Background driven SiD design decisions

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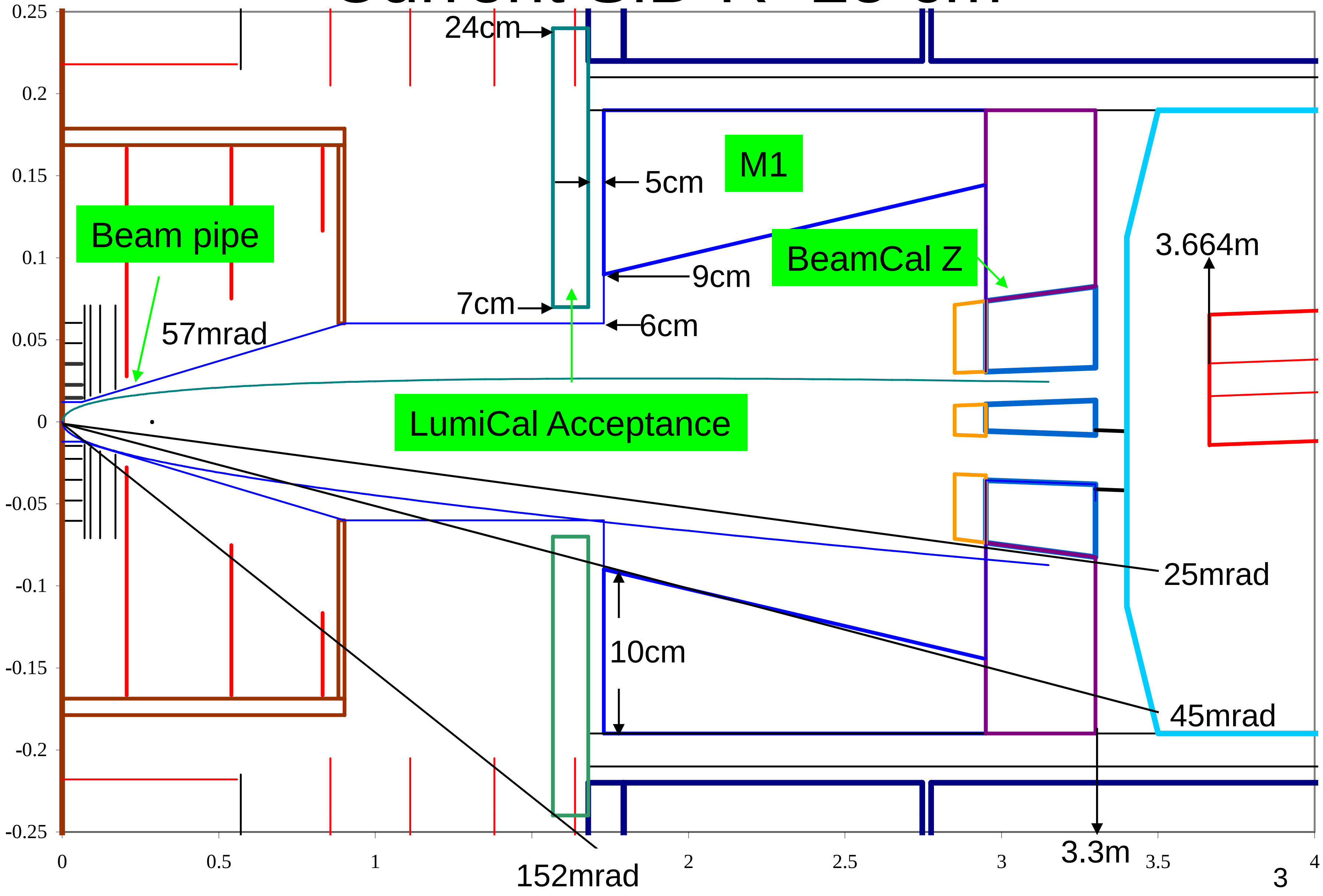
Backgrounds and Issues

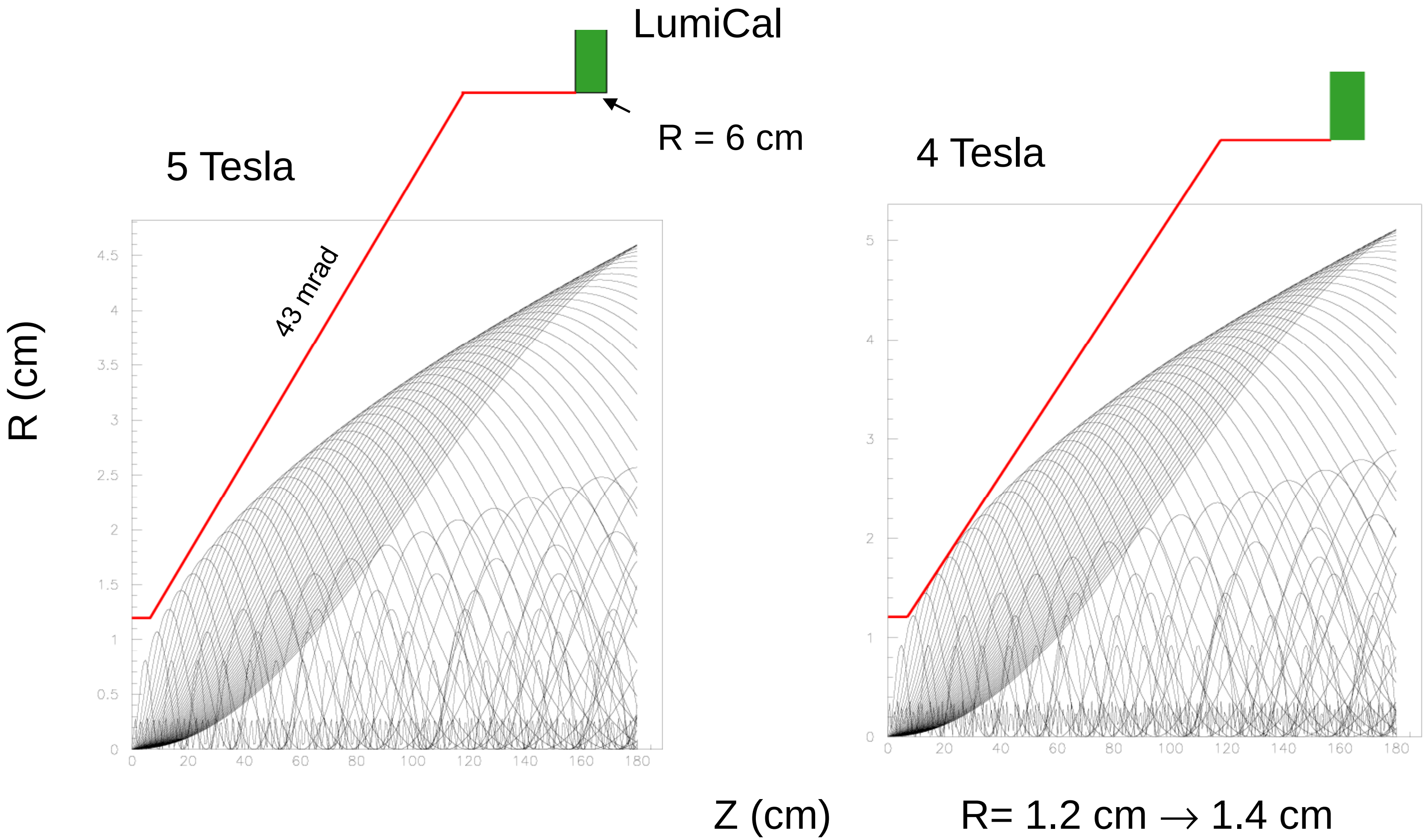
- Pairs
  - Beam pipe design
  - LumiCal, BeamCal acceptance and design
  - Mask design
  - Occupancy
  - Neutrons in VXD
  - Power load in QD0/QDEX cryostat
- Sync radiations
  - Apertures
  - Mask design
  - Power load in QD0/QDEX cryostat
- Disrupted beam, beamstrahlung photons, radiative Bhabhas
  - Extraction line apertures
  - Beam loss in extraction line and background in diagnostic systems
  - Power load in QD0/QDEX cryostat
  - Neutrons from the beam dump
- $\gamma\gamma \rightarrow$ hadrons/$\mu\mu$/$\tau\tau$
  - Dominant background in r>10 cm
  - Occupancy
  - BeamCal design, veto efficiency
- Beam gas
  - Vacuum requirement
  - Occupancy
- Muon production
  - Occupancy in muon system

Current SiD R<25 cm

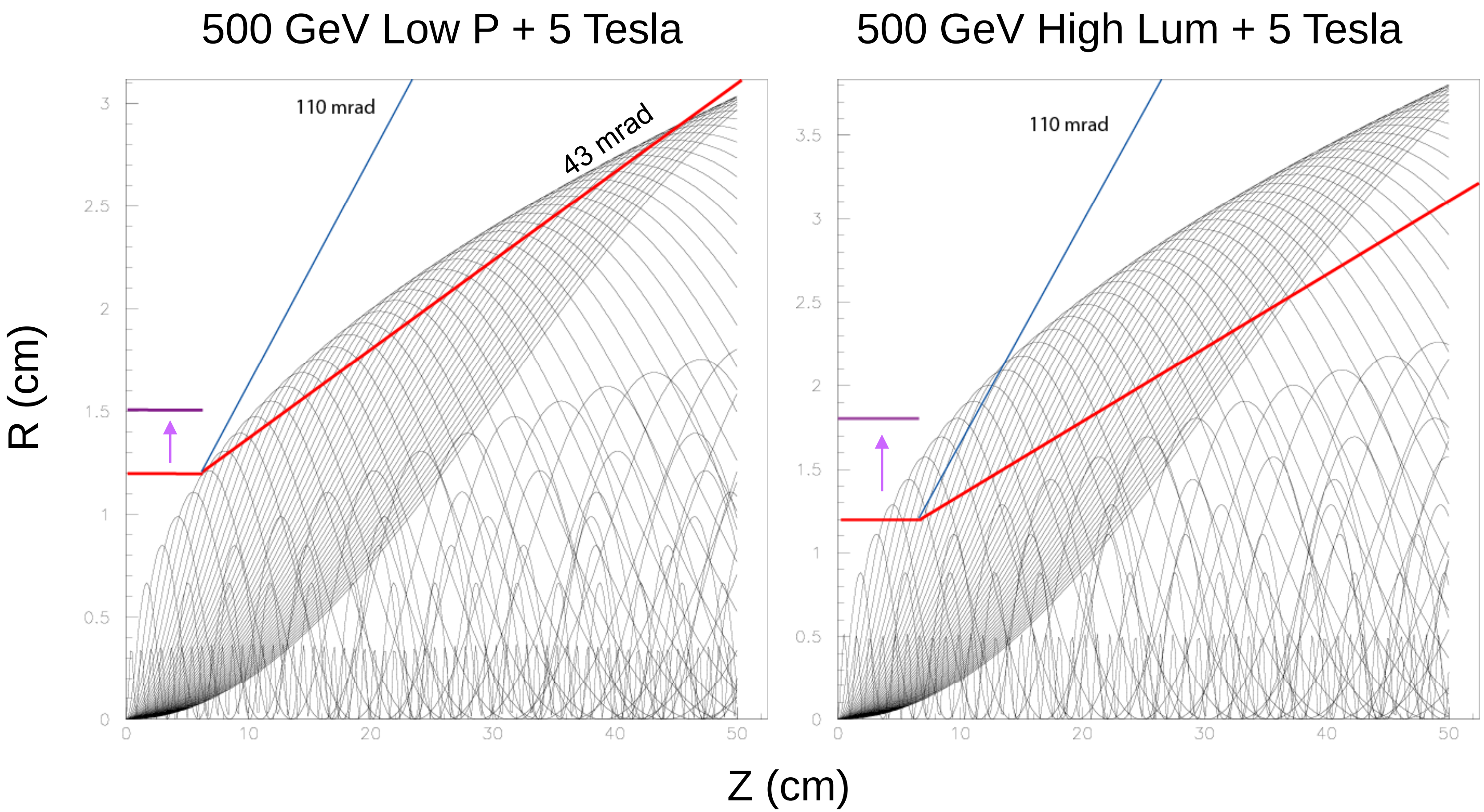


Current Beam pipe is designed for

ILC 500 GeV Nominal + 5 Tesla



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

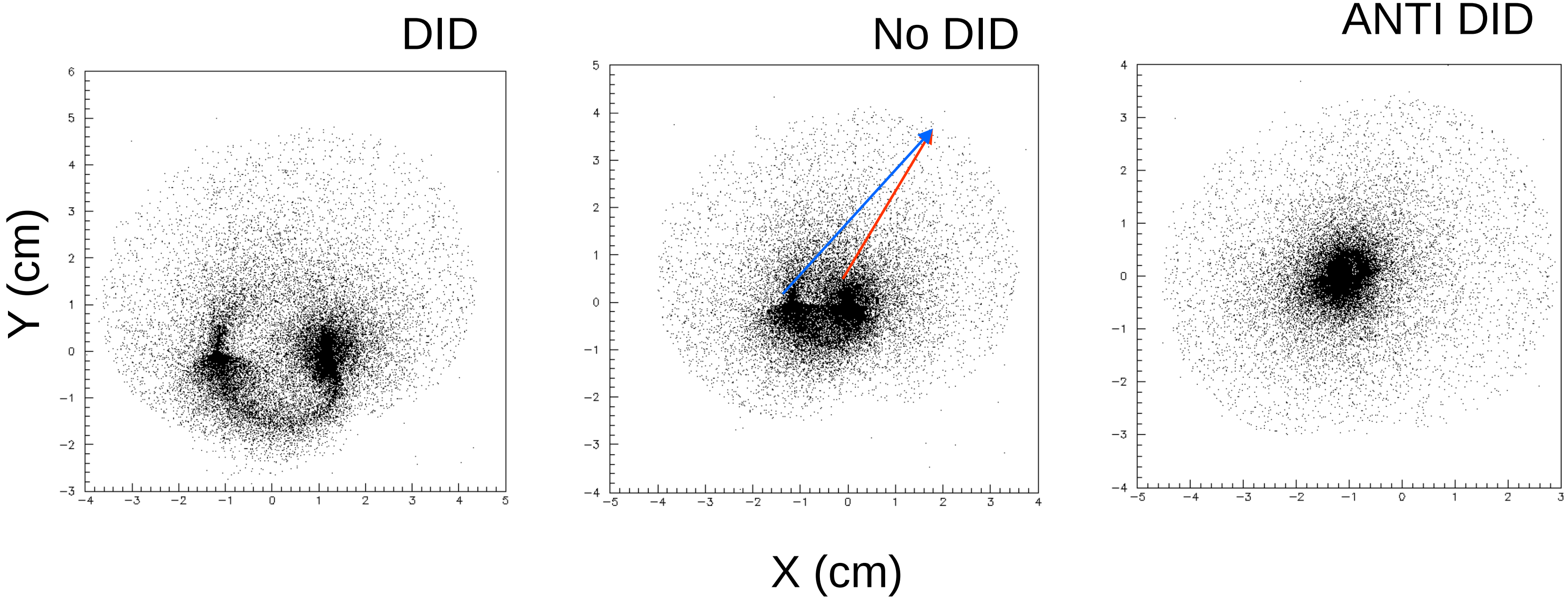


R= 1.2 cm → 1.5 cm (Low P), and R= 1.2 cm → 1.8 cm (High Lumi).

Pair distribution at Z = 168 cm

- 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



Pair Radius in cm at Z=168 cm

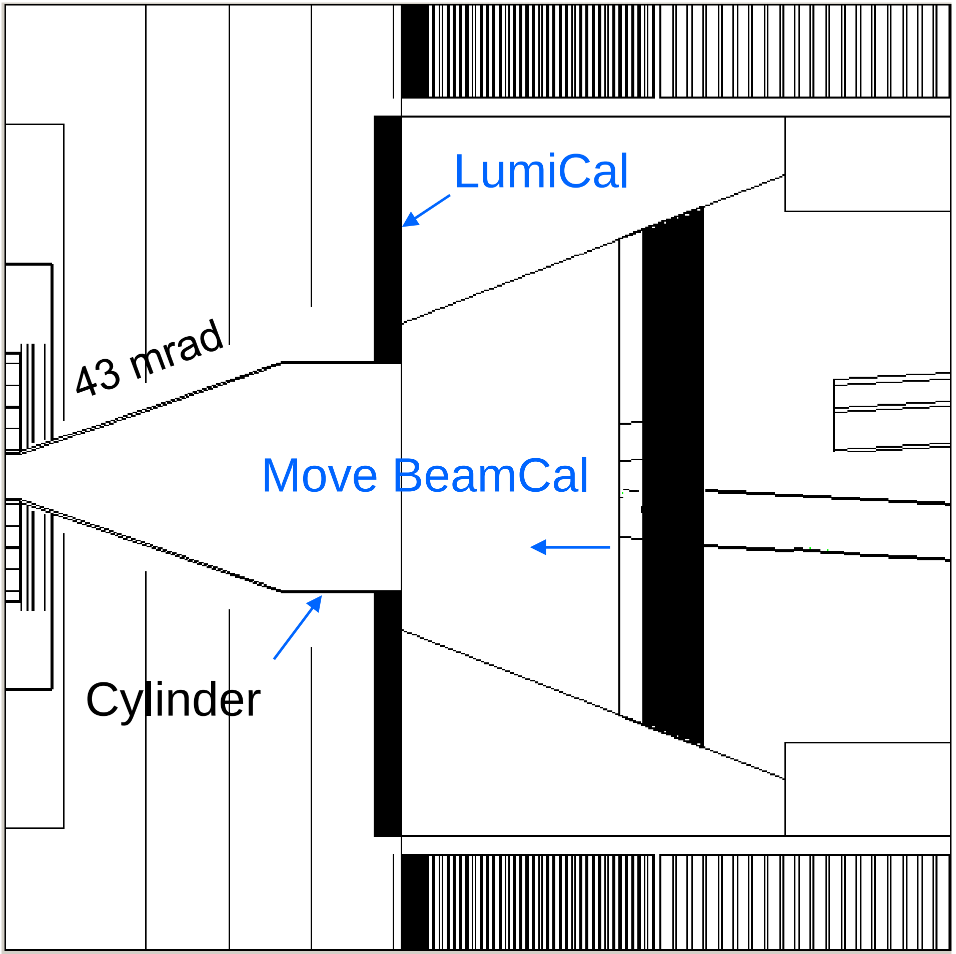
	4 Tesla			5 Tesla		
	ANTI-DID	NO DID	DID	ANTI-DID	NO DID	DID
Nominal	5.2 / 4.7	5.1 / 5.5	5.8 / 6.5	4.7 / 4.1	4.4 / 5.1	5.3 / 6.1
Low Q	4.7 / 4.2	4.4 / 5.1	5.3 / 6.0	4.2 / 3.8	3.8 / 4.6	4.8 / 5.6
High Y	4.6 / 4.2	4.6 / 5.1	5.5 / 6.0	4.3 / 3.9	4.1 / 4.6	4.9 / 5.7
Low P	6.3 / 6.0	6.2 / 6.8	6.8 / 7.6	5.7 / 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.)

LumiCal acceptance

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

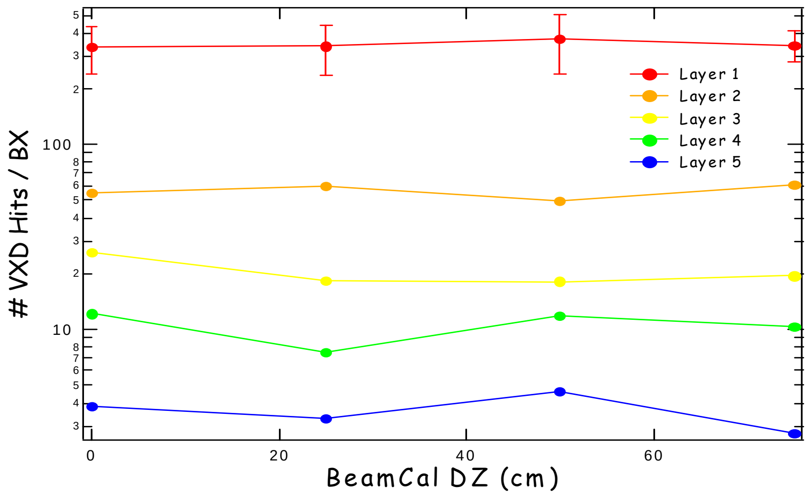
New SiD Geometry



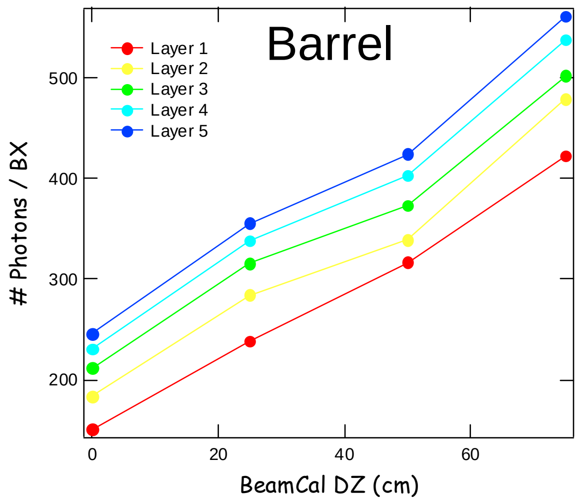
- LumiCal
  - Z=156.75 – 168 cm
  - R_{inside}=6cm
- Beampipe
  - Original 43 mrad cone + cylinder
- BeamCal
  - Study background as a function of BeamCal z
- M1 geometry is the same.

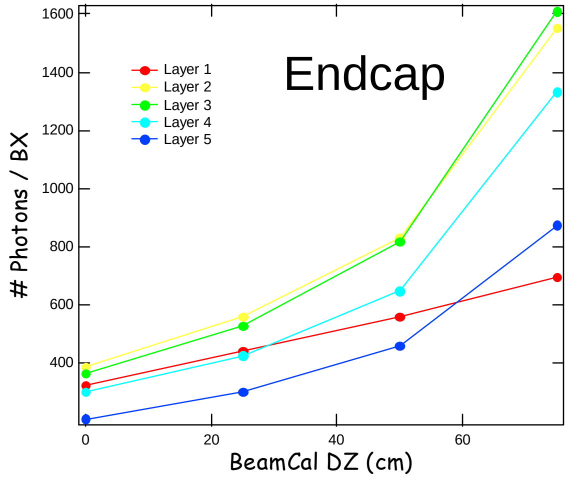
Tracker Hits vs. BeamCal DZ

Barrel VXD e+/e- hits



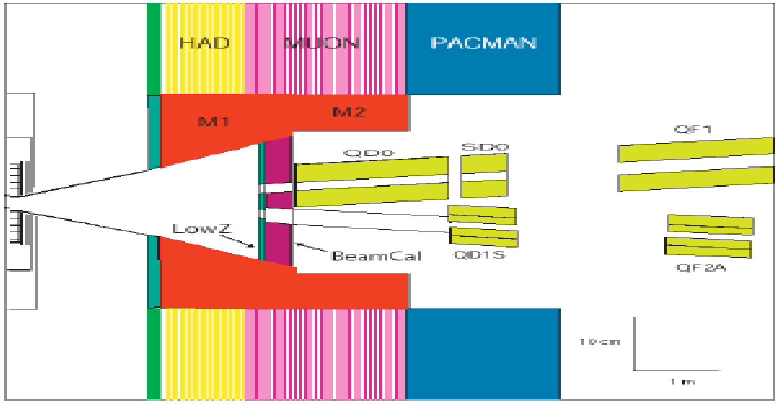
Si Tracker photons



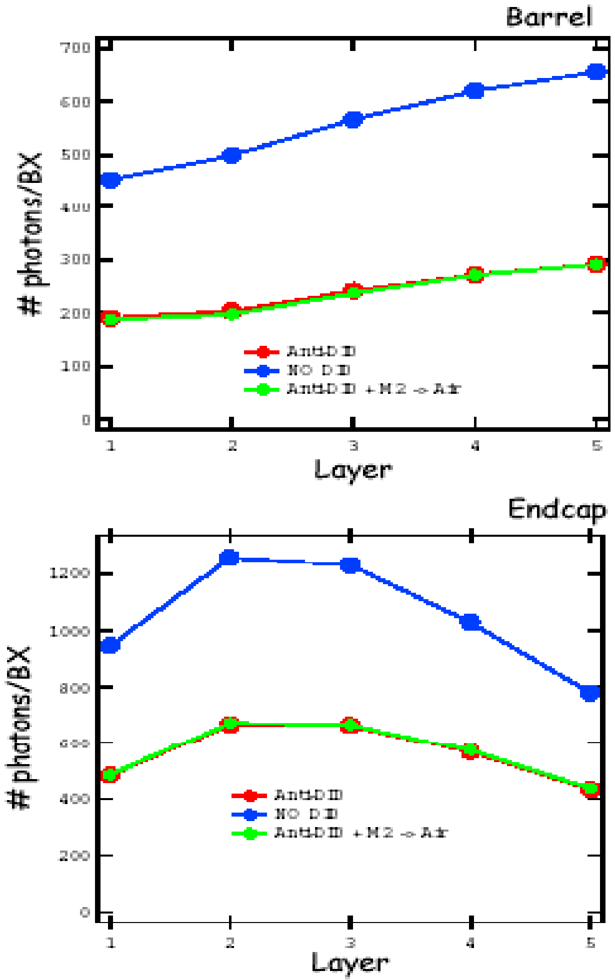


- VXD hits
  - No effects from LumiCal/BeamCal changes
- Si Tracker hits
  - Less photons (20%) due to smaller radius LumiCal
  - # photons increases by moving the BeamCal forward.
  - But the rate is acceptable if $\delta Z < 30$ cm.

Is M2 needed?



Si Tracker

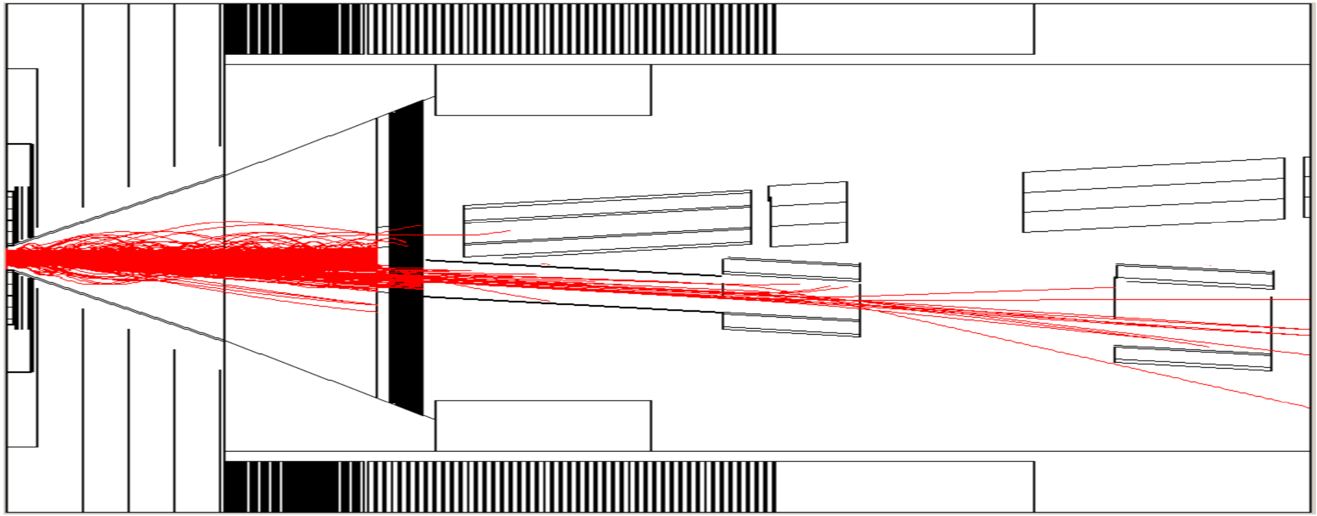


- NLC era simulation showed at least 6 cm-thick Tungsten is required to suppress low energy photons.
- Tungsten → Air does not increase tracker background.
- Does the muon system care about low energy photons?
- Yoke gaps may be stuff with heavy metal at small radius.

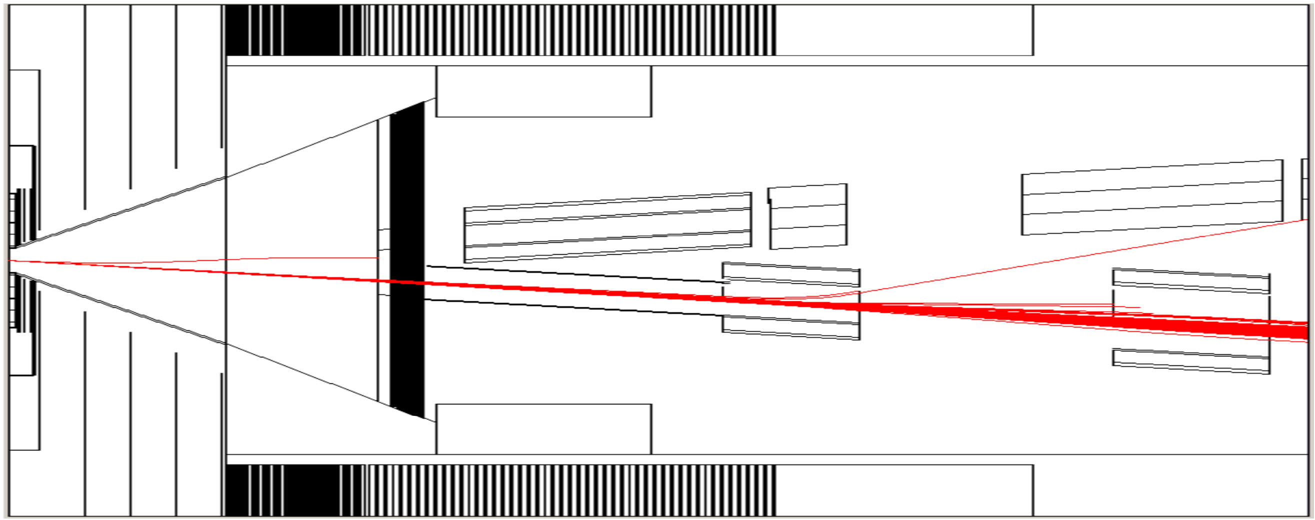
Power load in QD0/QDEX Cryostat is ~100 mW

Interaction is turned off.

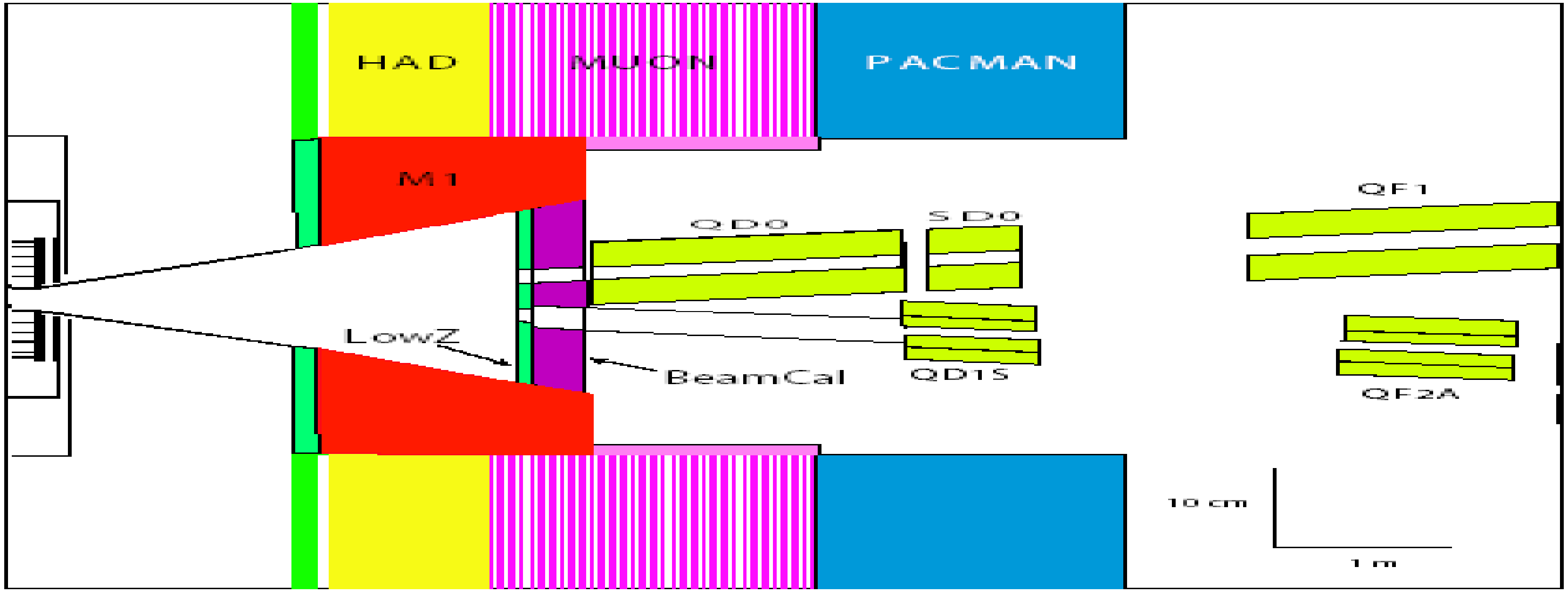
Pairs



Radiative
Bhabhas



Apertures for Sync Radiations



Apertures:

QD0

R=1.0 cm@z=-3.51 m

Beampipe@IP

1.2 cm@0.0m

Low Z

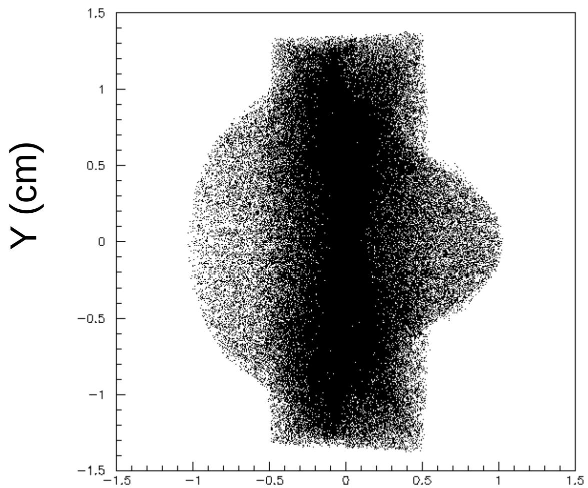
1.35 cm
@2.85-2.95m

QD1S

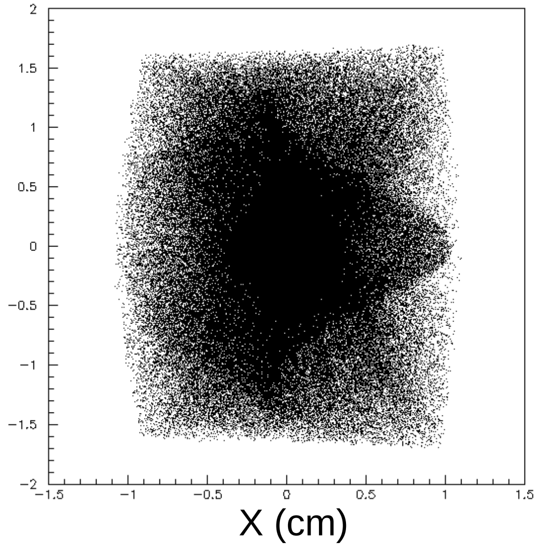
1.5 cm
@5.5-6.56m

Sync radiations from FF quads

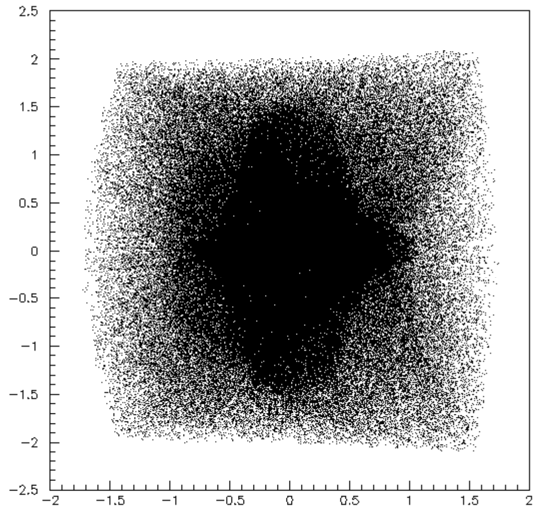
IP



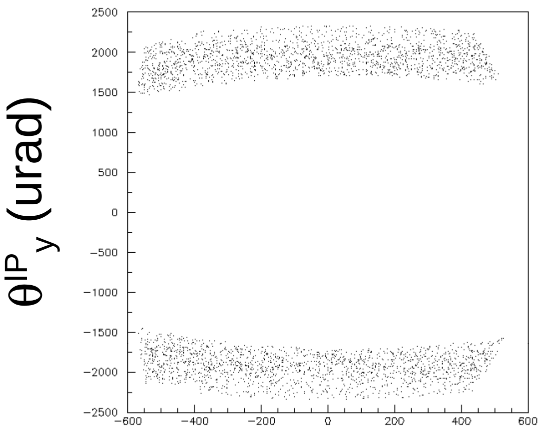
At Z=295 cm



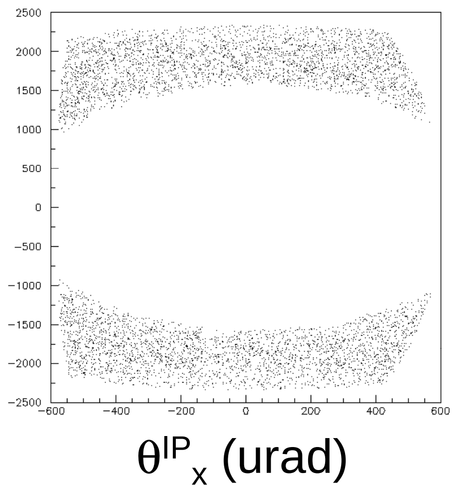
At Z=656 cm



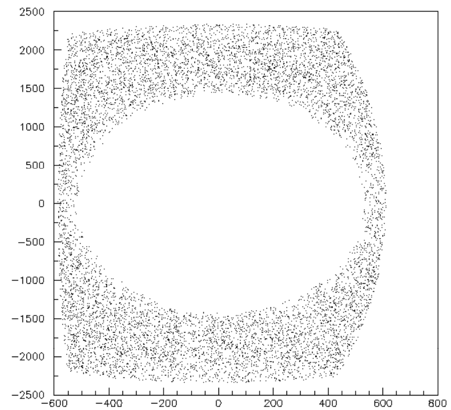
R > 1.2 cm



R > 1.35 cm

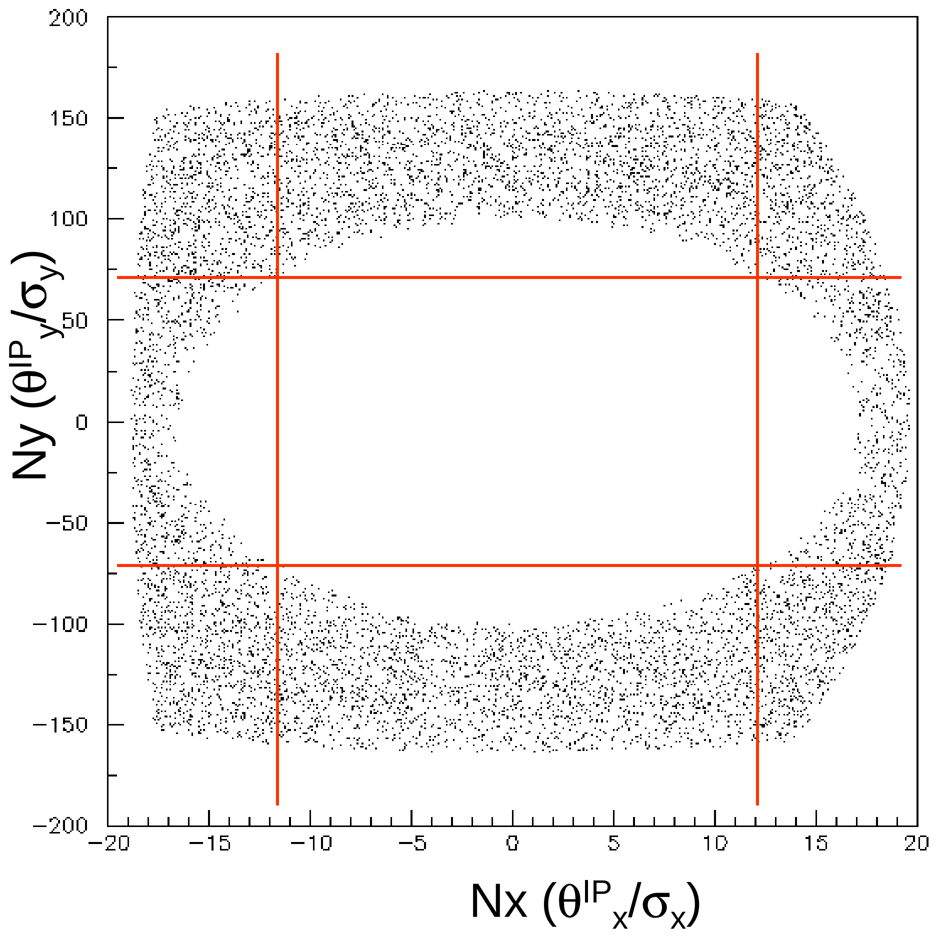


R > 1.5 cm



Collimation depth

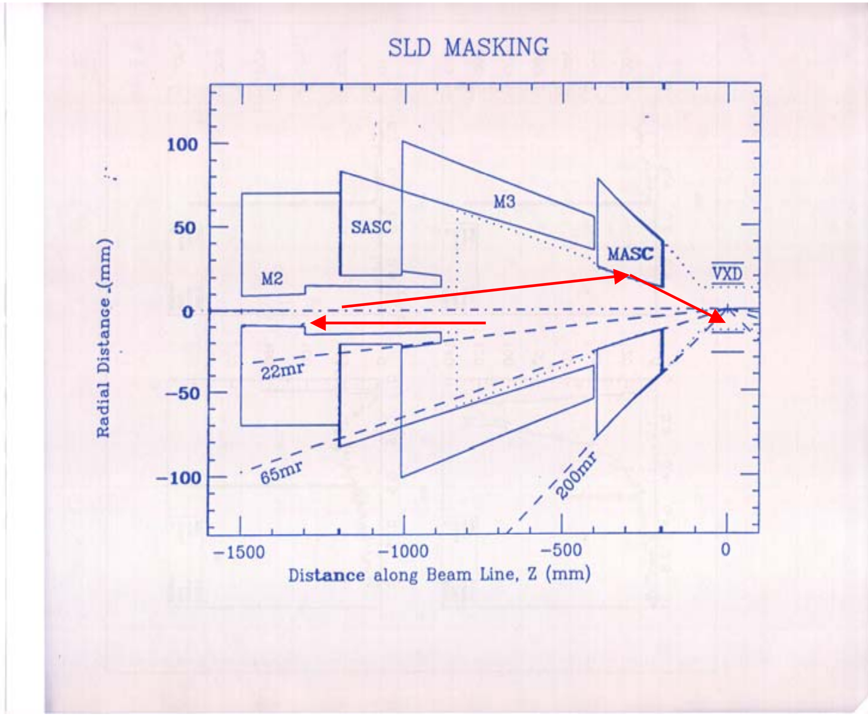
- First extraction quad constrains the collimation depth.
- Consistent with Frank Jackson (BILCW07)
  - 11.9σ_x 70.7σ_y in red lines
- Collimation depth cannot be defined by just two numbers.– The elliptical curve in (nx, ny) must be used.
- Does the collimation in the collimation section actually achieve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



Do we need a double-bounce Mask?

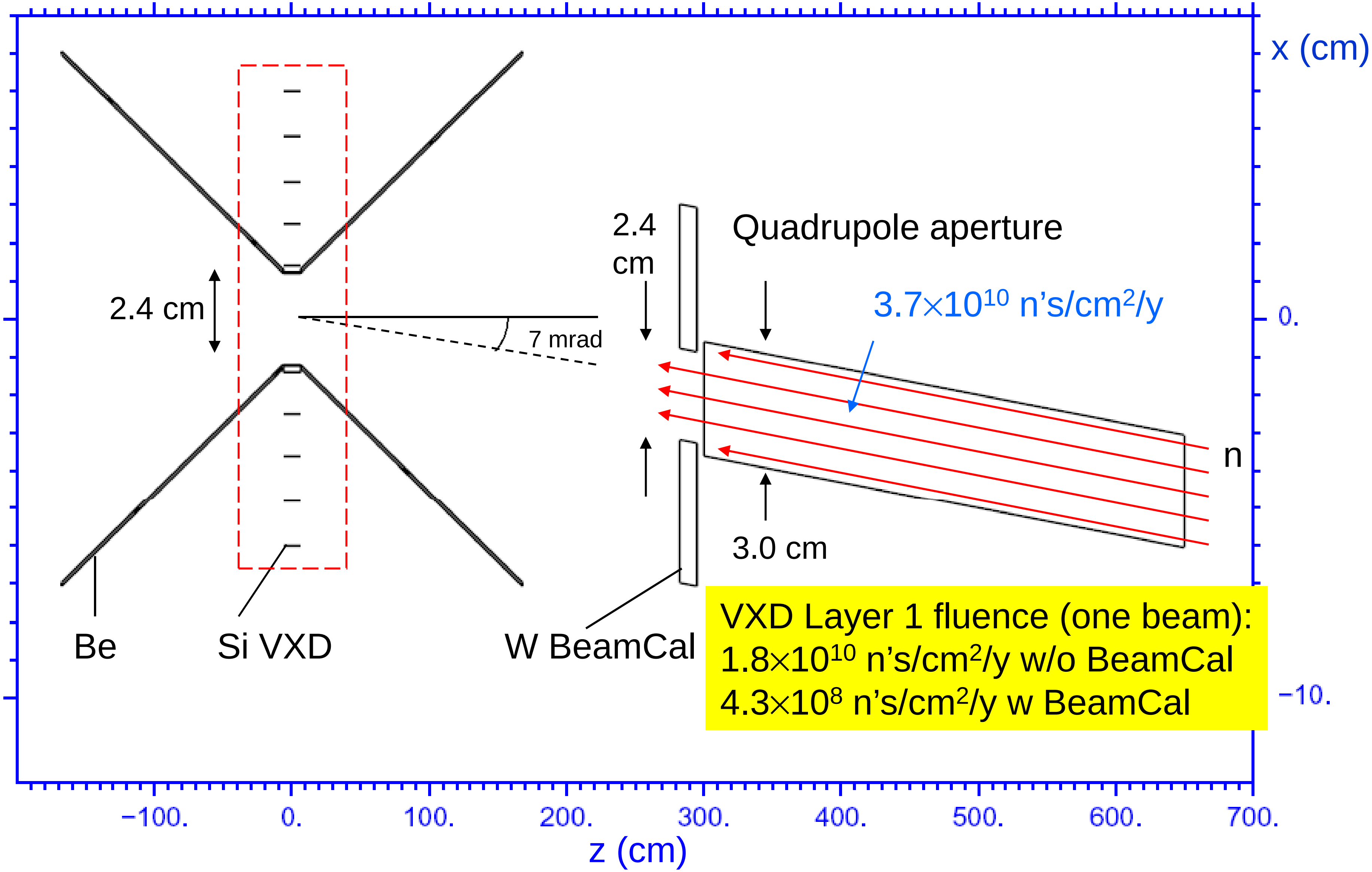
At SLD/SLC, SR was the problem

- Conical mask completely shadowed the beam pipe and VXD.
- Mask was designed so that photons need at least TWO bounces to hit VXD.



Neutrons from the Beam Dump

New FLUKA simulation (Darbha)



Neutrons in VXD (FLUKA)

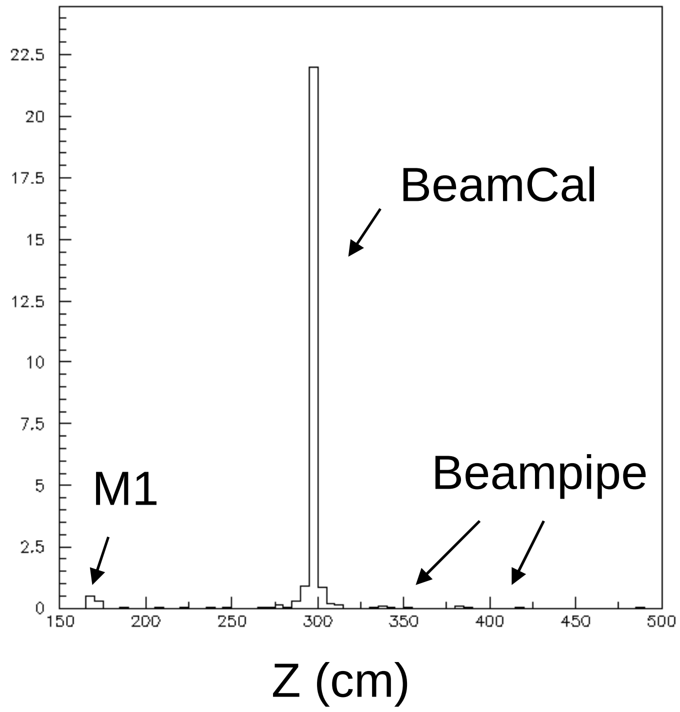
Neutrons from pairs

	Hits/cm^2/BX	Hits/cm^2/1x10^{7}sec
No DID	$(3.6 \pm 0.2)\times10^{-3}$	5.0×10^8
Anti-DID	$(2.4 \pm 0.2)\times10^{-3}$	3.4×10^8
DID	$(4.1 \pm 0.2)\times10^{-3}$	5.7×10^8

Neutrons from radiative Bhabhas

	Hits/cm^2/BX	Hits/cm^2/1x10^{7}sec
No DID	$(1.6 \pm 0.4)\times10^{-4}$	0.22×10^8
Anti-DID	$(0.3 \pm 0.2)\times10^{-4}$	0.04×10^8
DID	$(2.0 \pm 0.6)\times10^{-4}$	0.27×10^8

Neutron origins



- 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.