SiD VXD Conceptual Design

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Common Design Features

- Like other detector concepts, SiD VXD design is open to all sensor technology options which could be potentially used for SiD.
- The desired performance goals on spatial resolution, material budget, power requirement and hit density etc. are also in line with the current generic sensor R&D goals.

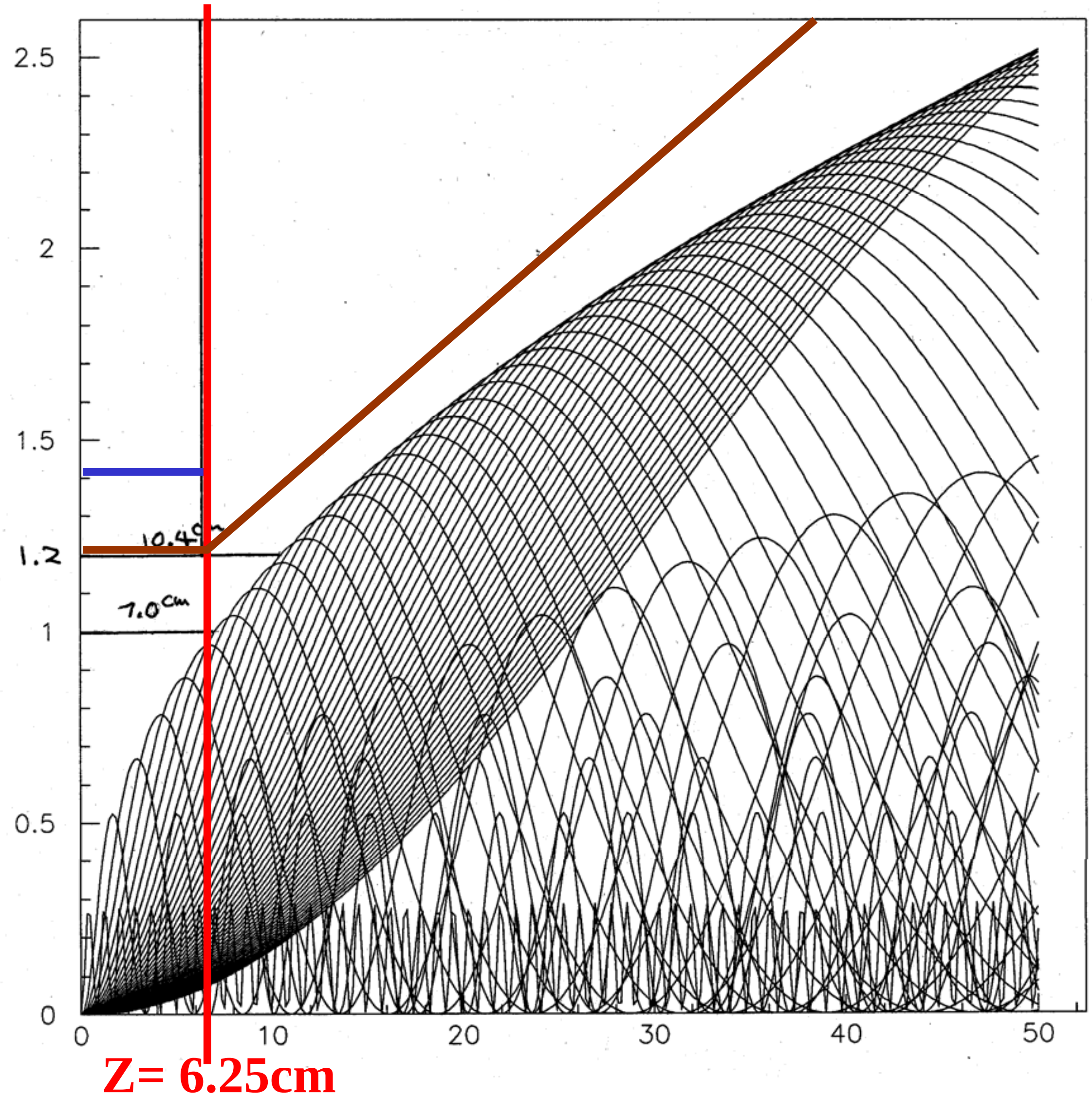
Special SiD Features

- **5T B field permitting smaller beam pipe and lower VXD starting radius.**
- **The VXD self-tracking is an essential as seed for the overall SiD tracking.**
- **Attempting a combined 5 barrel layer + 4 endcap disk VXD system.**

Beam pipe parameters

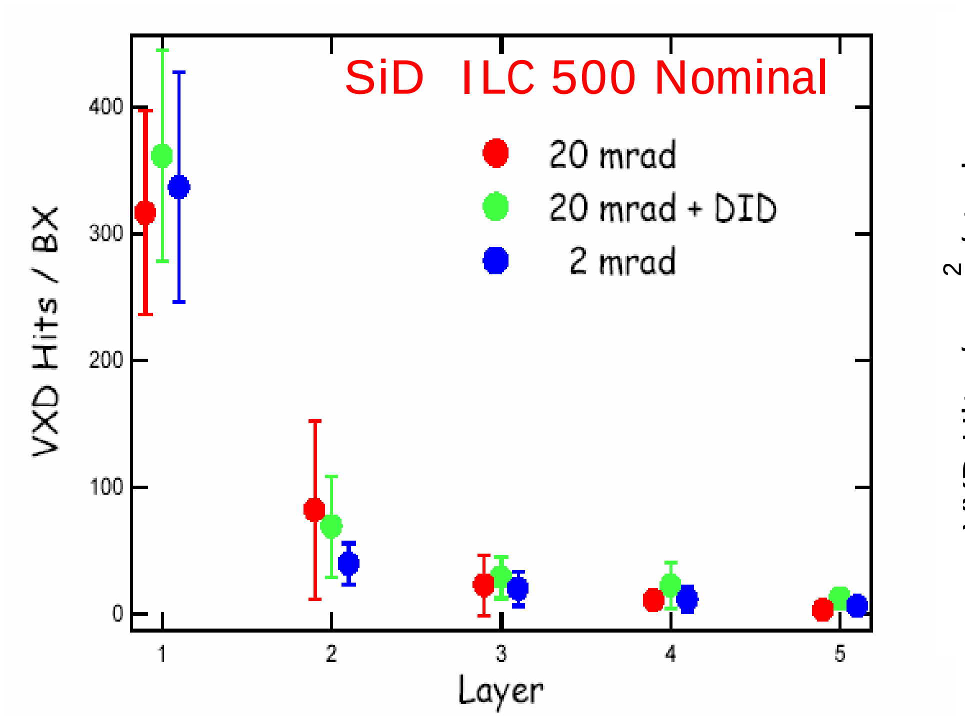
Beampipe inner radius is R=1.2cm and VXD sensors starts at R=1.4cm with a half barrel length of 6.25cm, principally to avoid the pairs background and with some safety margin.

500 GeV Nominal 5 Tesla +20mrad crosssing angle

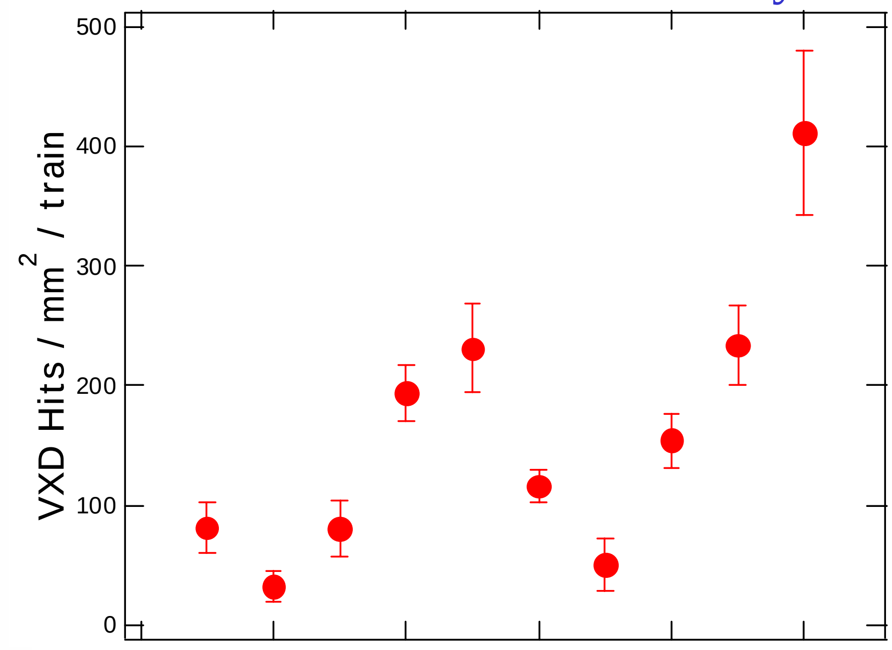


SiD Background rates

Takashi Maruyama



R=1.4 2.5 3.6 4.8 6.0



N Q Y P H N Q Y P H

500 GeV 1 TeV

Large rate difference between Layer 1 and outer layers

Needs at least x2 margin from nominal configuration

These are for pair background only. What about synchrotron radiation ?

SiD VXD Self-Tracking

- Real reconstruction code from Nicolai Sinev demonstrated good barrel performance at LCWS03 at Victoria with NLC background rate of 1 hit/mm^2.
- For barrel tracks within 5mm doca from IP, efficiency >98%.There is ~5% efficiency drop if there are only 4 hits.
- Endcap tracking reconstruction is now also running, but needs tuning. More spiraling tracks makes life tougher.
- This tracking code is under the lcsim framework and is being translated to work with LCIO.
- In case we are not comfortable with the efficiency or Layer 1 hit density, one possible strategy is to add another VXD layer to ensure robustness of tracking and less dependence on Layer 1. Extrapolating track into layer 1 as a last step could potentially tolerate background rate >1 hit/mm^2.

General VXD Design Activity

- The general requirement for the sensors are fairly clear so that much of the other parts of VXD design can proceed still to a large extent independent of the eventual chosen technology.
- One of the main activities since LCWS05 has been the geometry design studies which naturally brings out variety of overall system issues. The updated SiDAug05 geometry for GEANT is a starting baseline.
- Some key mechanical design issues are coming to focus, but much work is needed to bring real solutions.

General Strategy for Geometry Description

Sensor geometry is still simple cylinders and planes, but make sure average material is close to a more detailed description would give.

General philosophy on material: Start from a known working detector (SLD VXD3) to make sure all components are included. Reduction to material argued with plausible design changes item by item.

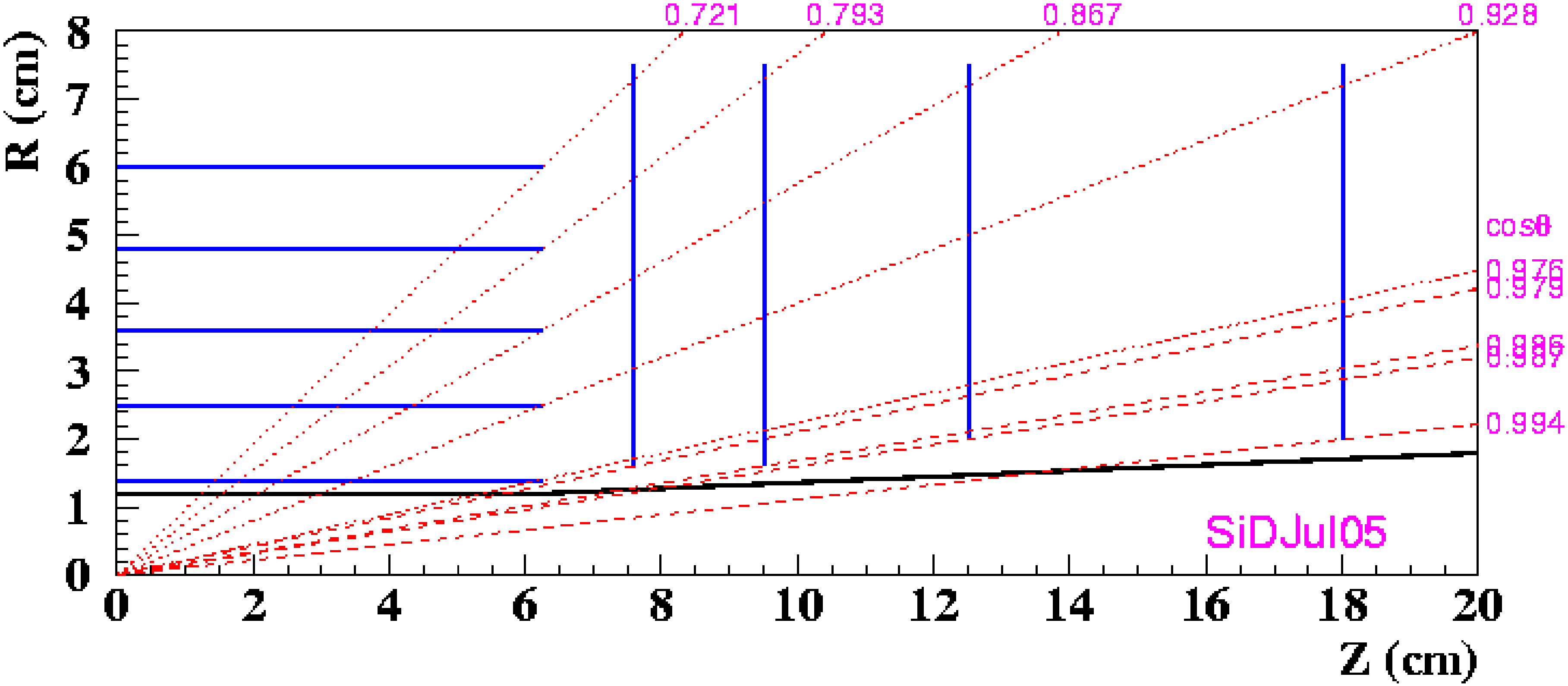
The geometry and material design are detailed on the SiD vertexing web page:

http://www-sid.slac.stanford.edu/vertexing/

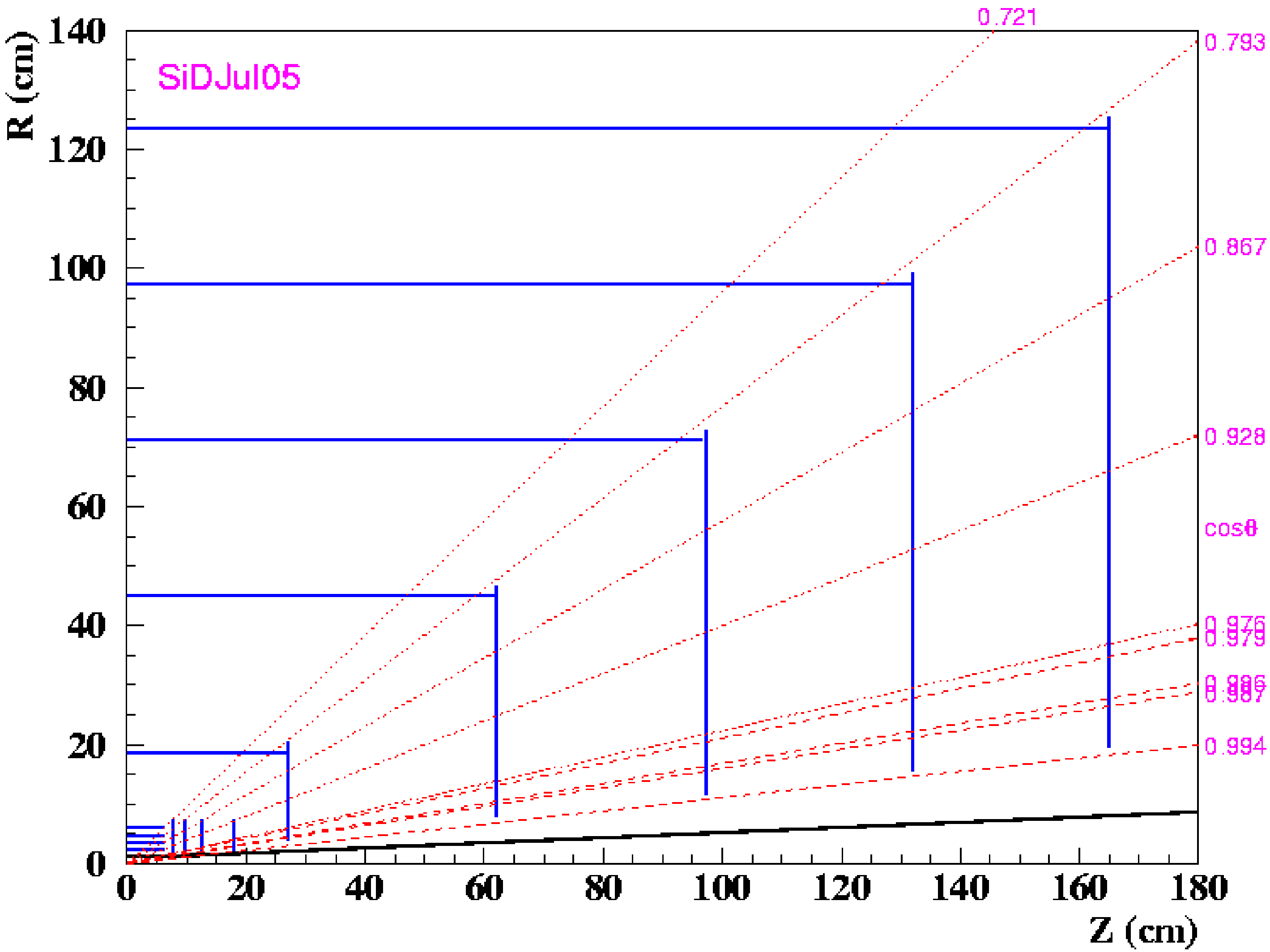
This is only the starting point !

Current SiD Geometry (SiDAug05)

The main feature of the current SiD VXD layout is the combination of relative short barrel and a set of endcap disks. By no means a proven winning strategy yet, but really needs to be explored (long barrel end region is sensitive to radial alignment and ionization fluctuation at very low θ)



Tracker+VXD matching

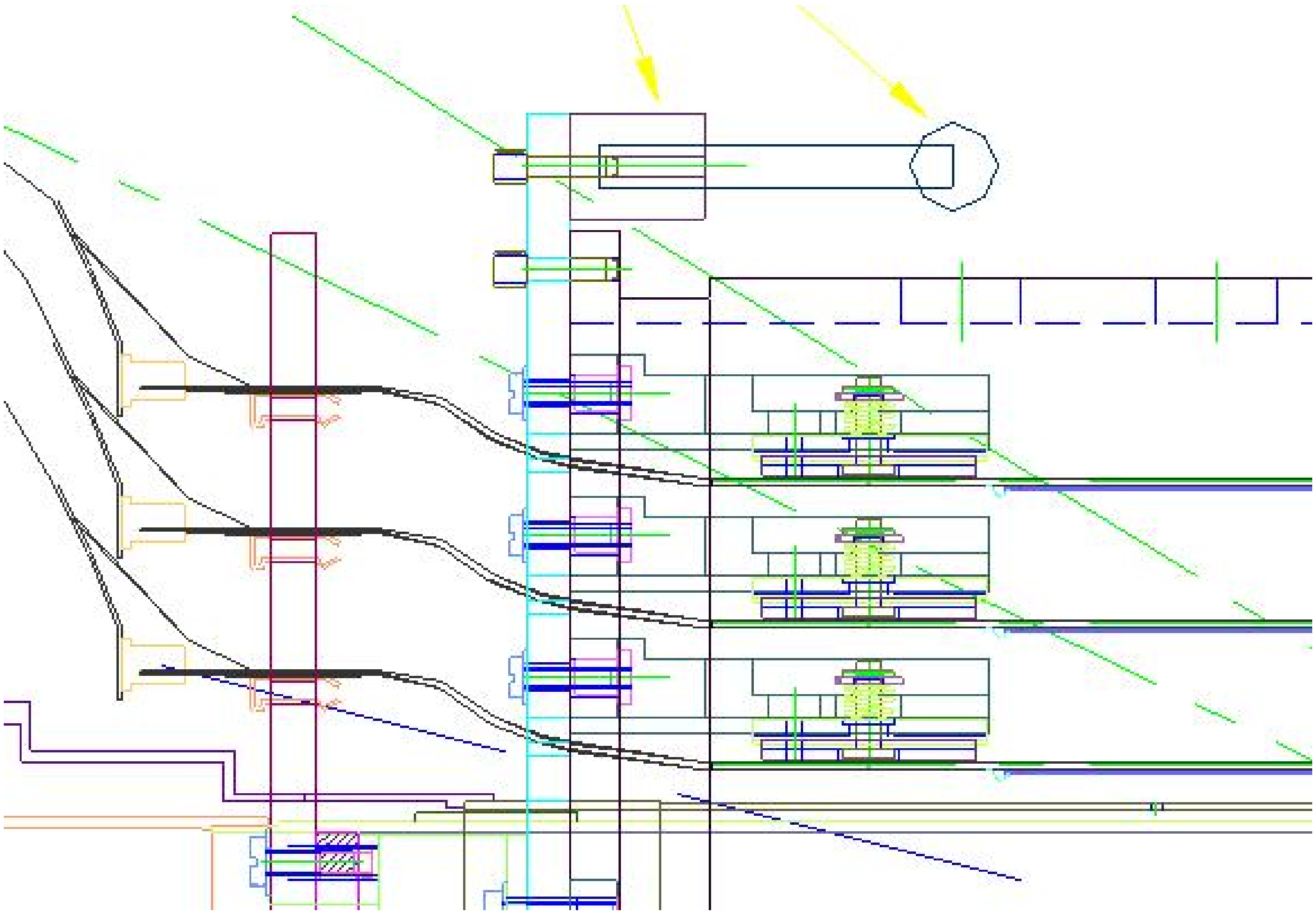


VXD Barrel Material

	SLD VXD3		SiD VXD	
Beampipe liner	Ti 50μm	0.14%	Ti 25μm	0.07%
Beampipe	Be 760μm	0.22%	Be 400μm	0.07%
Inner gas shell	Be 560μm	0.16%	(Note 1)	0
Ladder/layer		0.41%		0.11%
Outer gas shell	Be mesh	0.48%		0.28%
Cold N2 Gas		0.05%		0.05%
Cryostat coating	Al 500μm	0.58%		0.22%
Cryostat foam	Urethane	0.44%	NilFlam	0.12%

Note 1) Cooling gas can be brought in from two ends if overall power is low enough to for gas cooling.

SLD VXD3 endplate region



Due to tight time scale and no demand for endcap tracking, SLD VXD3 endplate design did not push hard for material reduction

Endcap Region Material

	SLD VXD3		SiD VXD
Barrel Endplate	Be/Fe/gap 3mm	1.5%	Composite ? 0.5%
Barrel support annulus	Be	~2.4%	1.0% ?
Ladder blocks	Al_2O_3 (smeared)	3.0%	1.0% ?
Striplines	Kapton/Cu (face on)	0.5%	0.2%
Stripline clamp support	Be plate with holes	~1.0%	0
Stripline connectors	Hit it 0.4%; smear	0.14%	0
Cryostat	Foam	0.4%	0.4%

- What to replace the sliding blocks ?
- Readout can be replaced by optical system similar to ATLAS (T>-10C) with a very small transceiver and thin fibers.
- Power strips can drop signal/clock lines.
- No need of clamp and connectors in active fiducial volume.

The argued reductions are still ‘conventional wisdom’. The challenge is to come up with a more radiacal design to reduce this further.

More Endcap materials

- The cone section of the beampipe is 1mm Be and need to add some liner which should be x3 thicker than center (back scattered photons from beam exit hole edges at Z=3.15m, are at ~43mrad to the coned section, while central section is ~14mrad). .
- Add disc mechanical support, 1mm thick Be rings with 7mm radial width around outer and inner perimeters of the discs (absorbing the material for space frame rods linking the rings.The real design may be more likely to be foam disks).
- A cone/cylinder of material just outside the coned section of beampipe for VXD fiber/strips concentrated in and a guess for Be cooling jacket.

Resolution Studies

- Not yet have full chain of code to examine resolution from GEANT output. Immediate goal is make a cheater track to fit true hits.
- Various other standalone tools can be used to check resolution consistency, and make quick geometry optimization .
- Fast simulation and engage in real vertexing analysis for physics benchmark. See Sonja Hillert’s vertex charge study.

Key Issues

- What mechanical realization could bring down the barrel endplate material (including power/signal cable routing) ? Warm sensors can make it much easier ? Alternative geometry (e.g. increased barrel length, or lamp shade?)

- What polar angle cutoff we should be aiming for ? Going beyond $\cos\theta=0.98$ require much more care on coned section of beam pipe: liner and Be thickness, endcap inner bore space and position of VXD services.

- Endcap disk support require more detailed design.

We are hoping to make some progress in generating ideas on these issues during Snowmass.