Higgs Branching Ratio from ZH→Hll

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On behalf of:

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Victoria Martin, Hajrah Tabbasam and Roberval Walsh

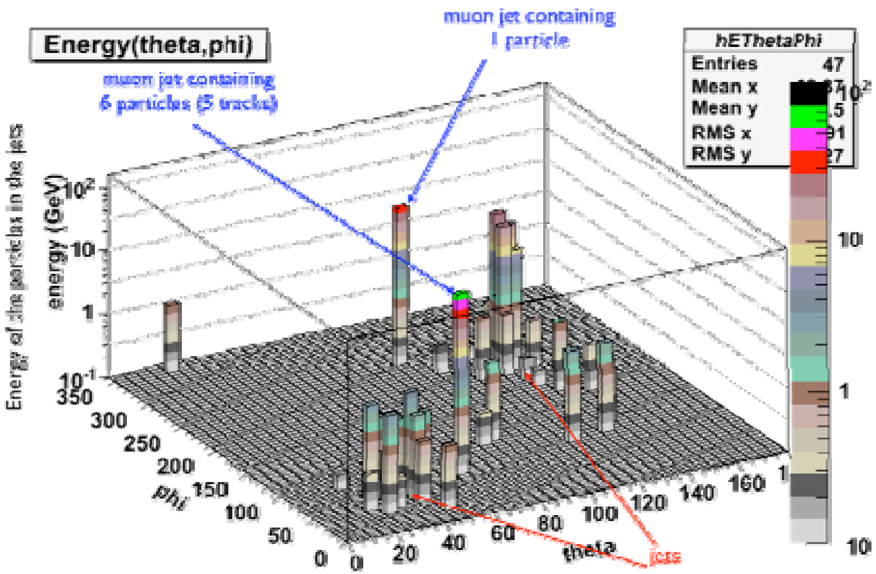
Also with some slides from Satoru Uozumi, Kobe University

Strategy

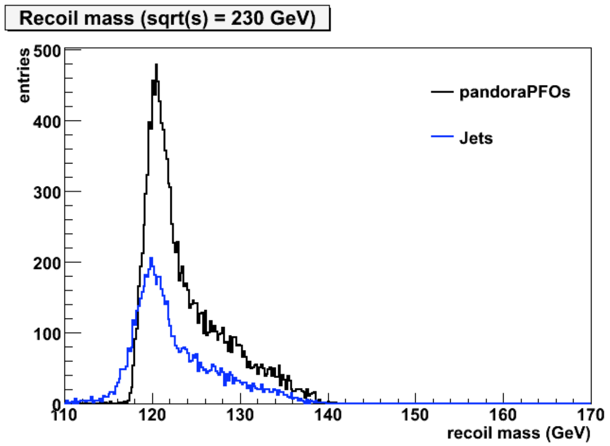
- Looking at events with 120 GeV Higgs and 250 GeV √s (some $Z \rightarrow \mu^+\mu^-$ studies done at 230 GeV √s).
- Bristol has been looking at $Z \rightarrow e^+e^-$.
- Edinburgh has been looking at $Z \rightarrow \mu^+\mu^-$.
- Concentrating on the ZZ background for the time being.
- Up until recently using our own samples, before moving over to the mass production samples. The following plots are first results from the LDCPrime_2Sc mass production (unless otherwise stated).

Lepton ID

Victoria Martin has already discussed the need to identify the primary leptons, remove them, and then recluster*.



Roberval Walsh



Roberval Walsh

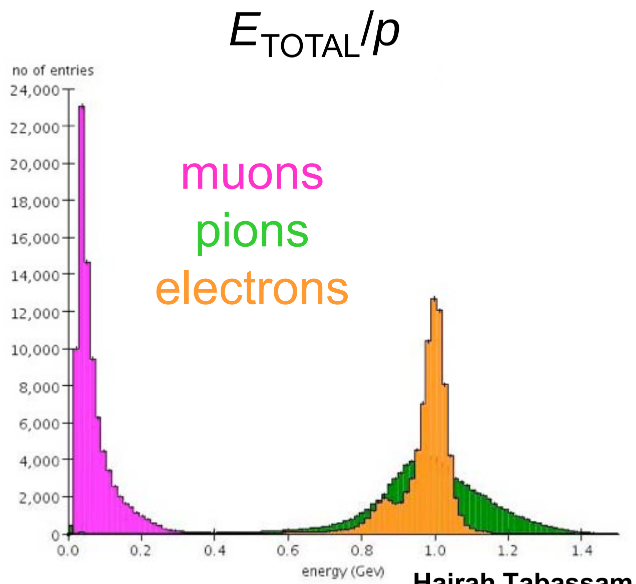
*See her talk to the working group on 30/July/2008

Muon ID

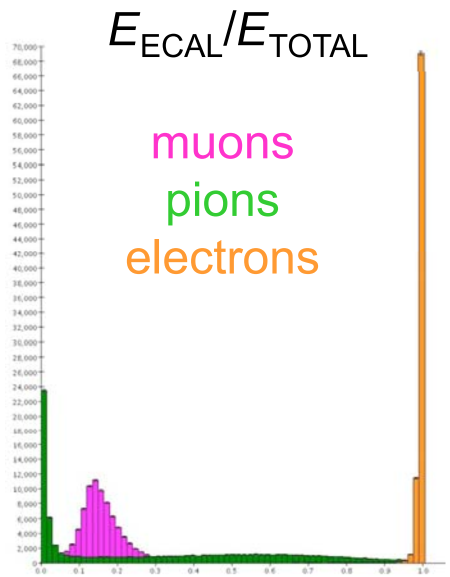
Hajrah Tabassam has been looking at single particle samples to develop a set of muon cuts

Muon cuts

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



Hajrah Tabassam



Hajrah Tabassam

Electron ID

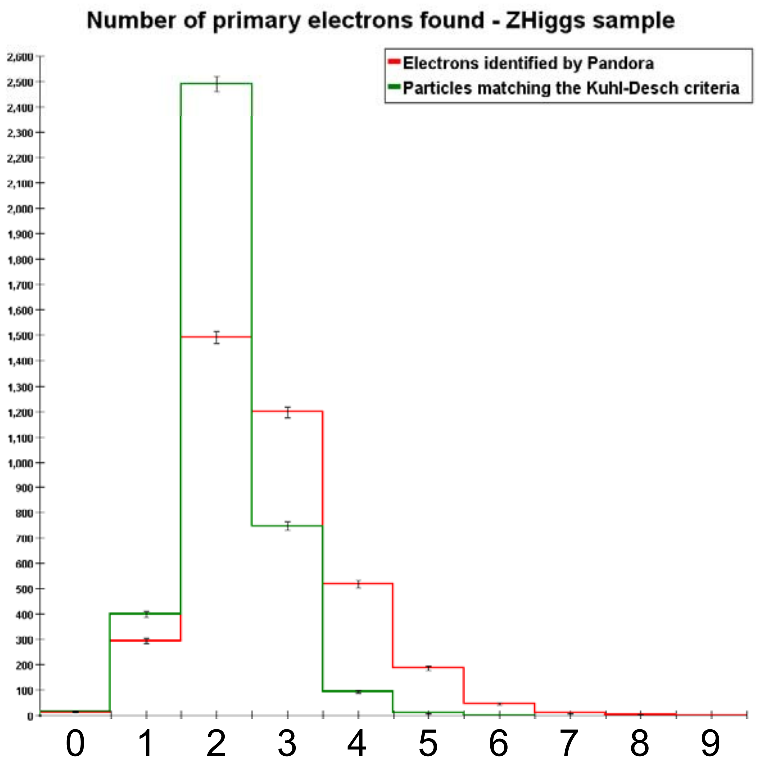
- Using the same electron ID as in the Kuhl-Desch LC Note*

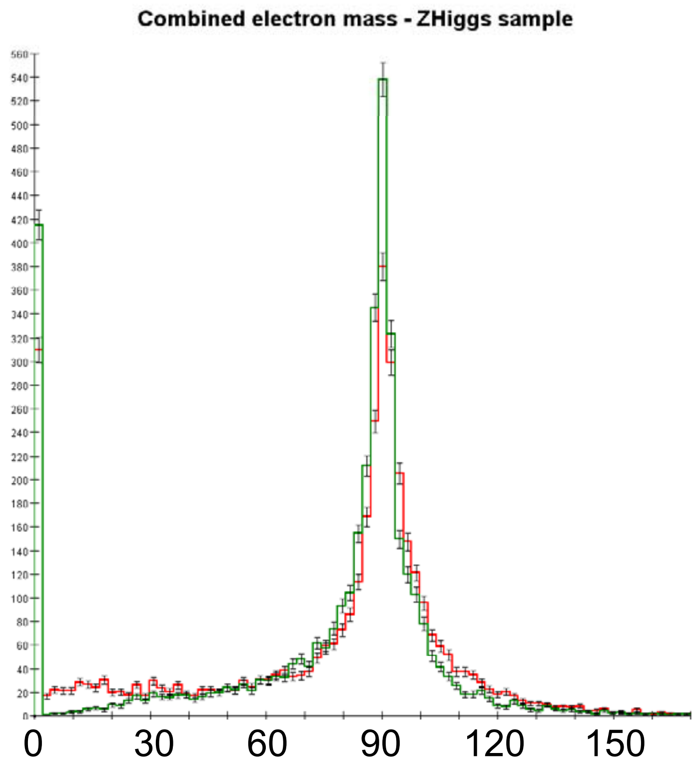
  - Track with momentum larger than 4 GeV associated to a calorimeter cluster
  - No other track within 5 degrees
  - The energy in the hadronic calorimeter must be less than 2 GeV and less than 5% of the total energy

*LC-PHSM-2007-002

Electron ID

These cuts perform slightly better than Pandora's internal electron ID



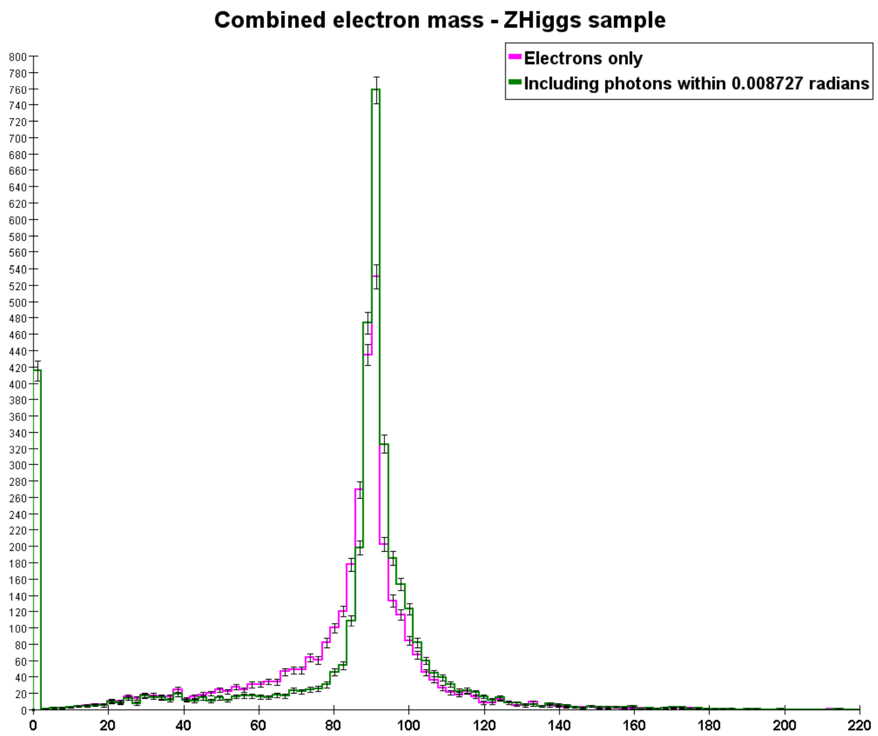


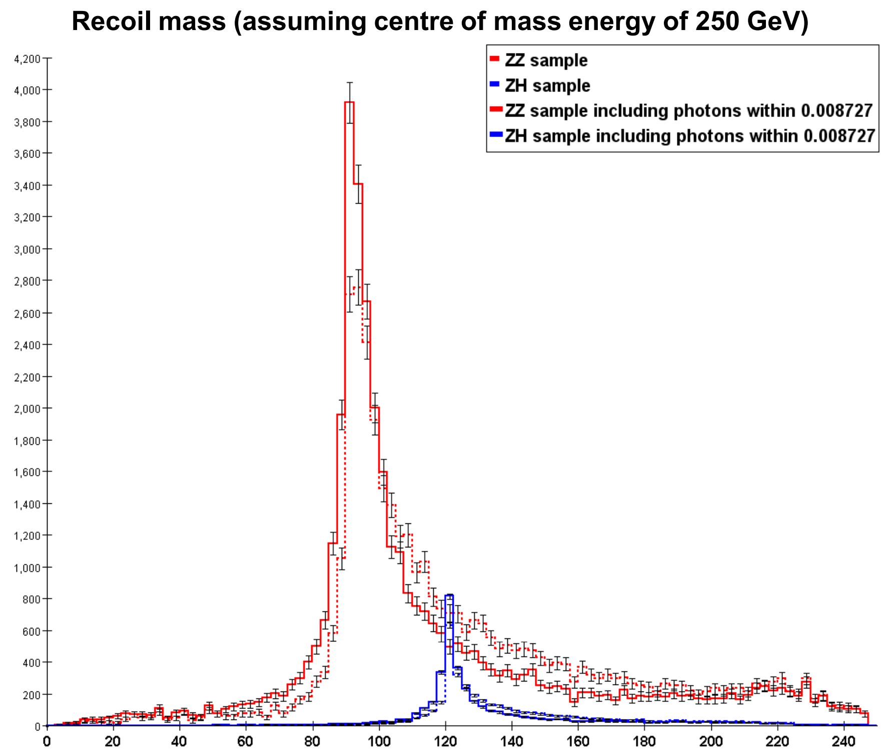
…although Pandora probably doesn't use an isolation cut.

Di-lepton mass

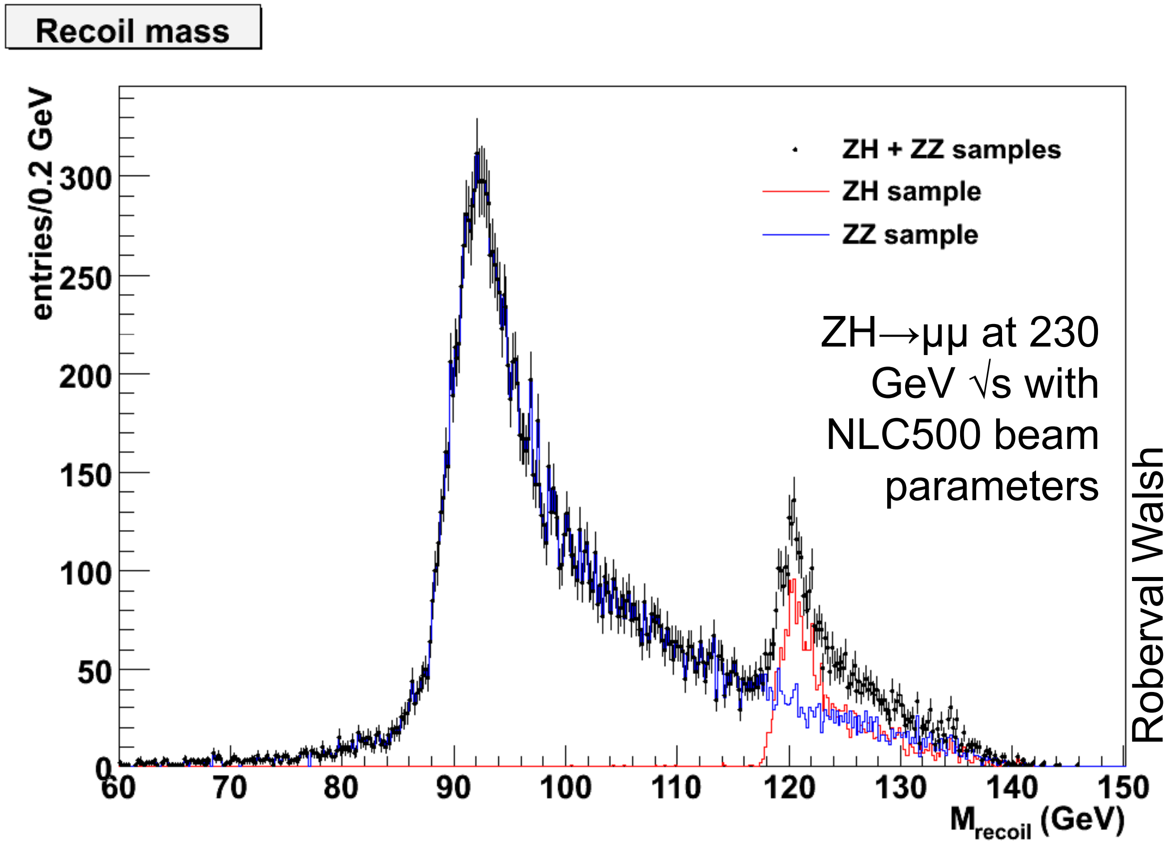
- The electron sample didn't give as good results as the muon sample.
- Observed that problem events had high energy bremsstrahlung.
- Tried looking for photons (as identified by Pandora) within a set angle of the identified electrons.

Bremsstrahlung





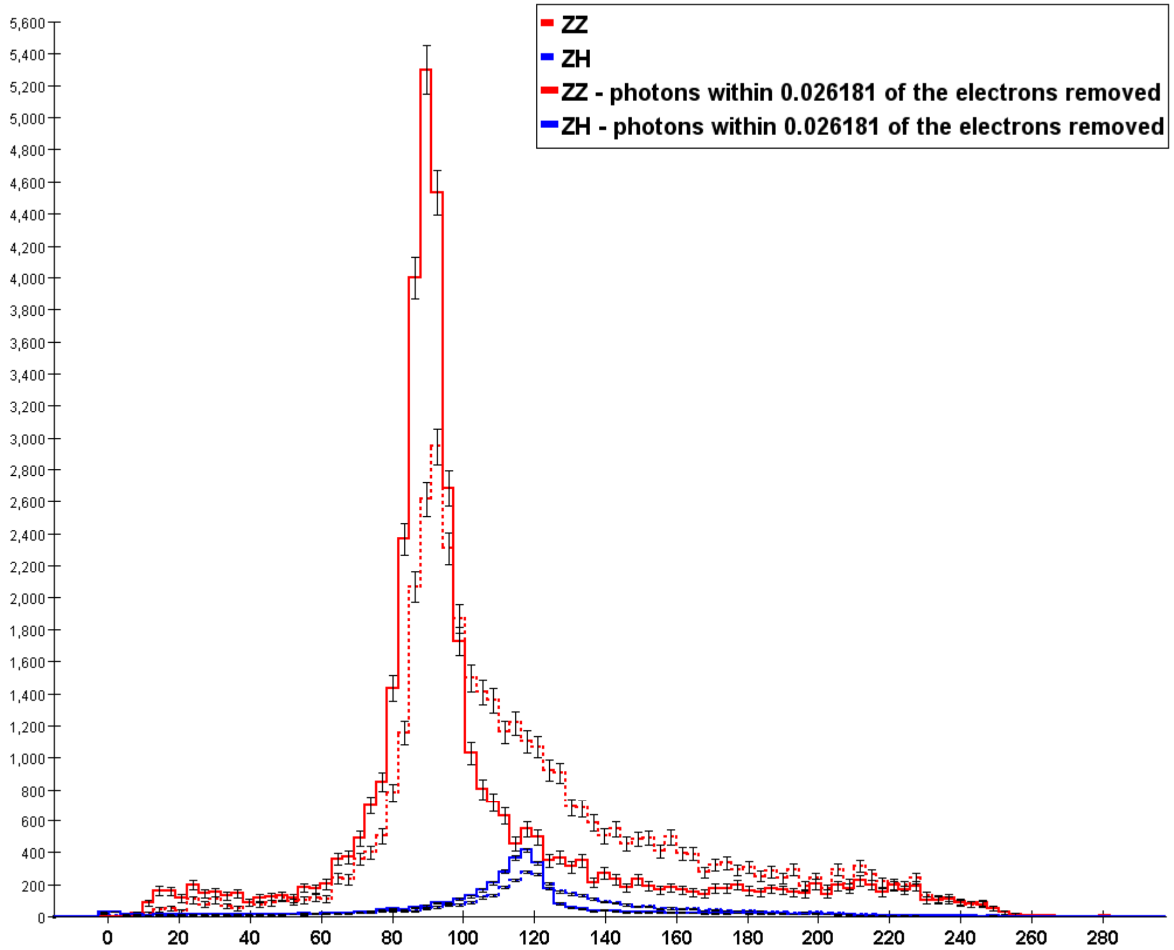
Recoil mass



The recoil mass for the mass production samples is much better than for our samples due to our over-estimation of the beam effects.

Di-jet mass

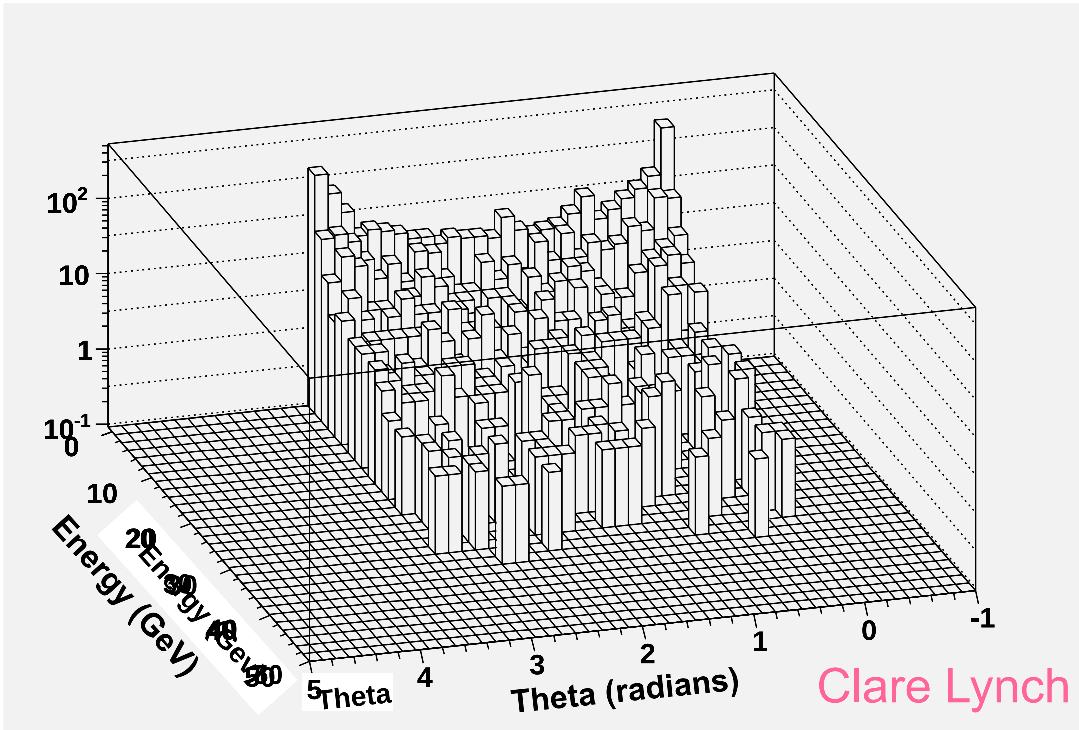
If forcing to n jets, need to be careful not to include anything that is not part of the jets.



ISR/Beamsstrahlung

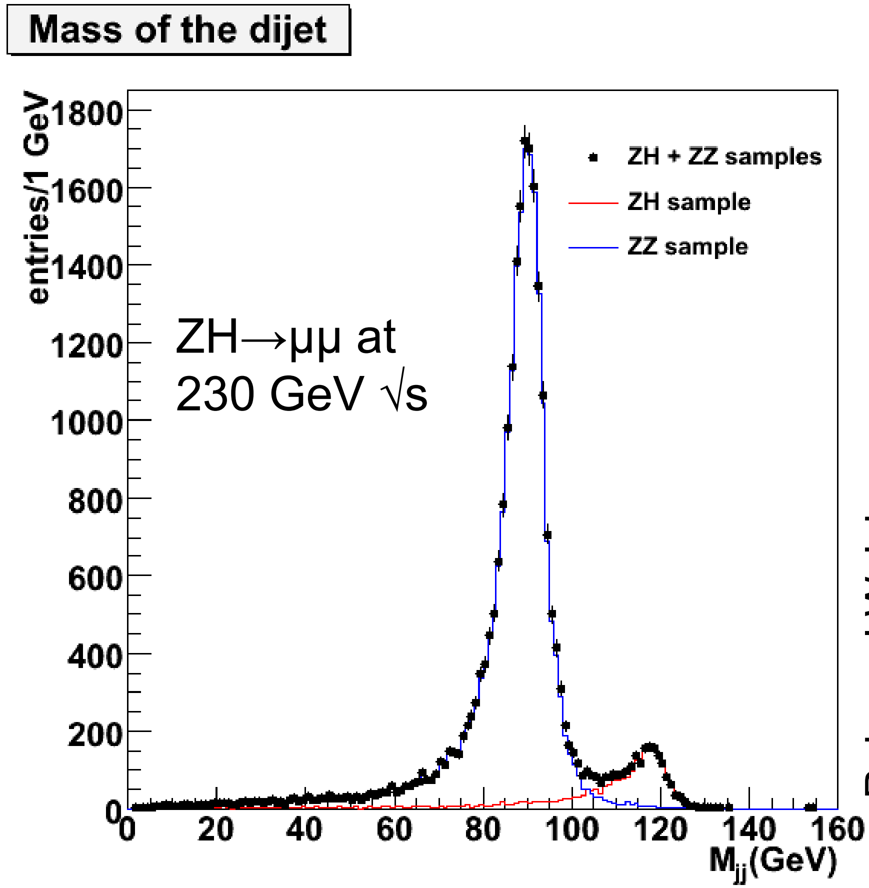
- The majority of Initial State Radiation/beamsstrahlung photons are low energy, but can decrease mass resolution if forced into the jets.

- Currently investigating identifying these to get a better idea of √s and hence better recoil mass measurements - how do you distinguish between initial and final state radiation?



Di-jet mass

• Observed low tails on the Higgs di-jet mass.



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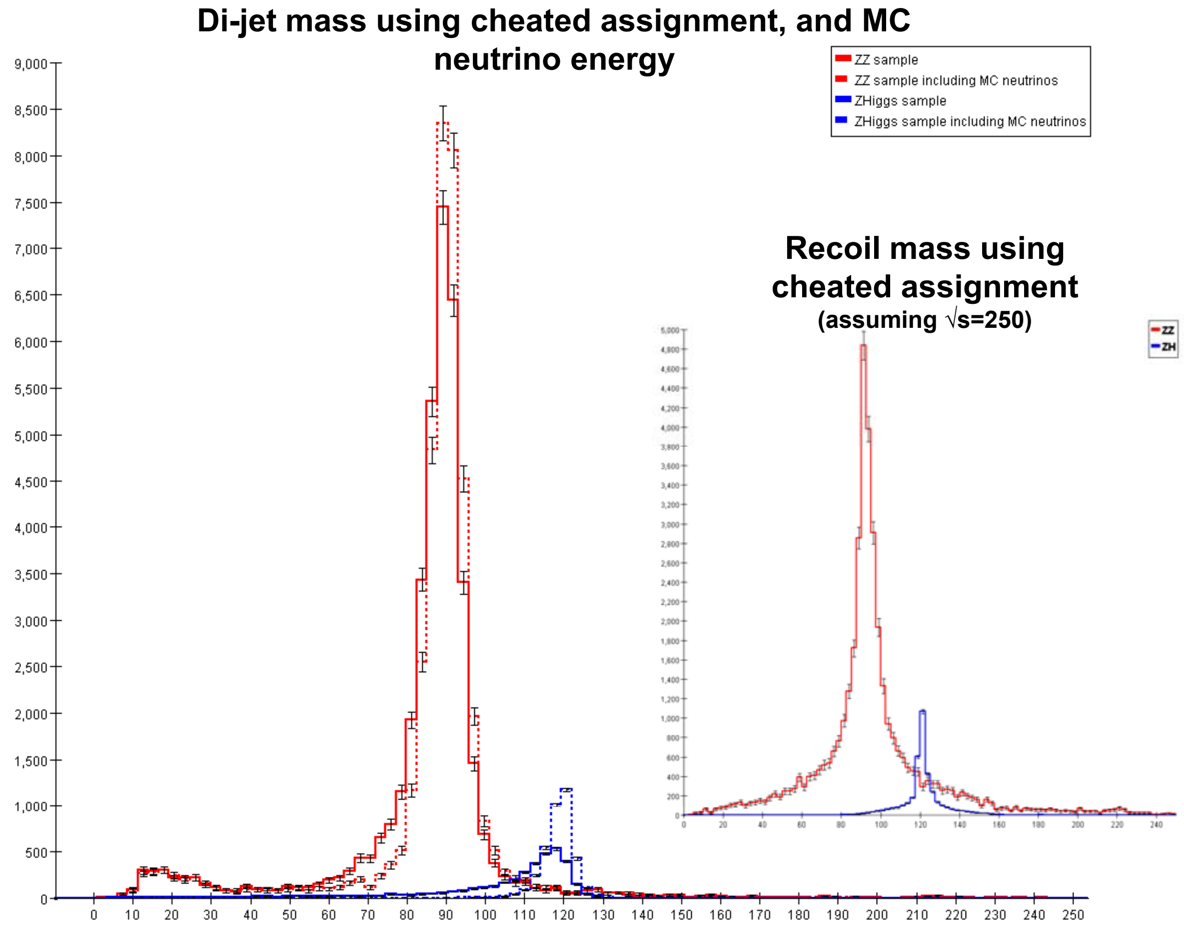
Neutrino effects

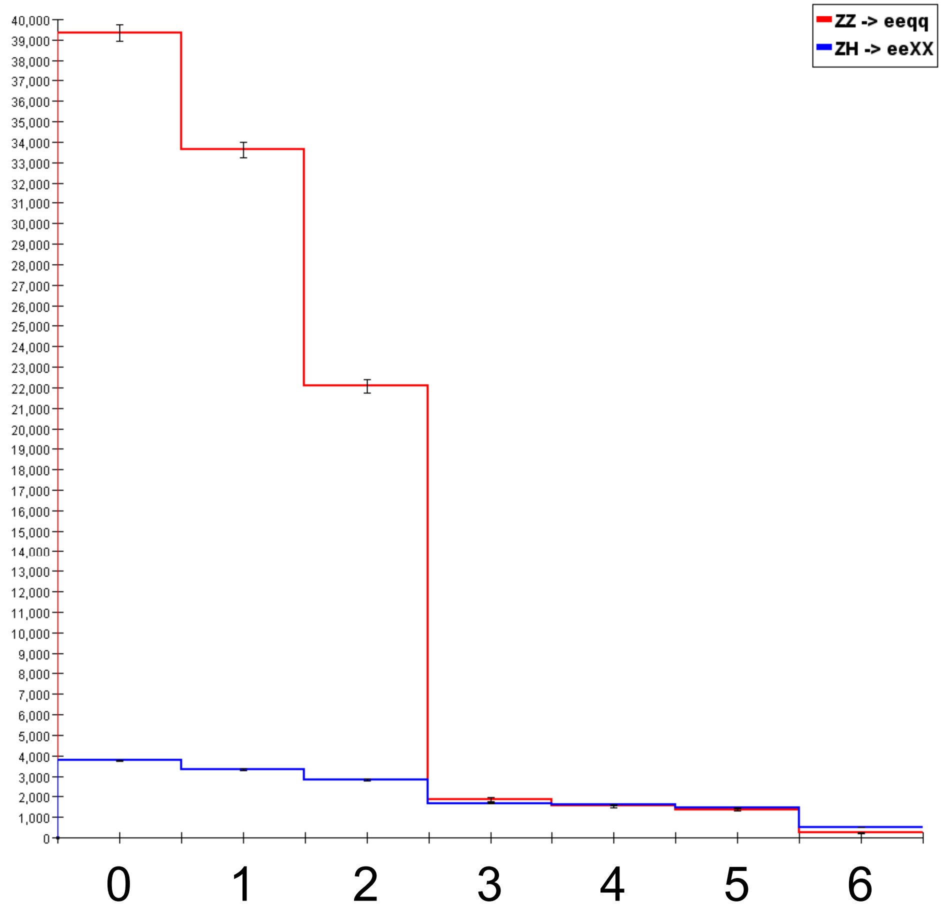
• Cutting on the di-jet mass biases the sample because decay modes involving neutrinos (e.g. H->bb) will be preferentially cut.

• Much better to cut on the recoil mass



Event selection

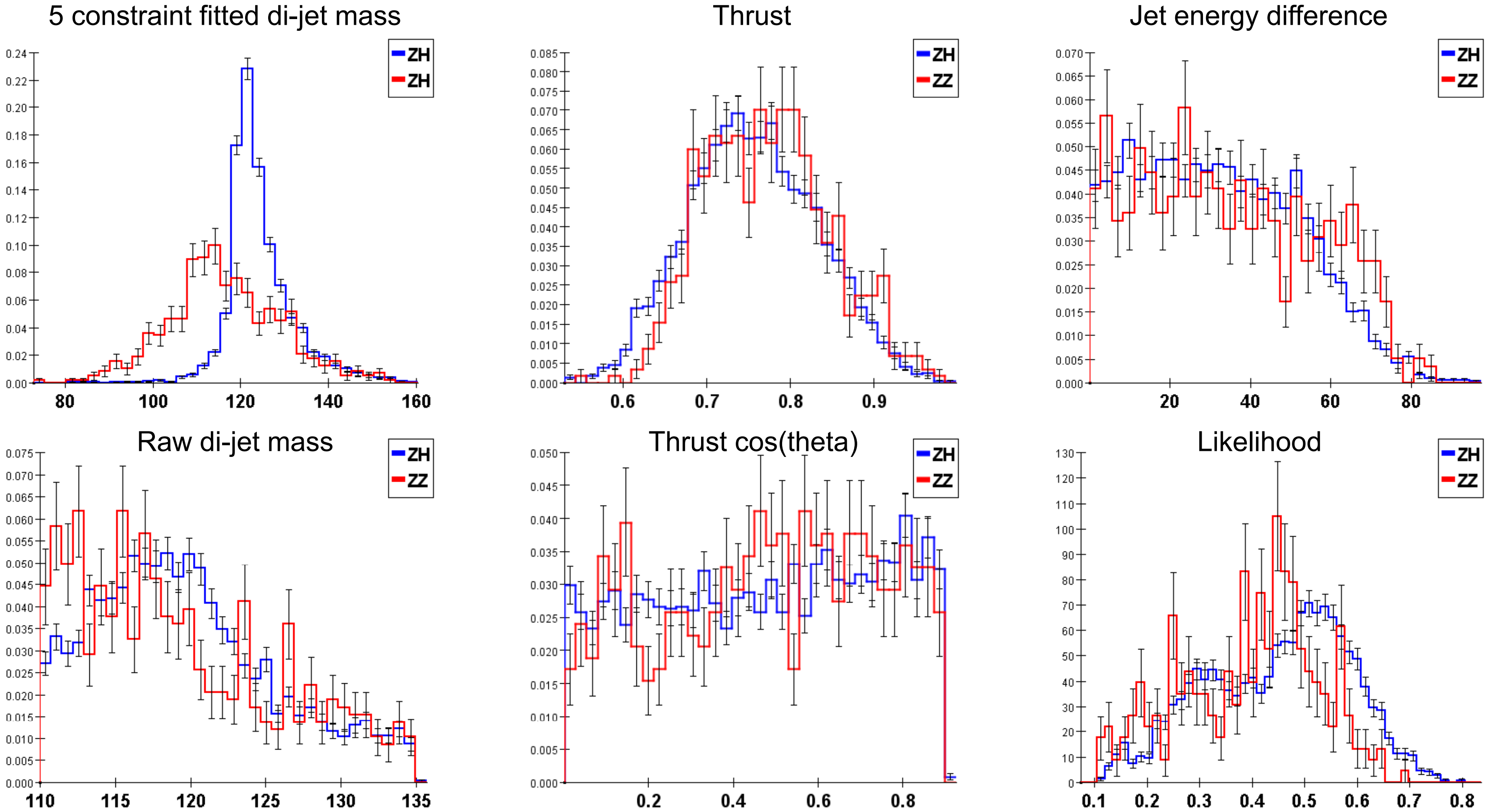
Number of events left after each cut



Currently still following the Kuhl-Desch approach:

1. More than 2 electrons
2. 70 < di-electron mass < 110 GeV
3. Di-jet mass > 100 GeV
4. Di-jet mass < 135 GeV
5. Thrust cos(theta) < 0.9
6. Likelihood cut (next slide)

Likelihood cut

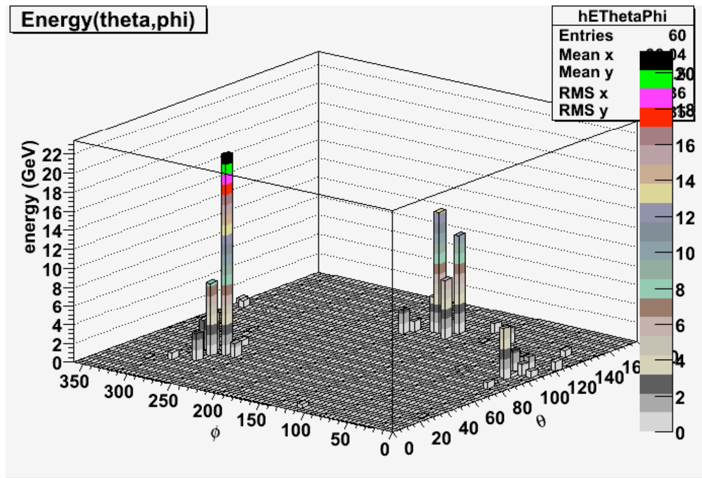


…needs a lot more work, and more statistics. Kuhl and Desch managed S/B ~ 2.8

Flavour tagging

We are currently considering whether to force to two jets, or to use a ycut that would keep gluon fragmentation in separate jets.

- This could potentially improve flavour tagging performance.



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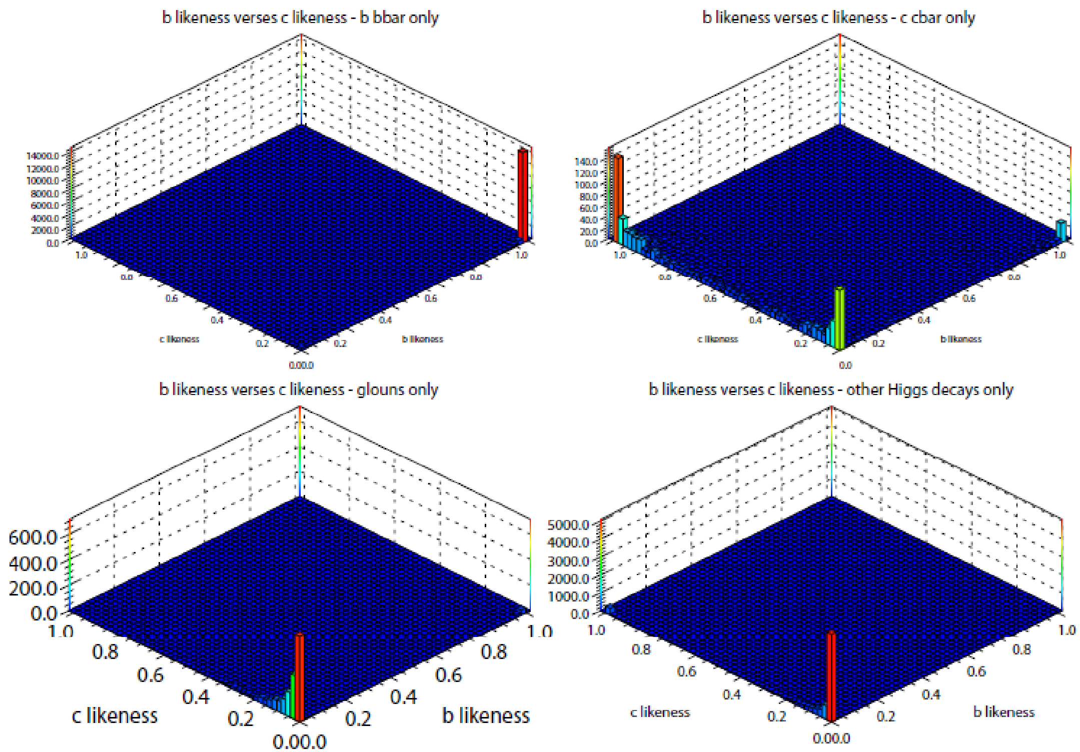
Branching ratio fit

The branching ratio is extracted by fitting to templates.

- Creating the templates will take a significant number of events, as well as test events to use them on.
- We may need to generate our own samples to complement the mass production samples



43000 event (before pre-cuts) LDC01_05Sc sample

Summary/Future plans

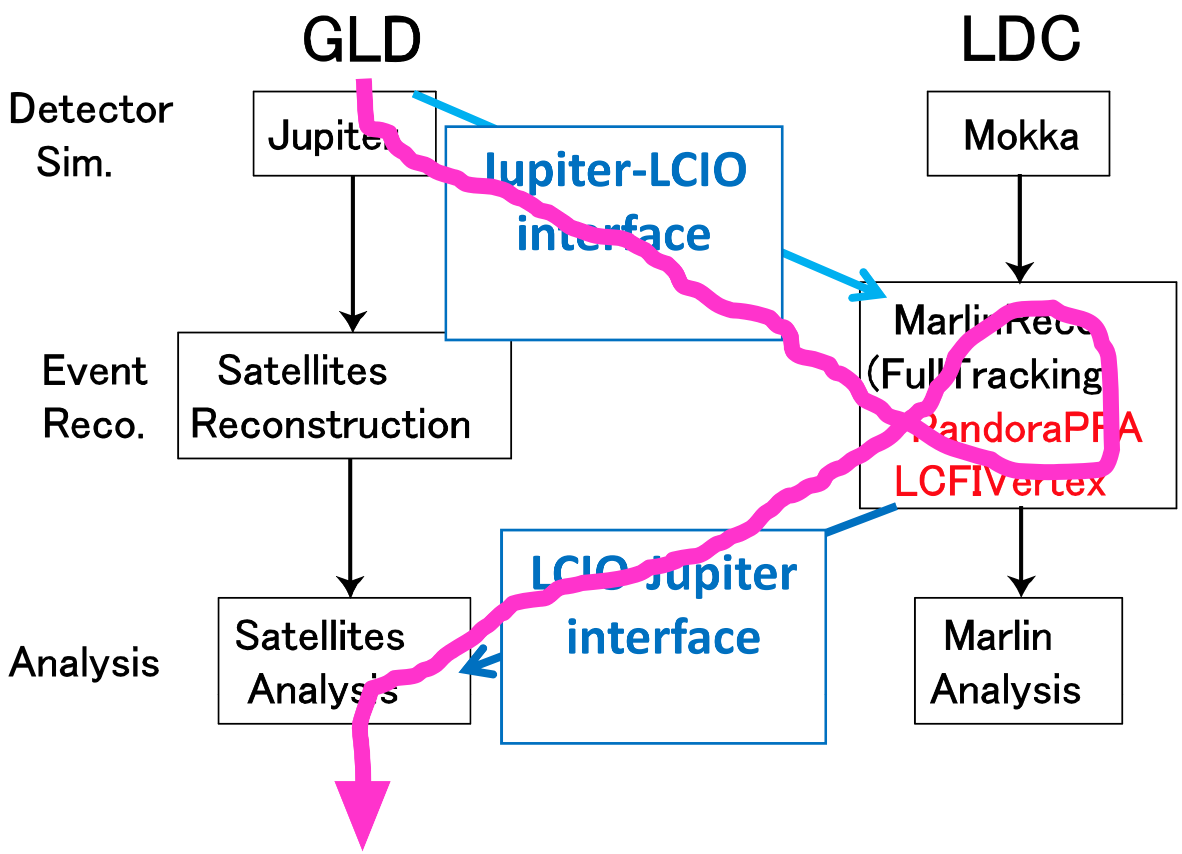
- Need to confirm sample cross sections.
- Selection cuts need tweaking and different likelihood variables should be investigated.
- Use the recoil mass as well as or instead of the di-jet mass for selection. How well can you determine $\sqrt{s}$ on an event by event basis?
- Need more events for the templates.
- Look at results for the different detectors, although we probably don't have the resources to create extra events for more than one detector.
- We need to investigate flavour tag performance for ycut and njet jet finding.

$H \rightarrow qq$ work in Japan

Satoru Uozumi apologises for being unable to attend, but has asked me to show some of the work ongoing in Japan.

ZH -> $\nu\nu qq$ with GLD-based geometries

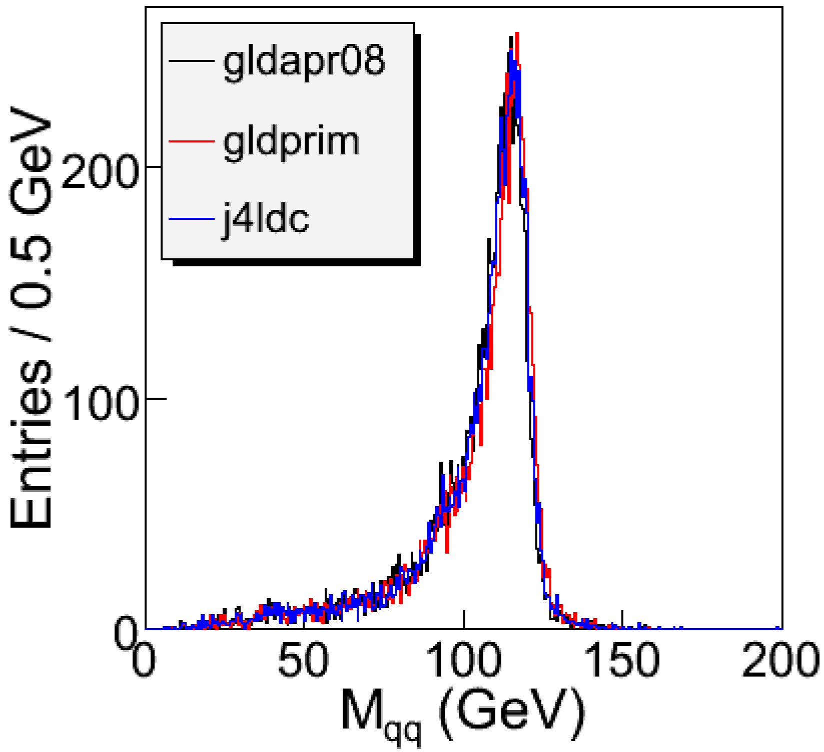
- Compare performance among 3 different geometries (GLD, GLD-prime, J4LDC)
- Data are generated by Jupiter, reconstructed on Marlin framework, analyzed with Satellites analysis libraries.



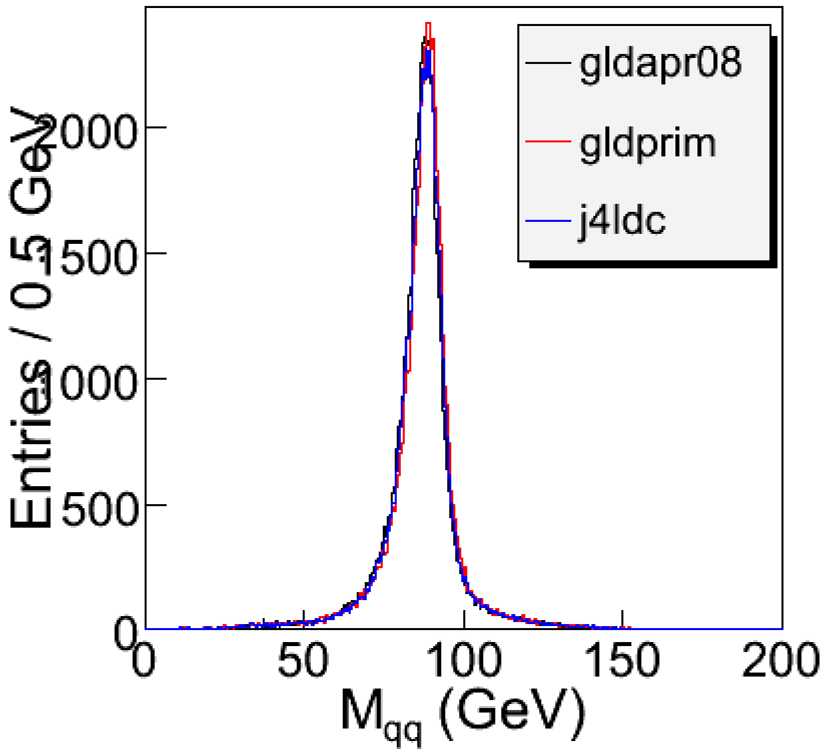
Satoru Uozumi

Reconstructed M_{qq} mass (CMS=250 GeV)

Zh -> ννqq (signal)



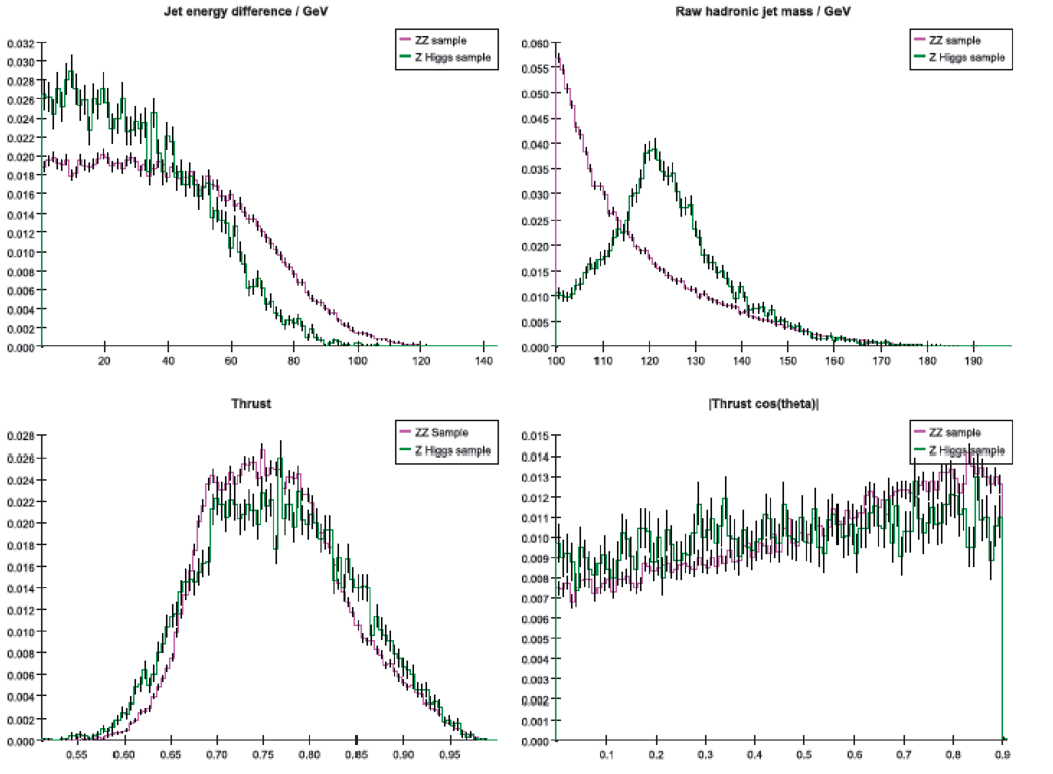
ZZ -> ννqq (BG)



- Di-jet mass from all types of quark jets.
- No kinematic selection is applied yet, optimization of the cuts and estimation of efficiency underway.
- At this level no significant difference can be seen between 3 geometries.

Satoru Uozumi

Additional material



Likelihood variables for a much larger LDC01_05Sc sample

~ 44000 ZH→eeH

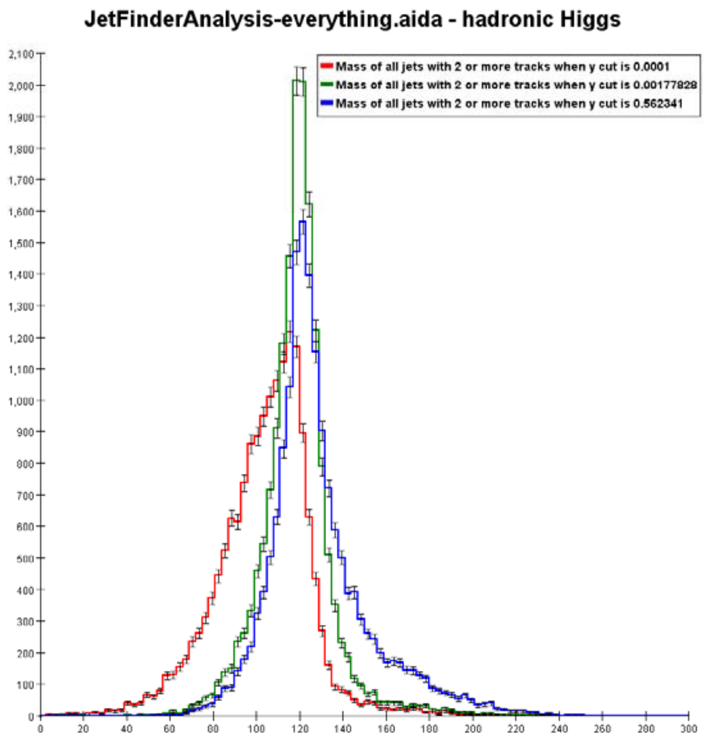
~491000 ZZ→eeqq

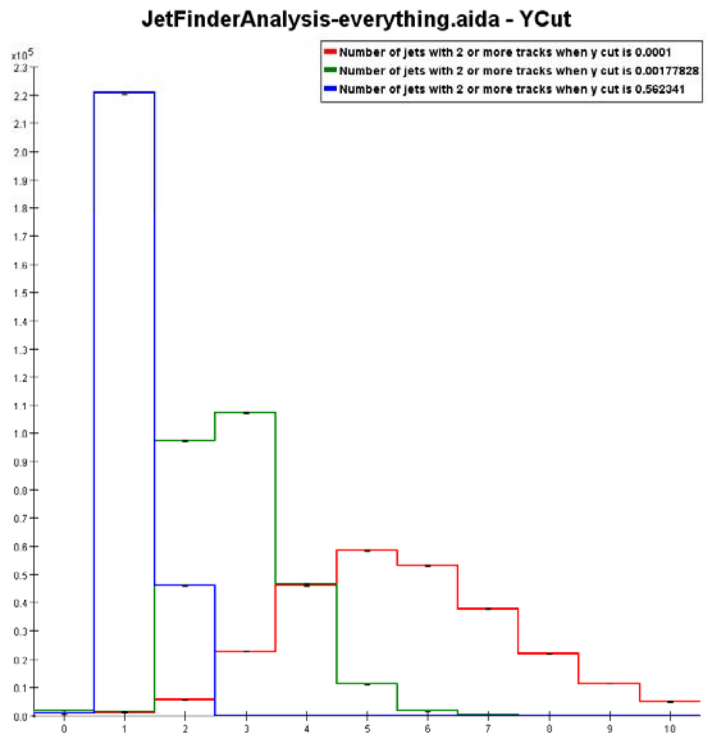
(before applying pre-cuts)

Additional material

Tried cutting unwanted particles (ISR etcetera) from the jets by using a low ycut and requiring jets to have at least 2 tracks.

Resulted in a large number of jets, could use these and recluster again but decided it was getting too fiddly.





Additional material

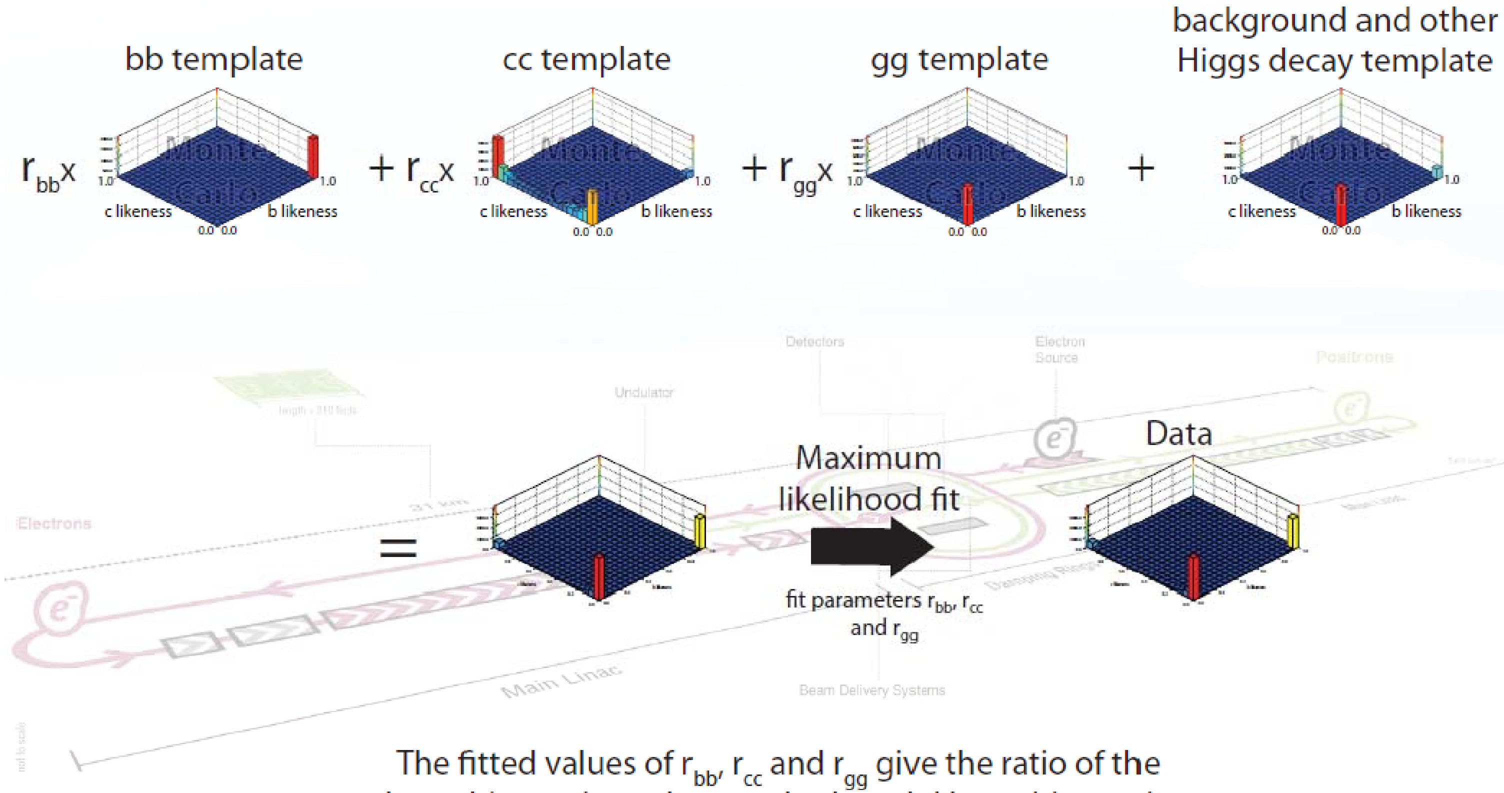
- Use two neural nets, one to tag each jet for b flavour, and one for c flavour
- Results are a value between 0 and 1
- These are used to create an event b-likeness and c-likeness using:

$$\text{b - likeness} = \frac{\text{b tag jet 1} \bullet \text{b tag jet 2}}{\text{b tag jet 1} \bullet \text{b tag jet 2} + (1 - \text{b tag jet 1}) \bullet (1 - \text{b tag jet 2})}$$

Likewise for c - likeness

this basically only gives a high value if both jets have a high tag value.

Additional material



The fitted values of r_{bb}, r_{cc} and r_{gg} give the ratio of the branching ratio to the standard model branching ratio
(after taking account of the cross sections)