# SiD IR & MDI
# Status & Comments

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# IR Engineering Workshop

"Critical Issues from the IRENG'07 Workshop" at SLAC Sept. 17-21, 2007 were presented by Andrei Seryi on Wednesday evening.

- Most discussions at IRENG'07 regarding detectors concepts and Push-Pull / Surface-Assembly touched on
  - **Civil: Cavern & surface layout, cranes, services**
  - **Cryo: 2°K/4°K Refrigerators for QD0 & plumbing**
  - **Andrei discussed these**

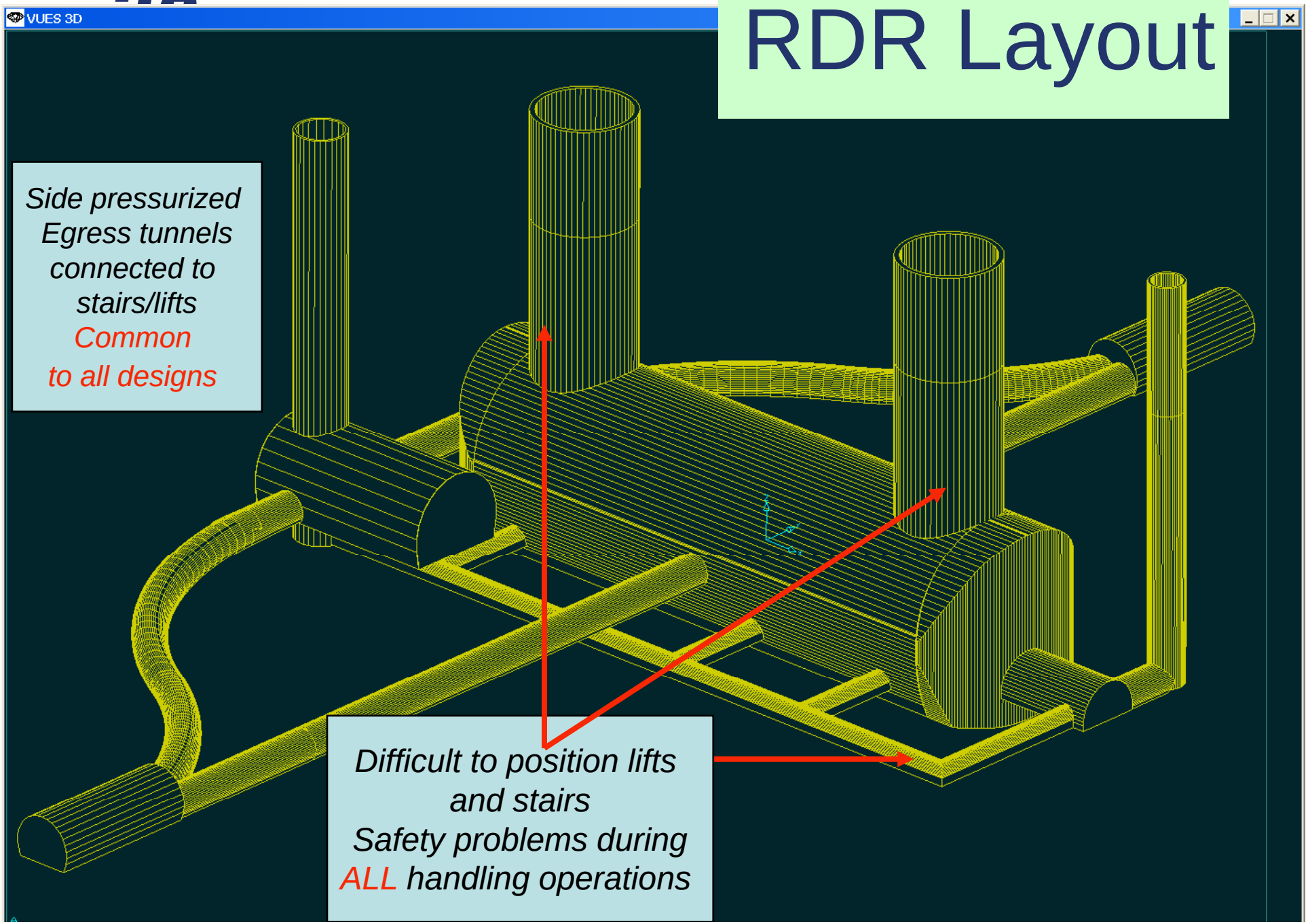
# Interaction with the BDS Group

- A number of IR design choices were made for the RDR which were not optimized from the SiD perspective
- Major contributions of CERN civil group to layout/cavern/assembly/platform/access discussion beginning after LCWS'07 in preparation for IRENG'07 via detailed layout schematics motivated by LEP and LHC experience
- Machine CFS group constantly asking for engineering details of detector when only concepts exist
- Detector Engineering lags Machine Engineering
- Fear growing that IR design decoupling from Si D and being driven by GLDc/LDC consortium

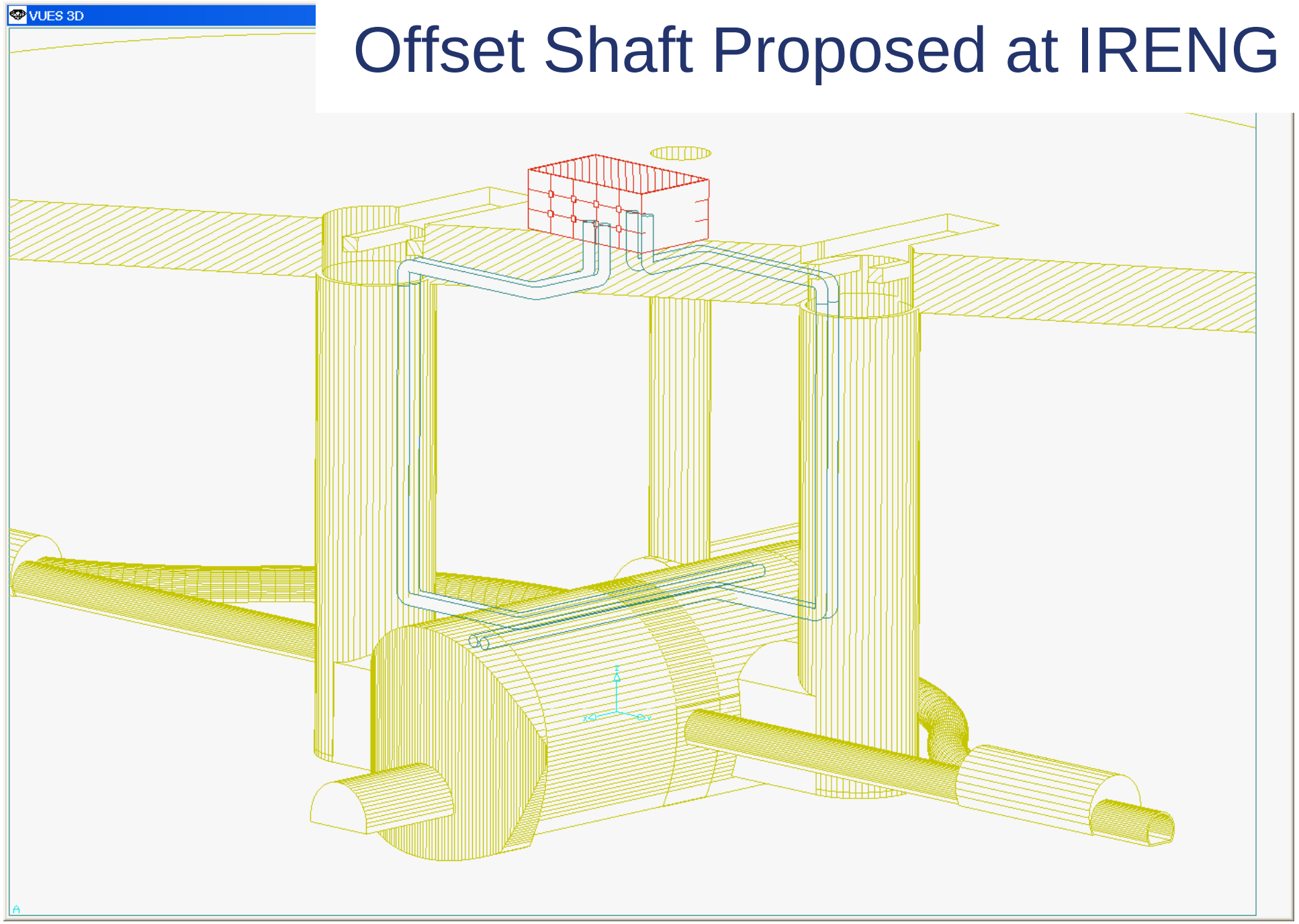
# Baseline IR design

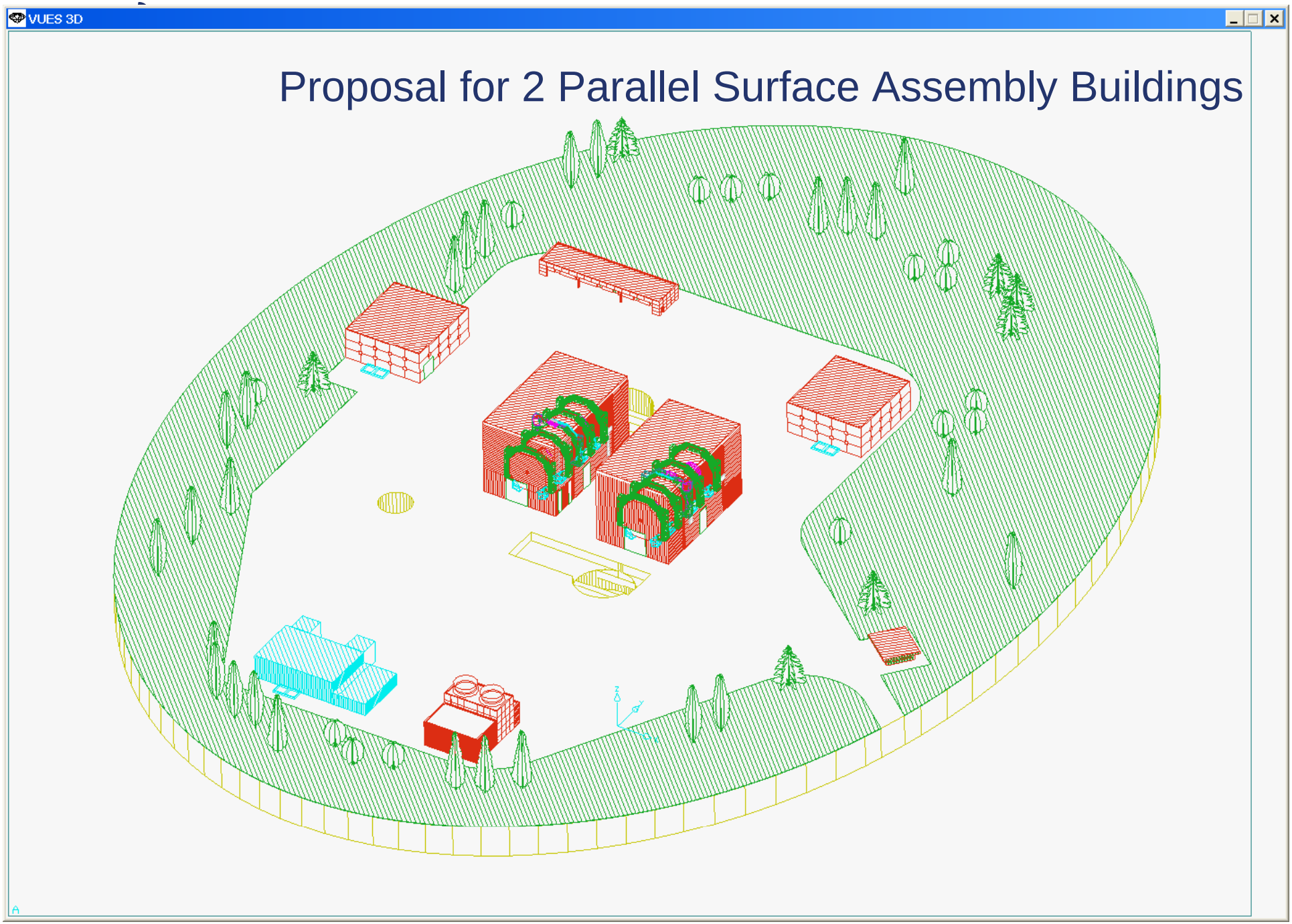
- Hall sized in width for GLDc
- Shaft diameter & crane/gantry capacity sized for GLDc/LDC
- RDR layout shows shafts over assembly hall and an asymmetric service cavern layout
- IRENG'07 version with offset shafts and symmetric service caverns will be submitted for change control
- All CERN produced civil x-sections show platform as mechanism for push-pull motion and boundary between detector and accelerator systems
- All BDS produced civil hall x-sections show a shielding wall separating the two detectors

# RDR Layout

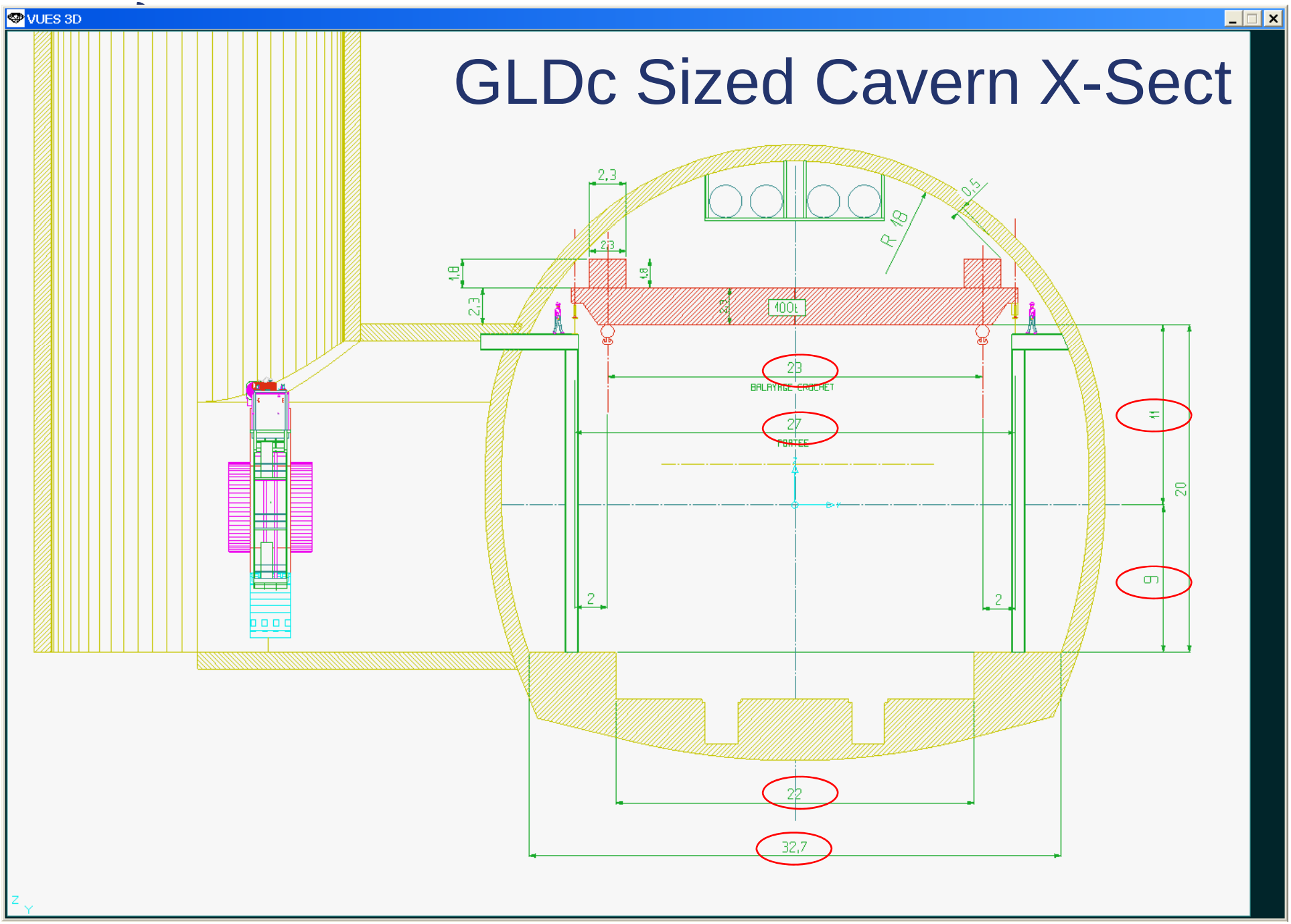

VUES 3D
Side pressurized Egress tunnels connected to stairs/lifts
Common to all designs
Difficult to position lifts and stairs
Safety problems during ALL handling operations

# Offset Shaft Proposed at IRENG

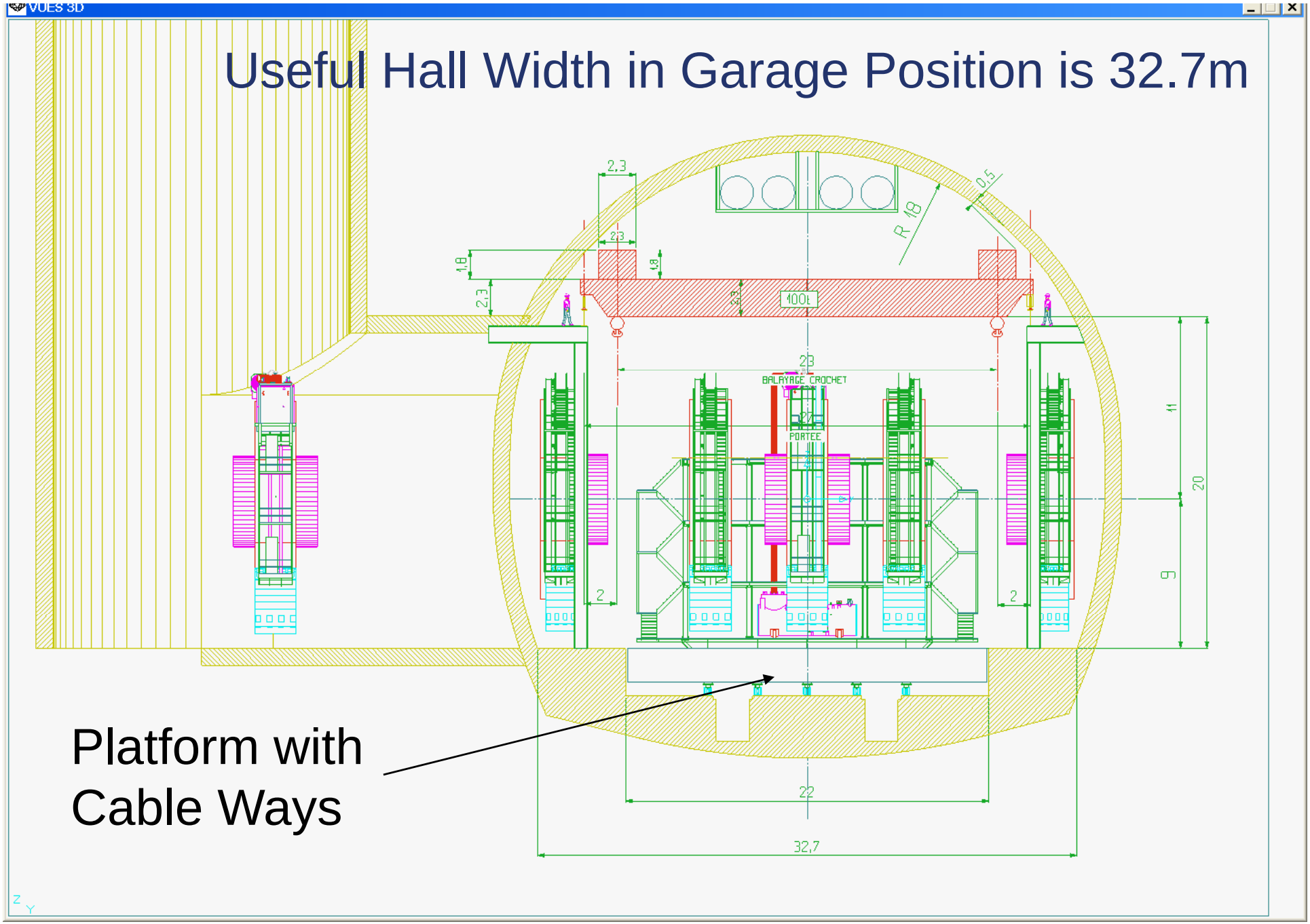



VUES 3D
Proposal for 2 Parallel Surface Assembly Buildings

# GLDc Sized Cavern X-Sect

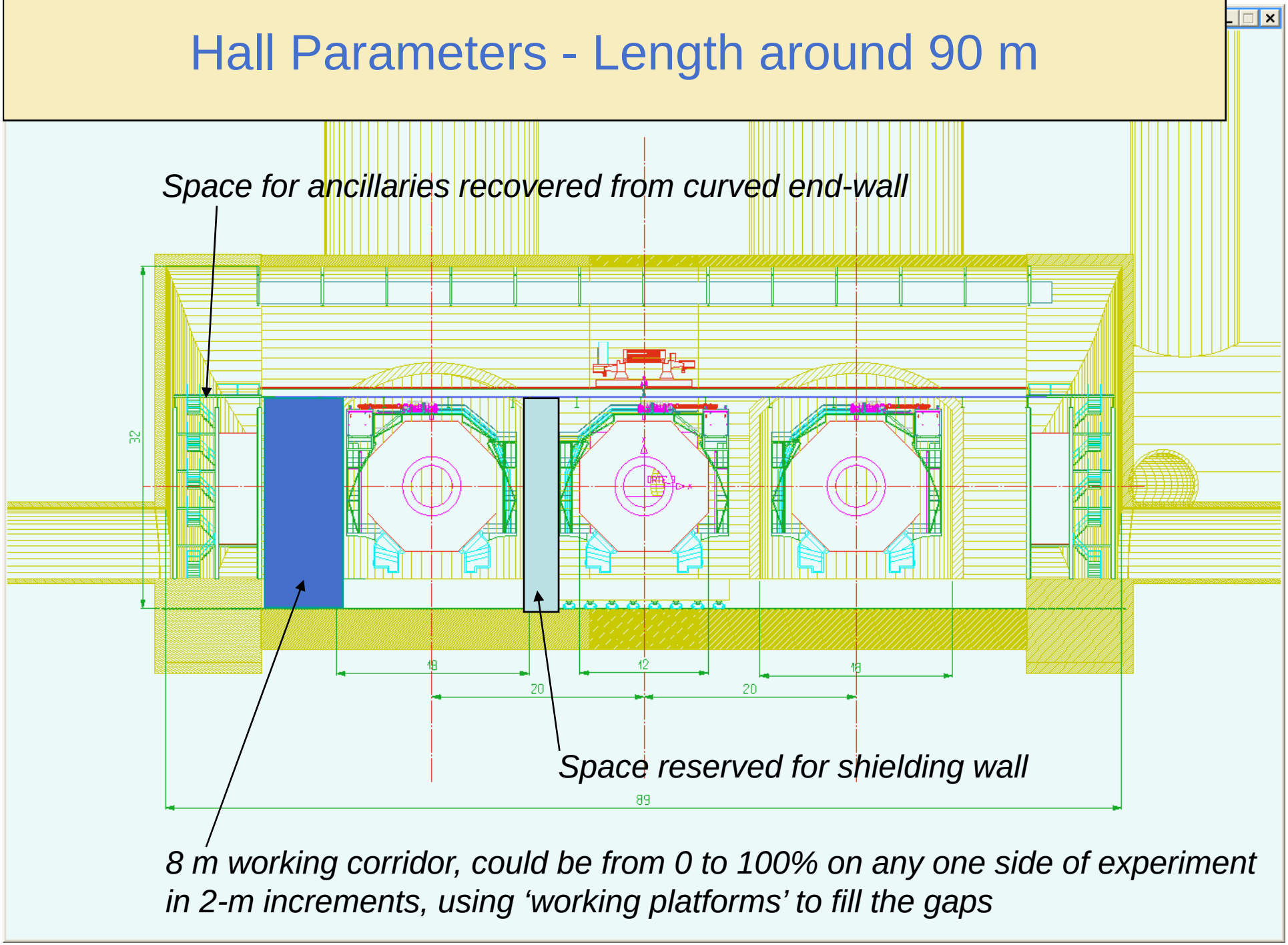


# Useful Hall Width in Garage Position is 32.7m

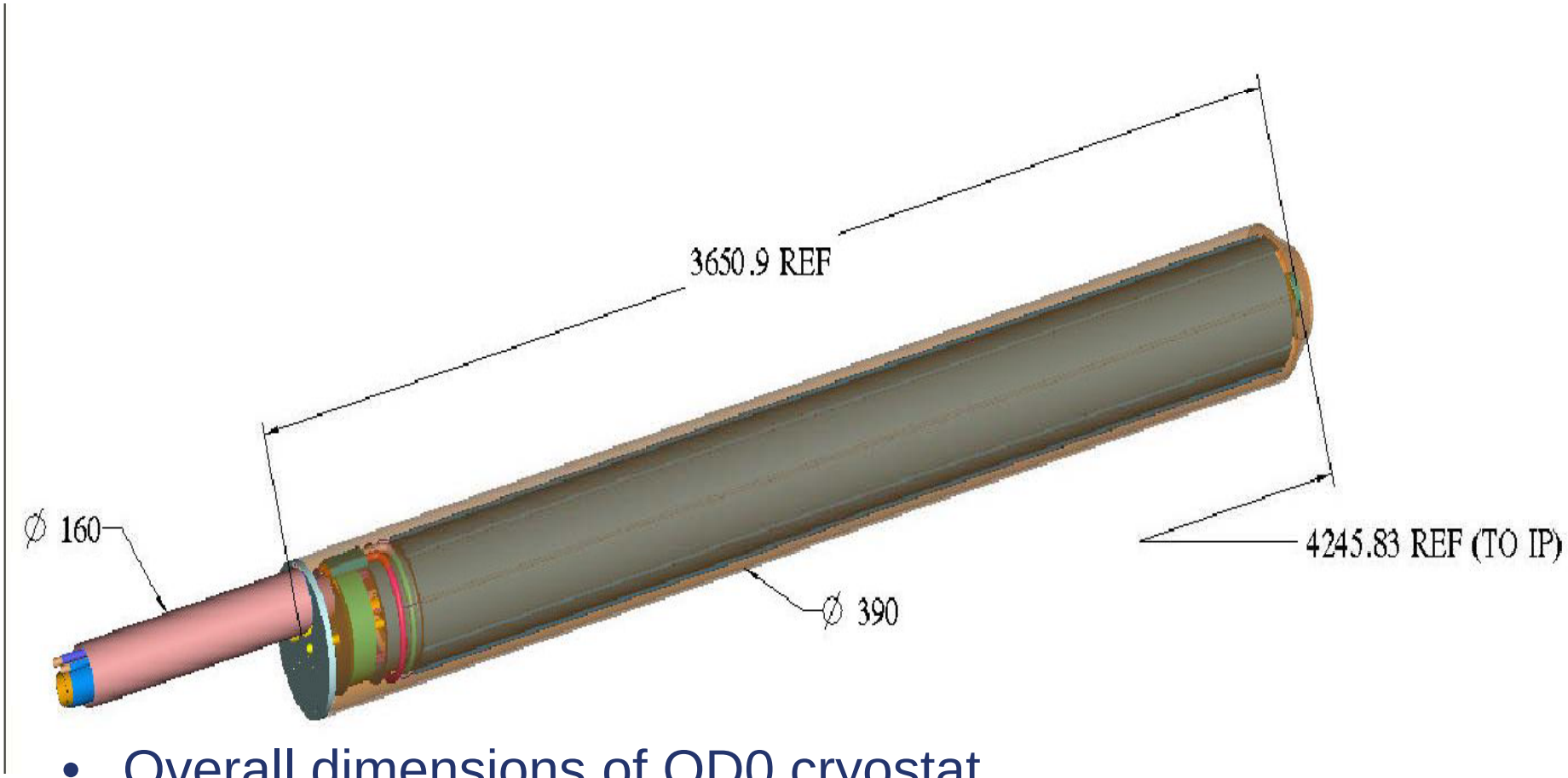



Platform with
Cable Ways

# Hall Parameters - Length around 90 m

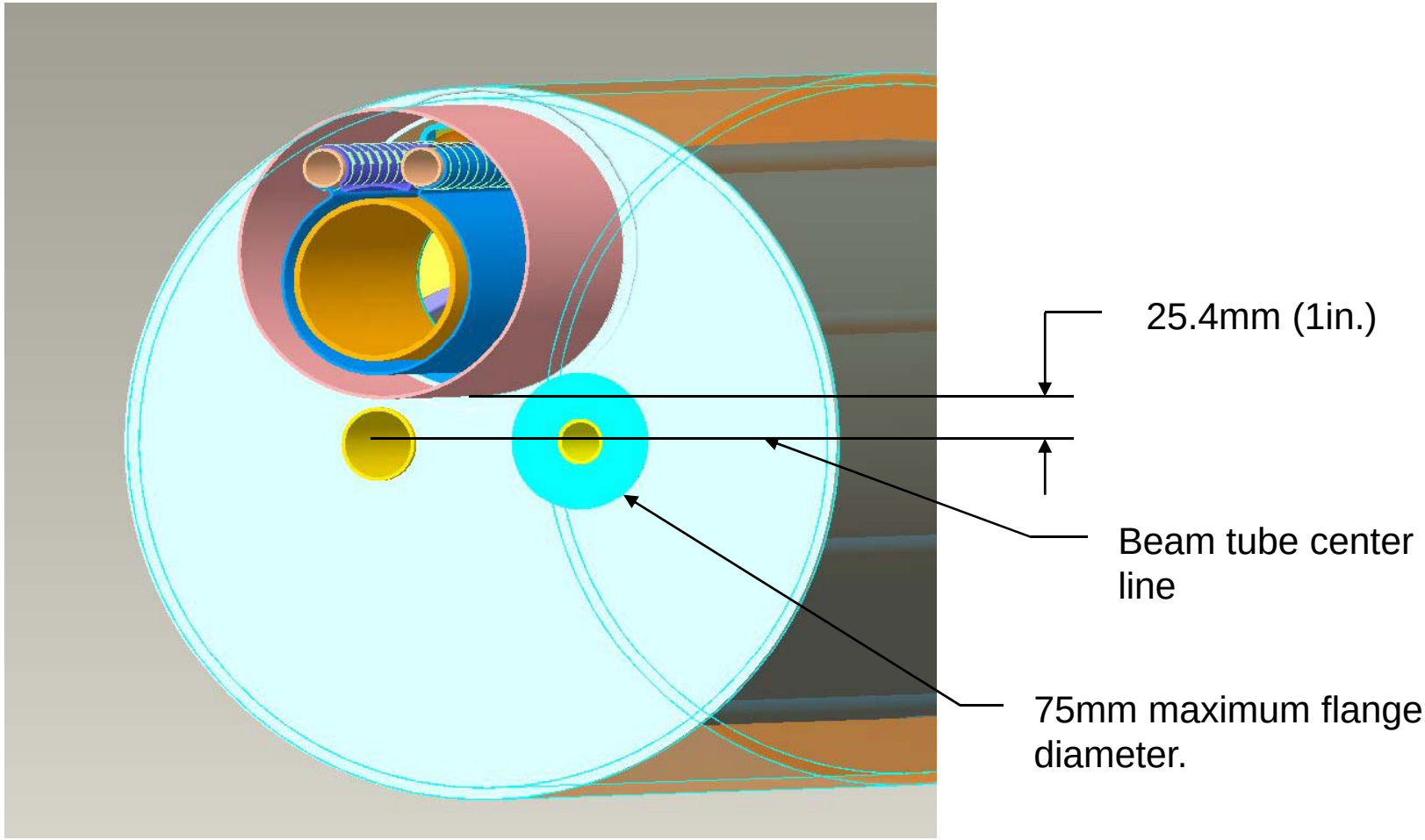


# QD0 CRYOSTAT @ IRENG'07

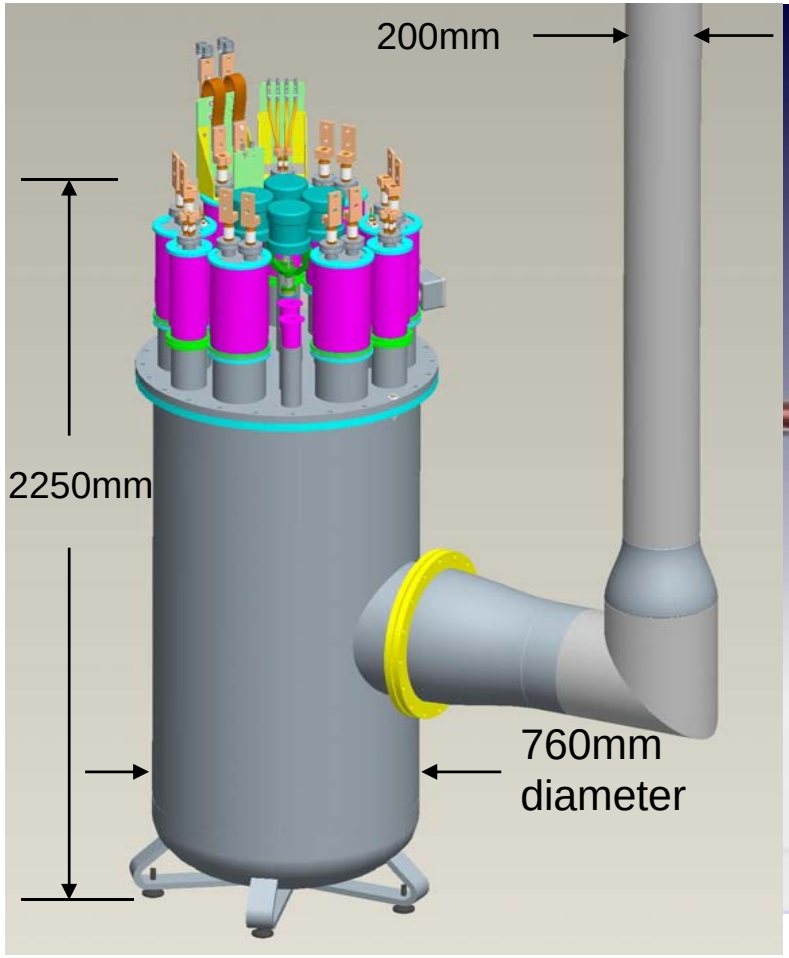


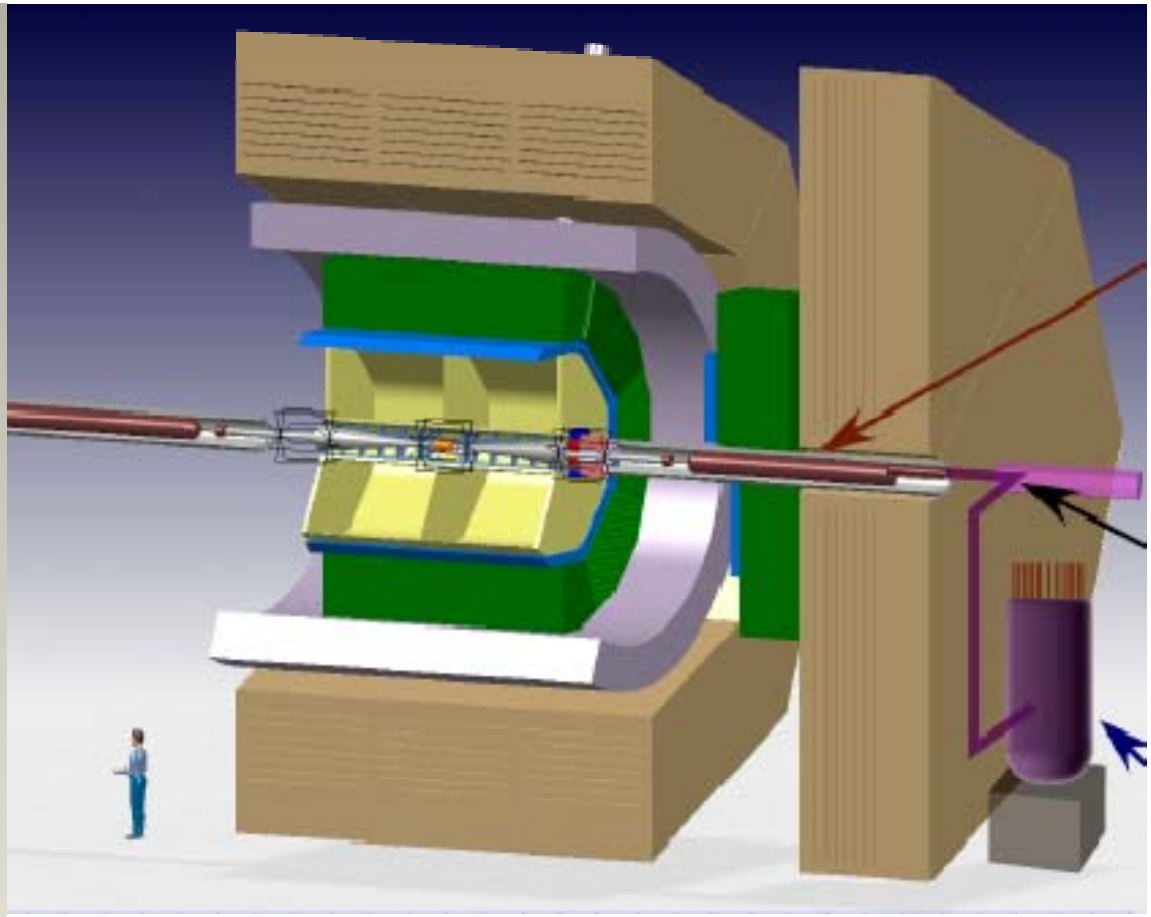

- Overall dimensions of QD0 cryostat.
- For L*= 3500mm distance to IP would be 3245mm

# Back End of QD0



# Interference Between Movable Door & QD0 Service Cryostat



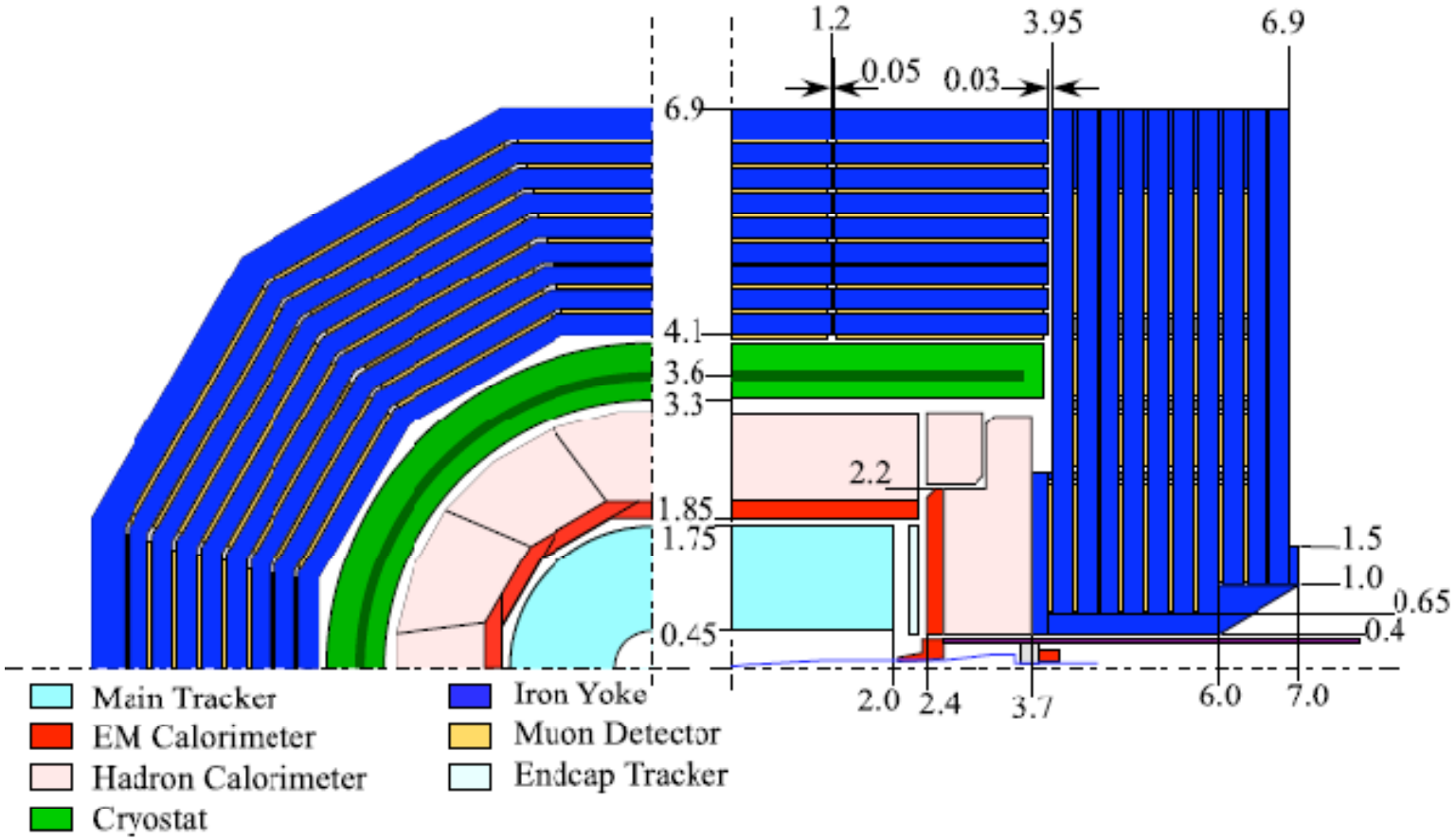



Overall service cryostat dimensions

# Personal Comments and Observations

- GLDc, LDC, & SiD are seriously treating Push-Pull (P-P) & Surface Assembly (S-A)
- 4th concept does not treat either P-P or S-A seriously
- GLDc design was introduced for IRENG'07 which incorporates a complete self-consistent model for push-pull, surface assembly, QD0 Support and PACMAN shielding
- Currently independent LDC design conceptually identical to GLDc

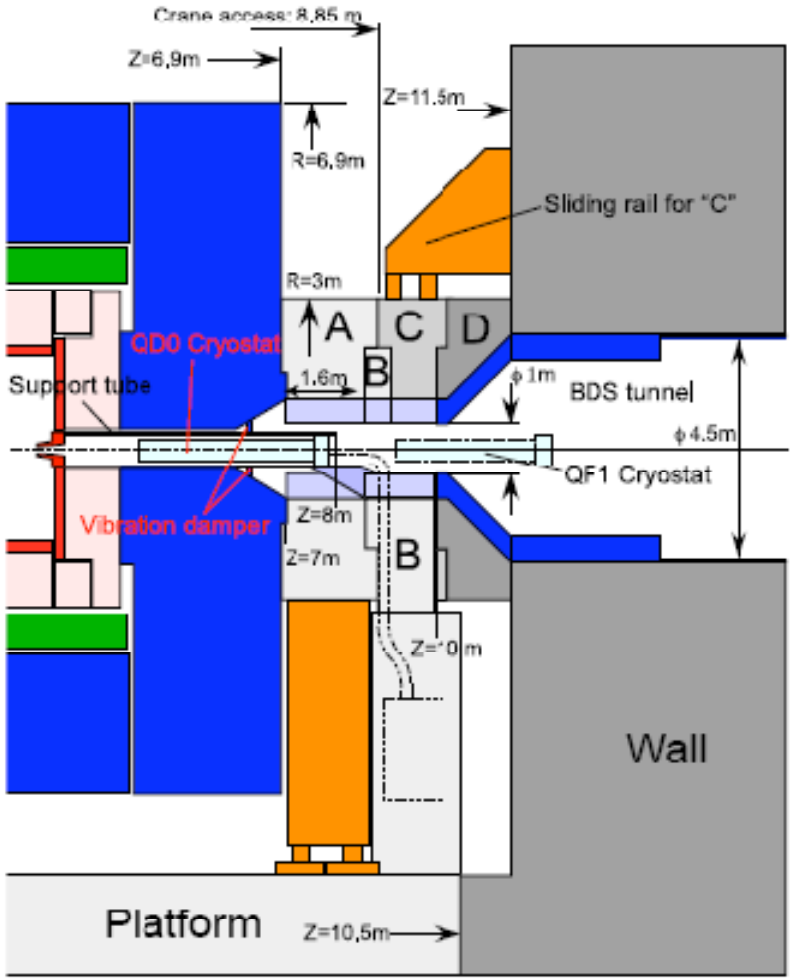
# Compact GLD = GLDc



# GLDc Assembly: 7 major pieces

- Barrel part (Yoke+ECAL+HCAL)
  - **5080+1130 T = 6210 T**
  - **Pure CMS style assembly can be done by splitting the barrel part into 3 rings**
- Each Door (Yoke + ECAL+HCAL)
  - **3050 T + 270T = 3320 T**
  - **and splitting each end cap part into two halves**
- Cranes:
  - **50~100 T underground depending on Pacman design**
  - **2,000 T crane for the shaft**
  - **80 T crane in the surface assembly hall**
    - set by 24 Fe yoke octants
- Shaft sizes, crane access and underground vault sized by CFS for GLDc as discussed by J. Osborne

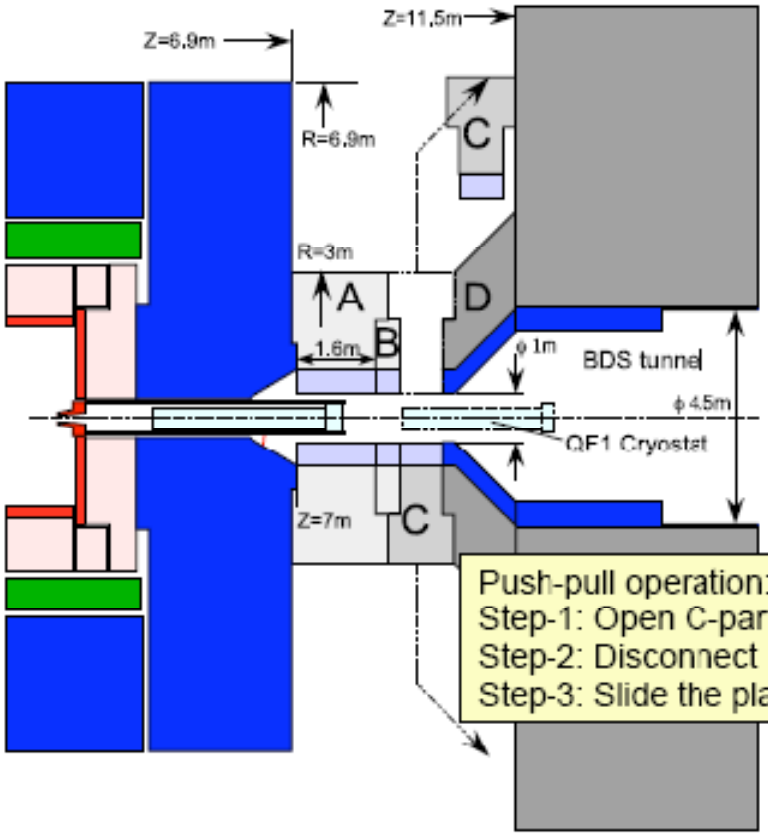
# GLDc QD0 Support Based on Cantilevered Support Tube with Base on 2 x 10.5m wide Platform



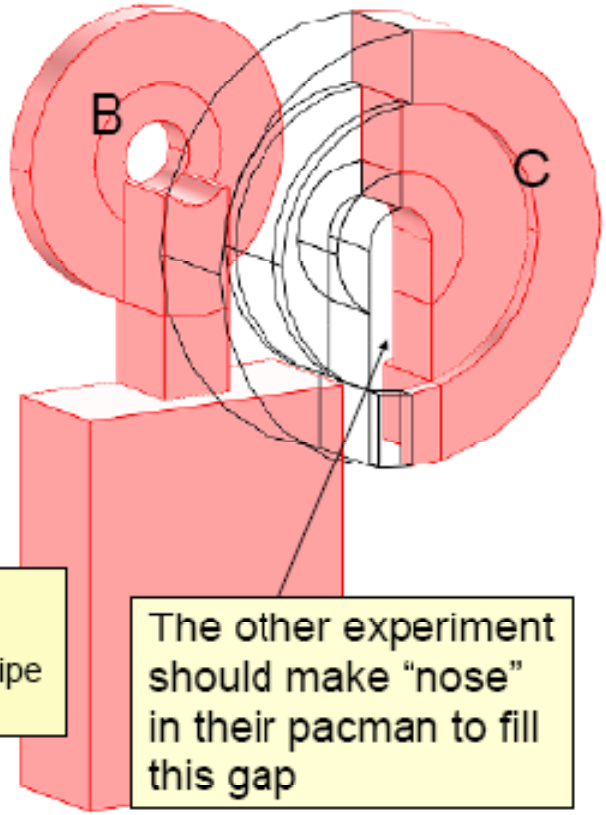

- A: slide sideway using air pad
- B: supported from the floor of platform
- QD0 cryostat is supported by the support tube and the support tube is supported from B
- We can put additional support for the support tube at the entrance of endcap yoke to damp the vibration, if necessary
- Upper part of B (~10 ton) must be removable by crane for installation and removal of the support tube
- C: slide along the wall (D) (common to both experiments) ~50 tonx2
- D: part of the wall
- Wall distance can be as small as 11.5 m from IP, if the crane can access to 2.65m from the wall
- Construction of C is done by a mobile crane (CMS style)
- Inner radius of pacman should be determined after design of gate valve etc. between QD0 and QF1 is fixed

# Disassembly of PACMAN for Push-Pull

- Plan view



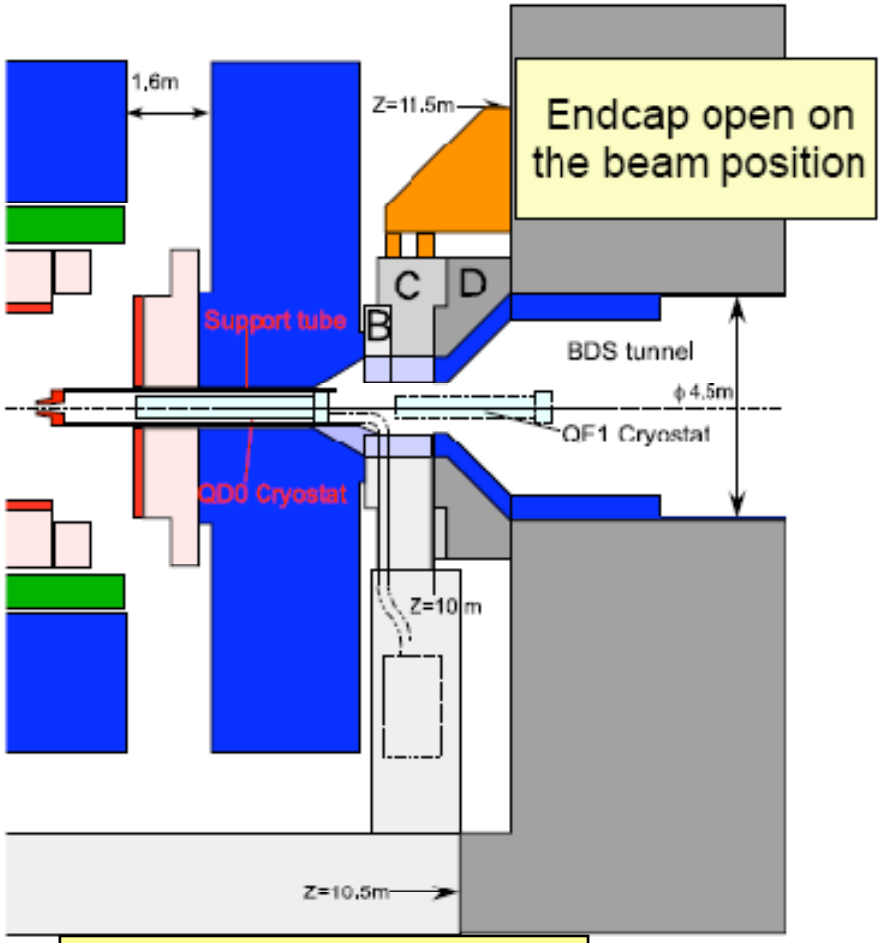

- 3D view



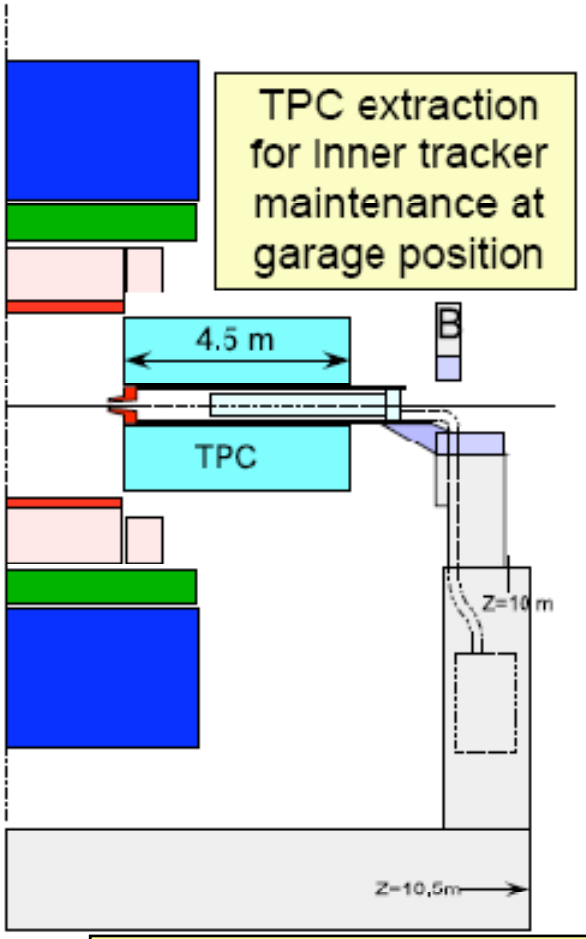

Push-pull operation:
Step-1: Open C-part
Step-2: Disconnect beam pipe
Step-3: Slide the platform

The other experiment should make "nose" in their pacman to fill this gap

# On-beamline & Off-beamline Access

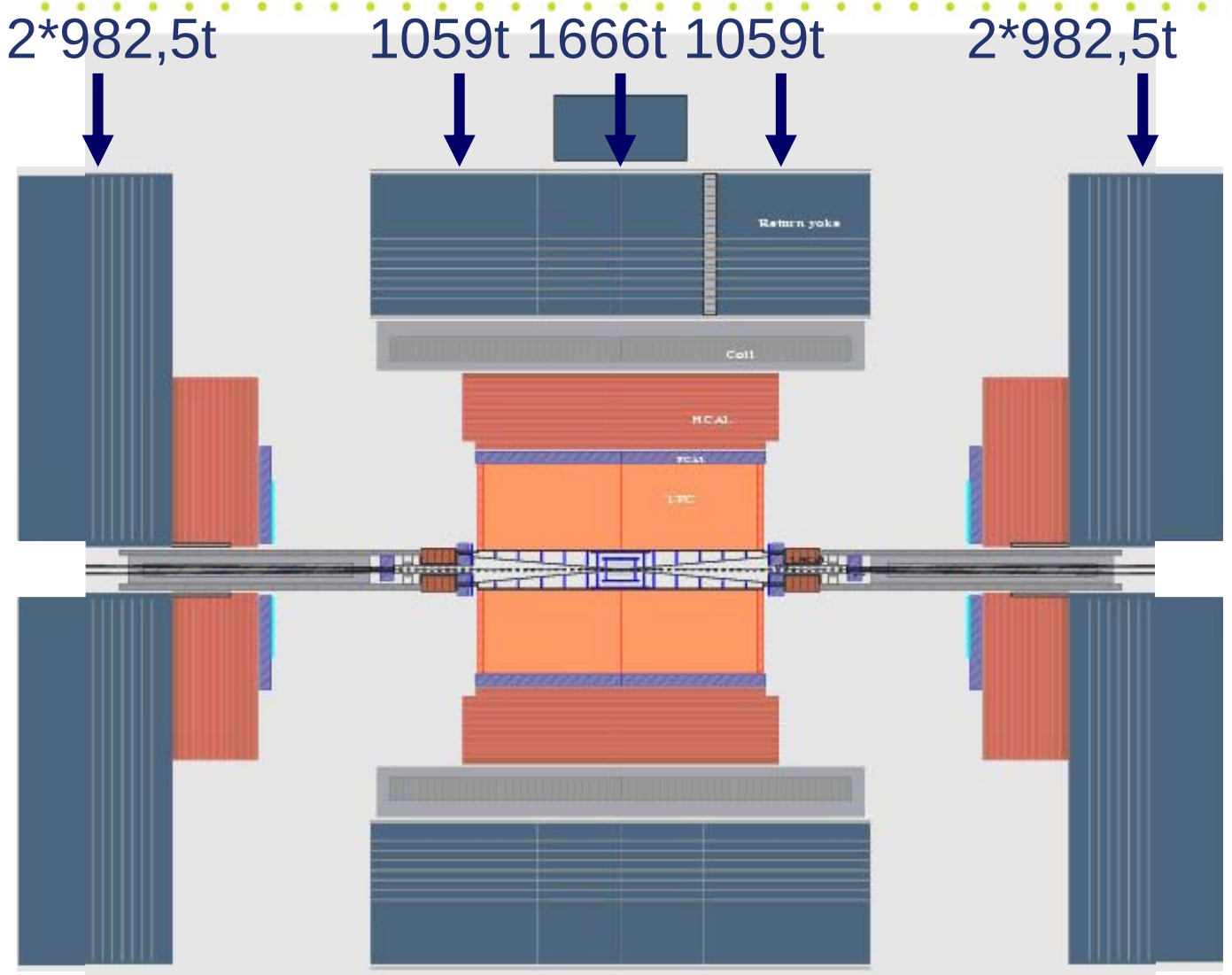



"A" Pacman split back and unsplit door rolls to tube support pillar




"A" & "B" Pacmen and Endcap Door split back

# LDC Assembly & Access Model Similar to GLDc



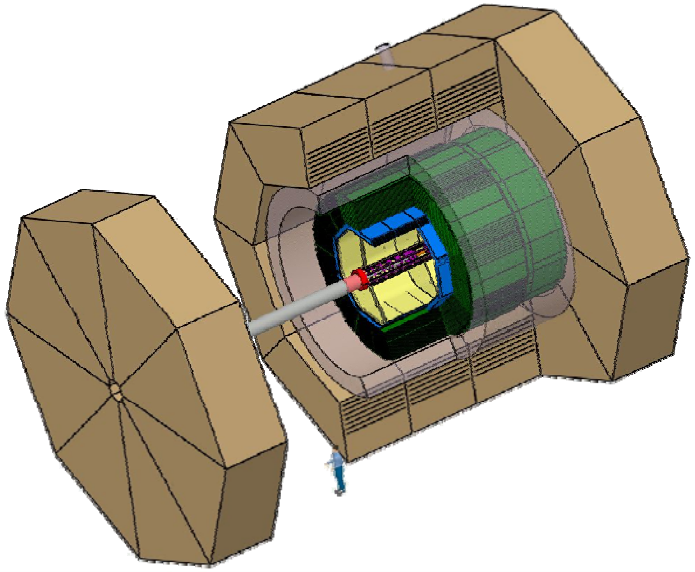

If not split the end cap pieces would be the heaviest part to be lowered!

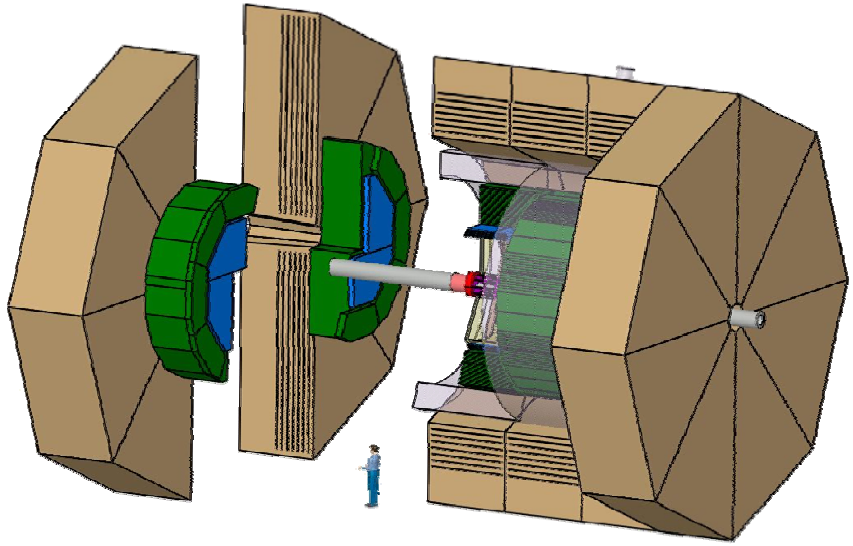
# Split Endcaps not Fundamental to Design

## Under Study!

- The structure of the detector should allow both.

**Factor 2 more bending if split!**



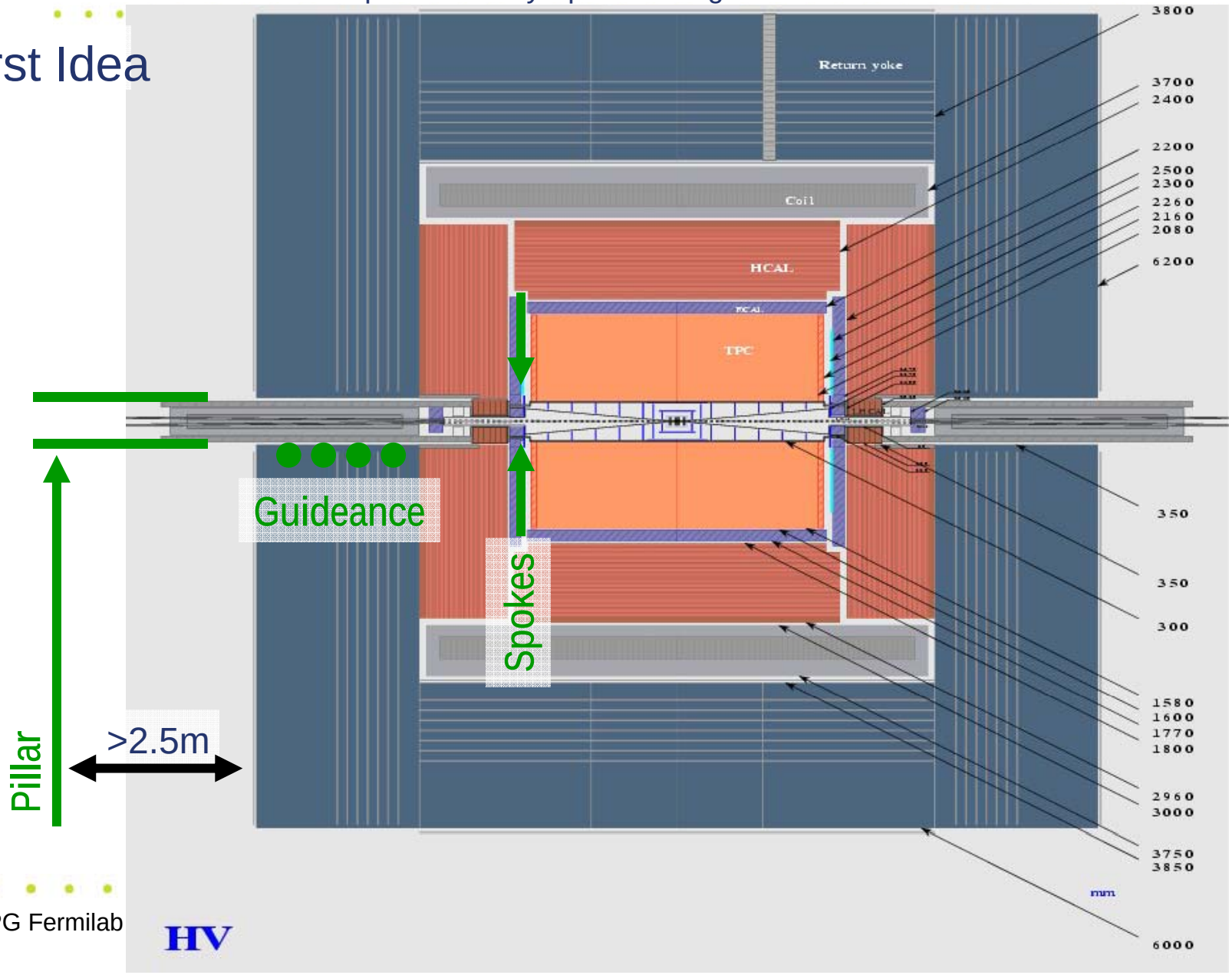


At the moment we prefer end cap halves bolted together with the possibility to open in an major operation if necessary!

# QD0/FCAL Held in Support Tube
# Support Tube Pillar Sets Max Door Opening

Tube Guided in EndCap and Held by Spoke Arrangement at TPC/ECAL Juncture

## First Idea



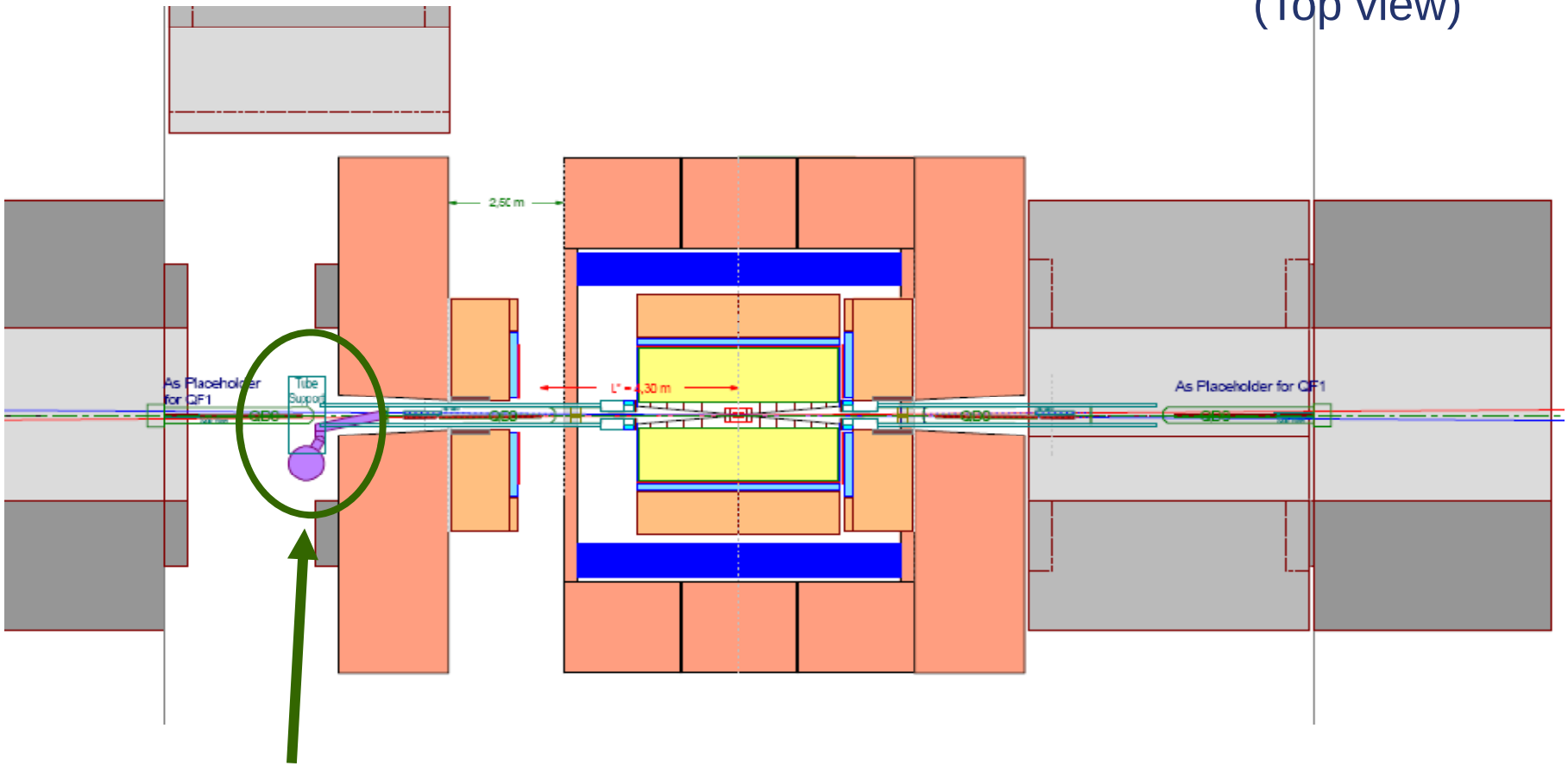



HV

# LDC Opens On-Beamline Via Split PacMan

Need 2.5-3m to access the detector

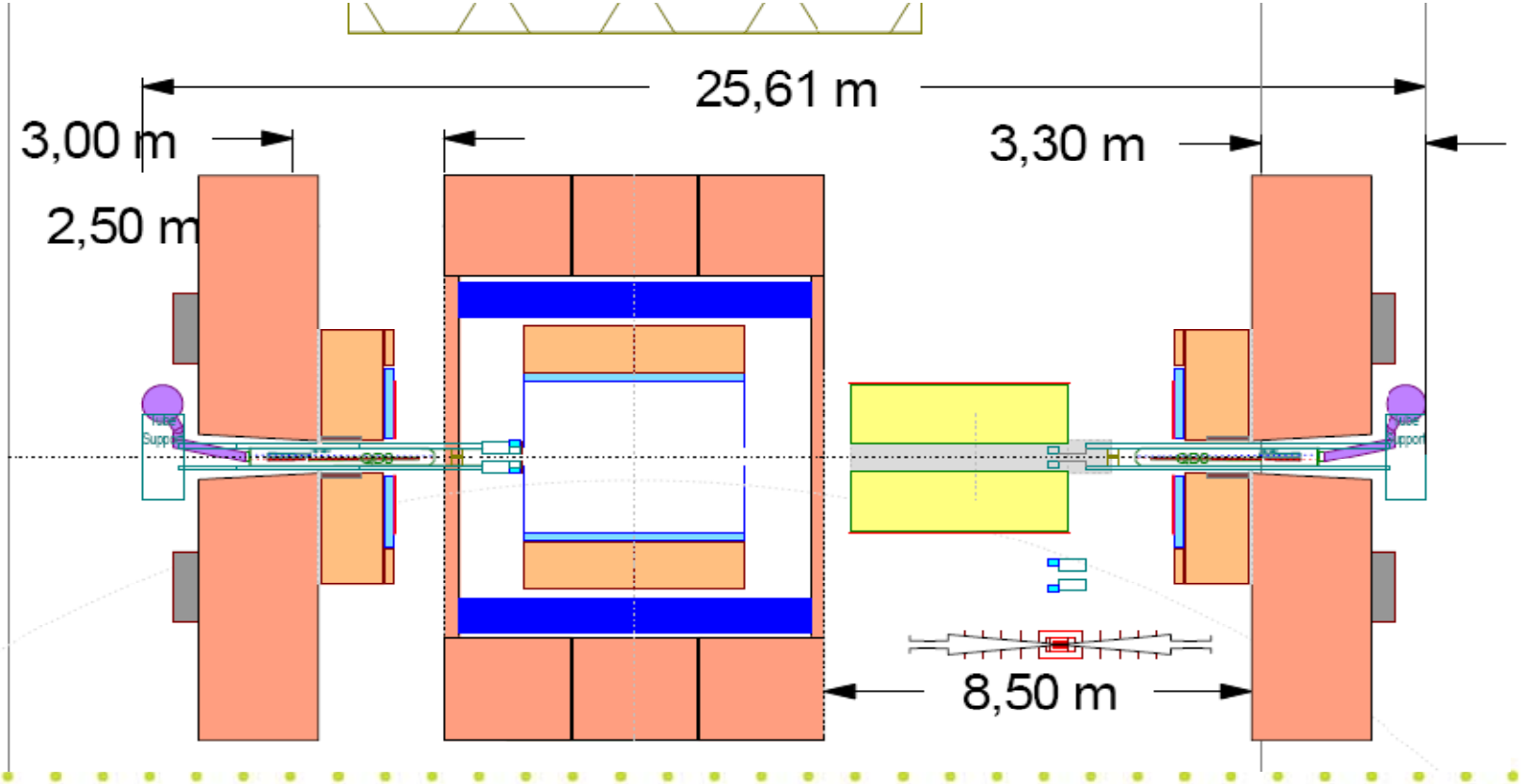
(Top view)




- **Support Structure Support**
- **Service Cryostat**
- **Supply Line close to QF1**

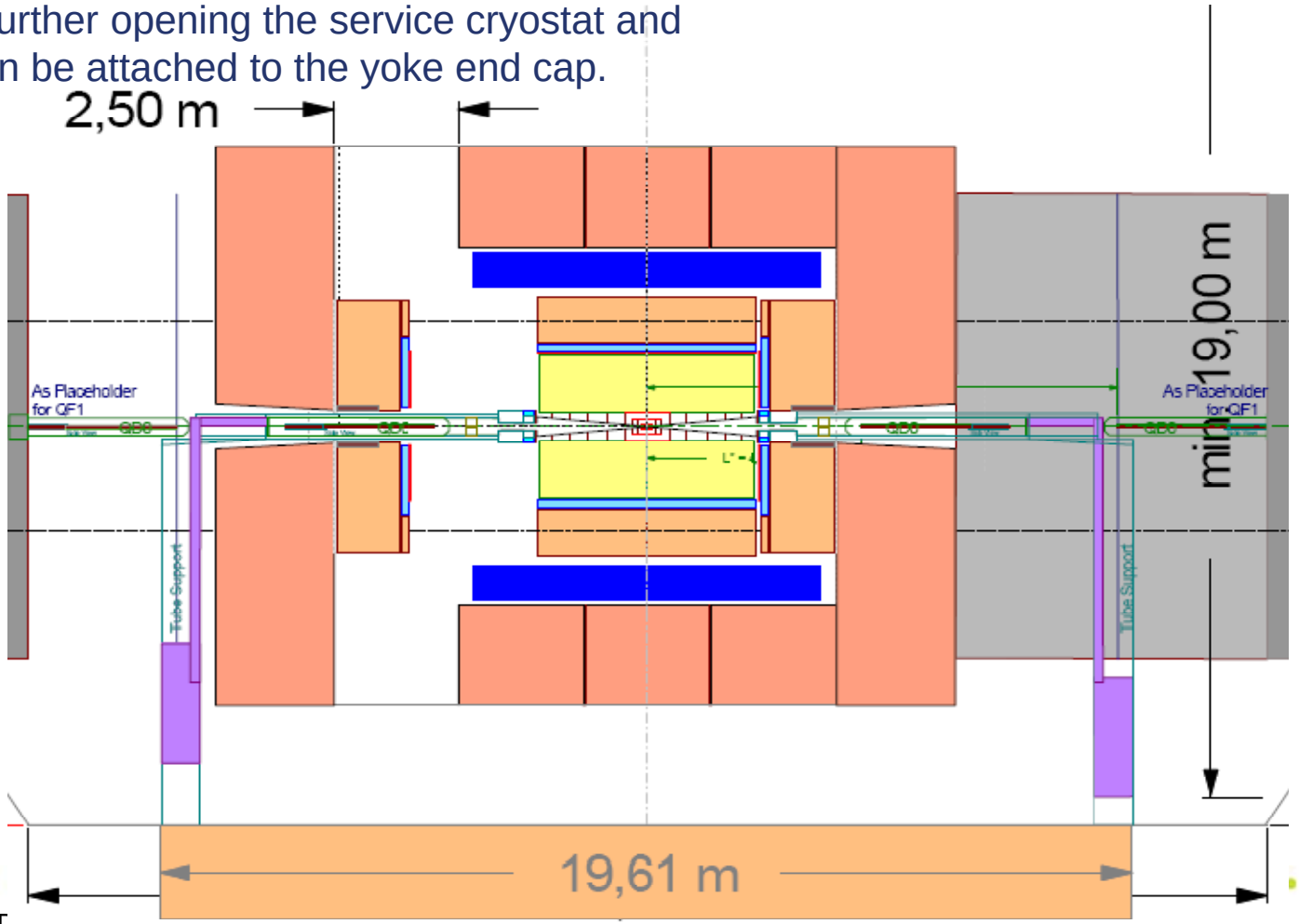
# TPC Exchange Off Beamline

- If not split, the end cap yoke has to be moved 8,5m longitudinal (or aside) for TPC exchange!
  - QD0 and service cryostat have to go with the end cap yoke while the Helium supply line is not cut!



# Similar Width “Platform” to GLDc

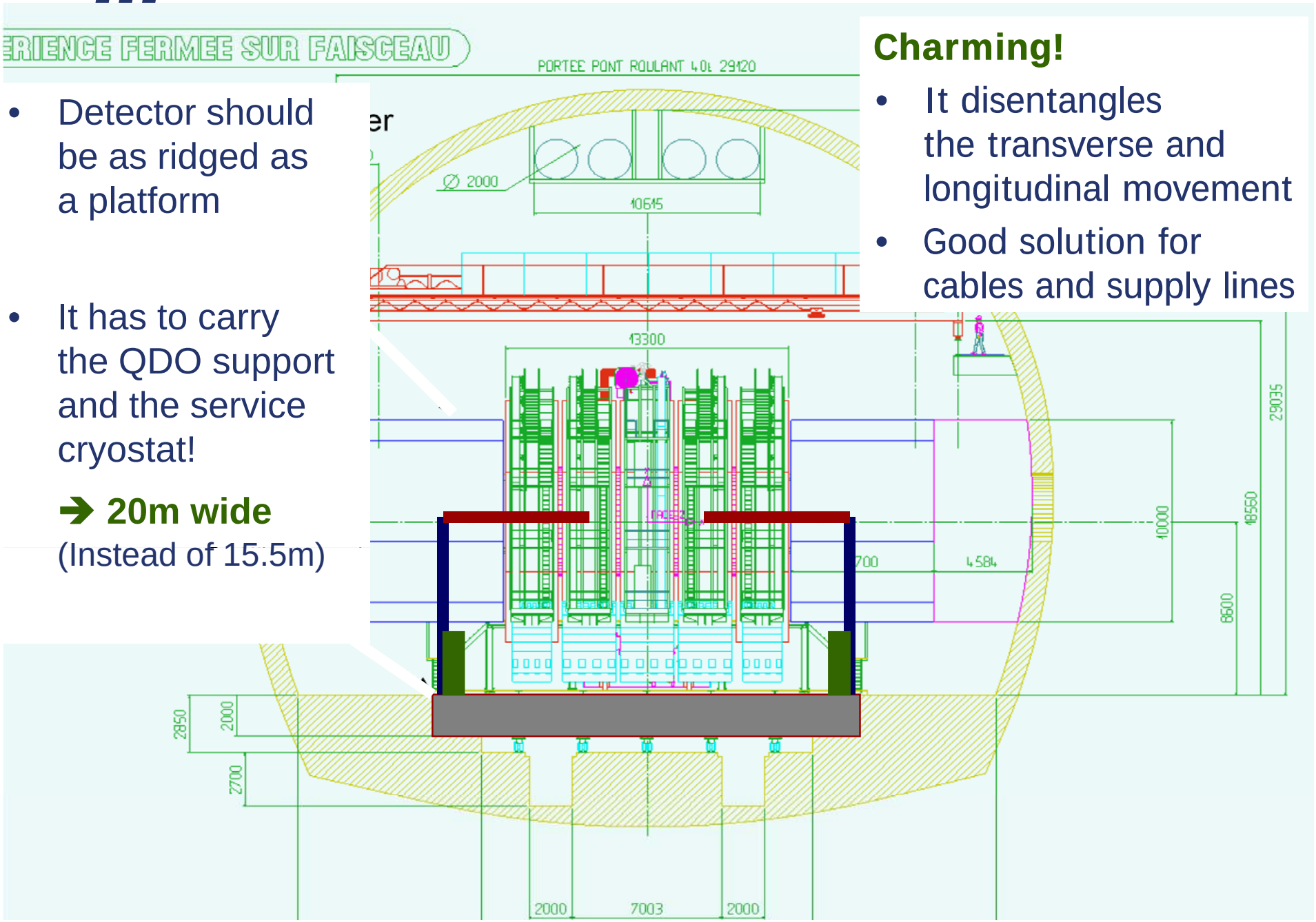
- The supply lines from the service cryostat to the QD0s go from the bottom through the shielding.
- The cryostats are connected via flexible lines to Helium supply.
- To allow a further opening the service cryostat and the QD0 can be attached to the yoke end cap.



# Relative Merits of Platform Under Discussion

- Detector should be as ridged as a platform
- It has to carry the QDO support and the service cryostat!

➔ **20m wide**
(Instead of 15.5m)




**Charming!**

- It disentangles the transverse and longitudinal movement
- Good solution for cables and supply lines

# SiD IR & MDI Design Philosophy

SiD has traditionally tried to incorporate self-consistent IR/MDI design based on assumptions that detector would

- **Have solid endcap doors**
- **Be self-shielded**

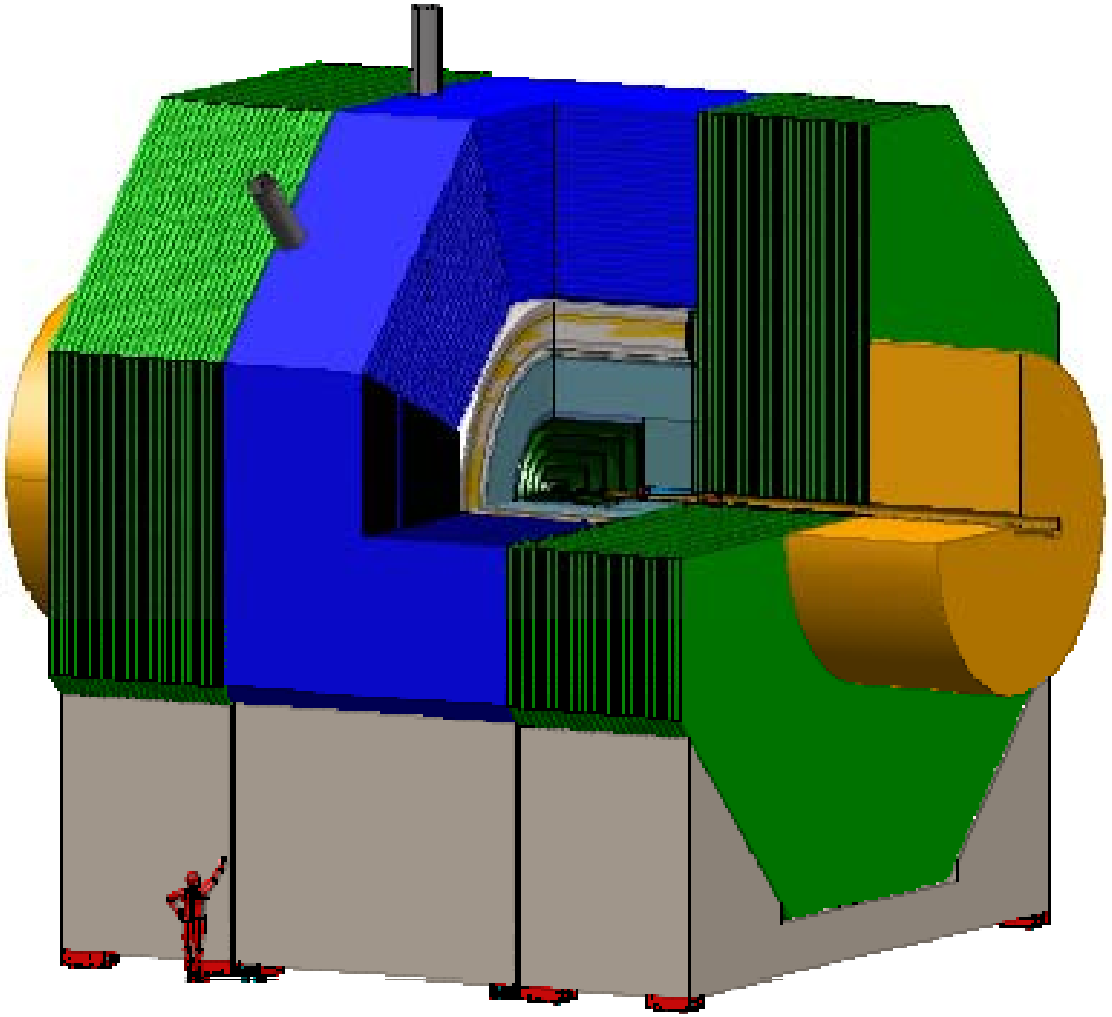
We have assumed push-pull would require

- **No connection of FCAL/Doublet support structure to a fixed point other than the detector**

# SiD MDI Developments

- Formation of ~10 member Si D Engineering team
  - **Some work by Marco Orunnio on push-pull cryo & magnet connections**
  - **No new work on FCAL/QD0 support**
- Detailed engineering calculations of beampipe by Bill Cooper for designs being put forward by FCAL group
- Clear design wishes by Bill Morse for beampipe/Lumical/FHcal/Beamcal that have not been blessed by SiD management
- Bill Cooper's IRENG'07 calculations show that FCAL/QD0 package mass requires more than two support bars
- Realization that FCAL/QD0 support will need some form of z-restraint

# SiD: Doors & Barrel Are Not Split Minimum of 3 pieces to lower



"Pure CMS" concept gantry requirements:

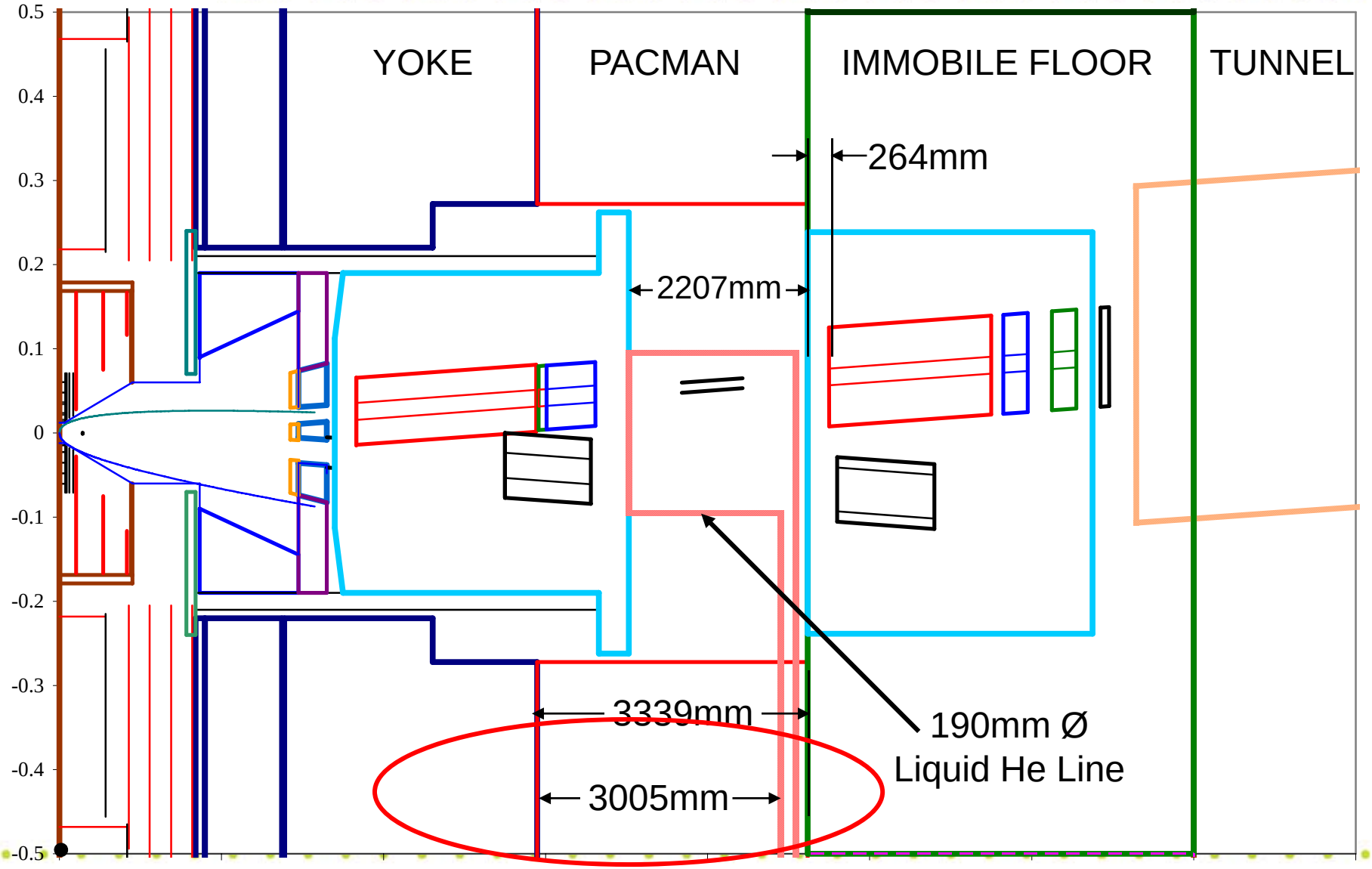
- 4000T Barrel
  - Arch supports, Yoke, H/E-cals, coil
- 2500 T Doors
  - Yoke, H/E-cals

See M. Breidenbach animations

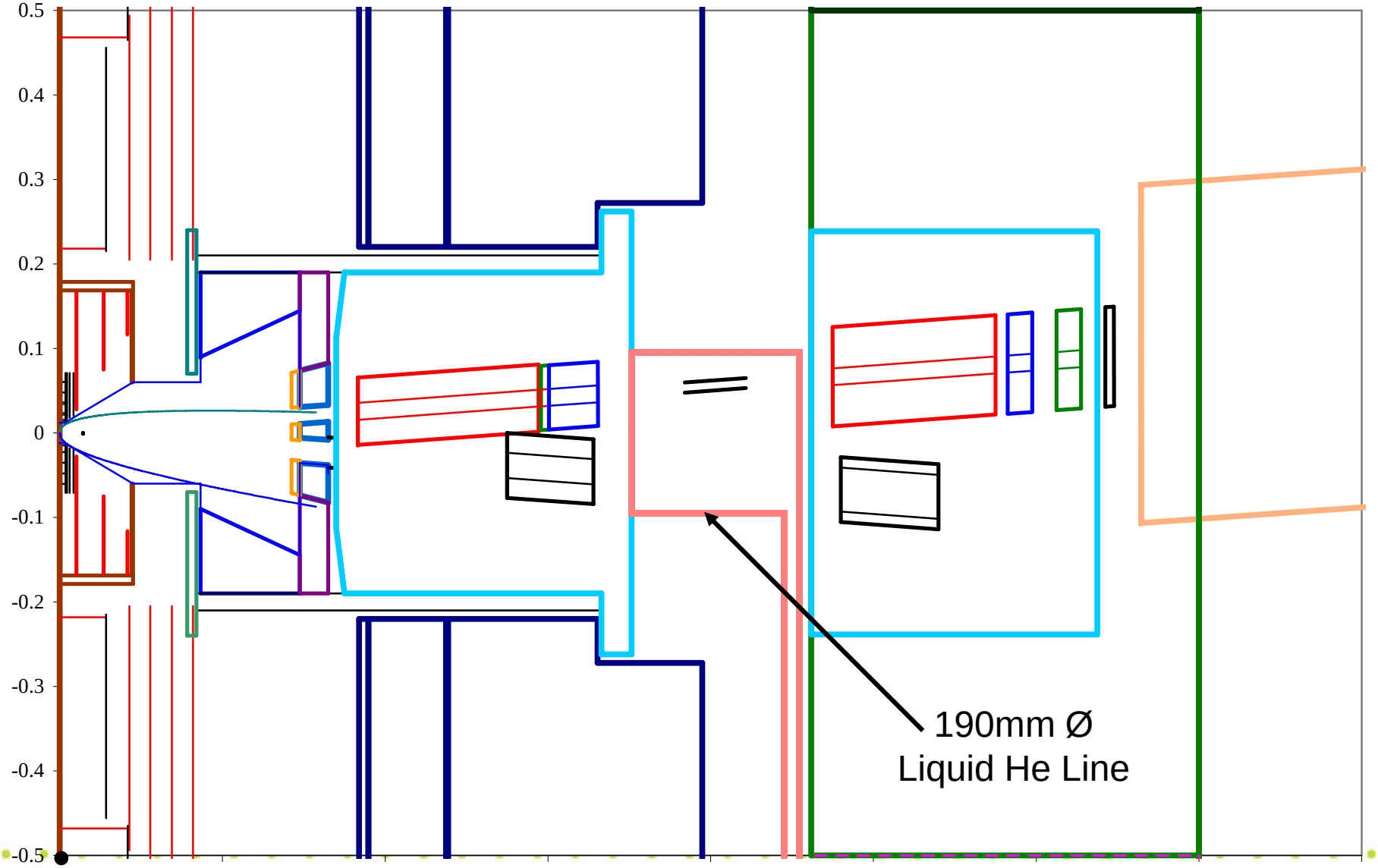
# A Surface Assembly/ Underground Reassembly Scenario for SiD
## 600T Surface crane & No Gantry

| M-Tons | Stainless HCAL Radiator | | Tunsgten HCAL Radiator | |
|---|---|---|---|---|
| | Barrel | Endcap x2 | Barrel | Endcap x2 |
| EM Cal | 59 | 19 | 59 | 19 |
| HCAL | 354 | 33 | 367 | 46 |
| Coil | 160 | | 116 | |
| Iron | 2966/8= 374.5 | 2130/4= 532.5 | 1785/8= 223.125 | 1284 |
| Support x 2 (each ~5%Fe) | 150 | 110 | 90 | 65 |
| Total to Lower | Loaded Coil=573 | Assembled Door=2402 | Loaded Coil=542 | Assembled Door=1479 |
| Shaft Diameter(m) | 8.3m | 10.4+2.0m | | |

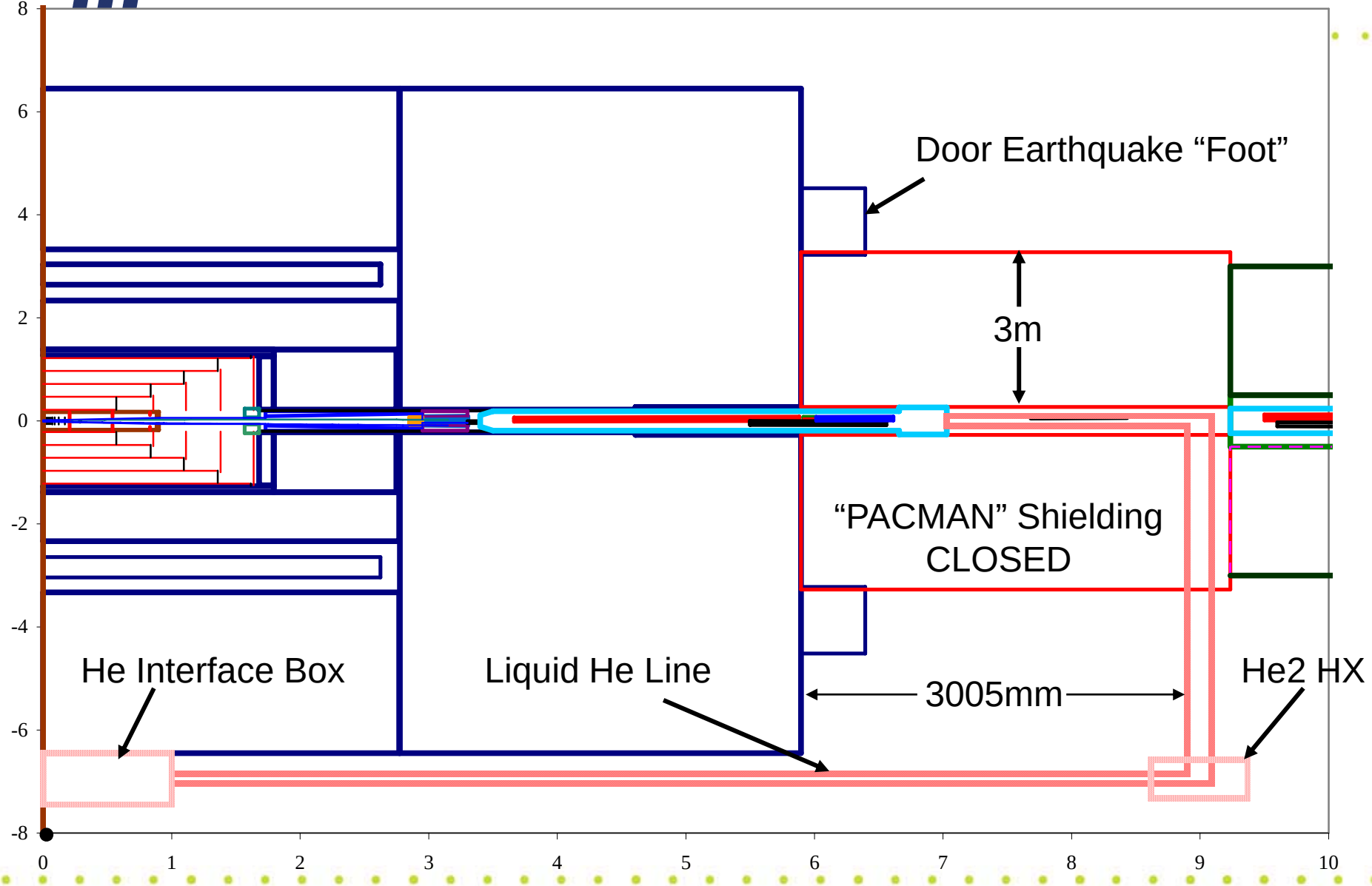
# SiD r<50cm, L*=3.664m, 14mrad, Push-Pull, QF@9.5m, Door Closed



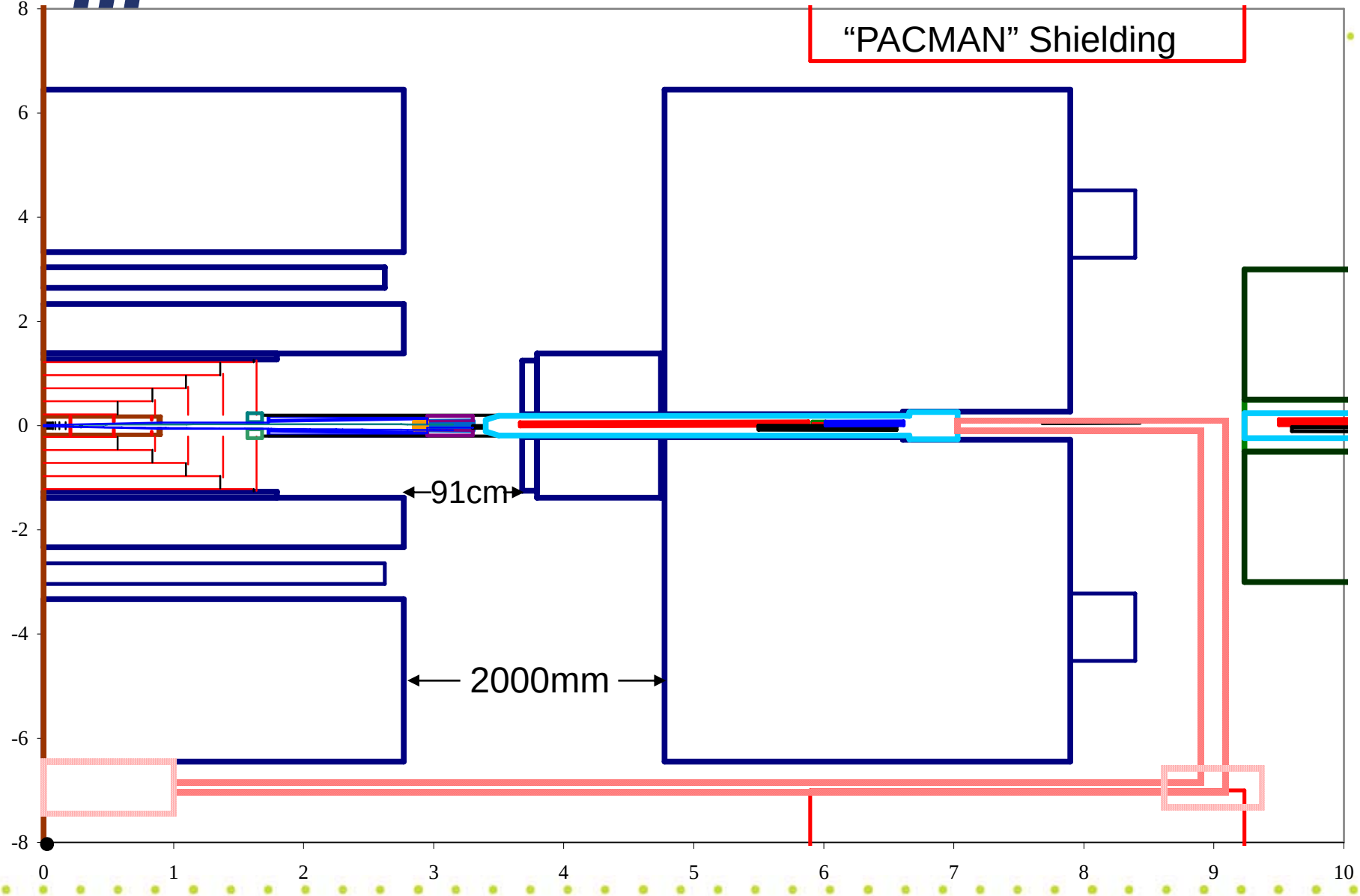
# SiD r<50cm, L*=3.664, 14mrad Crossing Angle, Push-Pull, Door **Open 2m**



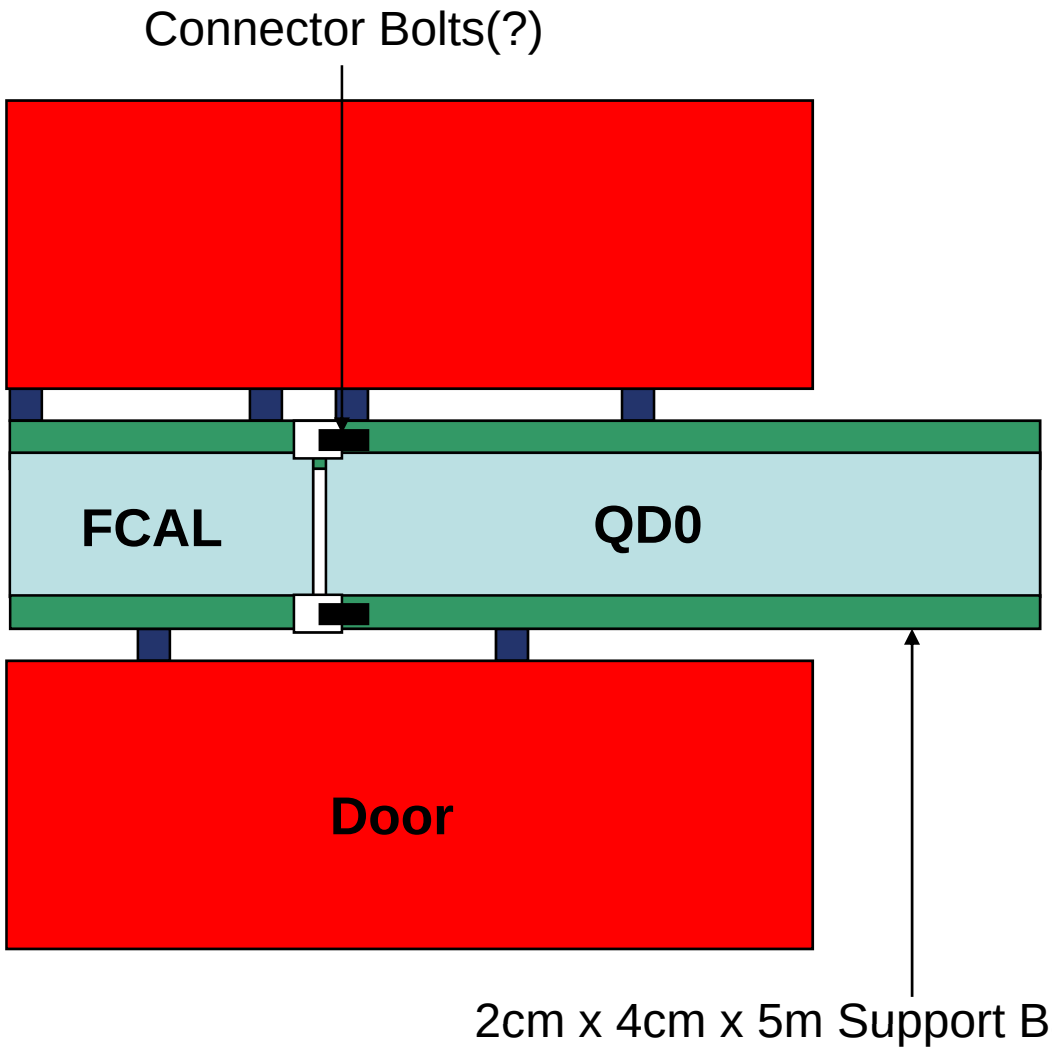
# Door Closed, Permanent QD0 Liquid He Line

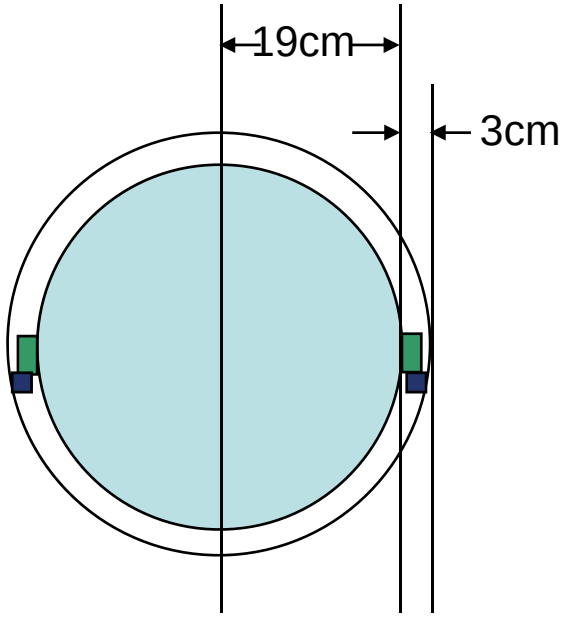


# Door Open, Permanent QD0 Liquid He Line

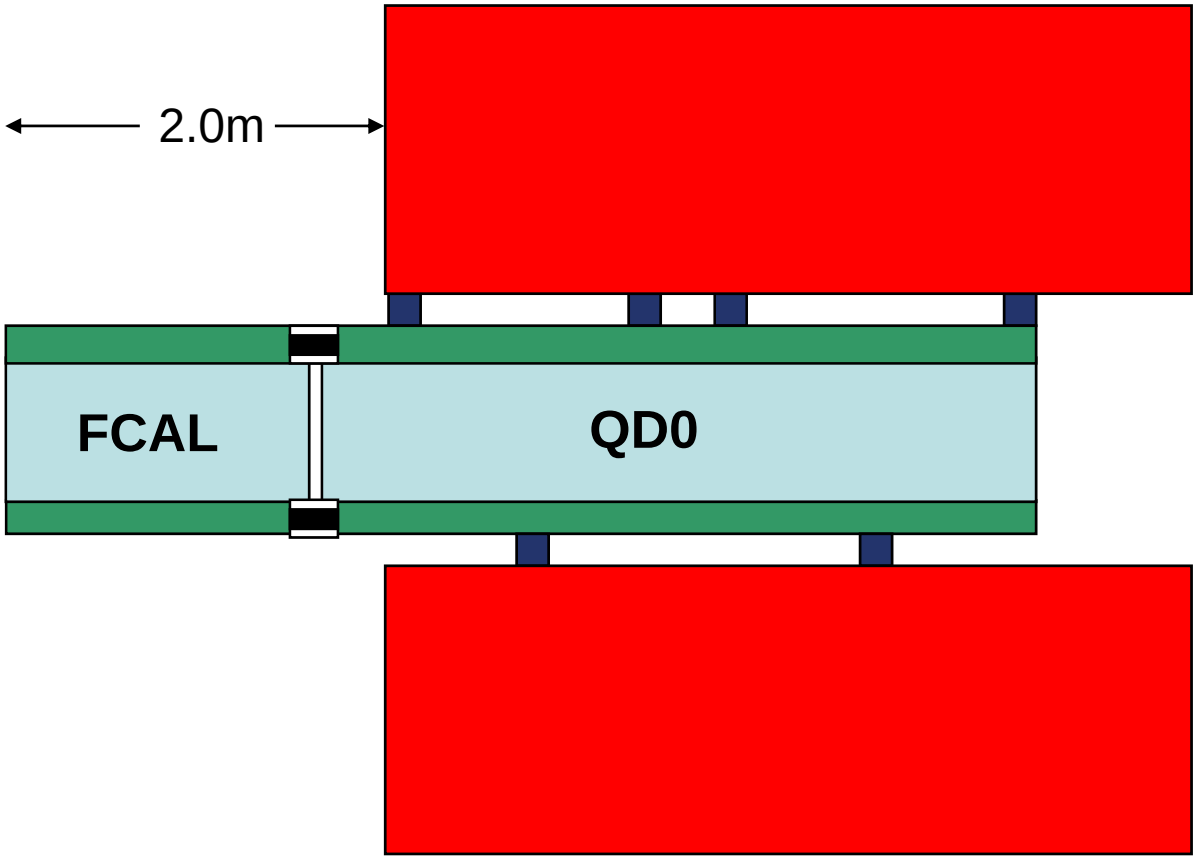


# FCAL/QD0 Supported with Door Closed



# FCAL/QD0 Supported with Door Open

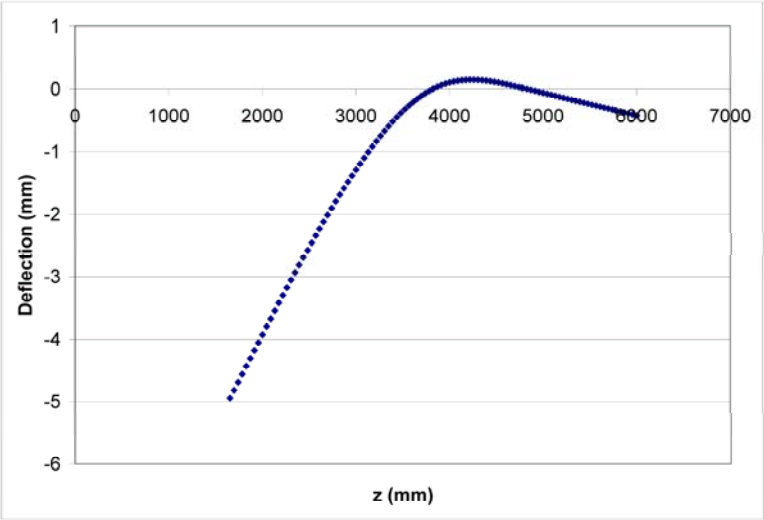


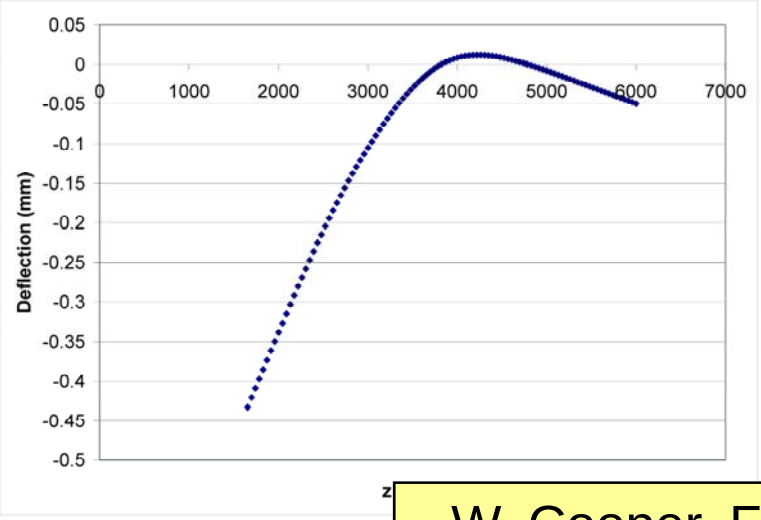

Whether Spider or tube used for Support, SiD has assumed it will be completely supported by door (not cantilevered off a post to the ground) but has not proposed a way to fix it in z when door opens

# Deflections of 2cm x 2cm Support Bars when Door Opens 2m

- Support points with rollers were assumed at front and rear of HCAL (Z = 3820, 4770 mm).
- Forward calorimeters supported at their ends as dead weights
- QD0 weight ignored

| 4 - 20 mm x 20 mm bars | Stepped cylinders (3, 10, 20 mm walls) |
|---|---|
| Deflection at front of Lumi-CAL = 4.9 mm | Deflection at front of Lumi-CAL = 0.43 mm |
| Stress in bars = 12.7 ksi | Stress in cylinders = 1.0 ksi |



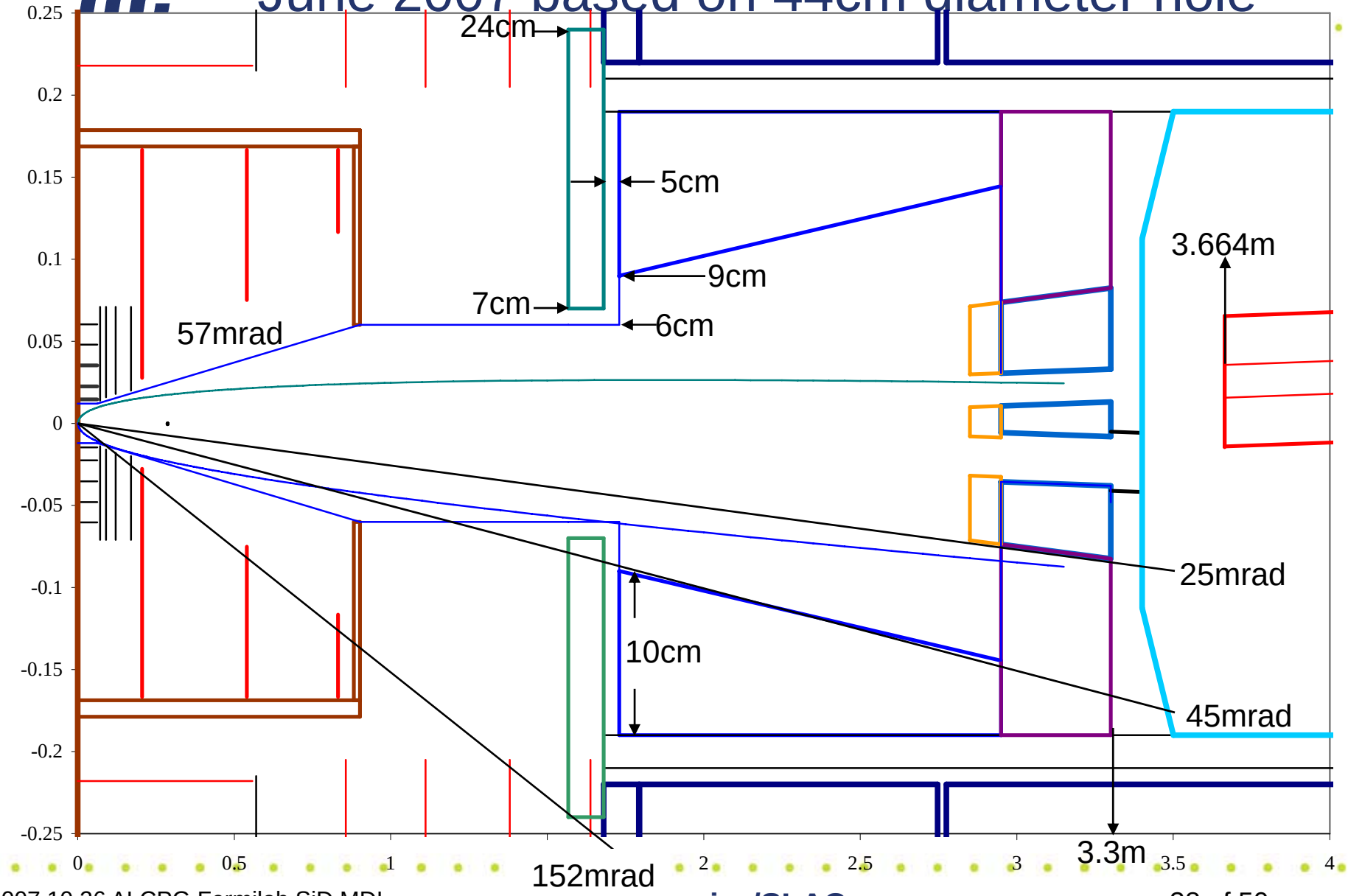





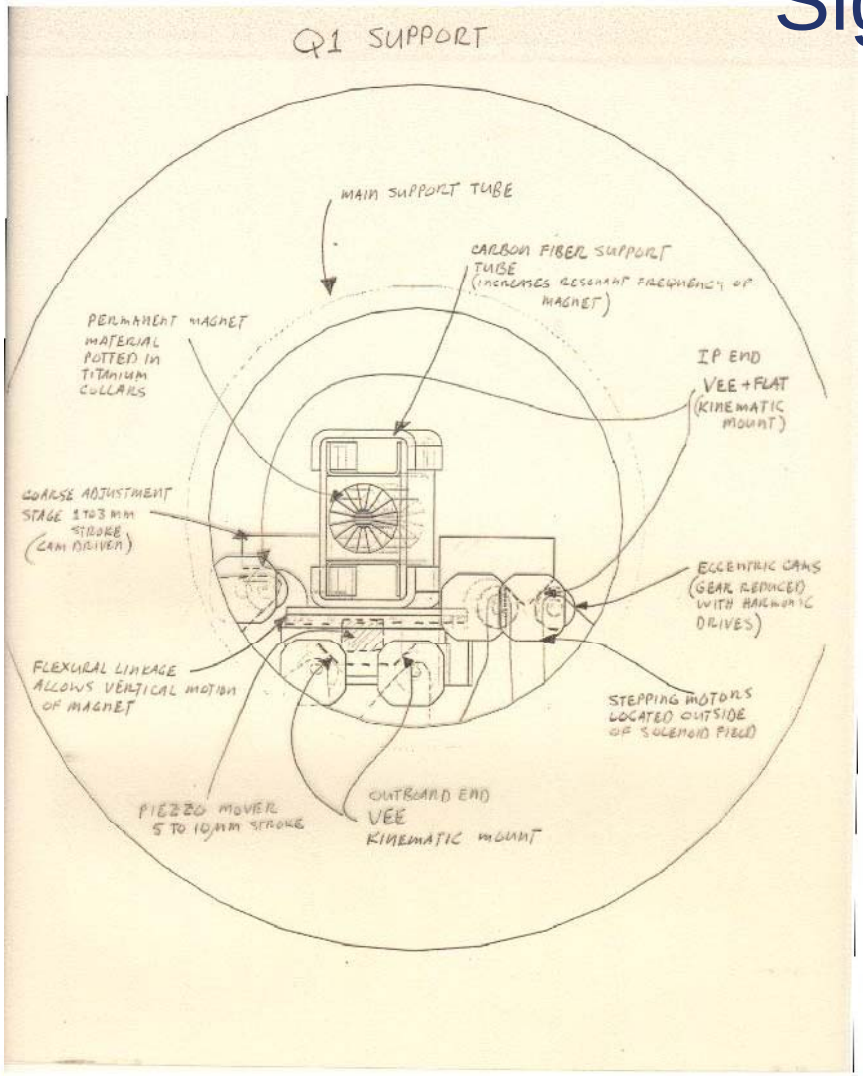

T. Markiewicz/SLAC

W. Cooper, FNAL

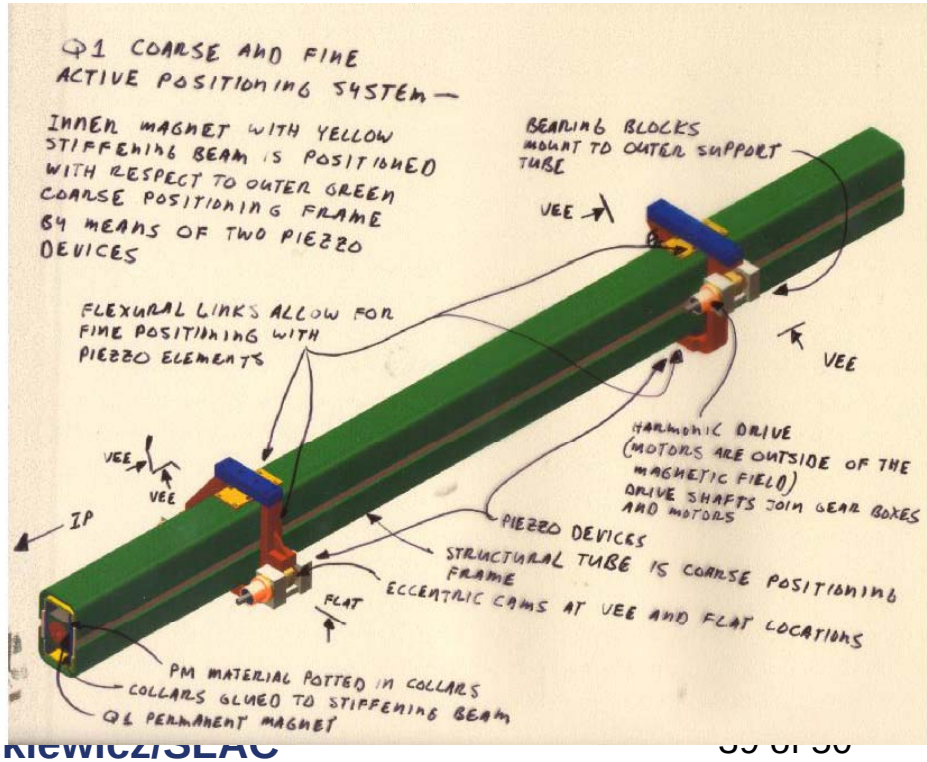
# Suggested FCAL Layout for Discussion June 2007 based on 44cm diameter hole



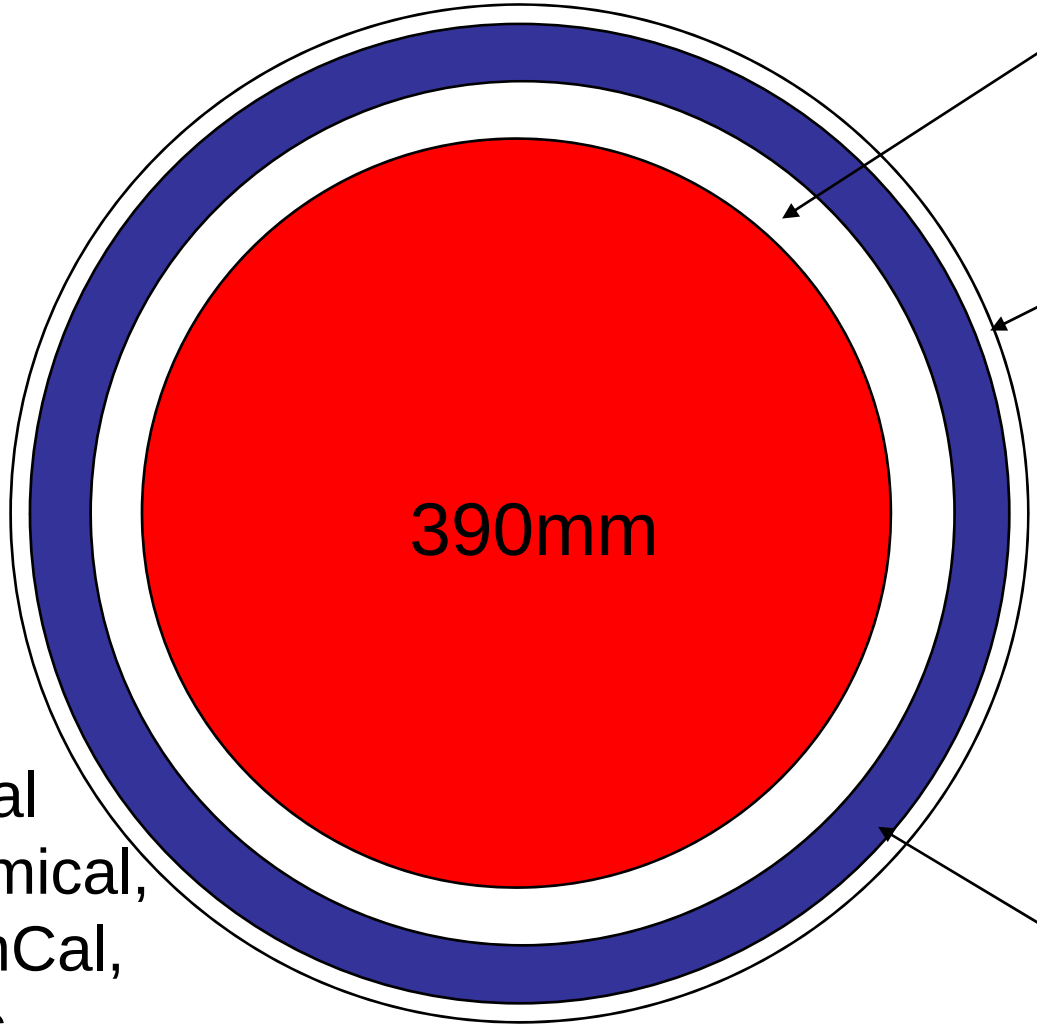
# QD0 Package Adjustment Mechanism Likely to Require Significant Radial Space




Knut Skarpaas 2000 Design of Integrated Coarse/Fine Cam/Piezo Mover System for a stiffened PM QD0

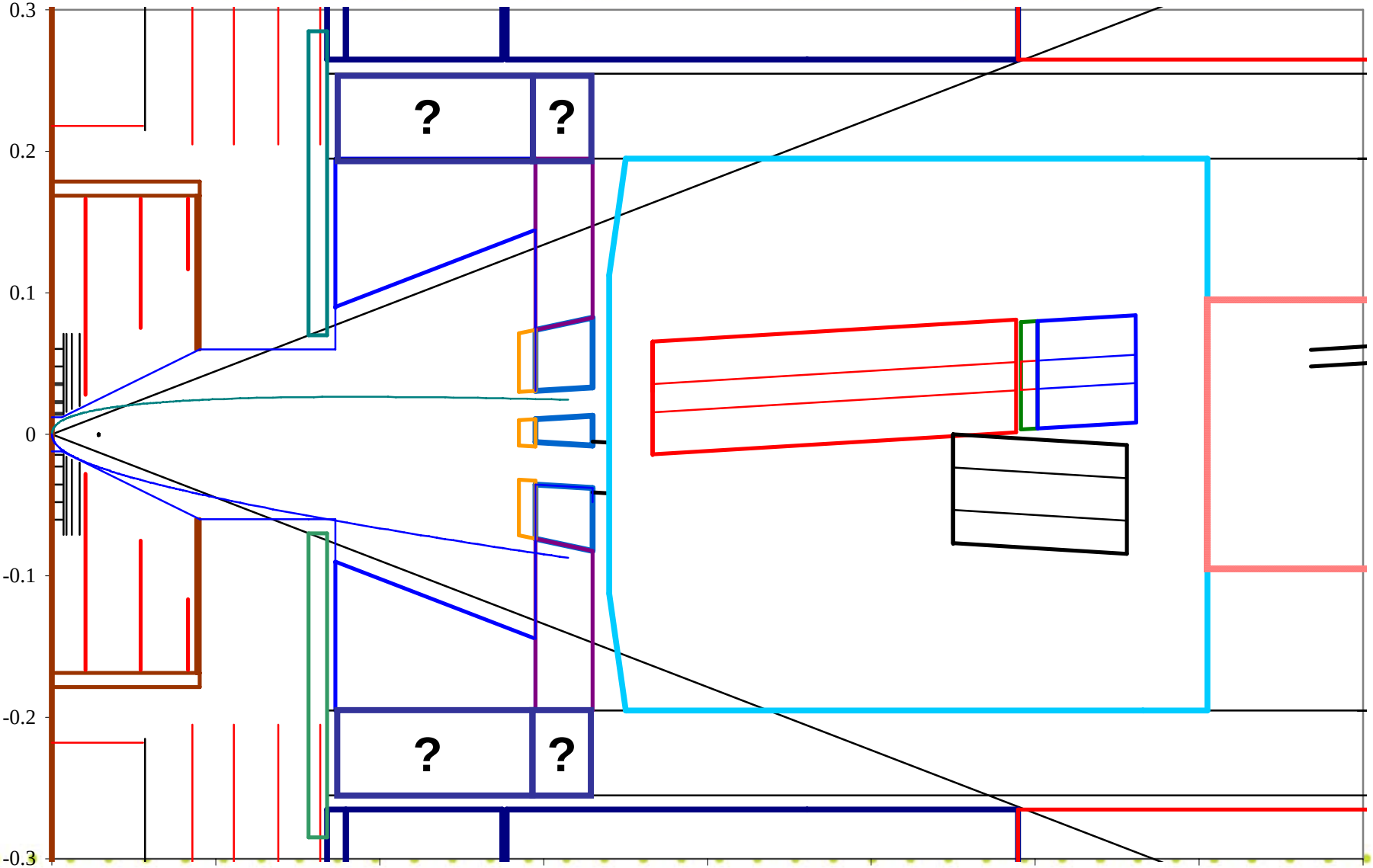


# 390mm QD0 + 2 x 30mm Support Tube Wall + 2 x 30mm space for adjustment mechanism + 2 x 10mm clearance = 530mm hole in door

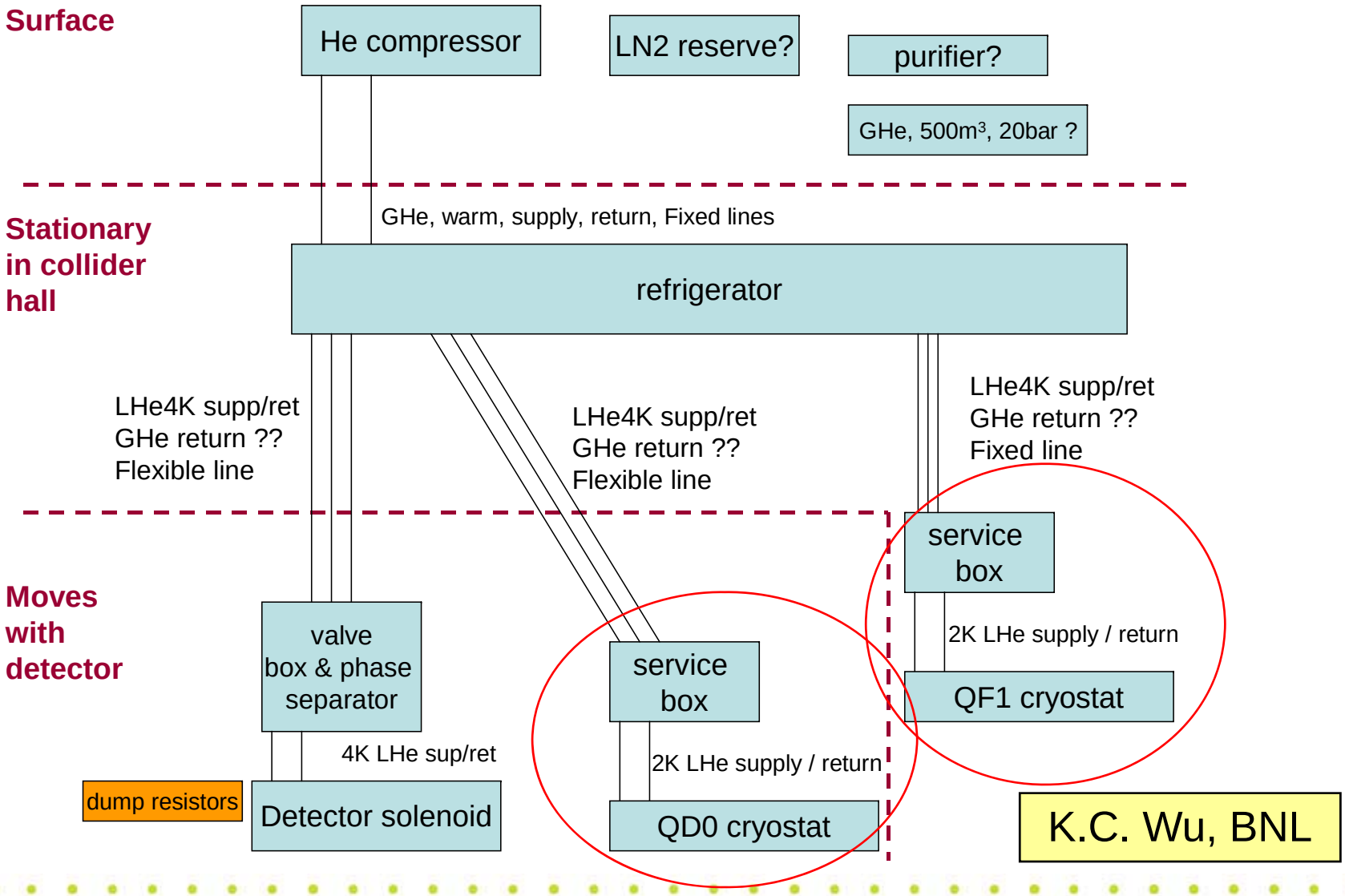



530mm total diameter of Lumical, FHCAL, BeamCal, Masks, etc.

# FCAL Region with r=26.5cm “R20” design



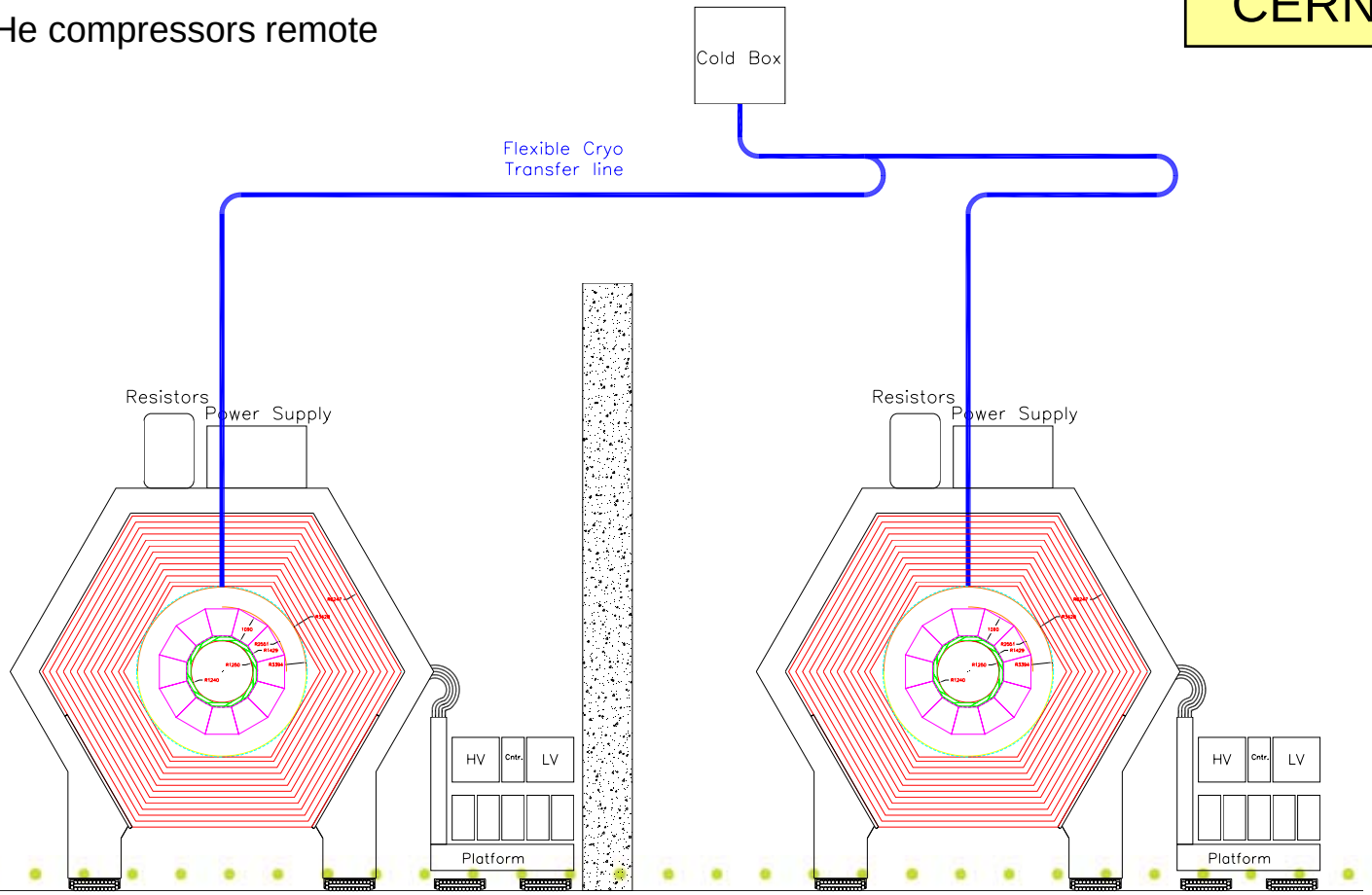
# Cryogenic Block Diagram in ILC IR Hall



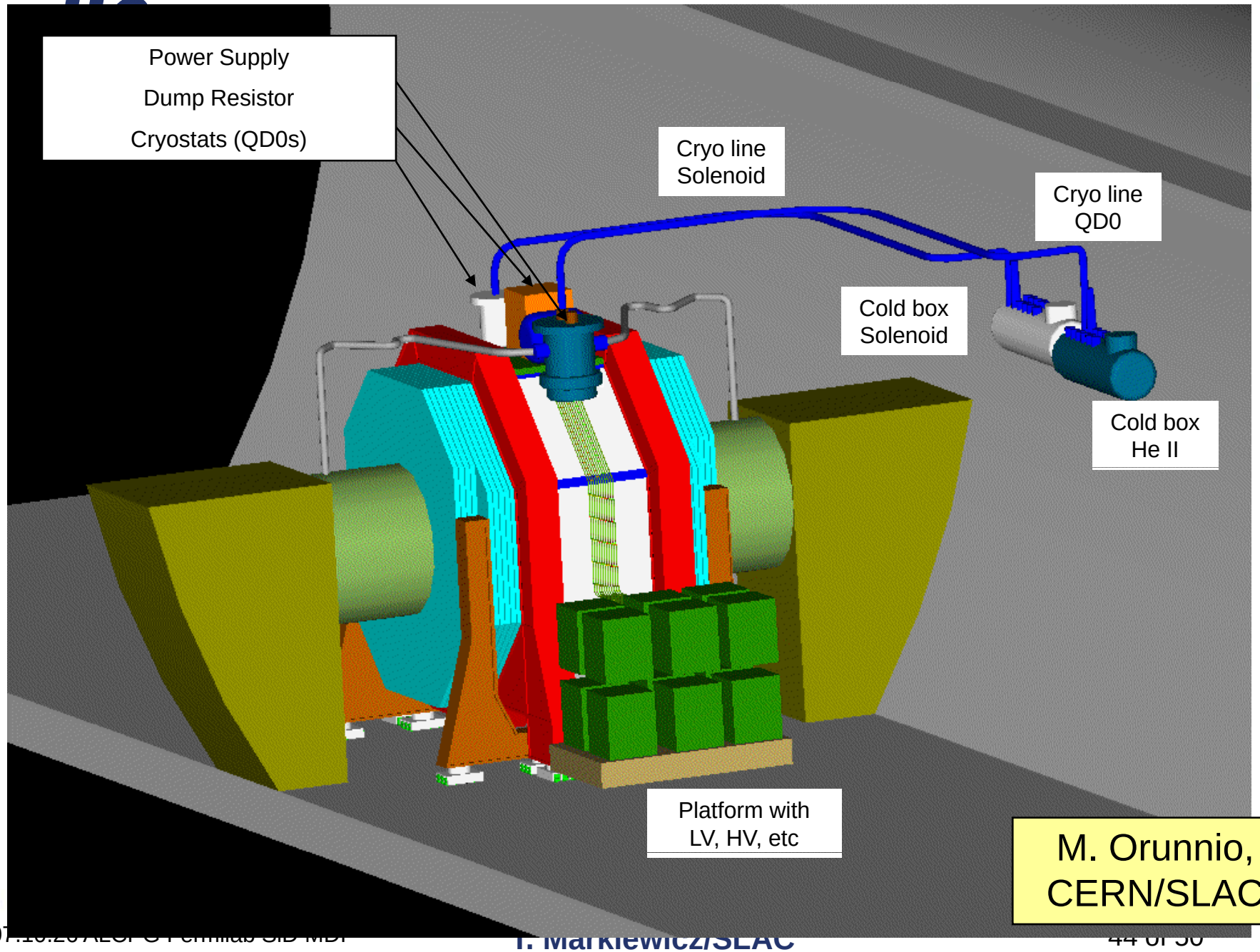
# SiD IR Hall Assumptions

1. Push-Pull and doors opening with Hilman Rollers
2. Racks and ancillaries on SiD or on a side platforms (location driven by the the fringe field)
3. Cold Box off detector (in the hall)
4. Flexible cryogenic transfer line (100mm OD) Solenoid-Cold box
5. He compressors remote

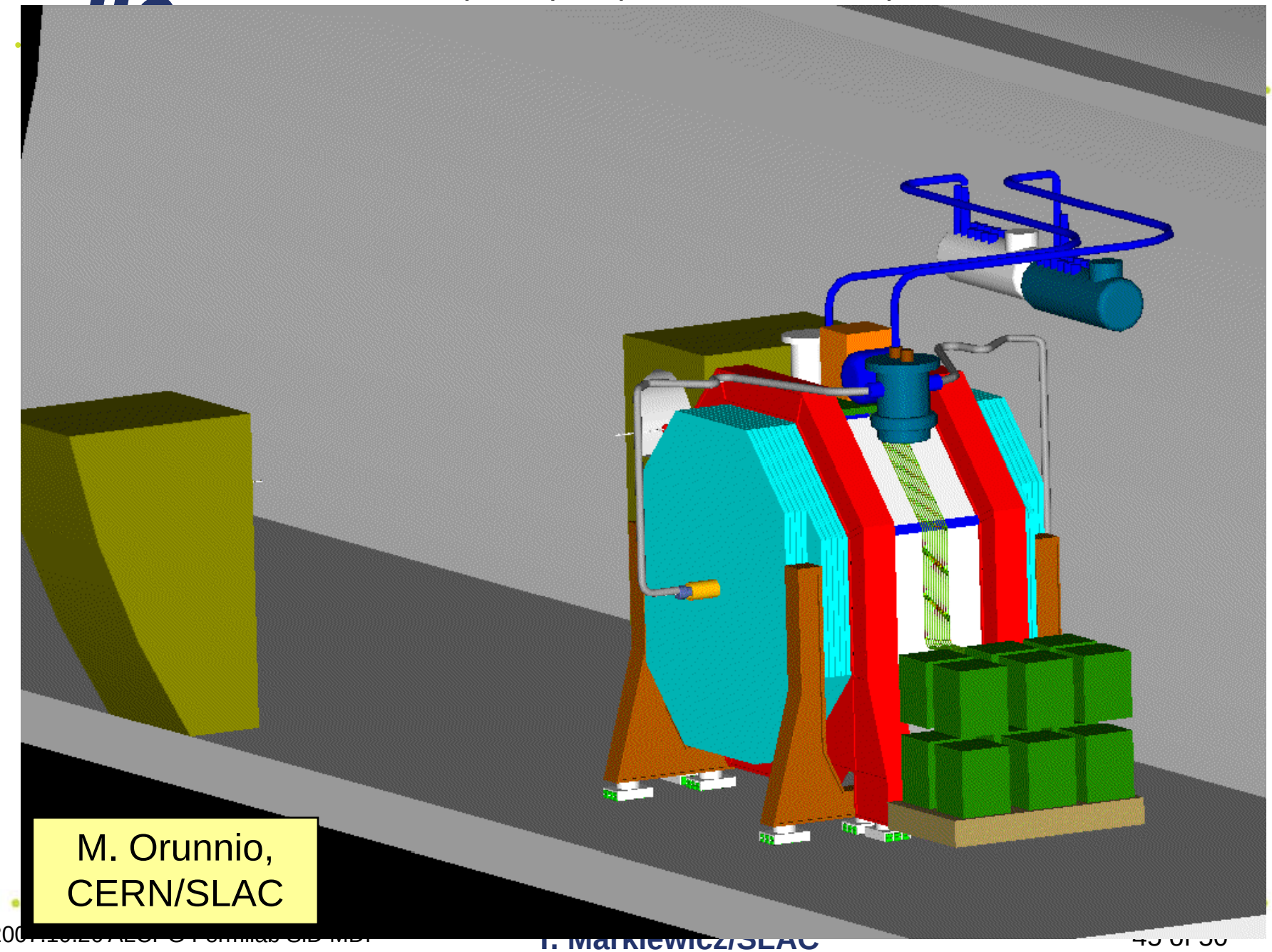
M. Orunnio, CERN/SLAC



# SiD closed on the beam



# SiD push-pull (30 meters stroke )



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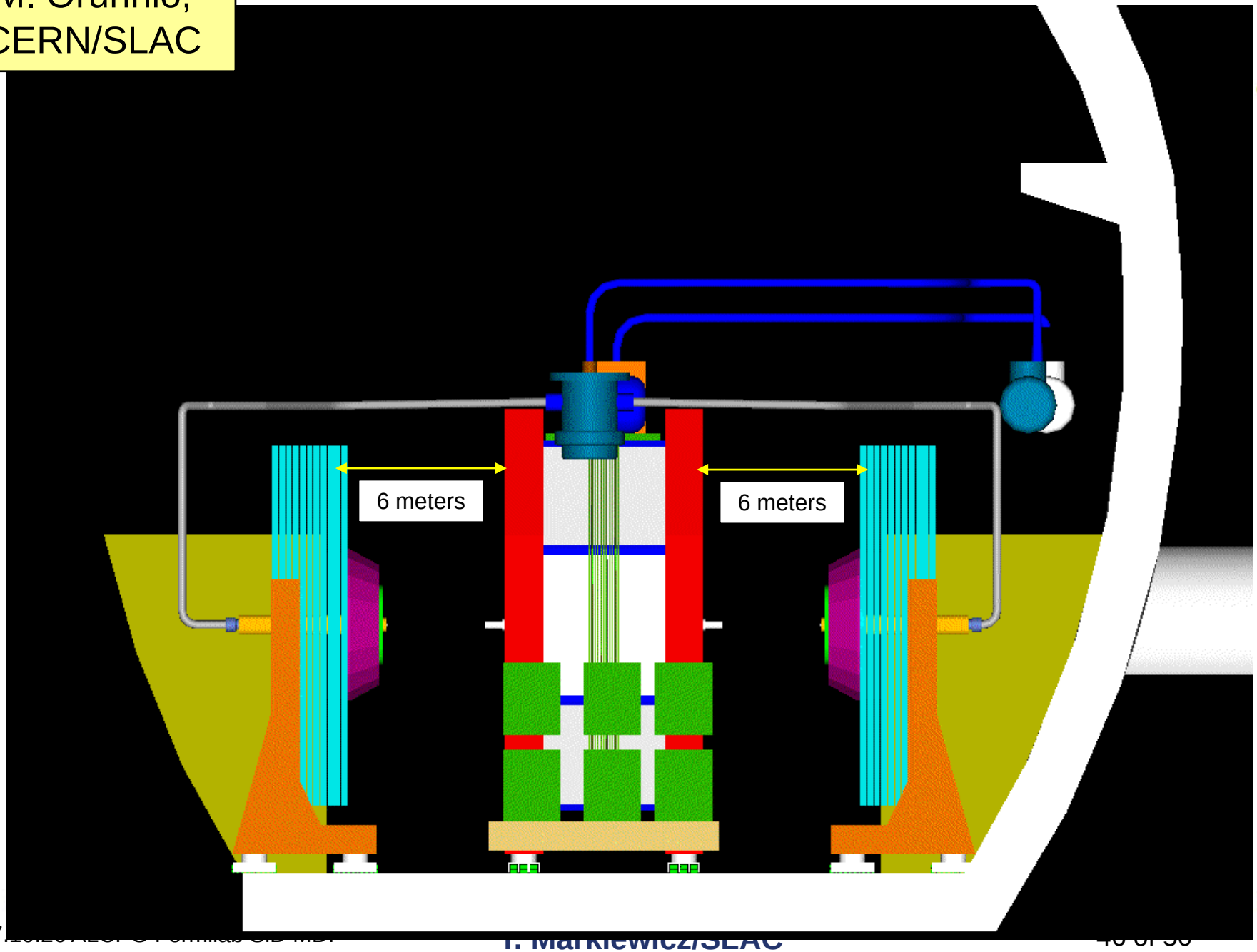
SiD opening @ 6 m off the beam



# Summary of Push Pull & Surface Assembly Aspects of MDI

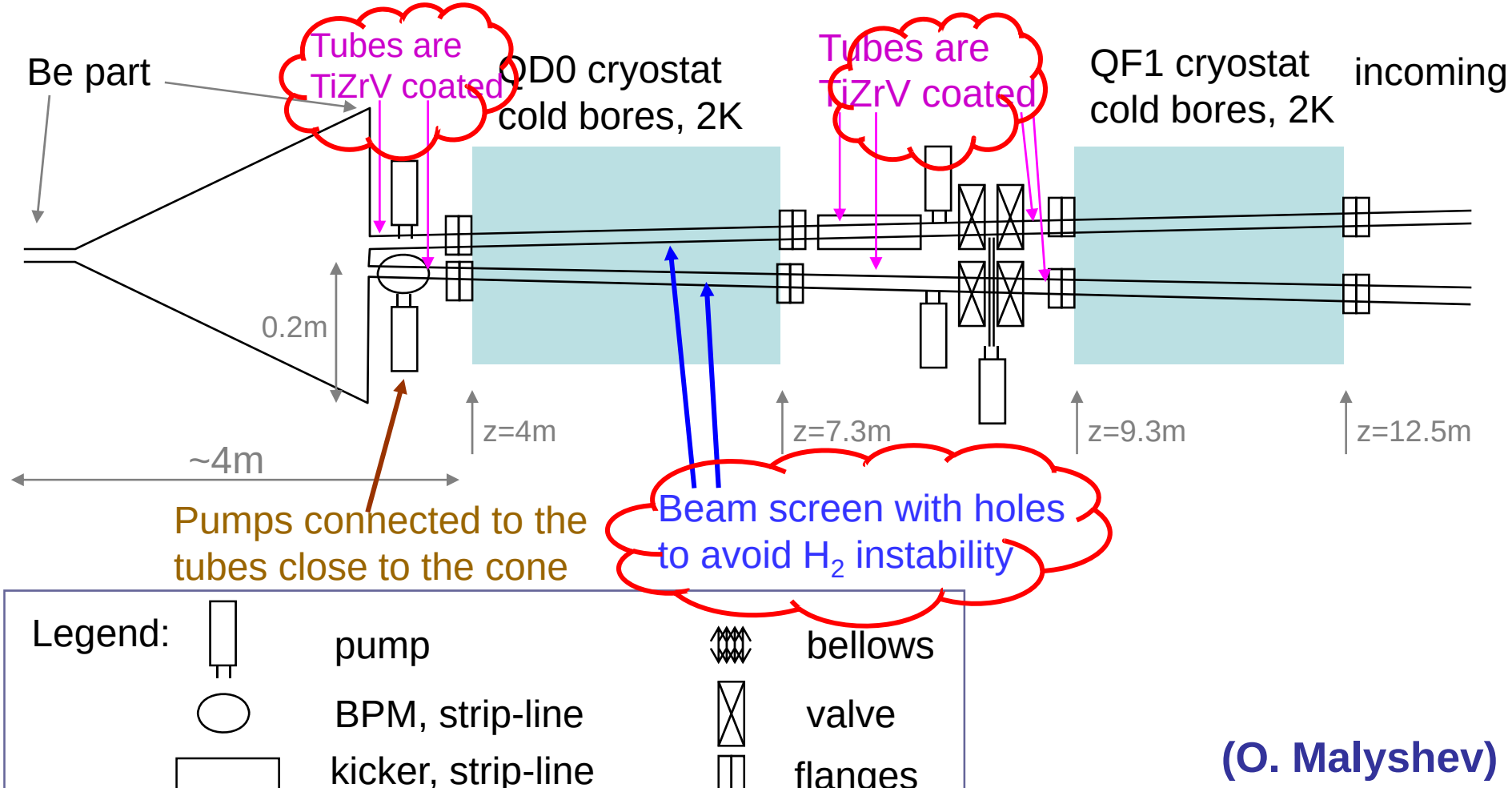
- GLDc and LDC have similar designs with similar crane/shaft requirements wherein FCAL/mask/QDO package supported in a tube off cantilevered off a pillar to ground (or platform)
- GLDc shows a moving platform while LDC says either platform or rollers would work
- SiD requires 2x gantry capacity for “CMS” surface assembly
  - **not convinced that non-CMS-like underground assembly is better**
  - **Feels (MIB at least) that platform is expensive solution germaine to CERN geology & LHC detector complexity**
- SiD FCAL/mask/QDO package supported in a spider or tube directly from doors
  - **Needs to address how z motion of support tube is controlled**

# Interface Issues

- 1st order self-consistent PACMAN shielding invoked by GLDc, LDC, SiD. However, engineering required
  - **To see underground crane capacity required**
    - GLDc shows 0.5m Fe / 2.0m concrete from r=0.5m
    - SiD shows 1.0m Fe/ 2.0m concrete from f=0.25m
    - Rad Phys calculation done for 0.5 m Fe / 2.0m Con from r=1.25m
  - **To understand where detector A to detector B PACMAN interface occurs**
  - **To understand how to remove detector A specific PACMAN shielding "trapped" on detector B side of the beamline**
    - Hinged to the doors of detector A?
- Platform A, platform B, Floor, detector A, detector B interfaces
  - **If "A" needs/desires moving platform solution, must "B" adopt as well**

# IR Vacuum_12: Potential Big Deal

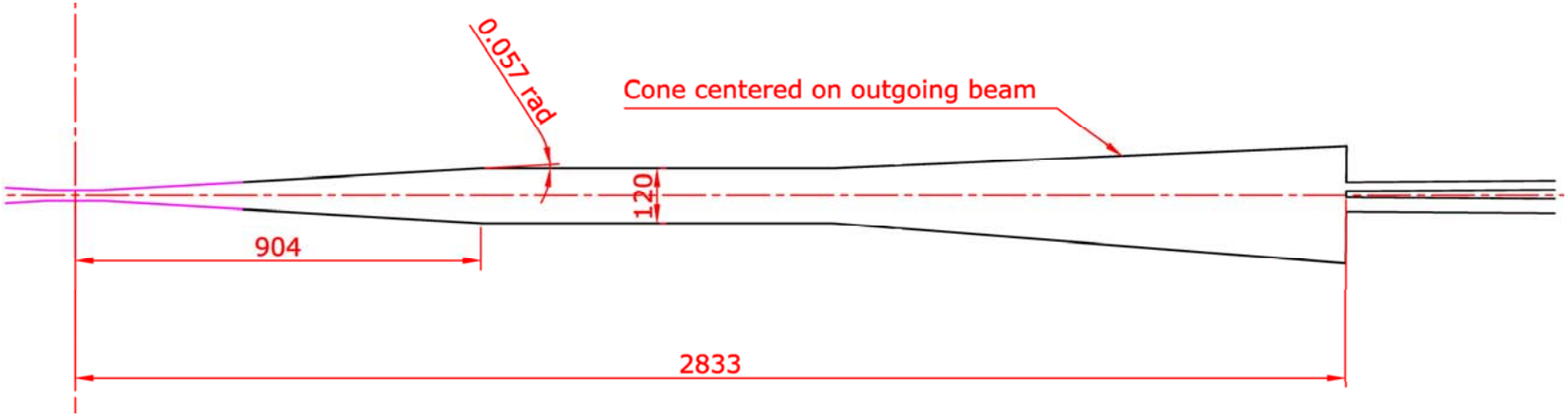
- Solution 2




**(O. Malyshev)**

# Beam Pipe Fabrication

- The present SiD design assumes stainless steel beyond Z = 759 mm.
  - **That allows more standard welding and fabrication techniques.**
  - **Beryllium to stainless transitions should be done by the fabricator of beryllium portions, but the stainless steel portions could be made by a different vendor.**
  - **Uriel Nauenberg has asked about the feasibility of using other materials (beryllium, aluminum) in the BeamCAL region; materials for that region are under discussion.**






**T. Markiewicz/SLAC**

W. Cooper, FNAL

# SiD MDI Recommendations

- Don't worry about BDS costs
  - **Embrace IRENG'07 shaft/support model**
  - **Insist on one gantry sized to lower loaded SiD barrel**
  - **Assume sliding platform for push-pull**
- Adopt same cantilevered support tube + fixed pillar as GLDc/LDC
- Size radius of support tube from ~20cm to ~30cm for the 390mm QD0 cryostat diameter and incorporate Knut Skarpaas 2000 design of cam + piezo mover system.
- Resize LumiCAL for this radius and develop an optimized design which accounts for increased mass of lumical, FHCAL, BEamcal, shielding, beampipe shape, electronics, and service pipe/cable ways
  - **Decide whether FCAL package shares QD0 mover system or not**