BASEL UNIVERSITY
THE CAMPUS AS A CITY WITHIN THE CITY

THE FORUM
RESEARCH OF PUBLIC SPACE TYPOLOGIES

INNOVATION
THE CONTRIBUTION OF THE BUILT ENVIRONMENT

BASELSCIENCEFORUM

The typological thought as theoretical and design exploration of innovation's physical assets

POLITECNICO DI MILANO
SCHOOL OF ARCHITECTURE, URBAN PLANNING AND CONSTRUCTION ENGINEERING
MASTER OF SCIENCE THESIS IN ARCHITECTURE -BUILDING ARCHITETCURE
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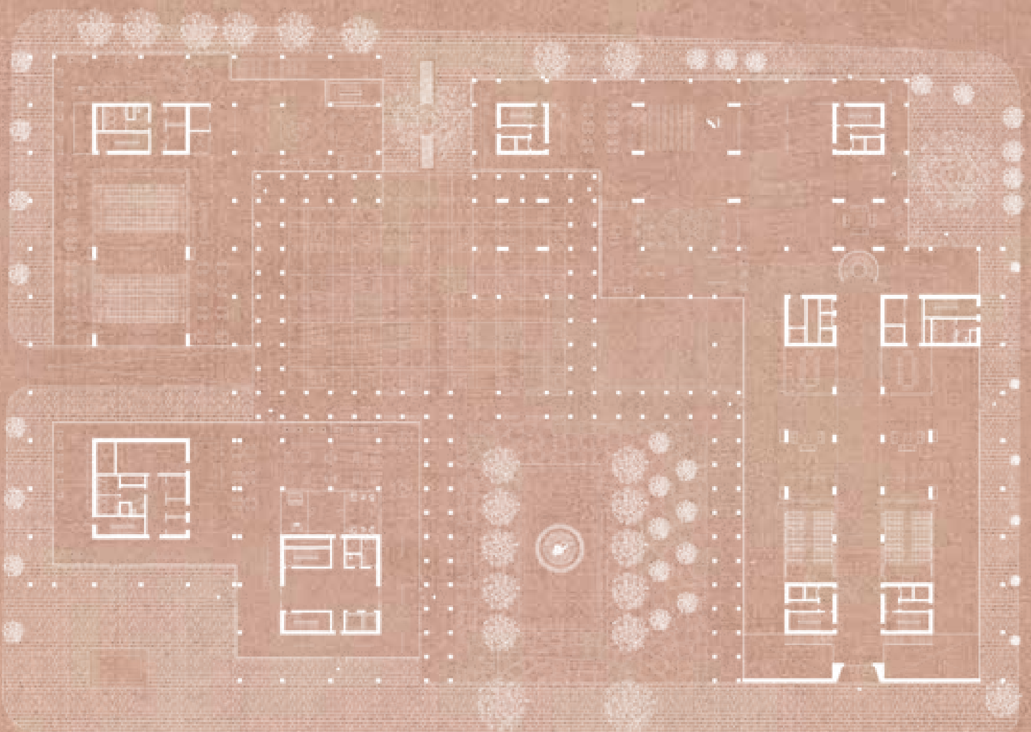
A.A. 2019-2020



Beatrice Tosini

Alla professoressa Battisti, che con la sua passione mi ricorda perché amo l'architettura;

a Ceren, che mi ha insegnato tanto in questo bellissimo ed intenso viaggio,

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Vi ringrazio e vi amo immensamente.

Bea

LIFESCIENCECAMPUS

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abstract

Rooted in the heart of the dynamic and flourishing city of Basel, the Schällemätteli Life Sciences Campus is planned to be redeveloped according to a vision of "open innovation", with the aim of becoming a leading international research and educational centre. The thesis explores, under both the theoretical and the design point of view, all the issues the conception of the transforming University Campus "missing tile" implies, to complete the academic overall urban strategy.

The city of Basel, strategically located at the trinational border and linked to the Rhine, is indeed the core a dynamic region rich of interactions, attracting world leading science companies, such as Novartis and Roche. This synergic system of high-quality research and production environments stimulated the rise of a "Life Science Cluster" with the worldwide highest concentration of Life Sciences companies, wherein the University of Basel plays a significant role.

Plot n° 4 main challenge lies in grafting into a unique site an innovative research and educational complex, accommodating the new Chemistry, Physics, SNI, Anatomy departments and several public facilities. At the border between Campus and City, as well as in between the historical city centre and the more recent "European city" of Basel a new civic place will grow up strongly embedded in the city's urban structure, history, and identity.

An in-depth research on "campus architectures" and historic public space typologies substantiated the design of a Science Forum as symbolic conclusion and "urban link" of the main public "backbone" crossing the sequence of University Campuses. The Forum embodies the "civic core" of a varied architectural ensemble, strengthened by an arcade that keeps together the diverse architectonic presences, making palpable a sense of continuity and identity.

The main entrance to the Forum is defined by the "Basilica", a "temple of science" conceived as a collector of people, and by a Tower, acting as a new landmark in the city skyline. The symbolic value of this typological aggregation is further strengthened by the façades, which propose a contemporary reinterpretation of paradigmatic Civic Architectures as an urban communication device. Moreover, the composition and material choices of the elevations play an important role in defining a public podium in continuity the urban history of Basel.

Finally, the project results as an integrated design able to conciliate innovative technical solutions, providing high-quality working and teaching environments, with the richness derived from historical public spaces. Basel Science Forum is then conceived as a new reference "place" within the city, where people can meet, share ideas, and transfer knowledge to generate innovation.

abstract

Radicato nel cuore della dinamica e fiorente città di Basilea, il Campus di Scienze Naturali Schällemätteli, è progettato per essere riqualificato secondo una visione di "innovazione aperta", finalizzato alla creazione di un istituto di ricerca ed istruzione all'avanguardia. La tesi esplora, sia da un punto di vista teorico che progettuale, tutte le questioni che la concezione del tassello mancante del Campus Universitario in trasformazione implica, per completare la complessiva strategia accademica urbana.
La città di Basilea, strategicamente collocata al confine tri-nazionale e adiacente al Reno, rappresenta il cuore di una regione dinamica e ricca di interazioni, in grado di attrarre aziende scientifiche leader come Novartis e Roche.
Questo sistema sinergico di ambienti di ricerca e produzione di alta qualità ha stimolato la crescita di un "Cluster" di Scienze Naturali con la più alta concentrazione al mondo di compagnie coinvolte in tale ambito, nel quale l'Università di Basilea svolge un ruolo fondamentale.
La principale sfida del lotto n°4 consiste nell'innestare in un sito unico un innovativo complesso di ricerca e formazione, ospitante i dipartimenti di Chimica, Fisica, Nanoscienza e Anatomia, oltre a diverse strutture pubbliche. Al confine tra Campus e Città, nonché punto di incontro tra il centro storico e la più recente "città Europea", un nuovo" luogo civico" prenderà forma, fortemente radicato nella struttura urbana, nella storia e nell'identità della città.
Un'approfondita ricerca sulle "architetture dei Campus" e sulle tipologie tradizionali di spazio pubblico ha corroborato la progettazione di un Foro Scientifico quale conclusione simbolica e "collegamento urbano" della "spina" pubblica che attraversa la sequenza dei Campus Universitari. Il Foro incarna il "nucleo civico" di un variegato complesso architettonico, rafforzato da un porticato che lega le diverse presenze architettoniche, rendendo palpabile un senso di continuità e identità.
L'ingresso principale al Foro è definito dalla "Basilica", un "tempio della scienza" concepito come luogo di aggregazione, e da una Torre, la quale funge da nuovo "landmark" nello skyline della città. Il valore simbolico di questa aggregazione tipologica è ulteriormente rafforzato dalle facciate, che propongono una rilettura contemporanea delle paradigmatiche "Architetture Civiche" quale strumento di comunicazione urbana. Inoltre, la composizione e la scelta dei materiali dei fronti giocano un ruolo importante nella definizione di un podio pubblico in continuità con la storia urbana di Basilea.
Infine, il progetto risulta come una progettazione integrata capace di conciliare soluzioni tecniche innovative, fornendo ambienti di lavoro e insegnamento di alta qualità, con la ricchezza derivata dagli spazi pubblici storici. Il Foro Scientifico di Basilea viene quindi concepito come un "luogo" di riferimento all'interno della città, dove le persone possono incontrarsi, condividere idee e trasferire, per generare innovazione.

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RHENVS FLVVIVS.


BASILEA
Basel.
Der Rhein.
Meridies
Occidens
Oriens
Septentrio

Castrum on the cathedral hill (around 380 AD)

Cathedral Hill, engraved by A. and E. Rouargue. 1862

Basel History

The city of Basel lies along the Rhine River, at the northern boundary of Switzerland where French, German and Swiss borders meet, therefore representing a strategic gate to the Swiss Rhineland. Main Swiss cities, originally ruled as city-states, distinguished themselves throughout the history according to the specific role they played within the territory: Zurich grew as the main militant organizer, Geneva affirmed itself as a radiating centre of international level, while Basel became known as a conciliatory, cosmopolitan mediator. Indeed, the city of Basel was able, since its origins, to generate knowledge and richness tanks to its ability to bring together the diversity and complexity characterizing its territory.

The Origins - "Gaulish Rauci"

The very first traces of a settlement in Basel are from the middle Palaeolithic period, (about 130.000 years ago), however, the more recent origins of the city can be dated back to the first century BC, when the Celtic settlement of the Gaulish Rauraci tribe was built on the north-western outskirts of the present city. At the time, the Münsterhügel (known as "cathedral hill"), and the banks of the Rhine, represent its main centres. Around the years 150 and 80 BC, the first unfortified Celtic settlement is indeed located in that area of Basel today occupied by the Novartis Campus, covering an area of around 15 hectares, as shown by archaeological discoveries. This large settlement took advantage of its broad agricultural hinterland, as well as of its strategic location along the river, to become a main hub for Celtic trade.

The Celtic Oppidum

Due to military and political reasons, the centre of the settlement is then re-located to the area which nowadays constitutes the historical centre of Basel. The first fortified settlement, the "oppidum", is constructed around the 80 BC by the Raurici Celts, using the so-called Marus Gallicus (a reinforced earth wall), the remains of which can still be seen near Münster Cathedral hill. The main gateway to the oppidum, naturally protected by the steep banks of the Rhine and by the secondary Birsig river, corresponds today to the Rittergasse area.

Saint-Jacques sur la Birse, 1444

Basel Münster Platz, 1764

The Roman Colonization

The Romanisation of the region begins with the Agusta Raurica colony, under Emperor Augustus Ceaser. By the end of II century AD, Augusta Raurica becomes the capital of the Roman Province ruling the region, as well as a rich commercial trading centre. In the III century, city walls are extended on the Rhine, and the main reason leading to city growth consists in the fact of being a fortification strategically located along the 'wet' frontier between the Imperium Romanum and the Germanic tribes (the Alemanni, the Juthungi and the Franks). The first mention of the name 'Basel' referred to the Roman fortification appeared in writing in the year 374, in occasion of Emperor Valentinian I's visit in the city.

From late antiquity to Middle Ages

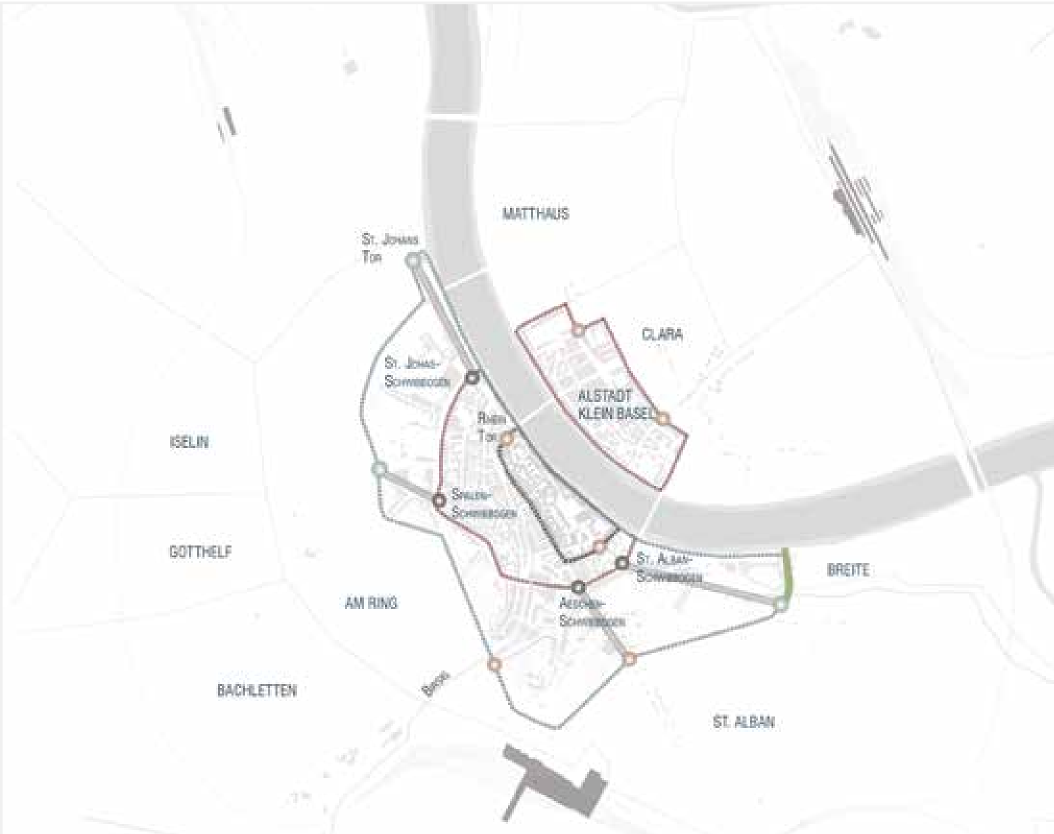
Since the V century, which represents the transition period from late antiquity to the early Middle Ages, the Rhine valley around Basel hosts three distinct populations along the river bend, living as separate groups: the Romance-speakers (descendants of the Gallo-Roman provincial population), the Alemanni and the Franks, two Germanic populations. In the following two centuries, the Rhine enhanced the growth of a linguistic and cultural boundary between the Romance-speakers living in the area of 'Grossbasel' and the Allemanic people in 'Kleinbasel'. Between late antiquity and the reign of Charlemagne, "Basileae" is ruled by a Bishop, until in 917 AD the city is attacked by Hungarian tribes, and in the V century it becomes part of the Holy Roman Empire. Basel Bishops earn the support of the Emperor, as proved by the foundation of today's Basel Münster, the construction of which began in 1019 AD, as well as by the construction of a bridge over the Rhine, which later allowed for the expansion of their authority over Kleinbasel, combined with Grossbasel in 1392.

City walls - Basel expansion

The city of Basel is surrounded by walls starting from the High Middle Ages, until the middle of the 19th century, and their presence strongly influenced its expansion and morphological configuration.

Roman Celtic City Walls, 300 AD

Inner City Walls, 1080-1230



Basel City Walls, 21st century

First City Walls

Basel city bird's eye view from the northeast, by Matthäus Merian 1615/1617

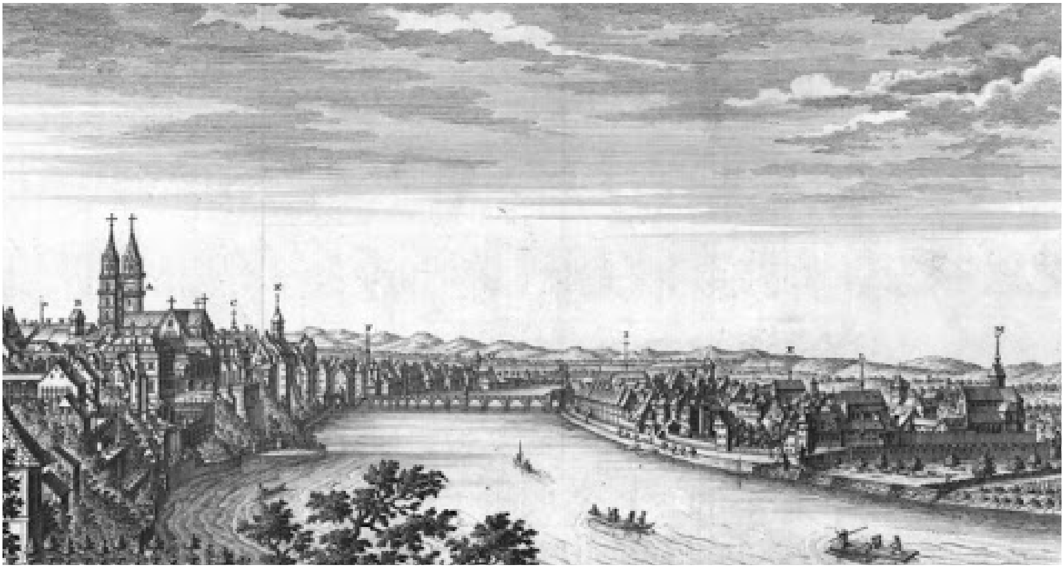
The first ring of Medieval city wall is completed around 1080 under bishop Burkhard von Fenis. Built around Grossbasel as a military protection, it marks a clear differentiation between the urban area, mainly involved with trade activities, and the surrounding countryside, hosting agricultural lands. The following ring, known as the Inner Wall, is built around 1230, being mostly identical to the Burkhard wall. In 1356, a strong earthquake causes massive damage in the city, and soon afterwards (1362 -1398) the construction of a larger wall complex, known as the Outer Wall, is carried out following the expansion of the city.

Walls are rebuilt and expanded to include newly constructed suburbs in the areas of St. Johann, Spaten and St. Alban Gates. City walls set the city boundaries until 1859, when the city's executives decided to raze the inner wall and gates to the ground, saving only three outer city gates and a short piece of the wall from demolition.

Urban & Rural Morphology

Under the morphological point of view, the main urban settlement of Basel is historically concentrated in the area of cathedral hill, until between the V and the VIII century, when new types of settlements started to develop in the villages and farmlands surrounding the urban nucleus. This resulted from the growing importance of agriculture, as an effect of the collapse of the provincial administration in the first half of the V century. New construction techniques are then introduced to replace stone with wood as main construction material for houses and farm buildings.


BASILEA
RHENVS
FLV
Armamentarium
Minor Basilea.
Carthusia
S. Nicolaus



View over River Rhine Bridge in Basel, 1754

Matthäus Merian's famous 1615 map of Basel shows that around 1615 the division between urban and rural areas is still defined by city walls, which border the densely built-up area emphasizing the rural topography beyond the walls. Such separation between urban and rural is still visible today in the characteristics of the urban fabric. Another important aspect, affecting the shaping of urban features, is that during the expansion of the "outer city walls" in the years between 1362 –1398, some agricultural areas included within the ring, such as the Aeschenvorstadt and St.-Alban-Vorstadt neighbourhoods, kept on being dedicated to agricultural activities. In contrast with the dense inner nucleus, the outer agricultural and rural land mainly determined the broader scale of future city blocks. In other words, the former nature of urban and rural areas influenced the further developments and the morphology of the city, in the modern era.

Modern developments

The differentiation between urban and suburban areas becomes clear when city walls are demolished in 1859. The city opening is followed by further infrastructural developments, such as the tramway system in 1897, changing the way of moving and living. Furthermore, Basel gradually grows as an industrial area, since the developments settled at the outskirts of Basel can exploit the Rhine river, using it as a source of water and transport mean. At that time, Basel started to host important chemistry plants, which initially consisted in dye production companies, setting the bases for further chemical and pharmaceutic developments of world-wide importance, such as Novartis and Roche. Indeed, the first industrial nucleus was located where the Novartis campus is housed today. The process speeded up especially after the opening of the east side Swiss Banhof train station in 1854.

Basilea. - Georg Braun & Frans Hogenberg, 1575

French Strassbourg - Basel Railway Station, Basel, 1847

Re-arrangements of the city fabric: The Modern Cluster of Clinics

A very interesting sector of the city to observe, is the one that today hosts the urban campus of Basel University, which represents the site of the project work exposed in the next chapters. The observation of its morphological features, together with the research of the historical events determining its transformations, represent a significant starting point to understand the evolution of the historical city centre of Basel: indeed, it shows how the city was able to reorganize and evolve its historical fabric, while preserving its original urban assets and rules.

Basel University was founded in 1460 and it always covered an important role for the cultural and economic growth of the city, especially with the establishment of the Faculty of Science in 1937. Its main headquarters were located in the *Palace of Margraves*, in the north-west of Basel, which was later on transformed into a hospital, and in the *area of Petersplazt*, where the nucleus of the modern cluster of clinics and University buildings was formed.

The scale of the urban blocks and fabric hosting the university buildings points out the specialty of the area and of the campus buildings, whi-

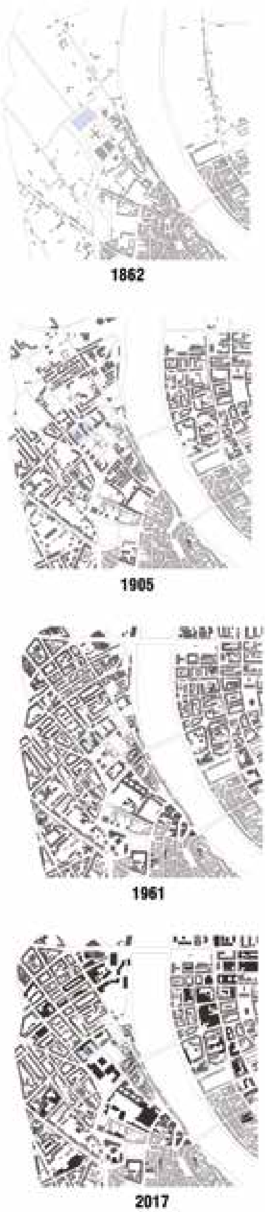
Basel city bird's eye view from the northeast, by Matthäus Merian 1642

ch tried to satisfy the demand of the growing science sectors in the city. Furthermore, the peculiar articulation of the cluster is also affected by its location close to one of the historical city gates, at the border between the historical town and the so-called "European city".

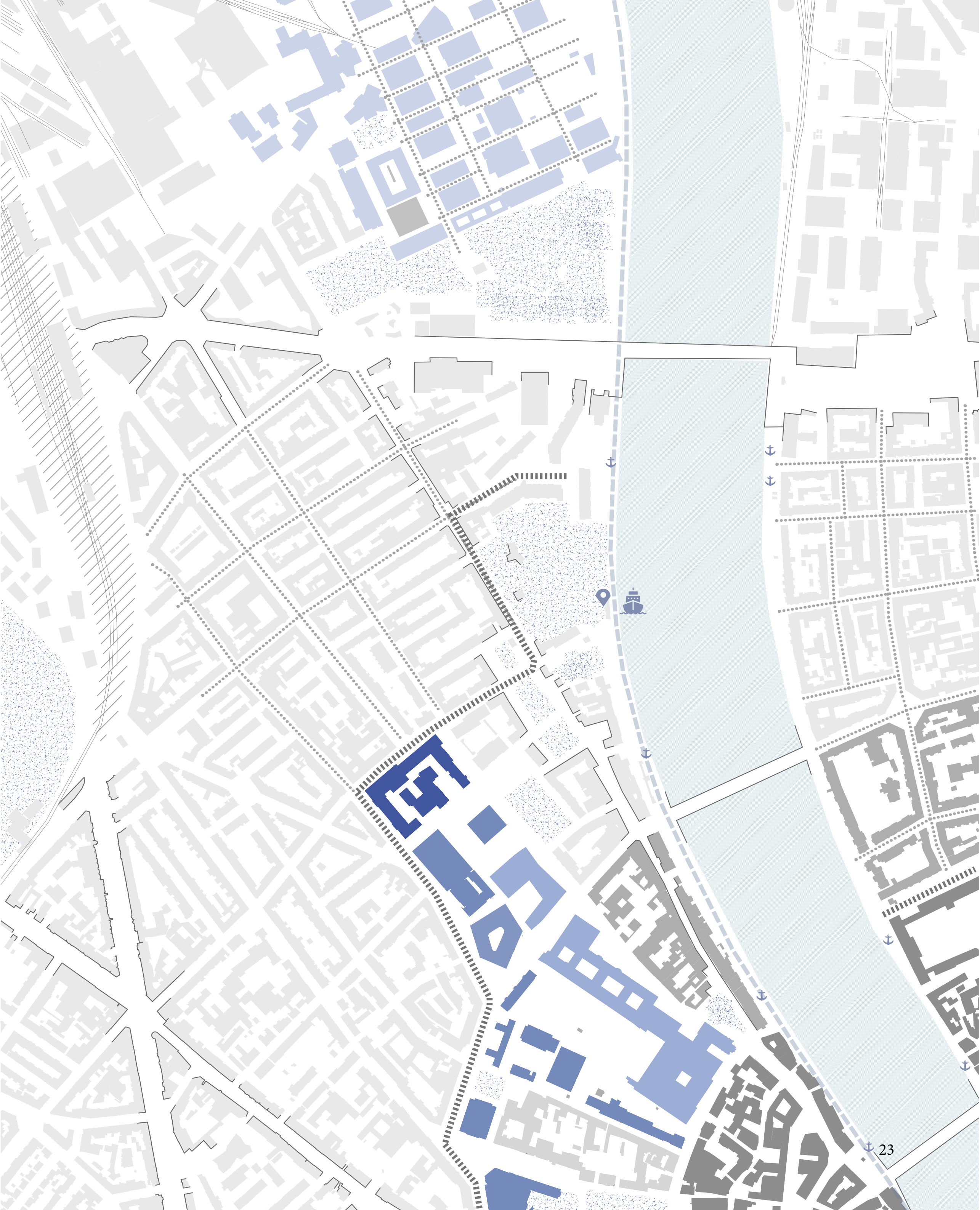
The clinic nucleus, indeed, is the result of the transformations occurred at the borders of the historical nucleus, as a consequence of its interaction with the further city expansions, governed by different rules. In the specific case of St Johann's neighbourhood, it can be noticed how the area is surrounded by a variety of districts causing peripheral urban friction, especially due to the presence of broad factories along the railway and the river. Another similar example is the area of St. Alban, on the south part of the city, where the factory quarter hosting paper string and tobacco production is located.

This shows how, proceeding radially from the historical centre towards the new "infrastructural railway ring", the city grew up to the location of productive settlements at the borders of the city: from that point on, such asset will affect further city expansions and the relationship between the centre and the surrounding territory, creating a strong threshold in between

Basel University on the river Rhine, 1842



them. Likewise St Alban, the northern district of St. Johann, bordering the project site, housed industrial quarters next to the riverside, flanked by large residential districts, with four-five storeys high blocks, dedicated to the workers.
The project site is then located in a very rich and complex area, close to historical city gate of St. Johann. It represents a border site, aiming to become a gate able to link the historical centre with its later expansions, defining the so-called "European city of Basel". Such goal is made harder to reach by the variety of its surrounding neighbourhoods, including residential, industrial, and public sectors. However, the richness deriving from this interaction, can represent the best combination of physical and social assets for the birth of an innovation district, rising from the original cluster of the Basel Life Sciences Campus.



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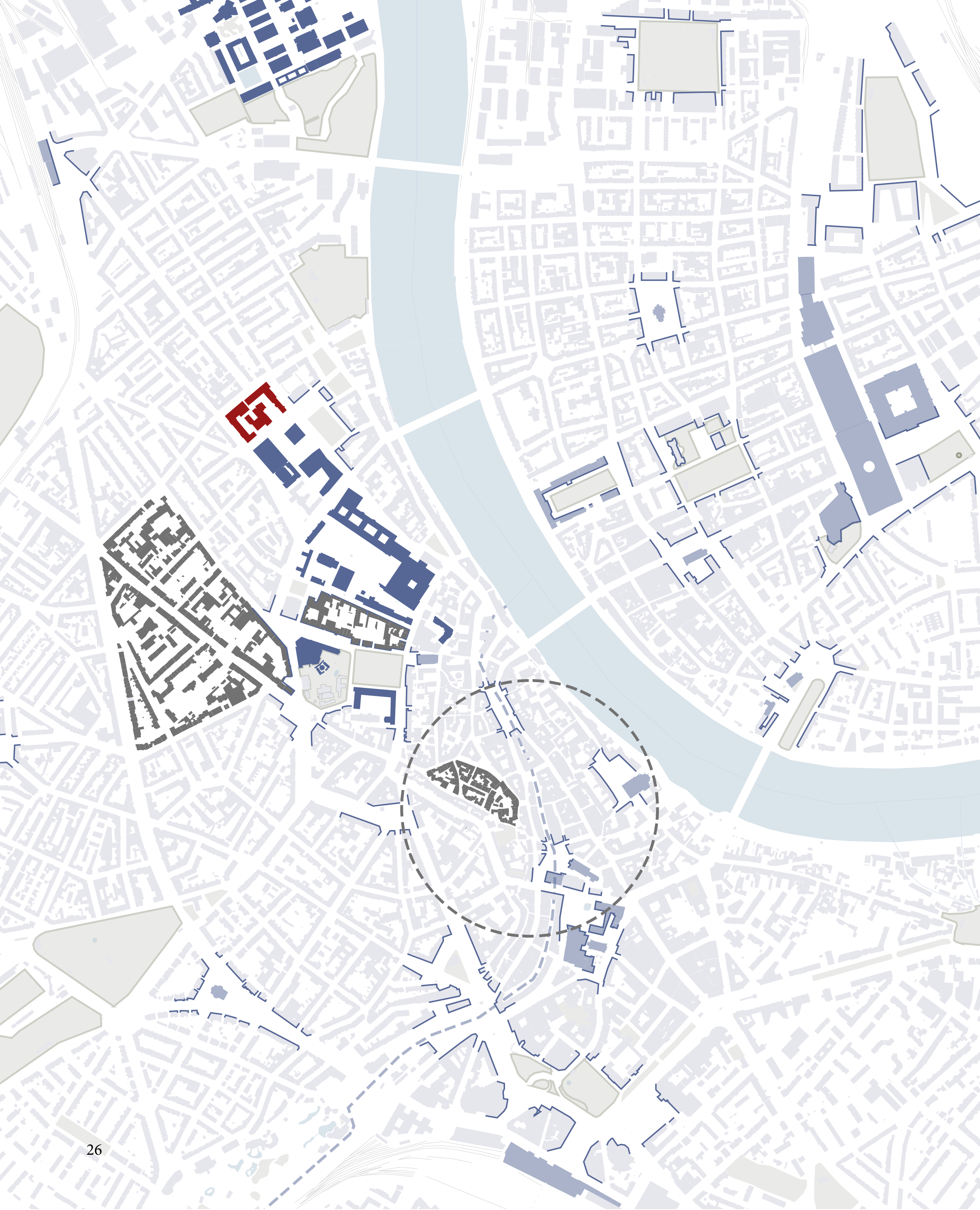
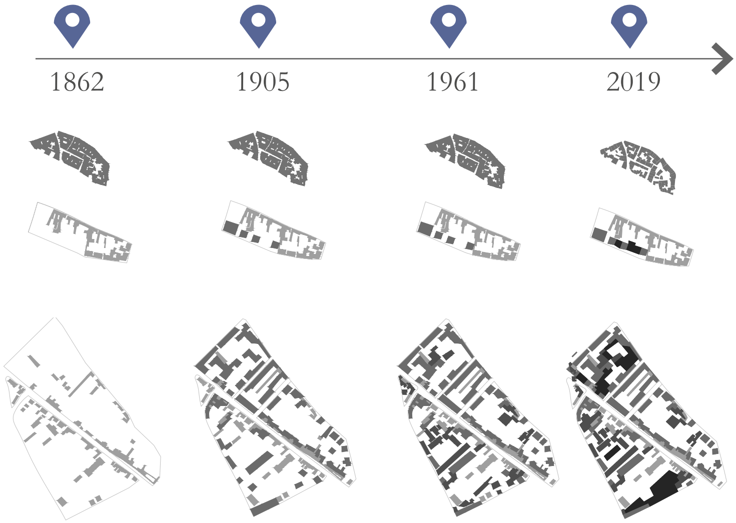
"the city & the campus"



Reading the existing

Identified rules

Continuity of street facades
Articulation of full and voids



City Morphology

As previously underlined, the evolution of **city morphology was strongly influenced by city walls**. The existing city typology is indeed characterized by the radial expansion of the urban development, the different phases of which can still be clearly distinguished. However, while the **main road-network still reflects the infrastructural assets supporting each expansion stage**, setting the generative matrices of the city, the **city blocks** contained within the successive "rings" of city walls, are **internally arranged in very peculiar ways**. Reading the morphological features of the **historical city centre**, for instance, the urban blocks appear as organic and articulated **small to medium-scale compounds**, resulting from the addition of **small-scale built forms** characterized by a **continuous facade along the street side**. Such configuration **creates special internal courts, introverted open spaces, and irregular internal streets layouts**. Furthermore, in the historic town, **dense urban blocks** are alternated with **several small-to-medium scale open spaces** which appear to be **interconnected** among themselves in **an organic and dynamic way,** linking together the main public spaces of Basel.

On the other hand, looking at the **modern developments** resulting from Basel industrial growth after the 1860's, **large-scale city blocks are arranged according to more regular patterns arranged according to the main infrastructural systems** leading towards the former rural, and later industrial, peripheral areas. **The change in scale of the city, however, did not obstacle the ability to maintain a sense of continuity in the city**: it is still possible to find, for instance, continuous facades on street sides and introverted open spaces. During the phase of site interpretation, **such strategies are identified as fundamental in guaranteeing the sense of continuity and identity** in the city or Basel, and therefore they have been taken into account in later design processes. One of the complexities of the project, indeed, is based on the need to understand and **conciliate the traditional University campus located in the historical city**, and following its rules, **with more contemporary campus typologies**.

Campus Typologies

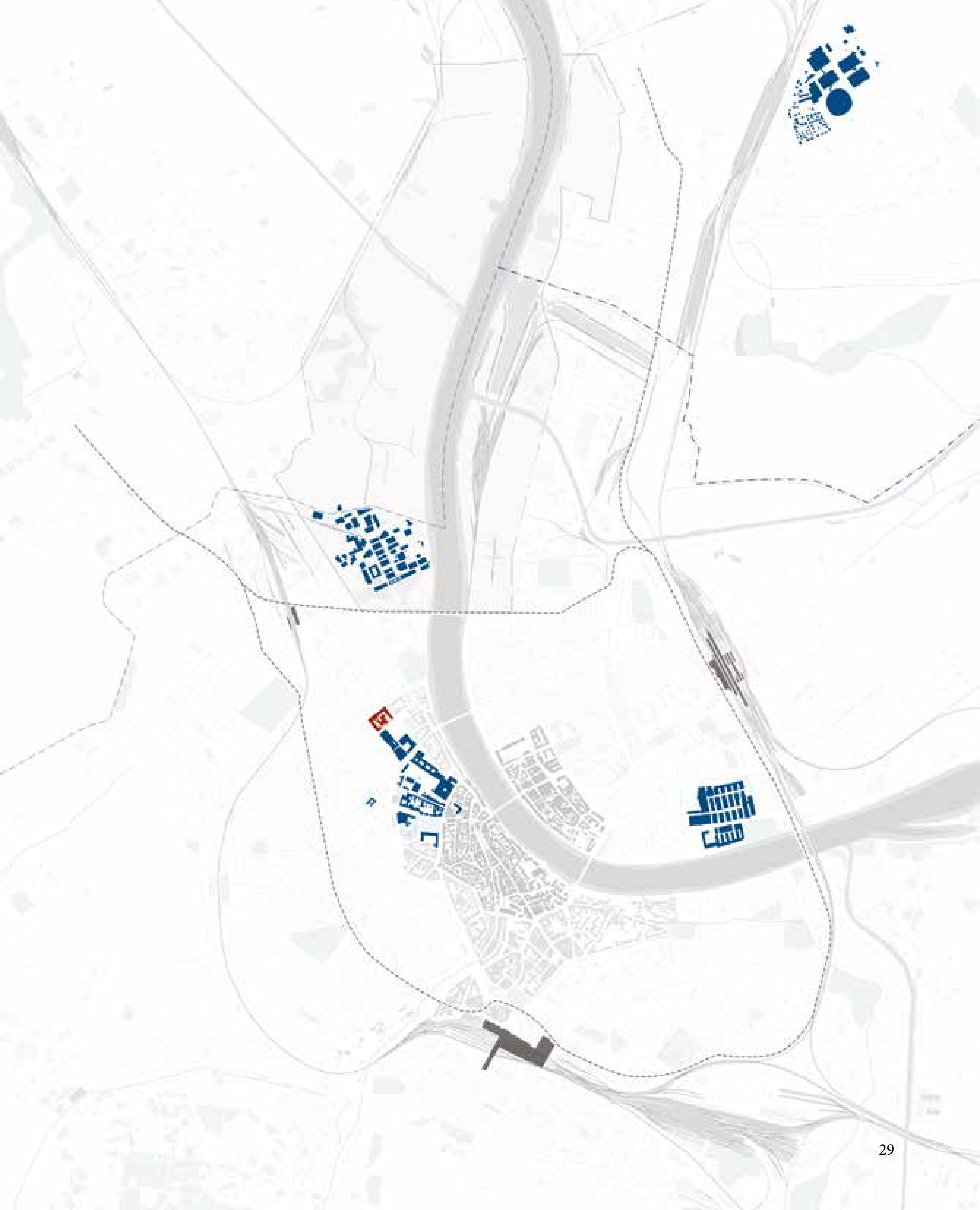
Basel hosts in its region several campus typologies, which is **useful to analyse** in order to understand how to proceed with the **design of a new campus, which is integrated but also improved with respect to existing models**.
The "campus" is a phenomenon of increasing relevance to modern urban planning, especially since Universities are reconsidering their location in society, undergoing deep reorganization and expansion of their physical assets.

The comparison between different campus typologies, especially **counterposing the urban campus located in the historical city centre, with** approaches belonging to **the isolated post-war university campus model**, helps to understand **how a campus can be structured**. Furthermore, the **comparison between open and closed campus** types allows to reason about the potentialities and limitations of each, trying to find the **best compromise to integrate the new campus within the existing city** and create a **stimulating and creative environment**. Debates about the desirability of openness and interaction with the urban environment versus "gated communities" demonstrate the need for further investigation on the shape and position of campuses in relationship to the city.

Three different interpretations of the **campus** typology existing in Basel are the **Novartis, Roche and Vitra Campuses**.
Analysing their **generative principles in relation to the old town's rule,** it is possible to understand the contemporary transition from **a "science city model" to the "city of science" one**.

In the case of **Novartis campus**, the masterplan, designed in 2001 by Magnago Lampugnani proposed to create a homogeneous experience within the campus, by **setting a regular grid and assigning the design of buildings to different architects**, with fixed plots. The rigidity of the structure is emphasized by the **hierarchical system of streets,** while it is softened by the **numerous open spaces,** trying to reproduce the richness and variety of an urban environment within the campus. Indeed, the site is **delimited and separated from the surrounding context by walls and gates**.

In the case of the more recent development plan for **Roche campus** in Basel, designed by Herzog & de Meuron in 2014, the **different Roche sites spread across the city were brought together**, with further additions, and organized in a very **dense and regular grid of city blocks**. Differently from Novartis, the campus was **conceived to be open towards the city**.

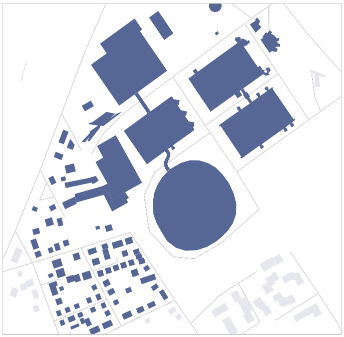


Novartis Headquarter Campus

- 3,5 km from city centre
- Closed gated campus
- Grid pattern
- Corporate Campus
- Pharmaceutics

Roche Headquarter Campus

- 2,5 km from city centre
- Closed not gated campus
- Grid pattern
- Corporate Campus
- Pharmaceutics



Vitra Design Campus

- 10 km from city centre
- Closed gated campus
- Organic structure
- Design and Architecture

University of Basel Campus

- 0-3km from city centre
- Open permeable campus
- Organic structure
- Inner city University Campus
- Education & Healthcare (University Hospital)

The planned consolidation of the existing industrial site is meant to avoid the risk of sprawl, making more efficient use of those parts of the site that have already been developed but cannot be expanded.

The **Vitra Campus** in Weil am Rhein, near Basel, shows instead a totally different structure, being also devoted to a different use. Indeed, the campus belonging to the **Swiss design and furniture company** is mainly dedicated to host an architectural park, the Vitra Design Museum. After a major fire destroyed a large part of the Vitra production facilities in 1981, the **site was developed into a heterogeneous ensemble of contemporary architecture**, defining a **unified corporate project**. They reflect a corporate philosophy that does not strive for a uniform image but **presents a variety of positions within the context of an open plan project**. With the aim of making the collection accessible to the public, **a museum was established as an independent foundation dedicated to the research and popularization of design and architecture**. Today the campus hosts manufacturing activities, exhibitions, shops, educational events and workshops.

The **inner-city campus of Basel University**, differently from the previous examples, is **not settled in a former industrial site redesigned according to a "tabula rasa" approach**: it is indeed integrated with the historical city fabric, and even when entire urban blocks have been rearranged to adapt to contemporary needs, **the existing city structure and features have been respected**.
Differently from the case of Novartis campus, which is designed starting from the scale of individual buildings (with plots vary in size from 62 by 35 meters, to 25 by 18 meters), **the urban structure of the University campus is mainly based on large urban blocks, hosting several buildings organically articulated**. Being located at the threshold between the historical nucleus of Basel and the surrounding European city extensions, campus is **generated by the intersection of the irregular traditional city fabric and the rational 19th century urban grid**. Similarly to Roche headquarter, the campus is conceived to be **open towards the city, and to promote urban densification, introducing new high-rise buildings**.
Moreover, the **campus involves a variety of buildings' scale and shape**, which for certain aspects is **comparable to** the characteristics of the **Vitra campus**, although the latter is not restricted by any pre-existing or superimposed structure. To conclude, similarly to what happens in the Novartis campus, where open spaces are frequently interrupting the built fabric, Basel University campus **accounts for several open spaces which, however, take the for of inner courtyards, hidden from the street**.

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“designing innovation”

Innovation at different scales

The city of Basel constitutes one of the world's most successful economic regions, being characterized by a **unique concentration of innovative companies, as well as by an outward-looking culture, an international environment and a strong framework for business and good working conditions.**
Along with its partners, the Canton of Basel-Stadt offers opportunities for networking and support services fostering innovation in the Basel region, carrying out a "smart city" strategy that is accelerating digitalization.

Starting from such considerations, it has been important to deepen the knowledge and understanding about **the role that the built environment has in stimulating innovation**, aiming at elaborating an urban strategy positively contributing to the common vision promoted by the city of Basel.

Literature research about the topic led to explore what Bruce Katz and Julie Wagner define as the contemporary **"geography of innovation"**, which witnesses a crucial change in paradigm from the "*suburban corridors of spatially isolated corporate campuses*" to the so-called **"innovation districts"**, where leading-edge institutions and companies are clustered, connecting with start-ups, business incubators and accelerators.

Nowadays, indeed, an increasing number of innovative firms and talented individuals prefer to cluster in dense, facility-rich districts in the cores of central city, where society is so diverse that a varied set of possibilities of where to live, work and play is provided, transforming the way in which buildings and entire districts are spatially arrayed, **favouring more integrated and vibrant urban environments**.

As knowledge and technology driven economy grows, companies and firms more openly generate new ideas and bring them to market by drawing on both internal and external sources, which is what Henry Chesbrough and others call **"open innovation"**, referring to the fact that "*the boundary between a firm and its surrounding environment is more porous, enabling innovation to move easily between the two*".
The rise of smaller companies involved in research and development also contributed to move toward open innovation, generating a stratified panorama of entities, prompting greater collaborations between firms and institutions of disparate sizes to develop and advance innovations.
The "open innovation" approach also affects where firms locate and how buildings and districts are designed, going from research labs to collaborative spaces or even mixed-use develop-

ments. The need to move to a different urban model is further motivated by the fact that in today's economic landscape, no one company can master all the necessary knowledge.

Therefore, the search for collaboration altered the design strategies to be adopted both inside and outside the company, embodying the requirement of flexibility, openness and change. Giants as Facebook and Google, for example, pioneered in the design of so-called "**hackable buildings**", with open floor plans that can be easily reconfigured to create dense and collaborative spaces for new teams and projects.

Beyond individual buildings, the design shifts mentioned extended also to the public and private realm, reshaping the relationship between buildings at the district scale, making innovation more porous. Ideas, for instance, can be brainstormed in public spaces, developed in shared workspaces, prototyped in private technology labs, and tested on public streets.

Innovation districts have the potential to generate "**inclusive and sustainable economic development**", involving different sectors and disciplines with the goal of co-inventing new discoveries for the market, multiplying employment and educational opportunities for disadvantaged populations.
Indeed, new companies prefer to start in collaborative spaces, where they can interact with other entrepreneurs, networking anything from knowledge to equipment, speeding up their growth.

Furthermore, unlike traditional urban revitalization interventions, focusing on the commercial aspects of development, such as housing, retail sports stadium and so on, innovation districts help their city and inhabitants to increase the value chain of global competitiveness by growing the firms, networks, and traded sectors.
They do so by setting strong bases to ease the commercialization of new ideas and the creation of new firms and jobs via proximity and collaboration, aiming at expanding employment and educational opportunities.

Innovation Districts

"Innovation districts are the ultimate mash up of entrepreneurs and educational institutions, start-ups and schools, mixed-use development and medical innovations, bike-sharing and bankable investments, all connected by transit, powered by clean energy, wired for digital technology, and fuelled by caffeine."

The Rise of Innovation Districts

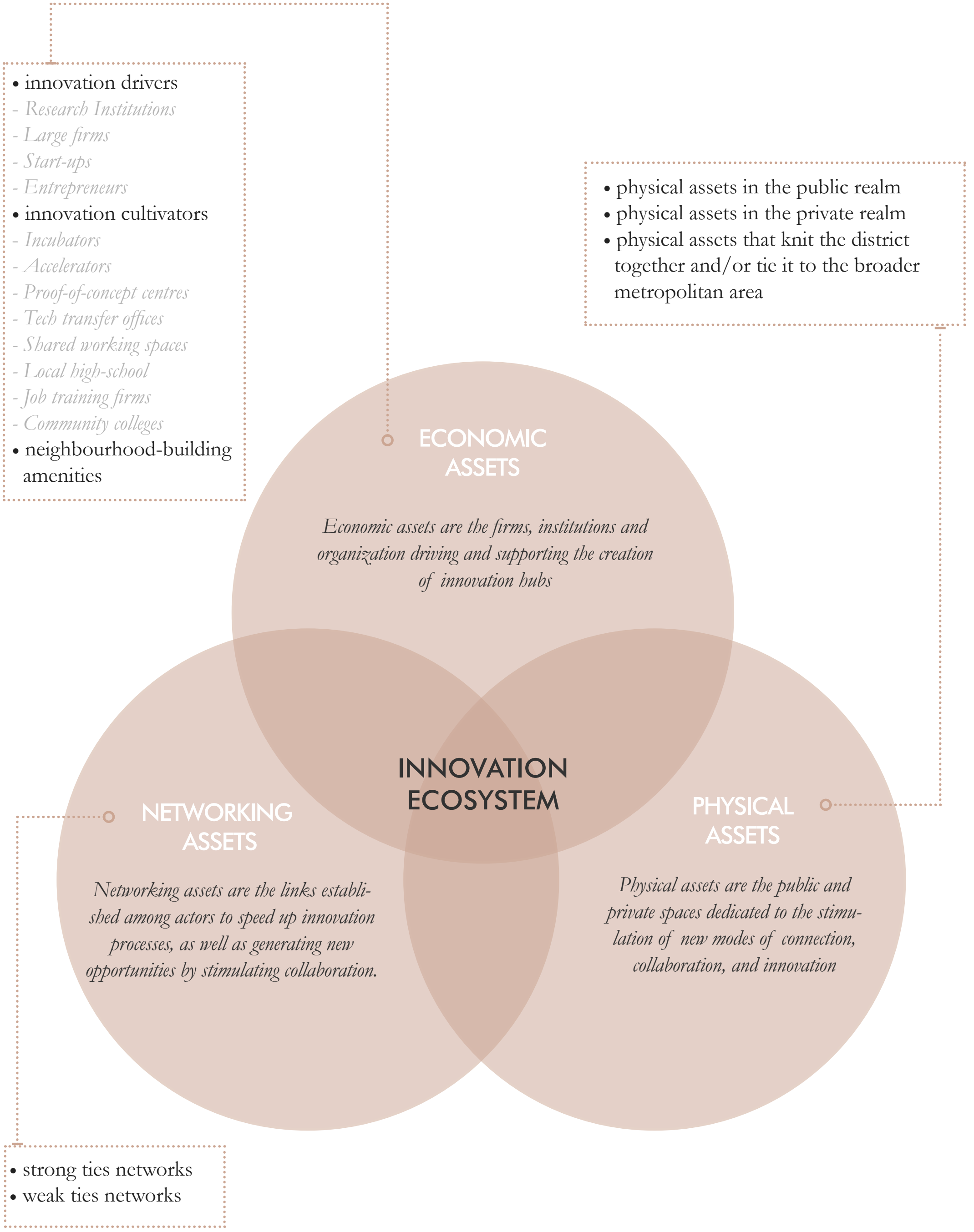
Innovation districts are still in an early trend that, because of their multi-dimensional nature, has yet to receive a systematic analysis. However, innovation districts are emerging in several cities and metropolitan areas worldwide, such as Barcelona, Berlin, London, Medellin, Montreal, Seoul, Stockholm, and Toronto. In the US, districts are emerging near anchor institutions in the downtowns and midtowns, often in underused areas that are re-invented.
Although form and function of innovation districts can vary, all contain **economic, physical, and networking assets**, interacting to create an **"innovation ecosystem, a synergistic relationship between people, firms, and place"**.

They aim to generate within the urban environment what Saskia Sasses defines **"cityness"**, a concept based on complexity, density, diversity of people and cultures, as well as on a layering of old and new. Focusing on the physical assets, they consist in the public and private spaces dedicated to the stimulation of new modes of connection, collaboration and innovation, and they are mainly distinguished into three groups.

1. The **physical assets in the public realm** are spaces open to the public that are conceived or re-arranged to be "digitally-accessible" (high-speed internet, wireless networks, computers, and digital displays) and enhancing networking. Public spaces can also be arranged to test innovative solution.

2. The **physical assets in the private realm** are privately-owned buildings and spaces stimulating innovation, encouraging shared work and lab spaces, being also more affordable for start-ups. New forms of micro-housing are also emerging, reducing private spaces in favour of larger public spaces.

3. The **physical assets that knit the district together and/or tie to the broader metropolis** consist in the regeneration of existing spaces and infrastructures (or creation of new ones) encouraging connectivity and exchange. Bike paths, sidewalks, pedestrian oriented streets, and public spaces strengthen the within the district, but also between it and surrounding environments.


• innovation drivers
- Research Institutions
- Large firms
- Start-ups
- Entrepreneurs
• innovation cultivators
- Incubators
- Accelerators
- Proof-of-concept centres
- Tech transfer offices
- Shared working spaces
- Local high-school
- Job training firms
- Community colleges
• neighbourhood-building amenities
• physical assets in the public realm
• physical assets in the private realm
• physical assets that knit the district together and/or tie it to the broader metropolitan area
ECONOMIC ASSETS
Economic assets are the firms, institutions and organization driving and supporting the creation of innovation hubs
INNOVATION ECOSYSTEM
NETWORKING ASSETS
Networking assets are the links established among actors to speed up innovation processes, as well as generating new opportunities by stimulating collaboration.
PHYSICAL ASSETS
Physical assets are the public and private spaces dedicated to the stimulation of new modes of connection, collaboration, and innovation
• strong ties networks
• weak ties networks

Main Typologies

Innovation districts can vary in type, size, density as well as in their different path toward growth, with some focusing on "tech/information", others dealing with life sciences, and others leading with creative industries, such as industrial design, media, and architecture.
However, according to literature, it is possible identify three major general models, according to the area in which they develop.

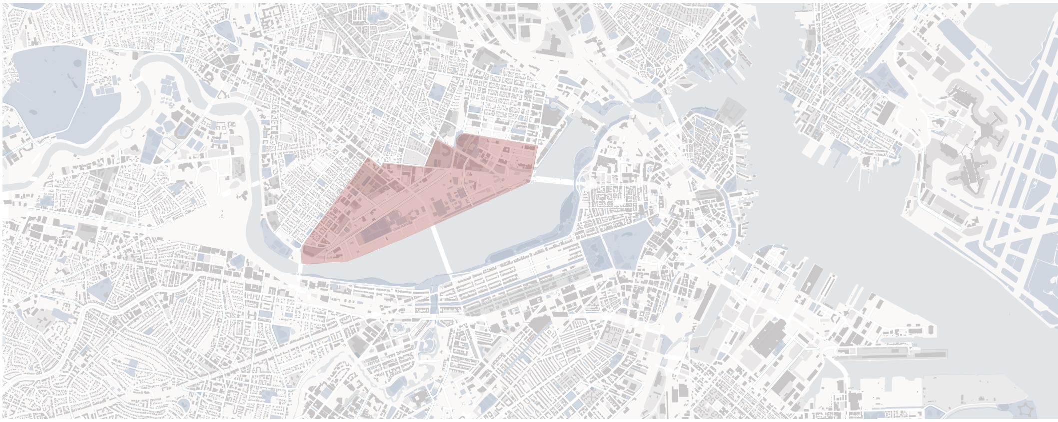
1. The **"anchor plus" model** is mainly found in the downtowns and mid-towns of central cities, and it is characterized by mixed-use developments on a broad scale, grown around major institutions and related anchor firms, entrepreneurs and spin-off companies involved with innovation..

2. The **"re-imagined urban areas" model** is located in former industrial or warehouse sites, undergoing physical and/or economic transformation, which can often take advantage of good infrastructural connections, historic building stock and proximity to city centres, where advanced research institutions are located.

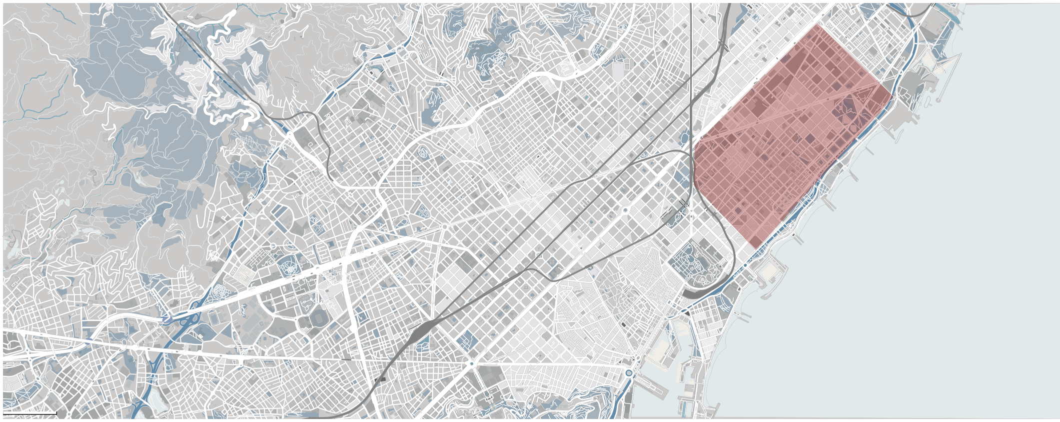
3. The **"urbanized science park" model** is often located in sub-urban areas where traditionally isolated innovation activities gather, urbanizing entire sites thanks to the increased density and setting of new mixed activities.

The "anchor plus" model results to be the one closer to the case of Basel Life Science Campus, being located in the city centre of Basel, close to main institutions and anchor companies, therefore further research has been carried out to deepen the knowledge about successful innovation districts belonging to this category.

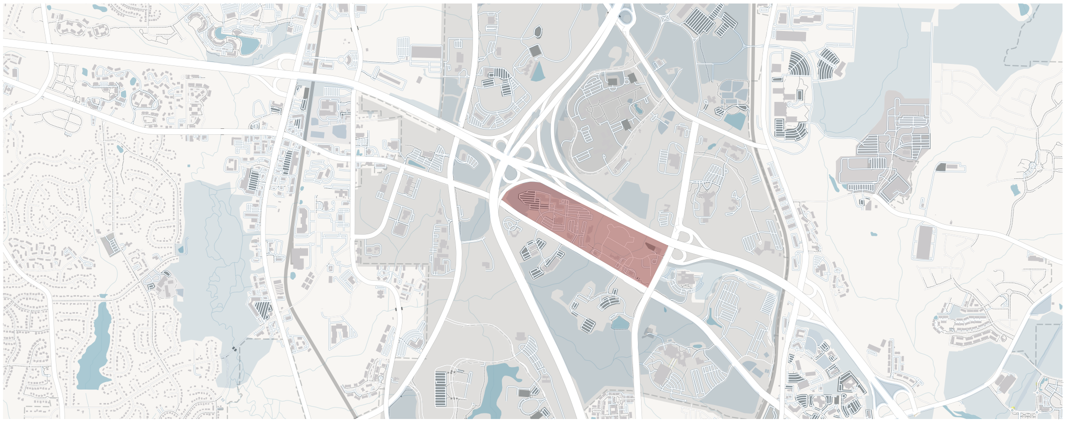
The most representative example of the "anchor plus" model is that of **Kendall Square in Cambridge**, Boston, **anchored by the MIT, and connected to Harvard, Mass General and other research institutions.**
The MIT always supported partnerships between industry and university, also handing over land owned by the institution to reach this objective. The result was the **rise of a sciences and pharmaceutical cluster**, around which several firms started to develop, attracting major technology companies as well.
The **Cambridge Innovation Centre is a representative example of interplay between university and private sphere**, being an independent organization hosted by the university with the aim of encouraging start-ups and entrepreneurs to enter the co-working environments it creates.
Furthermore, Kendall Square has also evolved as a **residential district, rich in facilities and opportunities**, guaranteeing the pros of a continuously evolving urban reality.



Kendall Square in Cambridge, Boston, USA - Major example of the "anchor plus" innovation distric model



22@Barcelona, Barcelona, SPAIN - Major example of the "re-imagined urban areas" innovation distric model



Research Triangle Park, Durham, USA - Major example of the "urbanized science park" innovation distric model

Basel life science cluster

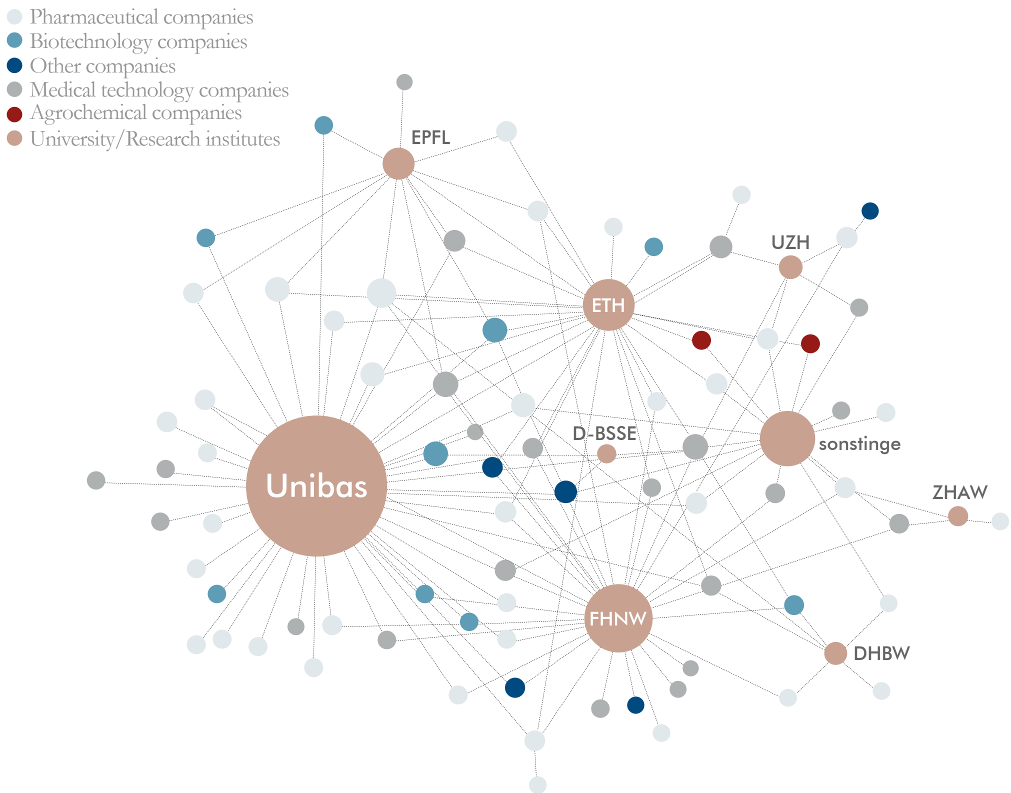
Basel is one of the world's leading locations for life sciences, and it hosts a cluster of companies and organizations open to cooperation aimed at generating innovative ideas and deliver them to the market.

Basel relishes on a **long-standing, historic tradition of involvement in the life sciences**, about five hundred years long, thanks to the expertise and knowledge reached by the pharmacists' guild of the Late Middle Ages, spread internationally by the humanist anatomists and printers, thus contributing to grow the fame of Basel. Such knowledge was then further developed thanks to the contribution the immigrants, carrying with them expertise, capital and business relationships, which starting from the settlement of activities producing dyes for the silk industry, ended up with specializing the city in the fields of chemistry, pharmacy and life sciences. The location of the city near the River Rhine optimized the production, transport, and the discharge of effluents.

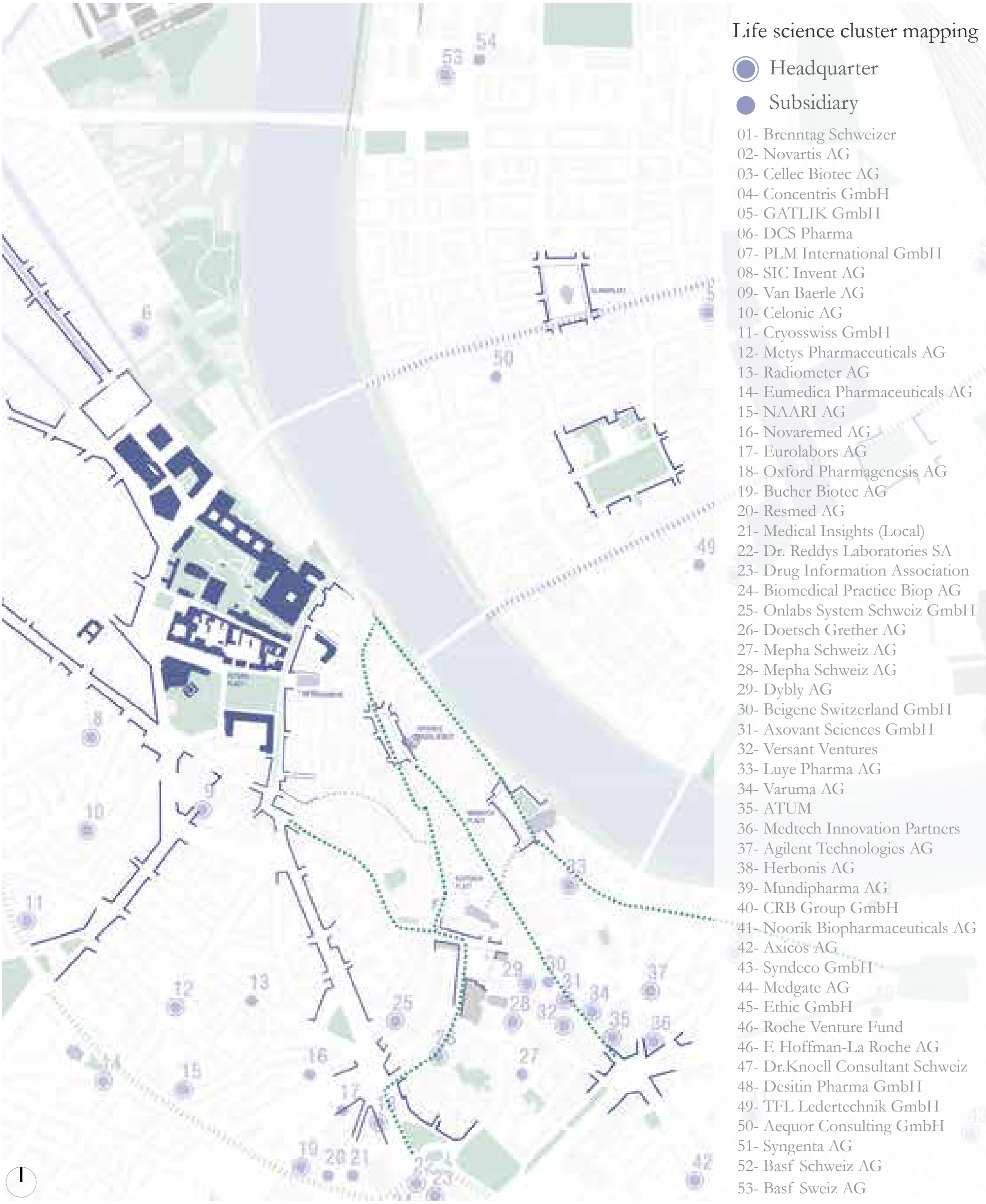
Nowadays, thanks to the settlement of hundreds of large and small businesses, Basel enlarged and updated its sectors of specialization adding to textile chemistry and pharmaceuticals also medical engineering, biotechnology, and agro-chemistry. **Basel is currently hosting the world's second and third-largest pharmaceutical companies in terms of revenues: Novartis and Roche.**
However, what can be detected in Basel is not only the presence of the headquarters of giant firms as the ones mentioned: indeed, a local concentration of similar enterprises is spread throughout the city, creating opportunities for innovation.

According to the researches carried out by the University of Basel, **in 2018 the number of life sciences companies surveyed in the region was equal to 766**, mainly concentrated in the cantons of Basel-Stadt and Basel-Landschaft, and with the most important industry being the pharmaceutical one (followed by mechanical engineering and biotechnology). The 20.2% of them provided information relatively to their **choice to locate themselves within the Basel Life Science Cluster,** asserting their **search for supporting and transport infrastructure, residential and leisure amenities**; furthermore, the **opportunities for collaboration and informal contacts** have been indicated as a further benefit. However, the lack of availability of high-skilled local workers was lamented, which leads companies to recruit skilled workers internationally. Exploring how companies, institutions and organizations within the cluster are interconnected in terms of business and research relationships, it is clear how **the University of Basel, together with its partners and associated institutions** (Biozentrum, University Hospital Basel, University Children's Hospital

Basel, Swiss TPH, FMI) **is influential in the establishment of life science networking assets.** Considering all the research findings explored, we started to elaborate a general **urban strategy for Basel Life Science Campus**, able to **combine the potentialities** identified in the study of the **city morphology and structure**, with the intention of contributing to **build physical assets suitable for the development of a successful innovation district** in Basel. In these terms, the project starts with a broader urban vision, which considers the specific needs of the current knowledge economy and labour market, and therefore trying to ease the networking between the subjects involved in the process of innovation.



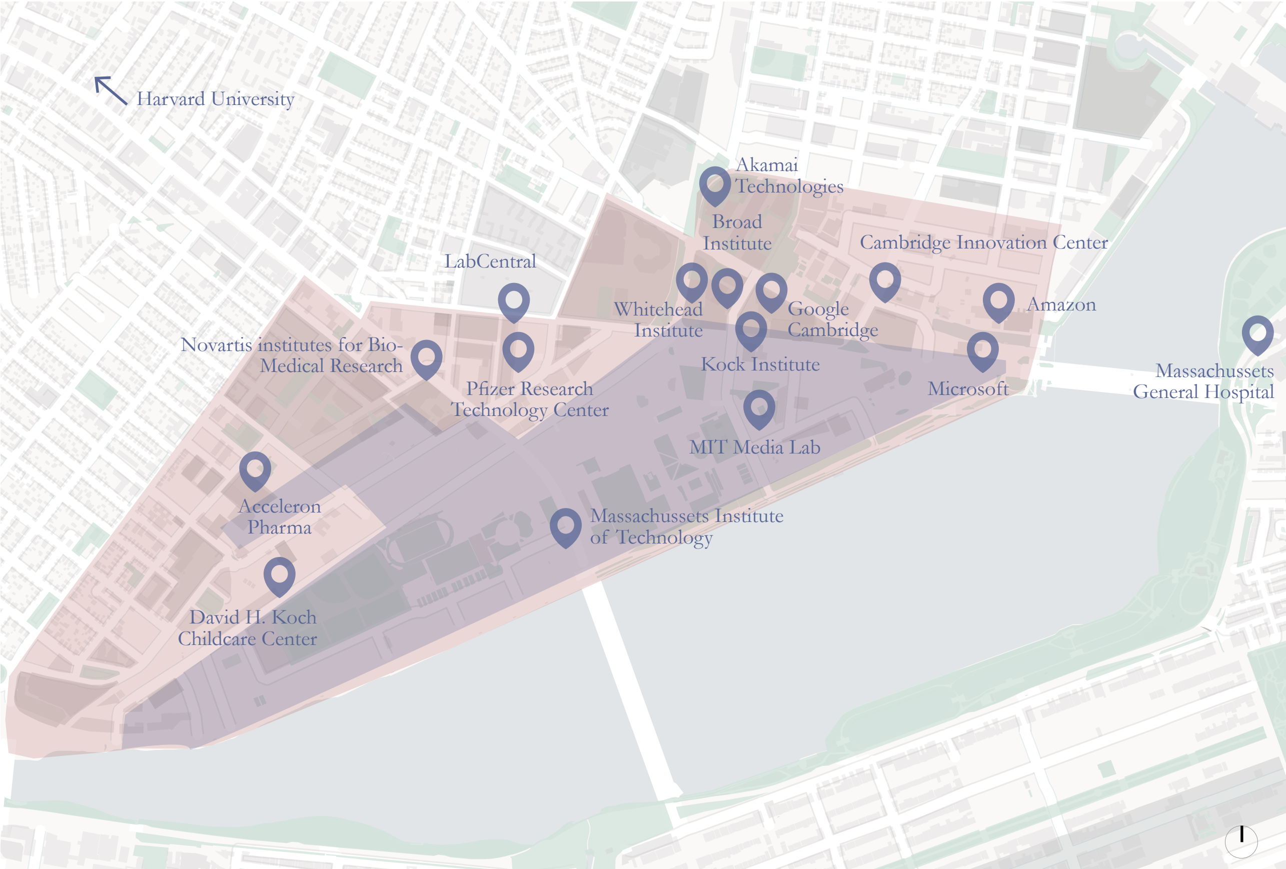
Reproduction of the network analysis carried out by Thomas Vogel, doctoral student of the University of Basel, Geography Department : the network shows how the University of Basel, together with the Biozentrum, University Hospital, University Children's Hospital Basel (UKBB), Swiss TPH, and FMI, is the key component in the Life Sciences Cluster network; not including Roche and Novartis.



Basel University *Green areas - existing* *Green routes - proposed* *Life sciences - Headquarter* *Life sciences -Subsidiary*

The comparison between Basel life science cluster and Kendall Square innovation District in Cambridge shows how both cities host a very **high concentration of companies relative to their size**. Another similarity consists in the fact that **both are science and pharmaceutical clusters**, involving anchor institutions, research centres and firms.

In both cases, **the role carried out by the University plays a central** role in **networking** all the different entities belonging to the system, and also in **providing the physical spaces** where interaction can take place.
In Basel it is also possible to notice how attractive and **dynamic urban environments tend to be preferred to isolated locations.** It is also for such reason that the **headquarters** of the two main pharmaceutical companies of Basel, **Novartis and Roche**, are trying to **adapt and better integrate their closed-campus organization with the richness of the surrounding city,** taking advantage of their proximity to the central area.



MIT University *Kendall Square Innovation District* *Cambridge science, pharmaceutical and innovation cluster*

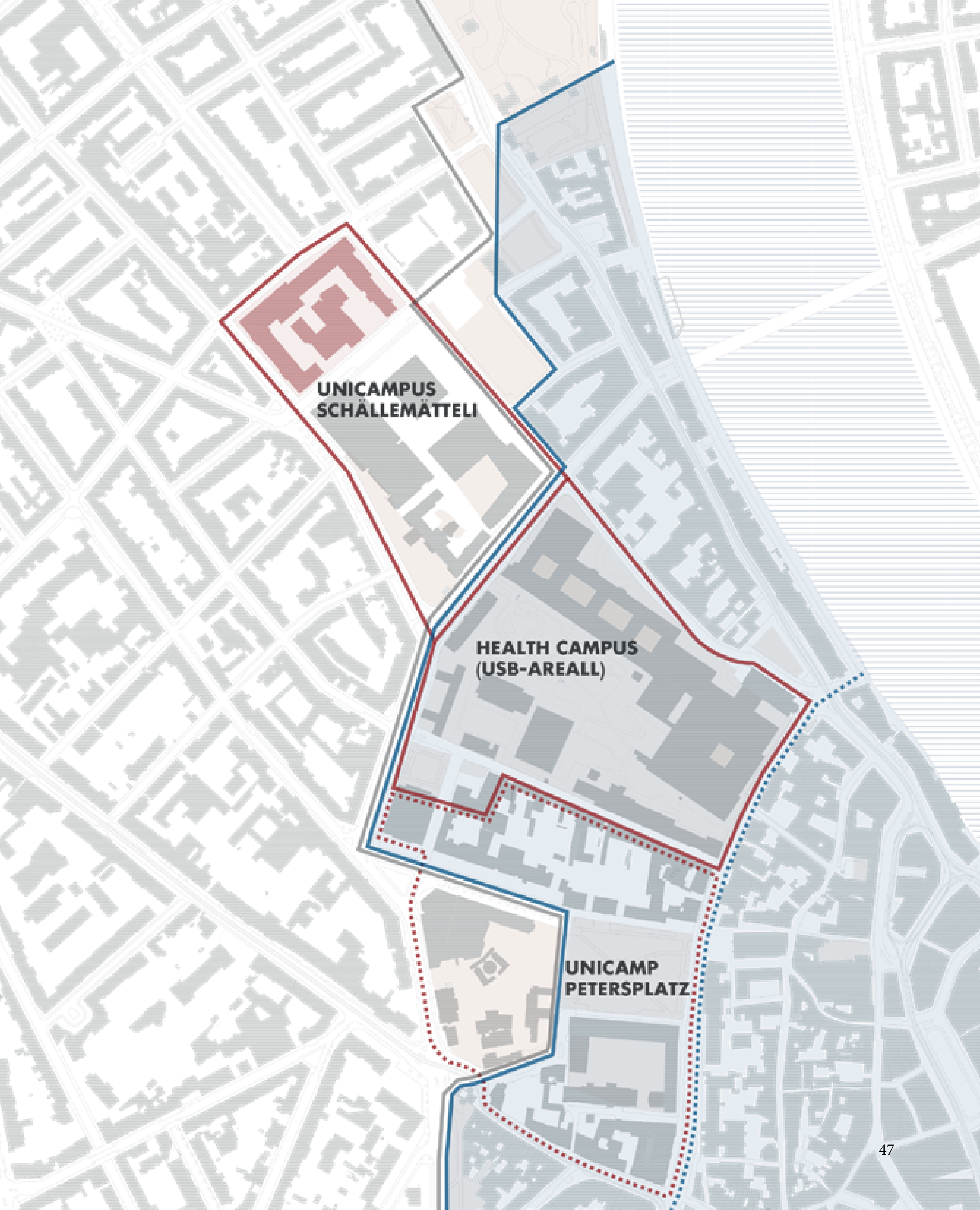
- 4 -

“campus schällemätteli”

Campus Schällemätteli

Basel Life Sciences Campus, named "Schällemätteli", is located at the borders of the historical city, near the residential district of St Johann. The campus is the result of the transformation of the physical assets of Basel University throughout the history, starting from its location in Margraves palace, later turned into a hospital, and around the medieval monastery garden of Petersplazt. The area formed the nucleus of the modern "Cluster of Clinics and University" of Basel. After city walls expansion in the 14th century, the campus towards the areas previously dedicated to agricultural activities, and later on it also extended towards the areas of the former French railway station and the historical prison. Today, Campus Schällemätteli is surrounded by various major university buildings (chemistry, physics, anatomy), as well as a more varied educational area located in the north-east side, (St. Johan, Pestalozzi, Vosges Schoolhouse). Finally, the upper borders of the campus are defined by residential districts, while the southern side hosts the University Hospital and other Healthcare facilities. Nowadays, the area under consideration hosts the so-called "Basel Life Sciences Cluster", which represents one of the leading centres for the creation of high-quality research environment in Basel, with the support of highly modern infrastructures.
As anticipated, the University of Basel pays particular attention to the fields involving Life Sciences, both for what concerns its research activities and the training of young scientists: such system is meant to support the industries located in Basel region, in terms of fields of study offered by the university, and in terms of infrastructures and networks provided. Basel territory counts, indeed, over 600 life sciences and biotech companies, other than Novartis and Roche, with a high growth rate.

The project area lies in the northern side of the Life Science Campus, defining the border between Campus and City, in the same way in which city walls had marked, in the same site, the distinction between the medieval city structure and further city extensions at the end of the 19th century. However, the area shows a strong potentiality to act as a "gate", rather than a border, conciliating two dimensions of the city. Indeed, the identification of a network of public spaces, linked in sequences inside of the campus blocks, together with the observation of the existing urban characteristics defining the identity of this portion of city, will represent main elements in the design process. The relationship between campus buildings and surrounding context will then be carefully designed and studied to create special reactions and nodes, strengthening their link with the city.
The reading of the context, and its reflection in the design process, also needs to consider the features characterizing the innovative research buildings that define the new re-developments of the Campus. Such architectures, located in the block adjacent to the project site, embody experimental typologies meant to reshape the working environment in innovative ways.


UNICAMPUS
SCHÄLLEMÄTTELI
HEALTH CAMPUS
(USB-AREALL)
UNICAMP
PETERSPLATZ

Life Sciences Campus Vision

The general vision leading the re-development of the Life Sciences Campus is that of **creating a cutting-edge research and educational centre for Basel University**, on the base of strategic principles.
The university aims to strengthen the efficiency of its system by constituting agile leadership structures able to connect the decentralized spheres of action contributing to the existence of the Life Sciences Cluster. The idea of "opening up the university" to maintain in close contact all the involved sectors, as well as public society, and the idea to expand the cooperation with partner institutions worldwide, significantly contribute to the social, cultural and economic life of the region. The richness of such environment would inspire business sectors and the general public, strengthening their identification and involvement with the university activities. Finally, by exploiting the "local advantages" deriving by its strategic position, the university aims to intensify the collaboration among the three countries bordering its metropolitan area.

According to this vision, the realization of the innovative Basel Life Sciences Schällemätteli Campus is now under development: some of the buildings involved in the contemporary dynamics of transformation include the University Hospital of Basel, with a new design proposal elaborated by *Herzog de Meuron*, or the new Biomedical Center redesigned according to the competition won by *Caruso St John Architects.* Also, the Department of Biosystems Science and Engineering (D-BSSE) of ETH Zurich is planned to be designed according to the project by *Nickl & Partners*.
The dimension and resonance of the redevelopment plan is thus able to underline the role of the university as a leading research and educational institution in the entire region of Basel, and the role of the Campus as a "catalyst" for the regeneration of urban spaces in continuity with the urban and architectural history of the city.
The University of Basel, in cooperation with the financing cantons of Basel- Landschaft and Basel-Stadt, also elaborated the further steps of this vision for the 2029, involving the construction of new buildings for the Departments of Biomedicine, Physics, and Chemistry. Their concentration in the same cluster is aimed to enhance co-operation in the research and teaching environment, promoting the exchange of skills and ideas to generate innovation within Basel Region.

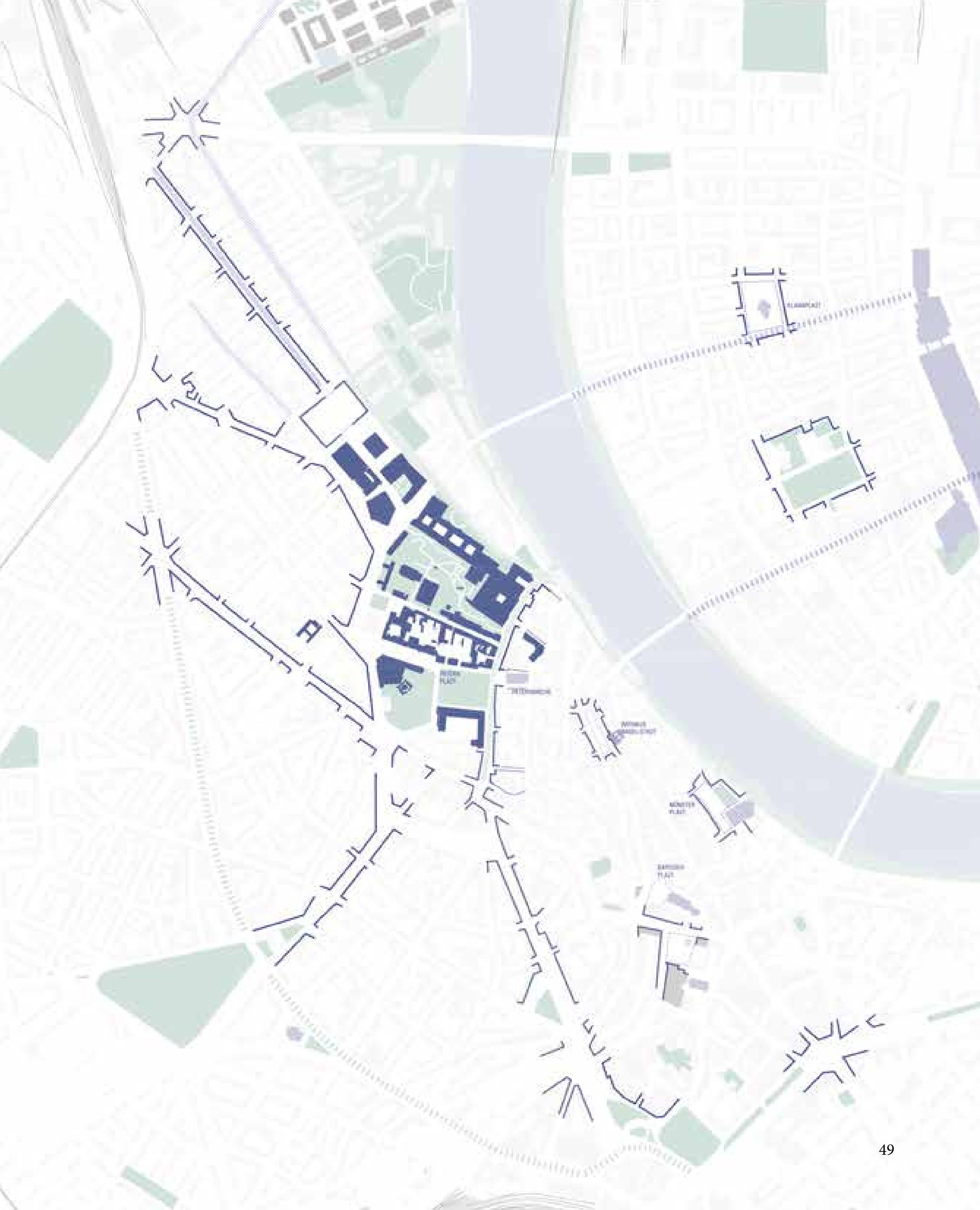
13.000 **students from over 100 nations, including 2.700 doctoral students**

Faculty of Science
Kingelbergstrasse 50, 4056 Basel

Department of Biozentrum
Department of Chemistry
Department of Physics
Swiss Nanoscience Institute

Faculty of Medicine
Kingelbergstrasse 61, 4056 Basel

D-BSSE ETH Zurich
Kingelbergstrasse 61, 4056 Basel

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n.2
n.3
n.4

Science District's building blocks

1.

NEW BIOZENTRUM

19 FLOORS

Newly built (2021)

23'400 sqm

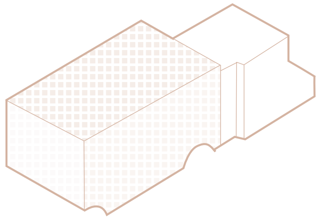
2.

DEPARTMENT OF BIOMEDICINE (DBM)

11 FLOORS

Further development (2025)

19'000 sqm



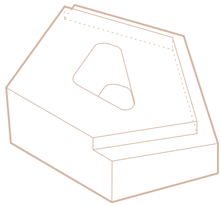
3.

D-BSSE - ETH ZURICH

8 FLOORS

Further development (2025)

?'000 sqm



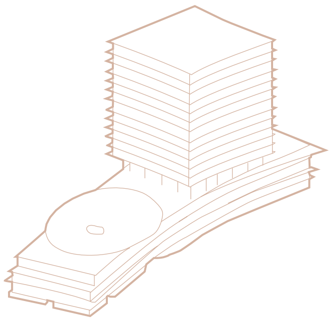
4.

BASEL UNIVERSITY HOSPITAL

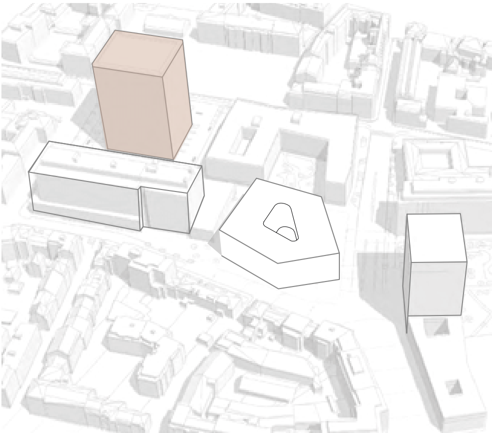
13 FLOORS

Further development (2025)

50'000 sqm



Biozentrum, Physical Model, Ilg Santer Architekten



Biozentrum

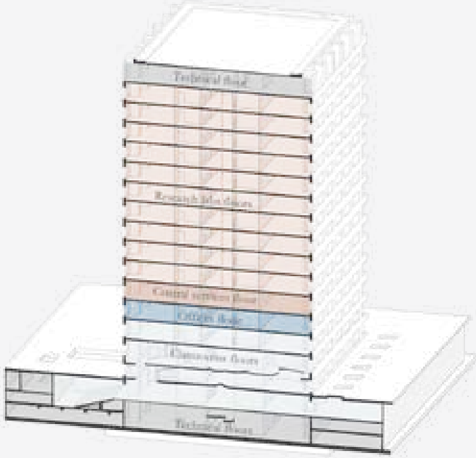
A stronghold in life sciences

Unique, interdisciplinary research

The new Biozentrum tower is one of the largest building construction projects in the history of the University, and it is the first foreseen building of the Life Sciences Campus. On October 1st, 1971, the first research building of Biozentrum opened: it served its purpose for over 50 years and it was the only interdisciplinary institute in Europe of its kind. Since the building was not able to meet today's Minergie standards and it was not possible to carry out the required work parallel to aimed operations, the building was redesigned according to the new vision for the Life Sciences Campus. The new volume was designed to ensure research activities are associated with the demands on the infrastructure.

The New Biozentrum Tower covers an area of 23'400 m2 and comprises 19 floors - 16 above ground and 3 basement levels- with a capacity able to serve 600 researchers and 800 students.

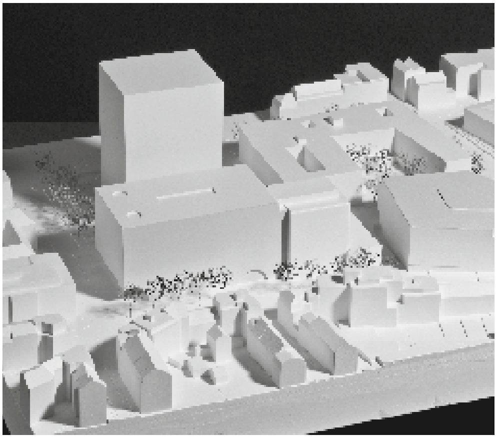
The Biozentrum, aiming to become a leading research institute organized for an interdisciplinary research environment, is designed in a way to benefit from scientific exchange. In the tower, indeed, ten floors are designed to accommodate four research groups in each, with meeting zones of adjacent floors that are joined through an open staircase. Shared technological platforms are distributed over all the floors to encourage encounters and informal dialogs, as well as to create an environment stimulating innovative ideas that arise from random discussions. Providing the best working environment in the overall complex, and including different demands of the technology platforms, this state-of-the-art infrastructure represents a challenge. Additionally, the new building will host



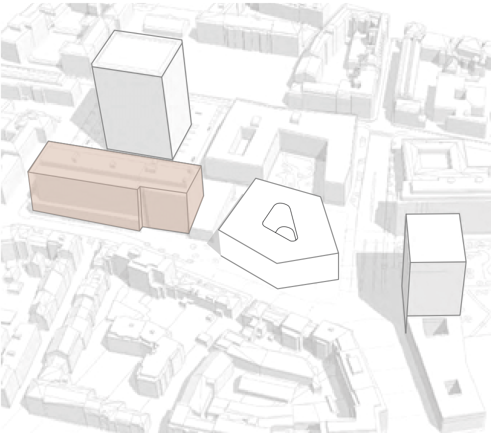
the University's IT-services, lecture halls, seminar rooms, and public cafeteria. The open ground level that surrounds the building has a freely accessible organization, with seating and water fountains creating public amenities for the whole Life Sciences Campus and city.

5 MAIN RESEARCH AREA

The Department of Biocenter covers an area of 17' 360 sqm that contains;
-Growth & Development
- Infection Biology
- Neurobiology
- Structural Biology & Biophysics
- Bioinformatics & System Biology



Department of Biomedicine, Physical Model, Caruso St. Johan Arch.



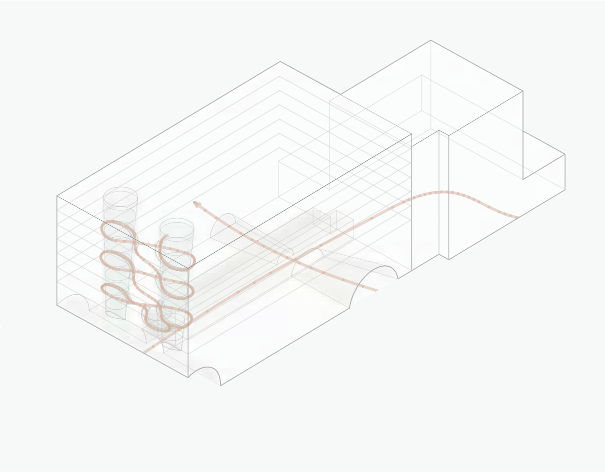
Department of Biomedicine

Caruso St John Architects were appointed to design the new centre for Biomedicine at Basel University after winning a competition in 2015. The building covers a total area of 19’000 m2, and it accommodates five experimental research laboratories that will host 70 research groups of approximately 7000 employees. According to planning, the date indicated to start operating is fixed at the beginning of the Autumn Semester 2025. The new volume will be integrated physically and functionally with the adjacent Pharma building. To improve co-operation, the department is located next to Biozentrum and to the D-BSSE of ETH Zurich, defining a common infrastructure for the university research and teaching environment at a short distance. The DBM will be completed as part of the development plan conceived for the life science cluster within Schällemätteli campus.

The building organization is arranged according to the needs of the scientific community. Lower floors accommodate collective amenities, while the upper seven floors are organized around the facility cores into flexible lab spaces, which could allow for further changes in the inner organization according to the needs of scientific research topics. A generous hall at the head of the building facing Pestalozzistrasse forms a focus for the various working spaces that are connected vertically with spiral stairs.

The skin of one big volume is formed by glass blocks, and the bowed surface of the glass units gives the building a characteristic look, typical of the industrial building surfaces form the 20th century, being both monumental as well as fragile. On the side of Pestalozzistrasse, the facade of the building is dramatically cut-away, being thought by the designers, as the prow of a ship to creates a special covered passage that emphasizes the civic quality of the building mass.

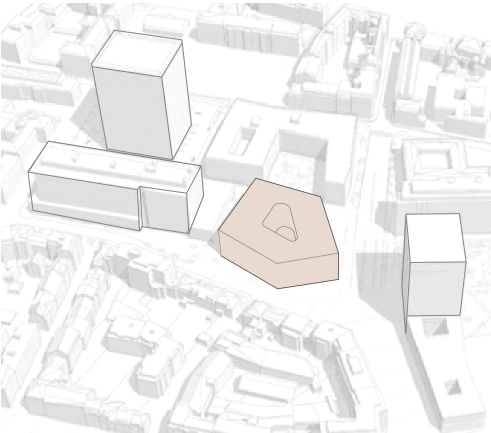
Biozentrum renovation competition proposal, Caruso St. Johan Architects, 2015



Circulation Path Diagram, Caruso St. Johan Architects, 2015

Circulation Path Diagram, Caruso St. Johan Architects, 2015

D-BSSE- ETH Zurich, Physical Model, Nickl & Partner



D-BSSE - ETH ZURICH

Laboratory and Research Building

The Department of Biosystems' Science and Engineering (D-BSSE), which belongs to Zurich Technical University despite being located within Basel University Campus, was designed by Nickl & Partners in 2014 as a competition proposal.

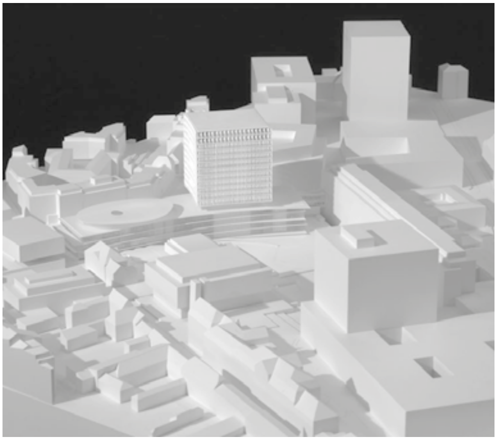
The D-BSSE, aiming to optimize the use of capital equipment and to provide expert support, serves a variety of training sessions: it enables both independent instrument operation and direct participation of users through dedicated professionals, thanks to the use of high-end technics that would be continuously maintained and updated. The building accommodates a research environment provided with access to state-of-art laboratory automation, which will be used in collaboration with the other departments of Basel University Life Science cluster.

The architectural composition arises from the deliberate decision not to build a landmark skyscraper, preferring instead a subtle and sustainable addition to the urban fabric.

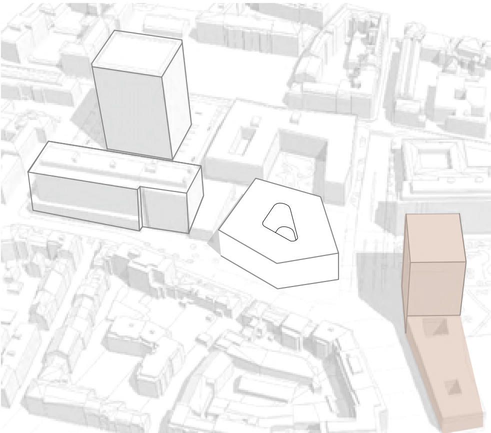
Indeed, the six-story high building has a slim, low-key format in the city. The volumetric design and the perimeter of the building follow the scale of the adjacent Children's Hospital not to overshade during the day. The floor plan is organized around a central atrium, designed in a way to bring different departments together and to provide functional flexibility, achieving a balanced but distinctive image through the very highest technological standards. The self-contained volume, with its compact design, offers a desirable working environment.

Department of Biosystems Science and Engineering (DBSSE) - ETH Zurich , Nickl & Partners, 2014, (Under Construction)

Department of Biosystems Science and Engineering (D-BSSE) - ETH Zurich , Central Atrium



University Hospital, Physical Model, Herzog & De Meuron

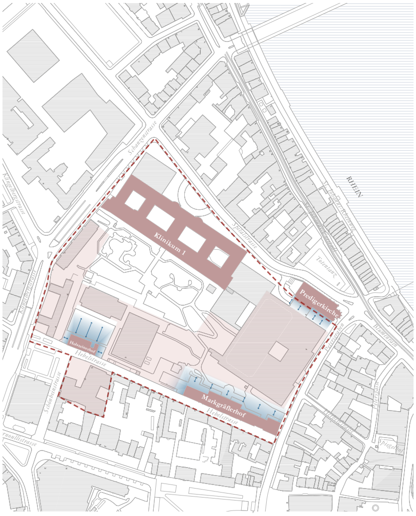


University Hospital of Basel

The "Health Campus Masterplan" is currently under development as a long-term oriented planning tool conceived to serve the University Hospital of Basel. The assigned plot "B" is indicated for the necessary replacement of Clinic 2 on the so called "Perimeter A" of Basel Hospital. In February 2020, further developments for the project have publicly announced, identifying other possible developments along Schanzenstrasse and Klingelbergstrasse as a part of "Perimeter B". The aim is to proceed with the development of the spatial planning strategy conceived to enhance the urban re-development of the area, asking for proposals able to reach the highest possible operational efficiency, which is to be evaluated.The selected project for the completion of Hospital complex (Clinic 2) was designed by Herzog & De Meuron in collaboration with Rapp Architekten. The proposed composition include three structures: a lower base building, a tower and a pavilion. The three-to four- storey base construction respect the height of the surrounding residential houses and it accompanies the geometry of Schanzenstrasse in a fine concave shape. The design also comprises a 13-storeys and 68-meter-tall high-rise, with a gross floor area of 50,000 square meters (538,195 sqf). The new structures will house the hospital's outpatient tumour and nephrology centres, as well as a host of new laboratories.The architecture is characterized by sweeping, convex and concave contours. Their origin is indebted to the shape of the plot; it follows the former city walls, which are now the ring road. The connection to Klinikum 1 on the side of the facade facing Schanzenstrasse also affects the design, redesigning the relationship with the hospital garden, and emphasizing the qualities of the inner-city hospital. The façade towards the city is finely structured with Brise Soleils, "mineral parasols" for a highly transparent facade, which direct daylight deep into the building.

Department of Biosystems Science and Engineering (DBSSE) - ETH Zurich , Nickl & Partners, 2014, (Under Construction)

Riverscape showing the high-rise vision for Basel, Zeichnung © Herzog & de Meuron



Listed heritage buildings in Perimeter B, Basel Hospital

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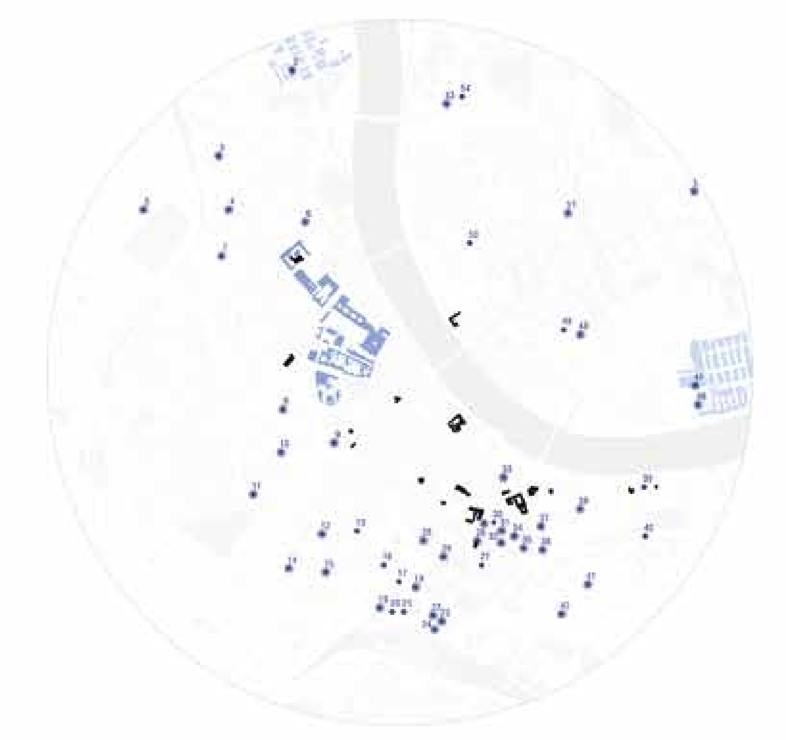
"design proposal"

urban strategy

Life Science Cluster



1. The **mapping of sites related to the fields of life sciences and chemistry**, with the intention to integrate the new campus with such a network. Indeed, the design of an "open ground" campus would create a suitable physical asset allowing to transfer the knowledge circulation throughout the city, by supporting social and economic interactions among the different sectors.

Dynamic Network

Green System

2. The **morphological reading of the city as a dynamic system of diagonally interlocked urban corridors,** which we aim at strengthening. The enhancement of such a structure would allow for a better interaction between the most important campus locations and the surrounding urban environment, defining an urban campus with a porous identity, supporting the technological research community.

3. The **definition of a green urban belt,** which would better characterize the identity of social interaction routes, integrating the previously identified dynamic system of open spaces between the campus and the main areas within the city. This would also allow to improve the quality of transport infrastructure and provide new leisure amenities.

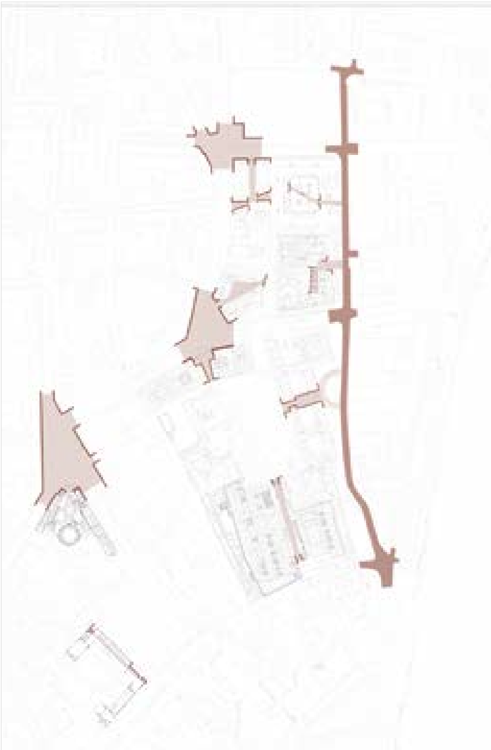
The Nodes

The leading design concepts have been determined after a careful reading of the surrounding context. First, analysing the context, it was noticed how the urban nodes along Klingelbergstrasse are characterized by the set-back of buildings facades in order to host small public spaces.

Logistics

Another important factor to be accounted for concerns the hierarchy of the existing infrastructure needs to be respected: Spitalstrasse constitutes, in fact, an important urban artery, which affects the design facing its border. Furthermore, the underground tunnel built under the campus surface needs to be integrated in the logistics of the new site.

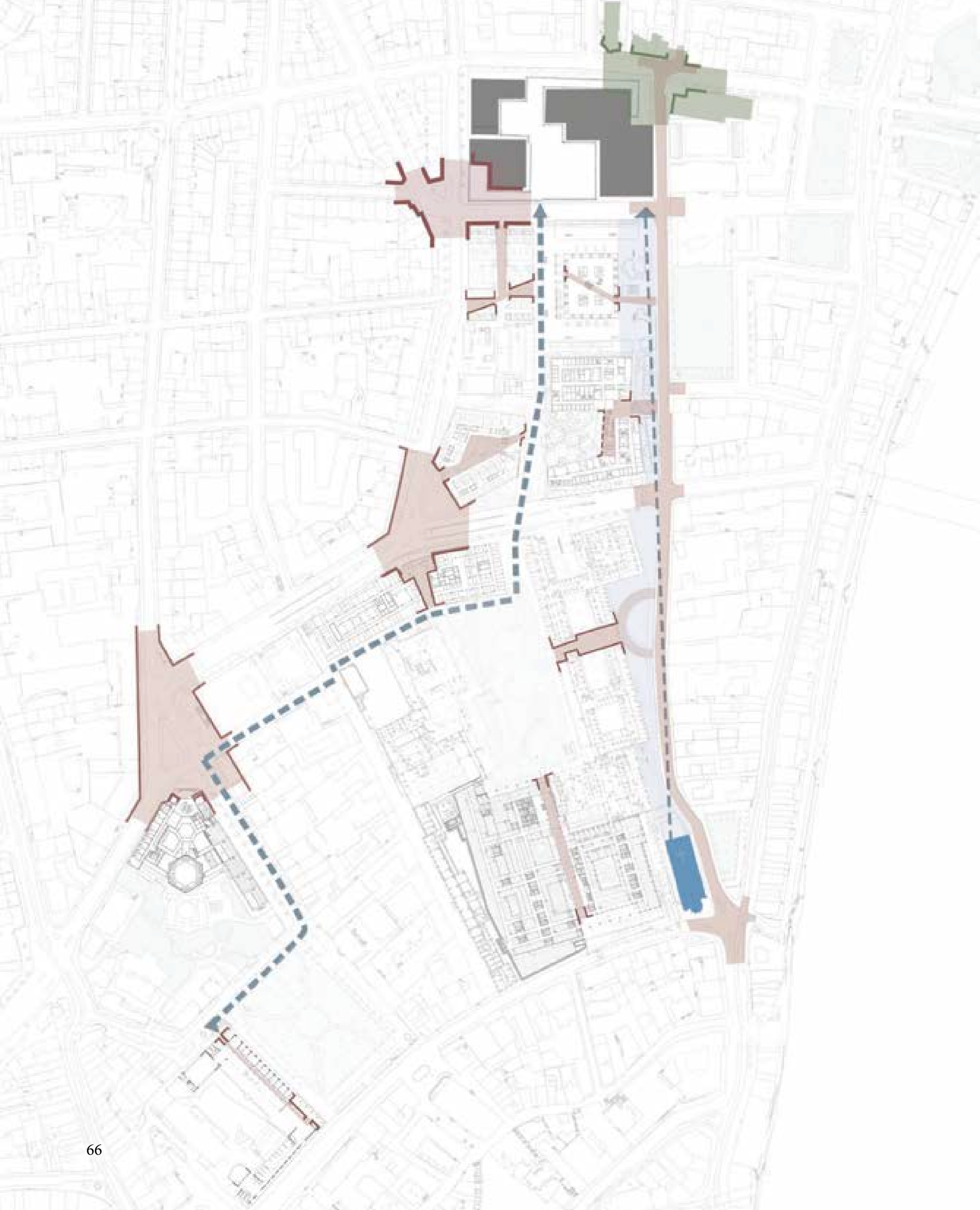
Hidden routes



Going deeper with the study of the ground floor strategy adopted in the other buildings located on campus, the tendency is to create direct connections from the entrances along the street sides and the open spaces located in the inner portions of the urban blocks.

Open space flow

The most interesting feature identified analysing the site, giving common identity to the campus blocks, is the continuous flow of open spaces defined by the specific morphology of the campus buildings in relation with the urban blocks. Indeed, different volumes are arranged along the borders of the plot, so as to create an introverted series of consequent, open spaces.



the concept

The main concept guiding the volumetric evolution of the design proposal consists in **designing a complex of buildings defining a sequence of public spaces as a continuation and completion of the continuous flow of open spaces characterizing the morphology of the campus blocks.** Starting from the **arrangement of a composition of different volumes around the borders** of the plot, the aim is to create an inner path crossing the backbone of the University campuses, linking its buildings. Successively, **volumes where further adjusted as an answer to the specific features of the surroundings**.

First, the **sizing of the open space** designed within the block was adjusted **with respect to the other open spaces hosted in the internal path** of the University campus. Then, being the site located in **between the campus and the residential** area, the complex was thought **as a gate, able to conjugate different scales, leading from city centre to** one of the main city **stations** (St. Johan).Therefore, the **main open space**, characterized by a generous size, is **oriented in such a way to openly face the campus**. Then, proceeding through the composition, **buildings are arranged so as to reduce the size of the open space while approaching the residential side** of the city.
The entrance to the block from that side is meant to act as an urban atrium, leading to a medium-size intimate square protected by the composition.

Considering previous site analysis, t**he system of urban nodes along Klingelbergstrasse was continued** with a design proposal reacting to the node between Klingelbergstrasse, Metzerstarsse and Pestalozzistrasse with a set-back, in order to **create an open space at the border with the residential neighbourhood**.

On the side of **Spitalstrasse**, instead, the study of the surroundings revealed the **constant setback of the building facades facing the main street.** The volumes on the eastern boarder of the plot were therefore set back at the ground floor level, while projecting the upper volume over the plot border, forming a covered portico. In such a way, taking advantage from the set-back of the buildings of the campus, it was been possible to create a symbolic **correspondence between one of the volumes of the composition and the church of the hospital, Predigerkirche, acting as a point of reference in the city**.

This urban action would also allow to **"close" the campus system on Spitalstrasse, by re-establishing a more traditional relationship between buildings' facades and street,** re-connecting it with the nearby residential district.
Maintaining the intention to react to the existing context, the **node between St. Johanns-Ring and Spitalstrasse** was also designed to host a small open space, bringing together the residential area and the entrance of the public schools located across the street, Vogesen and St. Johan.

Brief definition

Guidelines and constraints

Construction site n°4 is the last part of the Schällemätteli University Campus undergoing redesigned. Currently, it hosts the Departments of Forensic Medicine, Physics, Chemistry, SNI as well as the Anatomy and Biomedicine. With the exception of Forensic Medicine, other uses are planned to be kept on site, with the addition of further facilities.

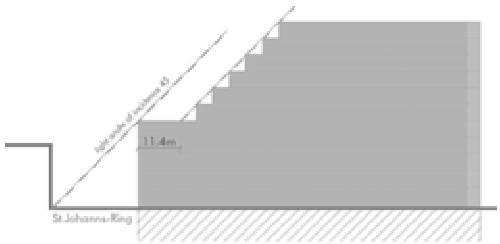
Due to the high level of complexity and the several topics, dependencies and several conditions to be taken into account, the University produced a brief examining the stages and proposals of competitive perimeters to prepare the competition on construction site n°4.

According to city planning, the construction field is 4 in the "Zone for uses in the public interest ", and its reconstruction is part of a redevelopment plan of the University estate, including all the four construction fields belonging to Schällemätteli Campus, involving plots 1 to 3 in a first moment, and site 4 later on. The development plan for site 4 includes several framework conditions which have to be taken into account during the design of the proposal, which concern:

- **Building Height**
- **Two-Hours Shadow**
- **Spitalstrasse**
- **Shell volume and GFA**

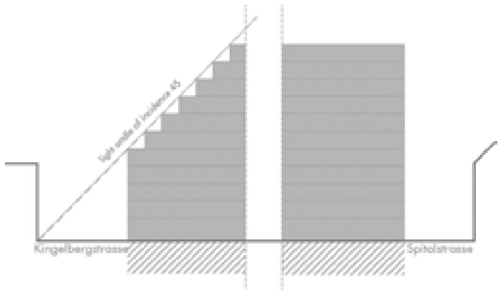
1. Building Height

The **maximum building height is fixed, according to development plan, to 50.5 meters.** This is below the 73m of the NBZ tower but over the 40m of the planned DBM, and far above the quarterly average the residential building of St. Johann.



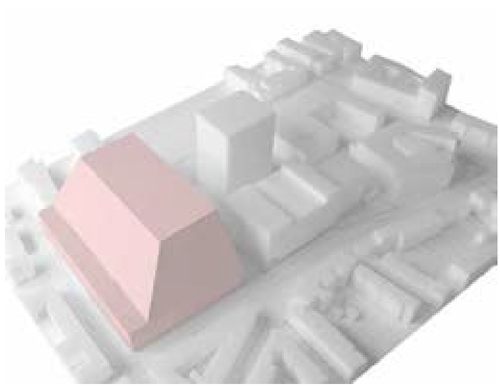
2. Two-Hour Shadow

Due to the orientation of the construction field and the limitations concerning the shading of residential buildings, mainly located along Klingelbergstrasse and St. Johanns-Ring, the **"two-hour-shadow"** regulation must be respected, **guaranteeing that no residential building will be subjected to shadow for more than one hour**. No regulation on shading is set for school buildings.



3. Spitalstrasse

Along **Spitalstrasse, special attention should be given to Vosges Schoolhouse**. Such buildings are mainly used during daytime, and even if break times are partially shaded, an a**ppropriate height and distance from the building line** must be maintained. Using the maximum height of 50.5 meters should be avoided.



4. Shell Volume and GFA

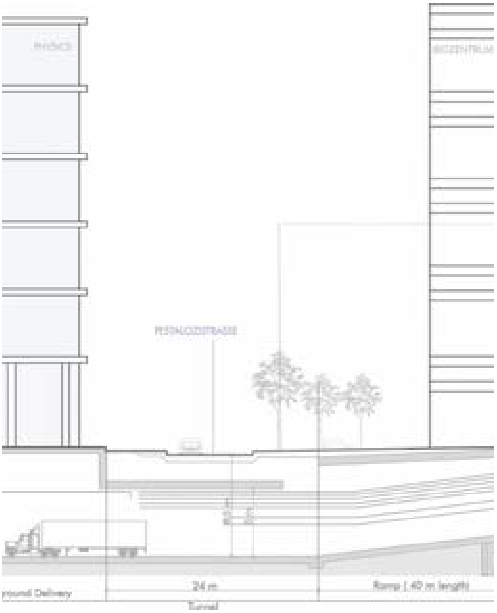
The **maximum shell volume** along Klingelbergtrasse is limited by a light **incidence angle of 45° and by a maximum height of 5 storeys**. Furthermore, along St. Johanns-Ring, the building line is supposed to be **set-back to 4,4m**. The **maximum GFA** is limited to **58.000 m^2 .**

Space program

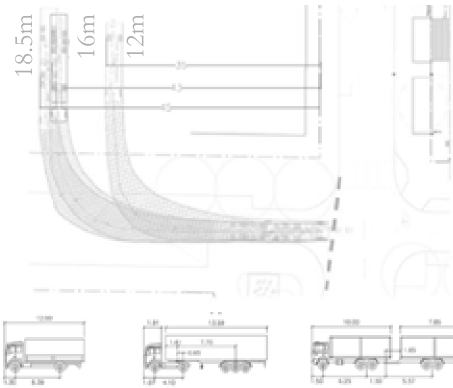
According to the development plan, the maximum gross floor area is of **5'8000 square meters.** Furthermore, the space program defined in May 2017, sets **usable areas for the different functions involved in the program,** with distinctions about the surfaces to be arranged **above ground**, and those to be provided on the **lower floors**.
The assumed floor height in the brief is of 4.5 meters, and the lecture theatres and the dissecting room are assumed to be one and a half stories high.
In addition to the indicated area, a reserve of 10% has been included to allow more freedom for the competition and to react to any program variation.

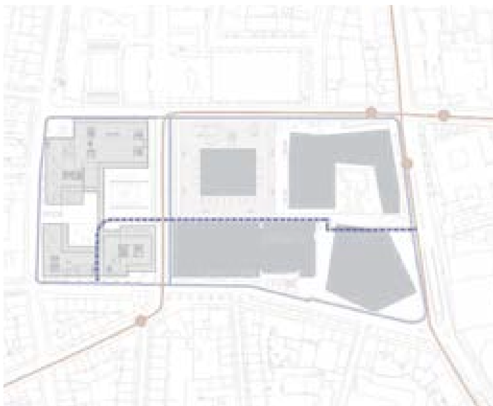
	Above ground	Underground	Total
Chemistry	24'002	5'456	29'458
Physics	7'689	2'618	10'307
SNI	3'817	3'256	7'073
Anatomy	3'489	2'897	6'386
Central Area	11'090	440	11'530
Animal Station	0	3'674	3'674
Total GFA + 10%	50'087	18'341	68'428

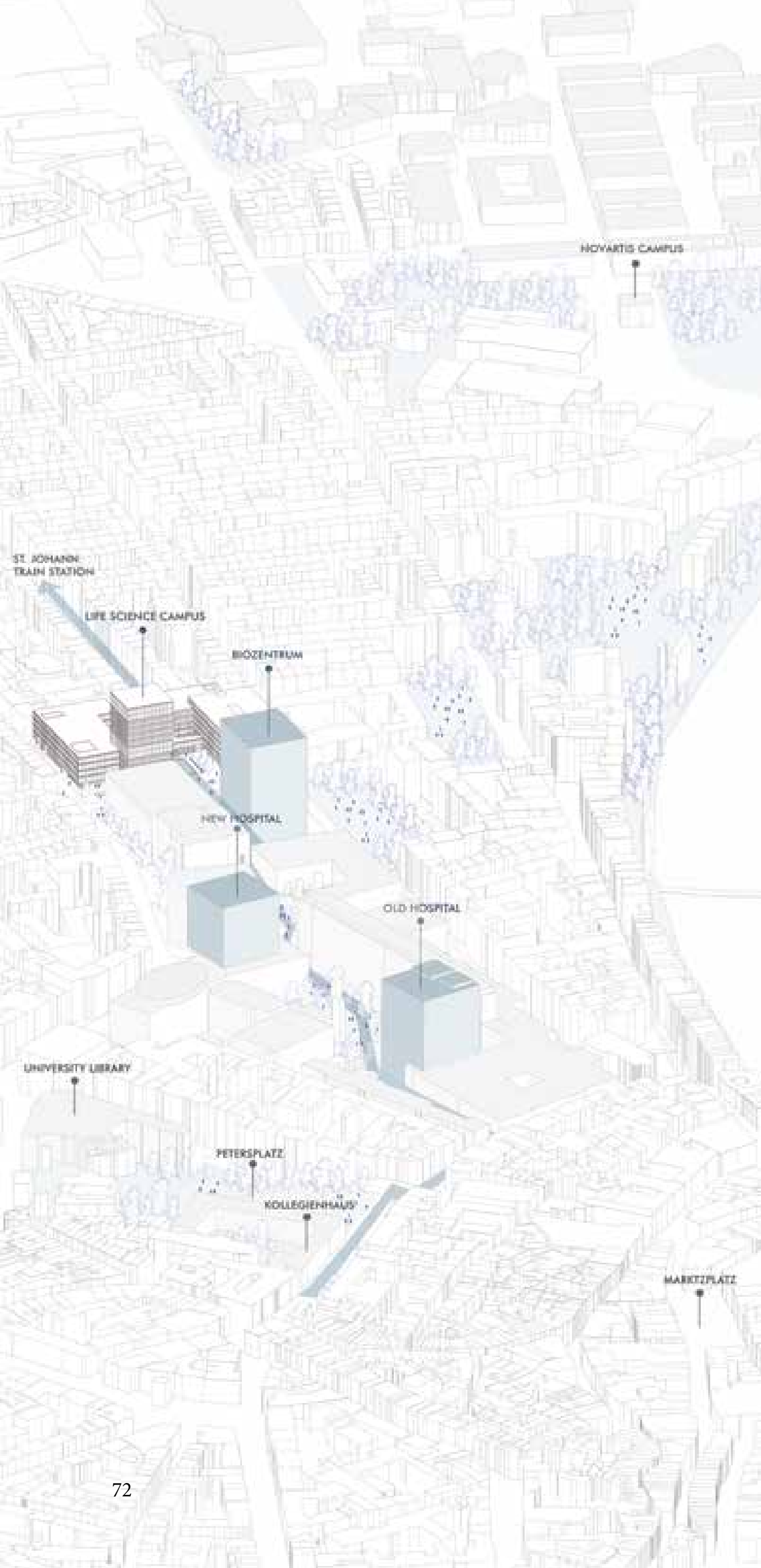
Logistic solutions



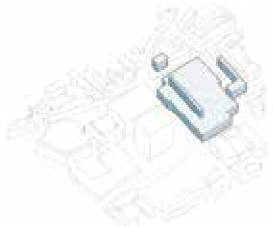
The site logistics of the construction sites within the Schällemätteli University Campus was originally considered in its entirety and recorded in the zoning plan of the city.
Such plan **foresees a logistics underground tunnel crossing through the construction fields 1, 2 and 3, and reappearing on construction field n°4, providing an exit to Klingelbergstrasse.** All site logistics from the material supply should work according to one-way traffic. Estimations have been carried out in order to determine the maximum distance from Pestalozzistrasse that would be required by a truck to drive from the tunnel up to Klingelbergstrasse. Different curvature have been approximated according to the possible maximum vehicle length: varying from the 12m of regular camions up to the 18.5m of articulated tracks.





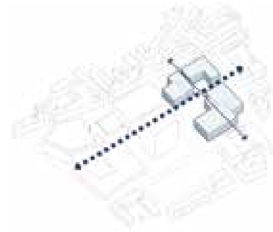


Plot definitiion

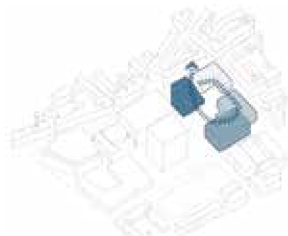


Reactions to the context

Definition of primary public space



Intersecting systems



Ascendent climax

volumetric evolution

The volumetric evolution started, as the design concept definition, from a careful reading and reaction to the surrounding built environment.
The complex was indeed defined as a **composition of four volumes**, combined so as two form two macro-compounds. The four volumes have then been **manipulated according to the context and to the intention of giving a specific identity to each of them.**

The buildings **along Klingelbelgstrasse and St. Johanns-Ring** have been set to a maximum height of **23 meters**, maintaining a similar scale to that of the **residential fabric** they face.
The building located at the **intersection between Pestalozzistrasse and Spitalstrasse**, instead, is slightly raised to **29 meters**, considering the presence of the **nearby public buildings**, and allowing to **make more gradual the change in scale characterizing the campus buildings**.
Eventually, the volume located at the **node between Klingelbergstrasse and Pestalozzistrasse, is turned into a tower of 60 meters**, carefully set-back from the residential side. Considering the average city scale, this tower can be considered as a high-rise building, which aims to insert itself in the more recent development of the cityscape, reacting to the scale of the buildings belonging to the campus, and especially to the presence of the nearby **Biozentrum tower** (73 meters high).

The composition results then in a sort of "**city within the city", characterized by the sense of variety and richness typical of the urban environment, while maintaining a sense of unity.**
The **gradual climax** determined by the differences in height among the volumes contributes itself to obtain a **compact composition**.

Furthermore, the variety of the composition allows to give a **specific identity to the different elements**, under several points of view: **symbolism, program distribution and urban role**.

It is at this point that the **definition of a new Science Forum for the city of Basel starts to take shape**. The **forum would be recognizable in the cityscape, at urban scal**e, thanks to the presence of the **tower** acting as a new **landmark**.
The gate of the forum towards the city centre would then be defined **by the tower and by the main representative building: the Basilica**, symbolically representing the **sacral temple of science and knowledge**, dominating the forum and virtually corresponding to Predigerkirche.
Eventually, the **lower fabric would correspond to the palaces defining the borders and dimension of the open space**, as in the traditional squares of the historical city centre.

Brief verification

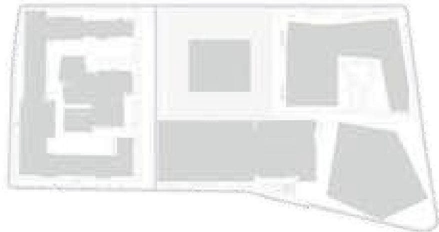
Construction phases & logistics

As defined by the University brief and by some urban regulations adopted in Basel, the volumetric definition of the project has been adjusted in order to respect all the necessary requirements.

First, **the redevelopment** of Campus Schällemätteli is supposed to take place in **two different phases, due to logistic reasons aimed at guaranteeing the continuity of the educational offer** while works are under development. This **affects the way in which the buildings are constructed and the way in which the program is distributed**. **Such necessity influenced the grouping of the four volumes in two macro-compounds**, to be built at different moments.

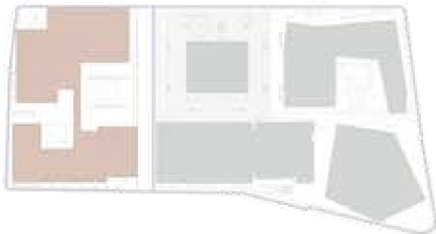
During the **first phase** of works, the **chemistry department is temporarily moved** to another site while **its existing seat is demolished** and replaced by an **L-shaped building**, formed by two contiguous volumes. The 6-storey high portion of the building, located at the crossroads between Pestalozzistrasse and Spitalstrasse, is then meant to host the new **Physics and SNI departments**. The portion of building set at the crossroads between St.Johanns-Ring and Spital Strasse is also meant to house the Anatomy department and the Anatomy museum, open to the public.
In the **second phase**, after **transferring the physics department to the buildings constructed in stage one, all remaining buildings are planned to be demolished**. This

Existing conditions

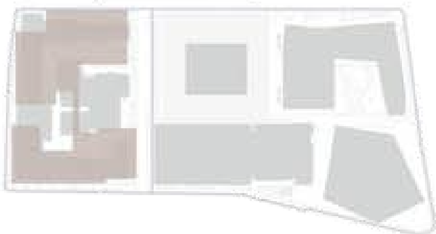


Phase one

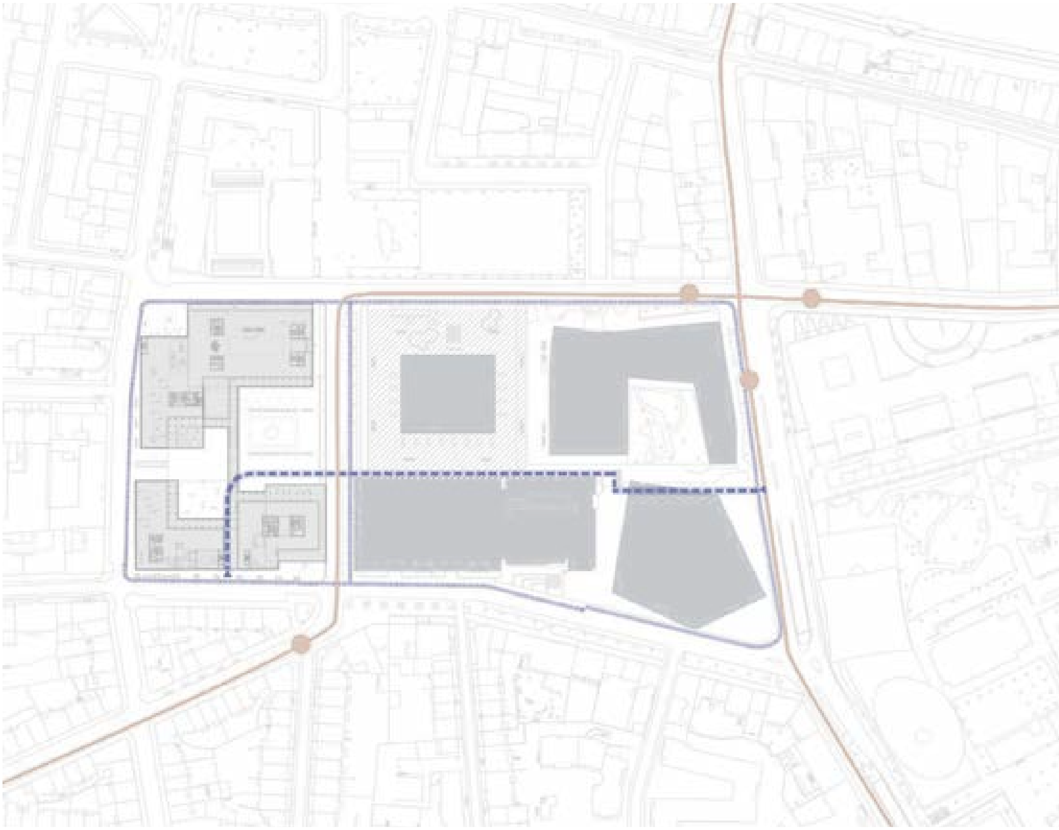
Phase two

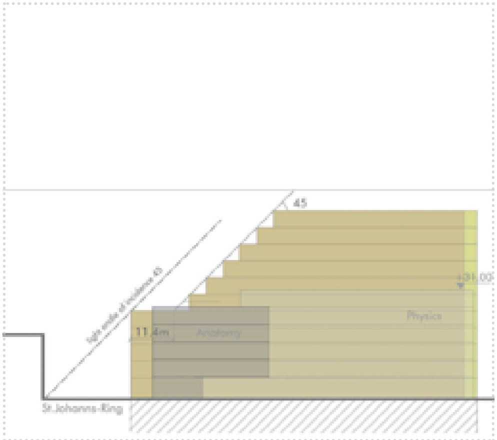


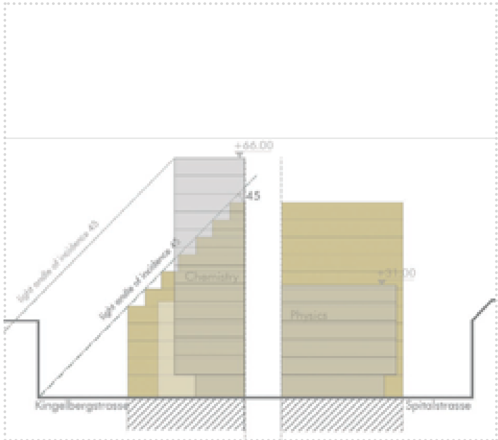
Overlapping new & old



phase concerns the construction of **two volumes having some functionally and spatially connected levels**, regarding the first five storeys and the basement for underground logistics. At the corner between Klingelbergstrasse and St.Johanns-Ring, **a five-storey building is going to be located, devoted to the new Chemistry department.** The **60-meter-high tower located at the corner between Pestalozistrasse and Klingelbergstrasse, is mainly meant to host facilities**, such as the research library and start-ups workplaces.
Furthermore, the volumetric composition has been taking into account the logistic needs concerning the exit of the underground campus tunnel, located on Kingelbergstrasse, defining the height of the tunnel as 8.5 m in total and the distance from Pestalozzistrasse to 50 m.

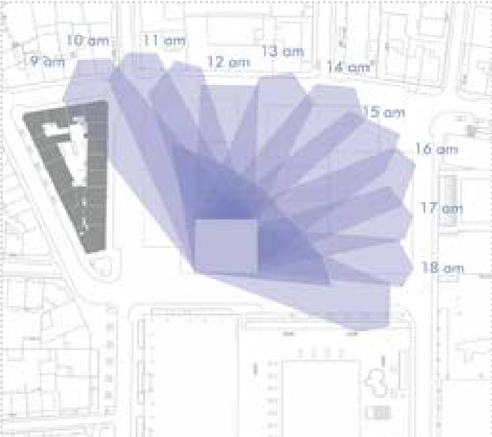


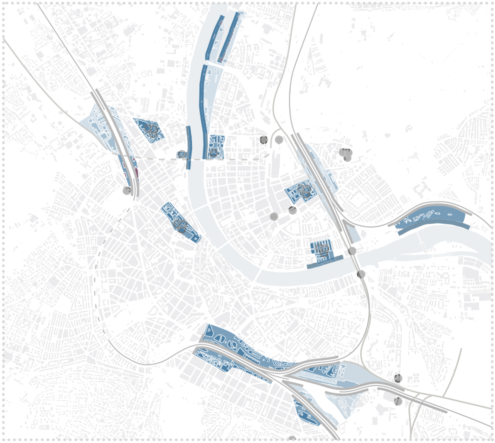




The volumetric design proposal is checked with respect to the maximum shell volume indicated, maintaining the buildings along the residential sides of Klingelbergstrasse and St.Johanns Ring at a maximum height of five storeys.

The design proposal is also checked with respect to the maximum height limitations and to the regulations concerning the angle of incidence, set at 45°. The proposal respects all the indications with the exception of the tower volume, which is higher than 50.5 meters.





The tower proposal is consciously crossing the border of the 50.5 m meters of height, however, its design has been adjusted several times in the project in order to guarantee the respect of the "two-hours shadow rule", meaning that the tower will not project its shadow on any residential building for more than a continuous hour.

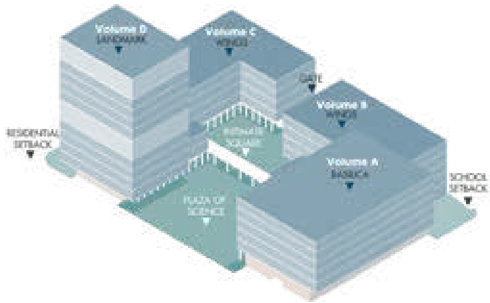
The tower proposal has been designed being aware of the current maximum height limitations, considering the more recent developments that have been carried out in Basel as well as newly planned projects as the one of the nearby Hospital by Herzog & de Meuron. Such considerations foresee the possibility of a relaxation of restriction about scale in the city of Basel, being our site included in the areas suitable to host high-rise buildings.

basel science forum

A anticipated, the innovative campus buildings have the aim to underline the university's positions as a leading research and educational institution in the region, becoming a reference point for the entire territory.

Keeping in mind this goal, the organization of the campus mainly derives from the continuation of the urban sequence of public spaces scattered along what is envisioned as a potential inner route crossing the University hospital and campus: the design area, where the new research centre will be located, would then represent its ending point, before opening up to the rest of the city. The conclusion of the inner campus path is meant to create a special environment, thought as a science plaza, where knowledge can be exchanged without being limited to experts and academics, but opening up to the city of Basel through the continuous urban network. The design of the masterplan is indeed supported by an urban strategy planned to enhance and stengthen the definition of a new path, which would start from the administrative building of Basel University in Petersplatz, and then cross the entire campus linking its buildings by means of continuous flow of public spaces.

Starting from the idea of developing a complex of buildings as urban catalyser, then, the design was aimed to create an urban system which could be identified as part of the existing city of Basel, and therefore characterized by a certain degree of differentiation and variety, yet ensuring a sense of continuity and identity within the system.



The final composition, composed by two "macro-buildings", is the result of the elaboration of 4 spatially integrated volumes, defined by taking into account specific reactions to the existing surrounding and urban framework.

Volume A hosts the physics department, as well as many other educational and public facilities.

Volume B mainly hosts public facilities at ground floor, the Anatomy and SNI Departments.

Volume C hosts the Chemistry department, partially included also in volume D, since the two are linked at some floors.

Volume D mainly hosts public, administrative and educational facilities, especially in the tower.

Approaching the site from Kingelbergstrasse

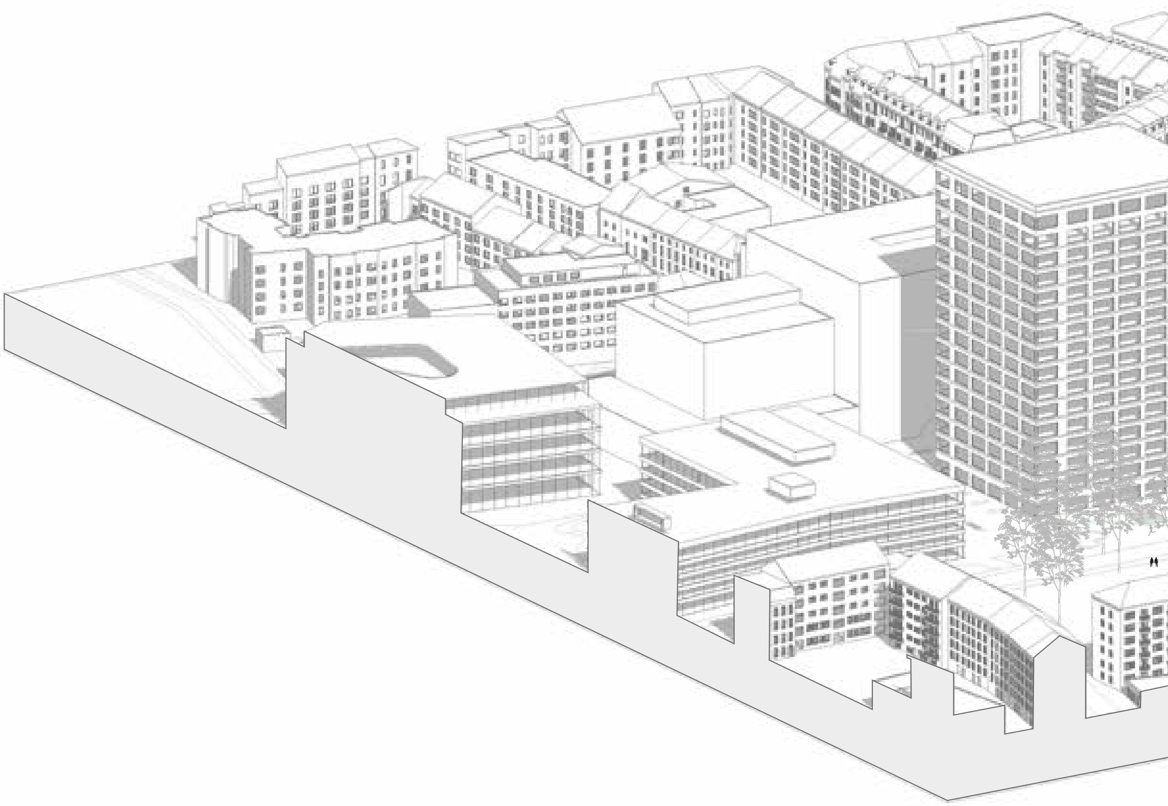
Node between Kingelbergstrasse and Pestalozzistrasse

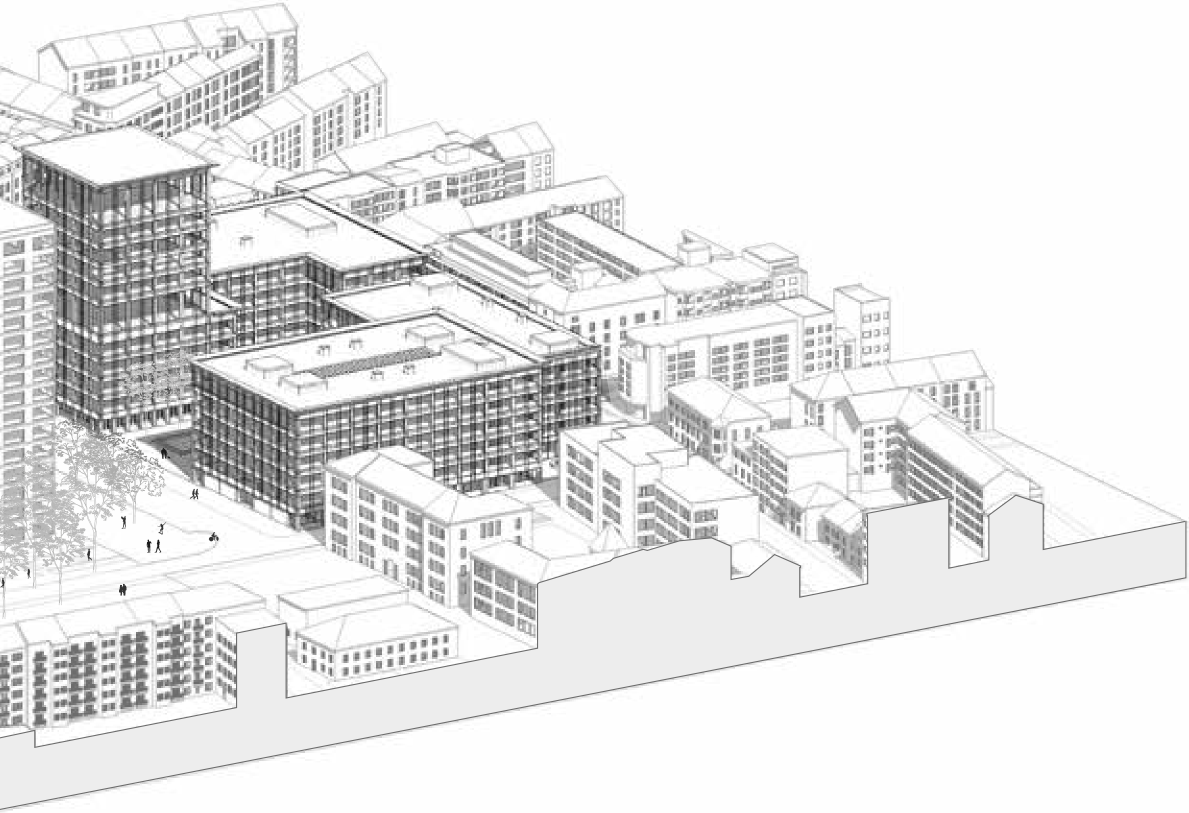
Approaching the site from Spitalstrasse

Approaching the site from internal street of campus

Entrance to the site, crossing Pestalozzistrasse

Approaching the site from Vogesenstrasse





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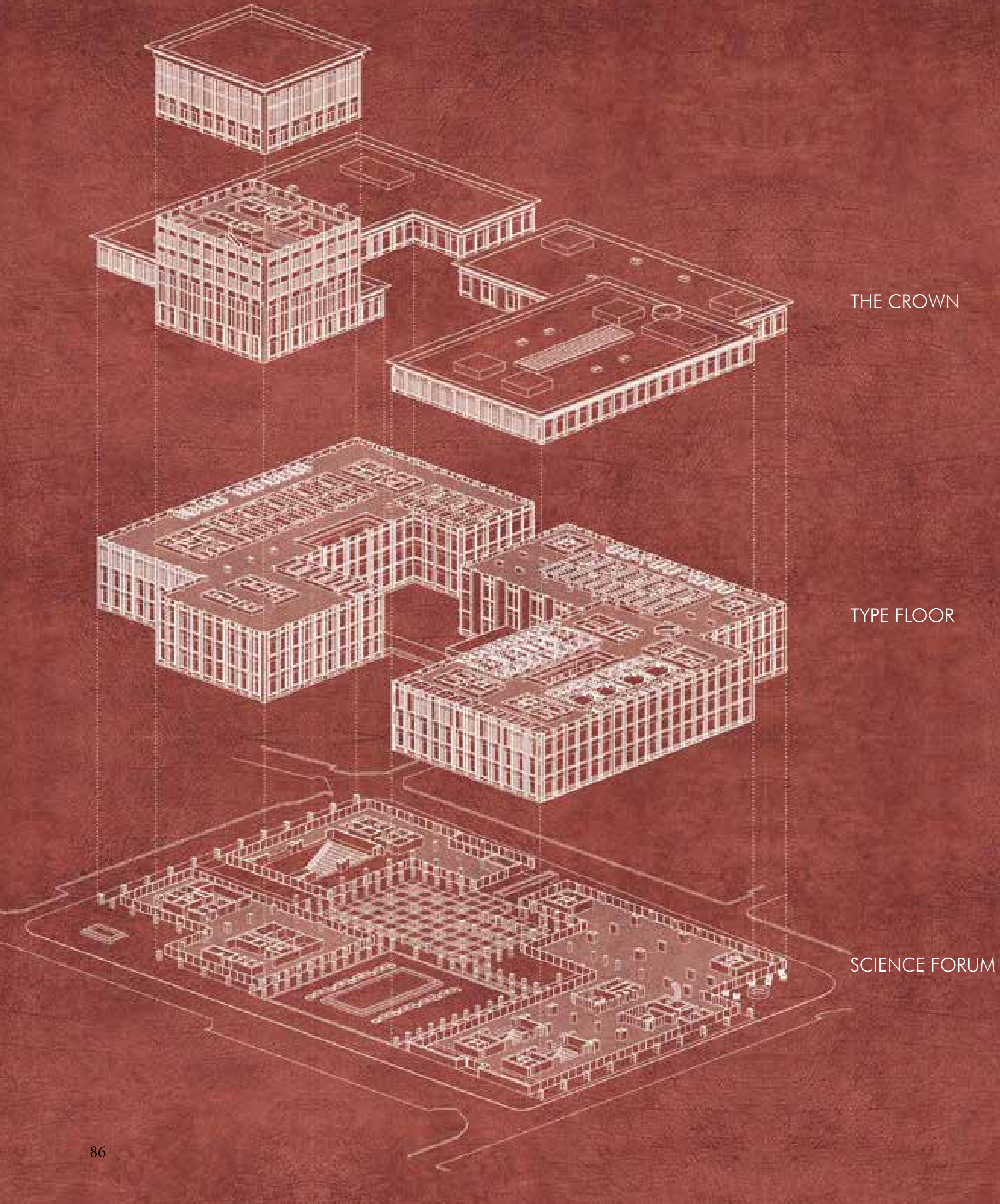
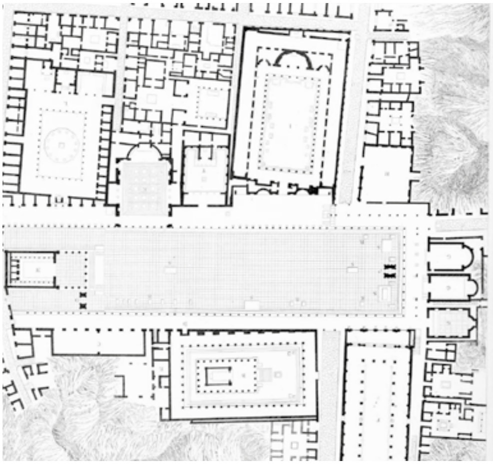
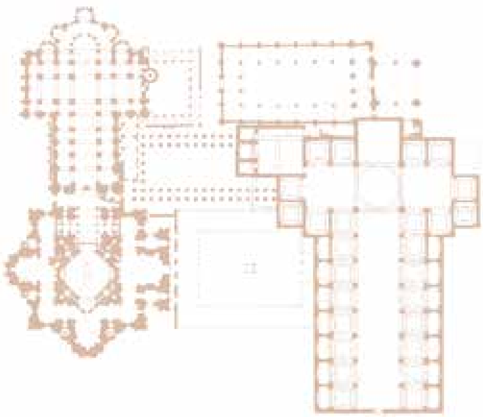
" basel science forum "


THE CROWN
TYPE FLOOR
SCIENCE FORUM



Roman Forum in Pompeii



Linear aggregation around central fulcrum

The type

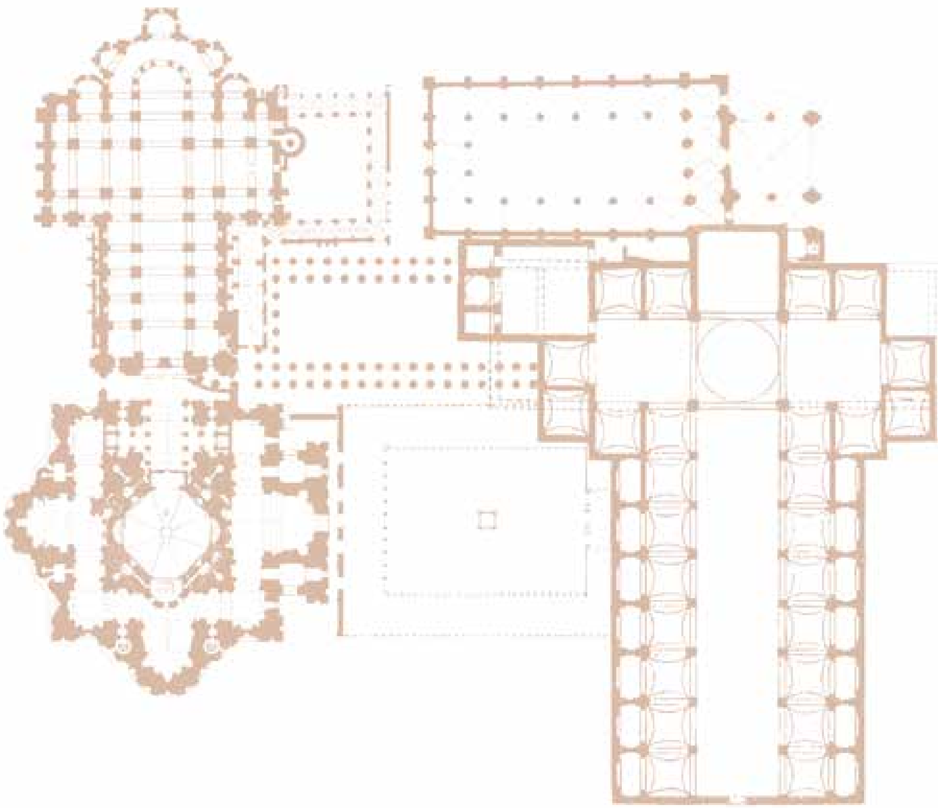
Variety & Continuity

The sense of variety and complexity defining this elaborated and diversified system, derives from the attempt of making it play a specific urban role within the city. The architectural ensemble is indeed generated by a clear urban gesture, which allows it to become a recognizable emblem within the context.

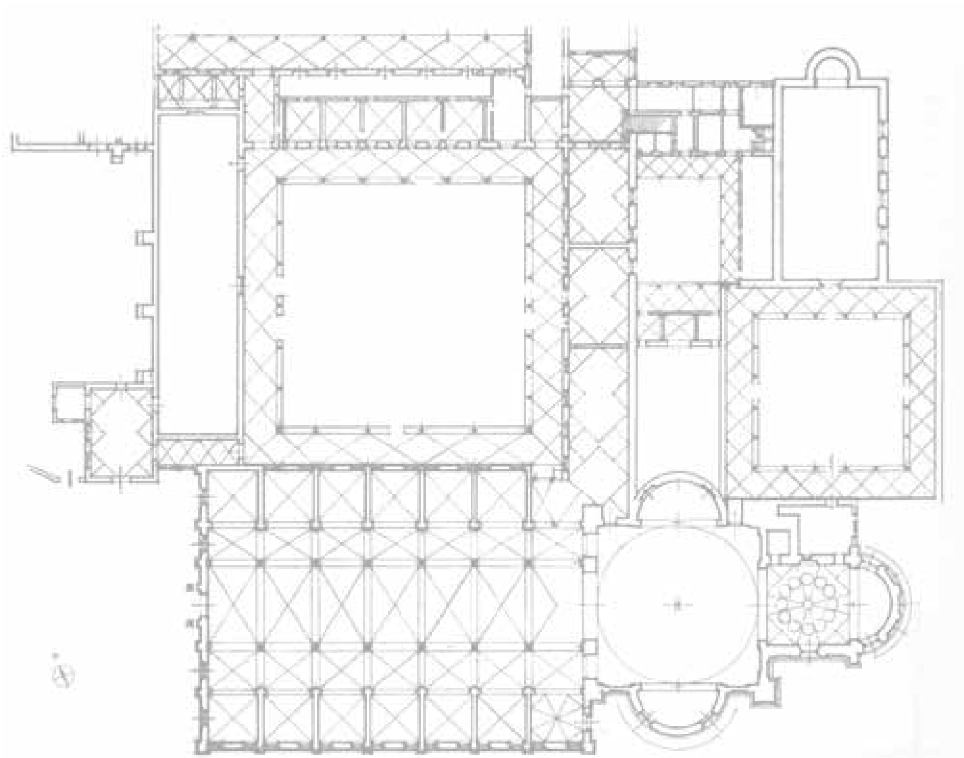
The organizational principle of the system is designed through the **linear aggregation of the buildings around a central fulcrum,** which is then articulated according to the continuation of the inner campus path, creating a spatial sequence between of different spaces, yet maintaining its identity.

Typological superimposition is then used to integrate different components into a new formal type, the unitary character of which is kept together by the ground-floor portico system, which defines a unified structure.

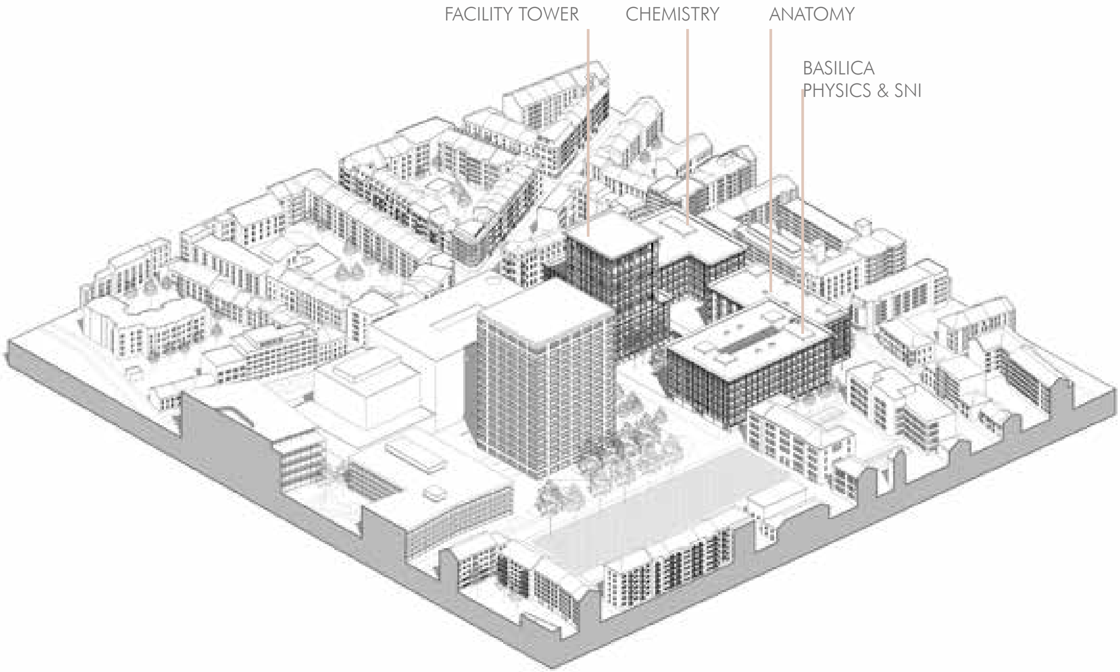
The four volumes defining the aggregation have then been manipulated according to the context, and according to the intention of giving a specific identity to each of them. The sense of unity and continuity, counterposing the variations deriving not only from the different needs of the numerous users, but also from the diversified characteristics of the built surroundings, is optimized in different ways. Indeed, the overall project comprises a variety of laboratory buildings, also hosting educational, research, administrative and public facilities of related to the University of Basel, and hosting in particular the Departments of Anatomy, Physics, SNI and Chemistry. The layout of interior organization is designed according to prescribed programs indicated by the University of Basel, as explained in next chapters, carrying out a process of integrated design involving several disciplines.



Research Center
Basel, Switzerland



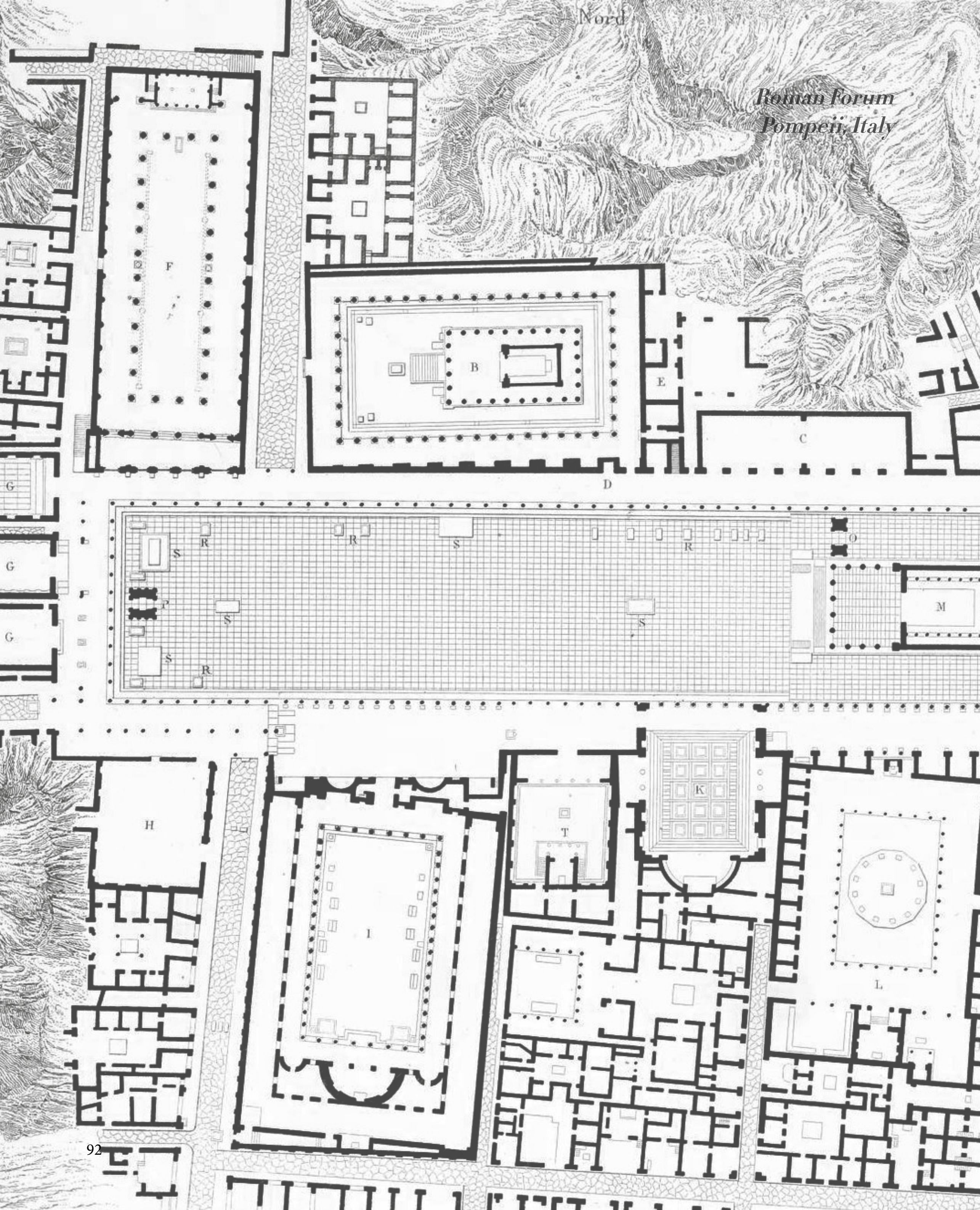
Santa Maria delle Grazie
Milan, Italy


FACILITY TOWER
CHEMISTRY
ANATOMY
BASILICA
PHYSICS & SNI

Science Forum Cluster

Articulated System

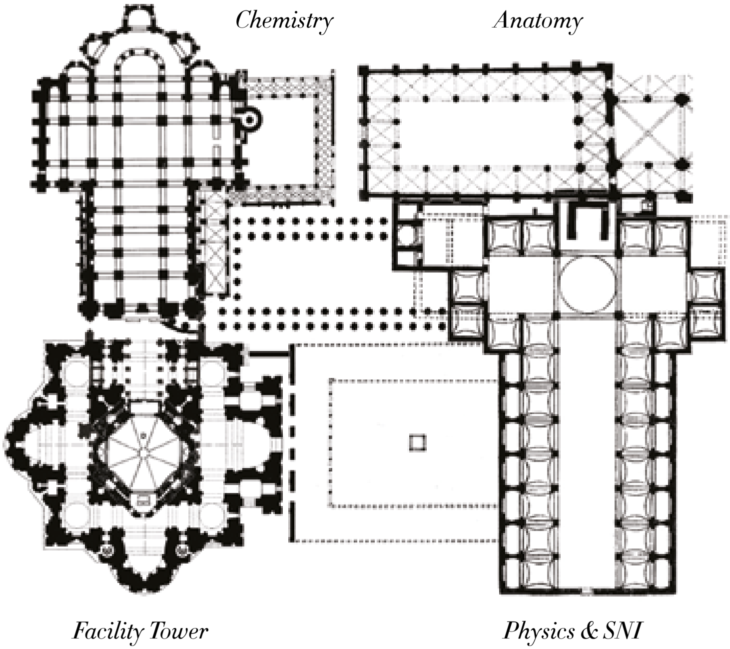
The gate of the forum towards the city centre of Basel is defined by the two most representative buildings: the Tower, defining a new urban landmark, and the Basilica (hosting the Physics and SNI departments), symbolically representing a sacral temple of science and knowledge which dominates the forum and virtually corresponds to Predigerkirche. Finally, the lower fabric corresponds to the palaces defining the borders and therefore the dimension of the open space, as in the traditional squares of the historical city centre.



Roman Forum
Pompeii, Italy

The forum

One of the **fundamental topic**s at the base of the project is that of the **"Forum"**.
The term "forum" was originally introduced in ancient Rome to **refer to the "public place"**: they represented the most important religious, political, economic, and educational centres of Roman cities.
Throughout history, the public forum served as the main vital hub for many cities, and similarly, the project for the Schällemätteli University Campus is developed starting from the intention of providing the city of Basel with a vital **"Forum of Science"**, able to represent a new reference point within the city, thanks to its capacity to **create opportunities of interaction and exchange, and therefore, of innovation.**
Such forum would emulate many functions of its Roman predecessor, allowing for **dynamic environments, networking and growth of local communities**.



Linear Aggregation Around a Central Fulcrum

Roman Forum

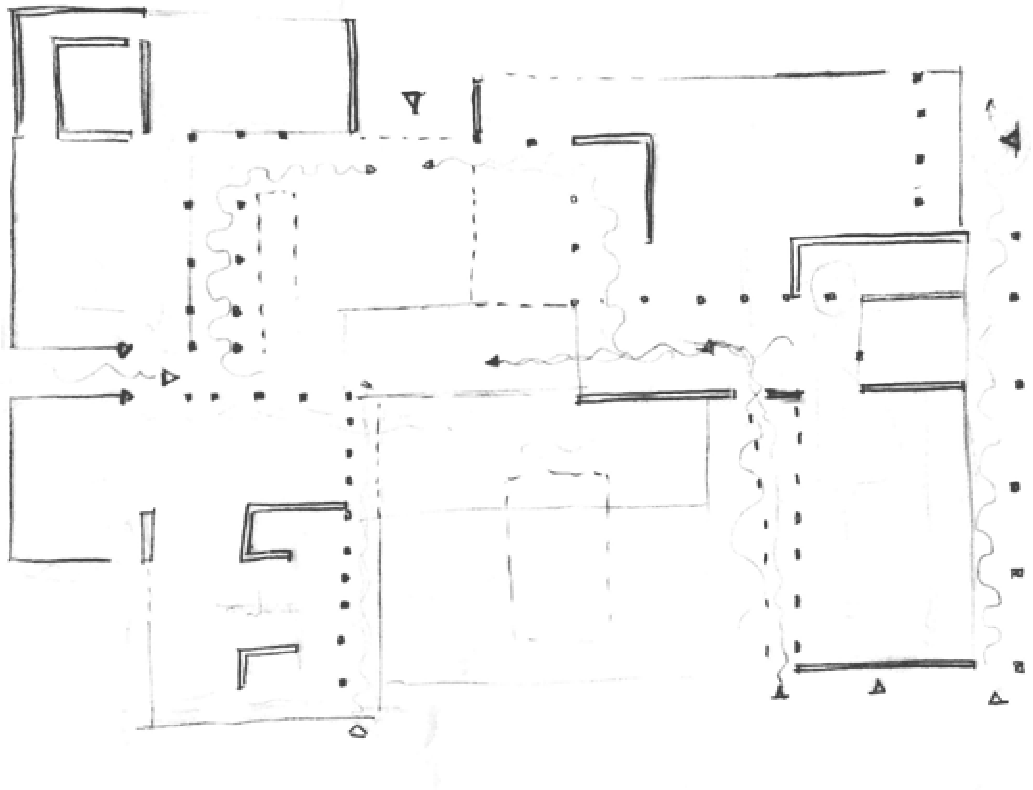
Typological Superimposition

Typological superimposition

it is used to integrate different components into a formal type keeping the unitary character of the arcade system that defines the unified structure.The four volumes have then been manipulated according to the context and to the intention of giving a specific identity to each of them.

Type aggregation

The Forum did not simply **host a broad variety of social activities**, yet it was **itself composed of diverse architectural typologies concretizing the dynamic cultural and economic networks** of Roman society.
It can be defined as an **aggregation around a centre,** in which the **different** components, referring to **defined typological forms** conceived as elementary architectural structures, **coexist and interact**.
The variety of elements involved in the composition increases its **richness in terms of architectural typologies, functions provided, categories of people involved:** such approach favours the networking between people involved in different sectors to share competences, skill and ideas.
Typological superimposition is also used to integrate different components or aspects into each elemental formal type, without losing the unitary character of the structure defining the system.



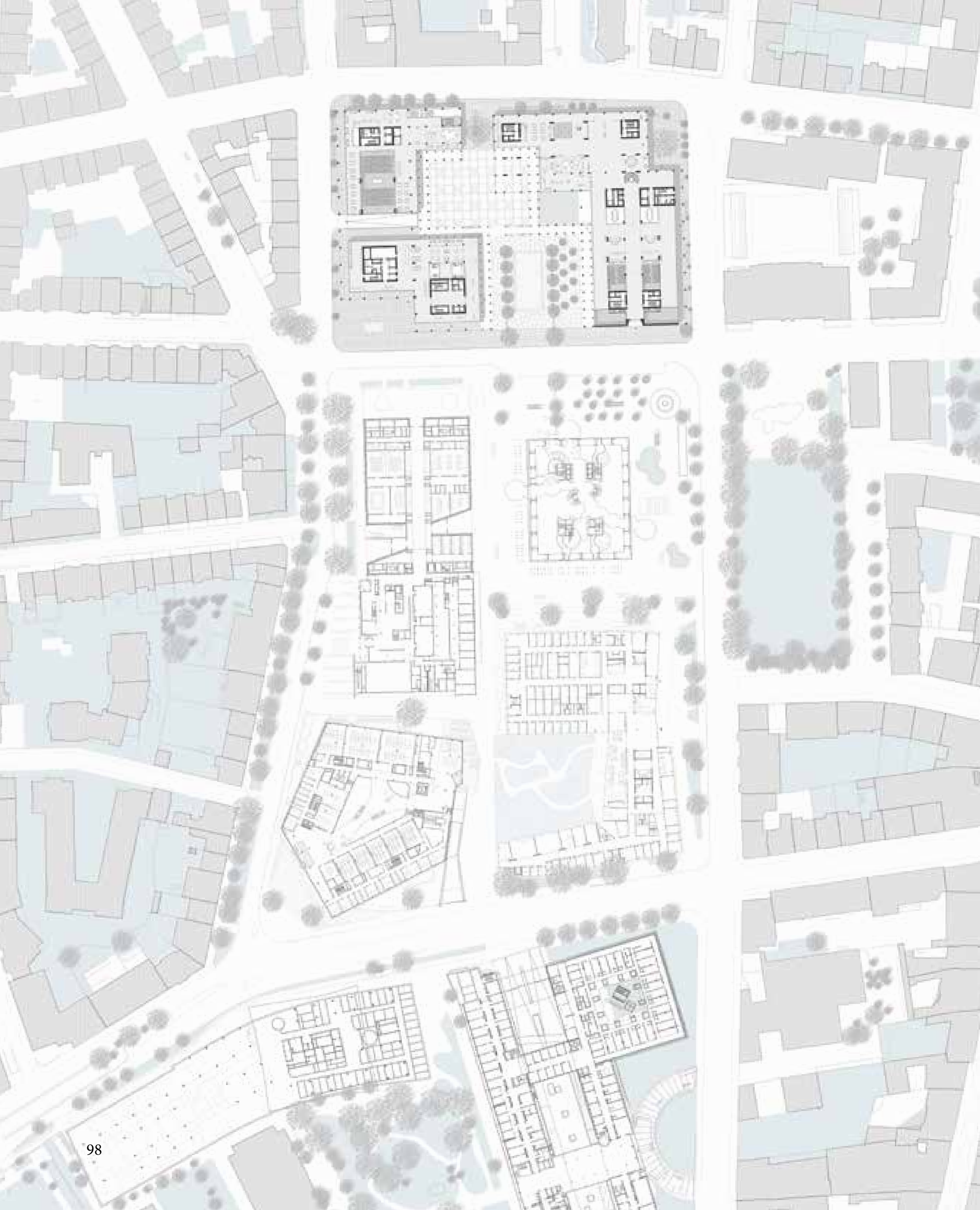
Concept sketch

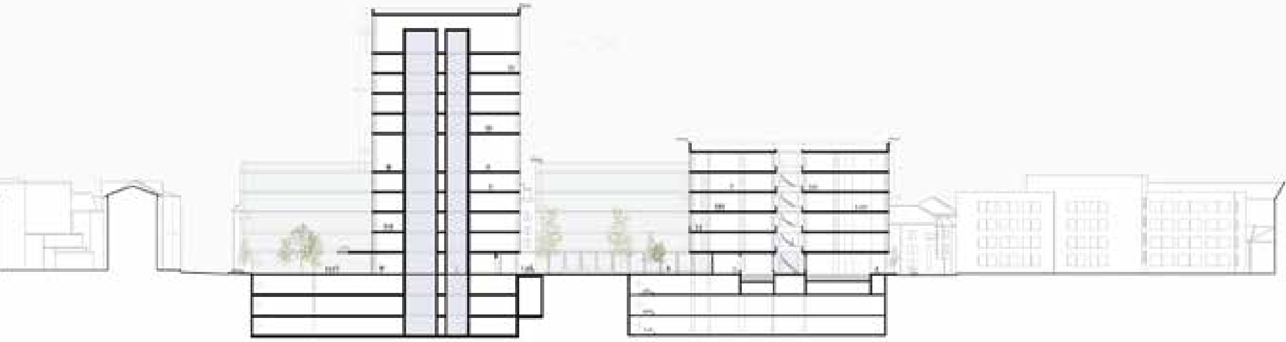
"The peculiarity of the typological thought is the ability to establish an active relationship with the architecture of the past, which going beyond pure contemplative admiration, allows us to grasp its relevance"

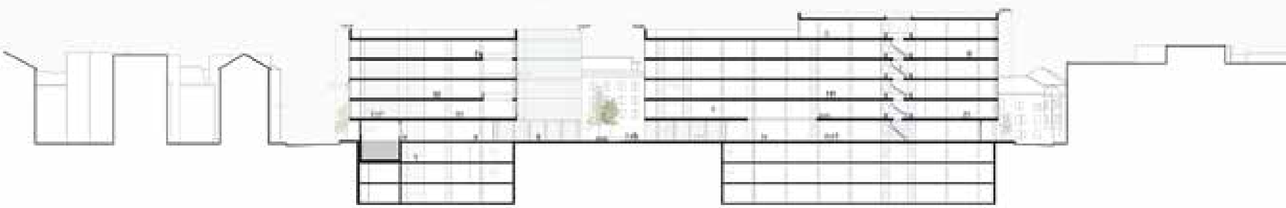
Carlos Martís Arís

Ground-floor plan

The **typological method** can lead to **generative and transformative processes**: indeed, projects can start to be conceived as **scenario of constant reinvention of existing types**. For instance, in typological aggregations it is very important to **deal with the sense of unity of the composition, despite the variations**. To bring the composition together, indeed, **forums used to be unified by a continuous system of columns**: an architectural element strongly affecting the **architectural language**, but also affecting the **management of circulation**. Such characteristics can be **reinvented and updated to contemporary needs and modes of expressions**, becoming a stimulating challenge and topic of research leading the project development.



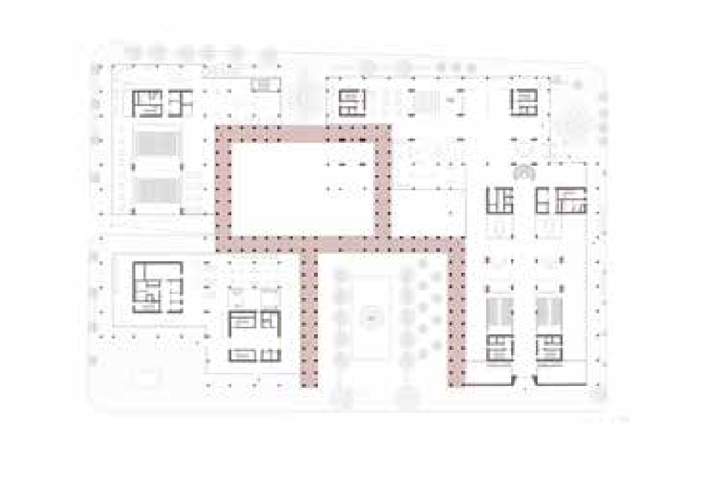




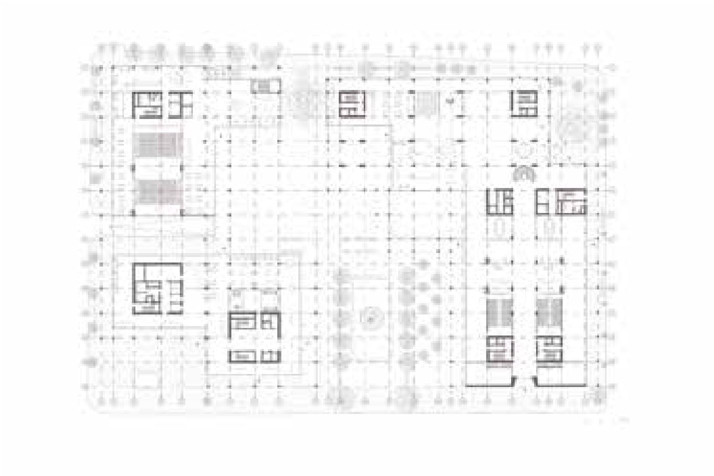
Early design sections in the context

The new **Basel Science Forum,** is conceived as a sequence of public spaces representing **a collector of people, and a point of encounter among different groups of people:** citizens, students, professors, researches, technicians, firms, start-ups and entrepreneurs.
Such intention is expressed by the space configuration of the open spaces, trying to **join different contexts and scales**, while giving unity to a series of **different "atmospheres"**, each with a specific identity. **It is meant to be such a rich and varied place that anyone can find its place**, while being in close relation with the others.

Portico System

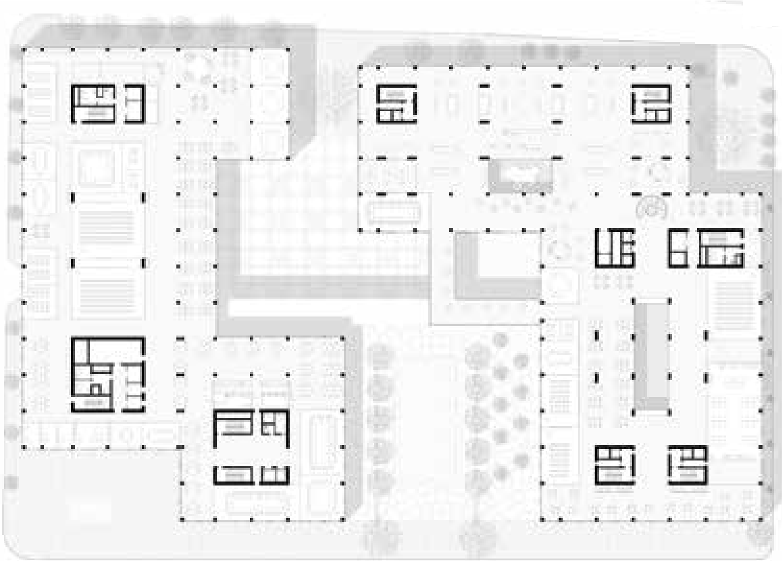


Structural grid

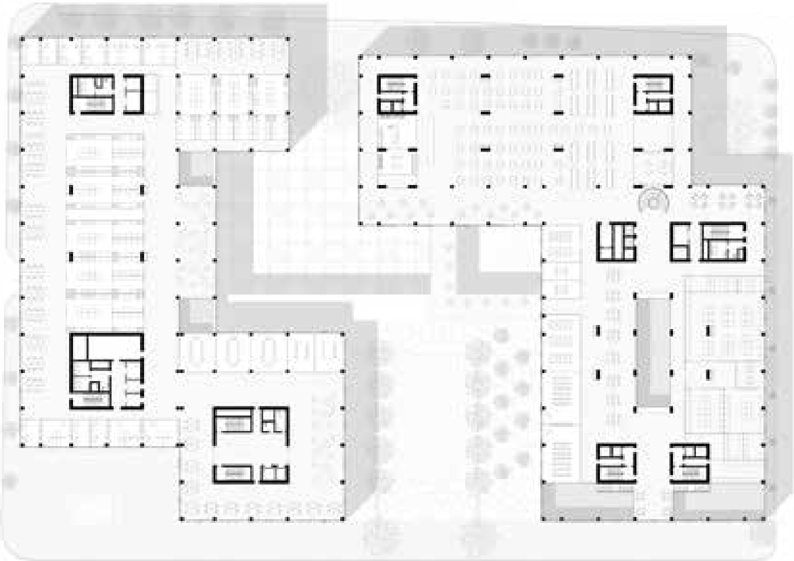


The Portico

The sense of **unity is generated by the continuous portico system linking the entire composition together** and providing a **common backdrop and language** to each side of the forum.
The portico also represents in **important threshold between indoor and outdoor environments**, where both people working or studying in the complex and other citizens can walk through to carry out several activities, **possibly bumping into each other and starting a conversation.**
The portico also become an important in the definition of the **structural layout.** Indeed, the system's layout has been adjusted according to **a regular grid with a main span of 7.2 meters**, with few variations, as this dimension was found out to be suitable for the design of laboratory buildings.
However, a further level of constraint was given by the attempt to **combine the structural grid with the rhythm of the portic**o, which had to be **maintained unchanged throughout the entire composition**, in order to give a sense of unity. **The portico rhythm has then been set at a half of the structural rhythm, with a constant span of 3,6m**.



First Floor Plan, +5.20 m



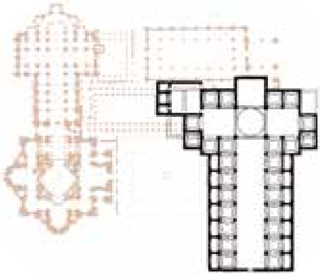
Second Floor Plan, +9.70 m

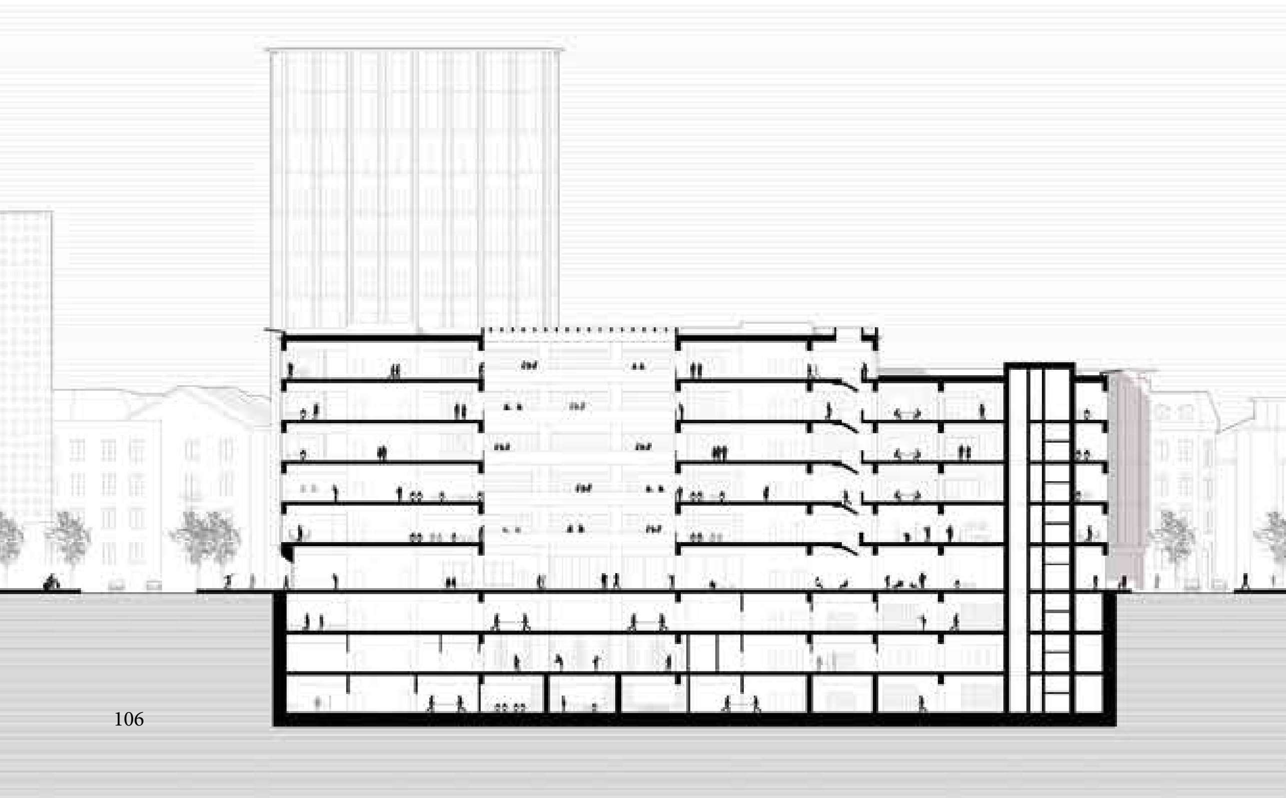
The Podium

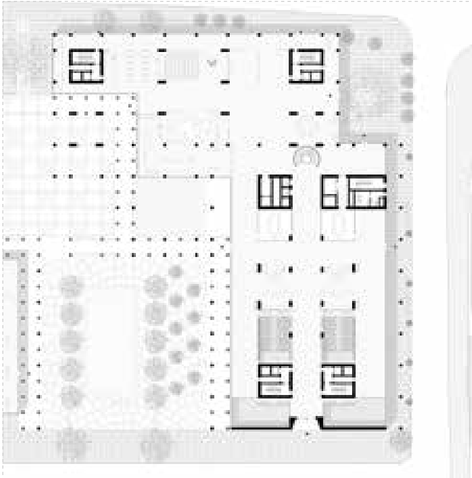
The ground floor of entire complex is kept public, forming a sort of **continuous common ground together with the open public space of the Science Forum**. Public functions are mainly distributed in the ground floor, first-floor, and partially in second-floor and -1 basement levels. Especially, ground-floor and first-floor levels form together a sort of **public podium**, to which also the second-floor level can be integrated at some degree. Indeed, the second level is mainly dedicated to educational functions, therefore creating a first threshold between spaces open to the public and spaces for students or professors.
The portico system, which defines both the inner and the outer perimeter of the buildings, emphasizes urban ground-level podium creates a transitional space and threshold in between the buildings of the campus ad well as in between the residential area and the university.
The **main features characterizing the podium** are, indeed, the **permeability of its borders, entirely glazed** at ground-floor level, and **set-back** with respect to the upper floors due to the presence of the **portico system**. Finally, the podium is characterized by its program, **open to the public**.

The basilica

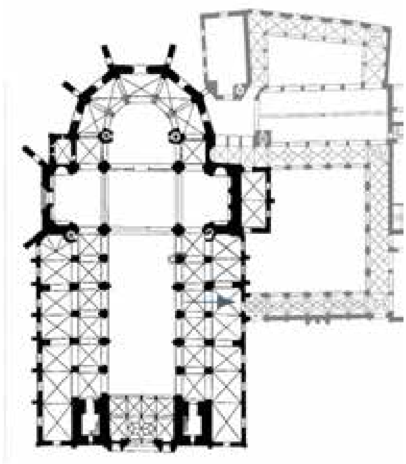
The starting point of the design idea for one of the volumes composing the university complex was the Basilica Typology, meant to be embodied by the most representative building of the campus. The building consists of a six-story laboratory building located on the crossroads between Spitalstraße, the principal artery of the campus, and Pestalozzistraße, and it hosts the new Physics and SNI departments. The longitudinal facades of the Basilica face on one side the Science Forum, and on the other side the south-east axis leading towards Basel St. Johann train station and Novartis Campus.







Physics Ground Floor Plan



Basel Münster Cathedral

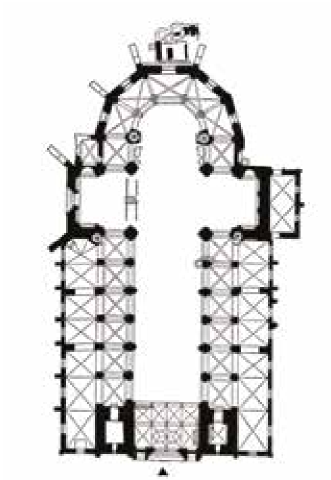
Typological characteristics

The typological method involves **generative and transformative processes as a design mechanism**. With such method, the architectural form of the campus building is obtained by re-elaborating traditional typologies according to the new century technological and structural advancements. The overall constructive and morphological solution allows the combination of different typologies, deriving by the multiple requirements that the building needs to satisfy, while maintaining a unique formal character. **The typological superimposition involves the Lichthof Type and the Basilica Type**. The first one takes into account the **needs related to the use of the building** (research labs), which is characterized by several floors hosting wide standard laboratory units, while the Basilica Plan Type answers to the needs of the **ground floor layout, in relationship with the public spaces.**

Basilica Type

The **basilica type** plan, in its **Christian** configuration, is taken as a reference due to the need to create a representative space, anticipated by a **main urban facade,** and characterized by a **longitudinal tension along a central nave**, which in case of the University building leads to a monumental staircase, allowing the access to the upper floors.

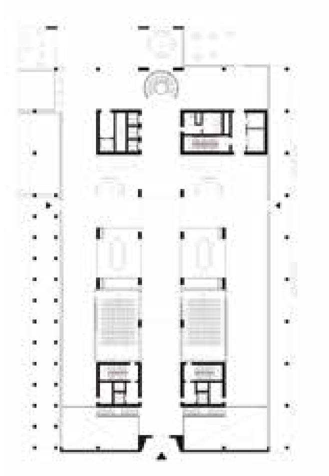
The **Roman Basilica type,** instead, is studied as a reference to design the main space of the University building **as a collector of people, where one of the longitudinal sides faces the public space**, as it was happening in the Roman forum. The Basilica plan we first took into consideration was that of **Basel Münster**, with the intention of re-creating a similar atmosphere to that of the historical public spaces in the city, introducing elements of continuity between the Roman Celtic city of Basel and the contemporary European city.



Basel Münster Cathedral

Christian Basilica - 1135 -

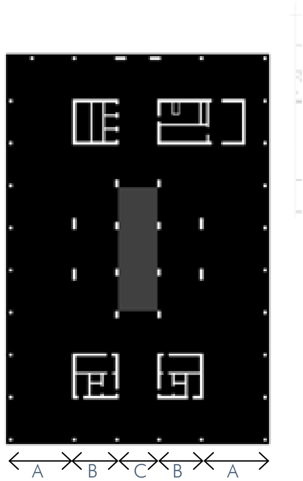
•*A system defined by four rows of* ***structural colonnades*** *divides the space into naves.* ***The outer masonry walls correspond to the load-bearing structure.***



Project Ground Floor Plan

Reinterpreted basilica type

• *Four rows of* ***structural columns*** *divide the space into naves.* ***Reinforced concrete load-bearing skeleton*** *independent from the outer envelope.*

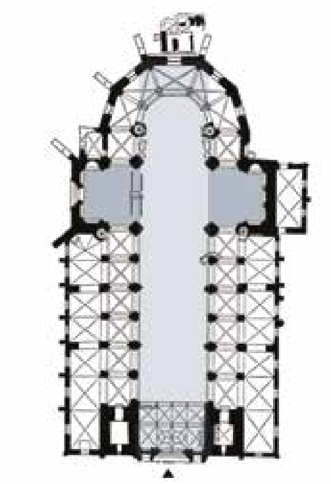


Project Structural Configuration

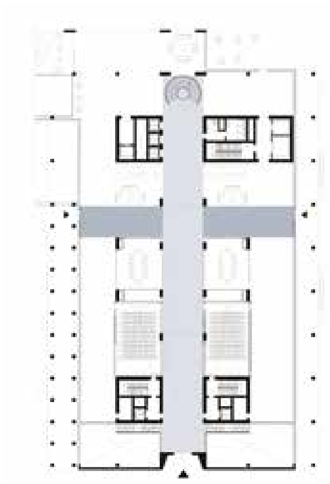
Abstraction of the system

• *The two cores closed to the entrance and the solid walls of the transept in Basel Münster recall the 4 cores of the contemporary plan*

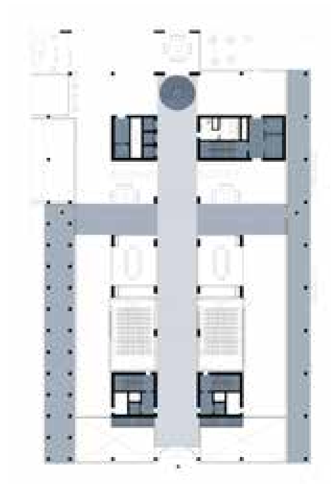
Distribution System



Basel Münster Cathedral
Layout plan



Physics Ground Floor Plan
Spatial organization

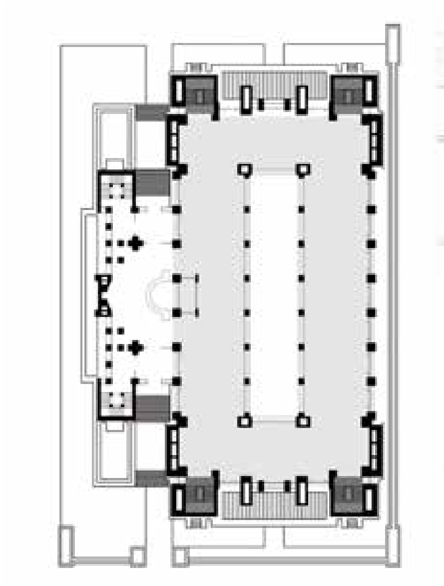


Structural Configuration
Access and Circulation System

• ***Longitudinal tension from the main entrance to the altar:*** *primary distribution through the main nave, secondary distribution along the transept.*

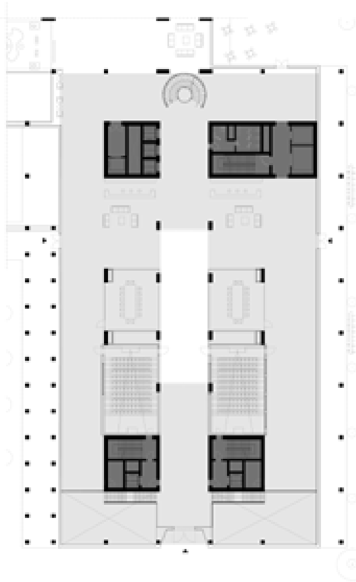
• ***Main entrance*** *on the short side of the building, which defines the* ***main facade*** *and leads to the main nave. Secondary distribution connecting the main public space with the main street.*

• ***The perimetral portico system*** *introduces a further level of complexity in the definition of an* ***in-between spaces distribution route****, related to the public space.*



Lichthof Type Plan

Larkin Administration Building
F. Llyod Wright, 1903



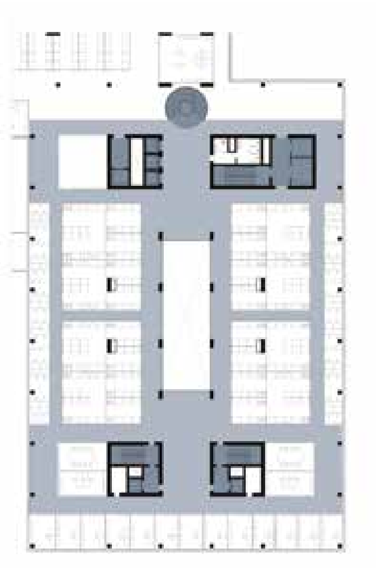
Project Ground Floor Plan

Physics & SNI Department
Campus schällemätteli, 2020

• Considering the needs related to the use of the building (research labs), characterized by several floors and by standard lab units, the Basilica Plan Type of the ground floor is overlapped at the upper floors with the so called Lichthof Plan Type.

• The design of the cores is planned in such a way to create a balanced layout, exploiting their location to create a series of "thresholds" or "buffer zones" dividing the different functional areas pf the building.

Functional distribution



Project Type Floor Plan

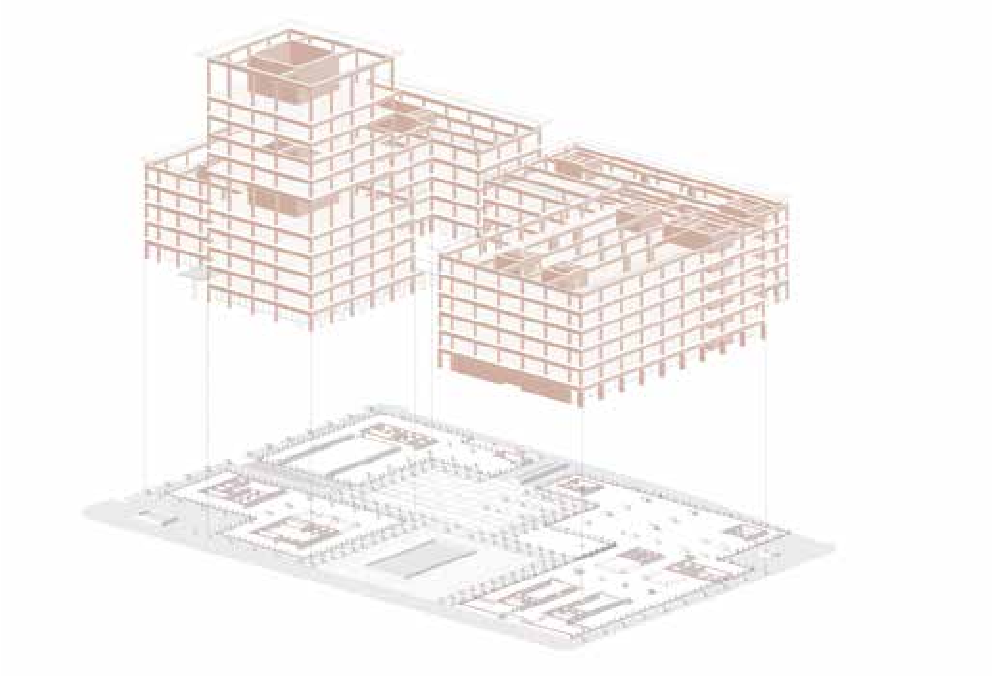
Circulation Diagram

Project Type Floor Plan

Program Layout

• The circulation path runs around the void of the central courtyard, which represents a space of interaction, as well as the buffer zones around the cores. The remaining circulation paths allow the functional movement between lab units and desks spaces.

• The laboratory spaces and the office areas are designed in such a way to optimize the level of flexibility of the structural layout, as well as the level continuity in the circulation, creating a better working environment.

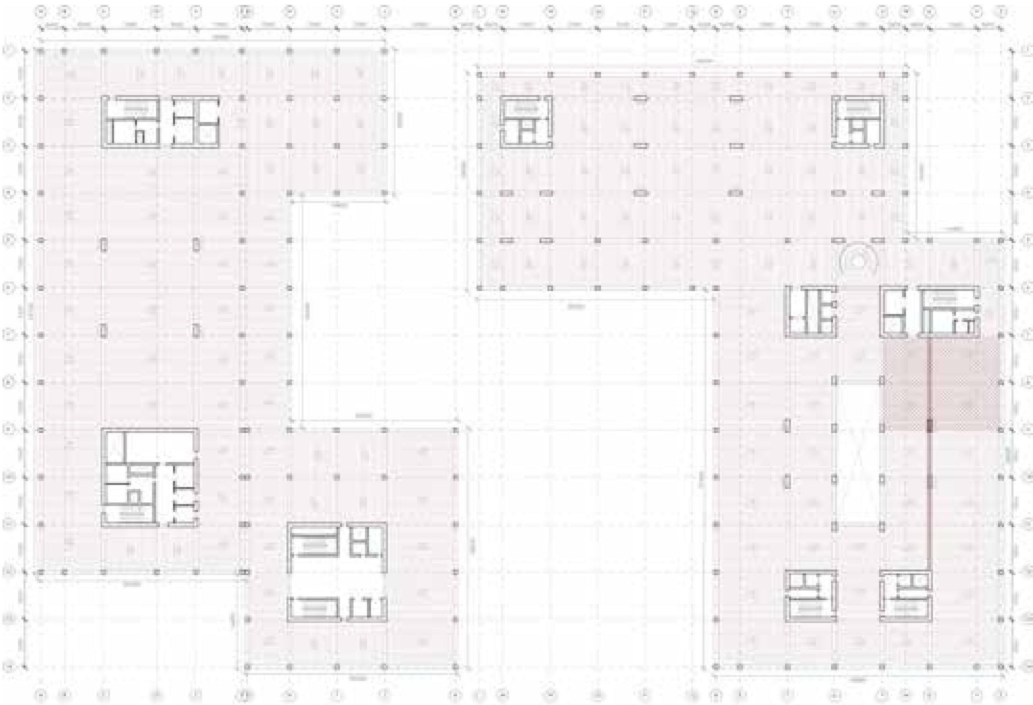


Structural layout

The **structural system** chosen is a homogeneous solution composed of **reinforced concrete columns and beams frame, supporting solid reinforced concrete slabs.** The choice of **concrete is related to the Swiss architectural tradition,** where the use of **structural concrete is predominant.**

As anticipated, the **structural grid is mainly based on a module of 7,2 meters**, considered as **optimal for hosting laboratory units**, while the **biggest span** is given by a double module of **14.4 meters**. **Structural columns**, characterized a section of **60x60cm**, carry the weight of **continuously supported beams**, **60x100cm**, which **run longitudinally along the main dimension of each volume**, emphasizing the sense of **continuous movement** along the "**main naves**" of the buildings, once again re-creating the spatial experience of Basilicas. The structural system had indeed been defined stating from the definition of the Basilica plan, and it has then been extended to the entire system, according to the constraints set by the continuous portico.

The structural grid has then been adjusted in order to optimize the type floor design for lab units: within the system it is also possible to identify some longitudinal columns associated with cavities meant to host the shafts needed to feed the labs, while others are simply meant to underline the longitudinal tension of the layout.



Structural Type Floor Plan,

+18.70 m

- 7 -

“project program”

the program

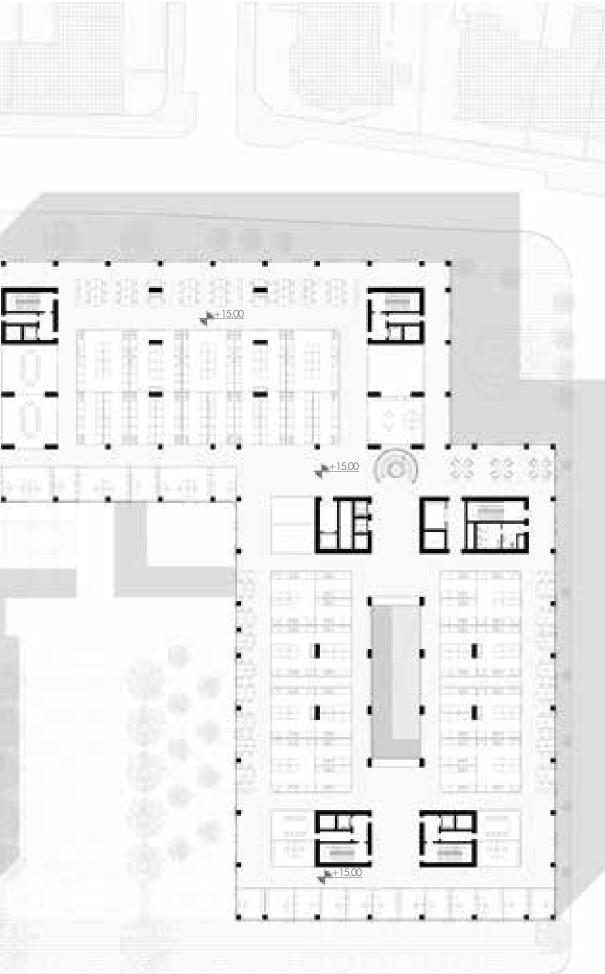
chemistry & tower

chemistry

19 research groups 20 double units	6'500 m2
- main hall	1'500 m2
- teaching area Laboratory area Lecture Area Classrooms Computer Rooms	1'500 m2
- meeting area	670 m2
- faculty staff representativre office	450 m2

tower 9'900m2

common facilities	575m2
public gallery	425m2
main hall	400m2
education center	
events area	
student facilities	2'100 m2
research library	1'100 m2
start-ups and co-working	1800 m2



physics & SNI anatomy

physics & SNI

24 Research units

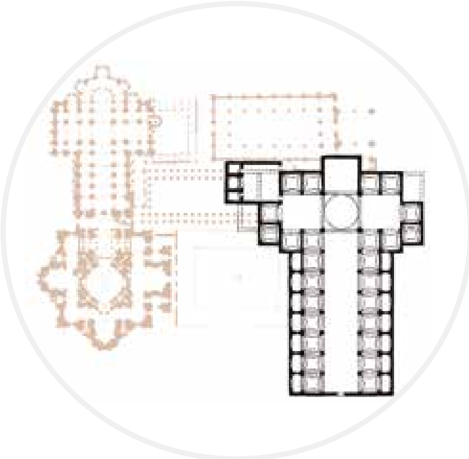
- **physics** department	10'307 m2
- **SNI** swiss nanoscience institute	7'073 m2
- **teaching area** Laboratory area Lecture area Classrooms Computer rooms	1'200 m2
- **animal station** (underground)	1'800 m2
- **meeting area**	360 m2

anatomy

7 reseach groups 3 double units	1000 m2
special rooms	700 m2
anatomy museum	800 m2

department of physics & SNI

The department of Physics and SNI includes all laboratory space with workplaces as well as offices, seminar rooms and social rooms for research. Additionally, the building includes animal station that serves for the further development in the field of science.



physics

The department of Physics of the University of Basel is a specialized international research centre in the fields of nano and quantum physics, cosmology, and particle physics. Two main focus area in the fields of modern physics are:

- nano and quantum physics

dealing with the structural research of the nanometre-scale along with understanding and controlling the process of quantum phenomena.

- cosmology and particle physics

developing the physical evolution theory of the universe with the examination of the matter and its fundamental particles.

These two interlocked fields underline the basic theory of quantum physics through a rapid development that shapes the technologies of the future in contribution to the scientific world view.

physics & SNI People

15 Professor
18 Lecturers
6 Administrative staff
5 Infrastructure and services
8 Emeriti

SNI swiss nanoscience institute

The Swiss Nanoscience Institute is founded by the University of Basel and Swiss Canton Aargau in 2006, and it is focused on interdisciplinary work and research topics related to Nanotechnology and Nanoscale Sciences. The transformation of knowledge and technology thanks to the contribution of the public is a significant pillar of SNI activities.

the program
physics & SNI

physics

19 research groups — 1000 m2

experimental physics
(10 single units)
- Quantum Atom Optic's Lab
- Nano-Photonics Group
- Nanophononics Lab
- Quantum Coherence Lab

theoretical physics
(6 single units)
- Quantum Optics Theory Group
- Condensed Matter Theory
- Computational Physics
- Quantum Sensing Lab

cosmology & particle physics
(2 single units)
- Nuclear & Particle Physics
- Particles & Cosmology

special rooms (underground)	1'300 m2
- Laboratory area	460 m2
- Data Analysis	100 m2
- LAser Laboratory	240 m2
- Mass spectrometer	100 m2
- CCLS - X-Ray and NMR Labs	400 m2

SNI swiss nanoscience institute

6 research laboratories — 700 m2

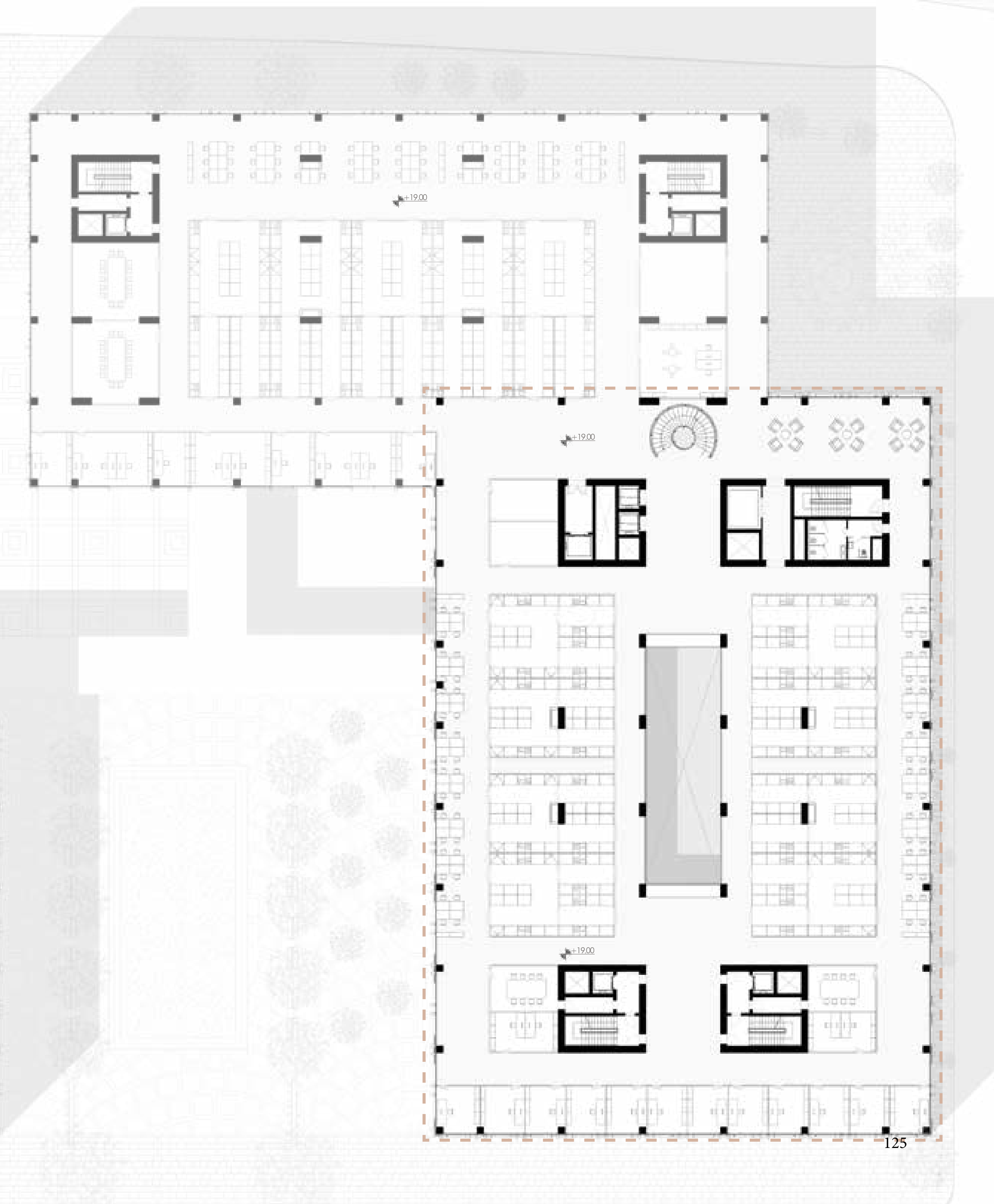
- Nano-mechanics & Nano-magnetism
- Quantum & Nanoelectronics Labs
- Nano Labs

physics & SNI

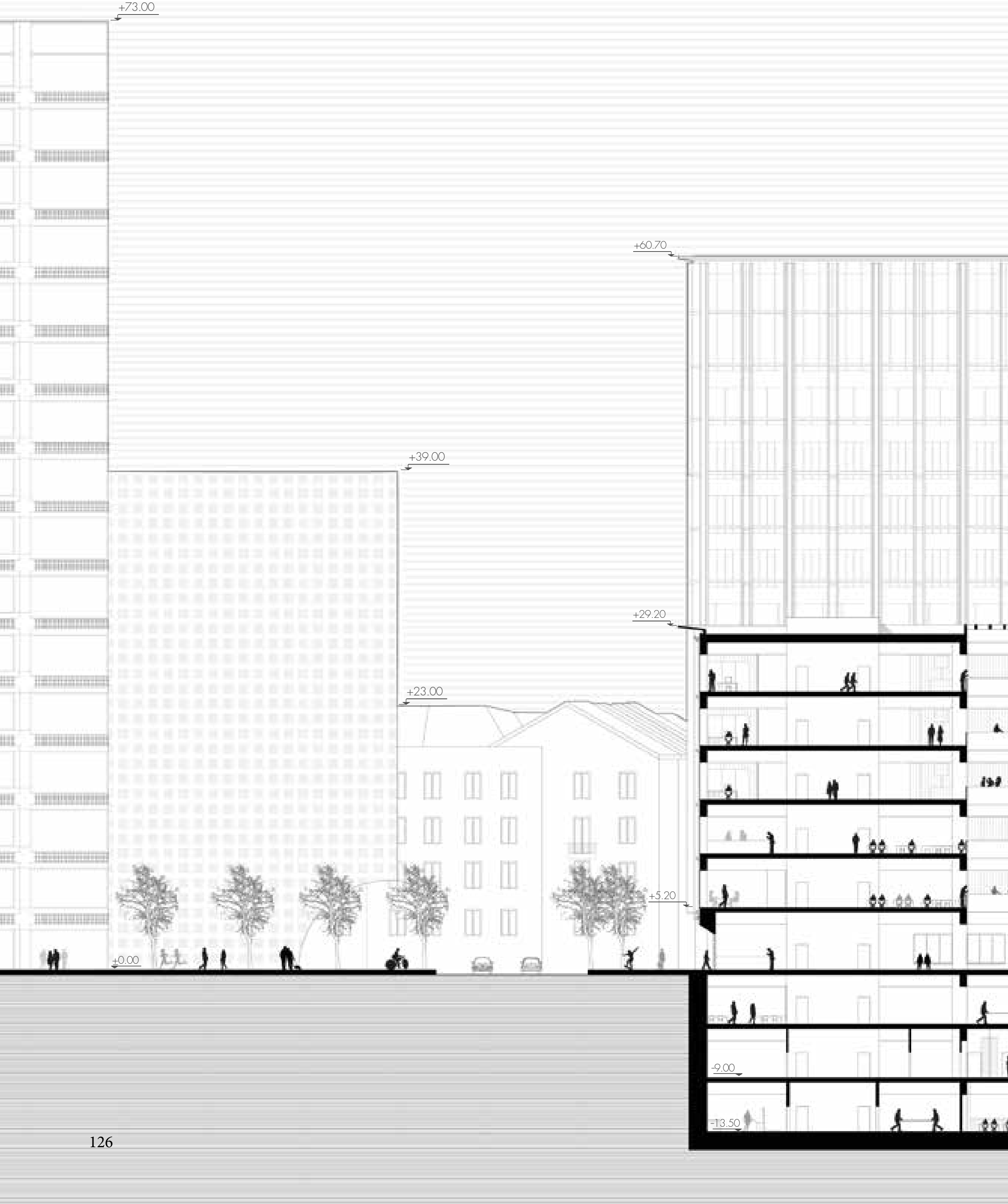
24 Research units

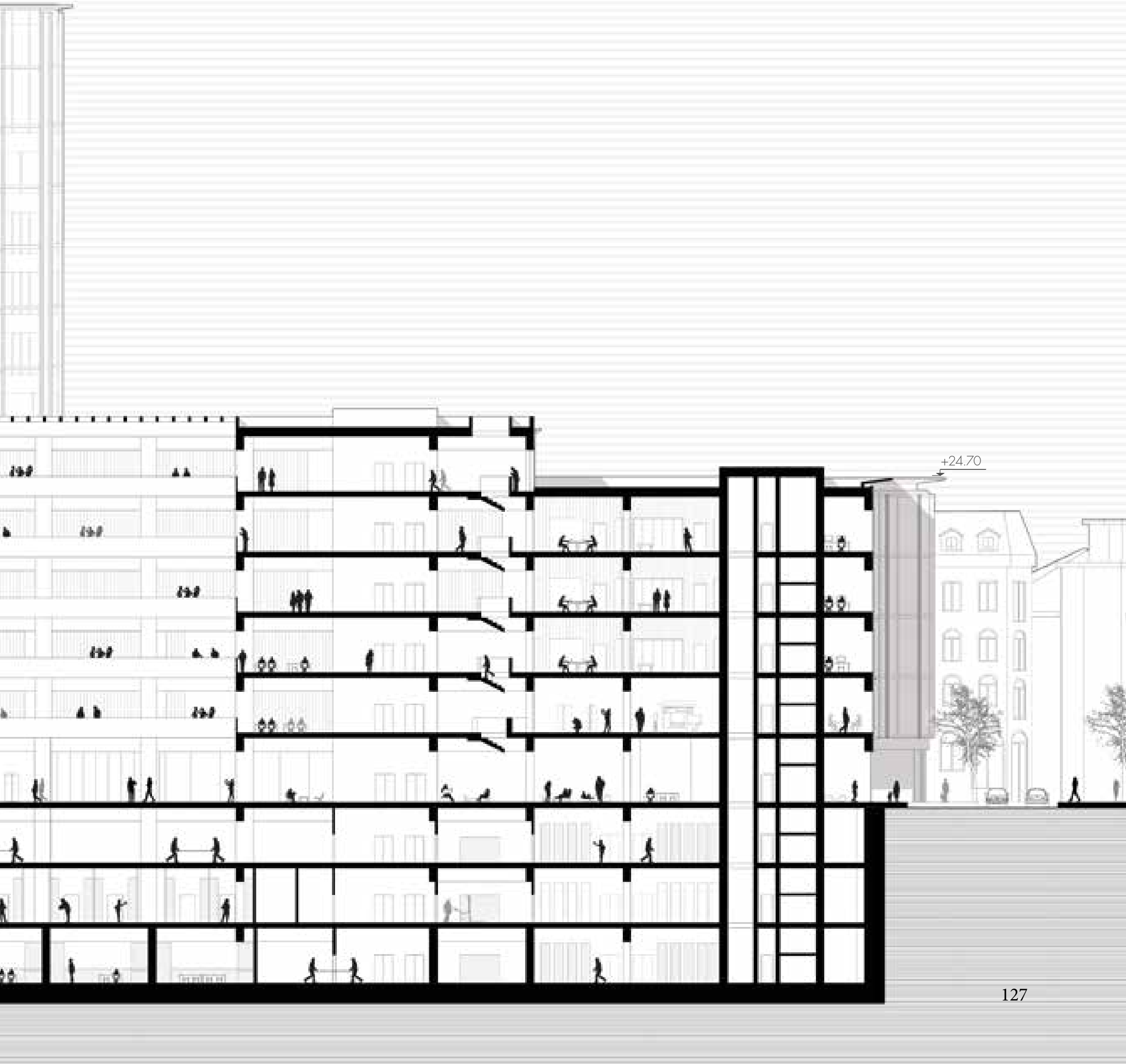
physics	10'307 m2
SNI swiss nanoscience institute	7'073 m2
teaching area Laboratory area Lecture area Classrooms Computer rooms	1'200 m2
animal station (underground)	1'800 m2
meeting area	360 m2

services & infrastructure
Nano Imaging Lab
LEcture Support
Administration
IT & Computer
Physics Library



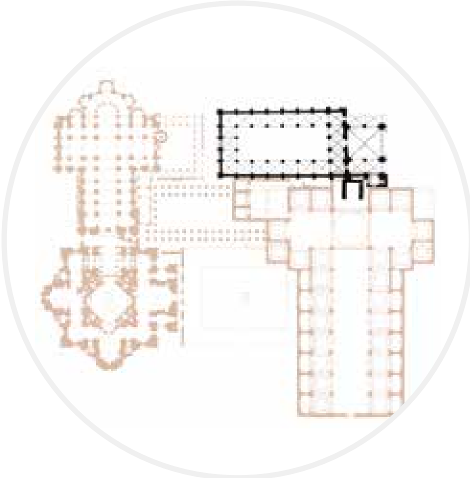
+19.00
+19.00
+19.00


+73.00
+60.70
+39.00
+29.20
+23.00
+5.20
±0.00
-9.00
-13.50


+24.70

institute of anatomy

The portion of building (B) set at the crossroads between St.Johanns-Ring and Spitalstraße is also meant to house the **anatomy department and the anatomy museum** open to the public. New anatomy laboratories designed concerning the new century technology to be able to ontain educational innovations and dissection resources.



anatomy department

7 research groups 1000 m2

- Research area (3 double units)
- Cell Adhesion
- Cellular Neurophysiology
- Development Genetics
- Development Neurobiology
- Histology
- Histology Core Facility
- Makroanatomy/Musculoskeletal
- Neuronal Development and Degeneration
- Sektion - Preparators

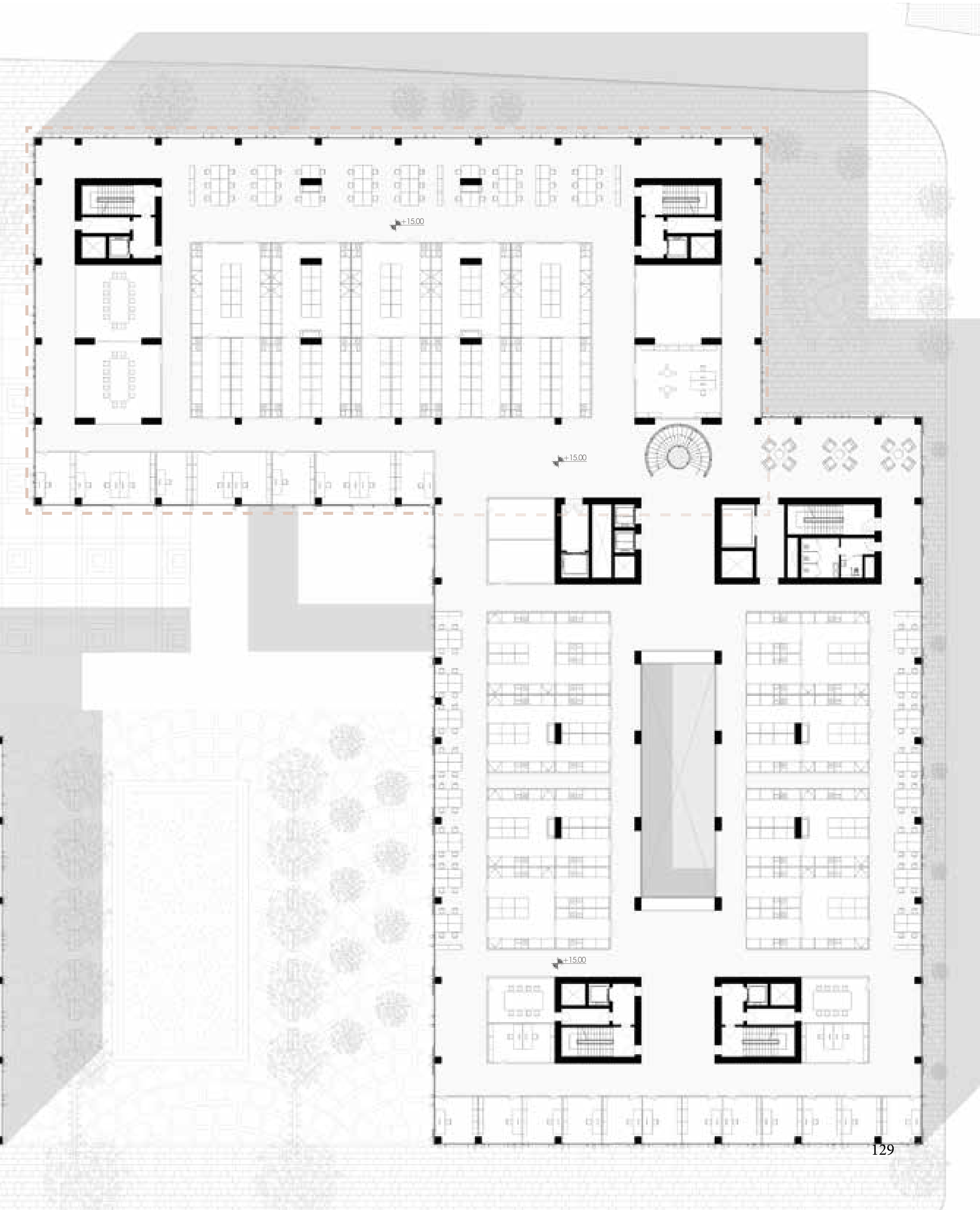
special rooms 700 m2

Dissection Room	310 m2
Main Auditorium - 230 seat	310 m2
Lecture Hall - 56 seat	80 m2

anatomy museum 800 m2

institute of anatomy People

1 Institute Director
8 Professor
8 Researcher and lecturer
9 Postdoc
11 PHD student
2 Master Student
4 Administrative staff
3 Infrastructure and services
8 Laboratory technicians
3 technical employees
3 secretaries
3 preparators (section unit)



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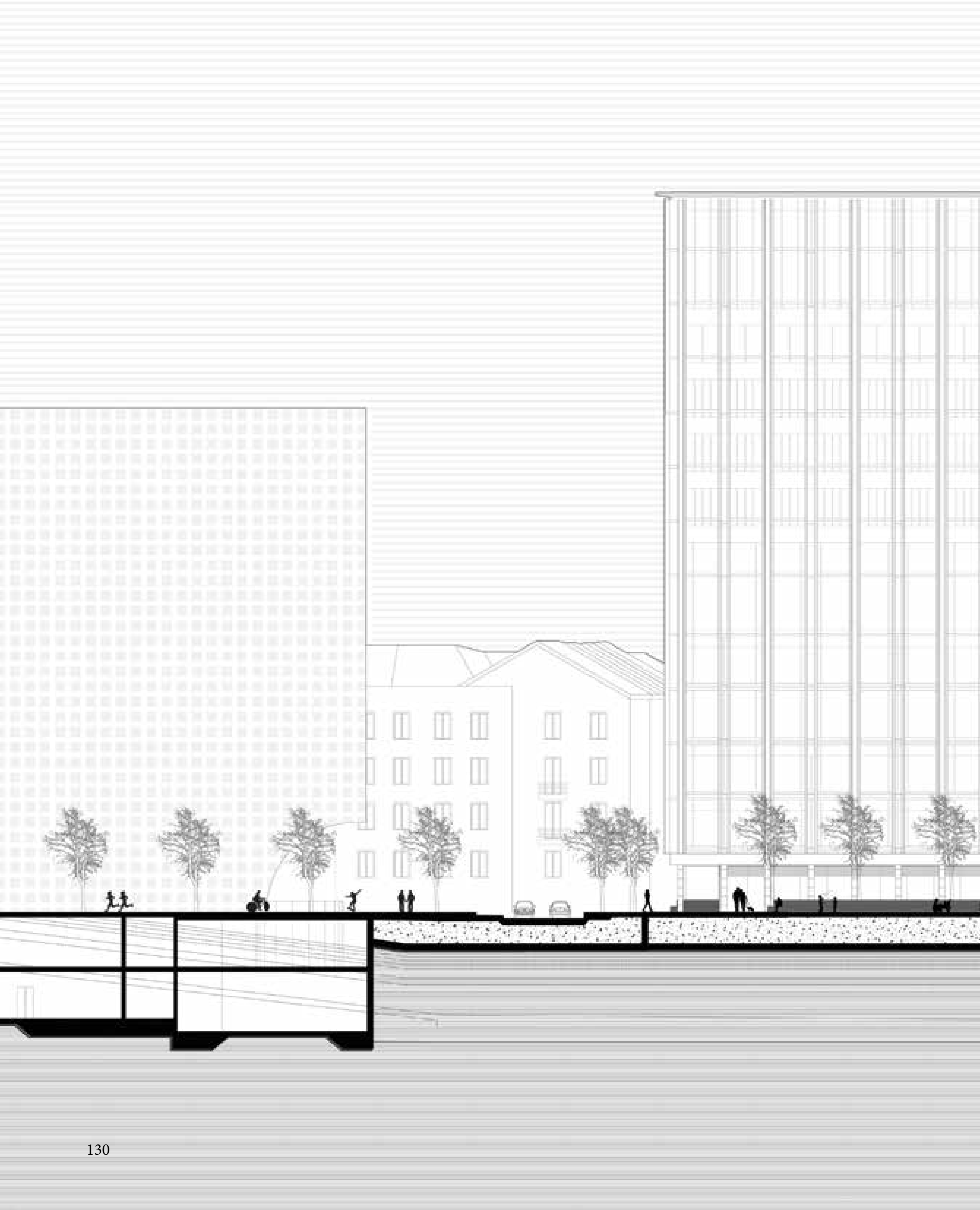
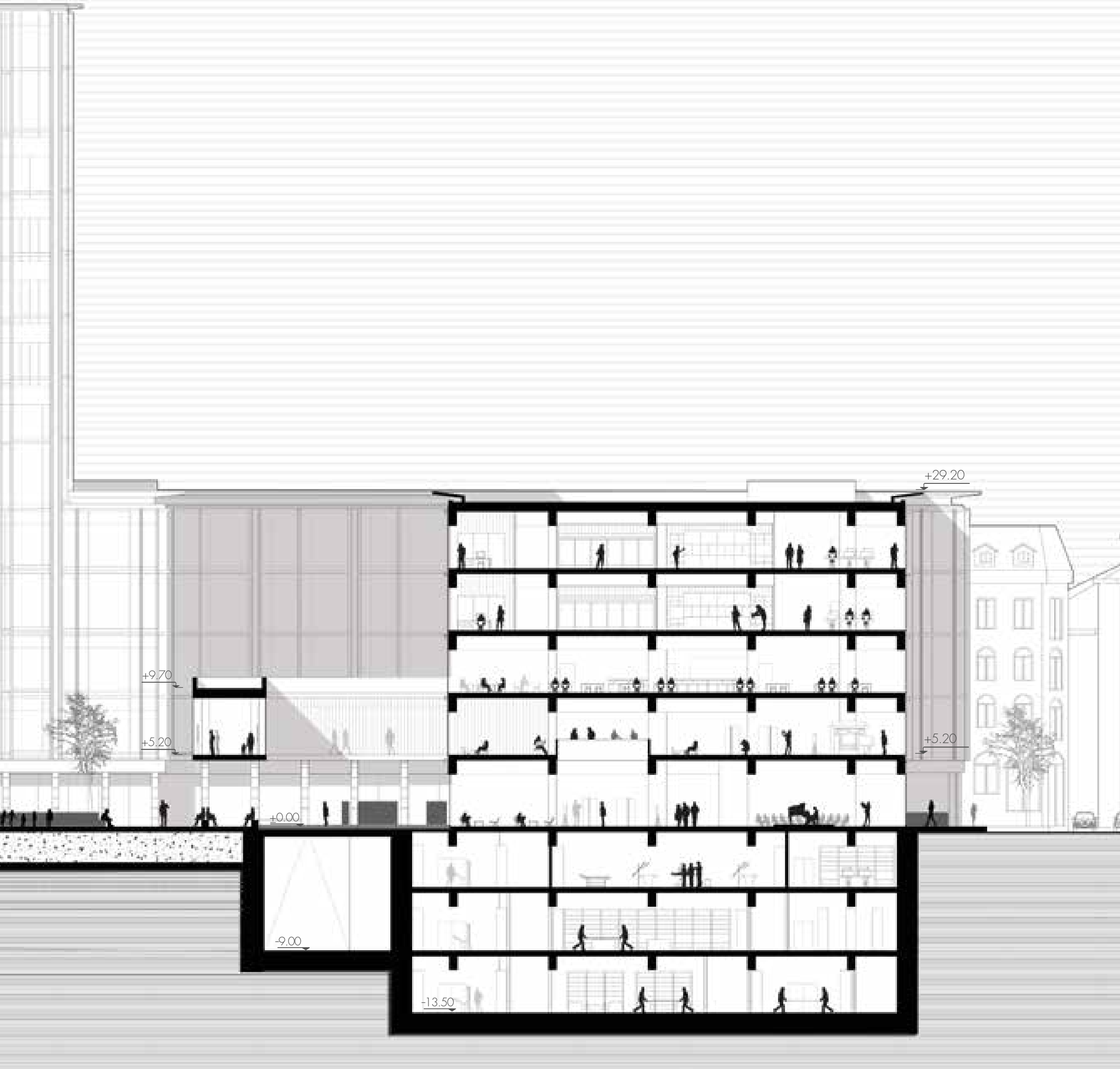
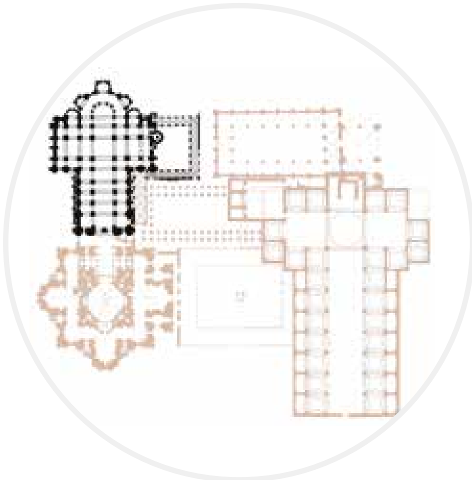



+29.20
+9.70
+5.20
+5.20
±0.00
-9.00
-13.50

chemistry department

At the corner between Klingelbergstraße and St.Johanns-Ring, a five-story building is devoted to host the new Chemistry department. Part of the volume stretches into a 60-meter high volume, named as Facility Tower, with which it shares, both functionally and spatially, the first five storeys, as well as the basement for underground logistics. The fronts along this crossroad are mainly shaped by residential blocks characterized by a maximum height of 30 meters, which influences the height of the designed building, defined in continuity with the Anatomy department along St. Johanns Ring.



chemistry

19 research groups 6'500 m2
20 double units

main hall 1'500 m2

teaching area 1'500 m2
- Laboratory area
- Lecture Area
- Classrooms
- Computer Rooms

meeting area
670 m2
faculty staff
rappresentative office 450 m2

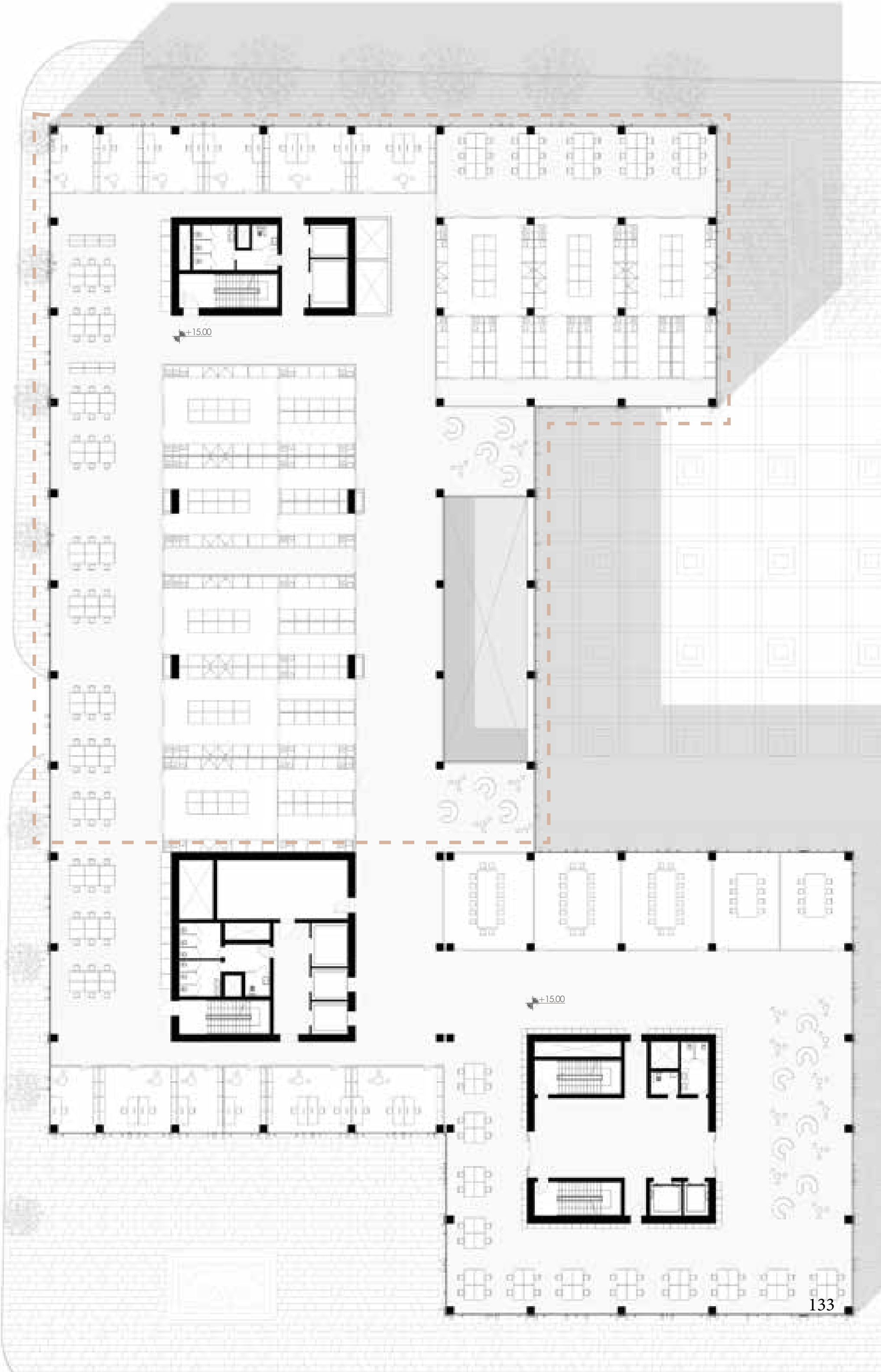
network and collaborations
- Swiss Nanoscience Institute (SNI)
- NCCR Molecular Systems Engineering
- C. and H. Dreyfus Foundation

chemistry department people

9 Professors & Privates Lecturers
23 Assistant lecturers
40 Postdocs
151 PHD students
13 Administrative staff
23 Infrastructure and services
11 Emeriti

8 research areas

- Inorganic Chemistry (IN)
- Organic Chemistry (ON)
- Physical Chemistry (PC)
- Synthesis & Catalysis (S&C)
- Nanomaterials (NM)
- Theoretical Chemistry (TC)
- Analytical Chemistry (AC)
- Biological Chemistry (BC)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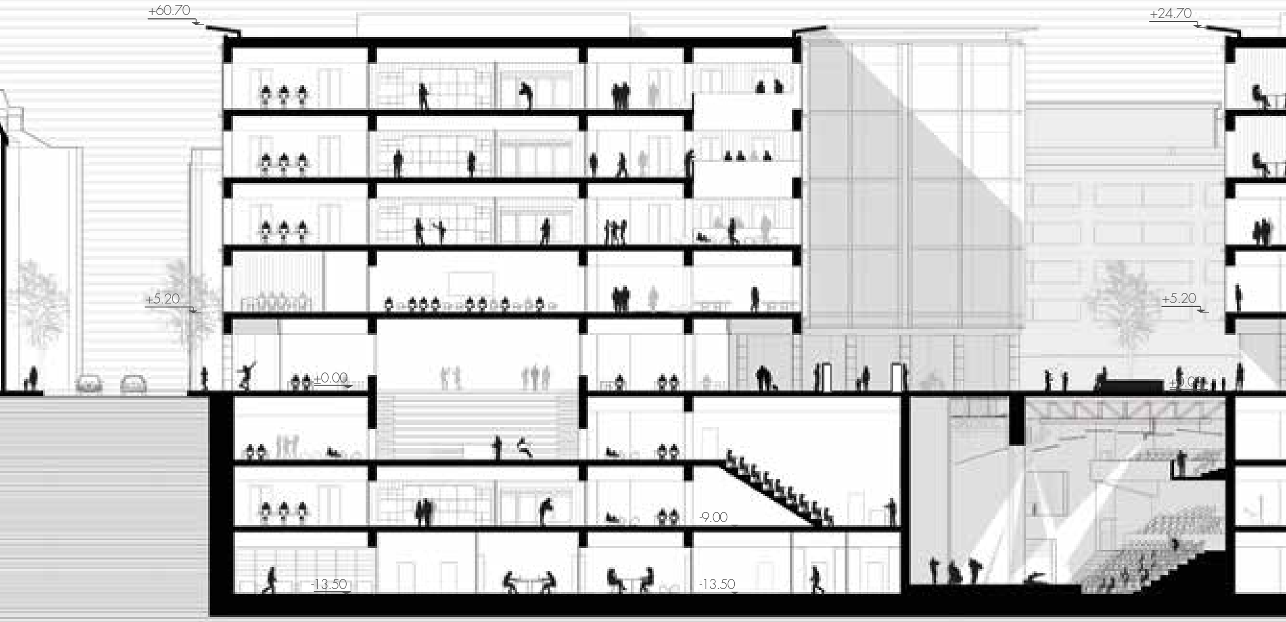
+60.70
+24.70
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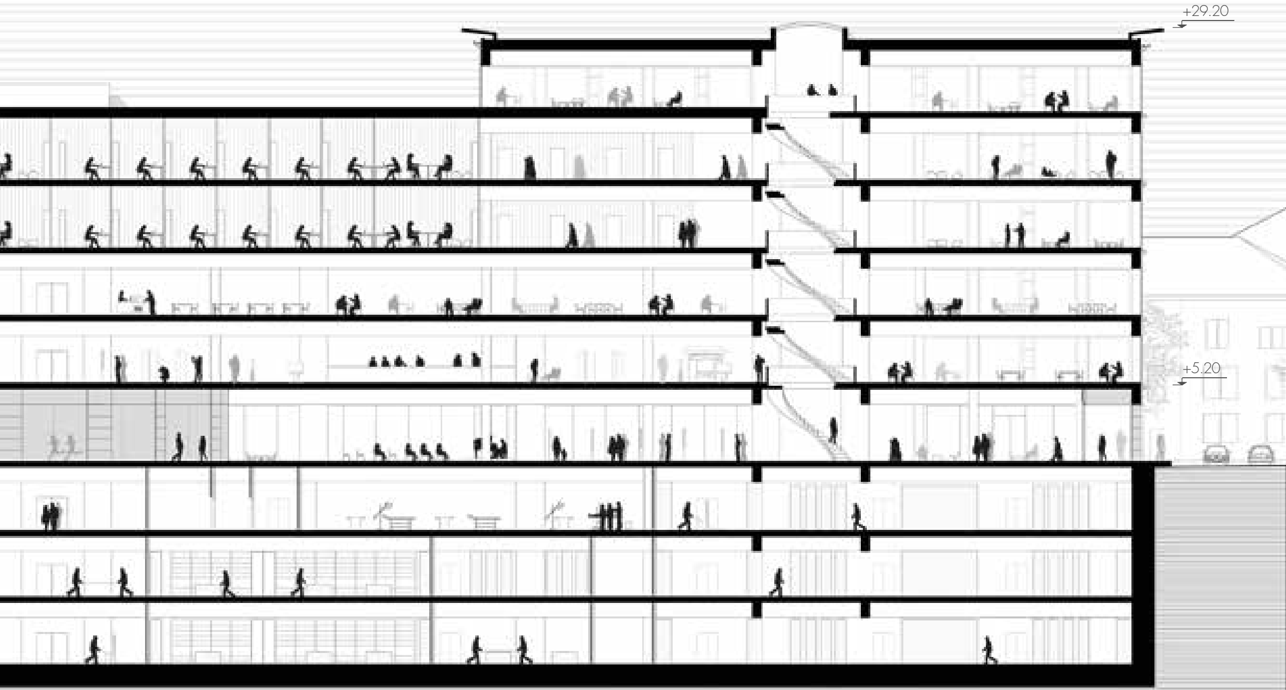
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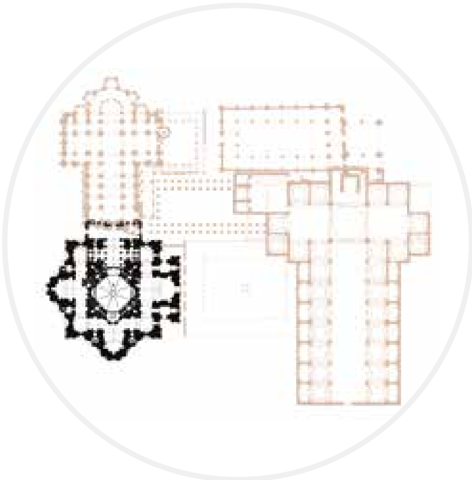
facility tower

At the interconnected corner among Klingelbergstraße, Pestalozzistraße and Metzerstraße, a fourteen-storey tower is located, hosting workspaces, a university library, multifunctional spaces, offices for the university community as well as for start-ups, and further social spaces.

The building is essentially a 14-storey tower, counting 11 floors above ground and 3 floors below ground, based on a "podium" created by the expansion of the chemistry department building. Such base contains common spaces that allow for a deep connection and interaction between the facility tower and the department.

Tower's facilities

common facilities	3'500m2
public gallery	575m2
main hall	425m2
education centre	400m2
events area	2'100 m2
student facilities	1'100 m2
research library	1800 m2
start-ups and co-working	380 m2

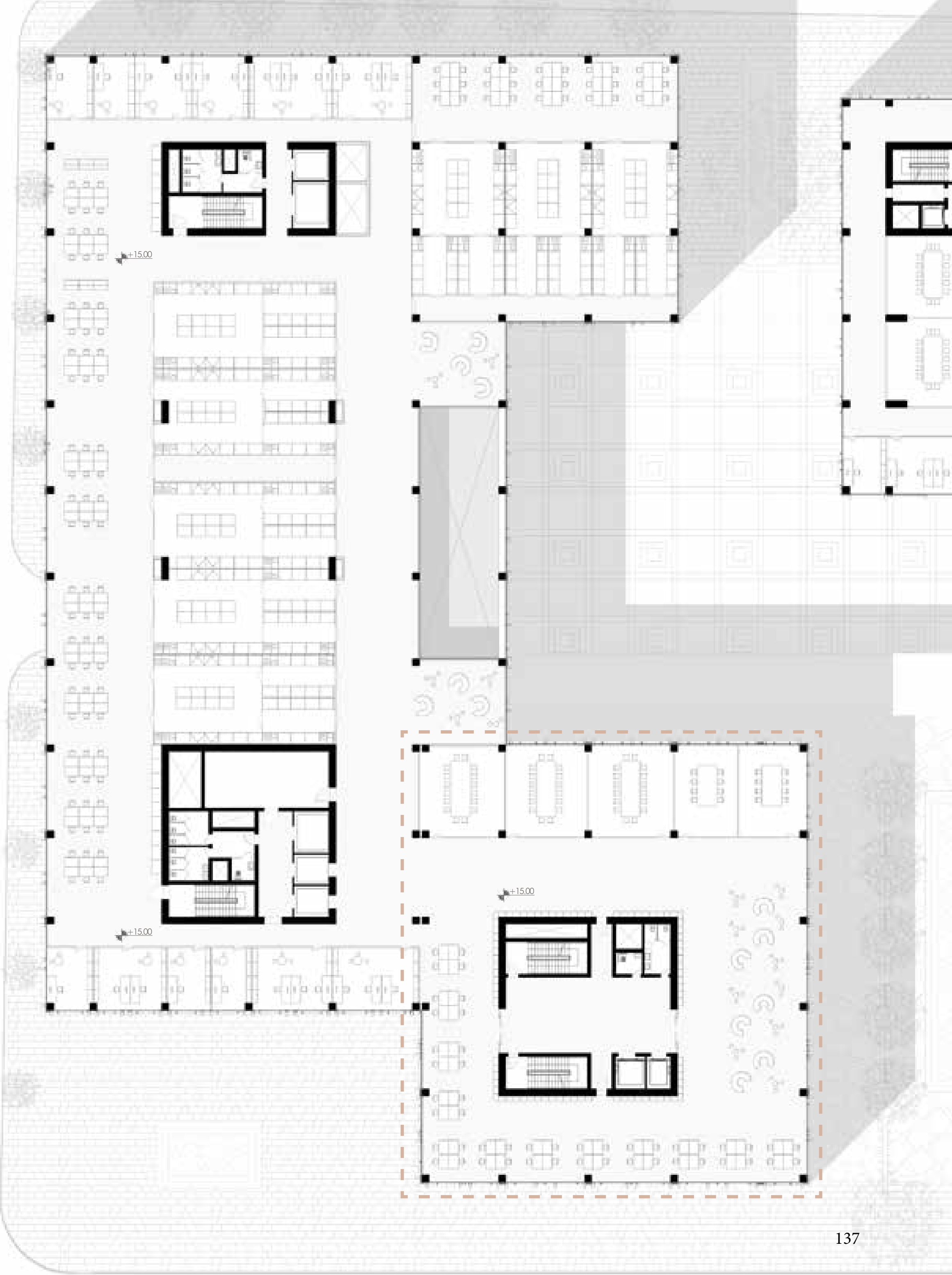


Skyline Landmark

Facility Tower

Urban Approach, peripheral nodes and secondary public spaces

The facility tower is complementary to the existing skyline of Basel Science District. The logic of this volumetric unit is capable of prefiguring morphological structural ideas, establishing in synthetic way the relationship of different aspects, while expressing the specific role played by each component. Strategical setbacks, in response to the existing urban context, lead to the idea of secondary intimate spaces and the important nodes. Moreover, the tower brings together other emerging science technology enterprises present in the city, with consequent public realm benefits and integration within the context, introducing a new typology of office space, as well as activating the surrounding public space.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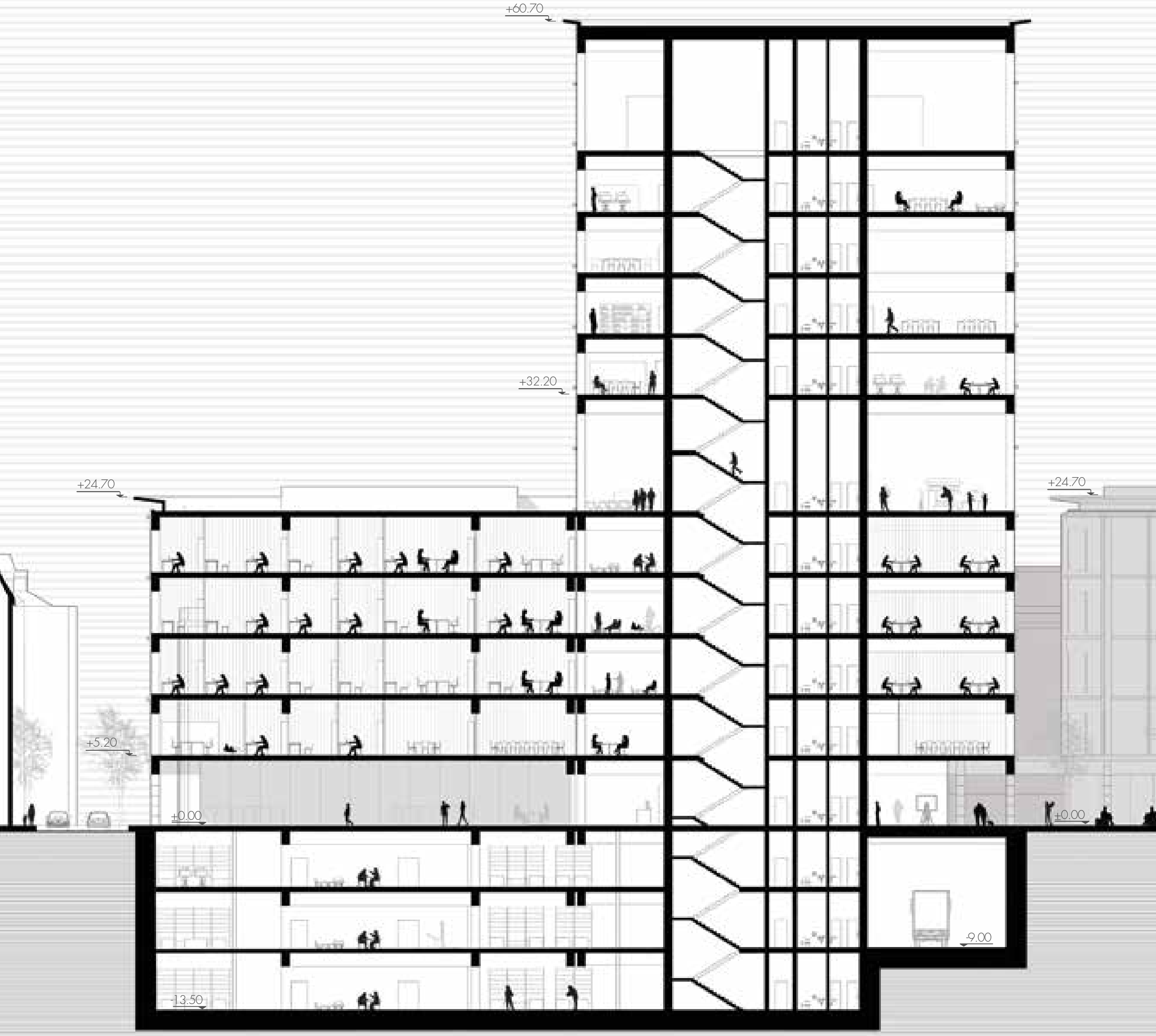
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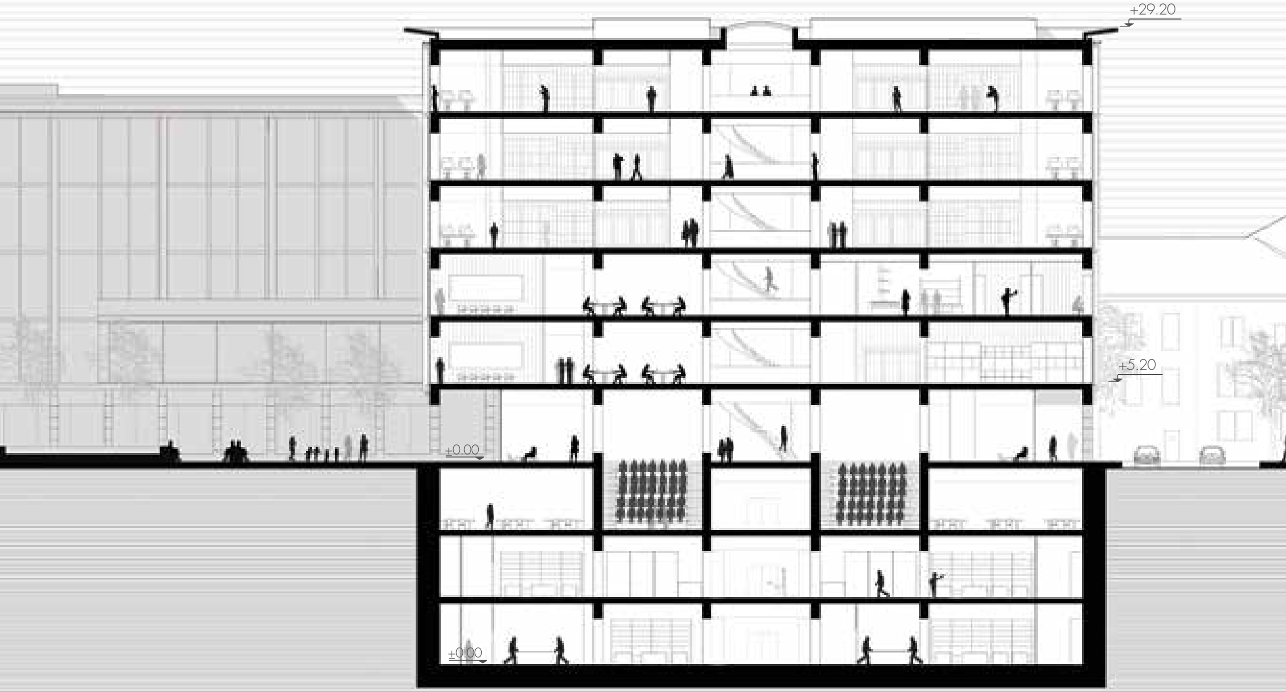
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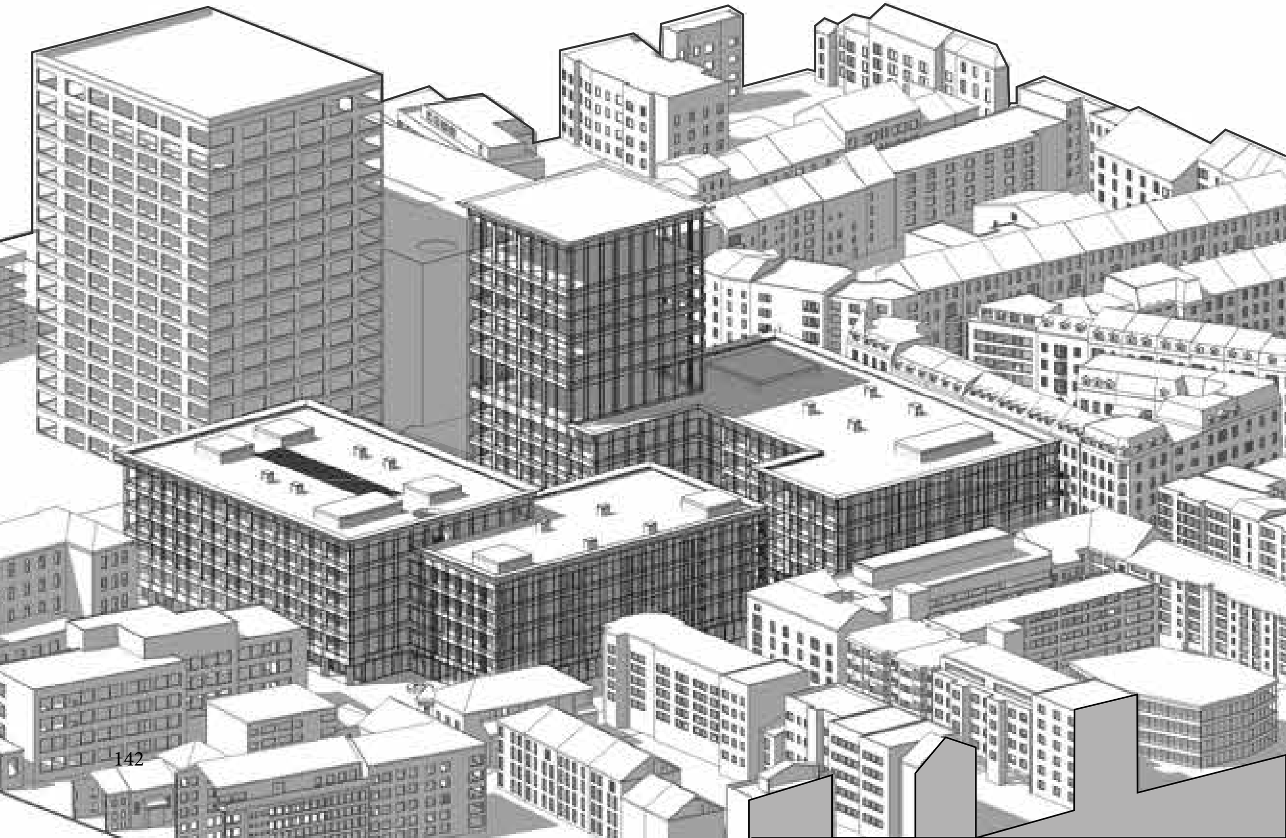
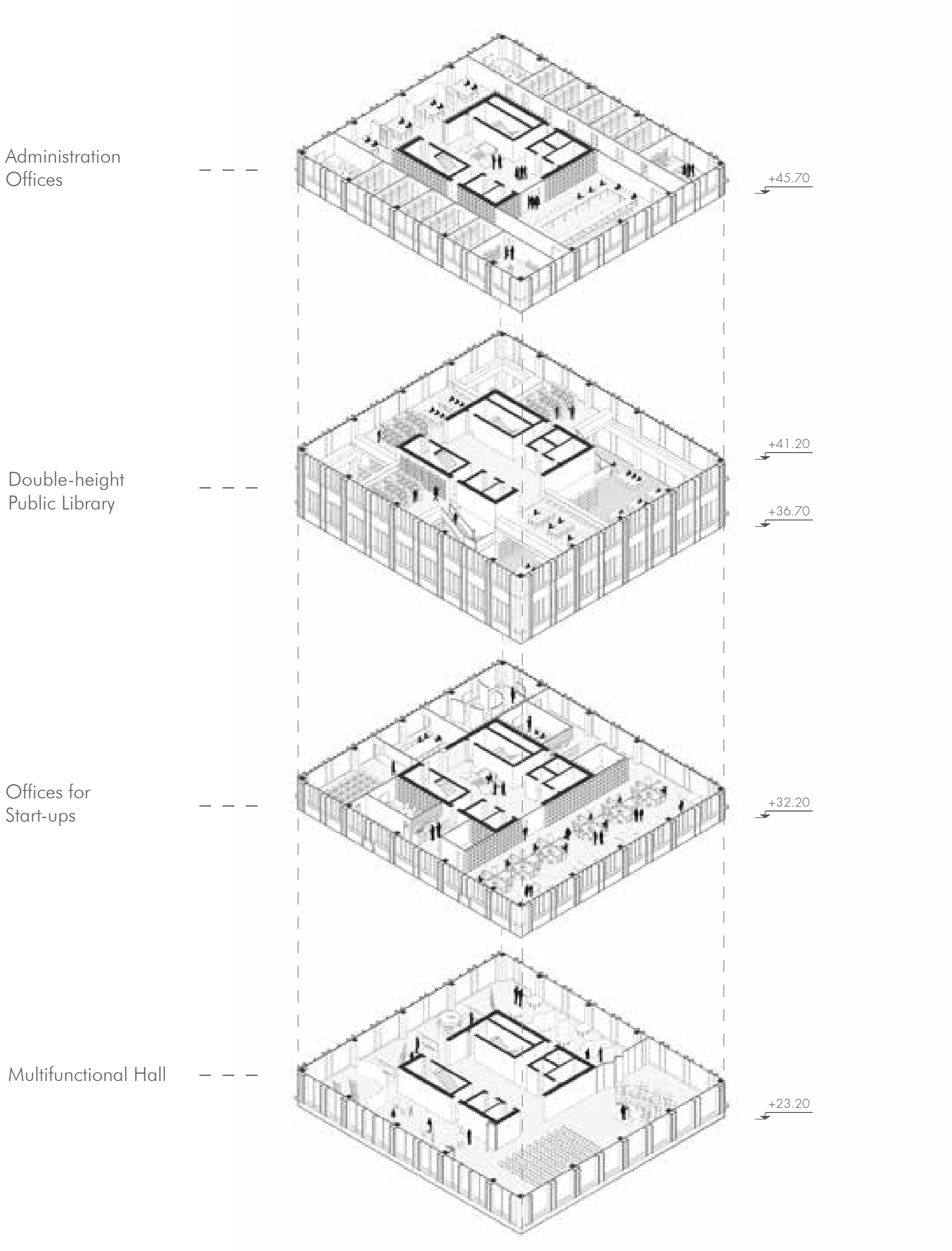
Skyline Landmark

Facility Tower





Verical Public Space

- 8 -

“ the landmark ”

modernist approach

The last element of the articulated system composing the university complex is the tower.
The Economist tower designed by Alison & Peter Smithson in London was taken as a reference due to the idea of creating a new cornerstone of the city's skyline, combined with a new public space.
In order to achieve a similar result, the main elements of the Economist's final urban image, as well as the designers' background guiding its design phase, are analysed as a case study.

Alison & Peter Smithson
20 January 1969 by Godfrey Argent

Alison & Peter Smithson
Beginning with a vocabulary of stripped-down modernism, the pair was among the first to question and challenge *modernist approaches to design and urban planning. Moreover,* Alison and Peter Smithson also participated, in a large part, to *the debates on Greek architecture* taking place in the architectural cultural environment of the mid-1950s in England. In those years, the focus of English architects was directed to the creation of a technique that could give the correct value to a building in its site and, at the same time, *revalidate the site through the building.*

Typological Influences
Le Corbusier affected the knowledge of the English architectural environment about Greek Architecture by focusing on two main aspects: the dynamic system that he discovered in the composition of the Acropolis' buildings, and the complete refinement of the type, involving both mechanical and geometric aspects. Rex Martienssen was the first to reflect and write about these ideas: for the Smithsons, Martienssen took the picturesque organization that Le Corbusier defined and systematized it. Indeed, he studied different examples of Greek shrines, showing how the layout of temples was based on the principles of perception: such concept deeply influenced the design method developed by the English couple.

the influence of greek temples

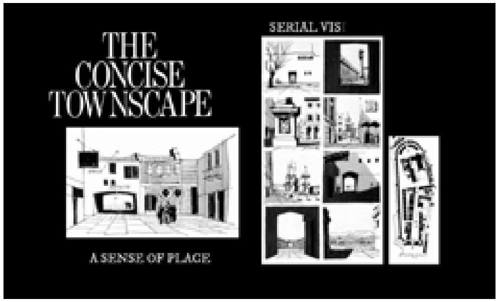
"Our generation's interest in Greek Architecture has come through the writings and work of Le Corbusier, who in his "Vers une Architecture" not only talks about machines for living in, but in the same breath about absolute architectural values as demonstrated in the Parthenon."

Peter Smithson, Without Rethoric

???

the influence of gordon cullen

Gordon Cullen (1914-1994). Architect and urban planner. His book "Townscape" is a treatise on perceptual values in the city, in which he exposes his theory based on vision and position on a journey or itinerary. Cullen postulated that it is not necessary to study the elements that constitute a set but how they are interwoven.

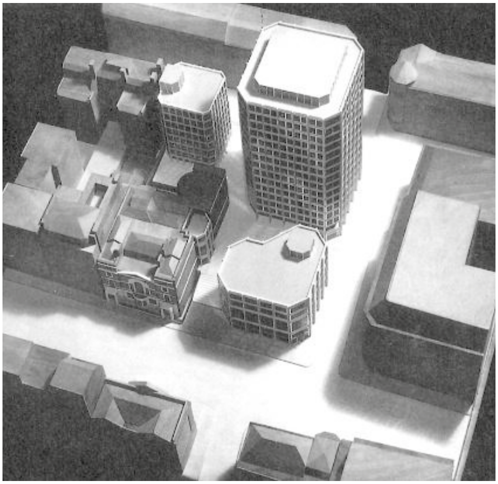


The Concise Townscape, Gordon Cullen, 1961

walls within the walls

Peter Smithson illustrates the walks through images of each of the serial and emerging visions that occur along the way, in the form of almost frames. The photographs are part of the testimony of the non-accidental succession of events in a process of spatial manipulation that transforms meaningless events into situations of emotional intensity.

walls within the walls, ...?



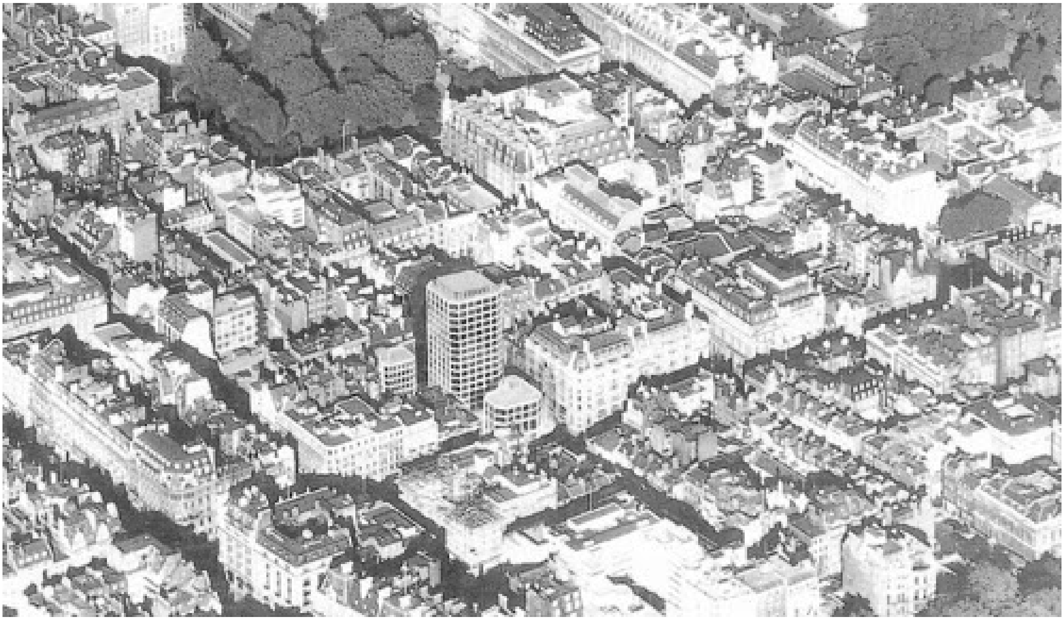
The Economist, Alison & Peter Smithson, 1964

the economist

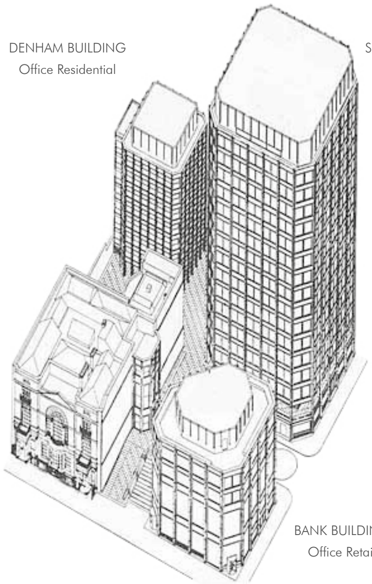
The project started by the intention of the London magazine to redevelop its buildings in order to expand its headquarter. The intervention also involved the neighbouring gentlemen's club, which needed to restructure its facilities and build additional rooms.
The Economist Plaza is now considered a milestone in the canon of modern architecture, and it is defined by a complex divided into three independent buildings:
The Economist Tower, counting 13 floors of offices and a residential upper storey.
The Bank Building, a 5-storey volume comprising two floors for offices, the bank hall, and businesses on the ground floor level.
The Residential Block, including 7 floors accommodating the Boodle's Club and apartments at the upper floors.

The Economist, Alison & Peter Smithson, 1964

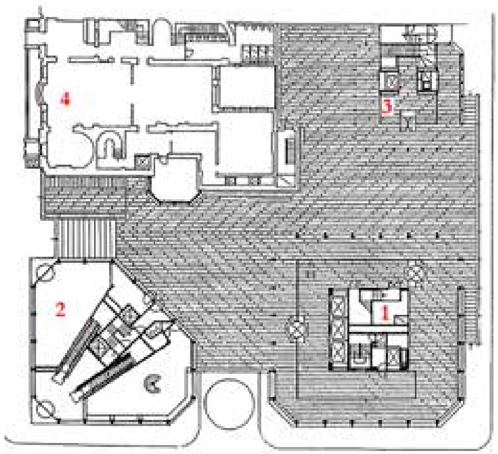
The Economist, South facade elevation



The Economist, Alison & Peter Smithson, 1964, London



The Economist, Alison & Peter Smithson, 1964



25 St. James Street, London
Dates: 1959- 1964 (built 1962 - 1964)

Ground Floor plan

1 Economist Tower
2 Bank Building
3 Residential Tower
4 Boodle's Club

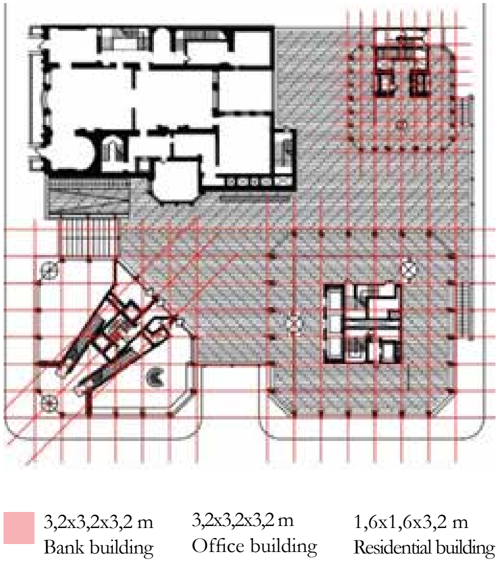
The Economist, Alison & Peter Smithson, 1964

Structure

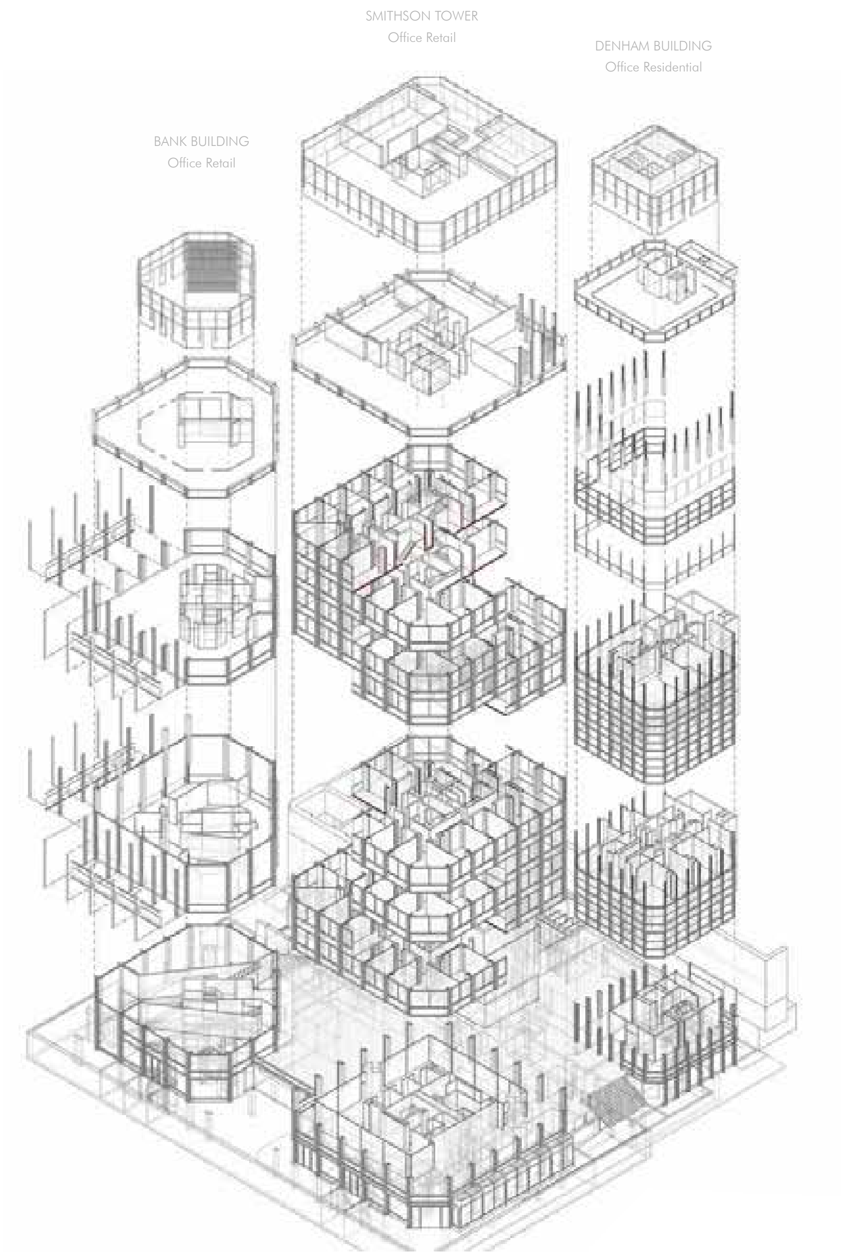
All buildings have a similar reinforced concrete structure composed of flat slabs supported by T- shaped columns and steel beams.
The basic module of the tower, as well as that of the bank building, is 3.20 meters – corresponding to the standard measure of an office for two people-, while the basic unit defining the residential tower is half of it, which means 1.60 meters.

The expression of the structural system and the directness of fair-face concrete were meant to convey meanings of a new society.

The Economist, Alison & Peter Smithson, 1964



The Economist, sructural organization



The Economist, Exploaded view by Alvaro Simón Merin

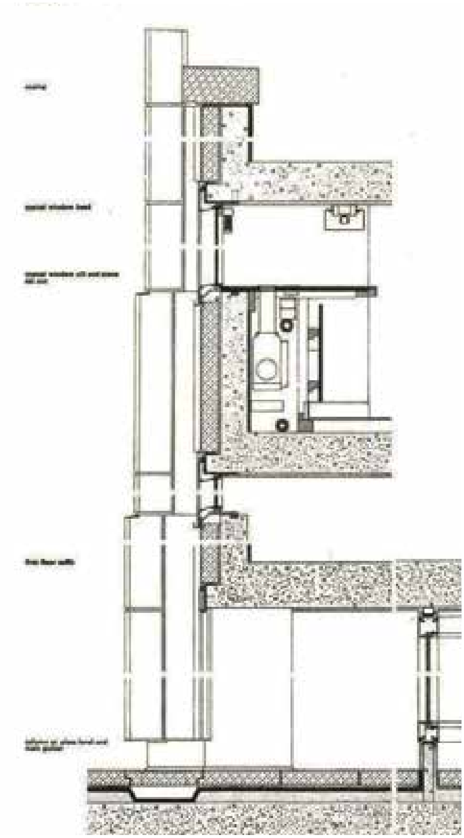
The Economist Tower, facade view

Façade

The material palette selected for the Economist Building reflects the taste of the New Brutalism: the clearly defined structure is indeed expressed through the use of rough-faced concrete elements, separated by large spans of sheet-glass windows. The external skin of the building is cladded in Portland Stone, a type of sandstone rich in marine fossils and known as the "cockroach". The porous material, with its grooves, creates peculiar textures and underlines the value of buildings on site. Details such as windows and channel sections, are made of stove-enamelled aluminium, while the plaza is paved with precast paving stones, made from Portland Stone aggregates.

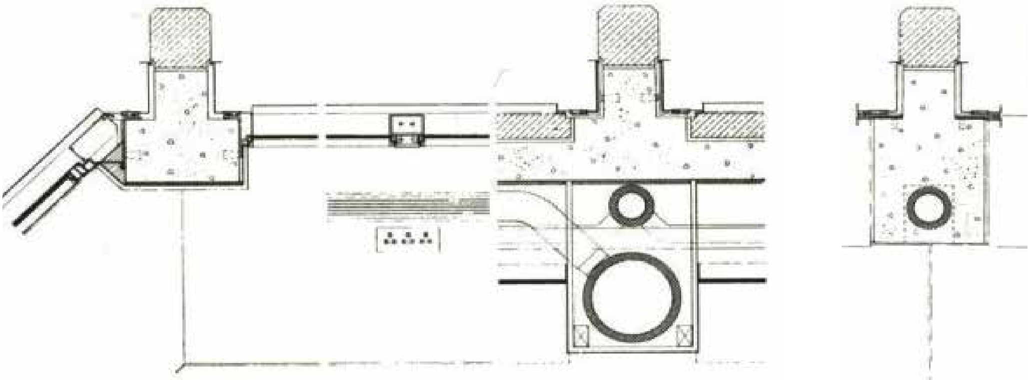
The Economist Tower, facade view

The Economist Tower, facade view

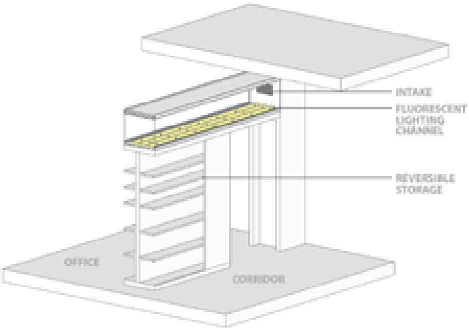


The Economist Tower, partial facade section

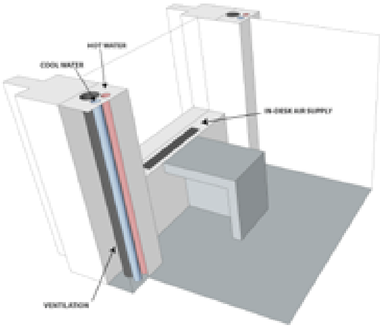
The Economist Tower, facade view



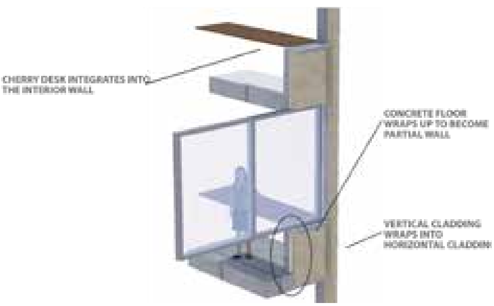
The Economist Tower partial facade plan



Lighting and ventilation systems integration principles



Lighting and ventilation systems integration principles

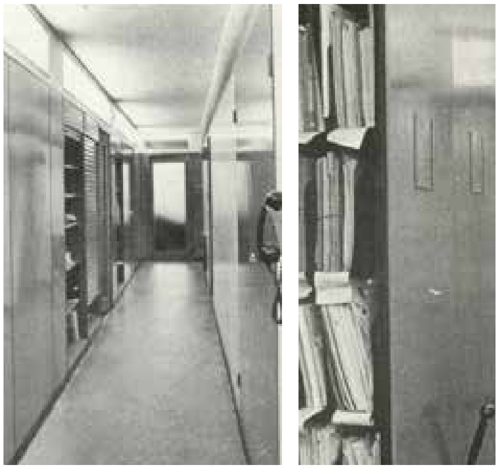


Lighting and ventilation systems integration principles

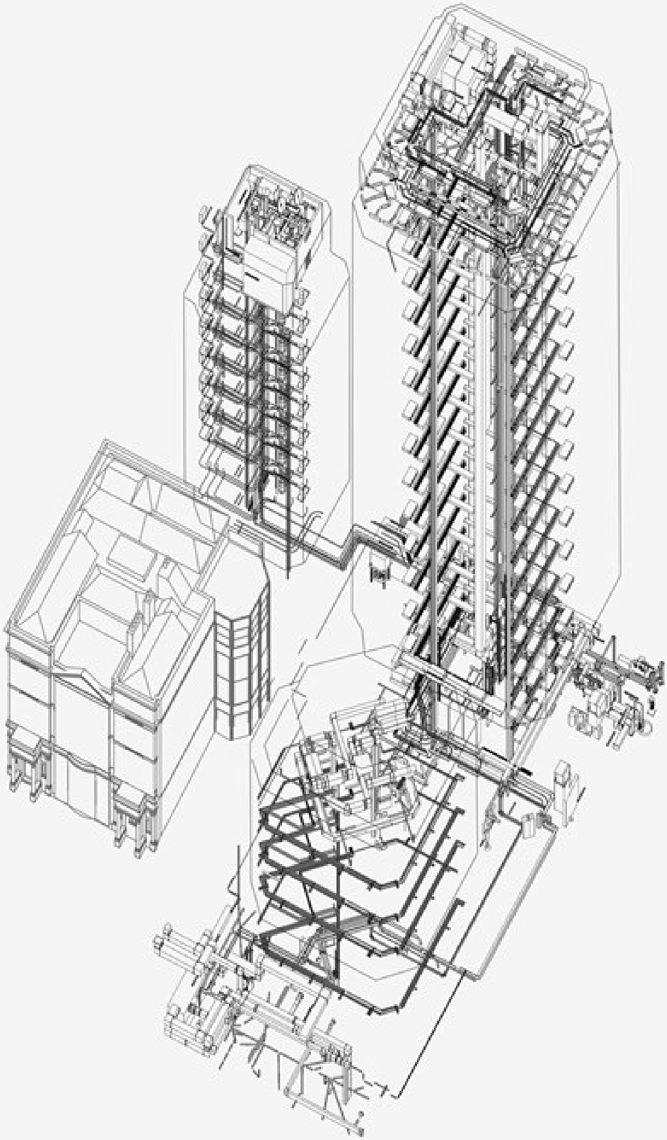
Technical Integrations

Building systems are seamlessly integrated with the building design. The mechanical chase for ventilation is placed within the columns, as a way to hide the system while effectively using the vertical nature of the column to transfer air and water effectively.

Interior furniture is also integrated with systems: for instance, desks contain air supplies that can be individually controlled, and that are supplied from the column HVAC system. Hot and cold-water pipes running through are also used to heat or cool the air. This created a well-designed and comfortable interior environment, intended to improve workers' conditions. Likewise, the Smithsons also integrated lighting and air handling appliances into the furniture through the use of movable bookshelves with "light vents".



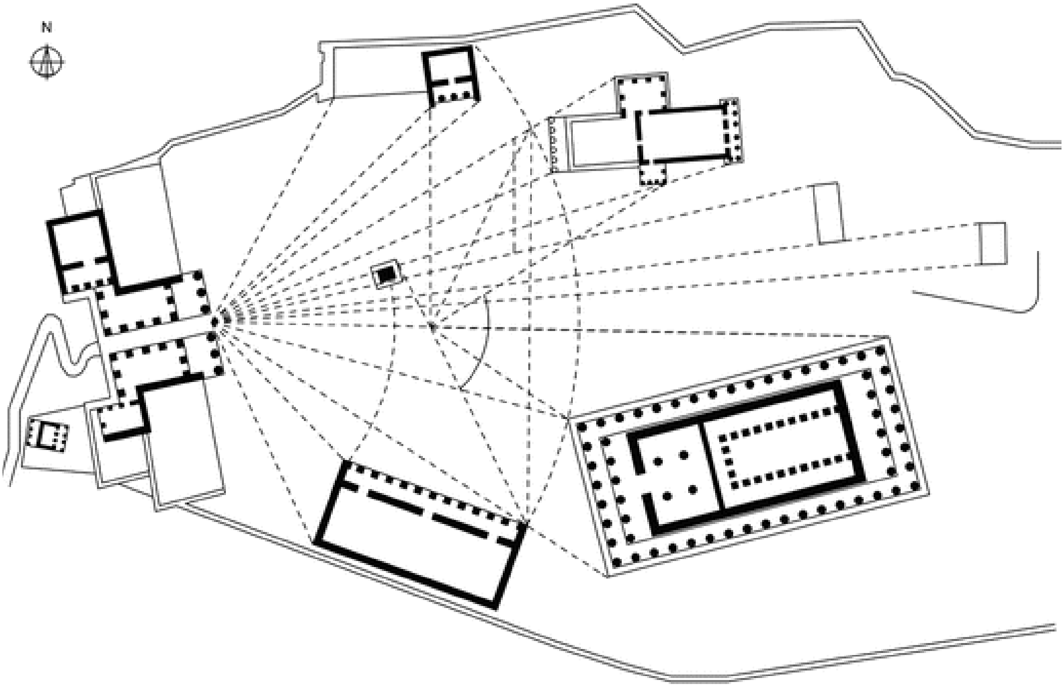
Views of integrated lighting system in corridors



The Economist
Technical System Integration

The journey

'' The journey as grammatical phrase
in a visual conversation”



The Acropolis

800-490 BC

Acropolis is identified with the temple of the sanctuary and the rest of the buildings with smaller temples organized according to sacral temple.

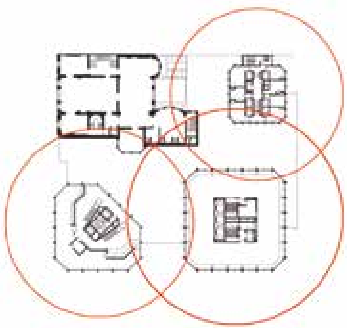
Role in the urban landscape

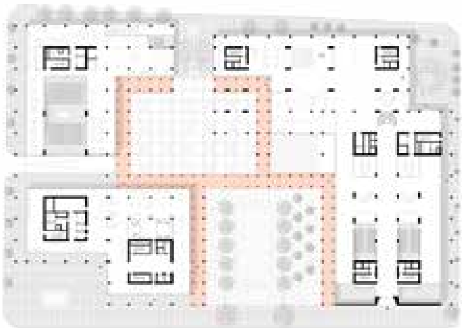
The Economist
Alison & Peter Smithson, 1959-1964

As in Greek sacral places, temples were not built as isolated objects but as parts of a dynamic urban environment.

Basel Science Forum

Focusing on the urban gesture of the building, the articulated system becomes a recognizable emblem in the context





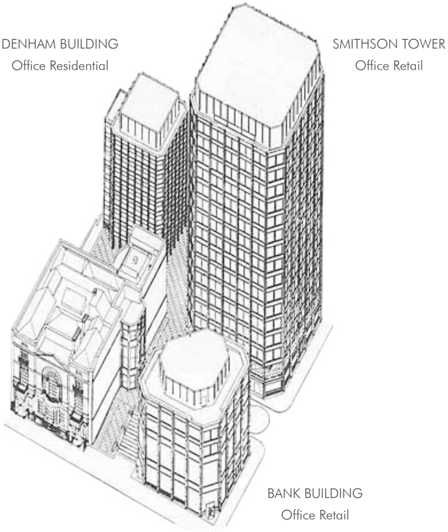
The Economist
Alison & Peter Smithson, 1959-1964

The traditional hierarchy in central composition is emphasized through the organization of buildings around the base-podium.

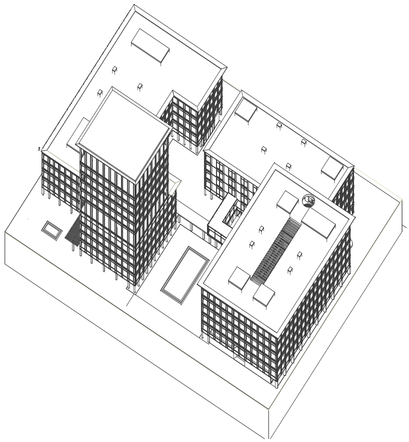
Basel Science Forum

The different dimensions of each plan configurations suggest a form of coordination that is based on continuous arcade system around central fulcrum.

Spatial Organization



The complex is divided into three independent buildings and each volume has different heights and house completely different functions.



Basel Science Forum

The four volumes have been manipulated according to the context and to the intention of giving a specific identity to each of them.

The Economist

Alison & Peter Smithson, 1959-1964

Given the architects' prior knowledge the influences we can venture the hypothesis that the Smithsons had a visual tool for spatial organization on the table during the evolution and development of The Economist project

Basel Science Forum

The repeated involuntary vision derived from walking or moving near buildings provoke the familiarization of the viewer through spatial intimate space in between.

The Gap

The Economist

Alison & Peter Smithson, 1959-1964

The complex is divided into three independent buildings and each volume has different heights and house completely different functions.

Basel Science Forum

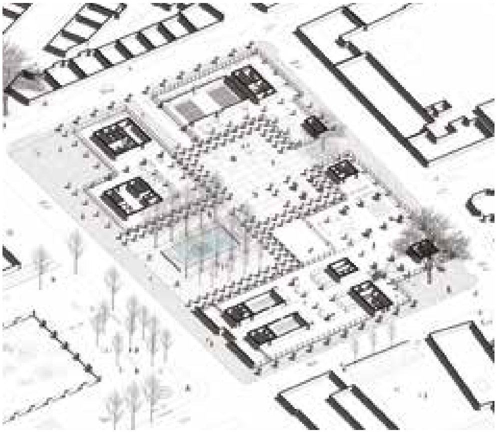
Alison & Peter Smithson, 1959-1964

The four volumes have been manipulated according to the context and to the intention of giving a specific identity to each of them.

The Podium

The Economist
Alison & Peter Smithson, 1959-1964

The author proposes the creation of an elevated plane that is a common substrate for buildings, a platform, containing all the elements of the group.



Basel Science Forum

The urban podium contains all the elements of the group, it is the base that unifies the set and that generates the system which supplies formal dimensions and the idea of unity

The Economist

- 9 -

“ façades design”

An urban contribition

The starting point for the composition of the elevations, defining the architectural language of the ensemble, is represented by the concept of "**civic architecture".**
The attempt was to design, with a contemporary language, an architecture able to **integrate with the existing city and to resist in time**; a contribution to the **"urban stage"** of Basel capable of transforming the city while respecting traditional architectural canons.

Considering the **functional program** of the University complex, mainly hosting laboratories, offices and classrooms, the need for **glazed façades** able to enlighten the deep interior spaces with natural light appeared mandatory.
Therefore, the challenge was to design a **curtain-wall facade** enriched by the compositional elements characterizing traditional examples of "civic architecture"

Finally, the composition of the façades was guided by the intention to give an identity to its different levels, conceiving a **tripartition** scheme that includes the **urban podium**, the **main upper body** of the building, and the **crowning**.
The idea of completing the design with an **iconic crowing unifying the entire system** underlines the strong urban role that the University Campus intends to cover, becoming a recognizable point of reference within the city.

Façades Impressions...

La Serenissima
Park Associati, Milan

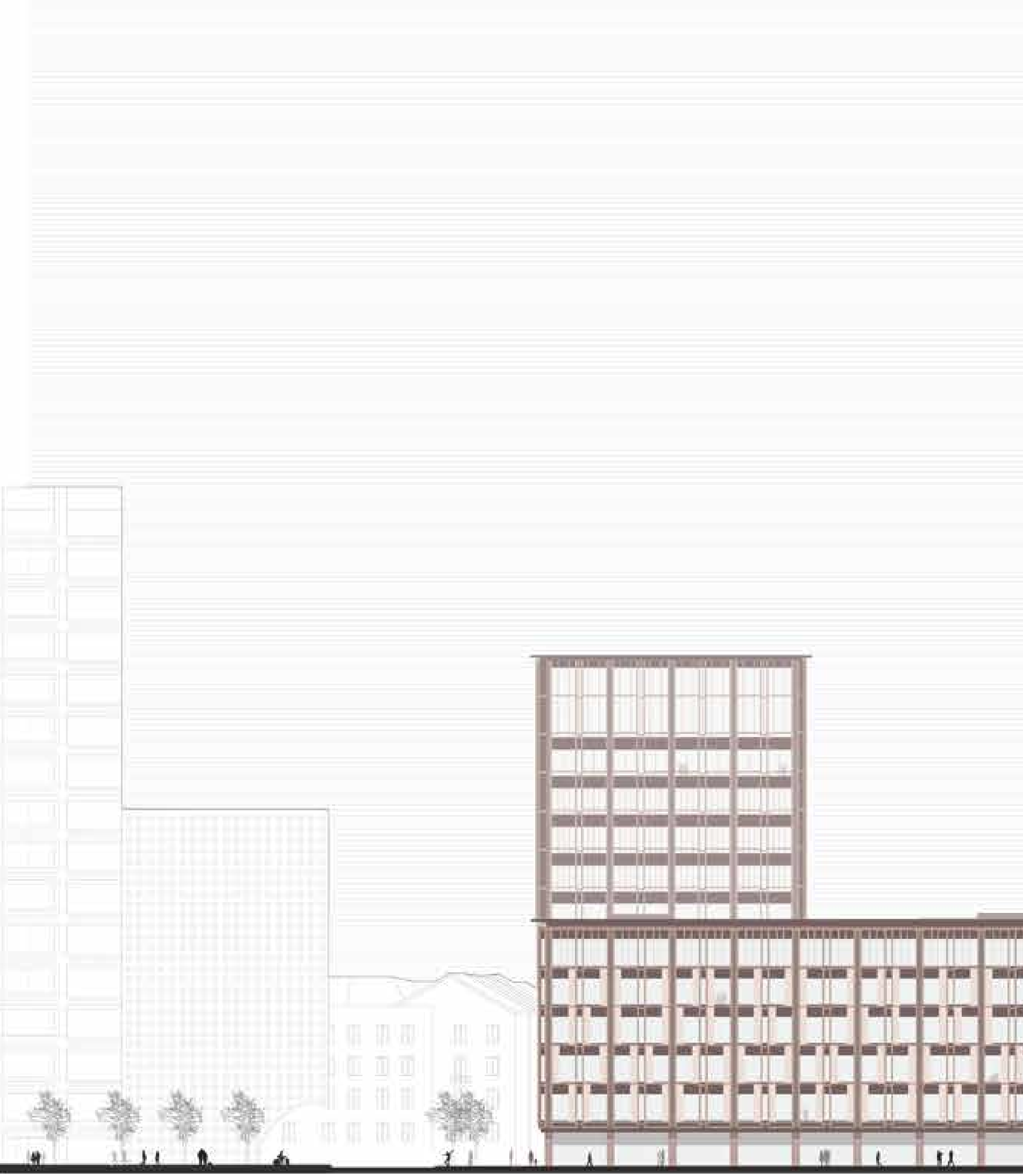
Office Building in Corso Europa
Vico Magistretti, Milan

Lavazza Headquarter

Cino Zucchi, Turin

Beecroft Building

Hawkins\Brown Architects, Oxford



Façade tripartition

The **longitudinal façade of the Basilica** building, defining the street front along Spitalstrasse, represented the **most challenging** elevation of the complex due to its strong urban value: the façade would indeed **contribute to the definition of the streetscape along one of the main arteries of the city**, leading from the centre of Basel towards St Johann's train station.

The design of the elevation was influenced by the **distinction between the public podium**, characterized by an almost entirely glazed facade, permeable towards the urban space even if screened by colonnades, **and the upper levels**. However, the will to guarantee a sense of continuity, able to keep the composition together, became one of the main criteria guiding design choices. The solution chosen consisted in the act of **underlining the presence, location and dimensions of the structural frame** supporting the building, which was inspired by the **typical compositional forms** characterizing traditional examples of **civic architecture**, with particular attention to the concept of "**speaking architecture**": an architecture able to express its own function or identity. **Shading devices such as aluminium fins and shutters** have then been used as further **elements of the composition, in coherence with the needs of the interior spaces**.

North-east Evelation

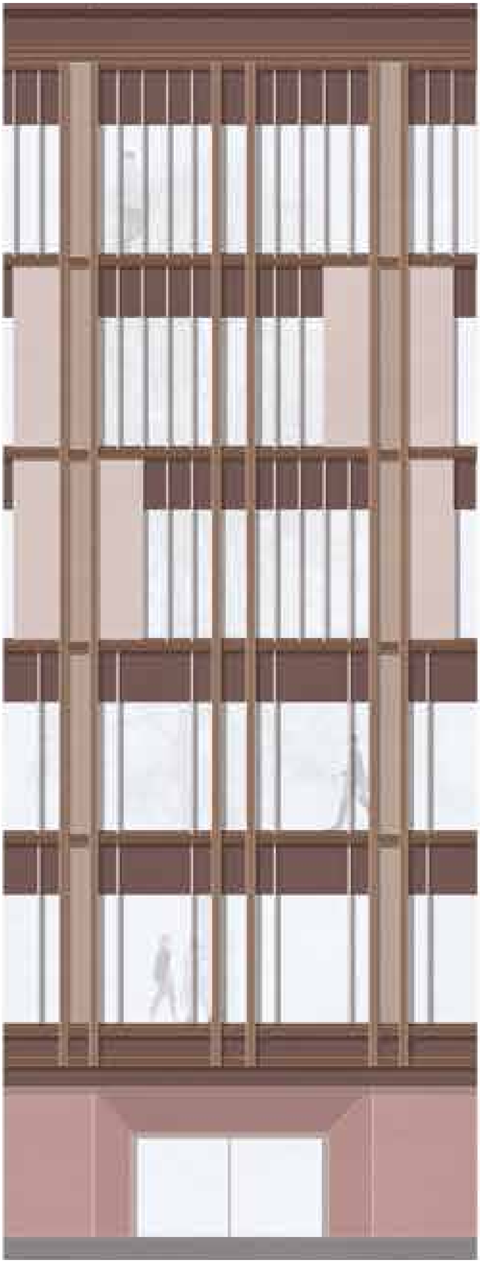
Modularity & Variety

The solution reached for the longitudinal façade of the Basilica building **set the main rules followed for the design of the other façades in the attempt of characterizing each volume with a different façade composition**, obtained by **arranging in different combination a limited series of elements**: spandrel panels, aluminium fins, shutters and extruded profiles.

In particular, each column would be characterized by a **unique main facade** when approached from what can be defined as the Forum's "entrance gate", fronting Pestalozzistrasse.

A certain degree of diversification is then introduced while playing with basic modules obtained from a limited set of components preserving the common identity of the composition. The richness of possible combinations was collected in the so-called "abacus of façades", calibrated in relationship with the specific context.

South-east Evelation



Physics Building

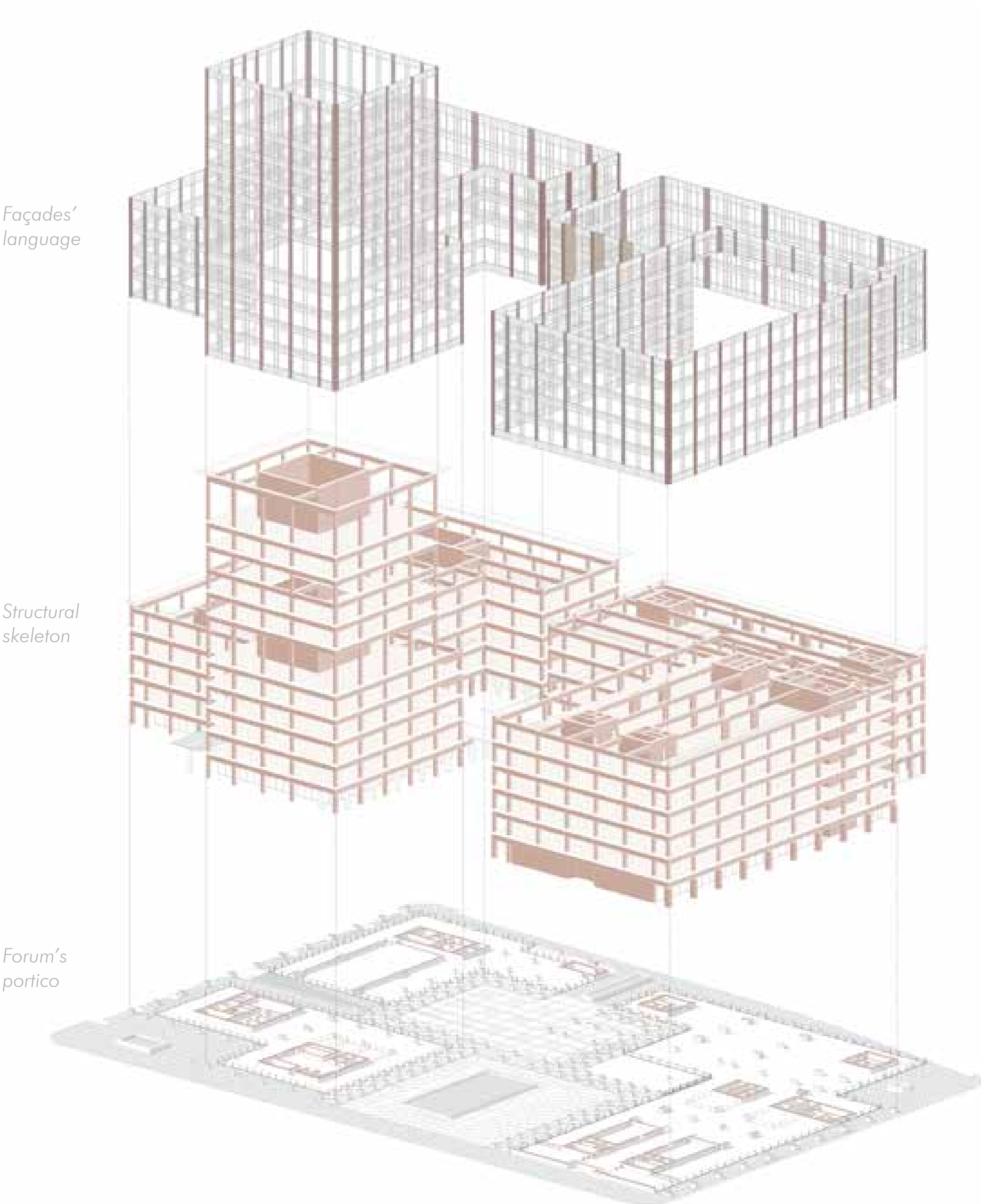
Main Façade - Pestalozzistrasse

Physics Building

Longitudinal Façade - Spitalstrasse

Anatomy Building
Main Façade - Science Forum

Chemistry Building
Street Façade - Klingelbergstrasse



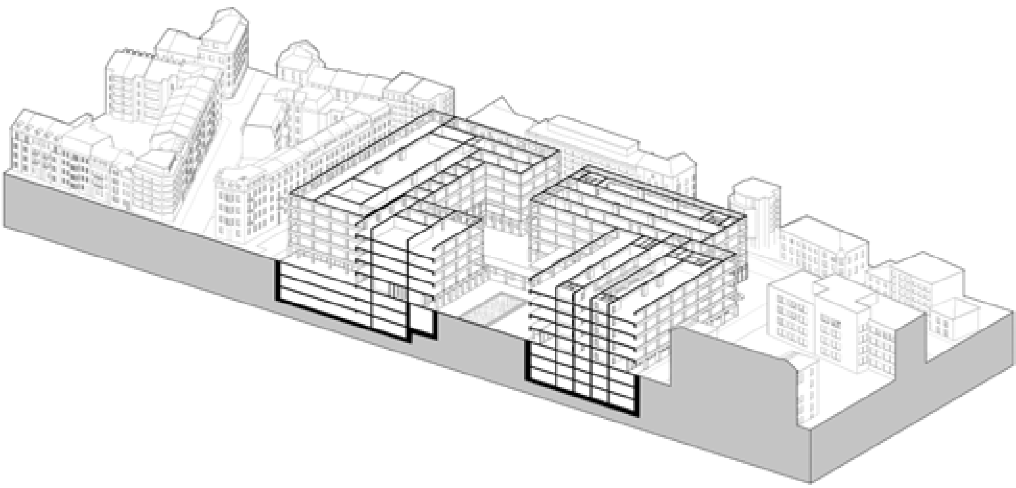
Main layers

Systems' Stratification

Structural integration

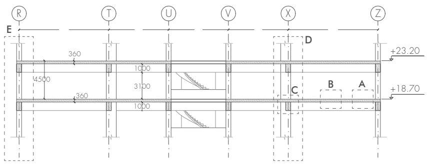
As mentioned, the **structural system** chosen is a homogeneous solution composed of **reinforced concrete columns and beams defining a skeleton frame and supporting solid reinforced concrete slabs.**
The structural issue is then **strongly integrated** with the **design of both the public space** of the forum at ground level, and of the **architectural language of the project.**

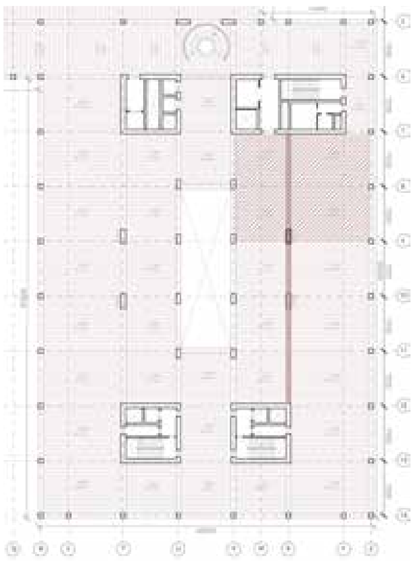
The structural frame, in coherence with the continuous forum portico, **establishes the scale and dimension of the public space**, but **also that of the curtain-wall façades**, strengthening the **sense of continuity and identity of the University campus** which, despite being formed by a compound of different volumes, clearly presents itself as a coherent and **unified system**.
The choice of a post and beam system is firstly dictated by the will to integrate portico and structure, while the choice of using only main beams that are continuously supported along the main naves is guided by the will to create a specific spatial experience of the inner space. Furthermore, the decision of **arranging the continuous beam in such a way to run along the entire perimeter** of the complex **affects the design of the facade,** influencing the ratio between opaque and transparent surfaces.



Structural dimensioning

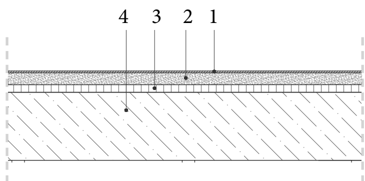
The **structural dimensioning** of particularly stressed elements, belonging to the Physics building, which represented the portion of the complex analysed in greater detail, determined the dimensioning of the facades' components. Therefore, starting from the **dimensioning and detailing of the largest slab** of the structural system, further calculations were carried out to design, at a preliminary level, also the dimension of structural beams and columns.
For what concerns columns, two main typologies have been designed: the standard squared columns characterized by a 60x60cm area, and the longitudinal columns associated with the shafts dedicated to systems.

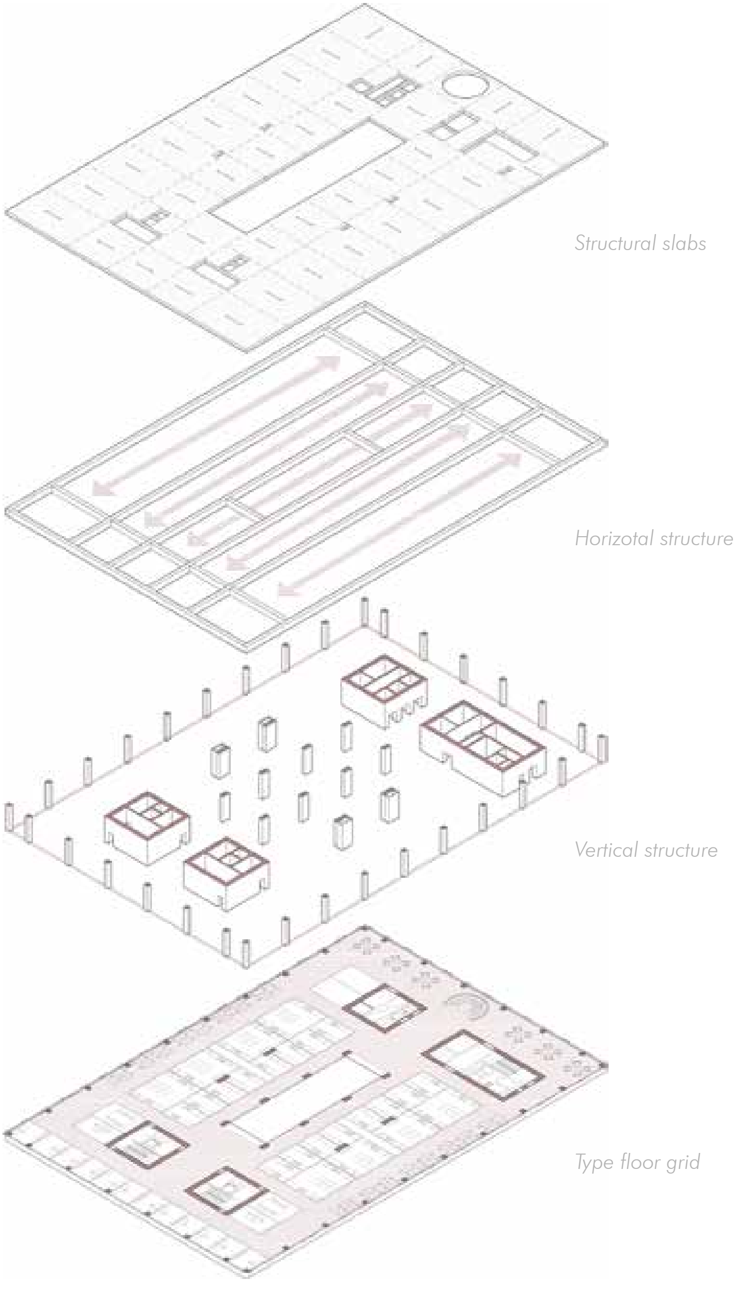




Slab Design - Load analysis
Laboratory Type Floor

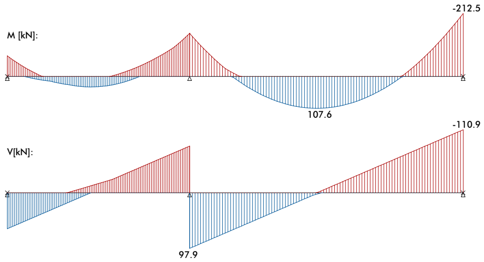
DEAD LOADS:	
1_Epoxy resin coating	negligible
2_Cement screed with inserted under floor heating	0,286 kN/m^2
3_Sound-thermal rock-wool insulation (RW rigid slabs)	0,470 kN/m^2
4_Solid concrete slab	9,000 kN/m^2
_Total gk	9,760 kN/m^2
LIVE LOADS:	
_Laboratory Building	4,000 kN/m^2
_Total qk	4,000 kN/m^2
LOAD COMBINATION:	
_w =1,35 gk + 1,5qk	19,20 kN/m^2

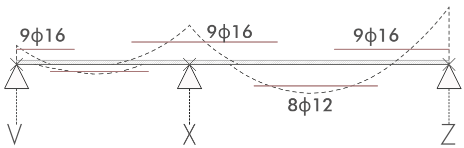




Structural layers
Basilica - Physics Building

Slab Design - Detailing main sections





SLAB AT SUPPORTS:
h_{slab} = 330mm
d_{slab} = 300mm
b_{slab} = 1000mm
Concrete cover = 22mm
φ/2=8mm
f_{ck} = 25 Nmm^2 (C25/30)
$M_{max,\ at\ support}$= 212,5 kNm

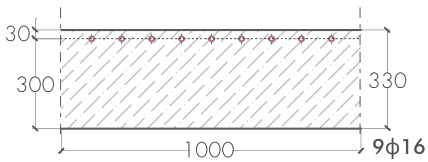
1_ Bending Reinforcement: K=0,094
with K_{bal}=0,167
$K < K_{bal}$ VERIFIED
2_ Level arm: z=273mm
3_ Reinforcement Area: A_s=1780 mm^2/m
4_ Reinforcement Ratio: ϱ=0,60%

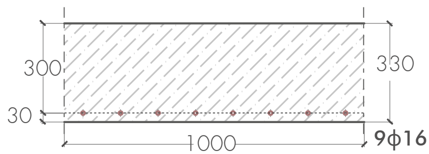
Tension Reinforcement
A_s/A_{rebars} = 9 φ 16 = 1809 mm^2 every 10cm

SLAB AT SPAN:
h_{slab} = 330mm
d_{slab} = 300mm
b_{slab} = 1000mm
Concrete cover = 24mm
φ/2=6mm
f_{ck} = 25 Nmm^2 (C25/30)
$M_{max,\ at\ span}$= 107,6 kNm

1_ Bending Reinforcement: K=0,048
with K_{bal}=0,167
$K < K_{bal}$ VERIFIED
2_ Level arm: z=288mm
3_ Reinforcement Area: A_s=858,9 mm^2/m
4_ Reinforcement Ratio: ϱ=0,29%

Tension Reinforcement
A_s/A_{rebars} = 9 φ 12 = 904 mm^2 every 10cm





Beam Design - Detailing main sections

BEAM AT SUPPORTS:

h_{beam} = 1000mm

d_{beam} = 885mm

b_{beam} = 600mm

Concrete cover = 50mm

φ/2=20mm

f_{ck} = 40 Nmm^2 (C40/50)

$M_{max,\ at\ support}$= 3400 kNm

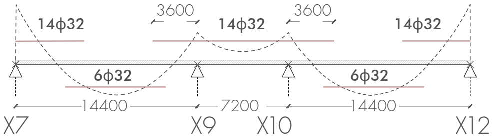
1_ Bending Reinforcement: K=0,181
with K_{bal}=0,167
$K < K_{bal}$ *NOT VERIFIED*
DOUBLE REINFORCEMENT NEEDED

2_ Reinforcement
Compression steel area: A_{s1}=718 mm^2
with d_1=50 mm and z_{bal}=725,7 mm
Tension steel area: A_s=10662 mm^2

3_ Reinforcement Ratio:
Compression reinforcement ratio: ϱ=0,14%
with 0,13%<ϱ< 4% *VERIFIED*
Tension reinforcement ratio: ϱ=2,01%
with 0,13%<ϱ< 4% *VERIFIED*

4_ Tension Reinforcement = 14 φ 32
arranged in 2 rows with 50mm of spacing in between them

5_ Compression Reinforcement = 2 φ 32



BEAM AT SPAN:

h_{beam} = 1000mm

d_{beam} = 950mm

b_{beam} = 600mm

Concrete cover = 34mm

φ/2=16mm

f_{ck} = 40 Nmm^2 (C40/50)

$M_{max,\ at\ support}$= 3400 kNm

1_ Bending Reinforcement: K=0,078
with K_{bal}=0,167
$K < K_{bal}$ VERIFIED

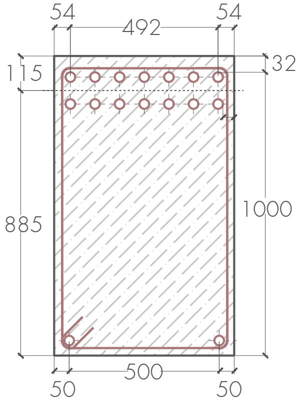
2_ Level arm: z= 883,5 mm

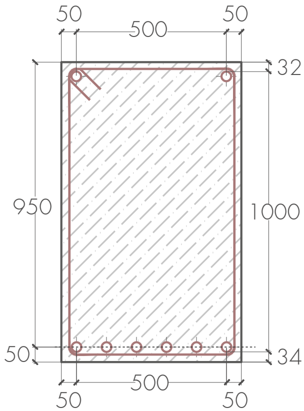
3_ Reinforcement Area: A_s=4423,37 mm^2/m

4_ Reinforcement Ratio: ϱ=0,78%
with 0,13%<ϱ< 4% *VERIFIED*

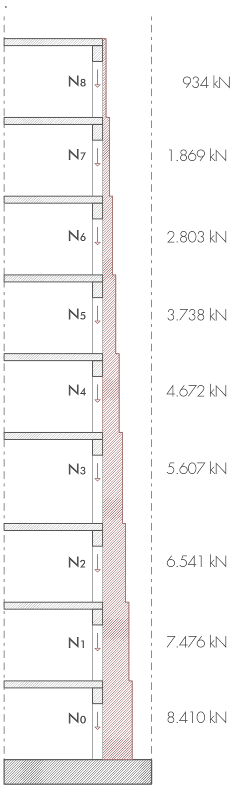
5_Tension Reinforcement
A_s/A_{rebars} = 6 φ 32 bars

6_Compression Reinforcement
$A_{s,min}$ = 2 φ 32 bars *(0,13% Ratio)*

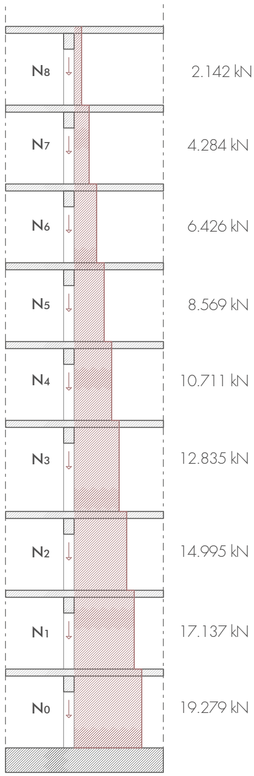




Normal Force
standard columns



Normal Force
shaft columns



Column Design - Detailing main sections

STANDARD COLUMN

1_ Load analysis

$A_{influence} = 40680 mm^2$

$w_k = 18{,}15 \ kN/m^2$

$N_{area\ load,\ from\ slab} = 738 \ kN$

$N_{beam} = 146 \ kN$

$N_{column\ self\text{-}weight} = 50{,}301 \ kN$

$N_{per\ each\ floor} = 934 \ kN$

$n°_{floor} = 9$

$N_{tot} = 8410 \ kN$

2_ Section verification

$h_{column,\ cross\ section}=0{,}60 \ m$

$b_{column,\ cross\ section}=0{,}60 \ m$

$A_{column,\ cross\ section}=0{,}36 \ m^2$

$H_{column,\ floor\ height}=4{,}14 \ m$

$f_{cd} = 28{,}3 \ MPa$

$f_{ck} = 50 \ MPa= 50 \ Nmm^2$ (C50/50)

$A_{required}= N_{tot}/0{,}85f_{cd} = 349204 \ mm^2$

with *0,85= moment coefficient*

if $b_{column}=0{,}60 \ m$ then $h_{column} \geq 0{,}582 \ m$

VERIFIED SINCE $h_{column,\ cross\ section}=0{,}6 \ m$

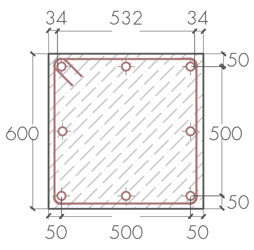
_Reinforcement design

$A_{s,column} = 1{,}5 \ \%$ of $A_{column,\ cross\ section}$

$A_{s,\ column}= 5400 \ mm^2$

$A_{column,\ cross\ section}=0{,}36 \ m^2$

$A_s/A_{rebars} = 8 \ \varphi \ 32$ bars



SHAFT COLUMN

1_ Load analysis

$A_{influence} = 97200 mm^2$

$w_k = 18{,}15 \ kN/m^2$

$N_{area\ load,\ from\ slab} = 1764 \ kN$

$N_{beam} = 219 \ kN$

$N_{column\ self\text{-}weight} = 159{,}2865 \ kN$

$N_{per\ each\ floor} = 2142 \ kN$

$n°_{floor} = 9$

$N_{tot} = 19279 \ kN$

2_ Section verification

$h_{column,\ cross\ section}=1{,}90 \ m$

$b_{column,\ cross\ section}=0{,}60 \ m$

$A_{column,\ cross\ section}=1{,}14 \ m^2$

$H_{column,\ floor\ height}=4{,}14 \ m$

$f_{cd} = 28{,}3 \ MPa$

$f_{ck} = 50 \ MPa= 50 \ Nmm^2$ (C50/50)

$A_{required}= N_{tot}/0{,}85f_{cd} = 800533 \ mm^2$

with *0,85= moment coefficient*

if $b_{column}=0{,}60 \ m$ then $h_{column} \geq 1{,}334 \ m$

VERIFIED SINCE $h_{column,\ cross\ section}=1{,}90 \ m$

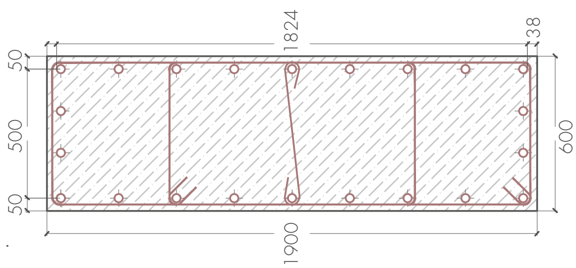
_Reinforcement design

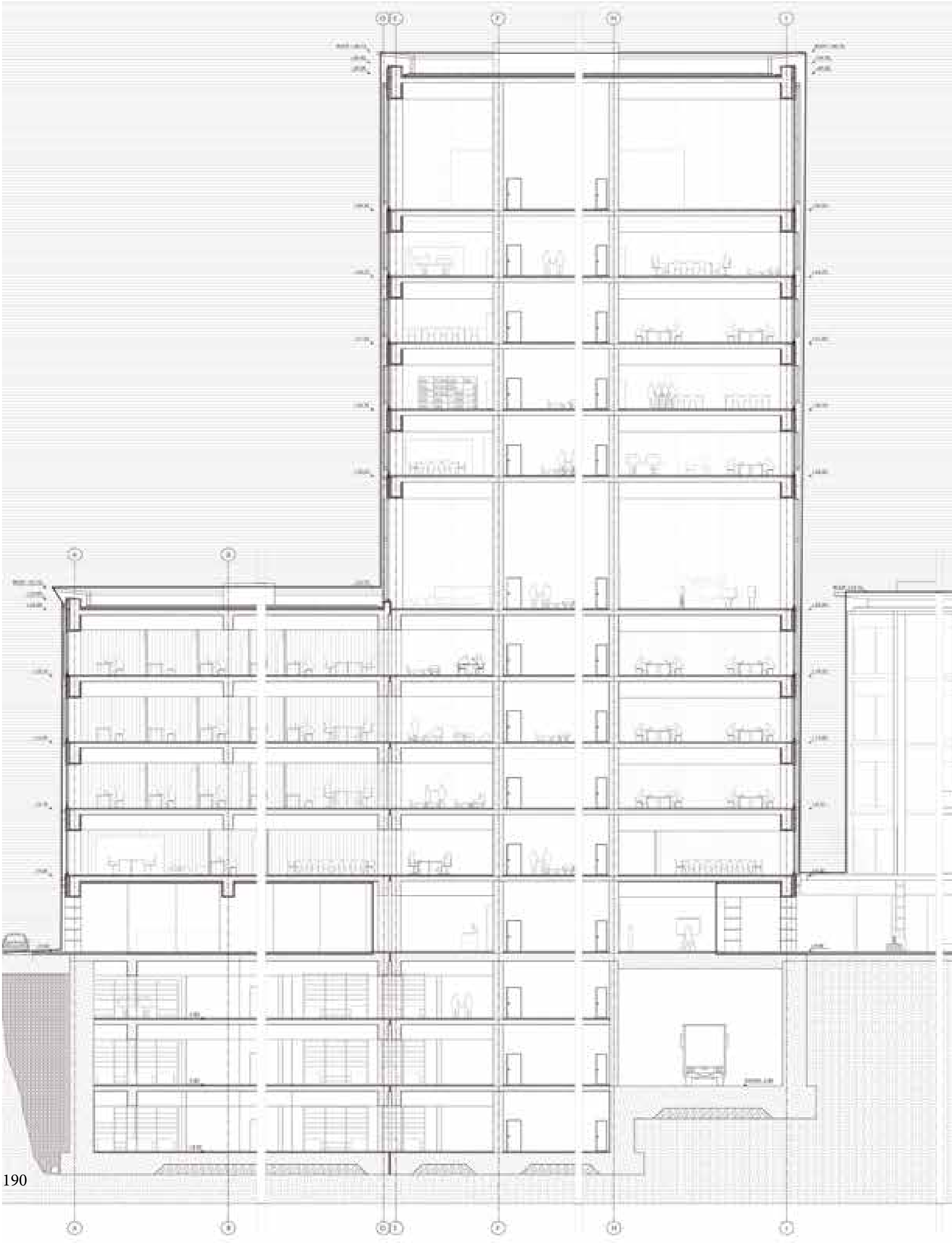
$A_{s,column} = 1{,}5 \ \%$ of $A_{column,\ cross\ section}$

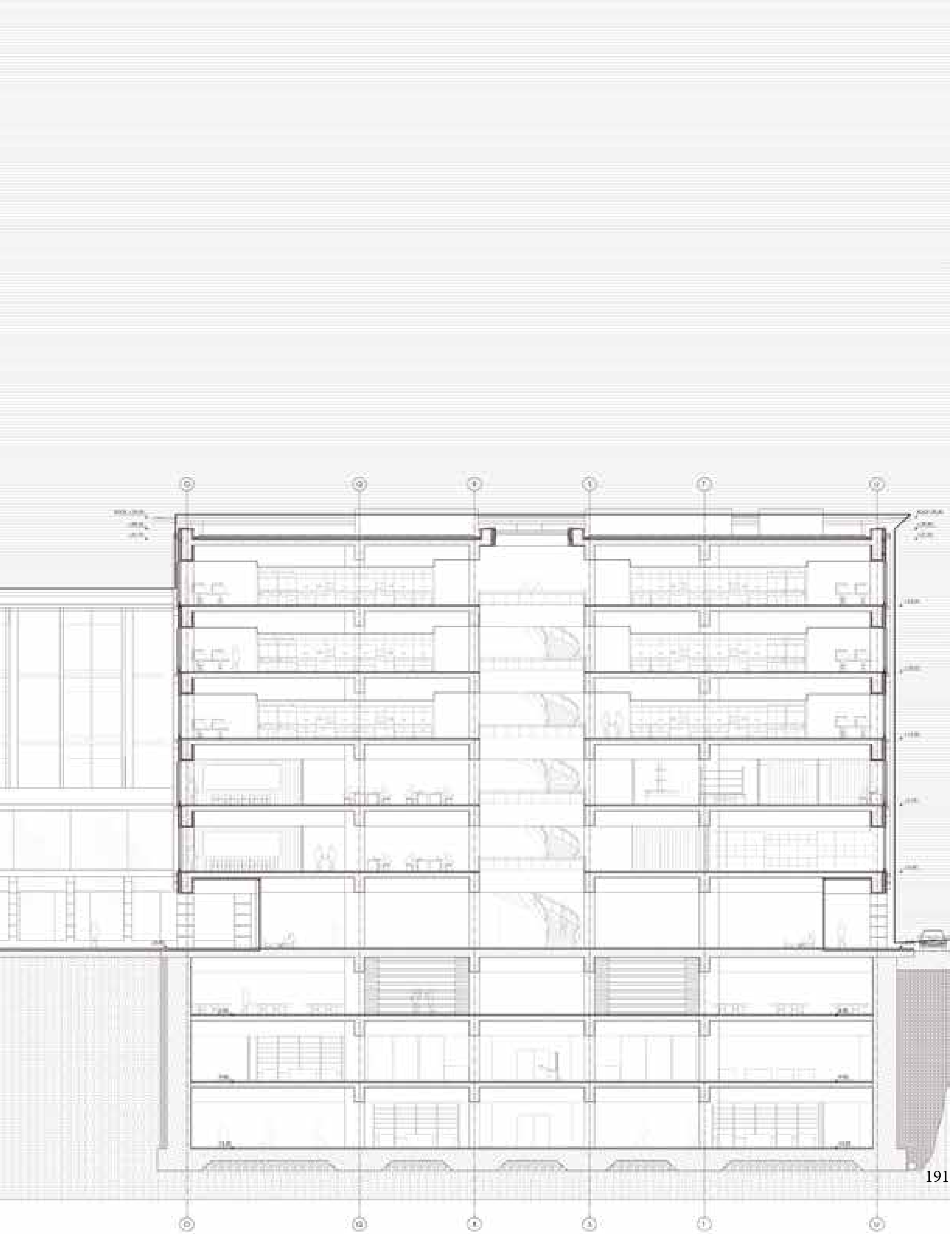
$A_{s,\ column}= 17100 \ mm^2$

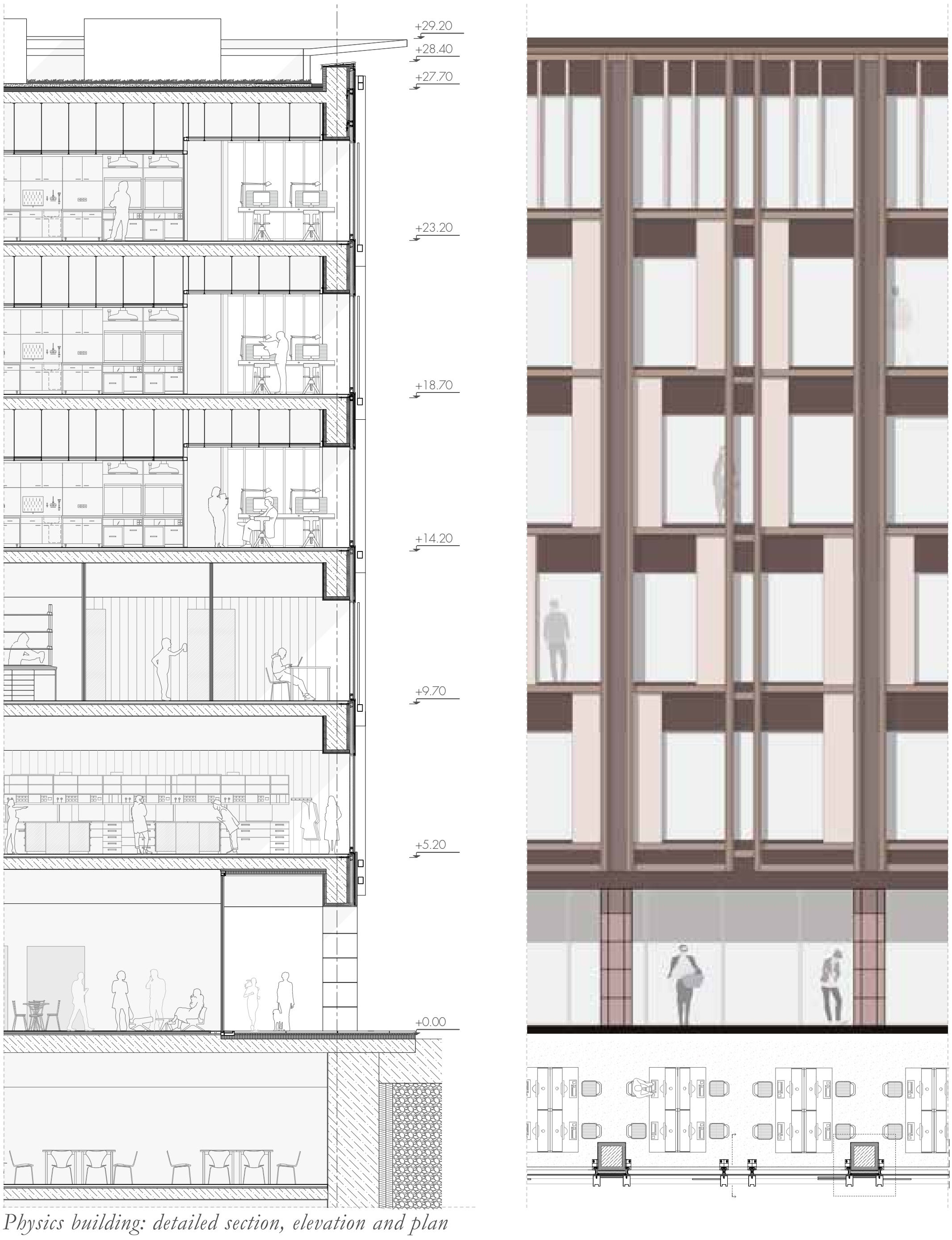
$A_{column,\ cross\ section}=1{,}14 \ m^2$

$A_s/A_{rebars} = 22 \ \varphi \ 32$ bars

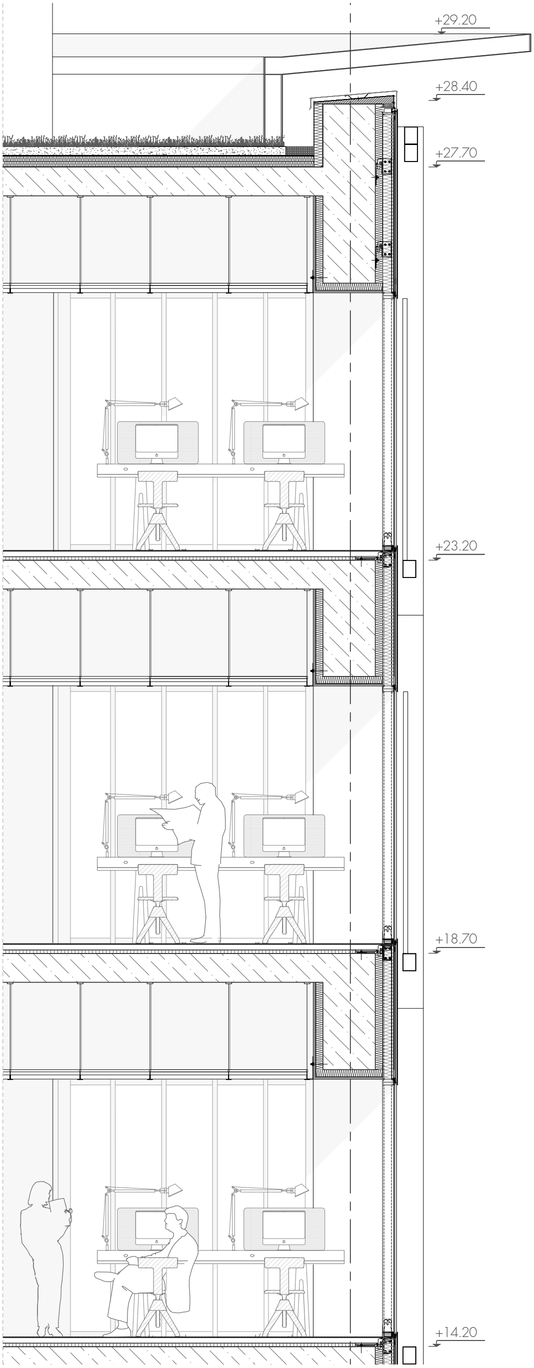








Physics building: detailed section, elevation and plan



Skin & Bones

The integration between **structural and architectural design** deeply **influences the design of façades**.

The basic **facade module** is based on the **main span** defining the structural grid, which is **7.2 meters wide**: each cellular unit of the curtain-wall system is designed in between the structural columns and in between the floor slabs, marking the presence of structural elements on the facade.

By means of an envelope cladding the structural frame of the building, the floor levels are covered with **spandrel panels corresponding to the height of the structural beam and slab beneath**. Similarly, opaque composite **panels underline** the dimension of the **vertical structural elements**, balancing the combination of vertical and horizontal elements.

A **second layer or aluminium profiles is then adopted to enrich the composition**, but also to **allow the fixing of shading elements** such as aluminium shatters and fins, while **acting as shading devices themselves**. Shading elements are then arranged in **different combinations** in order to create a **sense of movement**.
The different design and density of shading elements is also used to differentiate once again the crowning of the buildings.

Physics building: detailed section zoom-in

Envelope detailing

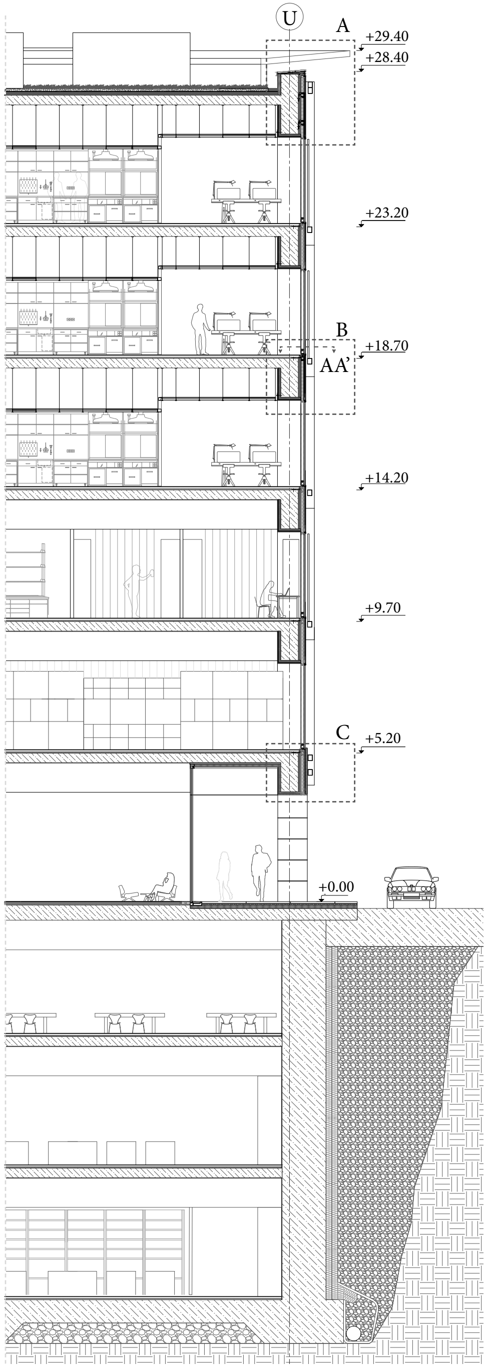
The **detailing of the envelope** proceeded in parallel with the detailing of **structural elements,** as well as with the **selection of specific products present on the market**.

After a long exploration of the different technological solutions available for glazed façades, the one that resulted as more coherent with the typological evolution of the building was a **unitised curtain-wall system applied as a cladding to the structural frame.**

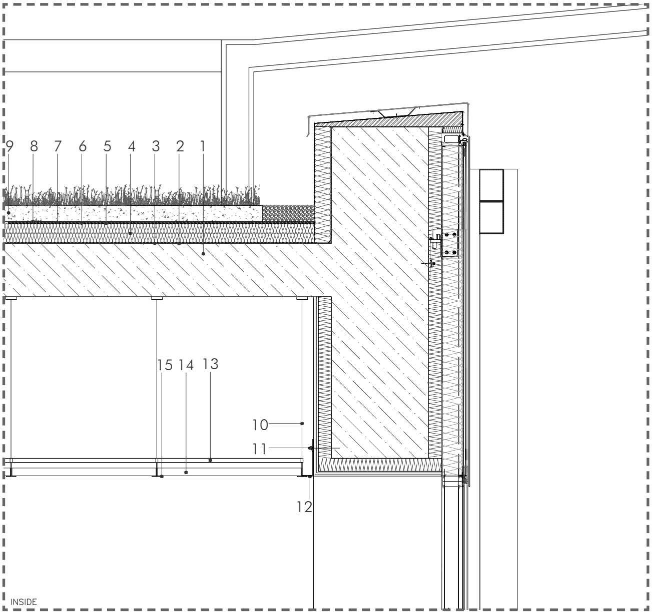
The exploitation of technical innovations allowed the design of a **highly customized and modular** curtain wall system, **unique** despite being composed of existing products, which guarantees its feasibility.

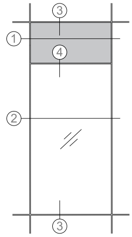
Each cellular unit is anchored to the reinforced concrete slabs by means of **vertical mullions**, designed in such a way to support, in turn, the extruded profiles enriching the composition.

Schüco Façade UCC 65 SG is a flexible and powerful modular system for unitised façades, for which all other componentscan be tailored perfectly to the façade, on an individual project basis. On the inside, its design is that of a unitised façade with narrow face widths of only 65 mm.



Physics building: complete technical detailed section

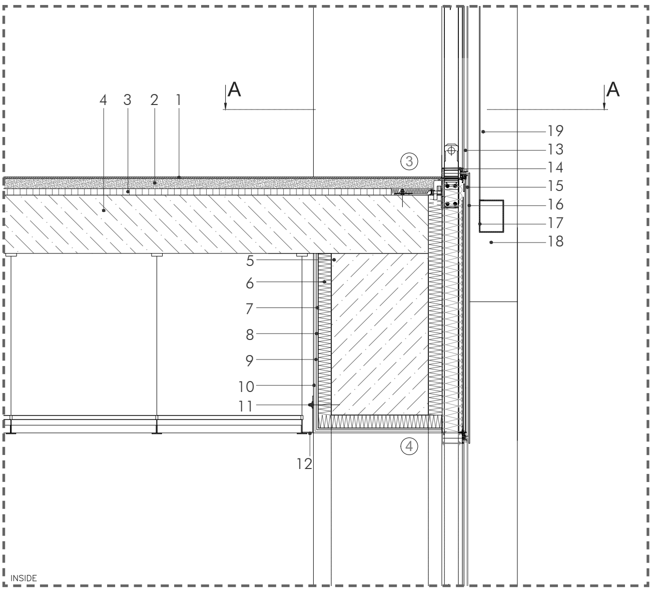




Detail A

DETAIL A - Green Roof Envelope

1 RC slab 330 mm
2 Splast primer 1 mm
3 Preflex - Elastomer bitumen membrane 4 mm
4 Rock mineral wool insulation 120 mm
5 Water proofing membrane 4 mm
6 Root barrier 1 mm
7 Drainage Layer 7 mm
8 Filter Layer 1.1 mm
9 Growing sobstrate 100 mm
10 Vernier suspension
11 Drilling screw
12 Ceiling wall angle 19*24*4 mm
13 Post cap profile
14 Ceiling panel
15 Partition connection profile



Detail B

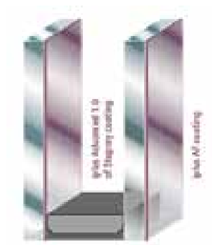
DETAIL B - Floor Envelope

1 2 component epoxy resin coating
2 Cement screed 80mm
3 Impact sound thermal insulation 40mm
4 Reinforced concrete slab 330 mm
5 Precast RC beam 600*1000 mm
6 XPS Insulation 100 mm
(applied with Forsafoam XPS glue)
7 Base coat 10mm
8 Reinforcing mesh
9 Base coat 10 mm
10 Stucco (primer and finish) 10 mm
11 Drilling screw
12 Ceiling wall angle 19*24*4 mm
13 ACG glass 28 mm
14 Horizontal mullion
15 Spandrel panel
16 Horizontal aluminium plate 6 mm
17 Horizontal aluminium profile 200*150 mm
18 Vertical aluminium profile 300*200 mm
19 Aluminium shading panel 5 mm

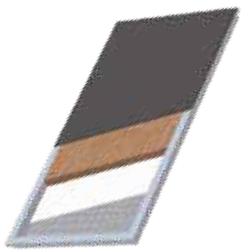
For what concerns the choice of a **glass** type, compatible to the **Schüco façade system**, the energy performance, and the contribution to the sustainability of the building level of the project represented decisive criteria.
Thermobel Advanced 0.8 is a double glazing providing an extremely **high level of thermal insulation**. It combines the exceptional insulation performance of a standard triple insulating glazing (**U** value of **0.8 W/m²K**) with the installation benefits of double glazing (compact thickness, lightweight). This is achieved by having a specific composition of low-e coatings combined with a thermal gas-filled spacer. Light transmission is maximised (LT= 72%) and the solar factor permits maximum use of free solar heat (SF = 50%).

Another important component in the design of the envelope is then represented by the **panels** defining the opaque portions of the curtainwall. **Isosta International VECOSTA Panels** are infill elements that can be used to create a unified look between the opaque sections and the vision areas of the façade.
One of the main reasons leading to the choice of a "cladding" curtainwall, was represented by the intention to **insulate the structural elements**, improving their thermal performance. **Beams and columns are indeed cased in a layer of XPS thermal insulation**, applied by means of an adhesive for bonding insulation panels (**Forsafoam XPS glue**).
Finally, the XPS panels are **internally** finished with a layer of **sand-colour stucco**, applied on a base coat of **Termoflex Adhesive Mortar** specific for XPS.

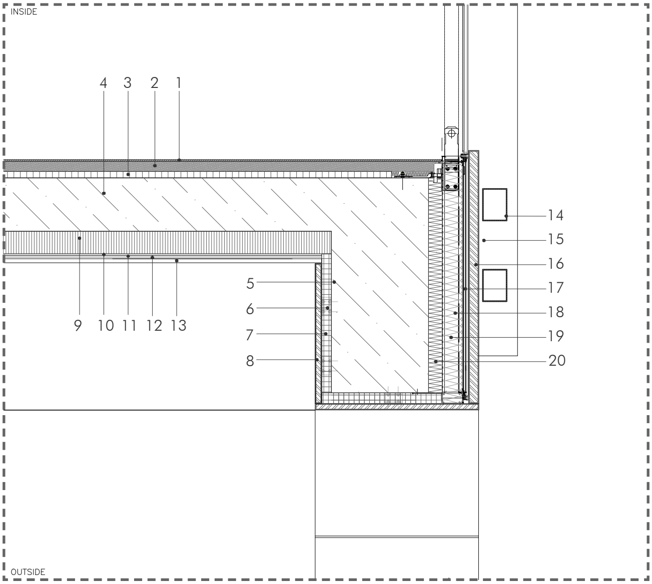
TECHNICAL INFO
Uf value: 2,2 W/(m^{2}K)
Material: Aluminuim
Max height: 3600mm
Max width: 2700mm
Max weight: 250 kg
Max glass: 36mm
EPD Recyclable



TECHNICAL INFO
Ug value of glass : 0.8 W/m²K
Free Solar Heat : 50%
Light Transmission: 72%
Min glass thickness: 20-22mm
Materials: Glass pane, Argon
Aluminium spaces, Zeolite
Dessicant, Polysobutylene
sealant, Silicone Sealant



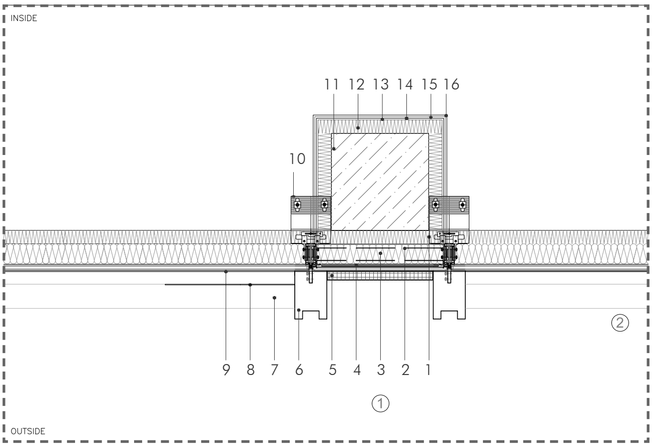
TECHNICAL INFO
Thermal insulation according
to IT249 standards
Materials: Aluminium
composite facing
XPS Insulation
Optional Plasterboard
Aluminum frame
Steel or aluminum facing



Detail C

DETAIL C - Facade Envelope Envelope

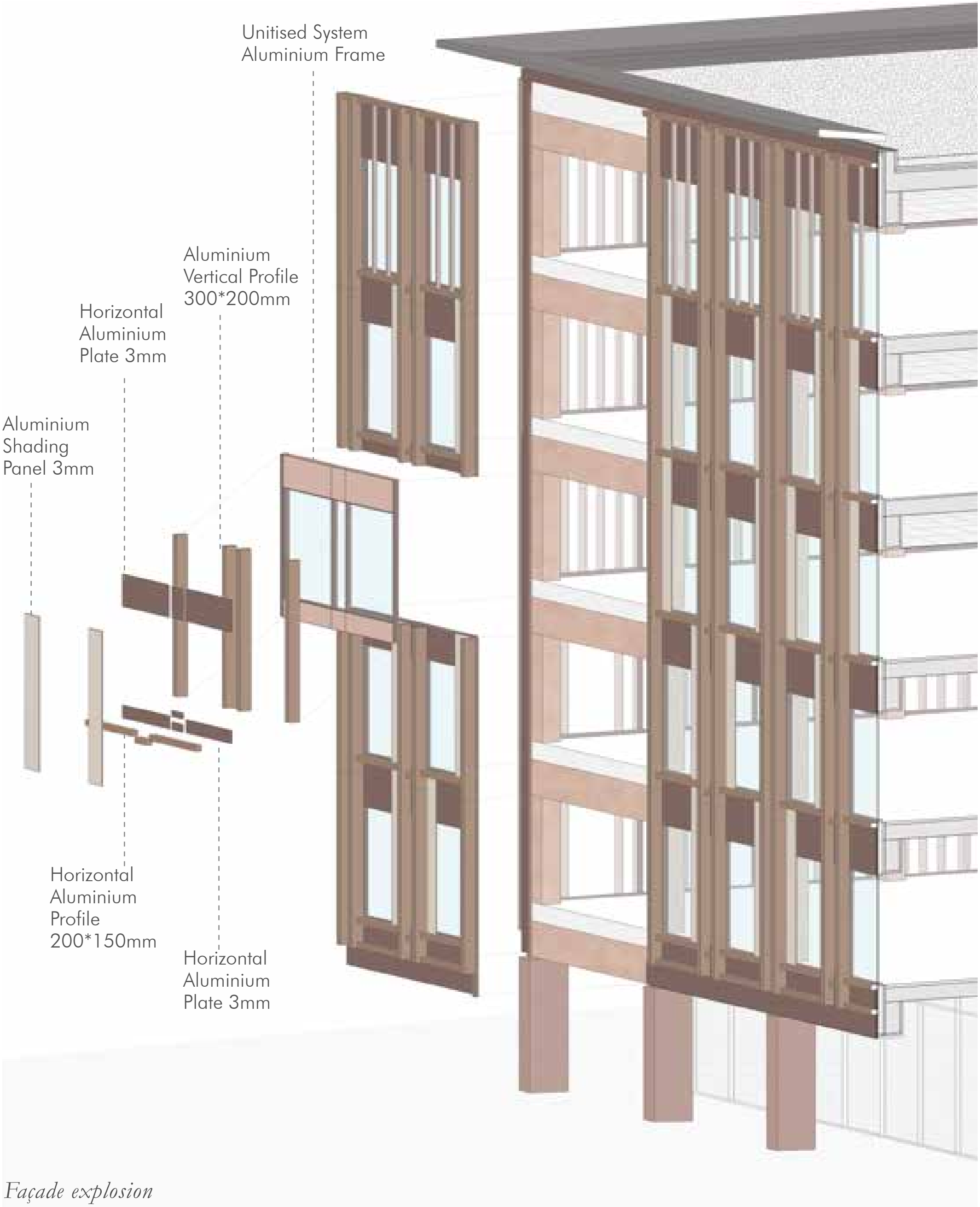
1 2 component epoxy resin coating
2 Cement screed 80mm
3 Impact sound thermal insulation 40mm
4 Reinforced concrete slab 330 mm
5 Precast RC beam 600*1000 mm
6 Support bracket
7 XPS Insulation 100 mm
8 Alucoband aluminium sandwich panel 0,5 mm aluminium , Mineral filled core with polymer adhesives
9 XPS Insulation 60 mm 2 layer (applied with Forsafoam XPS glue)
10 Base coat 10mm
11 Reinforcing mesh
12 Base coat 10 mm
13 Stucco (primer and finish) 10 mm
14 Horizontal aluminium profile 200*150 mm
15 Vertical aluminium profile 300*200 mm
16 Alucoband aluminium composite panel 0,5 mm aluminium , Mineral filled core with polymer adhesives
17 Opaque spandrel panel
18 XPS Insulation 120 mm
19 Horizontal mullion
20 XPS Insulation 100 mm



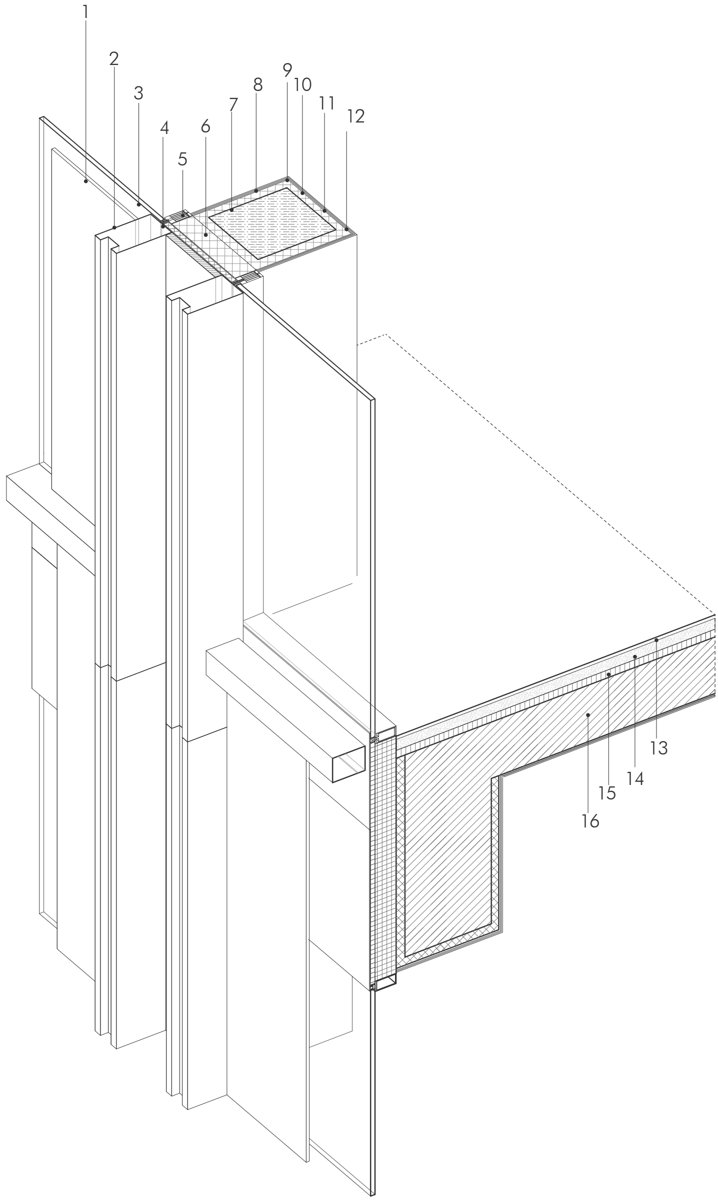
Detail AA'

DETAIL A-A - Facade Envelope Plan

1 XPS Insulation 100 mm
2 Horizontal mullion
3 XPS Insulation 120 mm
4 Opaque spandrel panel
5 Aluminium composite panel 60 mm
6 Vertical aluminium profile 300*200 mm
7 Horizontal aluminium profile 200*150 mm
8 Aluminium shading panel 5 mm
9 Aluminium plate 6 mm
10 Gravity bracket
11 RC Coloumn 600*600 mm
12 XPS Insulation 100 mm (applied with Forsafoam XPS glue)
13 Base coat 10mm
14 Reinforcing mesh
15 Base coat 10 mm
16 Stucco (primer and finish) 10 mm



Façade explosion



Façade detail

01- Aluminium shading panel 5 mm
02- Vertical aluminium profile 300*200 mm
03- ACG glass 28 mm
04- Spandrel panel
05- Horizontal mullion
06- XPS Insulation 120 mm
07- RC Column 600*600 mm
08- XPS Insulation 100 mm (applied with Forsafoam XPS glue)
09- Base coat 10mm
10- Reinforcing mesh
11- Base coat 10 mm
12- Stucco (primer and finish) 10 mm
13- Double component of epoxy resin coating
14- Cement screed 80mm
15- Impact sound thermal insulation 40mm
16- Reinforced concrete slab 330 mm

Double-faced façade

The **two-fold character of the building envelope** underlines the fundamental role played by the façade in the creation of a **peculiar atmospheres** both in the interior and exterior spaces. **Interiors** are characterized by the strong sensorial impressions generated by the **sand-colour stucco** used to paint the inner face of the building skin, but also by the **chromatic finishing of the aluminium profiles**. In fact, the realization of customized **superficial metallic finishing** allow to obtain a unique aesthetic characterization. The alternation of different rust, bronze and copper colours defines, instead, the mood of the **exteriors**, enriched by a composition of different **powder-painted** extruded profiles.

- 10 -

“sustainability strategy”

Sustainable design

BIM environment: LEED v4 Checklist

LEED v4 for BD+C: New Construction and Major Renovation

PROJECT NAME: BASEL LIFE SCIENCES CAMPUS

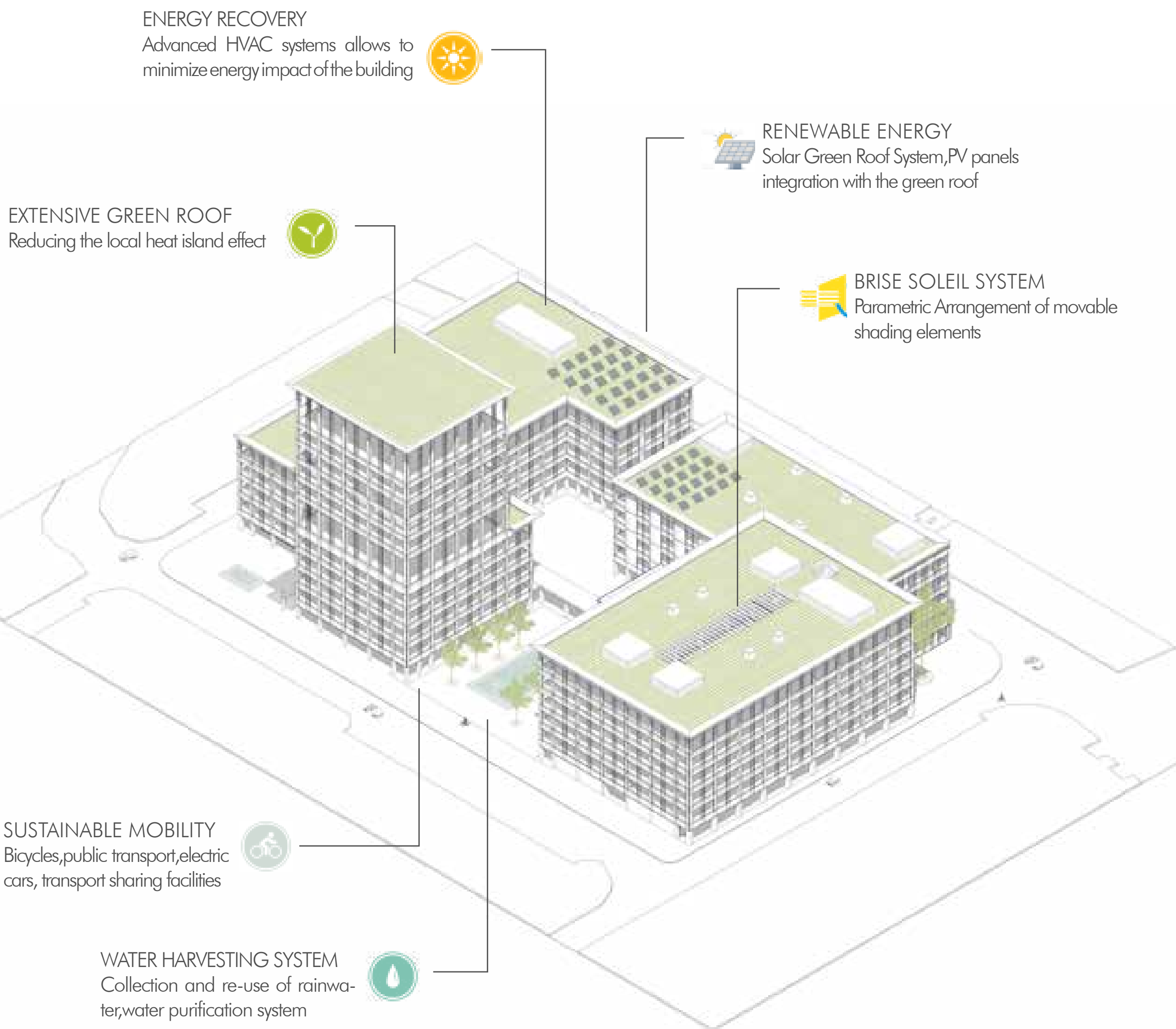
The project obtained a golden leed certificate, for a total score of 70/110 credits.

70 points

In 2005, the administration of the Canton of Basel-Stadt committed to a goal of becoming a carbon-neutral administration over a period of 25 years through a combination of reduction measures, such as energy efficiency in Cantonal buildings. According to such considerations, the design proposal was enriched by the elaboration of a preliminary design Environmental Strategy, elaborated following the criteria indicated by the LEED Checklist. As a result, the project obtained a golden Leed certificate, for a total score of 70/110 credits.

The proposed design is the project of a building complex belonging to the Life Science Campus of Basel University. In order to have the possibility to better understand and deepen the different aspects of such a complex program, the workflow process took advantage of the possibility to exploit BIM interoperability.
In order to take advantage of the positive characteristics of each software, 3D modelling was carried out both on Sketchup and on Revit, considering the possibility import components from one software to the other for specific design or graphic-related needs. Revit constituted then the main tool to exchange information between several BIM software, allowing to deepen different topics such as light analysis, energy analysis, material selection according to LCA (Life Cycle Assessment), and structural analysis.

Sustainability Strategy



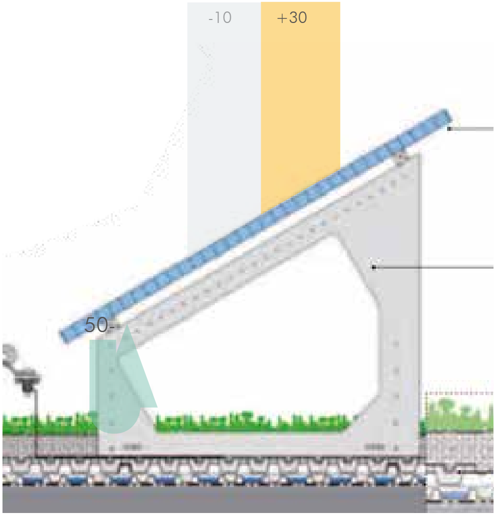
Photovoltaic systems

ENERGY AND ATMOSPHERE
RENEWABLE ENERGY PRODUCTION

33 points

Enhanced performance of photovoltaic modules of ZinCo Solar Base, combined with the green roof and significant synergy effects are achieved with combination of two system: Solar Green Roof.

The mounting system "Saddle" combines two solar frames onto a solar base. The inclination of panels directs the rainwater toward the aisle between the panels' rows, so that increased growth of the vegetation can be expected.

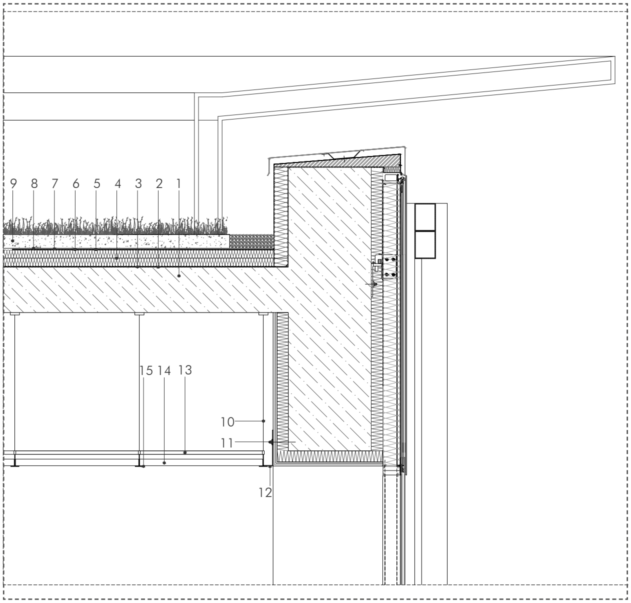


Solar Green Roof
Higher water retention
Higher evaporation and cooling
Minimum surface discharge

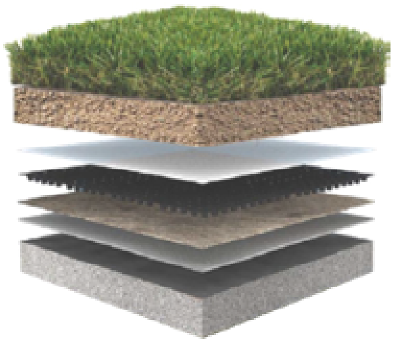
SolarVert® System Build-up

SUSTAINABLE SITES
HEAT ISLAND REDUCTION

10 points



The roof of the development hosts an extensive green roof, which forms a microclimate that reduces the local heat island effect, provides habitats, insulates the building, and minimizes the roof's water run-off.



Green Roof Envelope

1. RC slab 330 mm
2. Splast primer 1 mm
3. Preflex - Elastomer bitumenmebrane
4. Rock mineral wool insulation 120 mm
5. Water proofing membrane 4 mm
6. Root barrier 1 mm
7. Drainage Layer 7 mm
8. Filter Layer 1.1 mm
9. Growing substrate 100 mm
10. Vernier suspension
11. Drilling screw
12. L angle
13. Post cap profile
14. Ceiling panel 600*600 mm
15. Partition connection profile

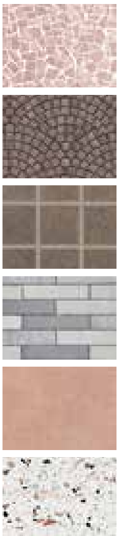

M A
T E
I R
I
A L
I T Y

Forum Materiality

MATERIALS AND RESOURCES
BUILDING LIFE CYCLE IMPACT REDUCTION 16 points

Very important was the use of **materials in the design of the ground floor space, both indoor and outdoor,** to increase the feeling of a **"common ground"** and of space continuity. In the design of the forum, **different materiality have been used to give character and identity** to the rich variety of public spaces provided, and the selections of the materials used has been mainly aimed at evoking the **traditional public squared of Basel**.

The historical city and many of its monuments are characterized by the use of **red and pinkish sandstones**, derived from regional caves. Starting from this reference, a series of natural and artificial paving materials have been selected: **pink sandstones** for the portico path, **granite cobblestones** for the main plaza, **concrete tiles** for the more intimate square. Similar materials are also used for the design of the **urban furniture** such as the seating around the central pool and the portico seating wall.
The materiality of the ground floor also involves the use of s**and-coloured stuccoes and fair-face concrete** with, together with the choice of **terrazzo flooring,** contribute to create a **sense of continuity between indoor and outdoor atmosphere**. Such feeling is also allowed by the extensive use of **clear glazing**, to obtain a permeable design.



Pink sandstone

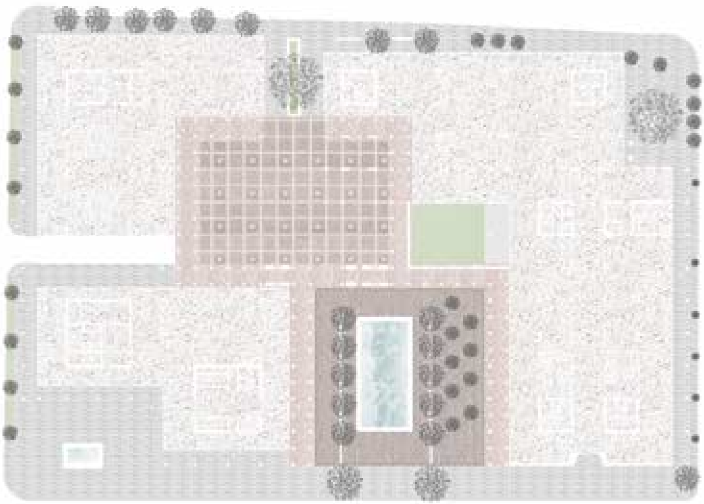
Granite cobblestones

Concrete tiles

Permeable concrete

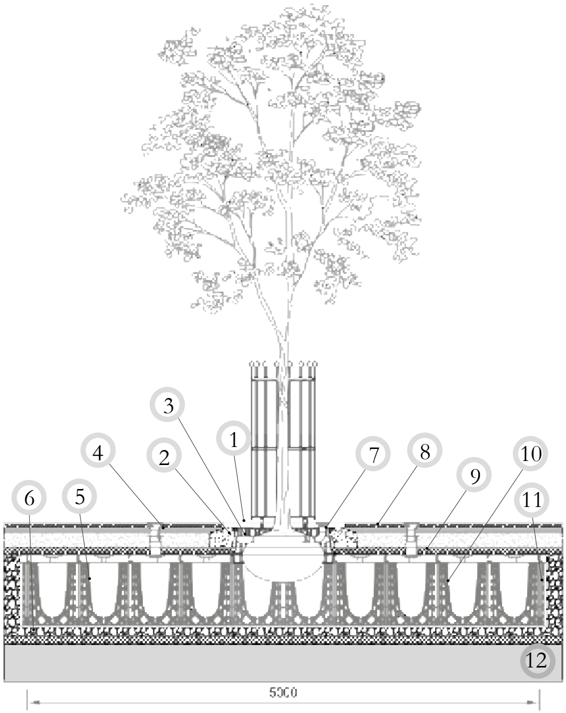
Sand-colored stucco

Terrazzo flooring



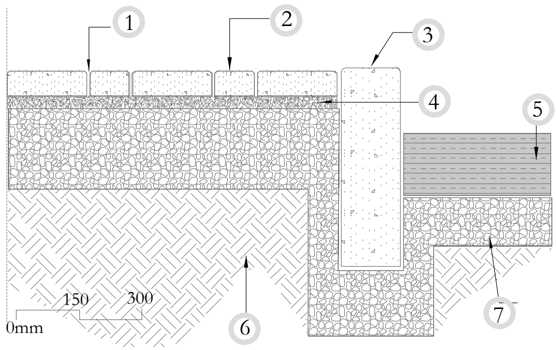
Stormwater tree pits

1. *1200mm x 1200mm tree tree grille c/w Root Rain Hydrogrille irrigation inlet*
2. *Galvanised tree grille support frame set on concrete haunch*
3. *RD1000-RS RootSpace*
4. *Arborvent 150 double inlet aeration / irrigation system*
5. *Strapped system c/w ground anchors*
6. *Drainage layer - 150mm*
7. *Root Rain Hydrogrille single inlet aeration/irrigation system with cast inlet*
8. *Pavement construction*
9. *Twinwall geonet laid over RootSpace structure*
10. *RootSpace structure - 1 module deep x 10 modules across x 6 modules wide*
11. *GRN20 plastic open reinforcing mesh, 20mm aperture laid below and around*
12. *Sub-base and drainage installed below RootSpace*



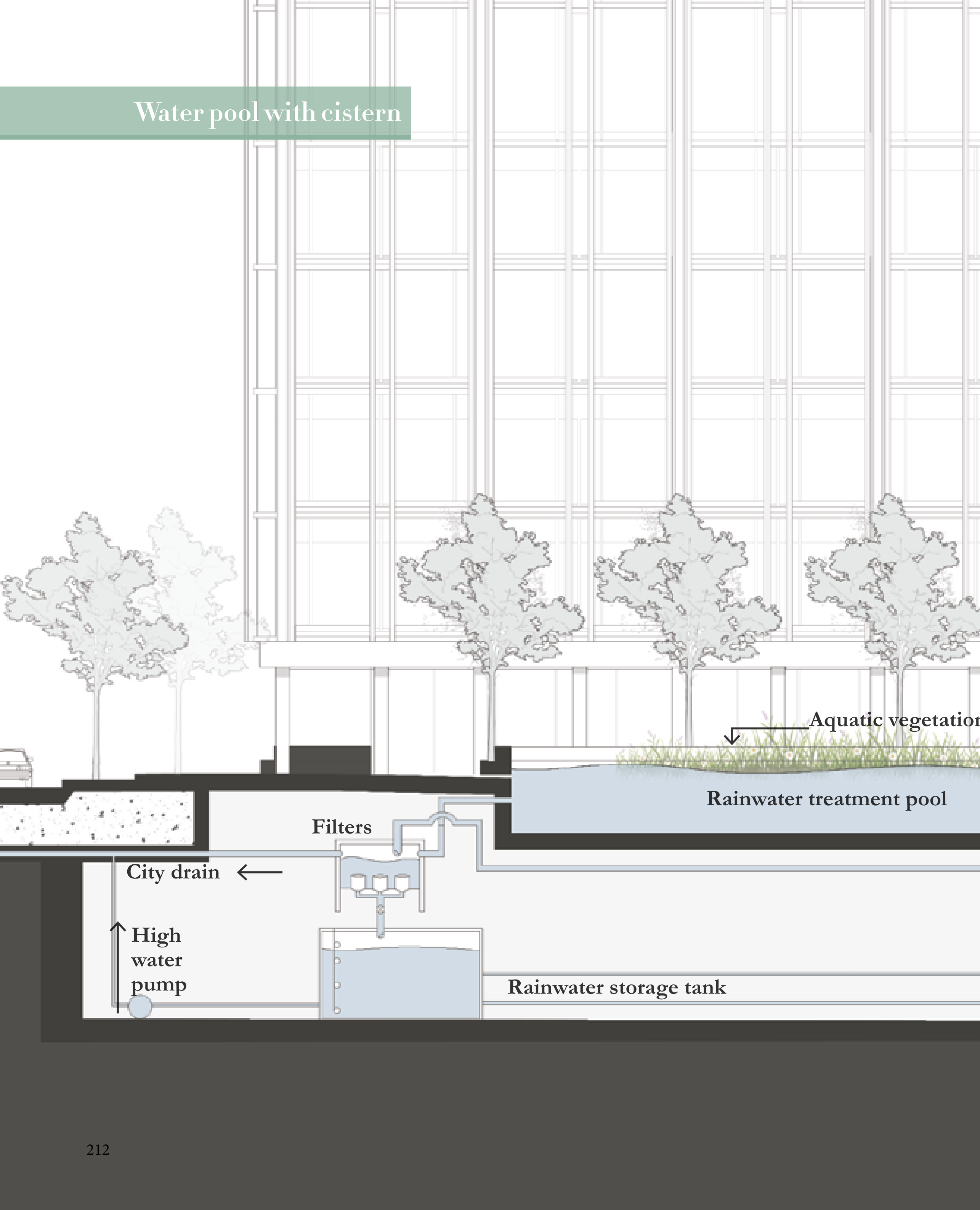
Permeable concrete pavers

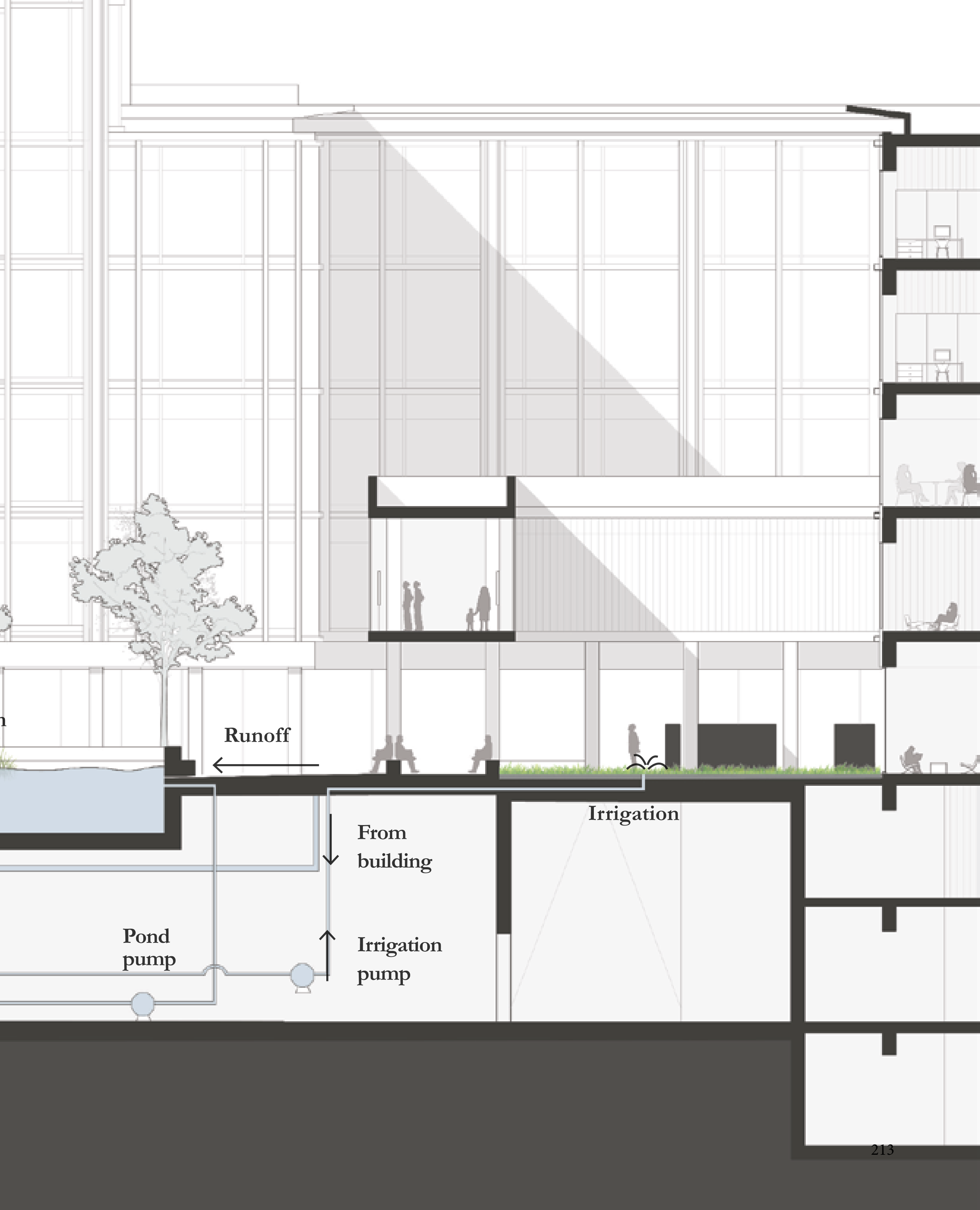
1. *Jointing Sand*
2. *Unilock Pavers, 60mm*
3. *Curb*
4. *Bedding Sand, 25mm*
5. *Road*
6. *Subgrade*
7. *Aggregate Base, 200mm*



The design of the forum also offers the opportunity to deal with **sustainability:** the planning and the detailing of the **open spaces** offered, indeed, the opportunity to integrate green and blue solutions in the project, while providing amenities to the users.
An example is given by **planting of new trees** in the public forum, provided with so-called "**stormwater tree pits**" able to improve water quality of local waterways, reduce peak runoff flows, increase groundwater infiltration, and improve the health of urban trees.
Another water management solution adopted on site is the use of **permeable concrete paving** for the perimeter of the urban block: pervious pavers have a high porosity that allows rainwater to pass through them into the ground below, reducing runoff and returning water to underground aquifers. It also traps suspended solids and pollutants, keeping them from polluting the water stream.
Furthermore, the design of the main open space also includes a **wide pool, combining both water features and vegetation, which are meant to function as part of a larger stormwater management system**: the water collected in the property is then drained through a stormwater filter to a **cistern located below the courtyard**.

Water pool with cistern

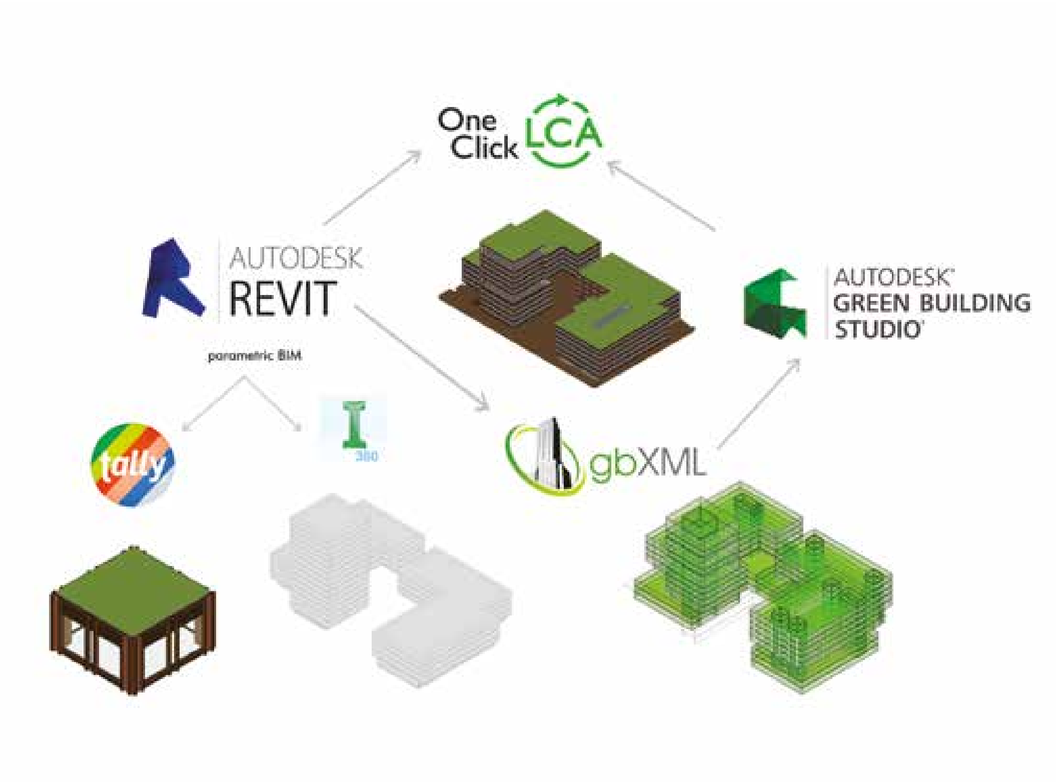



n
Runoff
Irrigation
From
building
Pond
pump
Irrigation
pump

BIM environment: Energy

Combining considerations related to the context, to regulations, to design intentions and to the program defined in the brief, the volumetric development of the design has been carried out trying to introduce BIM applications in order to optimize the result and support decision making. BIM software or platforms dedicated to energy, lighting, and environmental impact analysis.

Revit energy models need to be widely simplified with respect to an architectural ones: the level of simplification can go from mass modelling to the use of an energy model made of building components, which however simply includes the main floors and walls of the building, the cores and a very simplified envelope.



SOLAR RADIATION ANALYSIS
REVIT-INSIGHT

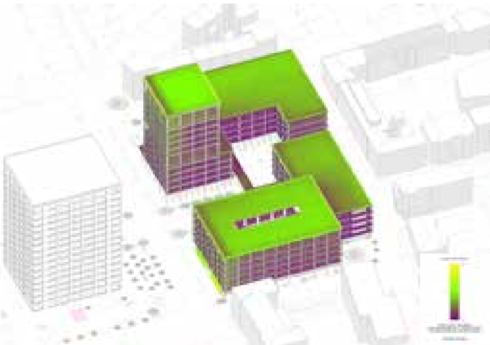
Sun Radiation Analysis have been carried out during the design process in Revit, thanks to the Insight plug-in application, in order to be aware of the solar exposure of the complex.

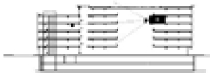
DAYLIGHT COMFORT ANALYSIS
VELUX DAYLIGHT VISUALIZER

The Revit Energy Model of the project was imported into the Green Building Studio platform, obtaining the following results.

DECEMBER 21st

JUNE 21st

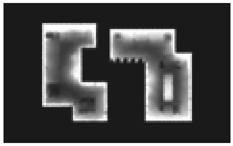




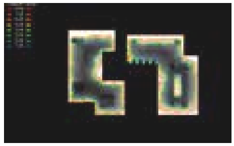
KEY PLAN-CENTRAL ATRIUM

KEY PLAN-OFFICE SPACES

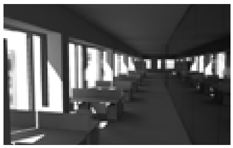
LUMINANCE ANALYSIS

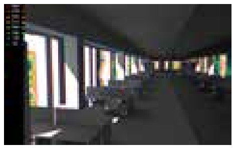


DAYLIGHT FACTOR - 21st MARCH

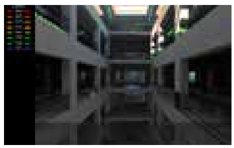


OFFICE SPCACE





CENTRAL ATRIUM



ENERGY OPTIMIZATION
GREEN BUILDING STUDIO

Energy model is exported from Revit using gbLMX file to other BIM software or platforms dedicated to energy analysis: the Revit Energy Model of the project was imported into the Green Building Studio platform, to obtain energy demand of the project containing the electricity, water and the benefits of photovoltaic panels.

Building Summary - Quick Stats	
Number of People:	11,662 people
Average Lighting Power Density:	12.90 W / m² ⬇
Average Equipment Power Density:	16.11 W / m²
Specific Fan Flow:	5.9 LPerSec / m²
Specific Fan Power:	-67,042.866 W / LPerSec ⬇
Specific Cooling:	0 m² / kW ⬇
Specific Heating:	0 m² / kW ⬇
Total Fan Flow:	407,185 LPerSec
Total Cooling Capacity:	-7,992,584 kW
Total Heating Capacity:	8,000,949 kW

Photovoltaic Potential (more details)	
Annual Energy Savings:	830,868 kWh
Total Installed Panel Cost:	CHF6,124,420
Nominal Rated Power:	766 kW
Total Panel Area:	5,544 m²
Maximum Payback Period:	49 years @ CHF0.09 / kWh

Wind Energy Potential	
Annual Electric Generation:	575 kWh

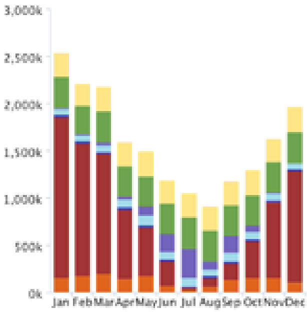
Energy, Carbon and Cost Summary	
Annual Energy Cost	CHF1,440,027
Lifecycle Cost	CHF19,613,165
Annual CO_2 Emissions	
Electric	0.0 Mg
Onsite Fuel	1,750.3 Mg
Large SUV Equivalent	175.4 SUVs / Year
Annual Energy	
Energy Use Intensity (EUI)	994 MJ / m² / year
Electric	9,456,727 kWh
Fuel	35,097,460 MJ
Annual Peak Demand	3,592.8 kW
Lifecycle Energy	
Electric	283,701,810 kW
Fuel	1,052,923,800 MJ

LEED Water Efficiency (more details)

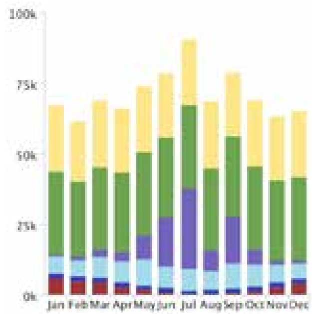
	L / yr	CHF / yr
Indoor:	54,478,360	CHF87,710
Outdoor:	696,701	CHF481
Total	**55,175,061**	**CHF88,191**

Natural Ventilation Potential	
Total Hours Mechanical Cooling Required:	6,276 Hours
Possible Natural Ventilation Hours:	1,848 Hours
Possible Annual Electric Energy Savings:	1,283,488 kWh
Possible Annual Electric Cost Savings:	CHF115,514
Net Hours Mechanical Cooling Required:	4,428 Hours

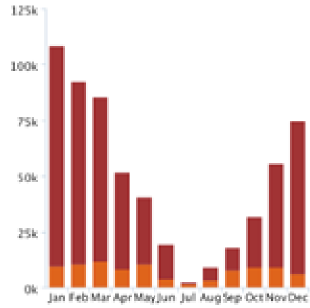
TOTAL ENERGY, COST



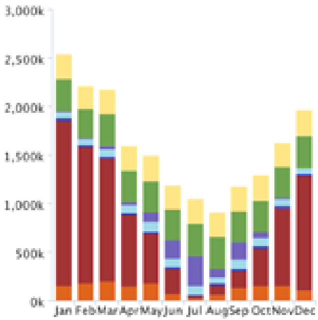
ELECTRICITY, COST



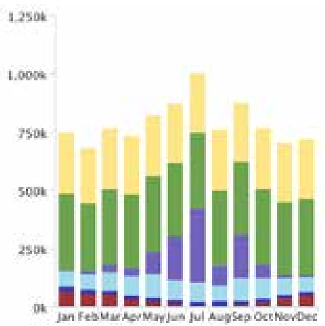
NATURAL GAS, COST



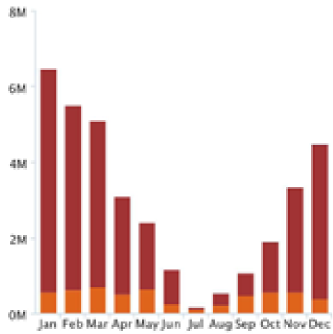
TOTAL ENERGY, kWh



ELECTRICITY, kWh



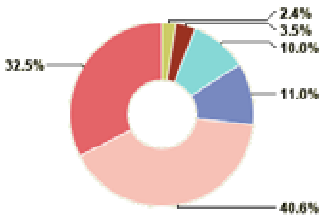
NATURAL GAS, MJ

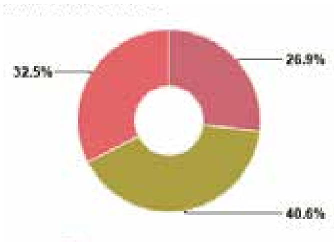


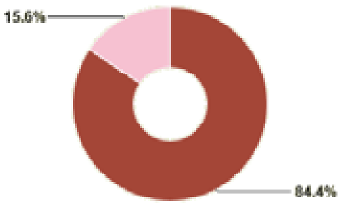
Area lights
Misc Equipment

Space cooling
Vent fans
Pump aux

Space heat
Hot water







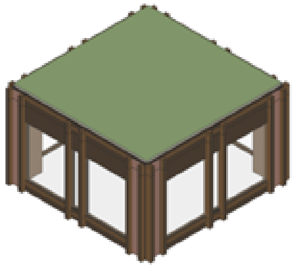
Pumps & Aux 2.4%
Space heating3.5%
Fans 10.0%
Space cooling 11.0%
Misc equip 40.6%
Lights 32.5%

HVAC 26.9%
Other 40.6%
Lights 32.5%

Space heating 84.4%
Hot water 15.6%

ENVIRONMENTAL IMPACT
REVIT - TALLY

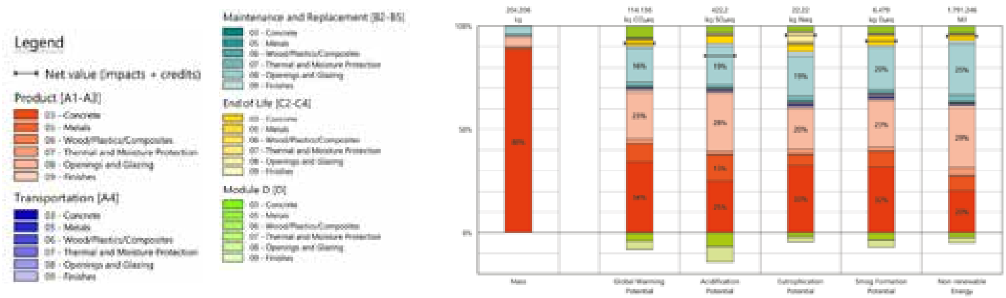
The building materials and quantities are assigned in Tally for a part of the building (a portion of facade) to guide the material choices according to analysis that show their impact on the overall sustainability.



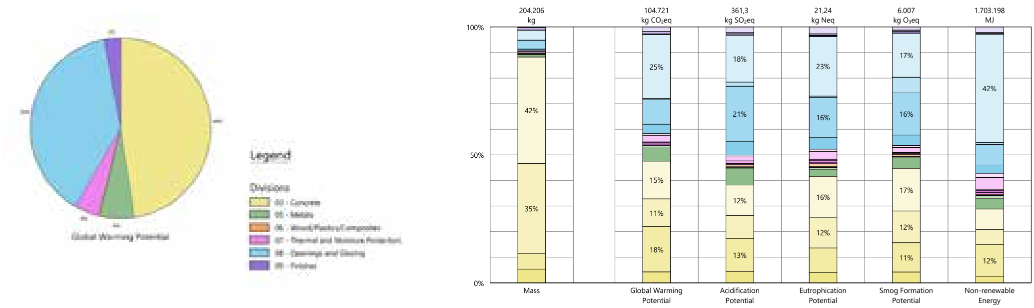
Environmental Impact Totals	Product Stage [A1-A3]	Construction Stage [A4]	Use Stage [B2-B5]	End of Life Stage [C2-C4]	Module D [D]
Global Warming (kg CO_2eq)	79.027	1.156	22.828	4.322	-2.612
Acidification (kg SO_2eq)	288,3	5,356	93,44	21,36	-47,2
Eutrophication (kg Neq)	13,55	0,4361	5,462	2,198	-0,4081
Smog Formation (kg O_3eq)	4.187	177,0	1.513	377,2	-248
Ozone Depletion (kg CFC-11eq)	5,952E-005	3,959E-011	8,168E-005	8,921E-009	-4,588E-005
Primary Energy (MJ)	1.230.127	16.808	573.497	68.305	-85.935
Non-renewable Energy (MJ)	1.103.659	16.406	545.304	63.865	-26.035
Renewable Energy (MJ)	126.990	406,4	28.398	4.511	-59.839

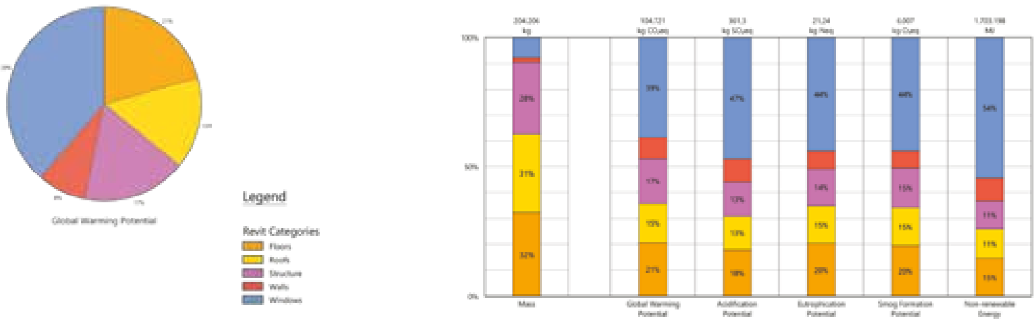
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m^2)	1,162	0,017	0,3357	0,06356	-0,03841
Acidification (kg SO_2eq/m^2)	0,00424	7,876E-005	0,001374	3,142E-004	-6,937E-004
Eutrophication (kg Neq/m^2)	1,993E-004	6,413E-006	8,032E-005	3,233E-005	-6,001E-006
Smog Formation (kg O_3eq/m^2)	0,06158	0,002603	0,02225	0,005546	-0,00364
Ozone Depletion (kg CFC-11eq/m^2)	8,752E-010	5,821E-016	1,201E-009	1,312E-013	-6,747E-010
Primary Energy (MJ/m^2)	18,09	0,2472	8,434	1,004	-1,26
Non-renewable Energy (MJ/m^2)	16,23	0,2413	8,019	0,9392	-0,3829
Renewable Energy (MJ/m^2)	1,868	0,005977	0,4176	0,06634	-0,88

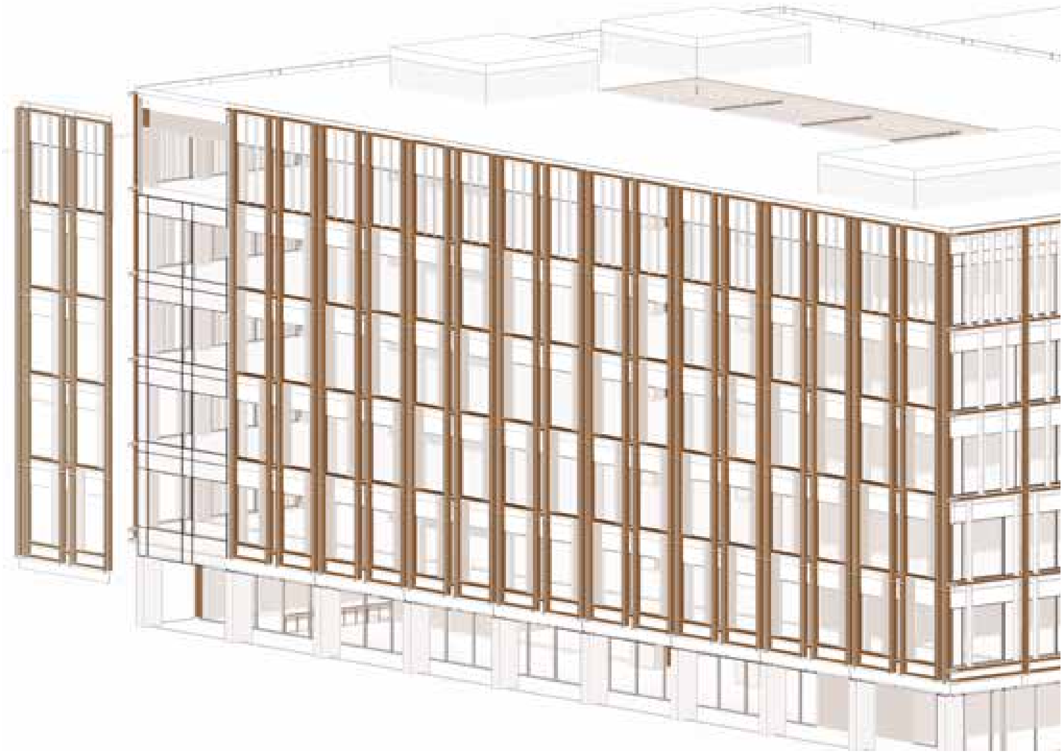
LIFE CYCLE STAGES



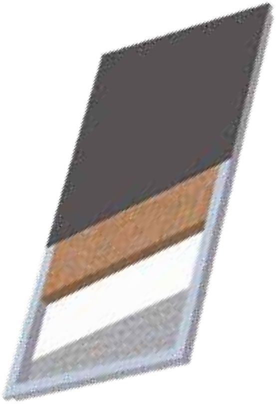
ENVIRONMENTAL IMPACT CATEGORIES







PHYSICS & SNI
NORTH -EAST FACADE

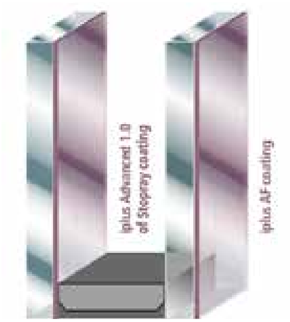


TECHNICAL INFORMATION
Thermal insulation in compliance with IT249 rules

MATERIAL
Aluminium composite facing
XPS Insulation
Optional Plasterboard
Aluminum frame
Steel or aluminum facing

SCHÜCO FACADE
UCC 65 SG

TECHNICAL INFORMATION
U value of frame : 2,2 W/(m2K)
Material : ALuminium
Max height: 3600 mm
Max. width 2700 mm
Max weight: 250 kg
Max. glass thickness : 36 mm
EPD Recycable

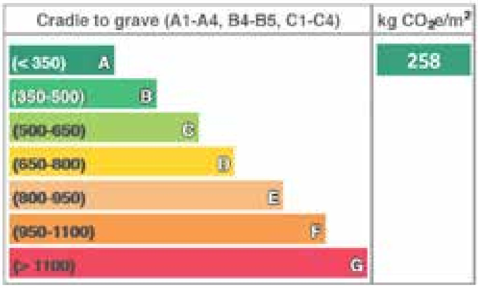


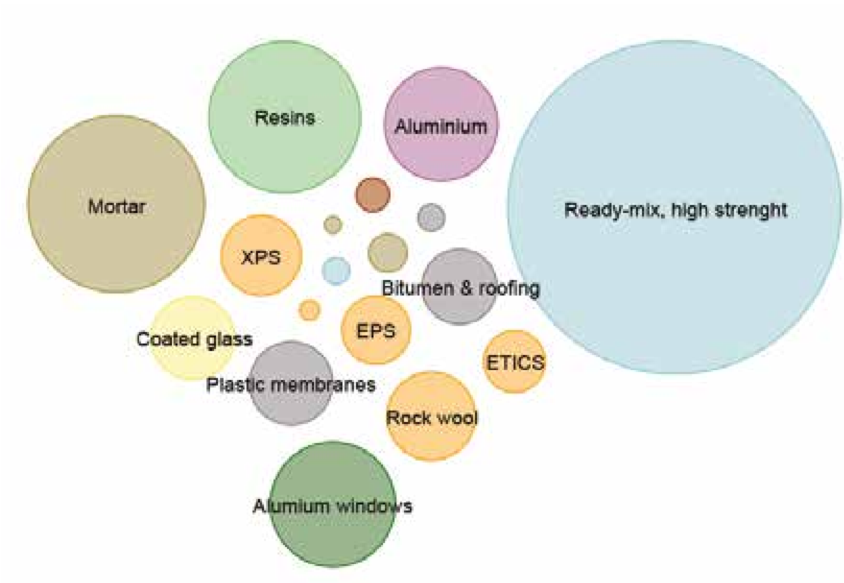
ACG GLASS THERMOBEL
ADVANCED 0.8

TECHNICAL INFORMATION
Ug value of glass : 0.8 W/m²K
Free Solar Heat : 50%
Light Transmission: 72%
Global warming potential
Total A1-A3 Production:
3.92E+01 kg CO2 eq/FU
Total life cycle
4.37E+01 kg CO2 eq/FU

LIFE CYCLE ASSESMENT
ONE CLICK LCA

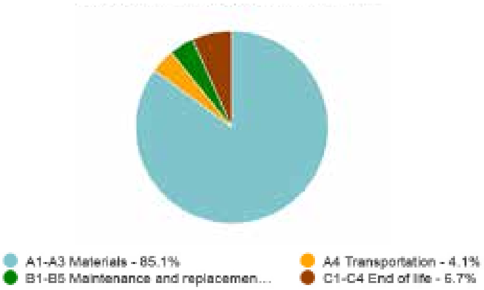
An in-depth form of analysis performed on whole buildings, manufactured building products and materials, and material assemblies to obtain a complete picture of the environmental impacts associated with a building.
OneClick has been run in a later stage, using the entire Revit model of the building complex. Also, in this case, the process was implemented at different stages of the design, leading the improvement of material choices.



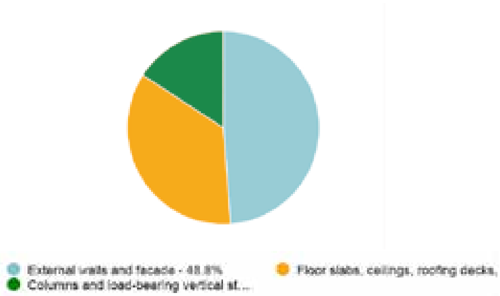


17 576 Tons CO_2e 5 kg CO_2e / m2 / year 878 808 € Social cost of carbon

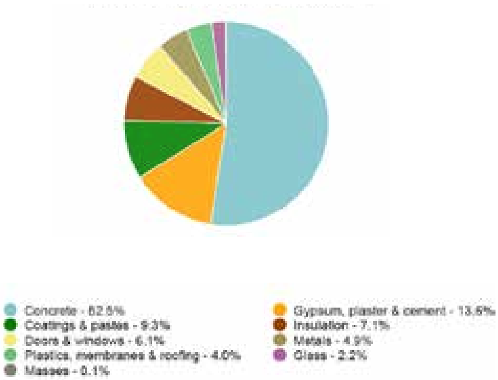
GLOBAL WARMING, kg CO2e LIFE CYCLE STAGES



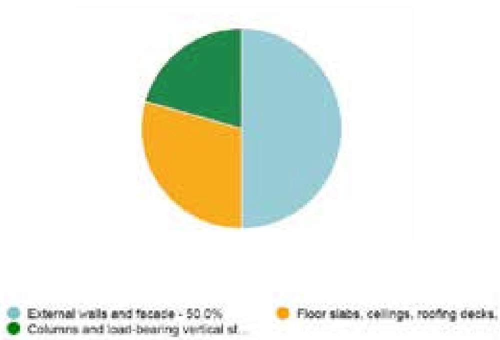
GLOBAL WARMING, kg CO2e CLASSIFICATIONS



GLOBAL WARMING, kg CO2e RESOURCE TYPES



MASS kg - CLASSIFICATIONS



- 11 -

" laboratory design"

Contemporary research labs

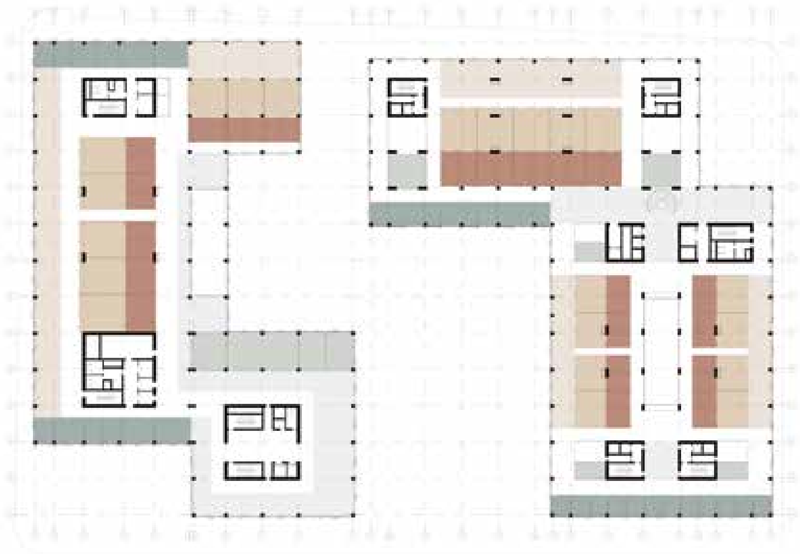
"Interdisciplinary communication as well as the need to provide research scientists with a pleasant work environment are the new paradigms of lab design, and are more strongly oriented to the rhetoric of New Economy architecture than to traditional factory structures."

***New Laboratories*, C. Klonk**

Considering the main use for which the buildings of Schällemätteli Campus' plot. n°4 are planned, one of the main research topics guiding the development of the project is the one concerning the **design of contemporary labs, specific for life sciences**.

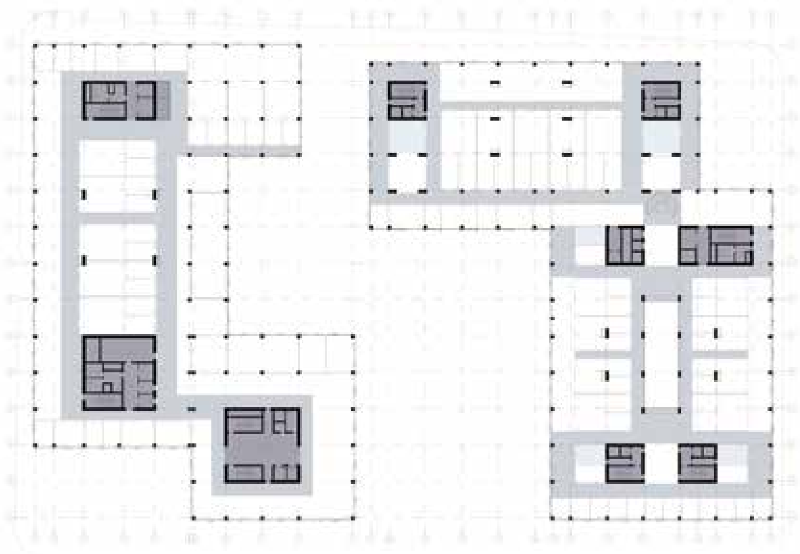
The capability of drawing international scientists deriving from the branding potential of high-quality and innovative research spaces, led the University of Basel to pay special care to the **definition of functional and efficient laboratory units**, able to satisfy the needs of scientists and to host specifically required technical systems, while providing a modern and pleasant working environment.
During the design phase, great importance was devoted to the concept of **flexibility**, a fundamental paradigm in contemporary laboratory architecture. The trend to so-called **"open labs", characterized by continuous, open-plan zones with large communal areas**, in opposition to the traditional individual "closed laboratory", is motivated by the intention to satisfy the needs

Functional type-floor plan diagram



Lab desks | Bench lab | Support lab | Meeting rooms | Offices | Informal areas

Services type-floor plan diagram



Circulation | Core facilities | Preparation areas

of a broad number of researchers, or research teams simultaneously, fostering impromptu encounters between scientists. Moreover, flexible arrangements are important not only in the laboratory itself, but also in the overall structural design of a research institute, allowing it to be altered in order to meet changing needs.
According to such considerations, the project aimed to **combine the conception of a flexible plan**, characterized by the arrangement of a structural scheme able to free broad spans from columns, **with the design of laboratory workstations as standardised modules**.

The typological method explained in the previous chapters represented a fundamental tool also in dealing with this topic, especially for what concerned the design of the Physics Department building.
Indeed, one of the most interesting cases in the evolution of the modern research building, with its typically high degree of structural flexibility, mutability and adaptability, was represented by the open spatial system proposed in the early 1950's by Frank Lloyd Wright for the *Larkin Company Administration Building of Buffalo, USA*.
With its central open plan circumscribed by mezzanines, defined as a "*Lichthof*", the building pioneered the shift from the closed space to the flexible configured open-plan zone.
Despite the typological discourse, the concept of **openness** suggested by this significant case study was applied, as extensively as possible, to the entire laboratory complex, enriched by a series of spaces dedicated to work breaks and informal meetings. The broad use of **transparency** in the design of inner spaces further enhanced this feeling in visual terms, **encouraging the maximum communication between researchers**.

Frank Lloyd Wright
Larkin Company Administration Building, Buffalo

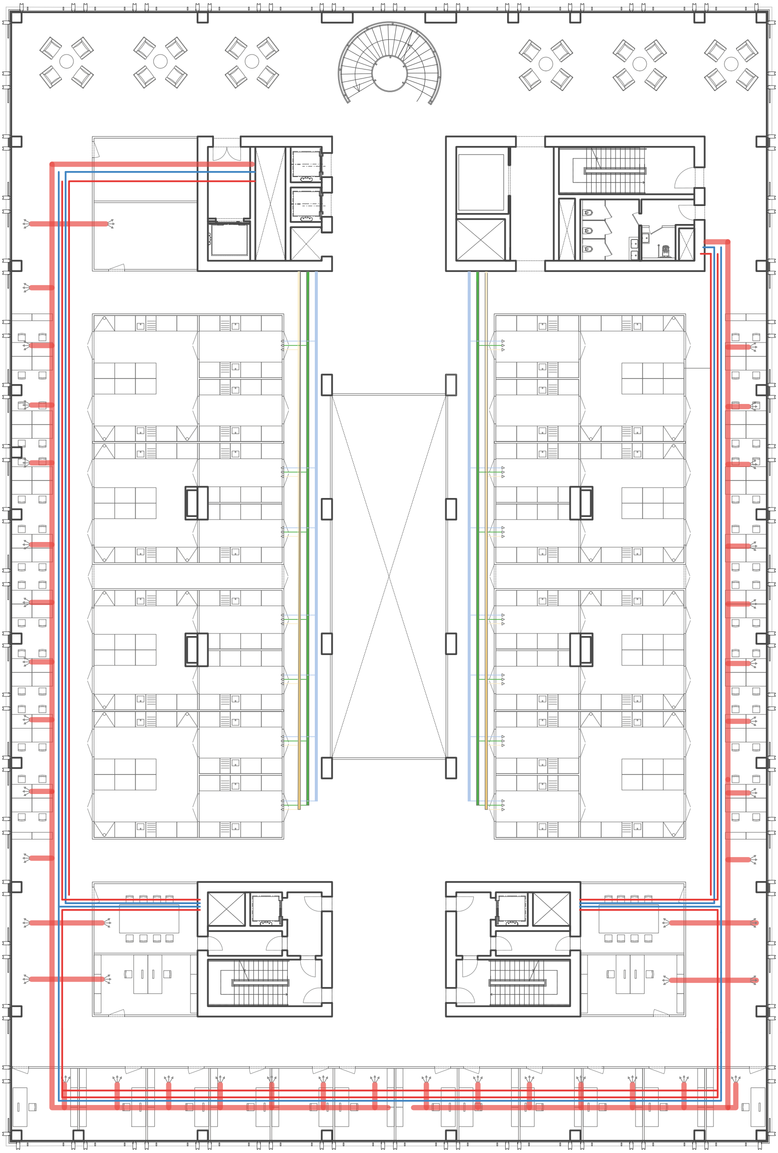
Building systems

The design of technical integrations, such as **building systems**, acquires a fundamental role in the design of laboratory buildings, due to their high level of complexity.
First of all, for what concerns the logistic distribution in section, **laboratory spaces have been concentrated in the upper floors of the building**, while the lower storeys are left for public and educational uses. Such program distribution also the differentiation and organization of the different required services.
Considering the presence of **both office spaces and laboratory units** within the type floor plan dedicated to the research departments, **two different typologies of HVAC systems** have been designed, according to standards, **to satisfy different needs**.
A **mixed air-water system was chosen for the design of office spaces**, as well as for common and informal areas. For what concerns the **laboratory units**, instead, an **all-air system has been preferred** to control and **prevent risks of contamination**.
It is in indeed preferrable to **conceive laboratory spaces as mono-zone systems** were contamination levels can be better regulated with a flow of fresh air at constant rate. On the other hand, **a multi-zone system** results as more suitable **for offices and shared spaces,** where it is possible to have variable air-flow fate approach, exploiting the **contribution of natural ventilation** to ensure the right amount of fresh air.
Among the advantages of using a mixed air-water system is the possibility to **regulate the thermostats in the individual rooms** of the multi-zone system, by controlling either the secondary water-flow rate of the secondary air-flow or both, **with economic benefits in terms of energy savings**.
An **independent all-air system** is also thought for one of the most technical areas of the complex: the **animal station**.
Located at the -2-basement level of the Physics and SNI department, the animal station is provided with a separate all-air system, served by its own air handling unit and ducts, reducing the risk of contamination. Carbon-activated filters are then used to filter the gas molecules and to remove any traces of contaminants.

Animal Station
-2 Basement level

LAB TYPE FLOOR PLAN

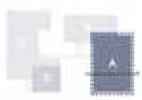
Ventilation system



Supply & Return Ducts

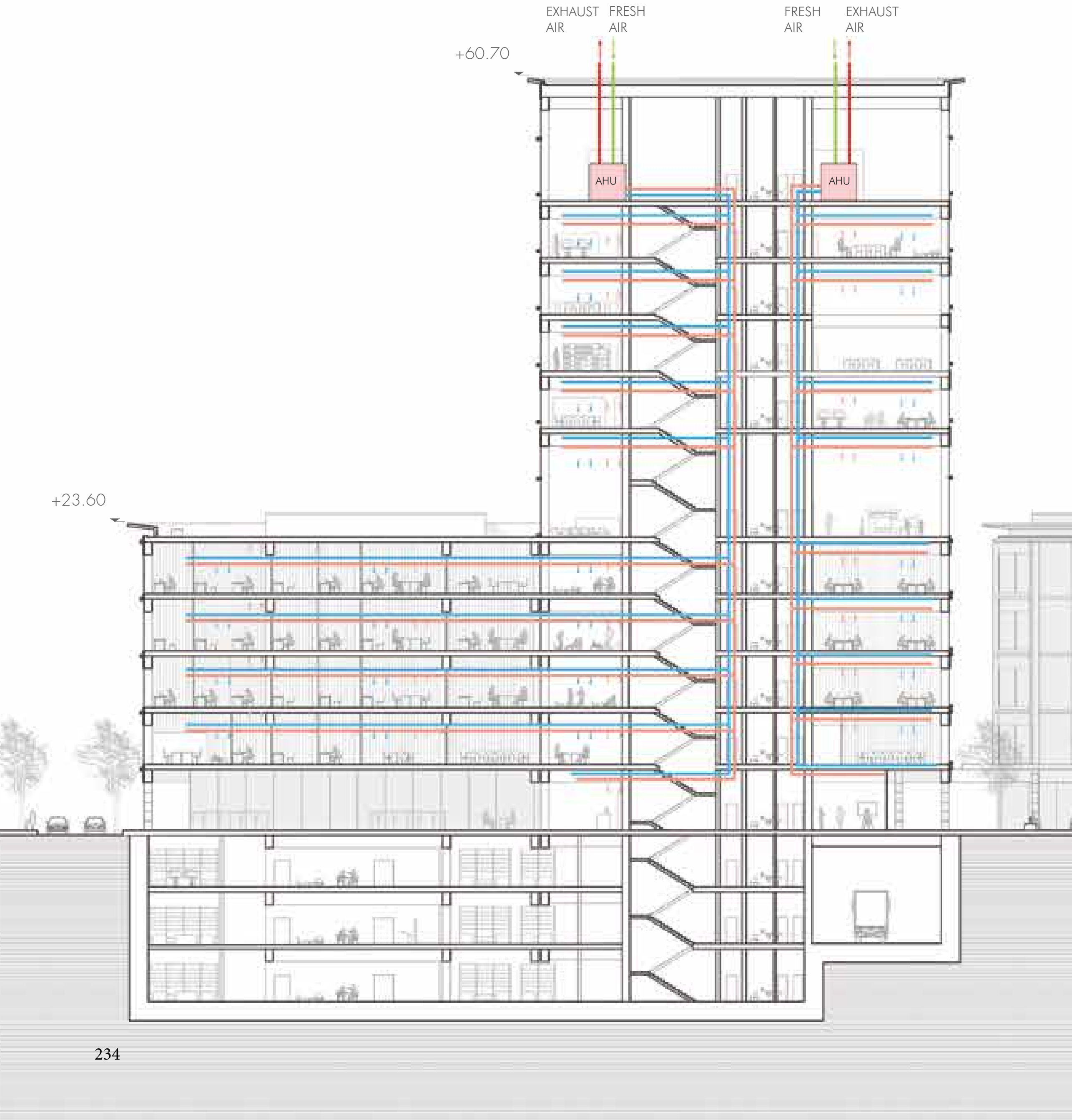
4 Pipes Heating & Cooling

Laboratory Cooling Equipment



CHEMISTRY - FACILITY TOWER

Mixed Air & Water System

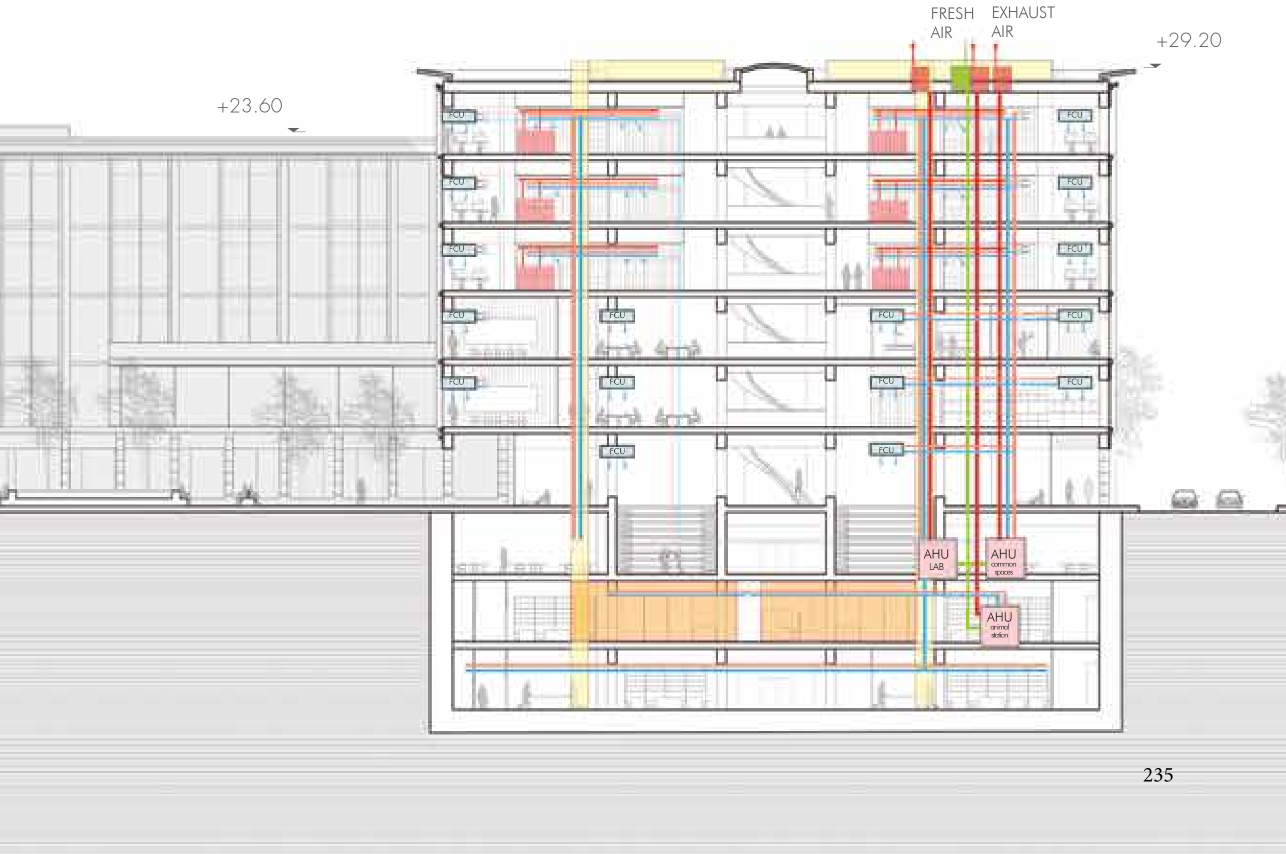


PHYSISCS + SNI

Mixed Air & Water System

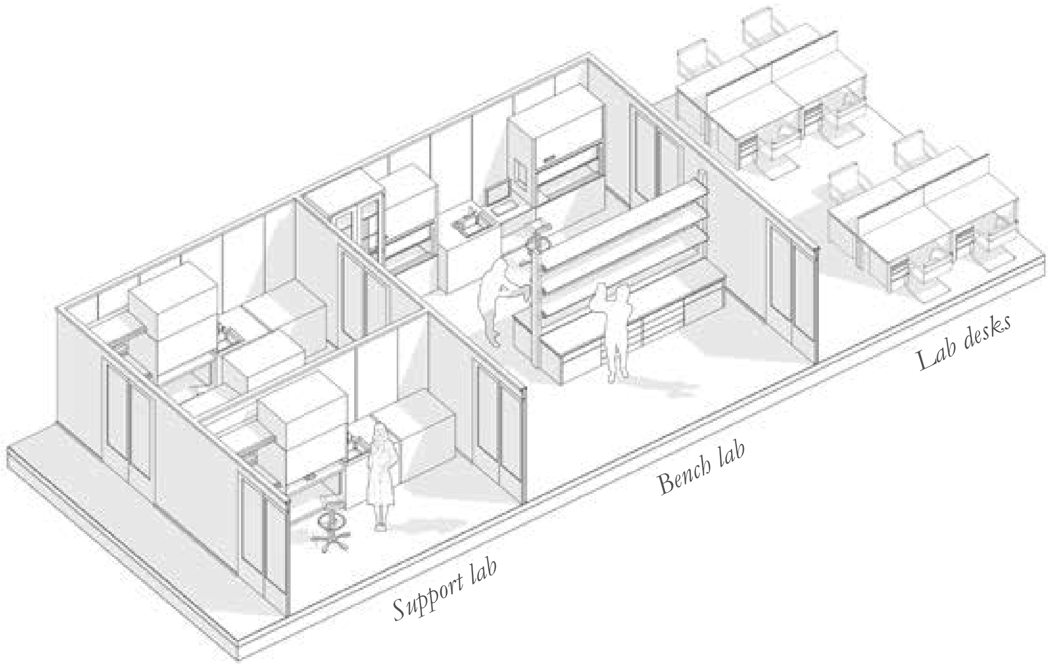
LABS & ANATOMY

All-Air System



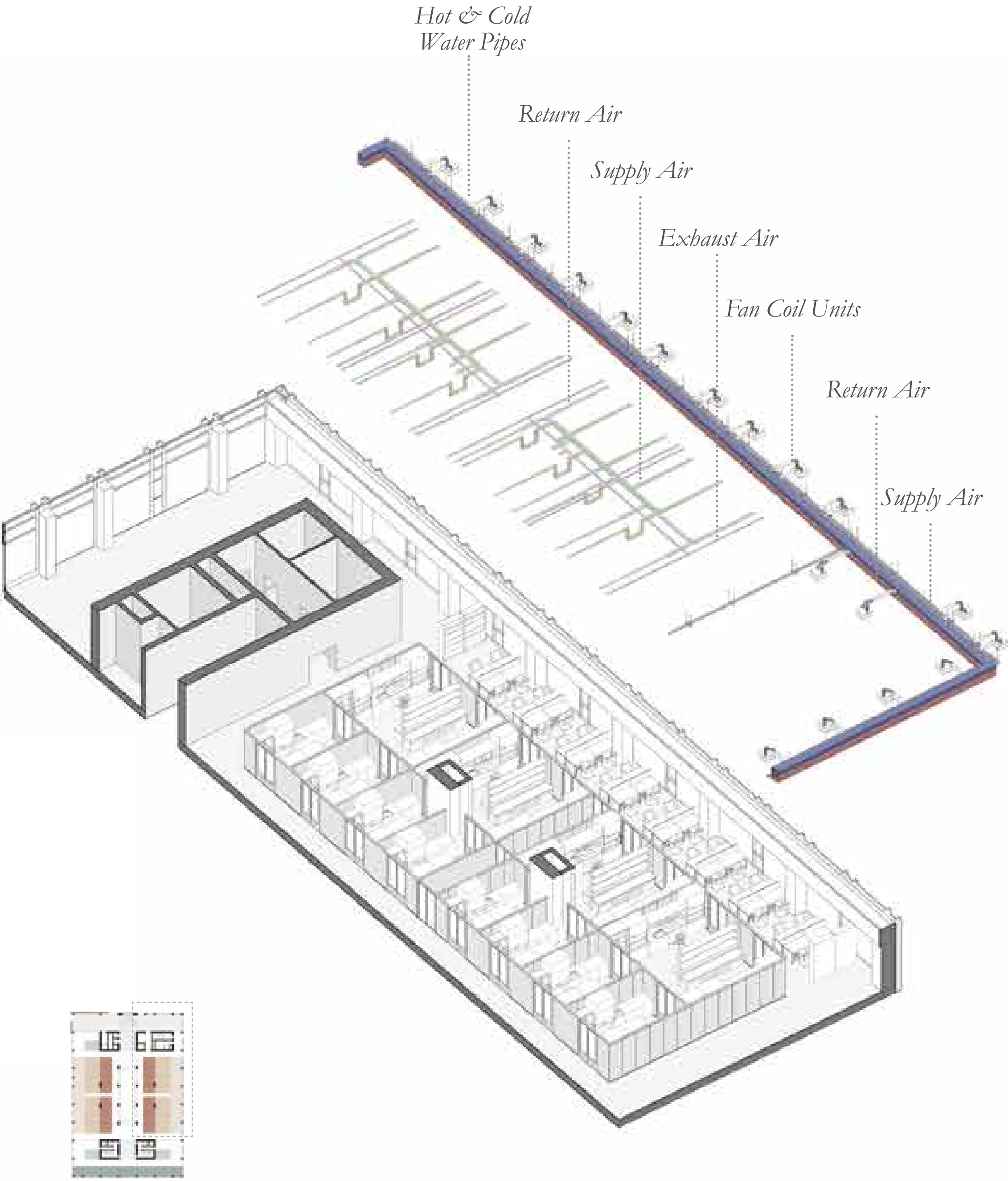
Standard laboratory units

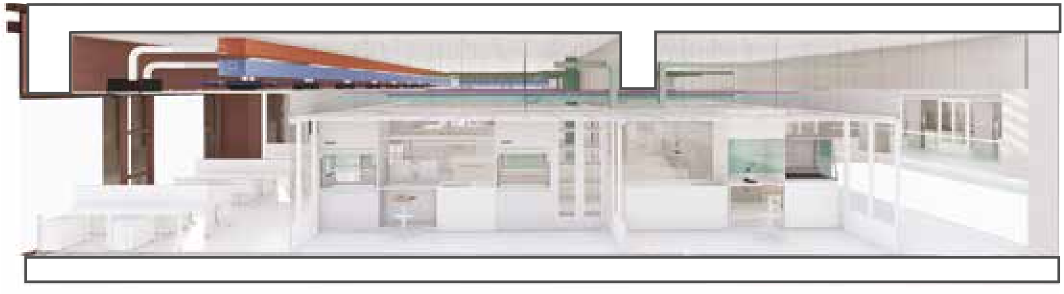
According to the **directives provided by the University of Basel** for the design of basic standard laboratory units, **each research module** is composed of three main functional areas: the **ancillary rooms (support labs),** the **bench laboratory,** and the **evaluation workstations' area.**
The type-floor plan dedicated to each research department is then the result of the combination of more standard units, the **dimensions** of which are **proportioned with the number or workstations** to be provided for each research team. The schematic type arrangement provided as a reference by the University of Basel has been defined respecting the distances between benches and office tables that are necessary to meet the requirements of the *Office of Economy and Labour*.



STANDARD LABORATORY

Basic Module including both lab and evaluation area


Hot & Cold
Water Pipes
Return Air
Supply Air
Exhaust Air
Fan Coil Units
Return Air
Supply Air



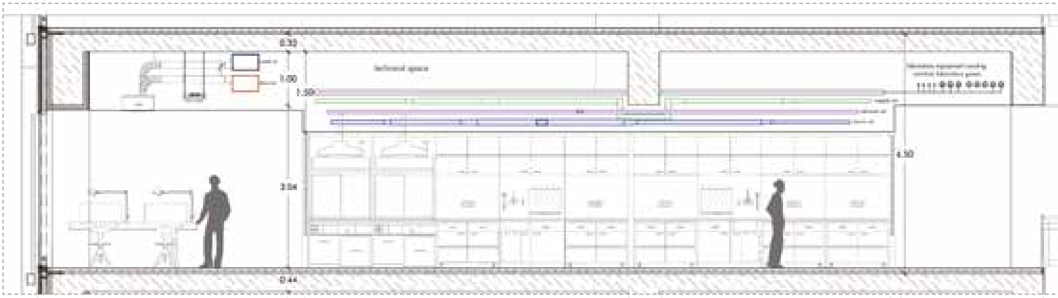
The essential features for the planning of a research unit, consisting of both standard laboratory and evaluation area, are:

- *One evaluation desk per scientist (min. 80x120 cm)*
- *1.5 laboratory bench workstation per scientist (Bench size 90x120cm)*

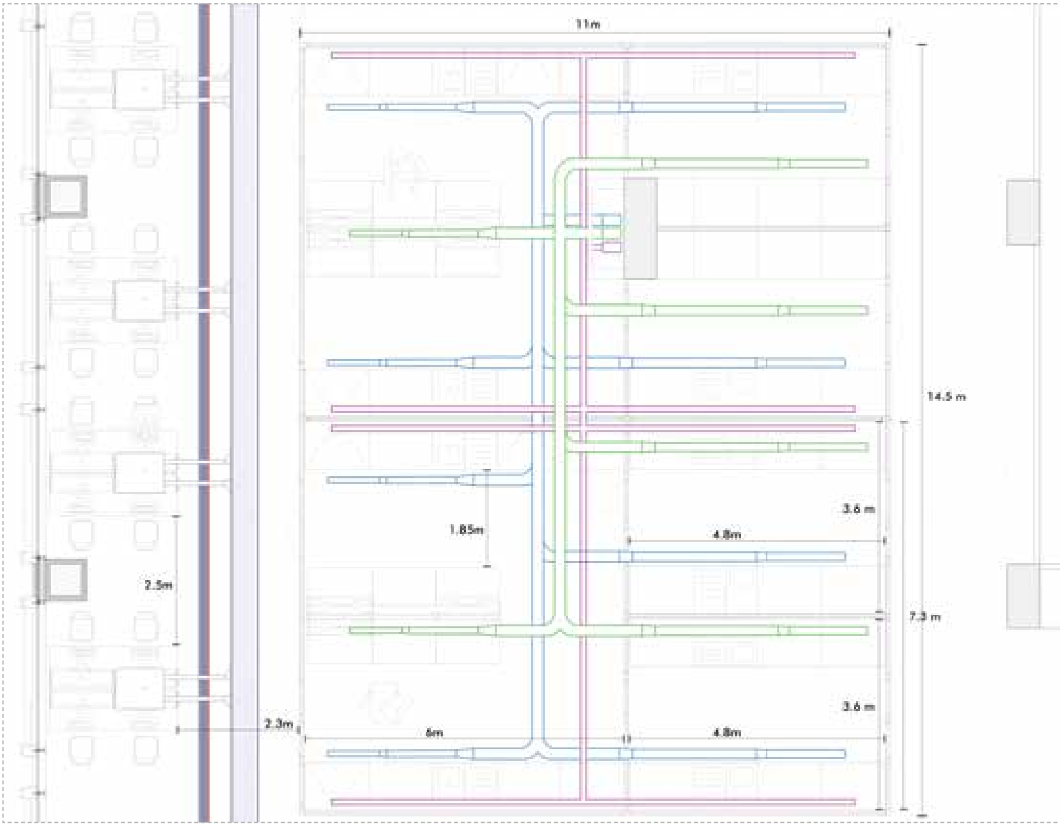
Laboratory and evaluation area, if necessary, can be separated by glazing with doors. The lab area is considered BSL-2 area (area of biosecurity of second level). For exits from this area, gowns and goggles must be deposited and hands washed. The special equipment required in each standard laboratory and evaluation area includes:

- *One hood for each standard laboratory*
- *An explosion proofed solvent cabinet*
- *Wall cupboards and media access, which should be arranged above the laboratory tables*
- *Computerized office chairs and tables with high voltage*
- *Storage for paper files*

For what concerns systems, **each laboratory** is served by an **all-air HVAC system** including **distinct pipes for air supply, air return and exhaust air**. The area of the **evaluation desks**, instead, is treated, as the other offices and shared spaces, by means of a **mixed air-water HVAC system** including **fan-coil units** heated and cooled by water pipes and hidden by a false-ceiling.



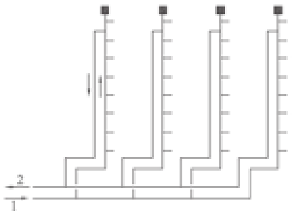
Evaluation desks | Bench Lab | Support Lab | Corridor



Evaluation desks | Bench Lab | Support Lab | Corridor

Water systsems

Finally, the design of building services also considered **water supply and drainage systems**, which begin at the supply point of the public potable water net, being connected to the city aqueduct of Basel. The water supply system is defined as a system with **bottom-up supply and hot water preparation at bottom level.**



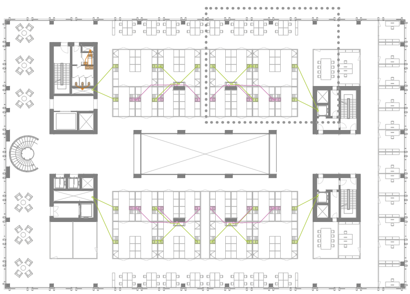
Calculations for the sizing of both hot and cold-water systems have been carried out according to the simplified method indicated by the norm EN 806-3.

For what concerns **water drainage**, instead, the adopted solution is the one defined by the standard EN UNI 12056 as **System I**, characterized by a single discharge stack system with partly filled branch discharge pipes.

The control of pressure in the discharge stack is then achieved thanks to the air flowing in the discharge stack and stack vent, defined according to a primary ventilated system configuration.

Furthermore, the design of the drainage system of life sciences laboratories is characterized by the differentiation between discharge pipes for **domestic water** and those for **chemically contaminated water**. For such reason, the calculations needed to dimension the two systems have been carried out separately.

Water Supply
Labs type-floor plan

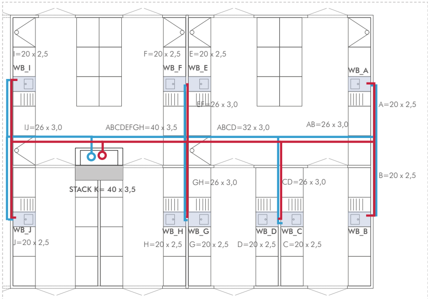


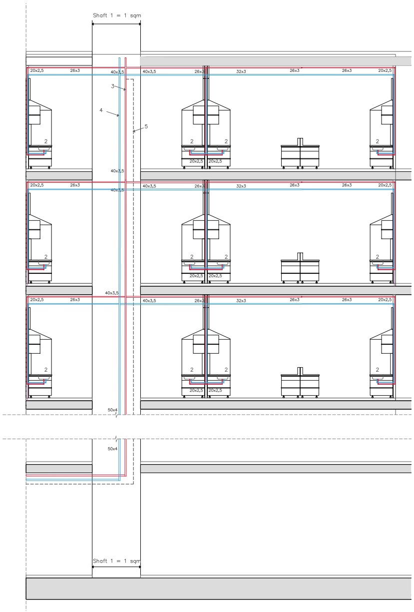
Water Drainage
Labs type-floor plan

Water Supply

Standard EN-806-3

Multilayer PEX/AL/PE-HD

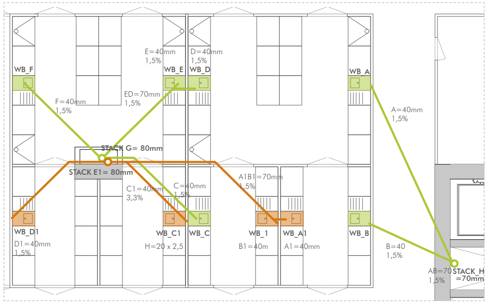


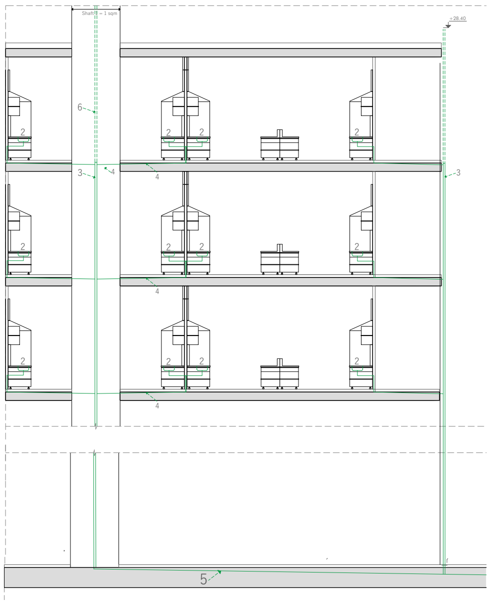


Water Drainage

Standard EN-UNI 12056-2

Multilayer PEX/AL/PE-HD





■ Hot water supply ■ Cold water supply

■ Domestic water ■ Chemichal water

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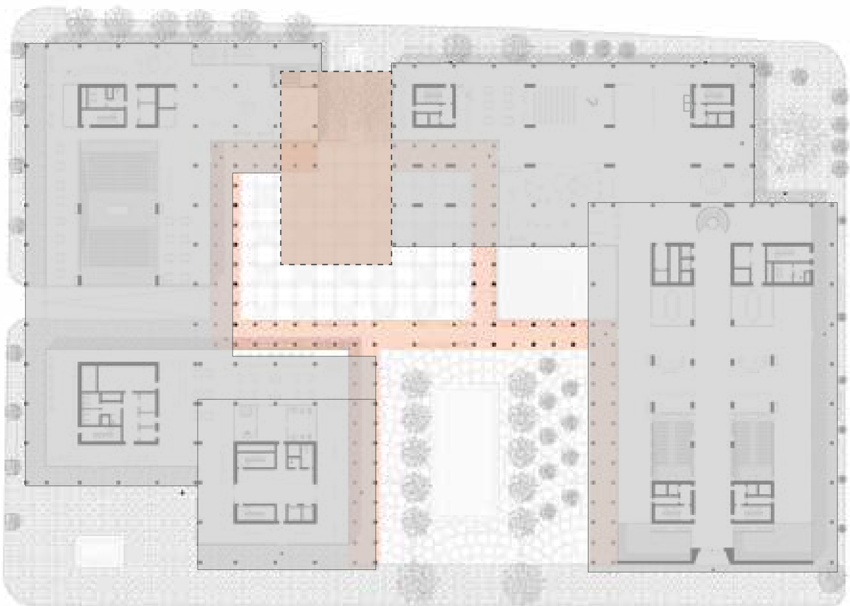
“ the auditorium ”

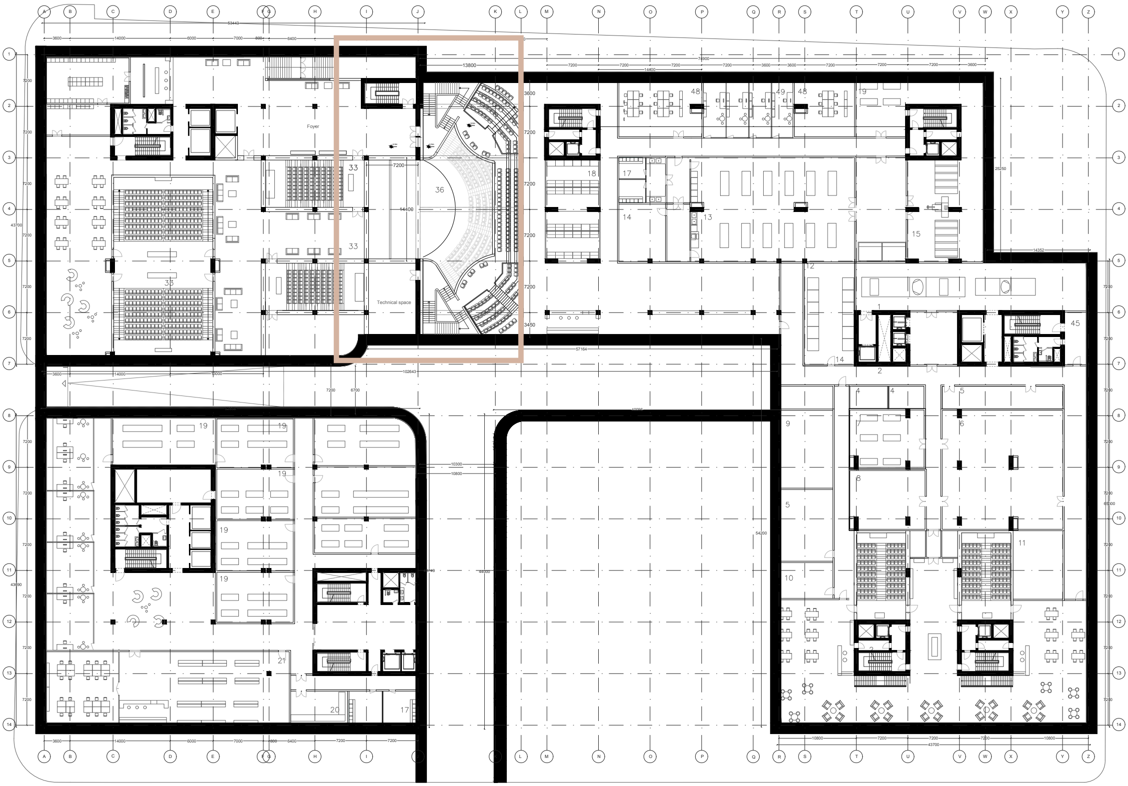
The auditorium

“In-between spaces”

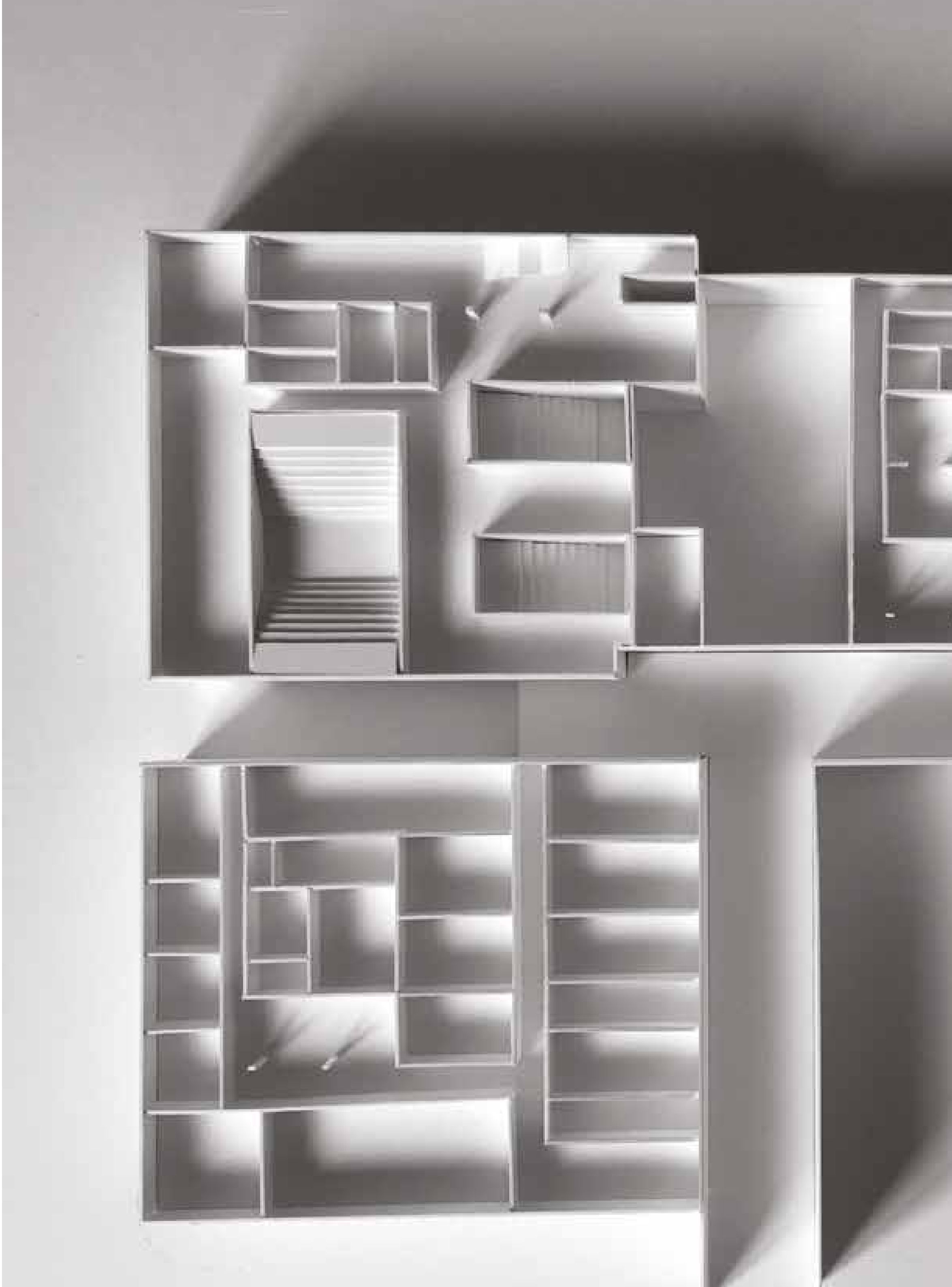
The multifunctional auditorium hall in the complex, which is open to both the university community and to the public, is chosen to deepen as a special design topic.
The main idea derives from defining the intermediate spaces with spatial configuration in relation to the urban morphology of the city and the social relations. By referring to the context, "in-between urban spaces" are defined in terms of use, size, and spatial configurations. The auditorium itself fits within a very compressed space located in between volumes of Institute of Anatomy and the Department of Chemistry. The main room is bordered by the structural border of the two volumes, while the stage area is located under the footprint of the Chemistry volume. According to architectural relationships between the inside and the outside, the auditorium is defined as an "hypogean" space while corresponding, above ground to the space of the forum which is defined by continuous portico system. The portico itself is linking the entire composition together and providing a common backdrop and language to each side of the forum as an open public space.

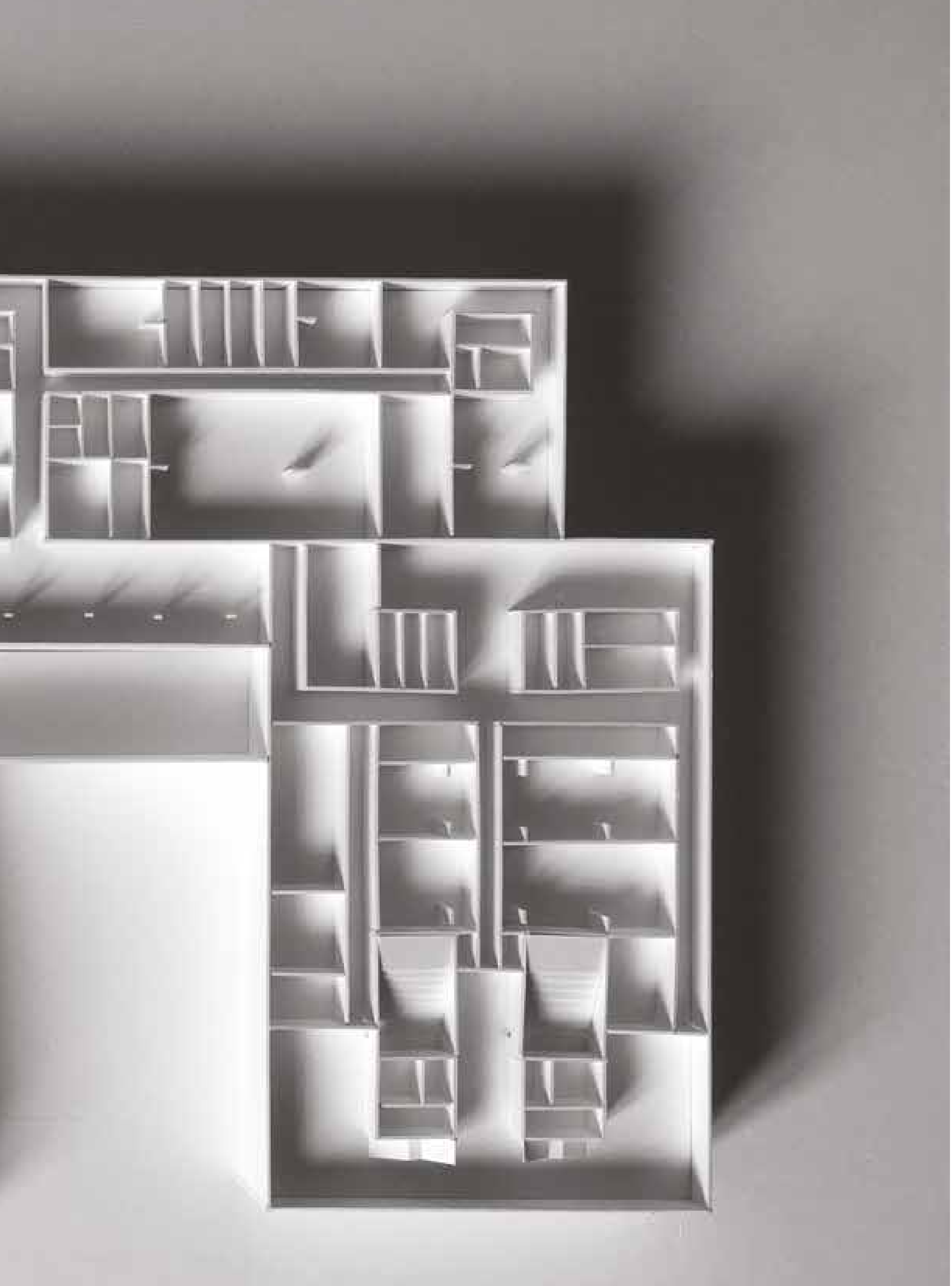


The Auditorium Hall
"space in-between"

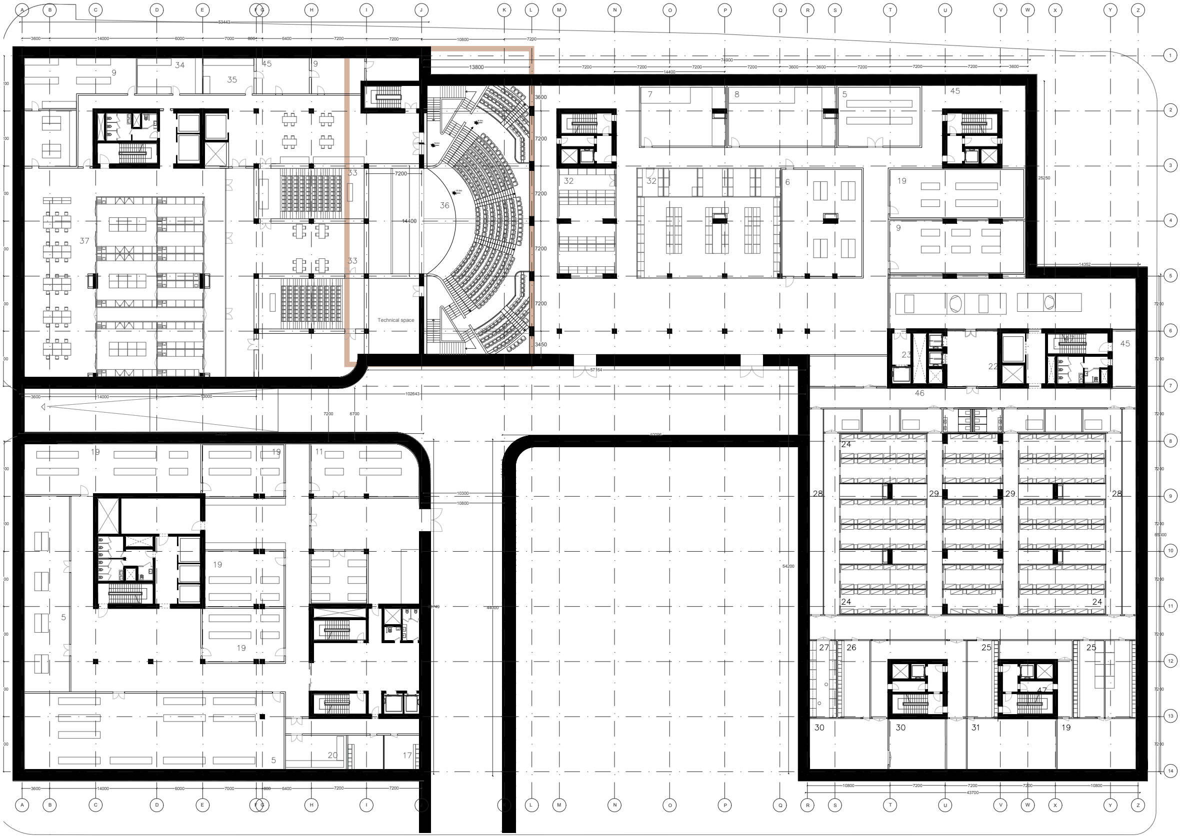


FLOOR PLAN LEVEL -10.00m
(-2 BASEMENT LEVEL)

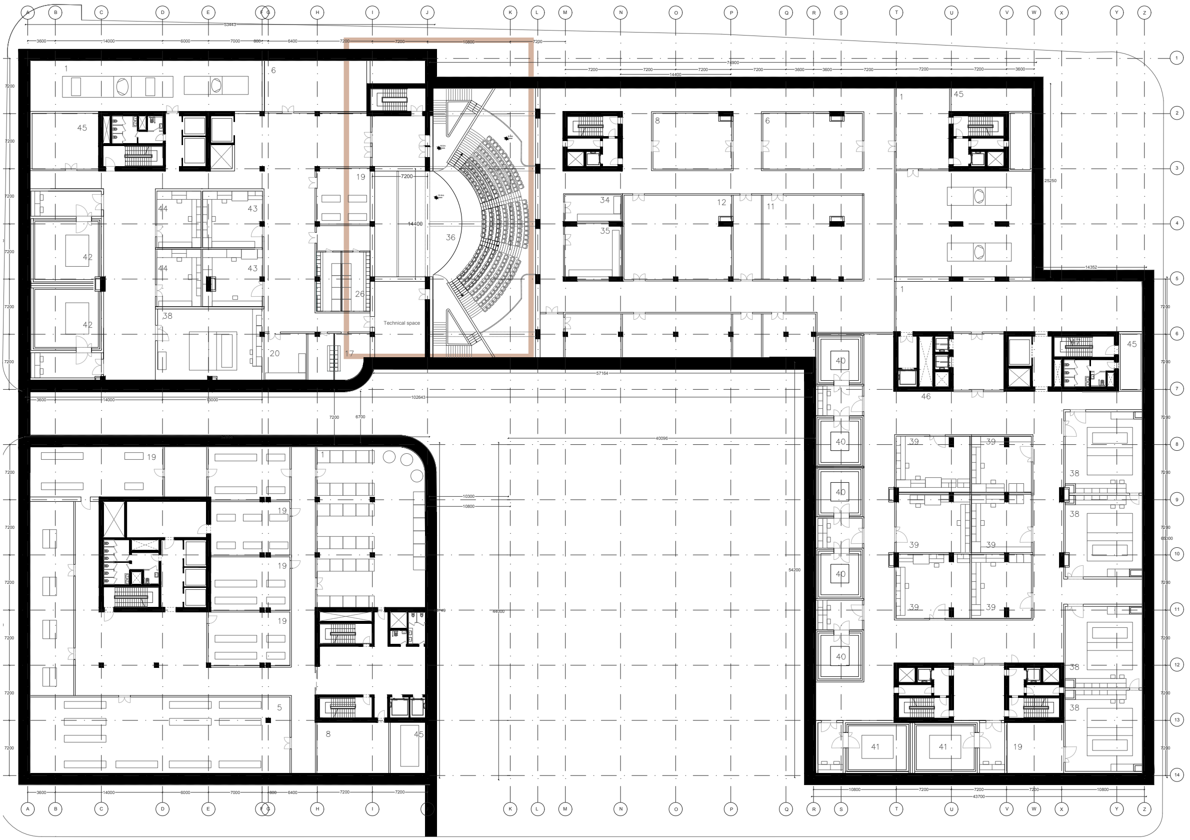




Planimetric configuration

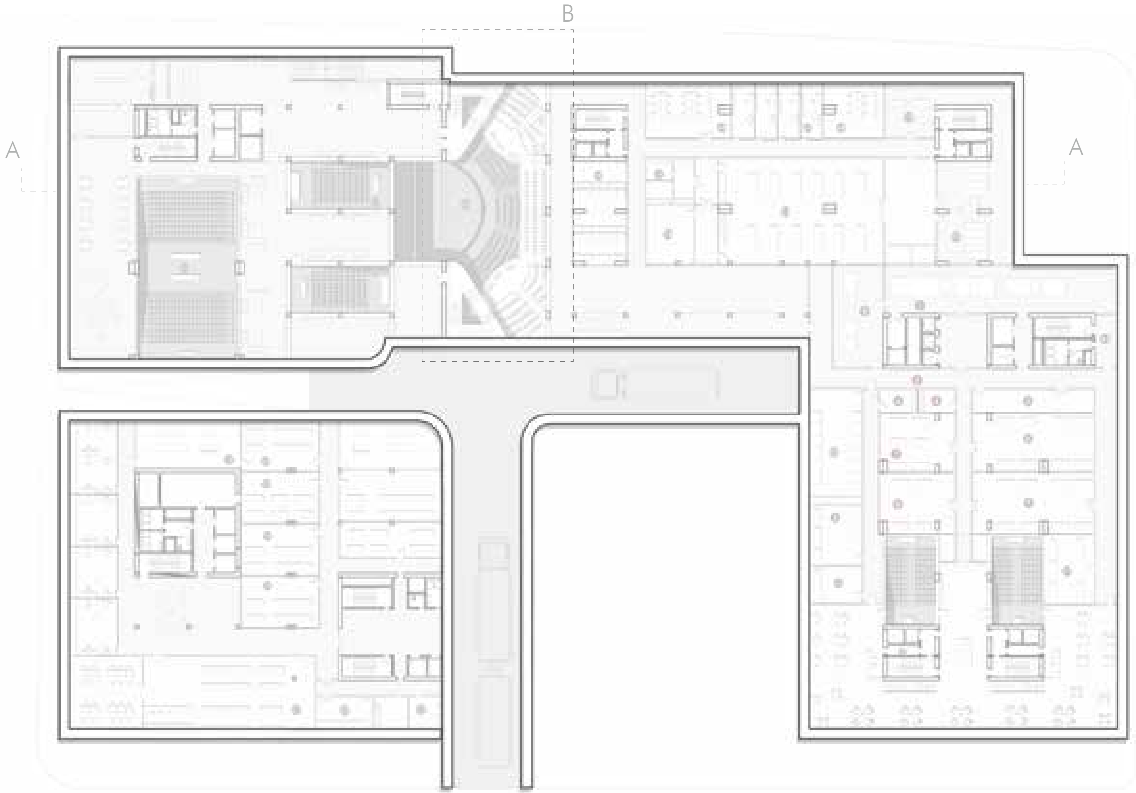


FLOOR PLAN LEVEL -10.00m
(-2 BASEMENT LEVEL)



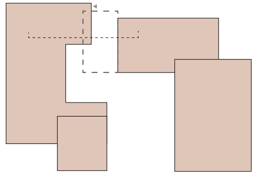
FLOOR PLAN LEVEL -11.00m
(-3 BASEMENT LEVEL)

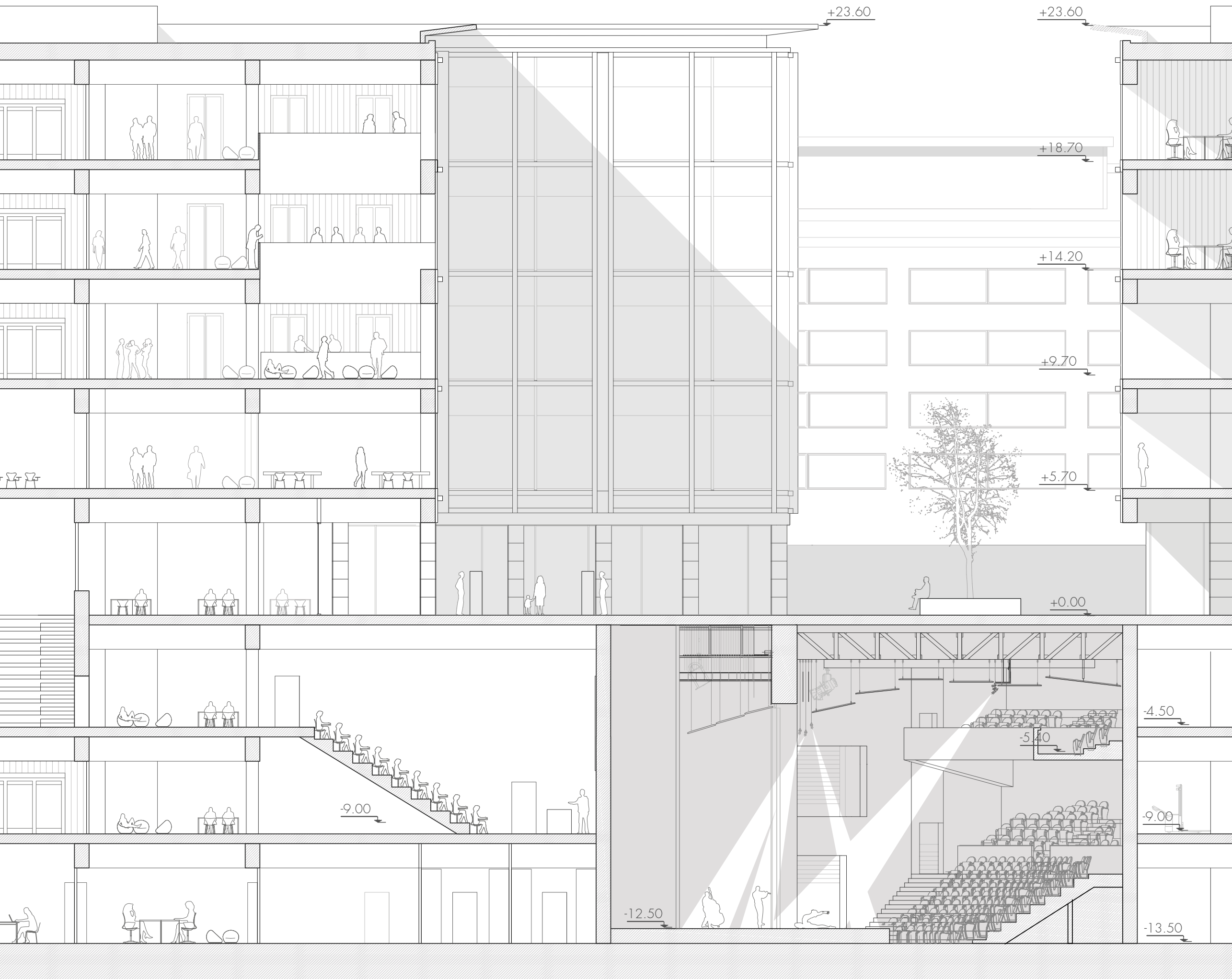
Hypogean public space



BASEMENT FLOOR PLAN LEVEL -2m

1. Technical Center Ventilation/ Laboratories
2. Outside air intake -ventilation animal rooms (4,5 sqm)
3. Shaft (rising) RDA, HK, exhaust air animal rooms (4.5 sqm)
4. Personal Wardrobe
5. Central disposal room
6. Technical center-refrigeration
7. Technical center-sanitary
8. Technical centerheating/steam
9. Disposal room solvent
10. Disposal for animal rooms
11. Warehouse workshops
12. Washing machines
13. Dissection room
14. Embedding Lab
15. Cadaver storage cooler
16. Freezer- Storage
17. Lockers room
18. Special labs
19. Facility- Storage
20. Cleaning Room
21. Archieve Professorsship
22. Bathroom
23. Autoclave
24. Animal rooms area
25. Security locker room with shower
26. Personal locker room without shower
27. Experiments incl. Irradiation (34 sqm)
28. Unclean Corridor
29. Clean Corridor
30. Room for ultra-freezer
31. Warehouse goods incl. Distribution counter
32. SNI-Physics internship laboratory
33. Lecture Area (stepped) Smal Auditorium 100 seat Medium Auditorim 200 seat
34. Isotope depot bearing
35. Gas bottle space
36. Auditorium
37. Chemistry lab area
38. Laser Laboratory
39. Clean Laboratory
40. Quiet laboratory
41. Scanning Tunneling Microscopy (STM) laboratory
42. X-Ray laboratory
43. CCLS Laboratory
44. NMR Laboratory
45. Power Station
46. Shaft 4 sqm plumbing, exhaust air officeElectric / MSRL 8 sqm
47. Shaft (rising) animal station

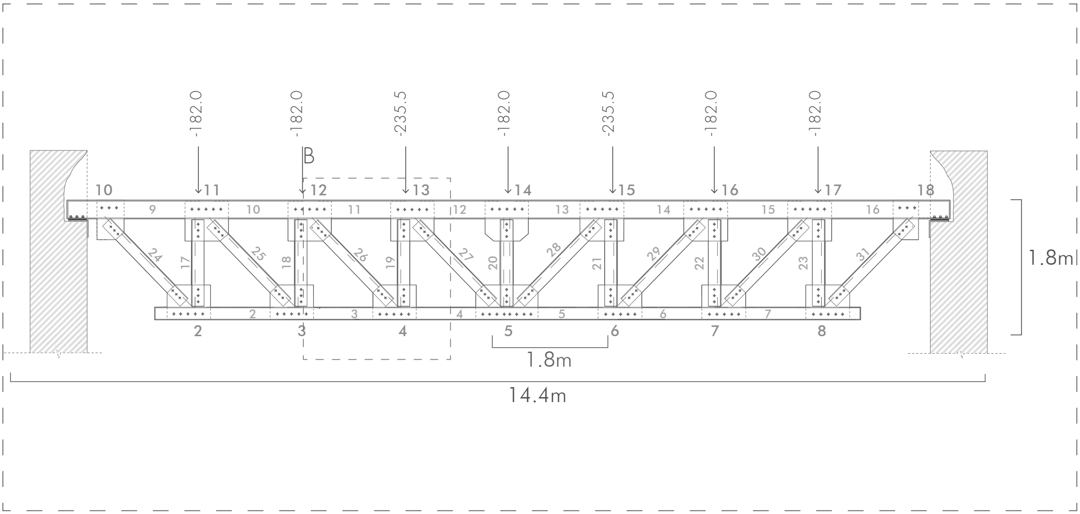




PARTIAL SECTION A-A

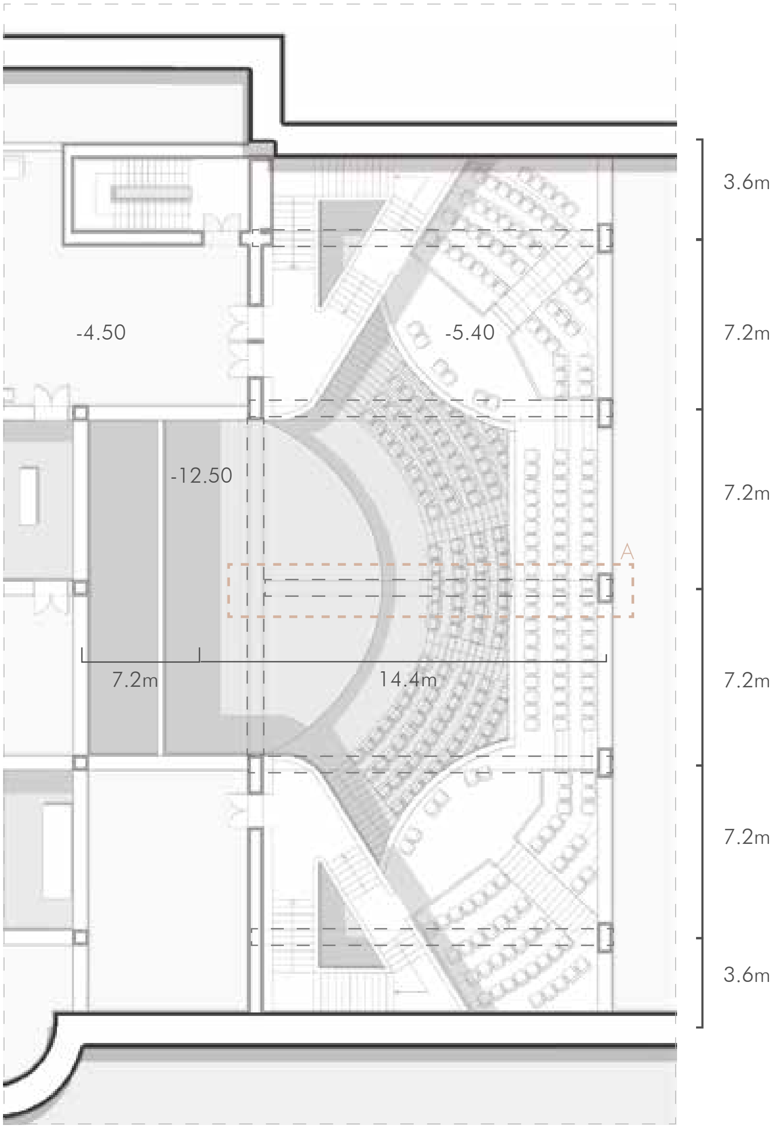
Auditorium stractural design

The auditorium occupies all the three basement levels below ground, and accessible from each level yet foreseeing a main entrance from -1 level which is provided directly from the residential side of Chemistry building, with a stair leading directly from the street to the -1 level (-4.5m) where a broad foyer is located. The main room of the auditorium is a rectangular space of 14.4m x 36m, and it is meant to be spanned by 14.4m long pratt truss system. The volume hosting the stage is instead a rectangular space with dimensions 7.2m x 14.4m. In order to free the area of the stage it is necessary to remove one column ending up in the middle of the stage, belonging to Chemistry building: such column is going to be replaced by a 4 m deep reinforced concrete wall beam, around 1 floor high. The stage is in the middle of one of the longer sides of the volume, with the 450 seats and there is no seat being more than 17m away from the stage, the bodies of the audience absorb acoustic vibrations, thus reducing echoing inside the auditorium.



AUDITORIUM TRUSS SYSTEM DEFINITION
TRUSS ELEVATION A

PARTIAL BASEMENT FLOOR PLAN LEVEL -2m



Auditorium roof envelope

The truss system of the auditorium hall is supposed to support the insulated composite panels insulating the auditorium room, the composite slabs made of corrugated sheets and reinforced concrete, and the top floors constituting the paving of the public plaza.

The truss structure is composed of members joint together at their end points and the members are connected with pinned connections. Since each truss members acts as an axial force member, subject to either axial tension or compression.

	NUMBER	MATERIAL	THICKNESS [m]	DENSITY [kN/m3]	WEIGHT [kN/m2]	
Non-Structural self weight G1	1	Pavement Stone	0,05	25	1,25	3,30
	2	Mortar	0,02	21	0,42	
	3	Screed	0,05	17,7	0,885	
	4	Moisture Layer	0,04	13	0,52	
	5	XPS thermal insulation layer	0,05	0,28	0,014	
	6	Impact-sound insulation (EPS)	0,05	4	0,2	
	7	Protection mat	0,004	-	0,004	
	8	Waterproofing membrane	0,002	5	0,01	
Structural self weight G2	9	Cast concrete	0,055	24	1,32	1,52
	10	Galvanized iron corrugated sheet	0,03	0,09	0,0027	
	11	Primary structural stel HEA 400	0.390		0,2	
	TOTAL				4,83	

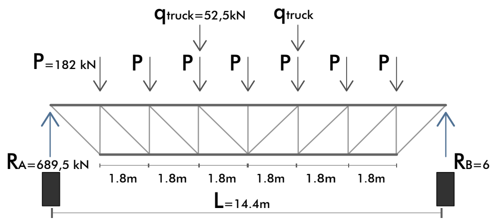
Load combination

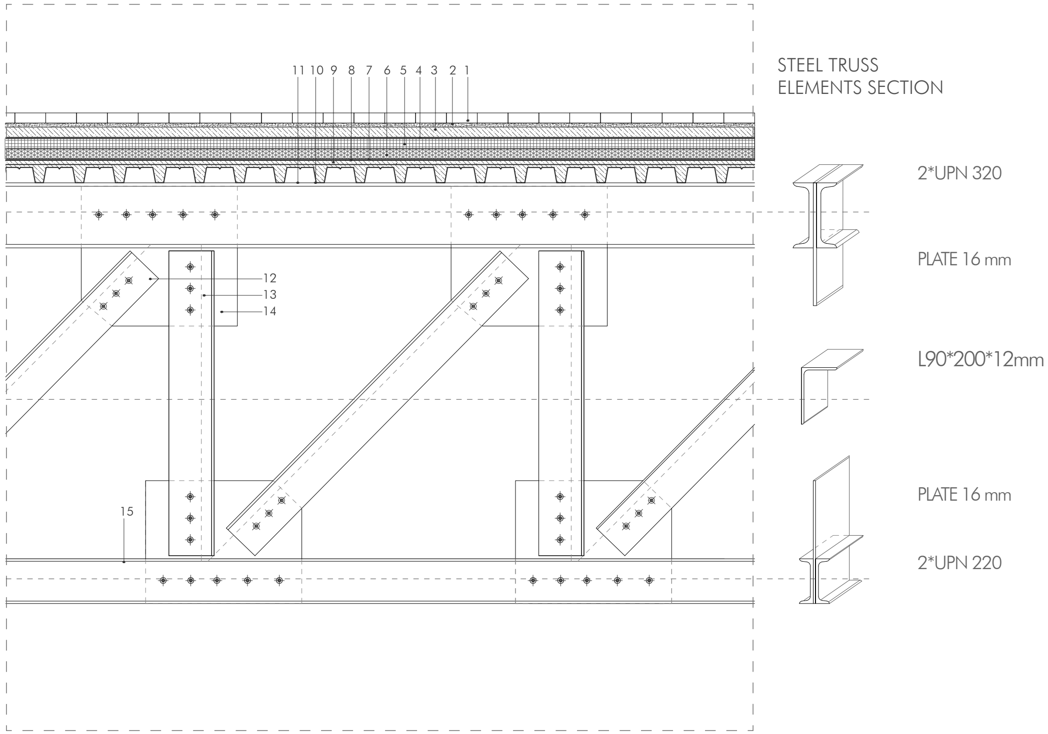
Considering the following values for the dead loads (gk) and live loads (qk), we carry out the load combination:

Permanent and variable actions:1,35 Gk+1,5 Qk

gk= 4,83 kN/m^2 qk=5,0 kN/m^2

$w = 1{,}35\,gk + 1{,}5qk = (1{,}35 \cdot 4{,}83\ kN/m^2) + (1{,}5 \cdot 5{,}00\ kN/m^2) = 14{,}02\ kN/m^2$





AUDITORIUM TRUSS SYSTEM
DETAIL B

Auditorium Roof Envelope

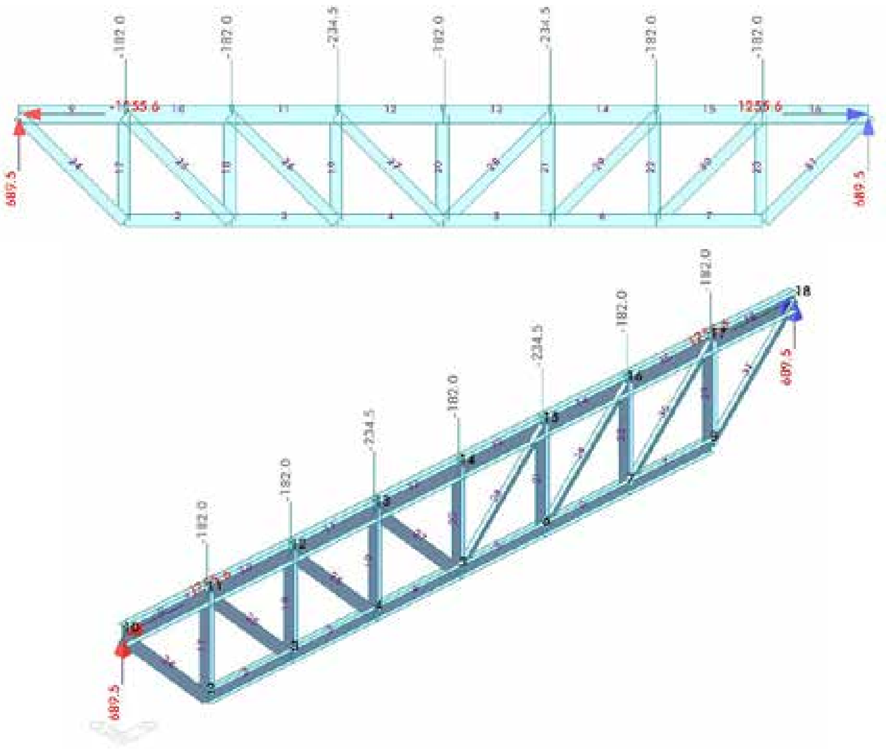
1 Pavement Stone (50 mm)
2 Mortar (20 mm)
3 Screed (50mm)
4 Moisture Layer (4 mm)
5 XPS thermal insulation layer (50 mm)
6 Impact-sound insulation (EPS) (50mm)
7 Protection mat (4mm)
8 Waterproofing membrane (2mm)
9 Cast concrete (55 mm)
10 Galvanized iron corrugated sheet (3mm)
11 Top chord UPN 320
12 Diagonal bracing L 90*200*12 mm
13 Vertical chord L 90*200*12 mm
14 Gusset Plate 16 mm
15 Bottom chord UPN 220

Midas analysis: verification

Finite Element Method (numerical method) is used by using the Midas software to satisfy the boundary conditions with the performance of the structure. The aspects that is specified with the program are: Geometry, Materials, Boundary conditions, Loads(forces).

Loads are defined on Midas model to and then the behaviour of each element is analysed. The structural system material (S355) and each element section is defined as;

- For top chord UPN 320
- For bottom chord UPN 220
- For bracings (web) L 90x200x12

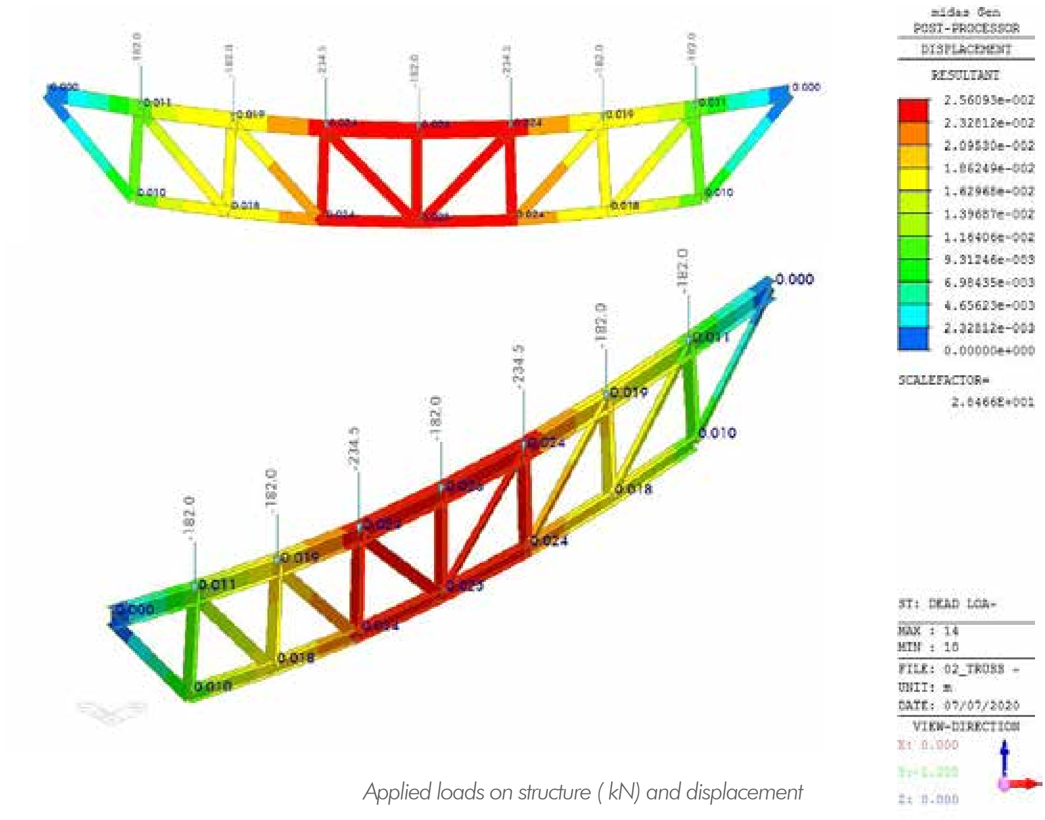


Applied loads on structure (kN) and reaction forces (kN)

Desplacement results

Larger displacement is obtained in the middle part of the truss system where the variable load of the track is applied in additionally to permanent and variable load. The maximum deflection obtained is equal to **0,025m.**

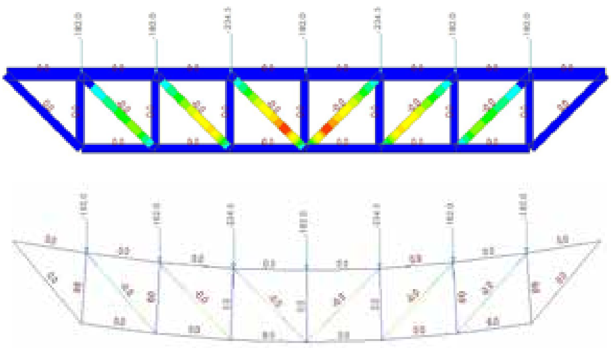
Considered that the span of the truss is L=14.4m, the limit value for the displacement results to be L/500=0,03m , and since 0,025m < 0,03m such condition is verified.

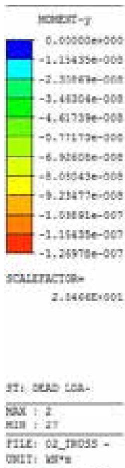


Applied loads on structure (kN) and displacement

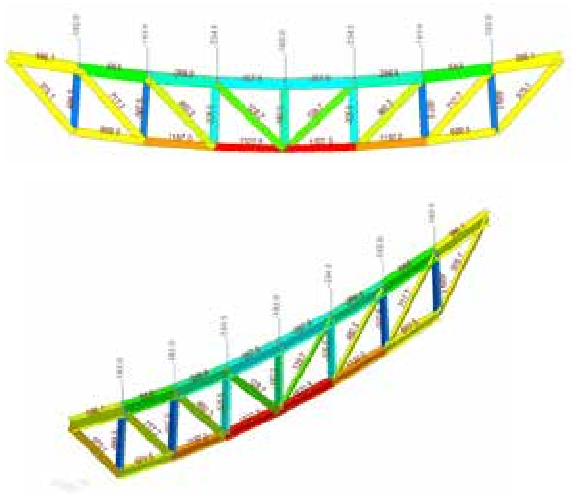
Moment diagram

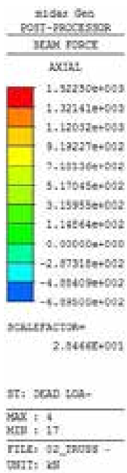
The moment diagram shows that the modelling of boundary conditions was carried out properly, since the bending moment value in each member is null.





Applied loads on structure (kN) and moment values

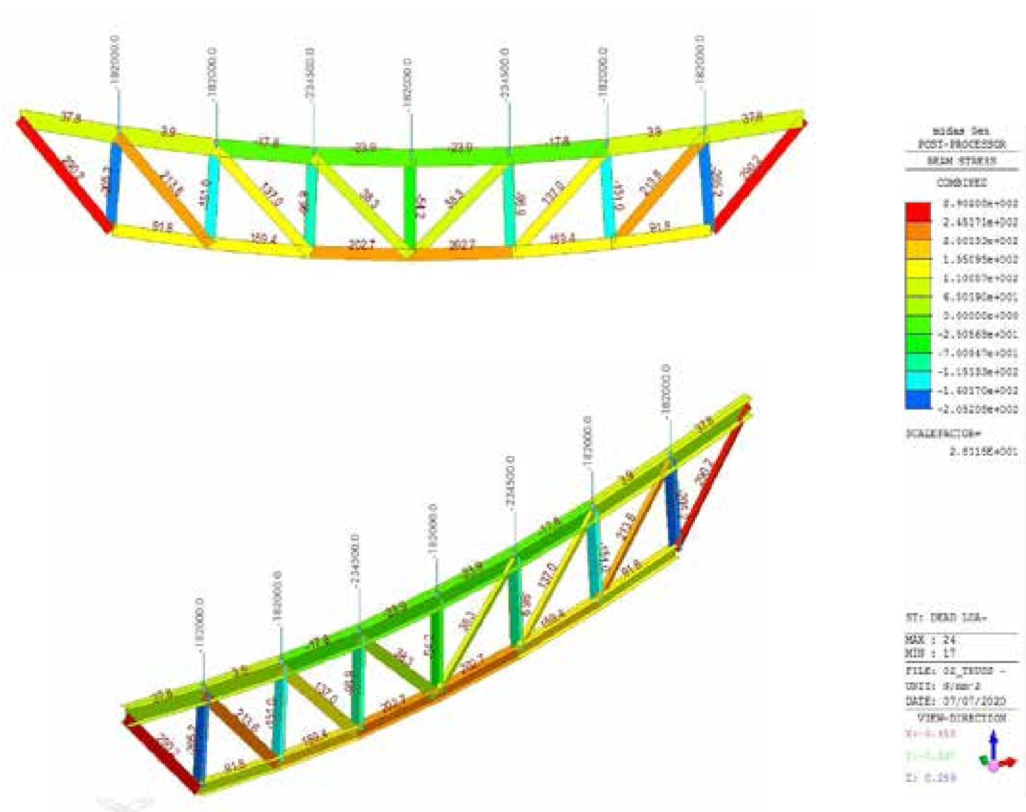




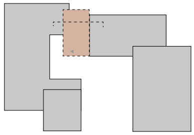
Applied loads on structure (kN) and axial forces (kN)

Beam stress analysis

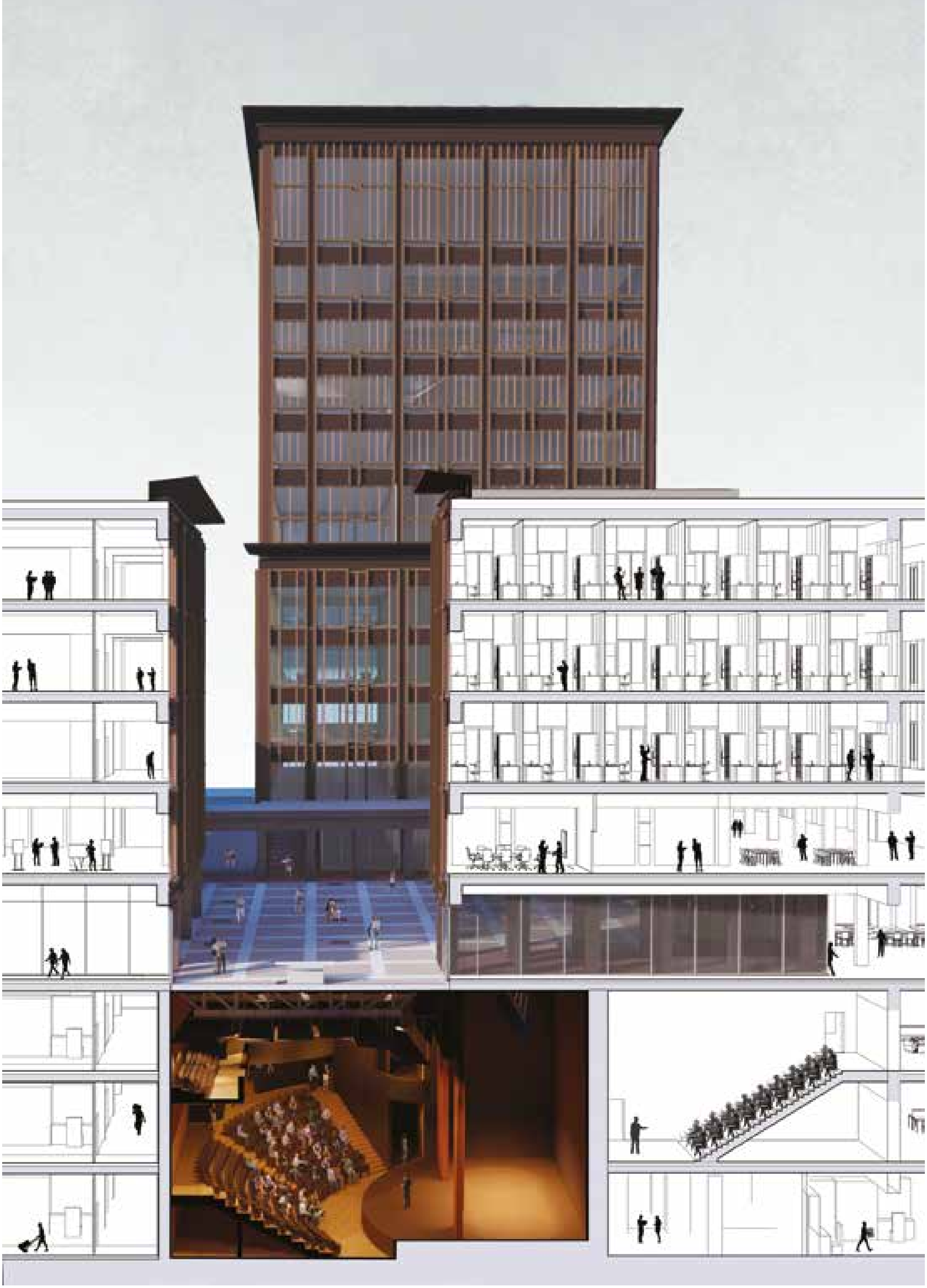
Beam stresses are verified since the maximum value obtained is equal to 290,2 N/mm^2 , and the yield strength of the steel used is equal to 355 MPa= 355 N/mm^2 , and therefore 290,2 N/mm^2 < 355 N/mm^2.



Applied loads on structure (N) and beam stresses (N/mm2)



The Auditorium Hall
"space in-between"



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"BIM: a new way of building"

BIM & Project Management

The development of **Building Information Modelling** as a **change of paradigm** in the design, construction and maintenance of architecture represents one of the **main drivers for the so-called Construction 4.0**.
The use of an **open format for data exchange**, such as the **IFC** (Industry Foundation Class) **standard**, allows to use the same file to share all the information of a project among the various subjects (architects, engineers, insulation designers, maintenance workers, etc.) involved in the life cycle of the building itself and between different platforms.
The introduction of BIM technologies defines, indeed, **a new way of managing the project**, offering several advantages in terms of better control on design and construction processes, **time and costs optimization**, management of the construction site as well as of the subsequent maintenance of the built fabric, for its entire life cycle.

Among the variety of sectors involved, this chapter focuses on the adoption of BIM to optimize the economic management of construction projects, such as the opportunity to monitor the economic commitment of construction works throughout the design phase, in which various subjects might be involved, requiring a continuous exchange of information; or the possibility of quickly evaluating the costs associated with different design and construction solutions, by extrapolating from the 3D architectural model all the geometric information and therefore accelerating costs estimation processes. The accuracy of the measurement and the consequent reduction of errors can be considered as further advantages.

U.S. General Services Administration (GSA) in its published report (GSA BIM Guide) defines **Building Information Modelling and Building Information Models** as follows:

"Building Information Modelling is the development and uses of a multi-faceted computer software data model to not only document a building design, but to simulate the construction and operation of a new capital facility or a recapitalized (modernized) facility. The resulting Building Information Model is a data-rich, object-based, intelligent, and parametric digital representation of the facility, from which views appropriate to various users' needs can be extracted and analysed to generate feedback and improvement of the facility design."

These definitions establish, indeed, a clear separation between regular 3D geometric models, containing very little intelligence, and BIM models, containing a high level of information.

BIM specific features that can effectively be used in the field of project management can be summarised as follows.

- Clash Detection
- Constructability
- Analysis
- Time & Cost Estimation (4D & 5D)
- Integration
- Quantity Take-off
- Element Based Models
- Collaboration and Team Building
- Communication

Focusing more on "Time and Cost Estimation", they refer to some specific features of BIM which enable project managers to visualize the construction project at any point in time and have a clear understanding of project phases.

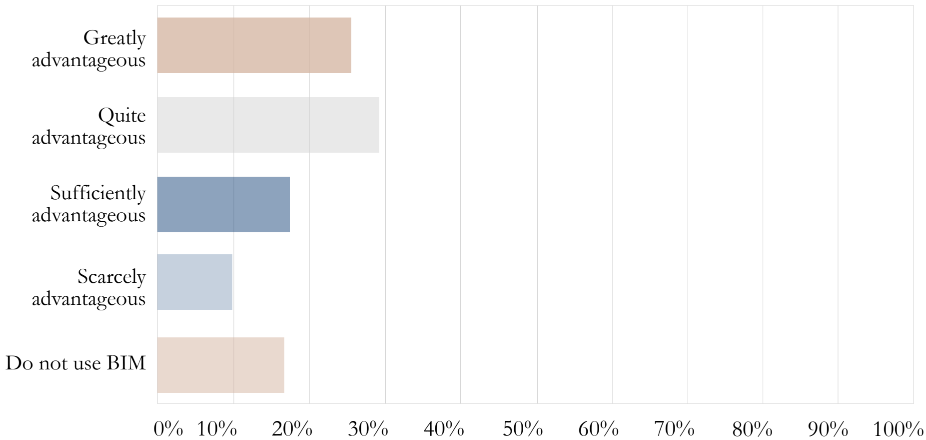
Time and cost estimation can be properly utilized in the first stages of a project and facilitate the decision-making process with minimum cost and time needed.
Furthermore, BIM has the capability to simulate the various alternatives for a construction project and hence helps project managers and executives to reliably predict the consequences of their decisions.

Time estimation (4D)	Linkage of objects to time plan
	Graphical visualization of project schedule
	Early detection of planning errors
	Optimization of logistical aspects)
Cost estimation (5D)	Connection of objects with price lists for different materials
	Easy value engineering analysis
	Accurate cost estimation at any point in the design phase
	Creates understanding regarding financial implications of design decisions

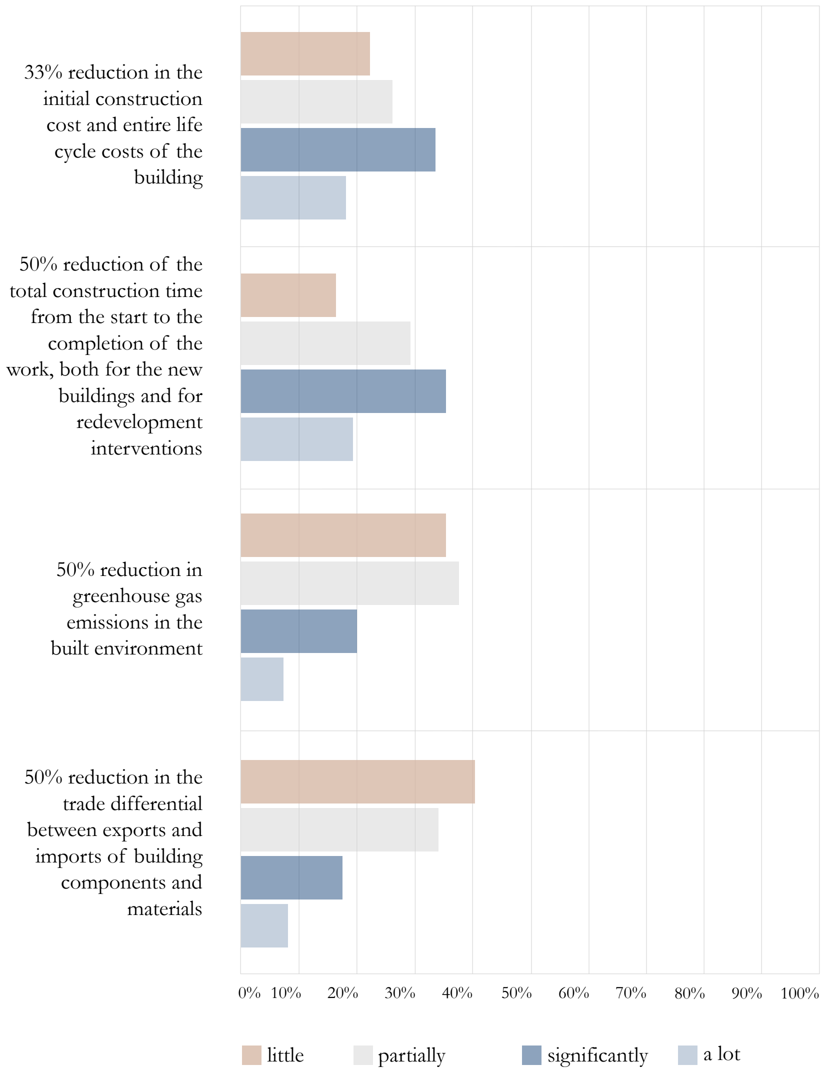
Thanks to the **BIM Report (2019)** elaborated by **ASSOBIM**, an association born to promote the diffusion of Building Information Modelling and its technological chain, it is possible to **obtain information relative to the condition of BIM market in Italy,** considering that the survey involves a significant panel of **more than 600 operators** including design studios, engineering companies, real estate, building and maintenance firms, public and private stakeholders, providing therefore a broad panorama.

According to the survey, time and cost reduction are the areas identified as those in which the adoption of BIM is most effective, and the impact of BIM in terms of time/cost reduction and competitiveness is positively evaluated by most companies.

1. Evaluation of the impact of BIM in terms of time/cost reduction and competitiveness in general.



2. Role of BIM in the achievement of specific results.



Project-based quantification of BIM benefits

The successful adoption of BIM ensures clear project evaluation and communication throughout the project team, and it can provide **optimum efficiency in time, cost quality and risk of a project's delivery and management**. In 2007, the **CIFE** (Center for Integrated Facility Engineering) of **Stanford University** evaluated the **economic advantages of BIM implementation on 10 case studies**.

The research focused on re**turn on investment (ROI) and savings**, and it produced the following results:

Year	Cost ($M)	Project	BIM Cost ($)	Direct BIM Savings ($)	Net BIM savings	BIM ROI (%)
2005	30	Ashley Overlook	5,000	(135,000)	(130,000)	2600
2006	54	Progressive Data Center	120,000	(395,000)	(232,000)	140
2006	47	Raleigh Marriott	4,288	(500,000)	(495,712)	11560
2006	16	GSU Library	10,000	(74, 120)	(64,120)	640
20 06	88	Mansion on Peachtree	1,440	(15,000)	(6,850)	940
2007	47	Aquarium Hilton	90,000	(800,000)	(710,000)	780
2007	58	1515 Wynkoop	3,800	(200,000)	(196,200)	5160
2007	82	HP Data Center	20,000	(67,500)	(47,500)	240
2007	14	Savannah State	5,000	(2,000,000)	(1,995,000)	39900
2007	32	NAU Sciences Lab	1,000	(330,000)	(329,000)	32900

BIM Economics (CIFE, 2007)

The projects evaluated show that favourable cost savings can be made through BIM implementation, and that positive values can be obtained as *rate of interest return* to the investor.

Furthermore, as some natural resources are non-renewable, the value of construction is **not just to maximize its profits from a financial perspective**. Instead, the ultimate objective is to pursue the minimum natural resource consumption per building area and as per the total. **Construction costs issues, indeed, relate to a low-carbon, environmentally friendly social responsibility.**

BIM technology is a promising way of addressing the costs and waste issues through the optimization of construction design, the management of construction assets, the minimization of unnecessary waste, and so on.

According to the creation of 5D information in BIM, **the difficulty and workload of short-cycle costs analysis can be reduced while the efficiency and accuracy of dynamically maintaining costs data can be greatly improved.**

In addition, through building information models that reflect actual costs information, it is **easy to identify which models are not assigned with the costs data when conducting quantity take-off or real-time inventory management.** The costs information can also be placed online for the remote access of costs information.

To enable construction enterprises to formulate accurate plans regarding manpower, materials and machines, BIM provides effective support, greatly reduces waste in the sector of resources, logistics and warehousing, and has a significant effect on limiting quota-materials, target costs decisions and consumption control.

According to studies reported by the *International Journal of Advanced Robotic Systems*, a **framework was established to measure the BIM return from a completed project** that was subject to the wide application of BIM.

The **Shanghai Disaster Recovery Centre** is a five-storey building constructed by the State Grid Corporation, counting four additional floors below ground, three of which were designed as computer rooms, precision air conditioning rooms and ancillary equipment rooms.

This project was confronted with many issues, such as the involvement of numerous professionals of diverse expertise, the complexity of the equipment and system involved, a tight schedule, tights requirement on costs control for materials and labour, and so on.

The evidence from the case study provides authentic data to explain **how the roles of conflict detection, the construction schedule and**

materials management and control may impact upon the cost.

Based on the calculation of the above project, the comprehensive application of BIM technology found more than 2,000 errors in the original design, concerning MEP systems. Using error classification and conflict inspection reports, the 500 most important errors were discovered and eliminated prior to the construction, reducing reworking, labour, and materials waste.

Another important benefit of BIM application concerns timing: by using 4D-based construction progress simulation, indeed, the construction process was optimized. As a whole, the construction schedule of the project 'Shanghai Disaster Recovery Centre' was shortened by three months.

Finally, BIM-based materials' management and control allowed the construction team to make the best use of materials and reduce waste and consumption to a minimum level.

The lessons learned from the project 'Shanghai Disaster Recovery Centre' provide evidence to support the potential benefits of cost-oriented arrangements of construction activities optimized via BIM. The visualization of construction activity analysis assists the costs planning operators in the identification of conflicts and in the communication of design alternatives that might be more cost-effective and time-saving, as the present-day BIM tools have already enabled a feedback system that tracks the impact of design changes associated with costs.

No.	Items	Issues			Time-saving		Cost-saving ($)
		Issues identified before construction	Issues identified in construction	Total	Time per each issue (day)	Total time-saving (day)	Cost-saving (%)
1	Level 1 issues	198	67	265	0.05	13.25	0.265
2	Level 2 issues	132	32	164	0.1	16.4	0.820
3	Level 3 issues	95	26	121	0.15	18.15	0.968
4	Level 4 issues	58	6	64	0.2	12.8	0.832
5	prefabrication	-	-	5	-	-	0.25
Total		483	131	614	-	65.6	2.91

Level 1 issues ： could be solved in site, not a major impact on the actual construction process
Level 2 issues ： shut down, waiting to be processed by technicians on site
Level 3 issues ： shut down, need to dismantle and reconstruction
Level 4 issues ： shut down, need to dismantle and reconstruction, and will change parts of the original design purpose

MEP design issues, time and costs saving data based on a BIM design review (Cost-saving (%) = [cost saving ($) / total MEP construction cost ($)] 100%)*

Another interesting study reported on MDPI in 2018 is that concerning a **railway construction site in South Korea**. The research focused on the **definition of indicators useful to carry out Cost-Benefit Analysis** concerning the application of BIM.
Indeed, by investigating a real project that could utilize BIM in planning and construction phases, the authors try to investigate a possible outline of advantages in BIM implementation, capturing possible financial benefits that a BIM could bring to a real project.

The authors identified 12 errors in 7 projects that could be prevented if BIM was implemented before construction. The total upfront costs required to provide a BIM for the seven projects was estimated $116,348. On the other hand, the total costs required to fix the errors in the seven projects was $166,486.

Incurred Reconstruction Costs Based on Redrawing Orders					
Estimates = (No. of labor) × (Man-hour/8 h) × (Daily fee based on level)					
Project	No. of Labor	Level	Man-hour	Daily fee	Estimates
The 1st Bridge	1	Manager	40	$650	$3250
	2	Coordinator	160	$420	$8400
	1	CAD operator	80	$220	$2200
Total redraw benefits that could be saved if BIM was implemented beforehand				$13,850	
Incurred reconstruction costs based on re-dimensioning orders					
Estimates = (No. of labor) × (Man-hour/8 h) × (Daily fee based on level)					
The 1st Bridge	2	CAD operator	24	$220	$660
The 5th Bridge	1	CAD operator	16	$220	$440
The 7th Bridge	2	CAD operator	40	$220	$1100
The 8th Bridge	2	CAD operator	32	$220	$88
Total re-dimension benefits that could be saved if BIM was implemented beforehand				$3080	
Total benefits that could be saved if BIM was implemented beforehand				$16,930	

Total possible benefits that could be saved during BIM work.

Despite the results of Cost-Benefit analysis, what is interesting is the procedure carried out to quantify and monetize the potential benefits deriving from BIM applications.
For instance, to calculate benefits that come from using a BIM in this case, the authors closely searched how much reworks in terms of planning and construction have occurred, and after that, authors calculated the additional costs. After estimating the total possible benefits of using BIM to fix the redrawing and re-dimensioning errors, also the associated costs in reconstruction orders have been calculated, distinguishing reconstruction into two phases: labour costs and material costs. Finally, the delayed construction due to errors was calculated based on the liquidated damage, estimated on different lengths of delays.
In this extent, the benefit–cost ratio can be estimated as 1.32 with a one-month delay and 1.36 with a three-month delay.

Projects	Errors	Solution		Estimates
The 1st Bridge	Retain wall and bridge interference	Rework		Estimate = (Volume) × (Unit fee)
The 1st Bridge	Girder and column level mismatch	Rework		
The 7th Bridge	Site elevation and drawing mismatch	Rework		
The 8th Bridge	Girder and column mismatch	Rework		
Labor fee estimate because of reconstruct				
Projects	Construction	Unit fee	Volume	Estimates
The 1st Bridge	Retaining wall	$47	1016M3	$47,752
The 7th Bridge	Sound-proof wall	$40	540M3	$21,600
The 8th Bridge	Concrete casting	$93	22.2M3	$2064.6
Subtotal				$71,416.6
Material fee estimate because of reconstruct				
The 1st Bridge	Retaining wall	$3	1016M3	$3048
The 7th Bridge	Sound-proof wall	$139	540M3	$75,060
The 8th Bridge	Concrete casting	$1.4	22.2M3	$31.08
Subtotal				$78,139.08
Total construction fees because of rework				$149,555.68

Total possible benefits that could be saved because of avoided reconstruction.

A benefit–cost ratio over 1.3 may sound too promising, and it does not guarantee all the projects using a BIM will enjoy the same benefits.

Nonetheless, what was significant about this research work consisted in its ability to provide an alternative perspective for the quantification of the benefits deriving from BIM implementation, which could enable new opportunities for future applications.

To provide a broader panorama, it is useful to mention also examples coming from more theoretical approaches. Some research works, indeed, attempt to measure the effectiveness of BIM as a tool in project management by defining a "*successfulness index*" for projects taken as case studies. In such case, the index is evaluated according to a set of criteria such as:
- *Project delivery according to its specifications;*
- *Project delivery within budget and time;*
- *Satisfaction of the client, end-users, and investors.*

Delay	Initial Costs	Damage %	Liquidated Damage	Total
+1 month delay	$166,486 ($149,556 + $16,930)	+1.5%	$2497.3	$168,983.3
+2 months delay		+3.0%	$4994.6	$171,480.6
+3 months delay		+4.5%	$7491.9	$173,977.9

Liquidated damage based on different length of construction delay.

BIM Cost	Design Rework Benefits	Construction Rework Benefits	Liquidated Damage Benefit	Total Benefits	B/C
$127,983 (10% allowance)	$16,930	$149,556	$2497.3(1.5%)	$168,984	1.32
			$4994.6(3.0%)	$171,481	1.34
			$7491.9(4.5%)	$173,978	1.36

Benefit–cost ratio based on different liquidated damage.

Dealing with complexity

One of the key advantages of BIM is that it **facilitates the development of detailed information and analysis much earlier in the building process**, to **improve decision making** and **reduce downstream changes**.
This allows planners, designers and builders to **better coordinate details and information amongst the multiple parties involved** in the process of developing and executing construction projects.
Furthermore, **the outbreak of Covid-19 added a further degree of complexity in the project coordination among stakeholders**.

However, Building Information Modelling tools can assist with the updating of projects and the comparing of data across a project's lifecycle Indeed, **BIM allows most of the workflow to live in the cloud** with solutions such as Autodesk's Construction Cloud, MTWO and Panzura.

These enable design and construction teams to coordinate seamlessly. By creating a single platform and source of current data that is always accessible, projects can be coordinated remotely during design, construction modelling, construction data gathering, digital asset handover and facilities management.

Covid-19 showed that those **businesses that invested earlier in a digitally powered workforce are managing better their work during the pandemic** and they are maintaining an enormous lead in productivity and efficiencies.

Finally, in addition to the higher difficulties set by the pandemic, it is also necessary to underline how todays' constructions need to satisfy **increasingly complex requirements**, which is particularly true for highly specialized projects such as **research laboratory** buildings, which provide a perfect **opportunity to harness the strengths of BIM even more.**

Dodge Data & Analytics (DD&A) has been conducting research on the emergence of BIM and the value it provides to the construction industry since 2007, and it has recently carried out further studies more specifically focused on how BIM tangibly improves outcomes on Complex Construction Projects. The data and analysis at the base of their report are based primarily on online surveys conducted with 391 owners, architects, engineers and contractors working in companies that implement BIM technologies in their work, as well as being involved with one of the following types of complex building projects:

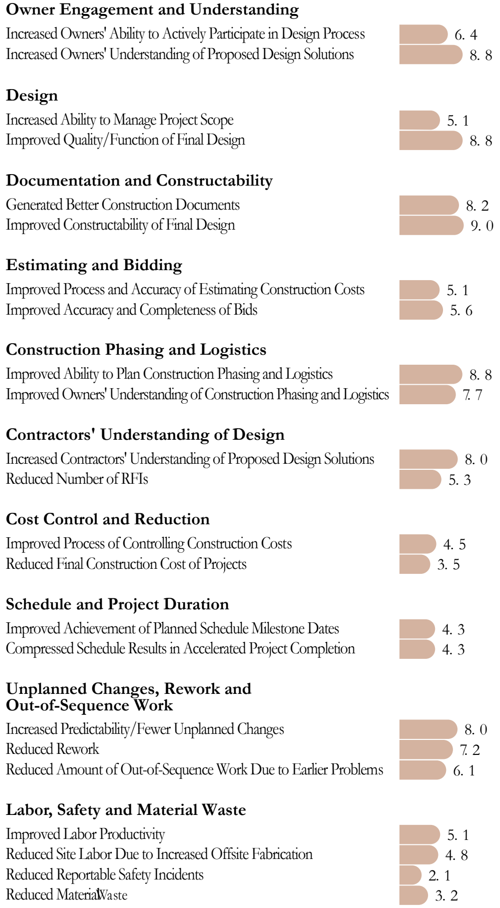
- *Data centres;*
- *Entertainment projects;*
- *Hospitals;*
- *Industrial/manufacturing buildings;*
- *Laboratories;*
- *Transportation buildings.*

According to this survey, many of the highest-scoring impacts of BIM on key outcomes for complex projects result to be related to design activities, such as "increased owners' understanding of proposed design solutions", "improved constructability of final design" and "improved quality/function of final design". Importantly, though, design-related improvements such as "generated better construction documents" drive better contractor engagement, which is suggested by the strong performance of "increased contractors' understanding of proposed design solutions".

Their enhanced understanding contributes to numerous benefits later in the construction process, such as "improved ability to plan construction phasing and logistics", "increased predictability/fewer unplanned changes", and "reduced rework". Future studies are expected to show ever-greater benefits from the cumulative impact of BIM on project outcomes.

Impact of BIM on Complex Project Outcomes
(Percentage of High and Very High Ratings, Converted to a 1–10 Scale)

Dodge Data & Analytics, 2015



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"bibliography & sitography"

Basel City

_DIENER, R., HERZOG, J., MEILI, M. DE MEURON, P. (2006) Switzerland: *An Urban Portrait,* ETH Studio Basel, Basel

_EQUIPE LIN (2015), *Synthèse concept urbain 3Land. Synthèse Raumkonzept 3Land*, (http://3-land.net/start/fr/ download/concept-urbain-3land-synthese/)

_ESPON (2010), *Metroborder. Cross-border Polycentric Metropolitan Regions. Final Report*, Luxembourg, European Spatial Planning Observation Network (ESPON)

_ETH STUDIO BASEL, (2013), *The City + Energy Investigating the Metabolism of Cities - Metropolitan analysis. Guidelines for a energy strategic project in Basel (Chatper 4.)* (source: http://www.studio-basel.com/projects/the-city-energy/)

_HERZOG, J., DE MEURON, P., HERZ, M. (2009), *MetroBasel. Un Modele de Region Metropolitaine Europeenne*, ETH Studio Basel

_IBA Basel 2020 (2013), *IBA Basel 2020 – IBA Memorandum and projects Summary*, retrieved April 18, 2016 (source: http://www.iba-basel.net)

_METROBASEL (2006), *Metrobasel – Vision 2020,* (source: http://www.metrobasel.ch)

_METROBASEL (2005), *Metrobasel. Report 2005* (source: http://www.metrobasel.ch)

_REGIERUNGSRAT DES KANTONS BASEL-STADT, (2011), *Bebauungsplan "Rheinfront"* source: http://www.grosserrat.bs.ch/dokumente/100372/000000372980.pdf)

_REGIERUNGSRAT DES KANTONS BASEL-STADT, (2005), *Betreffend Realisierung des Projekts "Neunutzung Hafen St. Johann – Campus Plus"* (source: www.wsu.bs.ch/dam/ jcr:c80030bc-67ce.../000000191035.pdf)

_WALTHER, O., & REITEL, B. (2013), *Cross-Border policy networks in the Basel region: The effect of national borders and brokerage roles. Space and Polity,* 17(2), 217-236.

Basel History

_M. HERZ, "*On Urban and Rural Life*" , p. 16-18, UNI NOVA, N131, May 2018

_J. BECHER "*Basel, Its Population and The City Walls*" , p. 120-22, UNI NOVA, N131, May 2018

_DICKINSON R., " *The West European Country: A Geographical Interpretation*" , 1951, p. 70-81, The International British Library of Sociology

_DICKINSON R., " *The West European Country: A Geographical Interpretation*" , Volume 12 1951, pp. 70-81, (Taylor & Francis 1998)

3Land Vision - IBA Basel

_http://iba-basel.net/de/
_http://3-land.net/start/
_http://www.studio-basel.com/eth-studio-basel.html
_www.eurodistrictbasel.eu

Campus Schällemätteli

_Kanton Basel-Stadt, *Hochschulareal St. Johann Campus Schällemätteli.* All documents since 2009, published and downloadable from: Grosser Rat Basel-Stadt -Kanton Basel-Stadt, http://www.grosserrat.bs.ch/de/)

_KANTON BASEL – STADT, https://www.bs.ch/

_KANTON BASEL – LANDSCHAFT, https://www.baselland.ch/

_UNIVERSITÄT BASEL, https://www.unibas.ch/de

_https://www.unibas.ch/de/Universitaet/Universitaet-in-Kuerze/Immobilien.html

_https://www.biozentrum.unibas.ch/about/biozentrum-at-a-glance/overview/

https://ethz.ch/en/campus/development/construction-projects/bss-projekt.html

Science, Knowledge, Innovation Districs and Campus

_CURVELO MAGDANIEL, F. (2016), *Technology campuses and cities. A study on the relation between innovation and the built environment at the urban area level* (A+BE I Architecture and the Built Environment), TU Delft Open, Delft

_HOEGER, K., & BINDELS, E. (2007), *Campus and the city: urban design for the knowledge society,* gta Verlag, ETH Zurich, Zurich

_KATZ, BRUCE, WAGNER JULIE, *The Rise of Innovation Districts: A New Geography of Innovation in America*, Metropolitan Policy Program at Brookings

_MIT SCHOOL OF ARCHITECTURE AND PLANNING (2011), *Innovation Technology. Innovation Park. A research Study: Nandasoft Innovation Technology. Development Park.*, Massachusetts Institute of Technology School of Architecture and Planning, Cambridge

_MOODYSSON, J., & JONSSON, O. (2007), *Knowledge collaboration and proximity the spatial organization of biotech innovation projects. European urban and regional studies*, 14(2), 115-131.

_RUSSELL, J. S. (1992), *The New Workplace*, Architectural Record, June 1992, p72.

Lab of the future

_FISHMAN, M. C., (2017), *LAB – Building a Home for Scientists*, Lars Müller, Publishers GmbH, Zurich

_GOLDSTEIN, R. N. (2006), *Architectural Design and the Collaborative Research Environment*, Cell 2006 Oct 20, 127(2), 243-6.

_HARRISON, A. L., SERRA, M., (2011) *Learning from Laboratories, in Log N°21* (WINTER 2011), Anyone Corporation, PP. 53-61 (http://www.jstor.org/stable/41765397)

_KLONCK, C. (2016), *New Laboratories: Historical and Critical Perspectives on Contemporary Developments,* De Gruyter, Digital original edition (April 11, 2016)

_WATCH, D. D., KLIMENT, S.A., PERKINS & WILL, (2008), *Building Types Basic For Research Laboratories*, John Wiley & Sons, Inc. https://www.laboratoryequipment.com/

Design research

NOVARTIS CAMPUS

_LEHNI, M., (2009), *Campus Development as part of the Novartis Sustainability Strategy*, ISCN-GULF Conference, Lausanne, June 2009

_MAGNAGO LAMPUGNANI, V. (2010), *The Novartis Campus Master Plan. An Architectural Communication Device, in a+u: Architecture and Urbanism*, 482 Novartis Campus 2010, Shinkenchiku-sha Co., Ltd

_MAGNAGO LAMPUGNANI, V. (Concept), (2002), *Novartis Campus*, Masterplan, St. Johann, Basel, Novartis, Basel

_NOVARTIS INTERNATIONAL AG (Ed.), (2014) *Novartis: How a leader in healthcare was created* out of Ciba, Geigy and Sandoz, Profile Books

_NOVARTIS INTERNATIONAL AG (2016), *Novartis in Switzerland* (source: https://www.novartis.com/sites/ www.novartis.com/files/ documents/NovartisPass_EN.pdf)

_NOVARTIS INTERNATIONAL AG (Ed.), (2009), Texts by BOUTELLIER, R., INGERSOLL R.,

_MAGNAGO LAMPUGNANI V., VON MATT, P., SCHATZ, G., STEELE, F. U.A.), *Novartis Campus. Eine moderne Arbeitswelt.* Voraussetzungen, Bausteine, Perspektiven, Hatje Cantz Verlag, Ostfildern

_JEHLE-SCHULTE STRATHAUS, U., (2014), *Novartis Campus - Seven Further Buildings*, Christoph Merian Verlag, Basel

_ZUNINO, M. G., (October 2009), *Office City* (source: http://www.abitare.it/it/architettura/2009/10/15/la-citta-degli-uffici/)

_ARQUITECTURA VIVA 134 (2010), *Laboratorio Basilea: Novartis, Roche, Actelion, Vitra: campus de autor,* AV, Madrid

_A+U (2010/11), *482 Novartis Campus 2010*, Shinkenchiku-sha Co., Ltd, www.campus.novartis.com

_CASABELLA 779 (2009) – *Novartis, Basel*, Mondadori Electa, Milano

_ARCHITEKTURMUSEUM BASEL, JEHLE-SCHULTE STRATHAUS, U. (ed.), (2005), *Forum 3: Diener, Federle, Wiederin,* C. Merian Verlag, Basel

_JEHLE-SCHULTE STRATHAUS, U. (ed.), (2015), *Novartis Campus - Asklepios 8: Herzog & de Meuron*, C. Merian Verlag, Basel

_JEHLE-SCHULTE STRATHAUS, U. (ed.), (2011), *Fabrikstrasse 22: David Chipperfiled*, C. Merian Verlag, Basel

_JEHLE-SCHULTE STRATHAUS, U. (ed.), (2009), *Fabrikstrasse 12: Vittorio Magnago Lampugnani,* C. Merian Verlag, Basel

_JEHLE-SCHULTE STRATHAUS, U. (ed.), (2008), *Fabrikstrasse 16: Adolf Krischanitz ,* C. Merian Verlag, Basel

URBAN DESIGN

_GREGOTTI V. (ED.), (1988), RASSEGNA 76, *Arcipelago Europa / The European Archipelago*, Editrice Compositori, Bologna

_JACOBS, J. (1961), *The Death and Life of Great American Cities*, Random House, New York

_LAMPUGNANI, V. M. (2011), *Urban Design as Craft. Eleven conversation and seven projects 1999-2011*, gta Verlag -ETH Zurich, Zurich

_SOLÀ-MORALES, M., (1978), *Towards a Definition. Analysis of Urban Growth in the Nineteenth Century*, in Lotus International 19 - *The Urban Block*, Editoriale Lotus, Milano, Lotus international 19 (1978)- *The Urban Block*, Editoriale Lotus, Milano

_BUSQUETS, J. (ED), CORREA, F. (COLL.), *Cities: 10 Lines: Approaches to City and Open Territory Design*, Barcelona, Actar, 2007

_J- BUSQUETS, *Defining the Urbanistic Project: Ten Contemporary Approaches*, in Krieger, A., Saunders, W.S. (Editors), Urban Design, University of Minnesota Press, Minneapolis | London

_J. BUSQUETS, (2010), *Models of urban project*, in Montaner, J.M., Zaida Muxí, F. A. (ed.), Critical Files. *The Barcelona Model 1973-2004, Ajuntament de Barcelona* - Department of Architectural Composition of the ETSAB-UPC

FAÇADE: AN URBAN CONTRIBUTION TO A SHARED LANDSCAPE

_ZAERA-POLO, A., TRUBY, S., KOOLHAAS, R., BOOM, I., AMO, HARVARD GRADUATE SCHOOL OF DESIGN, (2014), *Façade*, Elements, Marsilio, Venezia

_KRINSKY, C. H., (1988), *Gordon Bunshaft of Skidmore, Owings & Merrill, The Architectural History Foundation*, New York; The MIT Press, Cambridge

_SKIDMORE, OWINGS & MERRILL, (1974), *Architecture of Skidmore, Owings & Merrill, 1963-1973*, Architectural Press, London

_POGACNIK, M., RESEARCH UNIT ART OF BUILDING, UNIVERSITÀ IUAV DI VENEZIA, *Details. Architecture seen in section* (www.detailsinsection.org)

TRANSPARENCY

_ROWE, C., SLUTZKY, R. (1963), *Transparency: Literal and Phenomenal,* Perspecta, vol.8, pp.45-54/ vol.13/14, pp.287-301

_ROWE, C., SLUTZKY, R. (1997), *Transparency: Literal and Phenomenal,* Basel, Boston: Birkhäuser Verlag

_ARQUITECTURA VIVA (2002), *Issue 82 I-II 2002*, Synopses. Glass Codes

_MARTIN, R., (2003), *The Organizational Complex. Architecture, Media, and Corporate Space*, The MIT Press, Cambridge, Mass.

_MURRAY, S., (2009), *Contemporary Curtain Wall Architecture*, Princeton Architectural Press, New York

_SCHITTICH, C. (2017), *Building Skins. Concepts, Layers, Materials*, Birkhauser, Edition Details

Project development

VISION AND CONSTRUCTION

_FRAMPTON, K. (1995) *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*, The MIT Press, Cambridge, Mass.

_GREGOTTI, V. (1996), *Inside architecture* (translated by P. Wong, F. Zaccheo), Graham Foundation for Advanced Studies in the Fine Arts, The MIT Press, Cambridge, Massachusetts.

_GREGOTTI V. (2010), *Architecture, Means and Ends* (translated by L.G. Cochrane, The University of Chicago Press.

_MONEO R. (2004), *Theoretical Anxiety and Design Strategies in the Work of Eight Contemporary Architects,* The MIT Press, Cambridge, Massachusetts.

_BALMOND, C. (2002), *Informal*, Prestel Verlag, Munich- Berlin-London-New York

_DEPLAZES, A.(editor), (2008), *Constructing Architecture: Materials, Processes, Structures: a Handbook*, Birkhauser, Basel

_GAUZIN-MULLER, D. (2002), *Sustainable architecture and urbanism: concept, technologies, examples,* Birkhauser, Basel-Berlin-Boston

_ZIMMERMANN, A. (2009), *Constructing Landscape: Materials, Techniques, Structural components,* Birkhauser, Basel

BASEL ARCHITECTURAL ITINERARIES

_AA.VV. (2001), *A Matter of Art Contemporary Architecture in Schwitzerland*, Birkaiuser, Basel, Boston-Berlin

_AA.VV. (1998), *Architektur in 20. Jahrhundert Schweiz*, Prestel, Munchen

_AA.VV.(1947), *Moderne Schweizer Architektur 1925-45,* K. Wemer, Basel

_DAGUEME M. (editor) (1995), *Guida all'architettura del Novecento: Svizzera*, Electa, Milano

_FINGERHUTH C. (editor) (1988), *Bauten in Basel,* Wepf, Basel

_GUBLER J. (editor) (1994), *ABC 1924-28: avanguardia e architettura radicale,* Electa, Milano

_GUBLER J. (editor) (1994), *ABC 1924-28: avanguardia e architettura radicale,* Electa, Milano

_HERNANDEZ A. (2000), *Svizzera, in Magnago Lampugnani V. "Dizionario Skira dell'architettura del Novecento"*, Skira, Milano

_FRAMPTON K. (1993), *Storia dell'architettura moderna*, Zanichelli, Bologna

_GUBLER J. (ed.) (1994), *ABC 1924-28: avanguardia e architettura radicale*, Electa, Milano

_HERNANDEZ A. (2000), *Svizzera, in Magnago Lampugnani V. "Dizionario Skira dell'architettura del Novecento"*, Skira, Milano

_HUBER D. (1993), *Architekturfihrer Basel*, AM Architekturmuseum, Basel

_HUMBEL C. (1996), *Young Swiss Architects*, Birkauser, Basel-Boston-Berlin

_JEHLE-SCHULTE STRATHAUS U. (1999), *Junge Basler Architekturbiinos*, AM Architektur- Museum, Basel

_KRIES, M. (2014), *Vitra Campus: Architecture Design Industry*, Vitra Design Museum, Weil am Rhein

_ZELLER C. (1992), *Schweizer Architekturfihrer 1920-1990*, Werk, Zurich

_WINDHÖFEL, L. (2011), *Architectural Guide Basel. New Buildings in the Trinational City since 1980*, Birkhauser Basel, ed. 05/2014

SWISS ARCHITECTURE

_AUSSTELLUNG ARCHITEKTUR IM 20. JAHRHUNDERT: DEUTSCHLAND, (1998), *Architektur in 20*. Jahrhundert Schweiz, Prestel, München

_BILL, M. (1947), *Moderne Schweizer Architektur 1925-45*, K. Wemer, Basel

_DAGUEME M. (ed.) (1995), *Guida all'architettura del Novecento: Svizzera*, Electa, Milano

_FINGERHUTH C. (editor) (1988), *Bauten in Basel,* Wepf Basel

_FRAMPTON K. (1993), *Storia dell'architettura moderna*, Bologna

_GUBLER J. (ed.) (1994), *ABC 1924-28: avanguardia e architettura radicale,* Electa, Milano

_HERNANDEZ A. (2000), Svizzera, in MAGNAGO LAMPUGNANI V., *"Dizionario skira dell'architettura del Novecento"*, Skira, Milano

_HUBER D. (1993), *Architekturfihrer Basel,* AM Architekturmuseum, Basel

_HUMBEL C. (1996), *Young Swiss Architects*, Birkauser, Basel-Boston-Berlin

_JEHLE-SCHULTE STRATHAUS U. (editor) (1999), *Junge Basler Architekturbiinos*, AM Architektur-Museum, Basel 1999.

_LUCAN, L. (Ed.), MARCHAND, B. (Ed.), (2001), *A Matter of Art Contemporary Architecture in Schwitzerland*, Birkaiuser, Basel, Boston-Berlin

_ZELLER C. (1992), *Schweizer Architekturfihrer 1920-1990*, Werk, Zurich

SELECTED ABSTRACTS RELATED TO BASEL ITINERARIES

_ACKERMANN, M. (1995), *Figures of Artists at the Gates of the Factory. Projects by: Tadao Ando, Frank O. Gehry, Zada Hadid, Álvaro Siza,* in Lotus International 85 After the Guggenheim, Editoriale Lotus, Milano

_CARUSO, A. (2003), *Stazione ferroviaria di Basilea. Elogio della complessità, in Achi: Swiss review of architecture, engineering and urban planning*, 2003

_HERZOG, J., DE MEURON P. (2019), *Herzog & de Meuron Buildings in the Basel Region*, in www.herzogdemeuron.com

_KRIES, M. (2014), *Vitra Campus: Architecture Design Industry*, Vitra Design Museum, Weil am Rhein

_MADDALUNO, R., WALSER, D. (2003), *Basilea: occasioni di architettura contemporanea* (with english text), in AREA 70 "7x70", September /October 2003 (with Contemporary itinerary)

_MAGLICA, I., *Herzog + De Meuron. Museum der Kulturen*, Basilea, in Costruire in Laterizio 150, pag.18-23

_WINDHÖFEL, L. (2011), *Architectural Guide Basel. New Buildings in the Trinational City since 1980*, Birkhauser Basel, ed. 05/2014 (extract)

OTHER

_CAN, I.; HEATH, T. (2015), *In-between spaces and social interaction: a morphological analysis of Izmir using space syntax,* in Journal of Housing and the Built Environment, 31(1), Springer Verlag, https://doi.org/10.1007/s10901-015-9442-9

_HOEGER, K.; CHRISTIAANSE, K. (2007), *Campus and the City: Urban Design for the Knowlege Society",* gta Verlag / eth Zürich https://iadp.co/2018/01/04/campus-to-city-urban-design-for-universities-2/

_ https://biennalewiki.org/?p=1909

_https://averyreview.com/issues/12/the-two-towers [12] https://www.vitra.com/en-us/campus

_https://www.bs.ch/en/Portrait/economy/innovation-hub-basel.html

_CHESBOURGH, H., (2003),*The Era of Open Innovation,* MIT Sloan Management Review 44, 35-41.

_HOWDER, R., (2013), Personal communication from Randy Howder, Gensler, February 20, 2013.

_ http://www.lifesciencesbasel.com/en/

_ https://www.unibas.ch/en/Research/Uni-Nova/Uni-Nova-131/Uni-Nova-131-Where-the-life-sciences-are-concentrated.html

_https://architizer.com/blog/inspiration/collections/modern-fora/

_ VITRUVIUS, (1960), *"The Ten Books On Architecture."* New York, Dover Publications

_ MONEO, R., (1978), "*On Typology*", Oppositions, MLT Press, 13:22-45.

_ ARIS, C. M., (1993), *"Las variaciones de la identidad. Ensayo sobre el tipo en arquitectura"* Demarcación de Barcelona del Colegio de Arquitectos de Cataluña

A NEW WAY OF BUILDING

- ASSOBIM, 2019, *"BIM Report 2019",* Torino

- FAZLI, A., FATHI, S., ENFERADI, M.H., FAZLI, M., Fazli, FATHI, B., 2014, *"Appraising Effectiveness of Building Information Management (BIM) in Project Management",* Article in Procedia Technology 16 (2014) 1116-1125, Elsevier

- *ROKOOEI, S., 2015,"Building Information Modeling in Project Management: Necessities, Challenges and Outcomes",* Article in Procedia – Social and Behavioural Sciences 210 (2015) 87-95, Elsevier

- FAGGAL, A.A., MEKAWY, M.R., 2006, "*Using Building Modeling Technology to empower sustainable design"*

- *GSA BIM Guide Overview* (U.S. General Services Administration, 2007).

- *PMI. A Guide to the Project Management Body of Knowledge* (PMBOK® Guide). 2008. 5th edition. Project Management

Institute, Newton Square, Pennsylvania, USA

- TRENCH, S., 2012, *"Building Information Modelling Case Study",* Crossrail, (https://www.designingbuildings.co.uk/w/images/1/11/%28BIM%29_Building_Information_Modelling_Case_Study-_Stephen_Trench_.pdf)

-JRADE, A., LESSARD, J., 2015, *"An Integrated BIM System to Track the Time and Cost of Construction Projects: A Case Study",* Eul-Bum Lee, University of Ottawa, 161 Louis Pasteur Private, Ottawa, ON, Canada K1N 6N5X

- LI, J., HOU, L., WANG, X., WANG, J., GUO, J., ZHANG, S., JIAO, Y.,, 2014, "*A Project-based Quantification of BIM Benefits",* International Journal of Advanced Robotic Systems, 11:123 | doi: 10.5772/58448

- SHIN, M., H., LEE, H.,K., HWAN, Y., K., 2018, "*Benefit–Cost Analysis of Building Information Modeling (BIM) in a Railway Site",* MDPI, Licensee MDPI, Basel, Switzerland.