Conceptual design of the Crab Cavities vacuum system

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Many thanks to V. Baglin, C. Garion, N. Kos & M. Sitko

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EDMS: 1864637 v.1

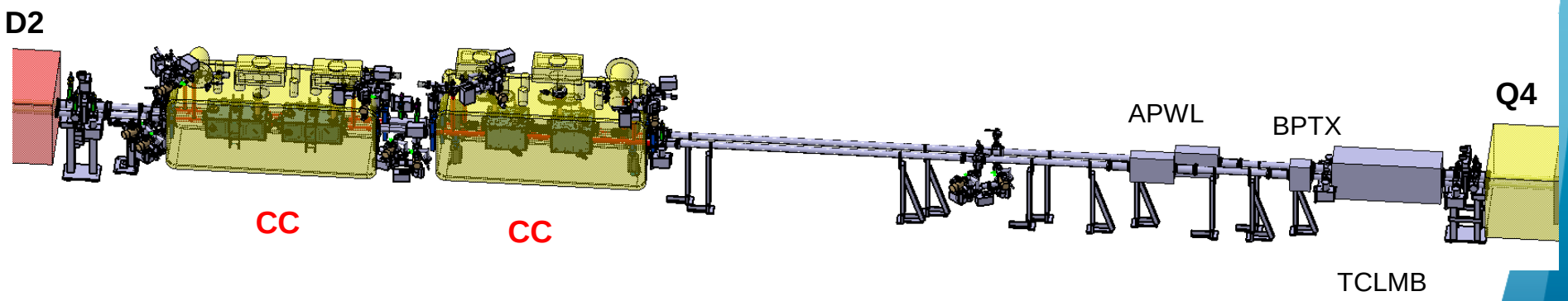
Outline

1. Introduction
2. Cryomodule vacuum system
3. Crab cavities interconnection
4. Conclusions

1. Introduction

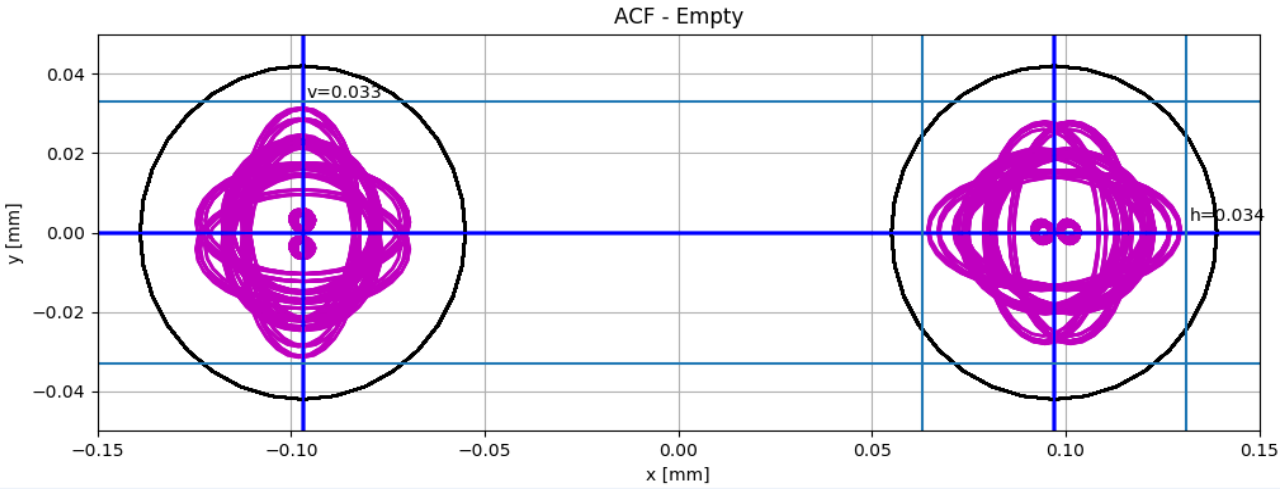
LSS1&5 Crab cavities layout

- Three double room temperature sectors bakeable and NEG coated.
- Two sectorized Crab Cavities modules: unbaked and operating at cryogenic temperature (2K).
- Three types of sector valves assemblies (VAB).
- The mechanical aperture of the cryomodule ID84 (could be reduced to ID80?)
- The mechanical aperture of the vacuum chambers is ID80 mm (could be increased to 91 mm if needed) and the flanges DN100.
- Space for vacuum operation to be defined.
- Compatible with the beam aperture.



Crab cavities maximum beam aperture

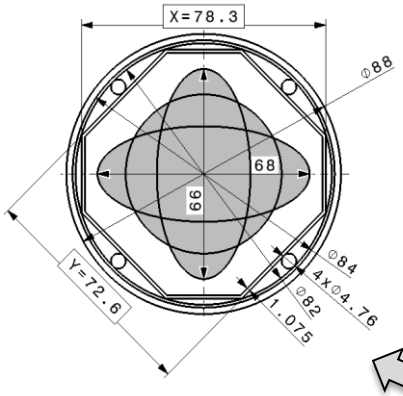
- Inputs given by WP2 (R. de Maria, 27/04/2017).
- The maximum beam size is given without any alignment and mechanical tolerance. It includes round, low beta, flat and VMD optics and 2 mm of IP shift.
- Maximum beam aperture given without any mechanical & alignment tolerance.
- Crab cavity aperture & alignment with respect to the 84 mm of mechanical aperture under study.



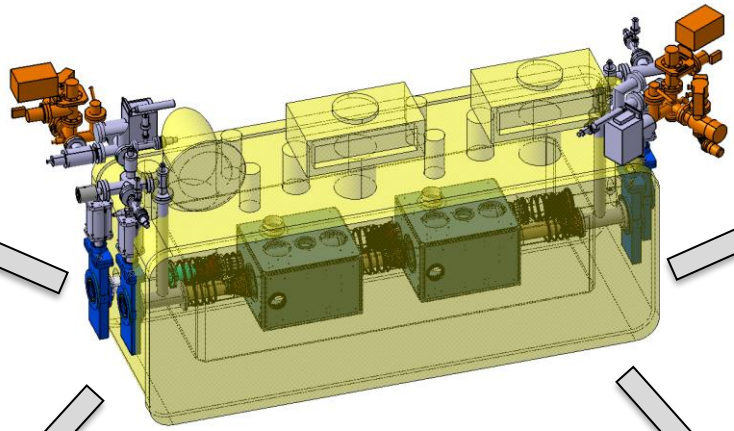
Max. beam size inside the Crab Cavities	
Vertical	66 mm
Horizontal	68 mm

2. Cryomodule vacuum system

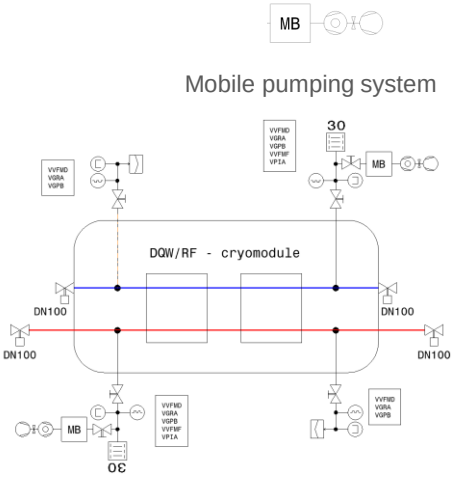
Preliminary design of the crab cavities cryomodule vacuum system



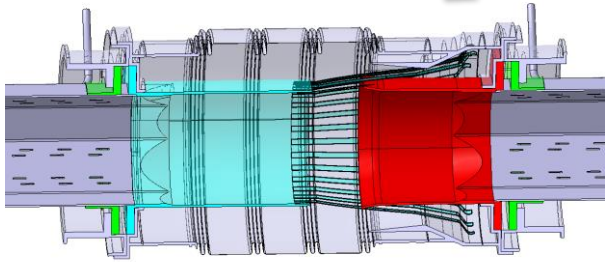
Beam screen assembly



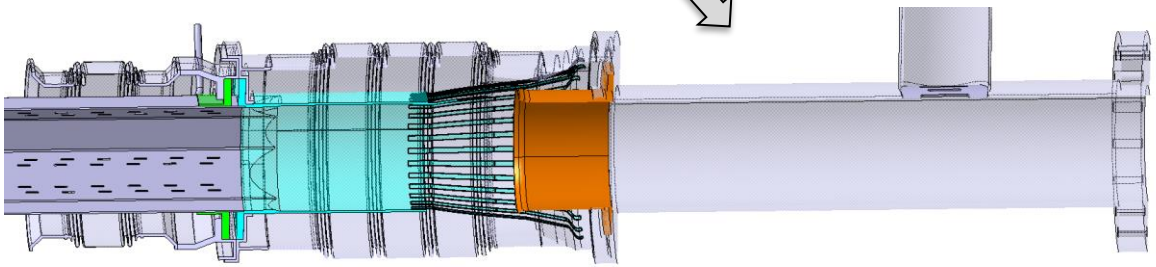
DQW Cryomodule mock-up
(ST0900622_01)



Vacuum instrumentation



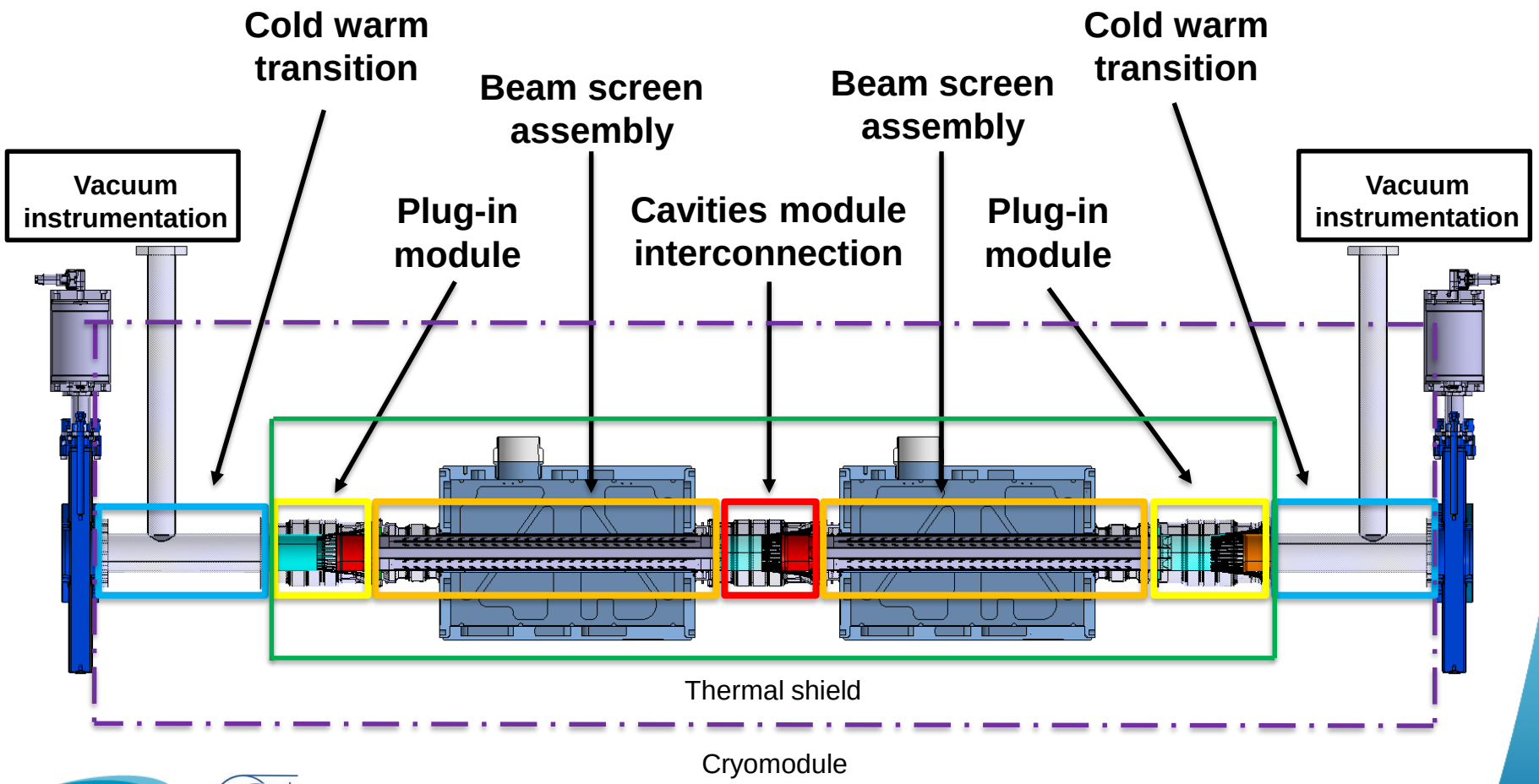
CC module interconnection



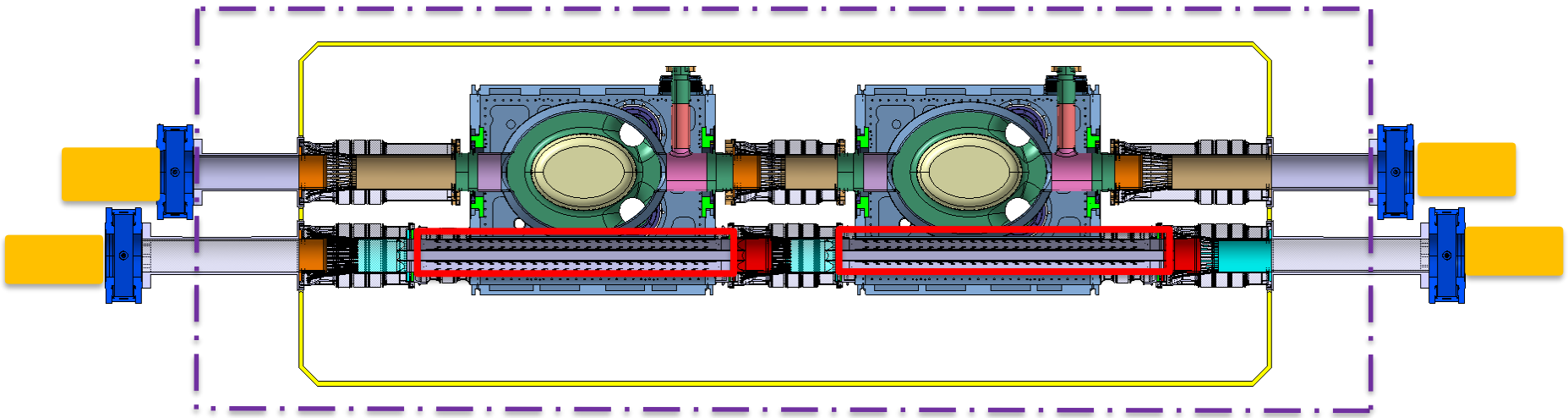
Plug-in module + Cold Warm Transition

Cross section DQW Cryomodule vacuum system in non-crab beamline

- Crab beam line has the same configuration but without beam screen assembly. In consequence, its mechanical aperture is circular.



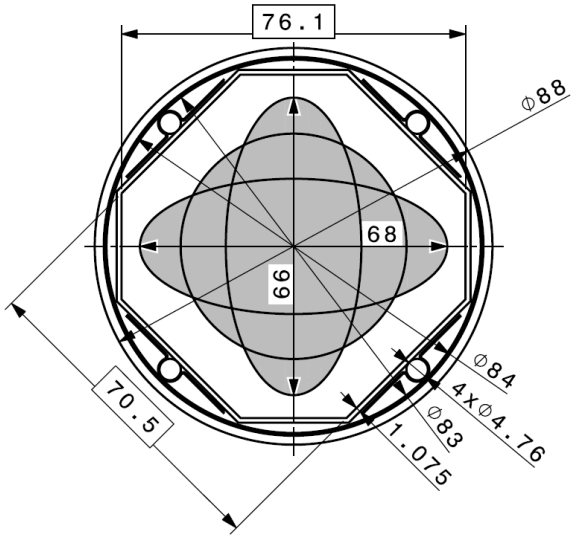
Coating schematic of the DQW Cryomodule vacuum system

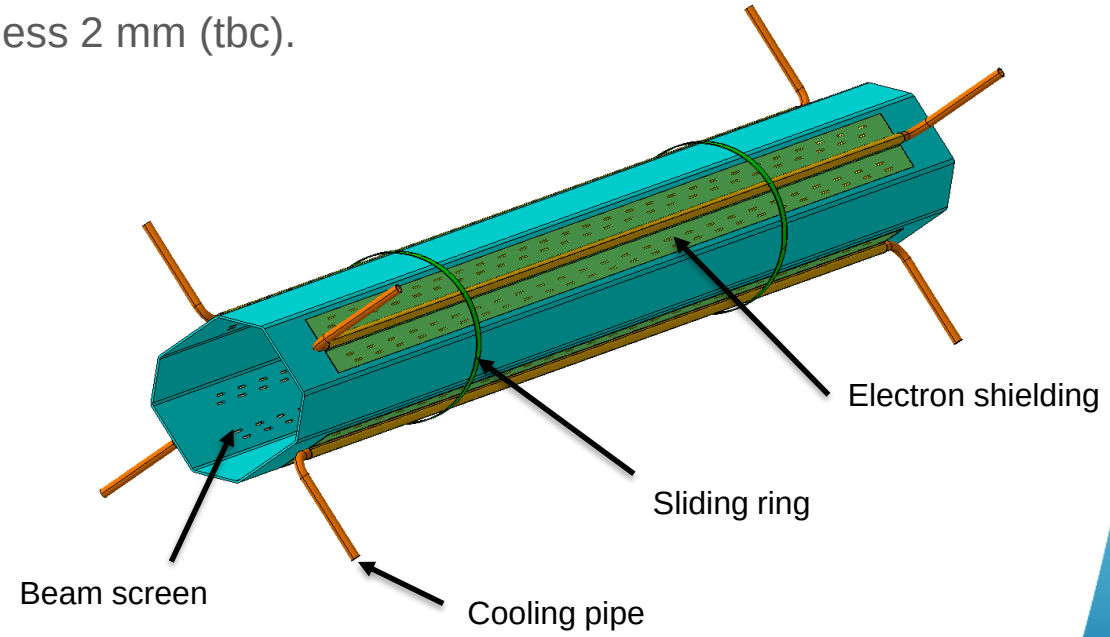


- Cryomodule
- RT Vacuum equipment NEG coated
- Beam screen a-C coated

Crab cavities beam screen draft

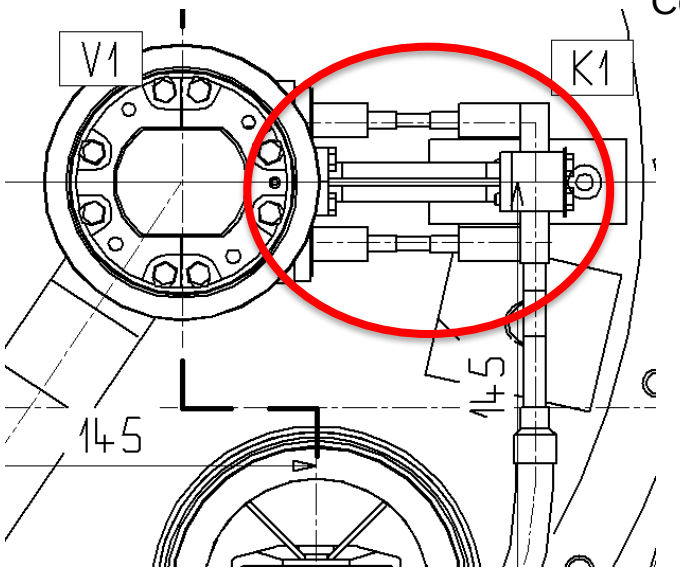
- Dimensions to be fixed.
- Irregular octagonal shape.
- OD/ID of 4.76/3.7 mm cooling tube (it can be increased if required but the mechanical aperture will be reduced).
- Electron shielding.
- Material: stainless steel (1 mm thickness) + co-laminated cooper layer (0.075 mm thickness).
- A-C coating on the cooper layer.
- 4.4 % transparency.
- Beam screen temperature 5-20K.
- Present cold bore with OD/ID of 88/84 mm in Titanium grade 2 to follow cryostats shrinkage during cool down .
  - Maximum cold bore thickness 2 mm (tbc).



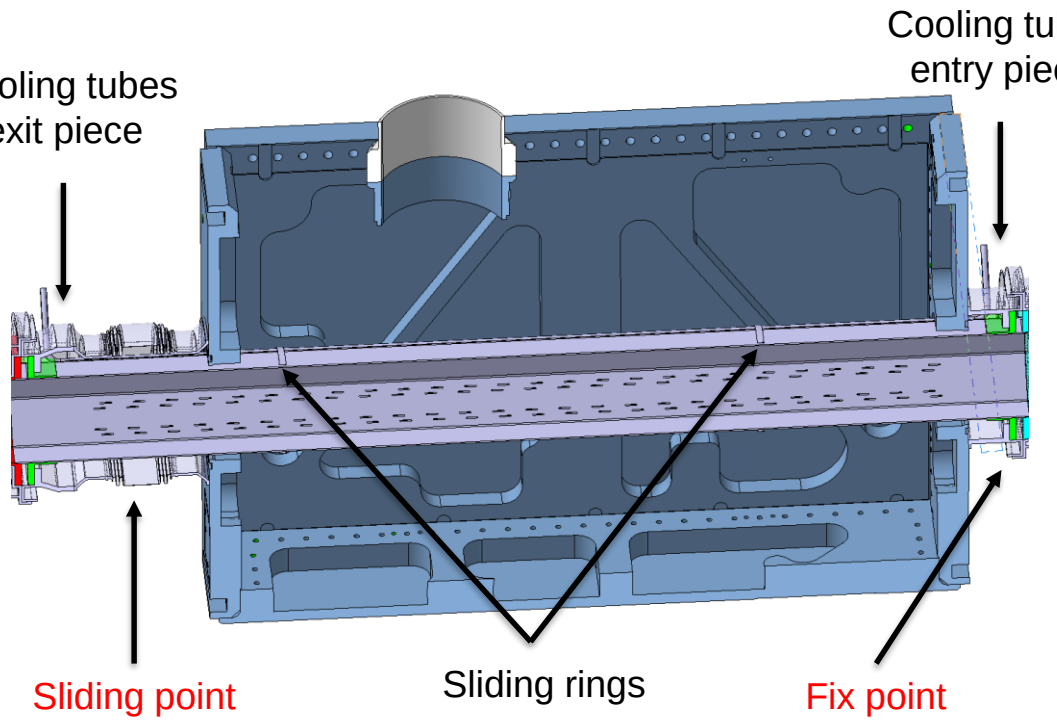


Beam screen supporting system

- The same concept than in a standard LHC interconnection.
  - LHC reference: LHCLIAQB0003.
- One fix point and one sliding point.
- Beam screen hold by the cold bore through the sliding rings.
- Flexible LHC system for the cooling tubes exit piece (cooling tubes interface with insulation vacuum) to be integrated and dimensioned.
  - LHC reference: LHCVSSB_0138.

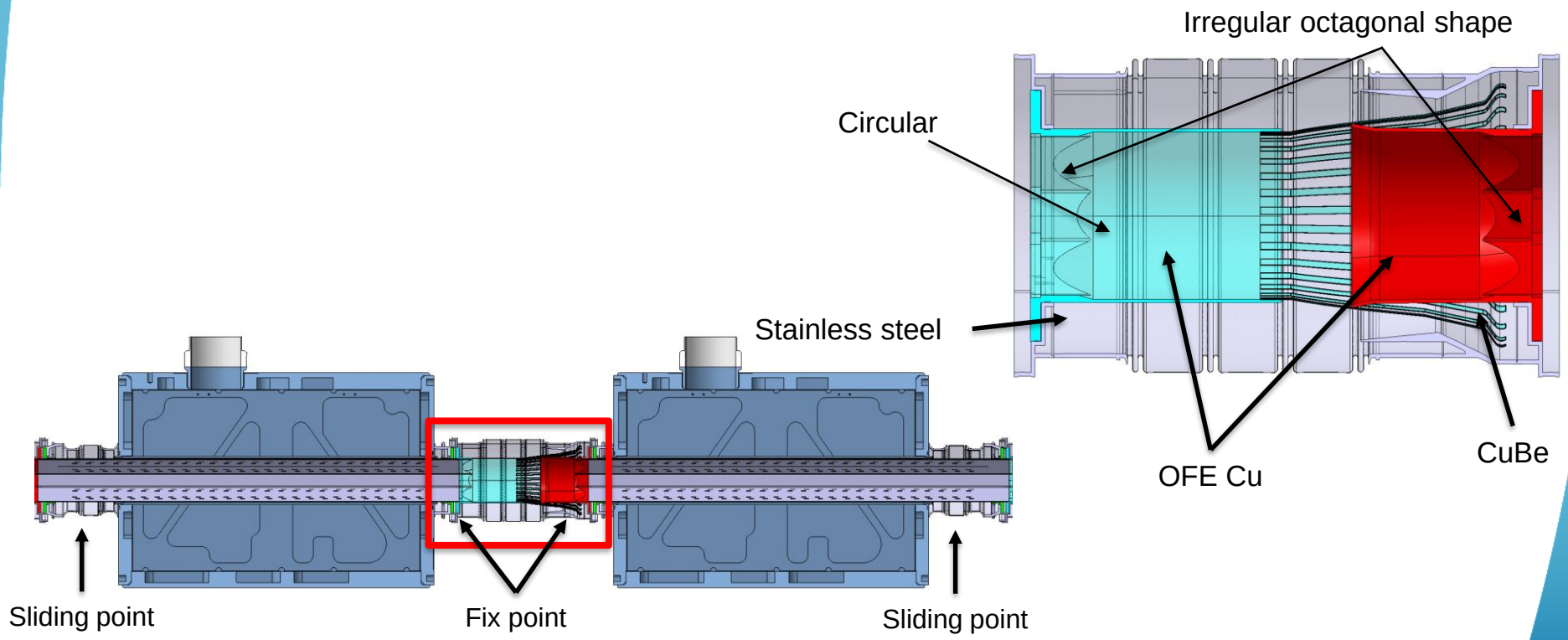


LHC exit cooling pipe flexible system



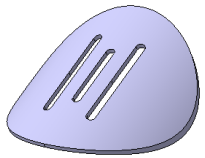
Crab cavities symmetry

- The same concept than in a standard LHC interconnection.
  - LHC reference: LHCLIAQB0003.
- Plug-in module to be sized from a standard LHC plug-in module.
  - LHC reference: LHCVBMV_0002.
- Transition form beam screen shape to circular on both extremities.
- The same materials and coating as in LHC standard plug-in module.
  - Rh coating on the RF fingers.
- Configuration compatibility for both sides of the interaction point under study.

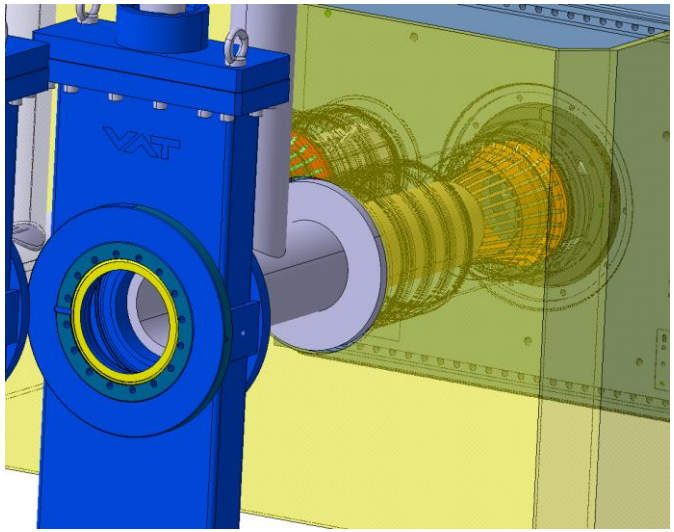


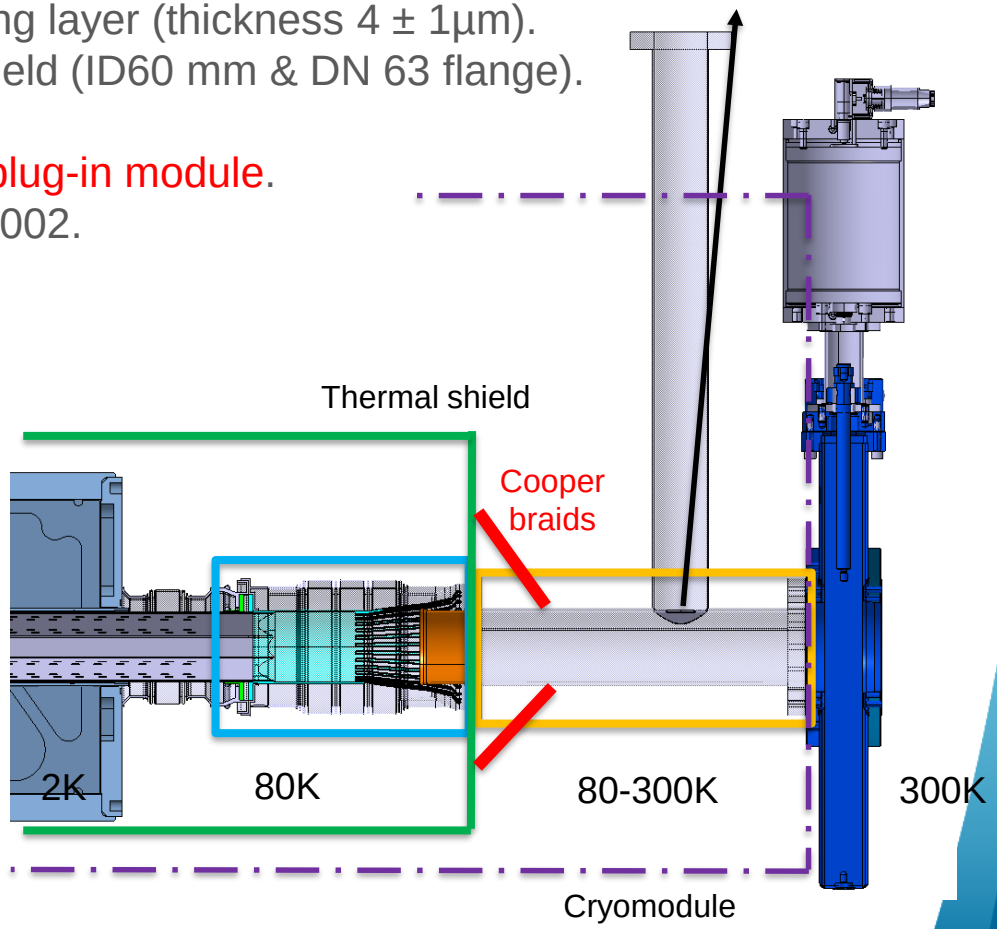
Plug-in module + Cold Warm Transition

- Cold warm transition (CWT):
  - The cryomodule doesn't shrink & it holds the sector valve.
    - The same concept as LSS1,2,5&8 Q1 cold warm transition.
  - Is not attached to the thermal shield as in LHC CWT.
  - Material:
    - Stainless steel + copper plating layer (thickness 4 ± 1µm).
  - Instrumentation port with beam shield (ID60 mm & DN 63 flange).
- Plug-in module:
  - To be sized from a standard LHC plug-in module.
    - LHC reference: LHCVBMV_0002.



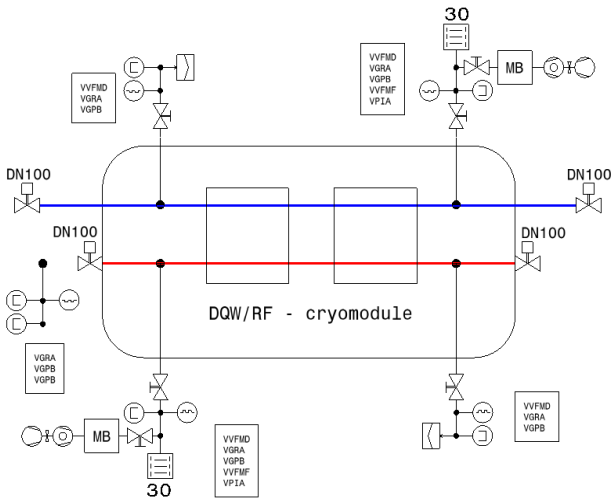
Beam slotted screen



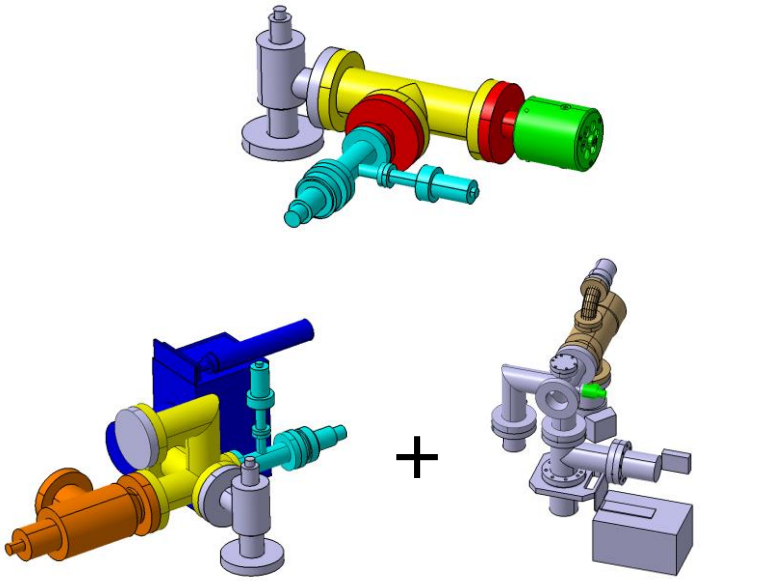


Vacuum instrumentation

- Instrumentation must be easily accessible for operation activities.
- Detailed integration study must be conducted and validated with WP4 and WP15.
- Interlocked sector valves.



Blue: crabbed beam
Red: non-crabbed beam



Mobile pumping system

3 different vacuum assemblies with the instrumentation required

Mobile pumping system

3. Crab cavities interconnection

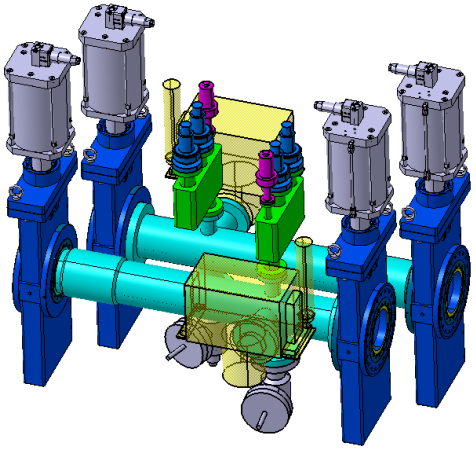
Cryomodule Interconnection

- A specific vacuum module must be designed with the following specifications:
  - Proposed length equals to 725 mm.
  - Enough strength to support all the instrumentation required in a vacuum sector.
  - The vacuum module must be bakeable up to 250 °C.
  - Flanges DN100.
  - NEG coated.

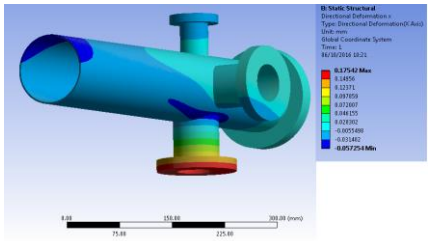
- The whole vacuum equipment is supported by the cryomodule.

- Detailed integration study is mandatory!

- Preliminary design done: EDMS 1841111.

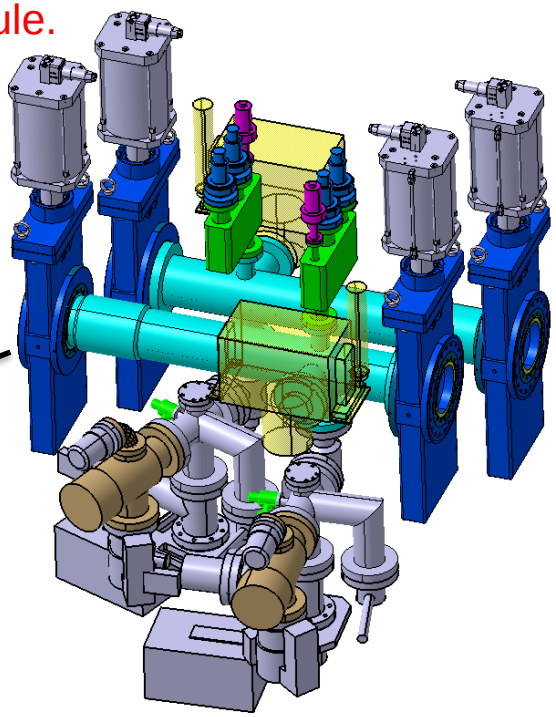


During operation



New vacuum module stress analysis

CC



CC

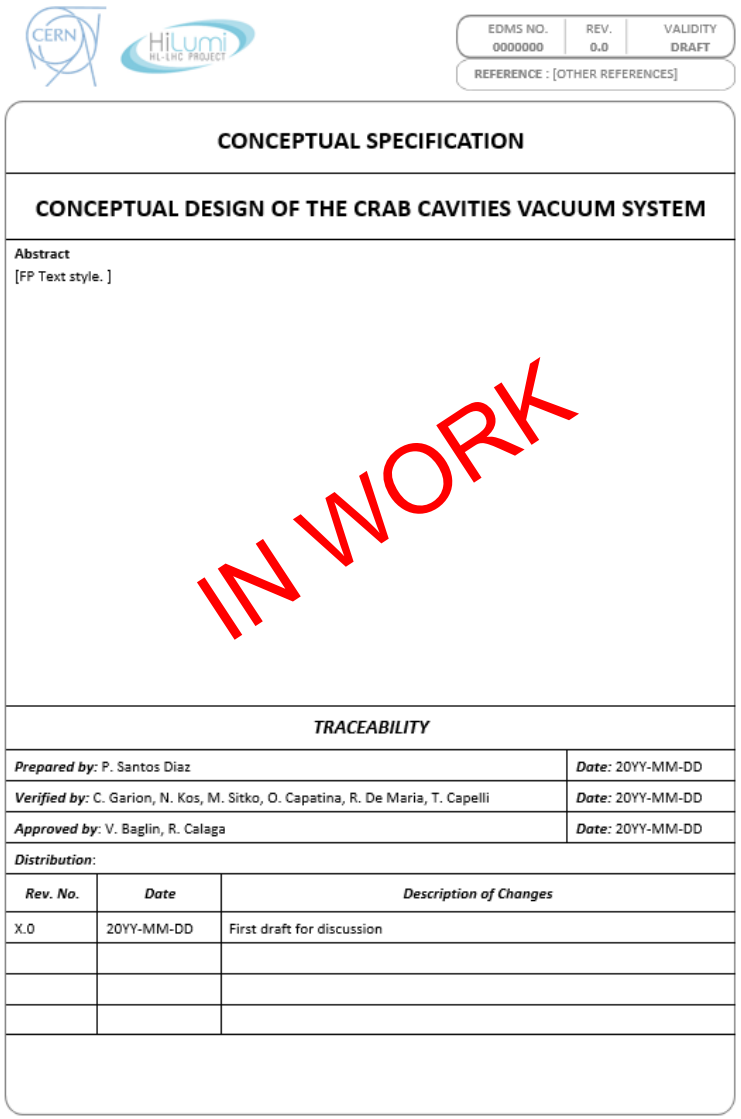
During vacuum intervention

4. Conclusions

Conclusions

- A conceptual vacuum system for the crab cavities is proposed.
- Vacuum system to be sized and integrated inside the DWQ & RF mock-up.
- A conceptual specification document to be done.
- Detailed vacuum instrumentation integration to be done.

Conceptual design document



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REFERENCE : [OTHER REFERENCES]

CONCEPTUAL SPECIFICATION

CONCEPTUAL DESIGN OF THE CRAB CAVITIES VACUUM SYSTEM

Abstract

[FP Text style.]

IN WORK

TRACEABILITY

Prepared by: P. Santos Diaz	***Date:*** 20YY-MM-DD
Verified by: C. Garion, N. Kos, M. Sitko, O. Capatina, R. De Maria, T. Capelli	***Date:*** 20YY-MM-DD
Approved by: V. Baglin, R. Calaga	***Date:*** 20YY-MM-DD
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Rev. No.	*Date*	*Description of Changes*
X.0	20YY-MM-DD	First draft for discussion

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