



ESS
Bilbao



**EUROPEAN
SPALLATION
SOURCE**

03. Design and Installation

ESS-Bilbao

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CDR PBW-PB & Vessel - 04 July 2019, Lund (ESS)

Table of contents

- 1 Introduction
- 2 Component Description
- 3 Operation
- 4 PBW System: Insertion and Extraction process.
- 5 Installation
- 6 Disassembling

Introduction

Design and Installation

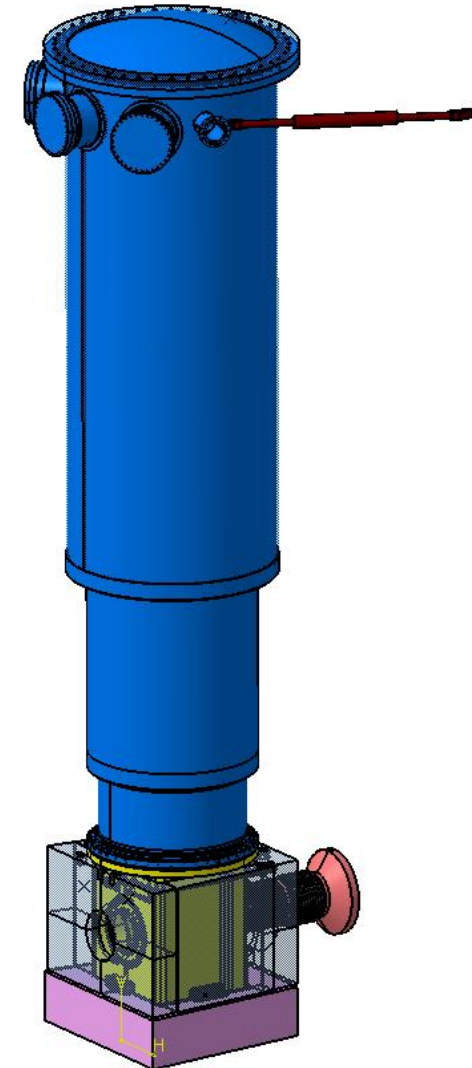
ESS Work-Packages

- The Spanish Government took the decision (2015) to make **ESS-Bilbao** the **only Spanish in-kind partner for the European Spallation Source (ESS)** project.
- ~ **50 qualified scientist and engineers** working in ESS-Bilbao for the ESS.
- Headquarters in **Zamudio (Bizkaia)** with offices in **Victoria-Gastéiz** and **Madrid**.
- ESS-Bilbao Consortium has been awarded for the design and manufacturing of the following **work packages**:
 - **Accelerator:**
 - Medium Energy Beam Transport (**MEBT**) section: Section of the Accelerator that goes between RFQ and DTL.
 - **RF systems**: Essential for the linear pulse accelerator (Linac) which accelerates a proton beam of 62.5 mA current to an energy peak of 2000 MeV.
 - **Target station:**
 - **Target systems**: Spallation material, target vessel, shaft and drive-unit.
 - **Moloth Vessel**
 - **Tunning Beam Dump**
 - **Proton Beam Window**
 - **Proton Beam Window Port Block and Vessel.**
 - **Proton Beam Instrumentation Plug**
 - **Instruments**: the neutron time-of-flight backscattering spectrometer of the European Spallation Source. ESS-Bilbao is the primary partner in the design, construction, installation and commissioning of the instrument
 - **Backscattering spectrometer** of the European Spallation Source called MIRACLES.

Design and Installation

ESS Work-Packages

- **PBW-PB and Vessel:**
 - Safety related components. **MQC4**.
 - Previously classified as **MQC3**, RCC-MRX class **N3Rx**. The complete design is based on this Design Code and classification.
 - PBW-Vessel and PBW-PB will be manufactured by **Nortemecánica**.
 - **Connecting Pipe is out of the tender**, due to recent changes.
- **Recent changes:**
 - Change in design pressure (May 2019)
 - Connecting Pipe **diameter** has been **reduced**. (May 2019)
 - **Flanged connections eliminated**, and replaced by welds. (Apr 2019)
 - **EPDM** Gasket in PBW-Vessel head. (May 2019)
 - **Spring energized gasket** between the PBW-PB and Vessel. (May 2019)

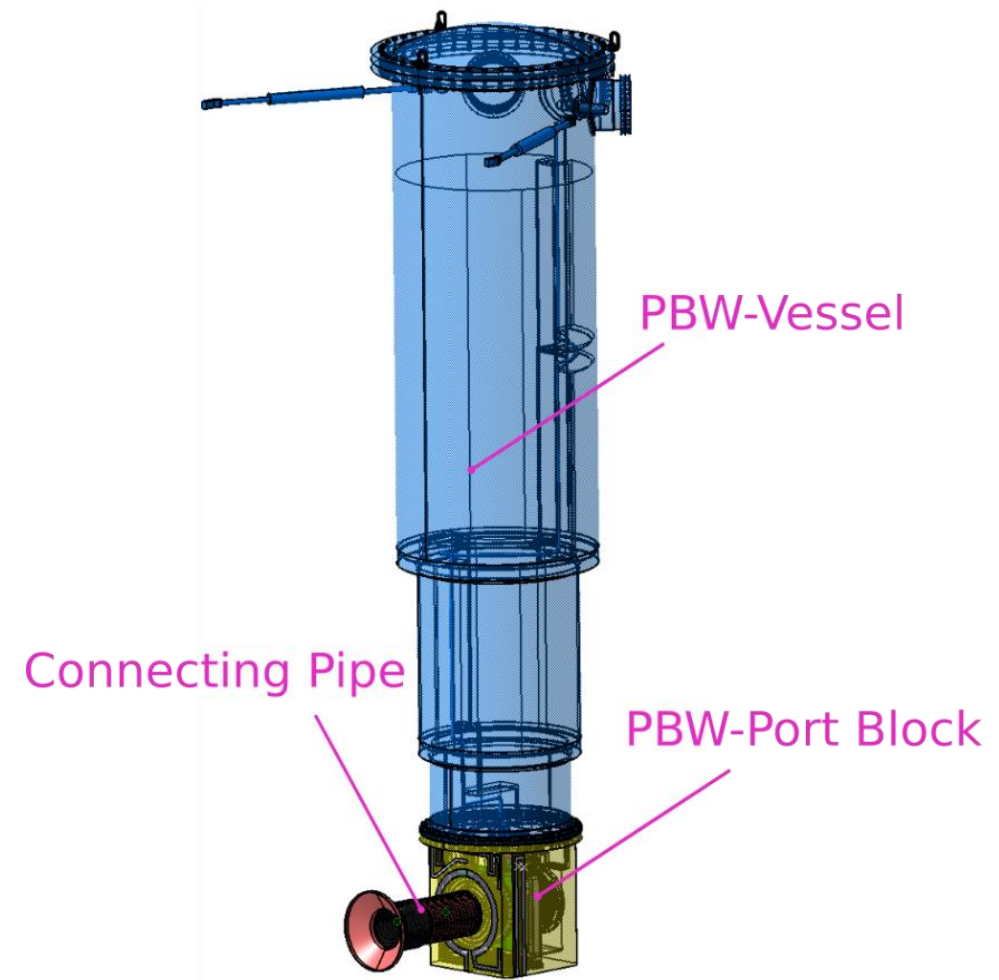


Description of the system

Design and Installation

Main components

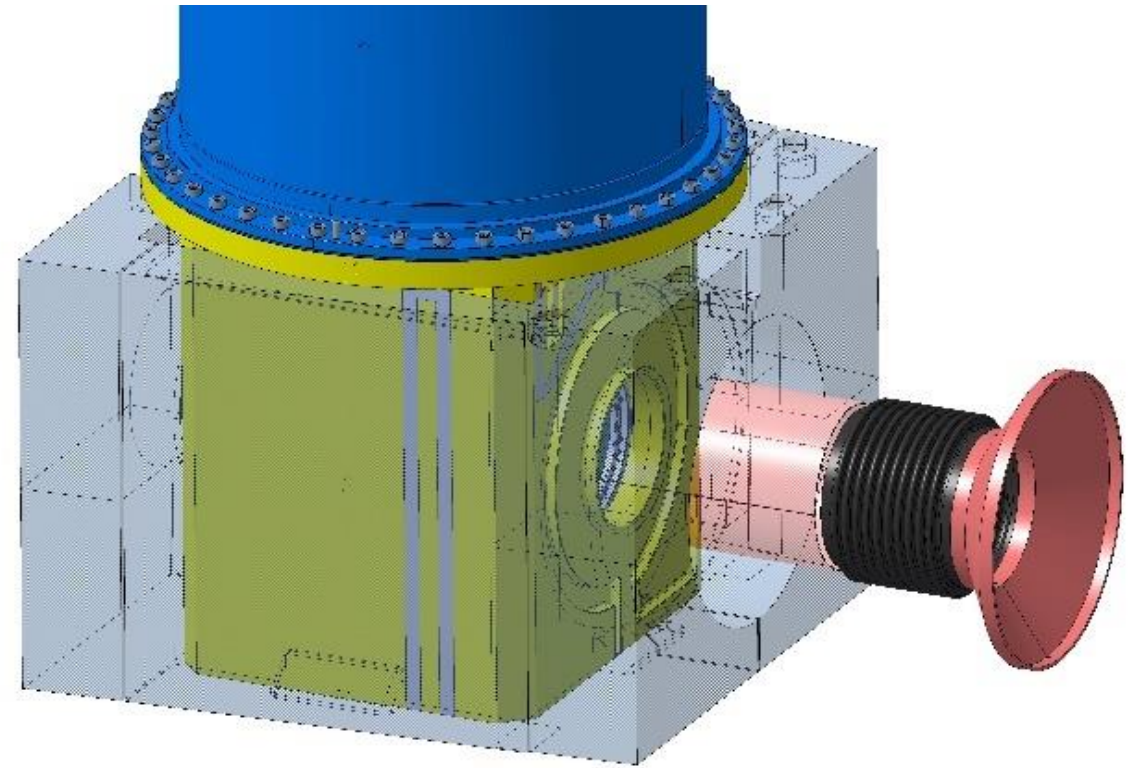
- **PBW-PB:**
 - Allocates the PBW.
 - Support for the PBW-System.
 - Sealing surface for pneumatic seals.
 - Surrounded by Intermediate shielding
- **PVW-Vessel:**
 - Support for PBW-System shielding blocks.
 - Transmits loads to the PB.
 - Surrounded by Outer shielding.
 - Feedthroughs for cooling&cabling.
- **Connecting Pipe:**
 - Connects the PB to the MV.
 - Decouples both systems by a bellow.
- **Shielding blocks:**
 - Fills the space between the PBW-PB and the immediate shielding.



Design and Installation

Main components

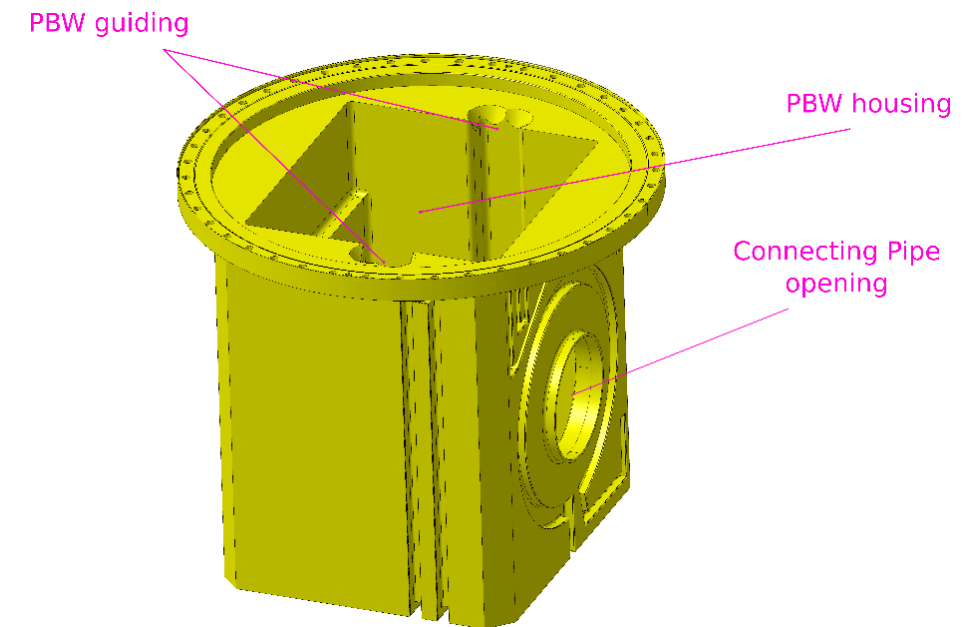
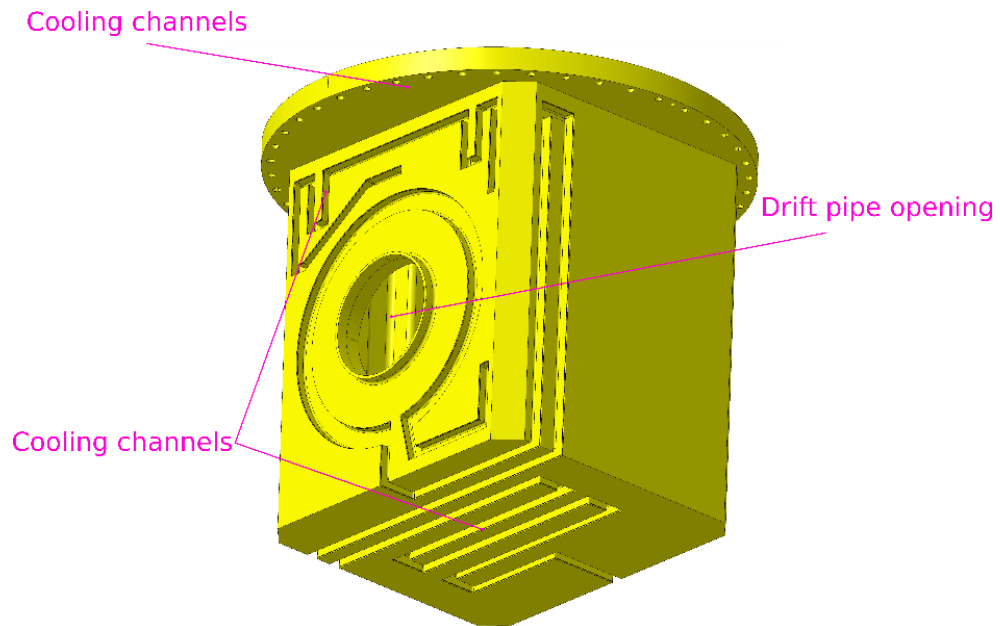
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 - Allocates the PBW.
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 - Sealing surface for pneumatic seals.
 - Surrounded by Intermediate shielding
- **PVW-Vessel:**
 - Support for PBW-System shielding blocks.
 - Transmits loads to the PB.
 - Surrounded by Outer shielding.
 - Feedthroughs for cooling&cabling.
- **Connecting Pipe:**
 - Connects the PB to the MV.
 - Decouples both systems by a bellow.
- **Shielding blocks:**
 - Fills the space between the PBW-PB and the immediate shielding.



Design and Installation

PBW-PB

- Inner geometry to accomodate PBW-System.
- Outer geometry
 - Cooling channels.
 - Connects to Drift Pipe
 - Connects to Connecting Pipe.

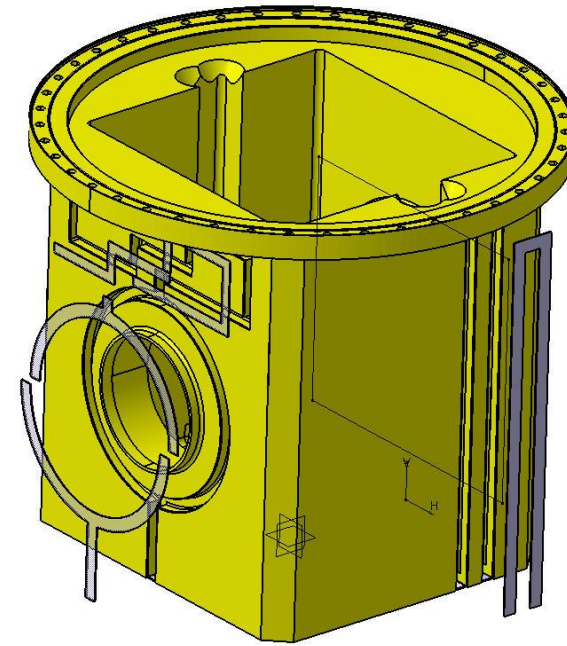
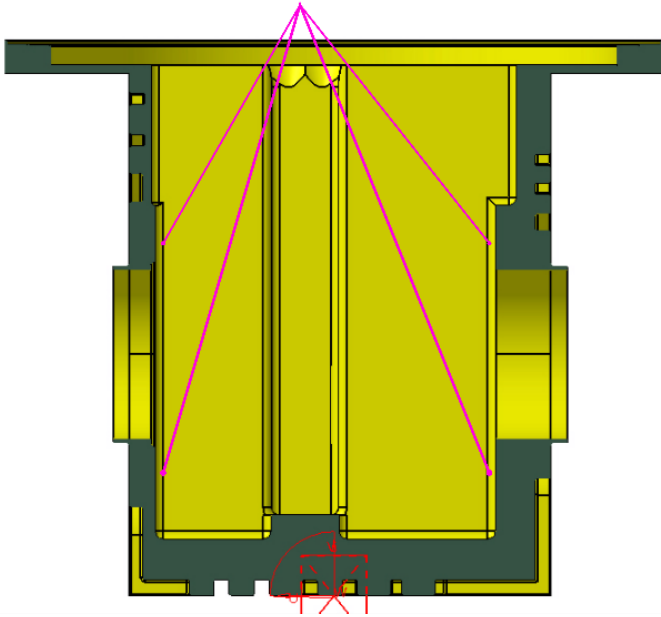


Design and Installation

PBW-PB

- Inner geometry to accomodate PBW-System.
- Outer geometry
 - Cooling channels.
 - Connects to Drift Pipe
 - Connects to Connecting Pipe.

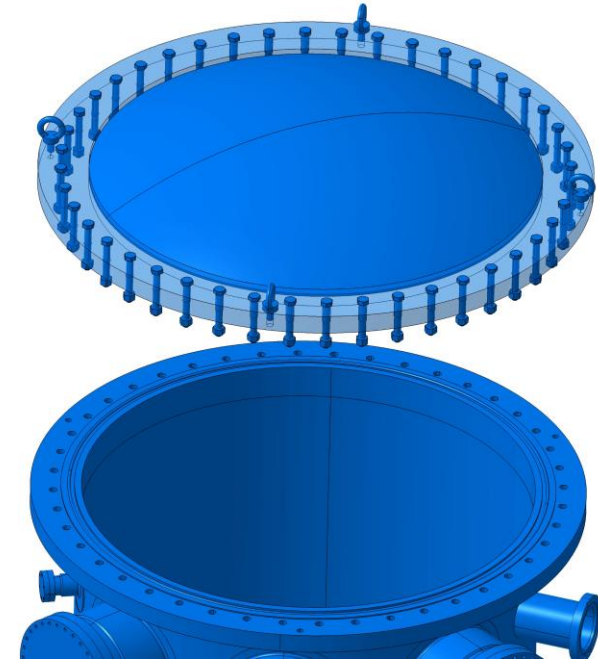
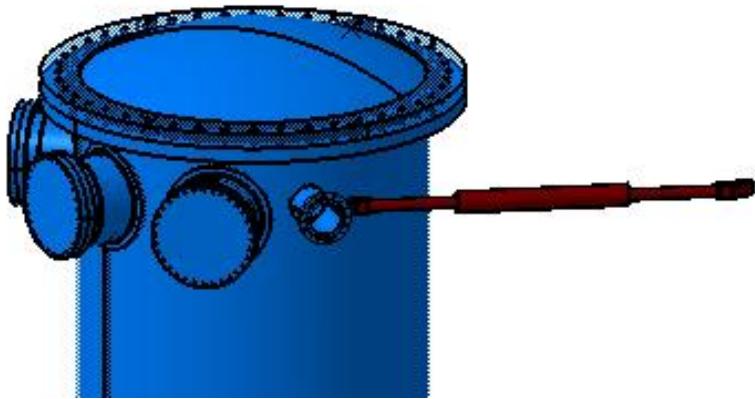
PBW sealing surfaces



Design and Installation

PBW-Vessel

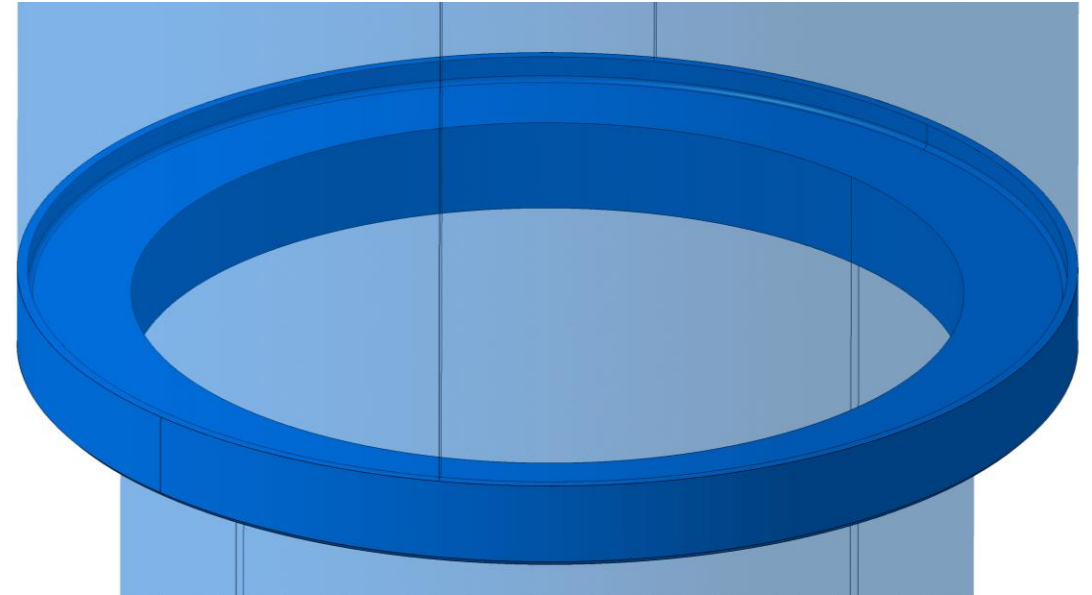
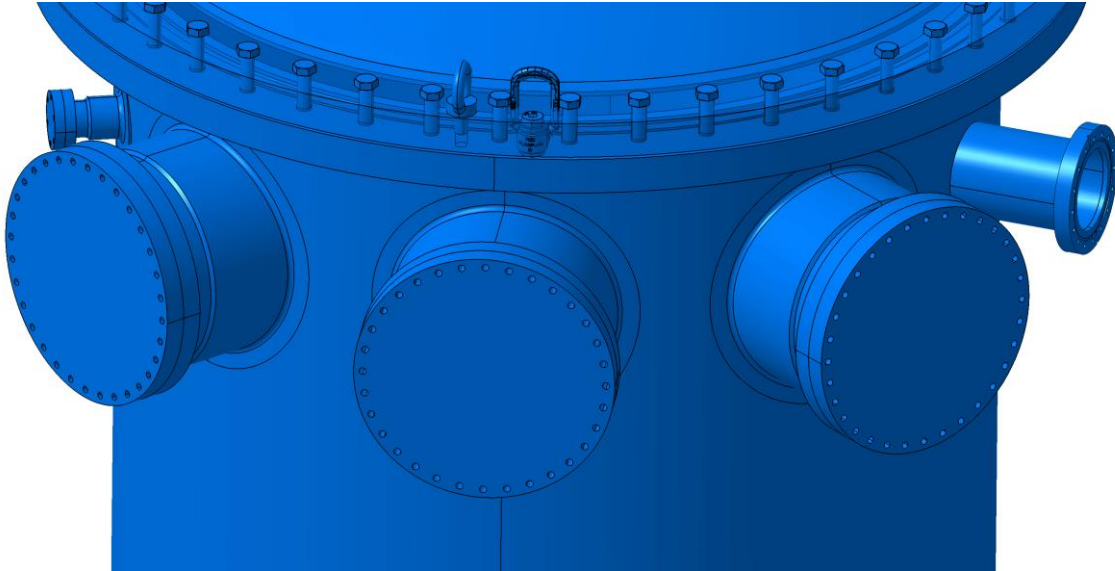
- Steped body.
- Vessel head and EPDM gasket.
- Connected to the MV with two rigid struts.



Design and Installation

PBW-Vessel

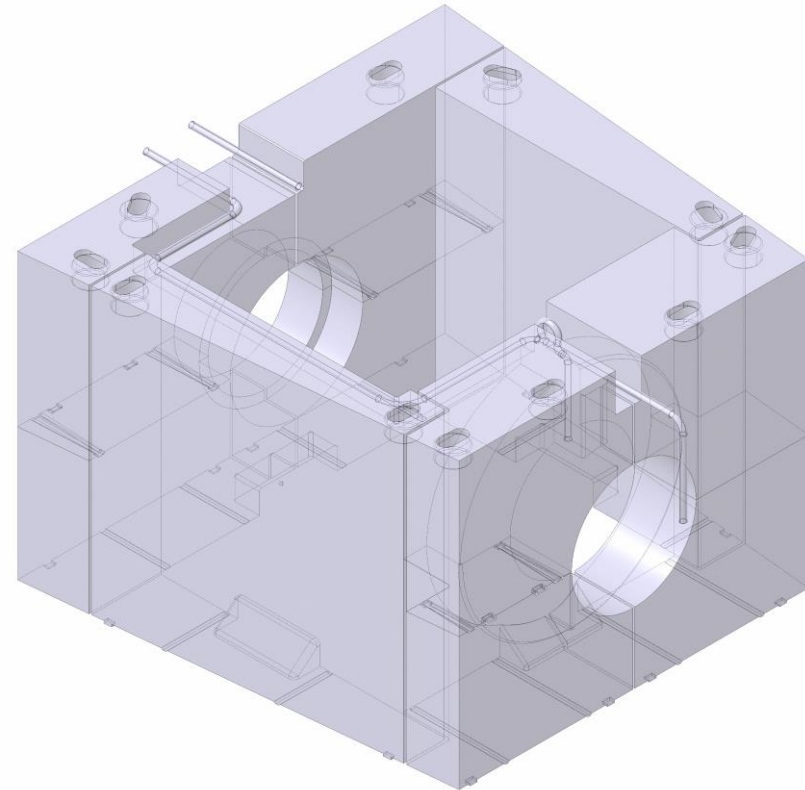
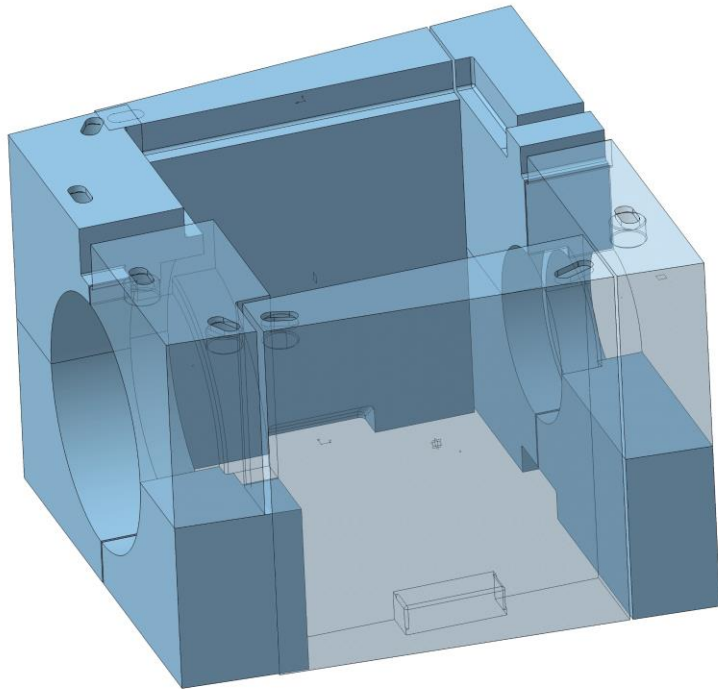
- 5 feedtroughs:
 - Cabling and water supply
 - Vacuum
- Reinforcement rings. Steeped.



Design and Installation

PBW-Shielding

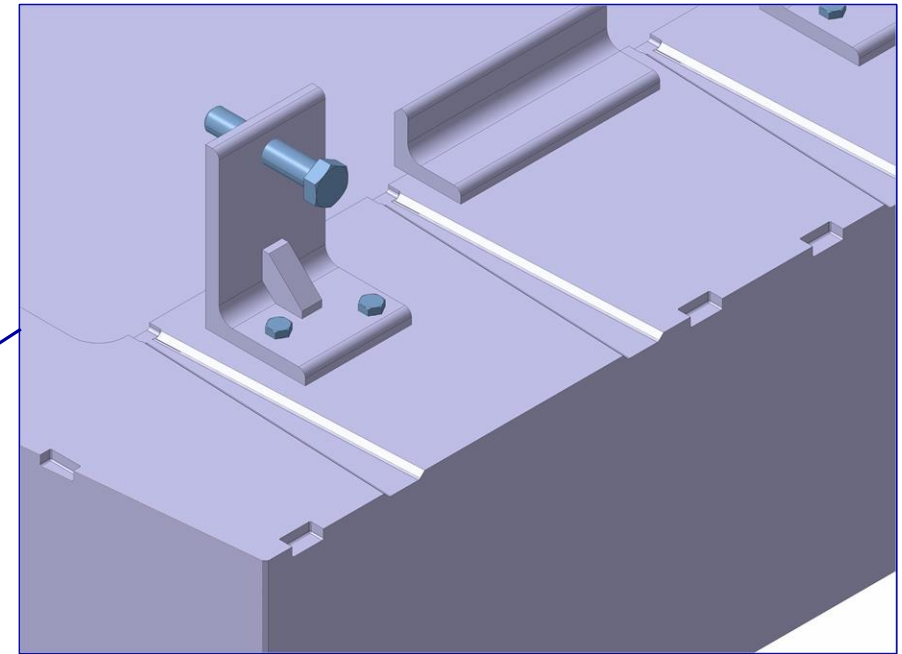
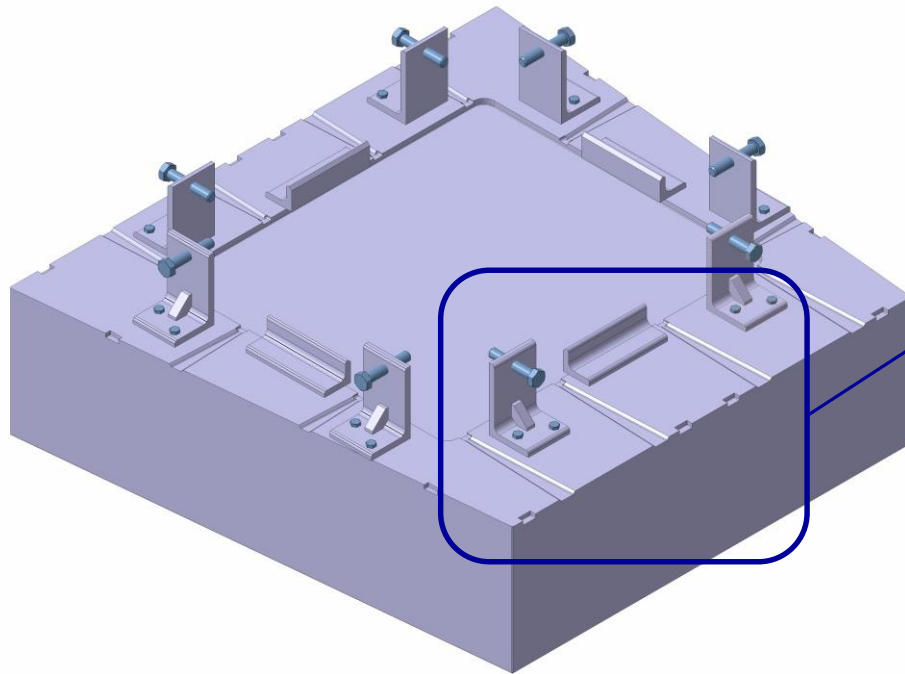
- Fill the space between the PBW and Intermediate shielding.
- No contact with the PB.



Design and Installation

Supporting Plate

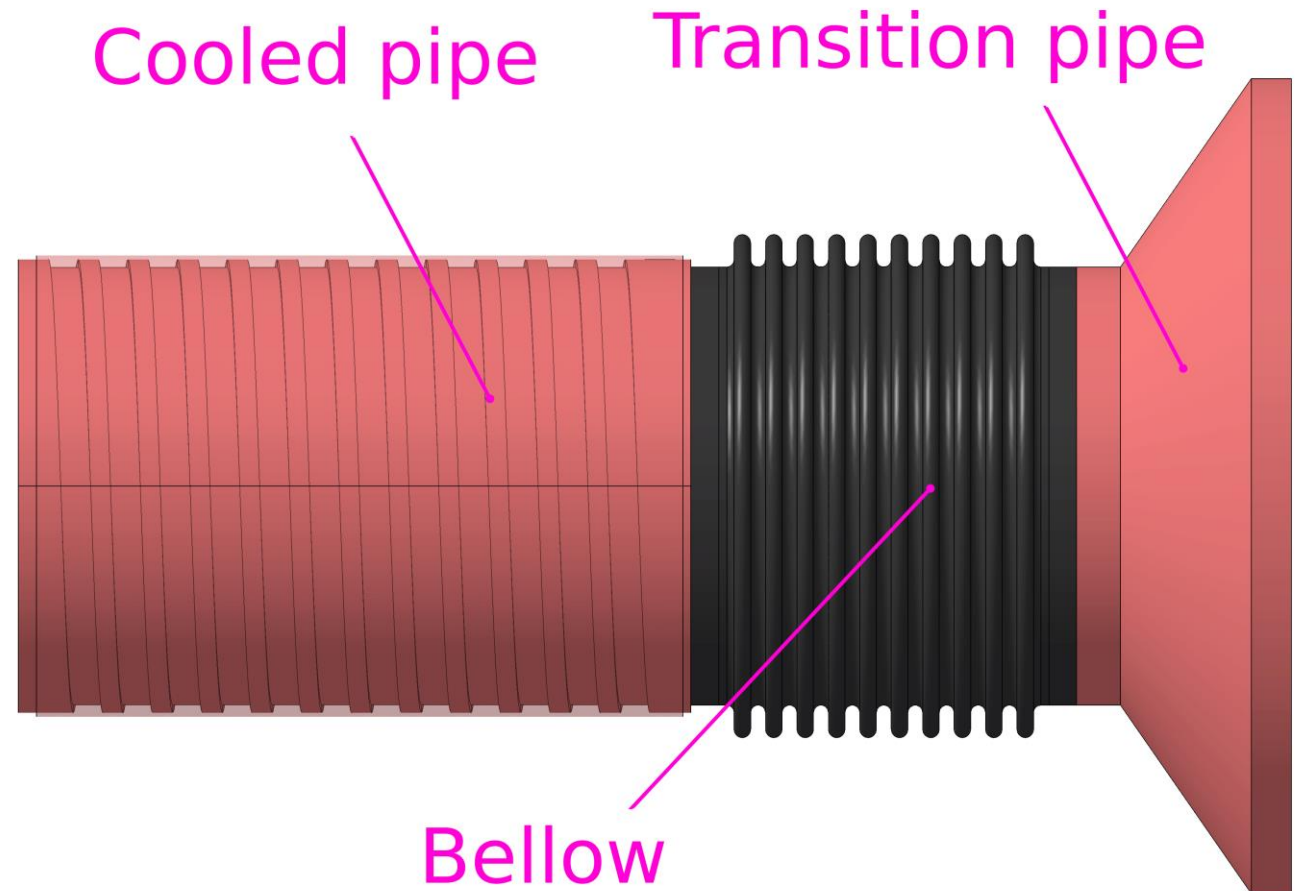
- OUT OF ESS-BILBAO SCOPE. Need to define ICD-R.
- Machined guiding wedges for the PB shielding.



Design and Installation

Connecting Pipe

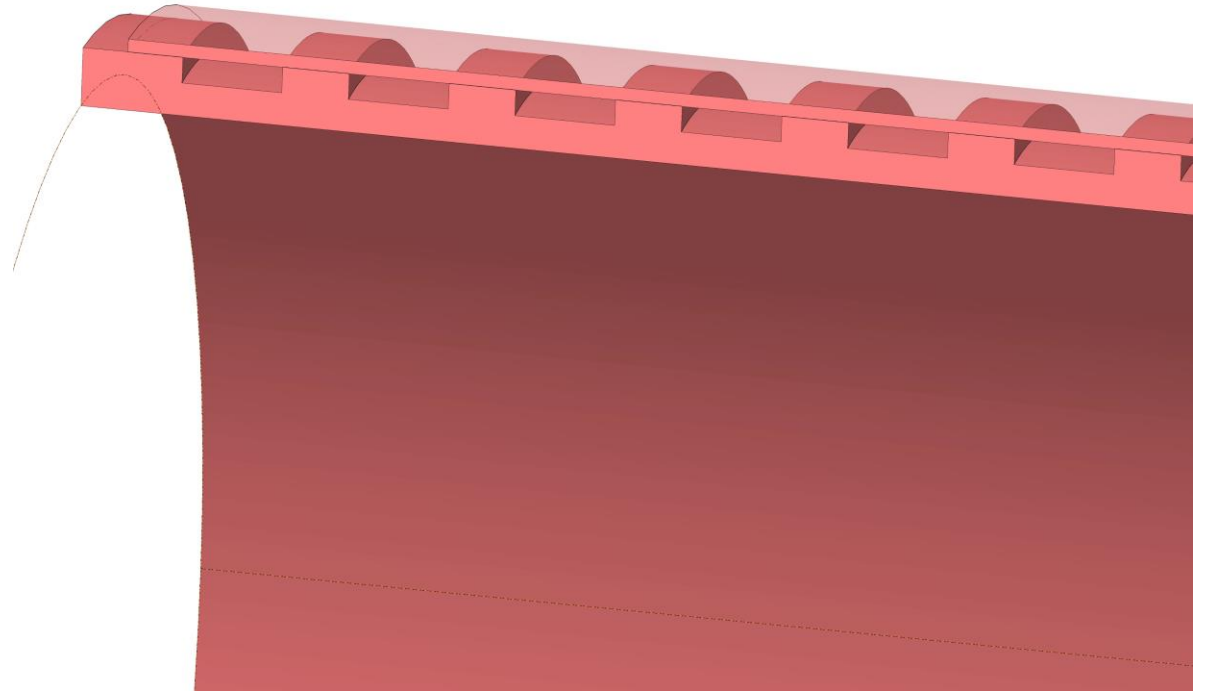
- Cooled body by an helical cooling channel, cover by a cylindrical plate.
- Bellow to decouple systems.
- Transition pipe to adapt current MV opening.



Design and Installation

Connecting Pipe

- Cooled body by an helical cooling channel, cover by a cylindrical plate.
- Bellow to decouple systems.
- Transition pipe to adapt current MV opening.

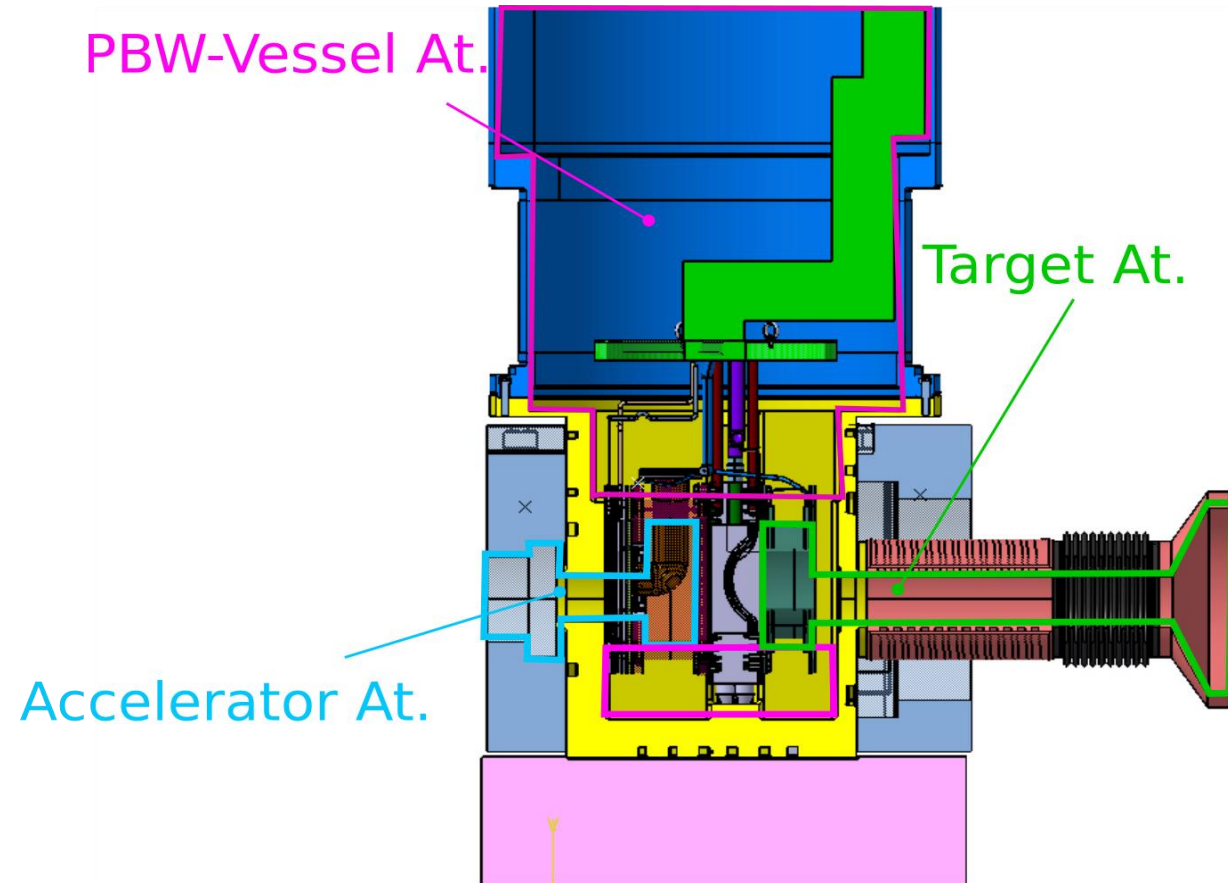


Operation

Design and Installation

Atmospheres

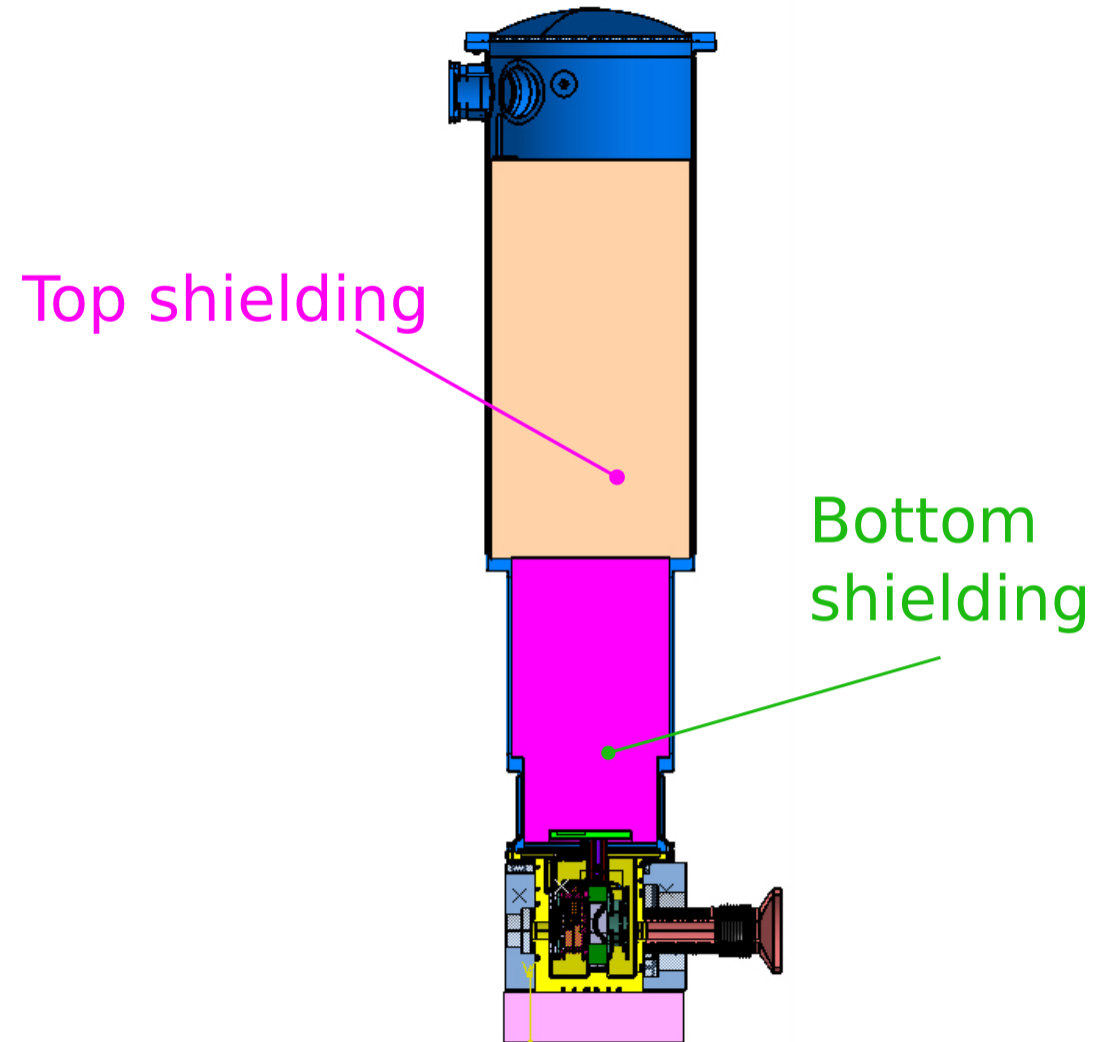
- Three atmospheres to separate.
- PBW closes the 3 at.
- Vessel atmosphere behaves as safety barrier between target and accelerator.



Design and Installation

Supporting function

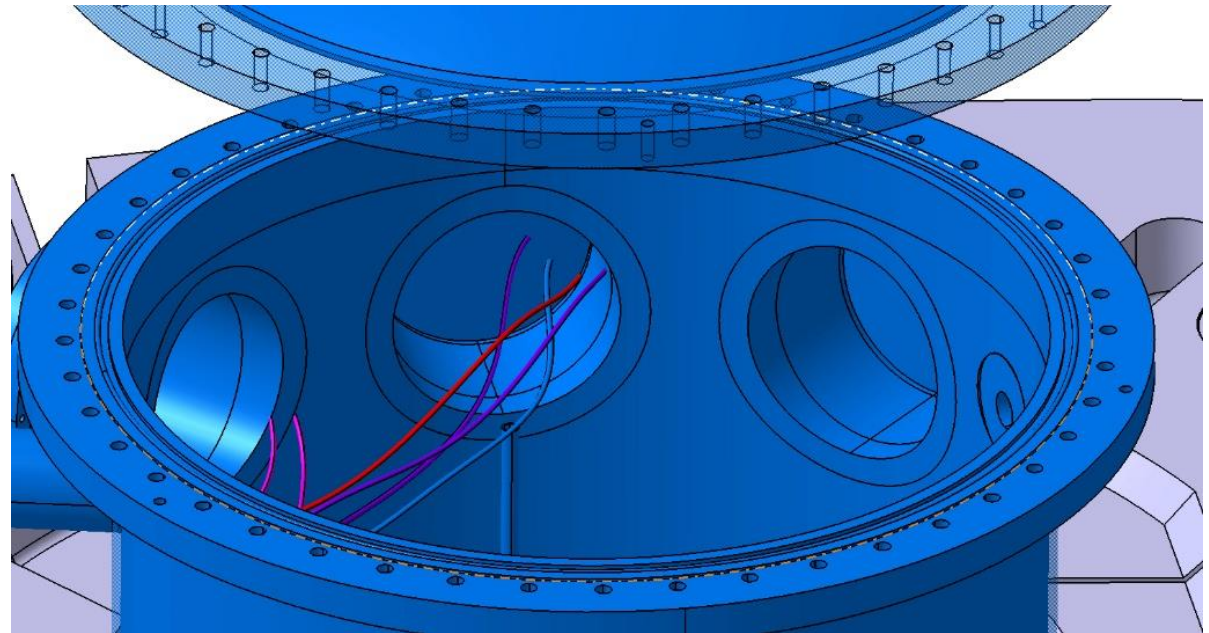
- Serves as support for shielding blocks.



Design and Installation

Feedthroughs

- DN250: media and cabling.
 - Flexible pipes and cabling.
 - Connected and disconnected to a blank flange.
 - Permits redesign in the future.

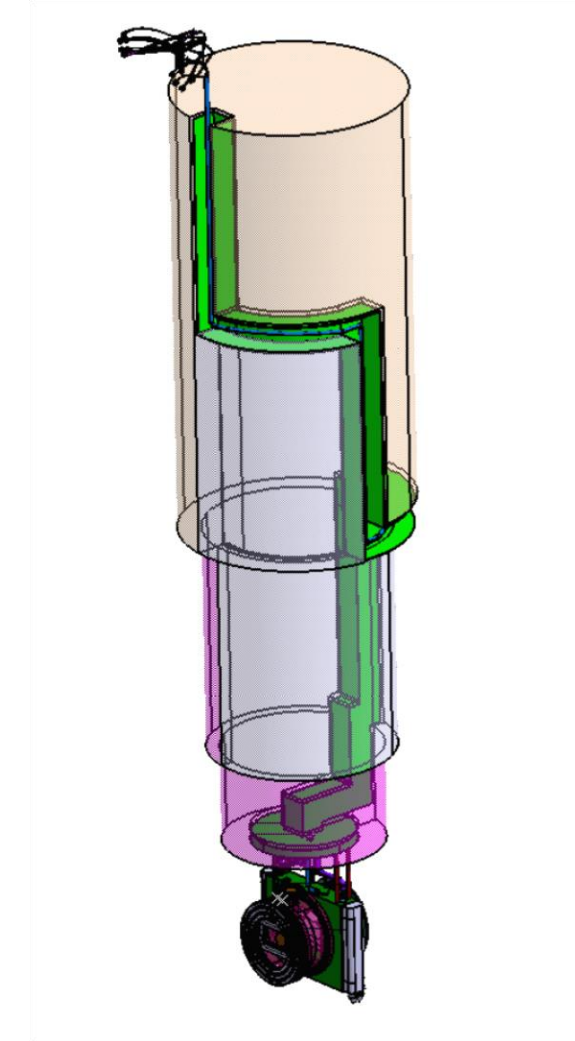
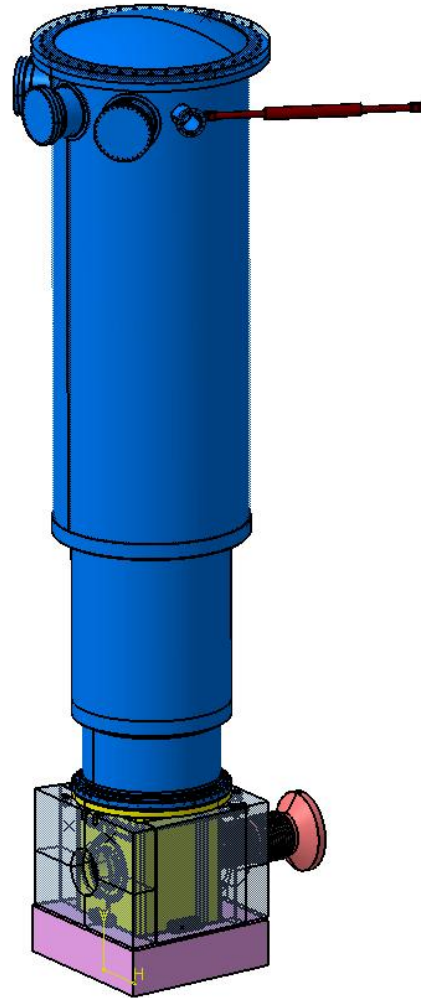


PBW System: Insertion and Extraction process.

Design and Installation

PBW-System

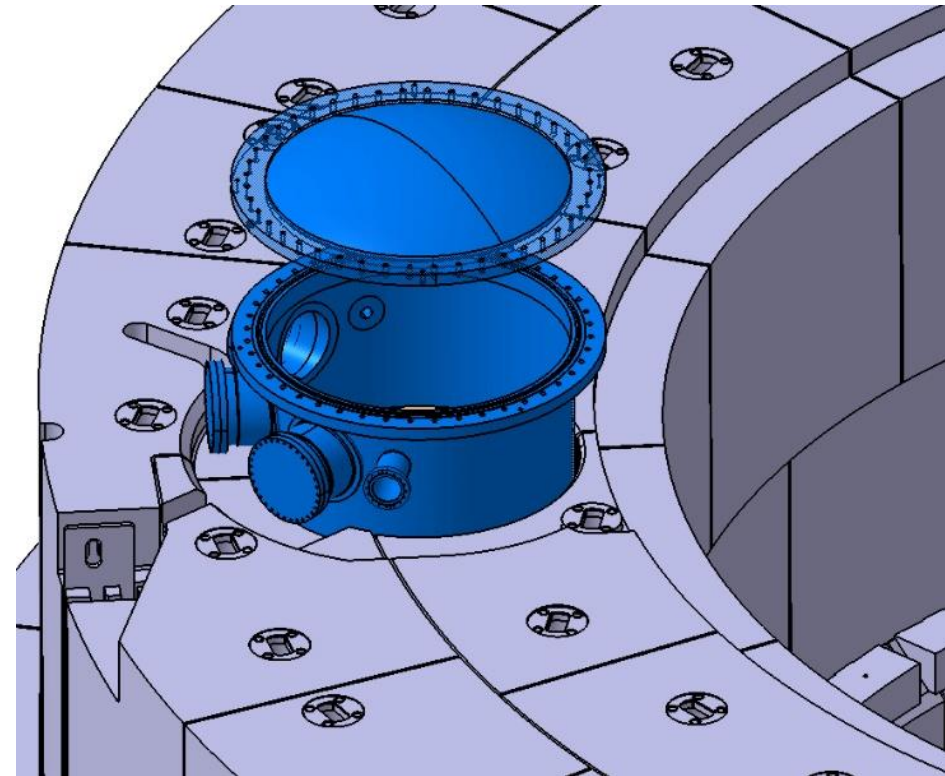
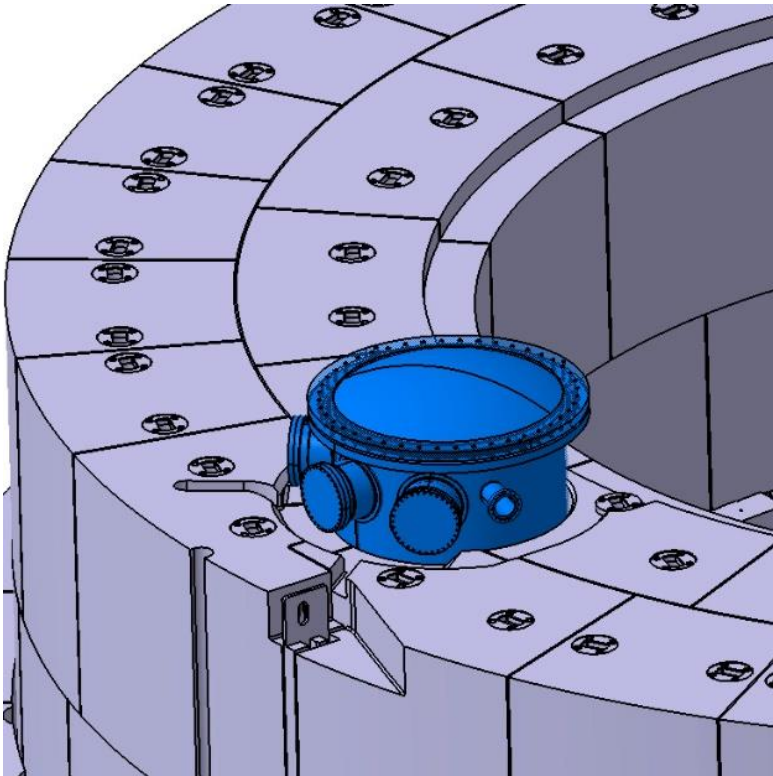
- PBW-Plug:
 - PBW and cooling frame.
 - Pillow seals.
 - Flanges.
 - Guiding box for cooling and cabling.
 - Acc. Instrumentation
- 2 Shielding blocks



Design and Installation

PBW-System

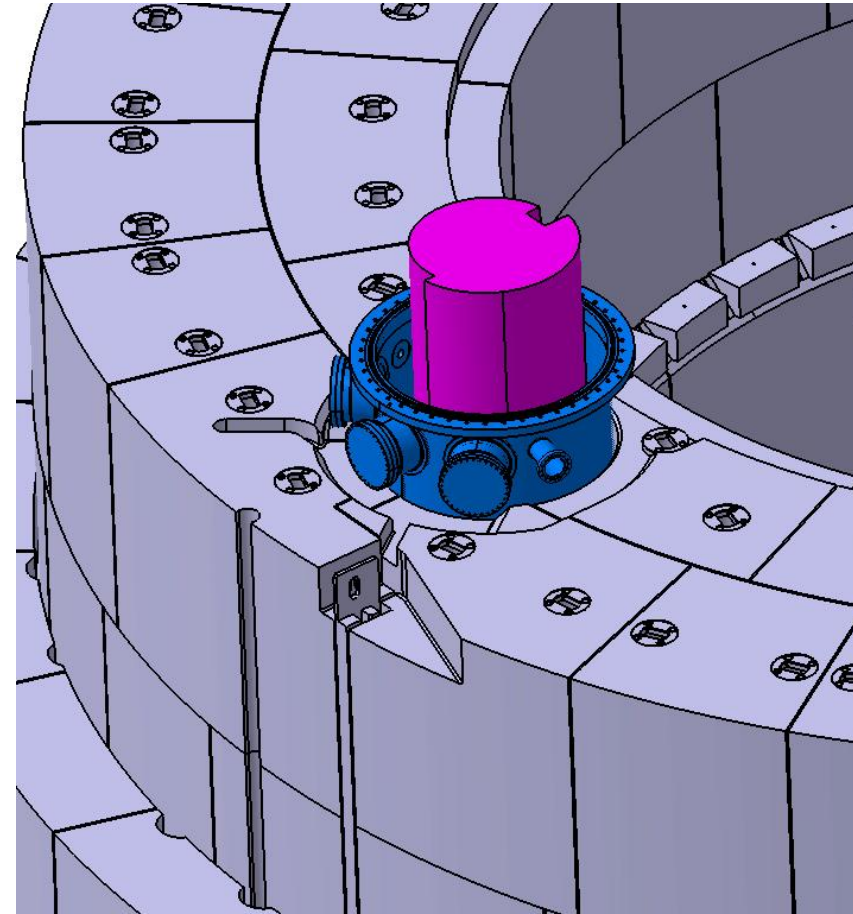
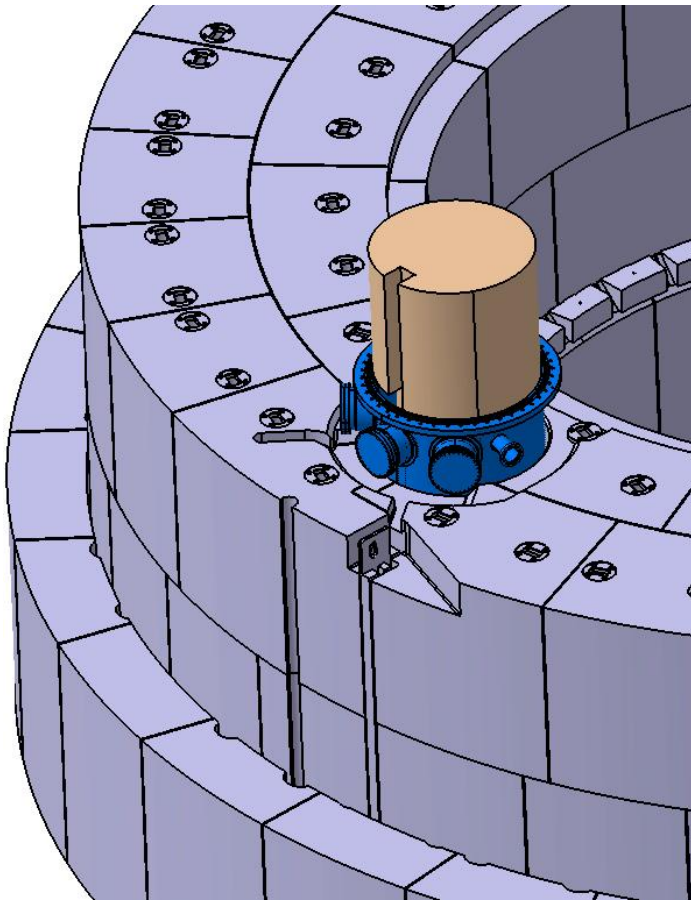
- Removal of Vessel head.



Design and Installation

PBW-System

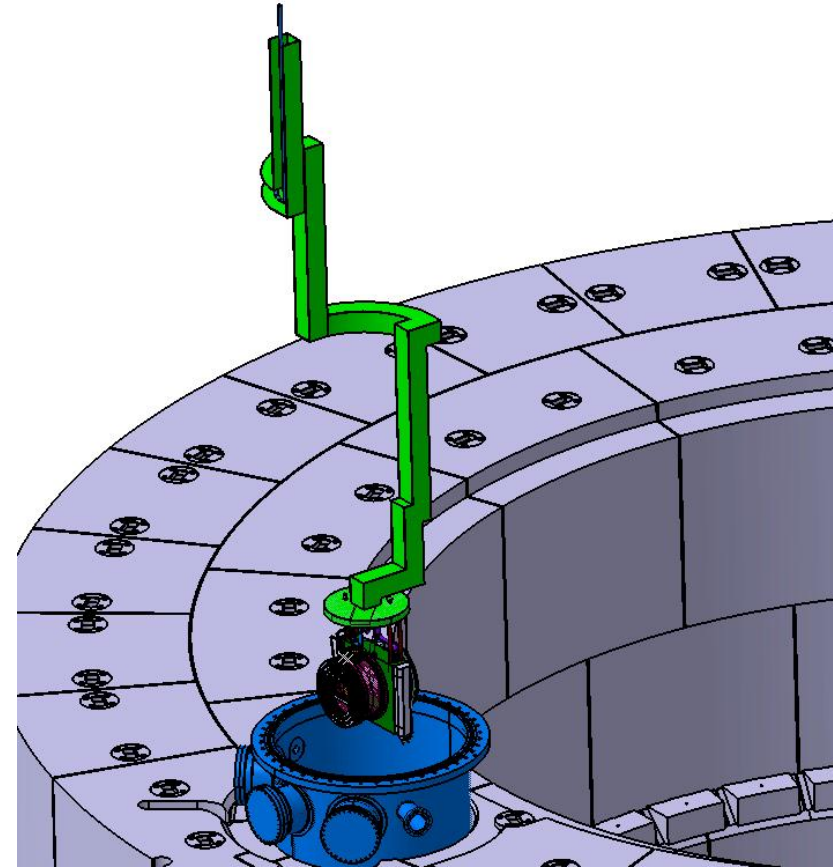
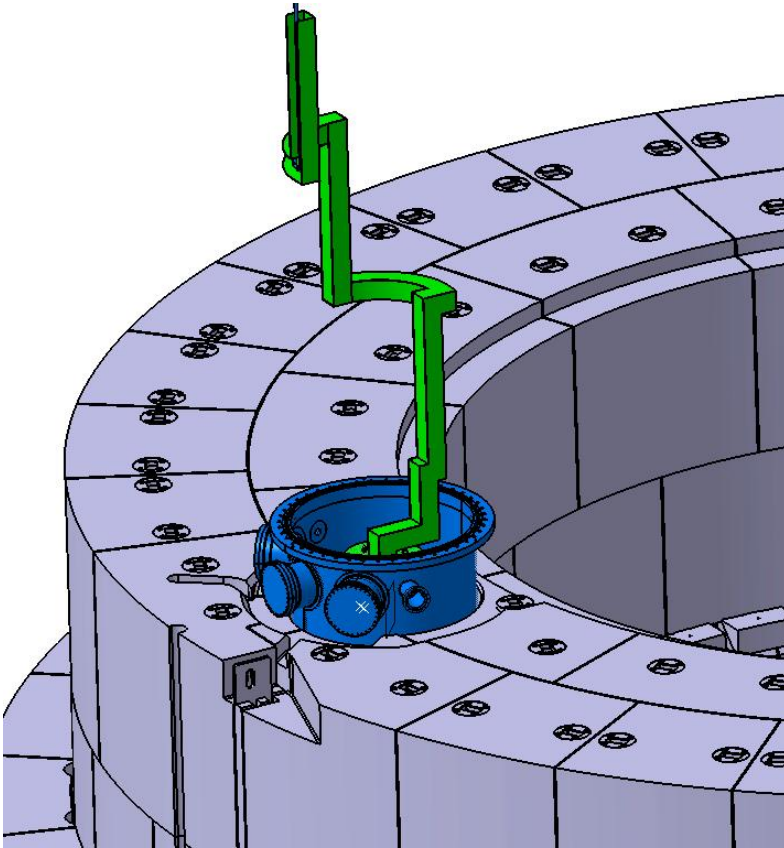
- Extraction of shielding blocks.



Design and Installation

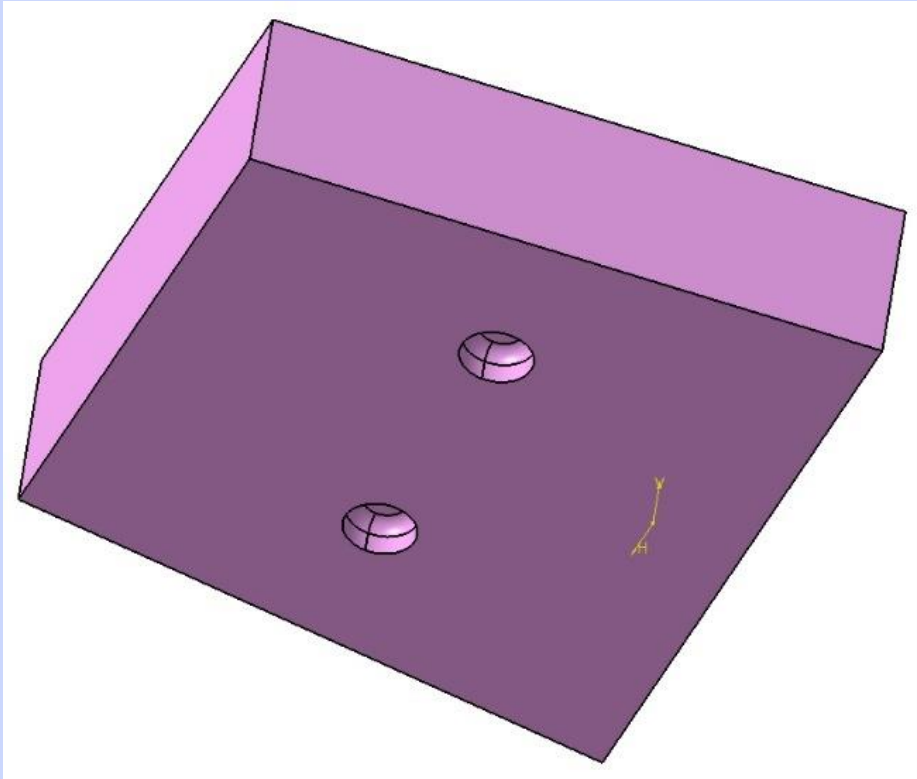
PBW-System

- Extraction of PBW-Plug.



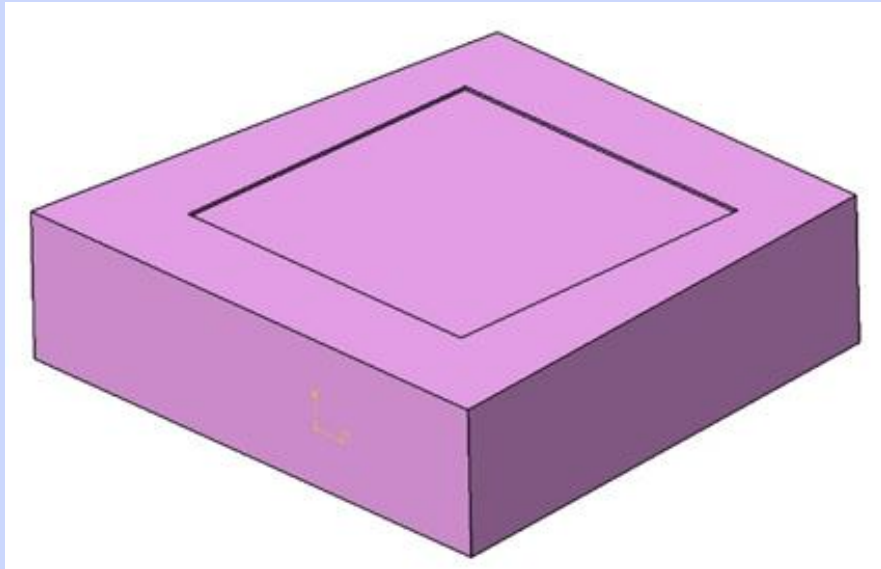
Installation Sequence

Design and Installation



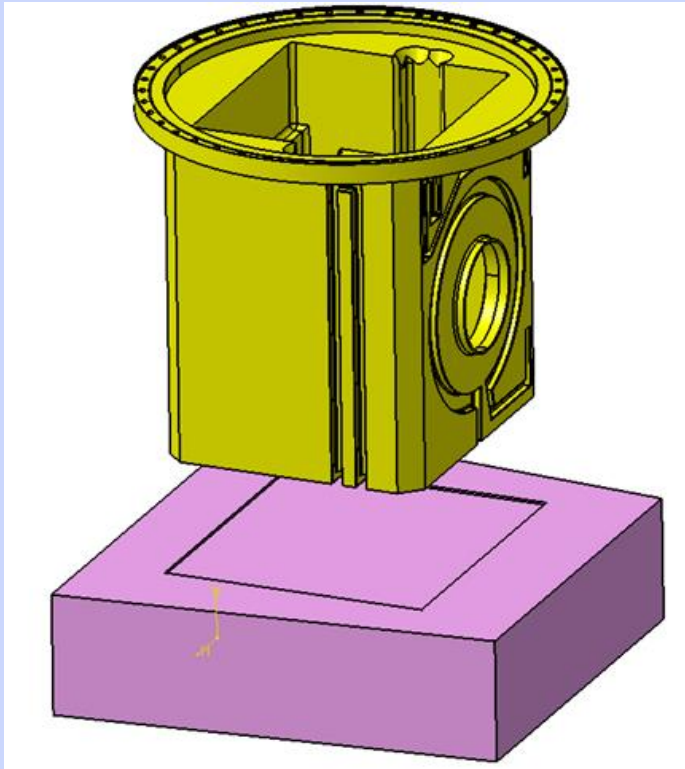
- Measure the baseplate by ESS after installation, and install alignment pucks.
- The Supporting plate (pink block, out of ESS-Bilbao scope) is placed over the baseplate. Z position (height) is guaranteed.
- The Supporting plate stands over the baseplate without fixed connection.

Design and Installation



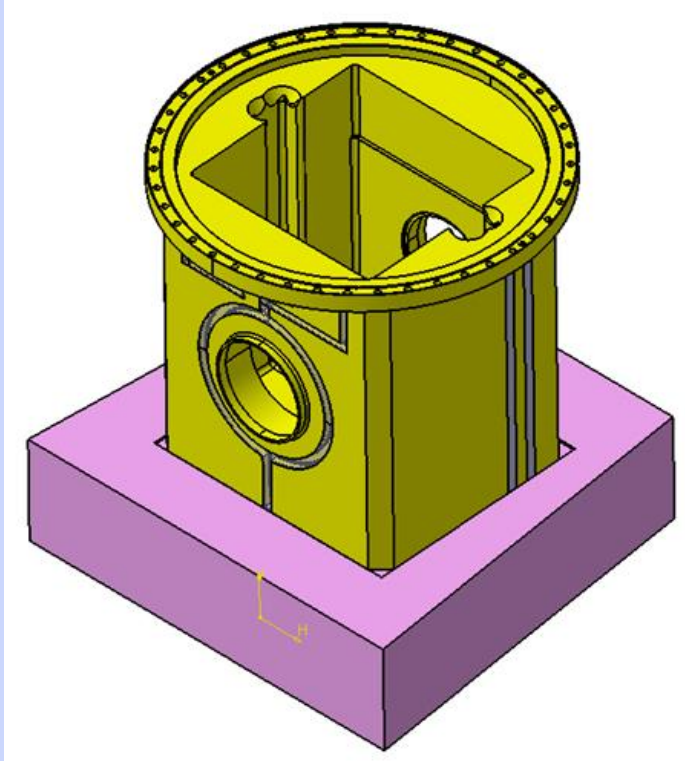
- The Supporting plate is in position. A 5mm recess has been prepared to ease positioning of the PB.

Design and Installation



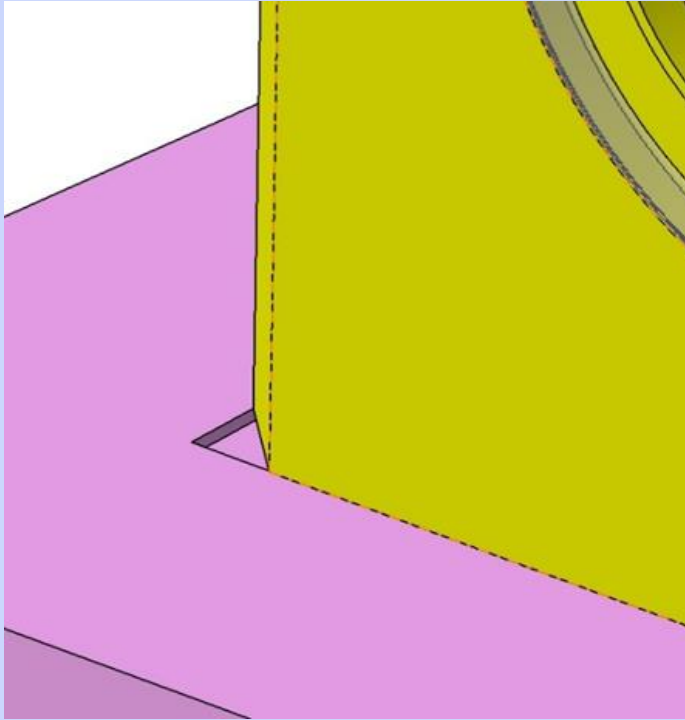
- Lift the PB with the High Bay crane, and lower down over the Supporting plate with human help.

Design and Installation



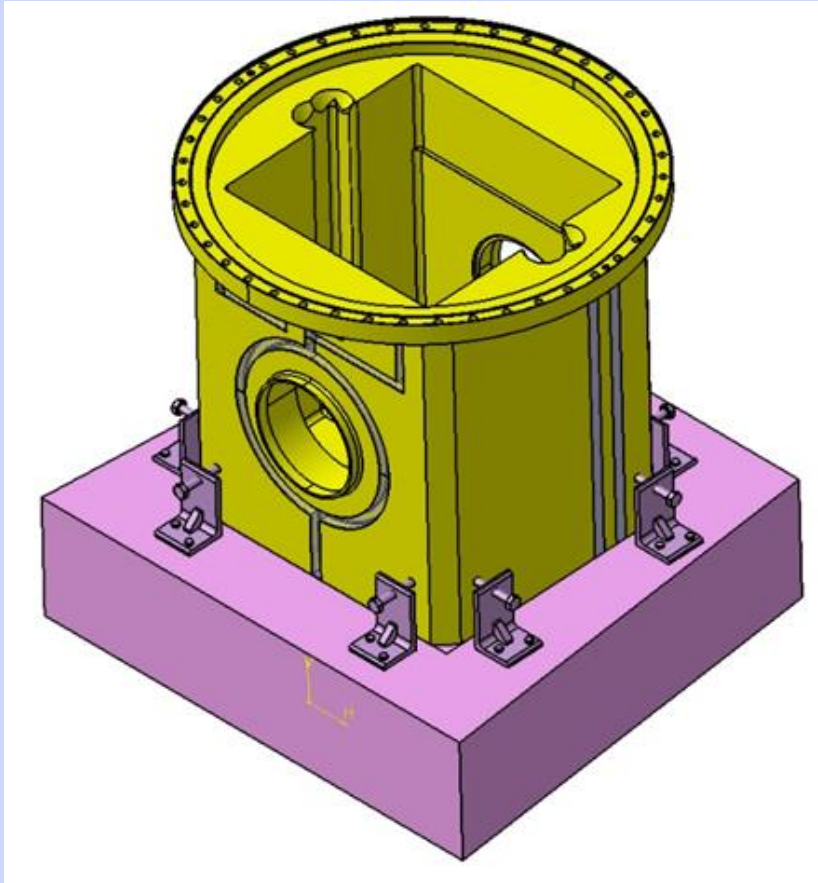
- Place the PB on the Supporting plate, and disconnect crane. Precision is not important at this stage.

Design and Installation



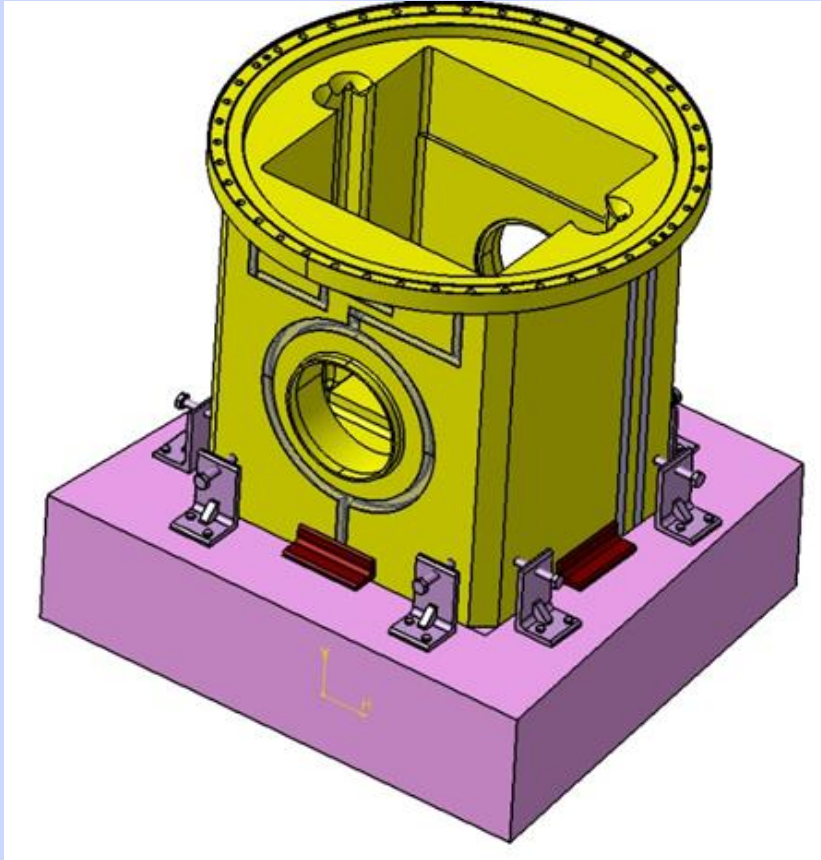
- The PB fits inside the recesses area.

Design and Installation



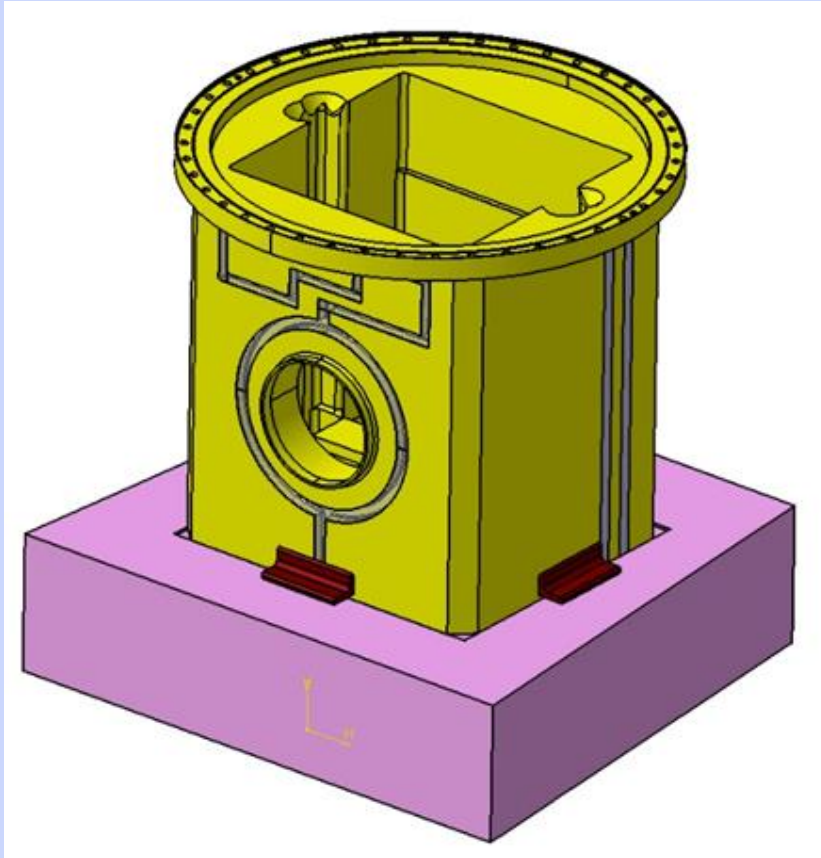
- Place removable “L-shaped” features. They are bolted to the Supporting plate.
- There are 2 screws per “L” to adjust the position of the PB.
- Position the PB by tightening bolts, that will push the PB walls and move it to desired position. An alignment system (laser) is needed.
- X,Y direction is hence guaranteed.

Design and Installation



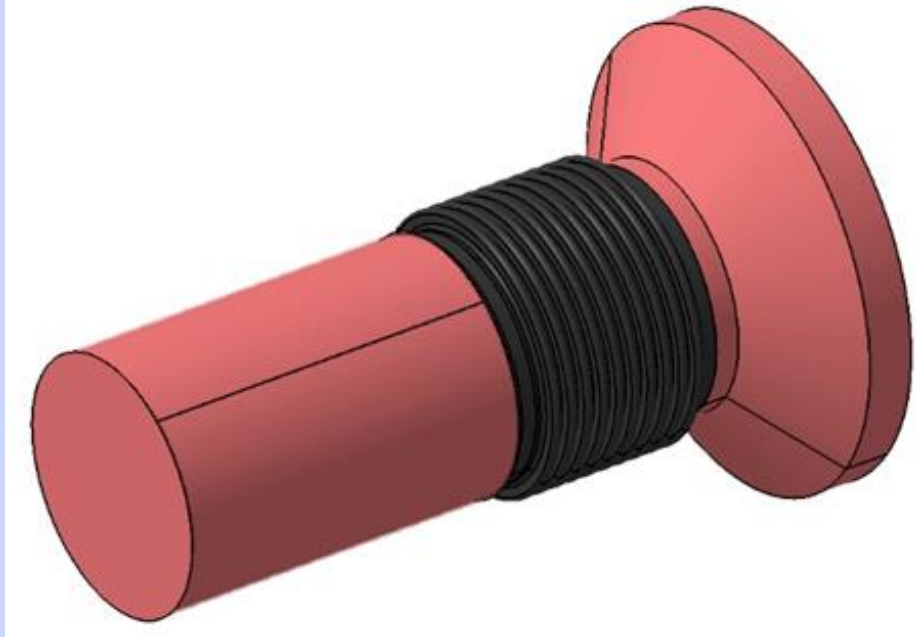
- Weld permanent features to the Supporting plate to prevent the PB from moving/overturning during seismic accident (do not weld to the PB). Chamfer the top to allow for later removal and replacing of the PB.
- Do not attach them to the PB (the PB moves freely, only friction can guarantee its position).

Design and Installation



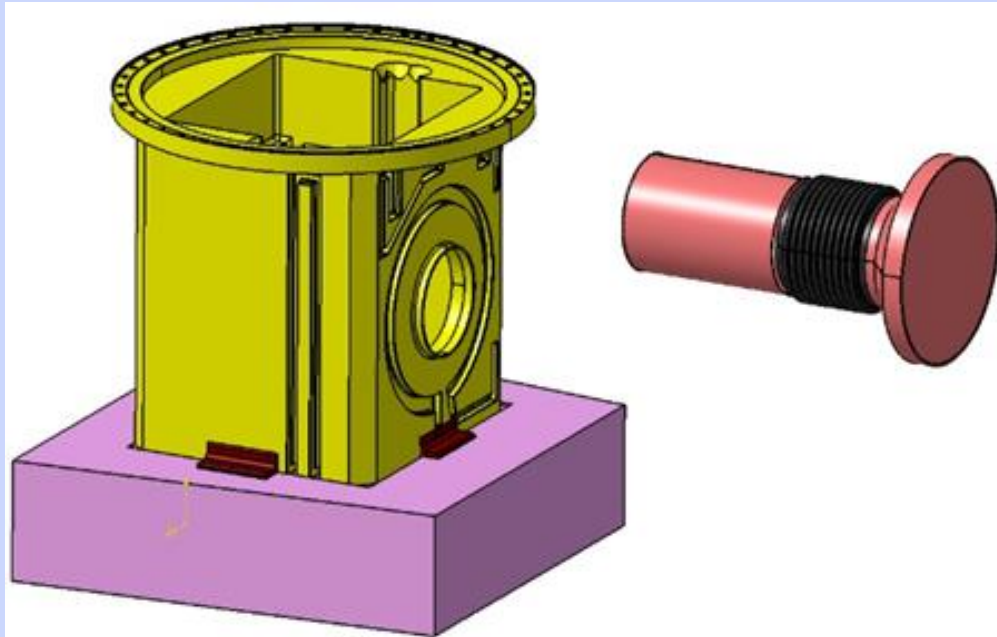
- Remove L-Shaped features.

Design and Installation



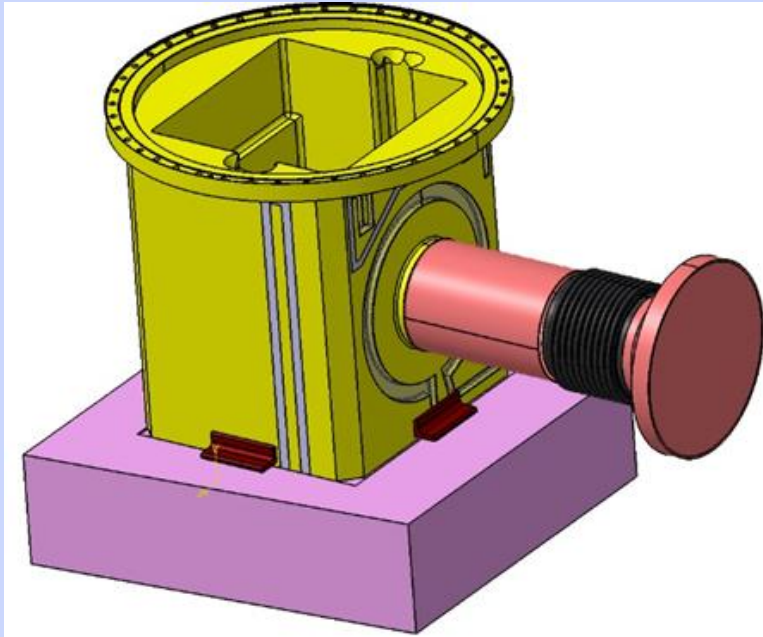
- Hold with the crane the Connecting Pipe+bellow during installation. Bellow in nominal length position.
- Both end are not cut yet, need previous measuring.

Design and Installation



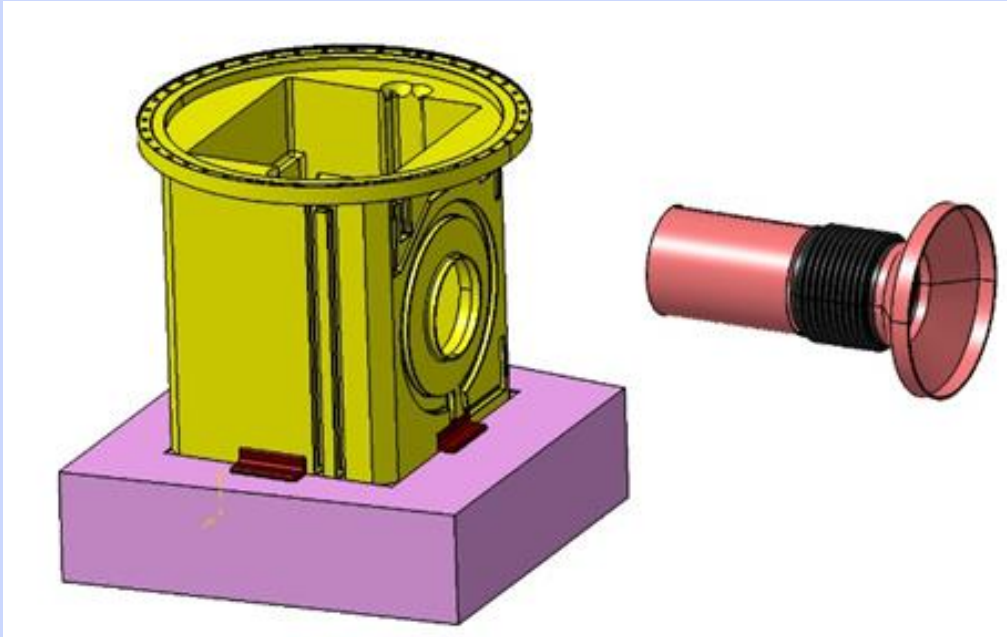
- Lower down the Connecting Pipe to measure distance between the PBW-PB and the MV opening to decide final length.

Design and Installation



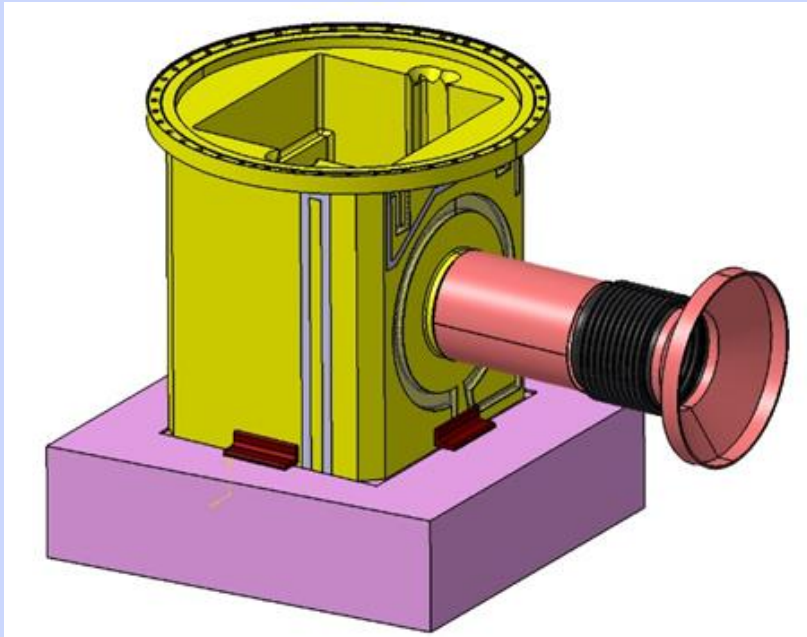
- **Measure and cut the Connecting Pipe.**

Design and Installation



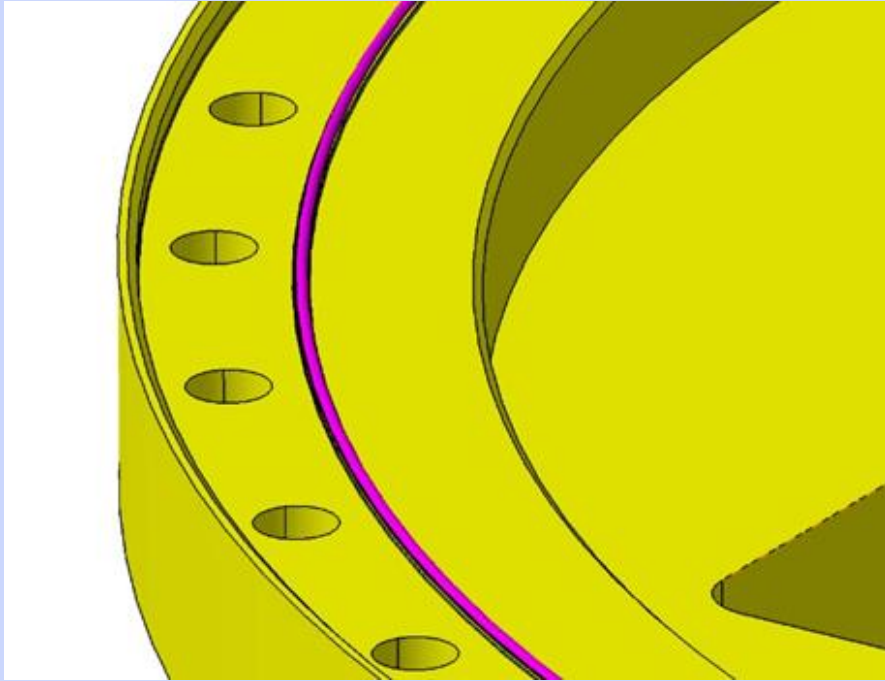
- Lower down again the Connecting Pipe.

Design and Installation



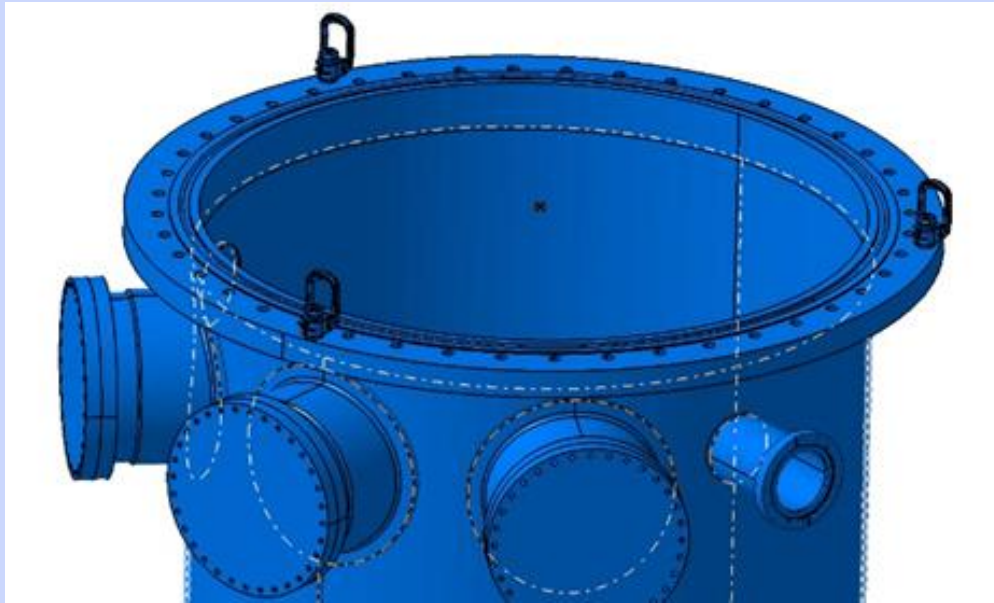
- Place in position and weld both ends:
 - To the PB opening.
 - To the MV-Vessel.

Design and Installation



- Place the spring energized (Helicoflex) gasket in position.

Design and Installation



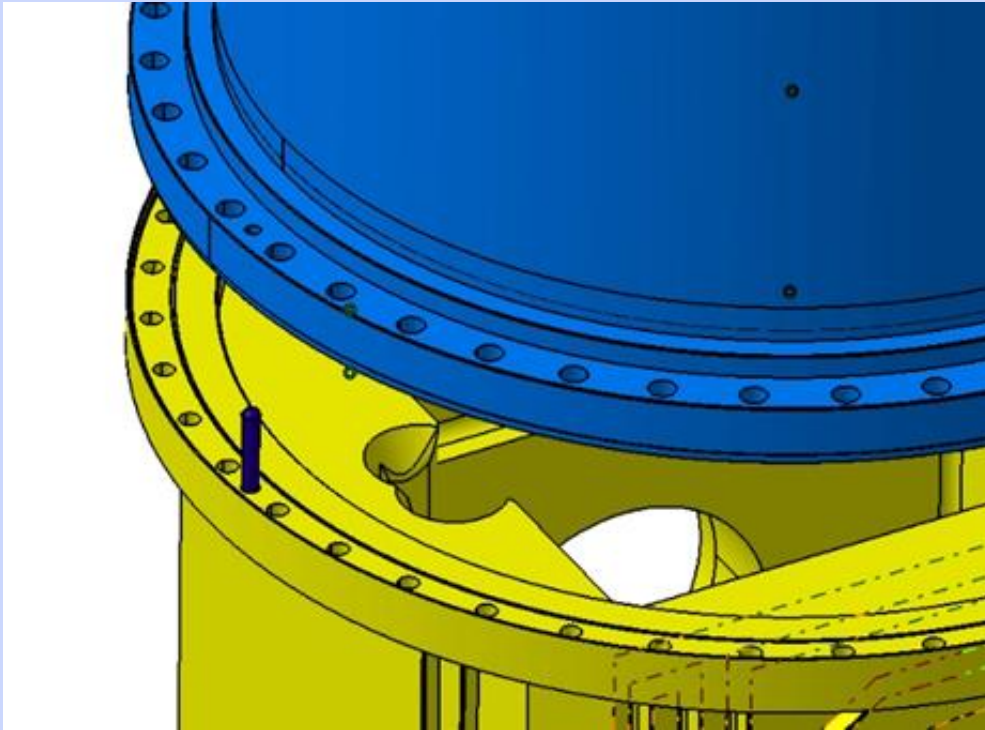
- Lift the PBW-Vessel with the high bay crane.

Design and Installation



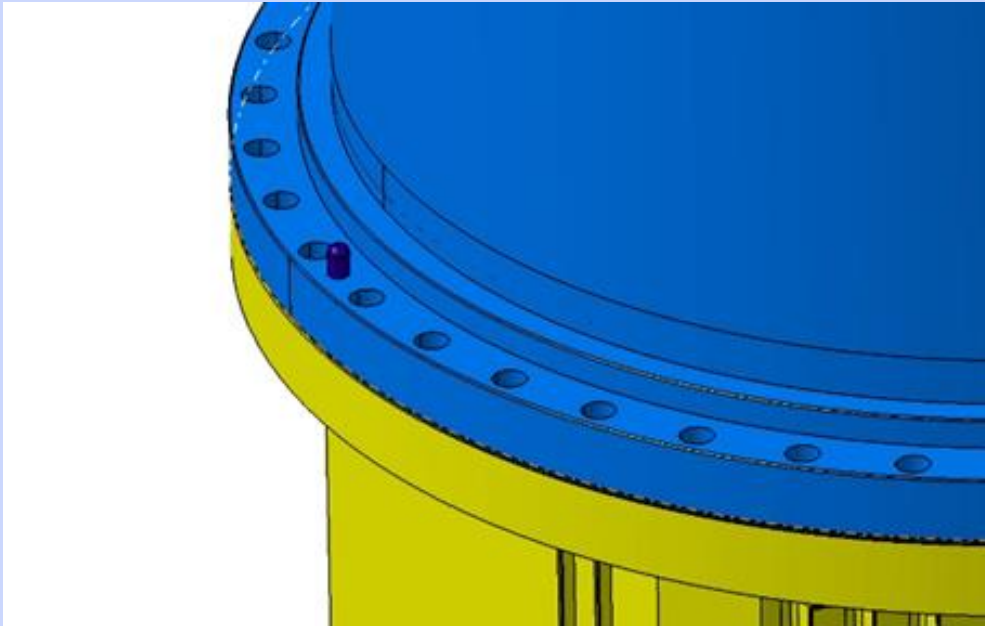
- Place and align it over the PBW-PB before completing lowering down, with human help.

Design and Installation



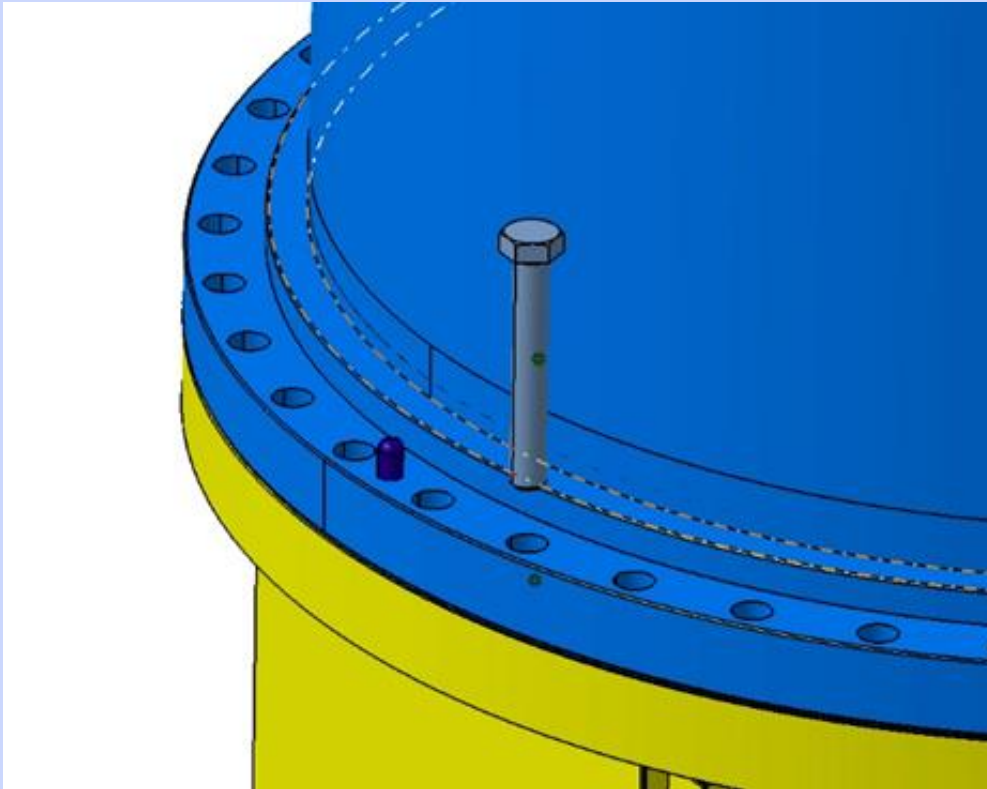
- Use guiding pins to center the PBW-Vessel flange.

Design and Installation



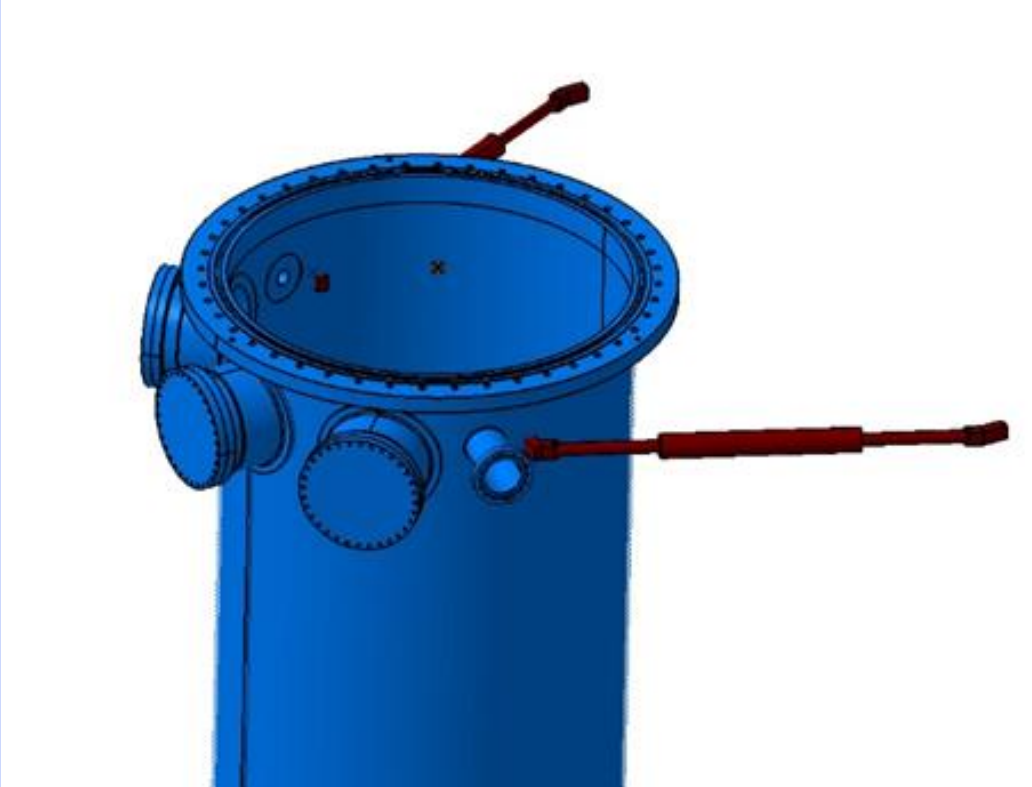
- Place the PBW-Vessel flange in the final position.

Design and Installation



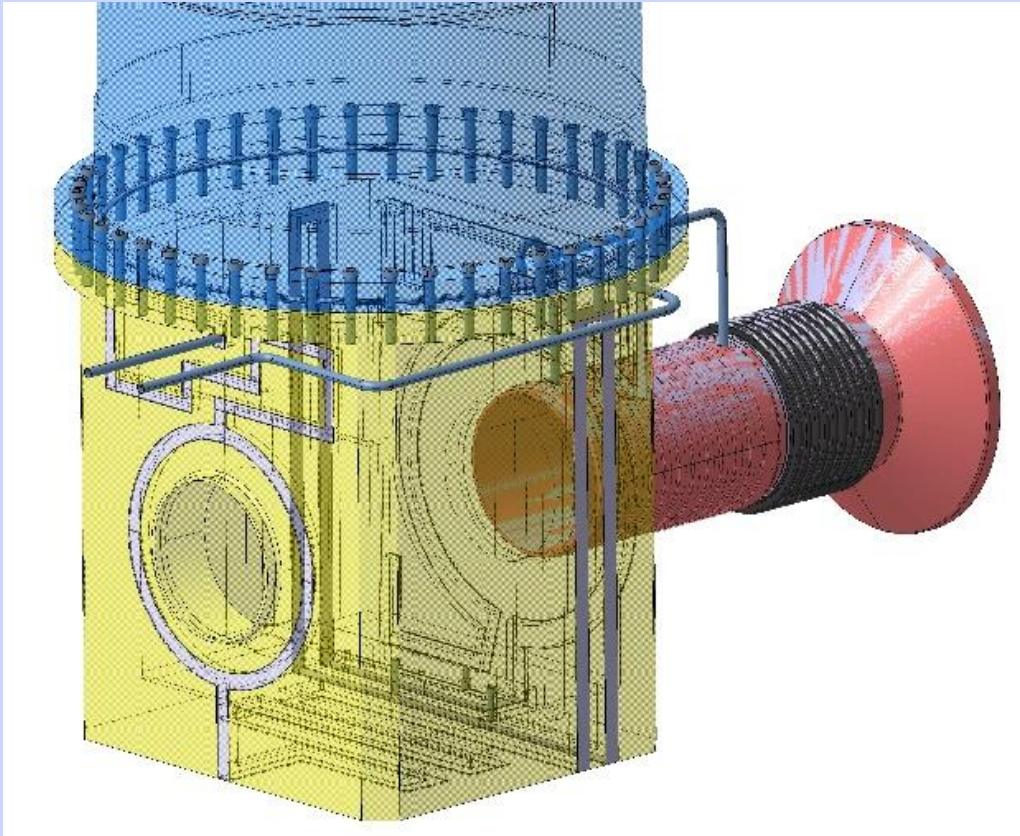
- Place bolts and tighten with torque according to instruction for the flanges/gasket assembly.
- Do not disconnect crane until finished. Instead, release lifting capacity step by step, as the bolts are being tighten.

Design and Installation



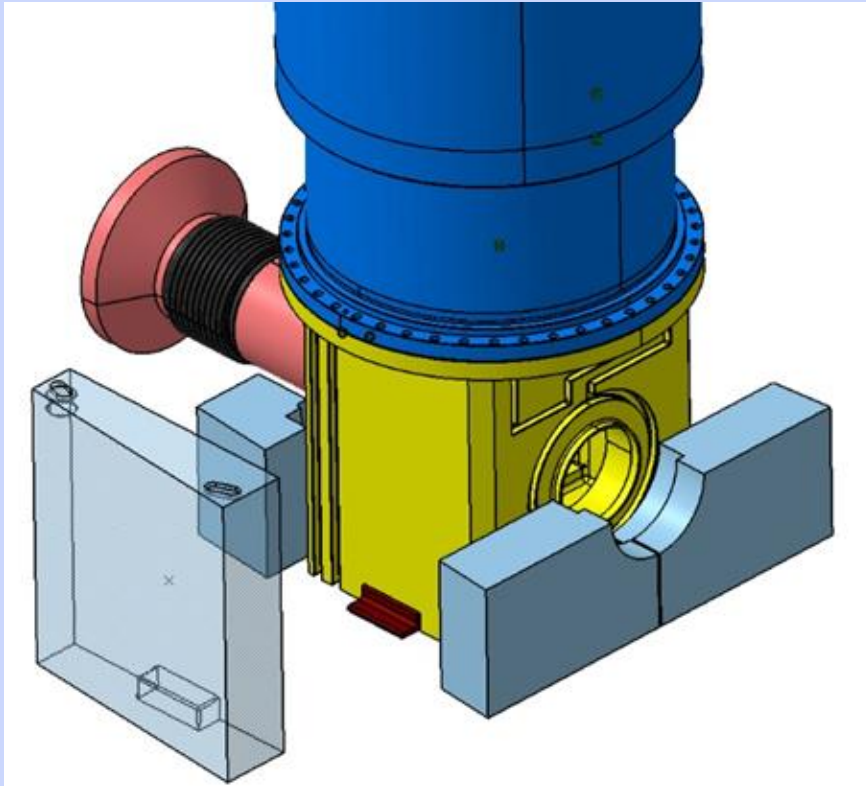
- Mount the struts in the weld-on brackets. Adjust length.

Design and Installation



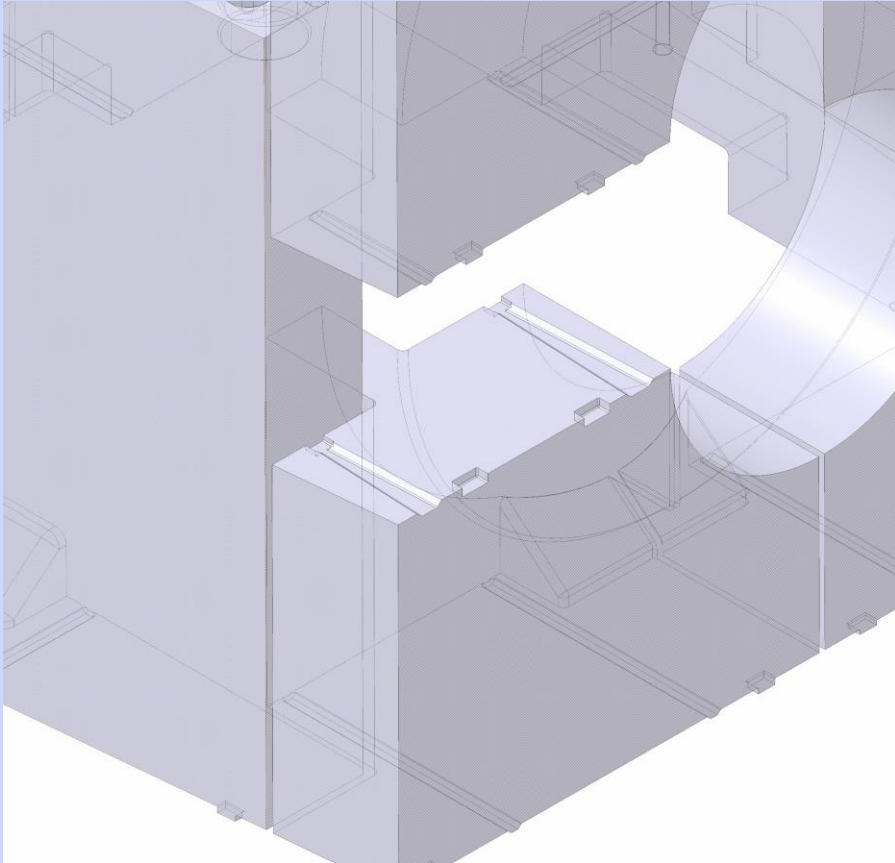
- Pipes will be routed and welded around the PB before installing the Shielding blocks.

Design and Installation



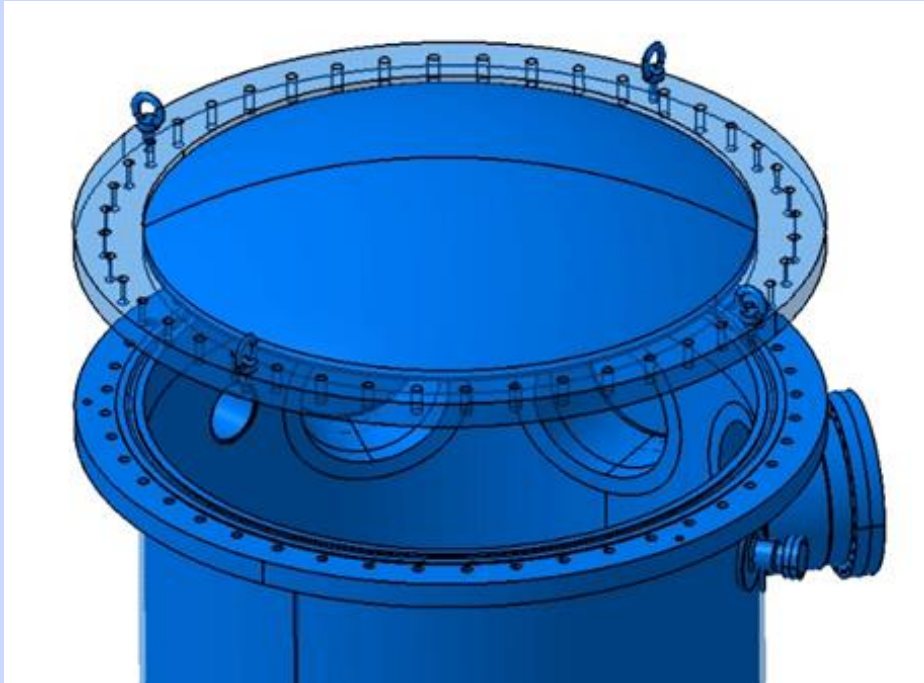
- Start installing the shielding blocks around the PB. Twist lock connection are prepared, so lateral movement is permitted to insert them towards the PB faces.

Design and Installation



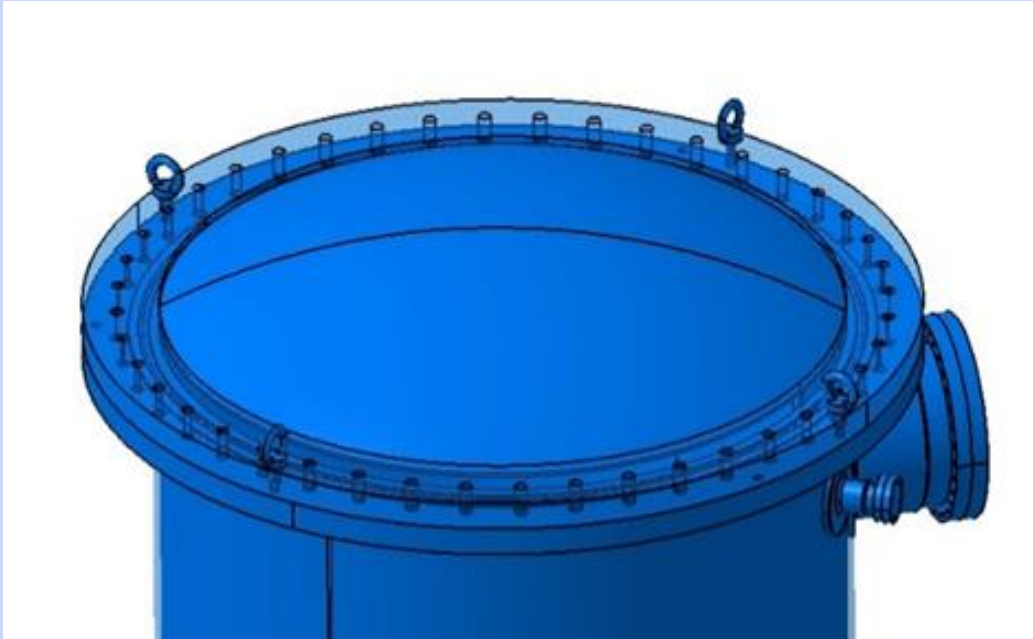
- **Complete the installation of the Shielding blocks.**
- **Use guiding features to place them in position, both in the Supporting plate and between blocks themselves.**

Design and Installation



- Install the vessel cap at the end of the sequence.
- Place the EPDM gasket.
- Lift it with the crane from the lifting eyes prepared.

Design and Installation



- Guide it with pins (same system as the PB) and place it in position.
- Tighten bolts with nuts below.

Disassembling process

Design and Installation

Preparation

- Dry-out of the cooling system.
- The outer and intermediate shielding must be removed first.

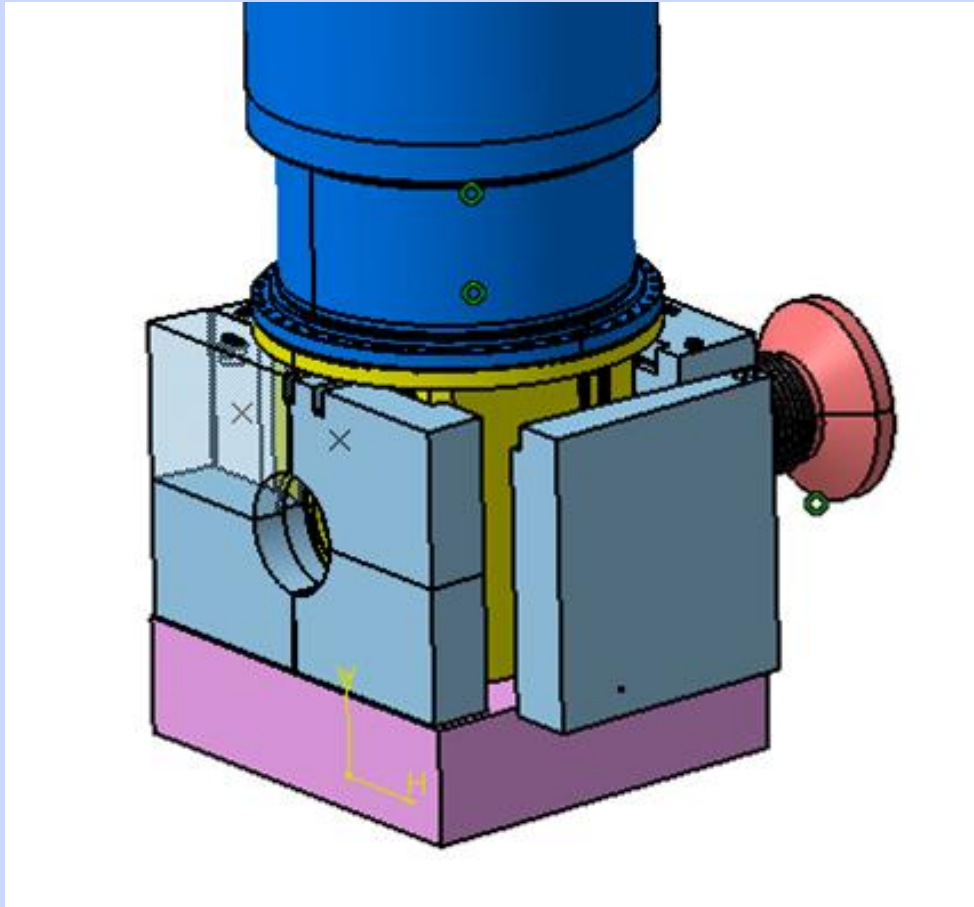
In-service Inspection

- To access from outside: Only need to remove shielding blocks.
- Access inside: remove PBW-System and Vessel.

Decommissioning

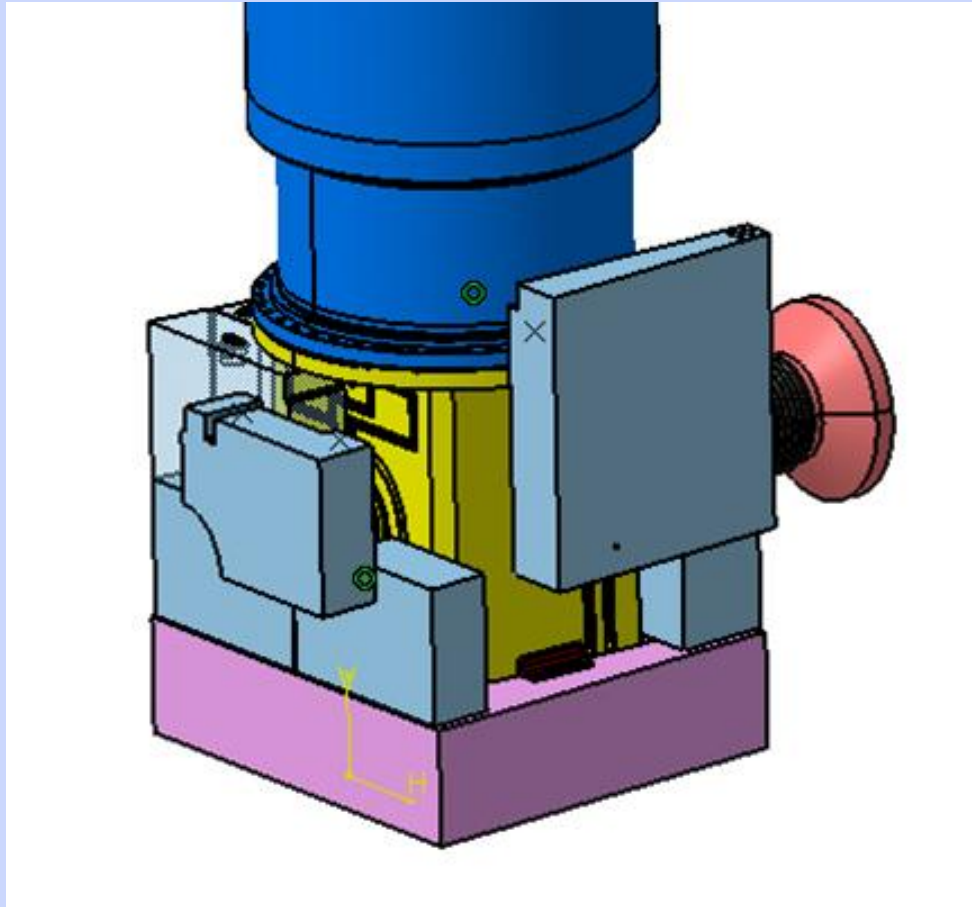
- Need to cut pipes of the cooling system.
- Need remote handling assistance to unscrew bolts.
- Need to cut Drift Pipe and Connecting Pipe to extract the PB.

Design and Installation



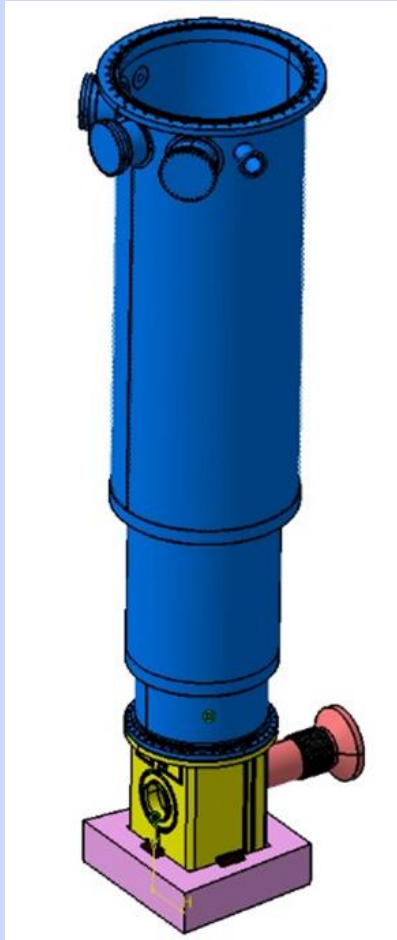
- Remove shielding blocks. The twisted lock connection permits to pull them aside and up.

Design and Installation



- Continue the removal of all shielding blocks. For inspection purposes, maybe only the upper part of the blocks is needed to be removed.

Design and Installation



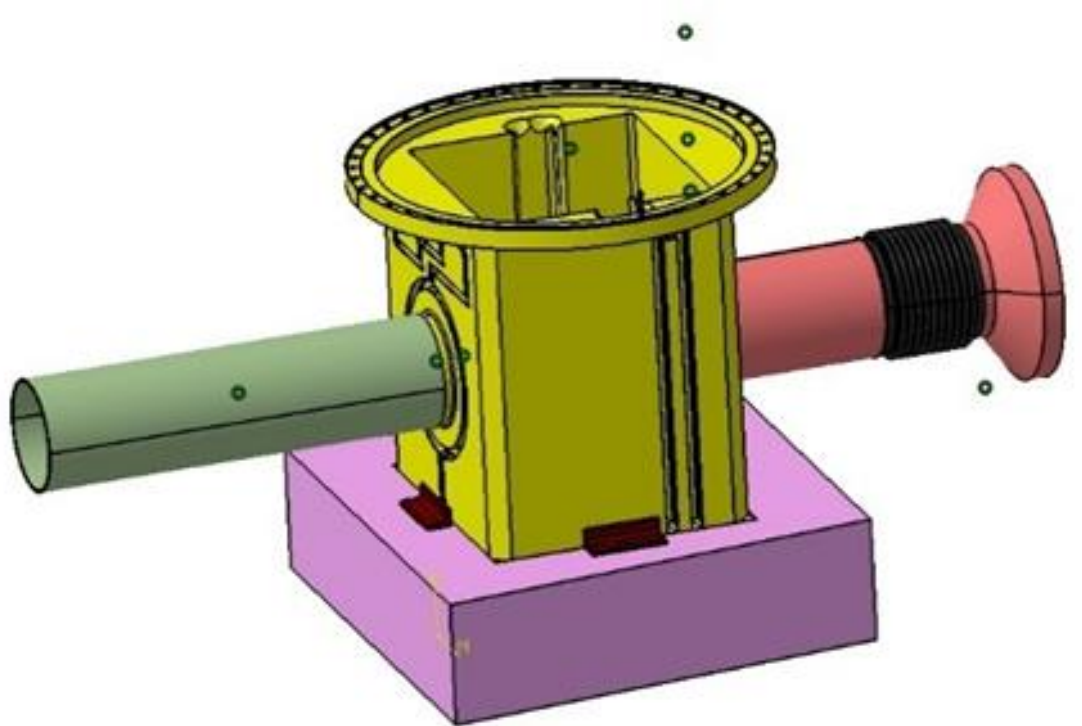
- **AT TOP:** Remove the vessel cap and the full PBW-System.
- **AT BOTTOM:** Unscrew the bolts in the flange that connects the PB and the Vessel.
- **Attach and hold the PBW-Vessel with the crane.**

Design and Installation



- Disconnect the struts from the MV.

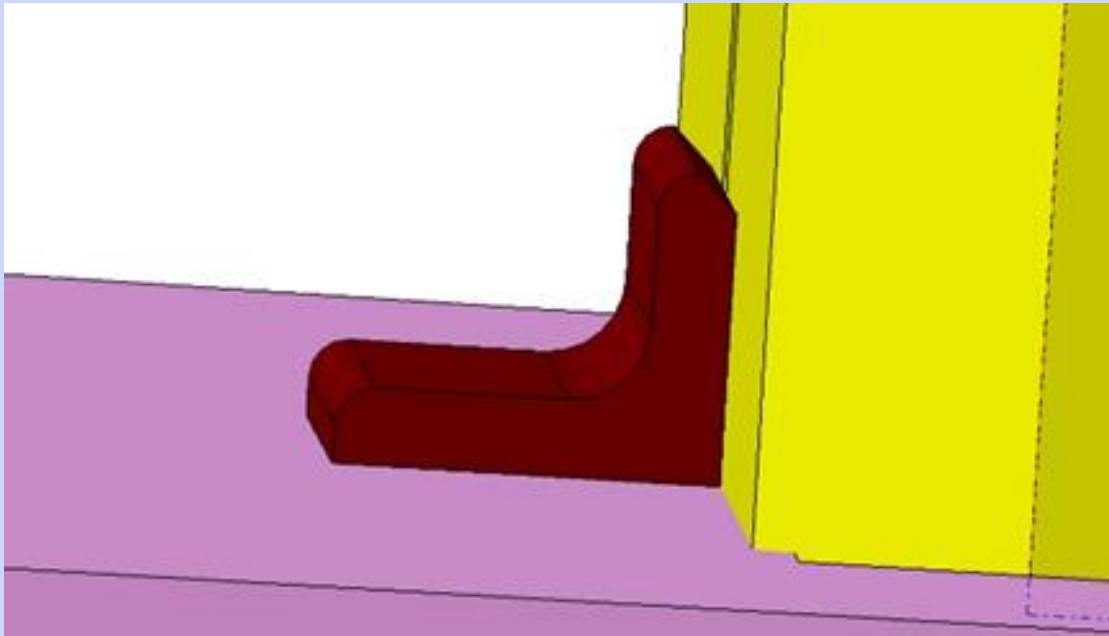
Design and Installation



- **Inspection:**
For in-service inspection, the PB is now fully accessible.
- **Decommissioning:**
For decommissioning, both the Drift Pipe and the Connecting Pipe must be cut to permit the PB extraction.
In case of accident with damage to the PB, this pipes should also be cut.

Design and Installation

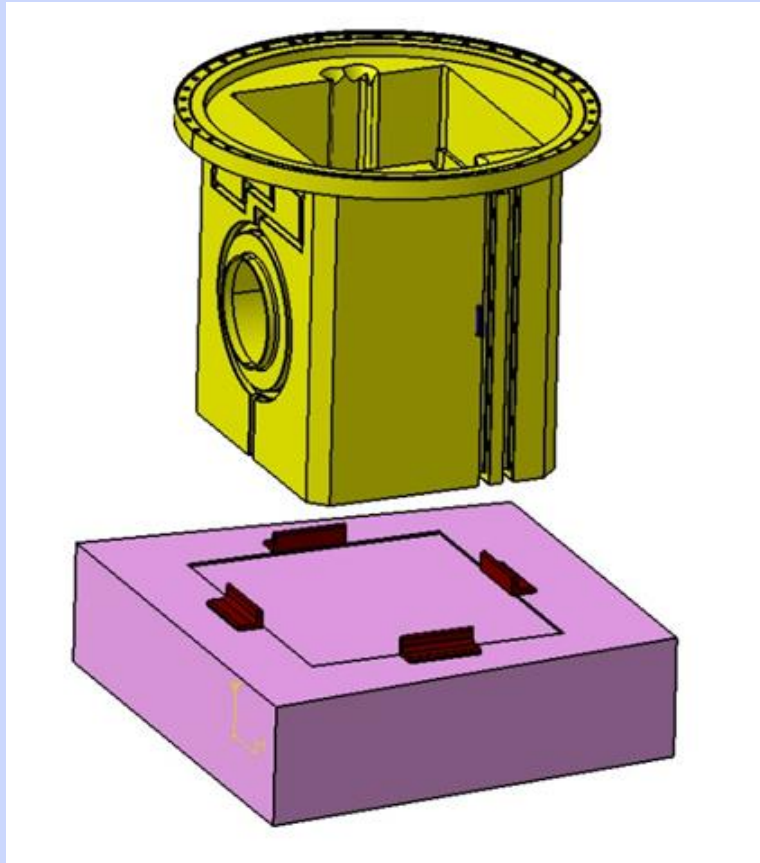
Replace or decommission



- The welded features have been prepared with chamfered edges to ease reinstallation the PB in case of accident.
- No realignment is needed, since the position is guaranteed by this features.

Design and Installation

Replace or decommission



- The PB can now be extracted and decommissioned or replaced in case it has suffered an accident.