Vertex Detectors for the LCD

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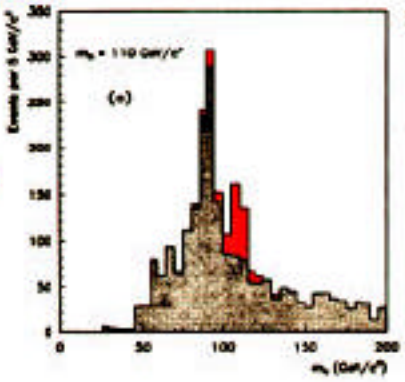
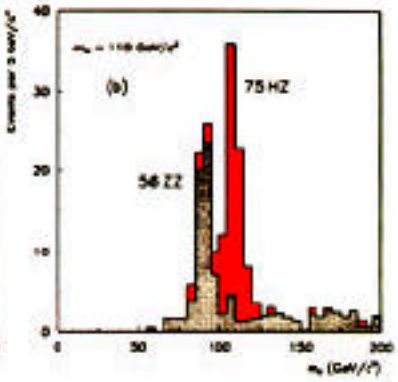
$e^+e^- \to ZH \to q\bar{q}b\bar{b}$ (4 jet topology) at 500 GeV w/ 10 fb^{-1} ($\sim \frac{1}{5}$ NLC yr)

1. $\equiv$ 4 jets w/ $M_{jet} < 45$ GeV ($e^+e^- \to q\bar{q}$)
2. $E_{tot} > 0.7\sqrt{s}$ ($t\bar{t}$, ZZ)
3. $\chi^2_{4C} < 5$ (fit) (WW)
4. $M_{ij} \sim M_Z$ (80–125 GeV)

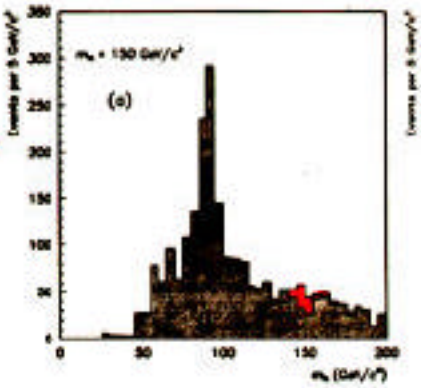
no b tag $\quad$ $b\bar{b}$ tag

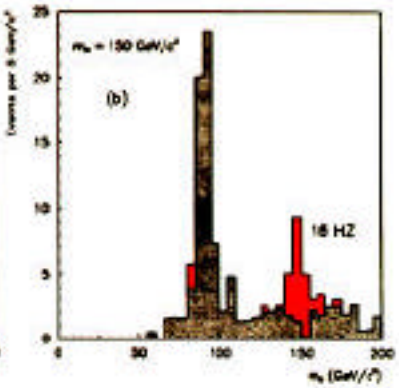
$M_H = 110$ GeV/c^2 →





$M_H = 150$ GeV/c^2 →





Jaeet

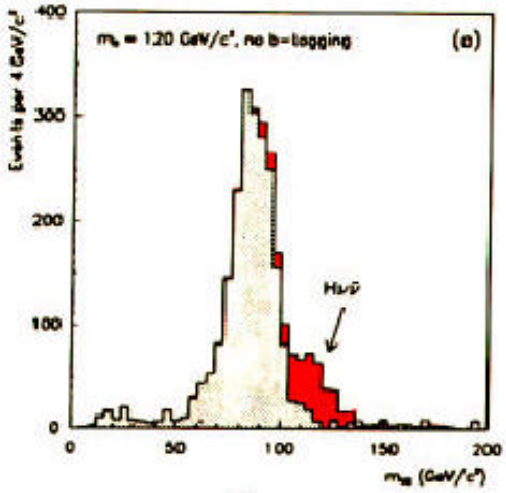
$e^+e^- \to H\nu\bar{\nu}$ @ $\sqrt{s} = 500$ GeV/c² w/ 10 fb^{-1} (~ $\frac{1}{5}$ NLC year)

1. $E_{miss} > \sqrt{s}/2$
2. ~~P_T~~ > 40 GeV/c
3. $M_{MM} > 200$ GeV/c²
4. $\theta_{prod} > 25°$
5. $\theta_{acop.} < 150°$
6. veto isolated leptons

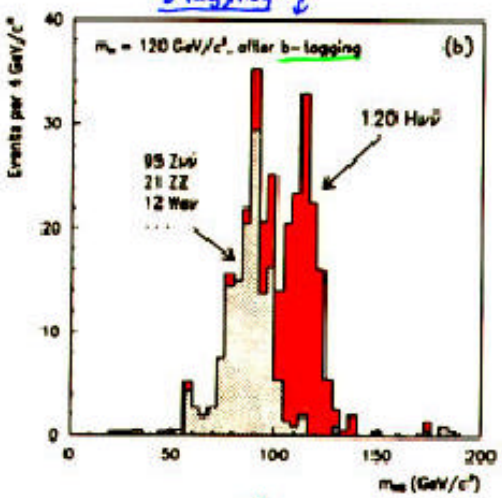
hermeticity

dijet mass resolution

b tagging ?



M_{MM}



M_{MM}

Vertex Detectors for the LCD

For the LCD Vertex Detector there are clear simulations AND hardware R&D issues

We will restrict discussion to R&D issues related to simulation studies

We are assuming that the vertex detector will be a CCD vertex detector

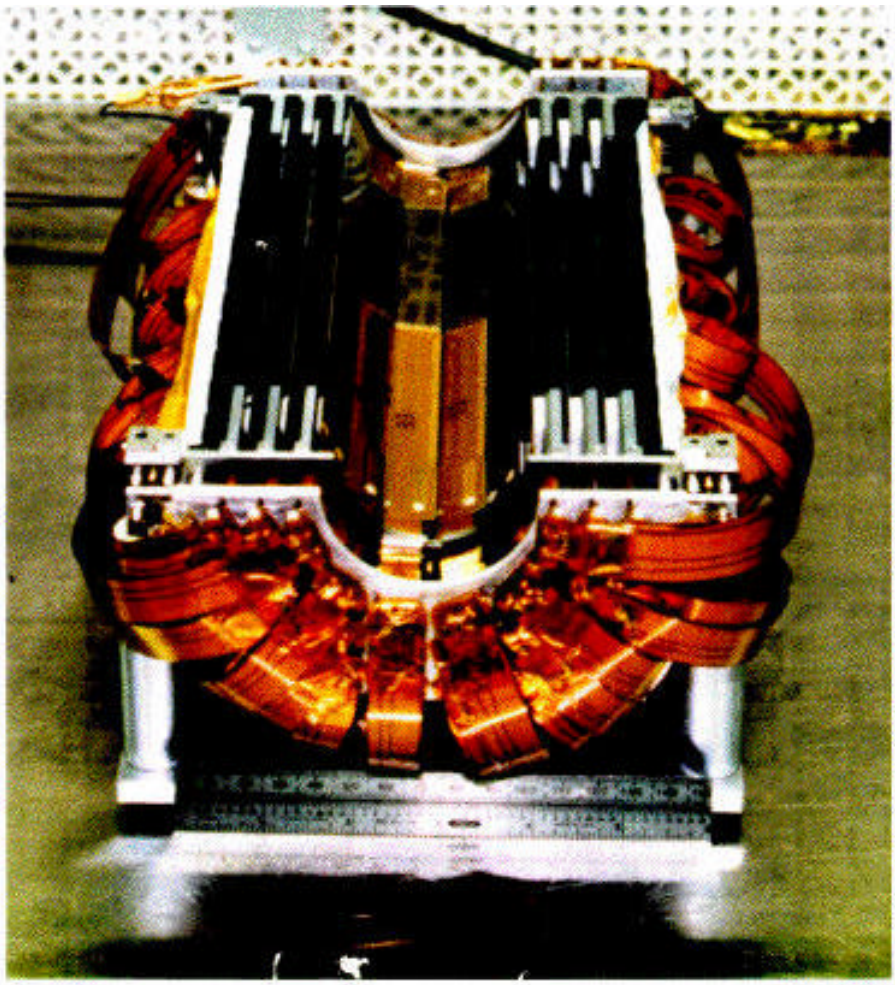
basically, an improved version of the SLD vertex detector

- more layers than SLD (3->5)
- thinner ladders than SLD (0.4% X_0 -> < 0.2% X_0)
- smaller inner radius than SLD (2.8 cm -> 1.2 cm)

therefore -> improved perfomance

Big issue on the hardware side is the radiation level (relative to damage) and the detector tolerance to the radiation

- we are working on this, but it is not a topic of this meeting



SLD
Vertex
Detector
Upgrade
(VXD3)

307,000,000
pixels
(20μm × 20μm × 20μm)

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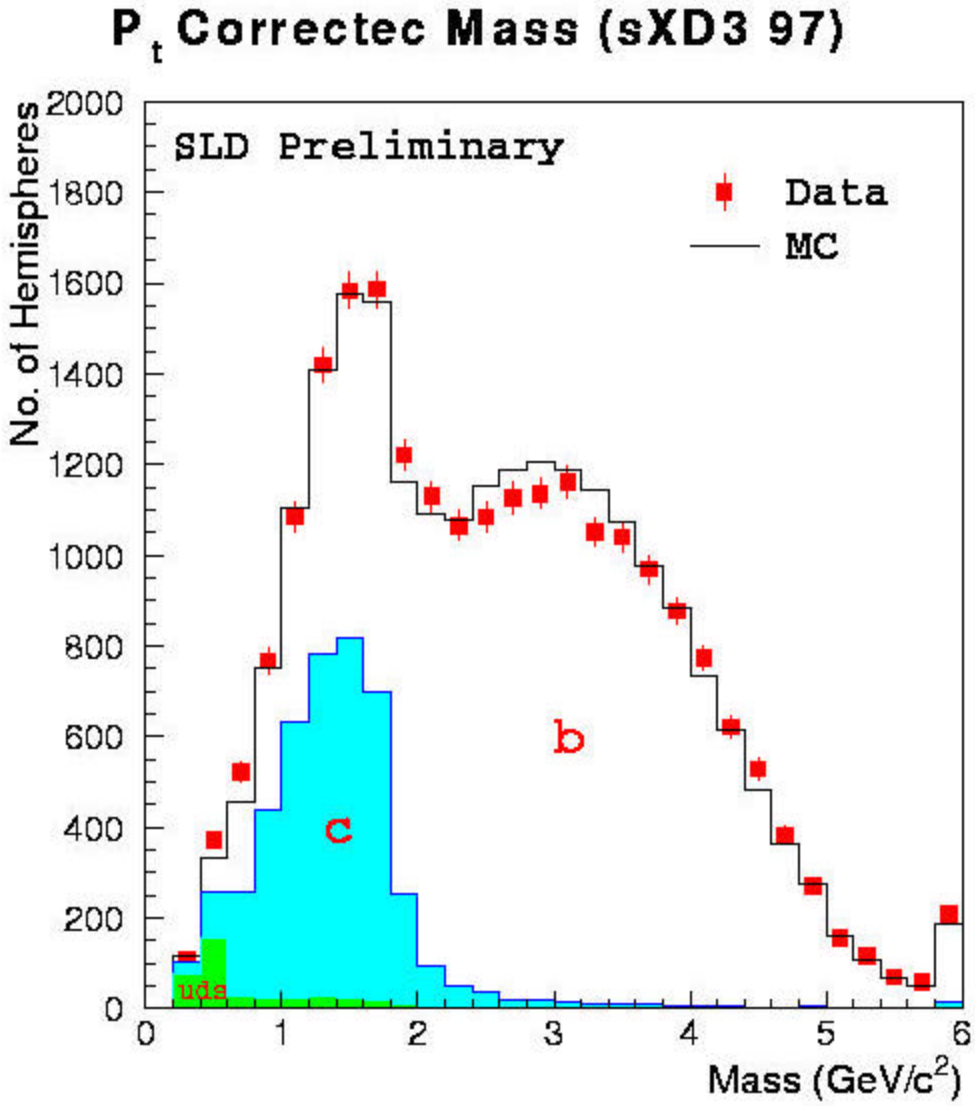
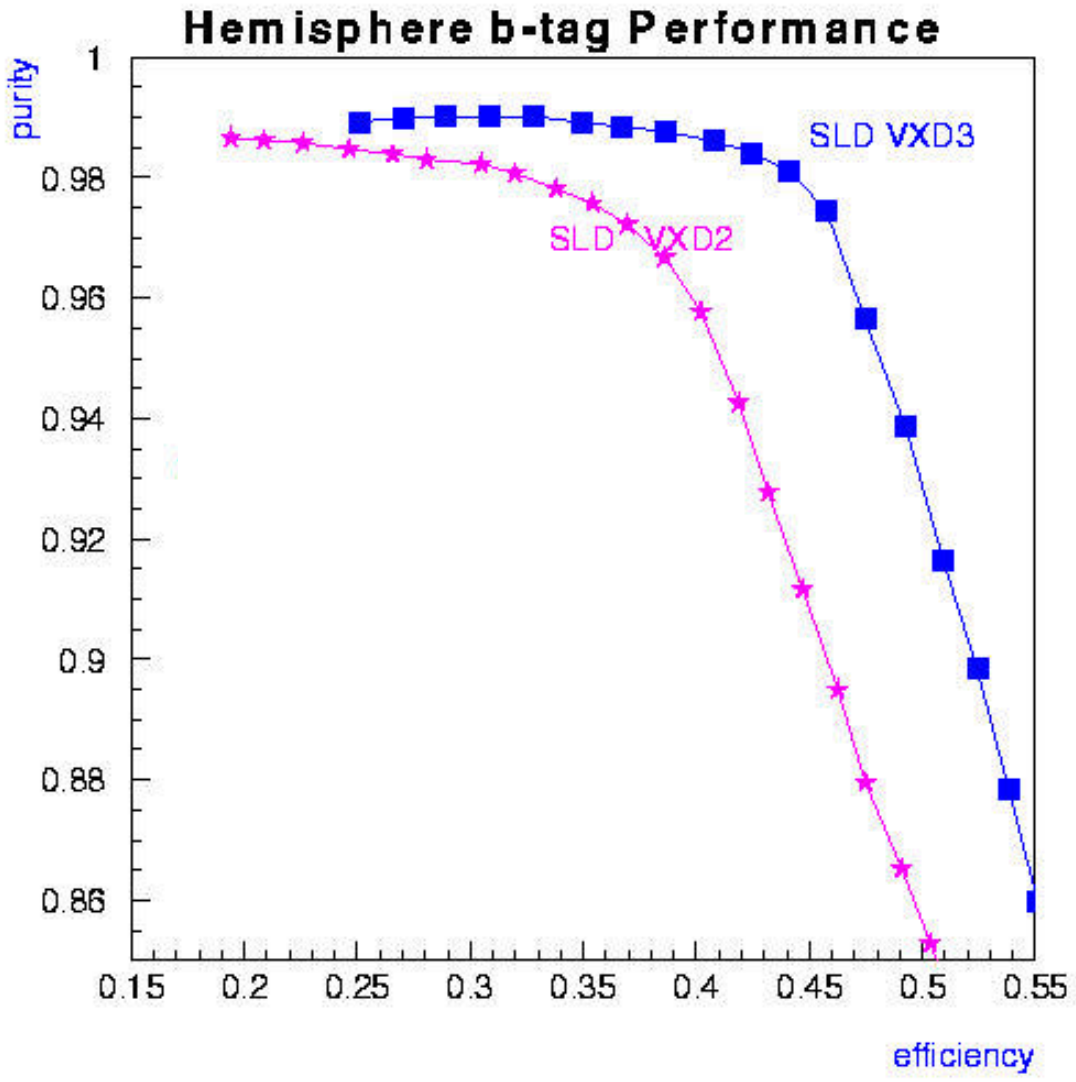

P t Correctec Mass (sXD3 97)
SLD Preliminary
Data
MC
No. of Hemispheres
2000
1800
1600
1400
1200
1000
800
600
400
200
0
b
c
uds
0
1
2
3
4
5
6
Mass (GeV/c2)



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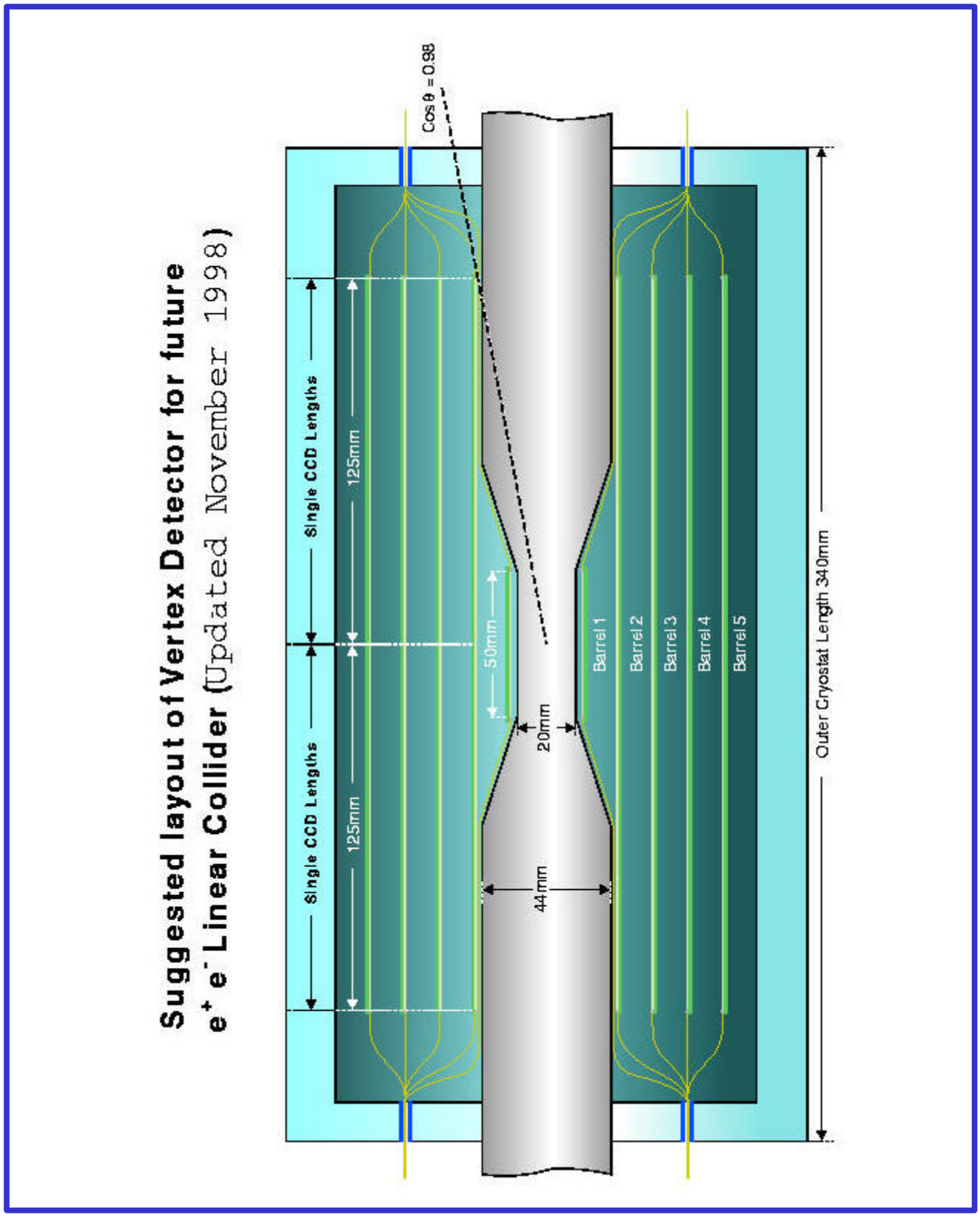

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What have we learned so far:

Bruce Schumm's parametrization of impact parameter resolution is pretty accurate

Model S

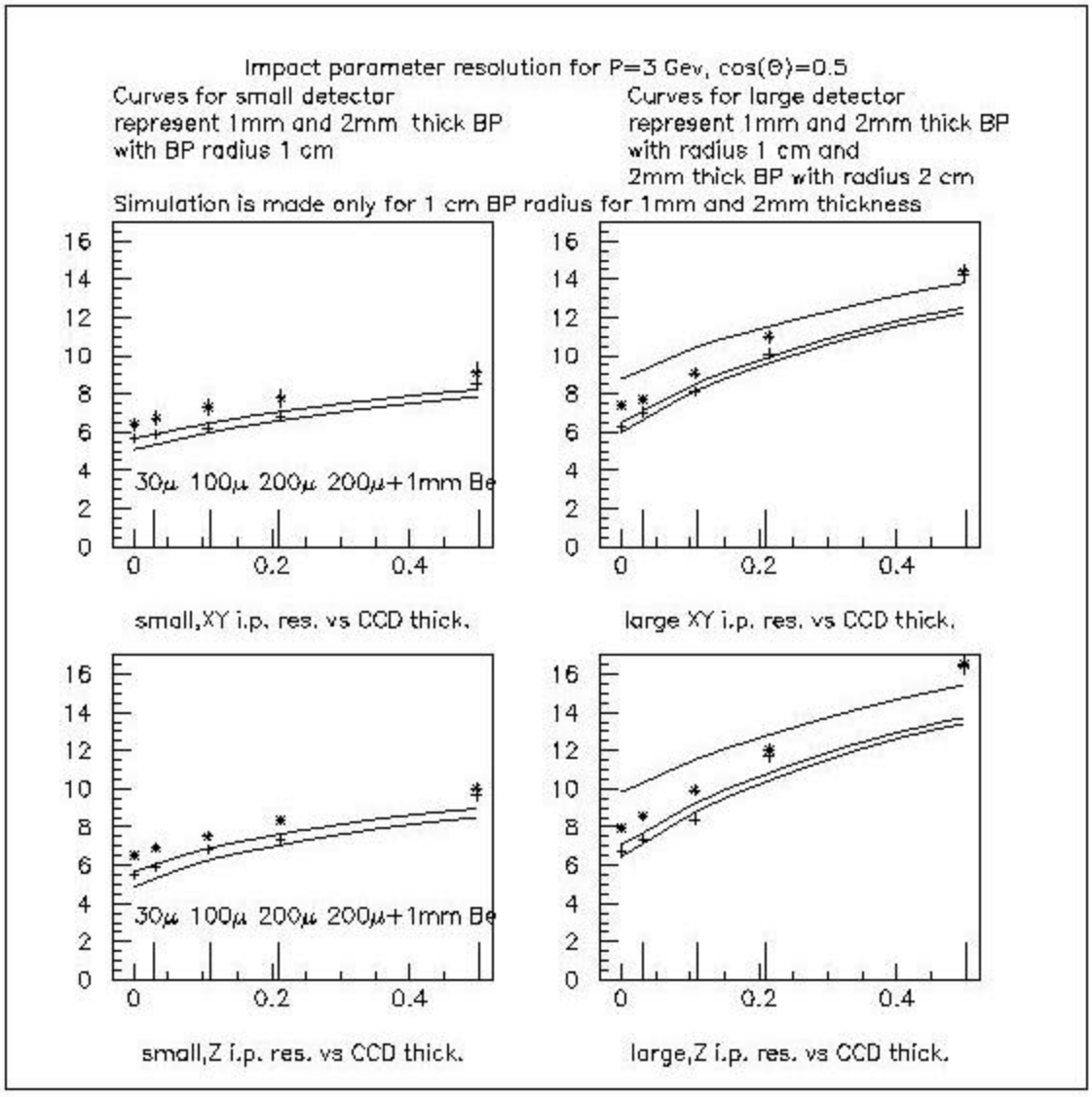
$$\sigma_b = (3\ \mu m \oplus 10\ \mu m / p \sin^{3/2}\theta)$$

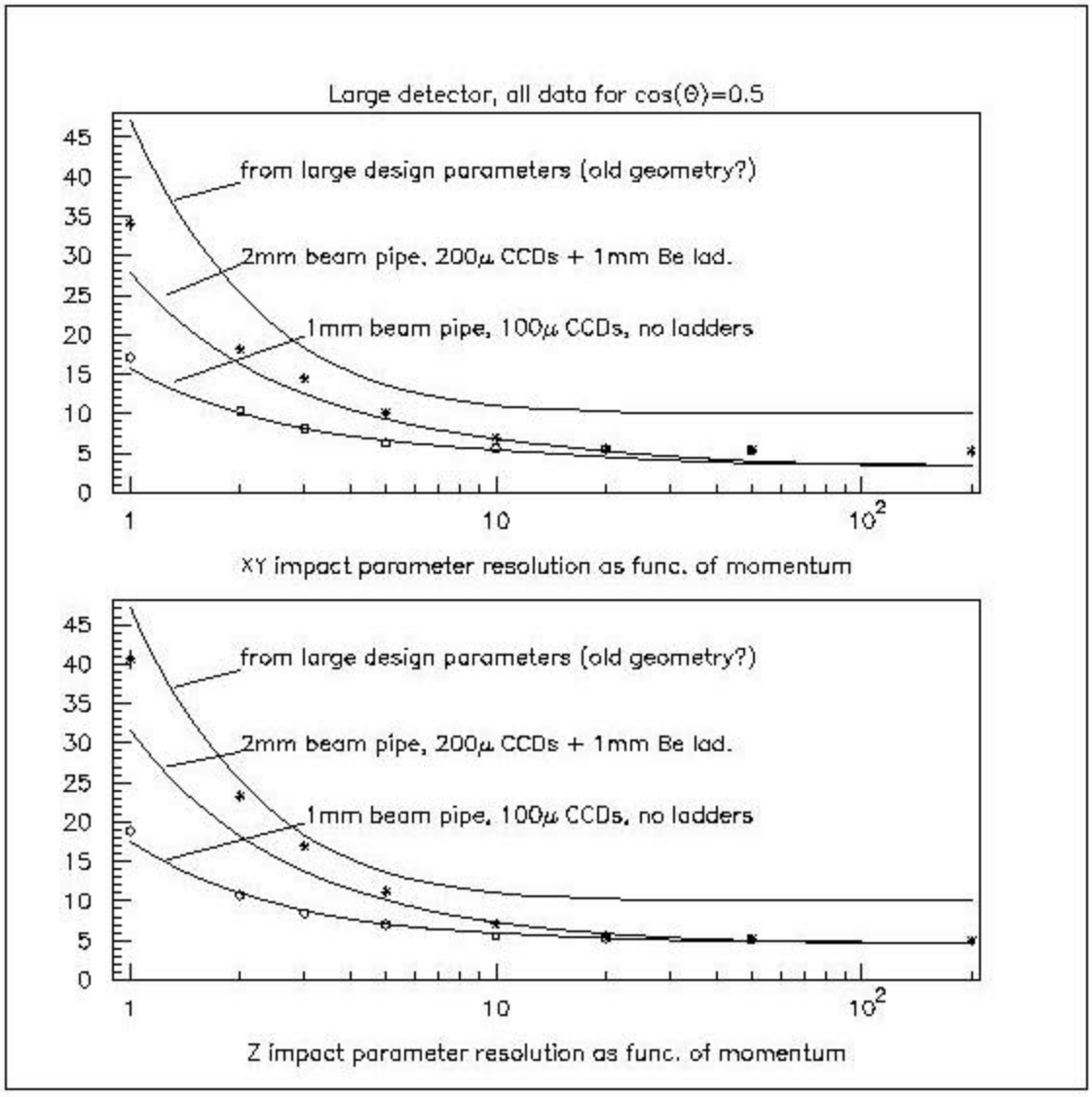
Model L

$$\sigma_b = (3.5\ \mu m \oplus 25\ \mu m / p \sin^{3/2}\theta)$$

The vertex detector has a large role in track finding for the S1 detector, and helps some for the L1 detector.

With the vertex detector, S1 tracking efficiency is 99%


Impact parameter resolution for P=3 Gev, cos(θ)=0.5
Curves for small detector
represent 1mm and 2mm thick BP
with BP radius 1 cm
Curves for large detector
represent 1mm and 2mm thick BP
with radius 1 cm and
2mm thick BP with radius 2 cm
Simulation is made only for 1 cm BP radius for 1mm and 2mm thickness
30μ 100μ 200μ 200μ+1mm Be
small,XY i.p. res. vs CCD thick.
large XY i.p. res. vs CCD thick.
30μ 100μ 200μ 200μ+1mm Be
small,Z i.p. res. vs CCD thick.
large,Z i.p. res. vs CCD thick.



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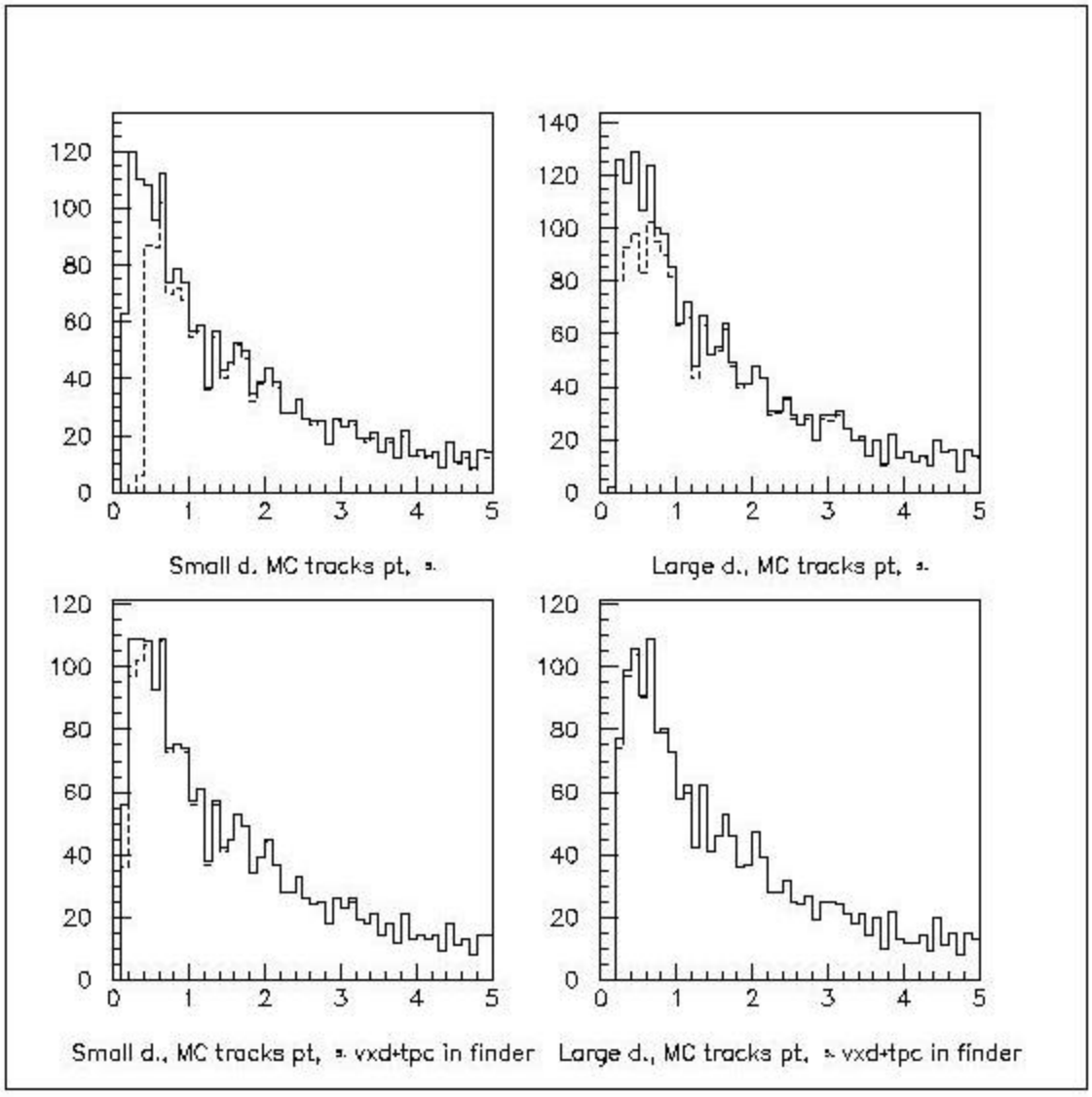
Small d. MC tracks pt.
Large d., MC tracks pt.
Small d., MC tracks pt, vxd+tpc in finder
Large d., MC tracks pt, vxd+tpc in finder

Issues needing study:

Dependence of performance on vertex detector parameters

Parameters:

- Inner radius
- Outer radius
- Number of barrels
- Angular coverage
- Hit Resolution
- Background pile-up
  - (layer dependent)

Performance measures:

- Impact parameter resolutions
- Tagging efficiencies and purities
  - b quarks
  - charm
  - taus
- Specific channels studies
  - eg. Higgs -> c c-bar

We need to incorporate vertex reconstruction into LCD simulations package

-> early fall (N. Sinev)

What modifications would be like for the next round of Monte Carlo runs?

Vertex Detector specific mods

1. reduce the beampipe thickness to 0.5 mm

2. change the CCD layout to Damerell's new layout:

http://hep.ph.liv.ac.uk/~green/lcfi/techdraw/VXDcol.ps

3. use the same CCD layout for both model S and model L

4. add the VXD cryostat to both detectors