

ESS Bilbao

MIRACLES STAP Spectroscopy

Félix J Villacorta, on behalf the MIRACLES Team

03/05/2022



MIRACLES core team



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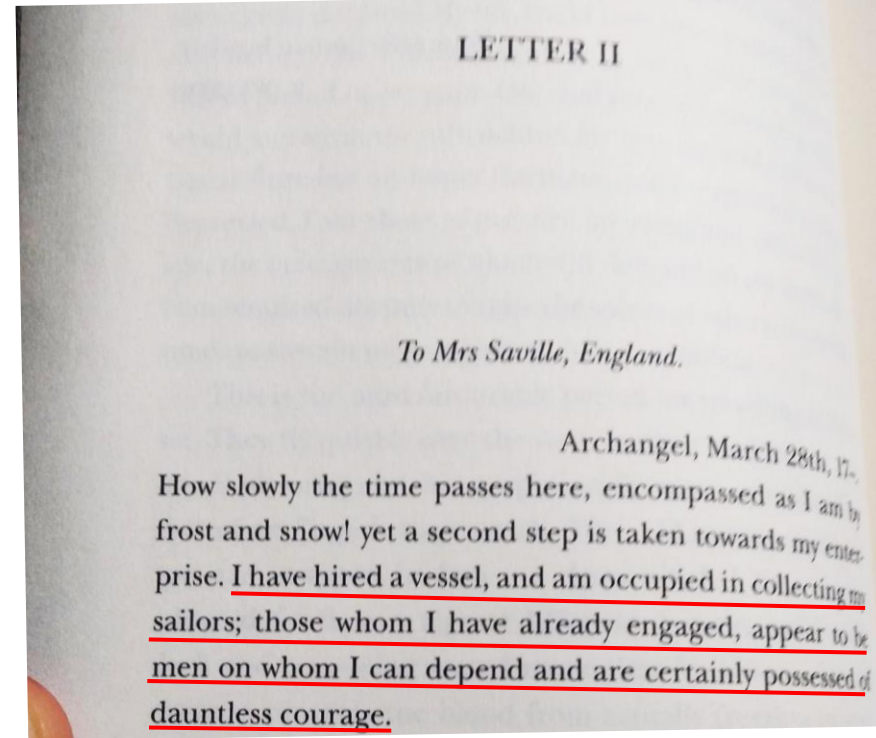
Gorka Bakedano



Heloisa N. Bordallo



Félix J. Villacorta



Intro

From STAP reports 2021:

- *We would like to request a **common formatting** between instrument team reports that helps us with making it easier to compare between projects. We ask that future reports be organized in parallel with the high-level work breakdown structure of the projects (**system integration and management, shielding, choppers, beam transport system, safety systems, instrument specific, etc.**)*
- *The TREX team included a **risk register** highlighting the components at risk. We think that this information is very useful for us. It would be very good to see this from all instruments.*
- *Similarly, we would like to see a **high-level installation schedule** for each instrument.*
- *Status design reviews & tenders*
- *More information would be desirable concerning the analyzer crystal assembly (a prototyping had been suggested a year ago) and the situation of staff (engineer, scientist, data science).*
- *A question from the previous STAP report concerning data modelling was not answered. A commissioning plan has not been provided.*

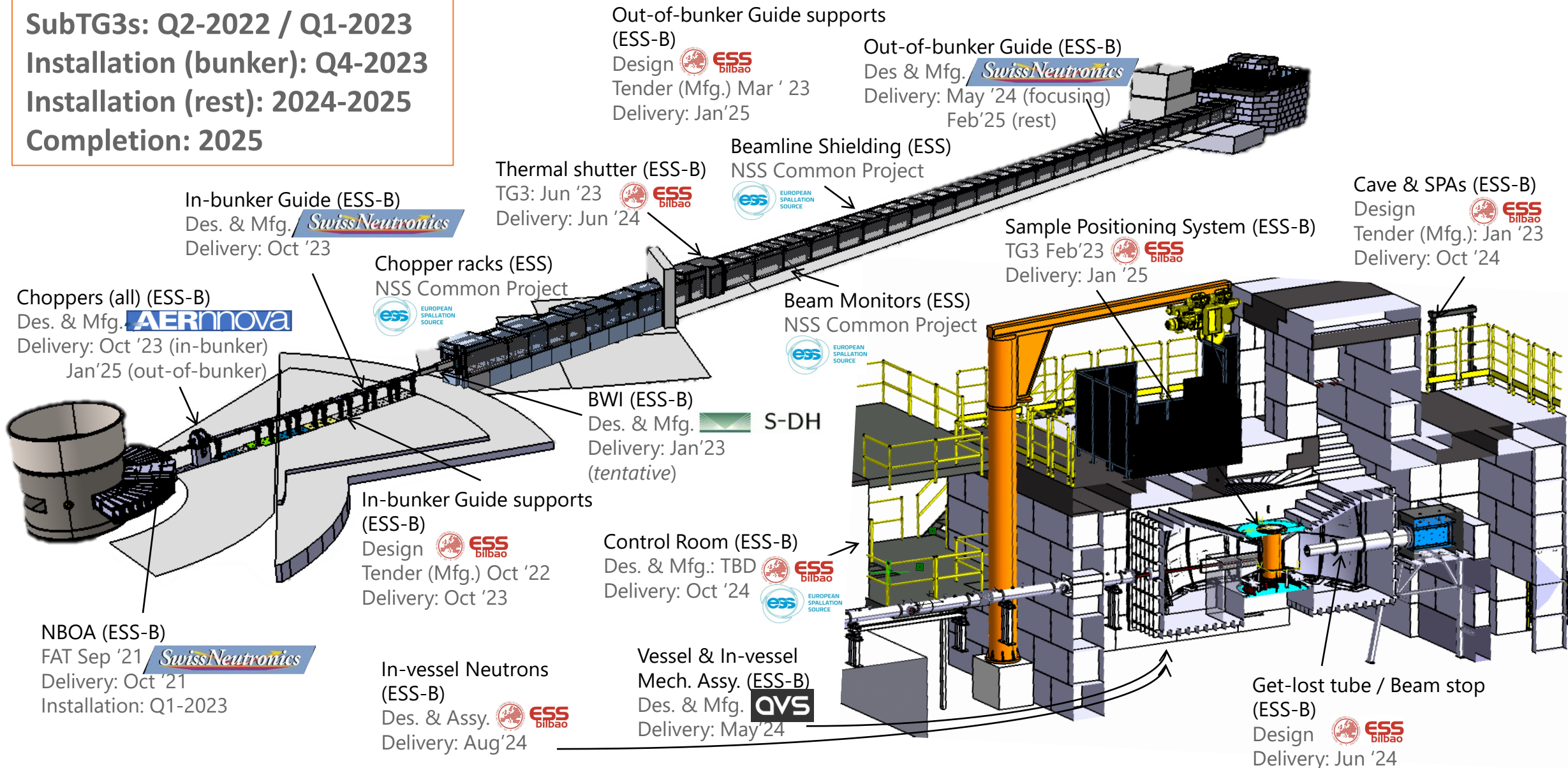


System Integration & Management



Status of MIRACLES instrument

SubTG3s: Q2-2022 / Q1-2023
Installation (bunker): Q4-2023
Installation (rest): 2024-2025
Completion: 2025

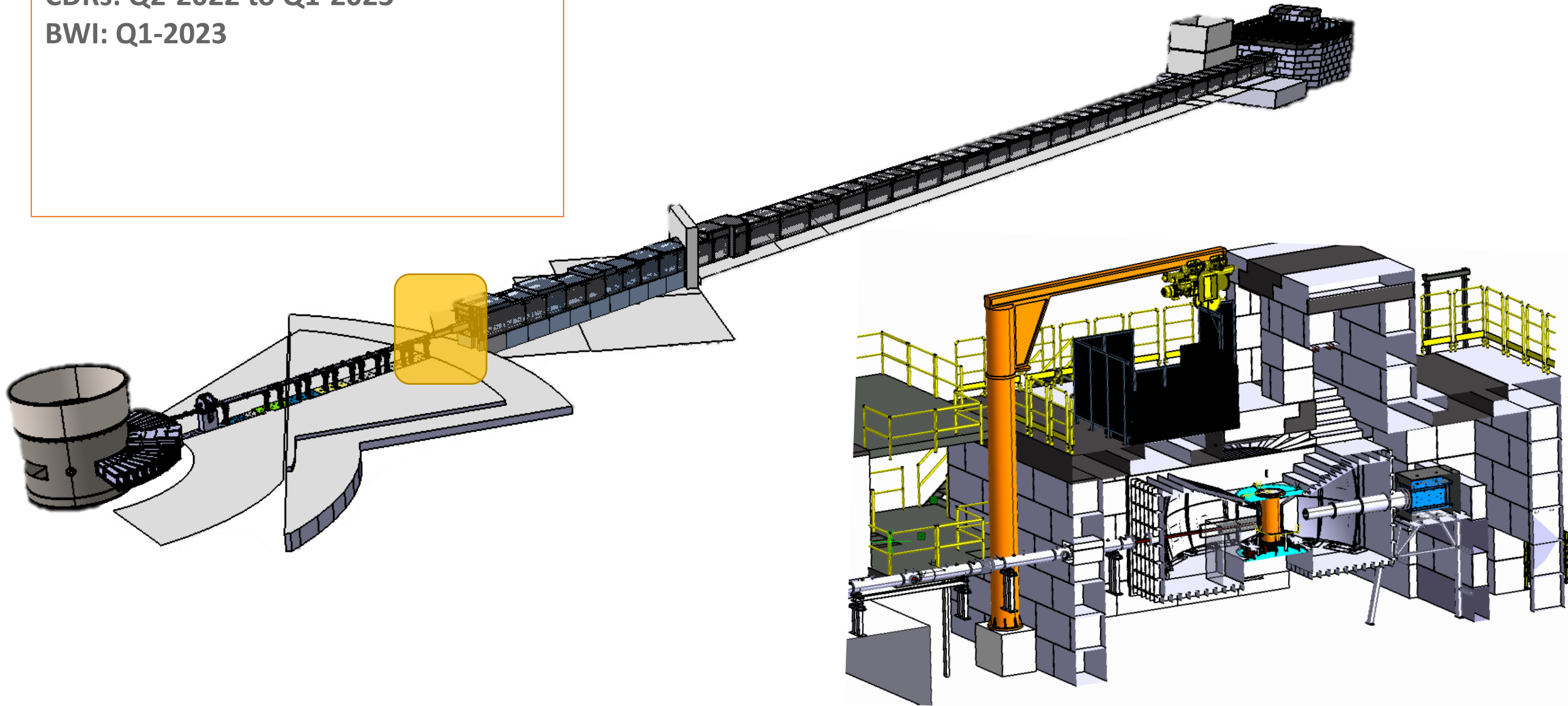


HL installation schedule (start date)



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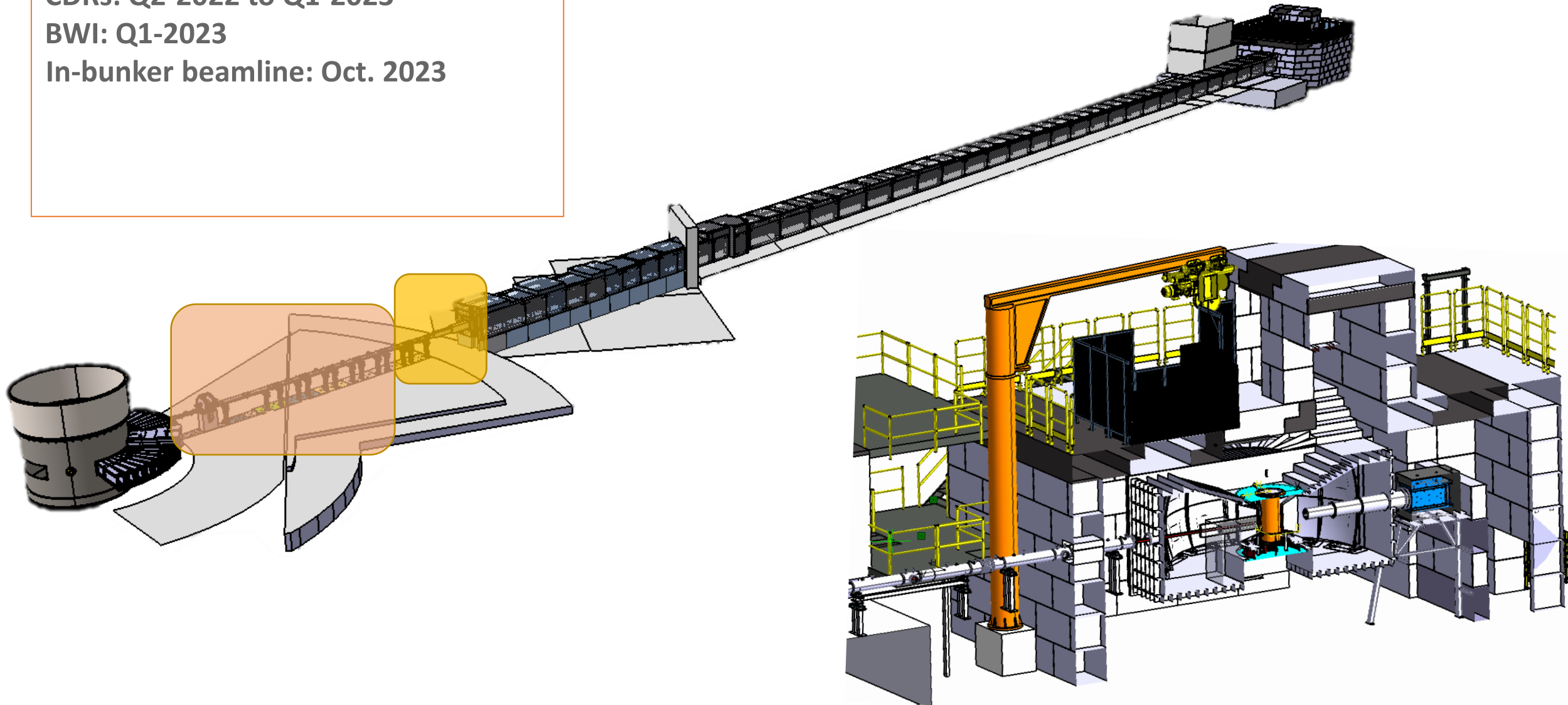
CDRs: Q2-2022 to Q1-2023
BWI: Q1-2023



HL installation schedule (start date)



CDRs: Q2-2022 to Q1-2023
BWI: Q1-2023
In-bunker beamline: Oct. 2023



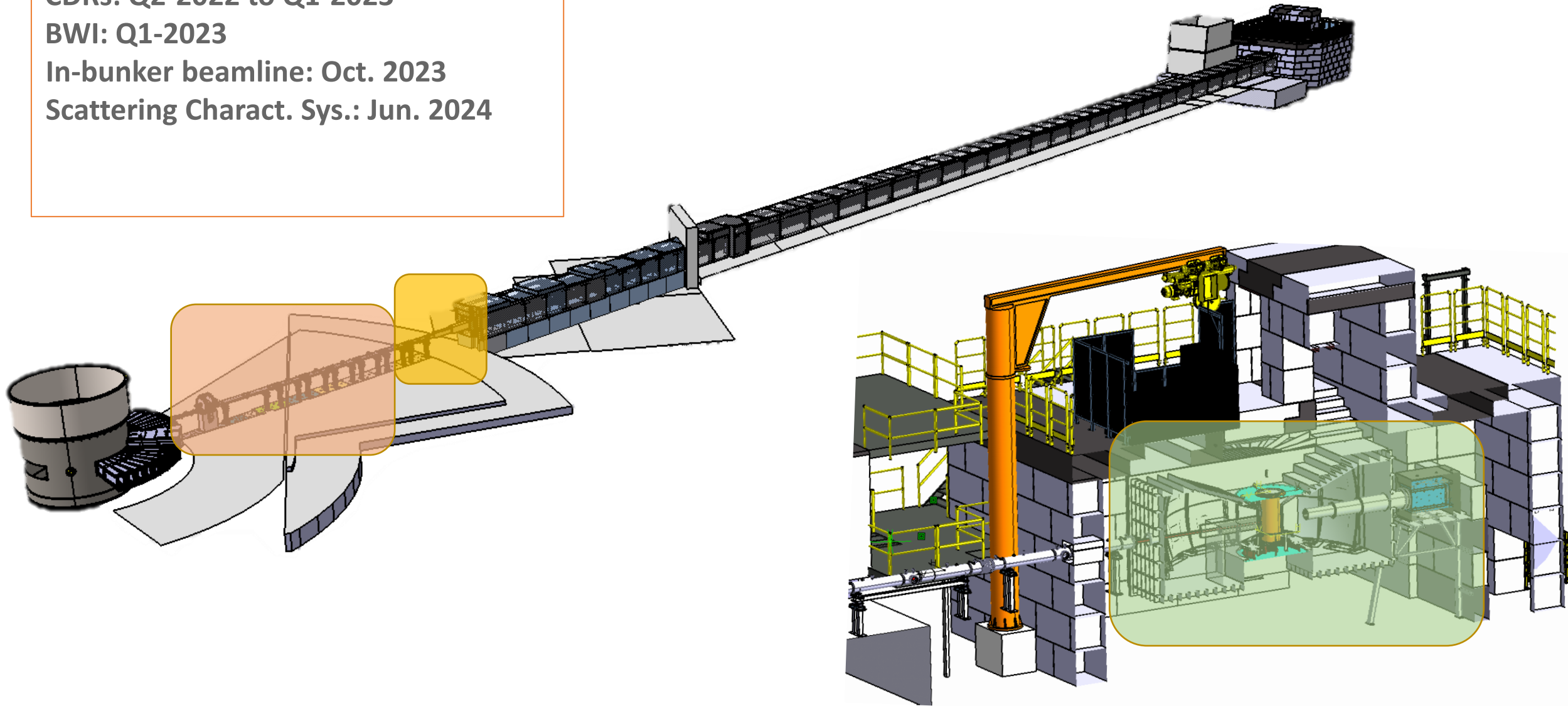
HL installation schedule (start date)

CDRs: Q2-2022 to Q1-2023

BWI: Q1-2023

In-bunker beamline: Oct. 2023

Scattering Charact. Sys.: Jun. 2024



HL installation schedule (start date)



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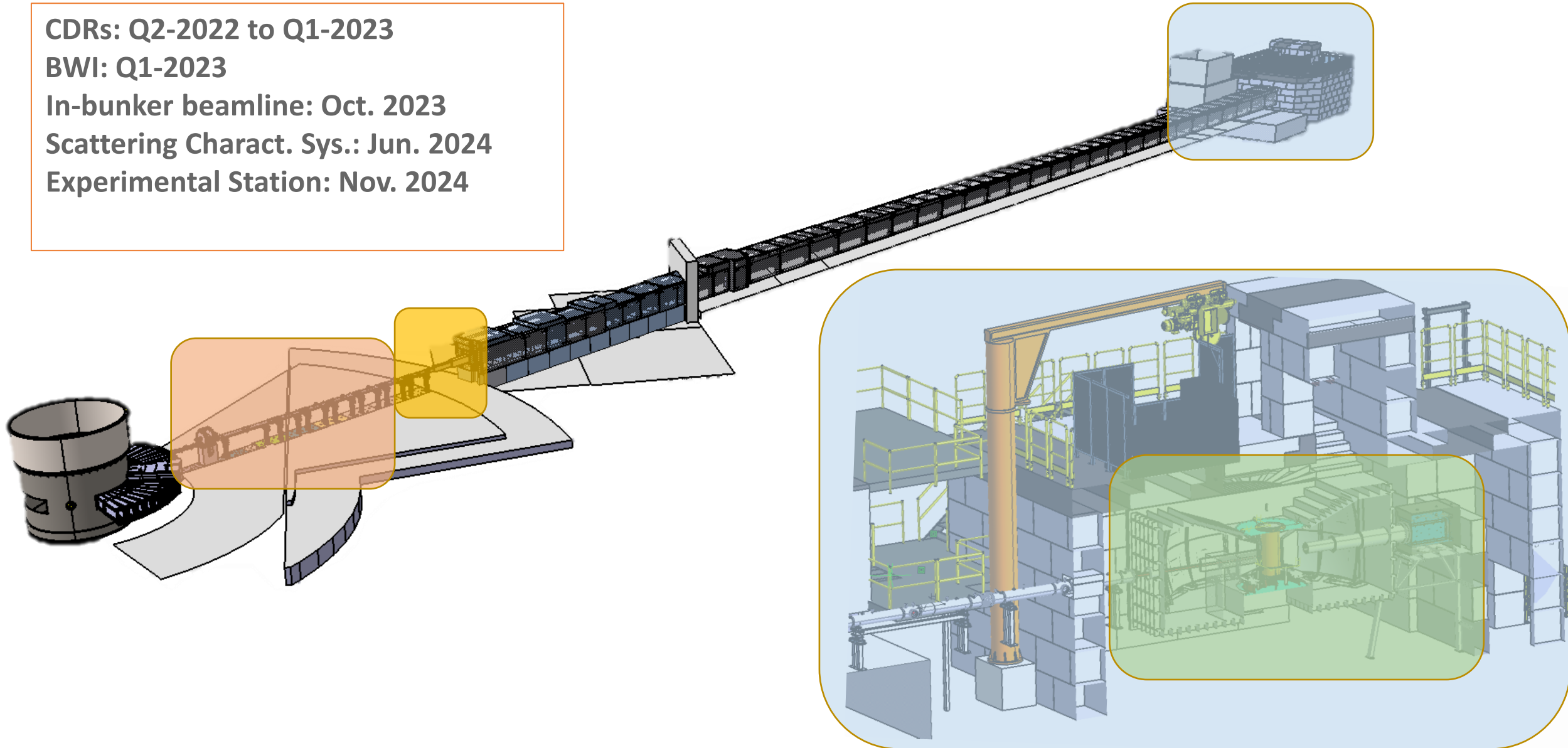
CDRs: Q2-2022 to Q1-2023

BWI: Q1-2023

In-bunker beamline: Oct. 2023

Scattering Charact. Sys.: Jun. 2024

Experimental Station: Nov. 2024



HL installation schedule (start date)



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CDRs: Q2-2022 to Q1-2023

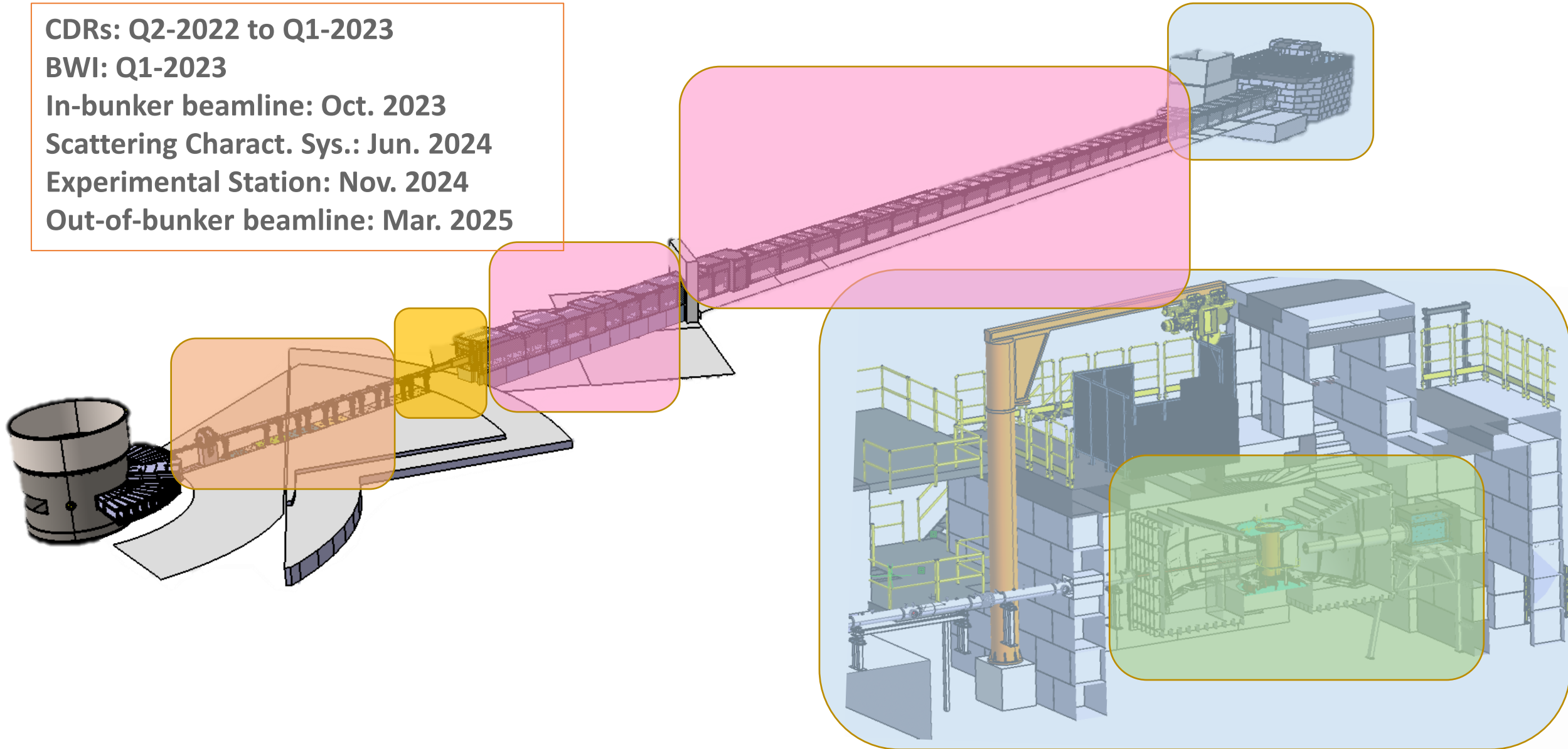
BWI: Q1-2023

In-bunker beamline: Oct. 2023

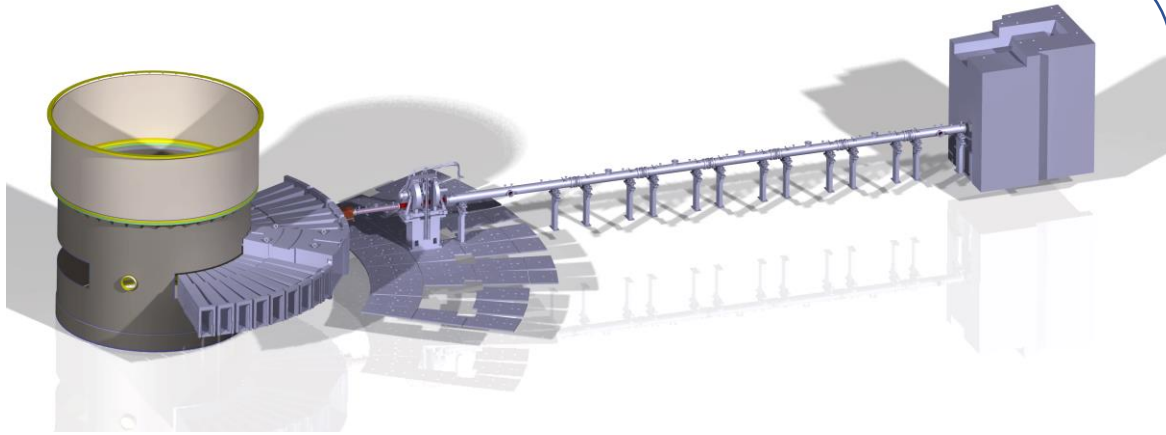
Scattering Charact. Sys.: Jun. 2024

Experimental Station: Nov. 2024

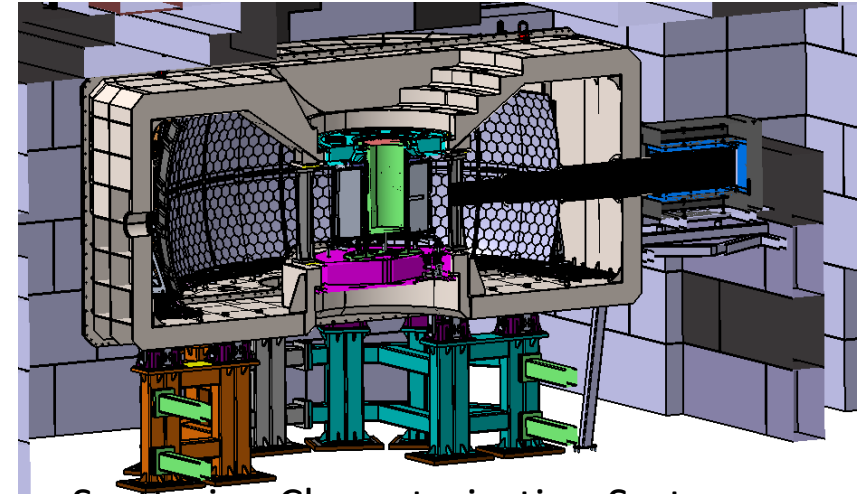
Out-of-bunker beamline: Mar. 2025



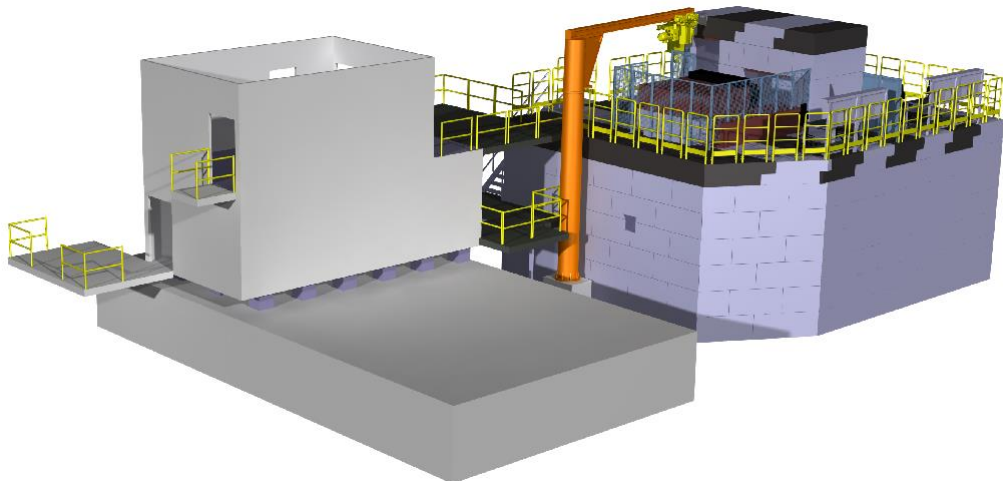
Installation schedule MIRACLES (proposal)



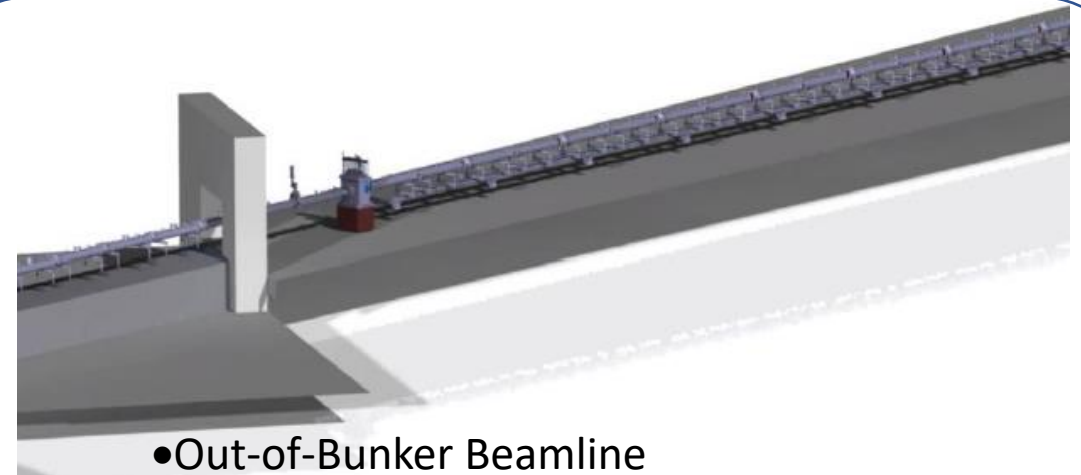
- In-Bunker Beamline
- October 2023 – December 2023



- Scattering Characterization System
- June 2024 – October 2024



- Experimental End Station
- November 2024 – January 2025



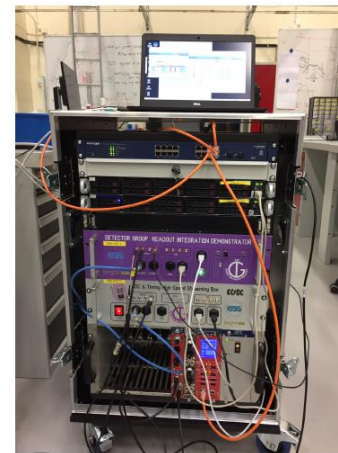
- Out-of-Bunker Beamline
- E01: Q3-2024
- E02/D03: March 2025 – July 2025

MIRACLES: NSS Common Projects

ESS Common Project	MIRACLES Involvement	Status
Beamline Shielding	In (participating actively)	Waiting
Beam Monitors	In	Project Frozen
Choppers	In (racks only)	KOM held June 2020 Agreement (TA) signed Dec. 2020
Electrical	Under discussion	Several meetings held in 2021
Utilities	Under discussion	



MIRACLES Distribution Board



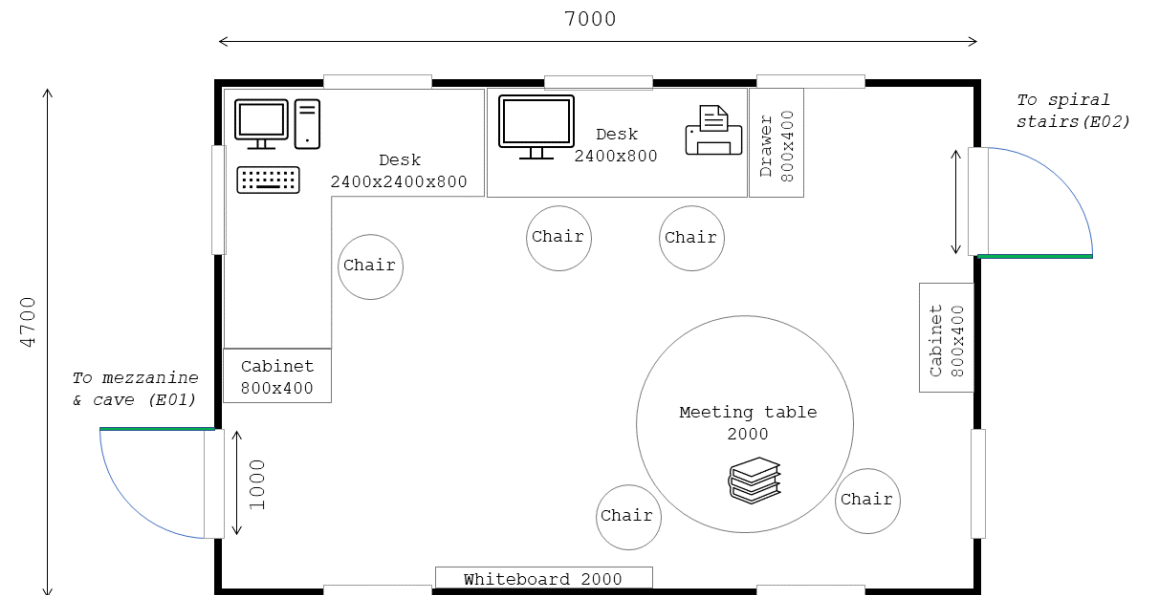
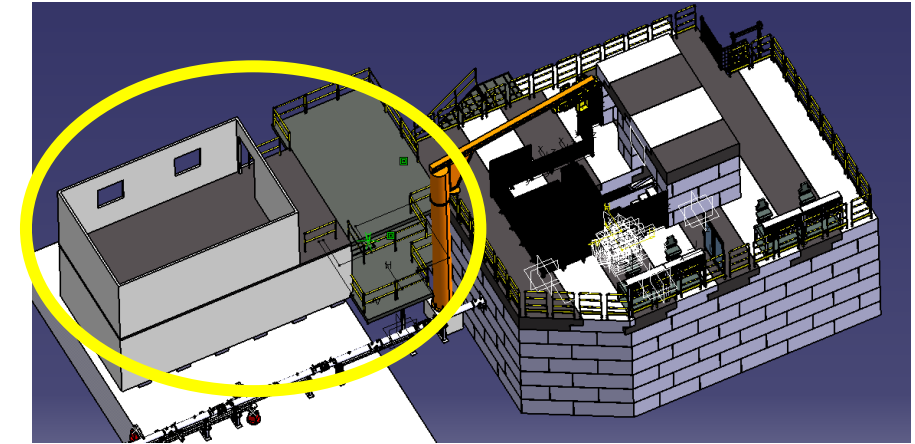
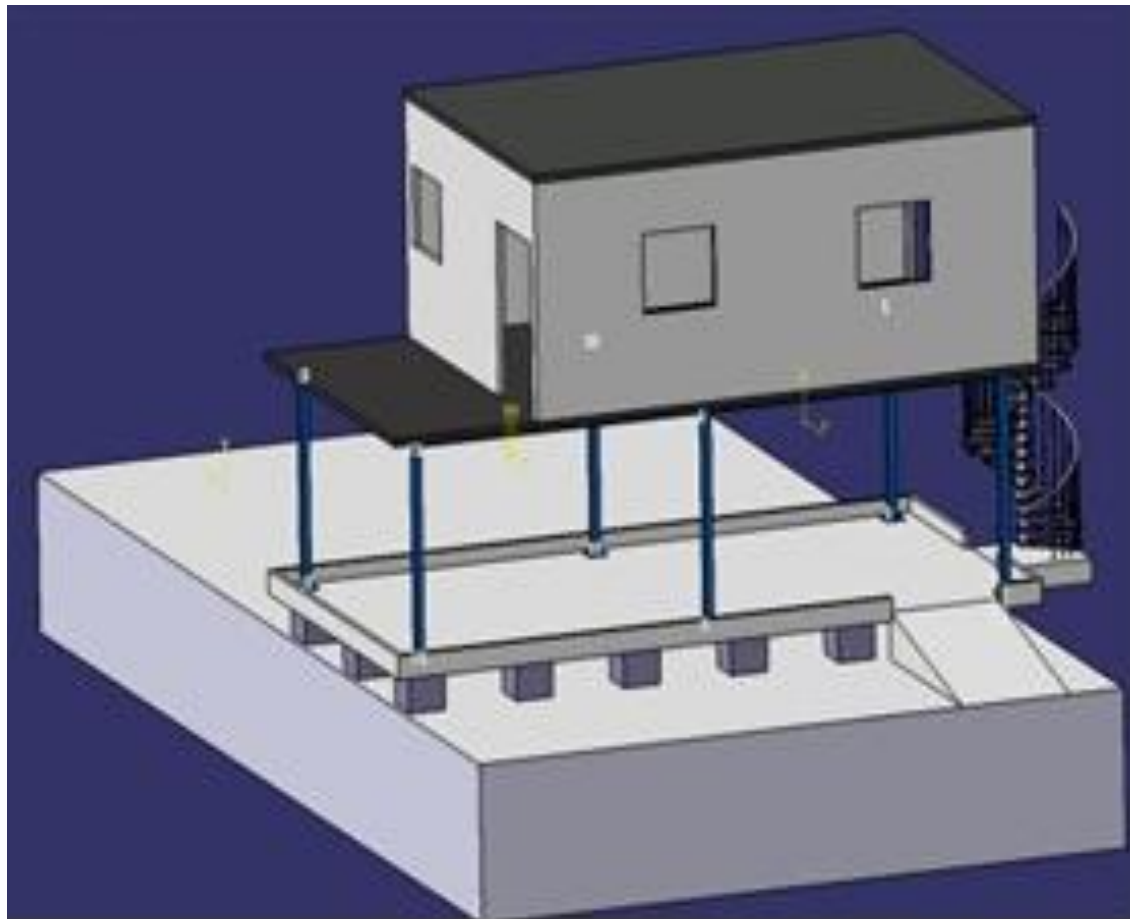
Baseline DAQ for BMs in the Utgård



The two MIRACLES Chopper racks

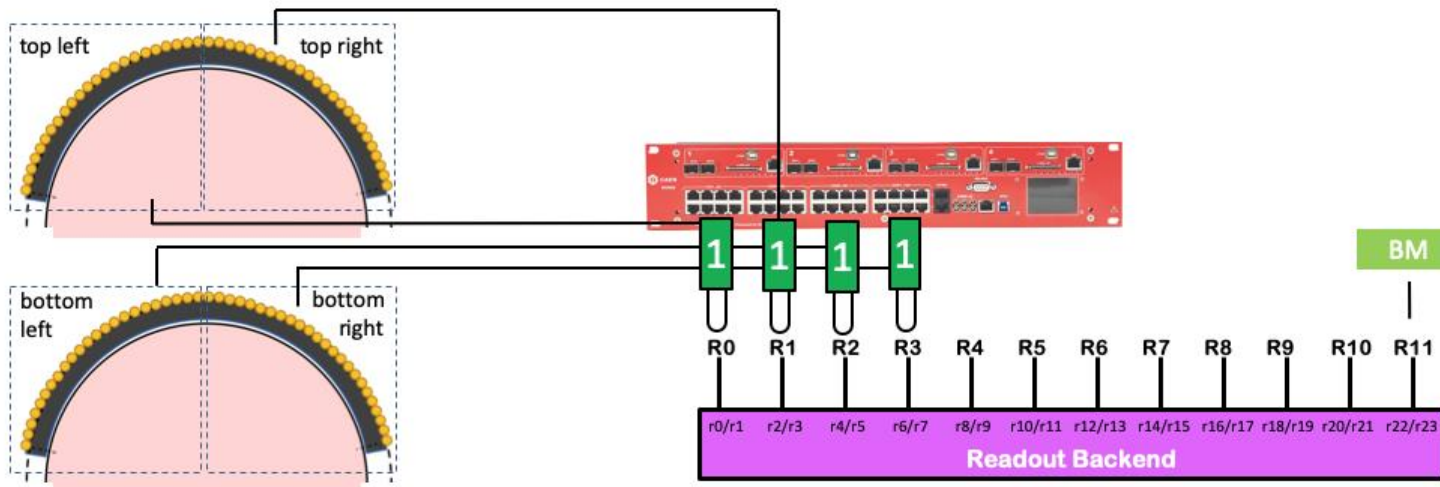
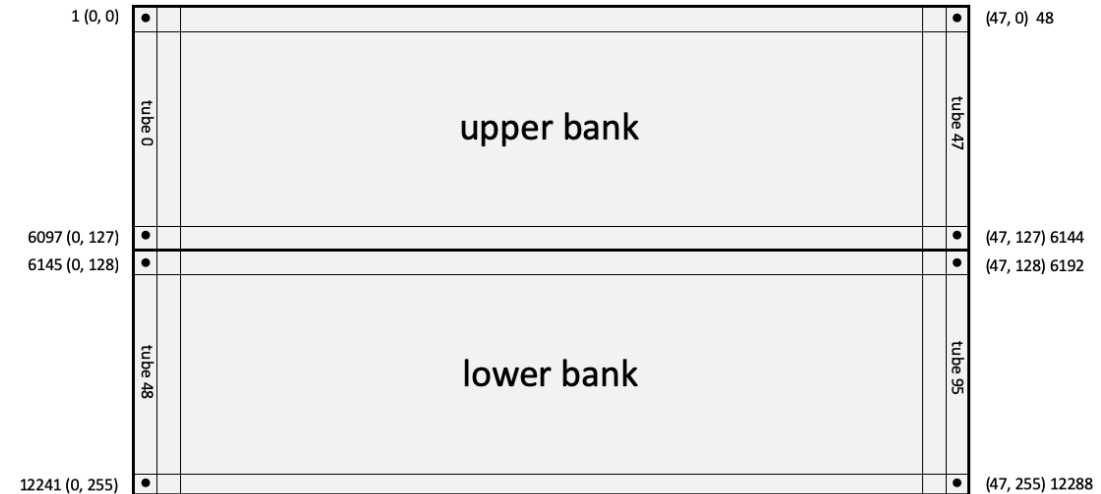
Control Hutch

First contacts with Facility Management (ESS) to deliver the MIRACLES control hutch.



Integration DMSC-MIRACLES

- w/ Morten Jagd Christensen (ESS)
- DAQ chain, from detectors to data management:
- Starting with ring allocation & digital mapping
- Geometrical resolution along the tube is (currently assumed to be) 128 discrete units
- $2 \times 48 \times 128 = 12288$ pixels
- Single Panel 2D detector with dimensions (48, 256)



Ring	Tube	Tubes
0	0	0/1
0	1	2/3
0	2	4/5
...
0	11	22/23
1	0	24/25
1	1	26/27
1	2	28/29
...
1	11	46/47
2	0	48/49
2	1	50/51
...
3	11	94/95

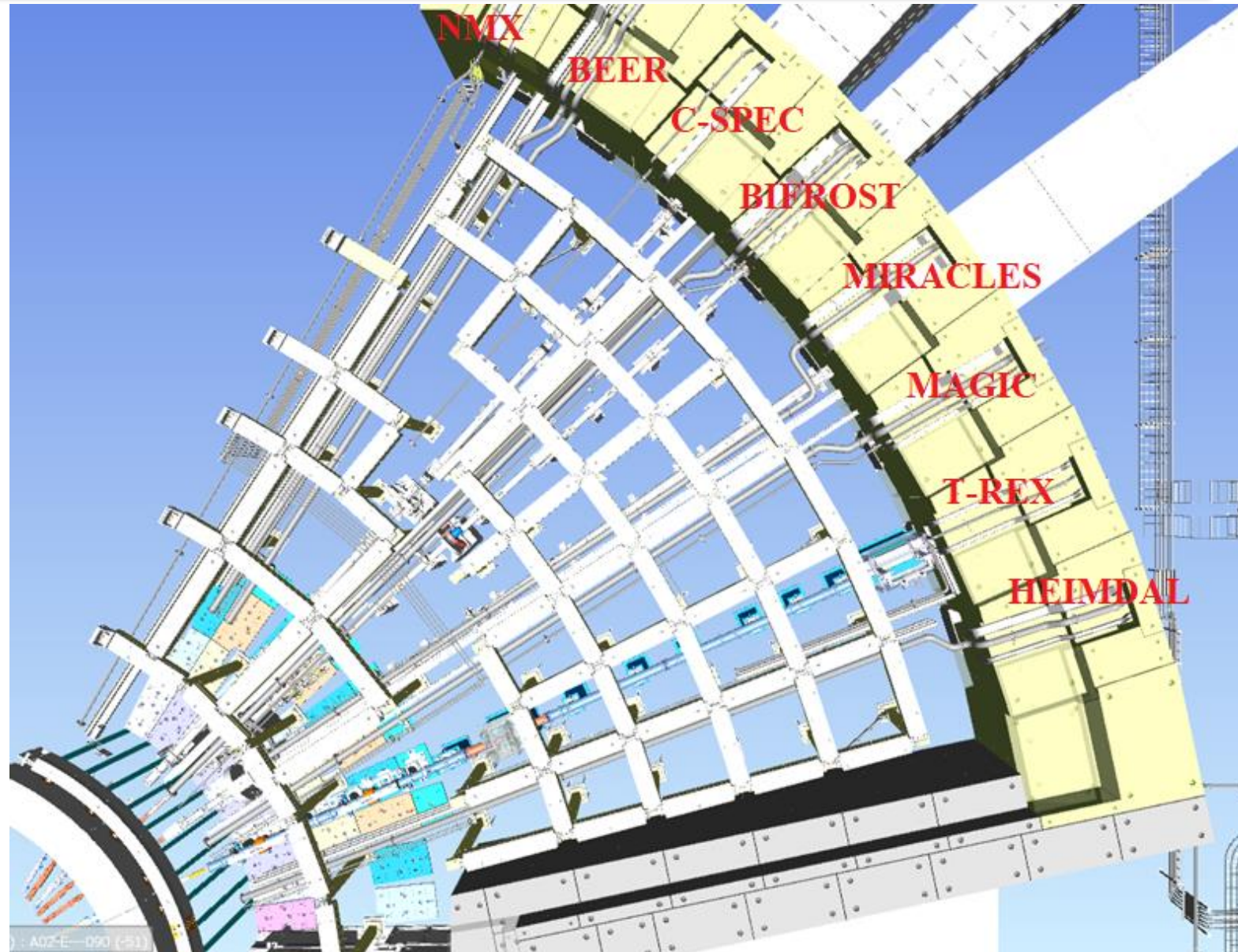
In-bunker services

- **In-bunker utilities**

Trays & routing inside bunker
(w/ Tahere Rostami)

- **Beamline through facility walls
(monolith & bunker)**

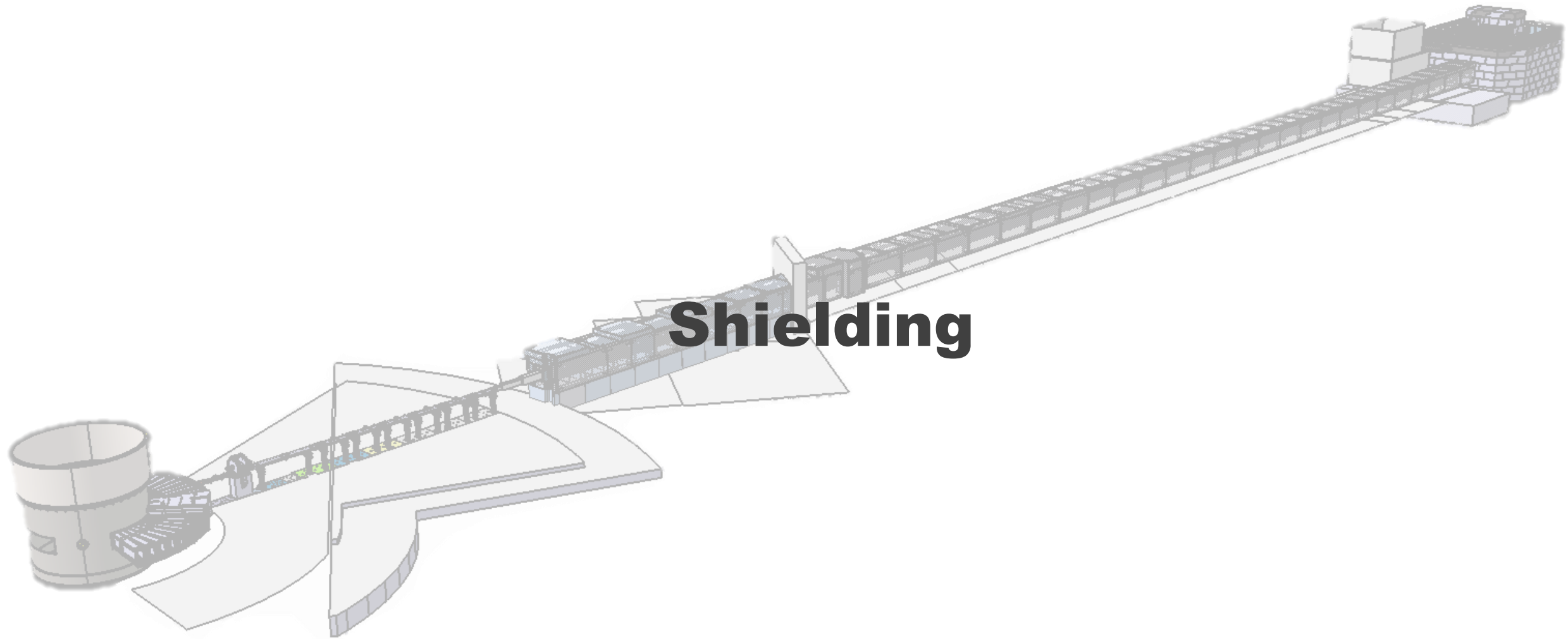
[see beam transport section (w/
Nicolas Breton)]



Risk register

- Main risks related to Cost & Schedule
- With evolution of the project & design, increasing importance of Quality risks (anticipated)

Top 5 Risks					
Title	Severity	Category	Responsible	Response	Trend
Unsuitable beam monitors	16	Quality	ESS	Reduce	New
Guide components cost increase	12	Cost	ESS-Bilbao	Accept	Steady
Scattering characterization system: cost increases	10	Cost	ESS-Bilbao	Accept	New
Cave: delivery delay	9	Schedule	ESS-Bilbao	Reduce	Steady
Delayed delivery of vacuum vessel	9	Schedule	ESS-Bilbao	Reduce	Steady

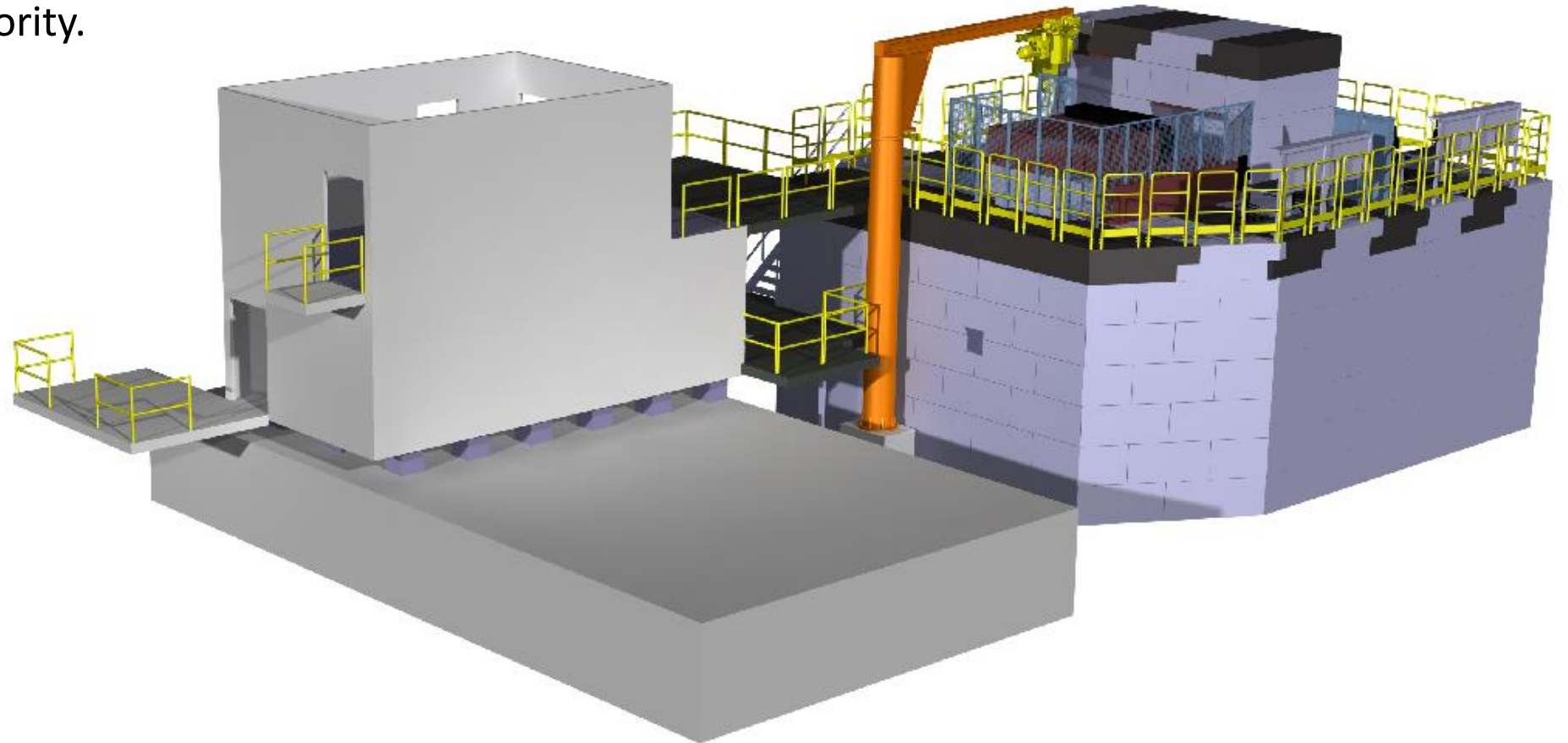


Shielding



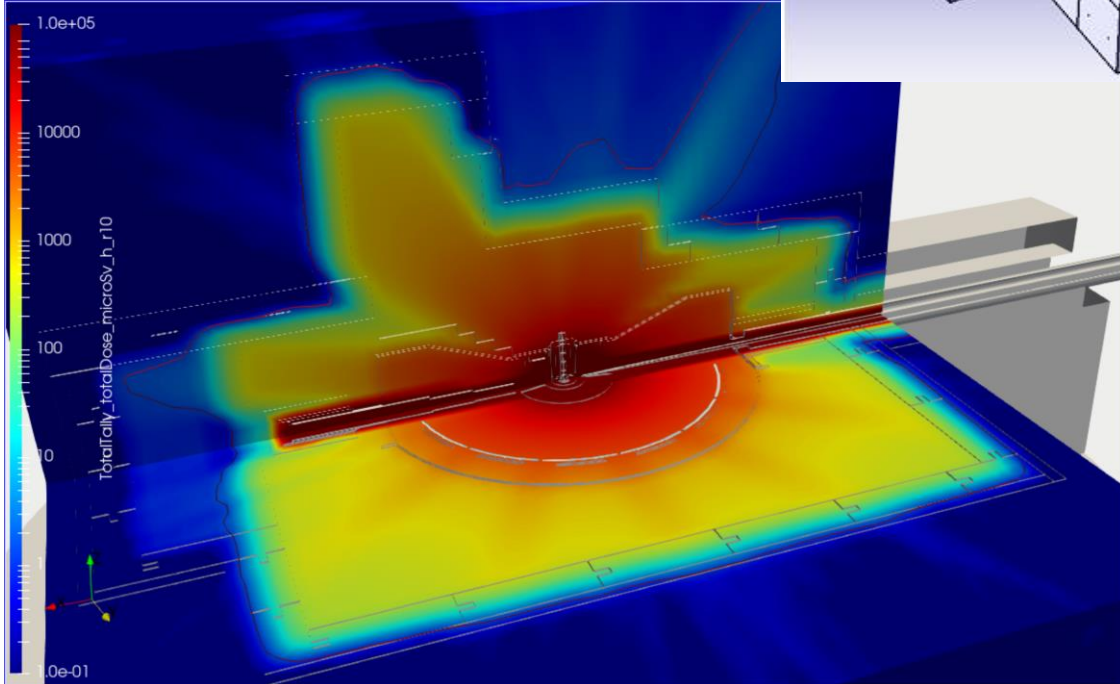
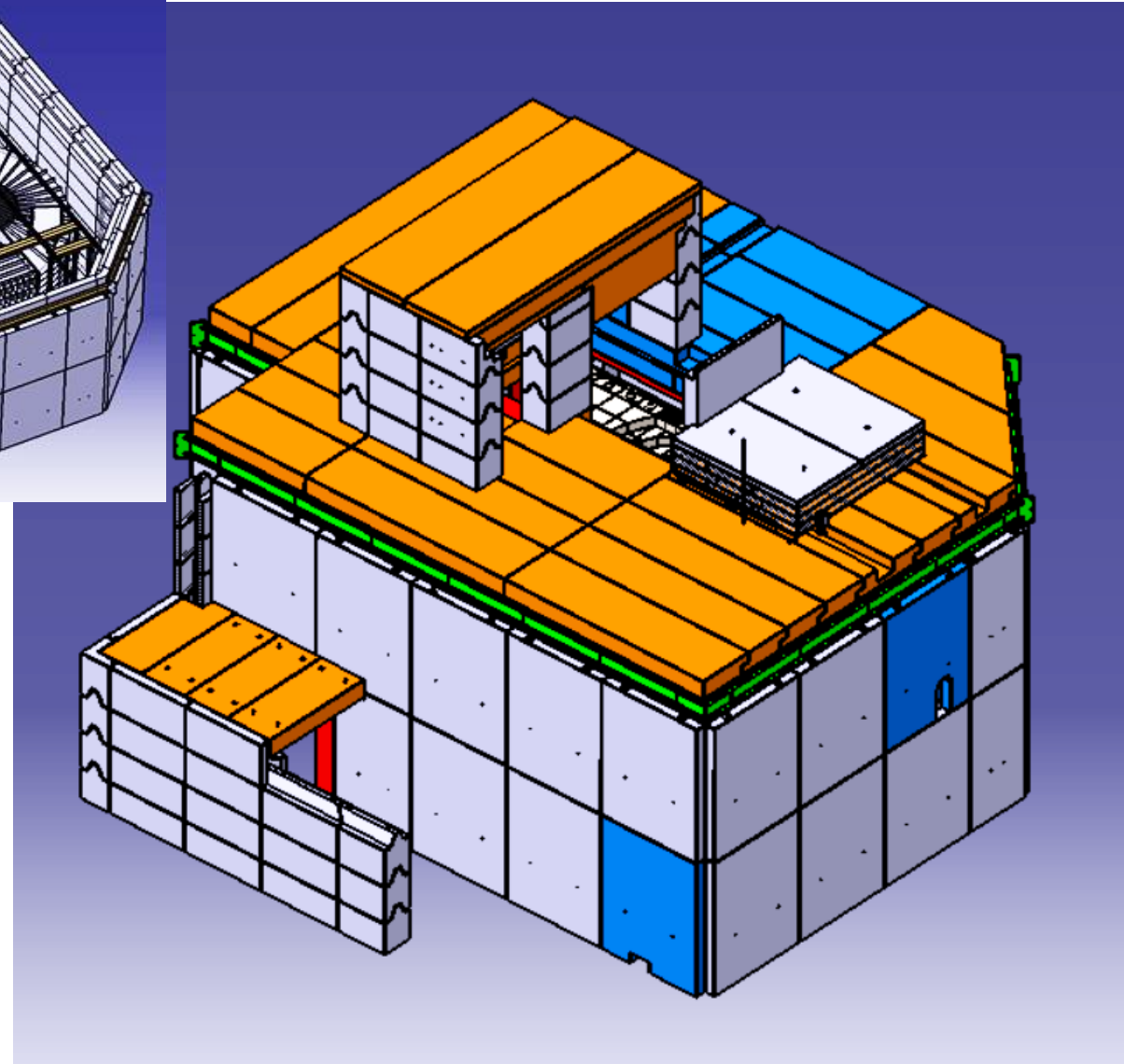
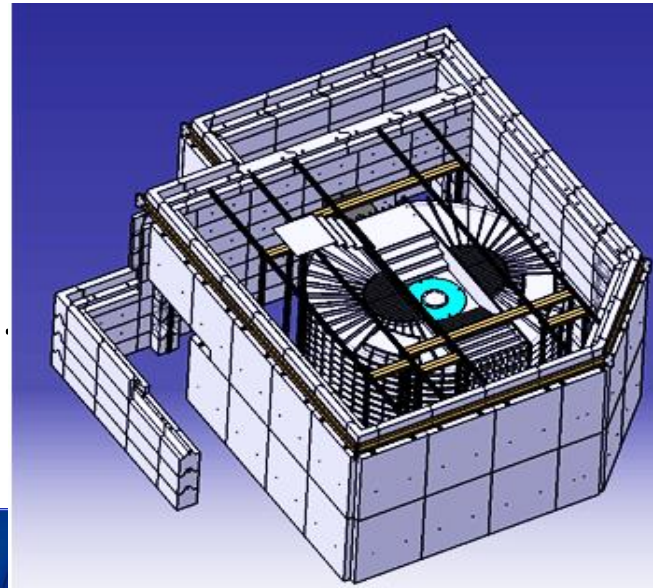
Experimental end station

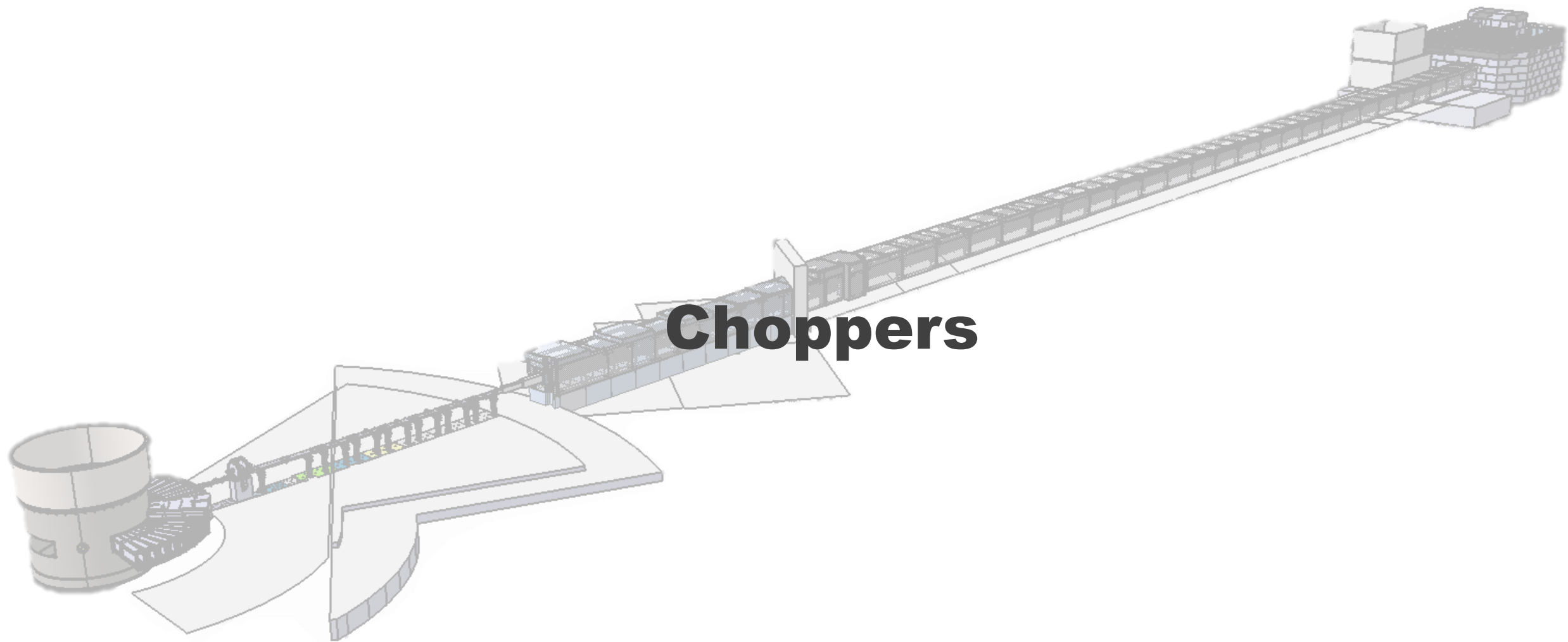
- Experiments will be carried out on cave's roof.
- Experimental areas (work benches, sample environment equipment, fence,...) will be located there.
- Design was moved ahead in time, because in-bunker SubTG3 takes priority.



Cave design

- Double wall.
- Reinforcements.
- Structural analysis ongoing.
- Feedthroughs & services.
- CDR expected by end of 2022.





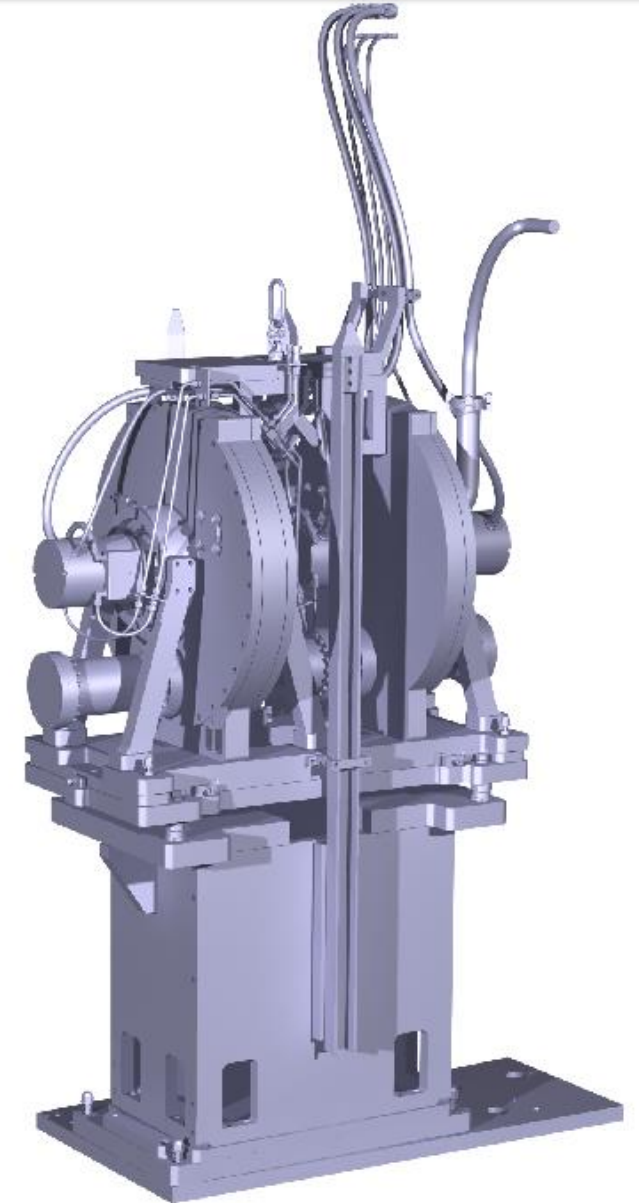
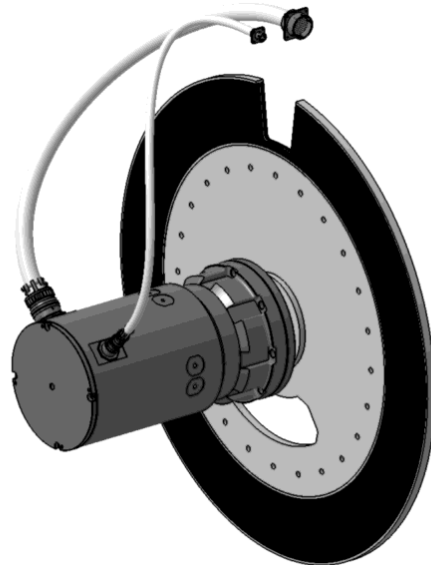
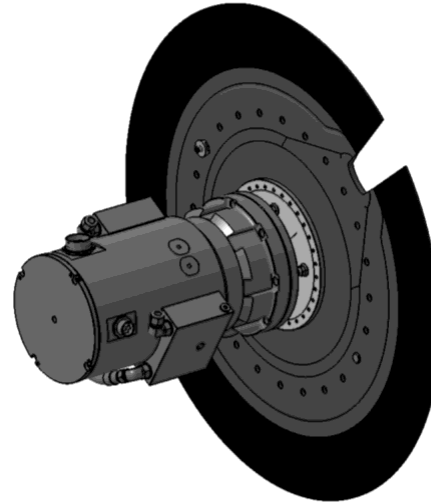
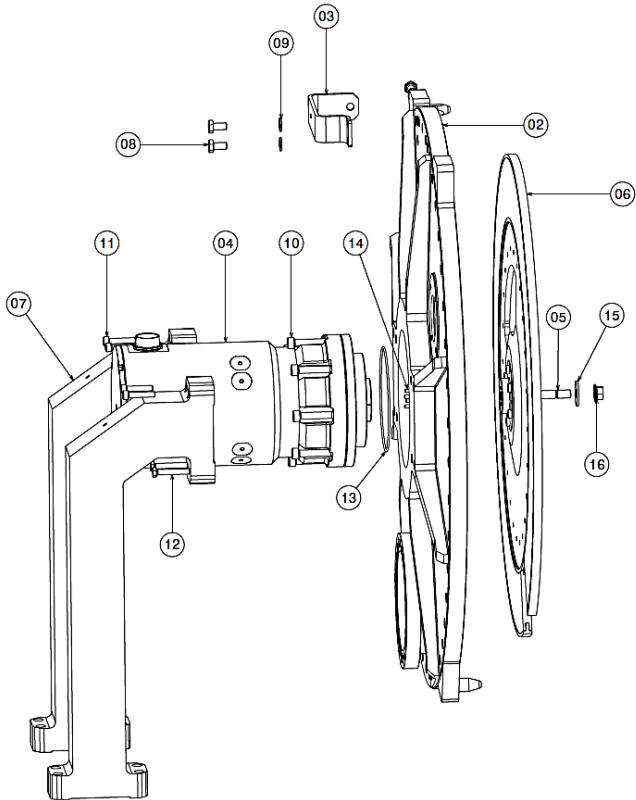
Choppers



PWD/PS Choppers (in-bunker)

- ✓ IDR Jan-2022
- ✓ Integration w/ guides & ESS infrastructure
- Sub-TG3 Q2-2022.
- Installation Q4-2023, hopefully

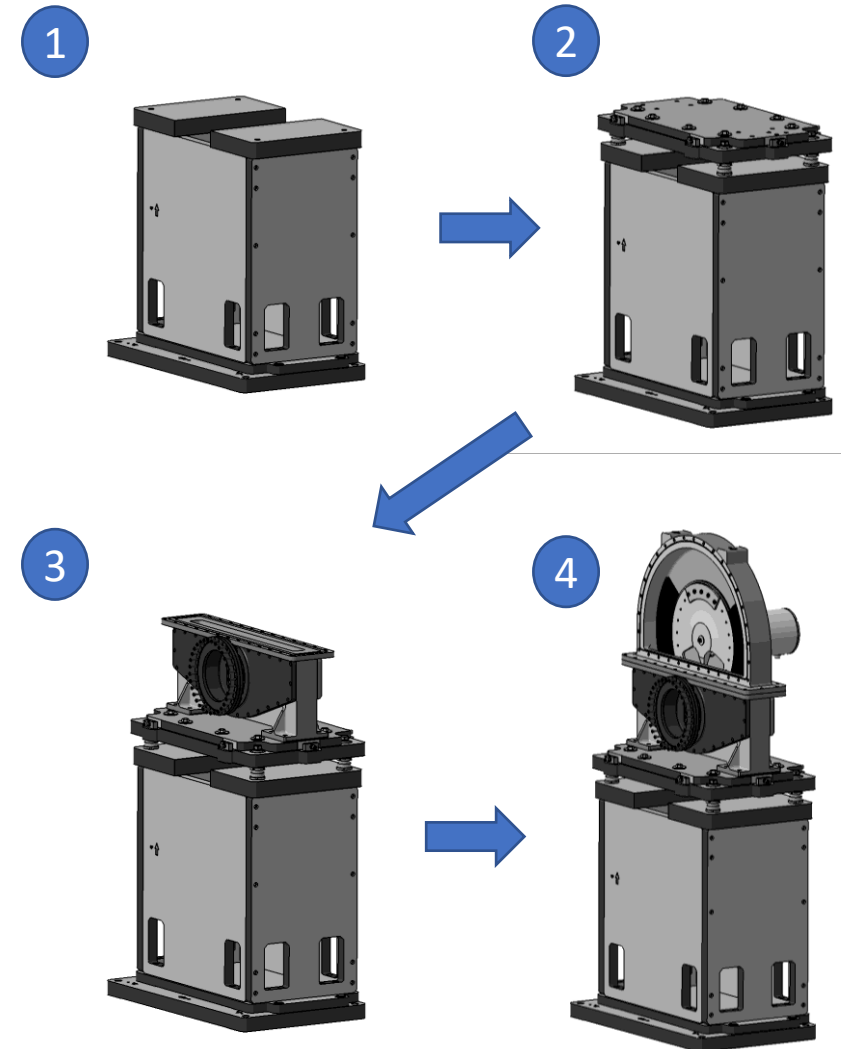
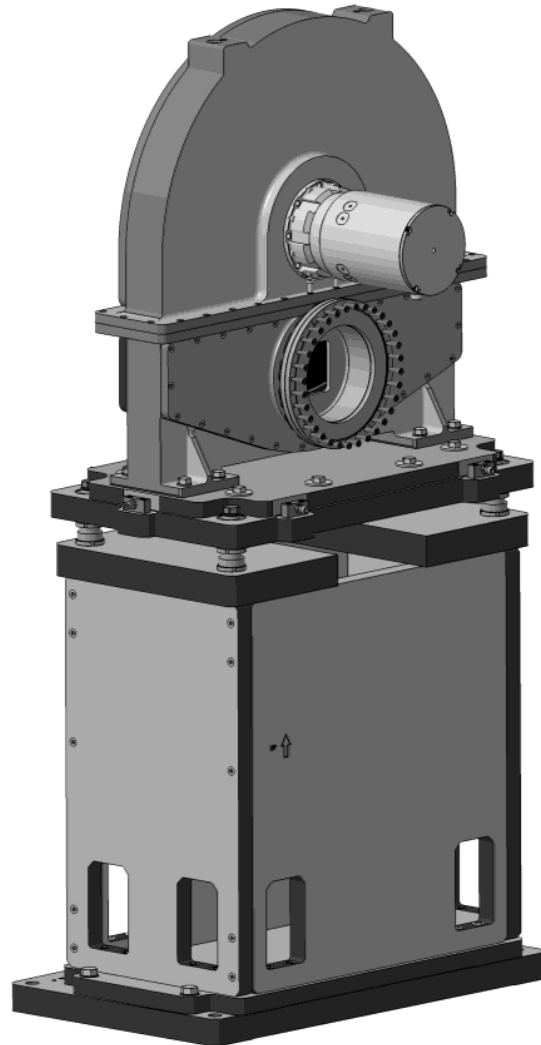
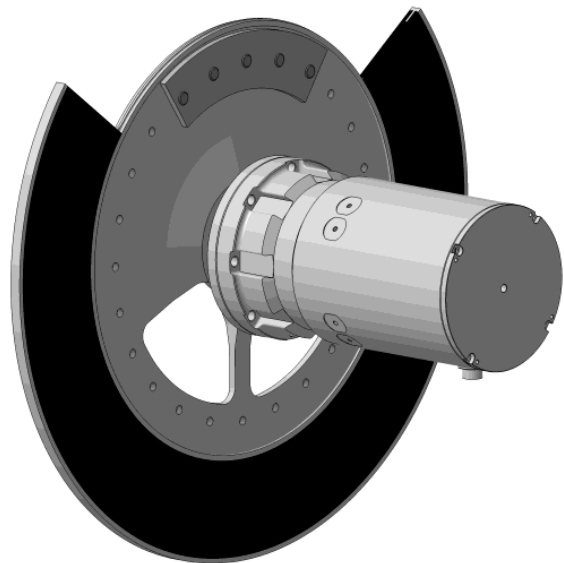
AERnova



FO Chopper (out-of-bunker)

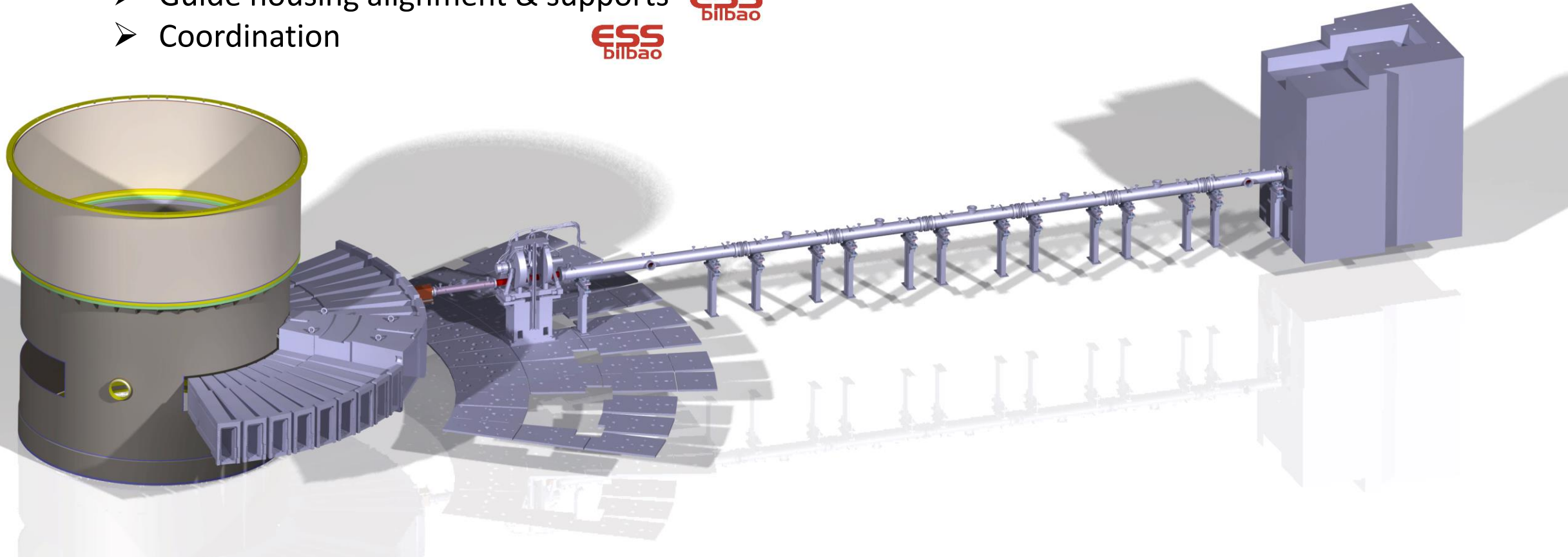
- ✓ IDR held 12th January
- Integration w/ guides & ESS infrastructure
- Sub-TG3 Q2-2022.
- Installation Q1-2025

AERnova



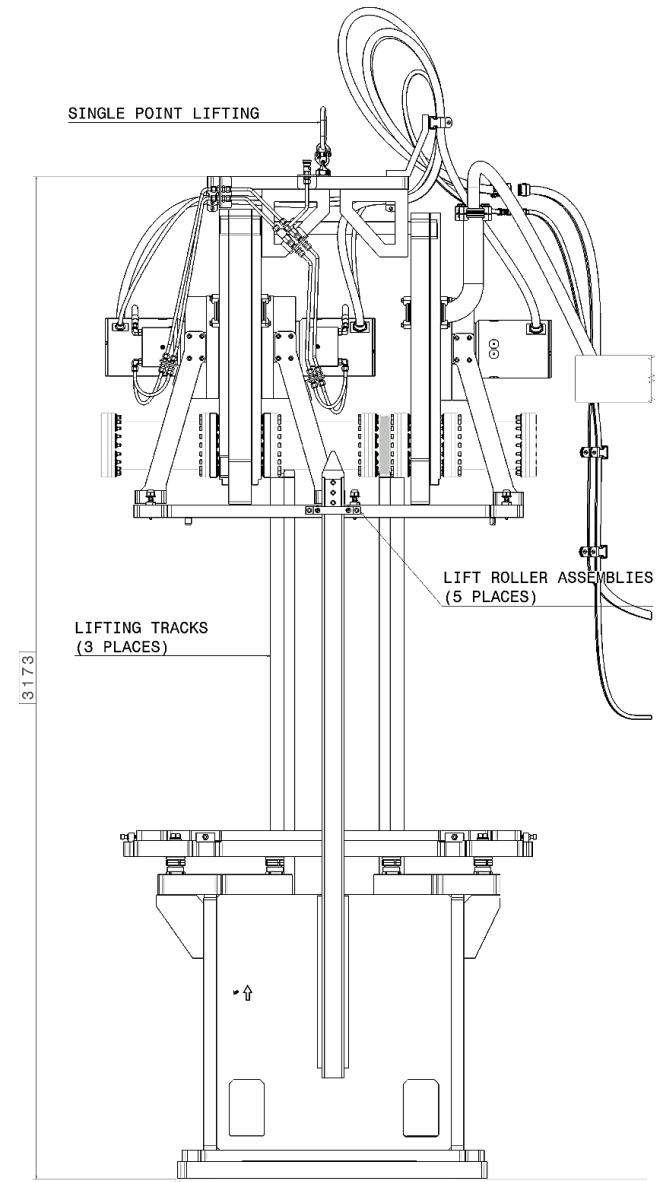
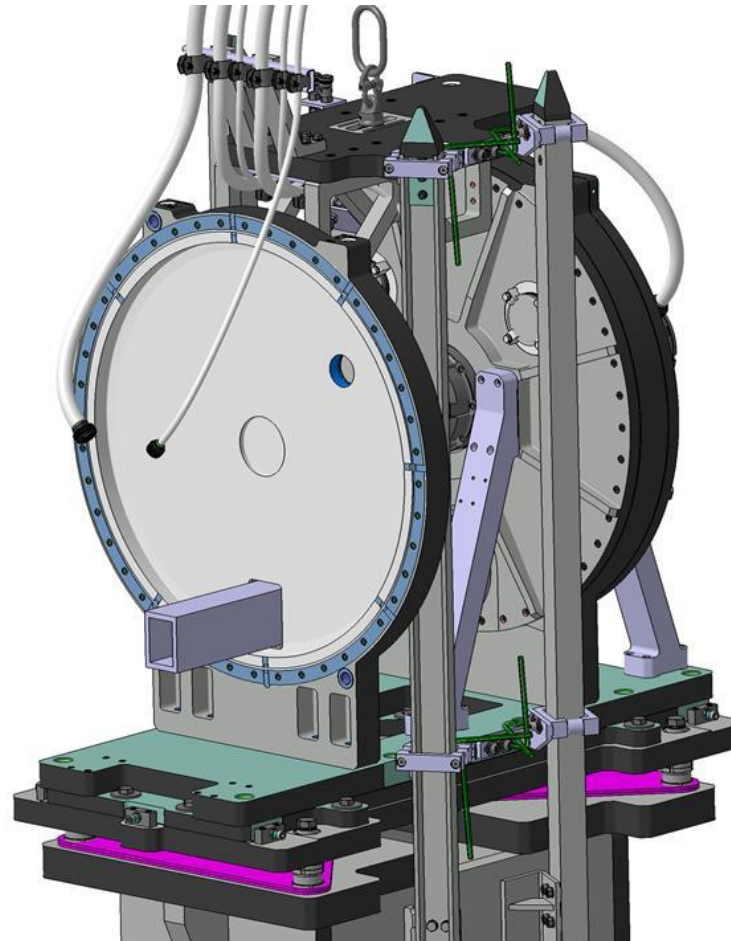
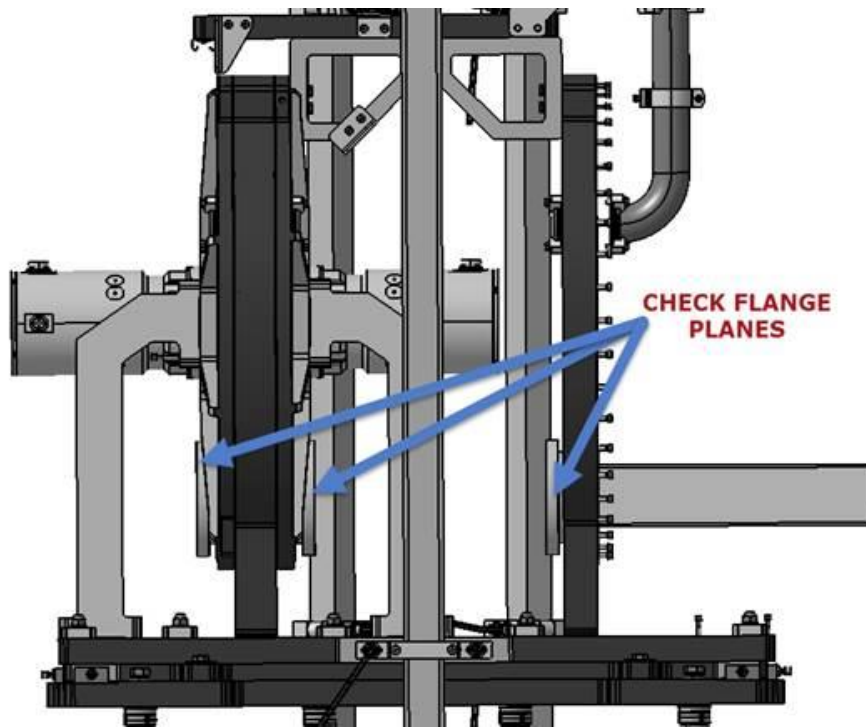
Beam Transport & Cond. System: In-bunker integration

- Choppers
- In-bunker guide
- BWI
- Infrastructure
- Guide housing alignment & supports
- Coordination



Guide/Choppers: In-bunker integration works

- Main challenge: integration and alignment of guide between choppers.
- Ex-situ installation.



Understanding motion control

- Aernnova's prototype in ESS-Bilbao premises
- Speed & Phase Tests, understanding SKF motion control.



Phase Testing Results
 Note: Veto Window [us] = Veto Window [deg]/(360 [deg/rev])/(speed [rev/s])*1e6

"CW" Rotation Direction

Rotation Speed	Ref. Frequency [Hz]	Veto Window (zx.xx μs)	Full Width Veto Window (zx.xx*)	Veto Window (zx.xx*)	Veto Count	Non-Veto Count	Tracking Time (Min)	% Efficiency Over Tracking Time	Phase Rep (std. dev) (us)	Phase Acc. (mean) (us)	Window Size: I1 (us)	Window Size: I2 (us)	Overall Achieved Veto Window (zx.xx*)	Motor Gain			
RPM	Hz													Kp	KI	KD	
840	14	14	10.70	0.11	0.054	241	3751	4.75	94%	3.052	-0.004	-0.90	13.00	0.035028	6	0.0001	300

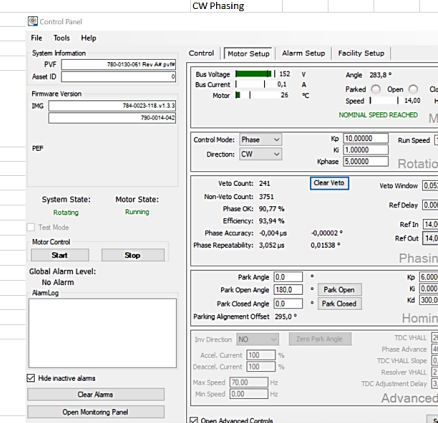
Add or remove rows as required

"CCW" Rotation Direction

Rotation Speed	Ref. Frequency [Hz]	Veto Window (zx.xx μs)	Full Width Veto Window (zx.xx*)	Veto Window (zx.xx*)	Veto Count	Non-Veto Count	Tracking Time (Min)	% Efficiency Over Tracking Time	Phase Rep (std. dev) (us)	Phase Acc. (mean) (us)	Window Size: I1 (us)	Window Size: I2 (us)	Overall Achieved Veto Window (zx.xx*)	Motor Gain			
RPM	Hz													Kp	KI	KD	
840	14	14	10.70	0.11	0.054	127	2149	2.71	94%	3.058	0.000	-10.00	13.00	0.0580	6	0.0001	300

Add or remove rows as required

Capture screenshots of the Motor Setup tab from MBScope C






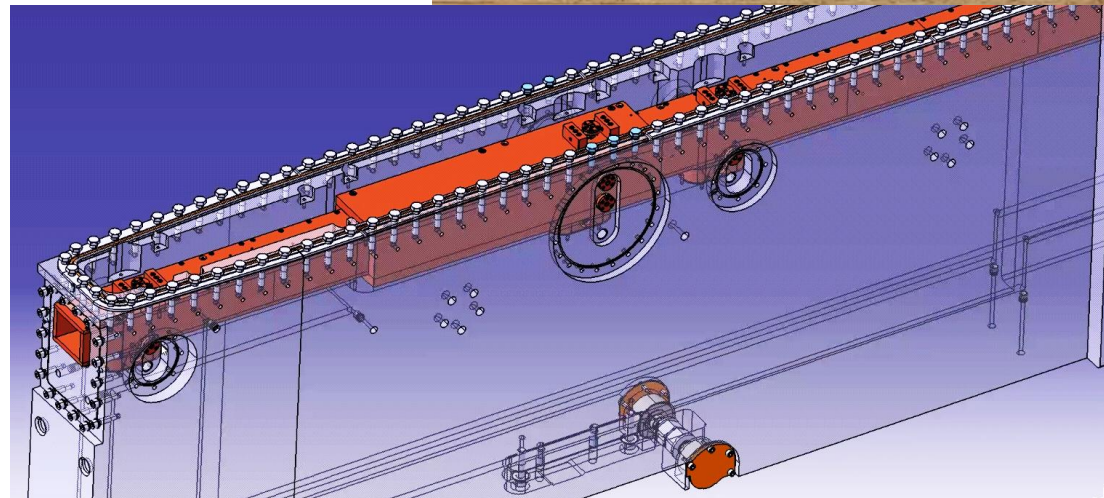
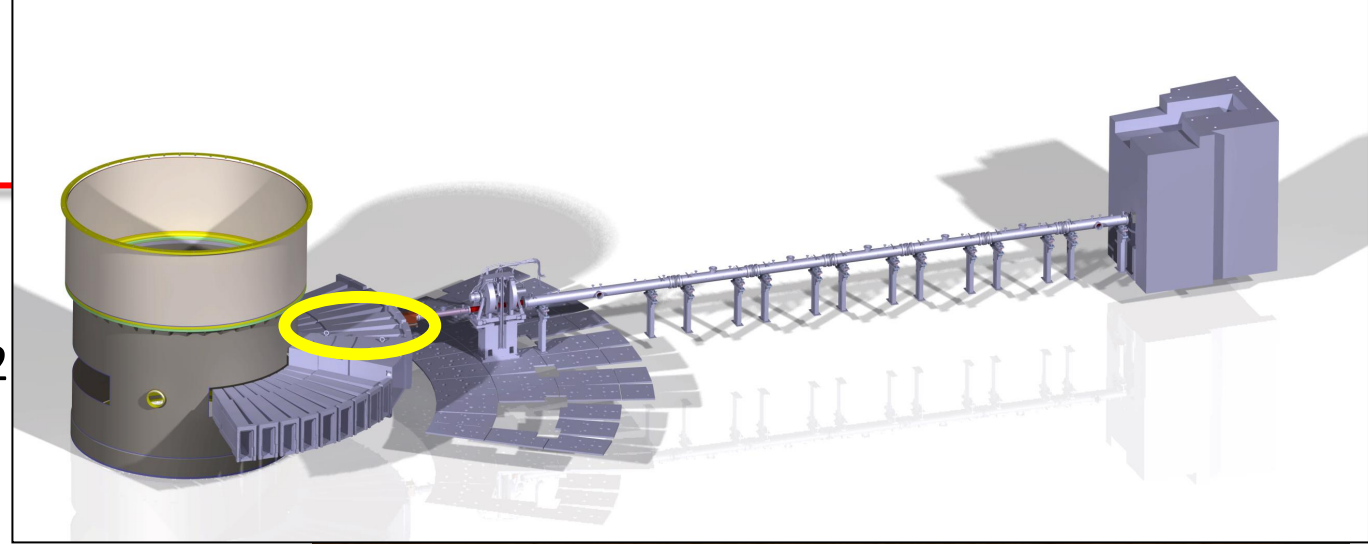
A 3D cutaway diagram of a beam transport system. The system consists of a long, narrow tunnel with a series of rectangular components (likely magnets or diagnostics) spaced along its length. At the left end, there is a large cylindrical structure, possibly a particle source or a target station. The tunnel is supported by a concrete structure that is cut away to reveal the internal components. The overall design is complex and technical.

Beam Transport System




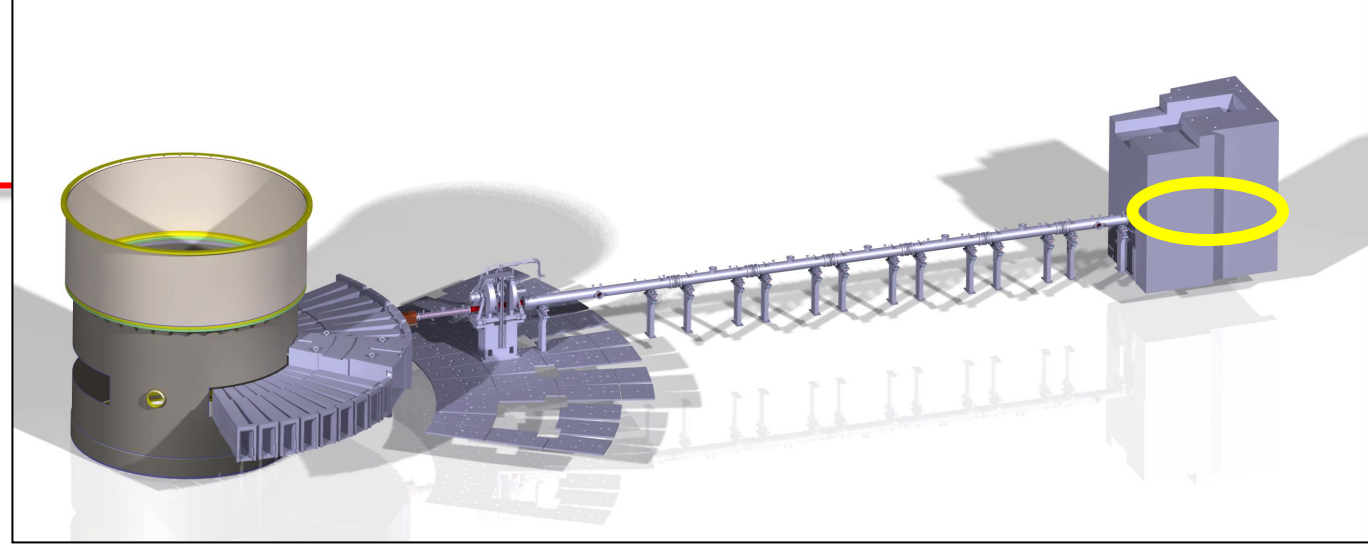
NBOA

- ✓ On site! October 2021
- ✓ CDR Integration NBPI (housing, ): April 2022
- Installation: Q1-2023

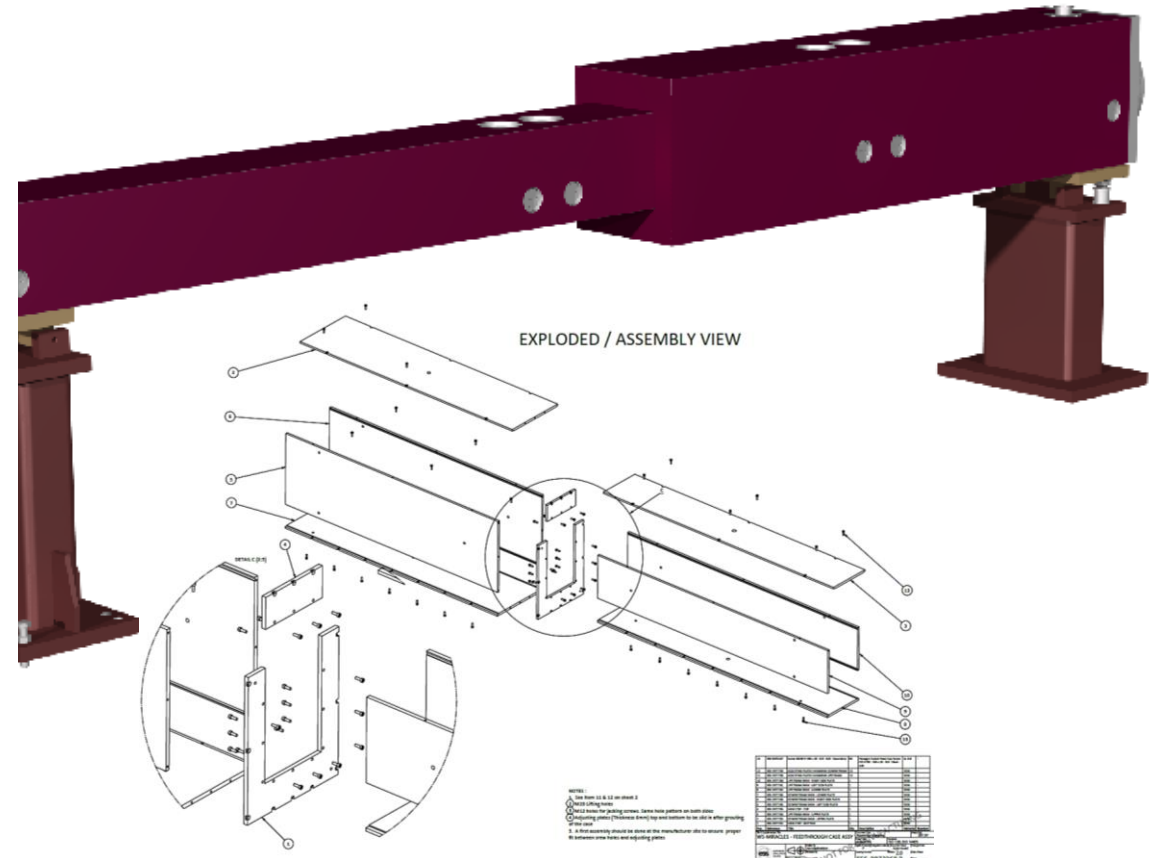
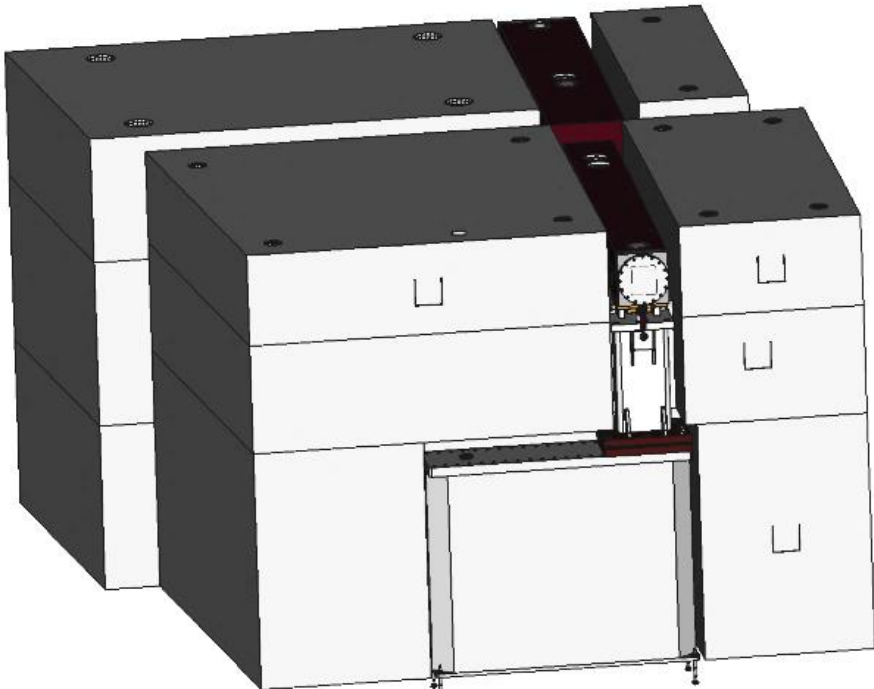


BWI

- ✓ Detailed design done! Sub-TG3 ASAP.
- CDR of BWF (housing,  EUROPEAN SPALLATION SOURCE): March 2022
- Installation? Q1-2023 (Vertical installation, good!)



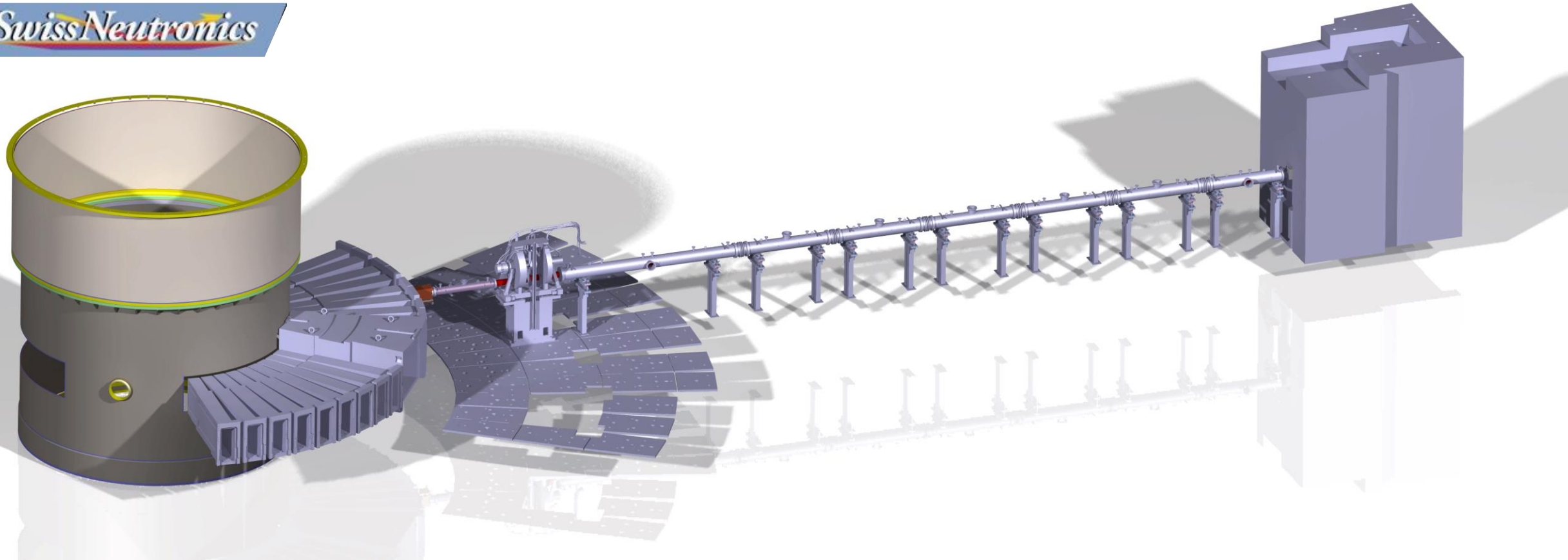
S-DH



In-bunker guide

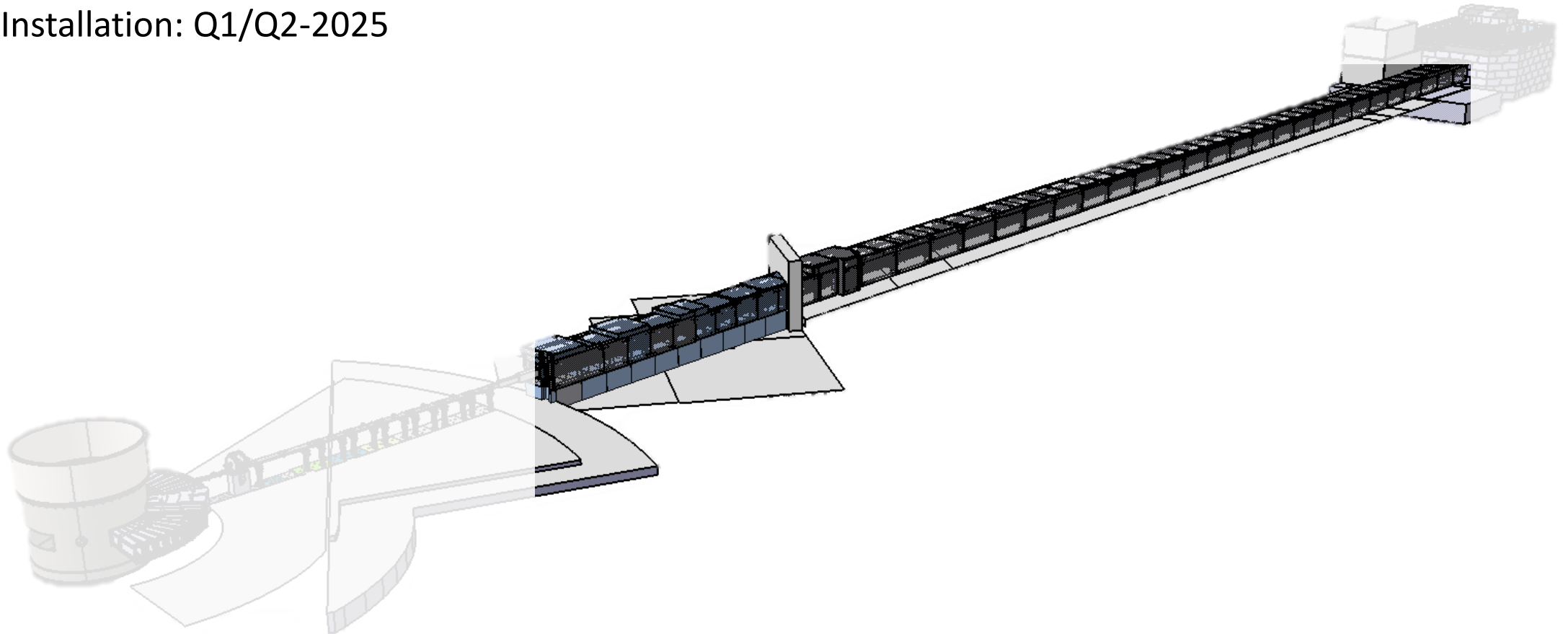
- Detailed design ongoing. Sub-TG3 this summer
- Installation? Q4-2023

SwissNeutronics



Out-of-bunker guide

- ✓ Tender: February 2022
- Awarded to...
- SubTG3 (CDR): Q1-2023
- Installation: Q1/Q2-2025



Safety Systems

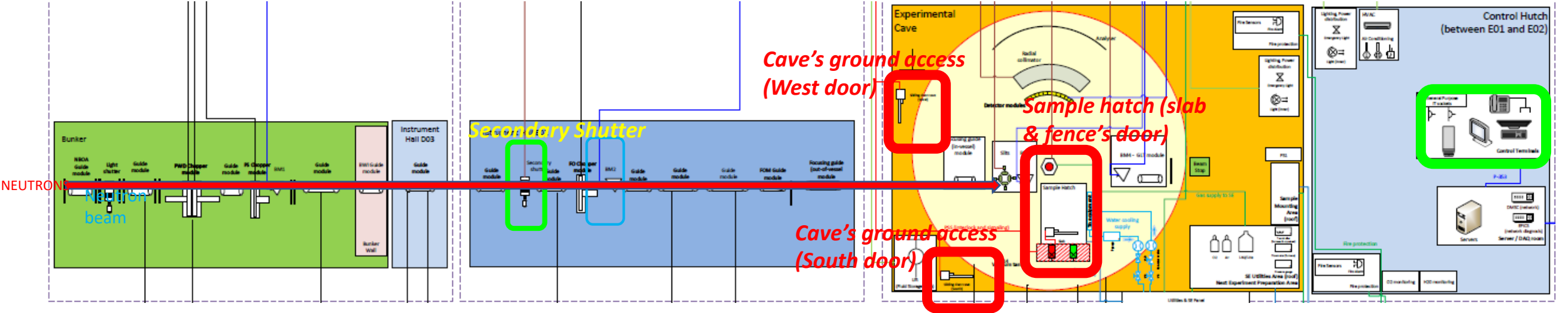


MIRACLES Operation Thermal shutter as Access shutter

During measurement: experiment *running*



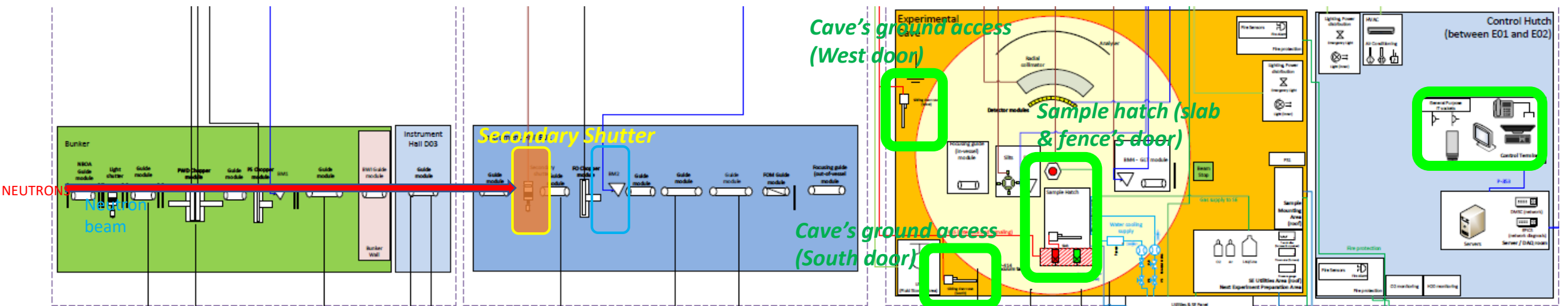
Shutter OPEN (Beam ON).



Access to hatch: changing sample, removing sample environment,...



Shutter CLOSE (Beam OFF).

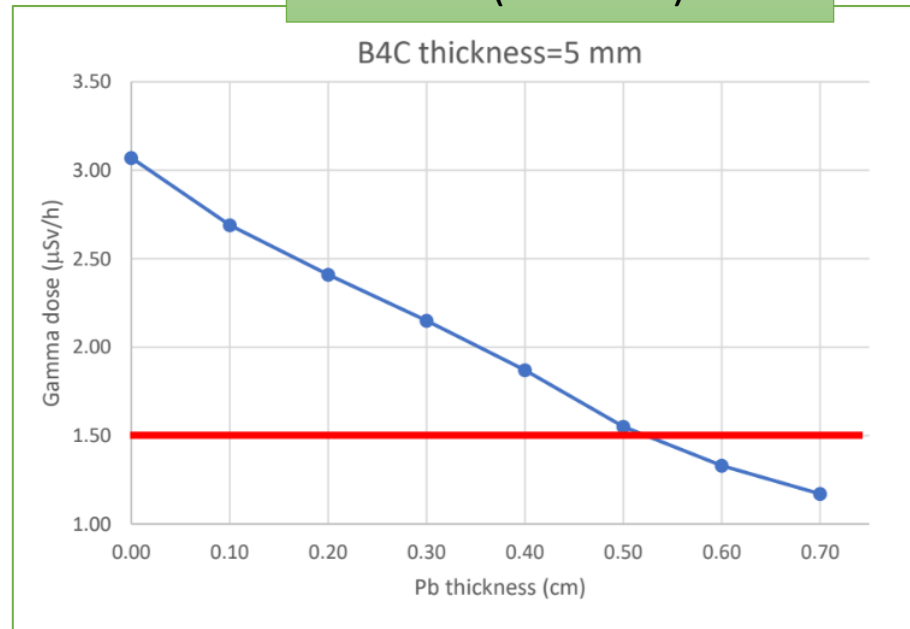
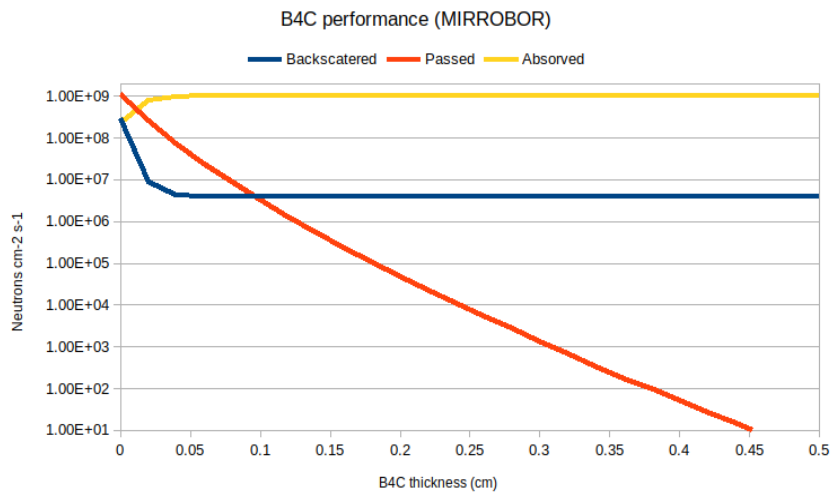
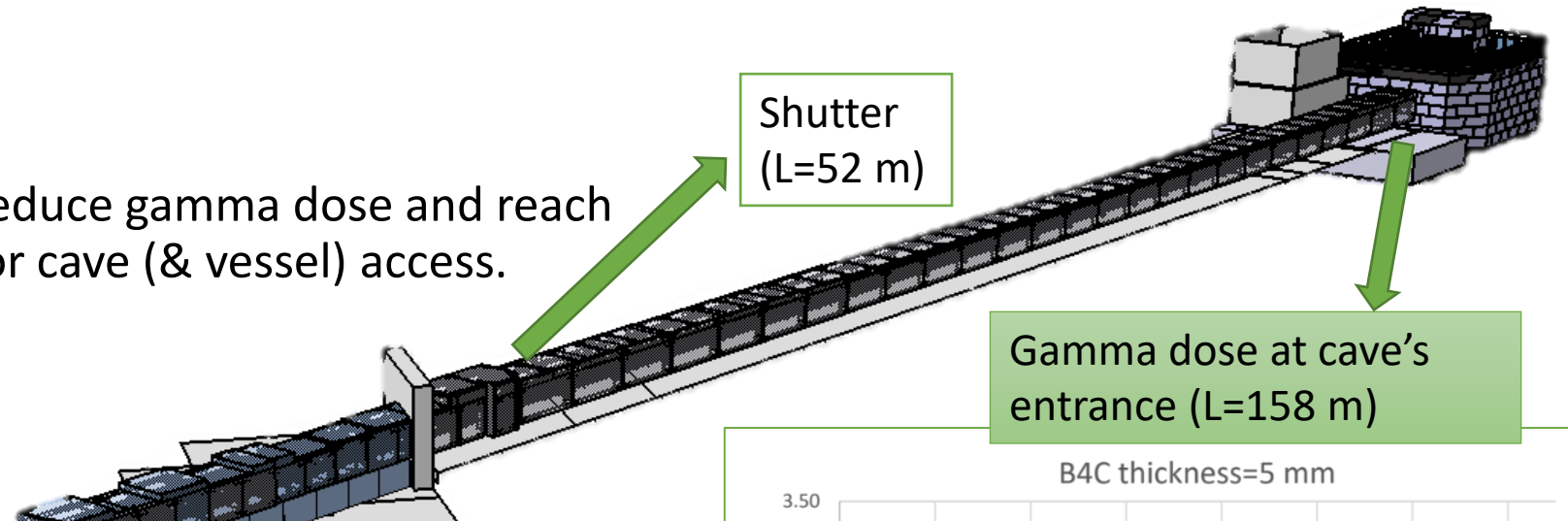
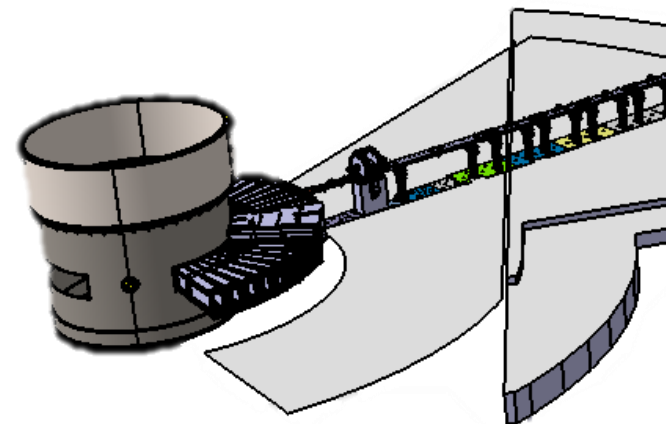


Thermal shutter

✓ IDR: October 2021

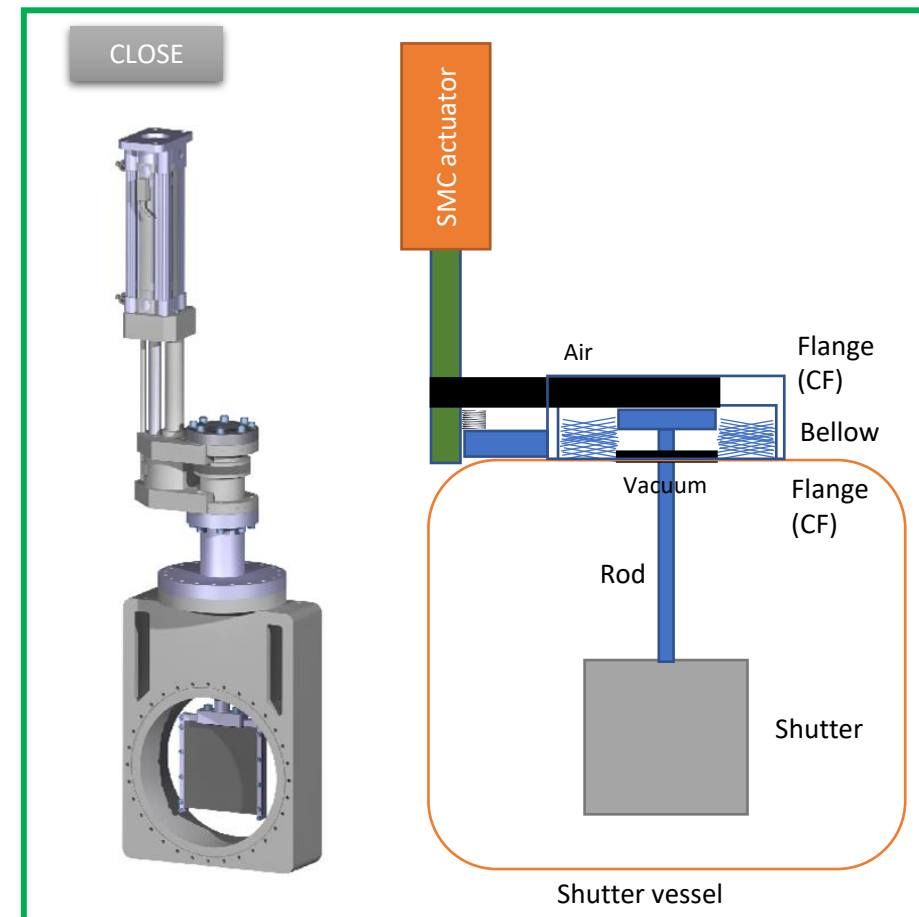
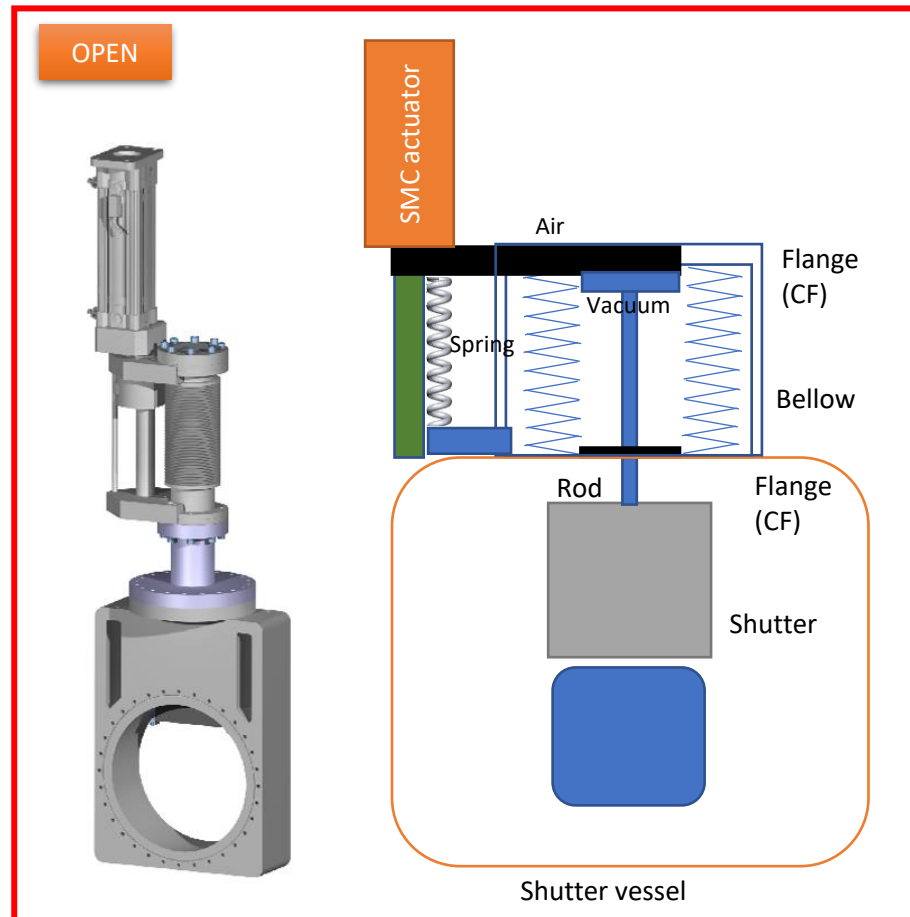
Blade (neutron stopper):

- 5 mm layer of B_4C (MIRROBOR).
- 6 mm layer of lead is enough to reduce gamma dose and reach the dose rate limit of $1.5 \mu Sv/h$ for cave (& vessel) access.



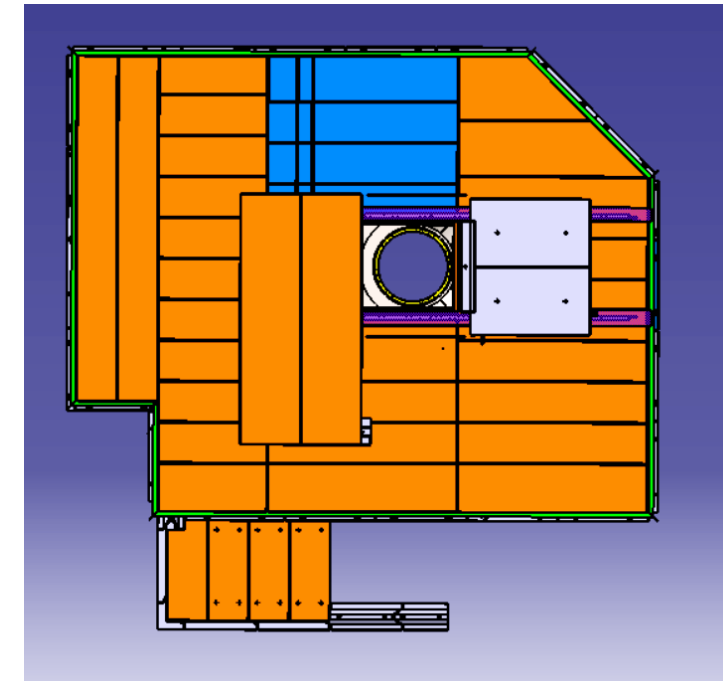
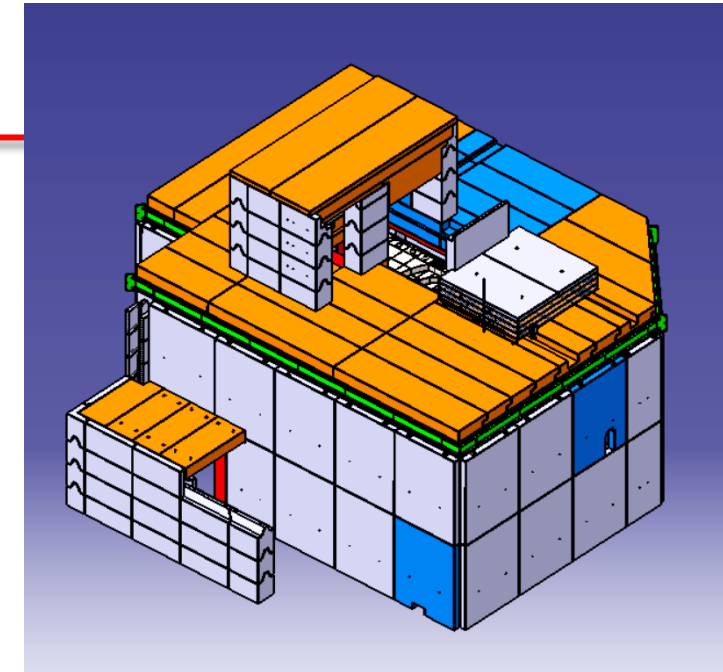
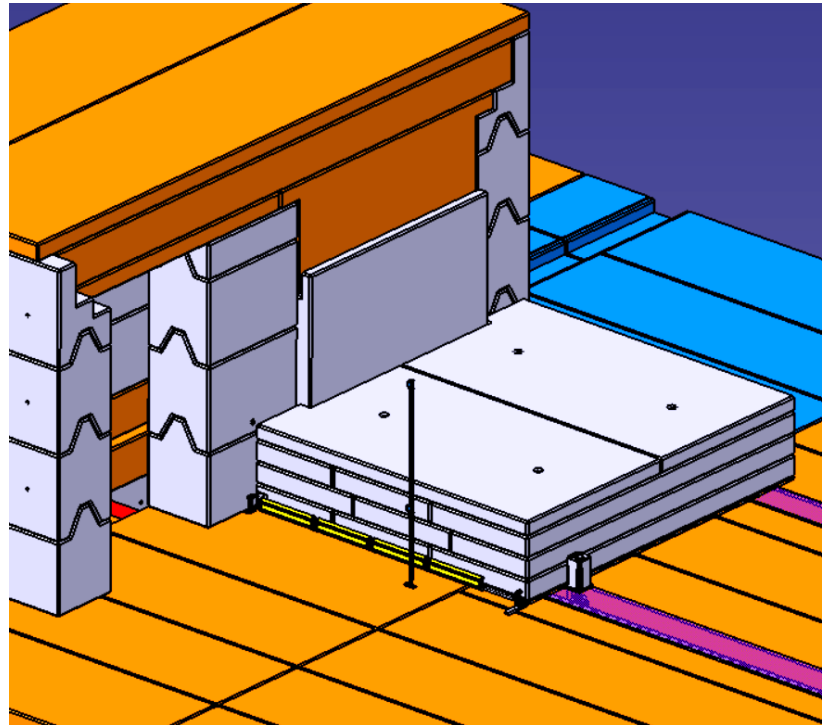
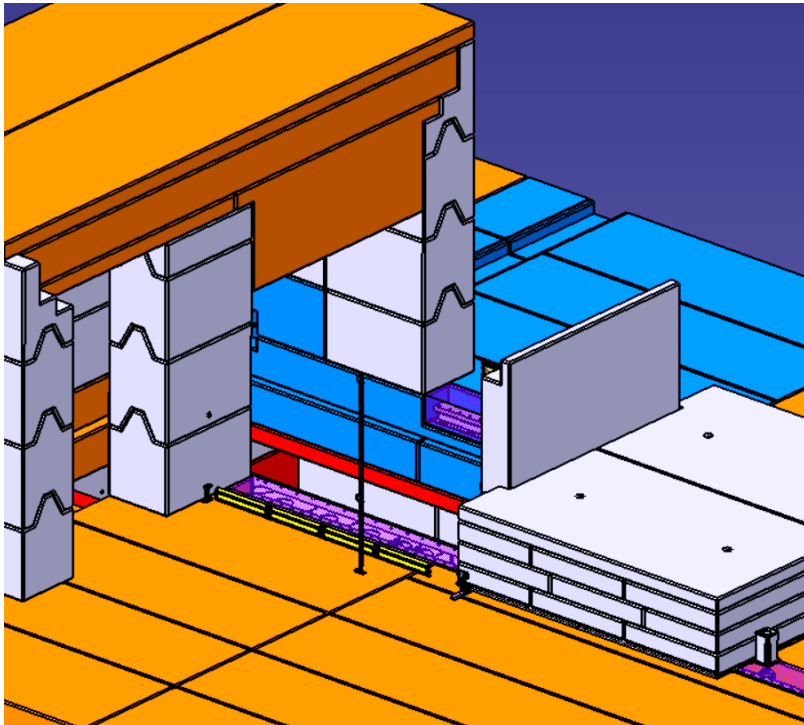
Thermal shutter

- Motion actuator: pneumatic cylinder. Actuator Stroke:150 mm.
- Shutter's weight ~ 15 kg. Blade weight < 1kg.
- Connected to PSS
- Fail safe mechanism



Sliding slab

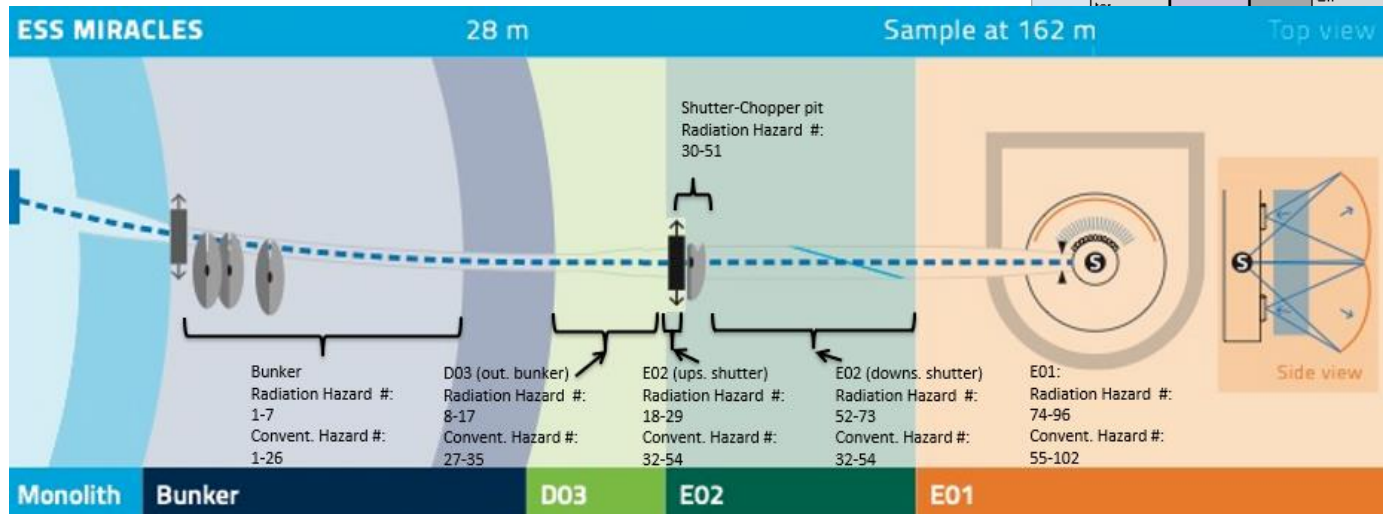
- Concrete multiblock slab (15-20 Tons)
- Guided by railed guides.
- Gearmotor which will move the load along the HEPCOMOTION MHD rack and pinion element.
- Connected to PSS & Shutter

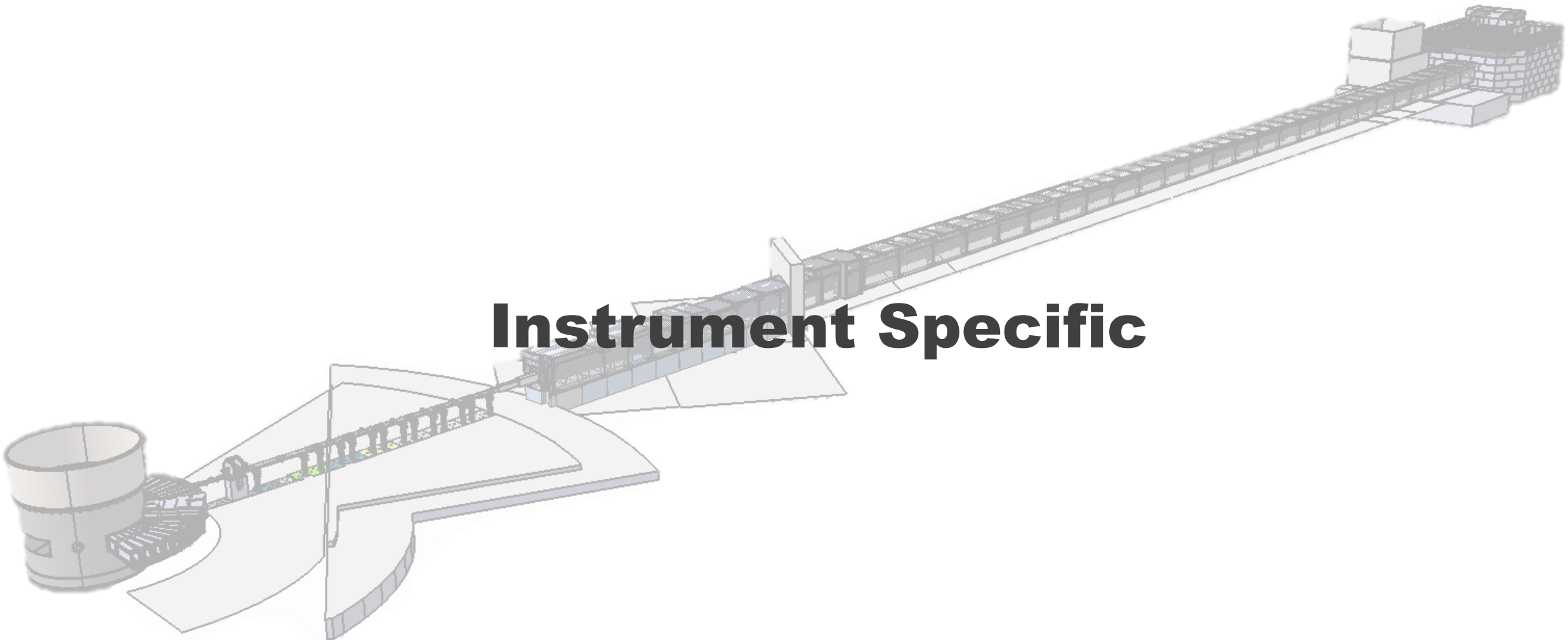


Instrument Hazard Analysis

- Listing Radiation & Conventional Hazards
- 1st draft submitted in March 2022
- Input for Hazard Identification Workshop & PSS

Building	Radiation Hazard Identification				Cause / Initiating Event	Person Affected	Source of Hazard	Sub Mode / Task	Likelihood per year (From H Category) ESS-000004	Risk Estimation and Reduction		
	1 Instrument Area	2 Instrument Sub-area	3 Radiation Hazard Number	4 Mode						11 Severity	12 Likelihood*Severity	13 Actions to Mitigate Risk (Risk Controls)
D03	Primary Spectrometer	Bunker	1	Proton beam Off	Access to the bunker during maintenance	Exposed worker without radiation safety task	Activated instrument components. Choppers/Guides/Monitors	N/A	H1 1	dose < 2 mSv/event		a) Shielding and barriers to prevent access to the bunker area beyond where the work takes place b) Signage.
D03	Primary Spectrometer	Bunker	2	Proton beam Off	Access to the bunker - Barriers and signage disregarded -	Exposed worker without radiation safety task	Activated instrument components. Choppers/Guides/Monitors	N/A	H3 1X10 ⁻³	2 < dose < 10 mSv/event		Radiation safety training required by all workers prior to accessing site. Badge access only. MIRACLES staff and users do not have access. Managed by bunker risk assessment.
D03	Primary Spectrometer	Bunker	3	Proton beam Off	Access to the bunker - Barriers and signage disregarded	Non-exposed worker	Activated instrument components. Choppers/Guides/Monitors	N/A	H3 1X10 ⁻³	2 < dose < 10 mSv/event		Radiation safety training required by all workers prior to accessing site. Badge access only. MIRACLES staff and users do not have access. Managed by bunker risk assessment.
					Worker remains in bunker when bunker is closed off after maintenance.	Exposed worker without radiation safety task	Prompt ionising radiation	N/A	H3 1X10 ⁻³	dose > 20 mSv/event		Check of bunker prior to closing. Audio and visual alarm prior to proton beam opening. Emergency stop of proton beam.
					Worker remains in bunker when bunker is closed off after maintenance.	Non-exposed worker	Prompt ionising radiation	N/A	H4 1X10 ⁻⁶	dose > 20 mSv/event		Check of bunker prior to closing. Audio and visual alarm prior to proton beam opening. Emergency stop of proton beam.
					Barriers and signage disregarded	Exposed worker without radiation safety task	Prompt ionising radiation	N/A	H4 1X10 ⁻⁵	dose > 20 mSv/event		Radiation safety training required by all workers prior to accessing site. PSS lock of bunker.
					Barriers and signage disregarded	Non-exposed worker	Prompt ionising radiation	N/A	H3 1X10 ⁻³	dose > 20 mSv/event		Radiation safety training required by all workers prior to accessing site. PSS lock of bunker.
					Person outside guide. Activated components within.	Exposed worker with radiation safety task	Activation from components (guide).	N/A	H1 1	dose < 2 mSv/event		Guide shielding to achieve radiation levels equal or less than 3 microSv/year on touch. Pit prevents radiation with beam on but this is with beam off.



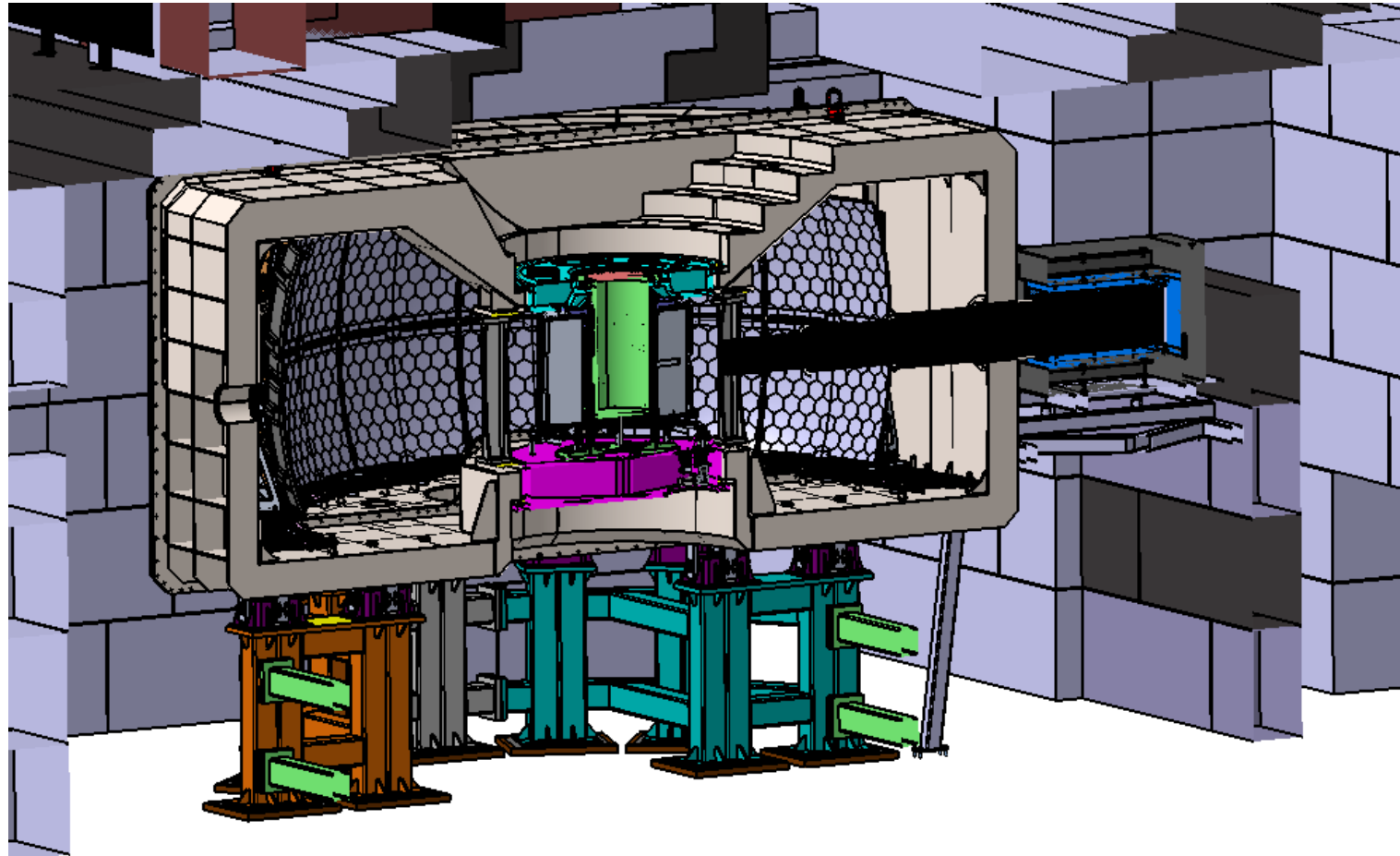


Instrument Specific



Scattering Characterization System

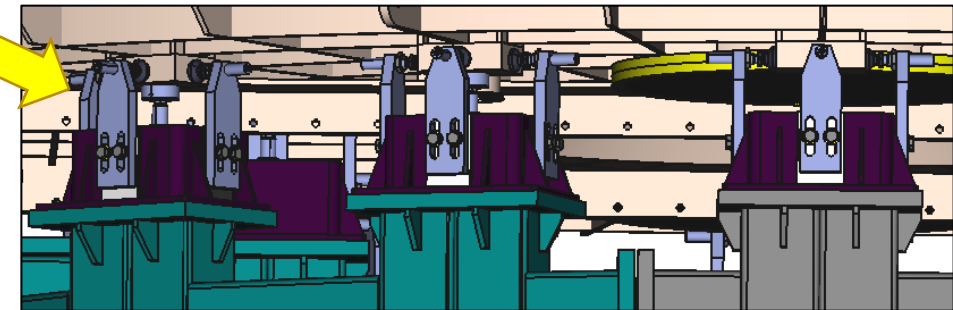
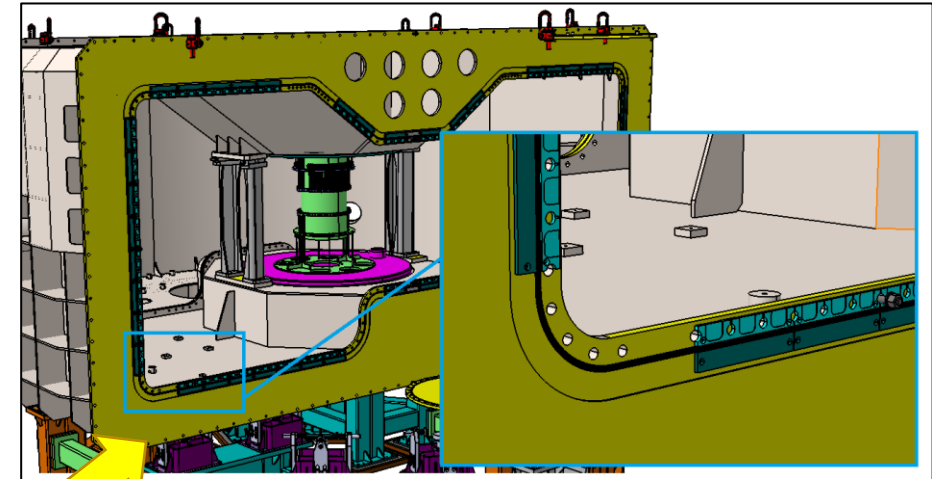
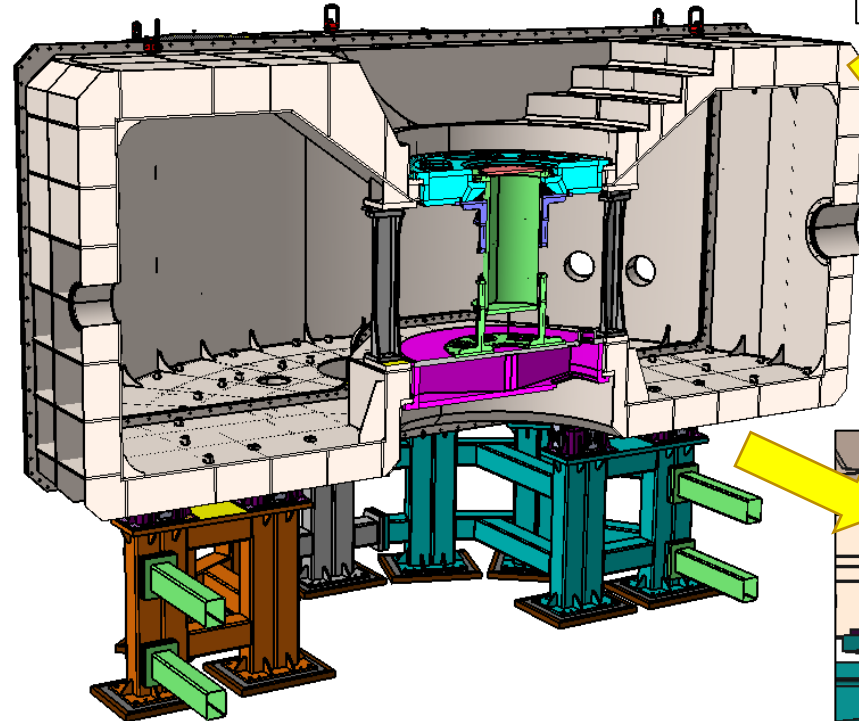
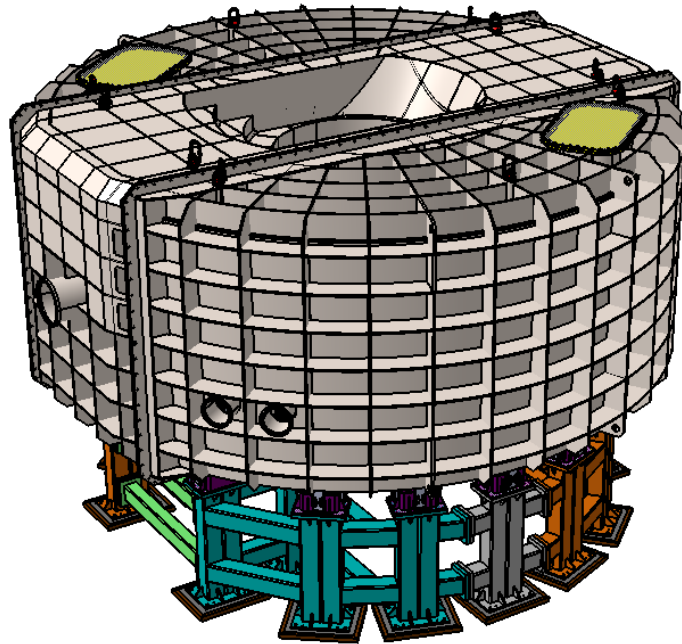
- ✓ IDR held 1st February
- Detailed design of mechanical assemblies
- Design & prototype detectors & integration ongoing
- SubTG3 after summer



Scattering Vessel

- ✓ Detailed design and interfaces
- ✓ Installation plan in progress
- ✓ Alignment & Supports
- ✓ Steel 316L (in agreement with Polarization Analysis project)
- ✓ Vacuum $\sim 1 \times 10^{-3}$ mbar

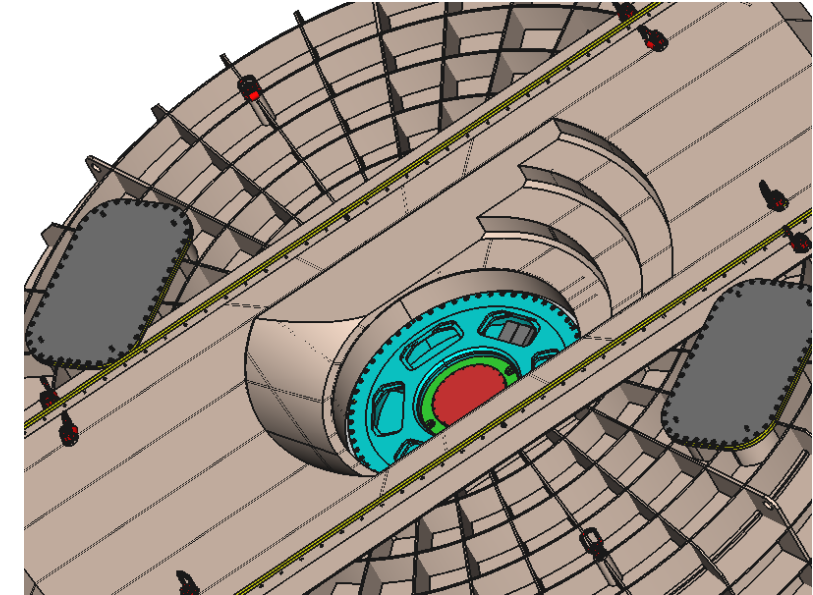
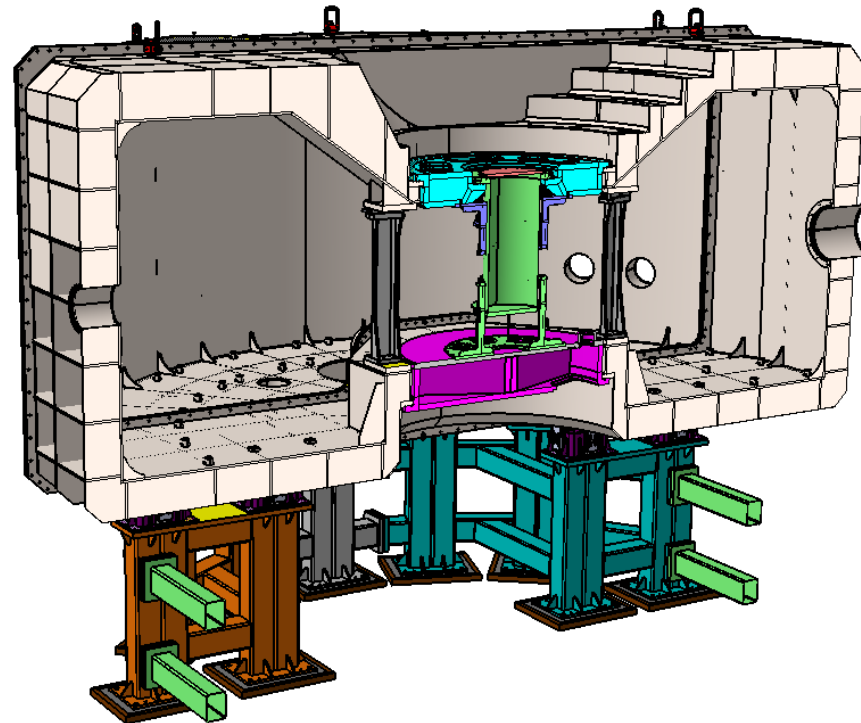
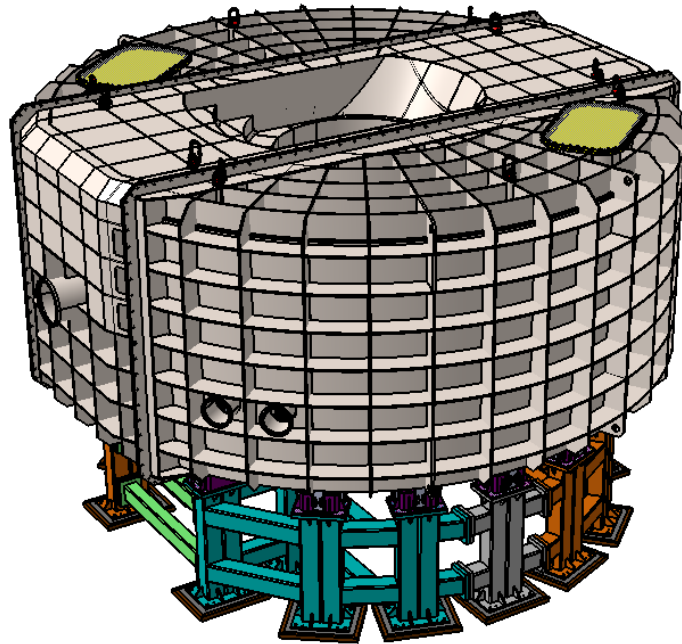
QVS



Scattering Vessel

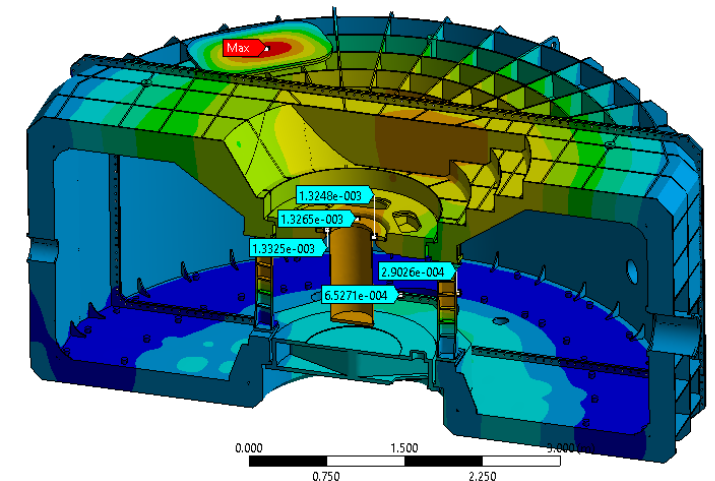
- ✓ Detailed design and interfaces
- ✓ Access to sample area incorporated
- ✓ Deflection at sample position: ≤ 1.5 mm (vertical)

QVS



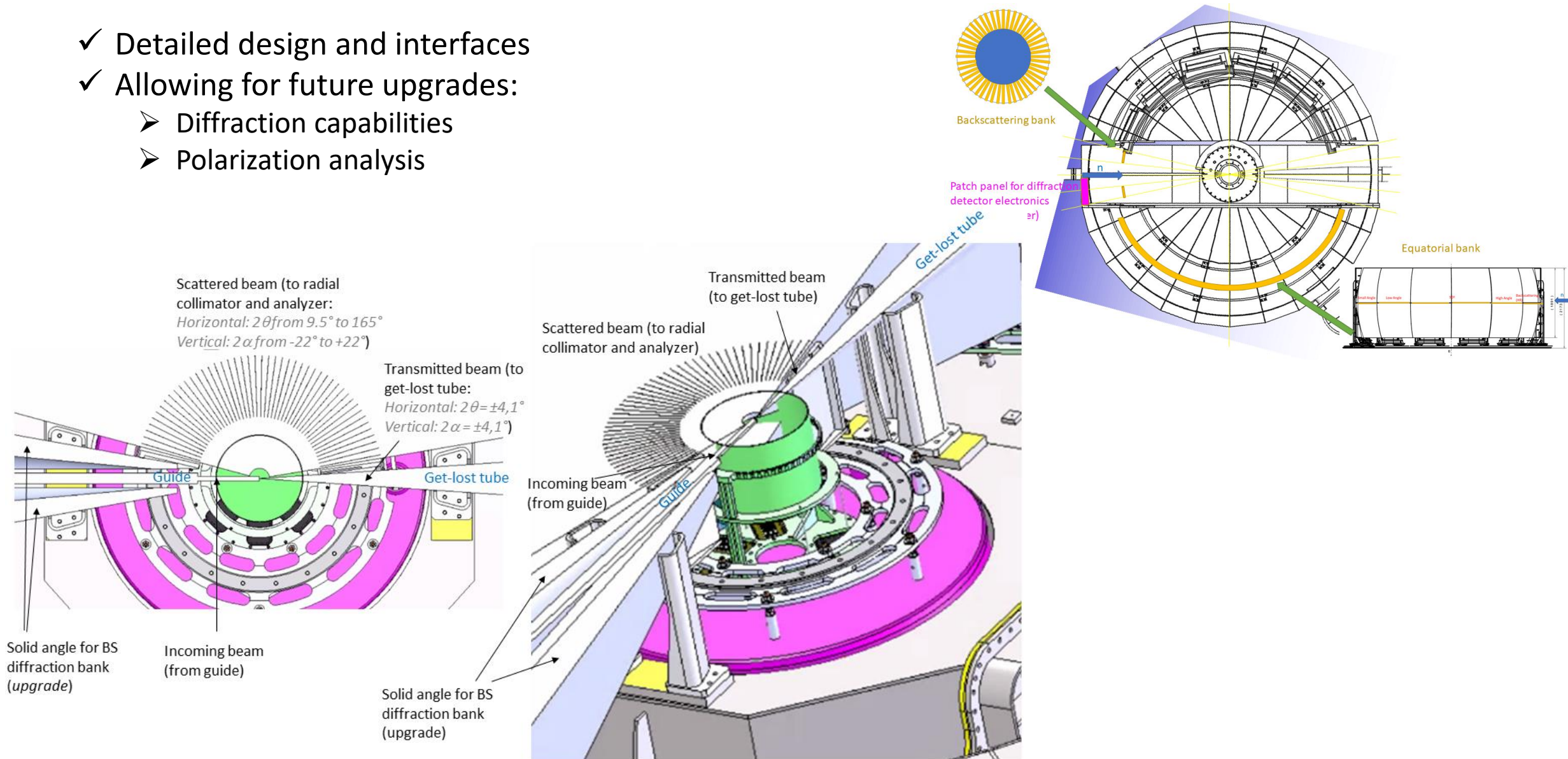
Total Deformation 2
Type: Total Deformation
Unit: m
Time: 2

0.0016193	Max
0.0014544	
0.0012895	
0.0011246	
0.00095967	
0.00079475	
0.00062984	
0.00046492	
0.0003	
5.7958e-7	Min



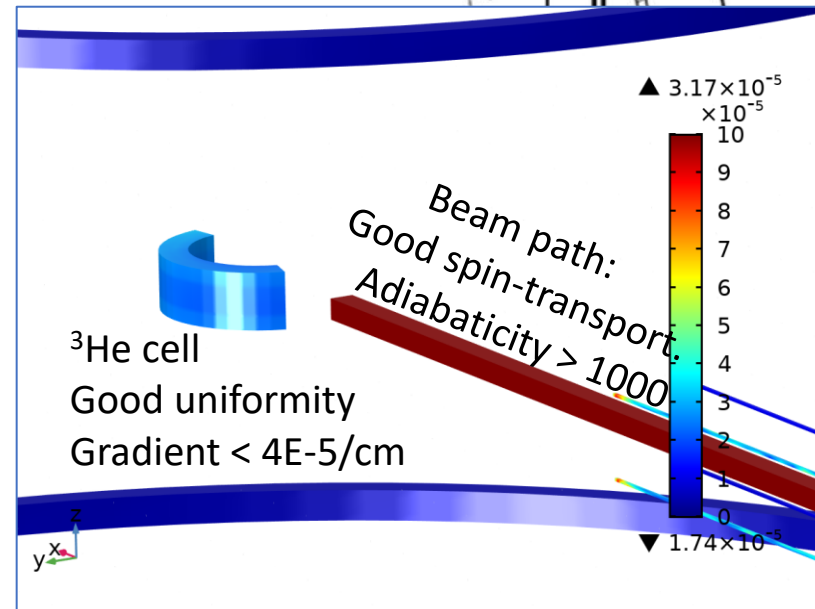
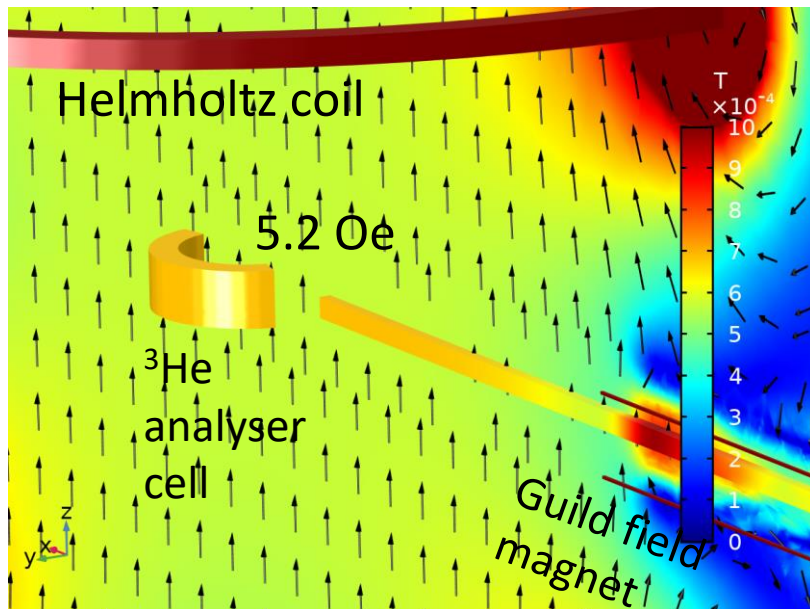
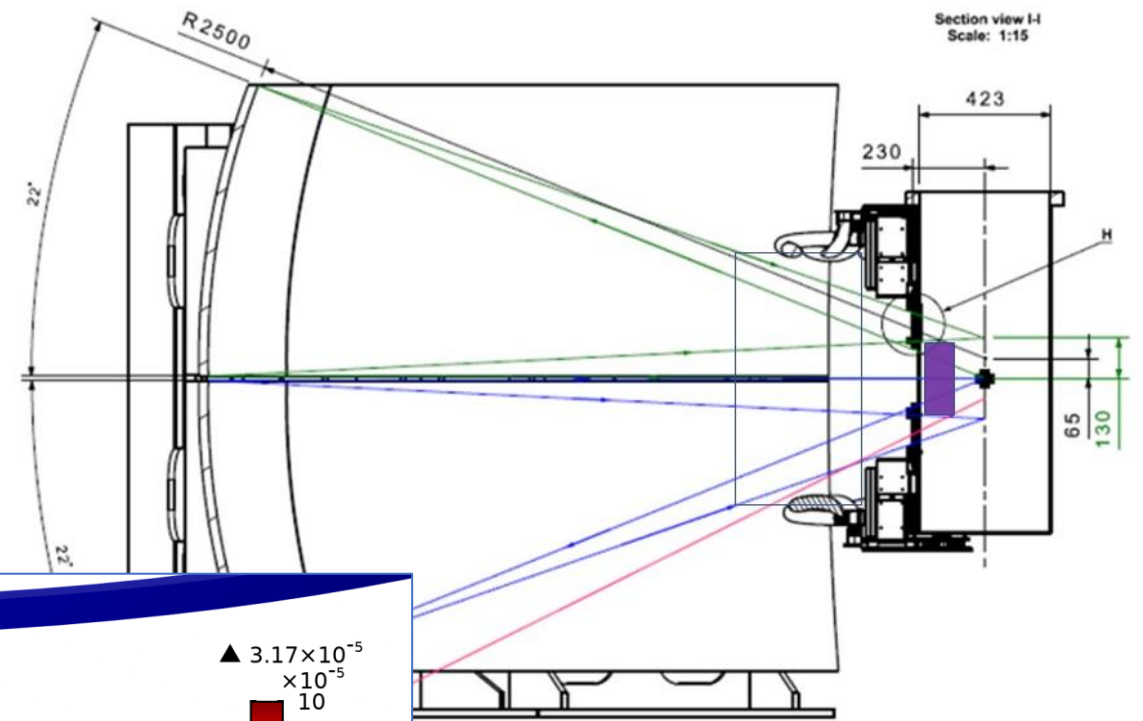
Scattering Vessel: Upgrade diffraction

- ✓ Detailed design and interfaces
- ✓ Allowing for future upgrades:
 - Diffraction capabilities
 - Polarization analysis



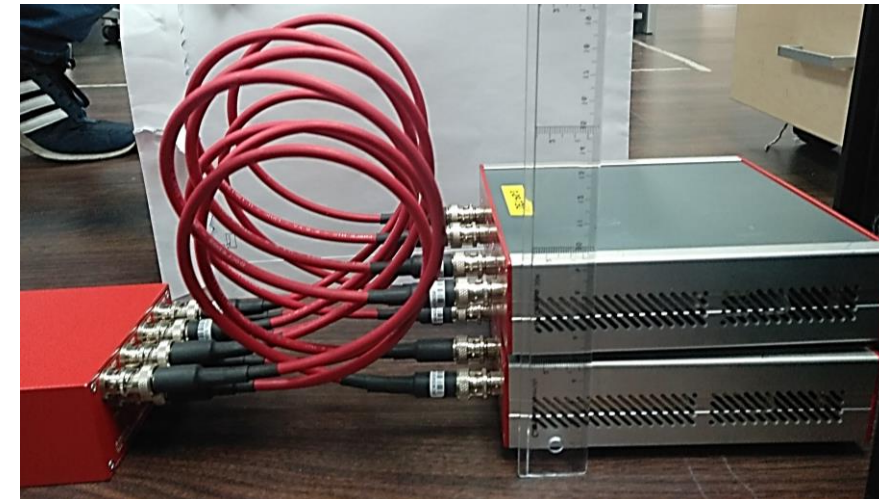
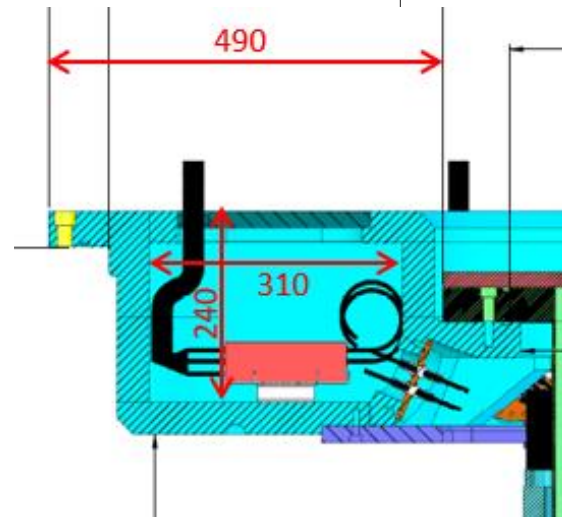
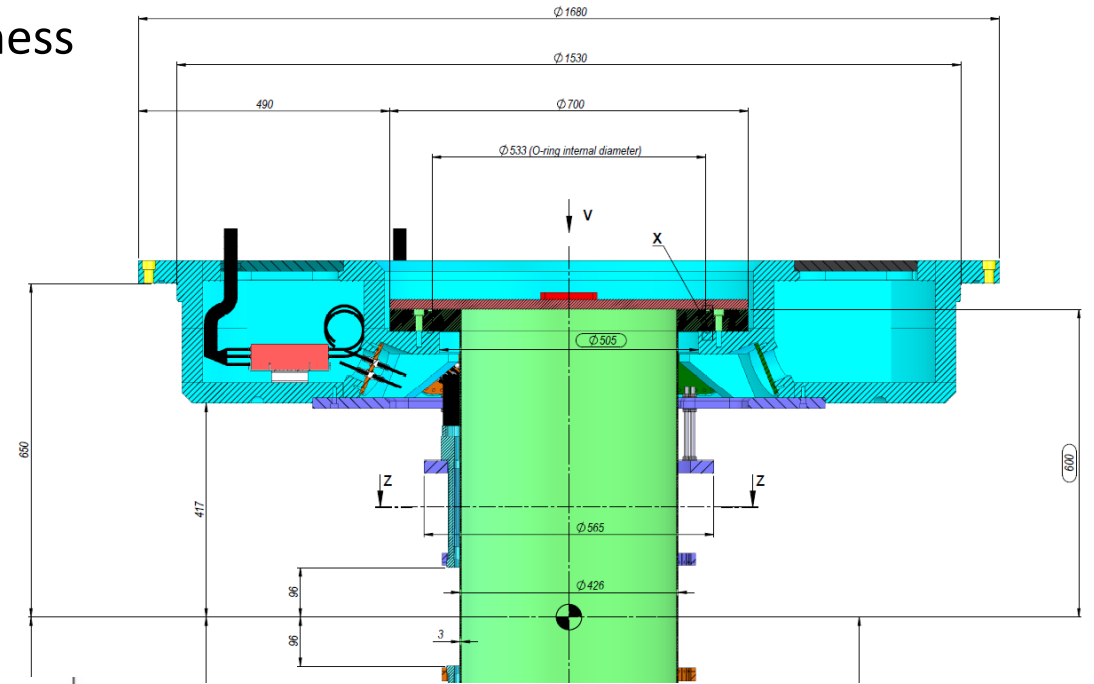
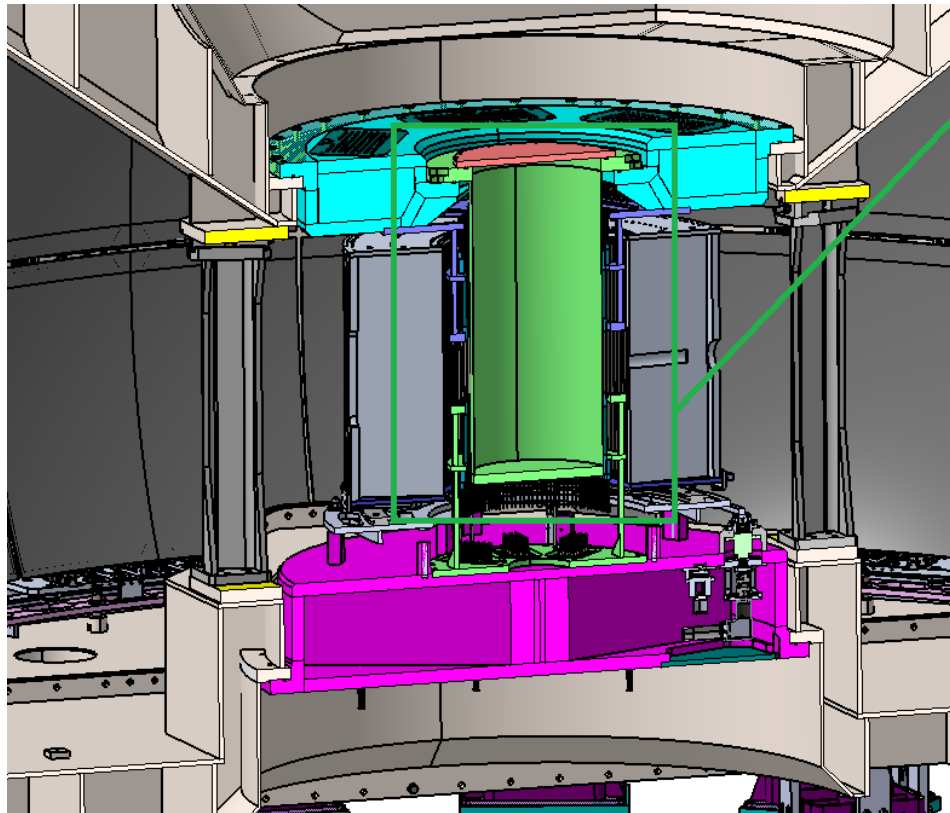
Scattering Vessel: Upgrade polarization analysis

- ✓ Detailed design and interfaces
- ✓ Allowing for future upgrades:
 - Diffraction capabilities
 - Polarization analysis
- ✓ Good timing between both projects
- ✓ Integration of PA components done
- 🚧 Currently: conceptual design



Sample chamber and PA boxes

- ✓ Sample chamber: structural analysis → 3 mm thickness
- ✓ Inner $\varnothing = 420$ mm
- ✓ Making easy maintenance works:
 - ✓ Sample chamber removable
 - ✓ Top lid removable
 - ✓ PAs in air, easily extracted if needed.

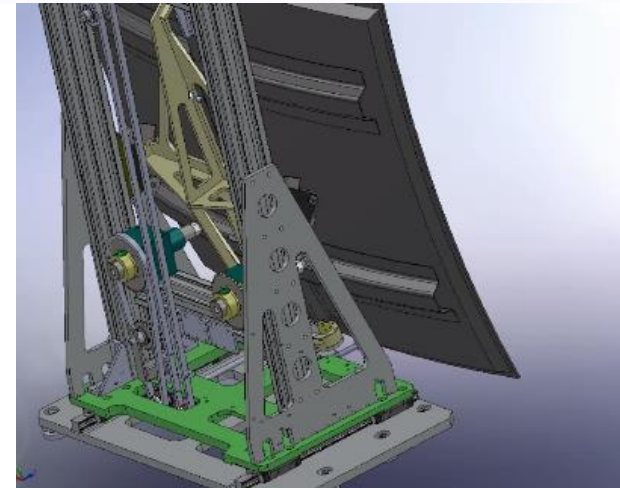
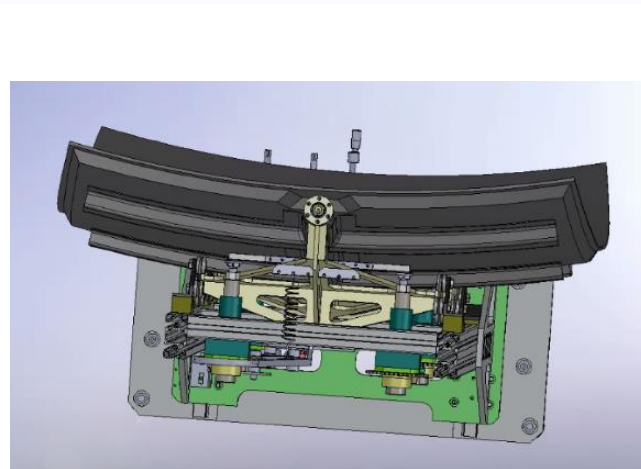
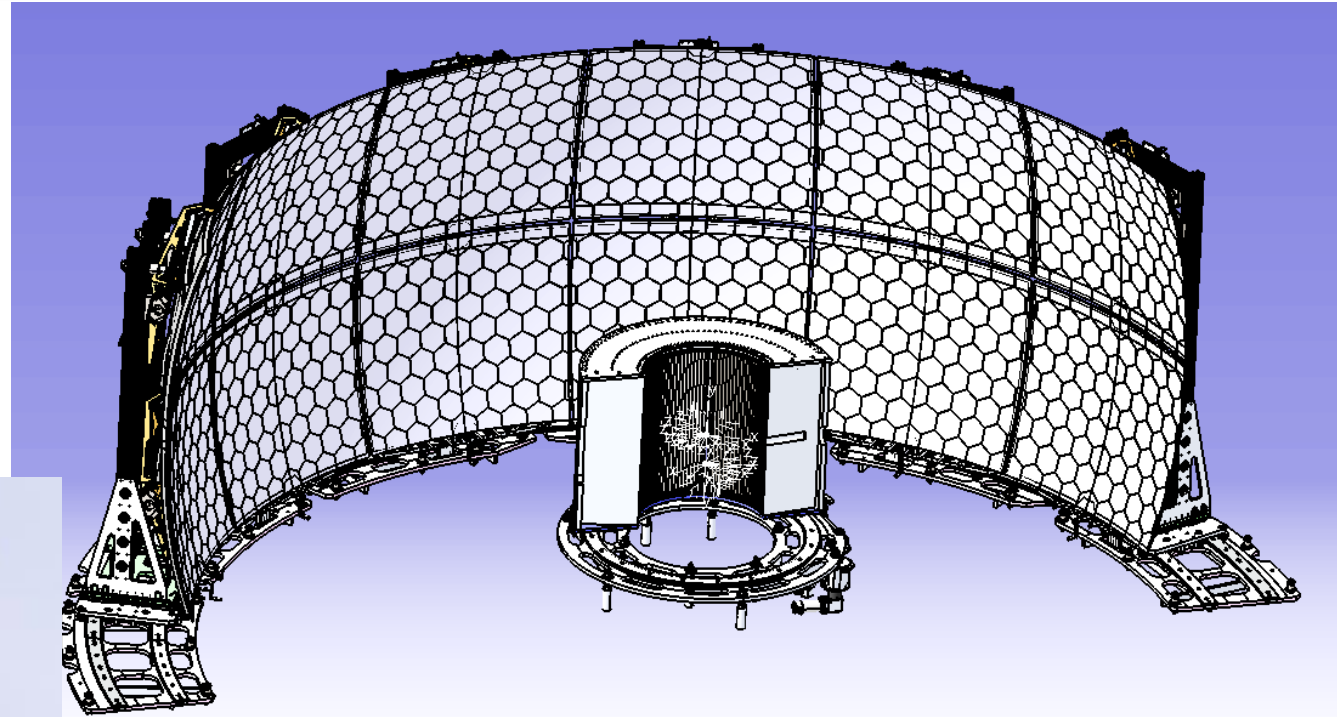


Analyzer: design

- ❖ Horizontal coverage analyzer: $[9.48-165]^\circ$
- ❖ Vertical coverage: $[-22,+22]^\circ$
- ❖ 2 spheres: $R=2500$ mm; $\Delta z=74,2$ mm

- ❖ Si(111) crystals reflecting near backscattering ($\gamma=3,6^\circ$) at neutron energy $E=2.08$ meV ($\lambda=6.27$ Å)

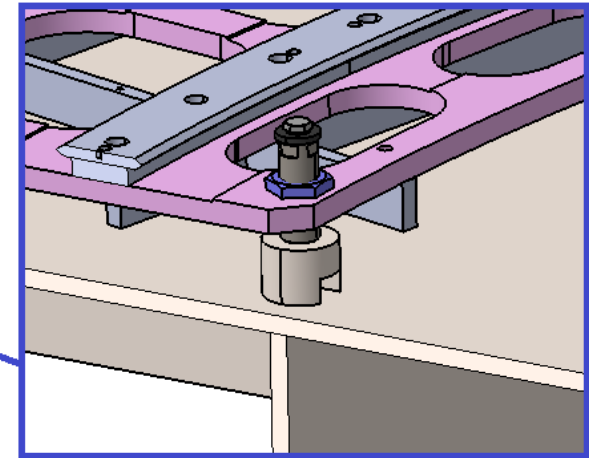
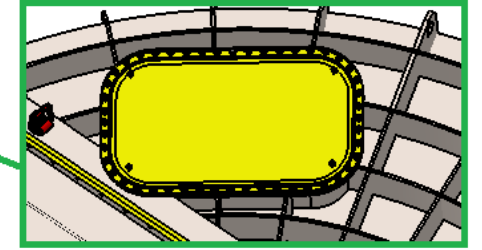
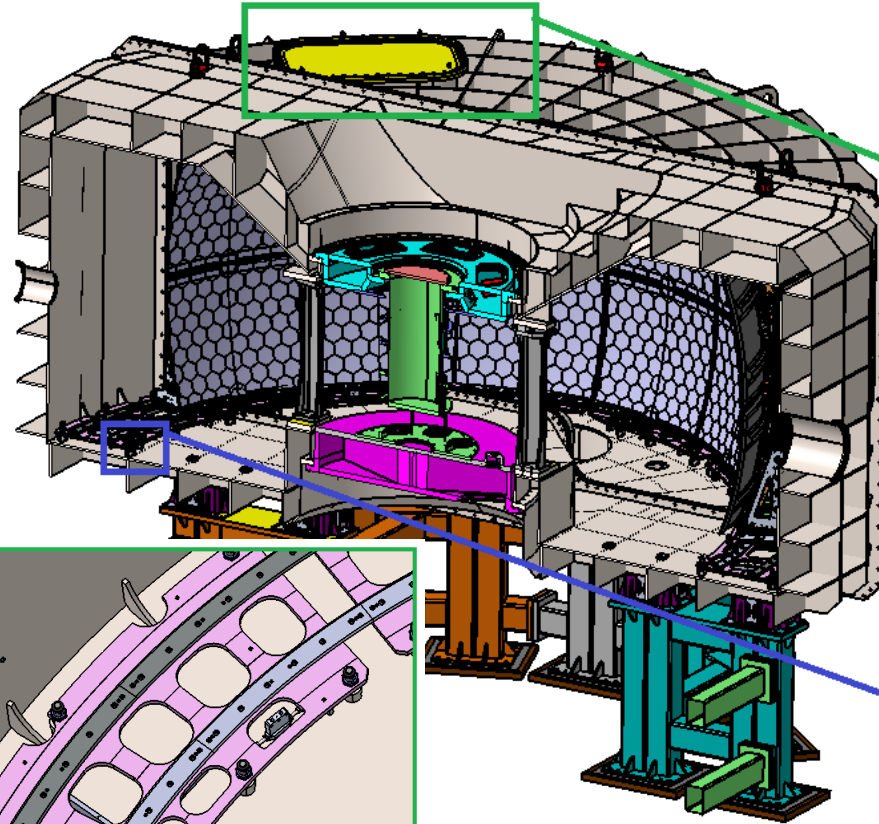
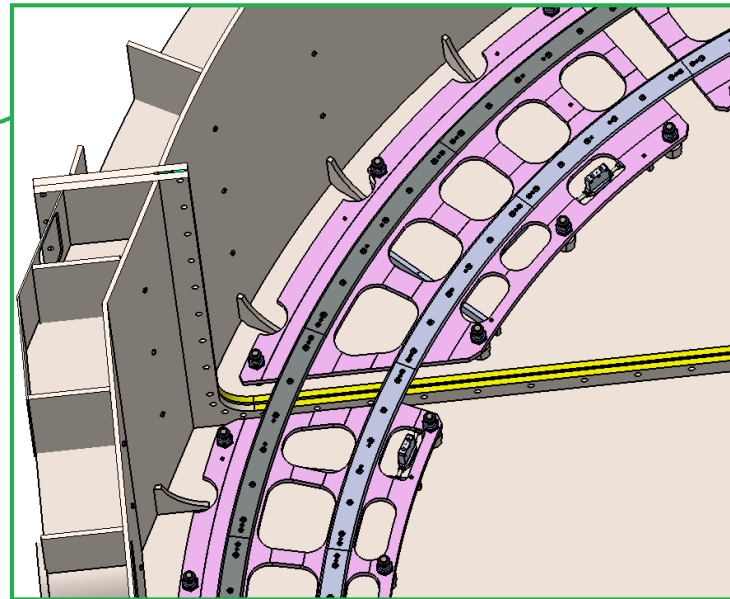
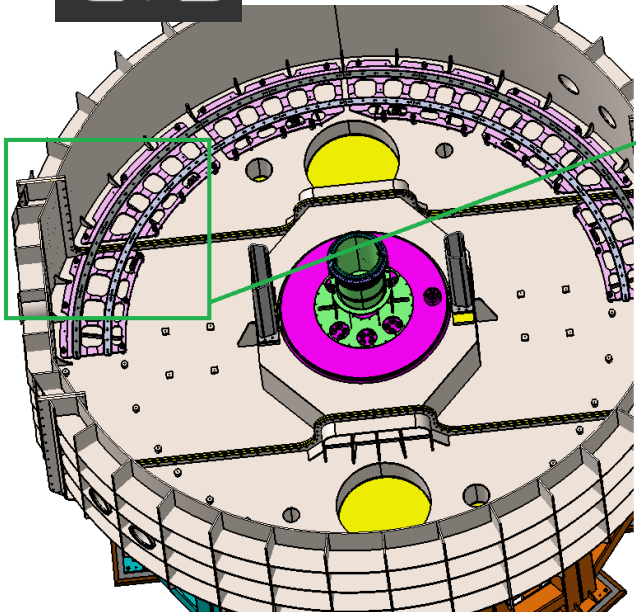
- ❖ Mechanical assembly
 - ❖ 12 panels (6 top + 6 bottom):
 - ❖ Panels: Carbon fiber (CFRP)
 - ❖ Height: 960mm
 - ❖ Width: 1040 mm
 - ❖ Supporting structure: SS



Analyzer: installation

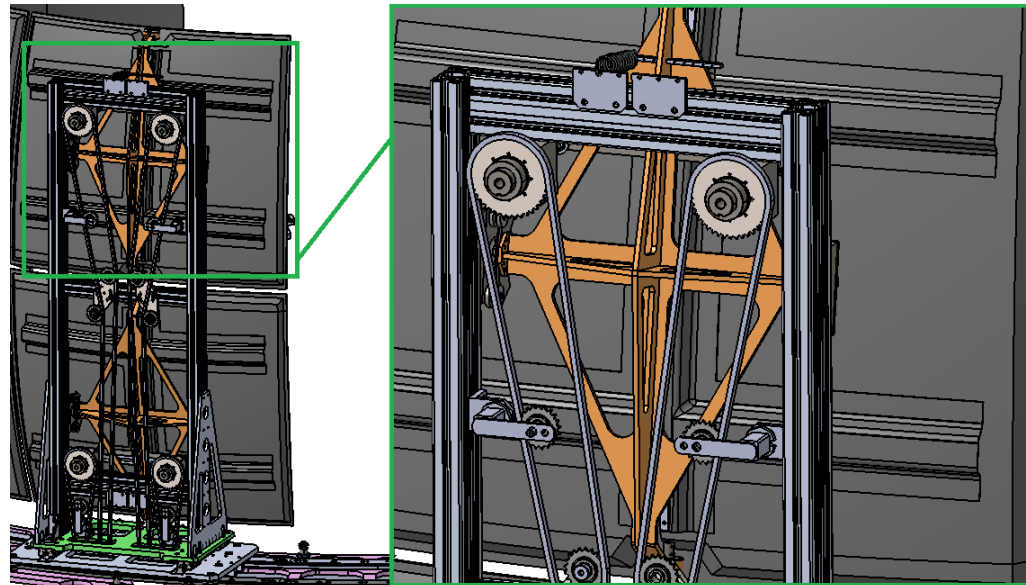
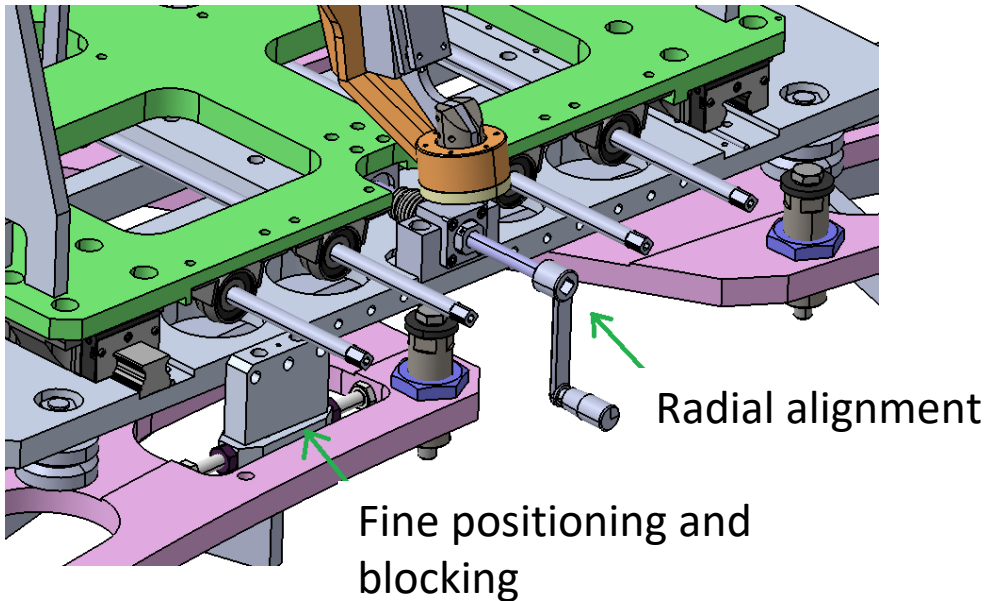
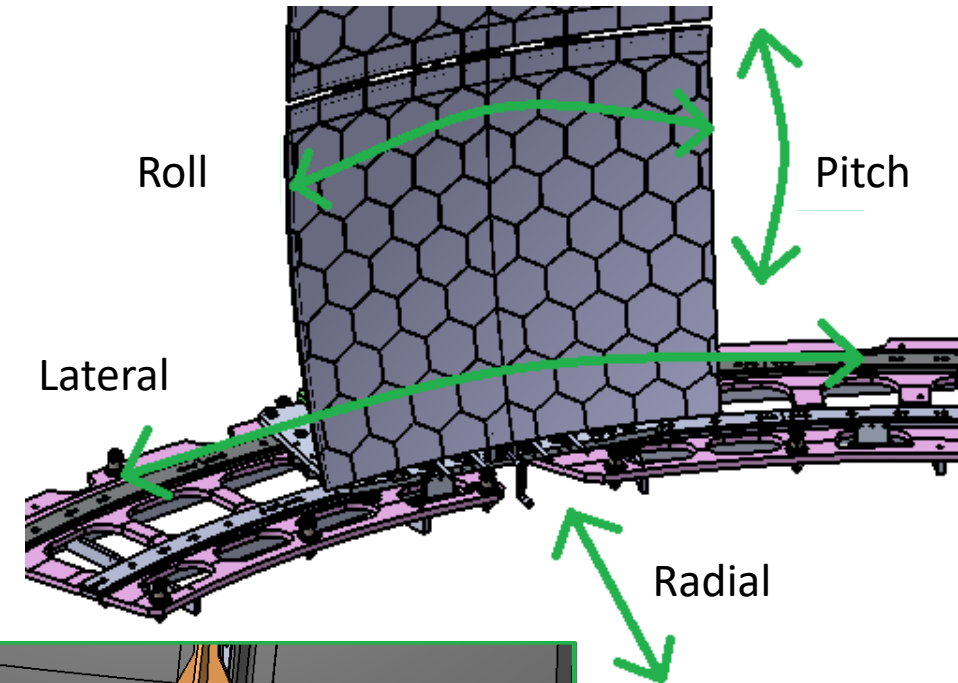
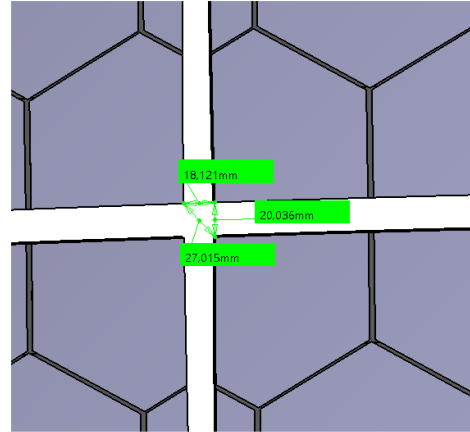
- ❖ Through the vessel hatch
- ❖ Every Support/Column installed one by one (E01 crane)
- ❖ Once settled at the rail, slide using the rails and place to position.
- ❖ Then, alignment

QVS

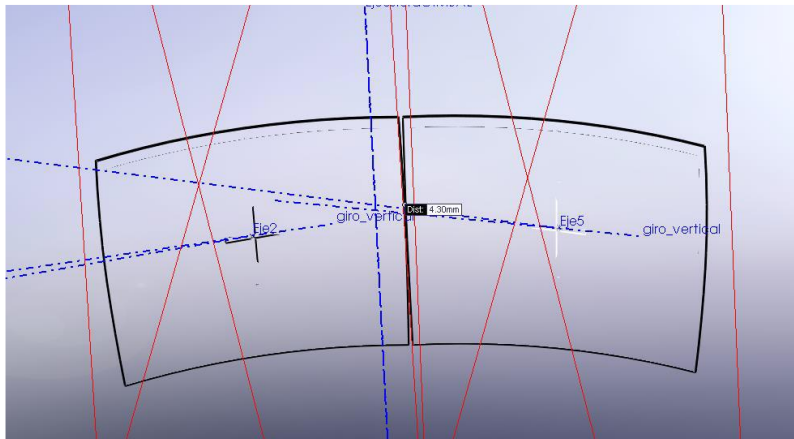
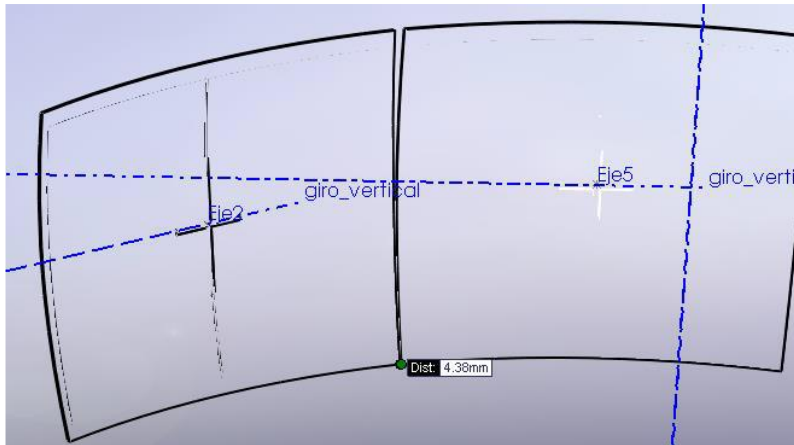
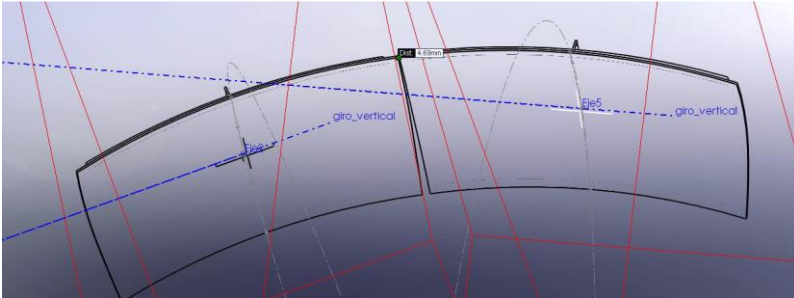


Analyzer: positioning & alignment

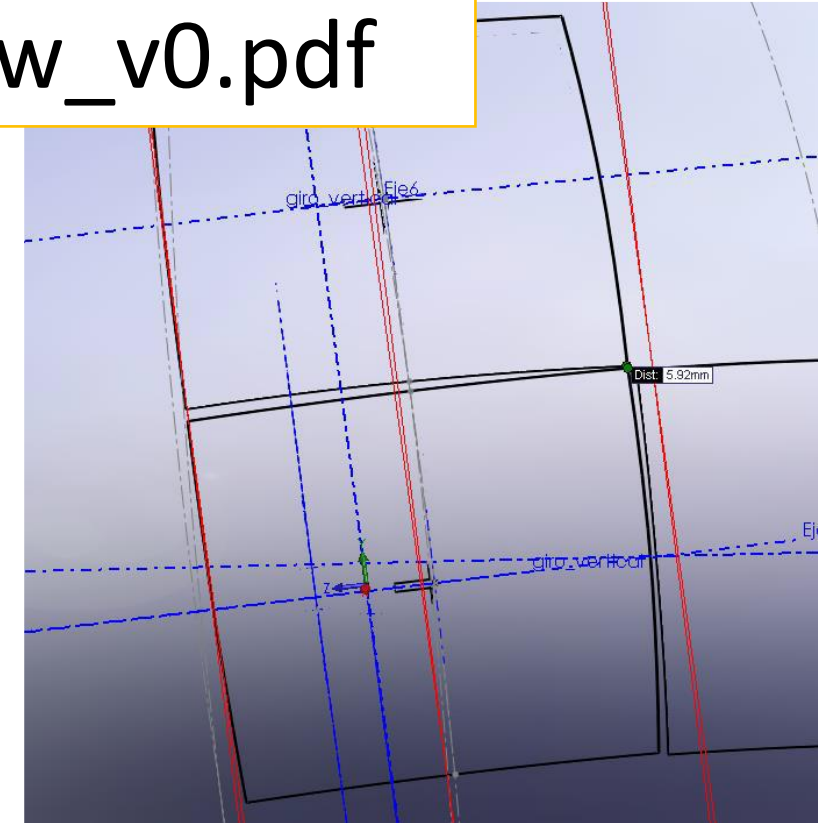
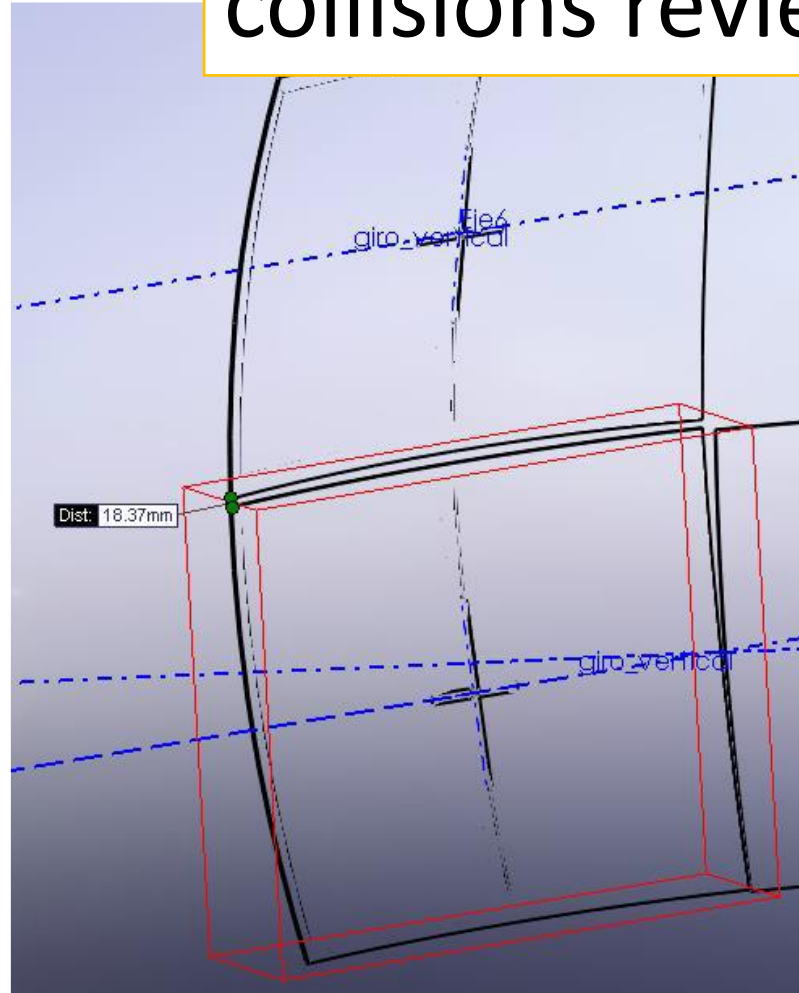
- ❖ Minimizing Gap: 20 mm (minimum gap worst case: 3 mm)
- ❖ [1] Lateral alignment (rail positioning)
- ❖ [2] Radial alignment (range: -5 to +10 mm)
- ❖ [3] Roll ($\pm 3^\circ$)
- ❖ [4] Pitch ($\pm 3^\circ$)



Analyzer: positioning & alignment



20220112_Analyser
collisions review_v0.pdf



Prototype analyzer

- MIRACLES analyzer (optical assembly): Si(111) wafers, 6 in. diameter, cut into hexagons, with $t \sim 700 \mu\text{m}$ (like DNA, IN16B, EMU, Spheres,...)

- ❑ PDR MIRACLES Scattering System: a systematic study is desirable[...] *“If the team plans to test the neutron reflectivity for different wafer thickness this probably needs to be done under realistic conditions and might require a backscattering spectrometer.”*
- ❑ STAP 2021: *“More information would be desirable concerning the analyzer crystal assembly (a prototyping had been suggested a year ago)”*

- Systematic study is under way

❖ Prototypes manufactured in 2022

❖ Measurements scheduled by 2023

- Thickness: 575 - 1250 μm
- Surface: etched vs. as-cut
- Method: CZ vs. FZ

- A collaboration:



From BATS to MIRACLES: Paving the way for European high-resolution neutron spectroscopy

Prof. Dr. Frank Schreiber
Eberhard Karls Universität Tübingen

Abstract:

High-resolution neutron backscattering spectroscopy benefits from substantial technical progress in recent years enabling new types of experiments. These include for instance measurements accessing hierarchically superimposed diffusive motions on the nanosecond time and nanometer length scale in a wide range of complex materials and fluids. Accordingly, the demand for beam time is very high. This project aims to add new capabilities and strengthen the European landscape of neutron backscattering spectroscopy by (1) ensuring reliable chopper operation of the BATS option on IN16B at the ILL given the high radiation loads and (2) by extending backscattering analyzer techniques at low scattering angles. These new capabilities will be established with demonstration experiments on IN16B at the ILL and will enable backscattering spectroscopy in the most reliable user operation and in the widest possible range in energy and momentum transfer. Work package (2) will moreover enhance the synergy with the MIRACLES team at the ESS.

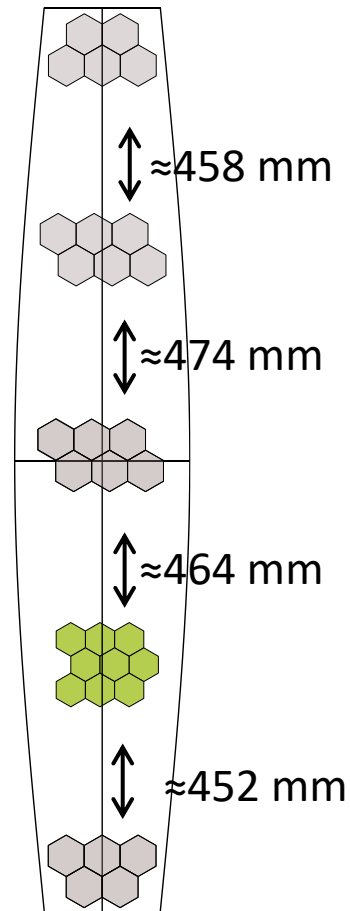
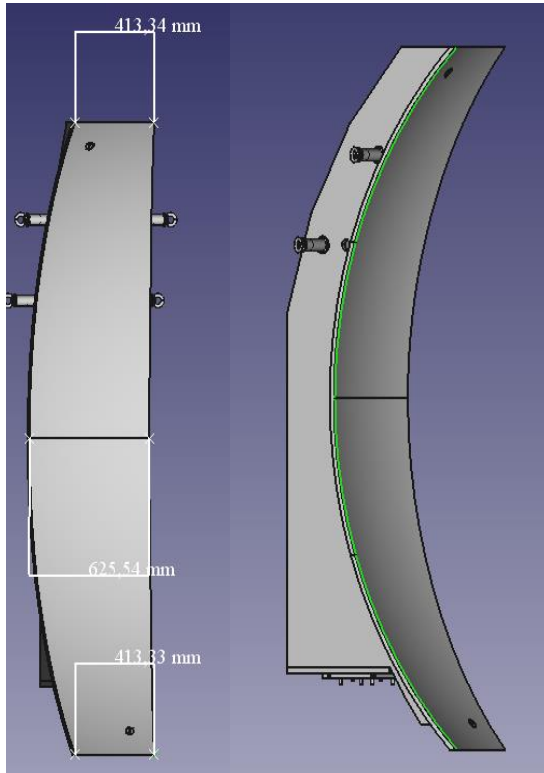


After purchasing the support structure and the silicon wafer material, the collaboration between IN16B and MIRACLES will continue with the process of crystal preparation, coating their back side with a neutron absorbing layer and gluing to the panels. Careful choice of the crystal parameters, coatings and assembly of the structure are vital parameters in achieving the desired energy resolution with optimum flux and minimal background. Realisation of this task will coincide with the preparation of prototype analyser panels for MIRACLES by ESS Bilbao. By participating in the subsequent commissioning phase, the MIRACLES team will get the opportunity to test their prototypes under real operating conditions in the IN16B spectrometer. This will help to prove the suitability of the chosen MIRACLES analyser design and contribute to the optimum performance of the future spectrometer at ESS.

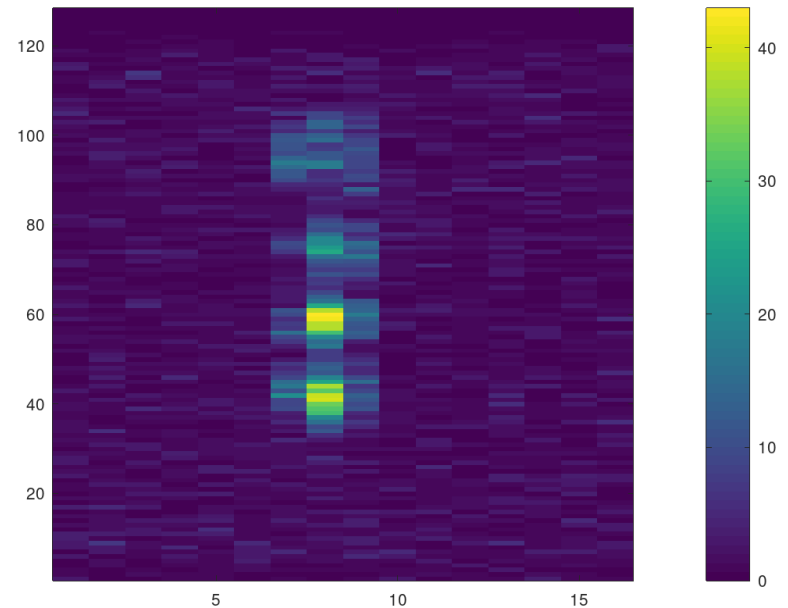
Prototype analyzer

- Collaboration: IN16B (ILL) – AVS – ESS-Bilbao
- AVS & ESS-Bilbao designs panel prototypes (with input from IN16B)
- AVS manufactures
- Measurements at IN16B (ILL)

- Environment, supports (gonio), etc...
- Minimum number of crystals (area) to get visible signal → $\sim 30 \times 30 \text{ cm}^2$
- Minimum distance between batches to distinguish adjacent signals → $\sim 50 \text{ cm}$

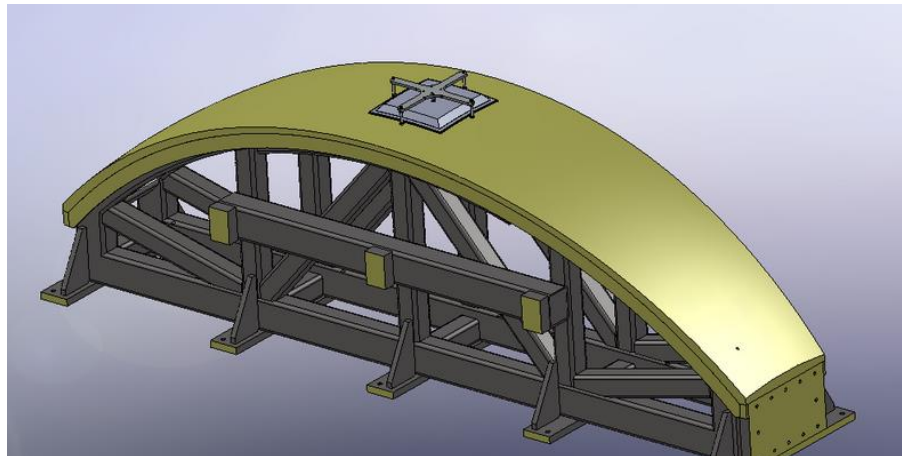
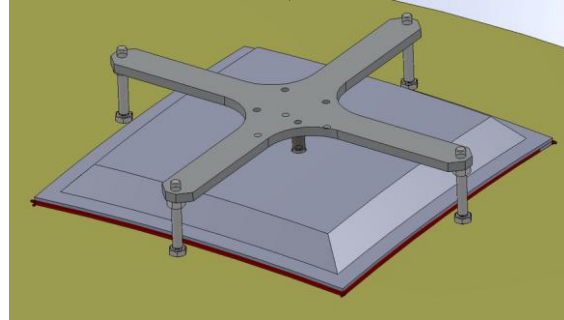


itor 0.237906 (0.24+-0.24 cps)#0.240187 (0.239522 sec) PSD 0.236888 (0.24+-0.24 cps) monitor 0.239345 (0.24+-0.23 cps)#0.239223 (0.240051 sec) PSD 0.2

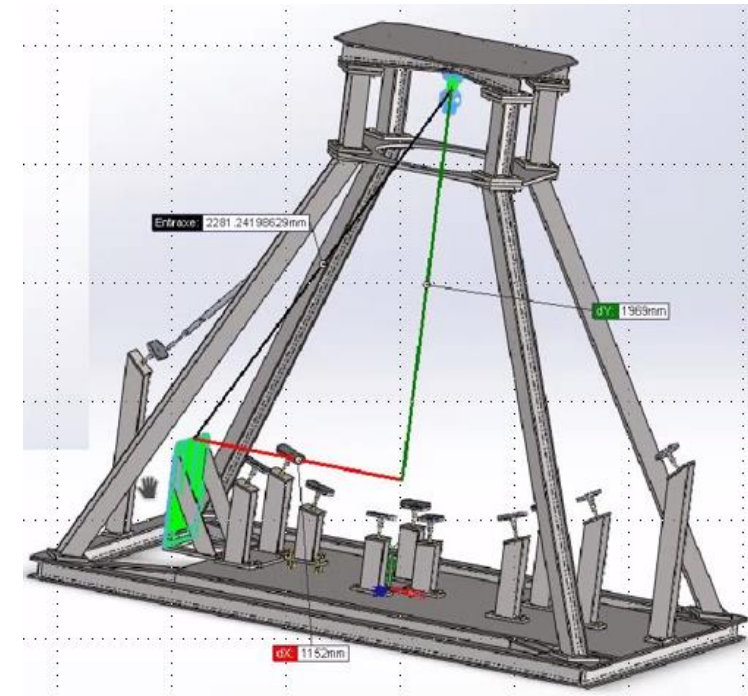


Prototype analyzer

Prototype options

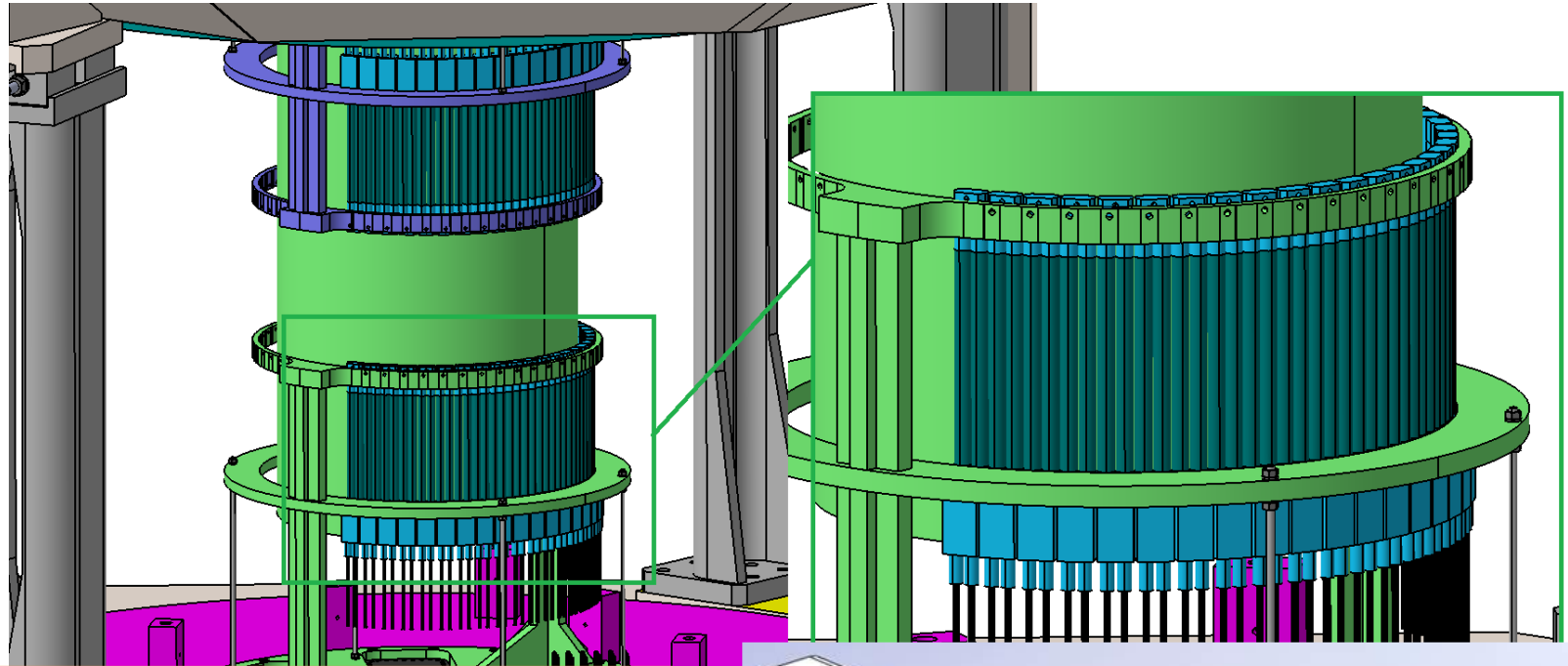


Materials and equipment



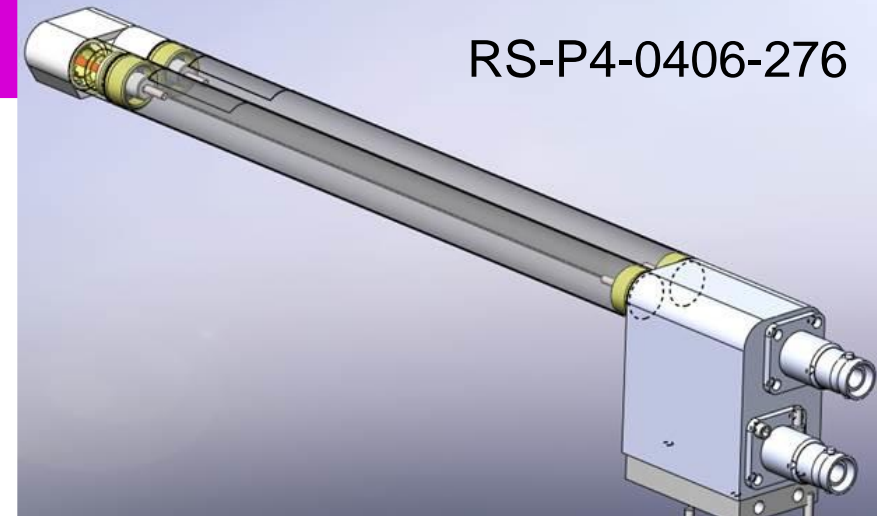
Detectors

- ❖ Horizontal coverage: $[9.48-165]^{\circ}$
- ❖ $R=230$ mm;
- ❖ 96 detector tubes
 - ❖ (48 top + 48 bottom)
 - ❖ Active length $\Delta z=150$ mm
 - ❖ Diameter $d=12.7$ mm
 - ❖ $P=8$ atm



❑ PDR MIRACLES Scattering System: The team is recommended to reduce the dead space, by enquiring if a compact U-coupling can be manufactured.

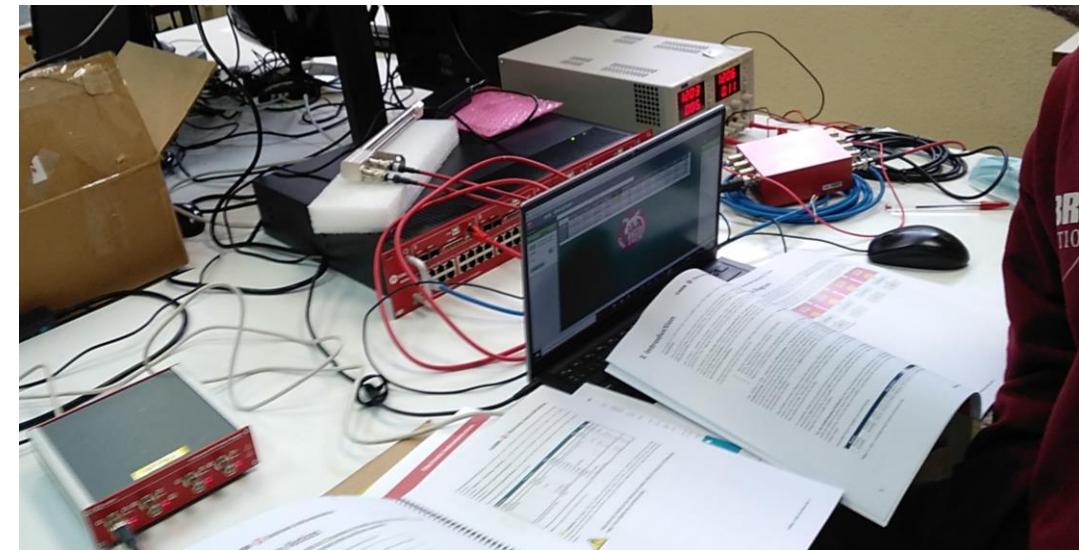
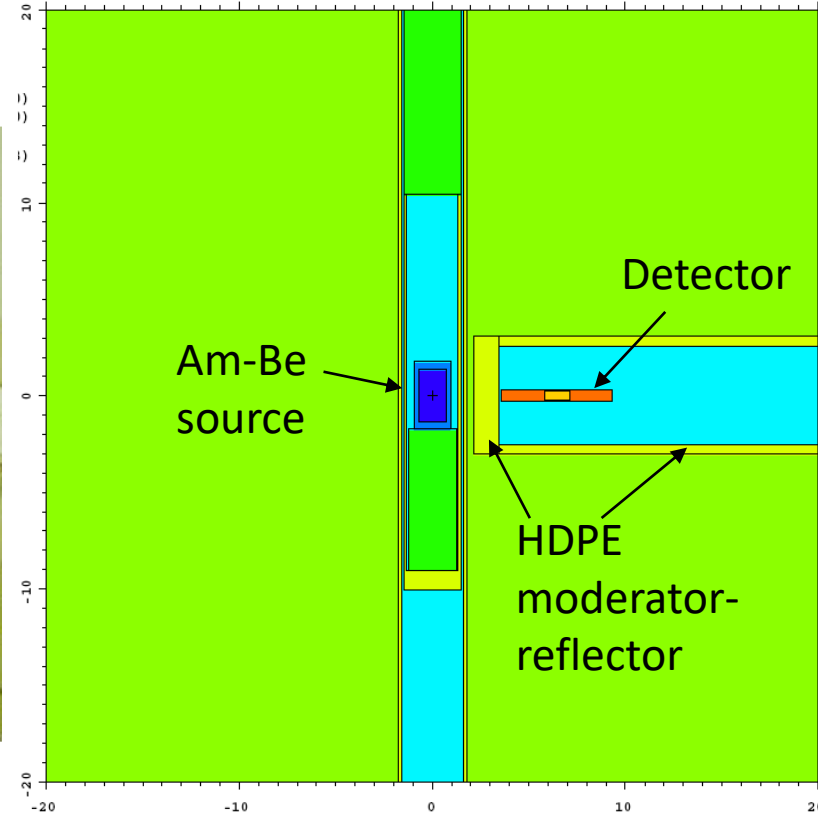
- ❖ A prototype to test U-connection is proposed (RS), minimizing gap between tubes: $\sim 0,5$ mm



Detectors: tests

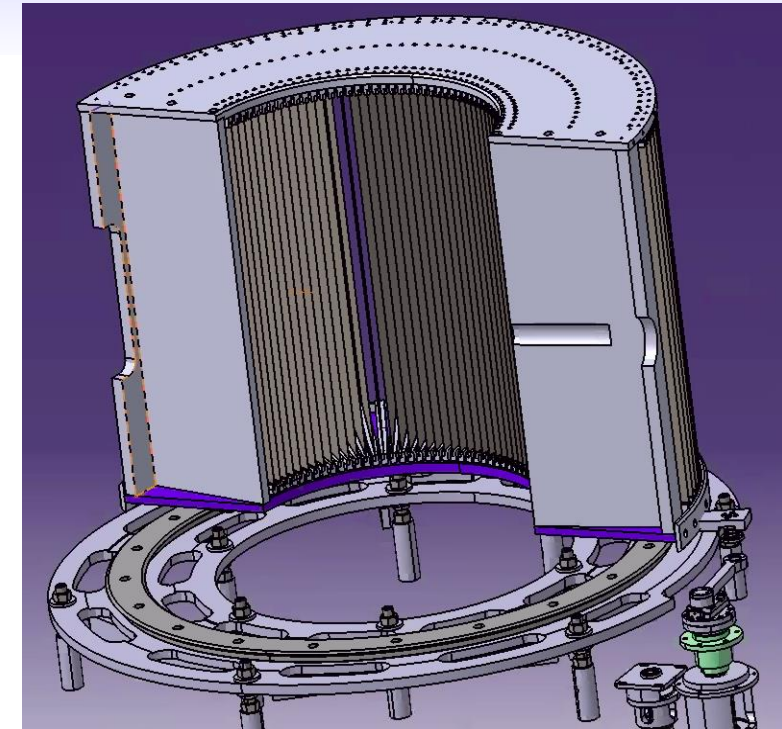
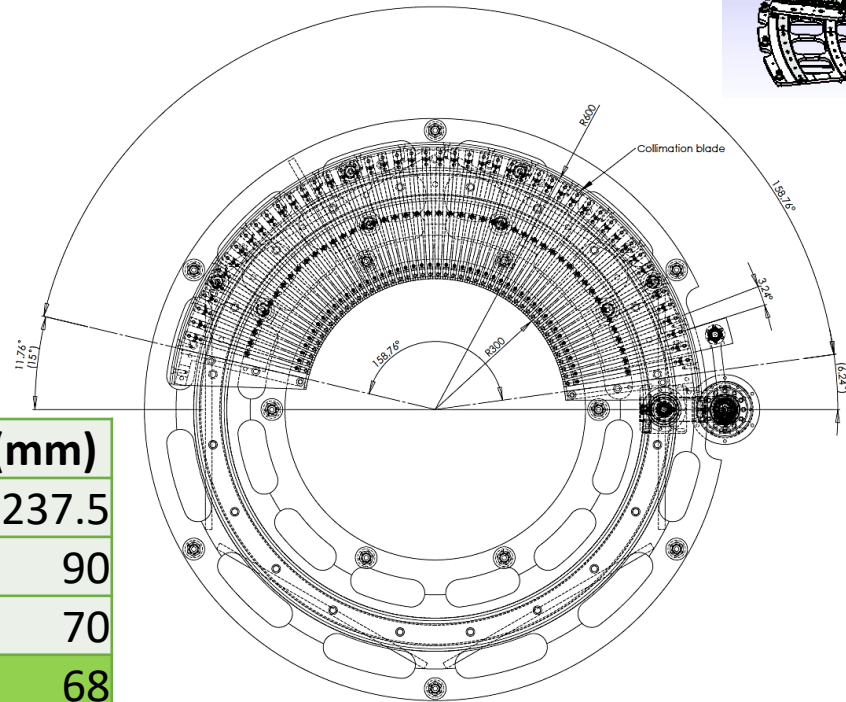
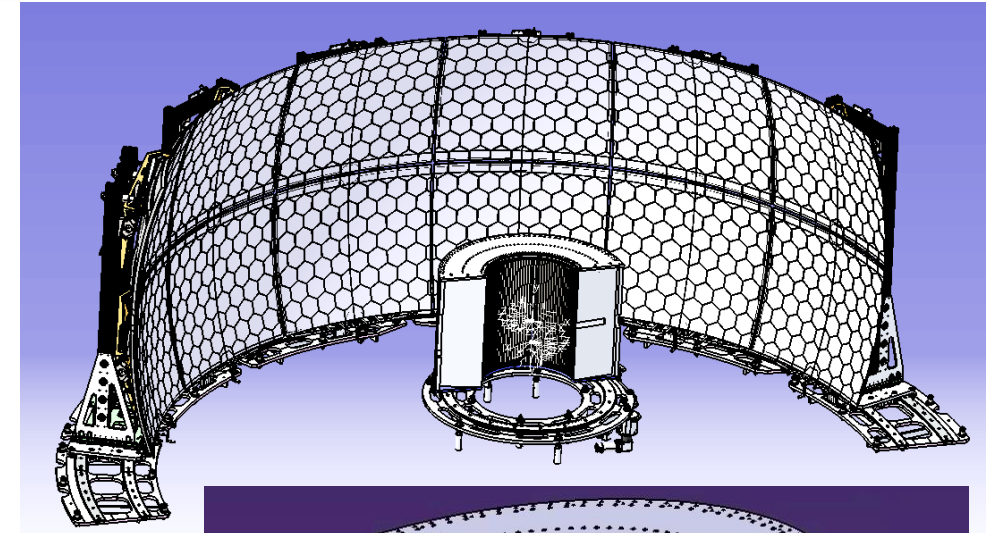


- ✓ Communication tests: OK
- Neutrons w/ Am-Be source at the UPM
- First tests at the UPM: 9-13 May 2022
- 2nd test (PSD): June 2022



Radial collimator: design

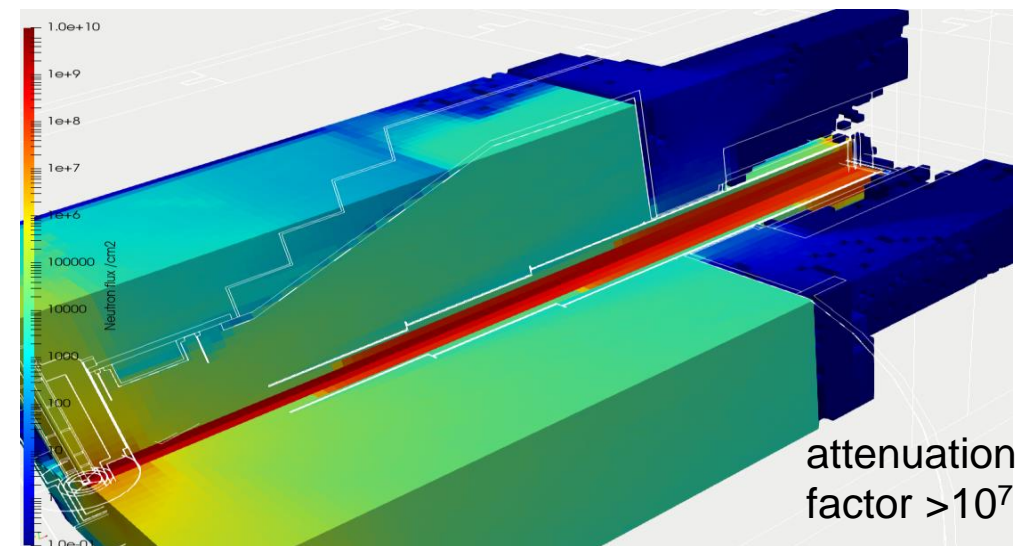
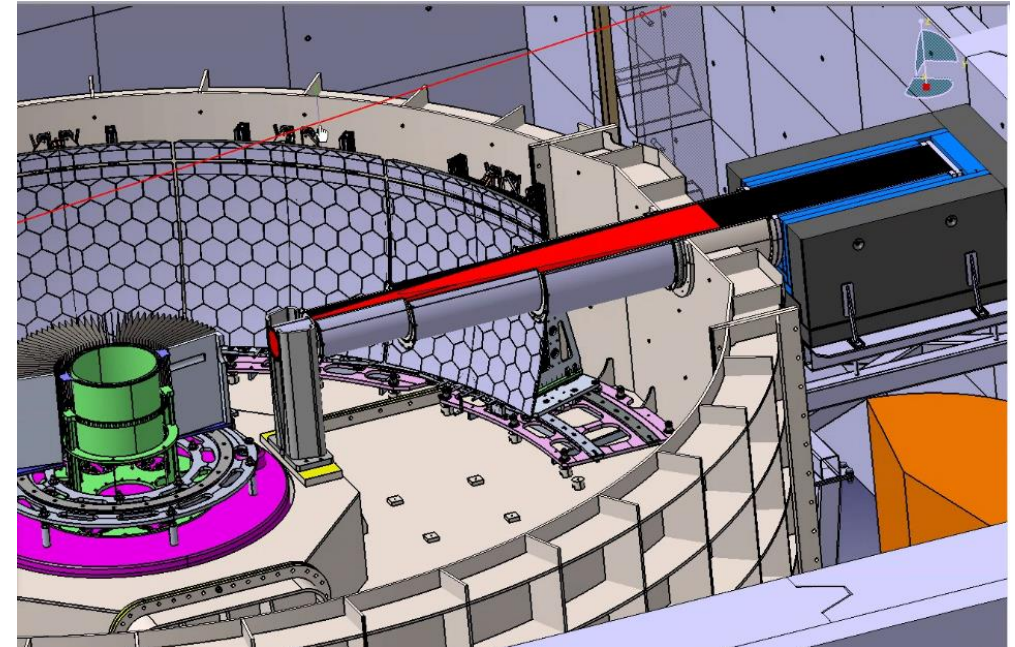
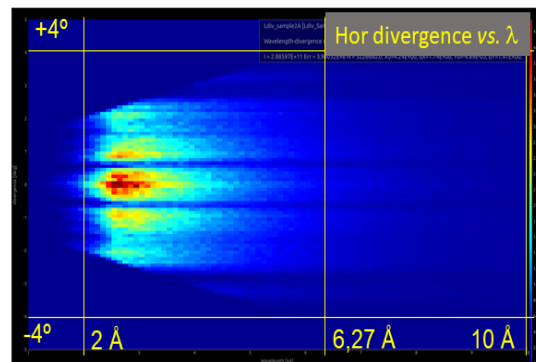
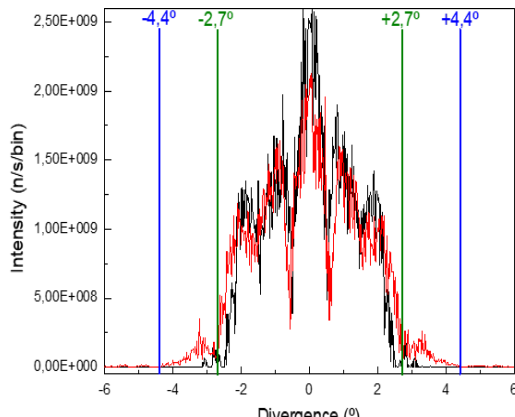
- ❖ Horizontal coverage analyzer: $[9.48-165]^\circ + 3.24^\circ$
- ❖ Slit size: 3.24°
- ❖ Vertical coverage: $[-22,+22]^\circ$
- ❖ Width of a lamella: $25 \mu\text{m Gd}_2\text{O}_3 + 100 \mu\text{m carbon fiber} + 25 \mu\text{m Gd}_2\text{O}_3$, rugosity: $\sim 0,8 \mu\text{m}$
- ❖ Mechanical assembly:
 - ❖ Frame & structure: Al
- ❖ Motion:
 - ❖ Crank-shaft mechanism
 - ❖ Frequency: 0.1 Hz



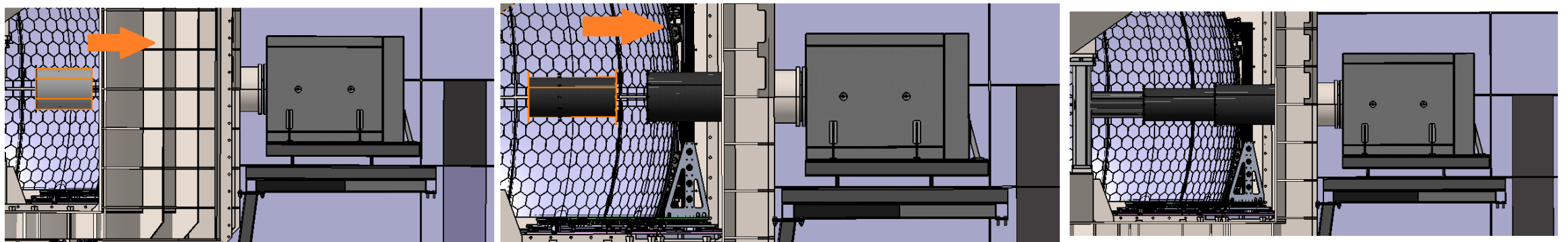
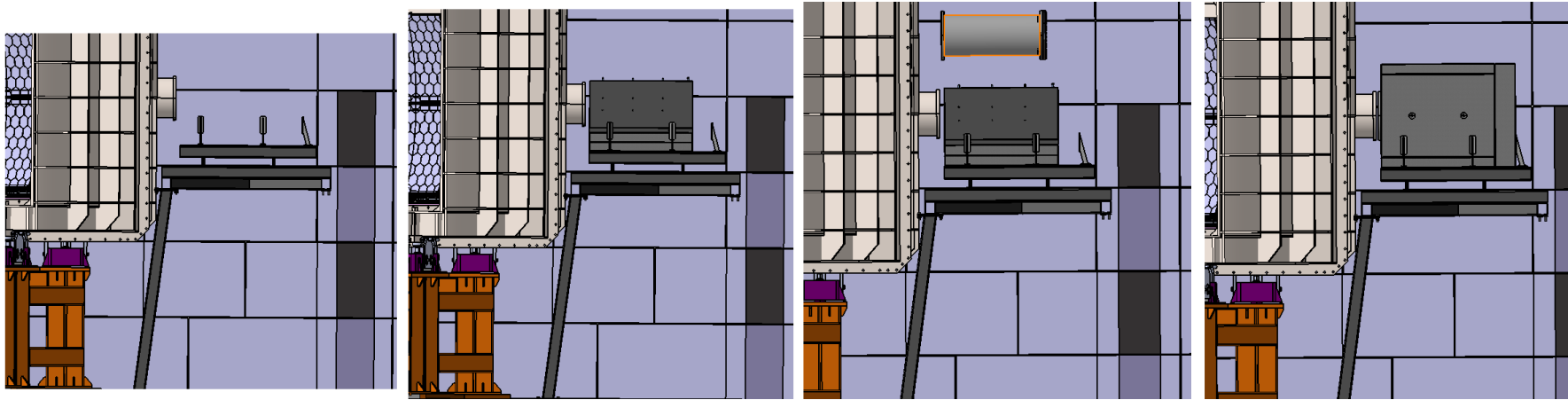
r_m (mm)	R_M (mm)	T	Sample bore (mm)
300	350	0.94	237.5
300	482	0.83	90
300	582	0.79	70
300	599	0.78	68
300	689	0.75	60

Get-lost tube / beam stop assembly

- ❖ Beam divergence is $\pm 2.7^\circ$, minimal tails up to $\pm 4.4^\circ$.
- ❖ Aperture: $\pm 4.4^\circ$ / Tapered shape $\pm 2.7^\circ$.
- ❖ Cold neutrons $\lambda > 2 \text{ \AA}$.
- ❖ Get-lost tube
 - ❖ B_4C 5 mm thickness, 20 % of ^{10}B , 80 % of ^{11}B
 - ❖ Lead foil wrap (0.5 mm thick)
- ❖ Beam stop
 - ❖ B_4C 50 mm thickness
 - ❖ Fe 200 mm thick
 - ❖ Concrete 300 mm thick

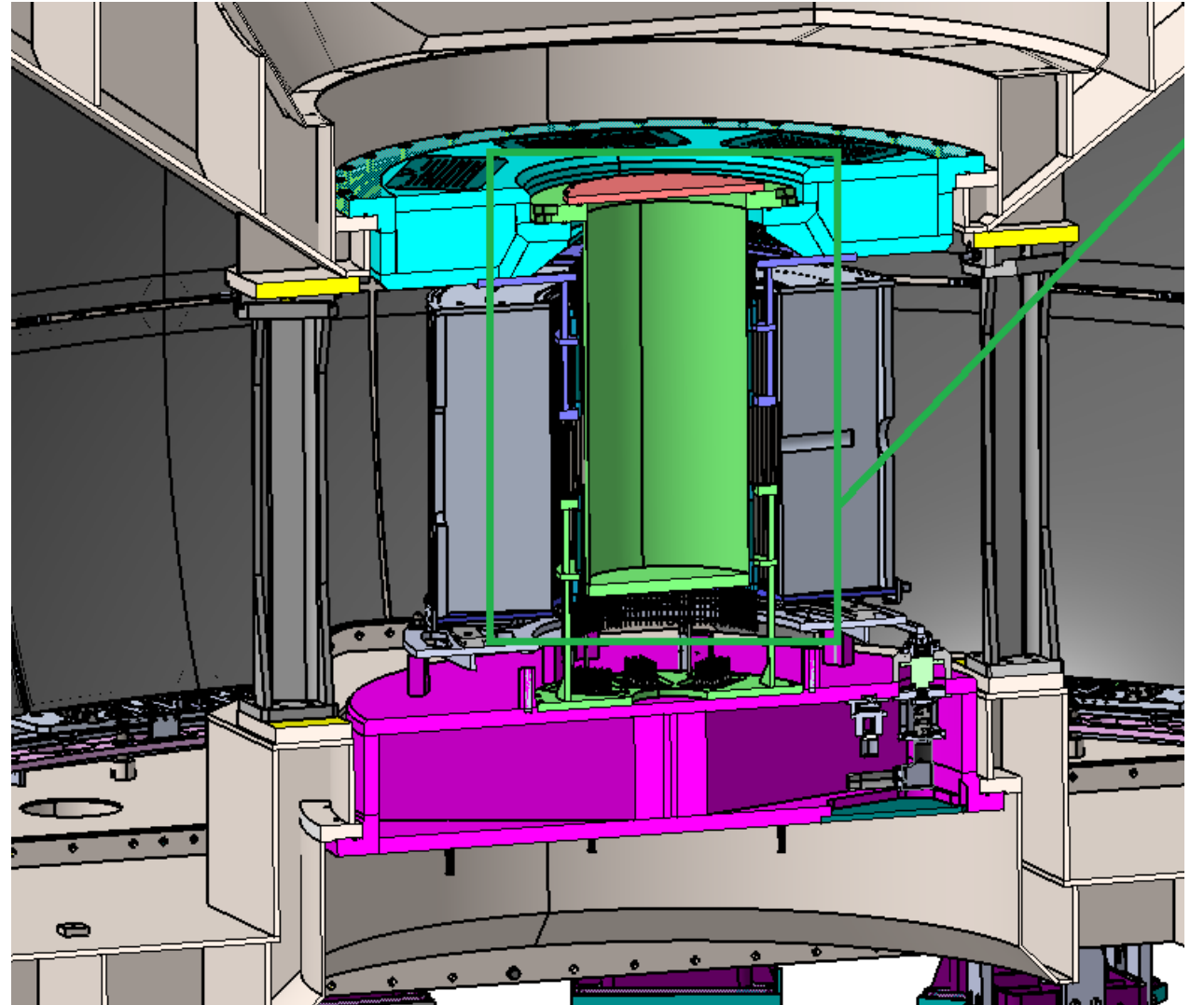


Installation sequence

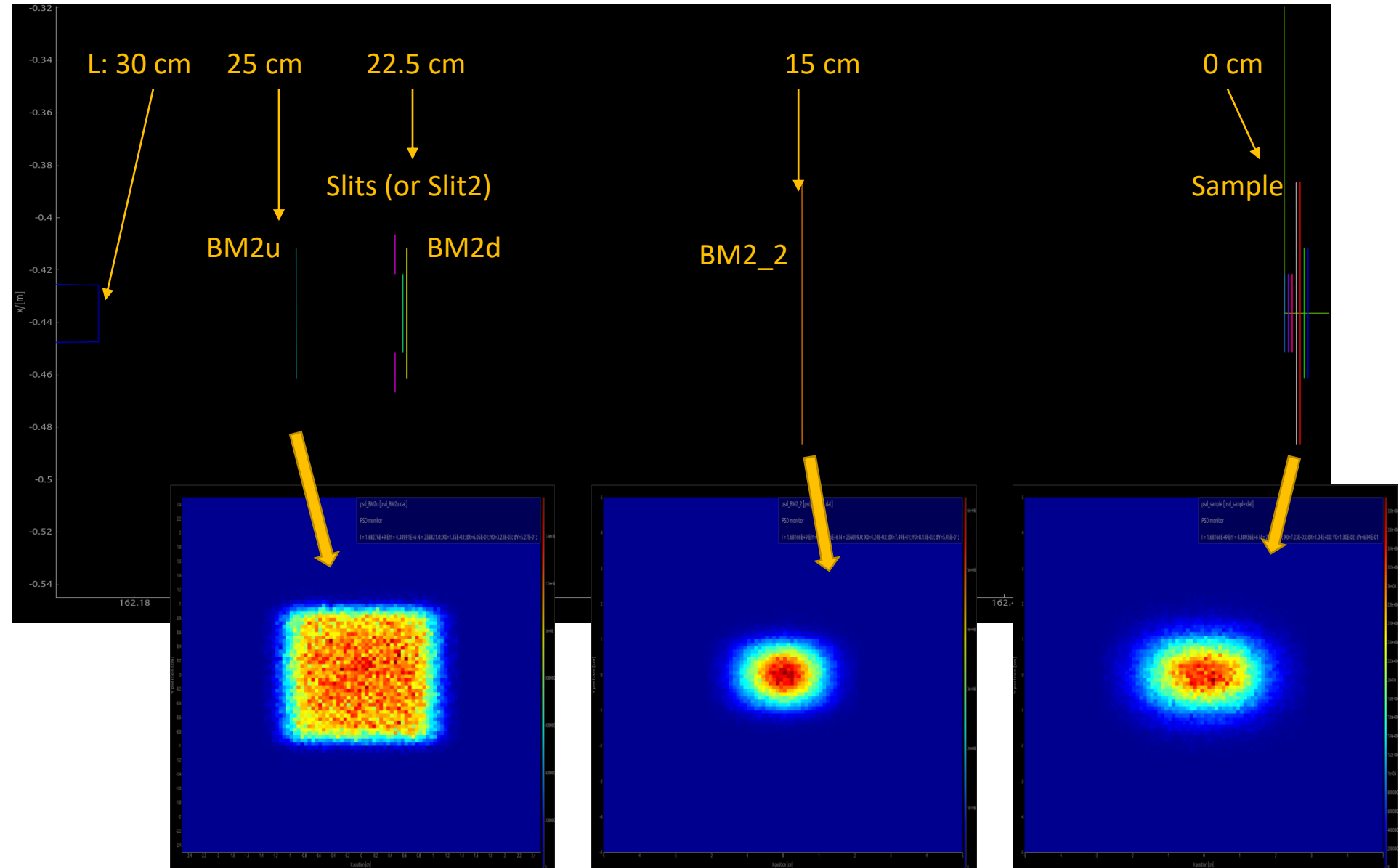


Slits

- MIRACLES planned to have motorized slits (to be controlled remotely).
- A first idea was to place the slits between guide and sample chamber.
- However, divergence distribution is high, and thus slits at this position might not be efficient to reduce beam size at the sample.
- Moreover, access to the slit is not easy at this position.
- Putting the slits inside the sample chamber will mostly solve both issues (mainly access).
- OF course, the dimensions of the slits should be reduced inside the sample chamber, and a new concept should be considered.

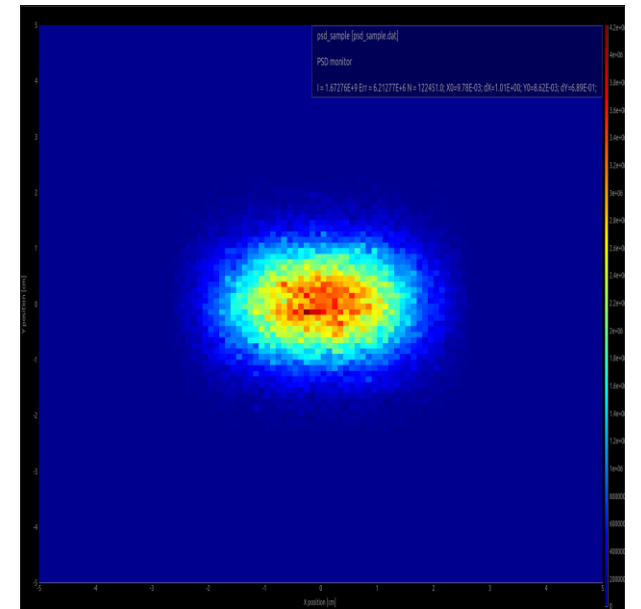
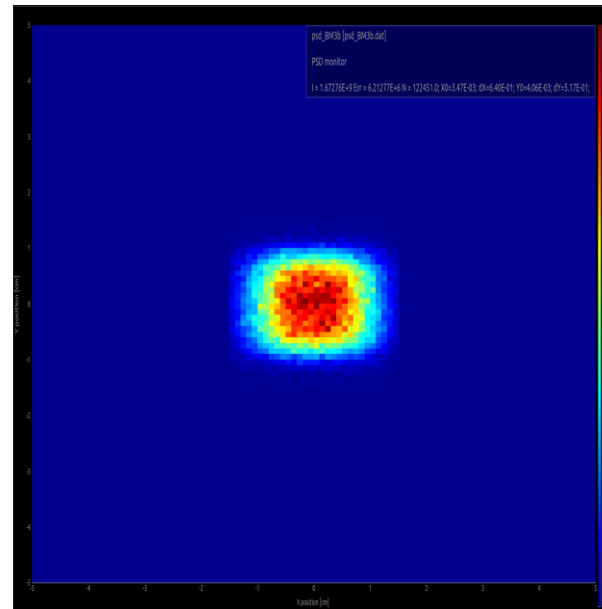
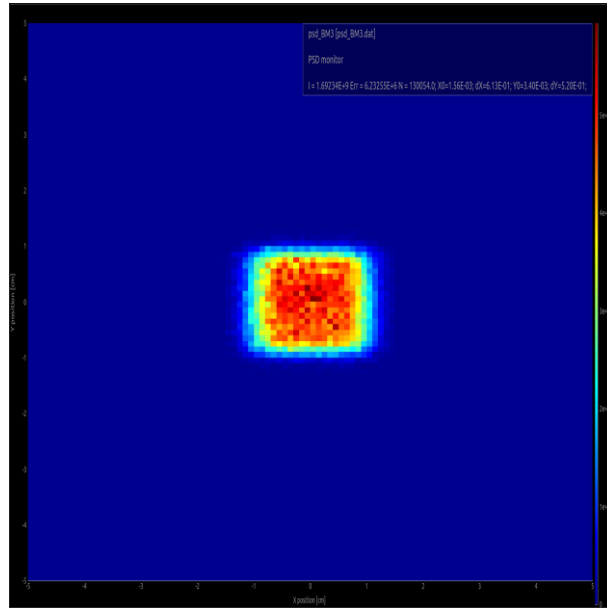


Slits calculations

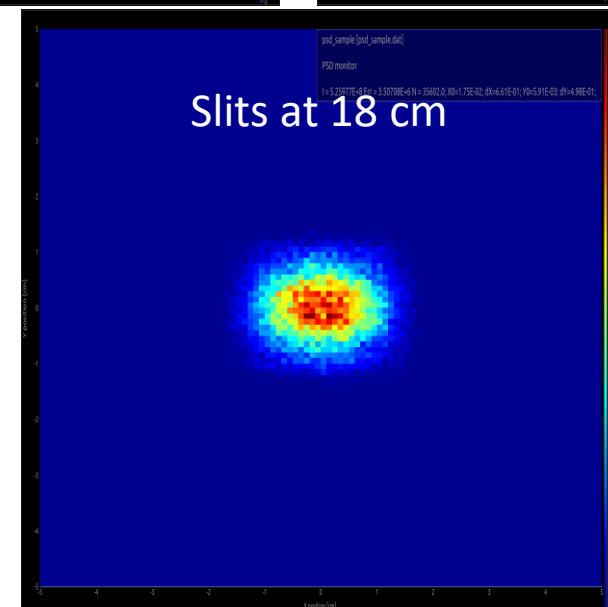
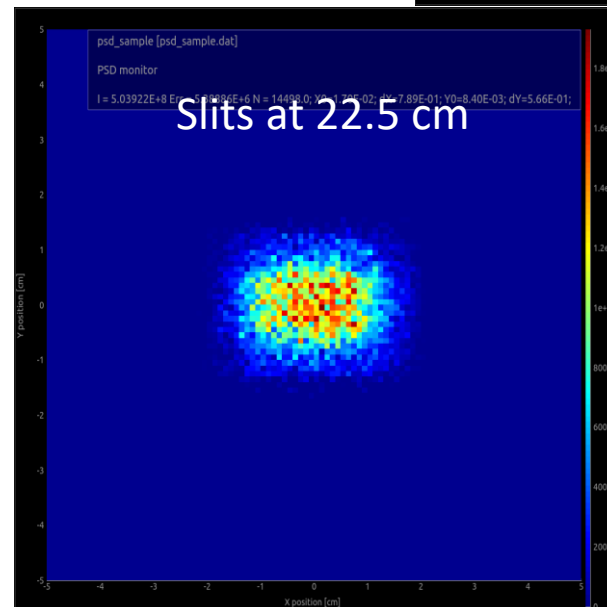


Slits calculations

Slits 3x3 cm²



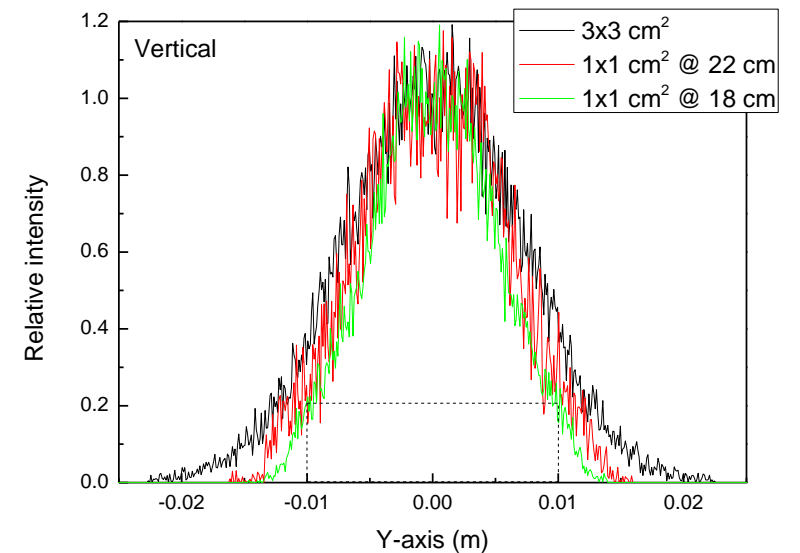
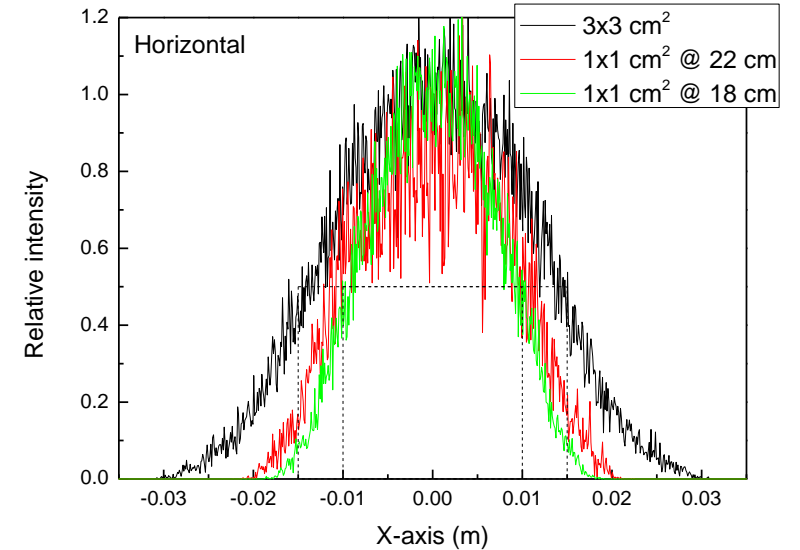
Slits 1x1 cm²



Slits calculations

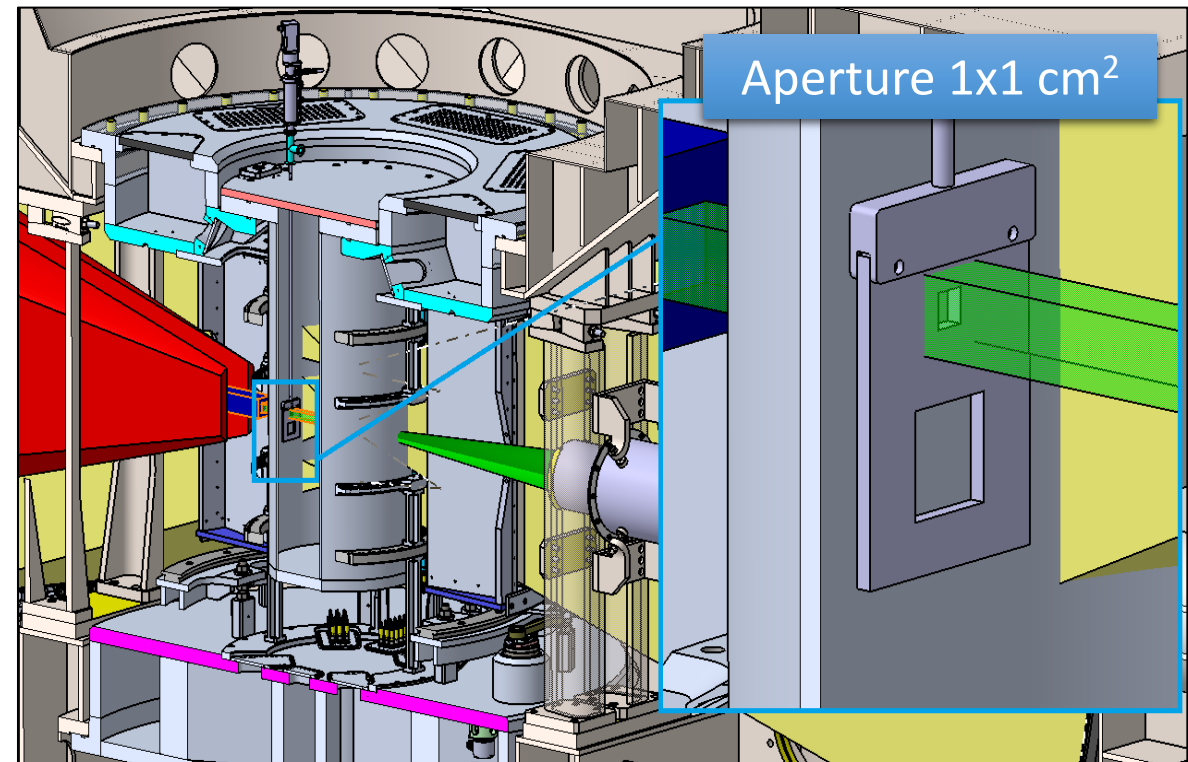
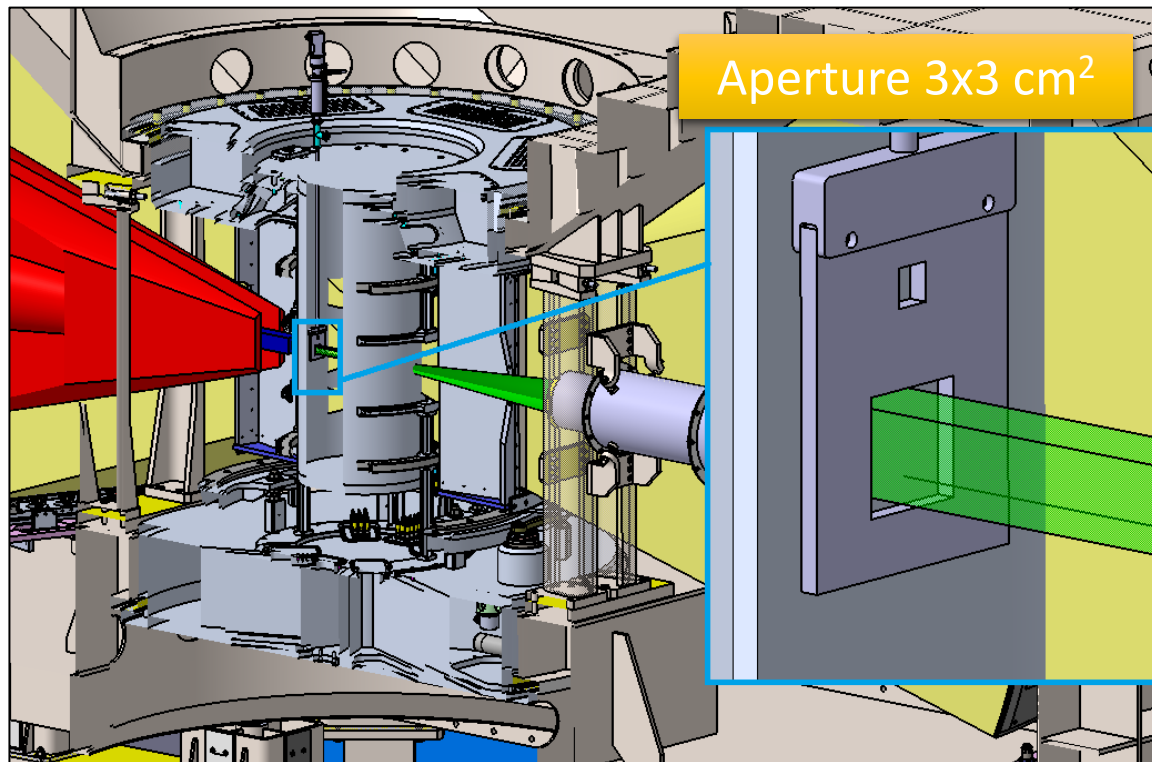
- Slits at 18 cm (inside the sample chamber) have a superior reduction effect in the beam size, with respect to the one located at 22.5 cm (inside the scattering vessel, between guide and sample chamber).
- However, for slits inside the sample chamber we need to go to a different design concept.

		Horizontal (FWHM)	Vertical (FWHM)	Horizontal (>10%)	Vertical (>10%)
3x3 cm ²	1st option	2,66 cm	1,66 cm	~4,2 cm	~3 cm
1x1 cm ²	22.5 cm	2,14 cm	1,44 cm	~3 cm	~2,5 cm
	18 cm	1,73 cm	1,24 cm	~2,7 cm	~2,2 cm



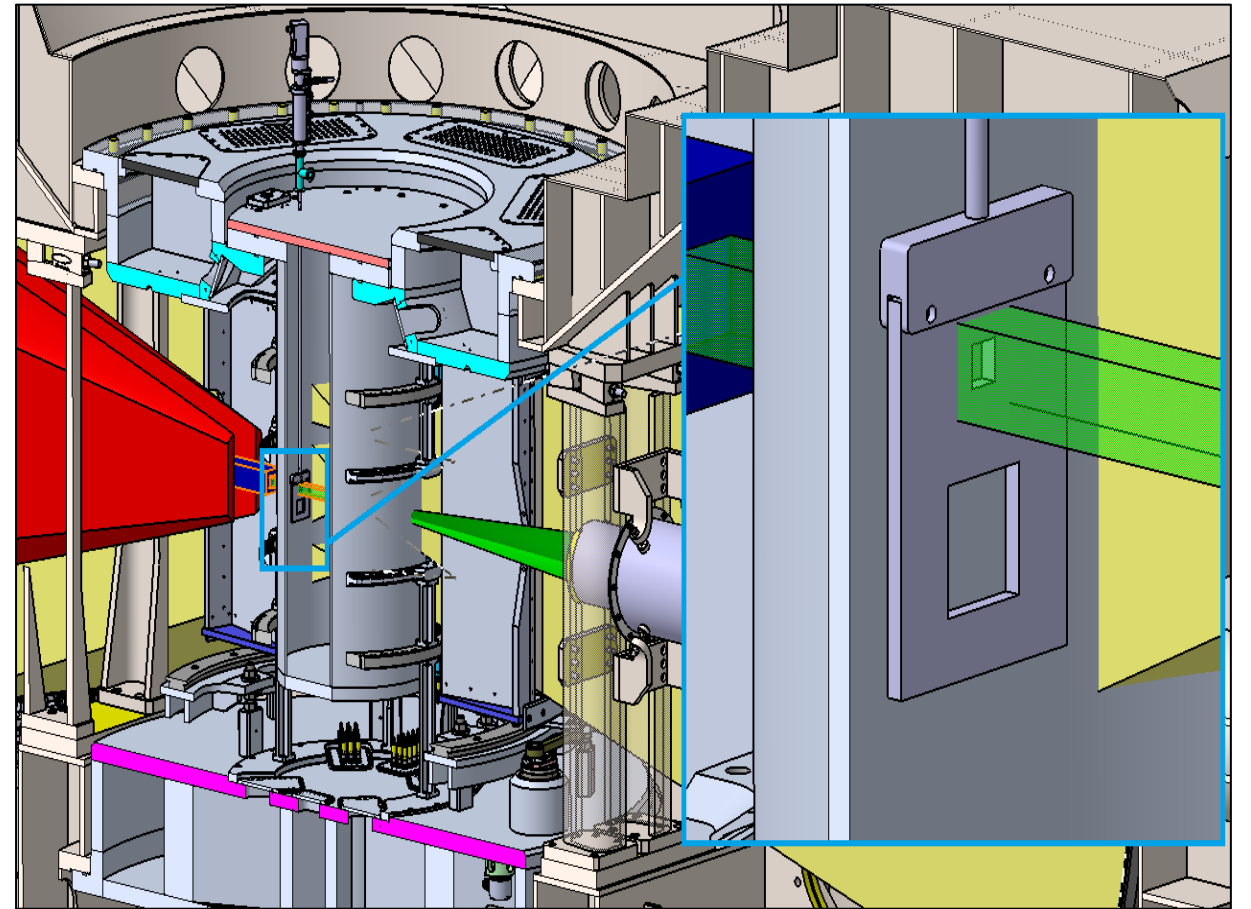
Slits design inside the sample chamber

- Slits at 18 cm will consist in a 2-aperture mask, controlled by a z-step motor, with 2 positions for the 3x3 aperture and the 1x1 aperture (a third position is envisioned that retracts the slit to allow full beam).
- ✓ Space requirements checked with the sample environment equipment that MIRACLES will use
- ✓ We only need a vacuum port (KF25) in the sample flange, it requires interface with the SE group.
- ✓ Also, access and maintenance of the slit is now very easy



Possibilities of the slits

- **Slits at 22.5 cm** (inside the scattering vessel, between guide and sample chamber), are not very efficient in reducing the beam size at the sample position. Moreover, easy access is not really possible.
- **Slits at 18 cm** (inside the sample chamber) have a superior reduction effect in the beam size (although it is not fantastic either). Moreover, access is very easy. We only need good interface with the SE group scope.
- **A third option is no slits**, and masking with cadmium the sample can. The most efficient option in terms of beam size, although apertures are fixed.





ESS Bilbao

