

## LCWS08

15-20 November 2008

Chicago

# Status of SiD Detector MDI work

Marco Oriunno, SLAC

With contributions of K.Krempetz, M.Breidenbach, F.Feyzi,  
T.Maruyama, B.Wands, W.Craddock T.Markiewicz, A.Seryi



## Toward the Lol

Kept focus on the IDAG questions to be addressed in the Lol by the detector concepts.

Detector Parameters frozen at the SiD meeting in Boulder, September 2008

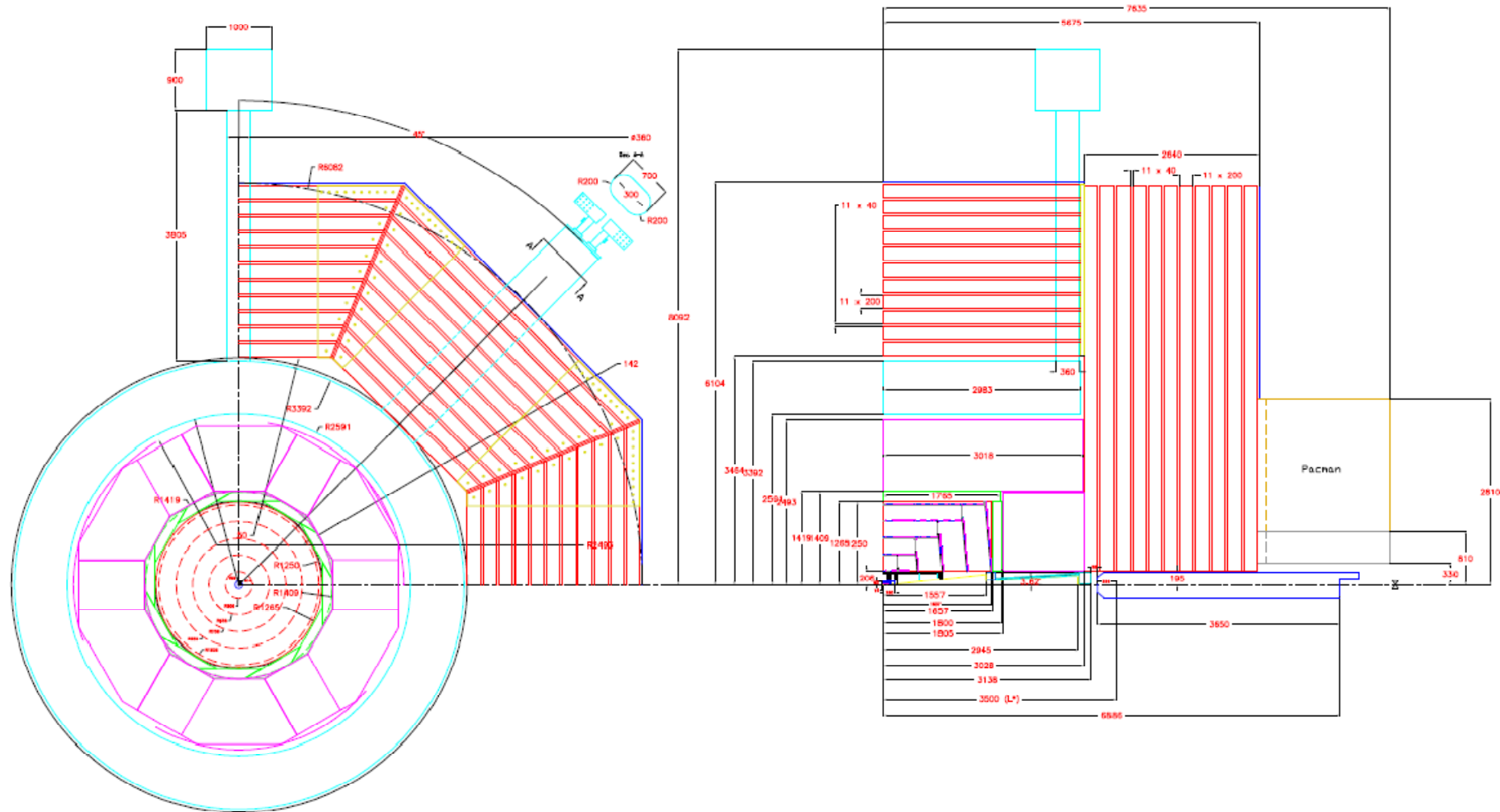
The engineering model is described by a set of parameters that enable the integration of the sub-systems.

At this stage of SiD it is not possible to say much more on cable and piping, both internal and umbilical. A first estimation of the amount of services is included in the model.

Integration studies of other ancillaries like magnet chimneys, cryogenics and Pacmen, also part of the engineering model

Available through ILCDOC/Engineering&Drawings

Available through ILCDOC/Engineering&Drawings



# The interface document

from ECFA08 Warsaw to LCWS08 Chicago

## EPAC08 Paper

### CHALLENGES AND CONCEPTS FOR DESIGN OF AN INTERACTION REGION WITH PUSH-PULL ARRANGEMENT OF DETECTORS – AN INTERFACE DOCUMENT\*

B.Parker (BNL), A.Herve, J.Osborne (CERN), A.Mikhailichenko (Cornell Univ.), K.Buesser (DESY), B.Ashmanskas, V.Kuchler, N.Mokhov (Fermilab), A.Enomoto, Y.Sugimoto, T.Tauchi, K.Tsuchiya (KEK), J.Weisend (NSF), P.Burrows (Oxford Univ.), T.Markiewicz, M.Oriunno, A.Seryi, M.Sullivan (SLAC), D.Angel-Kalinin (STFC), T.Sanuki, H.Yamamoto (Tohoku Univ.)

#### Abstract

Two experimental detectors working in a push-pull mode has been considered for the Interaction Region of the International Linear Collider [1]. The push-pull mode of operation sets specific requirements and challenges for many systems of detector and machine, in particular for the IR magnets, for the cryogenics and alignment system, for beamline shielding, for detector design and overall integration, and so on. These challenges and the identified conceptual solutions discussed in the paper intend to form a draft of the Interface Document which will be developed further in the nearest future. The authors of the present paper include the organizers and conveners of working groups of the workshop on engineering design of interaction region IRENG07 [2], the leaders of the IR Integration within Global Design Effort Beam Delivery System, and the representatives from each detector concept submitting the Letters Of Intent.

#### INTRODUCTION

The process of finding an acceptable technical solution for the Interaction Region involves searching a balance between complex and often contradictory requirements coming from machine or detector. An Interface Document was thought as a way to keep track of the achieved agreements and assumption, and also as the way to highlight existing contradictions and focus the efforts for their resolution. The latter imposes the present Interface Document to be an evolving entity. The first attempt of creation of the Interface Document was undertaken at the IRENG07 workshop. The paper presented represents the next draft, which will be further developed as an integral part of LC08 preparation.

#### FUNCTIONAL REQUIREMENTS

In this section, the minimal functional requirements, to which all detector concepts are bound, are summarized. These requirements are closely related to fundamental properties of design and less dependent on site location and similar specifics. In contrast, the next section will describe more detailed specification and outline the present working models and likely technical solutions.

The list of minimal functional requirement starts with the need to have two detectors in a single collider hall, able to work in turns, in push-pull mode.

\*Work supported in part by US DOE contract DE-AC02-76-SF00515.

The speed of push-pull operation is the first defining assumption. We set as the goal that hardware design should allow the moving operation, reconnections and possible rearrangements of shielding to be performed in a few days, or less than a week.

The range of detector sizes considered in the design include detectors with half size of 6-7 meters, performing optimally if the IP to start of QD0 quadrupole ( $L^*$  parameter) would be in the range of 3.5-4.5 meters (different  $L^*$  is allowed for different detectors), while the distance from IP to the second quadrupole QF1 is 9.5 meters, which drives many parameters of the design, including the hall width.

The off-beamline detector is shifted in the transverse direction to a garage position, located 15m from the IP. The radiation and magnetic environment, suitable for personnel access to the off-beamline detector during beam collision, are to be guaranteed by the beamline detector using their chosen solution.

The IR and detector design is to satisfy the beam parameters defined in the RDR [1] including nominal, Low N, Large Y and Low P parameter sets.

#### INTERFACE SPECIFICATIONS

The superconducting final doublets, consisting from QD0 and QF1 quadrupoles and sextupoles SD0 and SF1 are grouped into two independent cryostats, with QD0 cryostat penetrating almost entirely into the detector. The QD0 cryostat is specific for the detector design and moves together with detector during push pull operation, while the QF1 cryostat is common and rests in the tunnel.

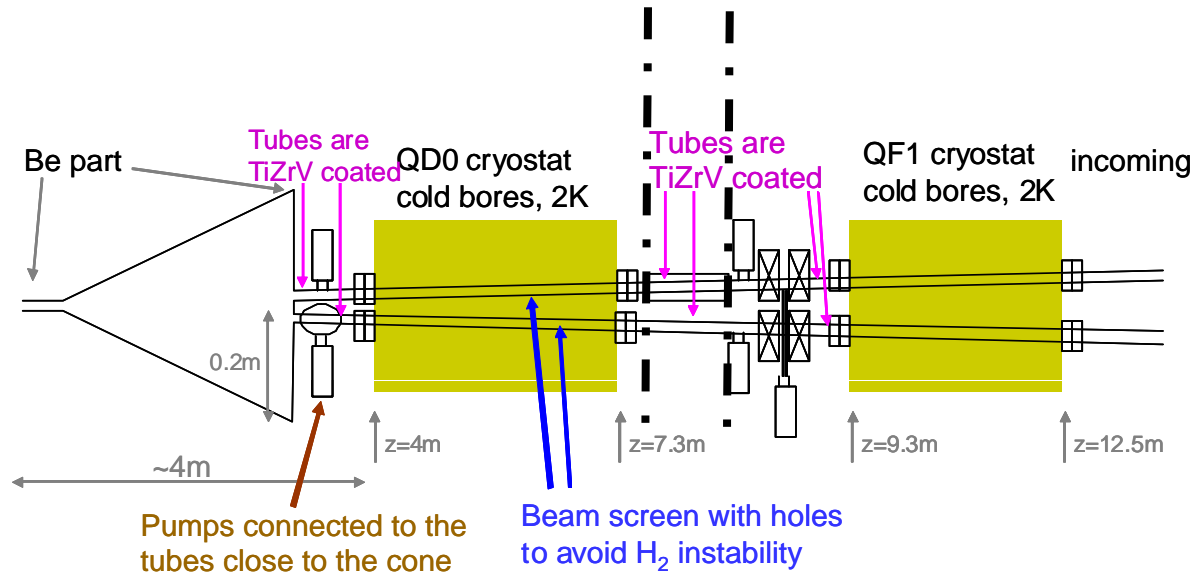
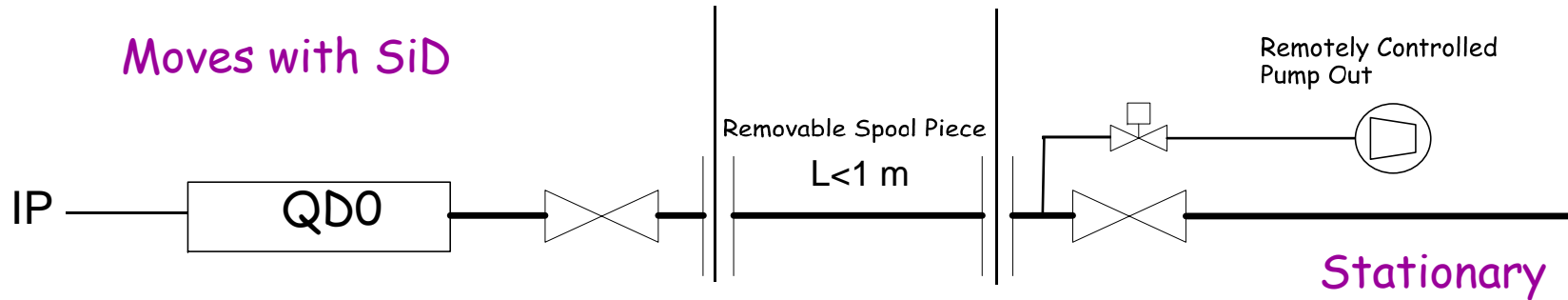
Radiation shielding is essential with two detectors occupying the same Interaction Region hall. The detector should either be self-shielded or need to assume responsibility for additional local fixed or movable shielding (walls) to provide an area accessible to people near the second detector when the first is running with beam. The radiation criteria to be satisfied are for normal operation and for an accident case. The radiation criteria will be developed in consultation with the project management. The criteria presently used for shielding design evaluation are those described in [3] and summarized below. In the normal operation, the dose anywhere near the non-operational second detector should be less than 0.5 mSv/hour. In the accident case the dose should be less than 250 mSv/h for maximum credible beam (simultaneous loss of both  $w^+$  and  $w^-$  beams).

## List of functional requirements

1. Two detectors in a single collider hall, able to work in turns, in push-pull mode.
2. The hardware design should allow the moving operation, reconnections and possible rearrangements of shielding to be performed in a few days, or less than a week.
3. The IP to start of QD0 quadrupole ( $L^*$  parameter) would be in the range of 3.5-4.5 meters (different  $L^*$  is allowed for different detectors), while the distance from IP to the second quadrupole QF1 is 9.5 meters.
4. The range of detector sizes considered in the design include detectors with half size of 6-7 meters, performing optimally
5. The off-beamline detector is shifted in transverse direction to a garage position, located 15m from the IP.
6. The radiation and magnetic environment, suitable for people access to the off-beamline detector during beam collision, are to be guaranteed by the beam line detector using their chosen solution.
7. The IR and detector design is to satisfy the beam parameters defined in the RDR [1] including nominal, Low N, Large Y and Low P parameter sets.

# Assembly Scenarios

- There appears to be a debate between surface and below ground assembly.
- However:
  - The major detector modules will be assembled elsewhere. This obviously includes the VXD, Tracker, EMCal, and HCal.
  - The muon detectors can be loaded into the iron elsewhere.
  - The solenoid will be wound elsewhere.
  - The amount of cabling and services on SiD is tiny compared to the LHC detectors.
- Therefore, we can choose among:
  - Assemble the barrel and doors above ground and lower the ~4Ktonne barrel and two ~2Ktonne doors.
  - Final assembly of the major steel components below ground. Depending on steel design, components might weigh 100-500 tonnes. The solenoid with calorimeters weighs ~700 tonnes, but calorimeters could be inserted later.
- Actual strategy depends on details of site and schedules



**Present vacuum requirements :**

**$P < 1$ nT in the BDS**

**$P < 100$ nT in the experimental region**

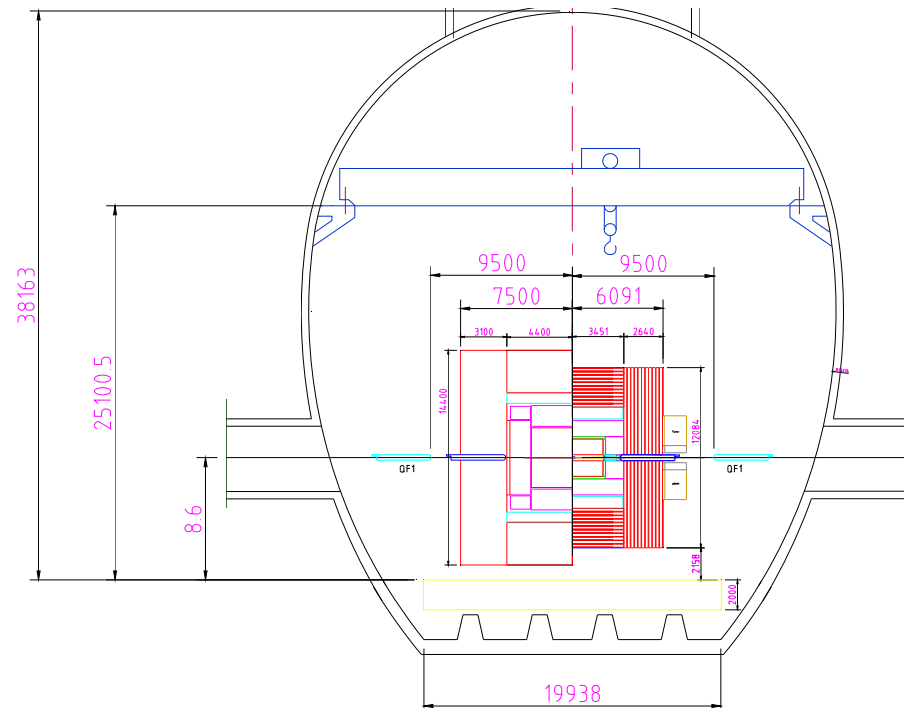
- Do we rely on the cryopumping from QD0
- Do we need extra pumps
- Do we need periodic bake out *in situ*.

**Actions required**

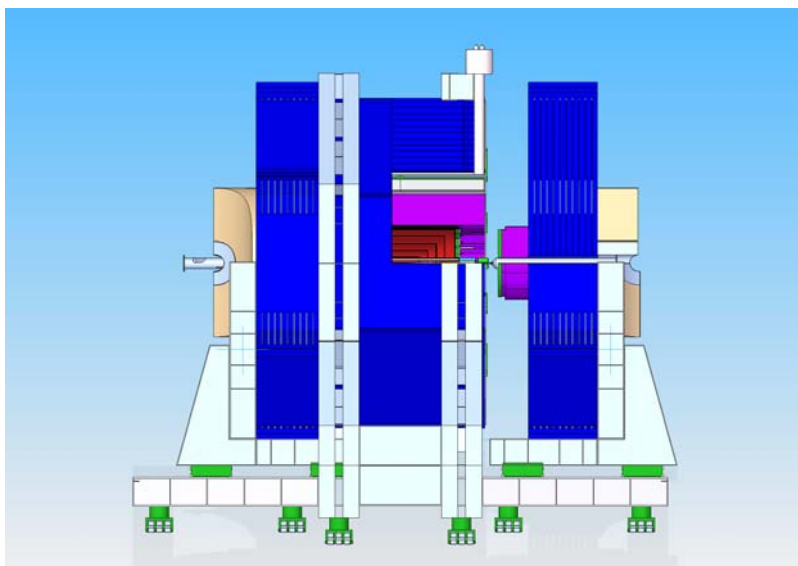
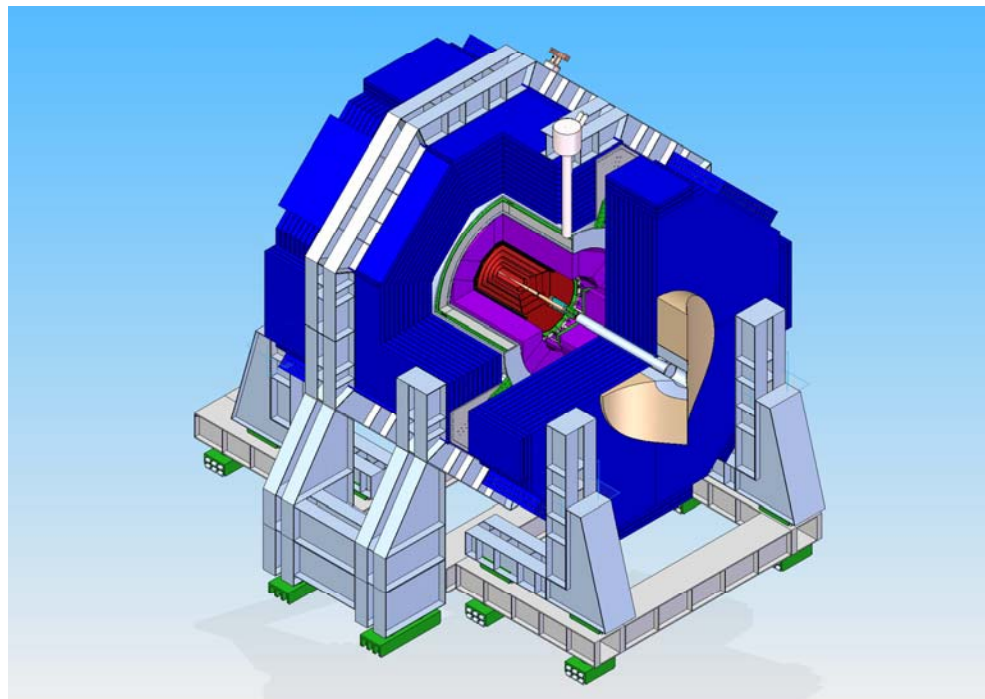
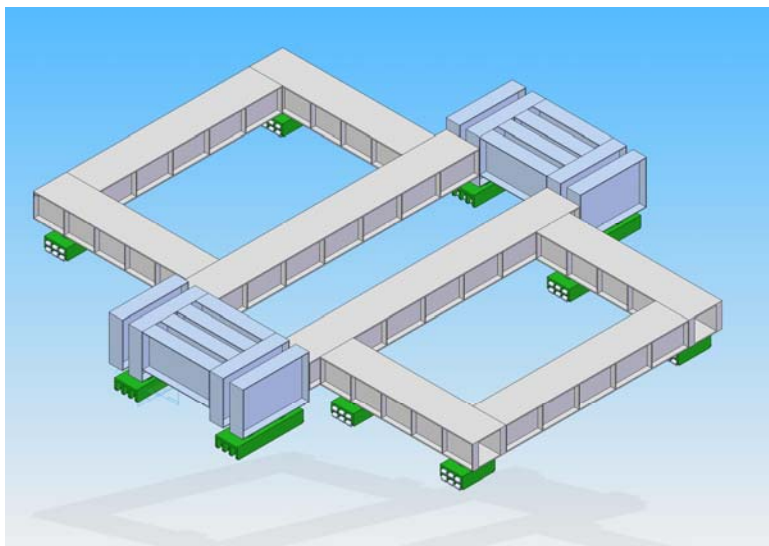
- Beam instrumentation def.
- Additional Shut-off valves location

# Platforms

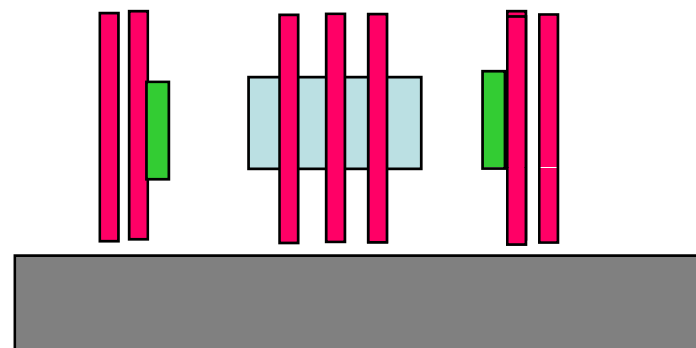
- Building the detector on a platform seems to have significant risks and costs with incommensurate benefits.
  - The major issue is vibration isolation to ensure luminosity.
  - The platform requires excavating the hall further below beamline, with roughly the same requirements on the “floor”.
  - It appears rather expensive to make a platform stiff enough if it is supported discretely.
  - SiD can adjust its elevation to match the beamline with its proposed undercarriage.





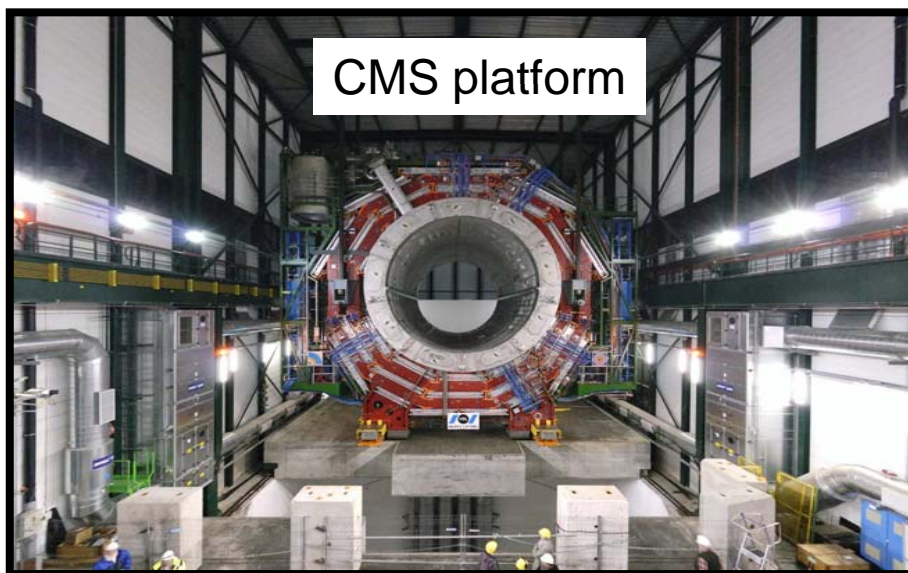


Phi sliced layout SiD

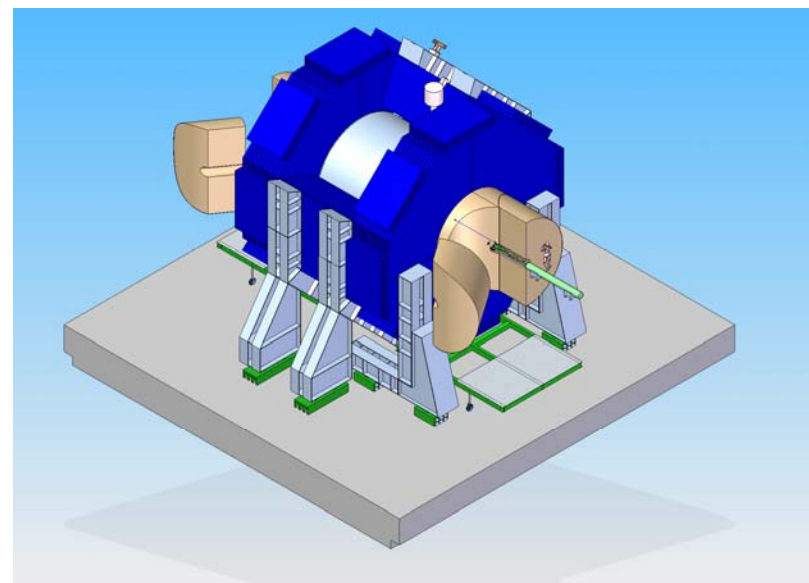


Zee sliced layout a la ILD/CMS

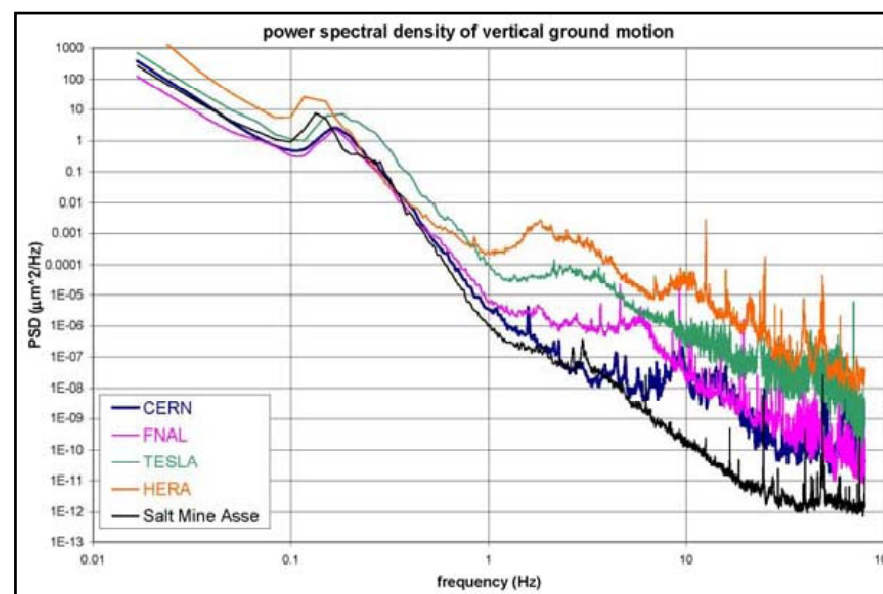
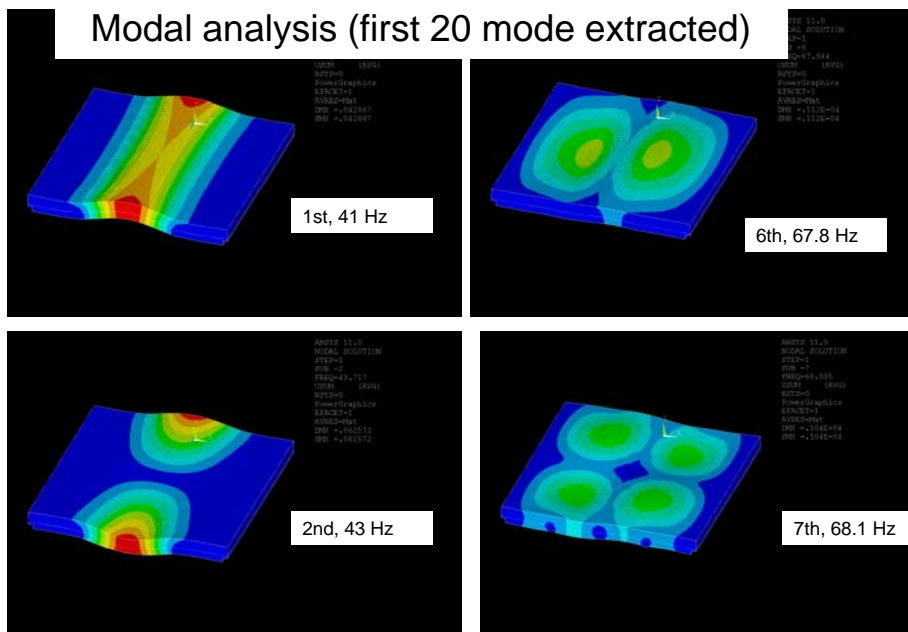




CMS platform



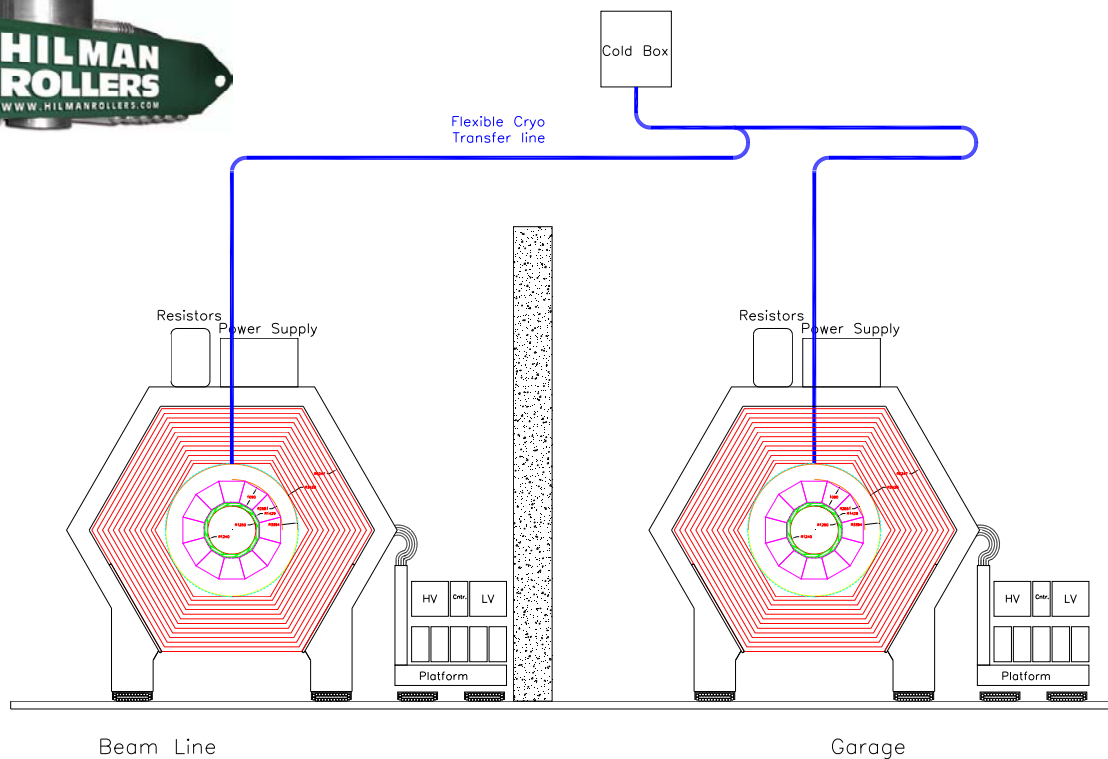
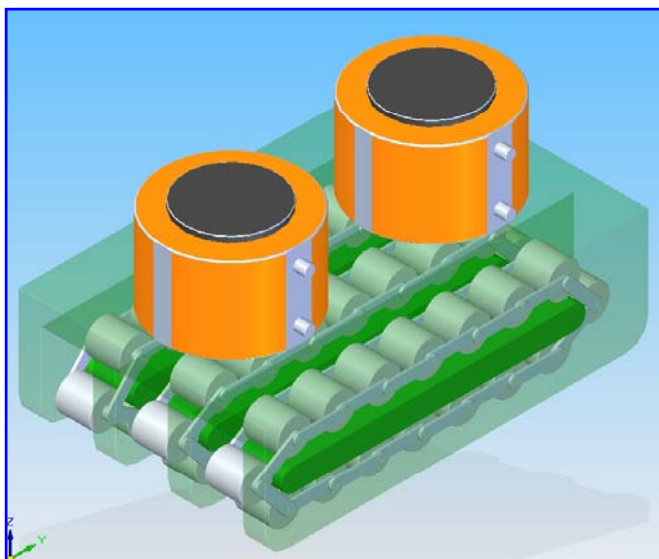
Modal analysis (first 20 mode extracted)

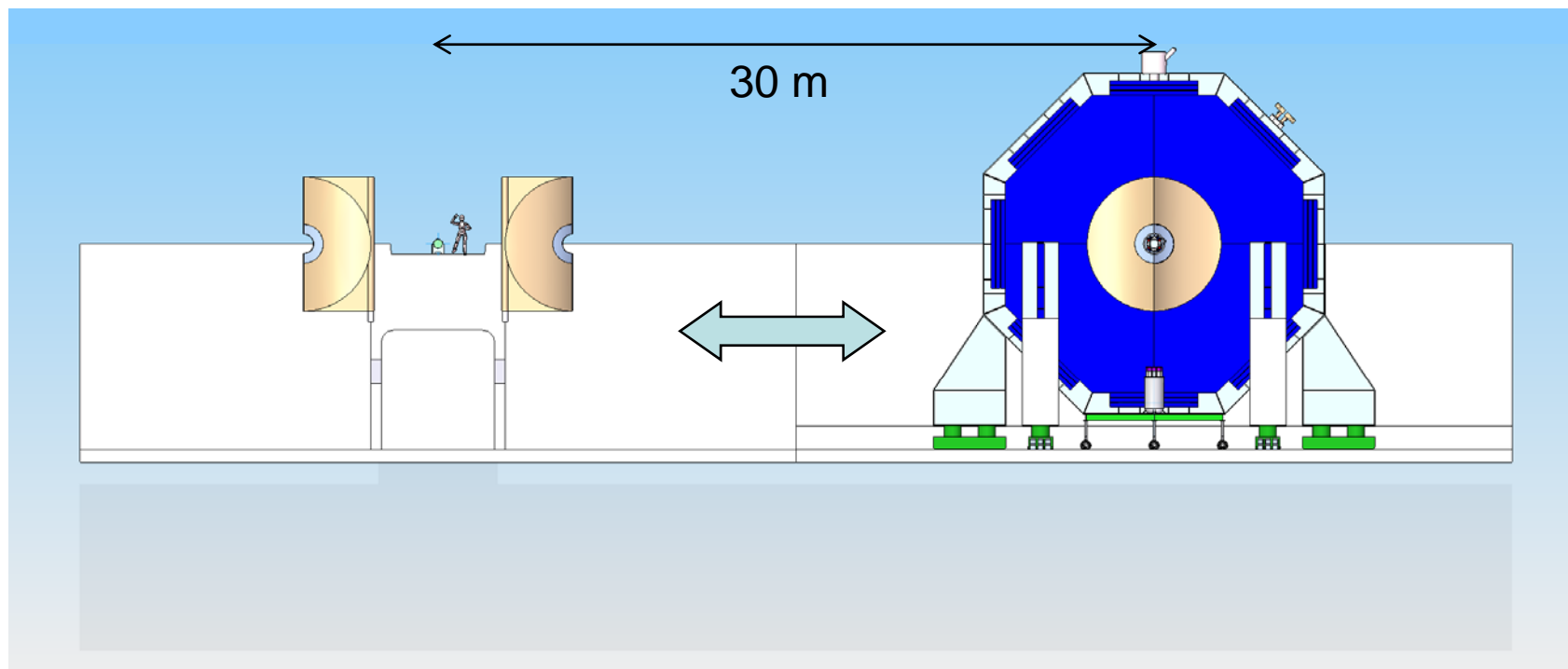
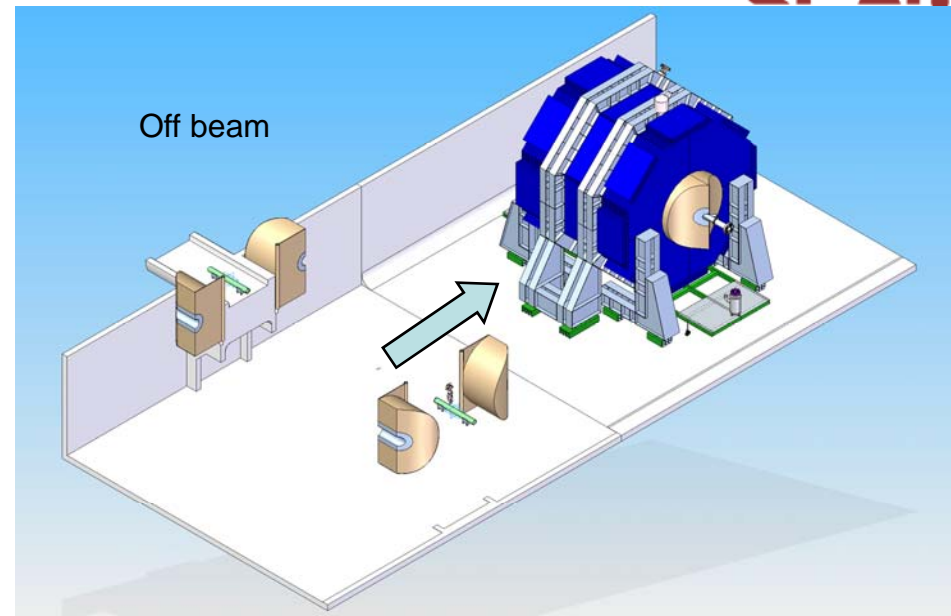
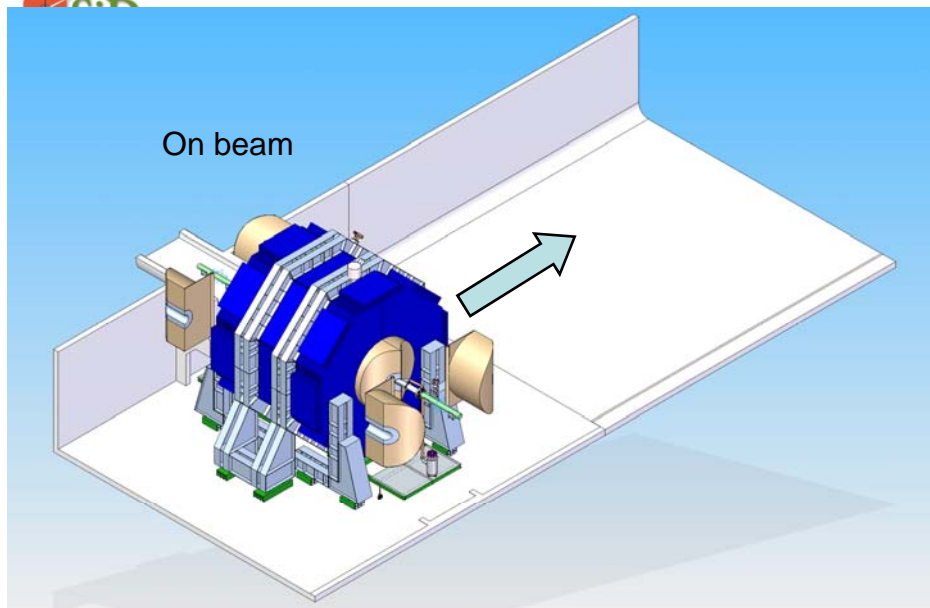


- The preferred transport approach is Hillman Rollers on hardened steel rails. There is no problem with Hillman capacity. Airpads are not preferred.
- Stiction may be 5% of the static load (~4 Ktonne)
- Perhaps drive the detector with rack and pinion system.
- Design for a velocity of 1-5 mm/sec.

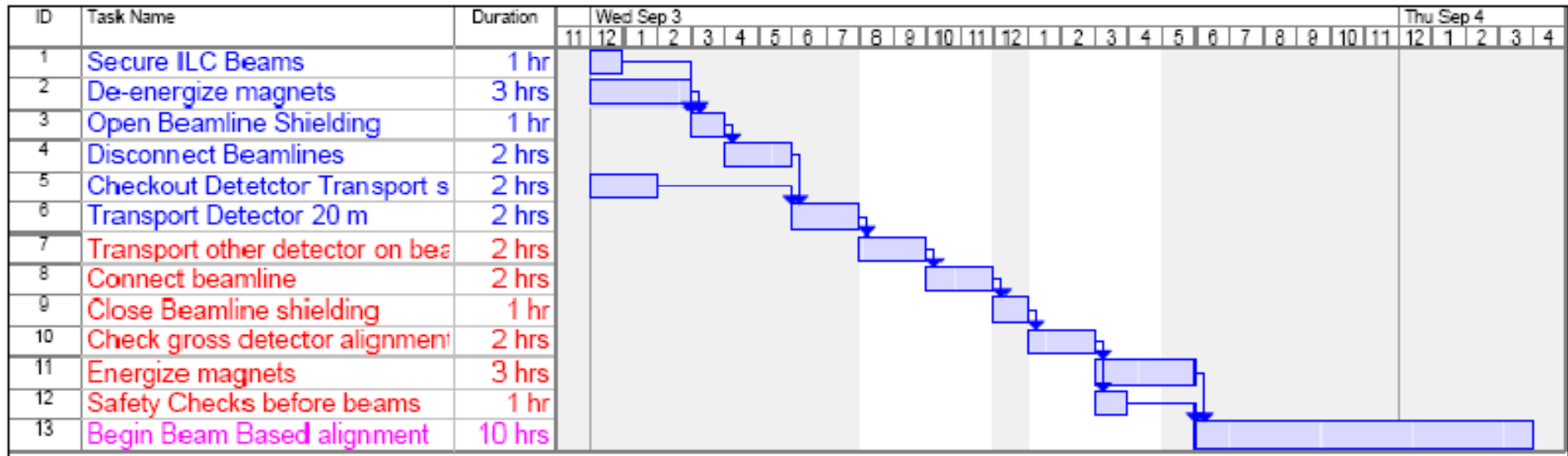


3.5 kton capacity  
recently manufactured





# Detectors Swap Time Estimate

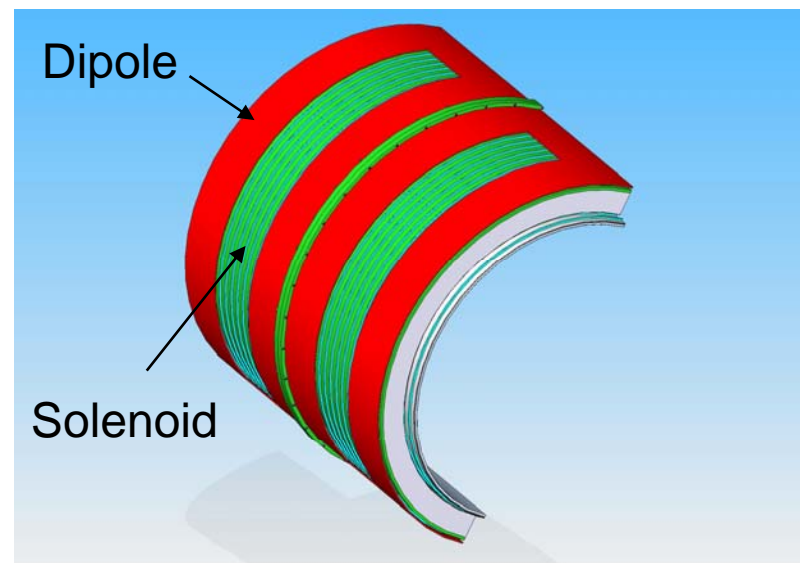
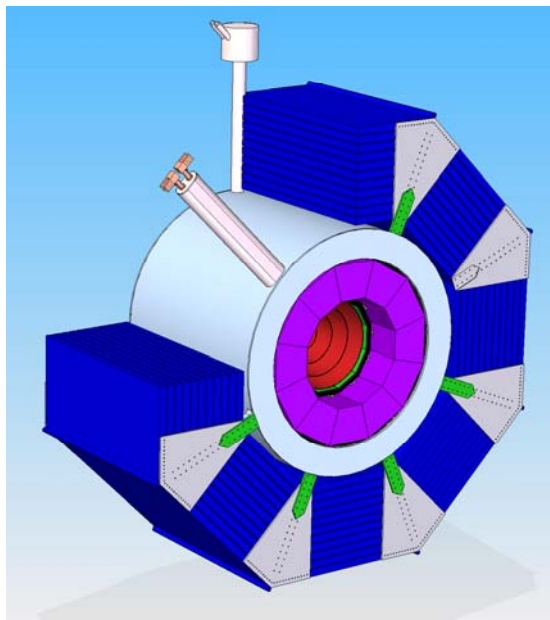
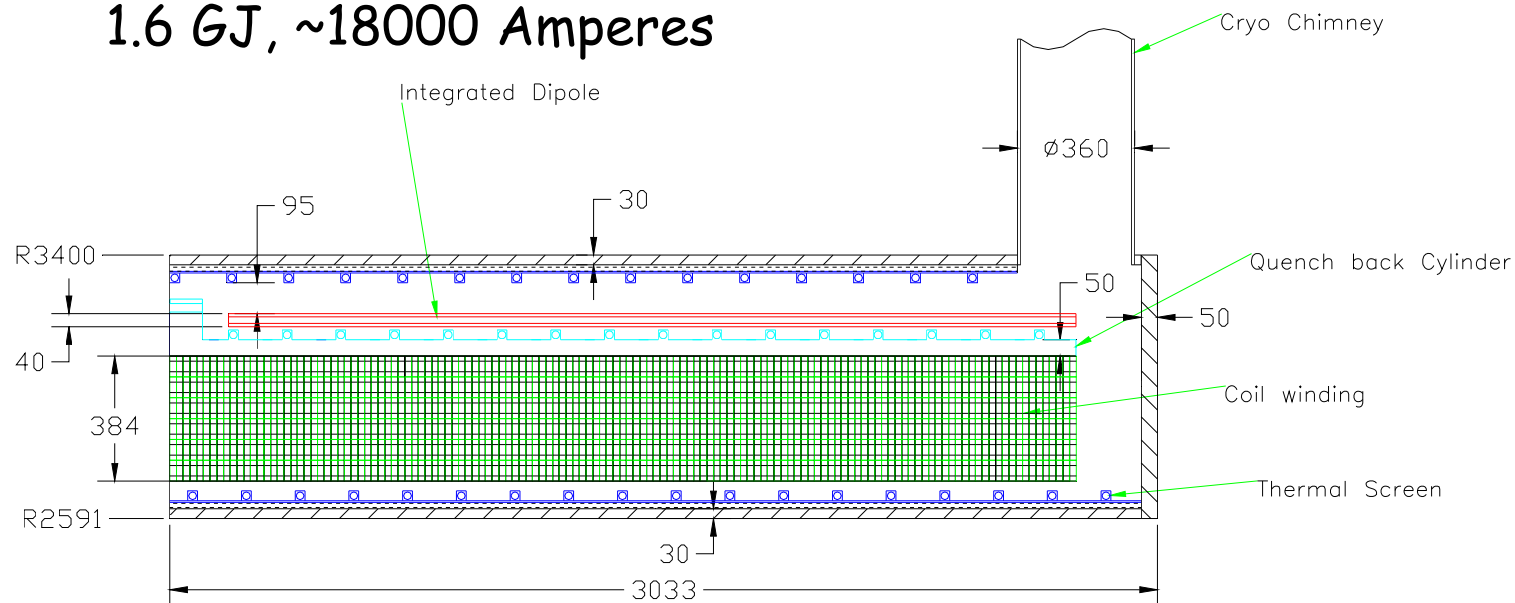


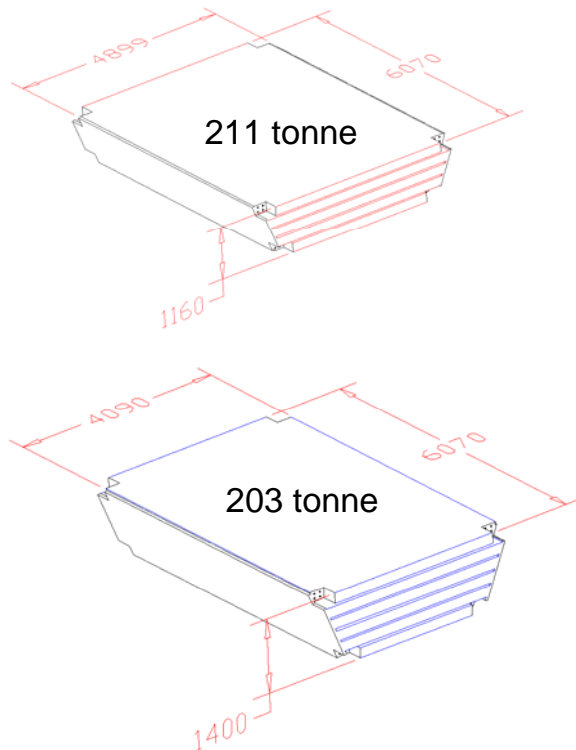
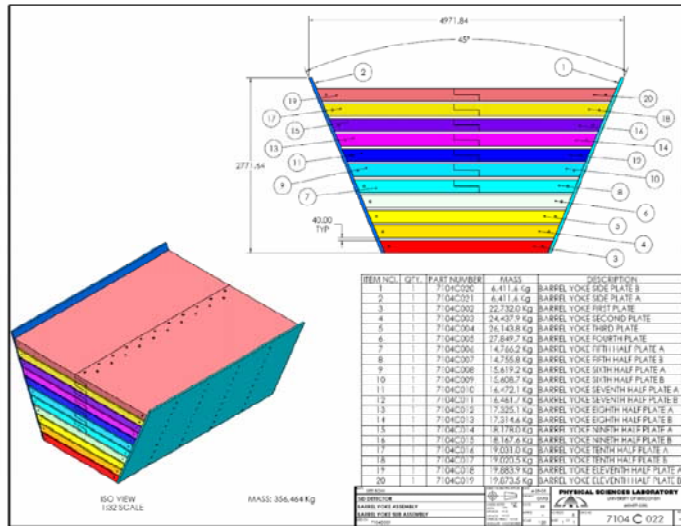
With careful engineering and an experienced, well rehearsed crew, it seems plausible to make the push-pull cycle, not including the beam based alignment and re-tuning of the machine, in less than a day.



Baseline design: 6 layers CMS conductor

1.6 GJ, ~18000 Amperes



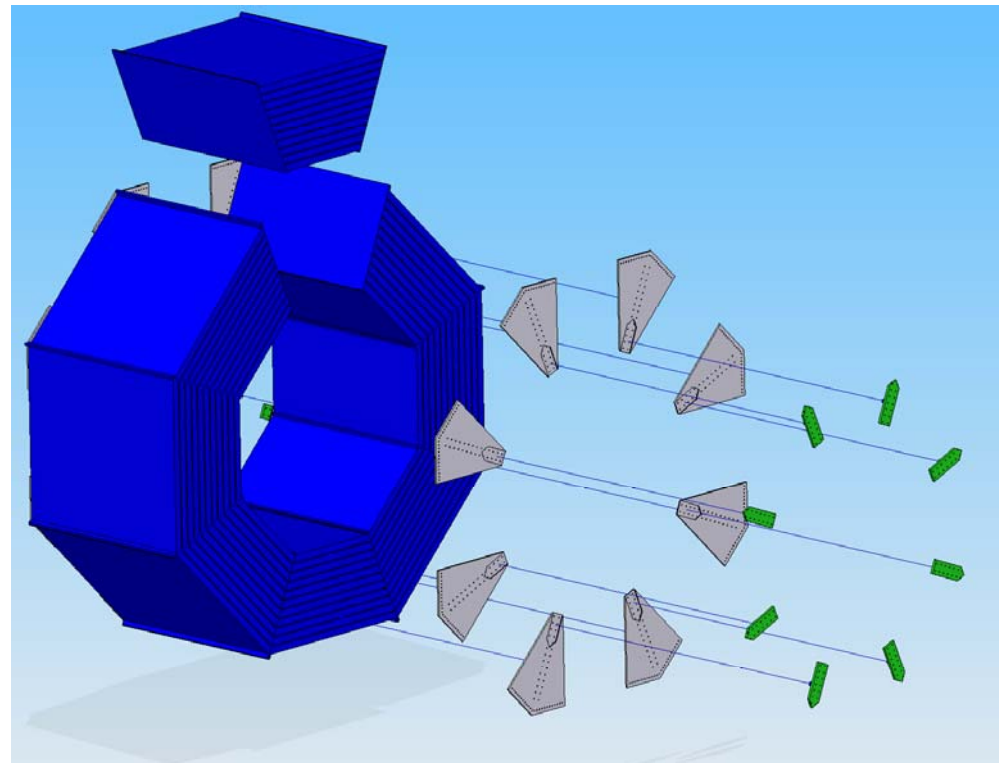


Bolted assembly, 144 plates 200 mm thick, 40mm gap

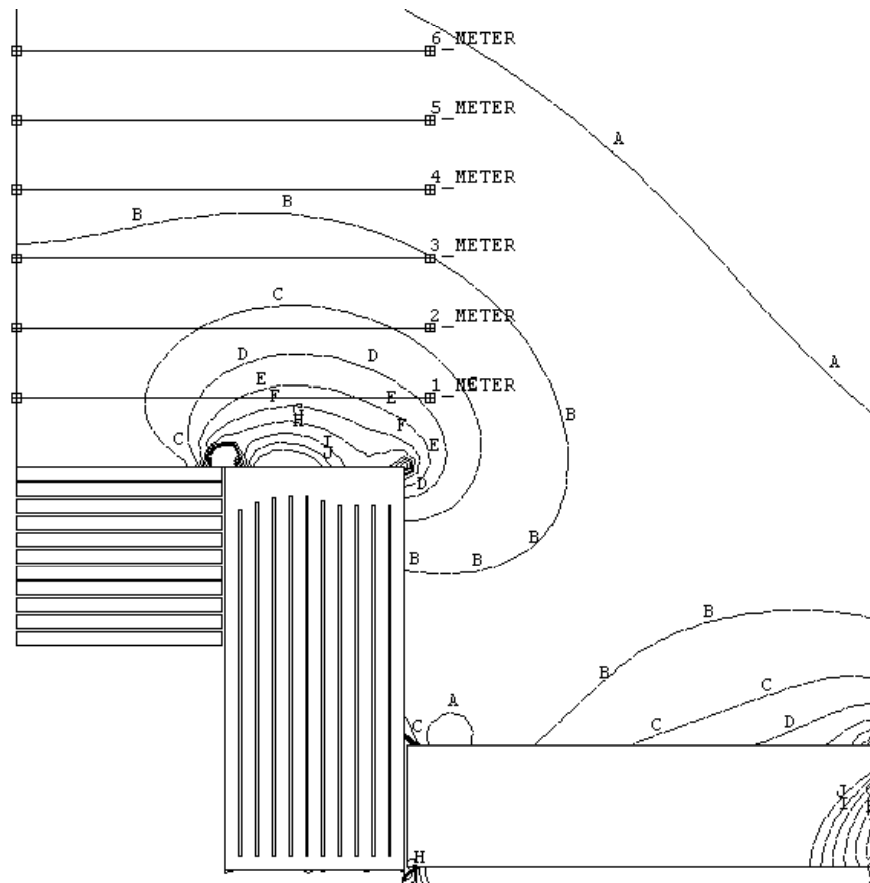
Opportunity to make blank assembly at the factory before shipping

Preliminary Contacts with Kawasaki Heavy Industries

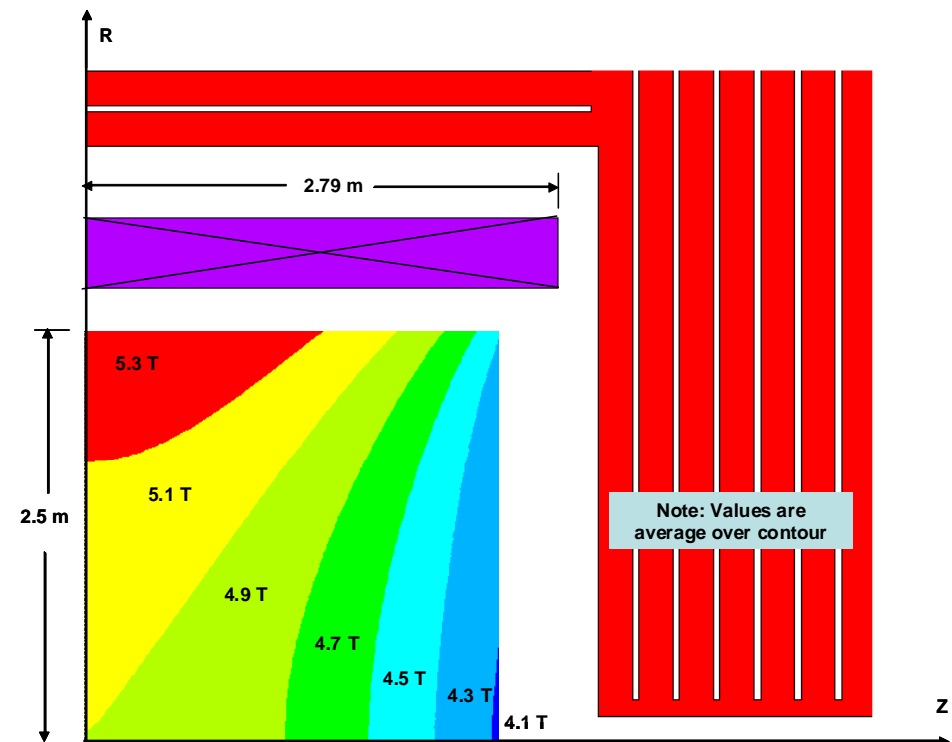
- Plate thickness tolerance for each: 0.1mm
- Plate flatness: 4mm (in a plate)
- Fabrication (assembling & welding) tolerance: 2mm
- Full trial assembly: capable (but need to study)



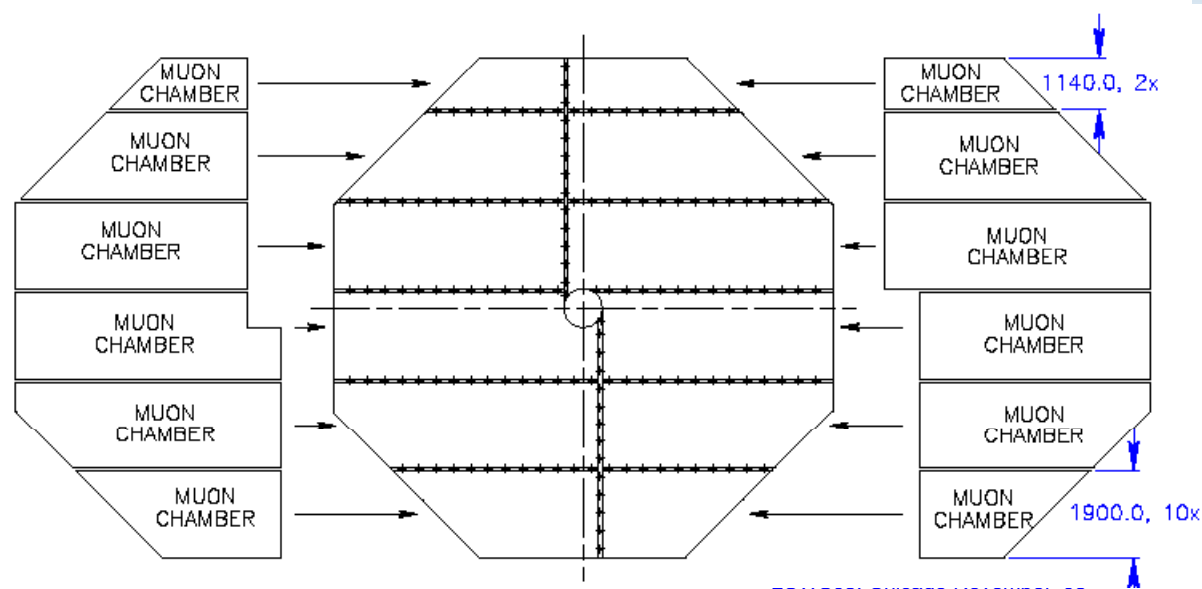
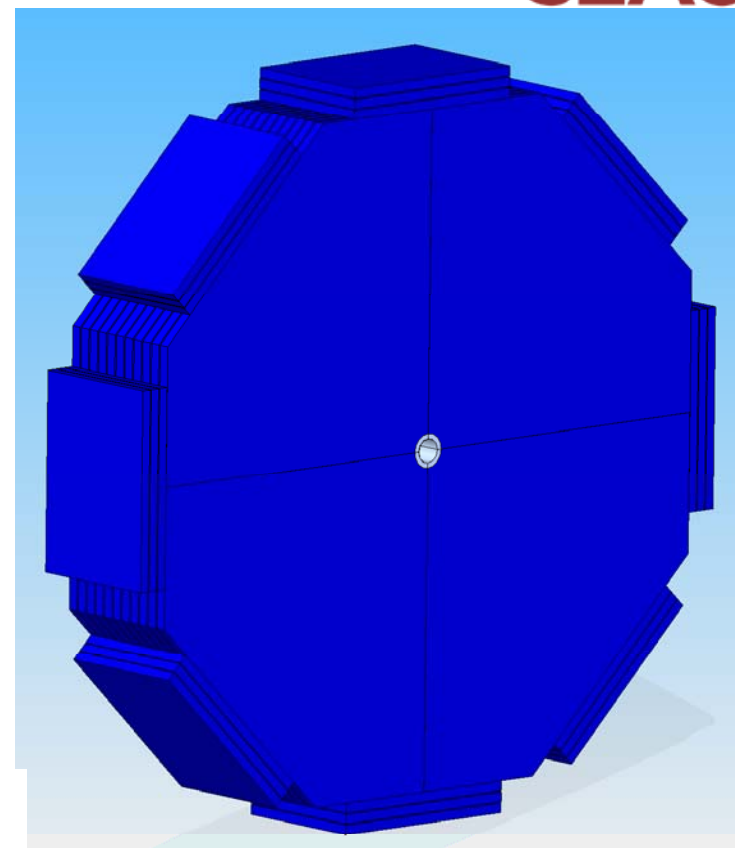
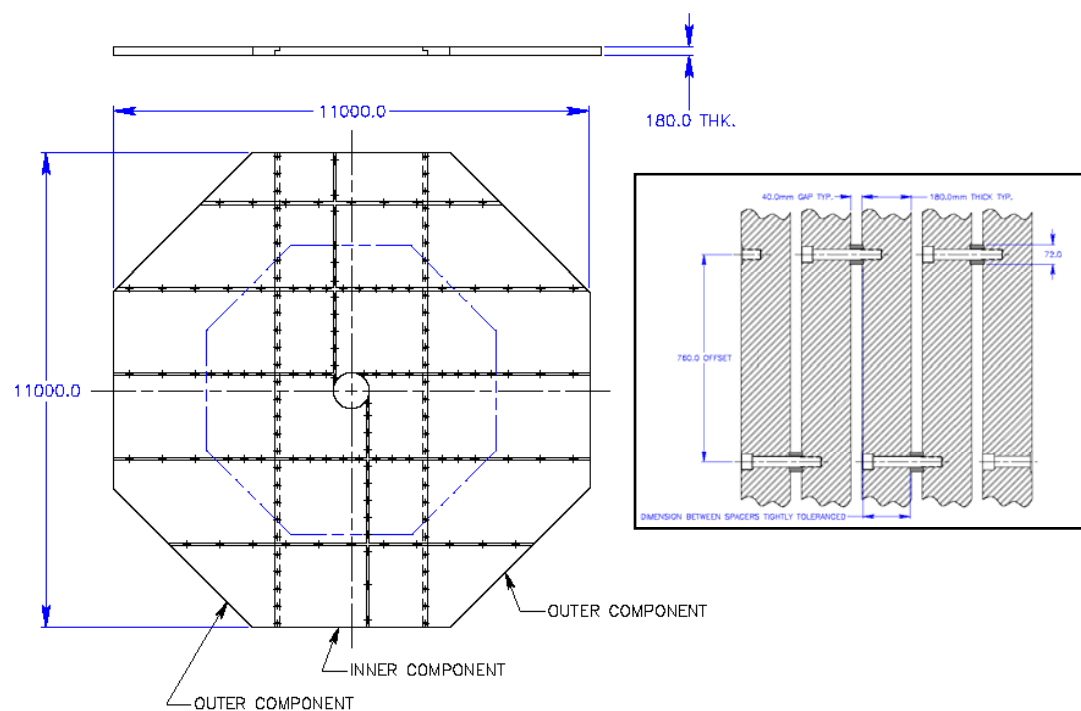
# Fringe Field Map



A	=50
B	=100
C	=150
D	=200
E	=250
F	=300
G	=350
H	=400
I	=450
J	=500

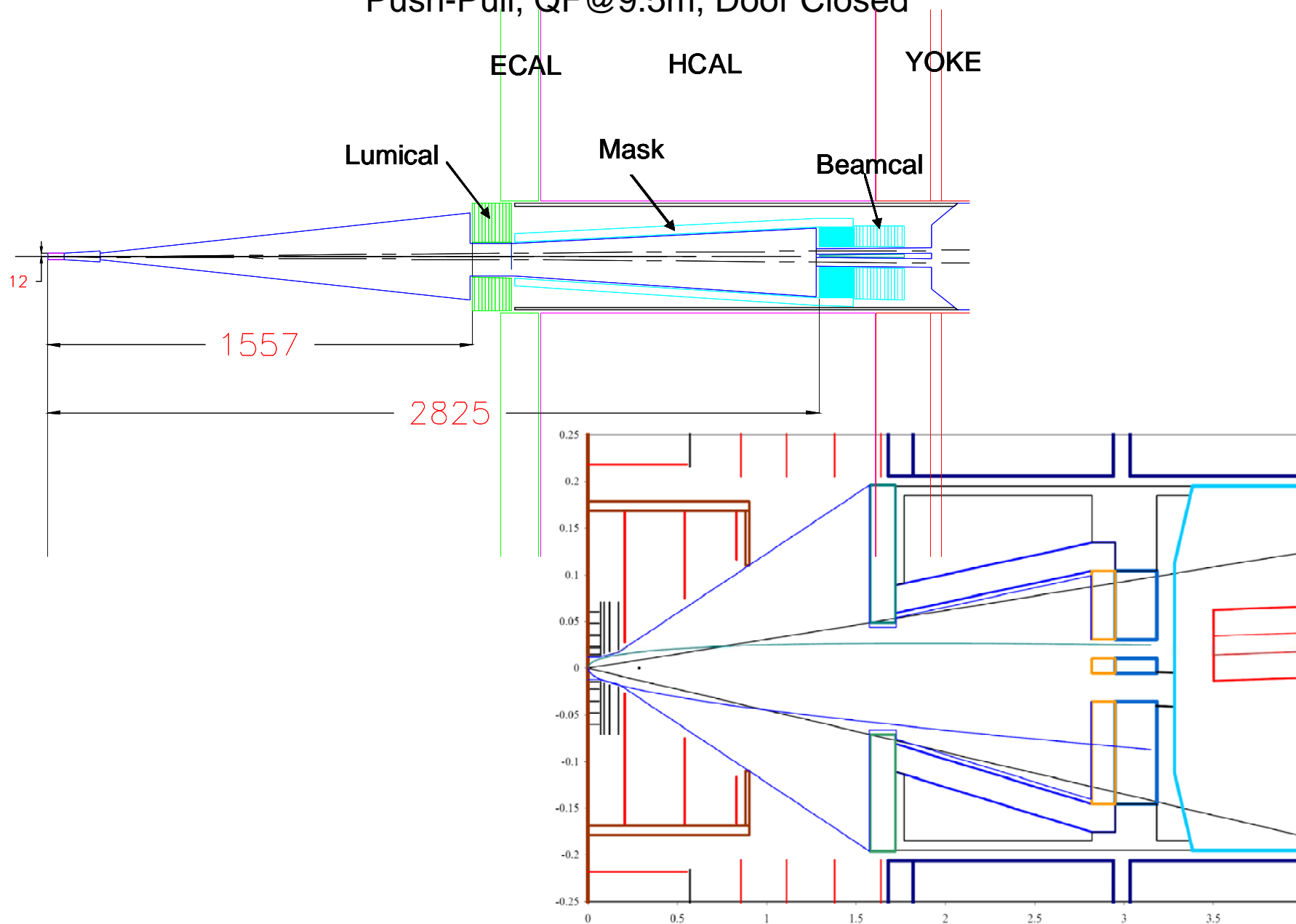


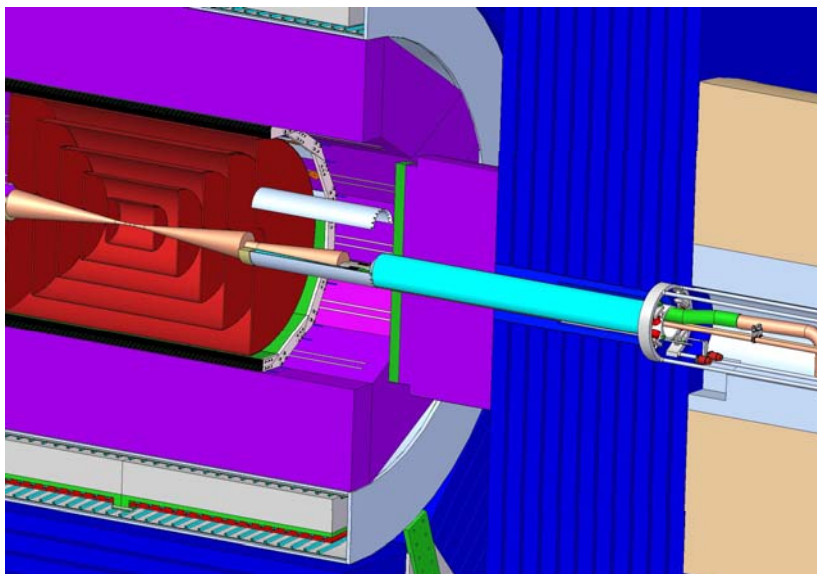




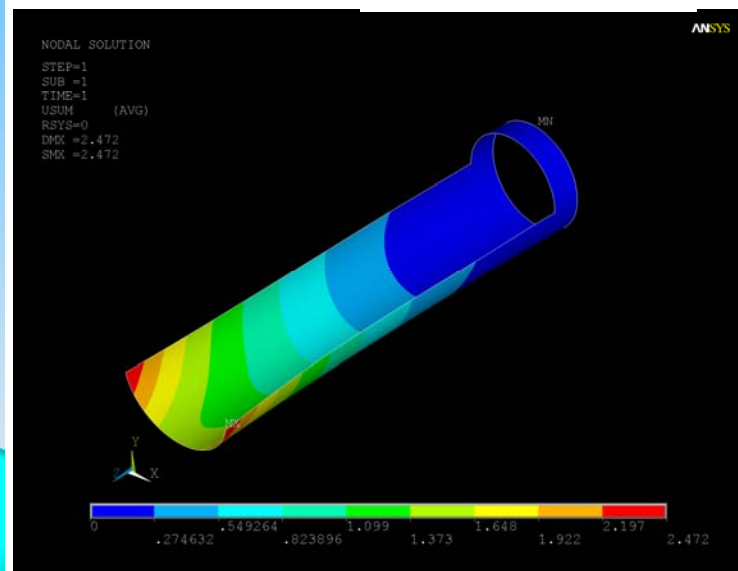
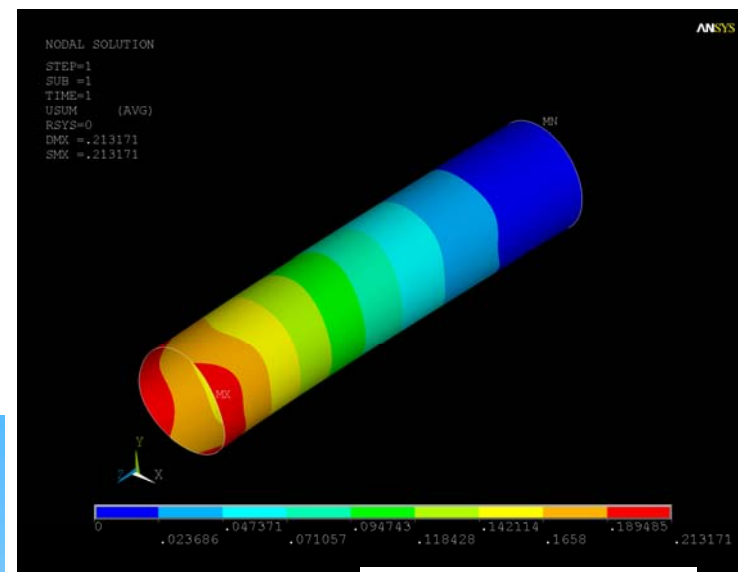
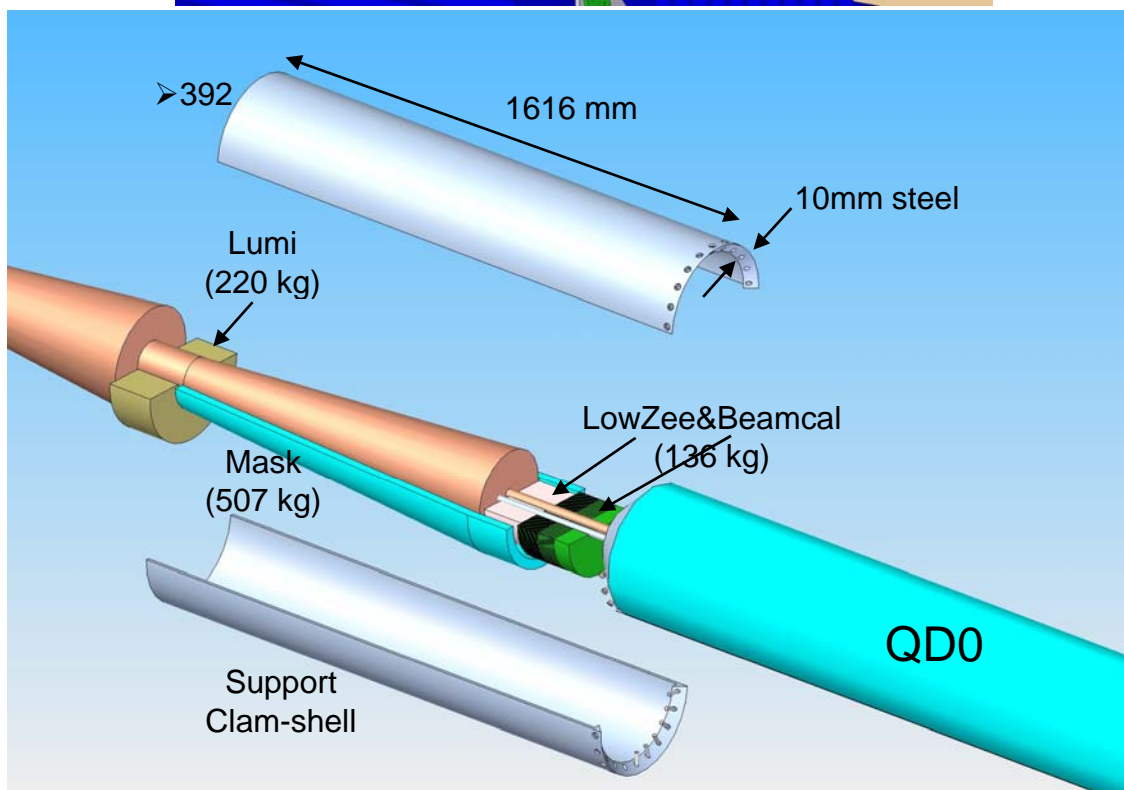
- Uses continuous cast steel plates rolled to 200 mm thickness
- 40mm gaps for muon identification chambers
- Plate-to-plate spacers are staggered for better muon identification coverage
- Bolted construction
- 100mm thick inner support cylinder

$L^*=3.664\text{m}$ , 14mrad,  
Push-Pull, QF@9.5m, Door Closed

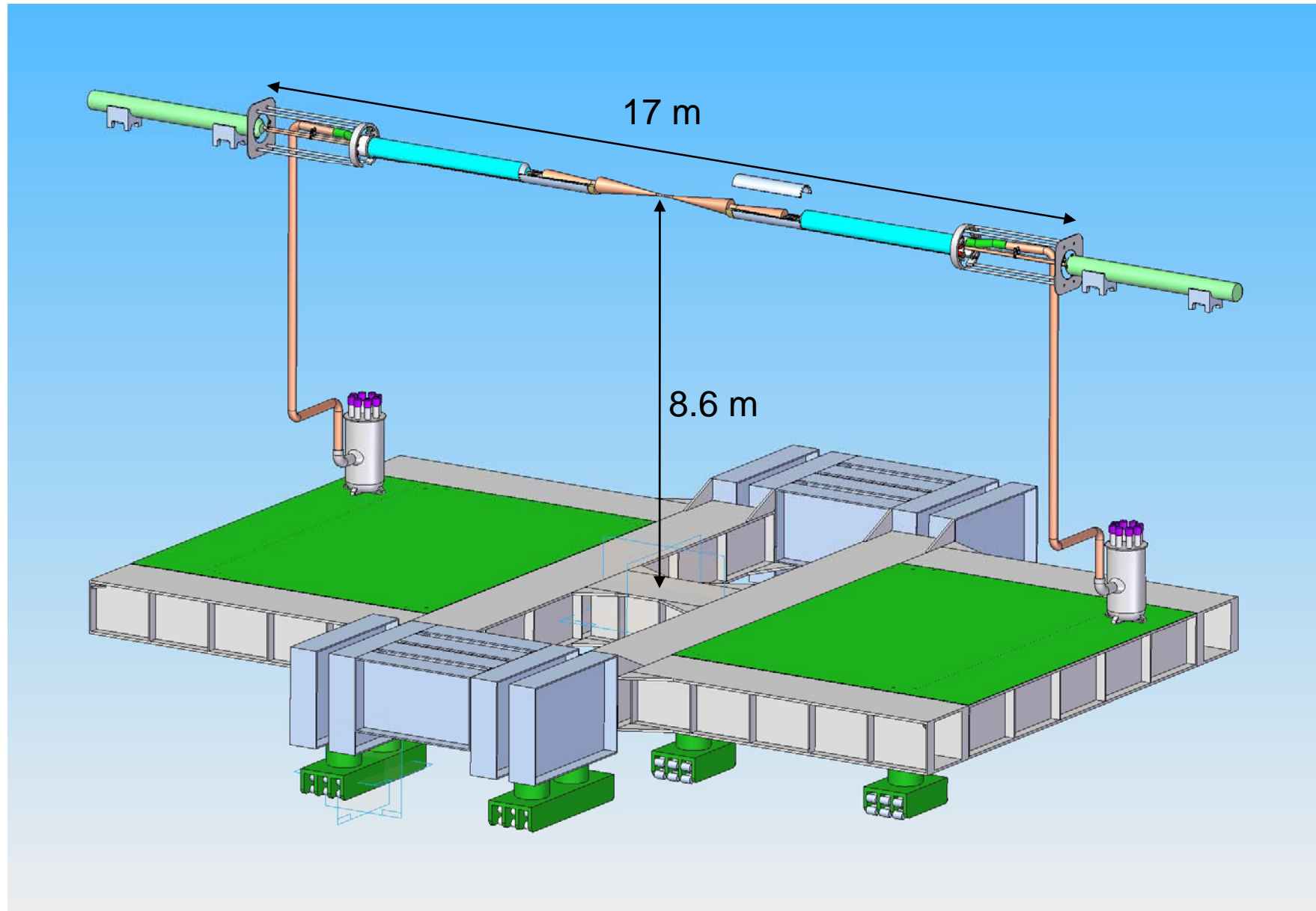


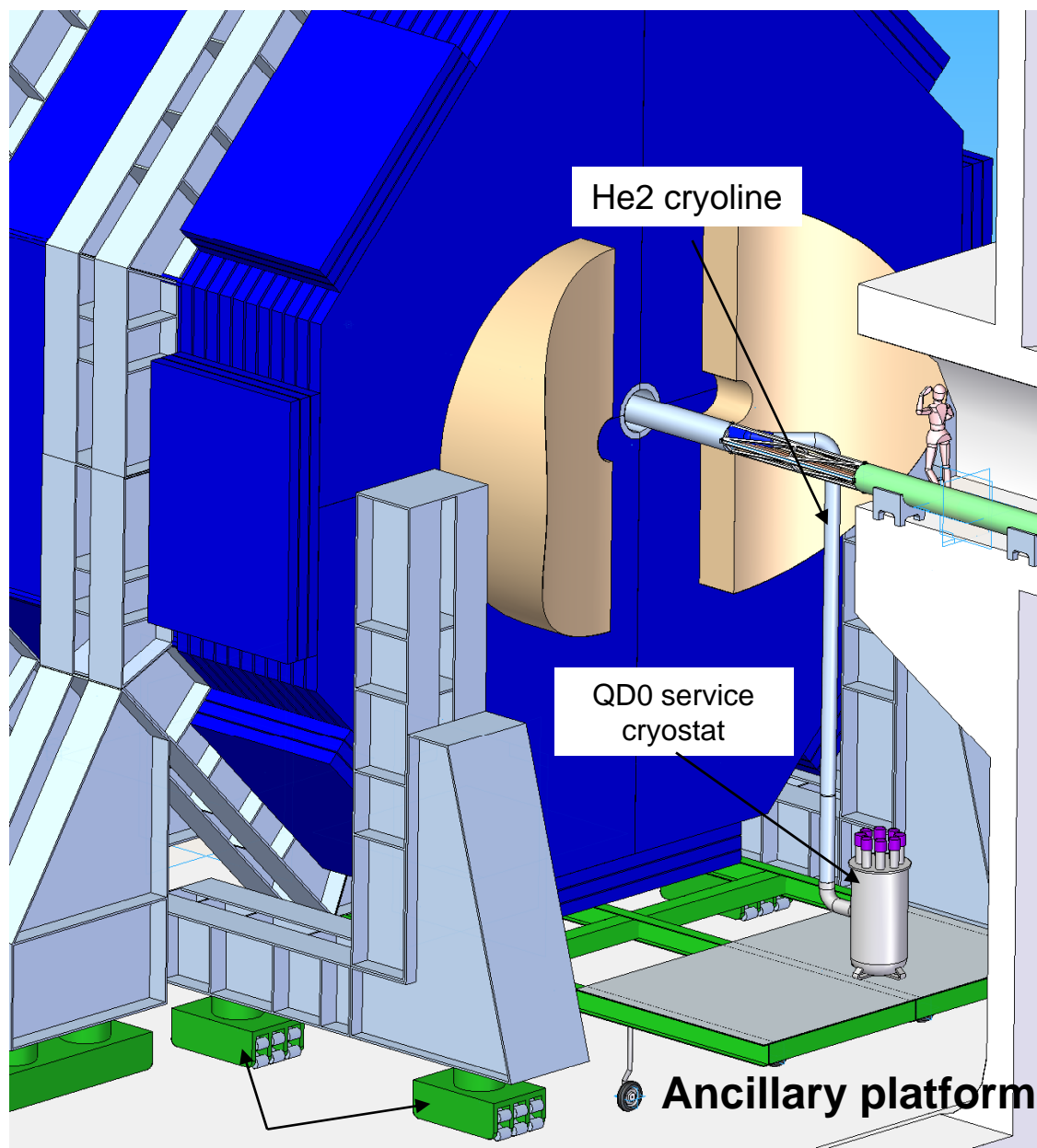


## Forward Integration



# Integration for the Push-Pull



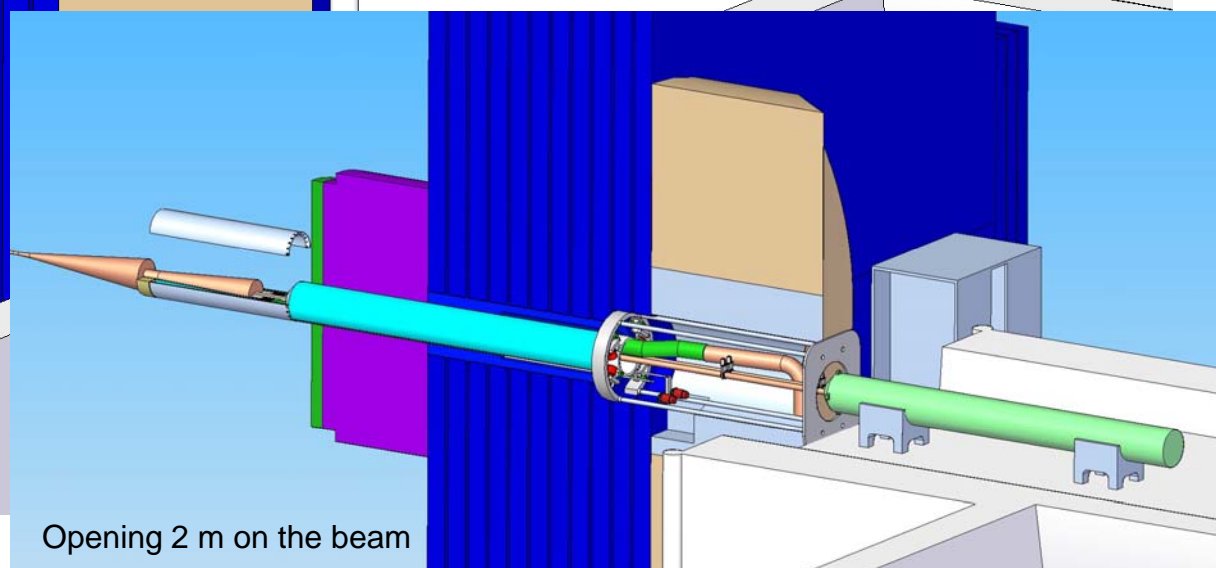
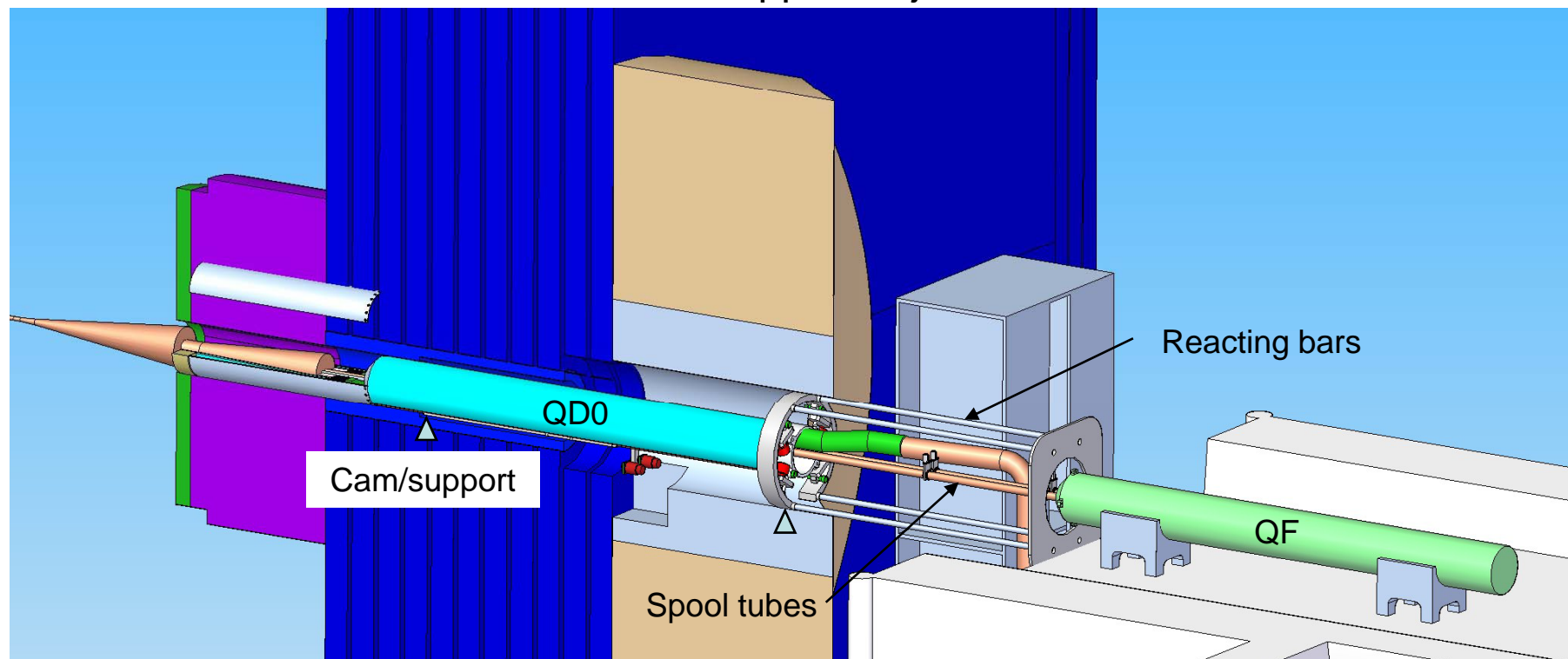


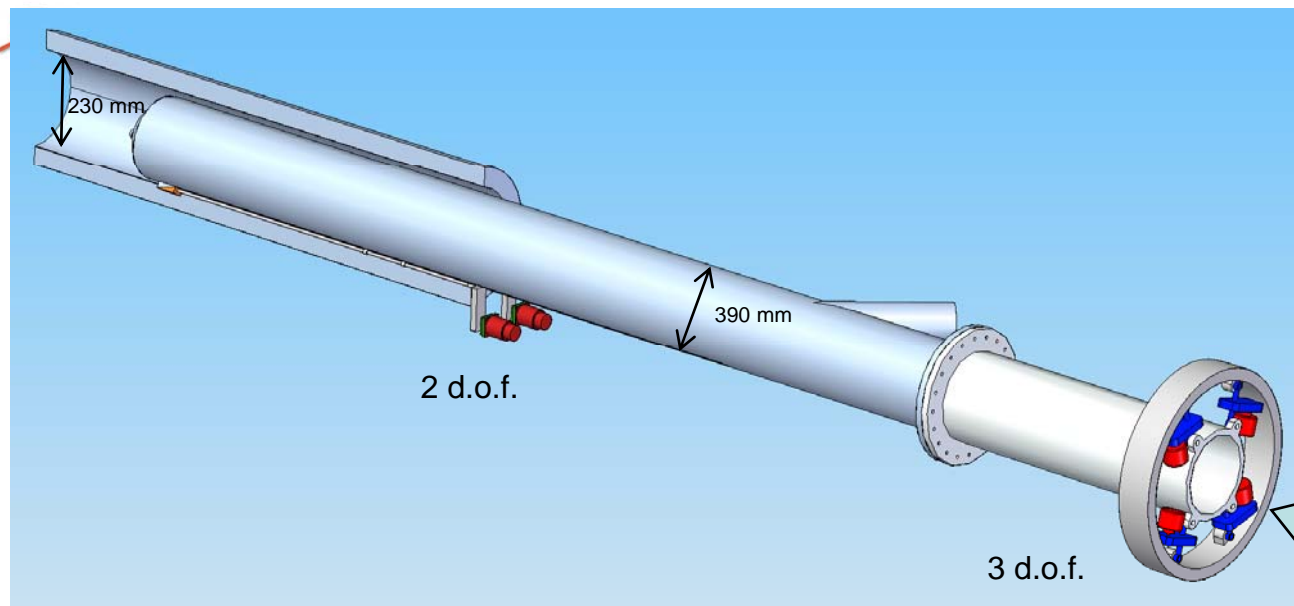
### 2 m opening on the beam,

1. The QD0 service cryostat on ancillary platform, fixed to the SiD barrel infrastructure
2. He2 cryoline rigid connected to QD0 through the Pacman
3. No relative movement between QD0 and He2 line when door opens.
4. The ancillary platform allows the QD0 cryogenics to travel with detector during push-pull
5. Additional space for racks, controls et al.

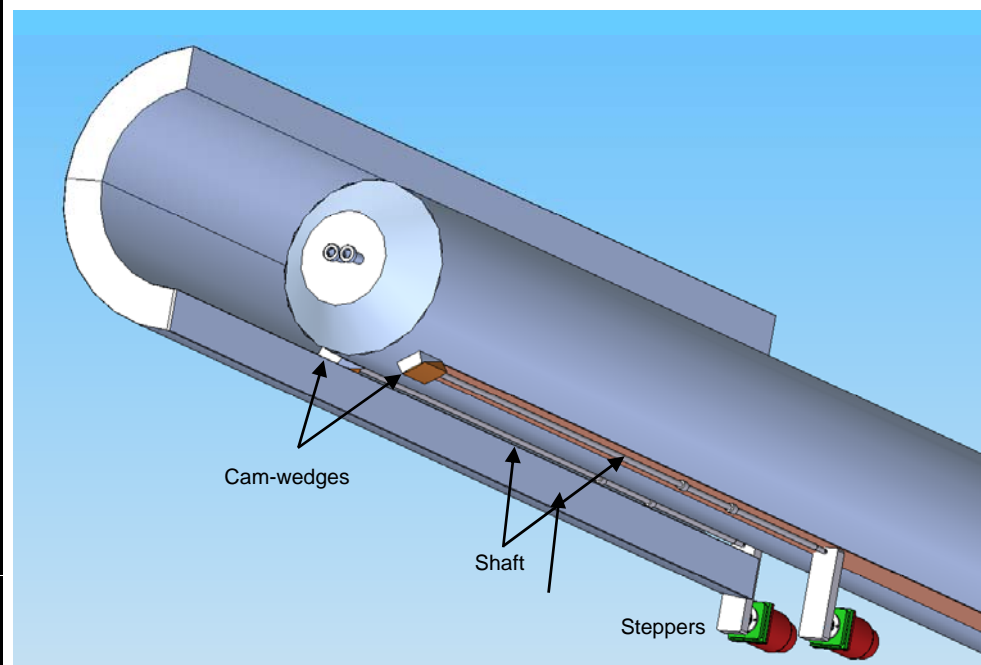
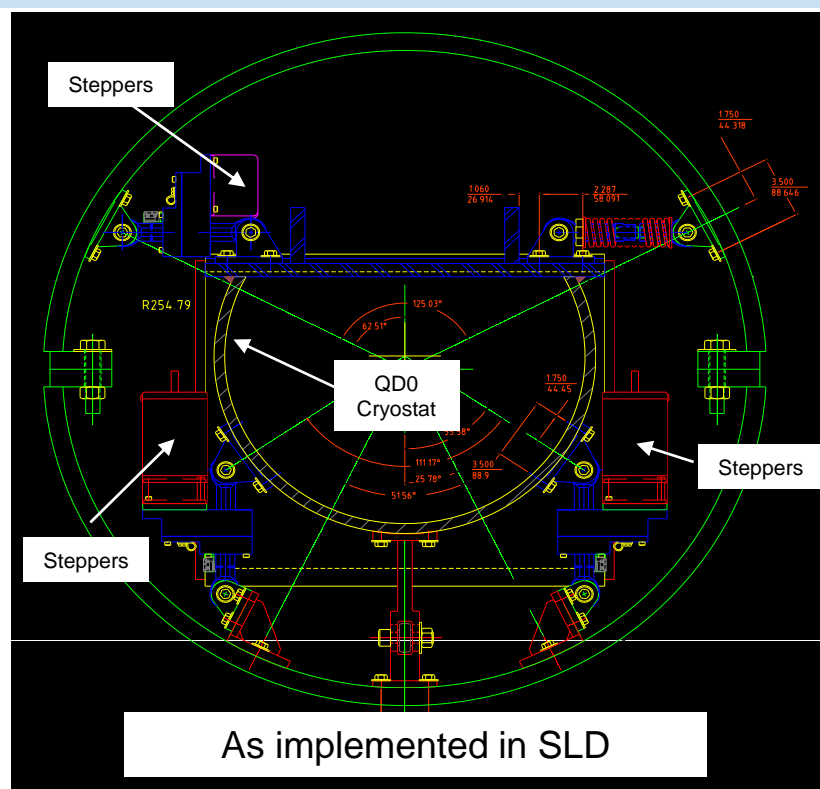
Hilman Rollers



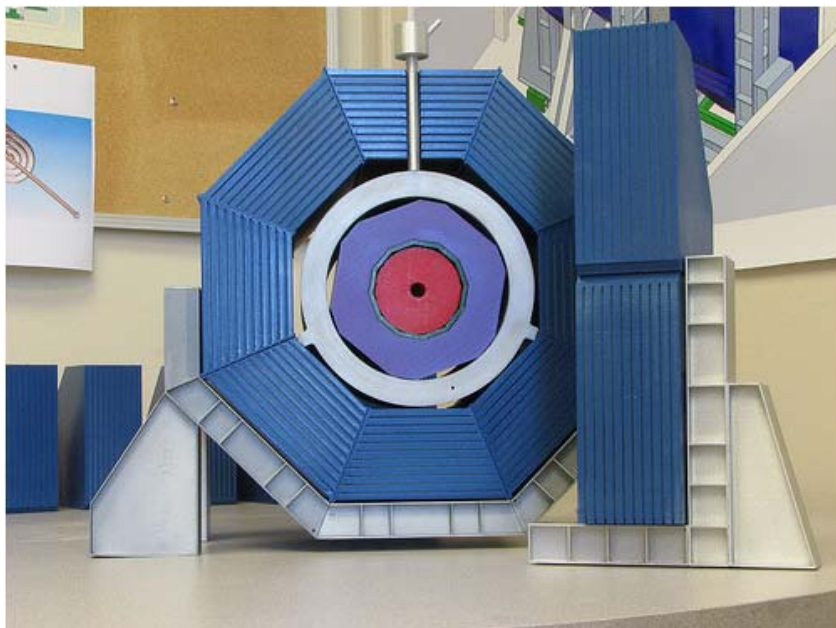
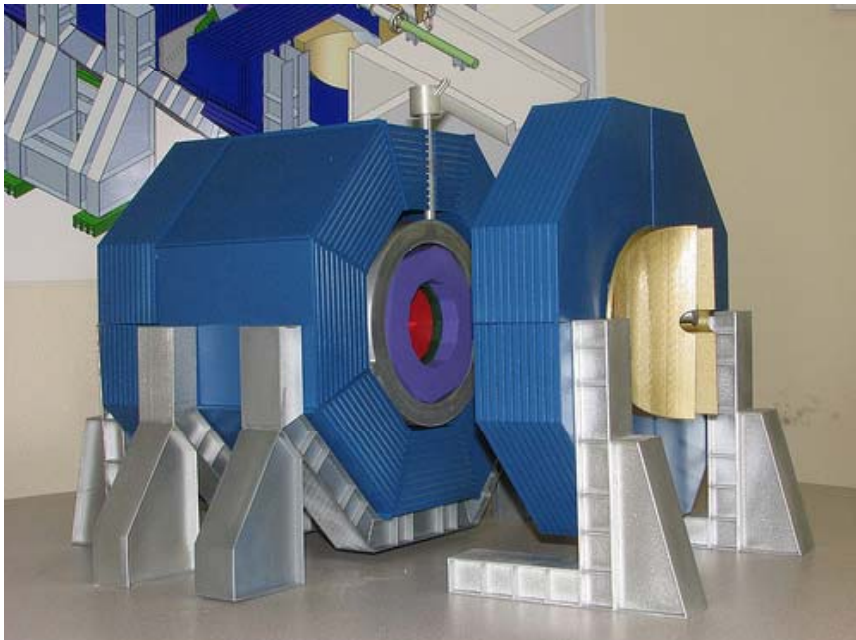




5 degrees of freedom  
mechanism, stepper  
motors with drive-cam

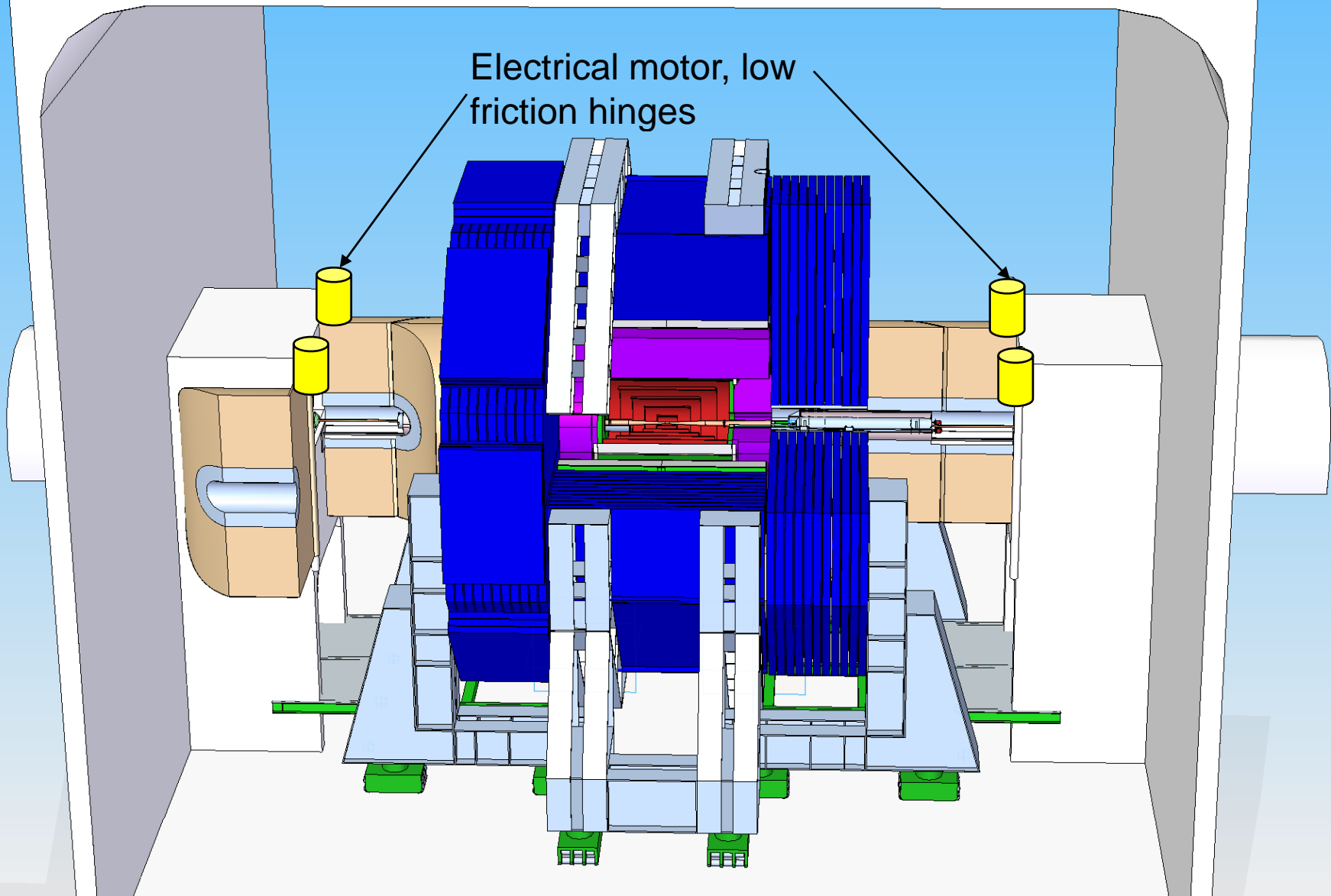




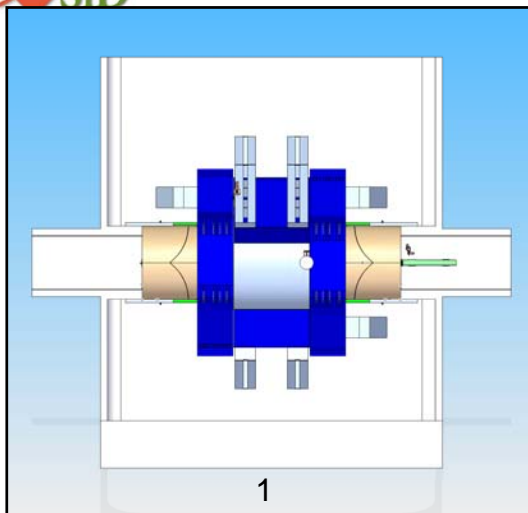


## Rotating Pacmen

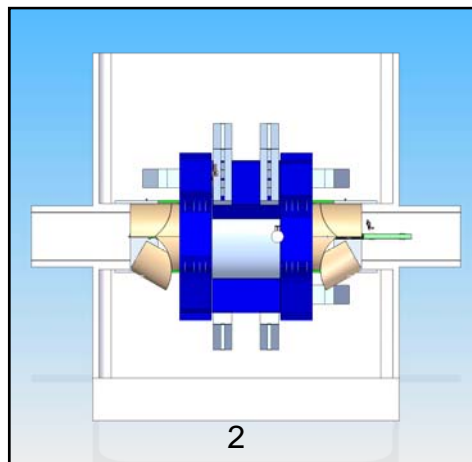
Electrical motor, low  
friction hinges



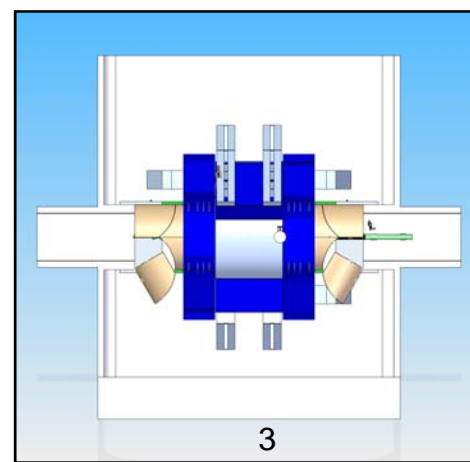
## Detector opening on the beam



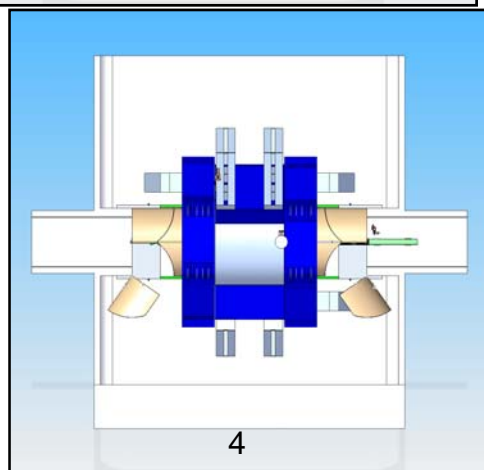
1



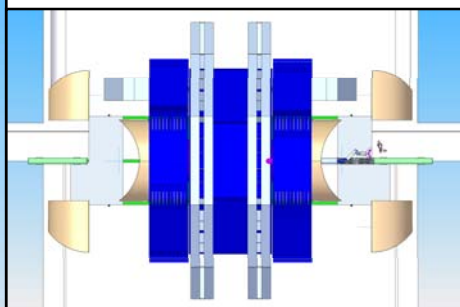
2



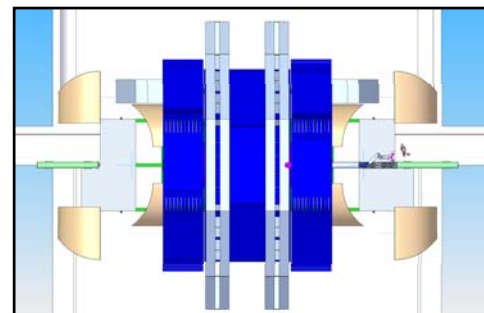
3



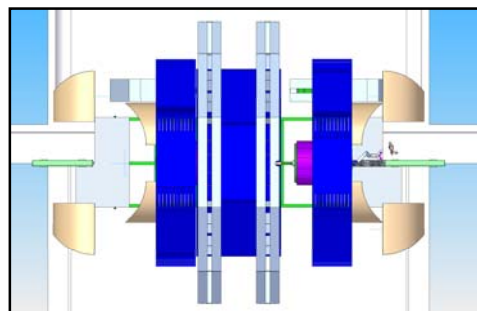
4



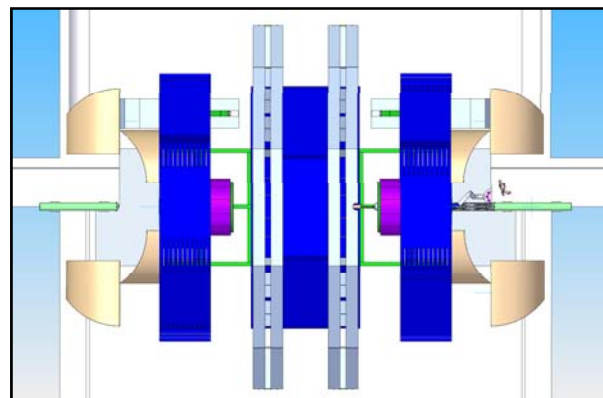
5



6



7



8

# Summary

- Focus on Lol
- Addressing answers form IDAG
- Work in progress to delivery a self consistent engineering model : Forward region, QD0 support, Push-Pull
- The expected progress on the sub-detector technology choice and design will allow terrific improvements of the integration, assembly and maintenance schemes.
- Keep momentum in the discussion of the MDI interface Functional Requirements Document