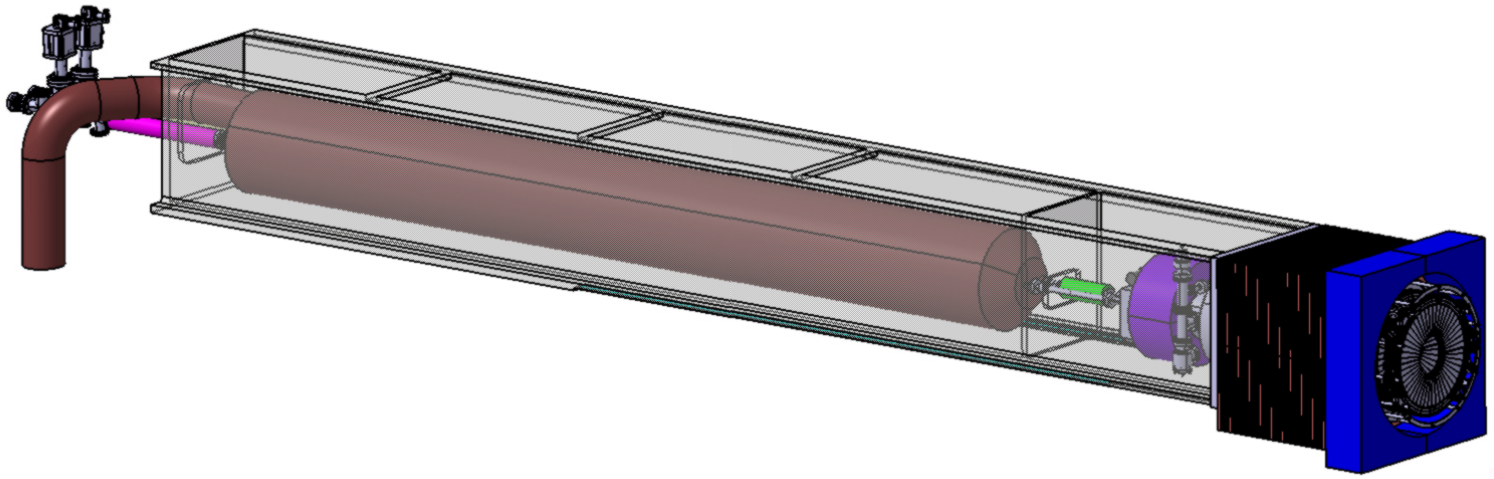
ILD2 square support tube solution

2nd ILD workshop - Cambridge



Outline

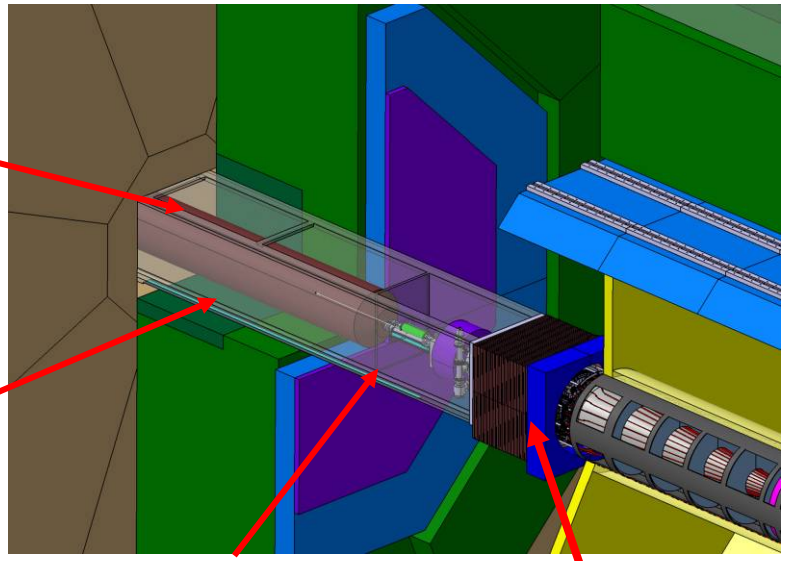
- Requirements on Forward region
- 2 Solutions of a square support tube
  - **Why a square tube?**
  - **Solution 1 : pillar + rails**
    - Principle
    - FEA calculations (deformation, stress, natural frequencies)
    - Alignment method
    - Conclusion
  - **Solution 2 : pillar + tie rods**
    - Principle
    - Alignment method
    - Conclusion
- Conclusion

Forward region

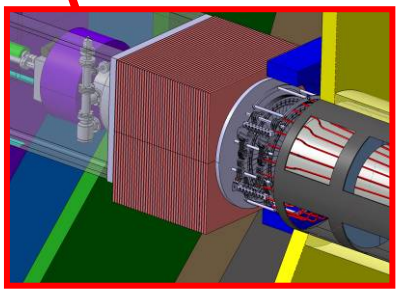
- Description

QD0
(superconducting magnet)

Support tube



Beam line components



Forward Cals

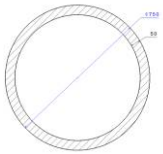
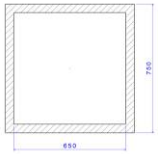
- Requirements on support tube
  - **Support all the forward components**
  - **Good vibration performance (QD0 stability)**
  - **Allowable amplitude**
    - Few mm in static load
    - About 50nm for ground motion (IR interface document)
  - **Alignment system is needed (in a mm range)**

Solution = square support tube

- Why a square support tube?
  - **Loading is only weight of each forward components**
  - **Higher moment of inertia allowed to use less material**

- Basic calculation (same thickness and external dimension)

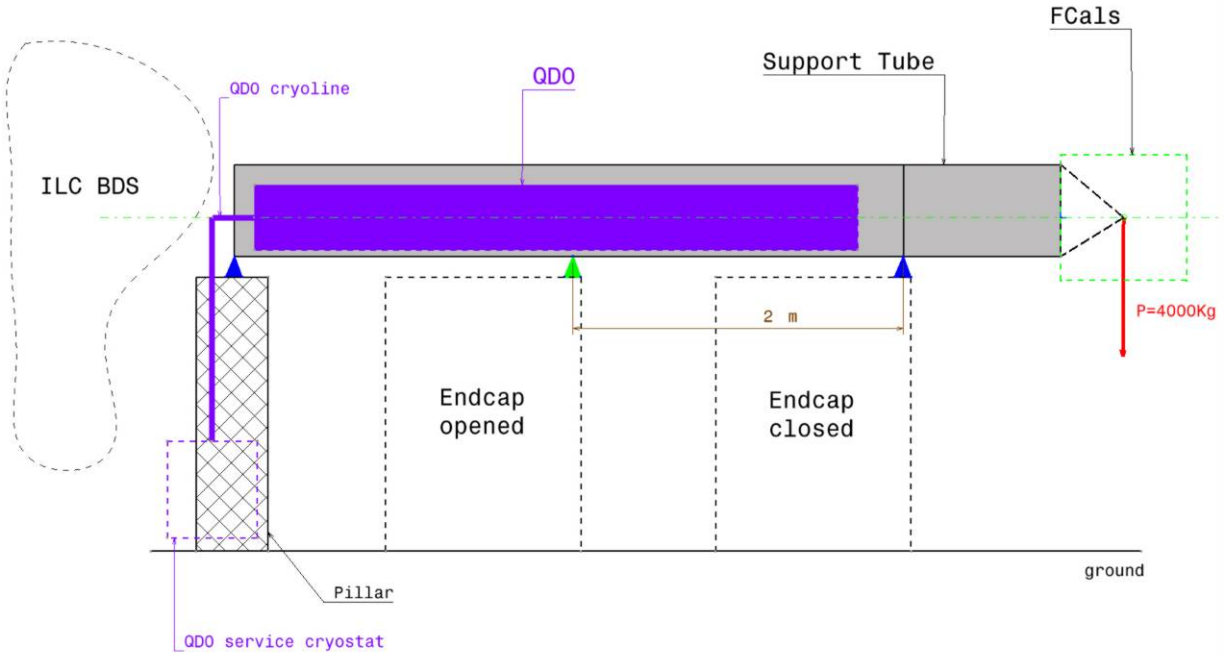
$$def = \frac{Fl^3}{3EI_{Gz}}$$

		
Moment of inertia (I_{Gz})	$\frac{\Pi}{64}(D^4 - d^4)$	$\frac{bh^3 - b'h'^3}{12}$
Calculation	$6{,}77.10^9 mm^4$	$11{,}5.10^9 mm^4$

➔ *For same loading and size, deformation is* ***reduced by 40%***

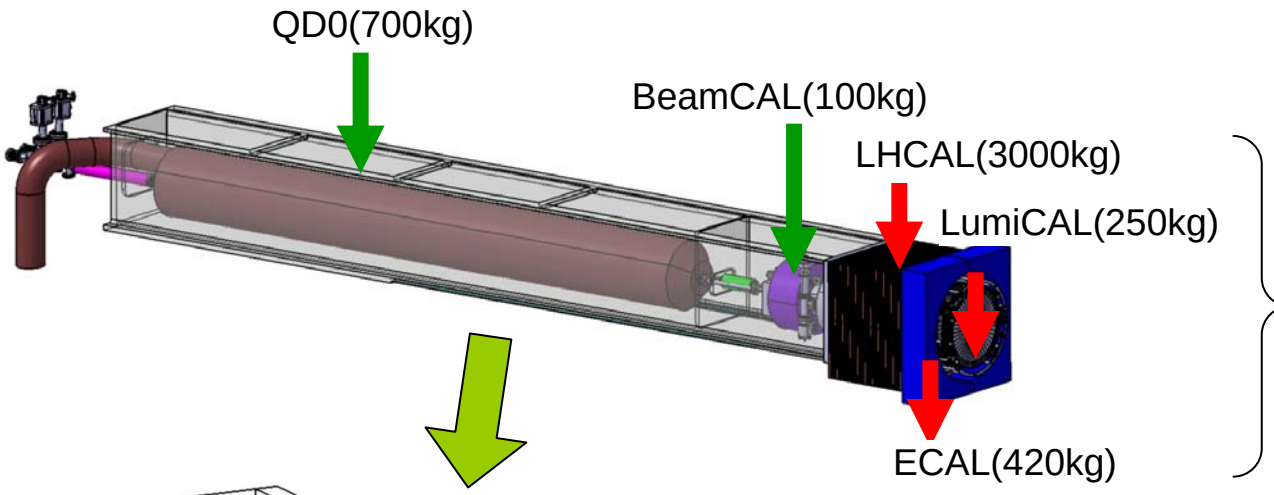
Solution 1

- Supported on
  - **Pillar from ground (machine side)**
  - **EndCap**

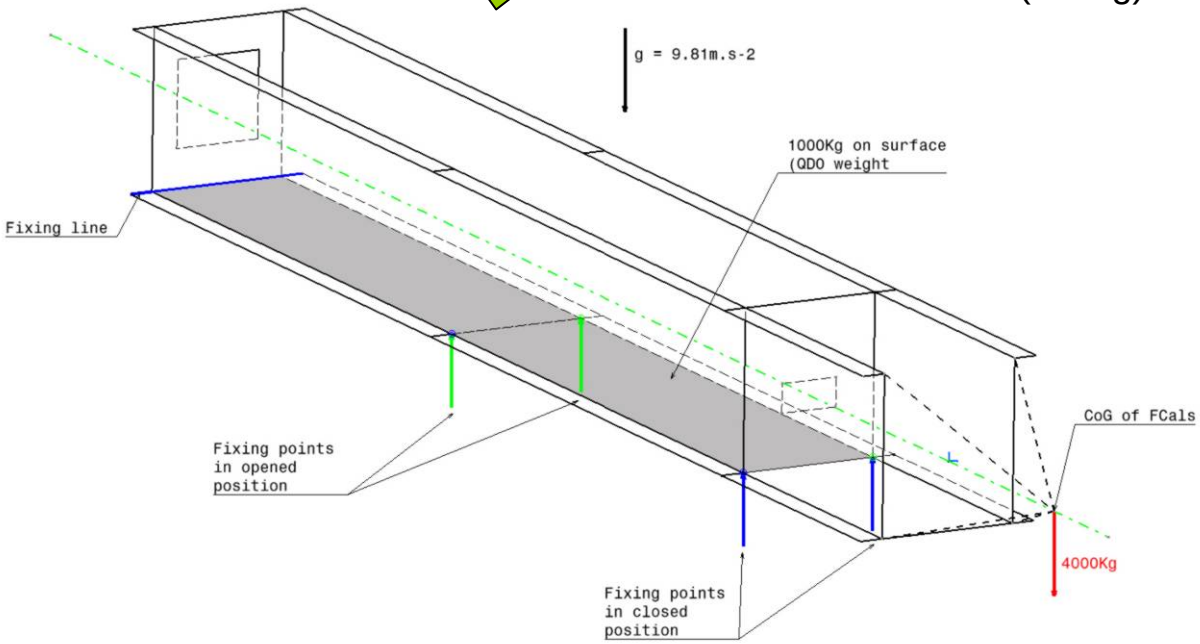


- Compared to cantilever solution
  - **Improve vibration stability**
  - **Reduce deformation and stress**

Model for calculations



Ab. 4000Kg for FCals



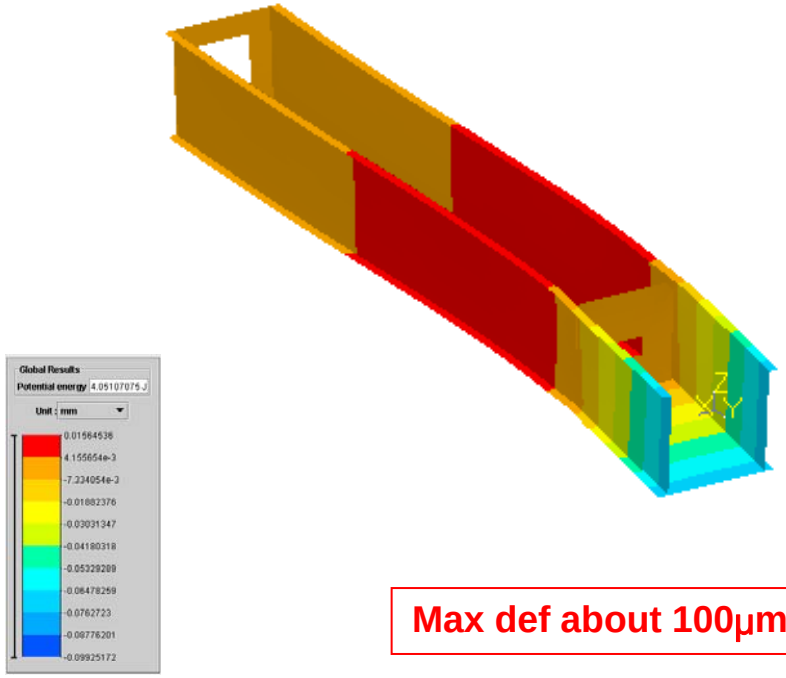
U shape is used for accessing to Forward components

If needed, structure could be reinforced by tie rods or else.

FEA Calculations (1)

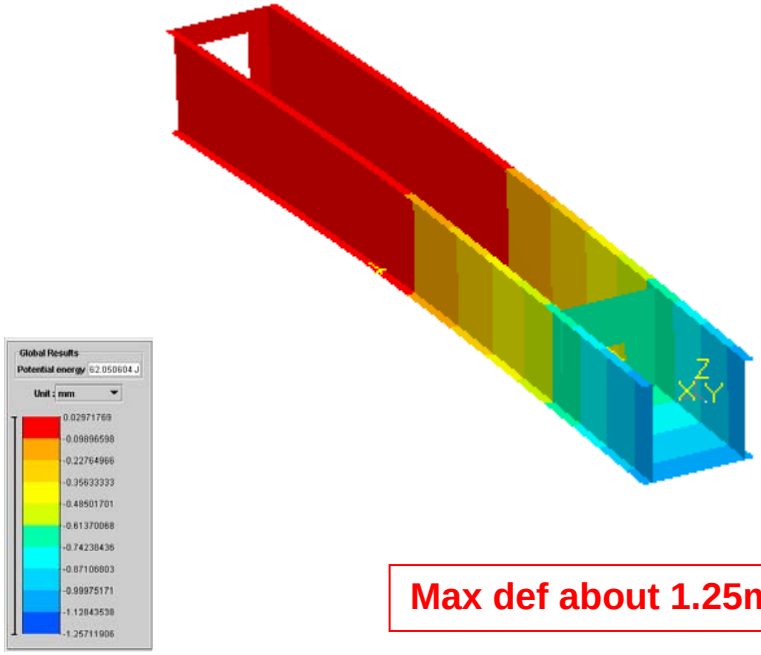
- Conditions
  - **In both conditions (open/close)**
  - **Stainless Steel *(E = 200 GPa)***
- Vertical deformation for 50mm thick

Endcap closed



Max def about 100µm

Endcap opened



Max def about 1.25mm

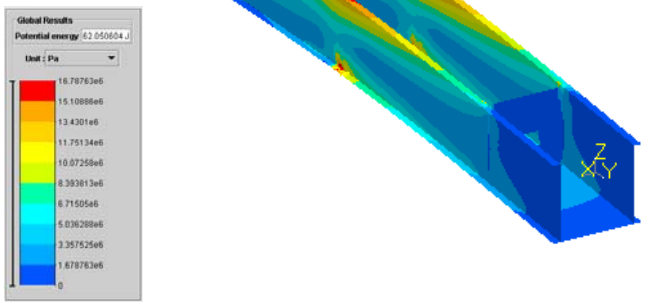
FEA Calculations (2)

- Stress for 50mm thick

Endcap closed

Max stress 10MPa

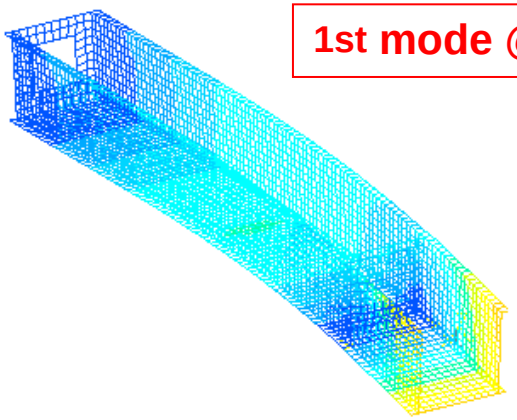
Endcap opened



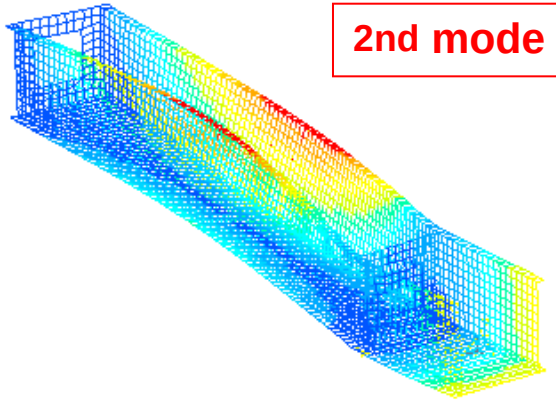
Max stress 16MPa

Natural frequencies

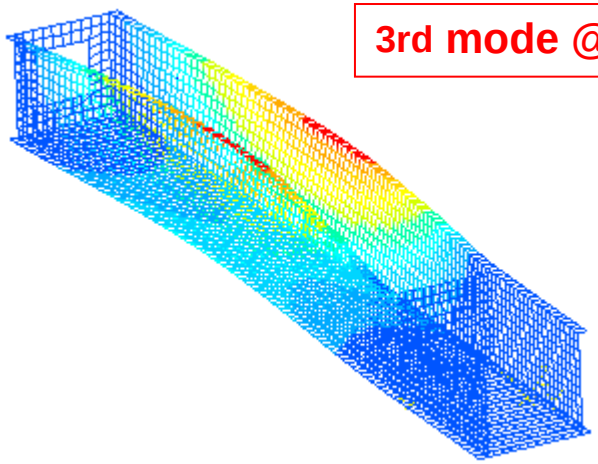
- For 50mm thick and Endcap closed



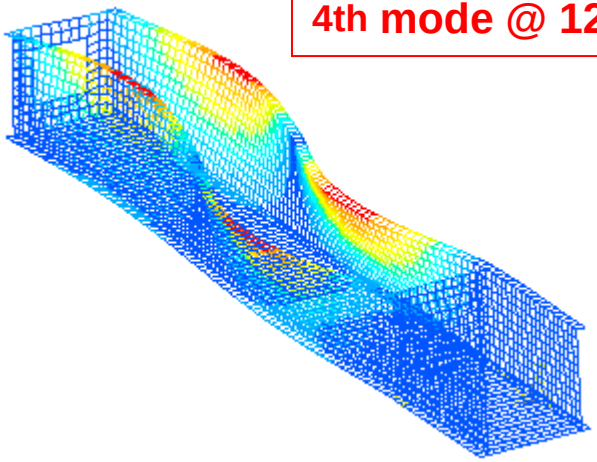
1st mode @ 44Hz



2nd mode @ 60Hz



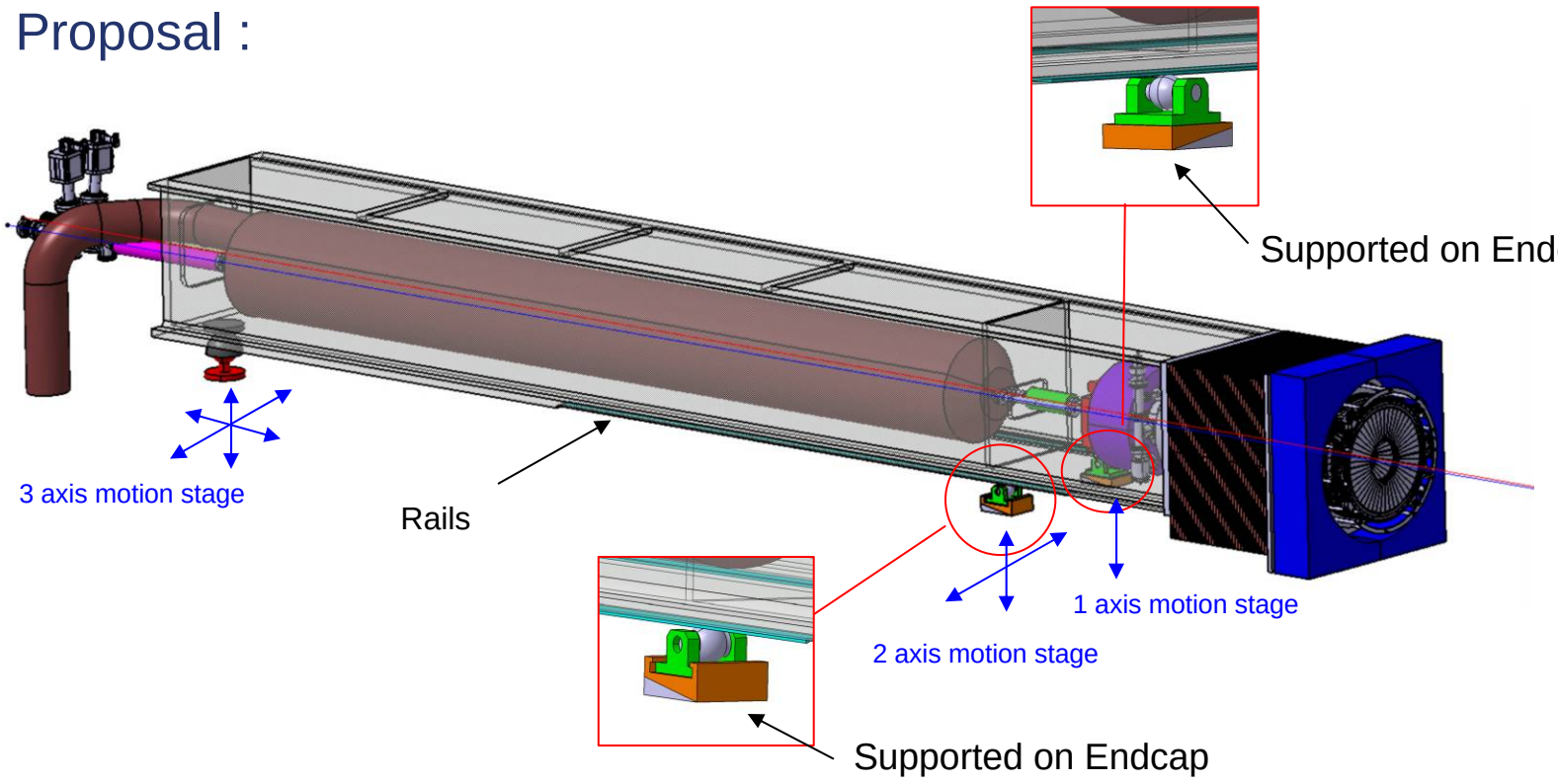
3rd mode @ 71Hz



4th mode @ 125Hz

Alignment method

- Need to adjust the position in a mm range
- Choose of an isostatic devide
  - **Allow relative movement of Endcap**
  - **Allow to relax tolerance**
- Proposal :



Conclusions on solution 1

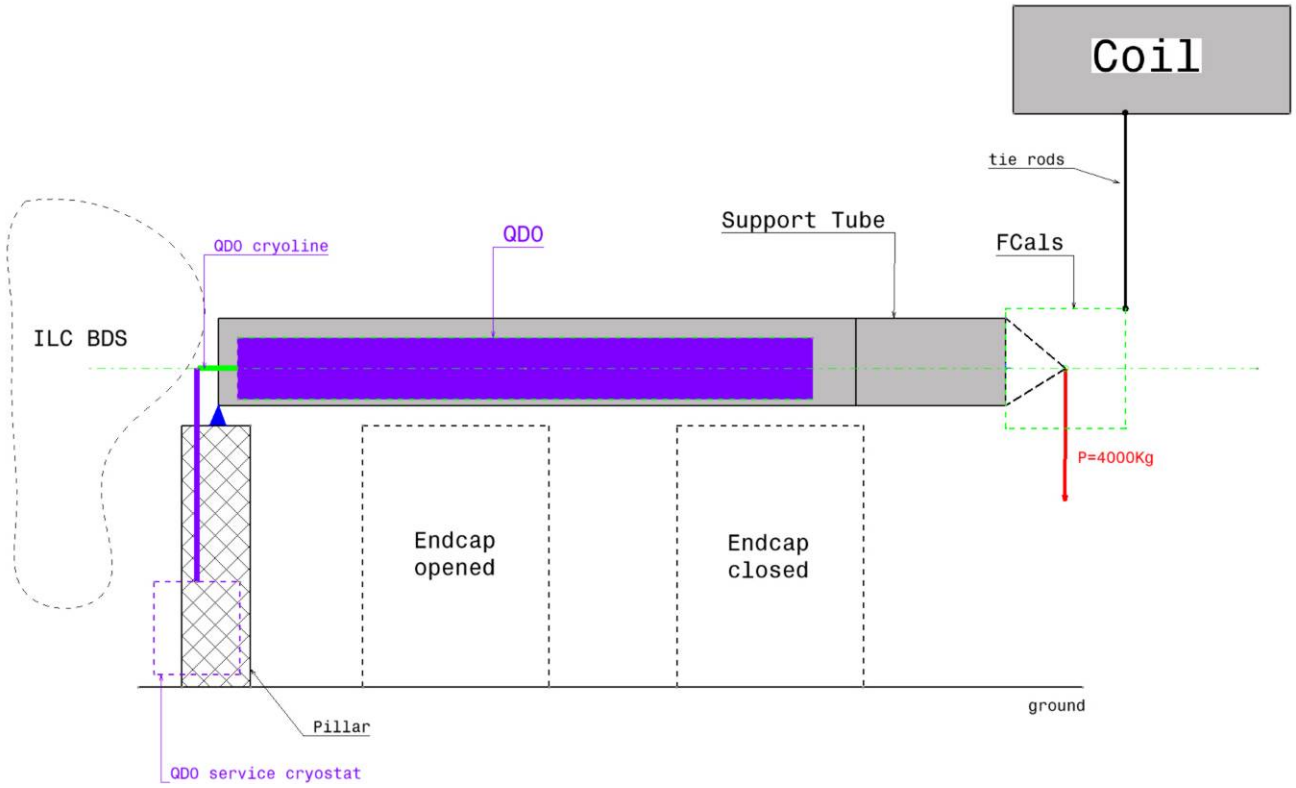
- Many pros
  - **Deformation / stress : OK**
  - **Natural frequencies : OK**
  - **Ground motion calculation under calcultion but seem OK**
  - **We can correct & adjust the position of support tube**
  - **No material in front of Calorimeter**

- BUT
  - **Need a complex system to align**
  - **Deformation is a function of the Endcap's position**
    - Problems on the forward component
    - On beam tube

⇨ we must discouple Endcap and support tube

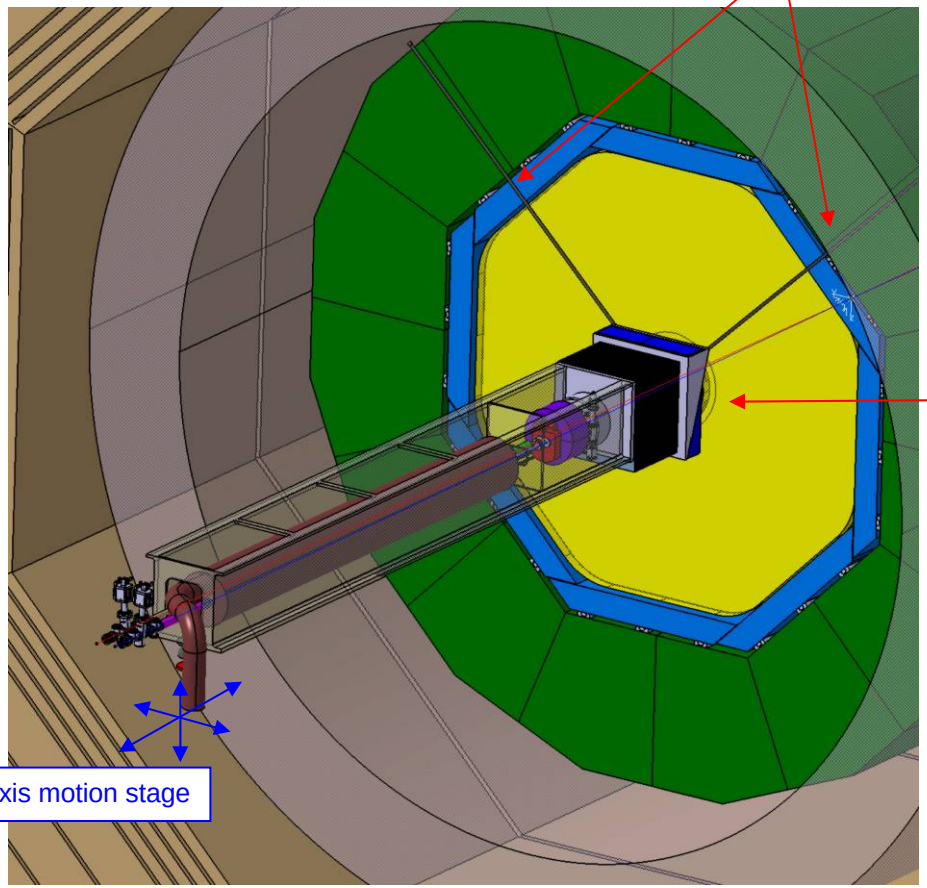
Solution 2

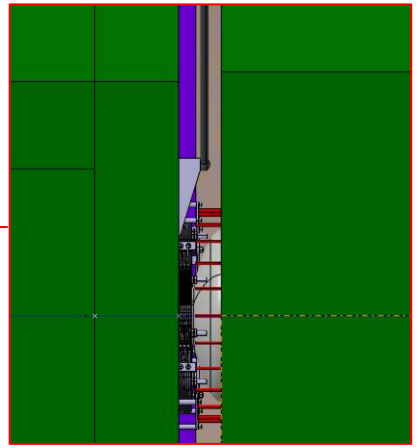
- Supported by
  - **Pillar from the ground (like solution 1)**
  - **Tie rods from the magnet to the FCals**



Alignment method

Adjustable tie rods





Conclusions on solution 2

- Some cons :
  - **Add material in front of Forward calos**
    (Possible to use Carbon Fiber for tie rods)
  - **Need calculations to optimise the link to support tube**
  - **Interaction with Ecalring dimension**

- But many pros :
  - **Better stability** *(fixed at extremity of the tube)*
  - **Completely independent to the EndCap**
  - **Easier to adjust with the tie rods**
  - **No need of active correction**
  - **Less deformation & stress** *(results may come)*

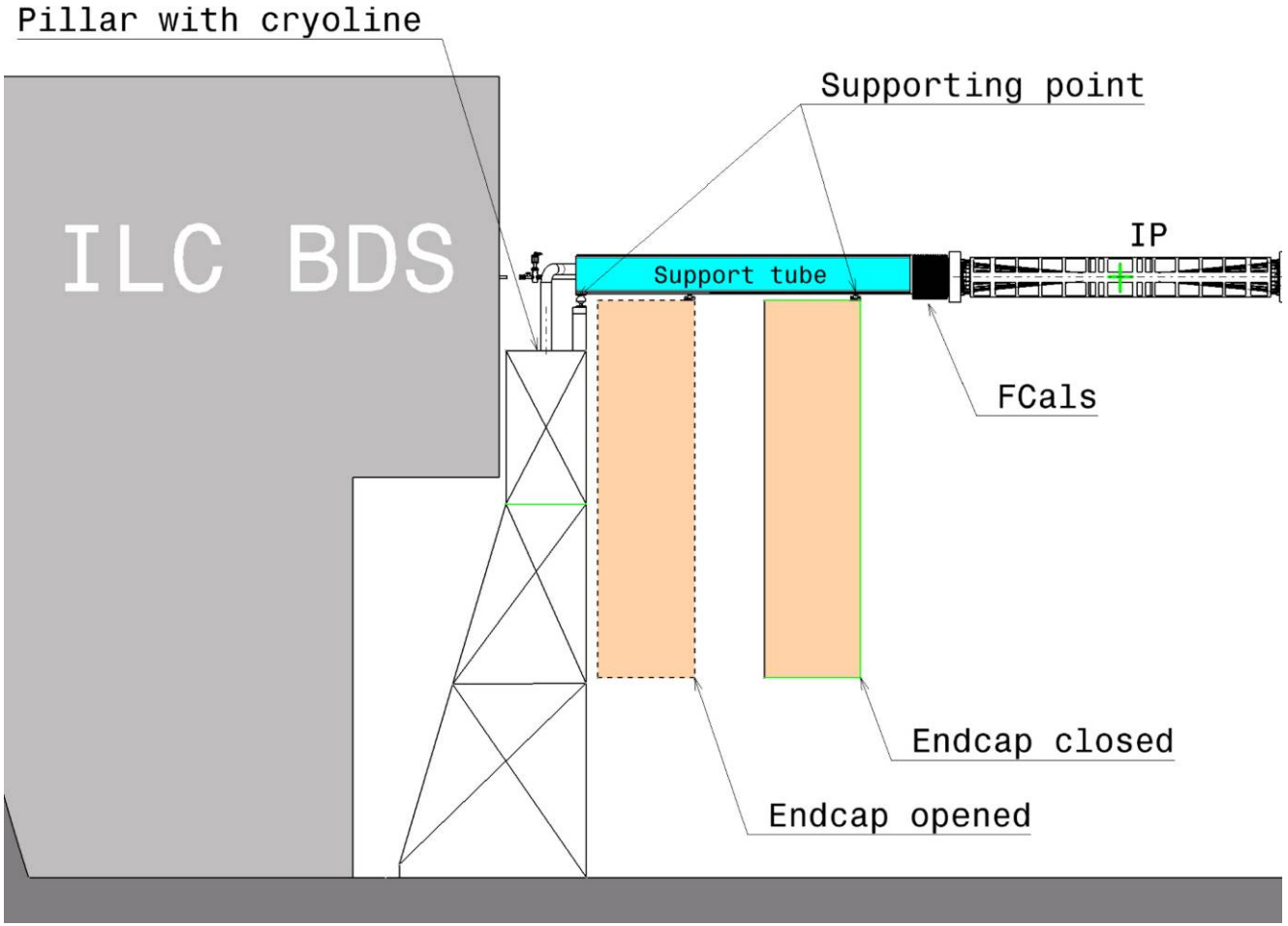
Choice….

- On using square tube
  - **Stiffer than round (ab. 40%)**
  - **More place for integrating components**

- On supporting method
  - **Each solution has it's own pros and cons**
  - **But I think that the 2nd one is better for mechanical reason :**
    - Less deformation (calculation would be performed)
    - More stability
    - No active correction of alignment
    - …
  - **Do you agree put some material budget in this area ?**

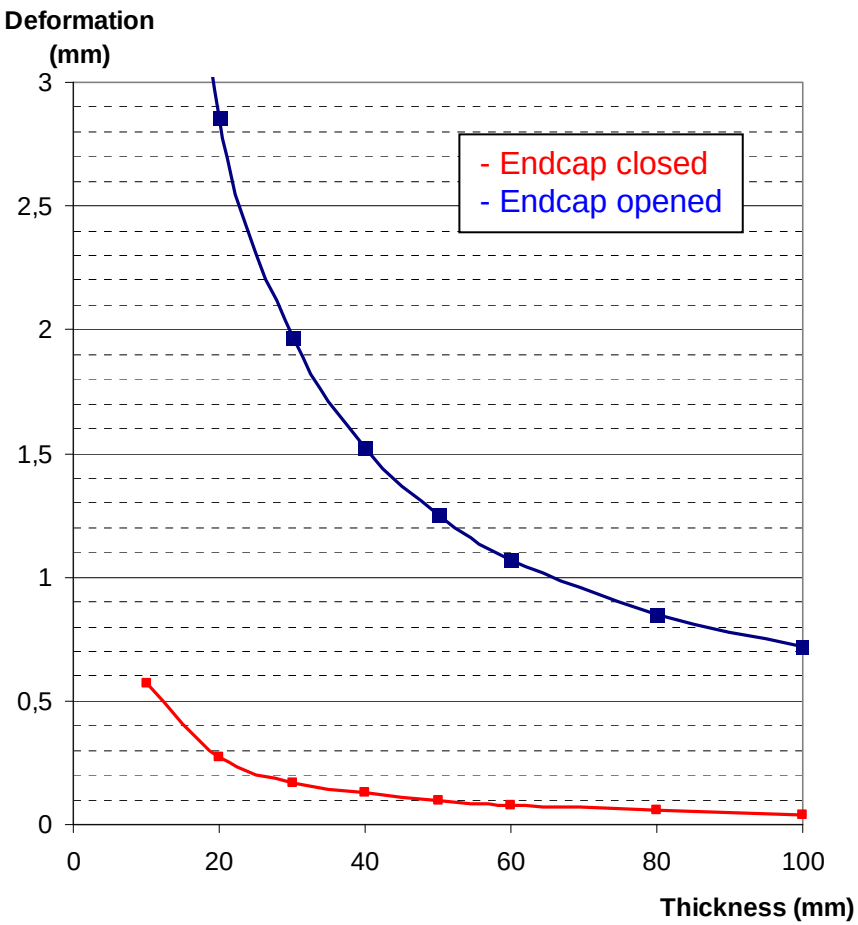
Extra slides

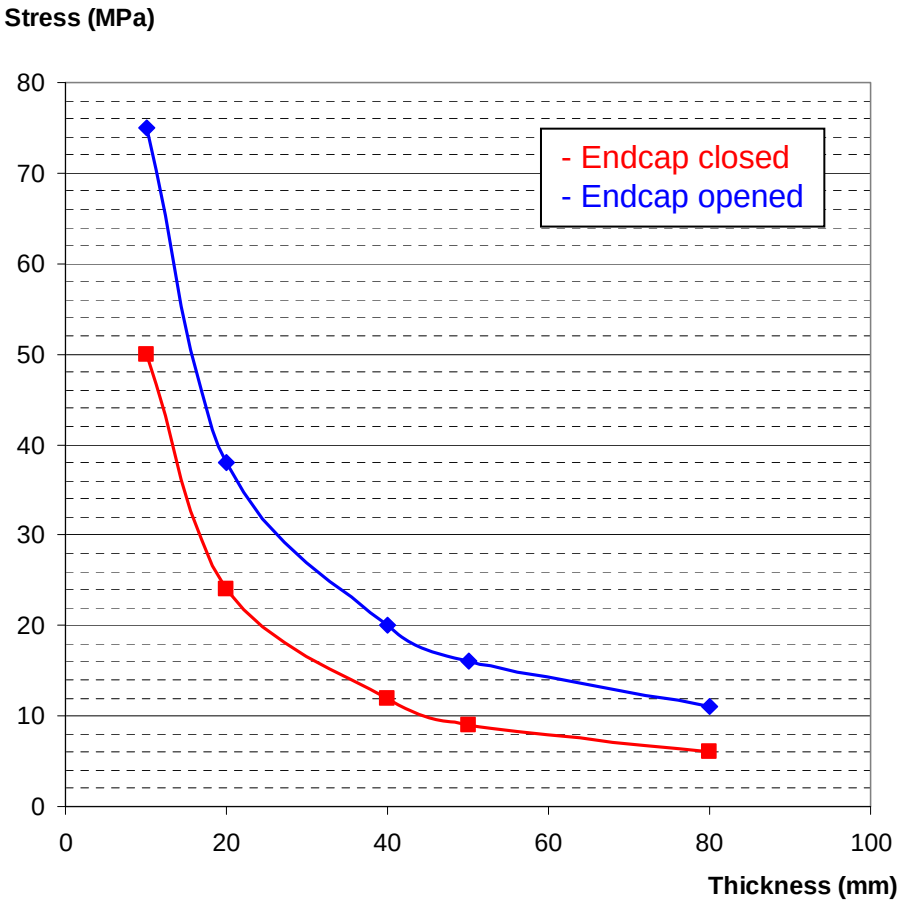
Solution 1


Pillar with cryoline
Supporting point
ILC BDS
IP
Support tube
FCals
Endcap closed
Endcap opened

FEA Calculations on solution 1

- Stress & deformation as function as thickness





Square tube – solution 1

- Natural frequency mode = f(thickness)