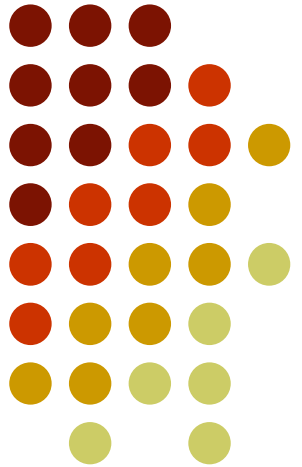
W mass reconstruction and jet calibration in ttbar events



Wai Ling WU
University of Michigan

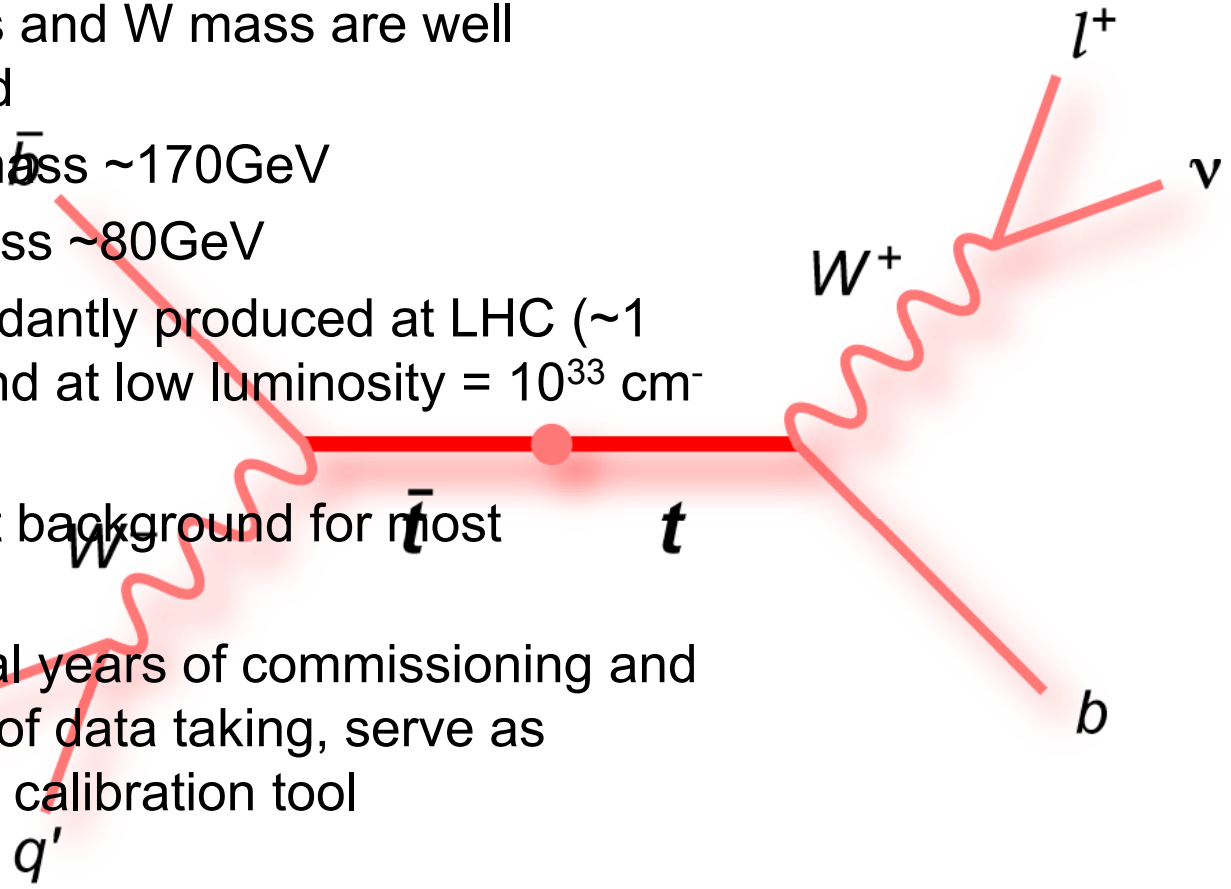
Advisors: Francesco SPANO, Columbia University
Tancredi CARLI, CERN

Overview

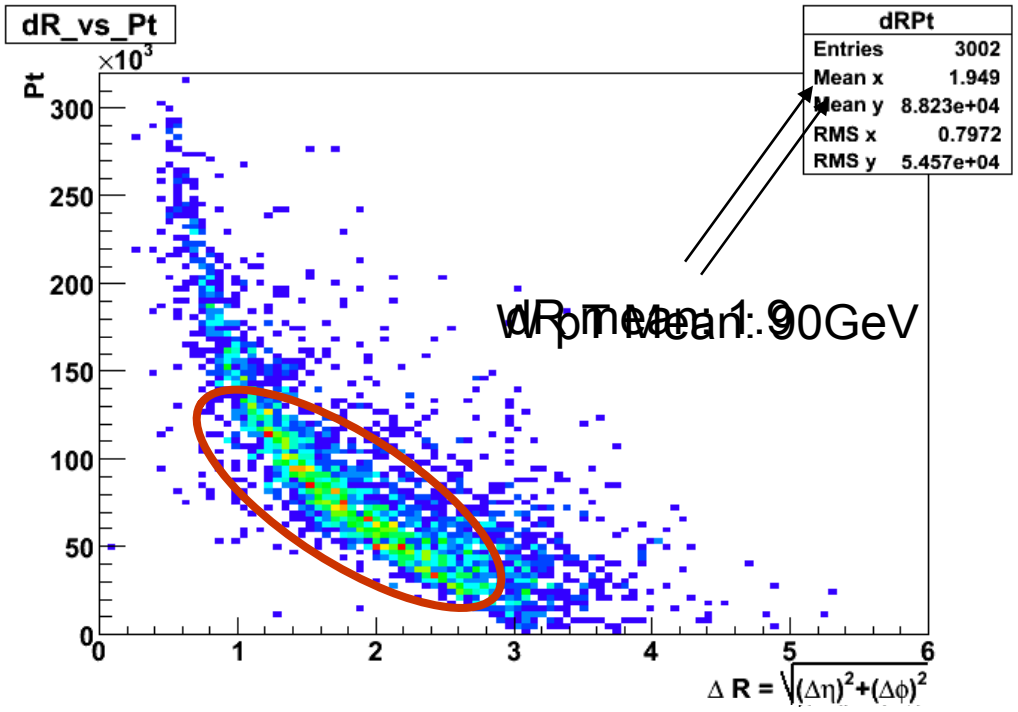
- Motivation of studying ttbar events
- Kinematics of W decay
- Comparison of jets made from towers and topoclusters

Why study ttbar events?

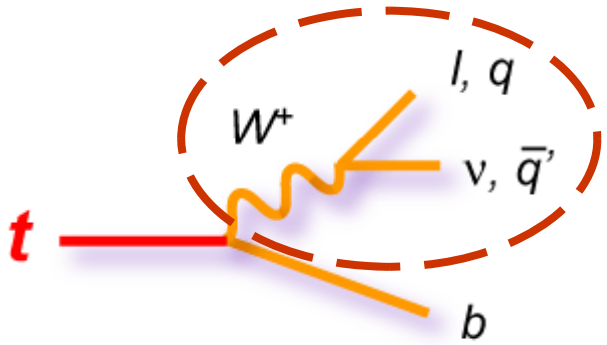
- Top mass and W mass are well measured
  - Top mass ~170GeV
  - W mass ~80GeV
- Top abundantly produced at LHC (~1 per second at low luminosity = 10^{33} cm^{-2} s^{-1}).
- Important background for most searches
- In the final years of commissioning and first year of data taking, serve as important calibration tool



Kinematics of W decay

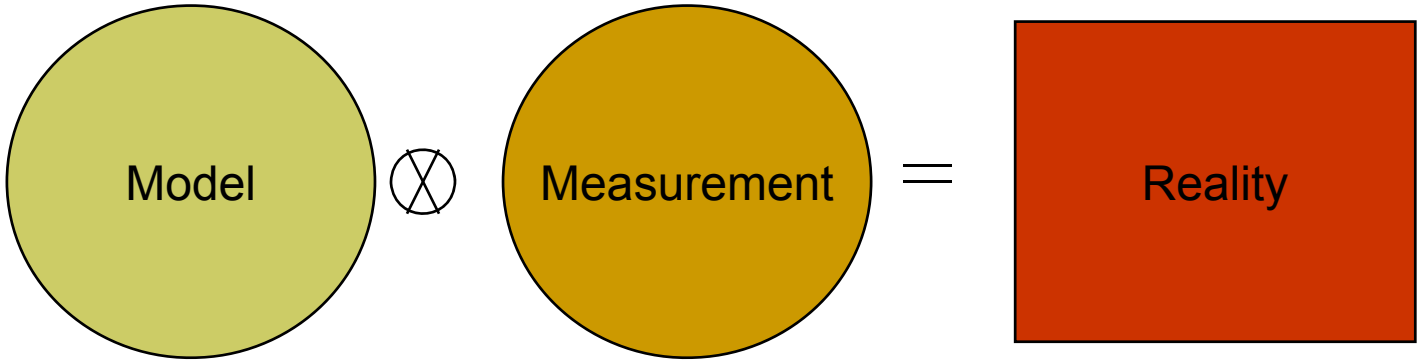


W mass ~80GeV



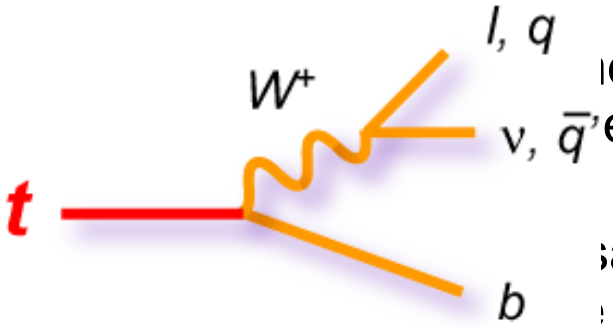
Excess momentum above W rest mass small
Thus not much Lorentz boost for the quarks
Therefore, ΔR large and using 0.4 as cone size in jet algorithm is a reasonable measure

Comparison between jets made from towers and topoclusters (1) – the idea



- I have...
  - generation level information and detector level information
- I can…
  - Adjust the model
  - When real data comes, use the model to find reality

Comparison between jets made from towers and topoclusters (2) – jets and sample differences

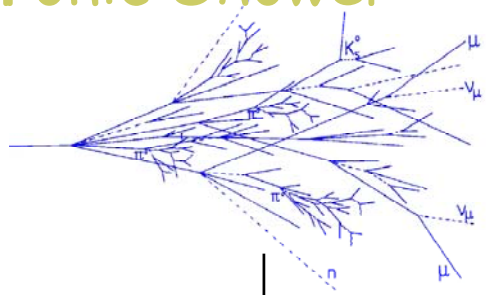


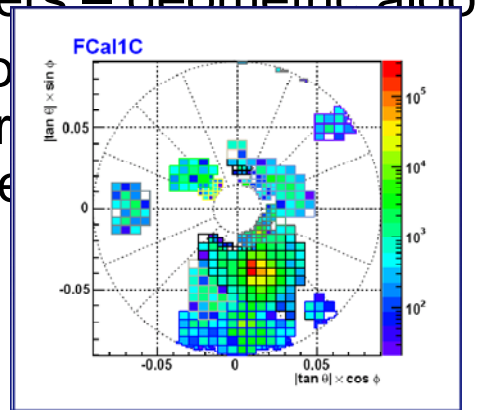
- ...eter
- ...ergy
- ...same

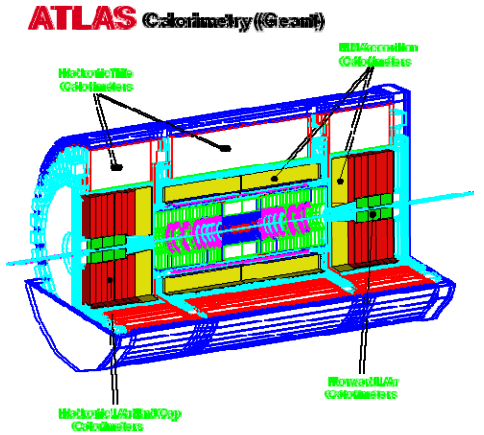
"energy blobs" differently

- Towers – geometric algorithm
- Topo... algor... supre...
- Both ...

Hadronic Shower







Comparison between jets made from towers and topoclusters (3) – matching algorithm

- Each quark is matched to all jets
- The shortest distance is the match

- In case of both quark match to same jet, compare the matching distances and the shorter one is the match. The other quark uses the 2nd shortest distance jet as match.

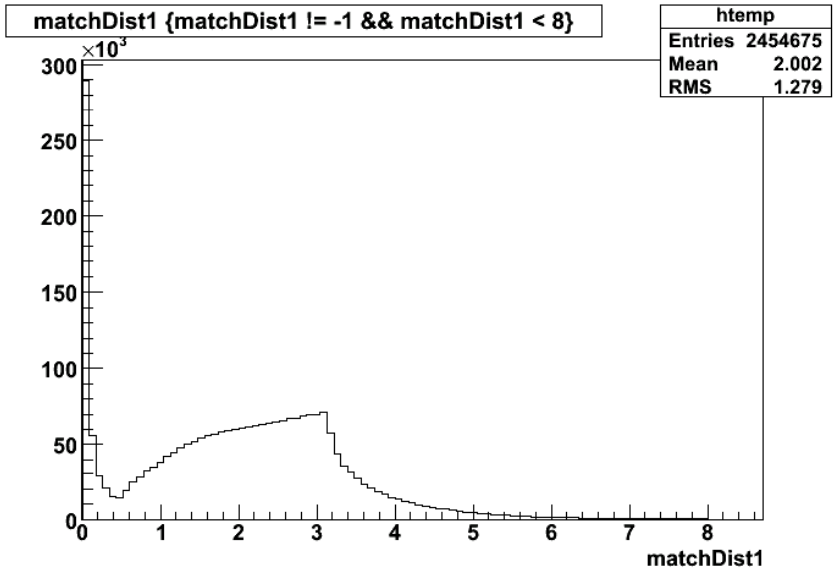
- In this case, q1 is matched to j1 and q2 is matched to j4

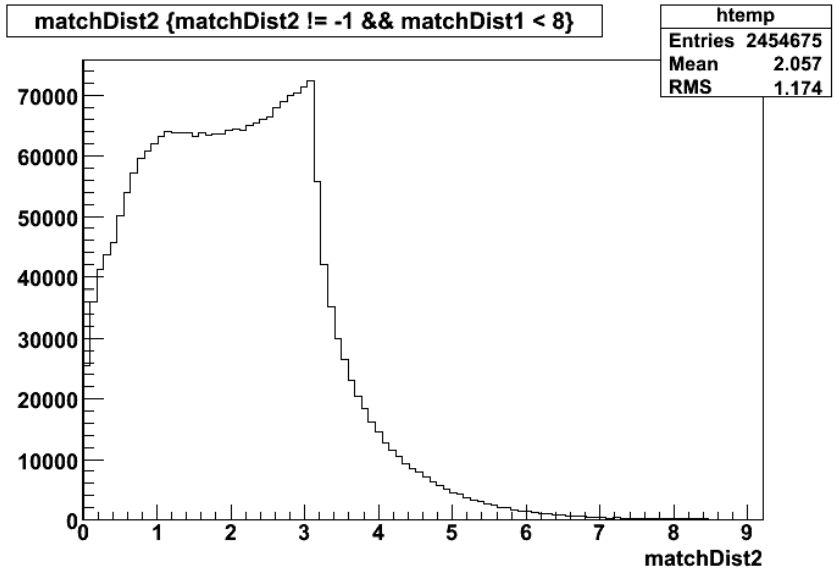
- Cuts are made in the final stage as to what ΔR is chosen

Example:

Quark	Jet	Matching Distance
1	1	0.0512714
1	2	4.1888058
1	3	2.0939157
1	4	1.1173507
2	1	0.7396227
2	2	4.5889246
2	3	1.5489442
2	4	1.2265931

Comparison between jets made from towers and topoclusters (3) – matching algorithm



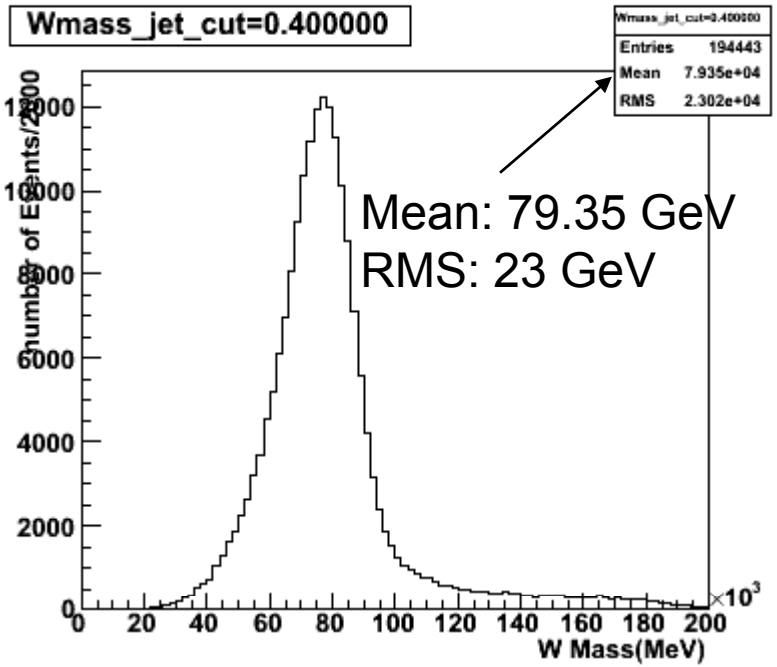


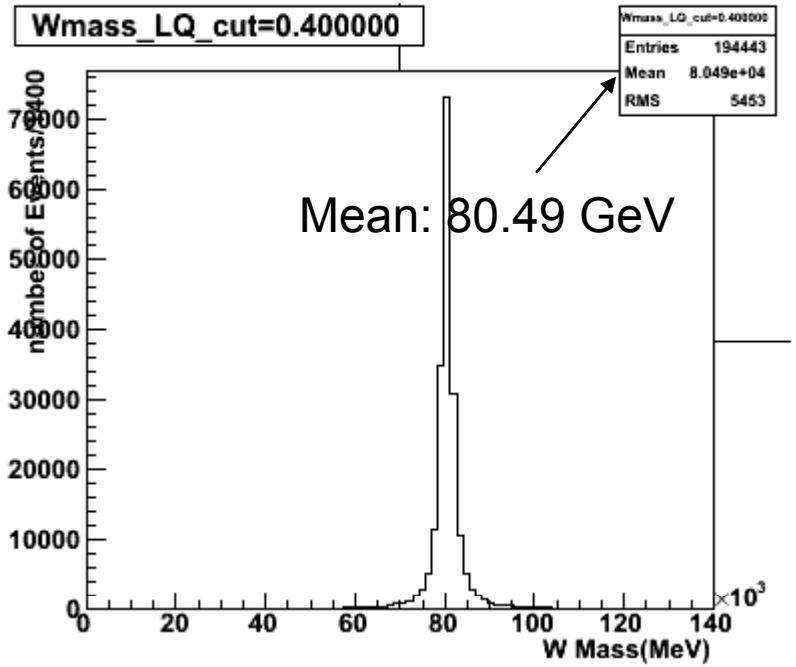
Matching distance distribution for the 1st quark and the 2nd quark

ΔR from 0.2 – 1.0 in steps of 0.2 is chosen to be the matching radii for performance check

Comparison between jets made from towers and topoclusters (4) – W mass

W mass is calculated from $m = \sqrt{(E^2 - \mathbf{p}^2)}$.

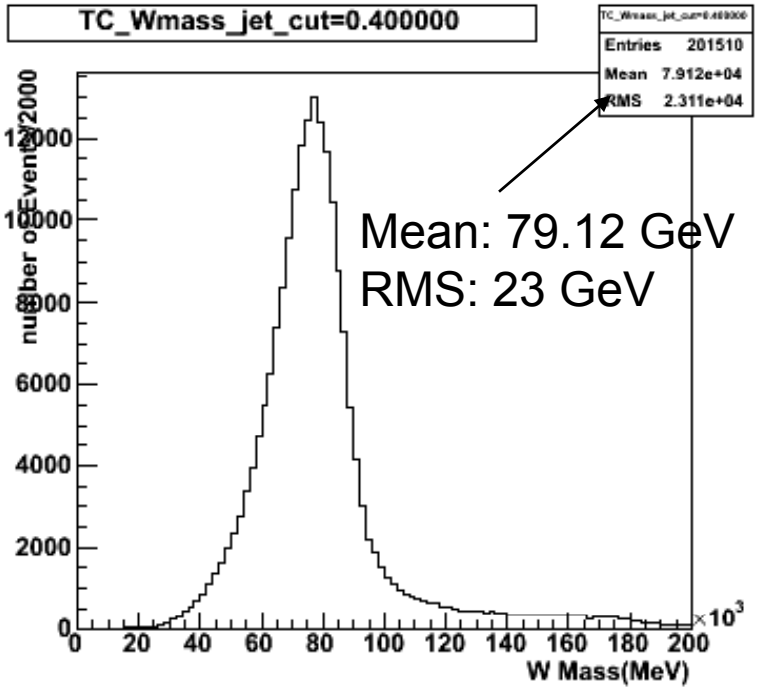


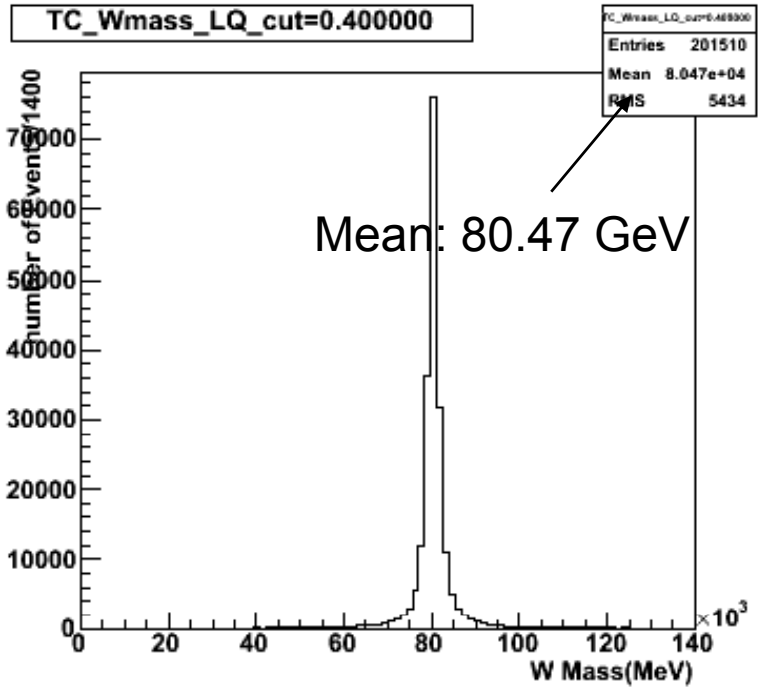


Towers – only $\Delta R < 0.4$ plots are shown

Comparison between jets made from towers and topoclusters (5) – W mass

W mass is calculated from $m = \sqrt{(E^2 - \mathbf{p}^2)}$.

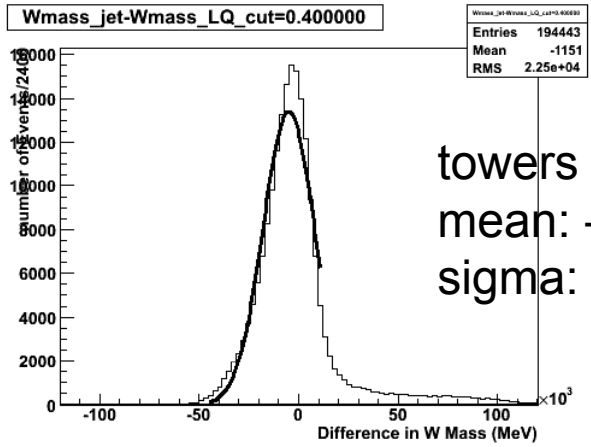




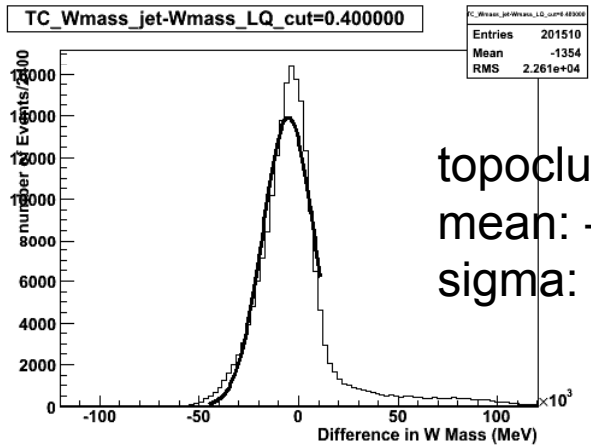
Topoclusters – only $\Delta R < 0.4$ plots are shown

Comparison between jets made from towers and topoclusters (6) – difference in W mass

- Difference b/w W Mass from jets and quarks on an event by event basis gives a measure of the expected bias
- Fitting the distribution with Gaussians with range = (-2*RMS, 0.5*RMS), where the RMS is extracted from the histogram

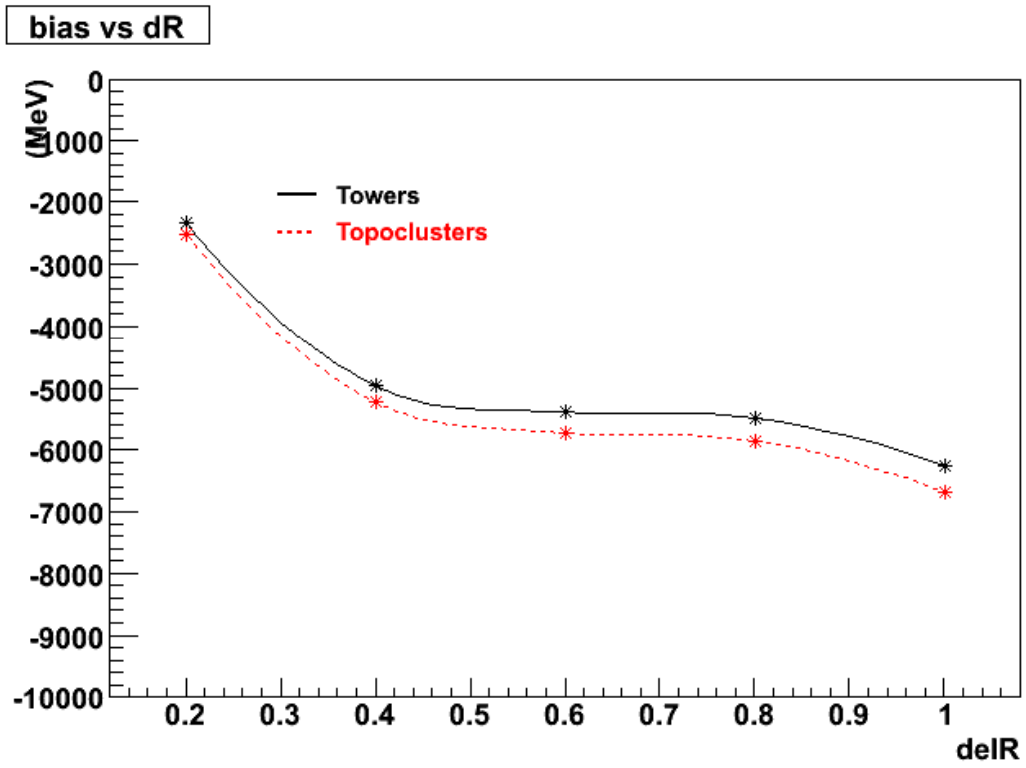


towers
mean: -4.96 GeV
sigma: 12.88 GeV



topoclusters
mean: -5.22 GeV
sigma: 12.78 GeV

Comparison between jets made from towers and topoclusters (7) – bias



The bias performances of the two samples are very similar, with the topo-cluster sample giving a higher bias in reconstructing the W mass.

Typical fractional difference in bias (take $\Delta R = 0.4$) is -5.27e-02 MeV. Thus about 50eV.

Many thanks to…

- Dr. Francesco Spano, Dr. Tancredi Carli, the Columbia Nevis group
- CERN
- University of Michigan
  - Prof. Jean Krisch
  - Prof. Homer Neal
  - Dr. Steven Goldfarb
  - Jeremy Herr
- Ford Motor Company
- National Science Foundation

Questions?