The Construction of the ESS Target Station
Current Progress and Challenges

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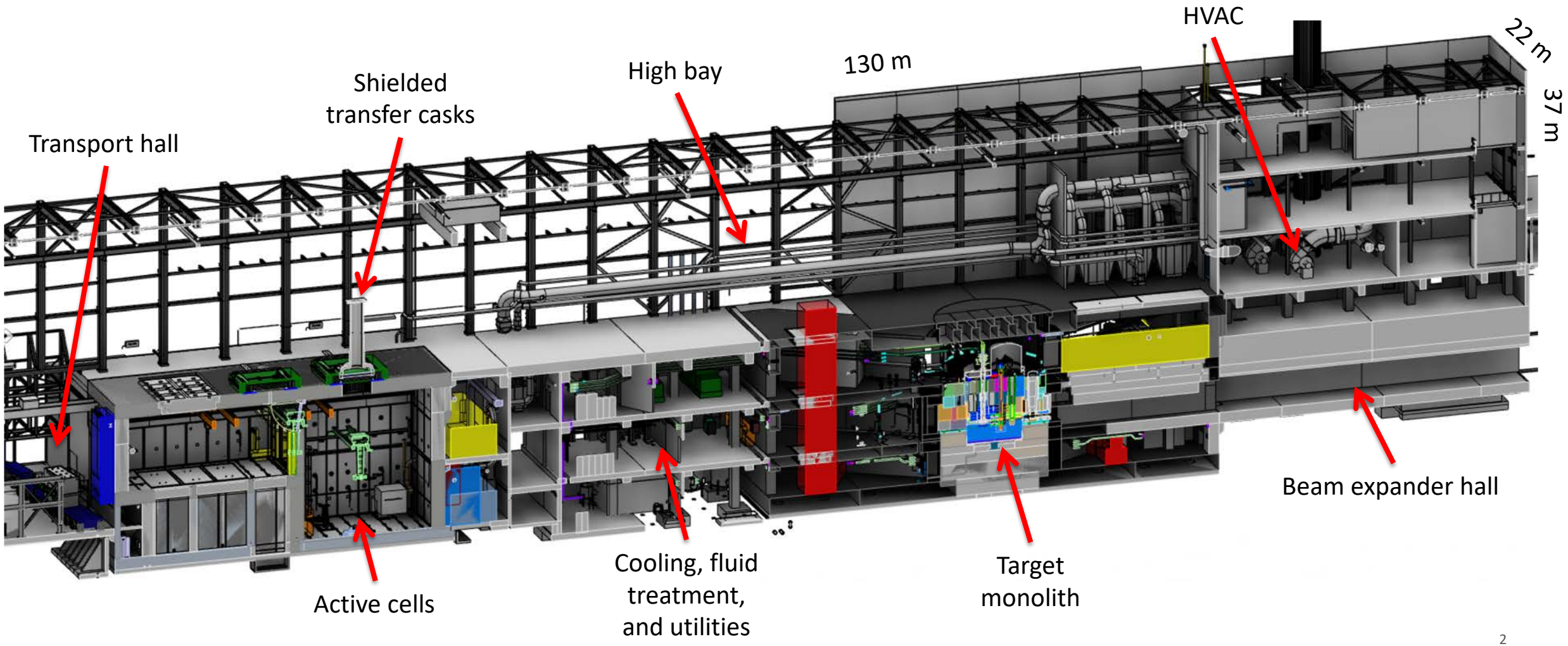
European Spallation Source ERIC

26th September 2019

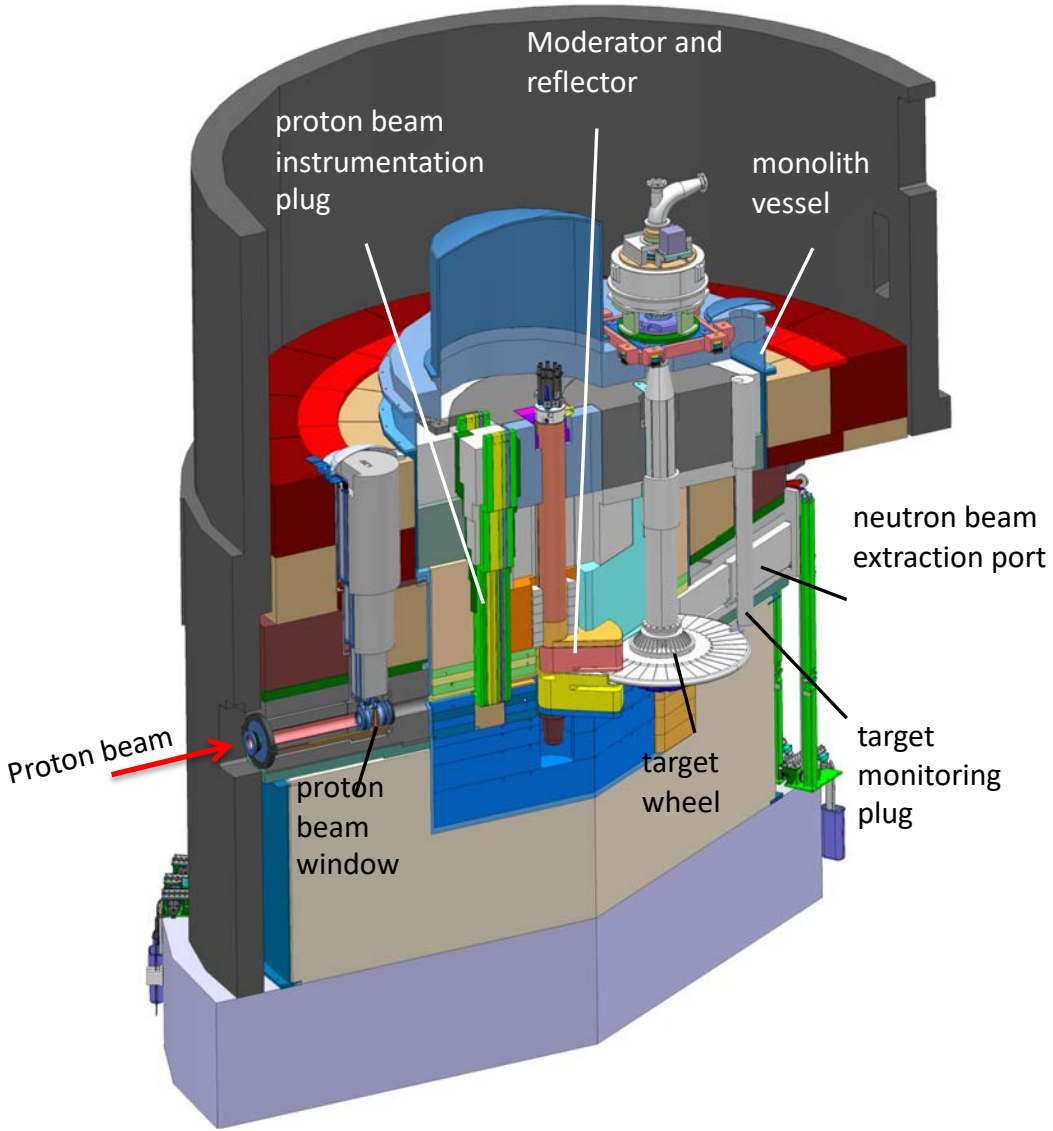
The ESS Target Station

Section cut of the building model



The ESS Target Station

Section cut of the central monolith



Rotating solid tungsten target

- 36 sectors
- Mass, total 11 tonnes, whereof 3 tonnes of W
- Rotates 23.3 rpm, synchronized with pulsed proton beam 14 Hz

Helium cooling of target material

- Mass flow 3 kg/s
- Pressure 11 bar
- Temperature inlet/outlet 40 °C/240 °C

Moderators

- Provisional locations of moderators above and beneath the target wheel.
- 1st MR plug exploits the upper space, offering:
  - ✓ Cold, 30 mm high, liquid H_2 moderators, 17 K
  - ✓ Thermal, 30 mm high, H_2O moderator, 300 K

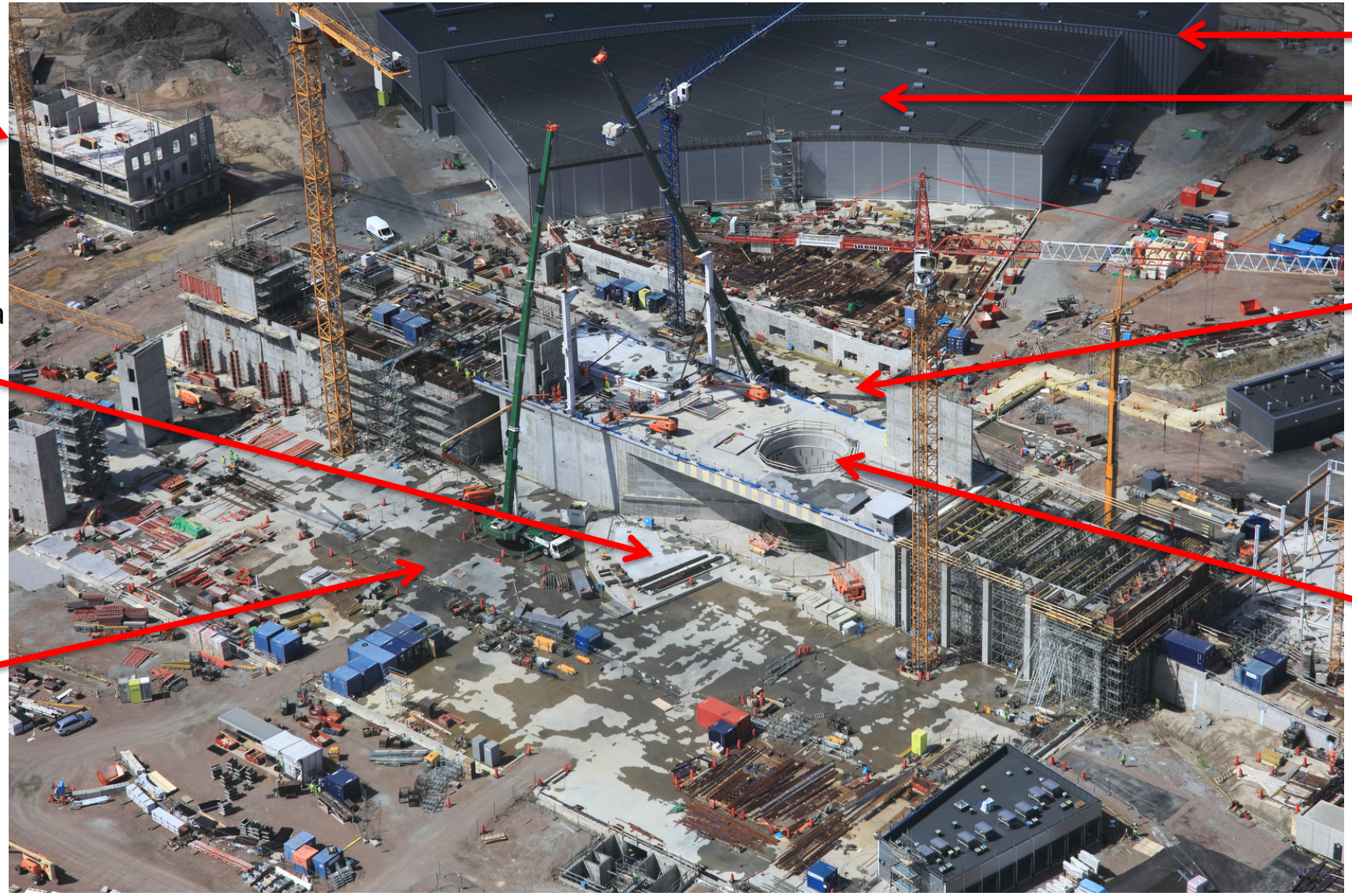
Neutron beam extraction

- Offers 42 neutron beam ports
- Allows neutron science instruments to view either upper or lower moderator position

Civil Construction Progress

The ESS Target Station

Recent photographs – aerial view mid-August 2019



The ESS Target Station

Recent photographs – side view 22nd September 2019

The ESS Target Station

Recent photographs – view from experimental hall 1 (D01)

Target Station D02
High bay trusses

Open space for the monolith

Instrument bunker area
south-east side

The ESS Target Station

Recent photographs – close up of instrument bunker area

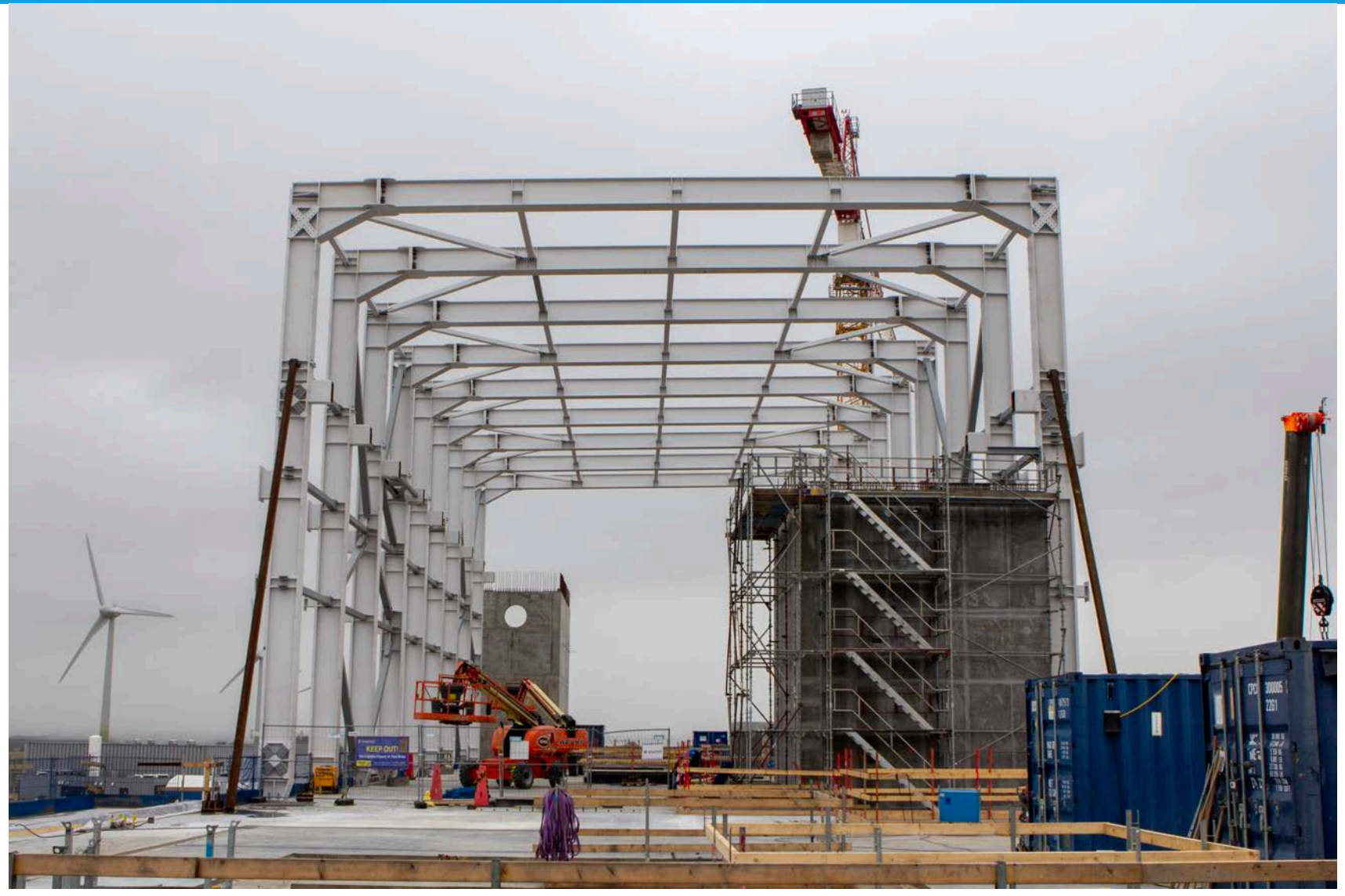
The ESS Target Station

Recent photographs – rooms for cooling and utility systems

- View from the location of the helium filters
- Angular walls towards the instrument bunker areas
- Wall penetrations for piping and cabling serving the monolith systems
  - Helium-cooling pipes
  - Water-cooling pipes
  - Electrical cables
  - Controls cables
- Highbay floor slab above the monolith area, with double thickness for shielding purpose

The ESS Target Station

Recent photographs – steel structure of the highbay being erected

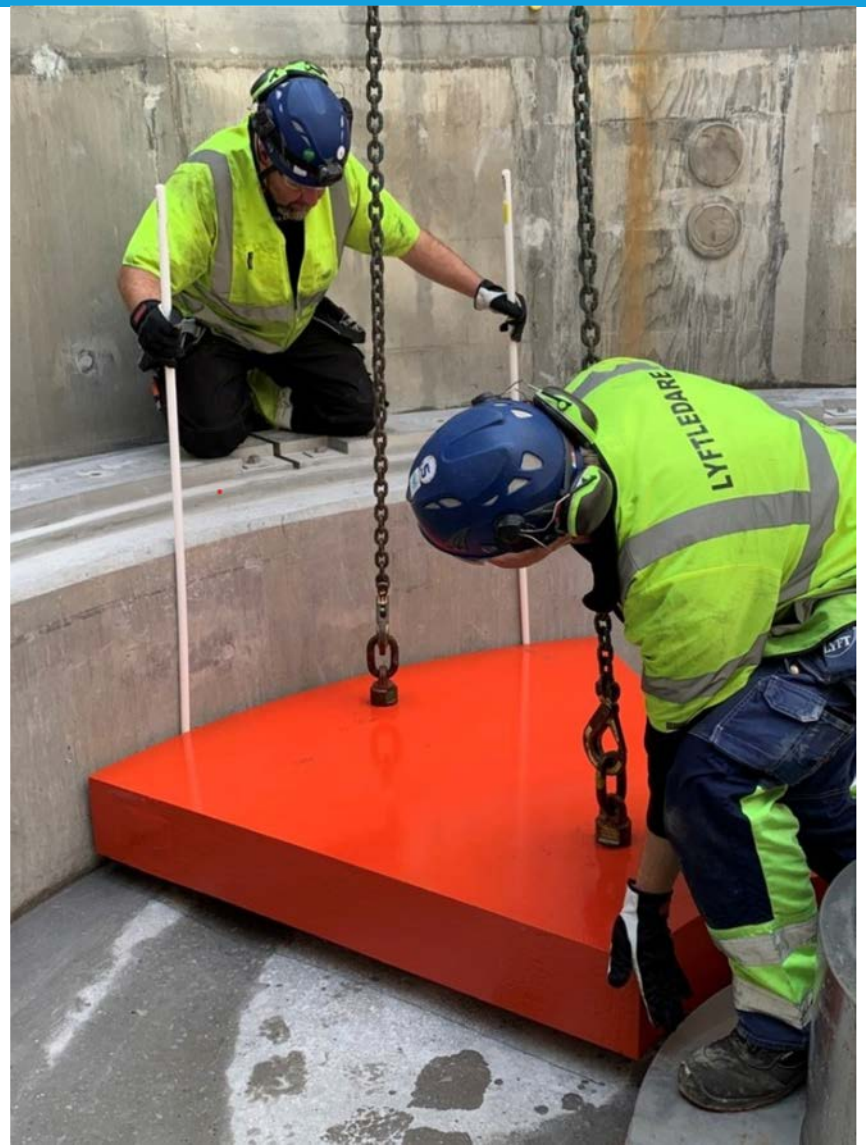


The ESS Campus Building B01 and Lab Building B02

Recent photographs – view from the Target Station highbay

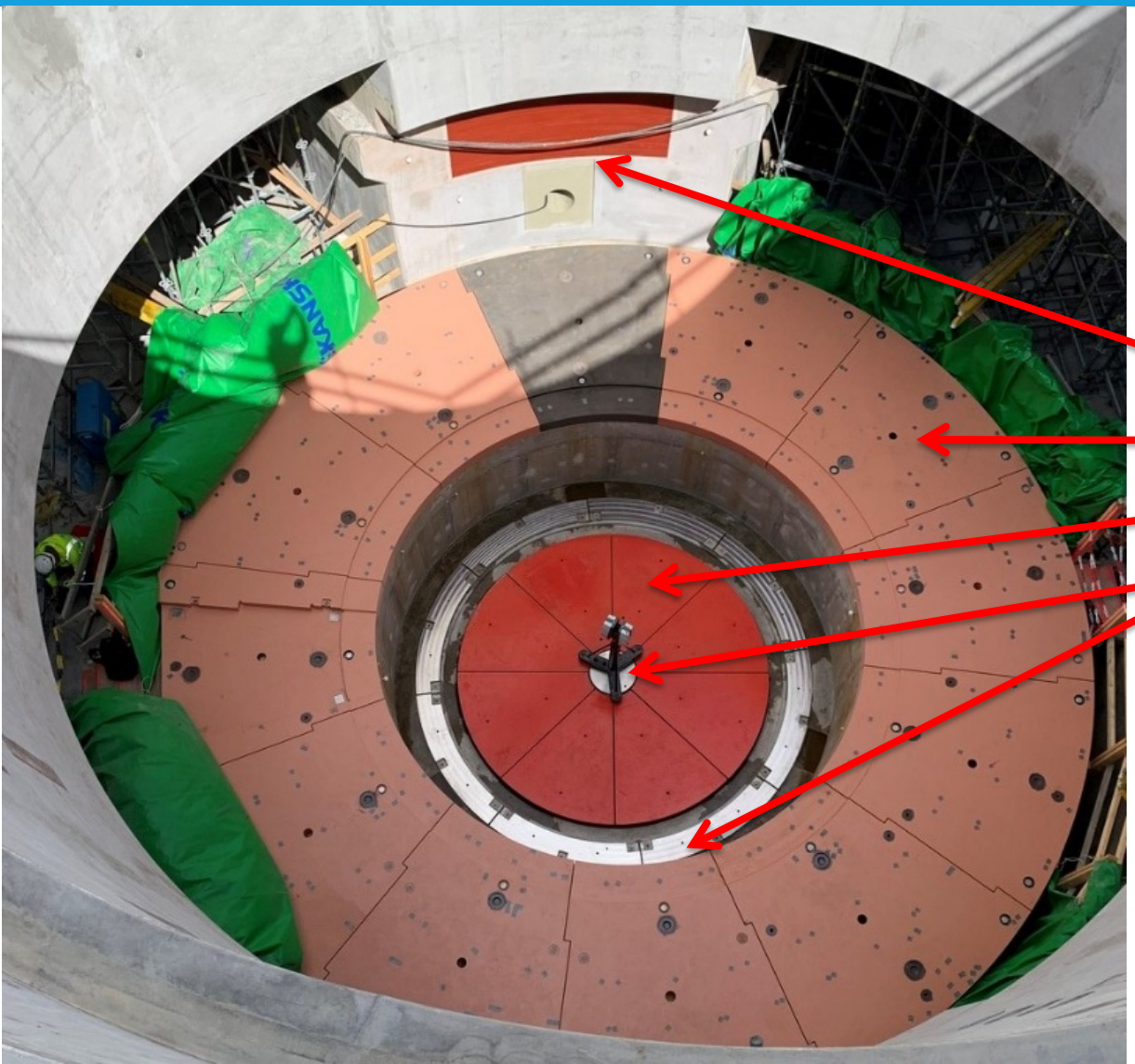
Site Installation Progress
- and Challenges

Site installations
Ground Shielding



Site installations

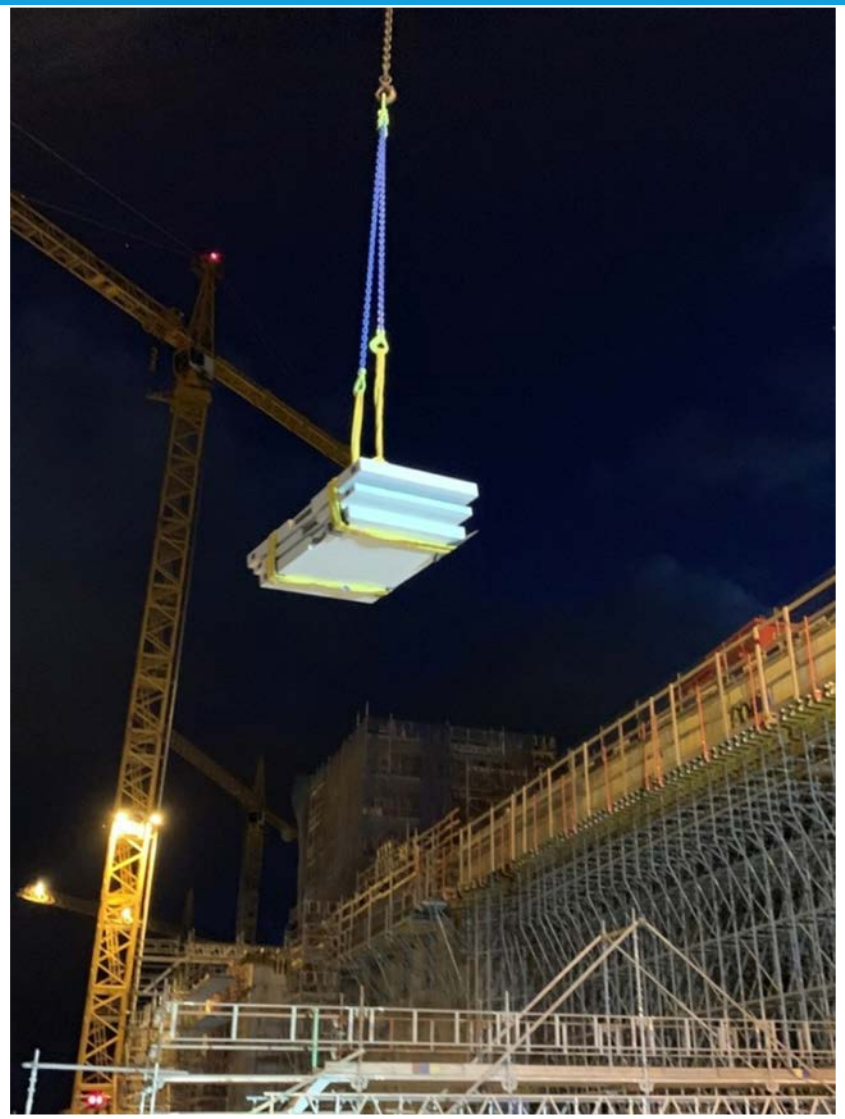
Monolith Vessel Supports, Monolith Baseplate, Ground Shielding, and Wall Embedments

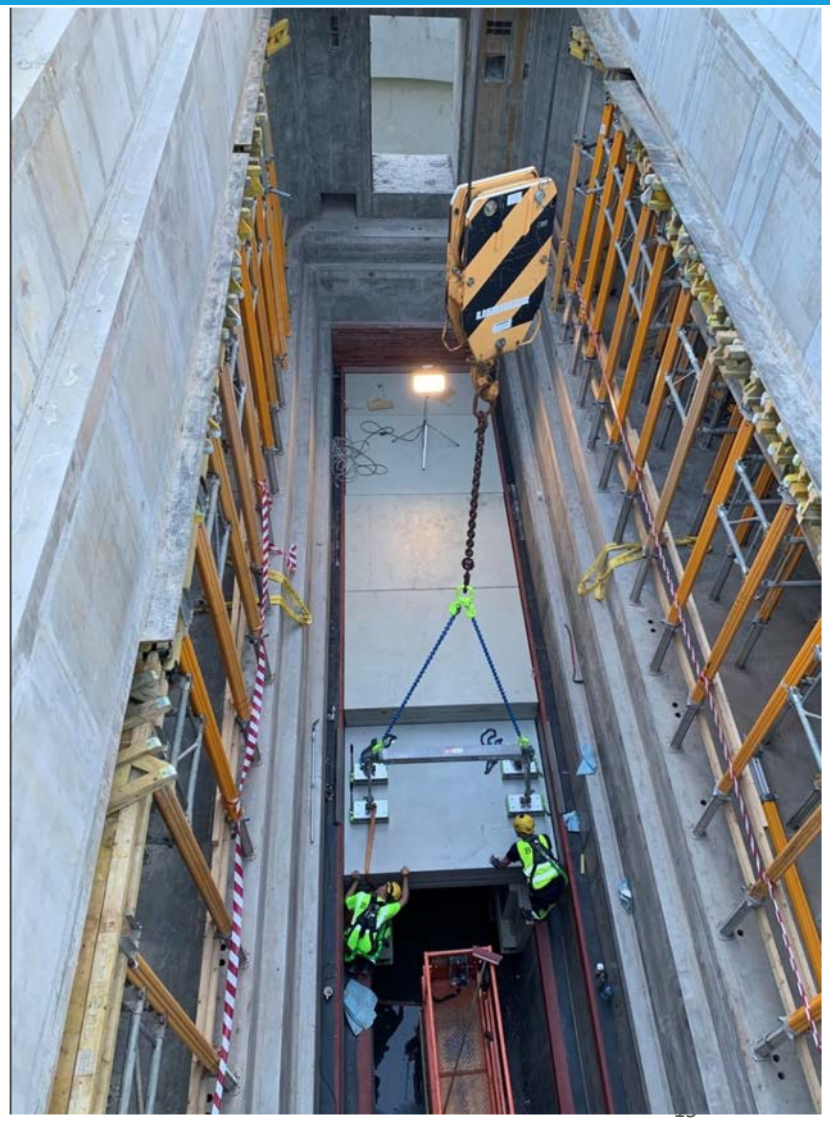


- Several heavy steel structures (~700 tonnes) have been installed, including
  - the proton beam wall penetration shielding
  - the monolith baseplates
  - the monolith ground shielding
  - the monolith vessel supports
  - and the D2T shielding (next slide)

Site installations

Bulk Shielding above D2T



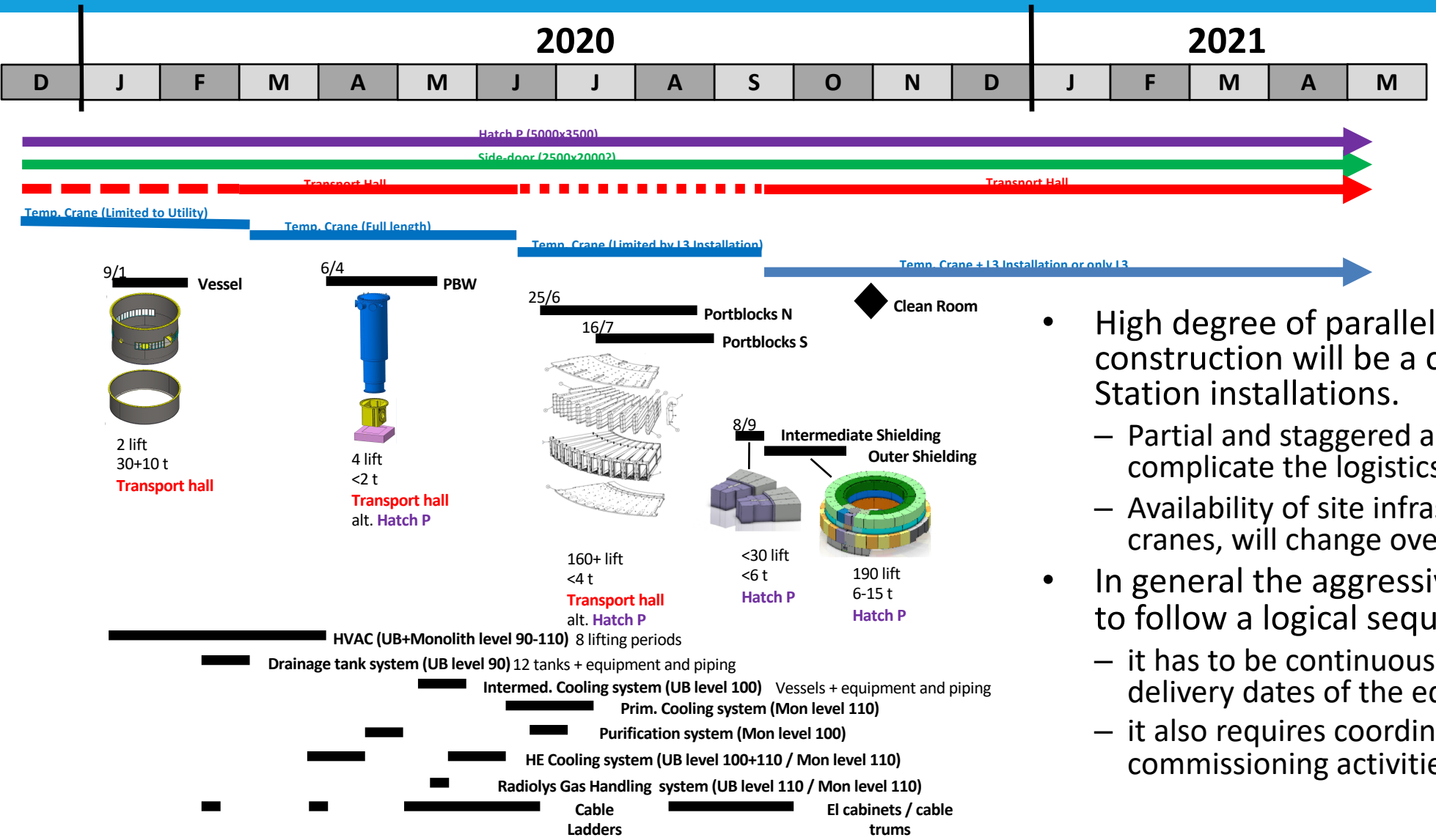


Site installations

Embedments for Neutron Shield wall

Notional installation schedule

Challenging coordination task with respect to availability of site services

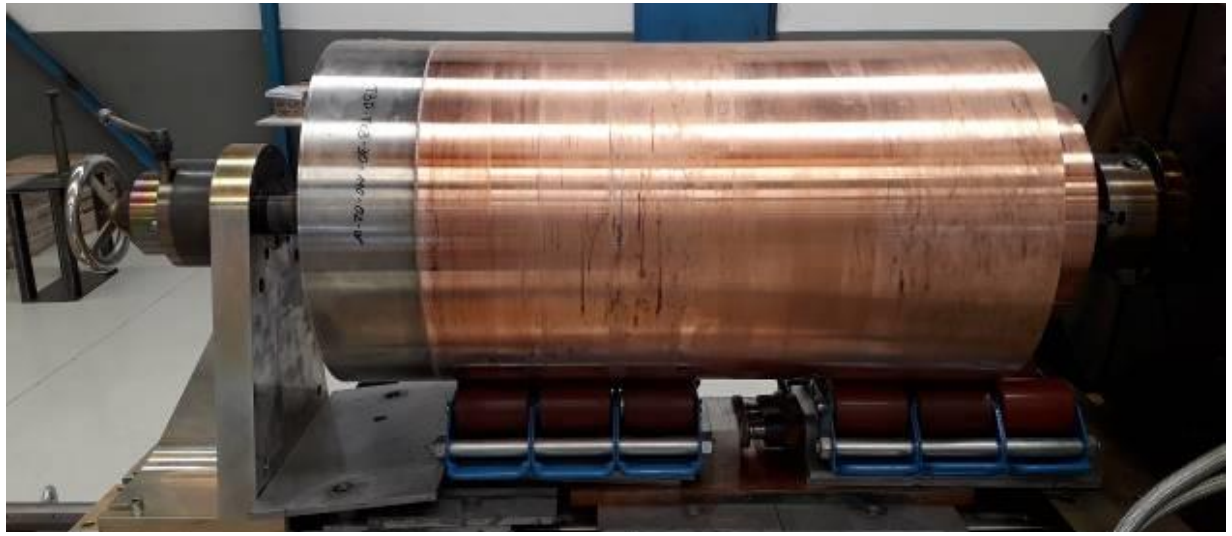


- High degree of parallelism with the civil construction will be a challenge for the Target Station installations.
  - Partial and staggered access to the buildings will complicate the logistics.
  - Availability of site infrastructure services, like cranes, will change over time.
- In general the aggressive installation plan needs to follow a logical sequence, but
  - it has to be continuously adopted to the actual delivery dates of the equipment
  - it also requires coordination with testing and commissioning activities

So, the Target Station has entered the installation phase!

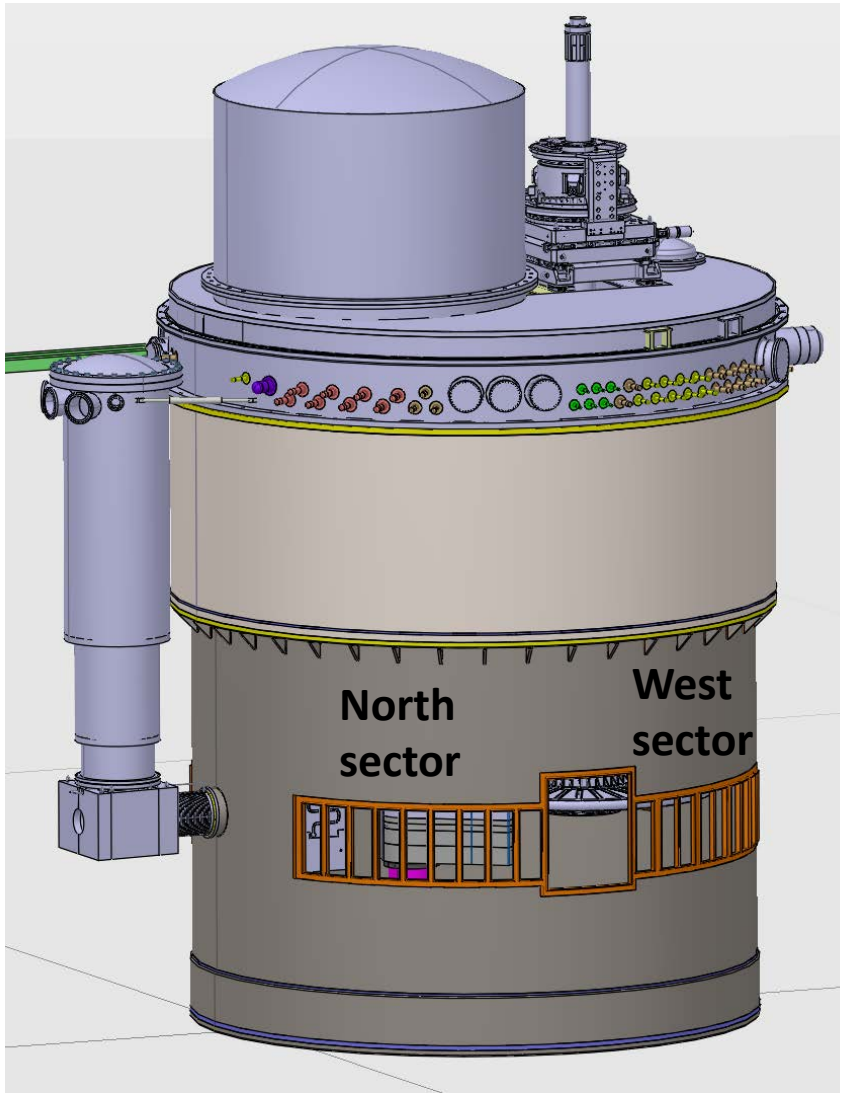
What's next?

- ACF liner plates will start being installed September
- Tuning Beam Dump is scheduled for installation in October/November
- Monolith Vessel installation activities begin in December/January.
- Cooling systems and HVAC installation starts 2019 Q1

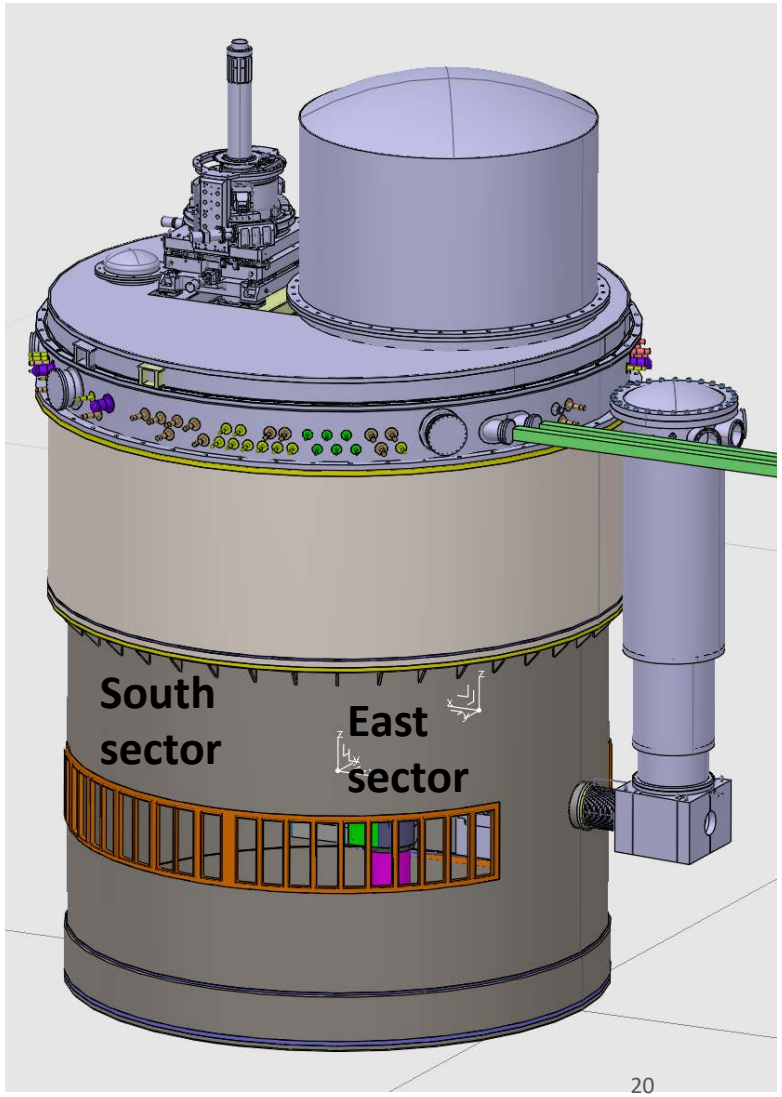


Target Station Deliveries' Progress - and Challenges

Monolith Vessel
In manufacturing



- The monolith vessel is in manufacturing
  - Diameter ~6 m,
  - Total height ~10 m
- Lower and mid part to be delivered by end of year



Monolith Vessel
In manufacturing

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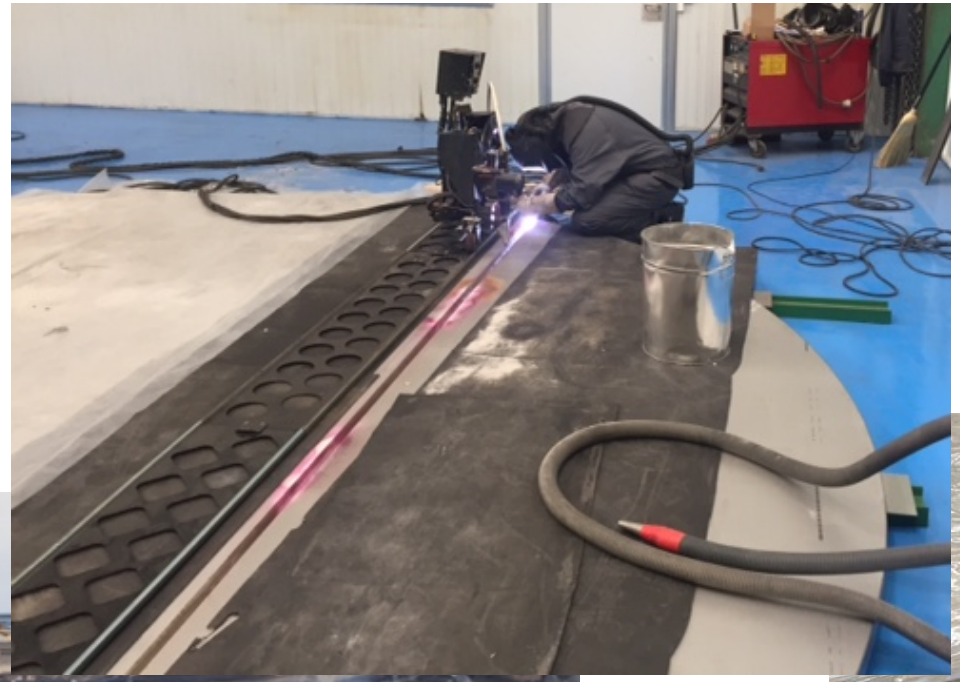
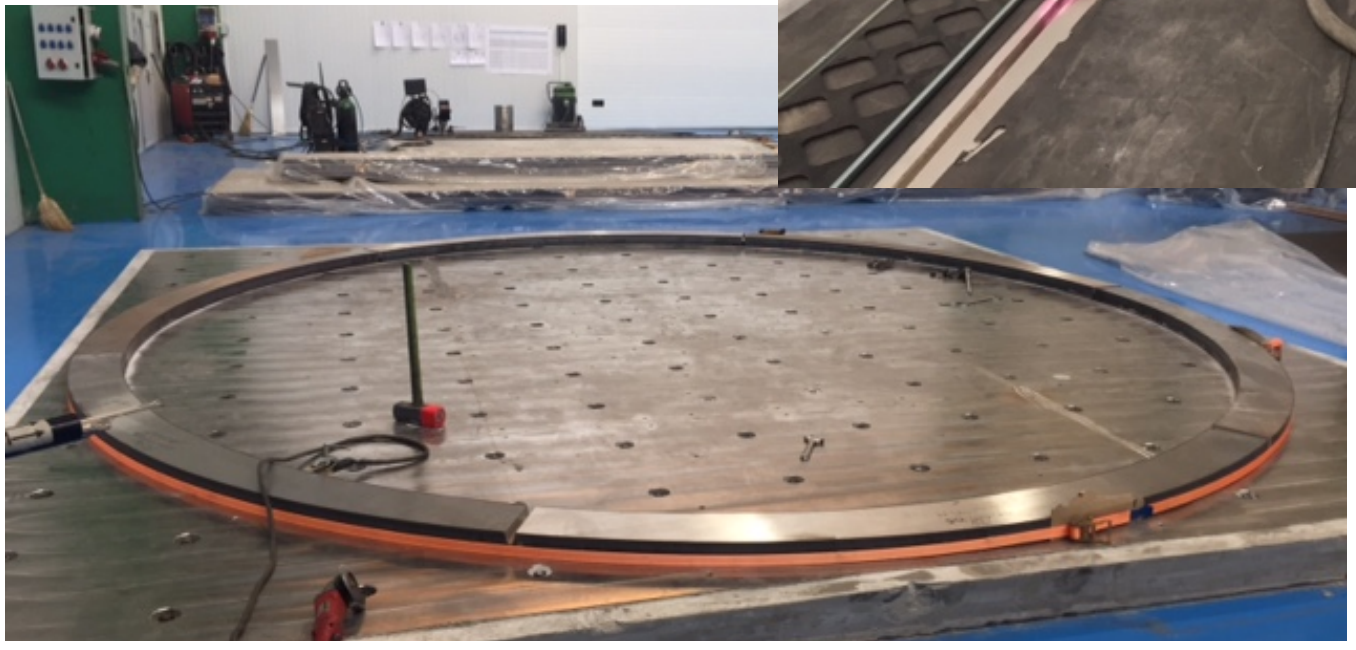


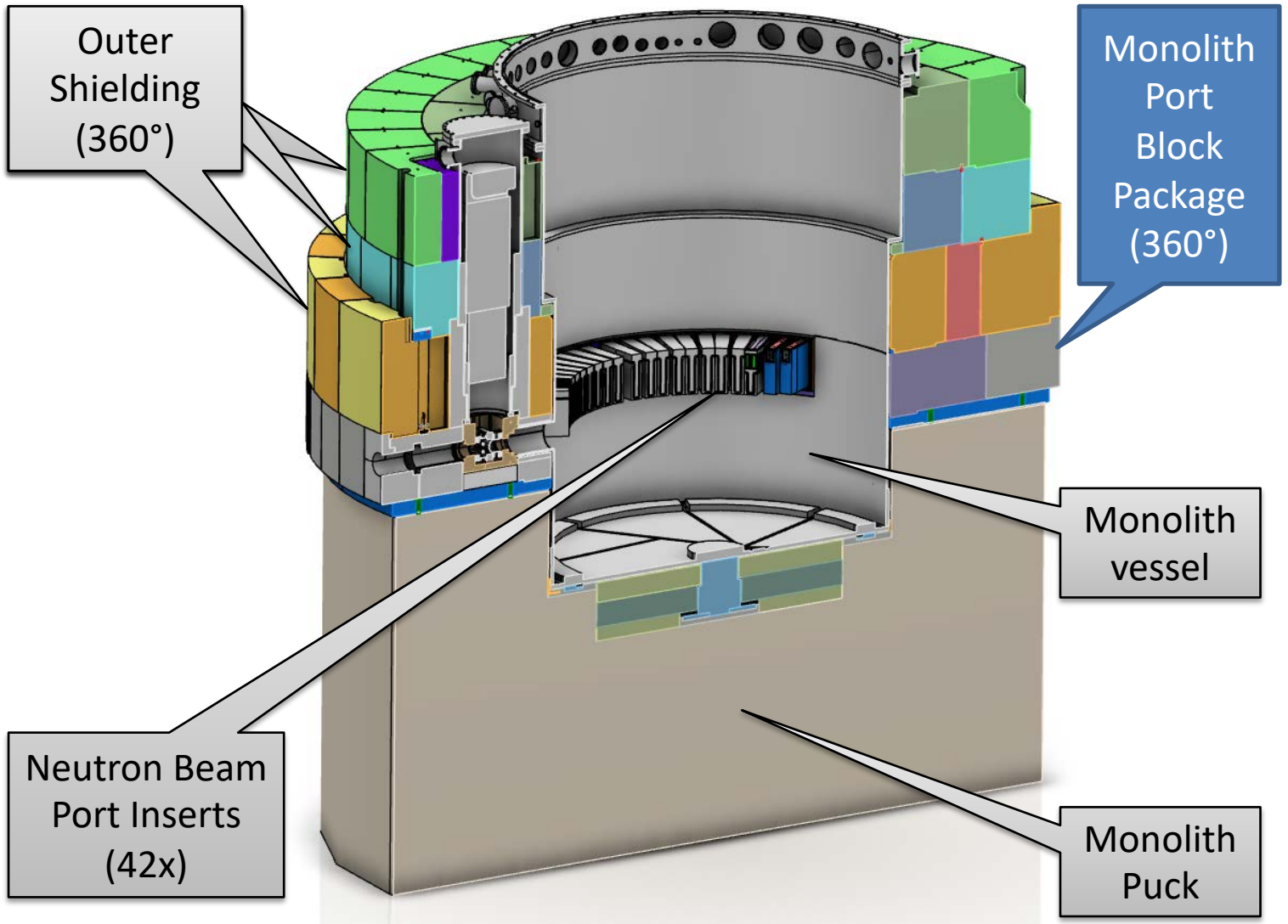
Vessel bottom plate perimeter ring

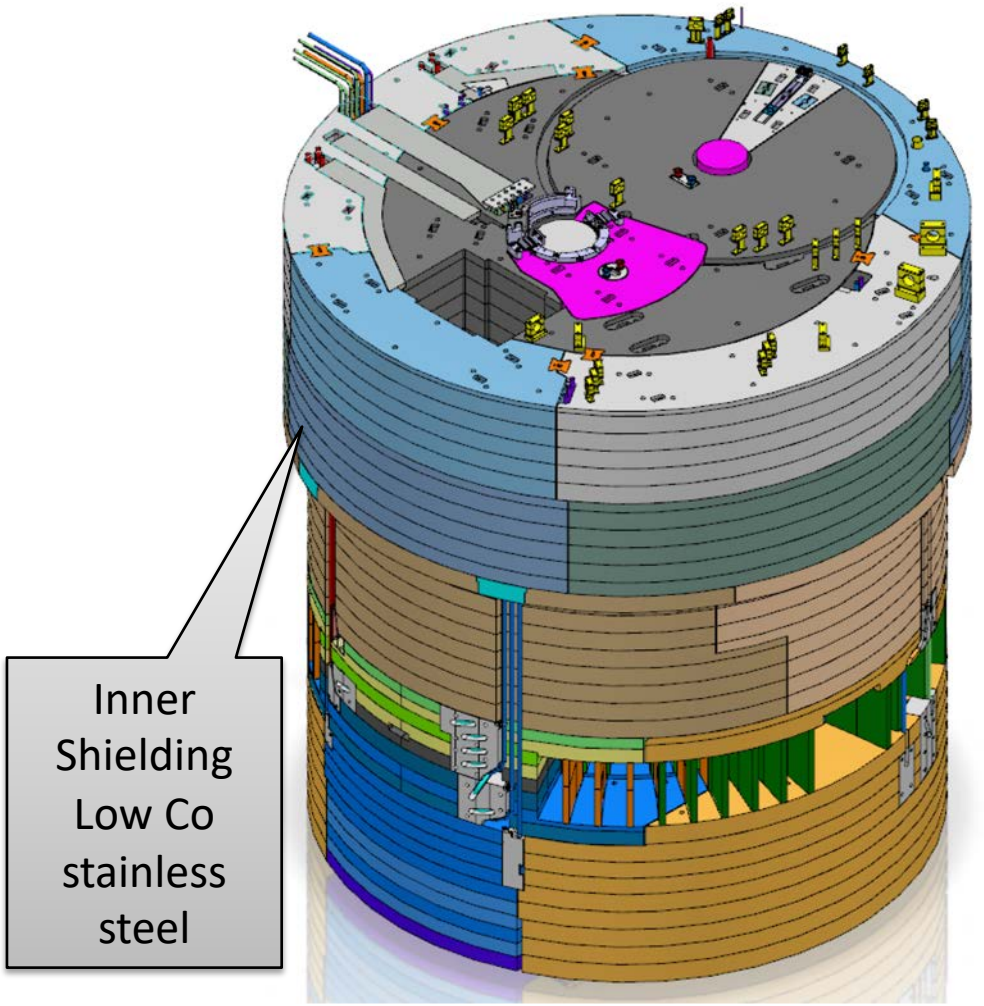


Vessel bottom plate fabrication through submerged arc welding technique

Monolith vessel, outer shielding, and inner shielding

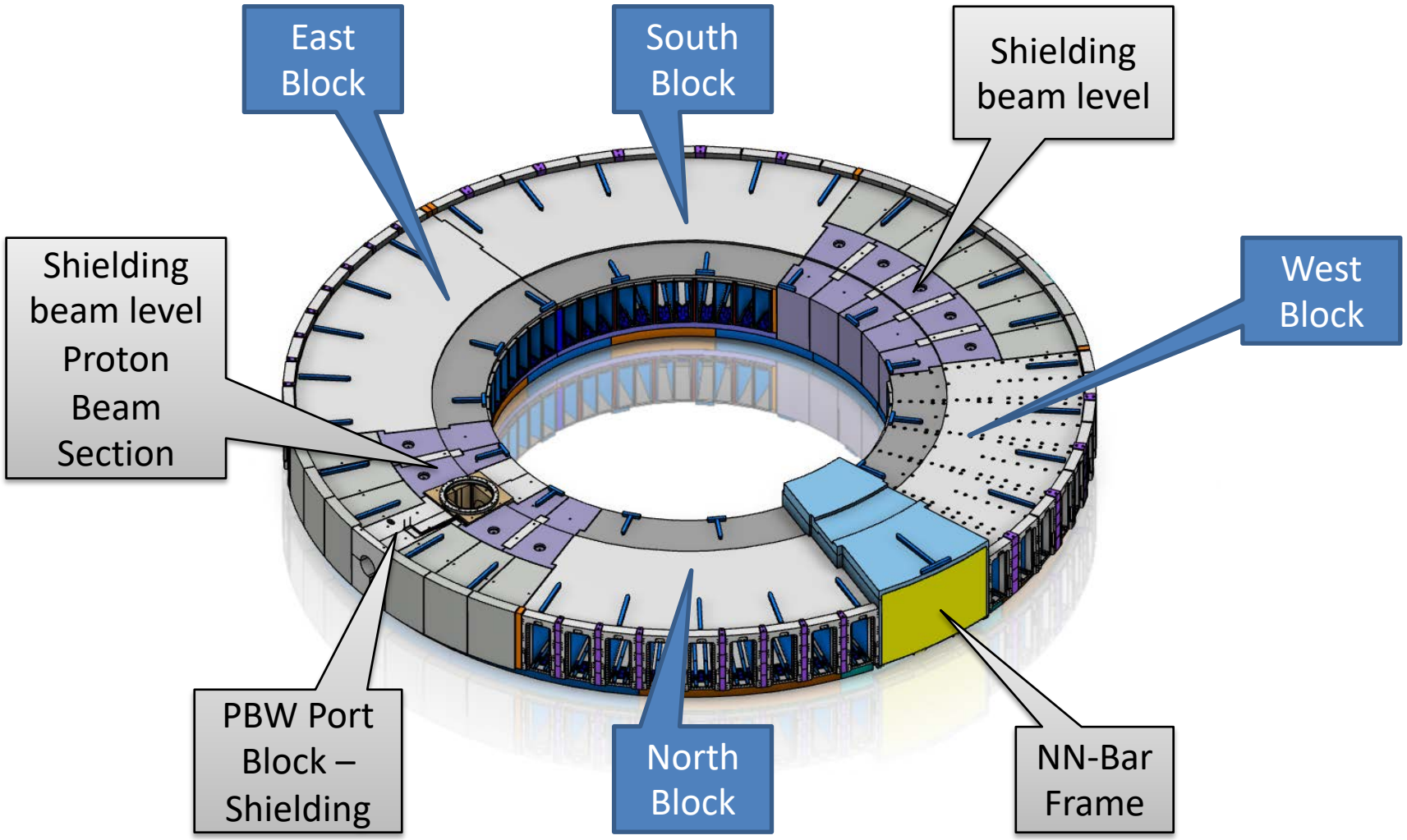
In manufacturing





Monolith Port Block Package

Material supply issues, but now in manufacturing



Steel supply challenges

Surface cracking issue incurred delays to material delivery

- We experienced severe problems with the stainless-steel material deliveries for the
  - Neutron Beam Port Block
  - Monolith Inner Shielding
  - Neutron Beam Port Inserts
- Initially, manly material quality issues, but also
  - Administrative problems
  - Logistics difficulties
  - Dimensional non-conformities
  - Material certification issues
- Resulting in up to three months of delay of the material supply

Steel supply challenges

Surface cracking issue incurred delays to material delivery

Neutron Beam Port Tubes

Now in manufacturing

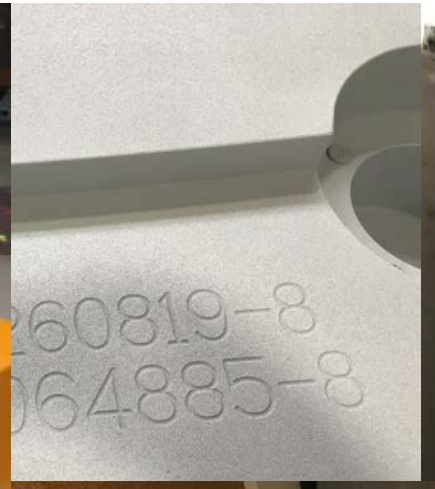
Bottom part of port tube, with insert alignment features

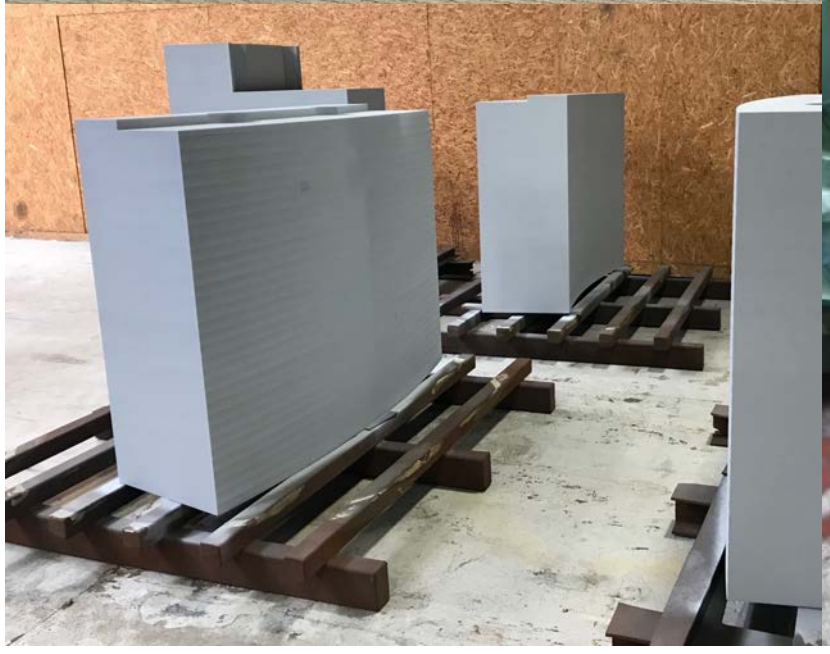
Port flange raw material

Top parts of port tubes

Monolith Outer Shielding

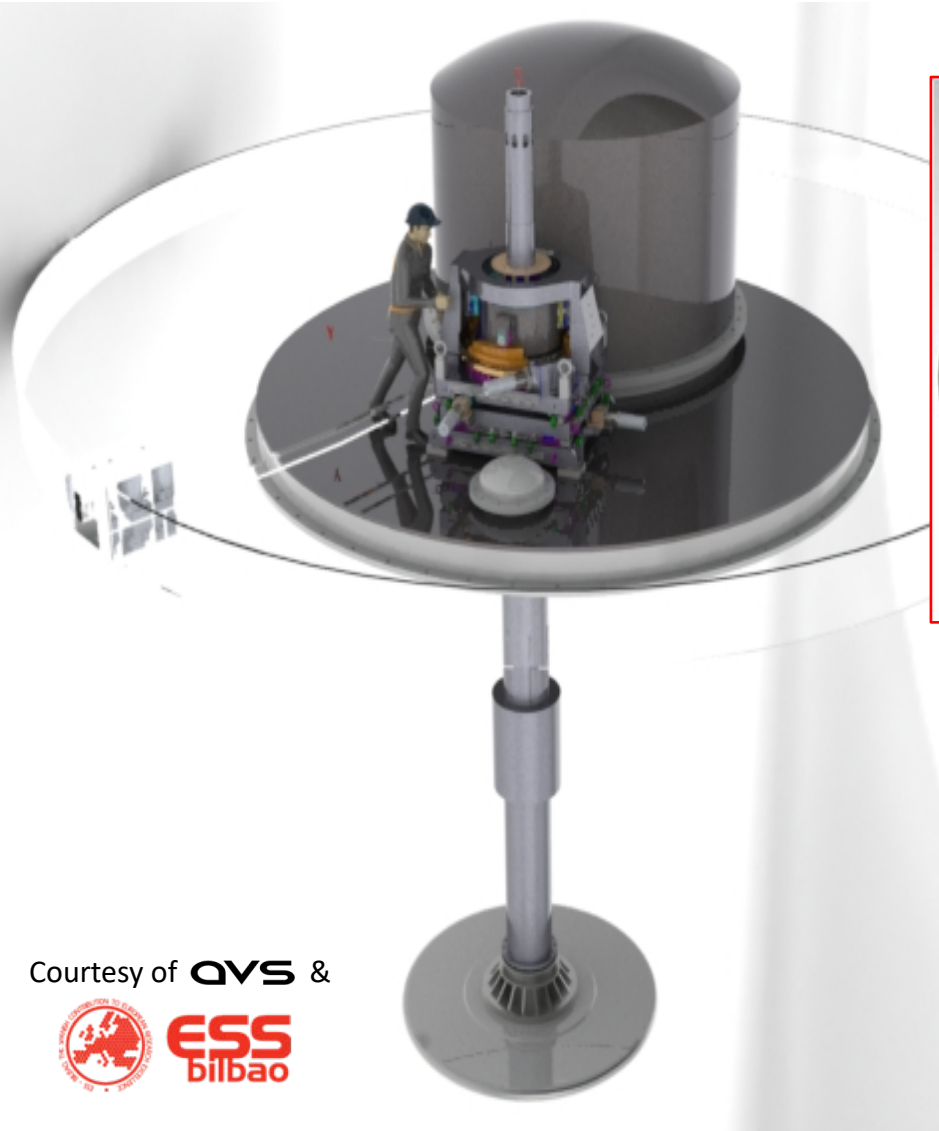
Blocks ready for shipment





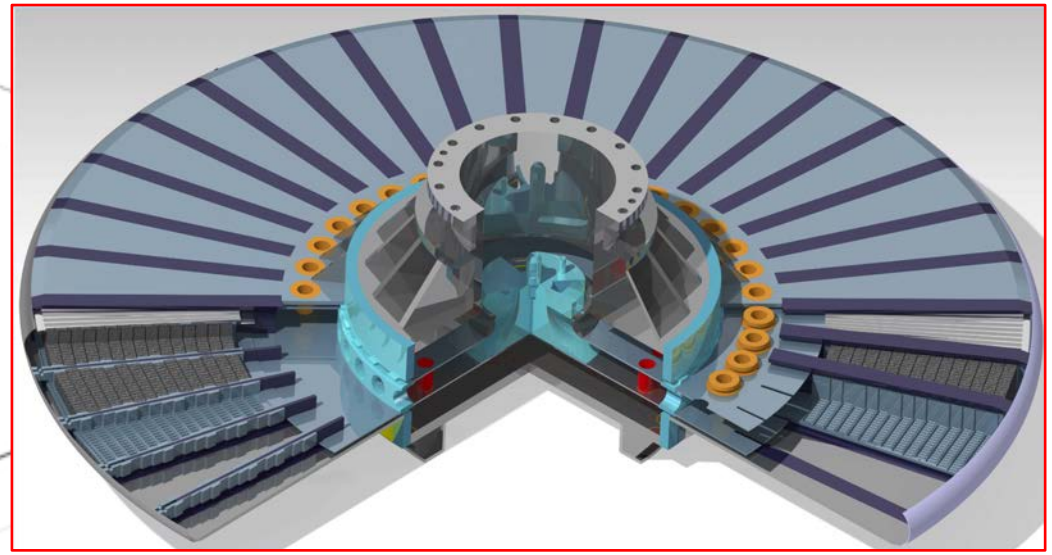
Target Systems

Several parts being fabricated, others about to begin

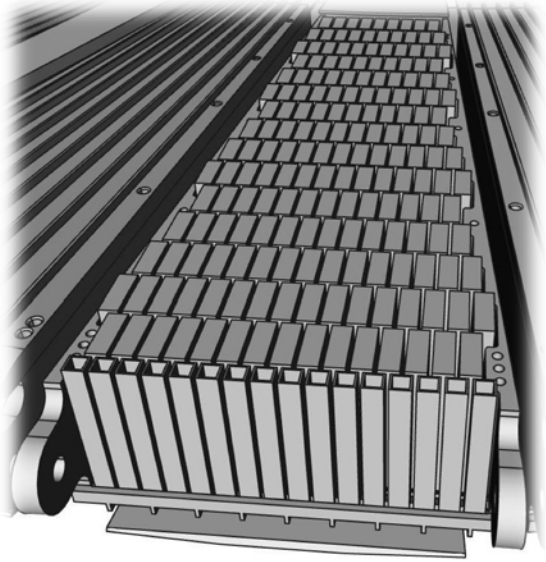


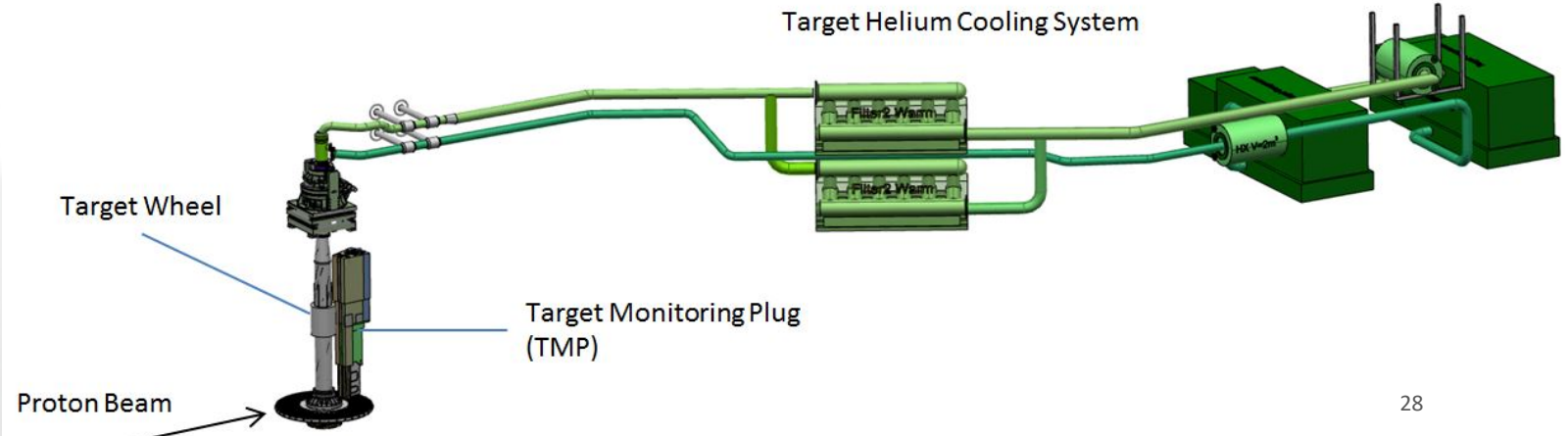
Courtesy of QVS &

ESS bilbao



Tungsten Bricks in Cassette

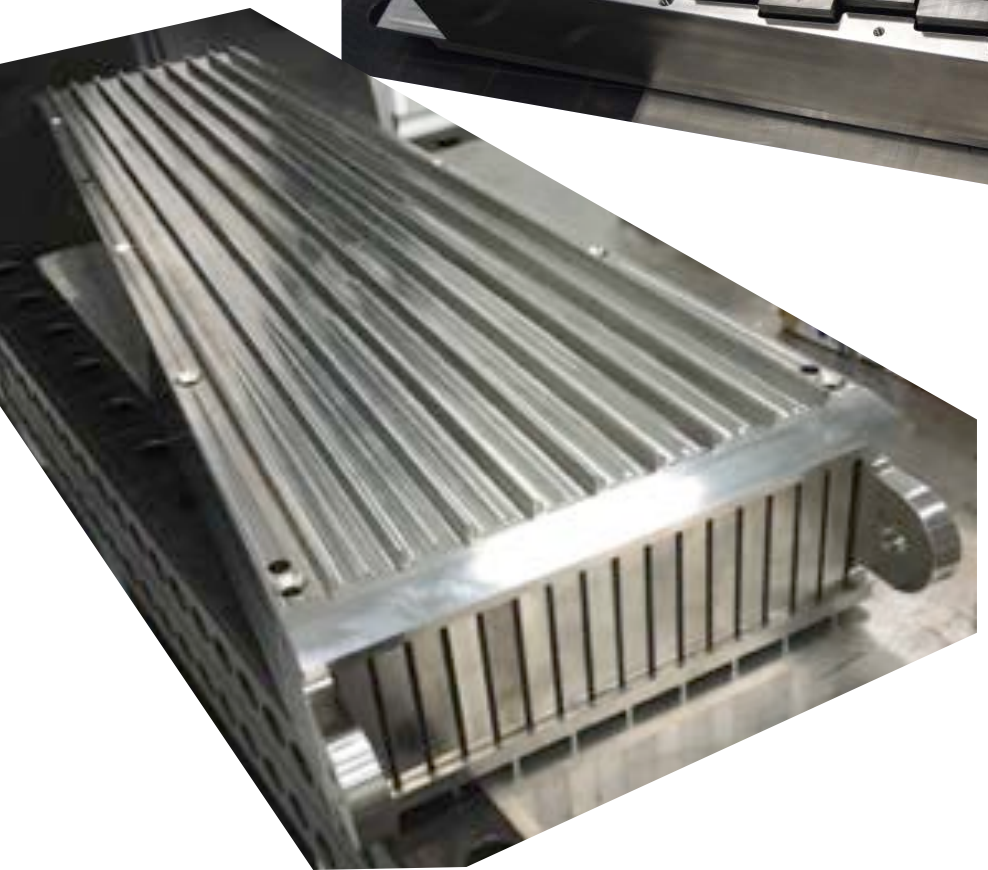




Target Wheel Cassettes

Tungsten bricks in cassettes, ready for assembly into the target wheel

Courtesy of



- 36 sectors, 10° each
- Total about 7000 bricks
  - (10 x 30 x 80) mm^3
- Tungsten of excellent quality

Target Wheel Challenges

Prototype #1 & #2 issues

Courtesy of

One Tungsten Cassette almost fitted into the Target Wheel Prototype. But the wheel structure shrinkage hindered it from being fully inserted

- Welding of the target wheel shroud turned out to be more challenging than expected, proven by three different prototypes
- Both #1 and #2 resulted in large deformations that did not satisfy the narrow gap tolerance requirement, neither internal to the cassettes nor external towards the moderators

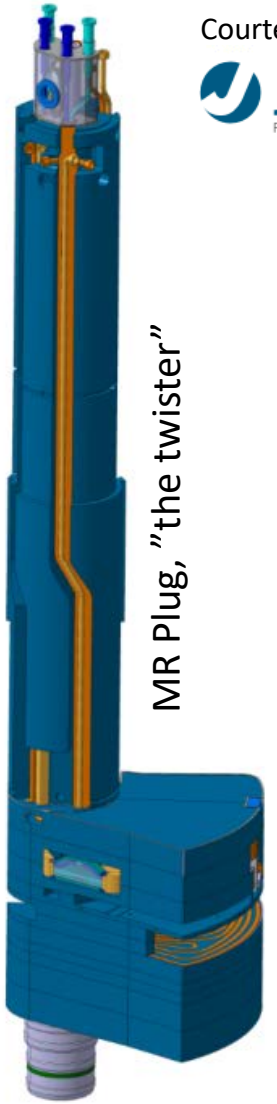
Target Wheel

Prototype #3 deemed sufficiently successful

- Modified design of the weld seams
  - Moved to low-stress areas
  - Reduced thickness along the seams
- Still deformations, but manageable
- Slightly relaxed internal dimensional tolerances
  - Increased gaps between wheel structure and cassettes
  - Introduction of “shims” to then seal off any undesired bypass flows

Moderator / Reflector Systems

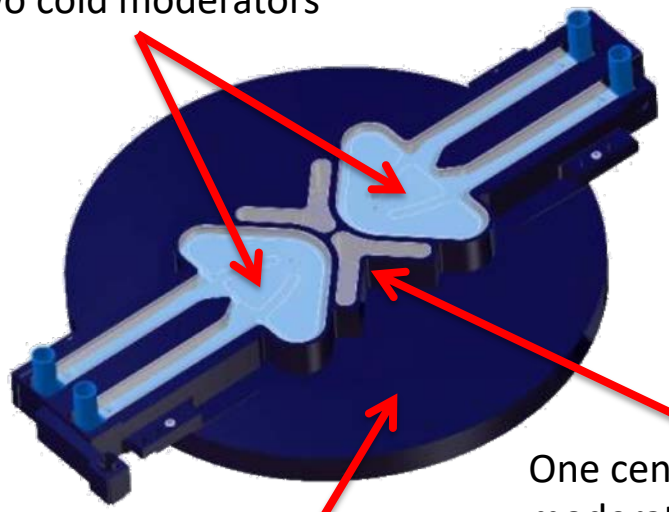
Parts in final manufacture and assembly



MR Plug, "the twister"

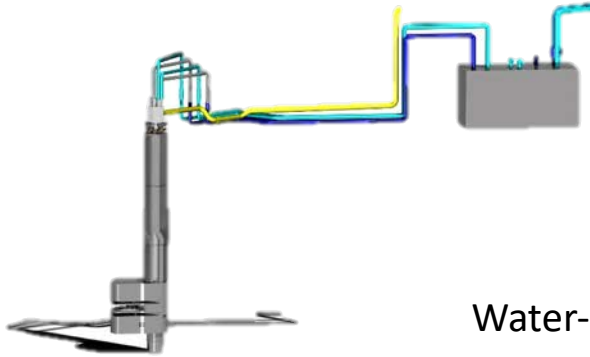
Courtesy of JÜLICH FORSCHUNGSZENTRUM

Two cold moderators



One central thermal moderator cross

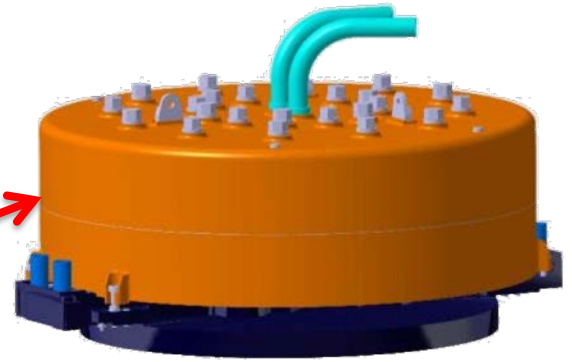
A thermal pre-moderator disk closest to the target wheel



Cryogenic

Hydrogen System

Cryostat internals



Water-cooled beryllium reflector

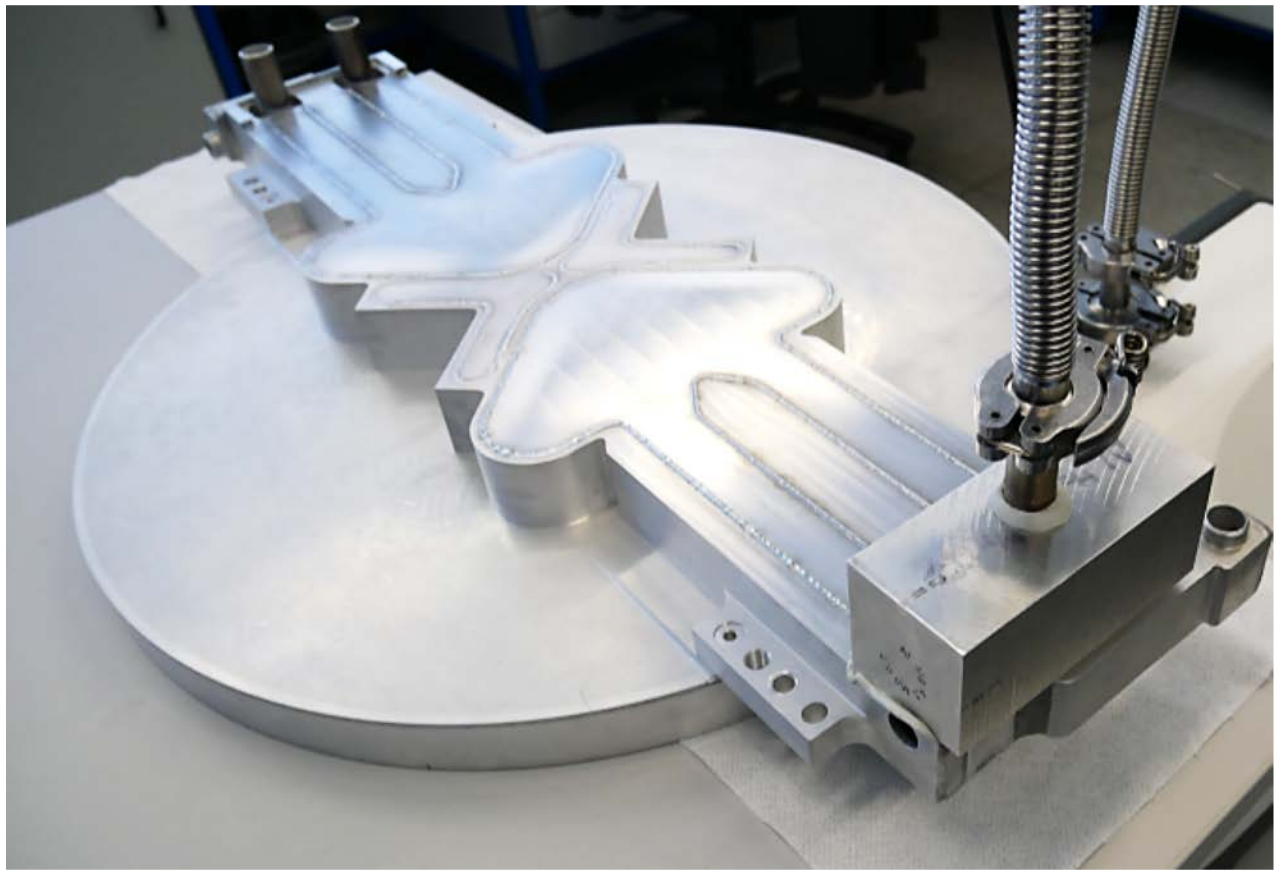
Moderator / Reflector Systems

The fabrication of the cold and thermal moderators is completed

Cold moderator vessels placed into their vacuum jackets in the thermal moderator and pre-moderator structure

Courtesy of JÜLICH FORSCHUNGSZENTRUM

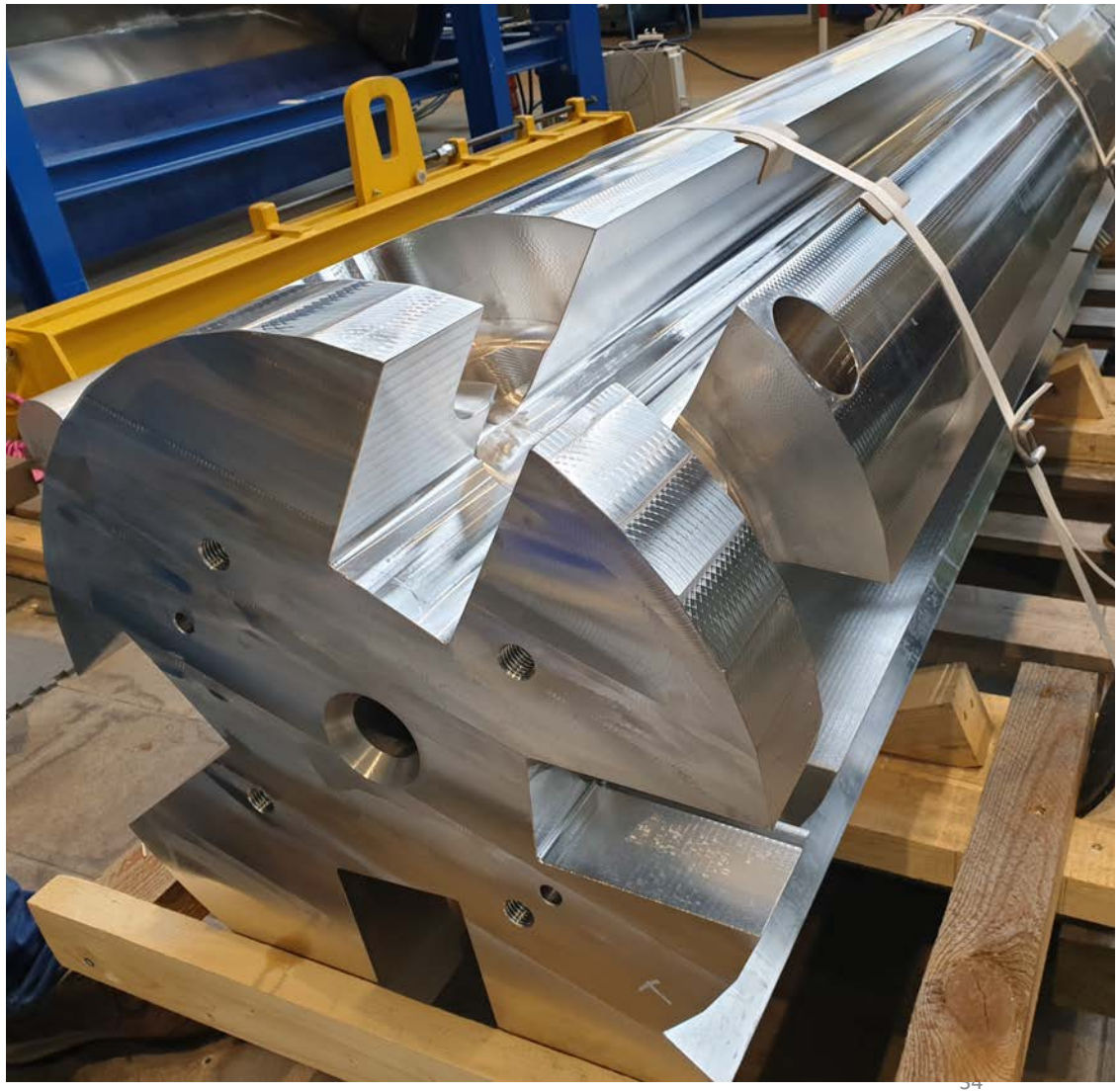
Completed moderator component being leak and pressure tested



Moderator / Reflector Systems

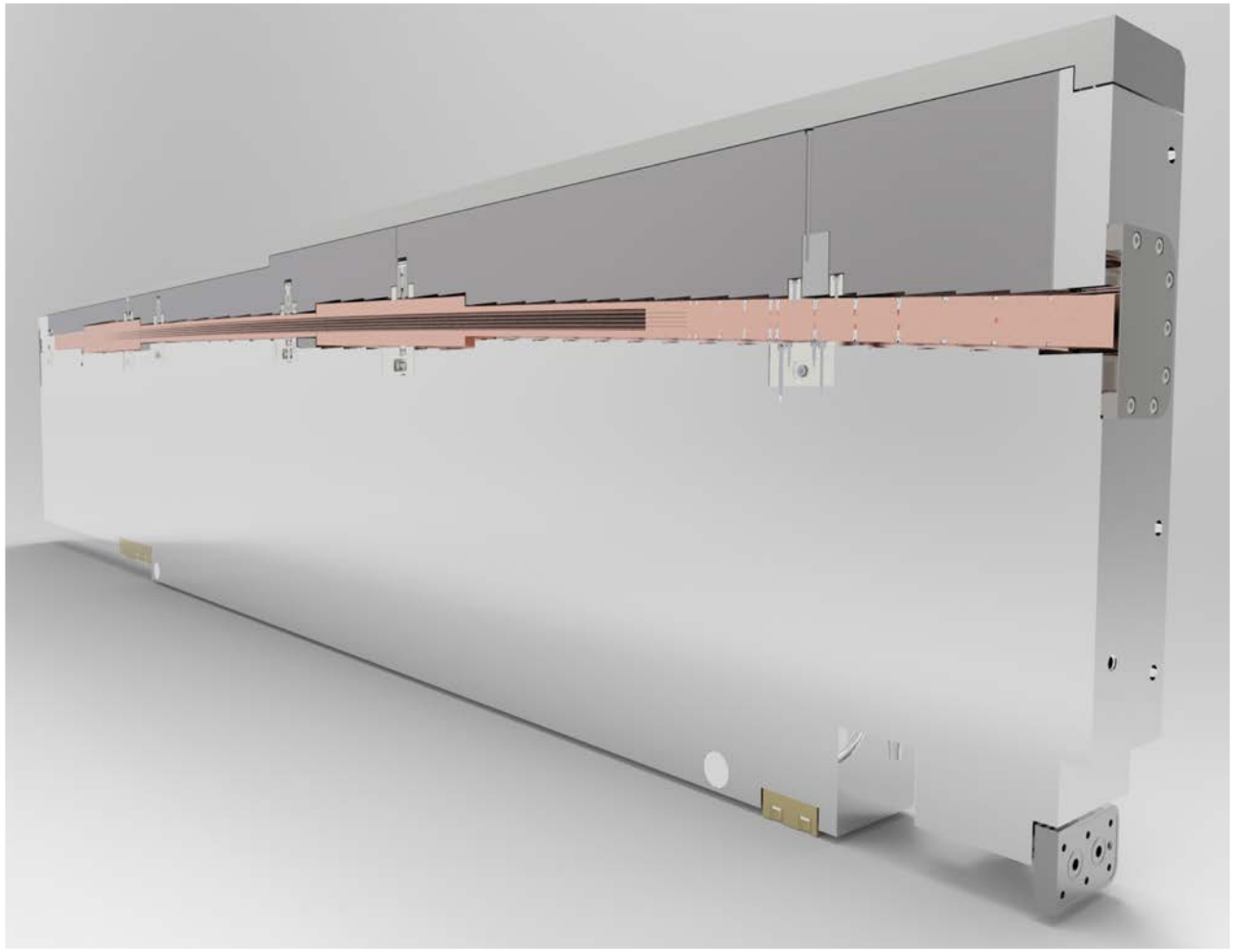
The twister shaft is ready for assembly

Courtesy of FZJ



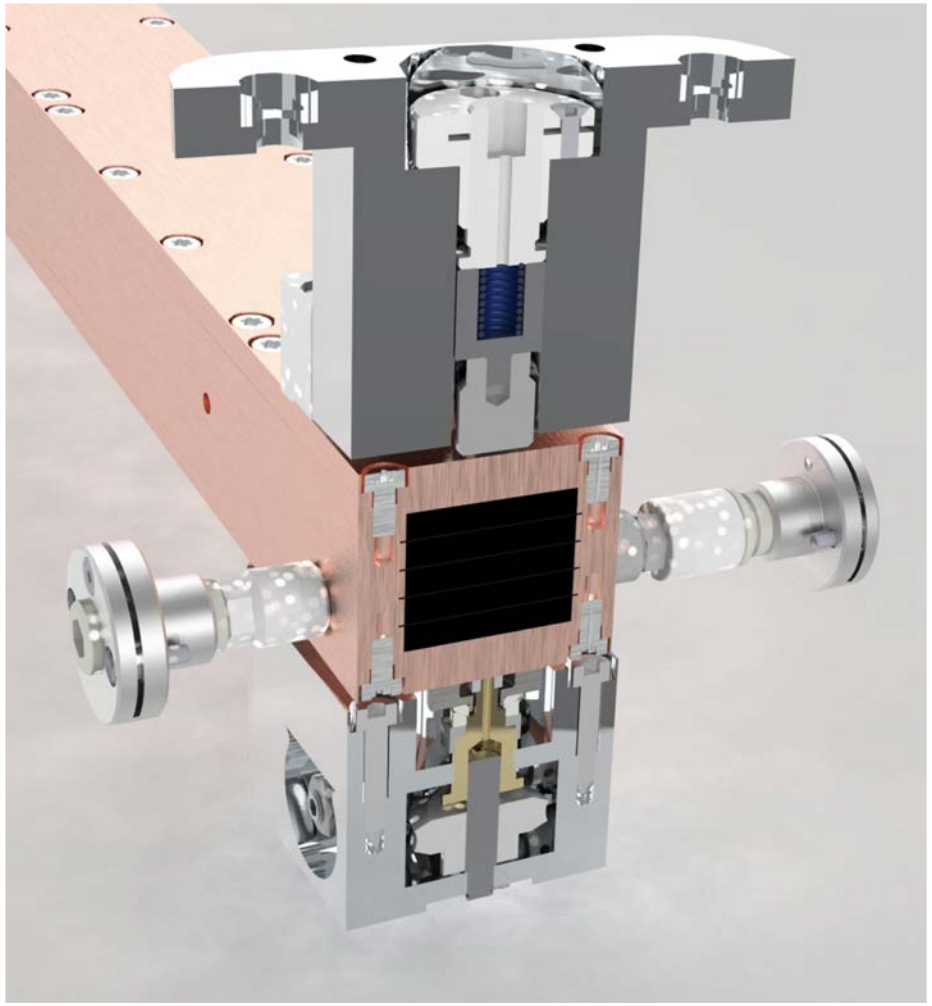
Neutron Beam Port Inserts

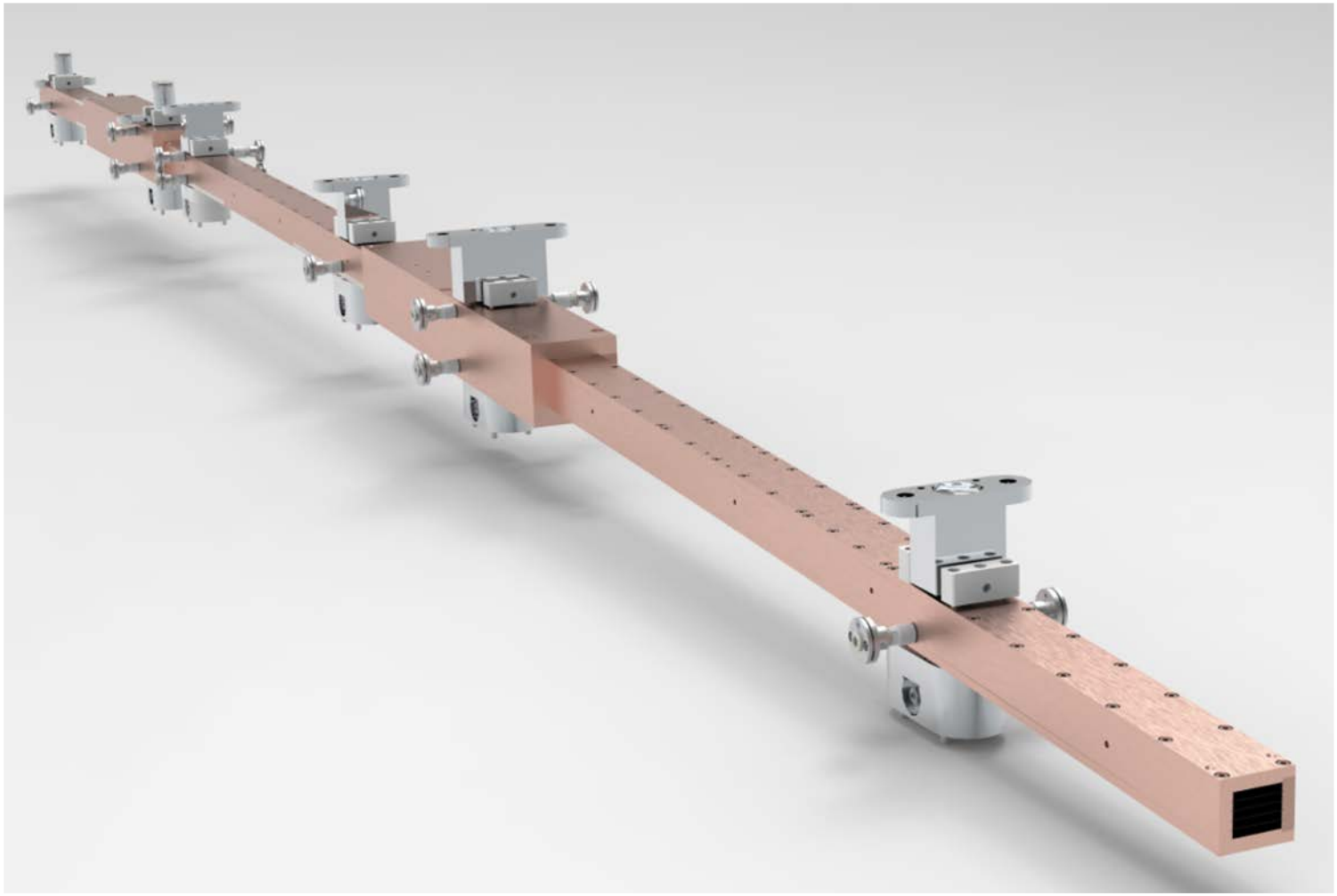
Modelling of individual inserts is ongoing for the 16 first instrument lines



Neutron Beam Optics Assemblies (NBOA)

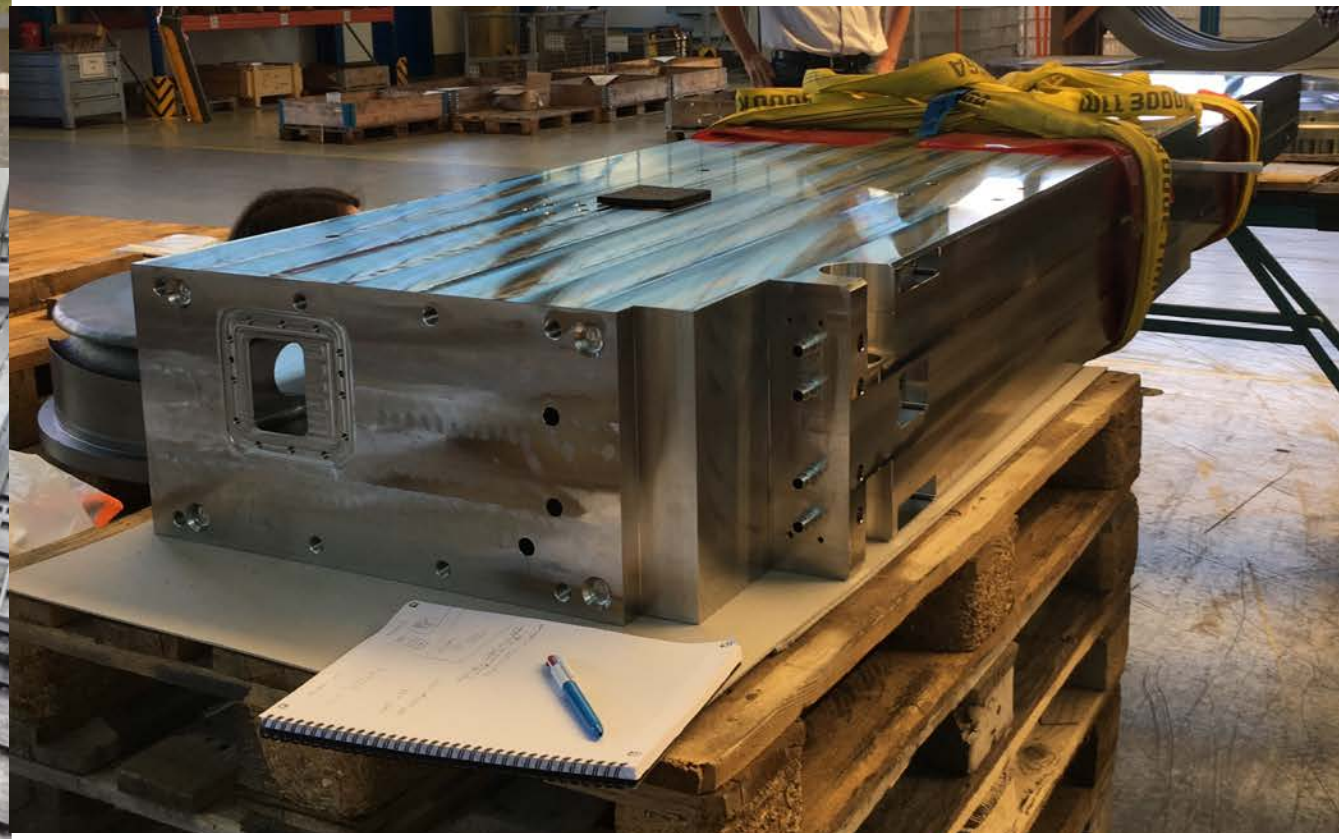
Integration of the design input from each instrument team





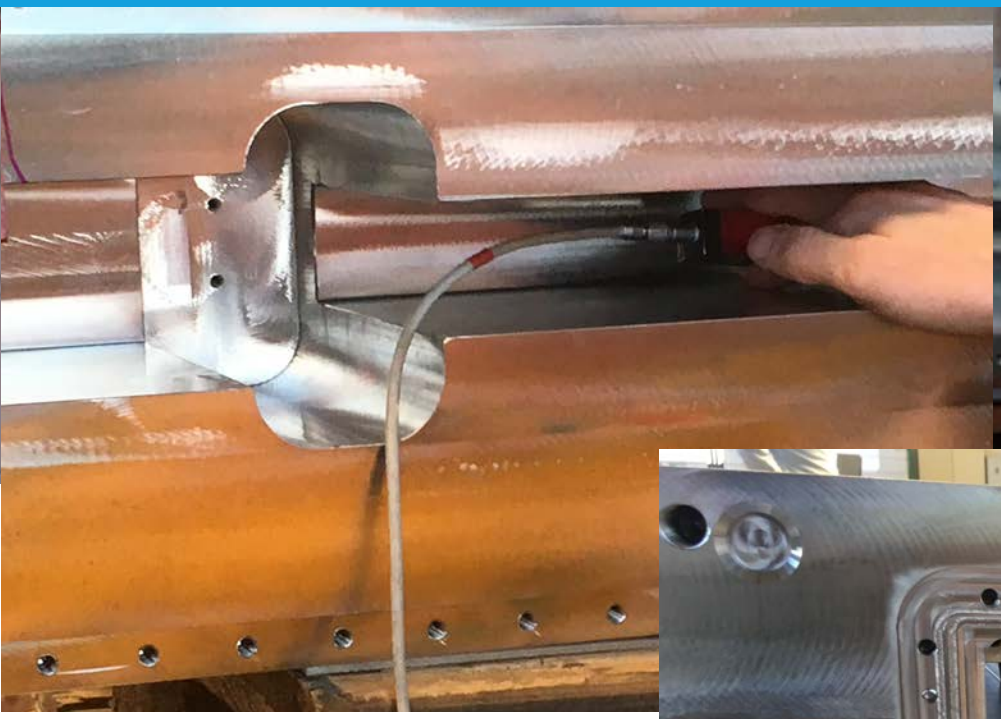
Neutron Beam Port Inserts

Manufacturing Prototype

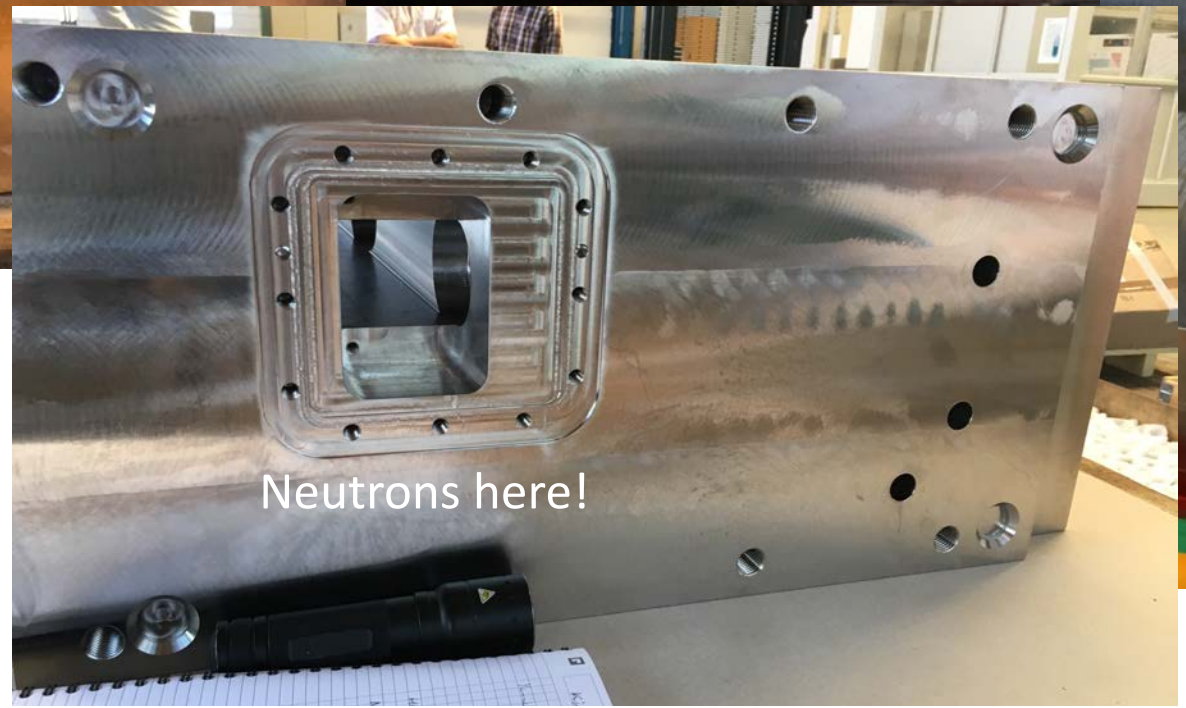


Neutron Beam Port Inserts

Manufacturing Prototype



Void for Neutron Beam Optics Assembly



Cut-out for rollers

The Active Cells Facility System

Most internal equipment now under contract

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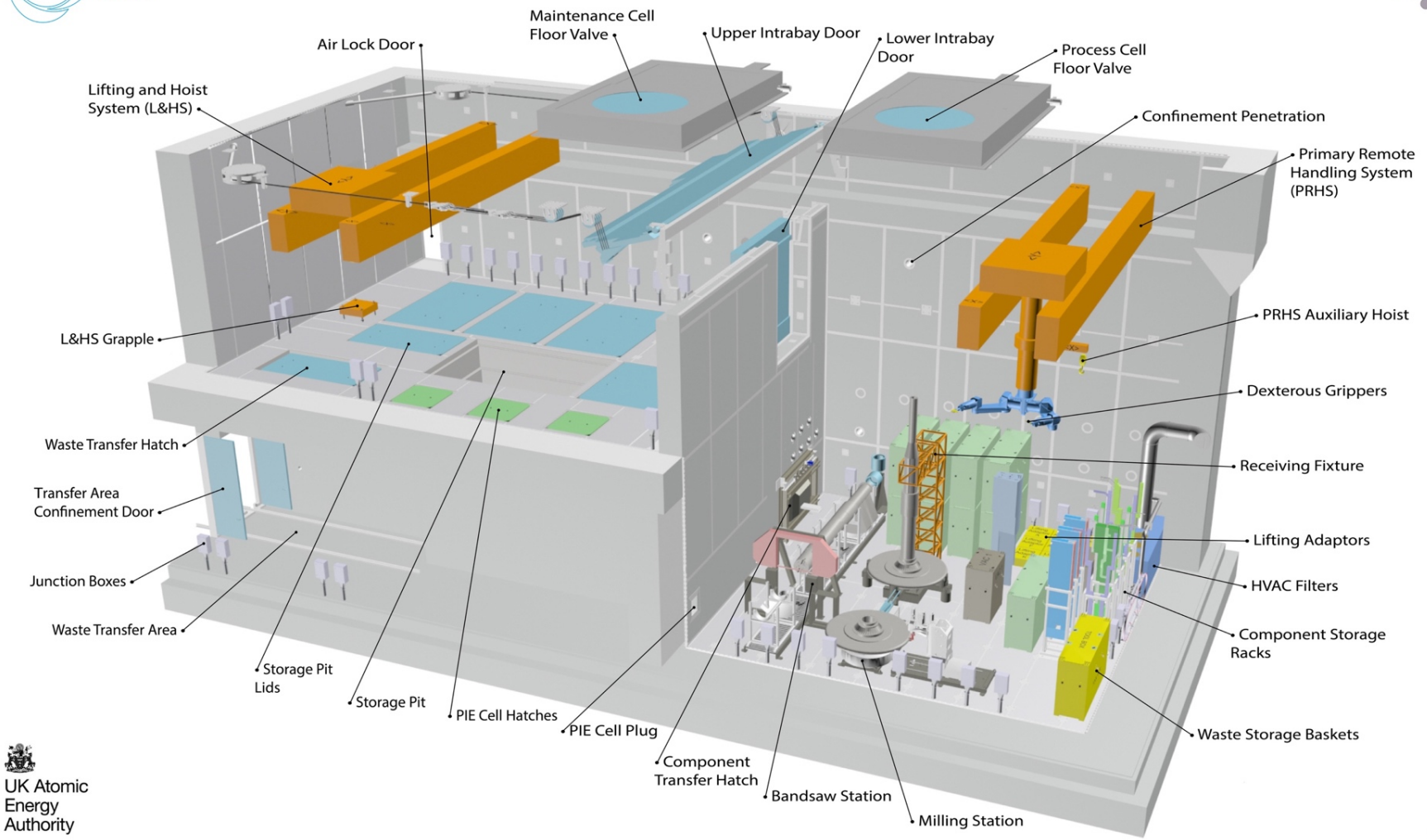
Cross-Section of the ESS Active Cells

RACE



Main Features:

- Built to handle waste in kSv/h range
- 30x15x12 (LxHxW)
- 1.3 m High Density Concrete
- No windows
- Process Cell
- Maintenance Cell
- Waste storage
- Waste shipment

UK Atomic Energy Authority

Active Cell Facility Stainless-Steel Liner

Recent photographs - Intallation of liner plates are ongoing

Active Cell Facility Stainless-Steel Liner

Recent photograph - Installation of liner plates are ongoing

- Innovative method for installing ceiling liner plates was successful
  - Plates tack-welded to the embedded liner beams,
  - Placed inside the concrete rebar and formwork, prior to the roof slab casting
- No observed concrete protrusion
- Final seal-welding of the ceiling liner is planned Oct/Nov 2019
- Following is the mounting of the liner plates onto the embedded wall beams and penetrations

Concluding remarks

ESS Target Station Construction Status

Achievements in 2019

- As of **September 2019**, the ESS Target Station construction project is **half complete** in terms of budget spent
- Project focus is now on procurement, manufacture and delivery of the TS systems
  - In-kind elements as well as direct commercial contracts
- **Several large steel structures have been installed** in parallel with concrete works
- **By end of year the civil construction will be completed** for the major building parts, allowing early access for significant system installations
- Commissioning of the **Target Moderator CryoPlant** has been successfully **completed**.

ESS Target Station Construction Status

Outlook for 2020 - 2022

- **Installation works** for the Target Station will ramp up heavily during **2020** Q1.
  - Monolith build, starting with the **Monolith Vessel, beginning of year**.
  - Imminently followed by **cooling systems, utility systems, HVAC system** installations.
  - Also, the **Active Cells Facility build** continues with extensive equipment installations.
- Generally, **2021** will be the year of system **testing, integration, and start-up** of the Target Station.
- **Target Ready for Beam milestone is March 2022**.
  - Currently the sub-project is carrying a negative float of about 6 months.
  - Remedies are pursued for minimising actual delays


Thank you for your attention!