Realistic Reconstruction of top Quark Pairs for the ILC

Talini Pinto Jayawardena (RAL)
Kristian Harder (RAL)
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Lancaster University

Overview

- Purpose of the analysis
- Choice of detector and simulation software
- Algorithms used for the reconstruction
- Reconstruction of the top mass – for 6 jet channel
- Next Steps
- Conclusion and Discussion

TTBar Analysis – Purpose and Aim

- Reconstruction of heavy particle decay to multi jet final state events crucial for ILC physics
- Event reconstruction optimization for ILC energies using only realistic algorithms
- Performance studies of detector options considered for the ILC
  - Enables the optimization of vertex detector, calorimeter currently undergoing R&D

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Top Reconstruction – 6 Jet Channel

- Three main top pair event topologies:
  - $t\bar{t} \rightarrow bbqqqq$ – 6 jets
  - $t\bar{t} \rightarrow bbqql\nu$ – 4 jets
  - $t\bar{t} \rightarrow bbl\nu l\nu$ – 2 jets

  Leptonic decays result in missing momentum
- 44% of the sample decaying to 6 jets give good statistics for reconstruction
- Large fraction of the energies in the final state visible
  - Small loss of energy in neutrinos

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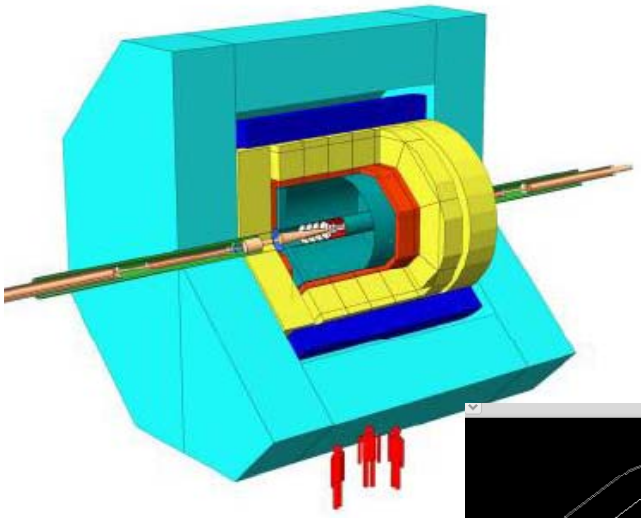
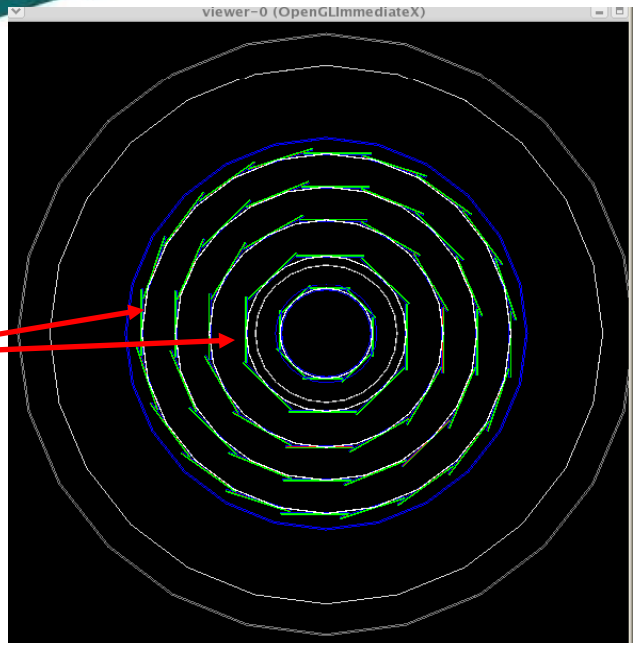
Simulation of Detector





Ladder structure in the vertex detector

- Use of the LDC detector concept
- GEANT4 simulation software MOKKA used to describe the detector model
- A good description of geometry, although with limited detail on support structure, cabling etc.

Algorithms for Reconstruction

- Uses the Marlin framework for the reconstruction of events from raw (simulated) data of the detector
- Applies PandoraPFA particle flow algorithm which associates tracks with calorimeter clusters to find the most precise description of each particle
  - Clustering and particle flow done in a single stage
- Track reconstruction includes full LDC tracking
  - Finds track segments in the TPC and silicon detector independently and associates them with each other
  - Assigns left over hits to the found tracks
- Secondary (+tertiary) vertexing and heavy flavour tagging performed by LCFIVertex
  - Heavy flavour tagging based on neural networks

⇨ Tracking+vertexing and calorimeter readout reconstructed without the use of MC information

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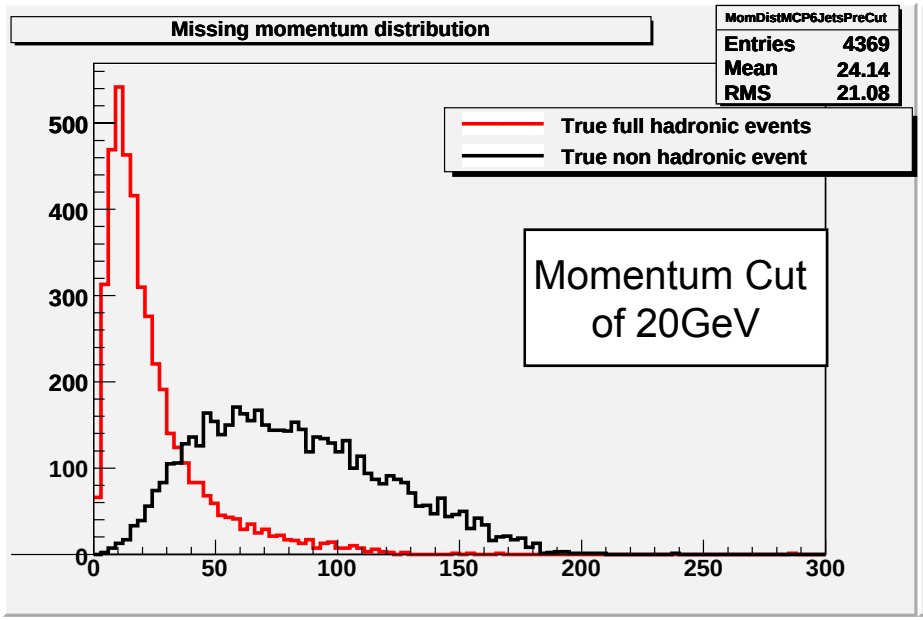
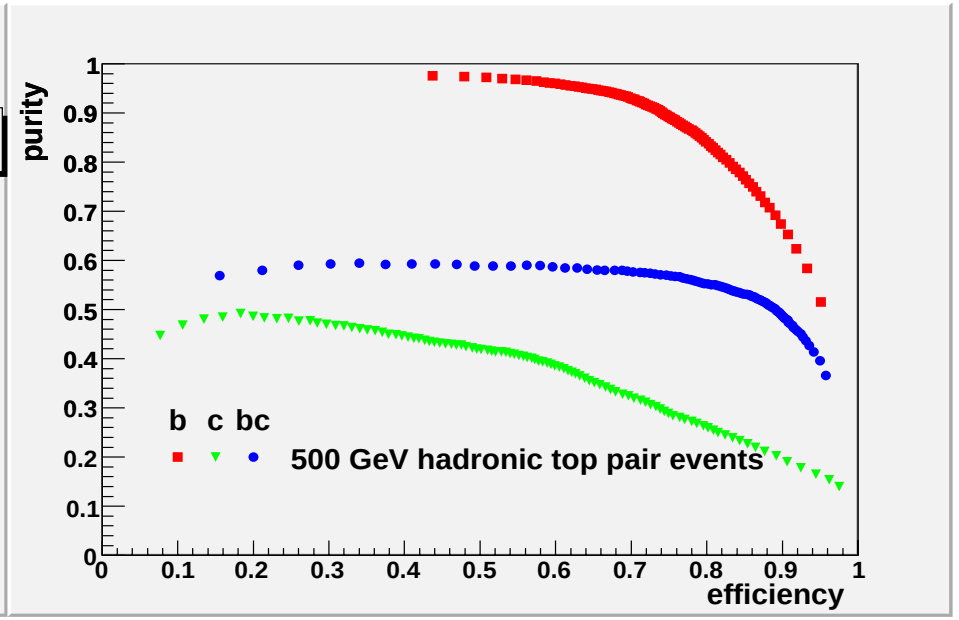
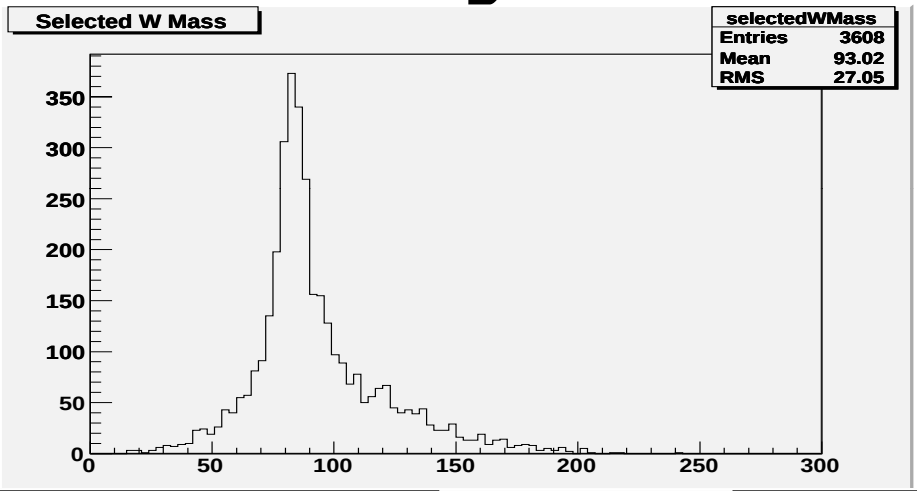
Top Reconstruction – Selecting the events

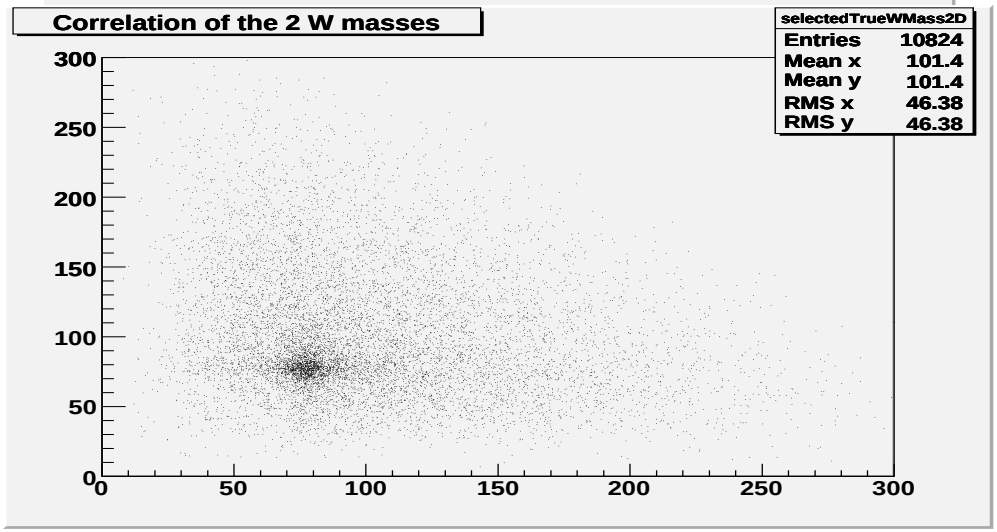
- Modified Durham jet finder (by Satoru Yamashita, OPAL) used to force 6 jets for all events
  - ensures that the actual 6 jet events are reconstructed well
- All hadronic jet channel selected by
  - Applying a veto on events with a large missing momentum
  - Requiring 2 b tags for each event (neural net jet likelihood)





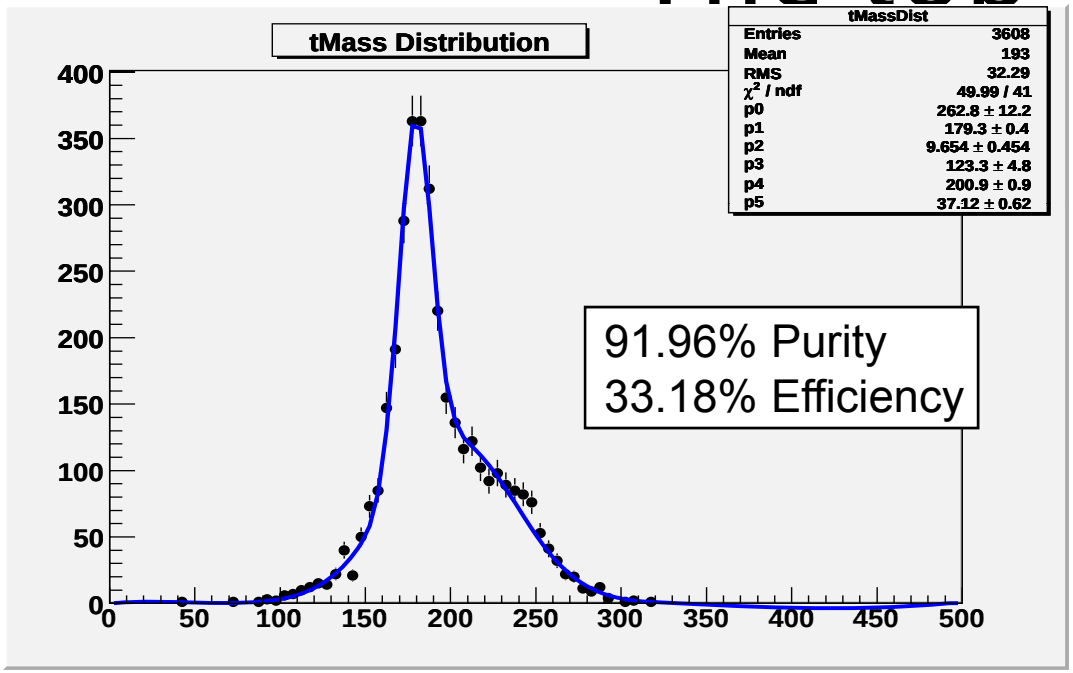
Top Reconstruction – Jet Combinations





- Need to separate the b jets from those of W
  - Jets having the two highest probability selected as the b jets
- Remaining 4 jets need to be separated to their correct W decay jet pairs
  - Combinations where the 2 masses are the least different are chosen as the best jet combinations
- Corresponding W-b jet combinations used to obtain the top mass
  - Jet combinations where the 2 masses are most similar regarded as the best combinations

Top Reconstruction – The top Mass



Mean of main mass distribution: 179GeV
Width: 9.6 GeV (Width with ideal cheated reconstruction = 9.1GeV)

NB: Purity/Efficiency values obtained for sample without background

- Energy scaling applied for b and W jet energies to improve calibration
  - Calibration obtained from scaling e+e- → bb, and e+e- → WW events to CMS energy
- Calibration procedure currently being improved
- Clear top mass peak observed
- Broader peak below the signal at higher energies most likely from wrong jet combinations

Next Steps

- Understand top mass resolution
- Test performance with background included
- Study different detector performances
- Include leptonic channels?

Summary

- Detector simulation and the reconstruction provide a realistic setup for ttbar analysis
- Good top mass reconstruction with simple selection criteria
- Jet pairing needs further investigation
- Next steps include testing algorithm with background included and continue on to detector performance studies

A work in progress. Still have to fine-tune the algorithm!