
tth, ($h \rightarrow bb$) with EventViews

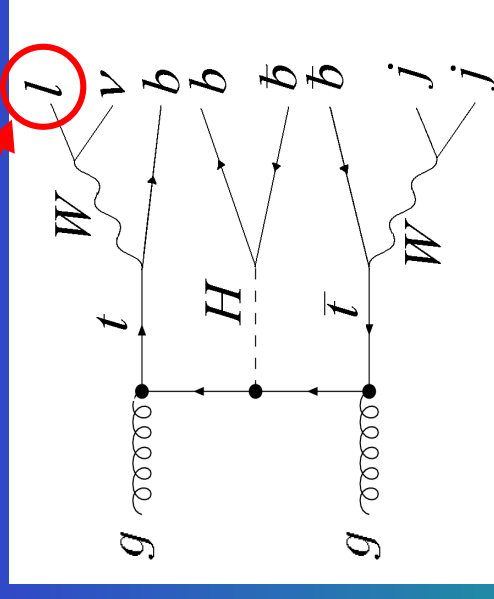
Chris Collins-Tooth, Christian Shaw
01-Jun-2006

Introduction

- Accessing the tth ($h \rightarrow b\bar{b}$) channel.
- Muon isolation and trigger lepton analysis.
- Jets:
 - Jet algorithms and parameters.
 - Jet energy ratios.
- Signal reconstruction and implications.
- Data: Privately produced samples v10.0.4, 20k events at each of 4 masses: 100-130 GeV.
- Aim: transfer lessons learned into CSC analysis / note.

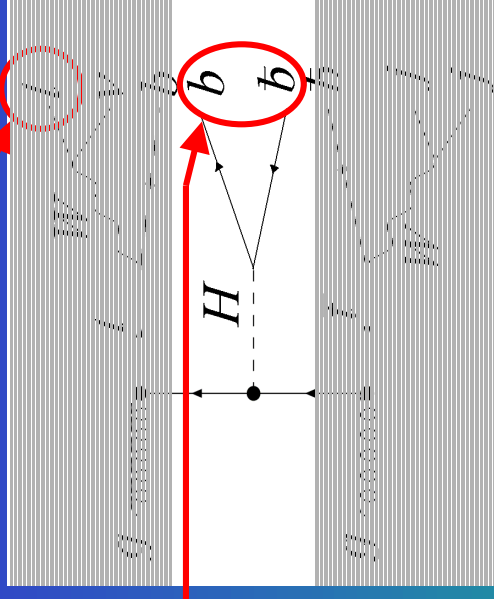
The $t\bar{t}h$ ($h \rightarrow b\bar{b}$) channel

- Event trigger is a high P_t lepton.



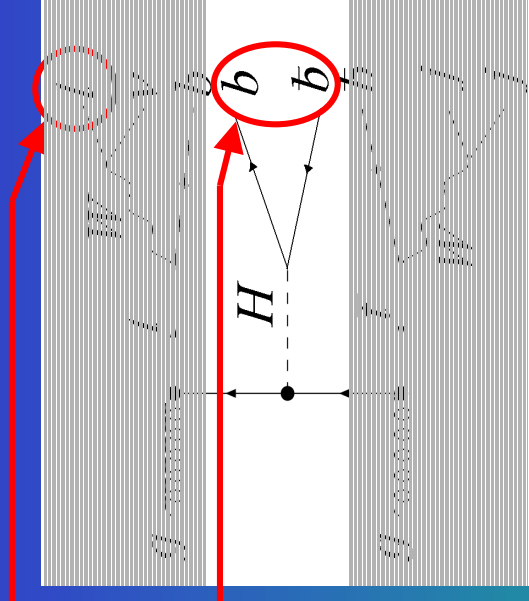
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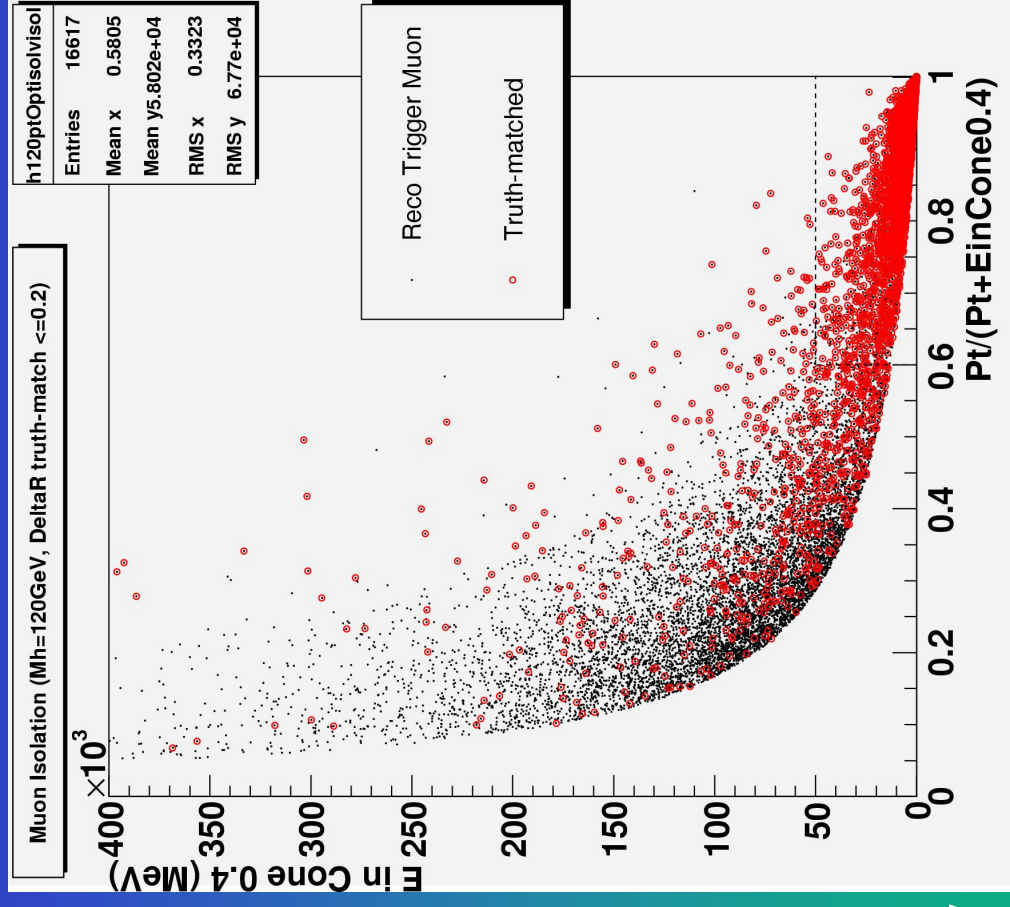
The $t\bar{t}h$ ($h \rightarrow b\bar{b}$) channel

- Event trigger is a high P_t lepton.
- Aim: throw away most of the event leaving the correct two b -jets, allowing M_h reconstruction.
- Many combinatorical possibilities!
- Keep combos in the list of possible “Event Views” until we can judge which is the most accurate (e.g. using reco M_t , M_W .)
- EventView software tools suited to this..



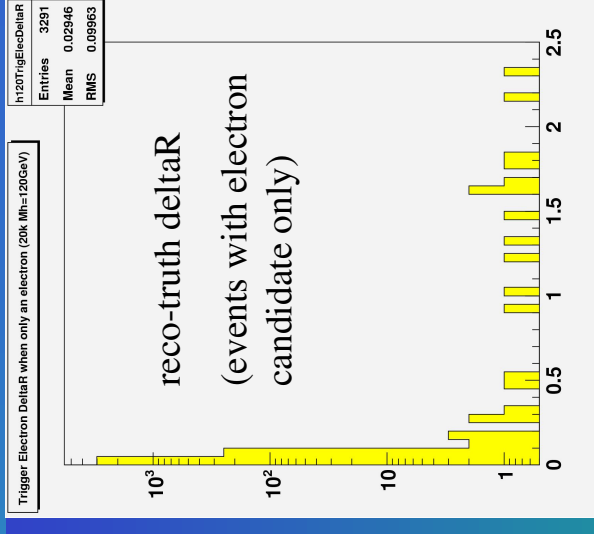
Muon Isolation and Pt

- Many “soft” μ ’s from b-jets.
- Often hard enough to qualify as trigger candidate muons.
- Must look at isolation.
- Red circles show reconstructed muons matched to the truth muon coming from the hard W (i.e. the true trigger μ).
- Apply cuts:
 - Energy in cone $0.4 < 50$ GeV
 - $Pt / (Pt + E_{\text{inCone}0.4}) > 0.6$.



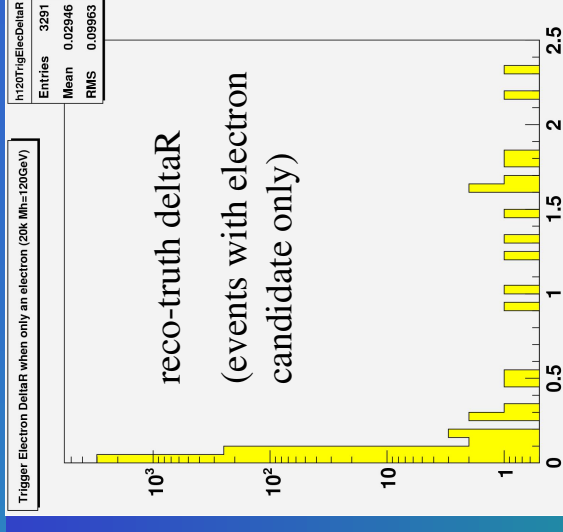
tth Trigger Lepton

- When only a trigger electron cand.
- “Trigger electron candidates” are:
 - $P_t > 25$ GeV
 - no soft electrons (author !=softEBuilder)
 - IsEM applied
 - Isolation: no more than 15 GeV in cone 0.45



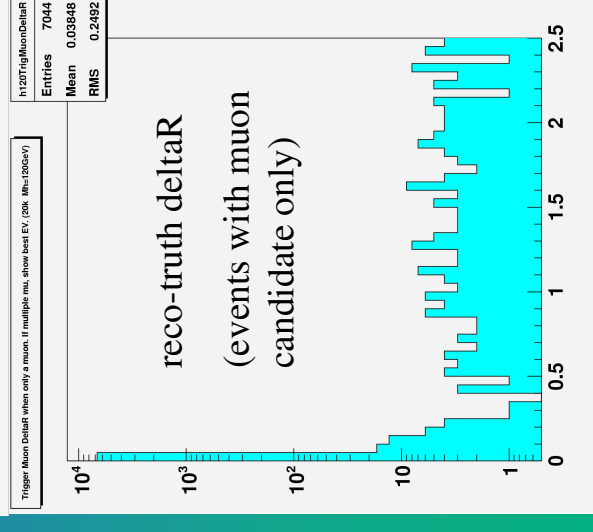
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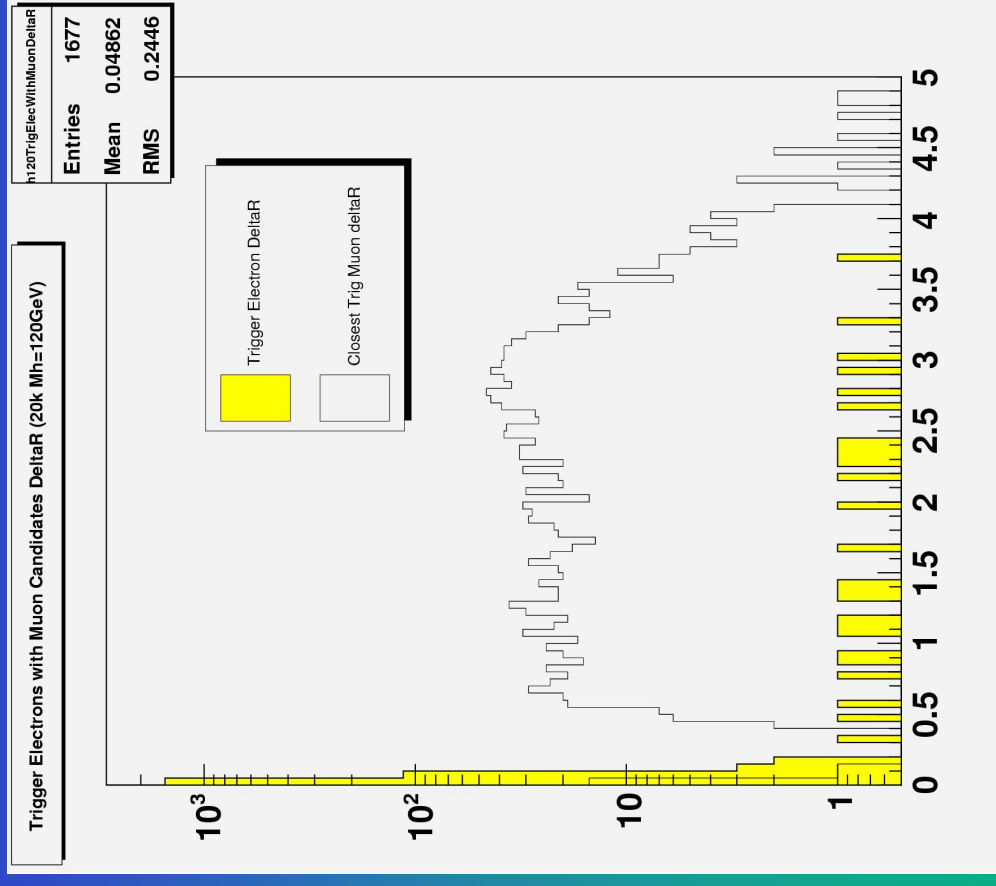
- When there's only μ trigger cand.
- “Trigger muon candidates” are:

- $P_t > 20$ GeV
- Muon track $\text{Chi}^2_{\text{NdofCut}} < 20$
- $E_{\text{inCone}0.4} < 50$ GeV
- $P_t / (P_t + E_{\text{inCone}0.4}) > 0.6$



When Event Has e & μ

- When we ID a trigger electron and some muons which qualify (they are hard enough)..
 - **use the electron!!**
- NB: events with >1 trigger electron candidate are very rare.



Next Step: jets

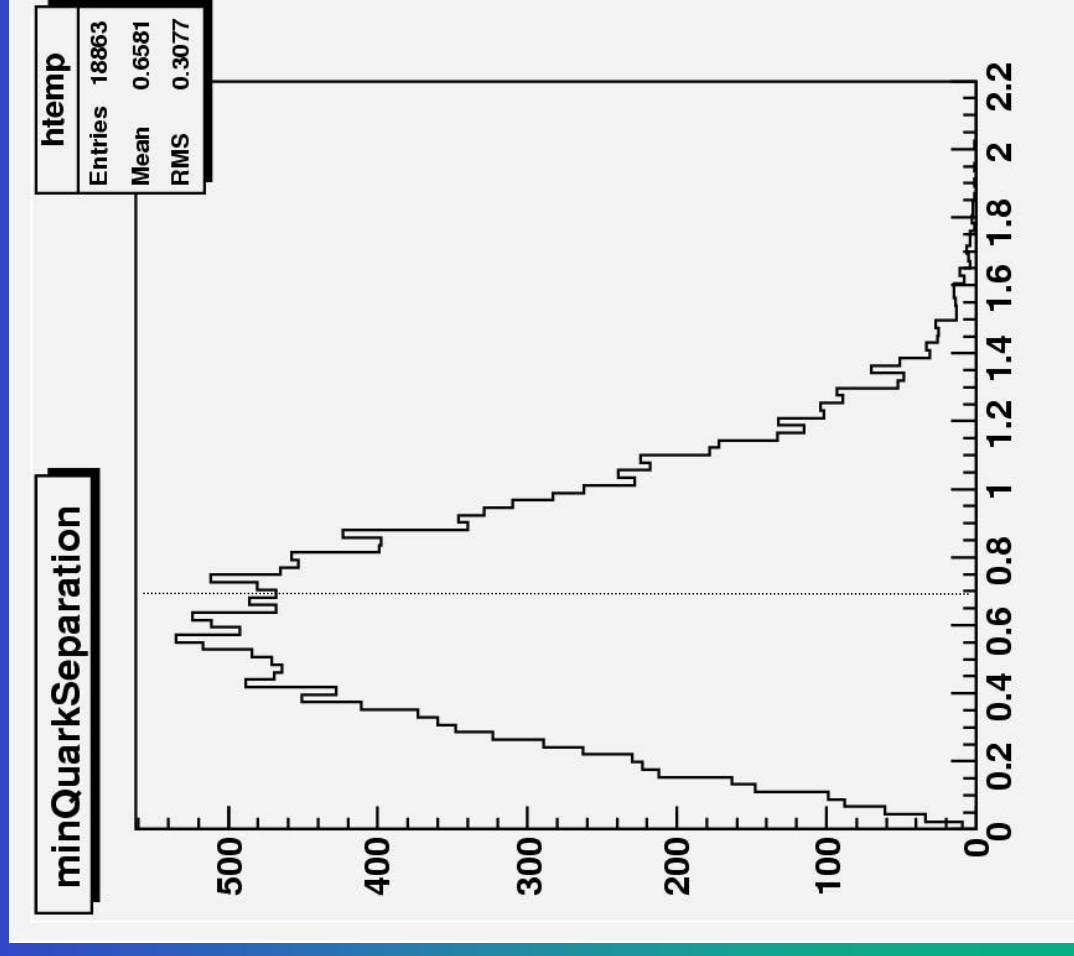
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 - lose many events because there aren't enough b-tags.

- Looked at:

Cone 0.7, 0.4, Kt 0.4

- $E_{\text{RecoJet}}/E_{\text{TruthJet}}$
 - **Detector mismeasurement**
- $E_{\text{TruthJet}}/E_{\text{Quark}}$
 - **Energy lost in “soft” μ, ν**
 - **Out of cone effects etc.**

- For the Kt jets, $E_{\text{RecoJet}}/E_{\text{TruthJet}}$ is very close to 1 (0.99994).



Next Step: jets

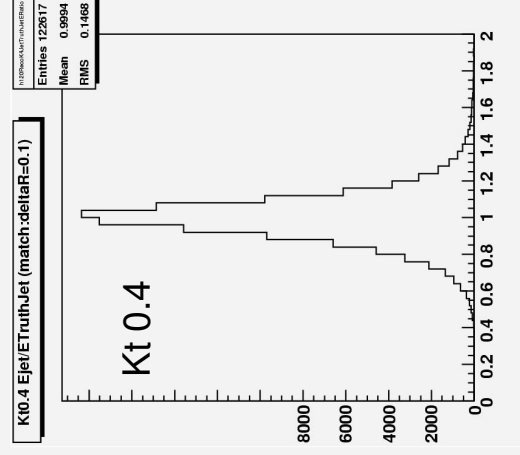
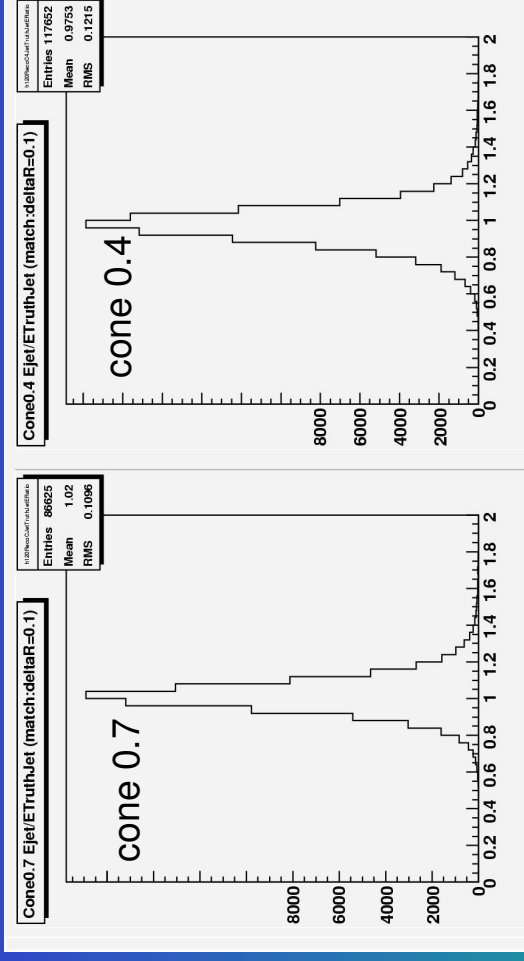
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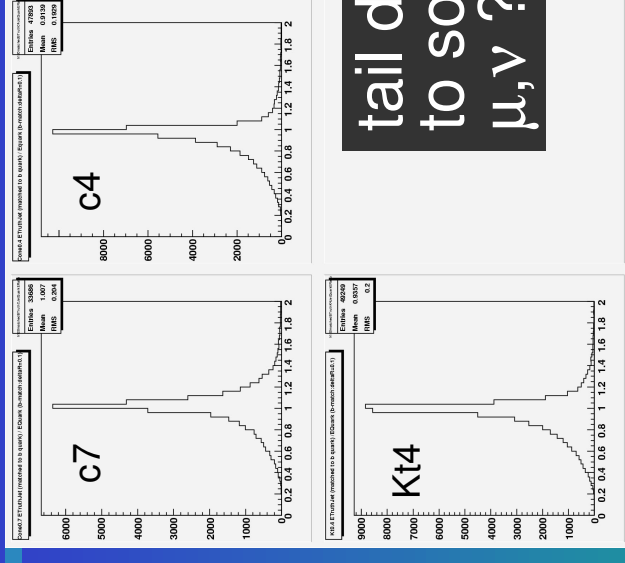
- For the Kt jets, $E_{\text{RecoJet}}/E_{\text{TruthJet}}$ is very close to 1 (0.9994).



- cone 0.7 gathers too much energy
- cone 0.4 calibration seems ~2.5% off!
- Kt 0.4 very close to 1.

Examine “clean” b-jets: no soft μ 's

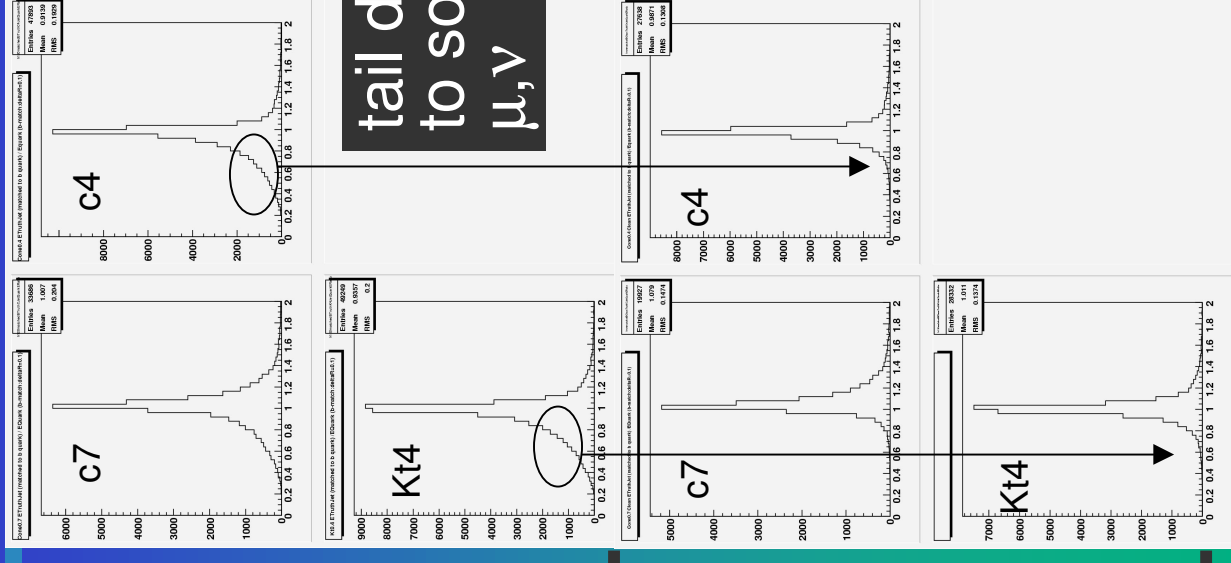
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tail due
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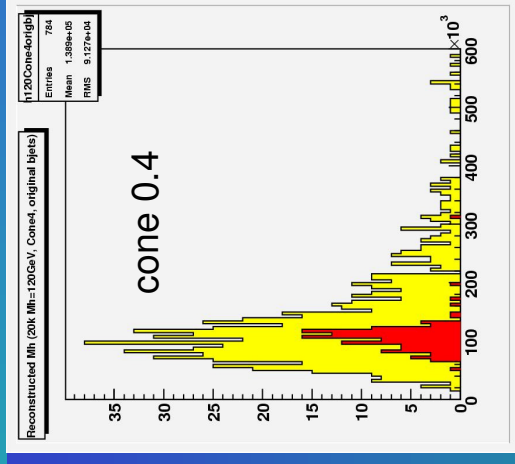
Examine “clean” b-jets: no soft μ 's

- $E_{\text{TruthJet}}/E_{\text{Quark}}$ tails seen in all Jet Algs.
- For bjets where no muon near the jet, tail goes and remainder is sharp peak.
- Investigated adding any reconstructed μ 's back into the jet.
- Obviously, the neutrino is missing too...
- NB: we already have missing Pt in the event from the trigger neutrino.



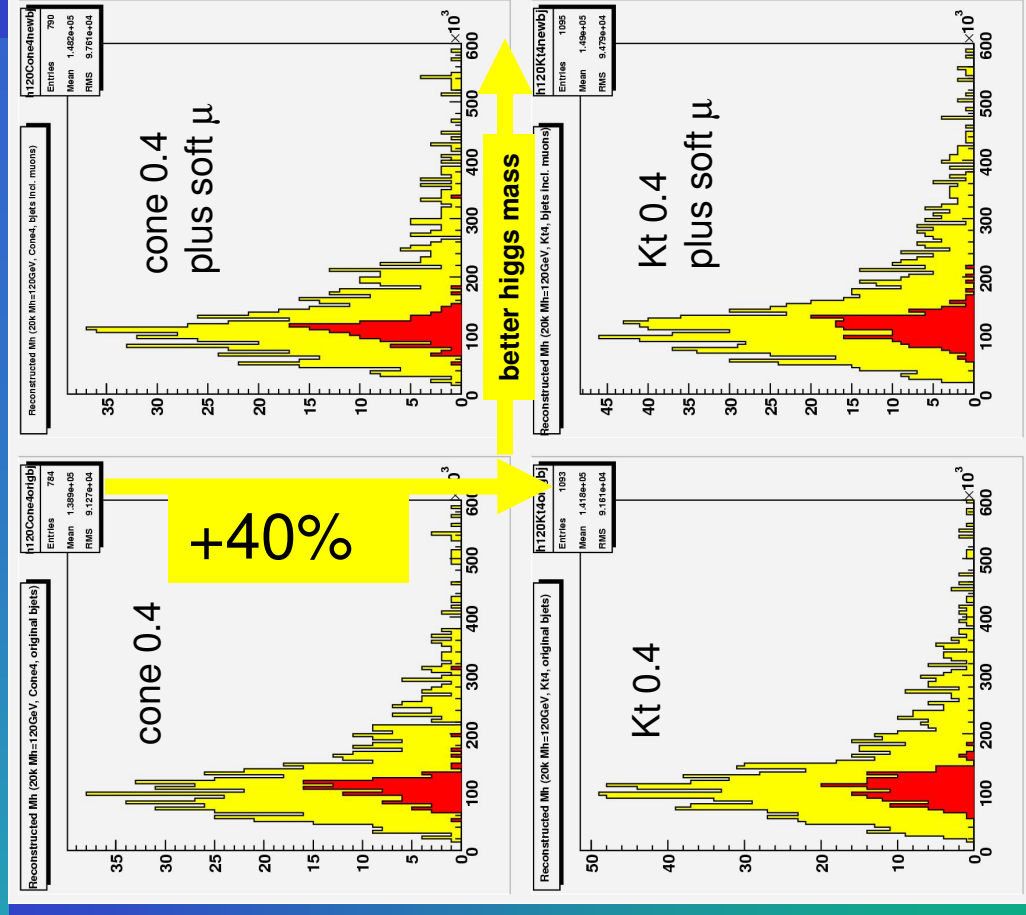
Signal Reconstruction

- Where Higgs made from correct b-jets, mass peak is quite narrow (red).
- The ‘best guess’ at the higgs mass (yellow) is broad.



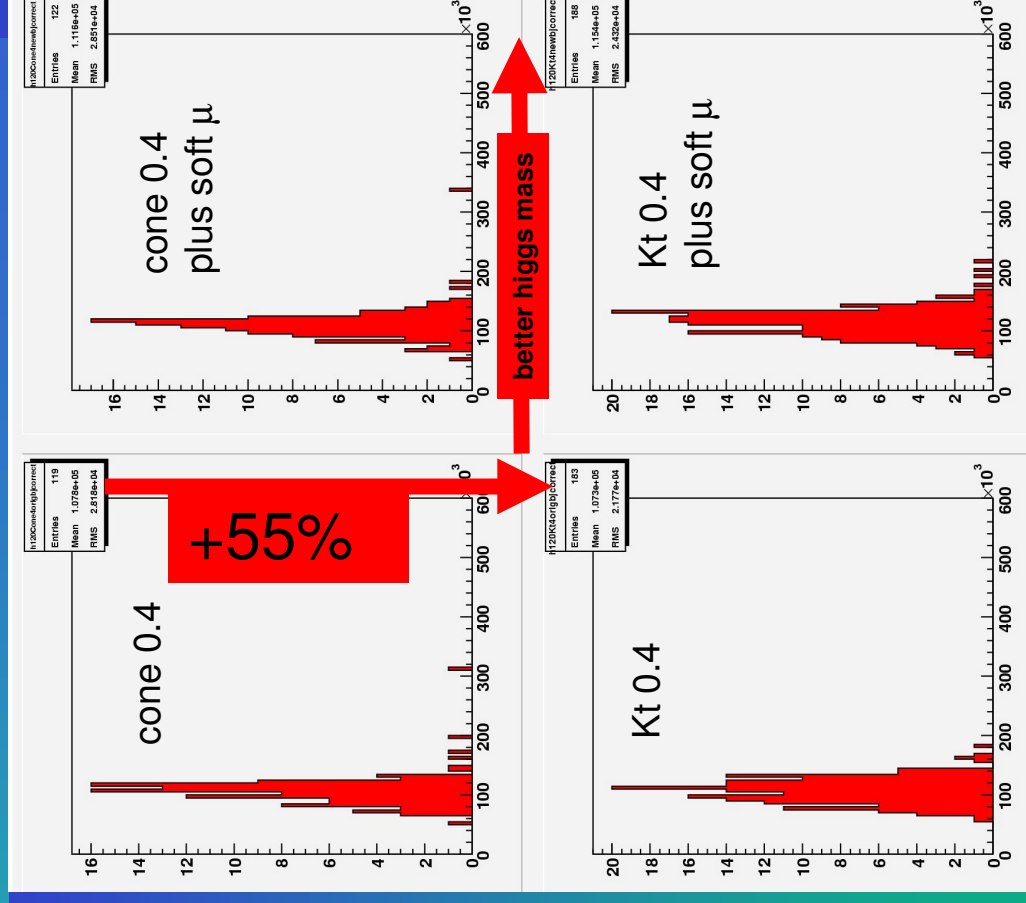
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- Using Kt & adding soft muons to jets:
 - We get ~40% extra signal events (jet multiplicity higher, so more events have 4 b-jets).
 - Improves number of correctly reco’d Higgs by ~50-75%, Lowers R.M.S.
 - Mean higgs mass approaches truth value.
- We are plagued by combinatoric background.
 - Reco’d mass highly sensitive to small b-jet energy changes.



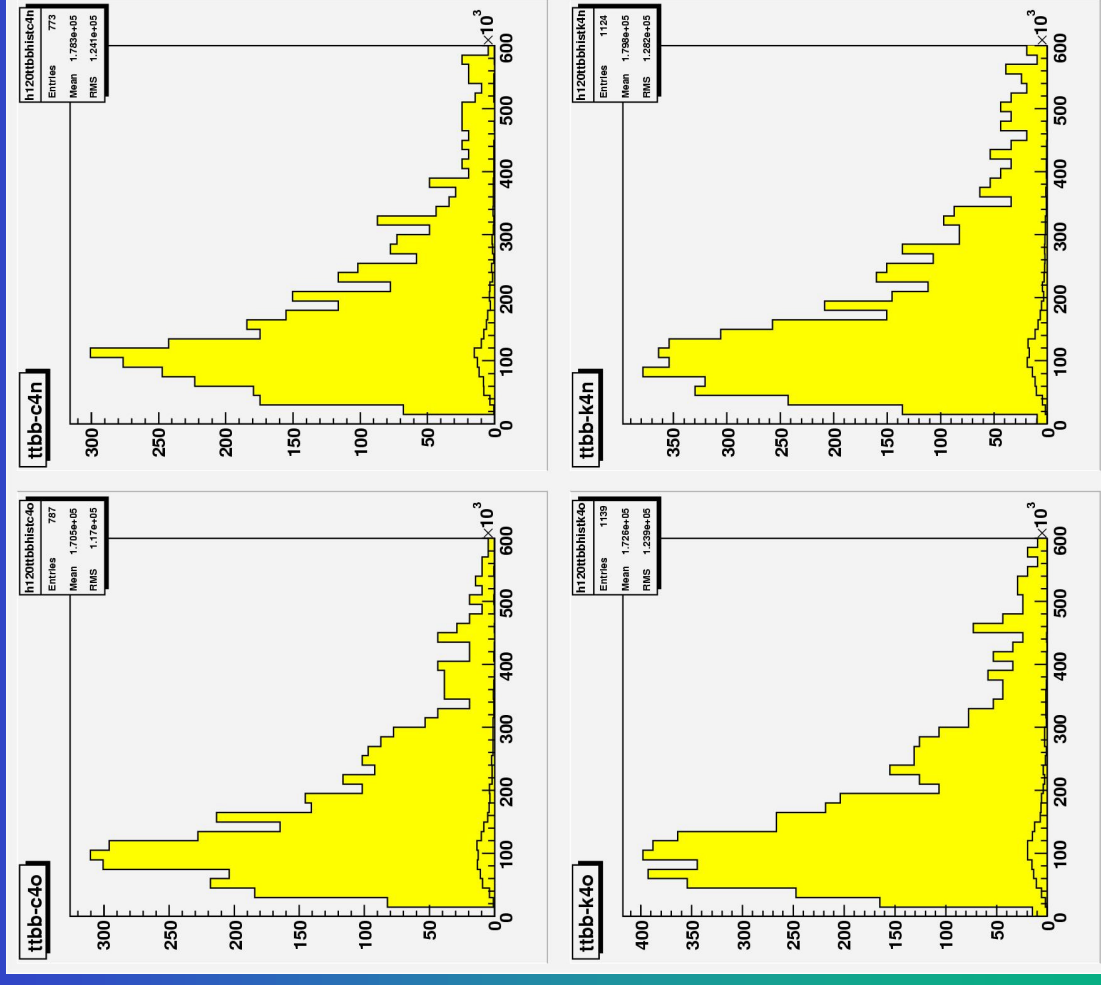
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Now the bad news...

- Mass peak is so broad that it mimics the shape of the dominant ttbb background.
- Uncertainties in the overall background normalisation will severely obscure the signal.
- We must strive to reconstruct the mass more accurately.
- Next step: analyse why we still get it wrong..?
- Also look into background removal cuts (eg $P_{t, \text{top}}$)



Things to take forward:

- Using Kt and soft muon re-addition is complimentary to Likelihood Analysis (J. Cammin et al.).
- Likelihood analysis improves significance too, but peak is still very broad.
- Kt in particular buys us
 - ~40% more signal and
 - ~50-75% improvement in correctly reconstructed signal.
 - But also increases background reconstruction..background removal cuts needed!
- Adding soft muons improves signal rate too, and also improves reconstructed mass.
- BUT reconstruction must be re-run to get Kt jets!

Trigger Thoughts

- Request a Trigger: Lepton $P_t > 20$ GeV.
- Is there a single stream for electrons AND muons?
- If not, must think about overlaps.
- Also, can we store #b-jets in TAG for all events with Lepton $P_t > 20$ GeV?
- Can I request this?