

SPL Intercavity support

Conceptual design review

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TE/MSC-CMI

Summary

- Introduction
- Requirements
- Concept scheme
- Conceptual design
- Proposed design
- Conclusion

Introduction

- Helium tank/double walled tube not stiff enough for cantilever
 - Support on tuner side
- Easiest way : connect on next cavity
- Require special design:
 - Cryogenic temperature
 - Vacuum
 - Thermal contraction

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Requirements

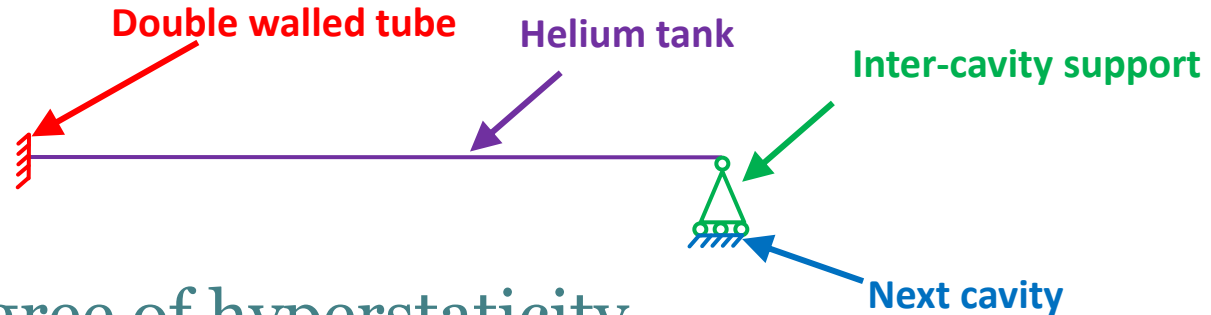
- Mechanical aspect
 - Sustain any load case (static, transport, thermal transient...)
 - Allow alignment
 - Keep alignment in steady state (warm → cold)
 - Minimum stress in helium tank
- Cryogenic temperature
 - Designed to work at 2K (transient)
 - Allow contraction of helium tank
- Installation and access
 - Installation out of clean room
 - Accessibility to tune alignment
 - No accessibility required after alignment

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Concept scheme

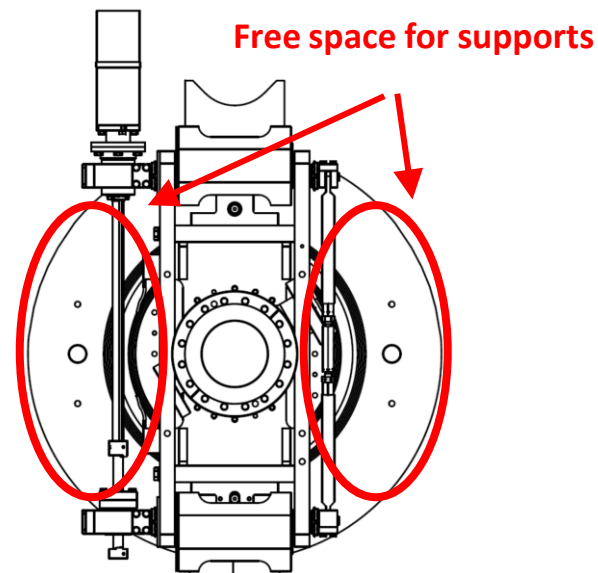
- Ideal



- Low degree of hyperstaticity
- Can be used in both plane (vertical and horizontal)

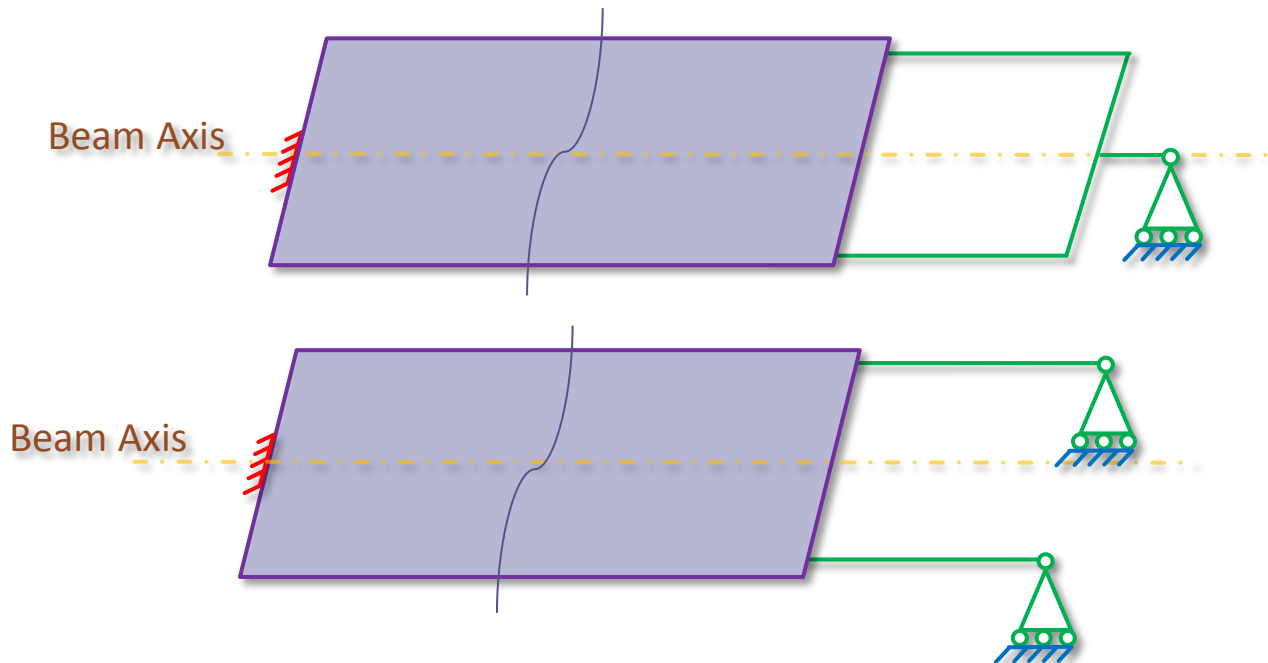
- Extremity of cavities

- 2 supports needed



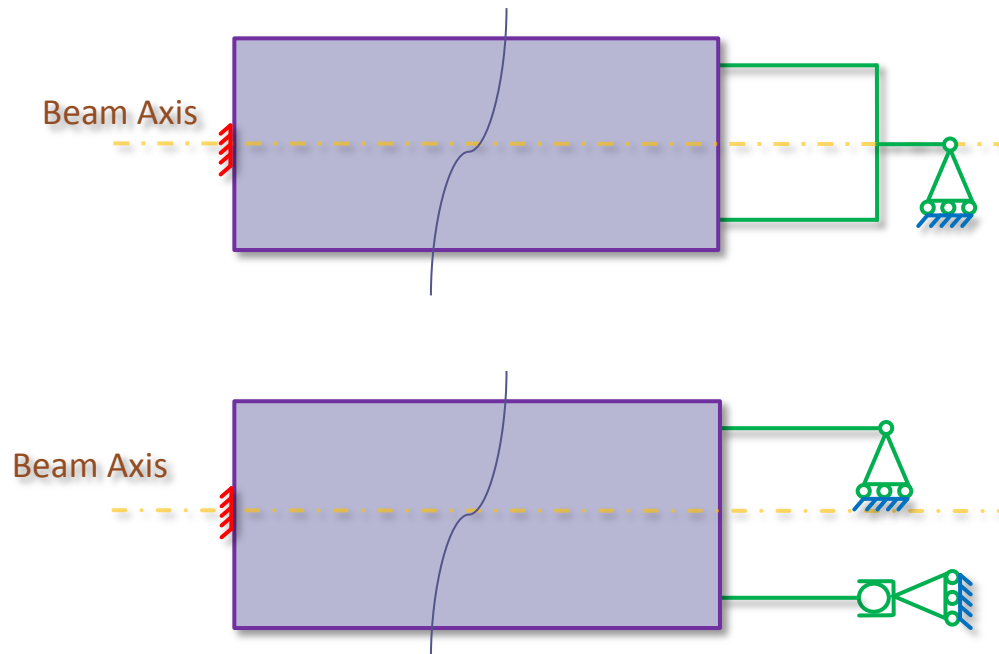
Concept scheme

- Support in vertical plane
 - Free longitudinal contraction
 - No displacement in vertical direction
 - Free rotation



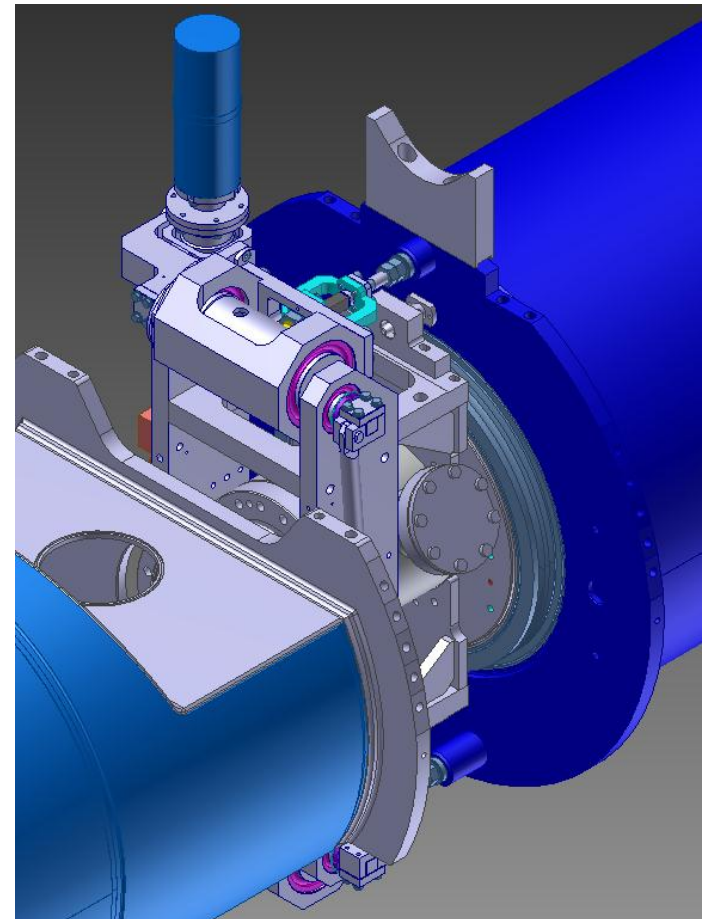
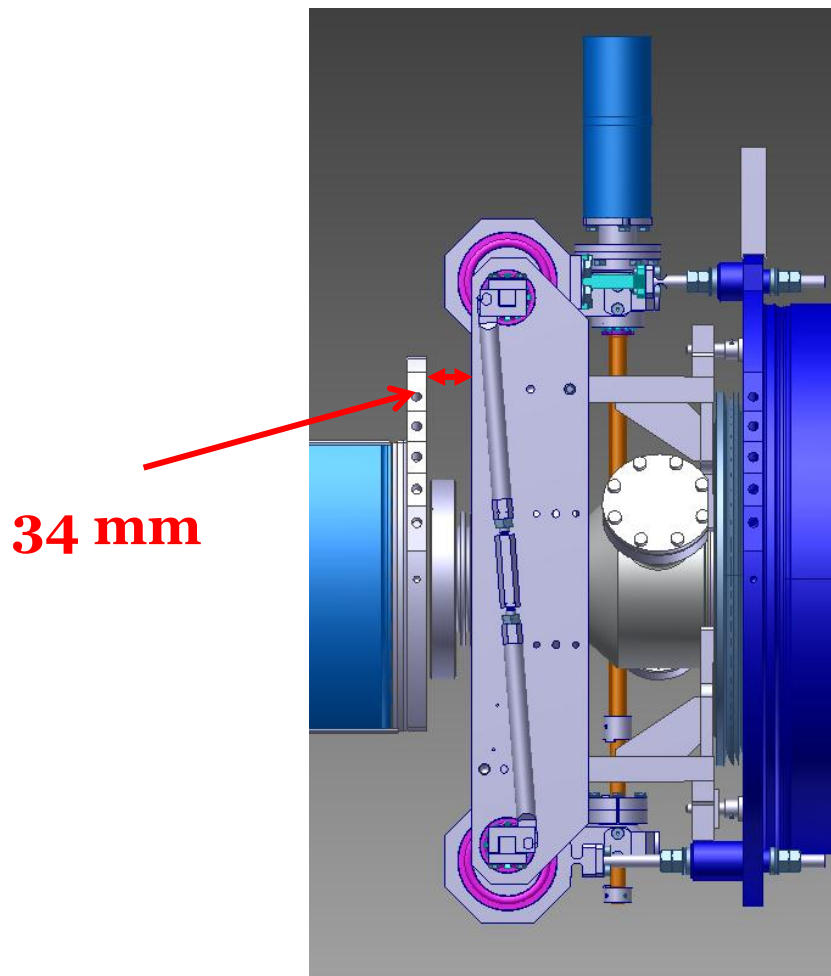
Concept scheme

- Support in horizontal plane
 - Free transversal contraction (transient)
 - Blocked transversal displacement of cavity
 - Free rotation



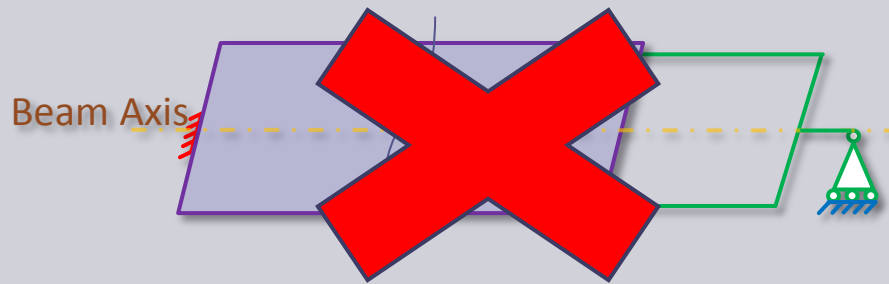
Concept scheme

- Space available

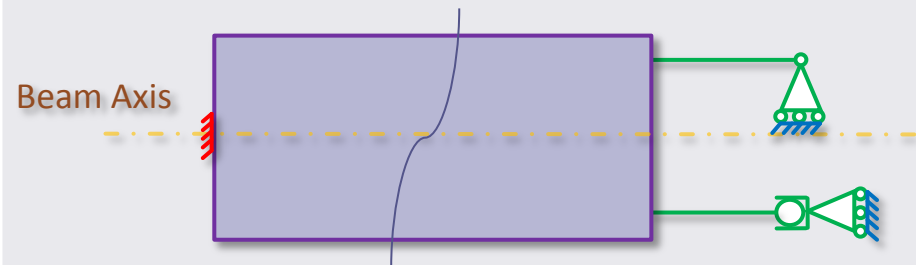
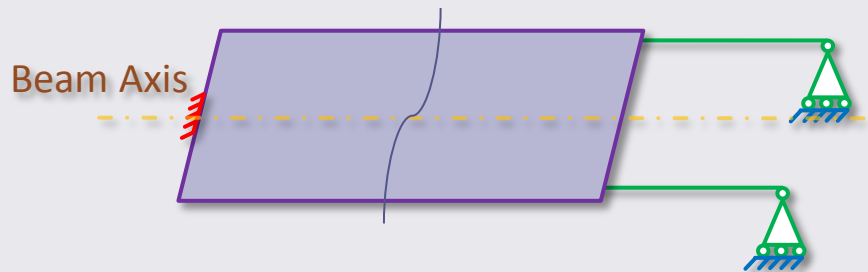
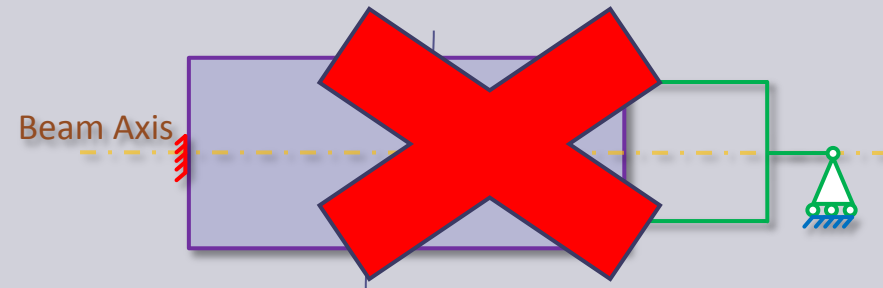


Concept scheme

Vertical support



Horizontal support

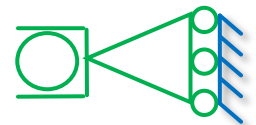
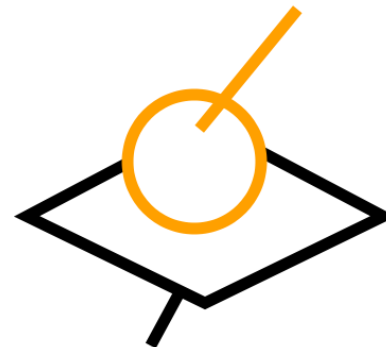
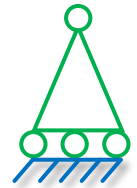


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Conceptual design

- Contacts
 - Sphere-cylinder
 - 1 free sliding, 2 blocked
 - Free rotation
 - Sphere-plane
 - 2 free sliding, 1 blocked
 - Free rotation
 - Redundancy
 - Limit maximum displacement

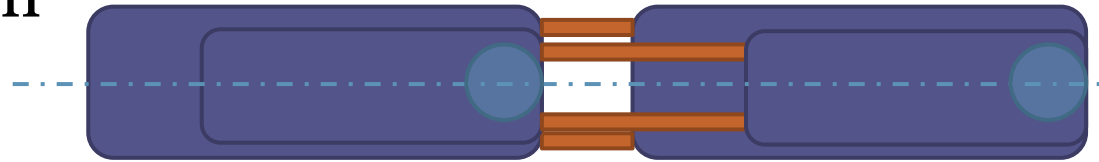


Conceptual design

- Thermal contraction

- Longitudinal

- 4.5 mm

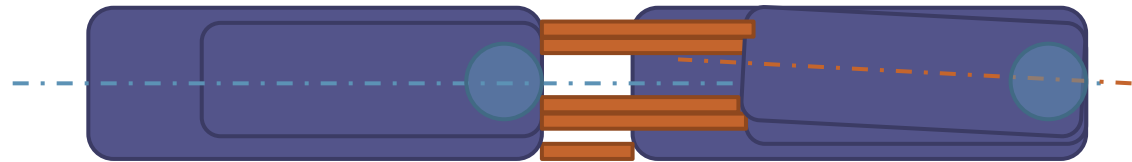


- Transversal

- 1.15 mm

- Max displacement of beam axis = 0.6 mm (transient)

→ deformation of helium tank

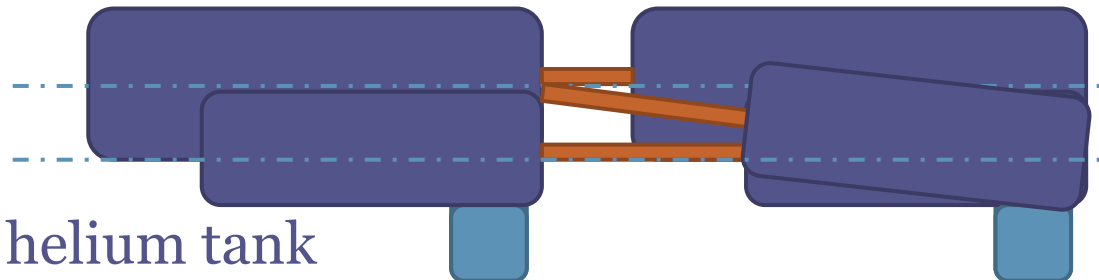


- Vertical

- 1.2 mm

- Blocked

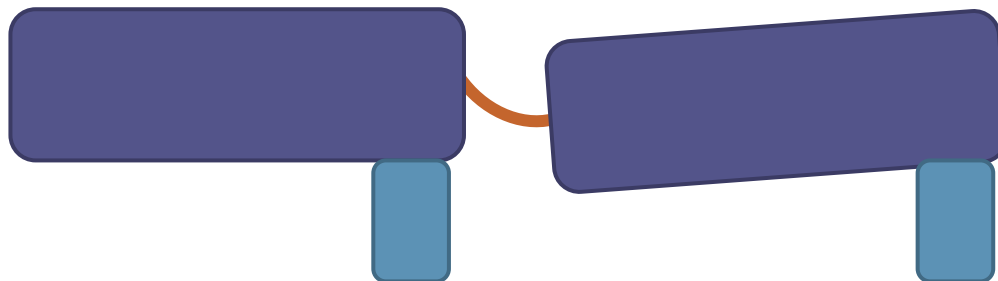
→ deformation of helium tank



Conceptual design

- Deformation
 - Alignment process not yet defined
 - Possible procedure
 - Alignment on a structure (supports not loaded)
 - Load transfer to vacuum vessel (supports loaded)
 - Alignment directly depends on supports

→ Limit deformations when loaded



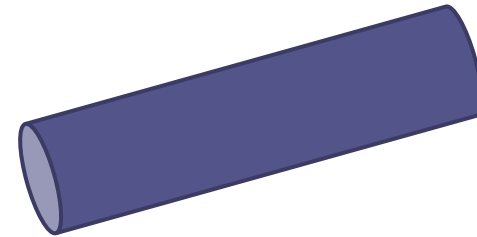
Conceptual design

- Deformation
 - Steady state
 - Displacement allowed : 0.02 mm
10% of alignment tolerance
 - Load : 500 N
1/4 of total weight (200 kg)
 - Length : 250 mm
 - Transport
 - Displacement allowed : 0.1 mm
 - Load : 1540 N (0.5 g)

Conceptual design

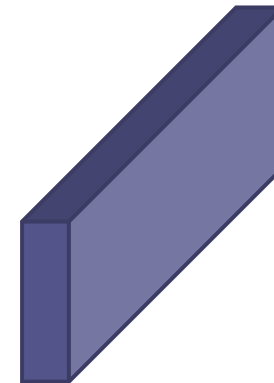
- Cylinder

Minimum diameter = 67 mm



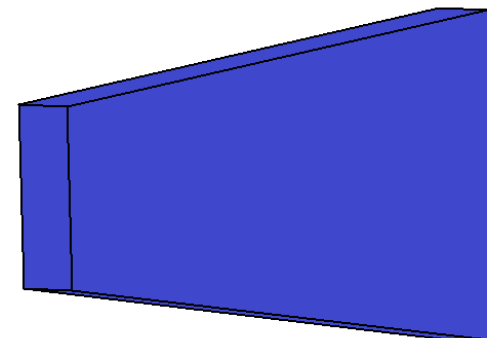
- Rectangle

Width [mm]	Height [mm]
10	106
15	92
20	84
25	78



- Triangle

Width [mm]	Height [mm]
10	152
15	132
20	121
25	112



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Proposed design

- **Contacts**
 - **Sphere-cylinder and sphere plane**
 - Non standard components
 - High stresses at contact point
 - Sphere-cylinder : 430 Mpa
 - Sphere-plane : 1300 MPa
 - Plastic deformation
- **Solutions**
 - Decrease stresses
 - Increase elastic limit

Proposed design

- Proposed solution
 - Spherical plain bearing
 - Rotation freedom (= sphere-sphere contact)
 - Standard components
 - Support very high load
 - Bad thermal contact
 - Sliding cylinder in spherical plain bearing
 - Cylinder-cylinder contact → low stresses
 - Easy to machine with standard tooling
 - Bad thermal contact

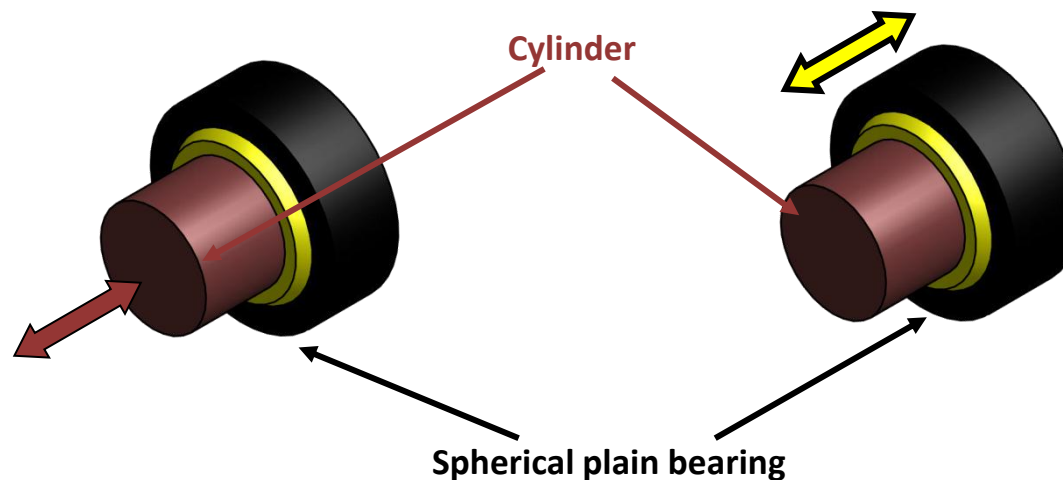
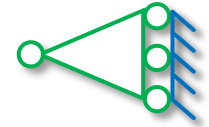
Has to be tested at low temperature under vacuum

Proposed design

- Proposed solution

- Sphere-cylinder

- Cylinder sliding in a spherical plain bearing
 - Spherical plain bearing sliding in a cylinder

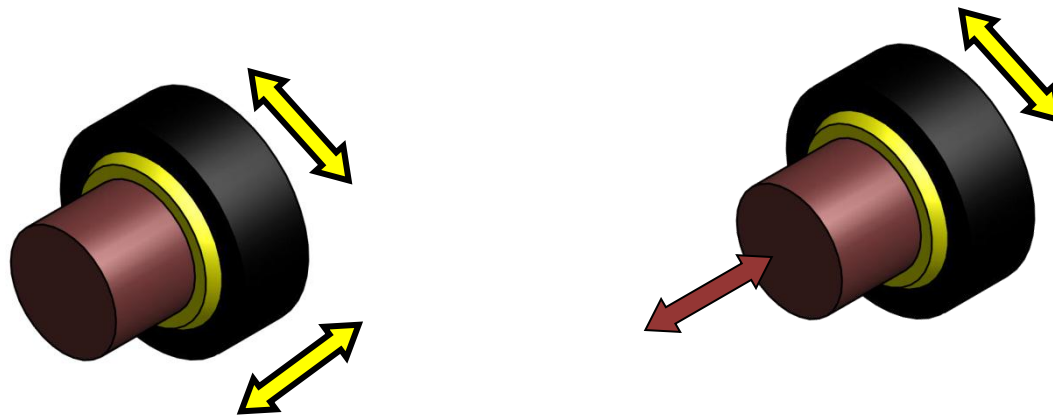
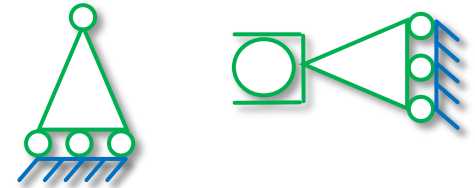


Proposed design

- Proposed solution

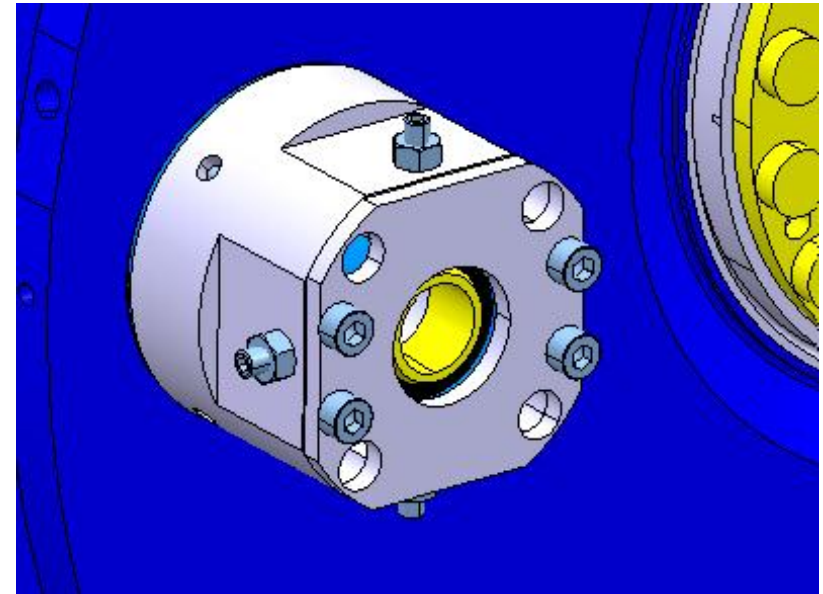
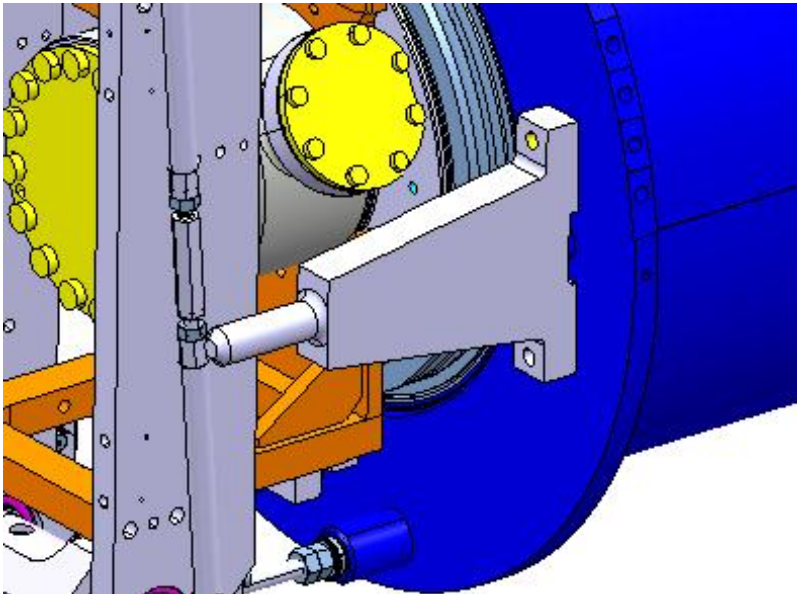
- Sphere-plane

- Spherical plain bearing sliding (on longitudinal and lateral axis) on a support
 - Cylinder sliding in a spherical plain bearing; spherical plain bearing sliding laterally on a support



Proposed design

- Proposed solution



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Conclusion

- Concept scheme and design
 - Acceptable stresses
 - Limited displacement

- Next step
 - Test spherical plain bearing solution
 - Displacement
 - Friction
 - Define interface to helium tank
 - Design final solution

Thank you for your attention

Conceptual design

- Reaction forces
 - Weight of the cavity
 - 200 kg
 - Acceleration during transport (0.5 g)
 - Max lateral force = 525 N
 - Max vertical force = 1540 N
 - Helium tank deformation (transient)
 - Vertical
 - Horizontal
- Redundancy
 - Helium tank never in cantilever
 - Each support → All forces