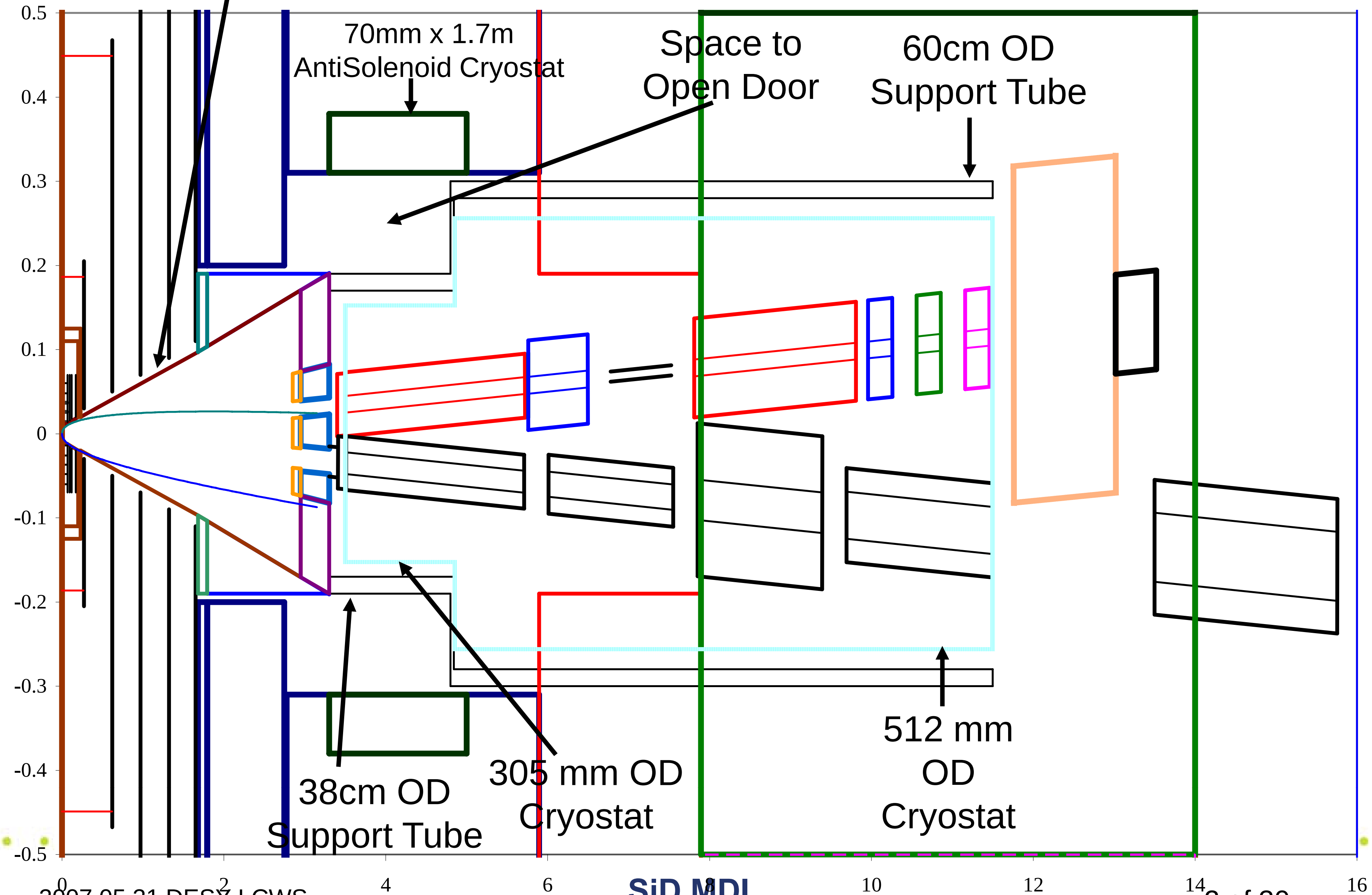
# SiD MDI Update

Tom Markiewicz/SLAC

LCWS'07 / DESY

31 May 2007

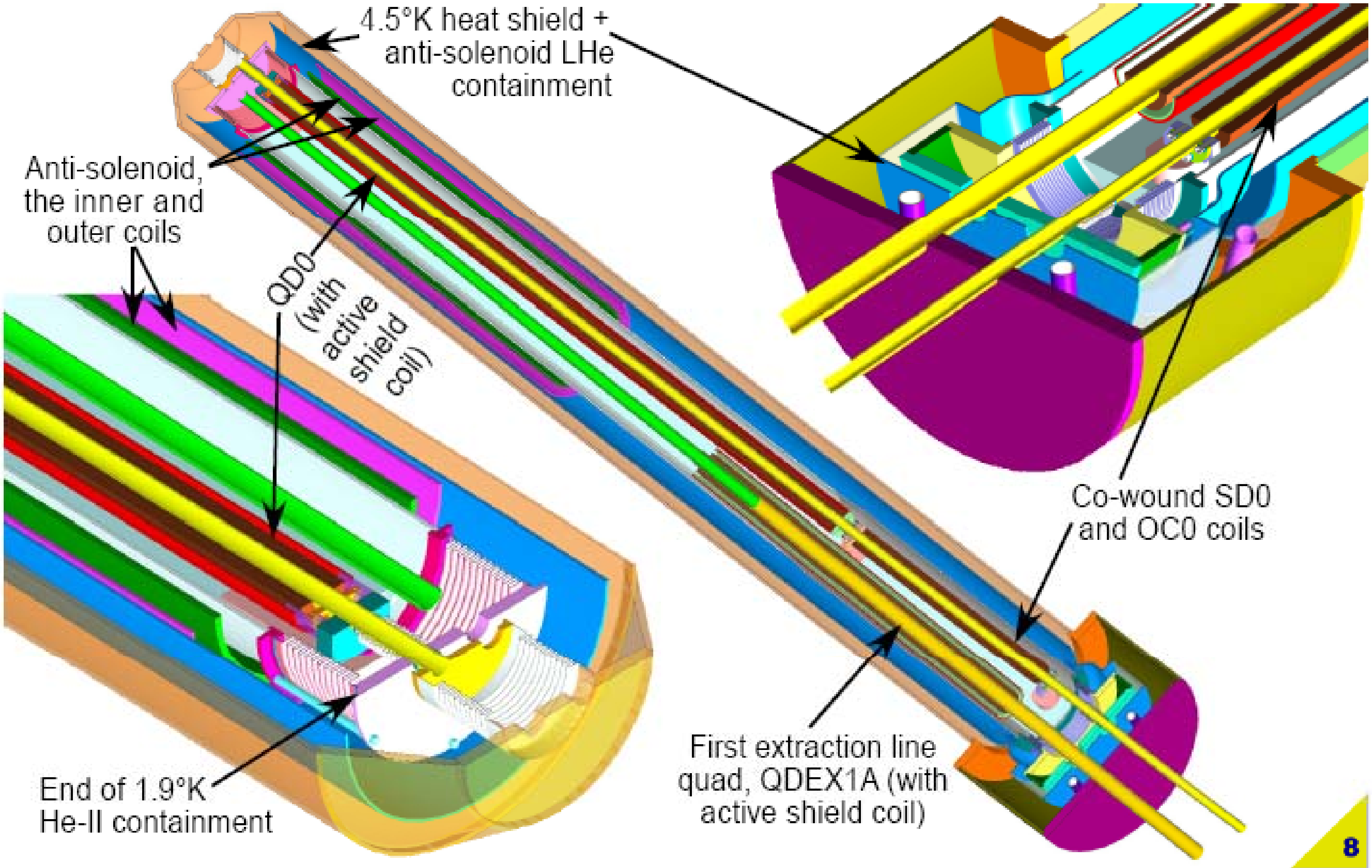
# 2006-05-07 BNL Discussion
# QD/QF in common stepped cryostat



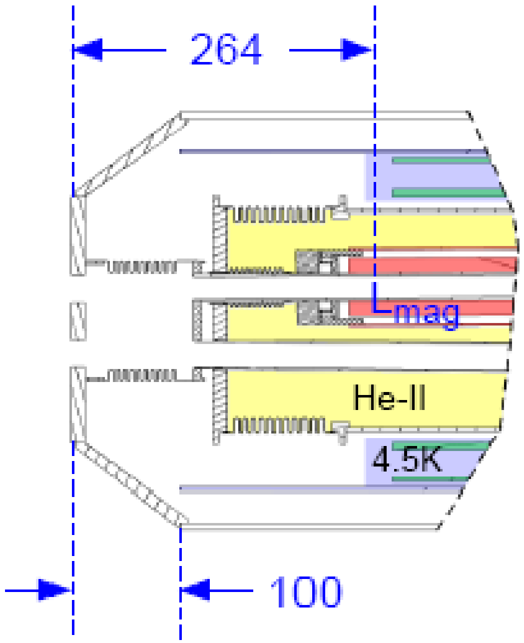
# Semi-recent developments affecting SiD MDI Design

- Push-Pull
  - **Separate cryostats for QD and QF magnets**
  - **QD0 carried by detector at optimized L***
    - Cantilevered support tube concept dead
  - **QF never moves & z of QF same for all detectors (z=9.5m: see Y. Nosochkov talk tomorrow)**
  - **Assume cryo supply of QD0 must move with SiD**
- BNL magnet engineering (two talks by B. Parker tomorrow)
  - **Well developed design for 380mm Ø QD0 magnet cryostat (L*=4.5m) with integrated anti-solenoid**
  - **Discussions & early estimates of required size & location of service cryostats for QD0 (heat exchanger, pump lines, current leads, etc.) have begun**
- SiD Detector changes
  - **VXD in 1.6m long cryostat with integrated forward tracking**
  - **Higher angle FWD tracking begins at r>r(QD0,FCAL)**
  - **Update of FCAL (=Lumical+Beamcal) to provide increased coverage & overlap**
  - **Beampipe size/shape between VXD and Lumical subject of intense debate**
- Integration & support issue cartoons for discussion
  - **Space for FCAL readout and access for VXD services (power, fiber,..)**
  - **FCAL+QD0 cryostat support**
  - **On/off beamline access**
  - **Assembly feasibility (flange location & space requirements)**
- Background Updates (all by Takashi Maruyama, SLAC)
  - **14 mrad beamline bkgnd calcs. for pairs, rad. bhabhas & SR (older SiD VXD & tracking design)**
  - **Minimum radius of VXD and Lumical due to pairs considering DID/Anti-DID and IP parameters**
  - **Systematic study of Δz (Lumical- Beamcal) and thickness/location of W masking (begun)**

# QD0 + QDEX1A + Anti-Solenoid in Cryostat

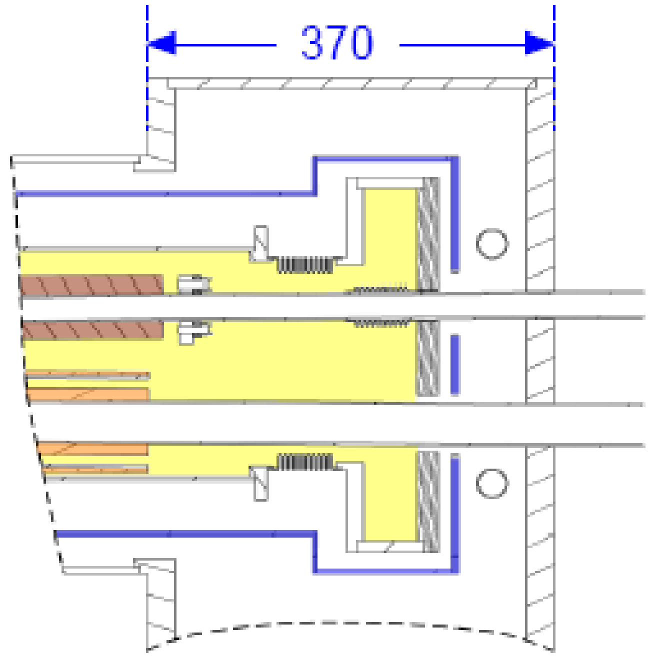


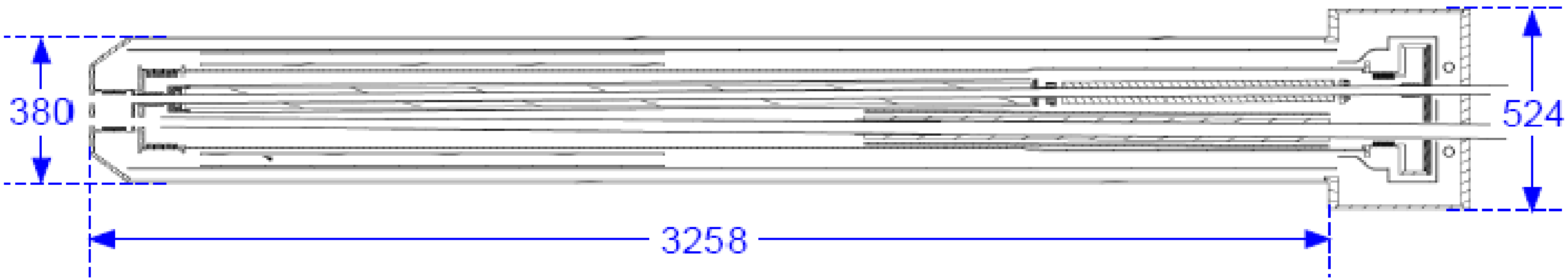
# Plan View - Details



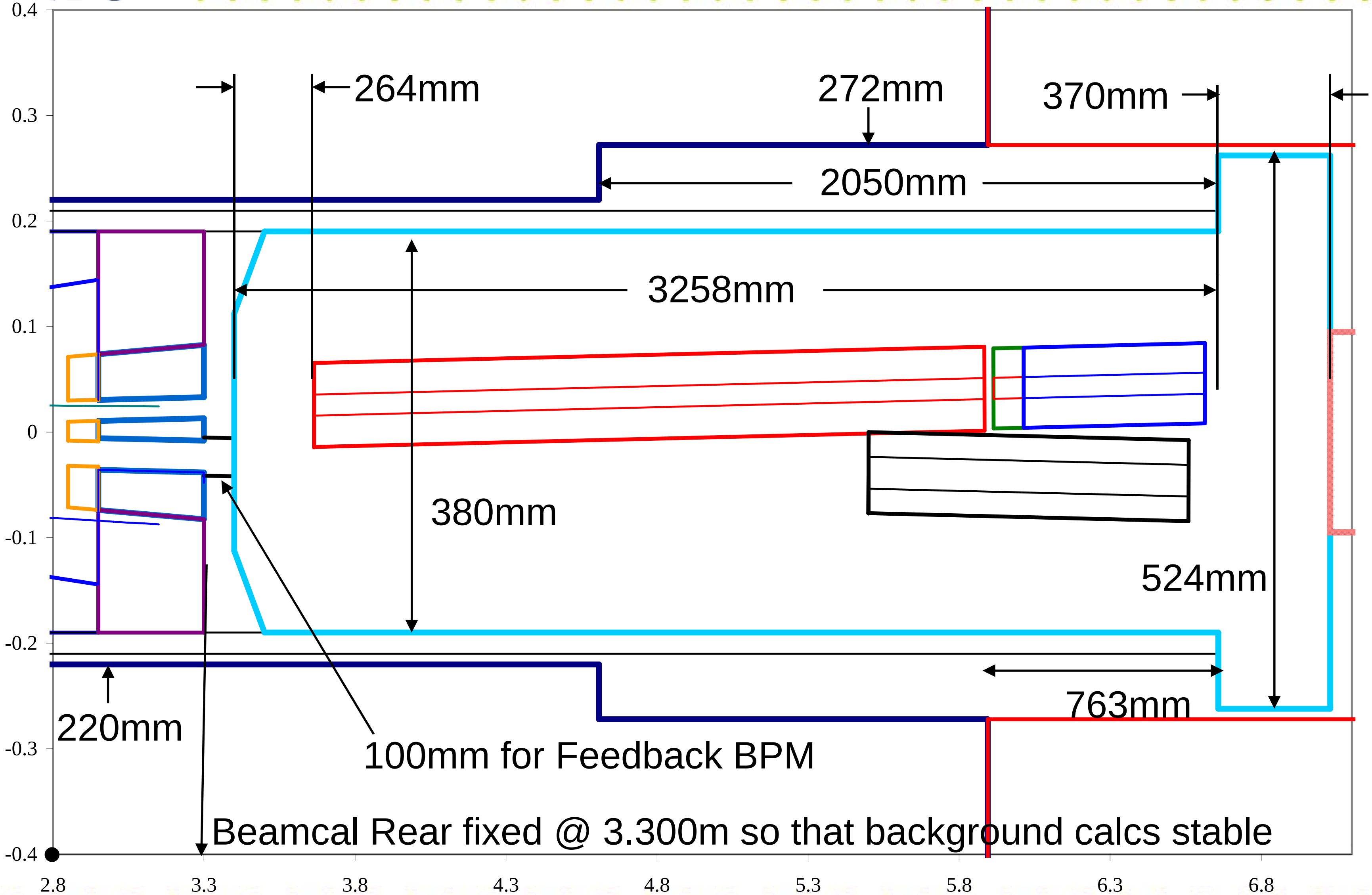

QD0 cryostat with a force neural anti-solenoid compatible with L* of up to 4.5 m.

Plan views are drawn at beams' common midplane; dimensions are as indicated in millimeters.

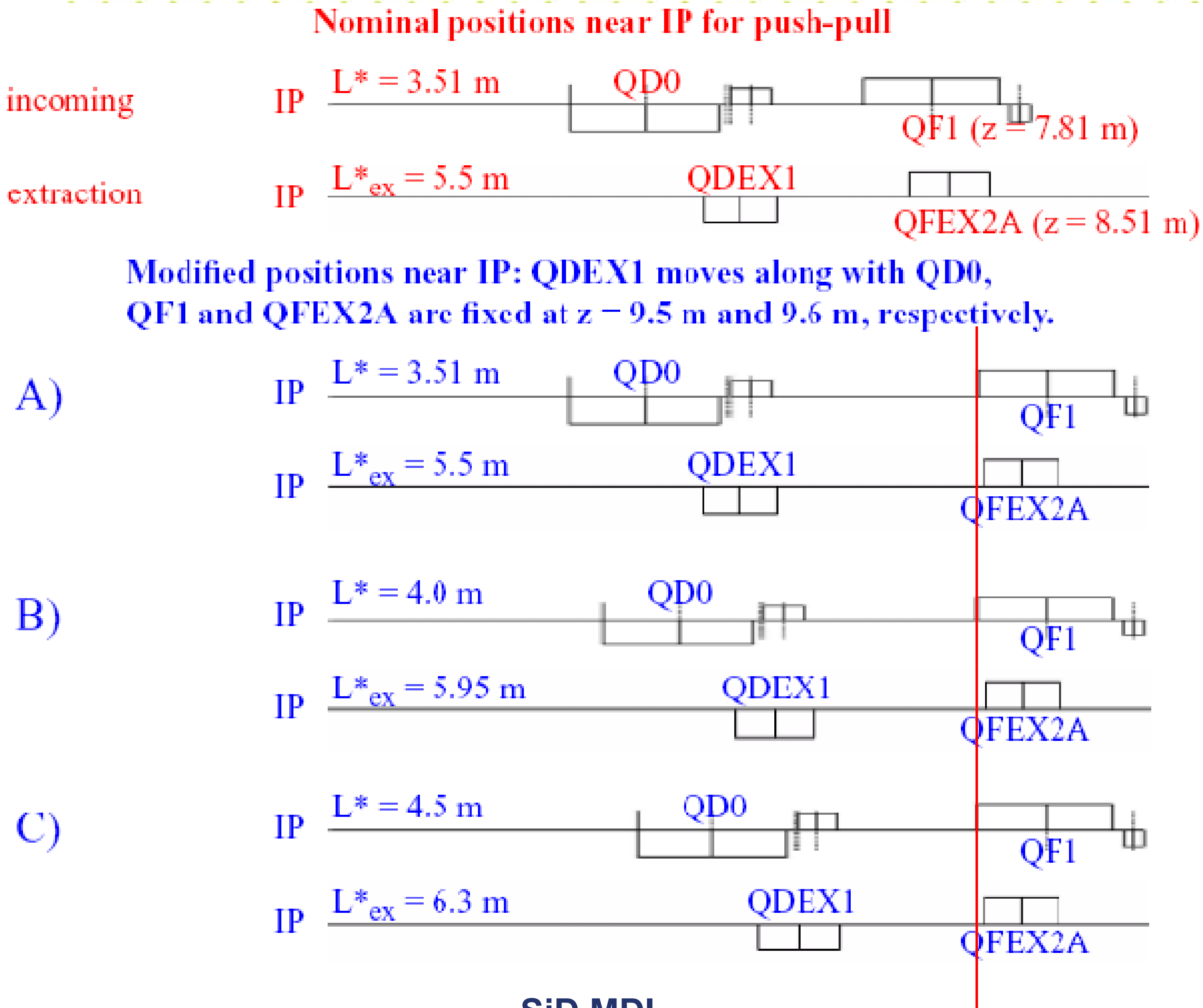


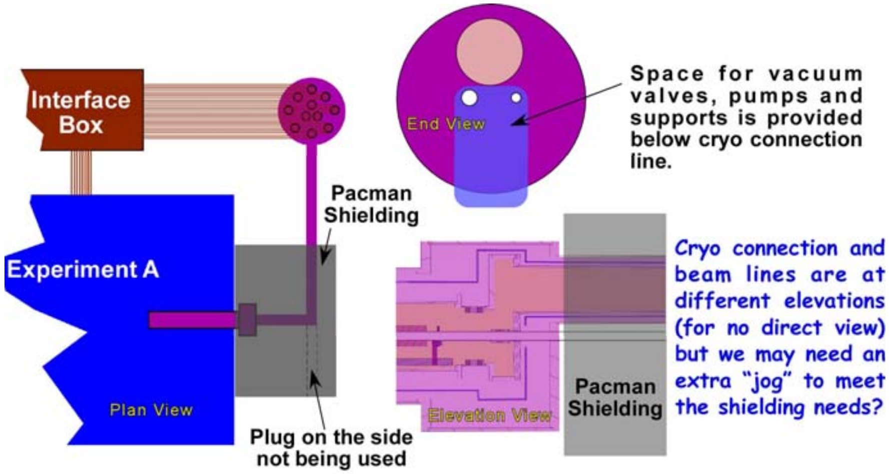
# QD0 Cryostat in SiD @ L*=3.664m

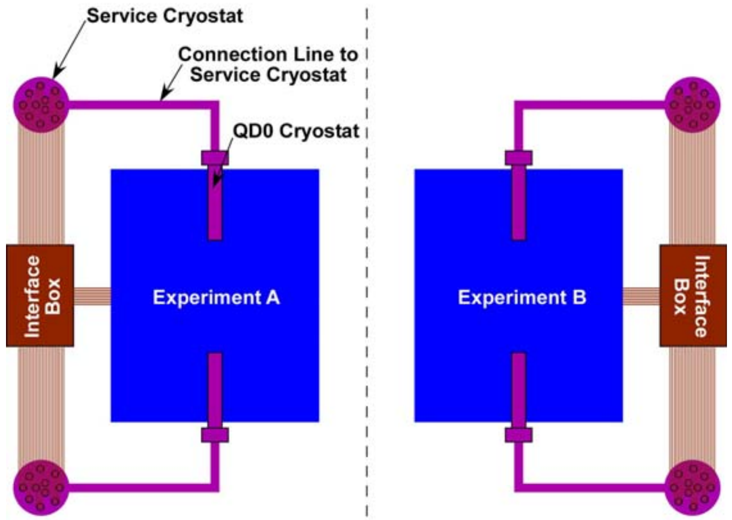


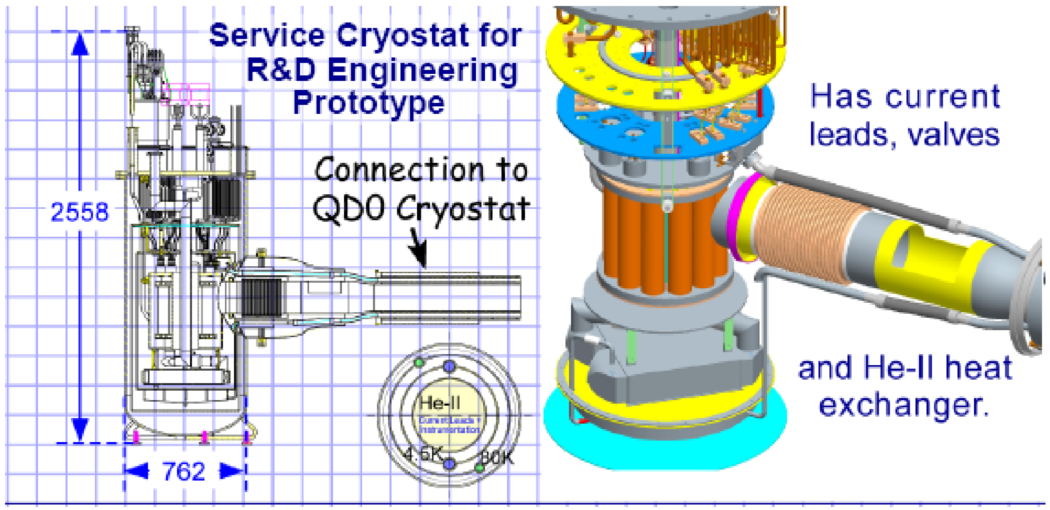
# Nosochkov Study: Fix QF1 @ 9.5m, L* chosen by Detector Concept: Study Extraction Losses, Collimation & Optics Sensitivity



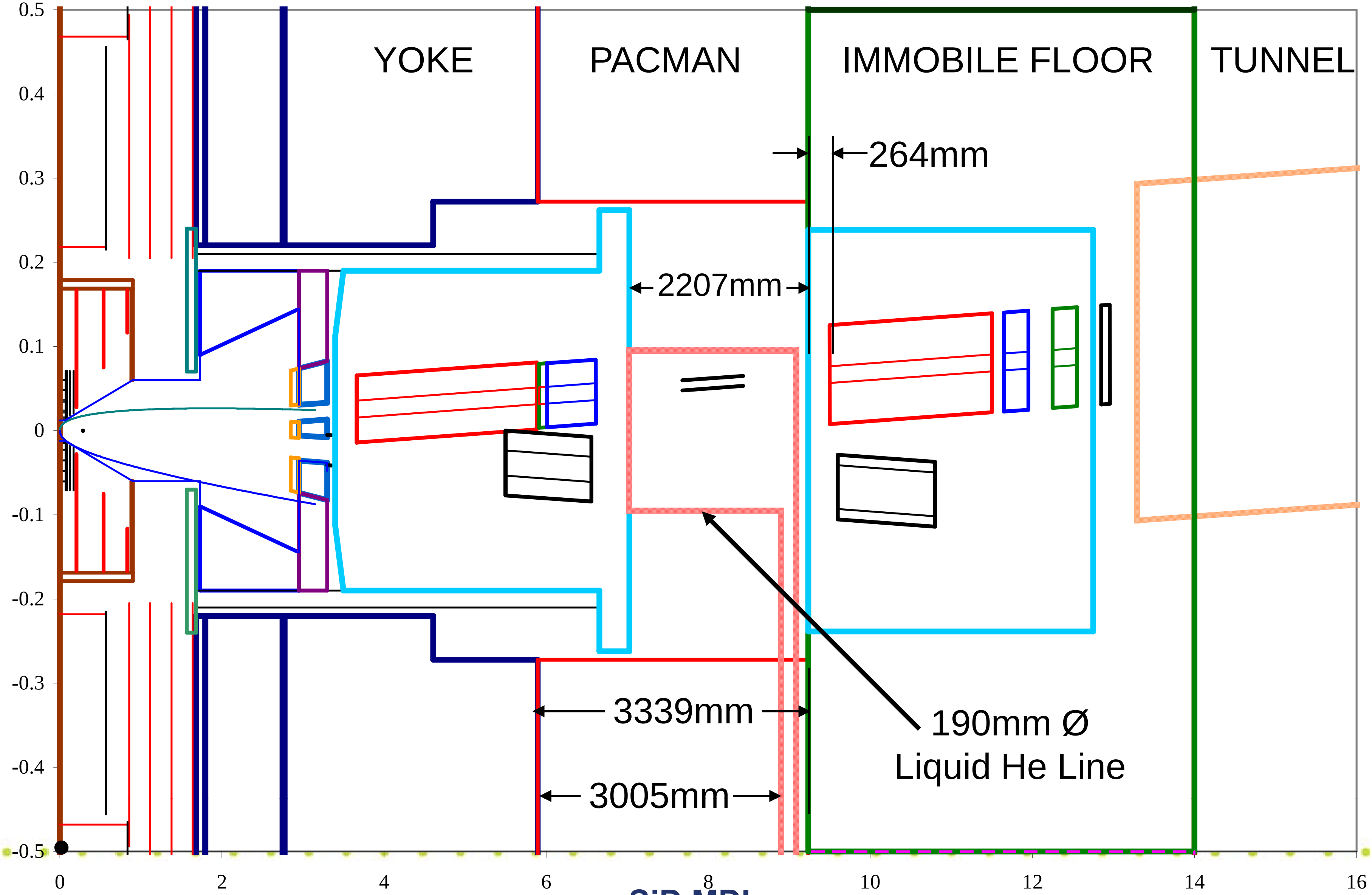
# Brett Parker's Schematics



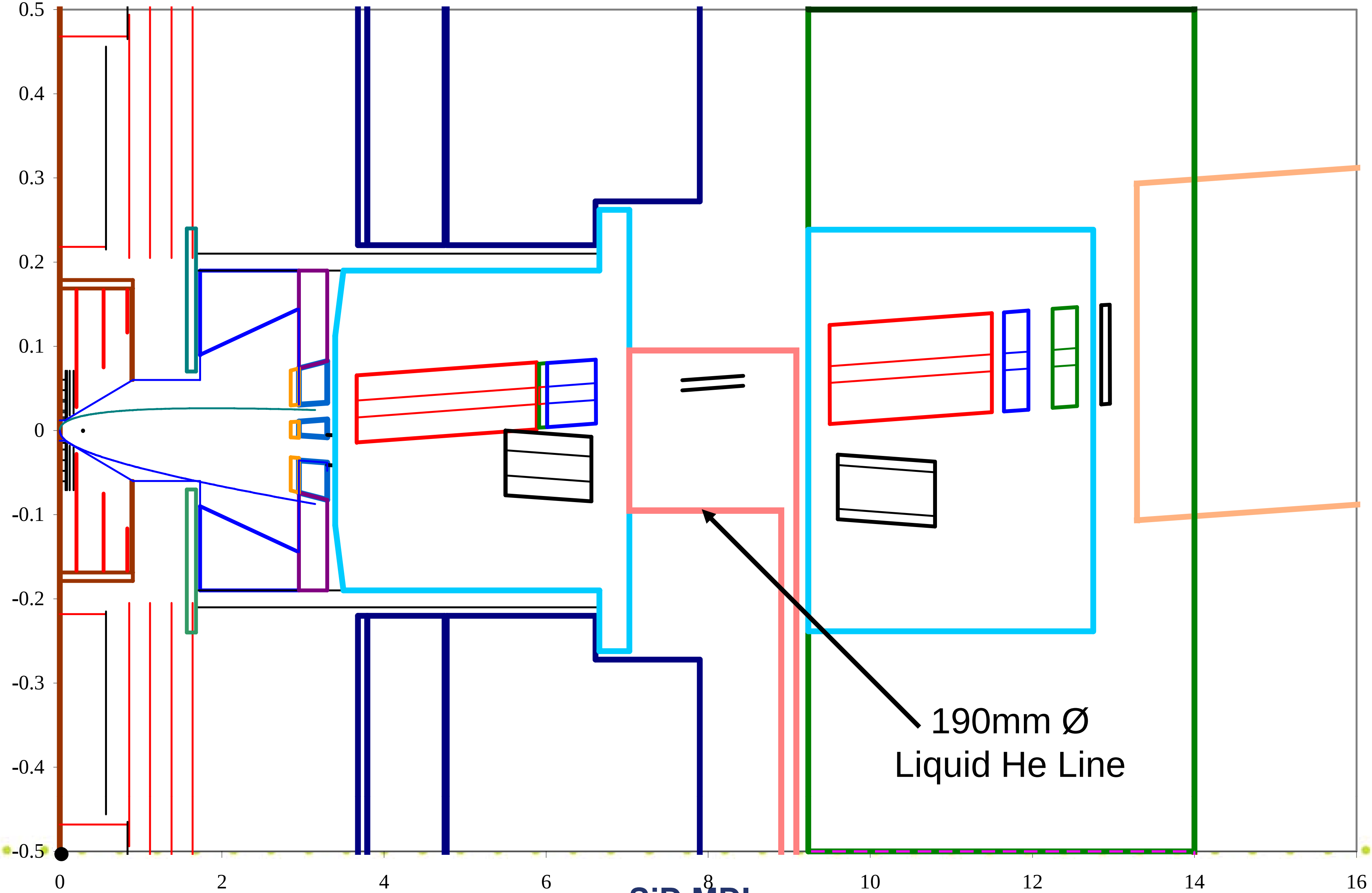



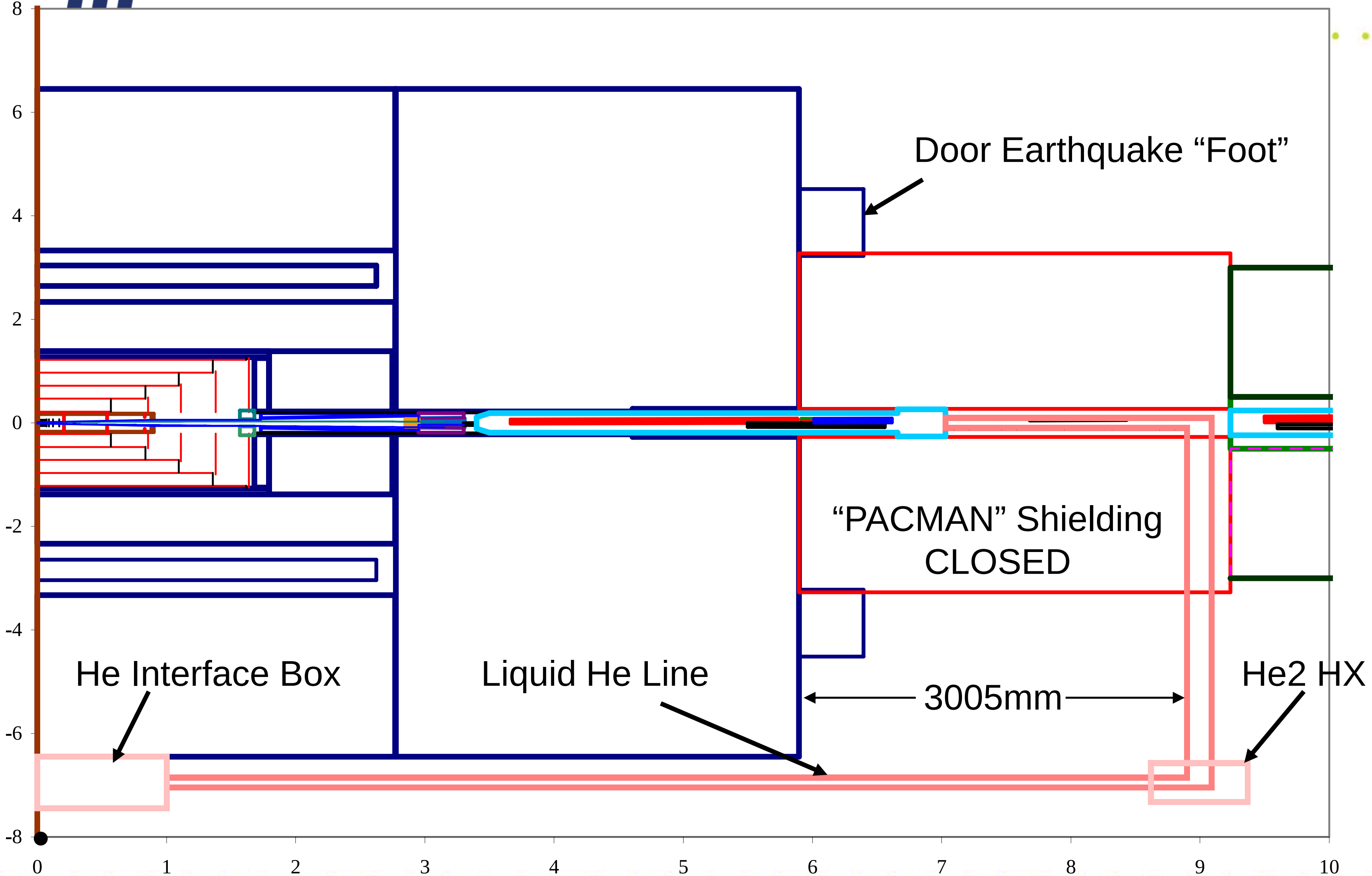
# SiD r<50cm, L*=3.664m, 14mrad, Push-Pull, QF@9.5m, Door Closed



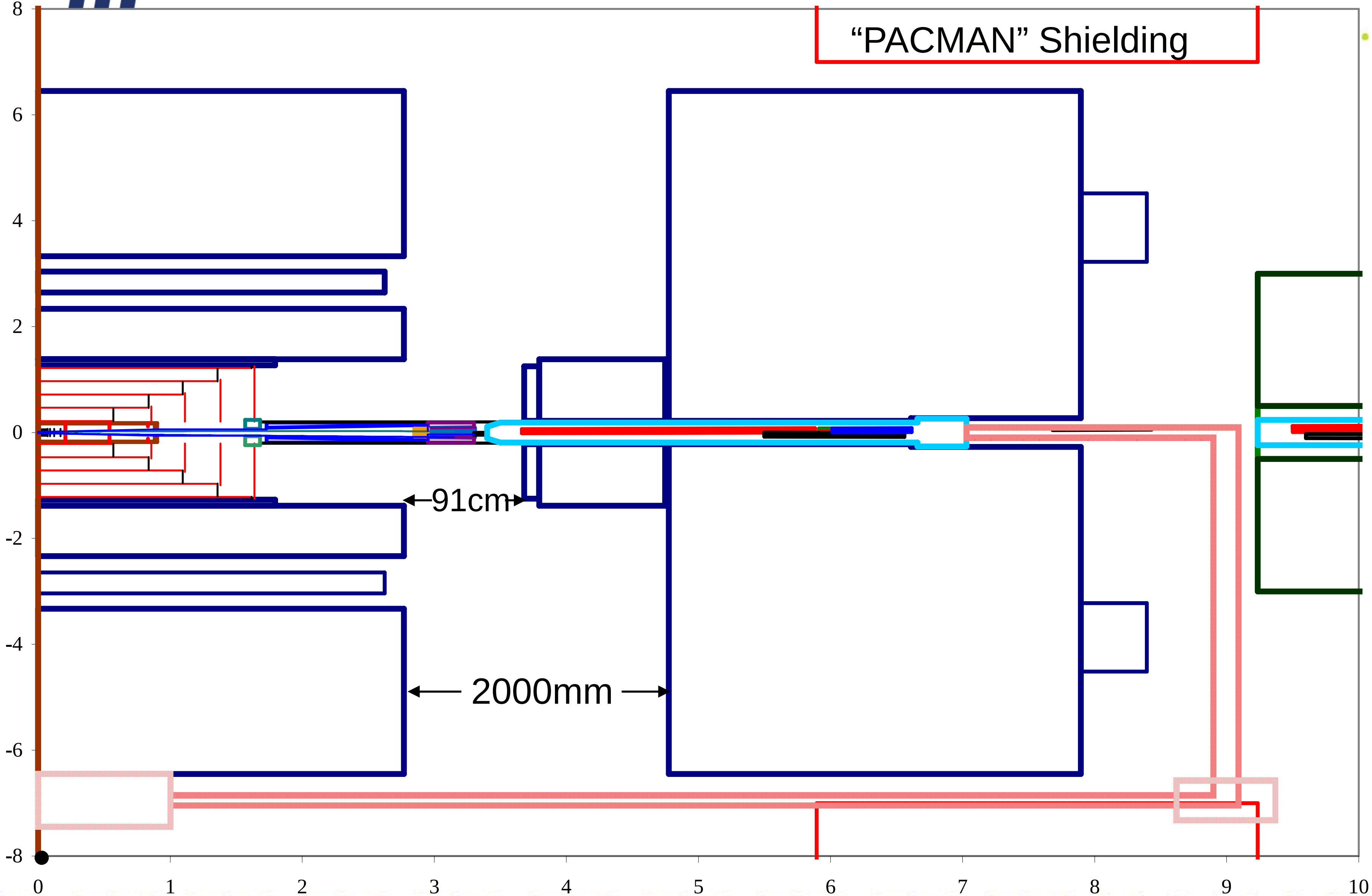
# SiD r<50cm, L*=3.664, 14mrad Crossing Angle, Push-Pull, Door **Open 2m**



# Door Closed, Permanent QD0 Liquid He Line

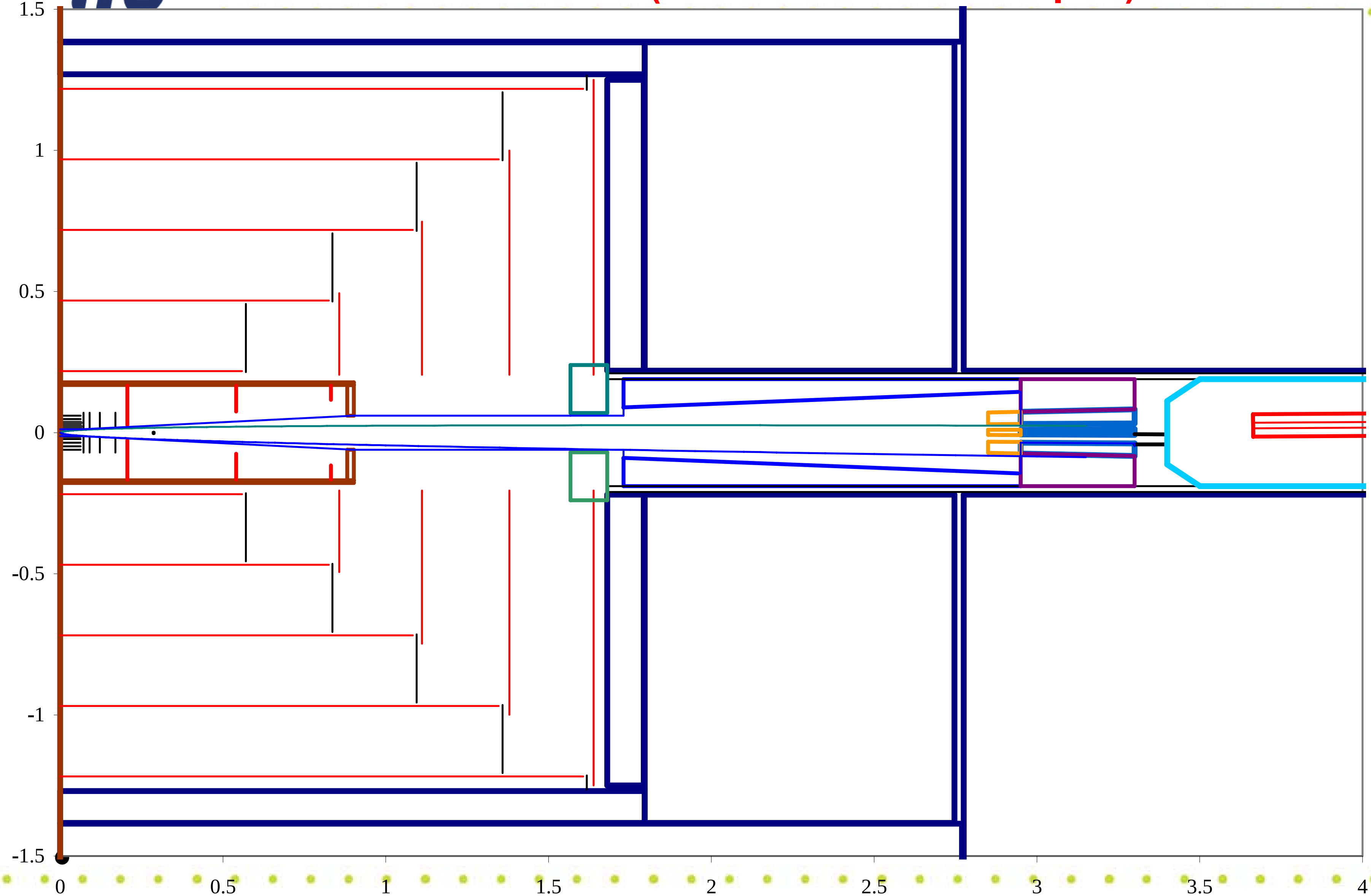


# Door Open, Permanent QD0 Liquid He Line

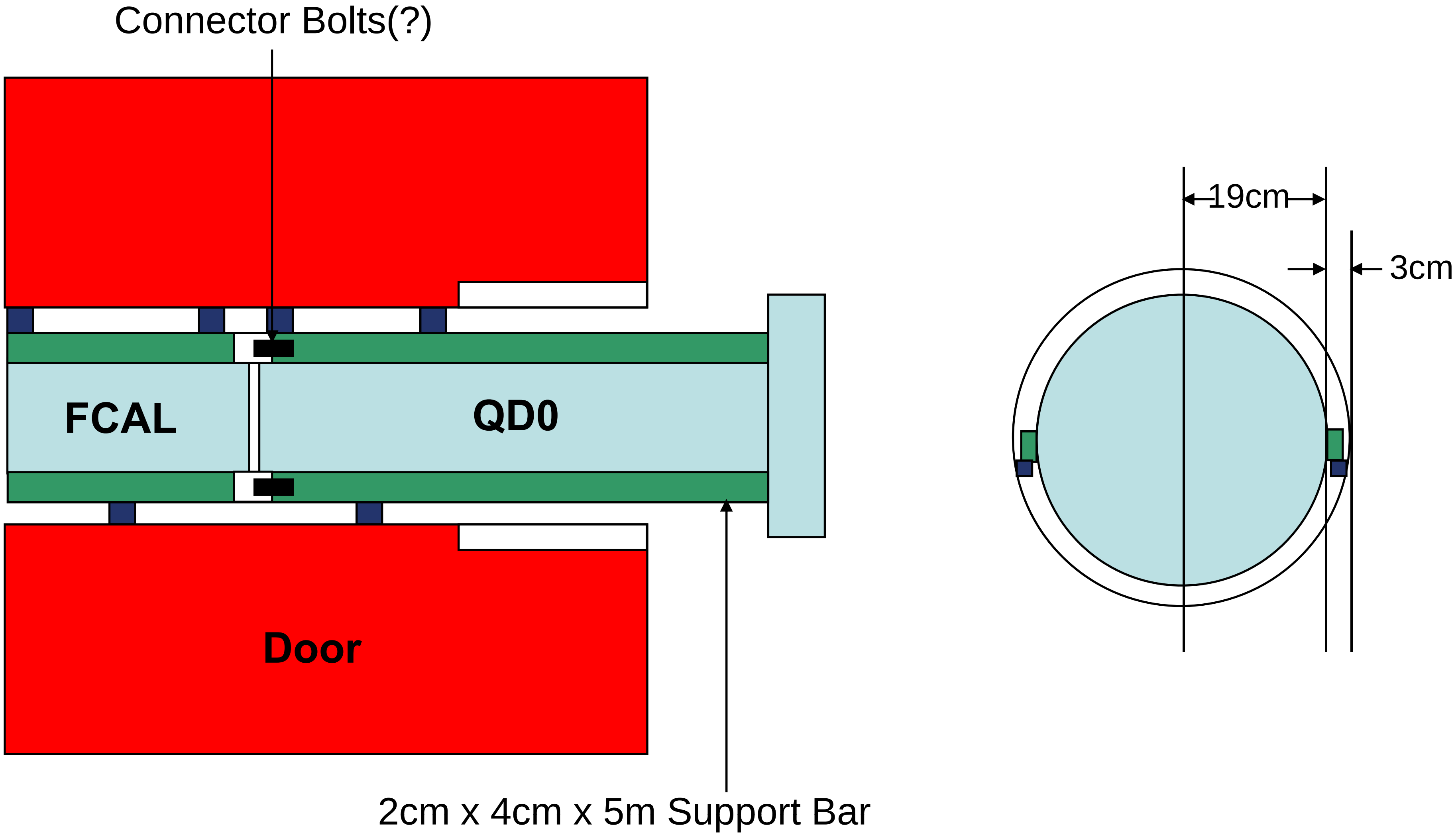


# Unlike SLD, Gossamer Tracker CANNOT Be used to Support FCAL+Mask Package → **MUST HANG OFF QD0**

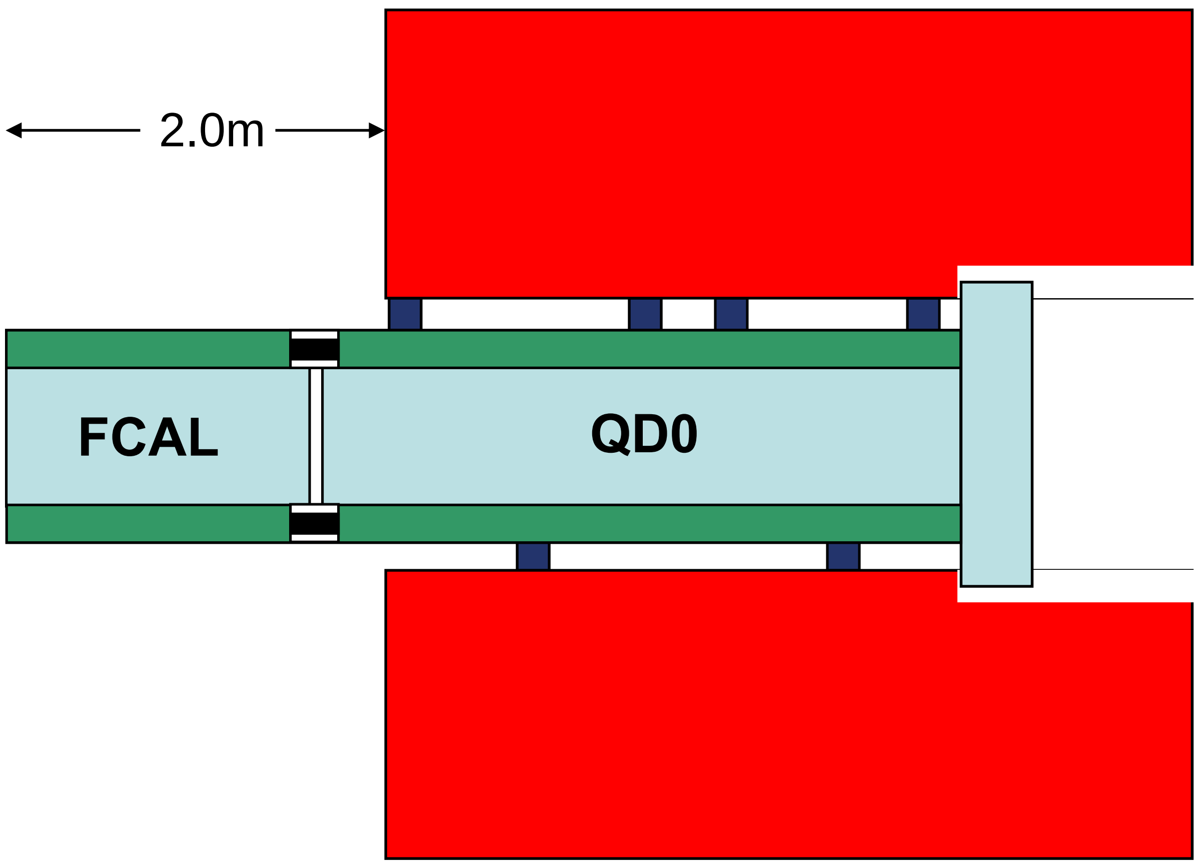
**(at least when door open)**



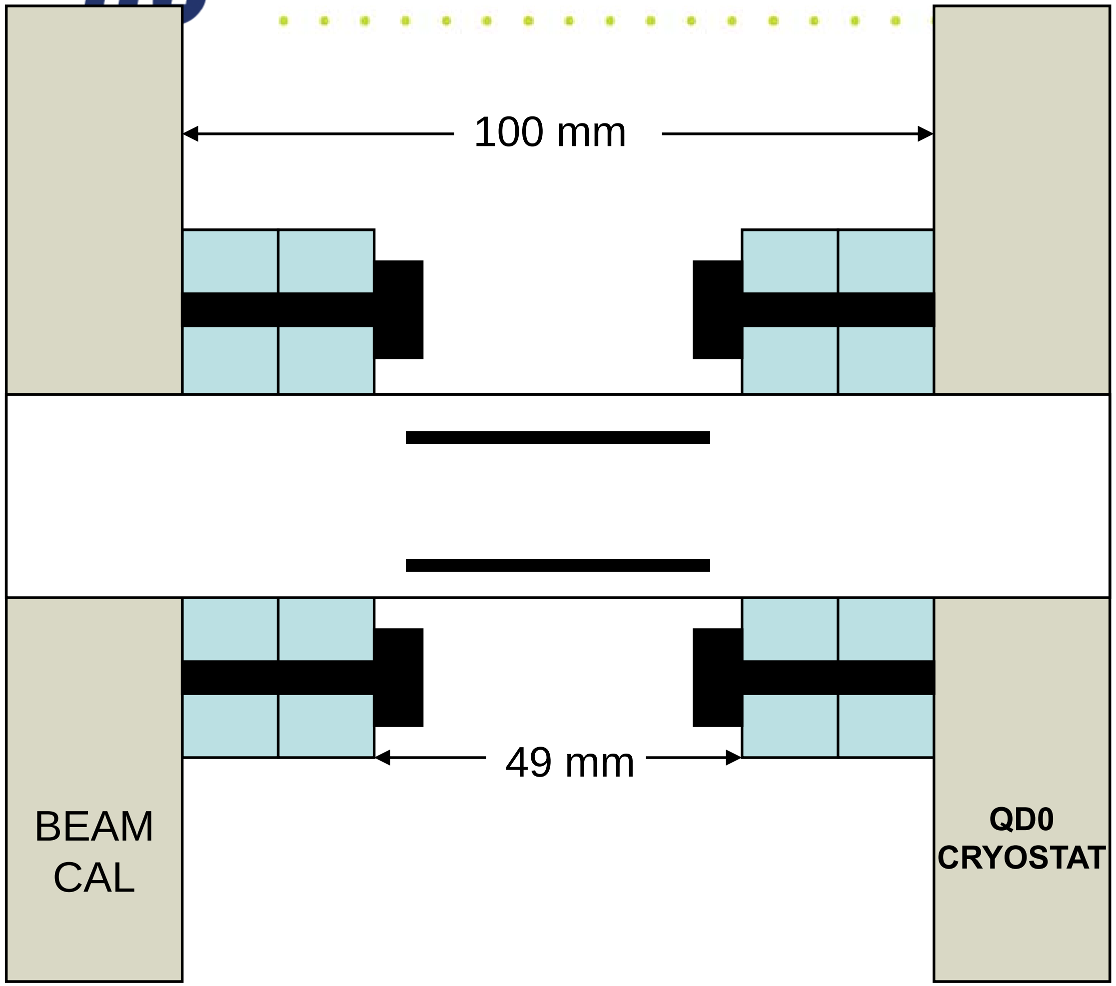
# FCAL/QD0 Supported with Door Closed



# FCAL/QD0 Supported with Door Open

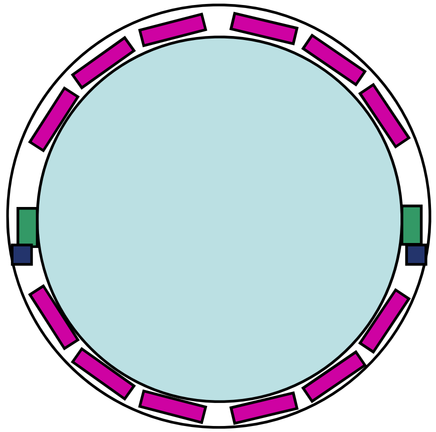


# Practical Details



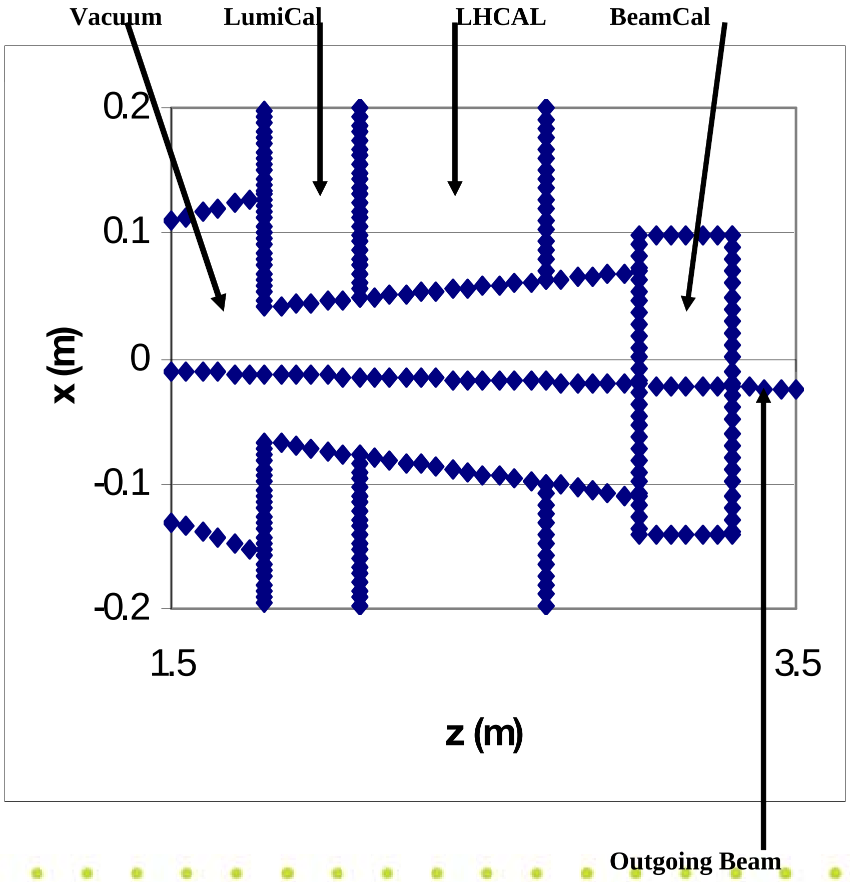

2 x 13.5mm Ø Beampipe (bellows?) with BPM
using 2.75” x 0.5” standard conflat flanges
1:1 scale

Space for Readout Services?



- SiD FCAL group focused on ONE Device which covers 30-80mrad and to a first approximation ignores LUMI aspects of BEAMCAL (inspired by LCD Design)

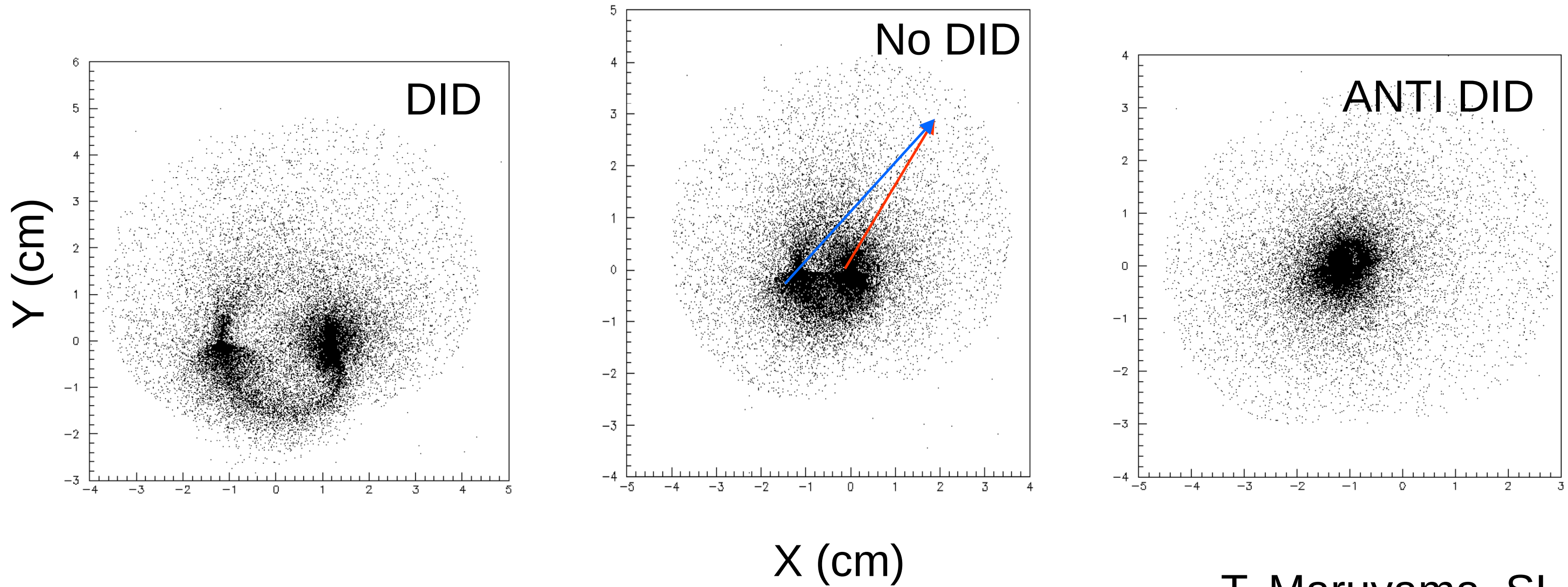
| | |
|---|---|
| LumiCal Inner Edge | ≈30mrad about outgoing beam |
| LumiCal Outer Edge | ≈113mrad about 0mrad (ECAL) |
| LumiCal Fiducial Region | ≈40-80mrad about outgoing beam |
| BeamCal Outer Edge | ≈40mrad about outgoing beam |
| LumiCal | ≈25 $X_0$ Silicon - Tungsten |
| BeamCal | ≈25 $X_0$ Rad-hard Silicon or Diamond - Tungsten |



## Study Pair distribution at Z = 168 cm to find minimum radius of beampipe and acceptance gain if LumiCal centered on Extraction Line

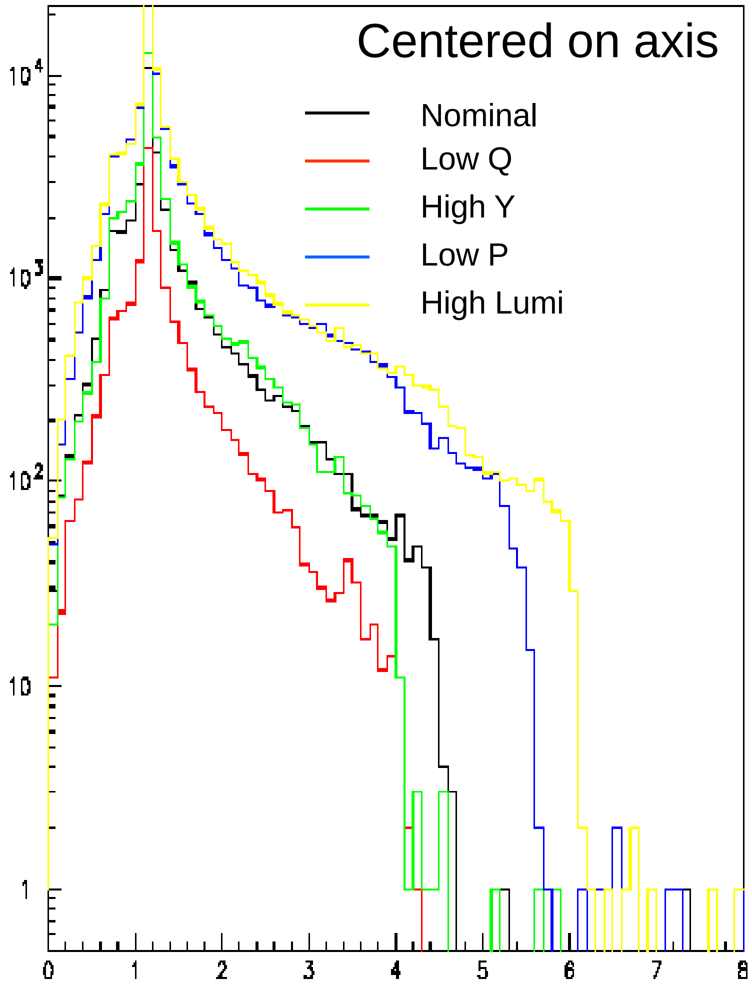
- Beam parameters – Nominal, Low Q, High Y, Low P, High Lumi
- Solenoid field strength – 5 Tesla vs. 4 Tesla
- Crossing angle (14 mrad) + DID/ANTI-DID

ILC 500 GeV Nominal beam parameters + 5 Tesla

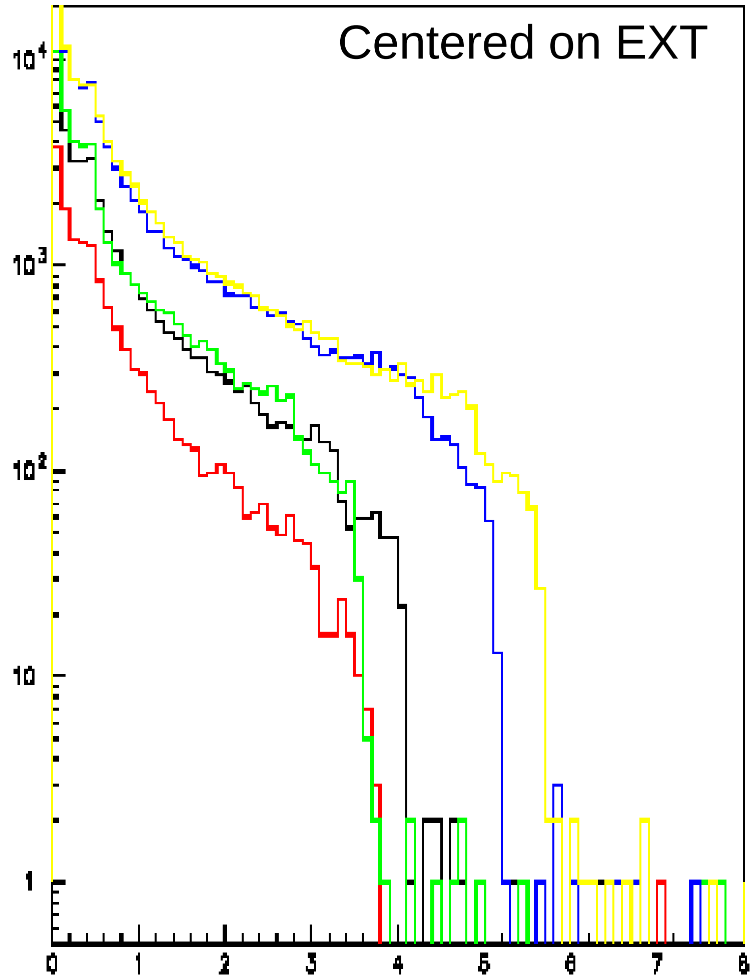



T. Maruyama, SLAC

ILC 500 GeV




R (cm ) from (0,0)




R (cm) from (-1.176 cm, 0.)

# Pair Radius in cm at Z=168 cm

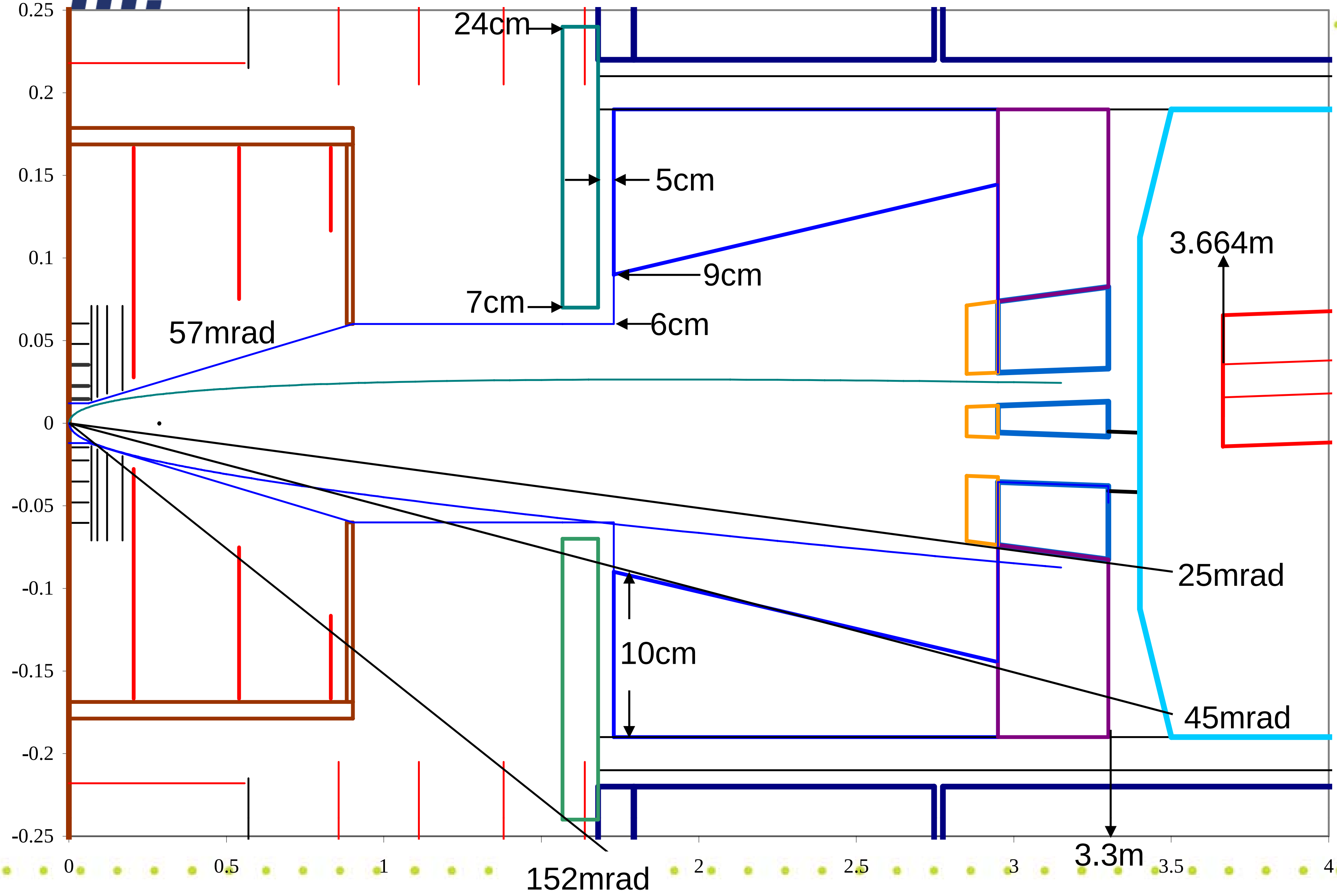
| | 4 Tesla | | | 5 Tesla | | |
|---|---|---|---|---|---|---|
| | ANTI-DID | NO DID | DID | ANTI-DID | NO DID | DID |
| Nominal | 5.2 / 4.7 | 5.1 / 5.5 | 5.8 / 6.5 | 4.7 / 4.1 | 4.4 / 5.1 | 5.3 / 6.1 |
| Low Q | 4.7 / 4.2 | 4.4 / 5.1 | 5.3 / 6.0 | 4.2 / 3.8 | 3.8 / 4.6 | 4.8 / 5.6 |
| High Y | 4.6 / 4.2 | 4.6 / 5.1 | 5.5 / 6.0 | 4.3 / 3.9 | 4.1 / 4.6 | 4.9 / 5.7 |
| Low P | 6.3 / 6.0 | 6.2 / 6.8 | 6.8 / 7.6 | 5.7 / 5.3 | 5.5 / 6.1 | 6.4 / 7.0 |
| High Lumi | 7.0 / 6.6 | 6.8 / 7.3 | 7.4 / 8.2 | 6.2 / 5.9 | 6.1 / 6.7 | 6.7 / 7.5 |

Radius in black is measured from solenoid axis (x,y) = (0., 0.).
Radius in red is measured from extraction line (x,y) = (-1.176 cm, 0.)

# LUMON acceptance

- Inner radius of LUMON can be smaller than 8.1 cm used previously
  - **Nominal + 5 Tesla: 8.1 cm $\rightarrow$ 5.0 cm (30 mrad)**
  - **4 Tesla $\rightarrow$ +3 mrad $\rightarrow$ 5.5 cm (33mrad)**
  - **Low P $\rightarrow$ +6 mrad $\rightarrow$ 6.0 cm (36mrad)**
  - **High Lumi $\rightarrow$ +9 mrad $\rightarrow$ 6.5 cm (39mrad)**
- Centering LUMON on the extraction line has an advantage only when ANTI-DID is used.

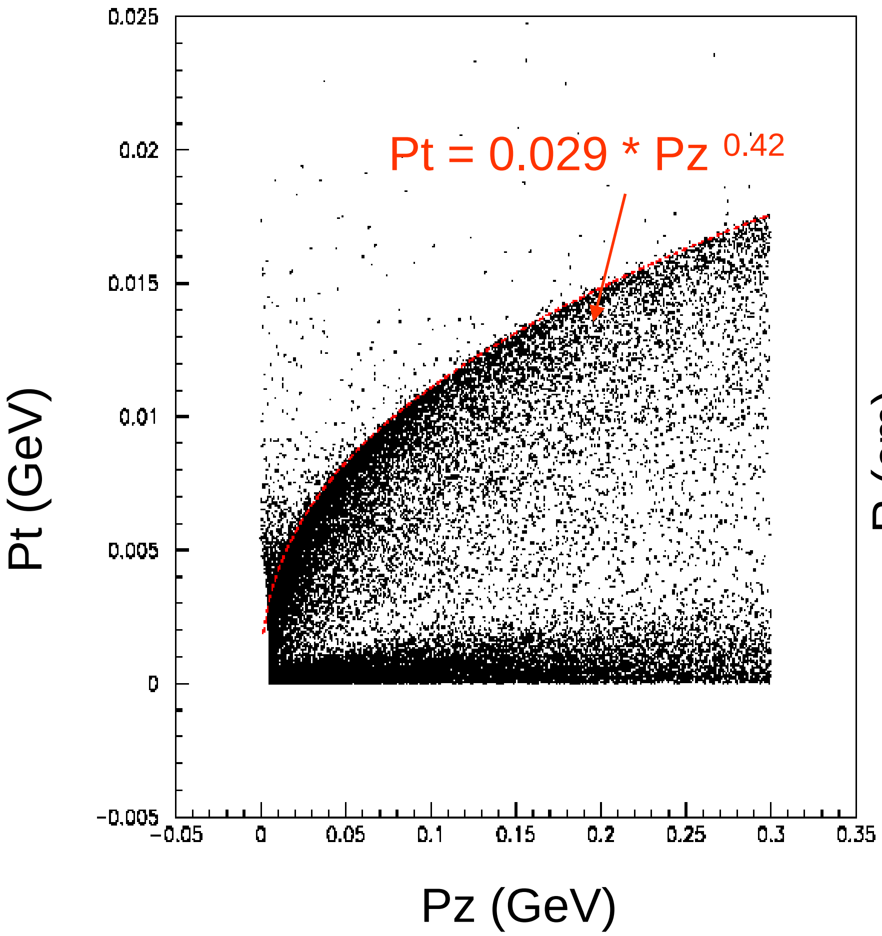
# Suggested FCAL Layout for Discussion

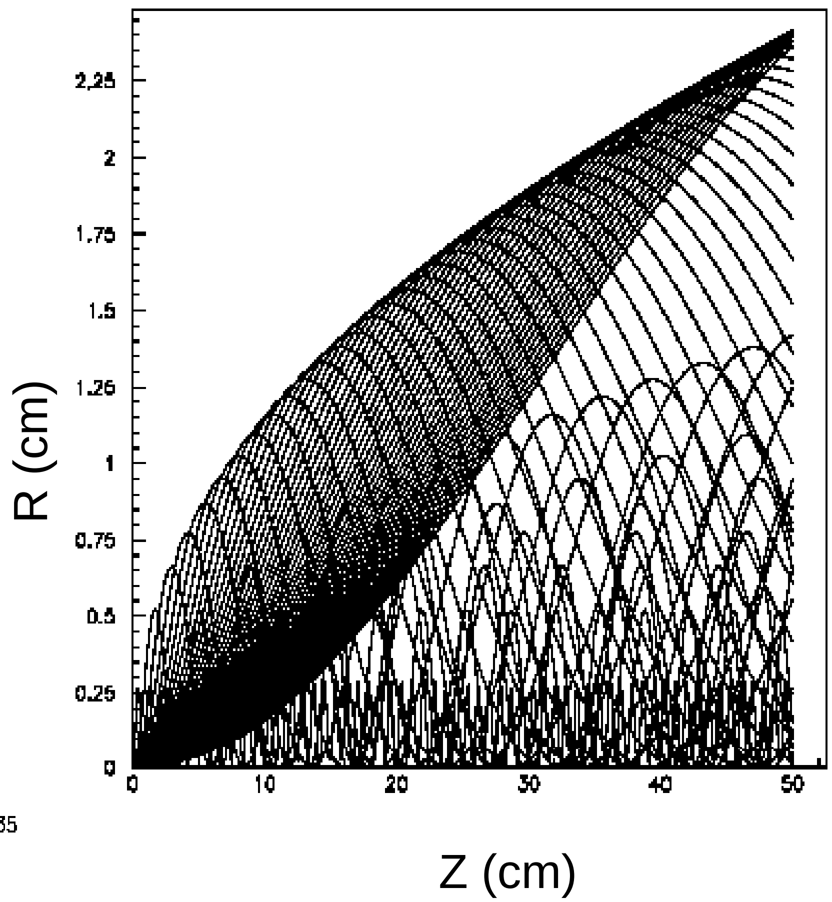


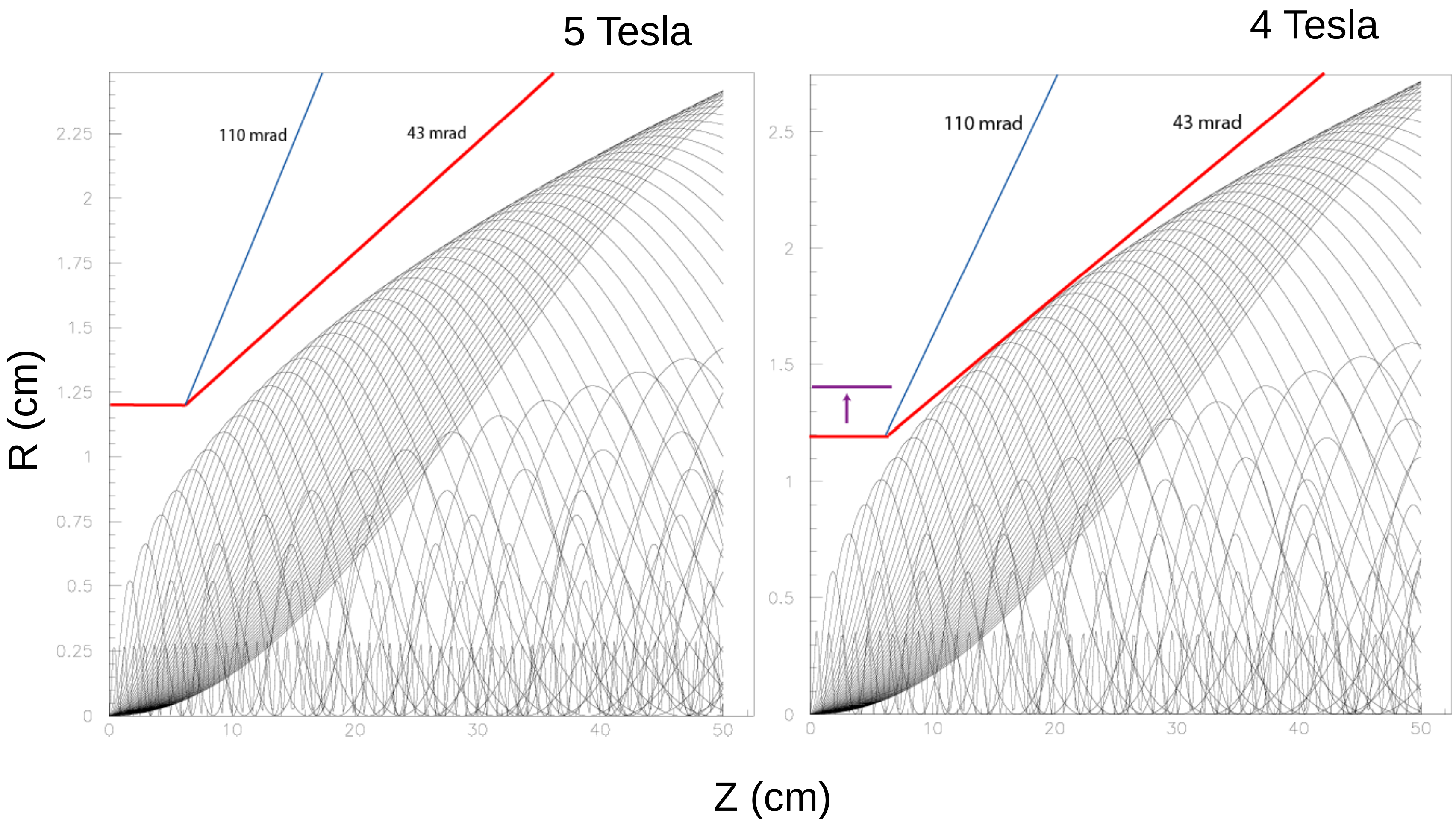
# Finding the pair edge

ILC 500 GeV Nominal Beam Parameters

5 Tesla + 14 mrad NO DID



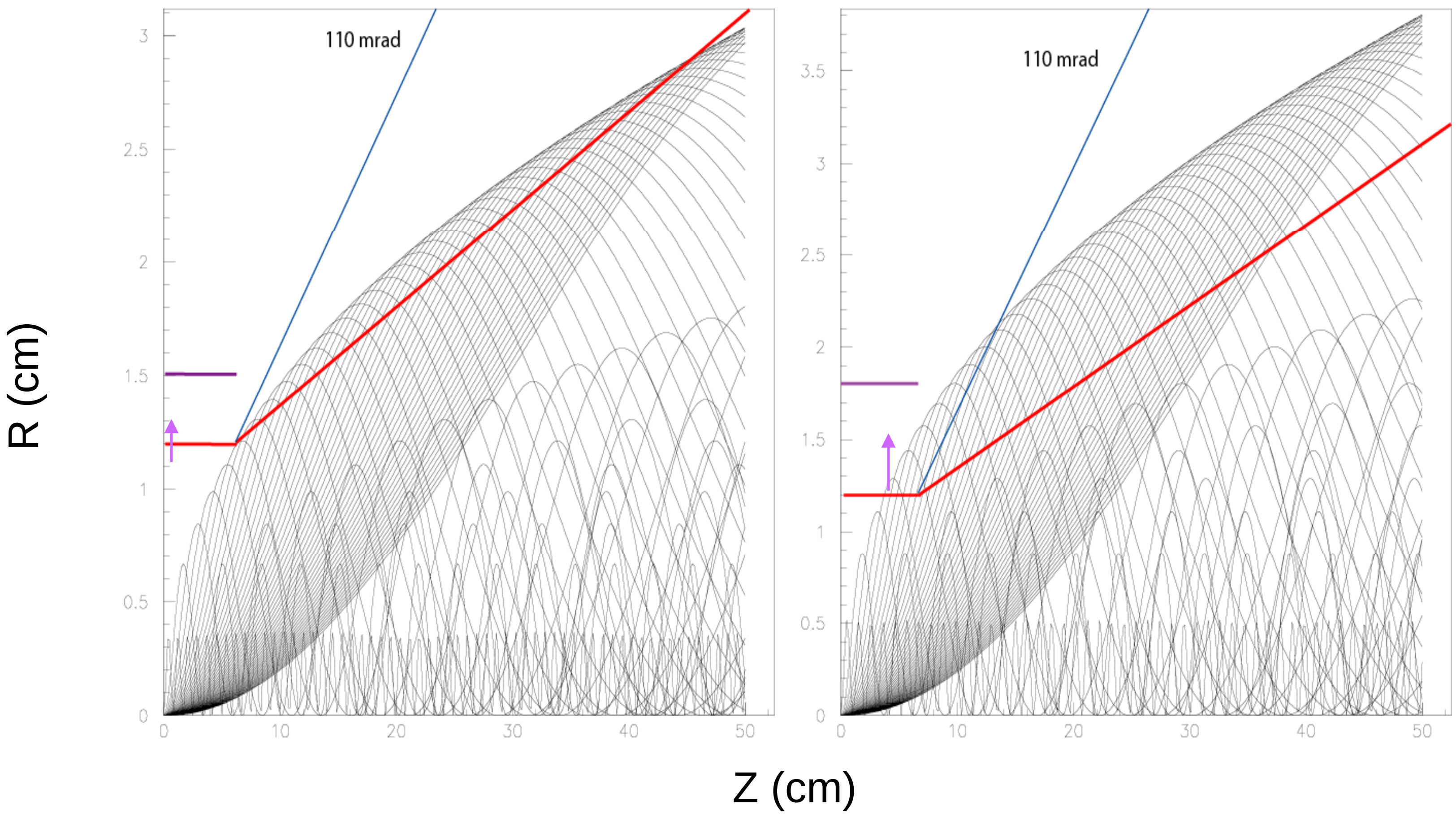





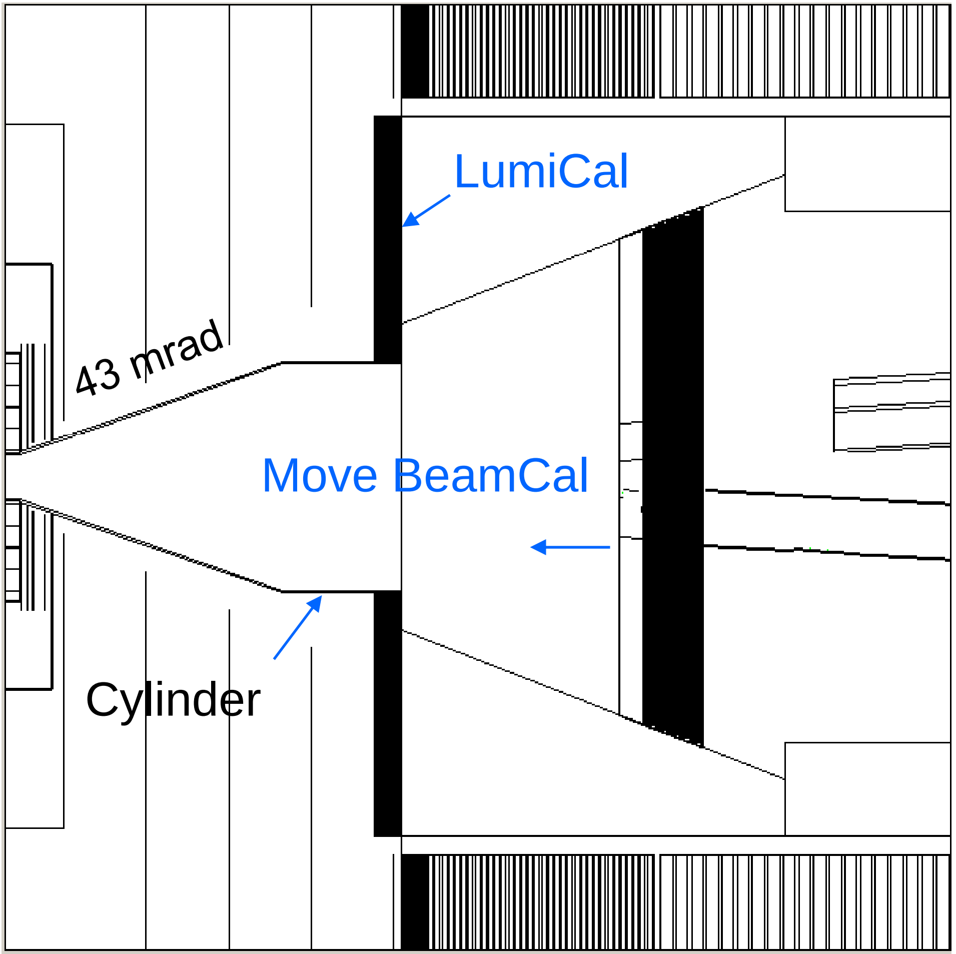

For 4 Tesla, R=1.2 cm is tight and 43 mrad is too small.
R=1.4 cm and 110 mrad beam-pipe would work.

# Current Beam pipe is not compatibe with the Low P or High Lumi options.

500 GeV Low P + 5 Tesla　　500 GeV High Lum + 5 Tesla

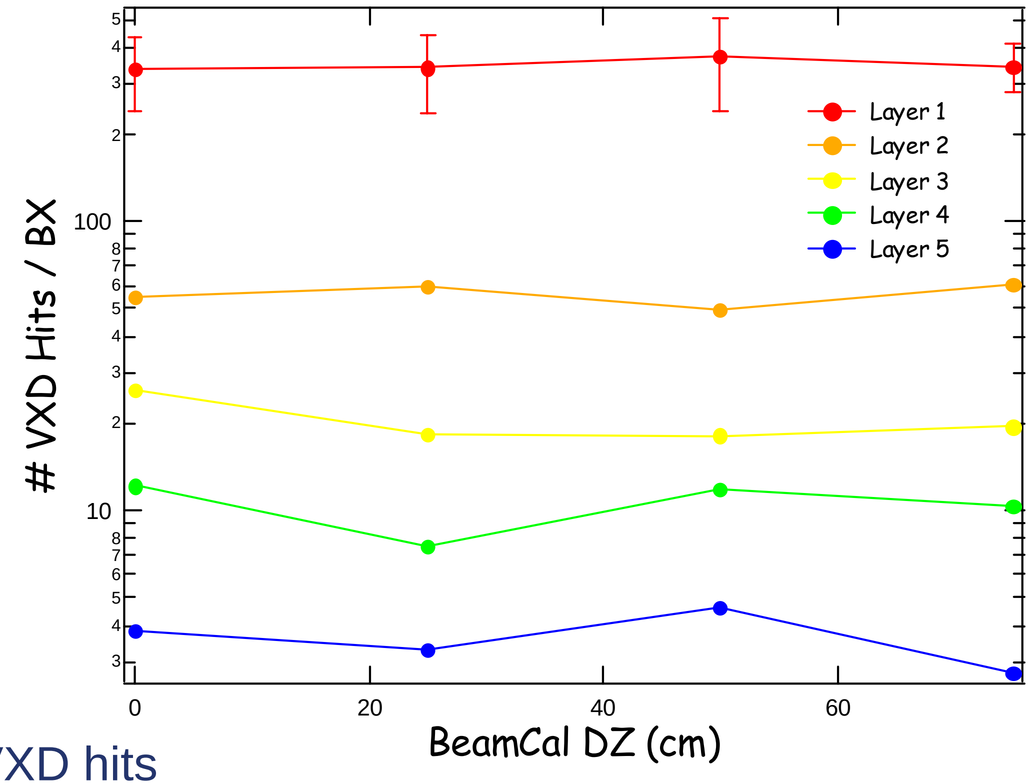


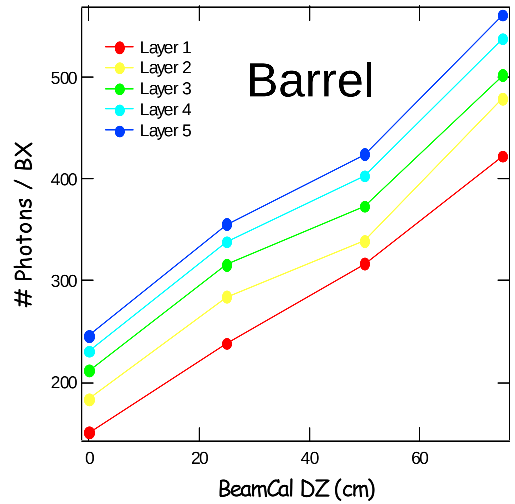

110 mrad beam-pipe would work as long as
R= 1.2 cm → 1.5 cm (Low P), and R= 1.2 cm → 1.8 cm (High Lumi).

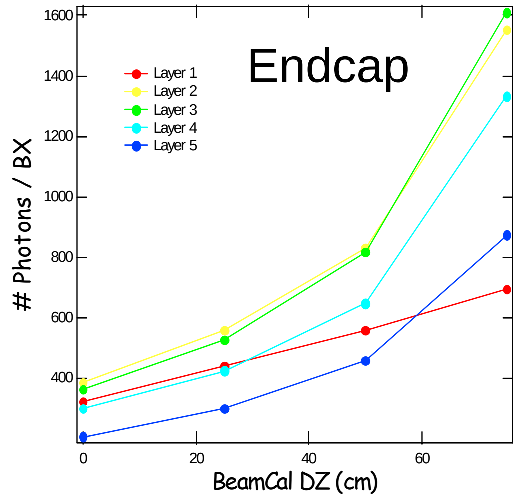



- LumiCal
  - **Z=156.75 – 168 cm**
  - **$R_{inside}$=6cm**
- Beampipe
  - **Original 43 mrad cone + cylinder**
- M1 geometry is the same.

# Si Tracker Photons vs. BeamCal DZ




VXD hits

**No effects from LumiCal/BeamCal changes**

Si Tracker hits

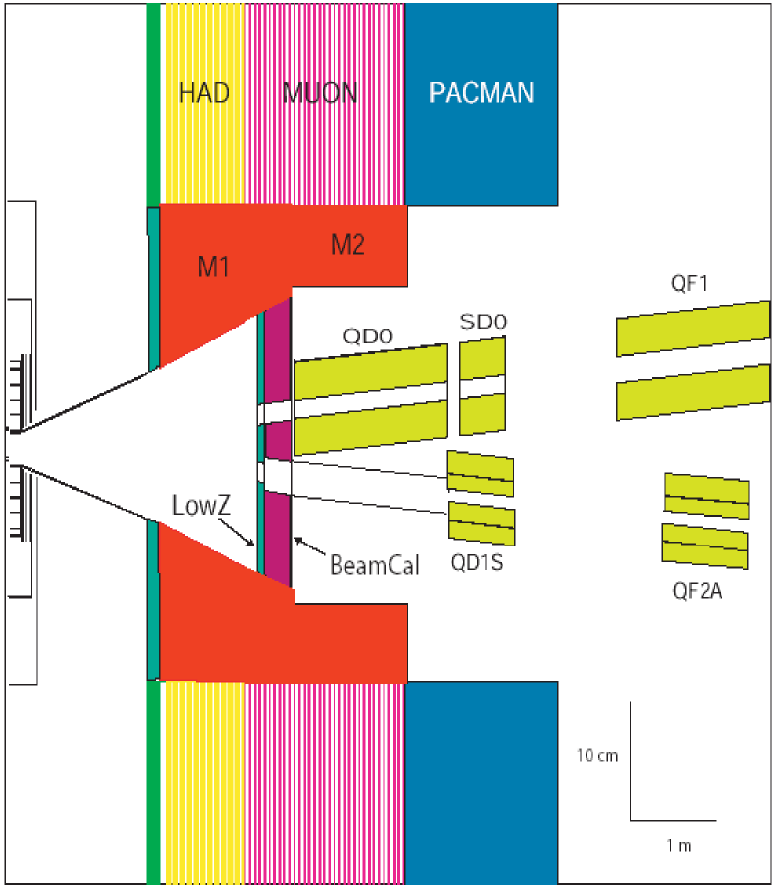
**New LumiCal has less photons**

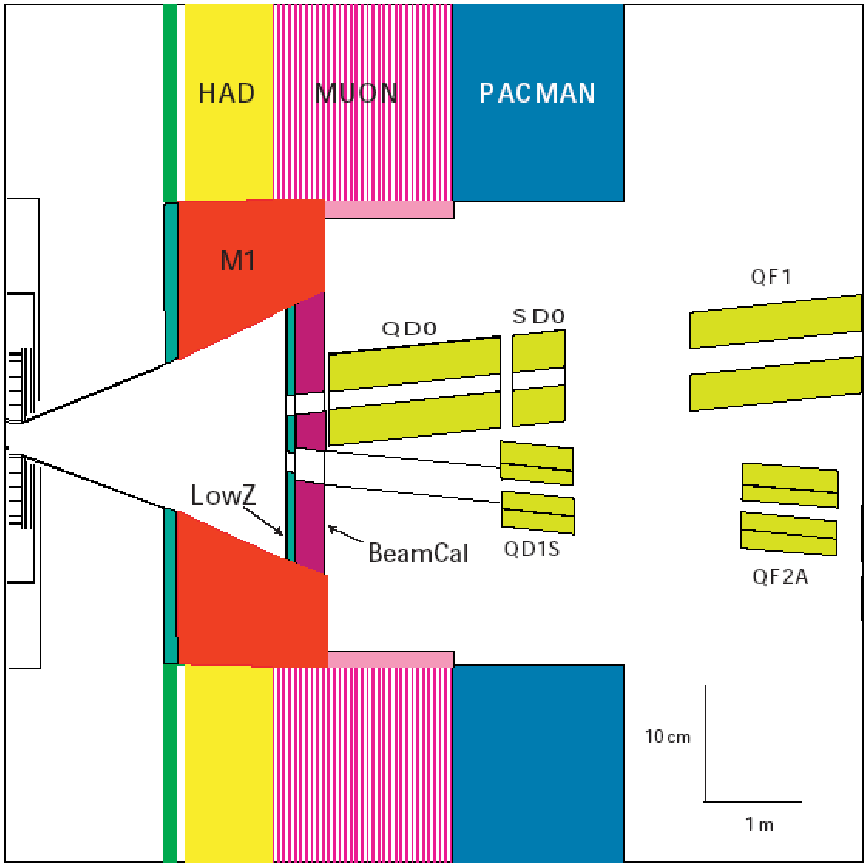
**# photons increases by moving the BeamCal forward.**

**But the rate is acceptable if $\delta Z < 30$ cm.**

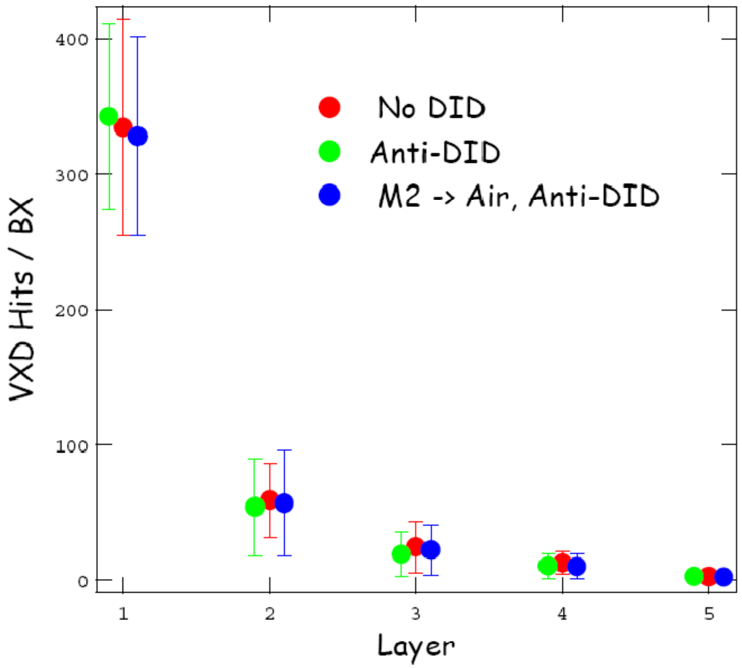
Endcap photon rate increases quadratically at $\delta Z > 30$ cm.

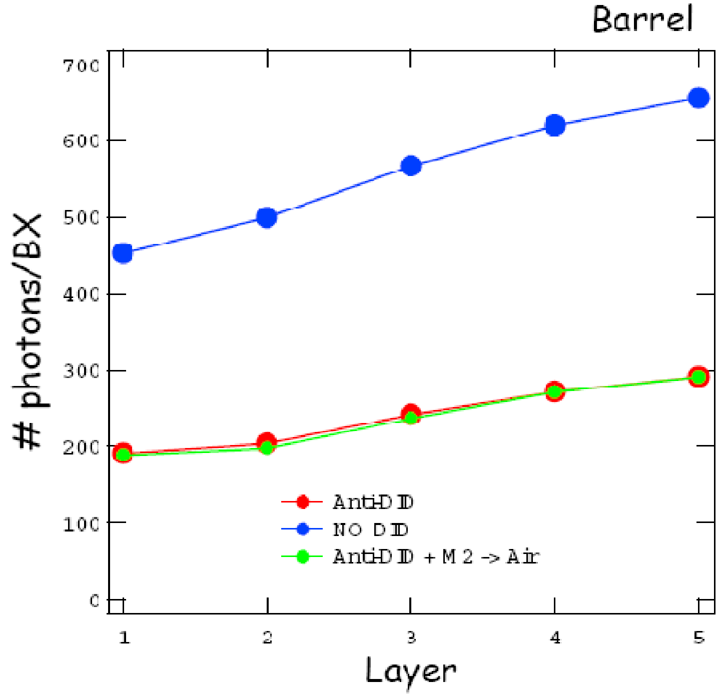
# Is M2 NEEDED or NOT????

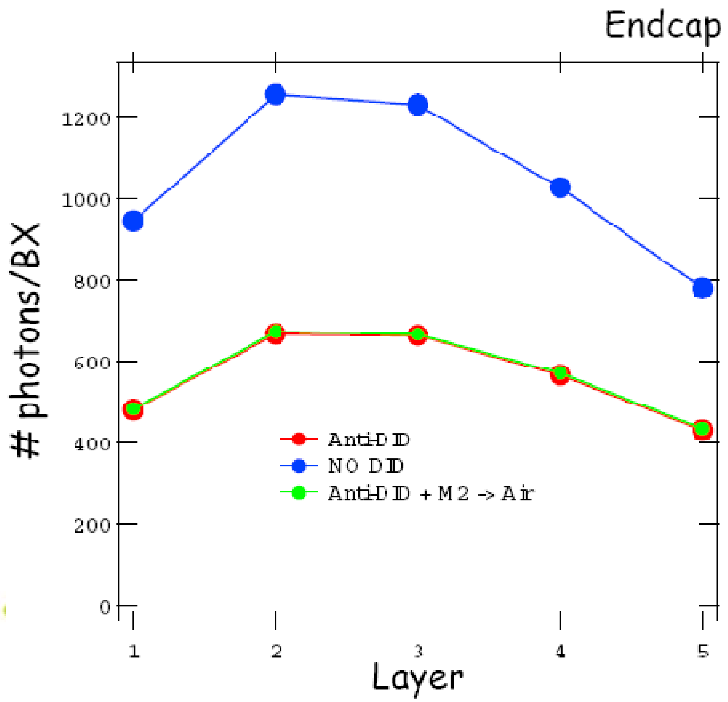


# No M2 Mask Needed



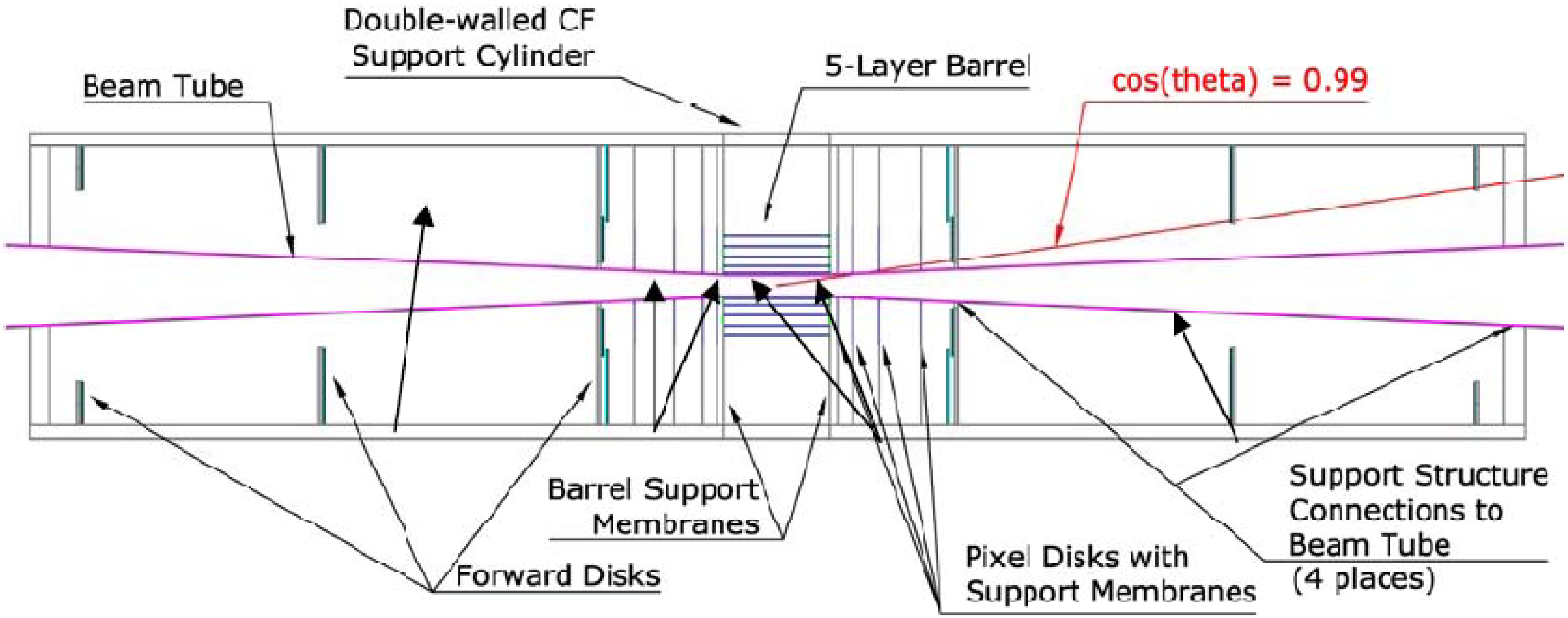



# Conclusions

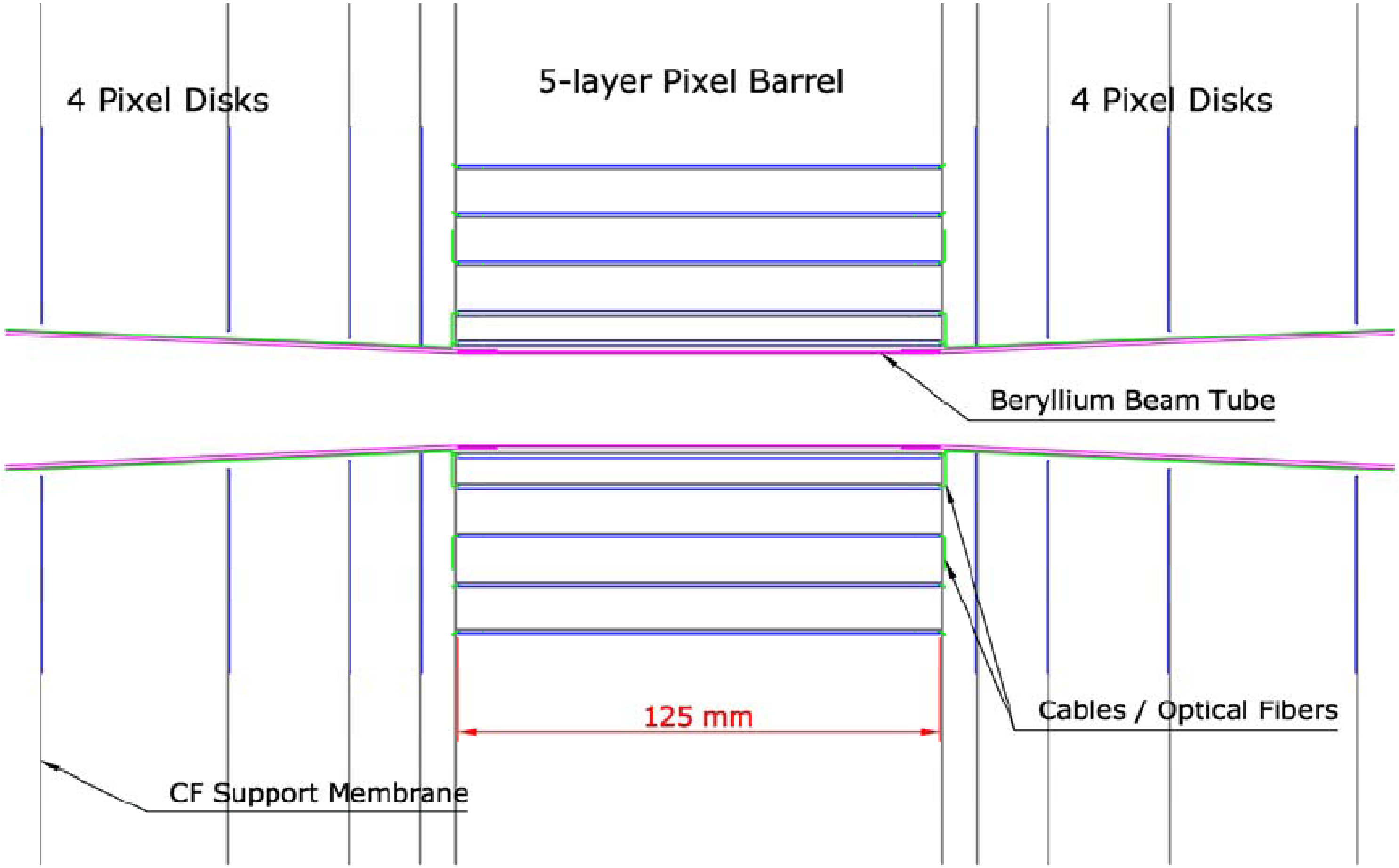
- Due to excellent work by Brett Parker & BNL cryo-engineering team and systematic studies done by Takashi Maruyama a SiD MDI design is being developed with "common sense" "engineering" proposals from Breidenbach, Burrows, TWM
- Everything presented is solely to aid discussion, nothing final
- Looking forward to September IR Engineering workshop and beginning of "real engineering"

# Bonus Material Follows

# VXD and Support Structures

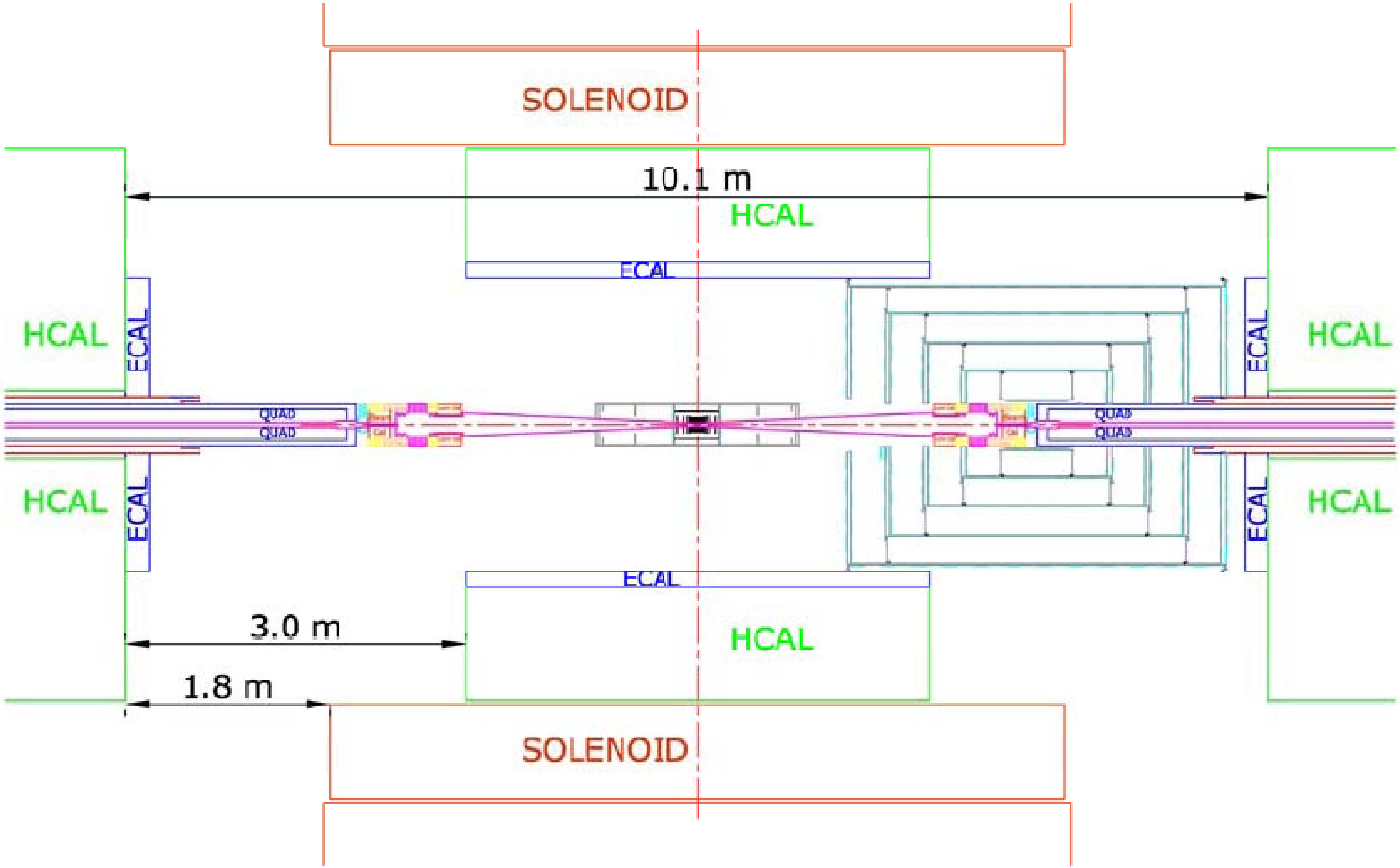


# R-Z View of the Pixel VXD



# SiD Open for Access to the VXD Region

## What Opening is Required for Access ON Beamline?



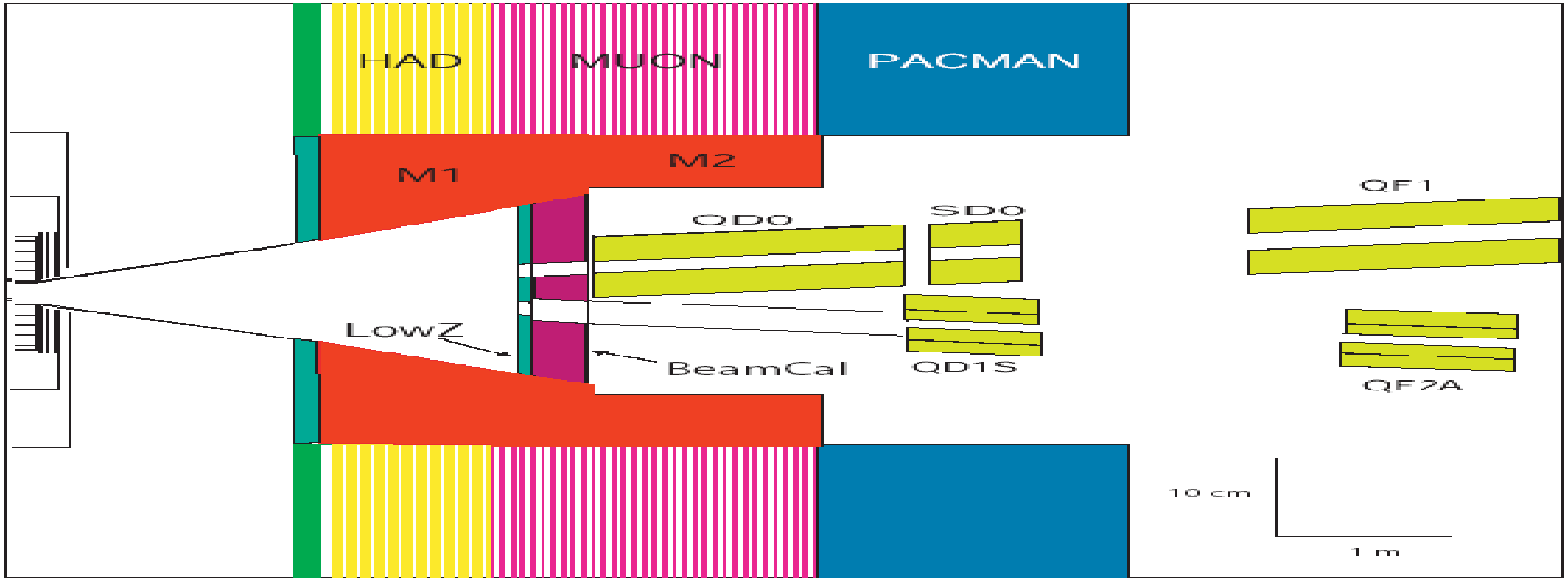
# Detector background update for L*=3.51 m, L*(ext)=5.5m

Takashi Maruyama

# Updates

- SiD Detector with 14 mrad crossing angle
  - **5 Tesla solenoid field map + Anti-DID field**
- L*=3.51 m and L* (ext)=5.50 m
- ILC 500 GeV Nominal beam parameters
- Sync radiations from FF quads
  - **No sync radiations in the beamline apertures.**
  - **Collimation depth**
- e+/e- background in vertex detector
- Photon background in Si tracker
- Neutrons in vertex detector

14 mrad crossing geometry in Geant 3 and FLUKA




Apertures:

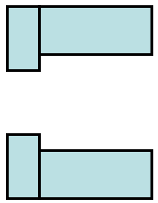
QD0

R=1.0 cm@z=-3.51 m

Beampipe@IP

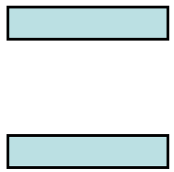
1.2 cm@0.0m

Low Z



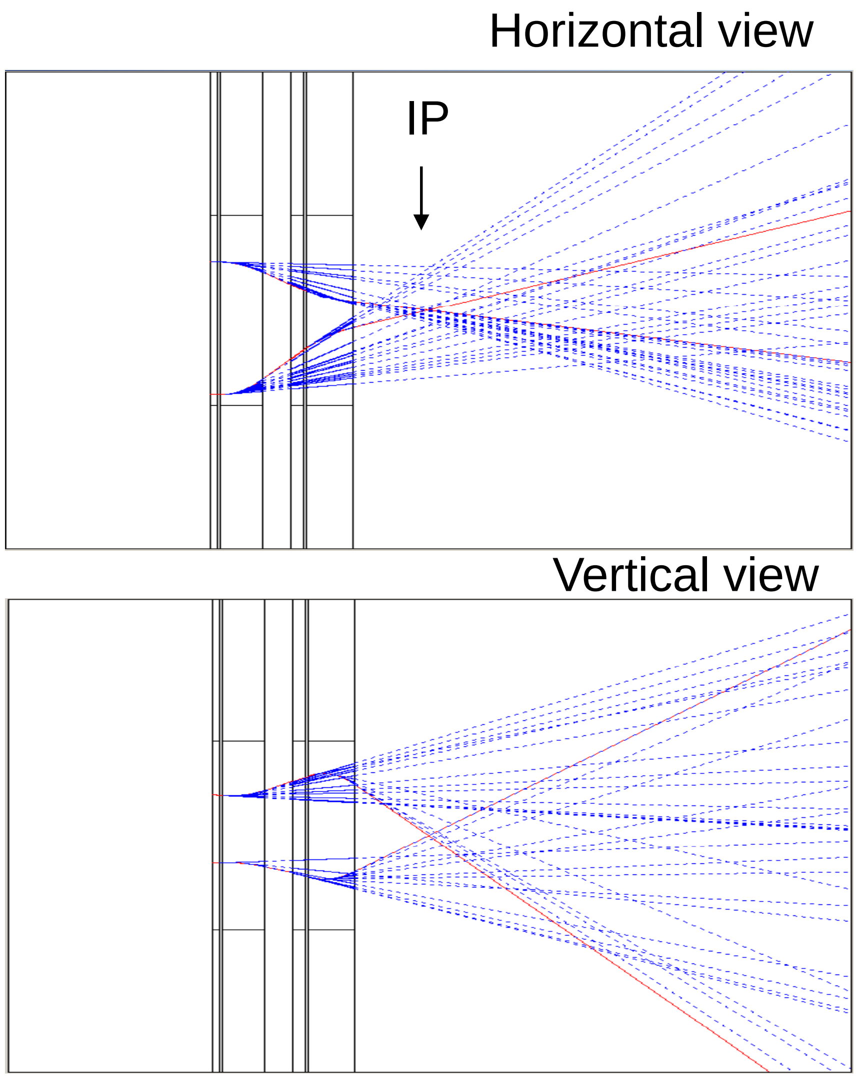
1.35 cm
@2.85-2.95m

QD1S

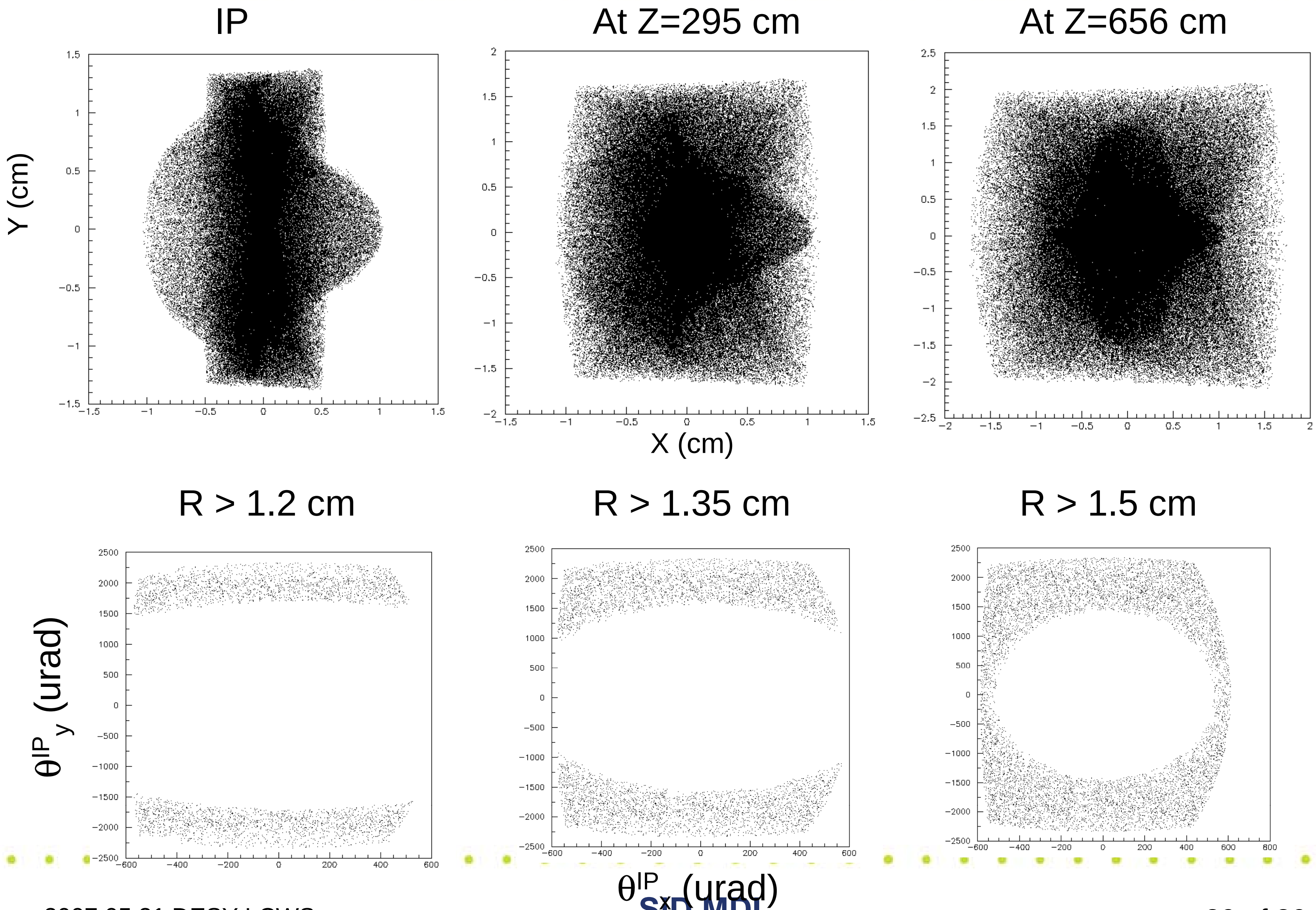


1.5 cm
@5.5-6.56m

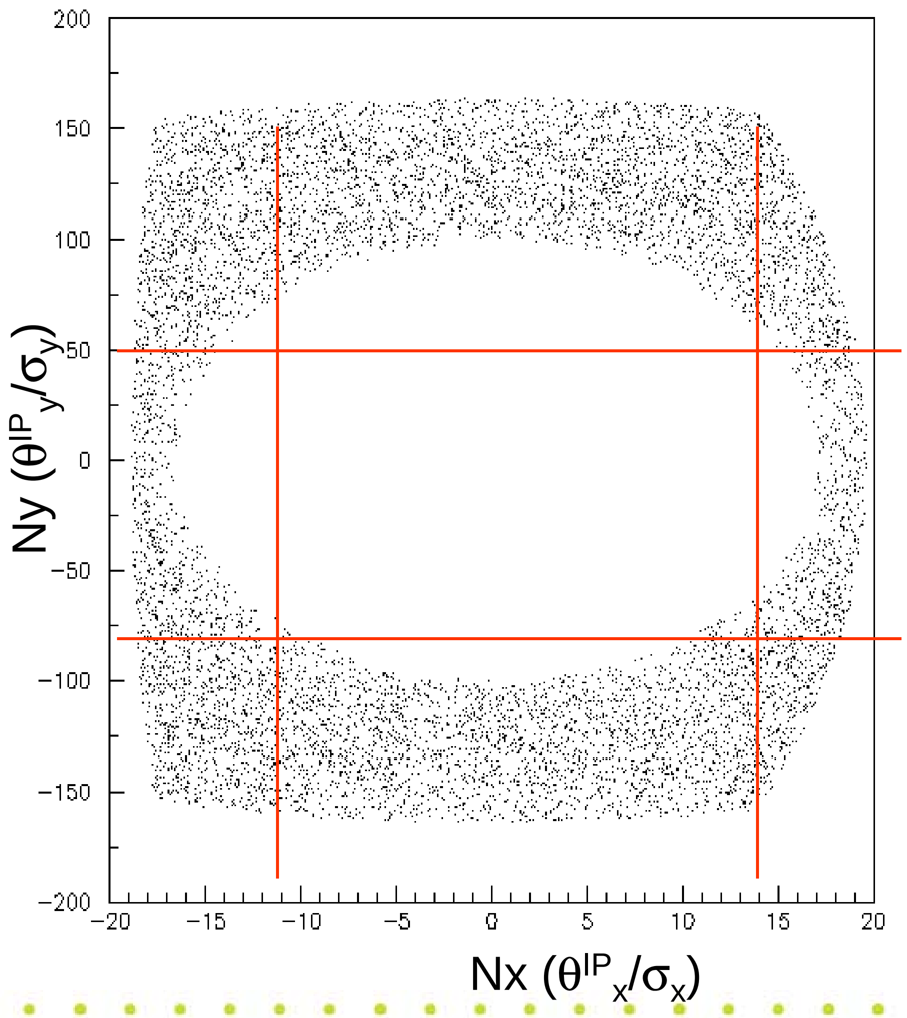
- Back track 250 GeV beam from IP to SF1 without sync radiation, then track from SF1 to IP with sync radiation generation.
- Look at sync radiations at IP, Z=295 cm (Low Z), and Z=656 cm (Extraction Quad exit).



# Sync radiations from FF quads



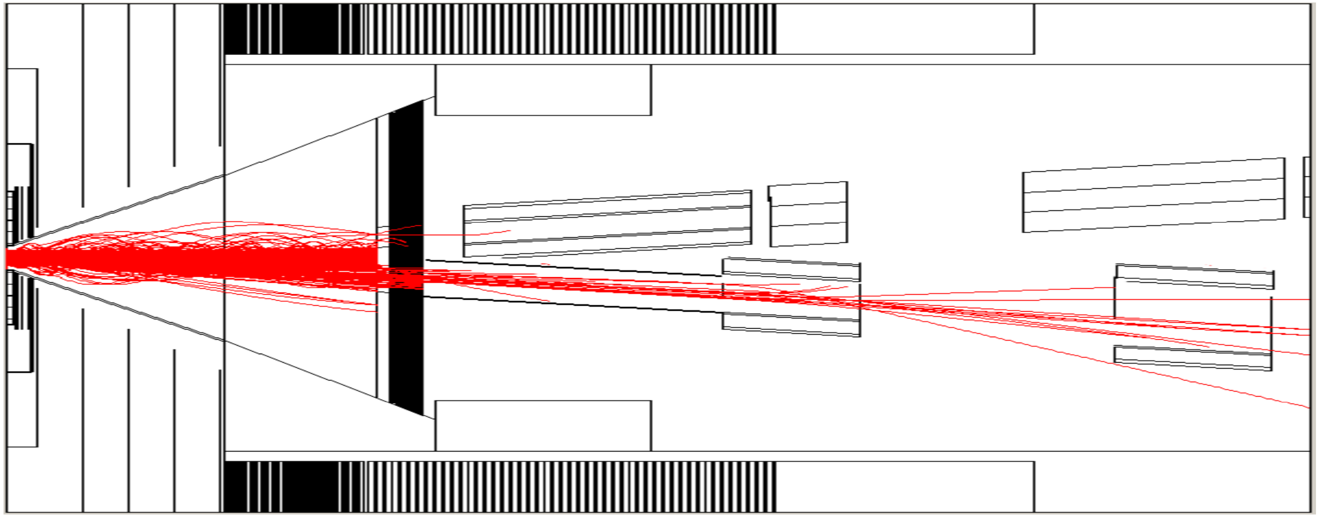
- First extraction quad constrains the collimation depth.
- Consistent with Frank Jackson (BILCW07)
  - **11.9σx 70.7σy in red lines**
- Collimation depth cannot be defined by just two numbers.– The elliptical curve in (nx, ny) must be used.
- Does the collimation in the collimation section actually achieve this collimation depth?
- Need to study re-population outside the collimation depth.



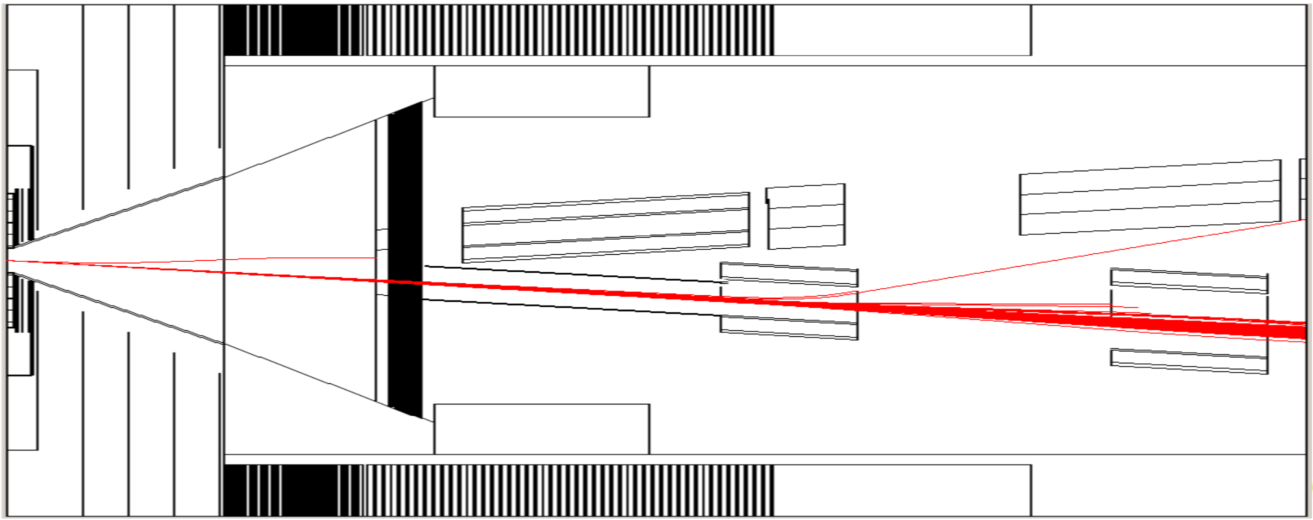
# Pairs and radiative Bhabhas in 14 mrad crossing geometry

Interaction is turned off.

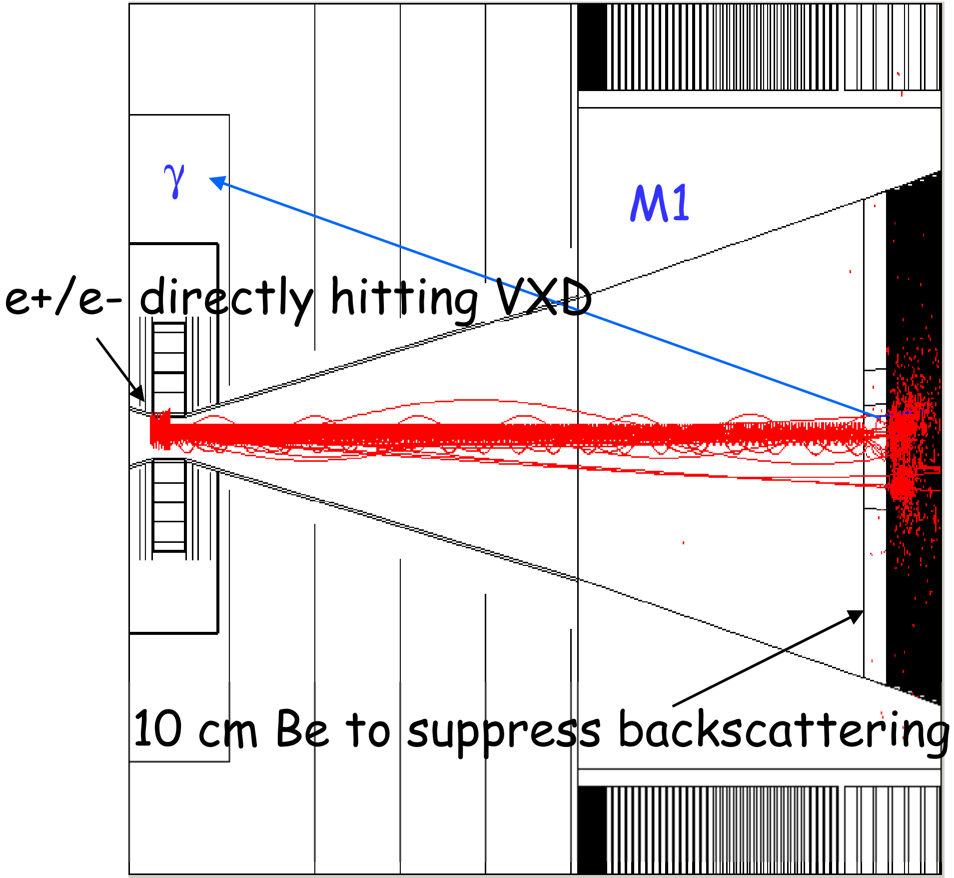
Pairs



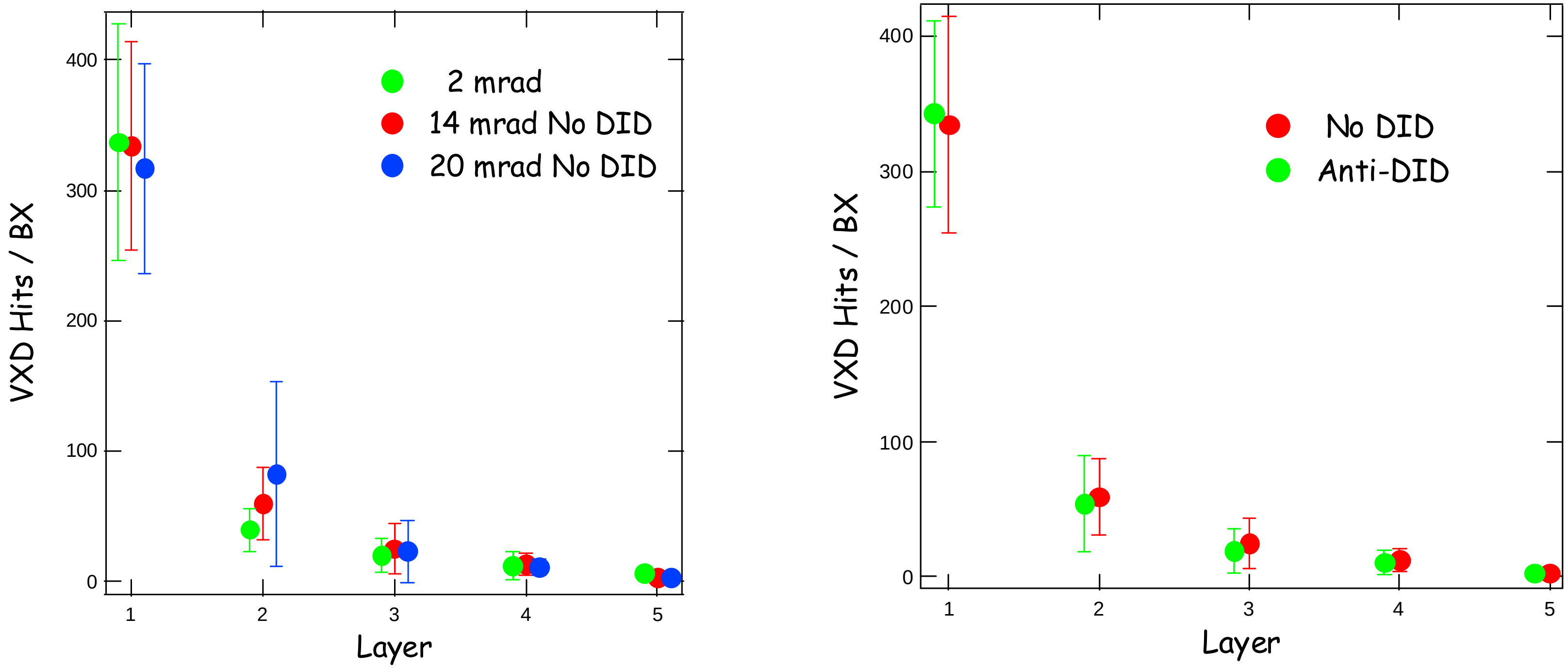
Radiative Bhabhas



# Pair background in Tracker

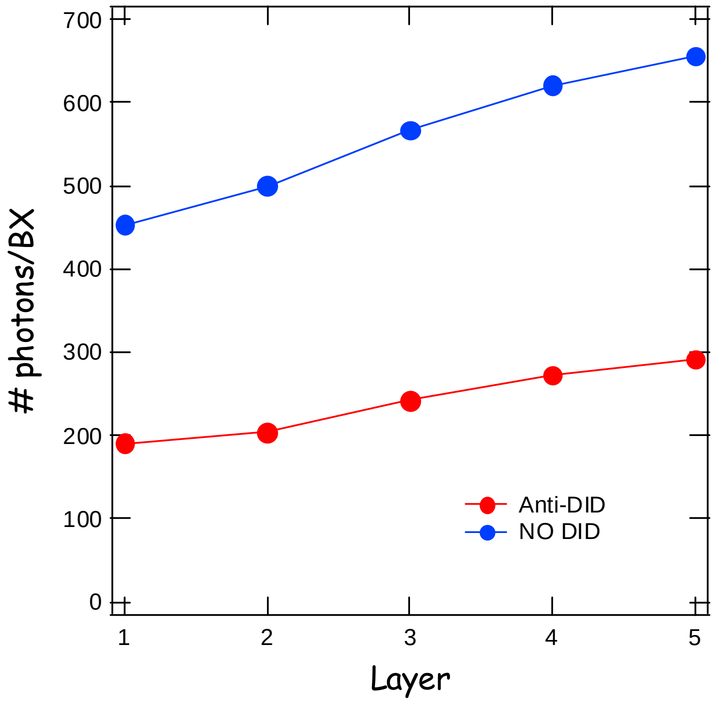


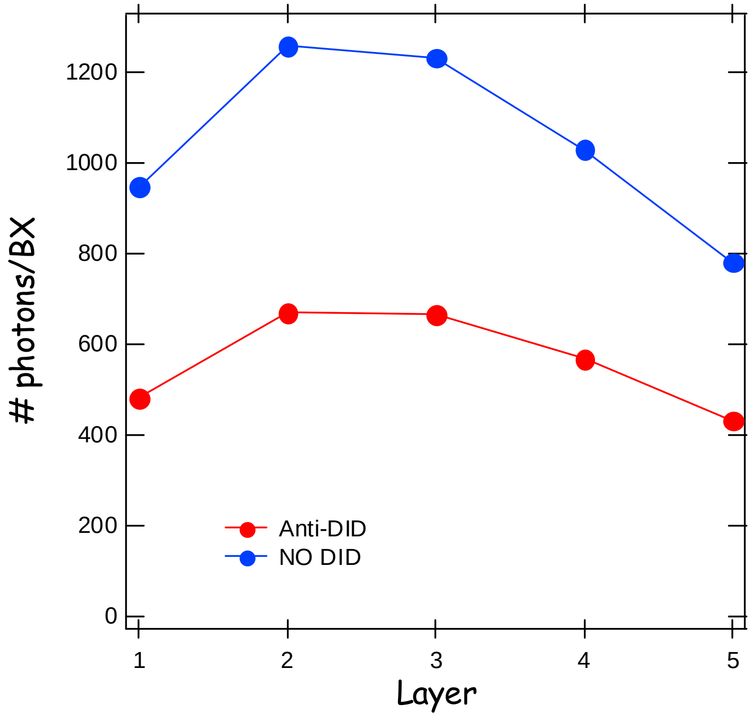

- **e+/e- directly hitting VXD and Si Tracker.**
  - e+/e- can spiral many times; multiple VXD hits
- **e+/e- backscattering from BeamCal is ~10% of VXD hits.**
- **Photons from beam pipe and VXD**
- **Photons from BeamCal**
  - M1 aperture and length are important




- Use 20 statistically independent bunches.
  - **Bunch-to-bunch fluctuation is much larger than the crossing angle difference or DID dependence.**
- e+/e- VXD hits come primarily from pairs directly reaching the vertex detector layers.
- Different L* designs should not have any significant effect.

# Photons into Si Tracker



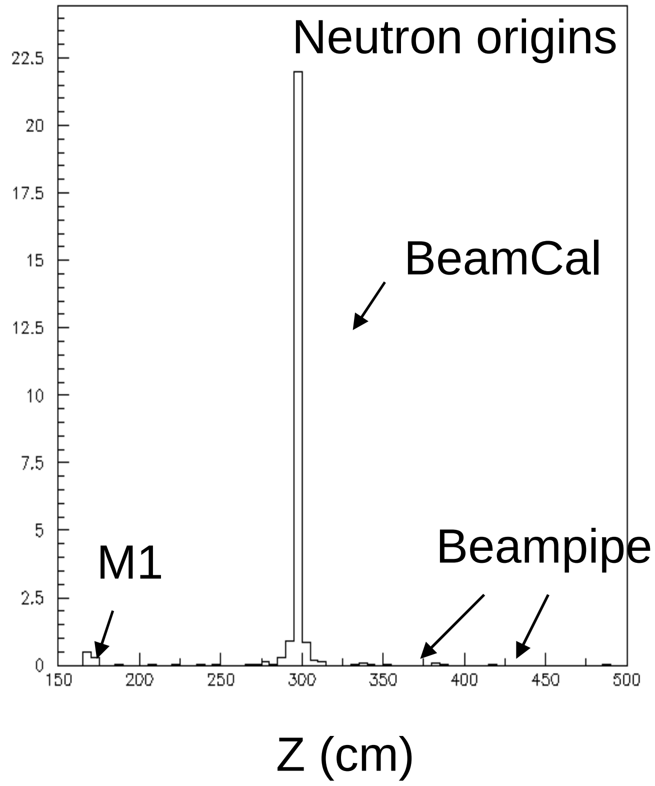




- Secondary photons generated in BeamCal dominate the tracker background.
  - **The more energy dumped in BeamCal, the more photons.**
- Smaller crossing angle is better.
- Anti-DID can reduce the photon rate by a factor of two; comparable to 2 mrad crossing.
- Different L* design should not affect the photon rate.

# Neutrons in VXD (FLUKA)

## Neutrons from pairs

| | Hits/cm$^2$/BX | Hits/cm$^2$/1x10$^7$sec |
|---|---|---|
| No DID | $(3.6 \pm 0.2)$x10$^{-3}$ | 5.0x10$^8$ |
| Anti-DID | $(2.4 \pm 0.2)$x10$^{-3}$ | 3.4x10$^8$ |
| DID | $(4.1 \pm 0.2)$x10$^{-3}$ | 5.7x10$^8$ |




## Neutrons from radiative Bhabhas

| | Hits/cm$^2$/BX | Hits/cm$^2$/1x10$^7$sec |
|---|---|---|
| No DID | $(1.6 \pm 0.4)$x10$^{-4}$ | 0.22x10$^8$ |
| Anti-DID | $(0.3 \pm 0.2)$x10$^{-4}$ | 0.04x10$^8$ |
| DID | $(2.0 \pm 0.6)$x10$^{-4}$ | 0.27x10$^8$ |

- Neutrons that reach the vertex detector are mostly generated in the BeamCal.
- Anti-DID can reduce the neutron flux.
- Different L* design should not affect the neutron flux.