Si Tracking Software

Present Status, Main Issues, Optimization

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on behalf of the SiLC Collaboration

Si Tracker Detector Geometry

- Fast Simulation Systems:
  - **SGV** (*M. Berggren, Marcel Vos*);
  - **LDT** (*M. Valentan*): simplifed description (text file).
- Full Simulation Systems:
  - **Mokka** (*V. Saveliev*): not fully implemented ILD_00;
  - **ILCroot** (*A. Charpy*): full & detailed description.
- New Geometry System:
  - will replace present Mokka-GEAR database system;
  - commitment to the “full description” as in ILCroot.

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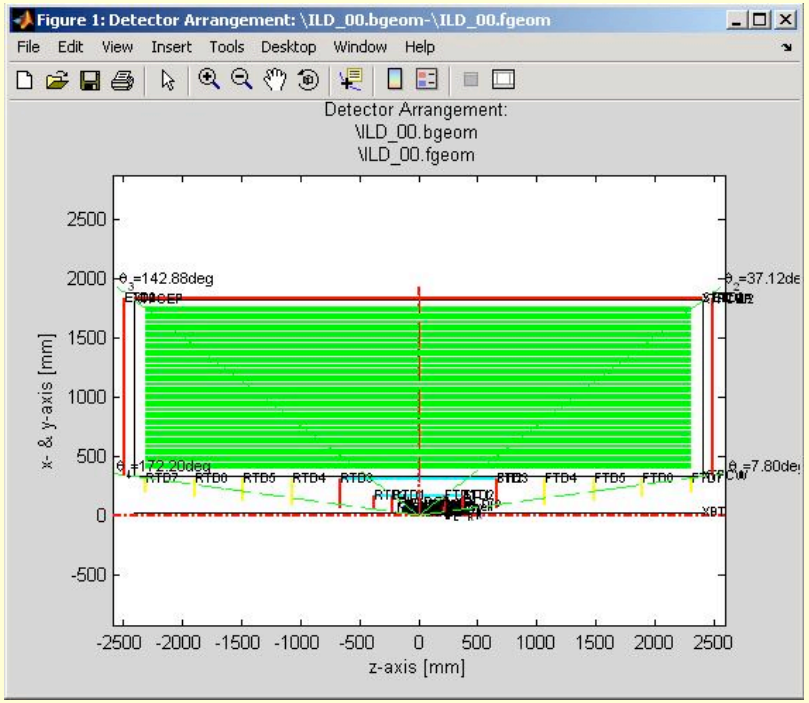
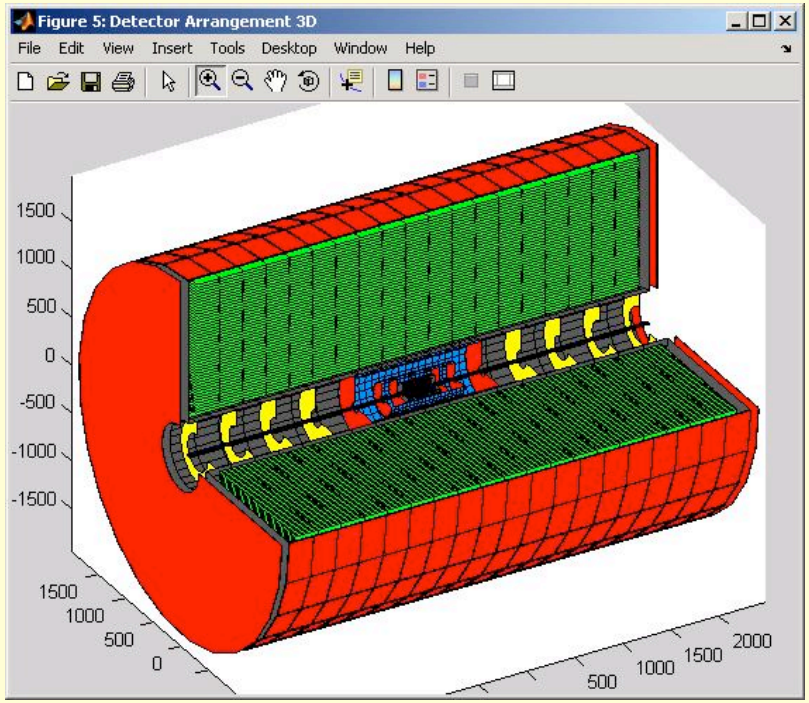
LDT's simple detector description
(based on ILD_00, October 2008)





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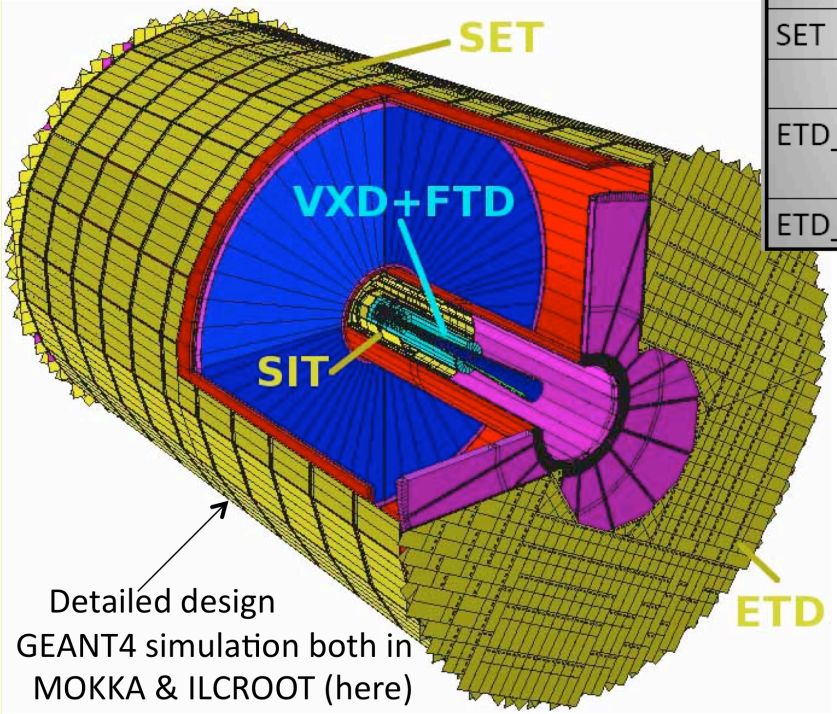
The Silicon Envelope in numbers

(current scheme)

ILD



Detailed design
GEANT4 simulation both in MOKKA & ILCROOT (here)
& mechanical design (CATIA) in progress

Component	Layer #	# modules	# sensors/ module	# channels	Total surface m2
SIT1	1st layer	33	3	66.000	0.9
	2nd layer	99	1	198.000	0.9
SIT2	1st layer	90	3	180.000	2.7
	2nd layer	270	1	540.000	2.7
SET	1st layer	1260	5	2.520.000	55.2
	2nd layer	1260	5	2.520.000	55.2
ETD_F	X or U or V	82/quad =328/layer =984/ETD	2 or 3 or possibly 4	2.000.000	30
ETD_B	idem	idem	idem	idem	30

Total number of channels:
10^6 (SIT) + $5x10^6$ (SET) + $4x10^6$ (2 ETD)
= **10 $x10^6$ channels**

Total area:
7 (SIT)+110 (SET) +2x30(ETDs) = **180 m^2**

Total number of modules:
500 (SIT) + 2500 (SET) + 2000 (ETDs)=
5000 modules with unique size sensors

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Si Tracker Material Budget

- Work on including realistic figures for
  - **Front/end electronics**;
  - **Cabling on detector;**
  - **"Cooling" of detector**.

Already a good approximation provided by the R&D activities; will be updated.

- Open questions: how important are
  - **Longitudinal resolution** (strip stereo angles – how) ?
  - **Time tagging** (relief bunch-train induced problems) ?
  - **ETD:** assess usefulness – for forward calorimetry ?
- Goal: optimization studies to be revisited
  - so far done mainly by LDT, to be redone by Full Sim.

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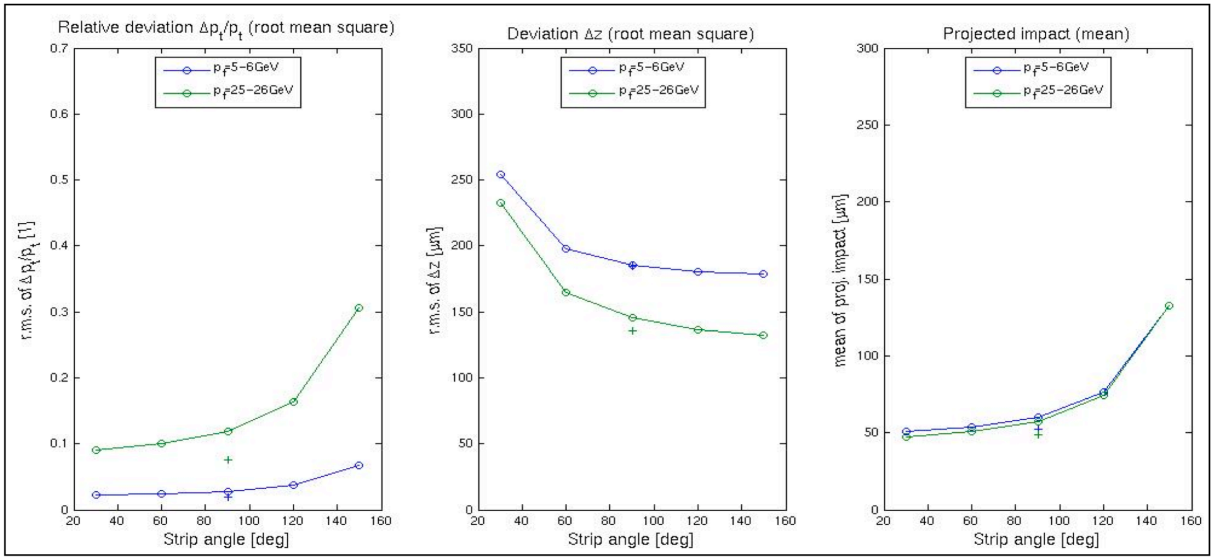
LDT barrel stereo optimization study
(SiLC, CERN, September 2007)

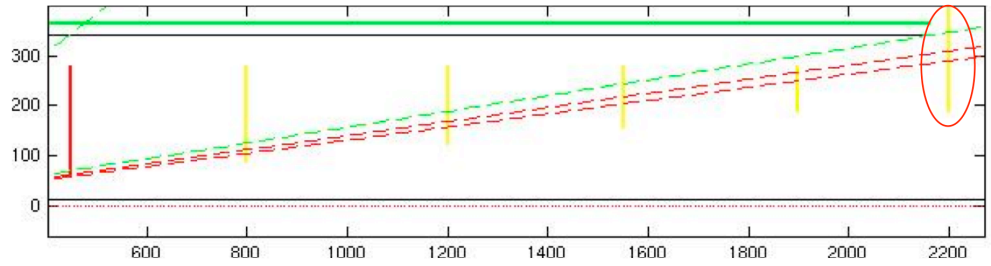
Results ($7.5° < \theta < 8°$, p_t = 5-6GeV; 25-26GeV)



+: Additional endcap

Strip distance d=90μm

Optimal case, see also next transparency



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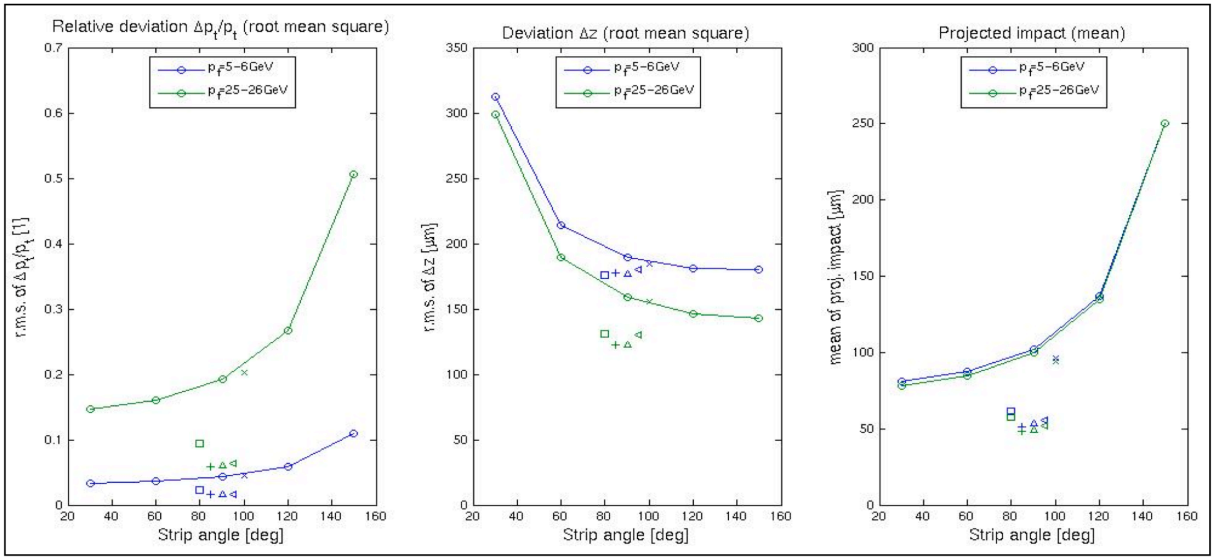
LDT barrel stereo optimization study
(SiLC, CERN, September 2007)

Results ($8.5° < \theta < 9°$, p_t = 5-6GeV; 25-26GeV)



□: Radius FTD7 increased

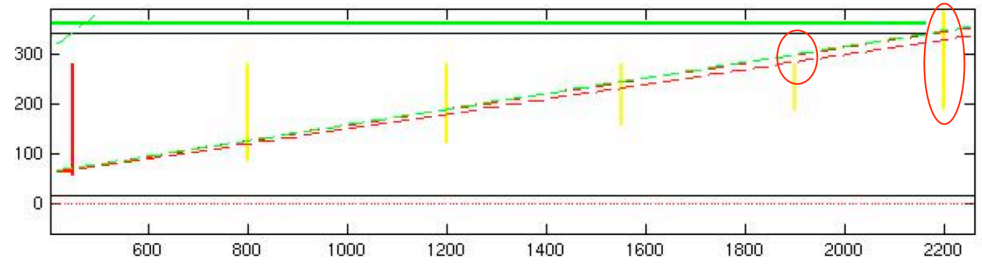
+: Add. endcap

△: Both

◁: Both with inefficiency

X: Original with ineff.

Strip distance
d=90μm



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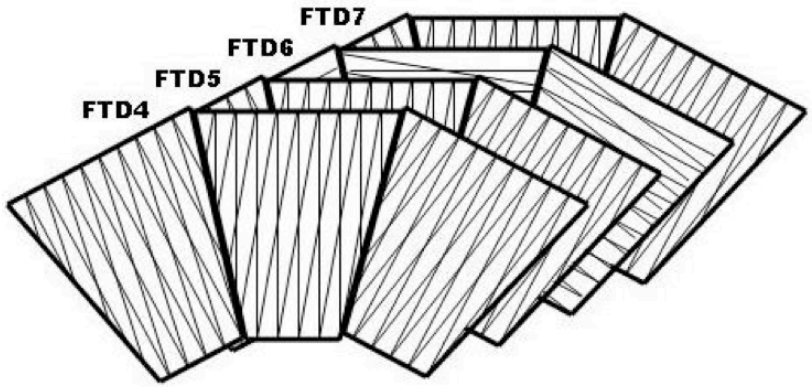
LDT forward stereo optimization study
(LCWS, Chicago, November 2008)

- The ILD reference design is already well configured. However, there is some potential for improvement.
- Proposal for an optimized forward tracker (with minimal diversity of sensors):

Layer	R [mm]	|z| [mm]	RL [%]	σ [μm]	d_{strip} [μm]	α [$^\circ$]	Type
FTD1	24.5-160	220	0.25	7	-	-	Pixels
FTD2	39.9-160	380	0.25	7	-	-	Pixels
FTD3	52.0-304	660	0.25	7	-	-	Pixels
FTD4	84.4-309	1070.6	0.65	-	25	6	Strips
FTD5	116.7-309	1481.2	0.65	-	25	6	Strips
FTD6	149-309	1891.8	0.65	-	25	6 (rot. by 90°)	Strips
FTD7	181.4-309	2302.5	0.65	-	25	6	Strips



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Si Tracker Software Tools
Track Reconstruction (1)

- Barrel Track Search (proposal):
  - Tracks with $\vartheta > 32.5^0$ have barrel (and EDT) hits only;
  - Tracks with $\vartheta > 45^0$ have substantial coverage by TPC;
  - Starting with tracks found by local P.R. in the TPC;
  - Extrapolation outwards to SET, inwards to SIT & VXD;
  - Associate SET and SIT & VXD hits with that track;
  - Stand-alone P.R. with orphaned SIT & VXD hits;
  - Extrapolation outwards to TPC and SET;
  - Associate orphaned TPC and SET hits with this track.

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Si Tracker Software Tools
Track Reconstruction (2)

- Forward Track Search (challenges):
  - Tracks with $\vartheta < 7.9^0$ have forward hits only (FTD);
  - $7.9^0 < \vartheta < 32.5^0$: complex barrel & forward mix, possibly involving VXD, SIT, TPC, ETD;
  - Rely on flexible stand-alone strategies to cope with above.
- Track Fit Strategies (barrel and fwd.):
  - Kalman Filter & Smoother, Adaptive Filter (e.g. DAF), efficient Outlier Removal;
  - Profit from the experience gained by LHC experiments.

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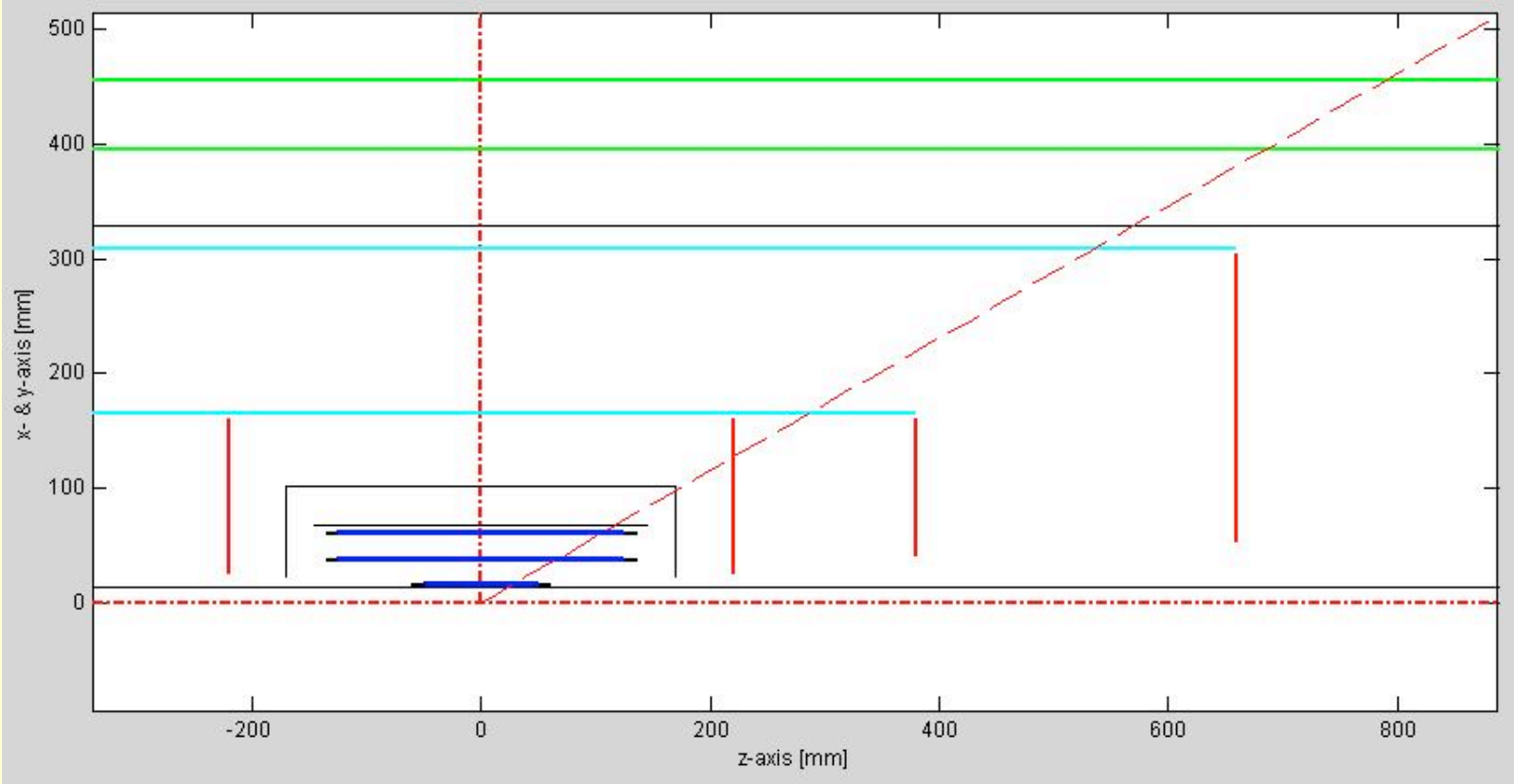
The Complex Intermediate Region

LDT asset: sequences of cylindrical and plane detector layers are flexibly handled by LDT !



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Si Tracker Software Tools
Track Reconstruction (3)

- Important open question:
  - Reliability of barrel track search starting with TPC ?
  - Alternative: stand-alone VXD & SIT, link TPC later.
- Suggested responsibilities:
  - Local Pattern Recognition in the TPC: LCTPC;
  - Stand-alone P.R. in VXD and Si Trackers: SiLC;
  - Track search and fit in the barrel region: DESY;
  - Track search and fit in the forward region: Vienna (involves a solid background study).

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Continue with Jordi Duarte

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Forward Silicon Tracking: An analysis example

J. Duarte Campderrós
on behalf of SiLC collaboration

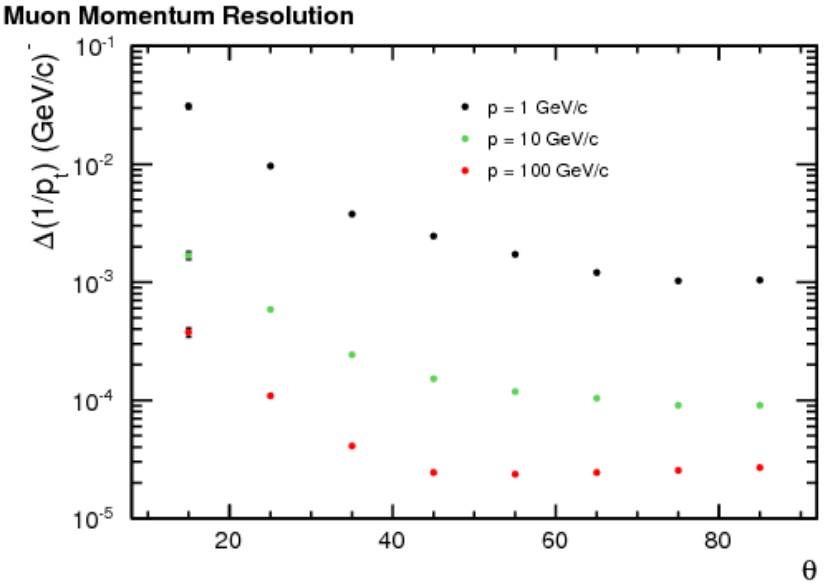
IFCA - U.Cantabria/CSIC

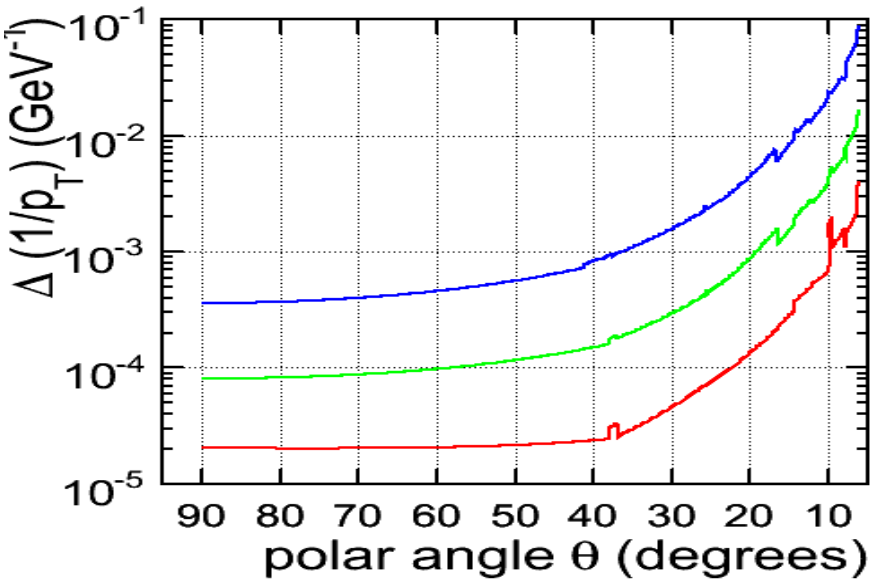
ILD software pre-Meeting
Paris, France
January 27 2010

Analysis Example

Post-LOI analysis: Momentum resolutions for electrons

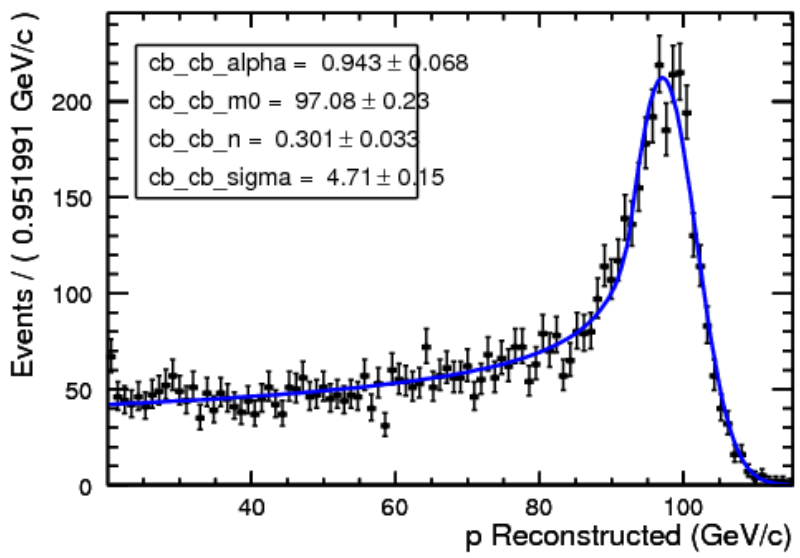
- Generated Single electron samples (private but available) at fixed p=100 GeV/c
- Simulated with **Mokka** (ILD_00 model) and Reconstructed following the standard processors availables in the framework
- Compared with LOI results for muons



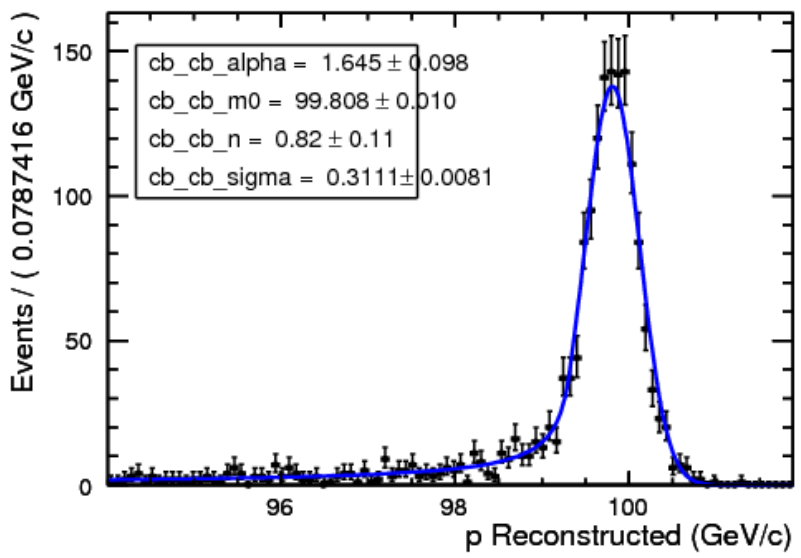


Energy loss

$5^o < \theta < 10^o$



$85^o < \theta < 90^o$

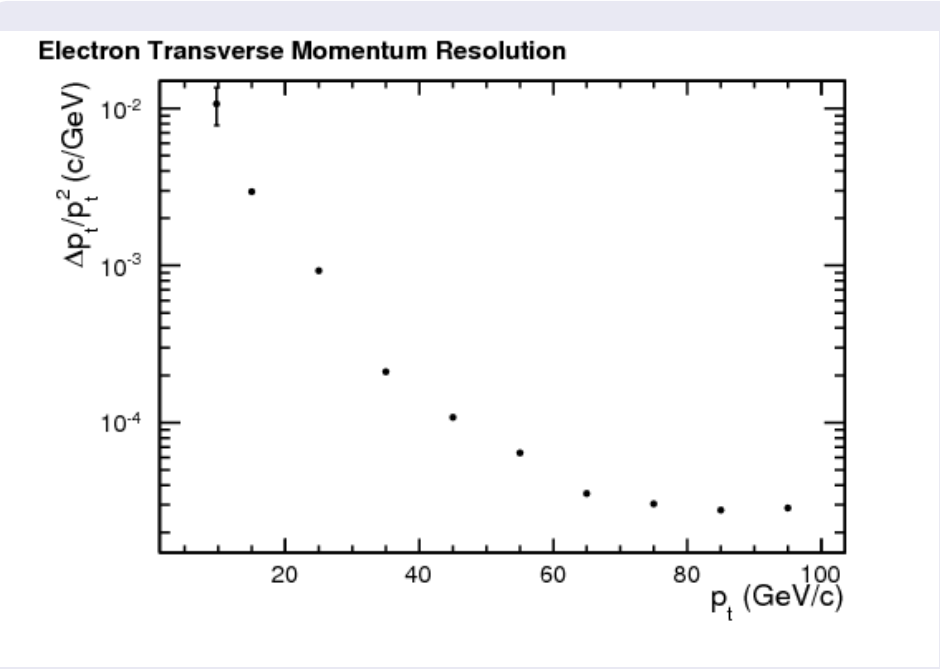


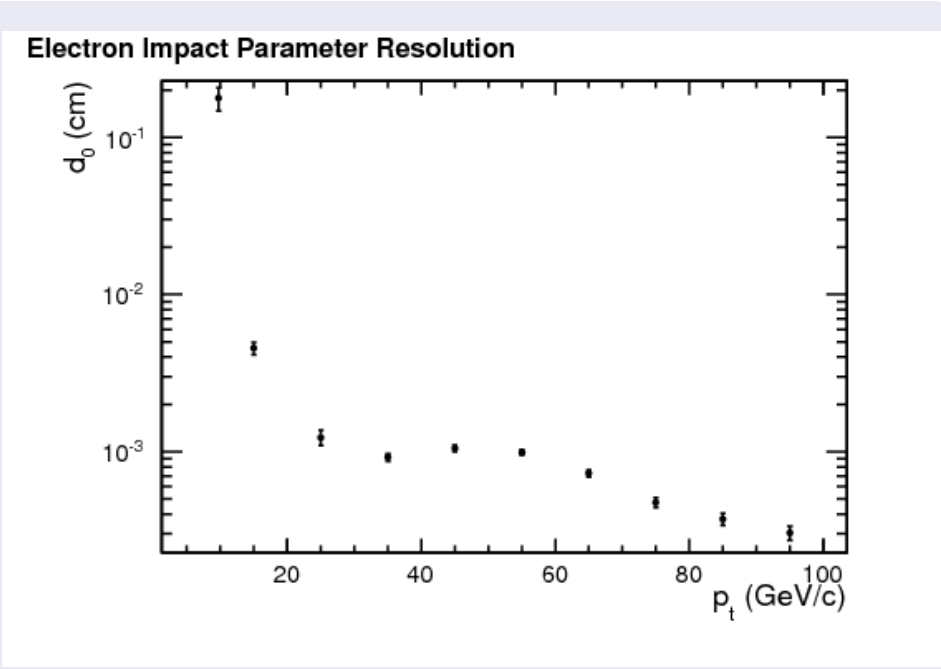
Energy Loss:

- 3 GeV/c in average (forward)
- 150-200 MeV/c in average (central)

Momentum an impact parameter resolution

Fixed p=100 GeV/c





Worse resolution than muons in the forward region, but in the same order.