Vertex Detectors for the LCD

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c^+e^- \rightarrow ZH \quad (4 \text{ jet topology}) \quad \text{at } 500 \text{ GeV} = 10^{-8} \quad (\sim 1 \text{ Nc yr})

1. \geq 4 \text{ jets} \quad \text{with } m_{H^+} < 45 \text{ GeV} \quad (c^+e^- \rightarrow q\bar{q})
2. E_{H^+} > 0.7 \text{ TeV} \quad (\pm \nu)
3. \chi^2_{\text{exp}} < 75 \quad (\pm \nu)
4. m_{H^+} = m_{H} \quad (80-125 \text{ GeV})

\begin{align*}
M_W &= 110 \text{ GeV/}c^2 \\
M_H &= 150 \text{ GeV/}c^2
\end{align*}
$e^- e^- \rightarrow H \nu \bar{\nu}$  \( \sqrt{s} = 500 \text{ GeV/c}^2 \) \( \Delta \vec{p} \leq 10^{-4} \text{ fm}^{-1} \) (\( \sim \frac{1}{2} \text{ LHC year} \))

1. $E_{\text{miss}} > 1 \text{ TeV}$
2. $p_T > 100 \text{ GeV/c}$
3. $M_H > 200 \text{ GeV/c}^2$
4. $\theta_{\text{had}} > 25^\circ$
5. $\theta_{\text{lep}} < 150^\circ$
6. veto isolated leptons

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[Diagrams showing $M_{UU}$ and $M_{U12}$ distributions for $m_H = 120 \text{ GeV/c}^2$, with and without $b$-tagging.]

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hermeticity
dijet mass resolution

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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% X₀ -> < 0.2% X₀)
smaller inner radius than SLD
(2.8 cm -> 1.2 cm)
	herefore -> improved performance

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.
SLT
Vertex
Detector
Upgrade
(VXD3)

307,000,000
pixels
(20μm x 20μm x 20μm)
Suggested layout of Vertex Detector for future $e^+ e^- \text{Linear Collider}$ (Updated November 1998)

- Single CCD Lengths: 125 mm
- Outer Cryostat Length: 340 mm
- Barrel 1, Barrel 2, Barrel 3, Barrel 4, Barrel 5

Cos $\theta = 0.98$
What have we learned so far:

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

Model S
\[ \sigma_b = \left( 3 \, \mu m \oplus 10 \, \mu m / p \sin^{3/2} \theta \right) \]

Model L
\[ \sigma_b = \left( 3.5 \, \mu m \oplus 25 \, \mu m / p \sin^{3/2} \theta \right) \]

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, $\cos(\theta)=0.5$

Curves for small detector represent 1 mm and 2 mm thick BP with BP radius 1 cm
Curves for large detector represent 1 mm and 2 mm thick BP with radius 1 cm and 2 mm thick BP with radius 2 cm
Simulation is made only for 1 cm BP radius for 1 mm and 2 mm thicknesses.
**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 $\rightarrow$ c c-bar

We need to incorporate vertex reconstruction into LCD simulations package
  $\rightarrow$ 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:

   [link](http://hep.ph.liv.ac.uk/~green/lcfl/techdraw/VXDcol.ps)

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

4. add the VXD cryostat to both detectors