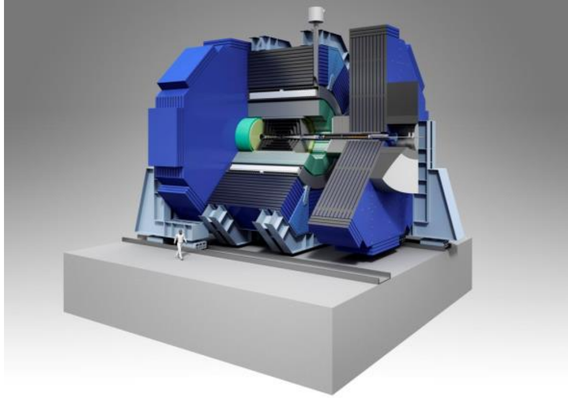


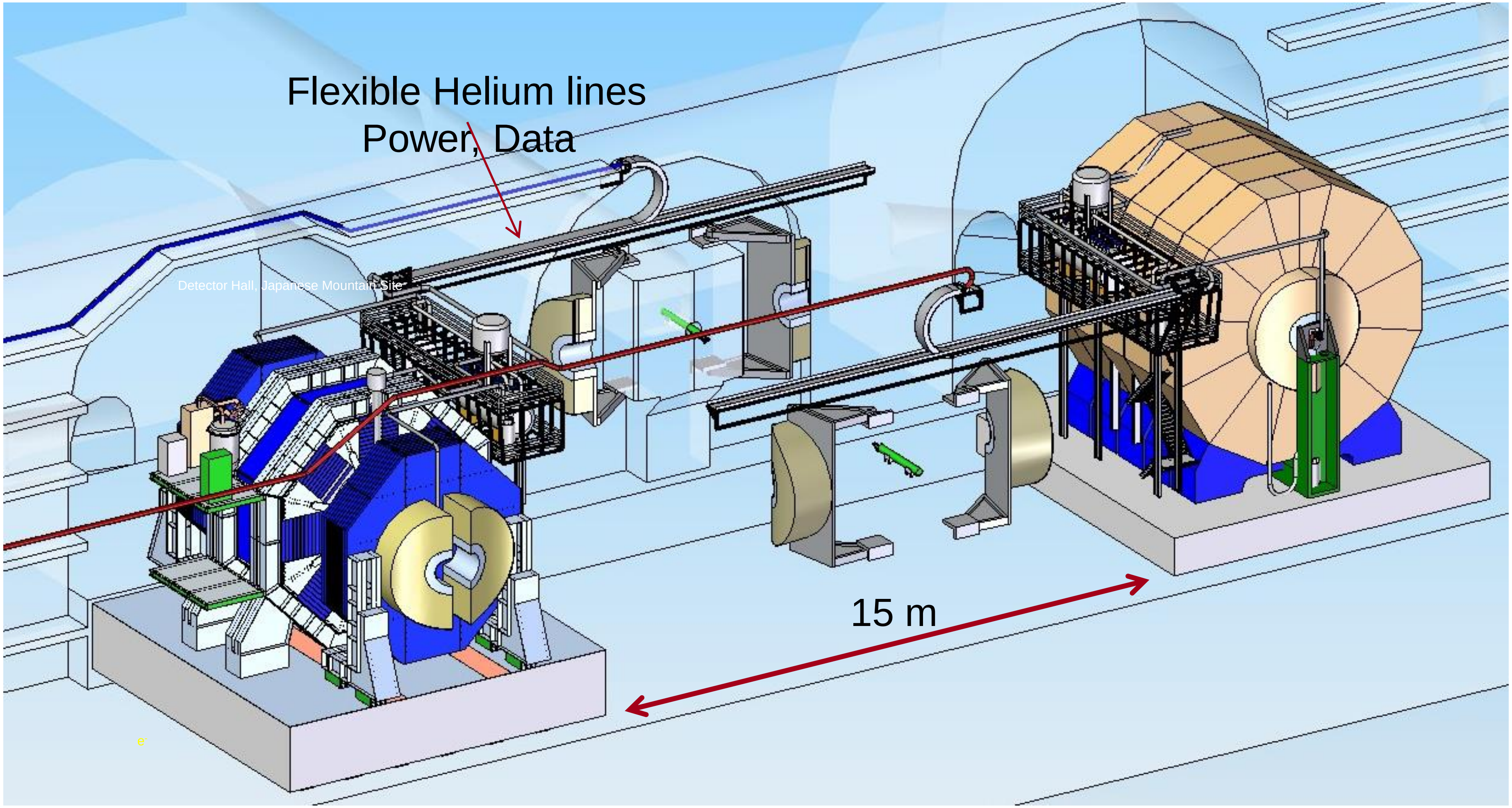
SID Opening

Marco Oriunno, Oct. 14 2021

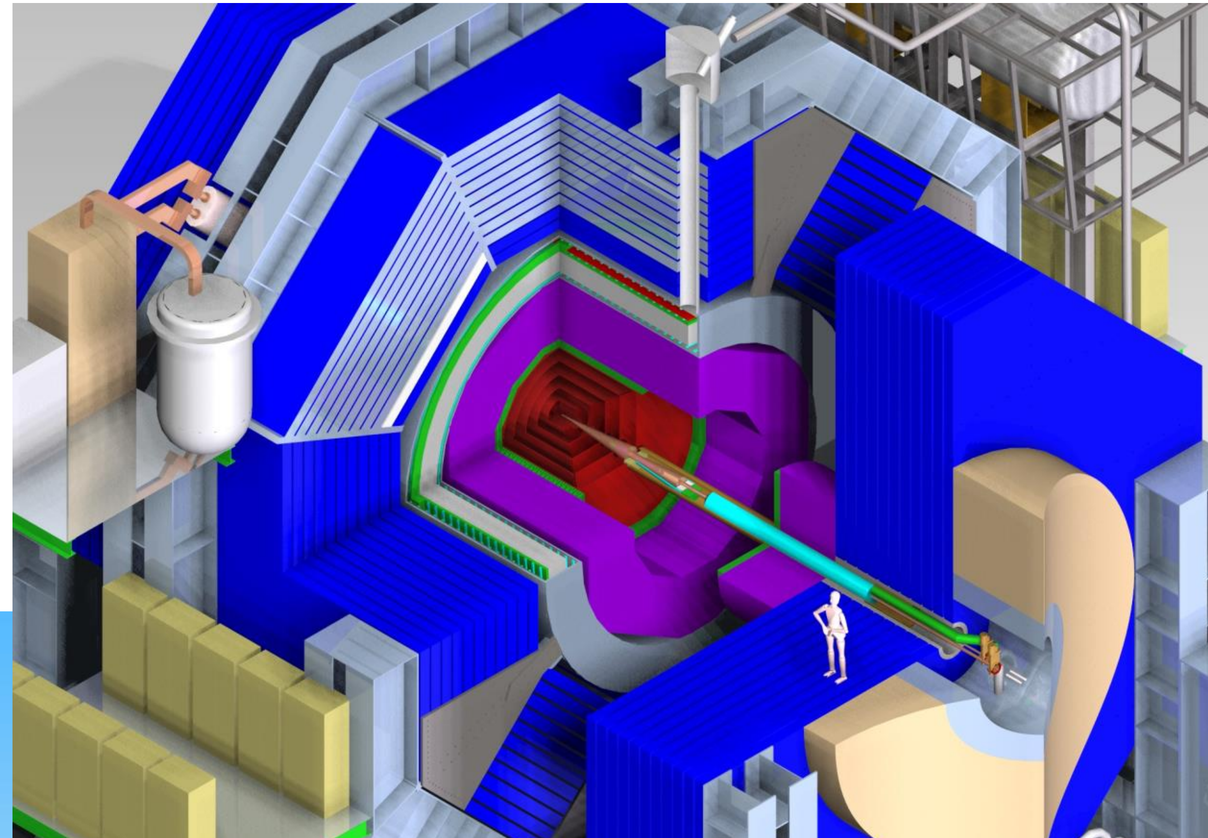
U.S. DEPARTMENT OF ENERGY
Office of Science

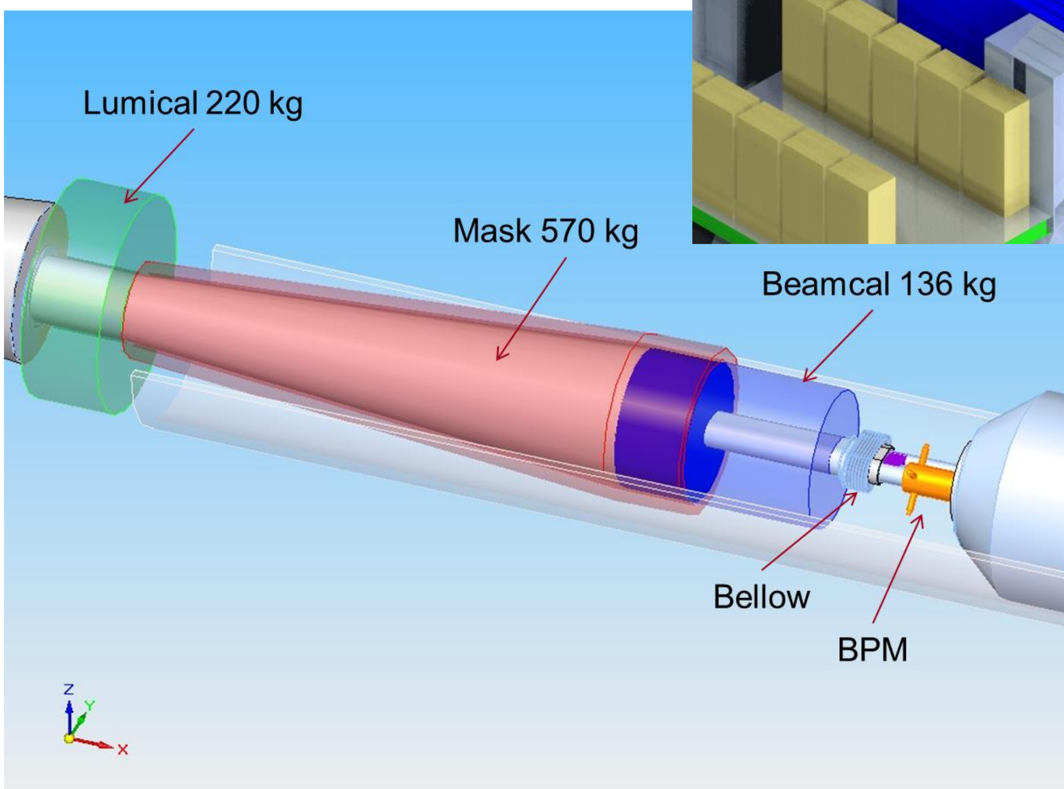
SLAC NATIONAL ACCELERATOR LABORATORY

Push-Pull : Engineering Concept



Platform on Rollers

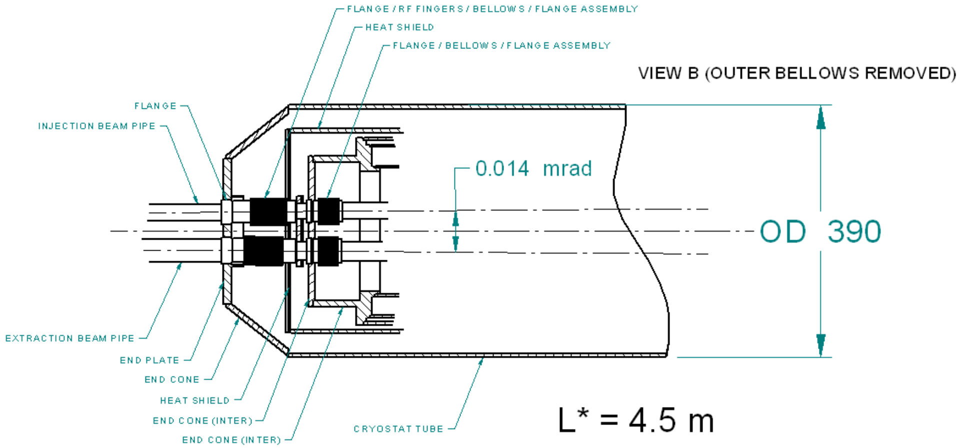




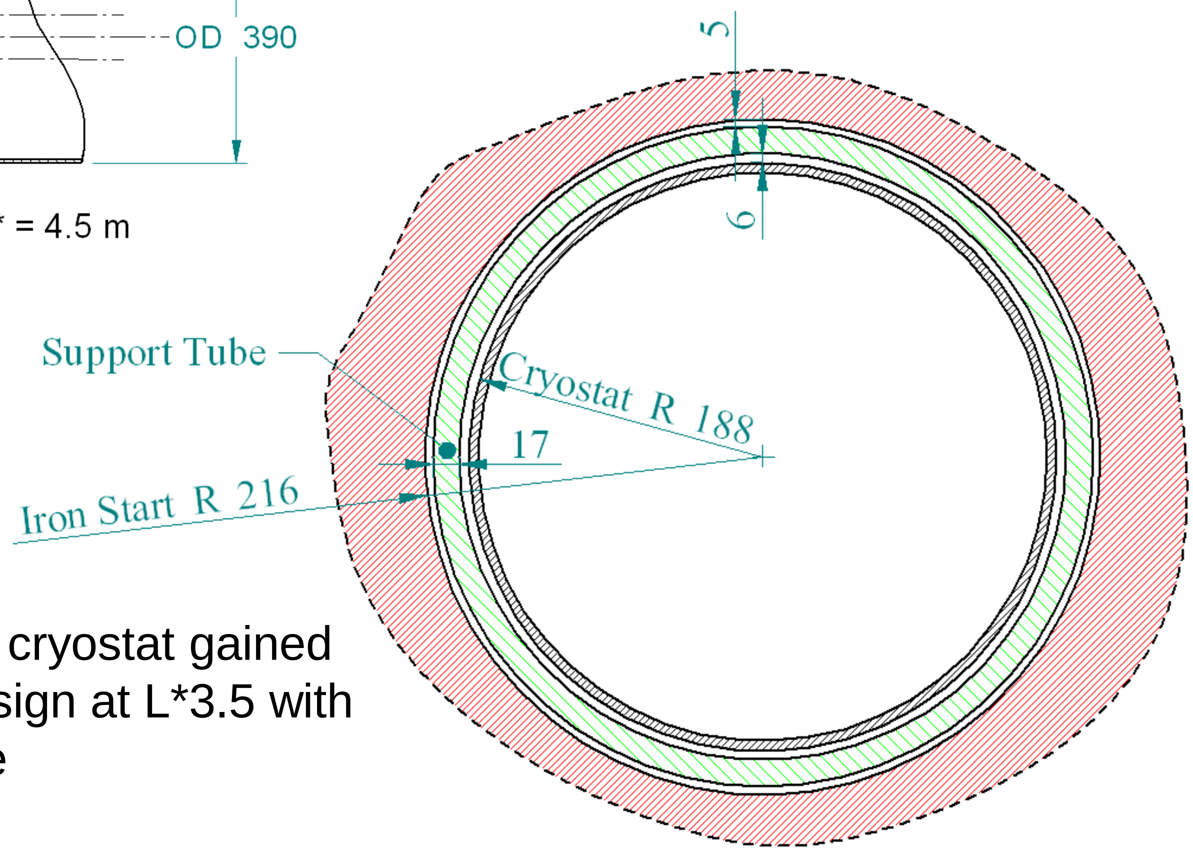
Lumical 220 kg
Mask 570 kg
Beamcal 136 kg
Bellow
BPM
Z
Y
X

Space Requirements

Current QD0 Prototype is designed for L* 4.5 m



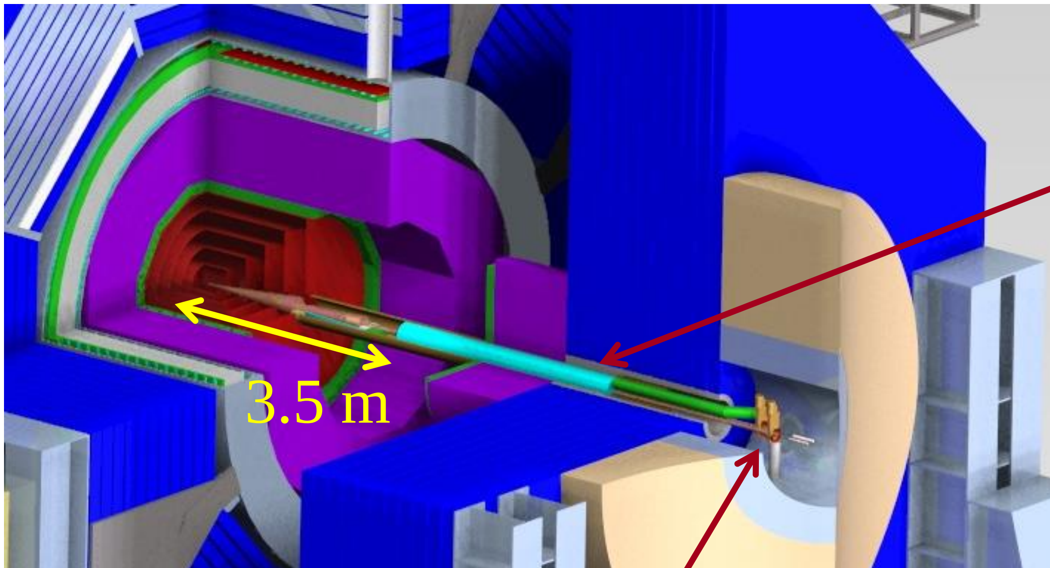
L* = 4.5 m

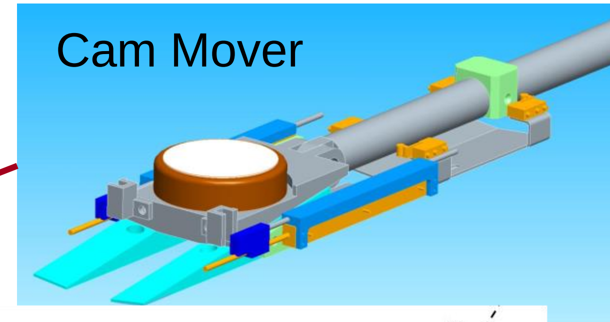


14 mm reduction of the QD0 cryostat gained moving the present QDO design at L*3.5 with the 14mrad crossing scheme
(1 m x 14 mrad = 14 mm)

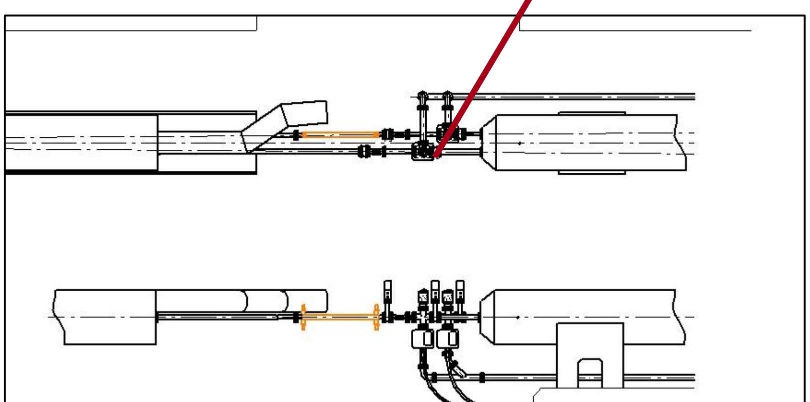
L* 3.5 m cross section

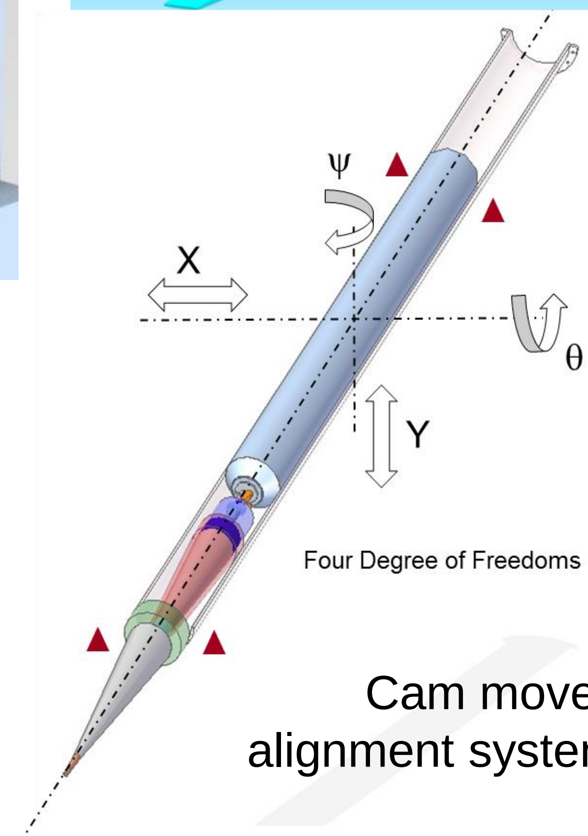
Final Focus System captured in the detector, short L*





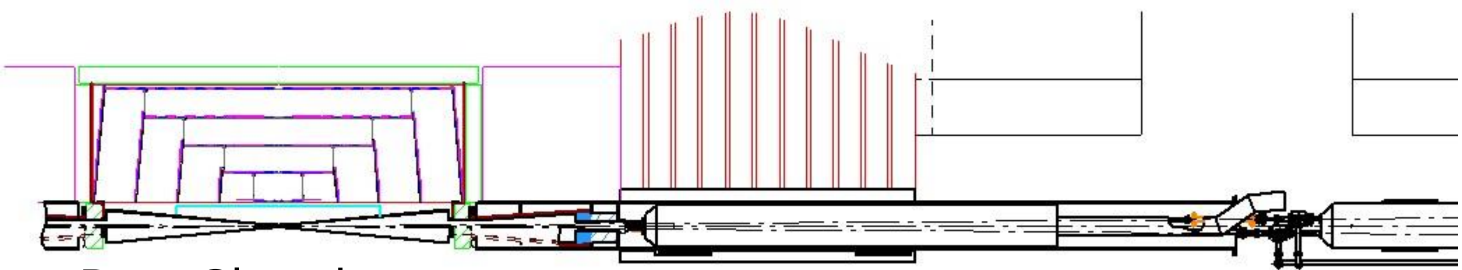
Fast Vacuum Interconnection for the Push-Pull





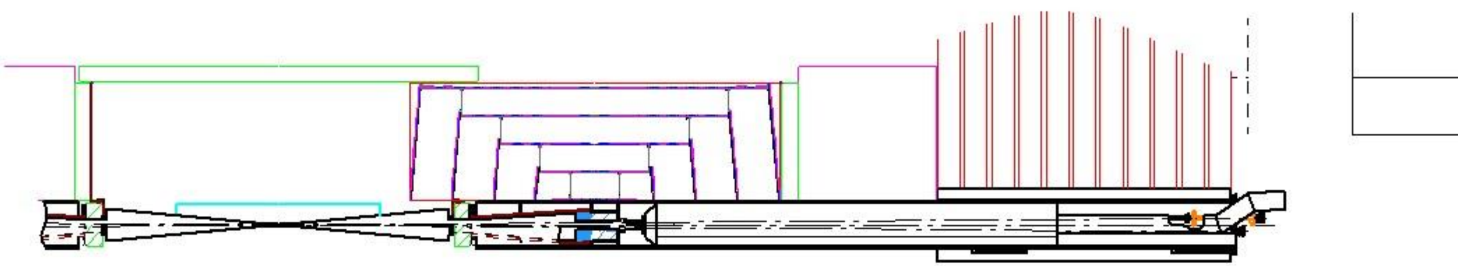
Cam movers
alignment system ~5um

Forward Region Diameter – Tracker maintenance



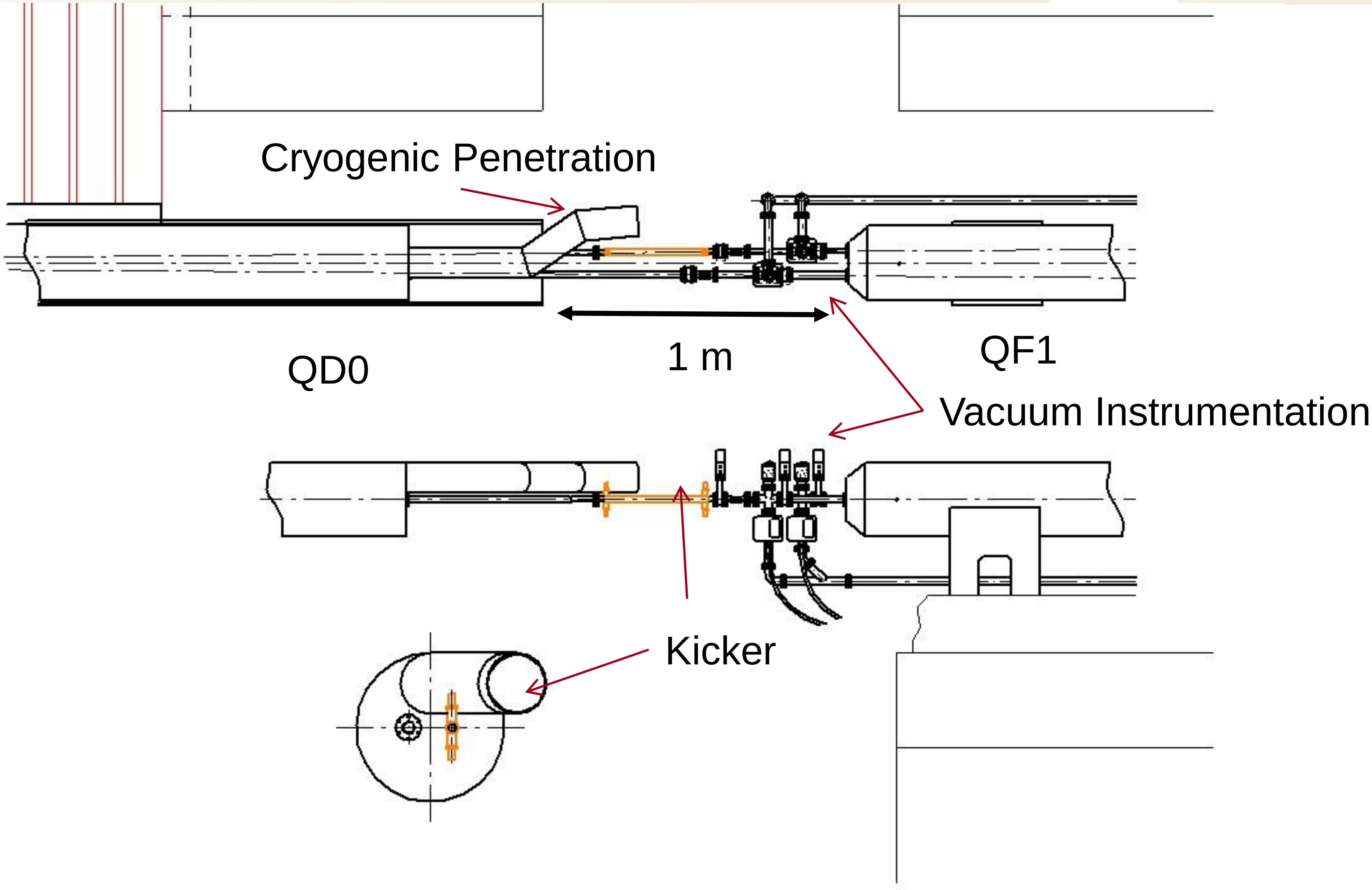
Door Closed

Door 2 m Open (On the beam line)



Door 3 m Open (Garage)

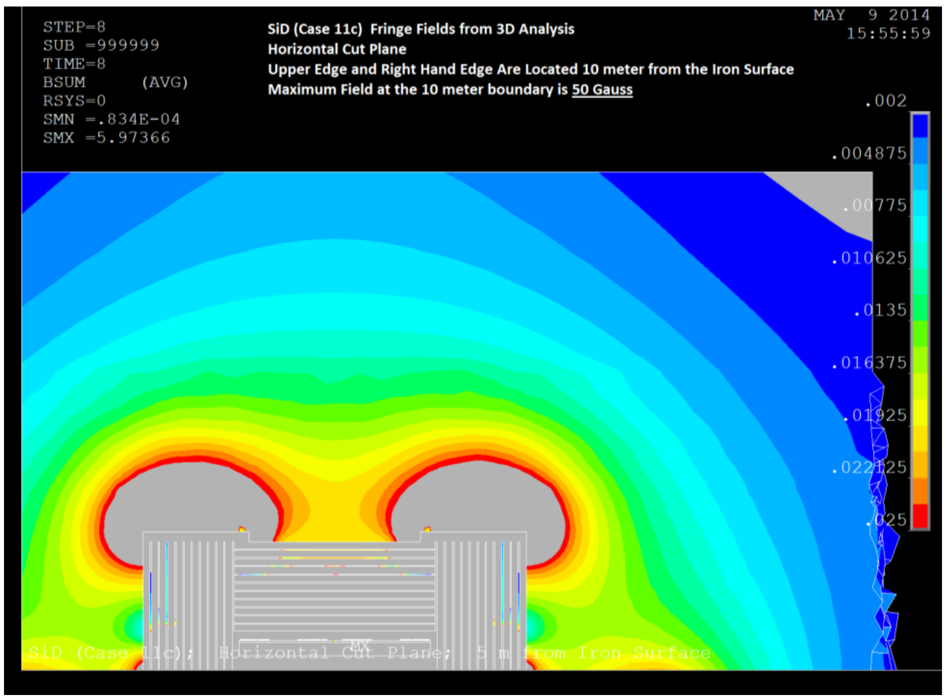
Interface QD0-QF1: Critical for Fast&Reliable Push-Pulls



Self Shielding – Magnetic Field and Radiation

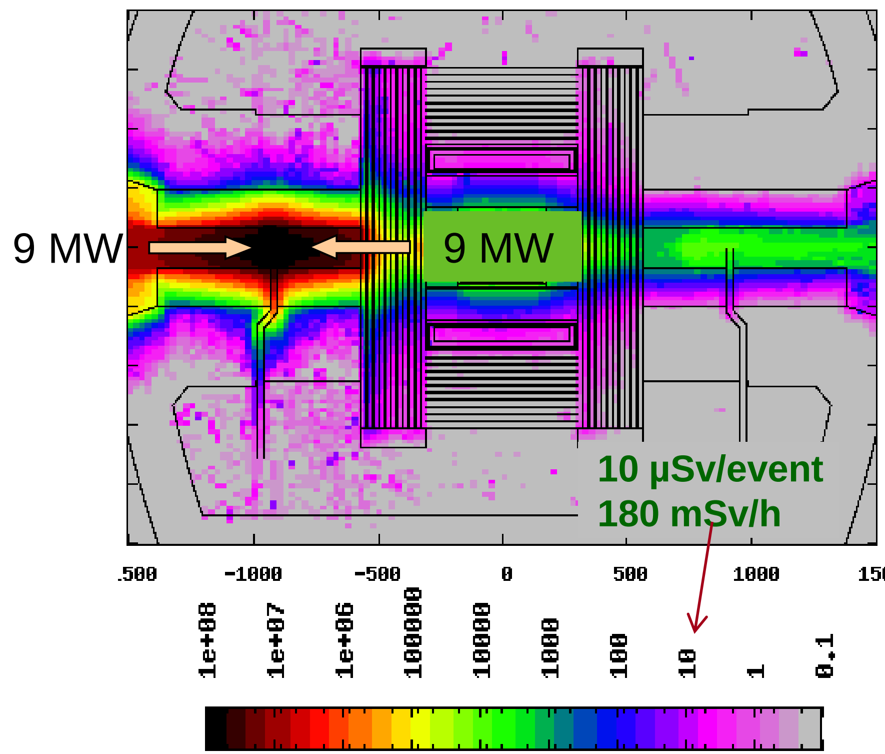
SLAC

1. Exposure limits to static magnetic field fixed by Local Authorities, 2T head, 8T limbs
2. Max. field set by not requiring special handling for tools ~50 gauss@15 meters
3. Max. radiation exposure, 10uSv/event or 180 mSv/h

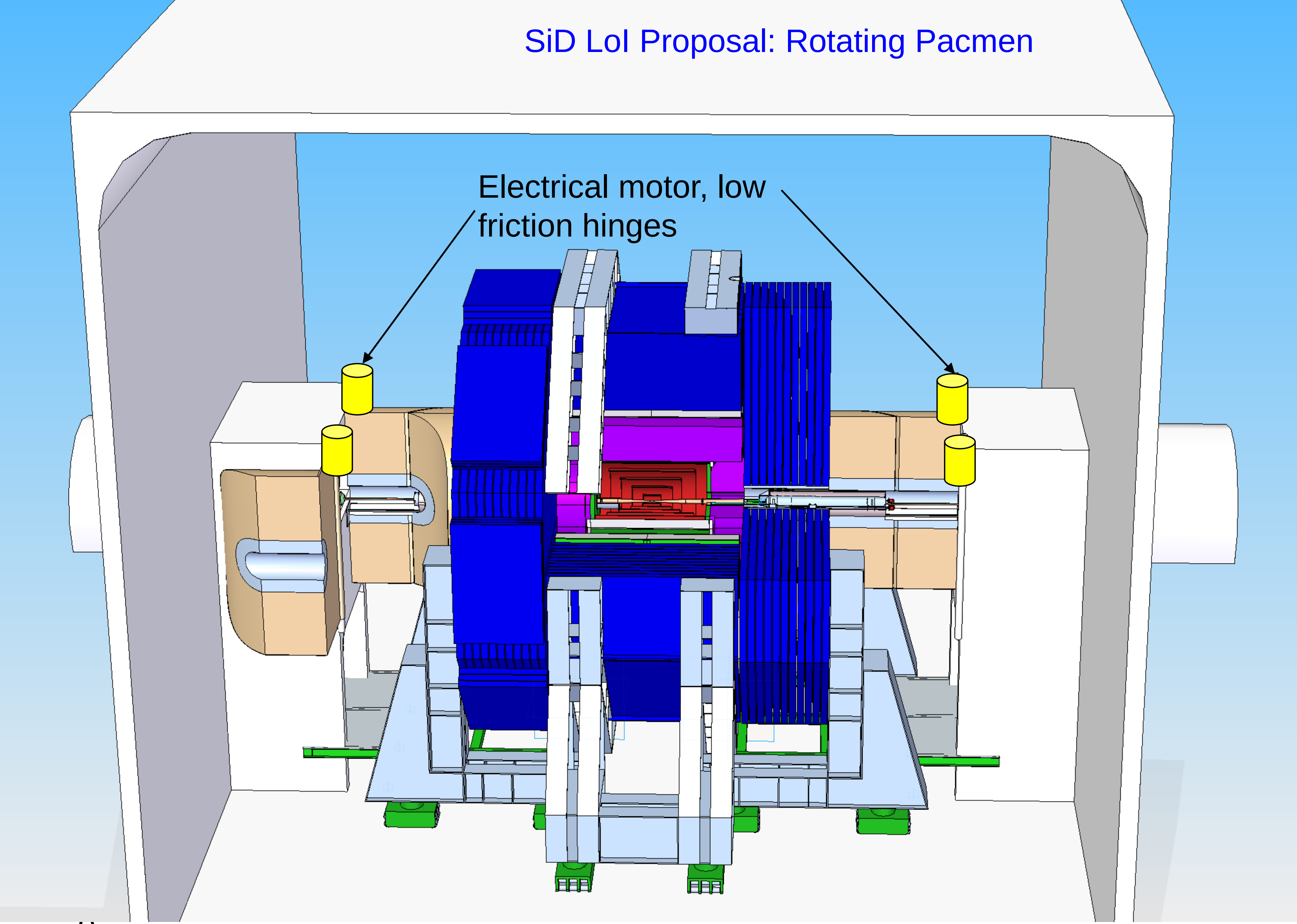


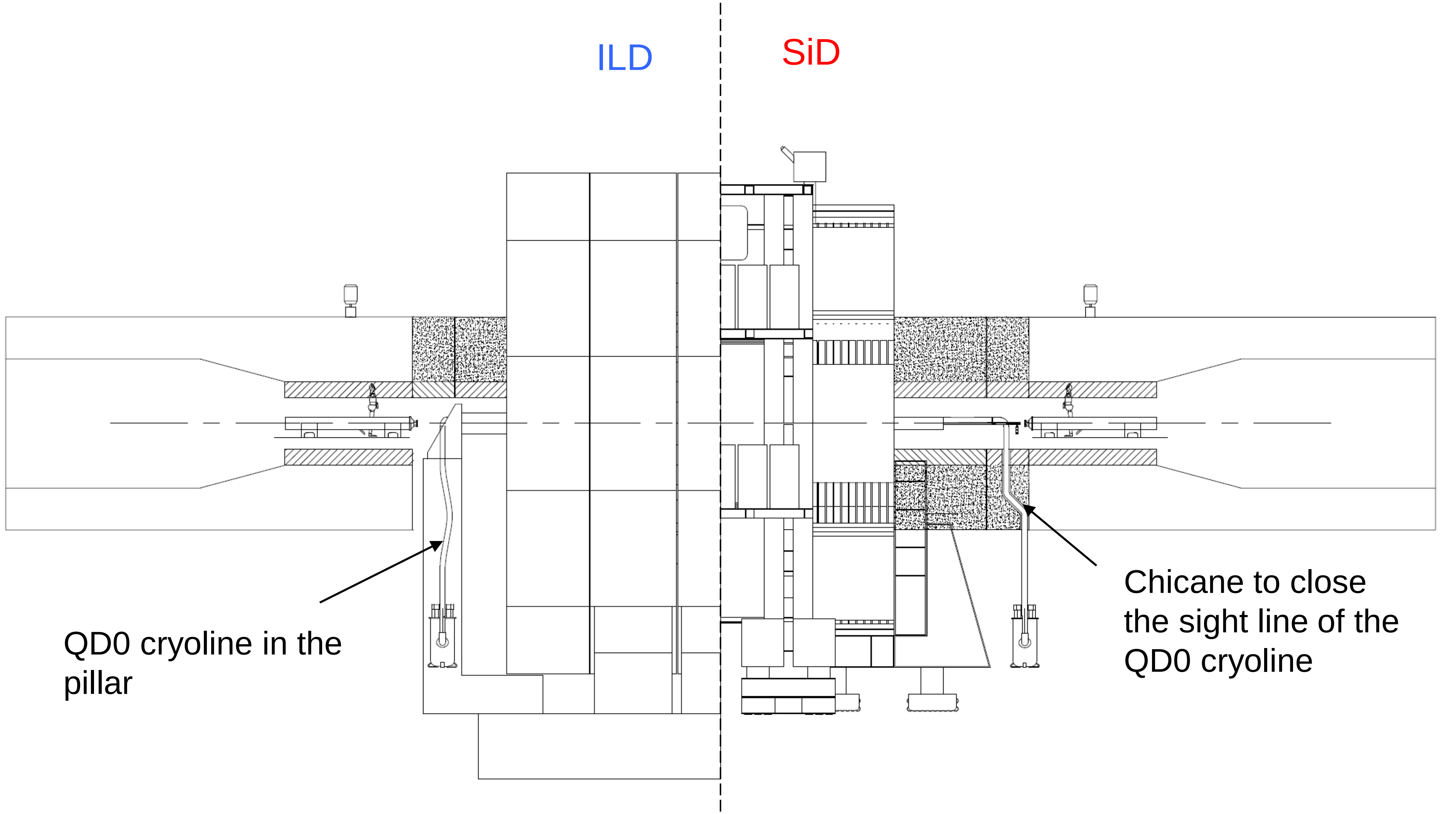
SID Fringe Field, < 50 gauss at15m

Full Train Loss 9+9 Mw on 20Xo Copper

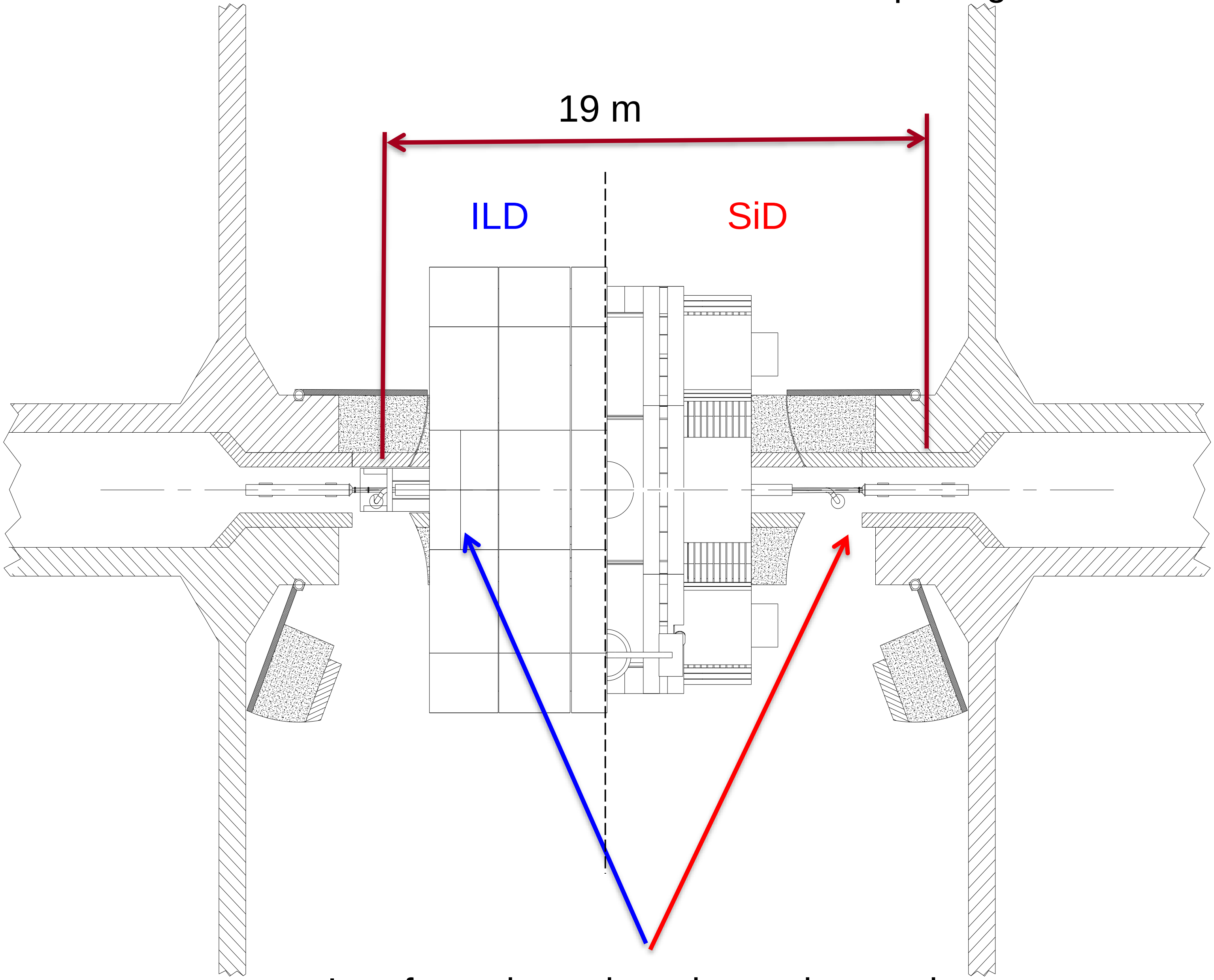


SiD LoI Proposal: Rotating Pacmen



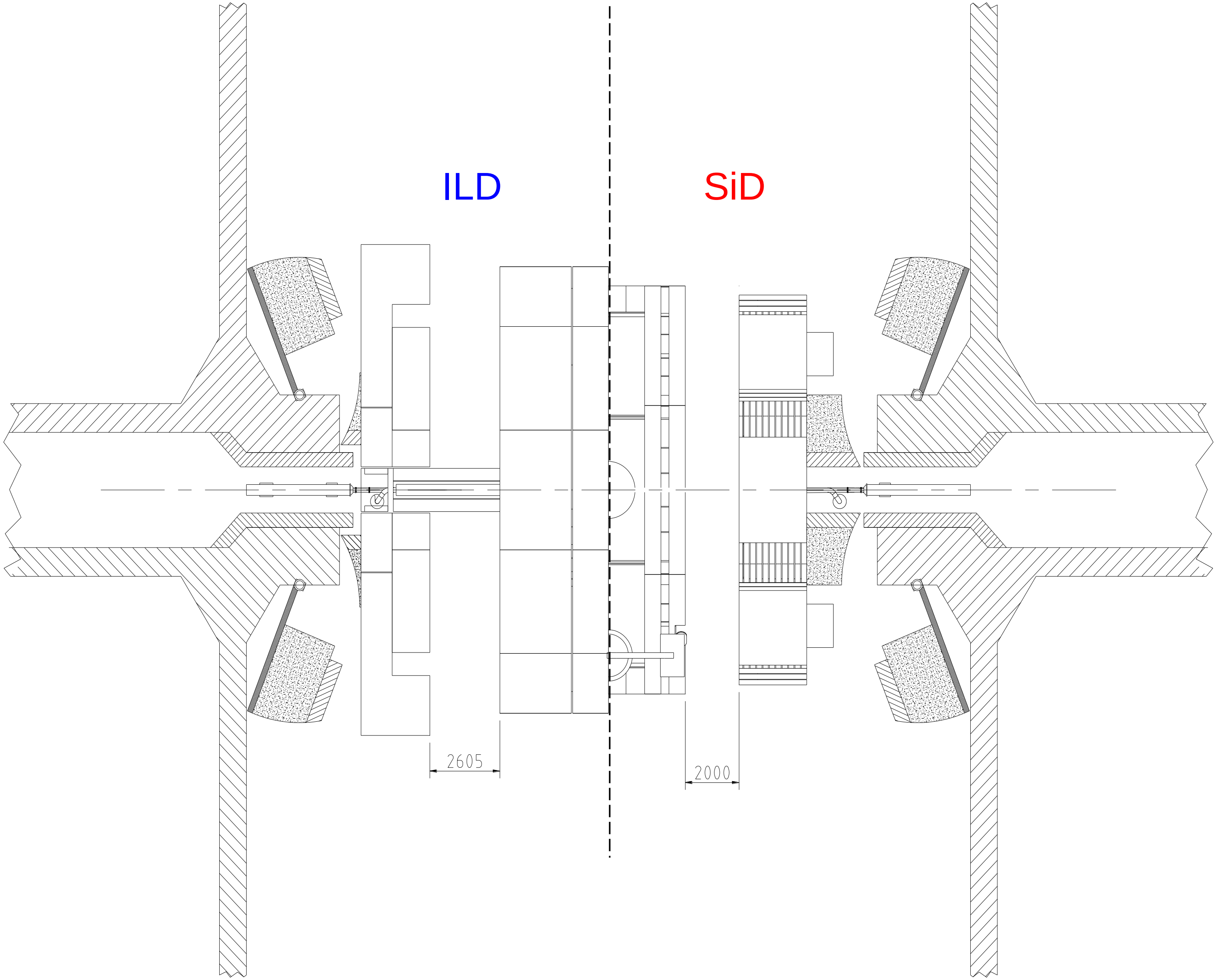

ILD
SiD
QD0 cryoline in the pillar
Chicane to close the sight line of the QD0 cryoline

Pacmen closed: Modified to allow ILD opening

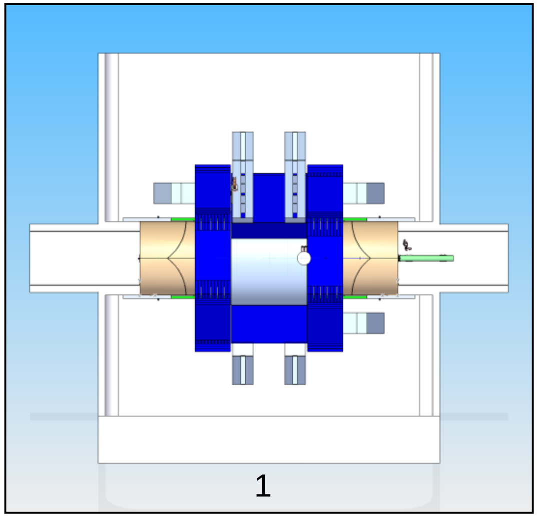


Interface pieces born by each experiment

Pacmen open



SiD opening on the beam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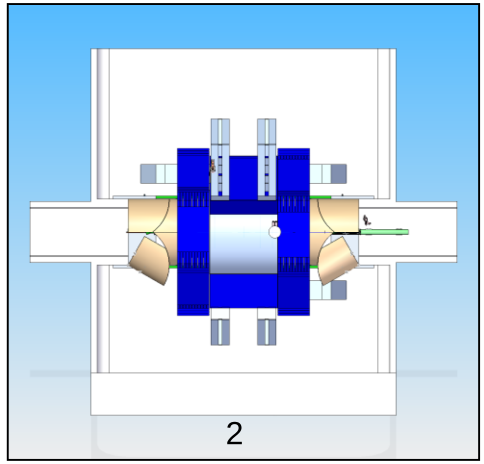
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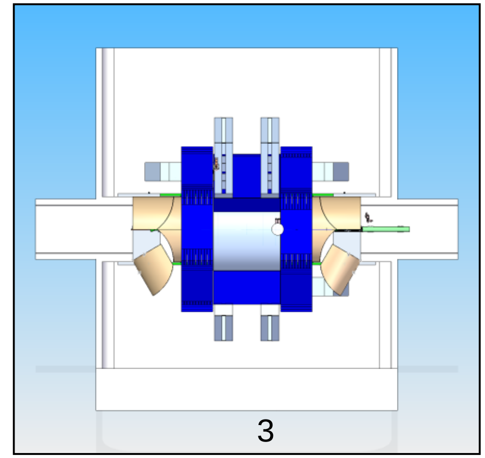
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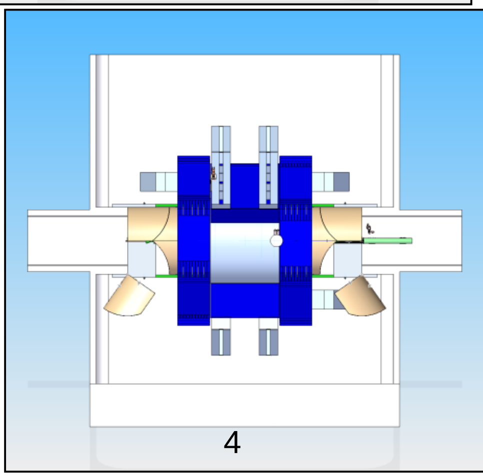
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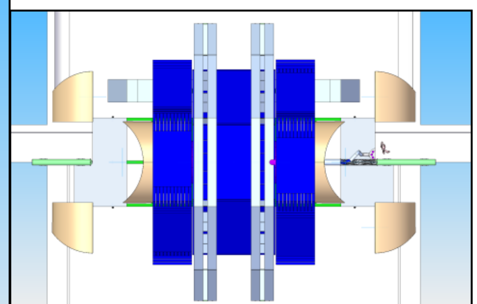
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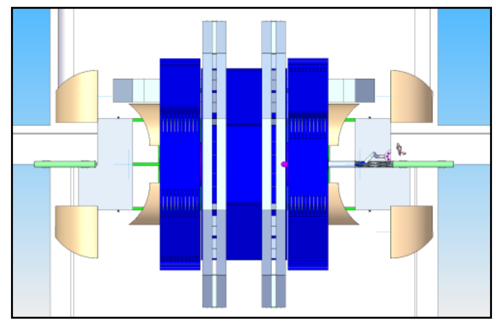
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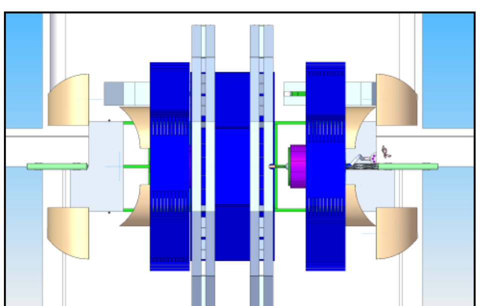
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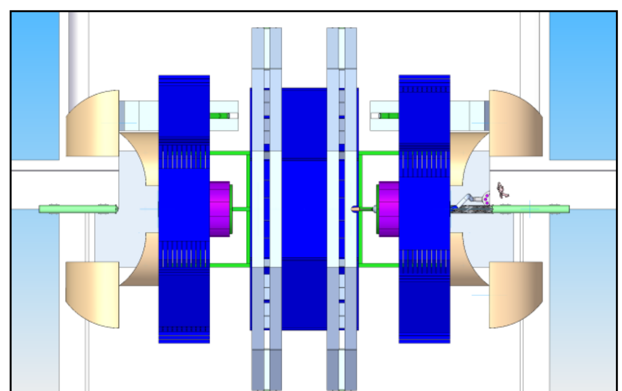
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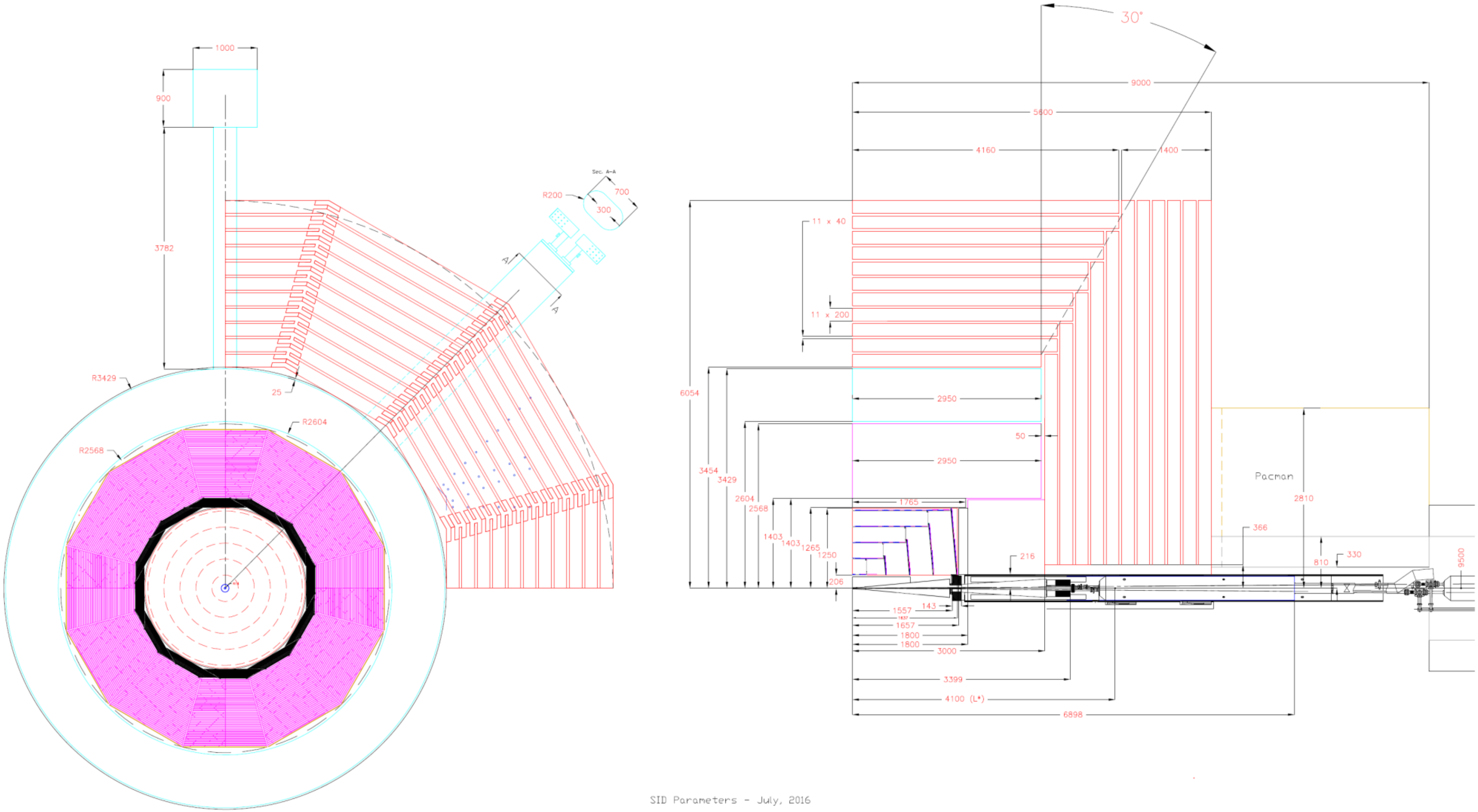
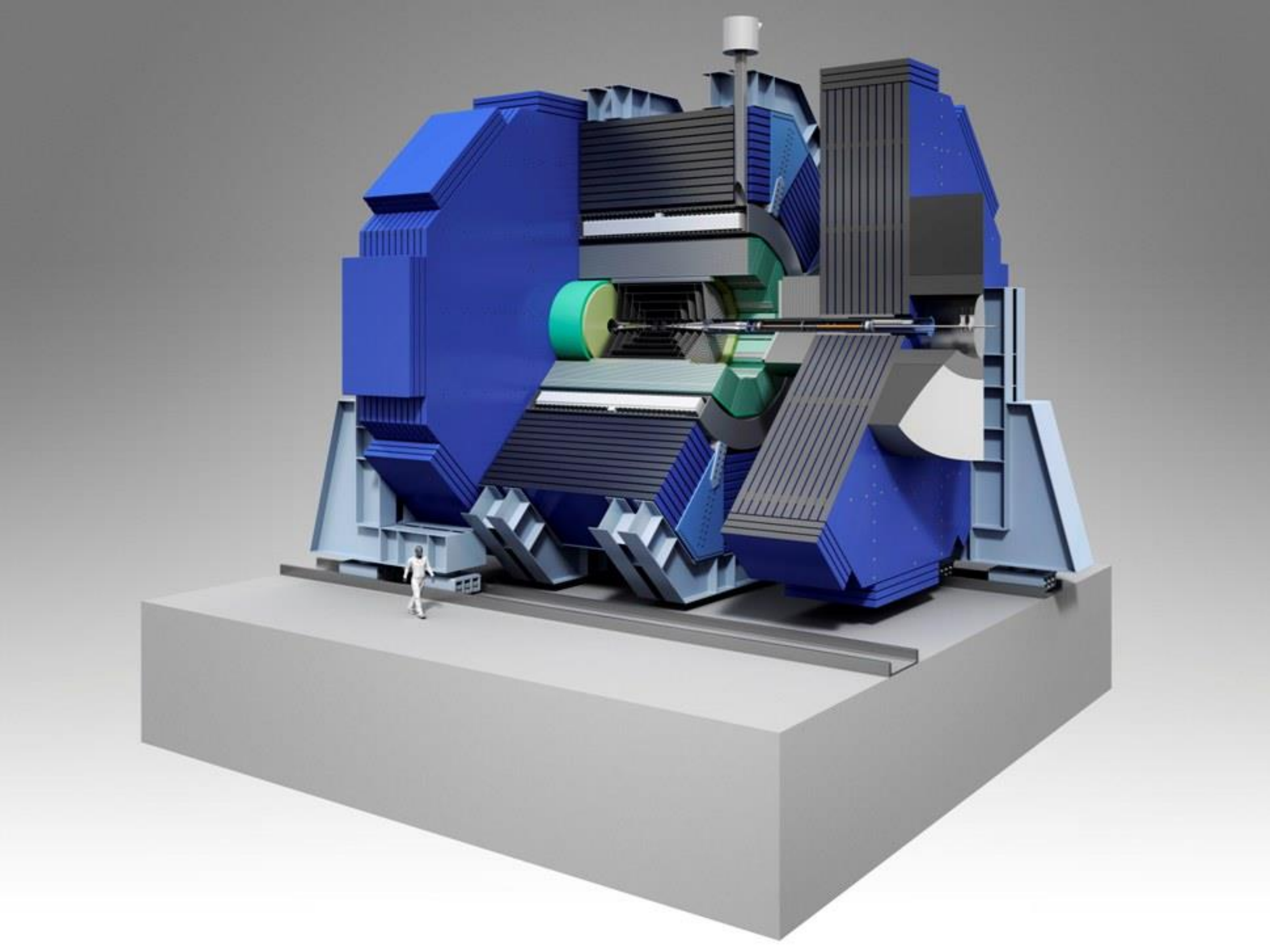
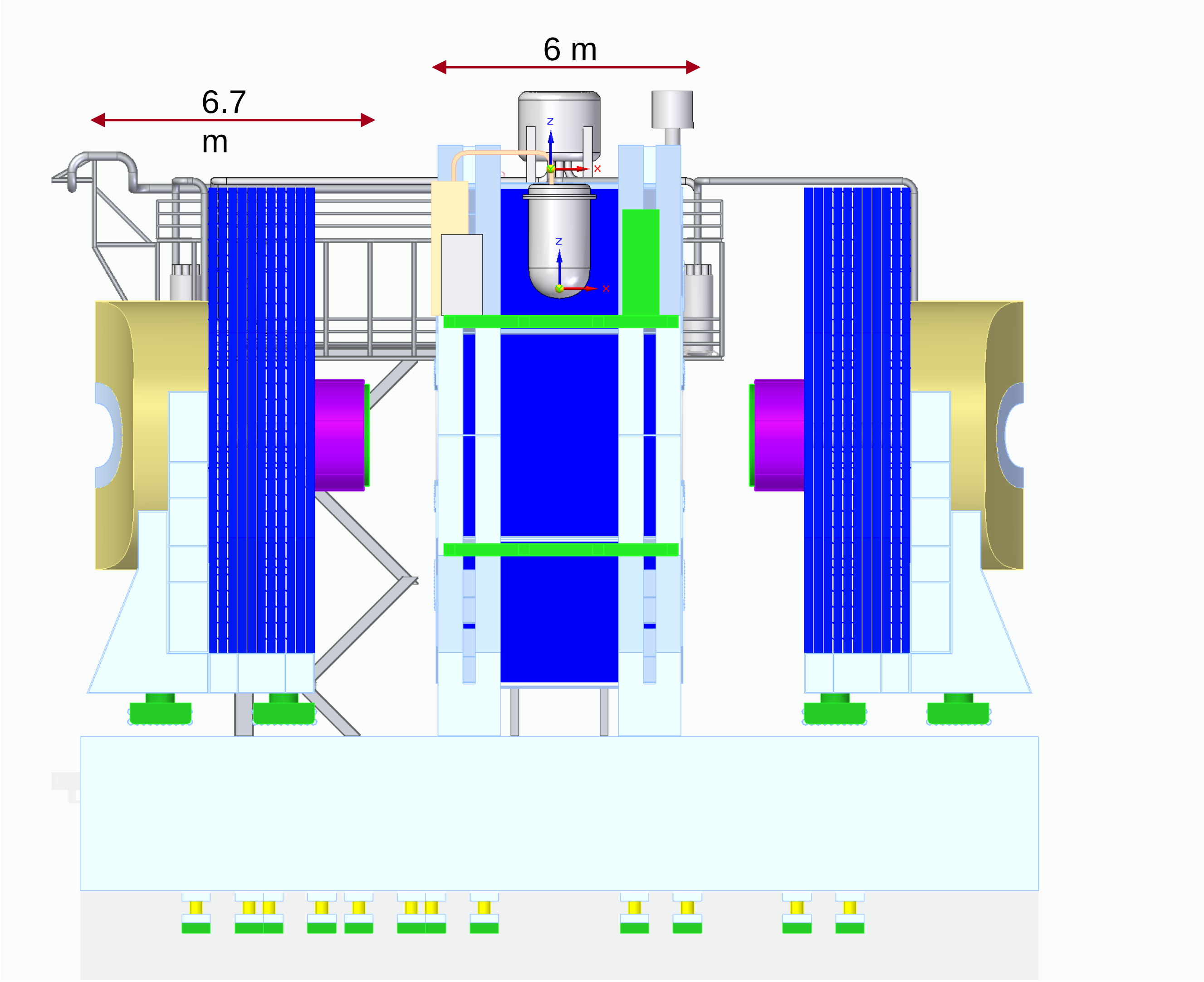
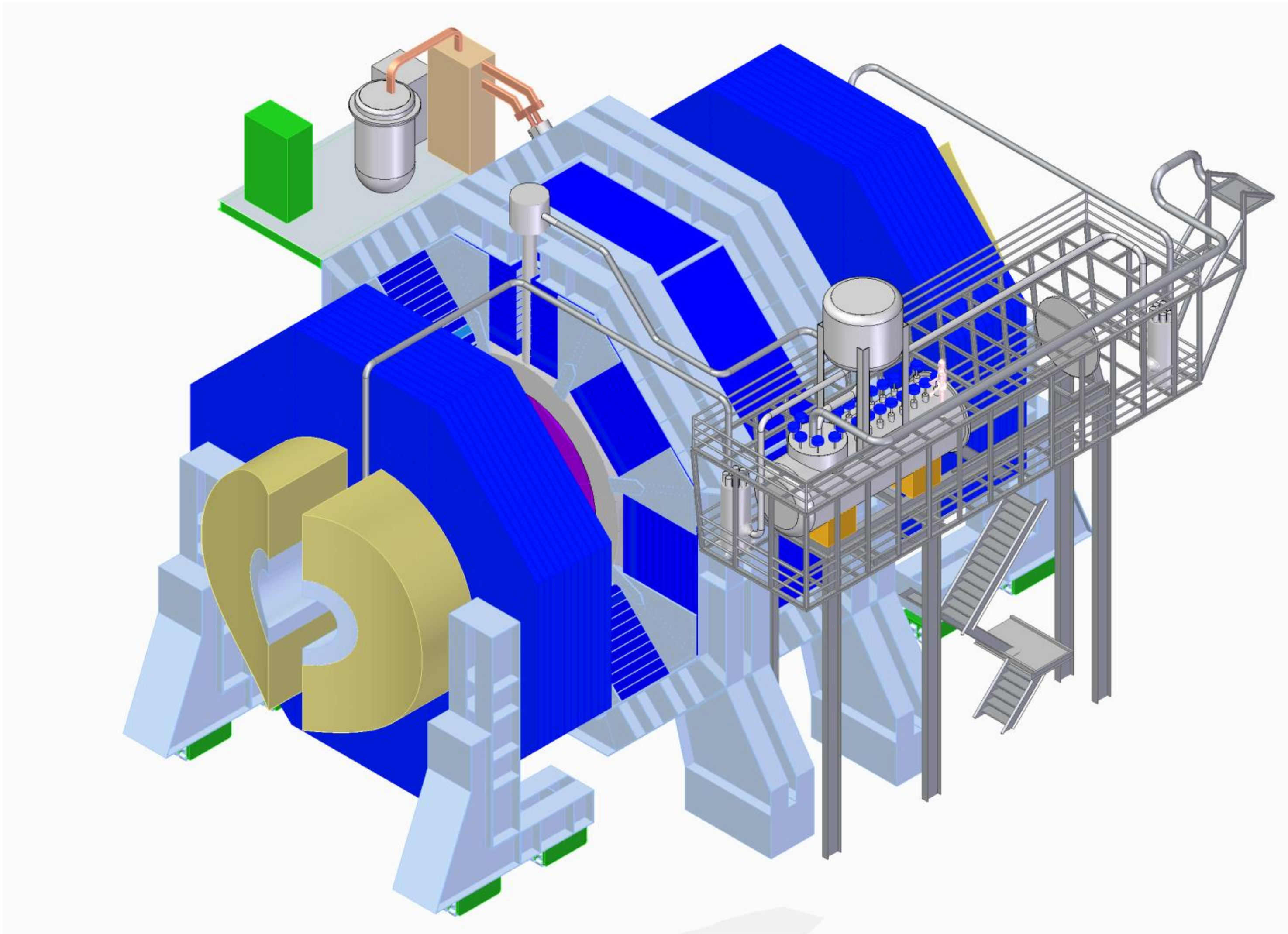


SID Parameters - July, 2016





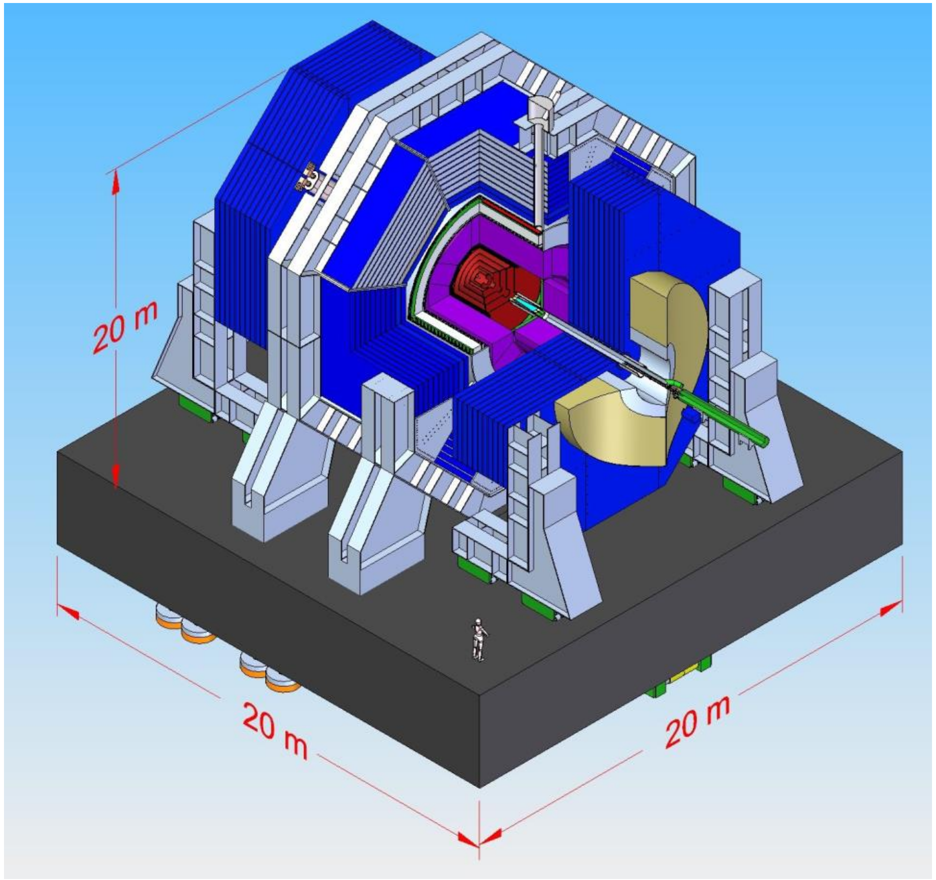
6 m
6.7
m

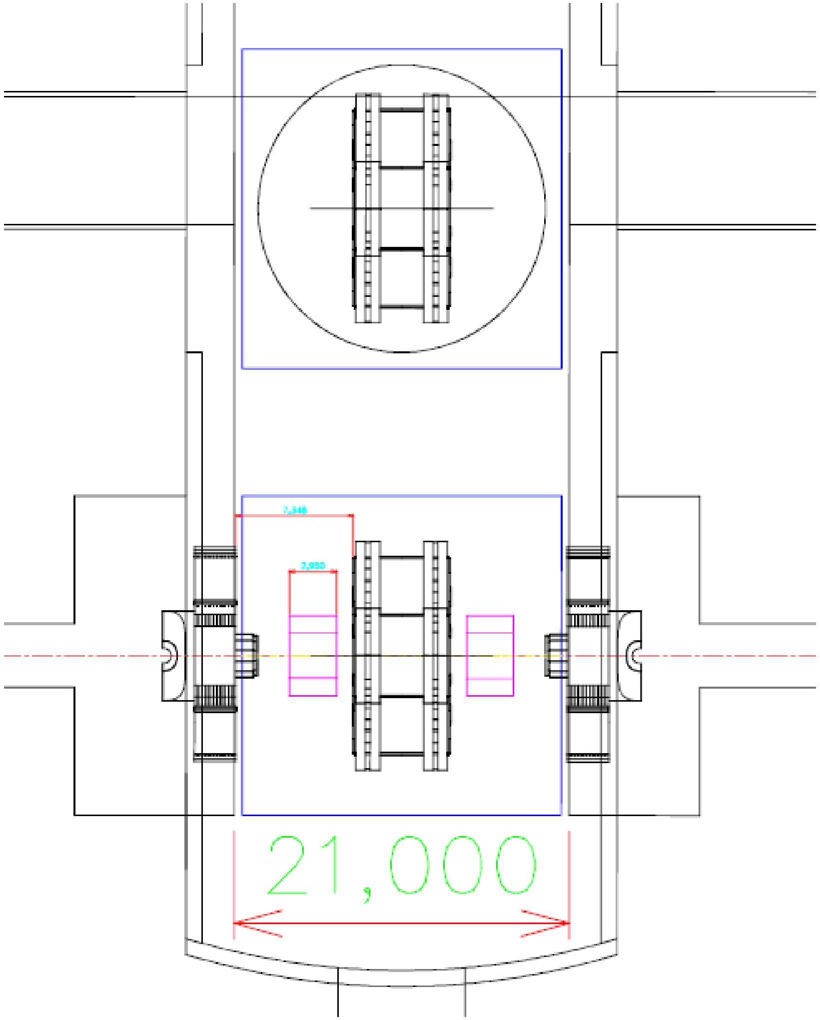


SPARE SLIDES

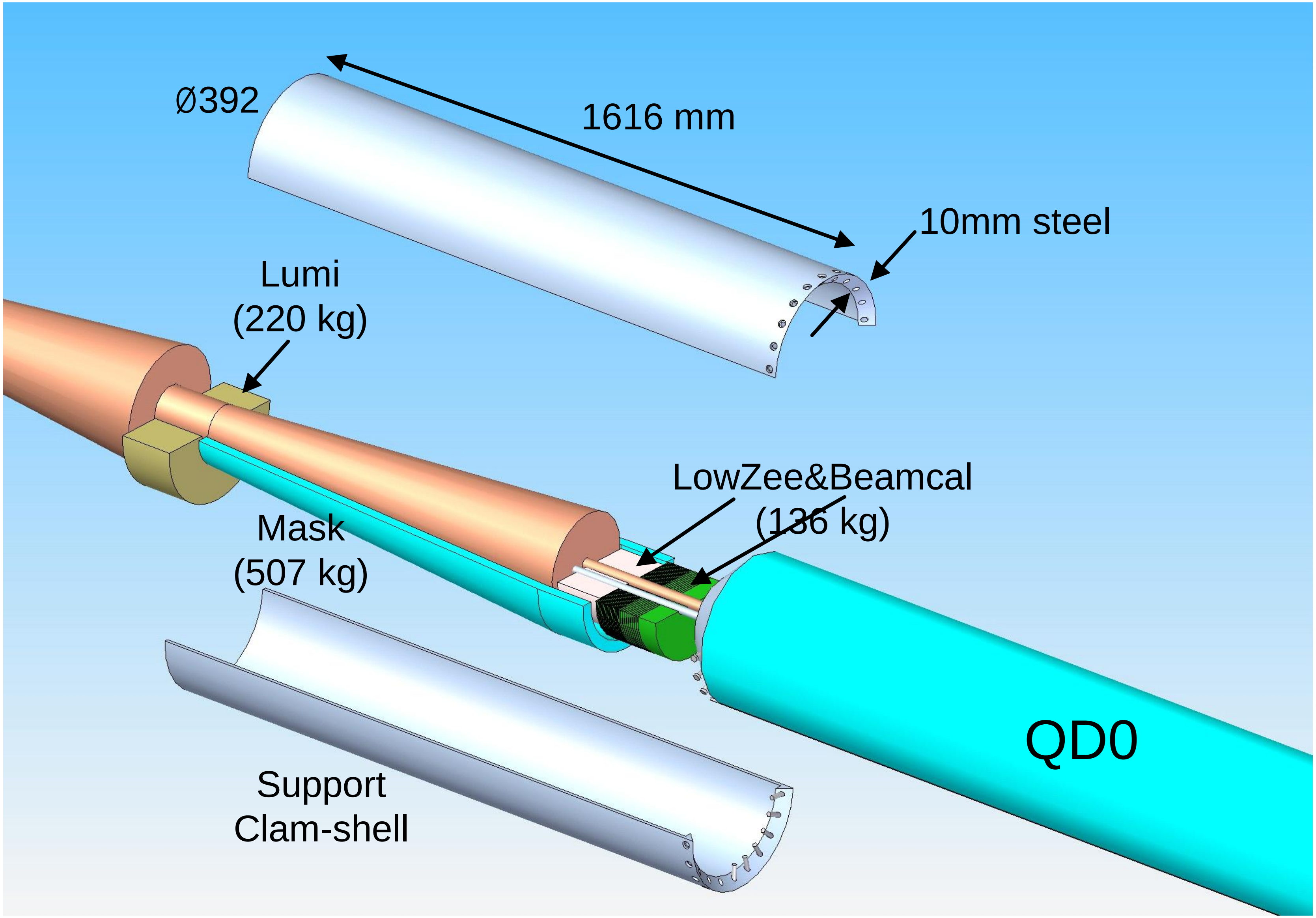
Cavern Width, at the floor level = 21 m

Set by the platform requirements
- 2 m opening on the beam
- Space for Cryogenics and Infra.





Forward Region engineering



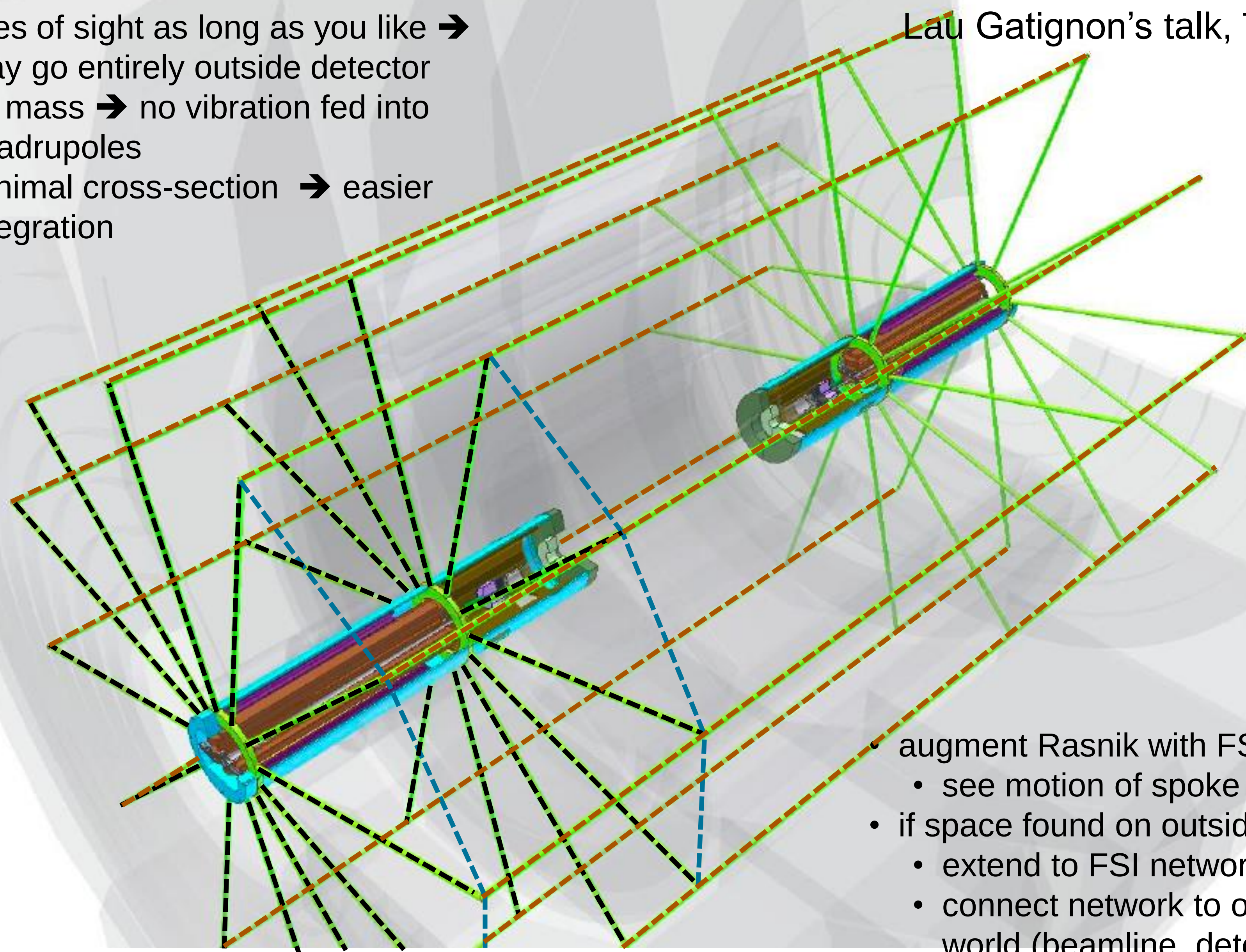
Harry van der Graaf / NIKHEF

(CLIC solution for FF pre-alignment from

Lau Gatignon's talk, Tue. am)

replace zerodure sokes with FSI lines

- lines of sight as long as you like ➔ may go entirely outside detector
- no mass ➔ no vibration fed into quadrupoles
- minimal cross-section ➔ easier integration



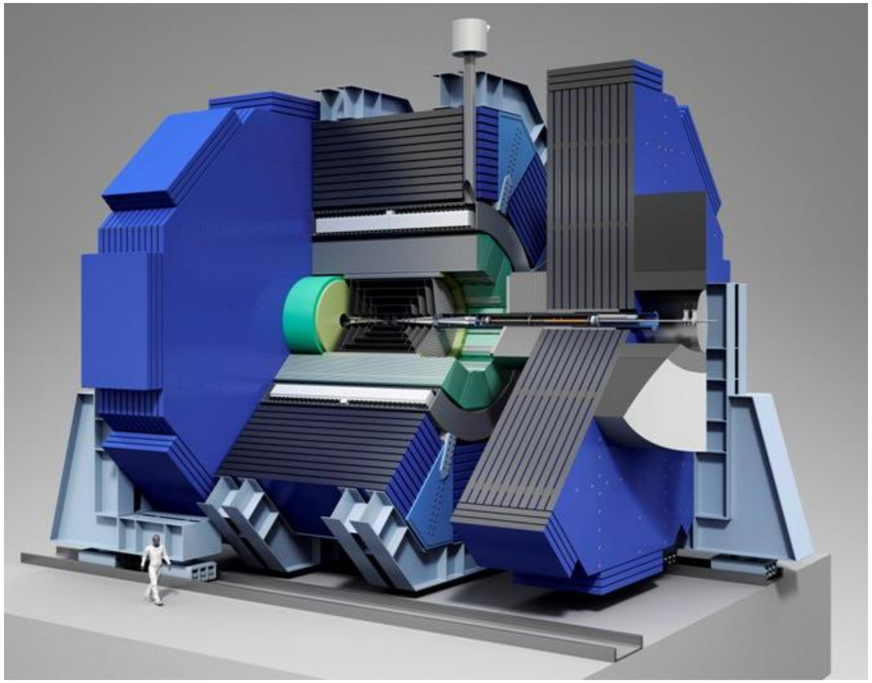
- augment Rasnik with FSI
  - see motion of spoke ends
- if space found on outside:
  - extend to FSI network
  - connect network to outside world (beamline, detector)

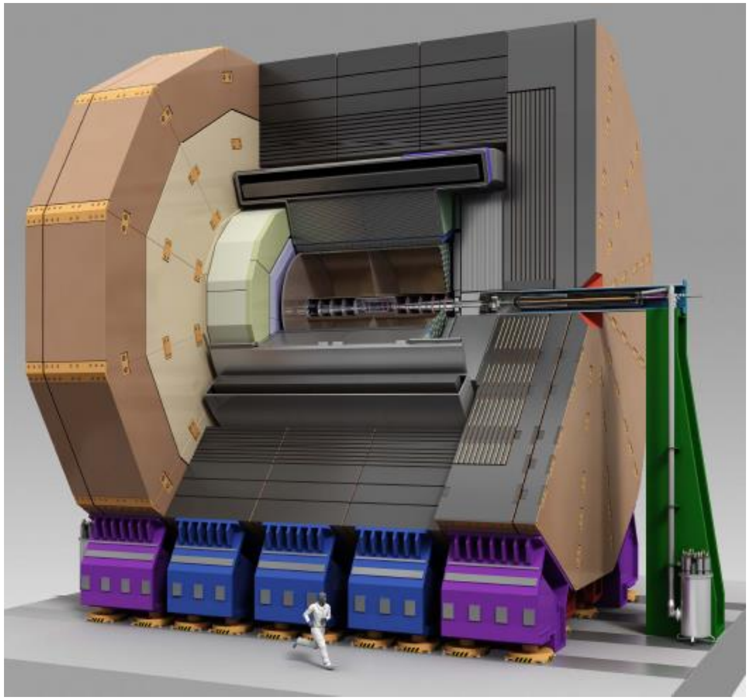
Self-Shielded Detectors

1. Iron design driven by the requirements of self shielding of Magnetic Field and the Radiation dose for the protection of the personnel working on the off-beam detector.

2. Larger Iron volume for an effective magnetic flux return with low fringe field.

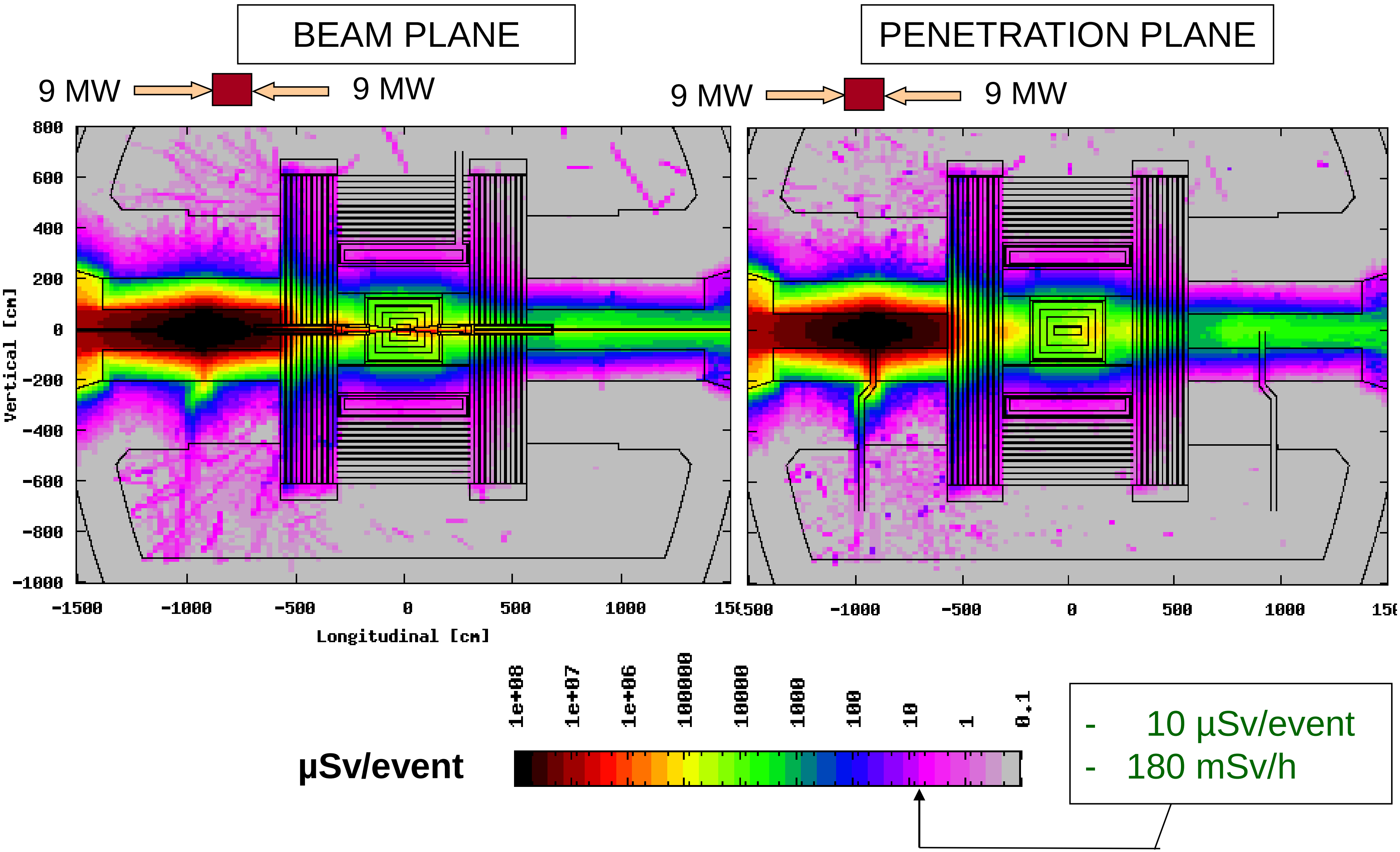
3. Increased costs, Optimization required





20 R.L. Cu target in IP-9 m. Large pacman.

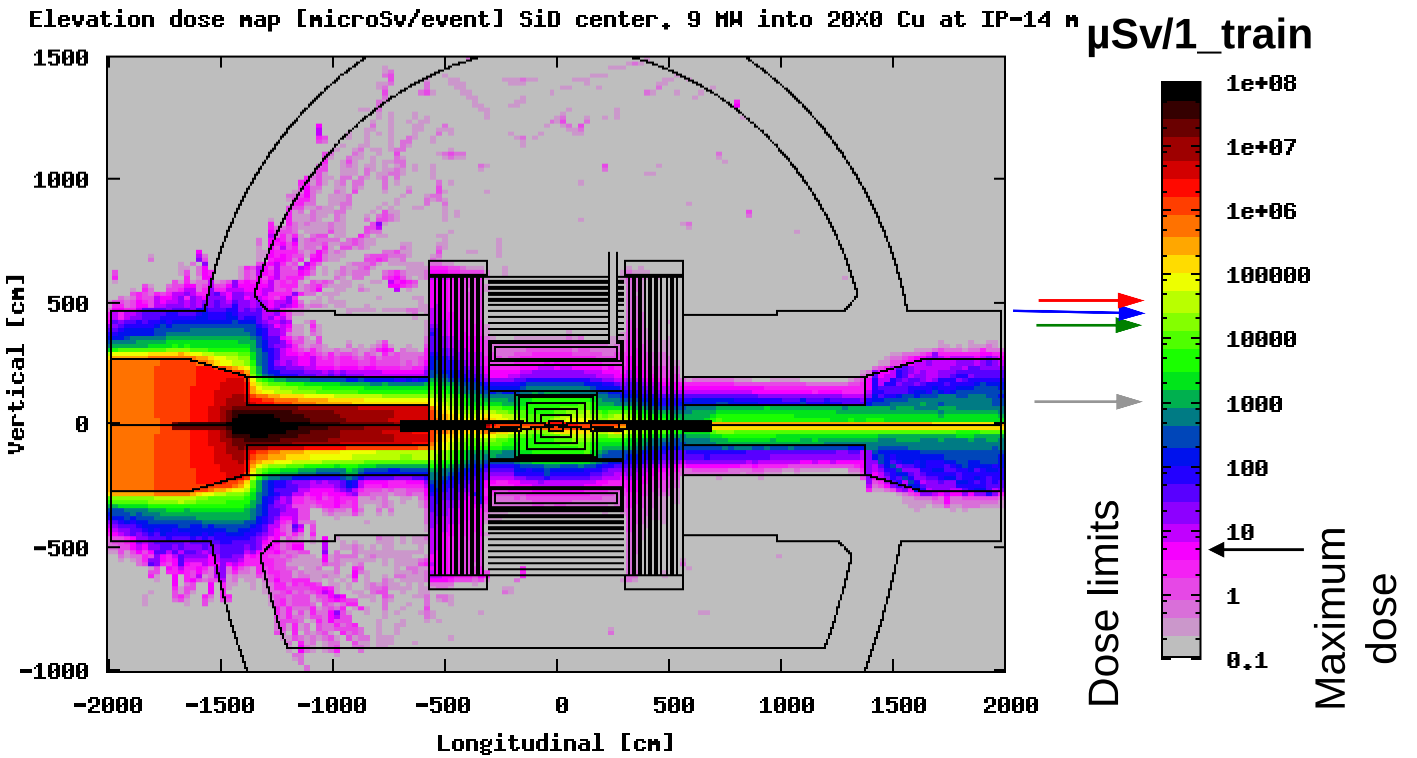
M.Santana, SLAC



20 R.L. Cu target in IP-14 m. Large pacman.

M.Santana, SLAC

9 MW



- The maximum **integrated dose** per event is ~8 μSv << 30 mSv

- The corresponding peak **dose rate** is ~140 mSv/h < 250 mSv/h

Vacuum Spec from Beam Gas Scattering

- Scattering inside the detector is negligible up to 1’000 nT

250 GeV e- → OD2.4 cm x 7 m long gas ($H_2/CO/CO_2$)

only Moller scattering off atomic electrons is significant.

Luminosity backgrounds (pairs, γγ→hadrons) are much higher

Within the IP region there are 0.02 - 0.04 hits/bunch (3-6 hits TPC) at an average energy of about 100 GeV/hit originating QD0–200 m from the IP.
Therefore 1 nT from QD0–200 m is conservative.

On the FD protection collimator there are 0.20 charged hits/bunch (33 hits TPC) at an average energy of about 240 GeV/hit and 0.06 photon hits/bunch (9 hits TPC) at an average energy of about 50 GeV/hit originating 0–800 m from the IP.
Therefore 10 nT from 200–800 m.

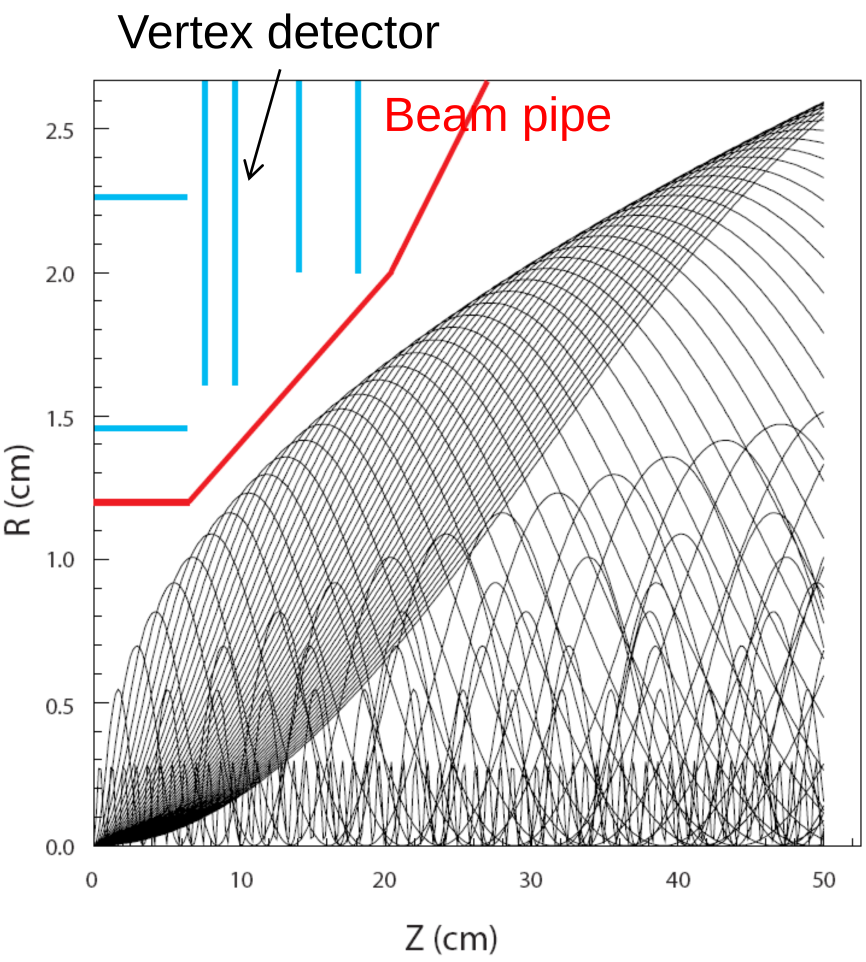
Beyond 800 m from the IP the pressure could conceivably be at least an order of magnitude higher than 10 nT, pending look at BGB background in the Compton polarimeter and energy spectrometer.

Pair edge and Beam pipe design

~200 k pairs/BX are produced.

Pairs develop a sharp edge and the beam pipe must be placed outside the edge.

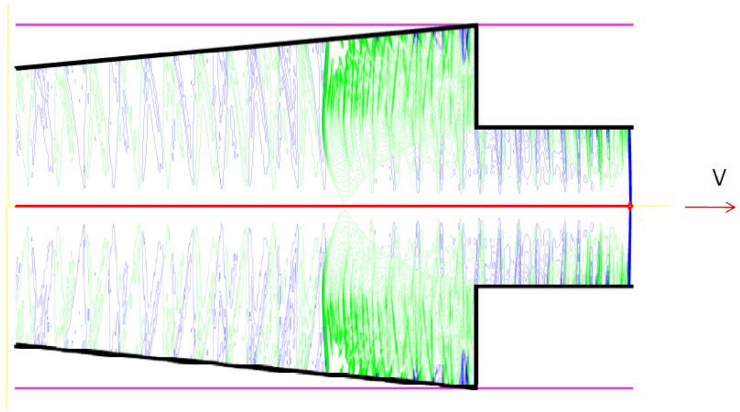
The pair edge is critically dependent on the IP beam parameters.



HOM heating at the IP and in QD0 *(S.Novokhatski, SLAC)*

- *Beam fields*
- *Wake potentials and loss power*
- *Trapped and propagating modes*
- *Frequency spectrum*
- *Resistive wake fields*
- *Total power loss*

Example of Wakefields



- The amount of beam energy loss in IR is very small.
- Spectrum of the wake fields is limited to 300 GHz
- Average power of the wake fields excited ~30 W nominal (6 kW pulsed)
- In the QD0 region the additional losses are of 4W (averaged) .
- BPMs and kickers must be added.

Harry van der Graaf / NIKHEF

(CLIC solution for FF pre-alignment from Lau Gatignon's talk, Tue. am)

replace zerodure sokes with FSI lines

- lines of sight as long as you like ➔ may go entirely outside detector
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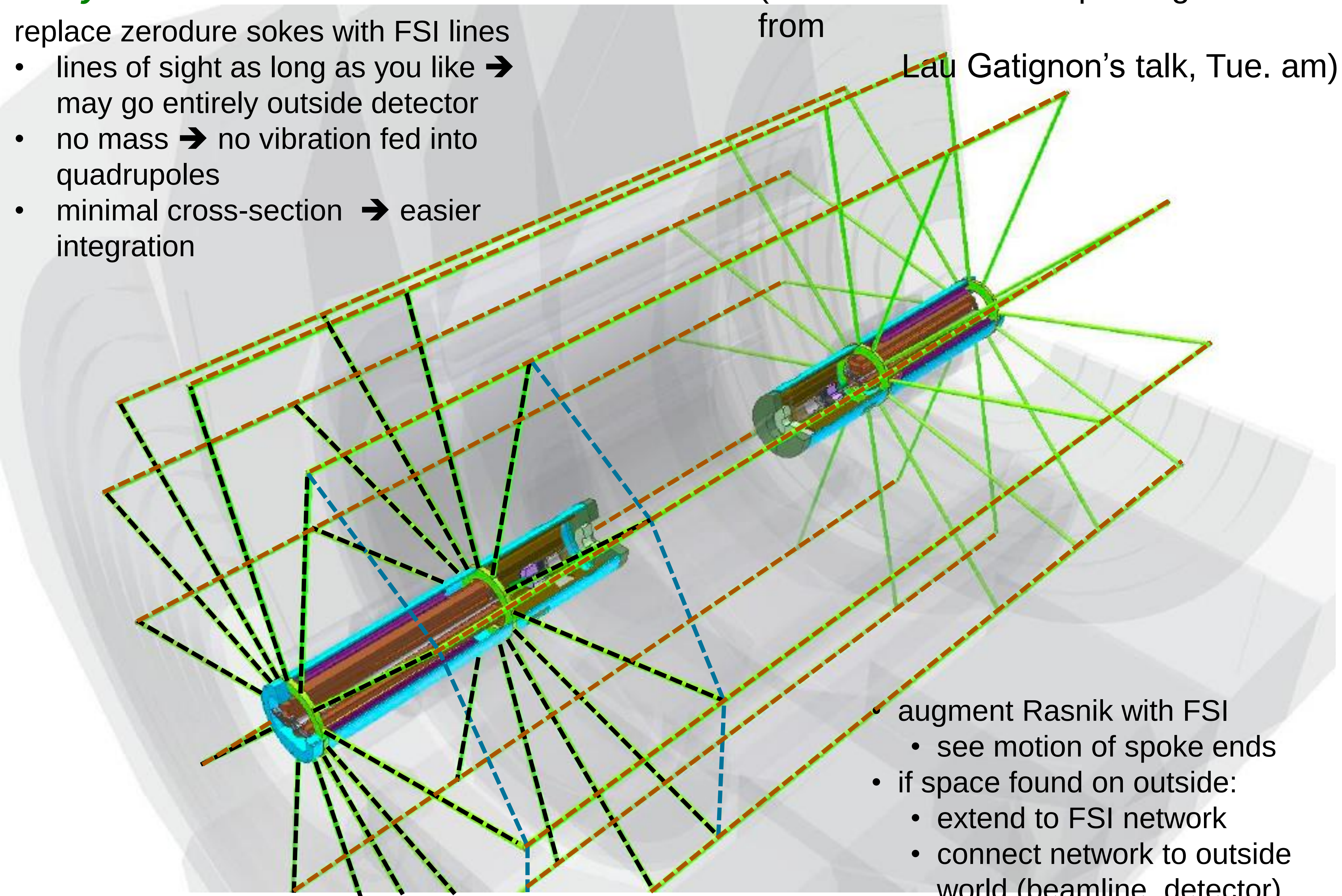
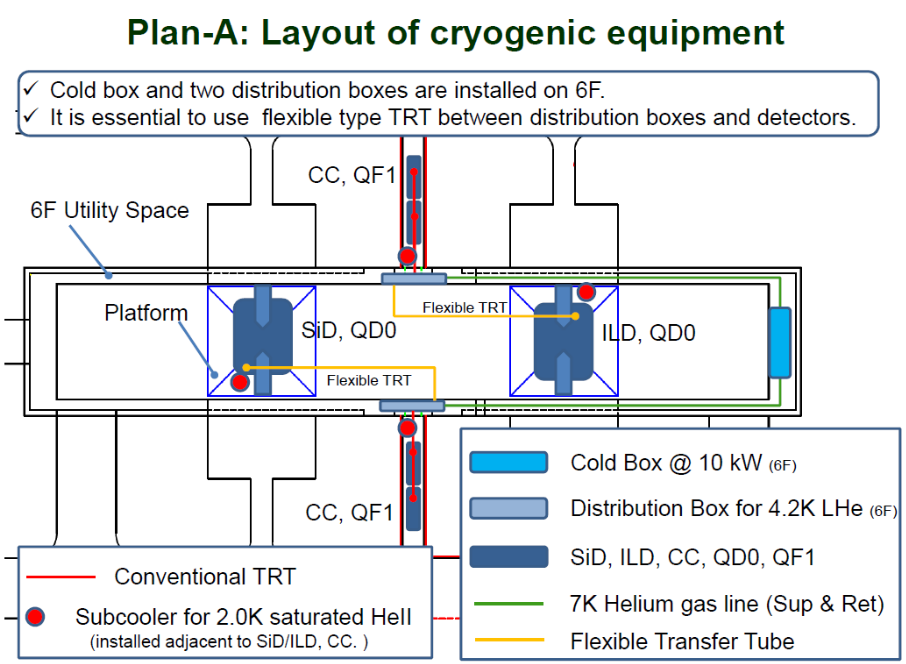


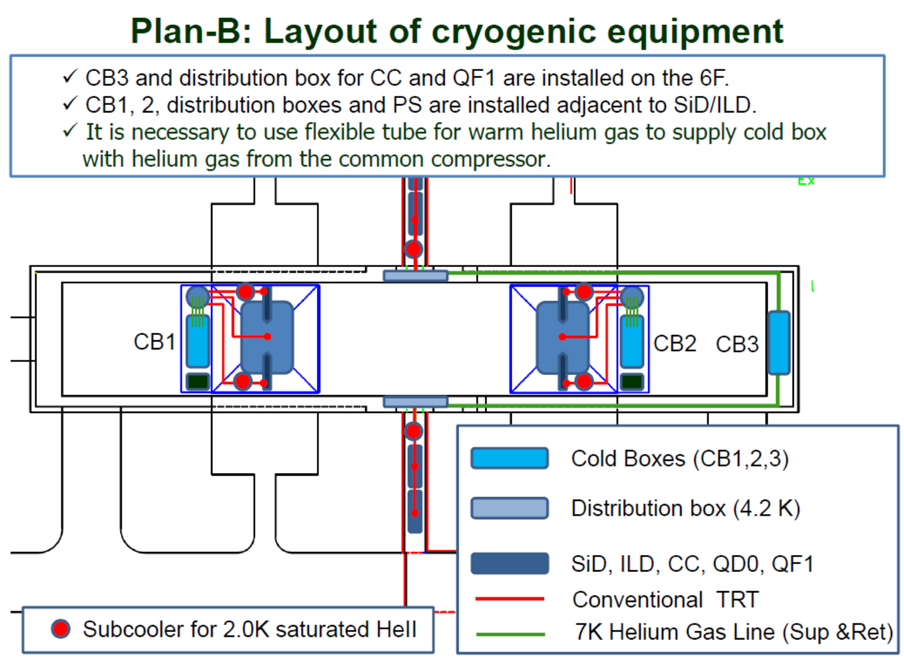
- augment Rasnik with FSI
  - see motion of spoke ends
- if space found on outside:
  - extend to FSI network
  - connect network to outside world (beamline, detector)

Cryogenic Layout : Two options

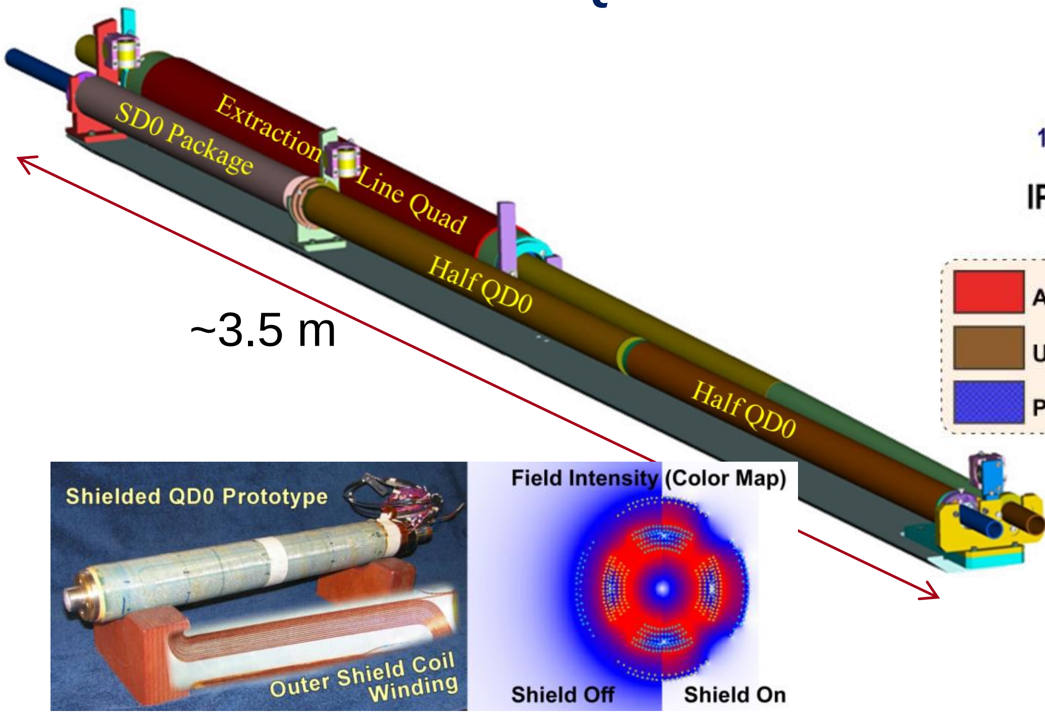
Plan A : Cold Boxes are stationary. Cold Transfer lines to each detector. Reliability for push-pull. Not off-the-shelf.

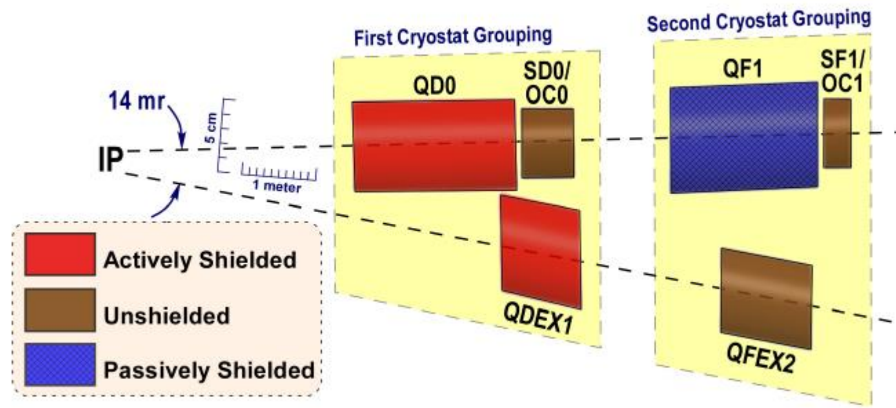
Plan B : Cold Boxes on the platform. Warm Transfer lines to each cold box. Vibrations, fringe field effects, space





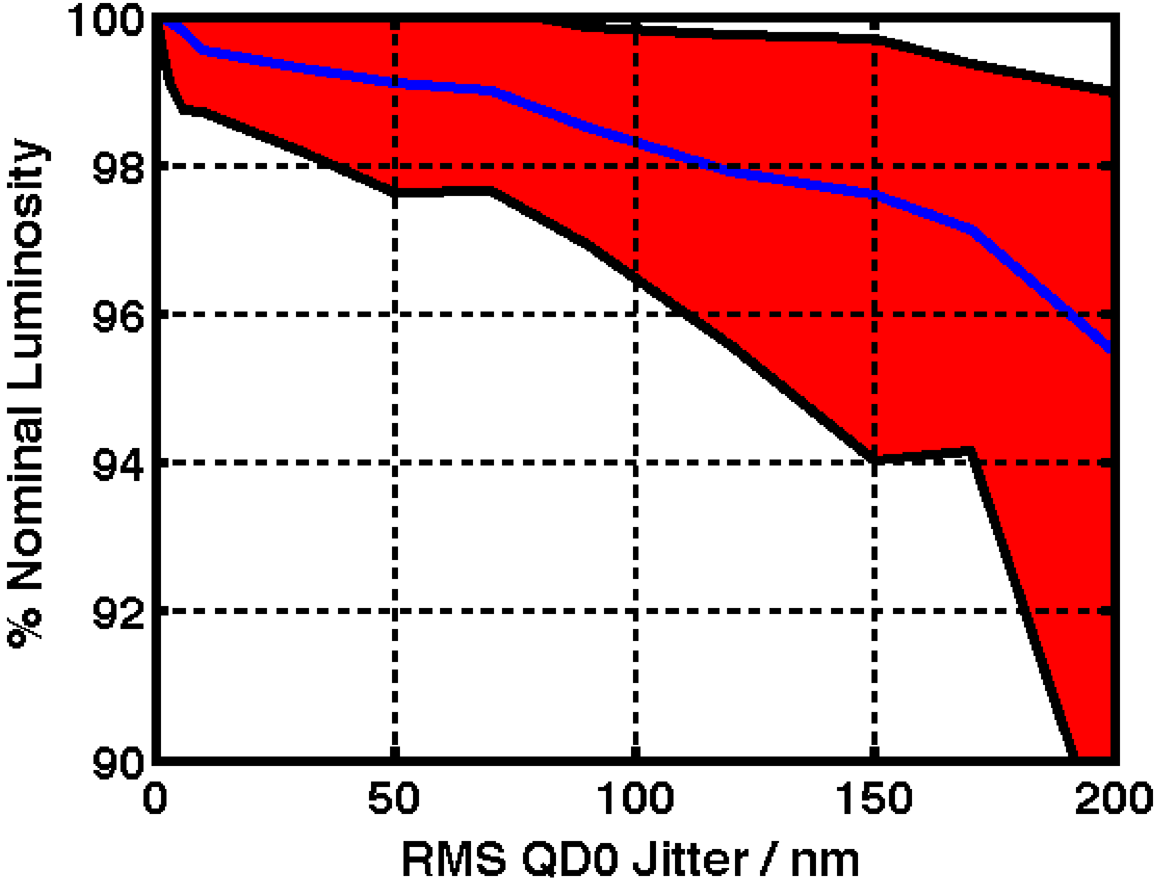
ILC QD0 : Cold Mass 2K Helium (BNL)





- Technology of the superconducting final focus magnets has been demonstrated by a series of short prototype multi-pole coils.
- QD0 magnet split into two coils to allow higher flexibility at lower energies.
- The quadrupoles closest to the IP are actually inside the detector solenoid.
- Actively shielded coil to control magnetic cross talk
- Additional large aperture anti-solenoid in the endcap region to avoid luminosity loss due to beam optics effects.
  - Large aperture Detector Integrated Dipole (DID) used to reduce detector background at high beam energies or to minimize orbit deflections at low beam energies.

Luminosity Loss vs. QD0 Jitter

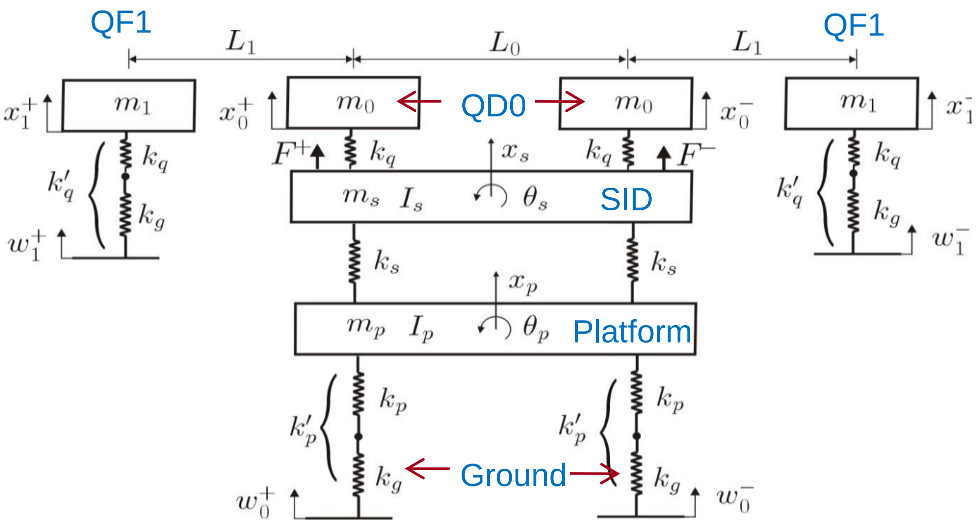


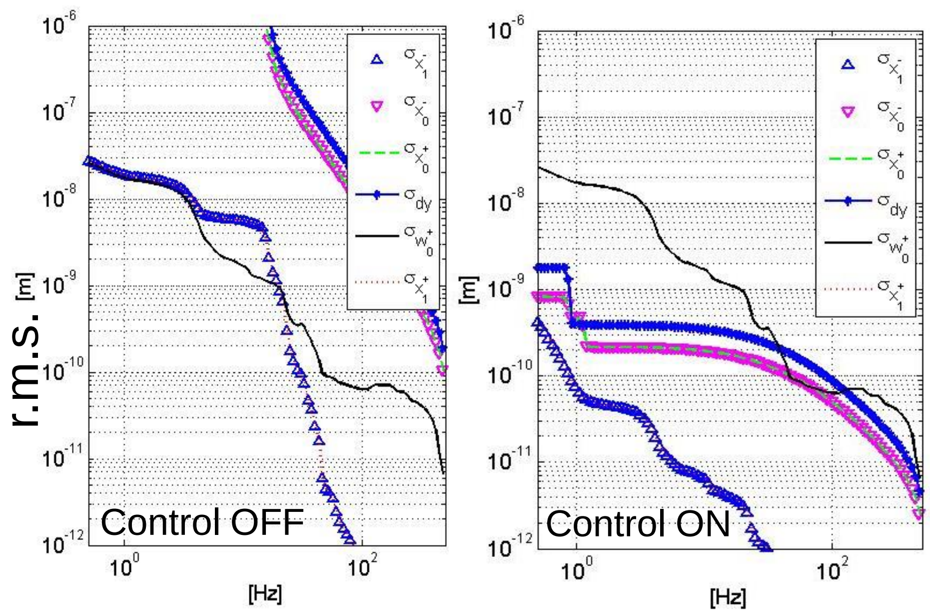
Data shown gives % nominal luminosity for different levels of uncorrelated QD0 jitter.

- 100 pulses simulated per jitter cases with FFB
- Mean, 10% & 90% CL results shown for each jitter point from 100 pulse simulations

Tolerance to keep luminosity loss <1% is <50nm RMS QD0 jitter.

Vibration Study (C.Collette, D.Thsilumba,ULB)



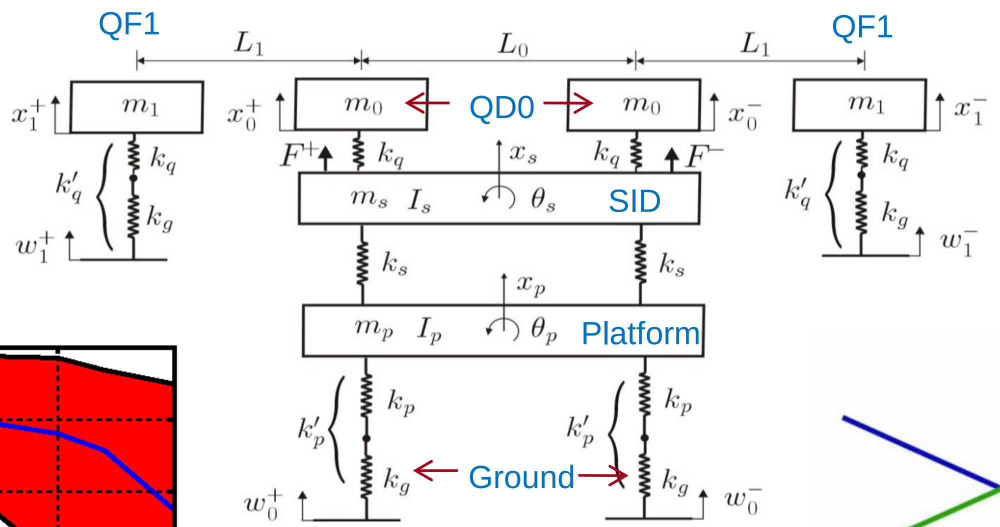


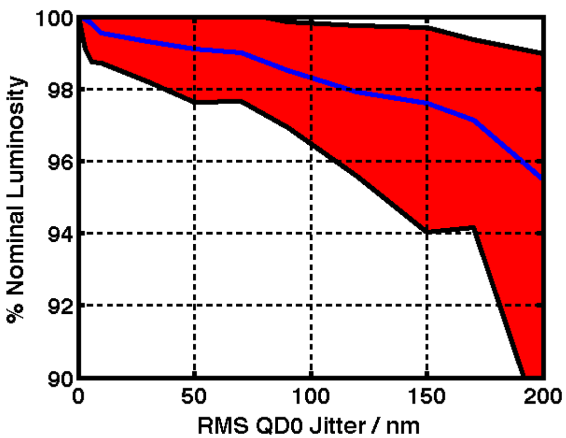
1. Ground Motions measured at the SLD detector hall
2. Conservative spectrum of the technical noise on the detector.
3. The model predicts that the maximum level of *r.m.s.* vibration seen by QDO is well below the capture range of the IP feedback system available in the ILC. With the addiction of an active stabilization system on QD0, it is also possible to achieve the stability requirements of CLIC.
4. Experimental measurements of the technical noise instrumenting CMS during LS1 with permanent vibration sensors

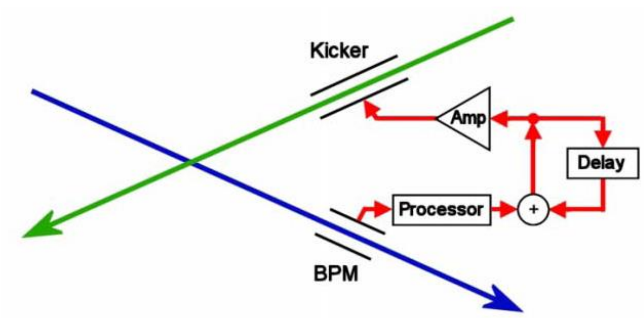
Luminosity Loss Mechanisms and Feedbacks

Mechanical Vibrations on the final focus system causes Luminosity Loss by the growth of the beam size and Colliding Beams misalignment at IP.

Ground Motion and the noise of the technical systems must be quantified with detailed model and kept under control with specific strategies







IP Feedback System

Luminosity Loss 1% with 50nm RMS jitter.

Interaction Region Layout

“Provide reliable collisions of ultra small beams (~few nanometers), with acceptable level of background”