$t\bar{t}H^0(H^0 \longrightarrow b\bar{b})$

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$t\bar{t}H^0$ at UCL- who we are

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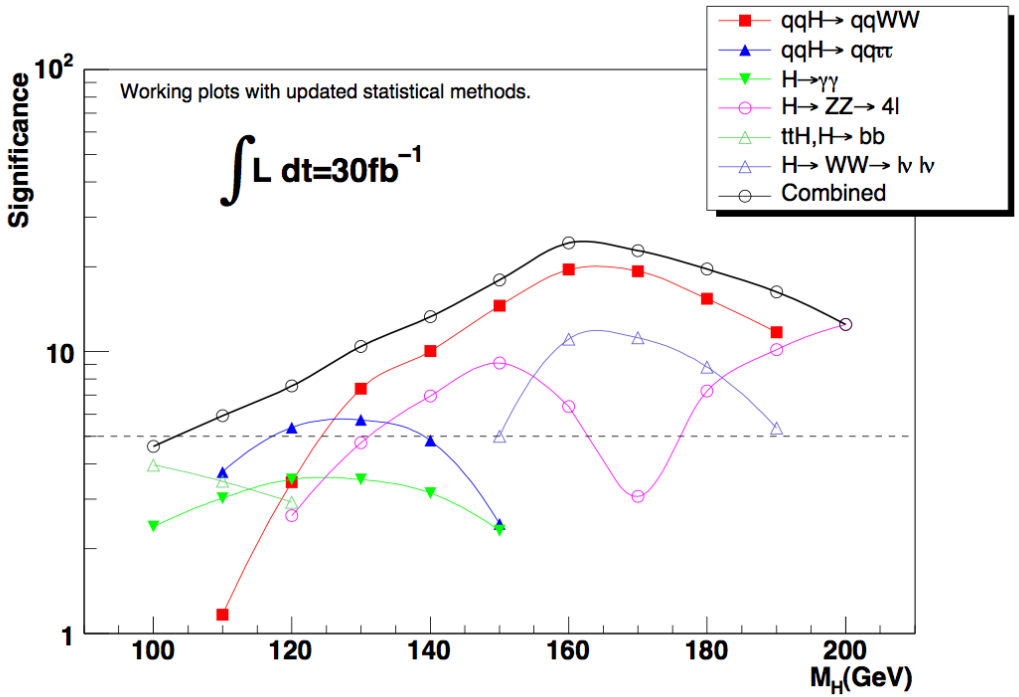
Introduction: low mass Higgs search

- Mass range for Higgs is 114 – 182 GeV (95% C.L.)
- Channels with potential for a low mass Higgs boson:

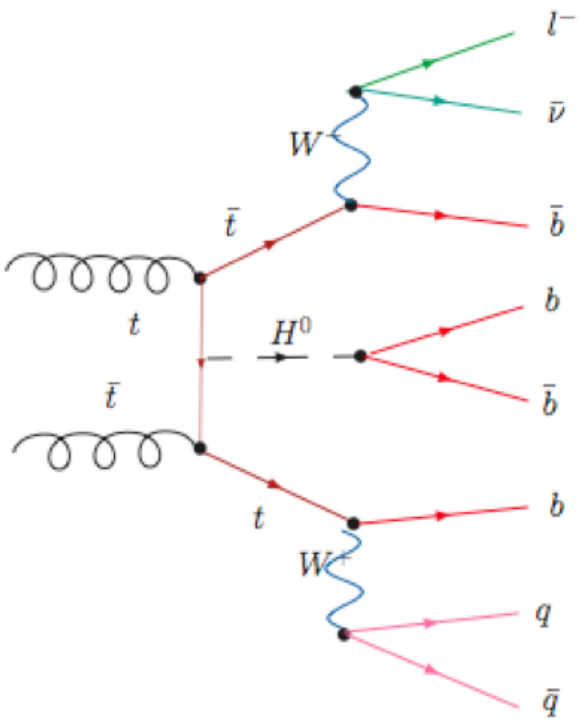
- $H^0 \rightarrow \gamma\gamma$
- $W/ZH^0(H^0 \rightarrow b\bar{b})$
- $H^0 \rightarrow \tau\tau$
- $\boxed{t\bar{t}H^0(H^0 \rightarrow b\bar{b})}$



- We need **all** of them.

Backgrounds

- **Rough** number of events for $L = 30 fb^{-1}$ passing 6 jets + lepton (4 jets b-tagged):



- $t\bar{t}H^0 : 1.48.10^3 (\sim 120)$
- $b\bar{b} : 37.10^3 (\sim 6)$
- $W + jets : 87.10^3 (\sim 8)$
- $Z + jets : 154 (\sim 0.01)$
- $t\bar{t}jj : 896.10^3 (\sim 770)$
- $t\bar{t}b\bar{b} : 30.10^3 + 2.9.10^3 (\sim 140 + 20)$

S. Boeser

- $\longrightarrow$ Important backgrounds are $t\bar{t}b\bar{b}$ and $t\bar{t}jj$

UCL

Artemis Deliverables

1. Determination of the background shape

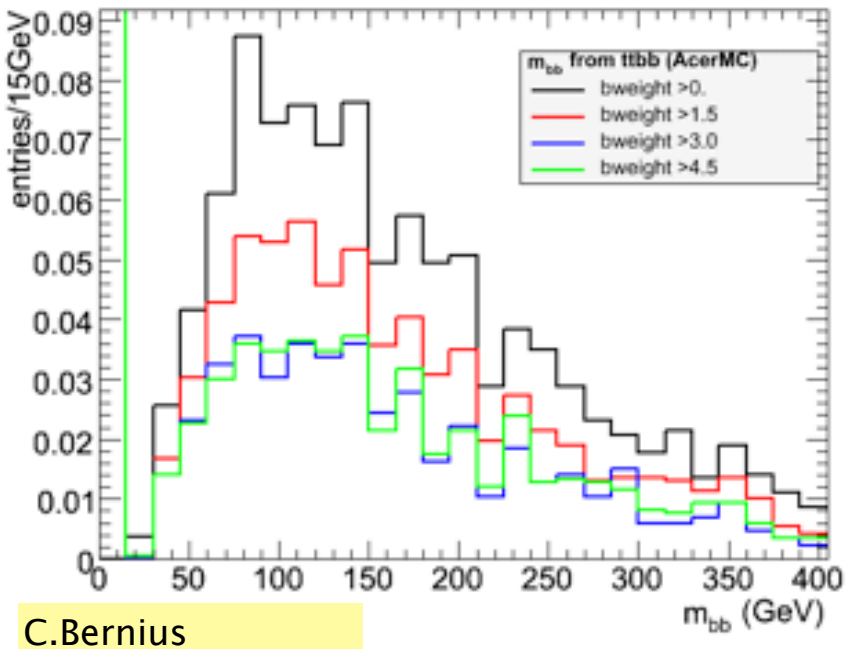
- Most troublesome backgrounds identified as $t\bar{t}b\bar{b}$ and $t\bar{t}jj$
- Kinematic cuts on jets may effect the way the background looks
- Must be able to understand these effects.

2. Determination of the signal

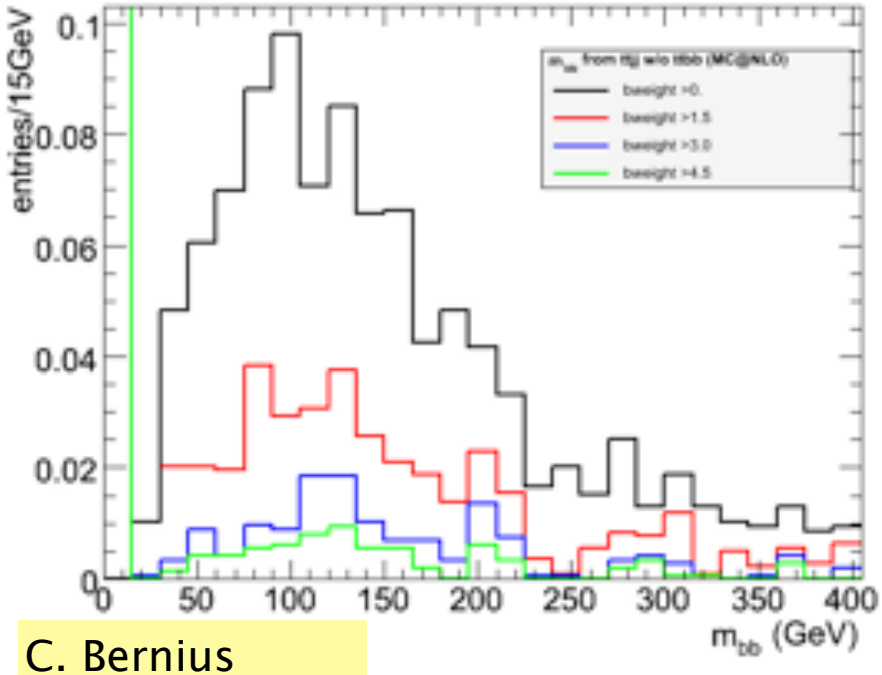
- We want an analysis that can spot the Higgs decay
- Current $\frac{signal}{\sqrt{background}}$ hovering around 1.8...
- Ideas to improve significance (largely by reducing the **combinatorial** background) include a new χ^2 and use of jet charge

Preselection cuts on b-weight of jets

- The requirement that 4 of our jets be b-tagged may introduce a bias
- Must understand how the choice of b-weight affects the shape of the background



C.Bernius

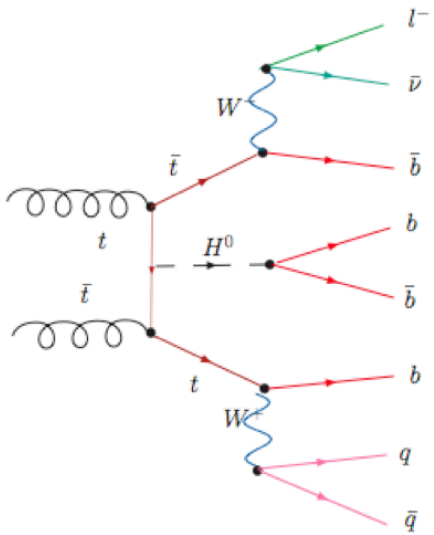


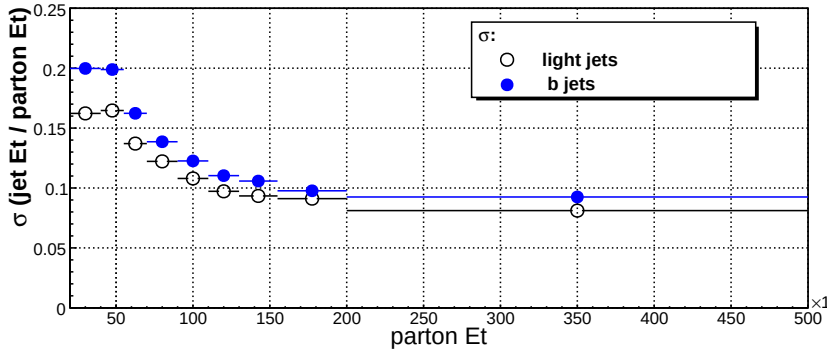
C. Bernius

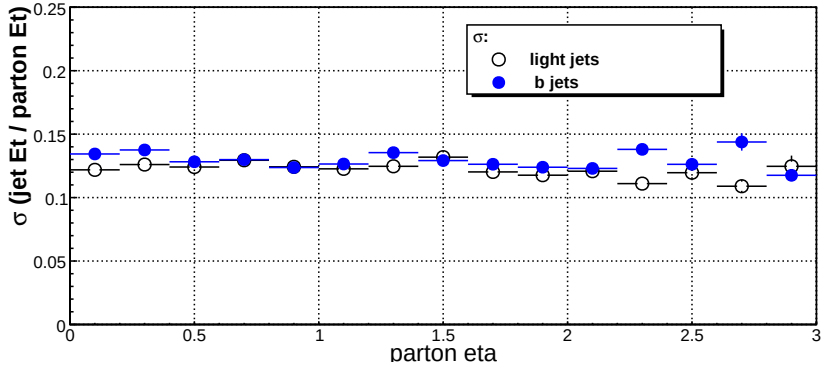
Event selection

- After p_T and b-weight cuts on the jets as part of our preselection, and the reconstruction of the leptonically decaying W:

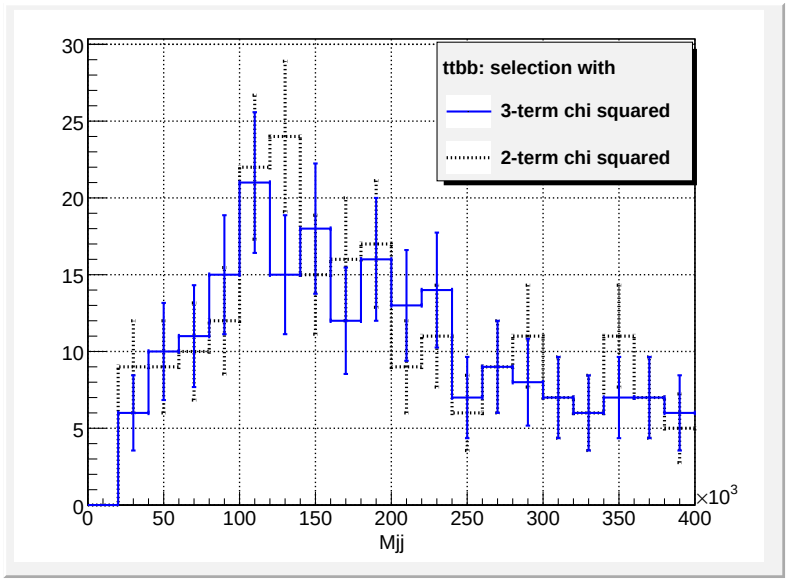
- We select the best 6 jet combination as being the one which minimises
- $\chi^2 = \frac{\Delta M^2_{leptop}}{\sigma^2_{bjet}} + \frac{\Delta M^2_{hadtop}}{\sigma^2_{bjet}} + \frac{\Delta M^2_{hadW}}{\sigma_{jet1} * \sigma_{jet2}}$
- $\chi^2 = \frac{\Delta M^2_{hadtop}}{\sigma^2_{m_{jjb}}} + \frac{\Delta M^2_{leptop}}{\sigma^2_{m_{lvb}}}$

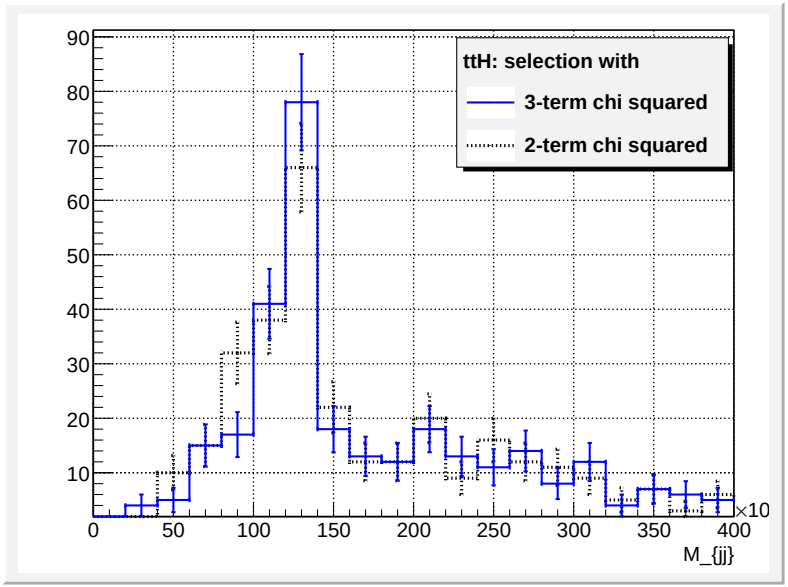






Effects of χ^2

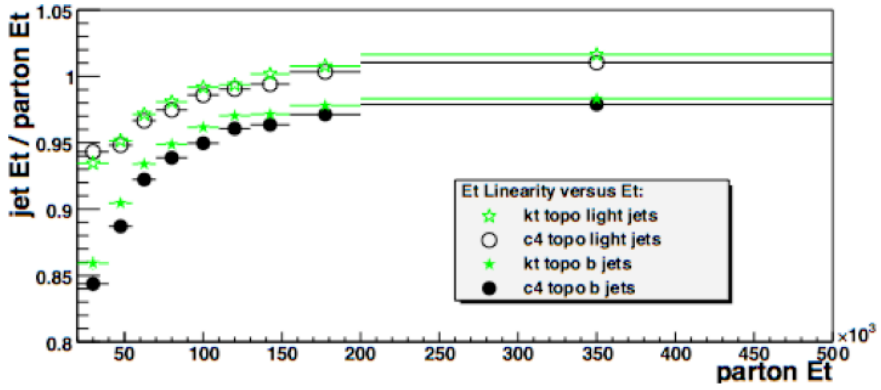


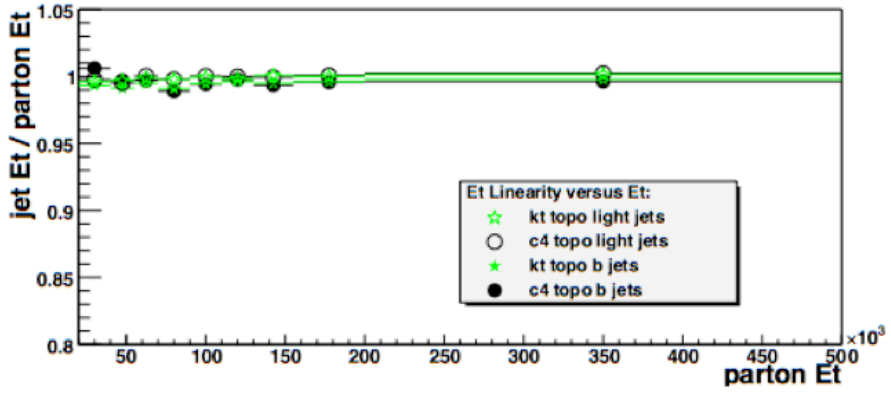


- The χ^2 performs better when fed $\sigma(E_T, bweight)$ and with the W_{jj} and t_{jjb} treated separately.
- Still the best χ^2 only selects **both** Higgs jets correctly in 30% of events....

The Jet Energy Scale

- Essential that we have an excellent knowledge of the JES
- Can't calibrate to truth level in real data!
- Techniques for calibration include using di-jet events (η) and $Z/\gamma + jets(E)$
- This is **not enough** for this channel:
  - different calibration coefficients for b and non-b jets
  - the event selection we apply can alter the JES
  - $t\bar{t}H^0$ may have a very different underlying event to eg $Z + jets$

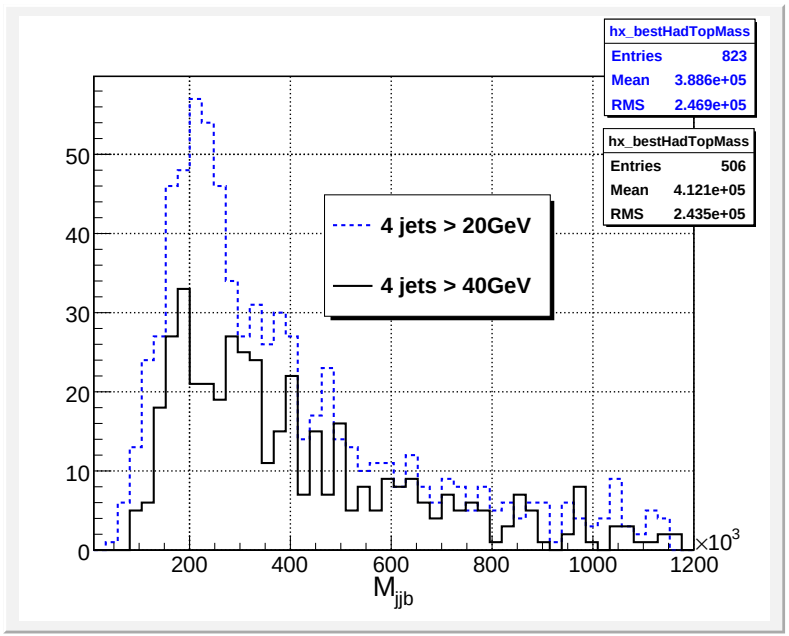


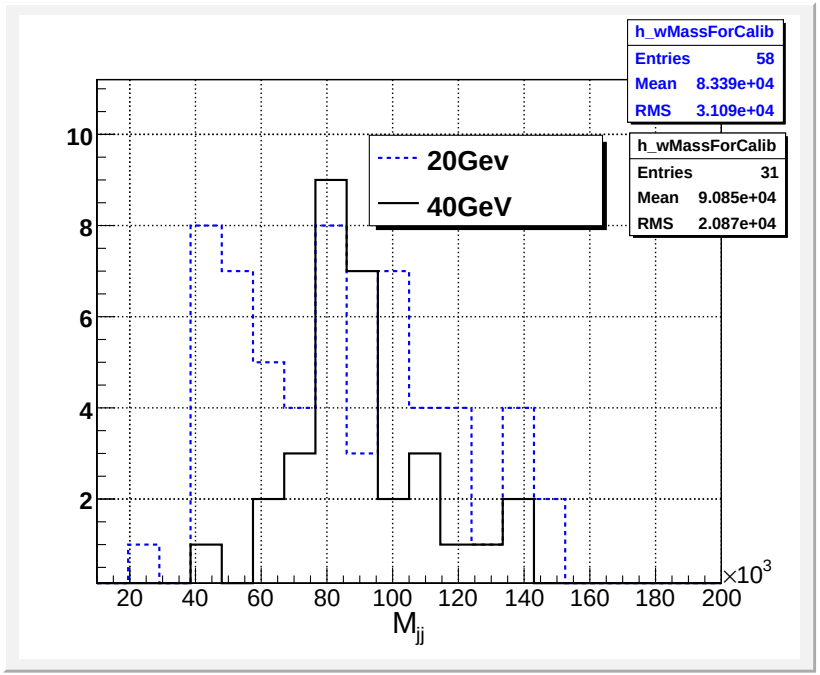


In situ jet calibration using the W_{jj} mass peak

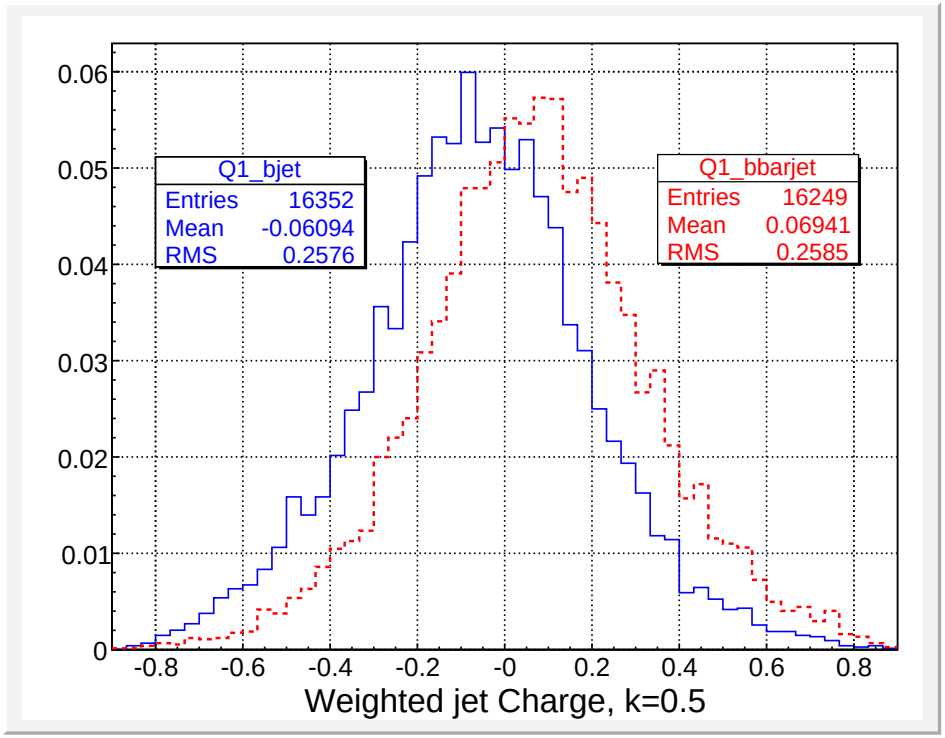
- Use methods similar to top group see: ATL-COM-PHYS-2008-073
- Important differences in preselection: $t\bar{t}H^0/t\bar{t}$ need $6jets \geq 20GeV$ / $4jets \geq 40GeV$

- High purity of W_{jj} is essential for jet calibration:- increased p_T cut and *exactly* 2 light jets
- Full Dress Rehearsal –very low statistics





Ongoing work: Jet Charge



- 4 b-jets in the event must be correctly assigned to H^0, t and $\bar{t}$
- Currently the best χ^2 method gives us the correct jets for the higgs in just 30% of events
- 50% of events have one of the b-jets from H^0 assigned to t or $\bar{t}$
- Use jets' tracks to calculate charge of $b\bar{b}$ pair and include in χ^2

- $Q_k = \sum_i q_i |p_i \cdot \hat{n}|^k$
- $k = 0.5$, Track $p_T \geq 1.0 GeV$, $d_0 \leq 0.1$ w.r.t **jet** primary vertex

Summary

- Plenty more work to be done on understanding the background shape, how it changes with kinematic cuts.
- New ideas to explore for helping to determine the signal: every little bit counts.
- First data will be very useful for in-situ jet calibration
- Exciting times!