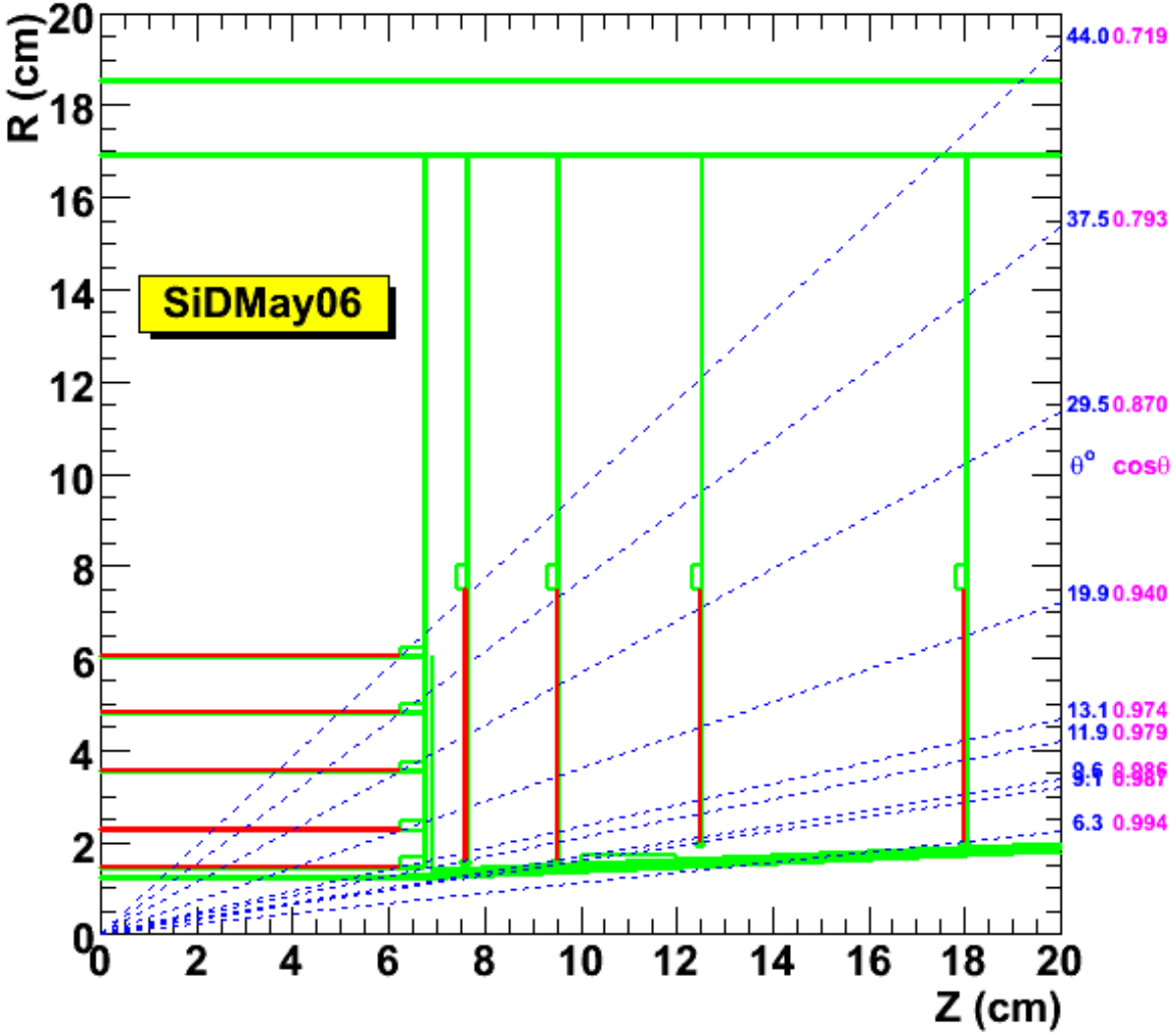
VXD DOD Summary (II)
Sensors & Other system Issues

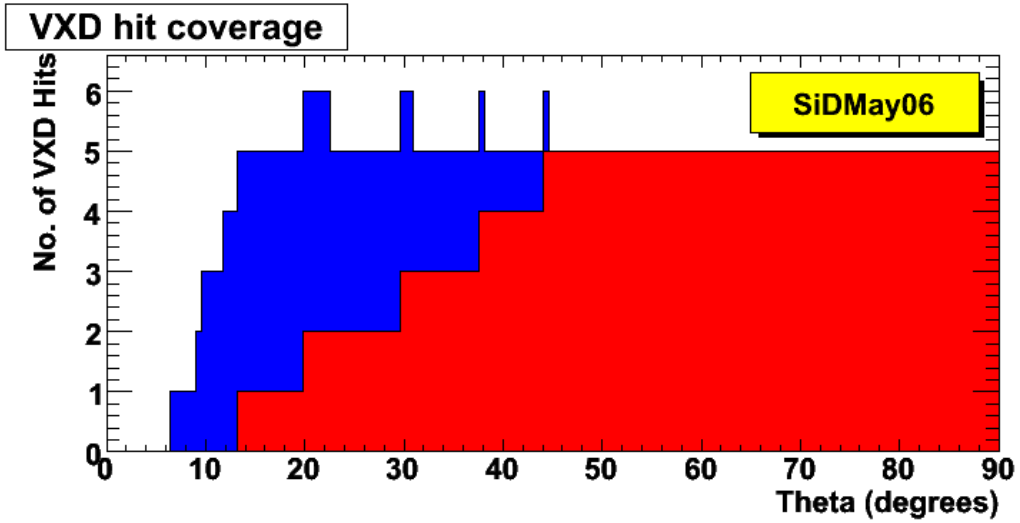
Readout/power material model in Geometry

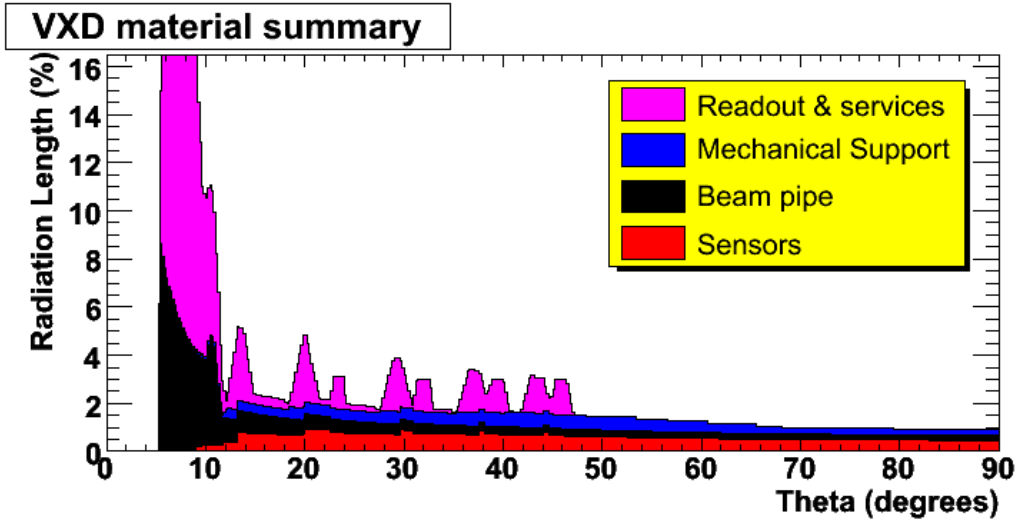


Ladder end region modeled by: 5mm long x ladder width x 2mm tall G10 blocks to represent optical transceiver and power connectors.

End face covered by power wires and fibers with variable density vs radius.

Material Summary





The new mechanical design is an essential step to make the endcap geometry work, but the readout/power models are still to be turned to a real design to establish this fully.

Power and Readout Design Issues

- Detailed scheme of carrying / testing and installing the sensors.
- How small can the optical components be ? How to anchor the fibers ?
- How to make the power connection ? LV wires or HV to DC-DC converters ? How small can the DC-DC converters be ?
- Many of these issues are also important R&D projects.

Sensor Requirements

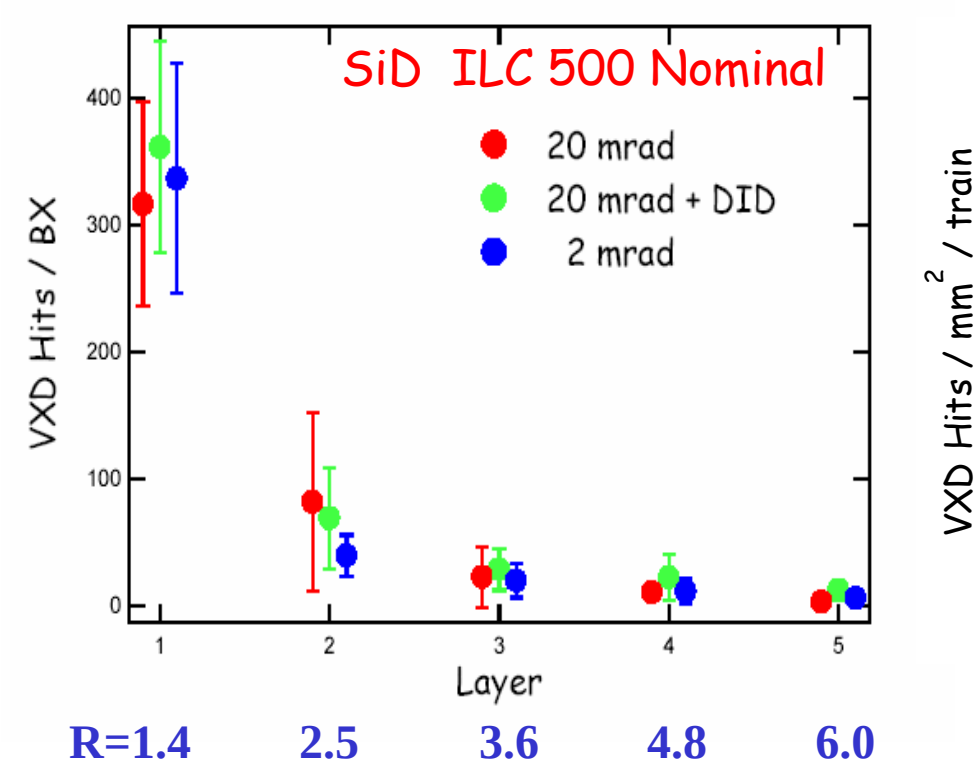
1. Spatial resolution $\sigma_\phi, \sigma_z < 5\mu m$ for all $\theta > 15^o$.
2. Two track resolution < 40μm.
3. Sensor+elex+support < 0.1%X_0 per layer.
4. Total barrel+endcap power < ~30+30W.
5. Cope with 5T B field.
6. Readout to achieve effective hit density at L1 <5 hit/mm^2 and outer layers <1 hit/mm^2.
7. Readout noise: allow threshold for $\varepsilon > 99\%$ while contribute to <30% of tracking hit density.
8. Insensitive to EMI and other detector noise.
9. Withstand 20Krad/year pair background dose and 10^9/cm^2/year 1 MeV neutron dose.

Sensor Readout Schemes

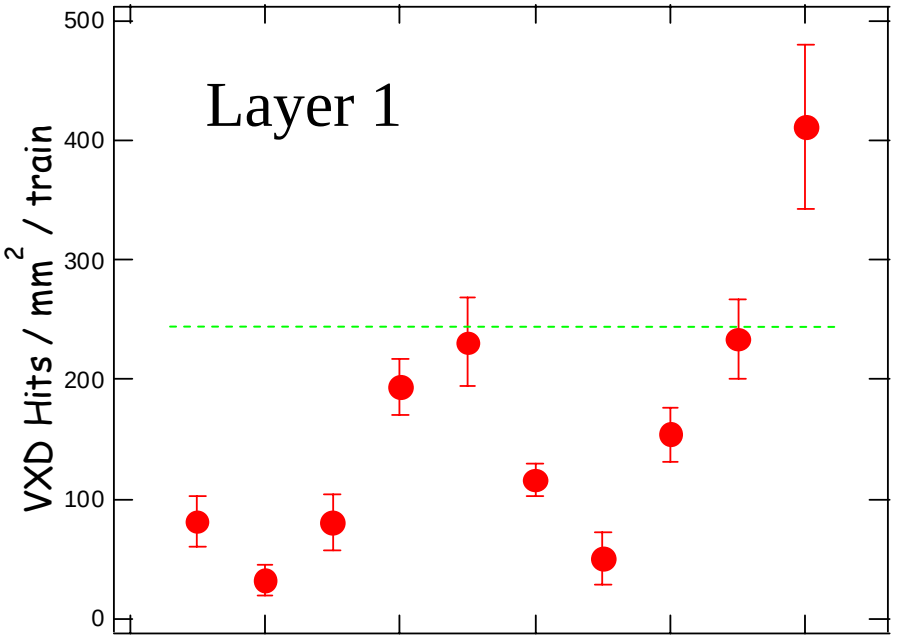
- Readout scheme:
  - Readout several times during crossing: CPCCD, DEPFET,MAPs.
  - Store hit for several intervals and readout at end of train: ISIS,FAPS
  - Store time tag and readout at end of train: ChronoPix
  - Integrate and readout at end of train: FPCCD.
- EMI sensitivity: FPCCD avoids it completely. ISIS also less sensitive. Others sensing charge during train could be sensitive to EMI.
- Time resolution:
  - ChronoPix targeting single crossing.
  - FPCCD has no timing.
  - Others can do 20-40 frames/train.

Hit Density Rate Target ?

Takashi Maruyama



R=1.4 2.5 3.6 4.8 6.0



Large rate difference between Layer 1 and outer layers

Needs some margin => 250 hits/mm^2/train

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

Hit Density Requirement

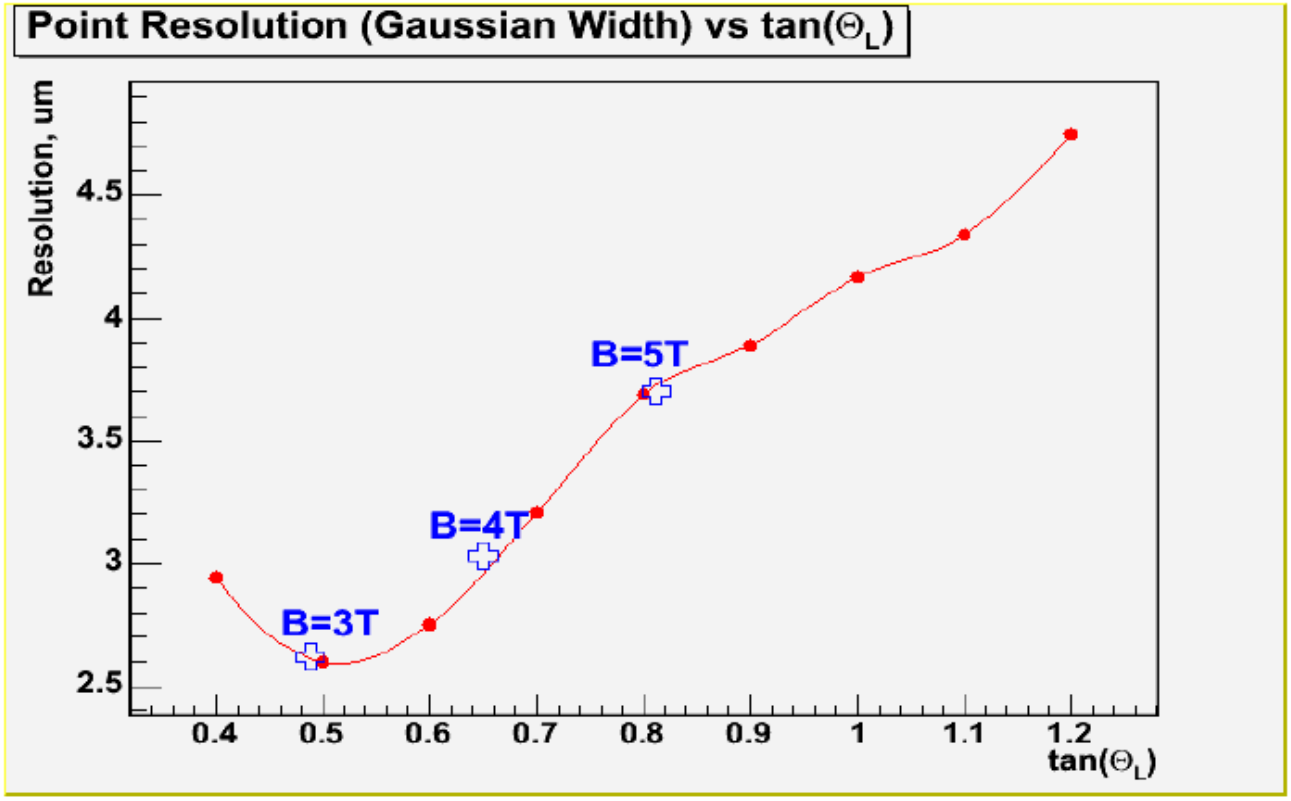
- If adopting 250 hits/mm^2/train as a target to deal with, 5 hits/mm^2 effective tracking density means reading out or store 50 frames per train which is beyond the 20-40 frames per train envisaged readout rate for most technologies.
- However, 5 hits/mm^2 is a guess. How much exactly can tracking tolerate on L1 ? Is SiD more sensitive than other concepts ?
- If we are arguing about a factor of 2, the situation is certainly not comfortable…

B Field Lorentz Angle Effect

- Noted this issue just before the SiD meeting in Dec/05, see ref W.De Boer et al, NIM A461, 200 (2001), NIM A478, 300 (2002).
- Nearly all candidate sensors are collecting electrons which have a factor of ~5 larger Lorentz angle compared to collecting holes.
- Actual Lorentz angle also depends on applied voltage (electric field) up to 2*depletion voltage and temperature. Close to 45° at 5T !
- Resolution effect should be smaller for thinner devices.
- Endcap affected very little, barrel rϕ effect largest.

B Field Lorentz Angle Effect

R-Φ Resolution



Alexei Raspereza

Ringberg vertex detector workshop

for DEPFET

Power Delivery

- Average power with pulsing 1/100:
  - CCDs are probably OK.
  - DEPFET current estimate 6W for the barrel.
  - CMOS devices may end up close to 30W ?
- Instantaneous power:
  - 30W*100 = 3KW or ~30W/sensor for 100 sensors. For an operating voltage of ~3V, this is 10A of current. Needs metal to get the current through.
  - For non-axial paths, the BxI force is substantial and pulsing !

Summary

- Sensor R&D still has no ideal option. The main short comings are marginal readout speed or power consumption/delivery. new ideas may be needed.
- Nice advance in mechanical design. Some details in integrating sensors are still needed.
- Readout and power delivery R&D are important to achieve realistic full system design.