Status of Top Quark Physics at Dortmund

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ATLAS-D top, MPI Munich, 18-19 May 2006
Status of top quark physics at Dortmund

Overview

• Our group

• What we did so far

• How to continue
Our group

• our present top physics group, some of them are just starting
  
  • Moritz Bunse (diploma student)
  Daniel Dobos (PhD student)
  Claus Gößling
  Reiner Klingenberg
  Ingo Reisinger (PhD student)
  Jörg Walbersloh (PhD student)

• we will hire a post-doc on analysis by autumn of 2006
Our group

• we have a strong background in the pixel detector of the ATLAS experiment

• we have a study on spatial resolution improvements in the pixel detector;

  it is part of the tool development for tracking and b-tagging which is especially useful for top physics
What we did so far

- improvements of the track fitting

- first look at ATLAS DC2 (data challenge) ntuples regarding top-anti-top production and their decay in the (semi-)leptonic channel

- analysis in the ATHENA ATLAS s/w environment using AODs (analysed object data)
Aim of ‘our’ tracking study

- so far ATHENA (10.4.0), the ATLAS reconstruction/analysis frame did not use the full information provided by the inner detectors, i.e. the charge information from the individual cells of the pixel detector

- but detector provides ‘analogue’ to improve on the spatial resolution of tracks and the vertex/secondary vertex determination
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- Improvements ~10%
  - first version is part of ATHENA 11.0.1

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I. Reisinger, Dortmund in collaboration w/ T. Lari, Milano
First look at ATLAS DC2 ntuples

- we become familiar with simulation data available from the ATLAS data challenge 2 (DC2) in respect to top quark production and decay
- had some first look at the samples including full- and semi-leptonic top-anti-top decays
- reconstruction of invariant masses of top and W-boson; a rudimentary study of angular correlations between jets, leptons
- data and useful analysis skeleton from NIKHEF and some additional coding for our own learning phase
Example: leptonic and hadronic top reconstruction
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- Reconstruction of the ‘leptonic’ top: transverse invariant mass of neutrino + ch. lepton + 4th jet
- Reconstruction of the ‘hadronic’ top: highest vectorial transverse momentum sum of 3 out of 4 jets
Example: leptonic and hadronic top reconstruction

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Example: reconstruction of the W boson

- choose jet combination of smallest angle, reconstruct invariant mass, get mostly W boson
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next step

- using ATHENA as the ATLAS simulation / reconstruction / analysis framework
Setting up the ATHENA environment

- started with local computer environment
  reused Duron + Pentium IV (32bit), Scientific Linux CERN 3.0.6
  and Sempron (64bit), SLC3 & SuSE10
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  want to enlarge to a (small) local cluster \textit{(later Tier3?)}
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- Computer Division of the University:
  Linux Cluster w/ 224 nodes / 464 CPUs, 64bit, SuSE10
  cluster not fully in operation yet, no ATHENA installation yet (*later Tier3?*)
Setting up the ATHENA environment

- Installation of ATLAS s/w framework ATHENA 11.0.42
- Tutorials
- Create an analysis environment for first studies with AODs
A word on our tutorials

- two interactive ATHENA tutorials organised within our groups to learn
  - structure and philosophy of the ATHENA framework
  - ATHENA terminology (Algorithms, Tools, Data Objects, Transient Data Store, Services, Data Converters, Properties ...)
  - the ATHENA full chain of data processing
  - package structure, checkout, modify, create, build and run
  - usage of CMT
  - usage of ATHENA services: e.g.: Message, RandomNumber, Histogram and NTuple services
  - detailed study of an t-tbar analysis example
  - AnalysisSkeleton as own analysis starting point
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  - AnalysisSkeleton as own analysis starting point
- our experience: a very useful starting point to become familiar, however, prefer learning by working on own tasks

D. Dobos
Examples of the AOD studies
(as snapshot from our playground)

• read AOD collections and fill preselected collections
• apply kinematic cuts, e.g. $E_t$, $P_t$, $\eta$, charge, ...
• apply particle type specific cuts: Jet (em. calo), $\mu$, $\chi^2$, ...
• histograms for all, MC truth and preselected particles
• residuals of kinematics

“preselection”
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<th>$\eta$</th>
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gap in the hadron calorimeter

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t-tbar reconstruction  
(first try to learn Athena methods) 

- reconstruct $W \rightarrow jj$ candidates with highest $P_t$ vector sum and $W$ mass constrain 
- reconstruct $W \rightarrow \ell \nu$ candidates from missing$E_t$, lepton and $W$ mass constrain 
- reconstruct $t \rightarrow W j$ and $t \rightarrow W b$ candidates and take combination with smallest deviation from expected top mass
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Tags on b-jets!
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Athena basics understood

![Graph showing mass reconstruction](image)

- Tags on b-jets!
- Both tops @ 175 GeV

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How to continue?

- continue learning phase
  - concerning the s/w, analysis and data environment

- continue on analysis techniques:
  - tool development
  - validation of new ATLAS simulation data (DC3)
Dortmund’s top interests and plans

- QCD
- Electroweak physics
- Higgs or new physics
Dortmund’s top interests and plans

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Dortmund’s top interests and plans

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in the leptonic / semi-leptonic channel
Dortmund’s top interests and plans

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Status of top quark physics at Dortmund

in the leptonic / semi-leptonic channel

single top / electro weak production

Wt associated production
End
Tracking studies

- ATLAS Pixel detector: innermost tracking detector with ~80 million 50x400 μm² cells
- provides three space points in barrel and/or disk layer
- a sector of the ATLAS barrel part has been used for detector performance studies combined test beam
- this emulates transversely (high $p_T$) emitted particles

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