Higgs branching ratio analysis - status report

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Strategy

- Looking at Z-Higgs events with m_H = 120 GeV/c^2, $\sqrt{s}$ = 230 or 250 GeV.
- Z decays $Z \rightarrow \mu^+\mu^-$ or $Z \rightarrow e^+e^-$
- We are currently using our own samples, (mainly) generated with
  - Mokka 06-06-p03
  - LDCPrime_02Sc
  - ILCSOFT 01-03-06
  - Bremstralung spectrum taken from Pandora-Pythia and given to Pythia. (WE KNOW THIS IS NOT IDEAL!)

- We will move to using the mass production sample as soon as available

- We are working on different parts of the analysis, with the aim of working out an overall strategy. Present some of our results here.

Contents

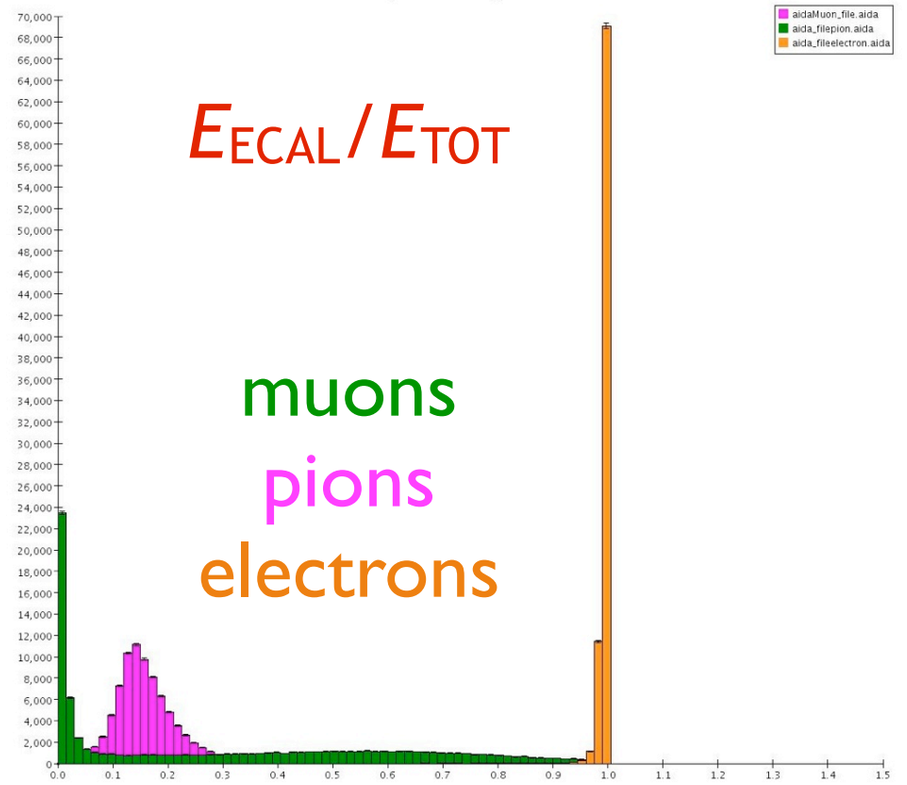
- Muon and Electron ID cuts
- *Z* reconstruction
- Recoil mass
- B- and C-jet tagging
- Separating signal, background and decay channels
- Conclusions

Lepton ID cuts

Hajrah Tabassam

- First iteration tuned on single particle samples with $45<p/\text{GeV}<60$

- Extract from PandoraPF0 collection:
  - E_{ECAL} } $E_{TOT} = E_{ECAL} + E_{HCAL}$
  - E_{HCAL}
  - p



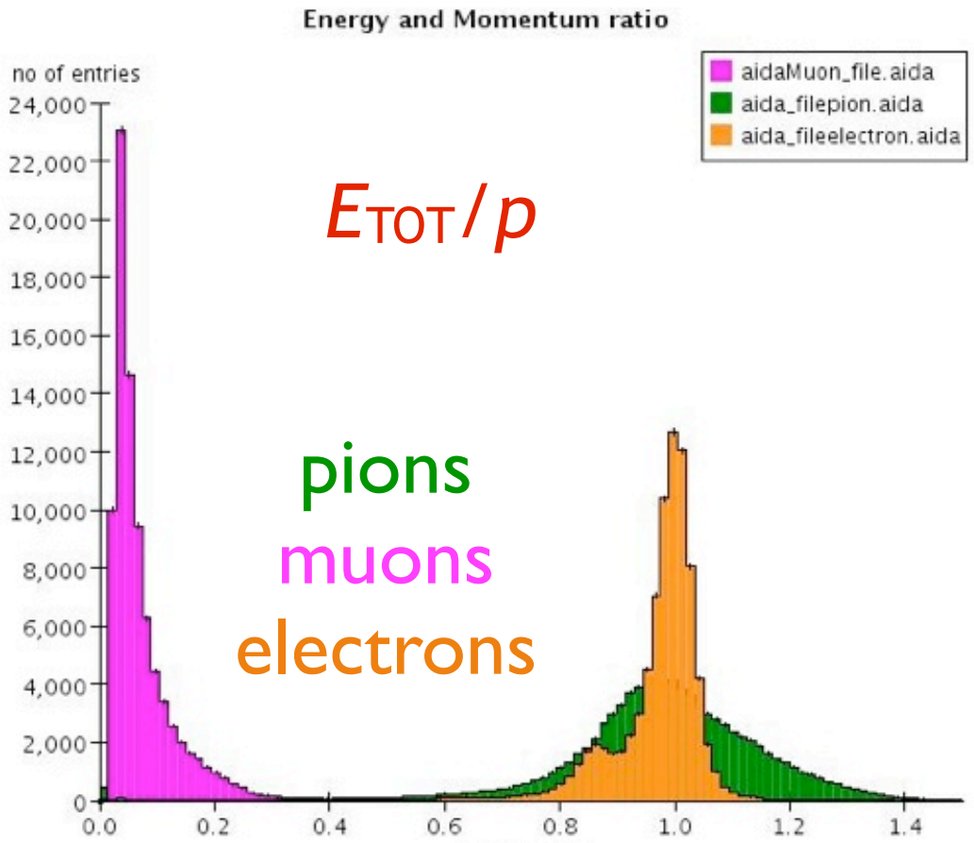
Electron cuts

1) $E_{ECAL}/E_{TOT} > 0.7$
2) $E_{TOT}/p > 0.9$

Muon cuts

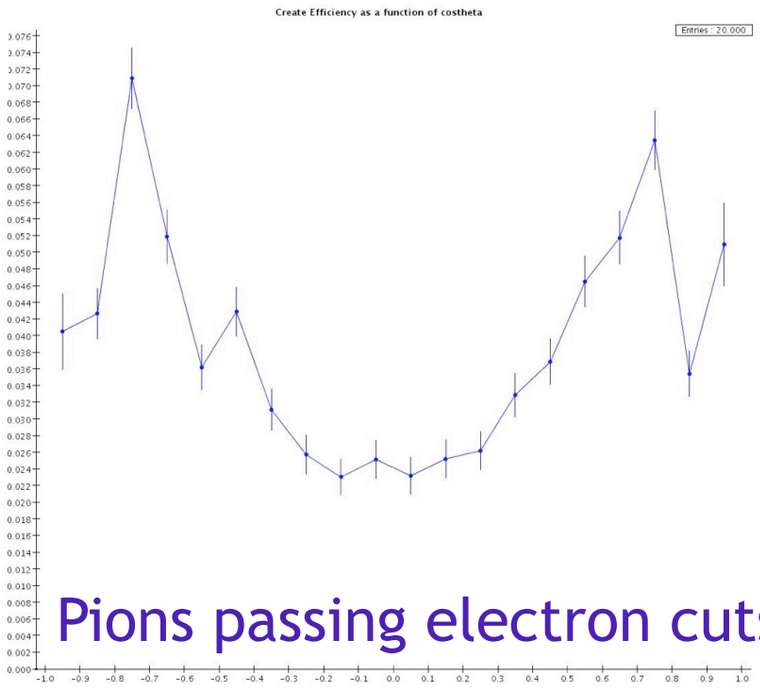
1) $E_{ECAL} < 2.5$ GeV
2) $E_{HCAL} < 15$ GeV
3) $E_{ECAL}/E_{TOT} < 0.5$
4) $E_{TOT}/p < 0.3$

efficiencies in %	electron cuts	muon cuts
e	98.57±0.06	~0
μ	0.03±0.01	97.5±0.05
π	3.88±0.06	0.46±0.003



Electron ID as as function of cos θ and momentum

ε=0.076

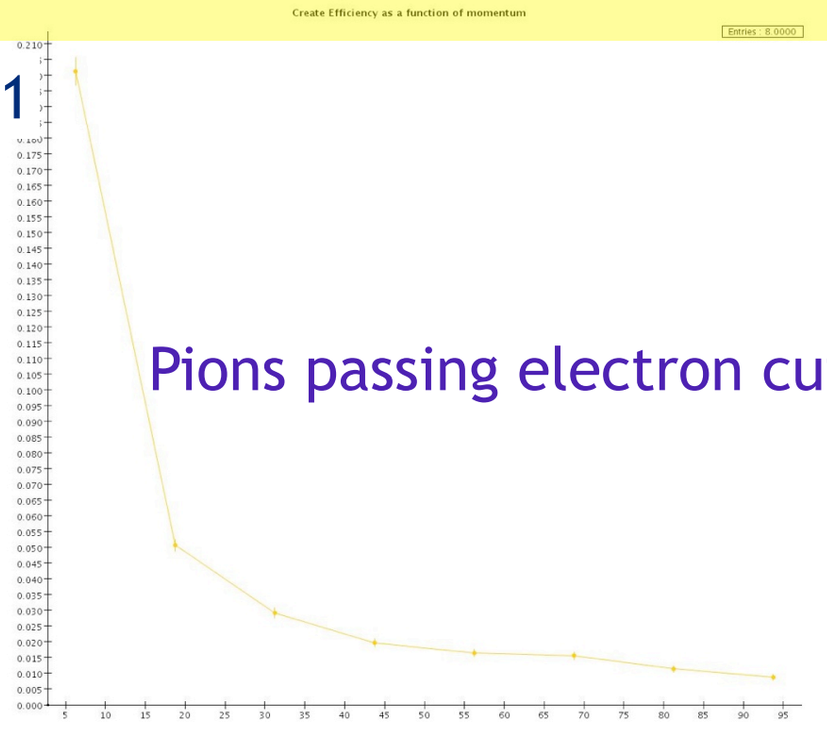


ε=0

Pions passing electron cuts

cos θ=-1 cos θ=+1

ε=0.21

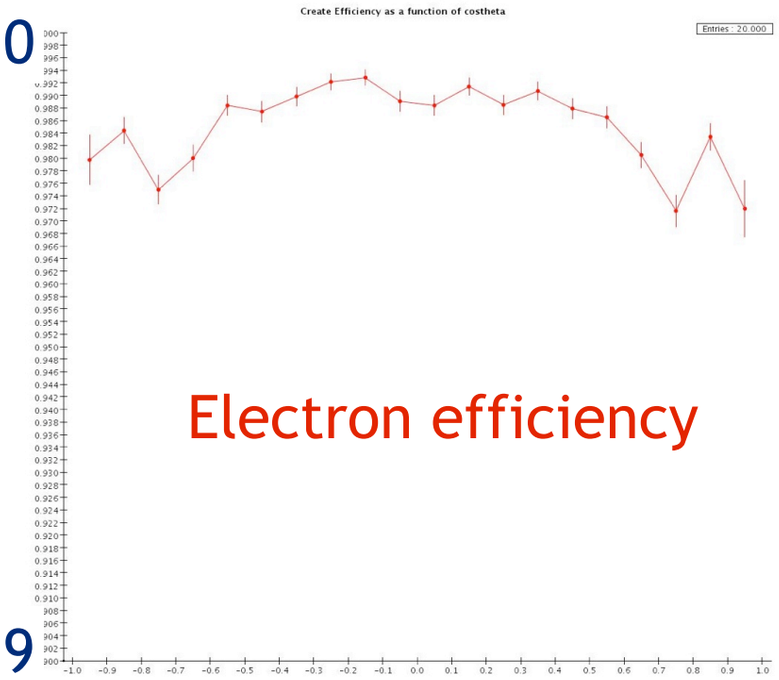


ε=0

Pions passing electron cuts

p=5GeV *p*=95GeV

ε=1.0

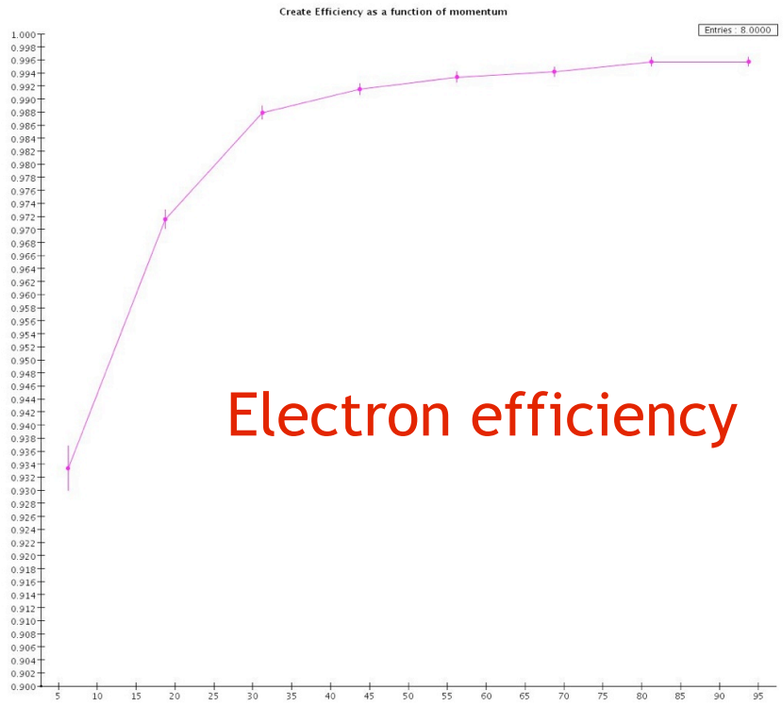


ε=0.9

Electron efficiency

cos θ=-1 cos θ=+1

ε=1.0



ε=0.9

Electron efficiency

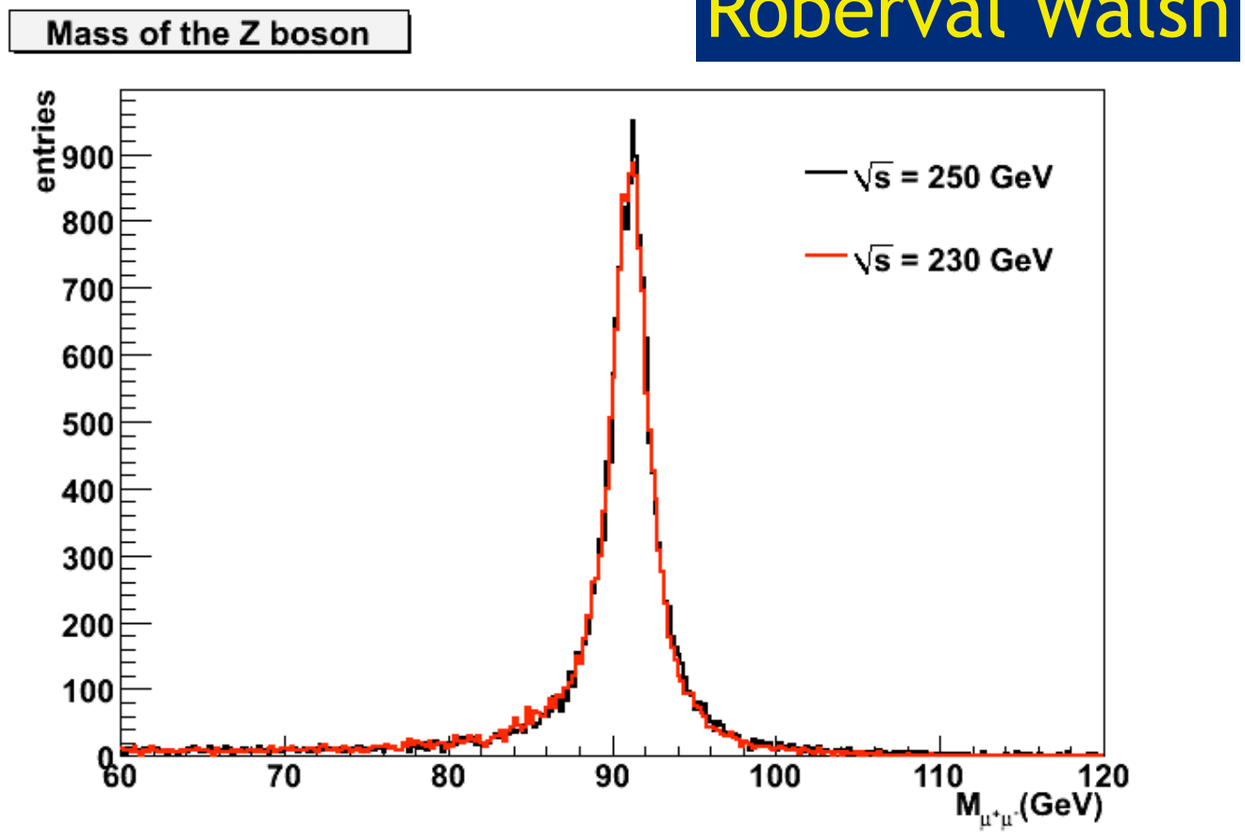
p=5GeV *p*=95GeV

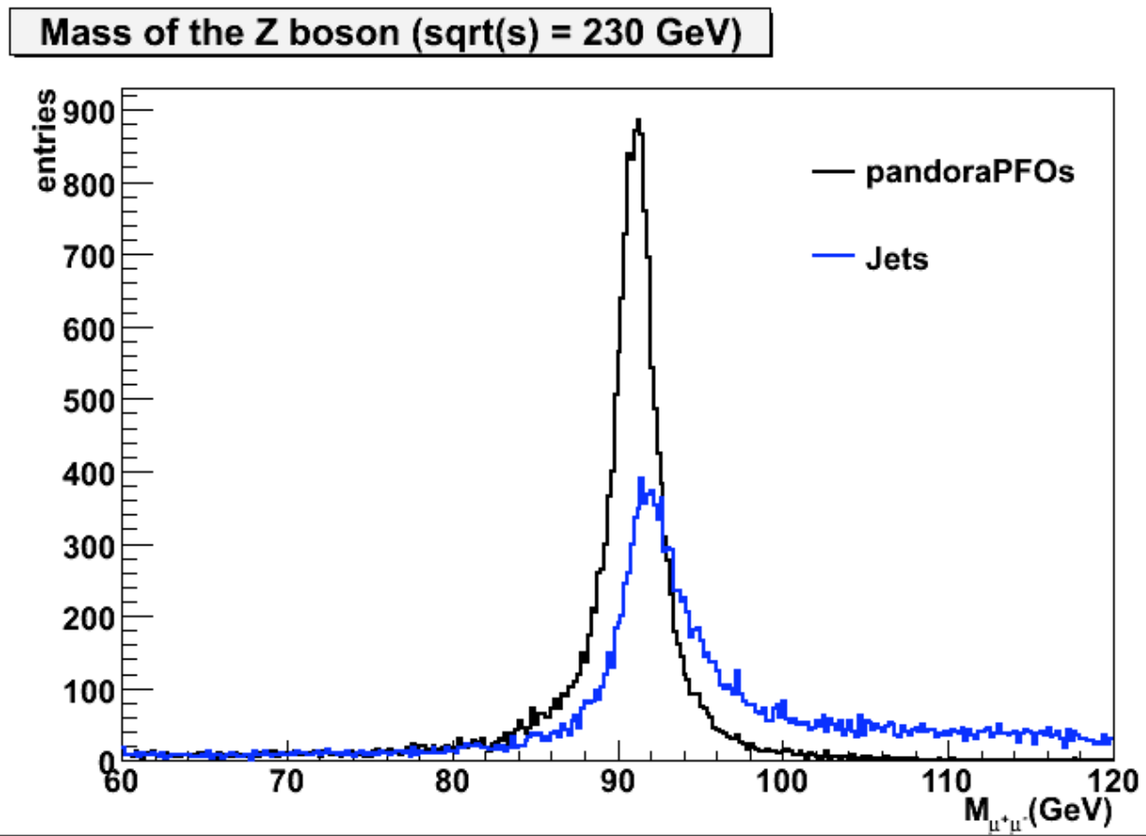
- Work underway refining cuts and calculate efficiency for muons from $Z(\rightarrow \mu^+\mu^-)H$ events.

$Z \to \mu^+\mu^-$ reconstruction

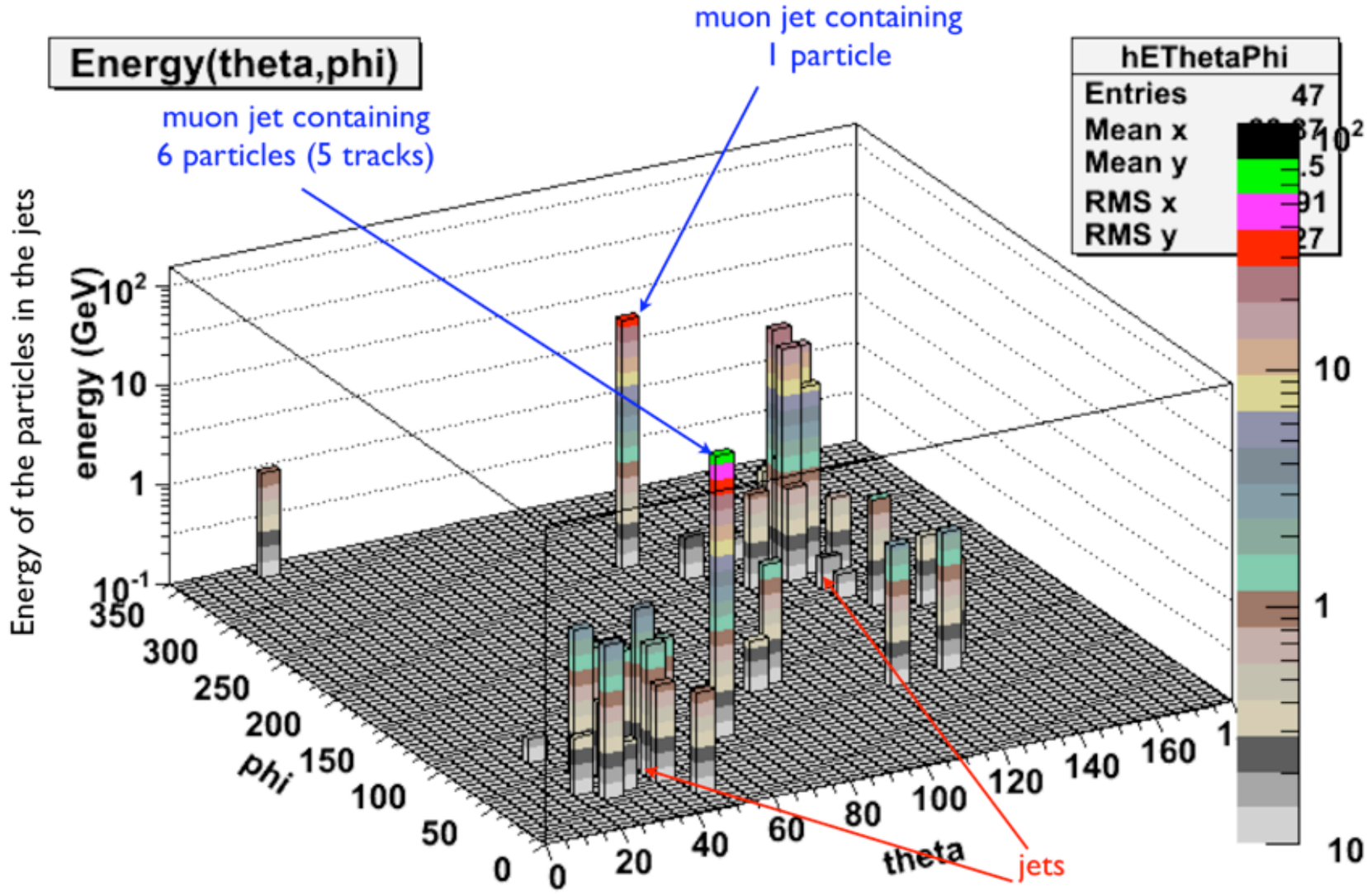
Roberval Walsh

- Use the muon ID selection to identify RecoParticles as muons
  - Using individual PandoraPF0s, as opposed to clustered jets, results in best resolution



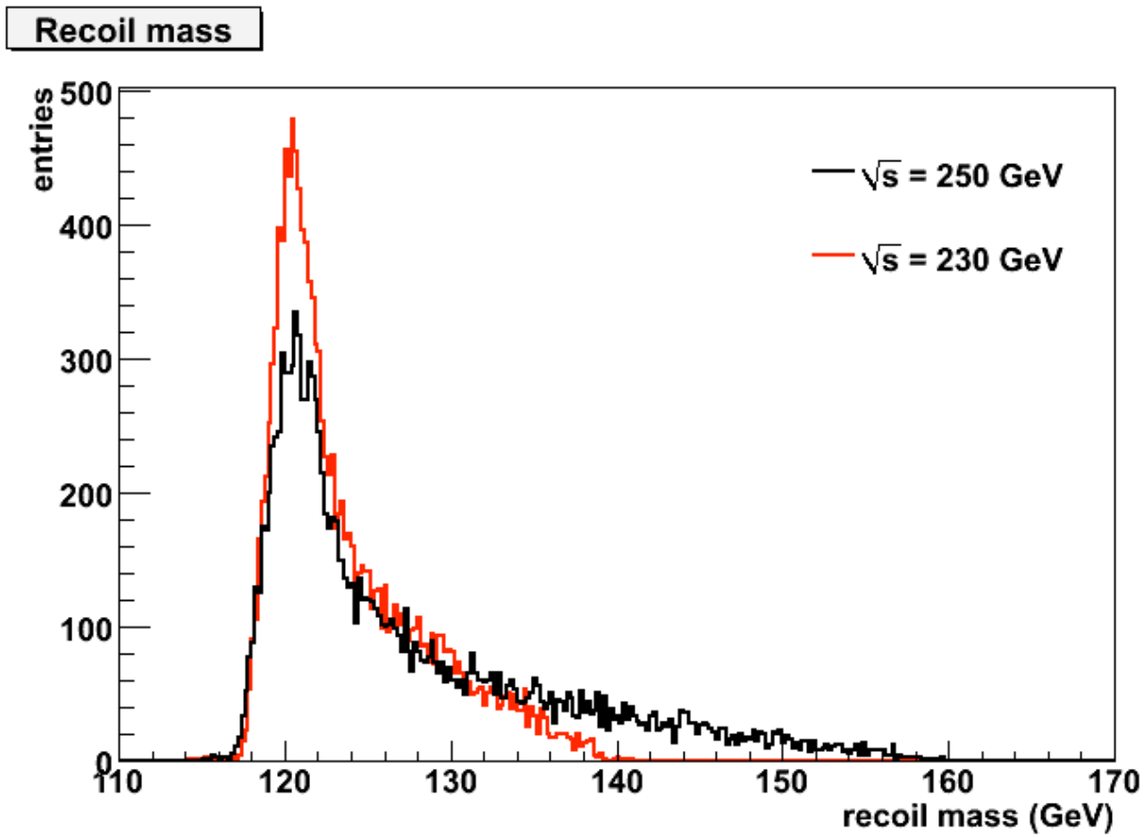


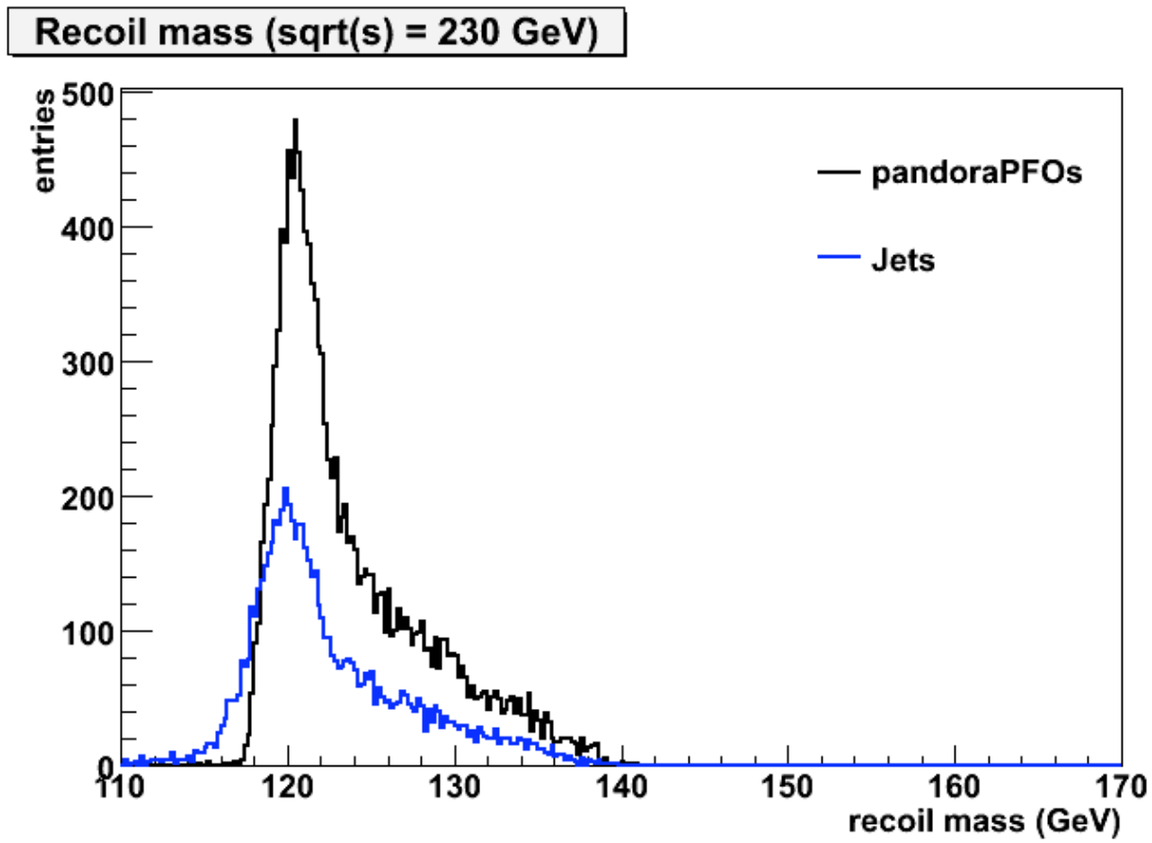
One $Z \to \mu^+\mu^-$ $H \to b\bar{b}$ event



- Conclusion: we need to remove the two identified muons and re-cluster the jets
- We will investigate clustering with 2-jets forcing and using a *y*-cut.
- Removal of leptons be more tricky for $Z \to e^+e^-$

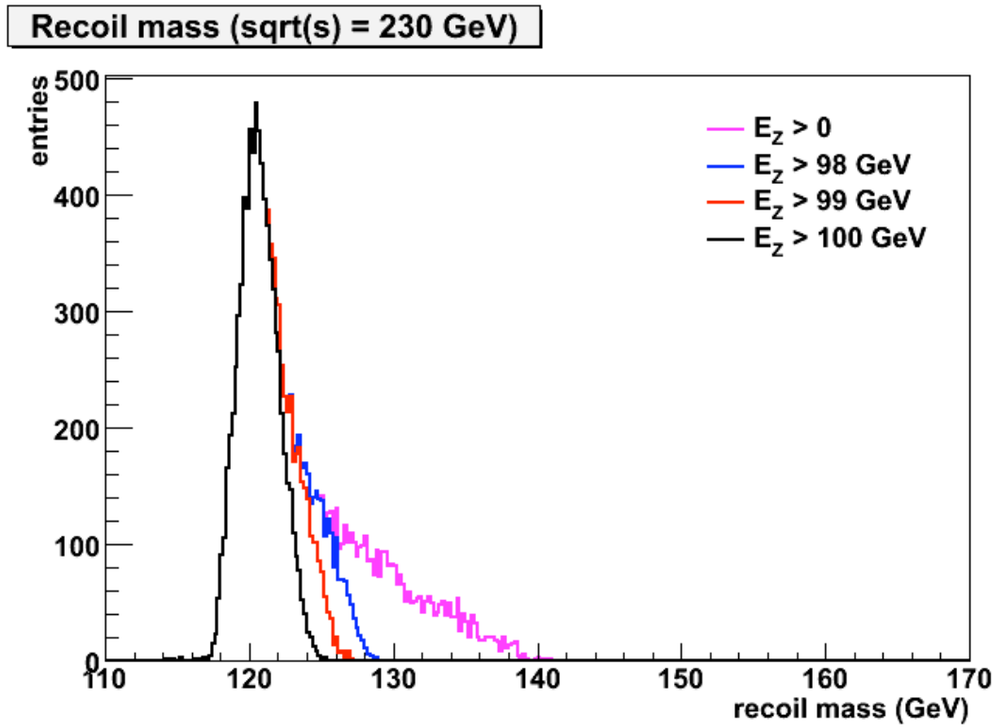
Recoil Mass reconstruction

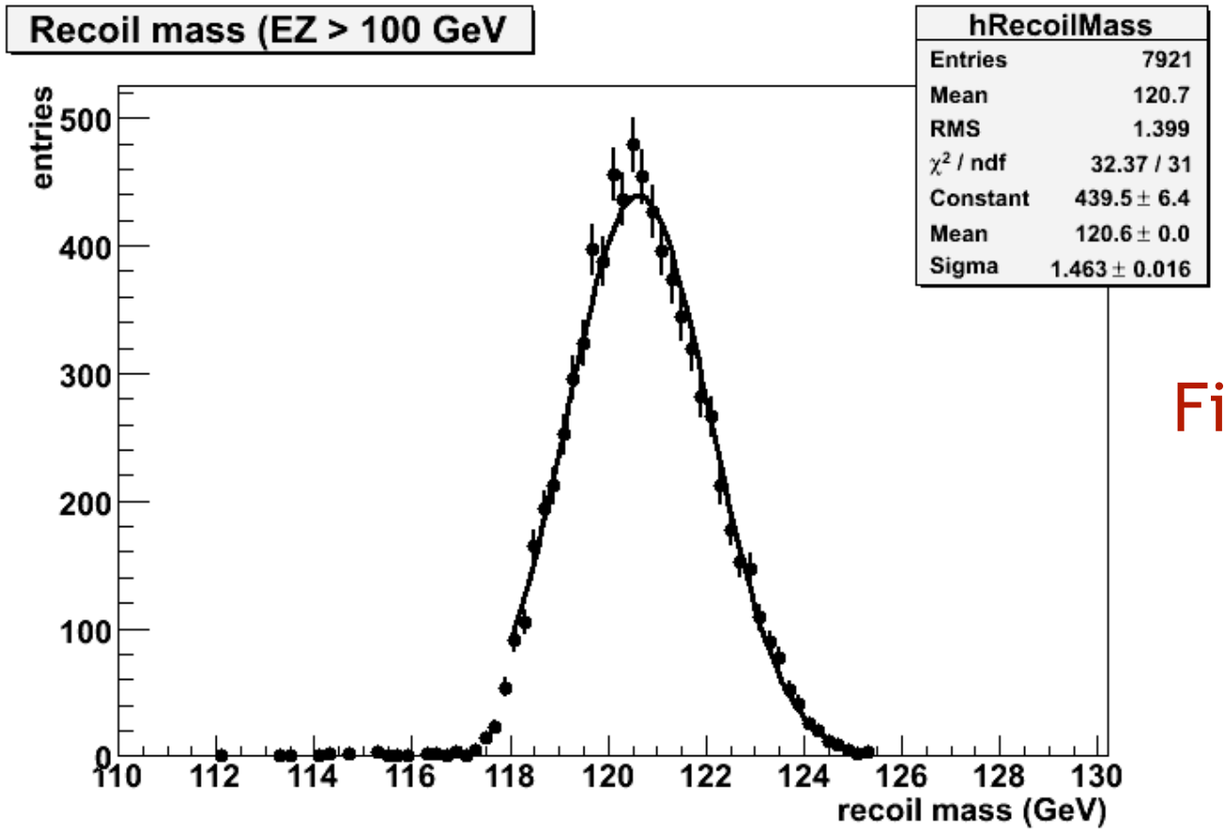




Recoil Mass reconstruction cont.

- We are considering cutting on Z boson energy to get remove beamstrahlung +ISR tail
  - Trade systematics by statistics?
  - Better significance?



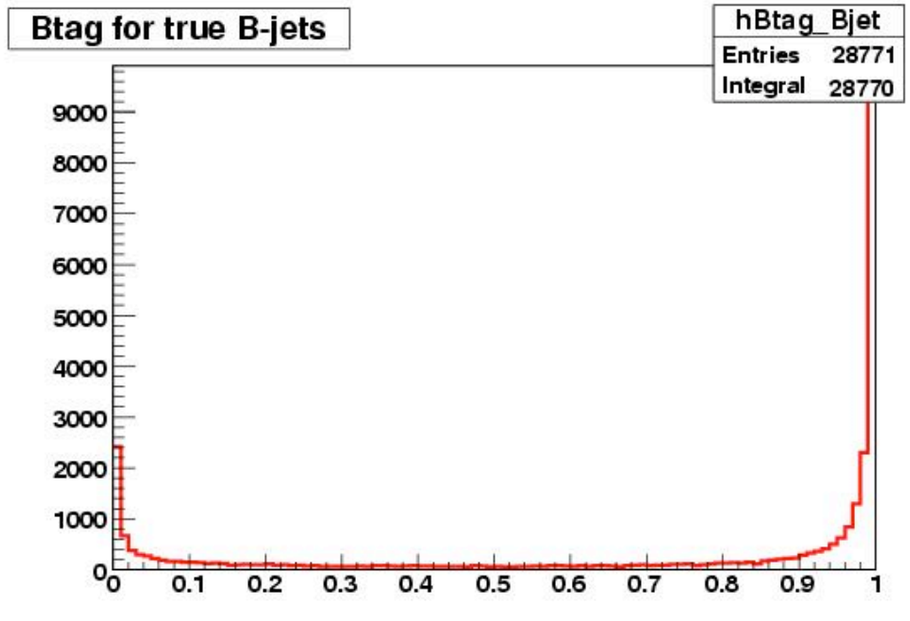


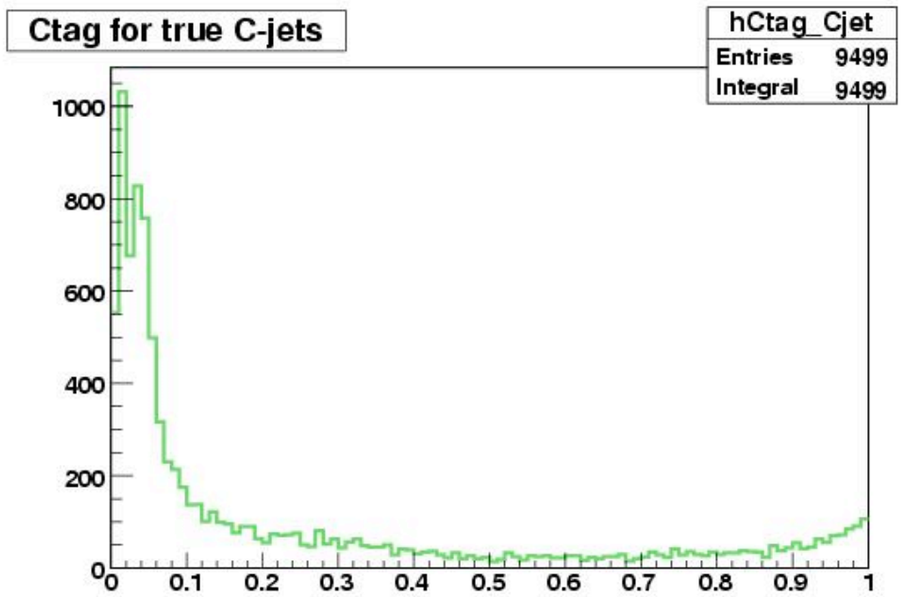
Fit to E_Z>100 GeV events
Mean: 120.6 GeV
σ: 1.46 GeV

Jet tagging

VM

- Using the information from LCFIVertex collection information for Durham_4Jets collections.
- To examine quality of tagging look at jets identified as true b-jets or c-jets (from MC)
- Tagging isn't optimum for this sample...
- We intend to retune the tagging and re-run

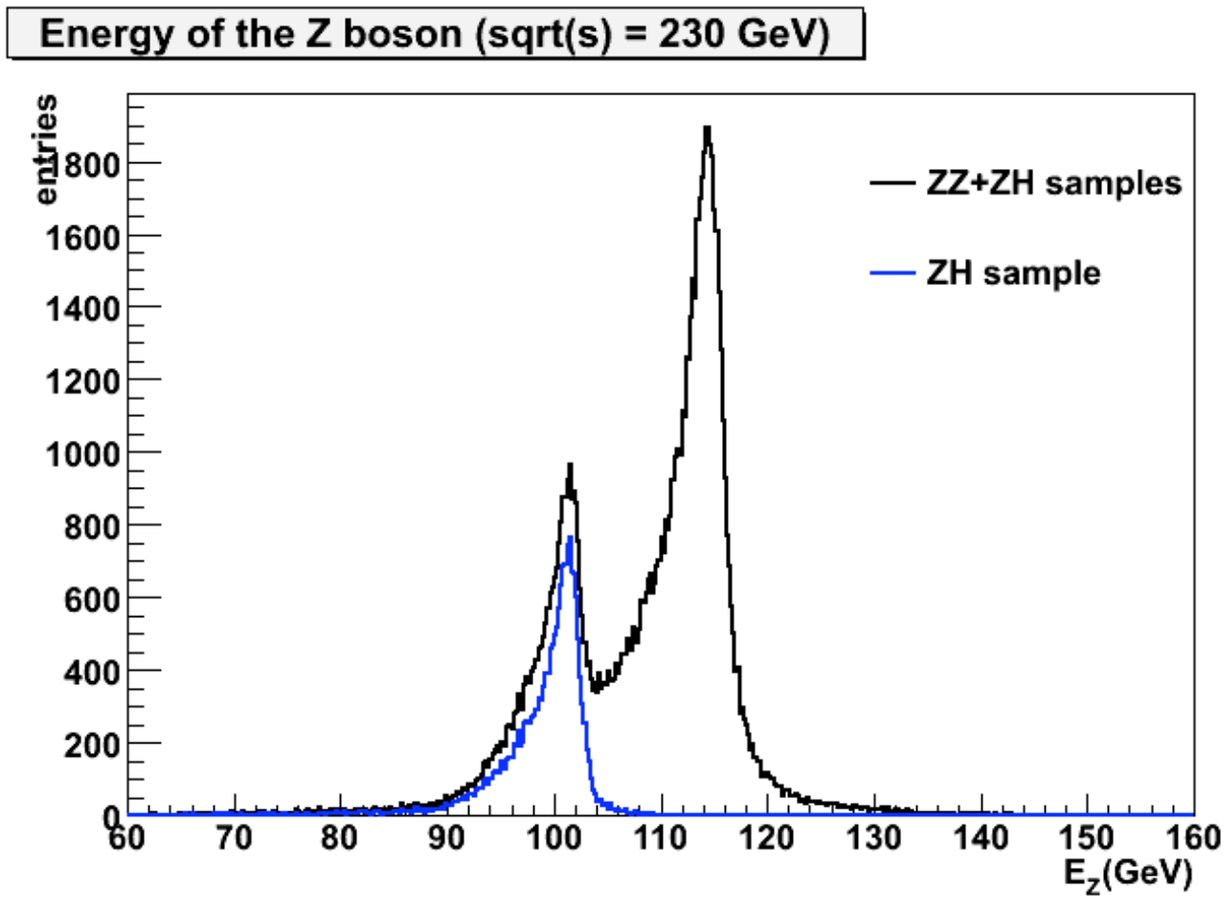


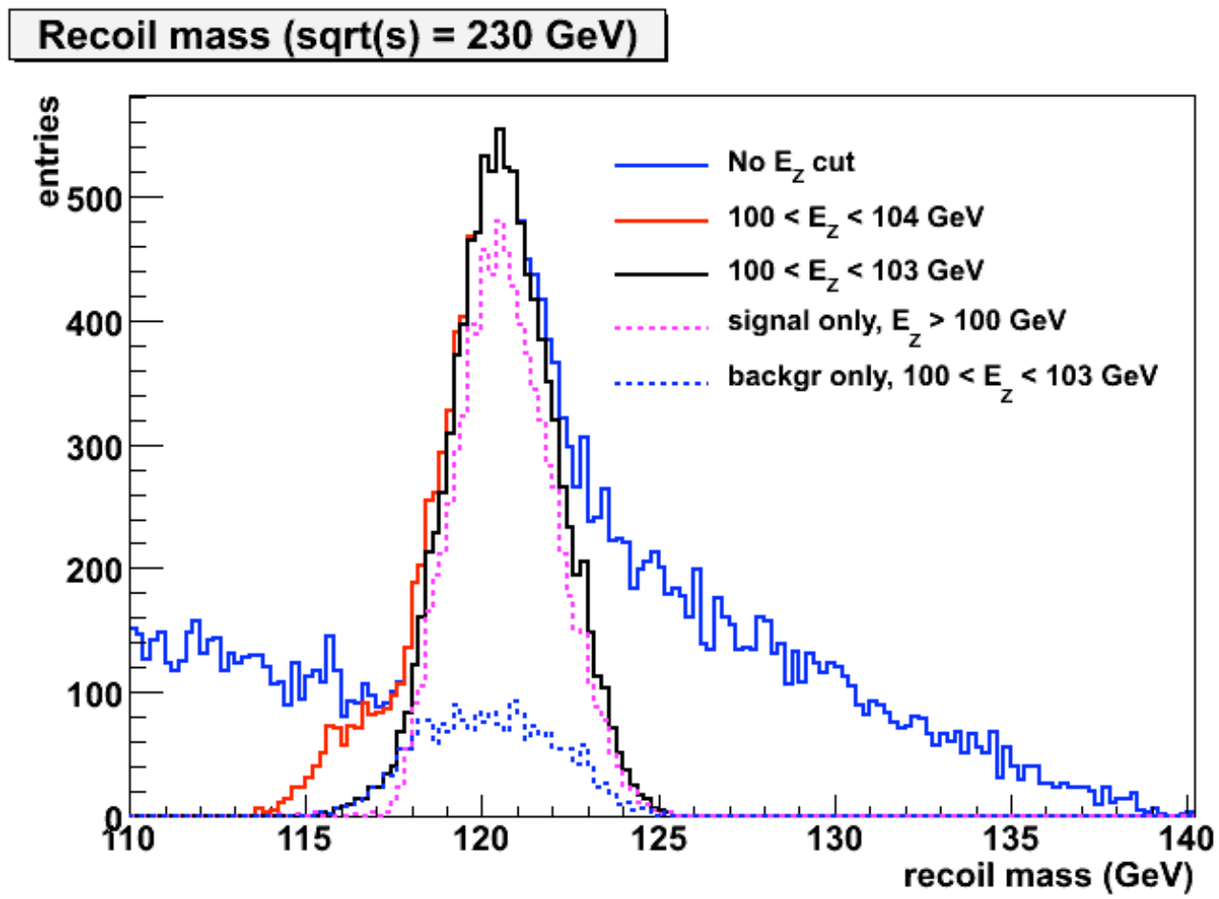


Separating Signal and ZZ background: lepton kinematics

Roberval Walsh

- First use a kinematic separation of *ZH* and *ZZ*
- Cut on E_Z >100 GeV, significantly reduces *ZZ* background.

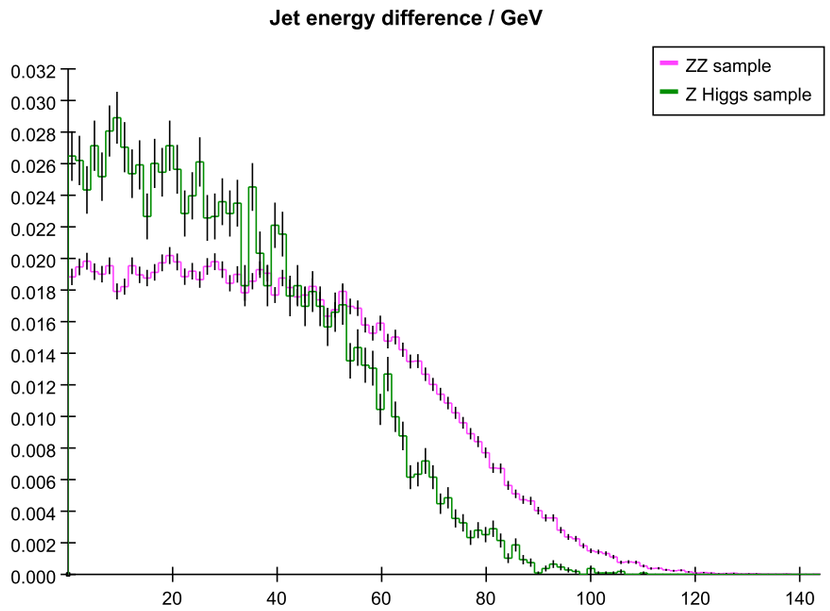


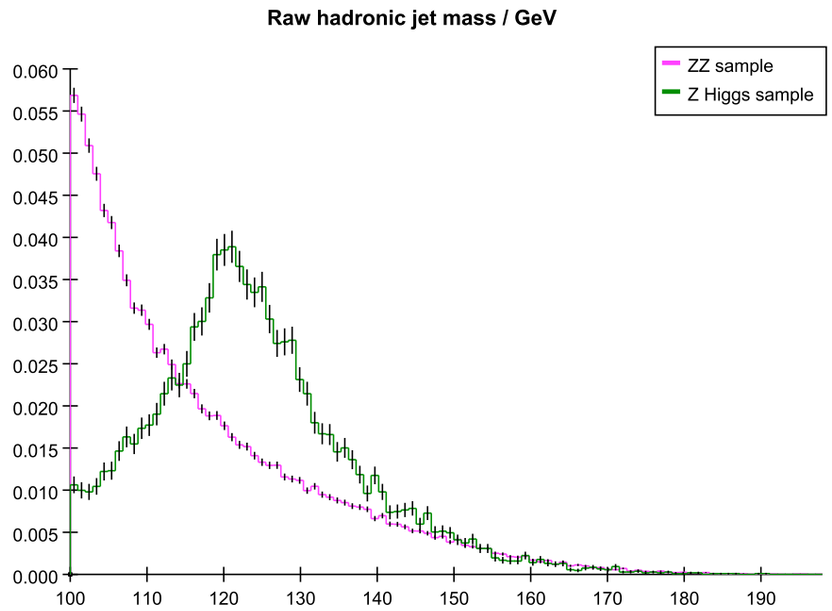


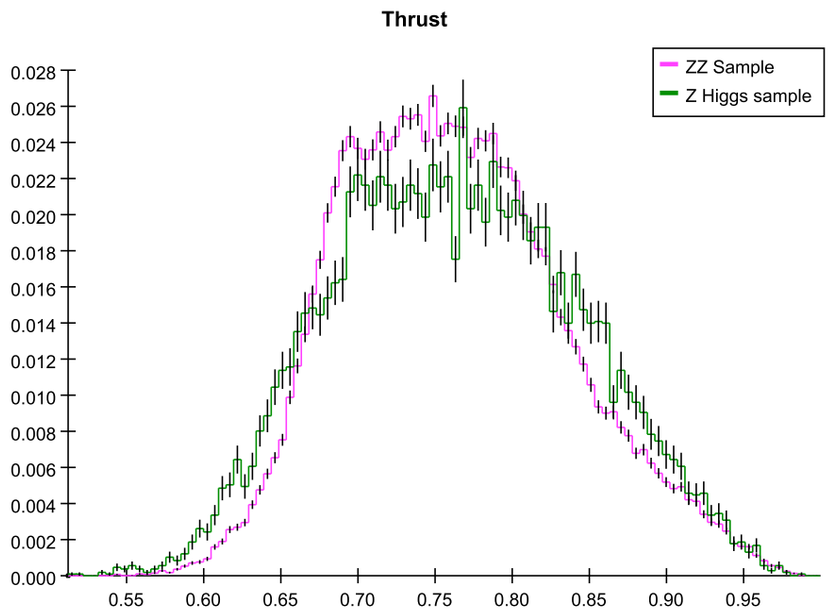
Separating Signal and ZZ background: jet kinematics

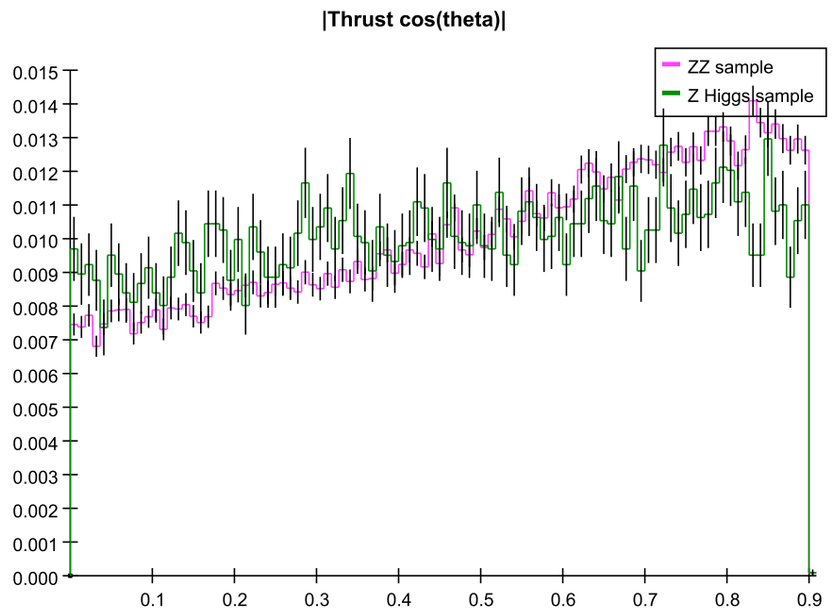
Mark Grimes

- e^+e^- + 2 jet events
- After removing the two electrons, and re-clustering with 2 jets.
- Following Kuhl and Desch, look at the jet kinematics to separate background and signal





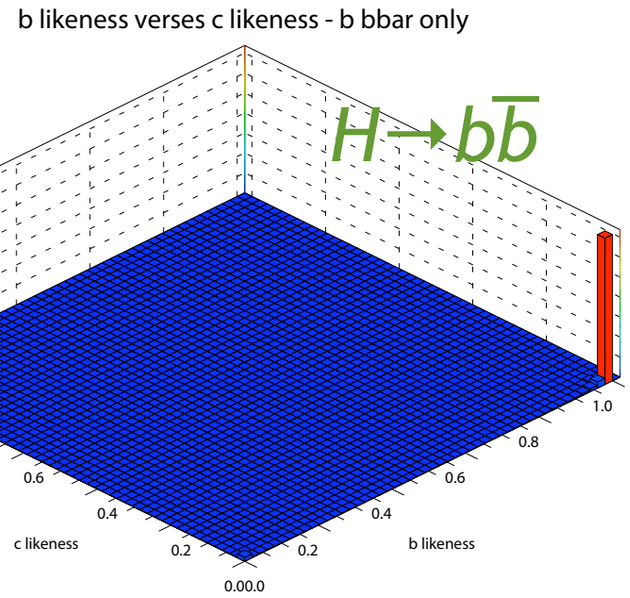


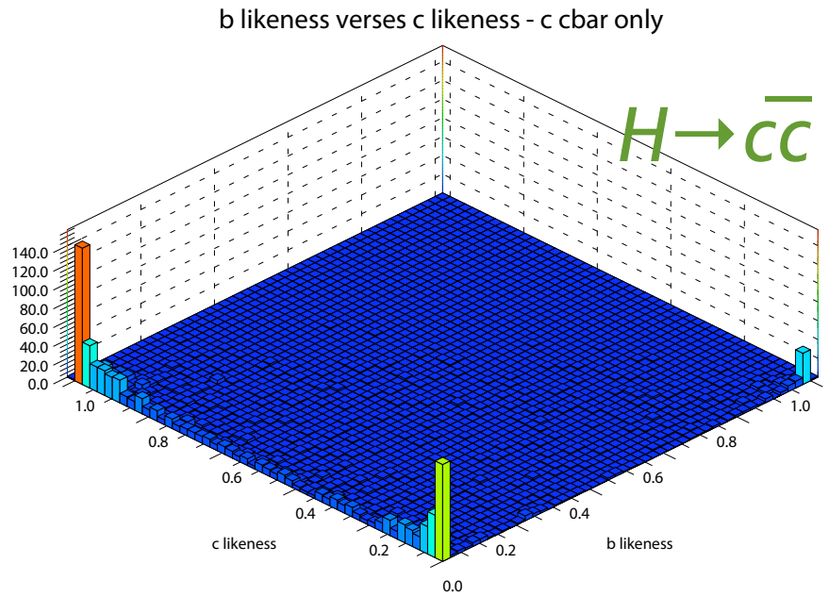


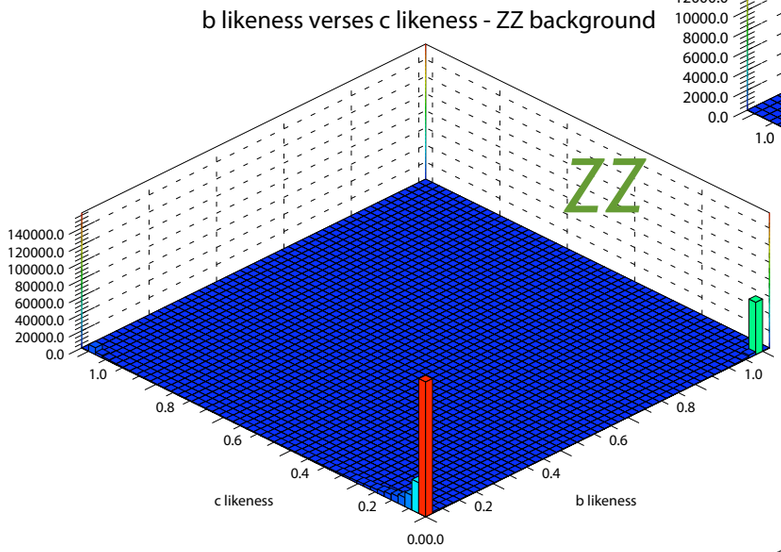
$b\bar{b}$ and $c\bar{c}$ likeness

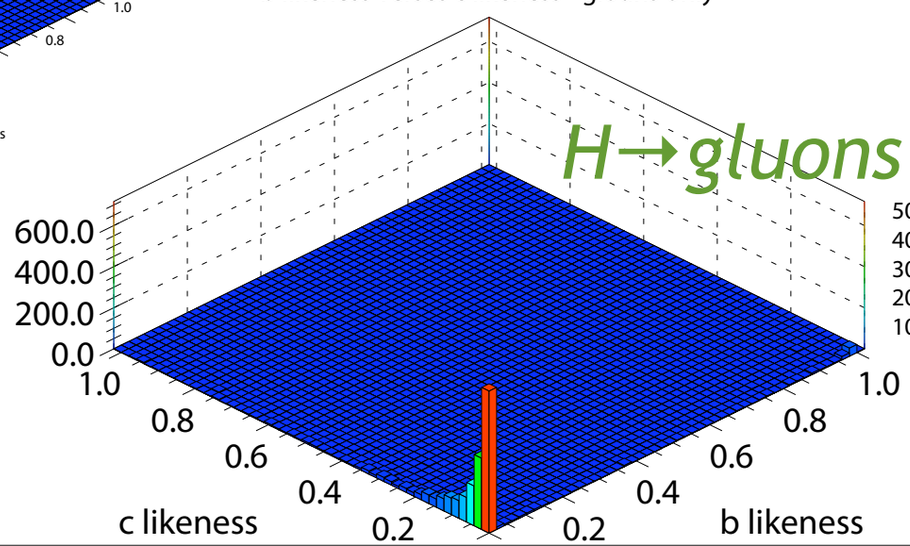
Mark Grimes

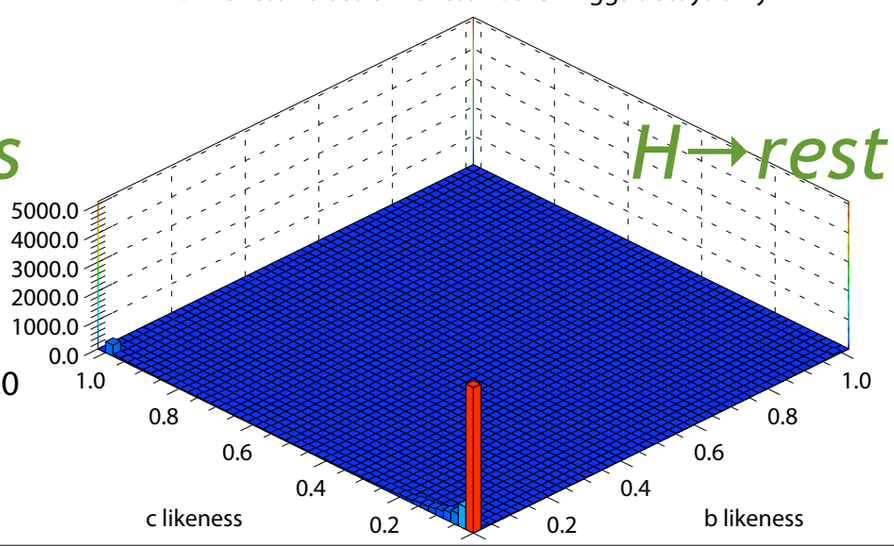
- Define the likeness variables, for a pair of jets, using the *b* and *c* NN tag values:
  - *b*-likeness= (b1*b2)/(b1*b2 + (1-b1)*(1-b2))
  - *c*-likeness= (c1*c2)/(c1*c2 + (1-c1)*(1-c2))
- Good discrimination between $H\rightarrow b\bar{b}$, $H\rightarrow c\bar{c}$ and ZZ
- Will use these as templates to fit to the observed distribution











Summary and Conclusions

- The software is finally ready for a reasonable analysis of the Higgs branching ratios.

- We are starting to develop a strategy for our analysis.
  - Can't use just the DST information. Need to:
    - indentify leptons, remove and re-cluster
    - tune and re-run *b* and *c* tagging for this signal
    - Use *b*-tag and *c*-tag likeness variables to fit for $ZH(\rightarrow b\bar{b})$, $ZH(\rightarrow c\bar{c})$ and ZZ.

- We intend to keep working on this analysis, however manpower is becoming an issue. We are happy to collaborate with other groups.