B	Filip Dufek	Ivan Holub	Jiří Petrů	**SECOND EDITION**	04/2020
A	Filip Dufek	Ivan Holub	Jiří Petrů	**FIRST EDITION**	07/2019
Rev.	**Prepared by**	**Reviewed by**	**Approved by**	**Description index**	**Date**

Document submitted for acceptance: YES – NO **Input document:**	**State:** Preliminary

Name:

EUROPEAN SPALLATION SOURCE
Technical report
Part B – Civil part
NIK 6.6#3 – Beamline for European Engineering Research

Document type: Report
Confidentiality level: Internal
Link: https://chess.esss.lu.se

This document is the property of European Spallation Source and may be reproduced or redistributed only with his consent

Building owner:

EUROPEAN SPALLATION SOURCE

Document number:

ESS-0461627

Address:
European Spallation Source – ERIC
Box 176, S-221 00 Lund, Sweden

Approved by: *Name & Signature*

In Kind Partner:

Partner's Document number:

Approved by: *Name & Signature*

Address:
Ústav jaderné fyziky Akademie věd ČR, v. v. i.
Řež 130, 250 68 Husinec – Řež, Czech Republic

Contractor:

NUVIA

Contractor's Document number:

Approved by: *Name & Signature*

Address:
NUVIA a.s.
Modřínová 1094, 674 01 Třebíč, Czech Republic

Format: A4	**Number of pages:** 25

ÚJV Řež, a. s. Divize ENERGOPROJEKT PRAHA	*Office* Na Žertvách 2247/29,180 00 Praha 8		
	Managing dept. 2505	*Processing dept.* 2503	*Discard label*
Project name ESS - BEER	*Object – operation unit* CO101		*Ordinal number* 002
Contract name NIK 6.6#3 Beamline for European Engineering Research			
Documentation name Detail design CO101 – BEER Experimental cave and control hutch area **Part B - Civil part** # TECHNICAL REPORT			*Copy number*
Worked by Filip Dufek	*Head of processing department* Ivan Holub	*Date* 04/2020	*Pages in document* 25
Checked by Zdeněk Vaněček	*Main project engineer* Jiří Petrů	*File* 002_ESS-0461627_DD_CIVIL_TR_r01.docx	

CONTENT

LIST OF ABBREVIATIONS

Abbreviation	Title
BEER	Beamline for European materials Engineering Research
CH	Control Hutch
CO	Civil object
ConOps	Concept of Operation Description
DMSC	Data Management and Software Centre
ESS	European Spallation Source
EC	Experimental Cave
GTR	General Technical Report
ICS	Integrated Control System
NSS	Neutron Scattering Systems
PS	Process system
PSS	Personal Safety System
TCS	Target Coordinate System
TR	Technical report

LIST OF FIGURES

LIST OF TABS

1 INPUT DATA

- Main coordinate system at the ESS, ESS-0035090 (11/2016)
- BEER Concept of Operation – v16 (14.4.2017)
- BEER Preliminary System Design – v8 (14.4.2017)
- Instrument layout from ESS - layout.dwg (03.07.2017)
- Manipulation area – Logistics.dwg (11/2017)
- Layout of the cell, variant 7 (7.9.2017)
- presentation IKON11 D03-E01-E02 Infrastructure b.pptx (21.9.2017)
- Floor deformation G01 (21.9.2017)
- Minutes from coordinate meetings (01-10/2018)
- Documentation for diffractometer BEER - Basic Design (11/2017)
- BEER TG3.1 Review Transmittal – Cave, shutter, shielding ESS-0506957 (12/2018)
- Static analysis of Experimental hall 3 (E01) floor slab, Tyréns (05/2019)
- ESS – Instrument Technical Interfaces ESS-0403282 (06/2019)

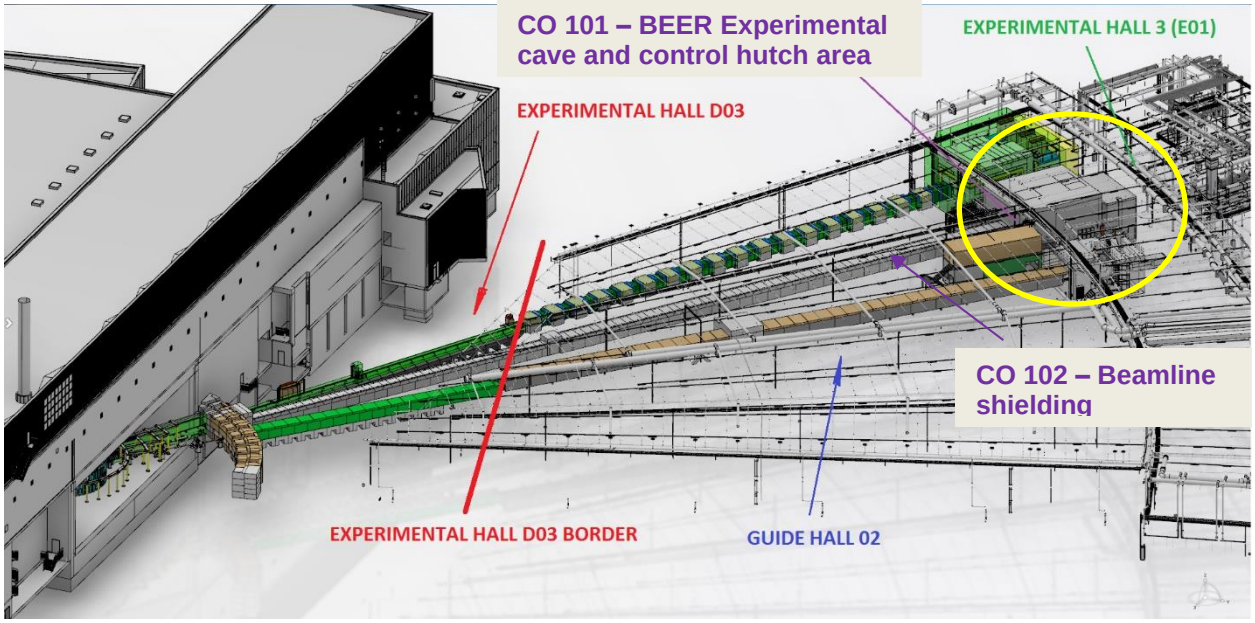
2 BUILDING PURPOSE

Project BEER instrument is an engineering neutron diffractometer designed mainly to allow fast in-situ experiments under real conditions.

This part of documentation includes solution of structural (civil) part of the CO 101 – BEER Experimental Cave and Control Hutch area, which consists of shielded pre-cast reinforced concrete Experimental Cave (EC) and spaces for preparing and controlling of samples – Control Hutch (CH). Experimental Cave is situated in part of Experimental hall 3 (E01) and follows the shielding tunnel (CO 102 – Beamline shielding) for conducting neutrons between the bunker wall and Experimental cave.

Contract name - project: **„Documentation for diffractometer BEER“**
Design degree: **Detail design**
Building character: **New building**

The schematic of the location of the shielding tunnel for the neutron guide (CO 102) and the Experimental cave and control hutch (CO 101), see picture No.1 and No.2/3:



Picture No.1 – layout view – CO 101, CO 102

3 ARCHITECTURAL, FINE, MATERIAL AND DISPOSITION BUILDING SOLUTION

The Experimental cave (EC) is located in the Experimental hall 3 (E01) on the inner wall and connects to the neutron guide shielding tunnel. The shielding tunnel passes through the guide hall - E02 and ends at a bunker in experimental hall 2 (D03) by the shutter pit.

Tab.1: Room / area marking of CO 101 BEER Experimental Cave and Control Hutch area

Mark	Room name	Part of	TCS Floor level [m]
1.00	Service Area	EC	-3.000
1.01a	Sample Preparation Area	CH	-3.000
1.01b	HVAC engine room	CH	-3.000
1.02	Experimental Cave	EC	-1.500
2.01	Staircase	CH	-3.000 to -1.500/+0.600
2.02	Control Hutch	CH	+0.600

The EC is a shielding construction enclosing the operational units for sample positioning and handling, detector systems, the end section of the focusing guide and apertures, a small bridge crane for manipulation of large samples and sample environments and another equipment needed for the experiments.

The EC shall allow personnel access when the proton beam is on the target. The dose level in the EC when the safety shutter is closed shall be < 3 μSv/h in accordance with ESS-0001786 and ESS-0051603. Access is required for sample changes, maintenance, repairs, or adjustments.

The shielding property of the EC shall provide sufficient protection (dose limit at the outside cave surface < 3 μSv/h) from the radiation even the safety shutter is open and an experiment is running. The inner space of the Experimental hall E01 is considered as the supervised area.

Next to the EC, there will be a two-storey enclosure - Control Hutch (CH). On the E01 floor level (-3.000 m below the TCS), there is a space for the experiment preparation (preparatory lab –

room no. 1.01a) and HVAC engine (room no. 1.01b). In the 2nd floor at +0.600 m, there is a Control room (CR) no. 2.02. Personal entrance to the 2nd floor is secured from the staircase (room 2.01).

The EC and CH are standing on the floor of the Experimental hall 3 (E01), at the level of TCS -3.000 m. The floor load of the Experimental hall 3 (E01) is 20t/m^2 (in accordance to Instrument Technical Interfaces ESS-0403282). The outer dimensions of the EC are 12.95×11.00 m x 7.5 (height) m.

The EC has internal clear dimensions of 11.75×9.90x5.30 (height) m. The internal floor level is TCS -1.500 m, i.e. 1500 mm above floor level of Experimental hall 3 (E01). Two entrances are designed to the EC. The personal entrance for fluent access is through an external steel staircase, the floor level TCS -1.500 m, by side EC wall. The entrance for the arrival of bulky samples and/or sample environments is through a shielding sliding door (DPS 01.07) with dimensions 2000 (width)×2200 (height)x220 (thickness) mm, at level TCS -3.000 m.

For the handling of samples and sample environments, a one-track bridge crane is fitted under the ceiling, with a load capacity of 4t, and span of 8.6 m.

The walls are designed as shielding pre-cast reinforced heavy concrete (density 3850 kg/m^3) vertical wall blocks with th=550 mm (straight side walls and rear wall). The front wall (towards the CH), and angled side wall with the th=650 mm. The EC celling is designed with three fixed ceiling beams and demountable ceiling panels (reinforced ordinary concrete – density 2300 kg/m^3).

The inside surfaces will be coated with boron carbide tiles (B_4C filler + binder) to ensure the required maximum dose of 3 μSv/h outside the cave and to protect the reinforcing construction of the walls/ceilling from an activation by thermal neutrons.
Note: material for B_4C tiles is in process of testing. Final choice will be specified as soon as possible.

An opening ø150 mm will be made in the front wall of the cave, on TCS level +0.137 m, following the neutron beam axis and serving as the entrance for the neutron guide system.

Note: the final dimension of EC front wall opening must be confirmed by the guide supplier before the element is manufactured!

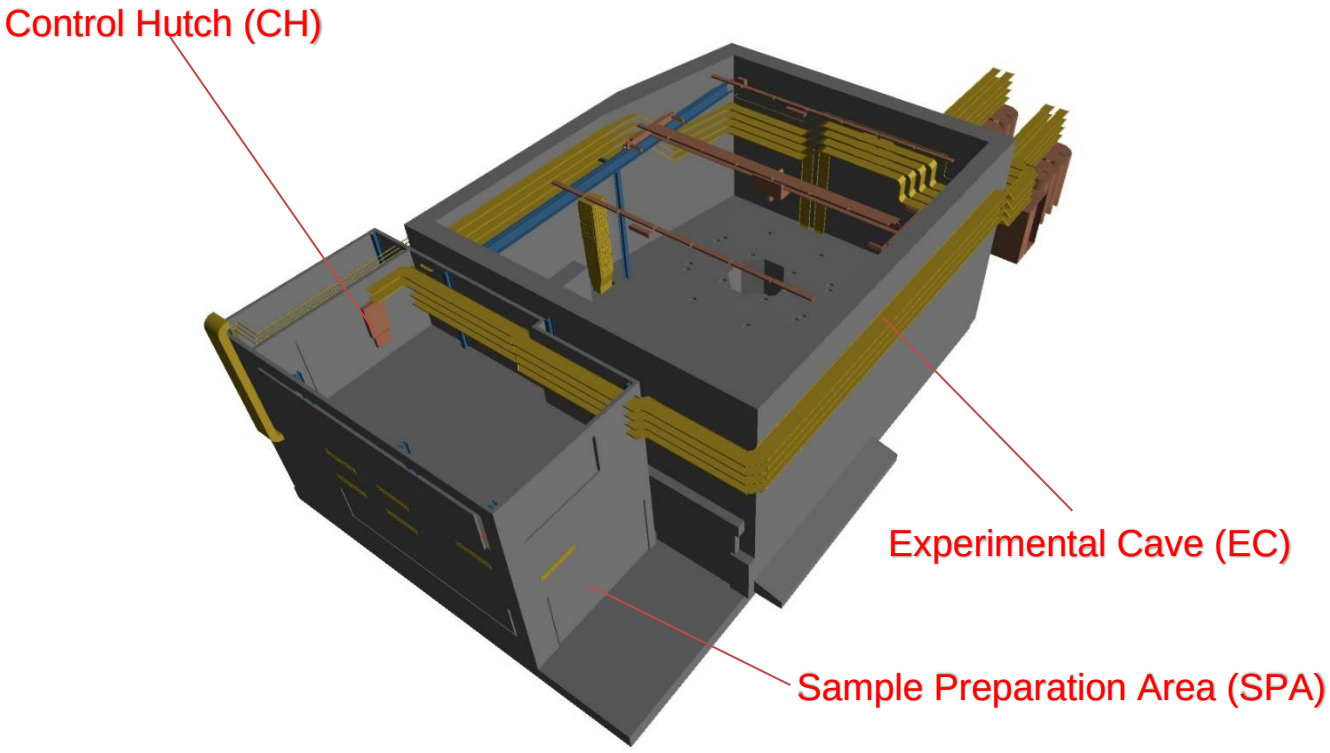
The entrance to the preparatory lab (in SPA of two-storey enclosure) is at a level of TCS -3.000 m through a sectional gate of 3500x2200 mm located near by the sliding door to the EC. The sectional gate is equipped by integral rotating door for quick personal access to the preparatory lab.

The sample preparation area will serve as a space for a sample preparation, sample environment alignment, sample storage and sample environment maintenance, as well as for running of some demanding experiments.

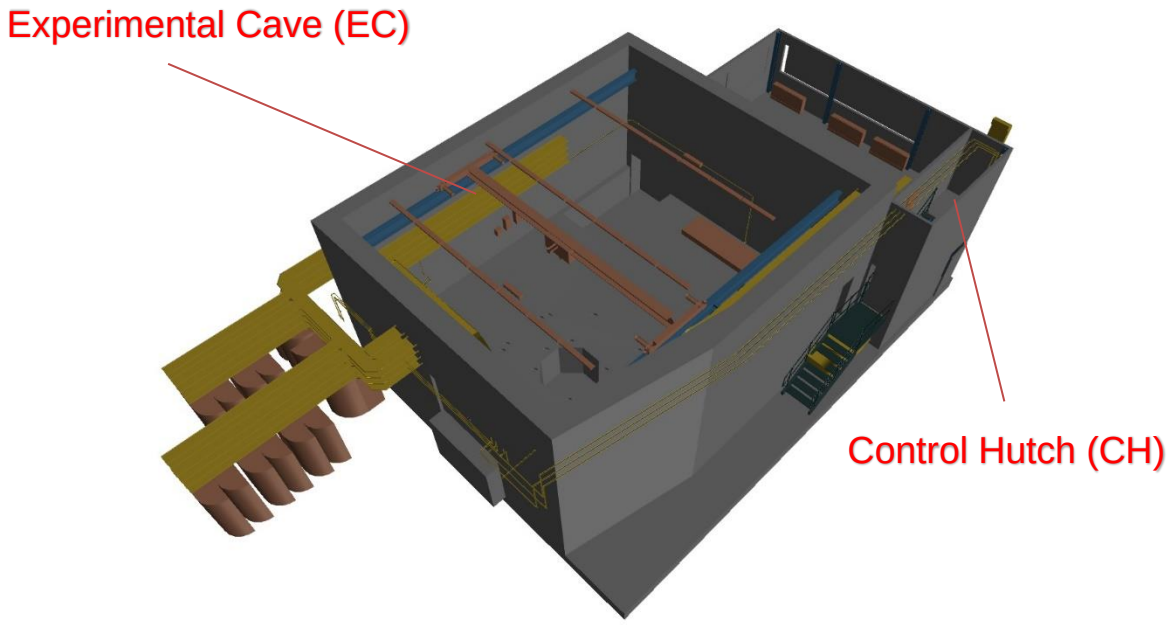
There is a control room in the 2nd floor at TCS +0.600 m. The control room will allow users to remotely control the whole instrument and its parts, provide the data analysis and survey the inner part of the cave on cameras. The user team in the control room usually consists of 1-4 people. The workspace is designed for up to 6 people.

The entrance to the 2nd floor is through a steel staircase from the floor level of the Experimental hall 3 (E01). The staircase also serves for easy access to the EC during the experiment setup, and sample exchange.

The two-storey CH enclosure is designed as mounted with a steel bearing structure. In the groundfloor peripheral and 2nd floor wall windows are designed with fixed glazing.



Picture No.2 – view of CO 101 BEER Experimental Cave and Control Hutch area (ceiling structures is not shown)



Picture No.3 – view of CO 101 BEER Experimental Cave and Control Hutch area (ceiling structures is not shown)

4 CAPACITIES, USEFUL AREAS, BUILT UP AREAS, ORIENTATION, LIGHTING

Tab.2: Capacities of CO 101 BEER Experimental Cave and Control Hutch area

Built up area of cave pre-cast structures:	141.16 m^2
Built up area of enclosure (control hutch):	45.60 m^2
Total built up area:	186.76 m^2
Enclosed area of experimental cave:	1050.30 m^3
Enclosed area of enclosure (control hutch):	296.40 m^3

The neutron beam axis is at TCS +0.137 m (TCS = target coordinate system).

The room illumination and lighting:
Primary illumination provides artificial lighting through a system of luminaires in Experimental cave and additionally with crane lights.
Primary illumination provides artificial lighting through a system of luminaires in Control Hutch. Control room is illuminated with number of aluminium windows with double glassed, fixed transparent - clear glass 2×5 mm. On the ground floor there are 5 windows, in the 2nd floor there are 9 windows.

5 STRUCTURAL AND CONSTRUCTION TECHNICAL SOLUTION

5.1 EXPERIMENTAL CAVE (EC)

5.1.1 FOUNDATIONS

The EC and CH are installed on the floor slab of the Experimental hall 3 (E01), thickness (th) of 500 mm, upper level of slab is TCS -3.000 m. The assessment and maximum load on the foundation slab, see static analysis, documents [1], [2], [3].

The EC peripheral foundations are made of pre-cast reinforced concrete blocks primary of th=750 mm with extended bottom (because of load distribution). Foundation block's h= 1200 mm. These foundation blocks are separated from E01 floor slab by a strip of heavy bitumen sheet (SBS modified bitumen sheet with a fiberglass support insert) th=3,5 mm. Under the floor level, the basement walls are also designed at the transport shaft, under the crane pillar, and at the placement of the technological equipment to ensure the optimum rigidity and load-bearing capacity of the Experimental cave elevated floor platform (level TCS -1.500 m). Basement wall thicknesses are 300 mm or 600 mm. Next there is designed foundation block (l=1700 mm, w=1000 mm, h=1450mm) between the octagonal foundation blocks and front peripheral wall of EC. This block forms the basis for placing the exchanger equipment. This massive foundation block of pre-cast reinforced concrete is separated from other related structures using an expansion joint th=20 mm. Expansion joint is filled with mineral wool. Expansion joint is installed by expansion joint cover (Miguan FP 80/35 NI ls).

At the sample tower shaft (pit for sample tower), the foundation walls structure is octagon-shaped. Inner clear width of octagonal pit is 1900 mm. There are designed two rows of foundation blocks (th= 600 mm) - the inner circumference of the octagon pit and below the detector devices near the sample. This will prevent the transmission of vibrations from the dynamic load from the stool above the rotary table. The massive foundation blocks are separated from E01 floor slab by a strip of heavy bitumen sheet (SBS modified with glass mat) in the same way as other foundation blocks (see above).
For service access to the space under the floor platform (service area, room No. 1.00), a check opening with steel inspection door is designed in the entrance shaft for arrival of bulky samples (transportation shaft), in the side wall of the shaft.

The foundation pre-cast blocks are designed from ordinary concrete (density 2300 kg/m3) strength class C30/37 - XC1 with B 500B reinforcement.

At the level of the foundation walls after the deformation, the gap before the front EC wall will be added by pre-cast support block. This filler provides support when connecting CO 102 to the EC wall. The support block is designed from C30/37 – XC1 with B 500B reinforcement.

Steel bearing construction of Control hutch (see construction part of documentation) will be mechanical anchored to the E01 floor reinforced-concrete slab (thickness of 500 mm). There will not be implemented any new foundations.

5.1.2 VERTICAL BEARING STRUCTURES

The walls of the cave are designed as shielding pre-cast reinforced concrete parts, th=550 mm (side and rear walls), the front wall adjoining the neutron shielding tunnel, th=650 mm. An opening (with clear diameter of 150 mm will be made in the front wall of the cave, the axis at level TCS +0.137 m, following the neutron beam axis and the shielding tunnel tunnel in Guide hall (E02).

Dimensions of ordinary wall part (panel): l=6300 mm, w= 720 mm, th= 550/650 mm.
For appropriate drawings see documents [2], [3], [4], [5].
For the service/personal entrance, the shielding partition block (chicane) is designed inside the cave th=550 mm, h=2500 mm. The space between side wall near personal entrance and shielding partition block has w=1200 mm.

Ordinary wall panels are complemented by corner and additional panels for peripheral wall connection. Wall panels are installed on foundation blocks (see above). The wall panels are mechanical switched to each other by internal steel rods and anchoring plates and then filled with grout. This connection creates a co-operating closed unit that will behave as a monolithic structure. The top of the wall panels is shaped to place ceiling panels.
The pre-cast wall parts are designed from reinforced heavy concrete (magnetite-containing concrete - density 3850 kg/m^3) C30/37 - XC1 with B 500B reinforcement.

The exact assembly procedure will be described in the supplier documentation.

To ensure shielding properties and protects wall structure from activation, the inside surfaces of the cave will be coated with special boron carbide tiles (B_4C filler + binder) – see paragraph “Surface finishes”.

<u>Experimental Cave - peripheral shielding wall composition (C1)</u>

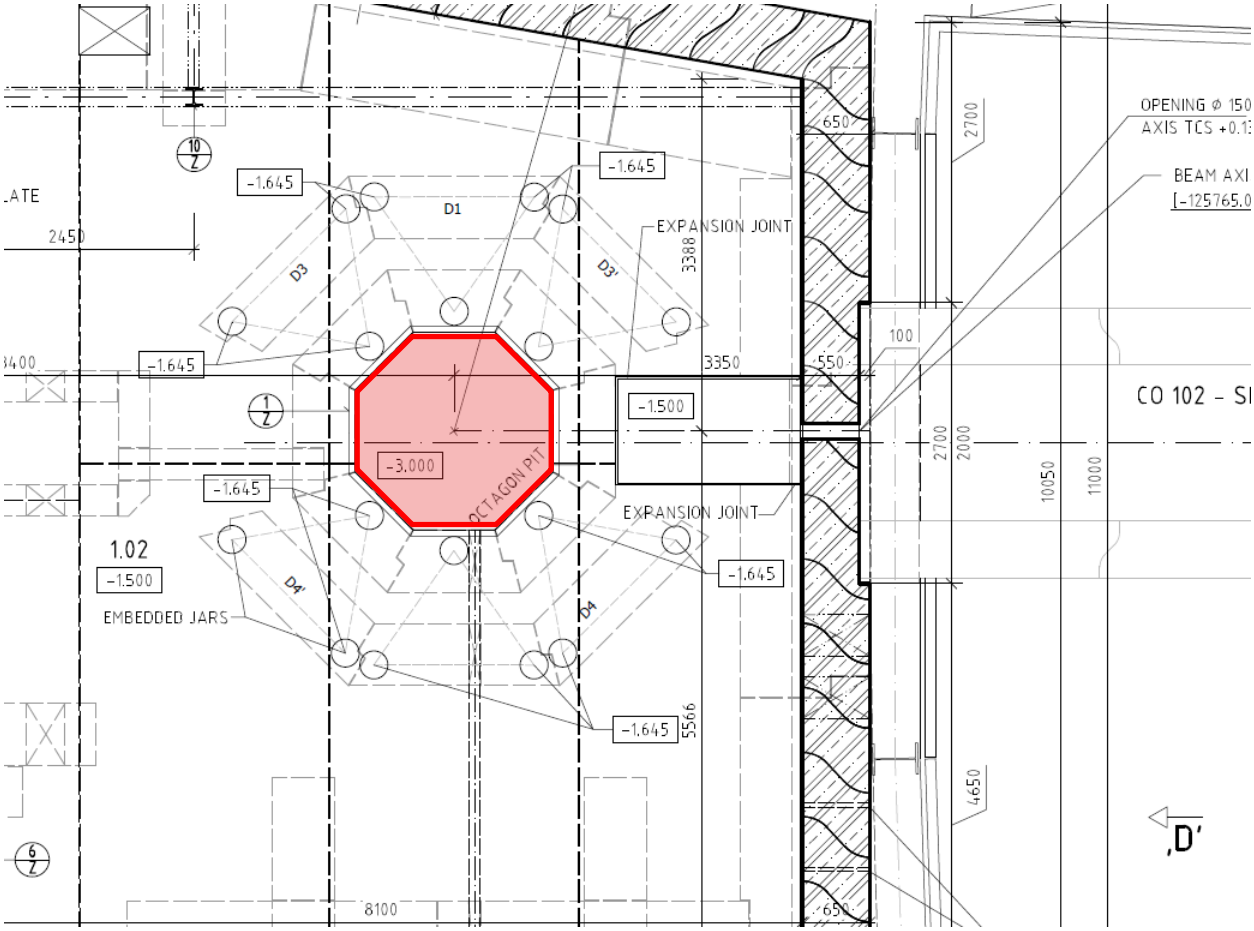
- outer finish coating - epoxy coating system, one-layer exterior coating (RAL 1028 - yellow),	th. 2,0 mm
- pre-cast reinforced concrete panels, heavy concrete C30/37 - XC1 (approx. 3850 kg/m3),	th. 550/650 mm
- tiles with B_4C, glued by MS polymer mastic (For example, Type: UniFix, Manufactured: Den Braven),	th. 8,0 mm
- final epoxy layer providing color shade (ral 7004 - signal grey),	th. 2,0 mm

A sets of cable trays penetrations trough the EC shielded peripheral walls are designed.
Penetrations are fitted in formwork during pre-cast wall blocks production. These are fitted in at angle of 45° + side 15° (avoidance of neutron passage from the EC).
The leading trays in EC or CH or Guide hall, including risers and conjunction parts, are supplied by the profession of electrical part DPS 01.03.

Opening for the cable wiring of the PSS system to the magnetic door lock for personnel access to the EC (hole with a diameter of less than 100 mm) will be drilled out in the perimeter vertical panel and sealed. The specific position and exact diameter of the opening will be determined on the basis of the implementer and PSS administrator (ESS).

5.1.3 HORIZONTAL BEARING - SUPPORTING STRUCTURES

The floor of the experimental cave (EC) is raised 1500 mm above the floor level of the Experimental hall 3 (E01) = TCS level -1.500 m. The floor (platform) is designed from pre-cast reinforced concrete panels, th=250 mm, concrete C30/37, XC1, density 2300 kg/m3. The floor panels will be laid on the foundation blocks, with the upper level at TCS -1.550 m. The floor composition with shielding properties is designed on the upper surface of platform. The maximum load on the platform is designed in the level of 4t/m^2 over the entire area, except the area between the sample tower shaft and the front wall where the maximum load will be increased to 5 t/m^2 due to the placement of an additional shielding of a guide exchanger. A transportation shaft with a foot print area of 2150×3650 mm is designed to enable large samples and sample environments handling in and out of the EC using air cushion platform moving on the base floor level (TCS -3.000 m). In the floor slab there are also hole designed for sample tower shaft. At the axis of the sample position the octagonal shaft with outer dimensions 1900×1900 mm is designed in the floor. The centre of octagonal pit for sample tower (sample position) is situated 3350 mm away from the front wall, where a stool for the sample tower will be placed (see above in Foundation chapter for more).



Picture No.4 – groundplan (level TCS -1.500 m – EC platform) of octagonal Pit for sample tower in EC

Experimental Cave - floor level TCS -3.000 m composition (C0)

- finish coating- epoxy layer (RAL 7004 - siganl grey),	th. 3,0 mm
- existing reinforced concrete slab of Experimental hall 3 (E01),	th. 500 mm

Experimental Cave - platform slab + floor (level TCS -1.500 m) composition (C2)

- final epoxy layer providing flatness and color shade (RAL 7004 - signal gray),	th. 3,0 mm
- tiles with B_4C, in full floor area glued, (For example, Type: FX glue Quartz, Manufactured: Den Braven)	th. 8,0 mm
- leveling layer (if needed) - self-leveling screed on cement basis,	th. ≈3,0 mm
- concrete screed (30 MPa),	th. 36 mm
- pre-cast reinforced concrete platform slab of ordinary concrete C30/37, XC1 (2300 kg/m^3),	th. 250 mm

The ceiling above the experimental cave is also designed as a shielding, pre-cast reinforced concrete – removable ceiling panels th= 700mm and 3 pcs of fixed ceiling beams.

The pre-cast ceiling panels are designed from normal concrete (density 2300 kg/m3) C30/37 - XC1 with B 500B reinforcement.

The ceiling beams are fixed. The ceiling panels are demountable. If necessary, they can be dismantled (using a crane (load capacity 10t) in the Experimental hall 3 (E01)) to handle the equipment inside the Cave.

Ceiling panels are fitted with anchor points for the fall protection system. Designed are anchors of type Topsafe TSL-200-BSR10, l=200 mm (total 7 pcs), with permanent stainless steel rope th=6,0 mm (2 segments: length 8,2 + 16,8 = 25,0 m). The TSL-200-BSR10 are anchored by chemical anchors to the ceiling panels.

Experimental cave - roof slab composition (C3)

- outer finish coating - epoxy coating system, one layer exterior coating (RAL 1028 - yellow),	th. 2,0 mm
- pre-cast reinforced concrete ceiling panels C30/37 - XC1 (2300 kg/m^3),	th. 700 mm
- tiles with B_4C, glued by MS polymer mastic (For example, Type: UniFix, Manufactured: Den Braven),	th. 8,0 mm

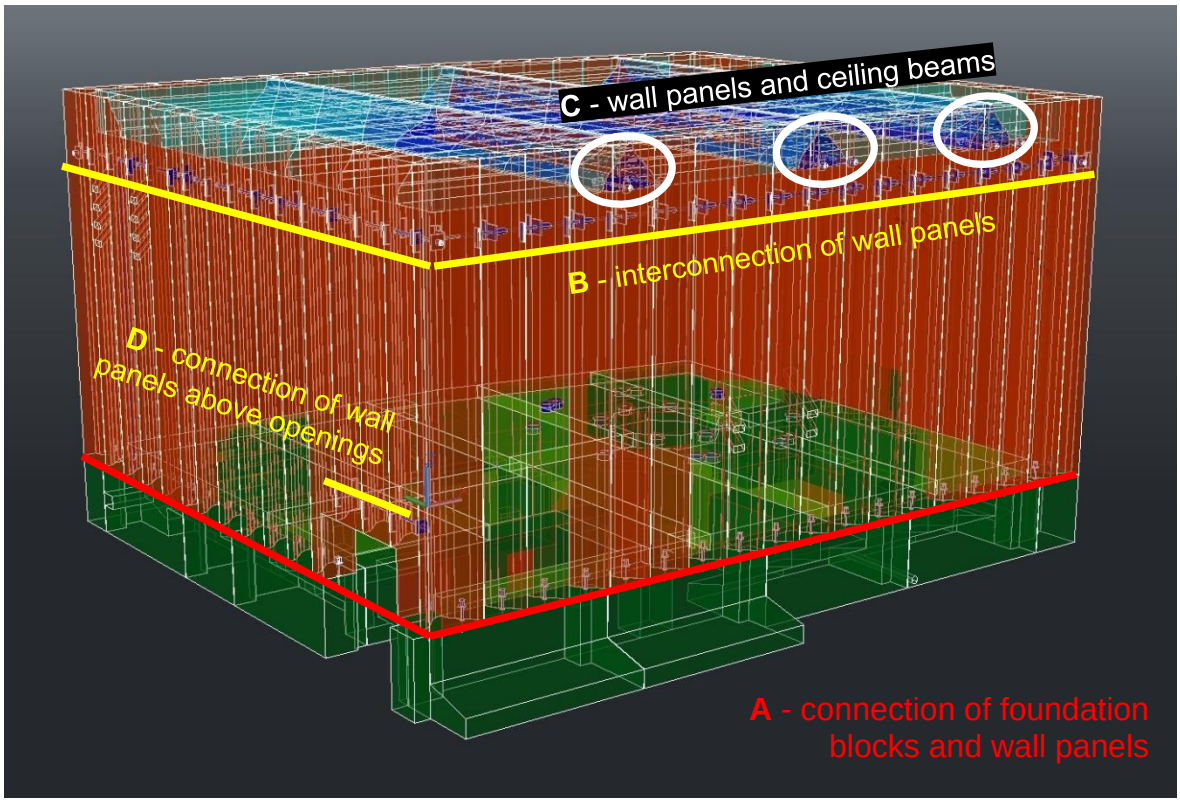
For appropriate drawings see documents [4], [5], [6].

5.1.4 CONNECTIONS OF PRE-CAST PARTS

Generally, the pre-cast panels are mechanical switched to each other by internal steel rods and anchoring plates and then filled with grout. This connection creates a co-operating closed unit that will behave as a monolithic structure. The rigid behavior of the structure will work after activation - tightening of all switching elements of mutual anchoring. The assumption of rigid behaviour of the structure has been implemented in the static assessment of the experimental cave structure in document No. 5043-F-180622 (ESS-0461611) [15], Static analysis and technical report.

The requirement to ensure the rigid connection of the individual pre-cast parts of the Experimental Cave structure must also be achieved with regard to the spreading of the force transmission to the floor of the Experimental hall 3 (E01). The contractor/supplier of the experimental cave structure must take this into account in its pre-production documentation and its working drawings.

The mutual connection systems of the pre-cast parts are designed in the concept of:
A - connection of foundation blocks and wall panels,
B - interconnection of wall panels,
C - connection of wall panels and ceiling beams.
D - connection of wall panels above openings
See below:

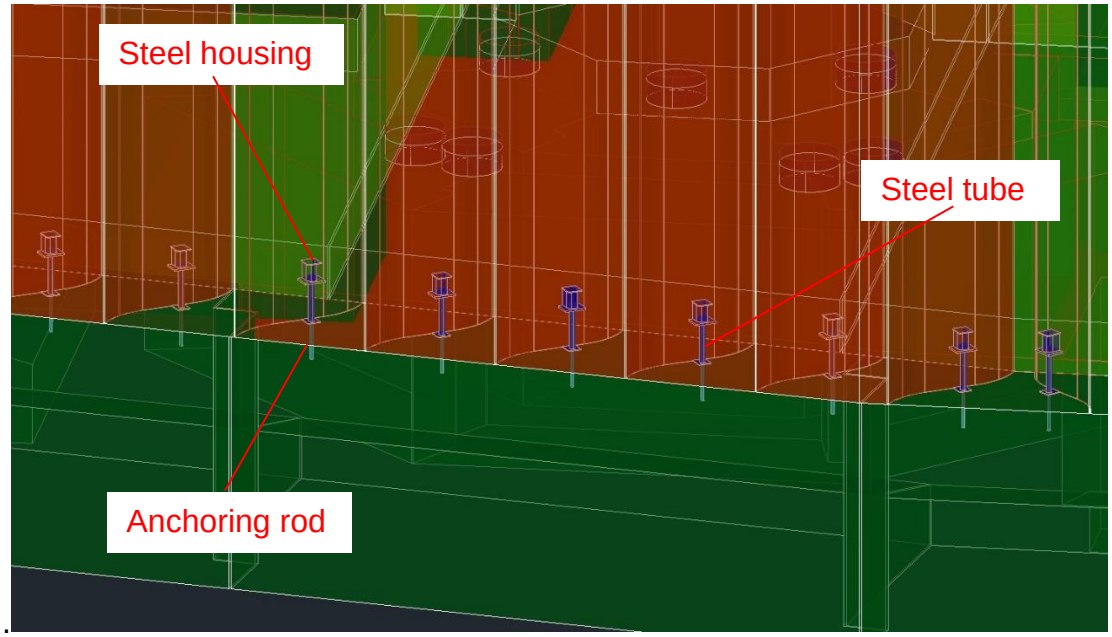


Picture No.5 – view of CO 101 BEER Experimental Cave

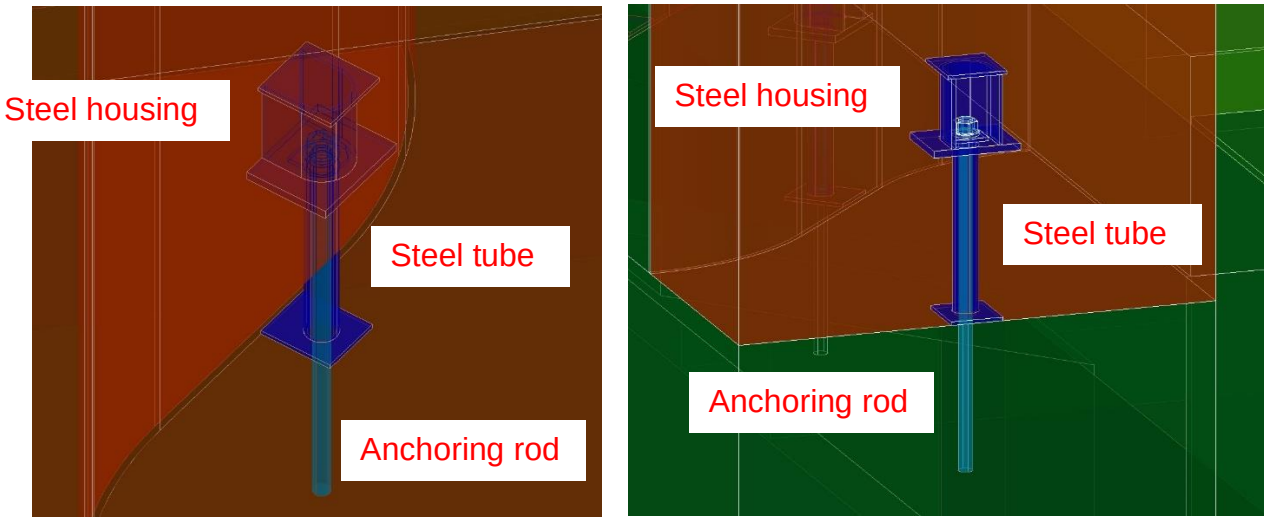
5.1.4.1 A - CONNECTION OF FOUNDATION BLOCKS AND WALL PANELS

The foundation blocks are connected to the wall panels by steel mandrels (threaded rods) built into the foundation block. The wall panel will be mounted on the mandrel, in the lower contact part with a locksmith in-built element - a tube with a housing for insert the tightening nut on the mandrel. The foundation block and wall panels will be connected from the joint between the wall

panels. After rectifying and switching the base and wall panels, the following wall panel can be installed. For illustration see pictures below.



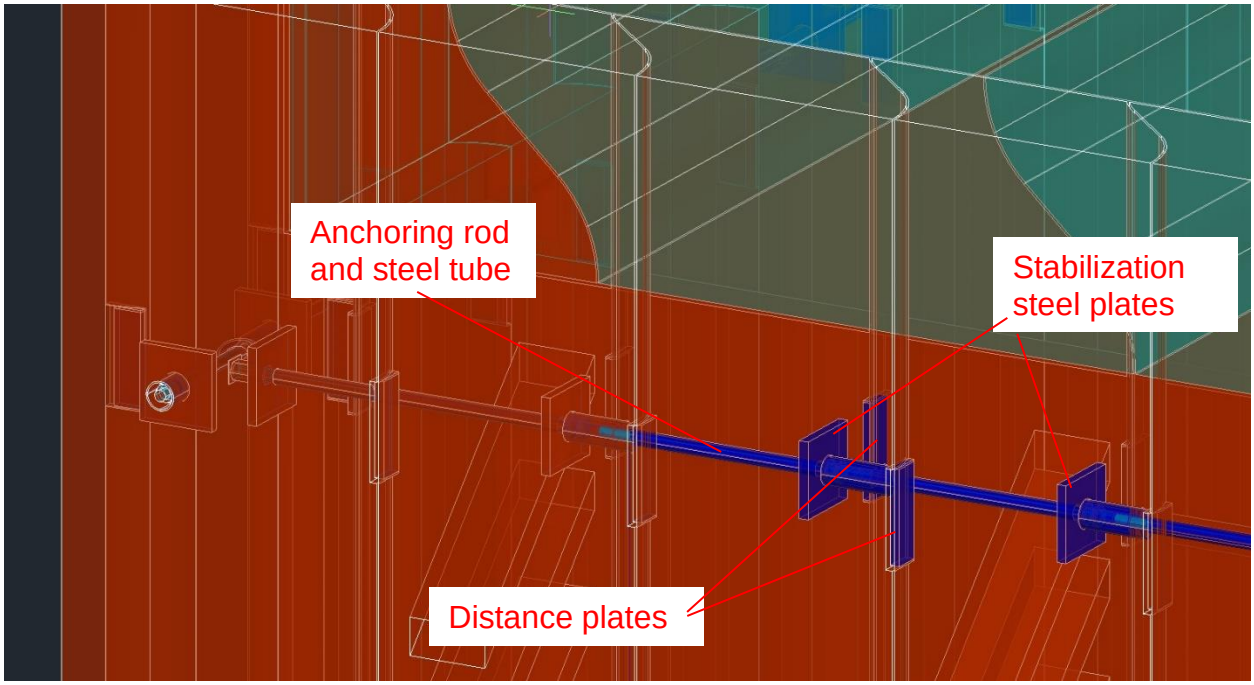
Picture No.6 – view of connection of foundation blocks with wall panels



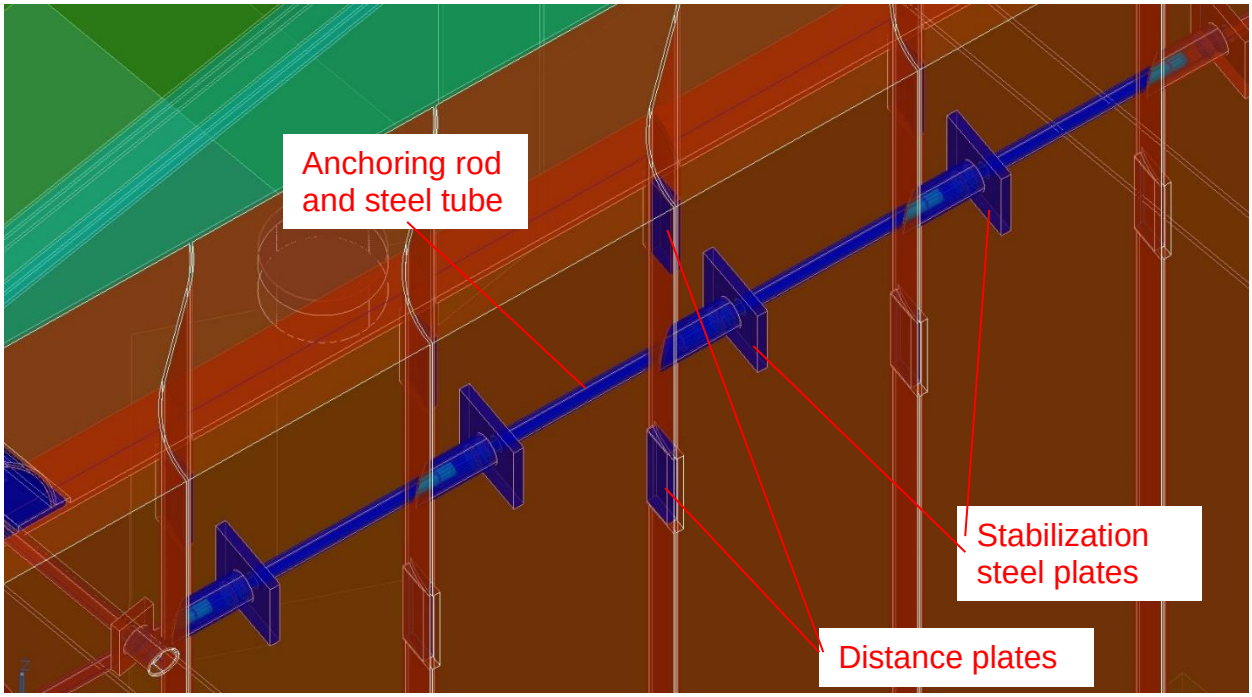
Picture No.7 – detail of foundation block and wall panel connection

5.1.4.2 B - INTERCONNECTION OF WALL PANELS

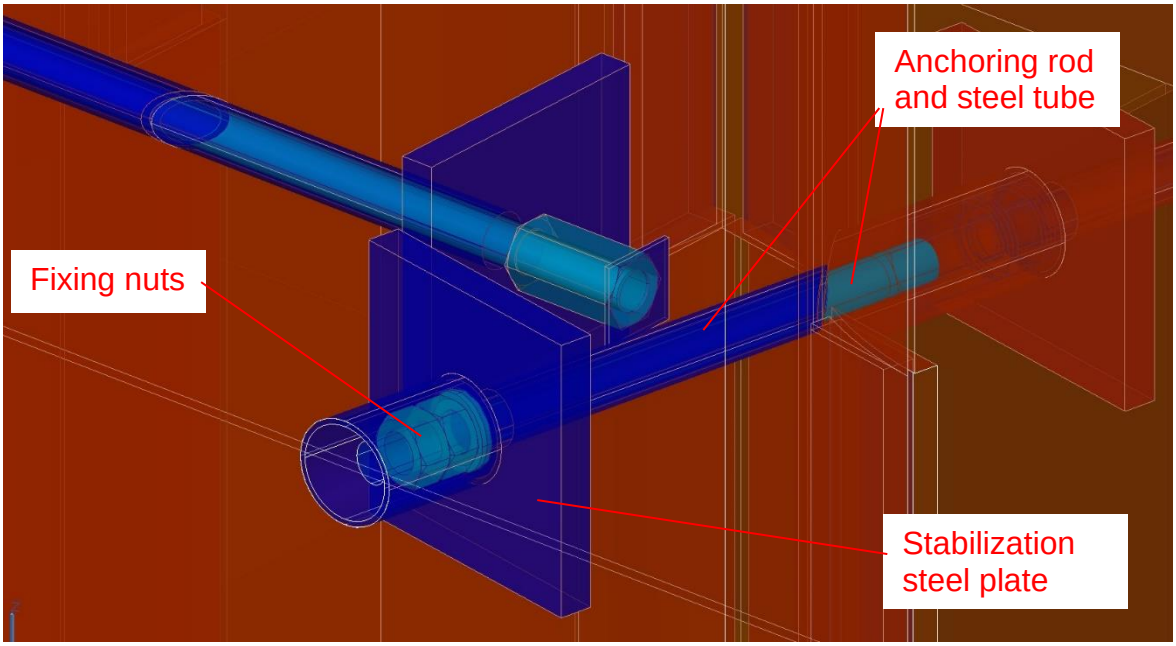
The interconnection of the wall panels is designed in the upper level of the vertical wall panels, approx. 900 mm below the panel head = approx. 200 mm below the level of the ceiling panels. Each wall panel has at its level a factory in-built locksmith element consisting of a tube and a stabilization steel plate which defines the position. A larger diameter steel tube is welded onto the stabilization plate within the joint. A mechanical connection will be made by nuts after insertion of the threaded rod. In addition, the joint at the height level at the factory is fitted with a distance plate at the outer and inner face of the wall panel. After mechanical joining of the panels, these plates define a precise mutual distance in the joint. For illustration see pictures below.



Picture No.8 – view of wall panels connection system



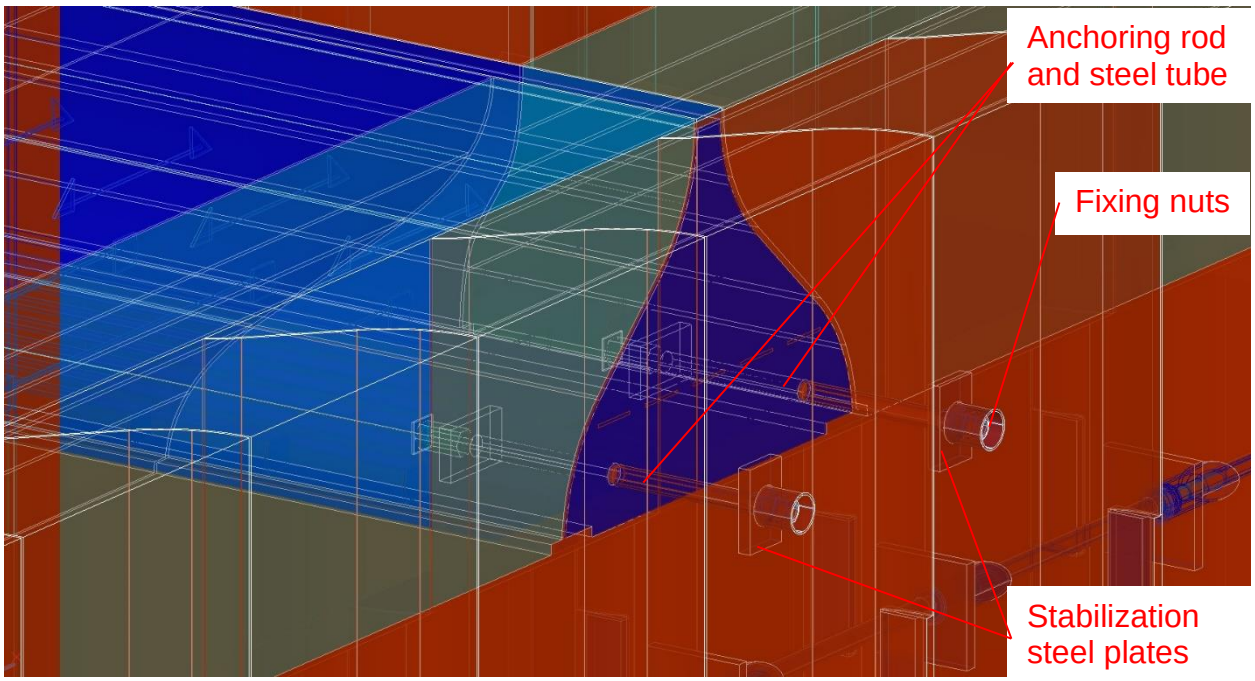
Picture No.9 – view of wall panels connection system



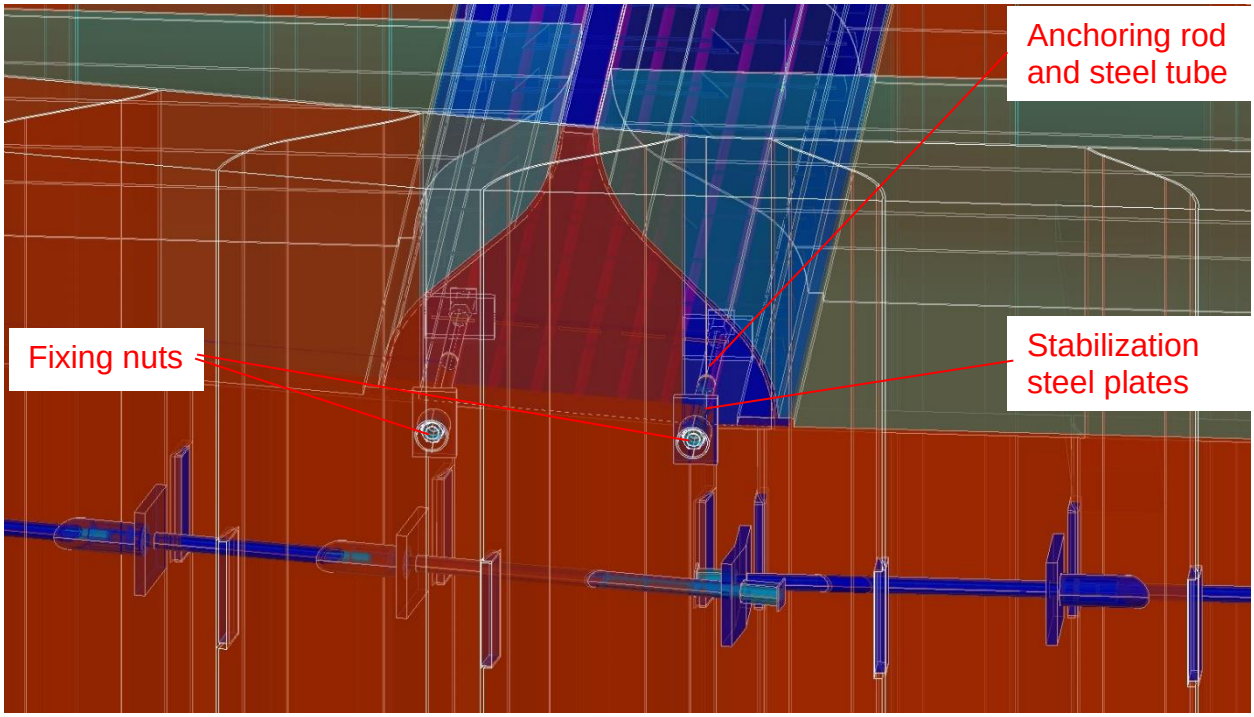
Picture No.10 – detail of wall panels connection system

5.1.4.3 C - CONNECTION OF WALL PANELS AND CEILING BEAMS

Ceiling beams (total 3 pieces) are designed as steel-concrete from prestressed concrete. The ceiling beam will always be placed on the tooth of the vertical wall panel. The head of the ceiling beam will be factory fitted with a locksmith element in the form of a stabilizing steel plate with a welded steel tube with an internal thread installed to insert and tighten the threaded anchoring rod. The threaded rod will be inserted into the head of the beam through the steel sleeve with the switching system in the head of the wall panel (locksmith element - tube with welded stabilizing steel plate inserted from the factory, tightening is possible from external space). For illustration see pictures below.



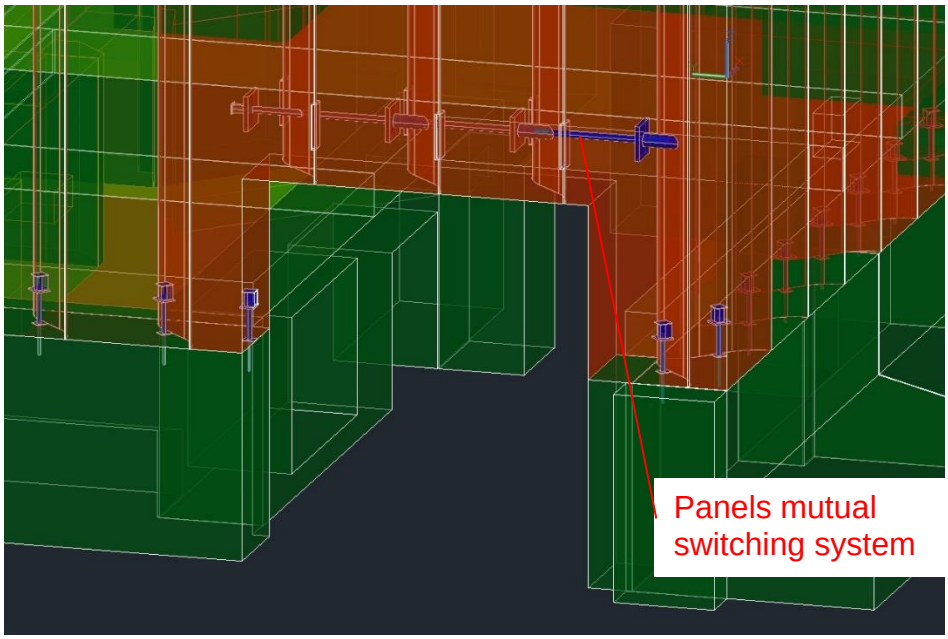
Picture No.11 – view of wall panels and ceiling beam connection



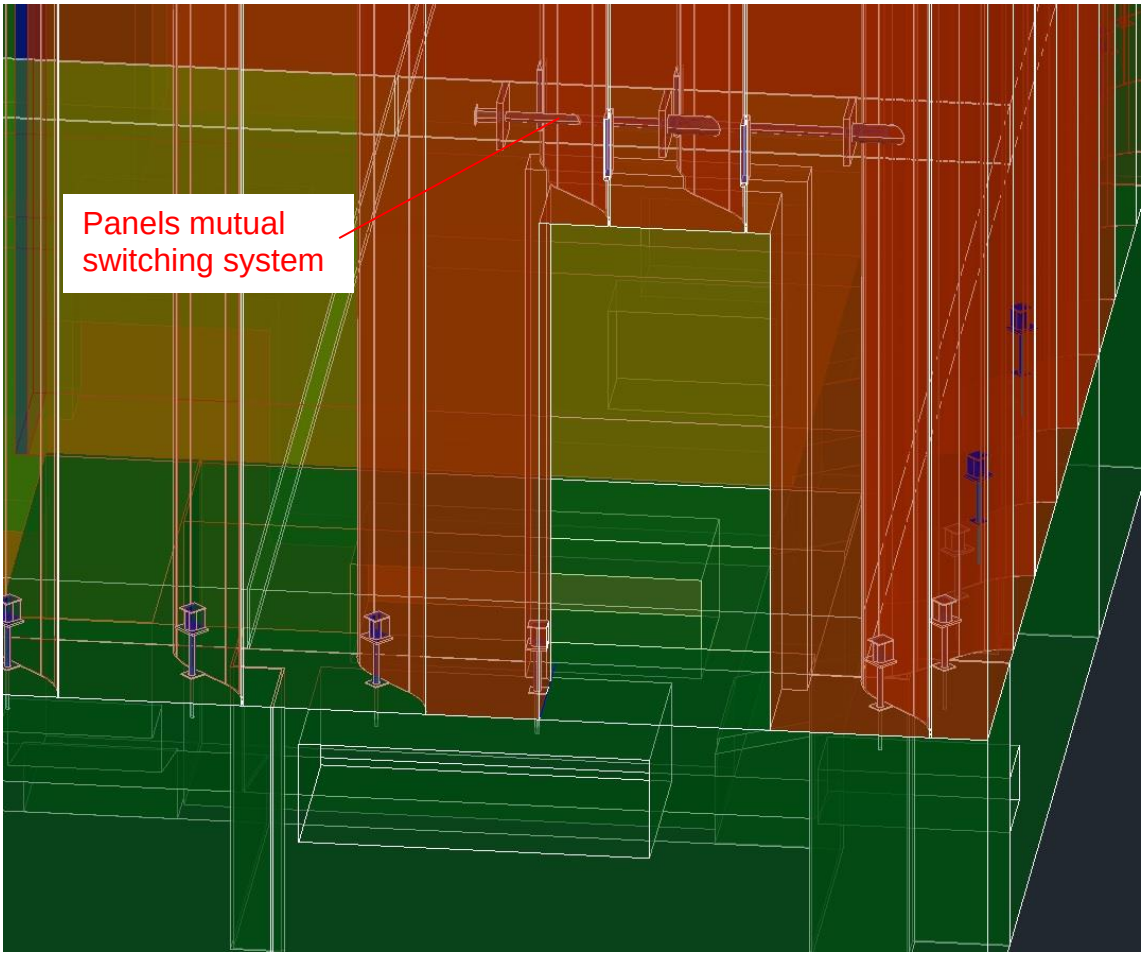
Picture No.12 – view of wall panels and ceiling beam connection

5.1.4.4 D - CONNECTION OF WALL PANELS ABOVE OPENINGS

At the location of the sliding door and the personal entrance to the EC, a sufficient bearing connection of the wall panels must be ensured (the wall panels in the space above the openings cannot be placed on the foundation blocks). Above the openings, the wall panels will be connected by mutual switching in the lower part (at the lintel level) with the anchoring system overlap into the first adjacent wall panels, which are placed on the foundation blocks.
For illustration see pictures below.



Picture No.13 – view of wall panels – opening for heavy sliding door, system of wall panels connection



Picture No.14 – view of wall panels – opening for personal access door, system of wall panels connection

5.1.5 STAIRCASE

The entrance to the EC is from the floor of an Experimental hall 3 (E01) at the level of TCS -3.000 m, using an external steel staircase (Locksmith product 8/Z + railing 9/Z). A steel entrance staircase arm has steps of dimensions 9×166.7 / 290 mm, w=1150 mm (clear 1000 mm). It is designed to overcome the height of 1500 mm. The external entrance arm - stairs follow the exit arm of staircase to enter the control room, on the 2nd floor in the CH. The staircase will be provided with a handrail of 1000 mm height – railing 9/Z.

For appropriate drawings see documents [8], [9], [10], [14].

5.1.6 FLOORS

The floor at the level TCS -1.500 m – on platform (slab of floor panels th=250 mm) in the EC will be provided with a concrete screed (30 MPa) th=36 mm, levelling layer (if needed) – self-levelling screed on cement basis th=3 mm, shielding tiles with B_4C powder and binder (as well as wall cladding – tiles) with th=8 mm, and the flatness of the final surface will be provided with epoxy layer (colour shade provide too) of th=3 mm. Concrete screed th=36 mm is divided in platform slabs dimensions raster by separating insert. The insert is designed in full height of screed 36 mm, th=10 mm (PE foam insert). The insert ensures partitioning into individual segments of floor panels with respect to decommissioning requirements.

Note: material for B_4C tiles is in process of testing. Final choice will be specified as soon as possible.

A number of anchor points are designed in the floor to attach detectors around the sample pit. A total of 18 anchoring points are designed. The anchor point consists of a recess of 145 mm in the floor. During the production of pre-cast floor/platform panels, a 270 mm stainless steel (th.2,0 mm) insert is inserted. The remaining layer of the composition of the floor follows the insert.

Due to the handling of samples on the air cushion, the floor surface will be connected to the floor of the Experimental hall 3 (E01) and the sample preparation area in the ground floor of the CH. To allow the smooth transport using the air cushion platform from the EC transport shaft to the preparatory lab in the ground floor of the CH, the part of the E01 floor (approx. 13.9 m^2) between these places will be levelled by the epoxy layer if necessary. The requirement for a type of surface treatment is raised by the supplier of the air cushion.

For appropriate drawings see documents [1], [2], [3], [4], [5].

Compositions of floors are mentioned above – see chap. 5.1.3

5.1.7 DOORS AND WINDOWS

Personal Entrance to the EC from the staircase area is at the level of TCS -1.500 m, one-wing rotating door, 900×2000 mm, with aluminum door frame, aluminum door wing with komaxit coating. Door wing is full – unglazed.

5.1.8 INSULATION

No thermal and sound insulation are solved to a large extent. The foundation blocks of the EC will be laid on the floor of an Experimental hall 3 (E01). The foundations / walls of Experimental cave are separated from E01 floor slab by strip of heavy bitumen sheet (SBS modified bitumen sheets with glass carrier liner and mineral fine grain on the top surface, total th=4,0 mm). It will insure easy decommissioning of EC structures.

5.1.9 LOCKSMITH'S CONSTRUCTION, WINDOWS AND DOORS

To enter the EC, at a level of TCS -1.500 m, a single-wing rotary door (aluminium wing and Al frame) is designed - dimensions 900×2000 mm. This door is equipped by magnetic lock connected on PSS.
To access the EC transport shaft, level -3.000 m, heavy shielding steel sliding doors of 2000×2200 mm with th=220 mm. This sliding door is solved separately in DPS 01.07 part.
To access the EC Service area (room No. 1.00) is designed simply steel one-wing rotary door by transport shaft. This door's dimension is 1000x1150 mm and it is locksmith's product (7/Z).

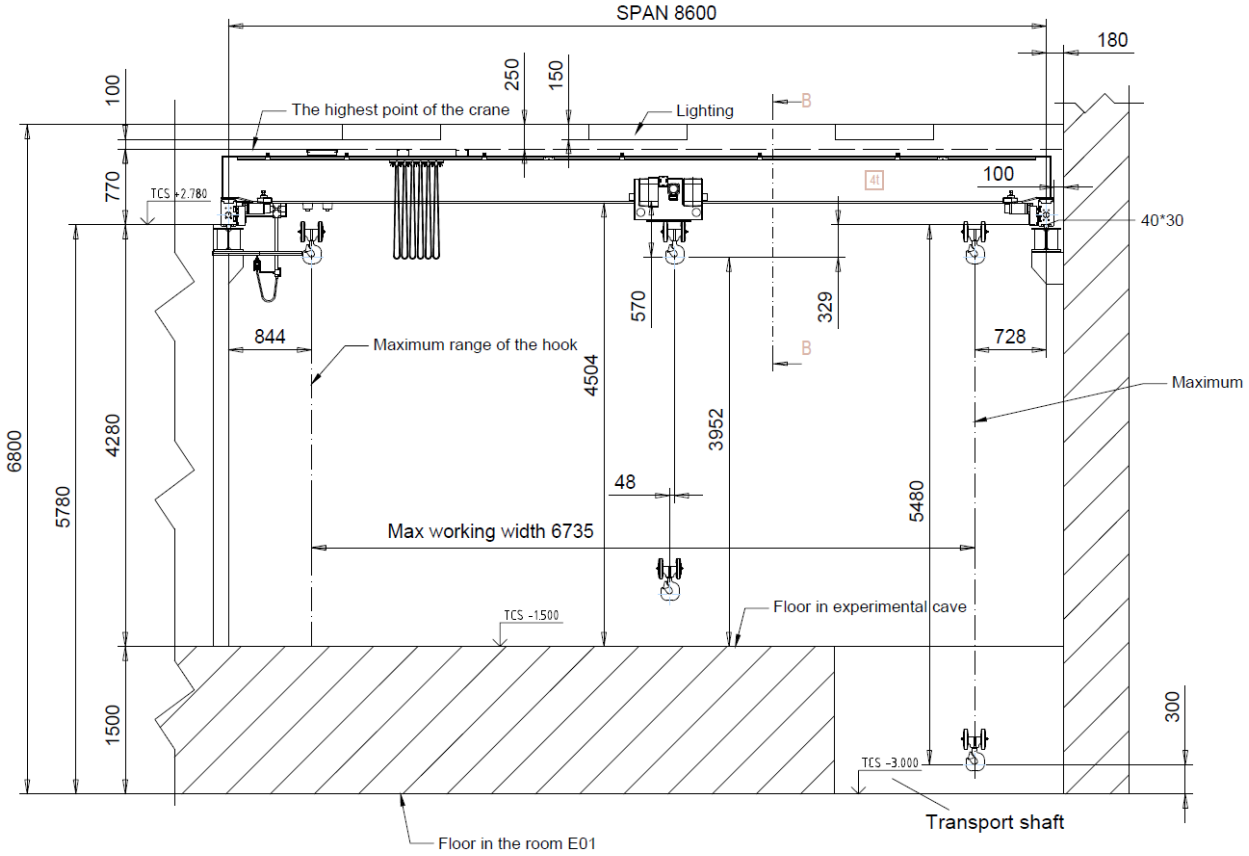
The edge of pit for sample tower will be lined at floor level with a 60×40×5 mm steel L profile octagonal 1-part "ring" fixed to the concrete floor. 1-part octagonal ring has to be fitted in a horizontal position absolutely exactly without any inaccuracies. Octagonal L profile ring will be factory fitted with a set of adjusting screws to allow height adjustment during installation. The ring will be fitted to the finished reinforced concrete platform, but before the floor composition execution (TCS -1.500 m). The top edge of the ring will finally align with the epoxy final layer of the EC platform floor (TCS -1.500 m).

For the crane track and its supporting, it is proposed to install steel support brackets into the EC walls before concreting, on which the crane beams will be installed. These elements are locksmith's products – see drawing arch. no. 5043-D-181795 - [10].

A removable railing from individual parts is designed near the transport shaft for bulky samples or equipment. It is a barrier against falling people. The EC platform will be fitted with side railing holders to fit the railings - see drawing arch. no. 5043-D-181795 - [10].

5.1.10 CRANE TRACK

Below the ceiling will be a crane track for a single-track bridge crane with a load capacity of 4t. Crane tracks will be mounted on brackets and steel anchor plates, with an upper rail level of TCS +2.780 m (crane track). One horizontal beam will be supported in the middle by a steel pillar. The crane track span is 8.6 m.
The steel structure of the crane track will be coated - polyurethane paint, shade 9005 - black.



Picture No.15 – schematic view of bridge crane (situated in EC)

The crane track is detailly solved in **DPS 01.02** part of the documentation.

5.1.11 SURFACE FINISHES

The inside surfaces will be coated with boron carbide tiles (B_4C filler + binder => see note in chap. 5.1.5) to ensure the required maximum dose of 3 μSv/h outside the cave and to protect the reinforcing construction of the walls/ceilling from an activation by thermal neutrons. The boron carbide tiles will be fixed by MS polymer mastic on the inner walls and glued by flexible screed on floor and covered by epoxy layer to ensure flatness and color shade.

<u>Characteristics of B_4C tiles:</u>

- The minimum required B_4C content per 1 m^2 of tiles is 2.8 kg/m^2,
- B_4C (boron carbide) in powder form with a particle size of up to 10 μm,

- The expected thickness of B_4C tiles is 8 mm and a size of 500 x 500 mm.

On the back wall of the cave a beam stop is to be equipped to attenuate the direct neutron beam. The beam stop was modeled as a 20 mm plate of B_4C housed in a lead shell th=30 mm. Total dimension of beam stop plate is 420 x 270 mm, th=50 mm. **Note: beam stop position is HOLD**.

Specifications of designed compositions in EC see chap. 5.1.2 and 5.1.3.

Steel doors, sliding doors and other locksmiths will be fitted with an epoxy coating for steel.

Color solution

The external walls and ceilings of the cave will be made in RAL 1028 - Yellow, (the exact shade will be determined according to the total color solution of the Experimental cave).

Door and gate color is designed RAL 1028 - Yellow, door frame and lining of the ramp in RAL 9005 - Black.

The inside surfaces will be coated with boron carbide tiles (B_4C filler + epoxy binder) – designed color in RAL 7004 – Signal grey.

5.2 CONTROL HUTCH (CH)

5.2.1 BEARING STRUCTURE AND OUTER CLADDING

The two-storey enclosure is designed as mounted with a steel bearing structure – see Construction part in part B of CO 101 Experimental Cave and Control Hutch documentation. Columns are designed from profile HEB 140. Longitudinal beams on second floor and on the roof, are from profile IPE 160. Cross beams sre designed from IPE 140 and the outer beam will be from UPE 140 profile.

Outside dimensions of enclosure are 9.5×4.8 m, h=6.5 m.

The outer cladding is made of plasterboard wall th=100 mm, composed of: 2× plasterboard plate th=12.5 mm with vinyl foil (Durafort), anchored to thin-walled sheet metal profiles, with inserted acoustic insulation of mineral wool th=60 mm. The wall of ground floor is based and anchored directly on the floor of Experimental hall 3 - E01. The optimum depth of anchorage is set to 70 mm.
The anchoring of the column of the CH steel structure must be done non-conducting so as not to interfere with the ground circuit of Experimental hall 3 - E01. The anchors will be drilled out of the existing reinforcement of E01 floor slab so that the anchors are not in contact with the reinforcement.

In the groundfloor peripheral and 2nd floor wall windows are designed with fixed glazing.

For appropriate drawings see documents [1], [2], [3], [4], [5], [7], [12].

Control Hutch – Sample preparation area floor composition (L0)

- finish coating - epoxy layer (RAL 7004 - siganl grey),	th. 3,0 mm
- existing reinforced concrete slab of Experimental hall 3 (E01)	

Control Hutch - peripheral walls (L1)

- outer cladding - plasterboard with vinyl foil approx. Durafort,	th. 12,5 mm
- acoustic insulation - mineral wool (mw) board; thin-walled profiles	th. 60 mm
- inside cladding - plasterboard with vinyl foil approx.. Durafort,	th. 12,5 mm

5.2.2 CEILINGS, ROOF

The ceiling above 1st floor and 2nd floor is made of steel beams, trapezoidal metal sheet and suspended plasterboard ceiling. On the ceiling of 1st floor will be realized mounted floor. On the ceiling of the 2nd floor there will be a roof made of DTD boards and FeZn sheet with finish coating, comaxit, color - gray.

Ceiling + floor above Sample preparation area composition (L2)

- Tread layer of floor – PVC, th. 3,0 mm
- Bearing layer – 2x OSB 3N board, th. 2 x 15 mm
- Impact (acoustic) insulation – mineral wool (MW) board, th. 20 mm
- Bearing layer – DTD board (chipboard plate), th. 16 mm
- Bearing layer – trapezoidal sheet, h. 40 mm
- Empty space in the level of ceiling beams I no. 140, th. 140 mm
- Installation space – hanging ceiling elements, th. 86 mm
- Cassette ceiling in raster (600/600 mm) – bearing profiles, mineral ceiling slabs, th. 15 mm

Ceiling above Control room part composition (L3)

- Bearing layer – DTD board (chipboard plate), th. 16 mm
- Bearing layer – trapezoidal sheet, h. 40 mm
- Empty space in the level of ceiling beams I no. 140, th. 140 mm
- Installation space – hanging ceiling elements, th. 86 mm
- Cassette ceiling in raster (600/600 mm) – bearing
- profiles, mineral ceiling slabs, th. 15 mm

For appropriate drawings see documents [2], [3], [7].

5.2.3 STAIRCASE

The entrance to the control room on the 2nd floor of enclosure (cabin) is by the steel staircase, following the outer steel staircase to enter the Experimental cave. The staircase will be covered with plasterboard with the same surface as the walls from the bottom side of the HVAC engine room. For more steel staircase information see chap. 5.1.4, Staircase of this Technical Report.

5.2.4 FLOORS

The floor in the sample preparation area is the floor of the Experimental hall 3 (E01). The floor surface will be made as a cast floor or concrete floor with an epoxy resin coating. Because of the handling of samples on the air cushion, the floor surface will be connected to the floor of the experimental hall and transport shaft space within the experimental cave.
The floor in the 2nd floor - see chap. 5.2.2, Ceilings, roof.

5.2.5 INSULATION

The walls (outer cladding) and partitions will be fitted with acoustic insulation from mineral wool tl. 60 mm (e.g. Rockwool Airrock ND).

5.2.6 DOORS AND WINDOWS

Entrance to the control room from the staircase area is at the level of TCS +0.600 m, one-wing rotating door, 800×2000 mm, with aluminium door frame, door wing with HPL laminate coating. The entrance to the preparatory lab is from level TCS -3.000 m by one-wing rotating door, 900×2200 mm, with aluminium door frame, door wing aluminium with Comaxite coating, partly glazed. A sectional gate door TCS 3500×2200 mm is designed for the arrival of samples and equipment.
The room illumination and lighting: Primary illumination provides artificial lighting through a system of luminaires. Control room is illuminated with number of aluminium windows with double glassed, fixed transparent - clear glass 2×5 mm. On the ground floor there are 5 windows, in the 2nd floor there are 9 windows.

For appropriate drawings see documents [11].

5.2.7 SURFACE FINISHES

The outer cladding will be made of plasterboards with Durafort vinyl foil, color white. Aluminum profiles, doors and window frames will be in surface finish – comaxite finish, gray color.

6 TECHNICAL AND TECHNOLOGIC EQUIPMENT

6.1 TECHNICAL EQUIPMENT

In the object of the EC and the CH, ventilation will be solved for room ventilation, internal wiring and information and communication technologies. System of HVAC is solved in separate part of documentation **DPS 01.01 (Part C of DD)**.

Electrical part **DPS 01.03 (Part D of DD)** solves:

- power supply distributions from ESS CF superior electrical diagrams to technology and appropriate cables,
- experimental BEER cave building nad CH electrical installation power supply (lighting and sockets) and appropriate cables,
- internal grounding of technology,
- main cable trays in BEER EC, CH including structures, construction, all mounting material, fireproof and sealing material

Utilities and media are brought to the instrument from the gallery. Media include N2, instrument grade compressed air, cooling water low. Utilities include office IT, office comms, power, MPS, PSS, DMSC, and ICS.
The technical facilities are solved in separate parts of the documentation.

6.2 TECHNOLOGICAL FACILITIES

Design of manipulation and transportation devices for transferring platforms with samples for experimental purposes is solved in separate part of the project documentation in part **DPS 01.02 (Part C of DD)**. The transfer is provided by bridge crane and air cushion. These devices are situated in an Experimental Cave and Preparatory lab.
In the object of the EC is designed a crane track for a single-track bridge crane with a span of 8.6 m. The crane will be used for handling samples and equipment in the interior of the experimental cave. The crane is fitted with a rope hoist with a load capacity of 4t. The surface of the crane is polyurethane varnish, in color: bridge - RAL 1033 - yellow, hoist – red.

The neutron diffractometer technology equipment located in the experimental cave space - a separate sample platform (rotating table), detectors, diffractometer end components, etc., are not part of this project.

The entrance for the arrival of bulky samples and/or sample environments is through a shielding sliding door is solved in **DPS 01.07 (Part D of DD)** with dimensions 2000 (width)×2200 (height)x170 (thickness) mm, at level TCS -3.000 m.

7 THERMAL TECHNICAL CHARACTERISTICS OF BUILDING STRUCTURES, WINDOWS AND DOORS

For this type of construction, the necessary requirements for the energy performance of the building are not specified and the thermal-technical assessment of the EC and CH object is not required / not included in this documentation.

Experimental Cave (EC) and Control Hutch (two storey enclosure) are located in the interior of the Experimental hall 3 (E01), therefore construction insulation is not required.

Windows and doors are solved in the relevant chapters of this technical report (chap. 5.1 for EC and chap. 5.2 for CH).

8 STATIC EVAULATION

There is no significant load on the structure and due to massive concrete walls is satisfied with the minimum degree of reinforcement for the concrete skeleton. The cave will be built from pre-cast parts of concrete. Each part of the pre-cast part will be connected by coupling pins and then filled with grout. This connection creates a co-operating closed unit that will behave as a monolithic structure. The concrete cave is only laid on the foundation concrete slab without any connection use in horizontal direction. In this case, horizontal forces are captured by friction between the walls and the foundation concrete slab. Due to heavy weight of cave this connection is satisfied and the structure is safety based.

The ceiling structure is made of pre-cast elements that are supported on the ceiling beams. It will be possible to lift the individual ceiling tiles to create a free space. Ceiling panels will not be connected by coupling pins and the joint between them will not be filled with grout.

In the cave is located crane track a load capacity 4t for transport of testing samples. This crane track will be mounted on the steel beam with cross-section I-400. Steel beam will be located on pre-built plates in concrete skeleton.

9 REFERENCES (LEGISLATION, AND TECHNICAL STANDARDS)

- BEER Concept of Operation – v16 (14.4.2017)
- BEER Preliminary System Design – v8 (14.4.2017)
- EN 1990 (2002+A1 2005) Basis of structural design
- ESS-0002381-Fire Safety Strategy Report.pdf (23.03.2017)
- EN 1990 Basis of structural design
- EN 1991-1-1 General actions - Densities, self-weight, imposed loads for buildings
- EN 1992-1-1 Design of concrete structures - Part 1-1: General rules and rules for buildings
- EN 1993-1-1 Design of steel structures - Part 1-1: General rules and rules for buildings

[1] ESS-0461613 – Ground plan level -3,000 m
[2] ESS-0461614 – Sections 1-1', 2-2', 6-6'
[3] ESS-0461615 – Sections 3-3', 4-4', 5-5'
[4] ESS-0461617 – Ground plan level -1,500 m
[5] ESS-0461618 – Ground plan level +0,600 m
[6] ESS-0461619 – Ground plan of the roof
[7] ESS-0461628 – Cassette ceiling
[8] ESS-0461622 – Staircase 8/Z – section, ground plan
[9] ESS-0461623 – Staircase 8/Z – section, detail 1,2
[10] ESS-0461624 – List of locksmith products
[11] ESS-0461629 – List of doors and windows
[12] ESS-0461626 – Views
[13] ESS-0461627 – Technical report
[14] ESS-0462075 – Railing 9/Z – view, detail 1, 2
[15] ESS-0461611 – Static analysis and technical report, Construction part - concrete structure