Reconstruction Efficiency of J/ψ at CBM Experiment

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Outline

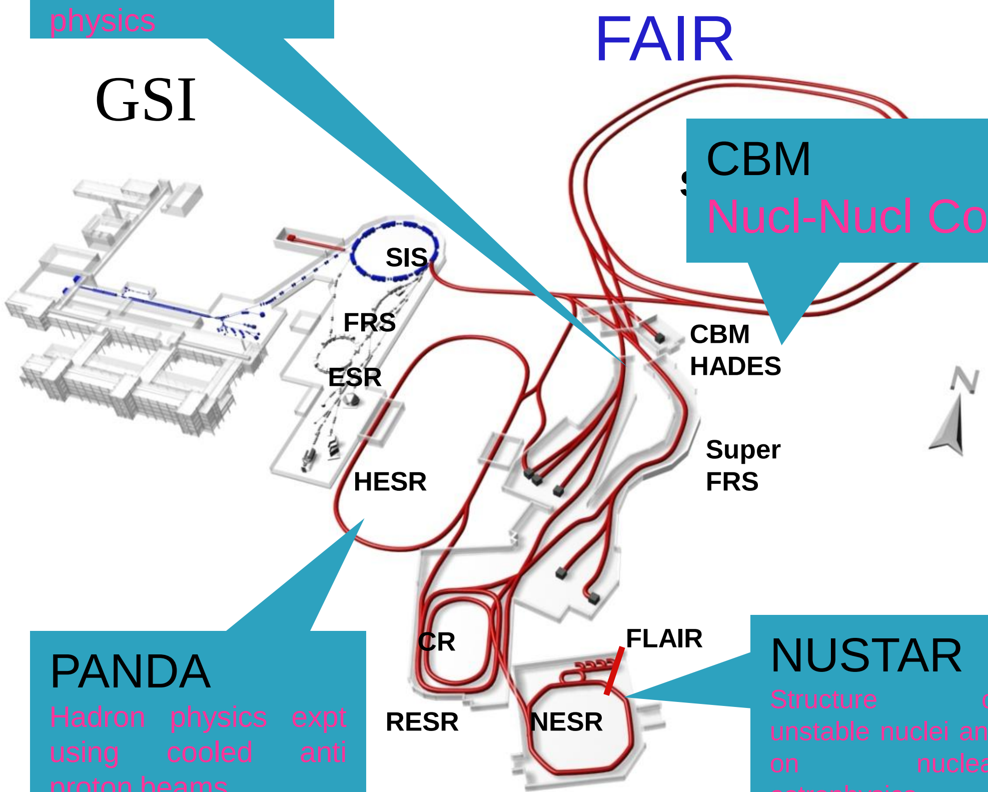
- MOTIVATION
- CBM EXPERIMENT
- MuCh GEOMETRY
- SIMULATION TOOLS AND CUTS
- ANALYSIS RESULTS
- CONCLUSION

MOTIVATION

- To investigate the highly compressed nuclear matter formed in the collisions in CBM Experiment.
- The aim is to study suppression of heavy quark resonances J/ψ. The suppression of these heavy quarks resonances is most promising signature of QGP.
- Optimization of MuCh Geometry.

Facility for Antiproton and Ion Research (FAIR)

International FAIR Project: ➔ Intensity Frontiers



PP
Setup for plasma physics

CBM
Nucl-Nucl Coll.

PANDA
Hadron physics expt using cooled anti proton beams

NUSTAR
Structure of unstable nuclei and on nuclear astrophysics

Primary Beams

- 10^{12}/s; 1.5-2 GeV/u; $^{238}U^{28+}$
- Factor 100-**1000** over present intensity
- 2(4)x10^{13}/s 30 GeV protons
- 10^{10}/s $^{238}U^{92+}$ up to 35 GeV/u
- up to 90 GeV protons

Secondary Beams

- Broad range of radioactive beams up to 1.5 - 2 GeV/u; up to factor **10 000** in intensity over present
- Antiprotons 0 - 15 GeV

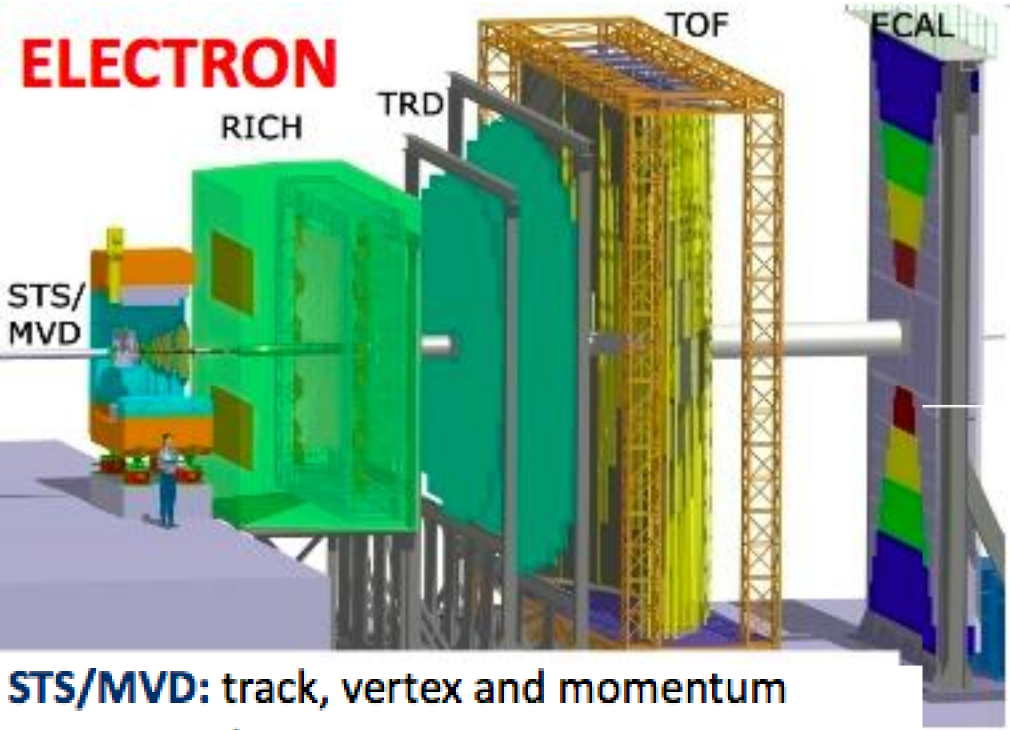
Storage and Cooler Rings

- Radioactive beams
- e^- – A (or Antiproton-A) collider
- 10^{11} stored and cooled 0.8 - 14.5 GeV antiprotons
- Polarized antiprotons(**?**)

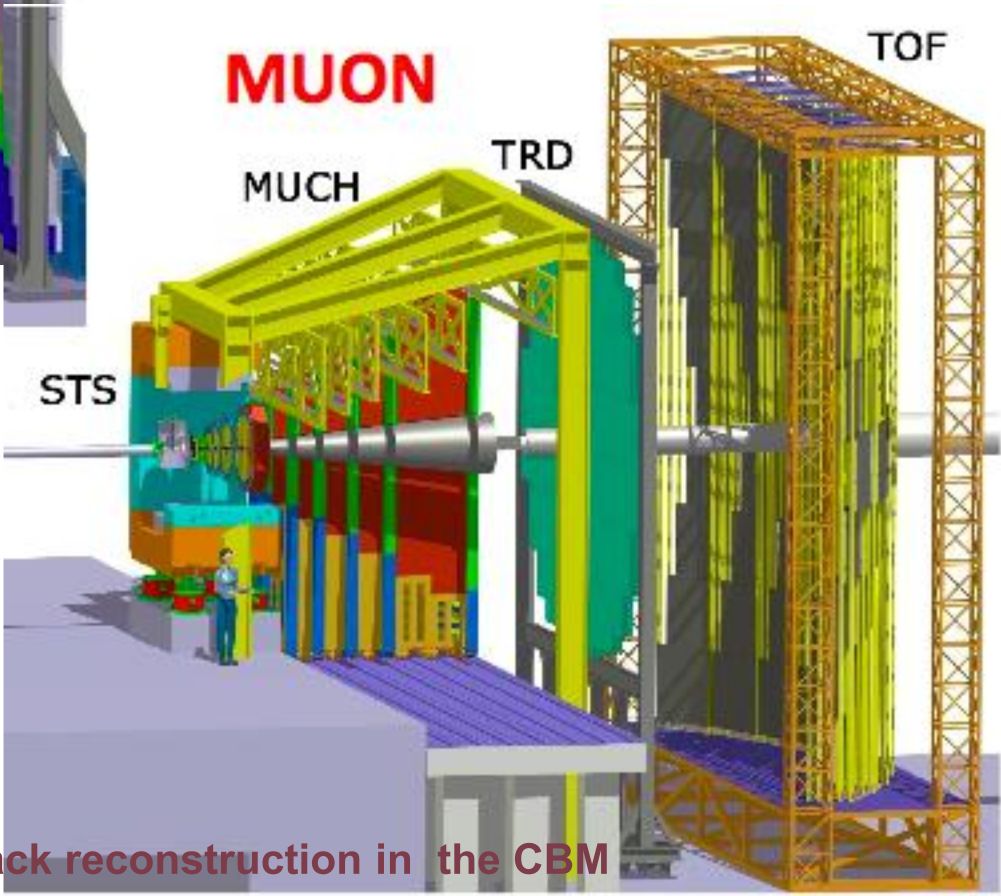
Key Technical Features

- Cooled beams
- Rapidly cycling superconducting magnets

CBM EXPERIMENT



• comprehensive measurement of hadron and lepton production in *pp, pA* and *AA* collisions from **8-45 AGeV** beam energy



STS/MVD: track, vertex and momentum reconstruction

RICH: electron identification **OR**
MUCH: muon identification

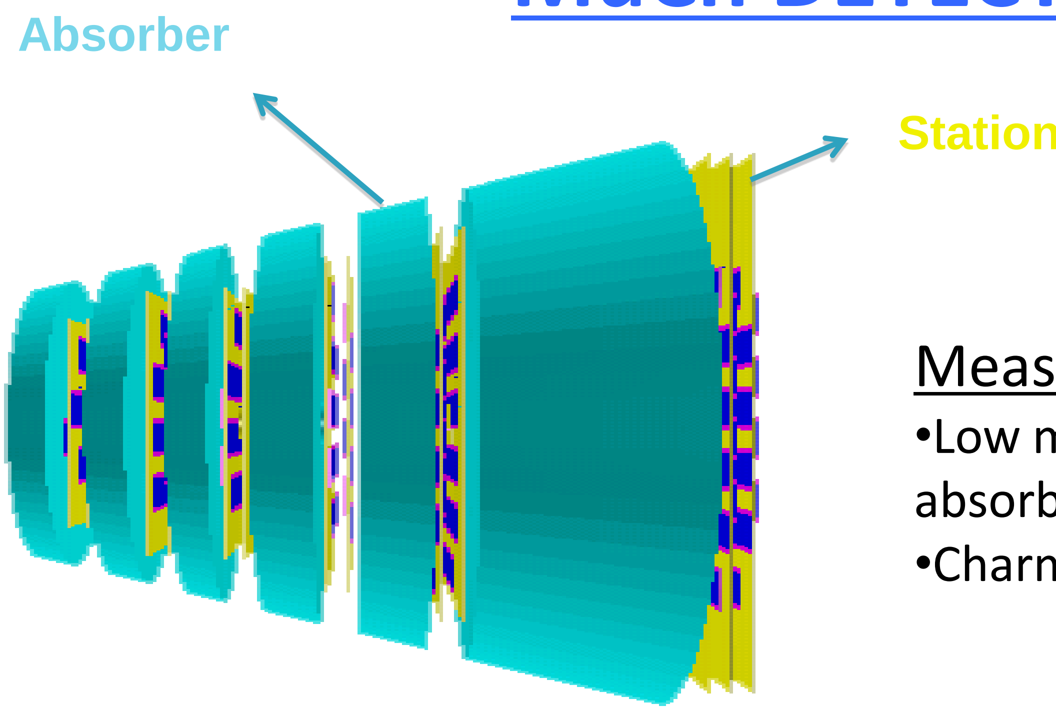
TRD: global tracking, electron identification

TOF: time of flight measurement for hadron identification

ECAL: photons and neutral particles

A. Lebedev, "Algorithms and software for track reconstruction in the CBM experiment"

MuCh DETECTOR



Measurement :

•Low mass vector meson -> 5 Fe absorber (125 cm)
•Charmonium -> 6 Fe absorbers (225 cm)

Detector challenges:

- High hit density (up to 1 hit per cm^2 per event)
- High event rates (10^7 events/s)
- Position resolution<300µm
- Choose alternating detector- absorber layout
- for continuos tracking of the muons through the absorber

Specification of distances:

Layer to layer:10cm
Abs. to layer: 0cm
Layer to Abs. : 10cm
Absorber thickness: 20 20 20 30 35 100

Simulation tools and cuts

J/ψ-production in Central Au-Au collision at 25 AGeV

Simulation tools:

PLUTO: one signal dimuon pair per event

UrQMD: background

Statistics: 10k

Cuts:

Hit criteria - 70%

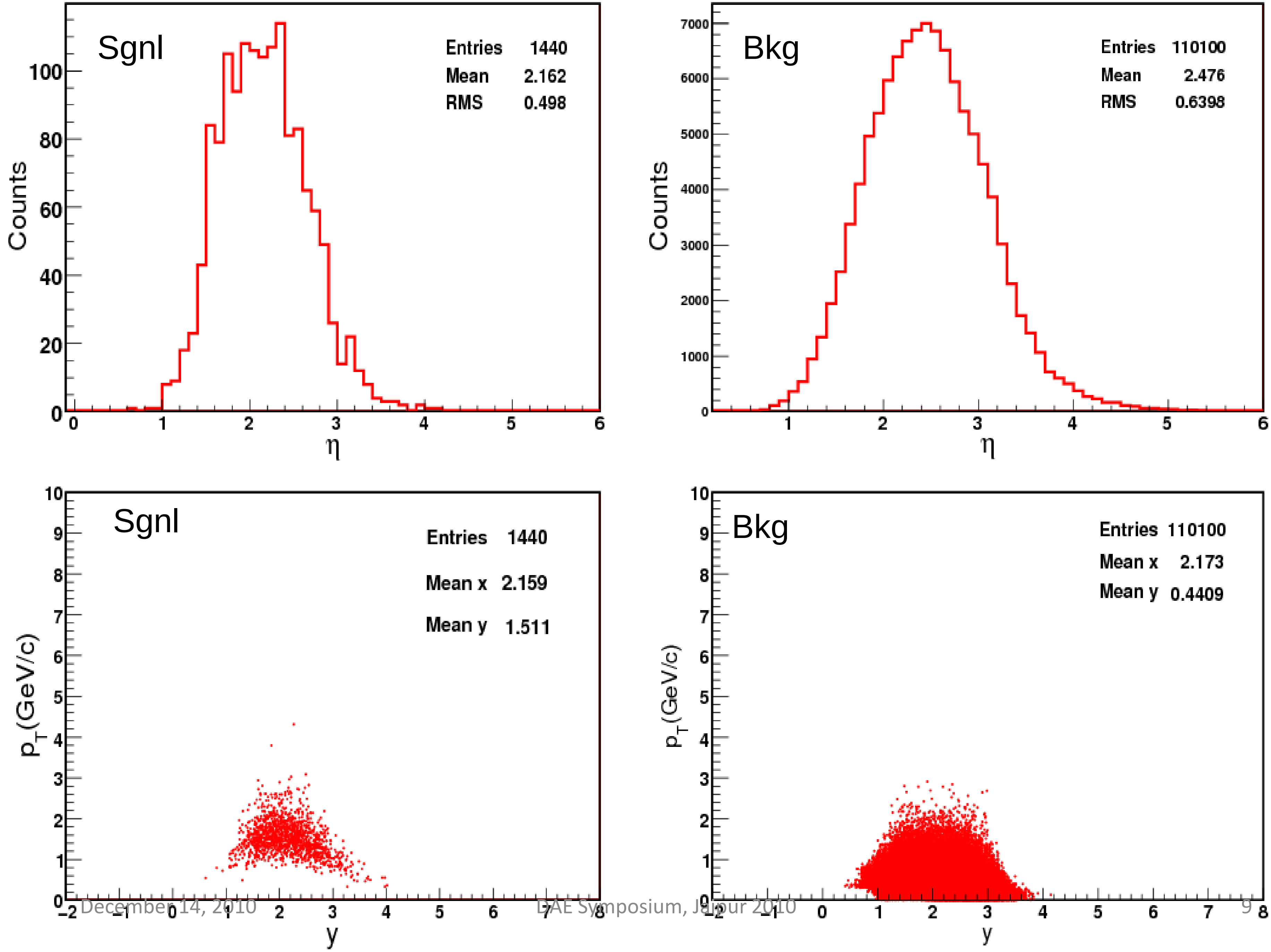
nMuchhits≥11

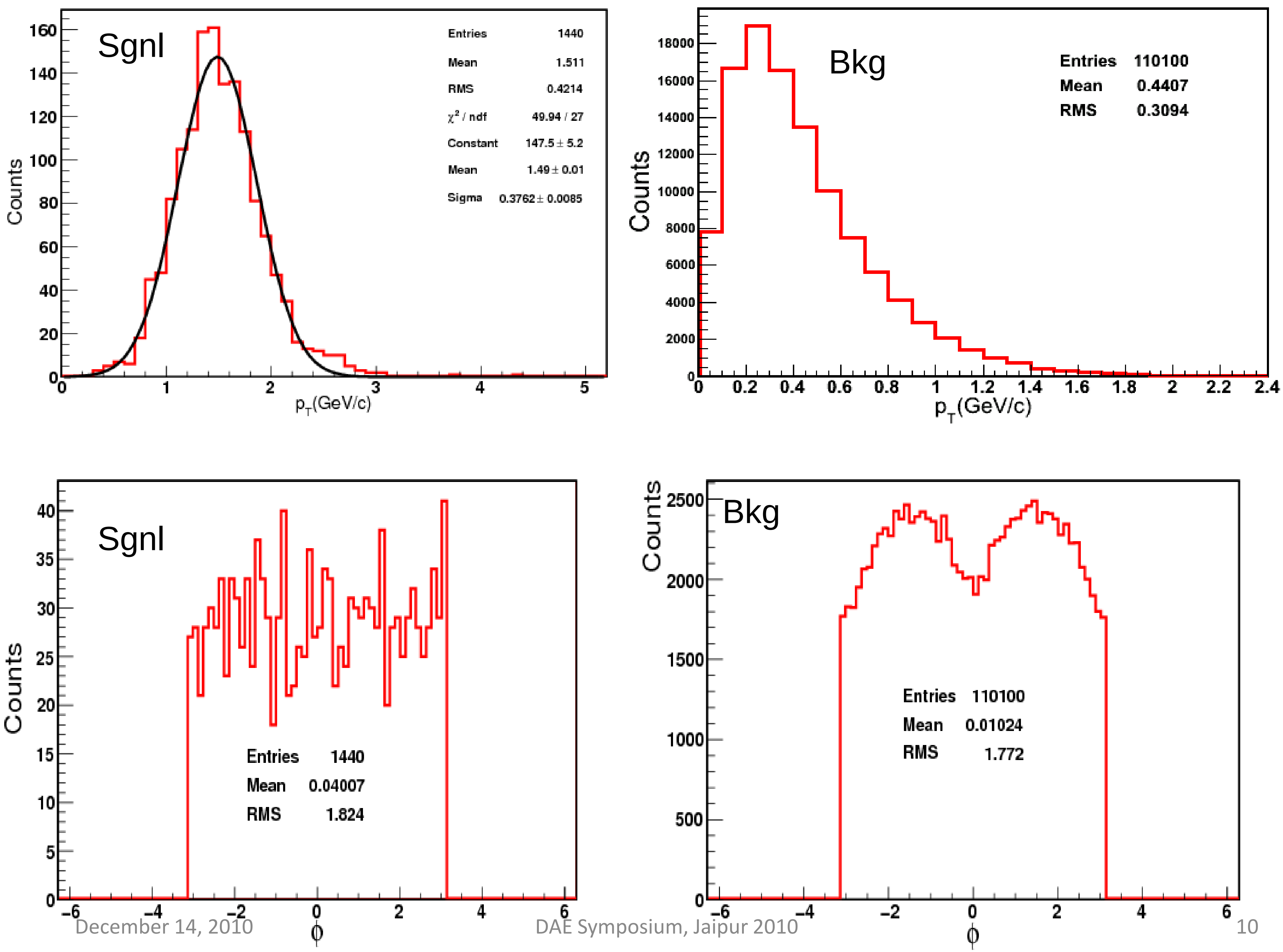
nSTShits≥4

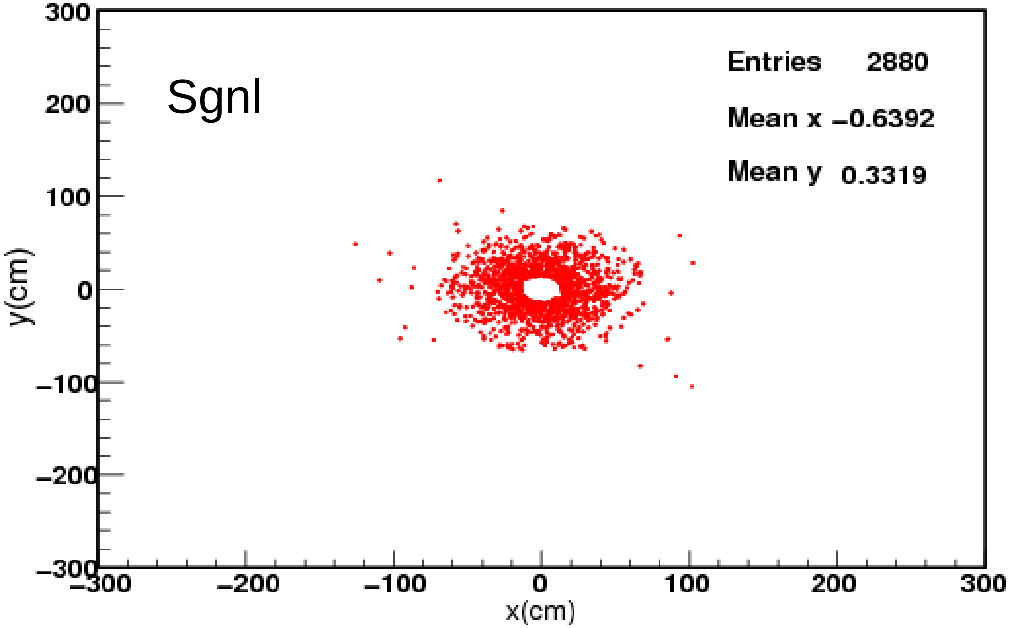
Track Pdg Code – 13

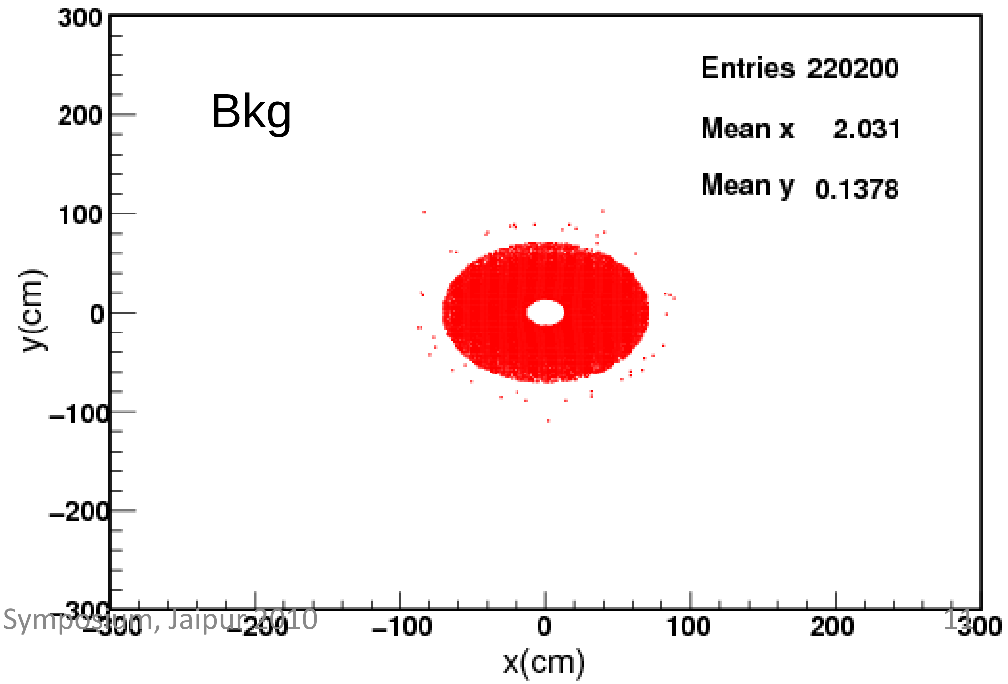
?

TRANSPORT QA PLOTS




Sgnl
Entries 1440
Mean 1.511
RMS 0.4214
χ² / ndf 49.94 / 27
Constant 147.5 ± 5.2
Mean 1.49 ± 0.01
Sigma 0.3762 ± 0.0085
Counts
p_T(GeV/c)
Bkg
Entries 110100
Mean 0.4407
RMS 0.3094
Counts
p_T(GeV/c)
Sgnl
Entries 1440
Mean 0.04007
RMS 1.824
Counts
ϕ
Bkg
Entries 110100
Mean 0.01024
RMS 1.772
Counts
ϕ


Sgnl
Entries 2880
Mean x −0.6392
Mean y 0.3319
y(cm)
x(cm)


Bkg
Entries 220200
Mean x 2.031
Mean y 0.1378
y(cm)
x(cm)

Reconstruction:

Segmentation scheme: Manual Segmentation

Station 1 (layer 1,2) : two regions (pad size: 0.5×0.5, 1.0×1.0)
Station 2 (layer 3,4) : two regions (pad size : 0.5×0.5, 1.0×1.0)
Station 3 (layer 5,6): one regions (pad size : 2.0×2.0)
Station 4 (layer 7,8) : one region (pad size: 2.0×2.0)
Station 5 (layer 9,10) : one region (pad size : 5.0× 5.0)
Station 6 (layer 11,12,13):one region (pad size: 5.0×5.0)

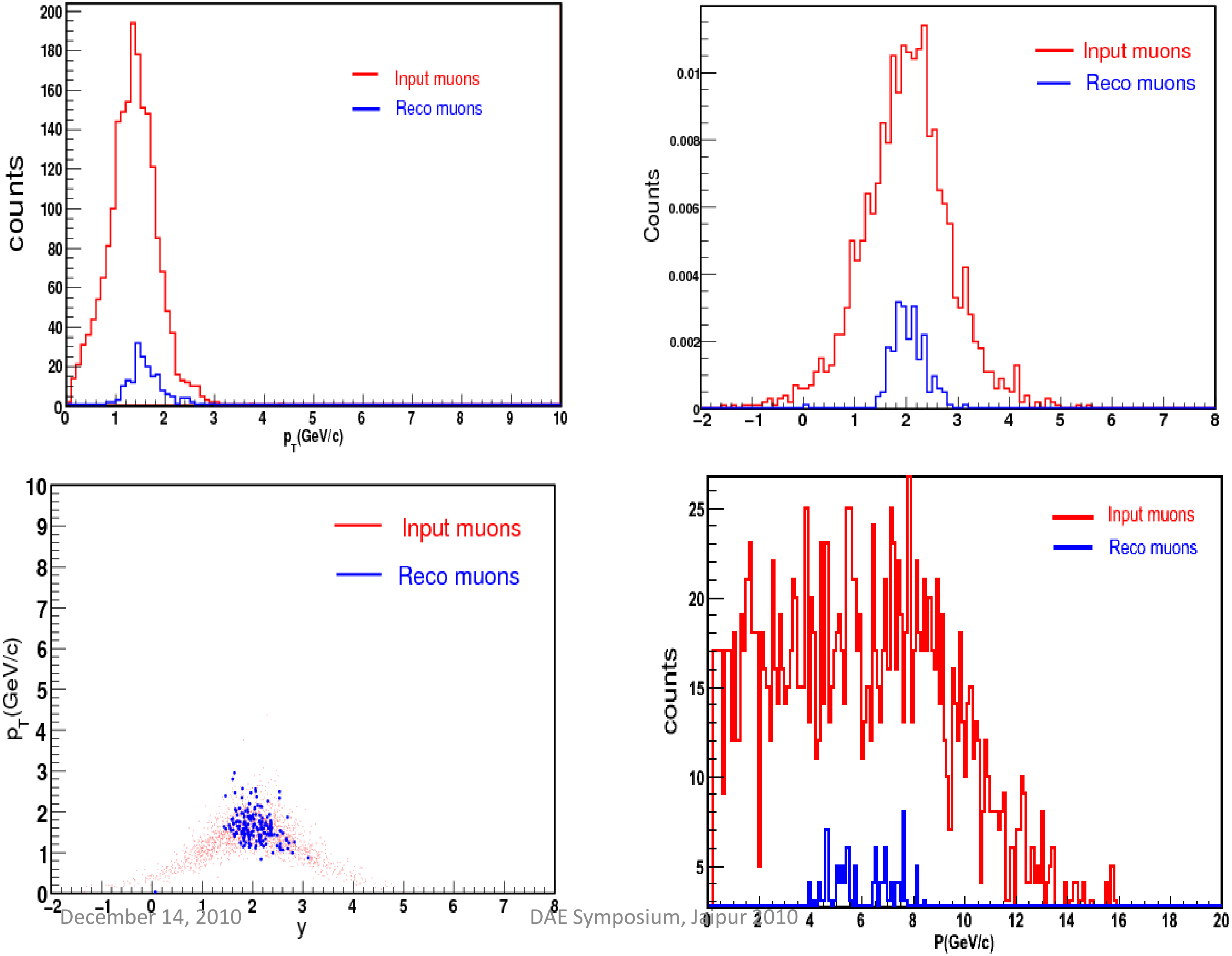
Optimisation to be done for

LMVM, Charmonia

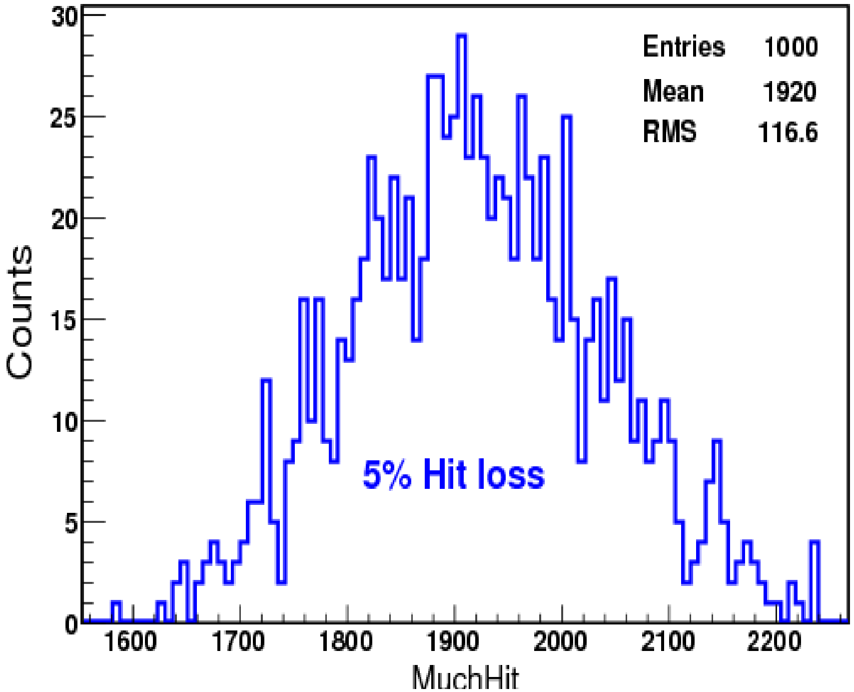
Reconstruction Efficiency, S/B

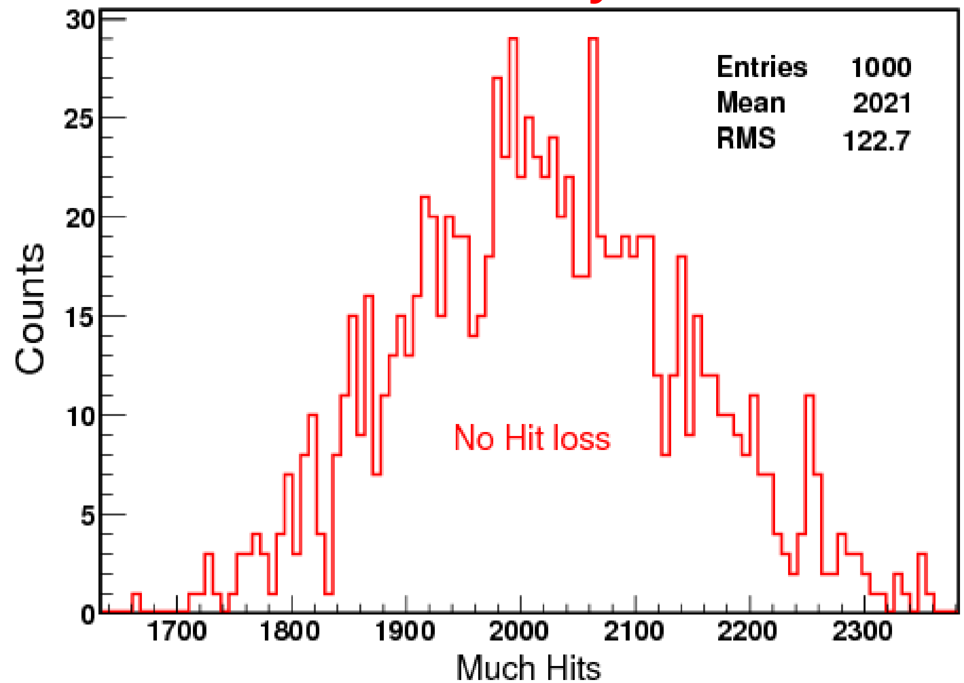
Implementation of detector in-efficiency at hit producer level.
w/o clustering

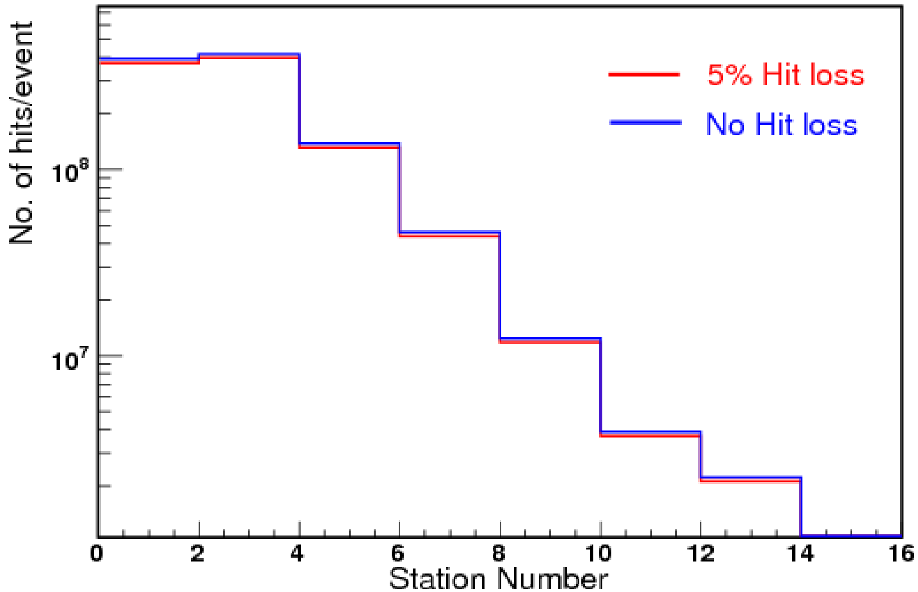
Comparison of Input Tracks and Reco Tracks

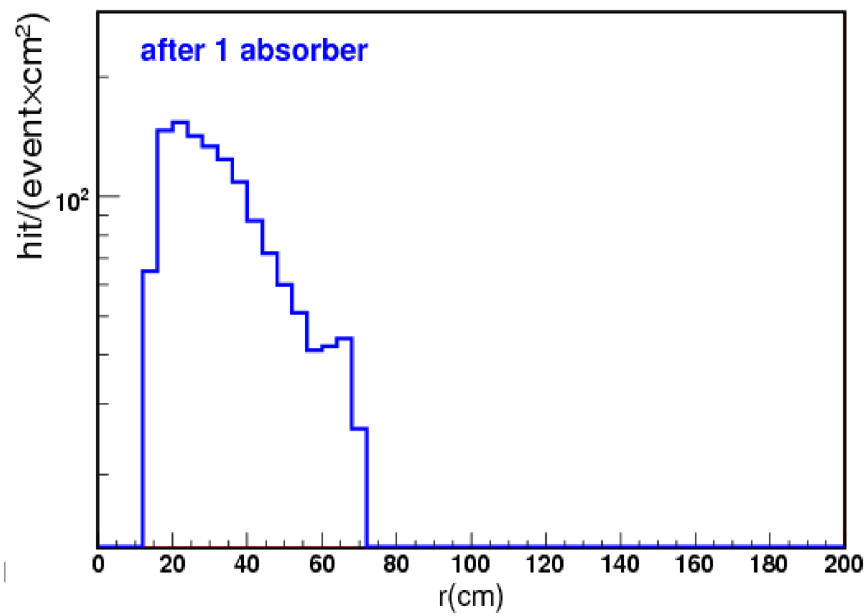


Implementation of detector inefficiency

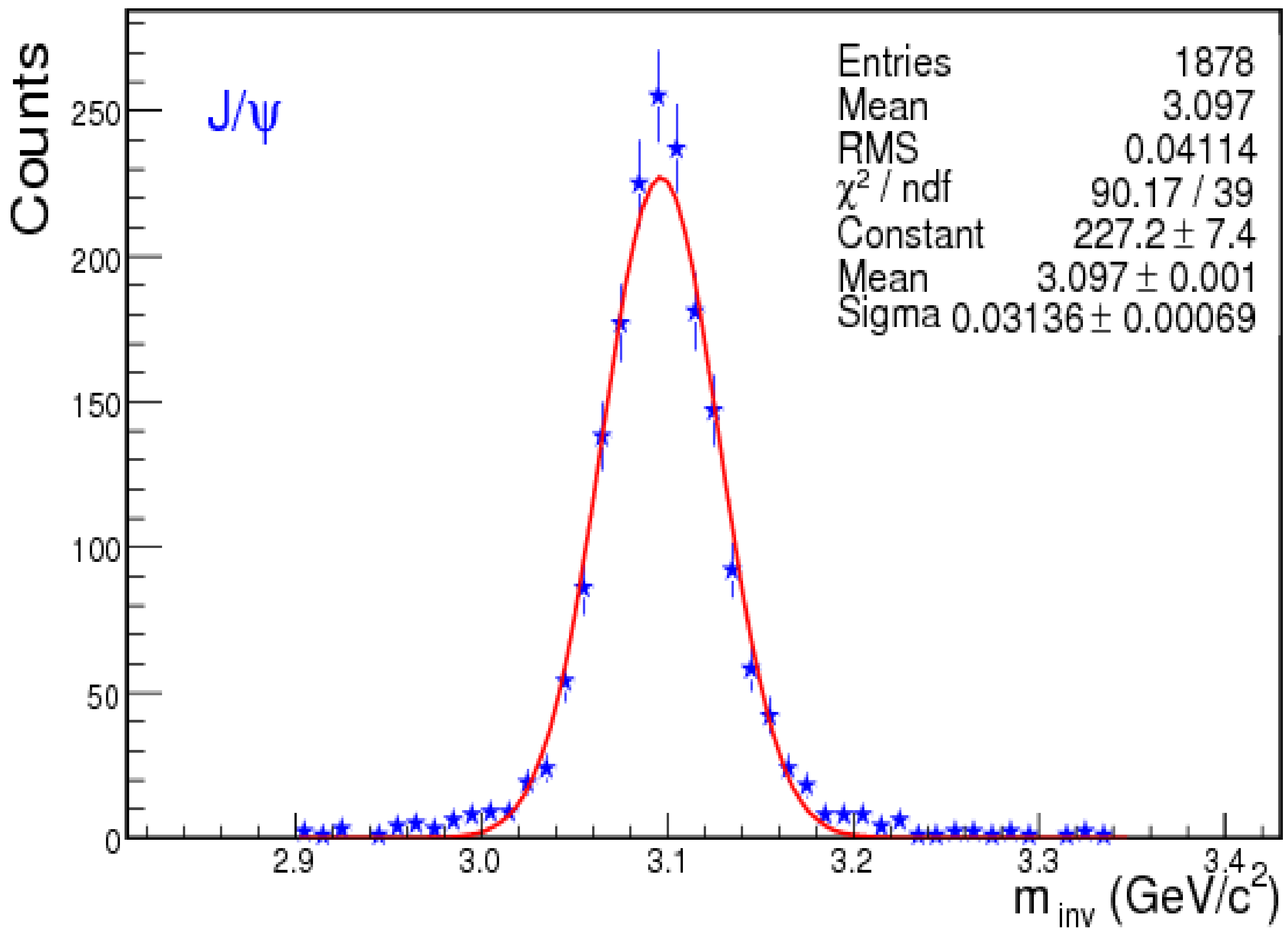


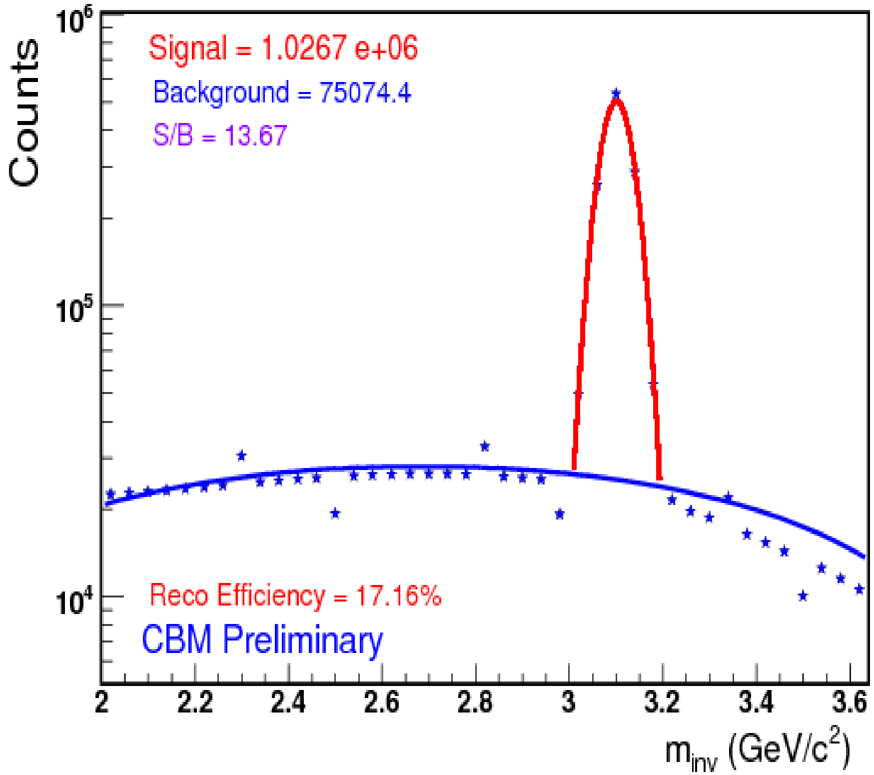






INVARIANT MASS SPECTRUM





Super Event (SE) analysis for bkg (Combine all the positive tracks with all the negative tracks over all the events excluding only the tracks from the same event)

Gaussian fit to signal

Polynomial fit to background

ANALYSIS RESULTS

Geometry	Without detector inefficiency		With 5% detector inefficiency	
	Reco. Eff.	S/B Ratio	Reco. Eff.	S/B Ratio
Standard Geometry (18 Stations)	16 %	15	13 %	12.26
Reduced Geometry (13 Stations)	17.16 %	13.67	14.11 %	10.93

CONCLUSIONS

➢The maximum hit density is reached at the inner layers of the muon detection system and hit density goes on decreasing as we move to the outer layers away from the target.

➢The use of the absorber in between stations reduces the background particles like muons resulting from the weak decay of pions, kaons, hadrons and secondary electrons.

➢The total absorber thickness has been optimized in such a way that it absorbs most of the background particles without affecting the signal reconstruction efficiency.

➢The comparison between input muon tracks generated by PLUTO from the decay of J/Ψ and reconstructed muon track shows that our detector coverage is such that it is able to detect the mid-rapidity region.

➢It has been observed that when the number of tracking station are reduced from 18 to 13, there is not any significant reduction either in reconstruction efficiency or in signal to background (s/b) ratio. This indicates that J/ψ is a easily reconstructable particle provided a suitable optimized thick absorber is used.

➢The implementation of detector in-efficiency ultimately results in loss of reconstructed MuCh hits which are used for reconstruction of tracks in the muon detection system and hence may affect the track reconstruction efficiency.

THANKS

FOR YOUR ATTENTION