Study of top mass at CMS using Bi–Event Subtraction Technique

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Outline

- Motivation of Bi-Event Subtraction Technique (BEST)
- BEST on $t\bar{t}$ semi-leptonic channel
- Datasets and event selection
- Closure test with MC
- Results
- Summary and prospects
Motivation of BEST

How to find $X \rightarrow jj$?

- Choose a best dijet candidate among cascade decays of interest
- Or, allow combinations and estimate effect of random combinations

Challenge for background modeling

- Should be model independent & no kinematic preferences
- Data driven method
- More sensitivity for new physics search with multi jets
Combinatorial background with BEST

- Mixture of jet information from different events will give random & uncorrelated pair of dijets
- Mass distributions from bi–event to subtract from the one with all jet combinations – resulting dijet distribution with most of the combinatorial background removed
- Published in the paper: Kamon et.al, PLB Vol 703, p475–478

Mixture of two events
Available Top reconstruction methods:

**Kinematic fit**
- $X^2$ fit to assumed mass constraints

**$M_{T2}$**
- Applicable to dileptons

**$M_3$**
- Invariant mass of 3 jet & dijet with highest $p_T$

And so on...
Top quark study with BEST

- Event topology with many jets
- Jet combination problem can be solved by BEST
- Strategy
  - Start from semi-leptonic channel
  - Extend to full-hadronic channel
Dataset and event selection

CM energy : 8TeV
MC : t\bar{t} MadGraph + Pythia & tauola
Real data : 2012 summer (~5fb^{-1})

Event selection
- Muon+3Jet triggered dataset
  1 isolated muon |\eta| < 2.1
  \geq 2 jets with p_T > 45GeV
  \geq 4 jets with p_T > 35GeV
  \geq 2 b tagged jets

Jet reconstruction and selection
- Particle Flow, Anti-kT (R=0.5) with JES
- p_T > 35GeV, |\eta| < 2.4
- b Tag algorithm based on SecVtx

W and top reconstruction
- No overlap between jets (\Delta R > 0.4)
- 2 untagged jet for W, +1 bjet for top
- No lepton/MET for mass reconstruction
Counting combinations

Objects in shorthand notation

- J : Jets from W
- b/HadB : b quark in hadronic top
- B/LepB : b quark in leptonic top
- k : jets not from top decay

<table>
<thead>
<tr>
<th>Objects in shorthand notation</th>
<th>W signal</th>
<th>J+J</th>
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<tbody>
<tr>
<td>biW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J+K</td>
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<tr>
<td>K+K</td>
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<tr>
<td>HadB+J(same top)</td>
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<tr>
<td>LepB+J</td>
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<tr>
<td>B+X</td>
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<tr>
<th>Same event</th>
<th>Bi event</th>
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<tr>
<td></td>
<td>W signal</td>
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<tr>
<td></td>
<td>Artificial background</td>
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<td>Reducible by b tagging</td>
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<table>
<thead>
<tr>
<th>Pairs</th>
<th>Counts</th>
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<tbody>
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<td>J+J</td>
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</tr>
<tr>
<td>J+J'</td>
<td>4</td>
<td></td>
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<tr>
<td>J+K</td>
<td>2n</td>
<td>J+K', K+J'</td>
<td>2(n+m)</td>
</tr>
<tr>
<td>K+K</td>
<td>n(n-1)/2</td>
<td>K+K'</td>
<td>nm</td>
</tr>
<tr>
<td>J+b</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>J+B</td>
<td>2</td>
<td>J+B', B+J'</td>
<td>8</td>
</tr>
<tr>
<td>b+B</td>
<td>1</td>
<td>b+B', B+B'</td>
<td>4</td>
</tr>
<tr>
<td>b+K, B+K</td>
<td>2n</td>
<td>b+K', B+K',...</td>
<td>2(n+m)</td>
</tr>
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</table>
MC closure test

Same event 8TeV

Bi event 8TeV

Work in progress
Three-jet mass distributions

Same event 8TeV

Bi event 8TeV

Work in progress
First look on real data

**Work in progress**

**Same event 8 TeV**

**Bi event 8 TeV**

Korean Physical Society 2012
Bi event subtraction with fitting

CMS work in progress, 5fb$^{-1}$ at $\sqrt{s}=8$TeV

- Same event
- All backgrounds
- Bi event
- BiW
- Signal

Work in progress
Possible applications

- Jet energy correction
  - A calibration tool with W jet resonance
- Measurement of top quark properties
  - Top quark mass and production cross section without kinematic assumptions
- Dijet and multi-jet resonance search
  - Model independent, data driven background estimation
  - Beyond Standard Model searches with multijets
Summary and prospects

- Combinatorial background with Bi-Event Subtraction Technique
- Successfully applied BEST to $t\bar{t}$ system
  - $W$ and top mass peak extraction with CMS 2012 data
    - Shown to be consistent with $W$ and top quark mass
    - Validation of technique with real data
- Method is rapidly developing
  - Aiming for independent measurement of top mass in 2012
  - Extension to BSM physics with Multi-jet