Generic ILC detector model for DELPHES

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on behalf of the on behalf of the ILC Delphes task force group

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Introduction

Delphes is a fast simulation framework, which allows to take into account only basic effects:

- detector acceptance,
- detector resolution,
- reconstruction efficiency

and provides also expected results of event reconstruction (as lepton identification, flavor taging and jet clustering).

No technical details are taken into account

Expected performances of ILD and SiD similar

➔ generic ILC detector model

based on earlier experience with ILD and SiD modeling

Introduction

Delphes simulation results on different levels:

- tracker tracks and calorimeter towers
  - momentum/energy smearing applied
  - tracking efficiency applied
- energy flow objects: (for particle flow reconstruction)
  - energy flow tracks, (for all charged particles)
  - photons and neutral hadrons (without matched track)
- reconstructed objects:
  - isolated electrons, muons, photons

    reconstruction efficiency and isolation cuts applied
  - exclusive jets clustering, N=2...6

    including multiple options for b- and c-tagging

Acceptance

- Calorimeter acceptance:

$\|\eta\|$ coverage	EM	HAD
Central	up to 3.0	up to 2.8
Forward	3.0 – 4.0	2.8 – 3.8
BeamCal	4.0 – 5.8	

- Tracking acceptance extended up to $|\eta| \leq 3$

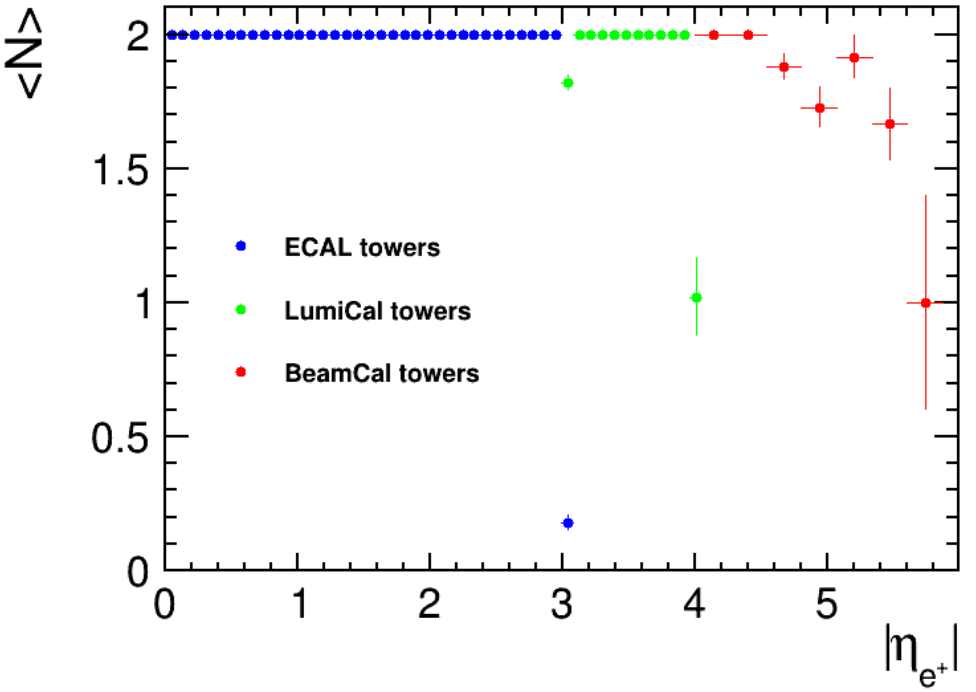
Most significant change w.r.t. old ILD and SiD models where acceptance was limited to $|\eta| \leq 2.4$-2.5

Forward calorimetry

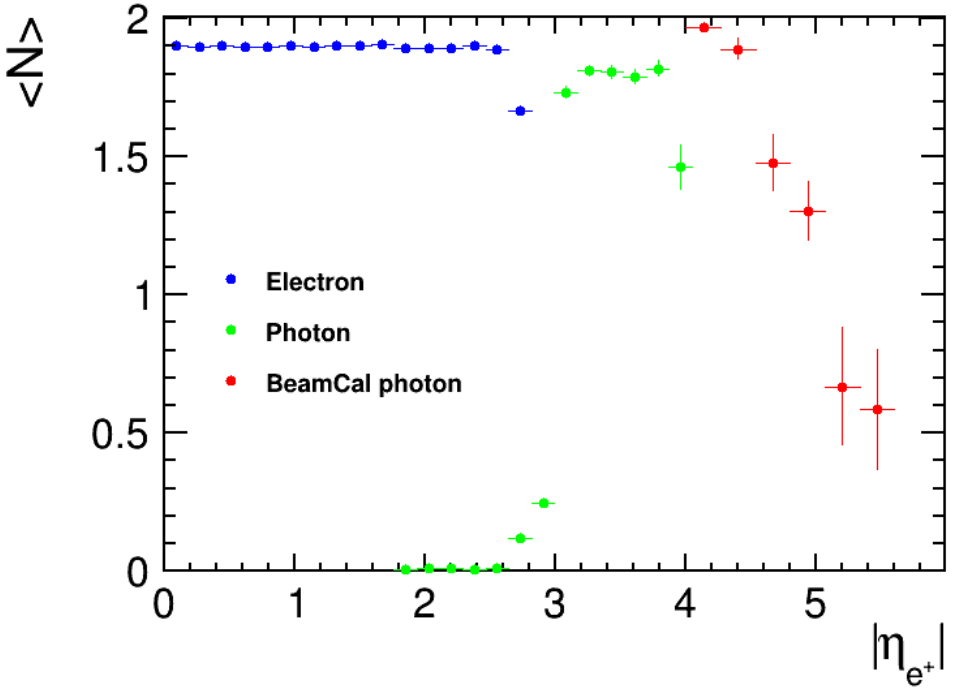
- LumiCal + LHCAL + BeamCal
  - Only LumiCal and LHCAL included in Particle Flow

Test samples of $Z \rightarrow e^+e^-$ events
(electron energies of 25, 50 and 100 GeV mixed)

Towers



Reconstructed objects

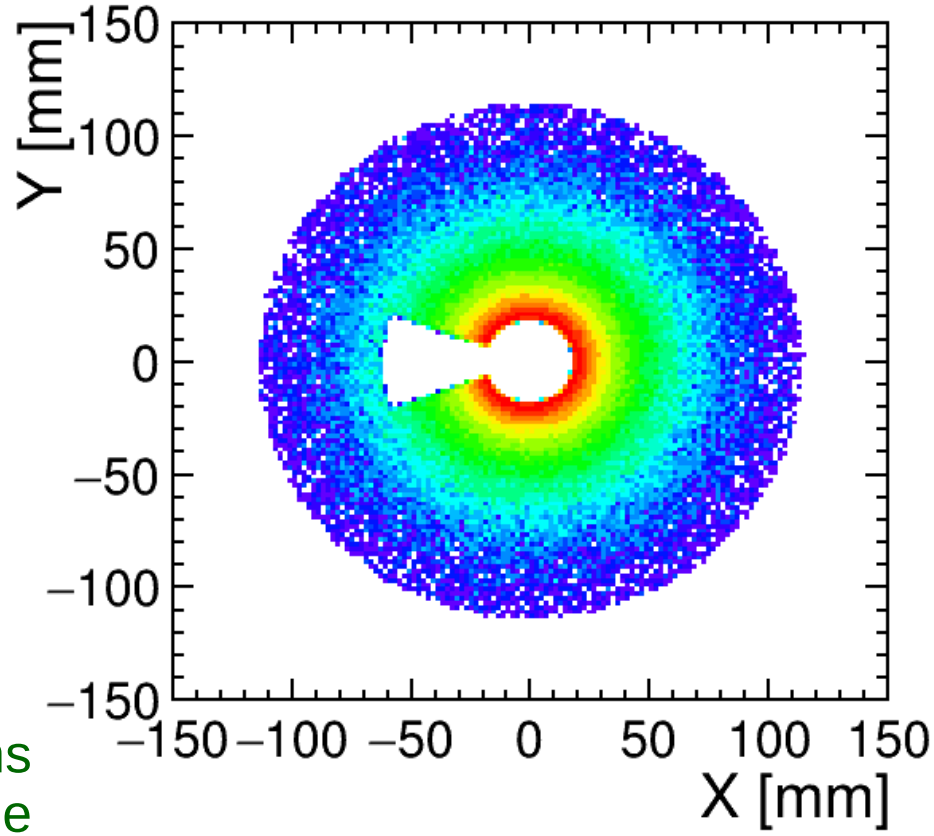


Forward calorimetry

- BeamCal acceptance
  - outgoing beam opening included in the description

Best way to model efficiency drop for $\Theta \leq 20$ mrad

Correctly takes into account FR acceptance correlation

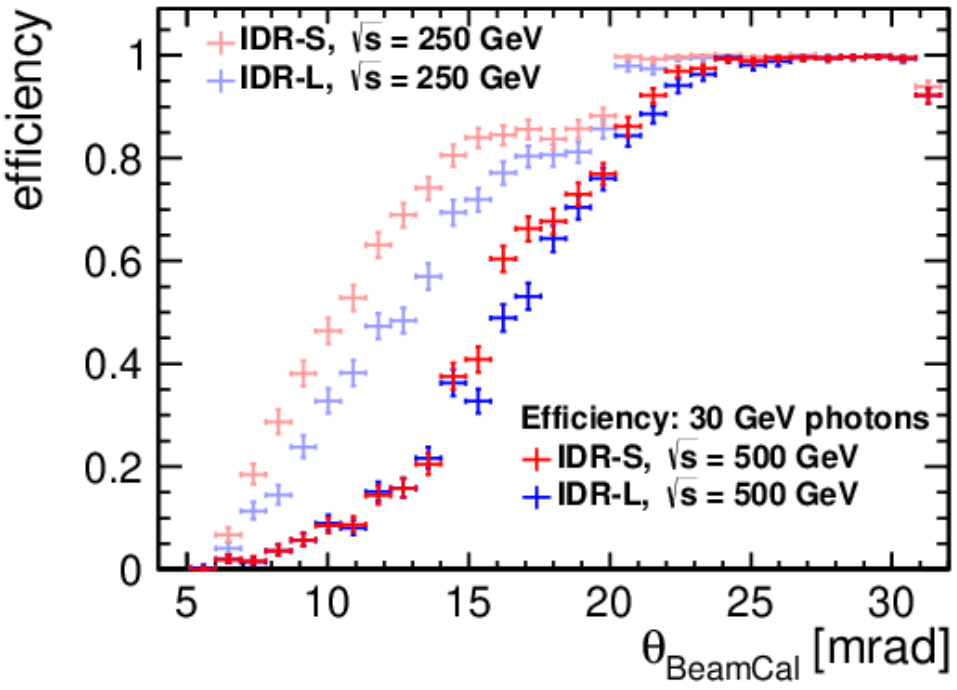


BeamCal tower hit positions for Bhabha event sample (log scale)

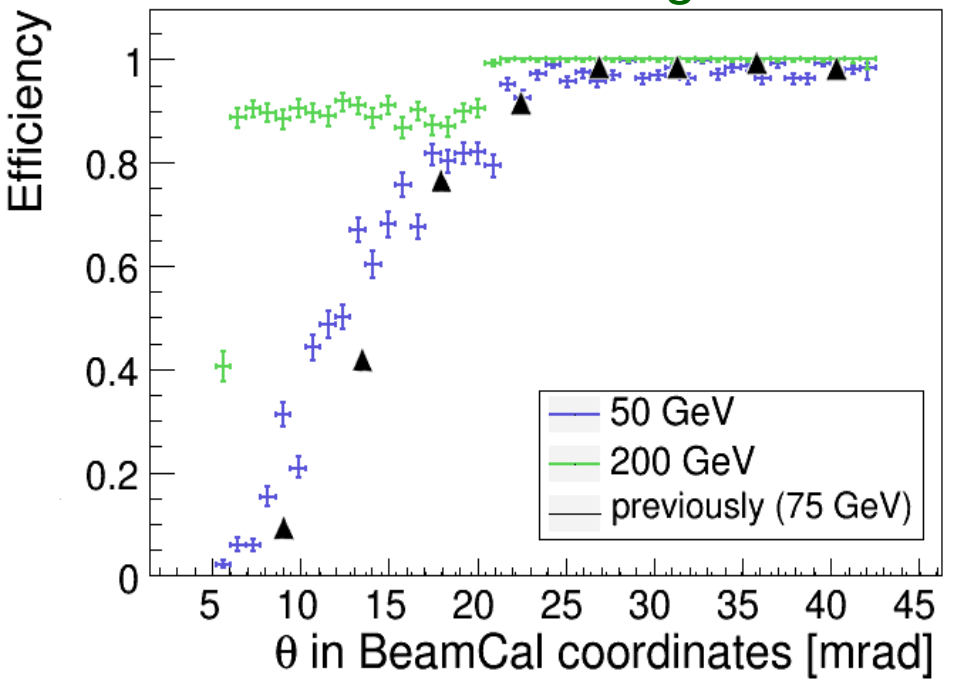
Forward calorimetry

- BeamCal efficiency
  - Based on ILC IDR and Moritz Hebermehl PhD Thesis

IDR Figure 8.8a



M.Hebermehl Figure 4.10



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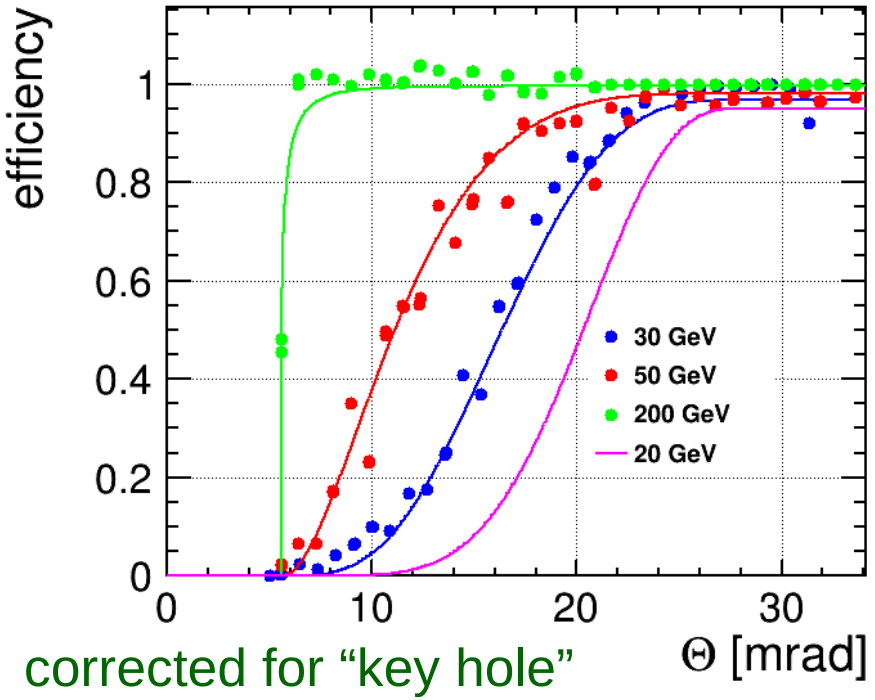
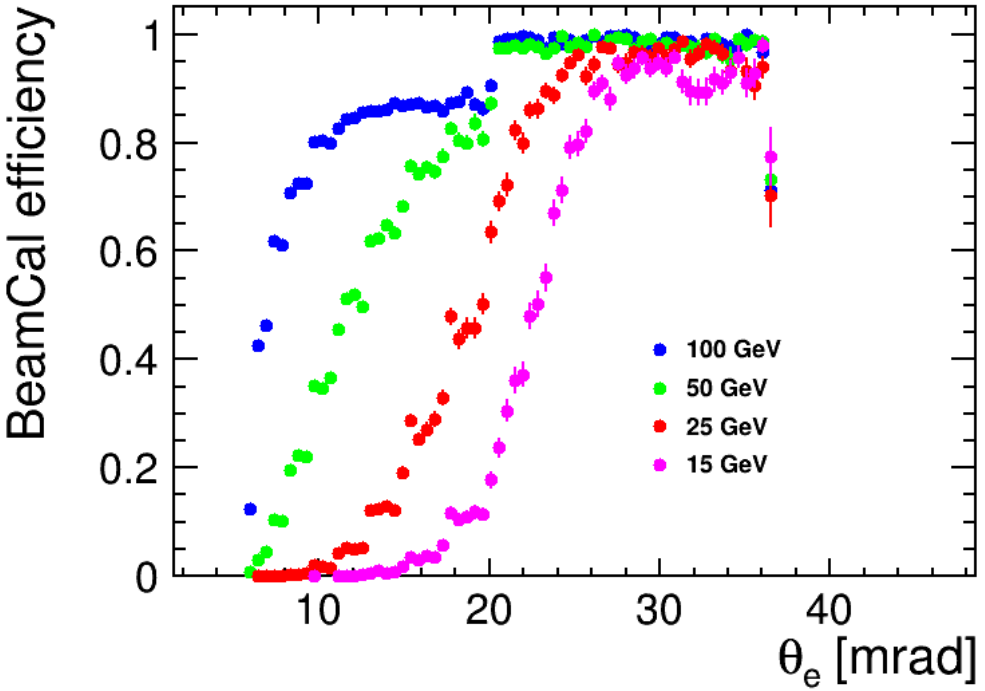
Functional fit to efficiency data



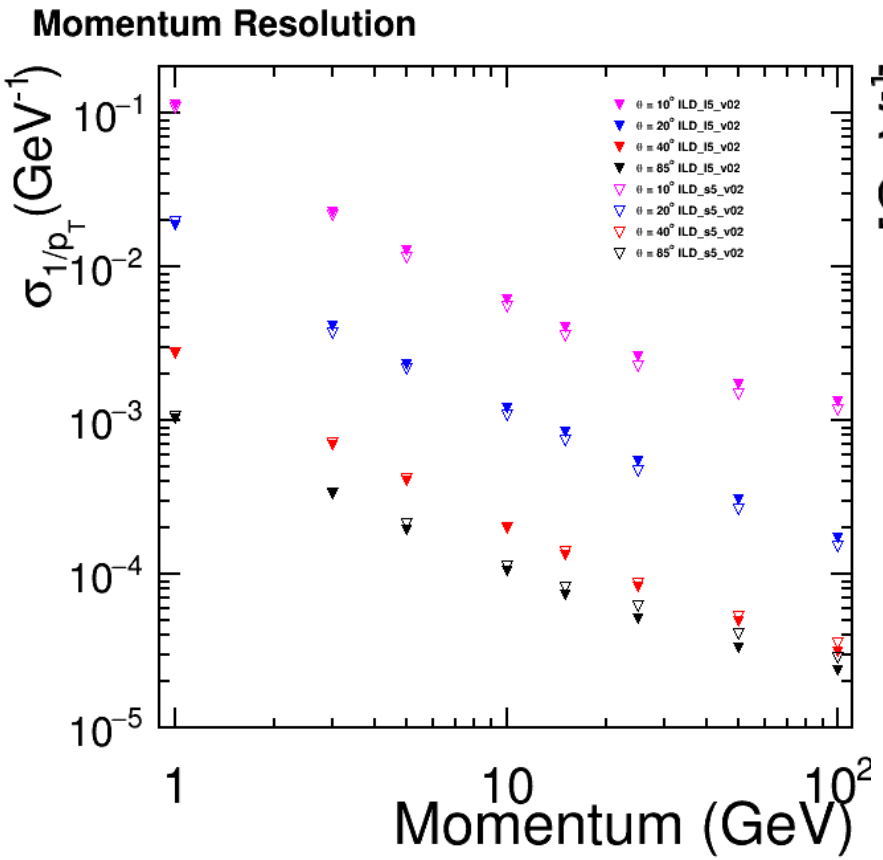
corrected for “key hole”

Delphes simulation

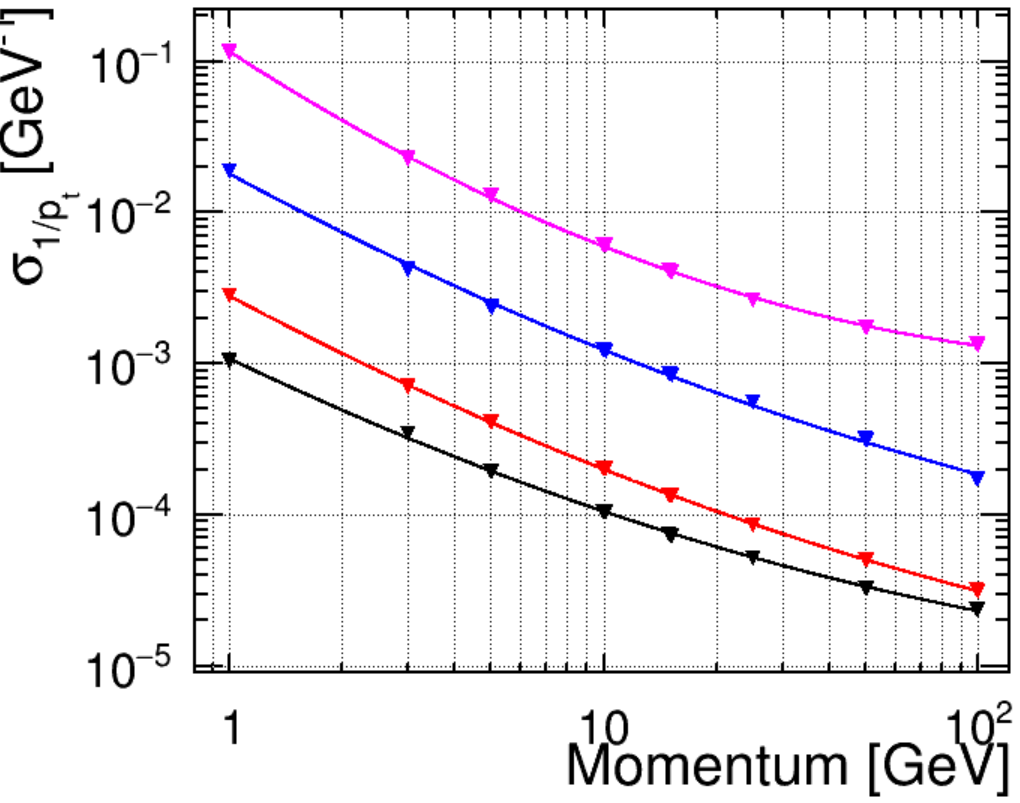


Tracking performance

- Track momentum resolution taken from IDR
  - Dedicated parametrisation used



Delphes: formula



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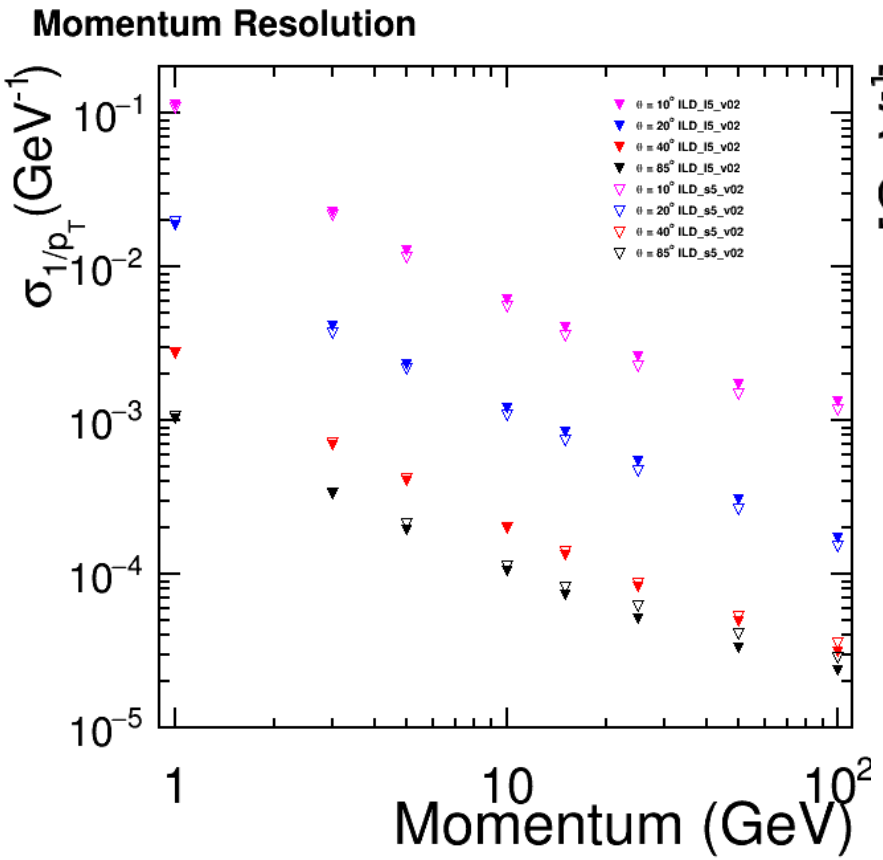
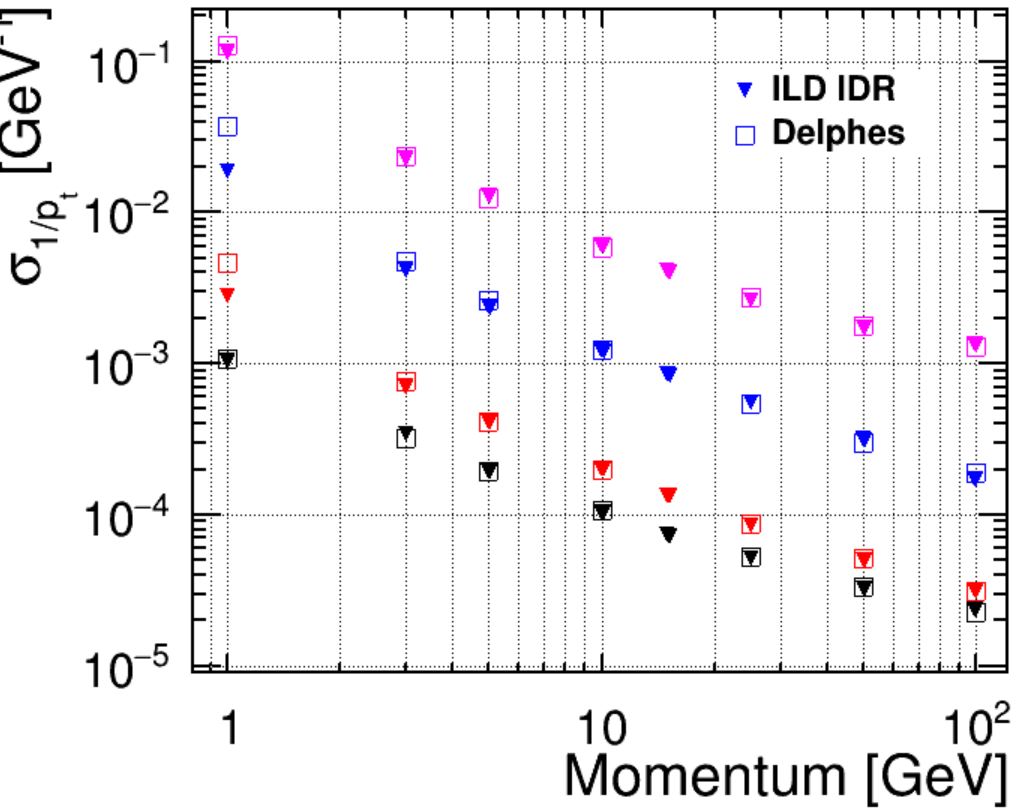


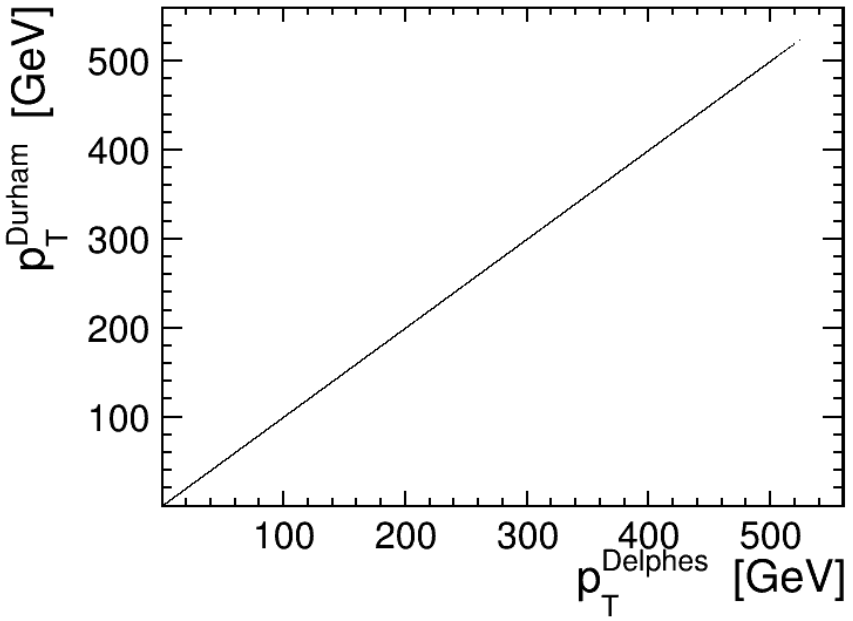
Delphes: **simulation results**

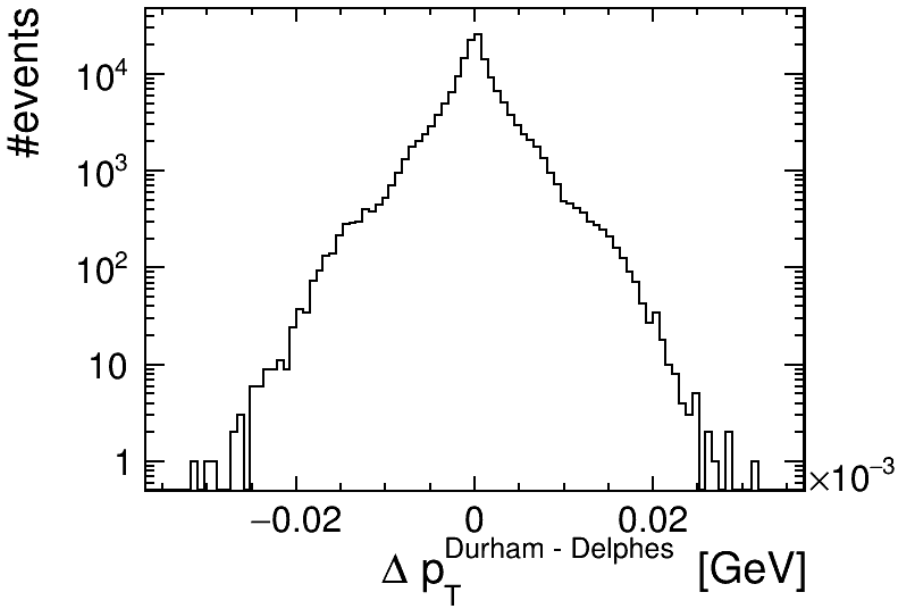


Jet clustering

- Durham (*ee_kt_algorithm* in FastJet) not implemented in Delphes (!)
- Results reproduced with proper VLC algorithm configuration (R=2, β=1, γ=0) for N=2...6

Comparison of Delphes jets (N=2) with Durham clustrisation in FastJet





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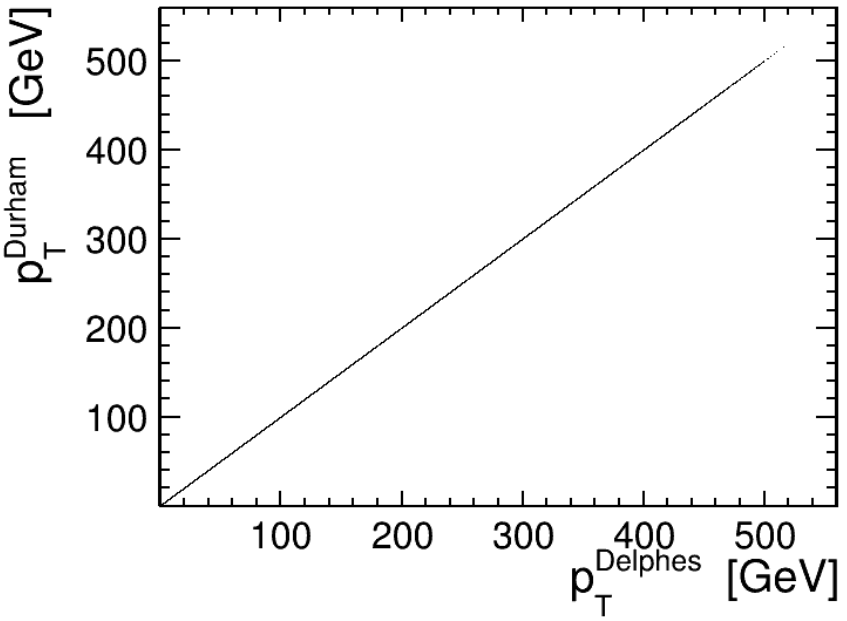
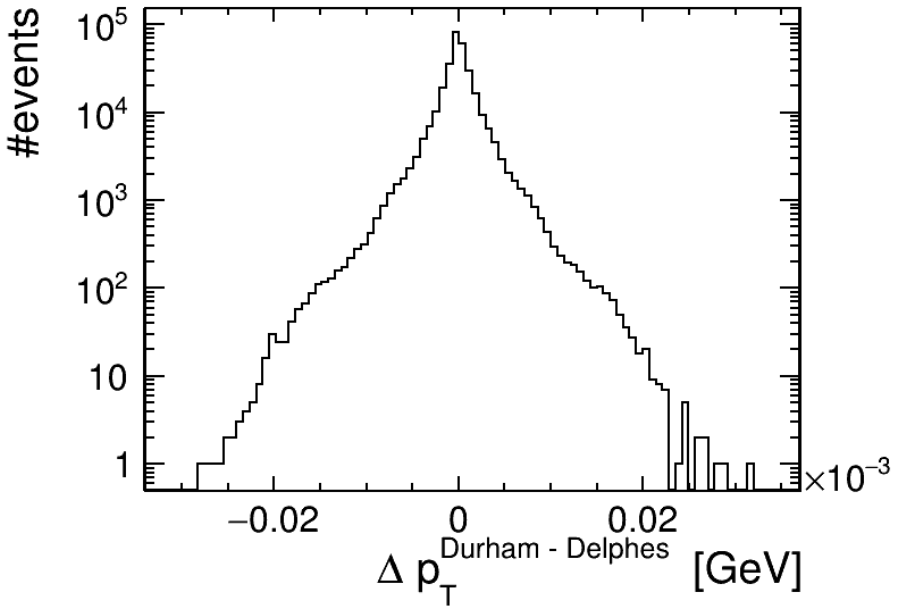
- Results reproduced with proper VLC algorithm configuration (R=2, β=1, γ=0) for N=2...6

Comparison of Delphes jets (N=4) with Durham clustrisation in FastJet



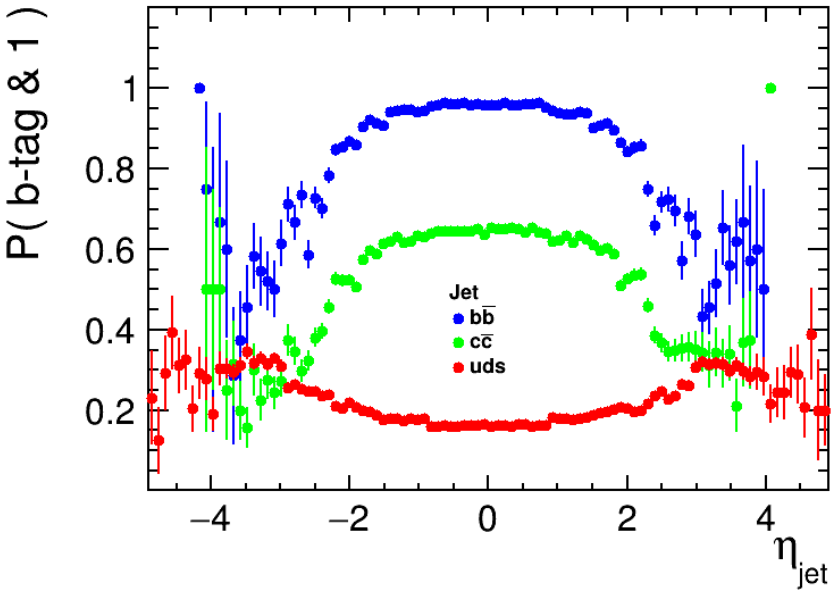


Jet flavor tagging

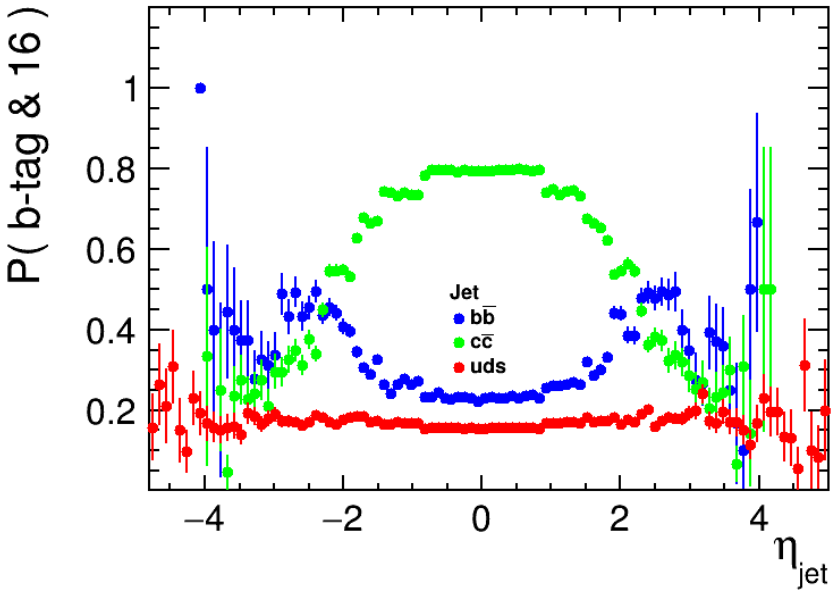
- Different levels (loose, medium, tight) implemented for both b- and c-tagging
- Stored as different bits in BTag (in jet class)

Loose selection:

b-tag



c-tag



Jet flavor tagging

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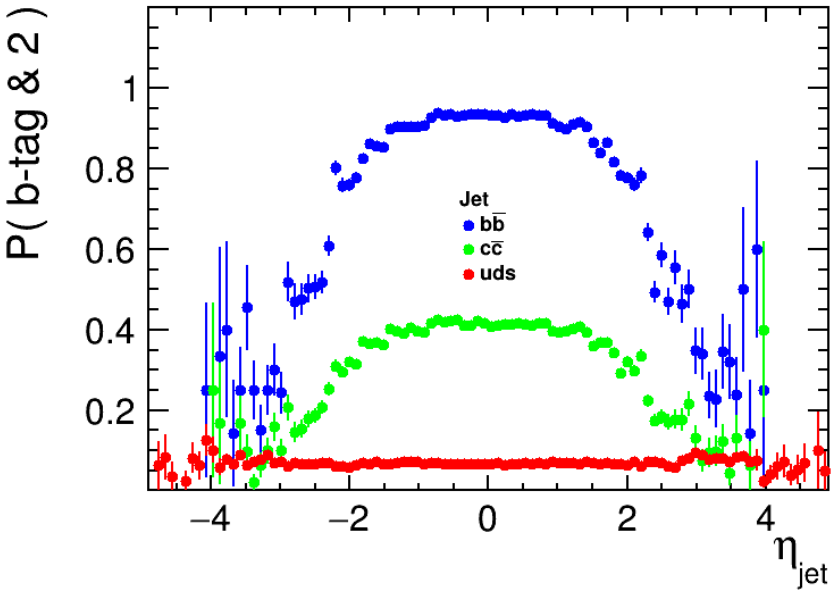
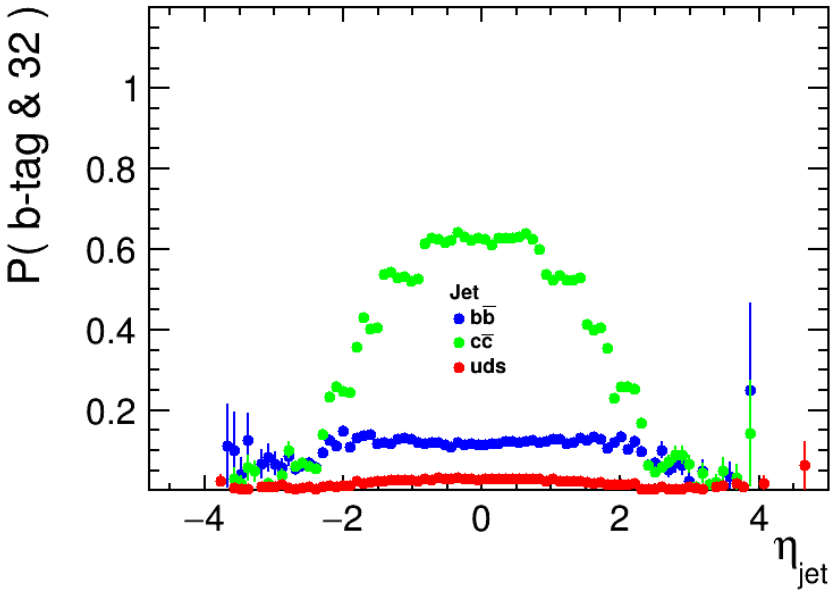
Medium selection:

b-tag



c-tag



Jet flavor tagging

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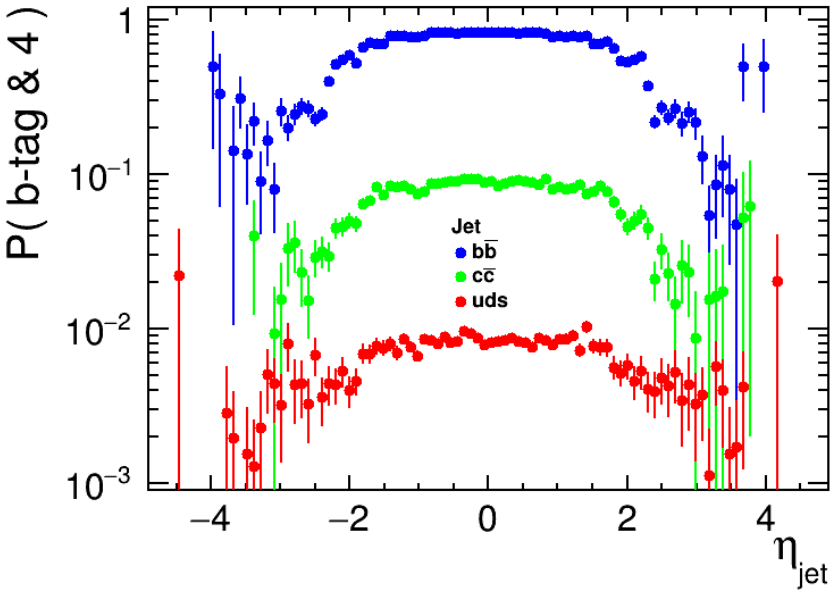
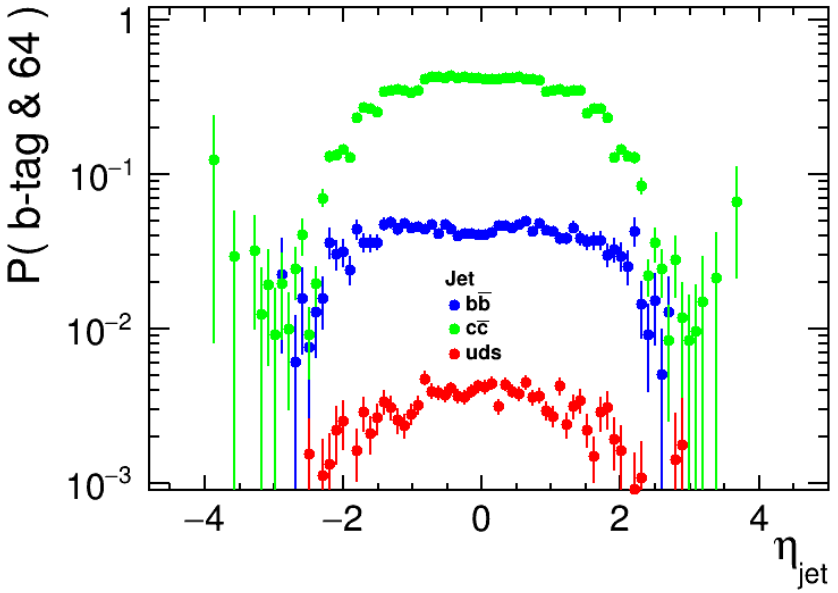
Tight selection:

b-tag



c-tag

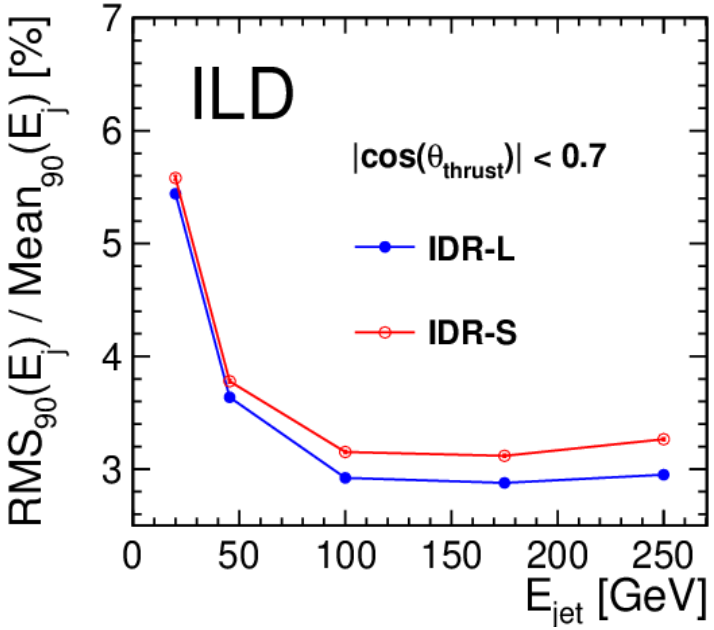


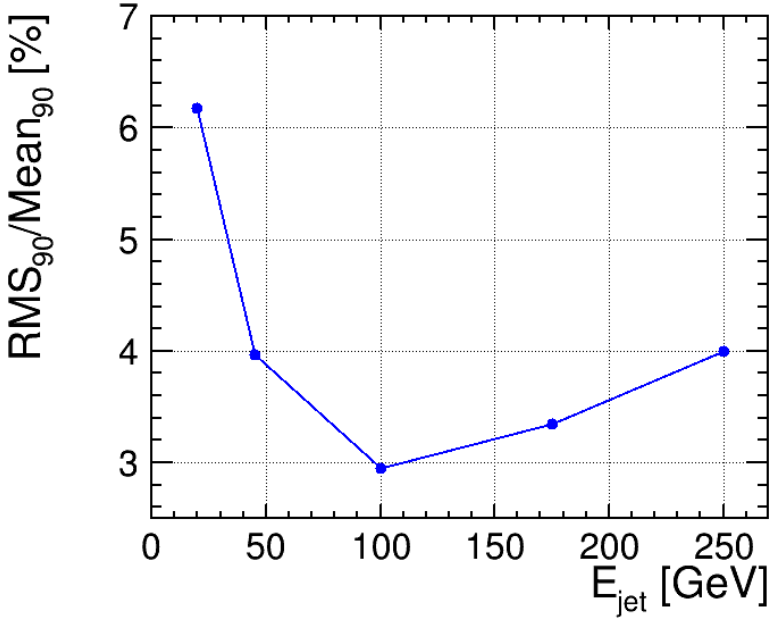
Jet energy resolution

- Particle flow very simplified in Delphes
- Jet energy resolution determined by calorimeter and tracking resolutions. Not much to tune…

Results strongly depend on jet definition/selection...

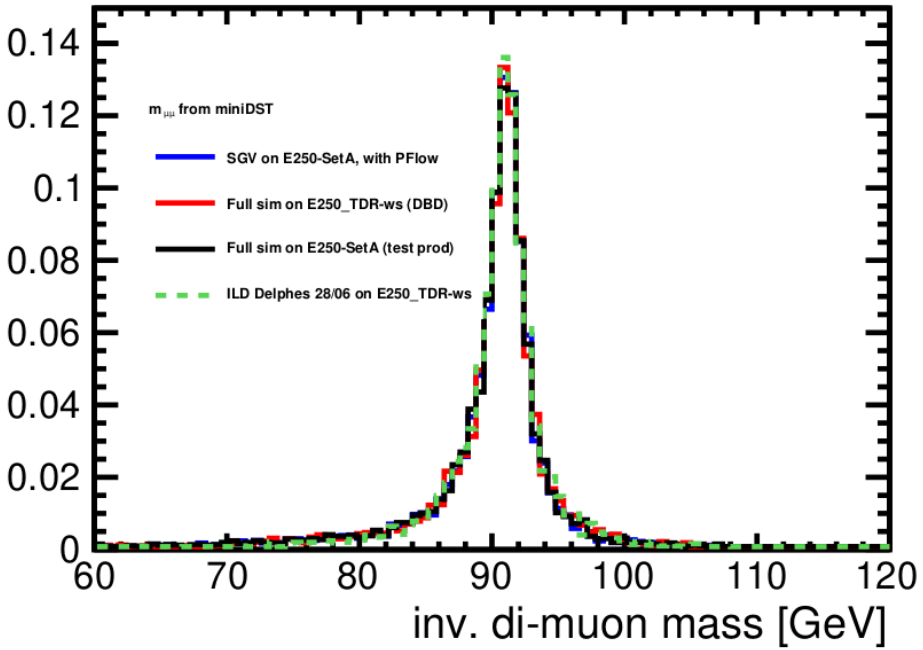
First look at JER for Z→ qq events (uds only), clustering with N=2, y_{23}<0.001

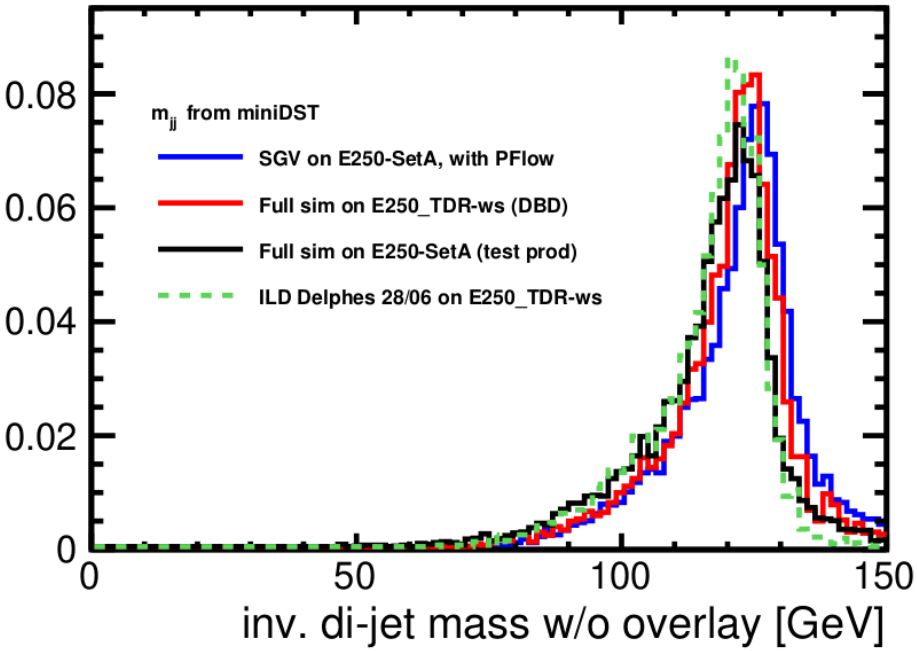




Performance

- First comparison of new Delphes model to SGV and full simulation results for $e^+e^- \rightarrow ZH \rightarrow \mu\mu qq$ (many thanks to Jenny List)





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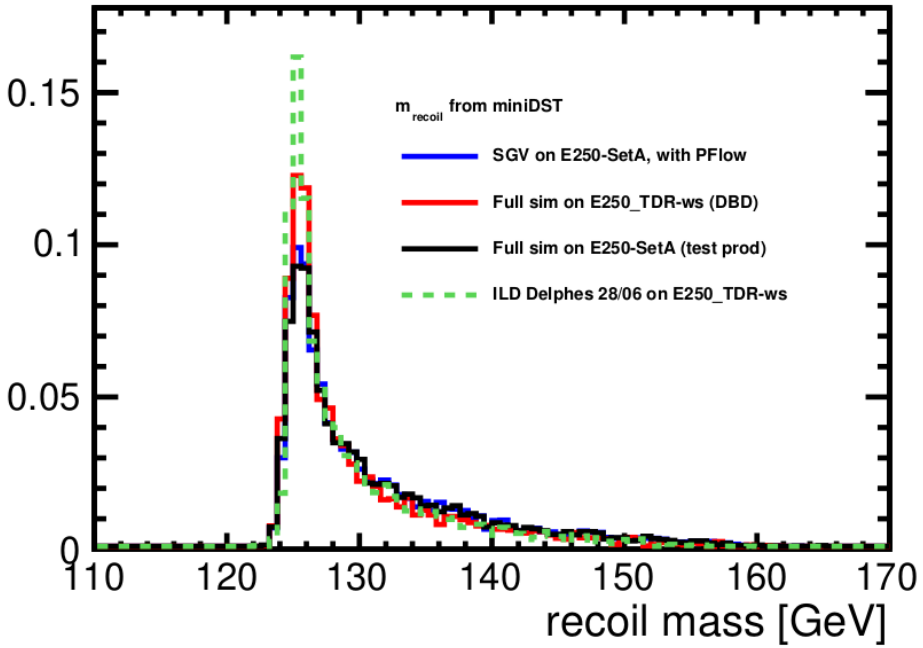
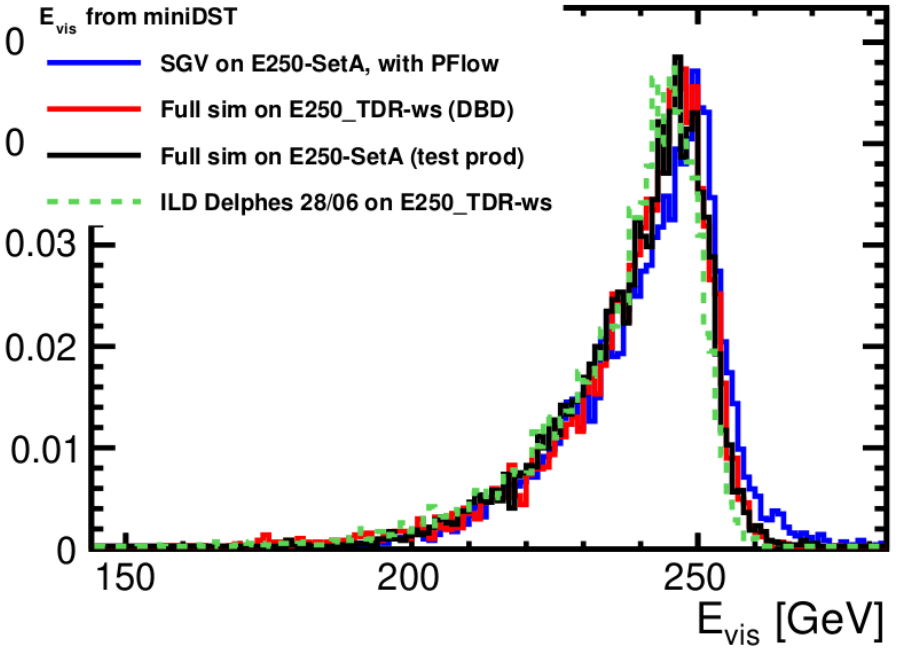




Conclusions

- New ILC detector model for Delphes
  - all major developments completed
  - general structure looks like final
  - details can still be adjusted if there are new inputs or test results
  - events can be stored in LCIO format (mini-DST)
  - **first release expected by end of July**
- Code is available at github:

  https://github.com/iLCSoft/ILCDelphes
- Documentation and examples will follow...

Thanks

Committing of the ILDDelphes model would not be possible without input, contributions and support received from:

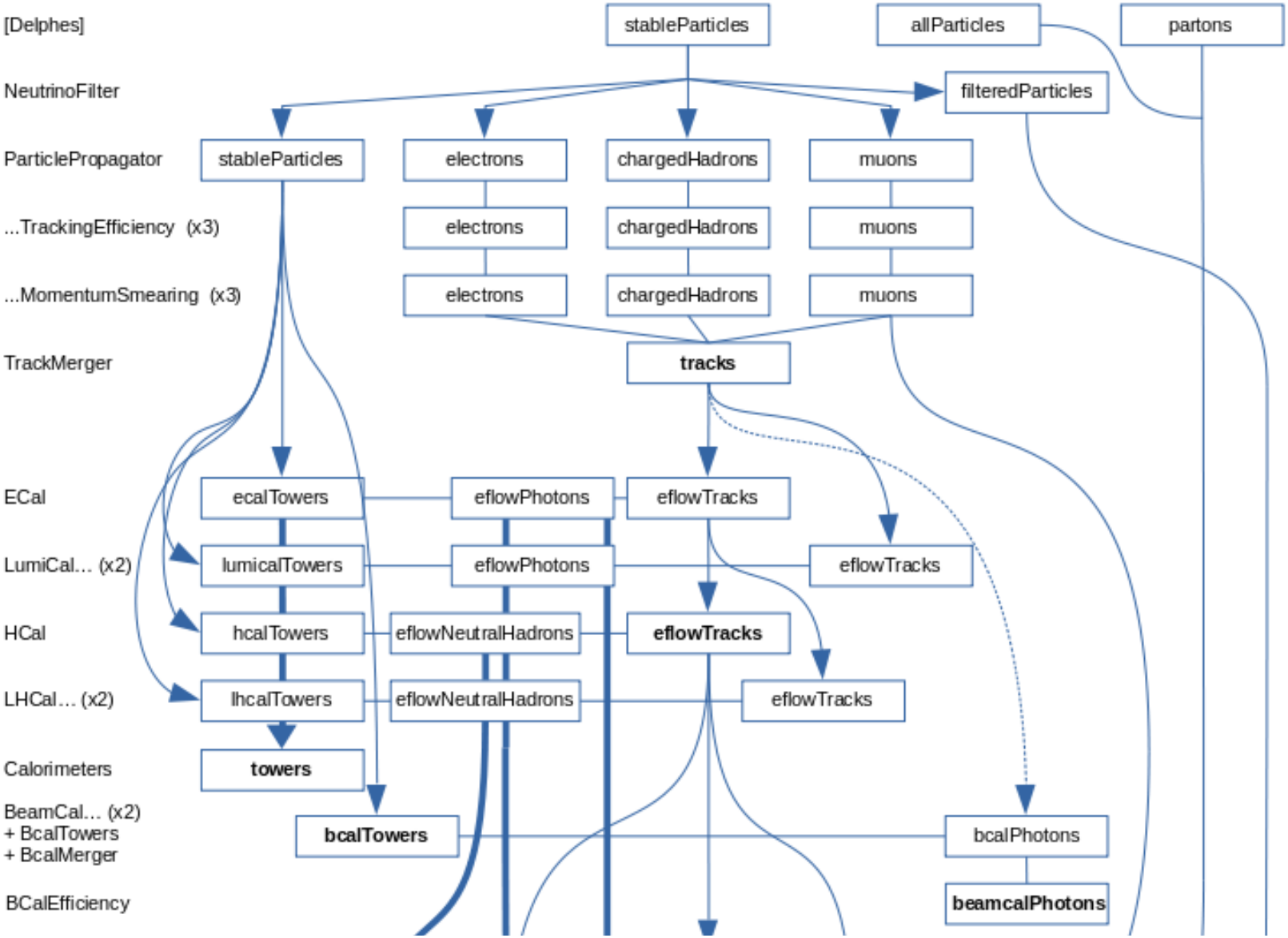
Jenny List, Marcel Vos, Pawel Sopicki, Frank Gaede, Carl Mikael Berggren, Daniel Jeans, Ryo Yonamine, Tomohiko Tanabe, André Sailer, Remi Ete, Shin-ichi Kawada

(in order of appearance in my mailbox)

Apologies if I misses someone...

Thank you!

Delphes data flow



Delphes data flow