Thoughts on Physics Analyses with ILD Full Simulation and Reconstruction

Marco Battaglia
UC Berkeley and LBNL

LAWRENCE BERKELEY NATIONAL LABORATORY

ILD NA Meeting
December 5, 2007

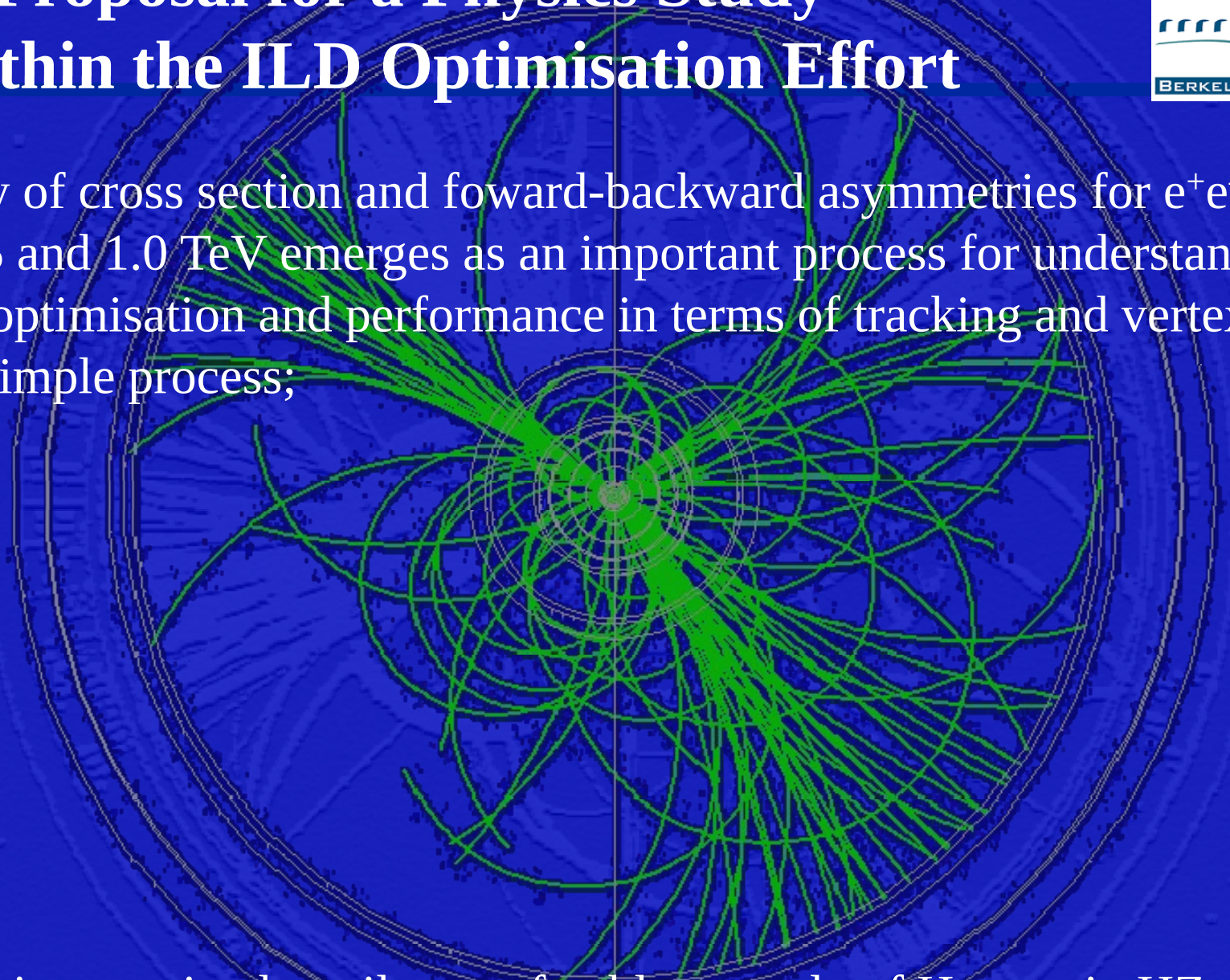
Report to the ILC World-wide Study

Physics Benchmarks for the ILC Detectors

arXiv:hep-ex/0603010 v1 6 Mar 2006

0. Single $e^{\pm}$, $\mu^{\pm}$, $\pi^{\pm}$, π^0, $K^{\pm}$, K^0_s, γ, u, s, c, b; $0 < |\cos\theta| < 1$, $0 < p < 500$ GeV
1. $e^+e^- \to f\bar{f}$, $f = e$, c, b at $\sqrt{s}$=1.0 TeV;
2. $e^+e^- \to Zh$, $\to \ell^+\ell^- X$, $m_h = 120$ GeV at $\sqrt{s}$=0.35 TeV;
3. $e^+e^- \to Zh$, $h \to c\bar{c}$, $\tau^+\tau^-$, WW^*, $m_h = 120$ GeV at $\sqrt{s}$=0.35 TeV;
4. $e^+e^- \to Zhh$, $m_h = 120$ GeV at $\sqrt{s}$=0.5 TeV;
5. $e^+e^- \to \tilde{e}_R\tilde{e}_R$ at Point 1 at $\sqrt{s}$=0.5 TeV;
6. $e^+e^- \to \tilde{\tau}_1\tilde{\tau}_1$, at Point 3 at $\sqrt{s}$=0.5 TeV;
7. $e^+e^- \to \chi^+_1\chi^-_1/\chi^0_2\chi^0_2$ at Point 5 at $\sqrt{s}$=0.5 TeV;

A Proposal for a Physics Study within the ILD Optimisation Effort



Study of cross section and foward-backward asymmetries for $e^+e^- \rightarrow cc$ at 0.5 and 1.0 TeV emerges as an important process for understanding ILD optimisation and performance in terms of tracking and vertexing in a simple process;

Experience gained, easily transferable to study of H → cc in HZ and Hνν

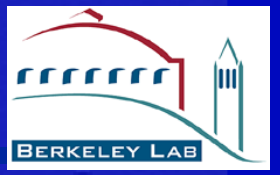
Experimental Ingredients

- charm tagging with ~democratic background;
  study jet flavour tagging capabilities down to small polar angle;
  optimise barrel/fwd transistion of VTX, material distribution,
  match to TRK, pair / $\gamma\gamma \rightarrow$ hadrons background sensitivity

- quark charge determination;
  study vertex charge and jet charge

- parton direction reconstruction, gluon radiation rejection;
  jet algorithms, use primary-secondary vertex vector,
  correction for νs in s.l. charm decays;

$e^+e^- \rightarrow cc$ at 0.5 and 1.0 TeV



$e^+e^- \rightarrow cc$ is an interesting process featuring sensitivity to tracking and vertexing performances and less critically dependent on PFAs;

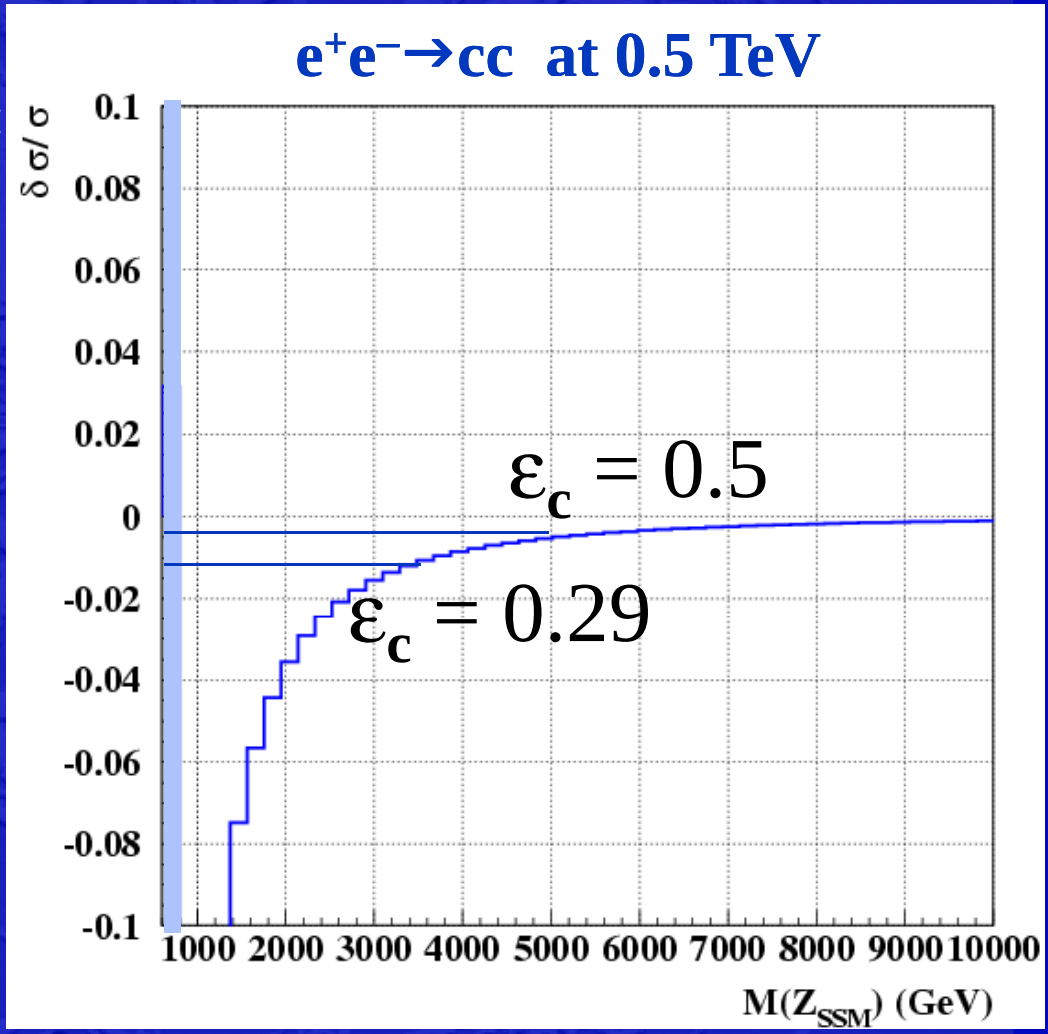
Most required software tools already available at 0^{th} order, need to optimise performances, study effect of various detector configurations;

Interpretation of ILD accuracy on σ_{cc} and A_{fb} in terms of sensitivity to New Physics, may engage theory community at FNAL and elsewhere;

$e^+e^- \rightarrow cc$ at 0.5 TeV

Measurement of cc cross section: moderate cross section, requires 2 tags and low background;

	σ_{ff} (pb)
cc	0.74
bb	0.40
μμ	0.45

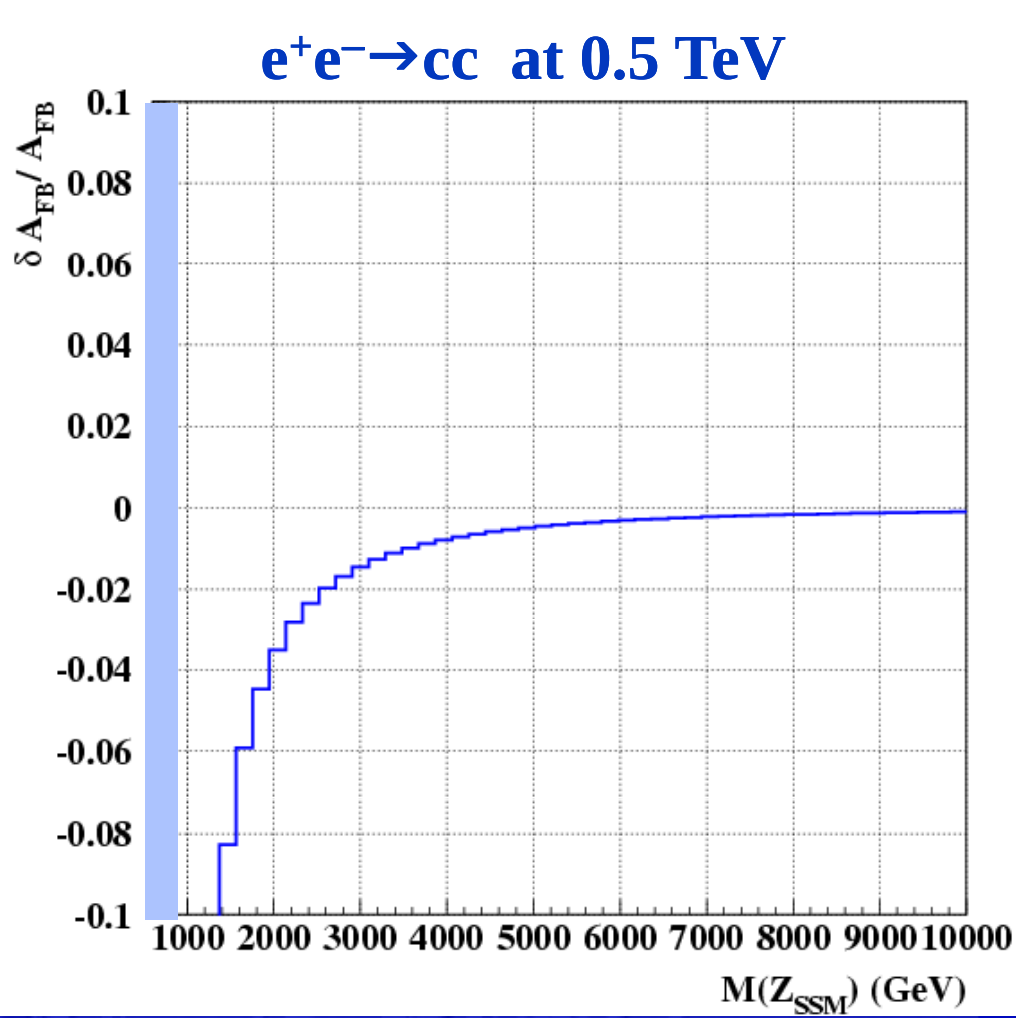


A_{FB} in $e^+e^- \to cc$ at 0.5 TeV

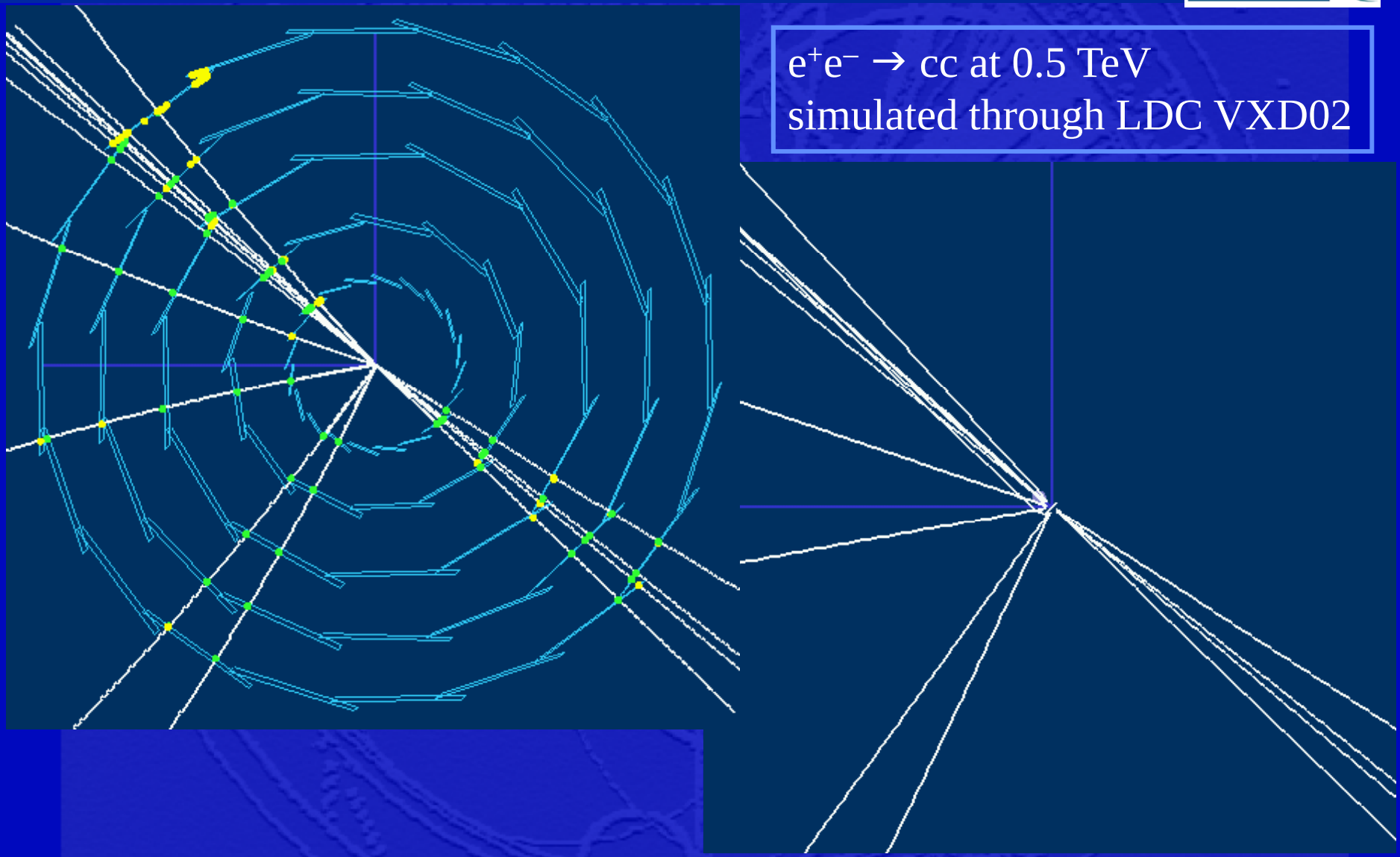
Further sensitivity on NP scale and nature can be obtained with A^{cc}_{FB} determination;

Experience at LEP with Jet charge algorithms;

Improved sensitivity expected using vertex charge, requires fwd coverage;



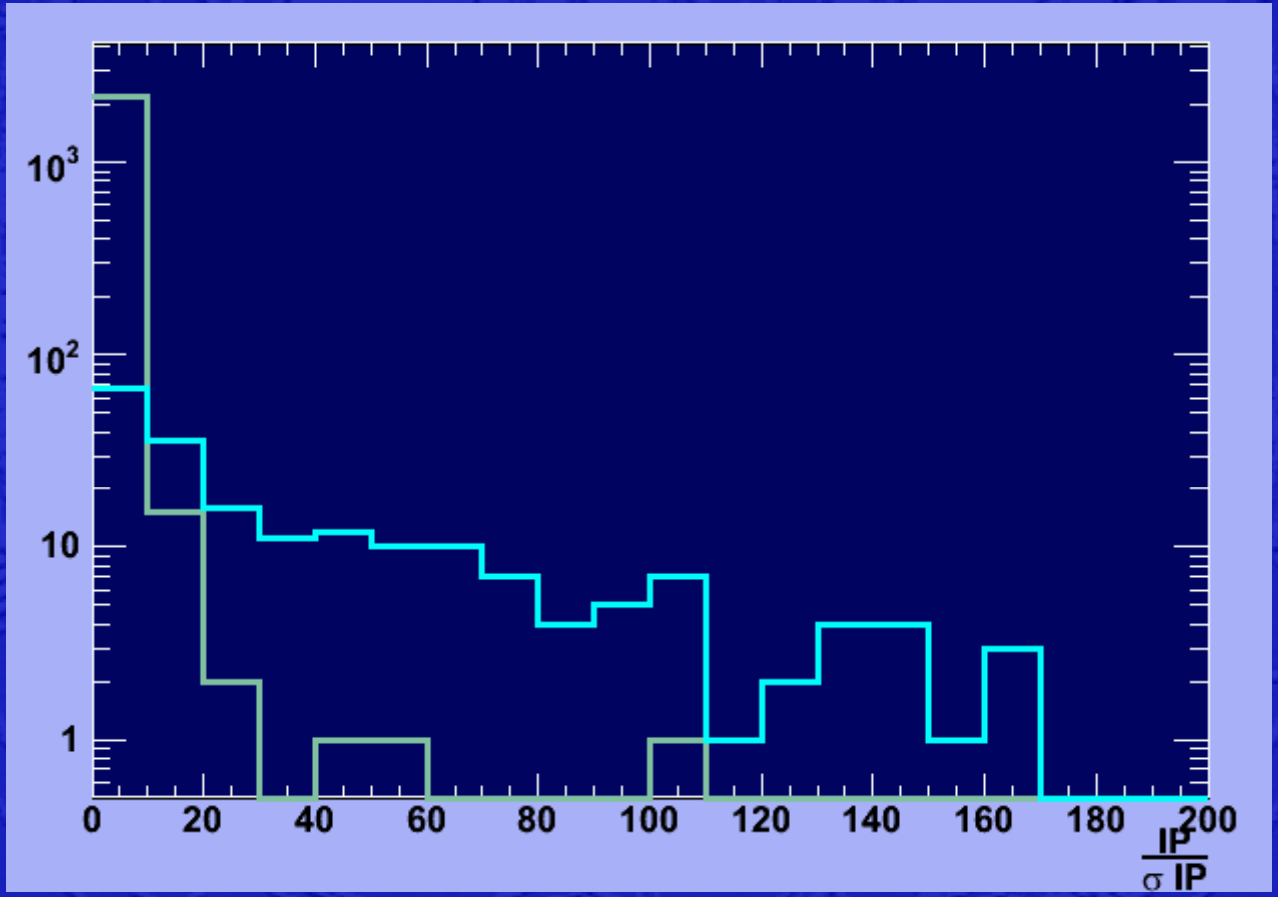
$e^+e^- \rightarrow cc$ at 0.5 TeV



$e^+e^- \rightarrow cc$ at 0.5 TeV
simulated through LDC VXD02

$e^+e^- \rightarrow cc$ at 0.5 TeV

Impact Parameter Significance



Charm Tagging vs. I.P. Resolution

Study change in efficiency of charm tagging in Z^0-like flavour composition

Geometry	σ_{IP} (μm)		
R1 1.2 cm ↓ 1.7 cm	$4 \oplus 7 / p_t$ $4 \oplus 10 / p_t$	c purity=0.7	ε_c = **0.49** ε_c = **0.46**
R1 1.2 cm ↓ 2.1 cm	$4 \oplus 7 / p_t$ $5.5 \oplus 14 / p_t$	c purity=0.7	ε_c = **0.49** ε_c = **0.40**
HPS	$11 \oplus 15 / p_t$	c purity=0.7	ε_c = **0.29**

Total efficiency = ε^N with N = number of jets to be tagged

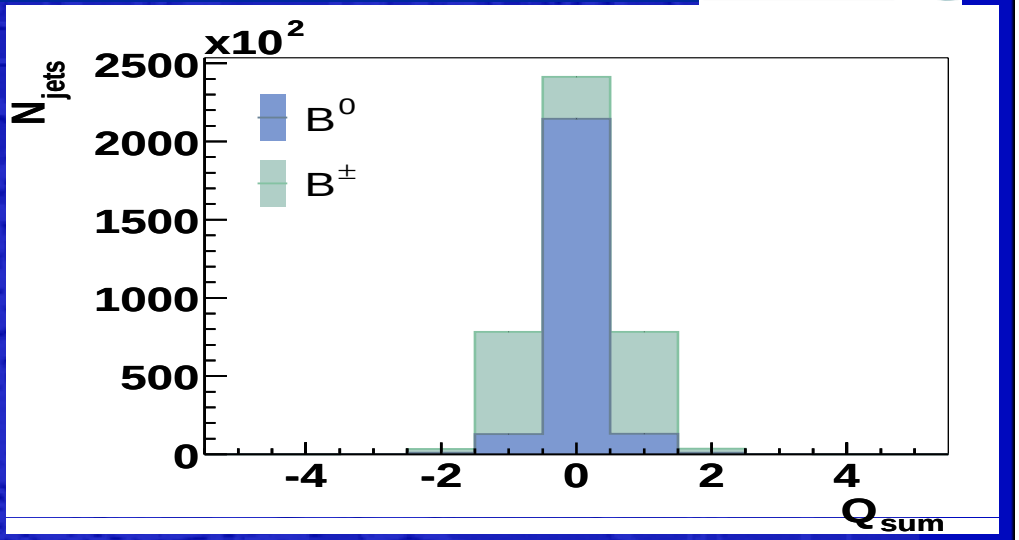
Hawking, LC-PHSM-2000-021

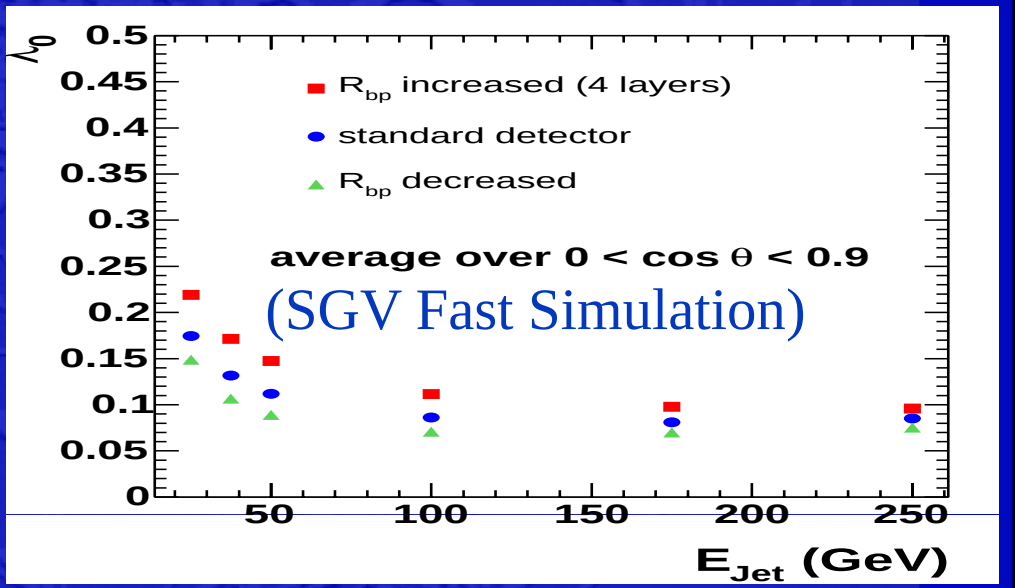
Vertex Charge

Vertex charge algorithms very promising for q-anti q discrimination in b and c jets

Vertex charge extremely sensitive to correct secondary particle tags: any mistake changes result by ± 1

No experience with vertex charge in charm jets:
$\langle N_{sec} \rangle = 1.7$





Hillert & LCFI
Ringberg 2006

Our group interested in optimisation and performance assessment with emphasis on vertex tracker and Verte-Main Tracker matching;

Significant effort already deployed in developing Vertex Tracker simulation (charge generation and digitisation) and reconstruction (pattern recognition and standalone tracking) validated on beam tests at 1.5 and 120 GeV;

Performed already an analysis with Mokka+MarlinReco for $e^+e^- \rightarrow H^0A^0$ with LDC at 1 TeV (B. Hooberman at ALCPG07)

Interested in joining forces with other groups to develop program of physics studies and optimisation within the ILD LoI effort.