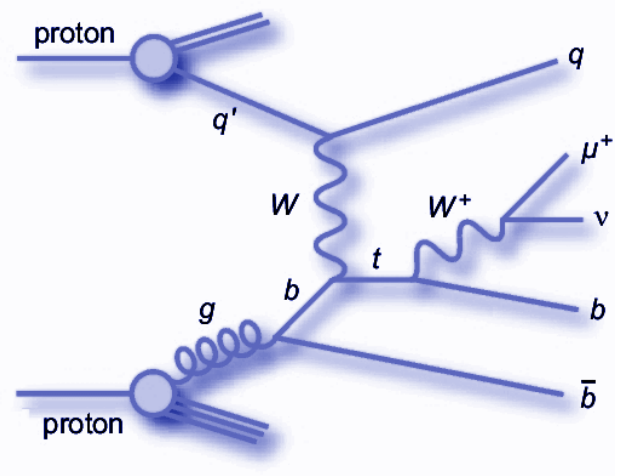
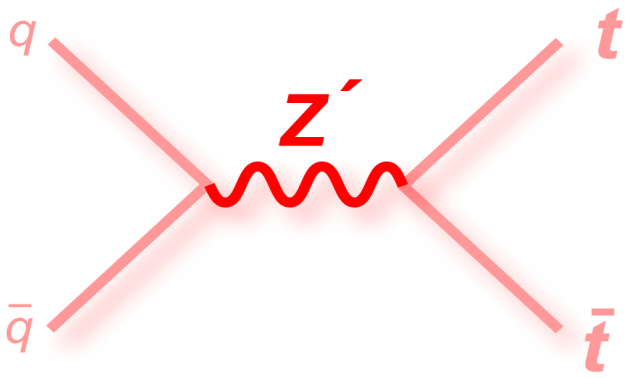
Measurement of Single Top Quark Production and Search for Resonances Decaying into Top Quark Pairs with the CMS Experiment





- Event selection
- Multivariate Analysis
- Event candidates in 2010 Dataset

- CMS PAS TOP-09-009
- Event candidate in 2010 Dataset

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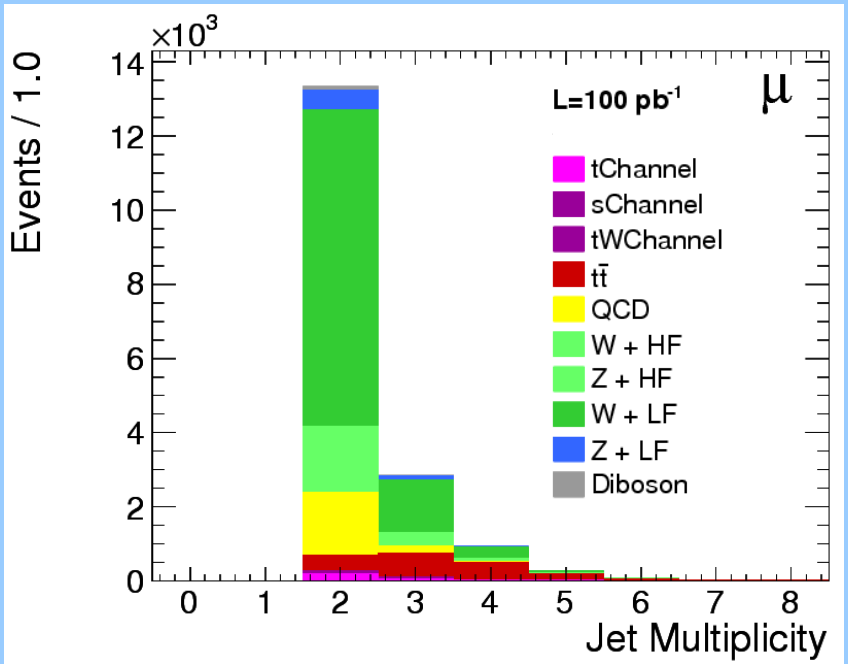
PHYSICS AT THE TERA SCALE
Helmholtz Alliance

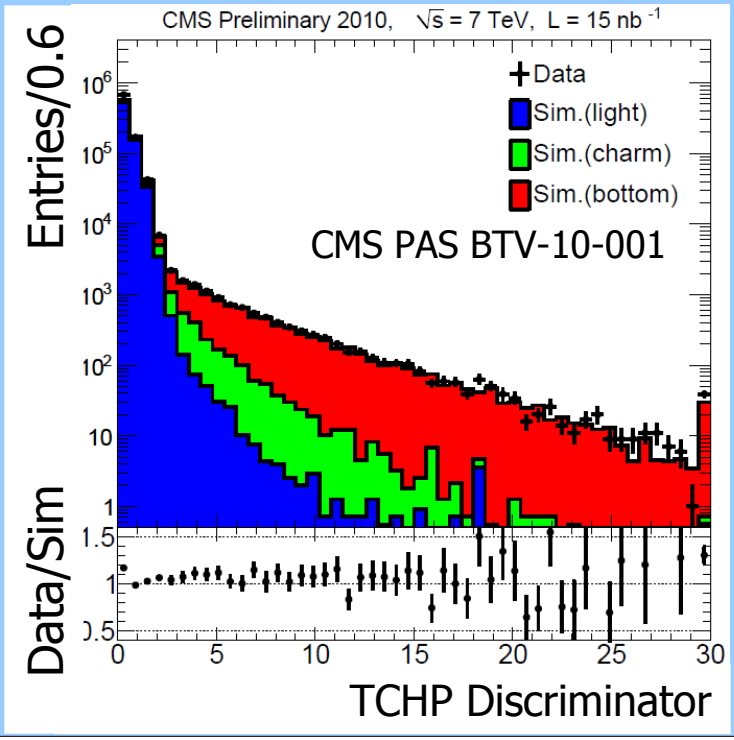
Pre-Selection

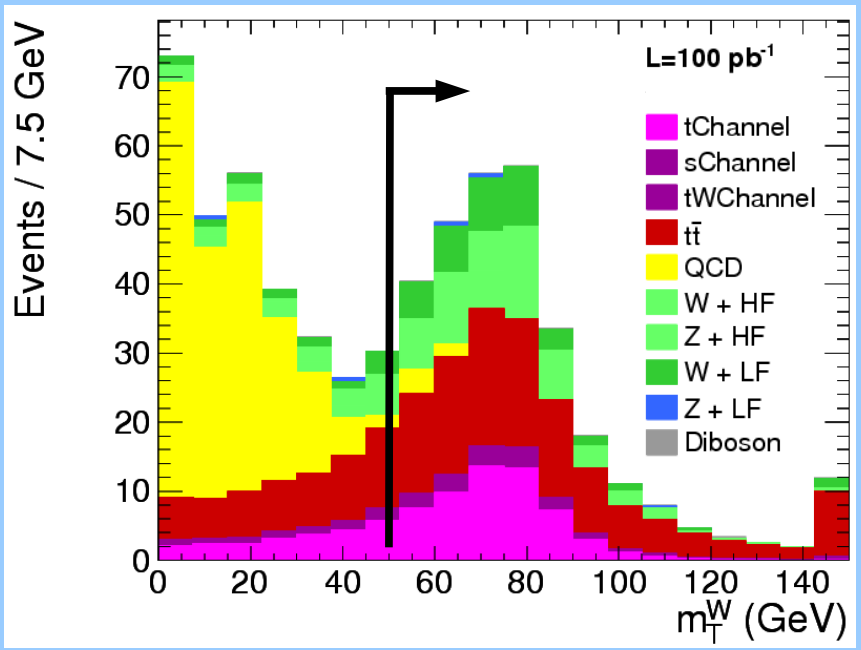
- one triggered isolated prompt muon
  - pT > 20 GeV
  - $|\eta| < 2.1$
- di-lepton veto



Event Selection

- one triggered isolated prompt muon
  - pT > 20 GeV
  - $|\eta| < 2.1$
- di-lepton veto
- exactly 2 antikt5 Particle Flow Jets
  - pT > 30 GeV
  - $|\eta| < 5$
  - min. one tight b-tagged jet
- $M_T(W) > 50$ GeV





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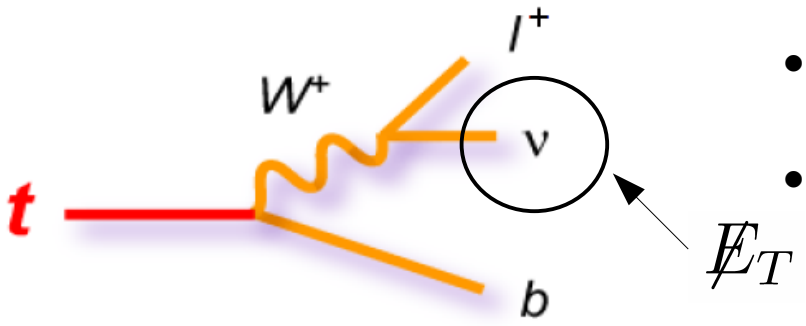
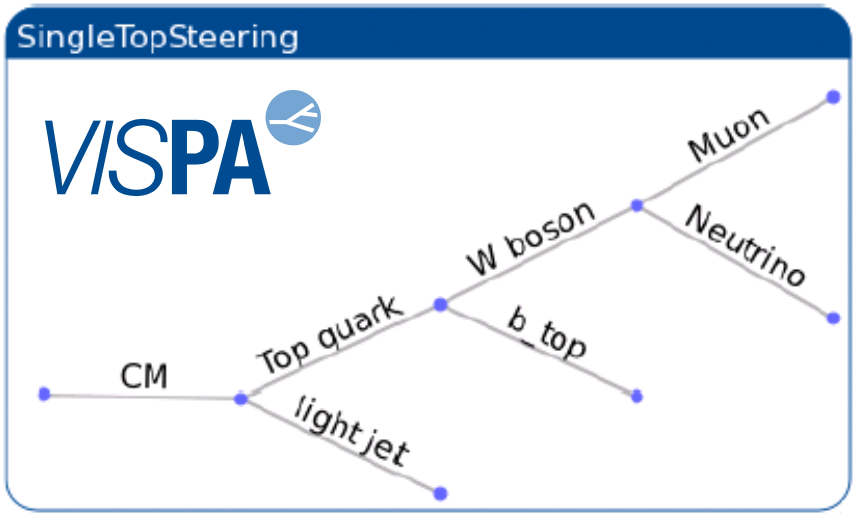
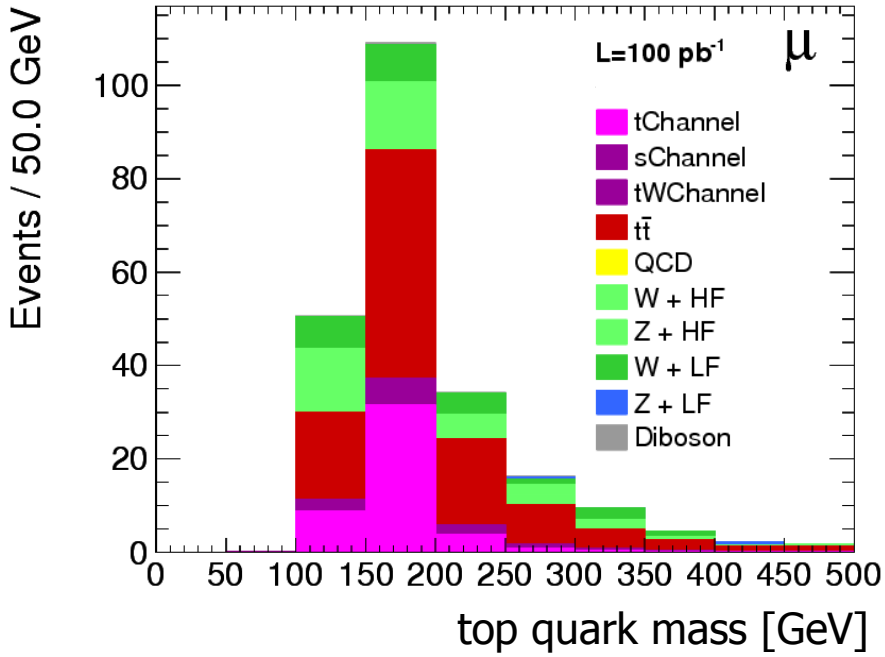
Single Top Quark Reconstruction

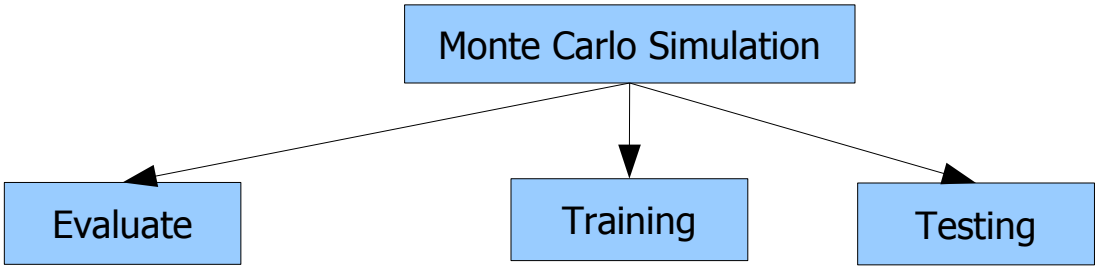


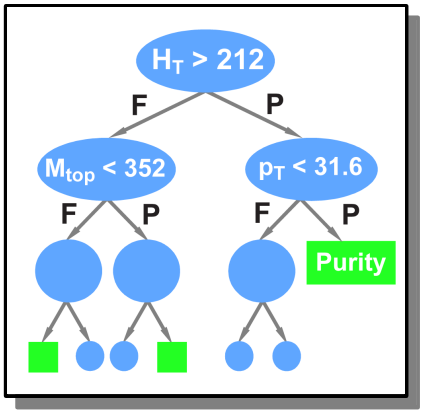
- Solve neutrino z-momentum
- W boson mass constraint
  - real solutions: smaller |pz|
  - complex solution: minimally modify MEx and MEy (Julia Bauer et al.)





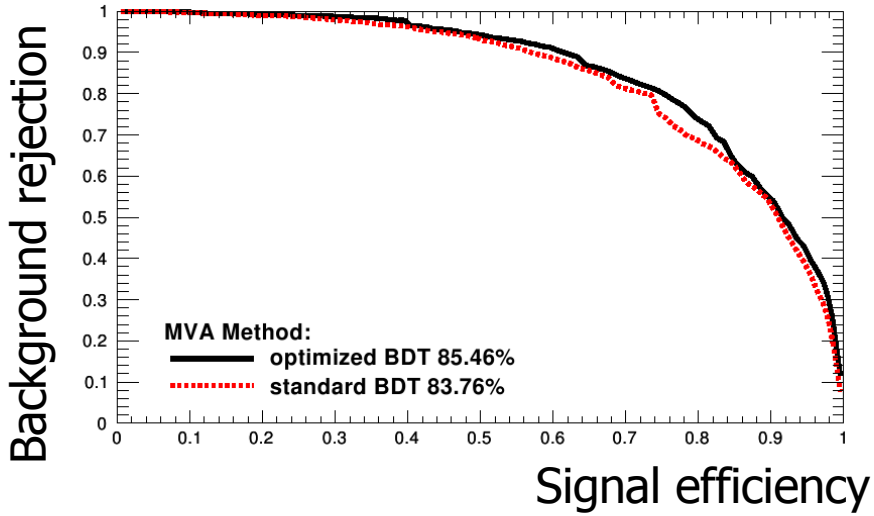
Boosted Decision Tree Analysis
- Background Separation -





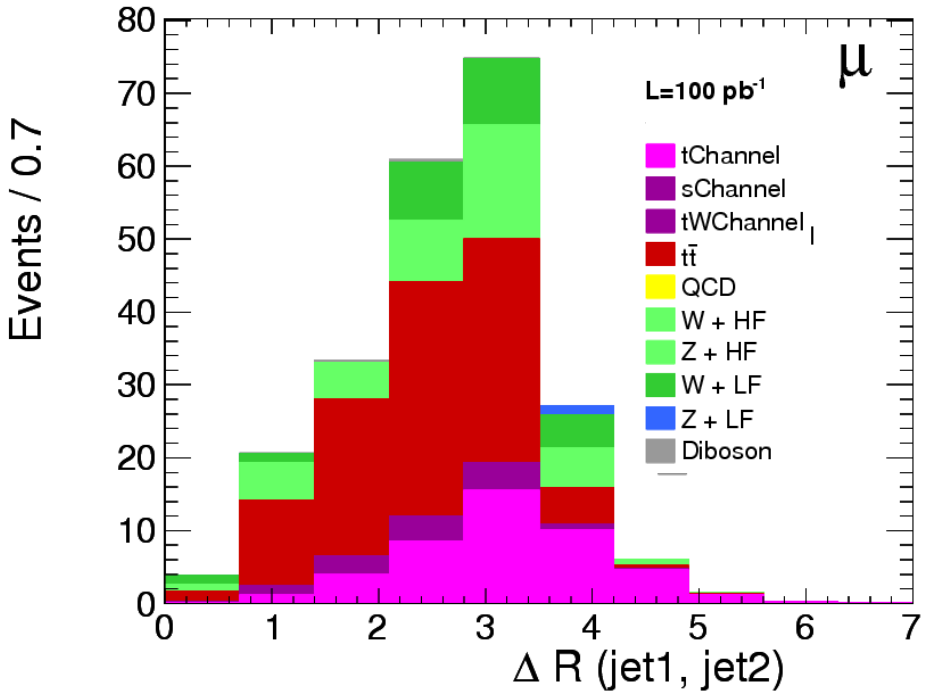
Optimize separation:

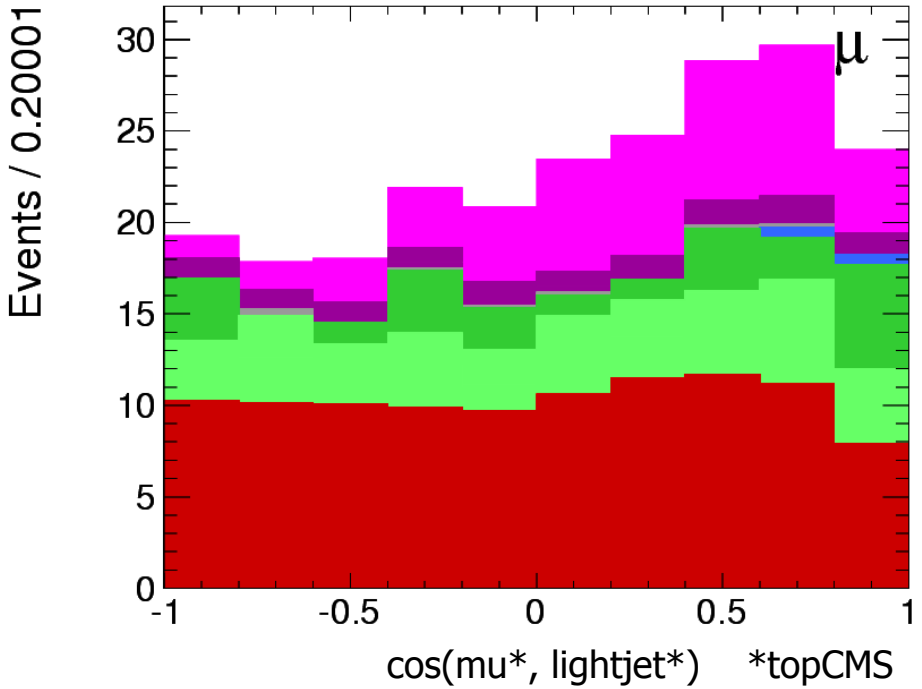
- Discriminating variables
- Configuration of Boosted Decision Tree



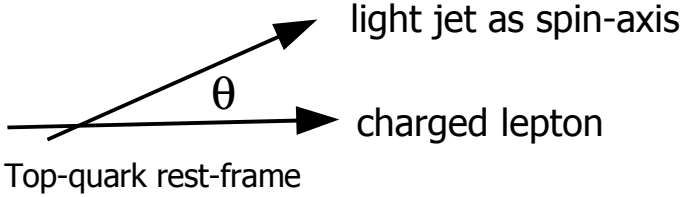
Good separation between signal and background:
54 variables: 85.5%

Discriminating Variables



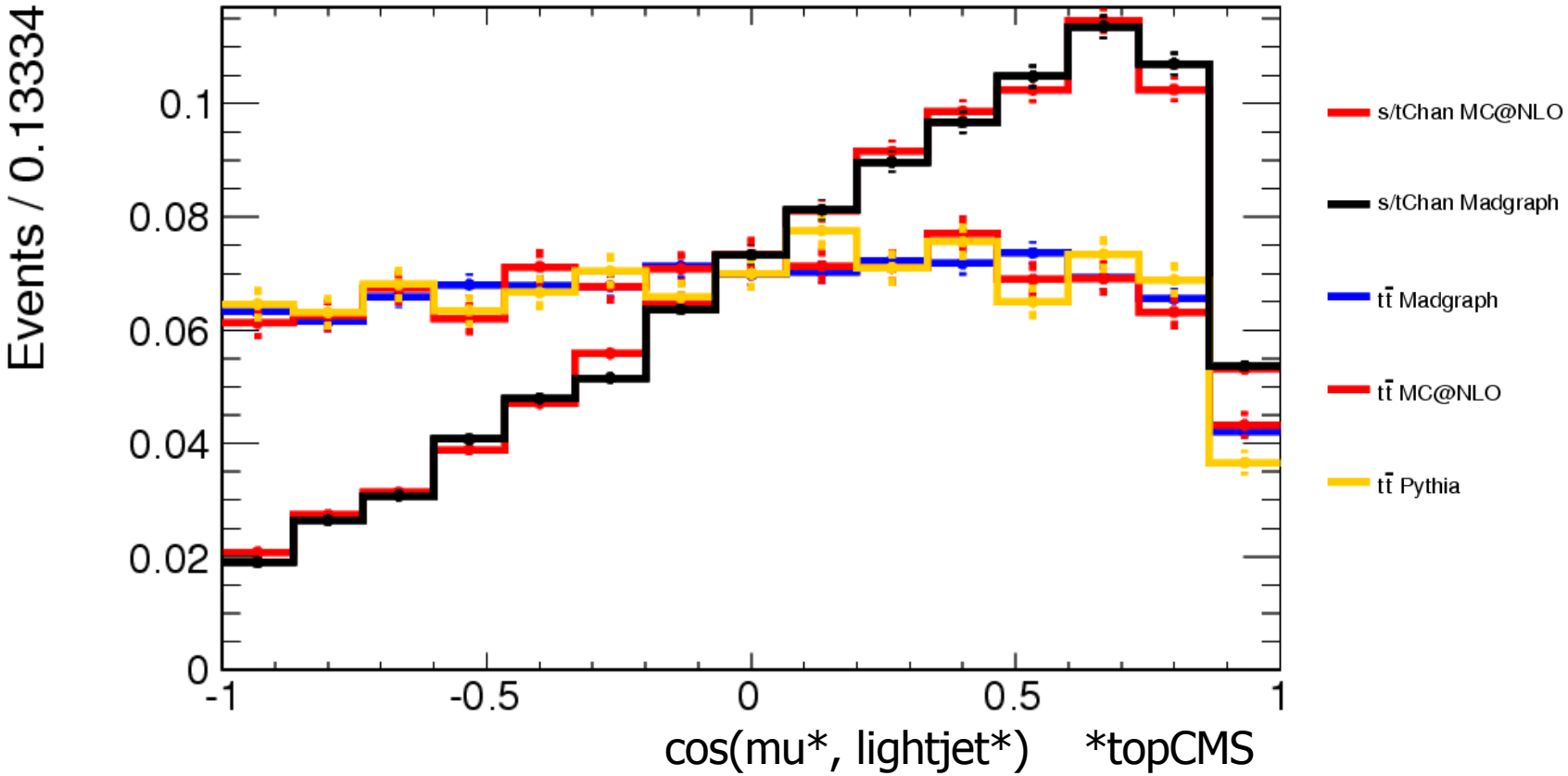


jet kinematics:
- b tagged jet central
- second jet from tChannel is forward
- second jet from ttbar is central



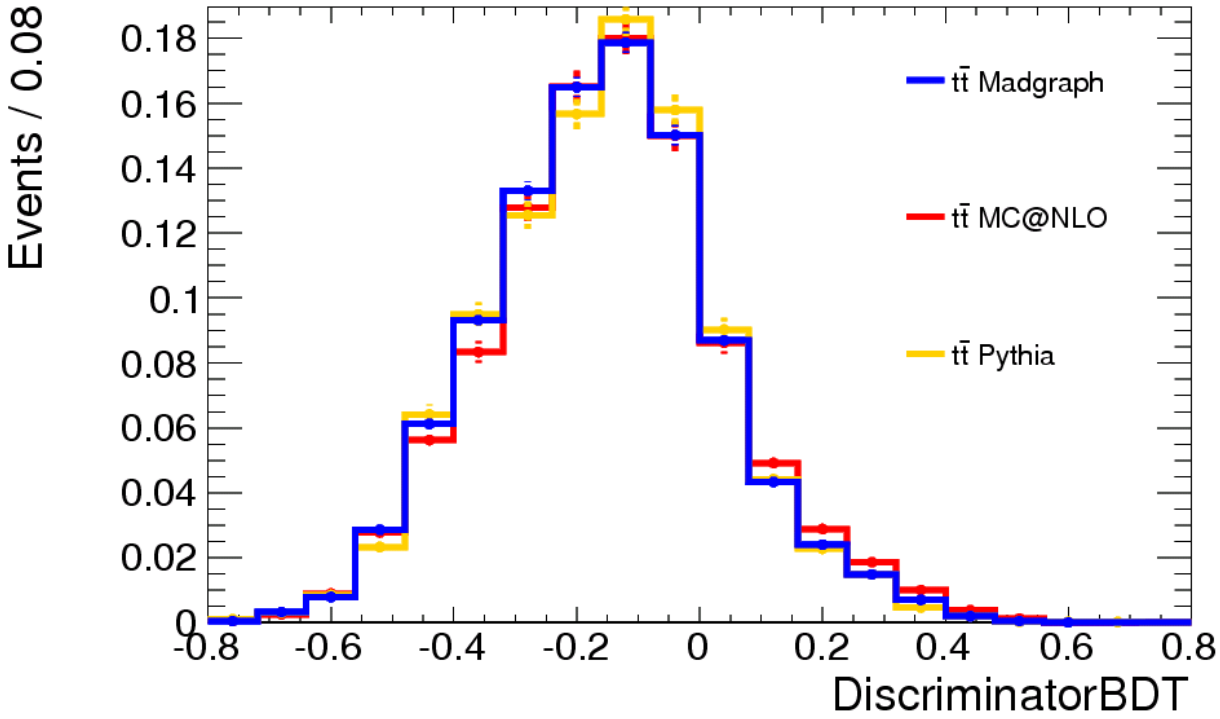
- Background: flat within statistical uncertainties
- Signal distribution: constantly growing up to 1

Comparison of different Generators Madgraph, MC@NLO and Pythia



- Ttbar background flat within uncertainties
  - Madgraph interfaced to Pythia, MC@NLO to Herwig
- Spin correlations well modelled in both Madgraph and MC @ NLO samples
- Reasonable agreement in all BDT input variables

Comparison of BDT Output for Madgraph, MC@NLO, Pythia

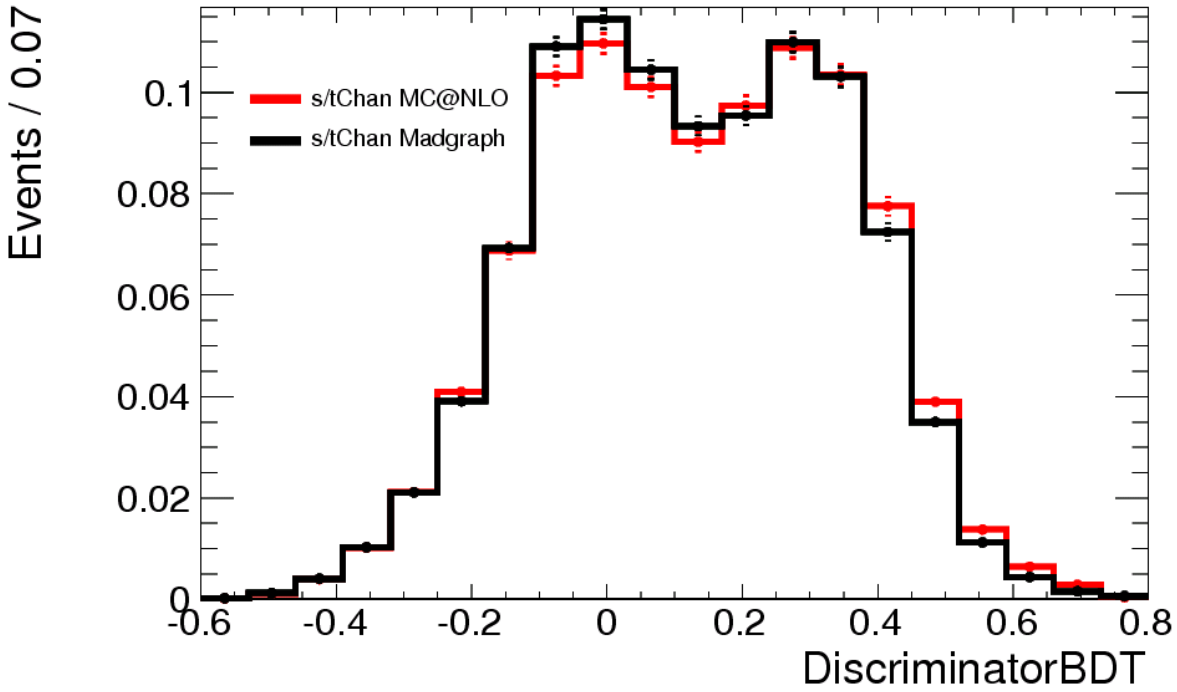


- BDT trained on Madgraph
→ training and testing events included in this plot
- Each distribution normalized

- Pythia more peak-like
- MC@NLO slightly shifted to higher BDT output values

Modelling uncertainties are small!

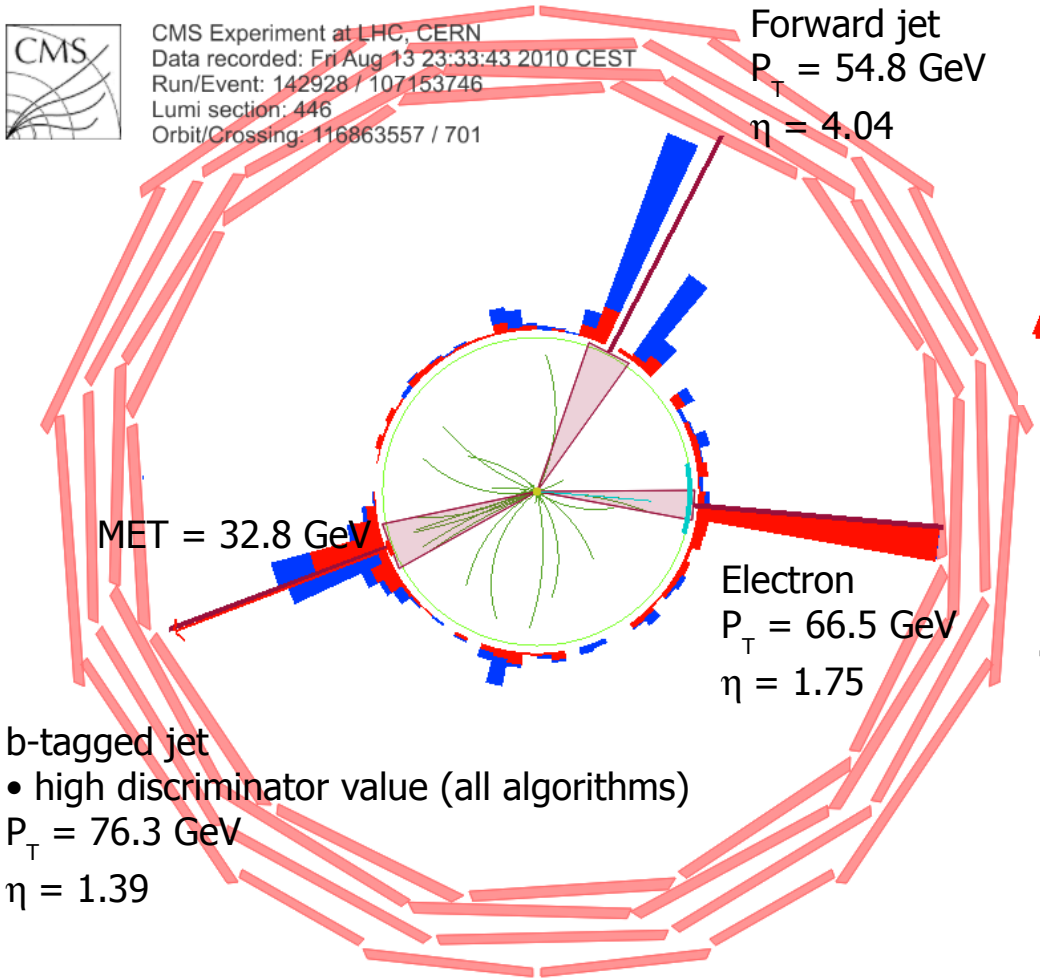
Comparison of BDT Output for Madgraph and MC@NLO

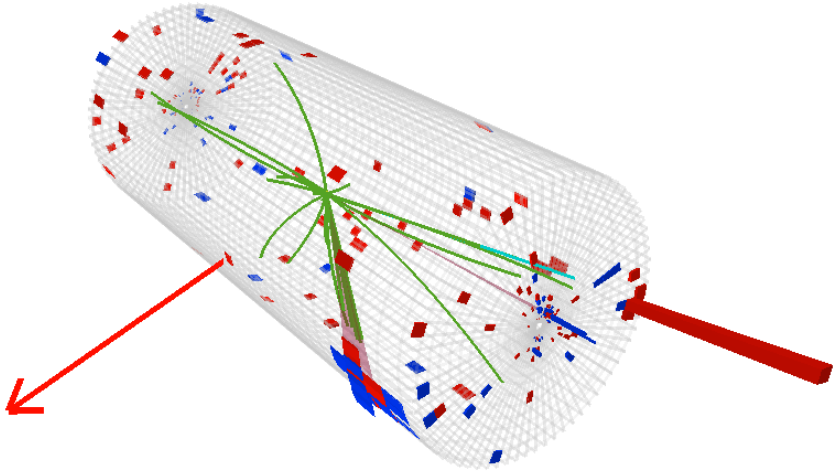


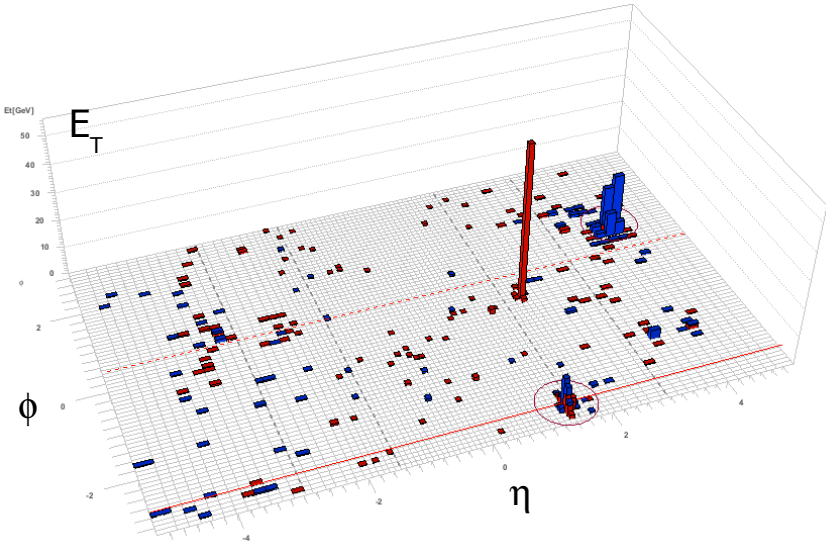
- BDT trained on Madgraph
→ training and testing events included in this plot
- Each distribution normalized

- NLO events better separated
- Modelling uncertainties are small!
→ Not sensitive to "hidden" correlations

- Single Top t Channel - Event Candidate







Transverse W boson mass: 91.4 GeV
Reconstructed top quark mass: 164.9 GeV

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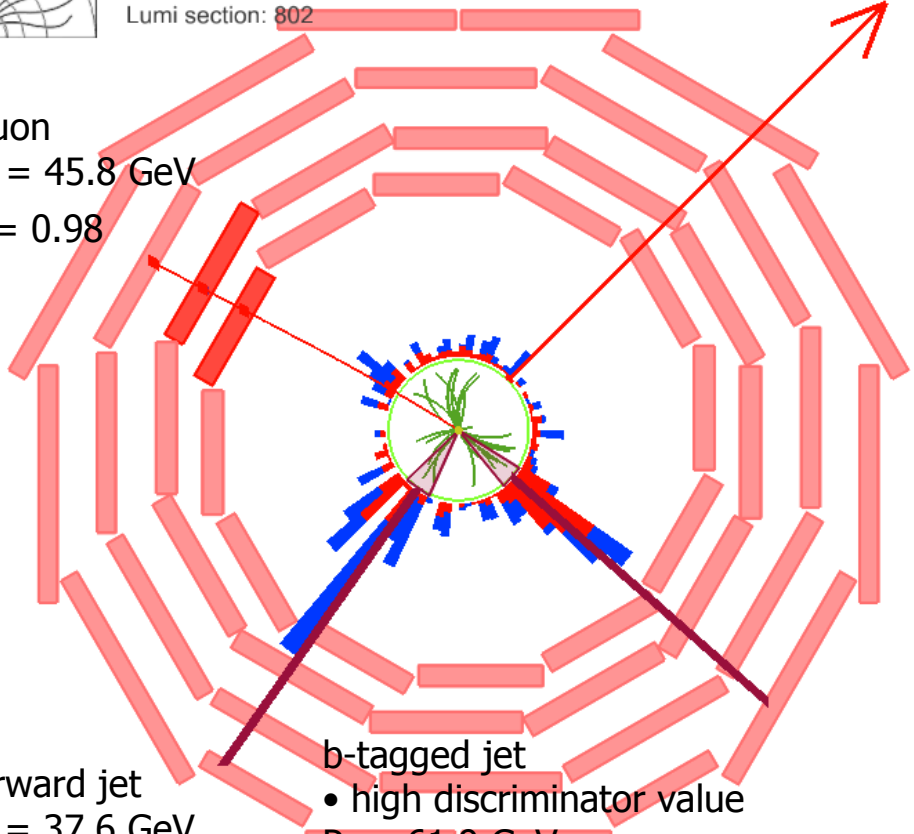
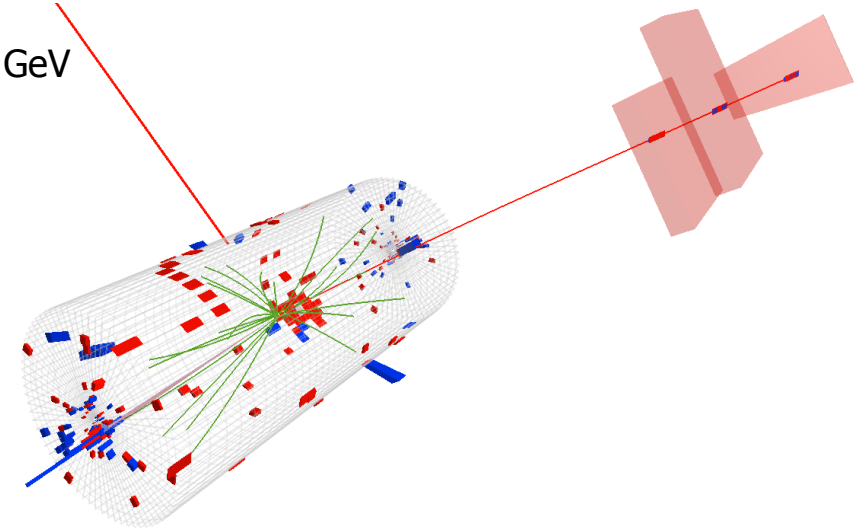
- Single Top t Channel - Event Candidate

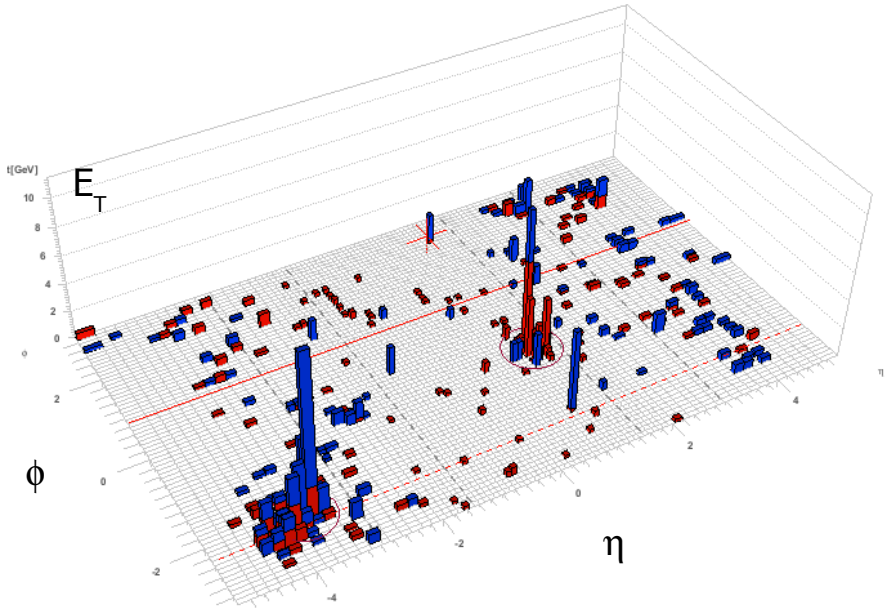
CMS Experiment at LHC, CERN
Data recorded: Thu Oct 28 04:29:38 2010 CEST
Run/Event: 149181 / 776938639
Lumi section: 802

MET = 63.9 GeV

Muon
P_T = 45.8 GeV
η = 0.98







forward jet
P_T = 37.6 GeV
η = -3.76

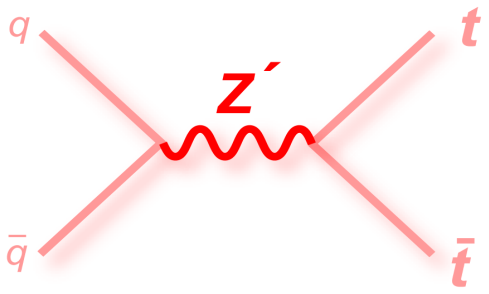
b-tagged jet
• high discriminator value
P_T = 61.9 GeV
η = 0.99

Transverse W boson mass: 66.9 GeV
Reconstructed top quark mass: 157.7 GeV

Search for Resonances Decaying into Top Quark Pairs

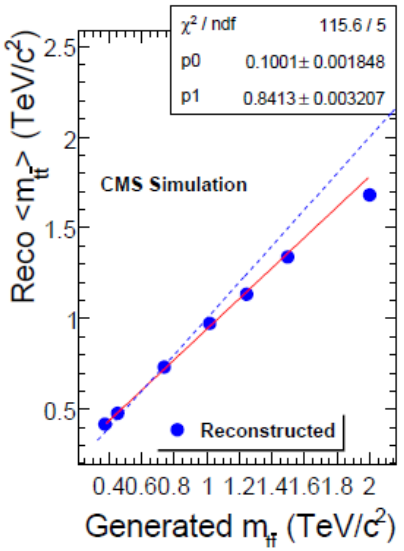
10 TeV

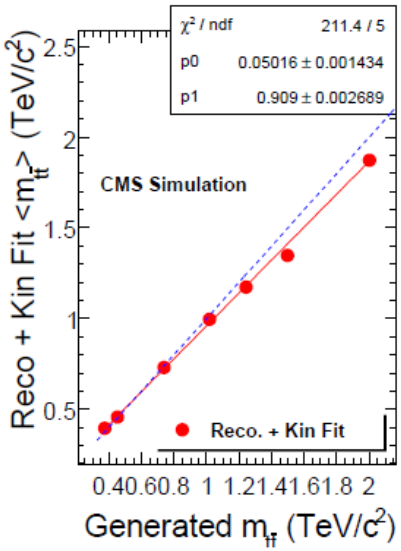
Event Selection

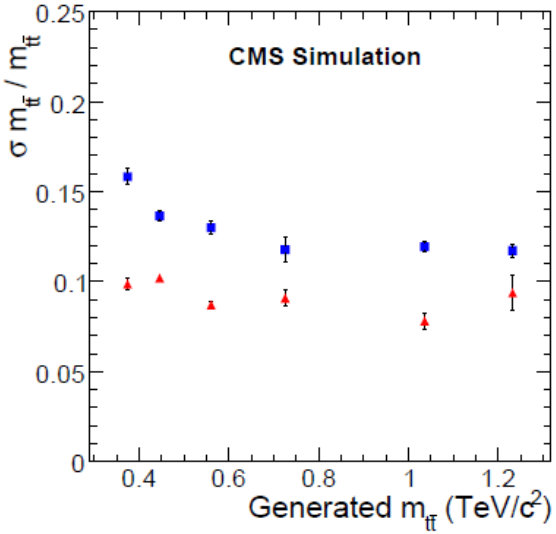


- semileptonic final state with a muon
  - one triggered isolated prompt muon
    - pT > 35 GeV
    - |η| < 2.1
  - >= 4 (Calo) Jets
    - pT > 35 GeV
    - |η| < 2.4
  - Dilepton veto

Event Reconstruction



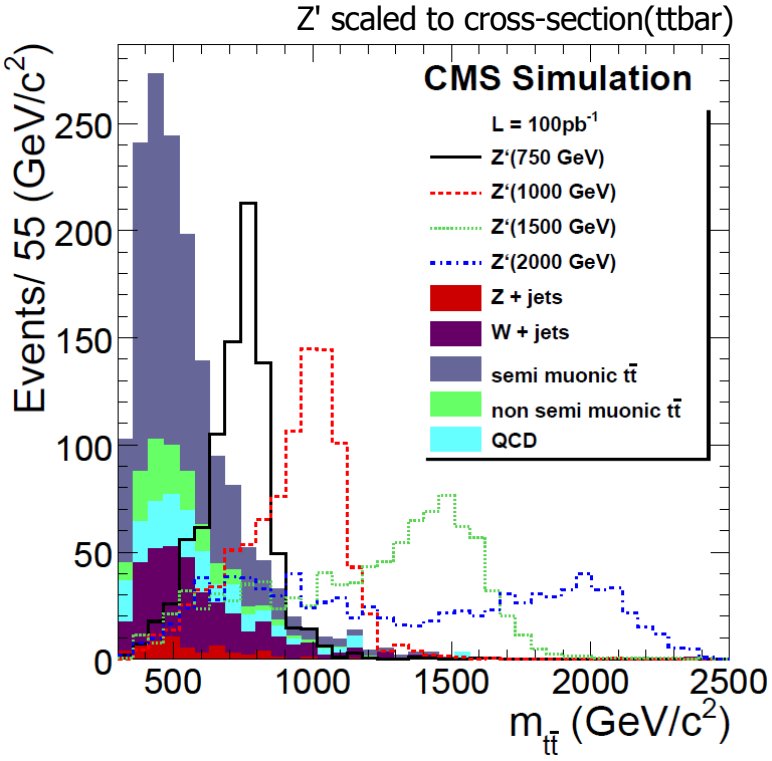




Using a Kinematic fit to reconstruct Mass(ttbar): Improved linearity & Improved resolution

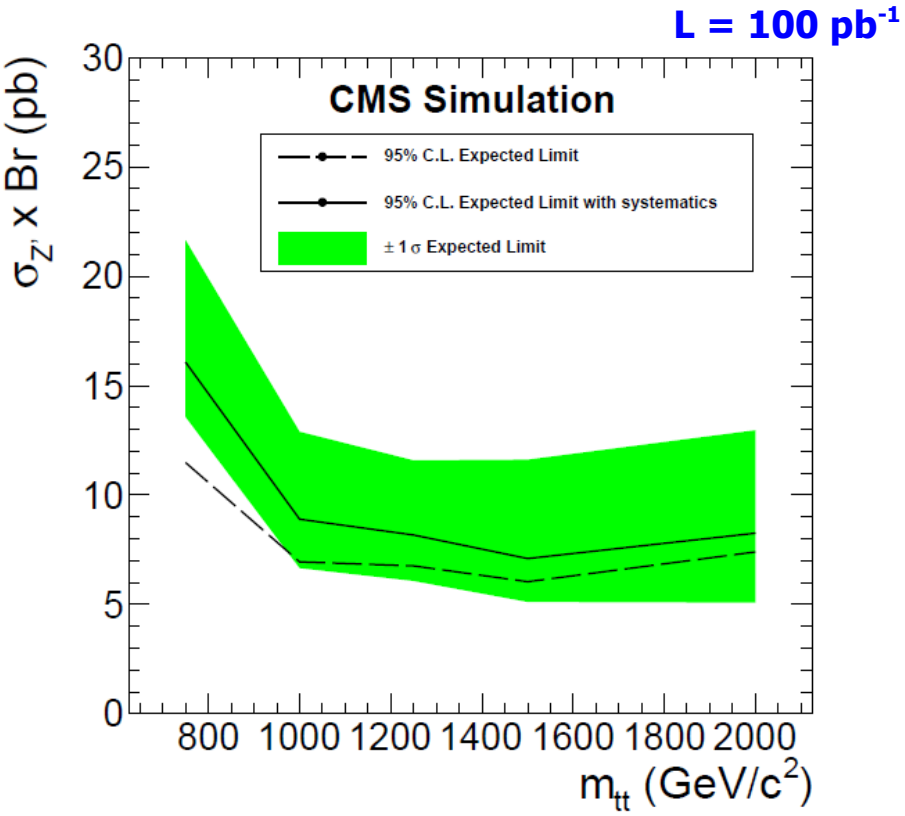
Search for Resonances Decaying into Top Quark Pairs

10 TeV

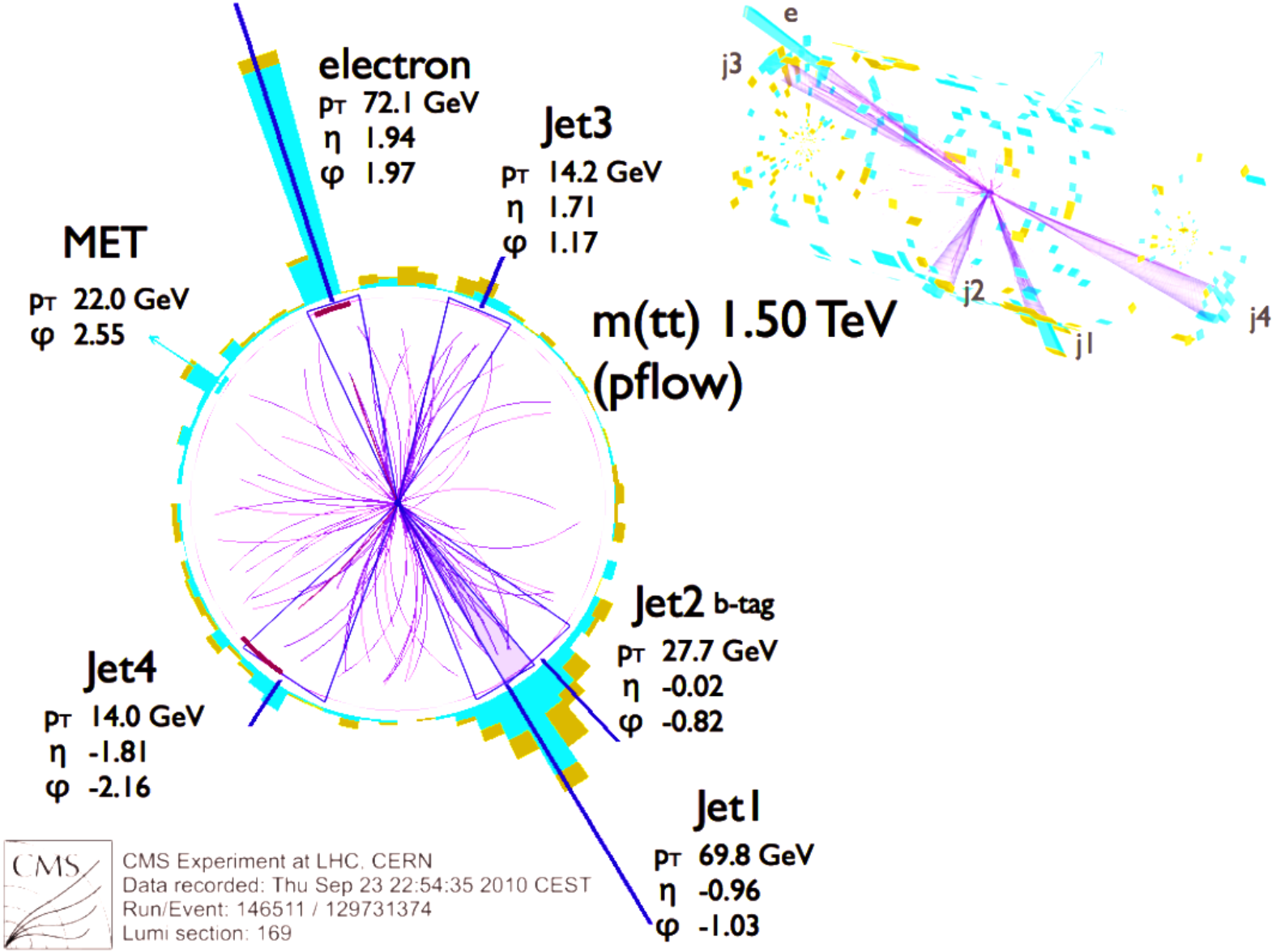


- Main backgrounds:
  - → Top quark pairs
  - → W + Jets
  - → QCD
- Data driven QCD Multijet background estimation from sideband region

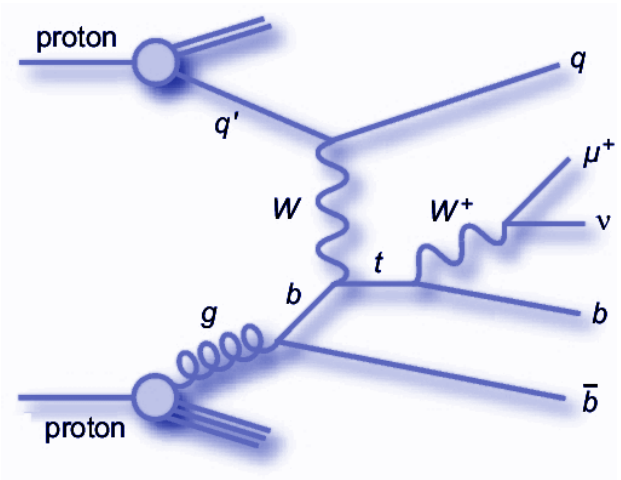
- Systematic uncertainties:
  - JES, JER +- 10%
  - Luminosity +- 10%
  - QCD estimation: +- 50%
  - Theoretical unc. on cross section
  - ISR/FSR on background
- Binned Likehood fit to mass distribution

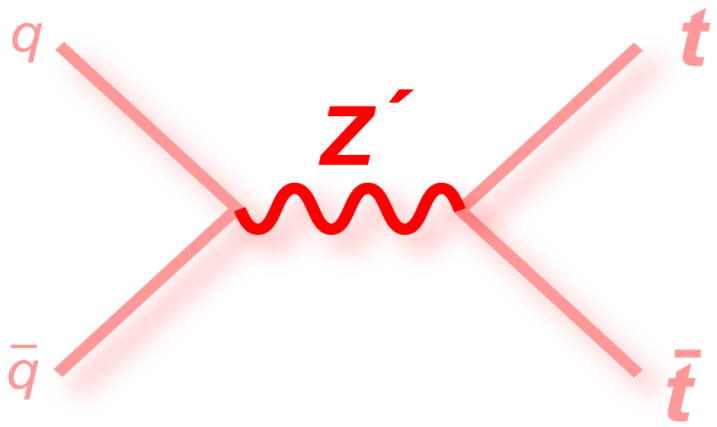


Event Candidate with high m(ttbar)



Conclusion





- First nice event candidates
- Studies on full 2010 7 TeV dataset are ongoing

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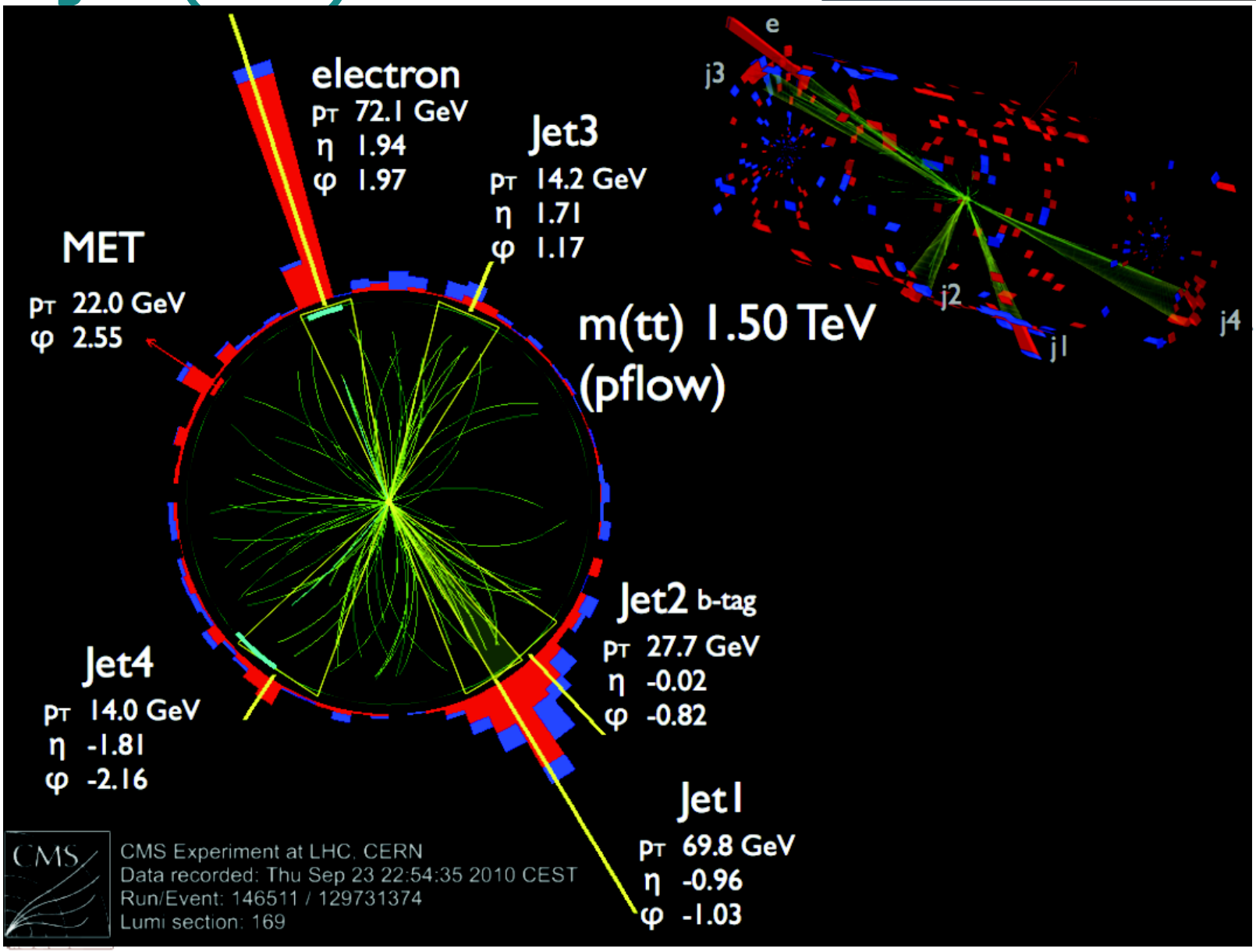
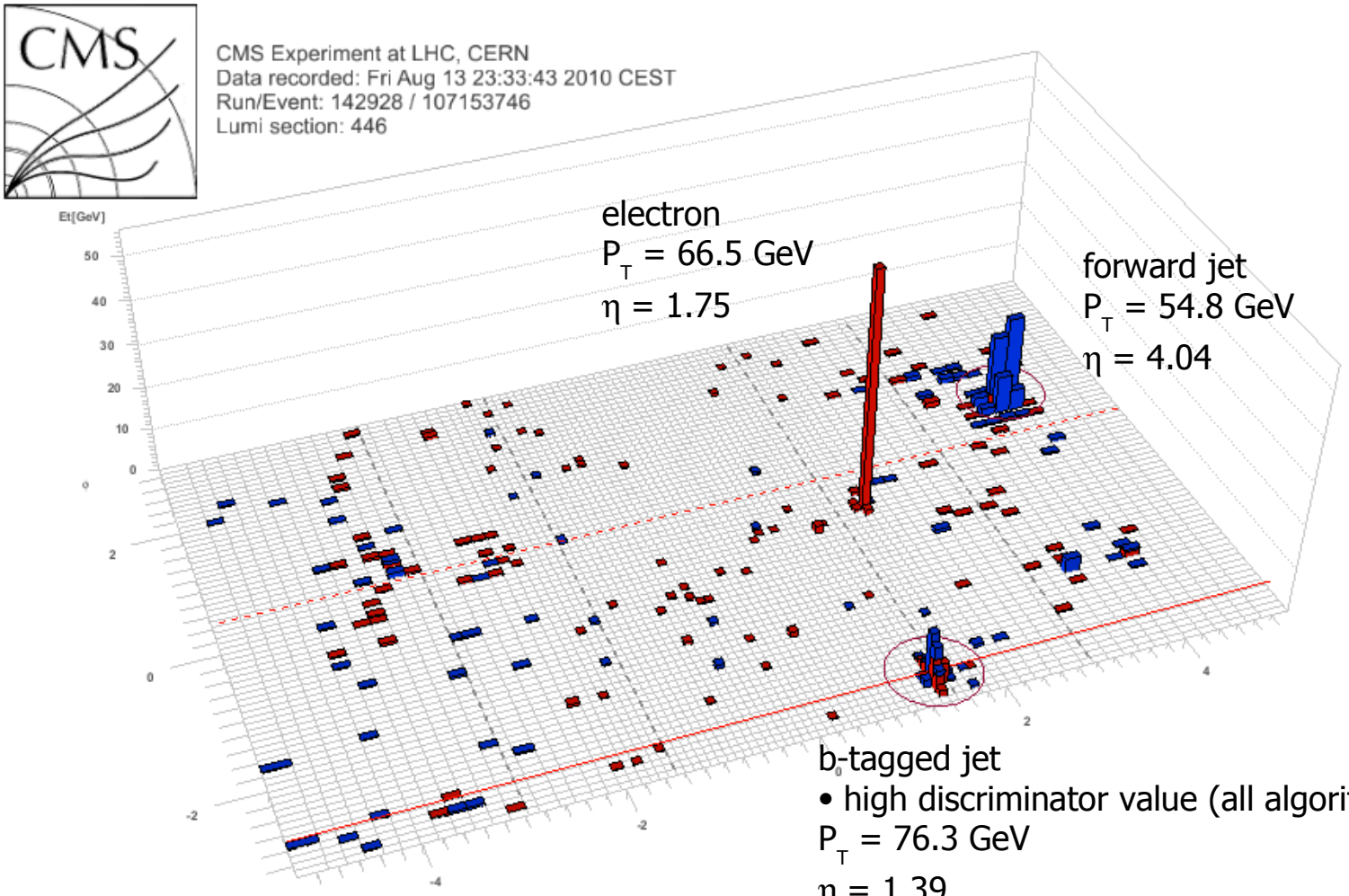
Backup

- High m(ttbar) Event Candidate



- Single Top t Channel -
Event Candidate: Electron Channel



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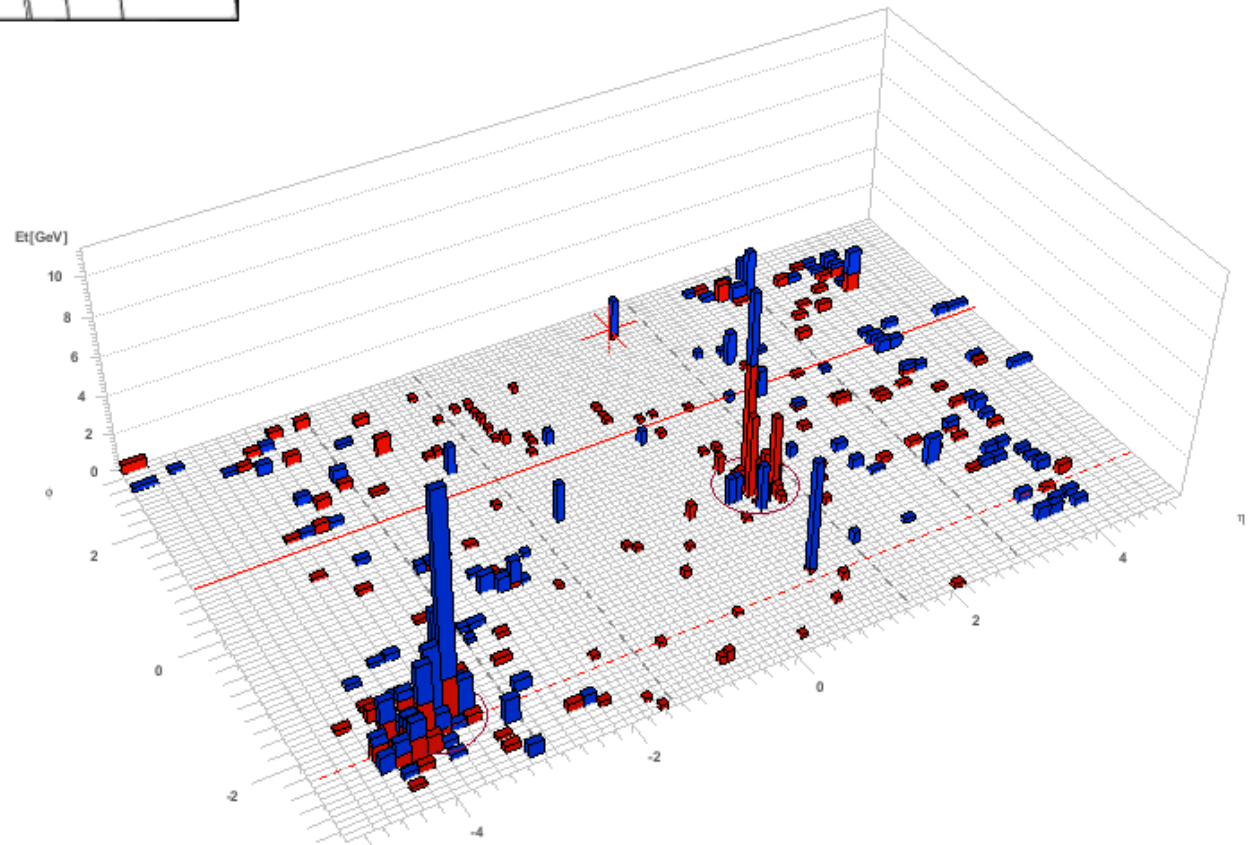
- Single Top t Channel -
Event Candidate: Muon Channel

CMS Experiment at LHC, CERN
Data recorded: Thu Oct 28 04:29:38 2010 CEST
Run/Event: 149181 / 776938639
Lumi section: 802



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