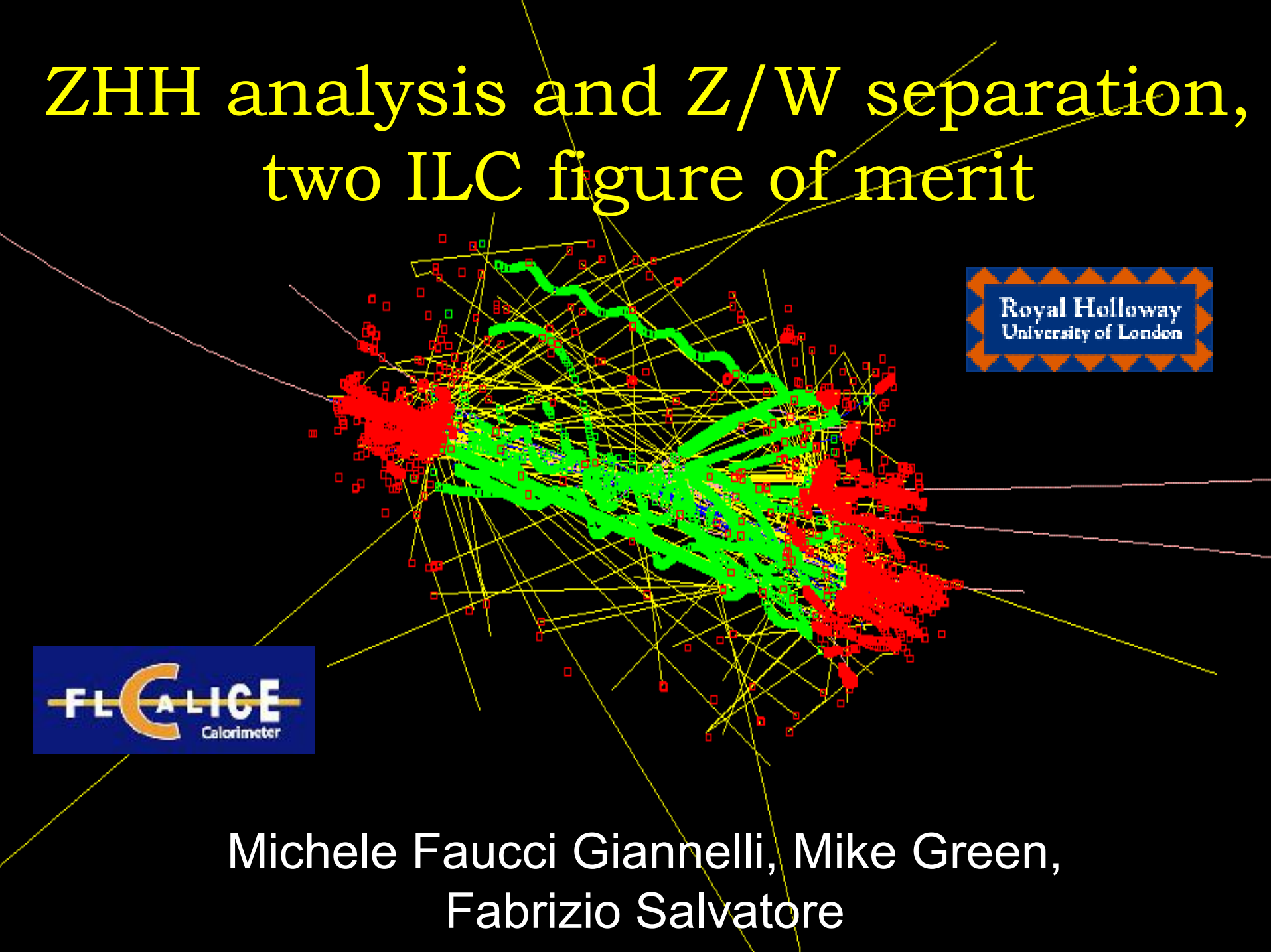
ZHH analysis and Z/W separation, two ILC figure of merit



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Fabrizio Salvatore

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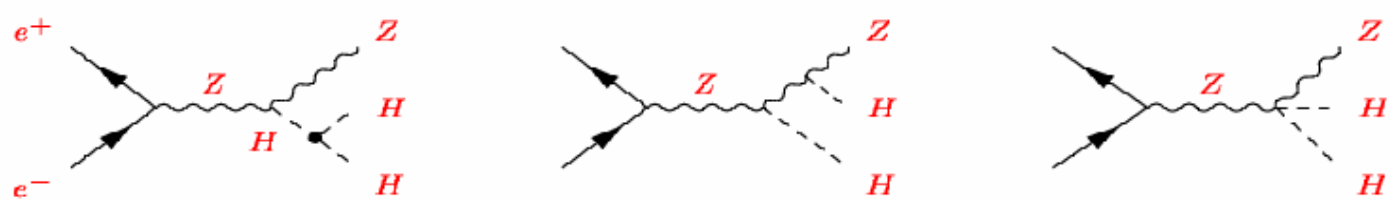
- Generation, simulation and reconstruction
- Analysis
- Conclusion

ZHH

- Study of Higgs self coupling constant



- These events can also be used as benchmark events for several detector/PFlow studies:
  - ECAL & HCAL performances,
  - Particle flow algorithms,
  - ....
- At the moment focus on Z→μ/e

Simulation

- Event generator: Pandora Pythia
  - BUT no three boson processes include $\Rightarrow$ move to WHIZARD
- Detector simulation: Mokka 06-00
  - Slow, problems with background studies
- Reconstruction: Marlin 0.9.4
  - With new MarlinReco!

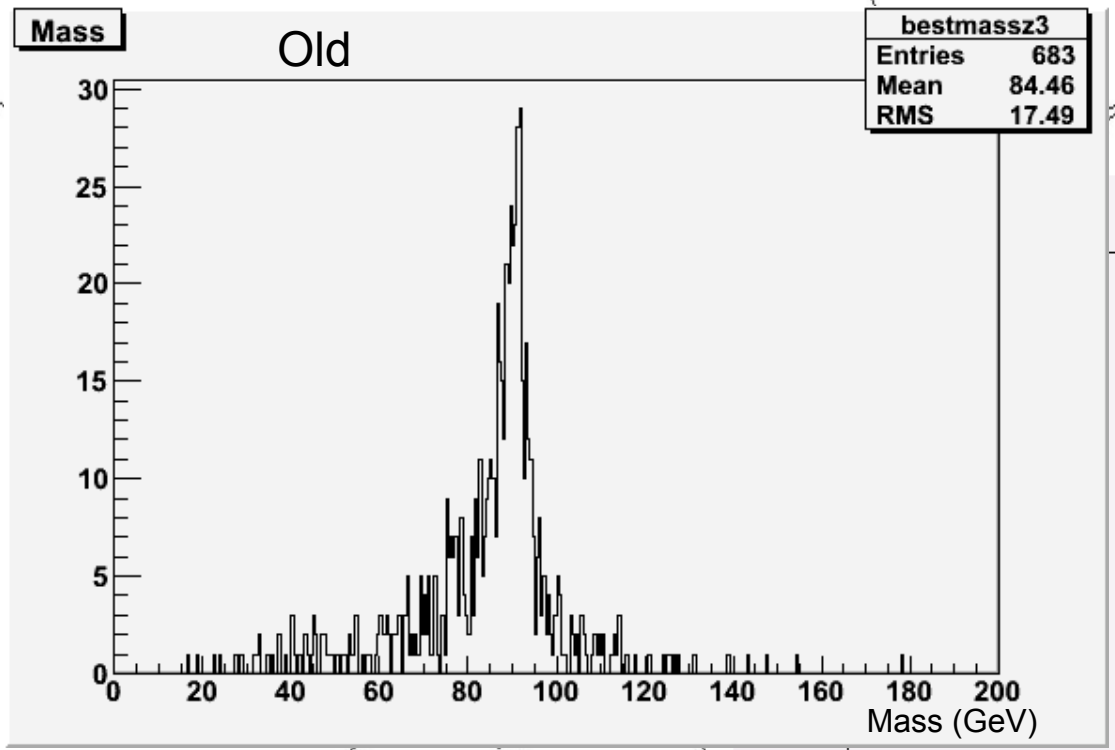
Z and Higgs selection

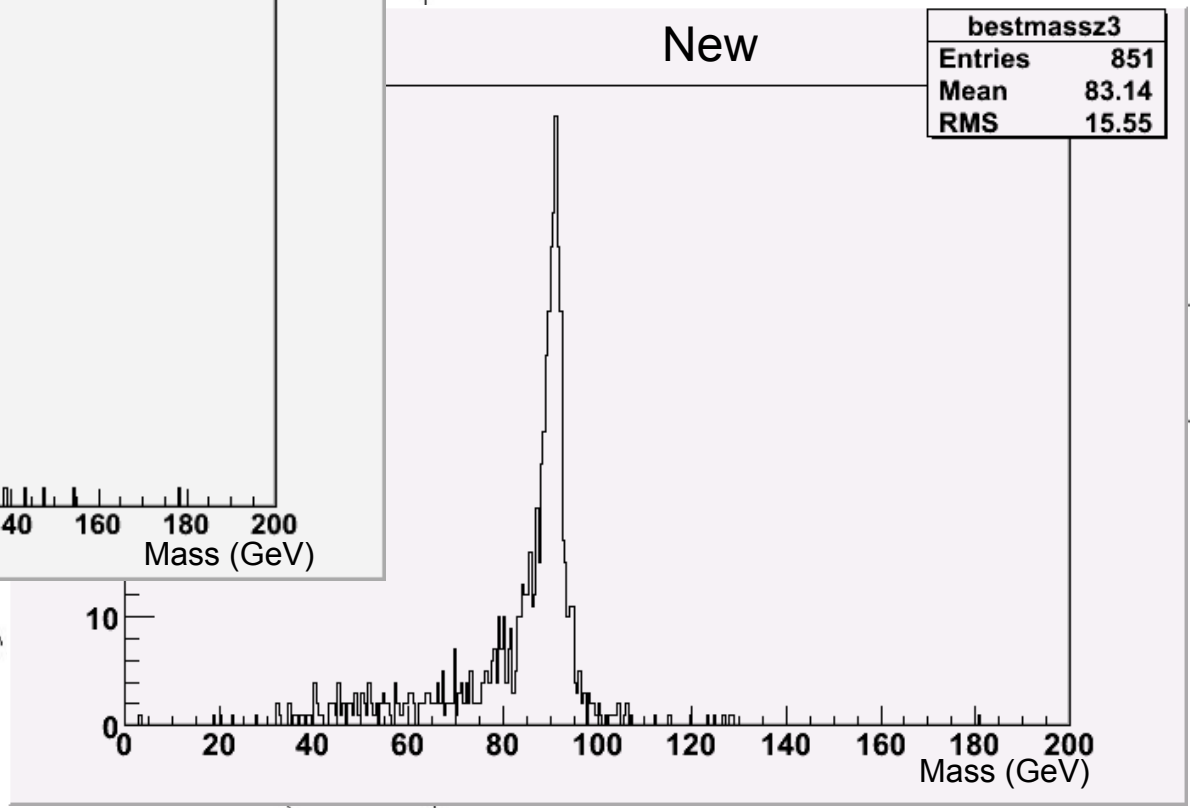
- For the Z:
  - two particle (electrons or muons) of opposite charge
  - Each of them must have an energy > 10 GeV

- For the Higgs:
  - Request 4 jets
  - Combine the jets to minimize

$$= (\quad - \quad) + (\quad - \quad)$$

ZHH, Z→leptons





New results, using Marlin 0.9.4

Efficiencies

Events	ε_{old}	ε_{new} LDC00	ε_{new} LDC01
Generated	1	1	1
After LEPTrack	0.71	0,97	0,96
After Z selection	0.71	0,97	0,96
After H selection	0.71	0,97	0,96

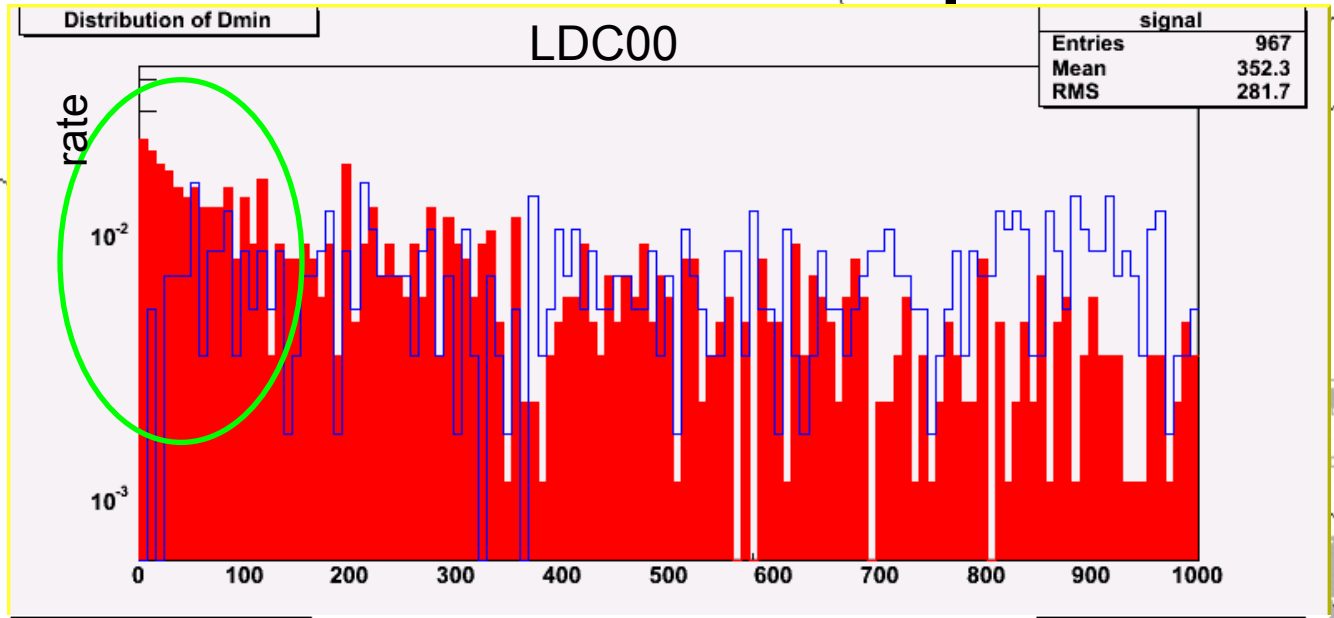
ZHH, first look at the backgrounds

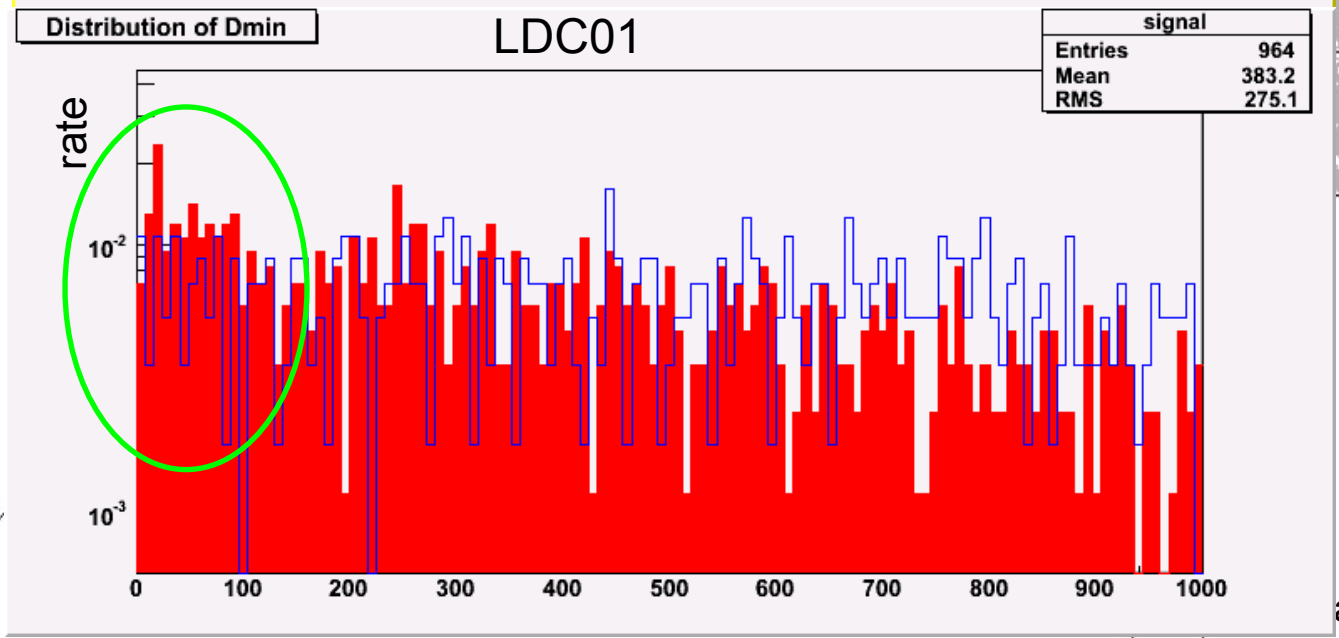
- Only ZZH and bbH available in Pandora.

Channels	Cross section (fb)
ZHH (total)	0.142
ZHH ($Z \rightarrow e^+e^-$)	0.00237
ZZH ($Z1 \rightarrow e^+e^-$,$Z2 \rightarrow bb$)	0.00358
bbH (total)	7.2

- Ratio bbH/ZHH ~ 3000

D^2 plot

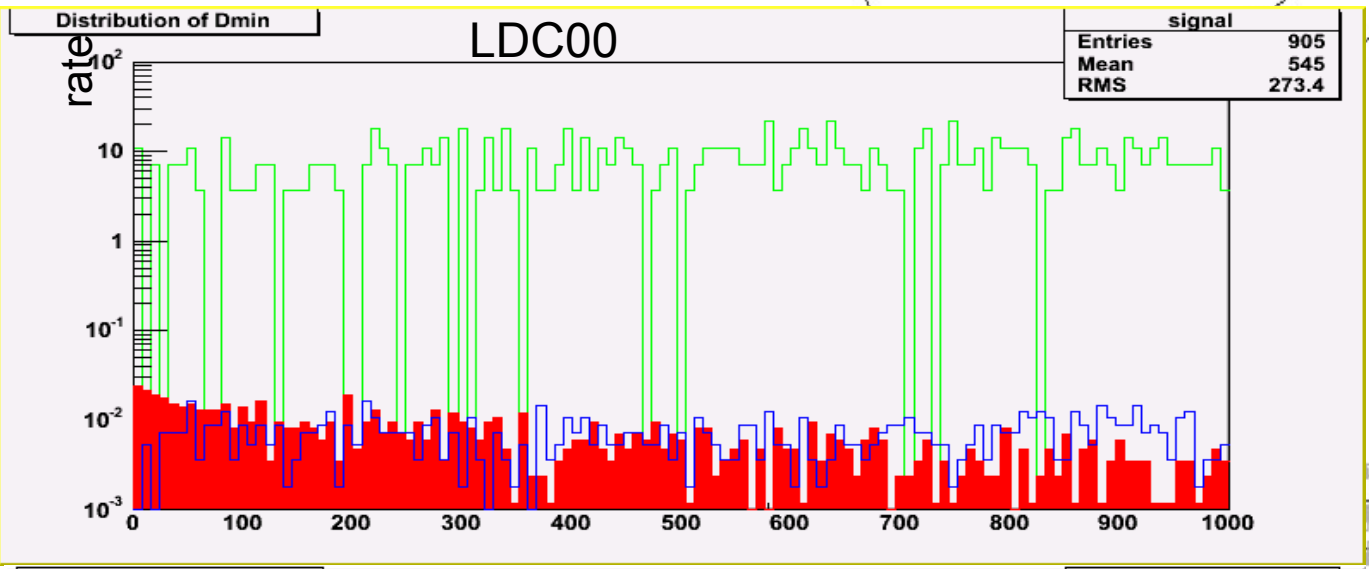




- Signal ZHH (Z→ μμ)
- ZZH Background

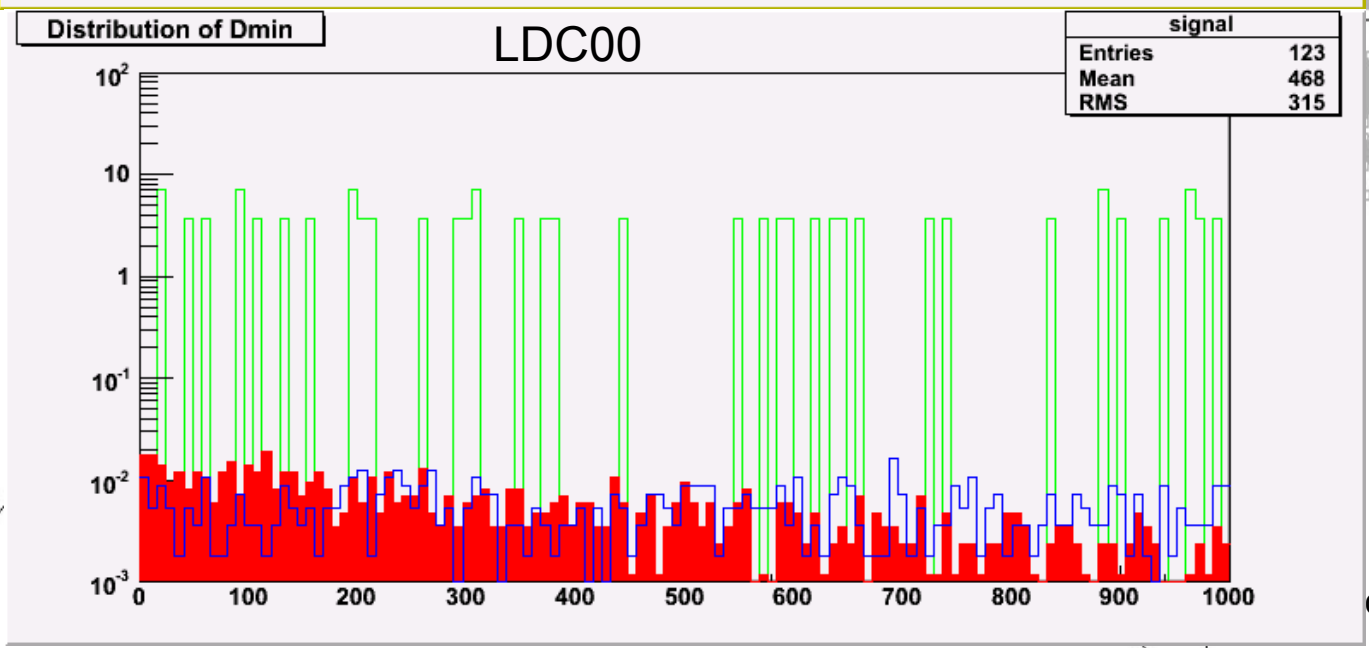
- **First physical evidence of the need of a bigger detector**

D^2 plot



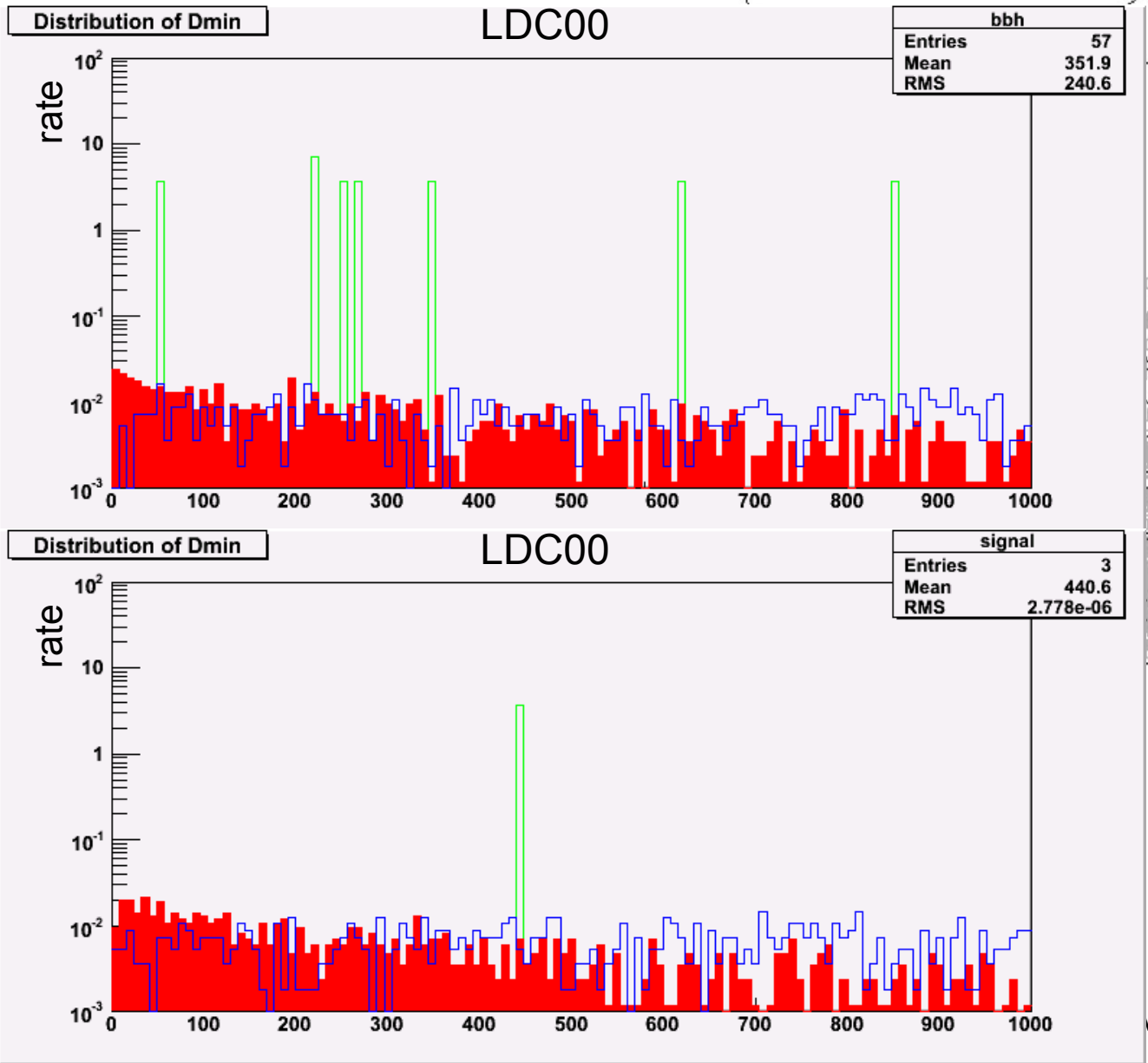
- Signal ZHH (Z→ μμ)
- ZZH Background
- bbH Background

No cut on Z mass



- Signal ZHH (Z→ ee)
- ZZH Background
- bbH Background

D^2 plot



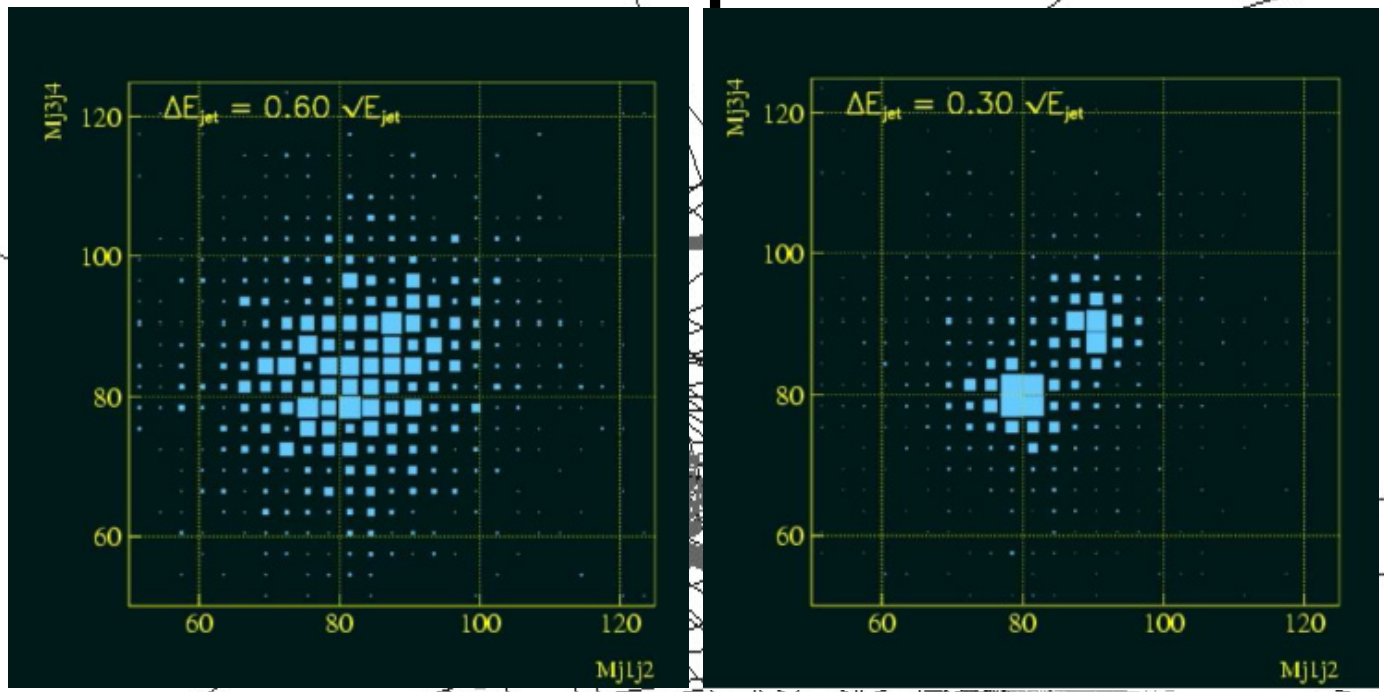
- Signal ZHH (Z→ μμ)
- ZZH Background
- bbH Background

With cut on Z

80 < Select < 100

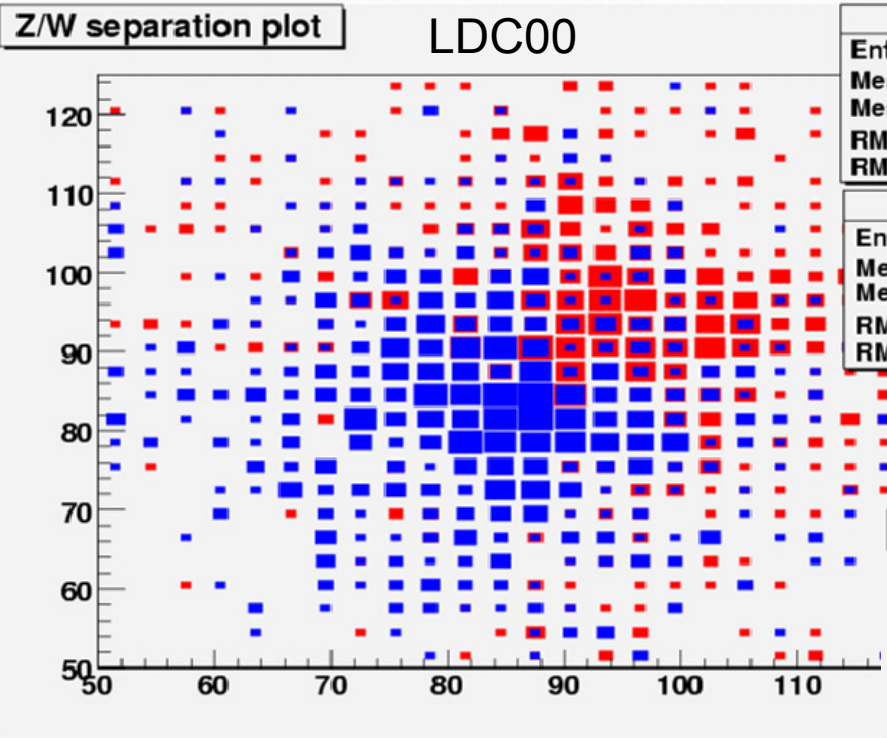
- Signal ZHH (Z→ ee)
- ZZH Background
- bbH Background

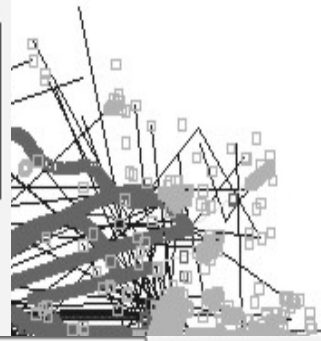
Z/W separation

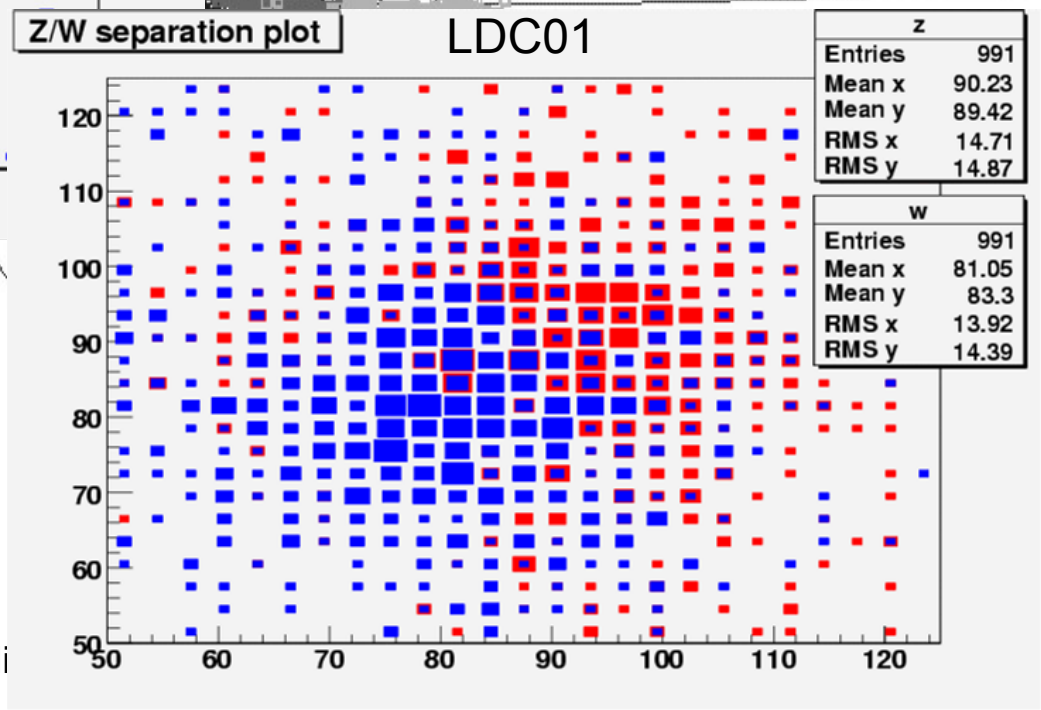


- Jet resolution is a key point for the physics at ILC
  - H→bb,
  - $t\bar{t}$,
  - SUSY (miss energy)
  - …

Z/W separation







Blue is WW

Red is ZZ

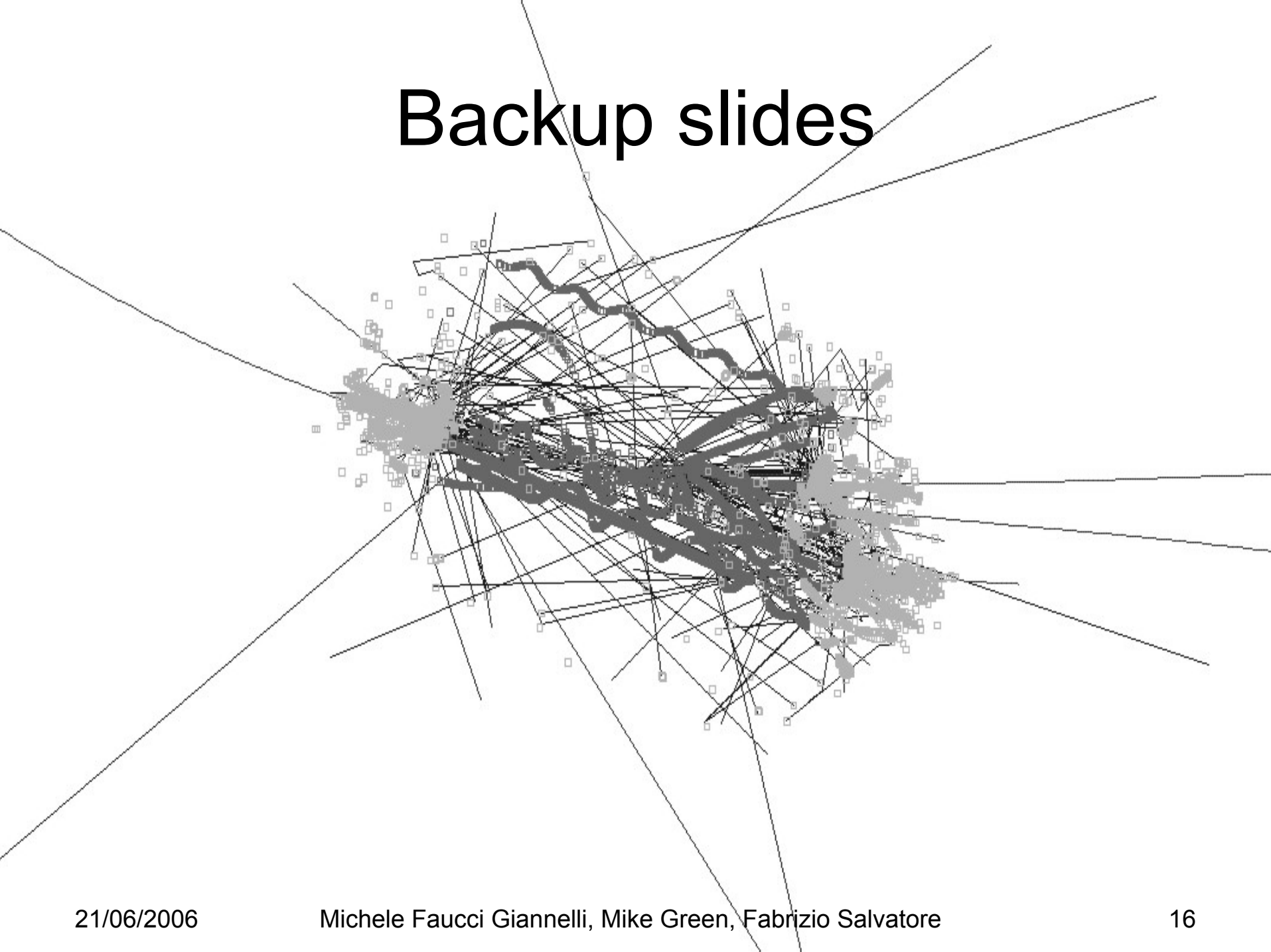
Conclusion

- New software installed, the new version of MarlinReco improved the analysis.
- First look at the background, as expected the biggest problem is the contamination.
- First physical evidence of the need of a bigger detector!
- We produced the Z/W separation plot, closer to 60%/√E that 30 %/√E.

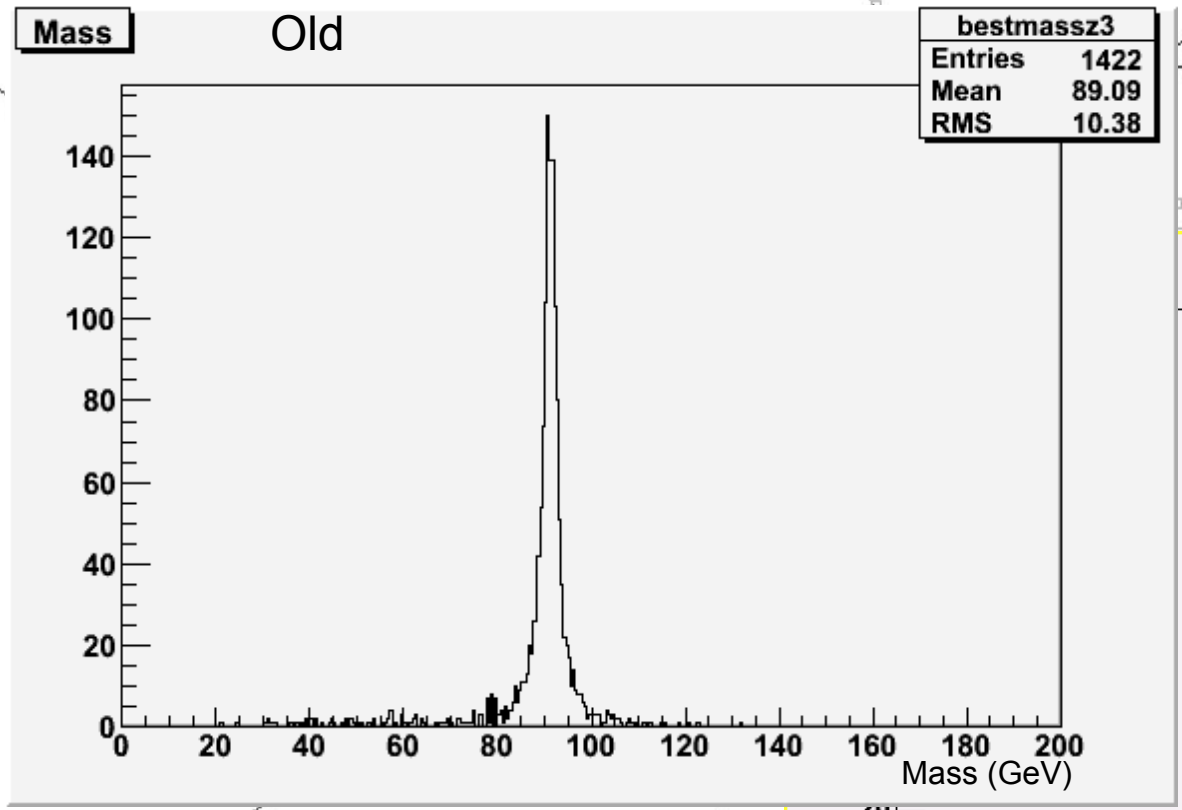
Future plans

- Continue ZHH analysis:
  - background,
  - WHIZARD/PANDORA comparison
  - 6j
- Z/W separation: routine is up and ready for Marlin developments
- Study of detector with different B fields
- Release of new Selection processors (muon identifier?)

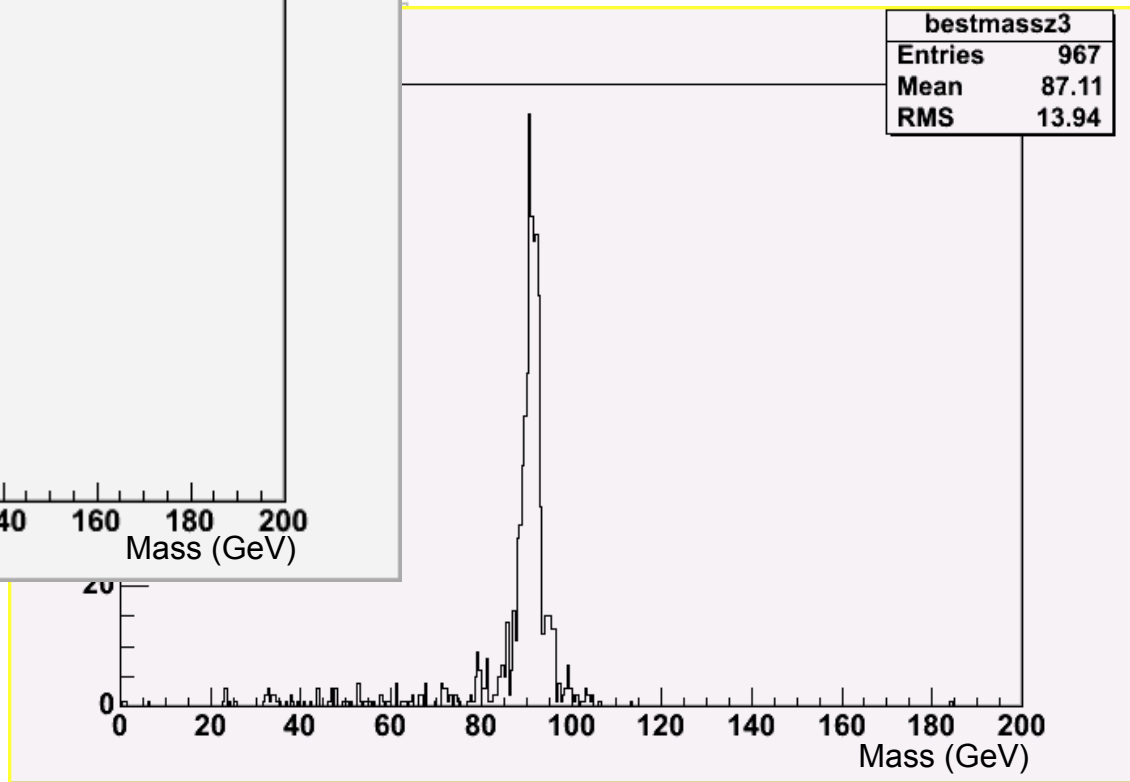
Backup slides



ZHH, Z→leptons

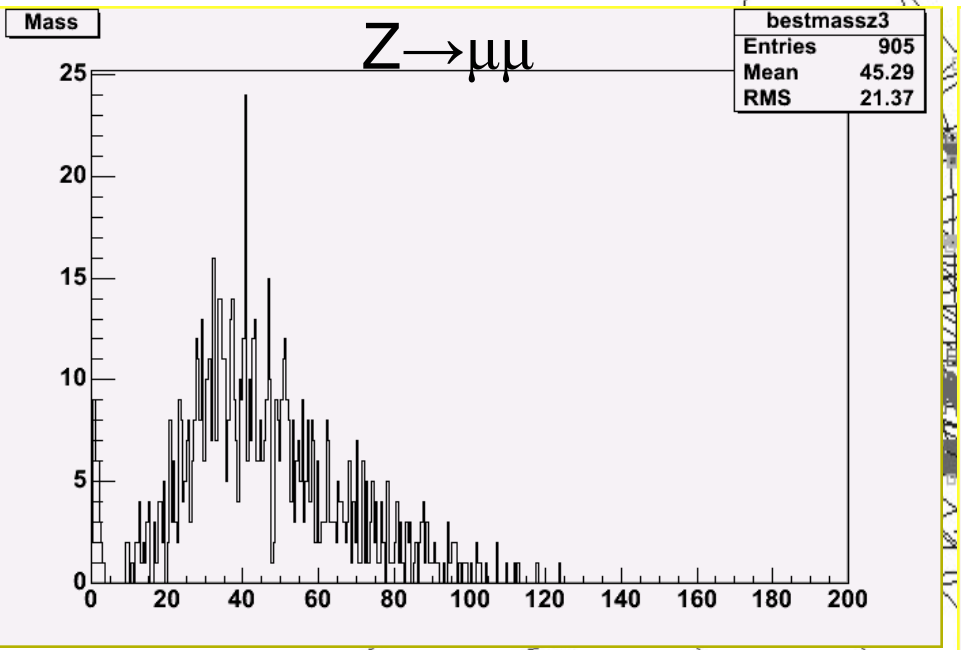


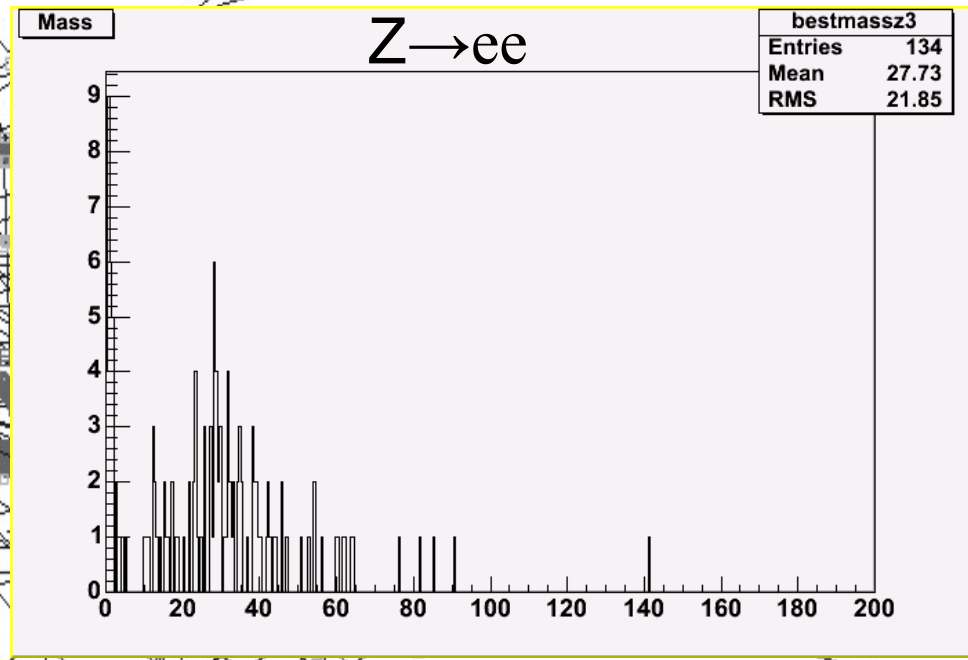
New



New results, using Marlin 0.9.4

Reconstructed Z Mass for bbH





- The difference due to the missing muon id:
  - Muons and pions are not separated
- Then “muons” are many more than electrons