

$$e^+e^- \rightarrow \nu\nu\mathbf{H}(\rightarrow \mu\mu)$$

Marcel Stanitzki

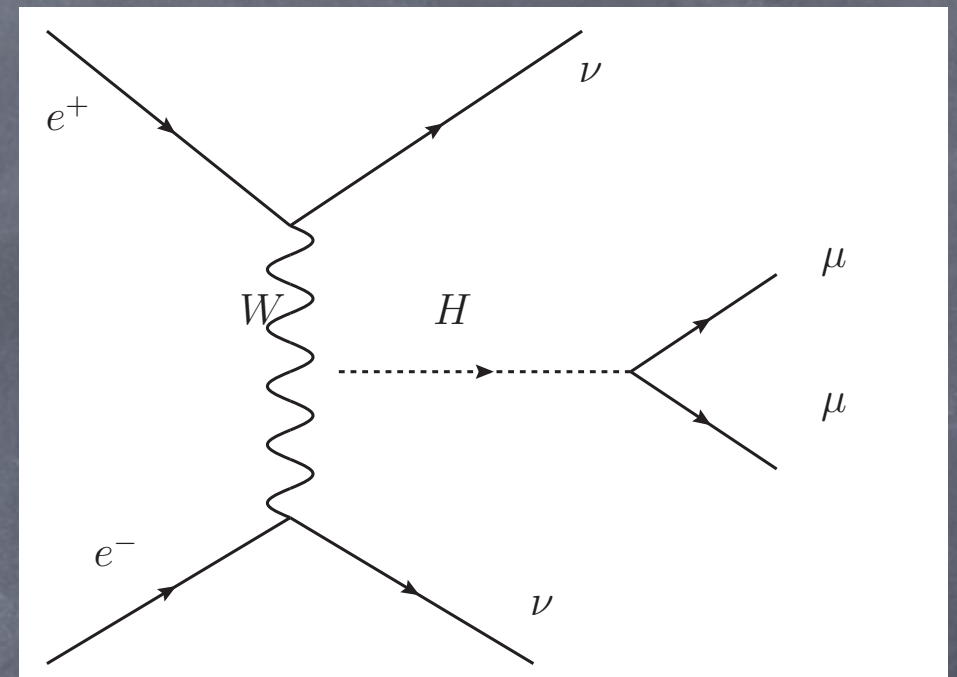
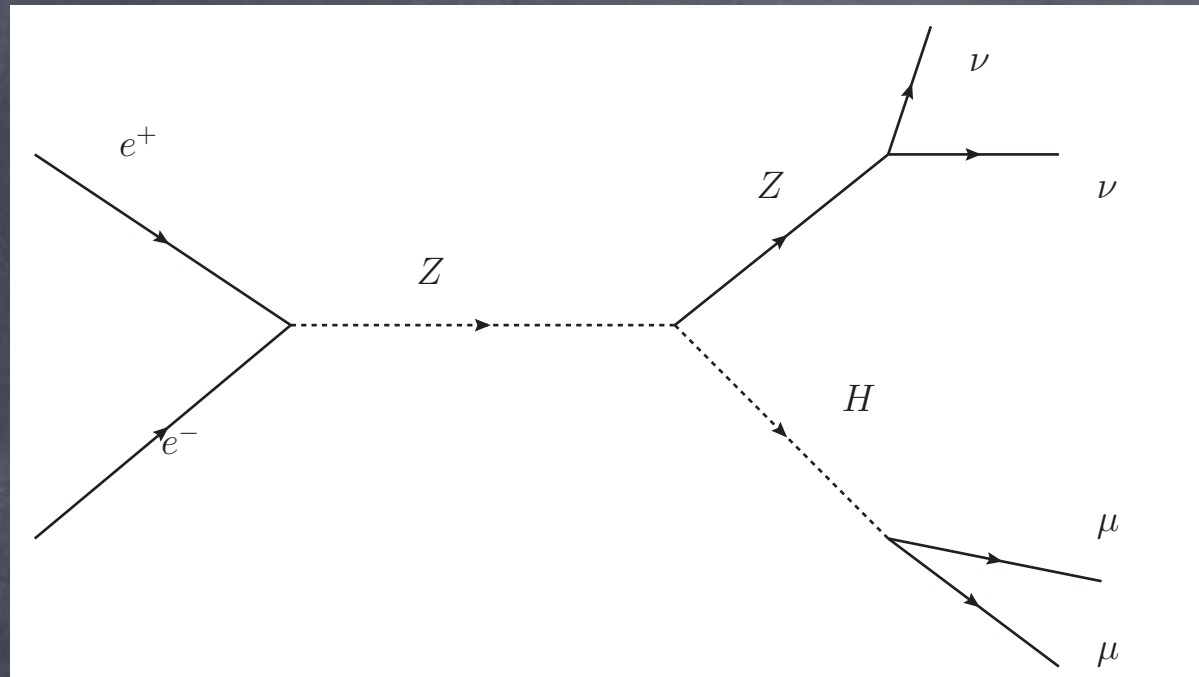
Jan Strube

Rutherford Appleton Laboratory

Motivation

- Golden channel to test second generation couplings
- Golden channel for track resolution benchmarking

Samples to consider



Backgrounds:

4 fermion

$WW \rightarrow \nu\mu \nu\mu$

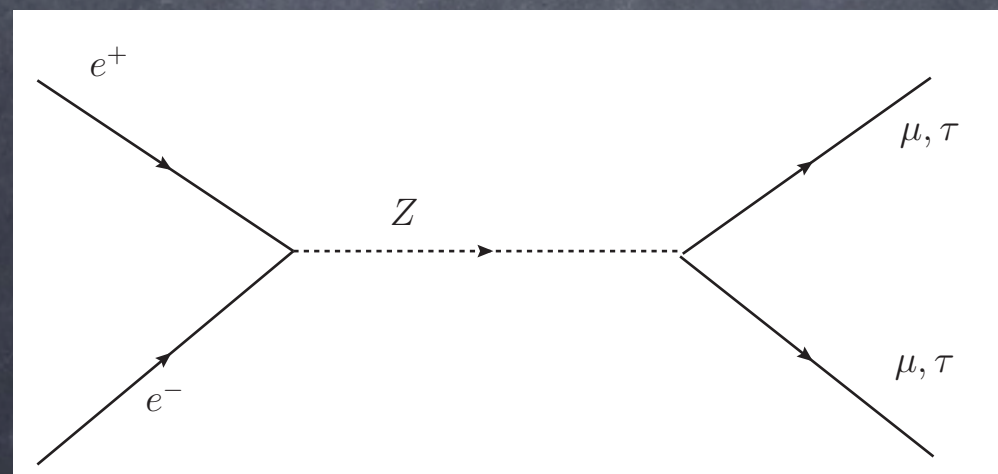
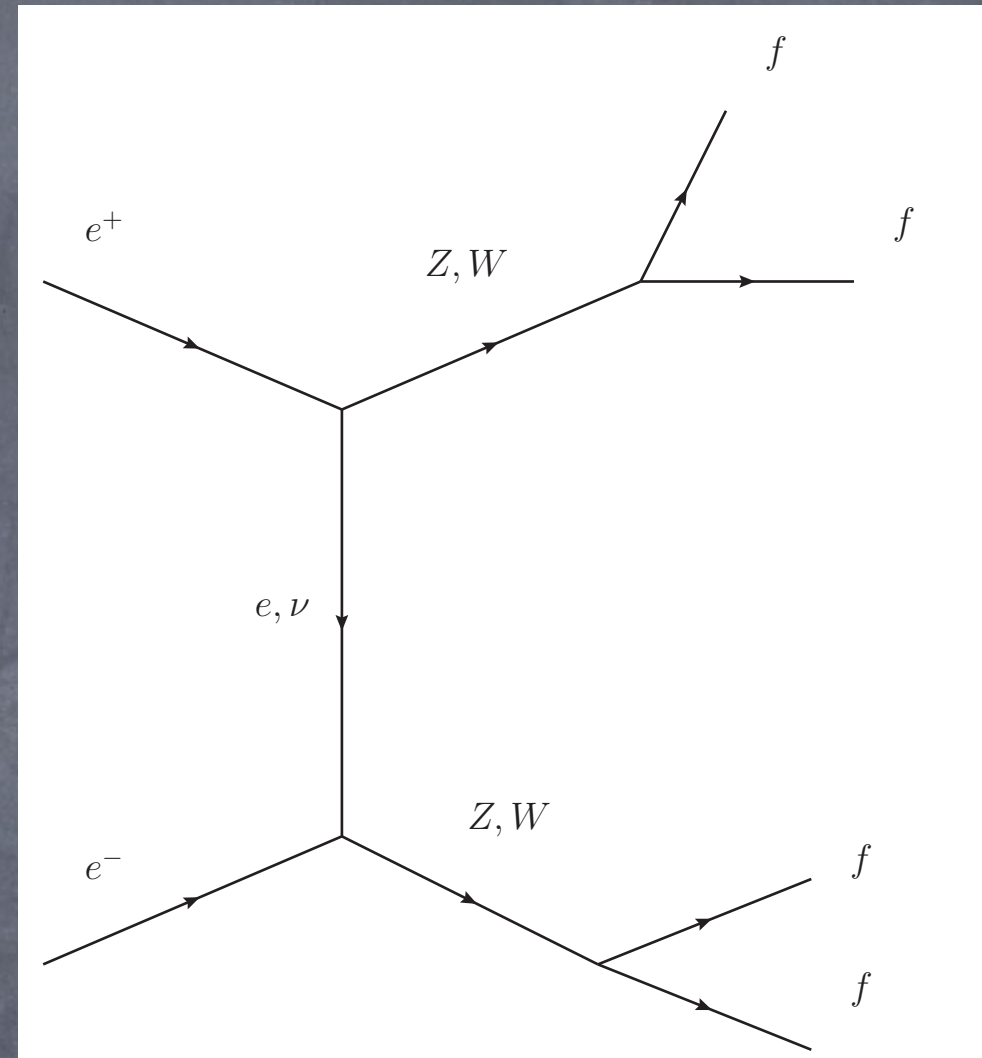
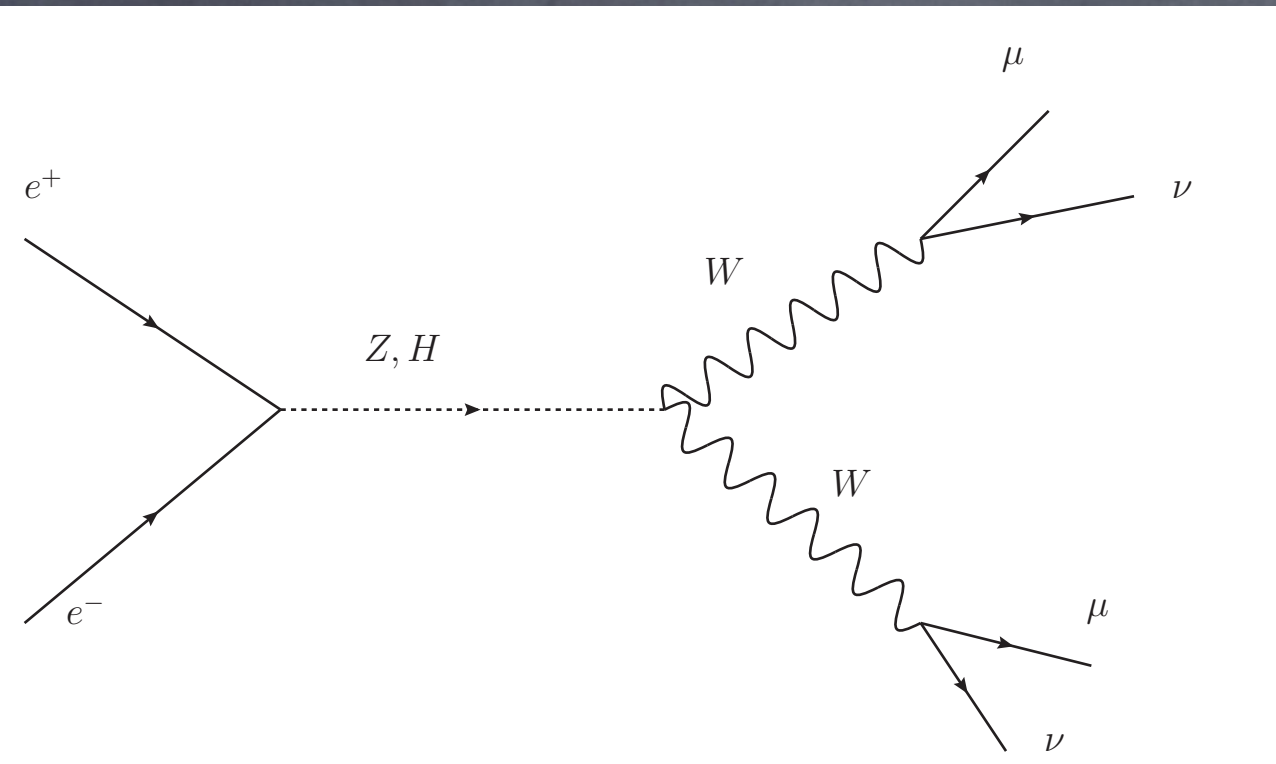
$ZZ \rightarrow \nu\nu \mu\mu$

$Z \rightarrow \mu\mu$

$Z \rightarrow \tau\tau$

Admixture depends
on the collision
energy

Backgrounds

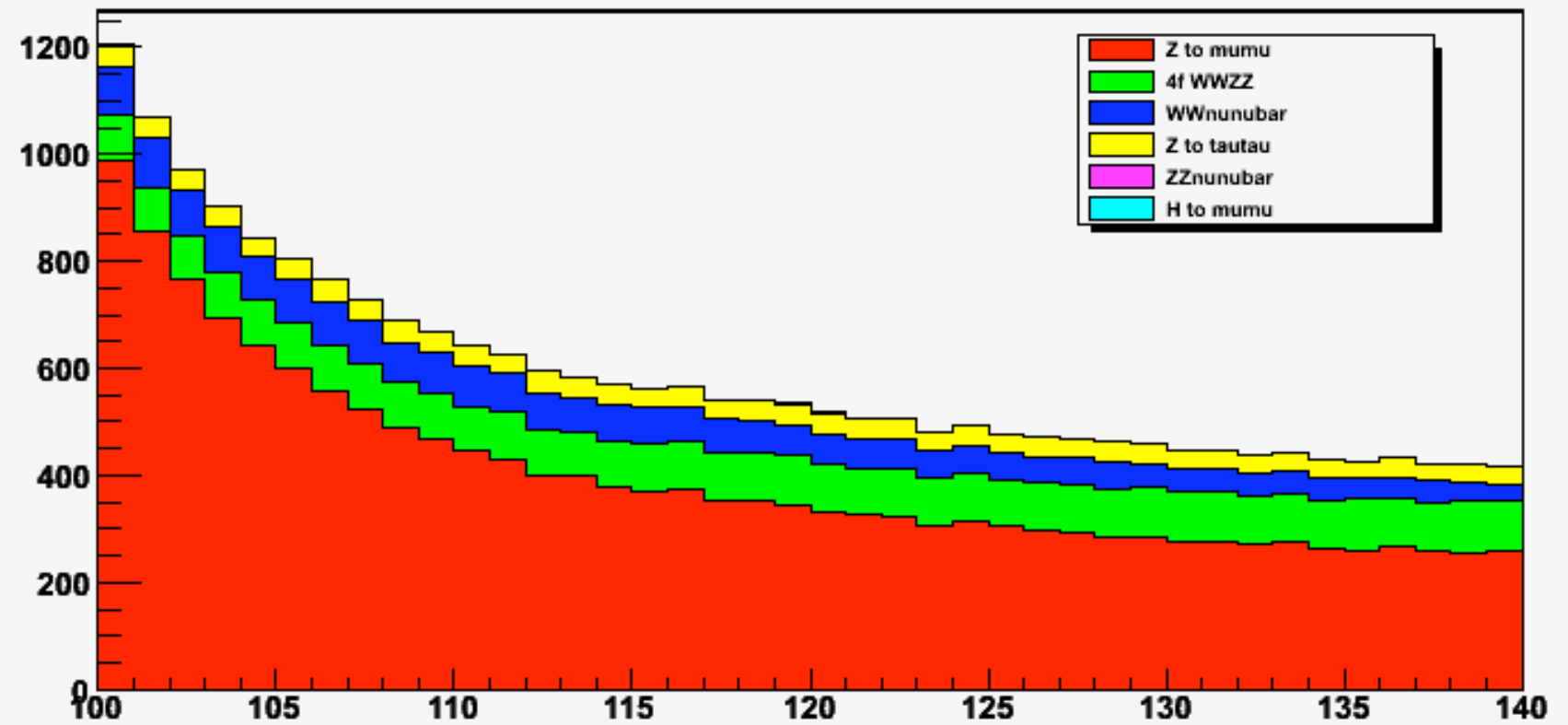


Analysis overview

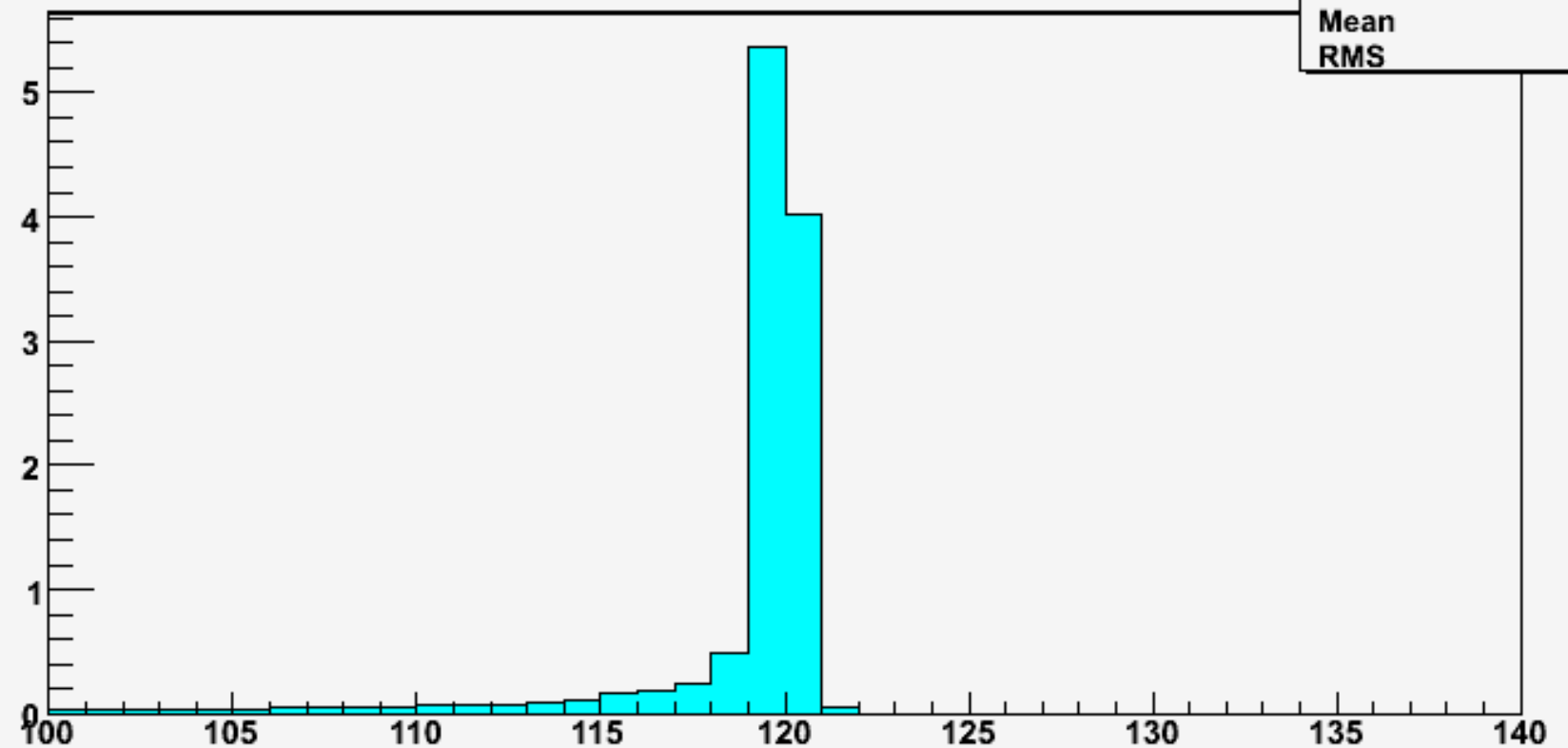
- Event generation (Pythia 6.4.13, no beamstrahlung)
 - Writing stdhep
- org.lcsim Fast MC for the training
 - Writing AIDA
- Event classification (TMVA)
 - AIDA to ROOT TTree
- Likelihood fitting (RooFit)

Starting
point

Stack: Dimuon mass 00 two muons required



H to mumu Dimuon mass 00 two muons required



H to mumu Dimuon mass 00 two muons required	
Entries	9868
Mean	118.9
RMS	3.087

Analysis Strategy

- Require muon ID(100 %)
- Event shapes
- Good muon selection (multi-variate classifier)
 - $\cos\Theta$, energy, pt, forward or endcap
- discriminating variable(s) (likelihood fit)
 - flat bg, peaking signal

Event Shape Cuts

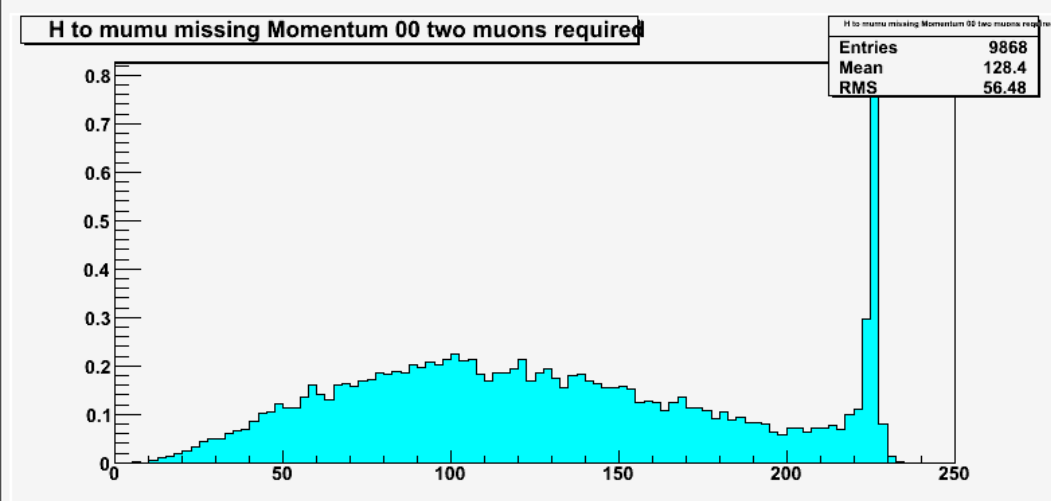
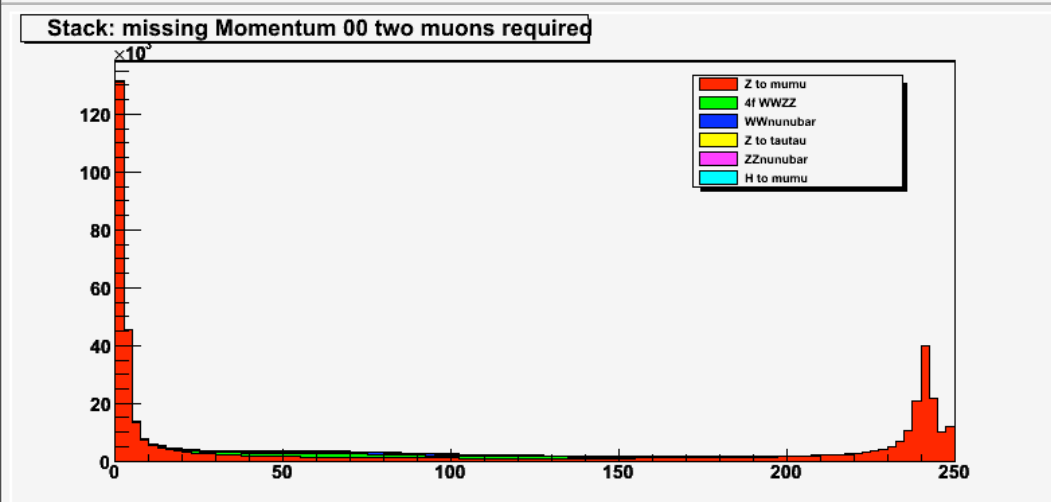
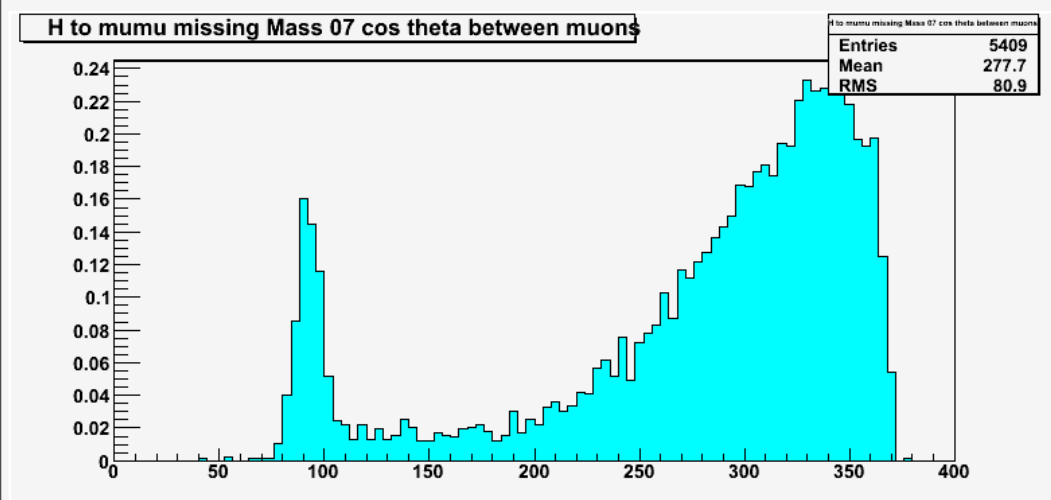
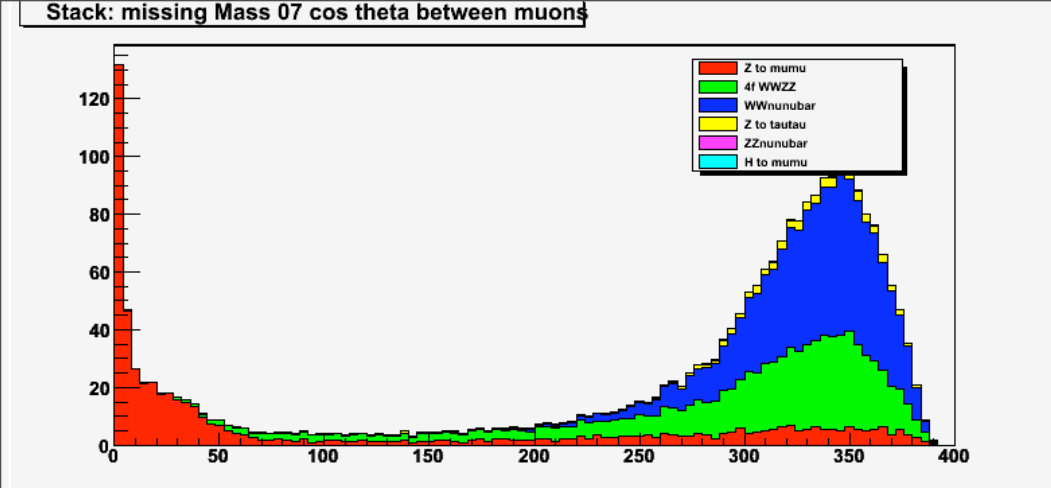
- Mass cut
- visible Energy
- acoplanarity: Angle in the transverse plane
- oblateness: Major thrust – minor thrust

Sample sizes

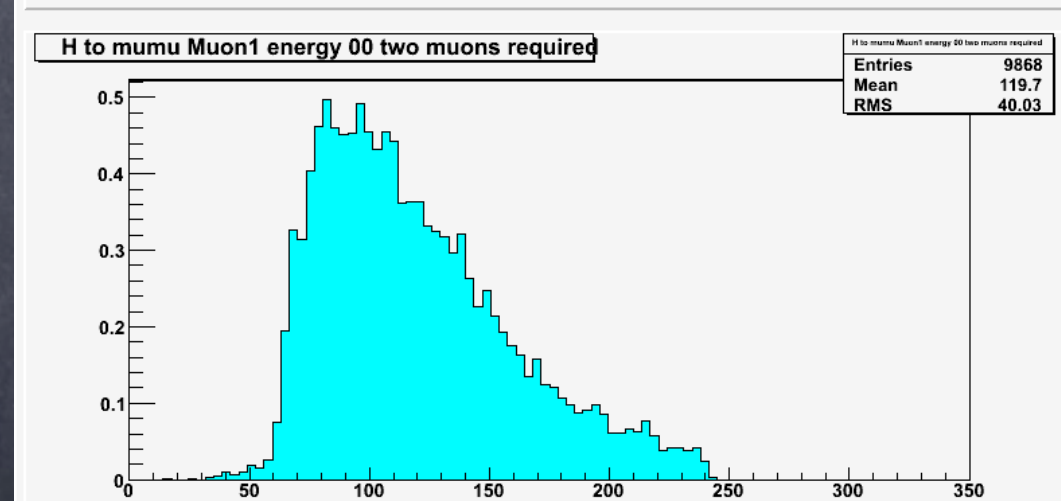
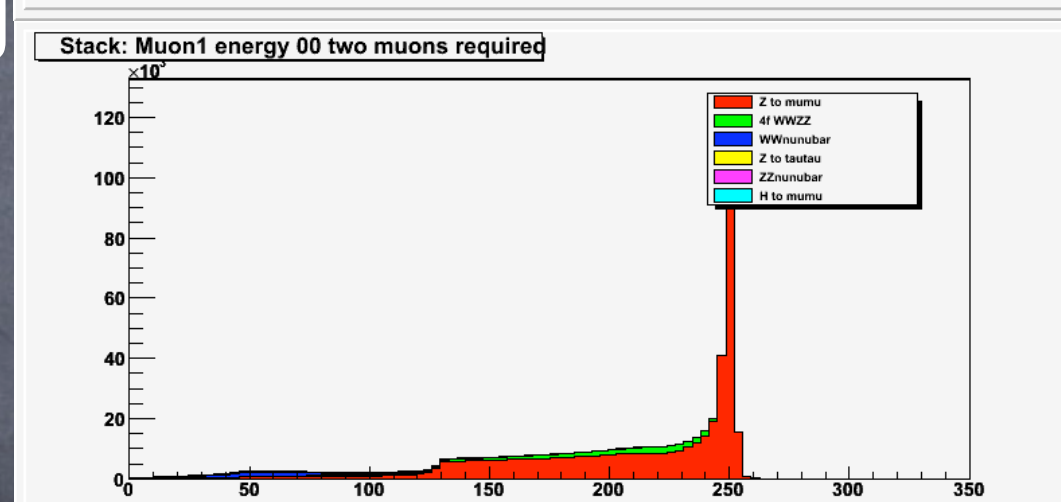
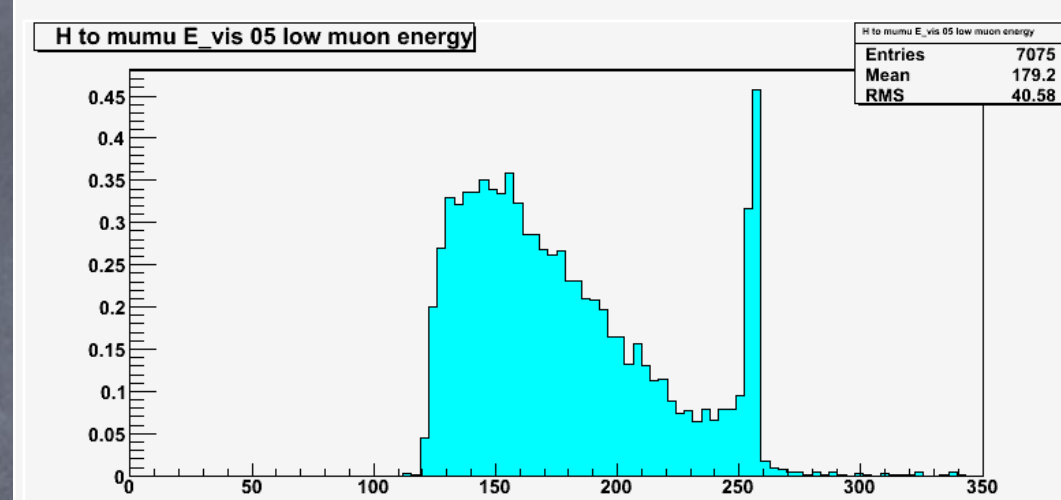
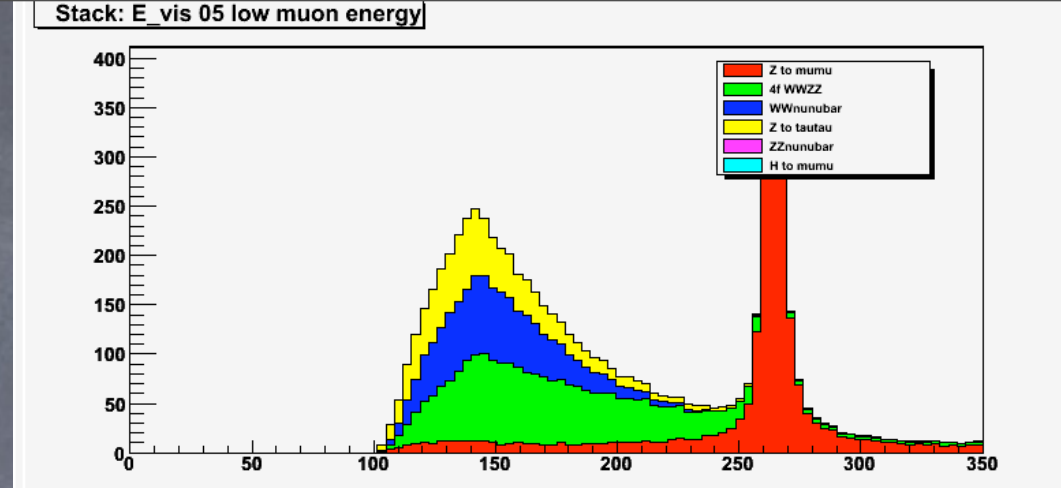
sample	tau tau	mu mu	4 f	WW nu nu	ZZ nu nu	signal
cross section	1.05 1E+03	1.07 1E+03	4.132 1E+02	3.13 1E+02	2.71 1E-03	2.41 1E-02
# available	1.1E+07	7.6E+06	5.8E+06	3.3E+06	50000	10000
shape cuts	825	6.8E+06	29068	9074	178	5114
scaled, 2 / ab	160.4	2867.9	4141.7	1721.3	0	24.6

Distinguishing Variables

- muon properties
 - $\cos \theta$
 - opening angle
 - energy
- Ratio of muon energies
- oblateness
- missing momentum
- mass
- missing mass

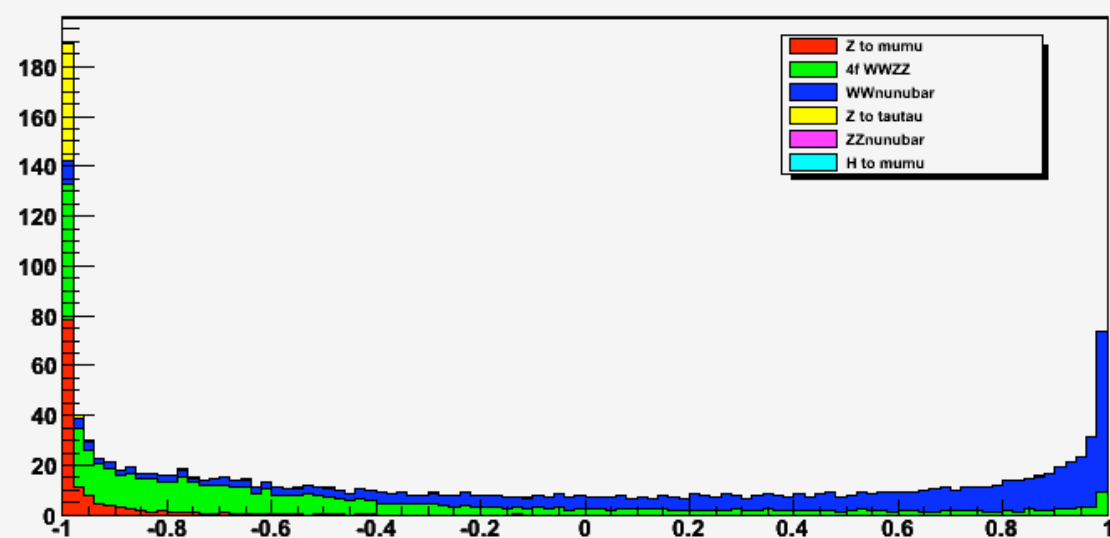


Some
Distinguishing
Variables

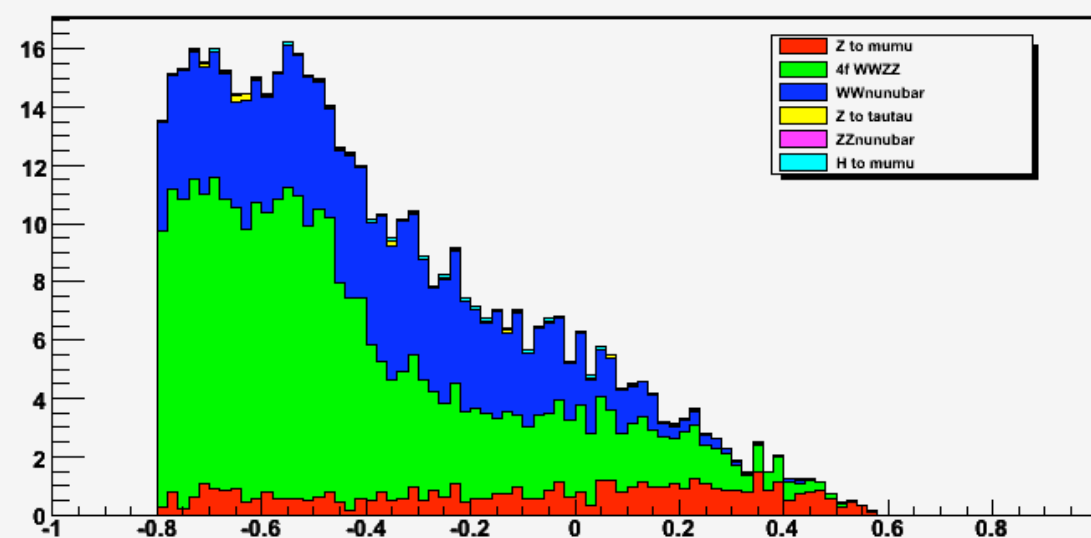


Variables for TMVA

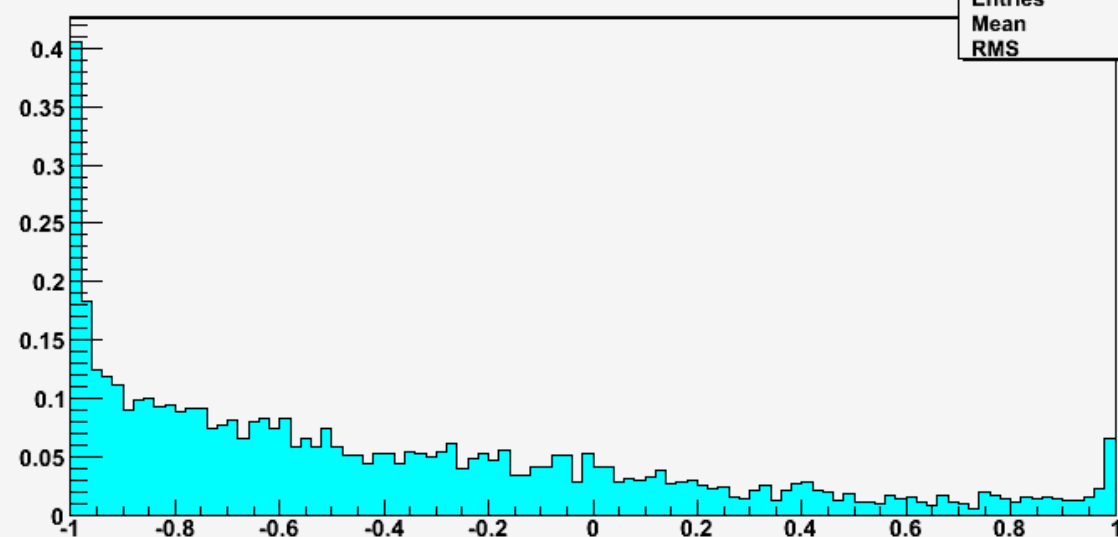
Stack: Acoplanarity 12 missing Momentum



Stack: cos theta 14 oblateness

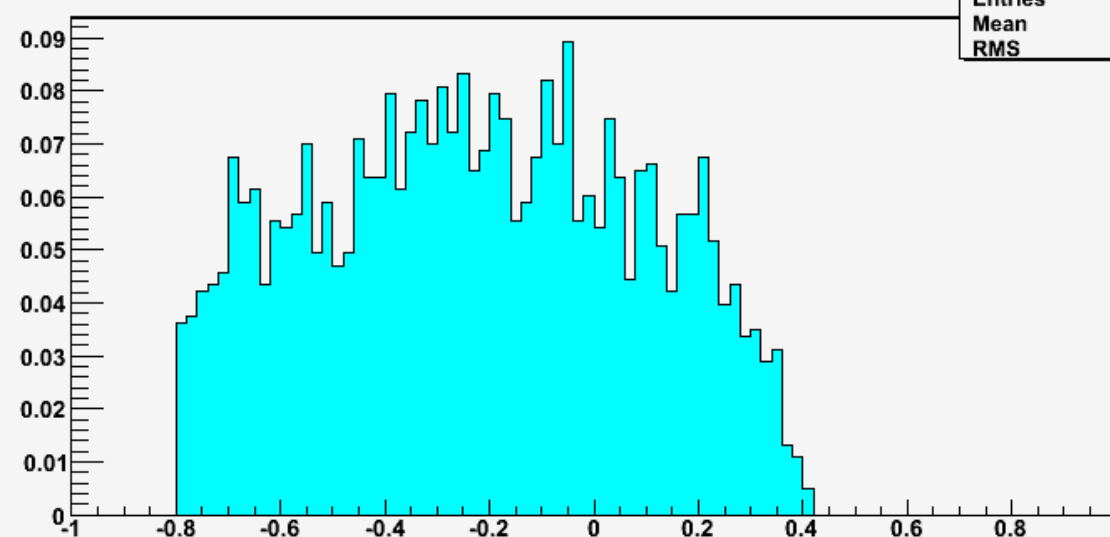


H to mumu Acoplanarity 12 missing Momentum



H to mumu Acoplanarity 12 missing Momentum	
Entries	3978
Mean	-0.4038
RMS	0.531

H to mumu cos theta 14 oblateness



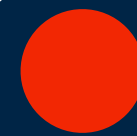
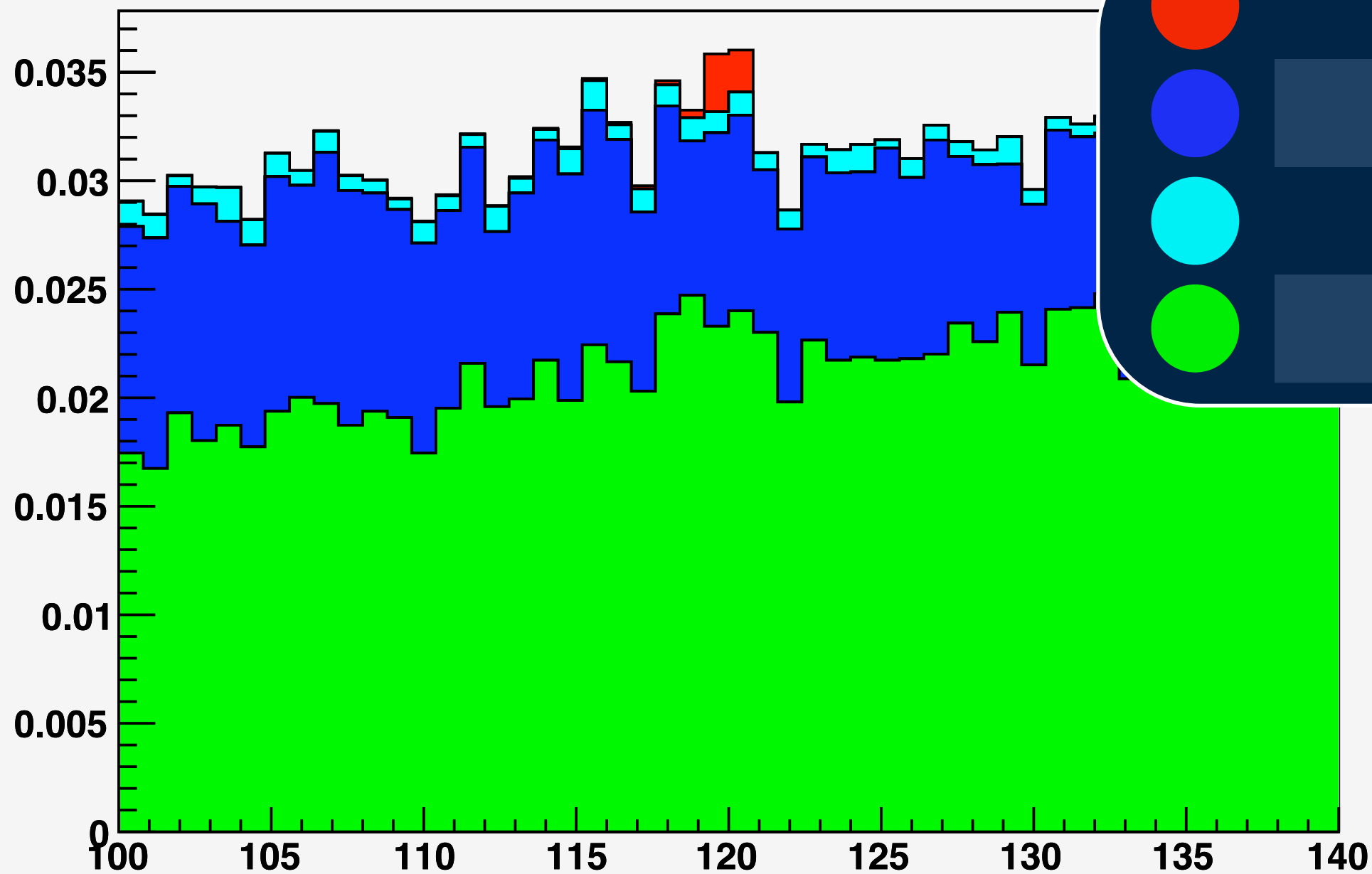
H to mumu cos theta 14 oblateness	
Entries	2851
Mean	-0.223
RMS	0.3085

Status

- Boosted Decision Trees for sample separation
 - Outperforms all other classifiers in TMVA (Fisher, various ANN, likelihood method, ...)
- Only MVA, no kinematic fits
 - 1.85 sigma separation...
- Training / fitting is statistics limited

After applying the classifier

stack of the mass histograms



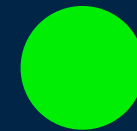
Signal



WW s-channel



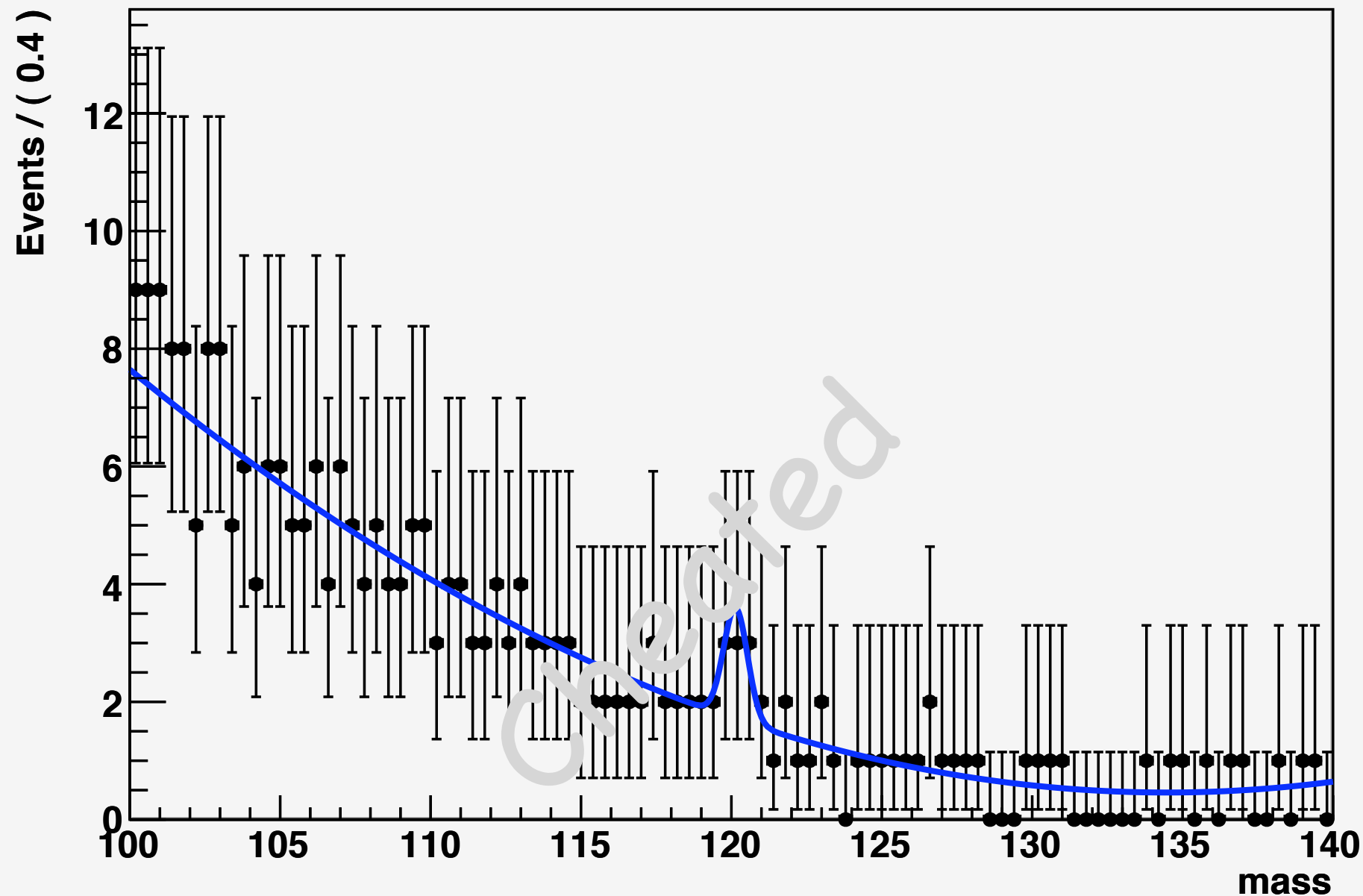
$\tau\tau$



4 fermion

Fitting status

A RooPlot of "mass"



- TMVA significance: 1.8 sigma
- RooFit significance:

Outlook and plans

- The analysis strategy seems to make sense
 - applicable to 250 GeV events
 - use ReconstructedParticles instead of FastMC
- Still need some dedicated background samples to understand differences between FastMC and full simulation
- Add $Z \rightarrow qq$ to gain statistics

The Grid

- 2 / ab background samples translate to 900 GB of data
- All accessible at RAL servers for faster turnaround
- using the Grid for simulation and reconstruction