CERN

1st Beam Dump Facility (BDF) Target Systems Advisory Committee (TSAC)

MECHANICAL DESIGN

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4/03/2025

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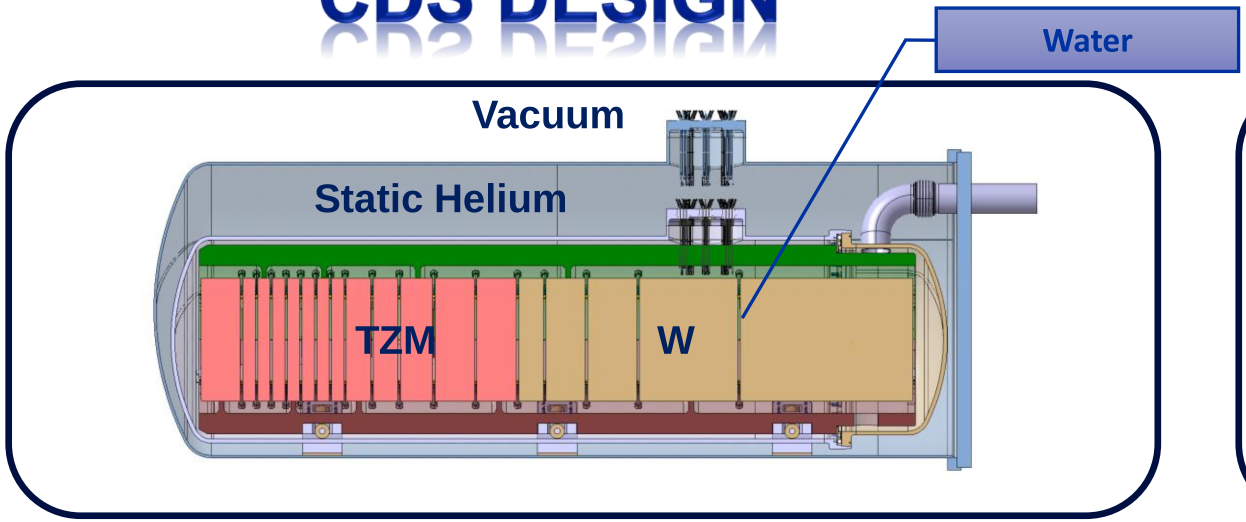
    - Alignment and interconnection.
  - Prototype 2026 design.

- **Manufacturing considerations**
  - Inconel welding, forming, machining.
  - R & D and tests needs.

CDS DESIGN



Water Cooling

- Inner vessel with circulated water (~ 22 bar)
- Outer vessel with static Helium (~ 1 bar)

Dimensions and materials

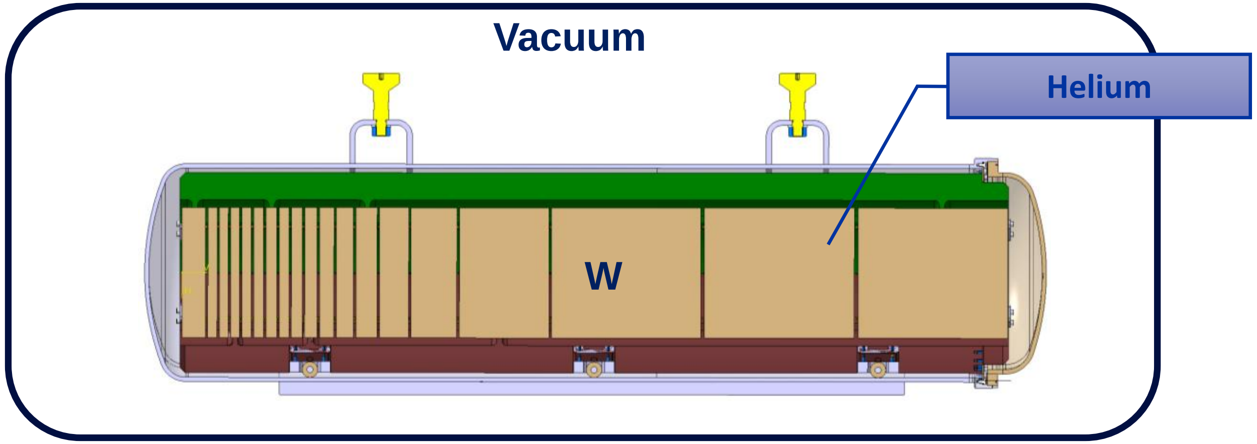
- Absorbing block: TZM (580 mm x ø250 mm) and Tungsten blocks (780 mm x ø250 mm). Total 1.36 m.
- Mass: ~2 tons (~0.9 tons of blocs)
- Vessel and windows material: Inconel 718

Instrumentation

- At least one thermocouple per block

Remote alignment & handling compliant

W HELIUM COOLED TARGET



Helium Cooling

- Vessel with circulated Helium (~ 16 bar, 25/200 °K)

Dimensions and materials

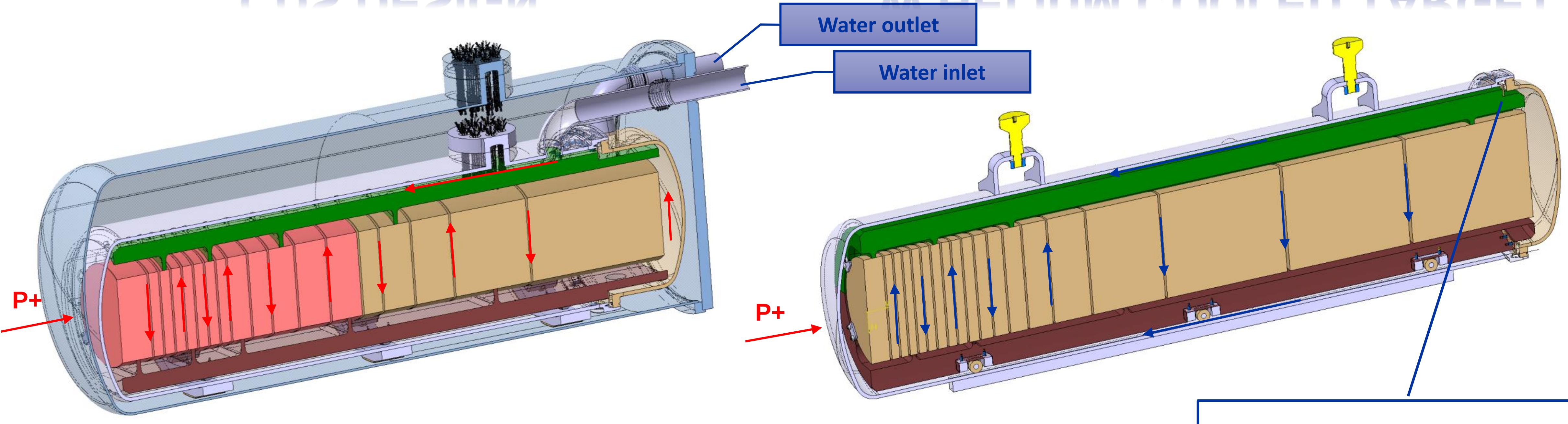
- Absorbing block: Pure Tungsten blocks (1.5 m x ø250 mm)
- Total Mass: ~2.3 tons (~1.3 tons of blocs)
- Vessel and windows material: Inconel 718

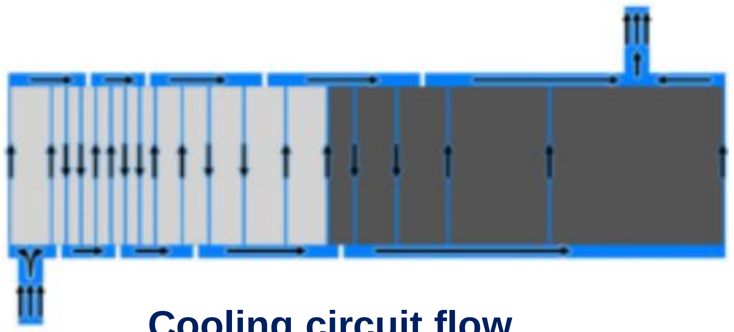
Instrumentation

- At least one thermocouple per block

Remote alignment & handling compliant

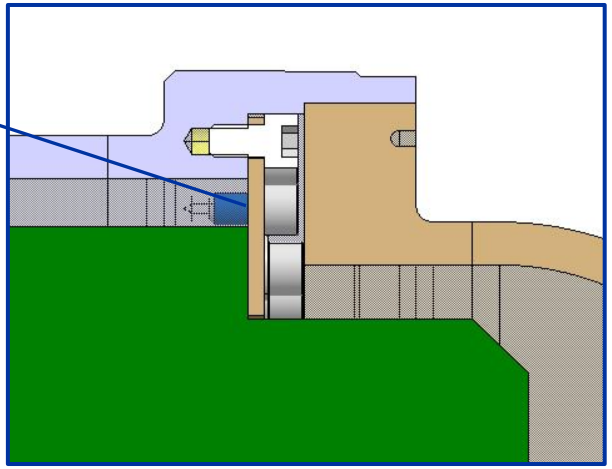
CDS DESIGN W HELIUM COOLED TARGET



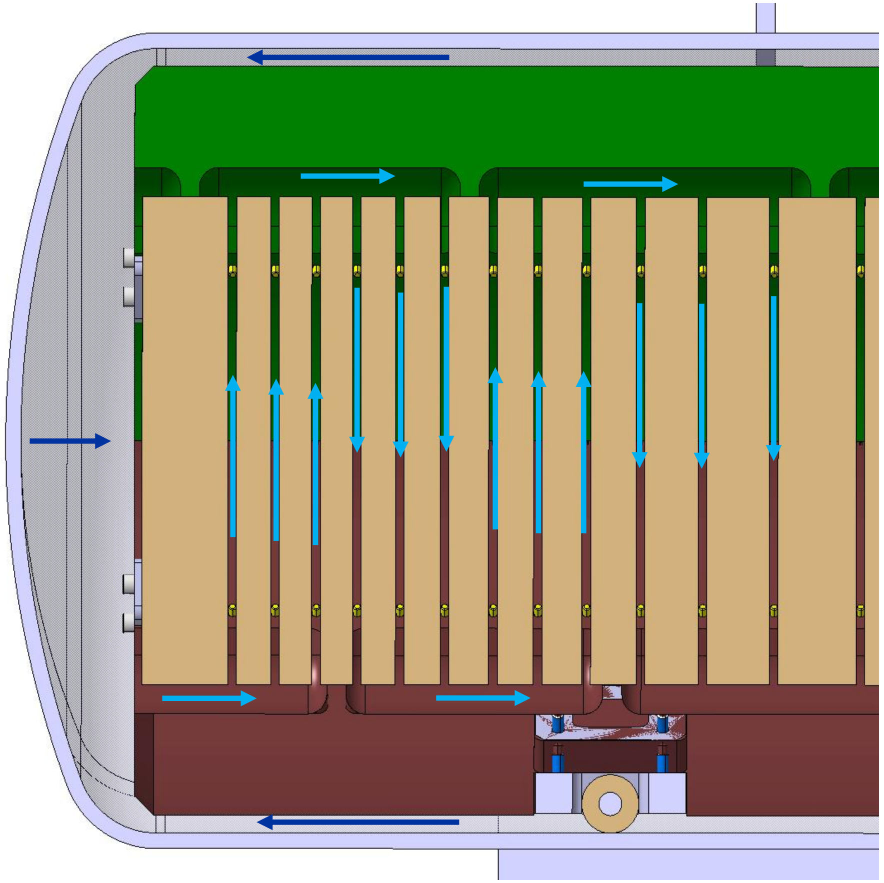


Cooling circuit flow

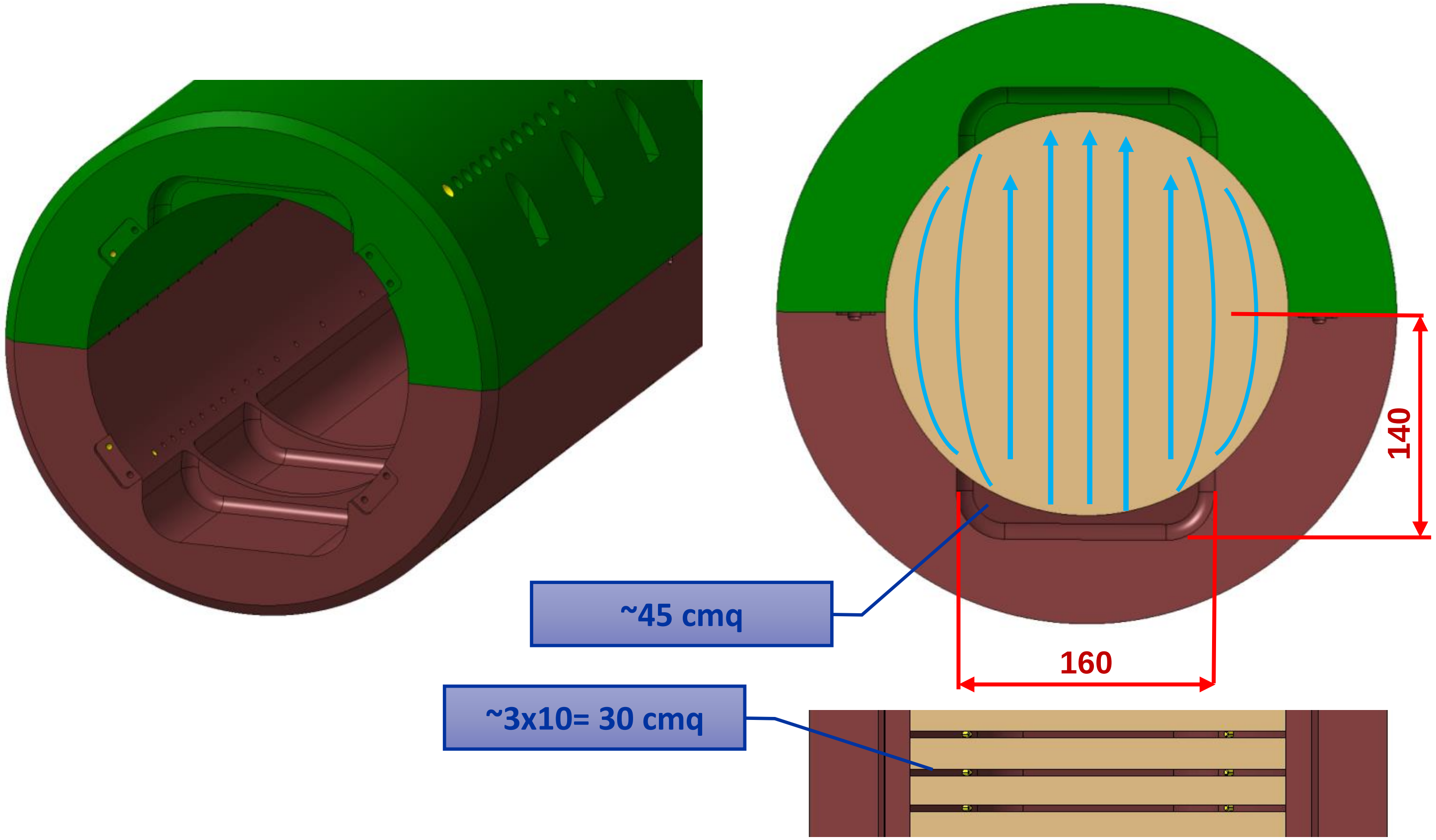
The principle of the cooling circuit of the two designs is identical. Mechanical barriers force the fluid to flow in a specific direction.



COOLING FLOW

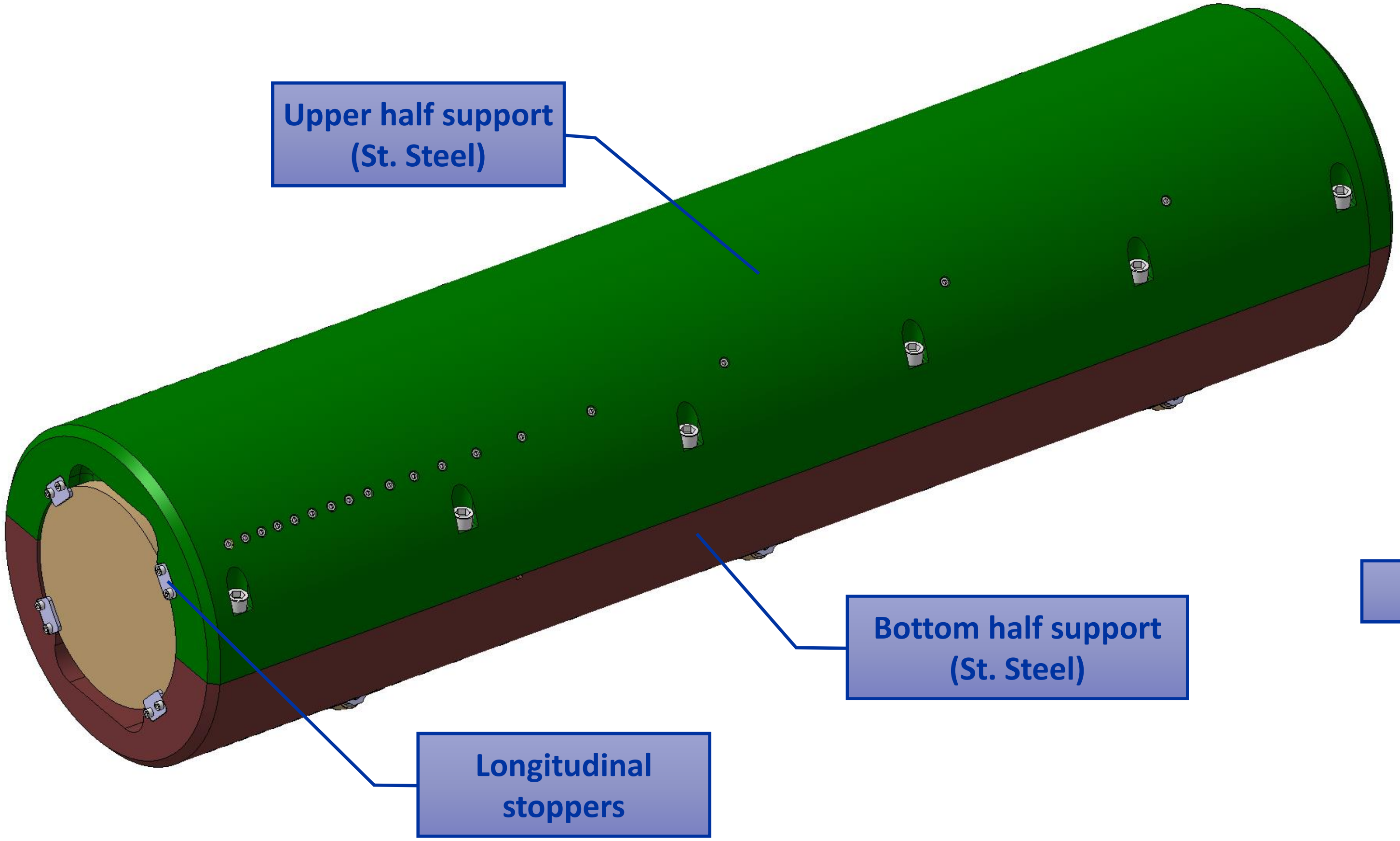


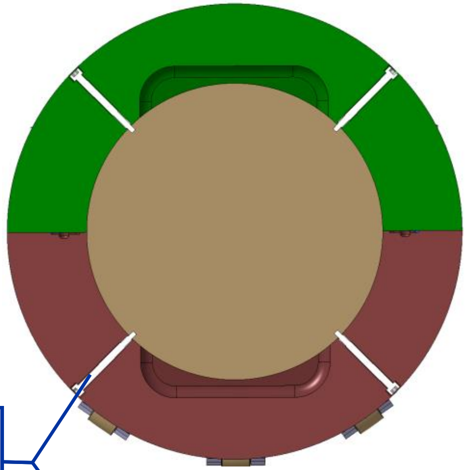
Flow section

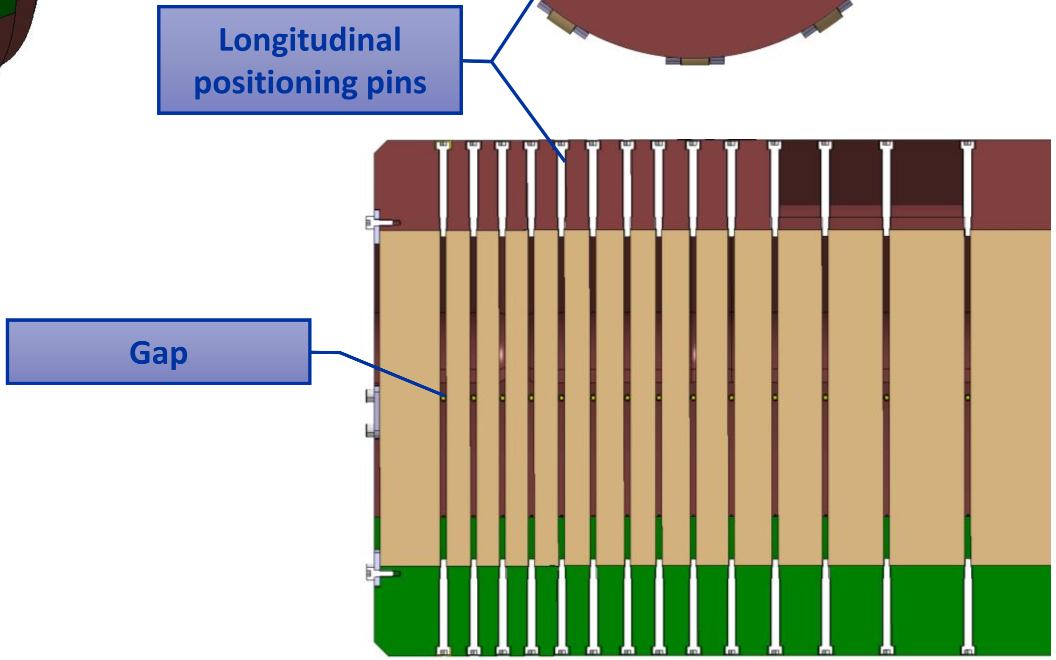


The shape of the internal surfaces of the supports is designed to create a barrier to the flow, forcing the water or the helium to pass between the blocks.

INSTALLATION AND ALIGNMENT OF THE BLOCK



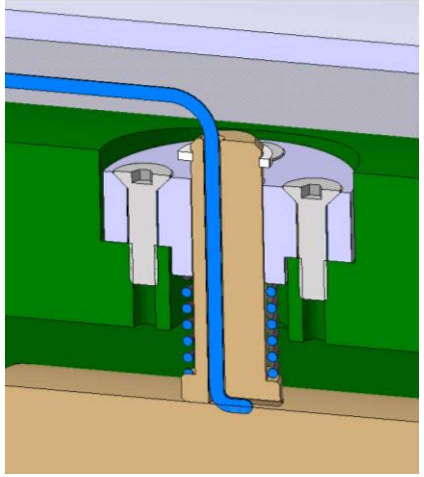


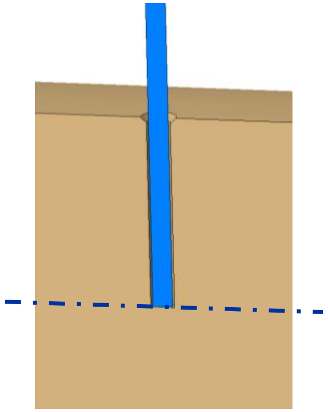


Considering the **thermal expansion**, the worst-case scenario is when tungsten heats up (up to 350°C) while the stainless-steel supports remain cooled. In this case, the gap could decrease by up to 0.5 mm.

Considering also the **mechanical tolerances** on supports and blocks, **the gap could be between 4 and 4.9 mm**.

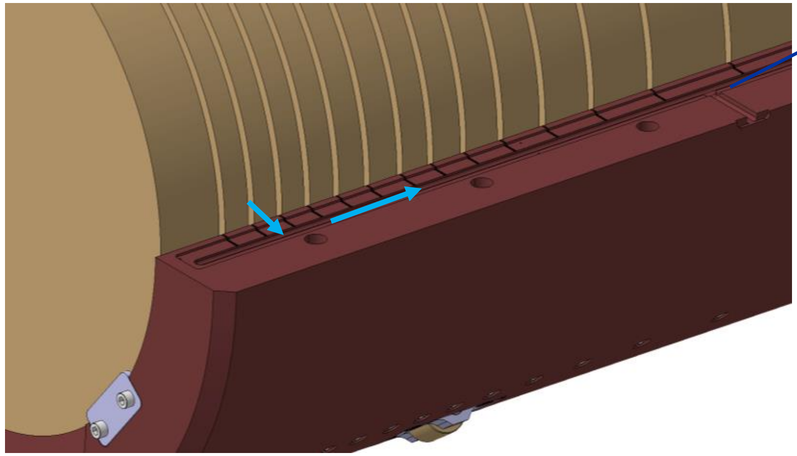
INSTRUMENTATION



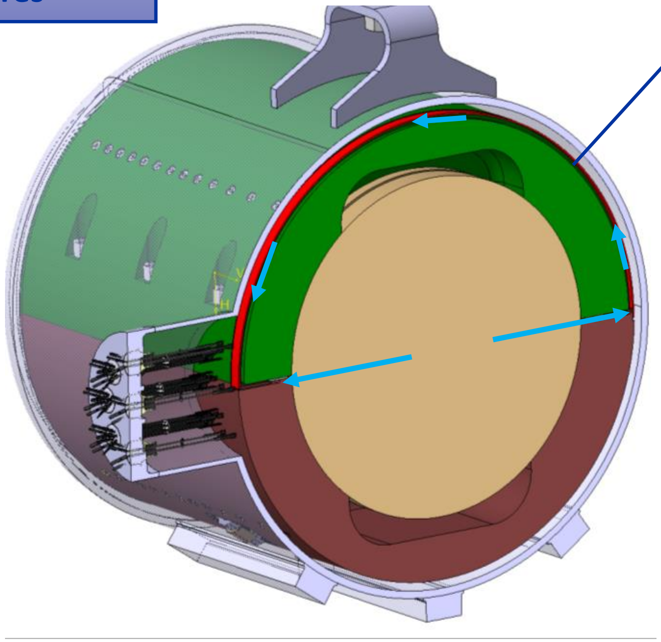


Each block will be equipped with at least one temperature sensor.

- Or **in contact with the external surfaces** without drilling the blocks. The temperature sensor is kept in contact using a spring.
- Or **inside the block**, up to the centre.
- Or **glued or welded between the blocks** (to be tested).



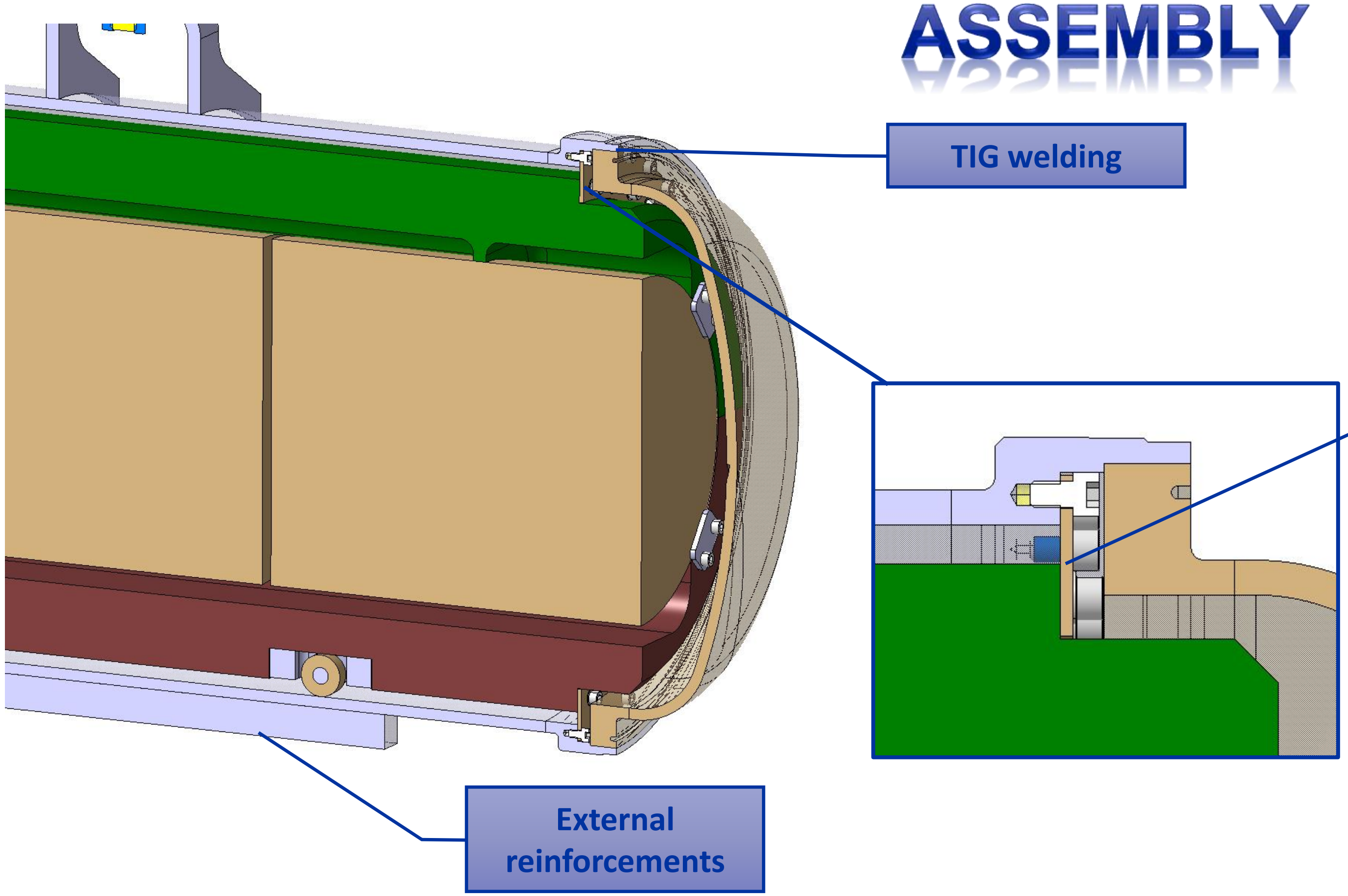
The sensor wires will be routed through dedicated grooves on the lower block, in order to be protected from the flow.

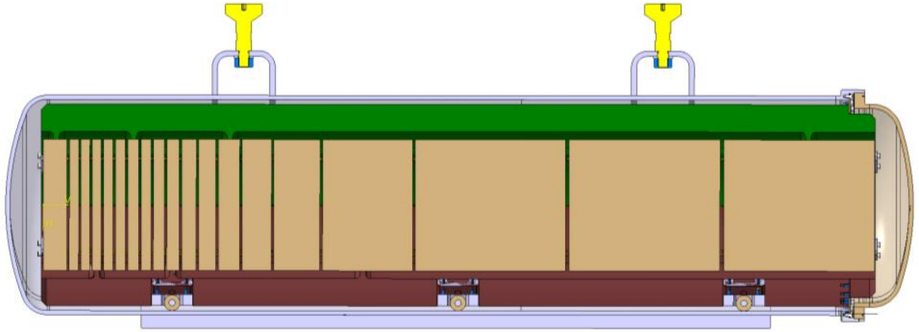


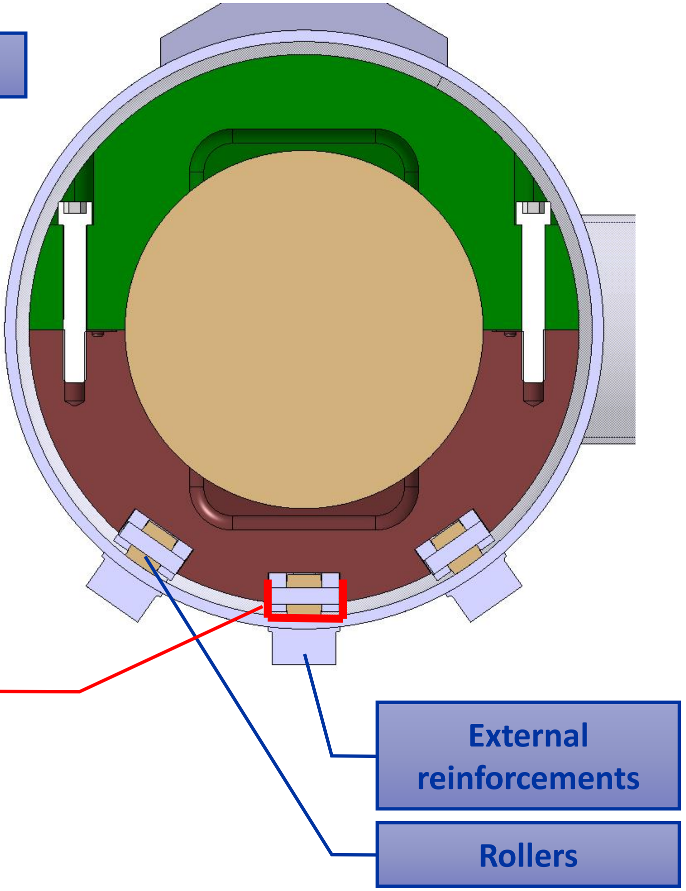
The sensor wires can exit on both sides of the blocks and run along a groove on the upper support to exit through a single feedthrough.

The wires are protected from the flow by a thin metal sheet.

ASSEMBLY



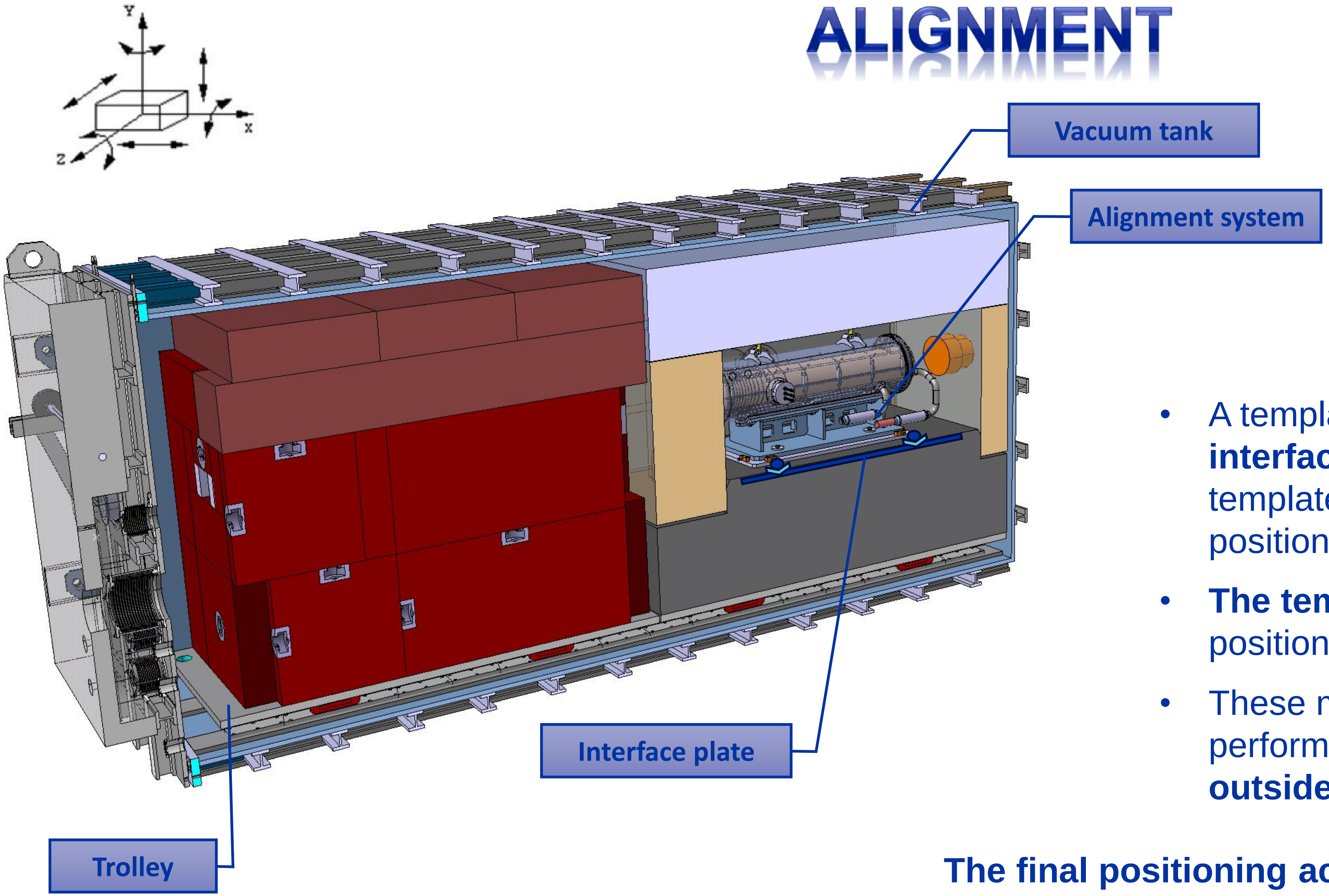




An angular alignment system will be added on a set of wheels.

The helium leak flange also defines the longitudinal position of the target.

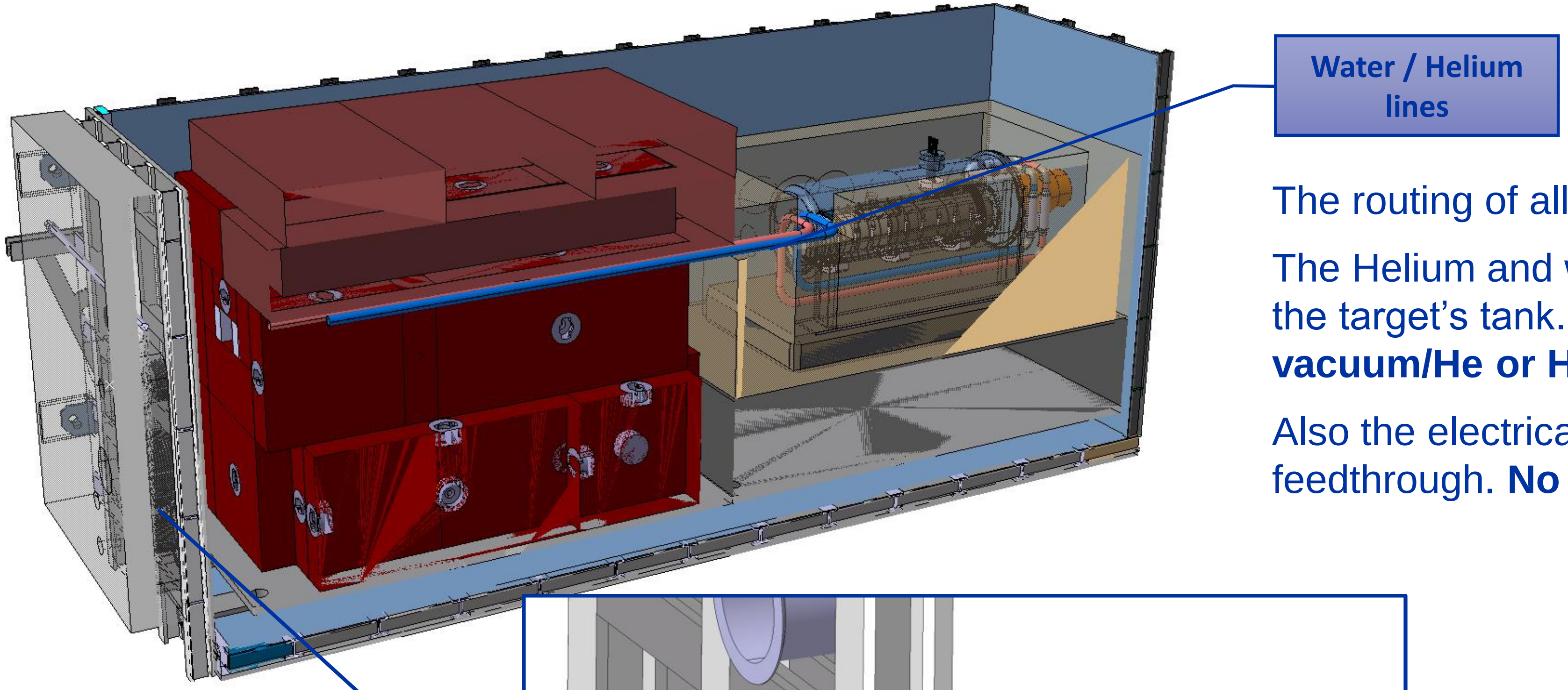
ALIGNMENT



- A template will be installed on the trolley on an **interface plate** which allows us to replace the template and reinstall the target in the same position.
- **The template will be measured** in the final position with respect to the vacuum tank.
- These measurements will be used for performing **fiducialization of the target outside** the tank.

The final positioning accuracy of the target with respect to the beam is expected to be within a **range of a few millimetres.**

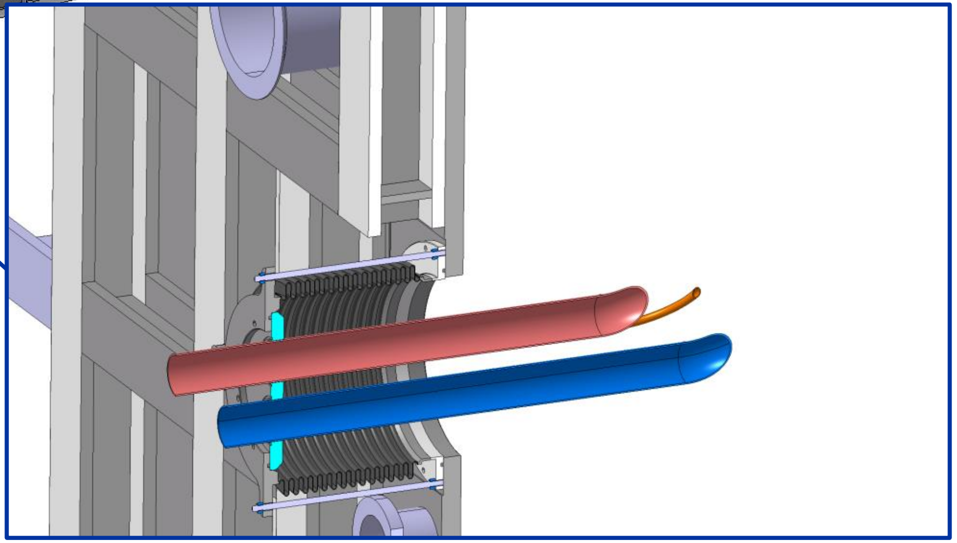
FEED LINES INTERCONNECTION



The routing of all interconnections lines is still under study.

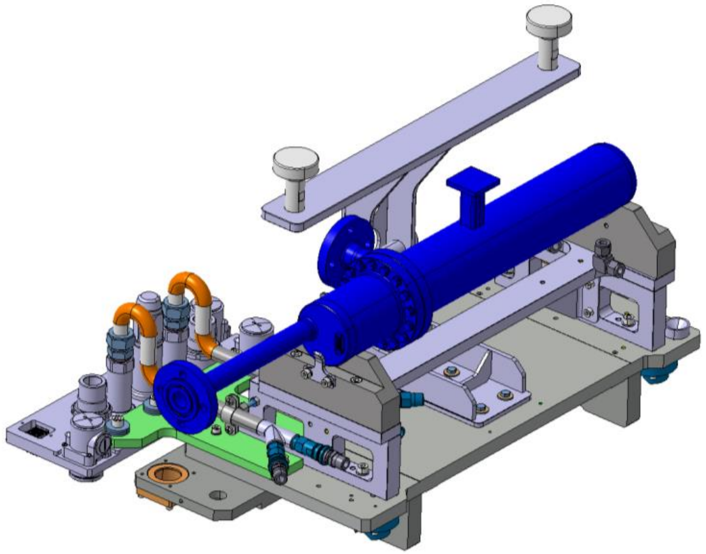
The Helium and water feed lines will be welded directly on the target's tank. **No bolted connections separating vacuum/He or He/H2O are expected**.

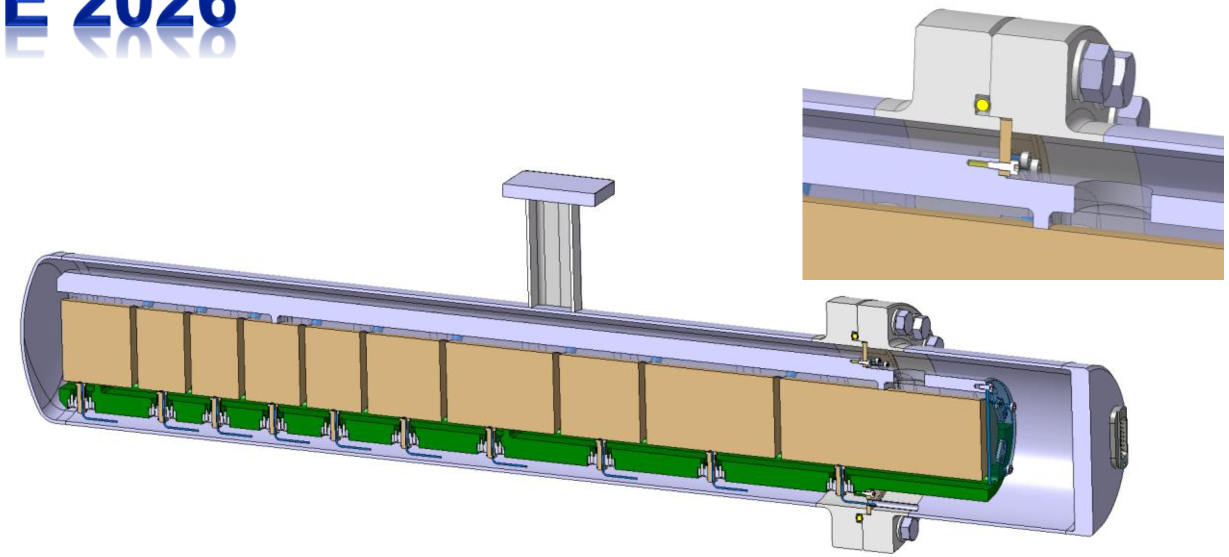
Also the electrical wire will be welded directly on the feedthrough. **No electrical connection are expected**.



All the lines will be connected and disconnected directly on the tank's door from outside to close the vacuum.

PROTOTYPE 2026





Mechanical specification

- Absorbing block: Pure Tungsten blocks (0.56 m x ø50 mm)
- Mass: ~45 kg
- Vessel and windows material: Inconel 718

Cooling

- Vessel with circulated Helium (~ 16 bar, 25/200 °K)

Instrumentation

- One thermocouple per block

Remote alignment & handling compliant

The design of the prototype is as similar as possible to the final target design, but reduced scale.

Differences:

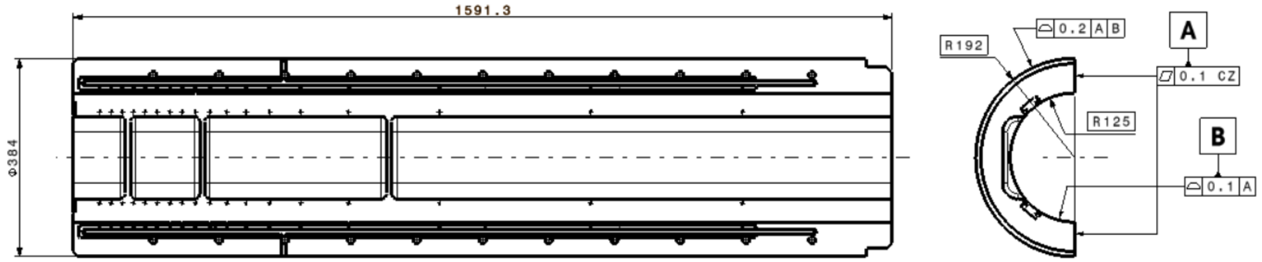
- Assembly procedures
- Prototype will be fully adapted for disassembly with **remote handling/robotic** means, to extract the core blocks for **post-irradiation examination**.

A special design is developing in collaboration with the robotics team.

MANUFACTURING CONSIDERATIONS

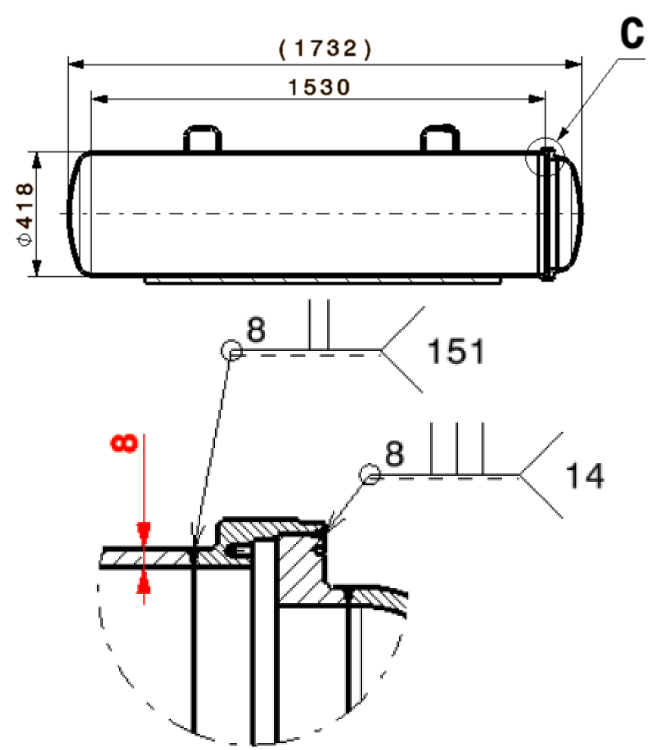
COMPONENTS MACHINING (Except for the blocks)

Very precise machining of big blocks on Stainless steel



CDS prototype

MANUFACTURING CONSIDERATIONS

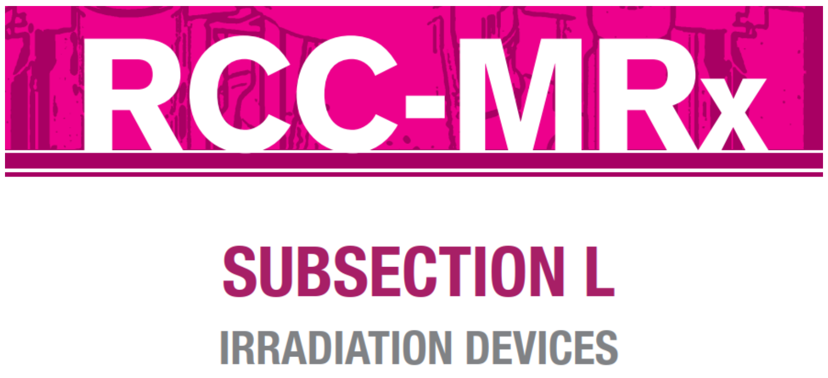


INCONEL 718 Pressure tank in activated area

Welding book following NF EN ISO 15614-1 + RCC-MRx code (DESIGN AND CONSTRUCTION RULES FOR MECHANICAL COMPONENTS OF NUCLEAR INSTALLATIONS) rules.

- Welding procedure specification record (WPQR) ISO 15614-1
- Welder qualification record (ISO 9606-1 / ISO 14732 for manual or automatic welding)
- Welding Procedure Specification (WPS) ISO 15609
- Non destructive tests on each welding: Surface inspection, Radiographic inspection, etc.
- Material certificates for the base material and for the filler metals.

Development and qualification needed. ~ 4 months



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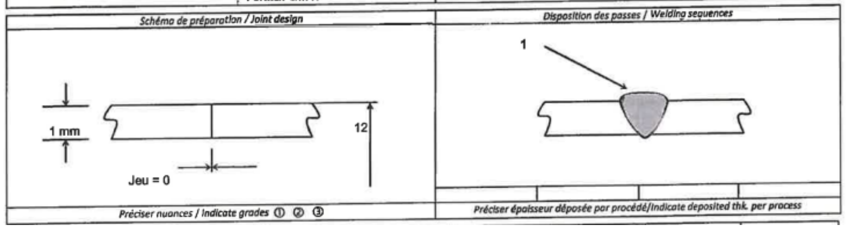
DMOS-p /p-WPS:	2020-05-FW	Matériaux de base/ Base material	①	②
Type d'assemblage/Type of Joint :	bout à bout	Groupe/ Sous groupe Group / Subgroup	8.1	8.1
Type de soudure/Type of weld :	pleine pénétration	Epaisseur (mm)/ Thickness	1	1
Reprise envers/Back Run :	/	Diamètre ext./ Outside diameter (mm)	12	12
Type de support envers/Type of Backing strip :	/	Forme de produit/ Product form	Tube	Tube
Nature du support envers/ Backing : ③	/	Autres informations / Other Informations: /1		
Gougeage ou meulage envers Back Gouging or Grinding	Profondeur /Depth : /mm Forme/Form : /			



CONCLUSION

- The design presented is a **concept design**.
- We have studied the **design and manufacturing feasibility**.
- The prototypes (2025 and 2026) will provide us further important indications for the final design.
  - Installation
  - Instrumentation
  - Manufacturing

Detailed design of the final target can start soon.

Thank you for your attention

home.cern

BLOC TRANSPORT

There are blocks between 10 and 280 kg.

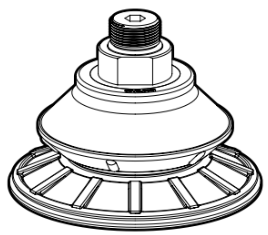
The transportation of the blocks will depend on material, cladding, possibility of have threated hols, etc…

Several techniques are considered:

- Suction cups
- “belt”
- Pliers for lifting

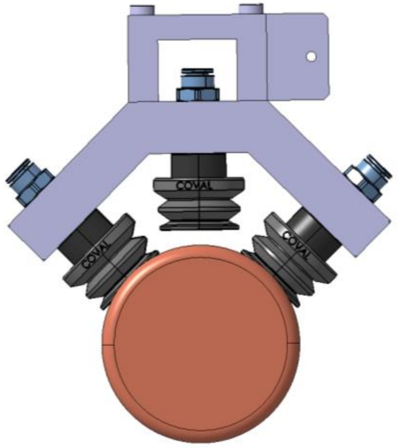
Probably, more than one technique will be used depending on the type of block.

CBC Suction Cup with 1.5 Bellows



	A at rest (mm)	Ø A gripping (mm)	(cm³)	(lbs) (1)	(lbs) (1)	Rmin (mm)	Rmin (mm)	Ø bore (mm)	tightening (mm)
CBC 22	21.5	22	1.6	3.8	3.8	25	30	6.3	wrench 22 + hex 6
CBC 30 (3)	32	34	5	9.0	9.0	30	32	6.3	wrench 22 + hex 6
CBC 45	47	48.7	11.47	15.7	20.2	36	45	6.3	wrench 22 + hex 6
CBC 60	62	64.5	25.31	31.5	29.2	44	62	6.3	wrench 22 + hex 6
CBC 85	85	88	66.54	51.7	54.0	65	115	6.3	wrench 22 + hex 6
CBC 115	115	119	141.47	94.4	87.7	84	140	6.3	wrench 22 + hex 8

	H1 (mm)	f (2) (mm)	G1 (mm)	G1' (mm)	Ø D (mm)	(g)			
						F38G	F38GA	M38G	C32
CBC 22	32	6	10	12.6	37	10	23	14	32.2
CBC 30 (3)	31	8	10	12.6	37	14	26.3	19	36.2
CBC 45	36	11	10	12.6	37	22	31.5	26	44.2
CBC 60	41	14	10	12.6	39	32	42	37	54.2
CBC 85	51	22	10	12.6	41	64	71.2	69	86.2
CBC 115	53	24	10	12.6	55	103	131.1	107	125.2



Pince pour levage de tubes, barres, bobines, et autres charges cylindriques

CODE	RG05	RG15	RG30	RG40
C.M.U (kg)	500	1000	2000	3000
A mini (mm)	50	100	200	250
A maxi (mm)	100	200	350	450
B maxi (mm)	276	492	836	1164
D (mm)	50	60	70	90
Epaisseur mors (mm)	37	37	37	37
poids (kg)	6	12	28	48