SPL
-
Cryostat and tooling

Patxi DUTHIL Patricia DUCHESNE Sébastien ROUSSELOT

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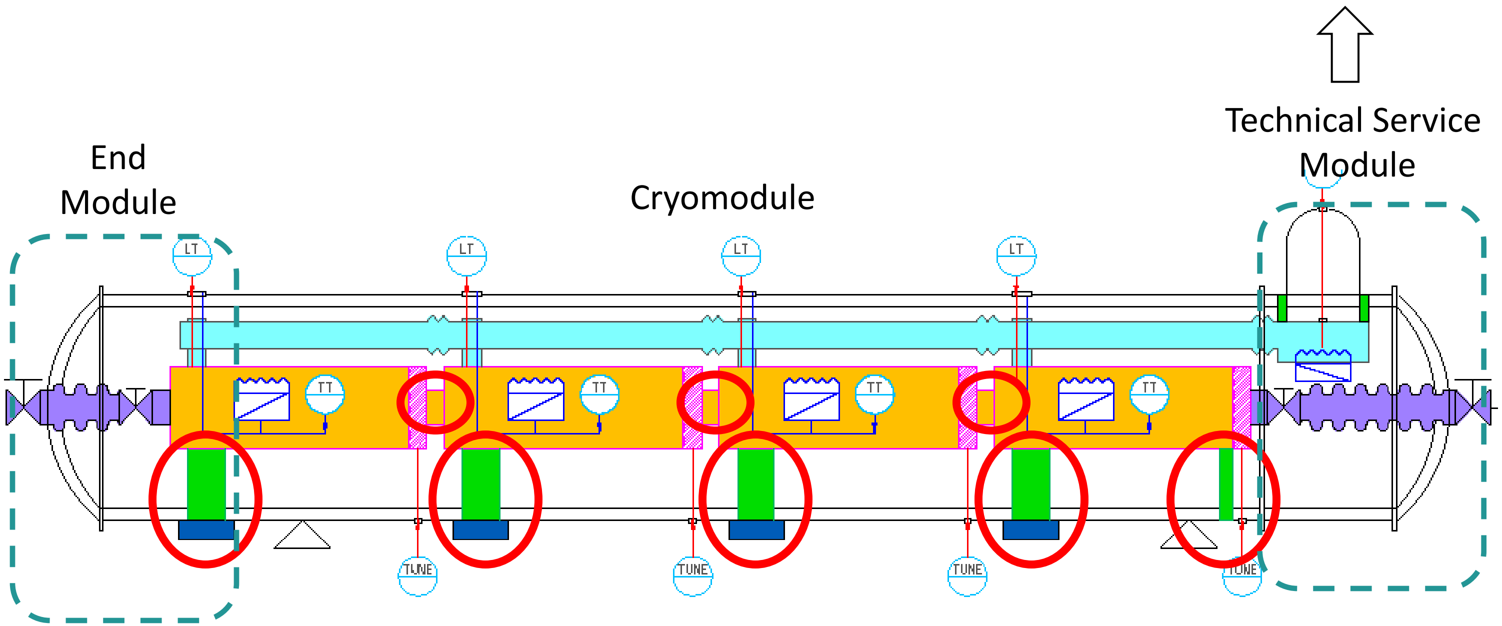
Cryostat - General layout



1.7% Slope (adjustable 0-2%)

A.Vande Craen (MSC-CI)

Cryostat - General layout

Transversal position specification

BUDGET OF TOLERANCE			
Step	**Sub-step**	**Tolerances (3σ)**	**Total envelopes**
Cryo-module assembly	Cavity and He vessel assembly	*± 0.1 mm*	Positioning of the cavity w.r.t. beam axis **± 0.5 mm**
	Supporting system assembly	*± 0.2 mm*	
	Vacuum vessel construction	*± 0.2 mm*	
Transport and handling (± 0.5 g any direction)	N.A.	*± 0.1 mm*	Stability of the cavity w.r.t. beam axis **± 0.3 mm**
Testing/operation	Vacuum pumping	*± 0.2 mm*	
	Cool-down		
	RF tests		
	Warm-up		
	Thermal cycles		

Construction precision

Long-term stability

Organization

- **CNRS centralizes the CAD models of :**
  - the cryostat
  - the CERN cavity and its CEA Helium tank
  - of the CEA tuner

  (validated during the CEA/CERN/IN2P3 meeting : October 15th 2010)

- **CNRS integrated and updated the CEA tank, tuner and the CERN cavity : 15/11/2010**

⇨ CNRS proposes the required modifications on

. the helium tank

. the tuner

to make the integration within the cryostat

⇨ Proposes have to be approved (or not) by CERN and CEA

⇨ Facilitate the integration

Cryostat – Vacuum vessel conceptual study

Grid of analysis

→ Analysis of the cryostating method

→ Analysis of the stress/deformation in regards of the specifications (alignment spec.)

→ Construction constrains and specifications

2 types of the cryostat vacuum vessel were studied

- Non-cylindrical cryostat allowing a vertical cryostating
  - More complex vessel design (need of a large opened window)
  - Simpler tooling for cryostating (to be discussed)
  - Smaller tank diameter : 1020mm (see cryostating method)
- Cylindrical allowing a longitudinal cryostating (LHC type)
  - Intrinsic better mechanical behaviour (inertia, vacuum)
  - Simpler construction
  - Larger diameter of the tank : 1500mm (see cryostating method)
  - Needs of windows for the accessibility of the cryostat components
  - Involves a more complex set of tooling (needs of lateral displacement)

Cryostat – Vacuum vessel conceptual study

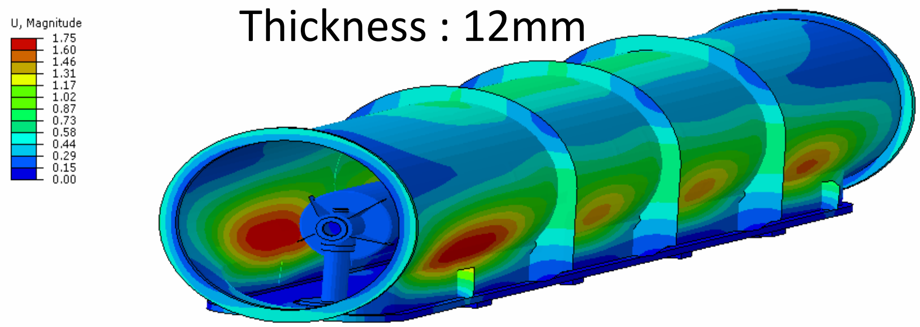
(Non-)cylindrical vessel allowing a vertical cryostating

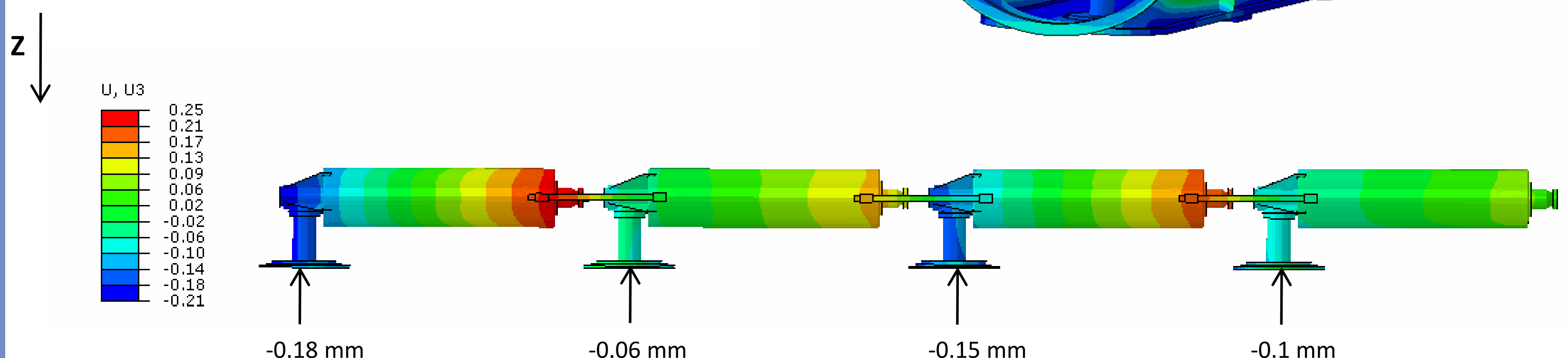
- Preliminary vessel concept :
  the geometry was taken from a pipe (→ cut cylinder)

Calculation of the displacements on the coupler flanges :

- external pressure of 1 bar (vacuum)
- acceleration : 1g
- with the load of 4 cavities & 4 tuners

∅ext = 1020mm
Thickness : 12mm





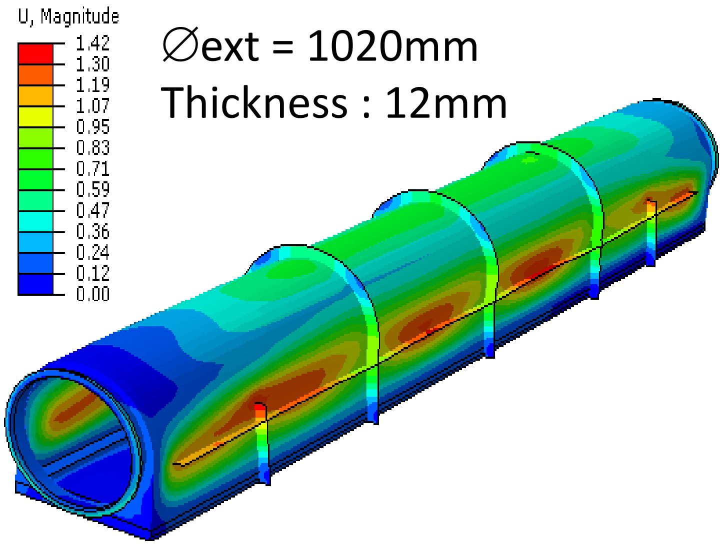
⇨ The weight of 4 cavities has a little influence on the deflexion
⇨ Maximum displacement obtained on coupler flange : 0.12 mm

Cryostat – Vacuum vessel conceptual study

Non-cylindrical vessel allowing a vertical cryostating

- Preliminary vessel concept → fabrication consideration : use of a 12mm thick rolled metal sheet (→ U shape)
  - external pressure of 1 bar on the tank to simulate vacuum constrain + 1g:

Øext = 1020mm
Thickness : 12mm



Maximum displacement on the coupler flanges : 0.12mm

⇨ Rigidity can be at least as good as the cut cylinder

⇨ Thus, with some optimization, it seems realistic to achieve the specs.
⇨ But the fabrication seems not to be easy (interface of the tank closing)
⇨ It probably deeply impacts the fabrication tolerances

- **Cyl. vessel allowing a longitudinal cryostating (LHC type)**

(→ cylinder : Intrinsic better mechanical behaviour)

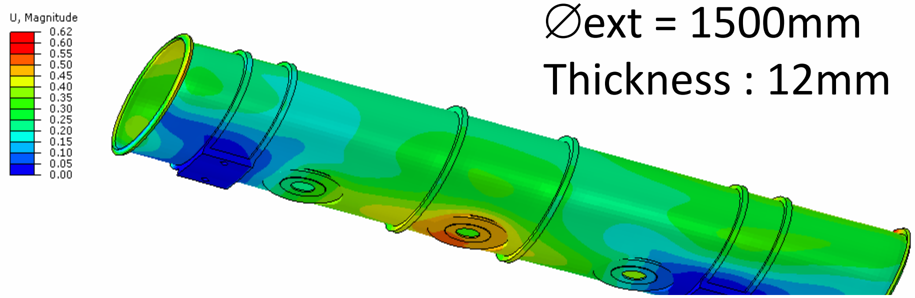
- ○ Example : external pressure of 1 bar on the tank to simulate vacuum constrain + 1g

∅ext = 1500mm

Thickness : 12mm

Distance between pods = 4500mm

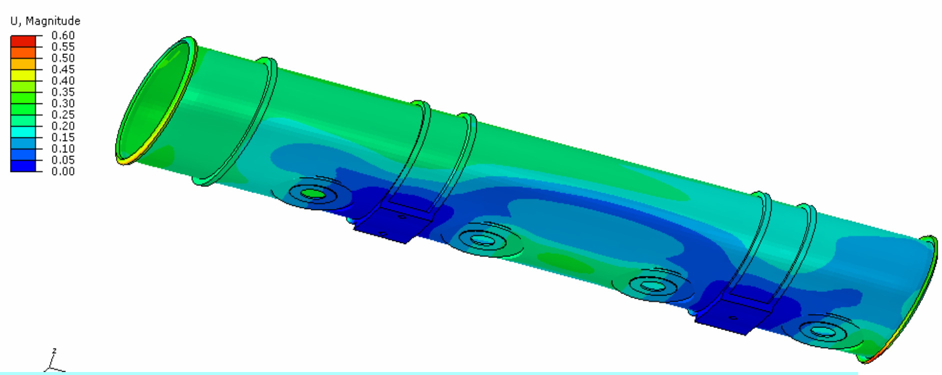
➔ ΔUmax (couplers flanges) = 0.3mm



- Way of optimization : position of the pods

Distance between pods = 3000mm

➔ ΔUmax (couplers flanges) < 0.1mm

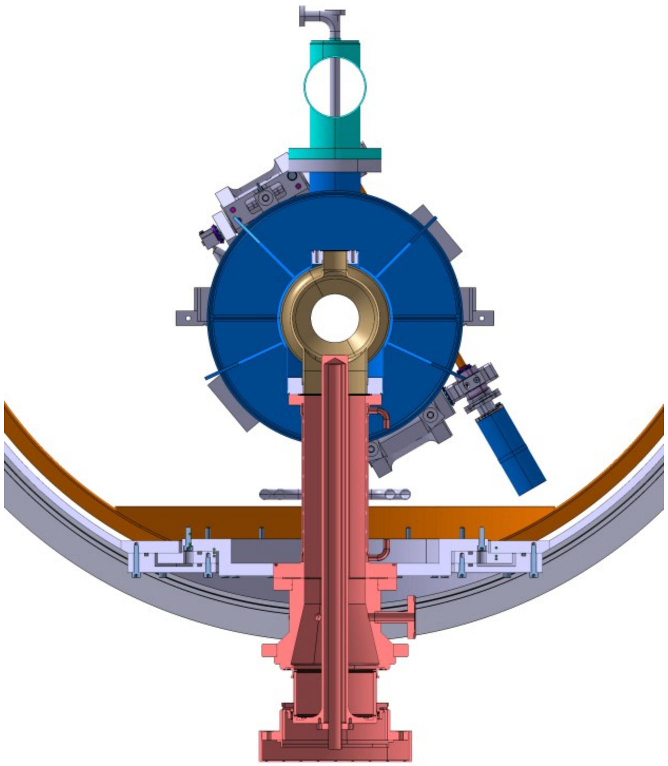


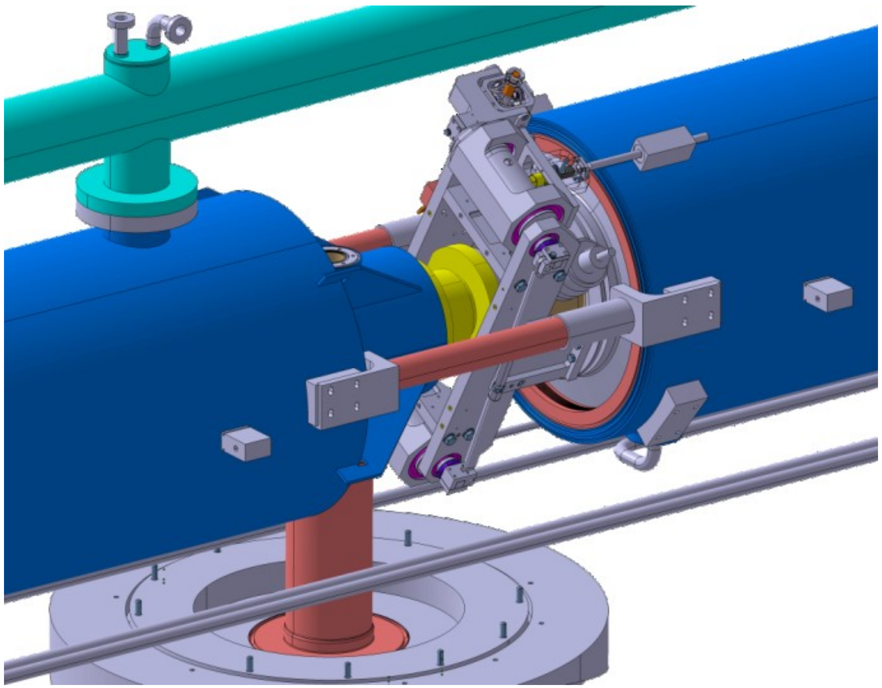
⇨ Optimization will aim at gaining on the estimated alignment tolerances

⇨ Optimization will be carried out in the frame of the detail study

Cryostat – Cavity Support system

- **Based on :**
  - Coupler bi-tube supporting
  - Cavities inter-connections

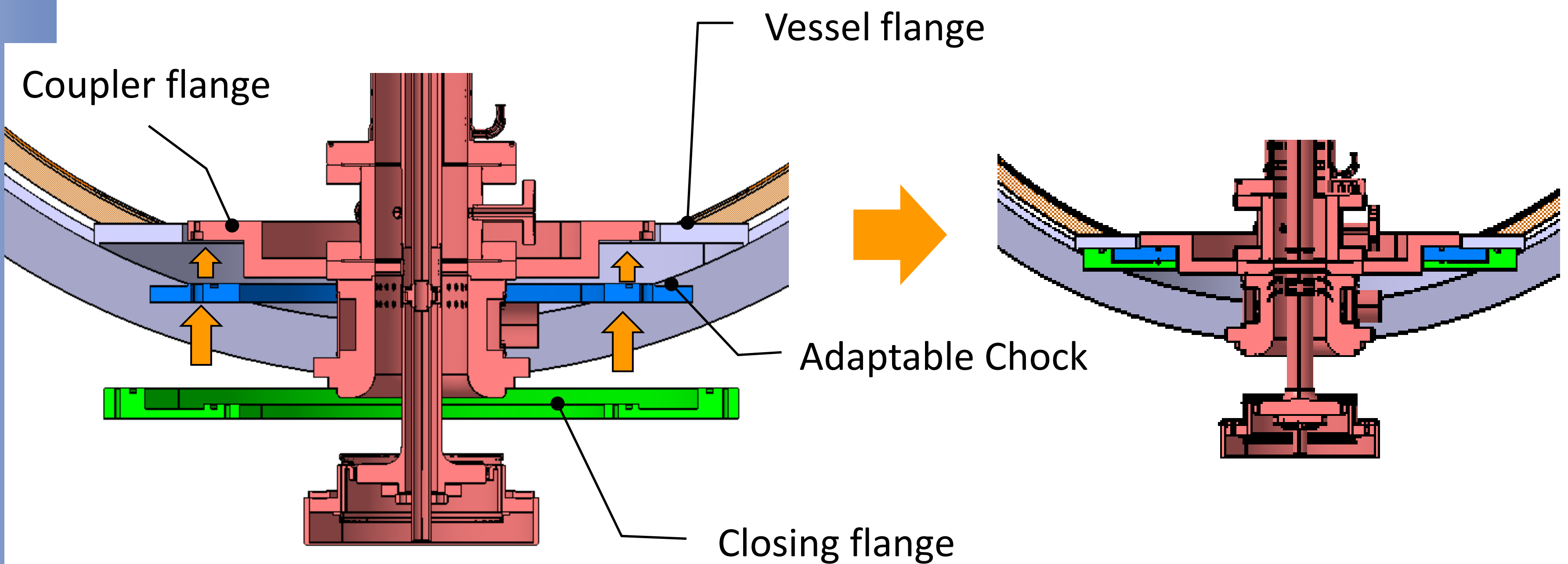




Cryostat – Cavity Support system

Coupler supporting

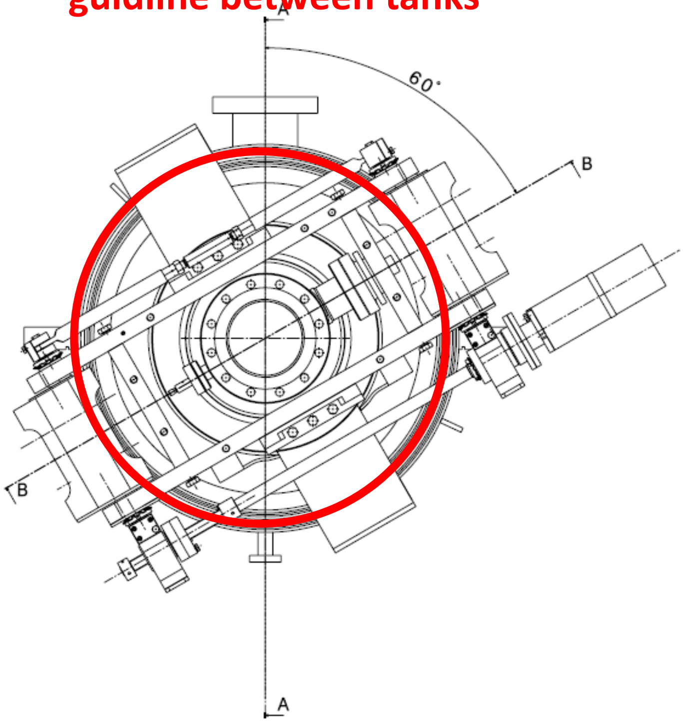
- Definition of the vacuum tank / coupler flange interface
  - in regards with the cryostating method



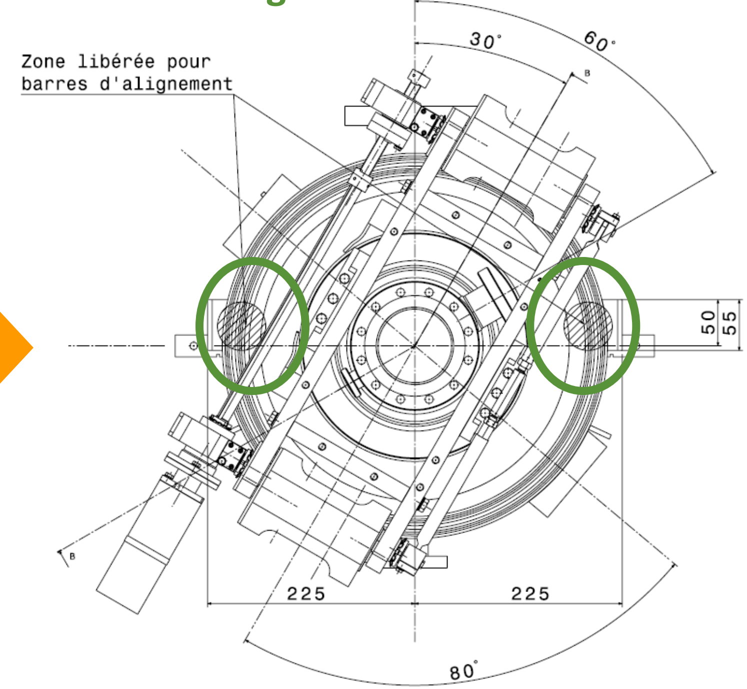
Cavities inter-connection problematic

- Magnetic shield + Tuner + HOM + RF pick-up → obstruction → needs of a compact inter-connection
- LHe tank : weld between the elbow and the tank shell
- Inter-connection needs to be mounted outside the clean room

No available areas for a guidline between tanks

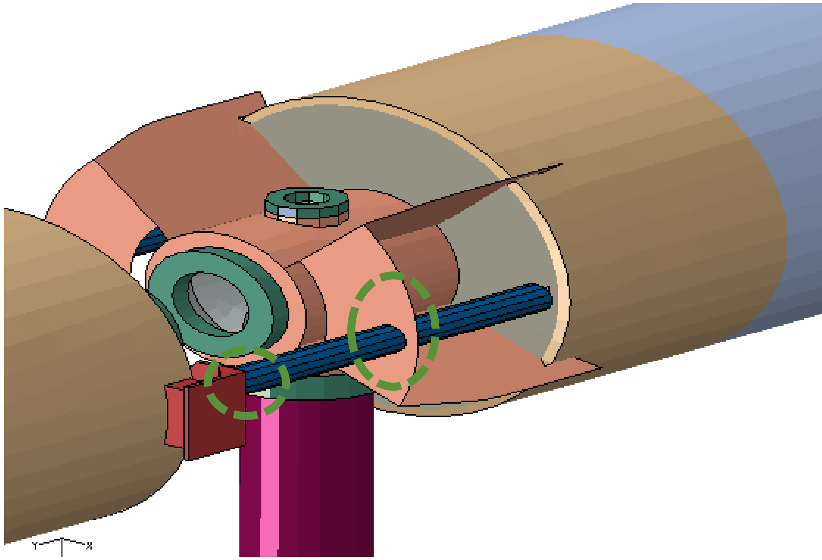


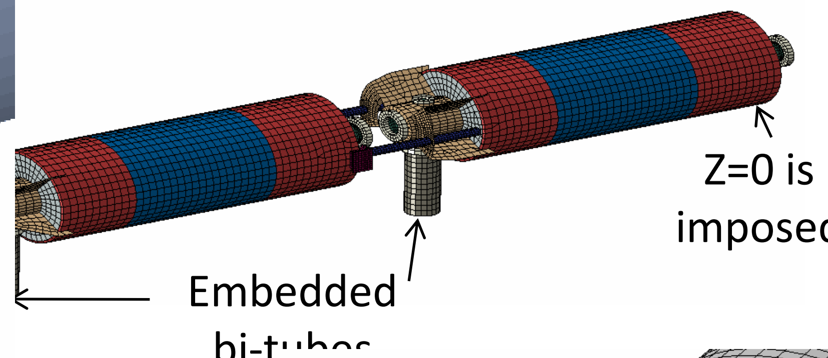
Available areas for a guidline between tanks

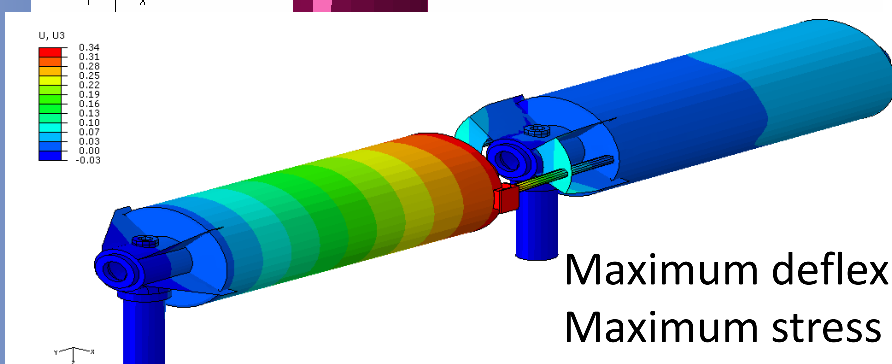


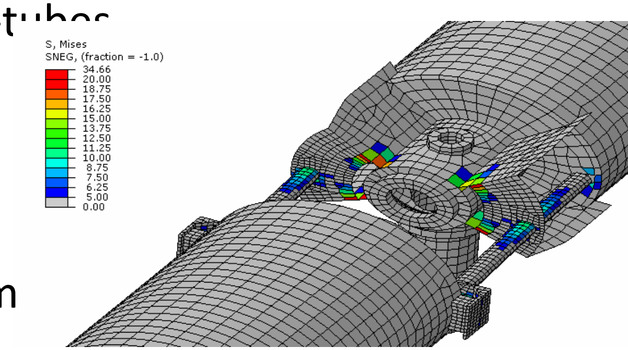
Cryostat – Cavity Support system – Cavities inter-connection

- **Preliminary concept (CERN) :** -2 x stainless steel ∅=35mm rods
  - Reinforcing plates on the helium tank to reduce the deflexion of the rods
  - Sliding without friction and no gap







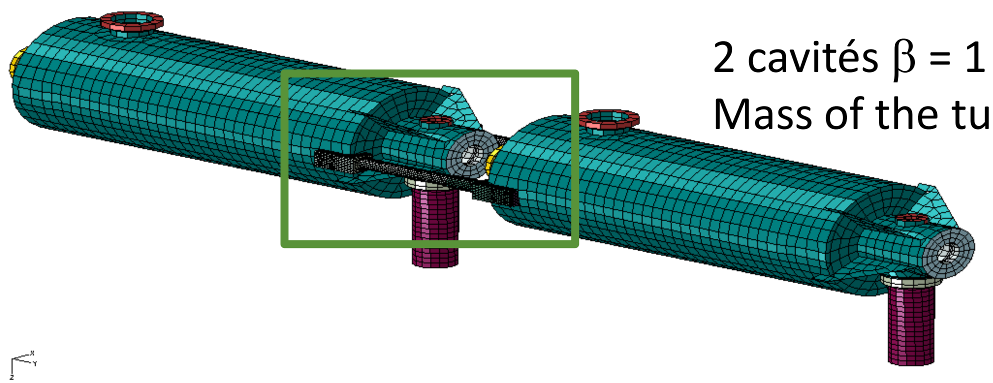


Maximum deflexion : 0.31mm
Maximum stress : 20MPa

⇨ Compact inter-connection
⇨ Critical links between : plates/rods ; rods/tank gasket (different materials, welded areas, mounting procedure during the cryosating)

Cryostat – Cavity Support system – Cavities inter-connection

Preliminary concept 2

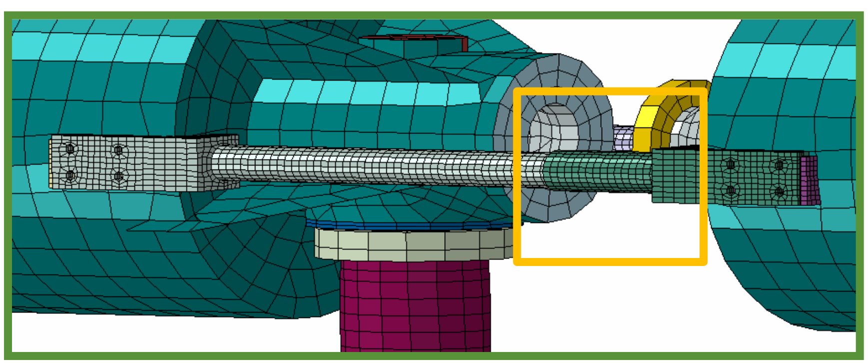


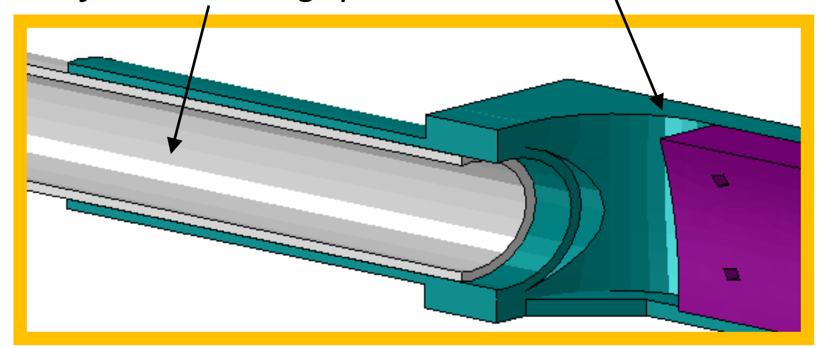
2 cavités β = 1 fixed at the bottom of their couplers
Mass of the tuner is taken into account

Possibility of adding 2 chocks for the y and z alignment procedure

<u>Assumptions</u> :
Stainless steel tubes (∅ext = 40mm ; e=3mm) and support
Titanium He tank

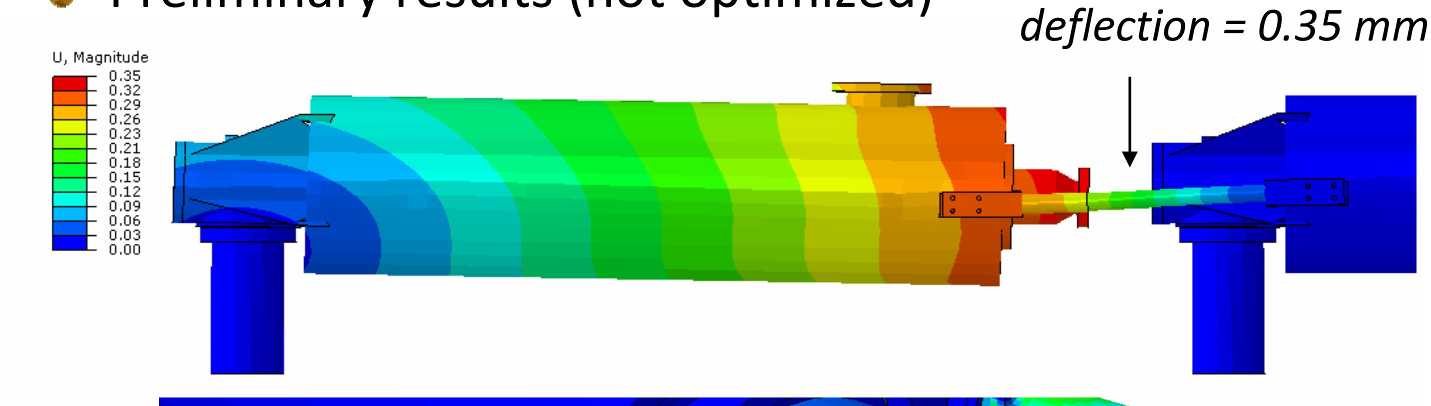
Sliding without friction - No gap

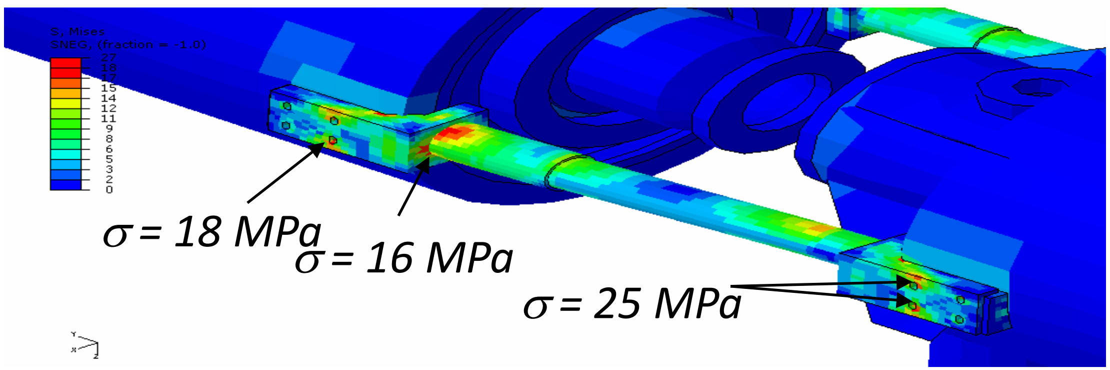




Preliminary concept 2

- Preliminary results (not optimized)





⇨ Small stress (elastic domain) ; but shear stress in the screws

⇨ Optimization :

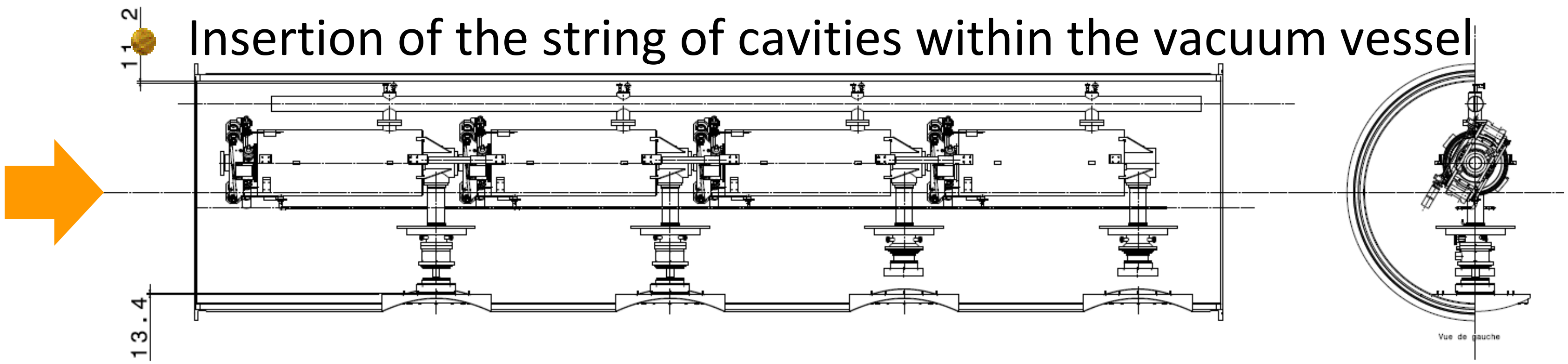
. stress (including shear stress) : shape of the brackets (U-shape)

. deflection : tube diameters / length of the slider / material

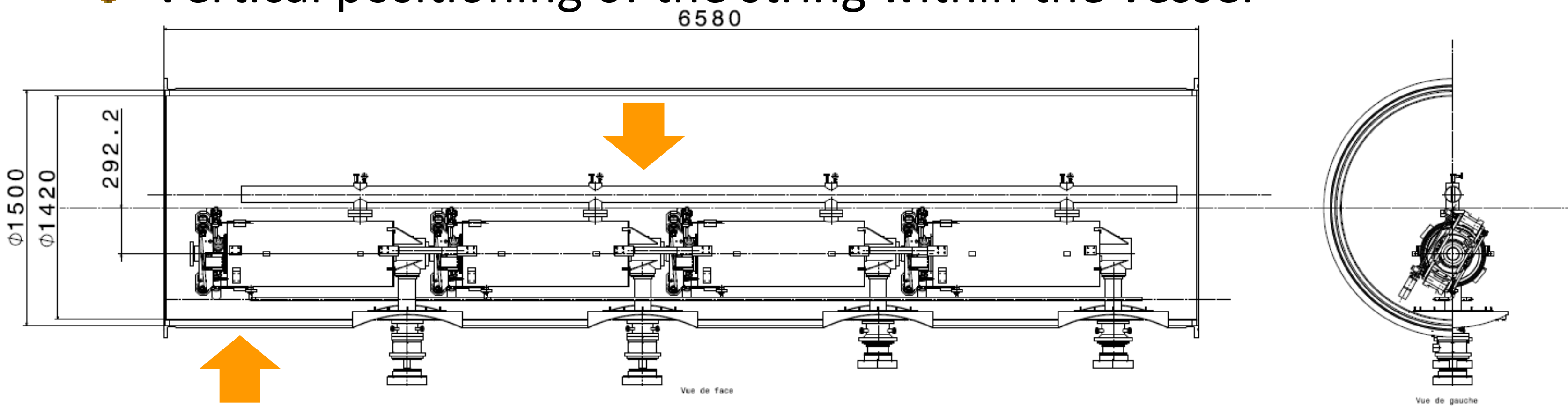
Cryostating procedure for a cylindrical vacuum vessel

General principle : longitudinal procedure

- Insertion of the string of cavities within the vacuum vessel

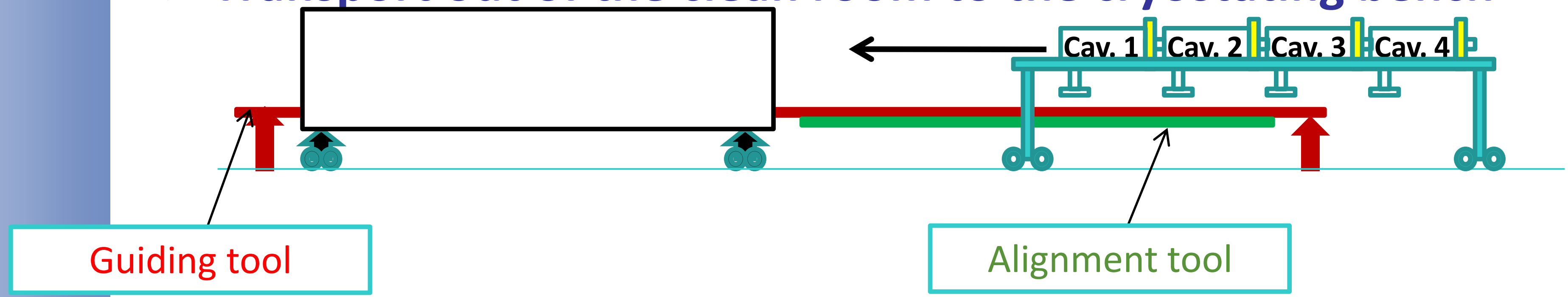


- Vertical positioning of the string within the vessel

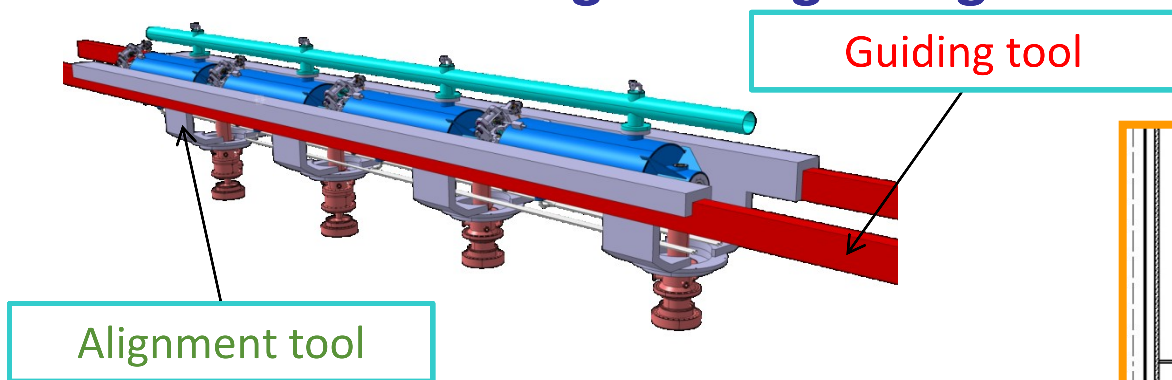


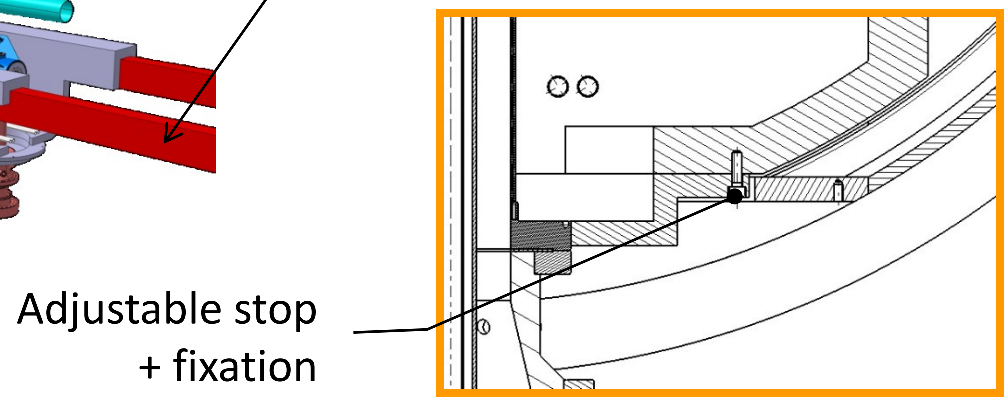
Cryostating procedure for a cylindrical vacuum vessel

- Transport out of the clean room to the cryostating bench

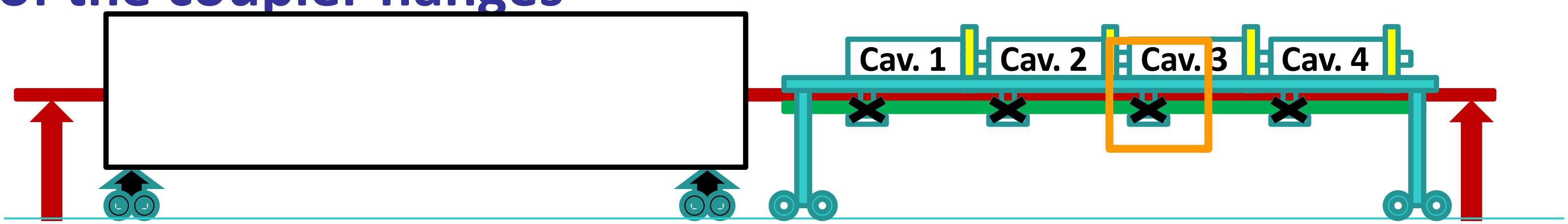


- Lift of the and alignment guiding tools



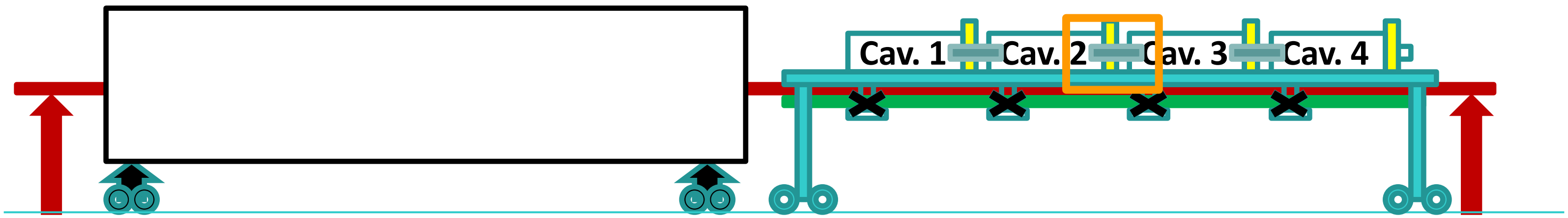


- Vertical positioning of the coupler flanges

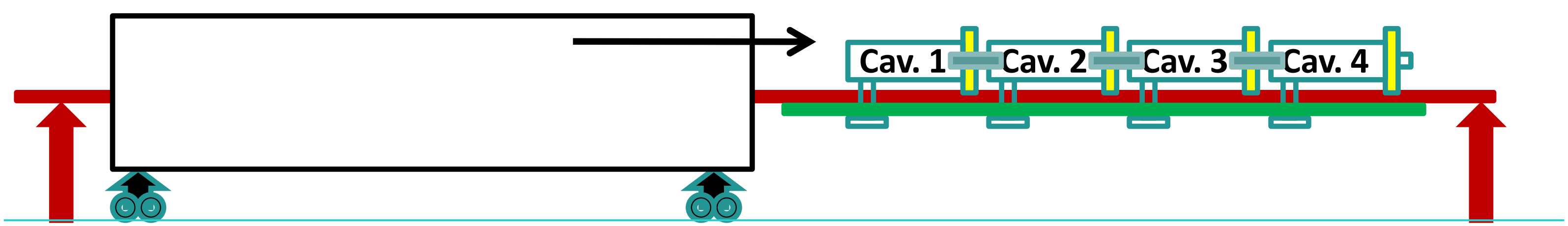


Cryostating procedure for a cylindrical vacuum vessel

- Lift of each cavity individually for alignment (not shown)
- Fixation of the support rods

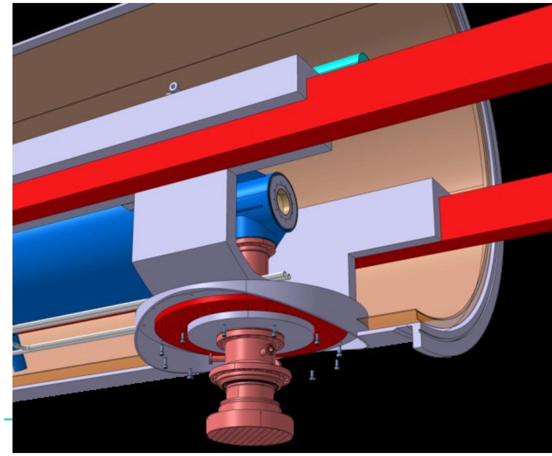


- Removing of the clean room trolley
- Moving of the vacuum vessel

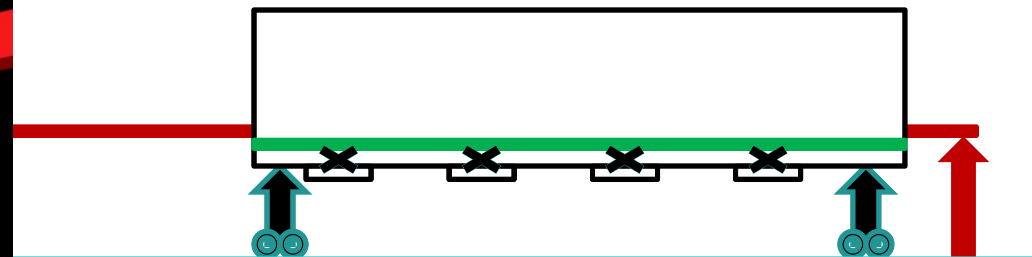


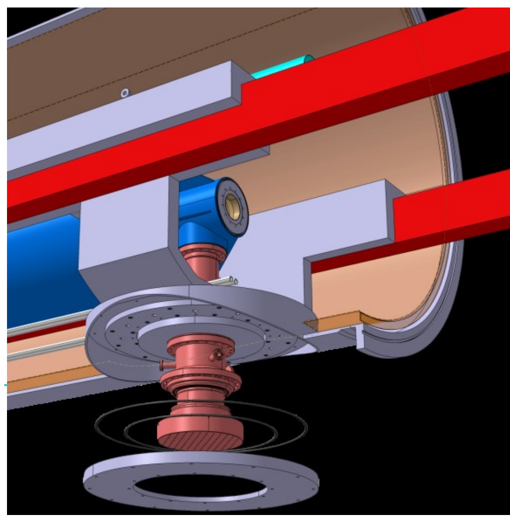
Cryostating procedure for a cylindrical vacuum vessel

- Lift of the vacuum vessel

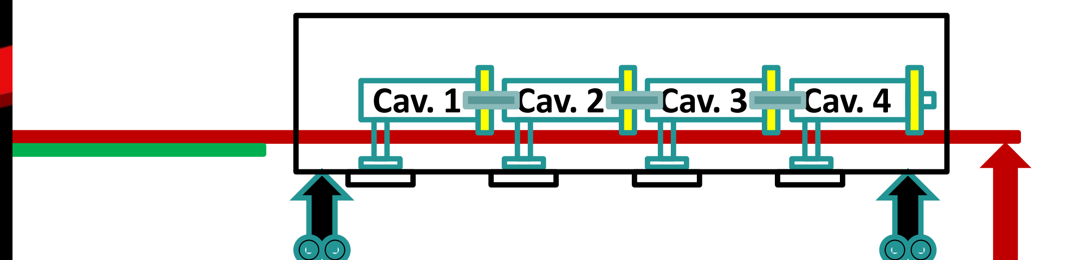


- …dicated chocks at the coupler/vessel

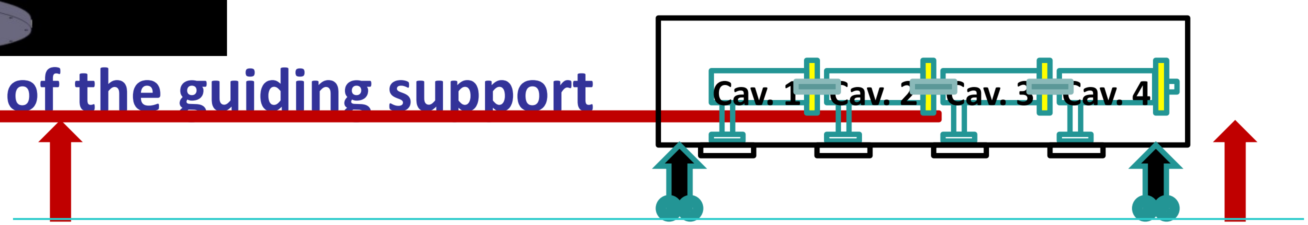




- …ignment tool and closing of the vacuum



- Removing of the guiding support



Perspectives

- **Conceptual design is still under progress :**
  - Cryostating procedure
  - Vacuum vessel design
    - Analysis of the cryostating method
    - Analysis of the stress/deformation in regards of the specifications (alignment spec.)
    - Construction constrains
  - Support design
    - Coupler flange / vacuum vessel interface
    - Inter-connection cavity
  - CNRS centralizes CAD models and makes propositions

Thank you for your attention