How to Optimise ILD?

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DESY

ILD Meeting @ ALCW
23.4.2015

Reminder: Last Discussion Nov. ‘14

1. Bottom-Up:

   The canonical set: Which detector performance aspects did we look at in the past?

   Complementing the canonical set: Which others are relevant and should be added?

2. Top-Down:

   What are the key physics observables?

   Which detector properties are they sensitive to?

   What is their status / coverage within ILD?

3. Discussion: YOU ;-)

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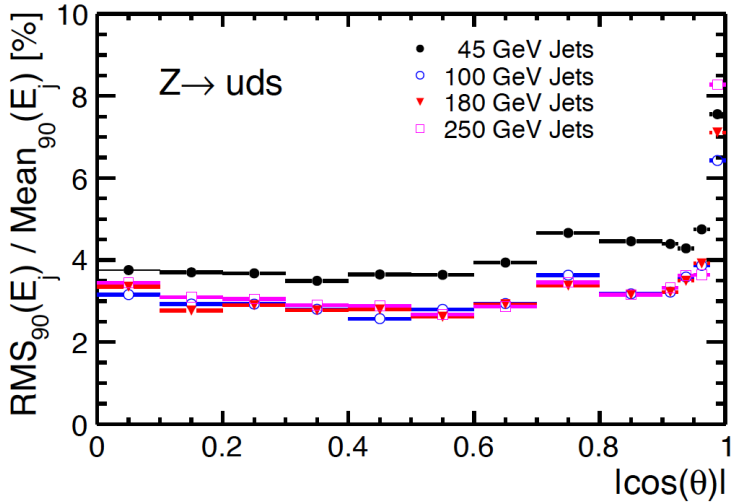
Junping’s talk

1. Bottom-Up: The Canonical Set

Jet Energy Resolution

RMS_{90}/E_{jet},
E_{jet} = 45, 100, 180, 250, (500) GeV
(ee->Z/gamma->uds w/o ISR)

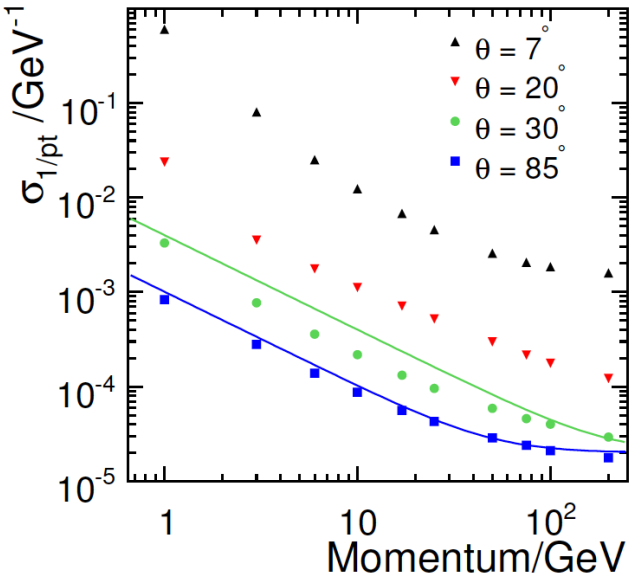


Tracking Resolutions

$\sigma_{1/pT}$ and $\sigma_{r\varphi}$

p_T = 1, ..., 100 (400) GeV

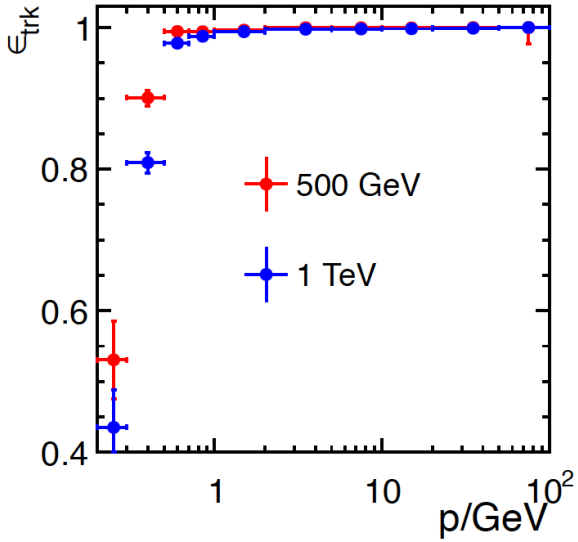
θ=85°,40°,20°,7°



1. Bottom-Up: The Canonical Set

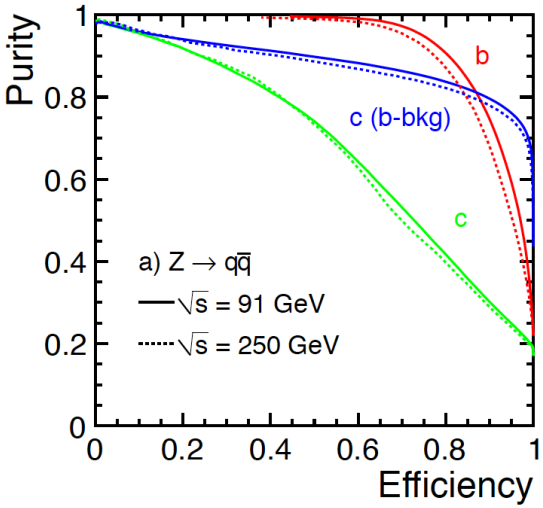
Tracking Efficiency

tt -> 6 jets & pair background,
excluding decays in flight (!)
p_T = 0.2, ..., 100 GeV
$|\cos\theta| < 0.99$



Flavour Tag

efficiency vs purity for
b, c & c (b-bkg)
Z->qq (91, 250 GeV)
Z->qqqqqq (500, 1000 GeV)



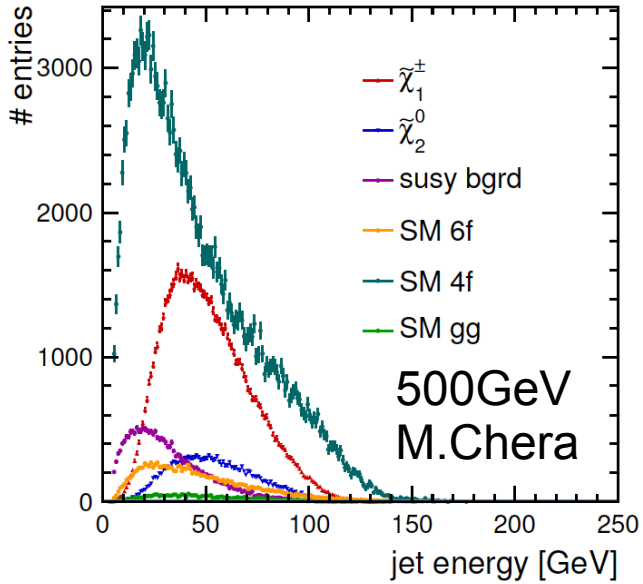
Complementing the Canonical Set

Jet Energy Resolution:

add E_{jet} = 5, 10, 15, 25, 35 GeV:

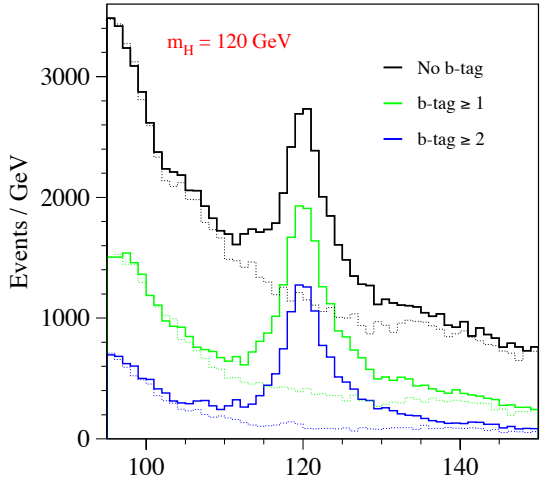
a lot of physics is HERE!

add JER for b and c jets ?



not only calorimetry, but also capability to identify semi-leptonic b/c decays and correct for neutrinos based on lepton momentum, exclusive decay modes, etc

-> non-trivial!!!
but important: eg m_H from H->bb
competitive to recoil mass,
in particular incl WW fusion



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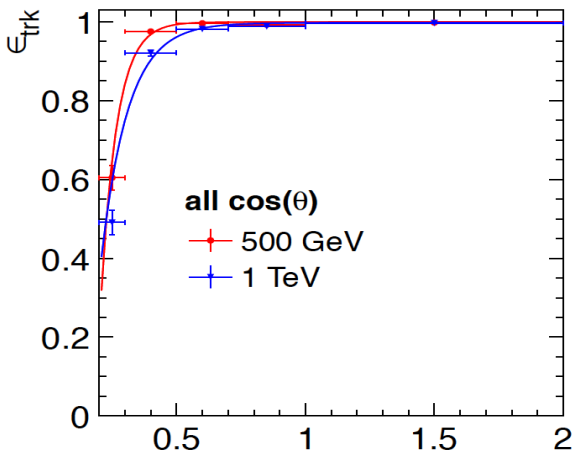
Complementing the Canonical Set

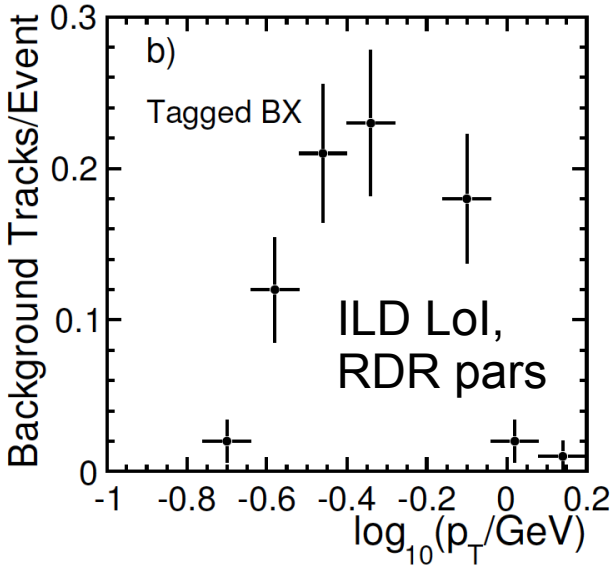
Tracking Resolutions & Efficiency



add p_T = 0.1, ... , 2 GeV in linear scale

add efficiency for tracks *not* originating from primary vertex

add fake tracks vs pt, vs cosθ



add dE/dx resolution?
so far only “goal” 5%

Complementing the Canonical Set

- Hermeticity (BSM, DM, missing mass for ZH <-> nunuH)
  detection efficiency for e, μ, γ, π, n vs cosθ
  from 0.1 GeV to 250 GeV

With realistic AntiDID field!

- Vertex charge (eg A_FB (top) in tt->6jets)
  probability to get correct vs jet momentum?
- Particle Identification (SM and BSM (?) precision)
  - e / μ / π^{+-} / p / K / n / π^0/ γ ID-Efficiencies and fake rates vs momentum/energy (0.1 to 250 GeV) and vs cosθ
  - isolated and in jets
- Photon reconstruction (eg WIMPs, gen. BSM)
  E, θ, φ resolutions, from 0.1 to 250 GeV and vs cosθ

One step further

- τ reconstruction (Higgs, BSM)
  - ID efficiency & mis-ID vs momentum and vs $\cos\theta$
  - separation (efficiency/purity) of individual τ decay modes
  - τ polarisation
- B and D hadrons
  - eg Λ_b (CP test in polarisation of Λ_b from Z decays)
  - eg $D^{(*)}$ (important for charm tag, soft tracks)
- Bhabhas (BSM, Lumi)
  - rejection efficiency of (radiative) Bhabha events

ILD Performance Package

- Goal: Allow to evaluated ILD performance in an efficient and well defined way
- currently contains tracking example:
  pulls, residuals on track parameters, efficiency
  first presented by Y.Voutsinas Feb 18, 2015
  - script to produce set of single muon events in Mokka ...
  - reconstruct them in Marlin..
  - including a DiagnosticsProcessor ...
  - and run root macros, incl GUI, to do plots...
  - and a README

excellent example, easy to add *your* favourite performance plot!

extendedable to more complicated cases (eg calibration, physics analysis, ...) as long as a well-defined sequence of steps exists!

Collecting Existing MC Samples

- Since the DBD mass production, additional MC has been made by several analyses using the official DBD software.
- Use limited resources efficiently:
  => make these available to all of ILD via Grid and ILCDirac File Catalogue
- Tino Calancha (KEK) and Shaojun Lu (DESY) kindly agreed to help with the actual uploading

Please send an email to Tino or Shaojun with
- **the location of your files and**
- **the generator meta-data!**

New MC Samples

- Many analyses suffer from low statistics
  - ttH: 6 fermion background @ 500 GeV
  - Higgs BRs
  - Higgs Self-Coupling
  - ....
- Reasonable requests should be realised in a resource conscious way

Let Junping and me know
- **for which processes, sqrt(s) etc you would be interested in additional MC**
- **if you are planning to produce significant amounts of MC yourself**

Significant advances in Reconstruction

- Tracking:
  - Silicon: Mini-Vectors & Cellular Automaton
- Vertexing:
  - adaptive vertex finding
- Clustering:
  - Pandora with timing cut?
  - Garlic?
- “bug fixes”:
  - correct number of overlays
- Particle ID:
  - dE/dx
  - Cluster Shape analysis

=> Make available to *all* analyses and benchmarking studies, avoid duplication of effort

consider re-reconstruction / re-DSTing ?!

How to proceed?

Complete & update our picture of performance of the DBD detector

- exploit all recent advances in reconstruction
- standardize performance evaluation: **ILDPerformance**

Proceed with transition to Whizard2

- prepare new set of SM samples
- enable dedicated studies (PS +matching, beam spectrum systematics....)

Finish new, DD4HEP-based simulation and reconstruction (c.f. Frank's talk)

and

convergenge onto ~2 *alternative* detector models

Full update of MC samples for benchmarking and physics studies

Discussion – YOU!