Benchmarking and LoI

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Compulsory LOI Benchmarking List

At a Dec 7 meeting between Sakue Yamada and representatives of SiD, ILD, 4th Concept, an agreed that the following reactions will be used for LOI Physics Benchmarking:

1. $e^+e^- \to Zh, \to \ell^+\ell^- X$, $l = e, \mu$; $m_h = 120$ GeV at $\sqrt{s}$=0.25 TeV
2. $e^+e^- \to Zh$, $Z \to q\bar{q}, \nu\bar{\nu}$; $h \to c\bar{c}, \mu^+\mu^-$; $m_h = 120$ GeV at $\sqrt{s}$=0.25 TeV
3. $e^+e^- \to \tau^+\tau^-$, at $\sqrt{s}$=0.5 TeV
4. $e^+e^- \to t\bar{t}$ at $\sqrt{s}$=0.5 TeV
5. $e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^-/\tilde{\chi}_2^0\tilde{\chi}_2^0 \to W^+W^-\tilde{\chi}_1^0\tilde{\chi}_1^0$ / $ZZ\tilde{\chi}_1^0\tilde{\chi}_1^0$ at $\sqrt{s}$=0.5 TeV

- WWS Software panel (Akiya Miyamoto, KEK, Ties Behnke, DESY, Norman Graf, SLAC,) in consultation with the detector concepts and the WWS Roadmap Panel and starting from the Benchmark Panel Report (Snowmass 2005)
- Had iterations in February and March to define observables more precisely

Outline

- General issues
- Status of analyses
- More general issues
- LoI

Benchmarking Issues

- Aims
  - Prove that detectors can still deliver physics with realistic material description and realistic algorithms
  - Comparison of concepts for a well defined set of processes
- Very CPU intense: can't use benchmarking processes to optimize subsystems
  - Can't vary parameters and redo MC
  - Need to draw a line between Benchmarking physics processes and Benchmarking of subsystem performance

MC Samples

- Signals
- SM backgrounds
  - No Higgs
  - Two photon processes
- Beam background
  - e+e- pairs; backscattered photons
- Two energies: 500 GeV and 250 GeV
- Total request: ~40M events
  - ~100 sec/event for GEANT, reconstruction takes comparable time or more
  - We have already chosen a subset of events to fully simulate

Analysis Model

- Use FastMC to develop analysis algorithms
  - Tuned to reproduce PFA results
- Use LCFI flavour tagging in Marlin

- Use full MC and Perfect/Matt's PFA
- Use real tracking

- This plan worked reasonably well – have the first analysis with Matt's PFA but so far haven't used tracking

Process 1

$e^+e^- \rightarrow ZH,\ H \rightarrow e^+e^-X,\ \mu^+\mu^-X$ (M_H=120 GeV, E_{cms}=250 GeV)

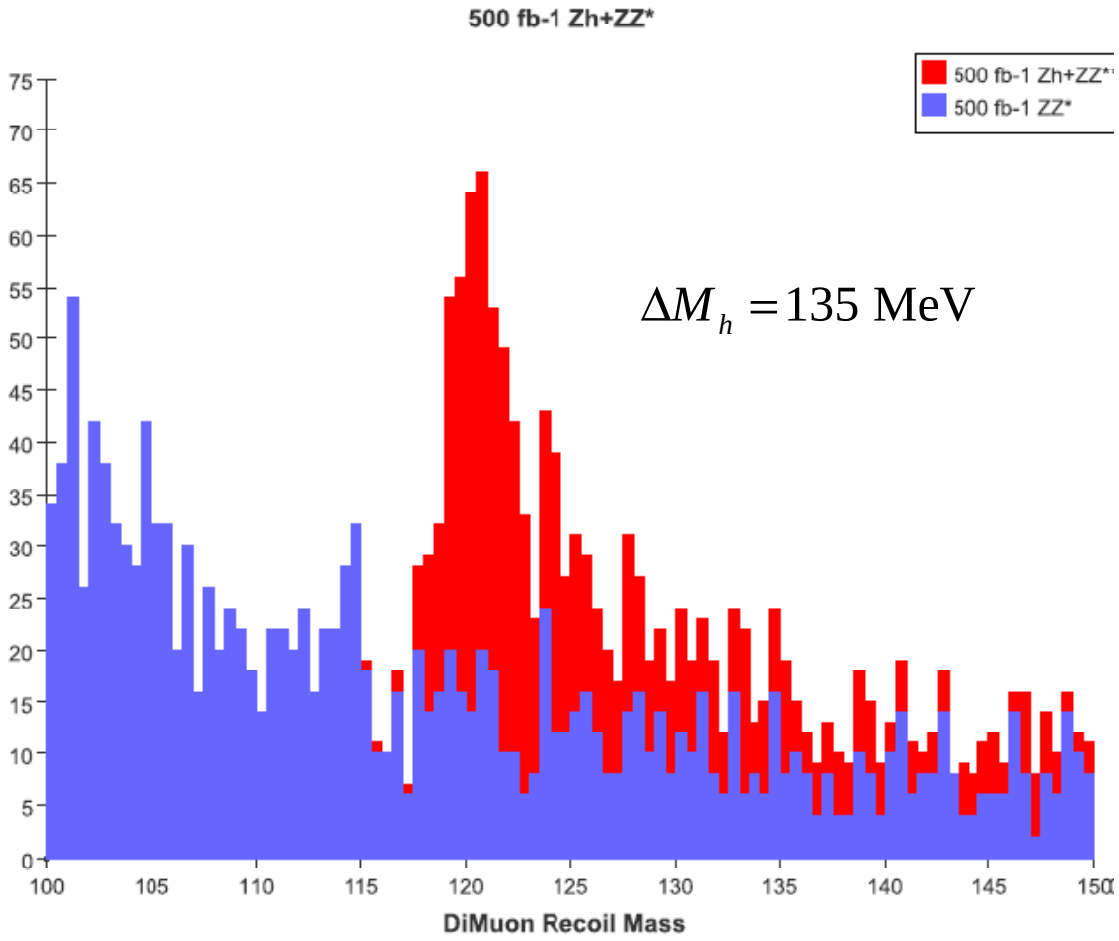
- Observables: Higgs Mass and cross section
- Status : done before with full MC
- Who: SLAC

Full MC Detector Simulation and Event Reconstruction of

$$e^+e^- \to ZH \to \mu^+\mu^- X$$

by Norm Graf

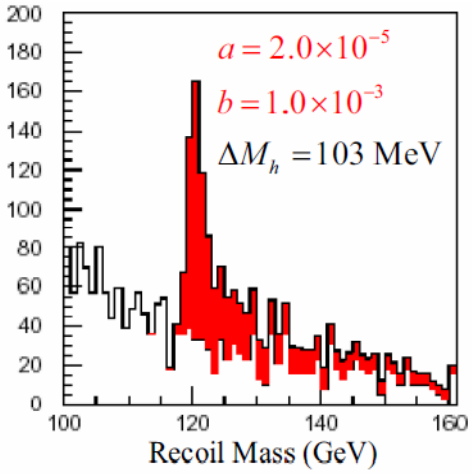
$$\sqrt{s} = 350\ GeV \quad L = 500\ fb^{-1}$$

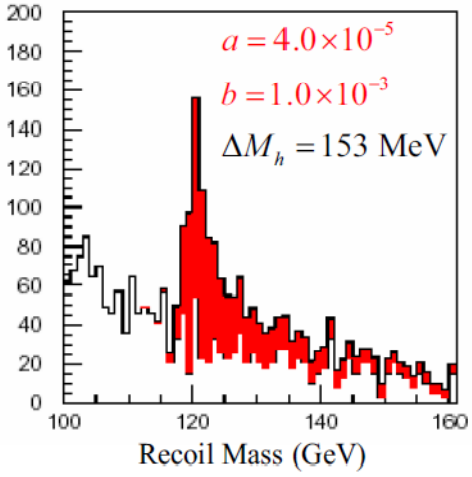


Still to Do:

$$e^+e^- \to ZH \to e^+e^- X$$

Old FASTMC study:



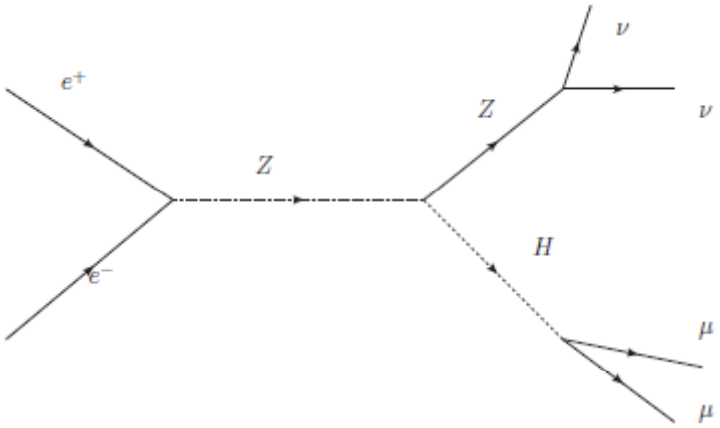


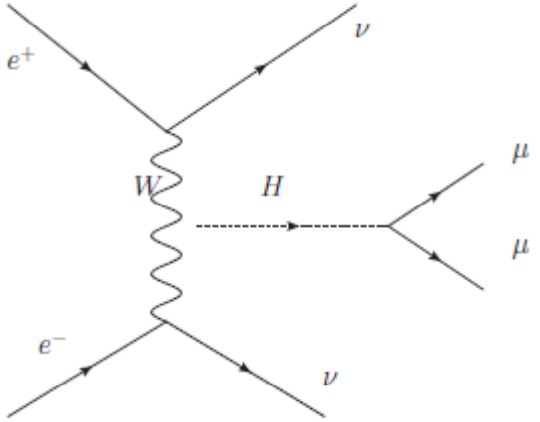
Process 2.1

$e^+e^- \rightarrow ZH$, $H \rightarrow cc$, $Z \rightarrow \nu\nu$ (M_H=120 GeV, E_{cms}=250 GeV)

$e^+e^- \rightarrow ZH$, $H \rightarrow cc$, $Z \rightarrow qq$ (M_H=120GeV, E_{cms}=250GeV)

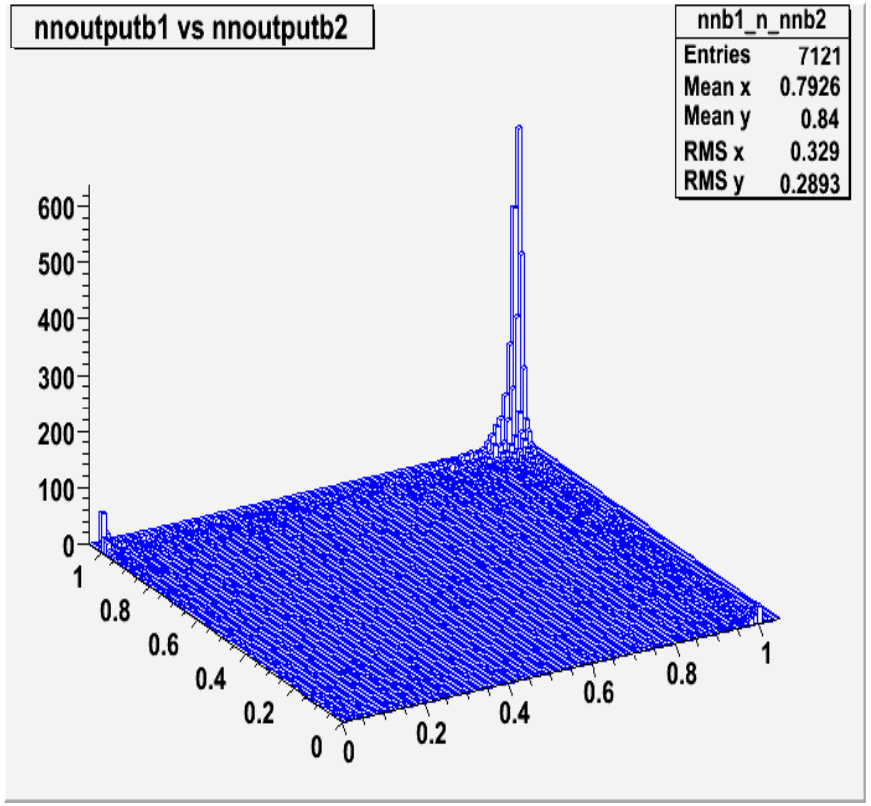
- charm tagging
- Observable: BR(H → cc)
- Who: Yambazi Banda (Oxford)
- Status: developing in fastMC
- Issue : t-channel is main contributor to ccνν final state, complicates measurement of BR



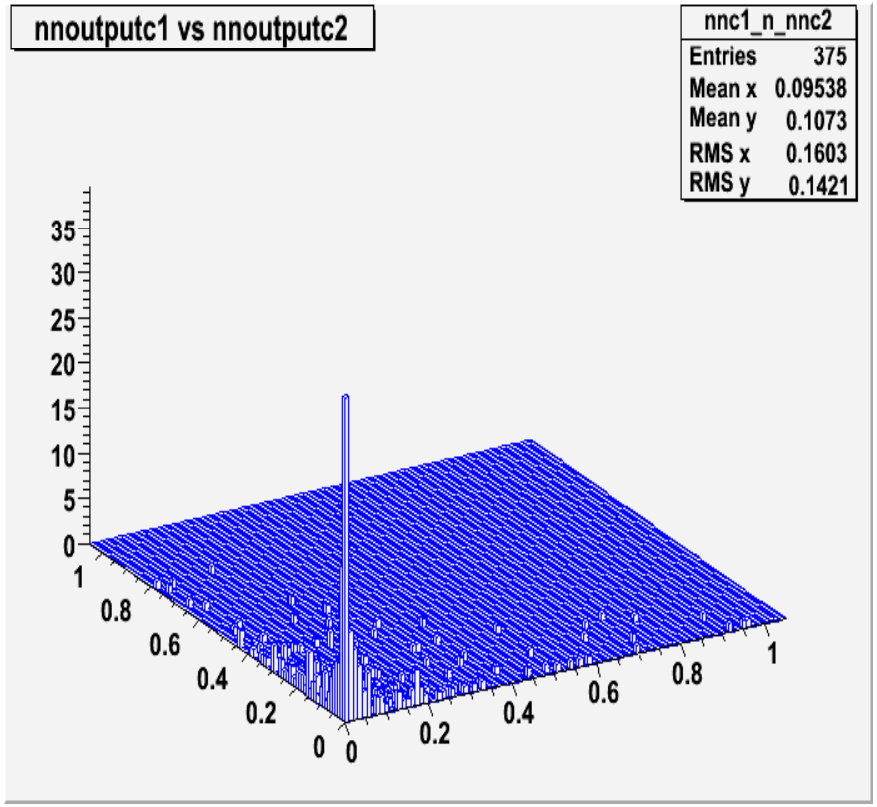


Study of ZH→ννcc
by Yambazi Banda (Oxford)

Jet1 b NN output vs Jet2 b NN output for H→bb



Jet1 c NN output vs Jet2 c NN output for H→cc



Process 2.2

$e^+e^- \rightarrow ZH, H \rightarrow \mu\mu, Z \rightarrow \nu\nu$ (M_H=120 GeV, E_{cms}=250 GeV)

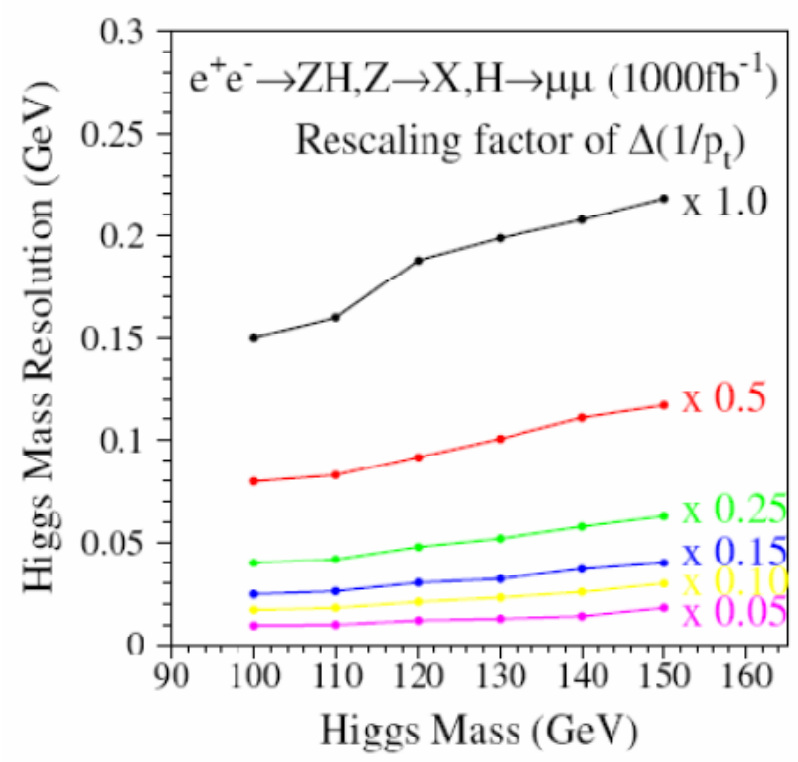
$e^+e^- \rightarrow ZH, H \rightarrow \mu\mu, Z \rightarrow qq$ (M_H=120GeV, E_{cms}=250GeV)

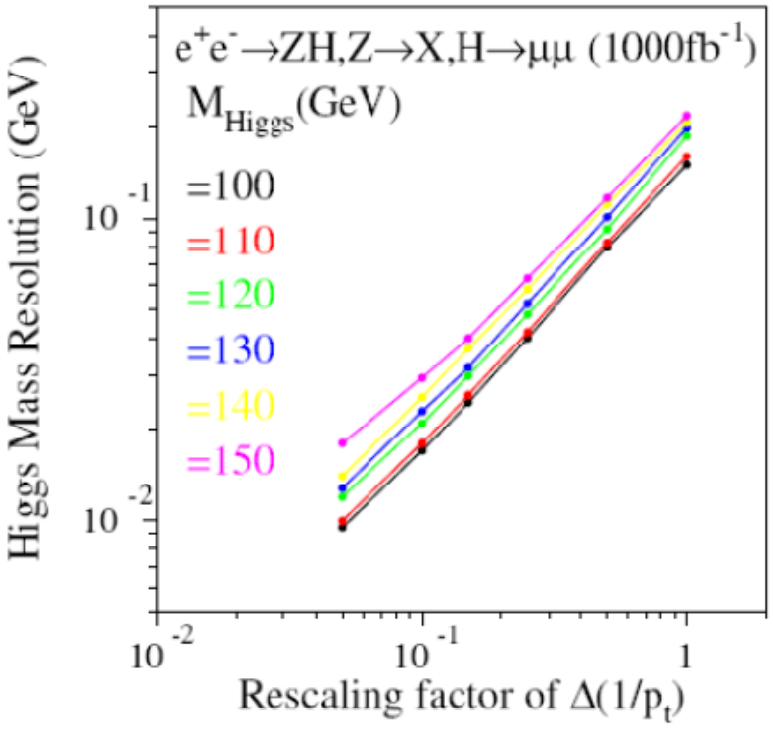
- Tracker resolution
- Observable: BR(H $\rightarrow \mu\mu$)
- Who: Michigan State / RAL

- Status : under development on fastMC

Impact of ILC Tracker Design on $e^+e^- \rightarrow H^0Z^0 \rightarrow \mu^+\mu^- X$ Analysis

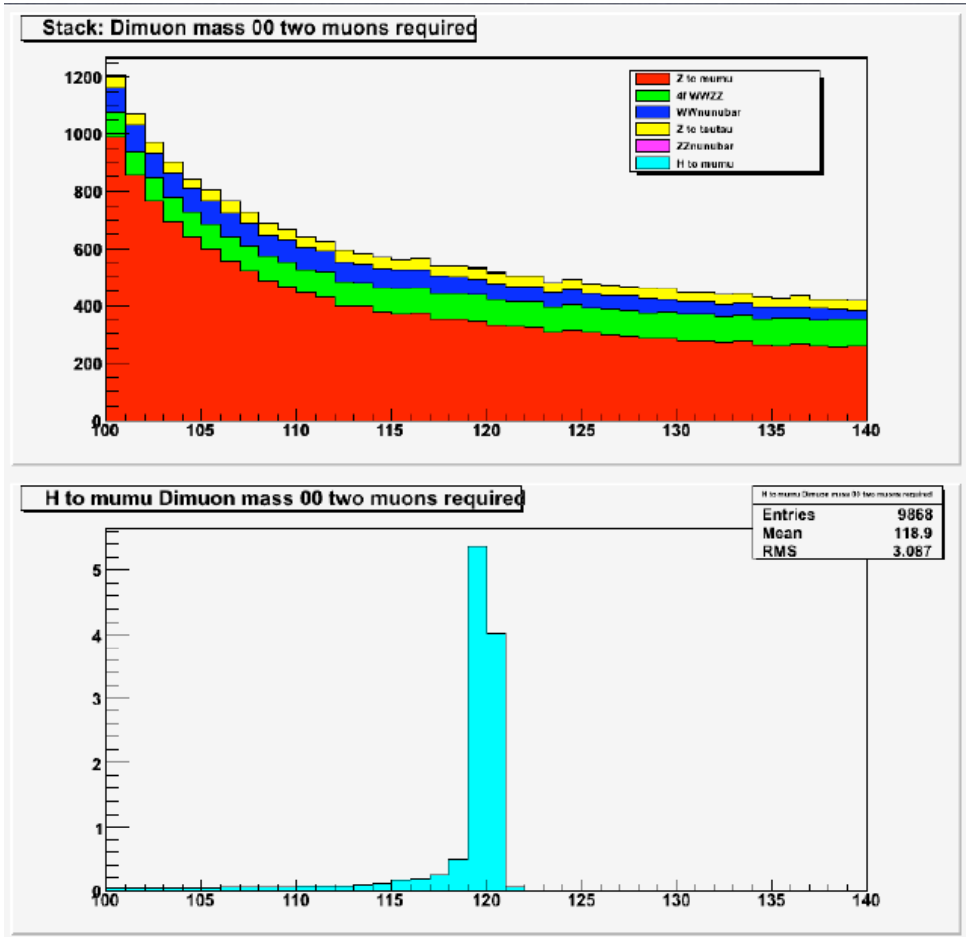
Hai-Jun Yang & Keith Riles
University of Michigan, Ann Arbor





RAL Analysis

- By Jan Strube/ Marcel Stanitzki
- Selected discriminating variables, will use BDT and mass fits to separate signal from bkg

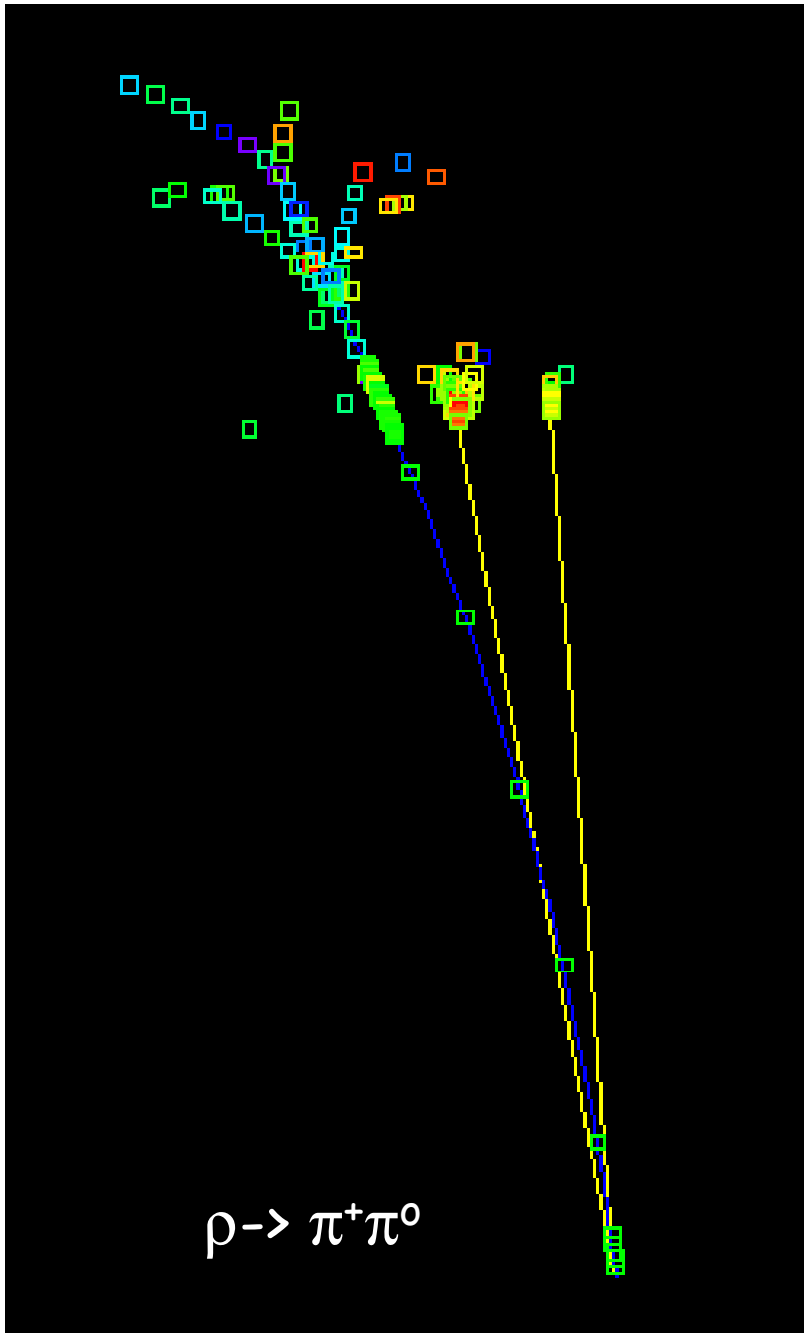


Process 3

$e^+e^- \rightarrow Z \rightarrow \tau^+\tau^-$ (E_{cms}=500 GeV)

- tau reconstruction, aspects of particle flow
- π^0 reconstruction
- tracking of very close-by tracks

- Observables: efficiency and purity for tau main decay modes with and without π^0
- Who: ? (SLAC)



Study of tau decay mode efficiency
and purity for 250 GeV tau's
is still needed for the
$\tau^+\tau^-$ benchmark

Process 4

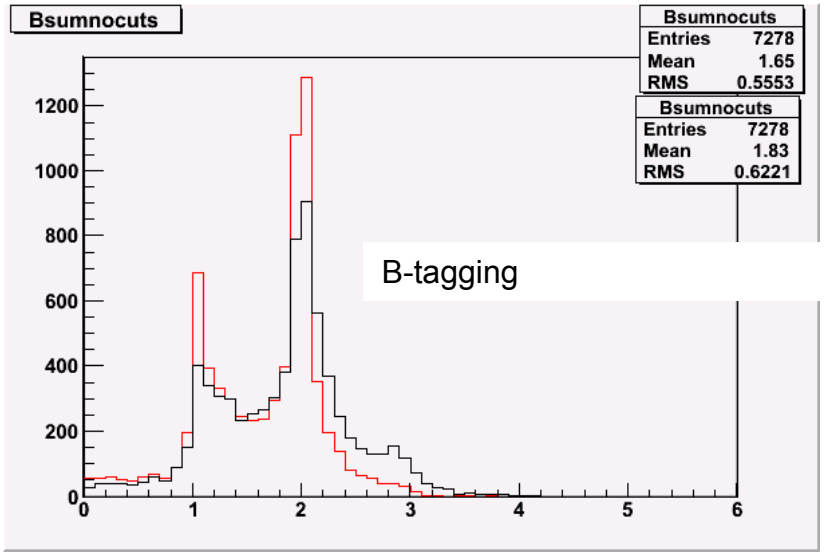
$e^+e^- \rightarrow tt$, $t \rightarrow bW$, $W \rightarrow qq'$ (M_{top}=175GeV, E_{cms}=500 GeV)

- multi jet final states, dense jet environment

- Observables: σ, A_{FB}, and m_{top}

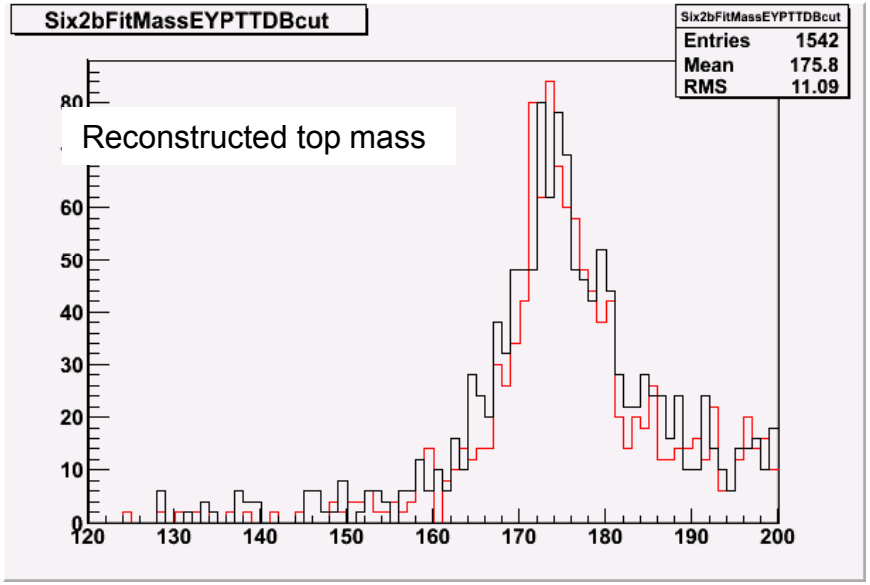
- Who: Erik Devetak (Oxford)
- Status: most advanced analysis, using Matt's PFA
- Issues: do we need to cover lepton modes?

Comparison of FastMC and Matt's PFA



fastMC

PFA



Process 5

$e^+e^- \rightarrow \chi^+\chi^- / \chi_2^0\chi_2^0$ (E_{cms}=500 GeV)

- particle flow (WW, ZZ separation)

- Observables: σ and χ^+, χ_2^0 masses
- Who: ? (Oxford)
- Status: just started
- Issues: make sure use the same SUSY point as ILD

Status of Analyses

- Developing analysis algorithms is on critical path now
  - PFA and tracking are available
- Funding issues obviously affected available effort and we have problems to find effort for two benchmarks

- Tracking needs to be tried asap
  - Current plan is to use it together with PFA, start with a small ttbar sample
  - Real tracking is essential for flavour ID

Definition of observables

- Finding ambiguities in definition of observables
  - t-channel for vv modes
  - Definition of signals
  - Analysis techniques
- Need to discuss it with other concepts in November at LCWS

Backgrounds (IDAG Q1)

- Preparation of samples with mixed bkgs requires considerable effort

Current plan:

- Do ttbar analysis with $\gamma\gamma \rightarrow$ hadrons, e+e- pair bkg
  - Assume one BC worth of bkgs
- Do all other analyses without these bkgs

- Assume that subsystems & reconstruction will study performance as function of beam bkg with much lighter MC samples.
  - Backscattered photons are very CPU intense to simulate

Benchmark at 1 TeV? (IDAG Q2)

- Not in the compulsory list
- Simulation of 1 TeV SM sample is a major task
  - CPU time ~ scales with energy
- Don’t have effort to do this with full MC

LoI

- 15 Nov : define all needed benchmarking plots for LoI, have a skeleton of the benchmarking section
- 15 Dec : First draft of benchmarking section with placeholders for plots & pieces which are not ready

Summary

- Good progress with generation of MC samples
- Exercised PFA with good results

- Physics analyses are on critical path now

- Need additional effort for tau tau and SUSY analyses from compulsory list

- Should be able to have results for all six compulsory processes for LoI