Mechanical design, integration and tooling

HL-LHC WP13
Beam Instrumentation

D. Gudkov, G. Schneider, M. Krupa

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- Mechanical differences between the three types of BPMS: Q1, Q2a-D1, D2
- Quasi-symmetric D2 BPM design
- Design of bodies
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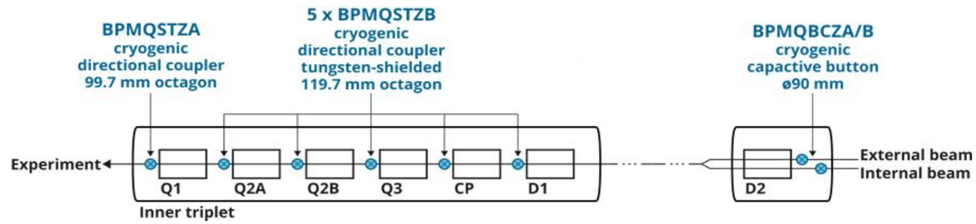
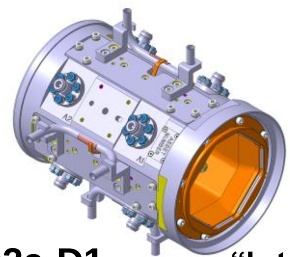
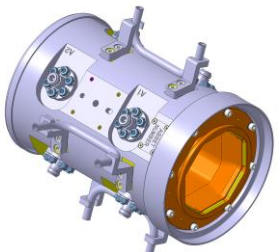
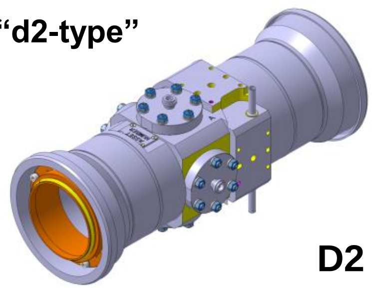
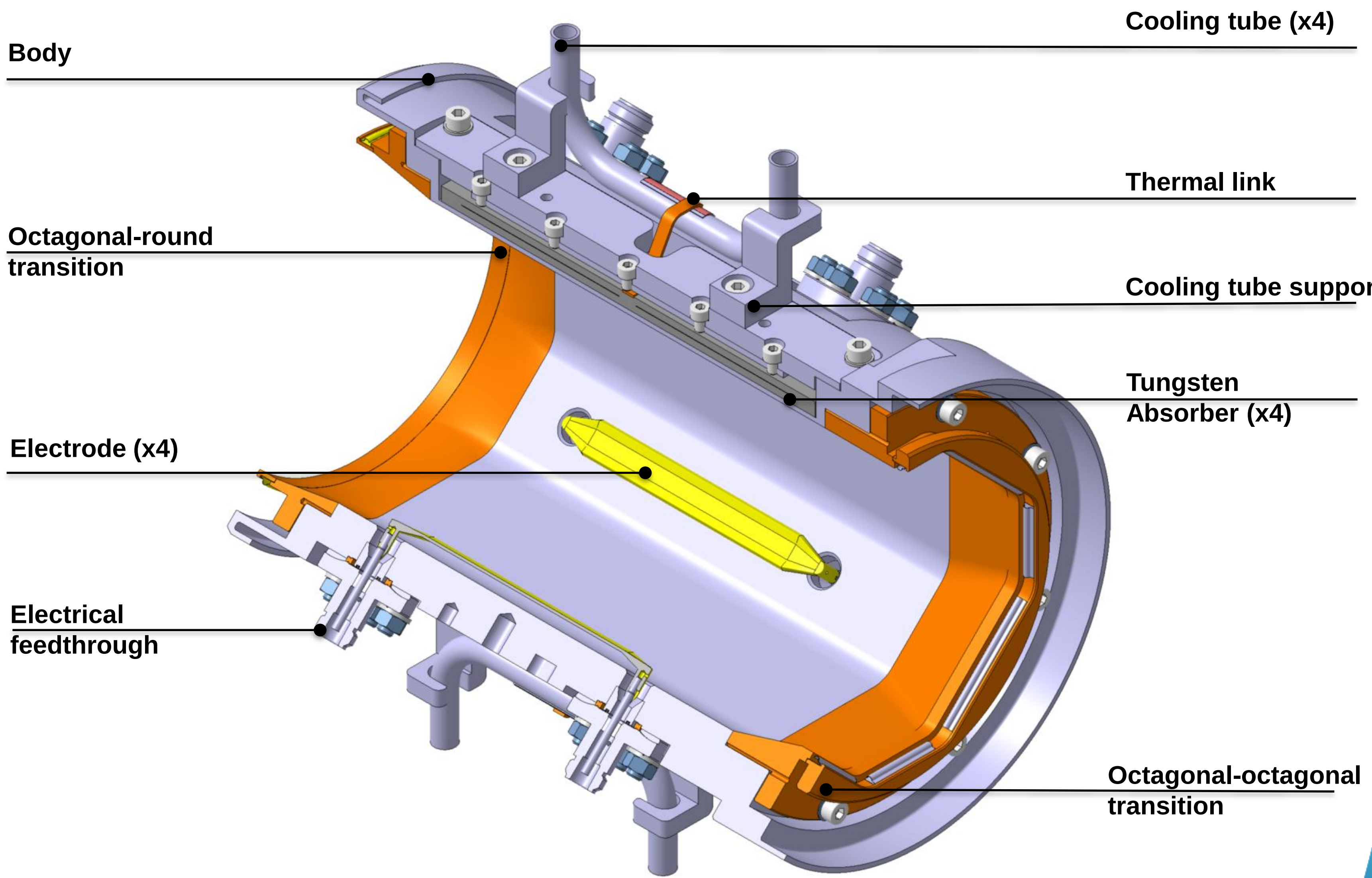
- Installation situation in cryostats
- Alignment procedure and tooling
- Status of Design Documentation

Mechanical differences between the three types of BPMs: Q1, Q2a-D1, D2

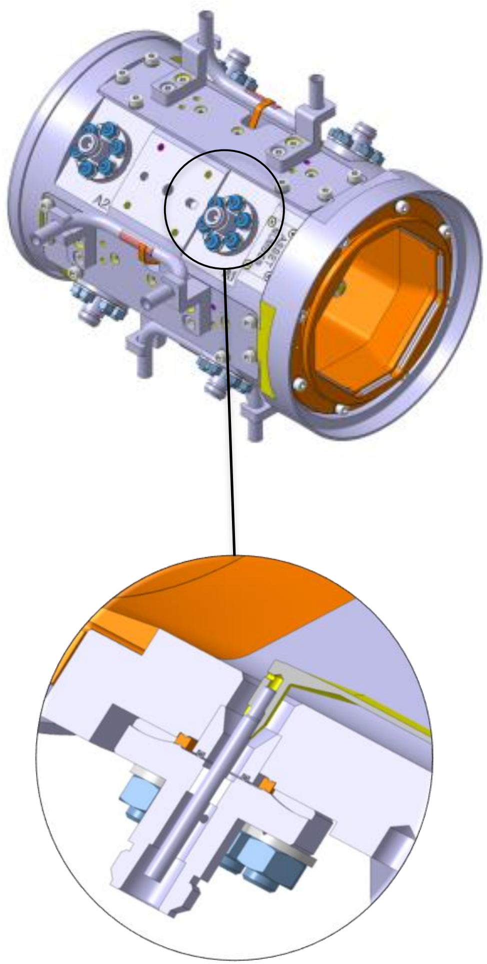


Picture	Type	Dimensions	Tungsten Absorbers	Aperture Shape
 **Q2a-D1** **“b-type”**	Directional coupler	D184xL270.6	yes	Octagonal
 **Q1** **“a-type”**	Directional coupler	D184xL270.6	no	Octagonal
“d2-type”  **D2**	button	D154xL398.4	no	Circular

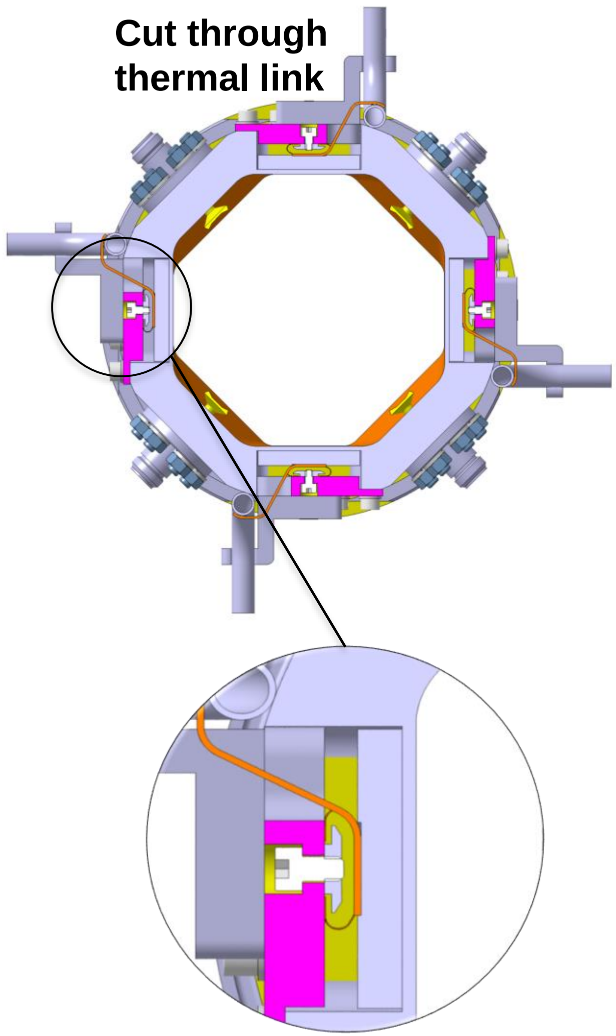
Mechanical differences between the three types of BPMs: Q2a-D1 (B-type)



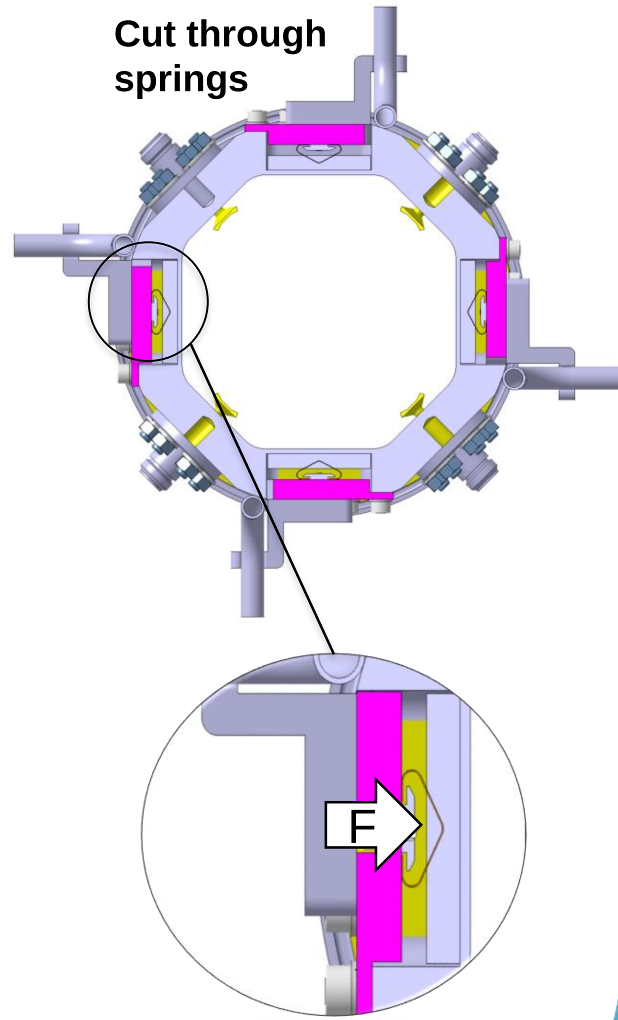
Mechanical differences between the three types of BPMs: Q2a-D1 (B-type), details



Feedthough-Electrode
M2.5 Interface

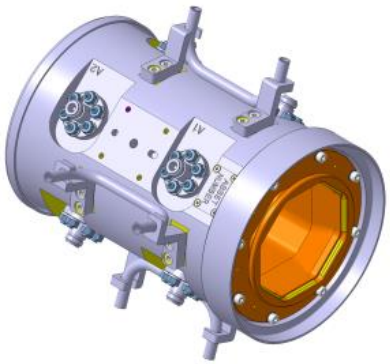


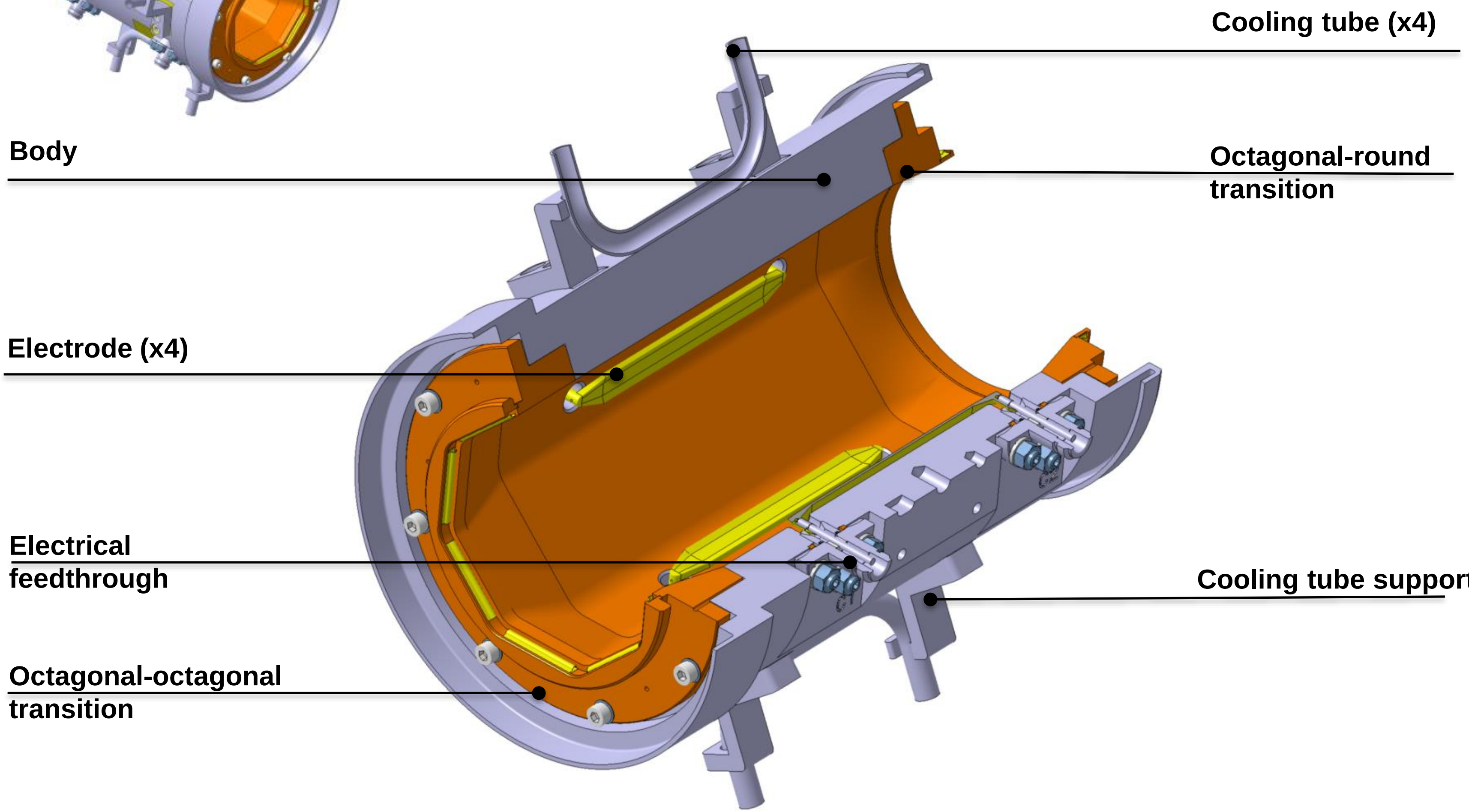
Thermal link
(Absorber – Tube)



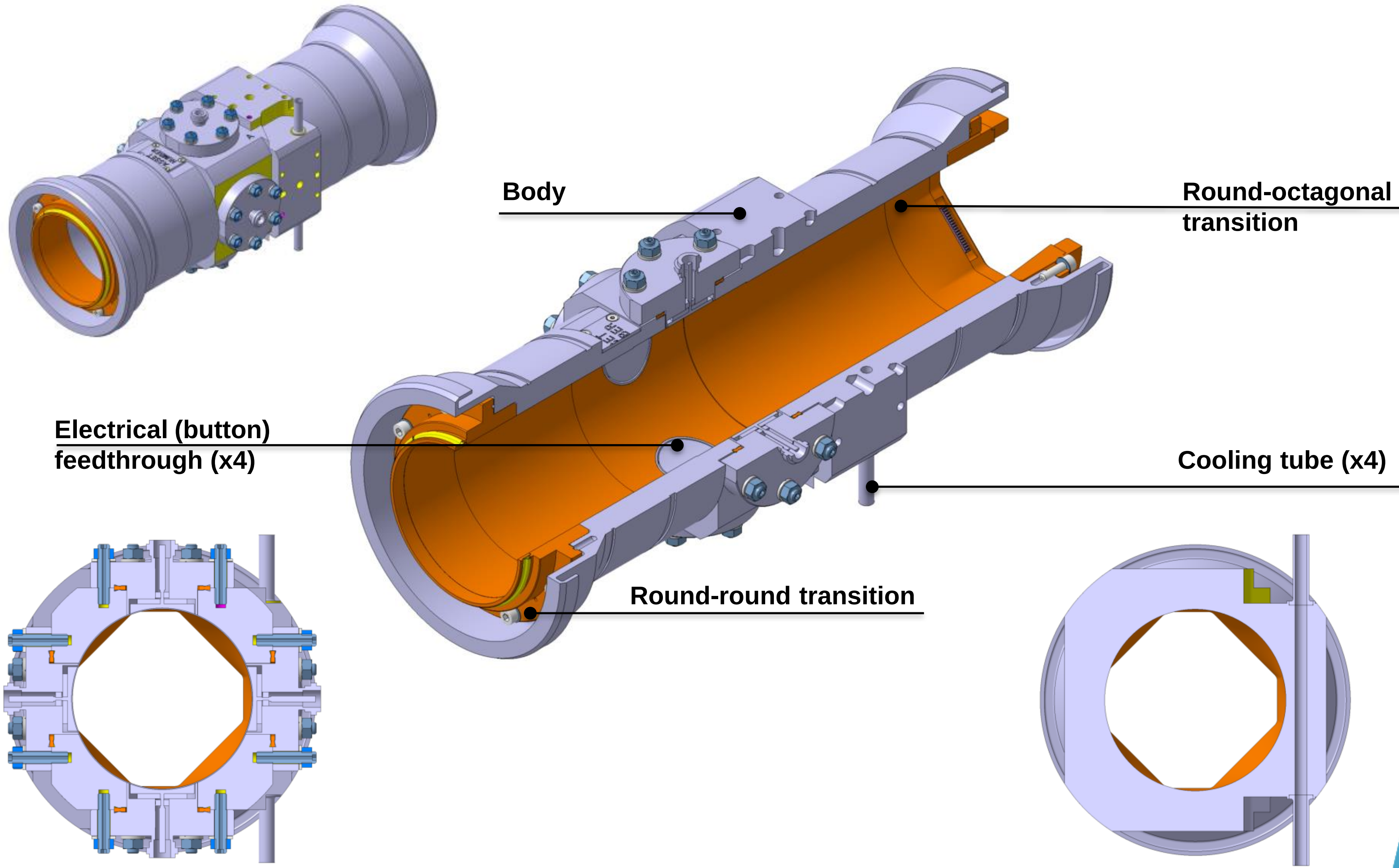
Spring
(4 mm stroke = 40 N)

Mechanical differences between the three types of BPMS:
Q1 (A-type)

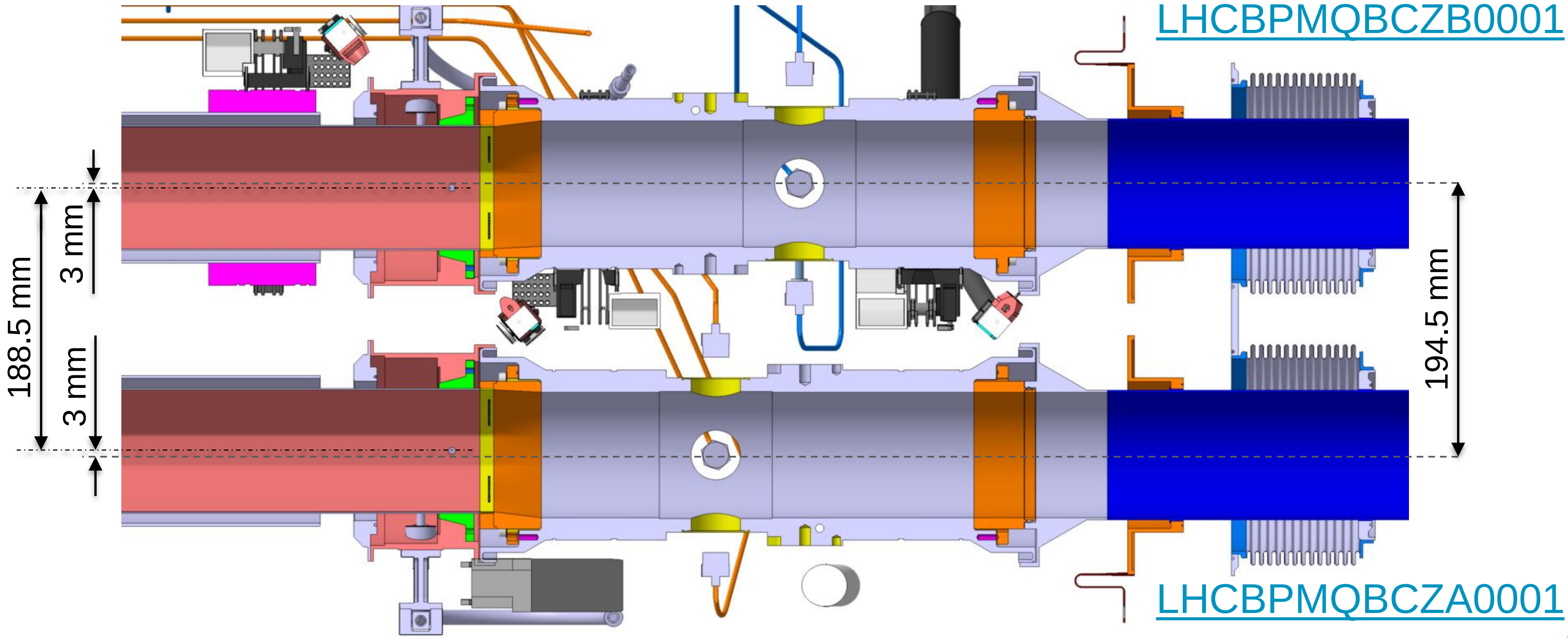




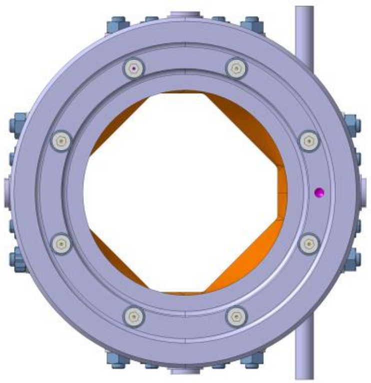
Mechanical differences between the three types of BPMS: D2



Mechanical differences between the three types of BPMS: Quasi-symmetric D2 BPM design

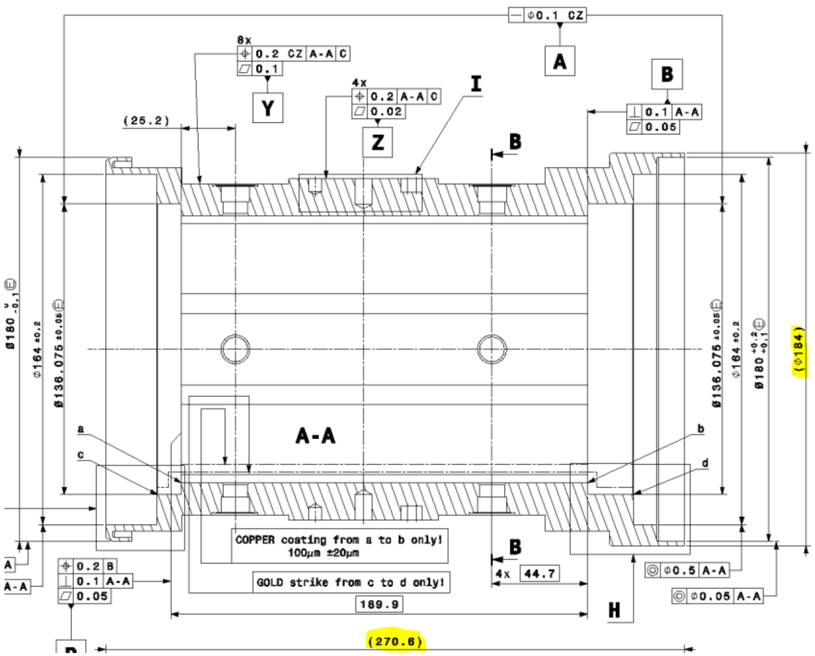


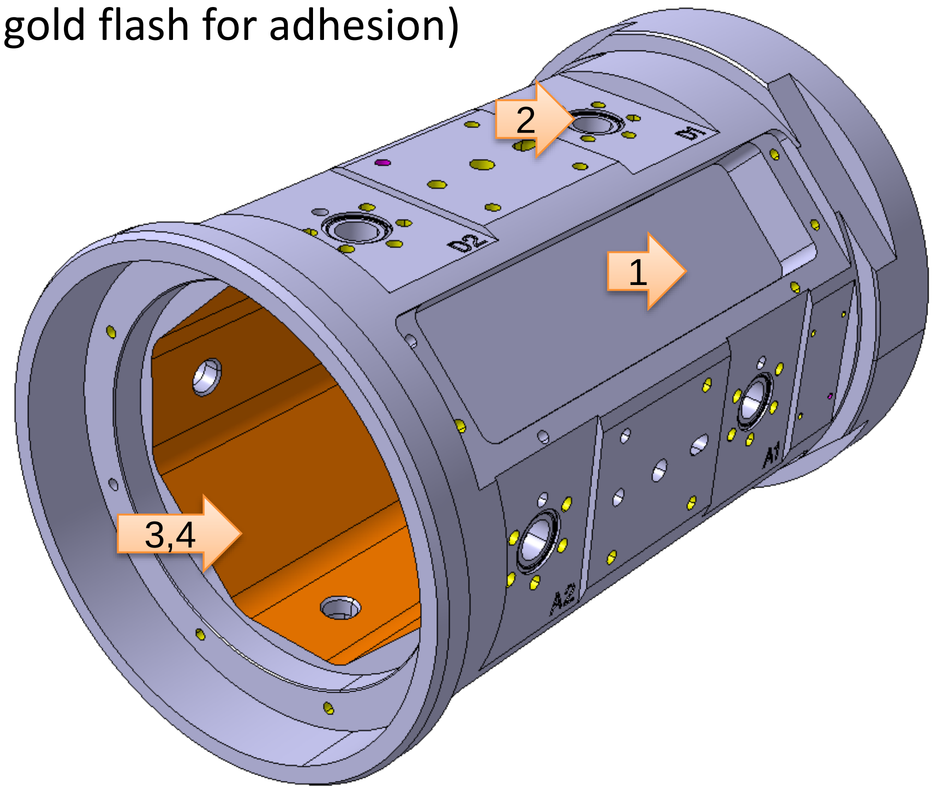
- Identical interfaces on both sides of the body
- Any type of transition can be installed on any side
- Octagonal-round transition can only be installed in one orientation (controlled by extra hole on the body face)



BPM Bodies Design
BPMQSTZB (Type B), LHCBPMQST_B0009

1. Material: CERN material spec. 1001 for 1.4429 round, forged blanks
2. Machined ConFlat interfaces (see next slide)
3. Octagonal shape (electroerosion wire cutting)
4. Copper electroplating 0.1 mm (with gold flash for adhesion)





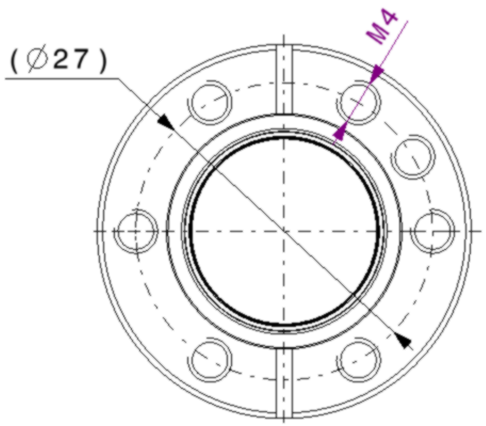
BPM Bodies Design. Details
BPMQSTZB (Type B), LHCBPMQST_B0009

Machined CF16 ConFlat interfaces were modified to address the following issues:

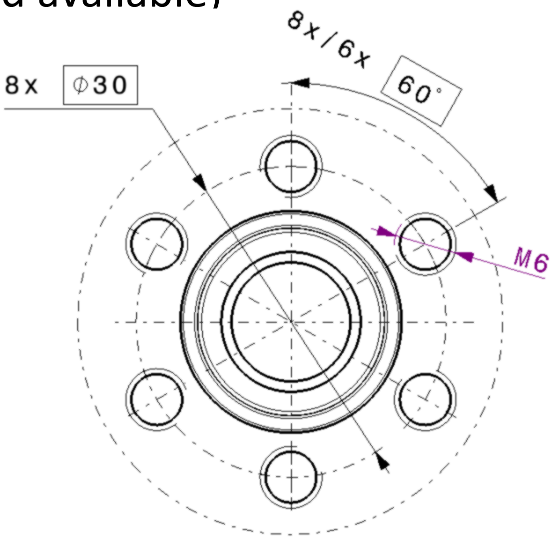
- M4 screws break risk
- Limited availability of M5 class 100 grade screws on the market
- M4 taps are difficult to machine
- M4 and M5 vented screws are difficult to make.

The decision was to switch to M6 screws:

- M6 taps are easier machine (cutting tool with inner cooling are available)
- Fewer risks in using M6 screws
- Class 80 M6 grade screws can be used (standard available)
- Study was made and feasibility proved



Standard CF16

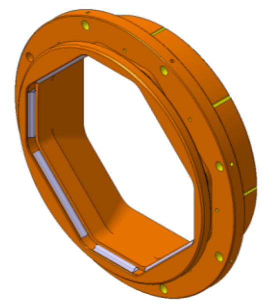


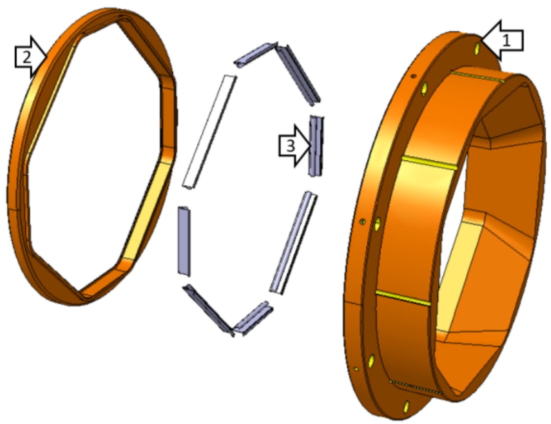
Modified CF16 for BPMs

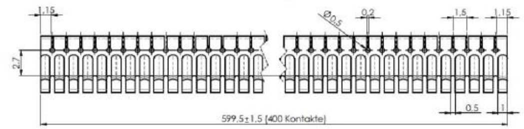
BPM Transitions Design
(LHCBPMQST_B0003 and LHCBPMQST_B0004)

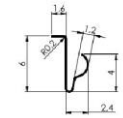
Machining of bases and inserts, cutting and forming of RF contacts → Cleaning of parts → Metrological control → Electron-beam welding → Metrological control → Welding quality control → Packaging

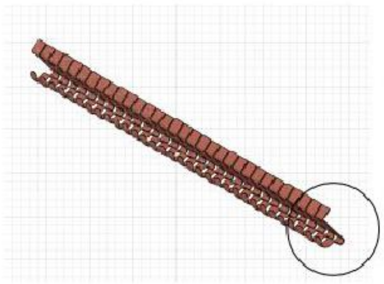
LHCBPMQST_B0003

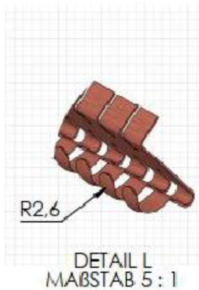




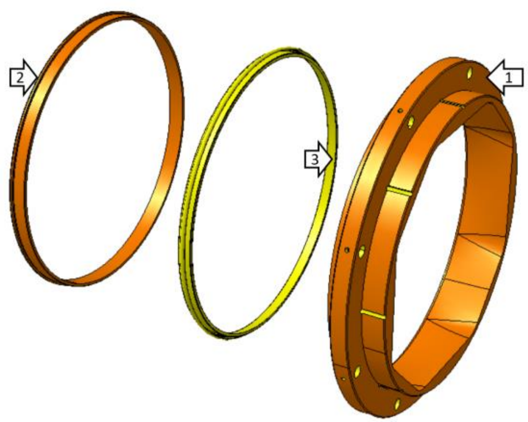


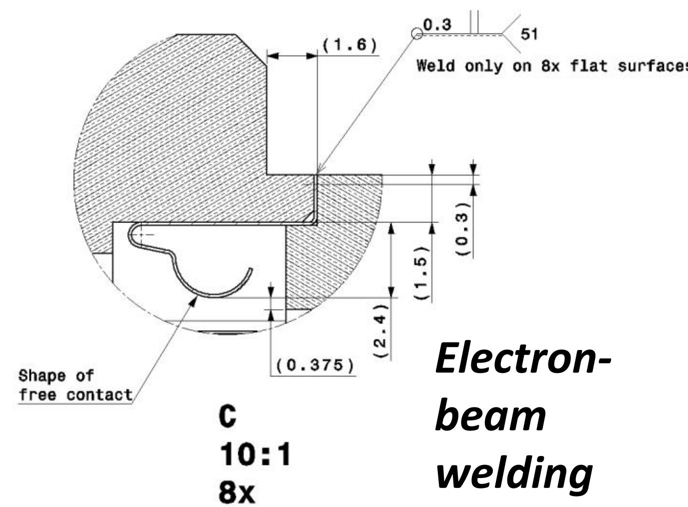






LHCBPMQST_B0004





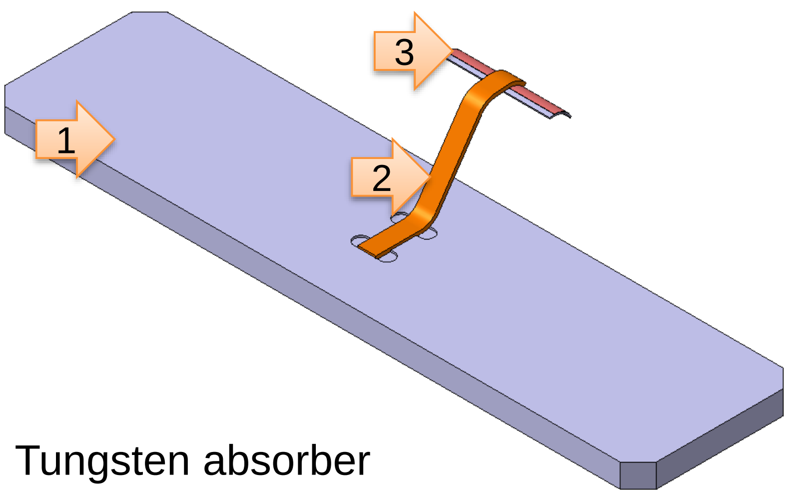
Electron-beam welding

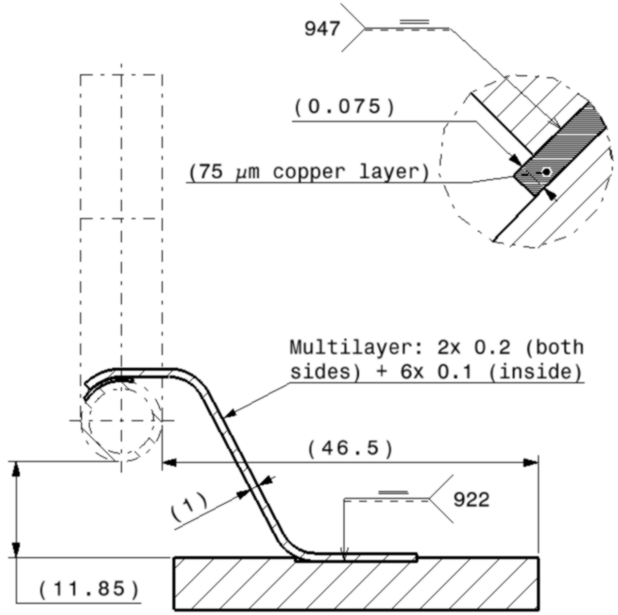
Synergies with TE/VSC: tungsten blocks, thermal links

Tungsten absorber – Copper strip – Interface plate assembly (LHCBPMQST_B0026)

Weld or braze interface plate and cooling strip → Braze interface plate-cooling strip subassmbly to the tungsten absorber → Quality control → Packaging

- Tungsten absorbers will be supplied by the TE-VSC
- Copper strip and interface plate are welded (ultrasound welding)
- Then the strip-interface plate subassembly is brazed to tungsten block





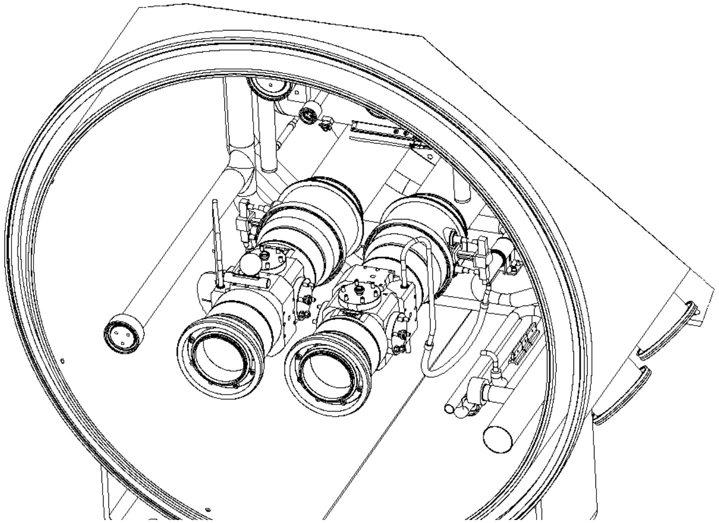
(1) Tungsten absorber
(2) Copper strip
(3) Interface plate (is laser-welded to the cooling tube)

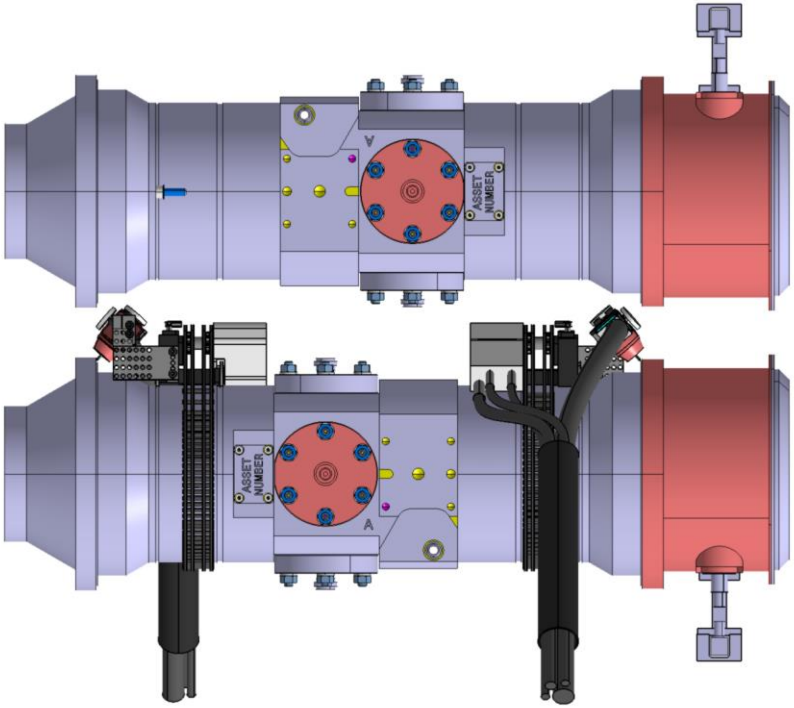
CERN Workshop has developed the manufacturing process which will be used to produce 100 pcs. subassemblies (process developed for VSC BS)

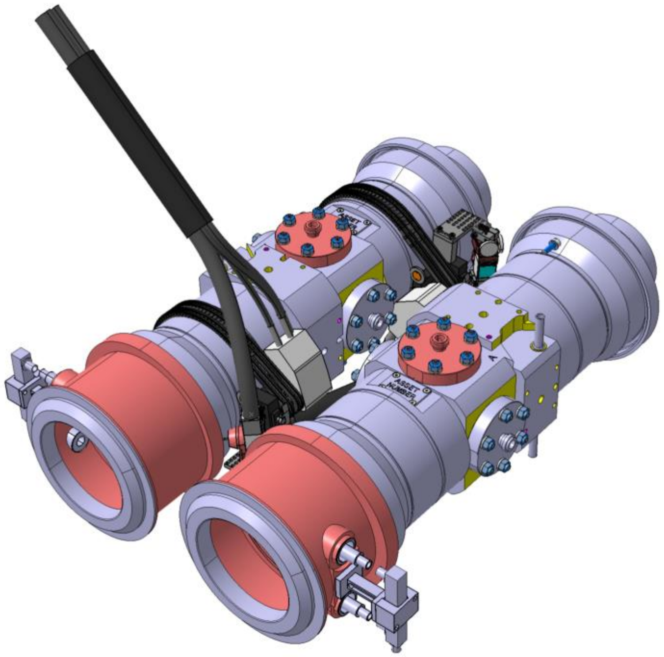
Installation situation in cryostats

D2 (LHCBPMQBCZA0002)

- BPM interfaces were discussed and agreed with TE-VSC
- 3D and 2D were prepared to study the integration of welding machines
- For successful installation: first weld BPM, then weld cooling tubes



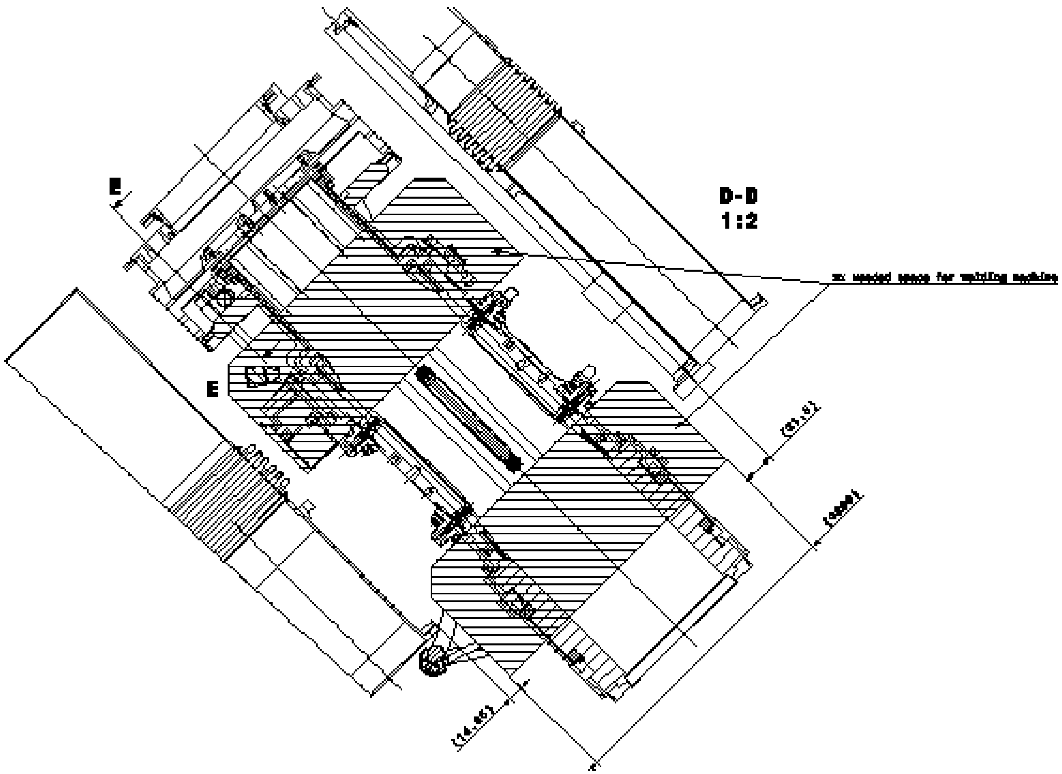


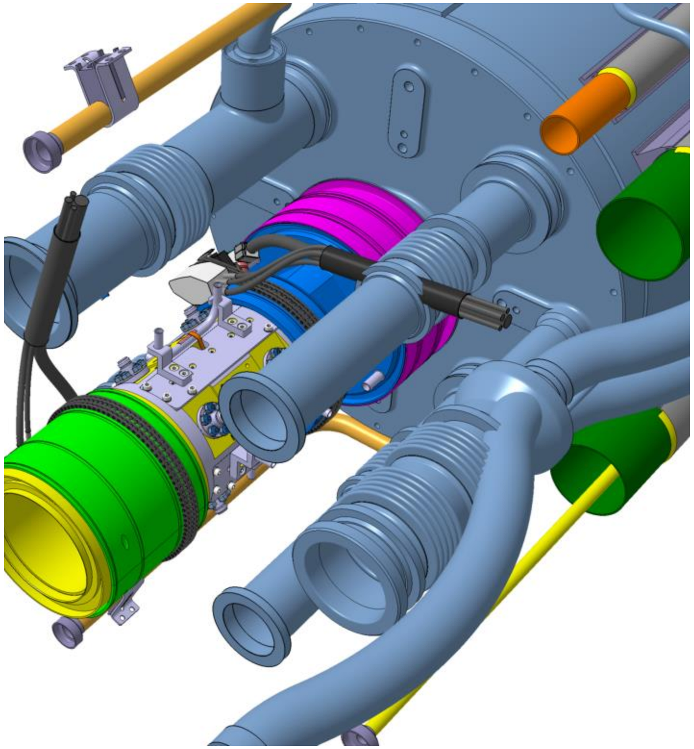


Installation situation in cryostats

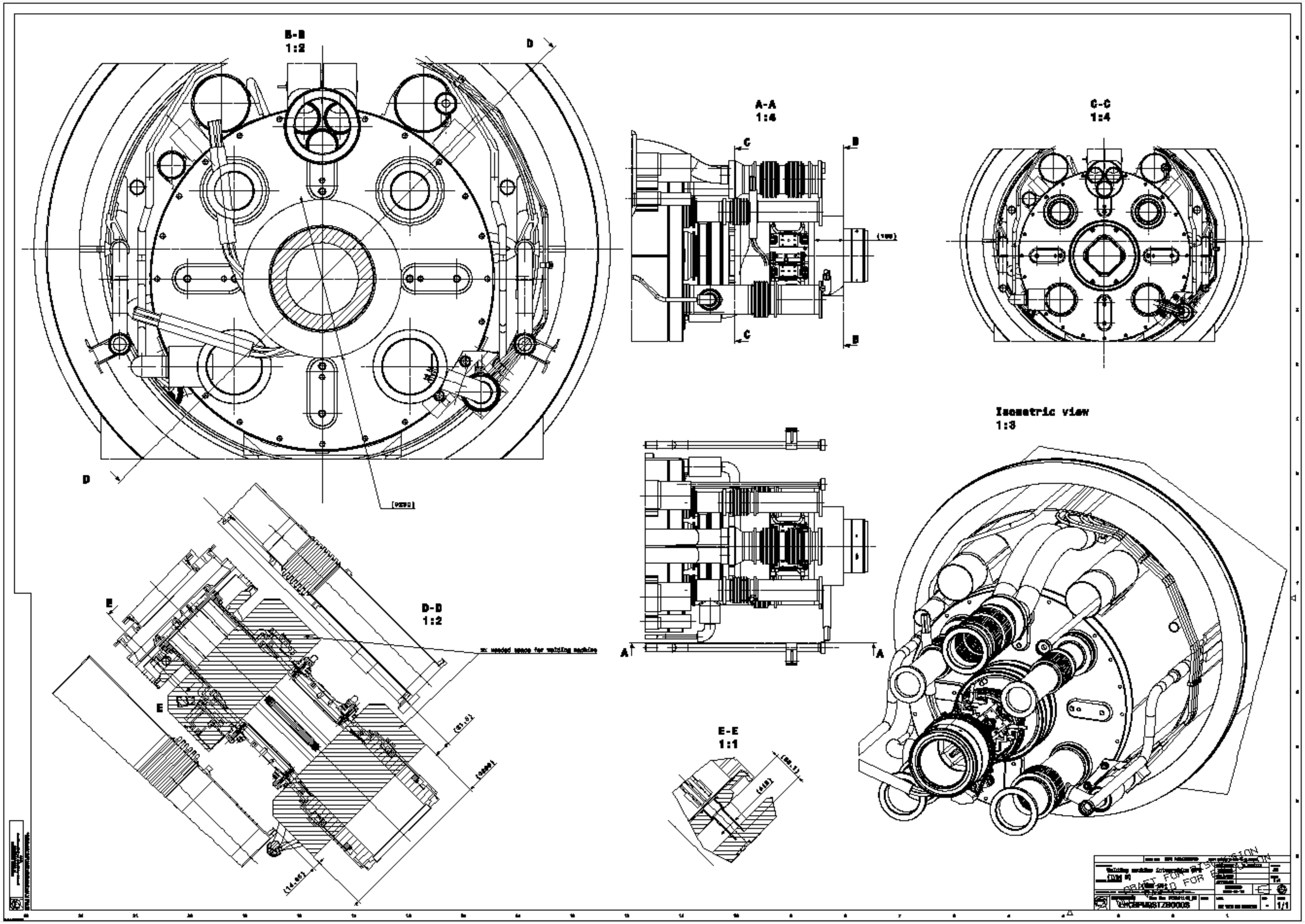
<u>Type B</u> (LHCBPMQSTZB0003)

- BPM interfaces were discussed and agreed with TE-VSC
- 3D and 2D were prepared to study the integration of welding machines
- For successful installation: first weld BPM, then weld cooling tubes





(LHCBPMQSTZB0003)



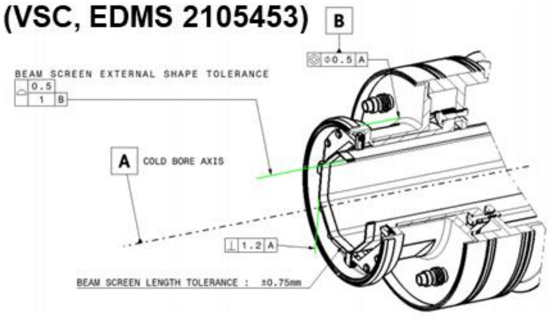
Alignment procedure and tooling

- Use experience from LHC construction
  - Proven installation alignment principles
  - The assembly sequence is defined in memorandum **EDMS 2105453**

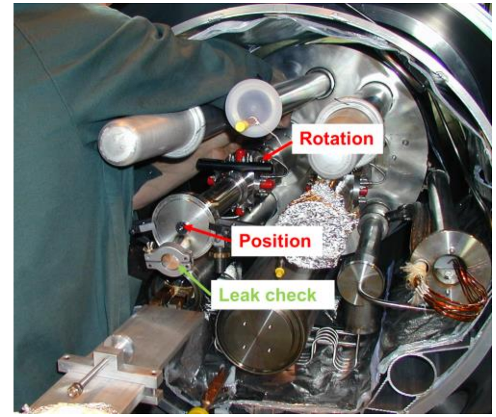
Installation and alignment sequence:

1. Install BPM installation and alignment tool (**to be designed**)
2. Install BPM
3. Align BPM to optimum position with help of screws and level gauges. The offset between this aligned BPM location to the nominal position, i.e. the misalignment, must be recorded.
4. Spot weld the BPM to the vacuum end tube at 8 points. The order of these welds should be such that any movement reduced the misalignment (i.e. starting with the point towards which the BPM should move).
5. Verify and record the position of the upstream end of the BPM after cool-down of the spot welds, the measurement must be recorded.
6. Final orbital weld. This weld should start at the point towards which the BPM should move to improve misalignment.
7. Verify and record the final position of the upstream end of the BPM after the welding process is complete. The measurement must be recorded.
8. Leak check of BPM beam screen weld.
9. Install and weld the cooling tubes, total 8 welds.
10. Leak check of cooling connection tubes, 8 welds.

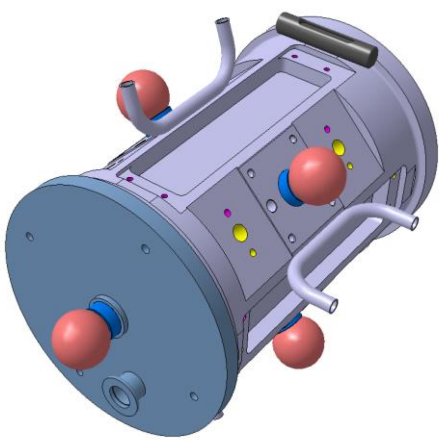
Beam Screen Interface (VSC, EDMS 2105453)

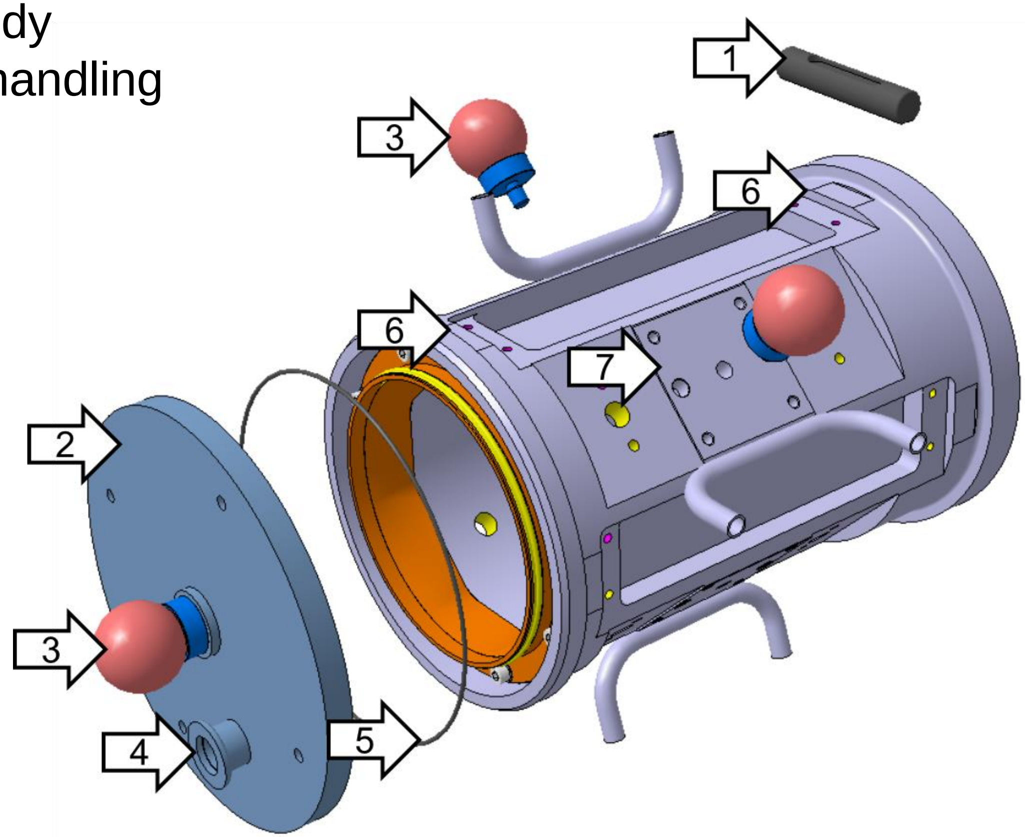


Alignment procedure and tooling



1. Level gauge WYLER Spirit Level 159-080-151-100
2. Alignment and vacuum sealing flange
3. LEICA TARGET 1,5“
4. KF16 port for leak tightness test
5. O-ring FPM D168 mm d2 mm
6. Flat surfaces on the BPM body
7. Features for alignment and handling





Dummy interface BPM is in production for future integration test

Targets and gauge were agreed with P. Bestmann

Status of design documentation

- 3D models are ready to prepare manufacturing drawings
- Preliminary versions of 2D manufacturing drawings are ready (all the details necessary for manufacturing)
- Minor details on 2D manufacturing drawings to be completed and drawings to be updated
- Integration study is underway but no showstoppers for manufacturing of BPM components

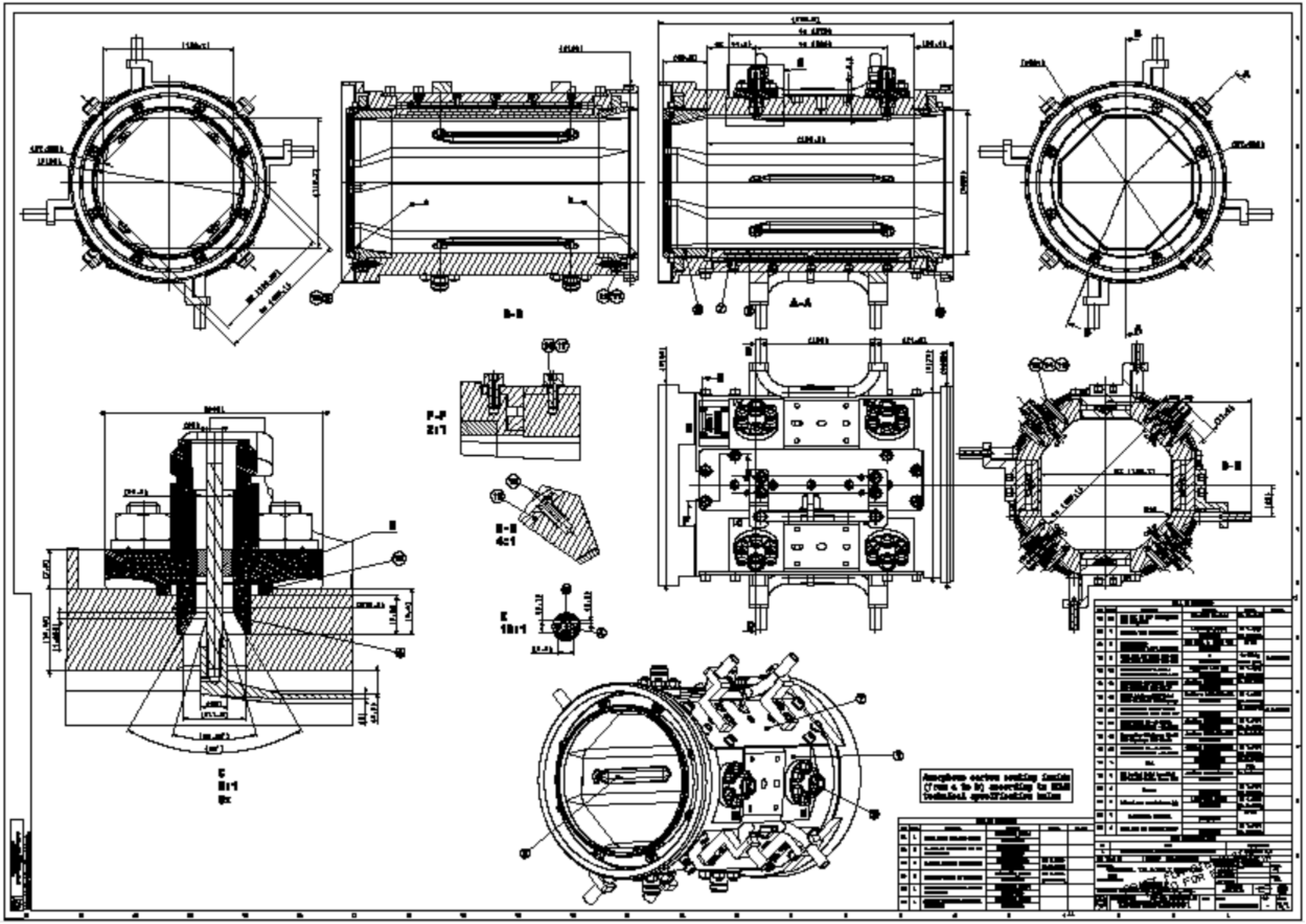
BPMQSTZ<u>B</u> LHCBPMQSTZB0001

BPMQSTZ<u>A</u> LHCBPMQSTZA0001

BPMQBCZ<u>A</u>/<u>B</u> LHCBPMQBCZA0001

and LHCBPMQBCZB0001

Status of design documentation



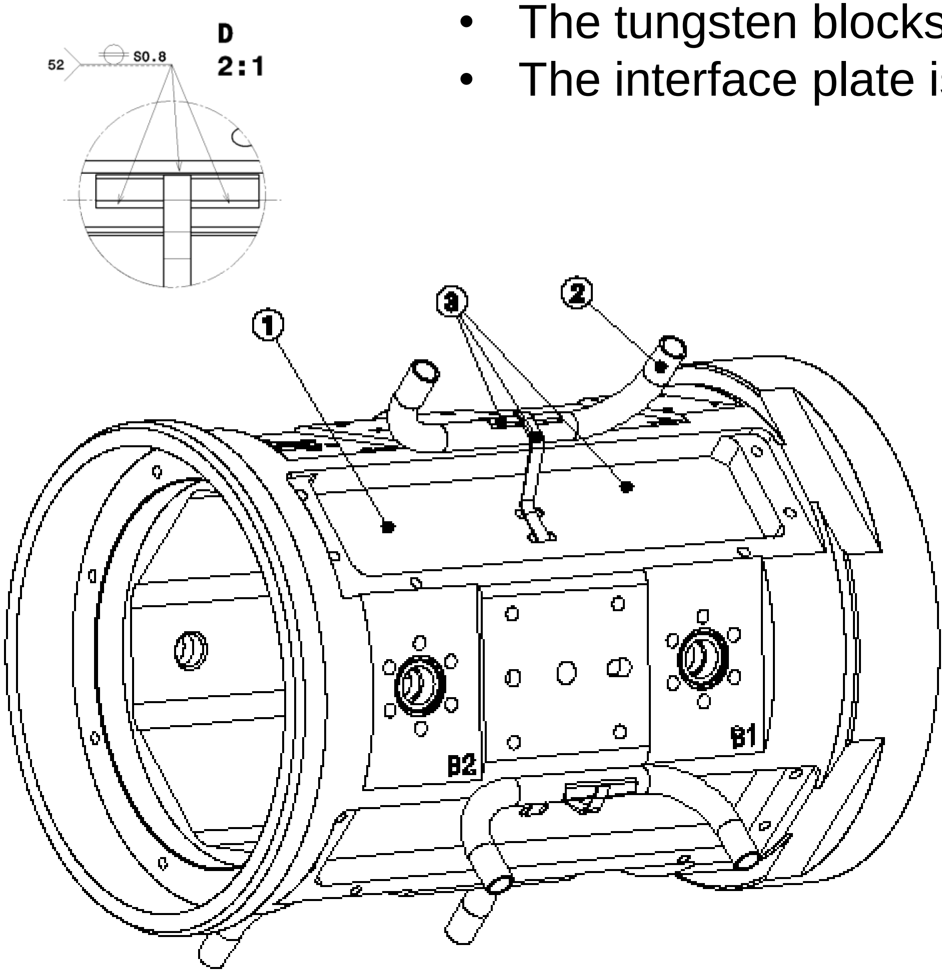
Thank you for your attention!

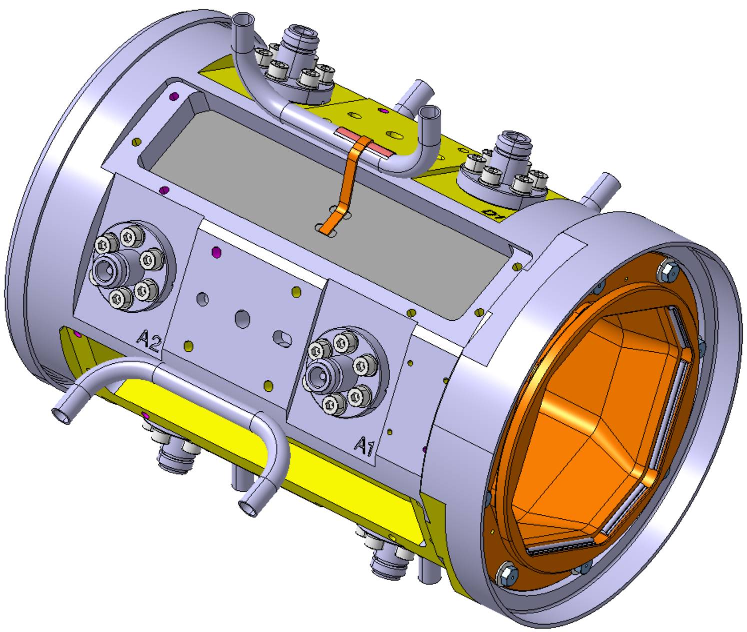
Special thanks for the input and discussions: N. Chritin, A. Demougeot, N. Kos, G. Favres, E. Rigutto, L. Prever-Loiri, R. Veness, K. Scibor, P. Bestmann, P. Costa Pinto, W. Vollenberg, P. Garritty, C. Garion, F. Santangelo, H. Garcia Gavela, M. Thiebert

backup

BPM Design Overview. BPMQSTZB
Body, welding tungsten – cooling subassembly (LHCBPMQST_B0002)

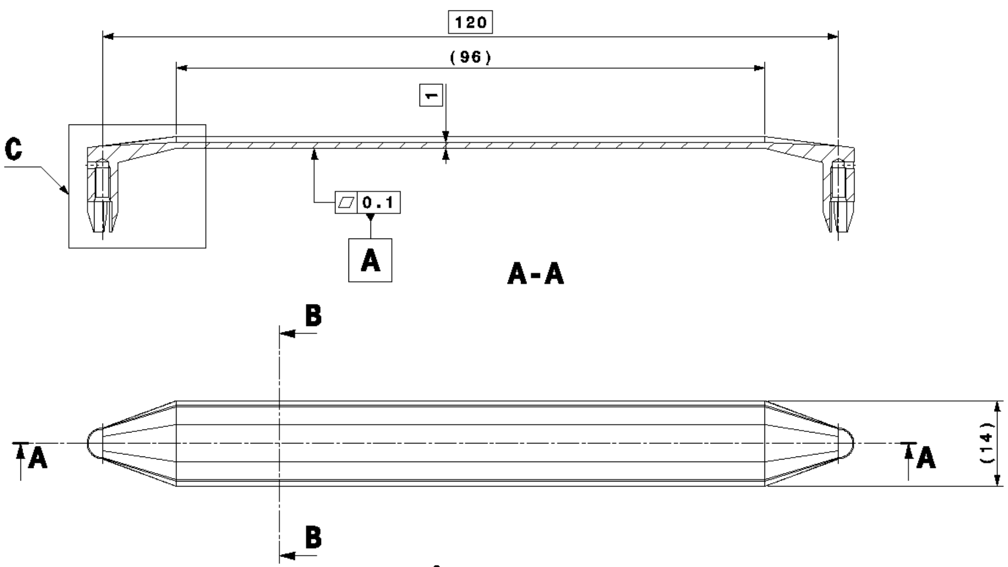
- Last welding step
- The tungsten blocks are put into the pockets on the body
- The interface plate is welded (laser) to the cooling tubes

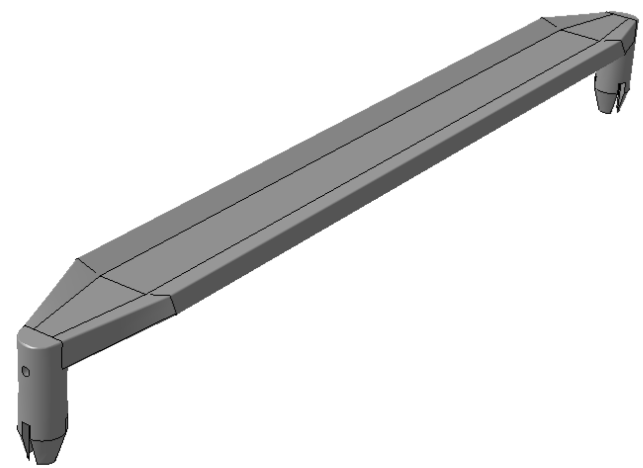




BPM Design Overview. BPMQSTZB Electrodes (LHCBPMQFT0003)

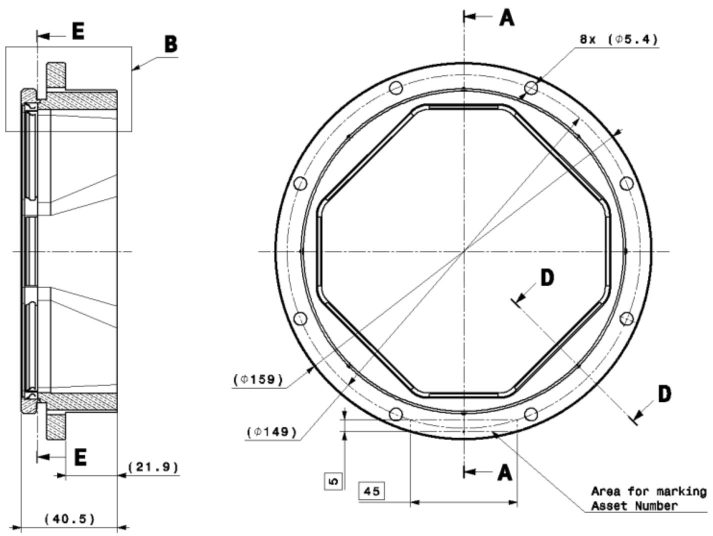
- Iterative design, several prototypes have been manufactured
- Design optimization is still underway, one more iteration is most likely OK
- Material: CERN material spec. 1000 for 1.4429 round, forged round bars



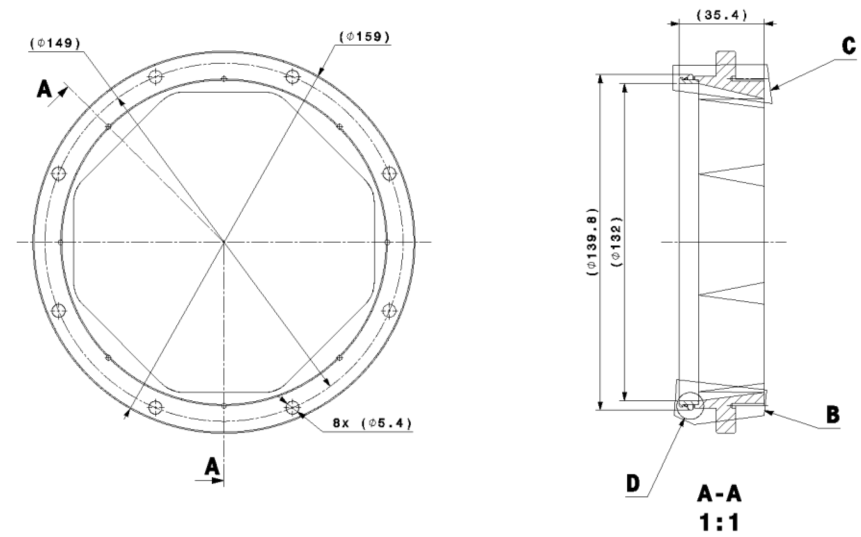


BPM Design Overview. BPMQSTZB
Transitions (LHCBPMQST_B0003 and LHCBPMQST_B0004)

LHCBPMQST_B0003



LHCBPMQST_B0004



- CERN material spec. 2000 for Oxygen-Free Electronic copper sheets – transition parts
- CuBe 17410 – electric contacts
- Electrical contacts are supplied in form of 600 mm strips