Summary of Reconstruction and Simulation

’08 11/20 Y. Takubo (Tohoku U.)

Speaker list (1)

We had 5 sessions and 23 speakers.

11/17 (Mon.)

MC production for LOI

- Gabriel : “Mokka status and latest developments”
- Paulo : “Going ahead with Mokka”
- Frank : “ILD Software Status – Preparations for the LOI”
- Norman : “ALCPG Software Status – Preparations for the LOI”

Reconstruction improvements

- Jenny : “Kinematic Fitting in the Presence of ISR”
- Marcel : “GARLIC”
- Ron : “SiD: Separating Detector Performance from PFA Confusion”
- Taikan : “New Jet Clustering and its Performance in Physics Studies”

11/18 (Tue.)

- Rich : “SiD Track Reconstruction”
- Windfried : “Implementation and Application of Kinematic Vertex Fitting in the ILD”
- Fedor : “Performance of the Tracking Systems with the 4th Concept”
- Steve : “Tracking Studies for ILD”
- Dmitry : “Integrated Tracking – Clustering Algorithm”
- Matteo : “Comparison of Central Trackers for the ILC”

Speaker list (2)

PFA & Detector optimization

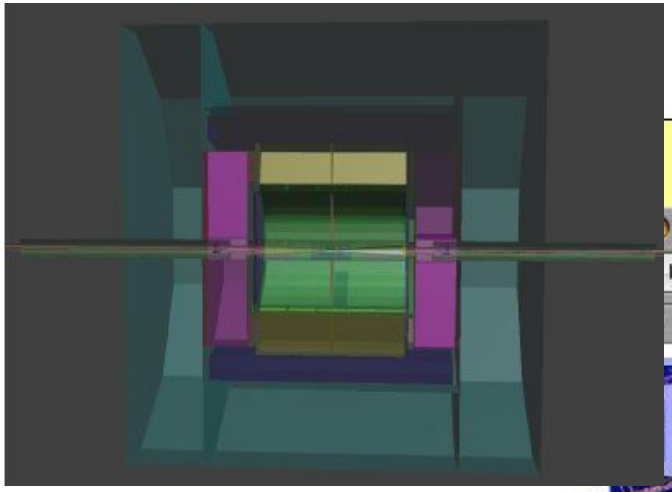
11/19 (Wed.)

- Mattew : “PFA Performance for SiD”
- Tae : “PFA Implementation and Plans for Future Improvements”
- Stephen : “PFA Algorithm”
- David : “PFA Progress and ILD Detector Optimization”
- Marcel : “Detector Optimization for SiD”
- Lucie : “Multi-TeV Detector Optimization Studies for CLIC”
- Michele : “Sensitivity of Higgs self-coupling at LDC”
- Timothy : “Status of SiD Benchmarking”
- Anna : “Jet Reconstruction and Physics Performance with the 4th Concept”

MC production for LOI

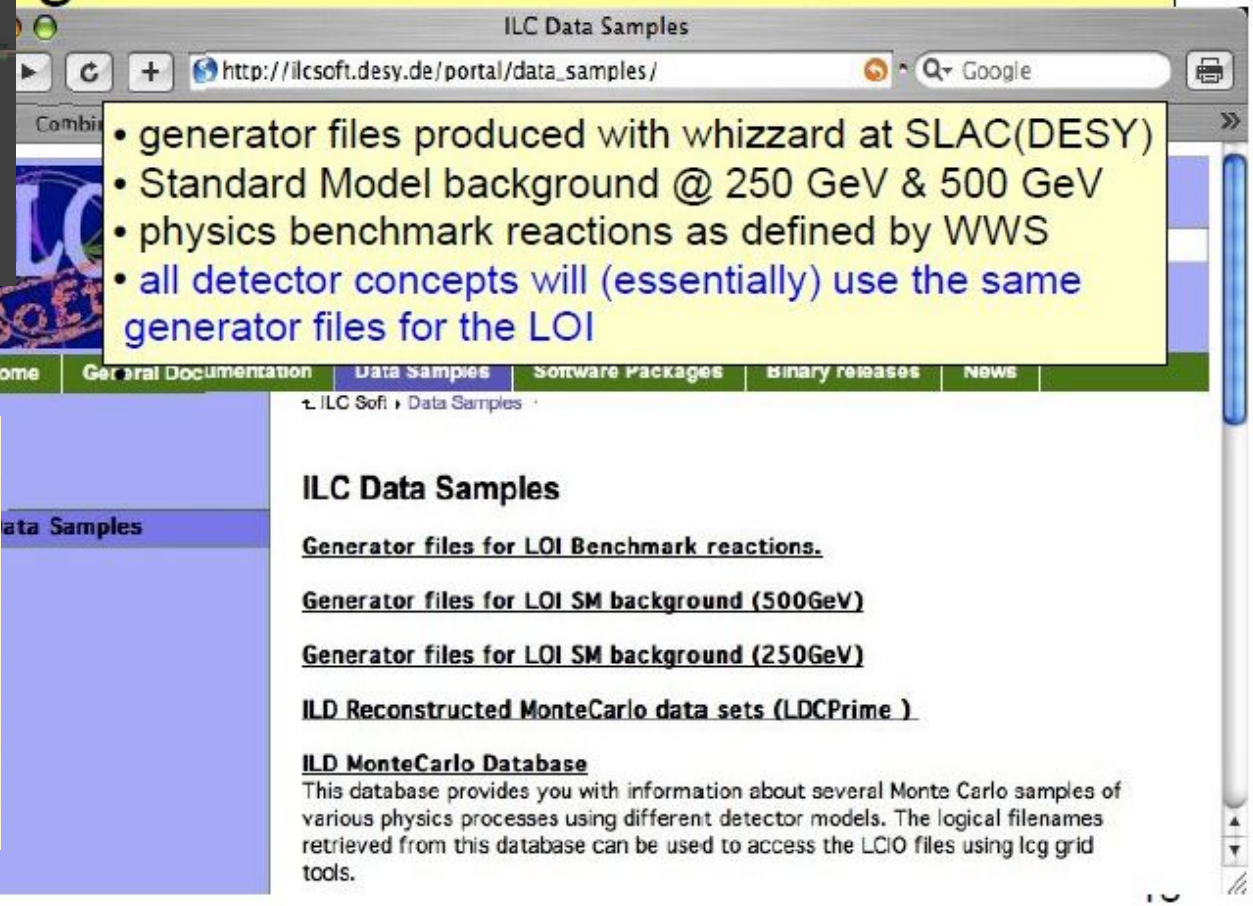
ILD data production

ILD_00 (Gabriel)

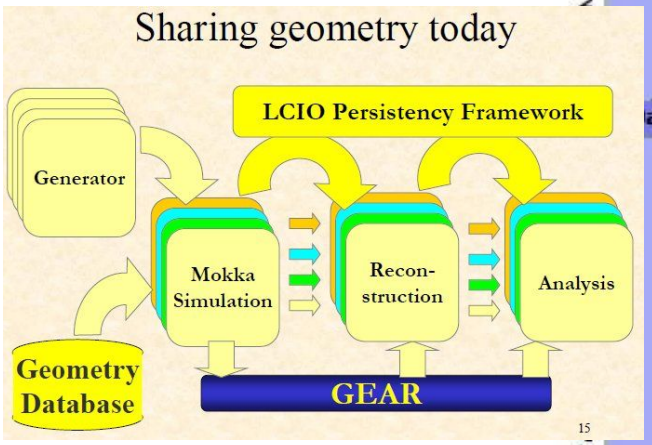


Frank

generator files to be simulated I



Paulo



SiD data production

Benchmarking Sim & Reco Summary*

Process	Gen	Sim	Reco
500_SM	7.2 M	✓	✓
500_top	2.2 M	✓	✓
500_tau	3.2 M	✓	✓
500_SUSY	-**	✗	✗
500_bckgrnd	~700 k	✓	✓
500_pairs	1500	✗***	✗
250_SM	7.9 M	✓	✓
250_higgs	~250 k	✓	✓

* Have not completed QA for all events/files to account for crashes, etc.
** Most whizard events have been generated, awaiting mixing.
*** Will use different field map to accurately track far-forward particles.

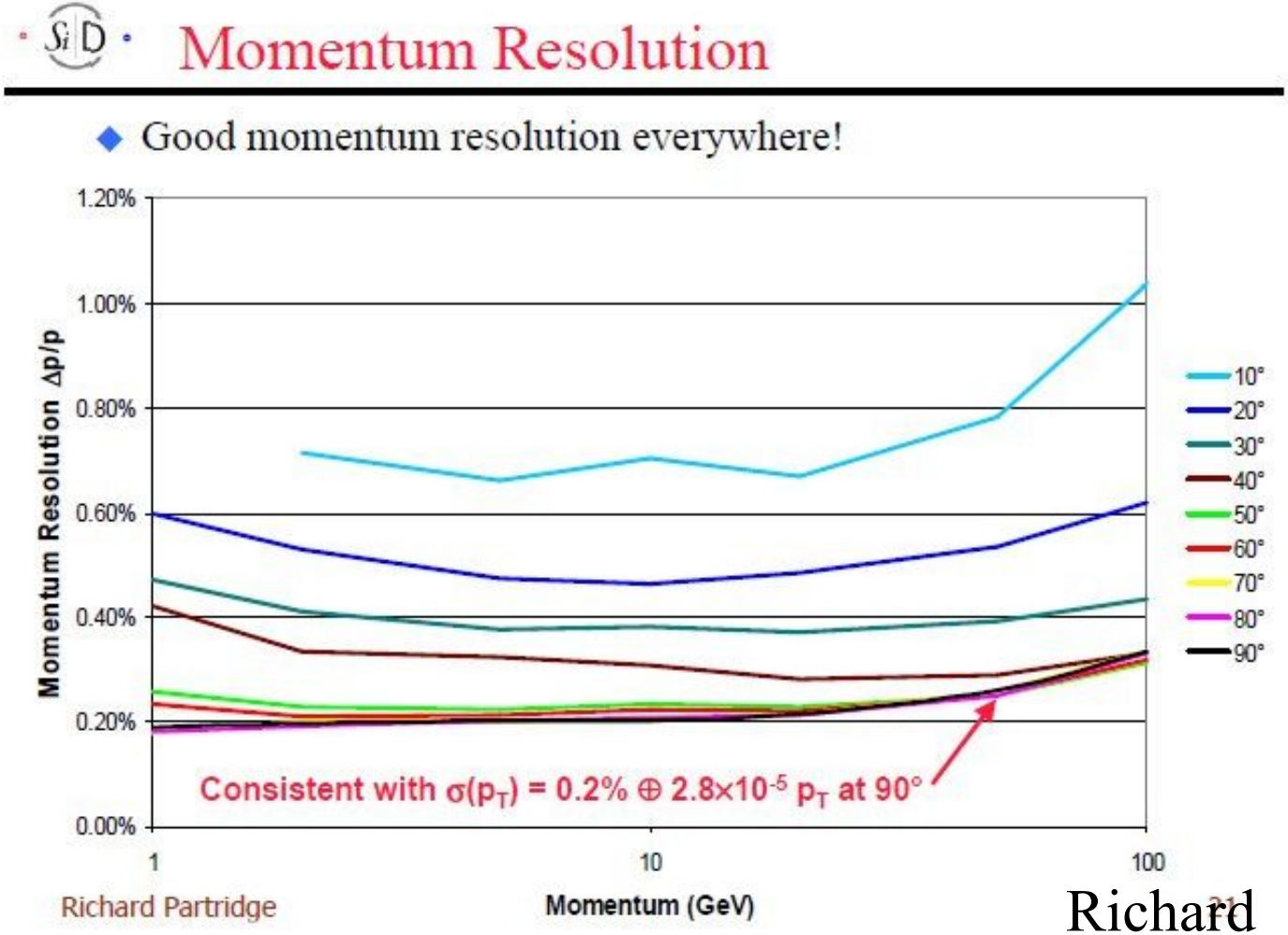
18

Norman

Reconstruction improvements

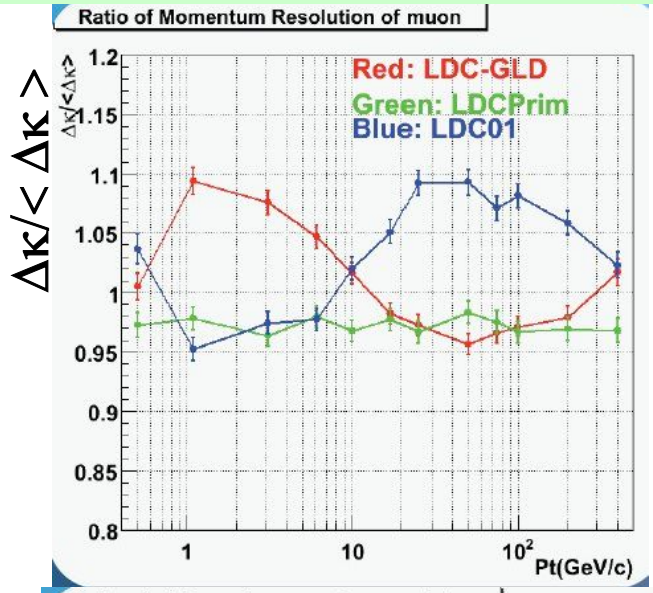
SiD track reconstruction

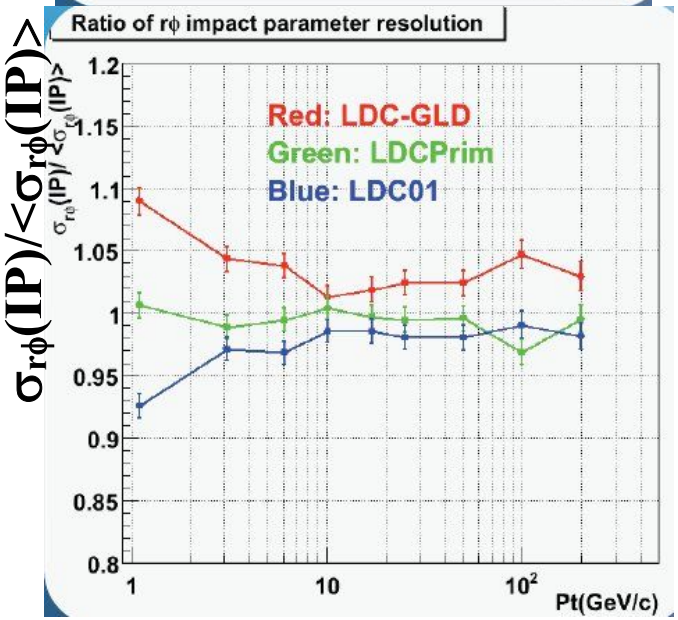
A new track reconstruction code in the org.lcsim framework has been developed.

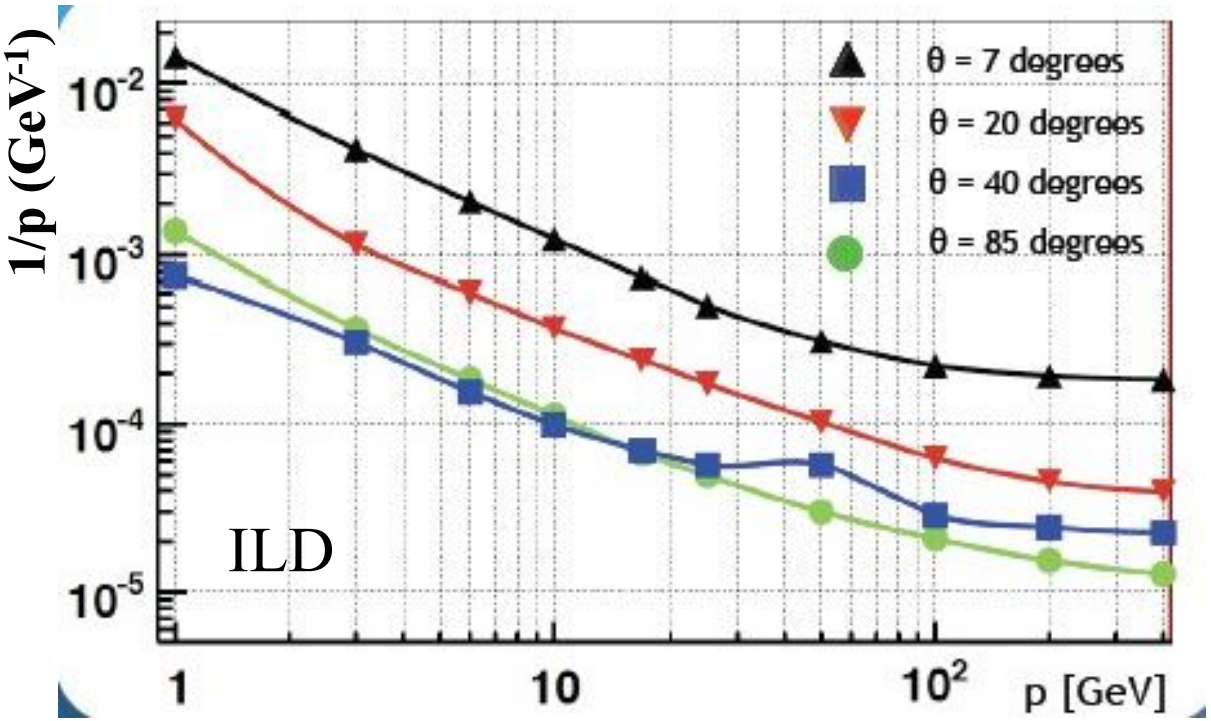


Richard

Tracking performance for ILD



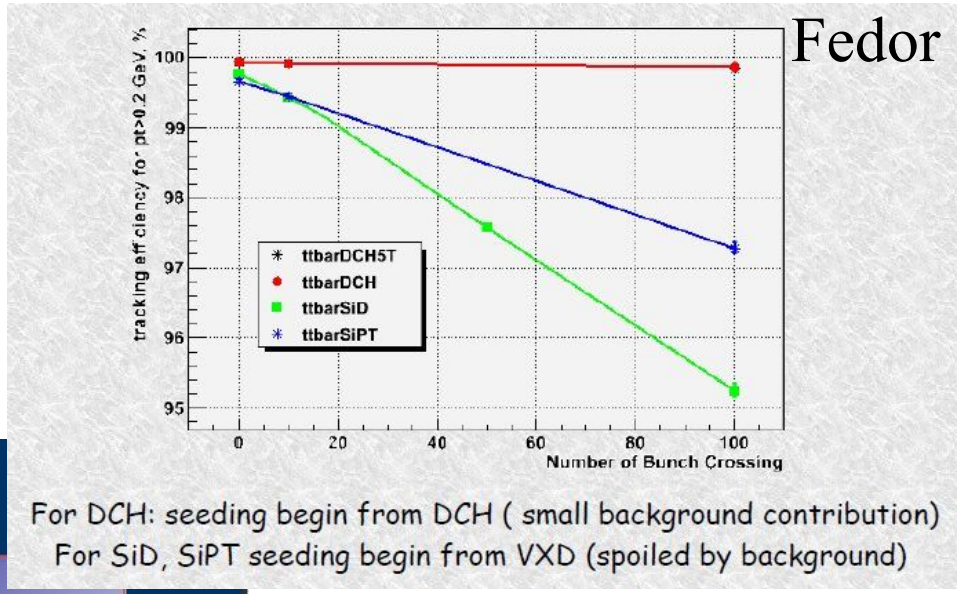




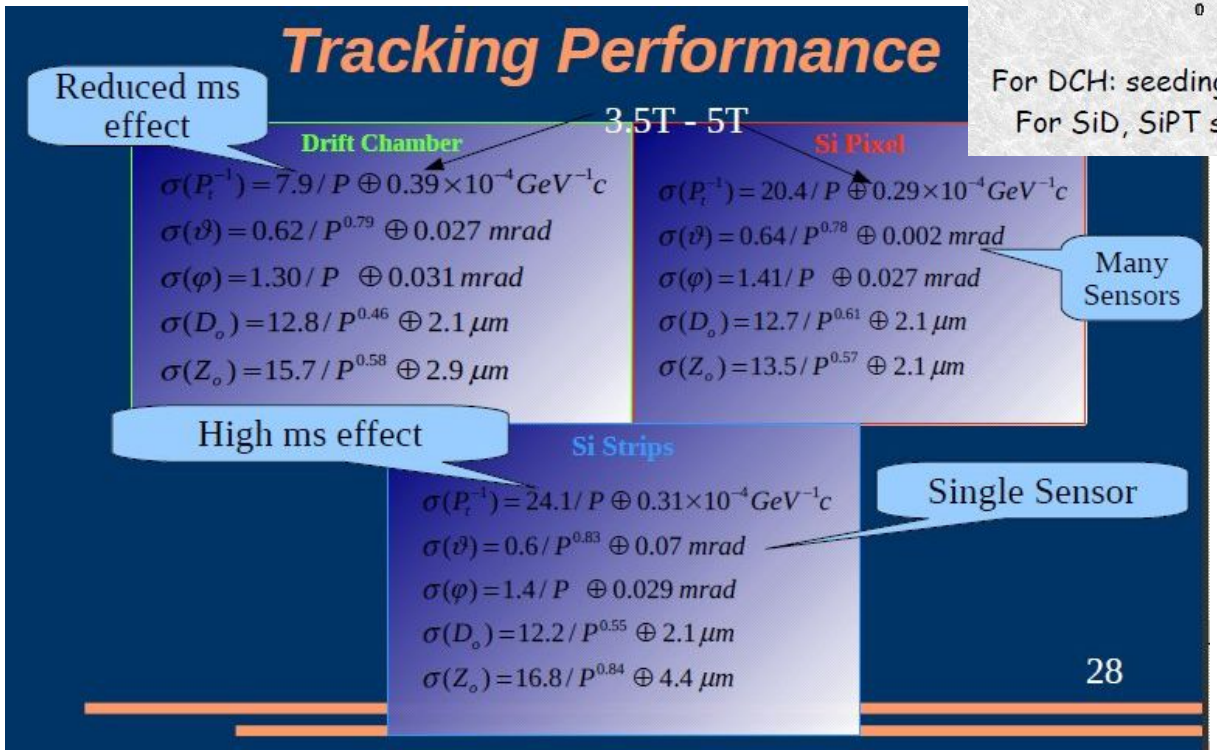
Steve

Tracking with drift chamber

Tracking performance was studied by using simulation framework in 4th concept.



Fedor



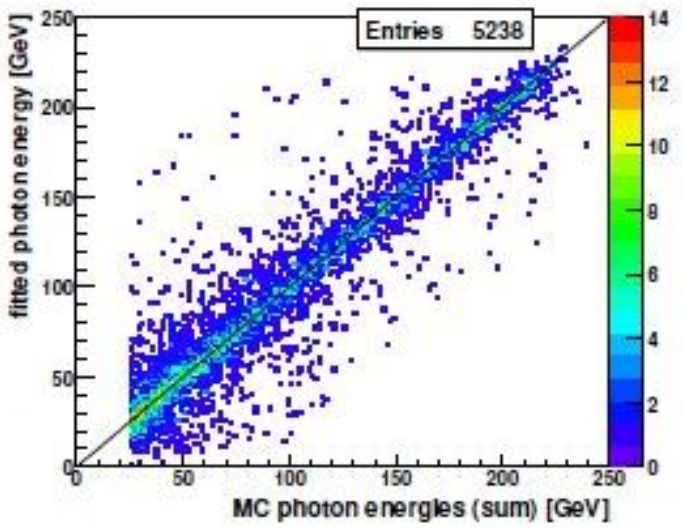
Matteo

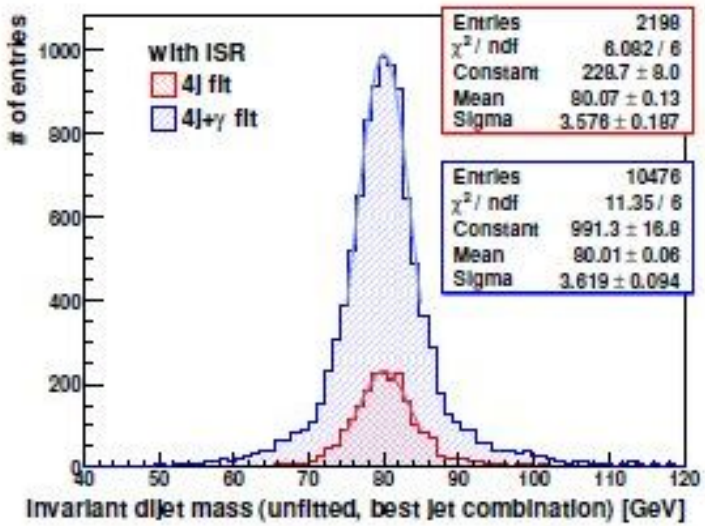
Kinematic fitting including ISR

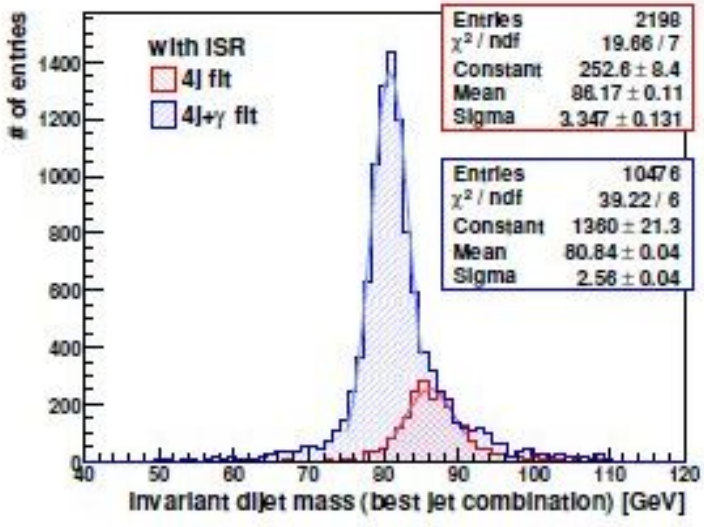
4 Jet + Photon Hypothesis

„with ISR “ sample

- nice correlation between E_γ^{rec} and E_γ^{MC}
- no shift in mass peak
- $\sigma_{M_{jj}}$: **3.6 GeV → 2.6 GeV**

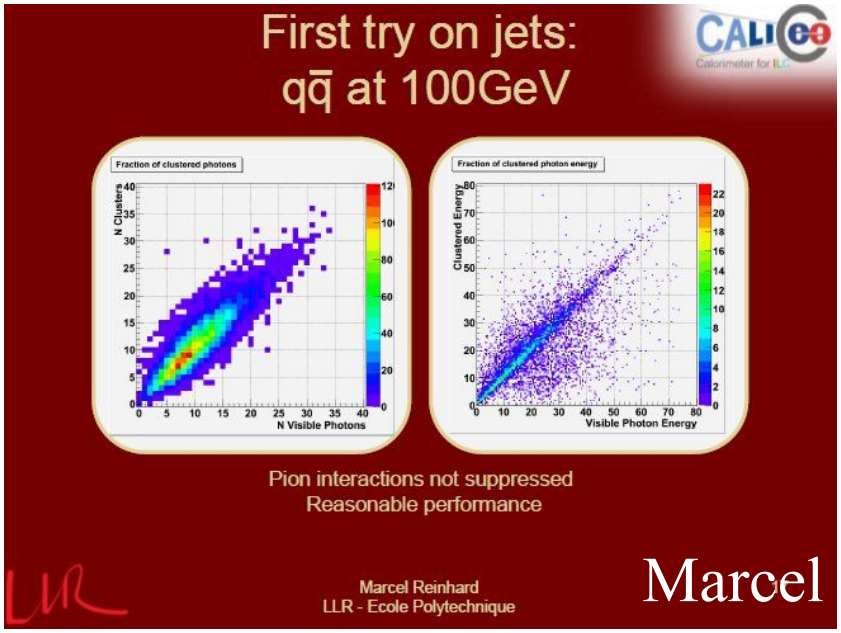


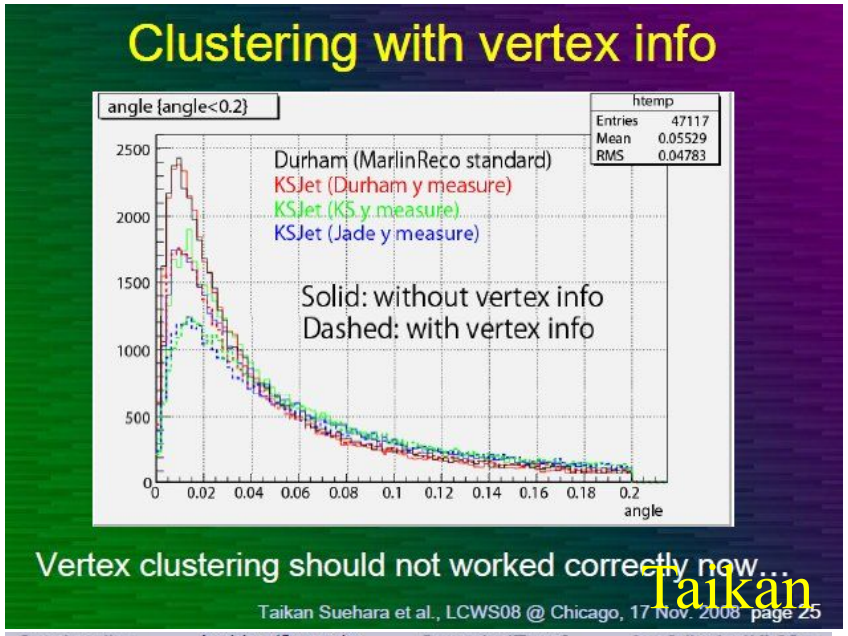


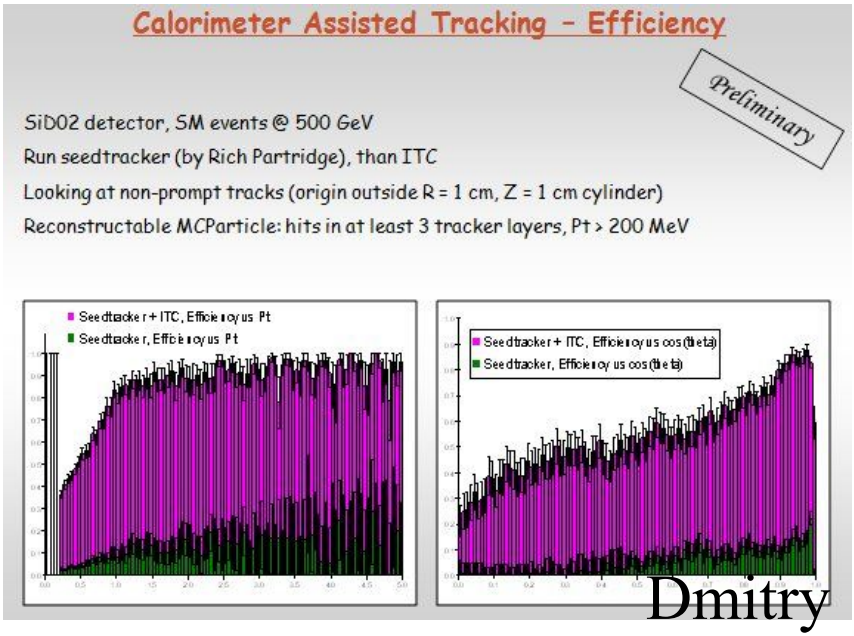


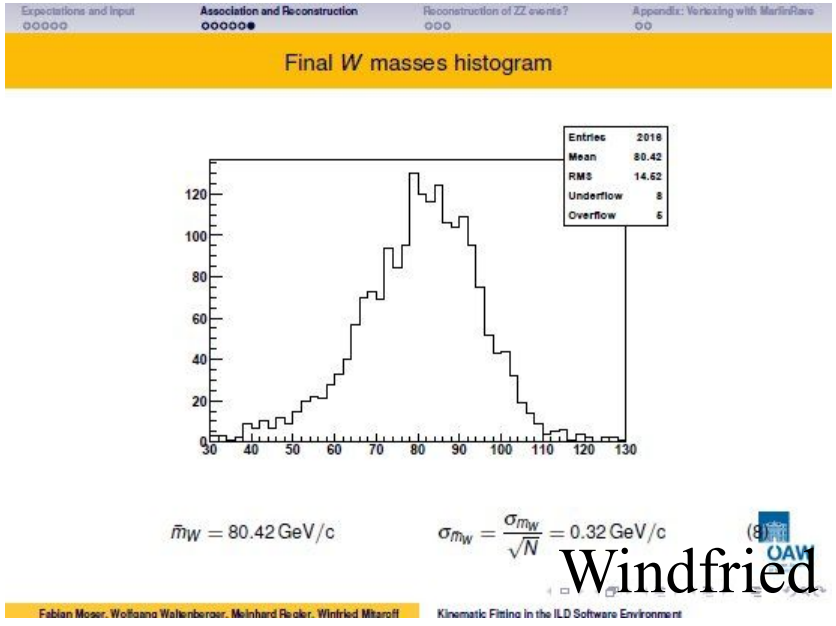
Jenny

Other reconstruction talks









PFA & Detector optimization

PFA performance for SiD

Comparison with Pandora

	org.lcsim sid02 Real tracking	org.lcsim sid02 Cheat tracking	Pandora SiDish pair A (mean)
qq90			$\Delta E_{CM}/E_{CM}$ = 3.1%
qq100	$\Delta E_{CM}/E_{CM}$ = 3.7%	$\Delta E_{CM}/E_{CM}$ = 3.4%	
qq200	$\Delta E_{CM}/E_{CM}$ = 3.0%	$\Delta E_{CM}/E_{CM}$ = 2.8%	$\Delta E_{CM}/E_{CM}$ = 2.8%

So numbers are not so far apart for similar detectors.

(... but what about qq360/qq500? No SiDish data yet -- CPU time limitations.)

18

Mat

PFA performance for ILD

❷ PandoraPFA and ILD

★ Results obtained with the very new Mokka model of the ILD concept

Performance (ILD) $Z \to d\bar{d}, Z \to u\bar{u}, Z \to s\bar{s}$

rms90 PandoraPFA v03-β

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	24.5 %	3.6 %
100 GeV	29.2 %	2.9 %
180 GeV	39.7 %	2.9 %
250 GeV	49.6 %	3.2 %

- Full G4 simulation
- "Realistic" detector, gaps etc.
- Full reconstruction inc. tracking
- Not yet optimised for ILD
- Calibration not final

★ Comfortably achieve ILC "goal" of $\sigma_E/E_j < 3.8$ % over full range of jet energies of interest at a TeV collider

★ For lower energy jets (< 100 GeV) calorimetric resolution more important than confusion – PFA is doing its job

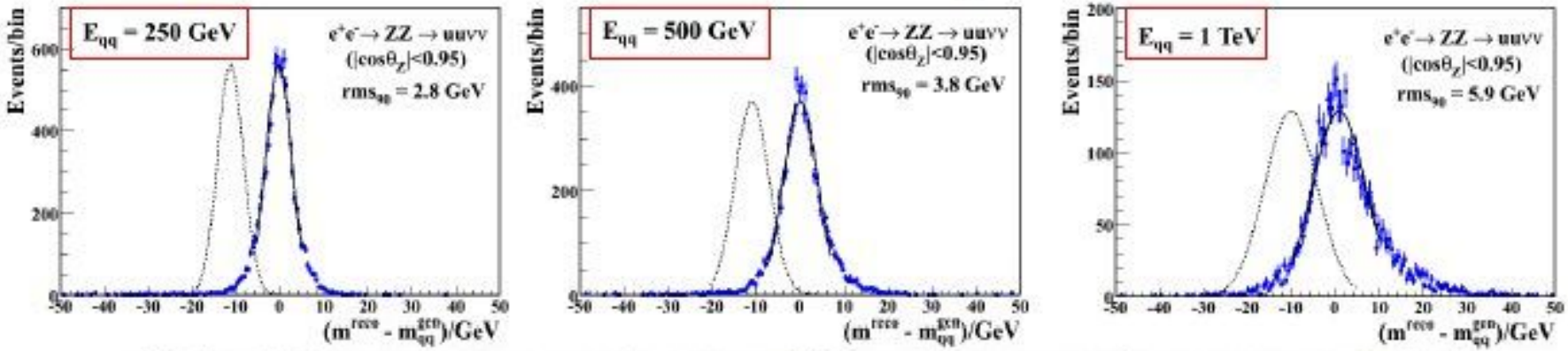
★ Current PFA code is not perfect – lower limit on performance

★ Believe moderate improvements will be obtained soon for higher energy jets, "work in progress"

David

PFA performance at high energy

★ Study Z mass resolution as function of E_Z



(dotted histograms represent approx. W lineshape assuming same resolution)

★ Results are not unpromising
- For 500 GeV Zs resolution still good enough to separate W/Z
- For 1 TeV Zs observe significant degradation
- However, HCAL probably too thin for these energies + algorithm not optimised for very high E

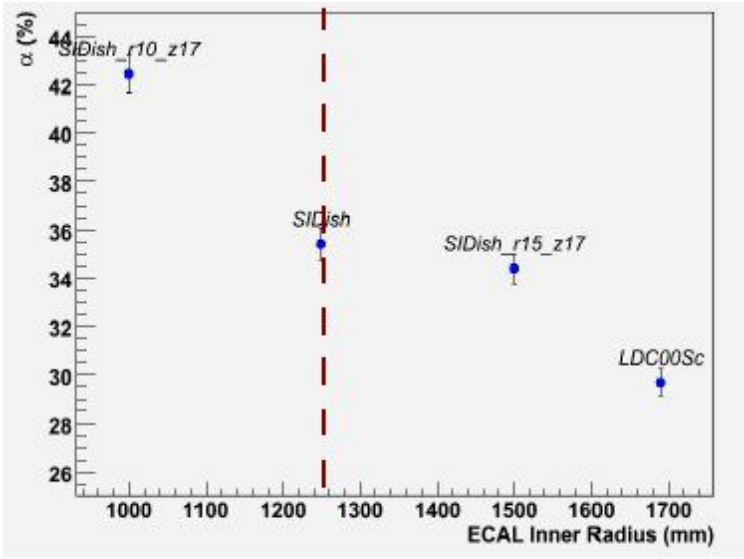
rms90 PandoraPFA v03-β

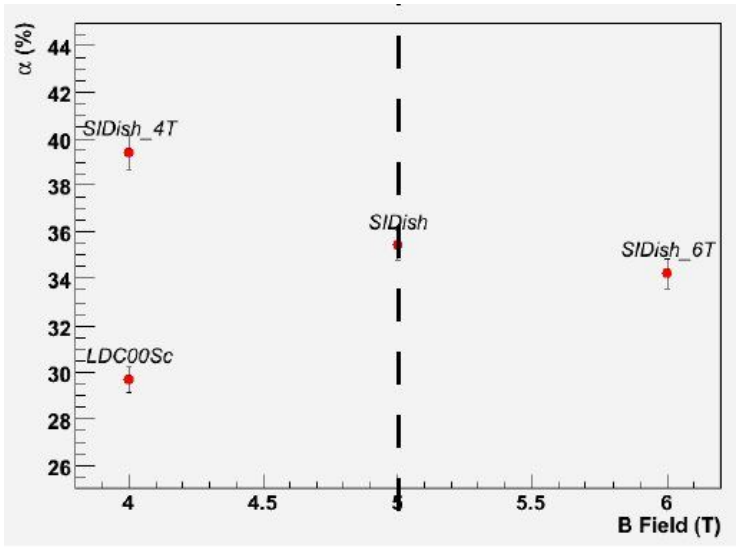
E_Z	σ_E/E	$\sigma_{m/m}$
125 GeV	2.4 %	2.7 %
250 GeV	2.5 %	3.1 %
500 GeV	3.1 %	4.1 %
1 TeV	4.2 %	6.2 %
1.5 TeV	5.6 %	8.2 %

Conclude: PFA not ruled for a 3 TeV collider detector

David

Optimization study for SiD





Making SiD02

	sid01	sid02-stretch	sid02
ECAL inner radius (m)	1.25	1.25	1.25
ECAL inner Z (m)	1.7	2.1	1.7
HCAL depth (λ_{iron})	4	4.5	4.5
HCAL layers	34	40	40
B Field	5	5	5

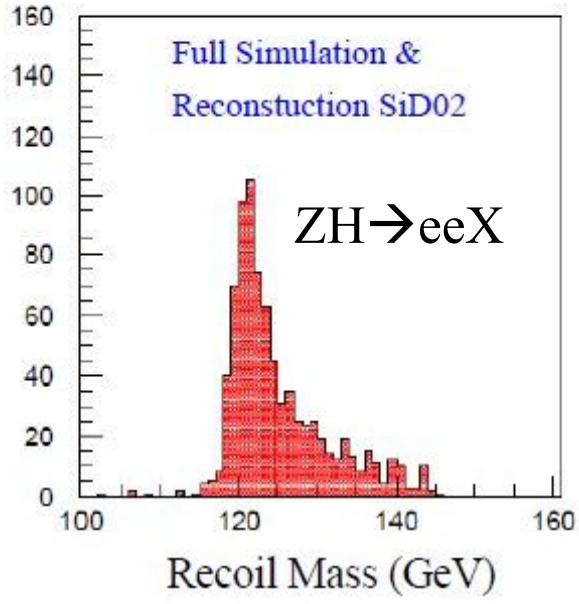
- Two versions proposed for sid02
  - standard
  - stretched
- Standard sid02 was chosen for LoI

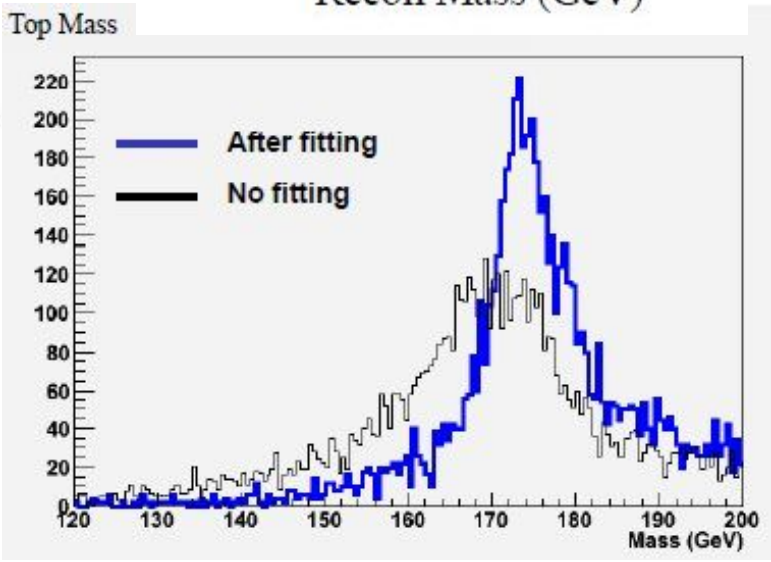
Marcel

Benchmark physics studies at SiD

Status of SiD Benchmarking for LOI

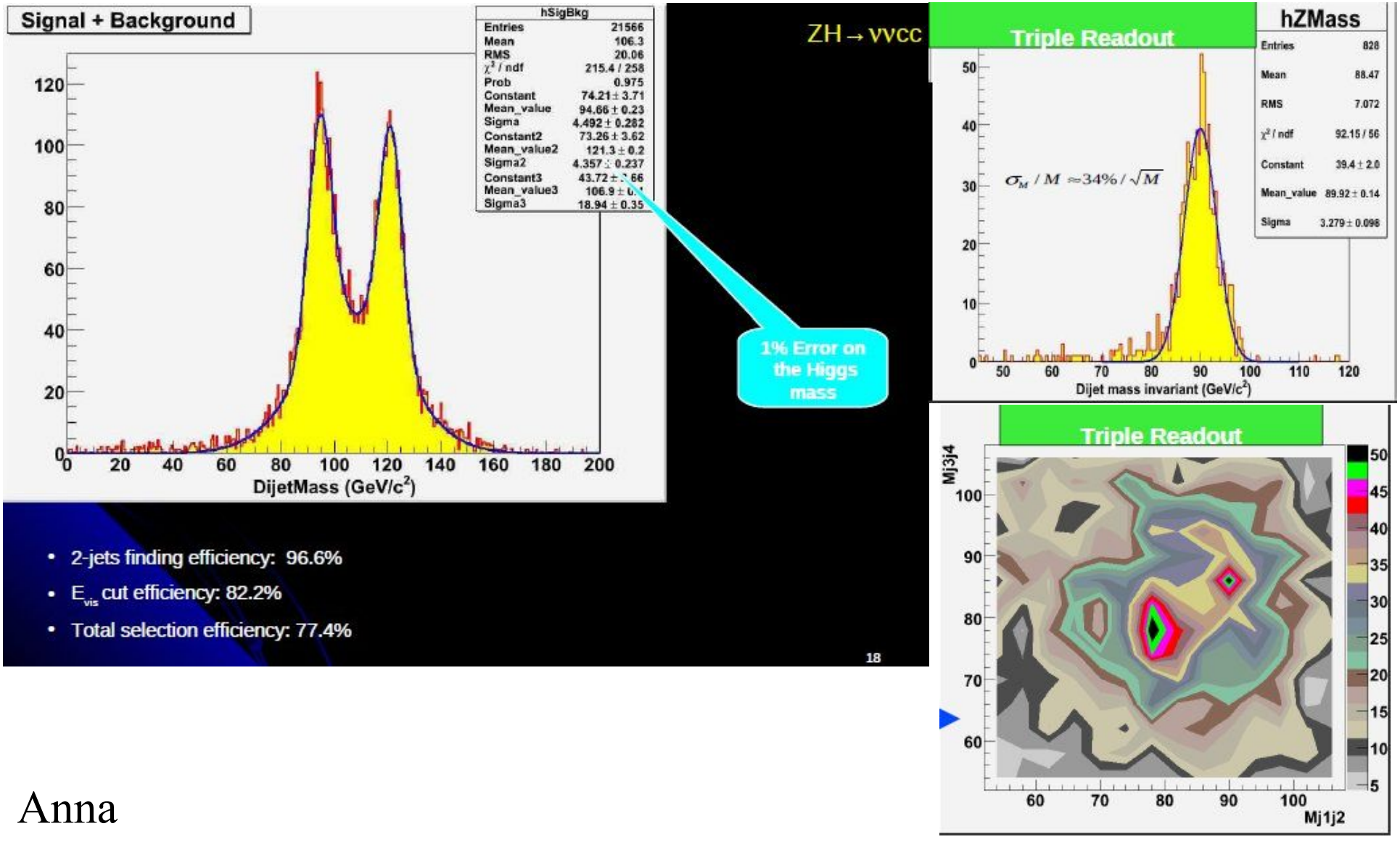
#	$\sqrt{s}$ (GeV)	Final State	Institution		Fraction of Work Completed			
			Stdhep	Analysis	Stdhep	Geant4	Reco	Analysis
1	250	e^+e^-H	SLAC	SLAC	0.3	0.3	0.3	0.9
1	250	$\mu^+\mu^-H$	SLAC	SLAC	0.3	0.3	0.3	0.9
2	250	$\nu\nu H \rightarrow \nu\nu c\bar{c}$	SLAC	Oxford	1.0	1.0	1.0	0.4
3	250	$qqH \rightarrow qqc\bar{c}$	SLAC	Oxford	1.0	1.0	1.0	0.2
2	250	$\nu\nu H \rightarrow \nu\nu\mu^+\mu^-$	SLAC	RAL	1.0	1.0	1.0	0.6
3	250	$qqH \rightarrow qq\mu^+\mu^-$	SLAC	RAL	1.0	1.0	1.0	0.6
4	500	$\tau^+\tau^-$	DESY	Stonybrook	1.0	1.0	1.0	0.1
5	500	$t\bar{t}$	SLAC	Oxford	1.0	1.0	1.0	0.9
6	500	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_2^0\tilde{\chi}_2^0$	DESY	Oxford	0.9	0.0	0.0	0.2
–	250	SM bkgd	SLAC	–	1.0	1.0	1.0	–
–	500	SM bkgd	SLAC	–	1.0	1.0	1.0	–





Timothy

Jet reconstruction & Physics performance at 4th



Anna

Higgs self coupling at ILD

Royal Holloway University of London

NN result

- The two networks give similar results:
  - 2 Var. : $S/\sqrt{(S+B)} = 0.57 \pm 0.06$
  - 3 Var. : $S/\sqrt{(S+B)} = 0.54 \pm 0.06$

B-tagging crucial for the analysis

Analysis	$S/\sqrt{(S+B)}$	S	B
Simple $\chi 2$	0.36 ± 0.01	13.5	1364.5
$\chi 2$ with b tag term	0.55 ± 0.06	4	47
$\chi 2$ with b tag term and kin. fit.	0.56 ± 0.06	6.4	124.4
NN two variables	0.57 ± 0.06	5.8	99.2
NN three variables	0.54 ± 0.06	7.5	186

- The resolution ($\frac{\sqrt{S+B}}{S}$) to such process is 180%

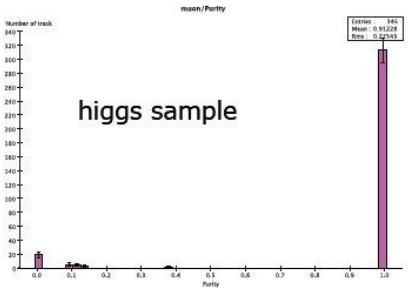
Michele

Other PFA & Detector optimization talks

Muon Efficiency

Preselection : cos(θ) < 0.95 , P > 2GeV

Sample (1000events)	Cheater track		Full track		MC
	Purity	Efficiency	Purity	Efficiency	
ttbar (500GeV)	513(88%)	583(51%)	476(84%)	565(49%)	1143
higgs (250GeV)	327(93%)	350(57%)	313(91%)	345(56%)	615



Purity
= number of hits from muon divided by number of hits from tracks

Tae

Possible future CLIC R&D

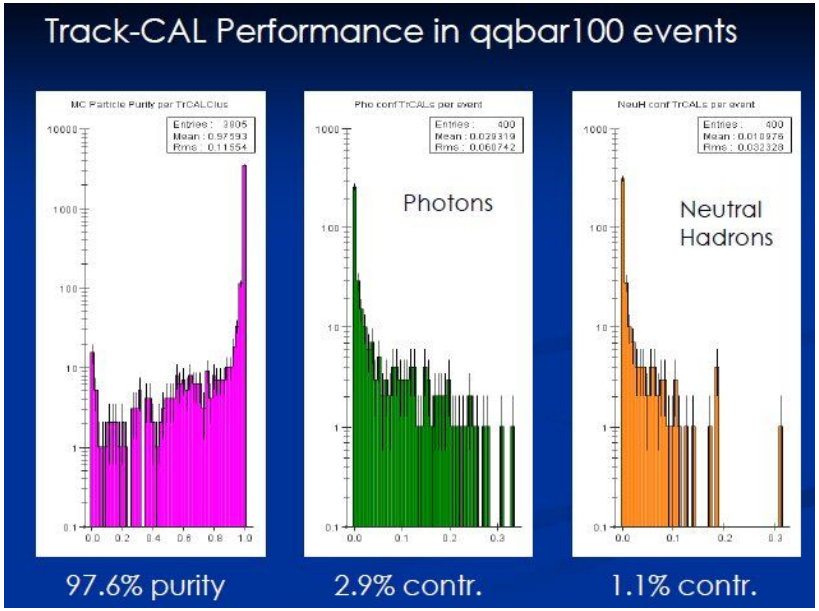
Preliminary list

1. Time stamping. Develop specific layers in tracker and calorimeter to reject background events from other bunches crossings (0.5 ns separation).
2. High-field solenoid conductor. Replacement of the pure aluminum coil stabilizer and replacement of the electron beam welding.
3. Mechanical engineering support. Integration, heavy HCAL, coil, stability issues, etc.
4. Alternative to PFA calorimetry (e.g. dual readout calorimetry with crystal fibres).
5. Synergy of R&D (approved CERN) between LC and SLHC for on-detector powering and for integrated silicon pixel detectors

To be carried out in collaboration with CERN and outside institutes

Lucie

Track-CAL Performance in qqbar100 events



Stephen

Summary

- MC production of benchmark processes is ongoing for physics study in LOI.
- Many modifications of the reconstruction method was reported. They will contribute improvement of physics measurement.
- The optimization procedures of the detector design was shown. The geometries of all the detector concepts were determined based on measurement performance.
- Physics benchmarks were well studied towards LOI at all the concept groups. We will be able to see excellent results in LOI.