CHAPTER 2

THE SITE, BUILDINGS AND UNDERGROUND STRUCTURES

2.1 INTRODUCTION

In terms of civil engineering, the needs of the LHC machine are, to a large extent, similar to the Large Electron Positron (LEP) machine which was constructed between 1984 and 1989. These needs consist principally of the main beam tunnel, access shafts from the surface to the underground areas together with various underground caverns and other ancillary structures for housing equipment that cannot be located on the surface. Buildings are required on the surface for housing compressors, ventilation equipment, electrical equipment, access control and control electronics.

Great care has been taken to re-use the existing civil engineering infrastructure that was created for LEP as much as possible and all LEP buildings, albeit some with modifications will be re-used for the LHC.

Despite the maximum use of existing facilities, additional infrastructure is required. For the machine, this is primarily for the new injection lines and for the beam dumps. In addition several small caverns are required to house equipment at various locations around the main beam tunnel. At Point 5, the machine requirements have been incorporated within the new infrastructure necessary for the CMS detector, thus eliminating the need for an additional and costly access shaft.

Of the four LHC experimental areas, two have been constructed on almost “green field” sites where there was very little existing infrastructure. As such, two large experimental zones for ATLAS and CMS have had to be constructed at points 1 and 5 respectively. These two new experimental zones are similar in that they both consist of two new large caverns, one for the detector and one for the services, together with various galleries, tunnels and chambers for housing equipment and providing access routes. On the surface an array of buildings are required for offices, cooling and ventilation equipment, cryogenic equipment installations and so on.

For the two smaller experiments (ALICE and LHCb) the existing infrastructure has required only minor modifications to accommodate the new detectors.

At some locations, such as Point 1, the new underground structures were situated very close to the existing LEP ones, which meant special protective measures had to be taken both before and during the LHC works and often entailed repair works afterwards.

Most of the Civil Engineering works for the LHC Project lasted in the region of 4.5 to 5 years with the exception of Point 5 (CMS experimental area) where it took approximately 6.5 years to complete. Work started as scheduled in April 1998 for Point 1 in Switzerland, while the start date was delayed until autumn of the same year for all other Civil Engineering works (on French territory) because of the late signing of the “Déclaration d’Utilité Publique”. Until November 2000 when CERN stopped LEP and dismantle the accelerator, the Civil Engineering work had to be carried out with the least possible disturbance to the operation of this machine (for instance all blasting was prohibited for underground excavations, precautions were taken to minimise the infiltration of dust in the LEP areas and movements of the existing LEP underground structures had to be minimized). After November 2000 these precautions could be relaxed, but the constraints from the general LHC programme meant that a lot of work had to be carried out in parallel.

Most of these works were completed and handed over to CERN in the period from the beginning to the middle of 2003, while at Point 5 the bulk of the underground and surface works was finished between April and July 2004 with only the CMS control building to be handed over to CERN later, in early 2005.

2.2 MAIN ASPECTS OF THE ADDITIONAL CIVIL ENGINEERING

2.2.1 Underground Structures

After some minor modifications the main ring tunnel constructed for LEP will be fully re-used for LHC. The tunnel consists of 8 straight sections connected by 8 arcs, the total circumference being some 26.7 km. It was excavated at depths varying between 45 and 170 m and with a horizontal slope of 1.4%, sloping down towards the lake. The position was selected so that most of the tunnel would be situated in the Lemanic

Basin molasse. The beam interaction points are in the centre of the 8 straight sections. Fig. 2.1 shows the underground structures schematically.

The two tunnels that will be used to transfer the proton beams between the SPS and LHC have the same finished internal diameter of 3 m and they are also nearly identical in length (approximately 2.5 km).

The transfer tunnel TI 2 links Point 2 of the LHC to the TT60 tunnel which in turn is connected to the SPS. The shaft in TI 2, located at the western end of the CERN Meyrin site, is the Project's only elliptical shaft. It is through this shaft that most of the magnets for the future machine, in particular the 1232, 15 m long cryo-dipoles, are to be lowered. The longitudinal section of this tunnel had to be modified during the design phase to take account of a dip in the molasse with an inflow of water, under the village of Saint-Genis-Pouilly (F). At the surface, two large buildings have been erected (one on top of the installation shaft and the other one adjacent) to house the transfer, preparation, sorting and some testing of the LHC machine cryo-magnets.

The second transfer tunnel, TI 8, links Point 4 of the SPS accelerator to Point 8 of the LHC. It has the advantage of an access shaft located near the point where it intersects with the SPS. It has a relatively uniform slope of 3.8% and lies within a depth span of approximately 50 m to 100 m.

The structures to be built for the beam dumps are on either side of Point 6, near the village of Versonnex in France. The tangential ejection of the beams and the distance required to disperse them made it necessary to excavate a 20 m long extraction cavern measuring 8 m in diameter, a 330 m long tunnel with a finished diameter of 3 m, and a 25 m long cavern measuring 9 m in diameter, linked to the existing tunnel by a short access/egress gallery on each side. Based on environmental and financial considerations, it was decided that all this work would be done from the existing shafts at Point 6, without creating a new access pit.

The two large experimental areas for the ATLAS and CMS detectors consist of two shafts, which are up to 20 m in diameter and approximately 65 m deep. These provide access to the experimental and service caverns. In the case of the ATLAS detector, the two main caverns are arranged perpendicularly, linked by five L-shaped tunnels. Two smaller caverns either side of the experimental area in the existing tunnel will house the electrical equipment for the LHC machine. This area is located at Point 1, opposite the main entrance to the CERN site at Meyrin in Switzerland. As the upper limit of the molasse rock lies at only 6 or 7 m below ground level, the excavation of the shafts did not pose any particular problems.

For the CMS detector, the two main caverns are arranged side by side to minimise the length of connections to detector. It is essential for the two caverns to be situated not more than 7 m apart, and it was therefore necessary to replace the molasse between them by a concrete "pillar" measuring 50 m long and 28 m high. This work was done in advance, after completion of the excavation of the two shafts and before that of the two large caverns. This area is located close to the French village of Cessy. Unlike the ATLAS experimental area, the level where the moraine meets the molasse is at a depth of more than 50 m, therefore there is only on average 18 m of molasse above the cavern crowns. The excavation of the shafts therefore required the use of a ground freezing technique. As in the case of the ATLAS area, several additional tunnels and caverns, including a complete by-pass tunnel running through the service cavern had to be built.

For experimental areas to house the two other detectors, ALICE and LHCb, the existing underground LEP infrastructure was re-used. The ALICE detector has been designed in such a way that it could fit in the UX25 cavern formerly dedicated to the L3 experiment. Modifications to underground structures included new foundations for a magnet in the UX25 cavern and a new passage called UP25 between this cavern and the LEP US25 chamber.

The LHCb detector will be housed inside the existing UX85 cavern, formally dedicated to the DELPHI experiment. Modifications to the UX85 cavern included the reinforcement of the headwall damaged by the swelling of the molasse rock, the erection of a partly prefabricated concrete shielding wall, and some truncation, or modification, of concrete walls.

2.2.2 Surface Buildings

On the surface, all existing LEP buildings will be re-used for LHC (Fig. 2.2). However, some modifications were needed. This included the construction of a clean room in building SXL2 and a counting room in building SX2. Several new buildings have been built to house new facilities required by the LHC.

At Point 1, a total of 8 new buildings have been erected in order to shelter:

- The shafts on top of the service experimental caverns,
- All services required for the running of the ATLAS detector.

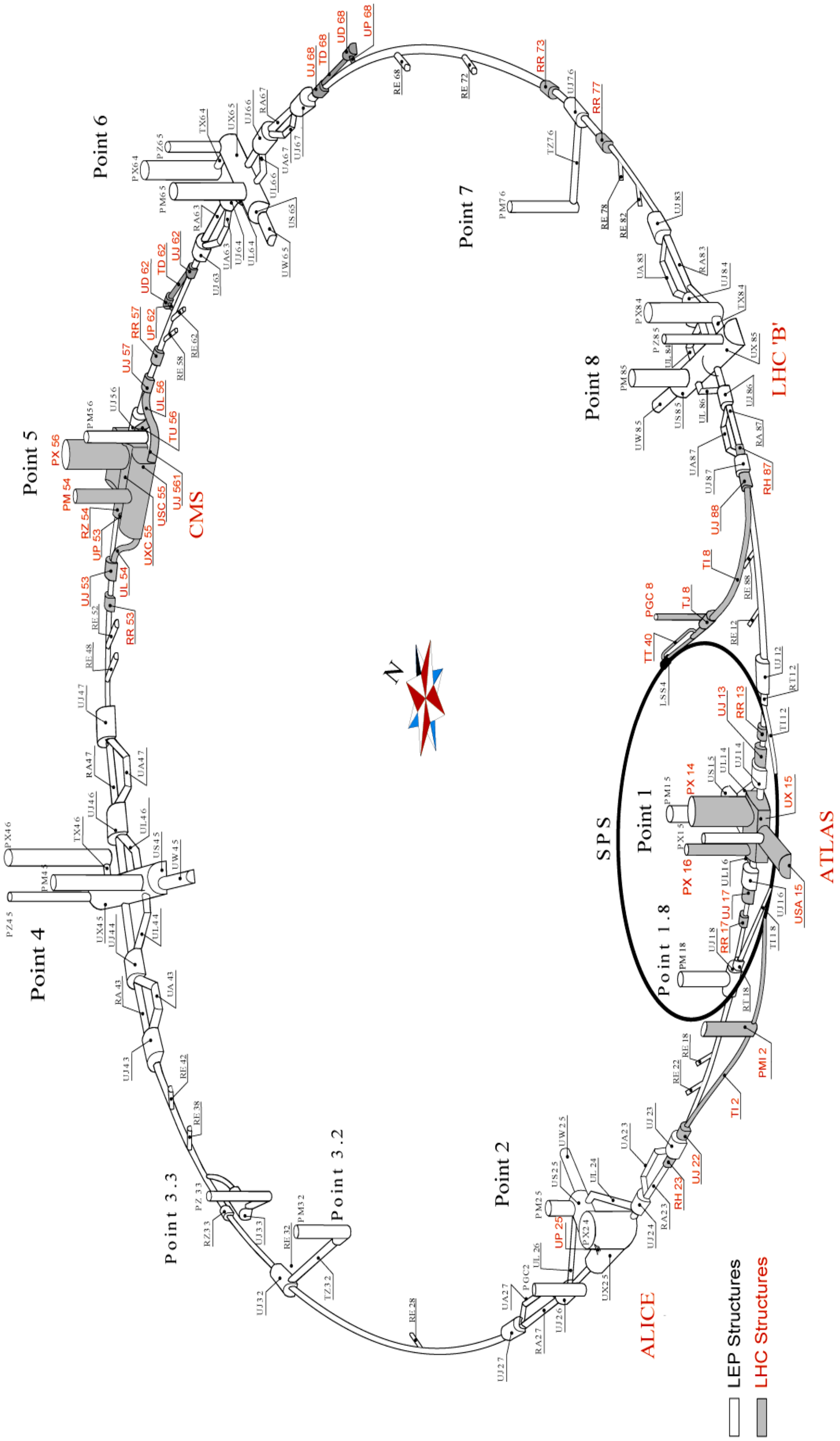

Figure 2.1: LEP and LHC underground structures

At Point 5, a total of 9 new buildings have been erected in order to shelter:

- The two shafts on top of the experimental cavern,
- The single shaft on top of the service cavern,
- All services required for the running of the CMS detector. The SX building was completed very early in the project to allow CMS to start pre-assembly of the detector.

Apart from the surface buildings mentioned above, new ones have been constructed at points 2, 4, 6 and 8 to house the cryogenic compressors for the LHC machine. Three other steel buildings were erected at points 2, 4 and 8 to house cryogenic equipment such as cold boxes. The total number of new buildings erected in the frame of the LHC Project amounts to thirty, representing a total gross surface area of 28 000 m^2.

2.3 GEOLOGY AND ENVIRONMENT

In view of its dimensions, there was no way to avoid locating the main tunnel of LEP in two very different geological zones. Most of the tunnel, i.e. about 23 km, has been excavated in the molasse of the Lemanic basin, which is a tertiary formation of consolidated fluvial and marine deposits of alpine origin. The remainder of the tunnel is situated in the piedmont region of the westernmost Secondary Period (Mesozoic) chain of the Jura.

In the Lemanic plane the molasse does not generally occur at the surface, but lies beneath moraine deposits consisting of gravels, sands and loams which can contain ground water. Such surface rock can pose problems for tunnel excavation since it does not lend itself to mechanised boring methods and is insufficiently stable bedrock for CERN accelerators. The upper limit of the underlying molasse lies at variable depths, ranging from several metres to over a hundred metres following the glacial ridges and furrows. It consists of sub-horizontal lentils of alternating sandstones and marls of variable composition. The nature and geo-mechanical characteristics of these rocks vary considerably, ranging from hard and cemented sandstones to soft marls.

In the piedmont region of the Jura, the tunnel had to pass through the transition and interface zones separating the deposits of the plane from the Jura massif itself before entering the compliant series of Cretaceous and Upper Jurassic rocks consisting of limestone and compact marls. These rocks constitute the anticline fold of the high chain of the Jura.

The whole region has been subjected to severe folding and as a result there are a lot of cracks. The Jura chain has many fissures, either running parallel to its axis, resulting in intense erosion centred on the summit fault or combined in two transverse directions. The massif has thus been segmented into successive blocks separated by faults.

As a result of exploratory test boring, the positioning of LEP was modified to avoid the Jura as much as possible. The final positioning included only 3 km in the piedmont region with a maximum rock cover of 170 m. To avoid a deep depression in the moraine detected in the eastern part of the project near Geneva-Cointrin airport, the main tunnel plane was inclined by 1.42% from the horizontal. This tilting of the tunnel's plane made it possible to optimise the depth of the access shafts, to site the main tunnel at greater depths below the inhabited areas of the plane and, conversely, to reduce the depth of the underground structures under the Jura mountains.

In the same way as for the LEP Project, the implantation of the LHC Project into the local environment required all relevant legal procedures to be followed. This implied firstly the writing of an Environmental Impact Study, which was submitted to the competent authorities and communicated to the general population in the spring of 1997. After this, the application of the normal procedures for reception of construction permits were prepared with the collaboration of external architects and submitted to the regulatory authorities. In following all these different procedures the aim has been to ensure that the LHC Project is integrated into the environment in the best possible way and that the risk of disturbing the population is reduced to a minimum. A number of changes to the original plans have in fact been introduced as a result of the many consultations with the people and authorities concerned.

It was part of the architects' task to ensure the best possible integration of the surface buildings into the environment. Acoustic insulation is of particular importance for installations that could be noisy. The fact that nearby houses are in most cases grouped to one side made it easier to provide suitable screens and plantations as a means to further reduce any residual disturbance.

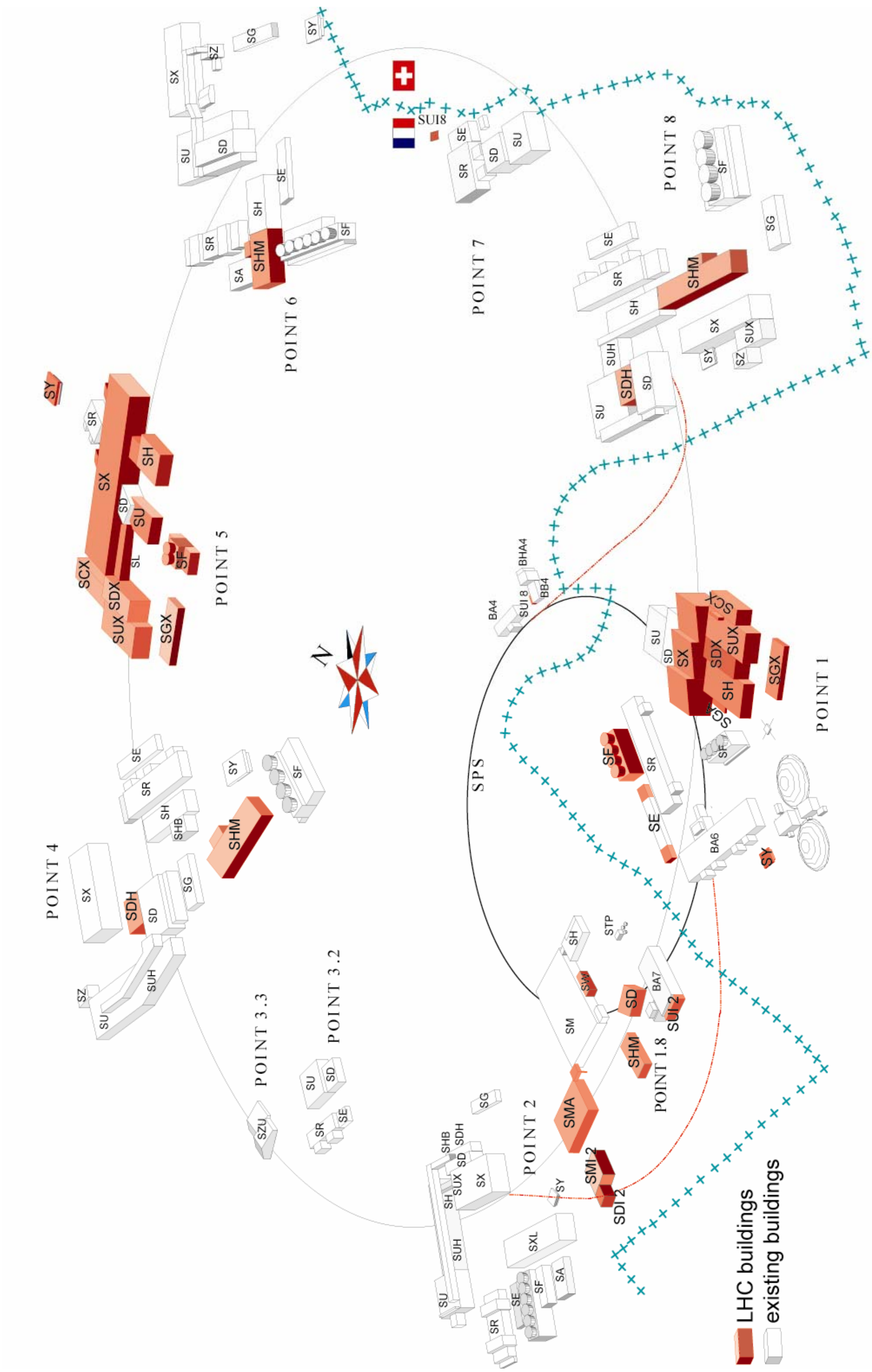

Figure 2.2: LEP and LHC buildings.

Where significant excavation work took place, like in points 1, 5 and 6, these screens were made from "hills" built with the excavation material from the underground works. Later, these mounds were covered with topsoil and planted to match the surrounding landscape.

The finished LEP tunnel in which the LHC Collider is placed is essentially a watertight concrete pipe and hence does not affect the water resources of the area. The only exception to this is in the Jura section of the tunnel, where an ingress of water could not be totally prevented during LEP works because of programme constraints. However, this has a very limited impact on the hydrogeology of this part of the Jura Mountains (see below).

2.4 THE MAIN BEAM TUNNEL

The normal tunnel cross-section (internal diameter of 3.76 m) is divided into two parts:

- The inner side of the ring, which is set aside for handling equipment and for the passage of personnel,
- The outer side, where the machine components and services will be installed – this layout was chosen partly to give free access from the inside of the ring and partly to allow the services to be installed on the same side as the machine.

Excavation of the LEP tunnel was done with full-face boring machines in the molasse. Stability conditions varied considerably in the vicinity of the Allondon fault, where vertical strata displacements of over 100 m were detected. Also, if poor quality and/or permeable rock were encountered, the performance of the required auxiliary operations – such as ground and rock support, grouting, and pilot hole drilling for the detection and delineation of adverse geological conditions – would have been severely hampered by the presence of a full-face machine. Therefore, the more flexible method of using explosives to drive the tunnel through the limestone was preferred.

While the finished internal diameter of the main tunnel is 3.76 m, the excavated diameter was 4.50 m, thus allowing the insertion of firstly a pre-cast concrete segmental lining, grouted to the rock and then a cast in-situ lining. In more detail, the tunnel lining in the molasse initially consisted of a concrete segmental shell, inserted, then contact-grouted to the rock as soon as it was practicable after excavation. This shell supports and preserves the inherent integrity of the rock. A second, cast in-situ lining was poured after the installation of waterproofing and drainage systems. In the molasse, a drainage system, placed between the linings, reduces or eliminates hydrostatic pressure in most cases, the treatment of the construction joints and the inner lining rendering the structure watertight. In the limestone strata, an initial lining consisting of a combination of rock bolting, sprayed concrete, wire mesh and possibly steel arches, has been placed prior to the definitive, cast in-situ concrete lining.

In zones of relatively high water pressure and/or high permeability, which were encountered in the Mesozoic limestone, waterproofing was achieved by a combination of grouting – using chemical and cement-based solutions which solidify within the rock matrix – and the insertion of a waterproof layer between the two linings.

Because problems were anticipated, the Jura section of the LEP tunnel was drilled and blasted, rather than using the full-face tunnelling machine. While being excavated, this region suffered inflows of water under high pressure with up to 200 litres per second, carrying silt and sand with it. These inflows were treated by grouting before the tunnel was lined with shotcrete, waterproofed and given a final concrete lining. Only one remained, with a steady inflow of 23 litres per second throughout the year, which could not be treated for planning reasons during LEP construction. Since then, on two occasions in 1990 and in 1993 pipes and drains were blocked by massive quantities of sand and the LEP machine was flooded, with a deposit of sand on its floor up to 20 cm deep. A number of studies involving external experts and consultants were performed to try and find an efficient solution to this problem, in view of the installation of the LHC machine in the LEP tunnel.

After a "submarine" solution including more than 600 m of heavy steel lining in the concerned area was rejected as too costly, it was finally decided to improve the existing drainage and protection facilities with the following works:

- Demolition and reconstruction of the RE38 alcove (to stand the external hydraulic pressure);
- Improvement of the LEP water drainage system;

- Installation in the LHC tunnel of a new 6 inch stainless steel pipe to carry the (possibly sandy) water to the TZ32 tunnel;
- Fixing of mesh panels in place on the vault of the LHC tunnel to protect personnel and equipment;
- A complete cleaning of the central drain blocked by grouting material in 1991.

On the other hand, it was decided to remove the dams in the TZ32 tunnel and let the flow of loaded water go directly into a pit at the bottom of the PM32 shaft where significantly improved pumps have been installed to take the water up to the existing decantation basins on the surface.

2.5 SURFACE AND UNDERGROUND STRUCTURES AND THEIR FUNCTIONS

Generally speaking all underground and surface structures for ATLAS and CMS experiments situated at points 1 and 5 respectively are new, while those for ALICE and LHCb experiments are those which were erected for the LEP experiments previously situated at points 2 and 8 respectively.

2.5.1 Surface structures

All LEP buildings will be re-used in the frame of the LHC project. On the following axonometric views and layouts, they are indicated as shapes with no fill, while buildings specifically erected for the LHC project are indicated by shapes filled in grey. Together with the axonometric and layout drawings, tables are shown which summarise the new characteristics of the buildings, as well as the lifts and tracking cranes which are available inside them.

At points 1, 2, 5 and 8, where the LHC new experiments are located, the buildings are of two kinds: those related to the need of the LHC machine and those for the detectors. In total 30 buildings have been erected for the LHC project in addition to the existing LEP ones, representing an additional 28 000 m^2 of gross surface area. All buildings housing noisy equipment are built with cast in-situ or prefabricated concrete with internal insulation. The main features of the various building types, together with their functions are summarised below:

LEP buildings

SA (points 2 and 6)
: Steel buildings dedicated to the LEP RF system. They are re-used in a different way for the LHC project. At Point 6, the length of the building was reduced to leave space for erection of the SHM building.

SD
: Steel building on top of PM shaft, giving access to the US caverns. They are used to transfer equipment to service caverns below a use which is unchanged for LHC.

SEE
: Concrete platform at ground level fitted with electrical equipment.

SEM-SES
: Concrete/steel single storey building with false floor used as electrical substations. This building has been extended at Point 1 to cope with the additional local requirements.

SF (points 2, 4, 6, 8)
: Concrete cooling towers to extract the heat loads from machine and former LEP experiment equipments. They are re-used for cooling the LHC machine components.

SG (points 2, 4, 6, 8)
: Concrete/steel buildings housing the equipment for the storage and mixing of gases for the LEP experiments. They will be re-used for storage.

SH (points 2, 4, 6, 8)
: Concrete building housing the cryo-compressors for the LEP experiments. They are re-used for the cooling of the LHC machine components.

SM (Point 1.8) Steel building which was used for various purposes at the time of LEP, mainly to test pieces of equipment. For the LHC, the SM18 building houses a cryogenic plant which serves two major testing facilities, the cryomagnets cold tests benches and the radio-frequency conditioning equipment.

SR Steel building with false floor, which was used to house the power converters of LEP. For the LHC they have been given a variety of new uses including housing clean rooms at Point 1.

SU Concrete building dedicated to the cooling and ventilation of machine areas. Use unchanged for the LHC.

SUH Concrete buildings housing ventilation and cooling equipment for the cryo-compressors.

SUX (Point 2) Concrete building housing the cooling and ventilation equipment for the L3 experiment, to be re-used for ALICE equipment.

SX (points 2, 4, 6, 8)
Steel buildings on top of the PX shafts, giving access to the UX caverns. They were used to transfer experimental equipment to these caverns. Their use will be the same in the frame of the LHC, for Points 2 (ALICE) and 8 (LHCb) while machine components will be transferred through SX4 and SX6.

SY (points 2, 4, 6, 8)
Concrete/steel buildings for access control of the even points of LEP. Their use is the same in the frame of the LHC project. They contain equipment which monitors the access gates to these sites and the safety systems.

SZ (points 4, 6, 8)
Concrete (Point 4) or steel buildings (points 6 and 8) on top of PZ shaft used for personnel access to the underground areas through the UX cavern.

LHC buildings

SCX (Points 1 and 5)
Office buildings required by ATLAS and CMS collaborations. These are 3-story (ATLAS) or 2-story (CMS) buildings of reinforced concrete with partial glass facades. They provide office space, together with the main experimental control room and some technical rooms, mainly for computing facilities.

SD (Point 1.8) Steel building over PM 1.8 shaft giving access to the UJ18 cavern and the LHC tunnel.

SDH (points 4 and 8)
Steel building housing cryogenic equipment for the LHC machine.

SDI (TI2 area, western end of the Meyrin site)
Steel building over the PMI2 shaft and the TI2 transfer tunnel. The building is used to transfer the LHC cryo-magnets from the surface to the TI2 tunnel, on their way to their final position in the LHC tunnel

SDX (points 1 and 5)
Steel buildings on top of the PM shafts for personnel and equipment access to the underground areas through the US caverns.

SF (points 1 and 5)
Concrete cooling towers for the ATLAS and CMS detectors. The SF1 tower also cools SPS BA6 and, to compensate, LHC Point 1.8 is partially cooled by the SPS loop.

SGX (points 1 and 5)
: Concrete/steel buildings for the storage and mixing of gases for the ATLAS and CMS detectors. As for the LEP, SG buildings, they have been specially designed so that in the unlikely case of an explosion within the building, the roof will come off, thus releasing the pressure within the building.

SH (points 1 and 5)
: Concrete buildings housing the cryogenic compressors and equipment required by the ATLAS and CMS experiments.

SHE (points 1, 1.8, 2, 3.2, 4, 5, 6, 7 and 8)
: Steel tanks for storage or recuperation of Helium, placed over two concrete foundations.

SHM (points 1.8, 4, 6 and 8)
: Concrete buildings housing cryo-compressors and their equipment for the cooling of the LHC machine.

SMA (Point 1.8) Steel building housing cryo-stating activities of the LHC cryo-dipoles.

SMI (TI2 area, west of the Meyrin site)
: Steel building used for storage and sorting of the cryo-dipoles for LHC, prior to their transfer to the TI2 tunnel.

SUI (SUI2 at Point 7 of the SPS, SUI8 at Point 4 of the SPS)
: Steel buildings housing the ventilation equipment respectively for TI2 and TI8 transfer tunnels.

SUX (points 1 and 5)
: Concrete buildings for housing the cooling and ventilation equipment required for the ATLAS and CMS underground areas.

SW (Point 1.8) Steel building housing cryogenic equipment used for tests in building SM18.

SX (points 1 and 5)
: Steel buildings (with wood cladding in the case of SX1) for the transfer and lowering of the ATLAS and CMS detectors components into the experimental caverns.

SY (points 1 and 5)
: Concrete/steel buildings for access control and safety monitoring of the ATLAS and CMS surface areas.

All buildings are surrounded by blacktopped access roads and car parks fitted with the necessary drainage facilities including oil separators.

2.5.2 Underground Structures

Except for the upper part of the shafts, all underground structures have been excavated in the molasse rock. After excavation, they all received a temporary lining (Austrian method) with bolts and shotcrete in various thicknesses, a waterproofing membrane (except for some sections of the LEP tunnel) connected to a drainage system and a final lining made of cast in-situ concrete of various thicknesses. On some occasions, halfen channels have been put in the final lining to allow easy fixing of pipes, cable trays and steel structures at a later stage.

LEP structures

PGC shafts (Point 2)
: Civil Engineering shaft used to carry out the underground works at Point 2. Now has been partially filled with crushed concrete from demolition works for LHC.

PM shafts (points 1, 1.8, 2, 3.2, 4, 5, 6, 7, 8)

Access shafts with stairs and lift, containing services and used for the transfer of equipment.

PX shafts (points 1, 2, 4, 6, 8)

Access shafts to experimental caverns for former LEP and LHC detectors. For the PX15 shaft, repair works, placing of a waterproofing membrane and casting of a concrete lining were carried out in the frame of the LHC project.

PZ shafts (points 3.3, 4, 6, 8)

Access shafts of underground caverns for personnel only.

RA tunnels (points 2, 4, 6, 8)

Straight tunnels between UJ caverns for machine equipment each side of even points.

RE Alcoves (16 units around LHC tunnel, 2 on every octant)

25 m long small caverns with access from the LHC tunnel, housing electrical distribution, cooling and control equipments.

RT chamber (Point 1.8)

Tunnel enlargement at Point 1.8 connecting the LEP/LHC tunnel to the UJ cavern at the bottom of the access shaft, housing electrical equipment.

RZ chamber (Point 3.3)

LEP tunnel enlargement at Point 3.3 used for the transfer of services from UJ33.

TU tunnel (points 4, 6, 7, 8)

Short bypass tunnels for the installation of ventilation equipment.

TX chamber (points 4, 6, 8)

Segment of tunnel between the base of the PX shafts and the extremity of the UX caverns, used to transfer equipment.

TZ tunnel (points 3.2, 3.3, 7)

Horizontal or inclined tunnels providing access from PZ or PM shafts to the nearest UJ cavern.

UA tunnels (points 2, 4, 6, 8)

Service and access tunnels between US caverns used for klystrons for the LEP machine. Now re-used to house the heavy current power converters of LHC and other electrical equipment.

UJ caverns (points 1, 1.8, 2, 3.2, 3.3, 4, 5, 6, 7, 8)

Service caverns housing electrical equipment dedicated to former LEP and now LHC machine.

UL tunnels (points 1, 2, 4, 6, 8)

Junction access tunnels between US and UJ caverns.

UP tunnels (Point 3.3)

Short access tunnel at Point 3.3 connecting the UJ33 cavern to the LEP/LHC tunnel. Now used to feed some of the services into LHC.

US caverns (points 1, 2, 3.2, 4, 6, 7, 8)

Service caverns housing electrical, electronic, cooling and cryogenic equipment adjacent to experimental caverns (re-used for ALICE and LHCb equipment in the case of US25 and US85)

UW caverns (points 2, 4, 6, 8)

Caverns directly connected to the US caverns, housing electrical and cooling equipment.

UX caverns (points 2, 4, 6, 8)

Caverns for former LEP detectors and ancillary facilities re-used for ALICE and LHCb detectors in the case of UX25 and UX85.
UX45 is re-used for the RF installation.

LHC structures

PGC shaft (Point 4 of the SPS)

Civil Engineering shaft used to carry out underground works for the TI8 tunnel, which has been sealed close to the surface after completion of the works.

PM shafts (points 1.8, I2, 5)

PM 1.8 shaft was an existing LEP shaft which has received concrete shielding at its base for LHC. PMI2 has no stairs or lift and is only for the passage of equipment unlike the others which are for access as well so they have stairs and lifts. The shafts are used to carry services and for the transfer of equipment.

PX shafts (points 1 and 5)

Access shafts used for the transfer of detector equipment to experimental caverns, fitted with air ducts in certain cases, such as PX14.

RH caverns (points 2 and 8)

Enlargement of RA tunnels close to UJ caverns to house the injected beam line.

RR caverns (points 1, 5, 7)

Service caverns housing power converters and other electrical equipment for LHC machine.

TD tunnels (Point 6)

Tunnels each side of Point 6 housing beam lines for extraction of beams towards UD caverns.

TI tunnels (points 2 and 8)

Tunnels used to transfer beams from the SPS to the LHC machine clockwise and anti-clockwise.

UD caverns (Point 6)

Caverns partially filled with steel blocks and graphite to stop the LHC beam after extraction each side of Point 6.

UJ caverns (points 1, 2, 5, 6, 8)

Service caverns housing electrical equipment for LHC machine and connecting the TI2 and TI8 tunnels to LHC tunnel (UJ22 and UJ88). Also used as enlargements for transport purposes.

US caverns (points 1 and 5)

Service caverns housing electrical, electronic, cooling and cryogenic equipment adjacent to experimental caverns.

UX caverns (points 1 and 5)

Caverns housing the two main LHC detectors ATLAS and CMS and ancillary facilities.

2.6 POINT 1

Models and layouts of surface building and underground structures at Point 1 (Figs. 2.3 to 2.6), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.1 to 2.4) are shown below.

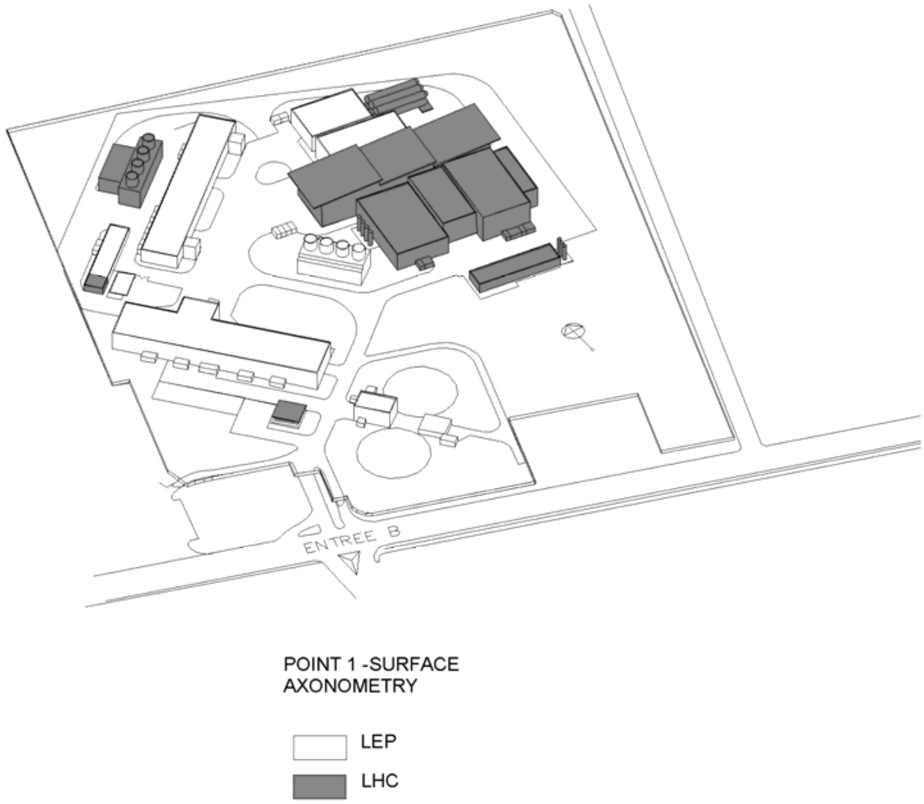

Figure 2.3: Point 1 surface axonometry

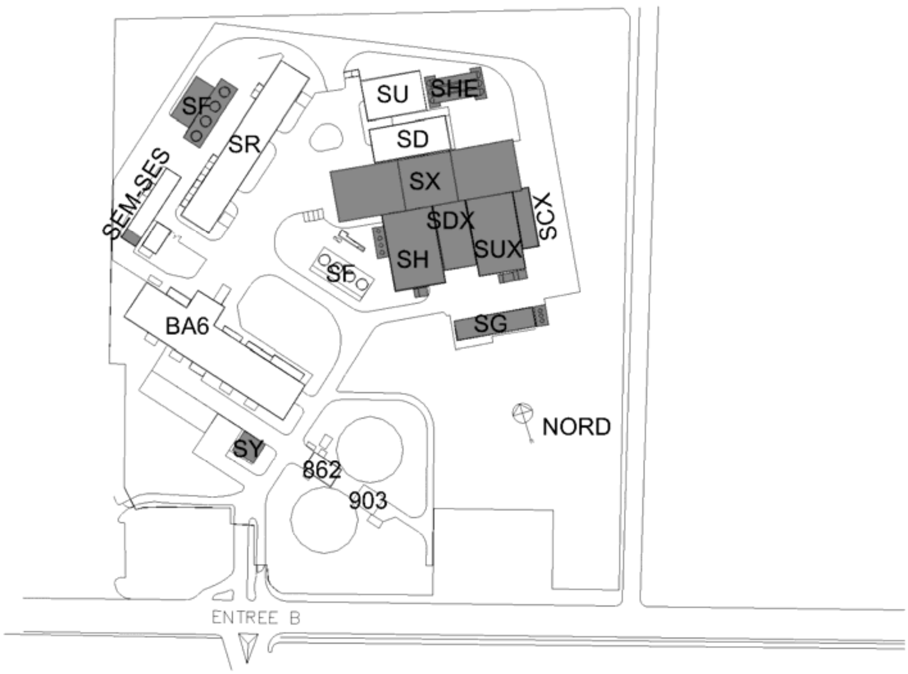

Figure 2.4: Point 1 surface layout

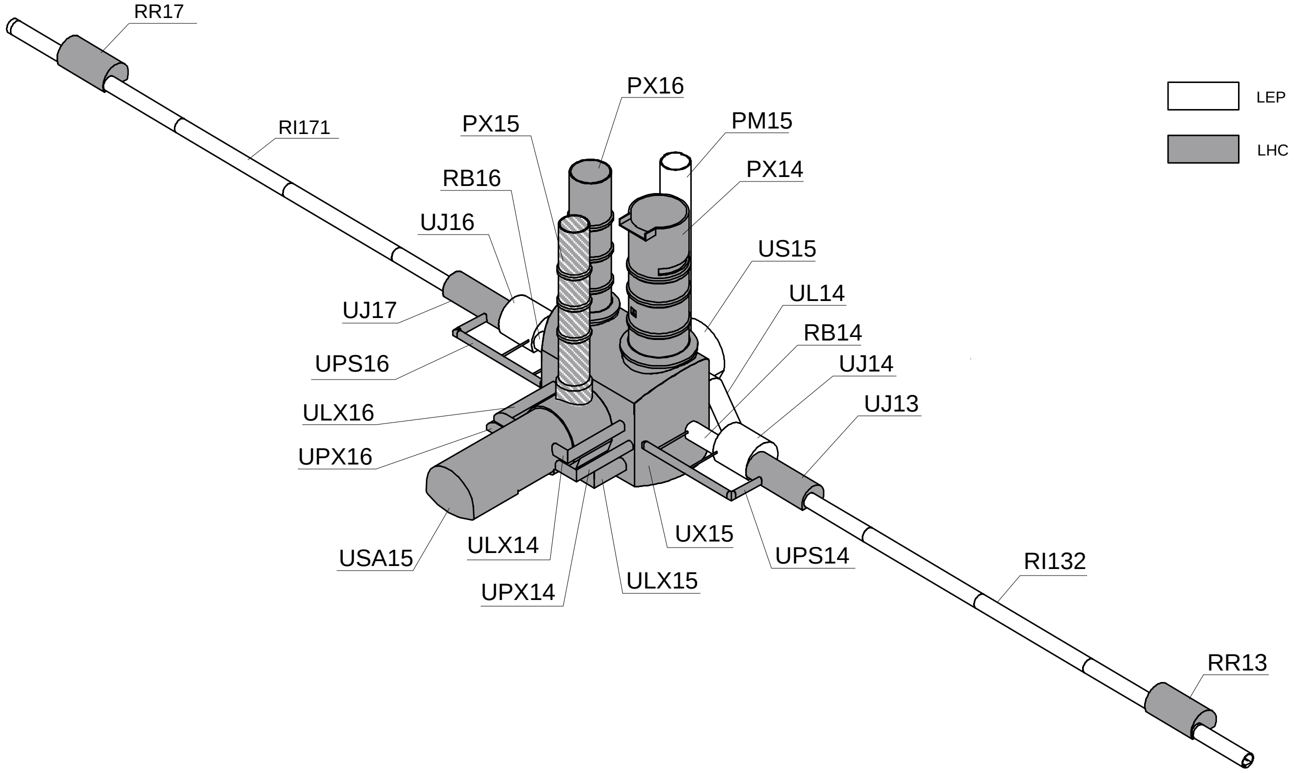

Figure 2.5: Point 1 underground axonometry

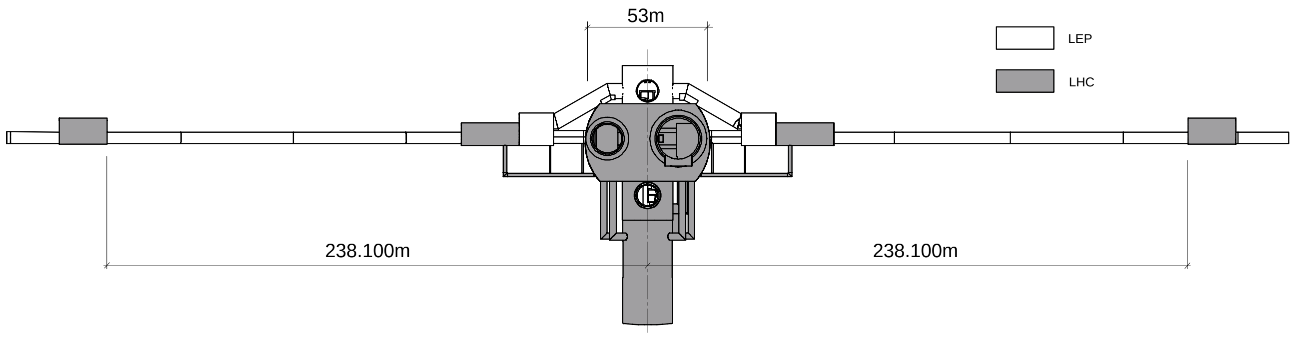

Figure 2.6: Point 1 underground layout

Table 2.1: Point 1 surface buildings

	Length m	Width m	Heigth m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SCX 1	25.00	6.00	9.65	150	1470		
SD 1	18.15	9.15	13.15	166	2185	6.00x6.00	
SDX 1	34.05	17.00	13.60	578	7050	6.00x6.00	
SE 1	50.35	15.60	5.10	785	4006		
SF 1	44.25	23.70	19.50	832	10376	4.00x4.00	
SGA 1	16.00	6.00		96			
SGX 1	40.60	10.40	4.25	422	1794		
SH 1	40.60	26.00	9.15	1055	9678	5.00x5.00	
SHE 1	32.77	16.00		524			
SR 1	93.10	17.15	7.46	1584	14826	3.95x4.00	3.95x4.00
SU 1	30.60	20.60	9.15	630	6205	5.00x5.00	
SUX 1	40.60	24.00	12.20	974	11887	5.00x5.00	
SX 1	84.60	24.00	17.70	2030	35938	(1) 8.00x9.50 (2) 8.00x14.00	5.00x5.00
SY 1	10.70	9.20	3.20	98	315		

Table 2.2: Point 1 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R 11	725.28	3.18	2.88	3.76	2306	6600
RE 12	24.70	4.62	3.45	5.00	101	311
R 12	379.95	3.18	2.88	3.76	1208	3467
RT 12	39.00	4.90	4.00	5.50	191	721
UJ 12	36.00	8.80	5.20	8.90	317	1359
TI 12	536.00	2.94	2.70	3.50	1576	4290
RI 12	206.25	3.62	3.45	4.40	746	2638
RI 13	180.40	3.62	3.45	4.40	653	3640
RR 13	20.00	9.90	6.80	10.40	198	1224
UJ 13	25.00	8.77	5.50	9.00	220	1041
UPS 14	52.52	1.20	2.00	1.20	63	118
UJ 14	14.00	13.30	7.90	13.50	186	1218
RB 14	14.24	3.62	3.45	4.40	51	15
PX 14			53.56	18.00		13628
PM 15			69.15	9.10		4500
PX 15			79.00	9.10		5135
PX 16			54.15	12.60		6751
UL 14	35.00	4.20	5.26	6.10	147	938
UL 16	35.00	4.20	5.26	6.10	147	938
ULX 14	30.60	2.60	2.60	2.60	79	184
UPX 14	52.52	2.20	2.20	2.20	71	140
US 15	20.75	16.20	13.37	21.40	346	4635
USA 15	62.00	19.30	12.60		1197	12951
UX 15	53.00	30.00	34.90		1494	50002
ULX 15	16.30	3.80	3.00	3.80	62	160
UPX 16	32.20	2.20	2.20	2.20	70	139
ULX 16	28.40	2.60	2.60	2.60	74	171
RB 16	13.99	3.62	3.45	4.40	50	106
UJ 16	14.00	13.30	7.90	13.50	186	1218
UPS 16	52.51	1.20	2.00	1.20	63	118
UJ 17	25.00	8.77	5.50	9.00	219	1040
RI 17	180.40	3.62	3.45	4.40	653	1370
RR 17	20.00	9.90	6.80	10.40	198	1223
TI 18	258.00	2.94	2.70	3.50	759	2048
RI 18	206.25	3.62	3.45	4.40	746	2638

Table 2.3: Point 1 gantry cranes

Stucture	Number	Capacity T	Speed m / min	Clearance of Floor m	Hook Travel m	Opening m x m
SD 1	PR 745	20	10	9.00	96.00	8.50x2.00
SR 1	PR 703	5	5	4.50		
SUH 1	PR 718	20	6	5.65		
SX 1	PR 776	140 x 2	3.4	9.30	103.00	
SX 1	PR 777	20	12	6.2	99.00	
SF 1	PR 762	3,2	5	8.55		
SH 1	PR 772	10	6	6.10		
SDX 1	PR 771	16	12.3	9.00	92.00	
SUX 1	PR 766	8	6	9.05		
UD 11	PR 775	30	5.2	10.30		
UX 15	PR 778	65	7.3	24.90		
UX 15	PR 779	65	7.3	24.90		

Table 2.4: Point 1 lifts

Stucture	Lift Number	Capacity kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 15	AS 714	3000 / 33	1	2.70x1.85	1.85 x 2.10
PX 15	AS 716	3000 / 40	1	2.70x1.85	1.85 x 2.10
UX 15	AS719	320 / 4	0.4	1.00x0.88	0.80x2.00
UX 15	AS 720	320 / 4	0.4	1.00x0.88	0.80x2.00

2.7 POINT 1.8

Models and layouts of surface building and underground structures at Point 1.8 (Figs. 2.7 to 2.10), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.5 to 2.8) are shown below.

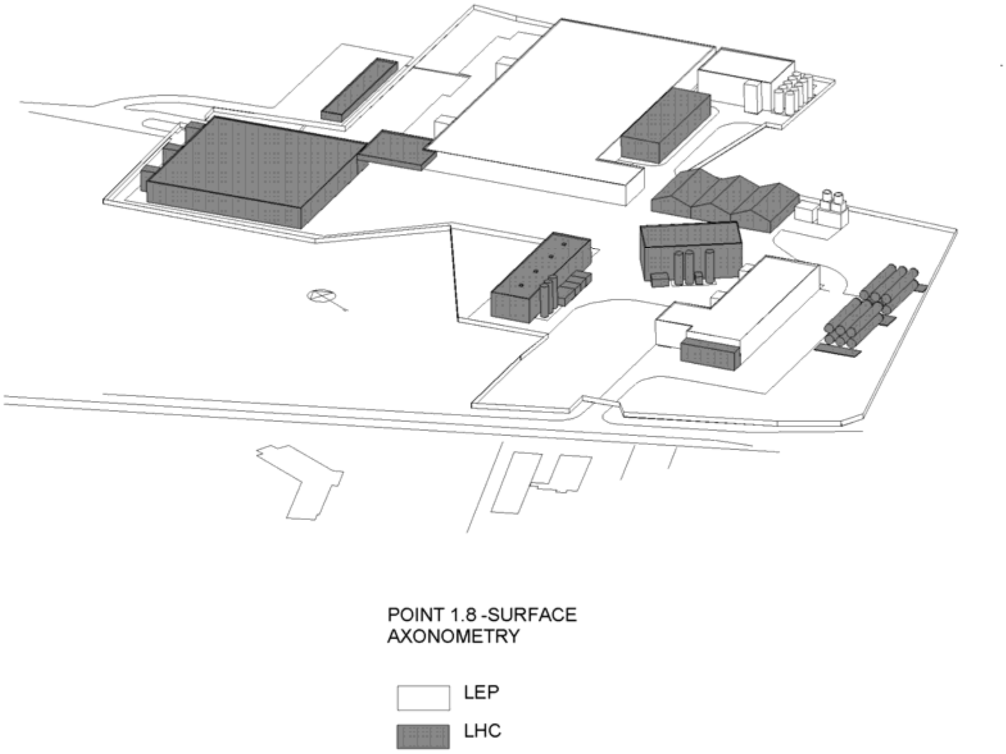

Figure 2.7: Point 1.8 surface axonometry

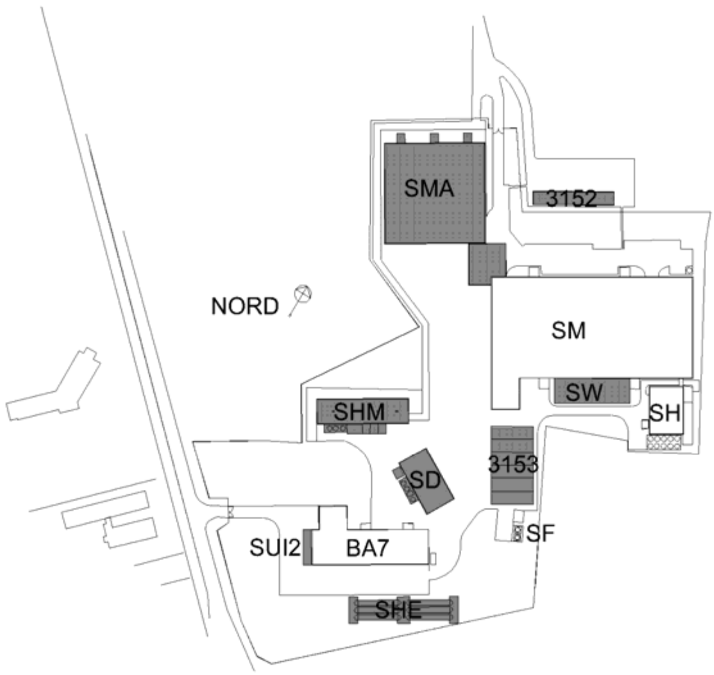

Figure 2.8: Point 1.8 surface layout

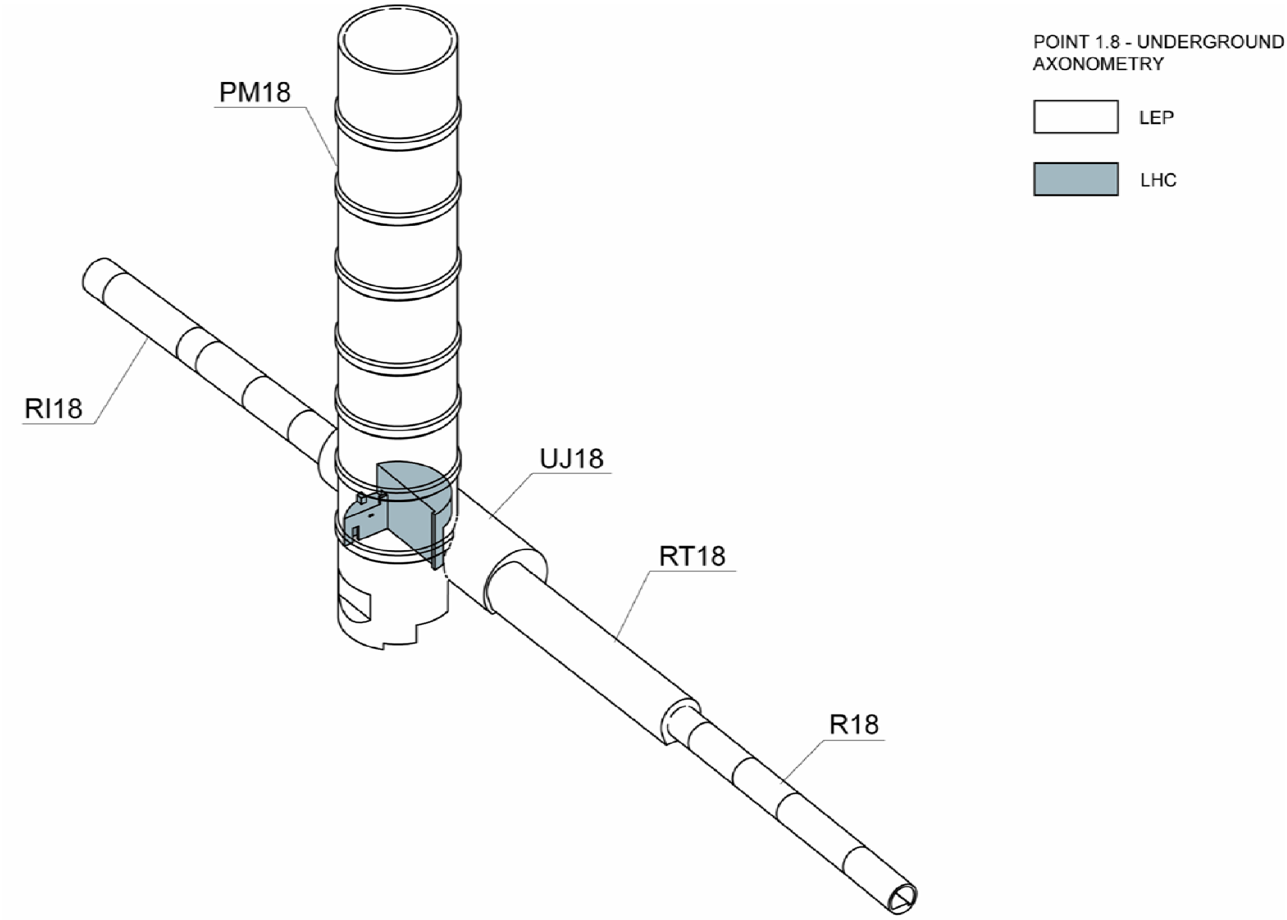

Figure 2.9: Point 1.8 underground axonometry

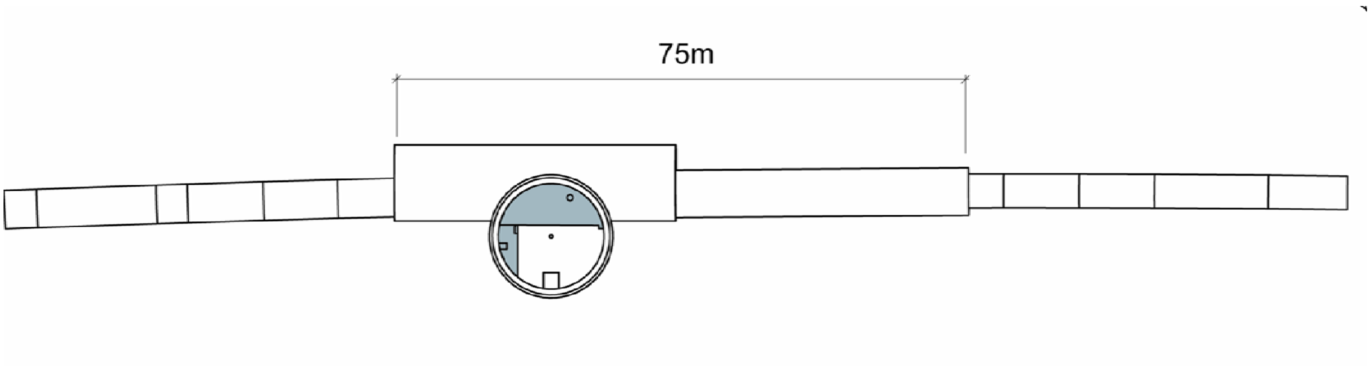

Figure 2.10: Point 1.8 underground layout

Table 2.5: Point 1.8 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xh(m)	Motorised Door W(m)xh(m)
SHB 18	34.75	5.65	9.00	195	1138		
SF 18	7.20	6.00	3.85	43	166		
SM 18	120.10	60.10	8.10	7530	61000	4.30x4.30	4.30x4.30
SMA 18	60.00	60.00	8.70	3600	31320	5.00x5.00	
SH 18	28.60	20.60	11.00	590	6490	5.00x5.00	
SD18	34.90	19.00	13.15	662	8710	6.00x6.00	
SHM 18	55.60	15.60	9.50	870	8265	5.00x5.00	4.00x5.00
SW 18	44.55	15.00	9.70	668	6480	3.99x4.02	3.99x4.02

Table 2.6: Point 1.8 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
TI 18	258.00	2.94	2.70	3.50	759	2048
UJ 18	36.00	8.80	5.20	8.90	317	1359
PM 18			76.36	14.00	154	11755
RT 18	39.00	4.90	4.00	5.50	191	721
R 18	379.95	3.18	2.88	3.76	1208	3467
RE 18	24.70	4.62	3.45	5.00	101	311
R 19	725.28	3.18	2.88	3.76	2306	6600

Table 2.7: Point 1.8 gantry cranes

Structure	Number	Capacity T	Speed m / min	Clearance of Floor m	Hook Travel m	Opening m x m
SM 18	PR 752	25	4	5.22		
SM18	PR 746	16	5	5.30		
SM18	PR 747	16	5	5.30		
SM18	PR 748	16	5	5.30		
SM18	PR 749	8	5	5.40		
SM18	PR 750	8	5	5.40		
SH18	PR 753	10	6	5.70		
SD18	PR 764	13	10	9.30	100.00	2.20x11.00
SHM 18	PR 763	20	6	5.70		

Table 2.8: Point 1.8 lifts

Stucture	Lift Number	Capacity kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 1.8	AS 701	1000 Kg 13 Pers	1.4	130x200	1.27x200

2.8 POINT I2

Models and layouts of surface building and underground structures at Point I2 (Figs. 2.11 to 2.14), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.9 to 2.11) are shown below.

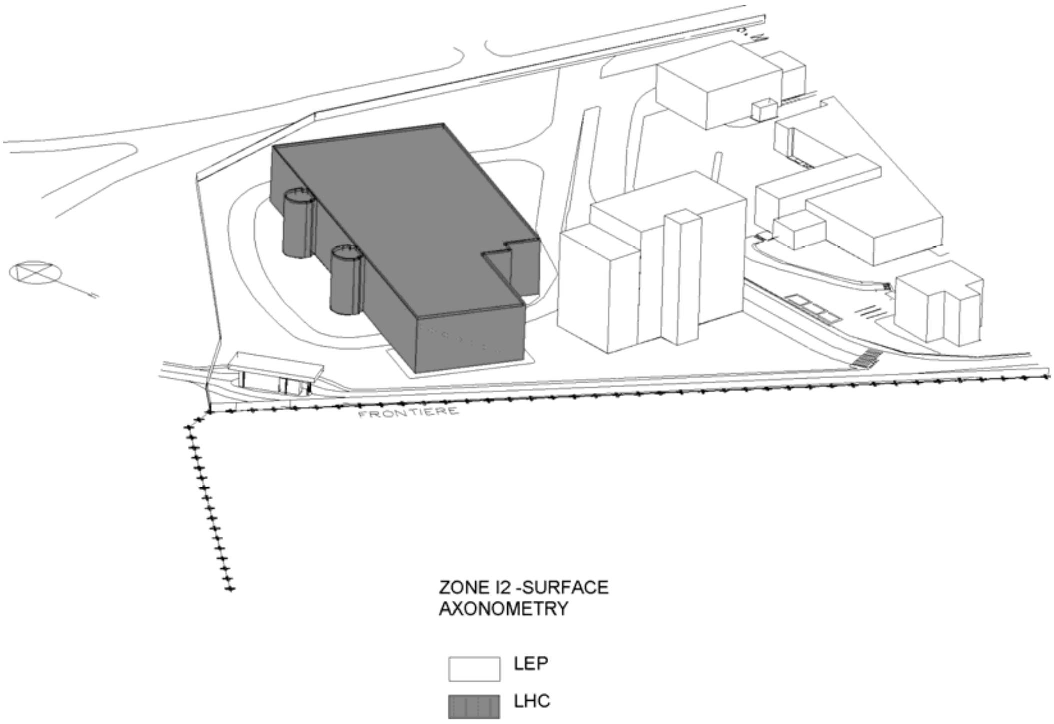

Figure 2.11: Point I2 surface axonometry

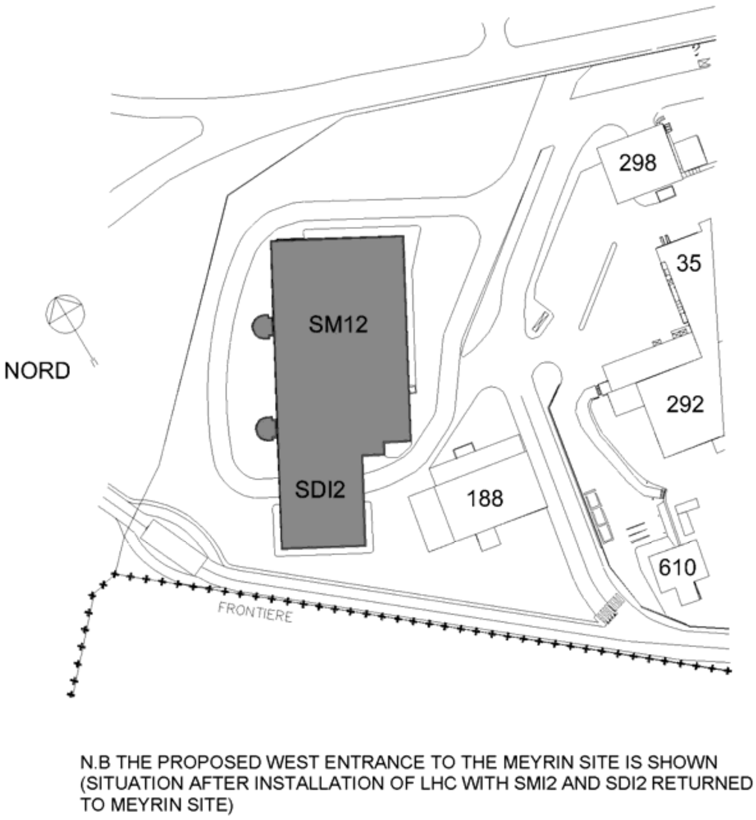

Figure 2.12: Point I2 surface layout

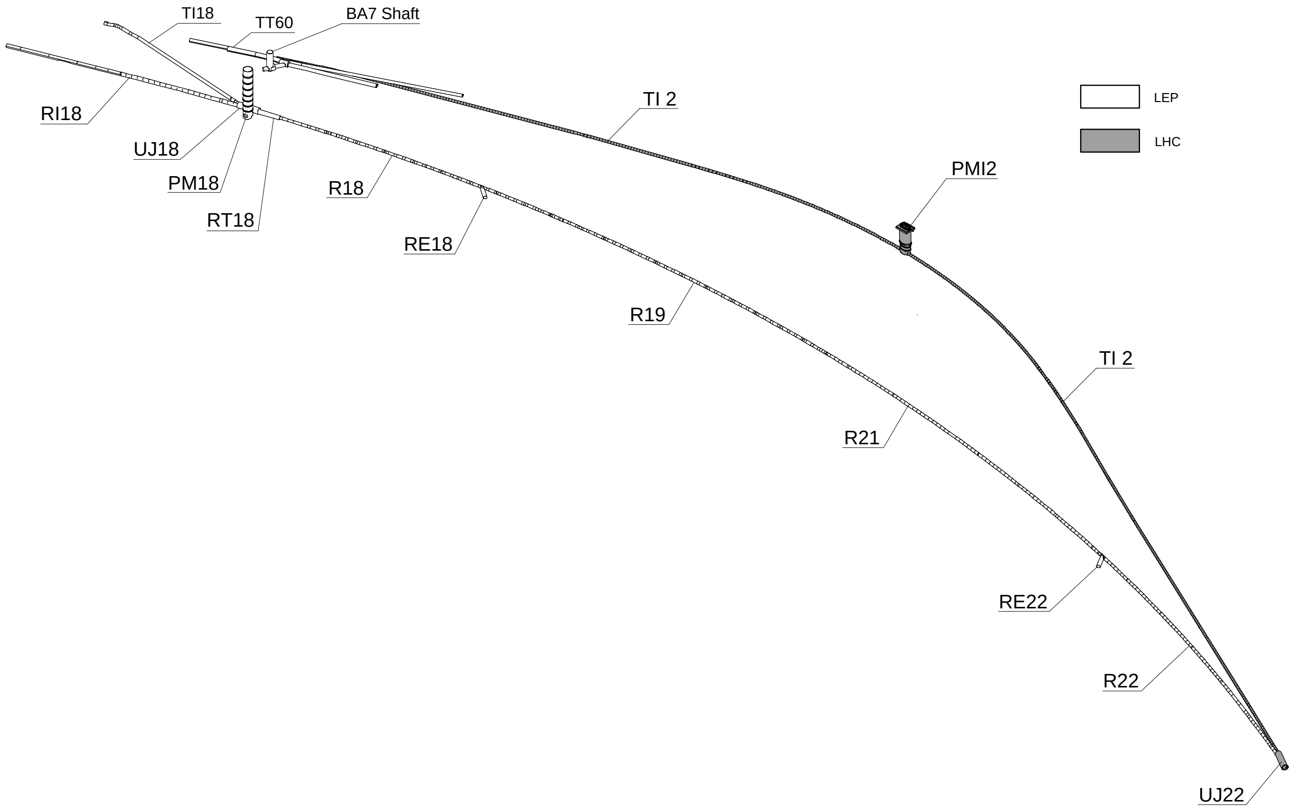

Figure 2.13: TI2 underground axonometry

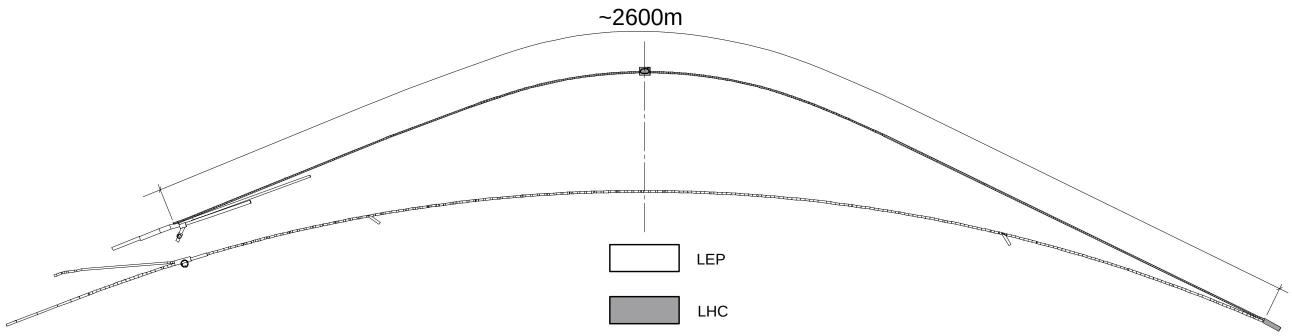

Figure 2.14: TI2 underground layout

Table 2.9: Point I2 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SMI 2	54.46	35.16	12.00	1915	22980	5.00x5.00	5.00x5.00
SDI 2	27.20	22.16	12.00	603	7233	5.00x5.00	5.00x5.00
SUI 2 *	21.10	6.10	7.10	129	1050	1.90x3.50	

* See Figs. 2.7 and 2.8 (Point 1.8)

Table 2.10: Point I2 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
PMI 2	18.80	12.80	47.03	18x12		8888
TI 2	2648.25	2.24	2.50	3.00	5922	13708
UJ 22	40.18	7.91	6.65	9.00	311	1690

Table 2.11: Point I2 gantry cranes

Structure	Number	Capacity T	Speed m / min	Clearance of Floor m	Hook Travel m	Opening m x m
SMI 2	222	8	6	8.00		
SDI 2/ SMI 2	223	40	10	7.00	54.00	18x9

2.9 POINT 2

Models and layouts of surface building and underground structures at Point 2 (Figs. 2.15 to 2.18), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.12 to 2.15) are shown below.

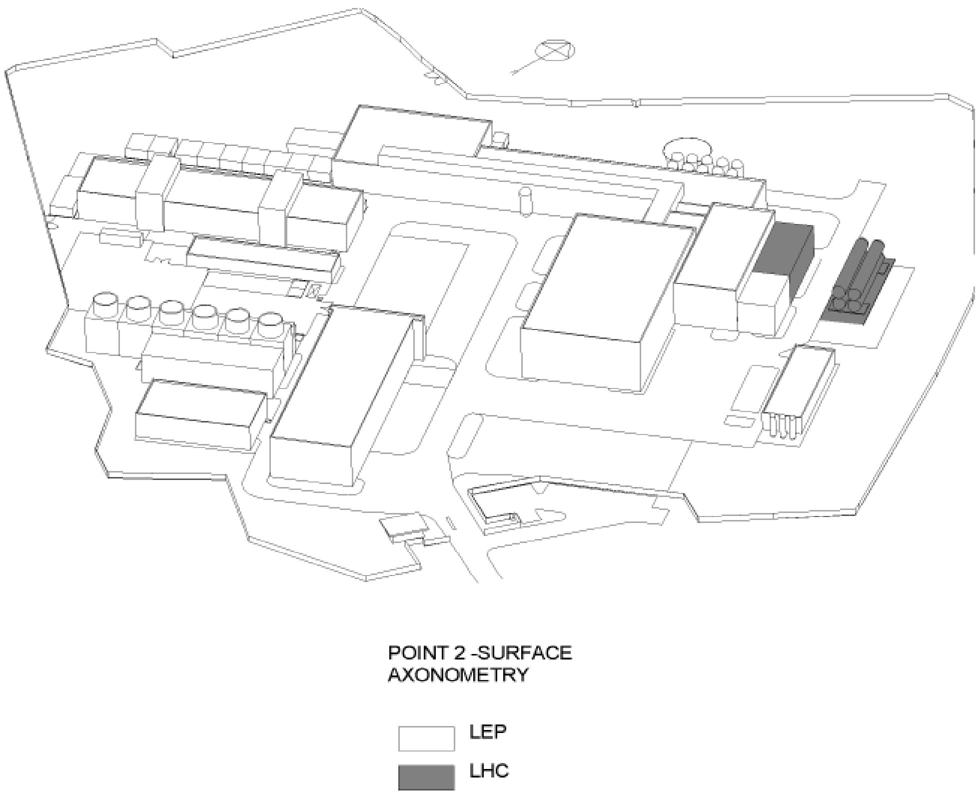

Figure 2.15: Point 2 surface axonometry

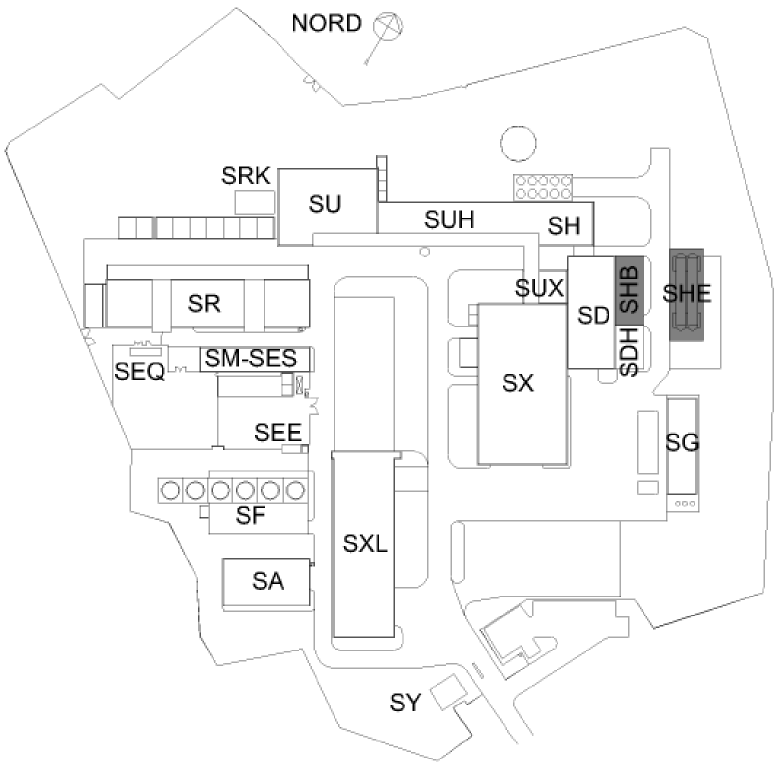

Figure 2.16: Point 2 surface layout

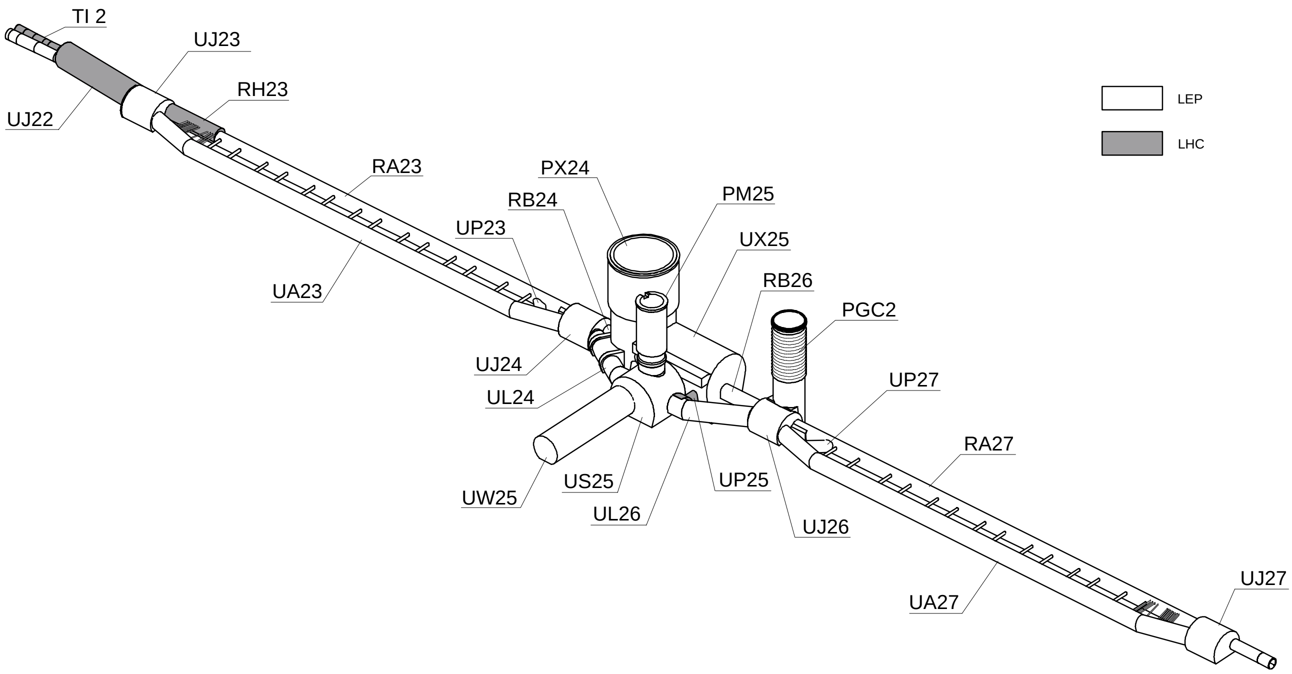

Figure 2.17: Point 2 underground axonometry

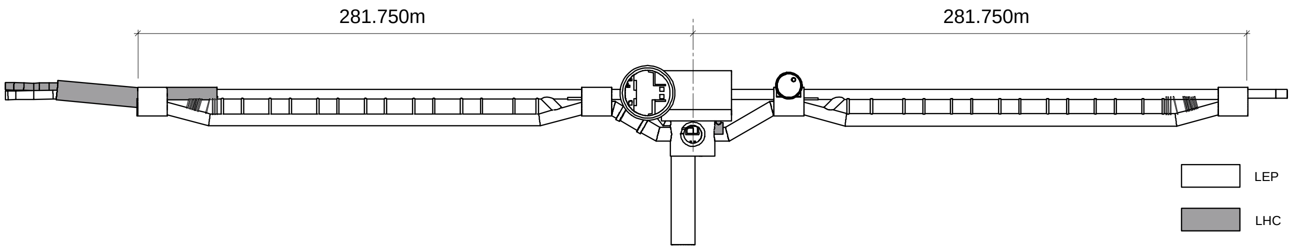

Figure 2.18: Point 2 underground layout

Table 2.12: Point 2 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SA 2	30.50	16.80	7.40	512	4583	4.95x4.95	
SHB 2	24.50	10.15	13.15	190	2500	3.00x3.00	
SXL 2	67.50	21.70	12.80	1465	18748	20.15x11.90	10.00x5.00
SR 2	50.35	15.60	9.60	785	7540	4.00x3.95	
SD 2	40.15	17.20	13.20	615	8249	6.00x5.95	
SDH 2	15.40	10.15	9.60	155	1442	3.00x3.00	
SE 2	39.00	9.00	3.85	864	3862		
SF 2	53.25	22.60	15.00	780	8355	4.00x4.00	
SG 2	34.20	10.60	4.80	345	2257		
SU 2	45.70	27.75	9.35	1136	10416	5.00x5.00	
SUH 2	38.20	15.60	9.35	593	6050	4.00x3.00	
SUX 2	15.60	12.15	12.05	190	2575	5.00x5.00	
SH 2	29.00	15.60	9.35	640	12862	5.00x5.00	
SX 2	57.30	31.20	16.00	1800	28880	9.00X8.00	
SY 2	10.50	8.60	3.10	89	562		

Table 2.13: Point 2 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R 21	721.18	3.18	2.88	3.76	2293	6563
RE 22	24.70	4.62	3.45	5.00	101	311
R 22	661.20	3.18	2.88	3.76	2103	6017
UJ 23	14.00	13.30	7.90	13.50	186	1218
RA 23	159.90	3.39	3.60	4.40	718	2821
UA 23	213.42	4.24	4.50	5.50	905	4439
UJ24	14.00	13.30	7.90	13.50	186	1218
UL 24	34.68	4.20	5.26	6.10	146	929
RB 24	7.38	3.39	3.60	4.40	25	98
PX 24			28.64	23.00	415	11900
PM 25			31.97	9.10	65	2078
US 25	21.40	16.20	13.37	0.00	346	4635
UX 25	53.50	15.50	22.70	21.40	829	21667
UP 25	5.70	1.90	2.45	1.90	10	24.500
RB 26	22.88	3.39	3.60	4.40	77	304
UL 26	34.68	4.20	5.26	6.10	146	929
UJ 26	14.00	13.30	7.90	13.50	186	1218
RA 27	211.87	3.39	3.60	4.40	718	2821
UA 27	213.42	4.24	4.50	5.50	905	4439
UJ 27	14.00	13.30	7.90	13.50	186	1218
R 28	661.20	3.18	2.88	3.76	2103	6017
RE 28	24.70	4.62	3.45	5.00	101	311
R 29	721.18	3.18	2.88	3.76	2293	6563
RH 23	25.50	4.24	4.50	5.50	108	1995

Table 2.14: Point 2 gantry cranes

Structure	Number	Capacity T	Speed m / min	Clearance of Floor m	Hook Travel m	Opening m x m
SD 2	PR 707	10	10	8.80	47.20	10.00x2.20
SR 2	PR 754	10	5	4.57		
SR 2	PR 726	5	5	4.50		
SA 2	PR 727	5	5	4.50		
SX 2	PR 709	63	10	8.10	54.30	14.00x20.00
SLX 2	PR 706	63	10	7.70		
SF 2	PR 728	3,2	5	8.00		
SH 2	PR 757	20	6	5.70		
SDH 2	PR 773	5	6	10.30		
UW 25	PR 729	3.2	5	5.94		
UX 25	PR 774	80	10	18.00		
UJ 22	PA ---	20		4.05		

Table 2.15: Point 2 lifts

Stucture	Lift Number	Capacity kg /n pers	Duration min	Cage Size L(m) x H(m)
PM 25	AS 702	3000/33	0.7	2.70x1.85
PX 24	AS 703	630/8	0.4	1.40x1.10
PX 24	AS 715	1000/13	0.4	2.10x1.10

2.10 POINT 3

Models and layouts of surface building and underground structures at Point 3 divided into Point 3.2 and Point 3.3 (Figs. 2.19 to 2.24), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.16 to 2.19) are shown below.

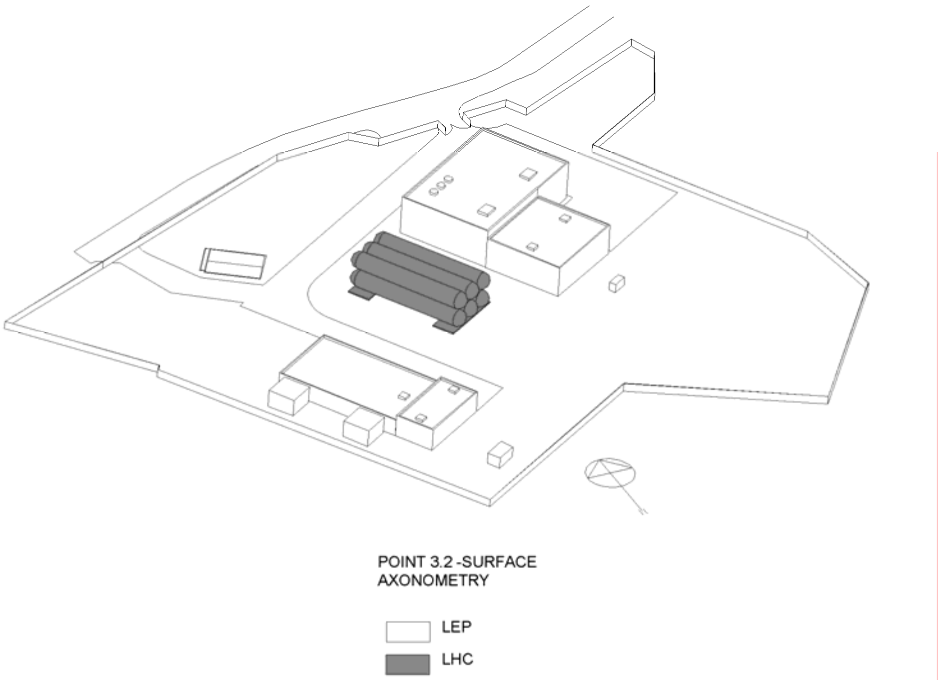

Figure 2.19: Point 3.2 surface axonometry

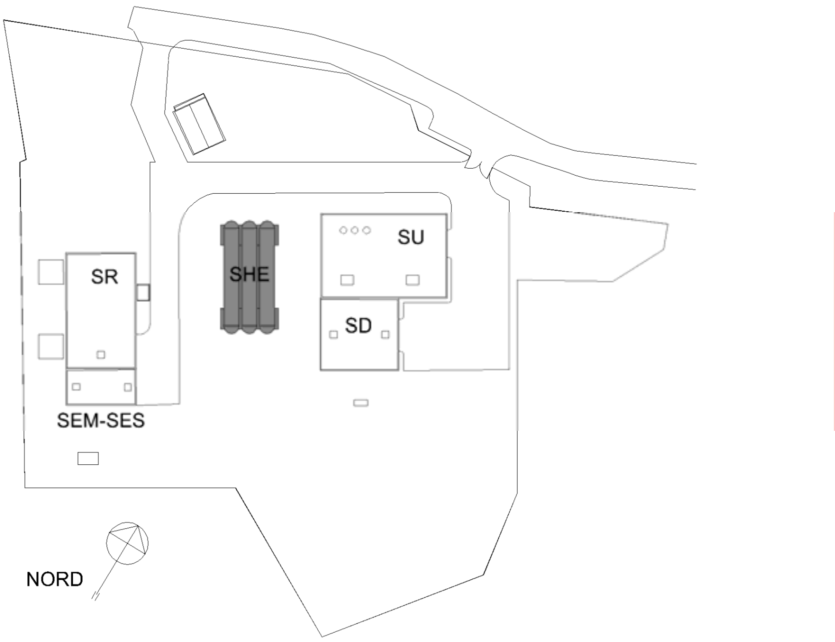

Figure 2.20: Point 3.2 surface layout

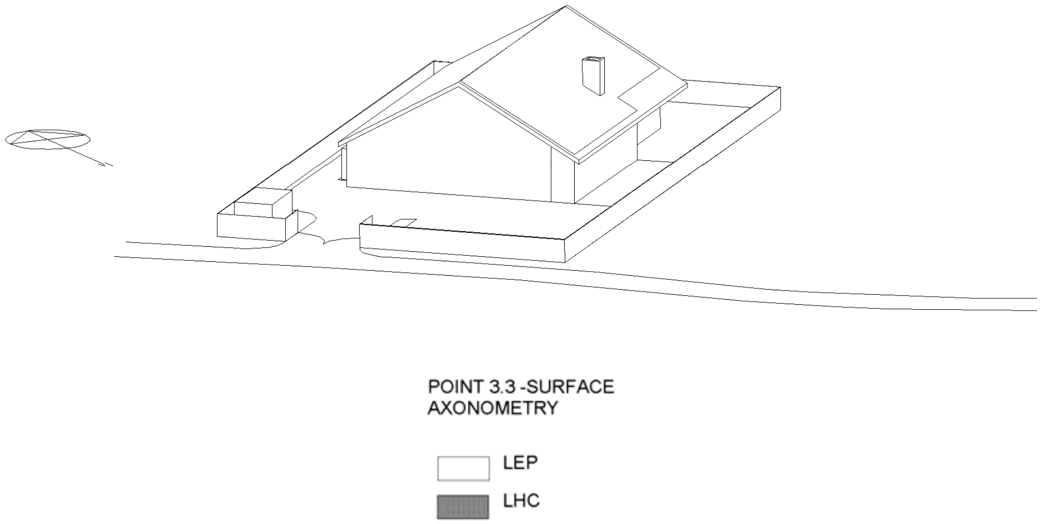

Figure 2.21: Point 3.3 surface axonometry

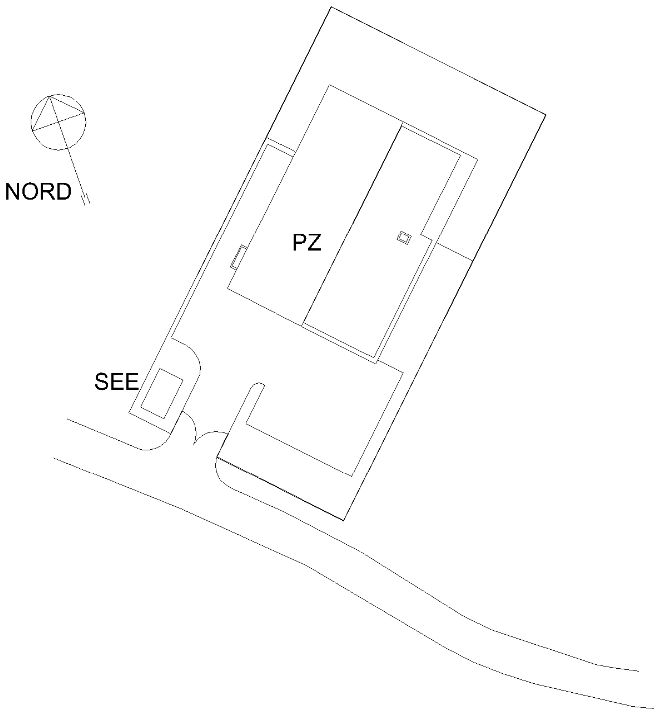

Figure 2.22: Point 3.3 surface layout

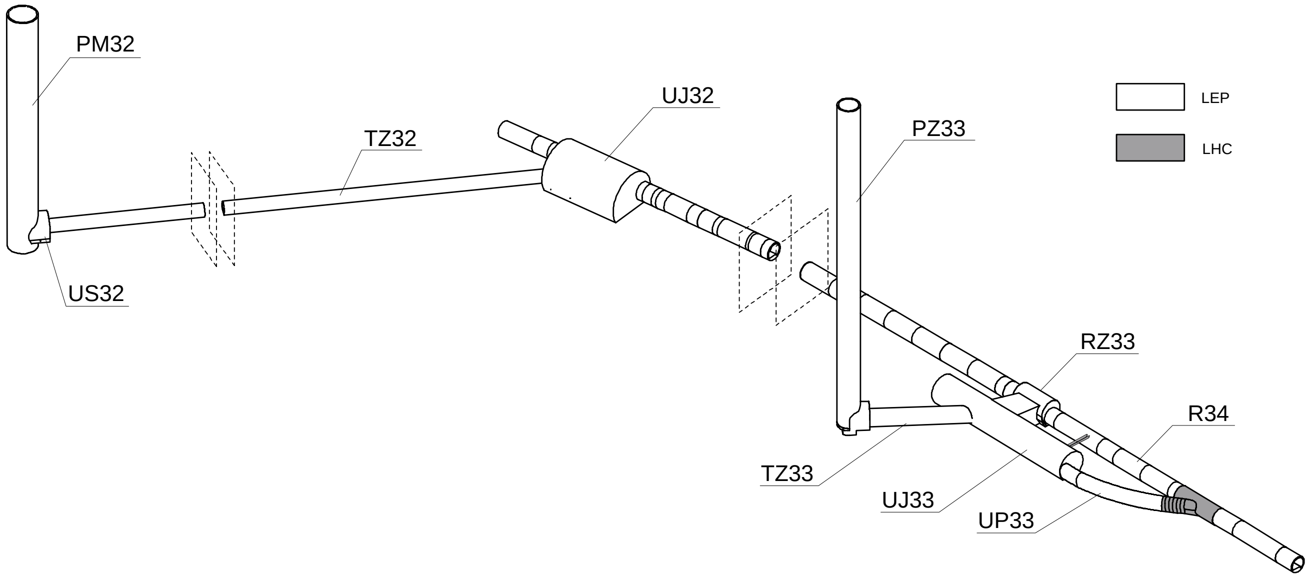

Figure 2.23: Point 3.2 and Point 3.3 underground axonomy

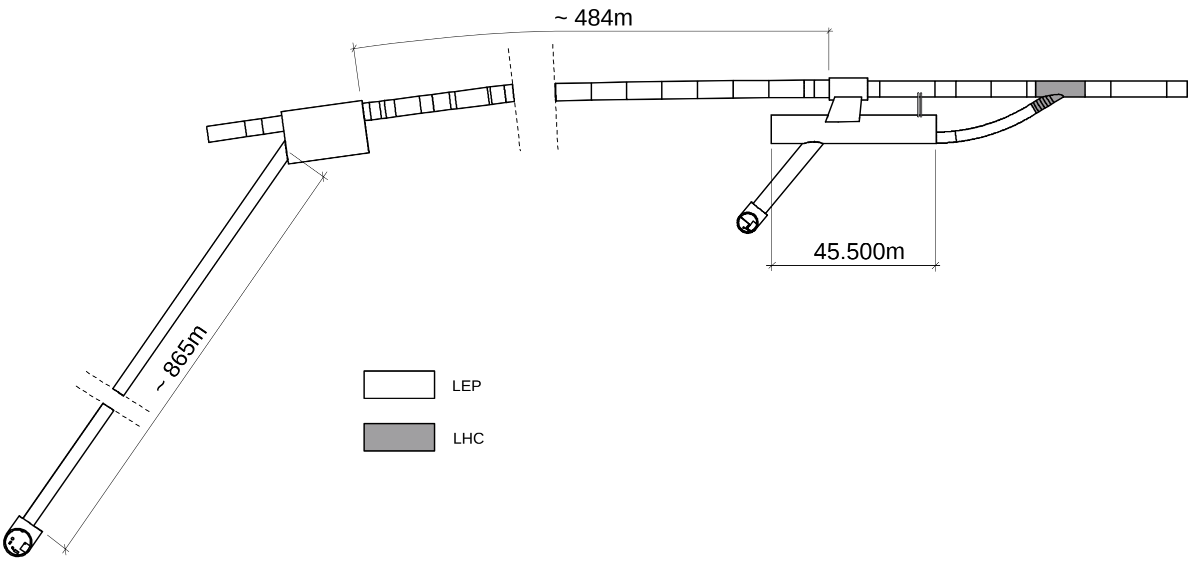

Figure 2.24: Point 3.2 and Point 3.3 underground layout

Table 2.16: Point 3 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SD 3	19.00	17.30	7.25	329	2878	4.00x3.95	
SU 3	30.60	20.60	8.90	630	6552	5.00x5.00	
SE 3	17.40	9.10	5.00	151	981	2.20x2.50	2.20x2.50
SR 3	28.30	17.15	3.85	526	2525	4.00x3.95	
SZ 33	18.4	9.60	8.70	516	3414		

Table 2.17: Point 3 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R31	721.18	3.18	2.88	3.76	2293	6563
R32	163.45	3.18	2.88	3.76	520	1487
UJ 32	22.00	13.34	8.70	13.50	293	2145
TZ32	869.00	2.37	2.55	3.10	2059	5735
R33	484.45	3.36	3.36	4.20	1628	5765
UJ33	45.50	6.71	4.50	7.00	305	1188
TZ33	19.67	3.18	2.88	3.76	63	179
US33	7.60	5.10	5.05		36	168
PZ33			93.00	5.10	20	1860
UP33	40.34	1.80	2.45	2.40	73	190
R34	267.15	3.18	2.88	3.76	850	2431
PM32			62.25	7.10	40	2490
US32	9.55	7.10	5.00	7.00	46	281
R36	281.75	3.18	2.88	3.76	896	2564
R37	479.85	3.18	2.88	3.76	1526	4367
R38	181.35	3.18	2.88	3.76	577	1650
RE38	24.70	4.62	3.45	5.00	101	311
R39	725.28	3.18	2.88	3.76	2306	6600

Table 2.18: Point 3 gantry cranes

Structure	Number	Capacity T	Speed m / min	Clearance of Floor m	Hook Travel m	Opening m x m
SR 3	PR 730	5	5	4.50		
SD 3	PA 1135	2	5	5.80		2.50x4.50

Table 2.19: Point 3 lifts

Stucture	Lift Number	Capacity kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 32	AS 704	1120 13	0.6	130 x 200	1.27 x 200
PZ 33	AS 705	1000 13	1.4	1.10x2.10	0.90x2.10

2.11 POINT 4

Models and layouts of surface building and underground structures at Point 4 (Figs. 2.25 to 2.28), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.20 to 2.23) are shown below.

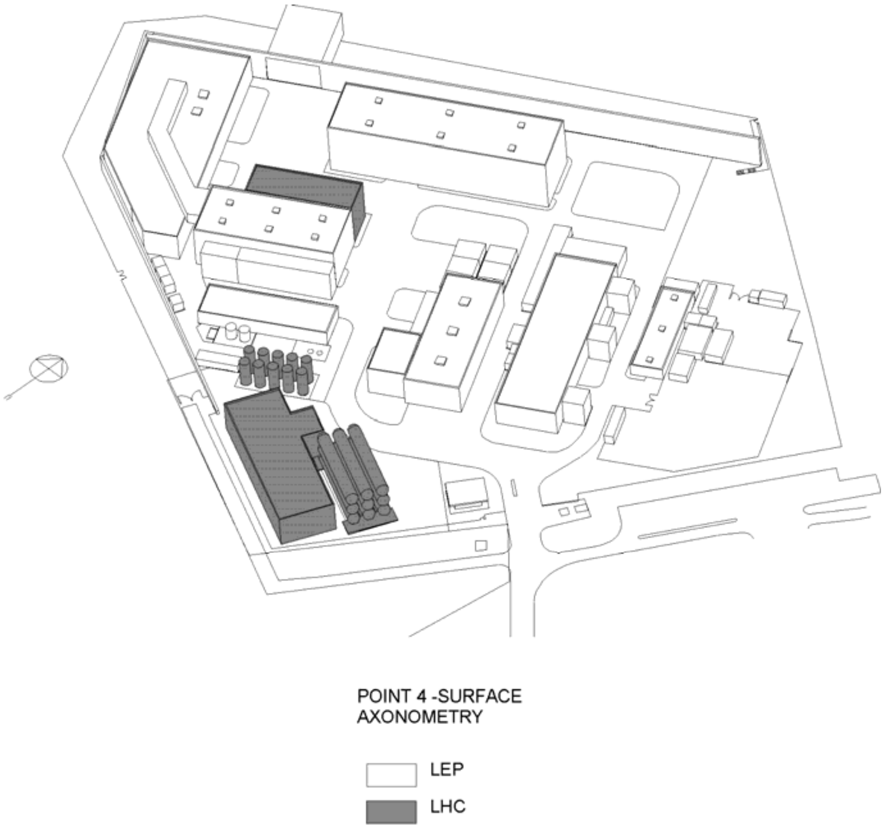

Figure 2.25: Point 4 surface axonometry

Figure 2.26: Point 4 surface layout

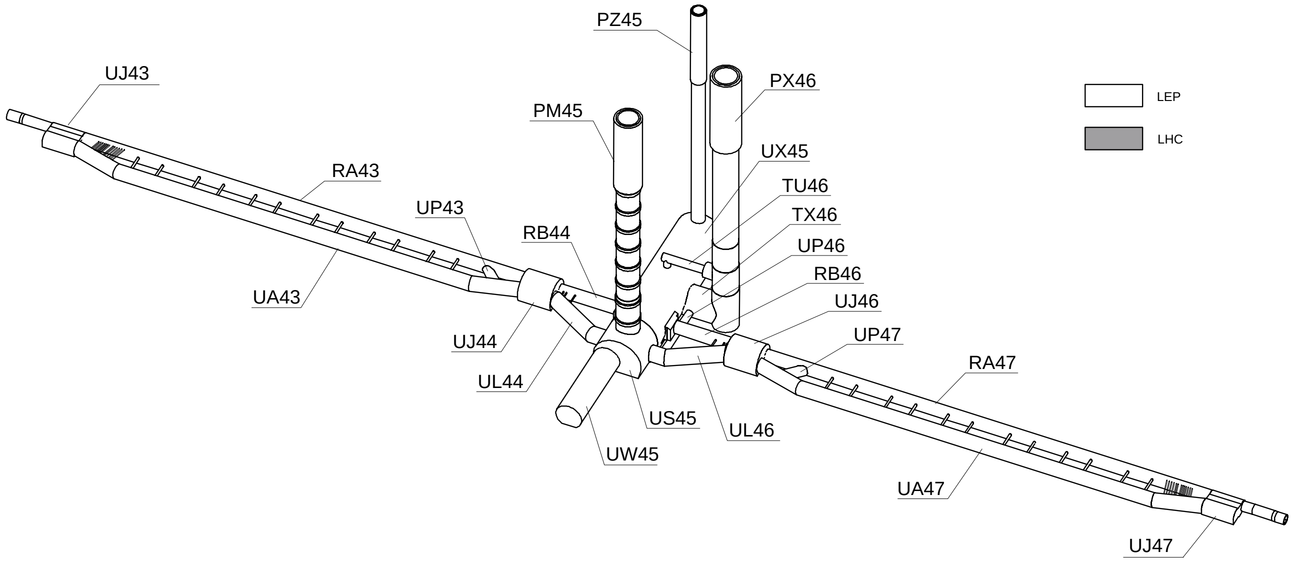

Figure 2.27: Point 4 underground axonometry

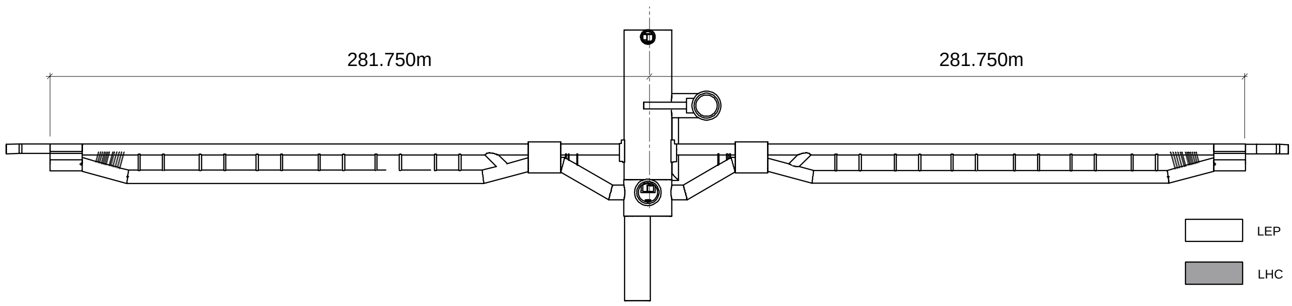

Figure 2.28: Point 4 underground layout

Table 2.20: Point 4 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door	Motorised Door
SHB 41	37.60	10.60	9.65	398.00	3470		
SDH 4	18.15	9.15	13.15	166.00	2185		
SHE 4	32.75	15.00		492.00			
SHM 4	50.35	15.60	9.60	785.50	7540	4.00x5.00	
SHB 4	37.20	10.60	9.00	163.00	1404	3.00x3.00	
SD 4	39.20	17.20	13.15	665.00	9742	6.00x5.95	
SE 4	34.80	9.00	3.85	271.00	2722		
SF 4	44.30	23.60	15.00	325.00	3306	4.00x4.00	
SG 4	36.20	10.60	4.66	532.00	2587		
SHBB	26.10	4.60	9.60	123.00	1365		
SR 4	57.30	17.15	7.36	910.00	6698	3.90x4.00	
SU 4	59.90	28.90	9.10	1325.00	11853	5.00x5.00	
SUH 4	28.80	15.60	9.30	415.00	4482	4.00x3.00	
SH 4	40.60	15.60	9.10	450.00	4095	5.00x5.00	
SX 4	61.15	17.20	16.00	1036.00	18130	6.00x4.00	7.60x8.00
SY 4	10.60	8.60	3.10	89.00	562		
SZ 4	20.95	15.90	8.40	334.00	3307		

Table 2.21: Point 4 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R 41	721.18	3.18	2.88	3.76	2293	6563
RE 42	24.70	4.62	3.45	5.00	101	311
R 42	661.20	3.18	2.88	3.76	2103	6017
UJ 43	14.00	11.20	4.50	5.50	156	326
RA 43	211.90	3.39	3.60	4.40	766	2981
UA 43	213.50	4.24	4.50	5.50	905	4439
UJ 44	14.00	13.30	7.90	13.50	186	1218
UL 44	34.70	4.20	5.26	6.10	146	930
RB 44	31.18	3.39	3.60	4.40	106	414
PM 45			124.60	9.10		8099
US 45	16.50	20.70	13.37	21.40	342	3897
UX 45	70.00	16.60	18.50	21.40	1162	23170
UW 45	45.00	9.30	8.40	11.00	418	3128
PZ 45			143.60	5.10		2480
PX 46			133.00	10.10		10640
TX 46	22.05	7.00	10.05	10.10	154	1808
UP 46	34.00	1.50	2.20	2.20	51	133
TU 46	22.65			2.50		111
RB 46	31.18	3.39	3.60	4.40	106	412
UL 46	34.70	4.20	5.26	6.10	146	930
UJ 46	14.00	13.30	7.90	13.50	186	1218
RA 47	225.87	3.39	3.60	4.40	766	2981
UA 47	213.50	4.24	4.50	5.50	905	4439
UJ 47	14.00	11.20	4.50	5.50	156	380
R 48	661.20	3.18	2.88	3.76	2103	6017
RE 48	24.70	4.62	3.45	5.00	100	311
R 49	721.18	3.18	2.88	3.76	2293	6563

Table 2.22: Point 4 gantry cranes

Stucture	Number	Capacity T	Speed m /min	Clearance of Floor m	Hook Travel m	Opening m x m
SD 4	PR 712	10 T	10	8.85	145.50	9.50x2.00
SR 4	PR 732	5 T	5	6.65		
SUH 4	PR 713	20 T	5	5.65		
SX 4	PR 714	80 T	6	9.85	153.45	Diameter 10.10
SF 4	PR 733	3,2 T	5	8.00		
SH 4	PR 755	20 T	6	6.10		
SHM 4	PR 769	20 T	6	5.70		
SDH 4	PR 770	5 T	6	10.30		
UW 25	PR 734	3.2 T	5	10.30		
UX 45	PR 710	40 T	10	13.50		
UX 45	PR 711	80 T	10	13.50		

Table 2.23: Point 4 lifts

Stucture	Lift Number	Capacity kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 45	AS 706	3000 33	1.4	2.70x1.85	1.85x2.10
PZ 45	AS 707	1000 13	0.8	2.10x1.10	0.90x2.10

2.12 POINT 5

Models and layouts of surface building and underground structures at Point 5 phases 1 and 2 (Figs. 2.29 to 2.34), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.24 to 2.27) are shown below.

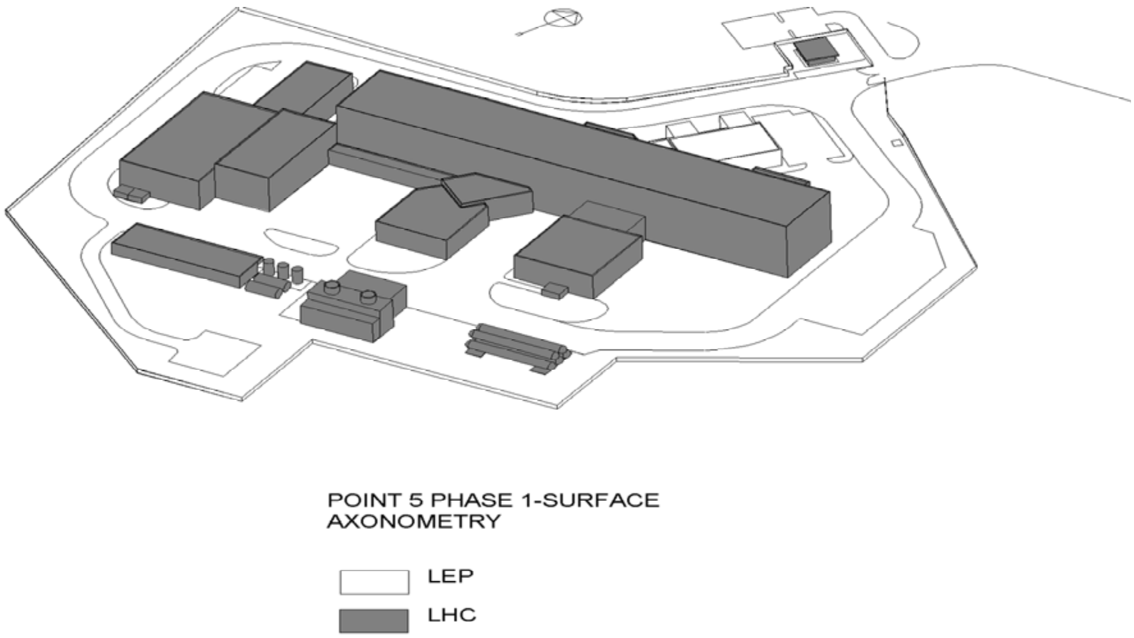

Figure 2.29: Point 5 Phase I surface axonometry

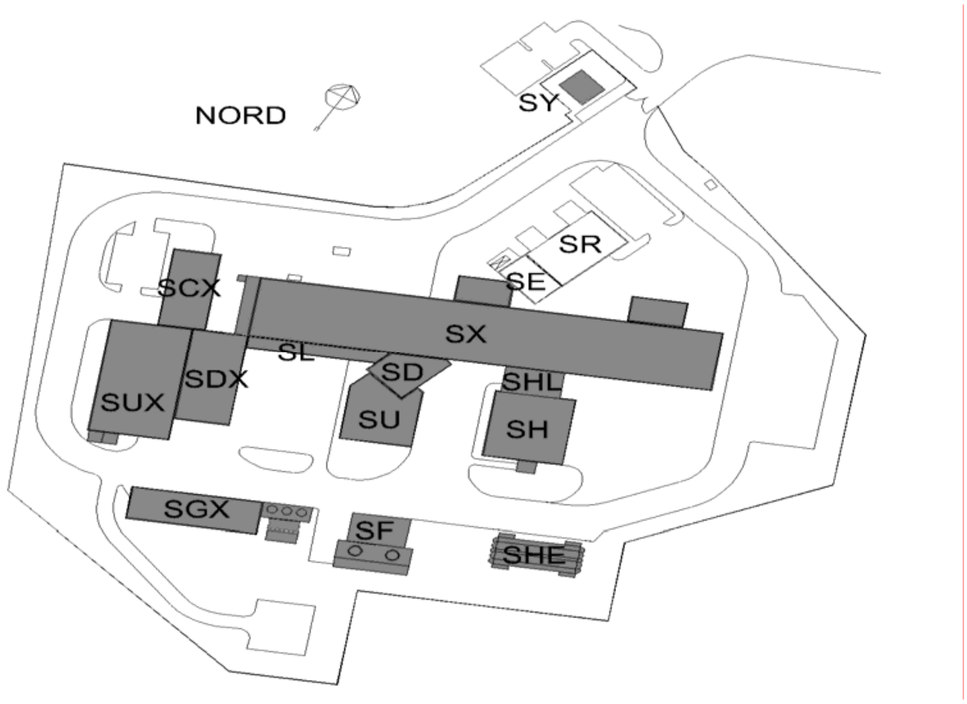

Figure 2.30: Point 5 Phase I surface layout

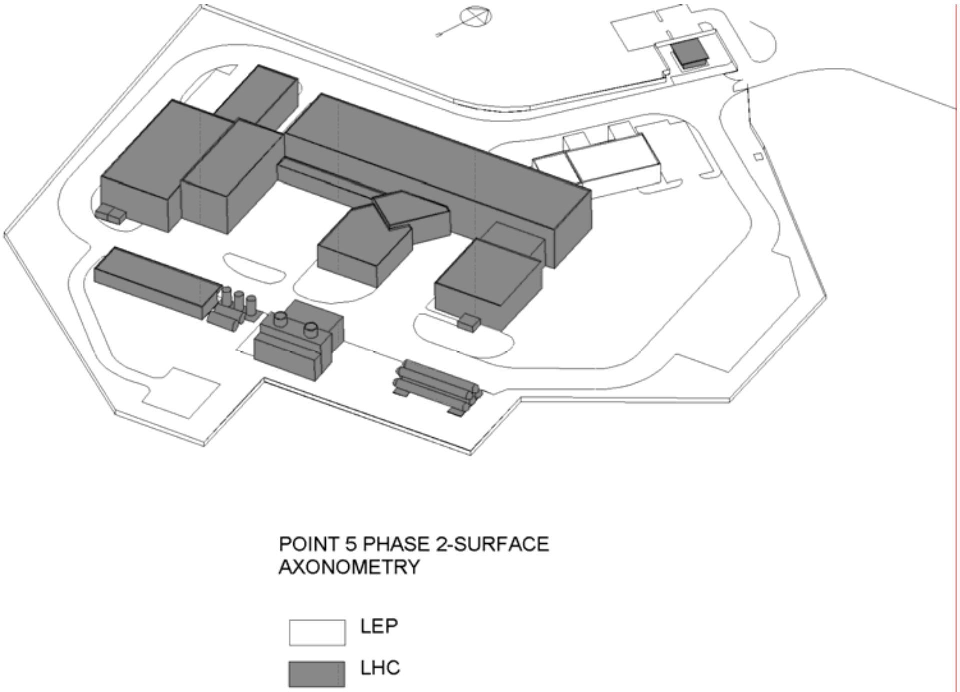

Figure 2.31: Point 5 Phase II surface axonometry

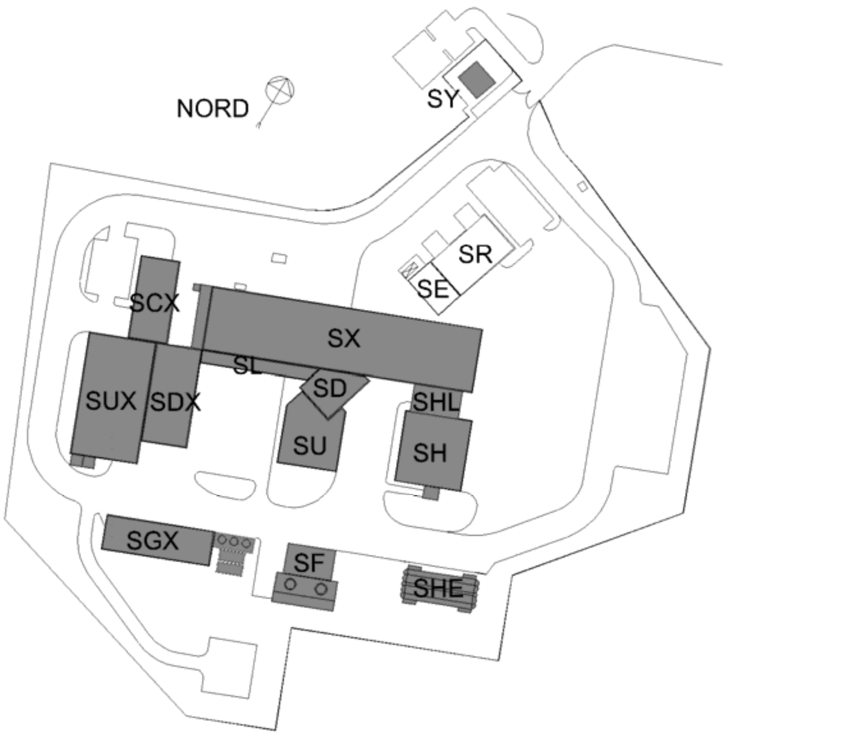

Figure 2.32: Point 5 Phase II surface layout

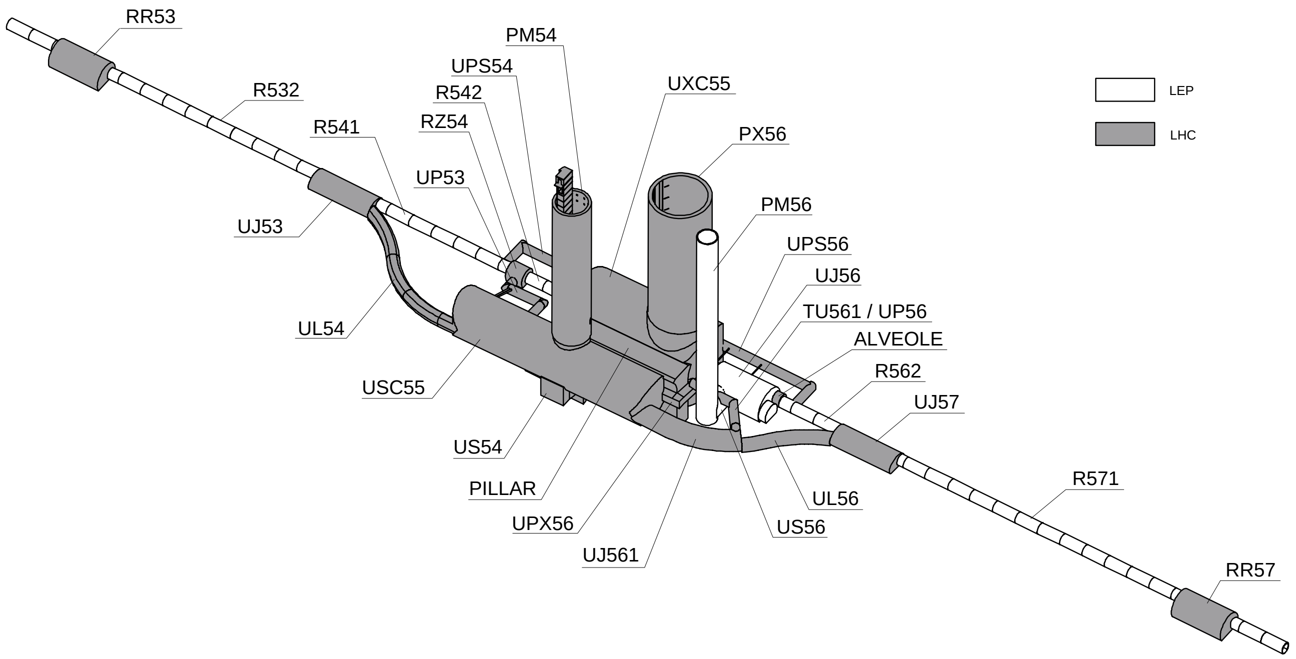

Figure 2.33: Point 5underground axonomy

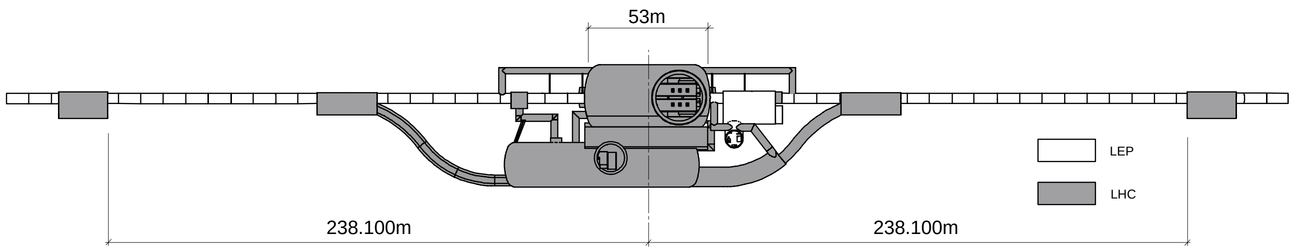

Figure 2.34: Point 5 underground layout

Table 2.24: Point 5 surface buildings

Building	Length m	Width m	Heigth m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SD 5	16.60*	15.60	10.00	330	3305		
SE 5	17.40	9.10	5.00	151	980		
SR 5	28.50	17.00	3.85	526	2814		
SHL 5	10.00	18.50	10.00	185	18500		
SCX 5	30.60	14.60	12.69	447	5402		
SHE 5	32.00	15.00					
SF 5	24.45	22.60	17.60	500	2766		
SGX 5	40.00	13.00	5.32	520	2766		
SDX 5	36.00	17.00	15.51	612	9492		
SU 5	22.55	22.10	8.90	498	4435		
SUX 5	44.94	24.80	14.65	1115	16114		
SH 5	26.40	24.67	10.75	651	7001		
SX 5 (1)	141.00	23.90	23.30	3313	77867	6.80x8.00x3	5.00x5.00x2
SX 5 (2)	102.00	23.50	16.00				
SHL 5	18.42	10.02	10.75	185	1984		
SY 5	10.70	9.20	3.29	98	323		

Table 2.25: Point 5 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
PM 54			67.80	12.10	115	7796
PM 56			85.00	7.10	40	3400
PX 56			62.50	20.50	330	20629
R 51	725.30	3.20	2.90	3.80	2306	6600
R 52	651.20	3.20	2.90	3.80	2071	5926
R 53	142.40	3.20	2.90	3.80	600	2125
R 54	84.17	3.20	2.90	3.80	302	1070
R 56	31.64	3.20	2.90	3.80	928	2655
R 57	190.80	3.20	2.90	3.80	750	2122
R 58	651.20	3.20	2.90	3.80	2071	5926
R 59	725.30	3.20	2.90	3.80	2306	6600
RE 52	24.70	4.60	3.50	5.00	101	311
RE 58	24.70	4.60	3.50	5.00	101	311
RR 53	20.00	9.96	6.65	10.40	199	1217
RR 57	20.00	9.96	6.65	10.40	199	1217
RZ 54	6.10	4.20	4.89	6.20	25	158
TU 56	16.00			2.00		64
TU 561	24.67	2.30	2.25	2.30	56	114
UJ 53	25.10	7.28	3.96	8.60	182	715
UJ 56	22.00	13.40	7.80	13.50	294	1870
UJ 561	38.91	6.36	4.89	7.51	247	1198
UJ 57	25.10	7.28	3.96	8.60	182	715
UL 54	68.11	3.35	2.95	3.90	228	660
UL 55	84.10	3.85	3.61	3.90	323	1168
UL 551	10.25	2.40	3.00		24	149
UL 56	35.60	3.35	2.95	3.90	119	345
UP 53	28.99	1.62	2.25	2.30	47	126
UP 531	2.50	3.21	3.05	3.90	8	32
UP 541	3.10	4.60	2.73	4.70	14	32
UP 55	34.53	1.62	2.25	2.30	56	150
UP 56	56.11	2.30		2.30	117	455
UPS 54	50.33	2.20	2.25	2.20	110	222
UPX 56	22.59	2.30	2.40		51	124
US 54	18.21	9.85	7.51		180	1357
US 56	10.60	7.10	5.00	7.10	64	314
USC 55	84.10	17.71	11.73	18.10	970	15856
UXC 55	53.10	26.66	24.22	26.60	920	29007
UL 552	10.25	2.40	3.00		24	201
UL 553	10.25	2.40	3.00		24	149

Table 2.26: Point 5 gantry cranes

Stucture	Number	Capacity T	Speed m /min	Clearance of Floor m	Hook Travel m	Opening m x m
SX 5	PR 758	80	5.95	18.30	115.30	Diameter 10.25
SX 5	PR 759	80	5.95	18.30	115.30	
SUX 5	PR 765	8	6	9.20		
SF 5	PR 767	3.2	5	8.15		
SDX 5	PR 759	80	5.95	10.00	106.90	Diameter 12.10
SR 5	PR 735	5	5.95	4.50		
SH 5	PR 761	10	6	6.30		
USC 55	PR 780	10	5	8.50		
UXC 55	PR 760	20	9.8	18.30		

Table 2.27: Point 5 lifts

Stucture	Lift Number	Capacity kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 56	AS 7--	1000 13	0.7	2.10x1.10	2.10x0.90
PM54	AS717	3000 33	1.1	2.70x1.85	1.85x2.10

2.13 POINT 6

Models and layouts of surface building and underground structures at Point 6 (Figs. 2.35 to 2.38), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.28 to 2.31) are shown below.

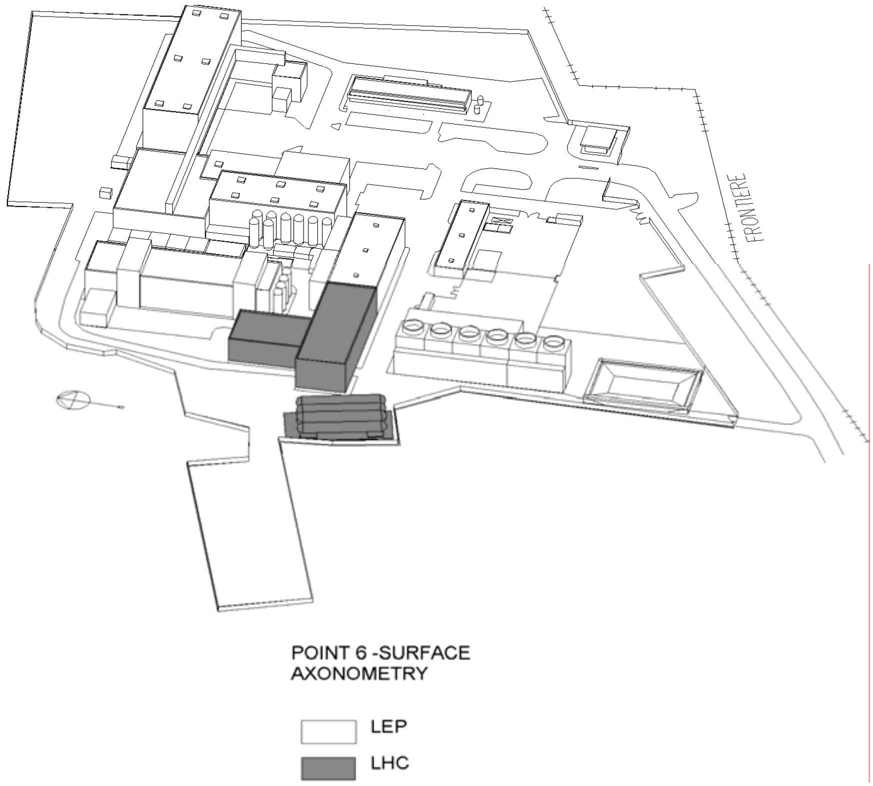

Figure 2.35: Point 6 surface axonometry

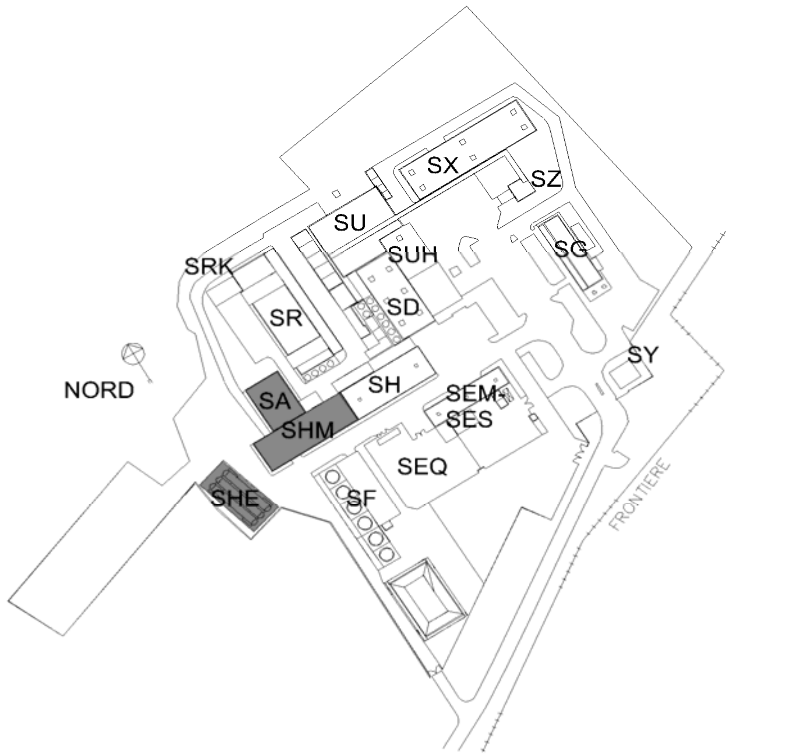

Figure 2.36: Point 6 surface layout

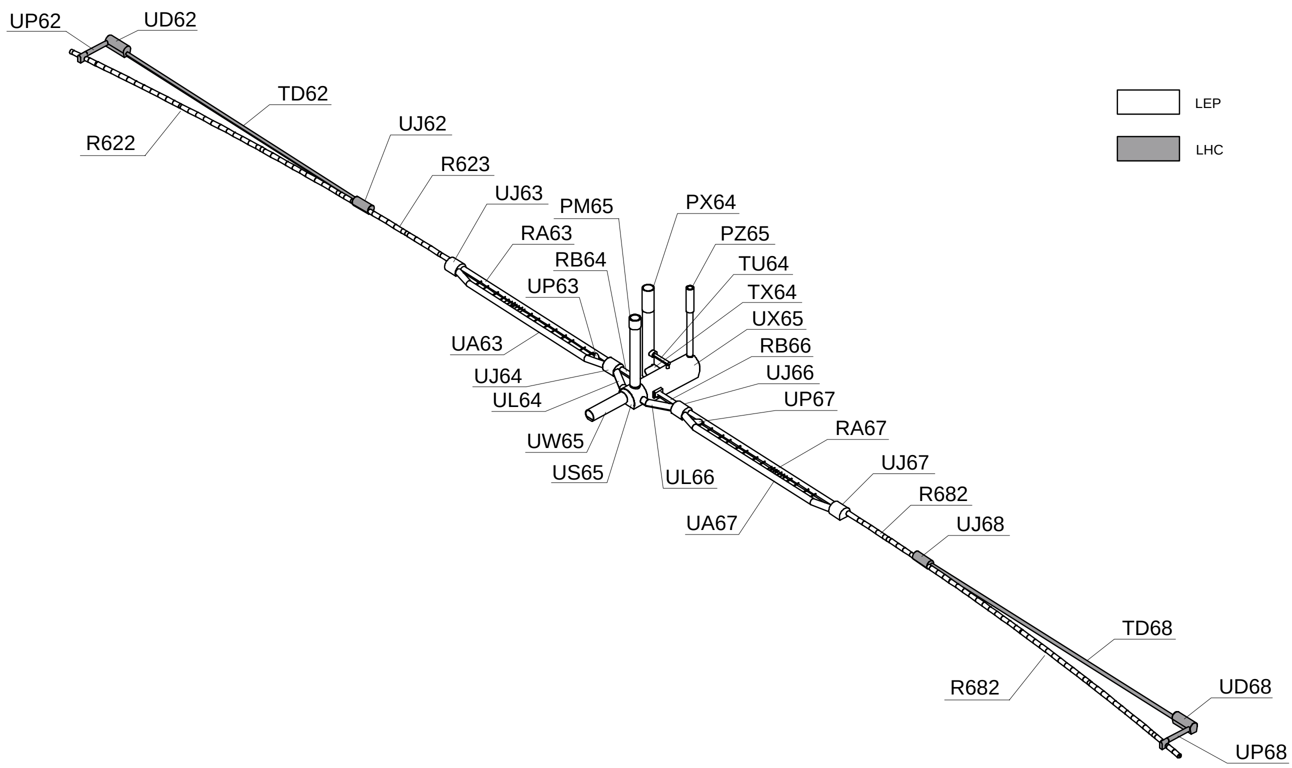

Figure 2.37: Point 6 underground axonometry

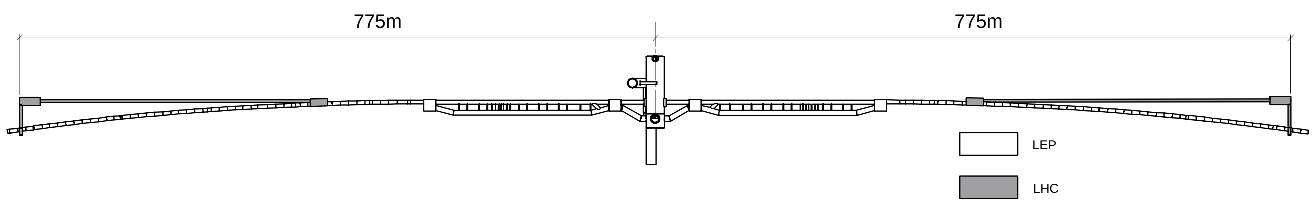

Figure 2.38: Point 6 underground layout

Table 2.28: Point 6 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SHB 61	25.00	6.00	9.65	150.00	1470.00		
SDH 6	18.15	9.15	13.15	166.00	2185.00		
SHE 6	32.75	15.00		491.00			
SHM 6	50.35	15.60	9.60	785.00	7540.00	4.00x5.00	
SA 6	23.35	17.00	6.81	475.00	3250.00	5.2x4.95	
SHB 6	40.90	5.50	11.70	225.00	2177.00	3.00x3.00	
SD 6	39.40	21.75	13.15	723.00	10592.00	6.00x6.00	
SE 6	39.05	9.00	3.85	834.00	3700.00		
SF 6	53.00	22.60	12.27	997.00	4620.00	4.00x4.00	
SG 6	36.20	11.60	4.66	501.00	2540.00		
SHBB 6	25.80	4.65	9.50	131.00	1276.00		
SR 6	57.20	16.90	12.30	1834.00	13345.00	3.9x4.00	
SU 6	35.60	28.60	9.30	1305.00	15183.00	5.00x5.00	
SUH 6	43.05	15.70	9.30	668.00	7610.00	4.00x3.00	
SH 6	40.60	15.50	11.70	733.00	7068.00	5.00x5.00	
SX 6	61.10	17.20	16.05	1058.00	18560.00	5.95x3.95	7.60x7.90
SY 6	10.70	9.20	3.25	97.00	603.00		
SZ 6	15.70	8.80	9.40	107.00	1006.00		

Table 2.29: Point 6 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R61	715.15	3.18	2.88	3.76	2274	6508
RE62	24.70	4.62	3.45	5.00	101	311
R62	641.20	3.18	2.88	3.76	2103	6017
UJ63	14.00	13.30	7.90	13.50	186	1218
RA63	211.85	3.39	3.60	4.40	718	2817
UA63	211.87	4.24	4.50	5.50	898	4407
UJ64	14.00	13.30	7.90	13.50	186	1218
UL64	34.60	4.20	5.26	6.10	145	923
RB64	31.48	3.39	3.60	4.40	107	418
PX64			90.90	10.10	93	7274
TX64	22.05	7.00	10.05	10.10	159	1808
UP64	37.90	1.50	2.20	2.20	57	148
PM65			81.42	9.10	65	5292
US65	16.20	20.72	13.37	21.40	335	3828
UX65	70.00	16.50	18.57	21.40	1155	23170
UW65	45.00	9.30	8.40	11.00	418	3106
PZ65			82.40	5.10	20	1683
TU64	22.65	0.00	0.00	2.50		111
RB66	31.55	3.39	3.60	4.40	107	418
UL66	34.60	4.20	5.26	6.10	145	923
UJ66	14.00	13.30	7.90	13.50	186	1218
RA67	211.85	3.39	3.60	4.40	718	2817
UA67	211.87	4.24	4.50	5.50	898	4343
UJ67	14.00	13.30	7.90	13.50	186	1218
R68	641.20	3.18	2.88	3.76	2103	6017
RE68	24.70	4.62	3.45	5.00	101	311
R69	715.15	3.18	2.88	3.76	2274	6508

Table 2.30: Point 6 gantry cranes

Structure	Number	Capacity T	Speed m/min	Clearance of Floor m	Hook Travel m	Opening m x m
SD 6	PR 717	10	10	8.85	107.50	8.90x2.10
SR 6	PR 737	5	5	6.65		
SUH 6	PR 718	20	5	5.65		
SX 6	PR 719	80	6	9.85	110.80	Diameter 10.10
SF 6	PR 739	3,2	5	8.00		
SH 6	PR 756	20	6	6.10		
SDH 6	PR 773	5	5	10.30		
UW 65	PR 756	20	5	6.10		
UD 62	PR 781	30	5	10.30		
UD 68	PR 775	30	5	10.30		
UX 65	PR 715	80	10	13.50		
UX 65	PR 716	40	10	13.50		

Table 2.31: Point 6 lifts

Stucture	Lift Number	Capacity kg/pers	Duration min	Cage Size L(m)xW(m)	Door Size W(m)xH(m)
PM 65	AS 709	3000 33	1	2.70x1.85	1.85x2.10
PZ 65	AS710	1000 13	0.6	2.10x1.10	0.90x2.10

2.14 POINT 7

Models and layouts of surface building and underground structures at Point 7 (Figs. 2.39 to 2.42), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.32 to 2.35) are shown below.

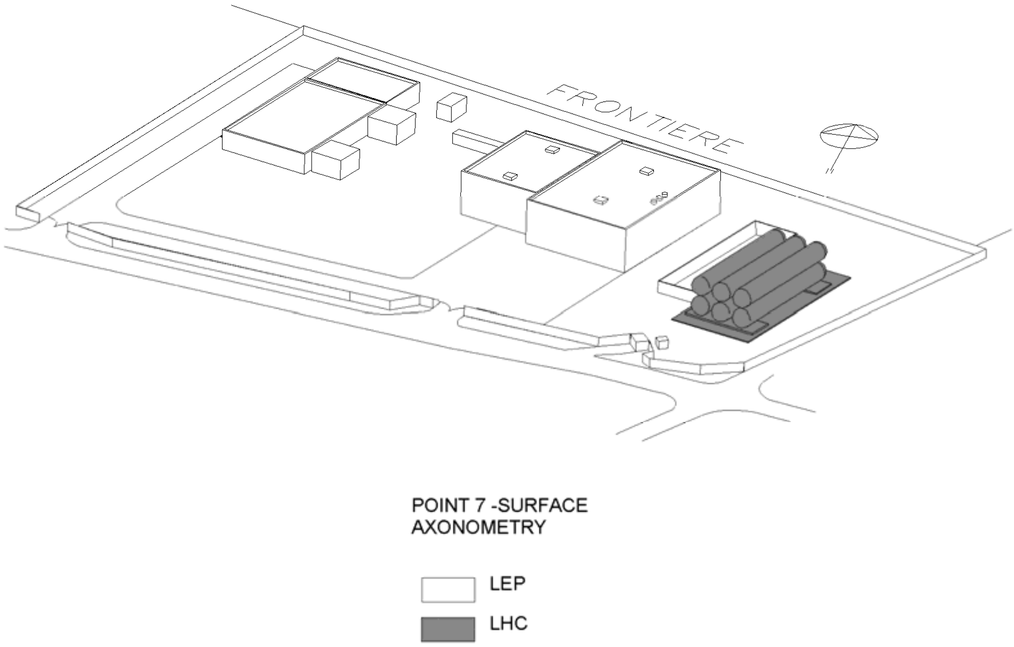

Figure 2.39: Point 7 surface axonometry

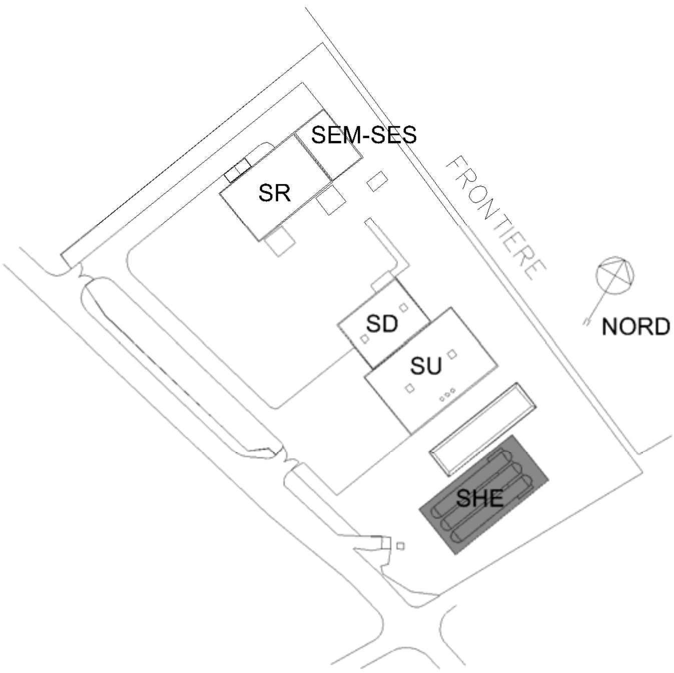

Figure 2.40: Point 7 surface layout

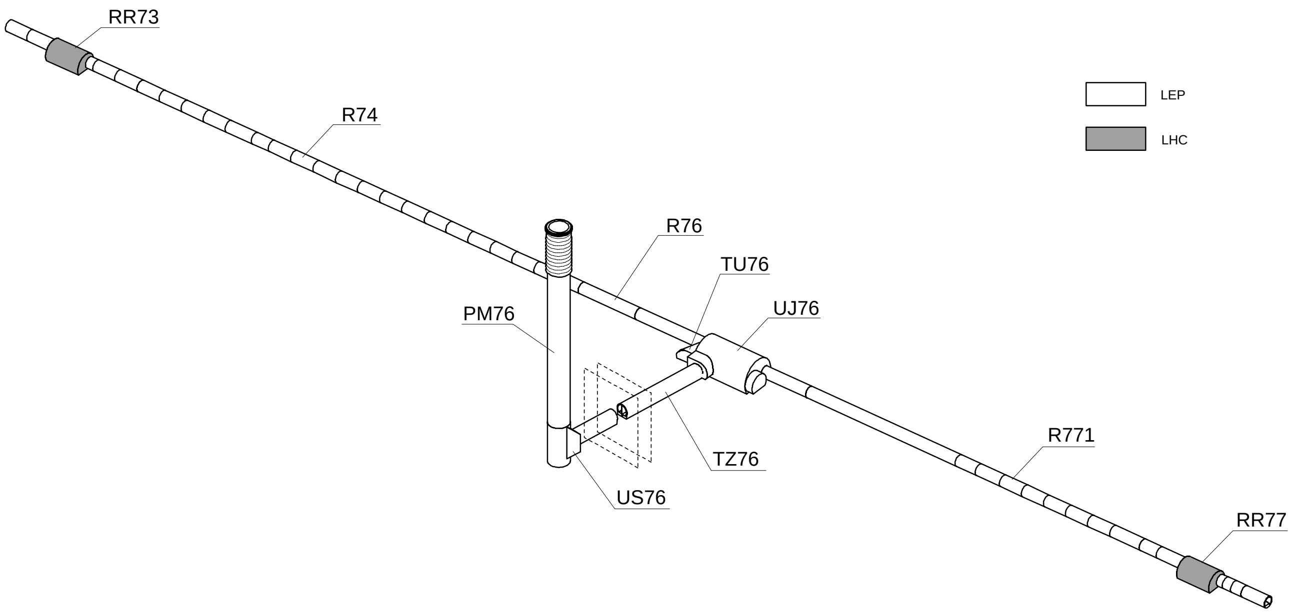

Figure 2.41: Point 7 underground axonometry

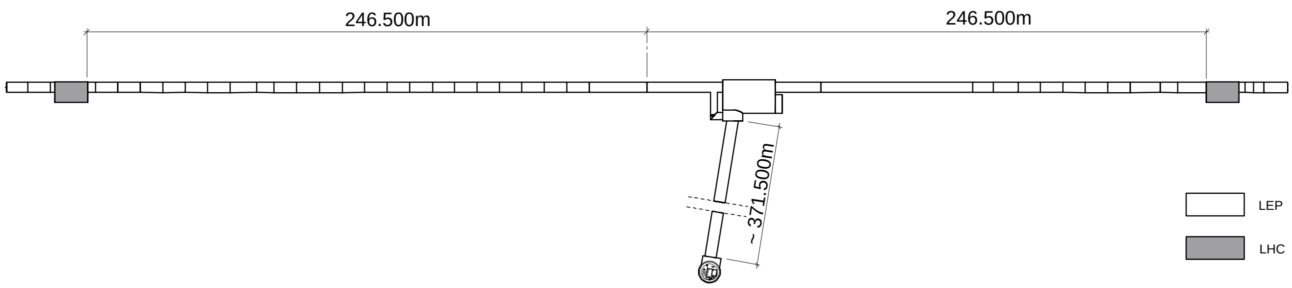

Figure 2.42: Point 7 underground layout

Table 2.32: Point 7 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SHE 7	32.75	11.70					
SD7	20.60	15.60	8.50	332.00	2184	4.00x3.95	
SE7	17.40	9.15	3.85	157.00	1018	2.20x2.50	2.20x2.50
SR7	28.30	17.15	3.85	526.00	2025		
SU7	30.60	20.60	8.50	630.00	6320	5.00x5.00	

Table 2.33: Point 7 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
RR 73	13.30	7.75	5.00	8.00	93.00	32
R 71	725.27	3.18	2.88	3.76	2306	6600
RE 72	24.70	4.62	3.45	5.00	101	311
R 72	651.19	3.18	2.88	3.76	2071	5926
R 73	187.50	3.18	2.88	3.76	600	2125
R 74	94.30	3.18	2.88	3.76	302	1070
PM 76			91.41	7.10	39	3565
US 76	9.60	7.10	5.00	0.00	63	313
TU 76	15.30			2.20		56
R 76	55.88	3.18	2.88	3.76	181	503
UJ 76	22.00	13.35	7.75	13.50	294	1870
R 77	225.87	3.18	2.88	3.76	732	2033
TZ 76	372.05	3.39	3.80	4.40	1262	5171
R 78	651.19	3.18	2.88	3.76	2071	5926
RE 78	24.70	4.62	3.45	5.00	101	311
RR 77	13.30	7.75	5.00	8.00	93	32.500
R 79	725.27	3.18	2.88	3.76	2306	6600

Table 2.34: Point 7 gantry cranes

Structure	Number	Capacity T	Speed m/min	Clearance of Floor m	Hook Travel m	Opening m x m
SR 7	PR 741	5 T	5	4.70		

Table 2.35: Point 7 lifts

Stucture	Lift Number	Capacity kg/pers	Duration min	Cage Size L(m)xW(m)	Door Size W(m)xH(m)
PM 76	AS 709	1000 13	0.6	2.10x1.10	2.10x.90

2.15 POINT 8

Models and layouts of surface building and underground structures at Point 8 (Figs. 2.43 to 2.46), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.36 to 2.38) are shown below.

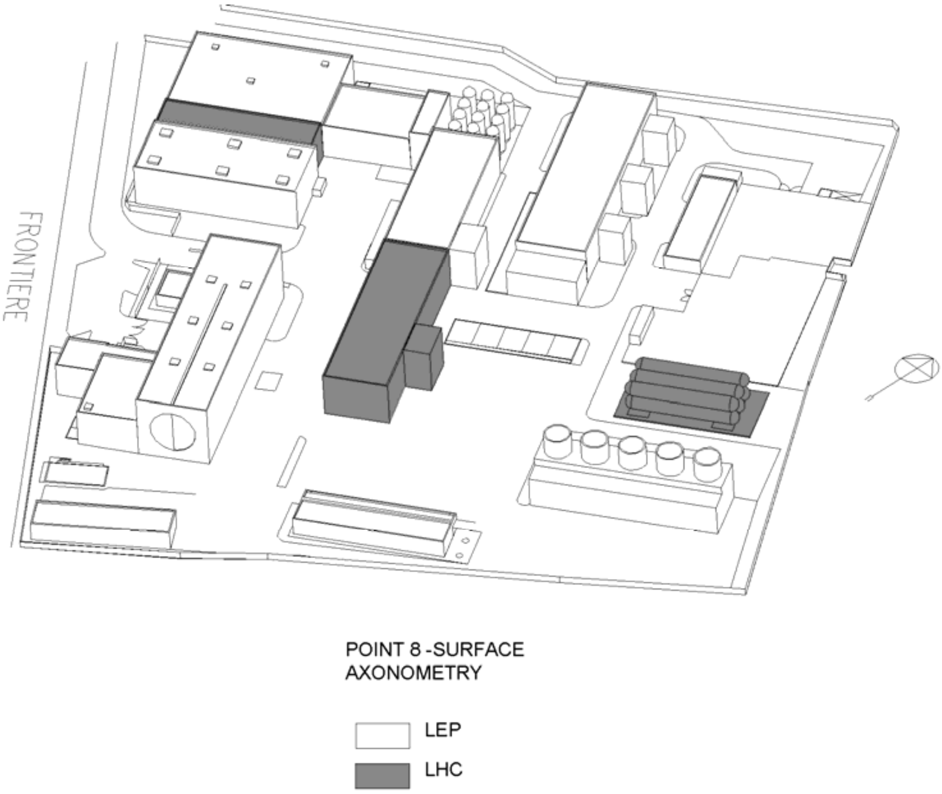

Figure 2.43: Point 8 surface axonometry

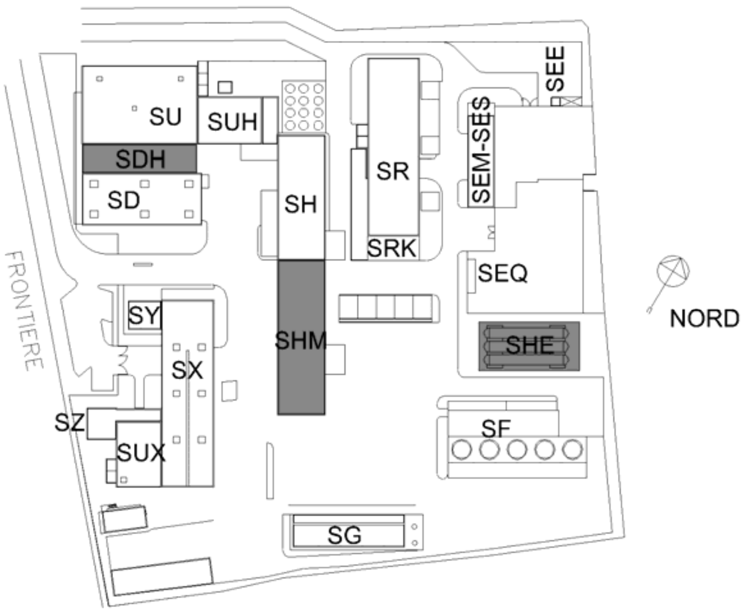

Figure 2.44: Point 8 surface layout

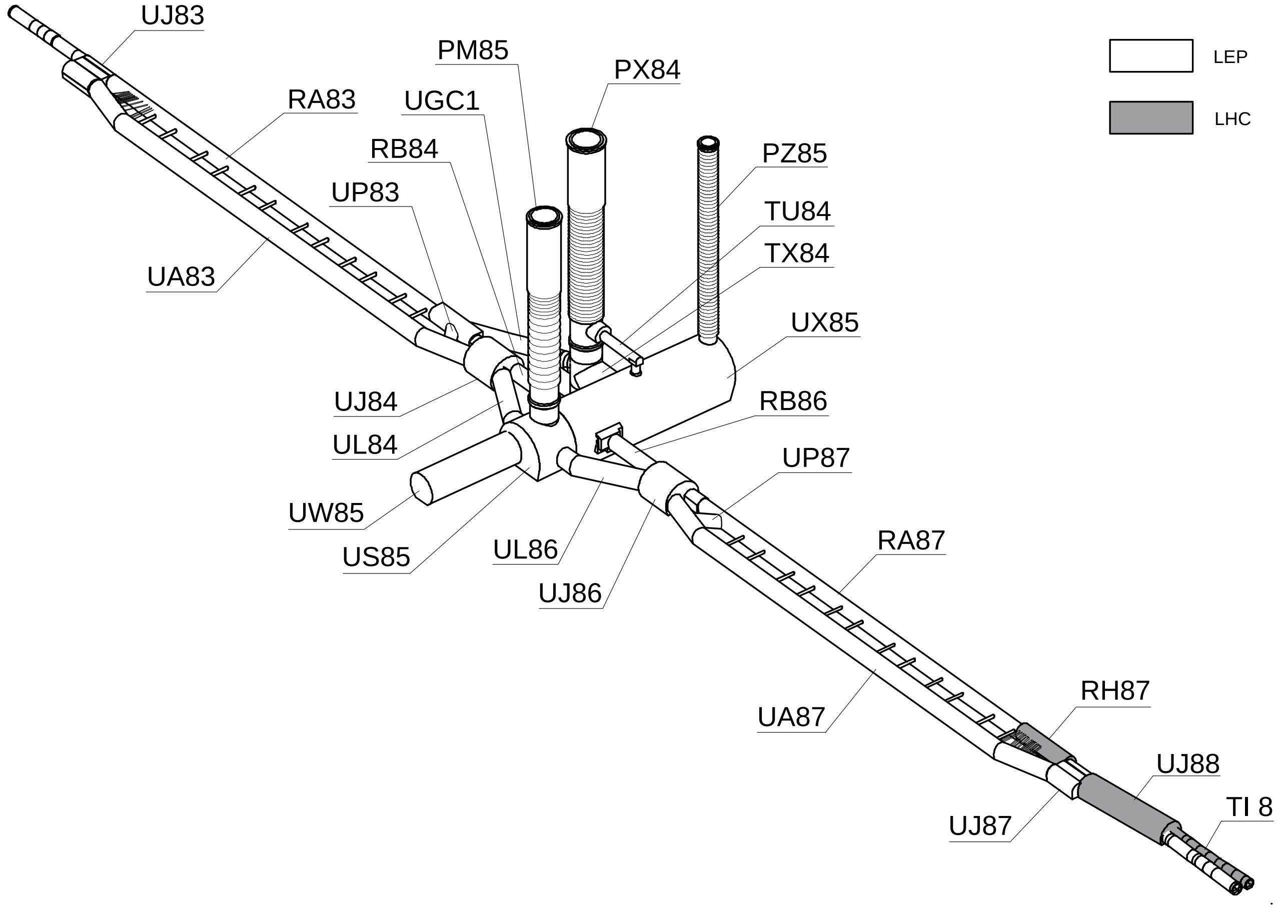

Figure 2.45: Point 8 underground axonometry

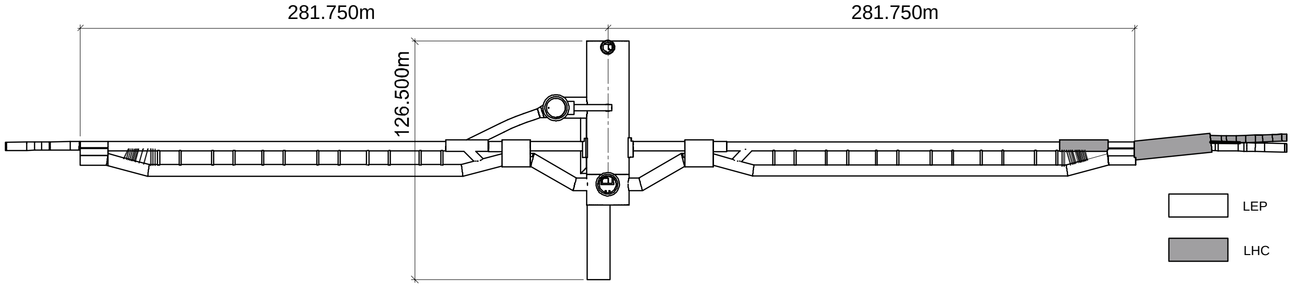

Figure 2.46: Point 8 underground layout

Table 2.36: Point 8 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
R81	721.18	3.18	2.88	3.76	2293	6563
RE82	24.70	4.62	3.45	5.00	101	311
R82	661.20	3.18	2.90	3.76	2103	6017
UJ83	14.00	11.20	4.50	5.50	156	326
RA83	211.90	3.39	3.60	4.40	766	2981
UA83	213.50	4.24	4.50	5.50	905	4483
UJ84	14.00	13.30	7.90	13.50	186	1218
UL84	34.60	4.20	5.26	6.10	145	927
RB84	31.18	3.39	3.60	4.40	106	415
PX84			93.24	10.10		7459
TX84	22.05	7.00	10.05	10.10	154	1808
UP84	33.95	1.50	2.20	2.20	51	131
PM85			86.21	9.10		5604
US85	16.50	20.72	13.37	21.40	342	3899
UX85	70.00	16.50	18.57	21.40	1155	23170
UW85	40.00	9.30	8.40	11.00	418	2720
PZ85			85.17	5.10		1703
TU84	22.65			2.50		111
RB86	31.18	3.39	3.60	4.40	106	415
UL86	34.60	4.20	5.26	6.10	145	927
UJ86	14.00	13.30	7.90	13.50	186	1218
RA87	200.87	3.39	3.60	4.40	612	2361
UA87	213.50	4.24	4.50	5.50	905	4483
UJ87	14.00	11.20	4.50	5.50	156	326
R88	661.20	3.18	2.88	3.76	2103	6017
RE88	24.70	4.62	3.45	5.00	100	311
R89	721.18	3.18	2.88	3.76	2293	6563
R 89	721.18	3.18	2.88	3.76	2293	6563
RH 87	25.00	6.15	4.50	6.60	153	618.750

Table 2.37: Point 8 gantry cranes

Structure	Number	Capacity T	Speed m/min	Clearance of Floor m	Hook Travel m	Opening m x m
SD 8	PR 722	10	10	8.85	108.45	8.50x2.00
SR 8	PR 723	5	5	6.65		
SUH 8	PR 724	20	5	5.65		
SX 8	PR 725	80	6	9.85	113.15	Diameter 10.10
SF 8	PR 743	3,2	5	8.00		
SH 8	PR 757	20	6	6.10		
SDH 8	PR 773	5	5	10.30		
UX 85	PR 720	80	10	13.50		
UX 85	PR 721	80	10	13.50		

Table 2.38 : Point 8 lifts

Stucture	Lift Number	Capacity Kg / pers	Duration min	Cage Size L(m) x H(m)	Door Size W(m) x H(m)
PM 85	AS 712	3000 33	0.9	2.70x1.85	1.85x2.10
PZ 85	AS713	1000 13	0.5	2.70x1.10	0.90x2.1

2.16 POINT I8

Models and layouts of surface building and underground structures at Point I8 (Figs. 2.47 to 2.50), as well as tables giving their main characteristics and details of the lifting equipment (Tabs. 2.39 to 2.40) are shown below.

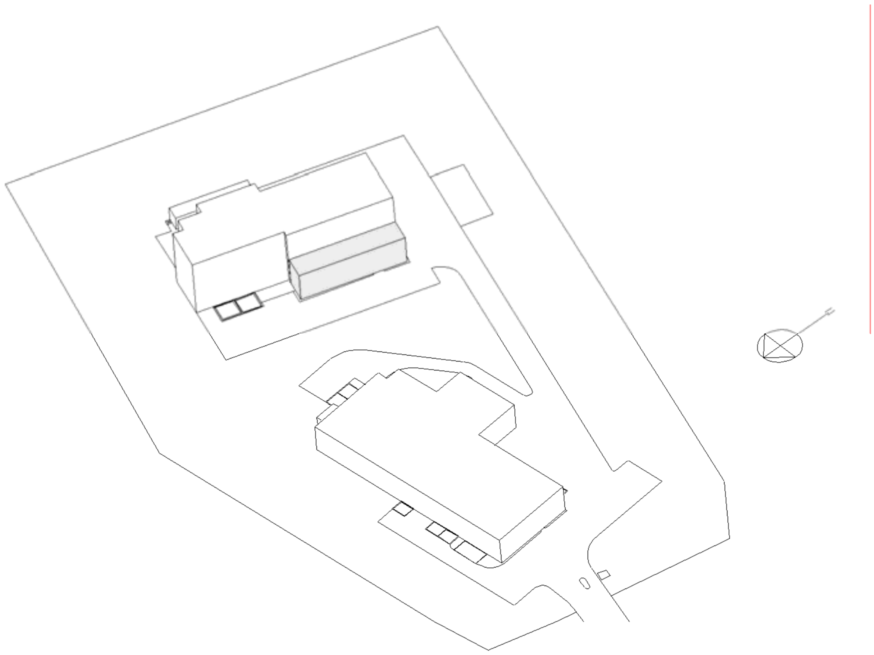

Figure 2.47: Point 4 SPS surface axonometry

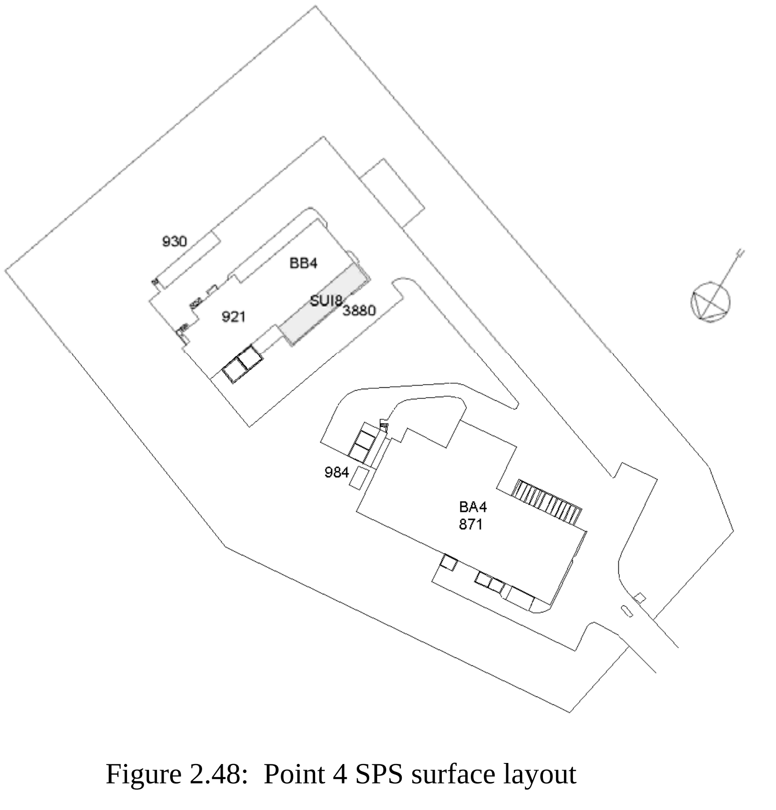

Figure 2.48: Point 4 SPS surface layout

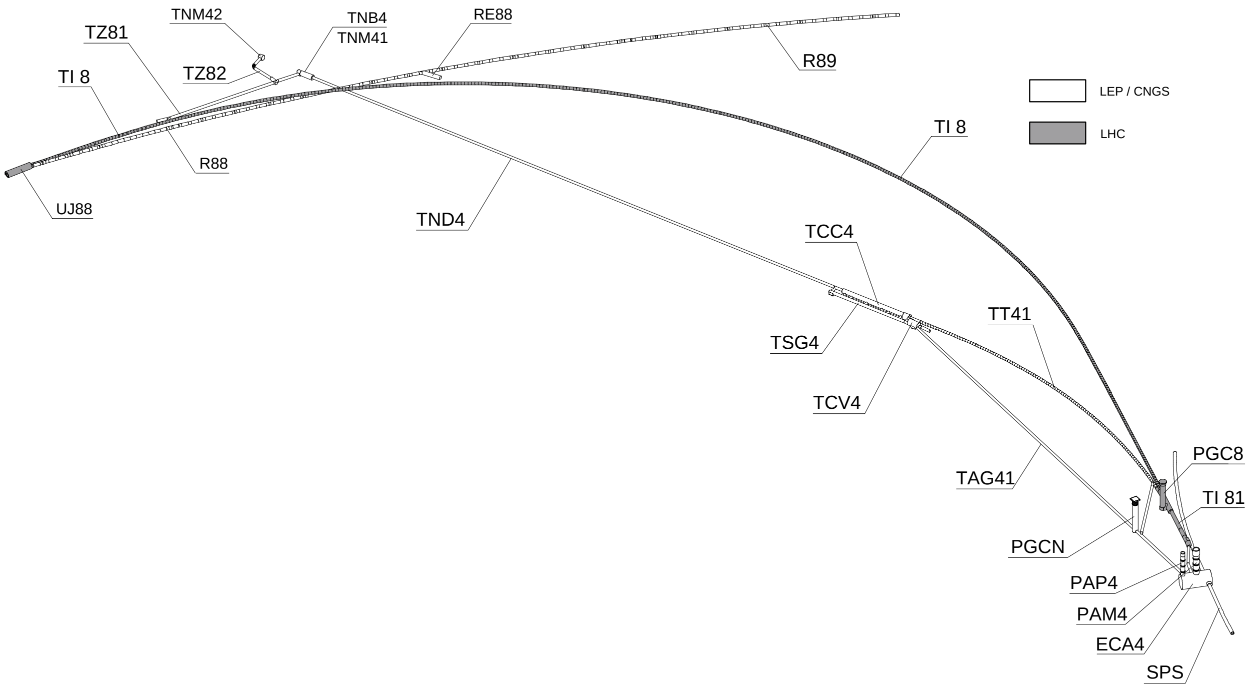

Figure 2.49: TI 8 underground axonomy

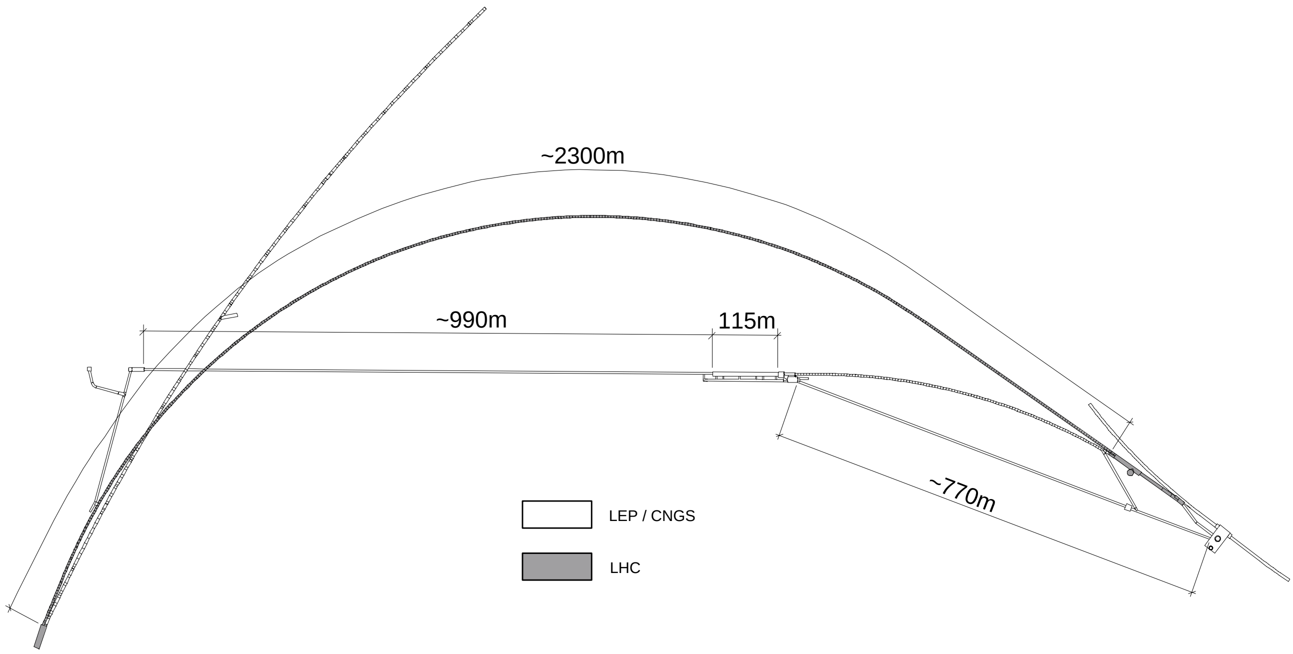

Figure 2.50: TI 8 underground layout

Table 2.39: Point I8 surface buildings

Structure	Length m	Width m	Height m	Floor Area m^2	Volume m^3	Motorised Door W(m)xH(m)	Motorised Door W(m)xH(m)
SUI8	26.00	5.57	7.50	145.00	1088	1.90x3.00	

Table 2.40: Point I8 underground structures

Structure	Length m	Width m	Height m	Diameter m	Floor Area m^2	Volume m^3
TJ 8	53.00	5.86	4.65	6.50	310	1335
TT40	90.65	4.40	3.60	4.40	400	1197
TZ40	77.70	2.24	2.50	3.00	175	478
PGC8			46.80 / 42.15	3.00		330
TI8	2285.00	2.24	2.50	3.00	5120	14050

2.17 PROPOSED NEW CONTROL CENTRE

As part of the restructuring to improve operational efficiency and to meet the needs of the LHC Project, the necessity for a single Accelerator Control Centre to replace the existing control rooms has emerged. This centre will also include the Cryogenics and Technical Control Rooms, which will be transferred from their present locations. It is essential that the new control centre is operational by February 2006.

In January 2004, the CERN Management decided that the location of this facility, named CCC for "CERN Control Centre", would be on the Prévessin Site, integrated on the side of the building currently housing the Prévessin Control Room (PCR). The new building, which will house the common control room itself, will have an area of 625 m^2 (25 m × 25 m), with an internal height of about 6 m.

The existing building will be totally refurbished and will house:

- Conference rooms
- Rest facilities for operators
- Toilets and showers
- Service rooms (including a maintenance laboratory, server and racks rooms)
- Technical rooms (for telecom, cooling and ventilation installations)

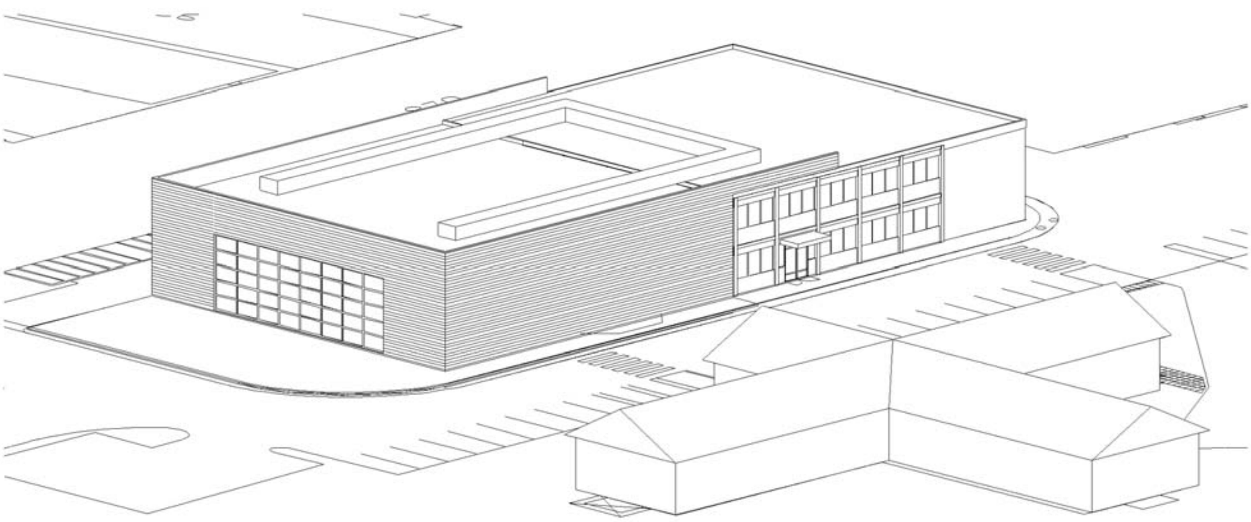

Figure 2.51: CERN Control Centre project axonometry

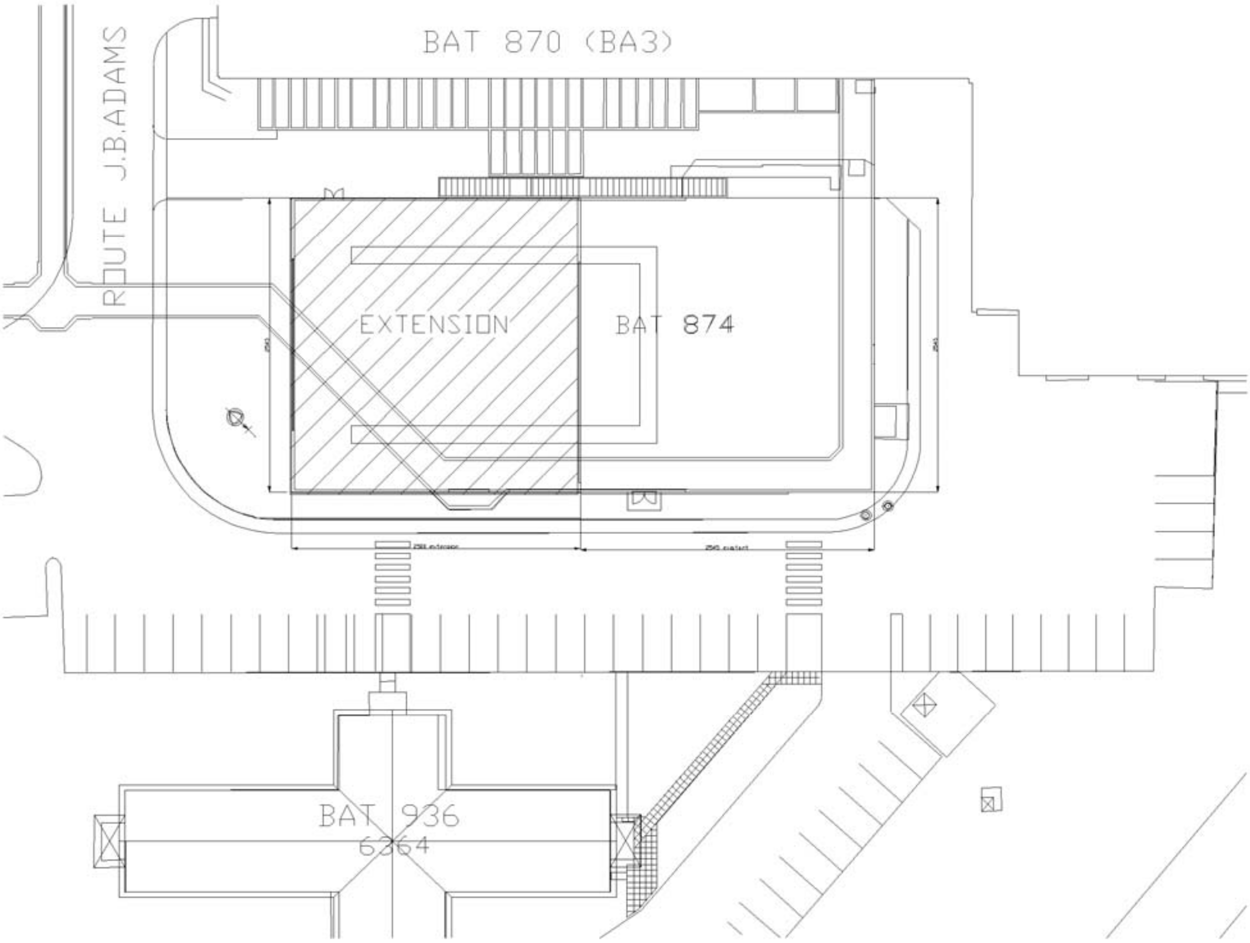

Figure 2.52: CERN Control Centre project plan view