BEER - System Integration and Verification Plan

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Revision (1): Components included in Revision (1): Work Unit 1 – Shielding and Work Unit 9 – Instrument Infrastructure

Revision (2): Components included in Revision (2): Work Unit 2 – Neutron Optics

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1. SCOPE

This document describes the activities to be carried out during Phase 4 – Installation and Cold Commissioning of the BEER instrument. The document currently describes those parts of the instrument that are part of the sub-TG3.1 and sub-TG3.2 process, but it is expected to be gradually extended to other parts in the further development of the project.

This document is an early draft which is to be further developed and refined during the Phase 3 and to culminate in a final version for TG4.

The sub-TG3 process described in this document include the following sub-systems:

Experimental Cave [1], that further contains the following PBS sub-systems:

- 13.6.6.5.2 – Experimental cave Utility distribution
- 13.6.6.5.3 – Experimental cave Support Infrastructure
- 13.6.6.5.4 – Experimental cave Shielding
- 13.6.6.5.5 – Experimental cave Structure
- 13.6.6.5.6 – Experimental cave Sample environment utilities supply

Auxiliary System [2], that further contains the following PBS sub-systems:

- 13.6.6.6 – Control Hutch
- 13.6.6.7 – Sample Preparation Area

Beam Transport and Conditioning [3], that further contains the following PBS sub-systems:

- 13.6.6.1.2.1.4 – Transport guide
- 13.6.6.1.2.1.5 – Focusing guide
- 13.6.6.1.2.2 – Guide housing (vacuum) – out of the bunker part
- 13.6.6.1.2.3 – Guide support system – out of the bunker part
- 13.6.6.1.4.5 – Beam shaping slit system
- 13.6.6.1.4.8 – Beam geometry conditioning support and alignment
- 13.6.6.1.4.9 – Exchangeable focussing guide system
- 13.6.6.1.8.3 – Safety Shutter
- 13.6.6.1.10 – Beamline shielding

2. ISSUING ORGANIZATION

Nuclear Physics Institute (NPI) in collaboration with suppliers of the sub-systems as NUVIA and Mirrotron.

3. CONTEXT

The BEER instrument is the engineering instrument dedicated to the in-situ and in-operando studies in the field of material science under real conditions. The novel technique of the pulse modulation will allow the fast strain scanning of even real shape engineering samples.

The experimental cave sub-system includes not only the civil structure of the cave but also the additional supporting sub-systems as power and utility distribution, HVAC and ventilation systems, support for sample environments auxiliary systems. The beam transport sub-system includes safety shutter, neutron guide, neutron guide support system and beamline shielding.

The auxiliary system includes all other sub-systems of the BEER instrument that are not part of the main sub-systems, as a control hutch and preparatory lab.

4. INSTALLATION PLANNING

This chapter describes works to be done for successful installation of the BEER instrument.

4.1. Work units

The works are divided into work units according to the *NSS Project Schedule Guideline* [4] and into installation packages according to the *Information requirements on instrument projects for integration and verification activities* [5].

Installation works are divided into the following work units:

- Work Unit 1 – Shielding (hereinafter also referred to as W.U.1),
- Work Unit 2 - Neutron Optics (hereinafter also referred to as W.U.2)
- Work Unit 9 – Instrument infrastructure (hereinafter also referred to as W.U.9).

The W.U.1 - Shielding includes the following PBS:

- 13.6.6.5.4 – Experimental cave Shielding
- 13.6.6.5.5 – Experimental cave Structure
- 13.6.6.1.10 – Beamline Shielding
- 13.6.6.1.8.3 – Safety Shutter

The W.U.2 – Neutron optics includes the following PBS:

- 13.6.6.1.2.1.4 – Transport guide
- 13.6.6.1.2.1.5 – Focusing guide
- 13.6.6.1.2.2 – Guide housing (vacuum) – out of the bunker part
- 13.6.6.1.2.3 – Guide support system – out of the bunker part
- 13.6.6.1.4.5 – Beam shaping slit system
- 13.6.6.1.4.8 – Beam geometry conditioning support and alignment
- 13.6.6.1.4.9 – Exchangeable focussing guide system

The W.U.9 – Instrument infrastructure includes the following PBS:

- 13.6.6.6 – Control Hutch
- 13.6.6.7 – Sample Preparation Area
- 13.6.6.5.2 – Experimental cave Utility distribution
- 13.6.6.5.3 – Experimental cave Support Infrastructure
- 13.6.6.5.6 – Experimental cave Sample environment utilities supply

4.2. Works description

4.2.1. Work Unit 1: Shielding

4.2.1.1. Experimental Cave

Location of the site: In the hall E01, in the area reserved for the BEER instrument.

Estimated time for its installation: 4 months (it must be specified more accurately in the next phase).

Installation works include the following activities:

- Transportation of concrete blocks and other assembly material to the site. Due to the large volume of concrete blocks and the limited storage space, we consider that the blocks will be imported gradually to the construction site and will be placed in the final position as soon as possible. Three main assembly steps in terms of time are currently being considered: The first step is to deliver and to assemble the foundations and the platform, the second step is to deliver and to assemble the walls, and the third step is to deliver and to assemble the ceiling.
- Surveying of the cave location.
- Installation (laying) of the bitumen foil as a separating layer between the floor in hall E01 and cave.
- Installation of the foundations (see Figure 1).

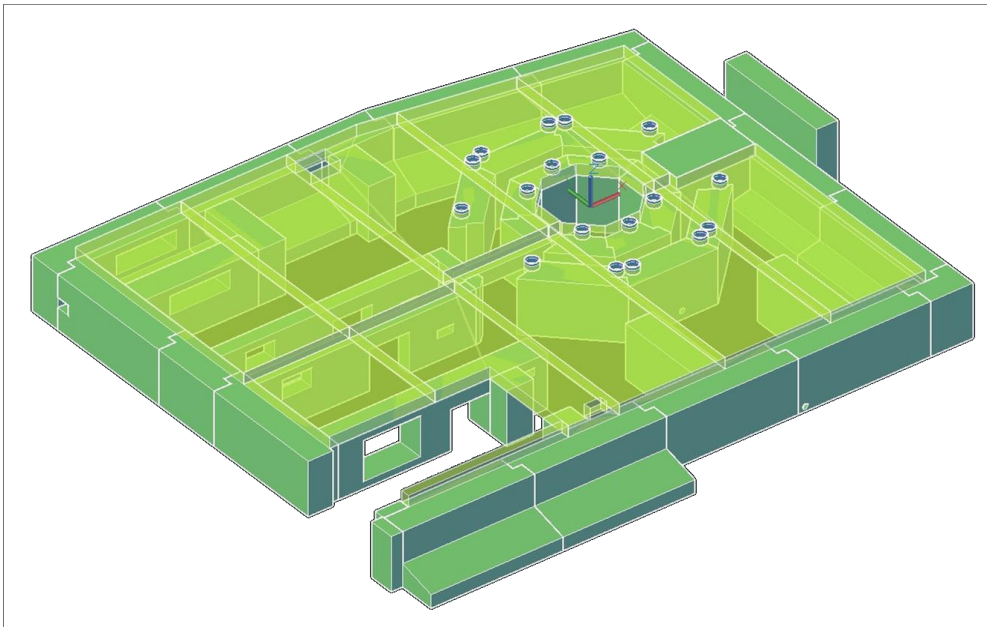


Figure 1: Layout of the experimental cave foundations and elevated platform.

- Installation of the platform blocks (see Figure 1)
- Installation of the walls (see Figure 2).

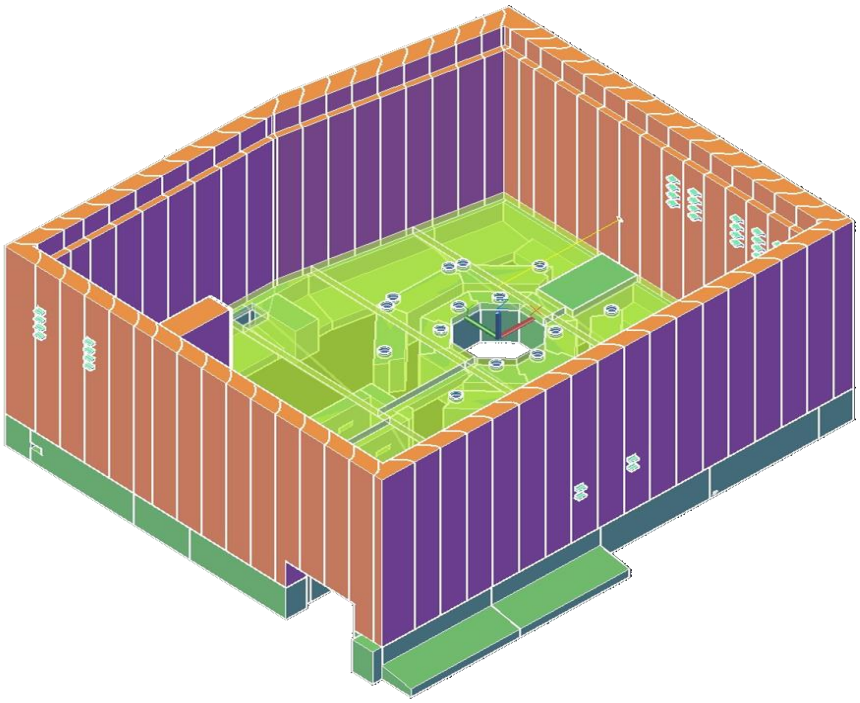


Figure 2: The schematics of the structure of the experimental cave walls.

- Installation of crane track made of steel profiles.
- Installation of the ceiling beams and the ceiling panels (see Figure 3).

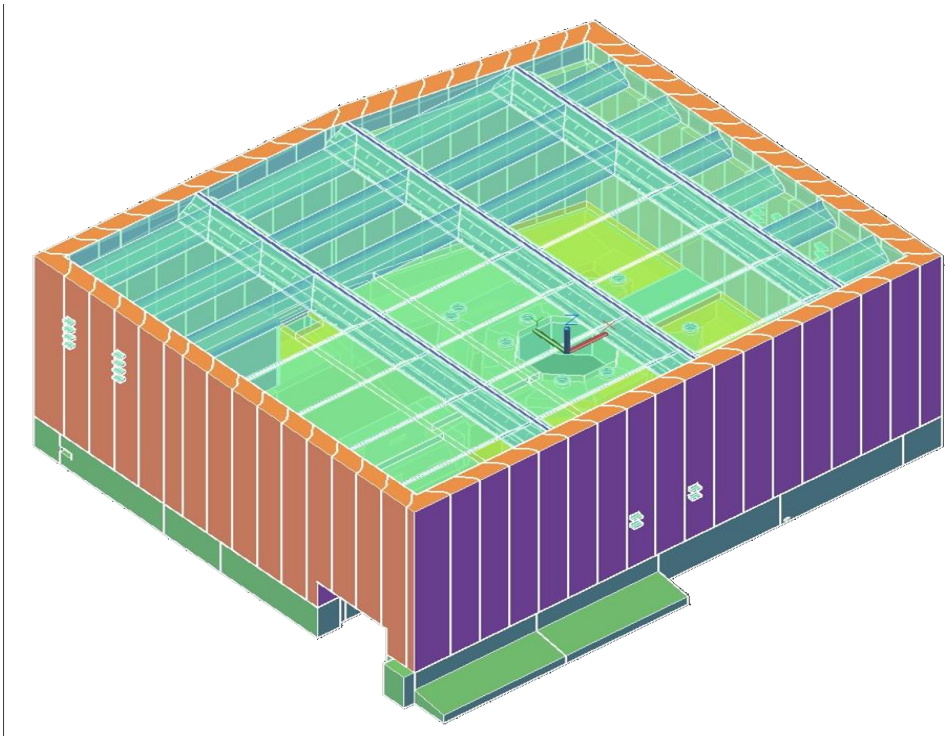


Figure 3: The schematics of the part of the ceiling panels on the experimental cave structure.

- Installation of the cave floor layers (concrete screed, tiles contain B_4C and final epoxy layer).
- Installation of tiles containing B_4C on the walls and ceiling.
- Painting of the walls and ceiling.

4.2.1.2. Beamline Shielding

Location of the site: In the hall E02 (further divided into two sections – E02.1 and E02.2) and D03, in the area reserved for the BEER instrument (along the W2 axis).

Estimated time for its installation: Installation in E02.1 about two months, installation in halls E02.2 and D03 about five months (it must be specified more accurately in the next phase).

Note: The BEER team joined the common shielding project conducted by ESS. This means that the tunnel shielding will be updated within the future revision. But as the tunnel shielding was already a part of the sub-TG3.1, we keep this text here as a preliminary integration and verification actions plan.

Installation works include the following activities:

- Transportation of concrete blocks and other assembly material to the site. The installation is divided into two steps. First, the shielding will be installed in E02.1 then the shielding in halls E02.2 and D03. For this reason, we assume that the delivery of the concrete blocks to the site will also be divided into these two steps.
- Surveying of the beamline shielding location.

- Implementation of local levelling of hall floor (where it is needed). The levelled layer will be done by cement screed.
- Installation of wall and ceiling blocks in section E02.1.
- Installation of elevation blocks in D03.
- Installation of the shielding parts in the concrete wall separating halls D03 and E02.
- Installation of the chopper pit in section E02.2 (chopper pit - see Figure 4).

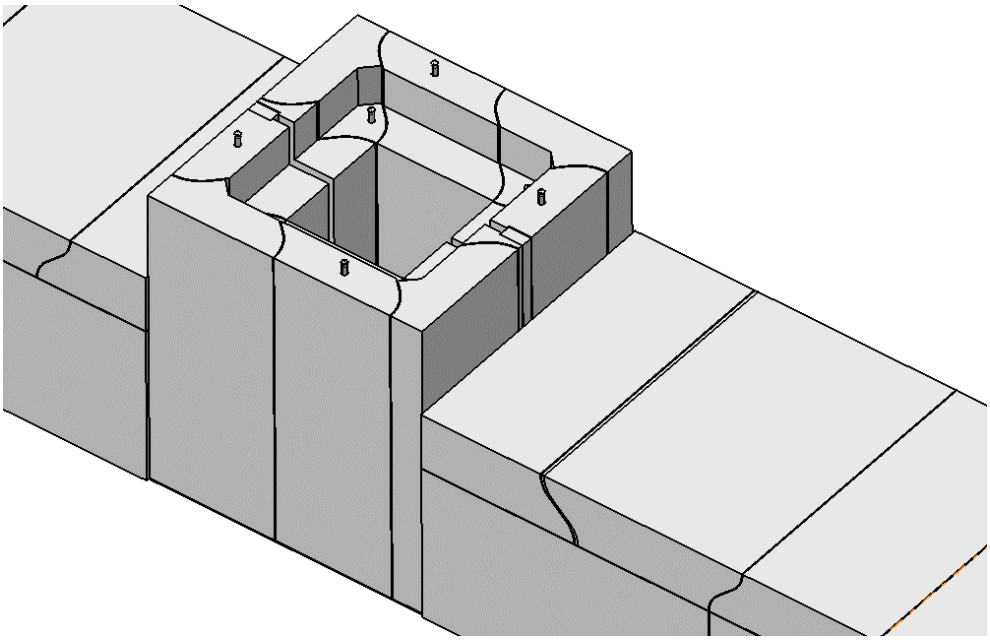


Figure 4: The shielding panels layout of the chopper pit in E02.2

- Installation of wall and ceiling blocks in section E02.2.
- Installation of the shutter pit in D03 (shutter pit – see Figure 5). The walls and ceiling are three-layer structures. A more detailed procedure for their installation will be added in the next phase after consultation with the manufacturer.

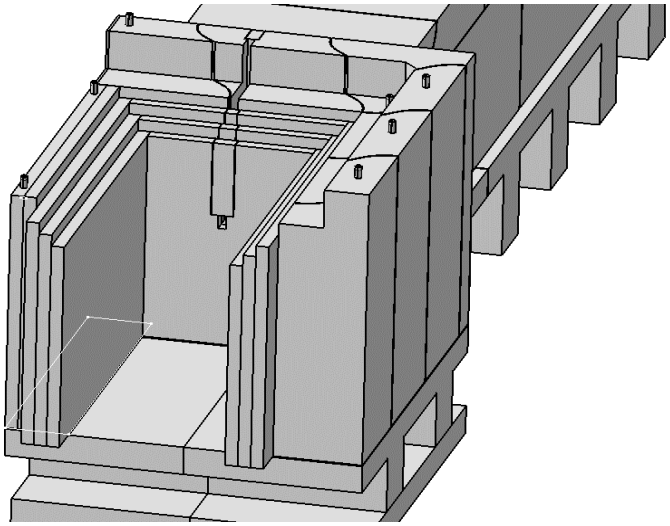


Figure 5: The layered structure of the shutter pit in D03.

- Installation of wall and ceiling blocks in section D03.
- Before the installation of the guides, the beamline shielding assembly will be partially dismantled for the access of the guide assembly workers and then re-assembled.

4.2.1.3. Heavy Sliding Door

Location of the site: In the hall E01, fixed to the cave rear wall to cover the sample access opening.

Estimated time for its installation: About one month (it must be specified more precisely in the next phase).

Installation works include the following activities:

- Transportation of door parts to the site – how much the individual parts will be assembled together at the manufacturing site before their transport to the site it must be discussed with the manufacturer in the next phase.
- Surveying of the position of the plates for consoles on the cave rear wall.
- Installation of the plates for consoles (see Figure 6) – plates are anchored to the cave rear wall with chemical anchors.
- Installation of the consoles (see Figure 6) – welded to plates.

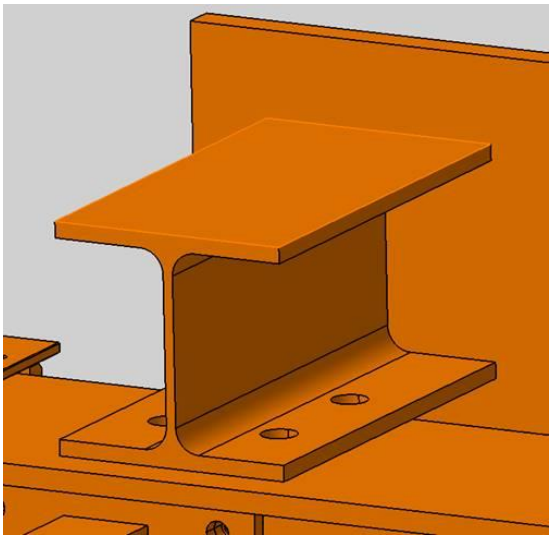


Figure 6: Plate and console for the supporting beam of the heavy door.

- Installation of the supporting beam (see Figure 7) – beam bolted to the consoles.

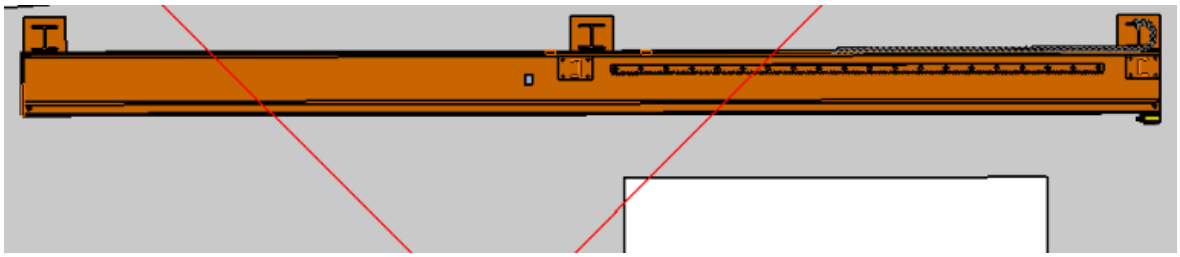


Figure 7: Whole supporting beam schematics above the door opening.

- Installation of the first part of carriages and shielding wing.
- Installation of the second part of carriages and shielding wing.
- Installation of mechanical and electrical components (drive, position switches, etc.). See Figure 8 for the complete door assembly.

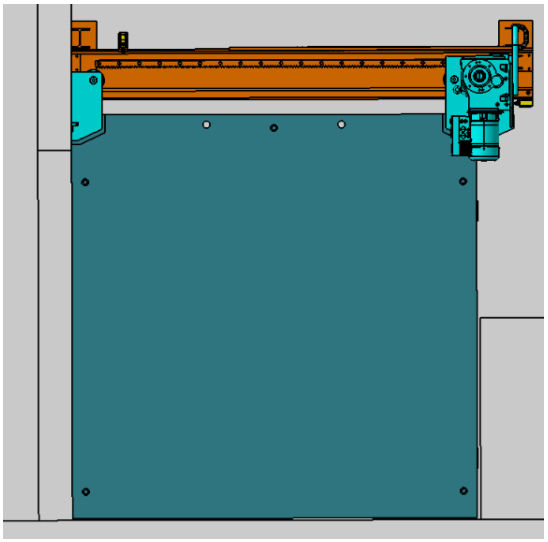


Figure 8: Heavy sliding door assembly when the shielding door is closed.

4.2.1.4. Safety Shutter

Location of the site: In the hall D03, axis W2, near the bunker wall.

Estimated time for its installation: About two months (it must be specified more accurately in the next phase).

Installation works include the following activities:

a) Transportation of shutter parts to the site – how much the individual parts will be assembled together at the manufacturing site before their transport to the site it must be discussed with the manufacturer in the next phase. We assume that the frames and the pneumatic piston will be assembled together before to their installation on site.

b) Surveying of the shutter position in D03.

c) Installation of the shutter frames (yellow and green parts – see Figure 9), pneumatic piston and the mock-up of the beam-stop (due to the weight of the original beam-stop only a mock-up made of lightweight material will be used in this step).

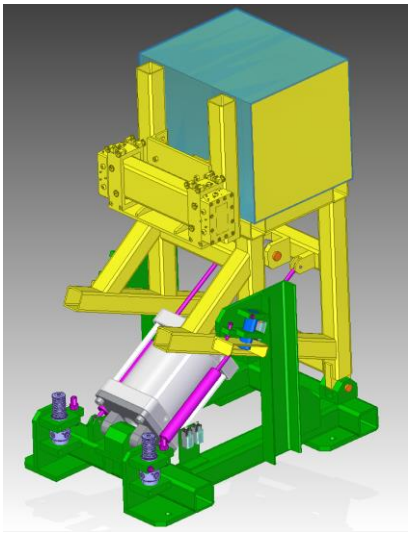


Figure 9: Design schematics of the safety shutter assembly.

- Checking the correct position – positioning in the marked area, close and open several times to avoid spatial collision with the pit walls or other equipment near the shutter).
- Final marking of places for anchoring the shutter structure.

Temporary relocation of the shutter assembly from its final position.

- Drilling holes into the base concrete block and mounting expansion anchors.
- Placing the shutter assembly in the final position.
- Checking the final location of the shutter assembly and tightening of anchors.
- Placing and fixing the beam-stop to the shutter assembly.
- Placing and fixing the guide insert to the shutter assembly.

- Final settings – positioning, collision control, checking the function of the shutter.

4.2.2. Work Unit 2: Neutron Optics

4.2.2.1. Neutron optics assembly on the safety shutter

Location of the site: In the D03 hall just after the bunker wall.

Description of the works and schedule dealing with the installation of this part of the neutron optics system is described in the separate document *BEER - Guide installation plan* [6].

4.2.2.2. Transport neutron optics out of the bunker, focusing optics and slit systems

Location of the site: It passes from the D03 into the E02 hall.

Description of the works and schedule dealing with the installation of this part of the neutron optics system is described in the separate document *BEER - Guide installation plan* [6].

4.2.2.3. Guide exchanger and guide exchanger optics

Location of the site: In the BEER experimental cave located in E01.

Description of the works and schedule dealing with the installation of this part of the neutron optics system is described in the separate document *BEER - Guide installation plan* [6].

4.2.3. Work Unit 9: Instrument infrastructure

4.2.3.1. Control Hutch and Sample Preparation Area

Location of the site: In the E01 hall, in the area reserved for the BEER instrument. Both spaces are in one two-storey building behind the cave rear wall. In the ground floor, there is the sample preparation area. The upper floor is the control hutch.

Estimated time for its installation: About two months (it must be specified more accurately in the next phase).

Installation works include the following activities:

- Transportation of structural components to the site. For anchoring to the hall floor - there is a plate welded to the foot of each column.
- Installation of steel columns and steel supporting structure of the ceiling between the floors. The columns are fixed to the hall floor with chemical anchors. The steel parts are connected to each other by screw connections (the steel structure is shown in Figure 10).

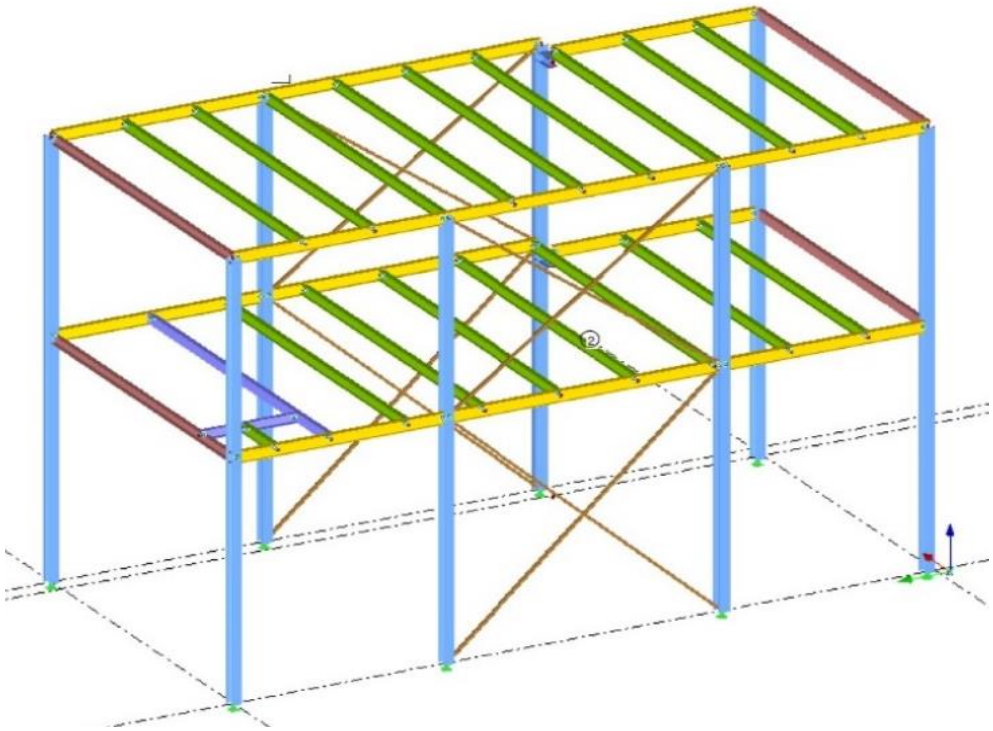


Figure 10: Steel structure of control hutch

- Installation of steel supporting structure of the ceiling above the control hutch (see Figure 10) and of steel staircase structure.
- Installation of the bearing layers of the ceilings/floors: trapezoidal sheet and particleboard.
- Installation of the bearing aluminium structure for the plasterboard walls, partitions and windows. Installation of door frames.
- Installation of the plasterboard walls and partitions – outside of the wall, application of acoustic insulation.
- Installation of the plasterboard walls and partitions – inside the wall.
- Installations of windows.
- Installation of the floor layers in control hutch (acoustic insulation, 2x particleboard and a final layer made from PVC).
- Installation of suspended ceilings in control hutch and sample preparation area (mineral cassettes in a raster of 600/600 mm).
- Installation of doors and sectional doors.

4.2.3.2. Electrical Installations

Location of the site: In the halls E01 and partly also in E02 (the ESS main cabinet is located in E02.1).

Estimated time for its installation: About two months (it must be specified more accurately in the next phase).

Installation works include the following activities:

- Transportation of components to the site.
- Installation of cable trays (see Figure 11) incl. grounding straps.

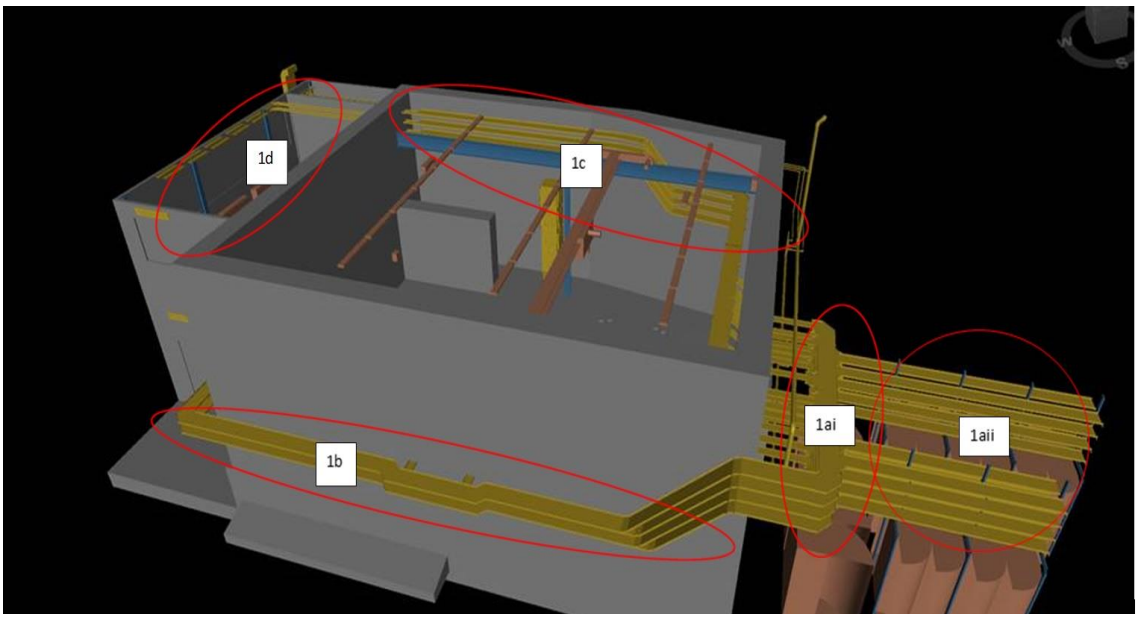


Figure 11: Cable trays

- Installation of distribution boards (1x in the sample preparation area, 1x in control hutch).
- Installation of power cables between the ESS main cabinet and the instrument distribution boards.
- Installation of lighting in the experimental cave.
- Installation of power cables inside the experimental cave.
- Installation of lighting in the sample preparation area and the control hutch.
- Installation of power cables inside the sample preparation area and the control hutch.
- Installation of power cables for instrument technical equipment (doors, crane) and HVAC.
- Installation of socket boxes SES inside the experimental cave and installation of power cables for their connection.
- Testing and revision of the electrical installations.

4.2.3.3. Utilities Distribution and Support Infrastructure

Location of the site: In the halls E01.

Estimated time for its installation: About two months (it must be specified more accurately in the next phase).

Installation works include the following activities:

- Transportation of components to the site.

- Installation of air handling unit (AHU) in HVAC engine room (the AHU is shown in Figure 12).

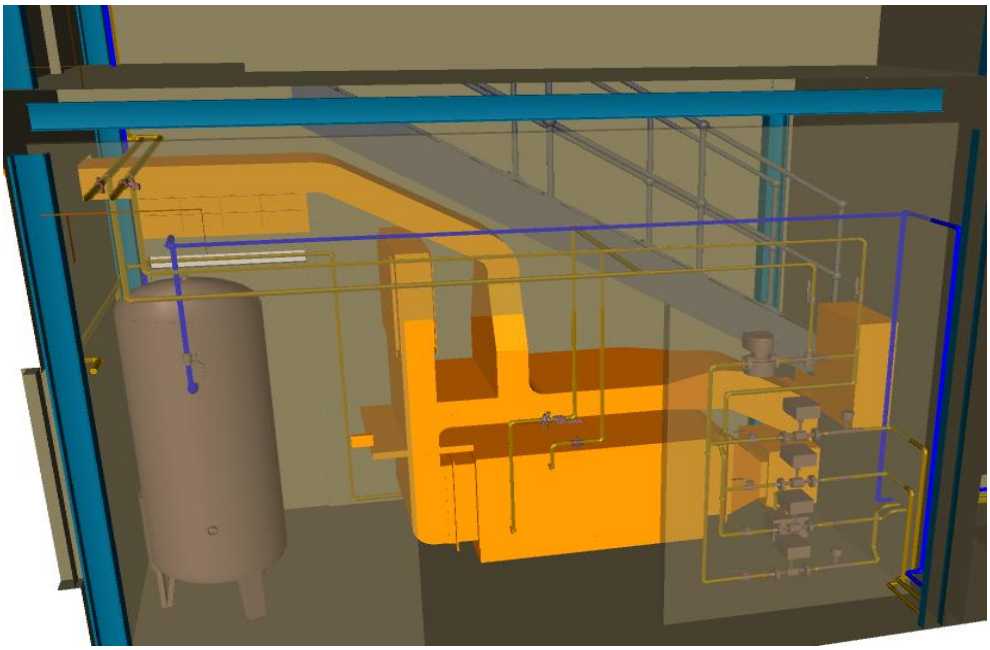


Figure 12: Air handling unit and air tank in the HVAC engine room

- Installation of ventilation duct in the cave. The duct is partially placed under the cave platform (see Figure 13).

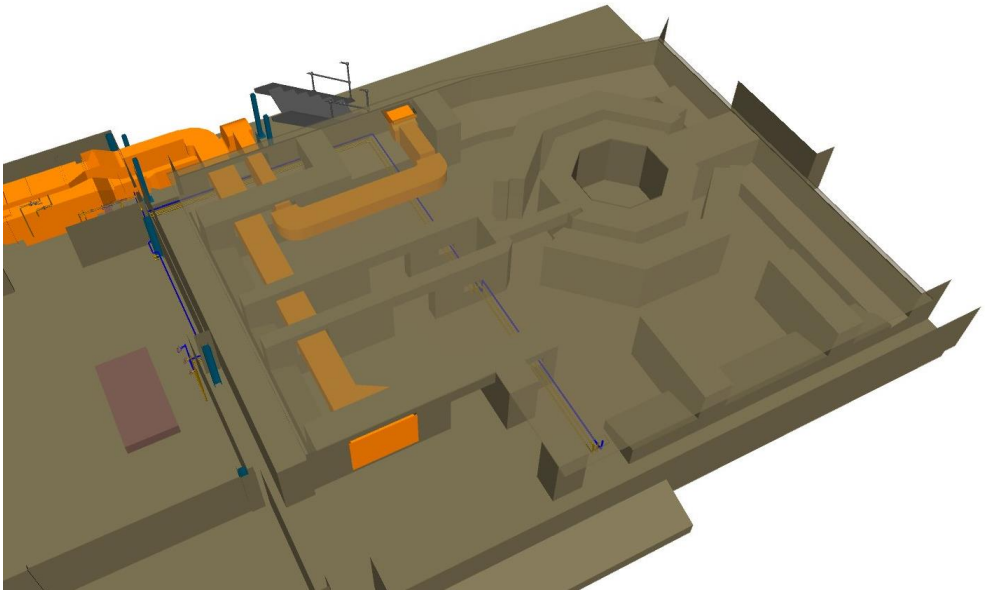


Figure 13: Ventilation duct under the cave platform

- Installation of an air tank in the HVAC engine room (the air tank is shown in Figure 12).
- Installation of fan-coils in the control hutch and sample preparation area.

- Installation of compressed air connection from ESS connection point to the air tank.
- Installation of compressed air pipelines in the cave and in the sample preparation area.
- Installation of cooling water connection from ESS connection point to the air unit and to the cave.
- Installation of nitrogen connection from ESS connection point to the cave.
- Installation of active air ducts from the ESS connection point to the cave.

4.2.3.4. Bridge Crane and Air Cushion

Location of the site: In the halls E01, inside the experimental cave.

Estimated time for its installation: About one month (it must be specified more accurately in the next phase).

Installation works include the following activities:

- Transportation of components to the site.
- Installation of the crane track (2x IPE profile placed on the consoles that are fixed to the cave walls).
- Assembly of the crane from individual components inside the cave.
- Lifting of the crane assembly and installation on the track.
- Assembly of air cushion from individual parts.
- Testing and commissioning of both devices.

4.3. Project schedule

The project schedule for sub-TG3.1 parts was created in accordance with the document NSS instrument project schedule guideline [4] and can be found in *APPENDIX 1* of this document. The schedule was created in MS Project. The individual activities listed in the schedule are broken down by work units, phases and PBS.

Project schedule dealing with the installation of the part of the neutron optical systems out of the bunker (sub-TG3.2) is depicted in *APPENDIX 2* of this document and together with the installation plan can also be found in the separate document *BEER - Guide installation plan* [6].

The project schedule is a draft which is to be further developed and refined during Phase 3 and to culminate in a final version for TG4. In particular, the schedule for Phase 4 Installation and Cold Commissioning will be further developed in detail during Phase 3 after consultation with each contractor/subcontractor involved in the installation. In the current project schedule, the activities in Phase 4 are only broken down by the expected installation packages to create a timeframe of Phase 4. These activities will be further divided into more sub-activities (detailed breakdown of Phase 4) during Phase 3.

In addition, the accuracy of the current schedule is influenced by the fact that the date of signing of the Technical Annex is not known at the time of writing this document. This affects and will affect the scheduling of phases 3 and 4.

4.4. Installation packages

The installation of the instrument is divided into installation packages. The parts that are included in sub-TG3.1 have been sorted into the following installation packages (I.P.):

- I.P.1 – Experimental Cave Shielding, Experimental cave Shielding (PBS 13.6.6.5.4, 13.6.6.5.5)
- I.P.2 – Beamline Shielding in E02.1 area (PBS 13.6.6.1.10)
- I.P.3 – Beamline Shielding in E02.2 and D03 area (PBS 13.6.6.1.10)
- I.P.4 – Heavy Sliding Door (PBS 13.6.6.5.4)
- I.P.5 – Safety Shutter (PBS 13.6.6.1.8.3)
- I.P.6 – Control Hutch and Sample Preparation Area (PBS 13.6.6.6, 13.6.6.7)
- I.P.7 – Electrical Installations (PBS 13.6.6.5.3)
- I.P.8 – Utilities Distribution and Support Infrastructure (PBS 13.6.6.5.2, 13.6.6.5.3, 13.6.6.5.6)
- I.P.9 – Local Crane and Air Cushion (PBS 13.6.6.5.3)
- I.P.10 – Neutron guides system in E02.1 area (up to the part W02-18 included) except parts slit SL1 and W02-19 (PBS 13.6.6.1.2.1.4, 13.6.6.1.2.1.5, 13.6.6.1.2.2, 13.6.6.1.2.3)
- I.P.11 – Neutron guides system in E02.1 area (parts slit SL1 and W02-19) and in the cave area (PBS 13.6.6.1.2.1.5, 13.6.6.1.2.2, 13.6.6.1.2.3, 13.6.6.1.4.5, 13.6.6.1.4.8, 13.6.6.1.4.9)
- I.P.12 – Neutron guides system in E02.2 and D03 area (PBS 13.6.6.1.2.1.4, 13.6.6.1.2.2, 13.6.6.1.2.3)

Each I.P. represents the entire number of physical components. An individual installation readiness review (IRR) is intended for each of these I.P.

5. INSTALLATION BINDER

The scope of documentation that is subject of review before installation starts is defined in Installation Binder. The installation documentation is a subject of Installation Readiness Review and shall be approved before installation works start.

The purpose of the Installation Binder is to collect all documents required to perform the site works. It shall contain documents produced during preparation of the works as well as documents produced during the installation.

ESS Installation Binder consists of folders described below.

5.1. List of Documents

This folder provides a list of all the documents under the other folders in the binder. Convenient for the overview, downloading or printing all the documents.

5.2. Scope of Work

This folder in the binder should provide a description of work in general terms, like:

- Interfaces;
- Boundaries and extent of activities to be performed (E.g. test/commissioning activities to be included.);
- Responsibility matrix.

5.3. Organisation

This folder should contain or refer to the following information:

- Project site organisation;
- In-kind / Contractor site organisation;
- Telephone/mail list to all site personnel.

5.4. Time Schedule

This folder should contain schedule information for the installation package, like an extract/snapshot from the planning system.

5.5. Risk Assessment Method Statement (RAMS)

This folder should contain information about:

- Installation sequence;
- Transportation route interference check;
- Job hazard analysis.

These documents will be provided by the Installation company under an installation contract.

5.6. Temporary services

This folder should contain information about the needed temporary services, like:

- Scaffolding;
- Laydown Areas (Storage);
- Site logistics;
- Cranes;
- Lifting;
- Temporary power and fluids;
- List of concrete boring and drilling;
- Etc.

These documents will be prepared according to the current state and shall be elaborated in more detail by the Installation company if necessary.

5.7. Drawings

This folder should only contain drawings related to installation works, like:

- Equipment Layout;
- Structural drawings;
- Isometric drawings;
- Mechanical drawings;
- Piping Layouts;
- Cable layout;
- Electrical drawings/diagrams;
- P&ID;
- Etc.

5.8. Installation procedures

This folder should contain information about installation procedures, like:

- Welding Procedure Specification;
- Electrical procedures;
- Cold bending;
- Anchor bolt installation procedure;
- Coupling installation procedure;
- Etc.

The installation procedures will be provided by the contractor/subcontractor.

5.9. Work permits

This folder should contain information about both Certificates and Permits (gathered during installation).

Certificates:

- Hot work;
- Forklift
- Crane;
- Etc.

Permits:

- Hot work;
- Electrical work;
- Ladder;
- Etc.

5.10. Daily diary

This folder should contain the notes of important/main activities, or events that occurred during the day. It is also used for reporting to management or as turn-over notes to other shifts.

5.11. Non-Conformity Report (NCR)

This folder should contain the Non-conformity reports and follow up lists.

5.12. QC – Installation & Test documentation

This folder should contain the inspection plans, protocols and certificates like:

- Inspection plans:
  - Structural installations;
  - Mechanical installations;
  - Electrical installations;
  - Pressure test program;
  - Etc.;
- Protocols:
  - Welding protocols;
  - NDT protocols;
  - Material certificates;
  - Pressure test protocol;
  - Couplings installation protocols;
  - Anchor installation protocols;
  - Visual inspection protocols;
  - Marking identification;
  - Corrosion protection;
- Installation Certificate of compliance.

5.13. List of Components & Material

This folder should contain lists giving information about components and materials for installation.

5.14. Reference documents

This folder should contain all other reference documents:

- Sketches;
- Manuals;
- Datasheets.

5.15. Test Readiness Review (TRR)

This folder should contain all documents regarding performed Test Readiness Reviews.

6. SITE PREPARATION

6.1. Interfaces definition end requirements

For installation of all packages:

- Halls are roofed and closed, no unauthorised access to installation areas, incl. other workers.
- Installation areas reserved for the instrument are clear without materials for other purposes.
- The real flatness of the floors is as declared.
- Material storage areas are available and free of material for other purposes.
- The access road is free and has spatial parameters as declared.
- Complete the bunker wall in the W2 axis.
- Min. temperature 10°C.
- Provide power and water supply for installation purposes.
- All the hall cranes are in operation, other lifting equipment provided by ESS is available.

To connect and test the instrument infrastructure:

- All utilities connection points are available to connect the instrument infrastructure (power, chilled water, nitrogen, compressed air, containment air etc.)
- All utilities in the halls are completed and put into operation and have the parameters as declared.

6.2. Transportation ways

Transportation ways should be defined by ESS based on these documents and plan of other installation works.

The most demanding in terms of logistics will be the transport and temporary storage of concrete blocks for all shielding structures. Their transport to the site will have to be planned in detail in the next stage and in close cooperation with the NSS Installation Coordinator. However, this applies to transport planning for other large parts such as heavy sliding door, steel structures etc.

6.3. Scaffolding needs

Scaffolding needs will be defined in more detail in the next phase. In most cases, mobile scaffolding and work platforms are intended to be used.

6.4. Cranes needs

Cranes needs will be defined in more detail in the next phase. The main need for cranes in terms of time will be for the unloading and installation of concrete shielding blocks. The use of all cranes and lifting equipment in all halls is expected.

6.5. Power and fluid needs

Three-phase and single-phase power and water will be needed shortly before installation.

6.6. Sanitary requirements

Sanitary requirements should be stated by ESS according to Swedish standards and the number of personnel on-site.

6.7. Lockable storage space

Lockable storage space for equipment and personal should be available for the installation companies on site.

6.8. On-site services

Various services and equipment will be available to rent on site. A separate document with a list of available services and equipment will be provided to the installation companies by ESS

7. RESOURCE PLANNING

7.1. Manpower needs

It is assumed that most of the workers who will carry out the installation work described in paragraph 4.1 will be employees of the contractor or subcontractor. In the next phase, their number will be planned for each activity throughout the installation. It is expected that the largest number of workers will be on-site at the time of finalizing the interior of the experimental cave and parallel installation of the control hutch. At this time, the total number of workers could be around 20 persons. In the other steps of the installation, a lower number of workers – up to 10 persons – is considered.

Regarding the staff provided by ESS - we assume the use of surveyors and qualified operators of cranes and other lifting equipment. Shortly before the installation, it is assumed that the temporary site switchboard is connected by an electrician provided by ESS.

7.2. Personnel qualifications

Installation must be carried out by qualified personnel according to the installation manual for each component.

7.2.1. Electricians

All works on electrical installations shall be carried out in accordance with local electrical safety regulations.

7.2.2. Welders

Welders and welding operators shall have passed the examination with approved results, according to EN ISO 9606 or EN 287-1 respectively EN ISO 14732. The certification shall be carried out by an Accredited Certification Body.

7.2.3. Authorisation for testing and inspection

Personnel carrying out NDT tasks shall have undergone training, examination and certification according to EN ISO 9712 or an equivalent system.

7.2.4. Crane drivers, slingers and signallers

Crane drivers, slingers and signallers shall have passed the examination with approved results according to EN 15513 respectively EN 12480-1 and ISO 9926-1 and the Sweden national regulations if applicable.

7.3. Requirements to the equipment, machines and tools

This chapter contains a description of proposed equipment, machines and tools except for the usual electrical or hand tools like drillers, screwdrivers, angle grinders etc.

All equipment, machines and tools shall have electrical inspection or/and other applicable inspections according to internal rules of the Installation company.

For unloading, assembly and installation of heavy components, the following equipment provided by ESS is expected:

- Crane in E01 hall.
- Crane in D03 hall.
- Forklift 5 ton.
- Forklift 10 ton.
- Gantry crane 10 ton.
- Mobile crane 10 ton.

A mobile scaffolding or platform is considered for installation of pipelines, ducts and electrical trays and cables.

8. COLD COMMISSIONING

Detailed cold commissioning procedure will be developed in the next two phases after it has been discussed in detail with the manufacturer and supplier. In the detail design phase, possible SAT procedures are outlined in this chapter.

8.1. Experimental Cave structure

- Visual inspection of the concrete structure:
  - The thickness of the joints between the blocks is within the tolerances.
  - The surface of the blocks is smooth, with no cracks and its flatness is within the tolerances.
  - The ceiling blocks and beams are free of visible deformation.
  - Each block is clearly labelled.
- Visual inspection of B containing tiles inside the cave:
  - The thickness of the joints between the tiles is minimized as much as possible.

- The surface of the tiles is free of cracks.

- Check flatness and integrity of the floor surface in the floor.
- Inspection of surface finish and fixing of small steel elements (railing, safety handles, corner beads, overrun protection, etc.).
- Visual inspection of painting.
- Checking the possibility of disassembling the structure – disassembly and reassembly of selected parts.

8.2. Beamline Shielding

- Visual inspection of the concrete structure:
  - The thickness of the joints between the blocks is within the tolerances.
  - The surface of the blocks is smooth, with no cracks and its flatness is within the tolerances.
  - The ceiling blocks and beams are free of visible deformation.
  - Each block is clearly labelled.
- Visual inspection of steel layer of the shutter pit:
  - The thickness of the joints between the steel parts is minimized as much as possible.
  - The roughness of the inner surface of the steel parts is in accordance with the prescribed parameters.
  - Fixing of individual parts to assembly is in accordance with manufacturing plans.
  - The coating of the steel parts is integral and in accordance with the specification.
- Visual inspection of B containing tiles inside the chopper pit:
  - The thickness of the joints between the tiles is minimized as much as possible.
  - The surface of the tiles is free of cracks.
- Inspection of surface finish and fixing of small steel elements (anti-unauthorized dismantling system, steel lugs, etc.).
- Visual inspection of painting.
- Checking the possibility of disassembling the structure – disassembly and reassembly of selected parts.

8.3. Heavy Sliding door

- Check of the performed FAT protocol and documentation package including:
  - Performed FAT Protocol.
  - Maintenance and User’s manual.
  - Recommended spare parts list.
  - Certificate of compliance.
  - As-built technical drawings (electrical, mechanical).

- Materials certificates/datasheets.
- Main equipment datasheets.
- Instruments calibration certificates.
- Welding Processes qualification.

- Check that all sliding door components are installed on-site according to the documentation package.
- Visual check of main components.
- Visual check of finishing.
- Test of opening/closing of the sliding door (Repeated number of cycles) using ESS BEER control system. During the tests should be checked:
  - The smoothness of the movement: No jerking, no mechanical shocks,
  - Accuracy of open/close position.
  - Clearances sufficient during the movement to avoid any risks of clashes during operation.
  - Sensors signals (including signal to PSS).
  - The time required to open/close the sliding door.
  - Check of input power.
- Test maintainability of the sliding door:
  - Test accessibility of components.
  - Test dismounting/mounting of components.
  - Test preventive maintenance operations.
  - Test of visual information of sliding door status.
- Training of operators.

8.4. Safety Shutter

- Check of the performed FAT protocol and documentation package including:
  - Performed FAT Protocol.
  - Maintenance and User's manual.
  - Recommended spare parts list.
  - Certificate of compliance.
  - As-built technical drawings (electrical, mechanical, pneumatic & process schemes).
  - Materials certificates/datasheets.
  - Main equipment datasheets.
  - Instruments calibration certificates.
  - Welding Processes qualification.
- Check that all shutter components are installed on-site according to documentation package.
- Visual check of main components.

- Visual check of finishing.
- Test of the adjustment operation of the neutron beam guide (including mechanical hard stops) fixed to the shutter by an operator (operator access, accuracy, the time required).
- Check of the vacuum conditions inside the neutron beam guide fixed to the shutter.
- Test of opening/closing of the shutter with normal operation (Repeated number of cycles) using ESS BEER control system. During the tests should be checked:
  - The smoothness of the movement: No jerking, no mechanical shocks,
  - Accuracy and repeatability of neutron beam guide positioning (shutter in opened position).
  - Position of the shielding compared to beam position (shutter in closed position).
  - Sufficient clearances during the movement to avoid any risks of clashes during operation.
  - Sensors signals (including signal to PSS).
  - The time required to open/close the shutter.
  - The behaviour of vacuum hoses during the movement.
  - Check compressed air leakages.
  - Check hydraulic leaks from control rates units and shock absorbers.
- Test maintainability of the shutter (considering space limitation in shutter pit):
  - Test accessibility of components.
  - Test dismounting/mounting of components.
  - Test preventive maintenance operations.
  - Test shutter operation with a local control unit.
  - Test of manual shutter locking.
  - Test of visual information of shutter status.
  - Test shutter rescue system.
- Test access to components during an inspection of the shutter.
- Test access to components around shutter (bunker window, fixed neutron guide).
- Test shutter fails safe function in case of air/electric supply loss:
  - Check that shutter closes.
  - Check the time required to close the shutter.
  - Check the mechanical deformation of the shutter frames.
  - Check the behaviour of shock absorbers.
  - Check the behaviour of vacuum hoses during the movement.
  - Check the position of the shielding compared to beam position (shutter in closed position),
  - Check sensors signals (including signal to PSS)

- Test that the shutter cannot be opened in case after electric/air supply loss.
- Training of operators.

8.5. Control Hutch and Sample Preparation Area

- Visual inspection of the structures:
  - The joints between the plasterboards are not visible.
  - The grid of suspended ceilings in both rooms is symmetrical; no cassette is missing.
  - The joints between windows and walls are tight.
  - The surface of the plasterboards is without mechanical damage.
  - All doors are fitted.
- Testing the functionality of the sectional door - the door moves in the entire range.
- Inspection of surface finish and fixing of small steel elements (railing, staircase, safety handles, corner beads, overrun protection, etc.).

8.6. Electrical Installations

- Check of the following test reports and documentation:
  - Wiring continuity test.
  - Insulation resistance test.
  - Earth continuity test.
  - Performance test.
  - Performed FAT protocols (testing of switchboards, etc.).
  - Maintenance and User´s manual.
  - Certificate of compliance.
  - Material certificates/datasheets.
  - Main equipment datasheets.
- Visual inspection of lighting – light intensity, shadows etc.
- Visual inspection of main components.
- Inspection of trays and their attachment to structures.
- Check of wiring tracing.

8.7. Utilities Distribution and Support Infrastructure

- Visual inspection of main components.
- Testing the operation of the air unit and its regulation.
- Testing the operation of the fan coils and their regulation.
- Air duct tightness control.
- Shut-off valves tightness control (containment air circuit).
- Chilled water – verification of pipe tightness by a pressure test.

- Chilled water – testing of pump and el. operated valves.
- Compressed air – verification of pipe tightness by a pressure test.
- Nitrogen - verification of pipe tightness by a pressure test.
- Inspection of pipe and duct attachment to structures.
- Submission of the following documentation:
  - Performed FAT protocols (testing of switchboards, etc.).
  - Maintenance and User´s manual.
  - Certificate of compliance.
  - Material certificates/datasheets.
  - Main equipment datasheets.

8.8. Bridge Crane

- Visual inspection or manual testing of the following:
  - All fasteners are firm.
  - Safety equipment and devices are installed completely.
  - The crane metal structures are in good condition with no deformation.
  - Wire rope on the pulley and drum is fixed correctly and reliably.
- Check all rotating devices is installed correctly and is able to rotate correctly.
- Crane brake should be accurate and reliable.
- All lubricating points should be lubricated with the required oil.
- Electrical equipment inspection.
- Test preparation – test site cleaning, load preparation, test personnel knowledge of the commissioning aims.
- Bridge crane no-load tests:
  - Trolley/hoist travel test.
  - Crane travel test.
  - No-load hook test.
- Bridge crane static load tests (test procedure according to the manufacturer).
- Movement load tests (test procedure according to the manufacturer).
- Submission of the following documentation:
  - Performed FAT protocols (testing of switchboards, etc.).
  - Maintenance and User´s manual.
  - Certificate of compliance.
  - Material certificates/datasheets.
  - Main equipment datasheets.

8.9. Verification of guide alignment

The installation engineer of Mirrotron will check it throughout the installation process by using laser tracker and laser station equipment. The alignment accuracy will be checked and confirmed by the ESS metrology group as well.

8.10. Functionality test of apertures

- Operating check of the mechanism
- Check of moving range
- Check repeatability

Change aperture window size of slit systems 1, 2, 3 in horizontal and vertical directions between end positions and measure displacement.

Verification of the slit system 3 (sample slit) displacement to different positions from the end position in beamline direction, and it's vertical-removal from the beam.

Note: To be decided whether test at manufacturer workshop is enough

8.11. Functionality test of guide exchangers

- Check of the operation of the mechanism
- Check of positioning accuracy
- Check of repeatability

Set the control program to achieve the required opening position of each changeable item. Check repeatability and measure position accuracy by changing between the idle and opening position of each interchangeable items.

Note: To be decided whether test at manufacturer workshop is enough

8.12. Vacuum test of the neutron guide vacuum housing system

- All neutron guides between the shutter up to the guide exchanger share the same evacuated sector.
- The neutron optical elements on the exchanger have their own vacuum casing.

The main neutron guide sections and the exchanger elements are connected, and the whole system should reach the standard vacuum level for neutron guide vacuum housings (< 0.01 mbar).

8.13. Accessibility of critical parts for re-alignment and maintenance

- Check of operating range of expansion bellows

9. GLOSSARY

Term	Definition
W.U.	Work Unit
I.P.	Installation Package
WBS	Work Breakdown Structure
PBS	Product Breakdown Structure
IRR	Installation Readiness Review
TRR	Test Readiness Review

Term	Definition
W.U.	Work Unit
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
RAMS	Risk Assessment Method Statement
NDT	Non-destructive testing
P&ID	Piping and instrumentation diagram
HVAC	Heating, Ventilation and Air Conditioning system

10. REFERENCES

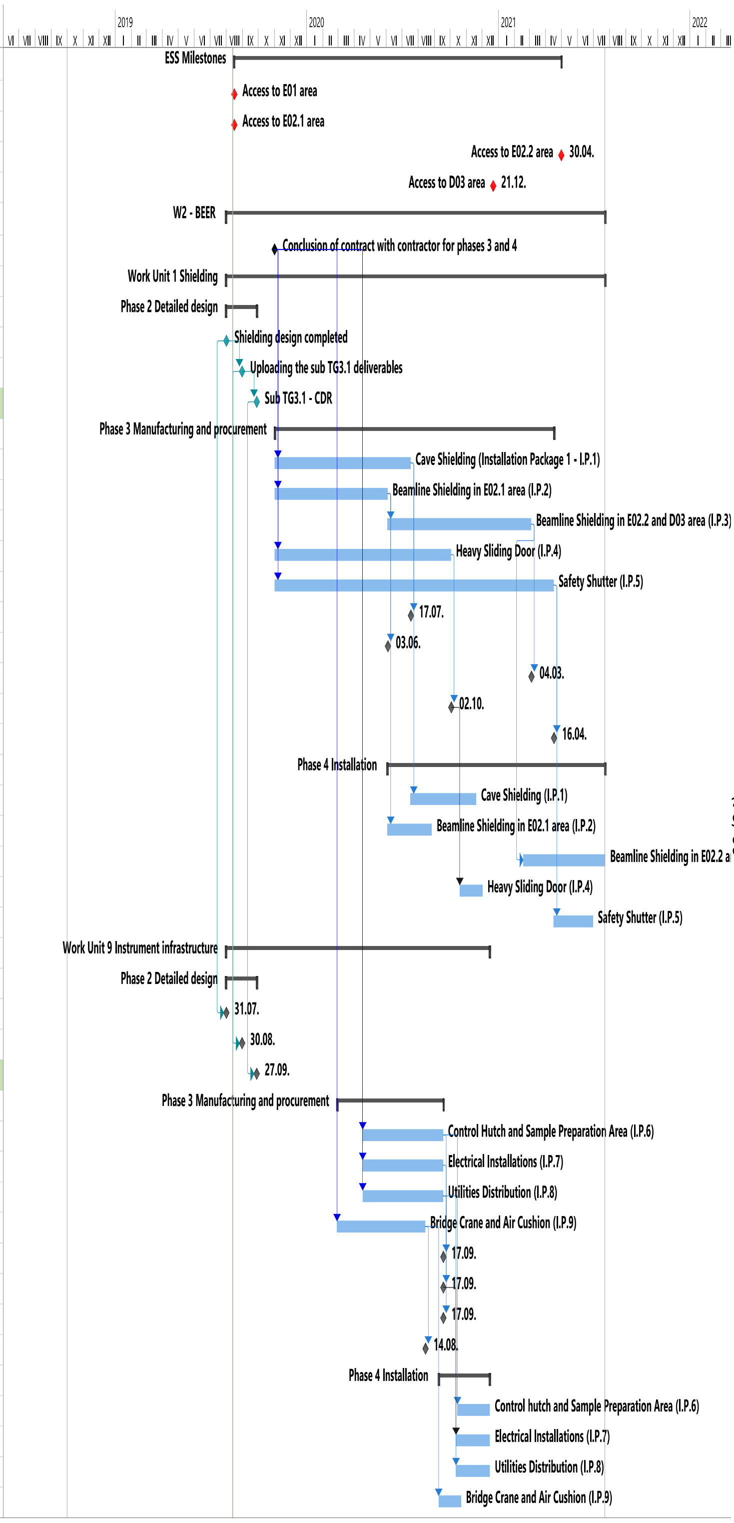
[1] BEER – Sub-System Design Description – Experimental Cave (ESS-0432351)
[2] BEER – Sub-System Design Description – Auxiliary System (ESS-0432355)
[3] BEER – Sub-System Design Description – Beam Transport and Conditioning (ESS-0432123)
[4] NSS instrument project schedule guideline (ESS-0115143)
[5] Information requirements on instrument projects for integration and verification activities (ESS-0115727)
[6] BEER - Guide installation plan (ESS-1838222)

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	R. Švejda	2019-08-16
2	Updated due to new template functionality in CHESS	H Björkman	2016-07-18

APPENDIX 1

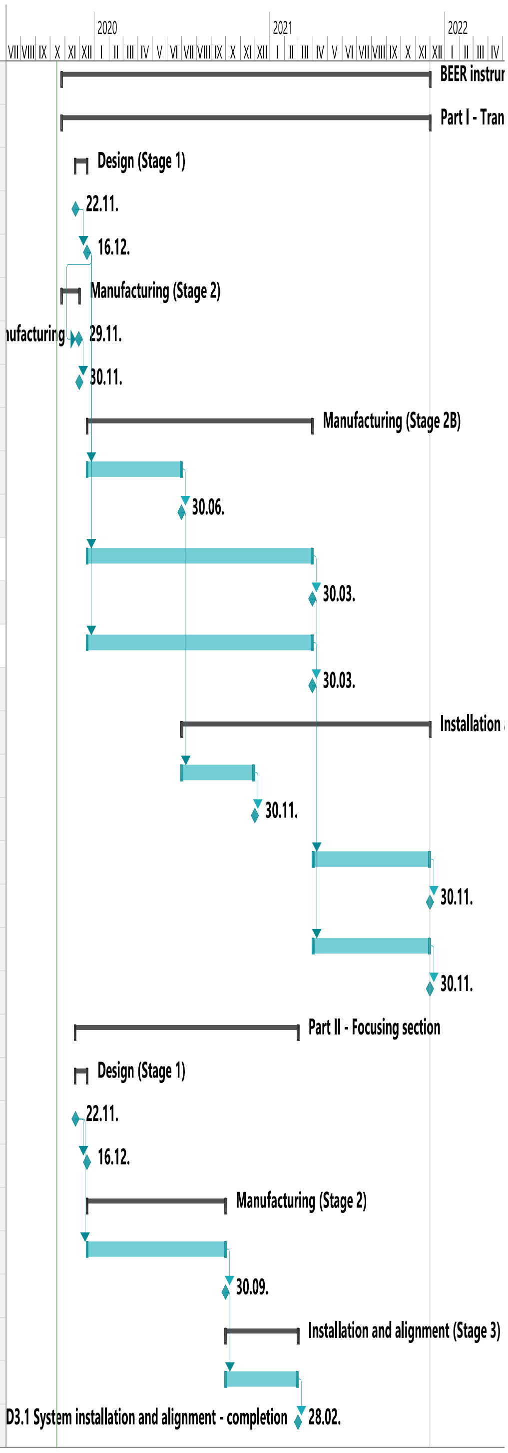
ID	Režim úkolu	Název úkolu	Duaration	Start	Finish
1		**ESS Milestones**	**447 dny**	**15.08. 19**	**30.04. 21**
2		Access to E01 area	1 den	15.08. 19	15.08. 19
3		Access to E02.1 area	1 den	15.08. 19	15.08. 19
4		Access to E02.2 area	1 den	30.04. 21	30.04. 21
5		Access to D03 area	1 den	21.12. 20	21.12. 20
6		**W2 - BEER**	**517 dny**	**31.07. 19**	**22.07. 21**
7		Conclusion of contract with contractor for phases 3 and 4	1 den	31.10. 19	31.10. 19
8		**Work Unit 1 Shielding**	**517 dny**	**31.07. 19**	**22.07. 21**
9		**Phase 2 Detailed design**	**43 dny**	**31.07. 19**	**27.09. 19**
10		Shielding design completed	1 den	31.07. 19	31.07. 19
11		Uploading the sub TG3.1 deliverables	1 den	30.08. 19	30.08. 19
12		Sub TG3.1 - CDR	1 den	27.09. 19	27.09. 19
13		**Phase 3 Manufacturing and procurement**	**381 dny**	**01.11. 19**	**16.04. 21**
14		Cave Shielding (Installation Package 1 - I.P.1)	185 dny	01.11. 19	16.07. 20
15		Beamline Shielding in E02.1 area (I.P.2)	153 dny	01.11. 19	02.06. 20
16		Beamline Shielding in E02.2 and D03 area (I.P.3)	196 dny	03.06. 20	03.03. 21
17		Heavy Sliding Door (I.P.4)	240 dny	01.11. 19	01.10. 20
18		Safety Shutter (I.P.5)	380 dny	01.11. 19	15.04. 21
19		Uploading the sub TG4.1 deliverables (I.P.1)	1 den	17.07. 20	17.07. 20
20		Uploading the sub TG4.2 deliverables (I.P.2)	1 den	03.06. 20	03.06. 20
21		Uploading the sub TG4.3 deliverables (I.P.3)	1 den	04.03. 21	04.03. 21
22		Uploading the sub TG4.4 deliverables (I.P.4)	1 den	02.10. 20	02.10. 20
23		Uploading the sub TG4.5 deliverables (I.P.5)	1 den	16.04. 21	16.04. 21
24		**Phase 4 Installation**	**297 dny**	**03.06. 20**	**22.07. 21**
25		Cave Shielding (I.P.1)	89 dny	17.07. 20	18.11. 20
26		Beamline Shielding in E02.1 area (I.P.2)	60 dny	03.06. 20	25.08. 20
27		Beamline Shielding in E02.2 and D03 area (I.P.3)	112 dny	17.02. 21	22.07. 21
28		Heavy Sliding Door (I.P.4)	31 dny	19.10. 20	30.11. 20
29		Safety Shutter (I.P.5)	53 dny	16.04. 21	29.06. 21
30		**Work Unit 9 Instrument infrastructure**	**359 dny**	**31.07. 19**	**14.12. 20**
31		**Phase 2 Detailed design**	**43 dny**	**31.07. 19**	**27.09. 19**
32		Infrastructure design completed	1 den	31.07. 19	31.07. 19
33		Uploading the sub TG3.1 deliverables	1 den	30.08. 19	30.08. 19
34		Sub TG3.1 - CDR	1 den	27.09. 19	27.09. 19
35		**Phase 3 Manufacturing and procurement**	**145 dny**	**28.02. 20**	**17.09. 20**
36		Control Hutch and Sample Preparation Area (I.P.6)	109 dny	17.04. 20	16.09. 20
37		Electrical Installations (I.P.7)	109 dny	17.04. 20	16.09. 20
38		Utilities Distribution (I.P.8)	109 dny	17.04. 20	16.09. 20
39		Bridge Crane and Air Cushion (I.P.9)	120 dny	28.02. 20	13.08. 20
40		Uploading the sub TG4.6 deliverables (I.P.6)	1 den	17.09. 20	17.09. 20
41		Uploading the sub TG4.7 deliverables (I.P.7)	1 den	17.09. 20	17.09. 20
42		Uploading the sub TG4.8 deliverables (I.P.8)	1 den	17.09. 20	17.09. 20
43		Uploading the sub TG4.9 deliverables (I.P.9)	1 den	14.08. 20	14.08. 20
44		**Phase 4 Installation**	**69 dny**	**09.09. 20**	**14.12. 20**
45		Control hutch and Sample Preparation Area (I.P.6)	43 dny	15.10. 20	14.12. 20
46		Electrical Installations (I.P.7)	46 dny	12.10. 20	14.12. 20
47		Utilities Distribution (I.P.8)	46 dny	12.10. 20	14.12. 20
48		Bridge Crane and Air Cushion (I.P.9)	30 dny	09.09. 20	20.10. 20



Úkol	Souhrn projektu	Ruční úkol	
Rozdělení	Neaktivní úkol	Pouze s dobou trvání	
Milník	Neaktivní milník		
Souhrnný	Neaktivní souhrn		

APPENDIX 2

ID	Název úkolu	Doba trvání	Zahájení	Dokončení
1	**BEER instrument: Optics part**	**548 dny**	**25.10. 19**	**30.11. 21**
2	**Part I - Transport section**	**548 dny**	**25.10. 19**	**30.11. 21**
3	**Design (Stage 1)**	**17 dny**	**22.11. 19**	**16.12. 19**
4	D1.4 Submission of Detailed Design for approval - Tollgate 3 Review (TG3)	1 den	22.11. 19	22.11. 19
5	D1.5 Finalization of the TG3 document package (depending on the review feedback)	1 den	16.12. 19	16.12. 19
6	**Manufacturing (Stage 2)**	**26 dny**	**25.10. 19**	**30.11. 19**
7	Early manufacturing	26 dny	25.10. 19	29.11. 19
8	D2A.1 Manufacturing progress verification with partial FAT	1 den	30.11. 19	30.11. 19
9	**Manufacturing (Stage 2B)**	**336 dny**	**17.12. 19**	**30.03. 21**
10	Timeframe for Manufacturing of the System components for E02-1	140 dny	17.12. 19	29.06. 20
11	D2B.1 First Delivery of System components to the ESS Site: E02-1	1 den	30.06. 20	30.06. 20
12	Timeframe for Manufacturing of neutron optics inserts for the shutter and shutter pit w	335 dny	17.12. 19	29.03. 21
13	D2B.2 Delivery of neutron optics inserts for the shutter and shutter pit wall	1 den	30.03. 21	30.03. 21
14	Timeframe for Manufacturing of the System components for E02-2, D03	335 dny	17.12. 19	29.03. 21
15	D2B.3 Second Delivery of System components to the ESS Site: E02-2, D03	1 den	30.03. 21	30.03. 21
16	**Installation and alignment (Stage 3)**	**370 dny**	**01.07. 20**	**30.11. 21**
17	Timeframe for System installation and alignment in E02-1	108 dny	01.07. 20	27.11. 20
18	D3.1 System installation and alignment in E02-1 - completion	1 den	30.11. 20	30.11. 20
19	Timeframe for System installation and alignment in shutter sector	173 dny	01.04. 21	29.11. 21
20	D3.2 System installation and alignment in shutter sector - completion	1 den	30.11. 21	30.11. 21
21	Timeframe for System installation and alignment in E02-2, D03	173 dny	01.04. 21	29.11. 21
22	D3.3 System installation and alignment in E02-2, D03 - completion	1 den	30.11. 21	30.11. 21
23	**Part II - Focusing section**	**331 dny**	**22.11. 19**	**28.02. 21**
24	**Design (Stage 1)**	**17 dny**	**22.11. 19**	**16.12. 19**
25	D1.3 Submission of Detailed Technical Design for approval - TG3 Review	1 den	22.11. 19	22.11. 19
26	D1.4 Finalization of the TG3 document pack (depending on the review feedback)	1 den	16.12. 19	16.12. 19
27	**Manufacturing (Stage 2)**	**207 dny**	**17.12. 19**	**30.09. 20**
28	Timeframe for Manufacturing of the focusing section	206 dny	17.12. 19	29.09. 20
29	D2.1 Delivery of System components to the ESS Site	1 den	30.09. 20	30.09. 20
30	**Installation and alignment (Stage 3)**	**107 dny**	**01.10. 20**	**28.02. 21**
31	Timeframe for System installation and alignment	107 dny	01.10. 20	26.02. 21
32	D3.1 System installation and alignment - completion	1 den	28.02. 21	28.02. 21



Úkol		Neaktivní úkol	
Rozdělení		Neaktivní milník	
Milník	◆	Neaktivní souhrn	
Souhrnný		Ruční úkol	
Souhrn projektu		Pouze s dobou trvání	