussions related to the facility provided a good input for the students to rethink and evaluate their projects. Students presented their work and models and had the opportunity for discussion and exchange with an international group of scientists and experts. Three projects were selected for a detailed presentation.

Results

Following this event, students were asked to prepare a final document that has been put together as a book publication. The book and student projects are to be presented in the frame of the International Conference on Environmental Systems (ICES 2016) in July in Vienna.

The input of our design studio was a great first step to show the importance of architecture for such a project.. This design studio has been the beginning of a fruitful cooperation. We would like to thank all involved for participating and look forward to the next steps.

EURO CARES

European Curation of Astromaterials Returned from Exploration of Space

Ludovic Ferrière & Aurore Hutzler

EURO-CARES is a three year, multinational project, funded under the European Commission's Horizon2020 research programme. Started in January 2015, the objective of this project is to create a roadmap for the implementation of a European Extra-terrestrial Sample Curation Facility (ESCF) that would be suitable for the curation of samples from all possible return missions to the Moon, asteroids and Mars.

Study and long-term curation of pristine extra-terrestrial samples imply to keep them as clean as possible, preventing sample contamination and alteration, while ensuring they remain contained in case of biohazards. The requirements for a combined high containment and ultraclean facility will naturally lead to the development of a highly specialised and unique facility that will require the development of novel scientific and engineering techniques.

EURO-CARES team work is organized around five distinct technical Work Packages (WP), led by competitive institutions, scientists and engineers from all over Europe:

*WP2: Planetary Protection

*WP3: Facilities and Infrastructure

*WP4: Instruments and Methods

*WP5: Analogue Samples

*WP6: Portable Receiving Technologies

Along with the scientific and technical requirements, EURO-CARES project is also focused on a high impact public engagement plan, especially with children, university students, the general public and policy makers, as well as our academic and industrial peers. A significant risk to the development of an ESCF is the public perception of extra-terrestrial samples, potentially containing biological entities, being deliberately returned to Earth without going through the sterilising process of exposure to cosmic-rays and harsh space environment. This could be of great concern to many people and could lead to major delays in the establishment of such a ESCF. Hence, open communication is of great importance.

Additional information on the EURO-CARES project is available on: www.euro-cares.eu

The Natural History Museum Vienna (NHMV) is part of the EURO-CARES consortium, with Mag. Dr. Ludovic Ferrière (chief-curator of the rock collection and co-curator of the prestigious meteorite collection) as leader of the WP3, dedicated to Facilities and Infrastructure, and Dr. Aurore Hutzler, post-doctoral researcher fully employed on the EURO-CARES project. The work being conducted in Vienna has for objective to define the state of the art facilities required to receive, contain and curate extra-terrestrial samples. All the aspects, from the building design to the storage of the samples to the curation are covered in close collaboration with the other WPs and also together with the expertise of international and local institutions and companies. It is in this context of a multidisciplinary approach, and search of building a local partnerships in Austria that the NHMV team approached expert architects from the Space Architecture department at the Technical University of Vienna (TU Wien). The design studio presented in this publication is the result of our fruitful collaboration.

The design brief was based on the EURO-CARES proposal, with the additional requirement that the facility would be based in Vienna. During an intensive workshop, a number of lectures were given by Aurore Hutzler, Ludovic Ferrière, and Allan Bennett to present the EURO-CARES project and the different technical requirement to the students. Fruitful and very interesting interactions with the students and student instructors took place physically at the TU Wien, at the NHMW, and through e-mail exchanges during the few weeks of the design studio. Then the students were invited to present the amazing work they have completed at the international meeting hosted at the Natural History Museum Vienna, in mid-April 2016.

Participants of the EURO-CARES WP3 Meeting at the Natural History Museum in Vienna (Photo: NHM Wien, Kurt Kracher)

EURO-CARES WP3 Meeting

„Designing a European extraterrestrial sample curation facility“
13th – 16th April, 2016, Natural History Museum Vienna.

As the other EURO-CARES Work Packages, WP3 had to organize in 2016 an international meeting gathering experts in the fields of: curation, architecture, biocontainment, robotics, cleanroom design, etc. to present work completed in their fields related to the project. This allowed discussions in how WP3 could progress.

Up to 55 persons attended the meeting with a number of experts from public institutions (such as NASA, CNES, University of Alberta, etc.) and companies (such as Merrick Canada ULC, Cleanroom Technology Austria, etc.).

Four sessions were organized, including one which was dedicated to architecture (entitled „Architecture and Design“) on Thursday 14th of April, with three invited expert talks, three oral presentations by the students and nine posters from the students.

The meeting was a very good opportunity for the experts to interact with the students, to receive feedback from scientists and engineers from various backgrounds, and to learn from the different presentations given during the meeting. It was also an overview of how researchers work and present their work, and how large European projects are built and led.
The work presented by the students was acclaimed by all the conference attendees who were impressed by the quality of the presented designs.

Instructors Lecturers

TU Vienna
NHM Vienna
EURO-CARES

Sandra Häuplik-Meusburger

Sandra Häuplik-Meusburger is Senior Lecturer at the Institute for Architecture and Design, Department for Building Construction and Design - HB2 at the Vienna UT. She is an architect at spacecraft Architektur and expert in habitability design solutions for extreme environments. Sandra is a member of the Space Architecture Technical Committee of the AIAA and chairs the Habitability and Human Factors Subcomittee. She has worked and collaborated on several aerospace design projects. Sandra has published several scientific papers and is author of the books Architecture for Astronauts - An Activity Based Approach (Springer 2011) and Space Architecture Education for Engineers and Architects - Designing and Planning Beyond Earth (Springer 2016).

San-Hwan Lu

San-Hwan Lu is Assistant Professor at the Institute for Architecture and Design, Department for Building Construction and Design - HB2 at the Vienna UT. His field of expertise is building technology and design. He has been working with international firms for over ten years in the realization of complex building envelope geometries of large scale projects. He has finished his PhD thesis on the development of sustainability from an international perspective.

Ludovic Ferrière

Ludovic Ferrière, chief curator of the rock collections and co-curator of the meteorite collection at the Natural History Museum Vienna (Austria), is a geologist by training (studied geology at different French and Canadian Universities before obtaining his PhD from the University of Vienna). In the last few years he contributed significantly to the preparation of the new presentations of the meteorite and rock collections and to the reorganization of the NHM collections according to modern standards. His research activities and expeditions all around the world allowed him to confirm three of the currently 188 recognized meteorite impact craters on Earth. He is involved in a number of European and International projects, including EURO-CARES as leader of the work package 3 („Facilities and Infrastructure“).

Aurore Hutzler

Aurore Hutzler is a geologist by training, with a focus on geochemistry. After completing her master degree in Planetary Sciences at the Ecole Normale Supérieure de Lyon, she obtained her PhD at Aix-Marseille University, France. Severalresearch study periods, mostly in the USand in Germany, in the last few years enhanced her multidisciplinary approach.
Her research on cosmochemistry of meteorites led her then to work on more pristine extra-terrestrial samples, from sample return missions. She is now a full-time post-doctoral researcher for the EURO-CARES project, mainly involved in WP3 and in outreach activities for the project. Her personal interests go from event planning to horse riding to dancing.

Allan Bennett

Allan Bennett leads a research group of 15 scientists specialising in air and water microbiology, disinfection, and biocontainment at Public Health England, Porton Down (UK). He has used his expertise to contribute to various ESA-funded projects on low temperature sterilisation, spacecraft cleanliness, and on defining requirements for Mars Sample Return Laboratories. He also carries out studies into healthcare acquired infections and environmental bacterial pathogens. He is a member of the ESA Planetary Protection Working Group and has over 50 peer-reviewed scientific publications.

Students and Overview of their Projects

Students are listed in alphabetical order.

Stephan Asboth (p.35)
Robert Baumgartner (p.35)
Jana Burakova (p.43)
Dea Garbucheva (p.105)
Carla Greber (p.53)





Elif Hayran (p.61)
Julius Heffner (p.69)
Poulin Justine (p.75)
Emre Kilic (p.83)
Iiana Koskinen (p.27)





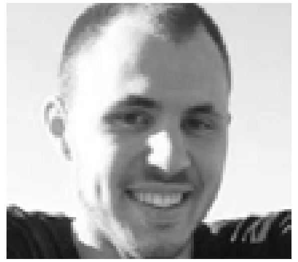
Maurice Fabien Nitsche (p.15)
Pavel Ritter (p.91)
Elena Todorova (p.99)
Barbara Tothova (p.43)
Konstantin Tsay (p.111)





Teodora Tyankova (p.99)
Fábián Villányi (p.115)
Ivan Vratnica (p.83)





Sample Curation Facility

Maurice Fabien Nitsche

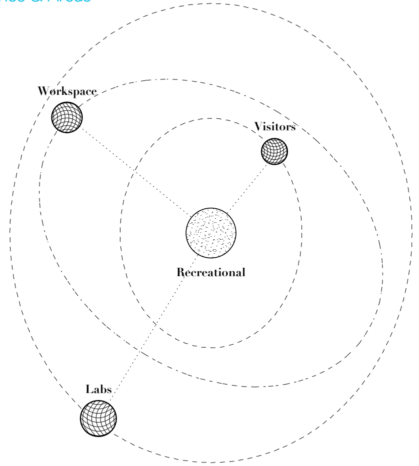
Location:	Vienna
Floor Area:	
Laboratories	2400 m^2
Office	850 m^2
Exhibition	450 m^2
Public	1900 m^2

Specific Characteristics:

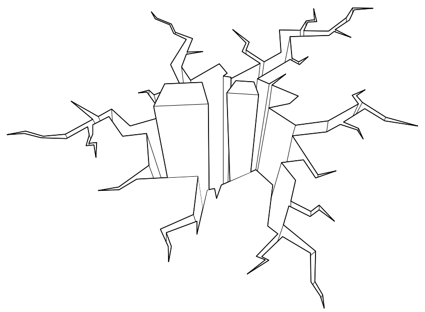
Three public buildings arise from the compound. The main floor and other levels are located underground. The labs are separated and connected by the working spaces.

The design follows the technical and organisational rules of BSL 3 & 4 laboratories. These requirements are the base for the design following a return mission from Moon or Mars. The given requirements are then translated in an organisational process. This builds an additional layer with the architectural idea of a functional workflow for the labs, the workspace and the public space. The project is situated in the Viennese Prater following infrastructural considerations.

Architectural Idea:
Lanes & Areas



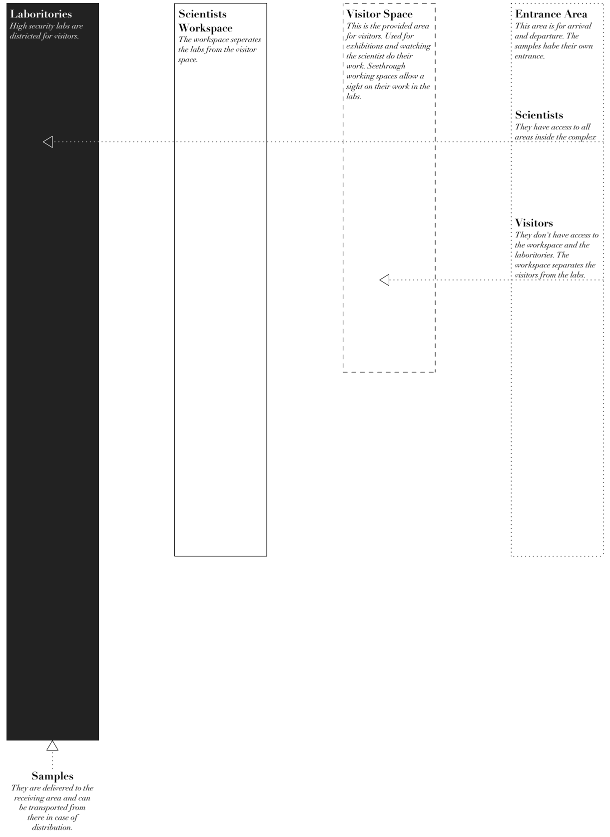
Architectural Idea:
Geological crack



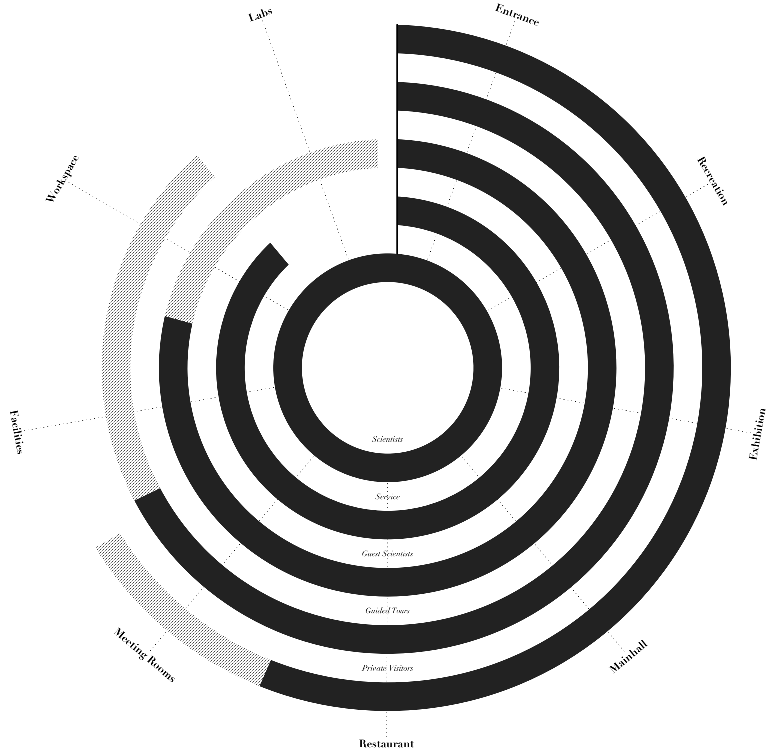
Organisation, Accessibility & Concept

During a preliminary workshop, functional requirements of rooms, areas and technical equipment for the design and construction of laboratories were given by scientists of the Natural History Museum Vienna.
The first step was to organize and connect the different areas. There are strict procedures for entering and working in BSL-4 laboratories and in cleanrooms.
Due to the design brief i decided to integrate a public area within the facility.
The following problems had to be addressed: How can the separation of the public, the workspace and the lab areas be ensured, but at the same time the public be given impressions of how the scientists are working within this facility?
The solution was an open workspace, which separates the public from the labs, which still gives the opportunity to gain insight in the labs throught the visually permeable work spaces.
The workspace can only be entered with a badge, the same for the labs afterwards.
The concept was to concentrate the public in the middle, surrounded by the workspace and in turn by the labs.

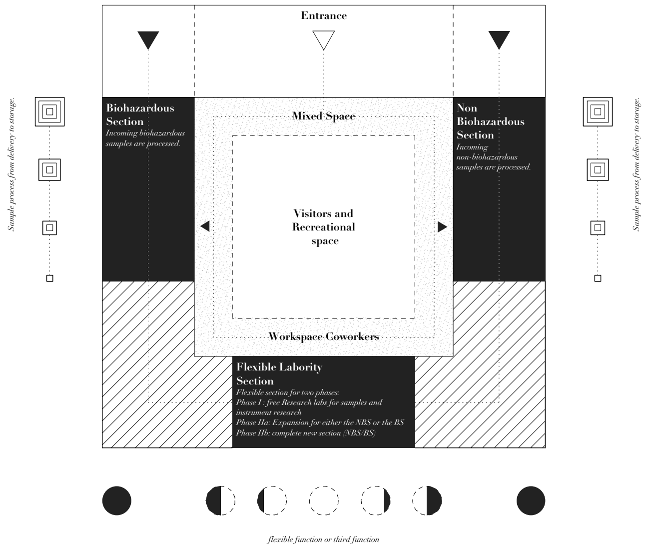
Organisation of the three areas



Accessibility



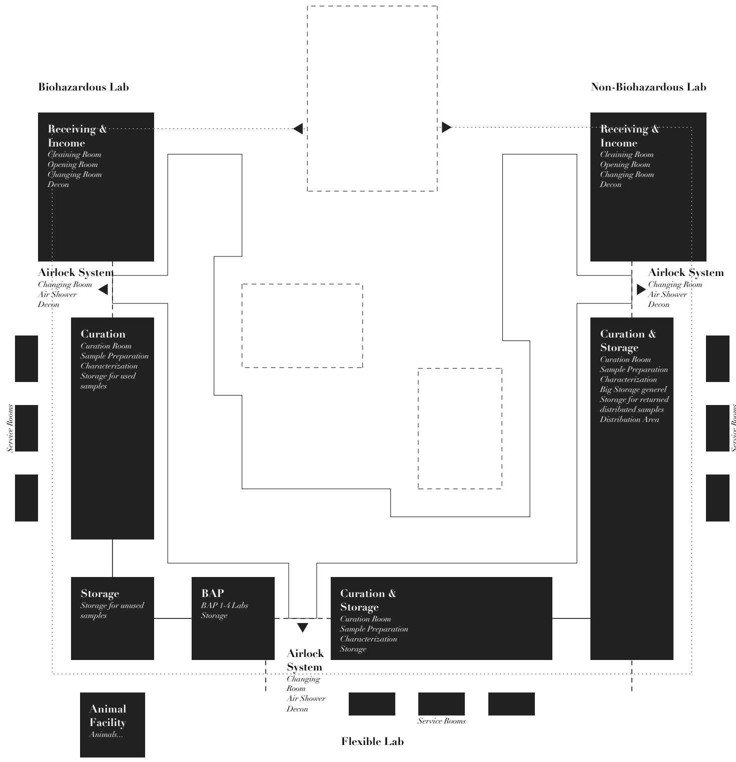
Organisational & Architectural Concept



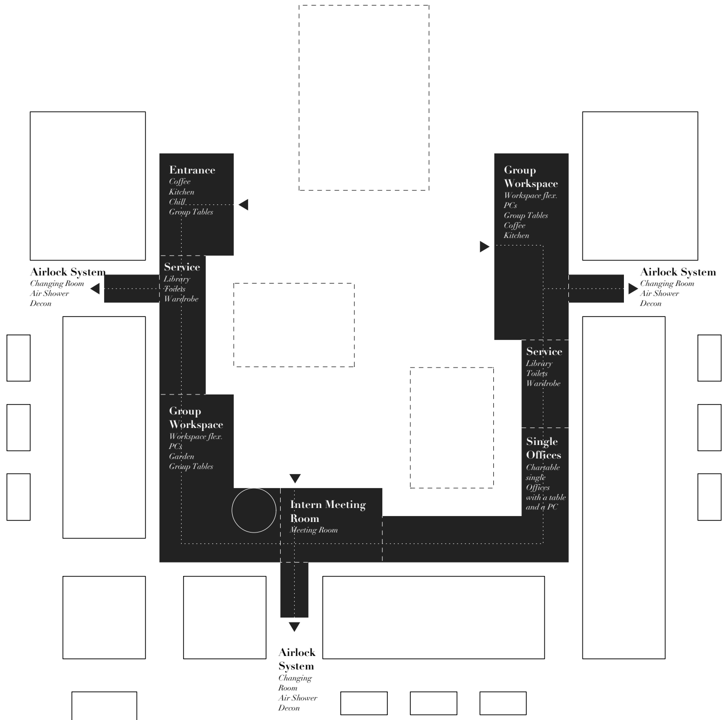
Transmission to Architecture: Laboratories, Workspace & Public Areas

This page shows the three different areas: the laboratory, workspace and public area. The first diagram shows the arrangement of the laboratories.
On the top the samples will be delivered through the entrance building and stored in the two receiving areas, for the BSL-4 lab on the left wing and the Clean Lab on the right wing. At the bottom wing there is a flexible lab for research, providing space to expand existing labs or a third sample mission.
After entering the laboratory process the sample goes from the opening and cleaning rooms through curation and finally to the storage rooms.
As mentioned there is the workspace between the labs and the public area. Within itself there are different areas for working and recreational purposes with different states and possibilities of working. The entire workspace area is open plan and surrounded by a glazing to the public space.
And finally the public space is built by three public volumes, that can be seen from outside, a patio for recreational purpose and the exhibitional hallway around the patio bordering to the workspace.

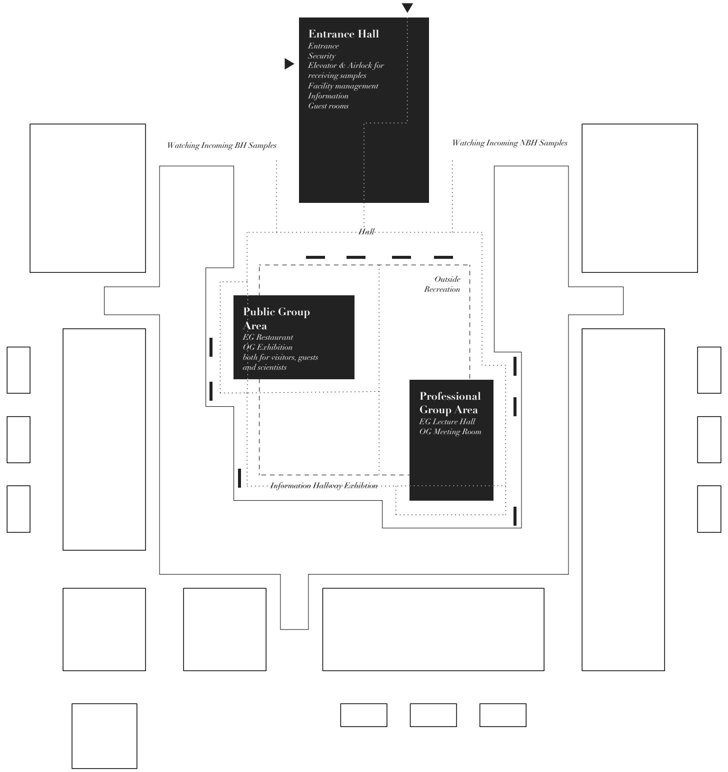
Laboritories



Workspace



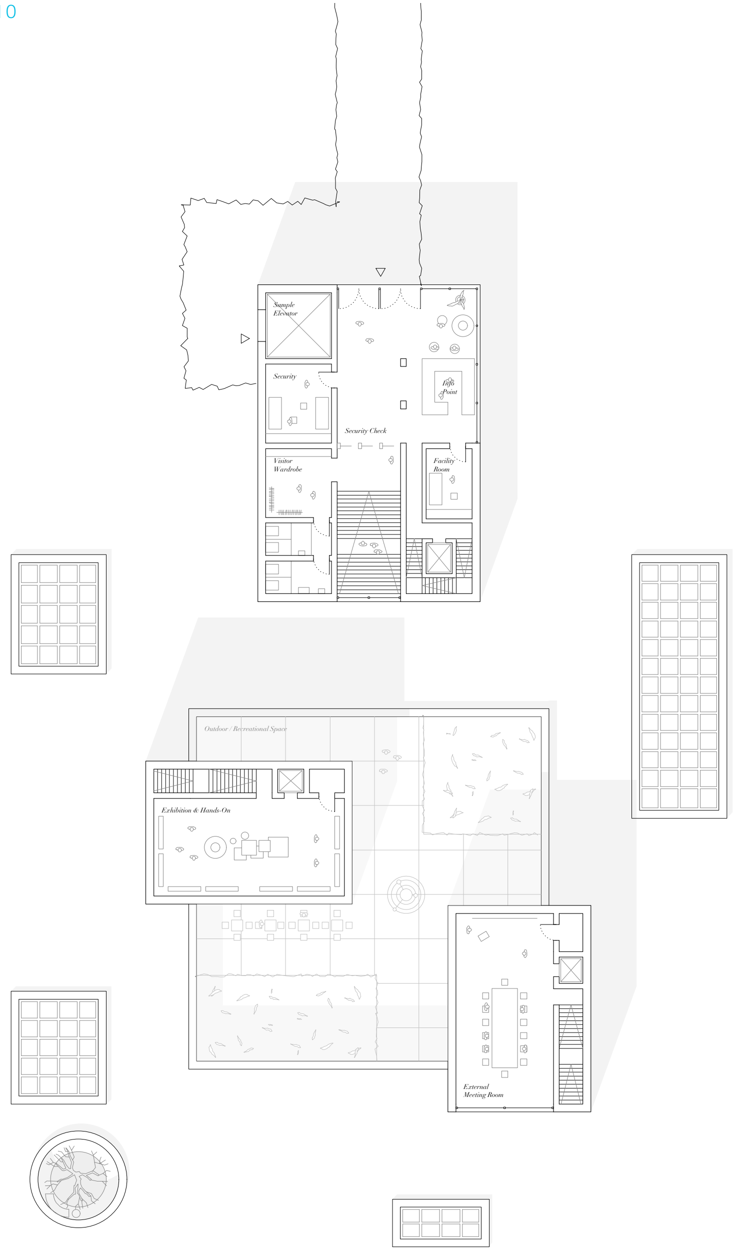
Public & Recreational Space



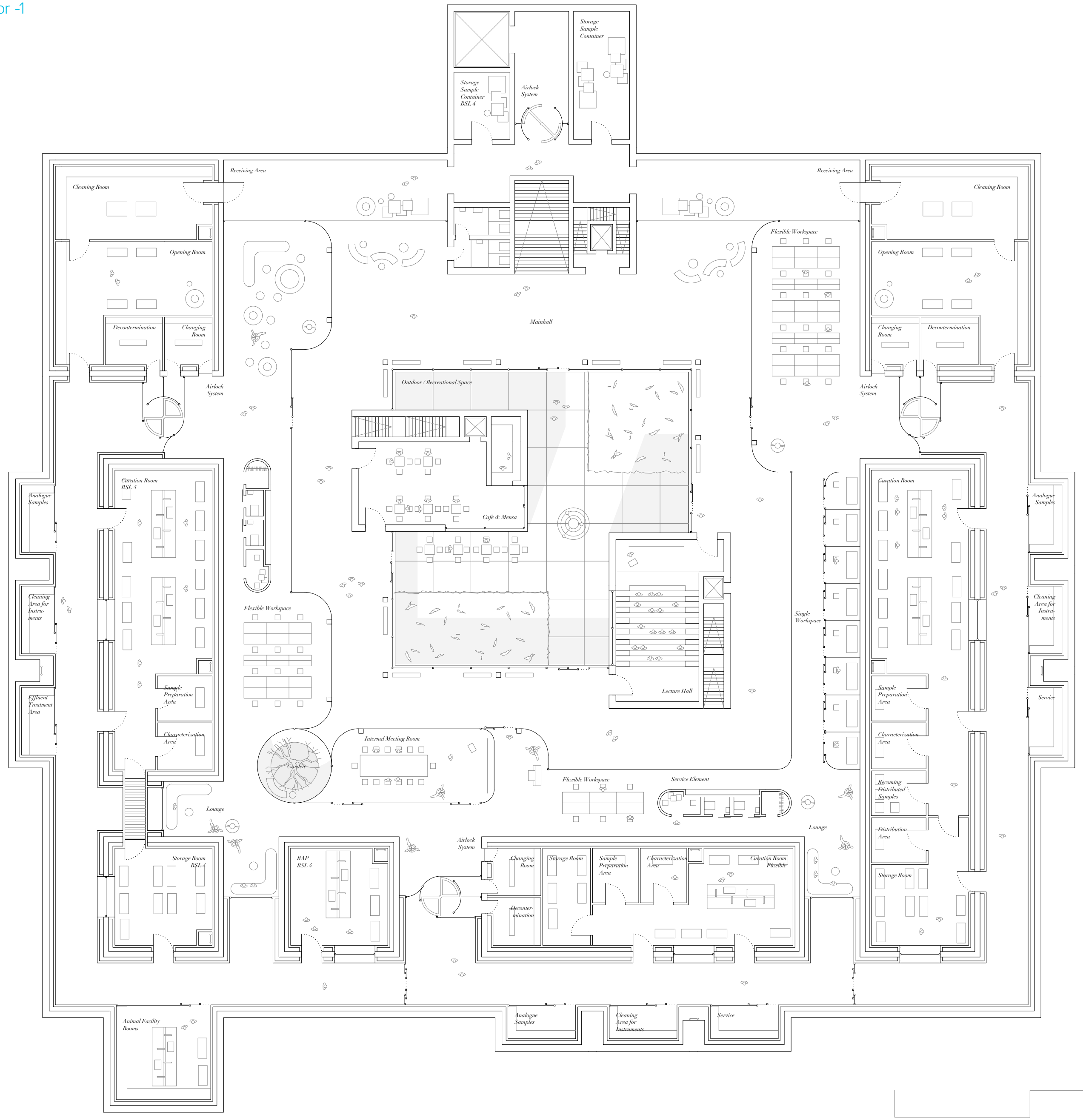
Floorplans

The first plan shows the entrance level. In the entrance building will be a waiting hall with an information counter, a wardrobe, toilets and the security checkpoint.
The smaller buildings contain an exhibitional hall with an external meeting room on top.
The second plan shows the mainfloor. On top is the building for incoming samples, scientists and the public. In the middle the public space with the patio, the hallway, a bistro and a lecture hall. Next to that are workspaces and in the outer wings the labs themselves.
The last plan shows the basement below the mainfloor on the underground level. The basement contains storage facilities and machines for the whole compound and the three buildings. Furthermore it also has a parking space in front of it. The mechanical rooms for the facility and the labs are located under the courtyard, surrounded by the gas and liquid systems for the labs. The testing facilities for the labs are directly beneath the laboratories.

Groundlevel 0

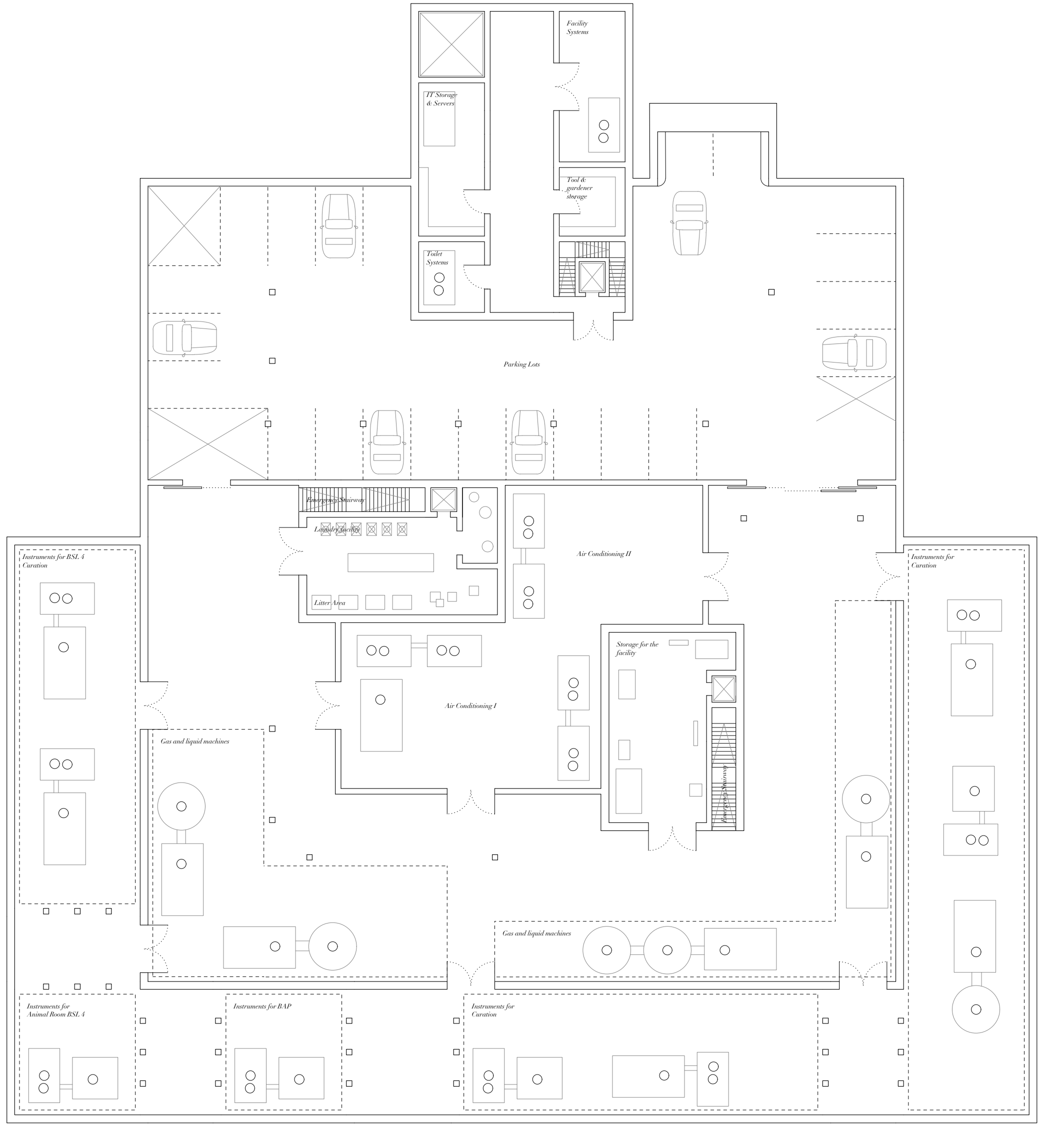


Mainfloor -1



10 m

Basement Level -2



10 m

Construction, Sections & Material

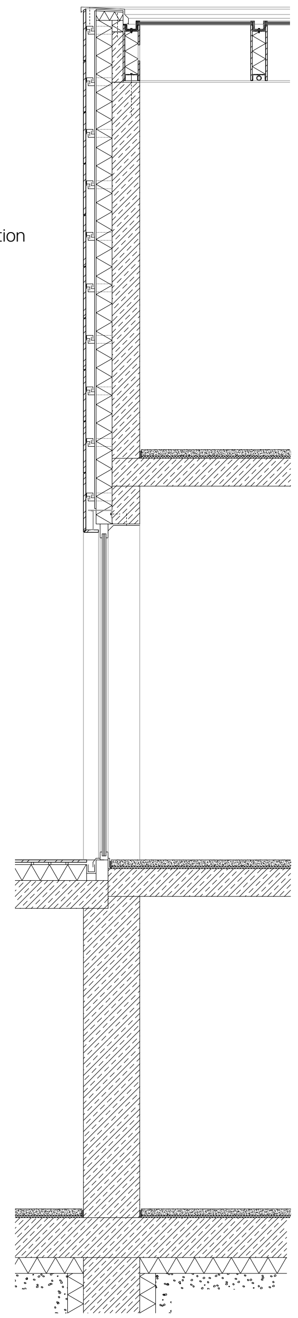
The structure itself is a simple reinforced concrete construction. The volumes of the public parts are clad in travertine with a light and whitened color tone. Flooring is based on industrial screed, resembling concrete surfaces. For the workspaces also only concrete is used. The overhead glazings are constructed with a cubicle system, based on a glazed steel structure.
The laboratories work as a box-in-the-box system. The outer construction material is reeinforced concrete, the material for the box is steel, aluminium or powder-coated material.
The first section shows the entrance of the building, through the hallway and the patio, the workspace and finally ends in the labs. The second section shows a clear cut through the different work-space areas. The third section shows the whole compound from lab to lab and the patio with the bistro/exhibtion building in the middle.
The point of view of the visualisation is located at the public space looking toward the glazed workspace with the labs in the background. In the foreground the public building parts with the window to the patio and the information/exhibi-tion panel in the hallway can be seen.

Steel cassette ceiling
Steelpanels
U-Profile as rain gutter
Overhead glazing slope
Insulation

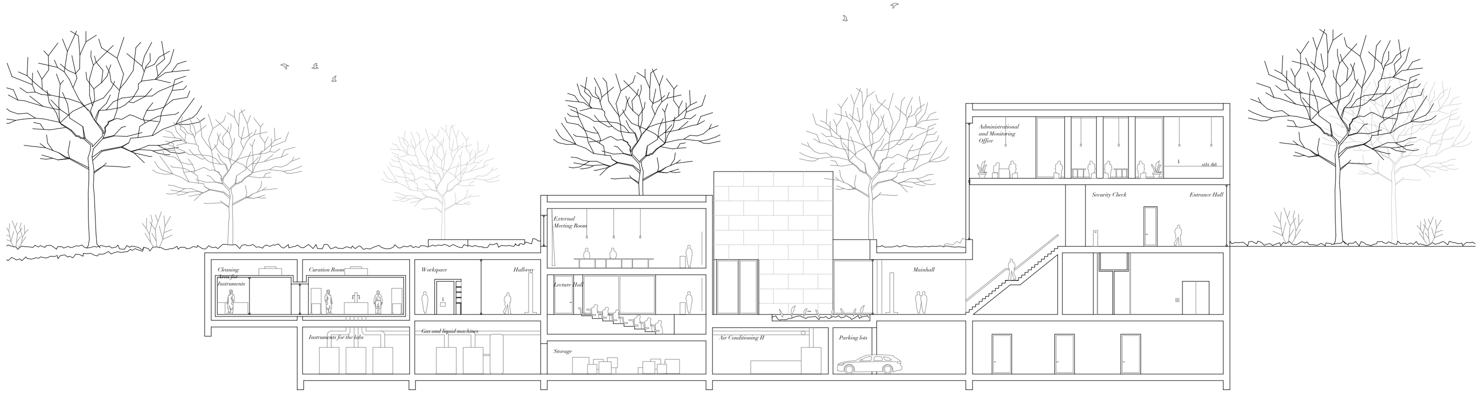
Facade
Travertine
Back Ventilation & Installation
Vapor Barrier
Insulation
Reinforced Concrete

Ceiling
Reinforced Concrete
Impaced Sound Insulation
Industrial polished Screed

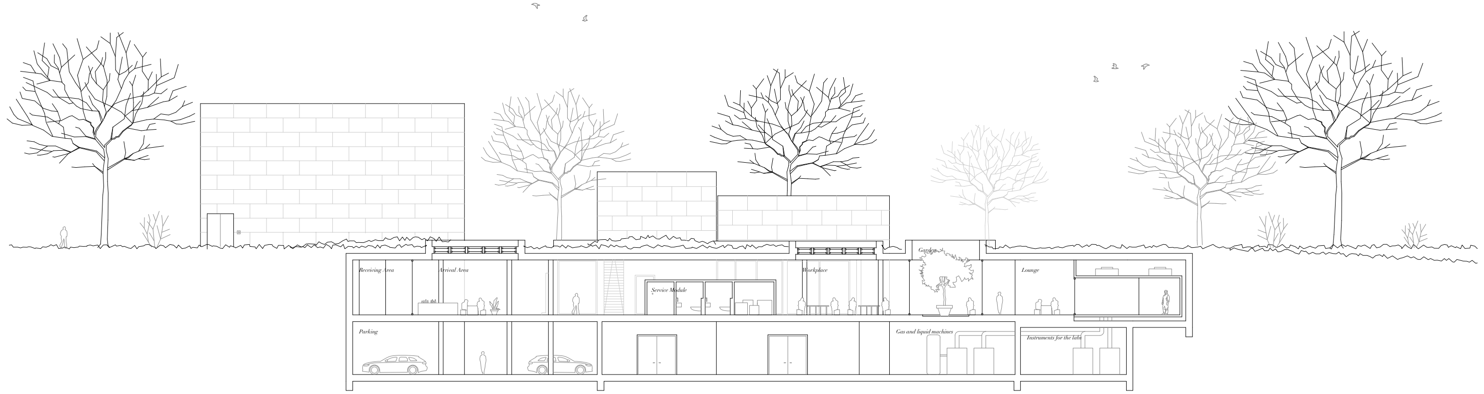
Floor
Granular Subbase
Insulation
Reinforced Concrete
Impaced Sound Insulation
Industrial polished Screed



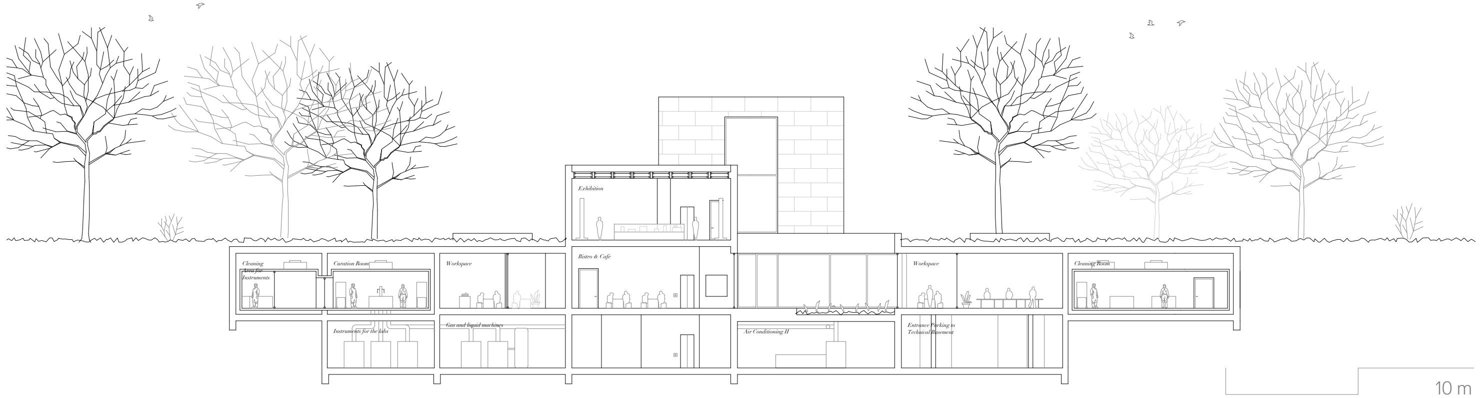
Section I: Entrance Building to Lab



Section II: Workspace



Section III: west to east through the compound



10 m

View towards courtyard

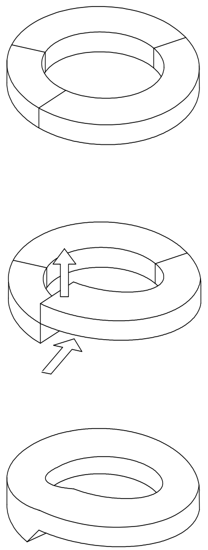
Ring Ring

Iina Koskinen

Location:	Vienna
Floor Area:	1588,4 m^2
Laboratories	275,6 m^2
Office	465,7 m^2
Public	454,5 m^2
Other	392,6 m^2

Specific Characteristics:

Mars theme outdoor exhibition, corten steel.



Ring ring is a circle-shaped building that comprises offices, laboratories and technical rooms. The area below the offices and the inside of the ring - the Mars theme courtyard - are public spaces.

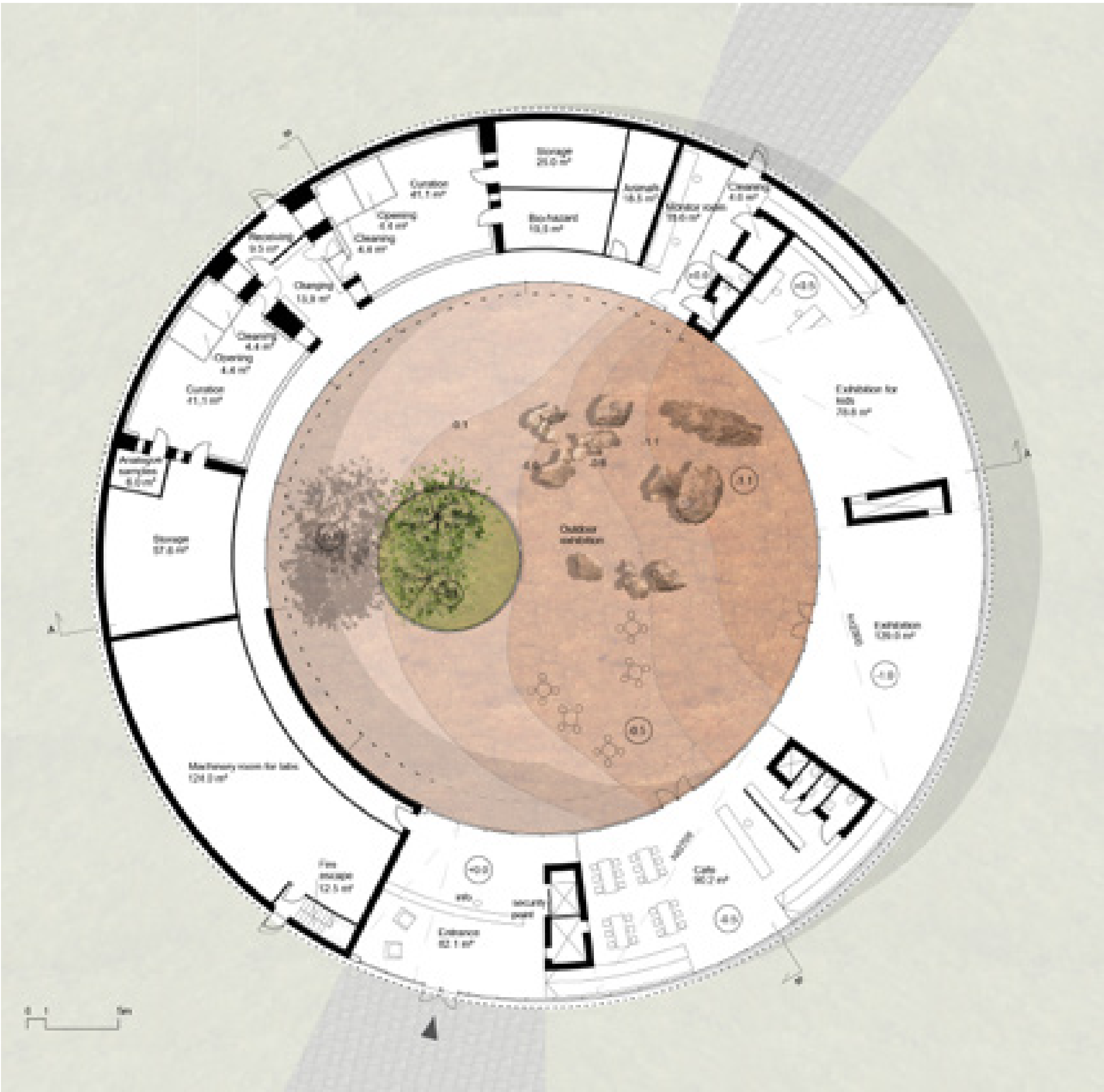
The entrance and public space is created by lifting and tilting one segment of the ring. At the same time the courtyard is connected to the public space.

The geometry also divides the scientific activities from the public; visitors can only access the open space, scientists can access all areas.

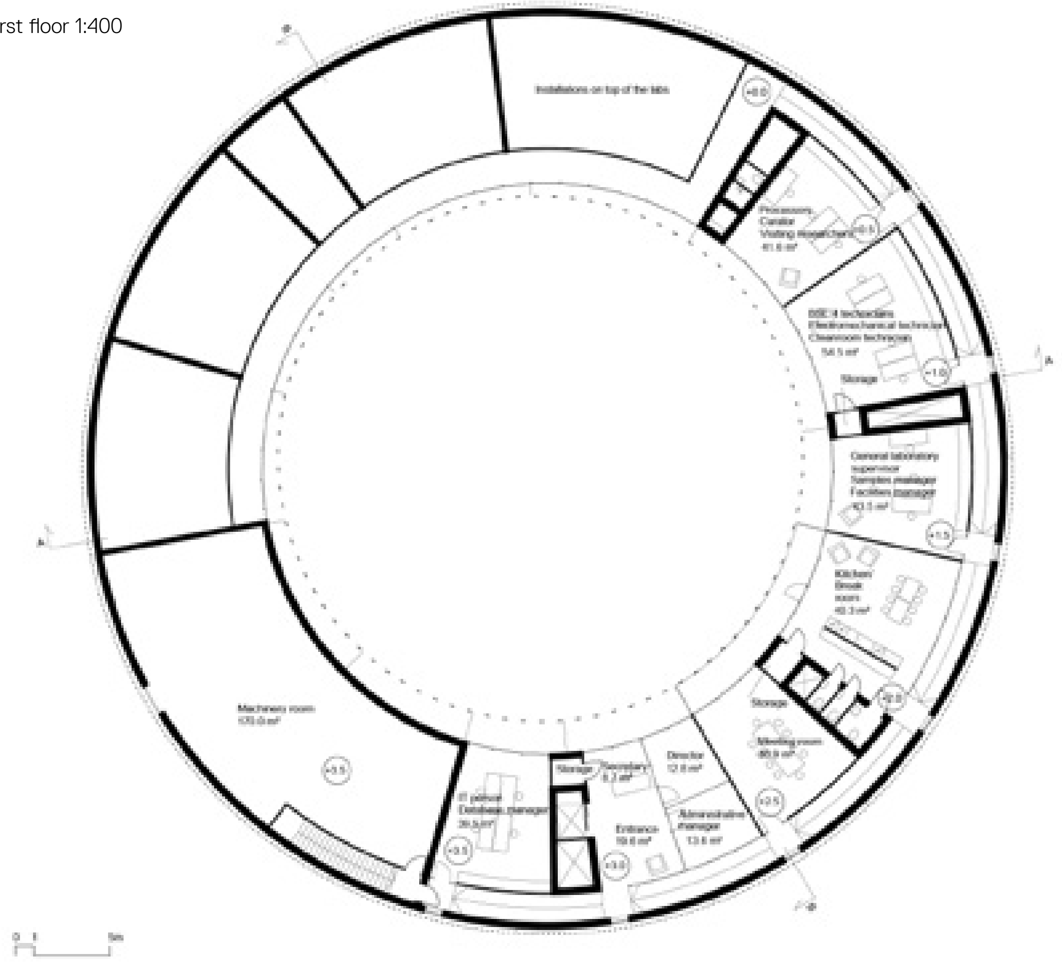
The ring is covered with perforated corten steel. The more it is perforated the more it becomes transparent. The public space is mainly dominated by glass.

Floorplans and section

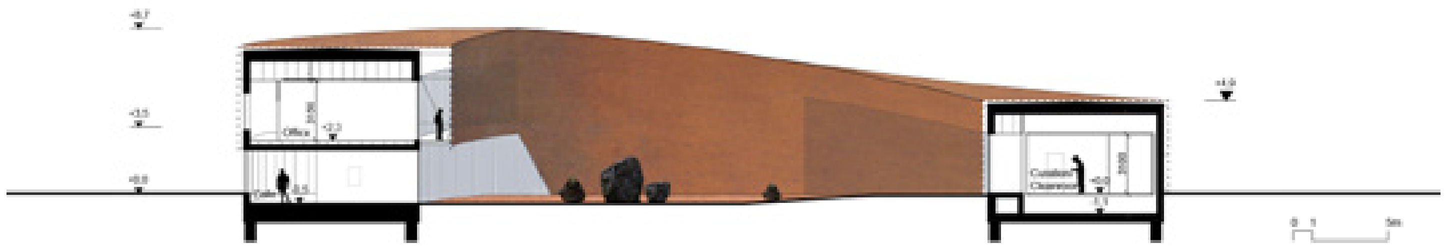
Groundfloor 1:400



First floor 1:400

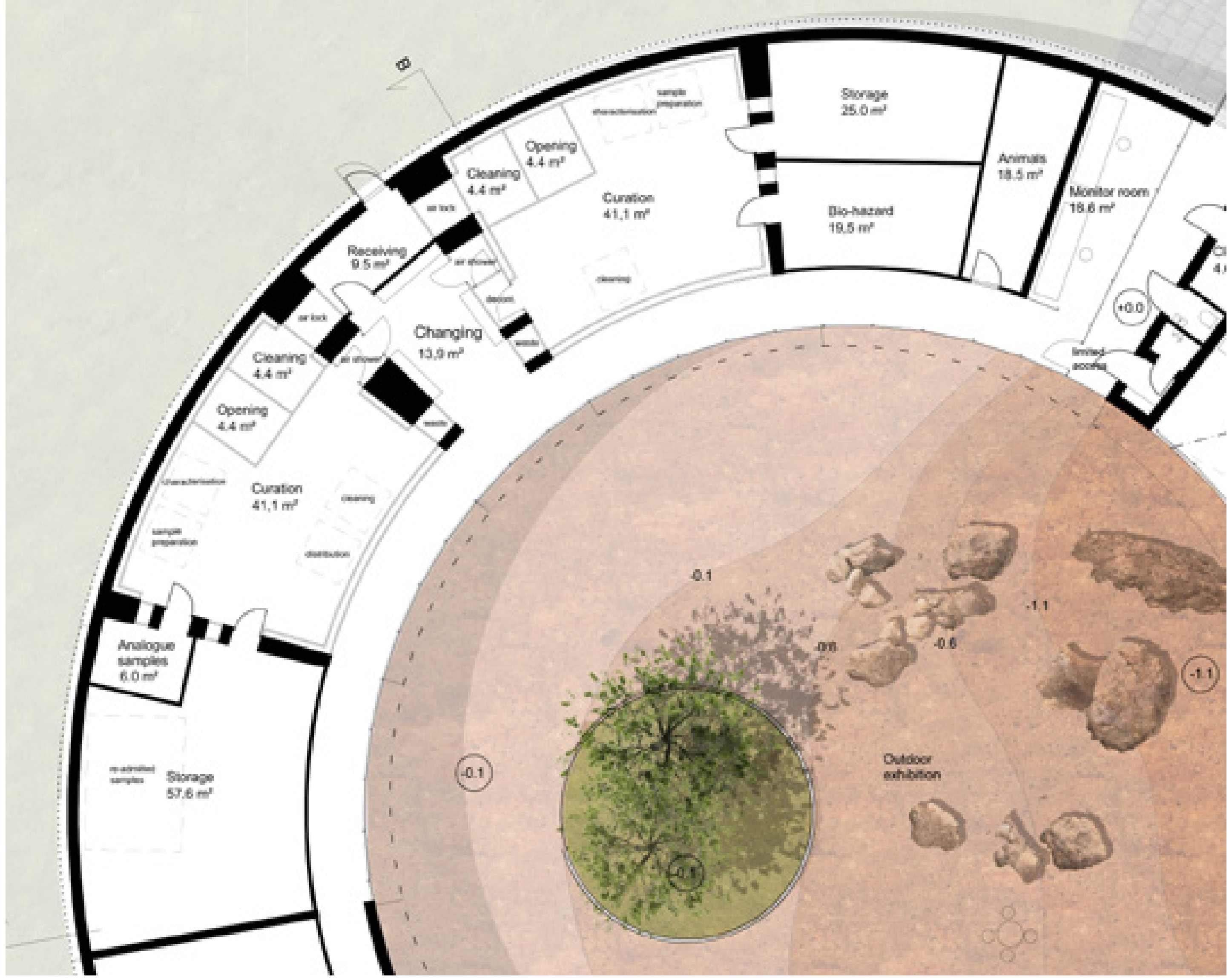


Section 1:400



Laboratories

Groundfloor 1:200

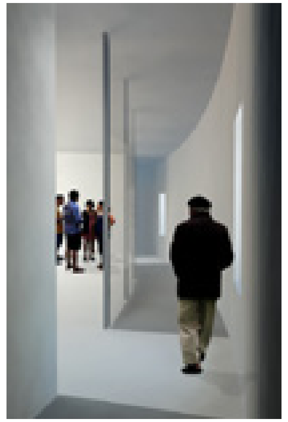


Views

Approach to the facilty

Entrance

First floor corridor



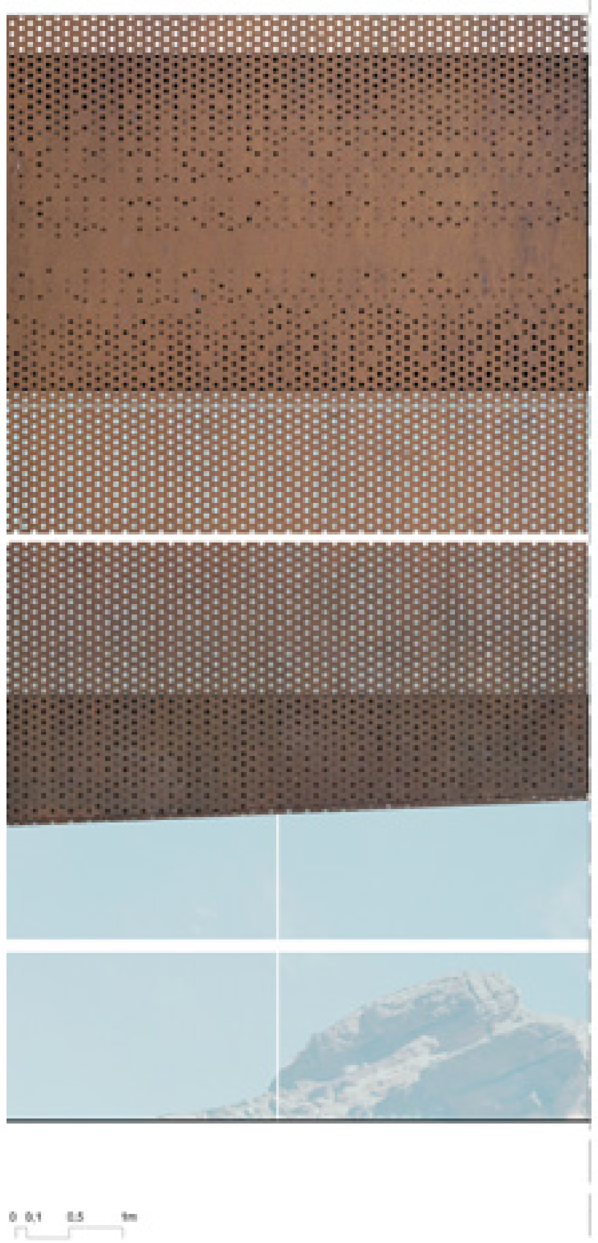
Office

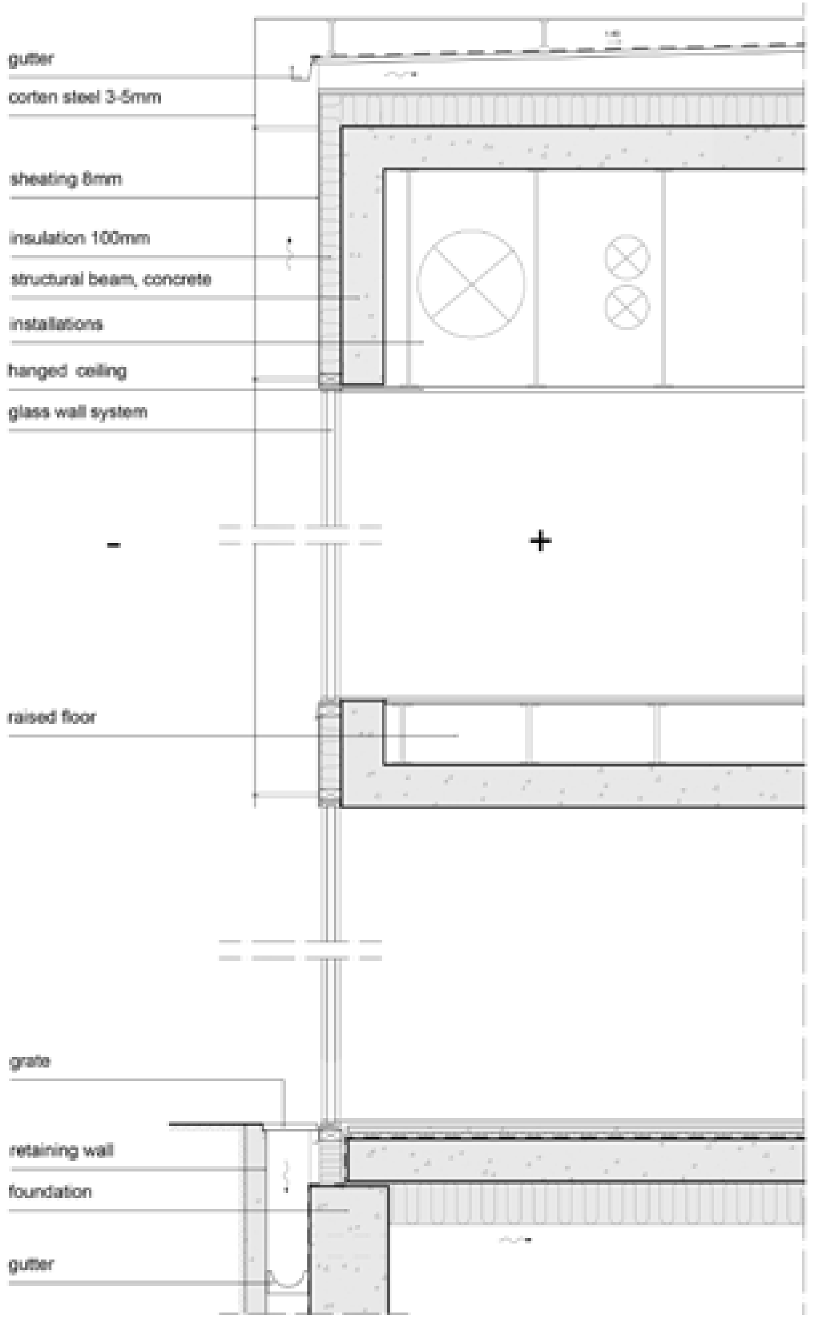
Corridor to labs

Facades, Materials, Detail

Facade 1:400

Facade 1:400





Detail

EUCFC European Curation Facility Center

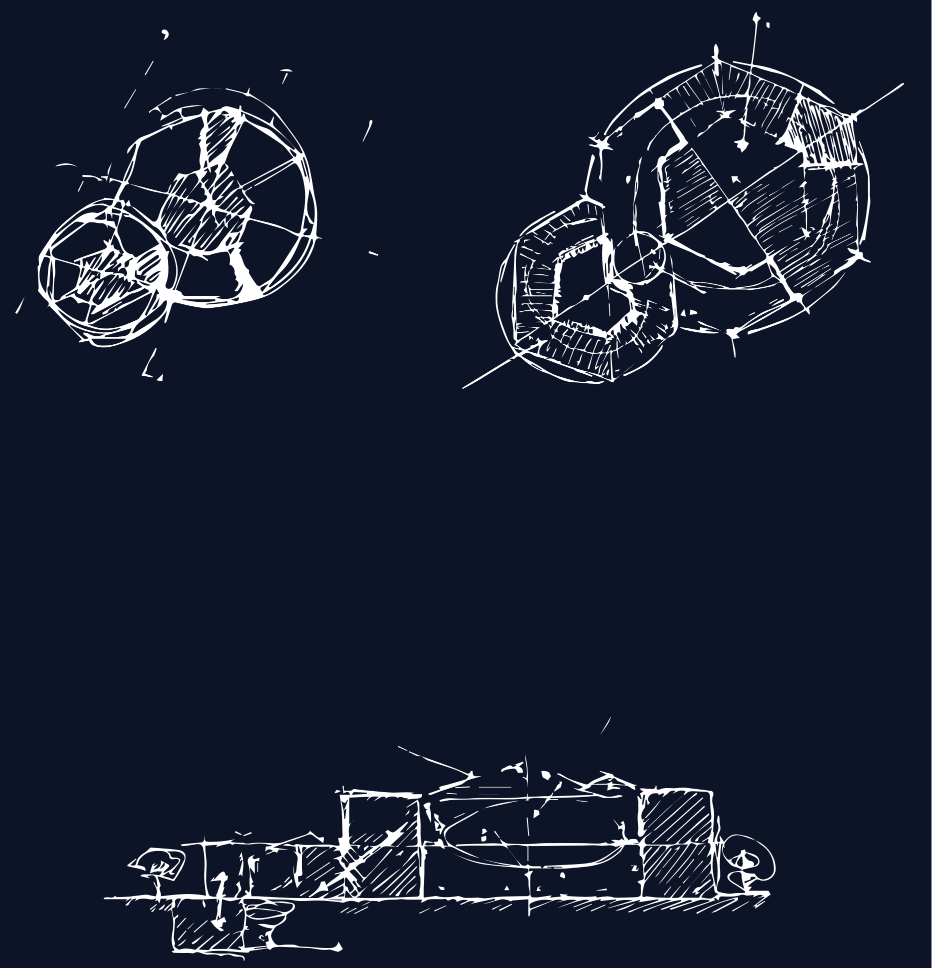
Robert Baumgartner, Stephan Asboth

Location:	Vienna
Floor Area:	
Laboratories	1300 m²
Office	890 m²
Exhibition	790 m²
Total	3000 m²

Samples from Mars will be returned to Earth, but where should they be received, examined, curated and stored? This project comprises a functional laboratory for extraterrestrial samples. Different layers within the building provide an environment to manage an optimal sample flow, from arrival to safe storage in the basement below the workspaces.

A public area is attached to the research facility, to allow public engagement with the facility and sample flow. The building is composed of two hexagons including areas for public presentation, a bistro and comfortable office rooms for permanent as well as guests researchers.

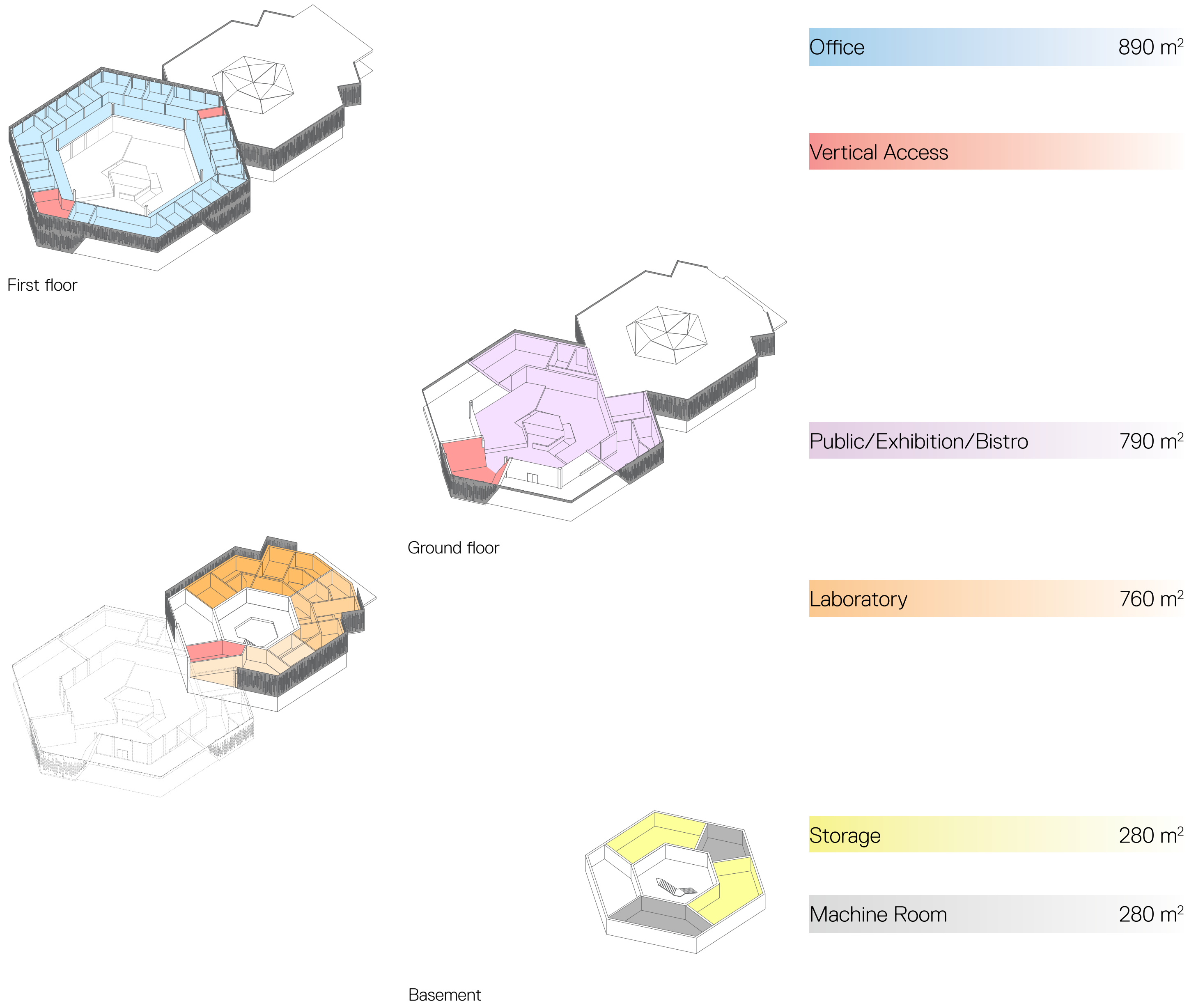
The visitors and the scientists are divided by the different floors but linked together through visual connections. The work process becomes transparent to support a better understanding of who is working on these fascinating samples from outer space.

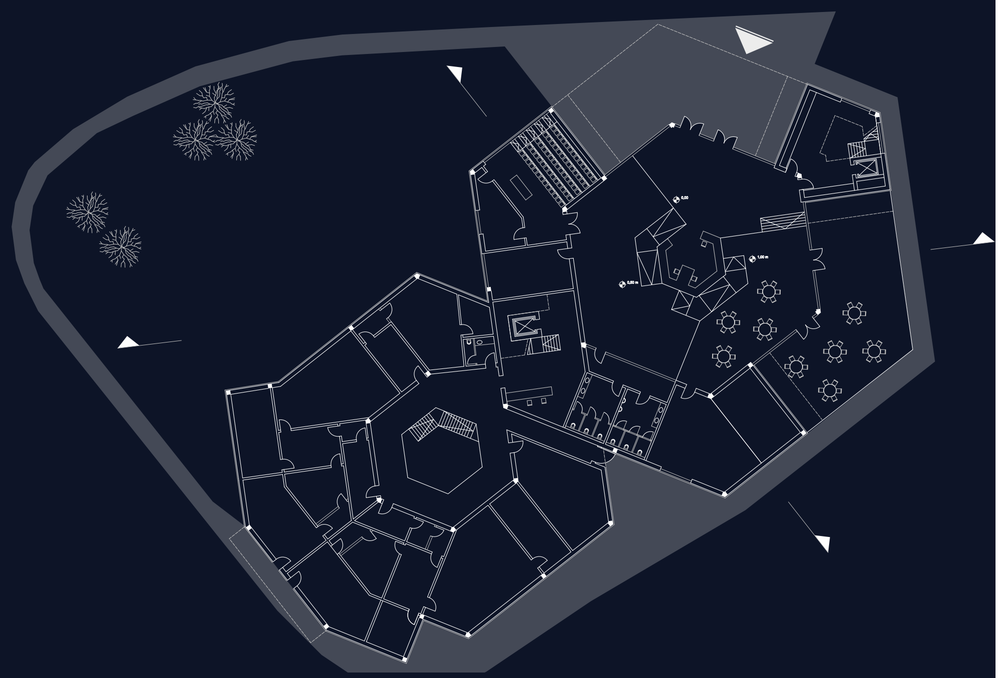


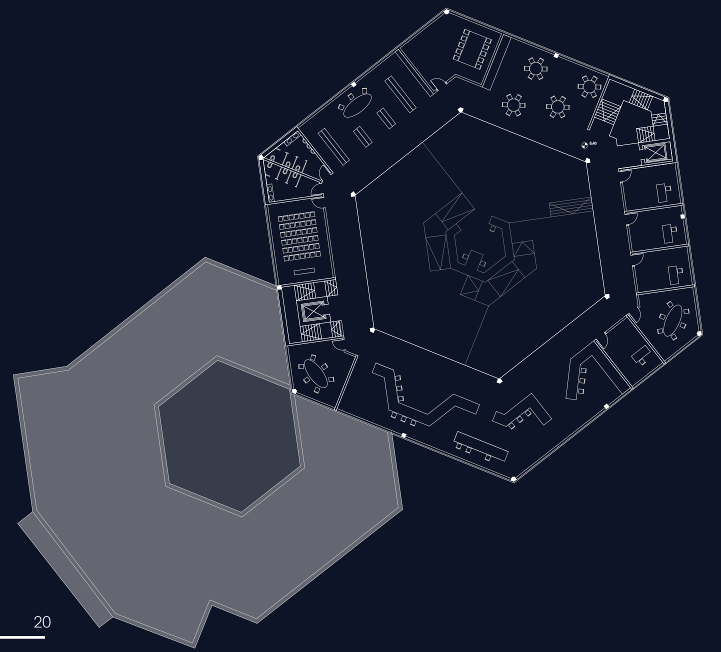
Idea & Concept

The basic concept of the building provides compact and flexible spaces for both science activities and public outreach. Both facility parts will interact with each other whilst remaining distinct from each other for security reasons. The form of the hexagon provides possibilities for expansion as well as interior flexibility. Due to extended time line, expandability as well as spatial flexibility are amongst the main foci of this project.

Functional Diagrams







Floor Plans & Sections

Ground floor

Public areas are located on the ground floor of the main hexagon, containing the lobby, an exhibition area, a cafeteria and a lecture hall.

The smaller hexagon comprises the laboratories and curation area for samples (analogue, restricted and unrestricted).

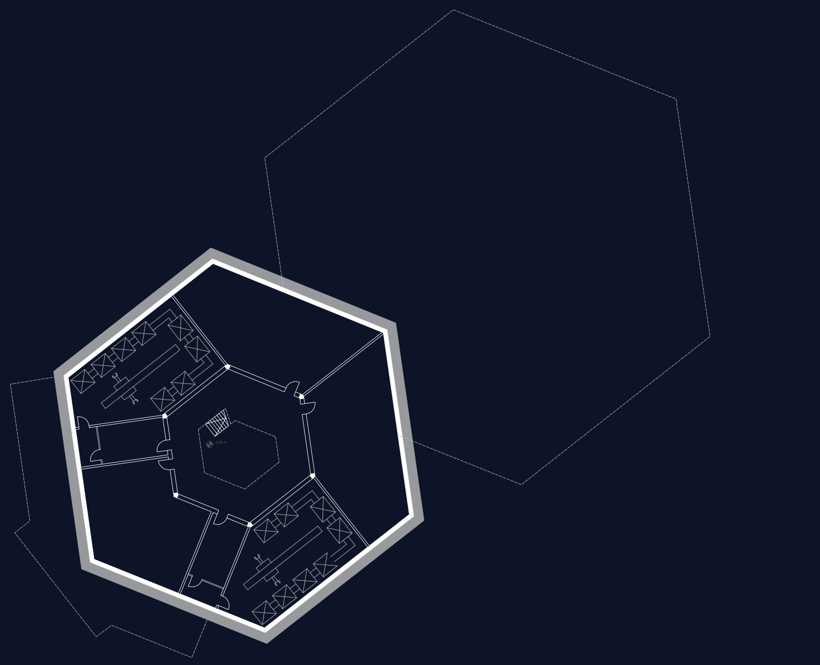
First floor

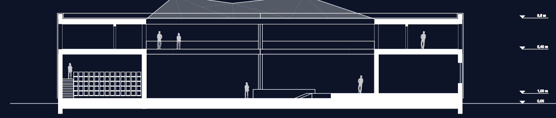
The offices are located on the first floor where both privacy and transparency is provided to the workers. The flexibility of the structure allows for areas where guest scientists can work.

Basement

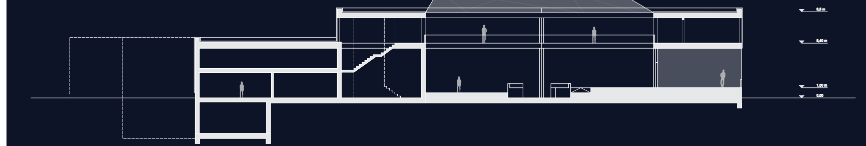
The basement is a safe area for the storage of samples. The samples are autonomously transported to the storage from the laboratory on the ground floor.

Machinery and equipment are stored in the basement and connected to the curation area above.

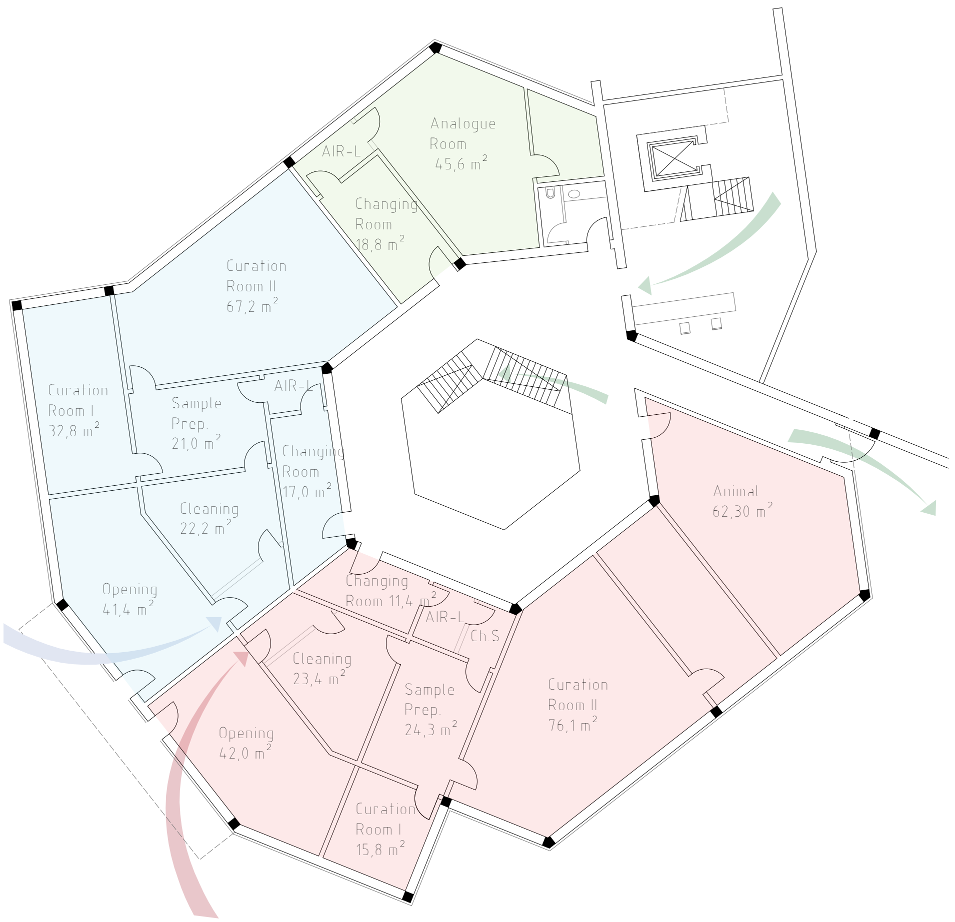




Section A



Section B

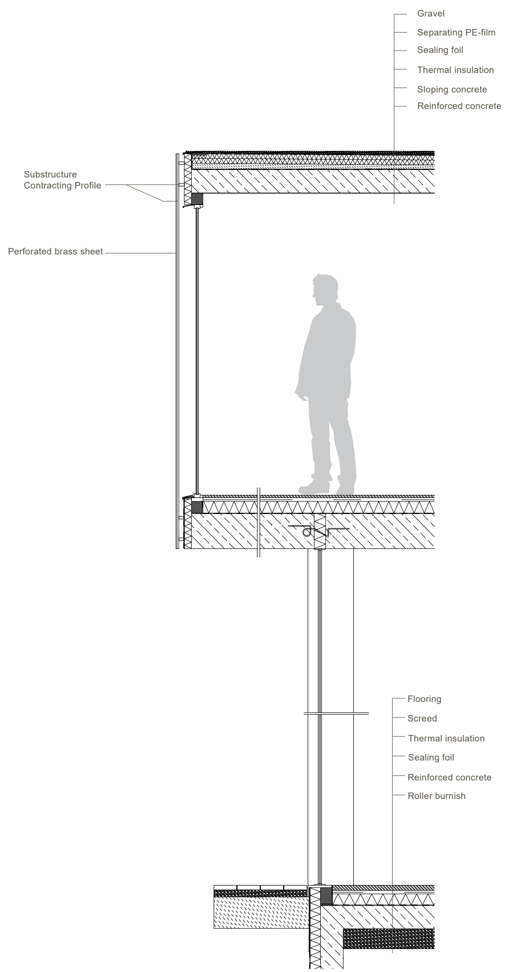


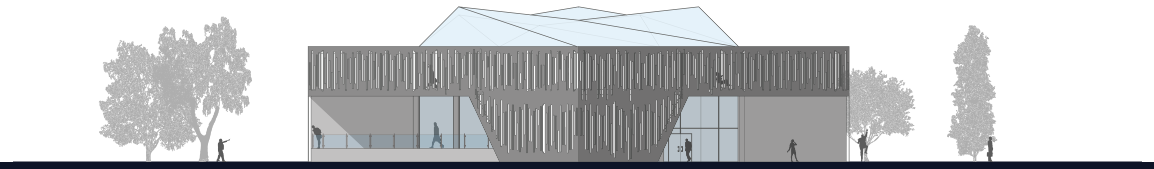
Laboratory Area

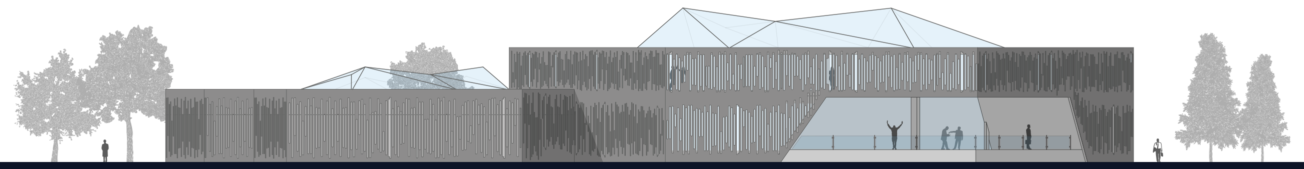
The laboratory area of the facility is an attached hexagon which could be extended by adding more hexagons to the existing one. This concept provides the necessary flexibility when it comes to planing for sample receiving from future expeditions.

The building construction is based on a beam-and-column structure, which offers a certain flexibility for spatial arrangements within. The form also offers layers which can provide different levels of cleanliness as well as security.

Construction Details







DUNE

Jana Burakova, Barbora Tothova

Location: Vienna

Floor Area:

Laboratories	364,81 m^2
Office	432,98 m^2
Exhibition	381,15 m^2

Specific Characteristics:

moon I mars I dunes I beauty I diversity I universe I adaptability I sustainability

The conceptual design of the building reflects the beauty and diversity of the universe.

On Mars, a wide range of interesting structures made by regolith can be found. The building features the creation of Mars dunes and their uniqueness. Every dune is different, unpredictable and adaptable. The same dynamic attributes are applied to the design.

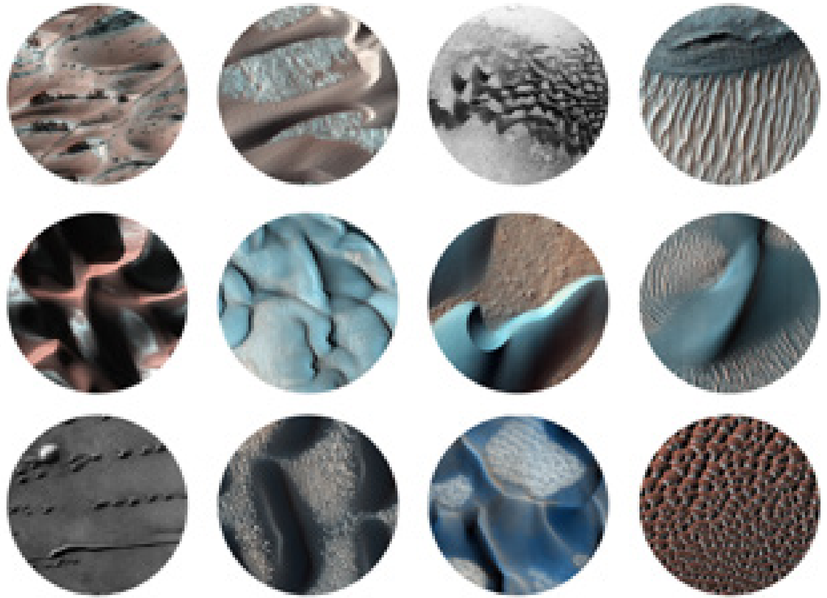
Shape follows the desired program and flow including secluded parts for scientific activities (research, office work, conferences) and public parts accesible for guest scientists and visitors (exhibition area, events, restaurant). Both areas are clearly differentiated, but connected to each other, offering suitable environments for work as well as social activities.

Openings in the roof of the laboratories and in the volume of the building bring sunlight towards inner spaces and allow the observation of spatialy secluded areas from the top.

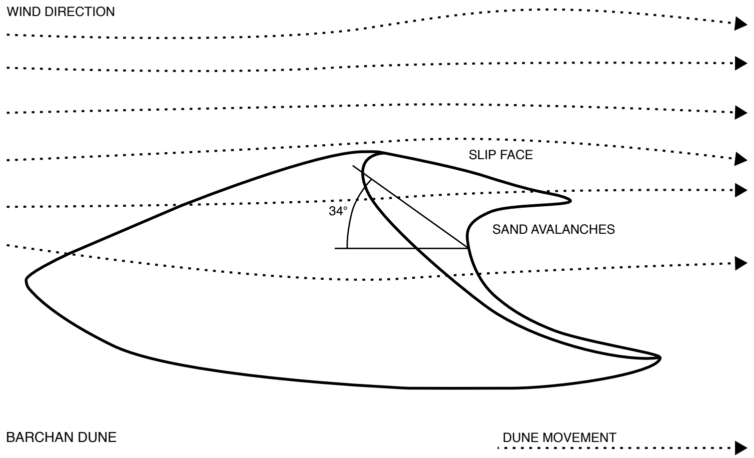
Concept

Martian regolith is the fine material found on the surface of Mars. Its properties differ from those of terrestrial soil. Martian dust and sand, even finer materials from the soil, cover vast expanses of Mars. Dunes and their movement create different types of morphologies and structures. This observation is the leading input for the building design following the principles of dune shaping.

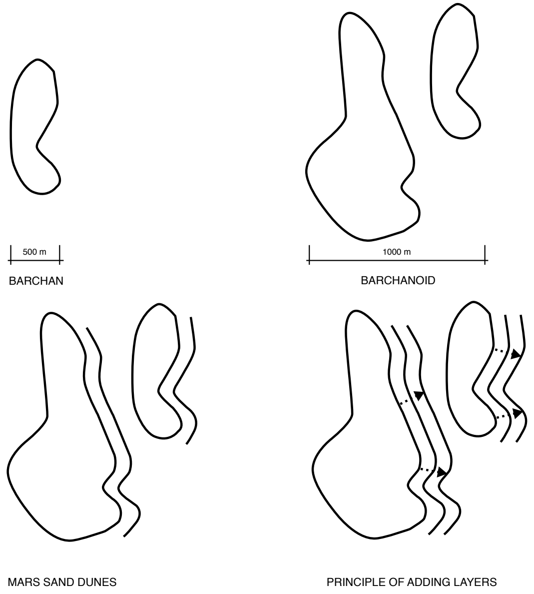
Classification of dunes



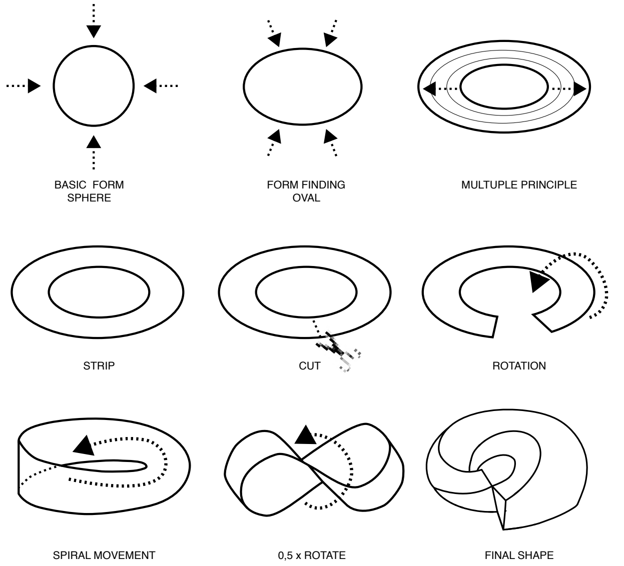
Mars dunes



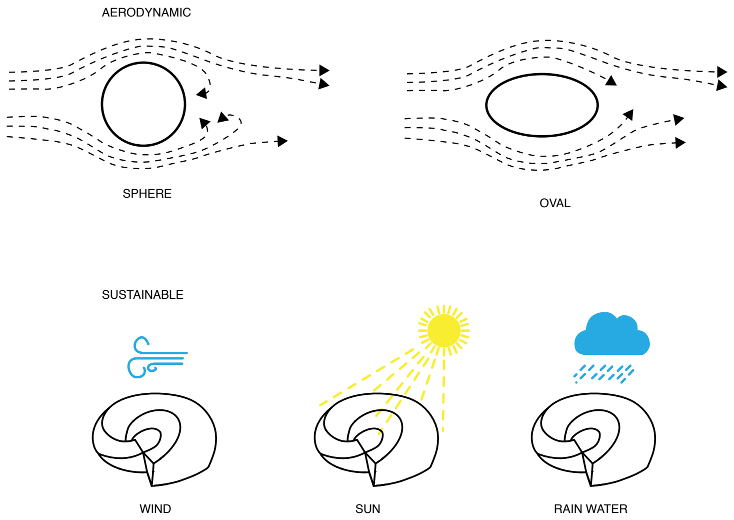
Dune shaping



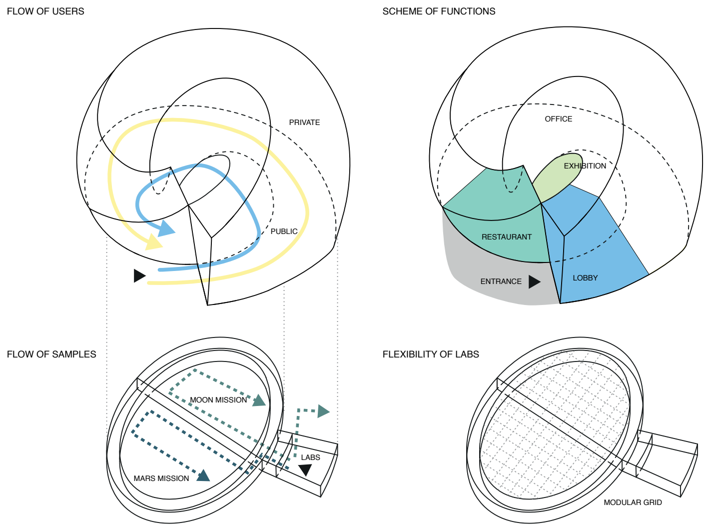
Dunes morphology



Form finding



Form properties

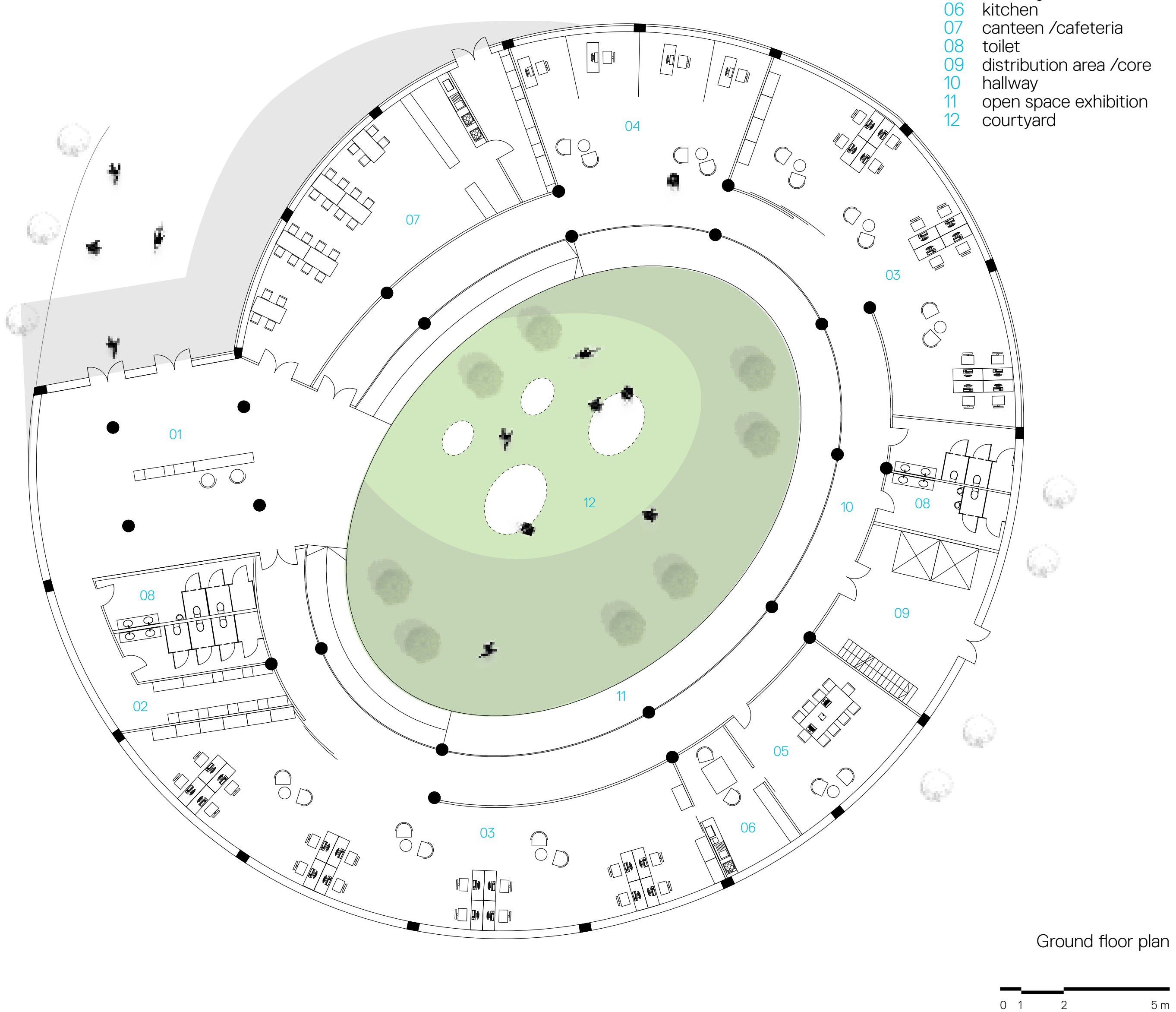


Building service schemes

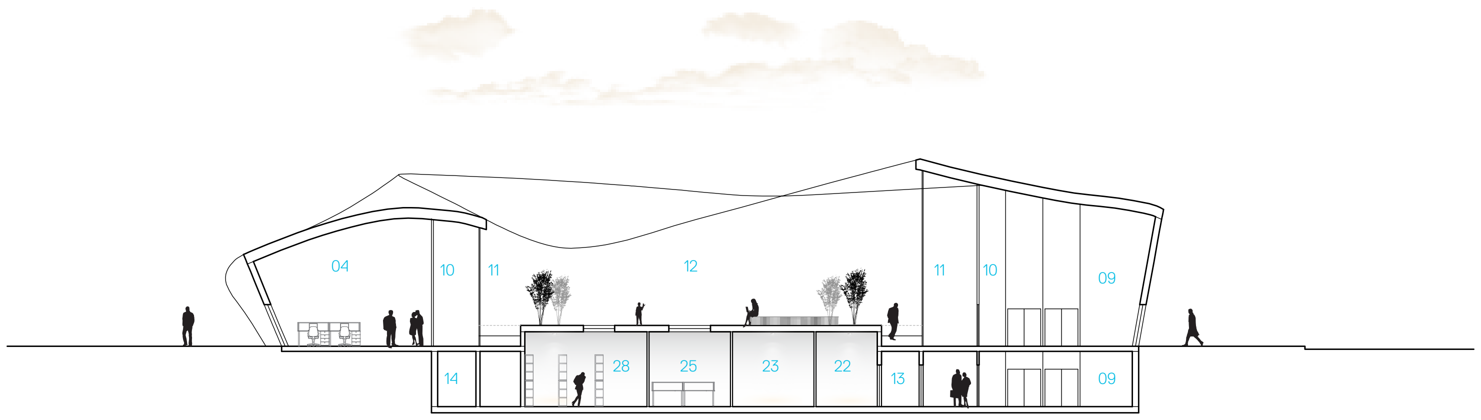
Floorplans and Sections

LEGEND

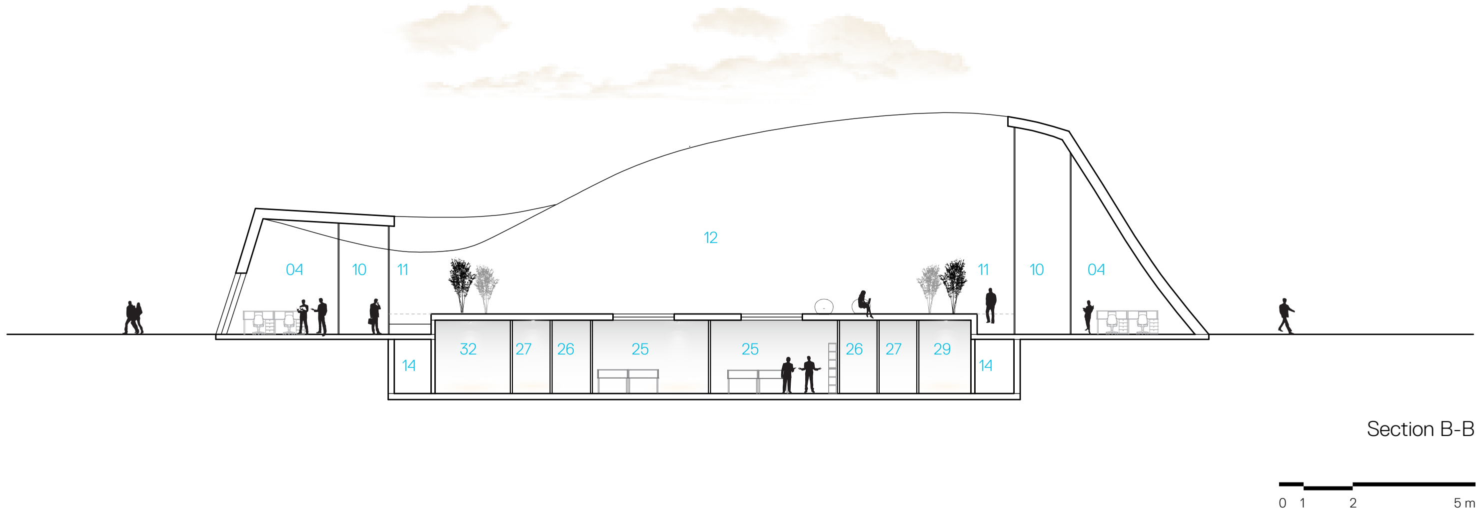
01 reception /entrance hall
02 cloakroom
03 open space offices
04 offices
05 meeting room
06 kitchen
07 canteen /cafeteria
08 toilet
09 distribution area /core
10 hallway
11 open space exhibition
12 courtyard



Ground floor plan

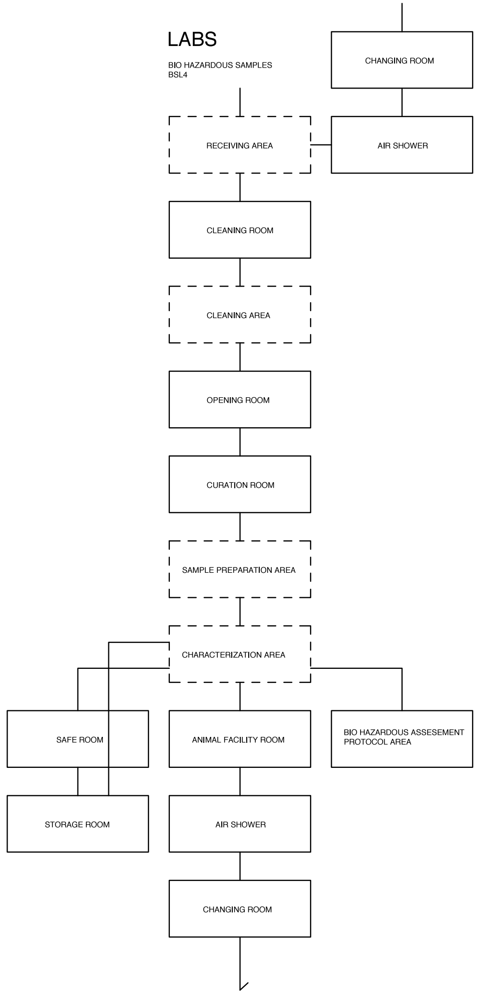


Section A-A

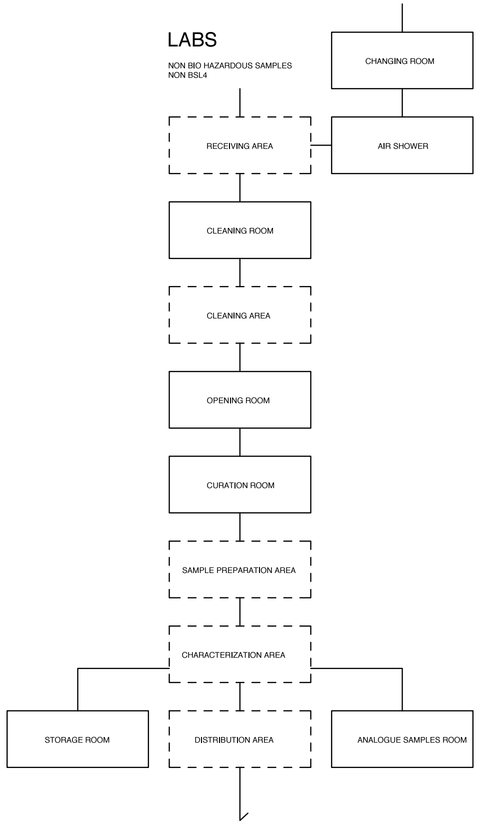


Section B-B

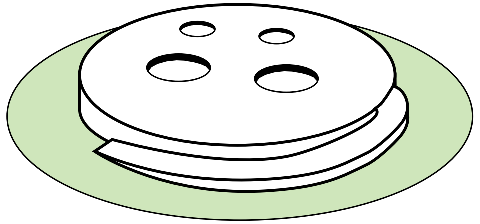
Laboratories



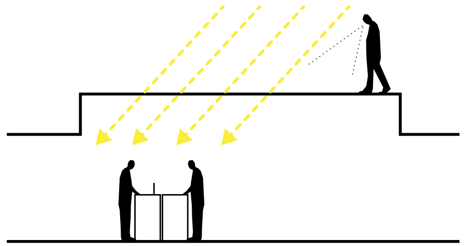
Bio Hazardous Sample labs scheme
Mars Mission



Non-Bio Hazardous Sample labs scheme
Moon Mission



ATRIUM /OPEN SPACE EXHIBITION



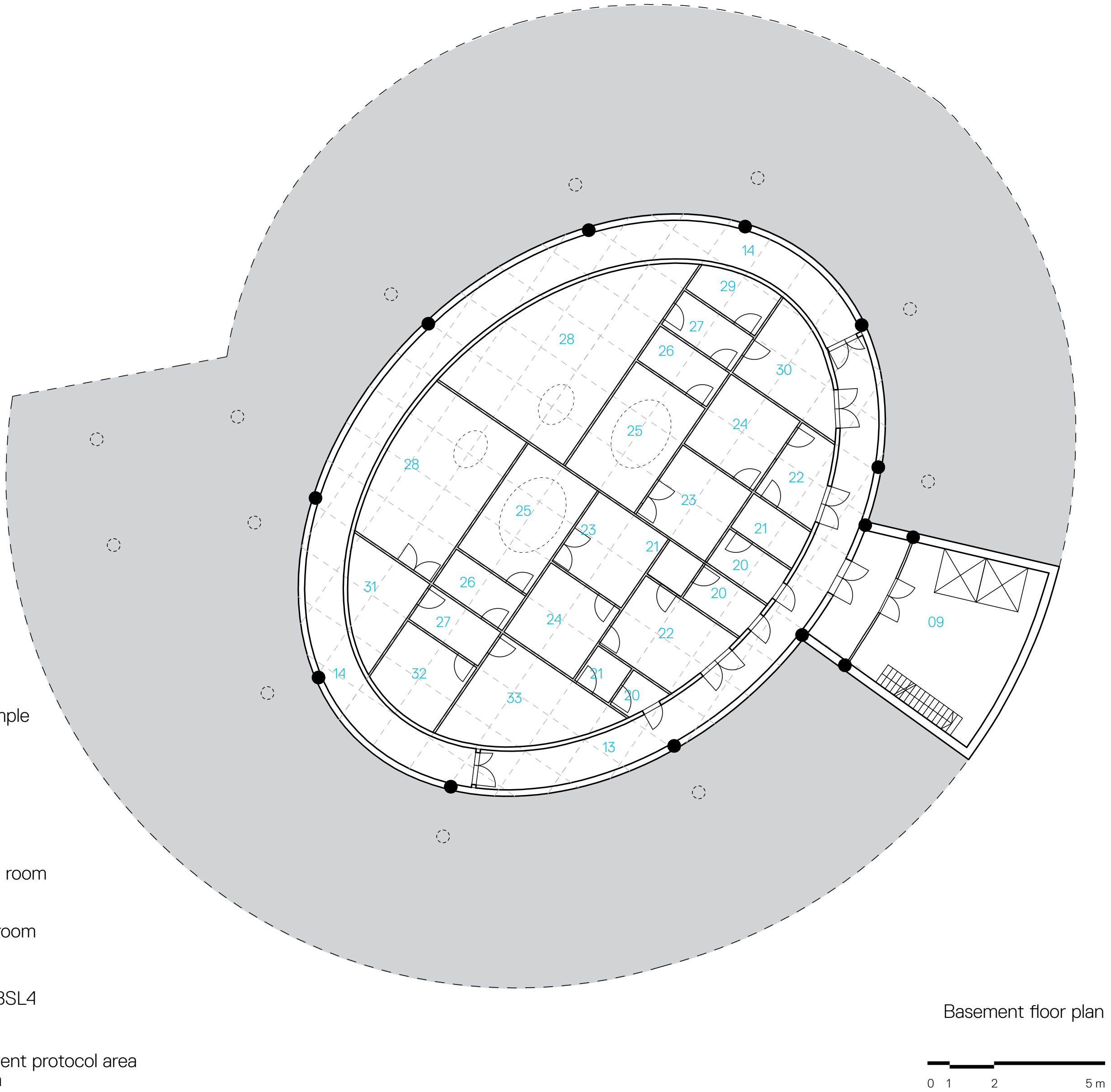
LABORATORIES

Scheme of visual connection

LEGEND
09 core
13 hallway
14 machinery & equipment

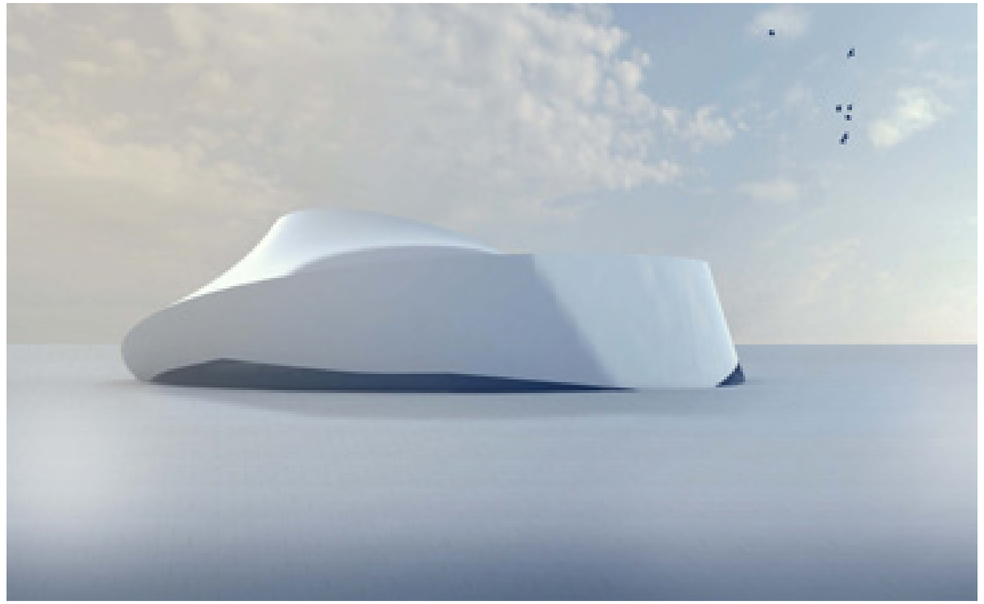
Non-Bio Hazardous Sample
Moon Mission
20 changing room
21 airshower
22 receiving
23 opening
24 cleaning
25 curation room
26 sample preparation room
27 characterization
28 storage room
29 analogue samples room
30 distribution

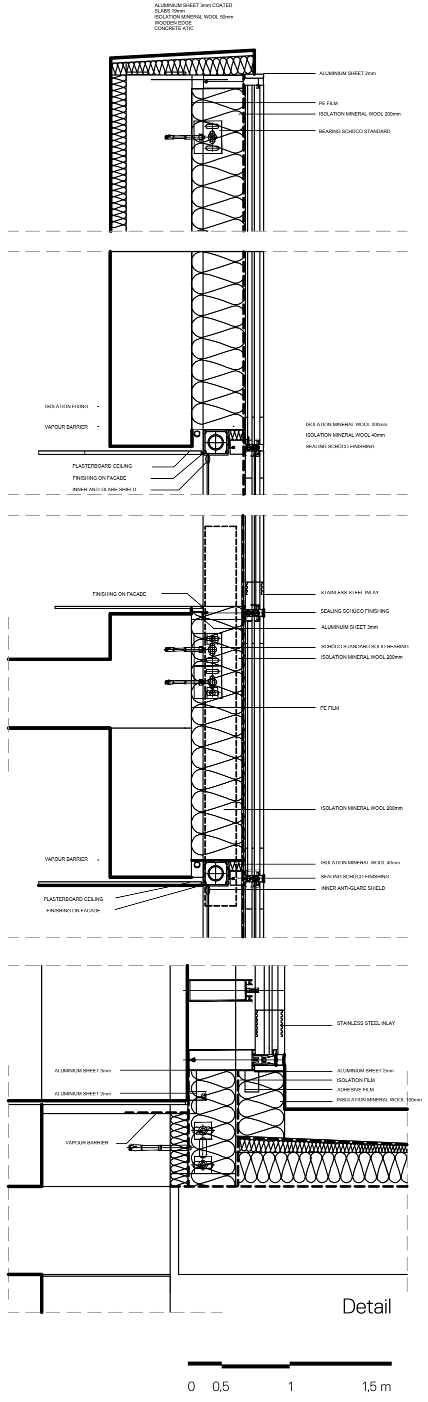
Bio Hazardous Sample BSL4
Mars Mission
31 safe room
32 biohazard assesement protocol area
33 animal facility room



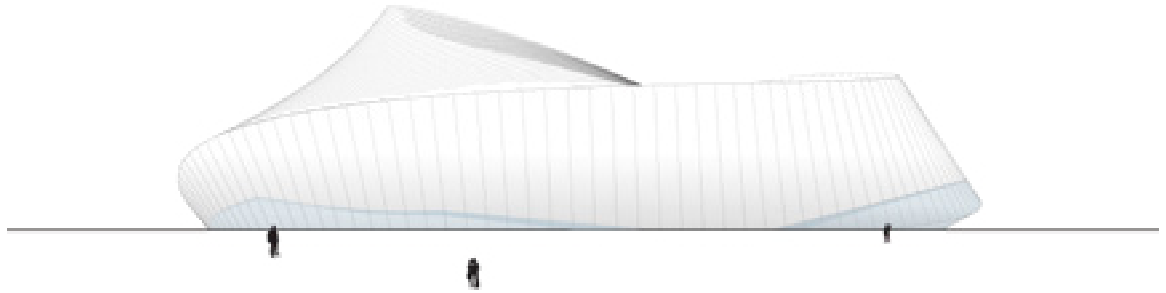
Basement floor plan

Construction, Material, Details

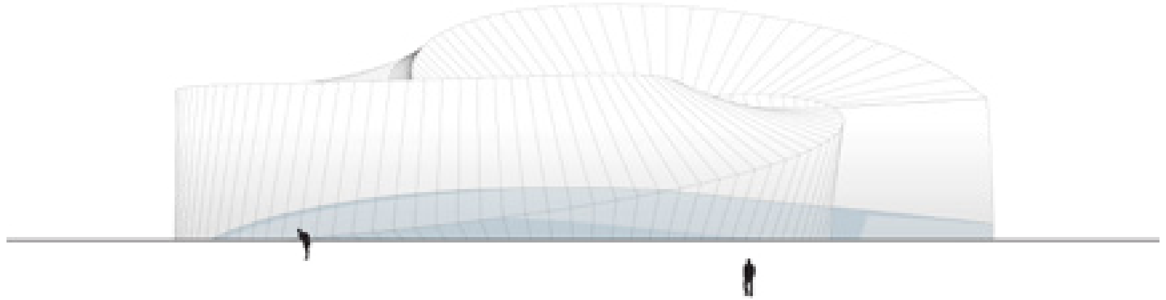




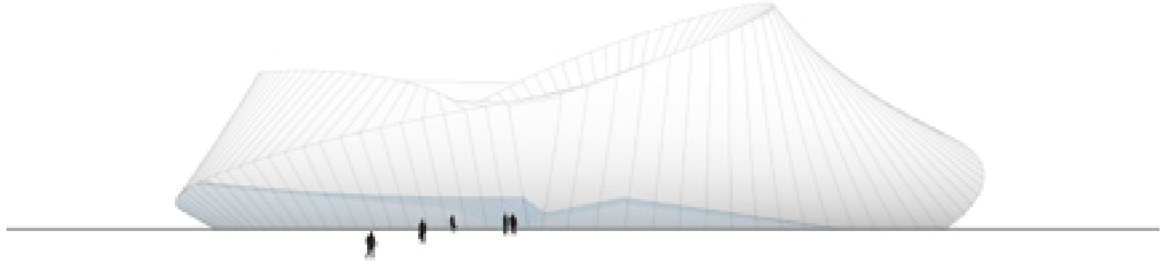
Detail



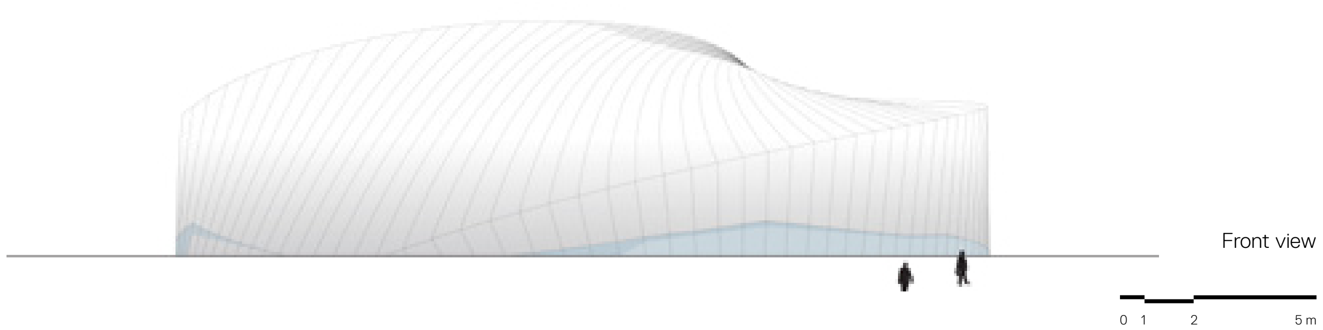
Right view



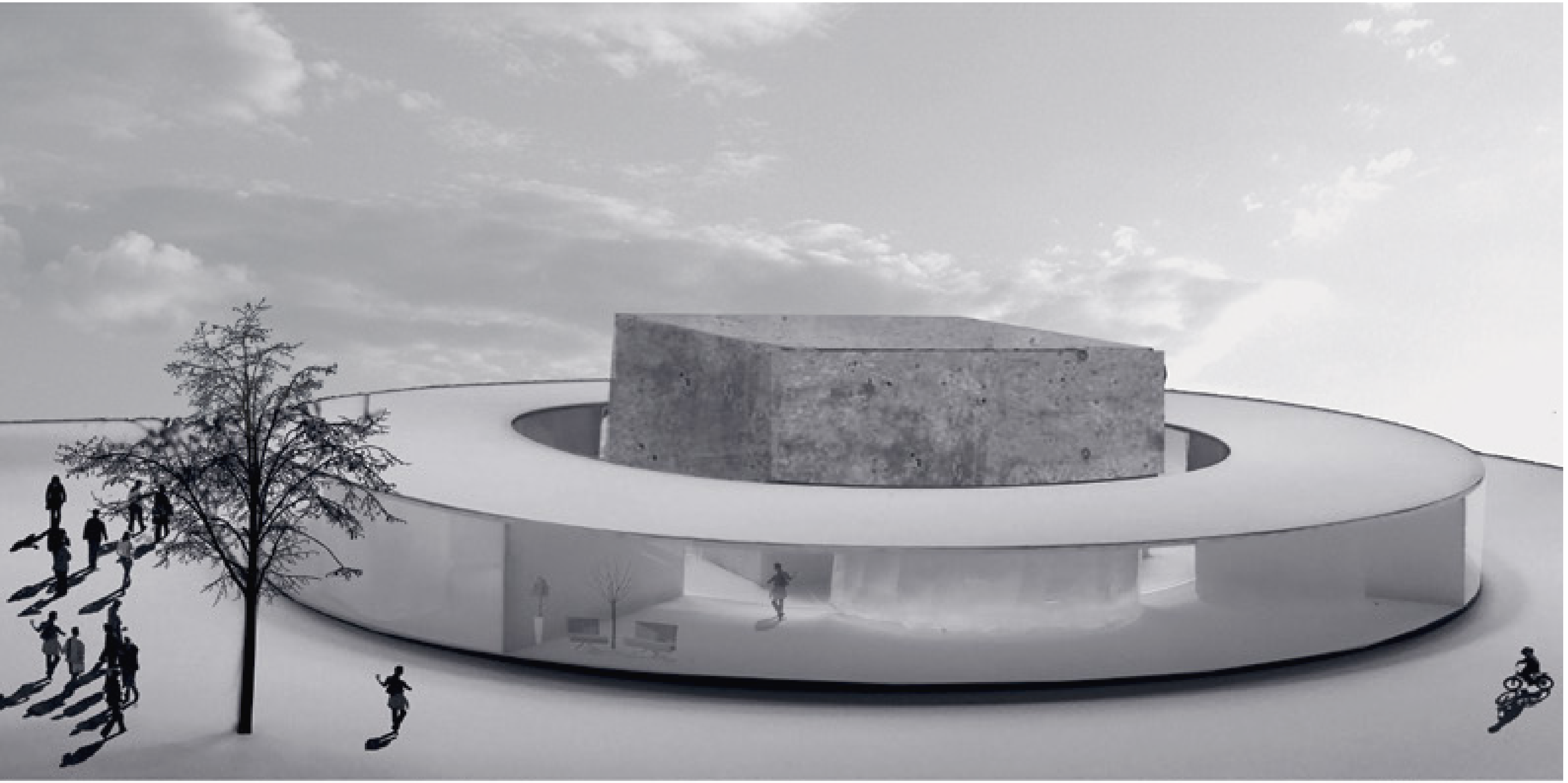
Back view



Left view



Front view



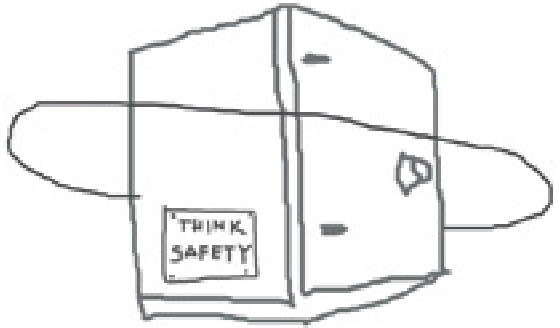
ESCF *European Extra-terrestrial Sample Curation Facility*

Carla Greber

Location:	Vienna
Floor Area:	
Laboratories	500 m²
Office	540 m²
Lecture room	142 m²
Cafe	142 m²
Kindergarden	260 m²

Specific Characteristics:

The labs are secluded.



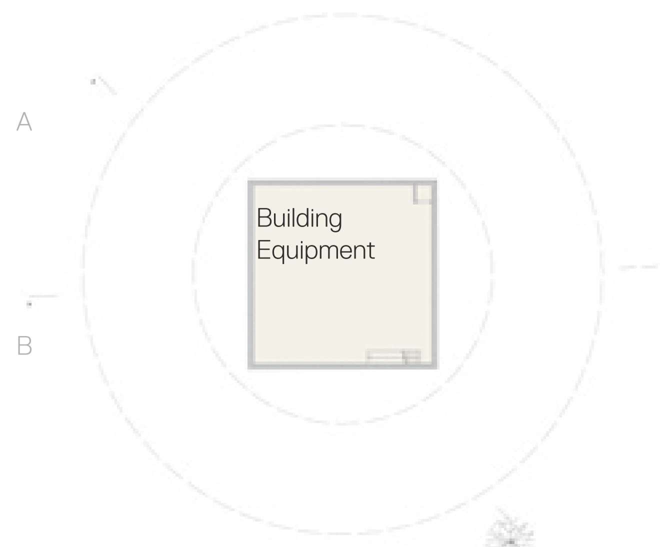
The basic concept puts a highly secured laboratory at the heart of the project. Following this idea, the building is separated into two distinct parts: the laboratories are at the centre of the building allowing the public to closely observe, while at the same time high security protocols seclude the research activities.

The circular area round the ‚safe lab' provides space for multiple functions, such as offices, lecture rooms, cafe and kindergarten. While the inner safe lab is characterized trough its solid design, the surrounding area is characterised by its lightness and transparency. The area between the lab and the circle generates open space.

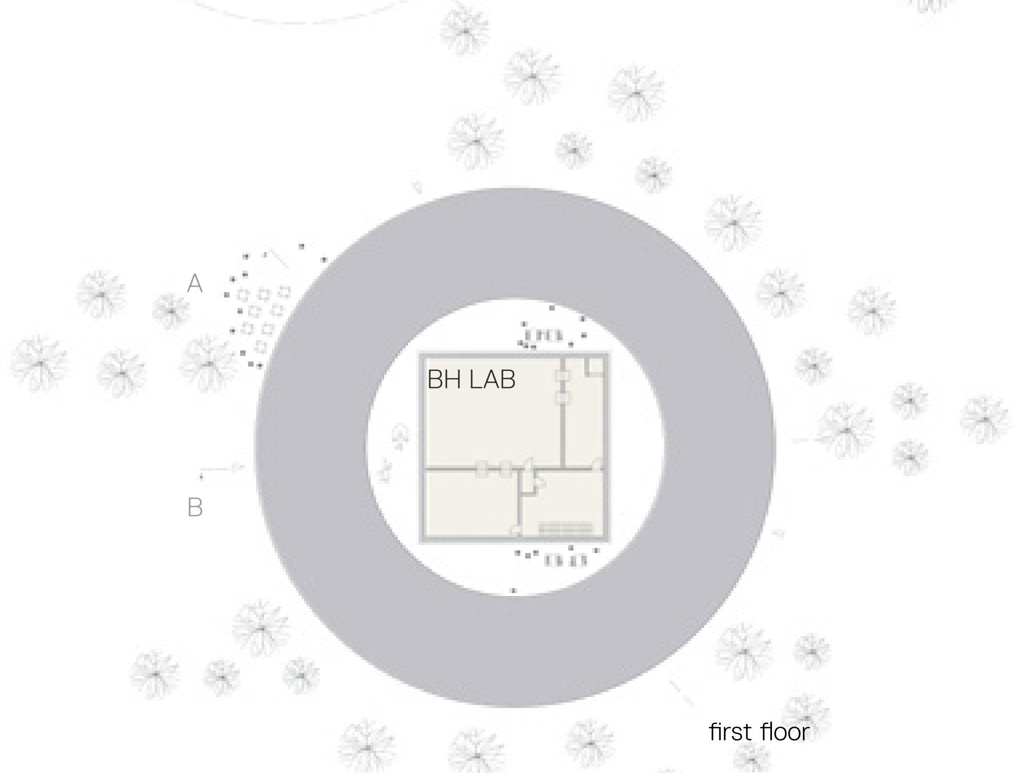
Floorplans & Sections

The circular floor plan is divided into 4 similar parts, surrounding the lab. Two of these ares are designated for a cafe, a lecture room and a kindergarden.
These are open to the public and provide space for exchange. The office spaces are located in the other two areas. They are more secluded and offer individual working places.

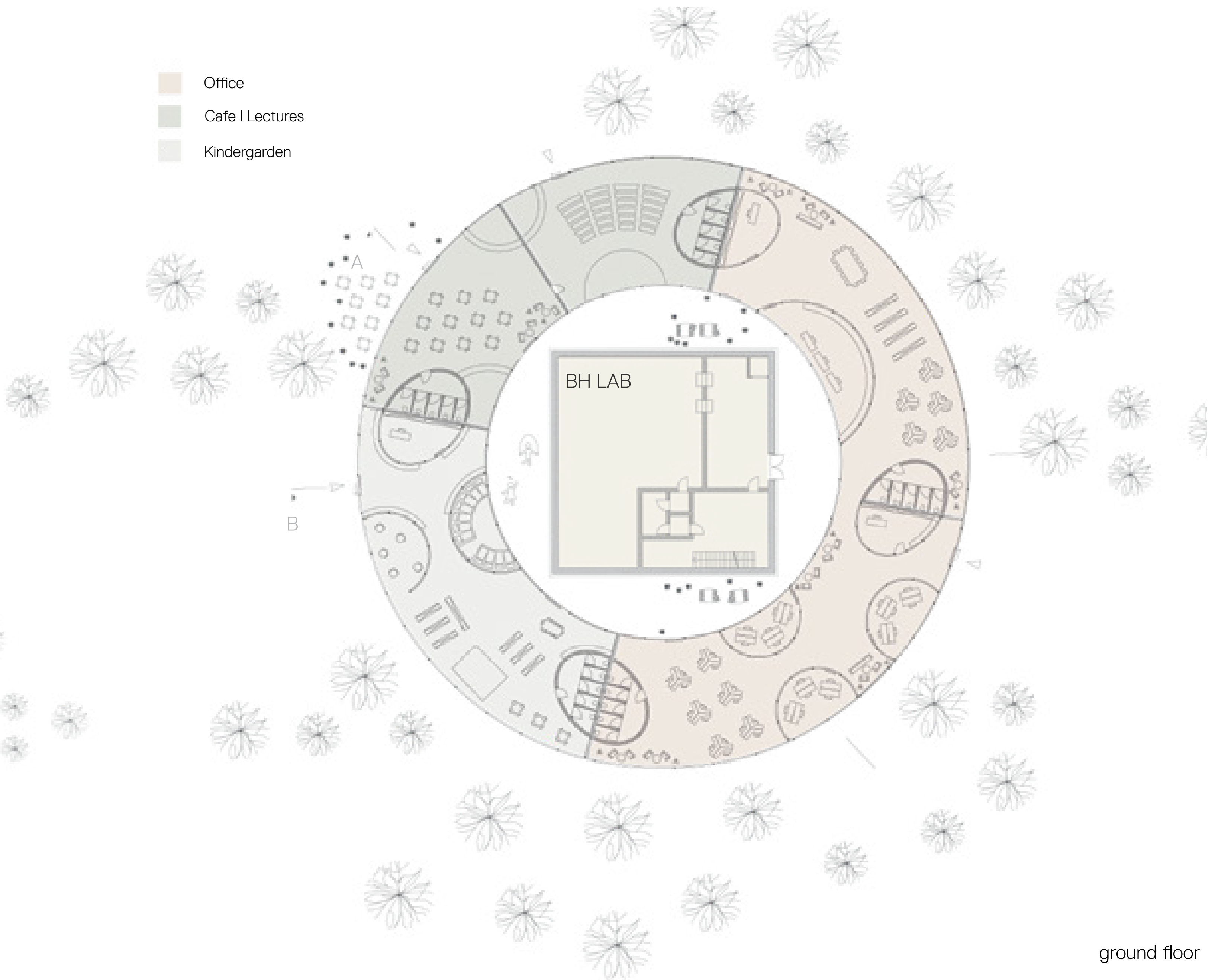
Overall, the building can be perceived as directionless - every room can be separately acessed from outside. Spaces are defined by inserted glass cylinders.



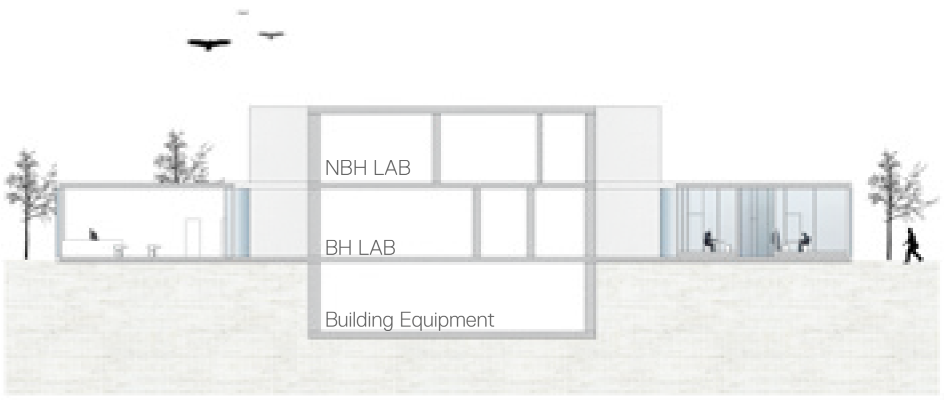
Basement



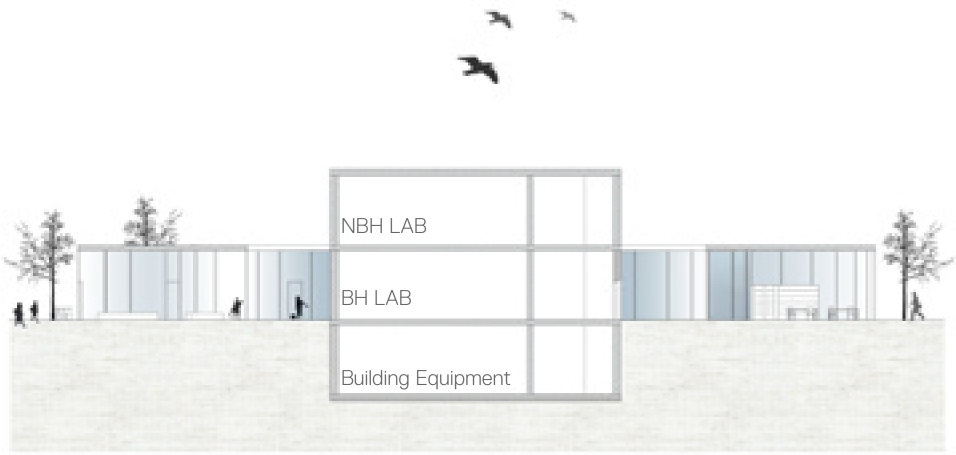
first floor



ground floor



A-A



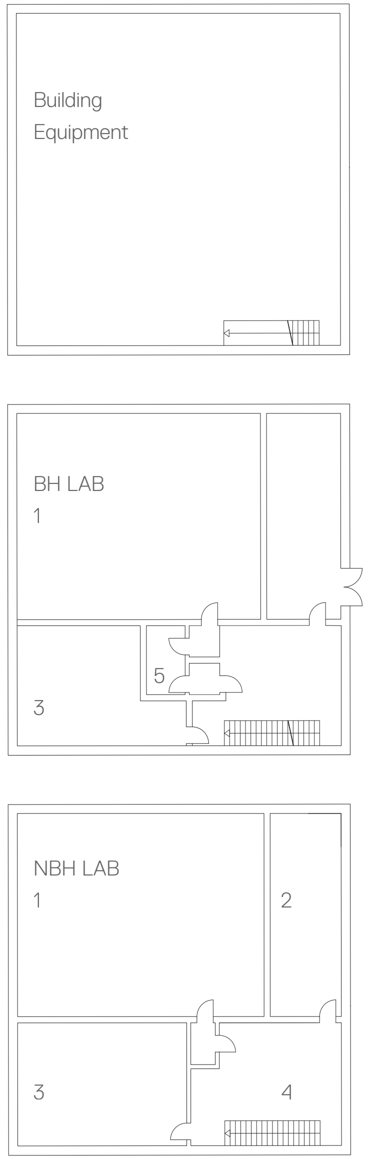
B-B

Laboratories

Due to their separation from the rest of the building and their square-cut floor plan, the laboratories can be arranged and adjusted to individual needs. Each floor measures about 250 m². The size of the lab can be further expanded through extending vertically. The basement accommodates both technical equipment and the delivery zone for the samples. The ground floor comprises of a biohazard lab, which includes an animal facility as well as a changing area. The first floor accommodates the non-biohazard lab. The floor plan of this floor is relatively similar to the biohazard lab, however, the animal facility is replaced with a room for analogue samples (3).

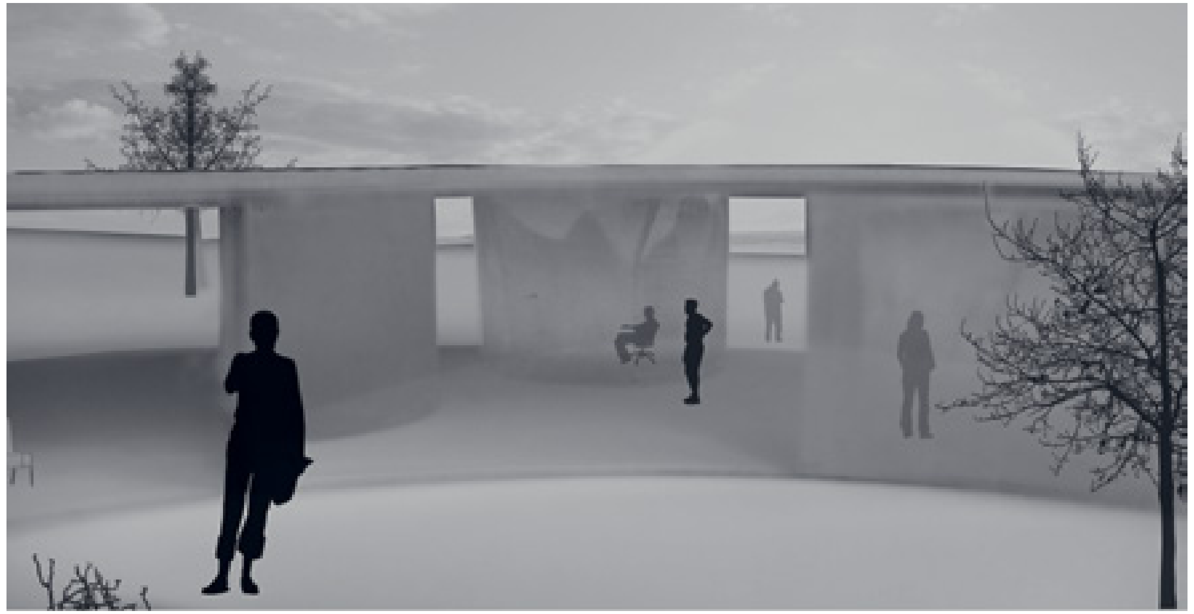
1	biohazard lab curation room, preparation area, characterisation area, assessment area storage	120m²
2	receiving, opening, cleaning	33m²
3	animal	40m²
4	changing	35m²
5	decontamination	6m²
6	shower	2m²
7	shower	2m²

1	not biohazard lab curation room, preparation area, characterisation area, storage	120m²
2	opening, cleaning	33m²
3	analogue sample	48m²
4	changing	40m²
5	shower	2m²

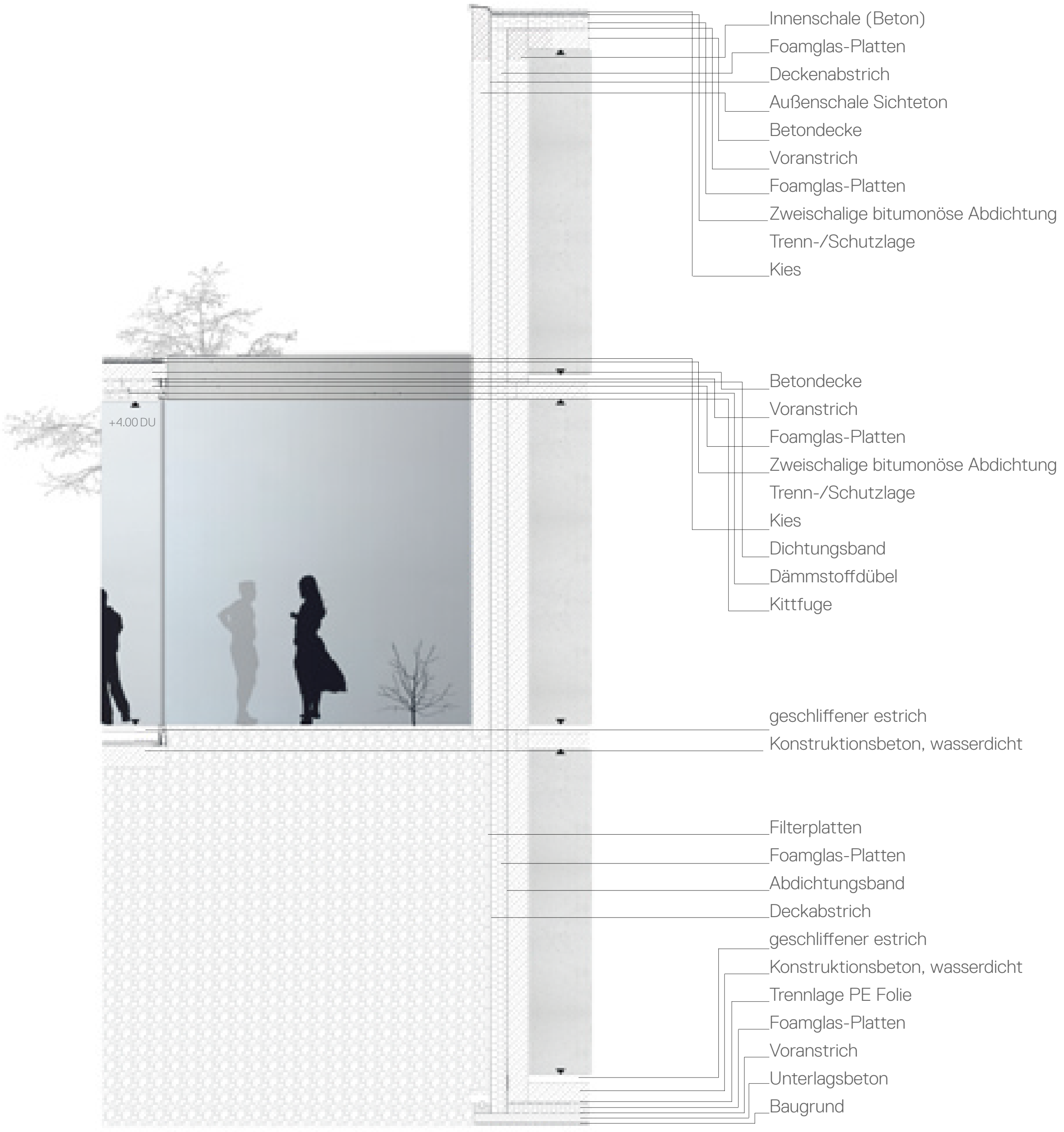


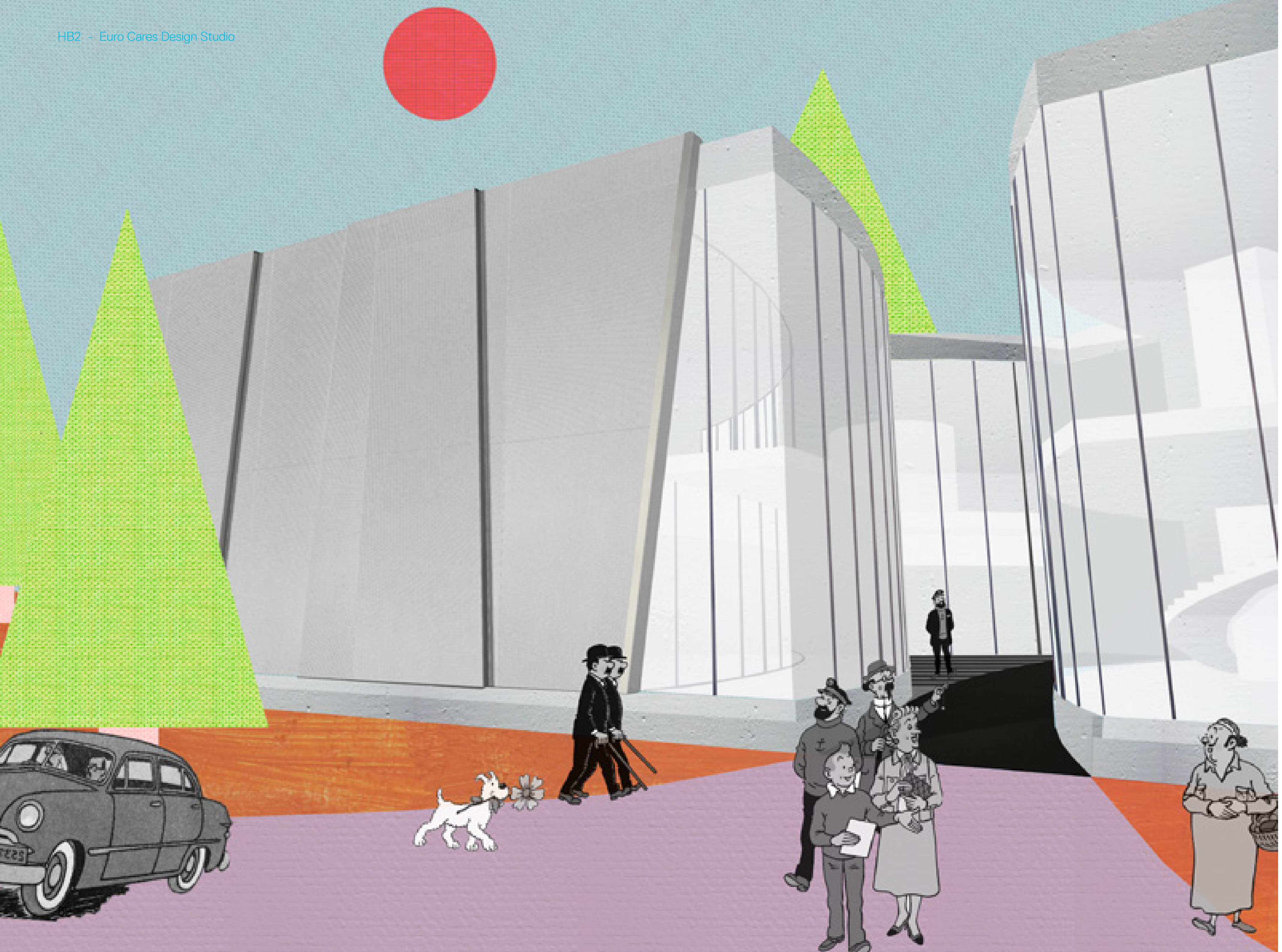
Construction, Material, Details

The laboratory, a massive concrete block, forms the core of the building. A double-layered wall with core insulation allows for a homogeneous visual appearance of the concrete, providing a seamless facade, reinforcing the ‚safe' character.
In contrast to the monumental character of the lab, the rest of the structure stands out with its lightness. It will be constructed as a frame structure, with steel columns supporting the flat roof. Frameless sliding doors in the floor-to-ceiling glass facade further contribute to the transparency of the design.



View from Lab to the office part.

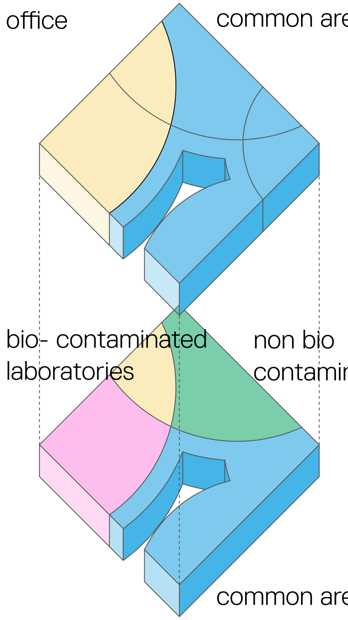




Fusion

Hayran Ismihan Elif

Location:	Vienna	
Floor Area:		
Laboratories	566	m^2
Office	330	m^2
Exhibition	72	m^2
Multimedia Library	137	m^2
Cafeteria	192	m^2
Common Space	265	m^2

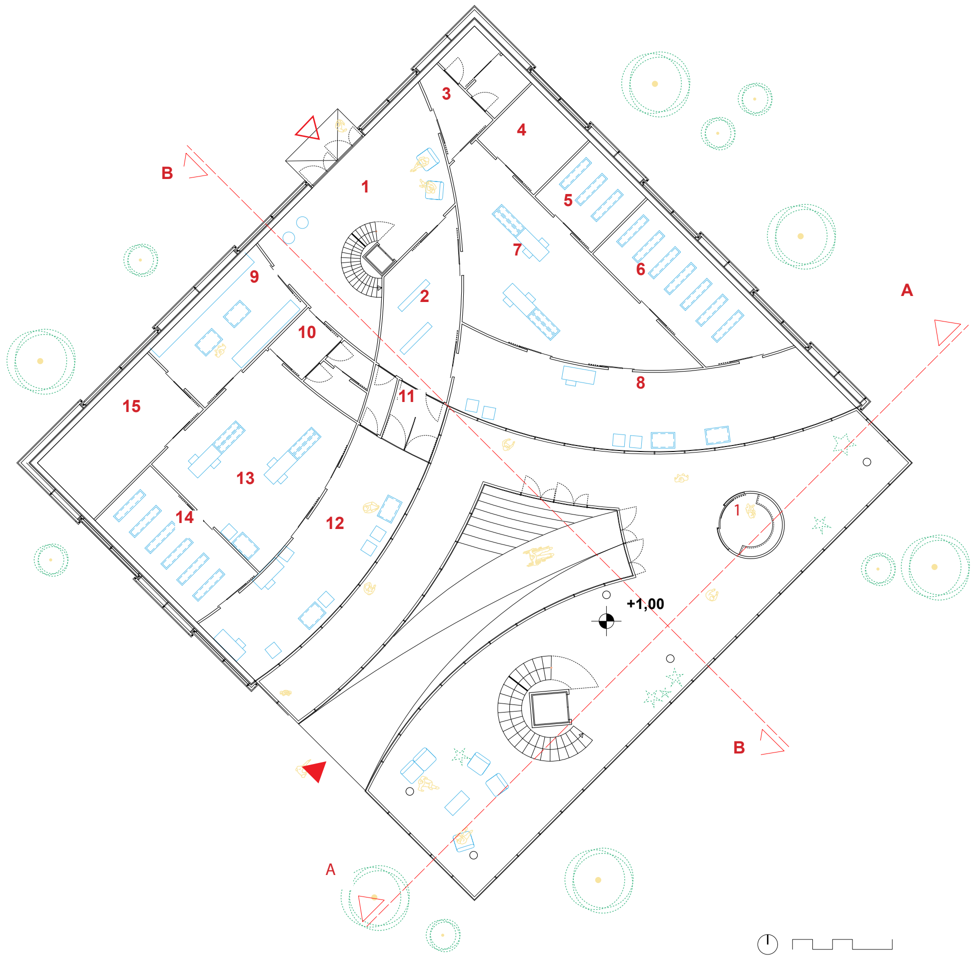


The main idea for the design project "Fusion" is creating a geometry combining organic and inorganic aspects of form. The laboratories are covered with glass on the inside in order to let visitors observe the scientists at work.

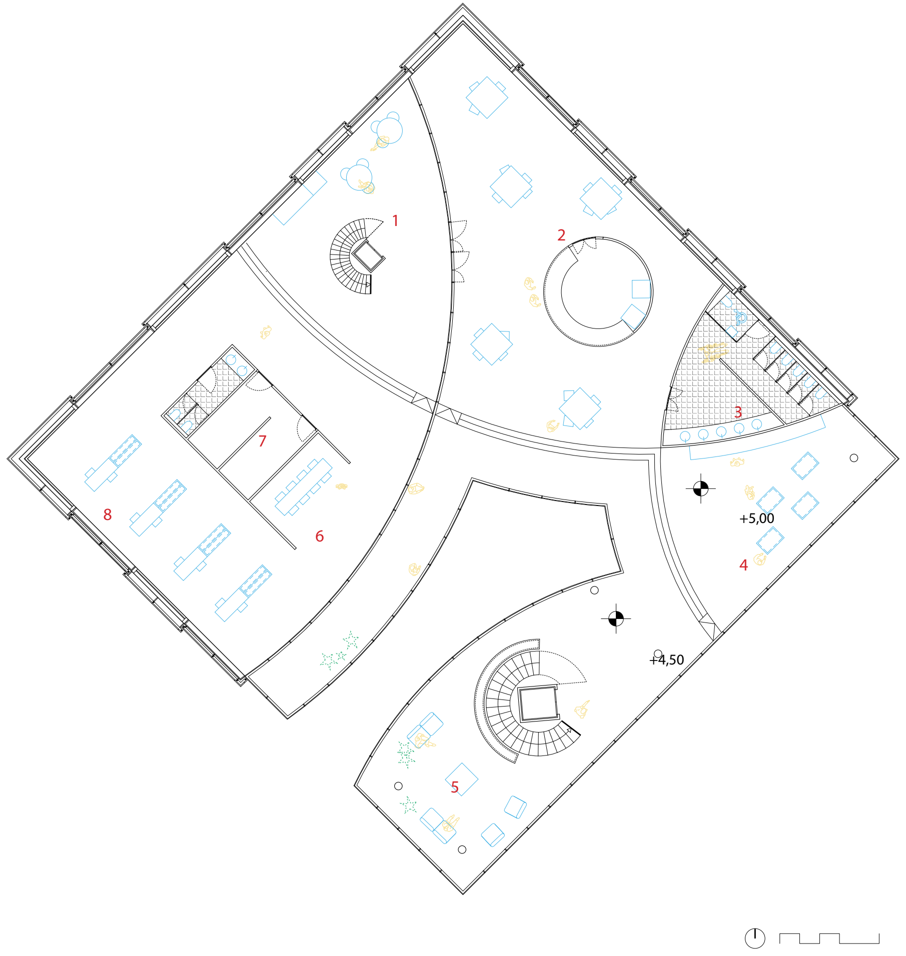
The project features two seperate laboratories for samples from asteroids and the Moon (non-bio contaminated facility) and for samples from Mars (bio contaminated). The laboratories include areas for sample handling and storage. There is also an office section for researchers, an exhibiton area, a multi-media library and a cafeteria.

The planing has been undertaken in collaboration with scientists from the EURO-CARES group. The EURO-CARES is funded by the European Comission and their mission is creating a roadmap for an European sample return curation facility which receives and curates samples returned from Asteroids, the Moon and Mars.

Floorplans
M 1:200

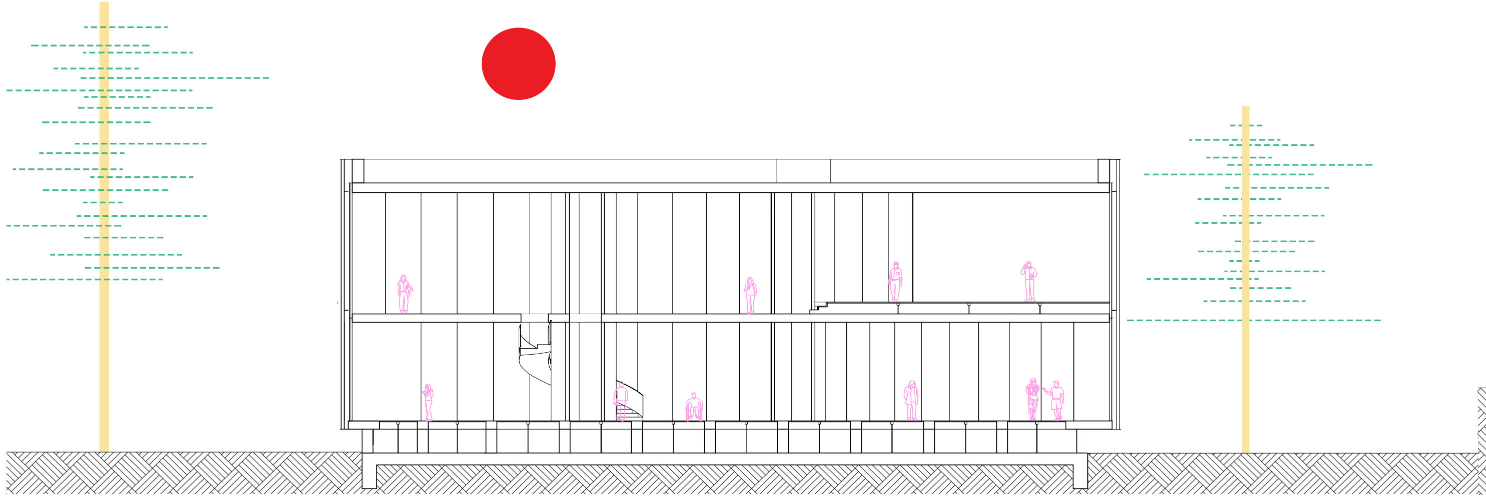


Non-Bio Contaminated Laboratories
1 Receiving Area
2 Changing Room
3 Opening & Cleaning Rooms
4 Returned Samples Room
5 Analogue Sample Room
6 Storage
7 Curation Room (Grey Area)
8 Curation Room
Bio Contaminated Laboratories
9 Research Animals Room
10 Opening & Cleaning Rooms
11 Airlocks
12 Curation Room
13 Curation Room (Grey Area)
14 Storage
15 Bio-Hazard Experiment Room

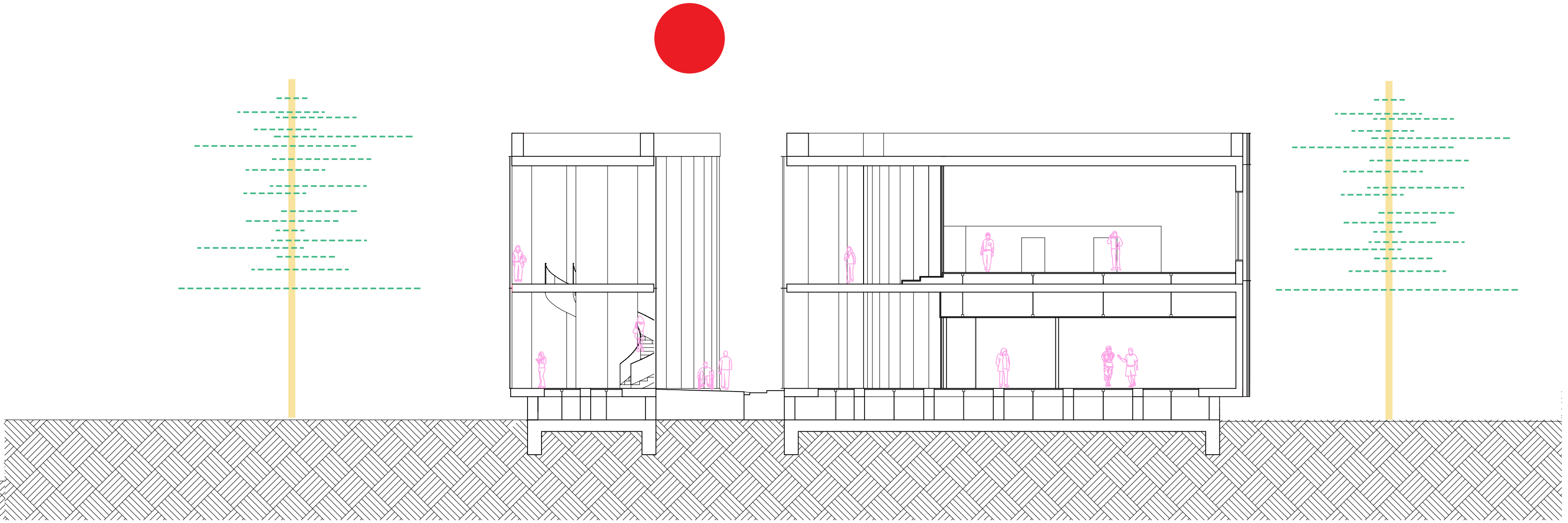


1 Kitchenette
2 Café
3 WC
4 Exhibiton Area
5 Multimedia Library
6 Meeting Area
7 Monitor Rooms
8 Office Area

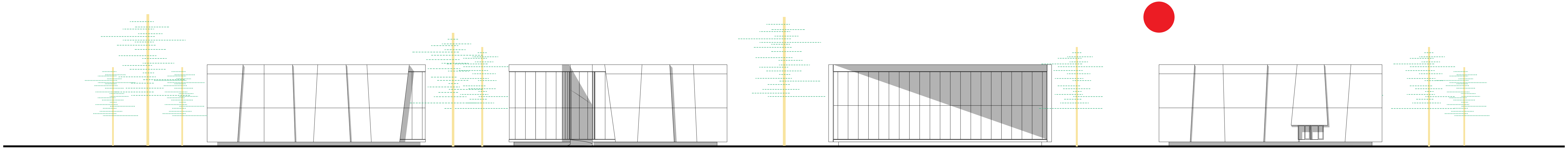
Sections and elevations
M 1:200



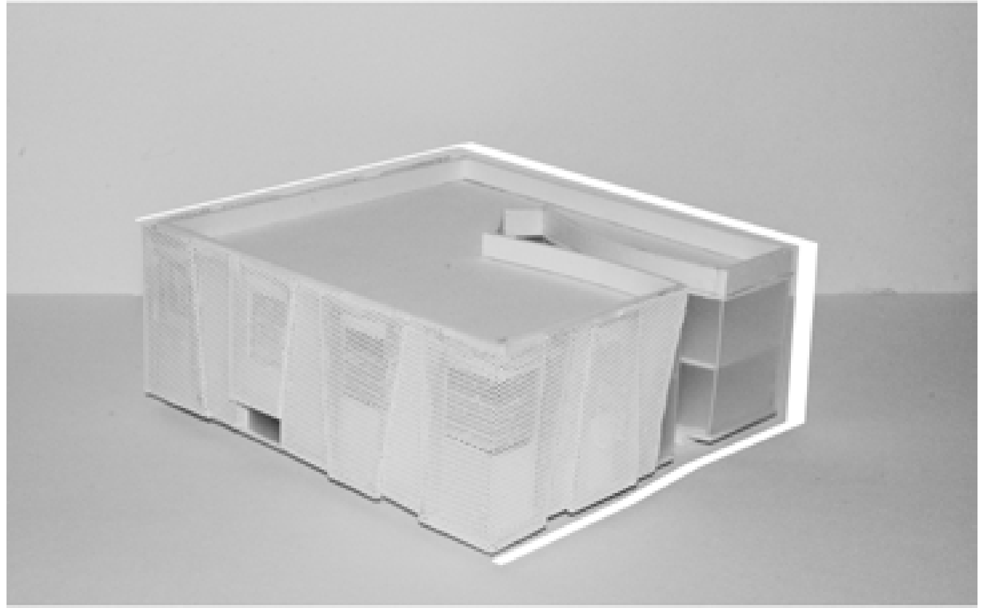
section A-A



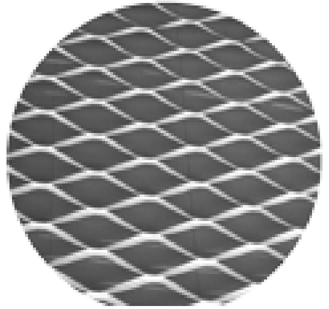
section B-B



Construction, Material, Details

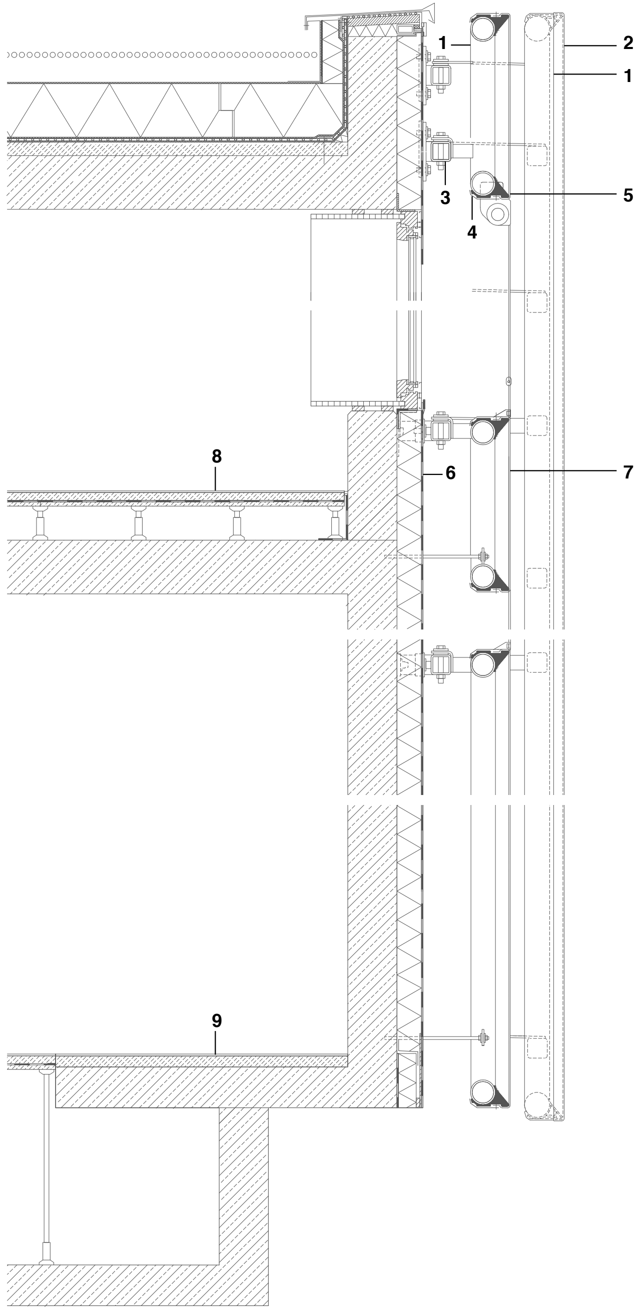


frosted glass



anodized aluminium mesh

white concrete



1 ø 101.6/4 mm Steel CHS facede frame, lacquered
2 glass-fibre fabric, silicone coated
3 80/80/4mm steel SHS cross-bracing
4 aluminium-sheet facing, clipped to 5
5 adapter: extruded aluminium section
6 polyester and glas-fibre sarking felt, polyacrilate coated, greyish blue 20 mm oriented strand board 265 mm cellulose thermal insulation vapour barrier; 20 mm oriented strand board 40 mm cellulose thermal insulation 60/40 mm timber batten supporting structure 10 mm gypsum board, sound absorptive
7 solar roller blind, glas-fibre fabric, Silicone coated, white
8 2.5 mm rubber flooring raised floor: 33-40 mm anhydrite screed (calcium sulphate), trowelled seperating layer
9 5mm coating, mineral-based 45 mm bonded screed

introvert.

Julius Simeon Heffner

Location:	Vienna
Floor Area:	
Laboratories	793 m²
Office	280 m²
Exhibition	148 m²
Auditorium	75 m²
Restaurant	96 m²
Conference Room	104 m²
Workshop Rooms	86 m²

Specific Characteristics:

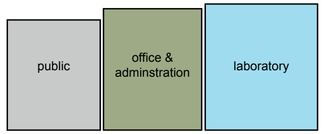
A compact monolithic structure comprising offices, laboratories and public areas.

The main idea is to connect the three main functions: office, public outreach and laboratories. Each main function is located in its own building section. Additional functions, such as communication zones, conference rooms, workshop rooms and relaxation areas are located between these sections.

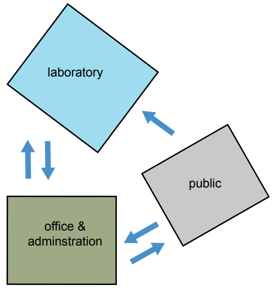
One focus of the design has been facilitating the interaction between different functions and the communication between the various user groups of the complex. The design of the building enables meetings between areas, which is ment to support the creativity and the workflow.

The three interconnected sections are lifted from the ground. The space below serves as a public space including the entrance of the building.
The final geometry is modified according to spatial requirements. The building's surface resembles a monolithic sculpture, a stone falling apart and drifting in pieces over time - like a rock on Mars.

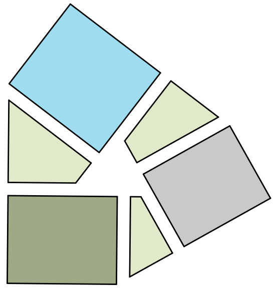
Concept



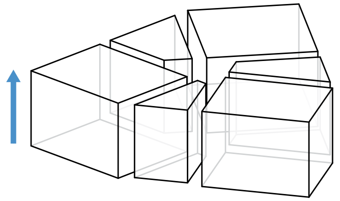
3 main functions



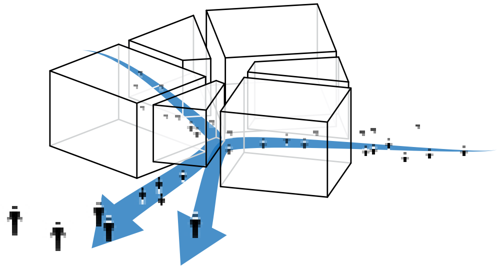
interactions



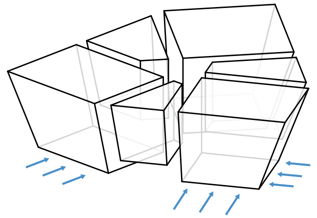
additional areas for interactions



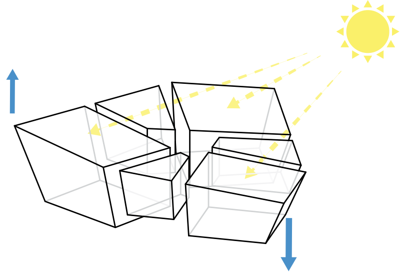
extrusion



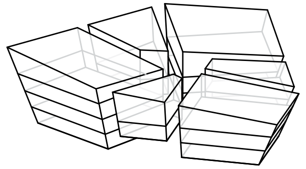
creation of outdoor space
for public flow



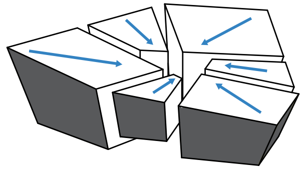
adapting the size to
requirements



optimizing from for
maximum daylight

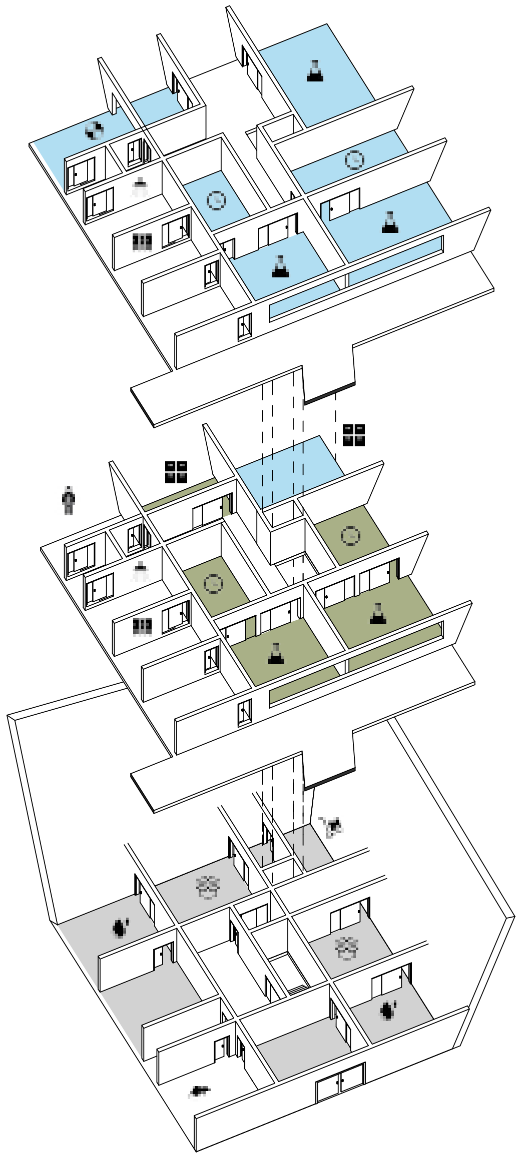


adding floors



set the focus
inside

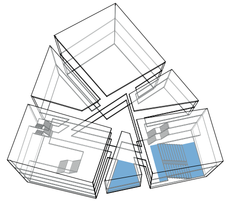
Functions



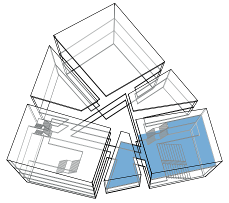
Areas

- Non-BSL 4
- BSL 4
- Receiving, Cleaning &opening

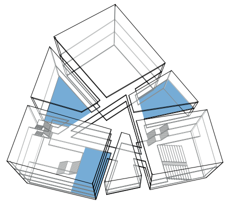
- Laboratory
- Curation
- Storage
- Analogues
- Cleaning
- Opening
- Distribution
- Animals
- Suit Room
- Changing Room
- Shower Room



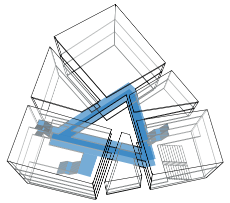
auditorium &
cloakroom



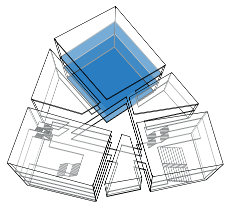
museum



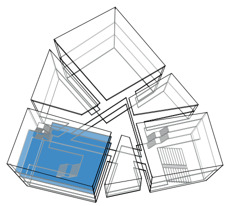
restaurant,conference
room & workshop
rooms



circulation

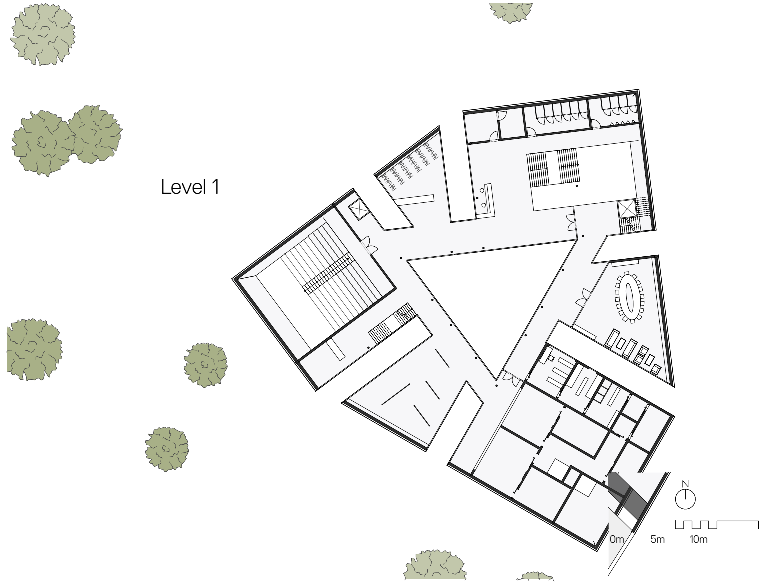


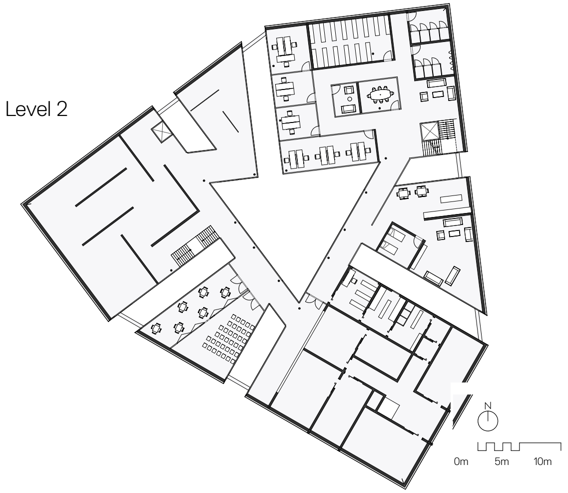
laboratory

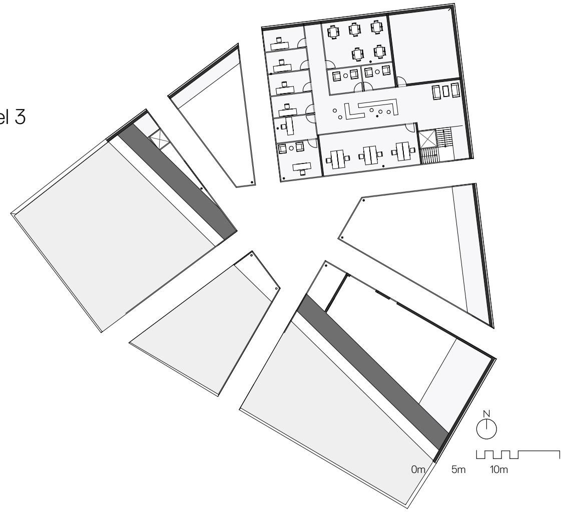


office

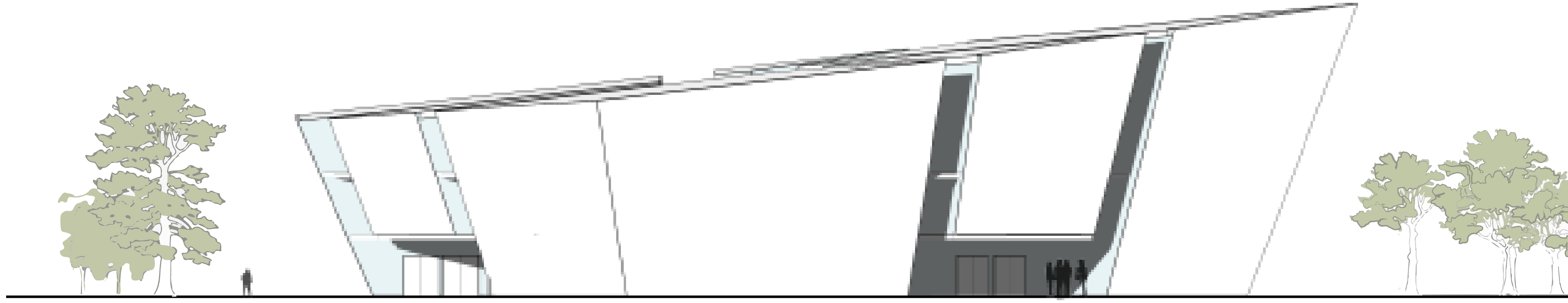
Floorplans





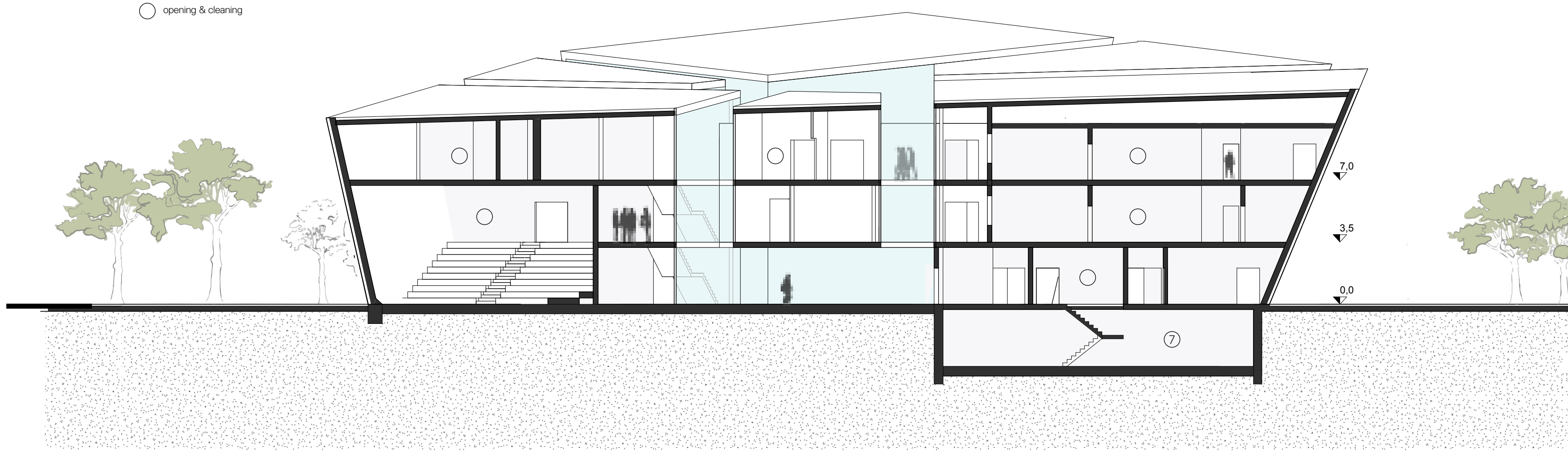


Elevations



Sections

1 auditorium
exhibition
office
BSL - 4 laboratory
non - BSL 4 laboratory
opening & cleaning

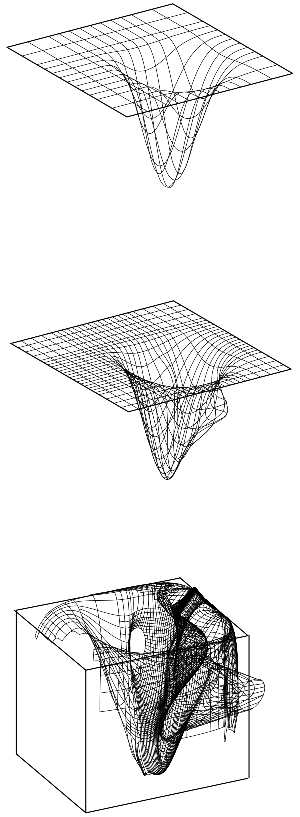


The Black Hole

Justine Poulin

Location:	Vienna
Floor Area:	
Laboratories	1040 m^2
Offices	1050 m^2
Lecture's Room	200 m^2
Cafeteria	200 m^2
Library	280 m^2

Designing an extra-terrestrial sample receiving and curation facility that requires to be operational within a decade requires a great deal of fore thought. The building must be able to face technical modulations, but more importantly, it must propose a design that will bridge time and current concerns. In the future, space discoveries may completely change the way we perceive and experience life. The concept of a black hole recalls this possibility. Its strong gravitational field attracts object to a center where the gravity is so strong that it distorts the four dimensions, including time, that constitute the basis of human knowledge. This unfolding of space brings up new perspectives and questions that are still not completely reachable yet. The shape of the building interprets the four dimensions' distortion, as its interior space freely unfolds around an open hole, the center of attraction for the building. Everything gravitates around it, and shapes, fairly orthogonal on the edges of the building, merge into each other as they get closer to the center. This building is a celebration of life-changing discoveries. Entering it, is like entering a world that is still undefined, a world that, with the help of the scientists, has the potential to be slowly revealed before our eyes.

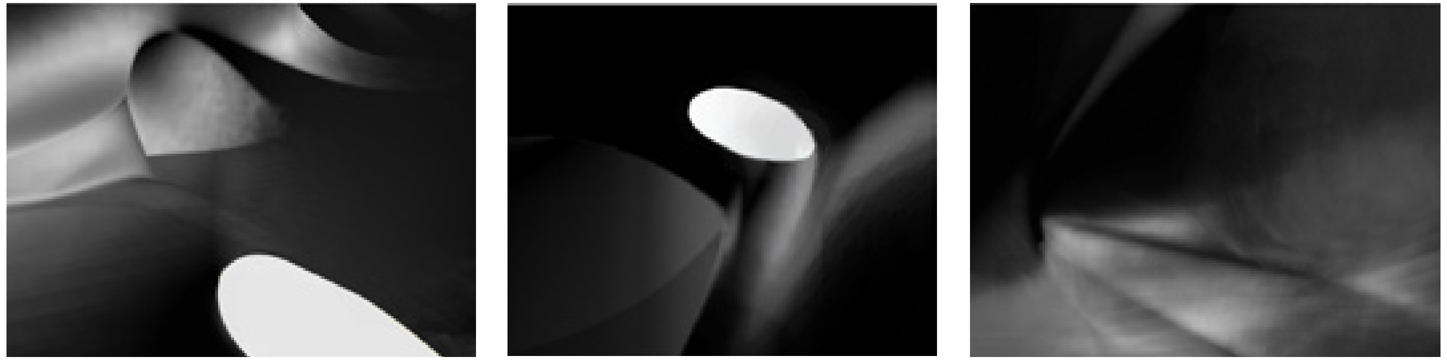


conceptual diagram

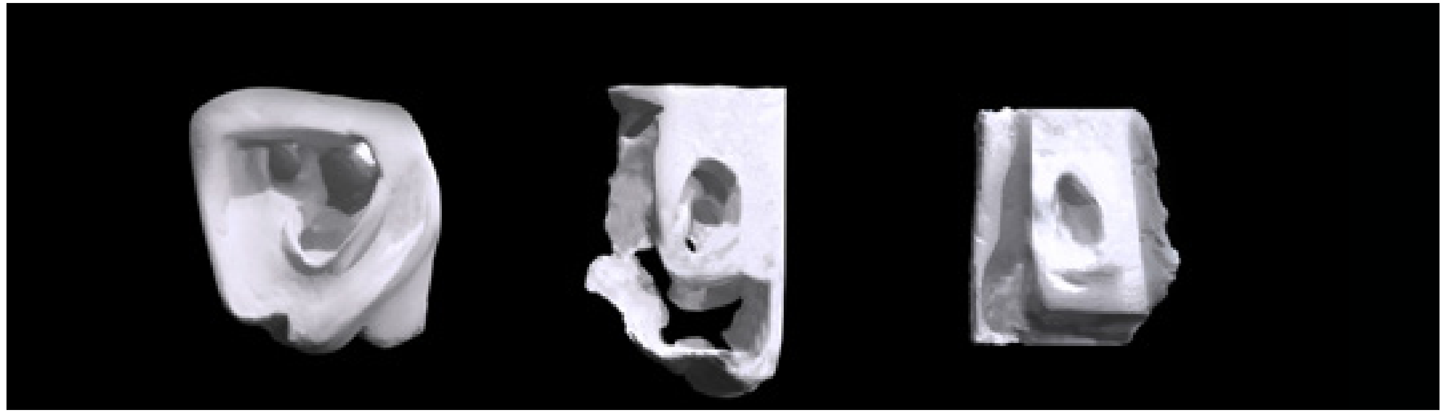
Conceptual Approach

The interior shaping of the building interprets the black hole's effect once applied to three dimensional plans. As a blanket that gets pulled down from one point, the gravitational fields attracts central points, pushing other masses away, in an attraction/repulsion relationship. The mass displacement created by multiple attraction points suggests cavities, walls, and floors that were the starting point of designing this building's massing.

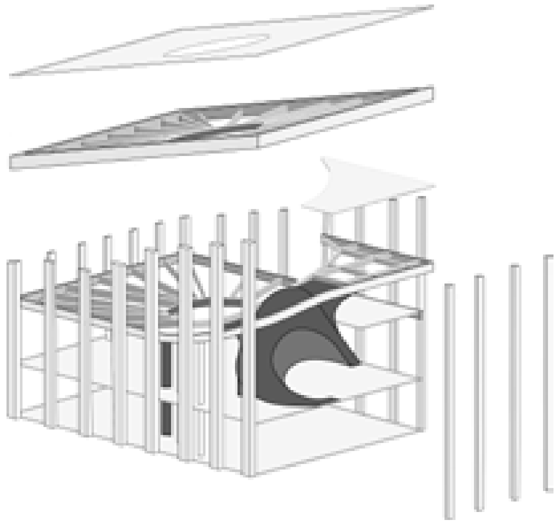
physical model to scale



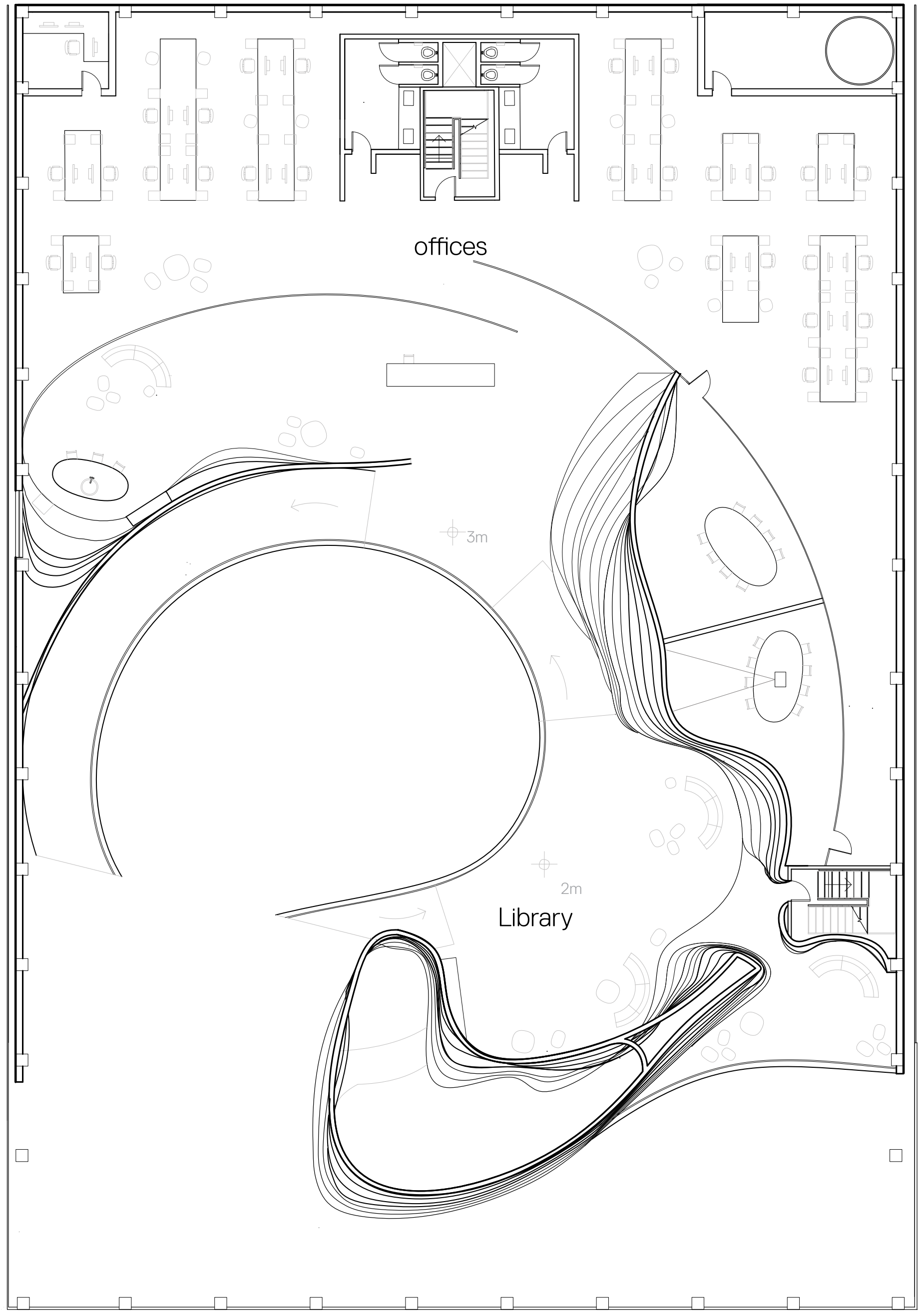
digital shape exploration



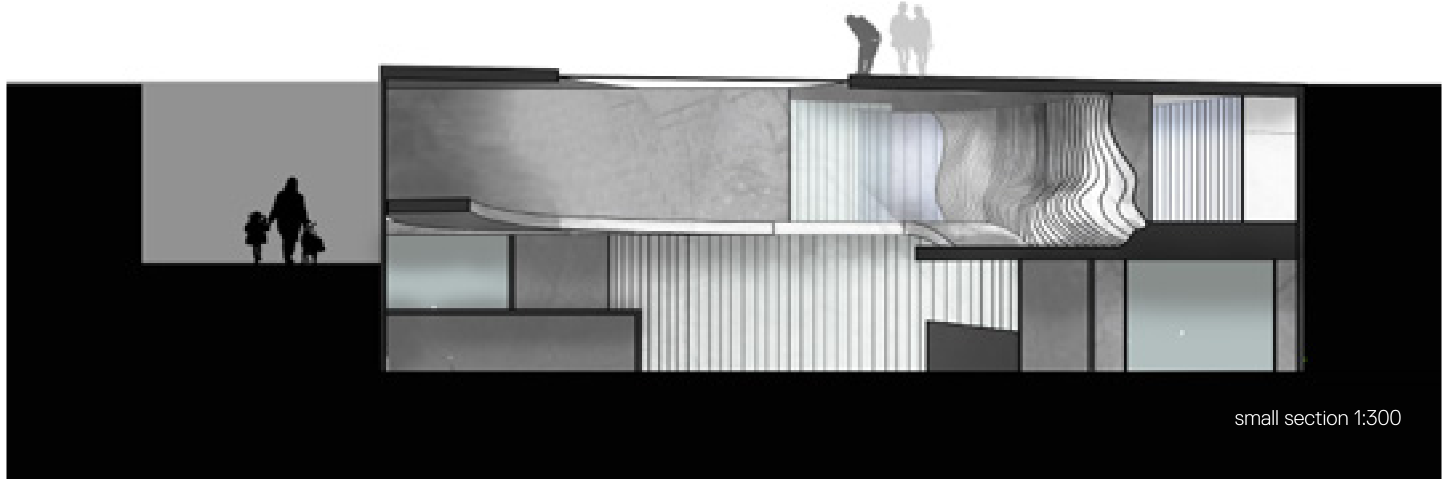
preliminary models



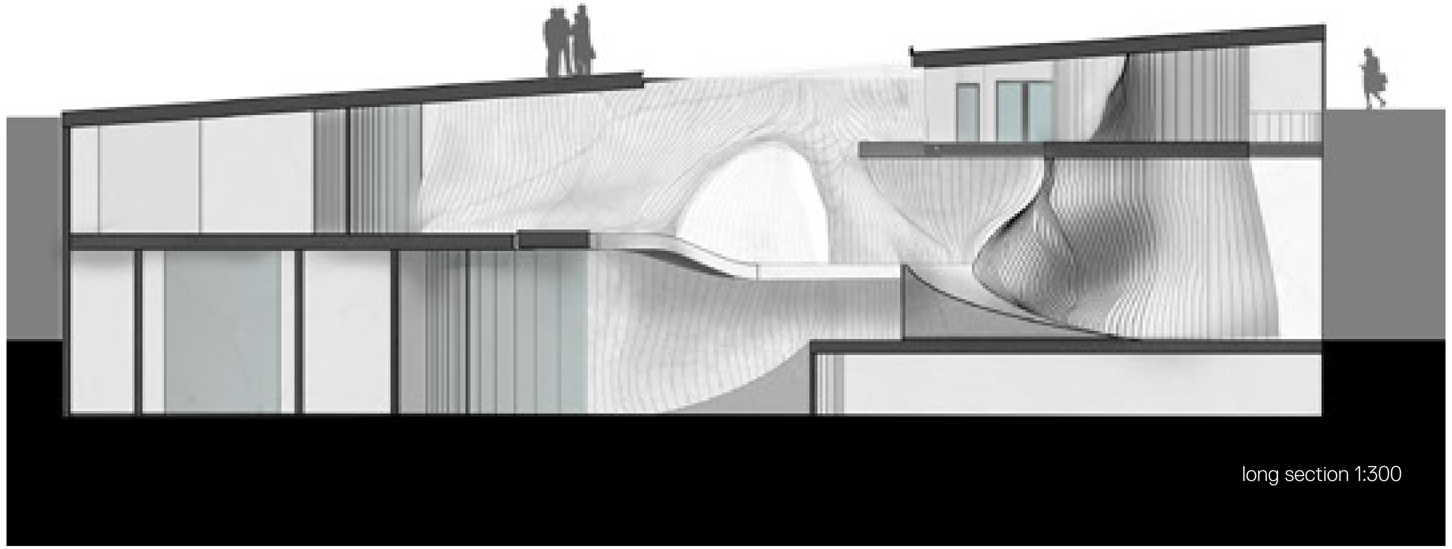
construction diagram



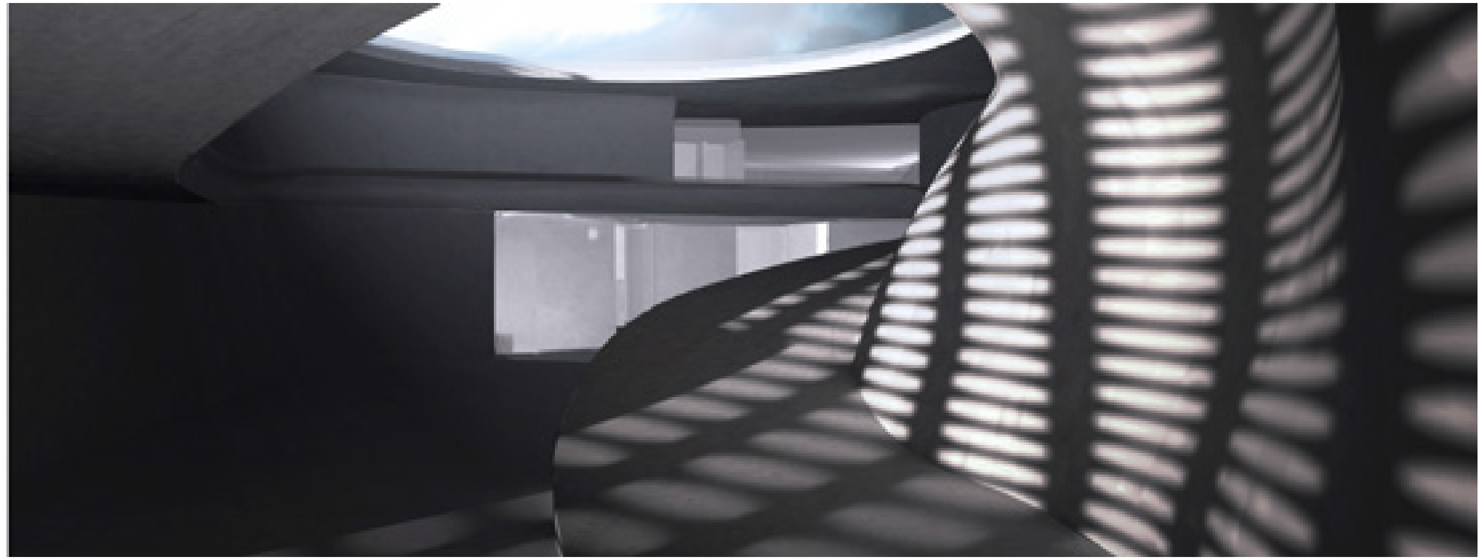
office floor plan 1:300



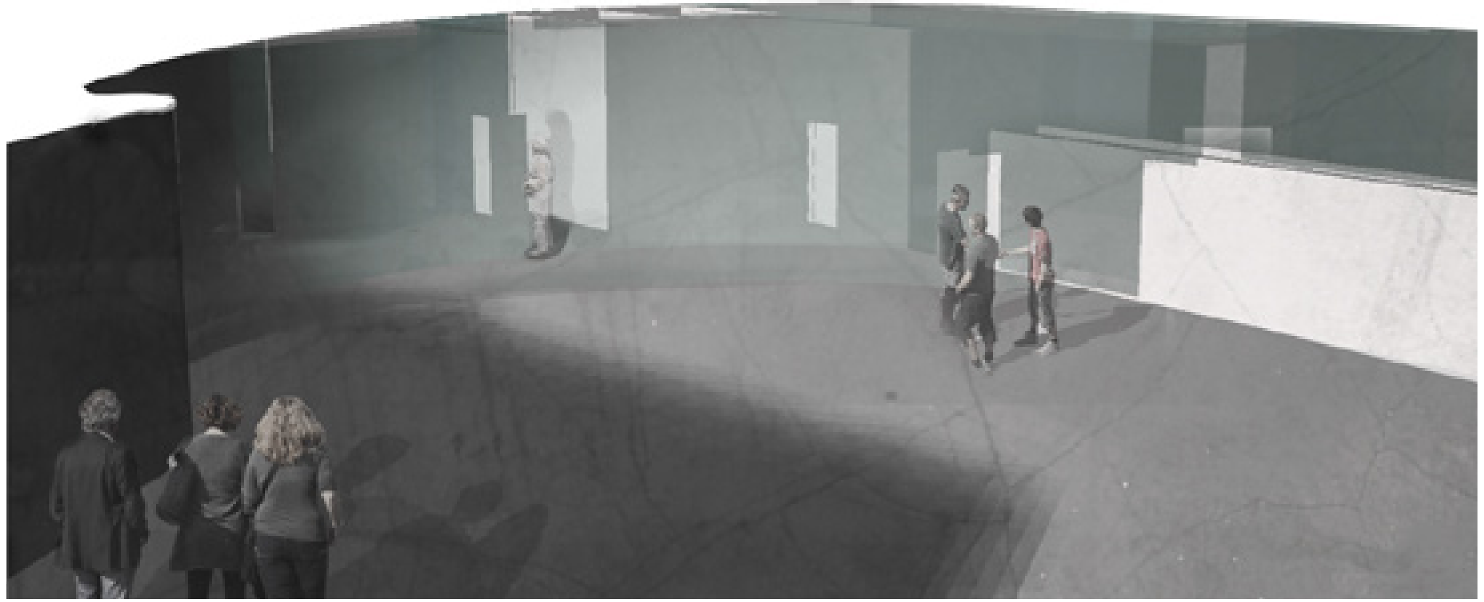
small section 1:300



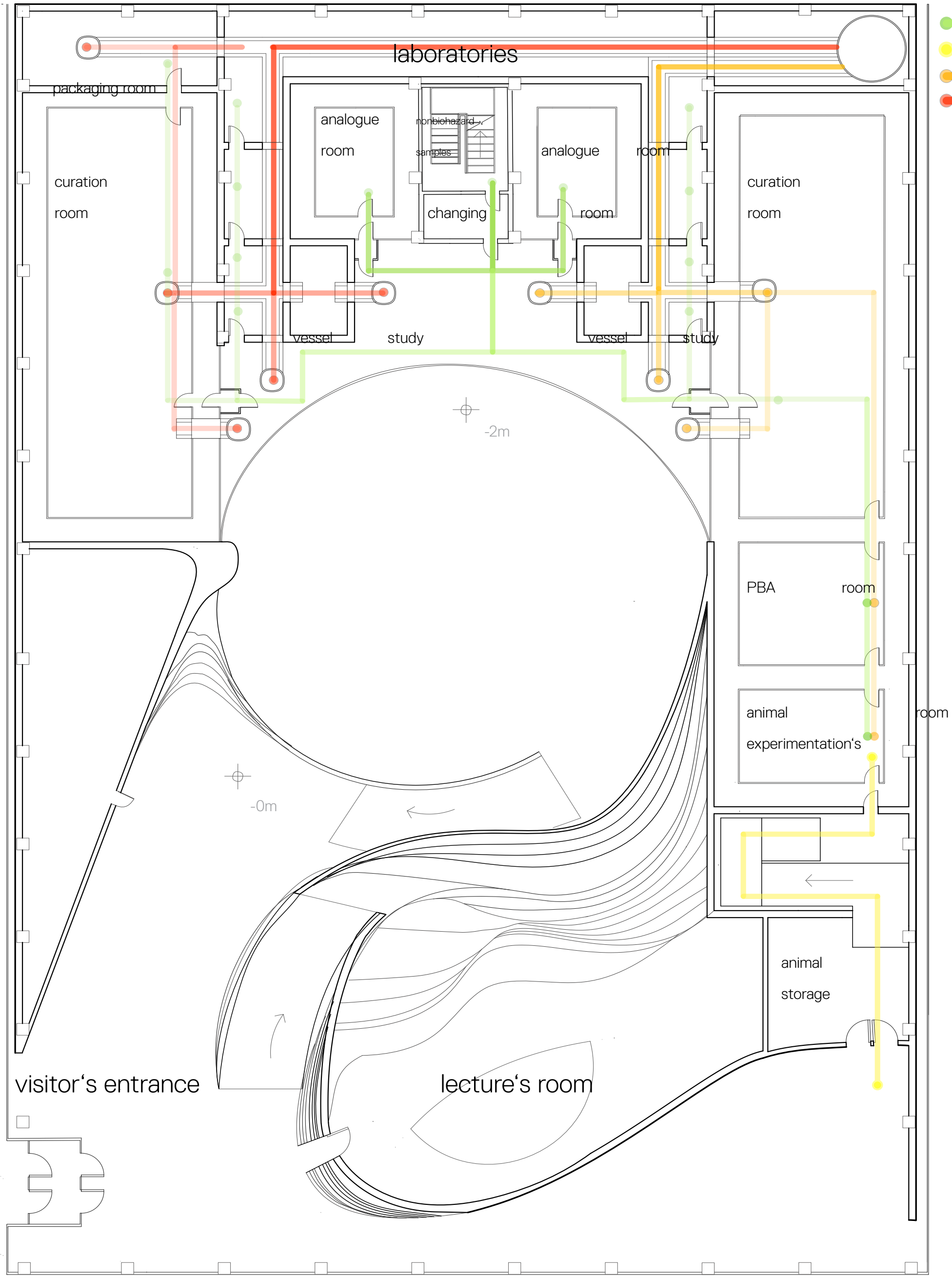
long section 1:300



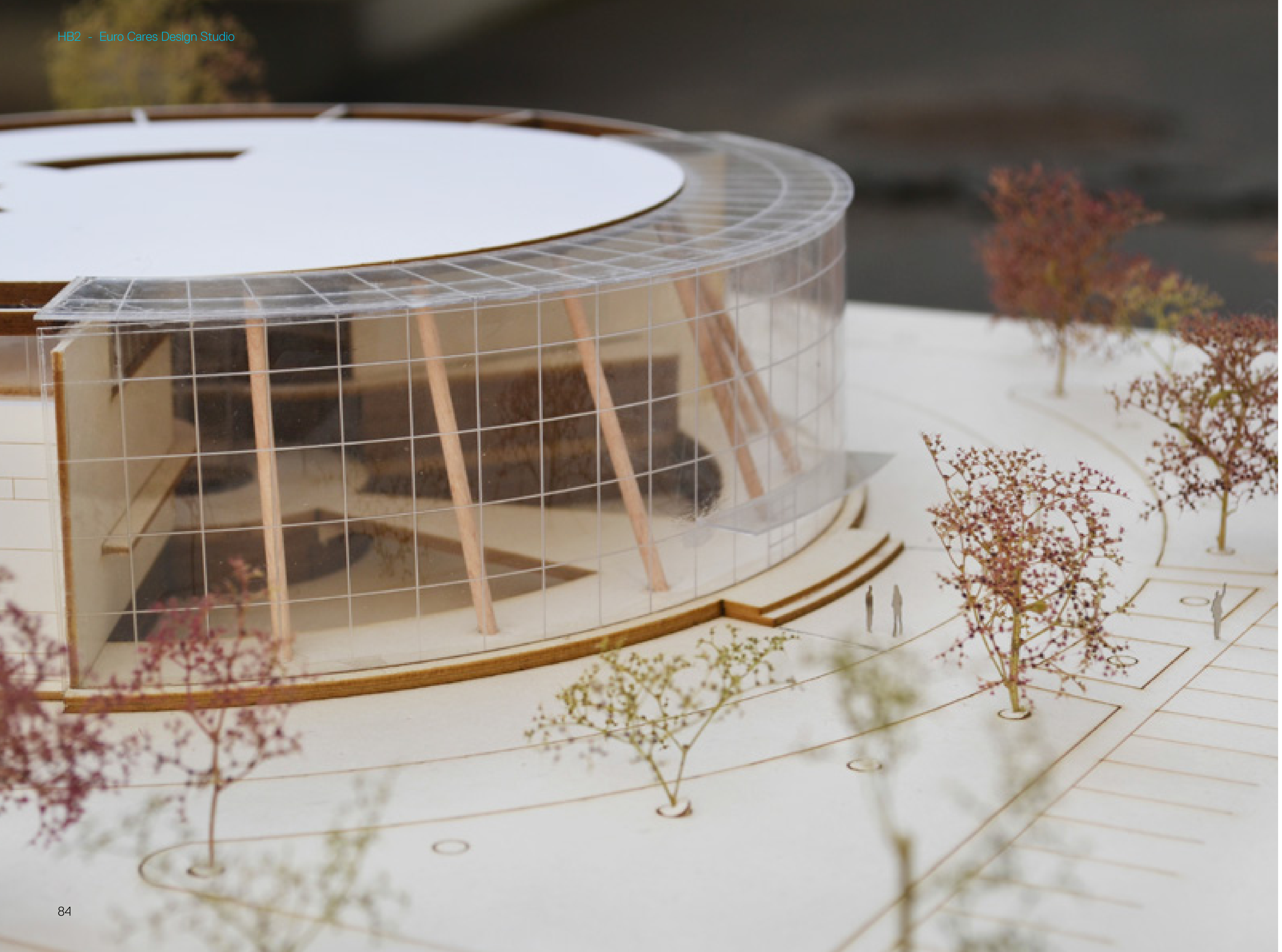
visitor's entrance



Laboratories



visitor's entrance
floor plan 1:300



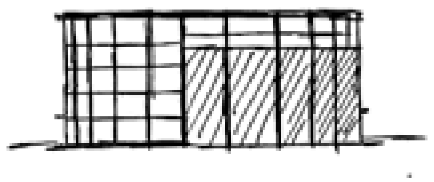
ESFC - Wien

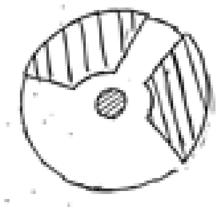
Ivan Vratnica, Emre Kilic

Location:	Vienna
Floor Area:	
Public Area	1307 m²
Exhibition	930 m²
Labs	
BSL4 Lab	350 m²
Lunar Lab	350 m²
Vault	175 m²
Technical	
BSL4	735 m²
(lvl -1)	325 m²
(lvl 1)	410 m²
Lunar Lab and Public & Offices	813 m²
(lvl -1)	413 m²
(lvl 1)	400 m²
Offices	741 m²
in total	~5000 m²

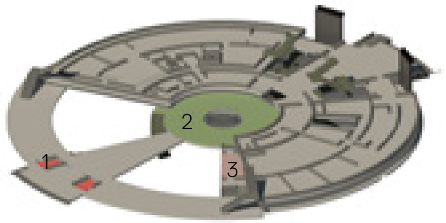
A curved design with a strong focus on functionality and public accessibility. Work and sample flow sequences through the labs have been extensively studied and form the basis of this facility design.

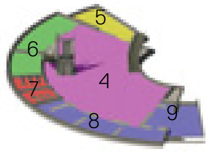
The vault for samples on display in the center of the facility is the main attraction of the public area.





Floorplans





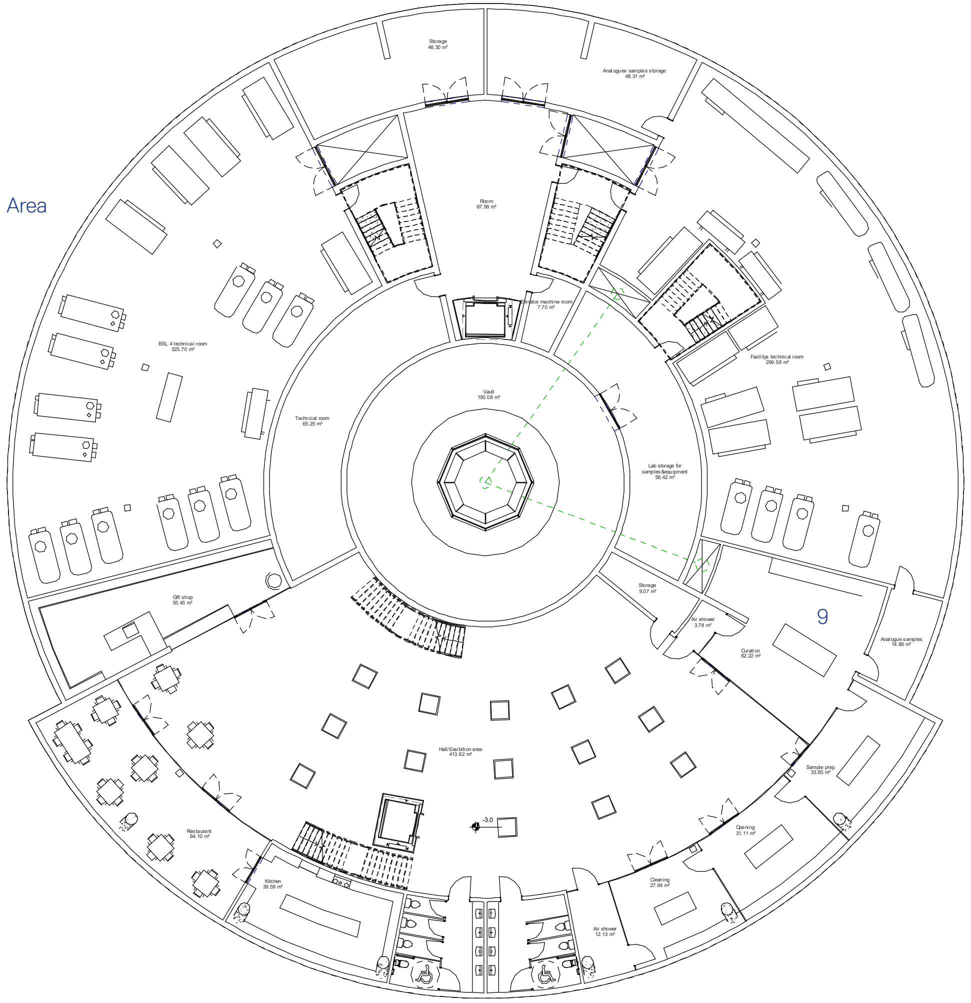
1. Security Room
2. Vault Area
3. Curation Room Viewing Area
4. Exhibition Area
5. Gift Shop
6. Restaurant
7. Restrooms
8. Mock Lab
9. Analogue Samples

Public access leads directly to the vault area where people can observe the samples. Stairs on the sides lead to a catwalk to observe the samples from an elevated vantage point.

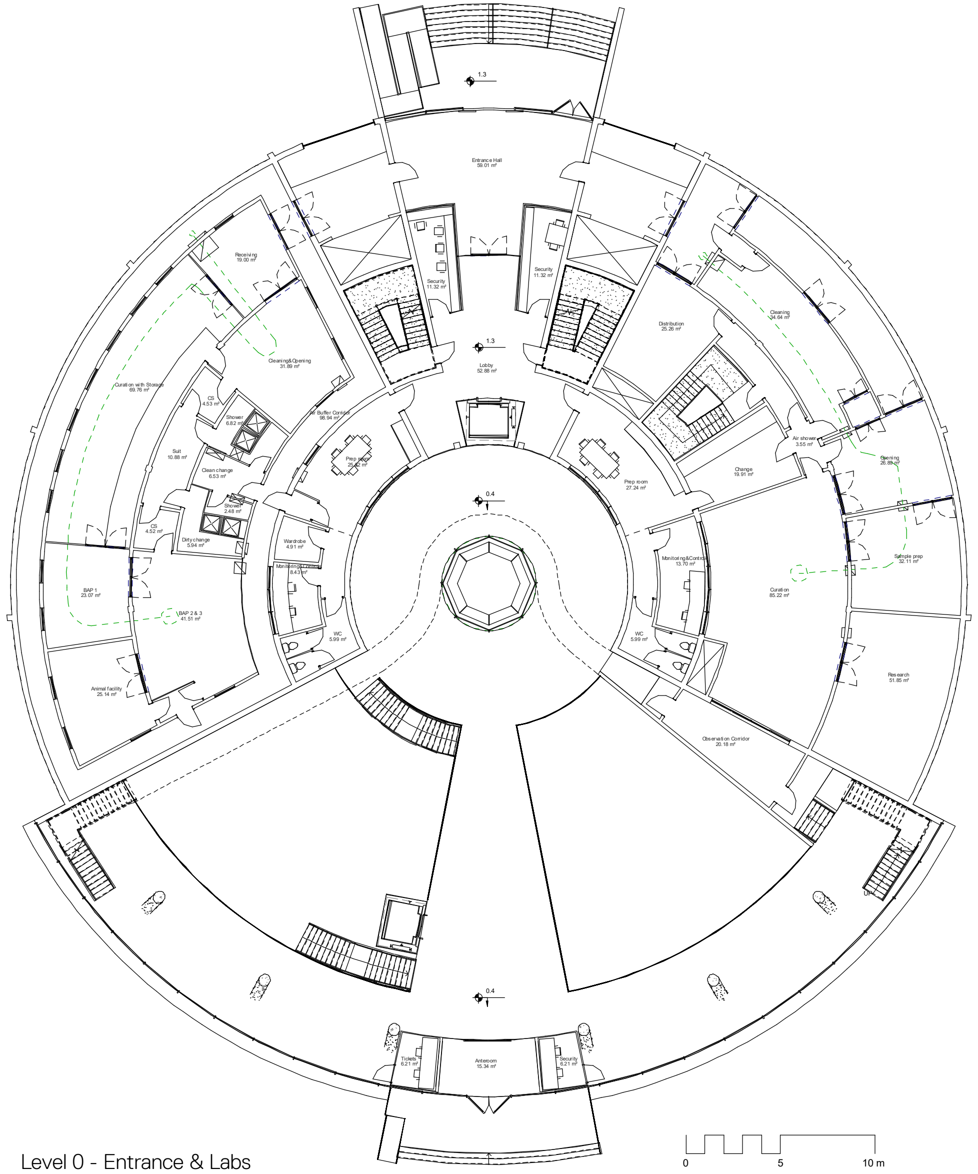
The transit room on the right side of the bridge has a window to the curation room so the public can observe the curation process.

The exhibition area is located in the centre of the basement of the building. A gift shop and the restaurant are located to the left.

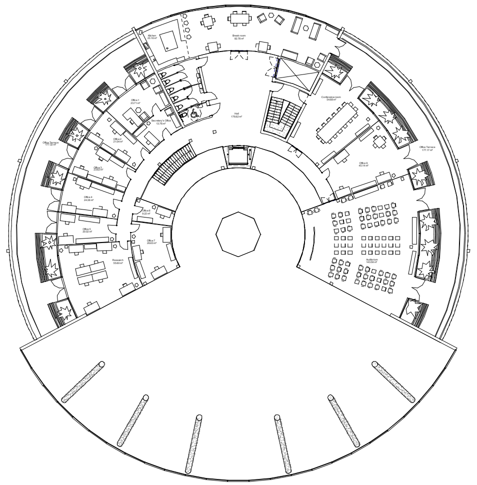
The mock lab on the right side is designed as a juxtaposition of rooms to simulate the curation process.



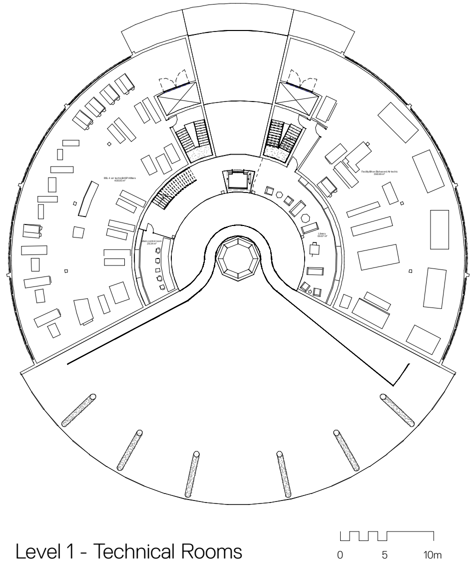
Level -1 - Basement



Level 0 - Entrance & Labs

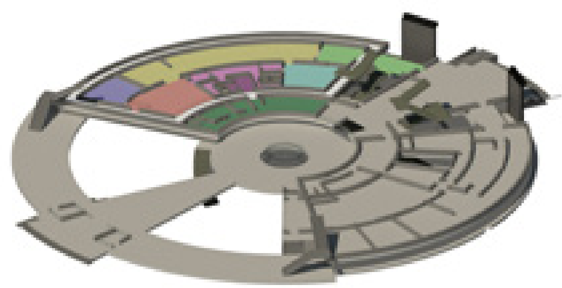


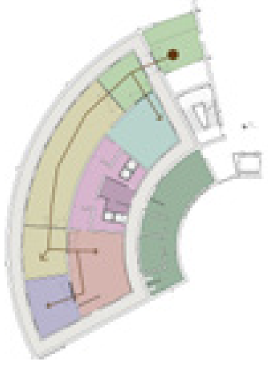
Level 2-Offices



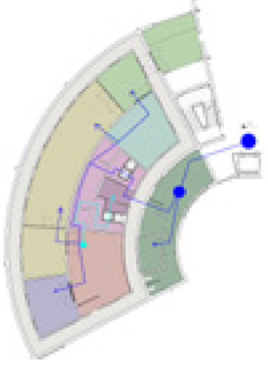
Level 1 - Technical Rooms

Laboratories





Equipment Flow

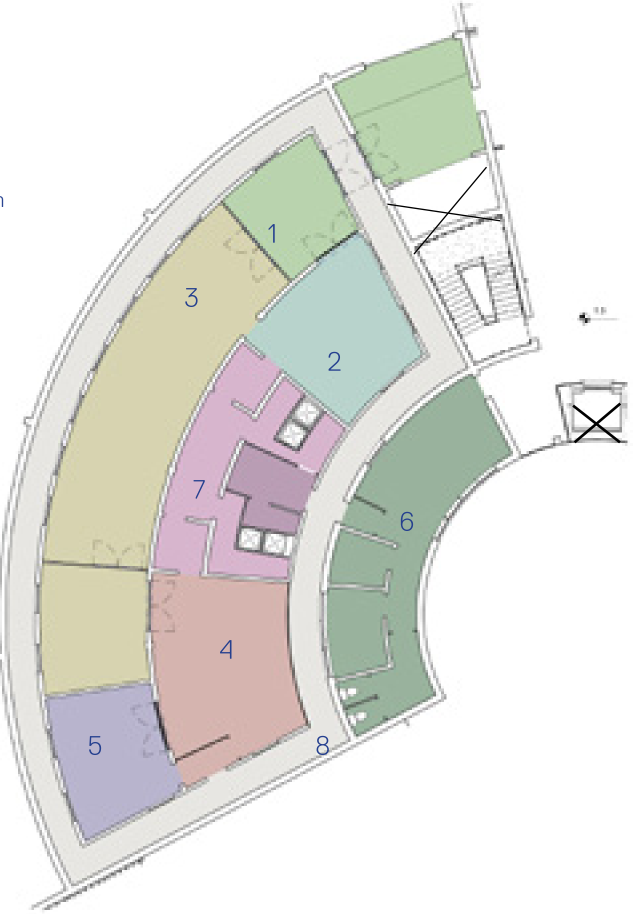


Researcher Flow

Sample Flow

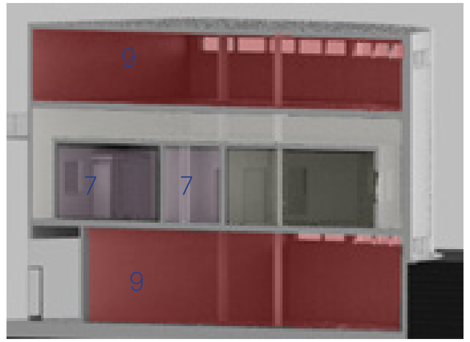
BSL4 Lab:

1. Receiving Area
2. Opening & Cleaning Area
3. Automated Curation & BAP 1
4. BAP 2 & 3
5. Animal Lab
6. Briefing and Monitoring Room
7. Shower and Changing
8. Air Buffer Corridor
9. Technical Rooms



BSL 4 Lab

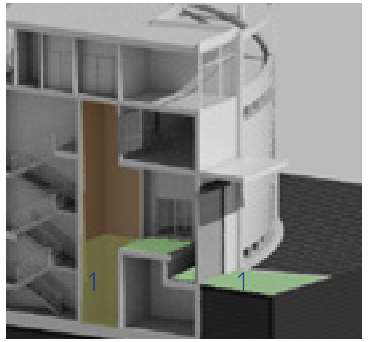
The BSL 4 Lab is surrounded by an air buffer corridor (8). In case of a breach in the airlocks this corridor acts as an extra barrier to ensure no aerosols are released from containment.
The long curation room (3) is automated to make interactions with possibly biohazard material safer. The machines can also be controlled from the monitor room (6).
Labs are placed in between technical rooms as seen below.



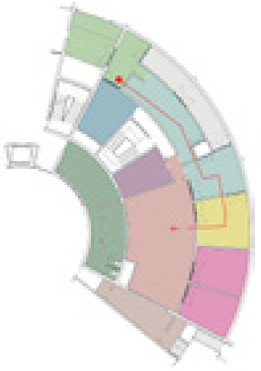
Sandwich System for Labs

Lunar Lab

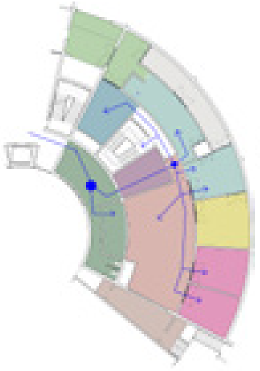
The Lunar Lab has larger rooms than the BSL 4 and lacks the Air Buffer Corridor. Opening and cleaning areas (2) are put in a row to make the cycle easier. They are also connected to each other with a corridor.
The curation area (6) is the largest room of the lab and is connected to each separate function to make access easier. It also shares a window with a public area so people can observe the curation process.



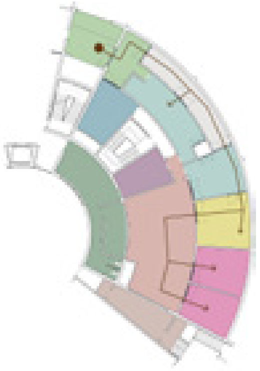
Receiving Area



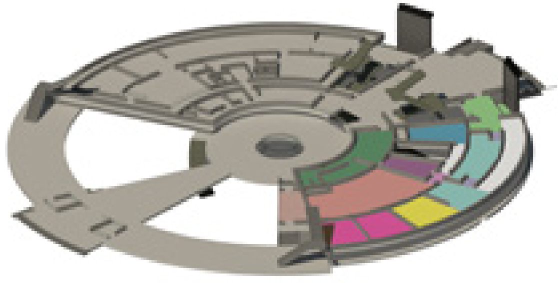
Sample Flow



Researcher Flow

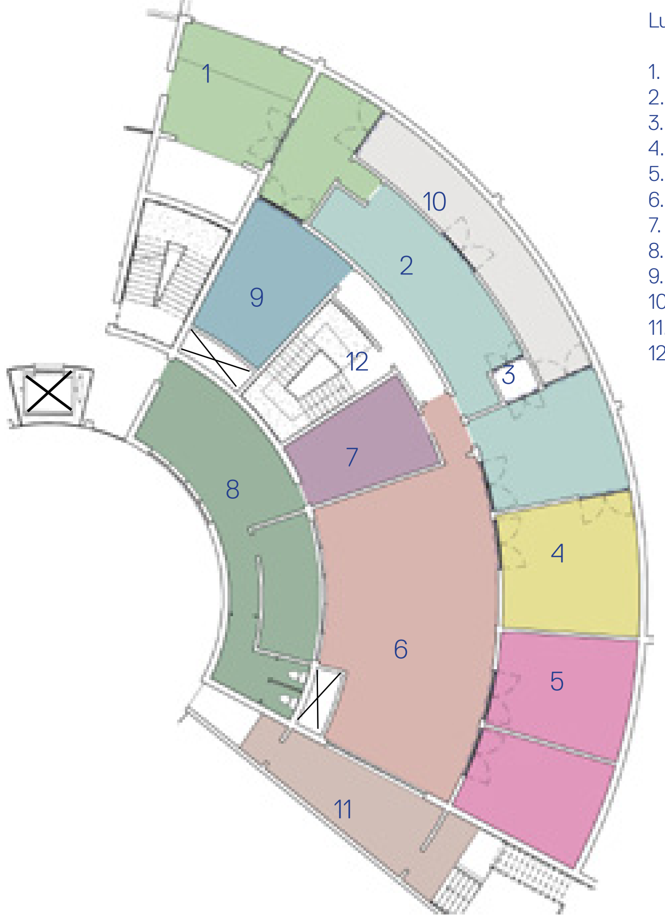


Equipment Flow

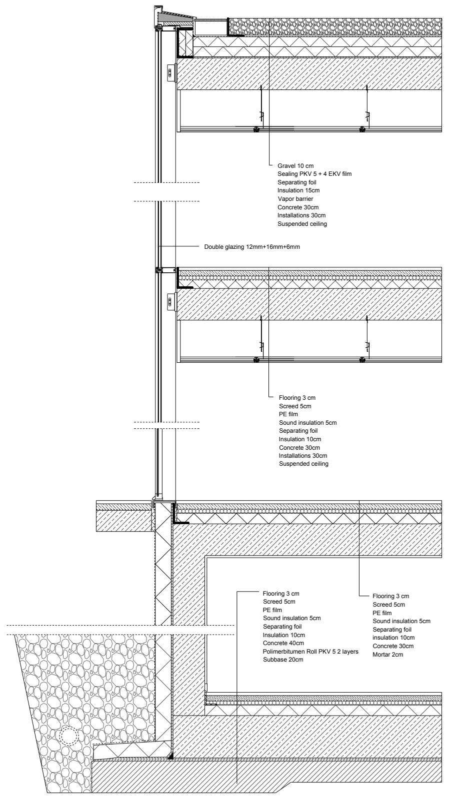


Lunar Lab:

1. Receiving Area
2. Opening & Cleaning Area
3. Airlocks
4. Sample Prep. Room
5. Research
6. Curation Area
7. Change Room
8. Briefing and Monitoring Room
9. Distribution Room
10. Corridors
11. Observation corridor
12. Stairs to the vault



Sections and Details

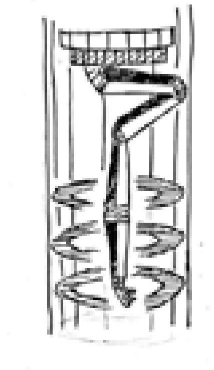


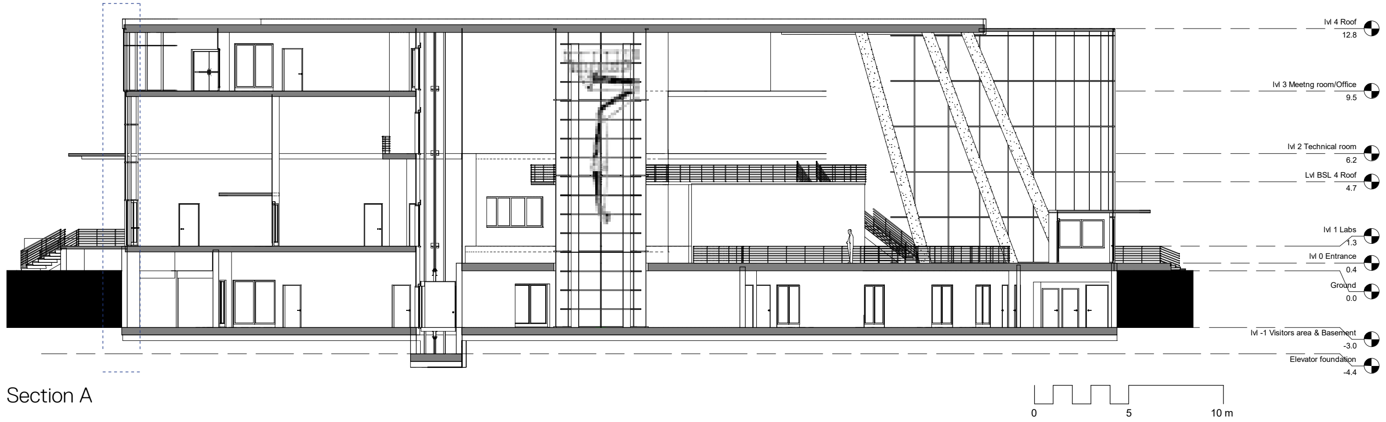
The Vault

The vault is located in the center area of the building. Exhibition samples are stored in the vault for visitors to observe. The vault can be observed from the lower level as well as from the catwalk.

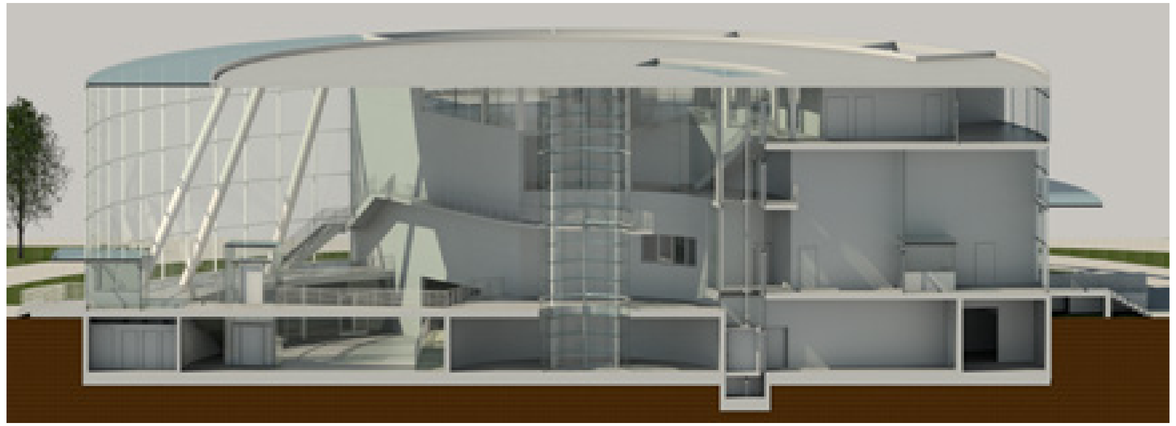
It consists of an upper and a lower part: A cylinder made from two layers of transparent security glass stretches from the storage area to the roof. Samples that require special care are stored in the lower part of the vault that is not observed by the public.

The vault is only accessible through the lunar lab in order to maintain a clean path. Only non-biohazardous samples are stored in the vault. The vault is automated and controlled from outside.



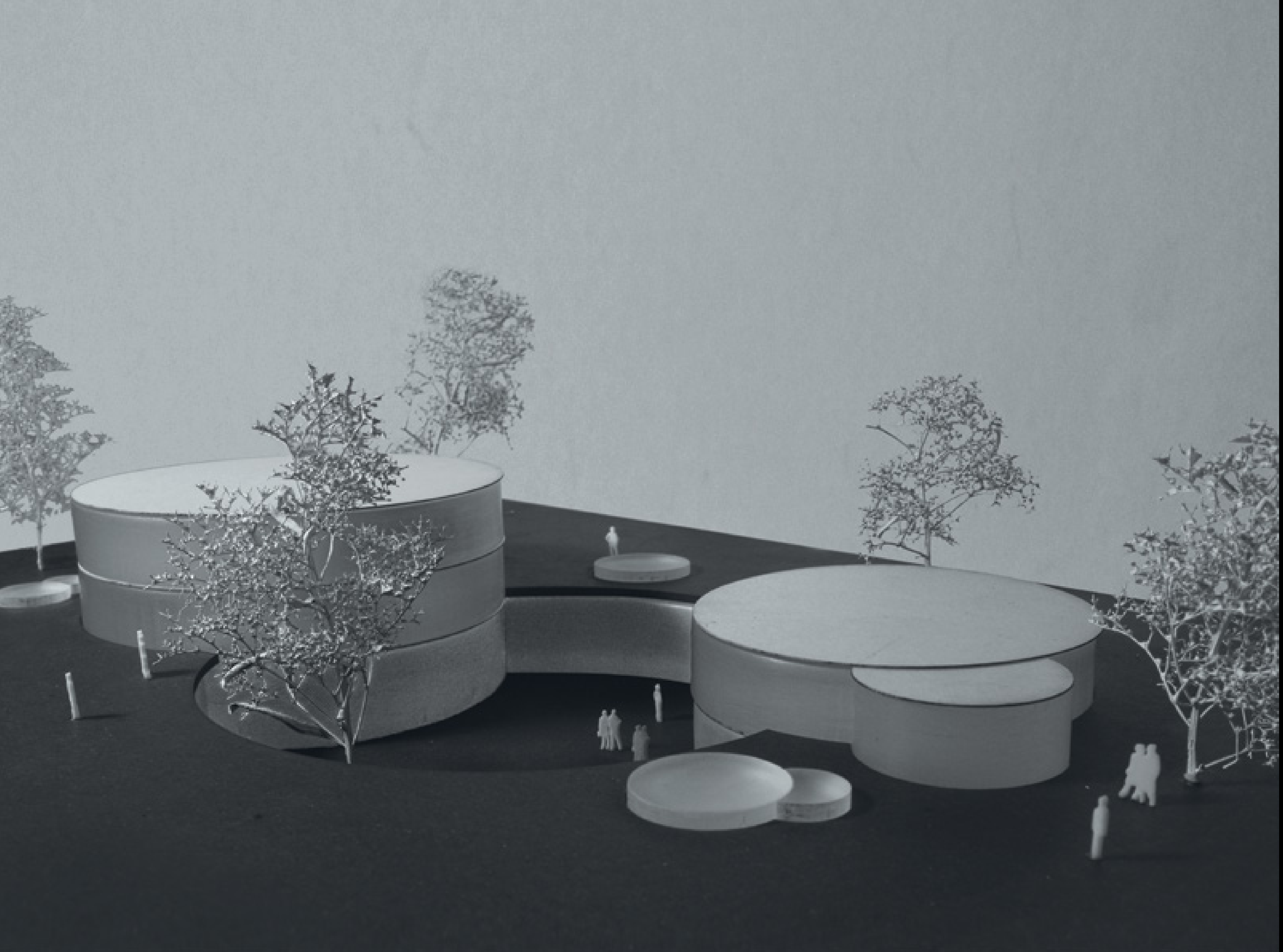


Section A



Section B

Section C



Extraterrestrial Center

Pavel Ritter

Location:	Vienna 18th district
Floor Area:	
Laboratories	633 m²
Office	440 m²
Exhibition	180 m²
Cafe	150 m²
Workshop	50 m²
Lecture	90 m²

Specific Characteristics:

Public involvement with workshops and lectures

The task was to design a laboratory for extraterrestrial sample handling and storage, as well as working spaces for researchers and a public facility for outreach work. These three parts are connected through a green space in the middle, which is the heart of the project.

The fact that this center will host the first Mars samples on Earth will generate a huge public interest. Thus, the goal is to involve the public as much as possible without disturbing scientists at work.

The building is located in a park between the institute for astronomy and the institute for meteorology and geophysics in the 18th district of Vienna. Here, students have the opportunity to study this topic further.

Office

The office building is supported by beams and columns, providing functional flexibility of the interior spaces.

In the middle of both floors, next to the stairs, is a shared space, where people can meet spontaniously. A kitchen is located on the first floor.

The offices itself are shared by four to six people and offer enough room for individual work spaces.

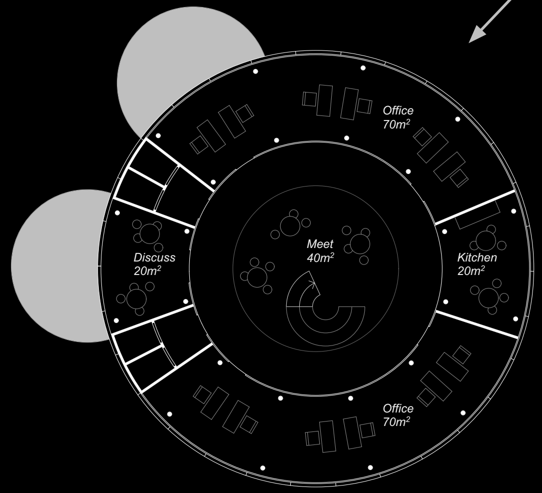
Additionally there are two quiet meeting rooms, one on each floor, for quick discussions and presentations as well as another big meeting room in the basement.

Visitors

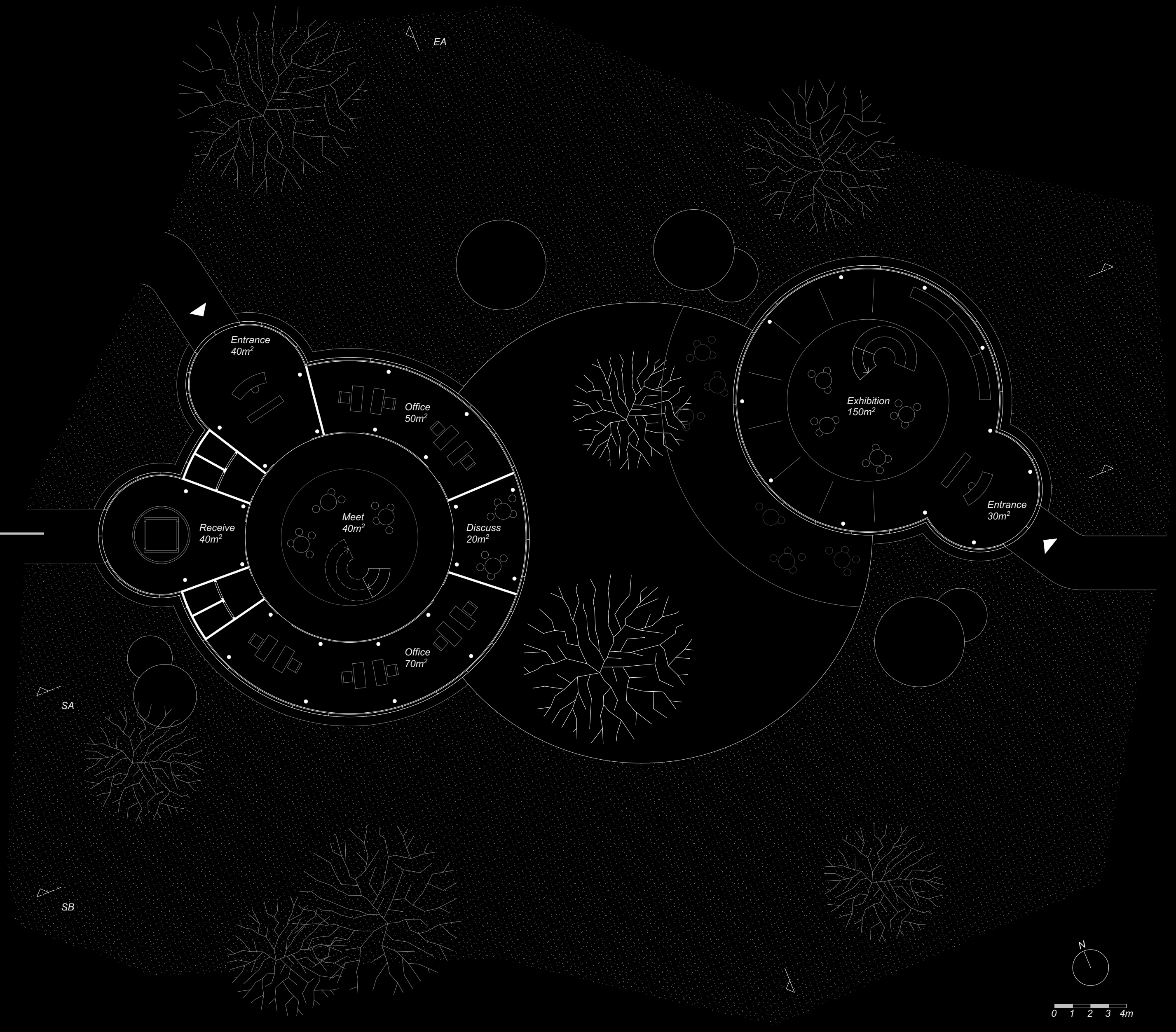
The public part includes a museum, a café with technical literature and two premises for workshops and lectures.

It is intended to host weekly workshops and talks for guest scientists, students, as well as children and other interested people without specific knowledge about the subject.

First Floor

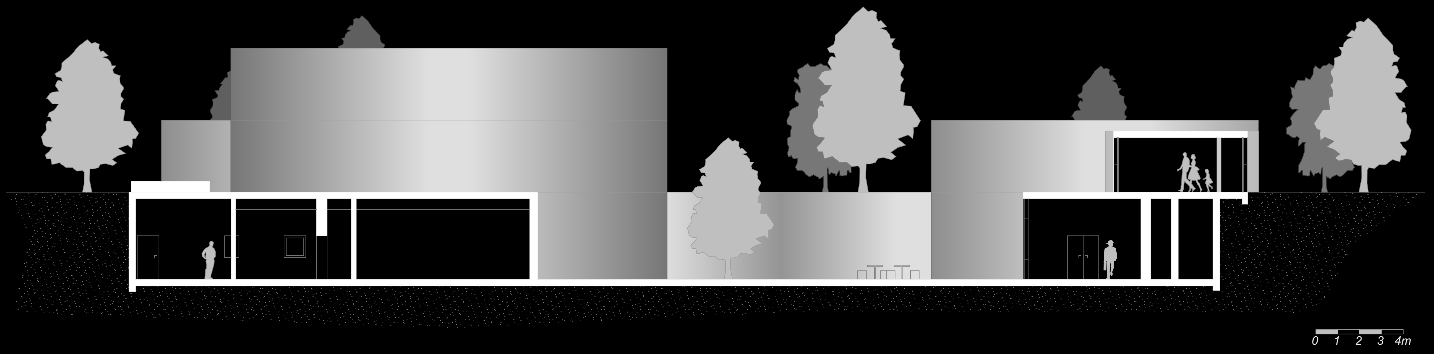


Ground Floor



Section SA

Section SB



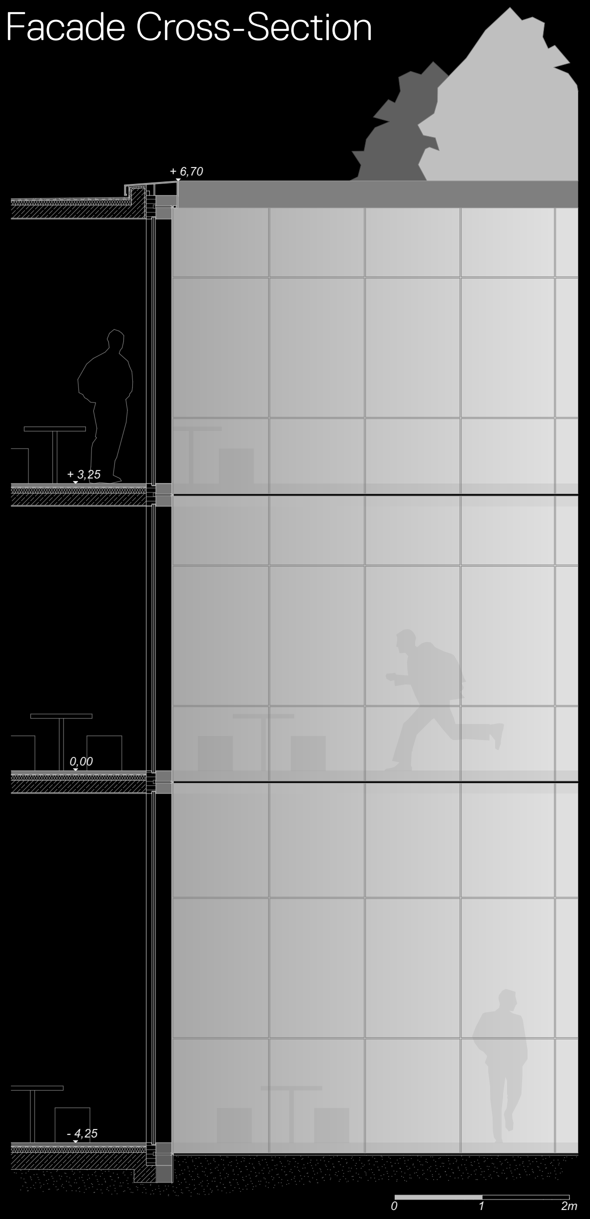
Materials

The curtain glass facade is the most important detail of the building. Considering it is located in a park, the transparancy to the public is very important. People are able to see what's happening inside, day and night.

The ceilings are made of reinforced concrete, with polished screed on top, while the columns are made of steel.

The surfaces that people are interacting with are made from a warm combination of wood and steel.

Facade Cross-Section



Laboratories

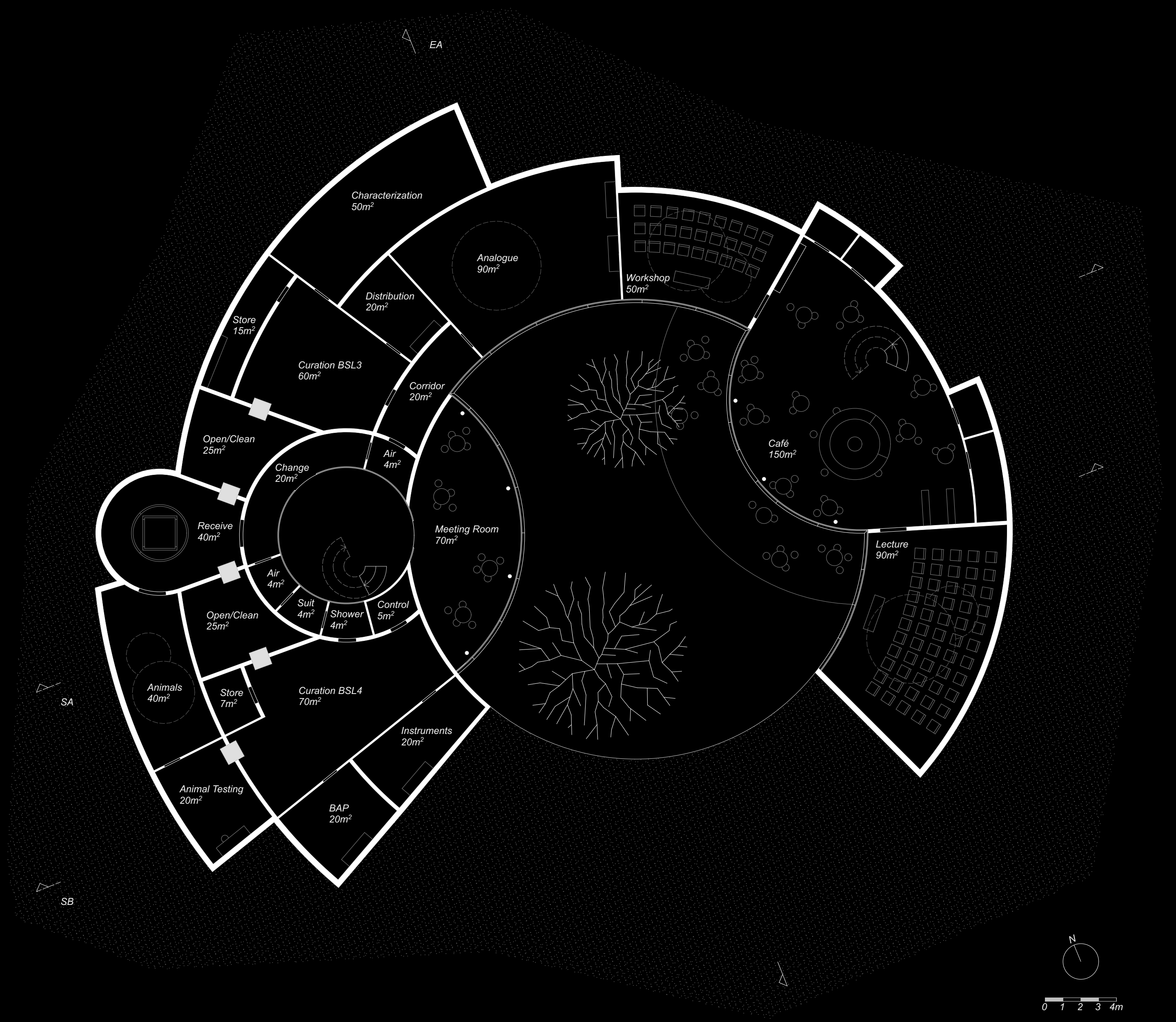
In fact, it's not recommended by the experts from NHM Vienna to have daylight or public viewing windows in most parts of the laboratories. They are located in the basement with all the technical support beneath. But scientists are working up to 8 hours a day in there, so daylight.

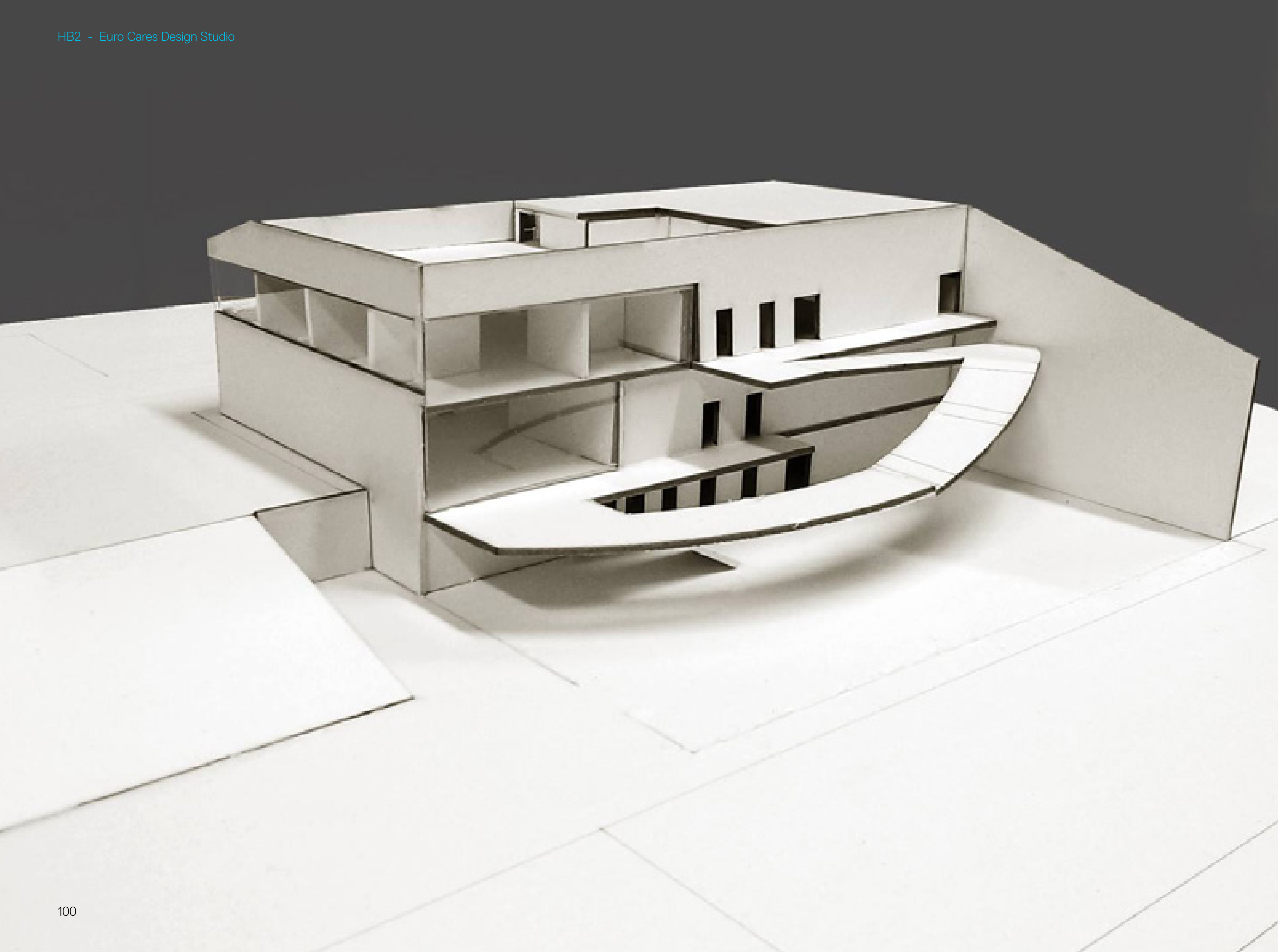
That's why the corridor of the BSL3 has daylight, which is also the connection to the analogue sample curation room. This room and the animal facility have daylight as well, entering through top lights from the ceiling. These top lights are found again above the workshop and the lecture theatre.

The windows, where light is entering to the basement are an additional benefit for the visual relationships between public areas and scientists. While you are sitting in the café you have visual contact to the people working in the facility. Another benefit is the connection to nature and the green space in the center.

Also there is a big meeting room beside the laboratory located to the garden, where scientists can have a break or discuss their research activities.

Basement





KoraStation

Elena Todorova, Teodora Tyankova

Location: Vienna

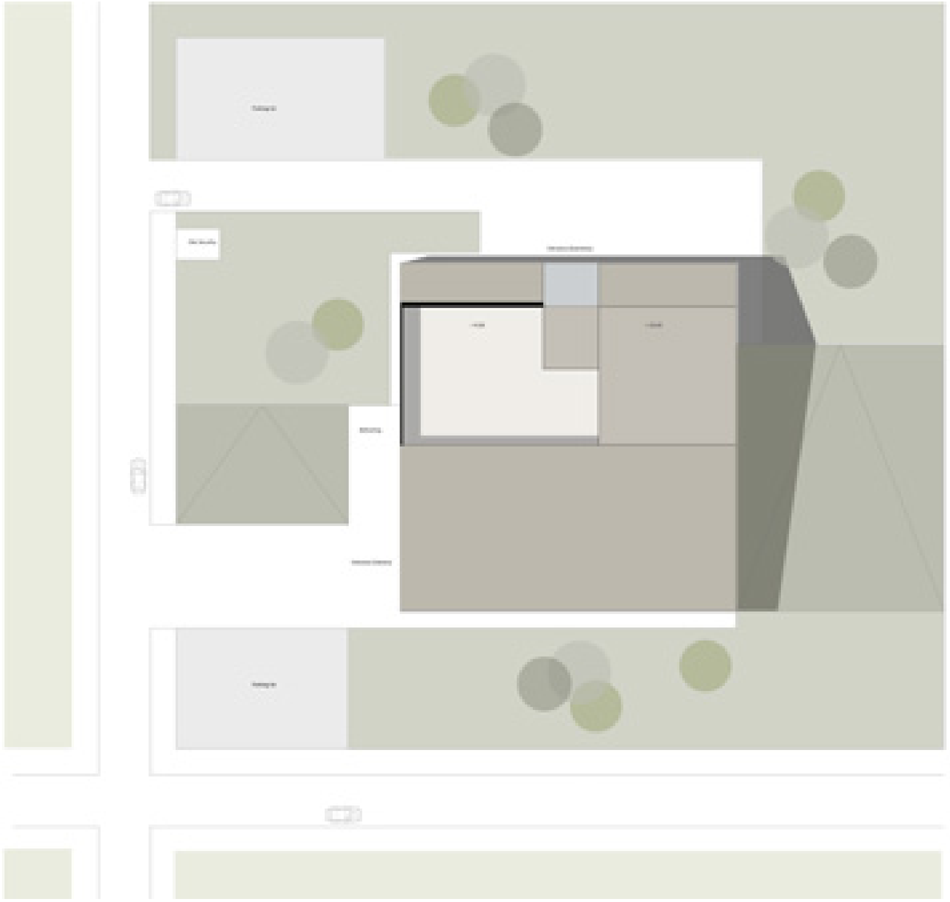
Floor Area:

Laboratories	780 m^2
Office	800 m^2
Exhibition	440 m^2
Cafe/Restaurant	160 m^2

Specific Characteristics:

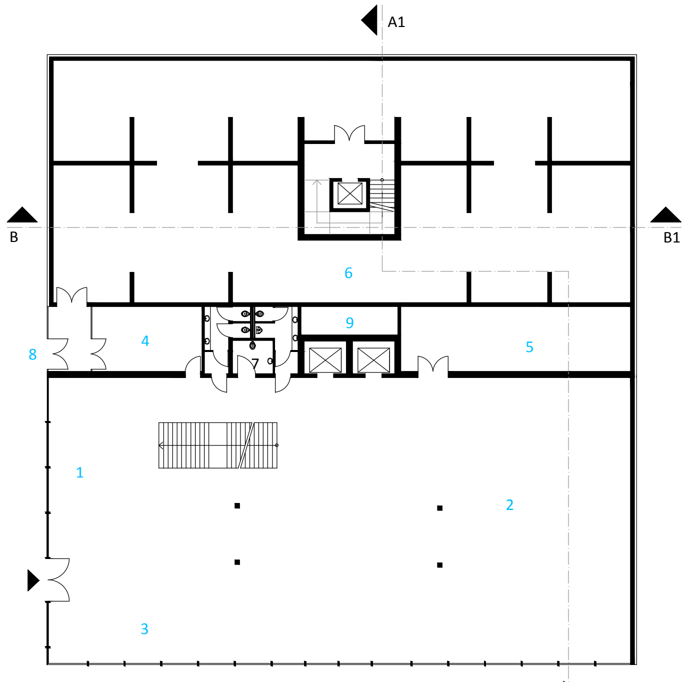
Functionality, Simplicity, Flexibility, Attainability

Our concept is focused on separating the different flows of people: scientists from visitors and, respectively, separating the public from individual workspaces. Whilst still having some common spaces connect the different flows.
The facility is situated on a site with a slope, providing ground-level access on two floors. The visitor entrance is located on the lower ground level, the entrance for the scientists is located on the upper ground level. The main entrance, the info point, cafe-restaurant and the exhibition area are all located on the lower level. From here stairs and elevators connect to a middle level where visitors can observe scientists working in the curation area with the stairs leading further up to the conference area.
The entrance for the scientists is located on the upper ground level, passing through several security checks. Near the scientist entrance is a waiting area and another information point. Non-biohazard or biohazard laboratories are located in a secure section of the facility after security checks. Mechanical rooms are located below the laboratories, while offices are located upstairs, connected to the conference room.

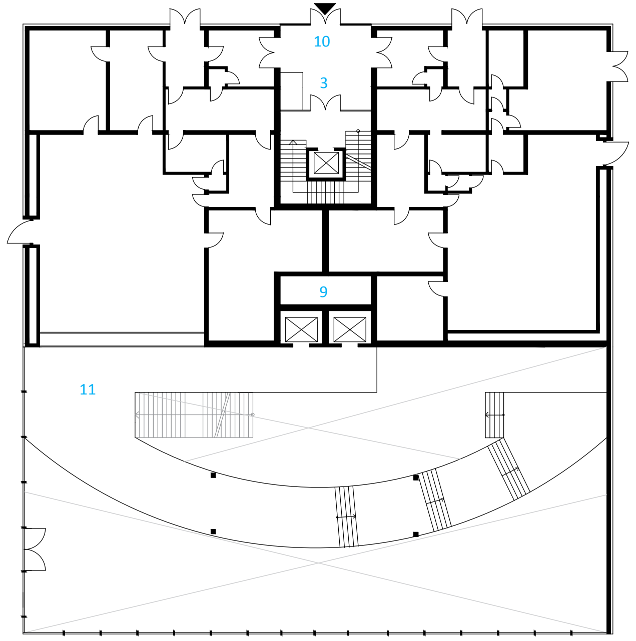


Site Plan

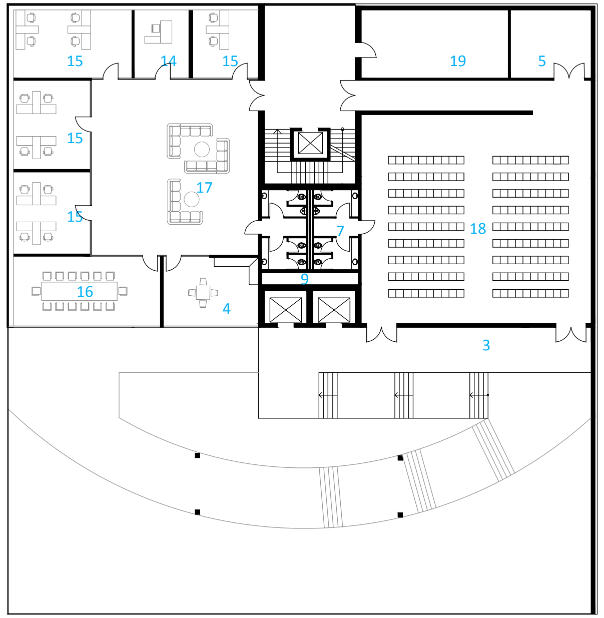
1. Cafe/Restaurant 280m²
2. Exhibition Area 315m²
3. Info/ Waiting area
4. Kitchen 31m²/28m²
5. Storage 64m²/28m²
6. Mechanical Part 500m²
7. Toilets 28m²
8. Delivering
9. Shaft
10. Laboratories
11. Observation (Curation area)
12. Check- in Control
13. Administration 16m²
14. Offices 27m²/ 35m²/ 20m²
15. Meeting Room 45m²
16. Informal Meetings 40m²
17. Conference 230m²
18. Monitoring 52m²
19. HEPA Filters
20. Lecture Room / Terrace



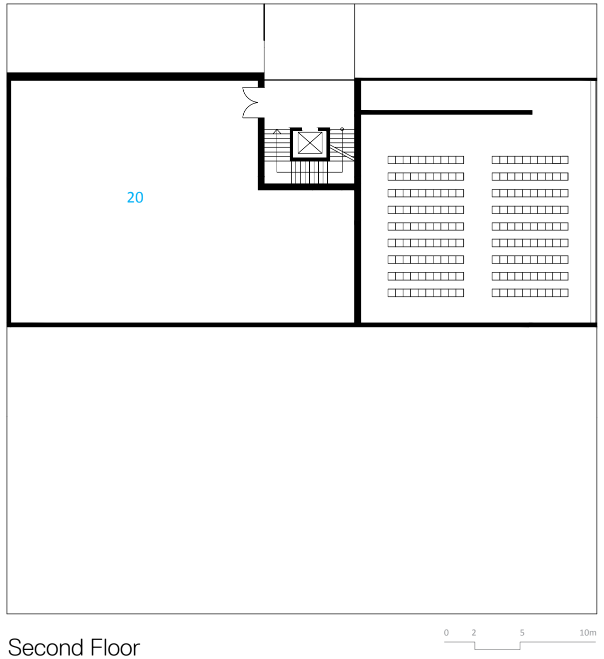
Ground Floor -1



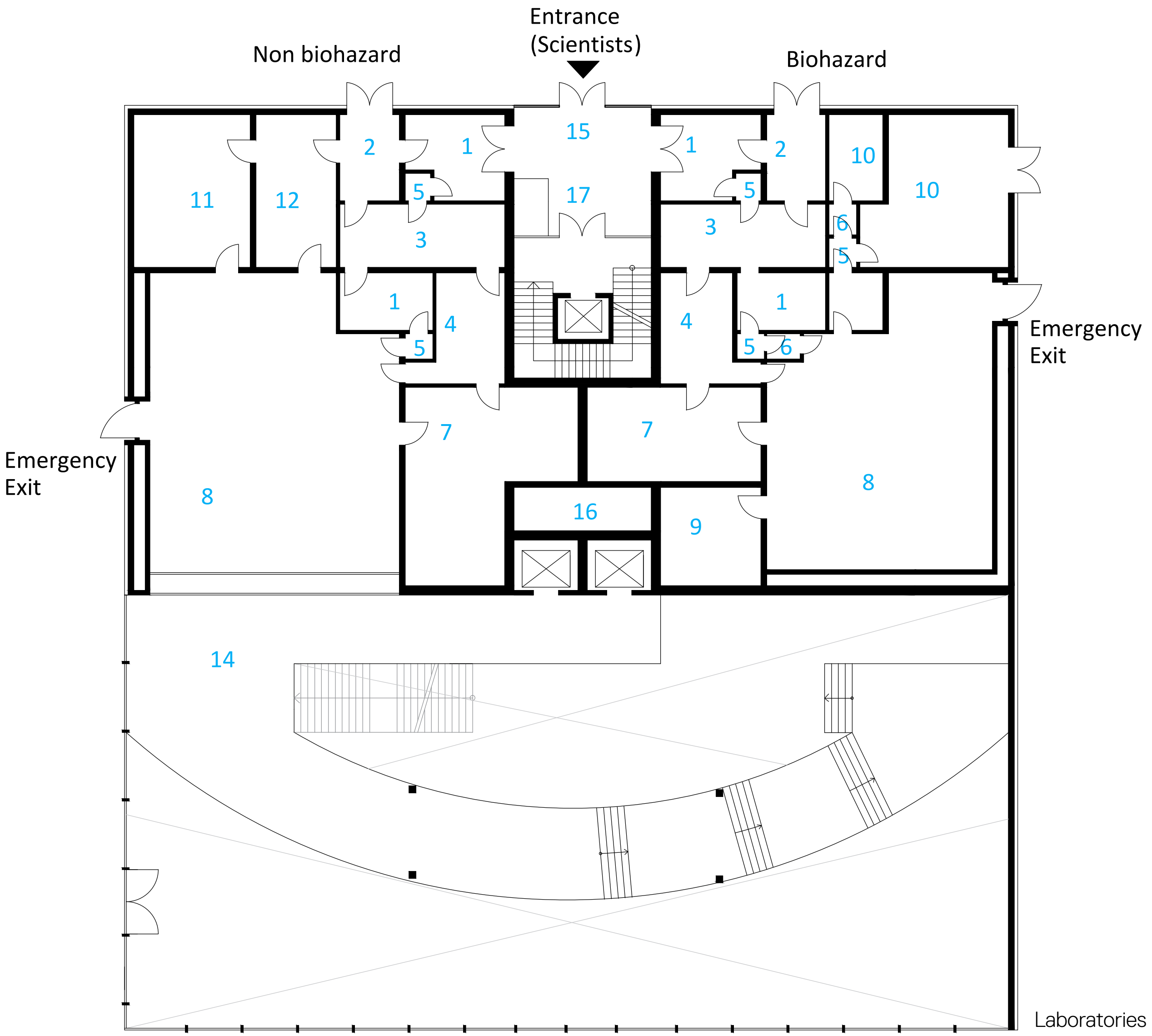
Ground Floor



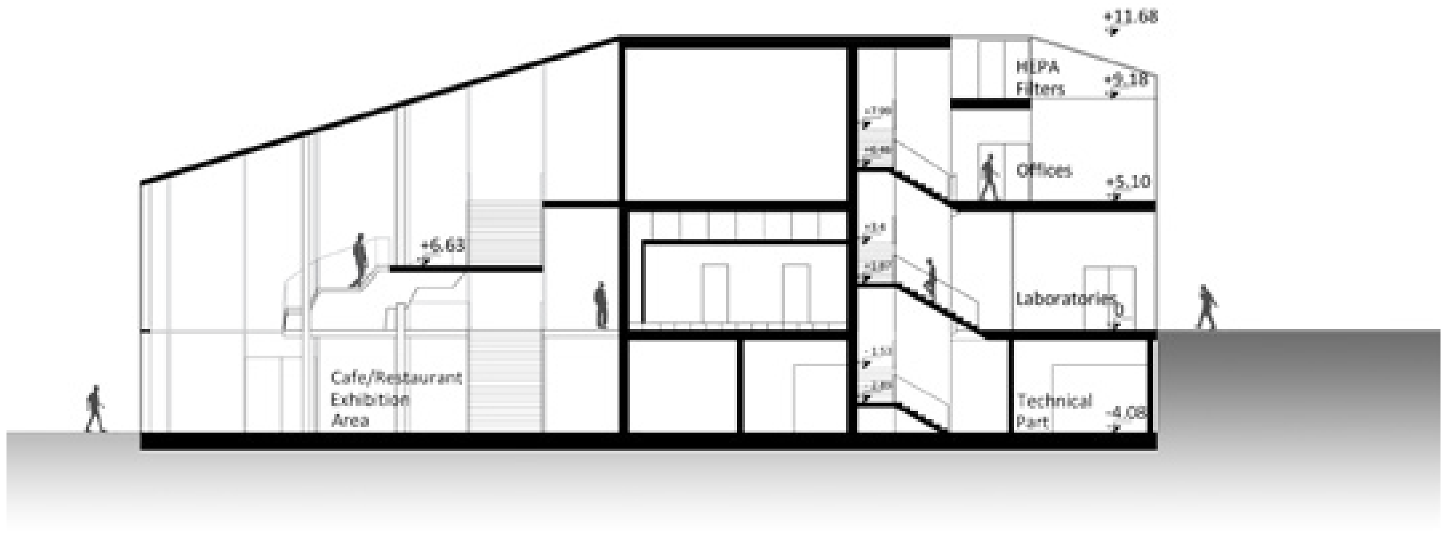
First Floor



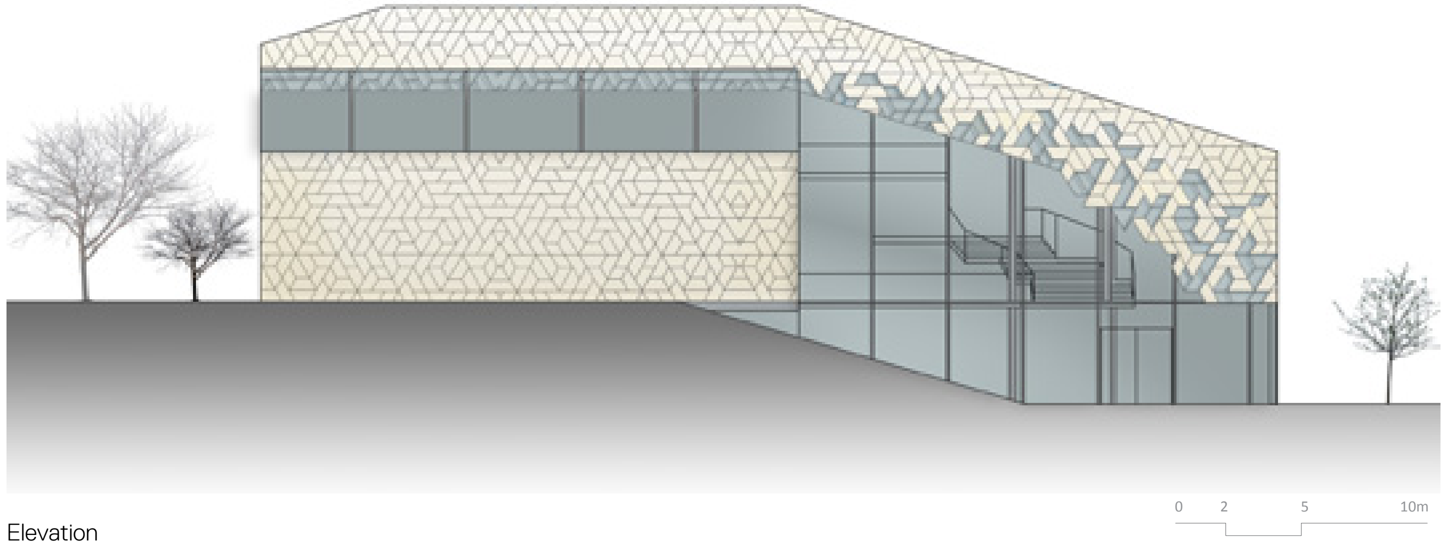
Second Floor



1. Changing Room 15m²
2. Receiving 10m²
3. Cleaning 20m²
4. Opening 14m²
5. Airlock 1,3m²
6. Shower 2,4m²
7. Storage 58m²/ 29m²
8. Curation/ Characterisation/ Sample Preparation Area 140m²
9. BAprotocol 24m²
10. Animals 52m²
11. Analogue Room 36m²
12. Distribution Area 22m²
13. Parking lot
14. Observation (Curation area)
15. Check- in Contol
16. Shaft
17. Info/ Waiting area



Section A-A1



Elevation

Interweaving

Dea Garboutcheva

Location:	Vienna
Floor Area:	
Laboratories	1420 m²
Office	1250 m²
Exhibition	490 m²
Conference room	190 m²

Specific Characteristics:

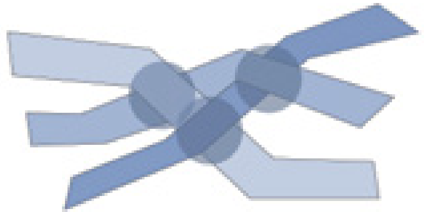
braid | interweaving | union | shared functions | degree of privacy | Interaction

The basic concept of the project is a mixed use building with three different aspects: labs, offices and a museum, for the receiving and curation of extra-terrestrial samples.
My concept is derived from the logic of a braid. Typically a braid consists of different parts, that function as an entire system when woven together into one another, crossing each other at certain section points.
Following this concept every building part has its own area, as well as areas that are shared with two other parts.
The conference hall can therefore be accessed from both the museum and the offices. The visitors of the museum can observe the working process in the curation room of the non-biohazardous lab, which is the section point between those two.

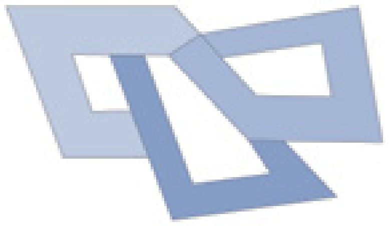
Consequently, through the separation of the three main functions of the building - museum, offices and labs - we manage different degrees of accessibility.
Through interweaving functions interaction between the different user types is provided.

Concept diagrams

Mixed use building



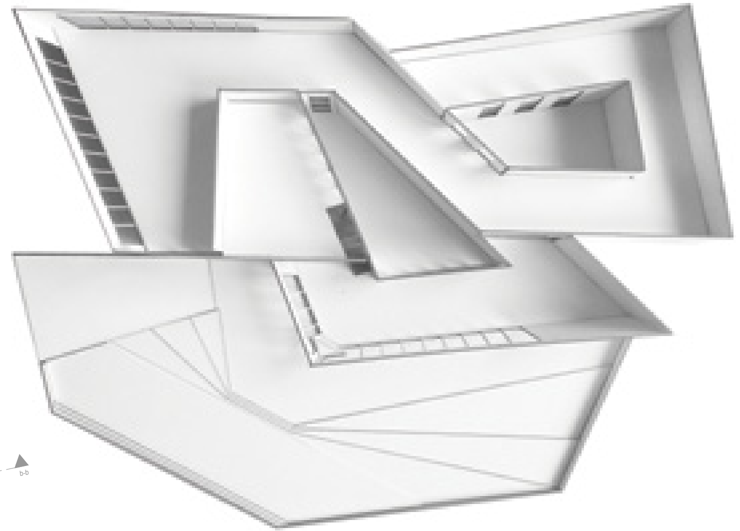
Shared areas | Functions



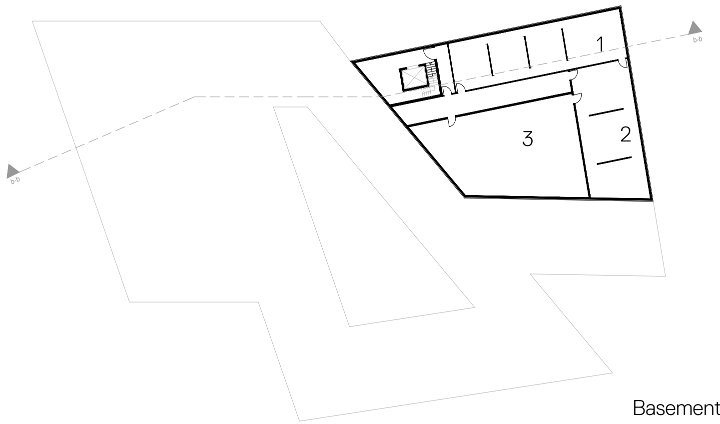
Form

Building

There are two entrances: A public entrance for the visitors of the museum and a separate entrance entrance for the facility's staff. The offices and the labs, are on different floors. Non-biohazardous labs and the offices for the scientists are located on the first floor, while the biohazard labs and the administration offices are located at the second level.

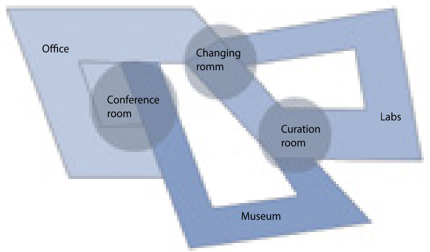


Physical model | Scale 1:50

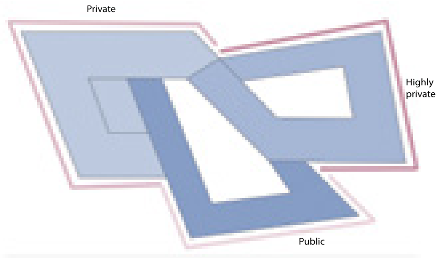


Basement

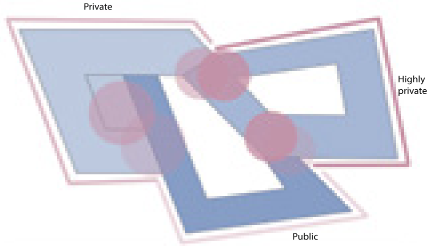
1 Non-biohazardous machine room
2 Biohazardous machine room
3 Shared machinig room



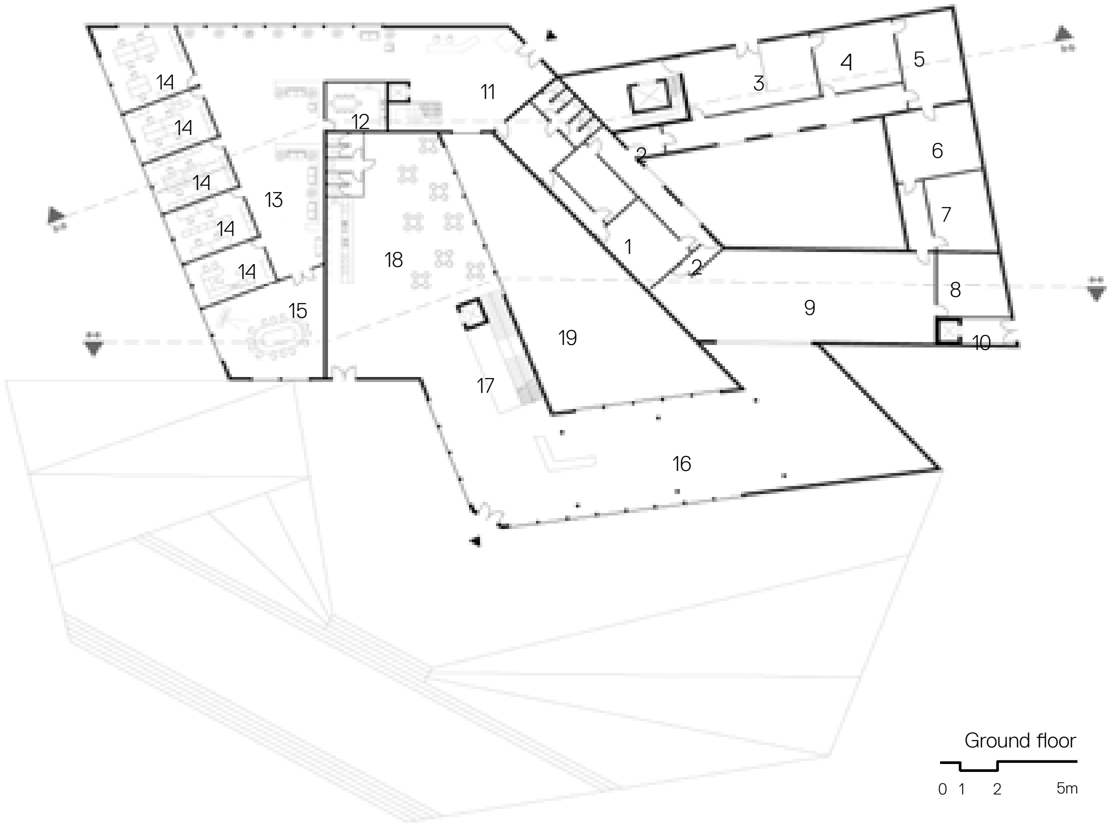
Programatic Blending



Degree of Accessibility



Interaction



Non-biohazardous lab:

1 Changing room
2 Airlock
3 Receiving
4 Cleaning
5 Opening
6 Storage
7 Analogue sample
8 Distribution
9 Curation/ Sample preparation/Characterisation
10 Animal entrance

Office areas:

11 Reception/ Security
12 Kitchenette
13 Lounge
14 Office
15 Meeting

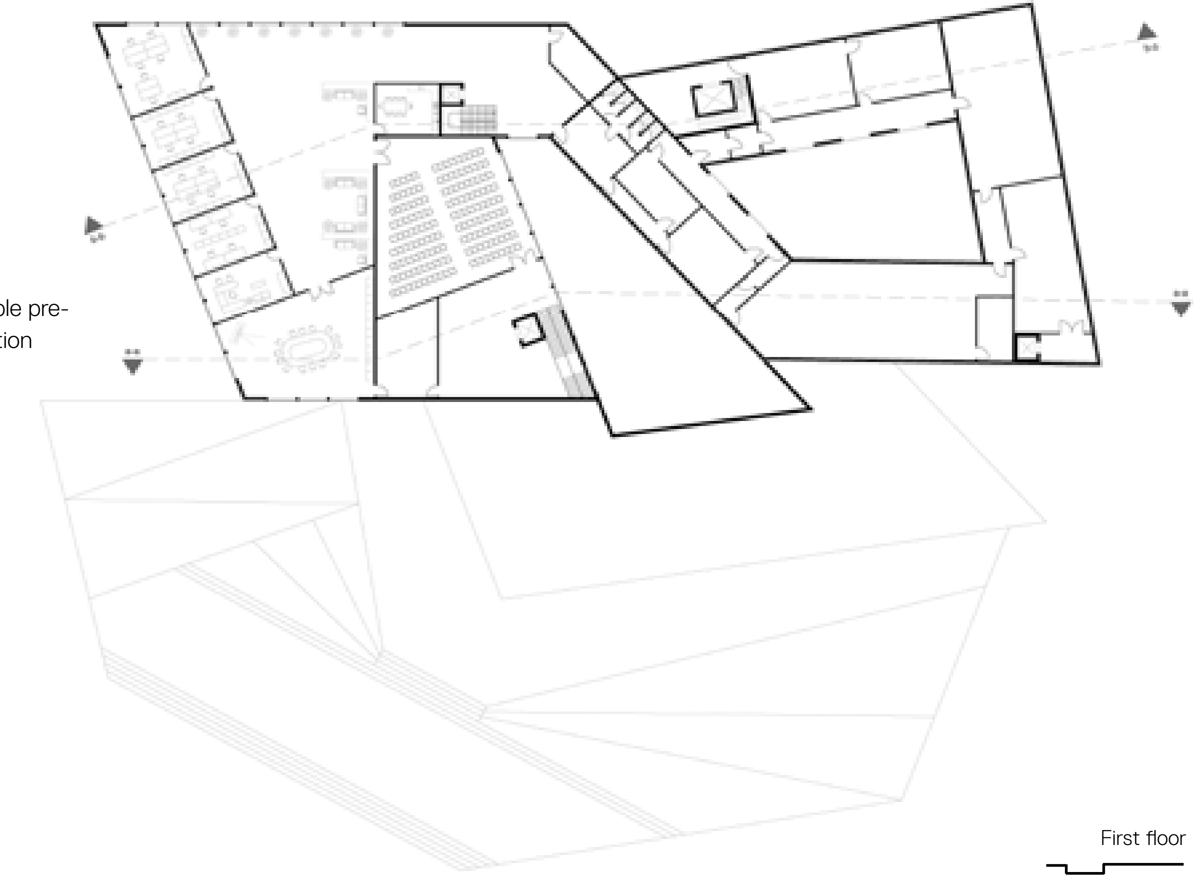
Public area:

16 Museum
17 Cloakroom
18 Cafe/ Restaurant
19 Outdoor space

Biohazardous lab:
1 Changing room
2 Airlock
3 Shower
4 Cleaning
5 Opening
6 Storage
7 Curation room/ Sample pre-paration/ Characterisation
8 BAProtocol
9 Animals

Office area:
10 Monitoring room
11 Kitchenette
12 Lounge
13 Office
14 Meeting room

Public area:
15 Conference hall

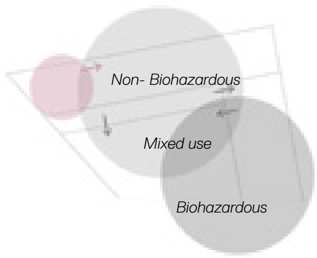


First floor

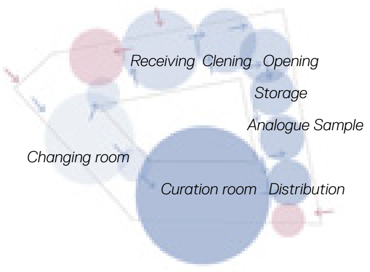
0 1 2 5m

Section B-B

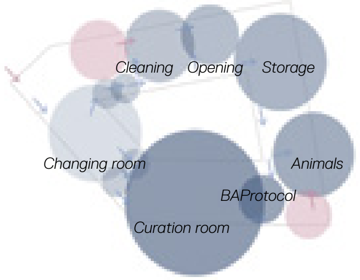
Laboratories



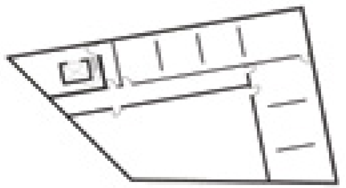
Machinery & Equipment



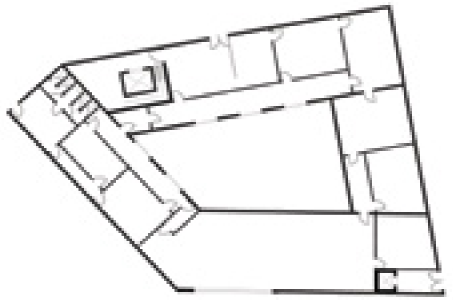
Non- Biohazardous Labs



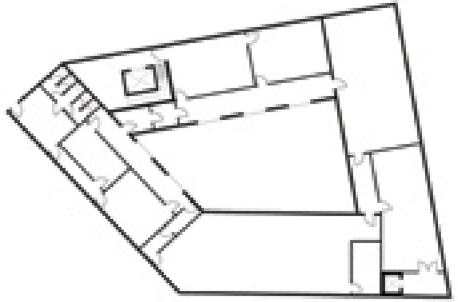
Biohazardous Labs



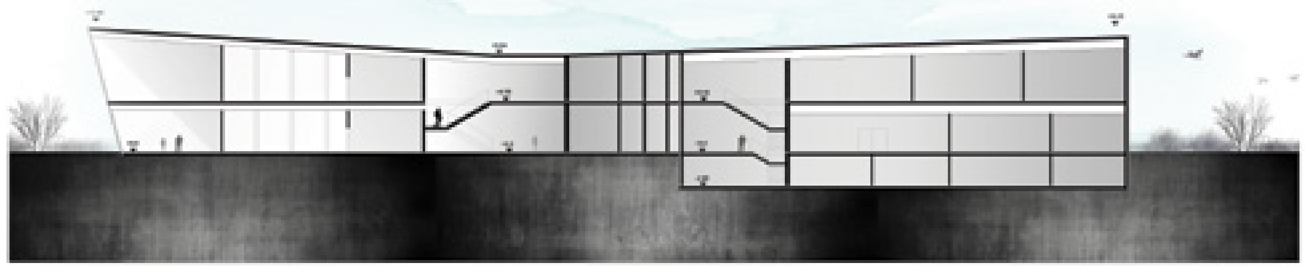
Basement



Ground floor

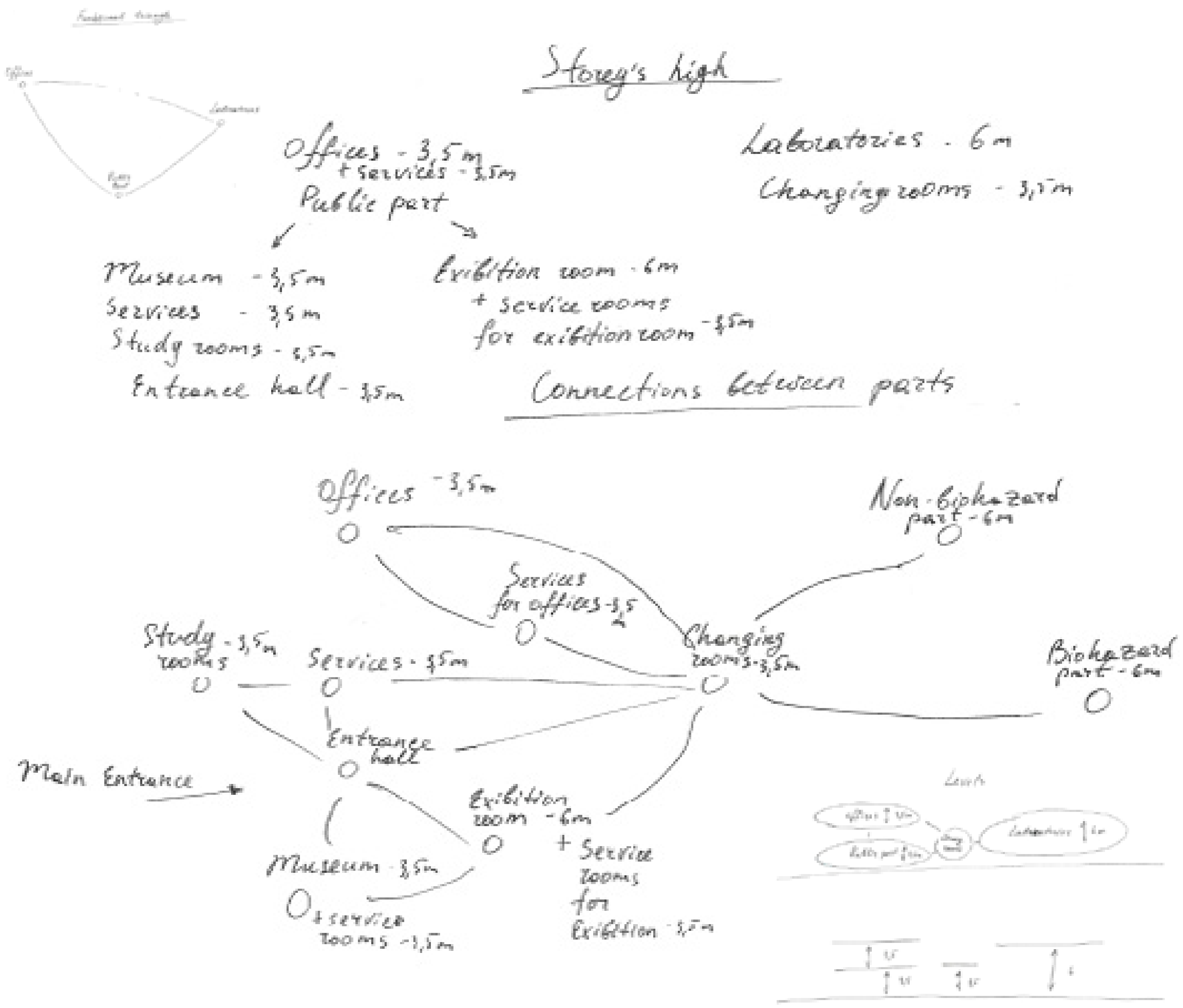


First floor



Section A-A

0 1 2 5m

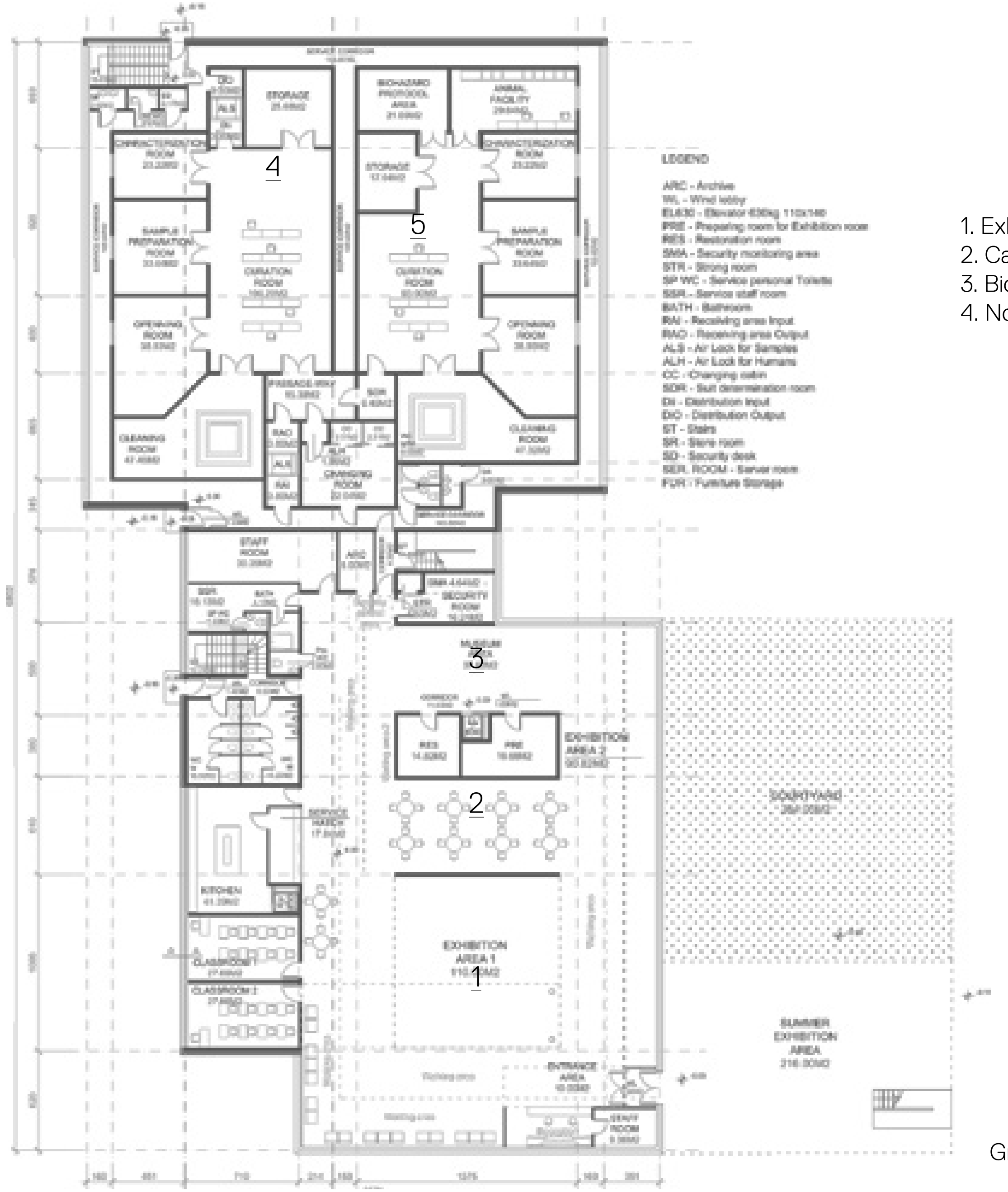


ECRLES

Konstantin Tsay

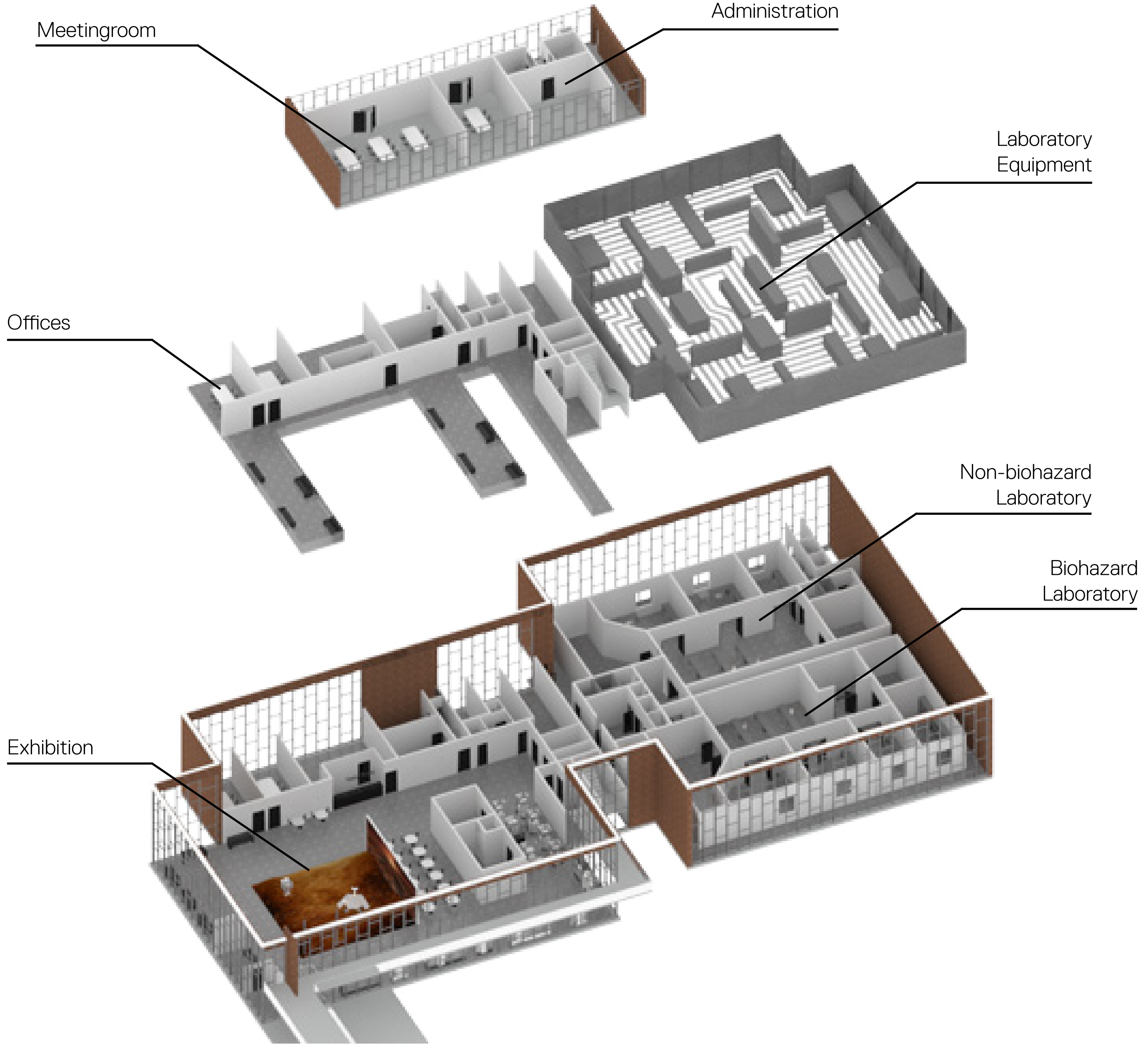
Location:	Vienna
Floor Area :	2045 m²
Laboratories	979 m²
Office	514 m²
Exhibition	635 m²
Cafe	130 m²
Meetings	301 m²

Exhibition Center and Research Laboratory of Extraterrestrial Samples. In this project common rooms concentrate around one central room, like electrons moving around a nucleus.
The building has four main functions: Exhibition, offices, biohazard laboratory, and a non-biohazard laboratory.
The building starts with the entrance hall.
Located to the right of the entrance for visitors and scientist are the exhibition and musem areas. This multifunctional room can host exhibits such as a Mars or Moon landscape simulation or a representation of other planetary landscapes, but can also serve as a space for project presentations.
On the left side is a study room. A reception area serves as a juncture between the public and the workspaces. From here scientists and workers enter the secure area with the offices and laboratories.



1. Exhibition
2. Cafe
3. Biohazard Laboratory
4. Non-biohazard laboratory

Ground floor

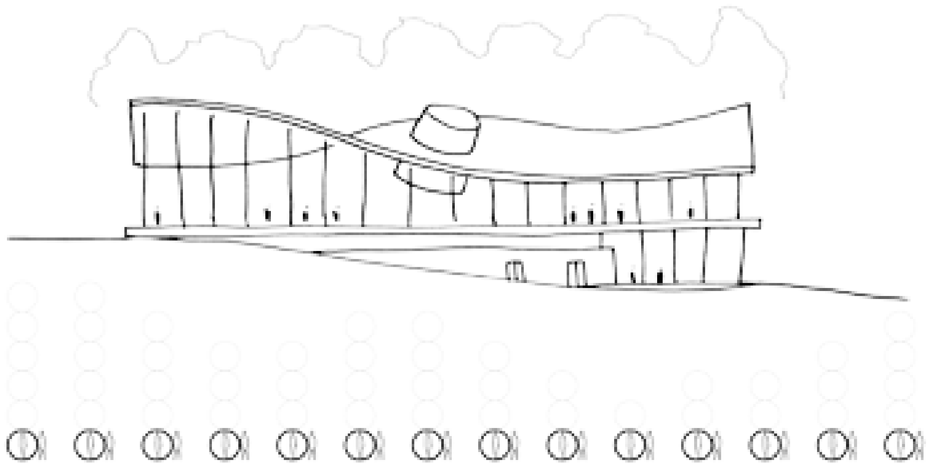


I E S C Institute of Extra-terrestrial Sample Curation

Fábián Villányi

Location:	Vienna Sternwartepark 18. district
Floor Area:	
Laboratories	810 m²
Office	720 m²
Conference	130 m²
Common areas	470 m²
Lounge	400 m²

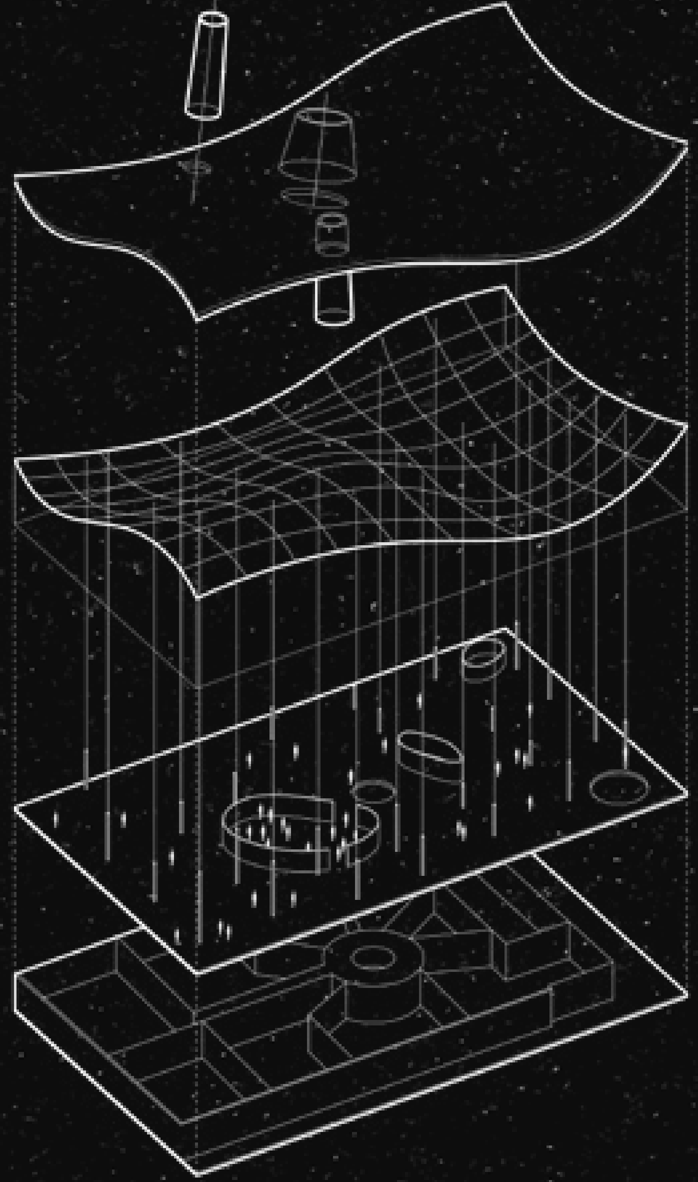
The design concept of this building is based on the analogy of ‚a conversation between scientists and the public'. Historically human development has always been driven by curiosity. Today's 24/7 society, with its short attention span, where people have less and less time for anything, stands in strong contrast to this idea of curiosity - learning through experiencing and experimenting. Science is especially affected. People just do not seem to have the passion to learn more and enhance their knowledge and thus miss the opportunity to realize the importance and advantages of it.



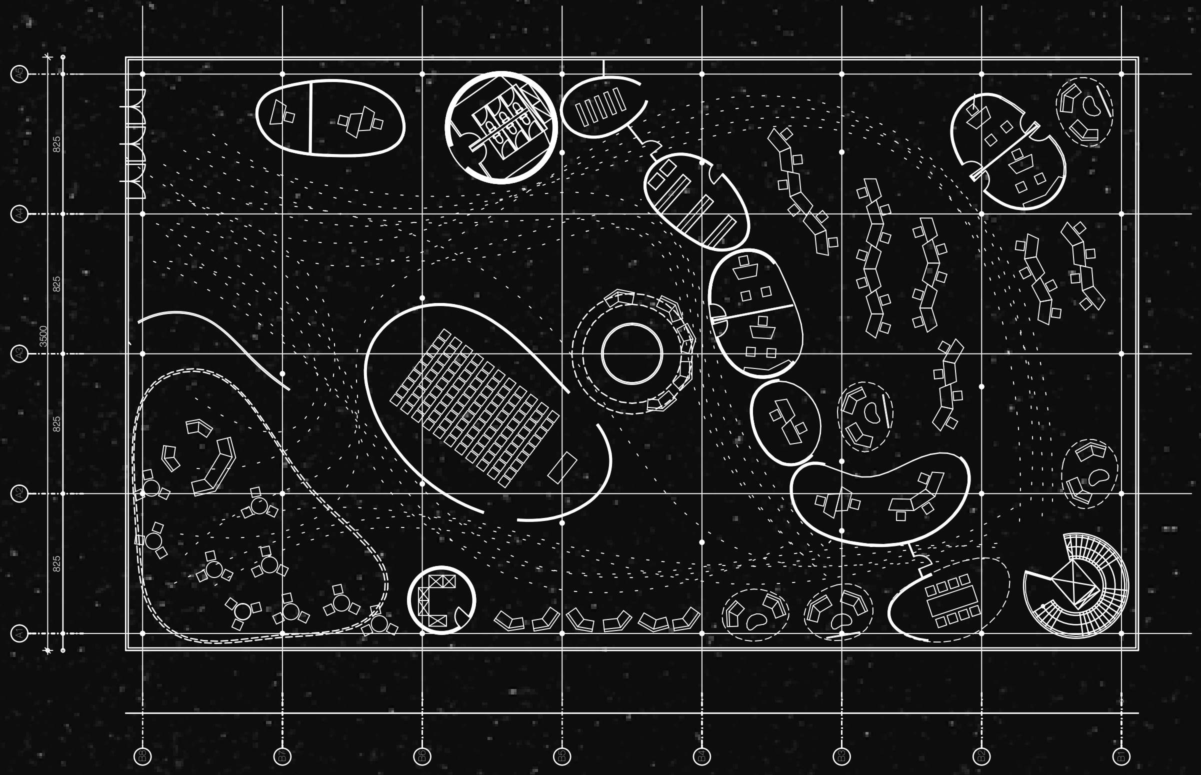
Floorplans

The project design employs parametricism in its most fundamental and simplest sense. The height of the spaces are influenced by the functions beneath: The more public an area, the higher the roof. At the same time, the more people have to concentrate on their individual work the more intimate and lower the room.

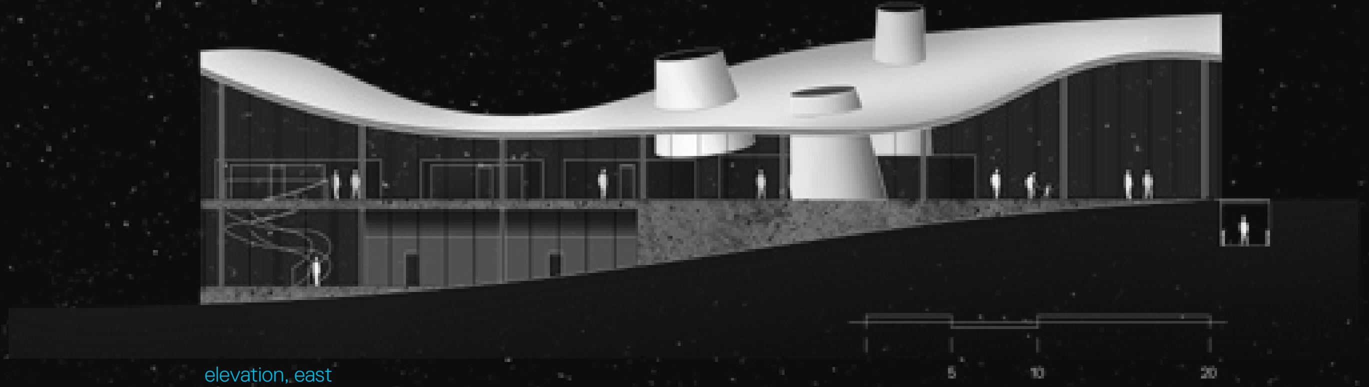
A goal was, to bring public and scientists together in a way that it is beneficial for both. Scientists on one hand need the trust of the general public but also financial support through the government. On the other hand the benefits of science to the general public are often not clearly perceived. Despite the progresses in all fields, enabled by the advances of science in the 21st century, the general public seems less interested in supporting scientific research. This is regrettable but understandable, as outcomes in the fundamental sciences probably will not change their own lifes - however the lives of future generations may depend on it.



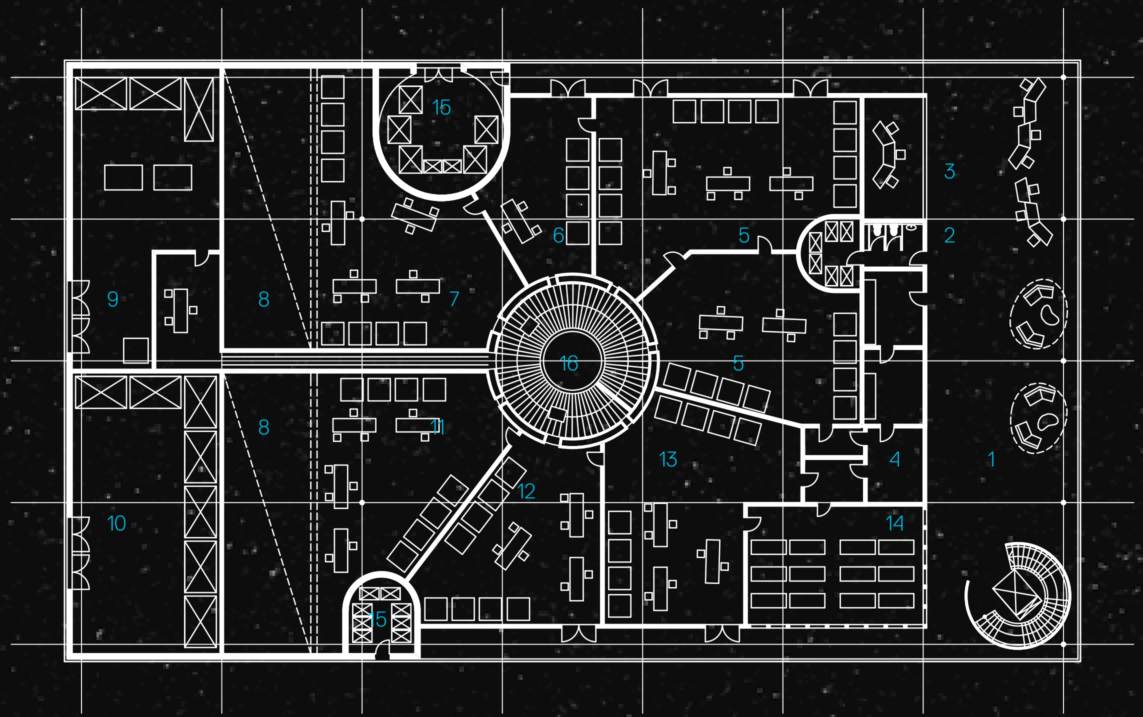
axonometry



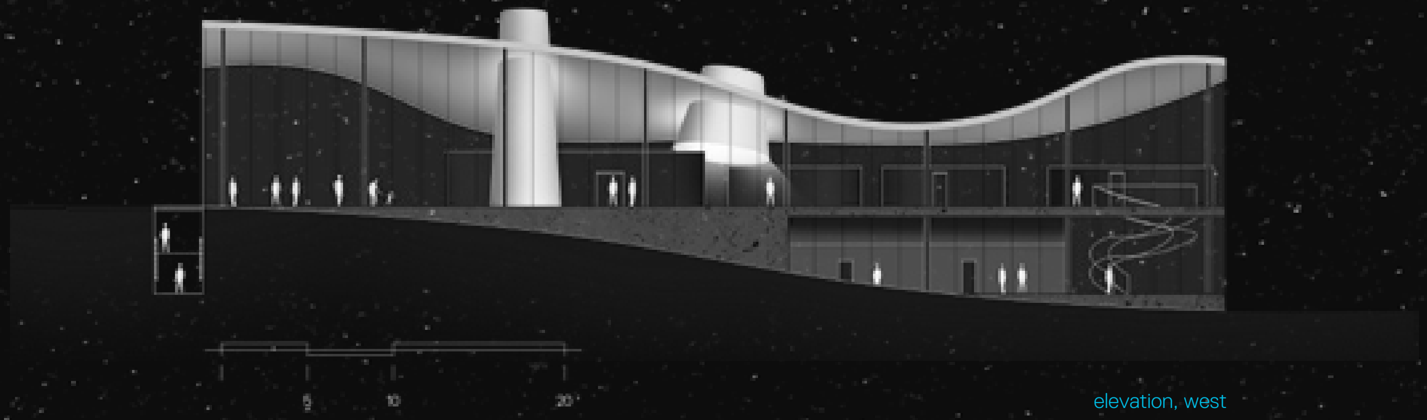
floorplan



elevation, east



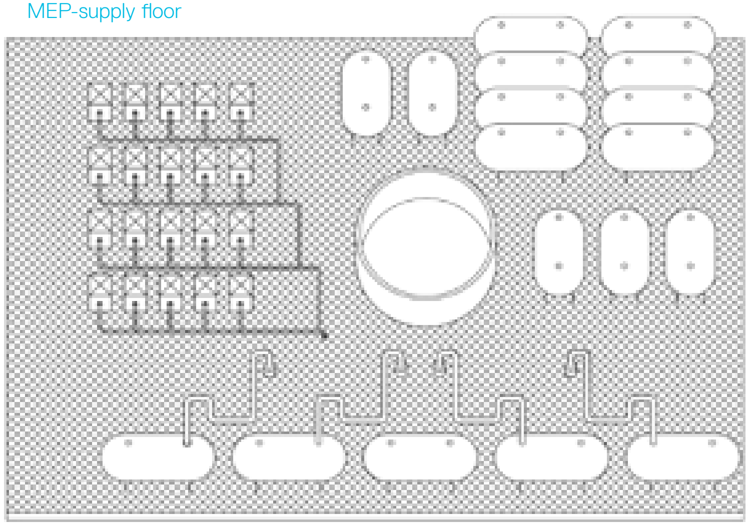
floorplan - laboratory level



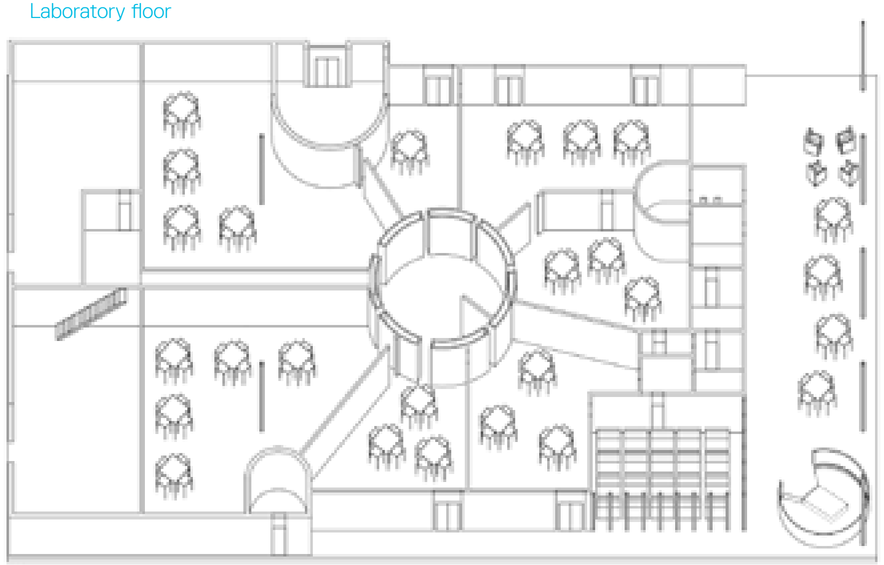
elevation, west

Laboratories

MEP-supply floor



Laboratory floor



The core is located in the geometrical midpoint of the floor plan, both laboratories (biohazard and non-biohazard) are placed around it, to its East and the West.
This arrangment minimizes the transportation of samples from room to room, since every sub-sample could be stored and delivered through a centrally located, automated dispensing system.

1 lounge
2 toilets
3 control room
4 entrance of the labs
5 curation room / non-bsl4
6 curation room / non-bsl4
7 analog curation / non-bsl4
8 possible future expansions
9 receiving area
10 main mep room
11 curation room / bsl4
12 curation room / bsl4
13 curation room / bsl4
14 animal facility room
15 secondary mep rooms
16 automated dispensing storage system / bsl4 + non-bsl4

Vienna University of Technology

Institute of Architecture and Design
Department for Building Construction and Design - HB2

European Extra-terrestrial Sample Curation Facility
Design Studio SS2016

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3 Requirements and basic specifications

3.1 Technical features

Laboratories located at basement level are more exposed to risks of flooding, but are provided with the best conditions for low vibration environment, low electromagnetic disturbance and high temperature stability. The choice to where the laboratories should be placed within a building will depend on the location of the ESCF and the potential risks associated with the specific location.

A relatively inexpensive and efficient way to reduce magnetic field is to install a set of wires around the room to be protected (the aspect of magnetic field is subject to a specific assessment, to be included in D3.3).

It is generally accepted that the minimum ratio between servicing areas and laboratories should be of 3:1 (Uwe Mueller-Doblies, personal communication). Additional space should be left for future development and also for "grey areas" (storage of consumables, instruments not fitting in cleanrooms or parts of instruments which do not need to be inside cleanrooms, etc.).

Waste systems should be kept separated between technical restricted units, technical unrestricted units and other units.

For unrestricted units, there is no biological threat for the environment. Liquid waste should be treated only for potential chemicals. Solid waste having been potentially in contact with samples (disposable tools, gloves, etc.) will be stored and carefully searched for sample particles before disposal with other waste following traditional systems.

For restricted units, liquid sewage should be treated with chemicals, then heated up. Solid waste should be autoclaved (>121°C) before release. All untreated waste should be stored in specific conditions according to their nature and potential risks before being treated.

3.2 Supply systems

It is necessary to have separate supply systems (power, water, ultra-pure water, air handling purified gases, waste, etc.) between restricted and unrestricted sample areas. There should be redundancy and emergency replacement systems for each supply chain. For electricity, redundancy can be done by installing two parallel independent sets of wires, by having specific contracts with the electricity supplier, and by having battery back-up and power generators.

3.3 Fire protection

Fire protection systems (passive and active) have to be adapted to the different parts of the facility. A system of fire-resistant doors is mandatory. For areas with high levels of cleanliness and/or containment, two independents fire doors (both can't be opened simultaneously, one has to be closed for the other to be opened) in a row are the best solution to satisfy the requirements.

The type of active fire protection system will depend on the area/room concerned, and the types of fire (class A to F) that may occur. In offices and public parts, without any samples, simple systems such as automatic water mist extinguishers or portable carbon dioxide extinguishers should be sufficient. In cleanrooms, but not directly in contact with the samples, it is necessary to use systems that will be easy to clean and leave no residue, such as the portable CleanGuard systems

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(http://www.ansul.com/en/us/pages/ProductSeries.aspx?ProductType=Clean+Agent+Portables). For fires in close vicinity of samples, particularly in closed environments like glovebox, inert gas are usually used. It is important to have a system dampening the increase of pressure during release of inert gas, in case the glovebox is at a negative pressure, so as not to break containment. In some BSL-4 facilities, there is no fire protection, only fire detection. The threat of stopping a fire and releasing an agent to the outside is too important, so the agreement is to let the facility burn down. Considering the value of restricted samples, this approach would not really be suitable.

In any case, temperature monitors should be installed all over the facility, with gradual alarm systems. Workers are regularly trained to deal with fire, and security measures are regularly tested and maintained.

Frequent meetings and rehearsal with local firefighters and specific training of the firefighters are of the upmost importance. Depending of the location of the facility, a devoted unit of firefighters could be directly on-site.

3.4 Contamination & Cleanliness

Depending on the work conducted in a laboratory, contaminants will not be the same. For example, biological contamination is to be avoided at all costs in a Life Detection laboratory, while it is somewhat less important when dealing with unrestricted samples (even all possible measures should be taken to prevent contamination). Figure 3 shows a non-exhaustive list of possible contaminants.

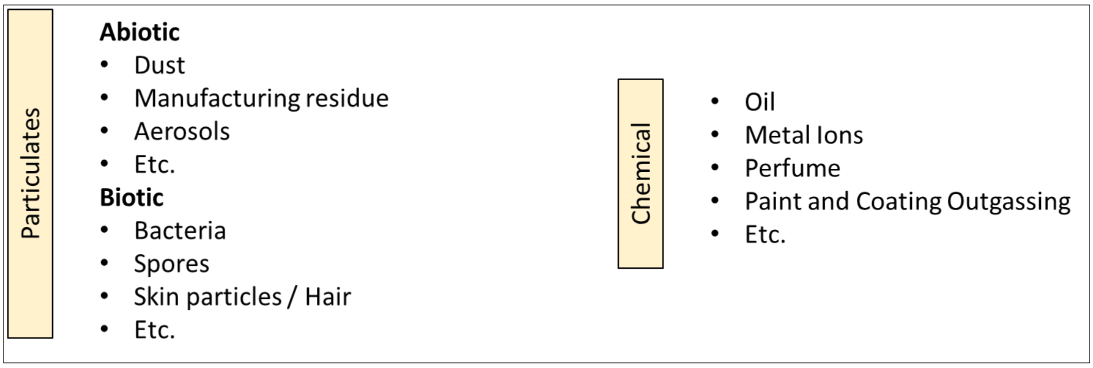

Figure 3 : Types and origins of contaminants in a cleanroom.

To achieve high standards of cleanliness, it is vital to assess the sources of contaminants. Figure 4 shows the main sources of contaminants.

For each sub-unit of the facility, based on the activities to be conducted (life detection, storage, preliminary characterization, etc.), a set of cleanliness levels will be determined in the next steps of the project. To achieve the determined level of cleanliness, specific measures will have to be taken (i.e., specific materials to be used) and cleaning and working protocols to be defined and planned in advance. In all cases, techniques of contamination monitoring will have to be set.

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Figure 4: Main sources of contaminants in a cleanroom.

Contamination and cleanliness controls must be done on a regular basis, on a weekly, monthly or annual basis, depending on the sub-unit and the targeted contaminant. These controls can be done either on-site and/or by an external company. It is recommended to have on-site trained personal for frequent checks, and to have an external company delivering a full overview every year, alongside with the validation of the cleanroom and BSL-4 units.

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4 Curation and Storage

4.1 Environmental parameters

Environmental parameters have to be first defined based on the samples' properties and closely monitored during curation and storage. During curation activities, the conditions have to be adapted to best preserve and protect the samples. For example, some biological samples must be stored at low temperatures e.g. -80C, however a human worker cannot work in such a cold environment. In such an environment it would be necessary to utilise robotic handling systems provided these are adapted in such a way to also tolerate such low temperatures

In general, storage can be done with parameters adapted to keep the sample pristine, while curation should happen using parameters chosen as a trade-off between pristine conditions and operability of the worker. However, it is important to consider what can happen to a sample if it is moved from "storage environment" to "curation environment".

High temperatures can changes the properties of a sample and enhance alteration. A solution is to keep the samples at the same temperature they have experienced at the sampling site, if possible. However, cold curation and storage (-80°C to -5°C) poses several technological and physical challenges (adapted materials, adapted filters, straining and clumsy working conditions, etc.). If samples do not specifically require to be kept under low temperature (e.g. presence of ice), a room temperature of 15 to 20°C would be the norm.

Some samples (asteroid, lunar) may have experienced vacuum or low-pressure atmosphere on their parent body. However, maintaining the samples under vacuum is very challenging in term of technology, and increase the risks. Hence, we do not consider vacuum as a long-term solution for storage and curation. Pressure will be kept close to the Earth pressure, with a carefully pressure cascade to accommodate cleanliness (positive pressure) and containment (negative pressure) requirements.

Humidity has to be kept low, using specific air conditioning system, in the laboratories. In the curation and storage cabinets, it has to be minimal. Some studies (e.g. Cooper et al., 2015) implies that even with strict control of moisture (<1ppb) during storage, there is enough atmospheric water to structurally damage a geological sample after a few dozens of years.

These parameters will be continuously monitored, in the cleanrooms and in the cabinets, with alarms if a parameter is getting out of the allowed ranges, to allow a prompt reaction.

4.2 Curation

4.2.1 Sub-sampling

In order to perform the basic characterisation, and then to disseminate sub-samples to external laboratories, it is important to subdivide the samples, knowing that in some cases it should be done in a way that the sub-sample is representative of the whole sample. Carter and Sephton (2013) have suggested a statistical approach to determine which size of a sub-sample can be representative of the parent sample. The conclusion is nanometre-sized particles are never representative, and micrometre-sized particles are poorly (90% probability) representative of the whole. In general, cubes are more representative than fragments (for the same volume), hence cutting would be

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preferred over breaking, for small particles. Any mm-sized particle will be representative of the whole, whether cube or fragment. The study uses Murchison, a highly homogenous (regarding mineralogy) carbonaceous chondrite. The results should be taken carefully into account in the case of non-homogenous samples, especially for breccias and for coarse-grained samples.

In most extra-terrestrial samples curation facilities, samples are prepared by breaking them, to reduce the contamination induced by the use of a saw (or of any other cutting devise). Other cutting techniques to subsample micrometre-sized particles will have to be researched.

Each sub-sample will be identified with a specific reference code so that it can be linked to its parent sample (see §Database).

4.2.2 Allocation of the samples

Allocation of the samples is mostly for unrestricted samples. In the case of restricted samples, they can be allocated 1) if proven devoid of any potential biohazard, hence after cautions LD and BAP, or 2) after efficient sterilisation, or 3) to laboratories specially equipped to deal with such samples, using a specific container (clean and contained) for transport (WP6, D6.3). In the case of 1) and 2), samples are considered as unrestricted. When possible, samples should be distributed in specific cases (not to be opened) allowing specific types of analysis, to keep the sample pristine.

We recommend the following loan protocol:

- An external laboratory requests part of the sample. An international committee of experts evaluates the research proposal.
- OR the international expert committee declares that a specific analysis should be done on top of the basic characterisation. An external laboratory is approached and a collaboration is fixed.
- Based on the requirements, the curator authorises the necessary subsampling and preparation.
- The subsample is allowed to leave the curation area, to reach the distribution area.
- It is properly packaged, and shipped using a trustworthy shipment solution.
- When receiving the sample, the external laboratory must acknowledge reception, using an appropriate form.
- After performing the agreed upon analysis, the external laboratory should send the results, so they can be added to the sample record history.
- The sample (if some is left) is returned to the ESCF, where it will be stored in a specific storage area.

4.2.3 Database

A searchable sample database that will be used in the ESCF will be designed with the general purpose of i) to collect - and partly make available to the public information about the curated samples, ii) to guarantee an efficient management of the samples inside the curation and their distribution to the scientific community. The software will act as a logbook to track and document all the actions performed on the (sub)-samples inside EURO-CARES and in external laboratories.

The sample categories of the database will be: i) Pristine samples (extraterrestrial and analogue samples). ii) Aliquots and preparations for staff training, sample classification, and subsample

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allocation to external laboratories. iii) Allocated and returned aliquots and preparations. iv) Residual masses of pristine samples.

Datasets linked to each sample will include: i) Identification (e.g. labelling, origin, imaging, state of matter, mass); ii) Classification (e.g. structural, compositional); iii) Preparation (e.g. type of preparation/mount, preparation/mount description and imaging); iv) Location (e.g. sample container/location in the facility). v) Allocation (e.g. requested samples, location outside the curation facility, research purposes and methods duration of the loan/donation, expected results). vi) Documentation (e.g. internal/external data and reports, scientific publications). vii) Public (selected data on-line, e.g. sample description and availability for research).

All the above information will be obtained and documented during the following procedures/actions: i) Cataloguing (identification, location); ii) Classification (to be meant as preliminary/basic classification); iii) Pre-delivery (preparation and allocation); iv) Post-delivery (check of returned samples for research, storage).

Efficient data collection and storage in the various laboratories of the facility will make use of state-of-the-art electronic devices (e.g. internet, wireless audio-video recorders, bar-coded samples, subsamples and preparations, etc.) enabling unambiguous link of data sets to samples.

4.3 Human or robotic approach?

Human and robotic manipulation have pros and cons. Human manipulation can be realized using gloveboxes, or a positive pressure suit (see e.g. Kuemin et al., 2011). When a clear workflow in the ESCF has been defined, with all relevant manipulations and protocols (input from WP4), a trade-off will be applied for each step, and relevant manipulation approach will be proposed. The advantages and disadvantages of human vs. robots will be discussed in further details in forthcoming deliverables (D3.3 and D3.4) as our compilation on this specific topic need also input from other WPs.

4.4 Storage

4.4.1 Inert gases: production and monitoring

Samples in sealed containers have to be kept under a constant flow of inert gas. Nitrogen is commonly used, but can induce some alteration effects on the samples in the long term, in term of composition, texture, etc. (Cooper et al, 2015). Another possibility is to use argon; this inert gas is heavier than air (hence it helps reducing the effects of a leak), but is more expensive, and Ar isotopes investigations can be challenging if the sample was stored under Ar. One recommendation might be that part of the sample is kept under N atmosphere and the other part under an Ar atmosphere.

Some gas can be produced on site, or purchased to an external producer (nitrogen), while some has to be purchased (argon). In both cases, gas has to be closely monitored, for several parameters:

- Trace elements (Ar, O_2, THC, etc.) are monitored for each batch (if purchased gas) or during production on site.
- Isotopes ratios are measured on a monthly basis.

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Production of N can be done from air or from liquid nitrogen. Commercial systems are easily available.

Life cycle of gas: gas can be either thrown away after going through the cabinets, or recycled. For potentially biohazardous samples, gas has to be cleaned and sterilised before any release.

4.4.2 Packaging

Whether it is during the transition phase from the landing site to the curation facility, sample canisters can be wrapped into specific bags, to ensure cleanliness and containment of the samples. Based on the semi-conductors industry, Ziplock polypropylene (PP) or Teflon bags with electrostatic discharge (ESD) protection are recommended, since 1) Ziplock closing system do not involve any heat sealing (potentially generating contaminants), and 2) PP and Teflon have a low outgassing and particle-shedding rate (see Vrublevskis et al., 2012). In addition, the anti-static protection helps with handling small particles.

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5 Employees of the facility

Below is an exhaustive list of persons expected to work in the facility with their respective function(s) and an estimation of the minimum number needed for the ESCF to operate (i.e., the evaluation of the number of persons is highly dependent of the activity inside the ESCF and thus, very difficult to estimate at this stage).

The following list considers an integrated approach for the facility. If the design concept is broken down to units, there might be replicas needed.

A total of about 20 to 40 persons is expected to work in a fully integrated facility.

The presented list was first compiled based on expertise of the WP3 team members and then completed using other sources, including personal working at the JSC (NASA) and JAXA.

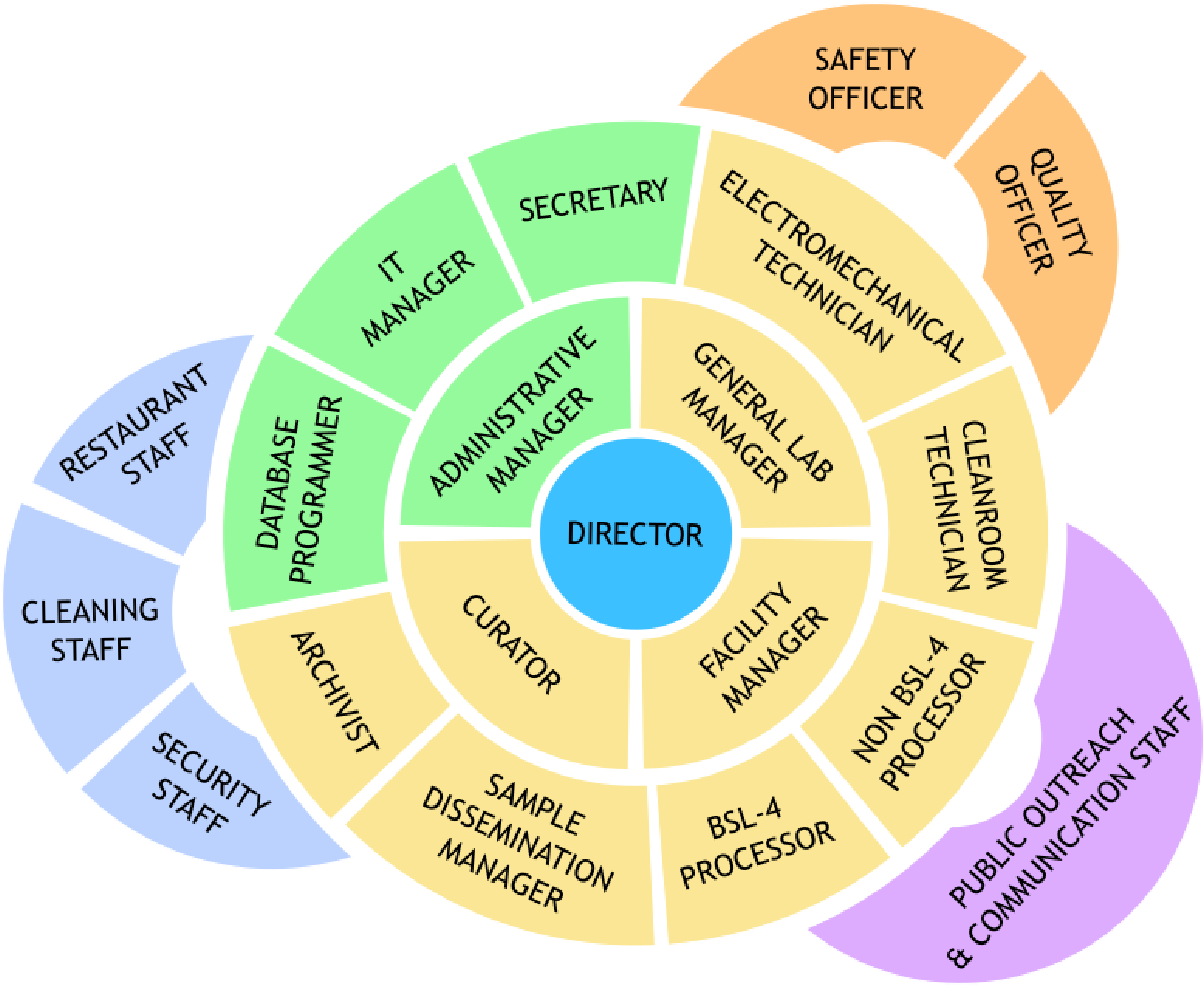

Figure 5: Proposed Organigram of the ESCF.

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Administrative staff

The administrative staff do not deal directly with the samples.

Director of the facility: Directs and manages all the facility operations. One full time person.

Administrative manager & Secretary: In charge of the business planning, finances, human resources, etc. Supports staff, handles personnel issues and assists with various other administrative tasks. Two full time persons.

Quality officer: Writes and reviews operating procedures in collaboration with science staff. Carries out quality audits. Interacts with external quality assessors. One full time person.

Safety officer: Provides safety advice, risk assessments and planned maintenance schedules for the facility. Carries out safety audits. Interacts with regulators. One full time person.

IT manager: Handles the day-to-day computer and network related issues. 1-2 full time person(s). Can be outsourced to an external company. If the facility is included in an already existing institution, there is no need of a dedicated worker.

Database manager/programmer: In charge of the database software (to develop, manage and maintain database(s) and the general website of the facility).1-2 full time person(s).

Public outreach & Communication staff: Organizes the activities of the Public outreach unit, promote the ESCF through communication media. Liaise with local associations and authorities for ensuring open communication. 1-2 full-time person(s).

Security staff: In charge of the security of the site and its assets. 2-3 full time persons. Can be outsourced to an external company. If the facility is included in an already existing institution, the number of dedicated workers can be reduced.

Restaurant staff: Applicable if catering is on site. Deals with the operation of the restaurant. 4-5 full time persons. If the facility is included in an already existing institution, no need of a dedicated workers.

Cleaning staff: In charge of the cleaning of the non-restricted areas (i.e., non-cleanroom parts) of the facility. One full time person. Can be outsourced to an external company. If the facility is included in an already existing institution, no need of a dedicated worker.

Science staff

Science staff deal with samples and maintenance of the facility.

Curator: Responsible for the curation of the samples. In charge of the handling, documentation, preparation, preservation and distribution/allocation of the samples. Also assumes managerial roles, supervises personnel and is involved in education and public outreach. The same person can be curator for multiple collections. One per mission and/or set of samples, full time.

General (laboratory) supervisor/manager: Provides oversight of day-to-day technical and scientific functions of the facility. One full time person.

Facility manager/engineer: Responsible for ensuring that the building operates correctly and is correctly maintained. May be responsible for contracting out servicing and maintenance (i.e. filter testing, room air flow validation, autoclaves, primary containment, equipment testing, etc.). One full time person (?).

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Sample dissemination manager: Responsible for dissemination of the samples to external science laboratories (and to education institutions). Deals with loan agreements, contracts, shipping and receiving of the samples, education & public outreach, etc. One full time person.

Archivist: Tracks the records associated with samples (loans, publications...). Can be associated with the sample dissemination manager, at first. One full time person (?).

Unrestricted processor: Performs the preliminary examination on sample containers and samples. Prepares samples for dissemination, according to requests. Processors are cross-trained to be able to work on several collections and several techniques. Training is performed with analogue samples. Unrestricted processors cannot work on potentially biohazardous samples, since it requires a specific and demanding training. Two full time persons (to be increased with time and multiplication of the samples/collections).

Restricted processor: Specially trained scientists/technician/engineer to handle restricted samples. Work on samples in the BSL-4 part, on life detection (including BAP). Must work in pair and for a limited time inside of the laboratory. 2-4 full time person(s). In case a robotic approach is preferred, workload will be reduced.

Cleanroom technician: Responsible for keeping the laboratories clean, cleaning the tools, helping with organization in the laboratories, etc. and of the training of facility staff and visiting researchers. 1-2 full time person(s).

Electromechanical technician: Fixes and maintains things in the laboratories (lights, microscopes, heat-sealers, etc.) and of the major infrastructure systems that supply the laboratories (i.e. air-handlers, liquid and gaseous N systems, UPW systems, etc.). Only light works, considering there will be full maintenance once or twice a year done by an external company. Can also build small custom things for the cleanrooms. 1-2 full time person(s).

5.1 Circulation of people in the facility

Workers can have access to different parts of the facility, depending on their security clearance. Each worker and visitor should hold a specific badge, and badge readers should be present all over the facility. People present their badge at each control point, to ensure a constant monitoring of their presence.

For technical staff, personal sensors or walkie-talkies can be used to know if the bearer is in security in the laboratory, and to indicate when the time limit of safe work inside of a given laboratory is reached. Such sensors can also be used to monitor other parameters.

5.2 Training of workers

Whether they are already qualified or not, specific workers will benefit from a training on curation and handling of precious extraterrestrial samples. The work on restricted samples is especially critical, and should be performed by well-trained processors.

Workers should be trained to first-aid procedures and fire security. Training on these important topics must be repeated ideally each year. Rehearsal of emergency procedures must be done at least once a year, but randomly, and for all the workers.

A plan of global training for all workers is very important. Training reduces the possible accidents (mainly for technical jobs), and the need for supervision, by making employees more independent. It improves the spirit and the productivity of workers, hence making them better assets for the ESCF.

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6 Major critical issues

Below is a short list of the major critical issues identified during the preparation of the *Preliminary Conceptual Design.*

- Involvement of architects from an early stage.
- Importance to clearly define and discuss terms, requirements and specifications to avoid problems of miscomprehension between what the curators and scientists want/need, what the engineers can design, and what the architects can plan and design for the construction.
- Cutting techniques for micrometre-sized particles.
- Public outreach is very attractive for decision makers and the scientific community. More detailed scenarios have to be envisioned.

7 Acronyms

BAP: Biohazard Assessment Protocol

BSL: BioSafety Level

ESCF: Extra-terrestrial Sample Curation Facility

ESD: Electrostatic Discharge

EURO-CARES: EUROpean Curation of Astromaterials Returned from Exploration of Space

LD: Life Detection

PP: Planetary Protection

PP: Polypropylene

PRF: Portable Receiving Facility

SCF: Sample Curation Facility

SRF: Sample Receiving Facility

WP: Work Package

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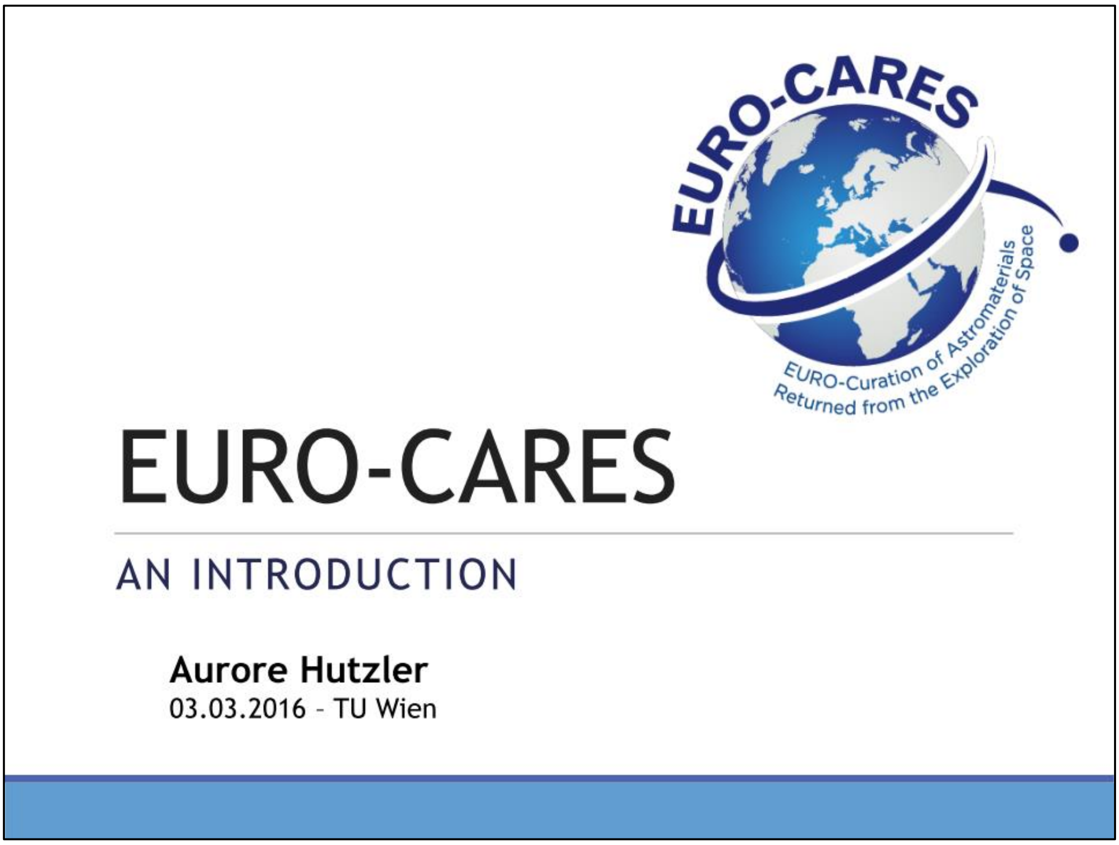
9 Appendix

9.1 Appendix A: EURO-CARES – An Introduction. Aurore Hutzler.



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Dr. Aurore Hutzler

Geologist with biology basics

Geochemistry – stable isotopes in oceanography

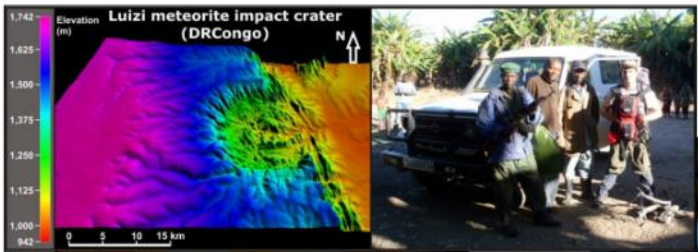
Ph. D.: The flux of meteorites on Earth: contribution of measuring the concentration of multiple cosmogenic nuclides, and collections in arid areas. CEREGE, Aix-Marseille University, 2015.

Meteorite collection and classification

EURO-CARES PDRA

Mag. Dr. Ludovic Ferrière

Geologist – Permanent position at the NHM Vienna
*Chief curator of the rock collection(s)
*Co-curator of the meteorite collection
+ A scientist…



EURO-CARES
Lead of WP3

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Outline

- ✓ What is EURO-CARES?
- ✓ Work Package 3: Facility and Infrastructures
- ✓ Functional Block Concept
- ✓ Technical requirements
- ✓ WP3 Meeting: Save the Date !

EURO-CARES

EURO-CARES: European Curation of Astromaterials Returned from the Exploration of Space

Funded by the European Commission, under the COMPET 8-2014 of Horizon 2020

January 2015 - December 2017

Mission: To roadmap a European Sample Return Curation Facility (ESCF) to receive and curate samples returned from Asteroids, the Moon, and Mars.

HORIZON 2020 : biggest EU Research and Innovation programme ever with ~€80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract.

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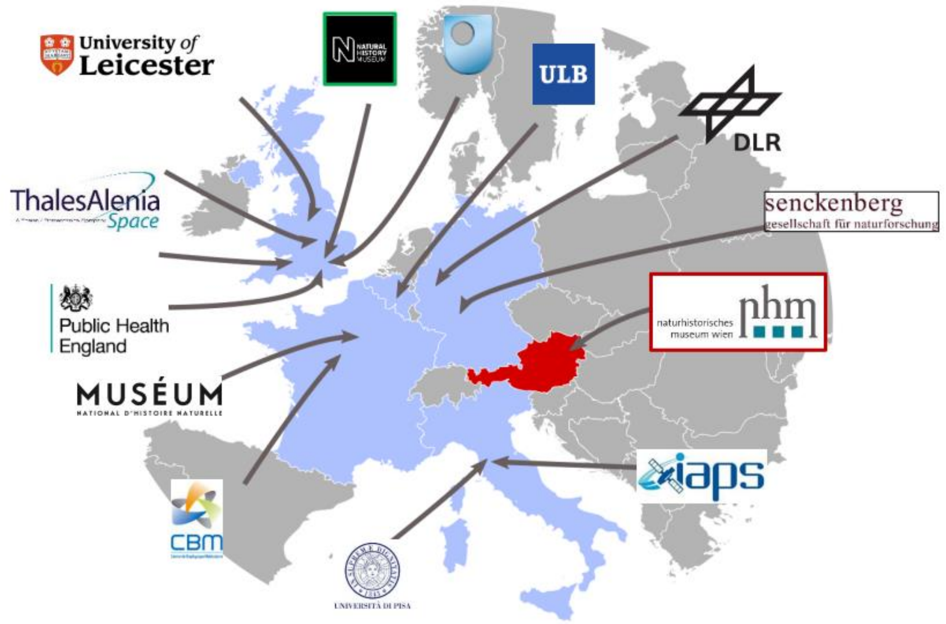
EURO-CARES



13 leading european institutions

EURO-CARES

Curation: keeping, protecting and adding value to objects in a collection.

Why do we need such a facility ? NASA, JAXA…

➡ No space curation facilities in Europe

➡ None of this kind in the world, **clean and contained!**

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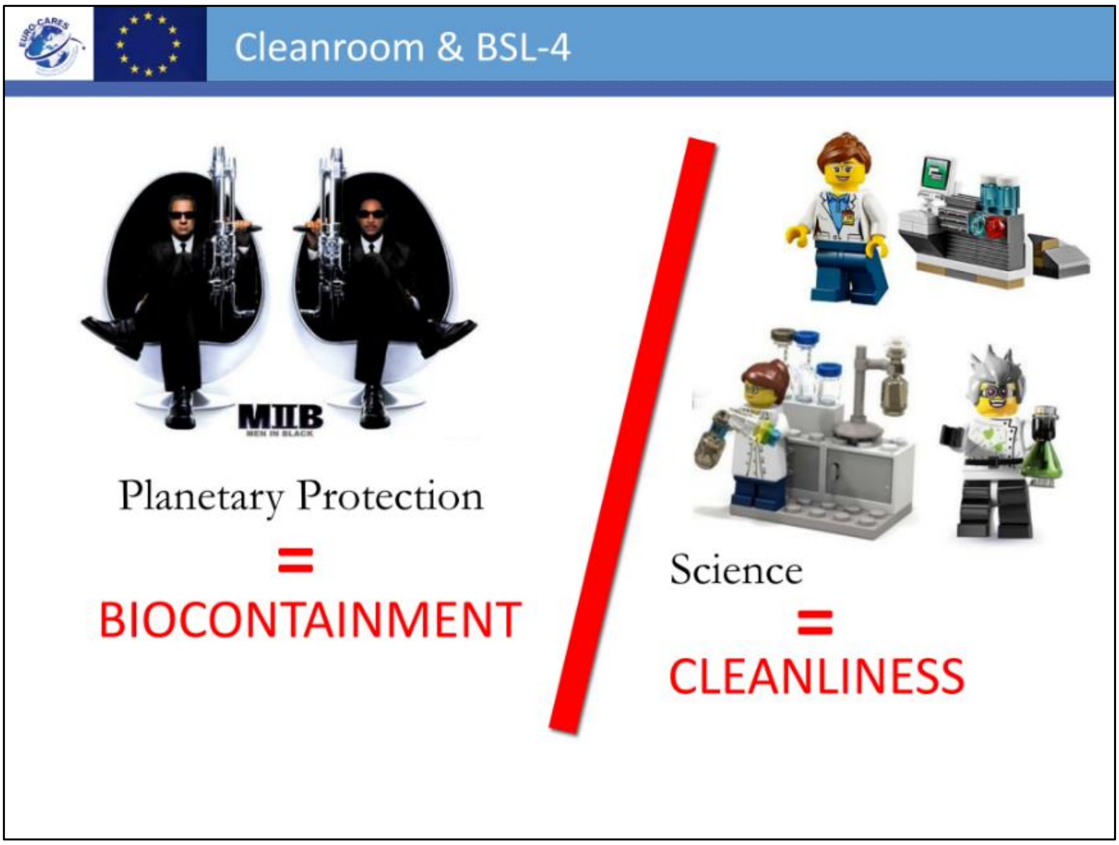

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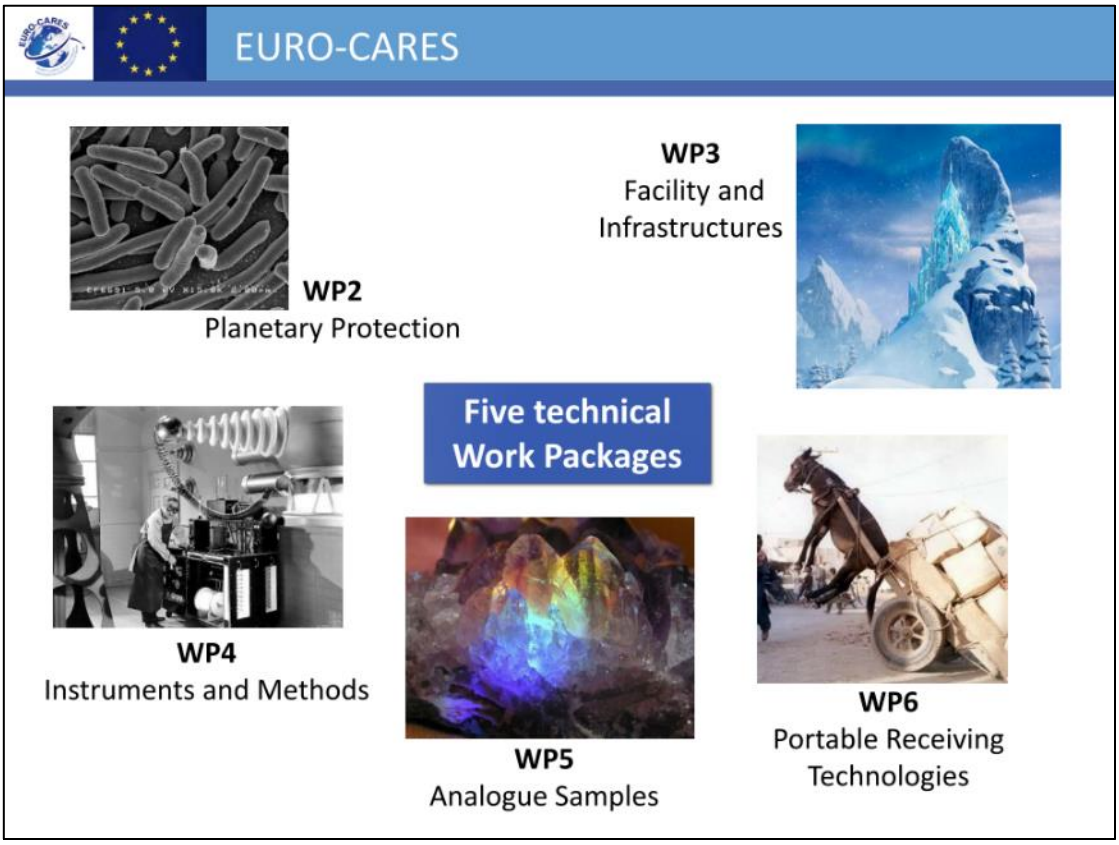

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Work Package 3

Work Package 3: Facility and Infrastructures

- ✓ Building
- ✓ Storage
- ✓ Curation

Lead: Ludovic Ferrière (NHMW)
Deputy: Allan Bennett (PHE)
Aurore Hutzler (NHMW)
John Robert Brucato (INAF)
Vinciane Debaille (ULB)
Luigi Folco (Pisa)
Andrea Longobardo (INAF)
Ernesto Palomba (INAF)
Tom Pottage (PHE)
Caroline Smith (NHM)

Work Package 3

Building
Construction, Security, Location requirement, Cleanliness and Containment requirements…

Storage of the samples:
Controlled pressure, temperature, atmospheric environment, magnetic field…
Various types and size of samples, not known yet!

- ✓ "unopened storage", for unprocessed samples,
- ✓ "working storage", for processed samples (designated for study and loan to other laboratories, etc.),
- ✓ "readmitted storage”
- ✓ Data, Analogue Samples, Witness plates…

Curation:
Preliminary examination, preparation of the samples, allocation…

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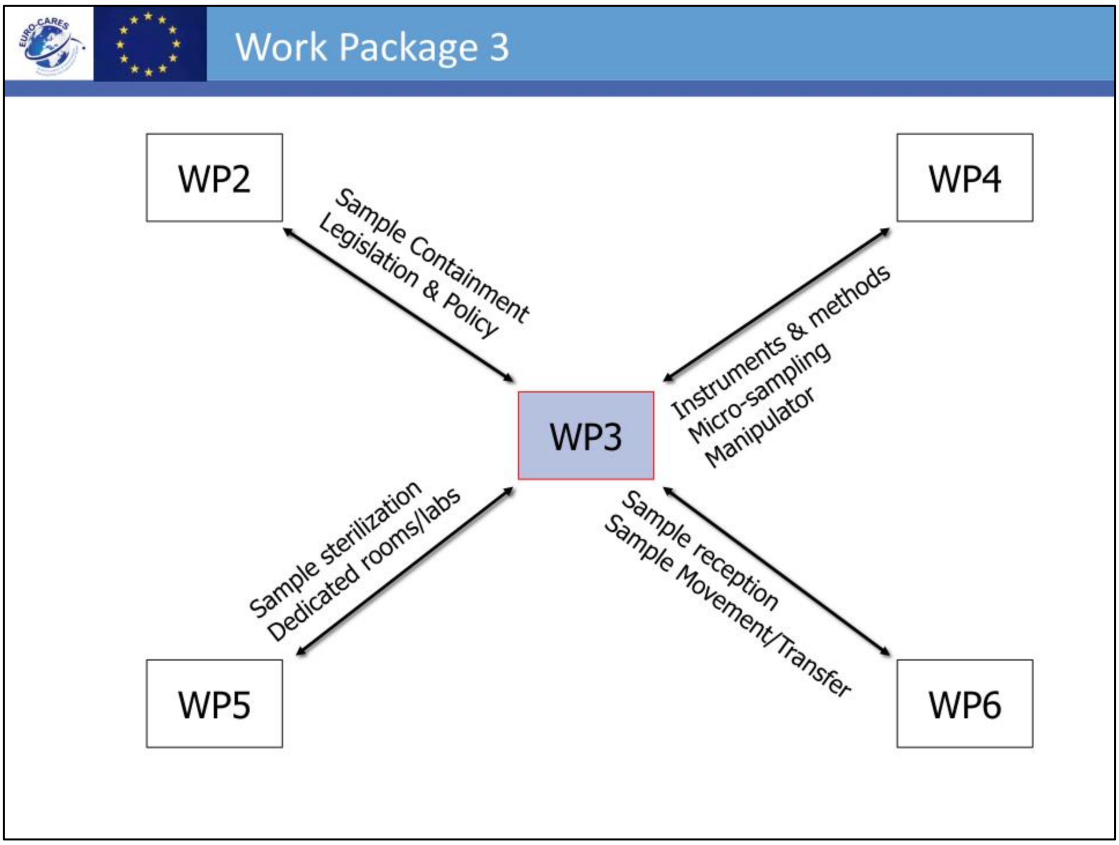

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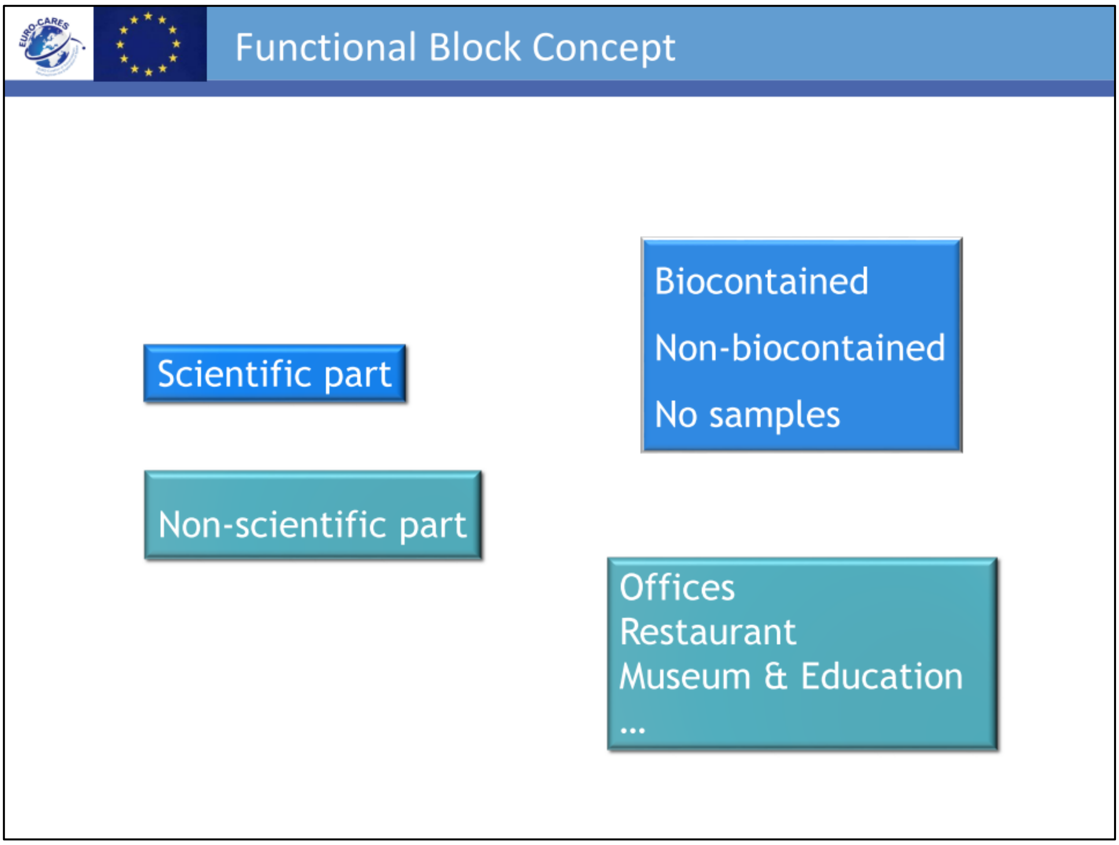

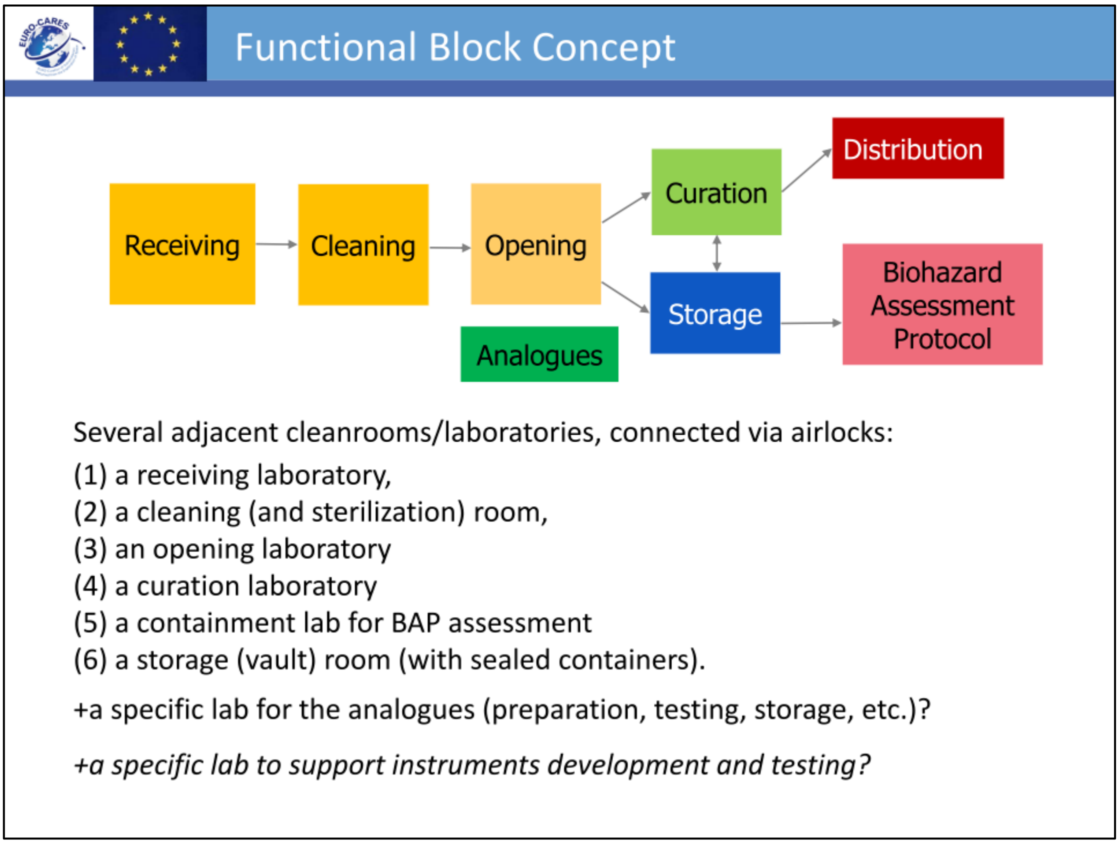

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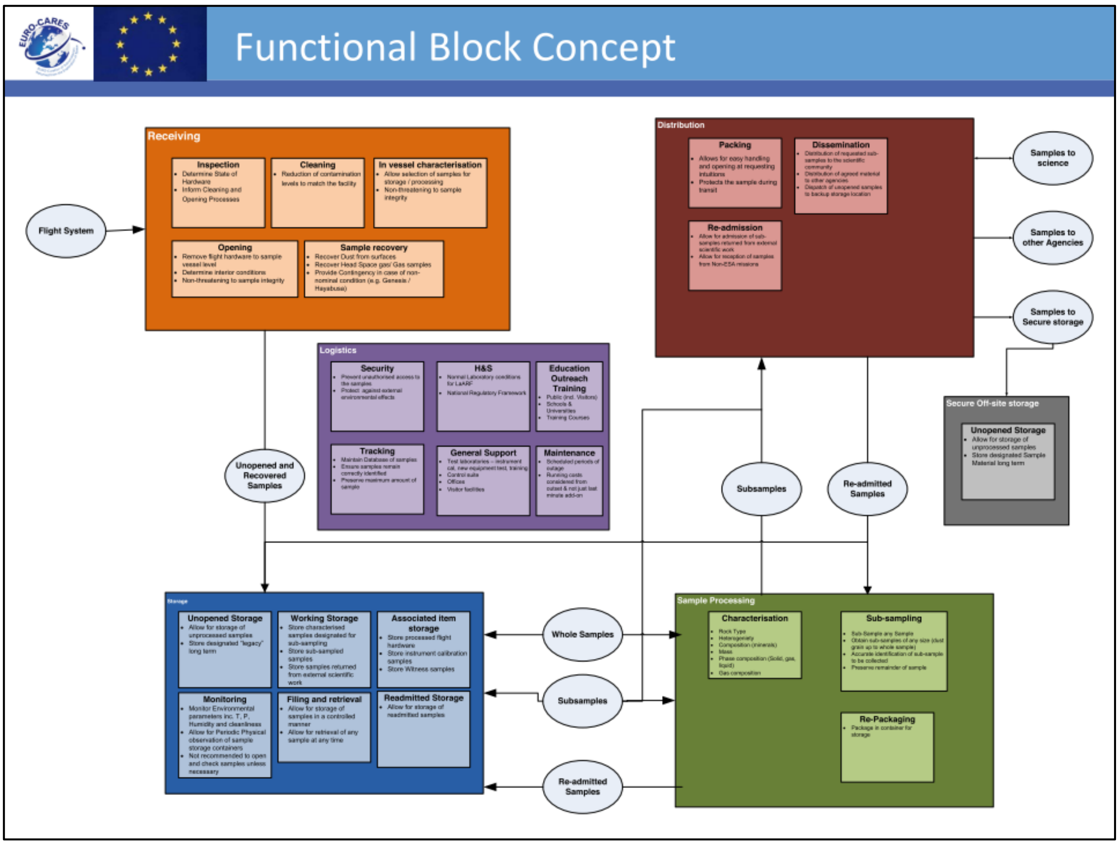

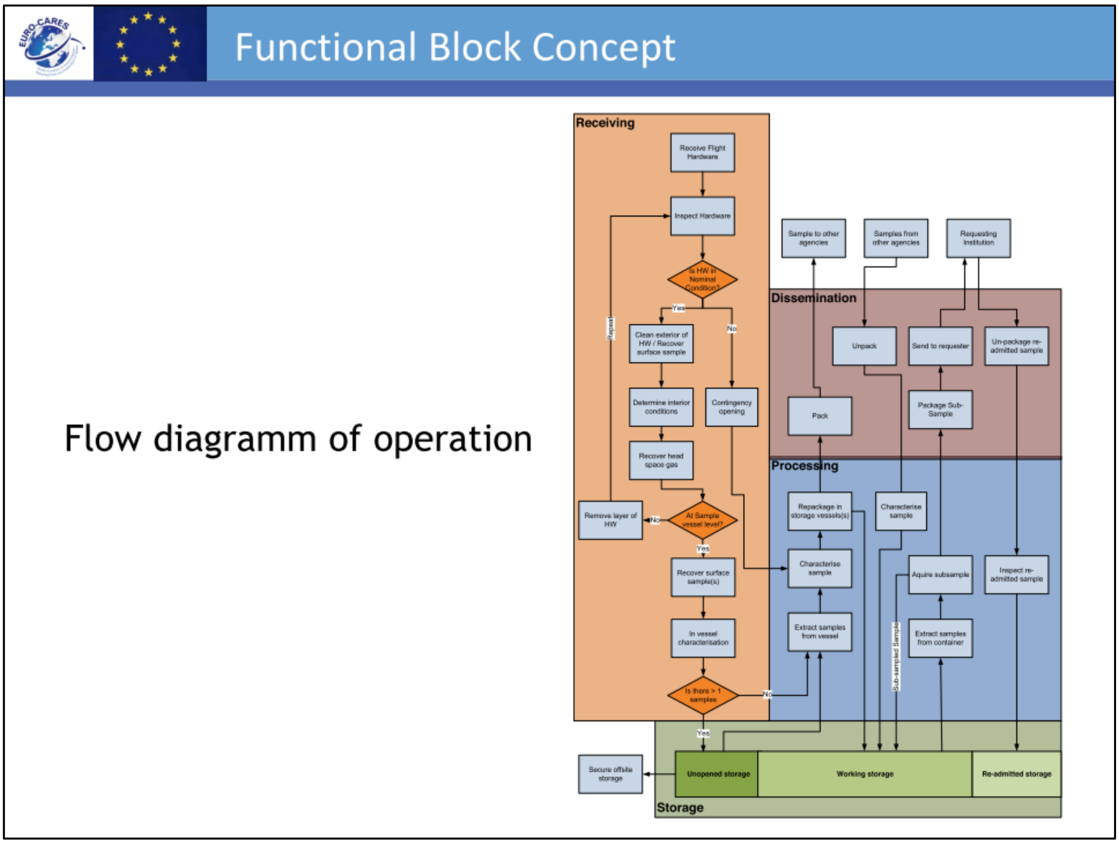

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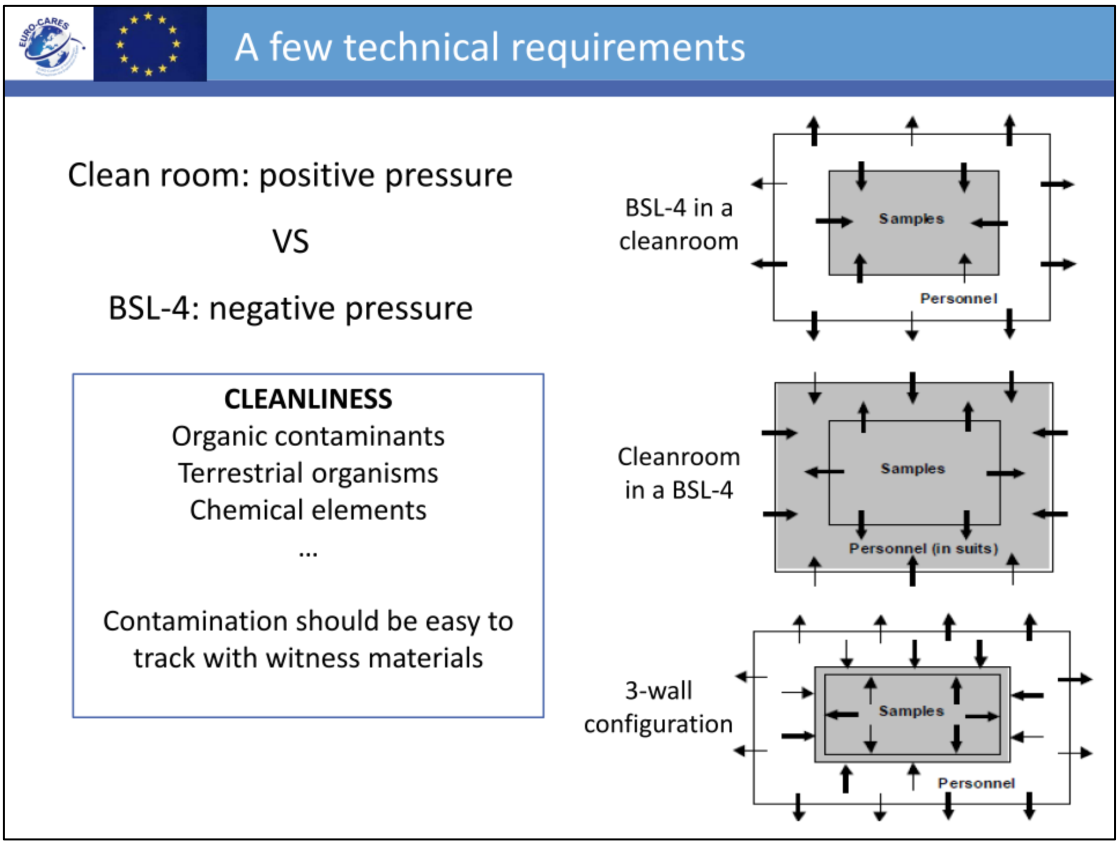

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A few technical requirements

Short list of accepted materials:

*stainless steel (304 and 316)

*pure aluminum and specific aluminum alloy

*quartz glass

*polytetrafluoroethylene (PTFE)

+ Viton (in case of Viton gloves cabinets)

Non accepted/authorized materials or to be avoided:

- Plastic
- Silicones & lubricants (robotics)
- Organic compounds (paint,…)

Low potential of contamination (outgassing, dust…) OR simple composition

A few technical requirements

Common requirements:

*HEPA filtrated air (in & out)

*pure nitrogen (or Ar) supply systems if necessary

*pressure control systems

*air-handling system(s)

*anti-static flooring and rounded corners

*…

Contamination Control

*"Passive" control with positive pressure ante-rooms

*Double walled isolators

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A few technical requirements

Safety and security:

Accidents happen in even the best facilities!

All necessary safety measures should be taken to prevent a catastrophe, whether natural or man-made, to protect not only the samples, but also the staff and local population.

To be considered are:
*Fire
*Storm
*Flooding
*Earthquake
*Electricity failure
*Vandalism / Human error
*"Political stability" of the country

A remote storage is necessary (in a distinct country).

A few technical requirements

Timing:

The planning of the facility design needs to start as early as possible (i.e. several years before the planned return sample date), ideally to finish the building at very least two years before any sample return, to have enough time to properly test the facility on analogue samples, to develop and validate procedures, and to train a dedicated multidisciplinary team.

Other issues to consider:

*Legislation & policy
*Maintenance and operation
*Location of the main facility + remote storage
*Feasibility, cost estimation, and timescales
*...

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Summary

Documents (in progress)

- ✓ Different rooms in the facility
- ✓ Sample flow in the facility
- ✓ People flow (and number) in the facility
- ✓ *Instruments suite for rooms requirements*

WP3 Workshop

SAVE THE DATE !

13-15 April, 2016
NHM Vienna

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WP3 Workshop

Wednesday (afternoon) 13/04: EURO-CARES team and Experts meeting

Thursday 14 & **Friday 15/04:** Open (WP3) meeting

Friday 15/04 Presentation of your work, ~10-12am.

Contacts

aurore.hutzler@ens-lyon.org

ludovic.ferriere@univie.ac.at

www.euro-cares.eu

Facebook and Twitter

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9.2 Appendix B: Persons expected to work in the facility. Ludovic Ferrière.

Persons expected to work in the facility

Administrative versus Scientific (/Technical) staff

A total of about 20 to 30/40 persons is expected to work in the facility + Robots!

Persons expected to work in the facility

Administrative staff:

***Director of the facility**
Directs and manages all the facility operations.
(1 full time person)

***Administrative manager & Secretary**
In charge of the business planning, finances, human resources, etc. Support staff, handles personnel issues, and assists with various other administrative tasks/duties.
(2 full time persons)

***IT person**
Handle the day-to-day computer and network related issues.
(1-2 full time person(s))

***Database manager/programmer**
In charge of the databases (to develop, manage, and maintain database(s)), of the general website of the facility, and all computer and network related issues.
(1-2 full time person(s)?)

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Persons expected to work in the facility

Scientific (/Technical) staff:

***Processors**
The persons who actually work on the samples; They take care of the preparation of the samples according to the requests. [to be cross trained to work in multiple collections (where skill sets are shared)].
2 full time persons (to be increased with time and multiplication of the samples/collections)

***Facilities Manager/Engineer**
Responsible for ensuring that the building operates correctly and is correctly maintained. May be responsible for contracting out servicing and maintenance (i.e., filter testing, room air flow validation, autoclaves, primary containment equipment testing, etc.).
1 full time person?

***Cleanroom Technician**
Responsible for keeping the labs clean, cleaning the tools, helping with organization in the labs, etc. and of the training of facility staff and **visiting researchers**.
1-2 full time person(s)

Persons expected to work in the facility

Scientific (/Technical) staff:

***Electromechanical Technician**
In charge to fix and maintain things in the laboratories (such as lights, microscopes, heat-sealers, etc.) and of the major infrastructure systems that supply the laboratories (i.e., air-handlers, liquid and gaseous N systems, UPW systems, etc.).
1-2 full time person(s)?

***BSL-4 Technician**
Specially trained scientists/technician/engineer to handle biohazardeous samples.
Work on samples in the BSL-4 part, on BAP.
2-4 full time person(s)?

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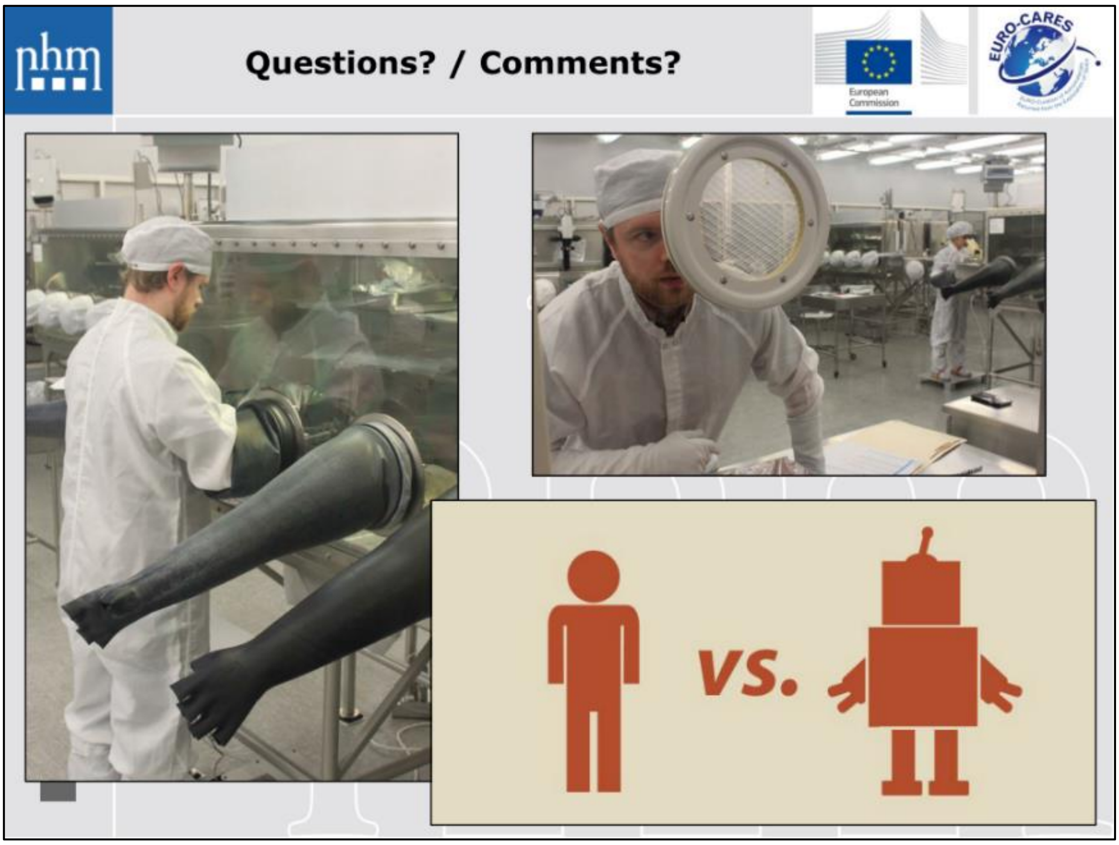

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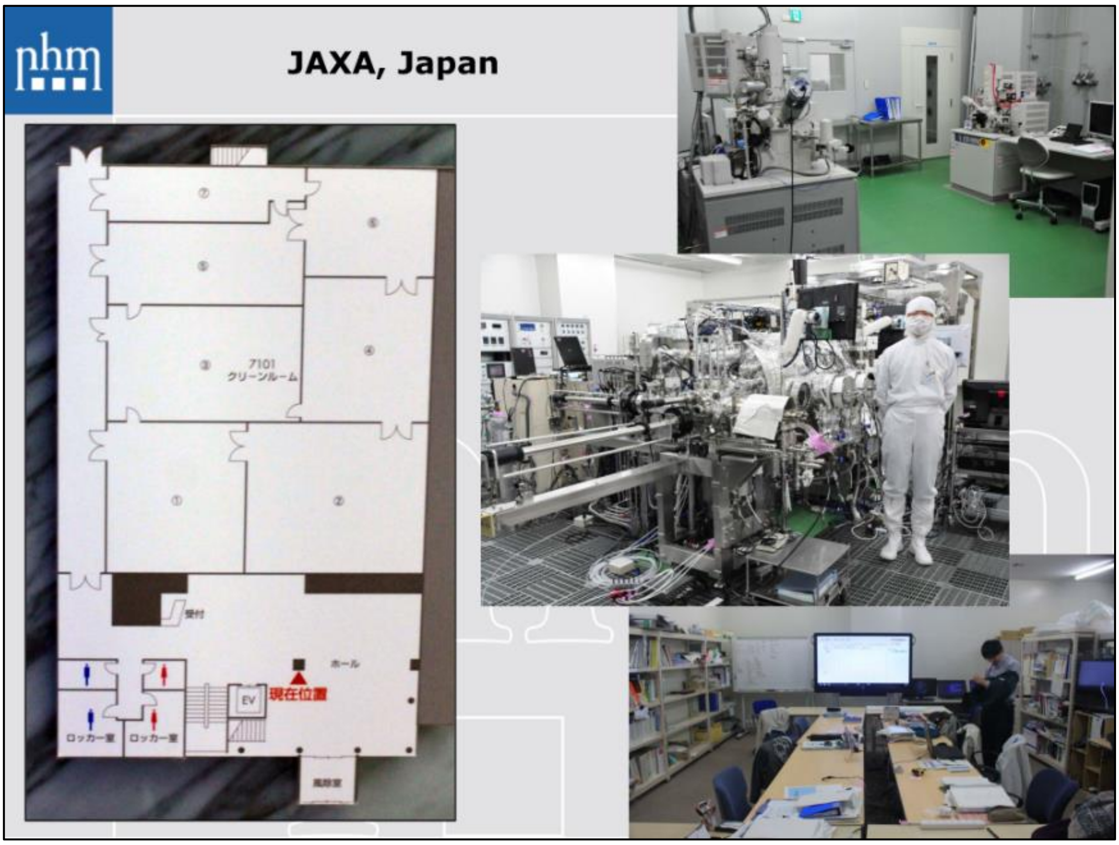

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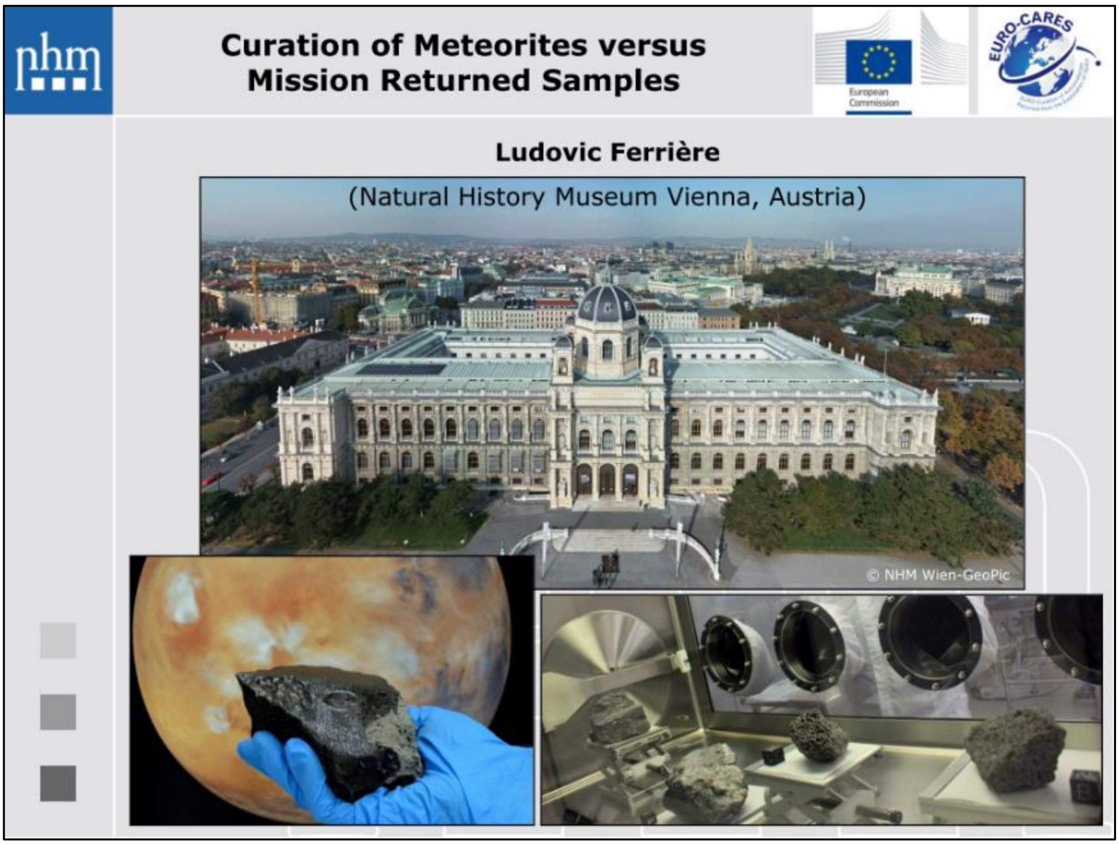
9.3 Appendix C: Curation of Meteorites versus Mission Returned Samples. Ludovic Ferrière.



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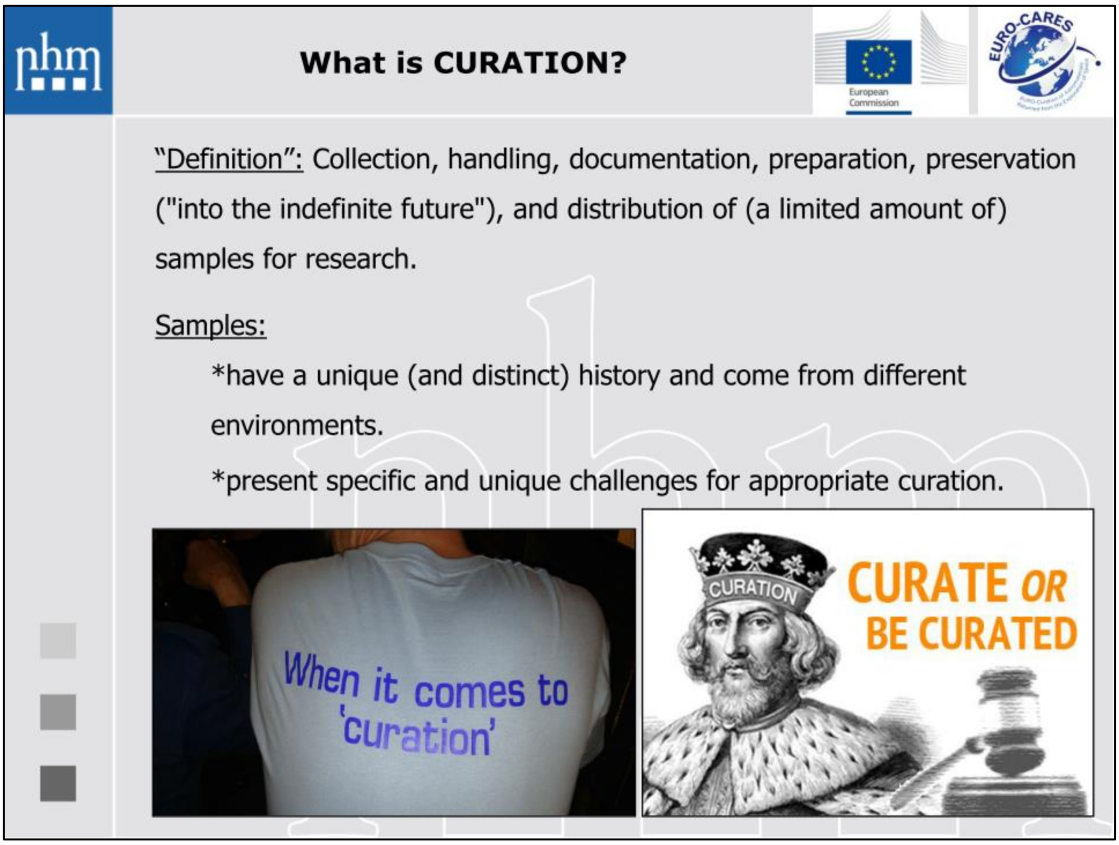

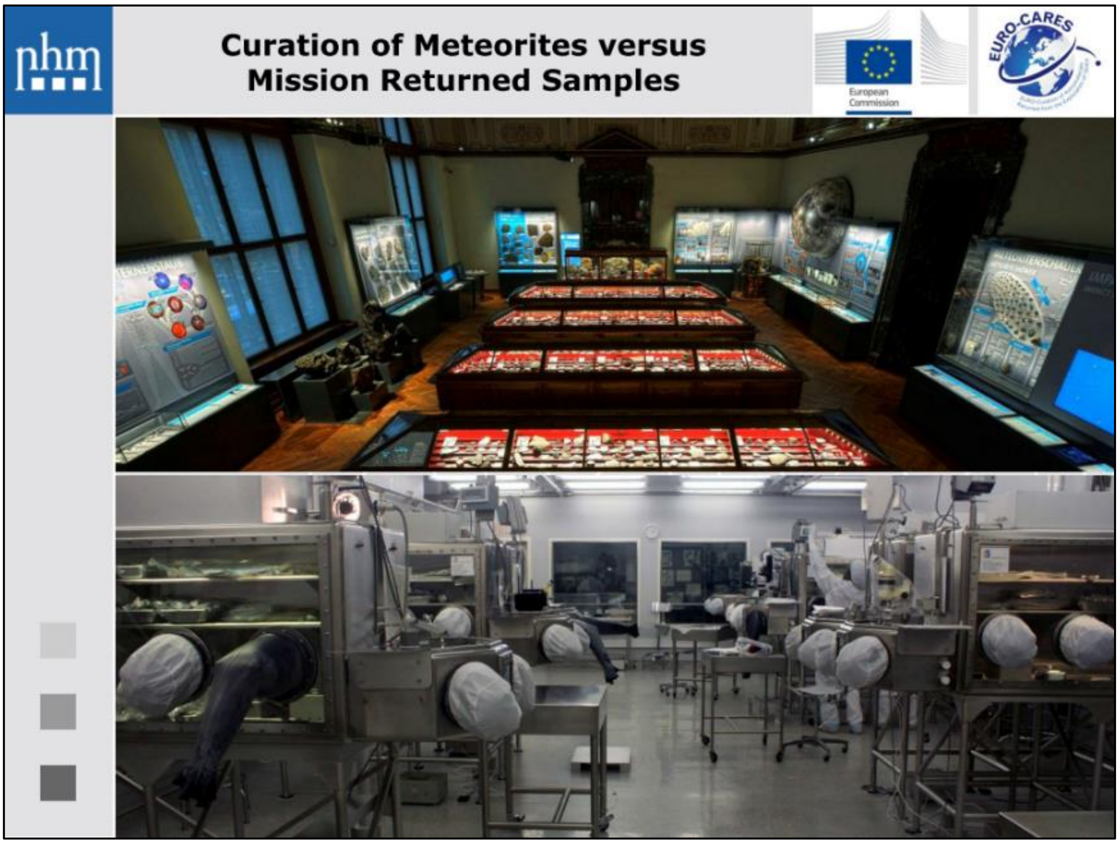

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Historic samples

The 39 kg iron meteorite Hraschina is the main piece of the meteorite fall of 1751 near Zagreb (Croatia).
It is the founding object of the Vienna meteorite collection.

Historic samples & Inventory books

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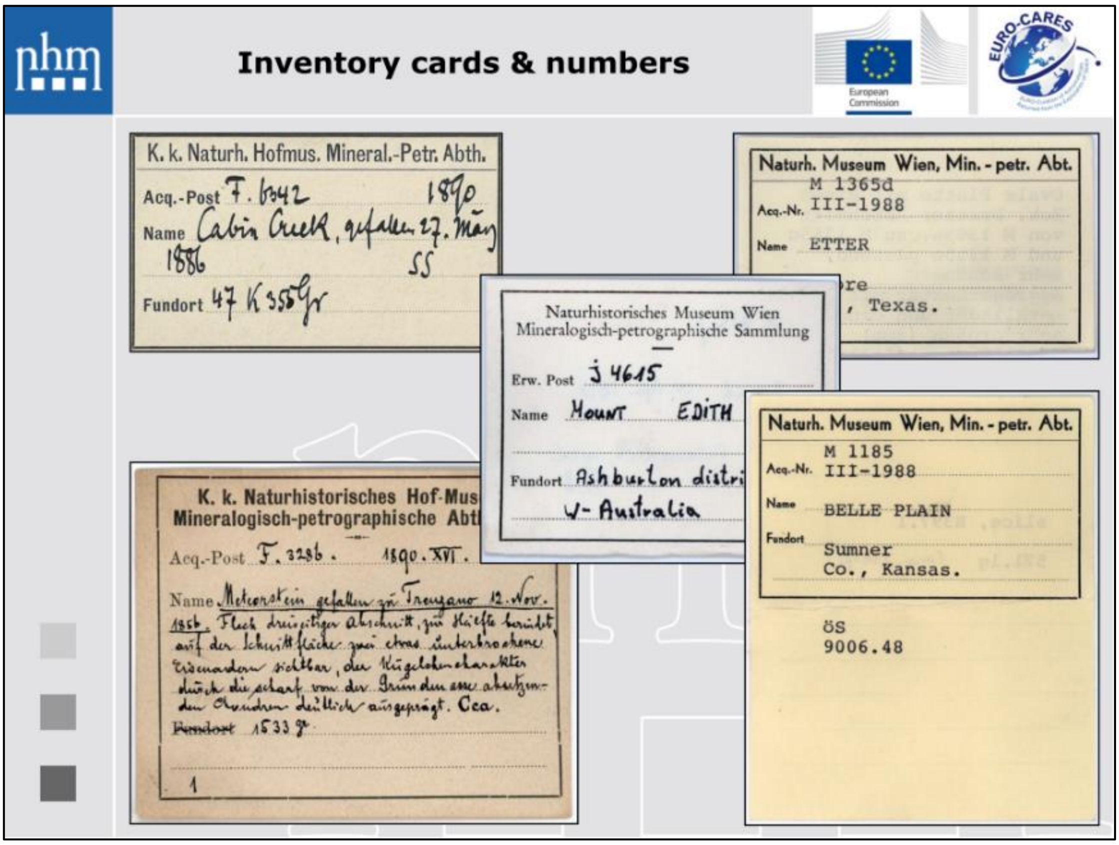

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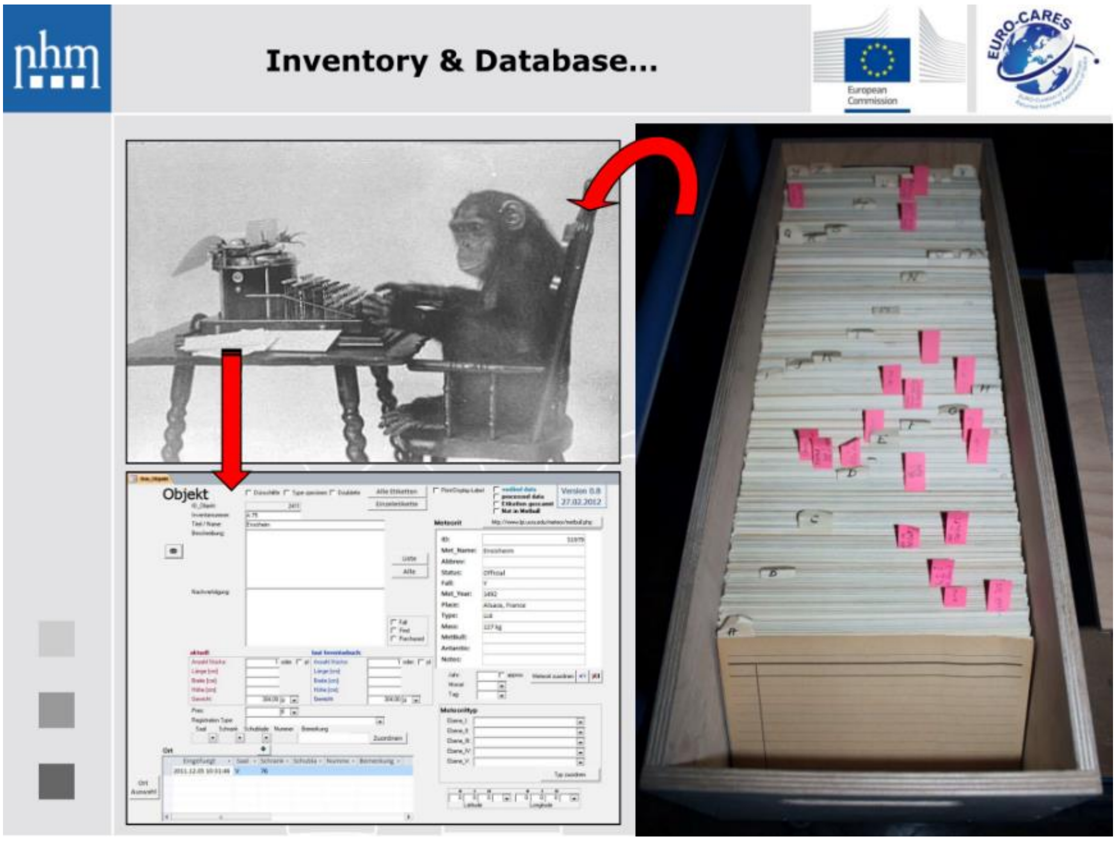

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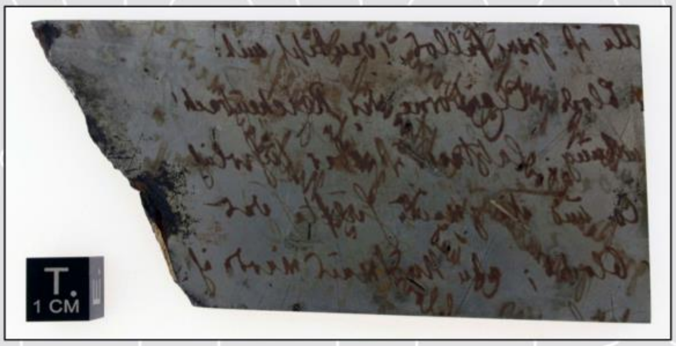
Important aspects to take into consideration

Meteorites arrive into collections either as samples recovered shortly after their fall on Earth, others (so-called finds) are collected mainly in hot and cold deserts and were exposed to Earth biosphere for hundreds or thousands of years.

All of these samples have interacted with the Earth atmosphere before being recovered on the ground.

Usually not much care is taken during the collection (excepted for most meteorites recovered in Antarctica) and then, the processing and traceability can be somewhat "chaotic".

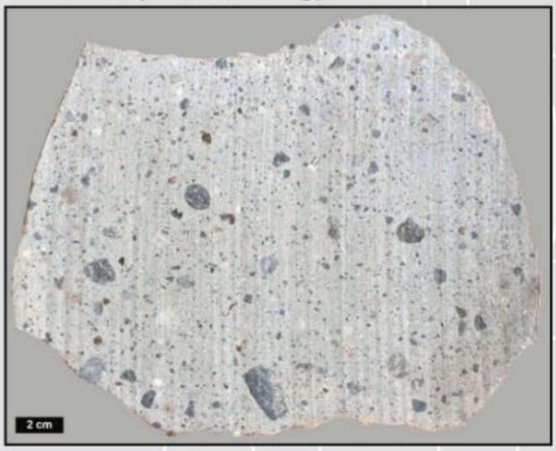
Lime Creek
(A 1026)



(Undocumented) Contamination

Meteorites are in contact with a large number of materials, liquids (in some cases the cutting is even done with tap water), and other unknown/undocumented contaminants.

DAG 779 (N 838 ; 662 g)



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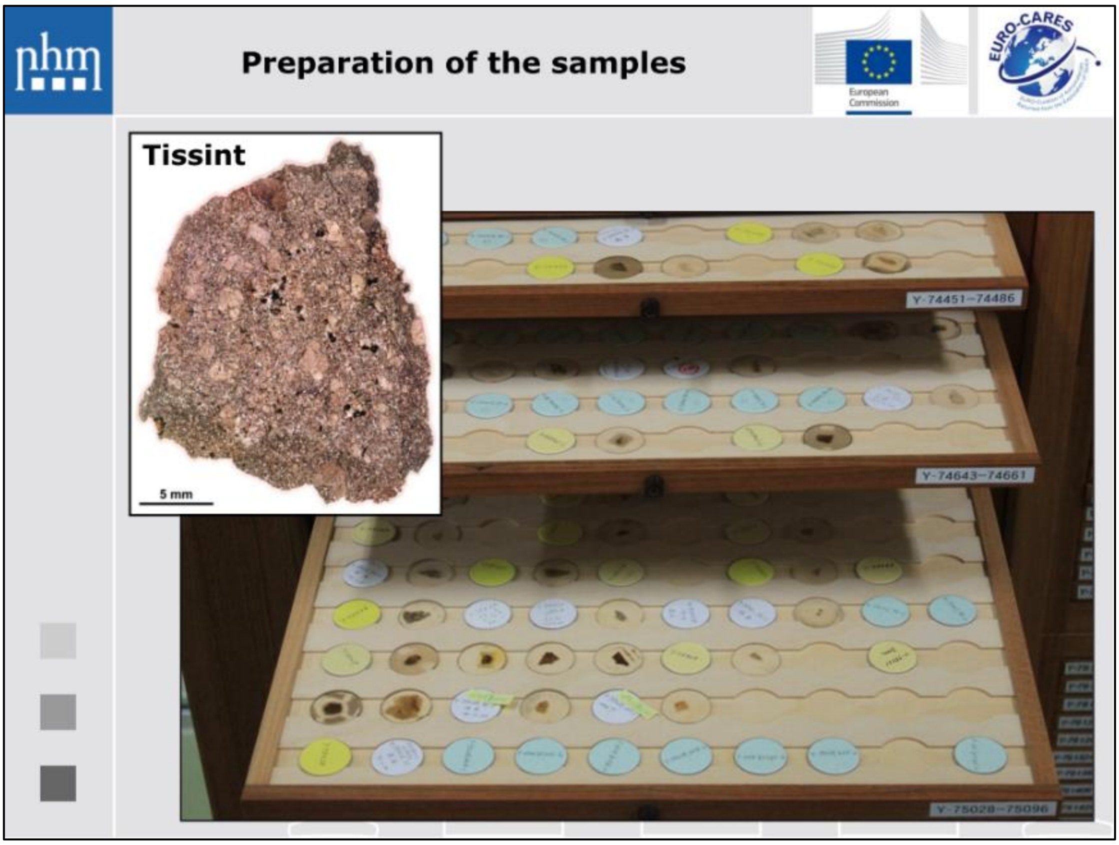

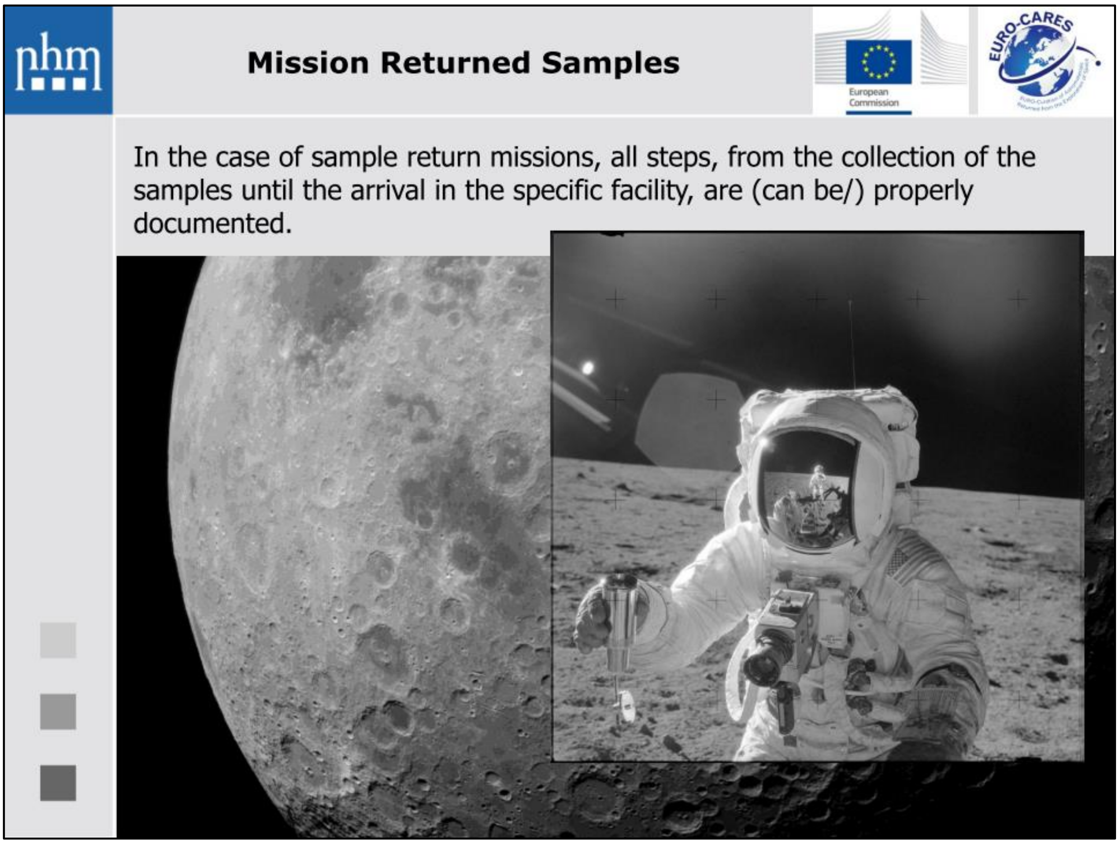

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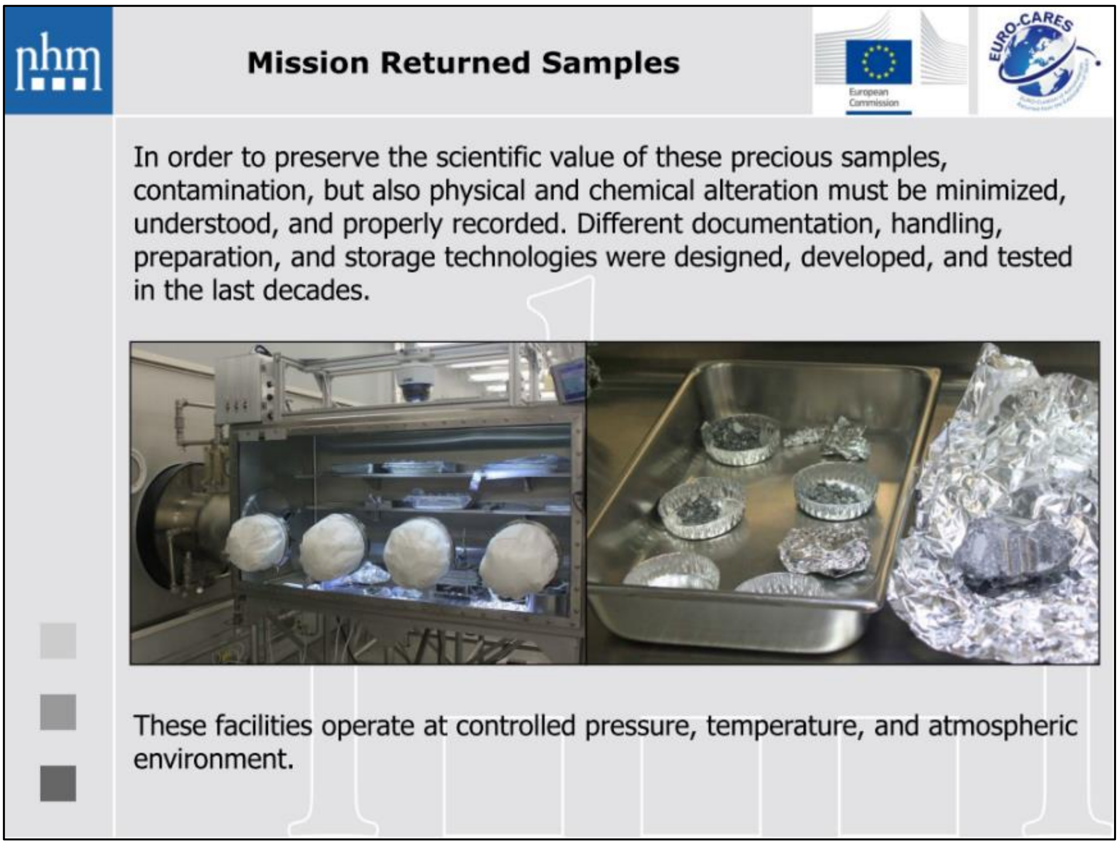

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Storage of Mission Returned Samples

Mission Returned Samples on display

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JSC (NASA), Houston, USA

*Lunar facility:

Pristine sample vault	111,8 m²
Pristine sample processing	100,9 m²
Return sample vault	74,6 m²
Return sample processing (samples going out)	29,6 m²
Return sample processing (samples coming back in)	17,4 m²

JSC (NASA), Houston, USA

*Cosmic dust: about 7 by 4 meters

*Stardust : about 6 m²

*Hayabusa: about 3 by 4 meters, approx.

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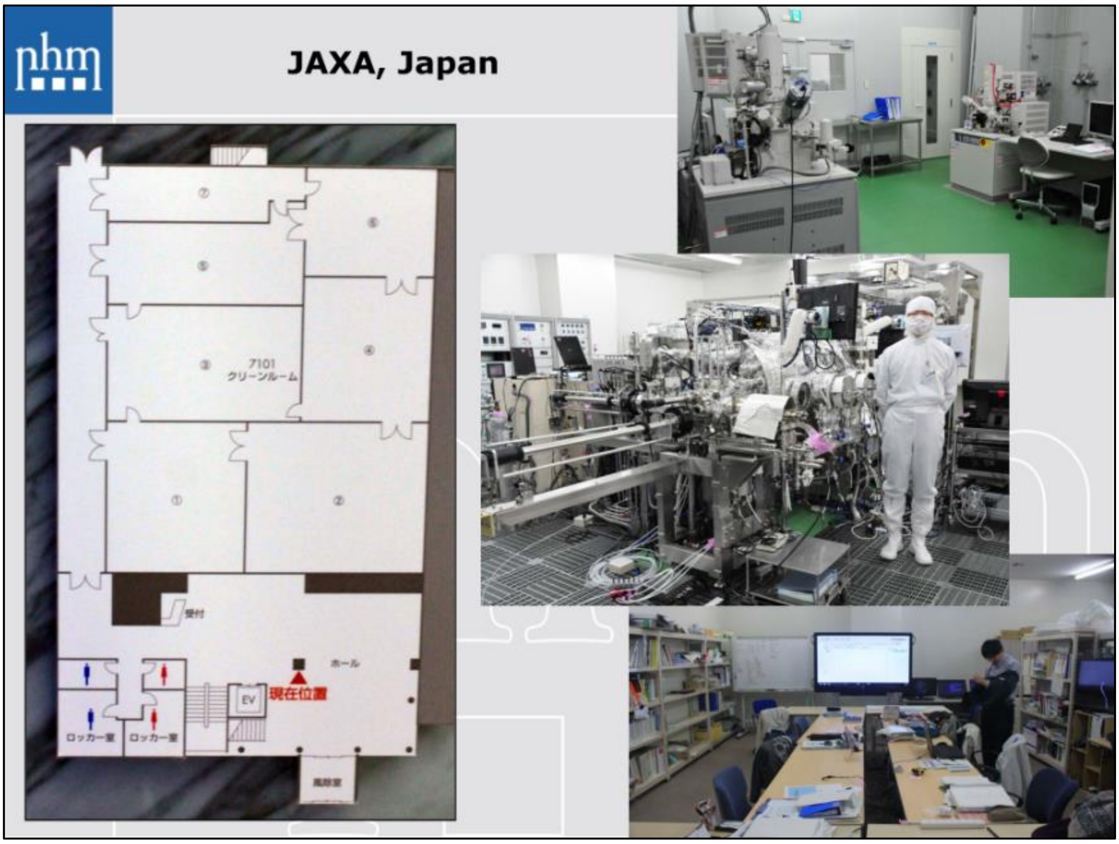

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JAXA, Japan

Ground floor:

Hayabusa1 sample room	88,6	100-1000
Electron microscope room	58,6	1000
Sample preparation room	45,9	1000
Manufacturing and cleaning room	56,9	10000
Garment room	23,2	100000
Hallway	53,8	NA
Monitor room	73,7	NA
Meeting room	71,6	NA

1st floor:

EPMA room	70,8	NA
TEM and SEM room	70,0	NA
Staff offices	43,7	NA

Basement:

Mechanical room	472,3	NA

Divers

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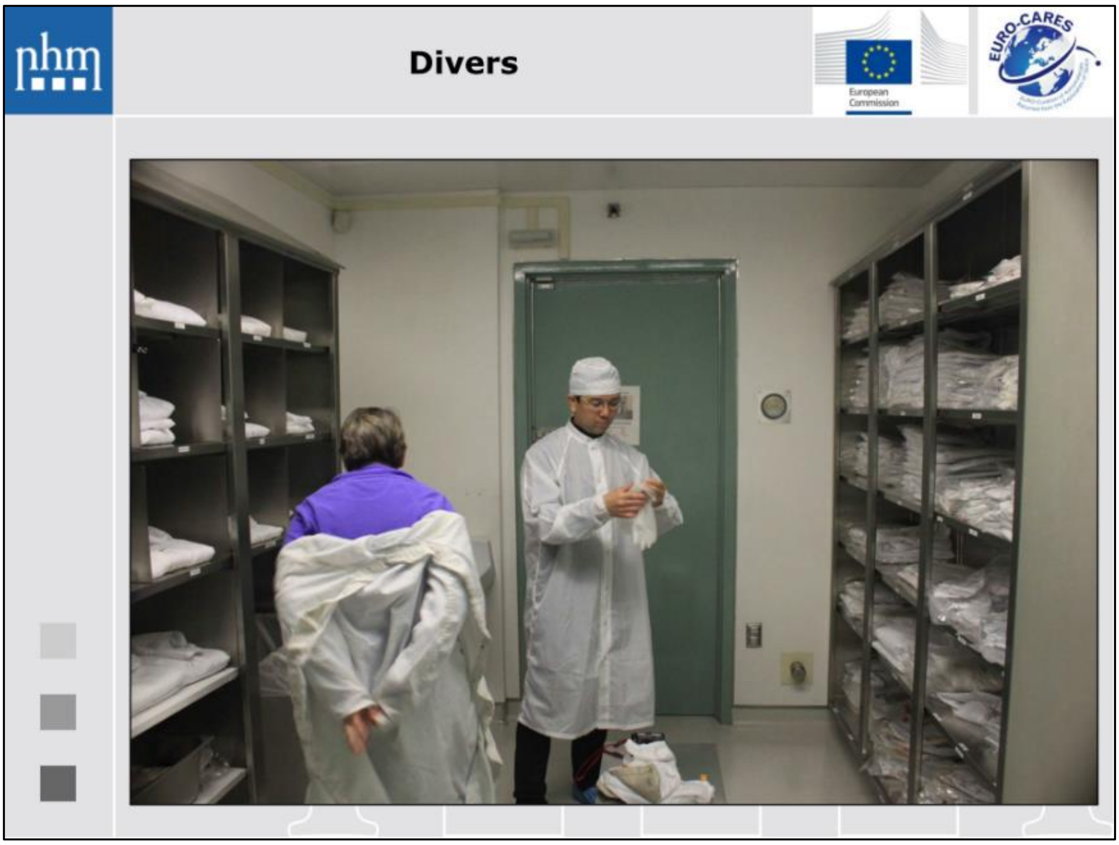

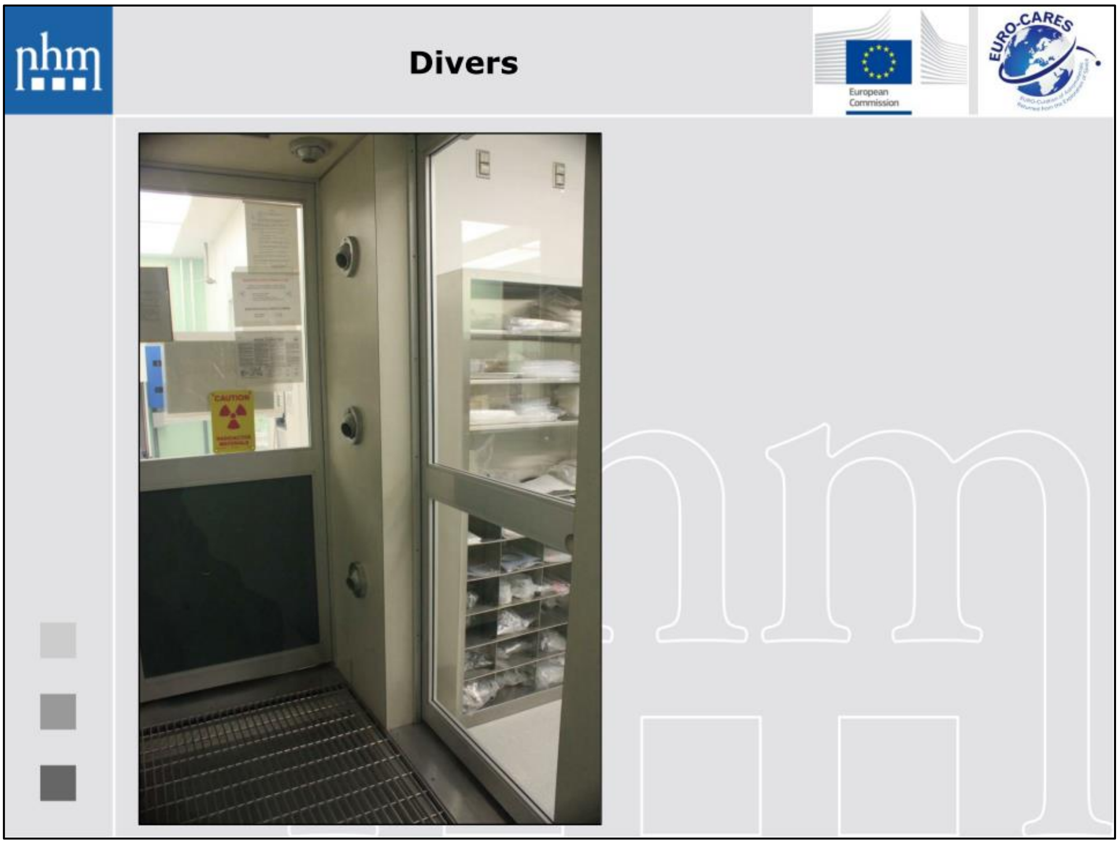

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9.4 Appendix D: Cleanrooms. Aurore Hutzler.

Comparison of different cleanliness classifications

Regulatory				Limiting values of each Air Cleanliness Class for differing particle sizes and reference volumes (according to ISO 14644-1)											
ISO 14644-1	EU-GMP „at rest“	EU-GMP „in operation“	US Fed. Standard 209E*	0.1 µm		0.2 µm		0.3 µm		0.5 µm		1.0 µm		5.0 µm	
				per m³	per cbf	per m³	per cbf	per m³	per cbf	per m³	per cbf	per m³	per cbf	per m³	per cbf
1				10	0,3	2	0,1								
2				100	3	24	1	10	0,3	4	0,1				
3				1.000	30	237	7	102	3	35	1	8	0,2		
			1	1.240	35	265	8	106	3	35	1				
4				10.000	300	2.370	67	1.020	29	352	9,9	83	2		
			10	12.000	340	2.650	75	1.060	29	353	10				
5				100.000	2.833	23.700	671	10.200	286	3.520	100	832	24	29	0,8
	A									3.520	100			20	0,6
		A								3.520	100			20	0,6
	B									3.520	100			29	0,8
			100			26.500	750	10.600	300	3.530	100				
6				1.000.000	28.329	237.000	6.710	102.000	2.890	35.200	977	8.320	235	293	8
			1.000							35.300	1.000			247	7
7										352.000	9.972	83.200	2.357	2.930	83
	C									352.000	9.972			2.900	82
		B								352.000	9.972			2.900	82
			10.000							353.000	10.000			2.470	70
8										3.520.000	99.716	832.000	23.569	29.300	830
	D									3.520.000	99.716			29.000	821
		C								3.520.000	99.716			29.000	821
			100.000							3.530.000	100.000			24.700	700
9										35.200.000	997.167	8.320.000	235.694	293.000	8.300

Page 15

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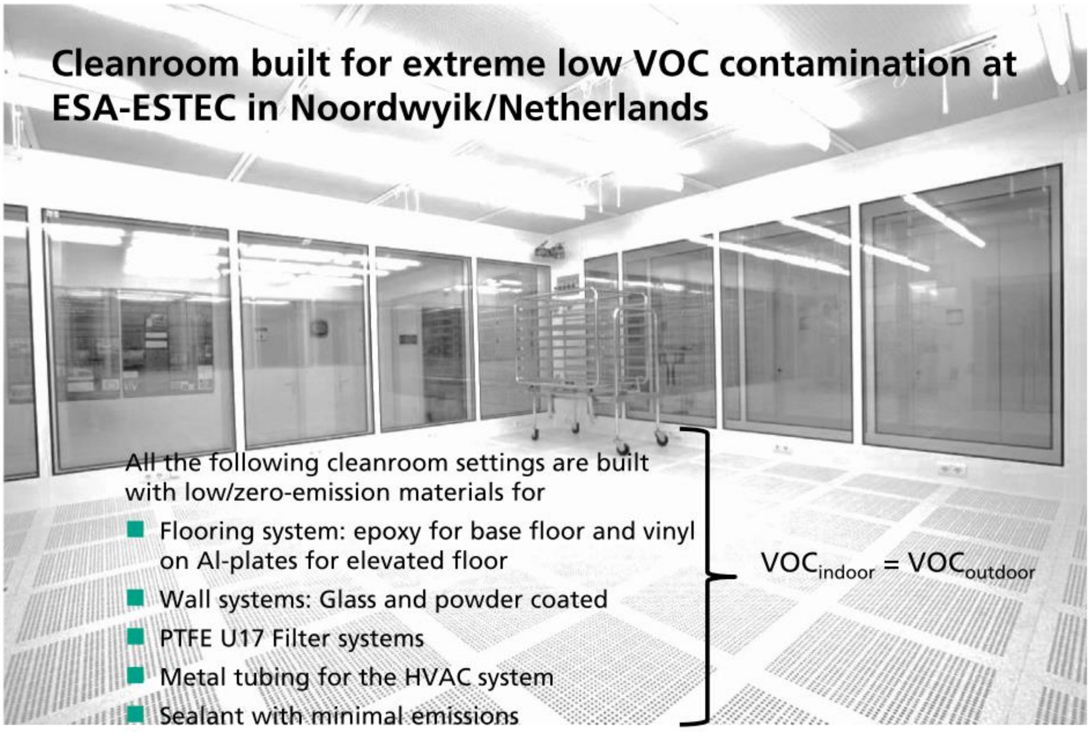

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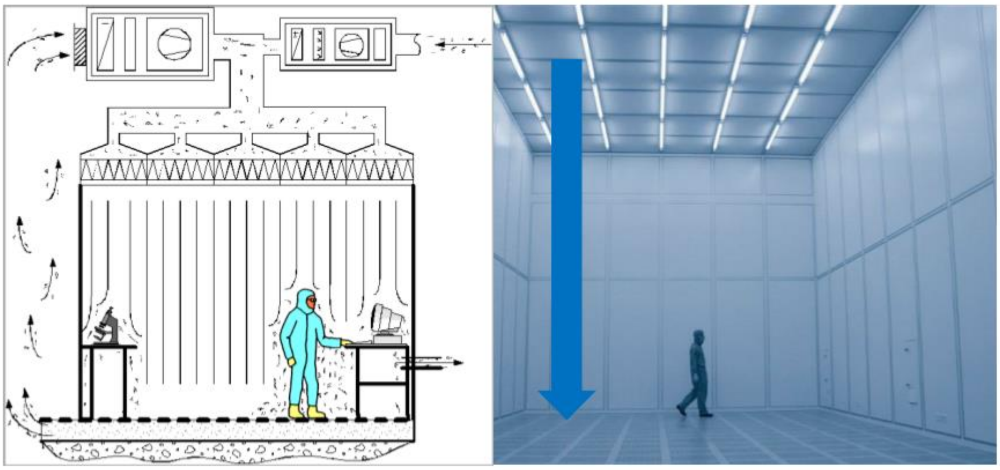
Cleanroom design
Low Turbulent Uni-directional Airflow (LTUA)



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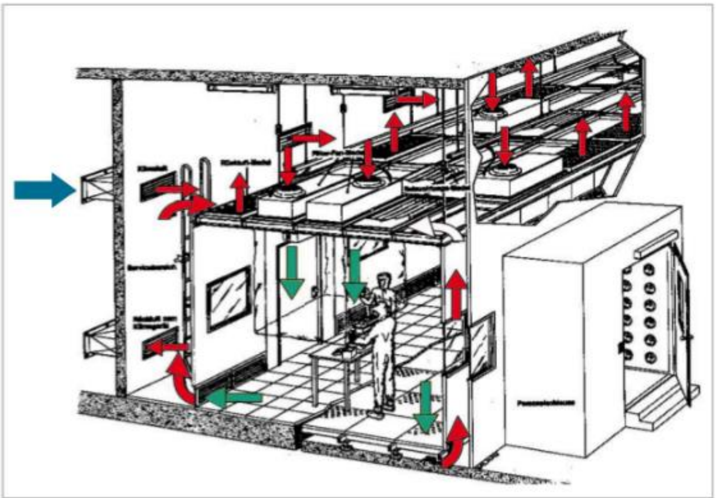
Cleanroom design
Cross-section through a cleanroom with LTUA

- Air entry
- Airflow in cleanroom
- Circulating air



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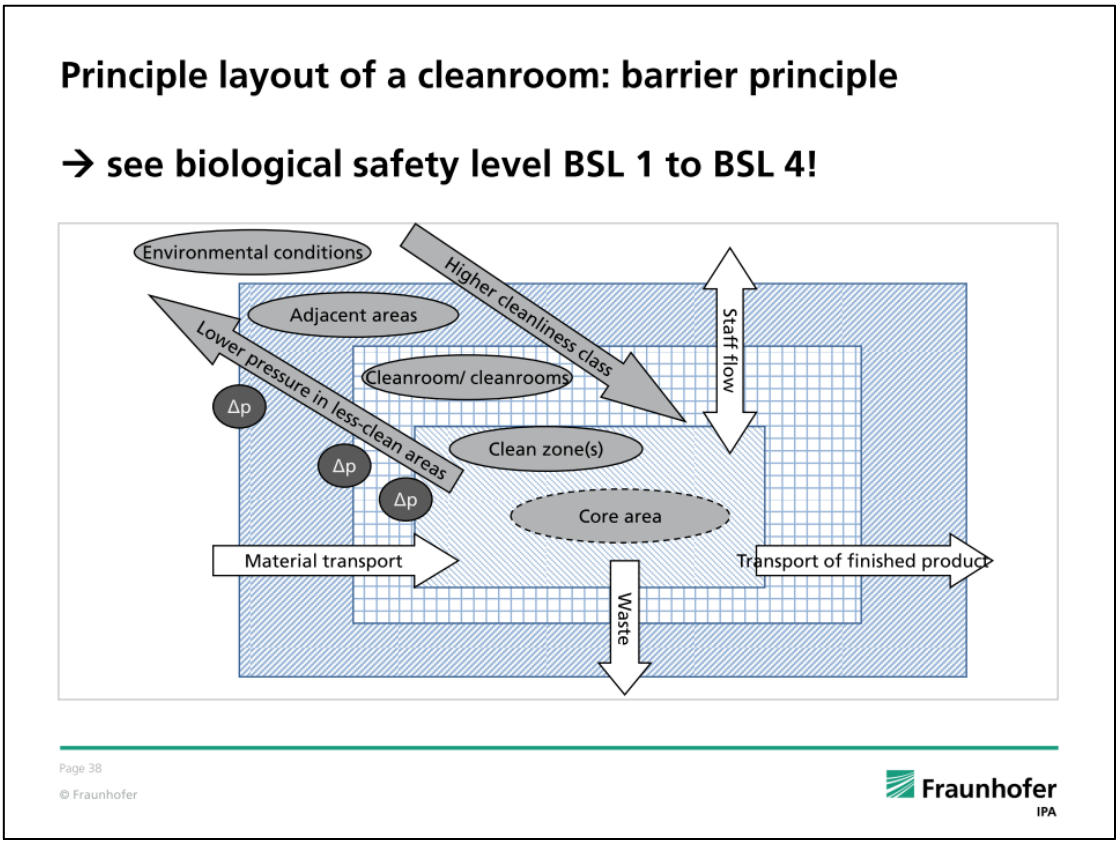

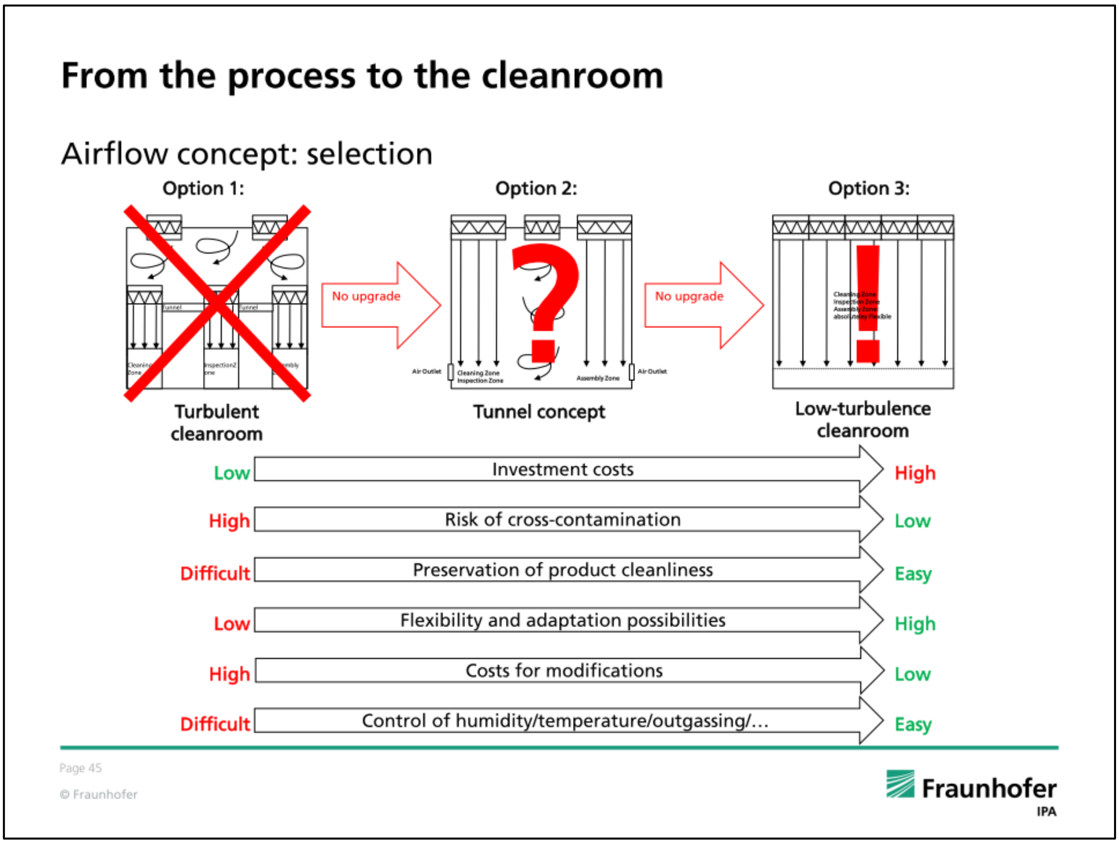

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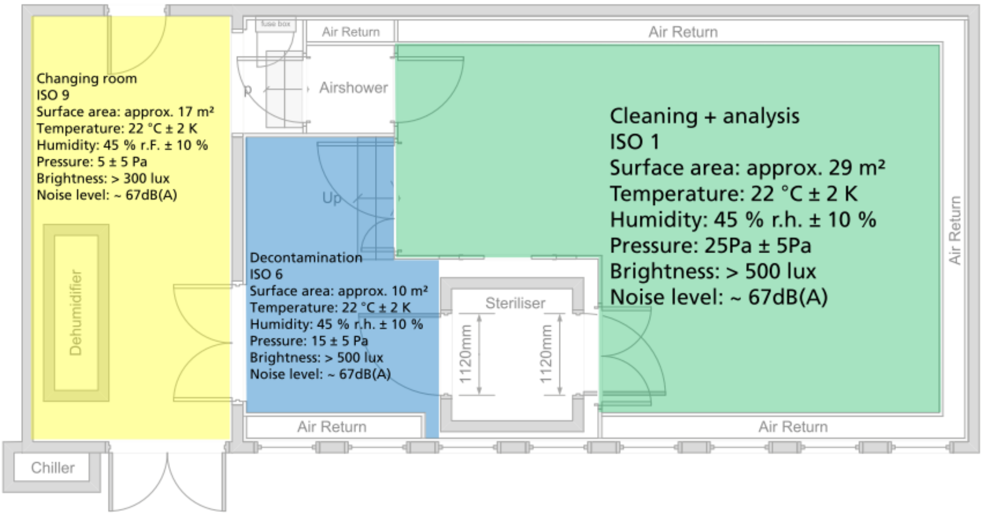
From the process to the cleanroom

Process environment: humidity, temperature, pressure, brightness
Operating media: water, compressed air, ultra-pure gases



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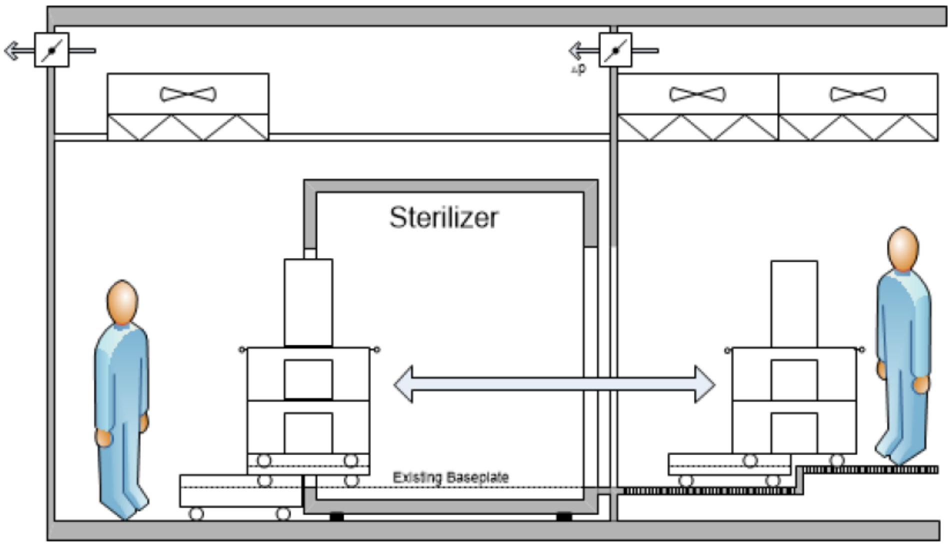
From the process to the cleanroom

Operating parameter: transfer concepts



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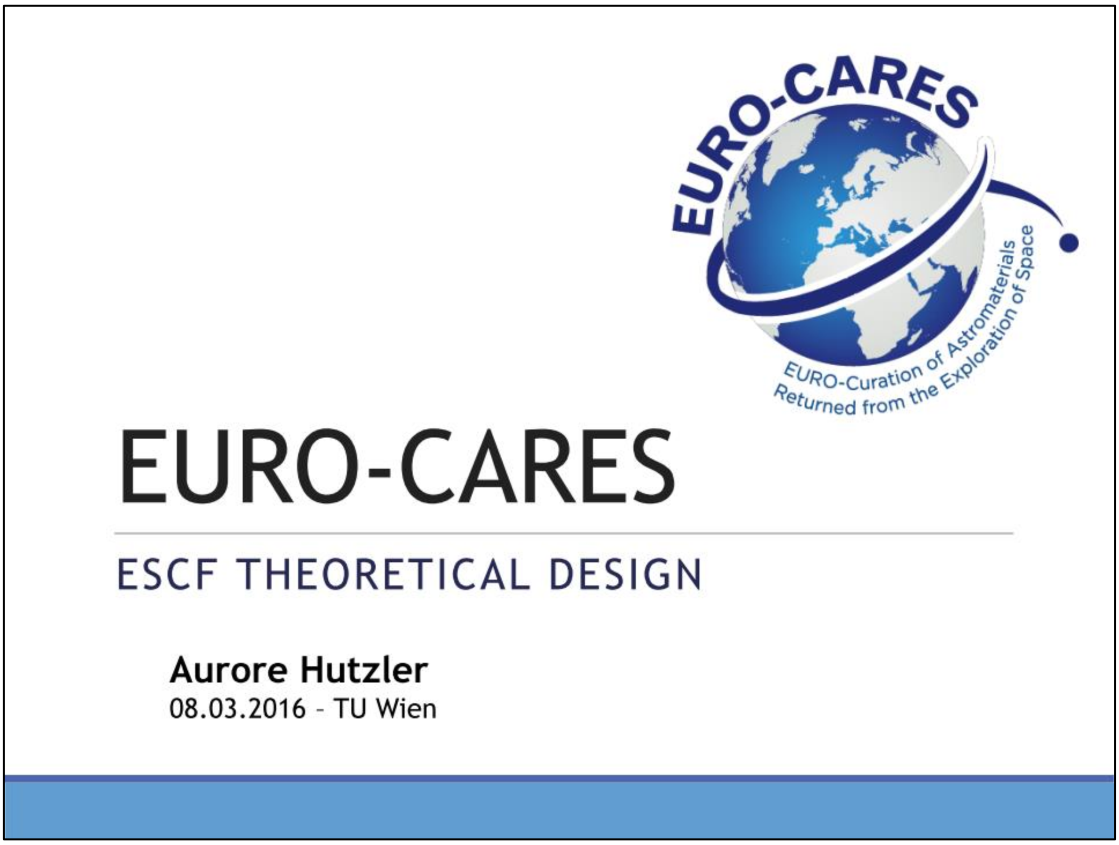
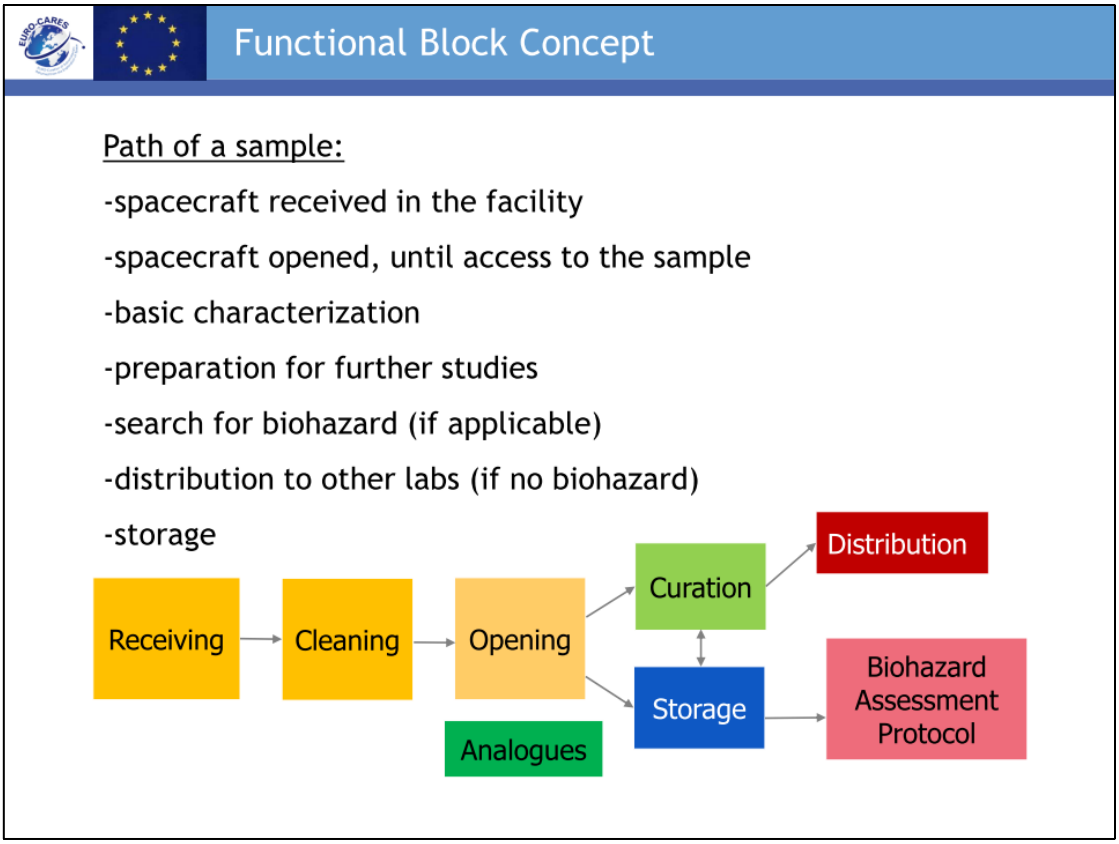
9.5 Appendix E: EURO-CARES – ESCF Theoretical Design. Aurore Hutzler.





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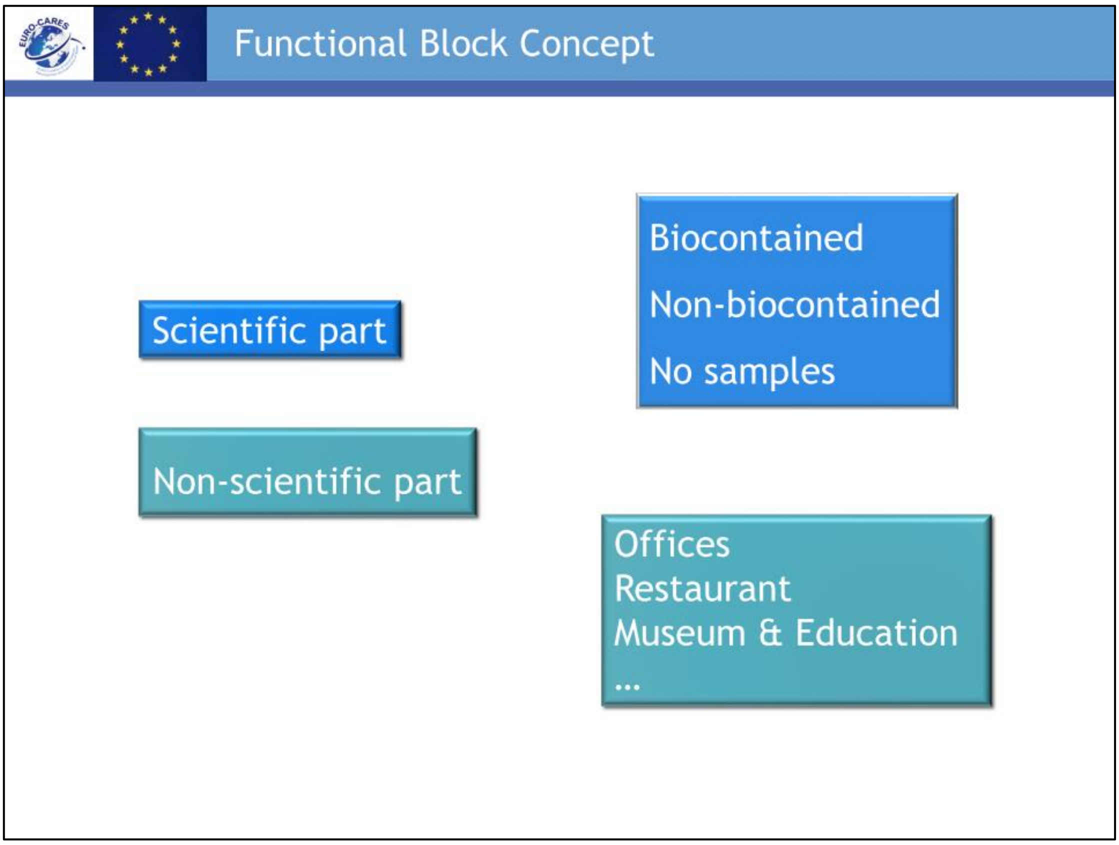

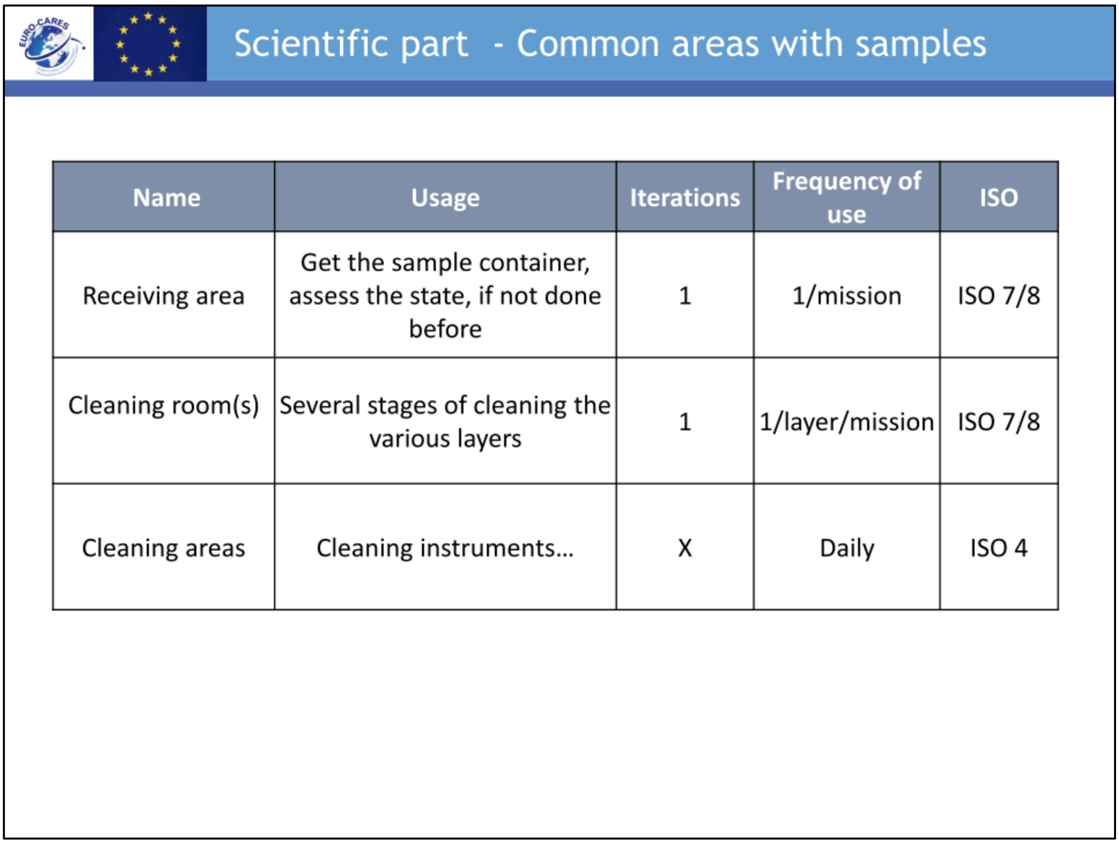

Scientific part - Common areas with samples

Name	Usage	Iterations	Frequency of use	ISO
Receiving area	Get the sample container, assess the state, if not done before	1	1/mission	ISO 7/8
Cleaning room(s)	Several stages of cleaning the various layers	1	1/layer/mission	ISO 7/8
Cleaning areas	Cleaning instruments…	X	Daily	ISO 4

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Scientific part – Non-biohazardous sample

Name	Usage	Iterations	Frequency of use	ISO
Opening room	The sample vessel is open	1	1/mission	class 10-100
Curation room	Sample handling, preparation, characterisation…	1	Daily	ISO 4 [2] or ISO 6 [3]
Sample preparation area	To prepare the samples, using e.g., saw and other preparation tools	1	Daily	ISO 4 to ISO 6
Characterisation area(s)	To host the different instruments to be used for the characterization of the samples, in or out of the container.	1	Daily	ISO 4 [2] or ISO 6 [3] / class 1000

Scientific part – Non-biohazardous sample

Name	Usage	Nber of iterations	Frequency of use	ISO
Storage room(s)	Store and preserve samples over a long period of time	1	Daily	ISO 4 [2] or ISO 6 [3] / class 100-1000
Distribution area	Samples to leave the facility, packaging	1	1-2/week	ISO 4 [2] or ISO 6 [3]
Analogue samples room	Storage, preparation, study of analogues samples.	1	Daily	TBD (WP5)
Changing/Garment room(s)	Change of clothes, more or less complete, before entering labs	1/ISO	Daily	Depending

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Scientific part - Biohazardous sample

Name	Usage	Nber of iterations	Frequency of use	ISO	
Opening area	The sample vessel is open	1	1/mission	class 10-100	BSL-4
Curation room	Sample handling, preparation, characterisation...	1	Daily	ISO 4 [2] or ISO 6 [3]	BSL-4
Sample preparation area	To prepare the samples, using e.g., saw and other preparation tools	1	Daily	ISO 6	BSL-4
Characterisatio n area(s)	To host the different instruments to be used for the characterization of the samples, in or out of the container; BAP 0	1	Daily	ISO 4 [2] or ISO 6 [3] / class 1000	BSL-4 or BSL-3 (container)

Scientific part - Biohazardous sample

Name	Usage	Nber of iterations	Frequency of use	ISO	BSL
Storage room(s) [/ Safe room]	Store and preserve samples over a long period of time	1	Daily	ISO 4 [2] or ISO 6 [3] / class 100-1000	BSL-4
Changing/Garment room(s)	change of clothes, more or less complete, before entering labs	1/ISO	Daily	Dependin g	BSL-2
Suit decontamination shower room	before leaving a suit BSL4 lab	1	Daily	ISO 4 [2] or ISO 6 [3]	BSL-4
Biohazard Assessment Protocol area	Search of life, past of present; BAP 1 & BAP 2	1	Daily	ISO 4 [2] or ISO 6 [3]	BSL-4
Animal facility rooms	Care of the animals, last step of BAP.	1	H24	ISO 9	BSL-2 to BSL-4

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Scientific part - Services

Name	Usage	Nber of iterations	Frequency of use	ISO
Air handling HVAC floor	Providing clean air in and out of the labs	1	Daily	ISO 9
Effluent treatment area	BSL-4: treating (autoclave, chemicals) of biohazardous effluents Not-BSL-4: neutralizing chemicals	1	Daily	ISO 9
Machining room(s) [in the basement?]	For pumps (for vacuum systems), a compressed air supply system, an ultra pure water supply system, nitrogen purifiers, etc.	1	Daily	ISO 9
Monitor (/ Control) room	Check of the parameters (T, P, humidity…). Remote control if necessary. Control of cameras. Check of employees. Shut-down of facility.	1-2	Daily	ISO 9

Non-scientific part

Name	Usage	Nber of iterations	Frequency of use
Meeting / Social rooms	Living and socializing space / Bridges between buildings	1/2	Daily
Information room(s) / "Museum"	Outreach and Public events	1	Daily
Offices	Host permanent staff (curators, engineers, technicians…), and invited researchers	1/permanent staff	Daily
Administration rooms	Permanent administrative staff	1/adm. staff	Daily

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Non-scientific part

Name	Usage	Nber of iterations	Frequency of use
Guest rooms	Host invited researchers; bedrooms, showers, kitchen (?)	Depending on location: 3 to 15	Daily
Restaurant	For permanent workers and invited researchers	1	Daily
Entrance hall		1	Daily
Security facility	Check people entering the site & security of the site	1	H24
Toilets/Bathrooms		> 1/15 workers	Daily

Work Package 3

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9.6 Appendix F: Introduction to Containment Microbiology. Allan Bennett.

Public Health England

Introduction to Containment Microbiology

Public Health England

What is containment?

Physical containment of pathogenic organisms (bacteria, viruses, protozoa, fungi etc) is required to prevent infection of laboratory workers or release into the surrounding community.

This allows us to work safely with the organisms in the lab, and keep those outside the laboratories safe.

Always several layers of protection

2 Containment Microbiology - How we keep you safe. Dec 2015

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Because we are culturing organisms we have to contain them

We always make sure there is more than just one layer of protection. The number of layers is in proportion to the risk.

3 Containment Microbiology - How we keep you safe. Dec 2015

Public Health England

Hazard Groups of organisms

HG 1 – Unlikely to cause disease.

HG 2 – Can cause human disease, may be hazardous to laboratory staff but are likely to already be in the community. Effective treatments are available. Examples are *Staphylococcus aureus*, influenza, some strains of *E.coli* and *Legionella*.

HG 3 – Can cause severe human disease, may be a serious hazard to laboratory staff; may spread to the community, but there is usually effective treatment available. Examples include *Bacillus anthracis* (anthrax), prions causing CJD, *Mycobacterium tuberculosis* and *E.coli 0157*.

HG 4 –Cause severe human disease, are a serious hazard to laboratory staff; likely to spread to the community and usually no effective treatment available. These are all viruses, for example Ebola.

4 Containment Microbiology - How we keep you safe. Dec 2015

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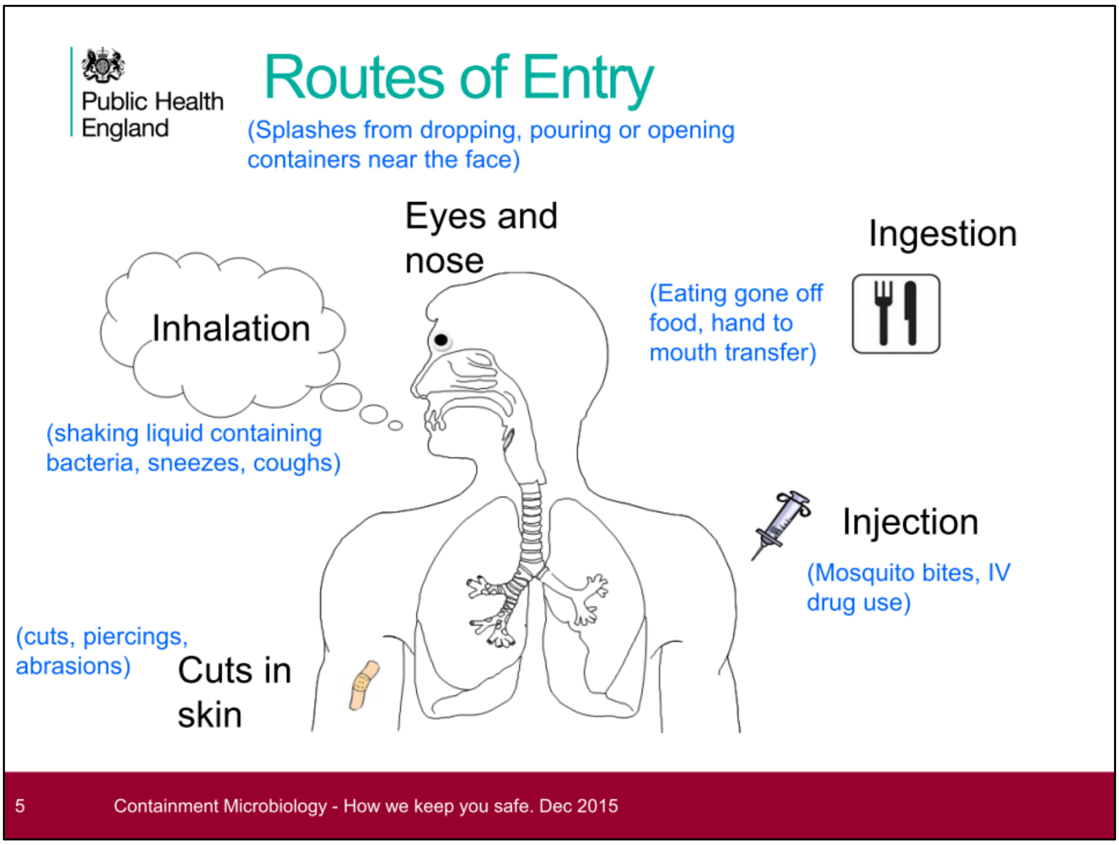

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Containment Level 3 laboratory

7 Containment Microbiology - How we keep you safe. Dec 2015

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Containment Level 4 laboratory

8 Containment Microbiology - How we keep you safe. Dec 2015

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Other measures

Safe working methods

Training/discipline

Equipment servicing/validation/monitoring

Hand washing

Vaccination

9 Containment Microbiology - How we keep you safe. Dec 2015

Public Health England

erinha
European Research Infrastructure on Highly Pathogenic Agents

How to design a high containment microbiology laboratory?

March 9th 2016

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ERINHA (www.erinha.eu)

11 Designing a containment laboratory

Public Health England

ERINHA

- To provide draft tools and guidelines to help engineers capture the needs of users and translate them into a building project that is feasible, economic and achievable, whilst meeting the requirements of its scientific staff.

12 Designing a containment laboratory

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Information required

- Project Brief
- Relevant Regulations and Guidance
- Scientific Input
- Technical Input
- Location
- Facilities Input

13 Designing a containment laboratory

Public Health England

Regulations & Guidance

- Biosafety
- Biosecurity
- Environment
- General Safety
  - Fire Codes
  - Building Codes
- Animal Welfare
- Quality

14 Designing a containment laboratory

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Public Health England

Biosafety Regulations & Guidance

- EU Directive 2000/54 Biological Agents
- Directive 2009/41/EC Contained Use of GMOs
- WHO Biosafety manual
- US BMBL
- UK ACDP and ACGM
  - Biological agents: Managing the risks in laboratories and healthcare premises http://www.hse.gov.uk/biosafety/biologagents.pdf
  - The management, design and operation of microbiological containment laboratories. http://www.hse.gov.uk/pubns/books/microbio-cont.htm
  - Guidance from the Scientific Advisory Committee on Genetic Modification http://www.hse.gov.uk/biosafety/gmo/acgm/acgmcomp/

15 Designing a containment laboratory

Public Health England

EU Directive 2000/54 Annex 3

	2	3	4
1. The workplace is to be separated from any other activities in the same building	No	Recommended	Yes
2.Input air and extract air to the workplace are to be filtered using (HEPA) or likewise	No	Yes on Extract Air	Yes on Inlet and Extract Air
3. Access is to be restricted to nominated workers only	Recommended	Yes	Yes via airlock
4. The workplace is to be sealable to permit disinfection	No	Recommended	Yes
5. Specified Disinfection Procedures	Yes	Yes	Yes

16 Designing a containment laboratory

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EU Directive 2000/54 Annex 3

	2	3	4
6. The workplace to be maintained at an air pressure negative to the atmosphere	No	Recommended	Yes
7. Efficient vector control	Recommended	Yes	Yes
8. Surfaces impervious to water and easy to clean	Yes for bench	Yes for bench and floor	Yes for bench, walls, floor and ceiling
9. Surfaces resistant to acids, alkalis, solvents, disinfectants	Recommended	Yes	Yes
10. Safe storage of biological agents	Recommended	Yes	Yes

17 Designing a containment laboratory

Public Health England

EU Directive 2000/54 Annex 3

	2	3	4
11. An observation window or alternative to be present so occupants can be seen	Recommended	Recommended	Yes
12. A laboratory is to contain its own equipment	No	Recommended	Yes
13. Infected material including any animal is to be handled in a safety cabinet or isolation or other suitable containment	Where appropriate	Yes, where infection is by airborne route	Yes
14. Incinerator for disposal of animal carcasses	Recommended	Yes, available	Yes, on site

18 Designing a containment laboratory

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What sort of facility do I need?

- There are no standard BSL2 or 3 or 4 facilities.
- Their design depends on what will happen in them
- There needs to be a clear high level description of what the laboratory is to be used for, a project brief
- This should define the laboratory function and give an idea of the volume of work to be carried out
- This will give an idea of the size of the project and the resources required for the design and construction process
- Does my organisation have experience in this area?

19 Designing a containment laboratory

Public Health England

User Requirement Specification

A document that specifies what the customer expects from the finished laboratory that will be provided to the architects/designer. Requirements may fall in a number of categories

Functional What are the critical system parameters to accomplish the mission?

Performance e.g leak tightness criteria

Security e.g Access Control

Environmental: Energy reduction, Heat recovery etc

Architectural: What will the building look like?

Design: Does the used have preferred design soultions?

20 Designing a containment laboratory

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Who needs to be involved in URS Development?

- Principal Investigator
  - High level Input
  - Scientific direction, Future-proofing
- Scientific and Technical Staff
  - Knowledge of process, material flows
  - Will tend to be conservative
- Biosafety Staff
  - Will have knowledge of regulation and guidance and understand national regulatory processes
  - May be consultant/contractor
- Facilities Manager/ Site Engineers
  - Act as an interpreter and facilitator between scientists and external engineers/designers/architects.
  - Familiar with local building practices i.e regulations and fire codes

21 Designing a containment laboratory

Public Health England

External Review

- People who have experience in the type of facility you wish to construct
- People who have recently built a facility
- Preferably, international and national
- Sanity Check
- Learn from their mistakes (and successes)

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Obtaining Input

- Making time
- Deputisation
- Questionnaires
- Facilitation
- International Networks
- Lessons learnt
- Workshops

23 Designing a containment laboratory

Public Health England

Information required

- Process Flows
  - People
  - Samples
  - Waste
    - Water
    - Air
    - Solid
  - Animal
    - Bedding
    - Waste
    - Food

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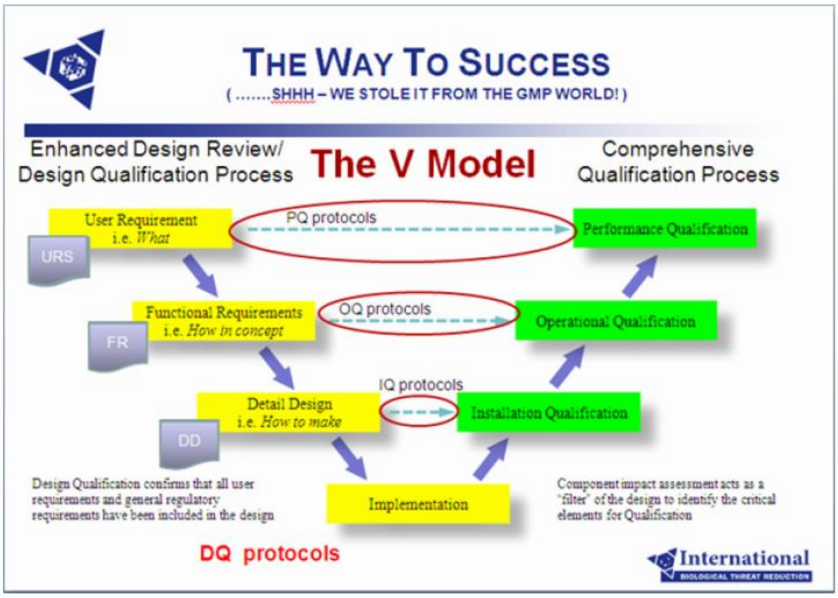
The V (for Vips) Model



28 Designing a containment laboratory

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Commissioning

- Commissioning is carried out to show that the laboratory will meet the user requirements.
- Needs to be carried out through the process not after completion
- Can be as simple as ensuring that penetration are made in the correct place

29 Designing a containment laboratory

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England

Summary

- Laboratory design depends on numerous factors, one of which is biosafety and containment level
- Gaining input from all involved at an early basis is important to avoid any late changes to design that will be expensive
- Process flows are a useful tool to ensure laboratory can function efficiently
- Commissioning throughout the construction will ensure facility meets user requirements

30 Designing a containment laboratory

S·E·A

© 2011

Analysing Mars Samples for Evidence of Life

Sample Containment and Science Preservation

STFC Harwell (UK), March 30/31, 2011

Receive Facility Requirements Study: SEA team

John Vrublevskis, SEA

Michael Guest, SEA

Allan Bennett, HPA

Caroline Smith, NHM

Health Protection Agency · Natural History Museum · stc · Gravatom Engineering Systems Limited · University of Leicester · Cranfield University · csem centre suisse d'électronique et de microtechnique

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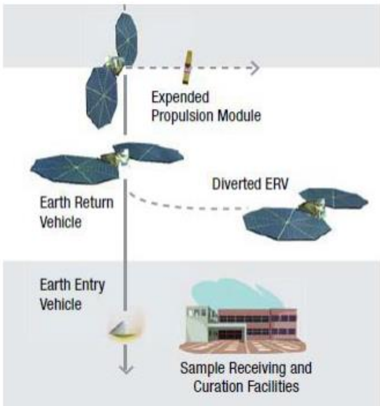
Study Background

© 2010

- The Mars Sample Return Sample Receiving Facility (MSR SRF) should:
  - Provide containment and contamination control for returned samples
  - Contain instruments and tools for cataloguing samples and conducting PP protocols (iMars)
  - Determine if the sample is safe for release to the scientific community
- The challenge is to Protect the Earth and Protect the Sample in the same space
- Study to determine requirements for a facility



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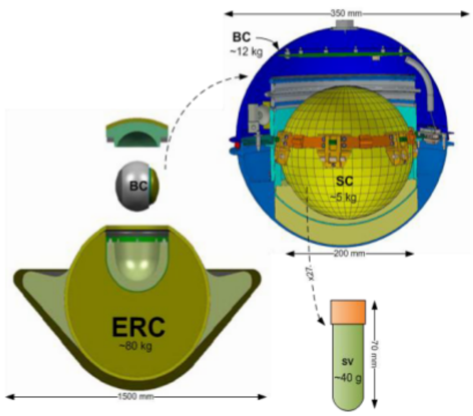
Requirements and Assumptions

© 2010

- "The primary function of facility is to contain the sample and if not contain then to neutralise it."
- The Flight Containment System (FCS)
  - Based on ESA BioSMos Study
- Sample environment
  - +18°C, with the potential to work with pristine samples at -20°C
  - Inert gas. Non-Toxic. N_2 or Ar
  - Low relative Humidity
  - Atmospheric pressure
  - Control of particulate and organic contamination
- Sample
  - Based on iMars definition
  - Diverse and dusty



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Current Containment for High Consequence Agents

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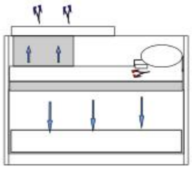
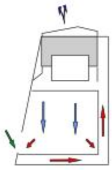
- Biosafety level 4
- Designed to handle agents with no effective treatment or prophylaxis such as Ebola and Marburg virus
- Glove boxes or positive pressure suits and Class II safety cabinets
- Directional air flow, dilution and HEPA filtration used to protect against aerosol risks
- Gloves and suits to protect against surface contact





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Why can we not use an existing BSL4 facility for Mars sample containment?

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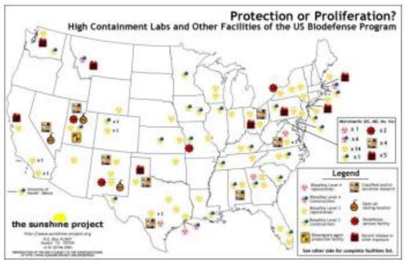
- Existing facilities handle liquid samples and use high volumetric change rates to remove any aerosol produced
- This approach is not suitable for Mars samples especially regolith
- Existing facilities are designed to protect operators with product protection given a lower weighting
- Negative pressure cascades allows ingress of contaminants
- Positive pressure suits allow human derived contamination
- Materials used may shed or off-gas and contaminate samples



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Science Preservation

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- Variety of assumed sample types
  - Rock cores
  - Surface regolith, soil and dust
  - Atmospheric samples
- Science preservation defined by different factors e.g.
  - Contamination control
  - Chemical/mineralogical integrity
  - Physical integrity
- SRF curation processes need to ensure highest level of science preservation

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Science Preservation

S·E·A © 2010

Contamination is the major consideration

- Prevention of organic contamination critical
  - Organic contamination leading to false positives during BAP
  - Compromise later scientific studies e.g. past Mars habitability, biosignatures etc.
- Inorganic contamination also highly undesirable
  - Compromise later scientific studies e.g. geochronology studies, planetary evolution
- Must ensure curation procedures do not introduce contamination AND do not cross-contaminate between different samples
  - Cross-contamination of more serious concern if MSR is a sample caching mission

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Science Preservation

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Physical integrity

- Sample orientation and physical integrity
  - Sedimentary samples
  - Core samples
- Aberrant magnetic fields can affect samples for future magnetic studies
- Sample handling system in curation area needs to be robust and flexible
  - Handle very small (micron) to ‘large’ (cm) samples
  - Simple sample preparation – splitting, chipping etc
  - Adaptable for non-nominal situations

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Facility Processes

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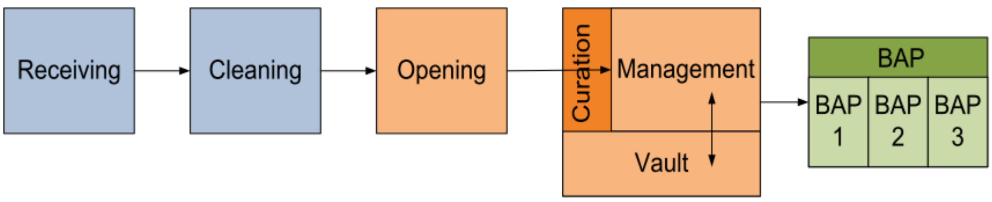

- Receiving – Opening the FCS down to the BC
- Cleaning – Precision cleaning the exterior of the BC
- Opening – Opening the BC, and accessing the samples
- Curation – Secure storage and management of the samples, including non-destructive analysis (“BAP 0”)
- BAP – Biohazard Assessment protocol
  - BAP 1 – “Destructive analysis”
  - BAP 2 – Microbiology and culture
  - BAP 3 – In-vivo, this was studied as best available method, but recommended that alternative approach should be taken

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Trade-off of options

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- Primary Containment
  - Suited Laboratory
  - Microbiological safety Cabinets
  - Static isolators
- Handling
  - Manual (Suits or gloves)
  - "Master Slave", through the wall mechanical manipulation
  - "Remote Manipulation", remotely controlled, or semi-autonomous robotics
- Contamination Control
  - "Passive" control with positive pressure ante-rooms
  - Double walled isolators
- Containment always at negative pressure

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Conceptual Design

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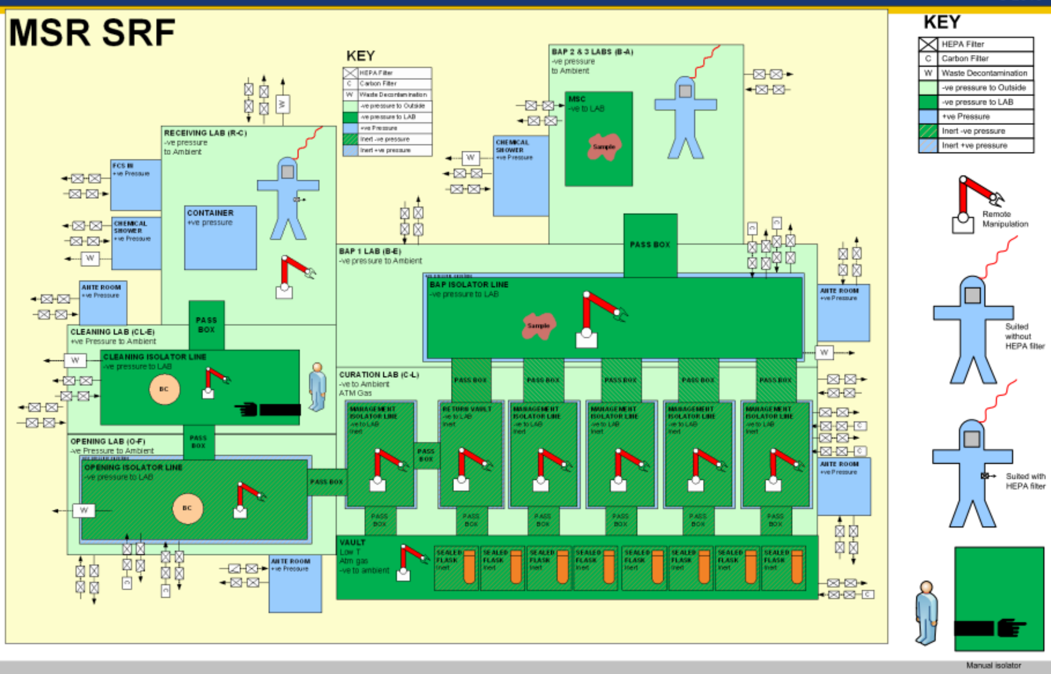

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Cleaning and Opening the FCS

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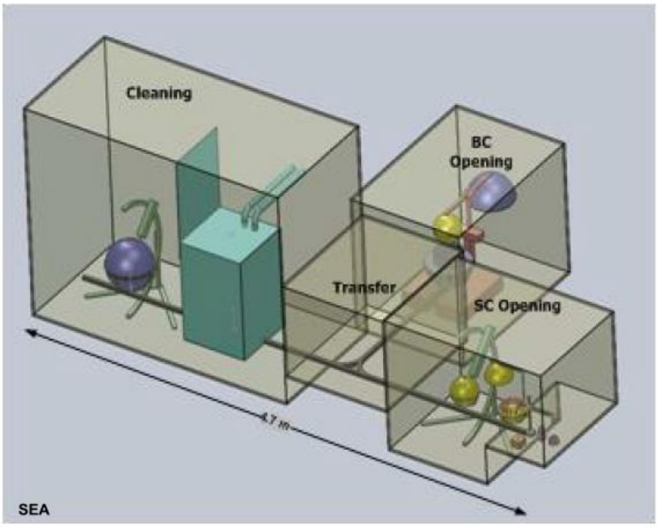
- Schematic design to assess requirements
  - Dual step cleaning process
  - BC Opening separated to minimise contamination transfer
  - Exterior of SC cleaned and dust collected
  - Head gas retrieved



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BAP 0

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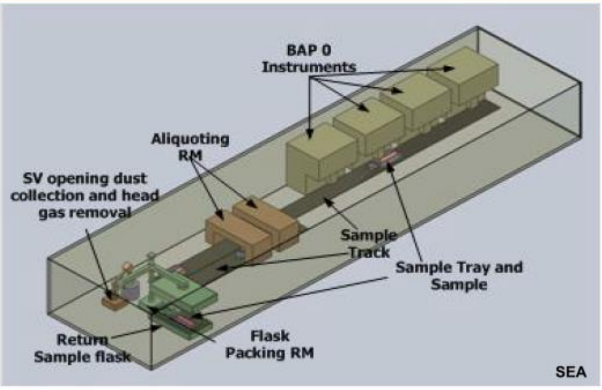

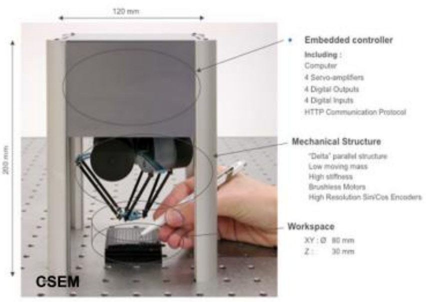

- Non-destructive sampling
  - Linear array of instruments with scanning heads
  - Sample placed on "tray"
  - Moved via tracked system
  - Dust and head gas collected from sample vessels
  - Aliquoting of sample by micro robotics

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Sample Vault

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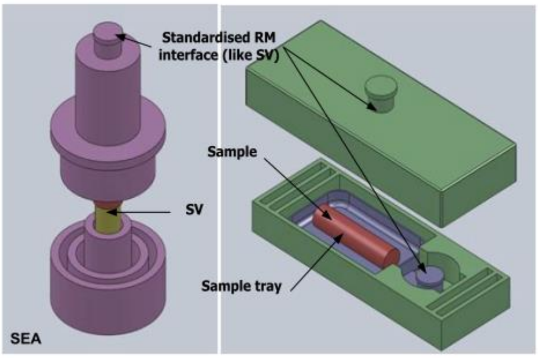
- Samples isolated in "Flasks"
  - "Pristine "flask for sample vessels
  - "Return" flasks contain sample trays from analysis
  - Common handling mechanism
  - Sealing system not defined



- Flasks could interface with containment via "docking system
- Vault storage can be based on commercial systems
  - High reliability
  - Low temperature operation
  - Inert environment operation

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Scientific Equipment

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- Indicative list of equipment developed
- BAP 0
  - Optical Microscopy
  - Raman Spectroscopy
  - X-Ray Fluorescence and Diffraction
  - Atomic Force Microscopy
  - Electron Microscopy
- BAP 1
  - FT-IR Spectroscopy
  - UV-Vis
  - Inductively Coupled Plasma techniques
  - ICP-Atomic Emission Spectroscopy (ICP-AES)
  - Liquid and Gas Chromatography
  - • Mass Spectroscopy
- BAP 2
  - Microbiology
  - Microcosm Studies
  - Cell Culture
  - Genetic Analysis
- BAP 2
  - Inoculations and Post Mortems
  - Imaging Systems (MRI, PET…)
  - Small Animal Containment
  - Large Animal Containment

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Laboratory

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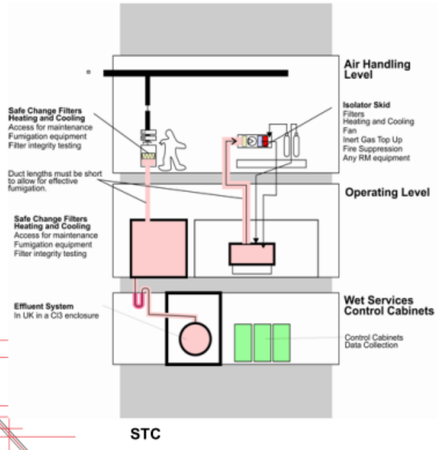
- 3 Level Laboratory design



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Technology Development

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- TRL scale developed for MSRF and roadmaps drawn
- Several technologies identified as critical for development:
  - 3 Double walled isolators
  - 3 RM equipment (specifically for cleaning the FCS and handling the sample)
  - 3 Isolator interior cleaning and material recovery systems
  - 3 Interfacing of scientific instrumentation with containment
  - 3 Contamination Controlled Biocontainment Suit

1	TRL1 Basic principles of technology observed and reported
2	TRL2 Technology concept and/or application formulated
3	TRL3 Analytical and laboratory studies to validate analytical predictions
4	TRL4 Component and/or basic mock-up validated in the laboratory environment
5	Component and/or basic mock-up validated in the relevant environment
6	TRL6 Facility/mock-up technology model or prototype demonstrated in the relevant environment)
7	TRL7 Facility technology prototype demonstrated in a operational environment
8	TRL8 Facility technology qualified through test and demonstration
9	TRL9 Facility technology "qualified" through successful facility operations

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