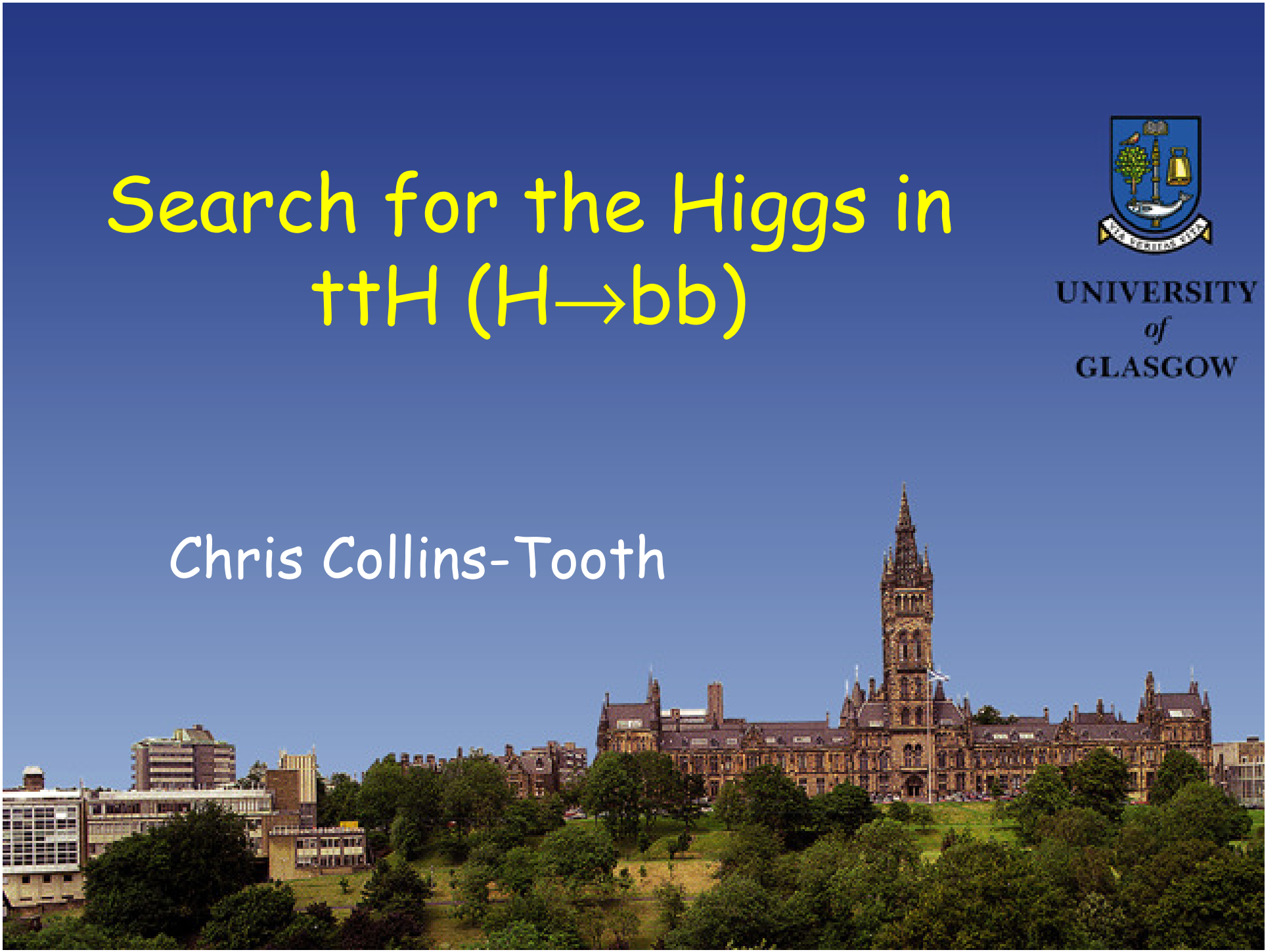
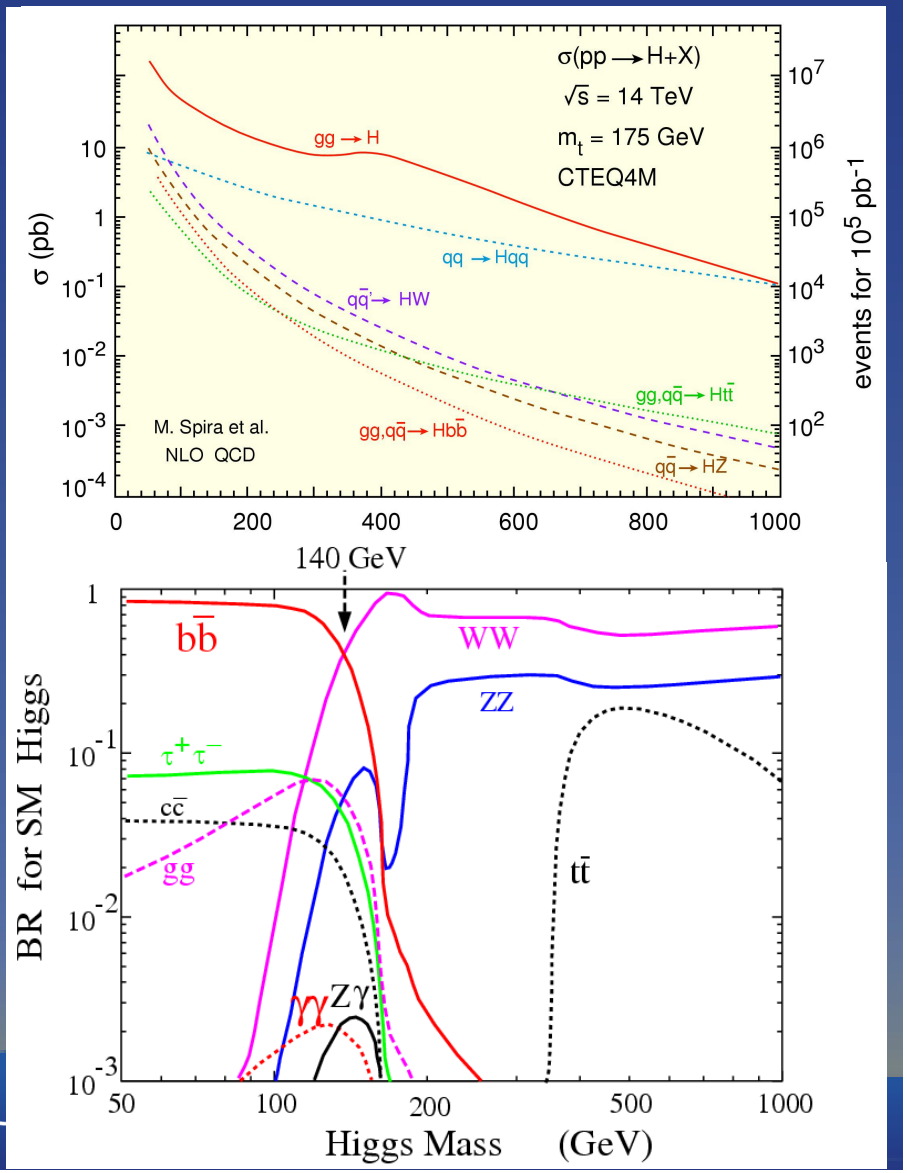
Search for the Higgs in ttH (H→bb)



Chris Collins-Tooth

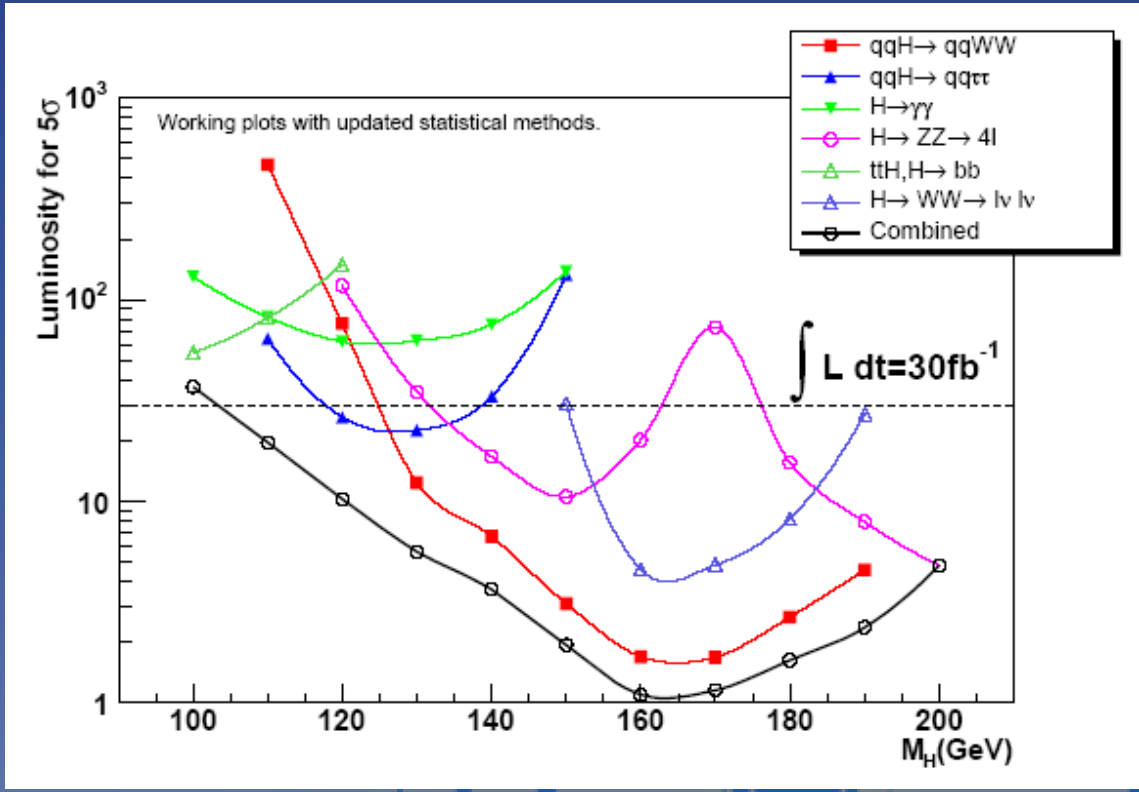
Higgs production and decay at the LHC

- gluon-gluon dominates production.
- Higgs decays predominantly (~80%) to b-quarks at low mass, dropping rapidly as M_H increases.
- ttH H→bb most viable only in a small mass window.



Higgs detection with ATLAS

- Clearly challenging if $M_H < 120$ GeV
  - For L=30 fb^{-1}, multiple channels will probably be needed!



[ATL-PHYS-2004-034]

Higgs with associated top

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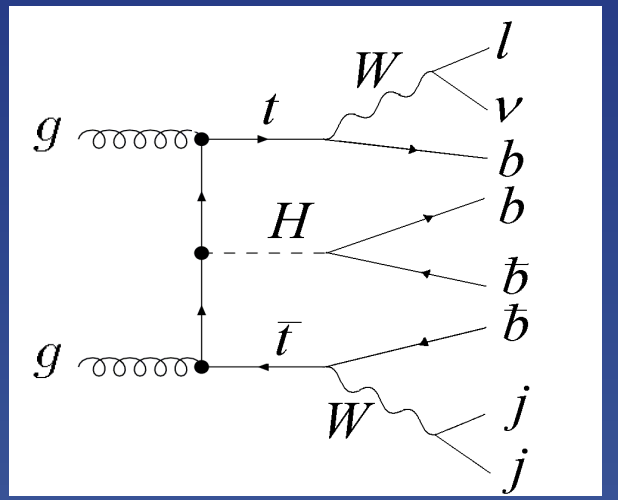

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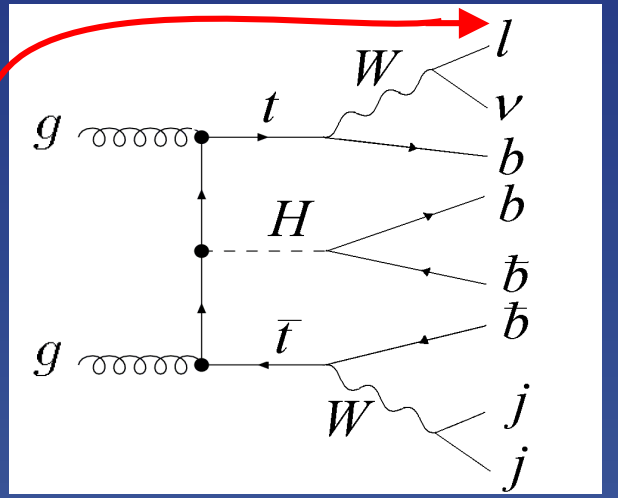

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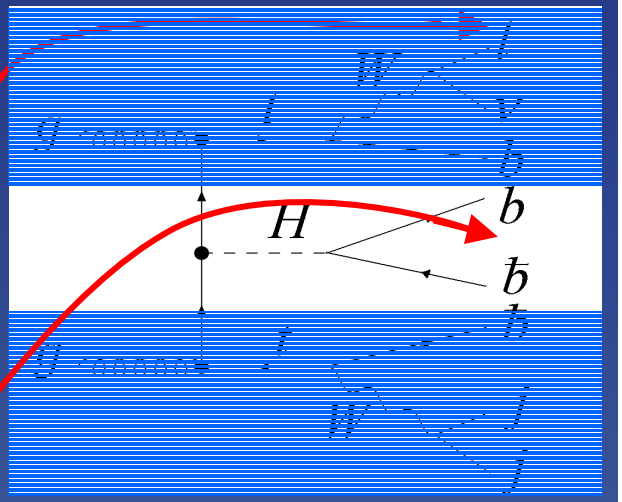

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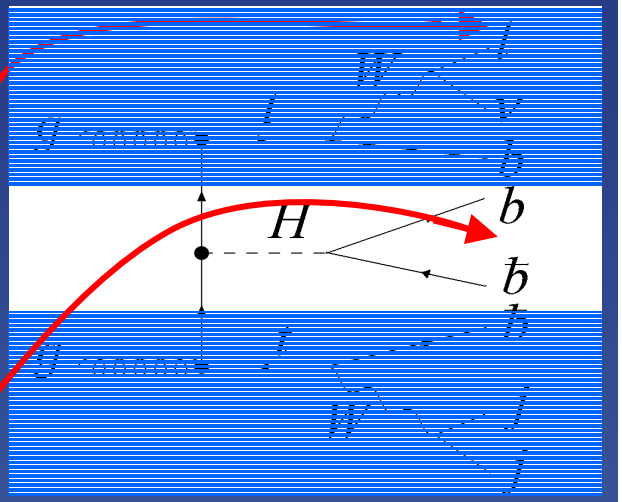


- Final state complex – many combinatorics.
- Likelihood or cuts-based approaches can be used to identify the best two bjets.

Reconstructing the final state for ttH ->lνjjbbbb

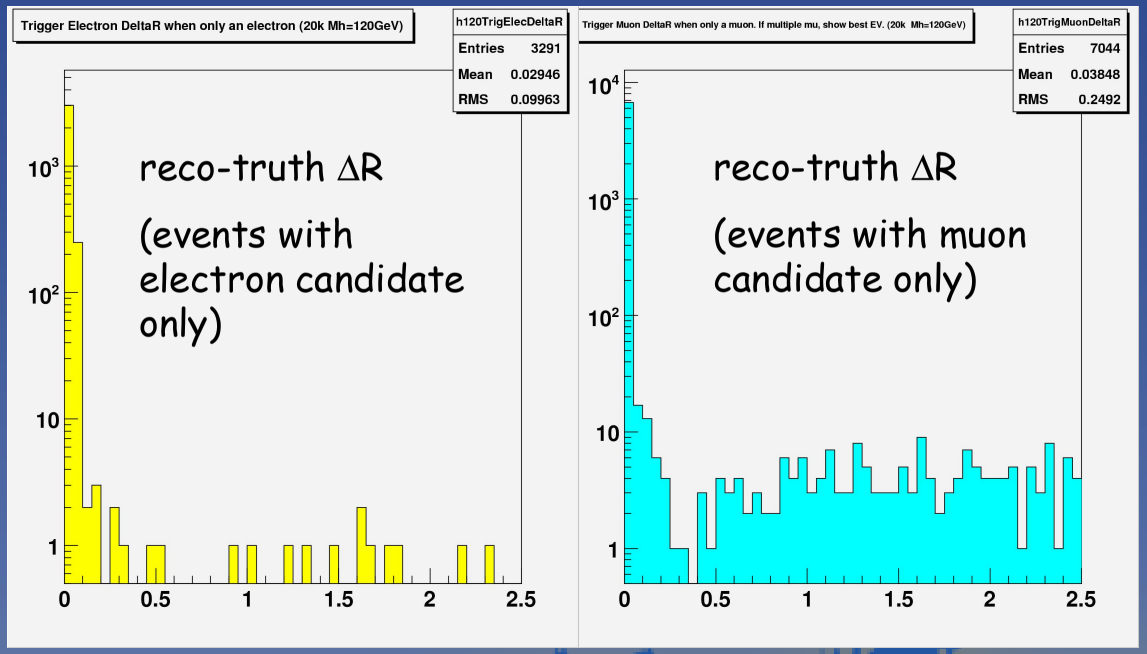
- High-Pt lepton from W (electron or muon) identified accurately..

Electrons:

Pt> 25 GeV

isEM=0xFF

Isol: <15GeV in cone 0.45



Muons:

Pt> 20 GeV

Chi2NdofCut < 20

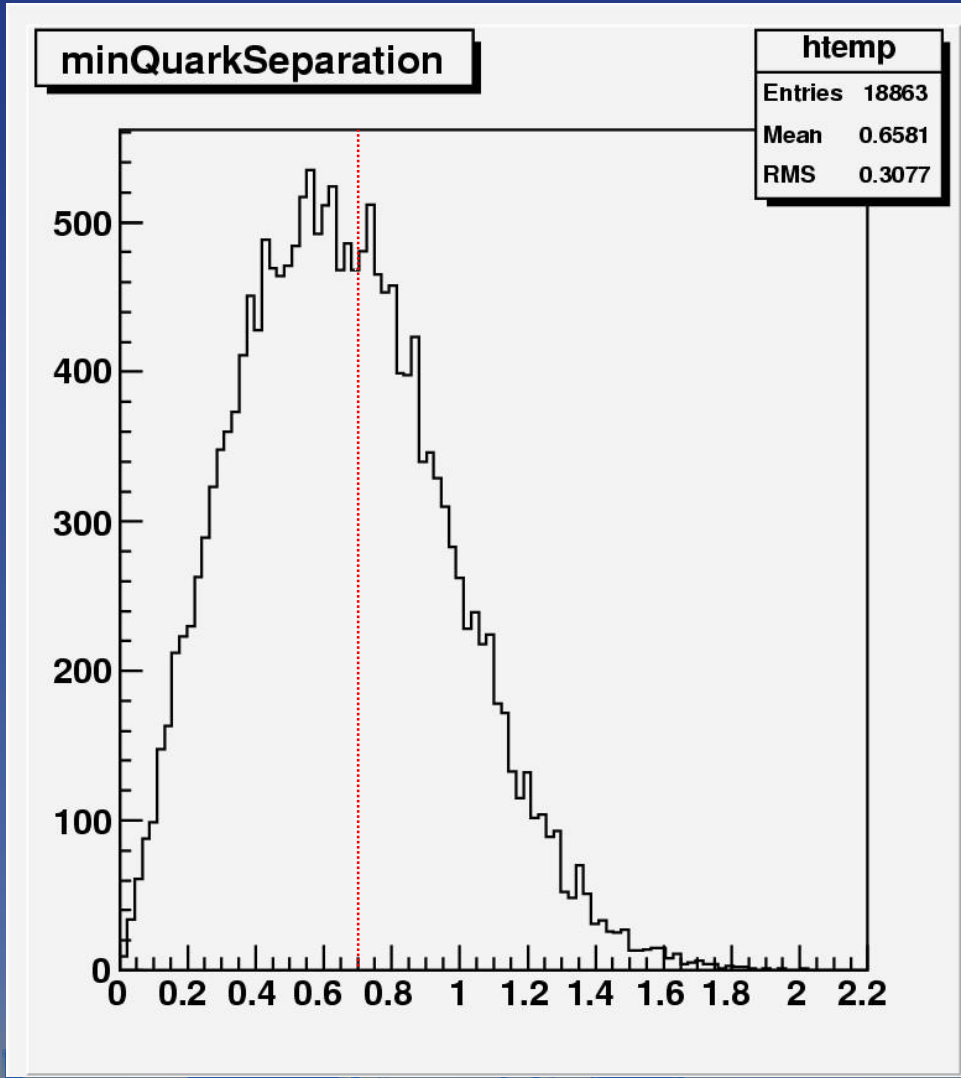
Isol: <50GeV in cone 0.4

$Pt/(Pt+E_{C0.4}) > 0.6$

Jets

- Cone 0.7 is just no good for this channel
  - lose many events because there aren't enough b-tags.
- Looked at:

  Cone 0.7, 0.4, Kt 0.4
  - $E_{RecoJet}/E_{TruthJet}$
    - Detector mismeasurement
  - $E_{TruthJet}/E_{Quark}$
    - Energy lost in "soft" μ,ν
    - Out of cone effects etc.
- For the Kt jets, $E_{RecoJet}/E_{TruthJet}$ is very close to 1 (0.9994).



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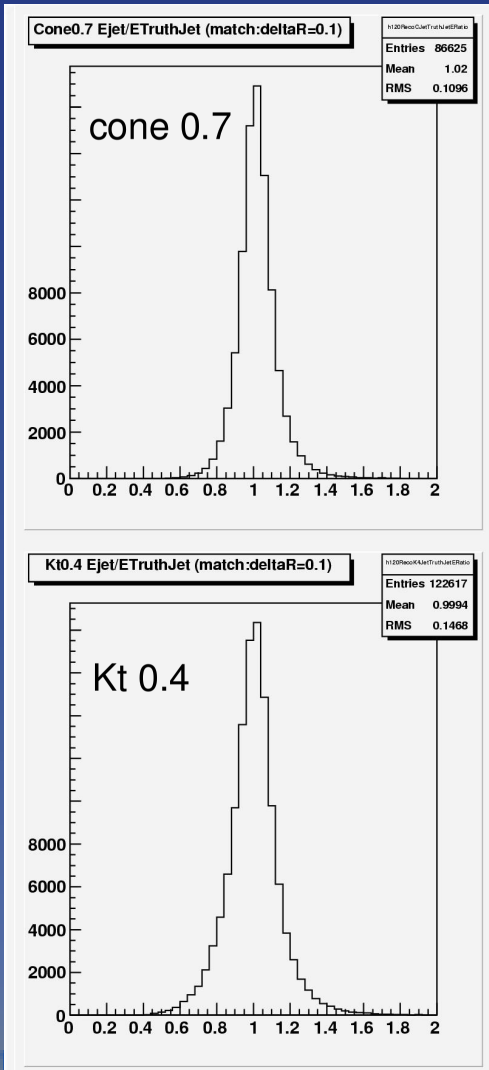
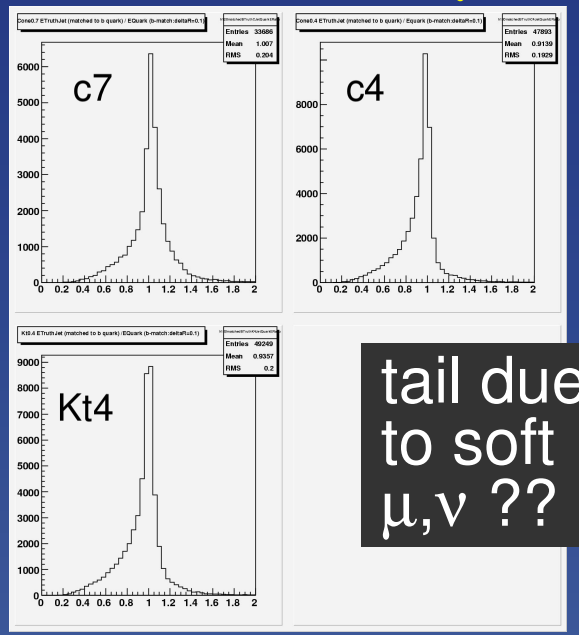


- **cone 0.7 gathers too much energy**
- **cone 0.4 doesn't gather enough**
- **Kt 0.4 very close to 1, but broader.**

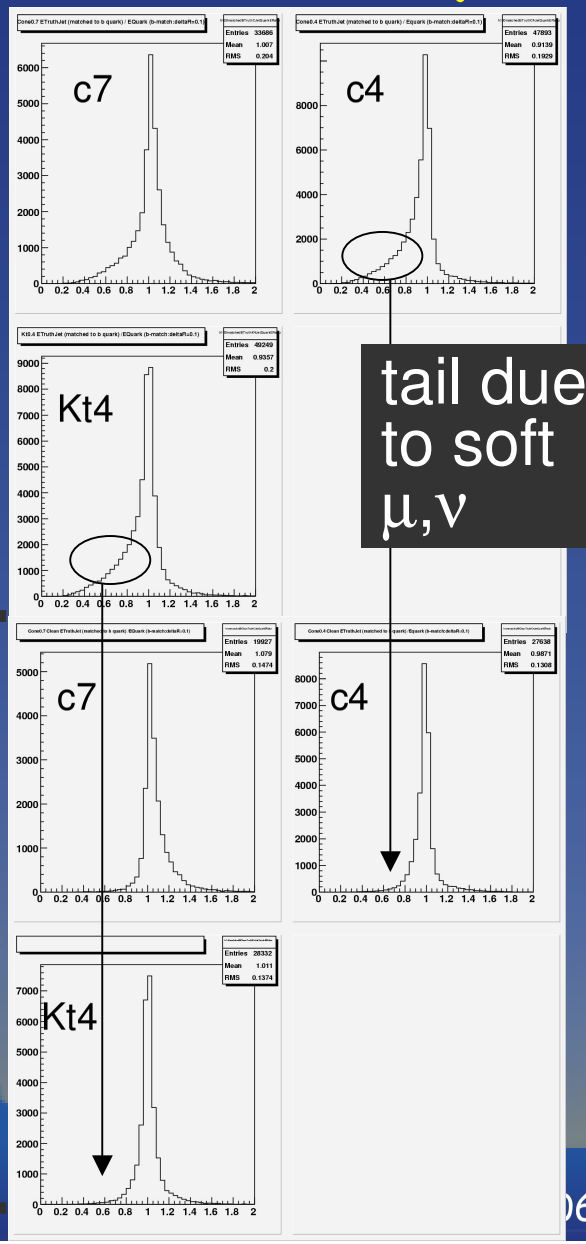
Examine "clean" b-jets: no soft μ's

- $E_{TruthJet}/E_{Quark}$ tails seen in all Jet Algs.



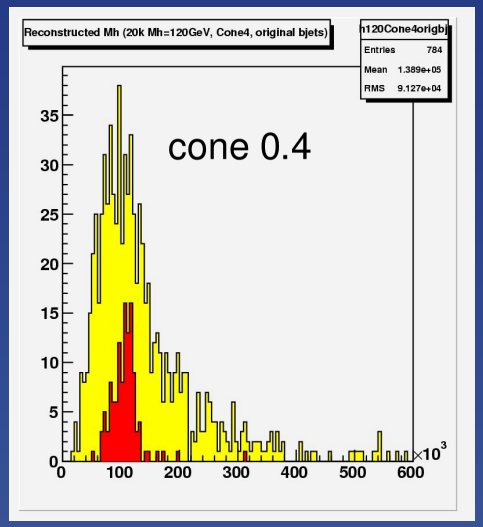
Examine "clean" b-jets: no soft μ's

- $E_{TruthJet}/E_{Quark}$ 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.



Higgs mass 'peak'

- Whether likelihood or cuts-based analysis is used, reconstructed M_H is very broad.
- Yellow plot shows reconstructed masses for all signal events passing cuts.
- Red plot shows events where correct jet combinations were used to reconstruct Higgs.



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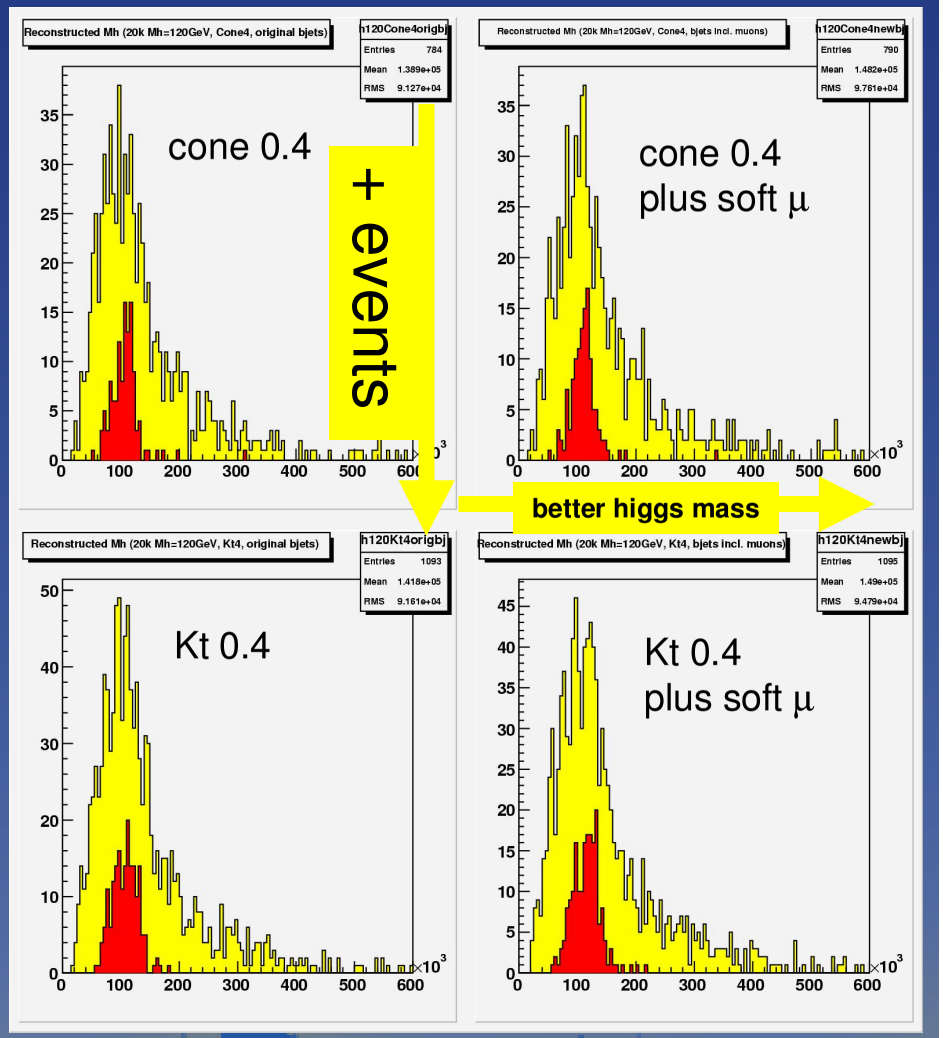

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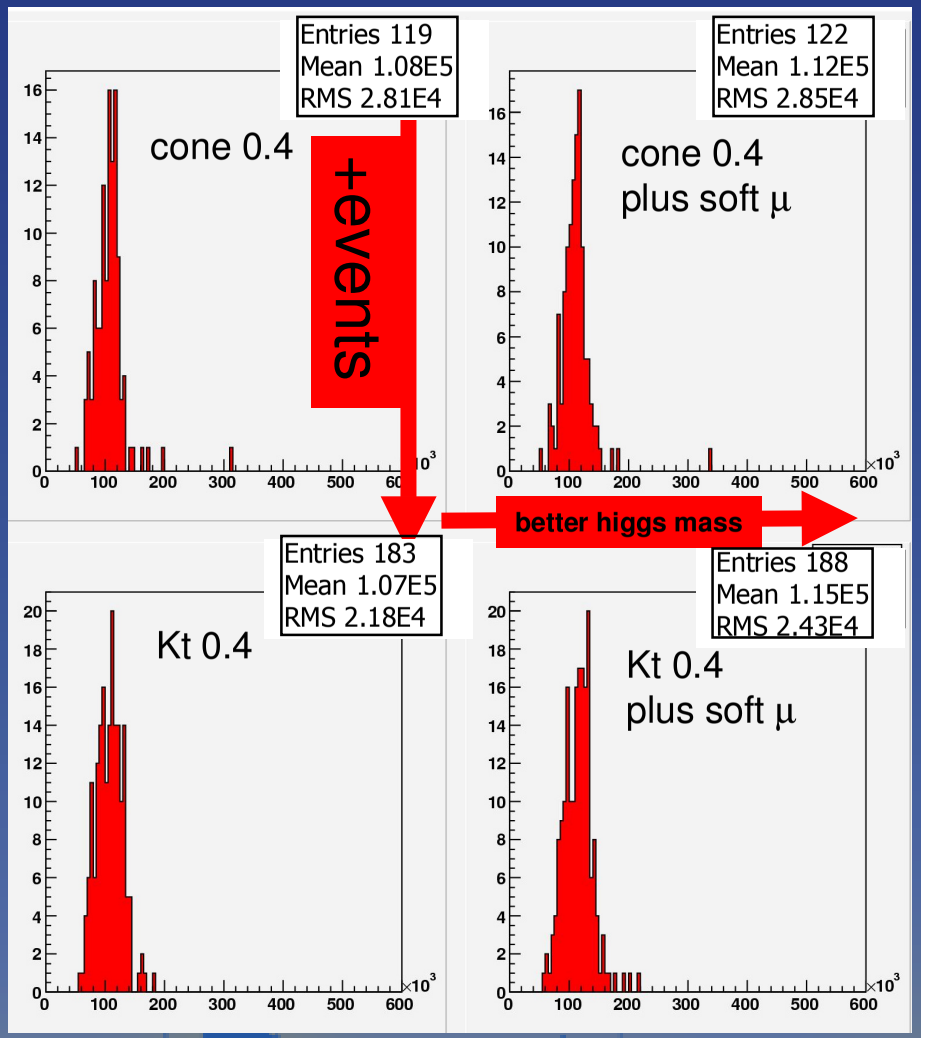


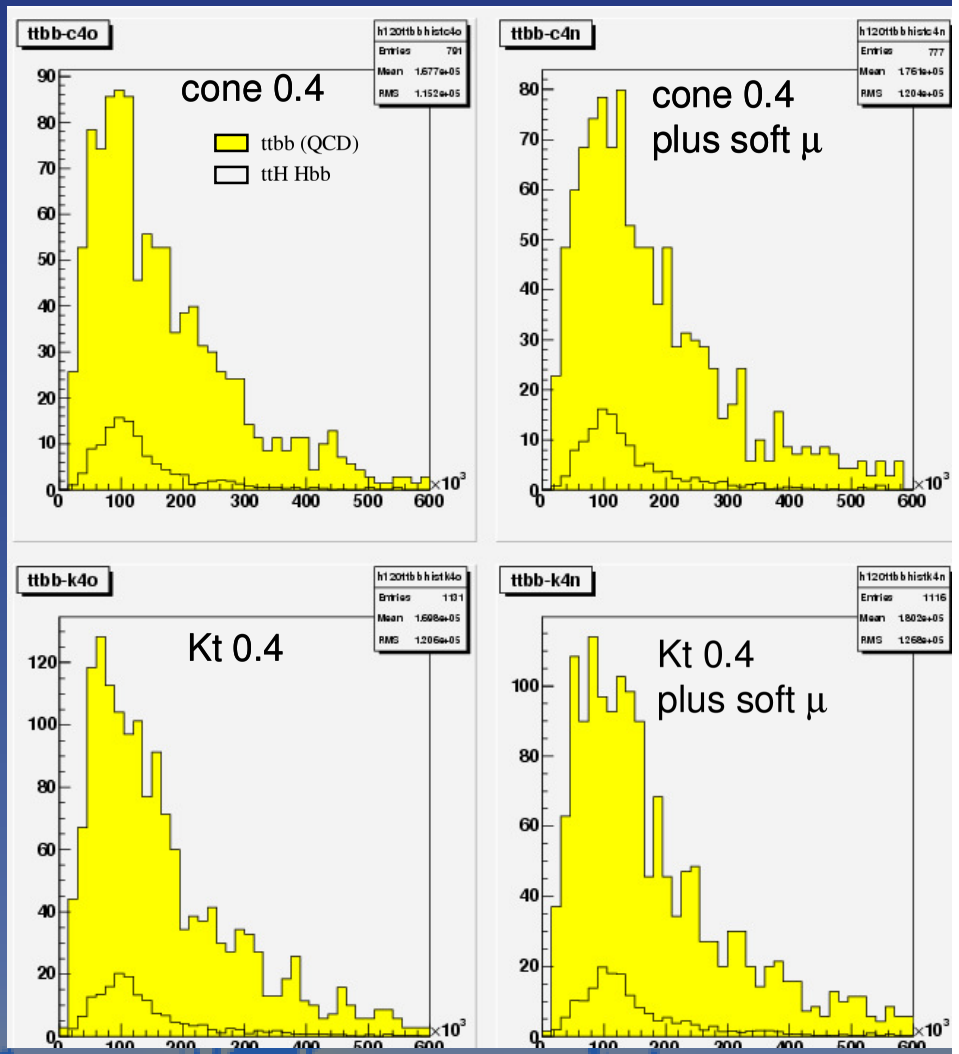
M_H=120 GeV

Backgrounds

- We have seen already the effect of combinatoric background.
- The main processes able to "masquerade" as ttH Hbb are:
  - ttjj where jj are either bb or are mistagged as bb
  - gg and qq -> ttbb
  - gg -> Z/W/γ -> ttbb
  - W or Z plus jets
- The overlap between ttjj (jj=bb) and ttbb.. will have to be removed, we are working on this.

Bad news..

- Signal shown along with the fully simulated gg->ttbb background normalised for 30fb^{-1}, it is clear we must improve the combinatorics.
- Otherwise, we are almost reduced to a 'counting experiment'.
- Systematic uncertainties on the bg normalisation will be a tough challenge.



M_H=120 GeV

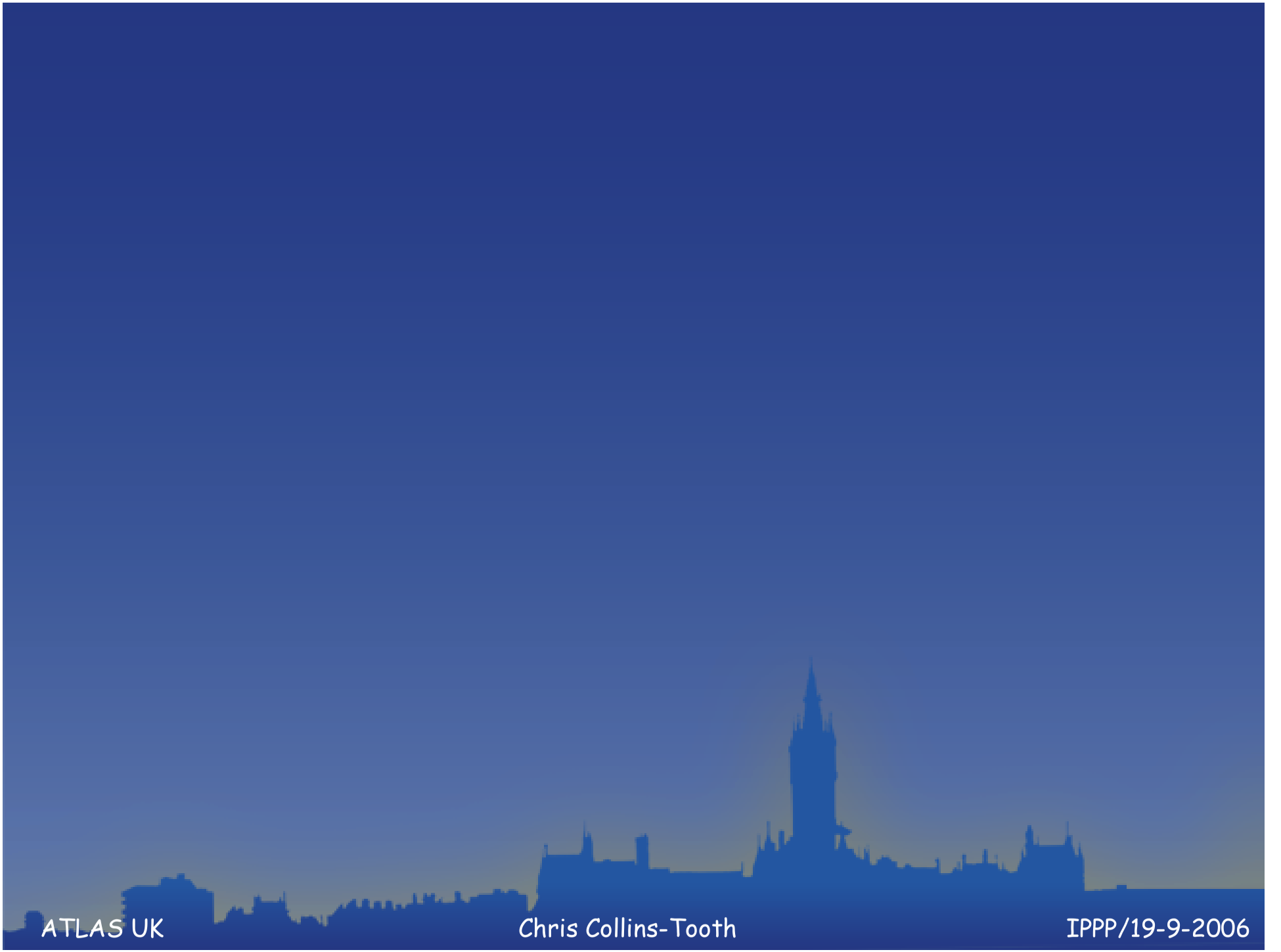
Things to take forward:

- Using Kt and soft muon re-addition is complimentary to Likelihood Analysis.
- Small changes in measured b-jet energy can have a large effect on M_H:
  - i.e. which b-jets are absorbed into the top-quarks.
- Many possibilities for improvement in the channel exist:
  - Jet algorithm Kt, Mid-Point...
  - b-tagging improved since Rome
  - "Soft muon" energies added back into jets.
  - Corresponding neutrinos not done yet!
  - Using >2 light jets to reconstruct the hadronic W
  - Likelihood analysis improvements

Shameless promotion…

- ATLAS "CSC" Notes
- Work just commencing on ttH Hbb note
- Not too late to join!
- See ATLAS TWiki page:

https://uimon.cern.ch/twiki/bin/view/Atlas/TtHhbbAnalysis


ATLAS UK
Chris Collins-Tooth
IPPP/19-9-2006