Muon analysis at Hiroshima University

ALICE MFT meeting at Hiroshima University
05/10/2015
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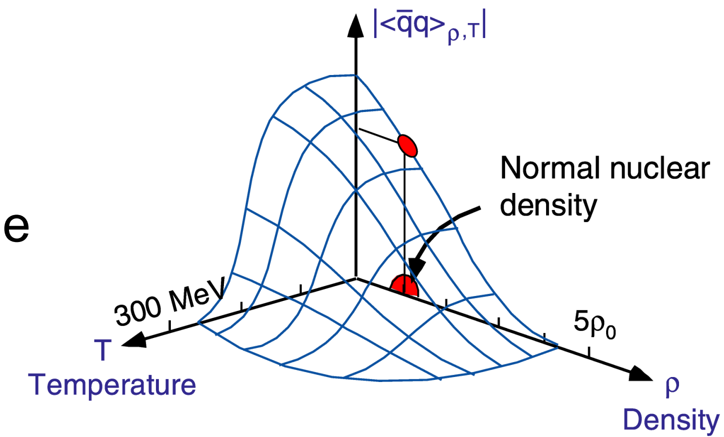
(Hiroshima University)

Contents

- Physics motivation
- Muon analysis in LHC15 runs (13 TeV)
- Muon Forward Tracker (MFT) simulation analysis

Physics motivation

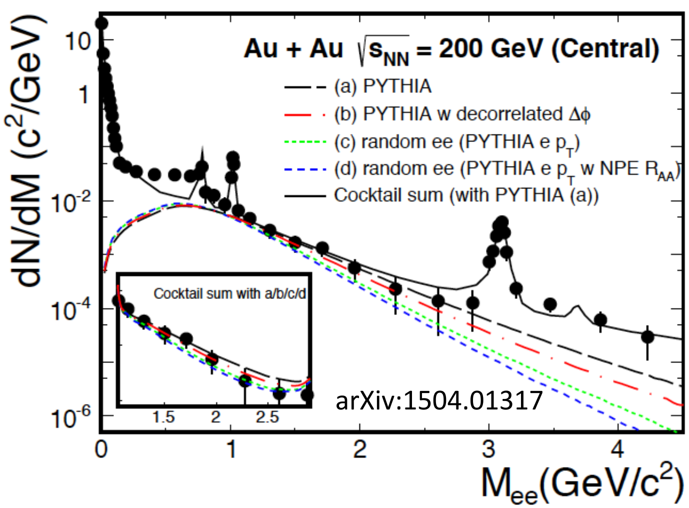
- Chiral symmetry restoration in hot medium.
  - Density is almost 0 and temperature is over 300MeV!
  - Chiral symmetry should be restored at LHC!!!



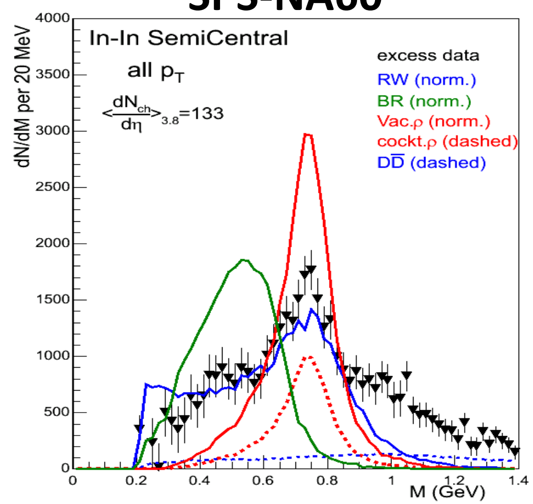
- Dilepton channel is golden channel to study in the medium.
  - Di-electron channel has much background (almost came from pi0)

- Imitate SPS-NA60 experiment successful!

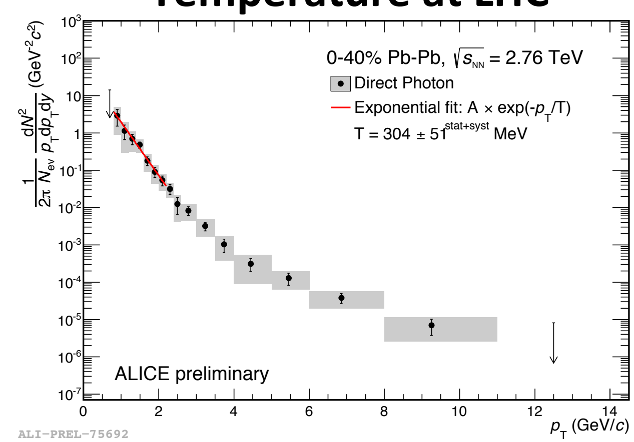
Dielectron measurement



SPS-NA60



Temperature at LHC



Muon analysis in run2

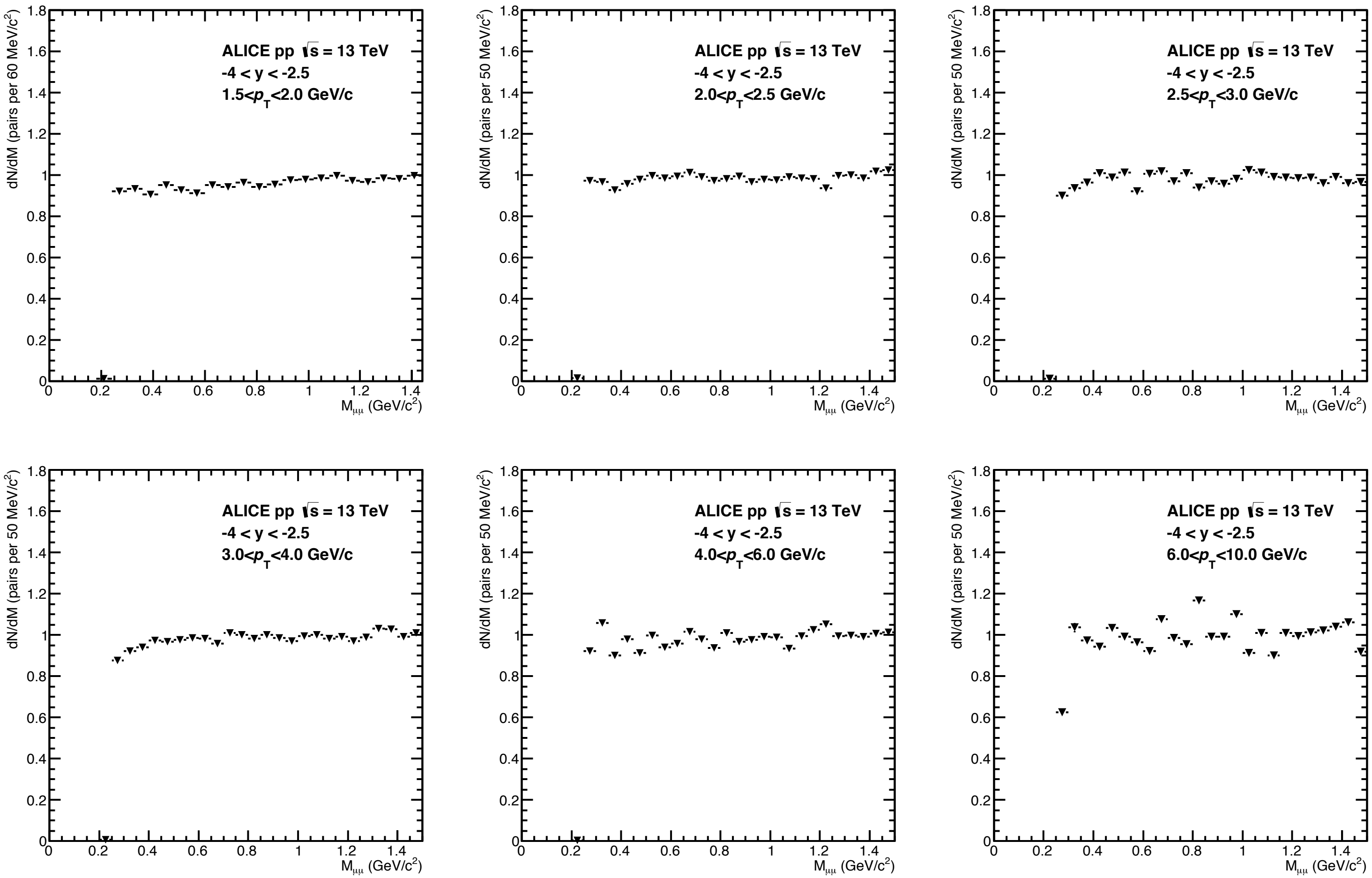
- Low and middle mass and low p_T physics
  - LHC15[g,h] kMUL and kMLL trigger
- Signal extraction
  - Combinatorial background
  - Cocktail method
- Estimate some efficiencies
  - Acceptance x reconstruction efficiency
  - Trigger efficiency
  - Rejection factor

Good run selection & muon track cut

- Period & FileName: LHC15[g,h]/pass1/AliAOD.Muons.root
- Detector:
  - At least [MUON_TRG] as Trigger
  - At least [MUON_TRG & MUON_TRK & SPD] as Readout
- Quality flag:
  - [MUON_TRG & MUON_TRK] Good run
  - [SPD] NOT Bad run
- Duration: > 10 m
- Shuttles:
  - GRP, SPD, MUON_TRG and MUON_TRK: DONE
- |vtx_z| < 10 cm
- Trigger: kMUL || kMLL
- Muon track cut criteria
  - $-4.0 < y_{\mu} < -2.5$
  - Chi2/ndf < 5.0
  - Match trigger track (track->MatchTrigger())
- Di-muon pair selection criteria
  - $-0.4 < \eta_{\mu\mu} < -2.5$

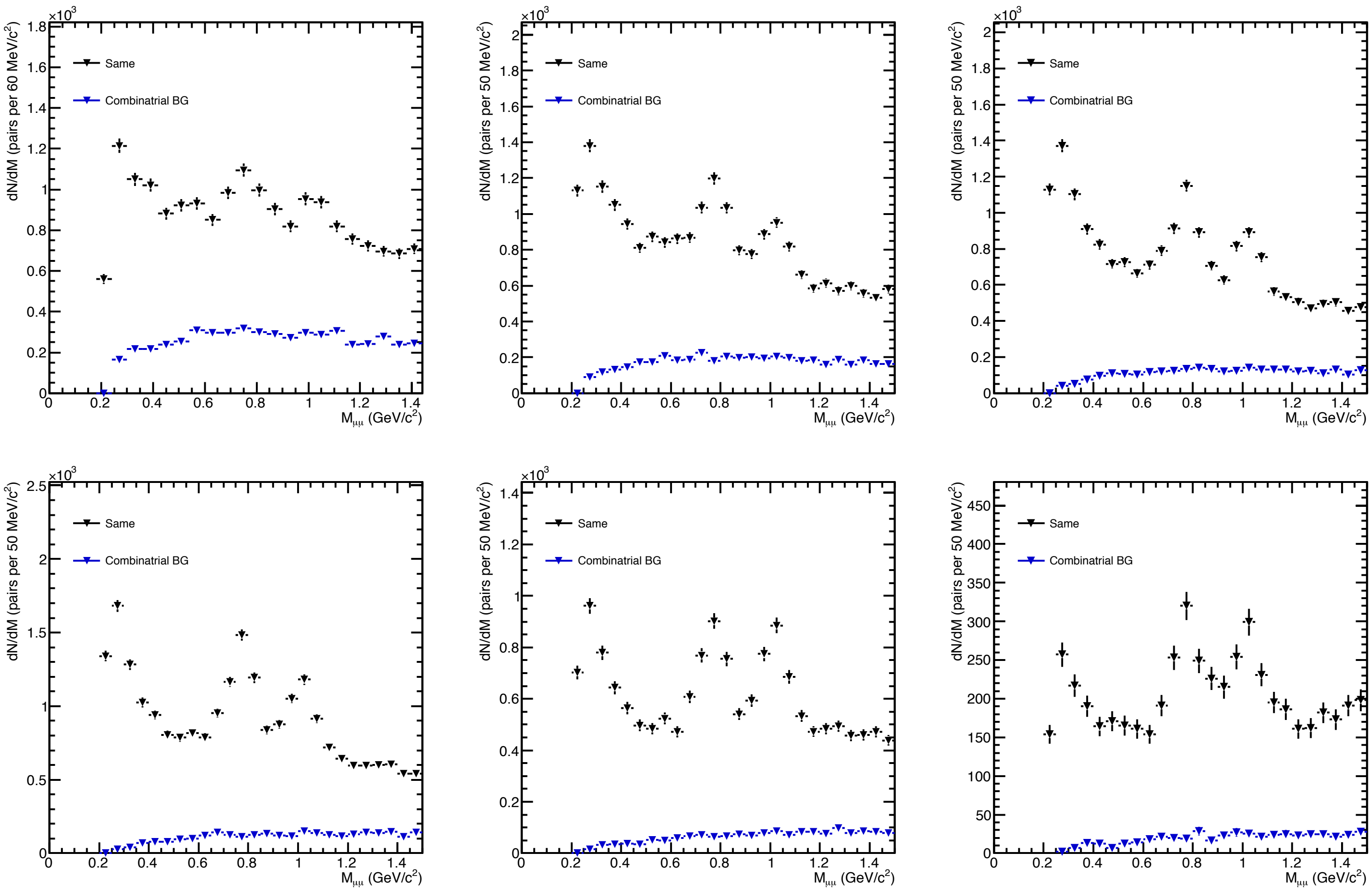
R factor

- R factor: N_{+-}^{mixed} / 2\sqrt($N^{mix}_{++}N^{mix}_{--}$)

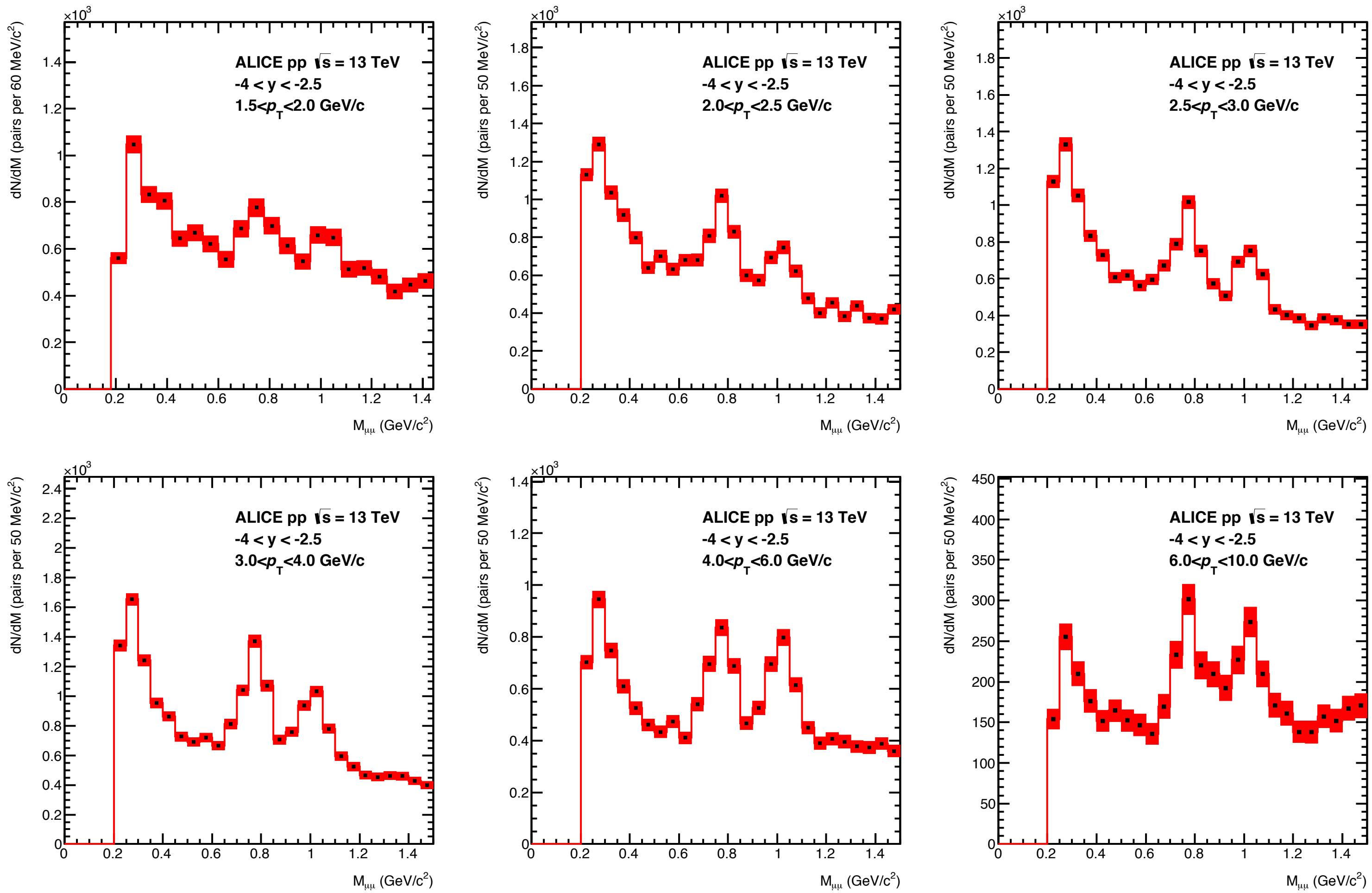


Invariant mass (same and scaled mixed event)

- Combinatorial distribution can be calculated
  - Normalization factor: 2R\sqrt($N_{++}N_{--}$)



Invariant mass spectrum (after combinatorial background subtraction)

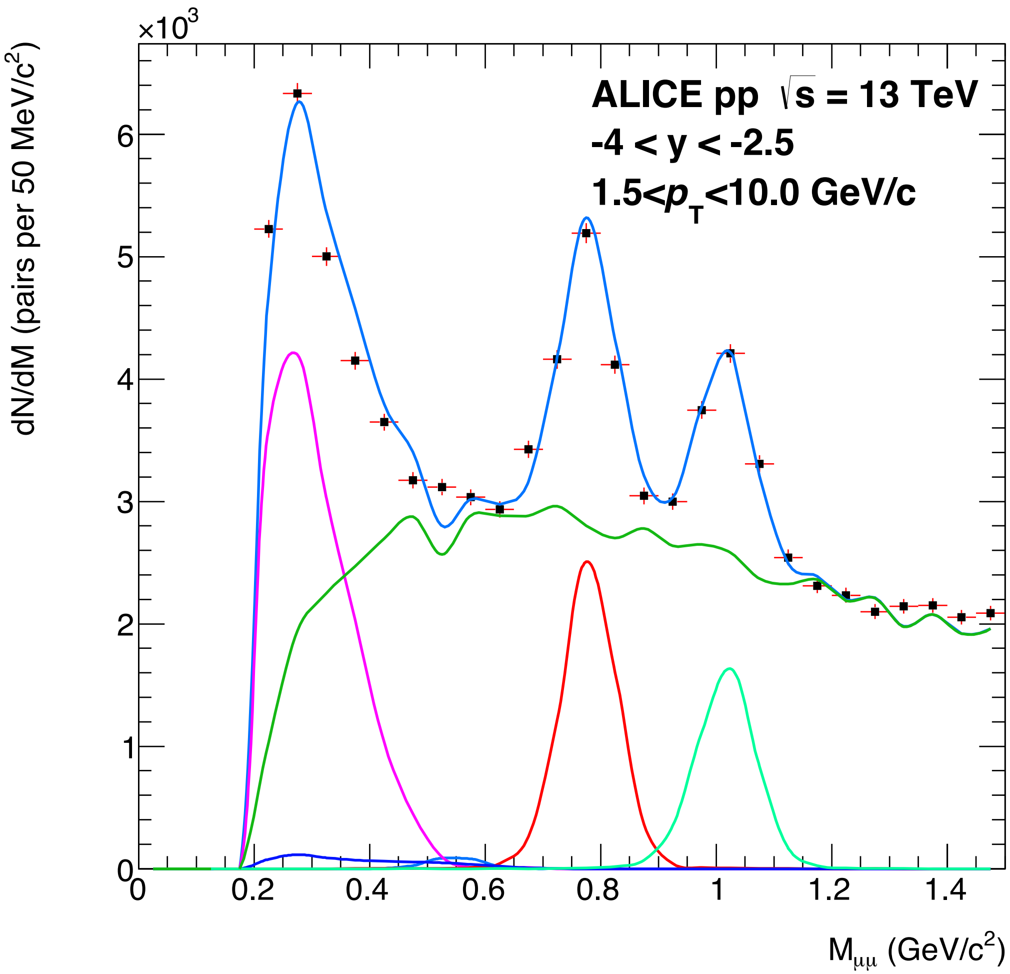


Single simulation for cocktail

- Single particle: AliMUONLMR & AliGenCorrHF
- Installed detector as Read-out
  - MUON
- Installed detector as just material
  - Absorber, Dipole, Hall, MUON, Pipe, Shield, Vzero and FMD
- Detector response
  - Used OCDB
- Primary vertex
  - ITS resolution comes from LHC15g3c pp13TeV MC production for LHC15f runs

Cocktail (very preliminary)

- NOT correct scale



All
Eta
Eta Dalitz
Omega
Omega Dalitz
Phi
cc_bar

Cocktail (very preliminary)

- NOT correct scale

All
Eta
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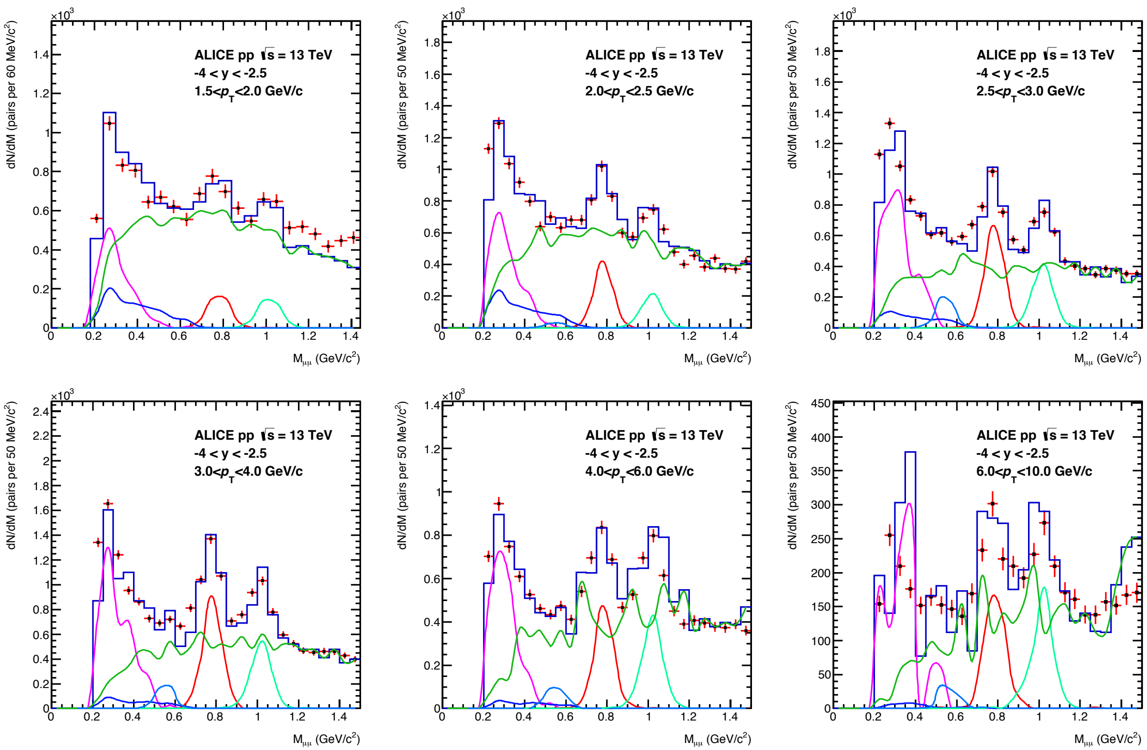
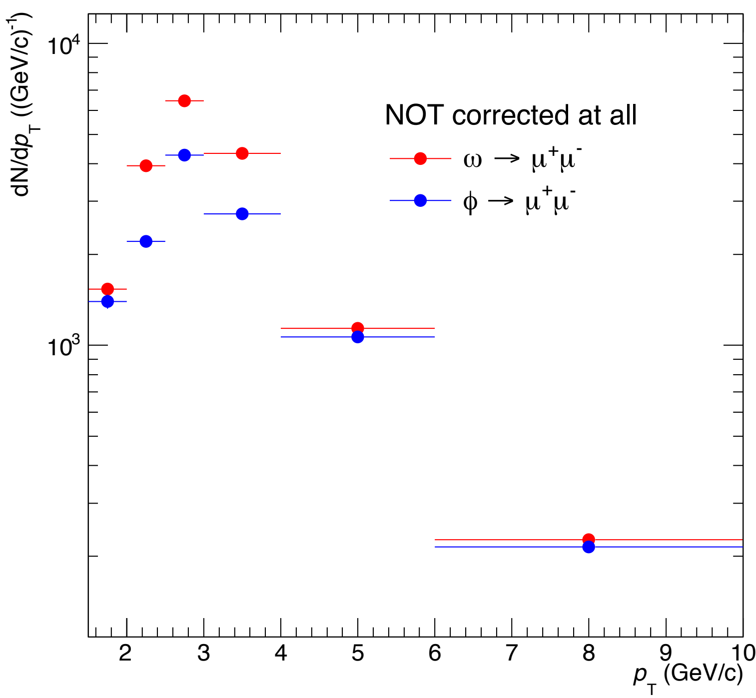
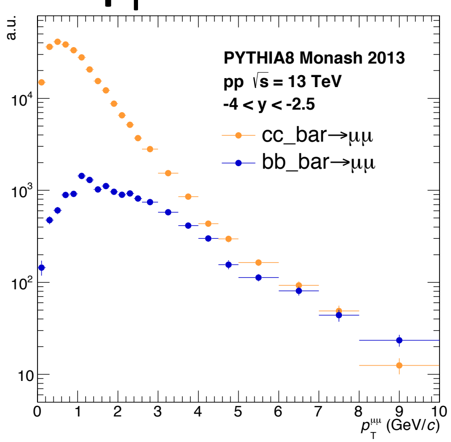


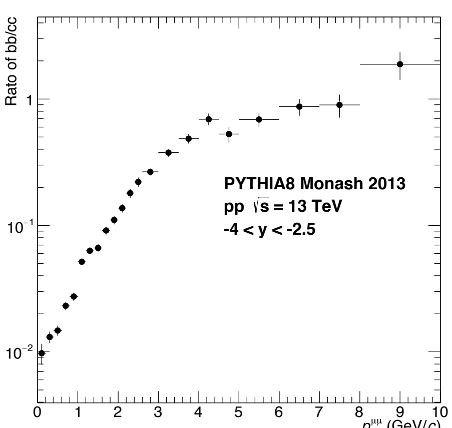


bb_bar contribution for LMR at 13 TeV

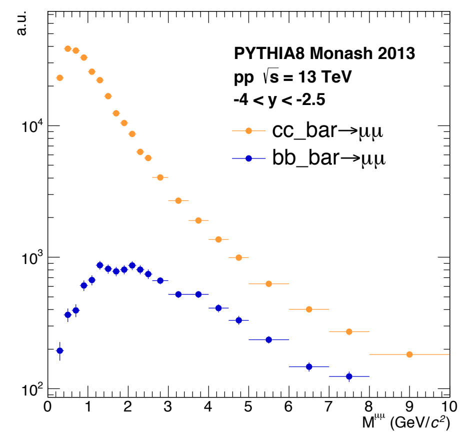
- PYTHIA8 Monash 2013 tunes

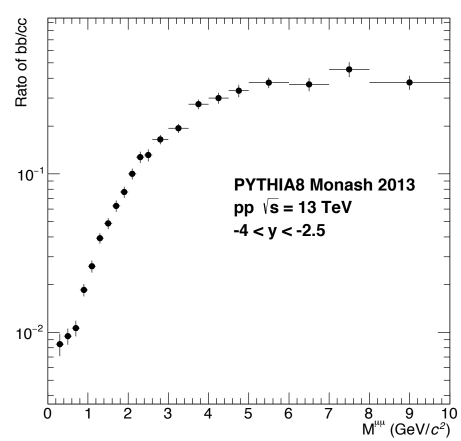
p_T distribution





Mass distribution





bb_bar contribution can be negligible in this region in 13 TeV.

Simulation to estimate some efficiencies

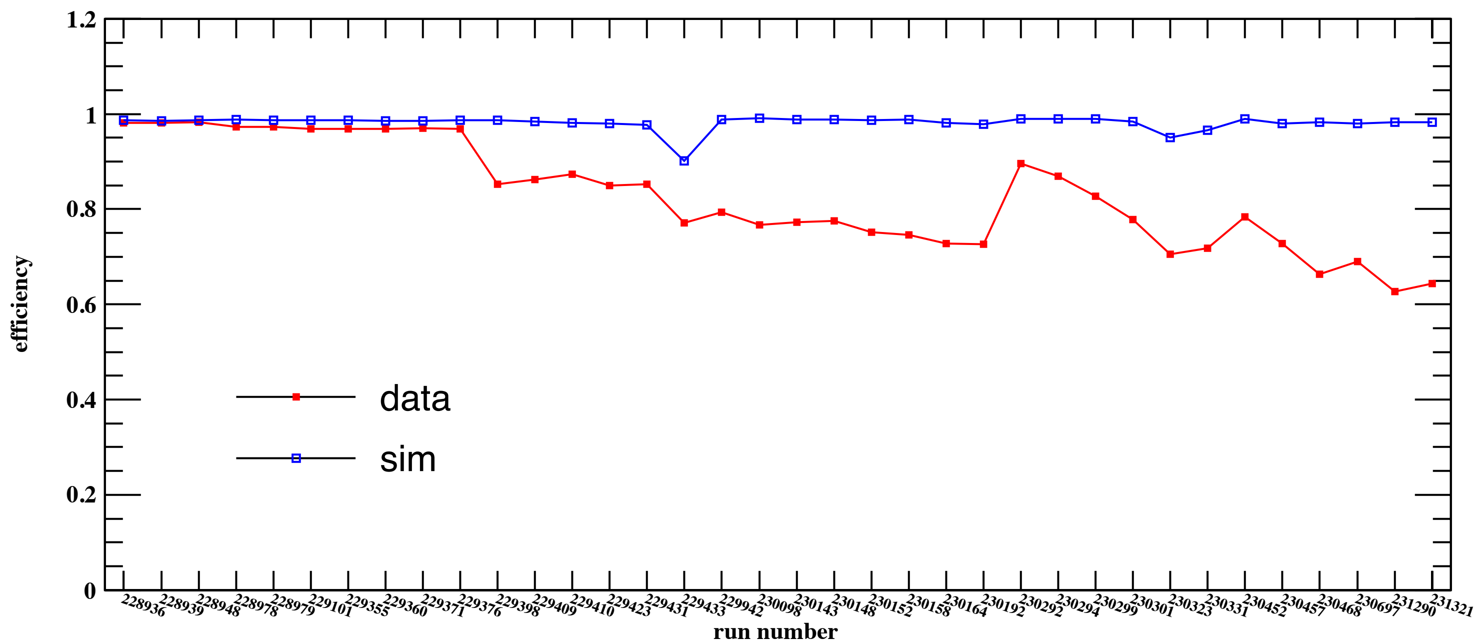
- Single muons simulation
  - AliGenBox ($\mu^+\mu^-$ each event)
  - -4.5 < y < -2.0 (wider than acceptance)
  - 0 < phi < 360
  - $0 < p_T < 100$ GeV/c
- Installed detector as Read-out
  - MUON
- Installed detector as just material
  - Absorber, Dipole, Hall, MUON, Pipe, Shield, Vzero and FMD
- Detector response
  - Used OCDB

- Hiroshima CPU cluster
  - The number of total 200 CPUs
  - OCDBs for these runs have been copied to Hiroshima cluster disk
  - 2 muons x 10,000 events x 35 runs with MUON detector as a read-out and the upper flow detectors as just material simulation takes 3 hours

Tracking efficiency

- Tracking efficiency of all chambers

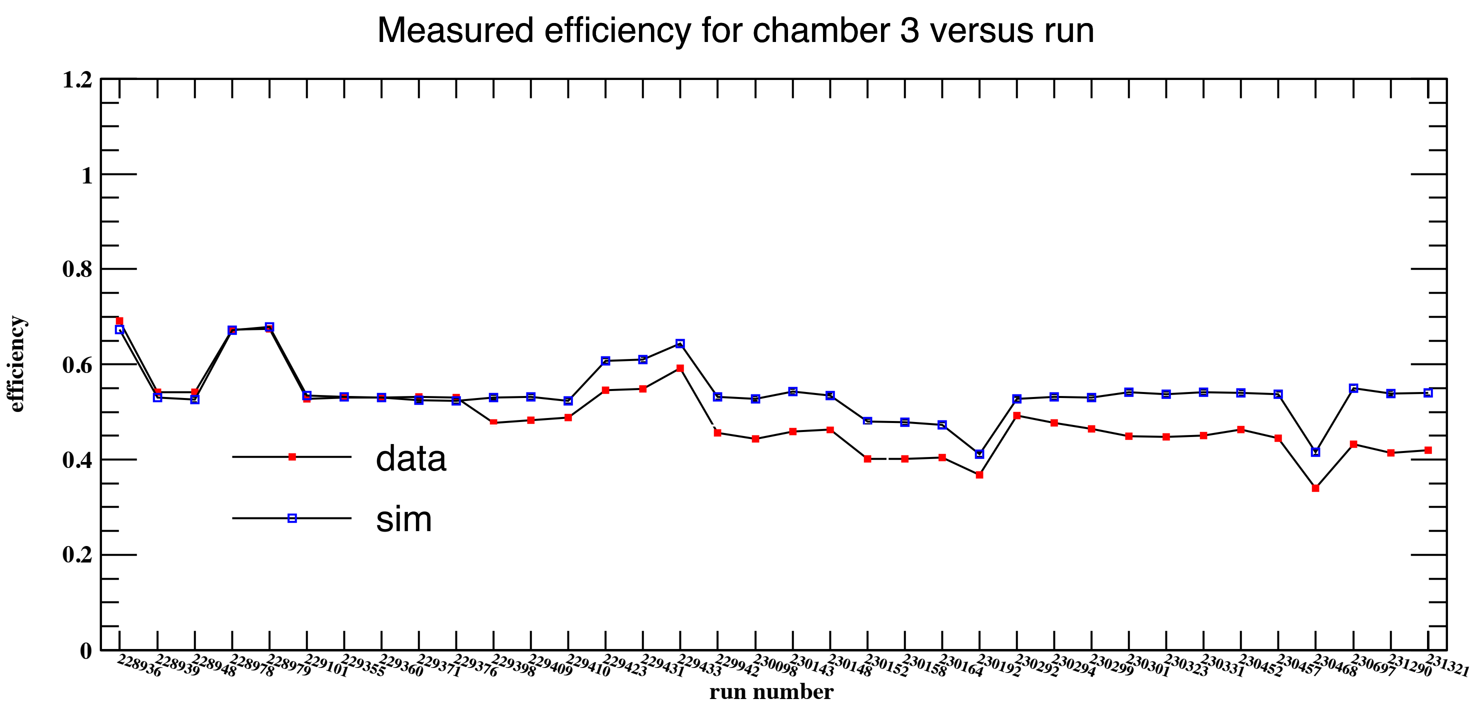
Measured tracking efficiency versus run



There are very big difference between data and simulation from 229398

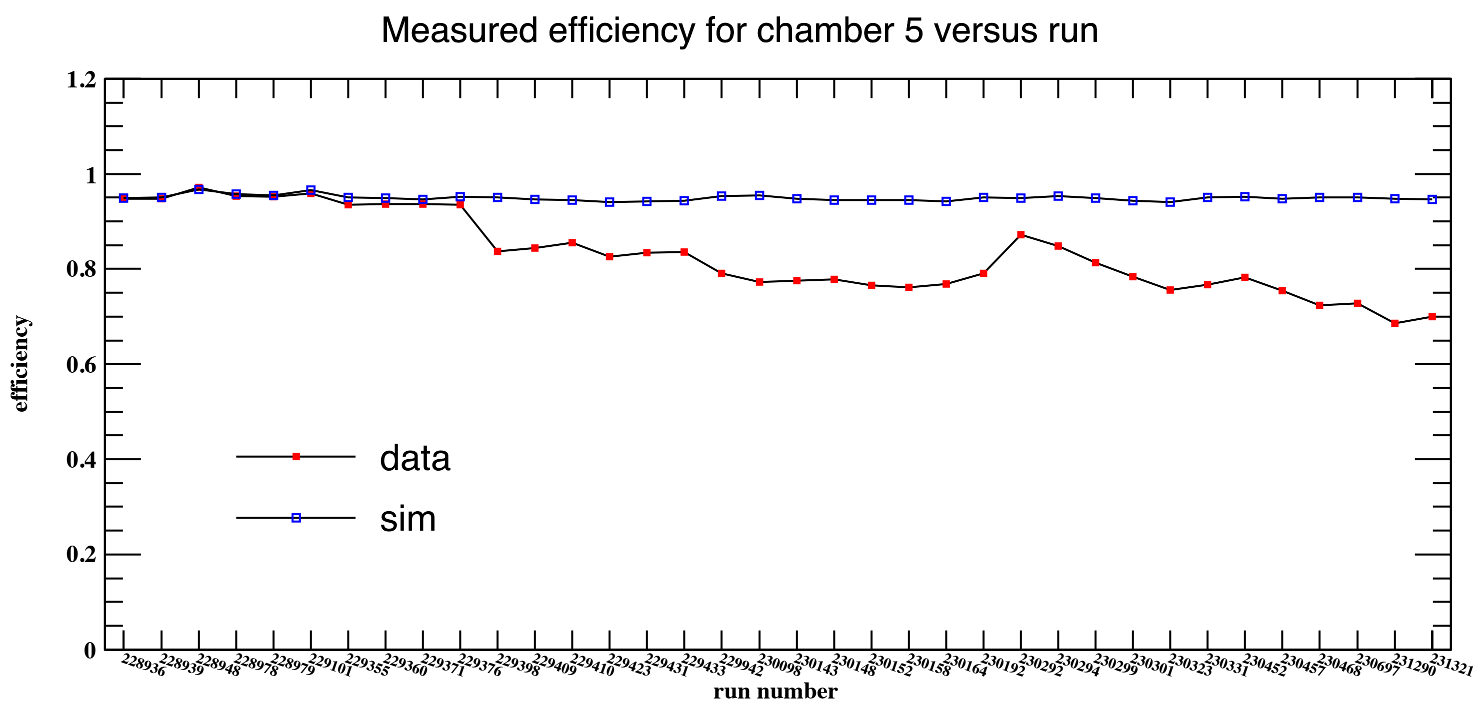
Tracking efficiency

- Tracking efficiency of chamber #3



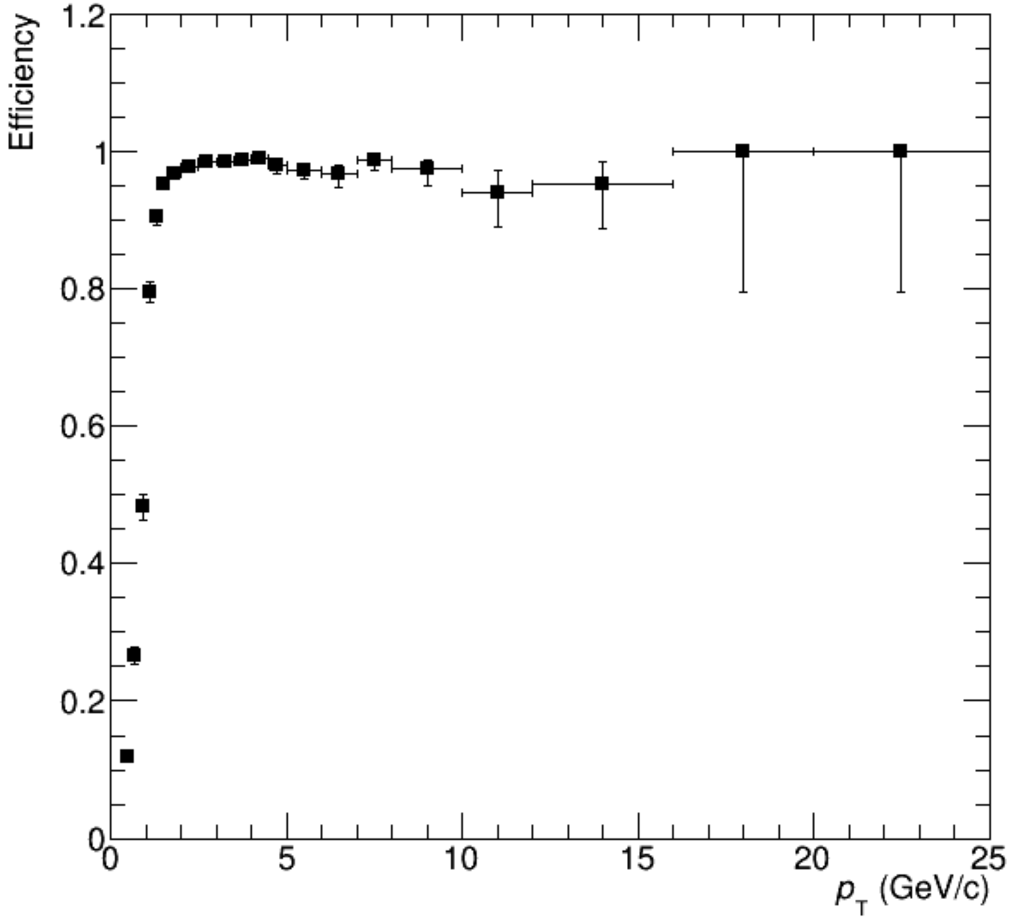
Tracking efficiency

- Tracking efficiency of chamber #5



OCDBs should be updated to simulate detector response correctly.

On going analysis

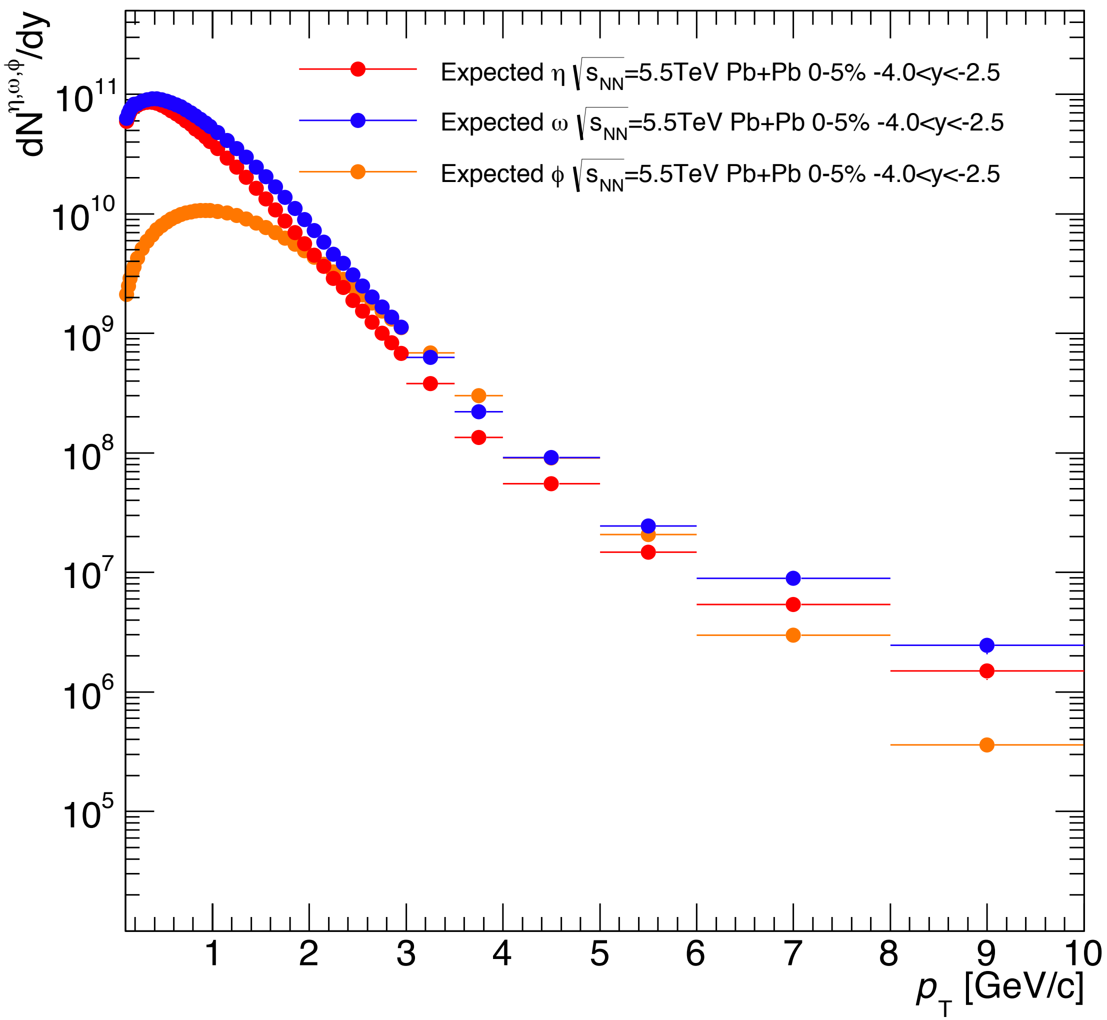


- Trigger efficiency
  - "Tag and Probe" method with J/psi peak
  - **We can estimate it with Triggered data (kMUL)**

MFT simulation analysis

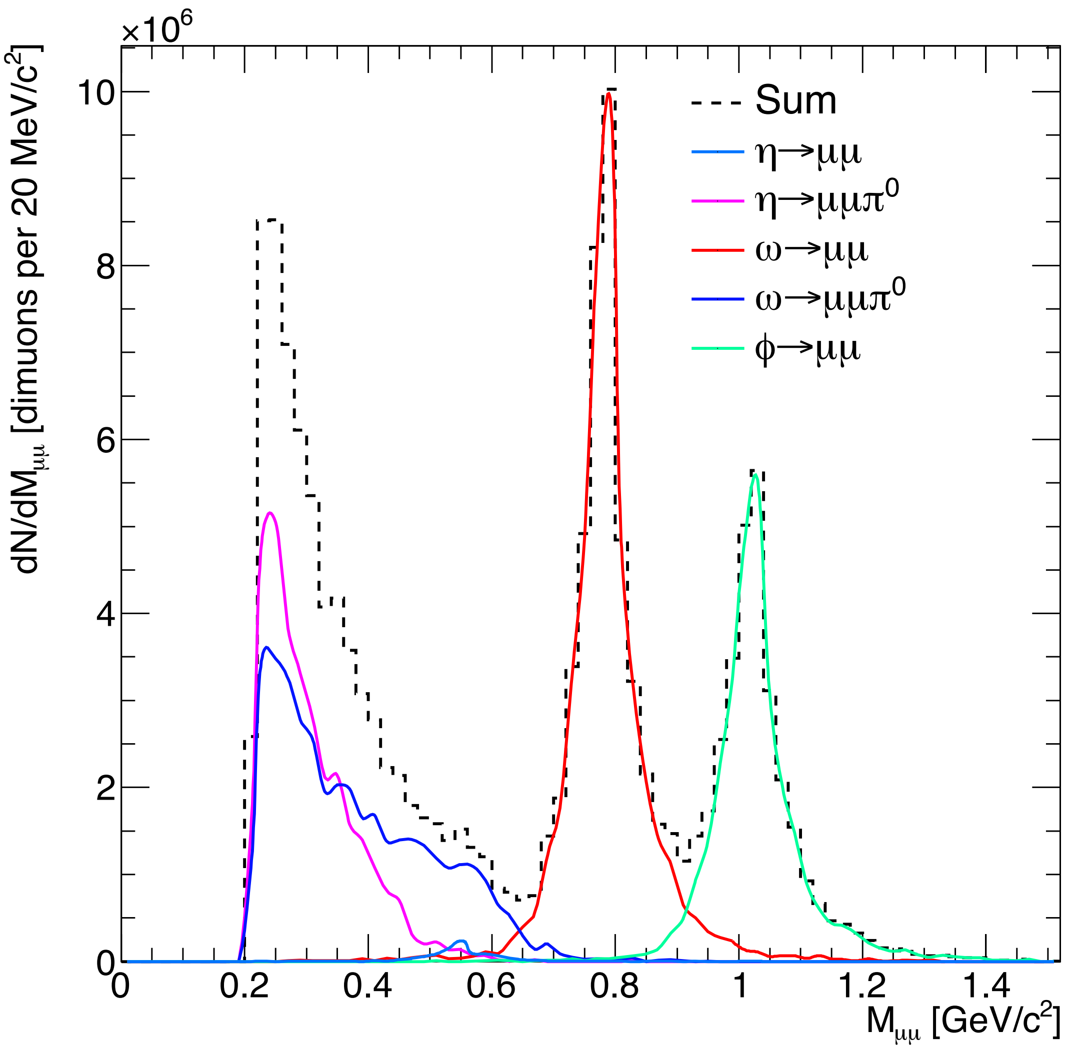
- Main goal is same as run2 physics
  - Low and middle mass and low p_T physics
- Estimate expected yield
  - PbPb @ 2.76 TeV: $10nb^{-1}$
- Improve low mass and low p_T measurement

Expected cross-section in PbPb collisions at 2.76 TeV



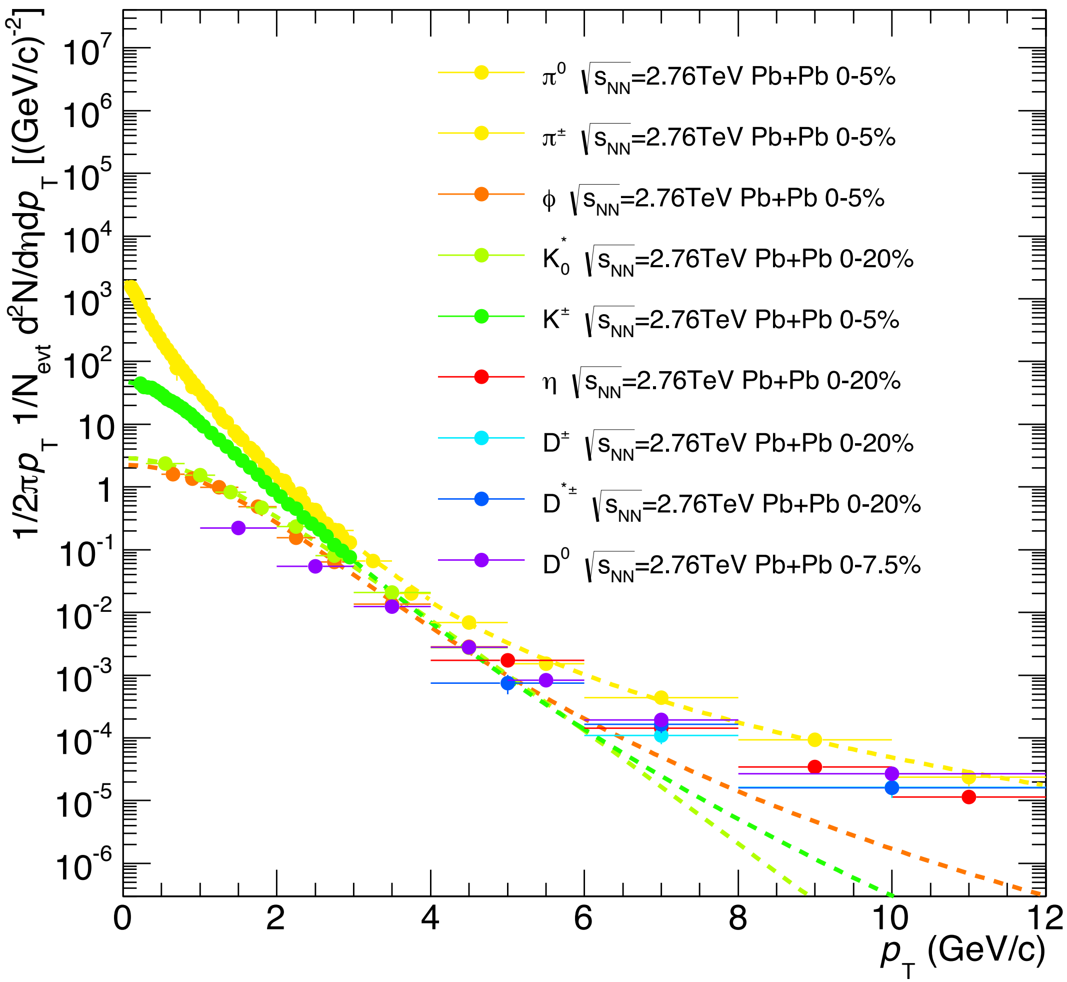
- Total production
  - $\sqrt{s_{NN}}$ = 5.5 TeV
  - Centrality: 0 – 5%
  - -4.0 < η < -2.5
- Calculated with
  - $\sqrt{s_{NN}}$ = 2.76 TeV results
  - PYTHIA8 monash 2013 tune

Expected invariant mass distribution in LMR



- $0. < p_T^{\mu\mu} < 3.$ (GeV/c)
- Central (0-5%): $10 nb^{-1}$
- PbPb $\sqrt{s_{NN}}$=5.5 TeV
- Consider Branching ratio and acceptance
- cc_bar contribution is under studied (next page)

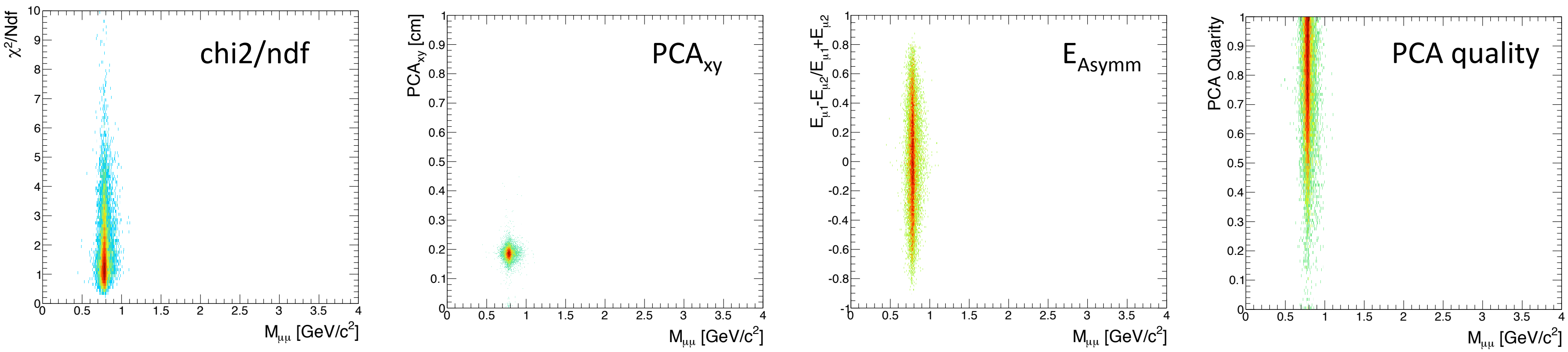
cc_bar contribution study



- D masons have been measured in PbPb collisions at 2.76 TeV by ALICE
- To estimate cc→μμ, left measured 2.76 TeV data and simulations, PYTHIA8 and/or HIJING will be used.
  - **Coming soon!!!**

Improve measurement of low p_T

- To improve,
  - Matching rate of low pT muon
  - S/B of low p_T di-muons
- To improve it, some cuts are tuning now.
  - For example…
    - Tracking chi2/ndf
    - PCA and PCA quality
    - Energy asymmetry of di-muons



Summary and outlook

- Hiroshima contribution to muon analysis has been started
  - Not only real data but also MFT simulation
  - Satoshi Yano (D3) and new B4 students
- Analysis of run2
  - Low mass region meson clear peaks are observed.
  - bb_bar contribution at 13 TeV can be negligible.
  - Tracking efficiency
    - Response of muon chambers have been measured in real data.
    - However, official OCDBs do not reproduce the response.
  - Trigger efficiency
    - Tag and Probe method was used to estimate it with real data.
- Preparation for run3
  - Main goal is very low p_T low and middle mass region mesons and continuum.
  - Low mass region main sources except cc_bar contribution are expected.
  - To improve very low p_T measurement, analysis cuts are studied.

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Hiroshima University has already started to analyze muon data for run2 and run3. We will contribute to Muon system physics actively!

Introduction about so far my analysis

- I finish almost Ph.D student
- So far, I analyze PHOS data to measure neutral mesons

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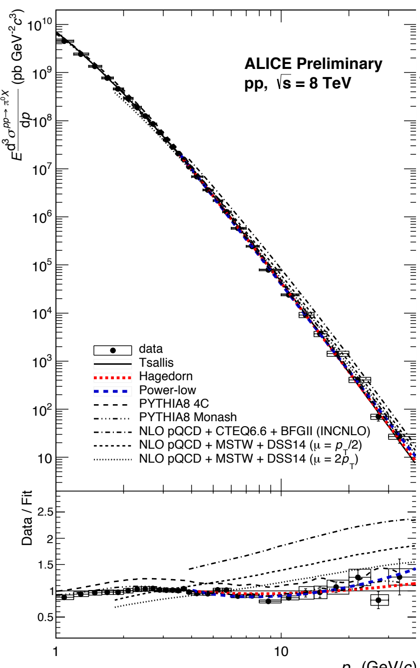
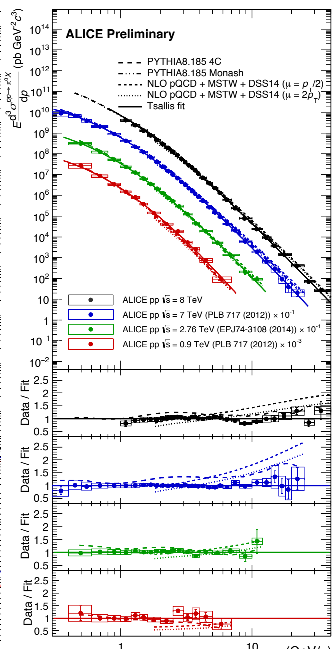
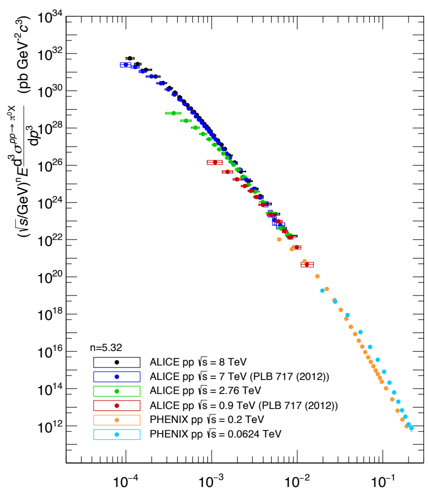
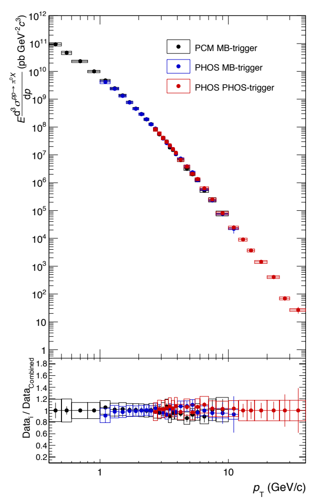
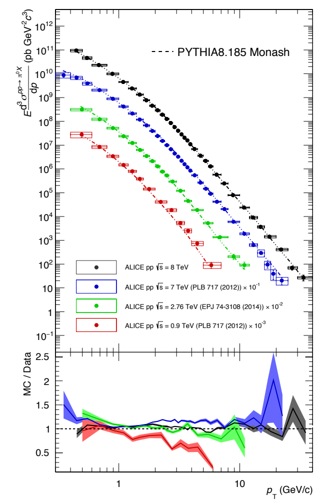
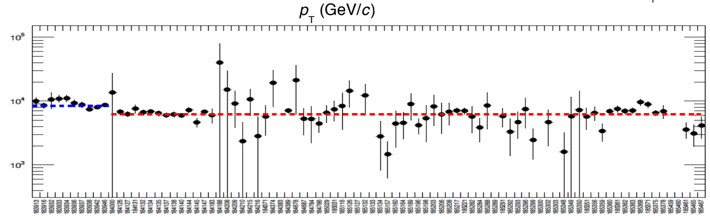


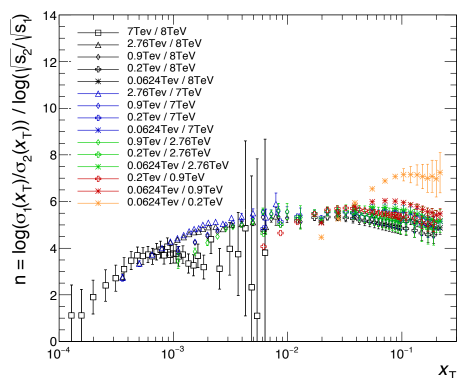


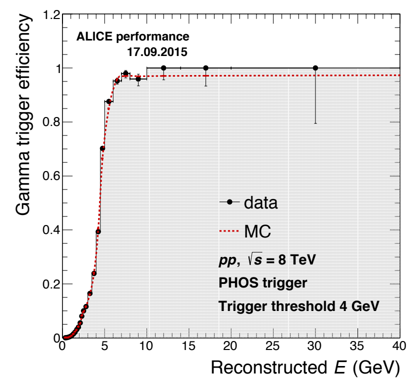










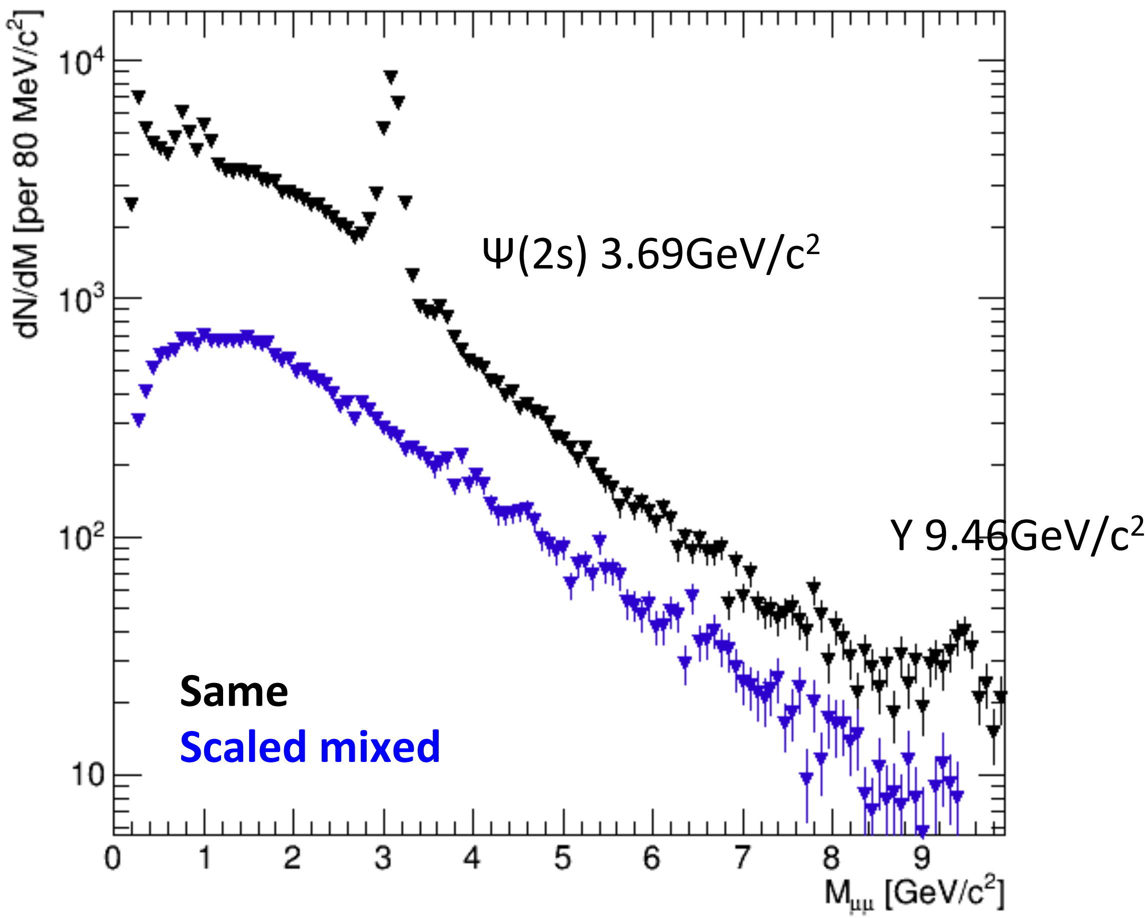


More and more…

Backup

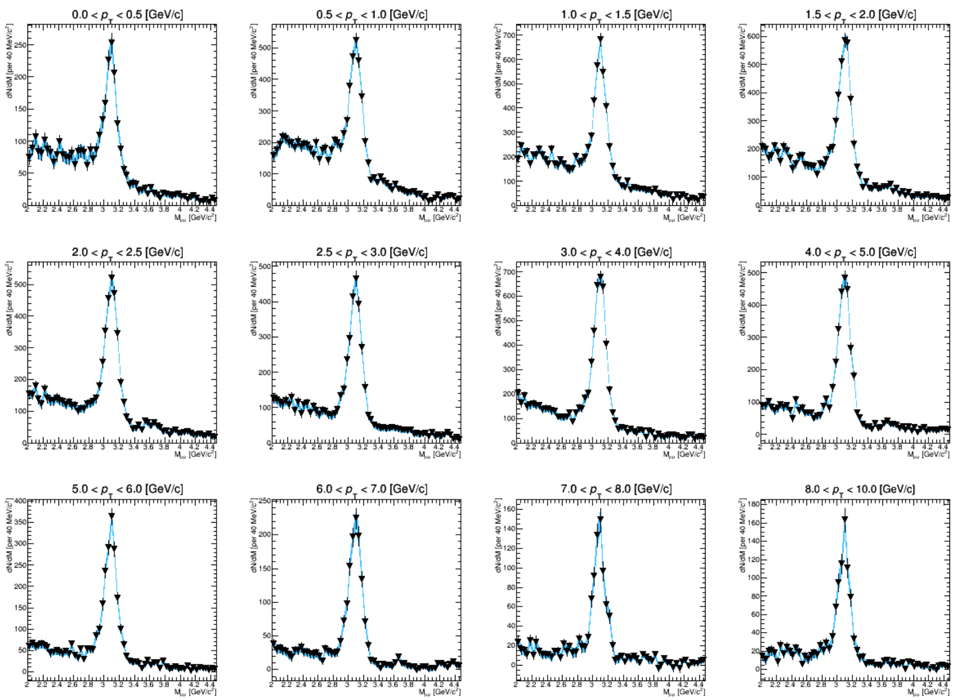
Check higher mass region

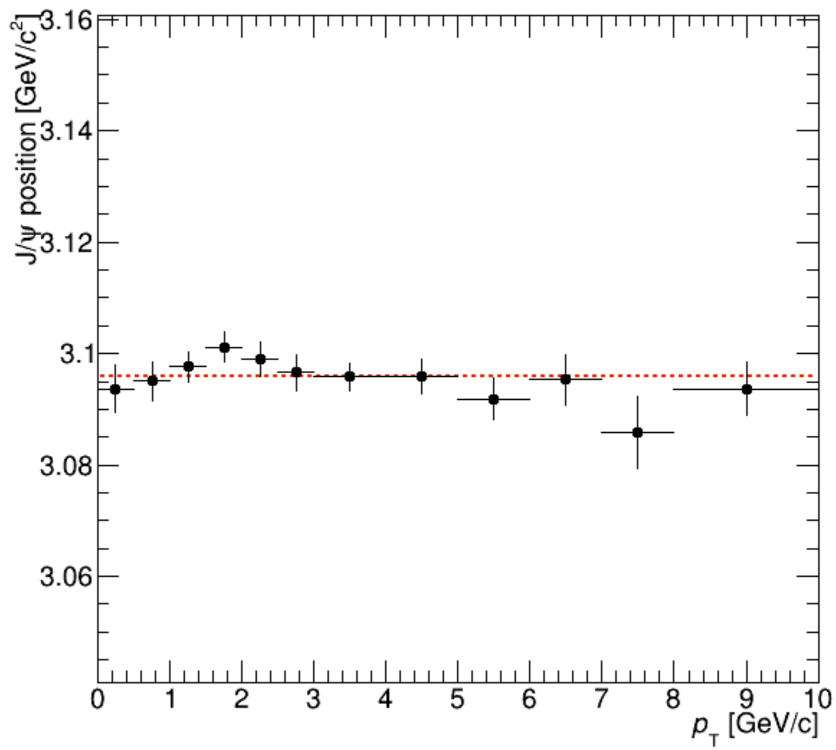
- Upsilon (9.46 GeV/c^2)



Muon momentum resolution

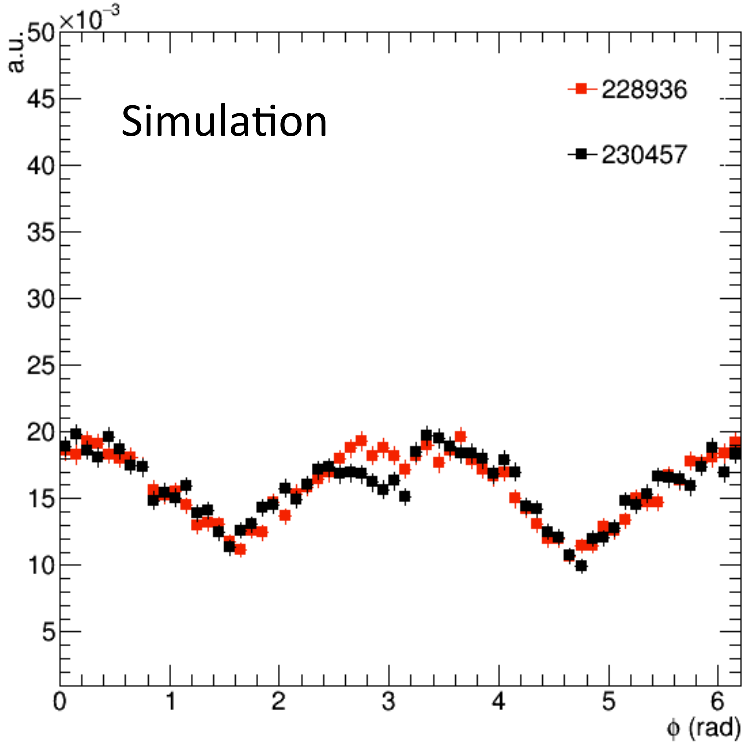
- To check muon system condition, J/psi peak was used

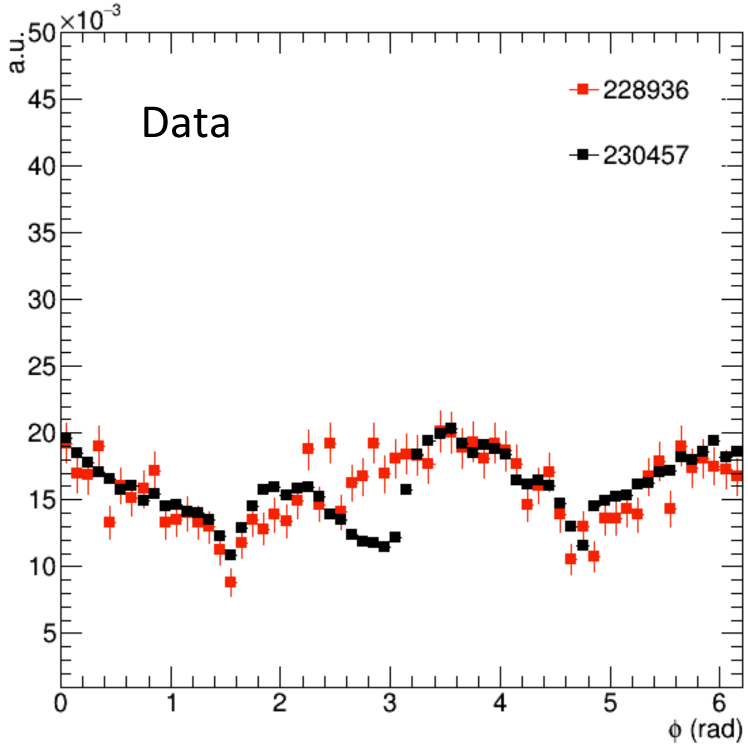




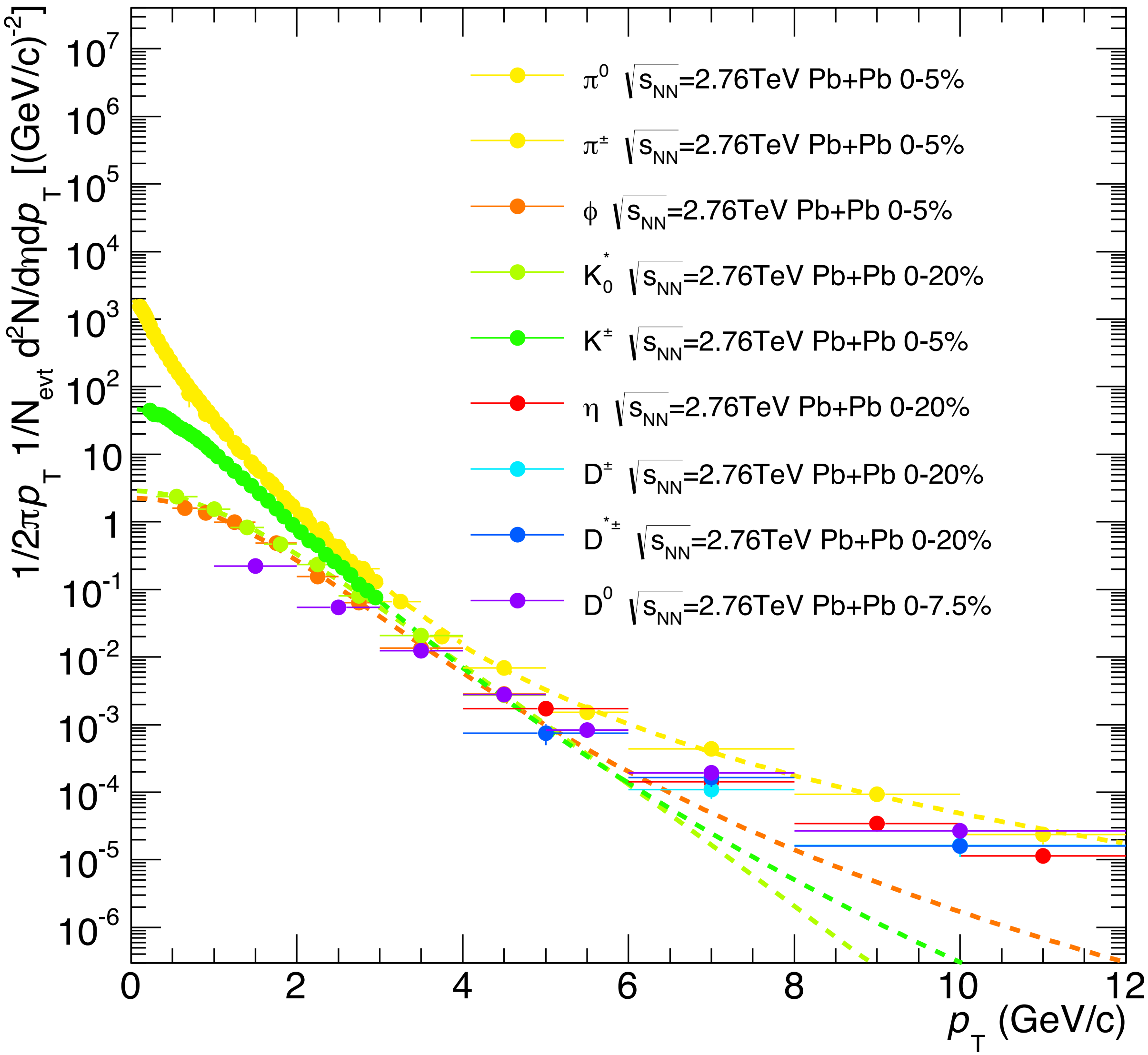
Check the simulation with OCDB

- I check the phi distribution in data and simulation





Expected cross section for cocktail



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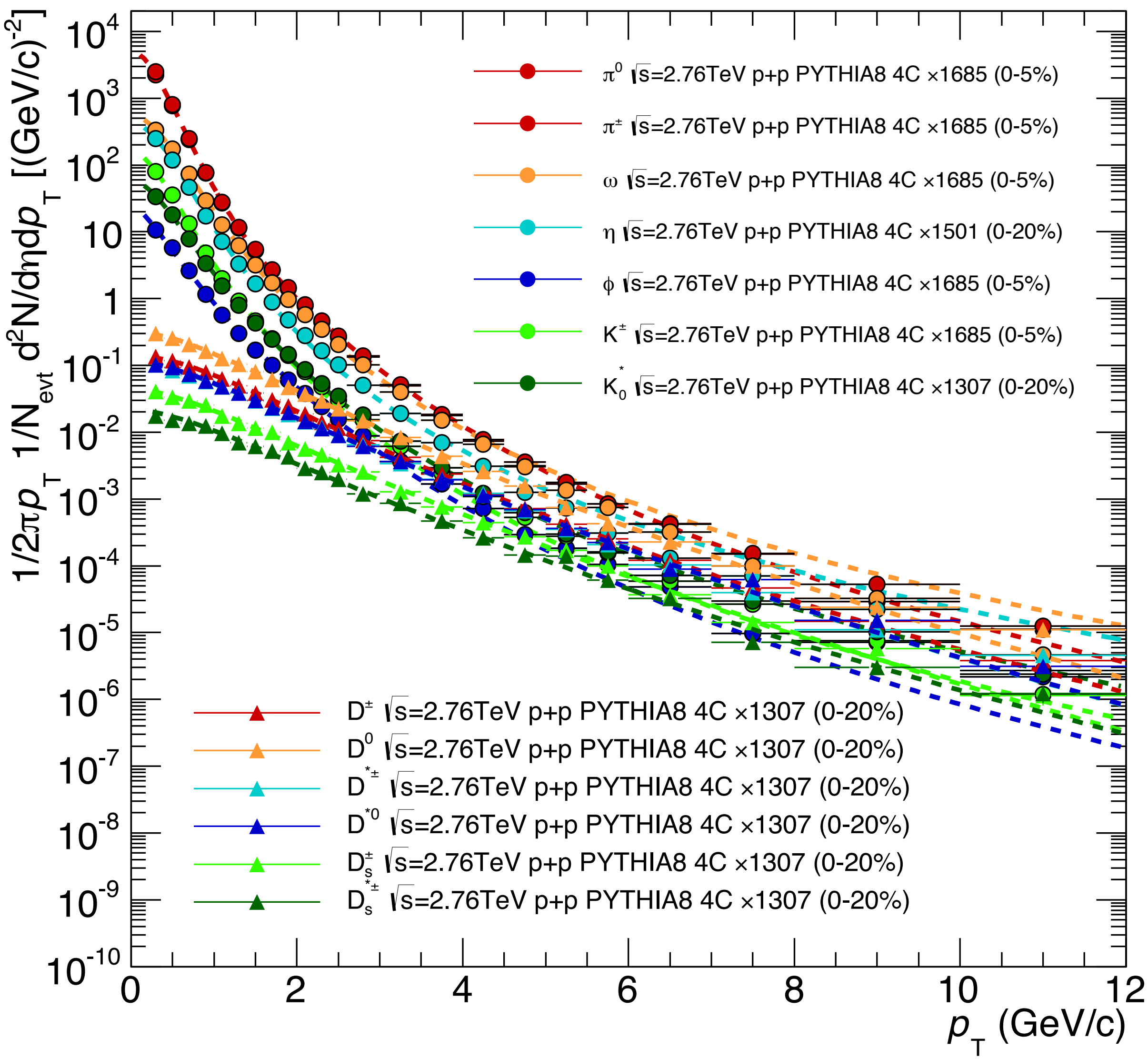

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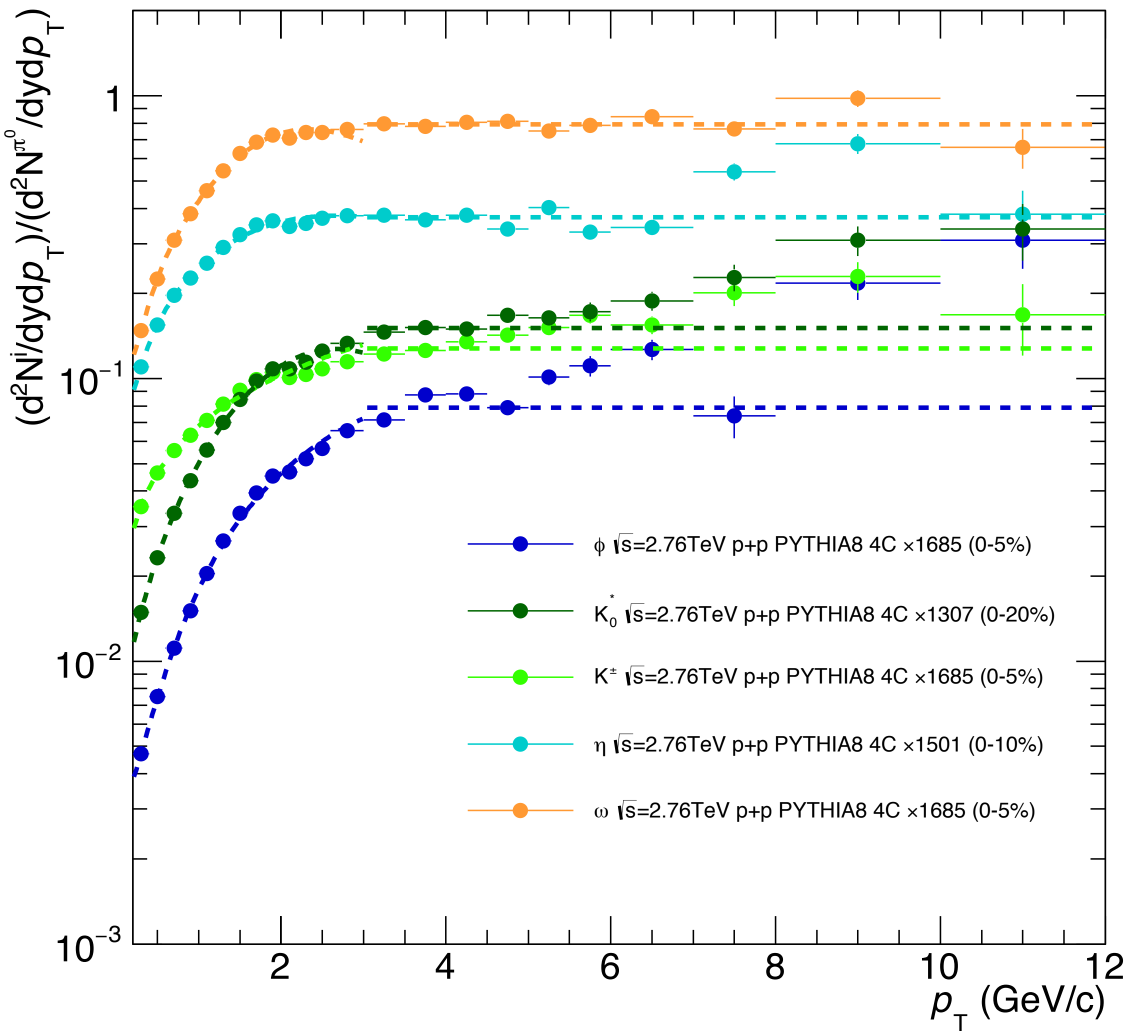

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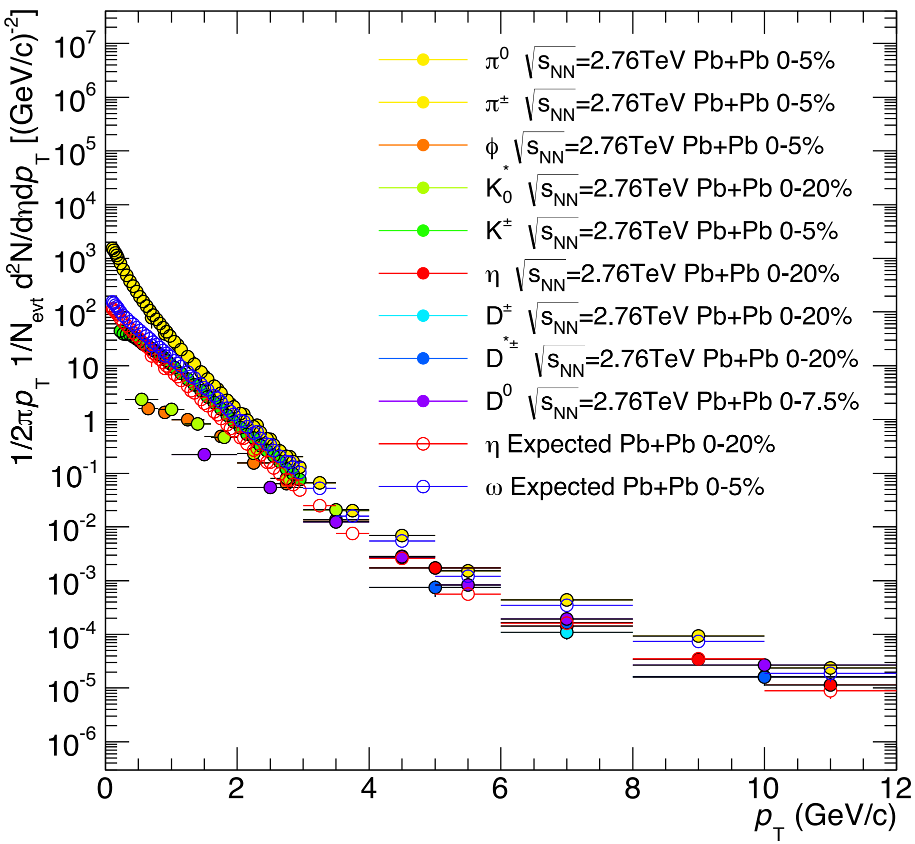

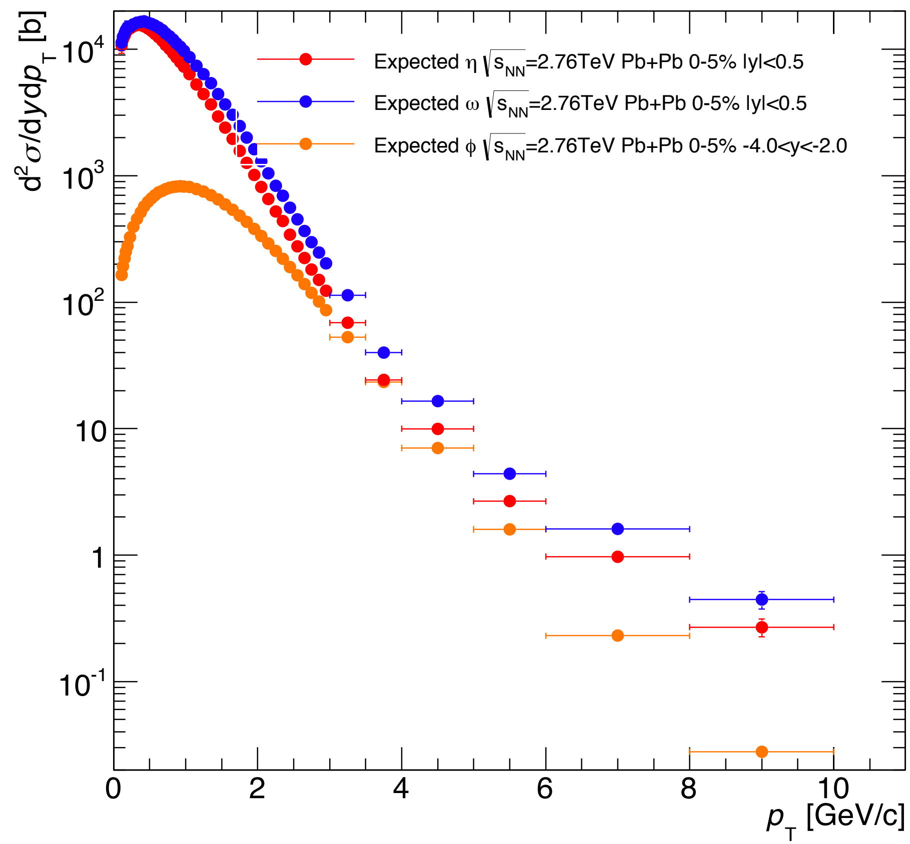

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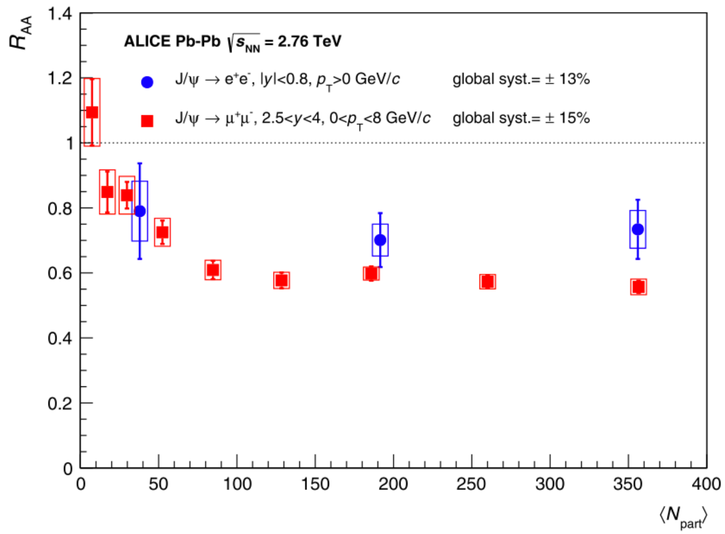
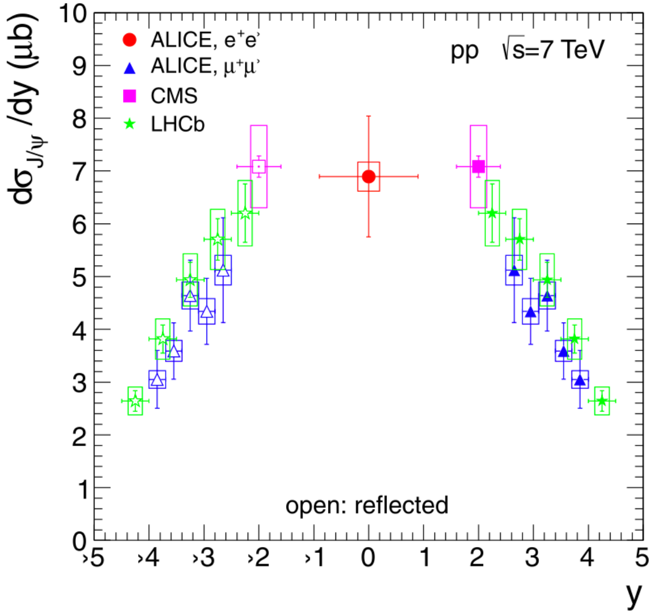
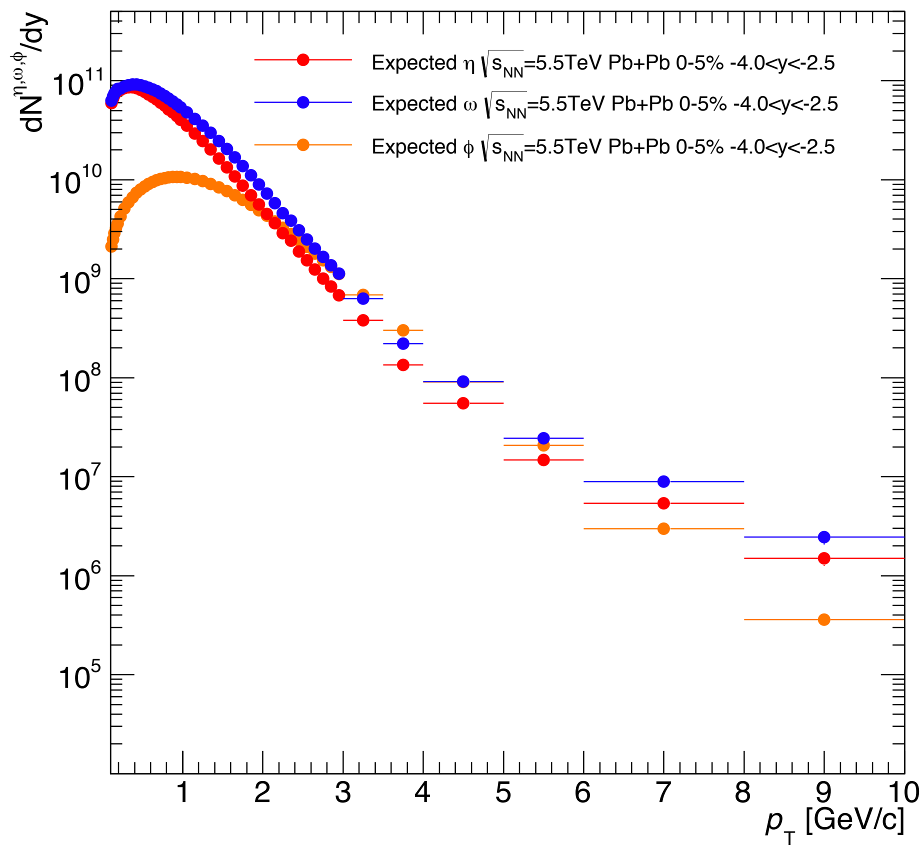
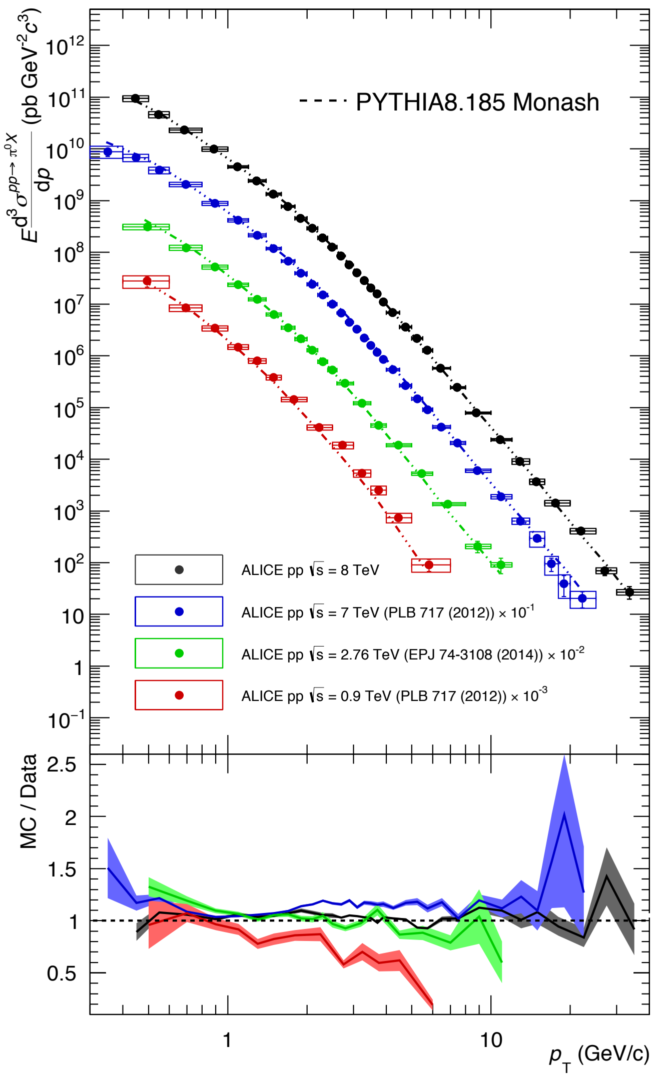






PYTHIA8 Monash 2013 tune

Monash 2013 tune



4C tune