Reconstructing Upsilons in di-muon channel in HI Events

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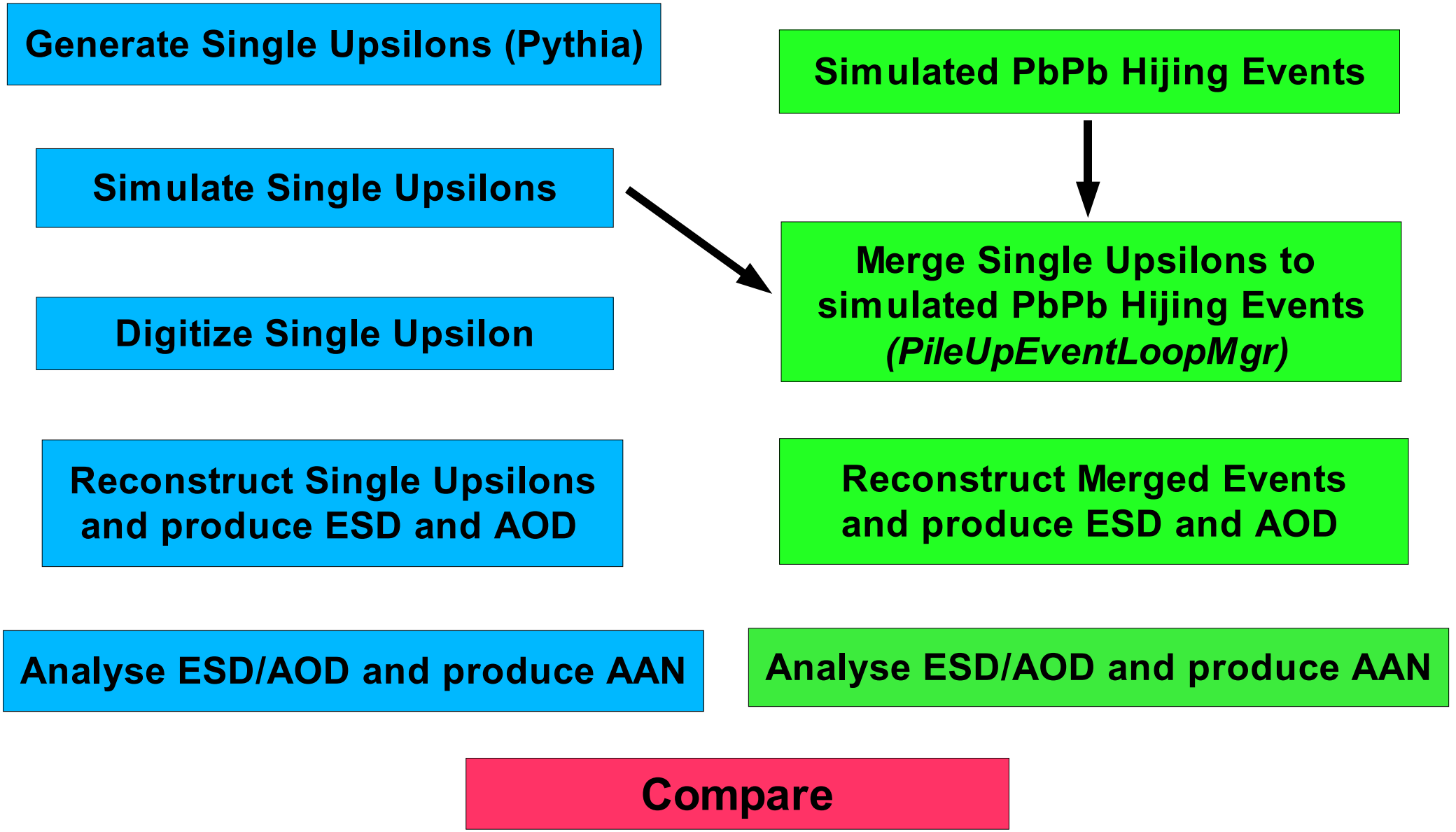
Immediate Goal: Study reconstruction efficiency and mass resolution for Upsilons in Heavy Ion events and learn in the process

Eventually, we would want to to improve
both efficiency and resolution
by adjusting reconstruction parameters or writing new code

Algorithm

This analysis was done with 11.0.3 version. We are now moving to 11.5.0



Heavy Ion Specifics

Reconstruction of even peripheral PbPb events takes forever with the default reconstruction settings (inner tracker too slow)

doiPatRec = False

doxKalman = True

```
XKalMan.PrimaryVertexSearch                = False
XKaDetectorBuilder.TRT                     = False
XKaMField.MagneticFieldService             = 4
XKalMan.ReconstructionStrategy             = 3
XKalMan.Selectivity                        = 9
XKalMan.MinNumberOfSilClusters             = 9
XKalMan.MinNumberOfUniqueSilClusters = 2
XKalMan.Xi2forPrecisionClusters            = 10.
XKalMan.MaxNumberHoles                     = 11
```

- AOD production takes forever (MC truth?)

Muon Reconstruction (1)

Standalone Muon Reconstruction: **Muonboy, MOORE**

Combined Muon Reconstruction:
Staco, MuTag, MuonIDCombined, MuonIDStandAlone

In our experience (with 11.0.3) only **Muonboy** and **Staco** results make sense for both singles and HI events.

Available in	*Data Access Key*	*C++ class*
ESD	MuonboyTrackParticles	TrackParticleContainer
ESD	StacoTrackParticles	TrackParticleContainer
AOD	StacoMuonCollection	MuonContainer
AOD	MuidMuonContainer	MuonContainer

Muon Reconstruction (2)

1) Single Upsilons with $-1 < \eta < 1$ (η and P_T distributions from pythia)

   Upsilons in pythia pp events with forced Upsilon production:

2) Full reconstruction (default settings)

3) HI settings (some stuff turned off or adjusted for HI events)

   HI events (PbPb @ 5.5 TeV):

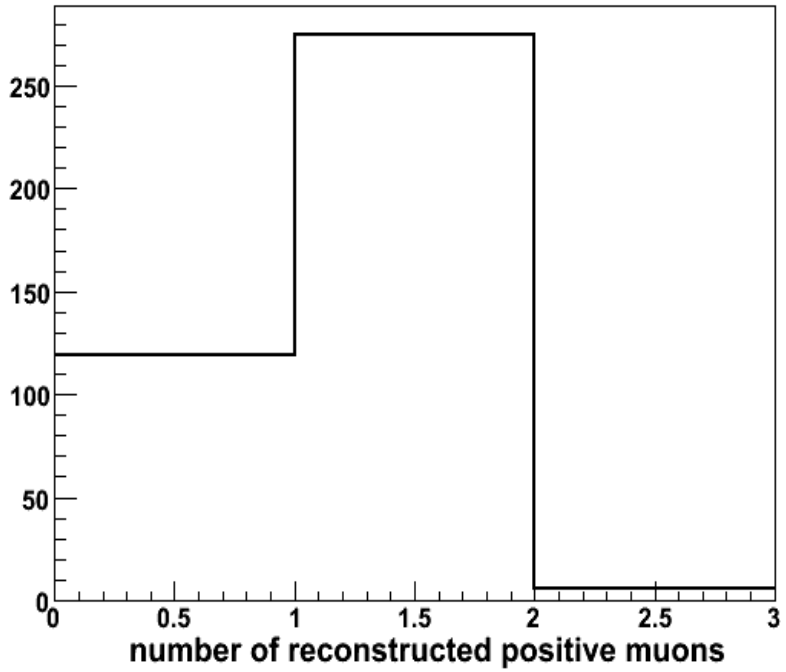
4) Single Upsilons merged with b=6 Hijing events (HI settings)

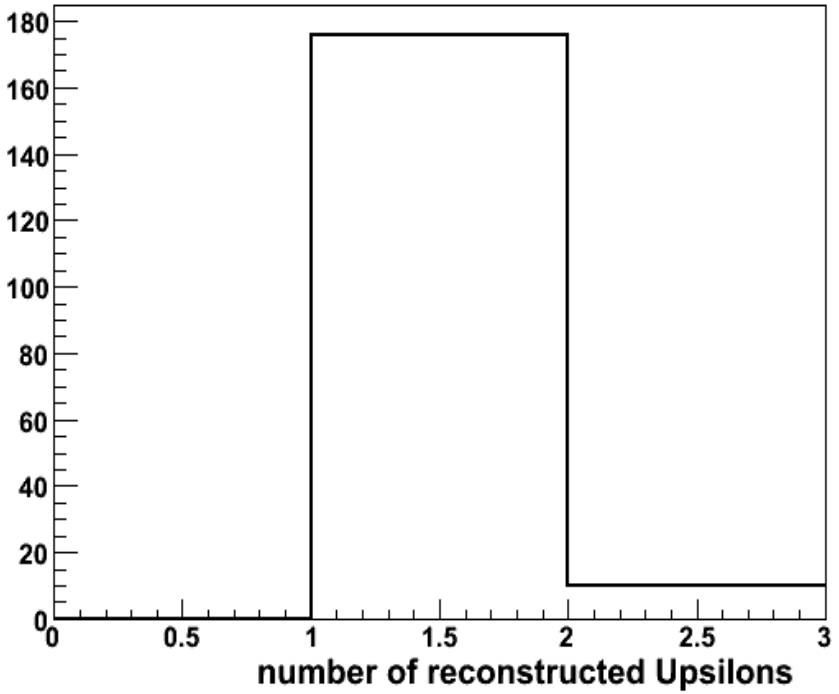
Each event was used several times with a different single Upsilon.

Single Upsilons

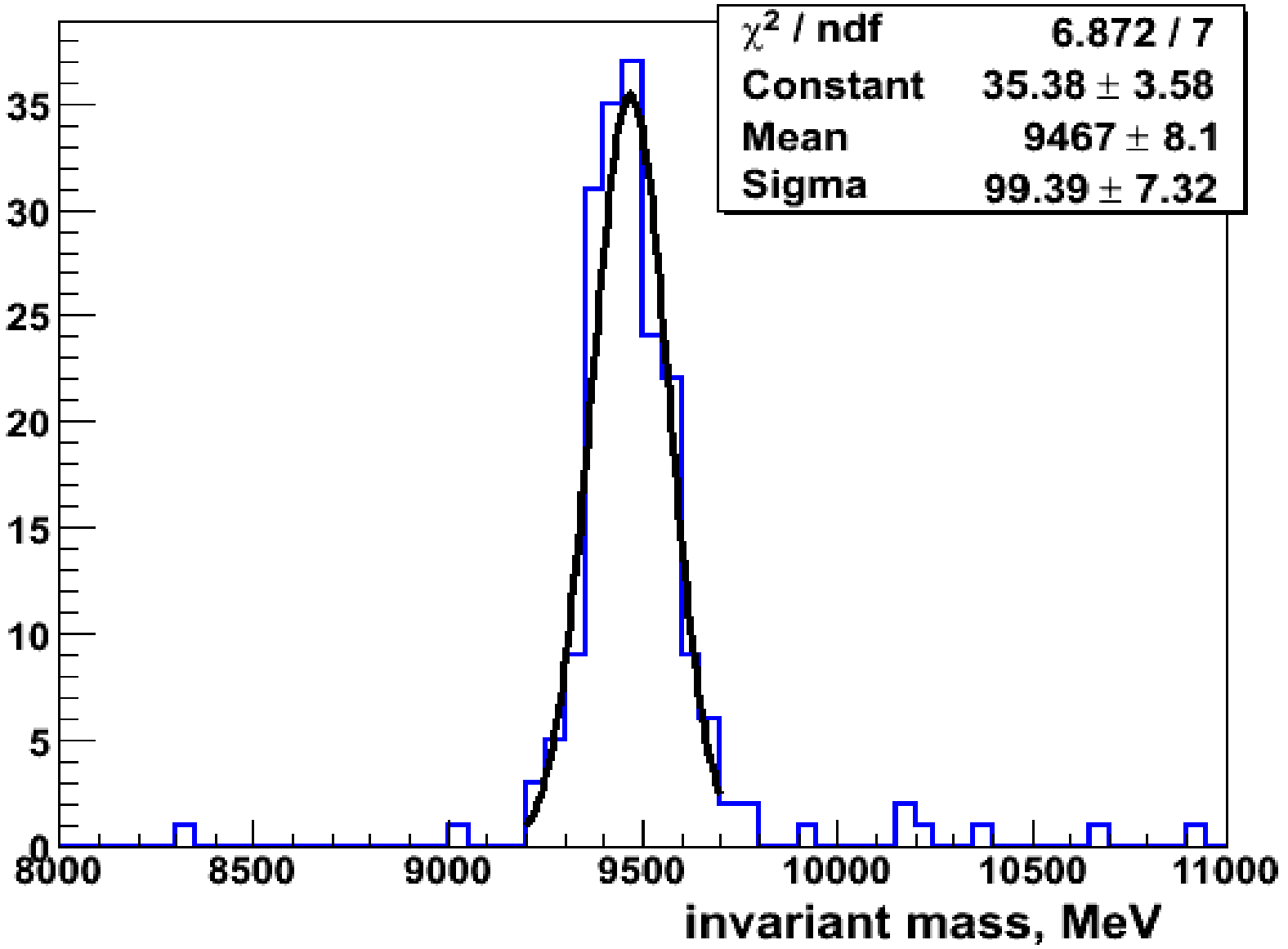
Generate single Upsilons decaying to muons, using Pythia.
Pseudorapidity range: -1.0 to 1.0, all transverse momenta.
Approximately half of all single Upsilons reconstructed in AOD (~46% Staco, ~51% MuID).
Only ~1/4 of all single Upsilons are reconstructed in ESD ???

Problem: some muons are split in two



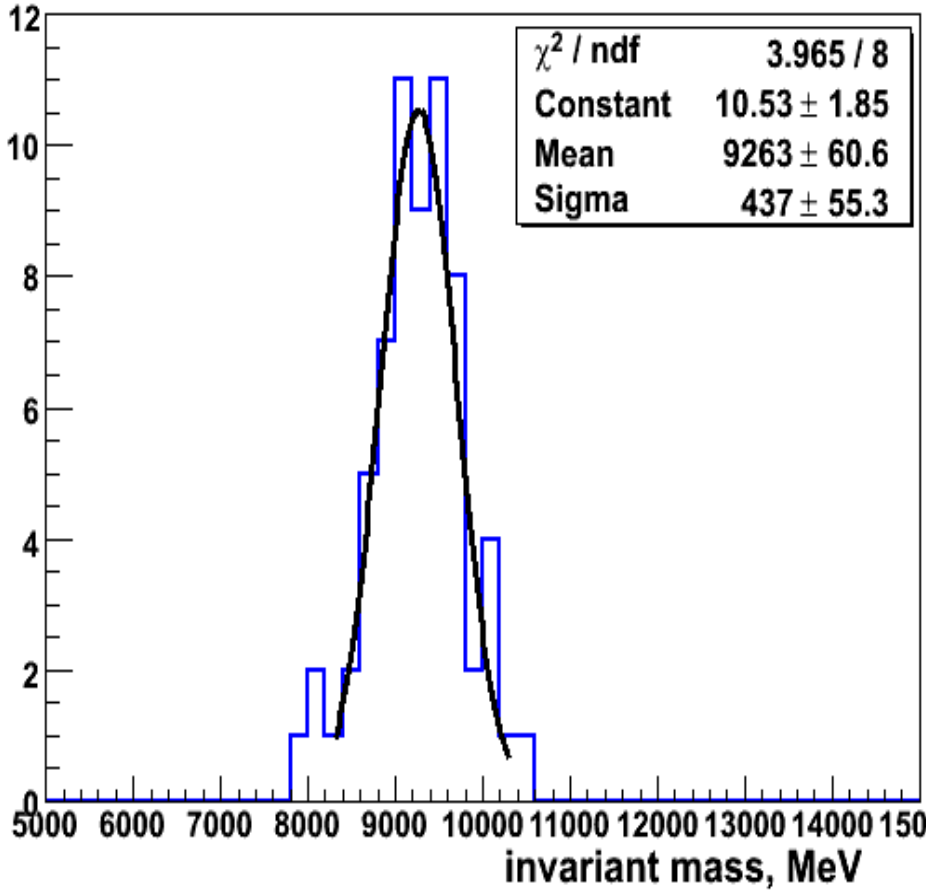


Single Upsilons Mass in AOD (MuID)



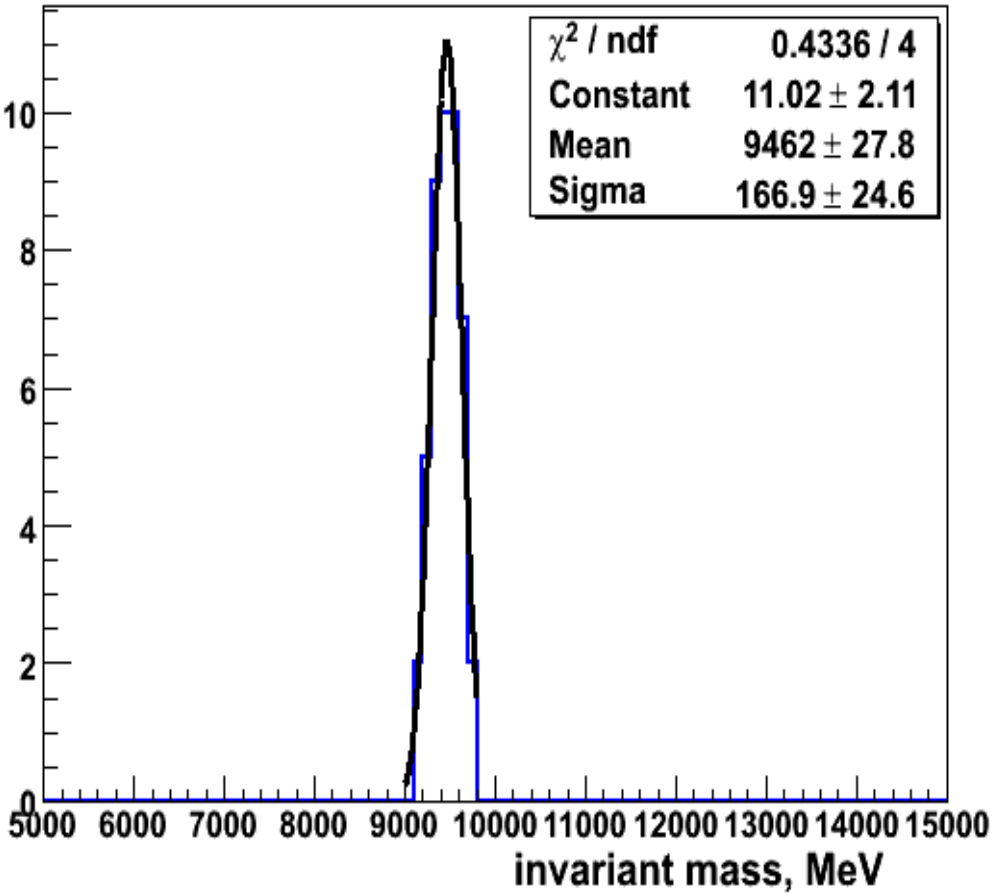
Single Upsilon Mass in ESD

Muonboy



Staco

efficiency relative to Muonboy ~ 70%



Merged HI Events

Hijing was used to generate PbPb events @ 5.5 TeV.

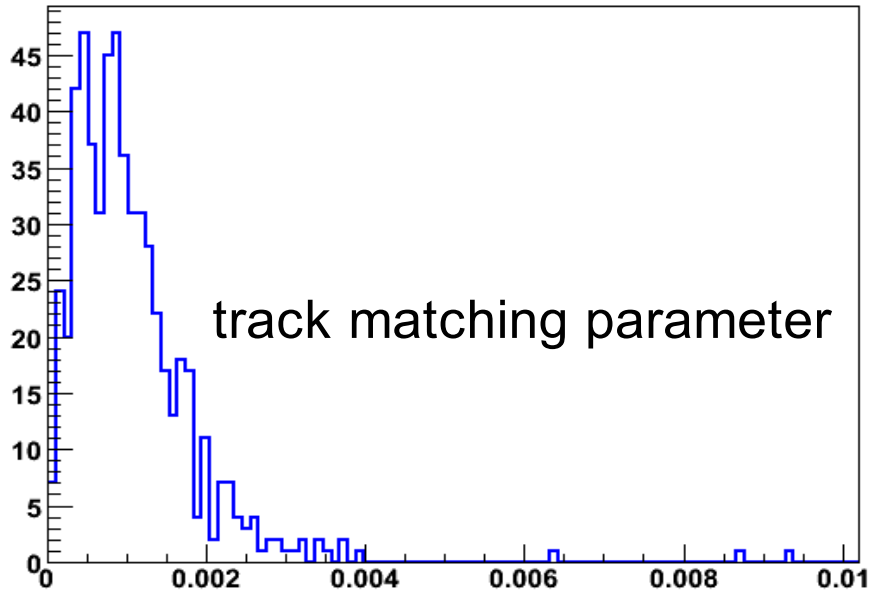
PileUpEventLoopMgr is used to merge Upsilons to PbPb events.

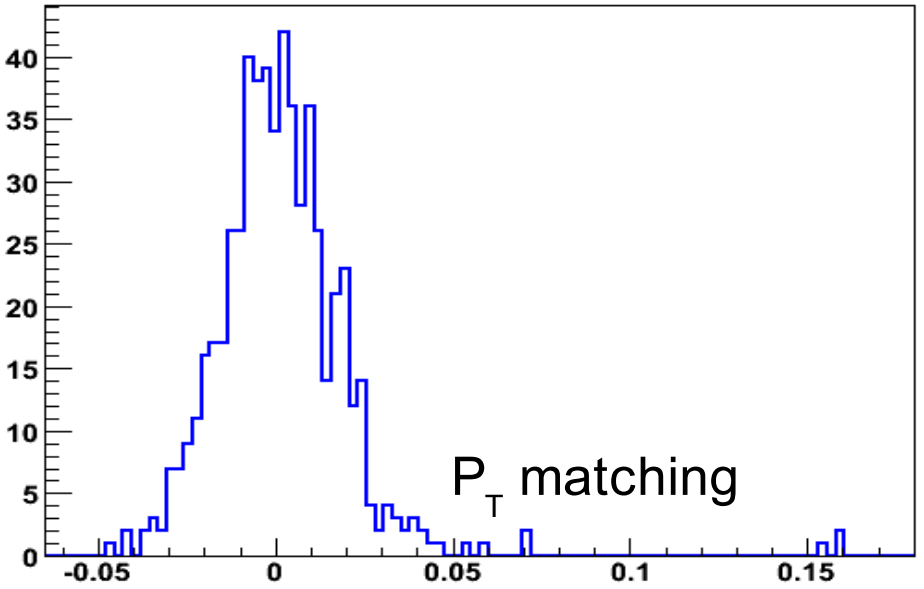
This study uses b=6 Hijing events merged with single Upsilons and pp pythia events with forced Upsilon production.

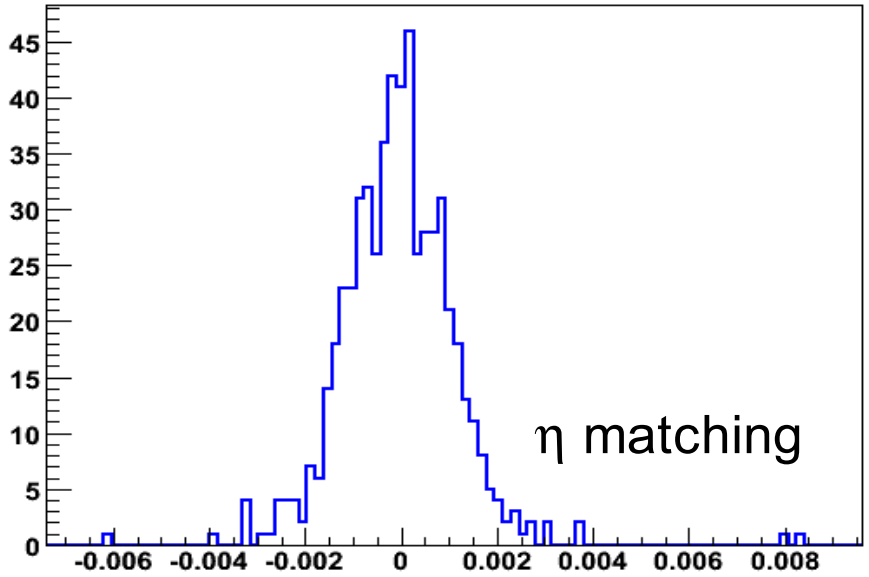
iPatRec turned off, tuned *xKalman* for HI events.

Each Hijing event was used several times with different Upsilon events.

Using MC Truth information (matchR)







Using single Upsilons determine matching parameters and use them for merged Upsilon/HI events.

dR < 0.004

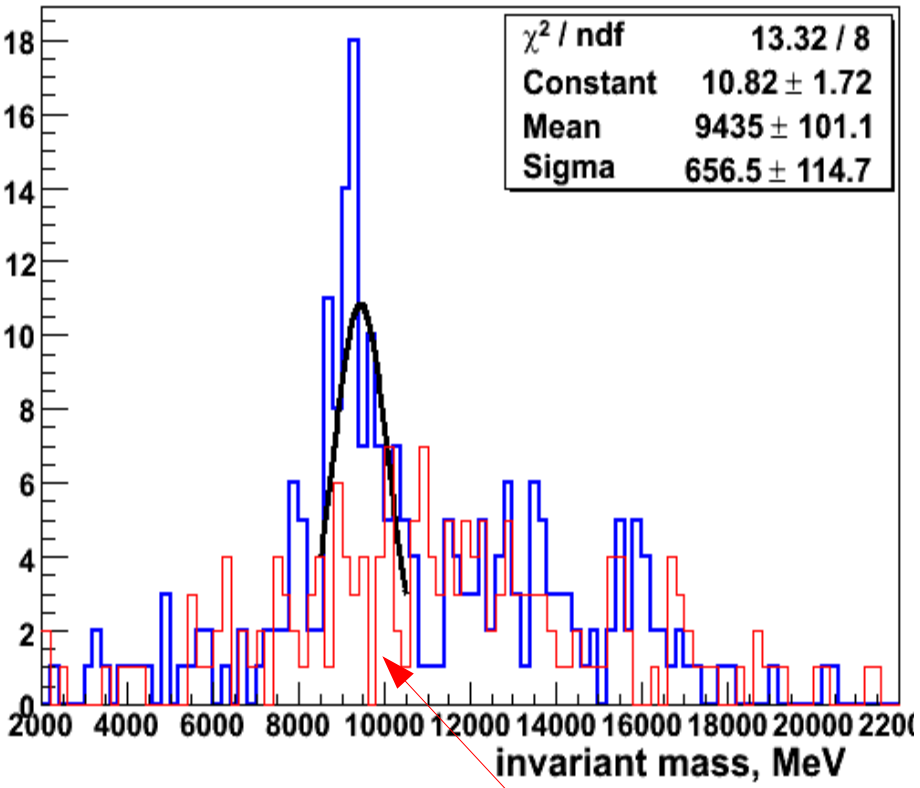
abs(dPt) < 0.05

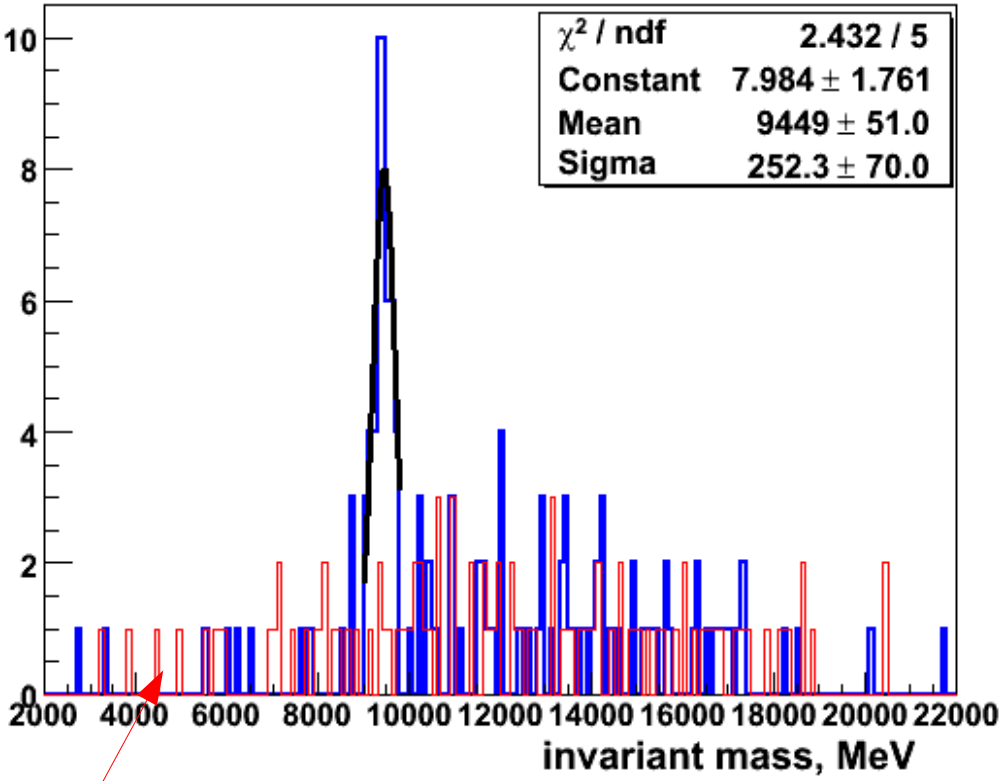
abs(dEta) < 0.003

Upsilons merged to PbPb events with b=6

Muonboy
efficiency relative to singles = 95%

Staco
efficiency relative to singles = 85%





same sign combinatorial background

Reconstruction Efficiency times Acceptance

	Single HI	Pythia Full	Pythia HI	Merged HI
ESD Muonboy	16.3 +- 2%	18.6 +- 1%	18.6 +- 2%	(95 +-3%)
ESD Staco	11.3 +- 2%	16.9 +- 1%	15.7 +- 2%	(85 +-3%)
AOD Staco	32.8 +- 2%	25.1 +- 1%	25.0 +- 2%	0
AOD Muid	0	33.3 +- 1%	0	0

relative to singles

Mass Resolution, MeV

	Single HI	Pythia Full	Pythia HI	Merged HI
ESD Muonboy	466 +- 64	580 +- 38	580 +- 38	656 +- 115
ESD Staco	167 +- 25	169 +- 12	198 +- 16	252 +- 70
AOD Staco	184 +- 16	139 +- 9	209 +- 15	N/A
AOD Muid	N/A	142 +- 9	N/A	N/A

Conclusions and Outlook

Good news:

- Event merging and reconstruction of HI events work
- Upsilons are reconstructed with reasonably good efficiency and mass resolution in PbPb @ 5.5TeV events (b=6).

Some Problems:

- Muon track splitting (1-2%)
- What happens in ESD-AOD transition?
- AODs can not be produced for HI events
- Reconstruction takes too much time (20-25 min per b=6 event)

Plans for the future:

- Learn more about muon reconstruction algorithms
- More simulations, merging with more central events