Detector Vibration and QD0 Support

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- Support of QD0 at ILC, computations made at KEK for ILD and at SLAC for SiD
- Vibration measurement made around CMS at CERN
- Conclusion drawn for CLIC
- Concept design for supporting QD0 at CLIC
  - Compatibility with experiment
  - Compatibility with machine elements
  - Compatibility with push-pull
- Conclusions

Vibrations and Simulations in ILC

- The supporting of QD0 in LC is a critical element.
- It must provide a local “stable ground” to allow precise stabilization of the QD0 proper
- It must be compatible with the experiment lay-out.
- It must be compatible with the machine lay-out.
- It must be compatible with the push-pull scheme.

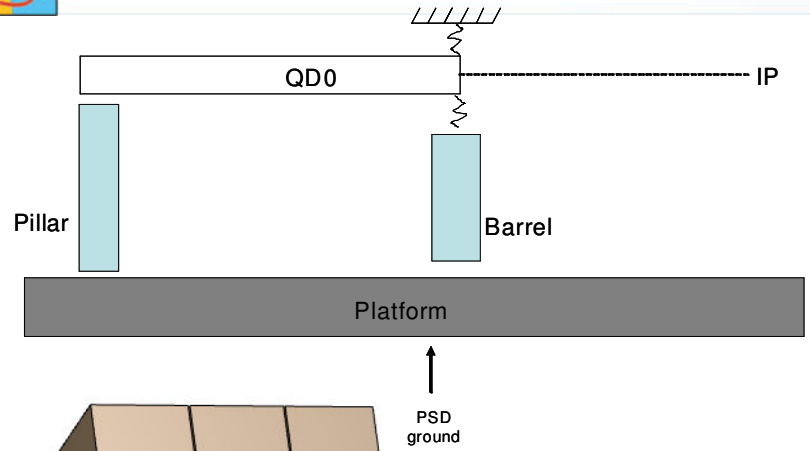
Vibrations and Simulations in ILC

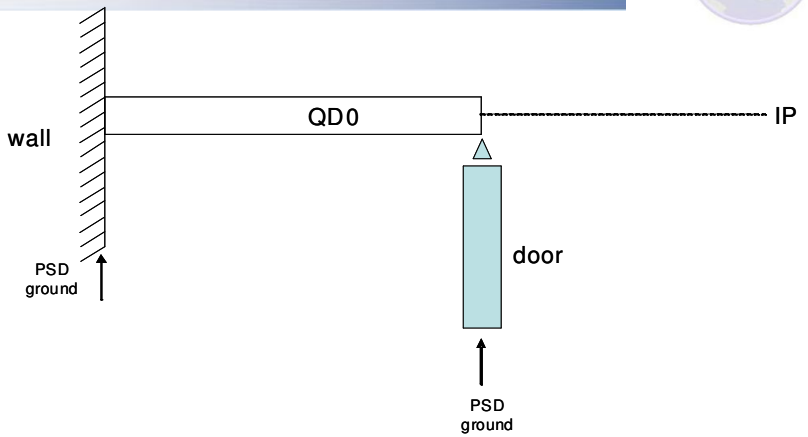
• A study of the performances of the QD0 supports in ILC (for ILD and SiD) has been started in June.

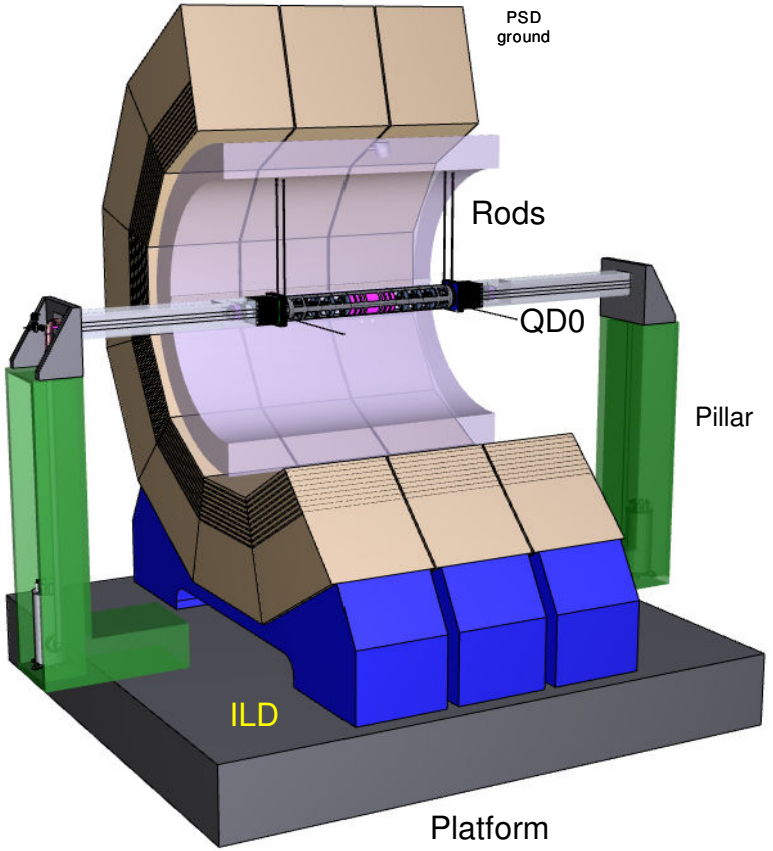
• Because of the size of the ILC beam and the electric feed back, which allows excursions of 50nm vertically and 300nm horizontally, a good target is to reach a stability of :

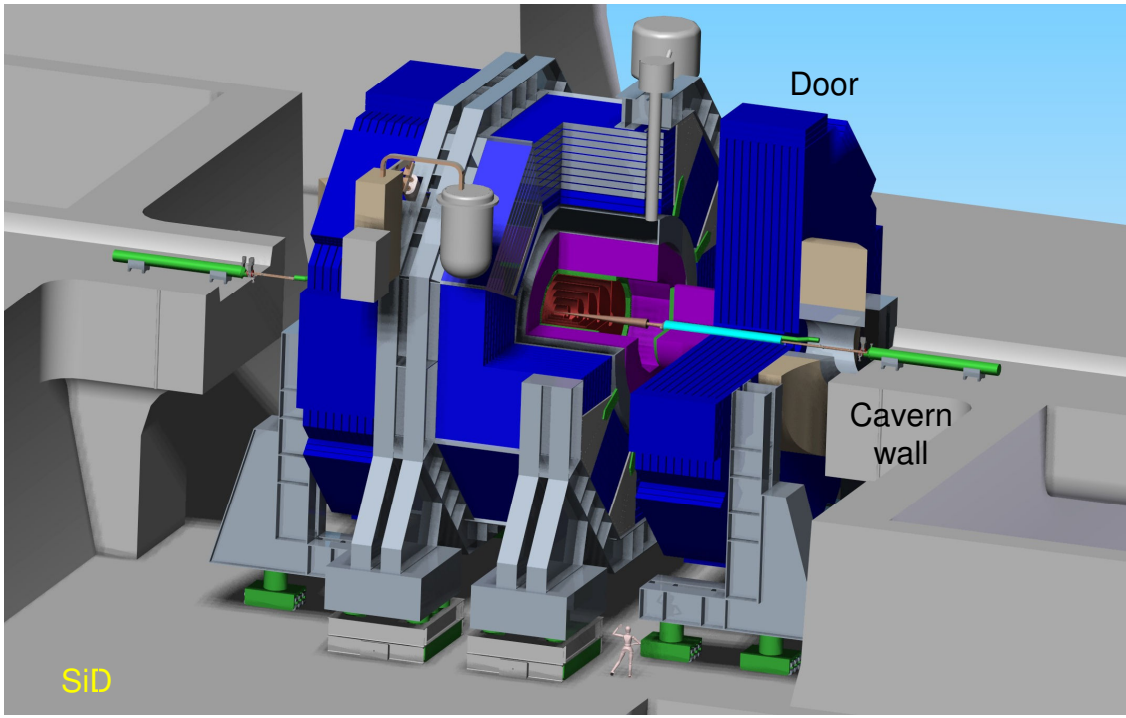
- 10nm vertically
- 60nm horizontally.

QD0 supports for ILD and SiD in LoIs







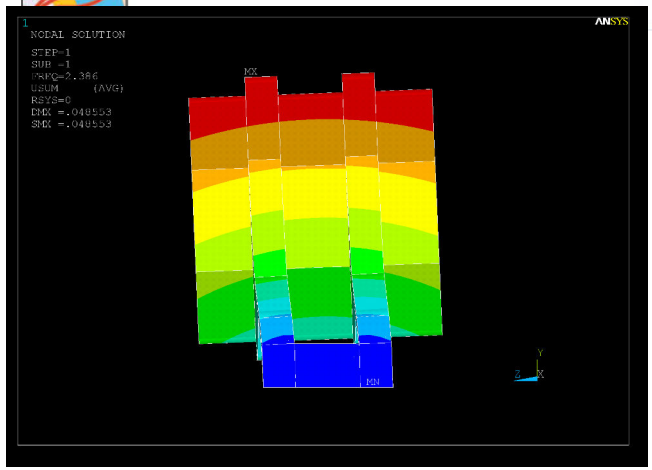


Vibrations and Simulations in ILC

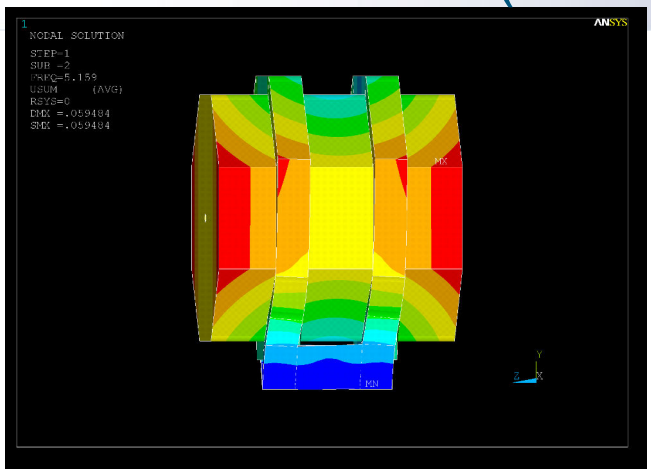
- Clearly the performances of:
  - Ground (excitation spectrum).
  - Yoke
  - Support

must be taken into account to understand the vibrations expected at QD0 level.

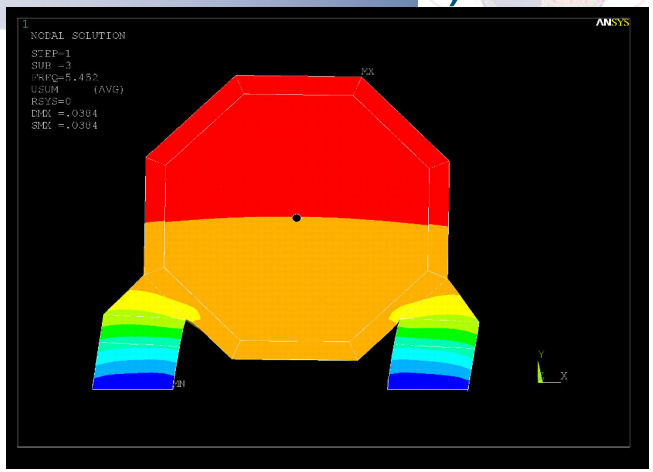
Free vibration modes of SiD (M. Oriunno/SLAC)



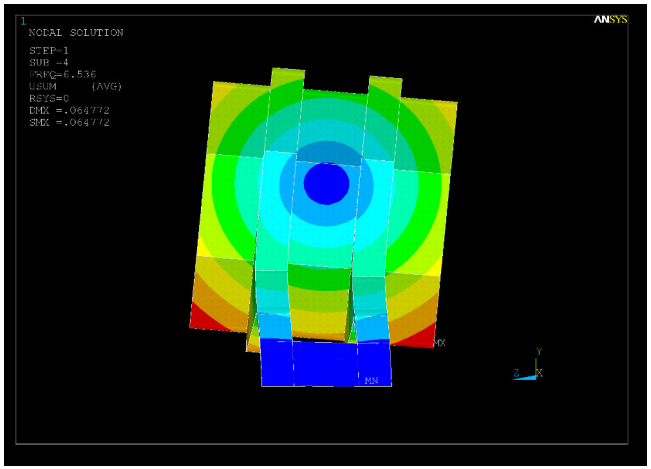
1st Mode, 2.38 Hz



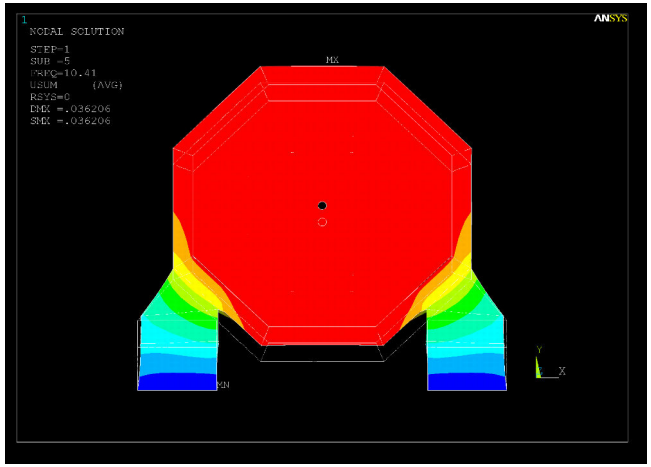
2nd Mode, 5.15 Hz



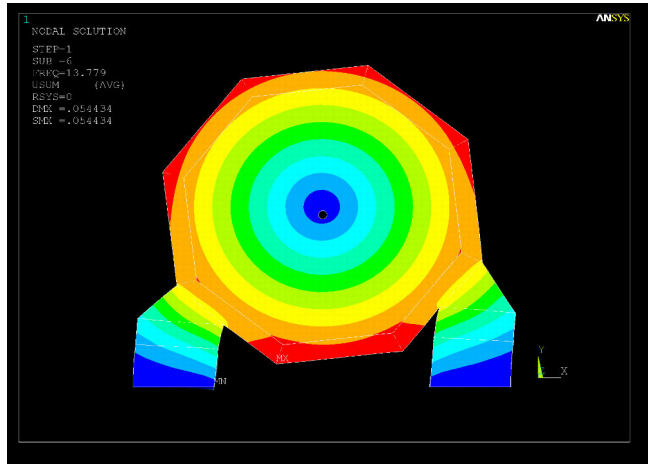
3rd Mode, 5.45 Hz



4th Mode, 6.53 Hz



5th Mode, 10.42 Hz



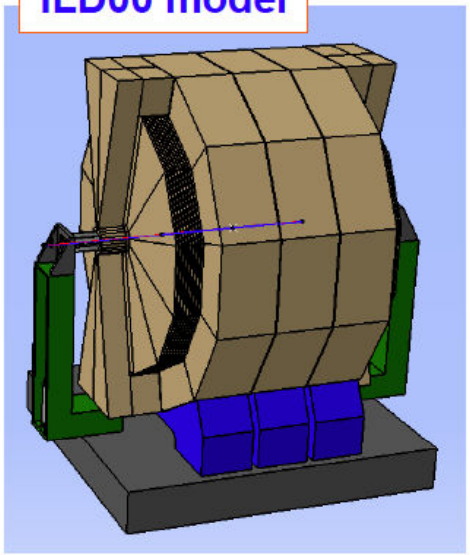
6th Mode, 13.7 Hz

Vertical motion

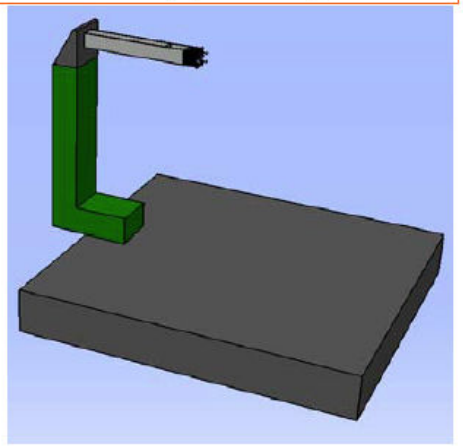
Vibration and Simulation for ILD (H. Yamaoka/KEK)

Vibration properties of the ILD QD0 support system has been studied.

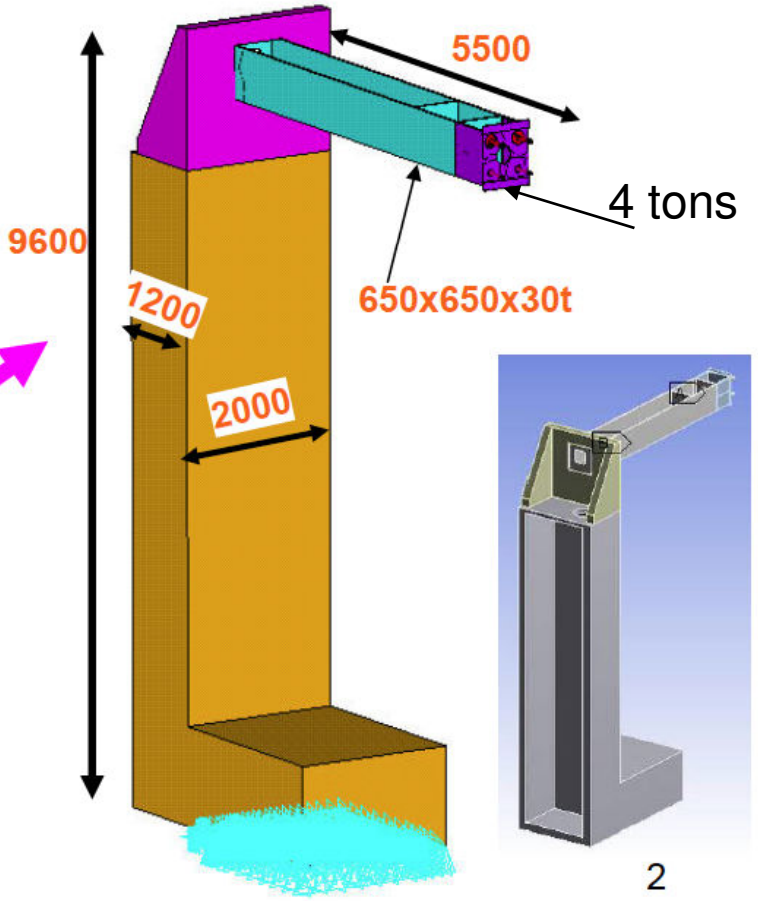
ILD00 model



ILD QD0 support system



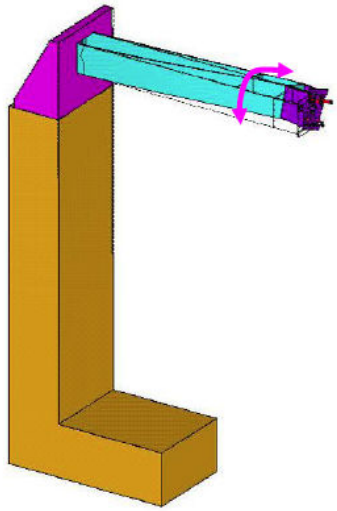
ANSYS model



Vibrations and Simulations for ILD

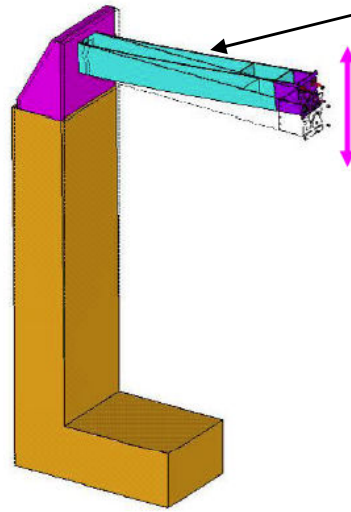
Natural frequency

4.5Hz

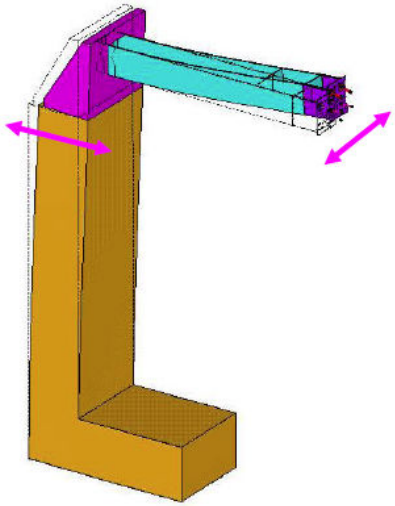


7.9Hz

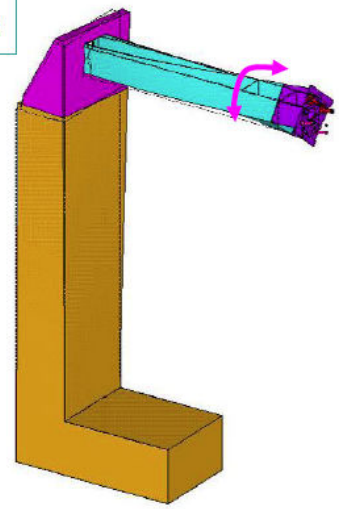
No cover !



10.4Hz



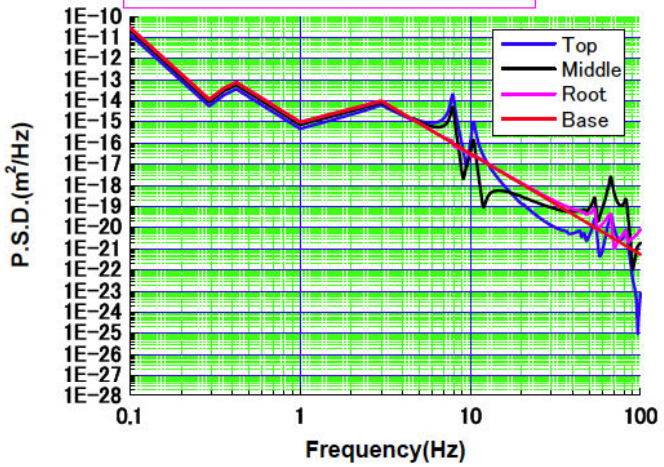
13.6Hz

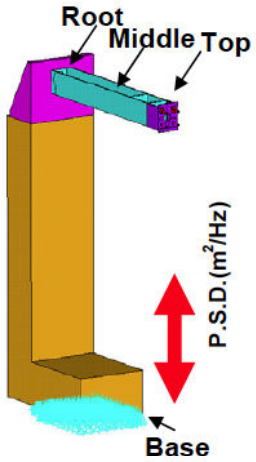


Vibration and Simulation for ILD

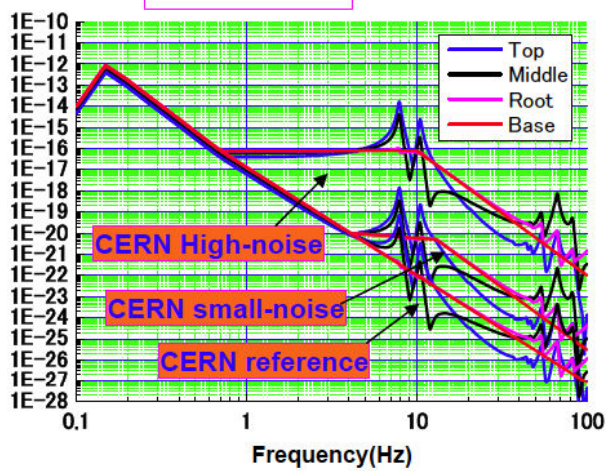
Calculation results: *Vertical direction*

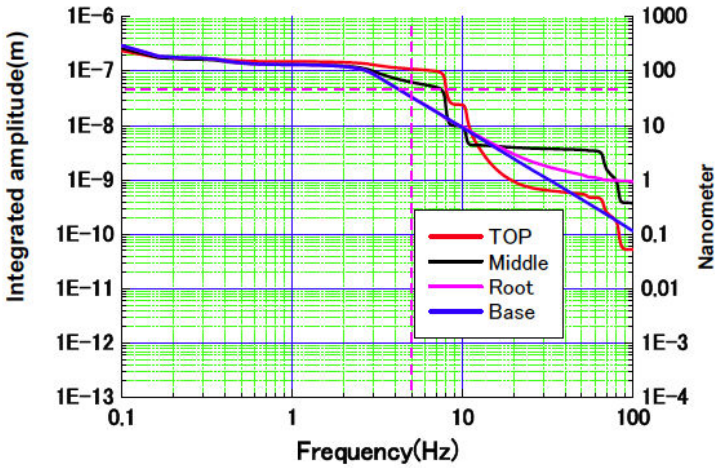
ATF-2004Feb10-17:00UD

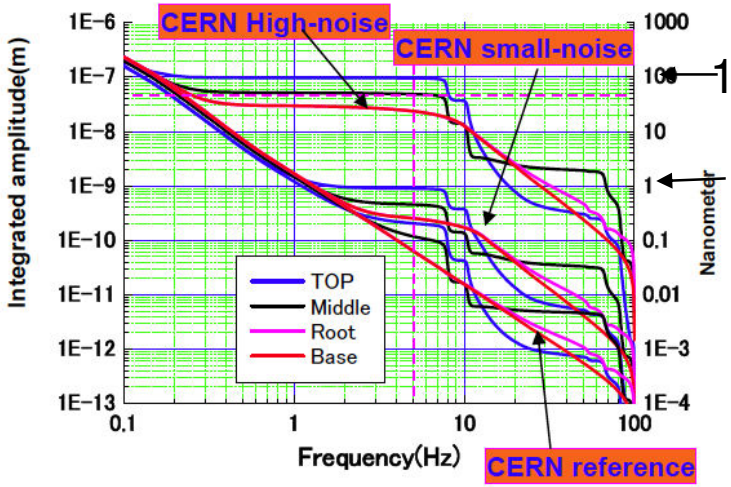




CERN-Data







100nm

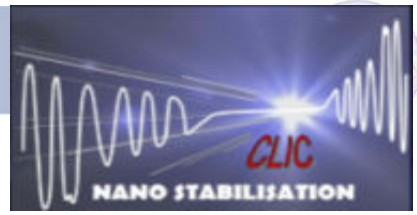
1nm

➔ **Integrated amplitude at 5Hz:** Larger than 50nm.(ATF, CERN High)
Much smaller than 50nm(CERN small, Reference)

Excitation spectrum at CMS

- To validate the studies and benchmark the models, ILD and SiD have asked to measure vibration excitation spectra in one LHC experimental area.
- To complement a campaign in the machine tunnel, new measurements* have been made last month around CMS with cooling stopped and presented at the Annecy Workshop two weeks ago.

(Mechanical Lab K. Artoos, M. Guinchard, C. Hauviller)



(Extract from)

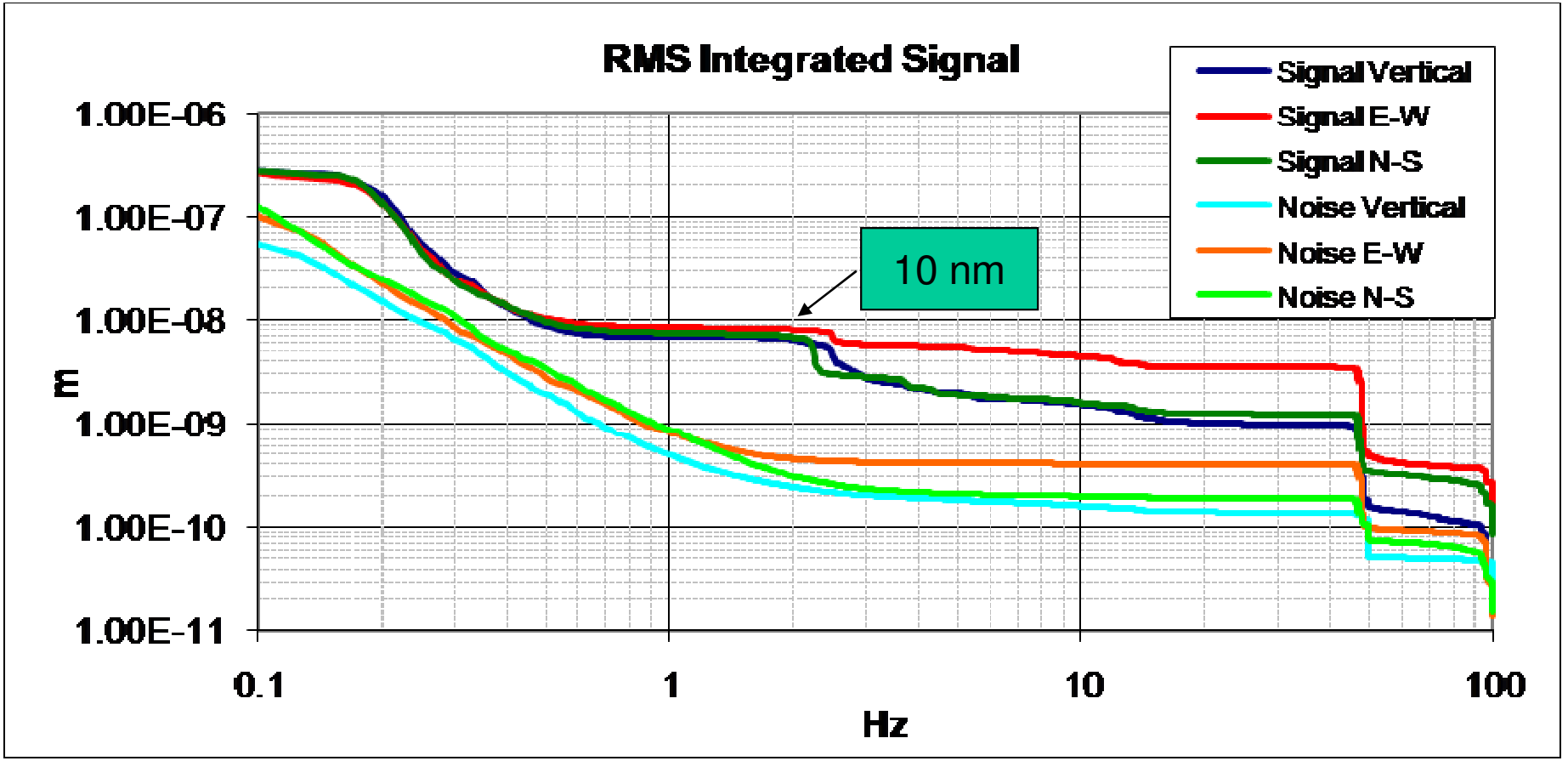
CMS Motion Measurements

C. Hauviller , K. Artoos, M. Guinchard

Mechanical Measurement Lab, 2009.21.09
EDMS no. **1027459**

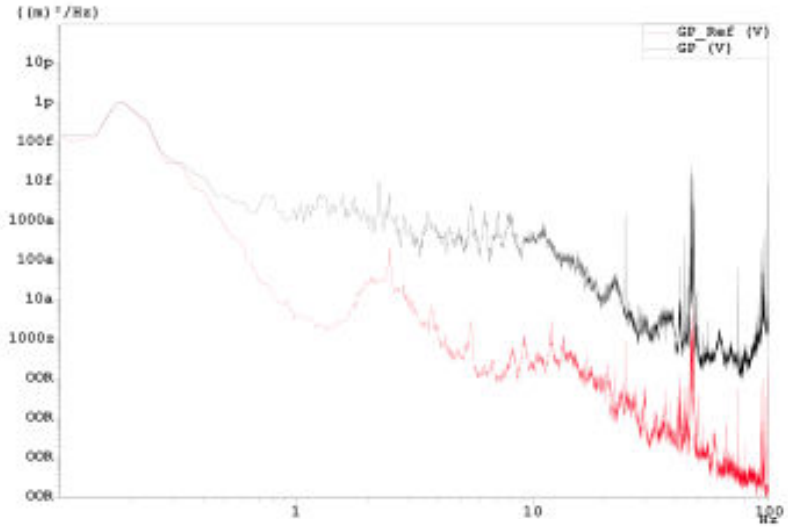
Ground motion measurement in CMS

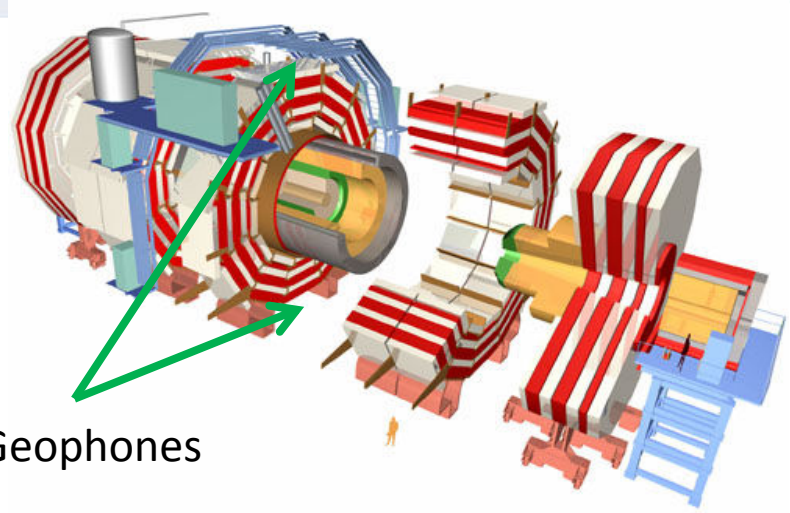
- To measure the ground vibration, two geophones were placed close together on the floor under YB0.
- The measurements were provided while the **cooling systems were off.**



CMS top of Yoke measurement

PSD of the signals Vertical direction

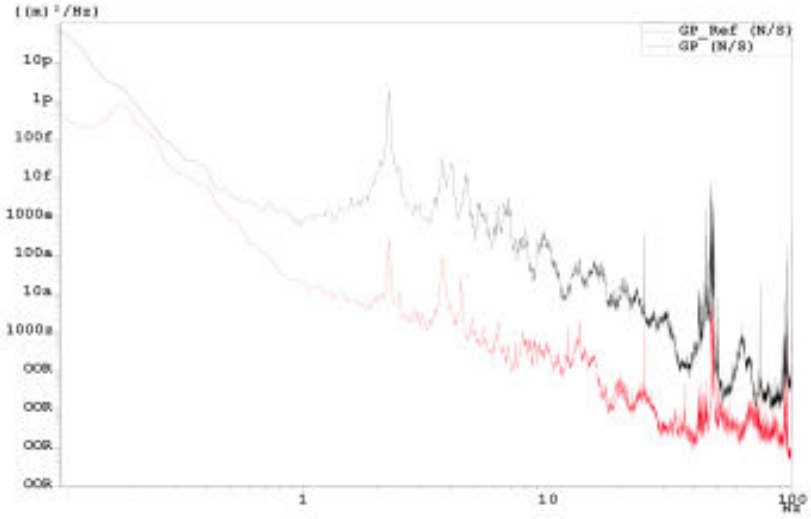


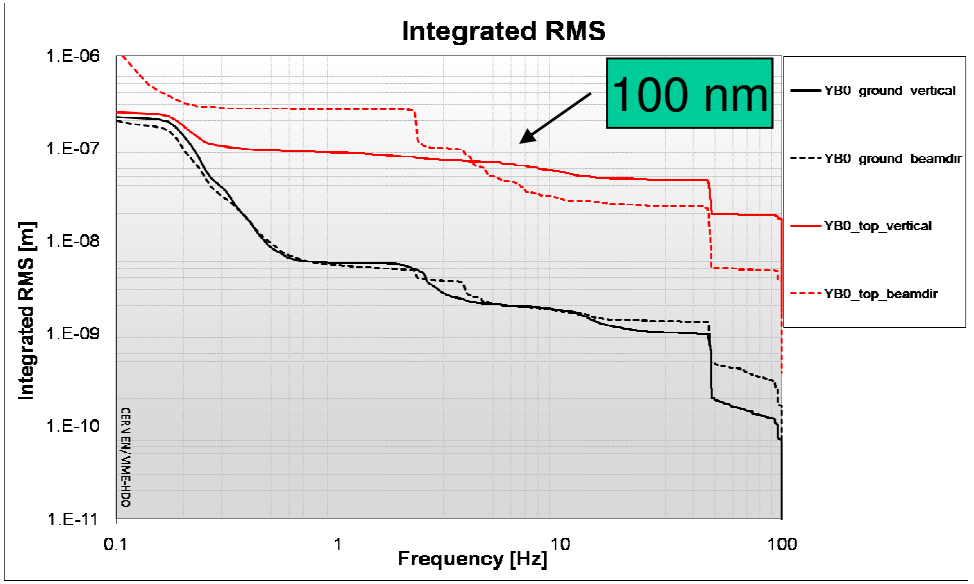


Geophones

Cooling system OFF

PSD of the signals Beam direction





Results for ILC

From the first results it seems that in ILC, with some more improvement in the supporting schemes, the stability goal may be reached.

However it also shows that in all cases a given stability criteria must be coupled to:

- A given design taking into account its own rigidities and natural frequencies.
- An expected local excitation spectrum.

CLIC Considerations

For CLIC the problems are similar, however due to beam size and limitations in feed-back possibilities the *ultimate stability value for QD0 is less than 1 nm.*

It means that a special effort must be made to provide a dedicated support with a stability around 3 nm (or less) to provide a good basis to the QD0 stabilization team.

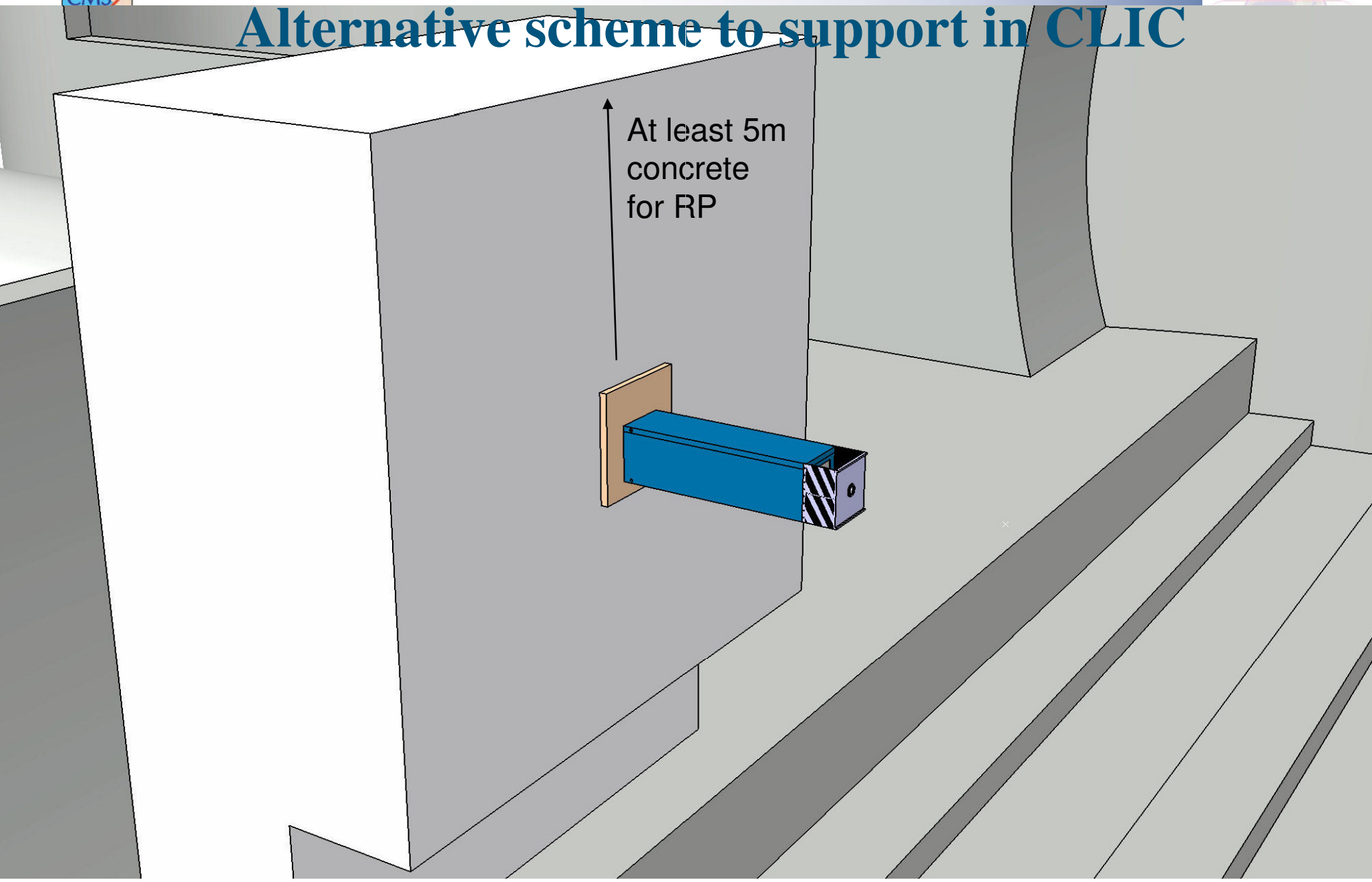
Supporting QD0 in CLIC

- Measurements tend to confirm the idea that the QD0 support must be independent from the experiment.
- However, to obtain the peak luminosity, the last focusing magnet must penetrate inside the experiment.
- To get the best results, the QD0 support must be shortened and strengthened.
- In addition the nearby machine and experimental areas must be designed to minimize (suppress) ground vibration.

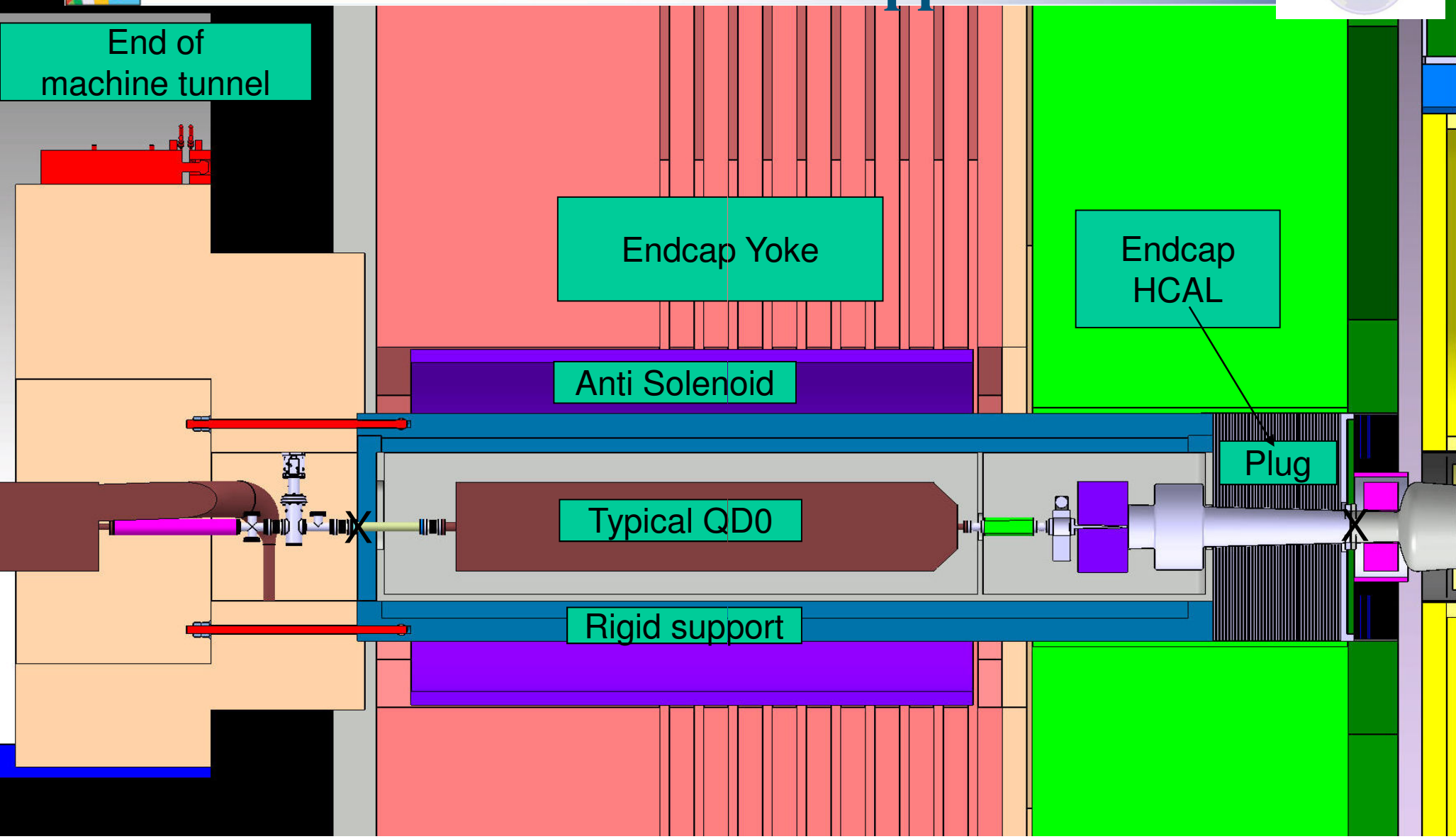
Alternative scheme to support QD0

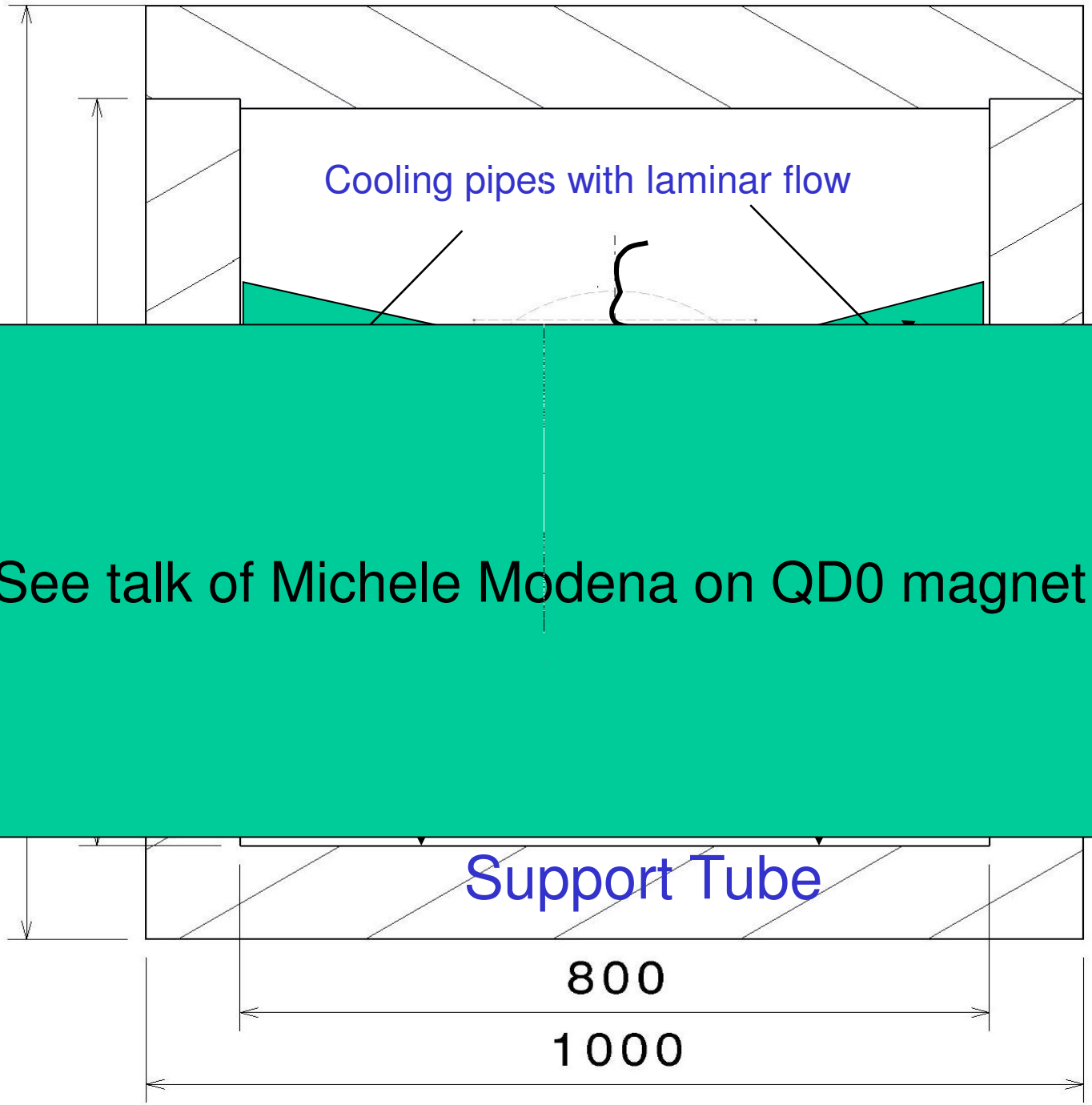
- If CLIC experiments abandon the opening on IP (which is *very* limited and not so important if the push-pull movement is as quickly done as expected) then there are solutions.
- One can move a solid supporting point way inside the experiment
- Transport this (decoupled) heavy support/QD0 assembly to the Garage position with the Experiment,
- Then extract it.

Alternative scheme to support in CLIC



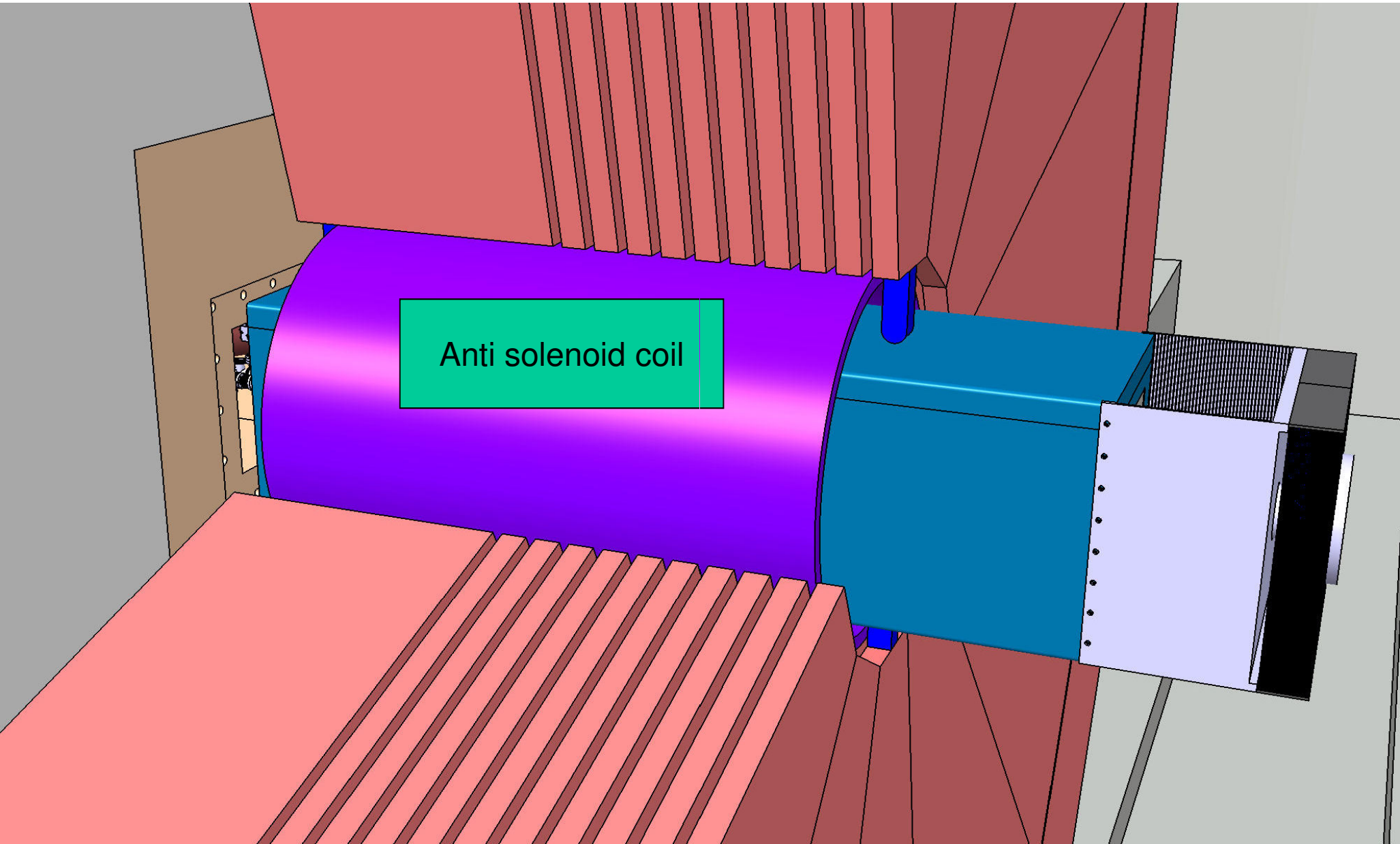
Alternative scheme to support in CLIC



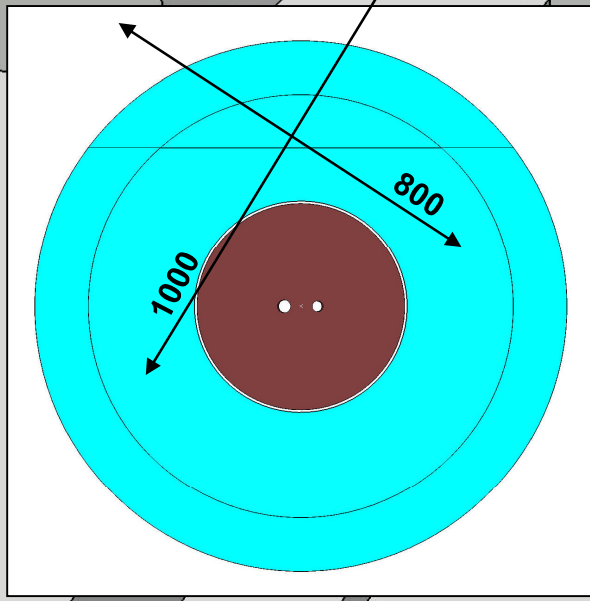


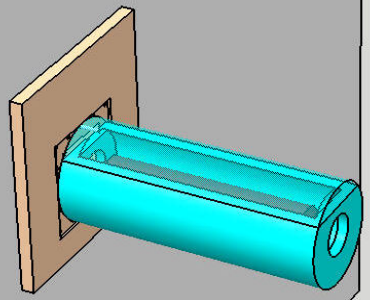
See talk of Michele Modena on QD0 magnet

If permanent magnets are used fo QD0 an anti-solenoid is needed

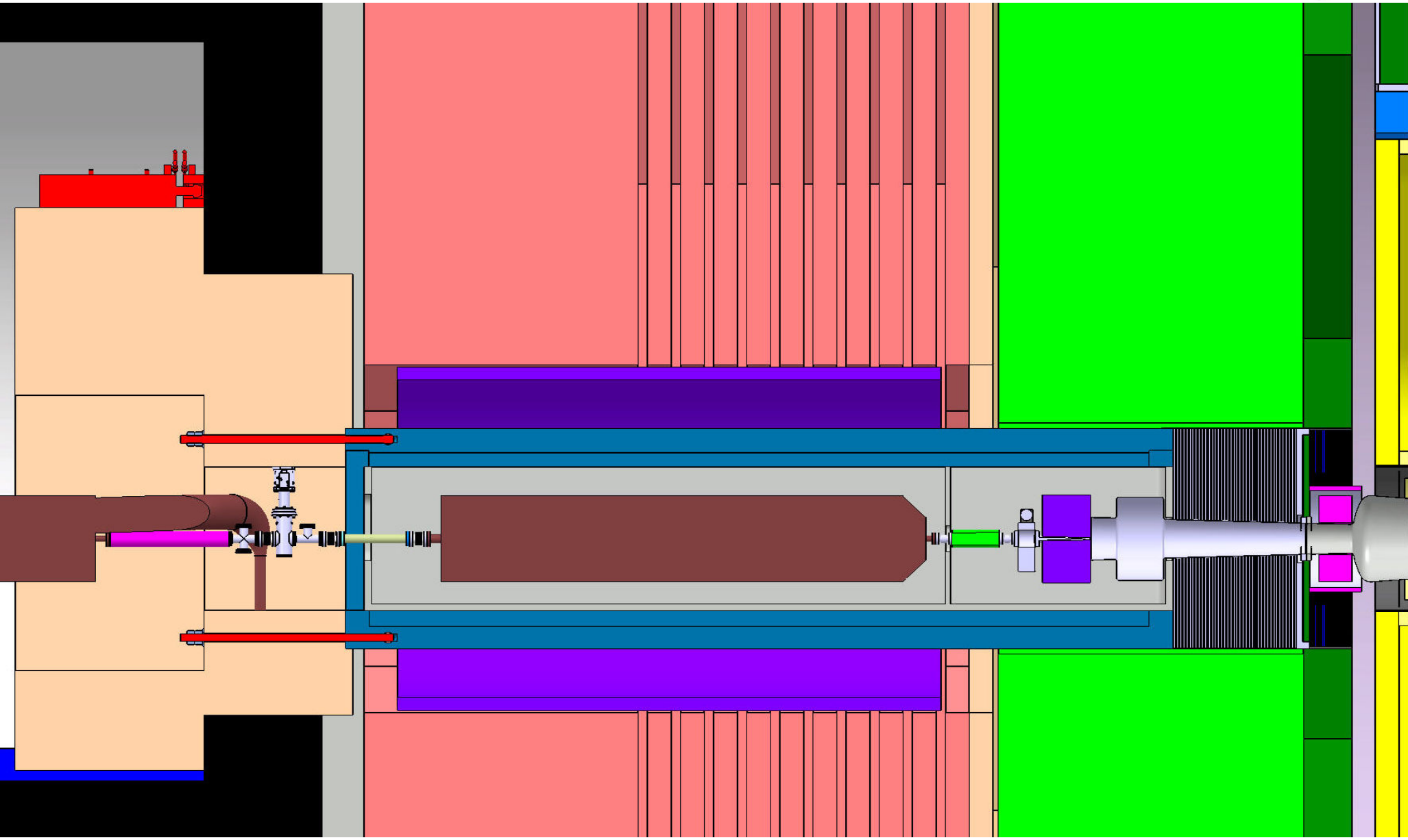


Then maybe a round support-tube will be preferable…

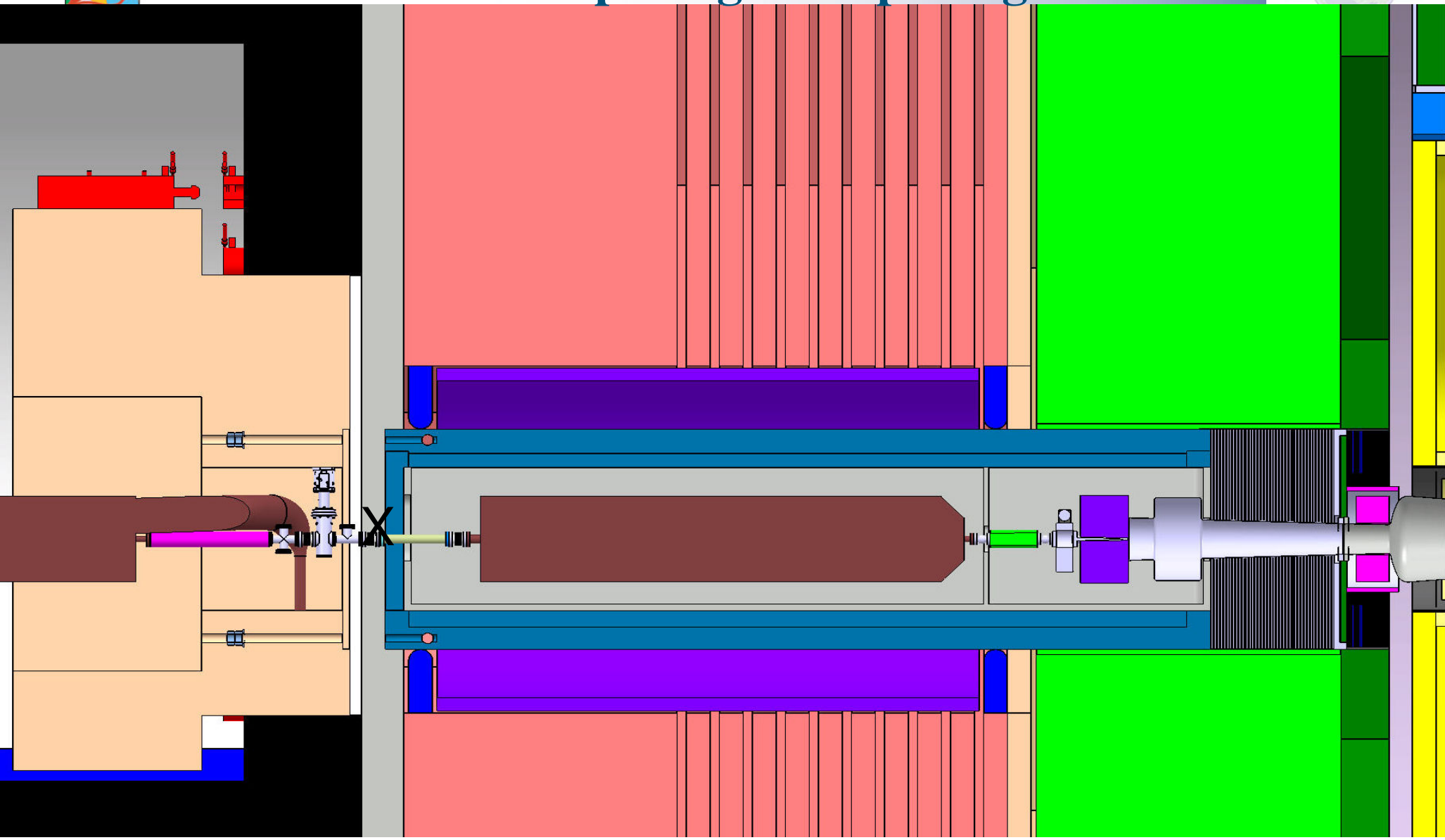




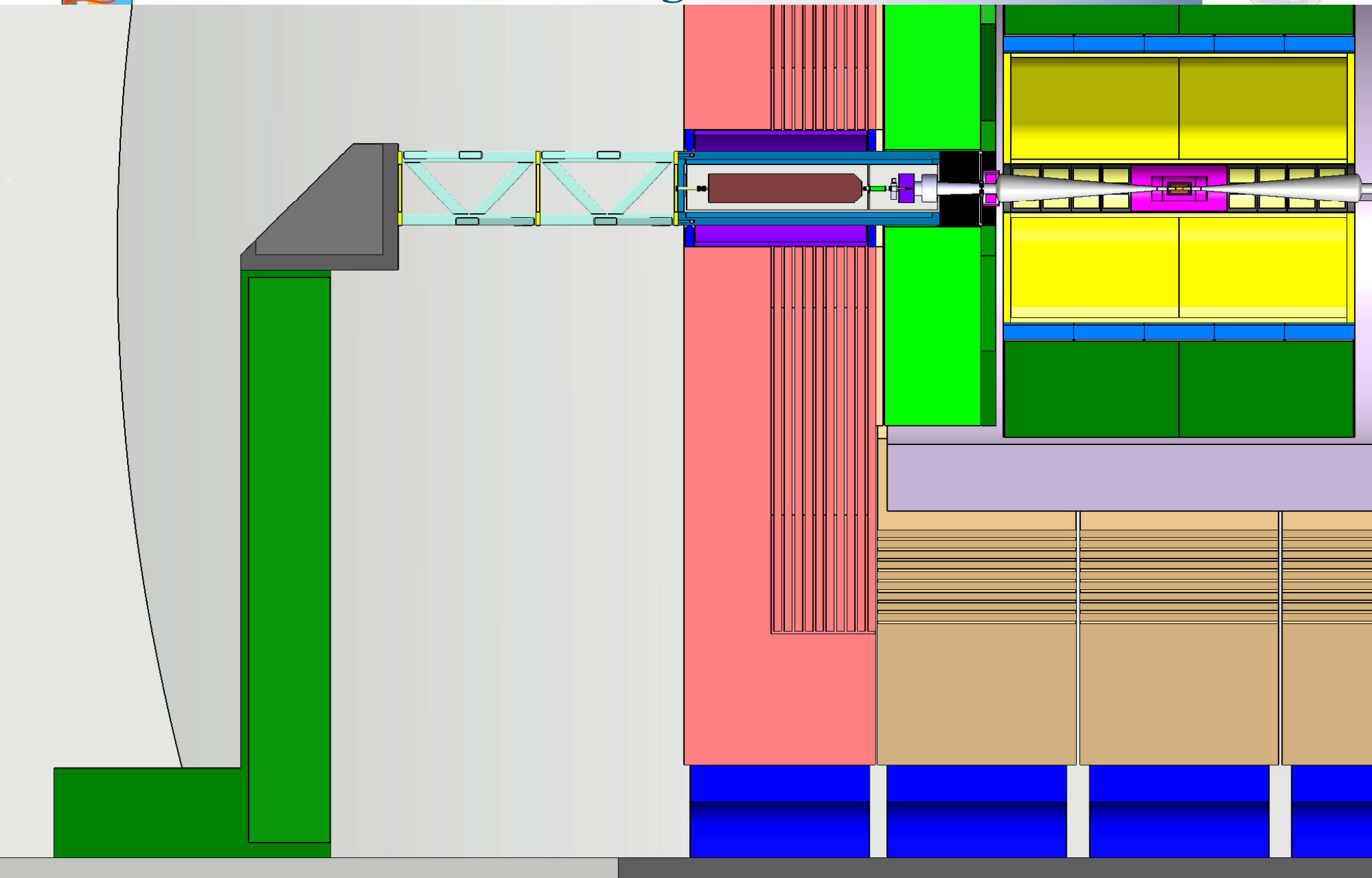
On IP



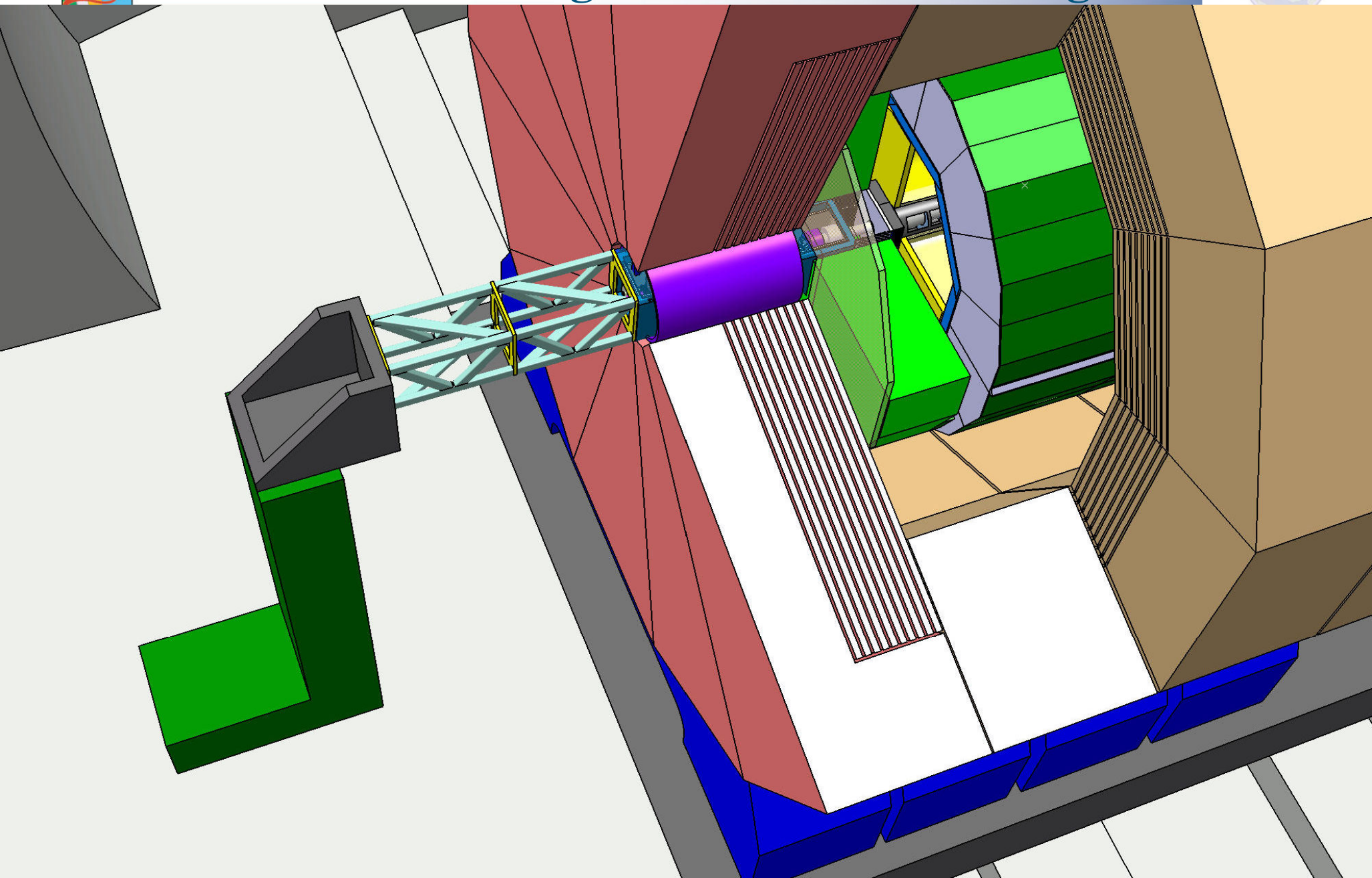
Preparing for Opening



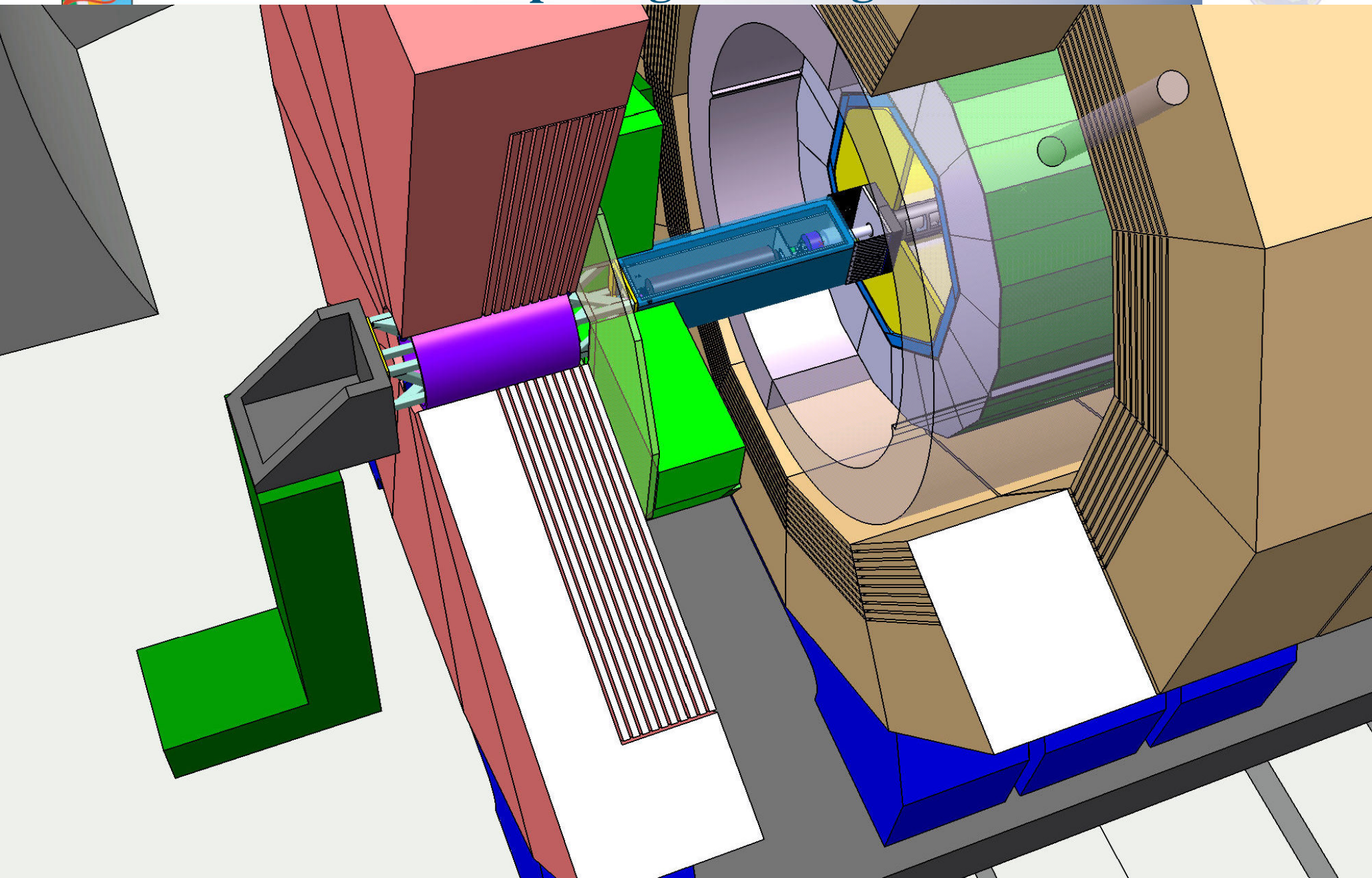
In Garage Position



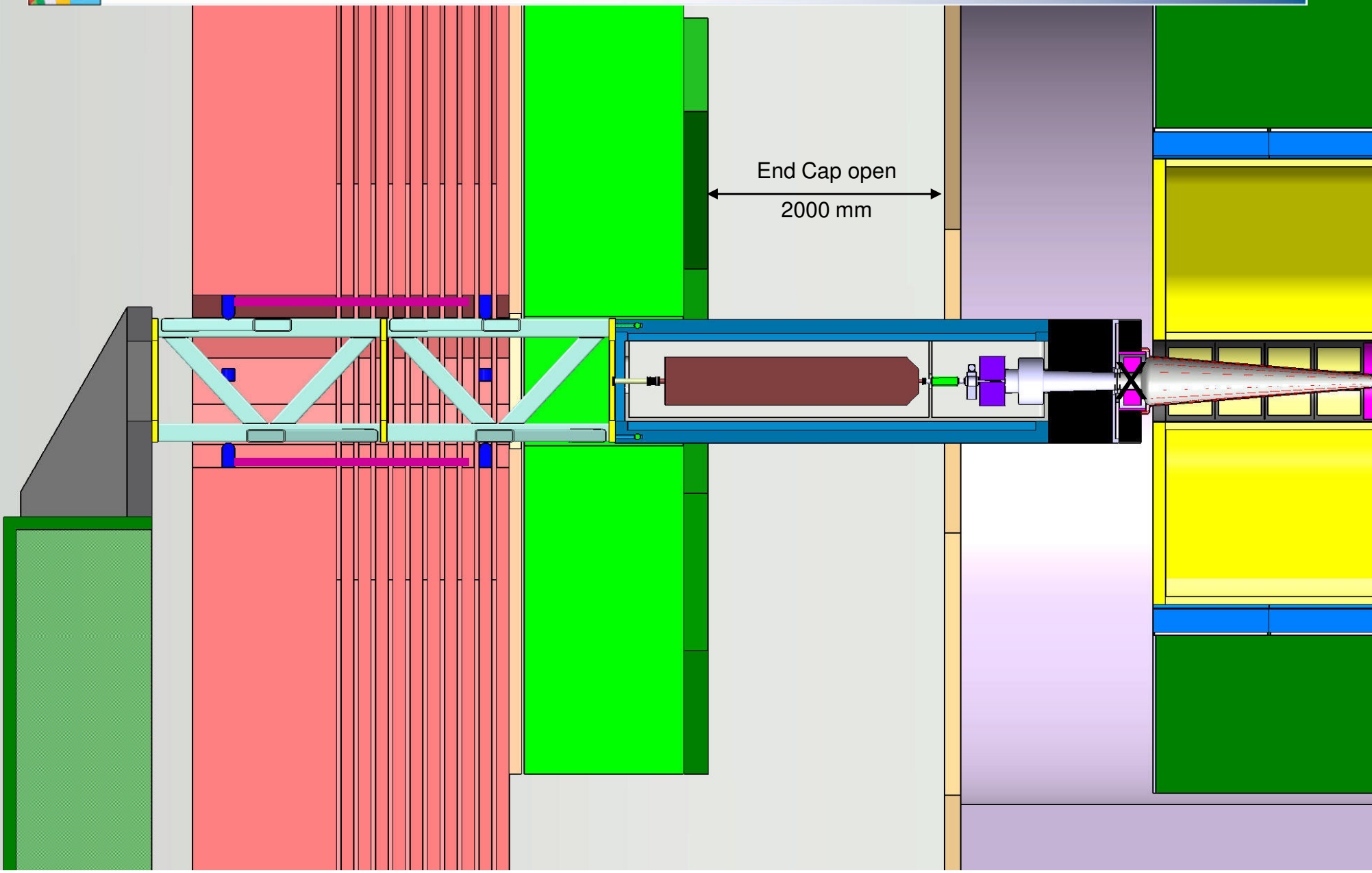
In Garage Position add a tooling



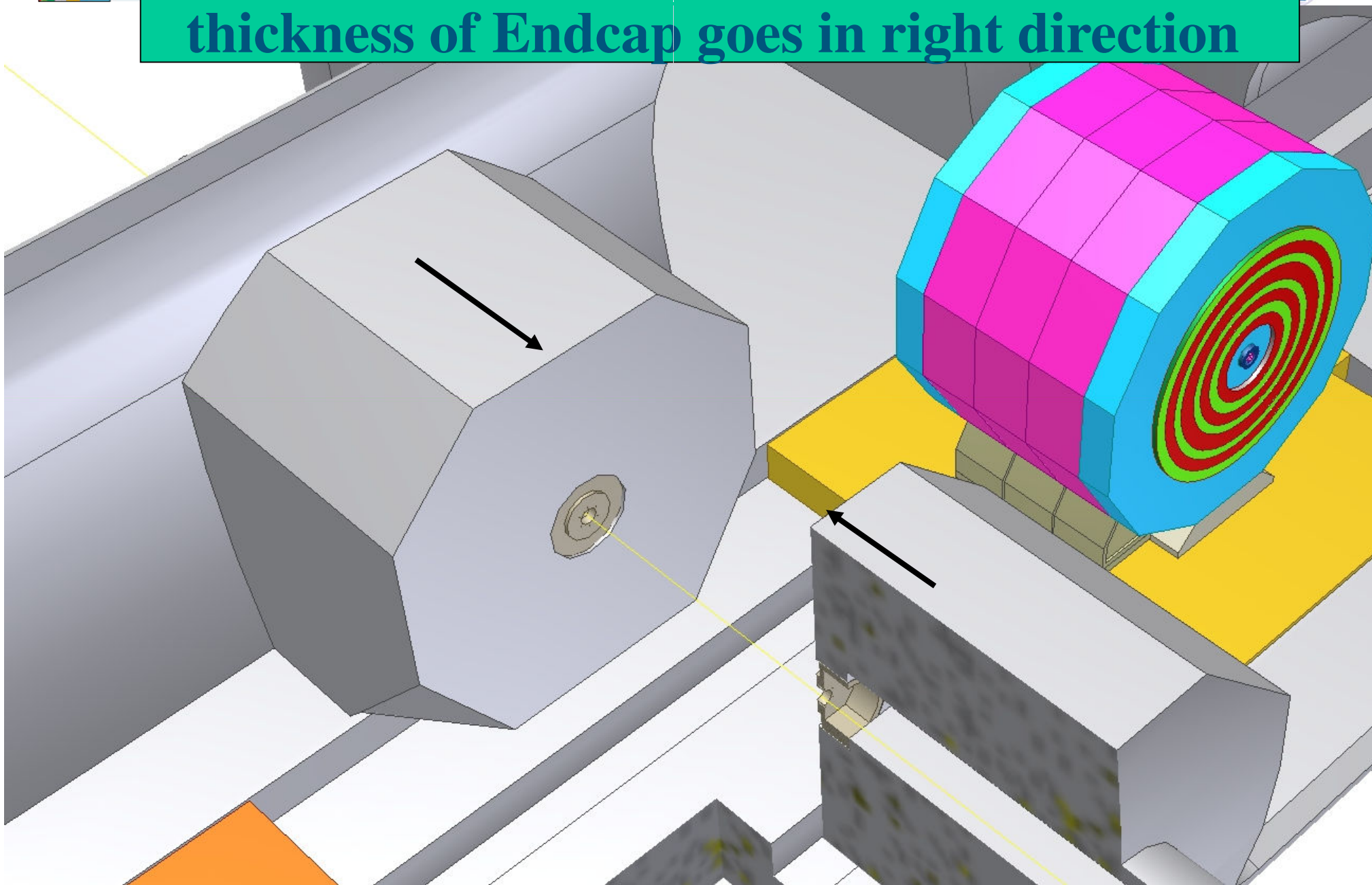
Opening in Garage Position



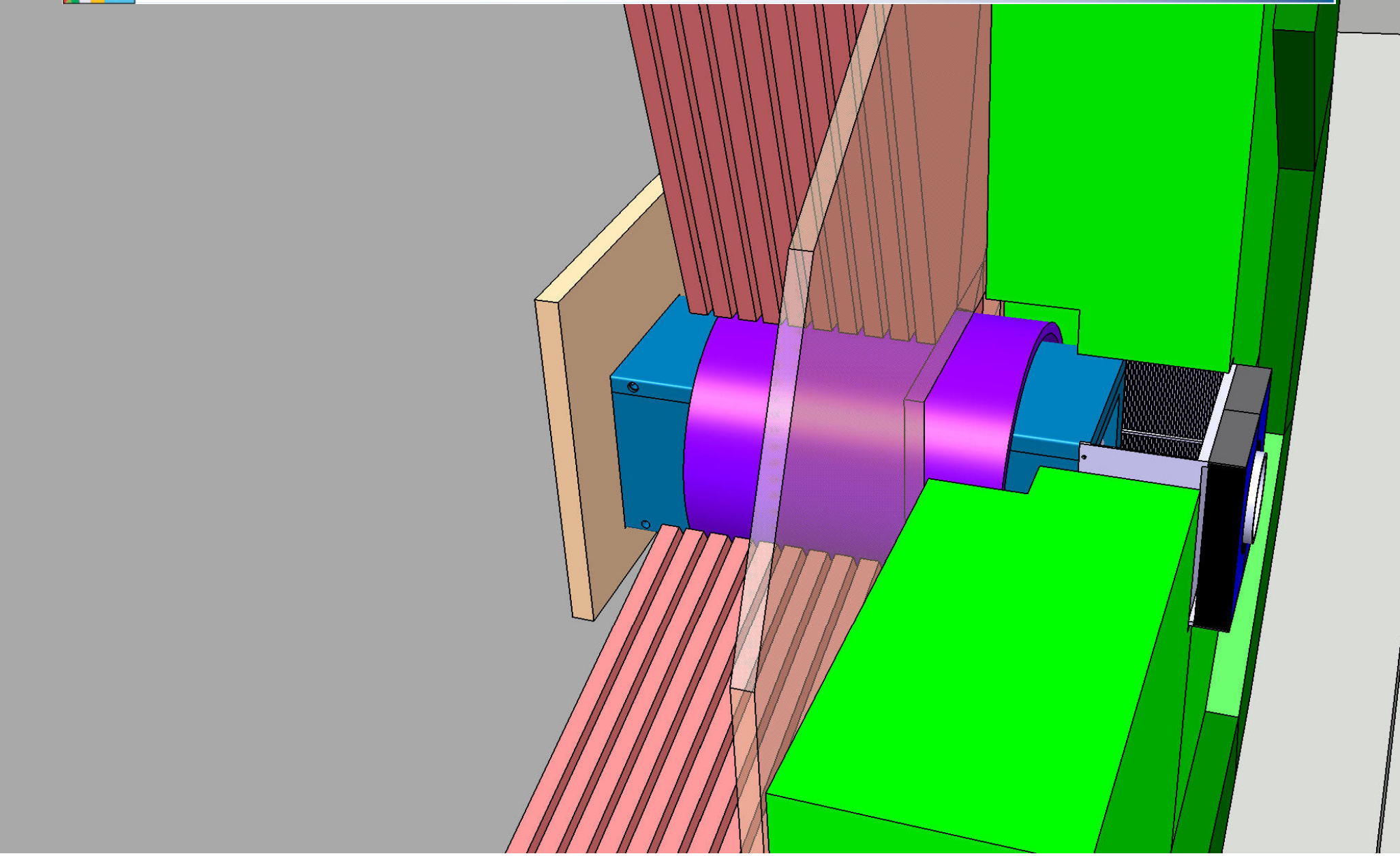
Opening in Garage Position to cut BP



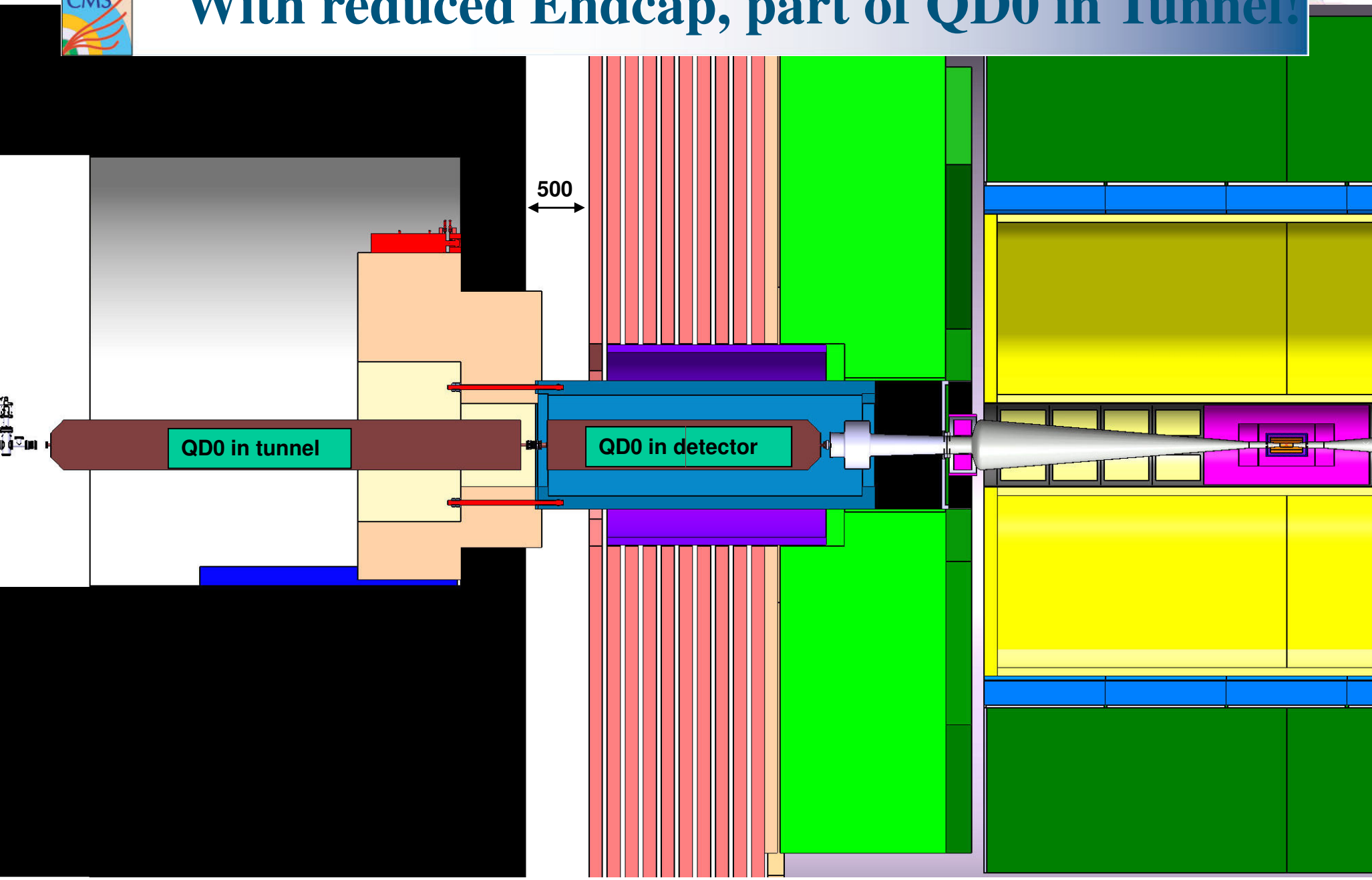
Proposal of H. Gerwig to reduce thickness of Endcap goes in right direction



Even shorter Support Tube !



With reduced Endcap, part of QD0 in Tunnel!



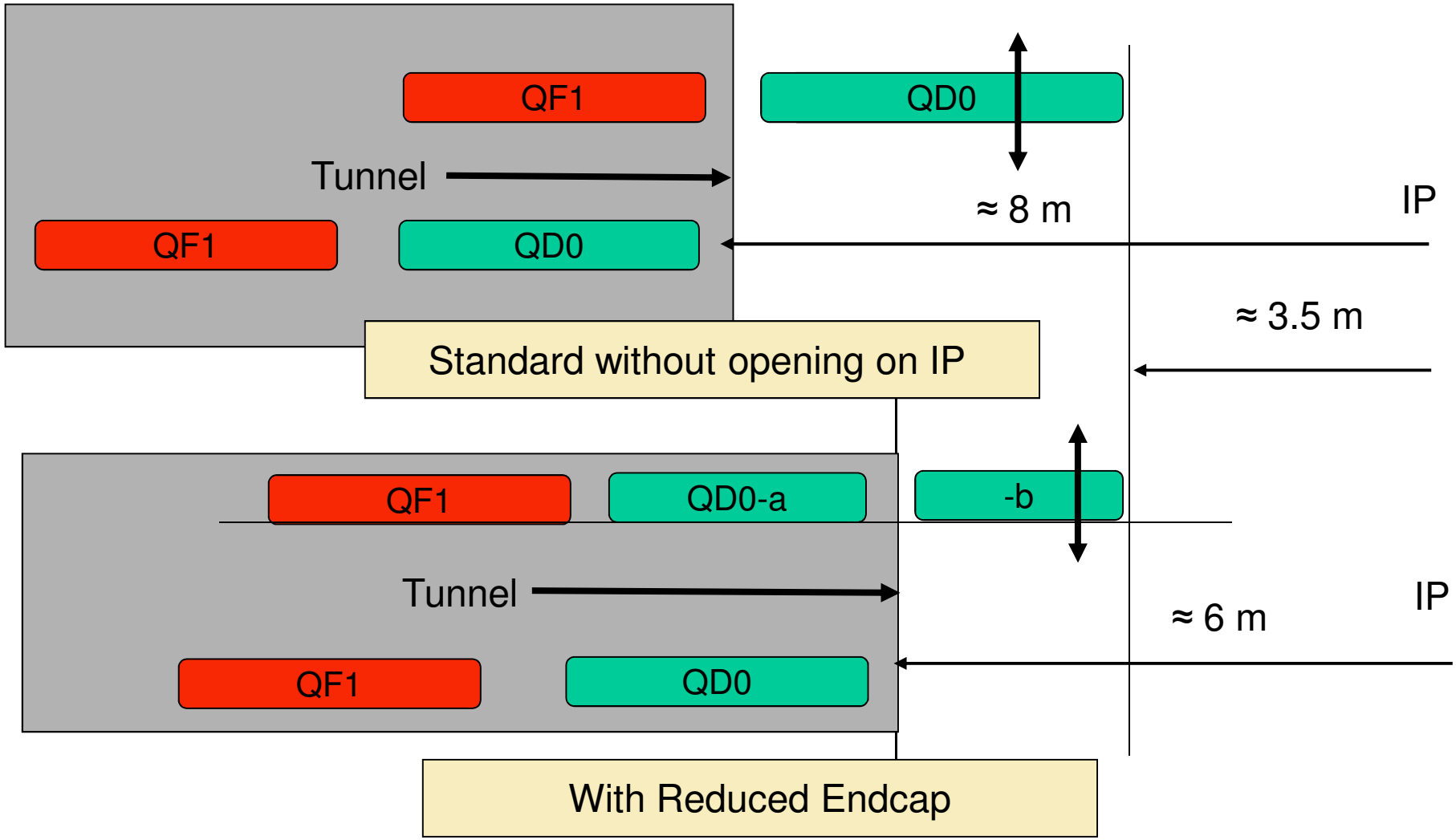
Vibration consideration

- If the QD0 support does not touch the experiment, then the experiment/Platform assembly can be fully decoupled from the ground
- Experiment is then coupled only through beam pipe (with bellows) and acoustic noise!

This would also greatly simplify the design of the experiment and allows:

- Taking more equipment on board
- Water cooling of front-end electronics
- And so on

Summary: possible configurations of last FF



Conclusions

- Computations made for ILD and SiD suggest that a short and rigid support may work for CLIC if the environment is “quiet”.
- Obtaining a “quiet” environment requests that *special effort* must be made in the design of machine and experimental area *from the beginning*, for example:
  - isolating rotating machines and noisy elements,
  - having no water pipe in direct contact with concrete,
  - and so on ….

Conclusions

- The vibration measurements performed on CMS tend to confirm that QD0 support must not touch the experiment.
- A short and strong support compatible with the experiment and push-pull scenario and allowing L* of 3.5 m can be designed, *but will this be sufficient*?
- Confirmation computations using a *credible excitation spectrum* for the nearby tunnel must continue (H. Gerwig et al.).