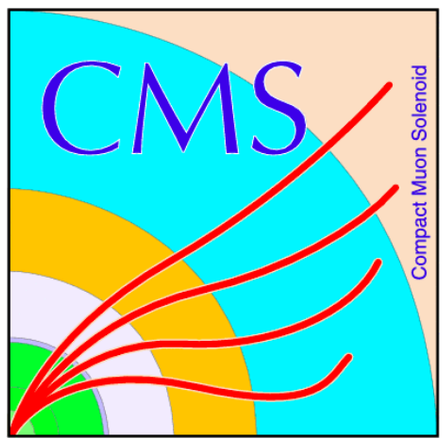
Photon R_AA at 5 TeV



Yeonju Go

2017 Dec. 08

Datasets

- **PbPb**
  - DATA : /mnt/hadoop/cms/store/user/richard/2015-Data-promptRECO-photonSkims/HIPhoton40AndZ/PbPb-photonHLTFilter-v3/160202_145715
  - MC :
    - /mnt/hadoop/cms/store/user/tatar/official/Pythia8_AllQCDPhoton*Flt30_Hydjet_Cymbal_MB/HINPbPbWinter16DR-75X_mcRun2_HeavyIon_v14-v1-FOREST/0.root (* : 15,30,50,80,120)
    - /mnt/hadoop/cms/store/user/tatar/official/Pythia8_EmEnrichedDijet*_Hydjet_Cymbal_MB/HINPbPbWinter16DR-75X_mcRun2_HeavyIon_v14-v1-FOREST/0.root (* : 30,50,80,120,170)

- **pp**
  - DATA : /mnt/hadoop/cms/store/user/luck/2015-Data-promptRECO-photonSkims/pp-photonHLTFilter-v0-HiForest/0.root
  - MC :
    - Pythia8_Photon*_pp502_TuneCUETP8M1-HINppWinter16DR-75X_mcRun2_asymptotic_ppAt5TeV_v3-v1_forest_v1 (* : 15,30,50,80,120)
    - Pythia8_EmEnrDijet*_pp502_TuneCUETP8M1-HINppWinter16DR-75X_mcRun2_asymptotic_ppAt5TeV_forest_v1/0.root (* : 30,50,80,120,170)

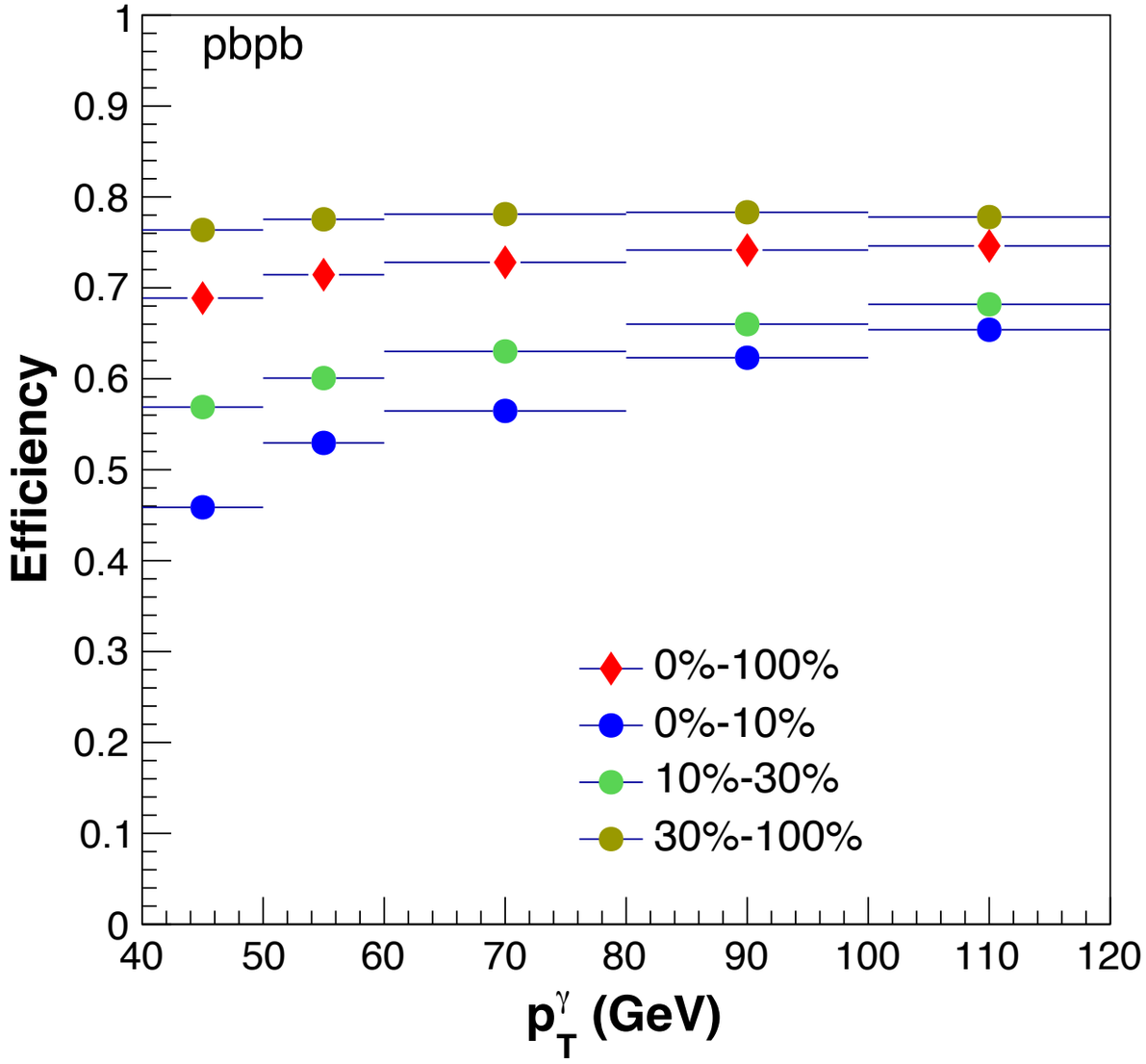
Cuts and corrections

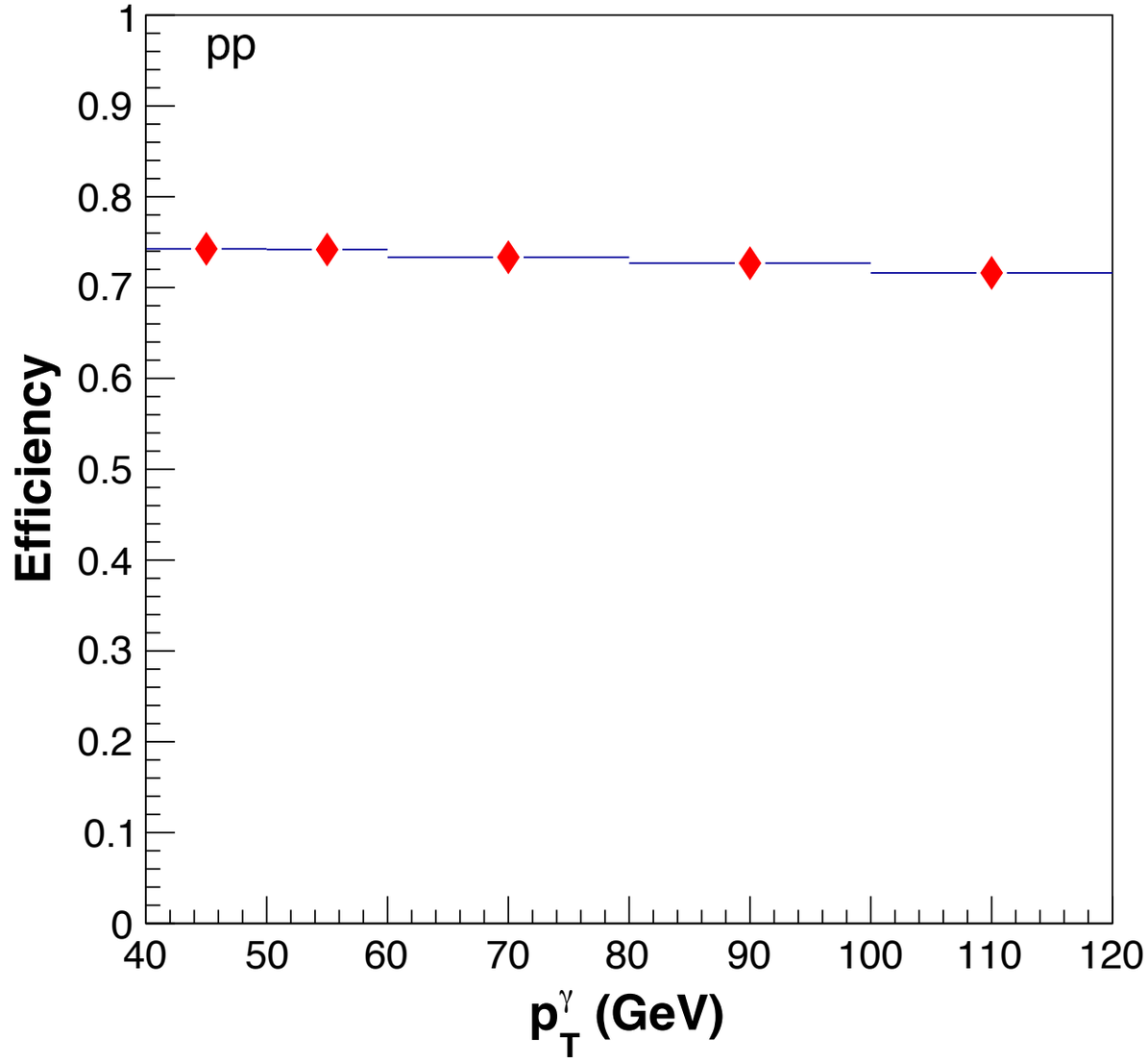
- **Kinematic range**
  - |eta|<1.44
  - photon pt > 40 GeV

- **Trigger : HLT_HISinglePhoton40_Eta1p5_v1**
- **Event Selection : pcollisionEventSelection**

- **Corrections**
  - Photon 2015 Noise (hotspot) rejection
  - Electron contamination
  - Photon energy correction
  - sumIso correction

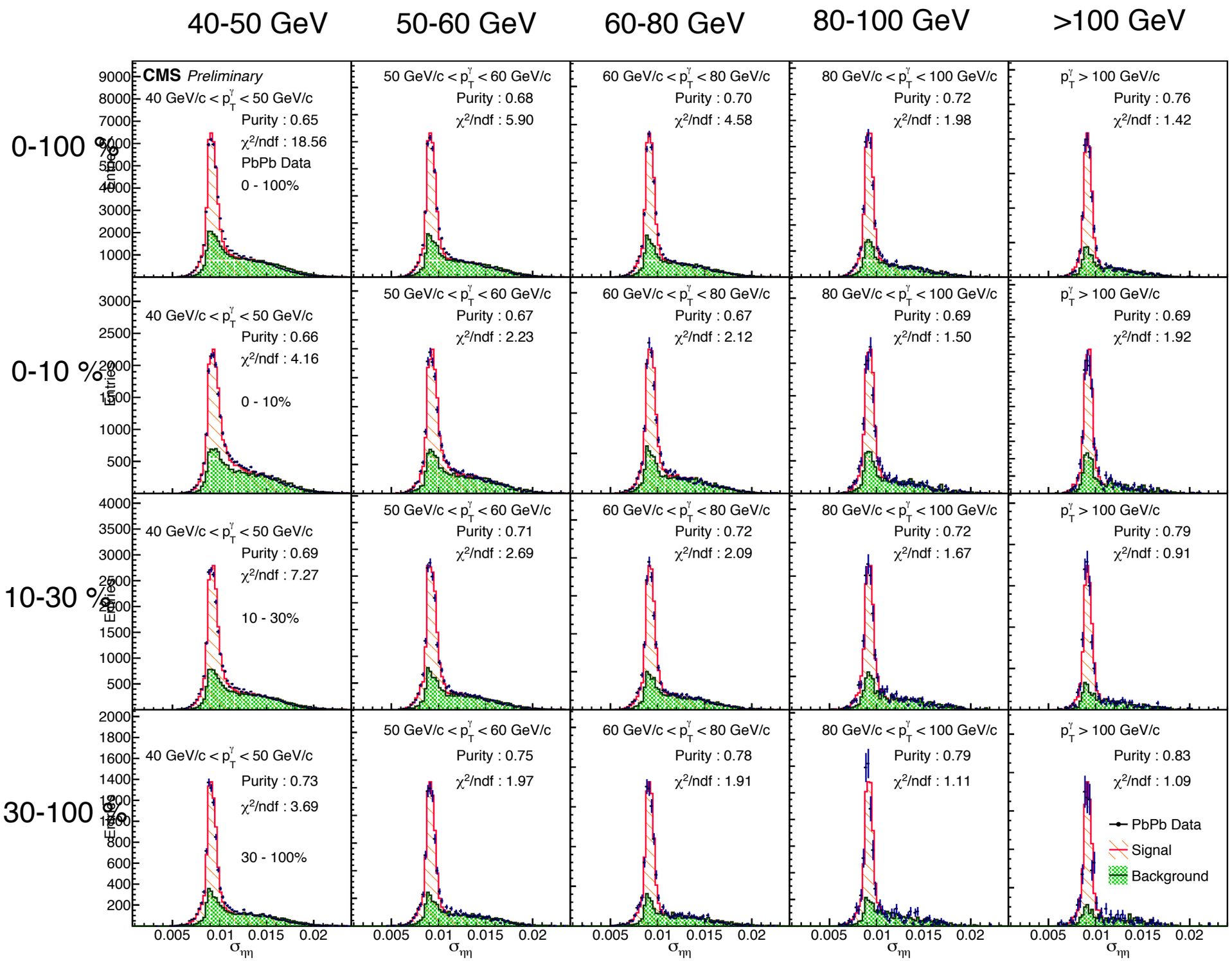
Efficiency





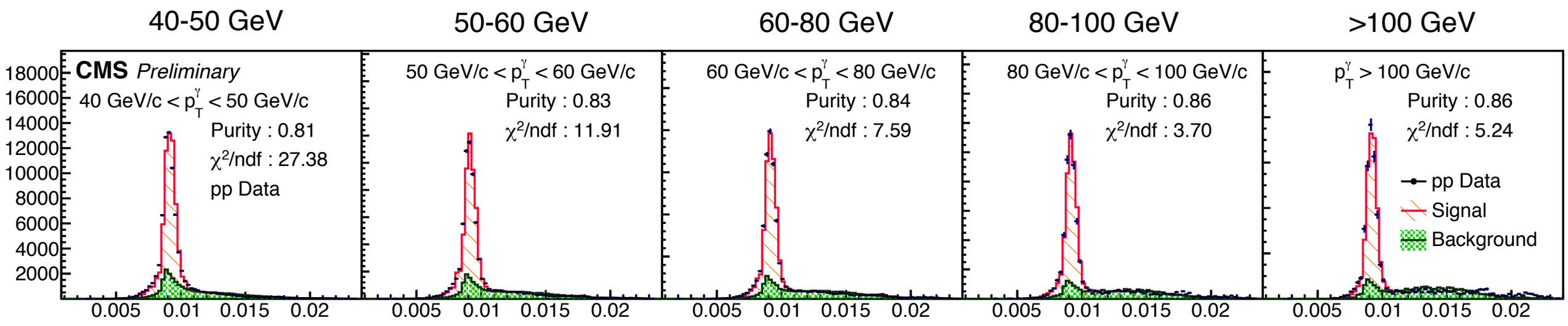
- **Obtained from MC**
- **Total efficiency (pp selection is the same as pbpb)**
  - Trigger+reconstruction+isolation
  - Isolation condition
    - phoHoverE < 0.1
    - phoSigmaIEtaIEta_2012 < 0.010
    - sumIso < 1 GeV

Purity (PbPb)



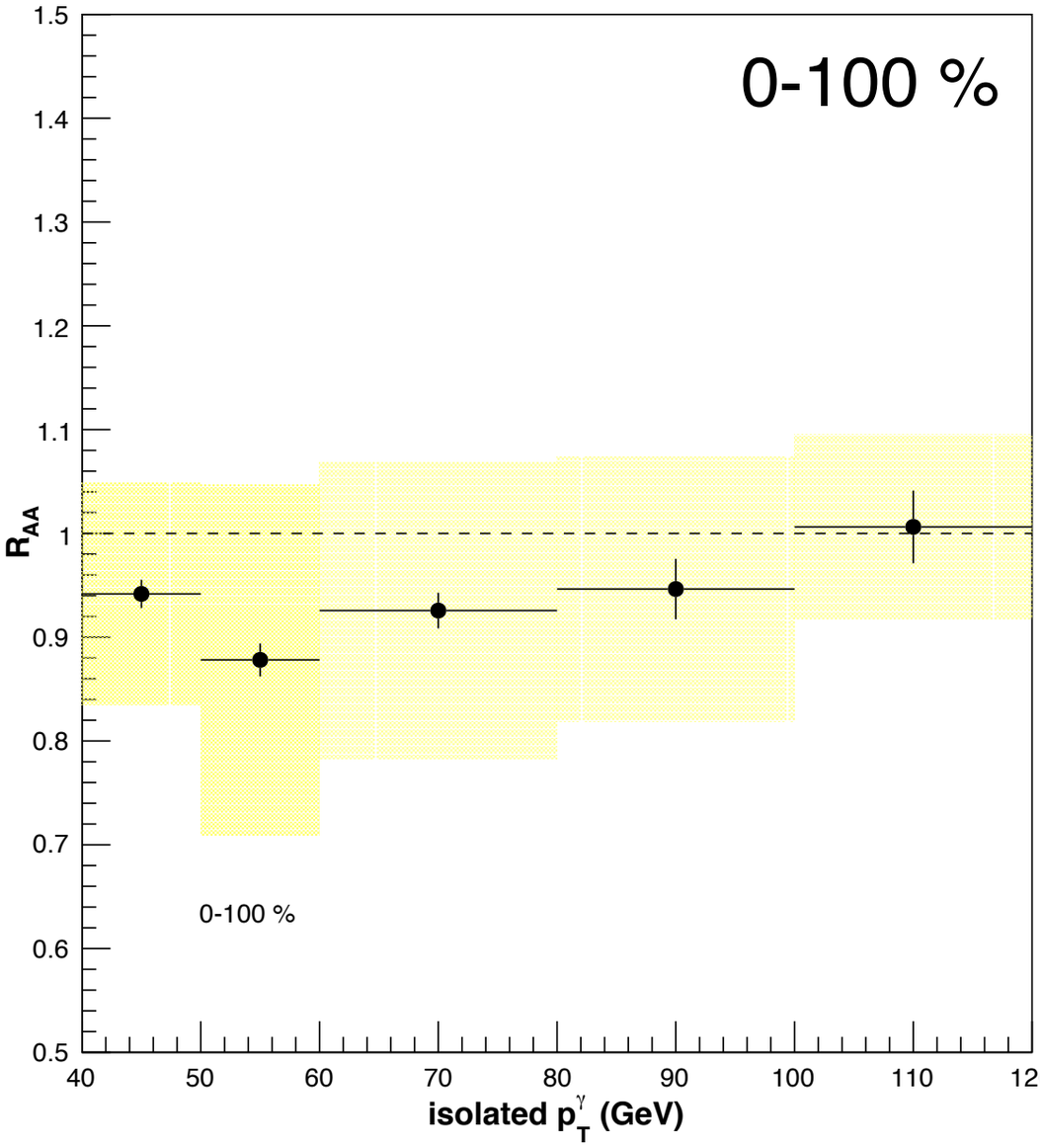
- **Signal template cut :**
  - genId = 22
  - |genMomId| <= 22
  - genCalIso < 5
  - Signal selection
- **Sideband cut :**
  - 10 < sumIso < 20

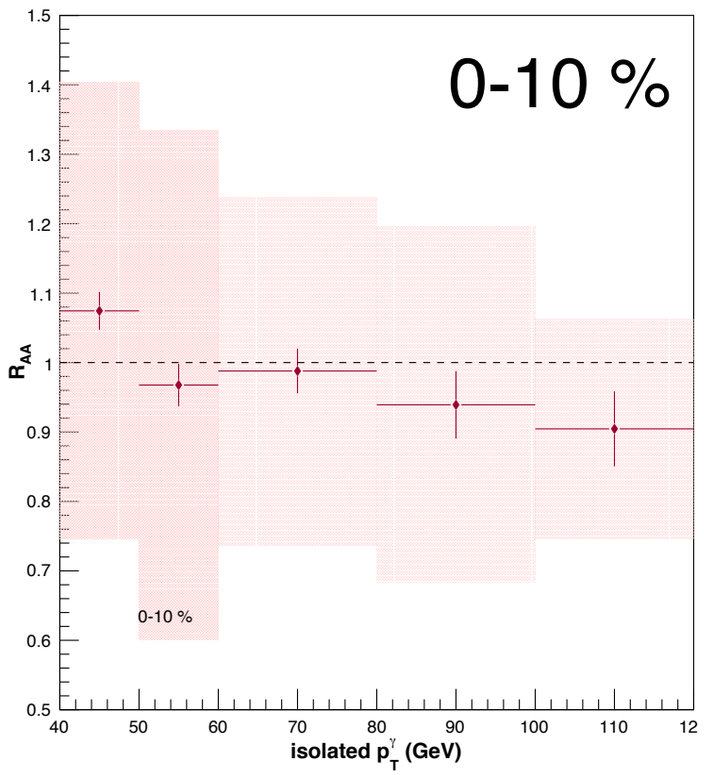
Puity (pp)

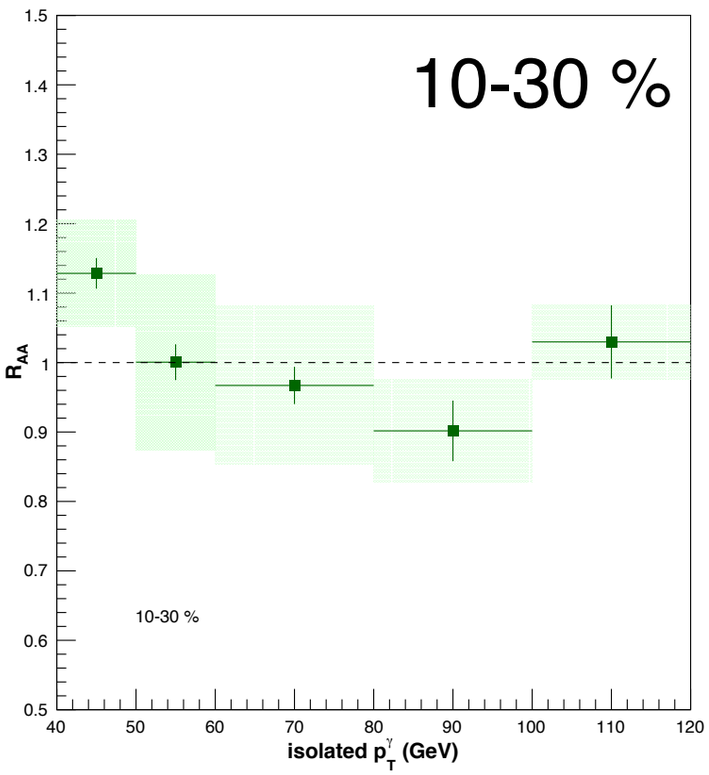


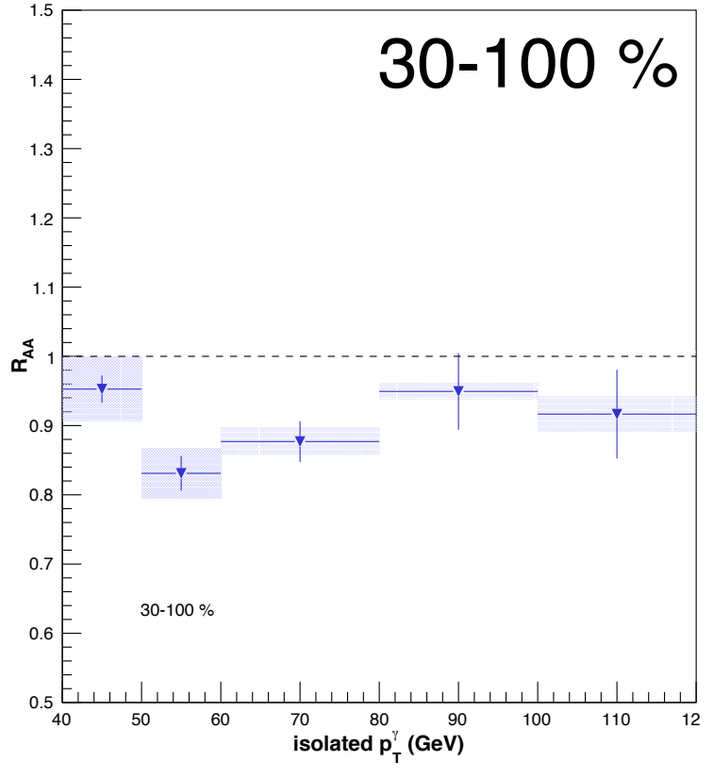
- **Signal template cut**
  - phoHoverE < 0.1
  - phoSigmaIEtaIEta_2012 < 0.010
  - sumIso < 1 GeV
  - the same as PbPb
- **Sideband cut**
  - 10 < sumIso < 20
  - the same with PbPb sideband cut

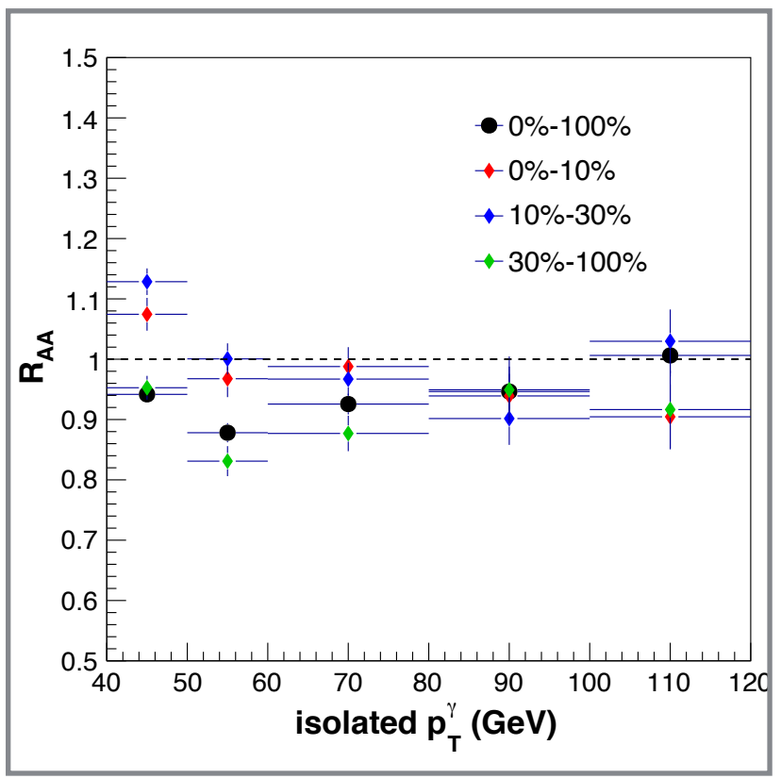
R_AA









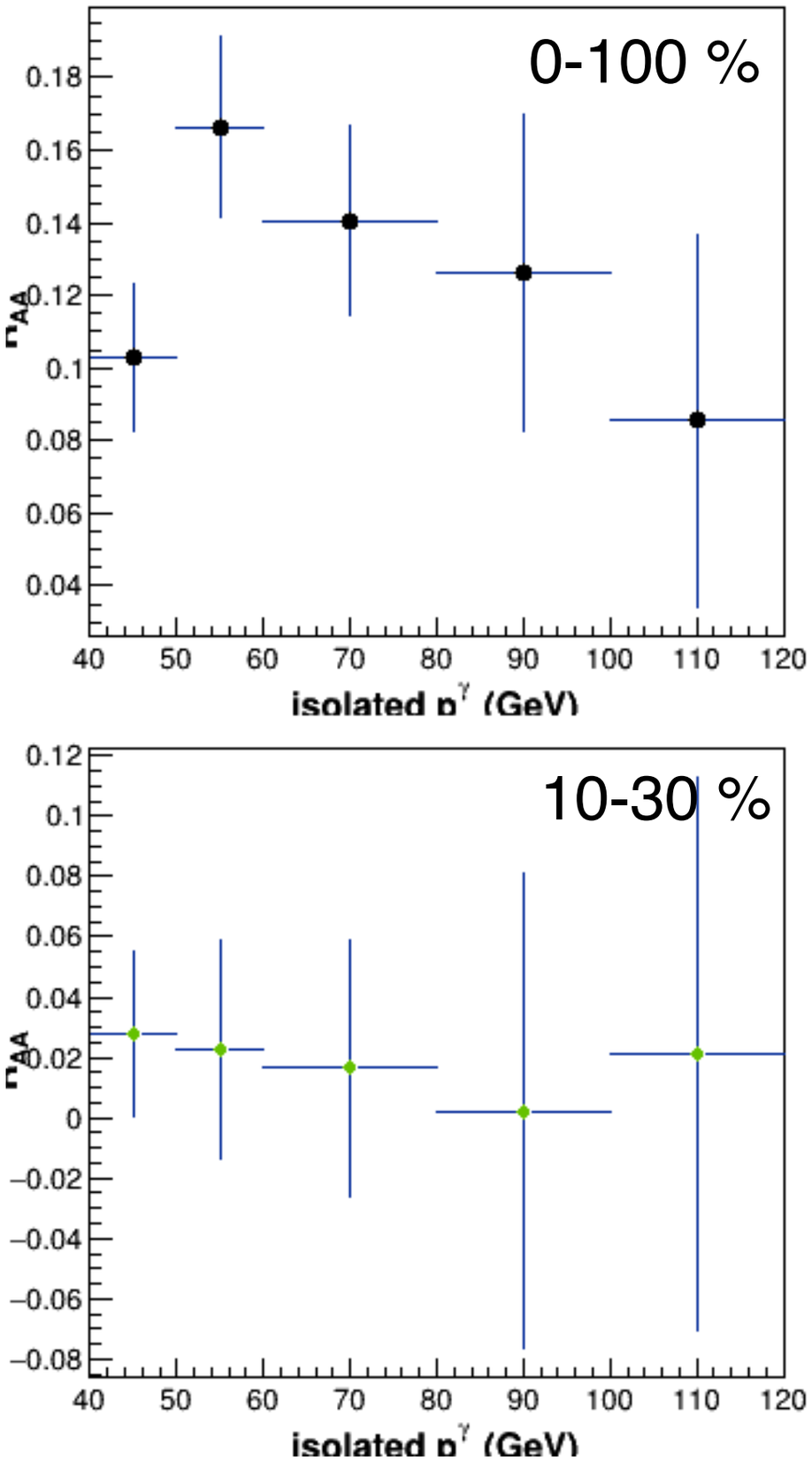


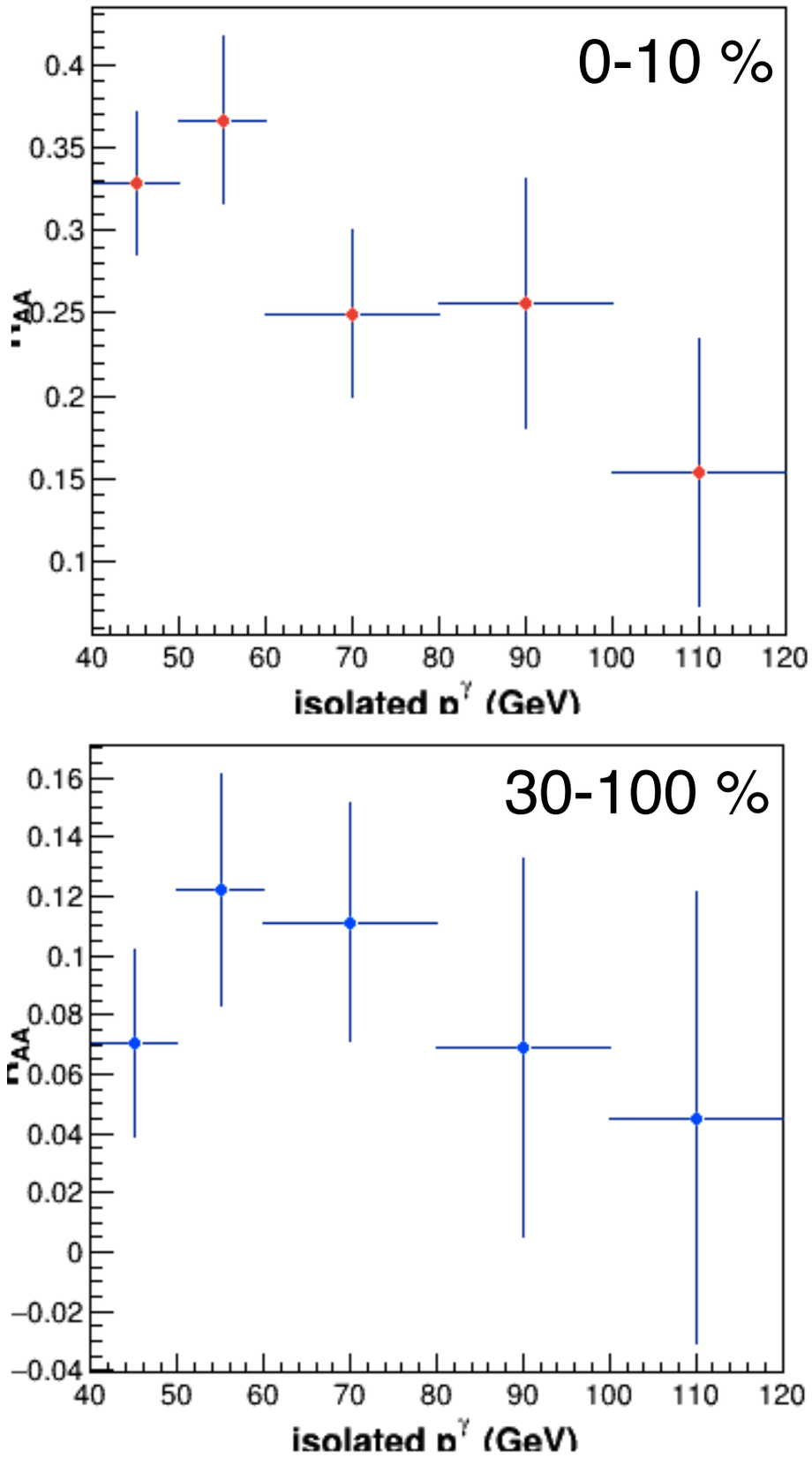
- **Q) statistical uncertainties for purity?**

Systematics

- **Photon Energy Scale**
  - Photon energy correction On/Off (Current)
  - Will be updated with the difference between correction in DATA and MC
- **Purity**
  - 1. Sideband cut variation
    - 5 < sumIso < 10
    - 20 < sumIso < 30
  - 2. Signal template shift
  - 3. TMVA (Toolkit for Multi-variate data Analysis)
- **Electron Contamination**
  - Electron rejection cut On/Off (Current)
  - Will be updated with 1/4 of it
    - turning off the electron contamination increases the electron fraction up to 20% and the typical fraction of the remaining electron is estimated to be up to 5%
- **Photon Energy Isolation**
  - MC true gen cut On/Off
- **Photon Efficiency**

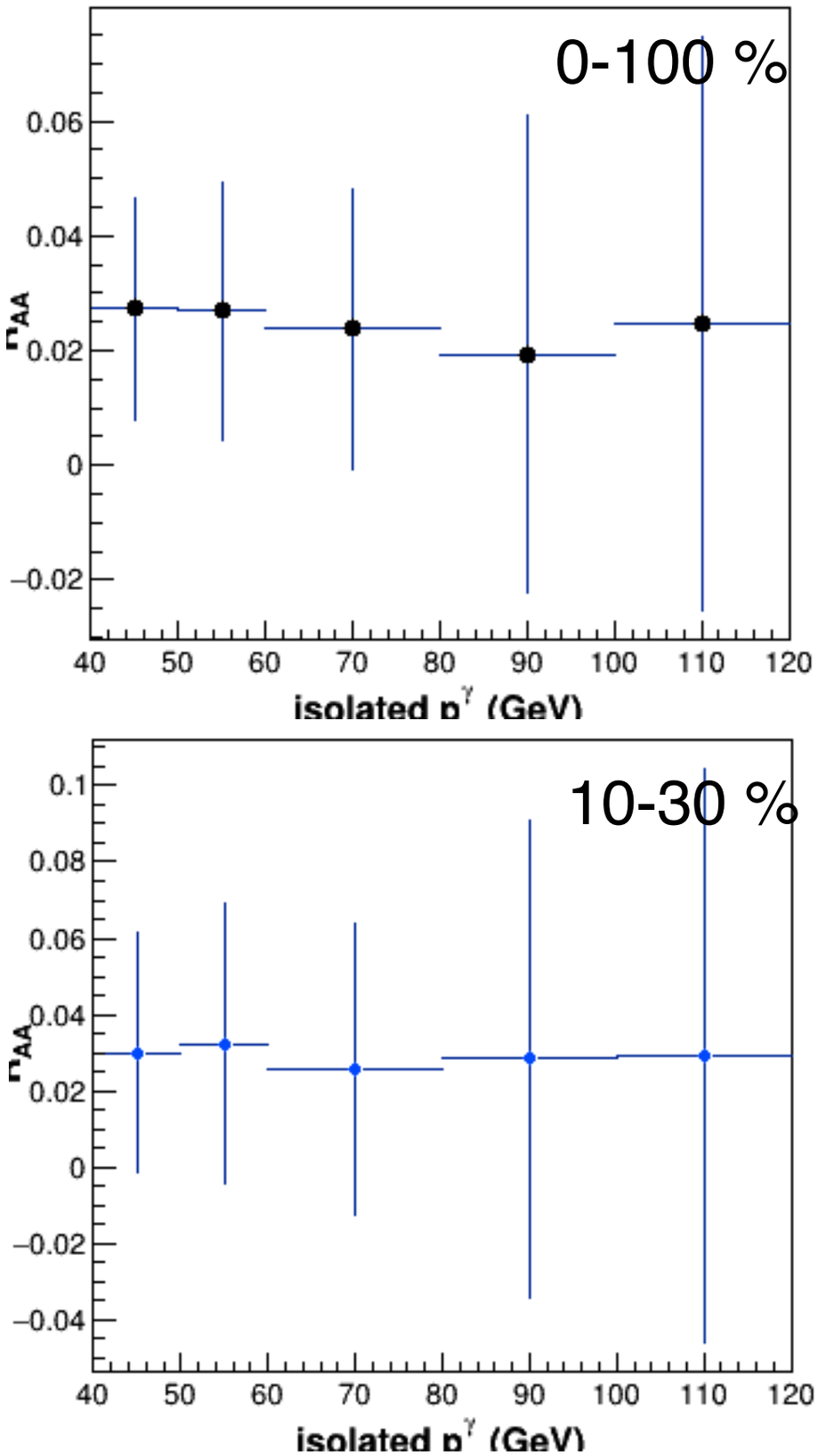
Systematic - Photon Energy Scale

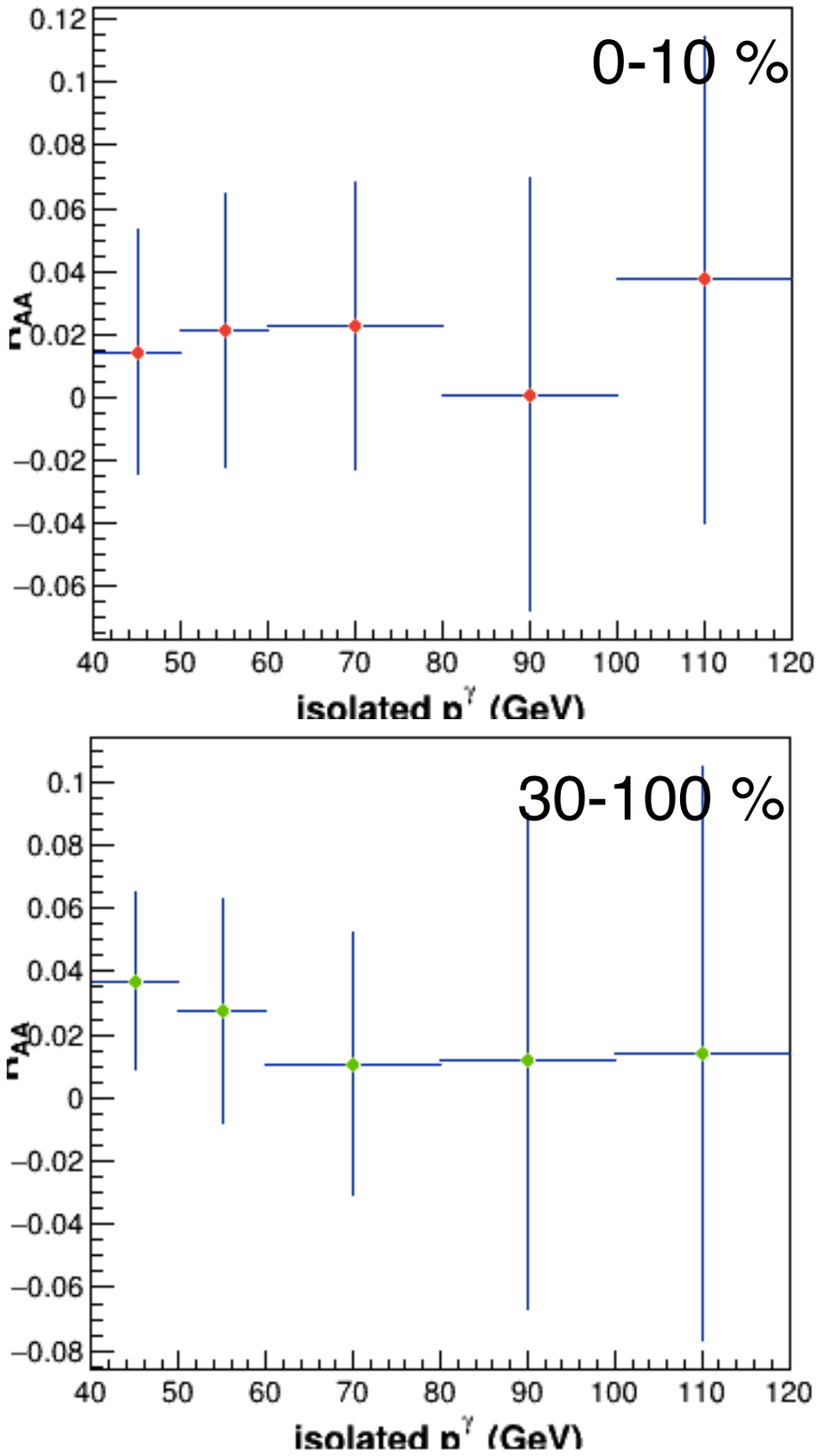




- **Y-axis ; | R_AA_variation - R_AA_nominal |**
- **10~20%**

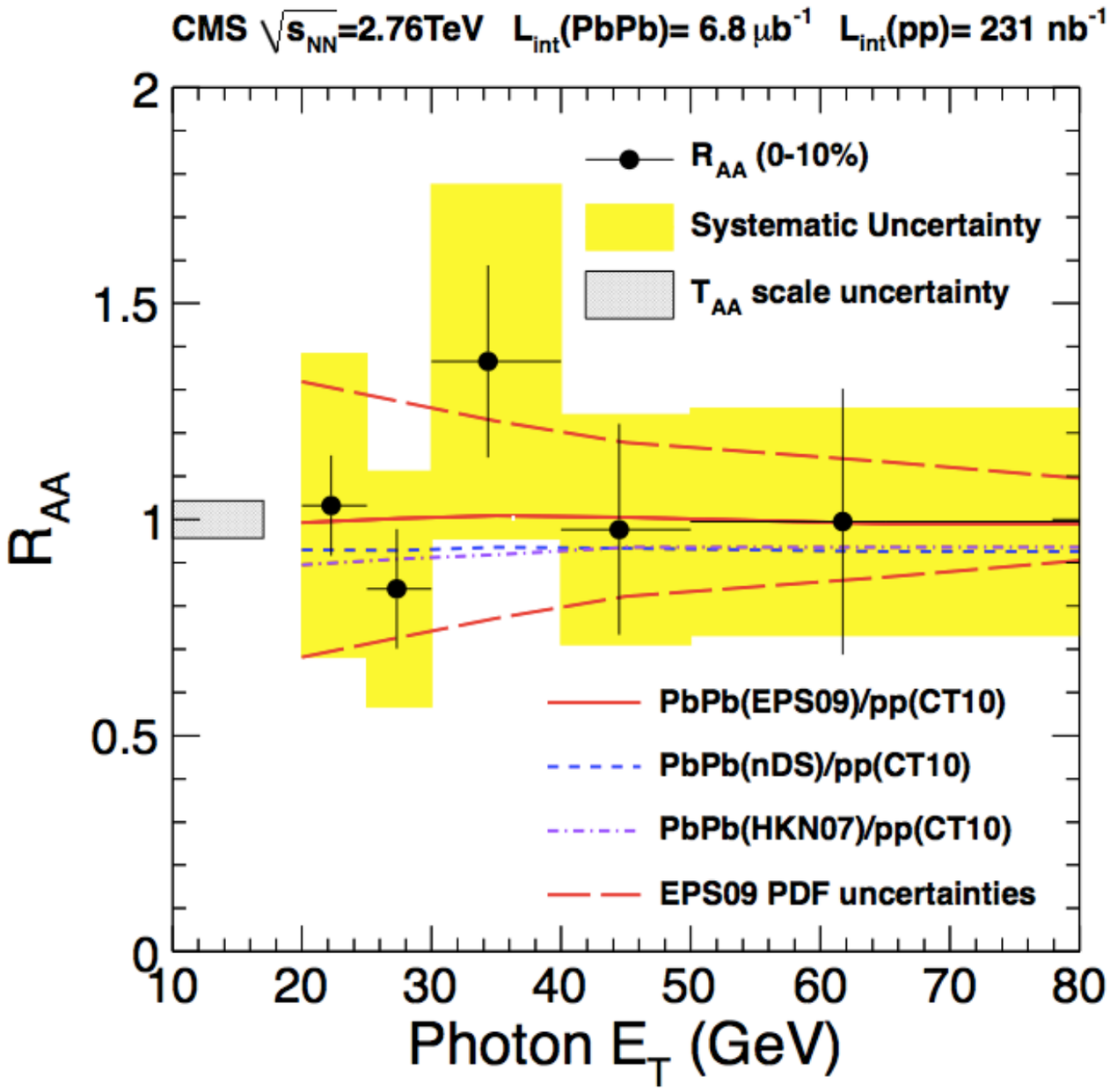
Systematic - Photon Energy Scale



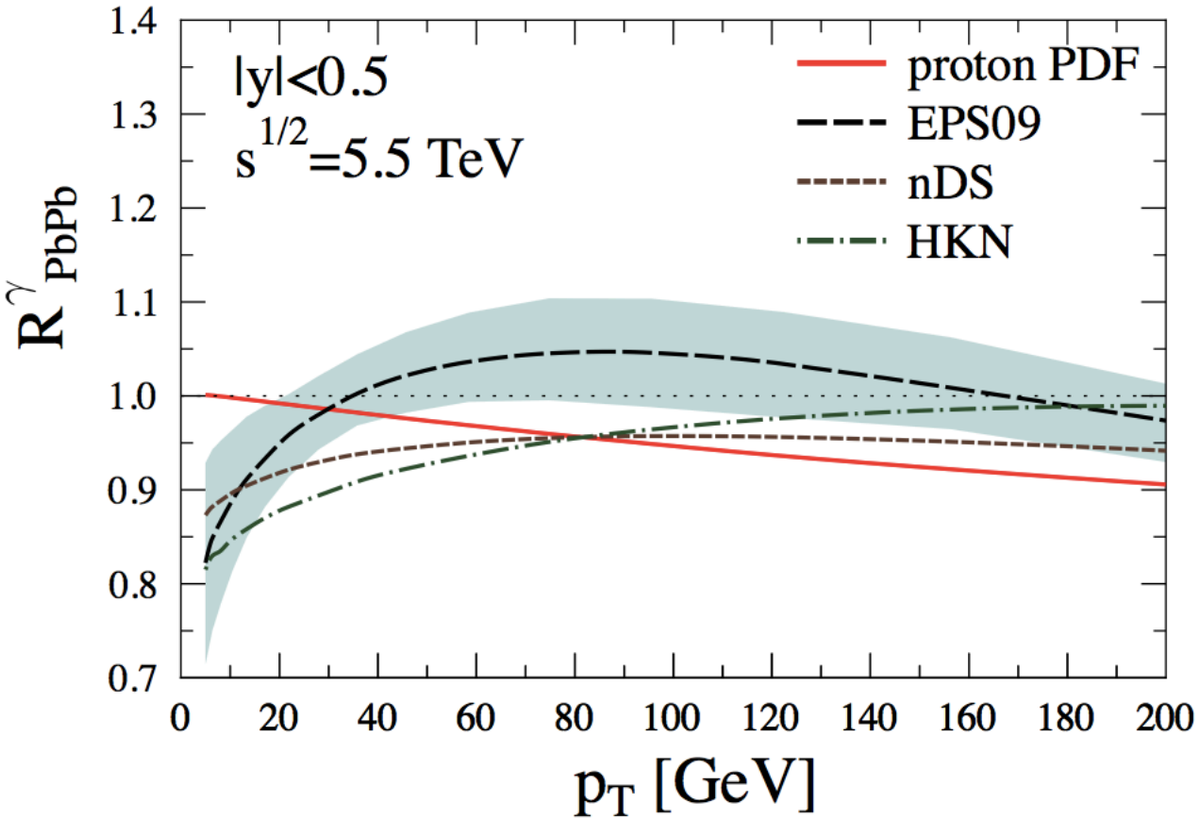


- **Y-axis ; | R_AA_variation - R_AA_nominal |**
- **~1 % (after 1/4 quoation)**

BACK UP



PLB 710 (2012) 256



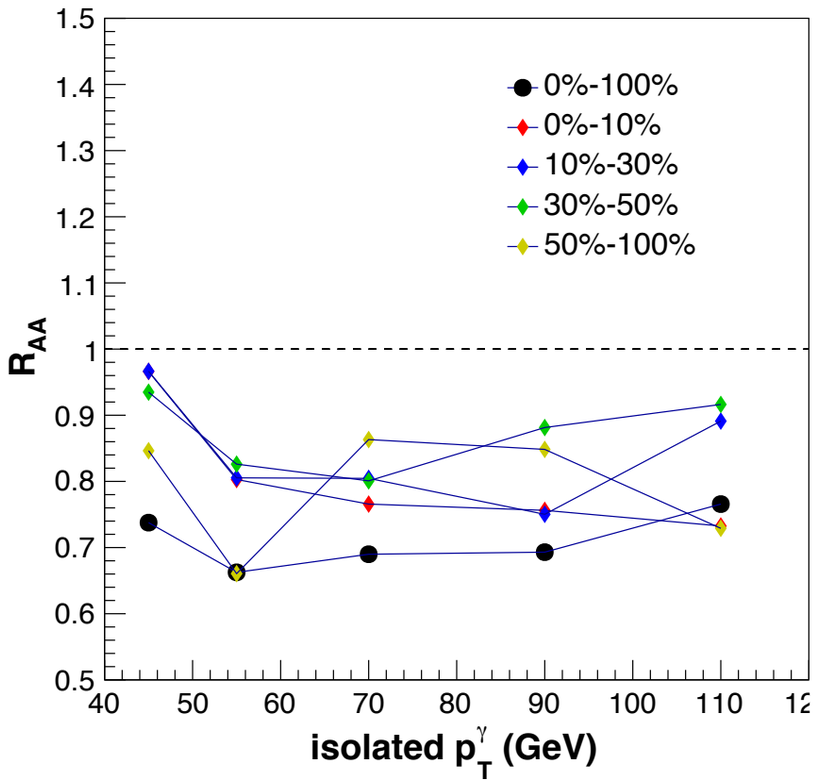
JHEP04(2011)055

Purity systematic

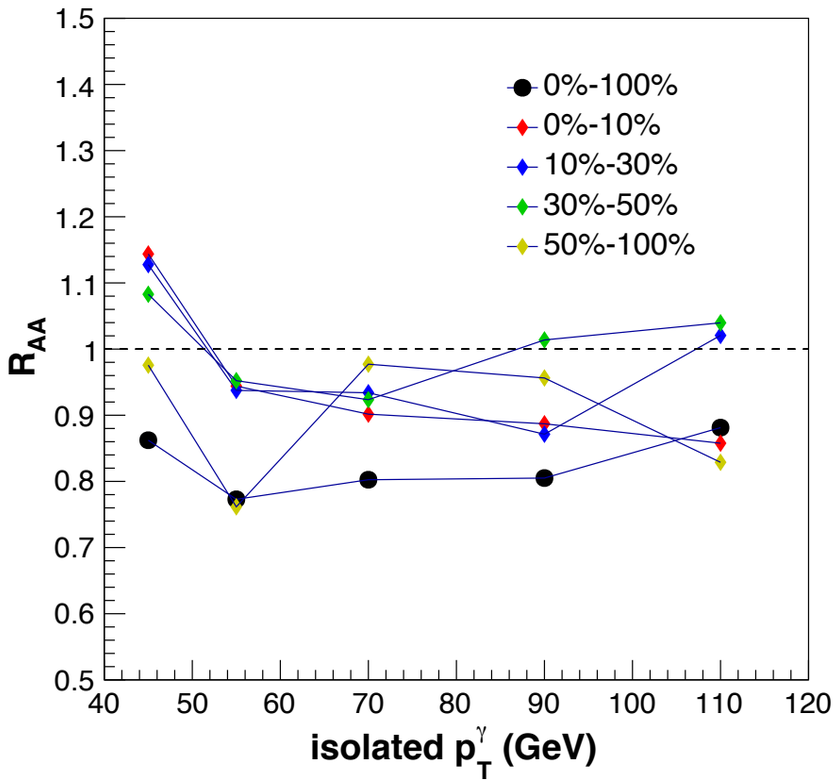
Purity variation +- 0.1

- **When pbpb purity is changed by 0.1**

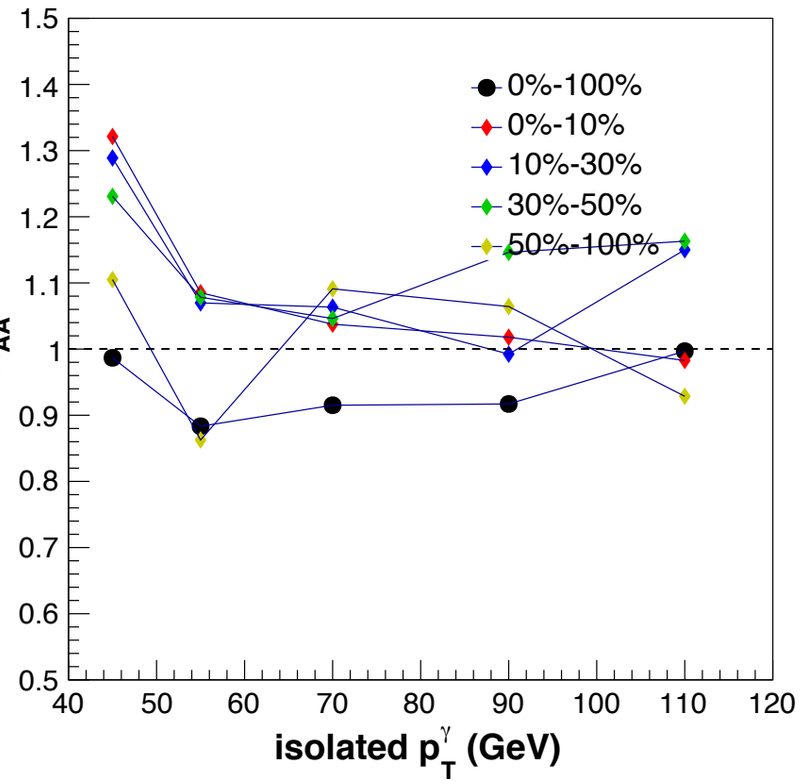
- 0.1



nominal



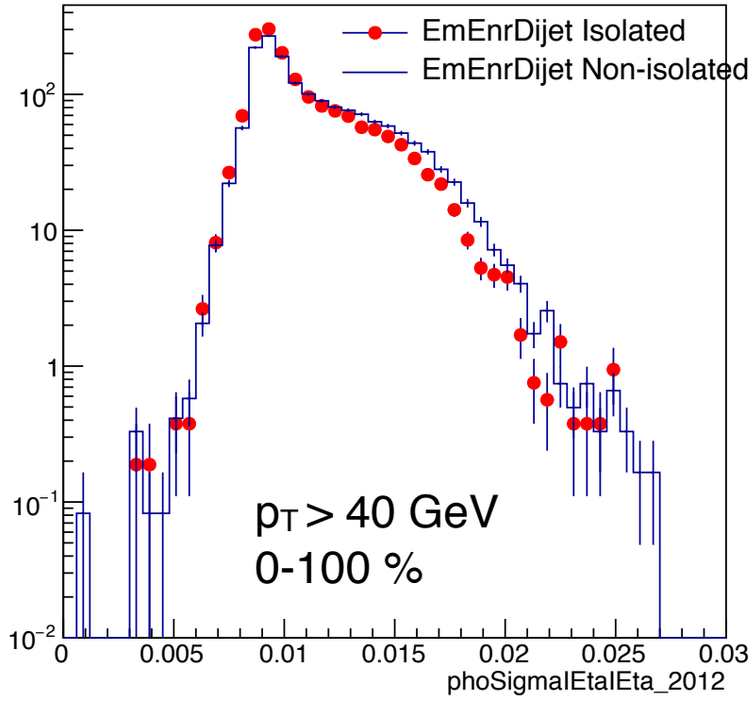
+ 0.1

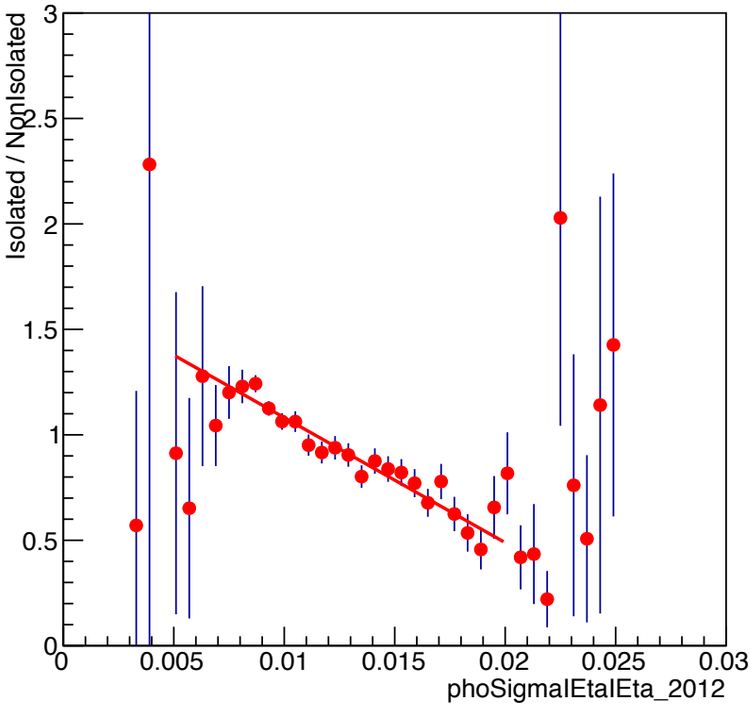


sideband template weighting

- **Current purity method**
  - background photon template comes from sideband selection
  - assumption : isolated background photon distribution in sigmaIEtaIEta is the same with non-isolated(sideband) photon's -> NOT true

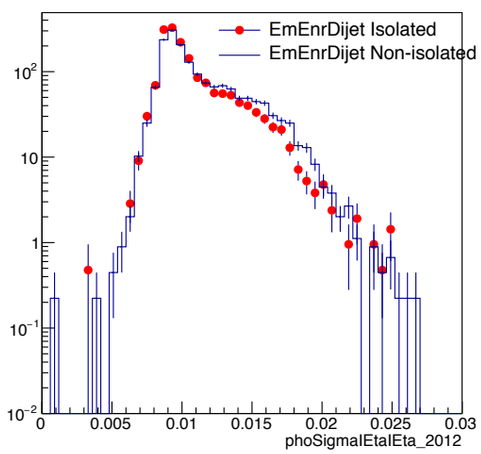
- **Sideband template weighting**
  - ratio between isolated and non-isolated photon's sigmaIEtaIEta dist. fit as linear function
  - sideband template from data can be weighted by the linear function

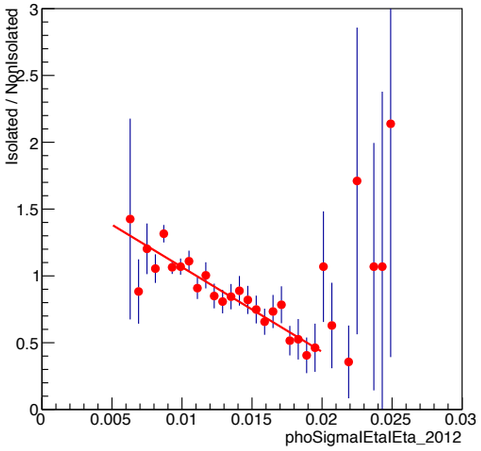




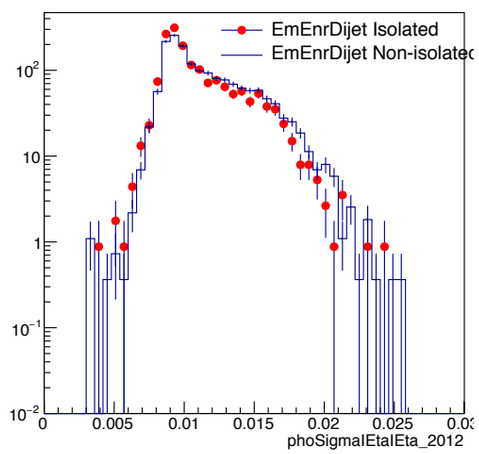
Sideband comparison b/w iso. and non-iso. bkg photons

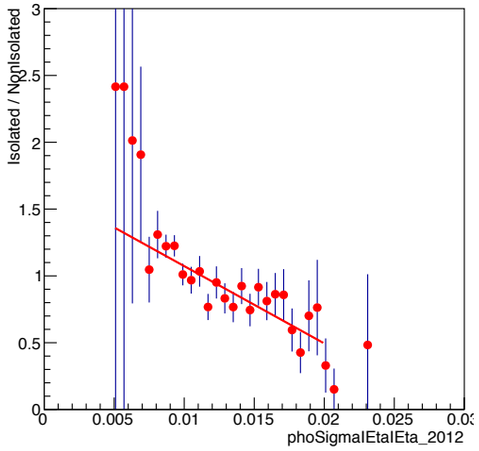
40-50 GeV



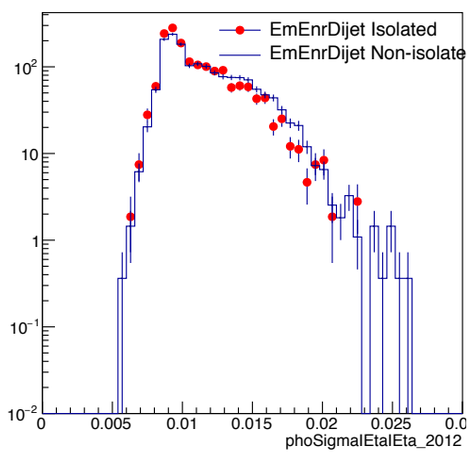


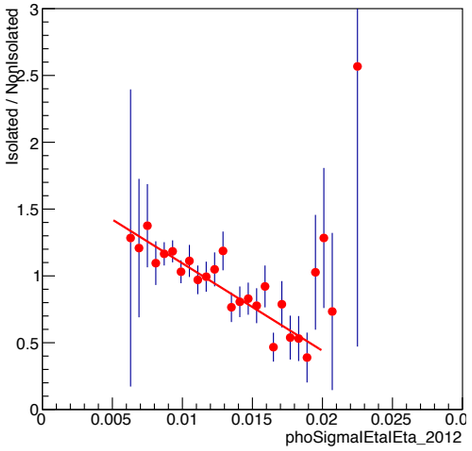
50-60 GeV



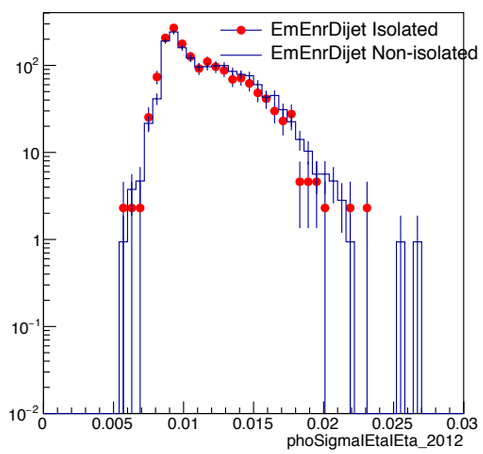


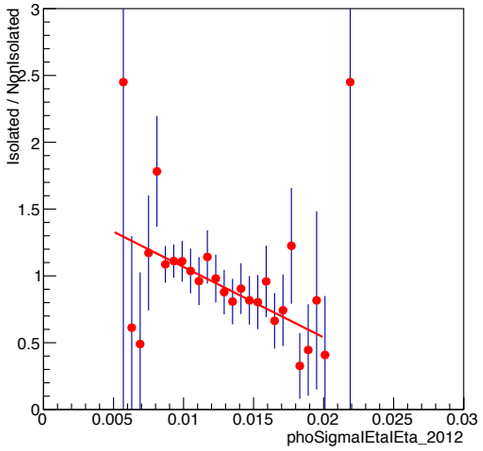
60-80 GeV



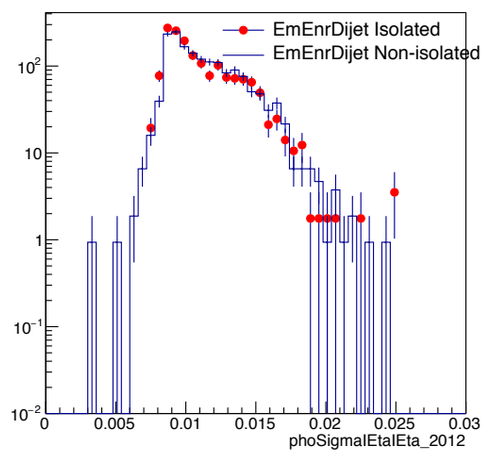


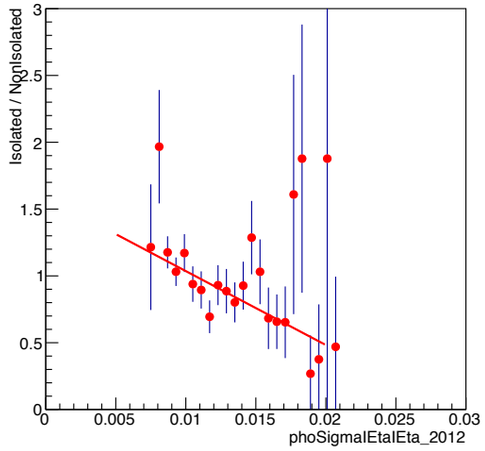
80-100 GeV



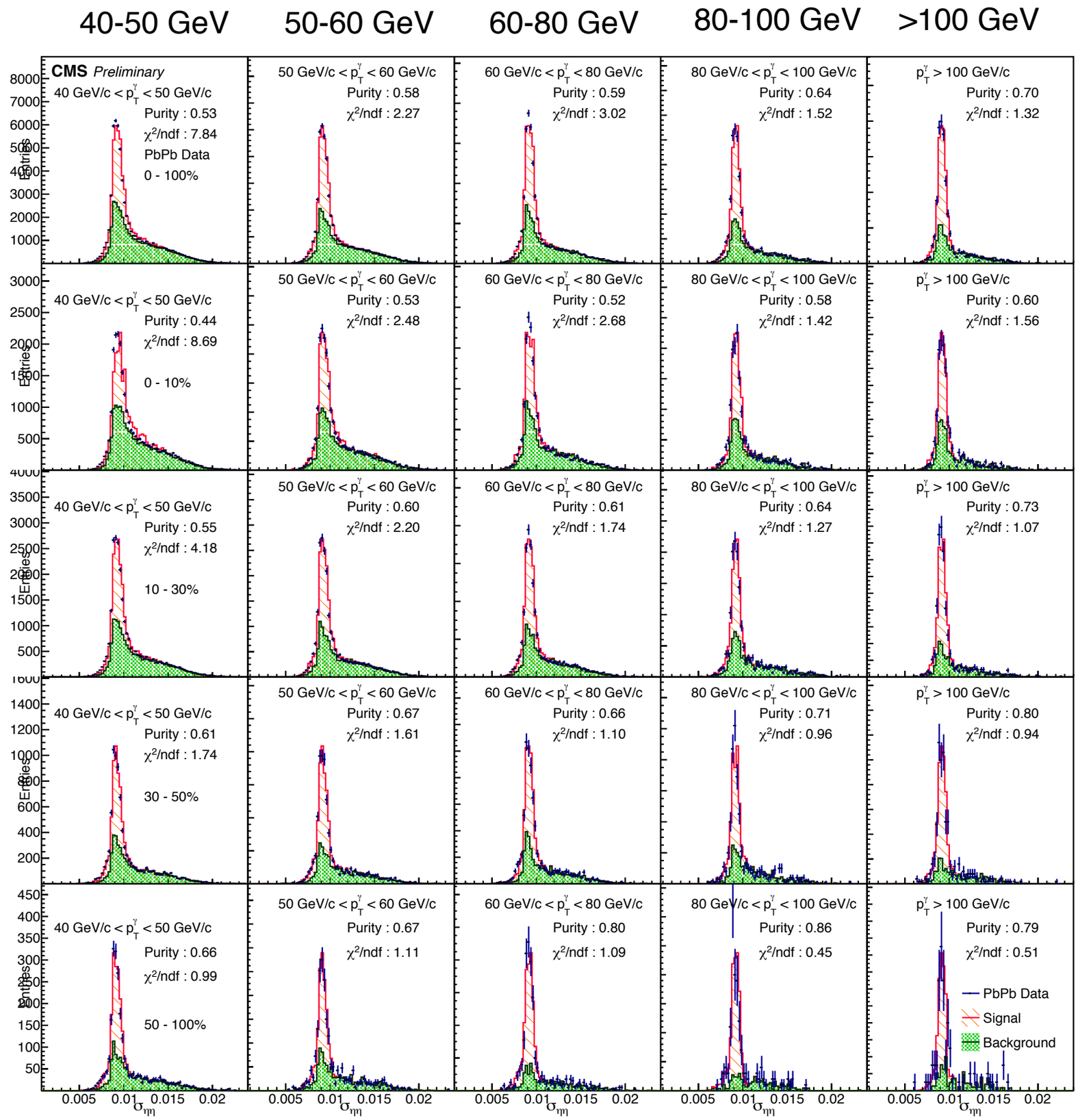


>100 GeV



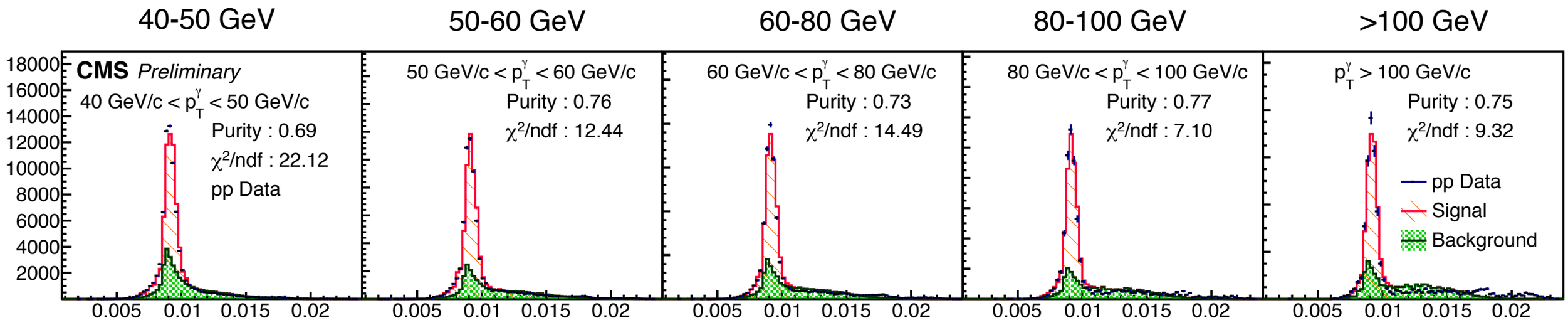


Purity with sideband weighting (PbPb)



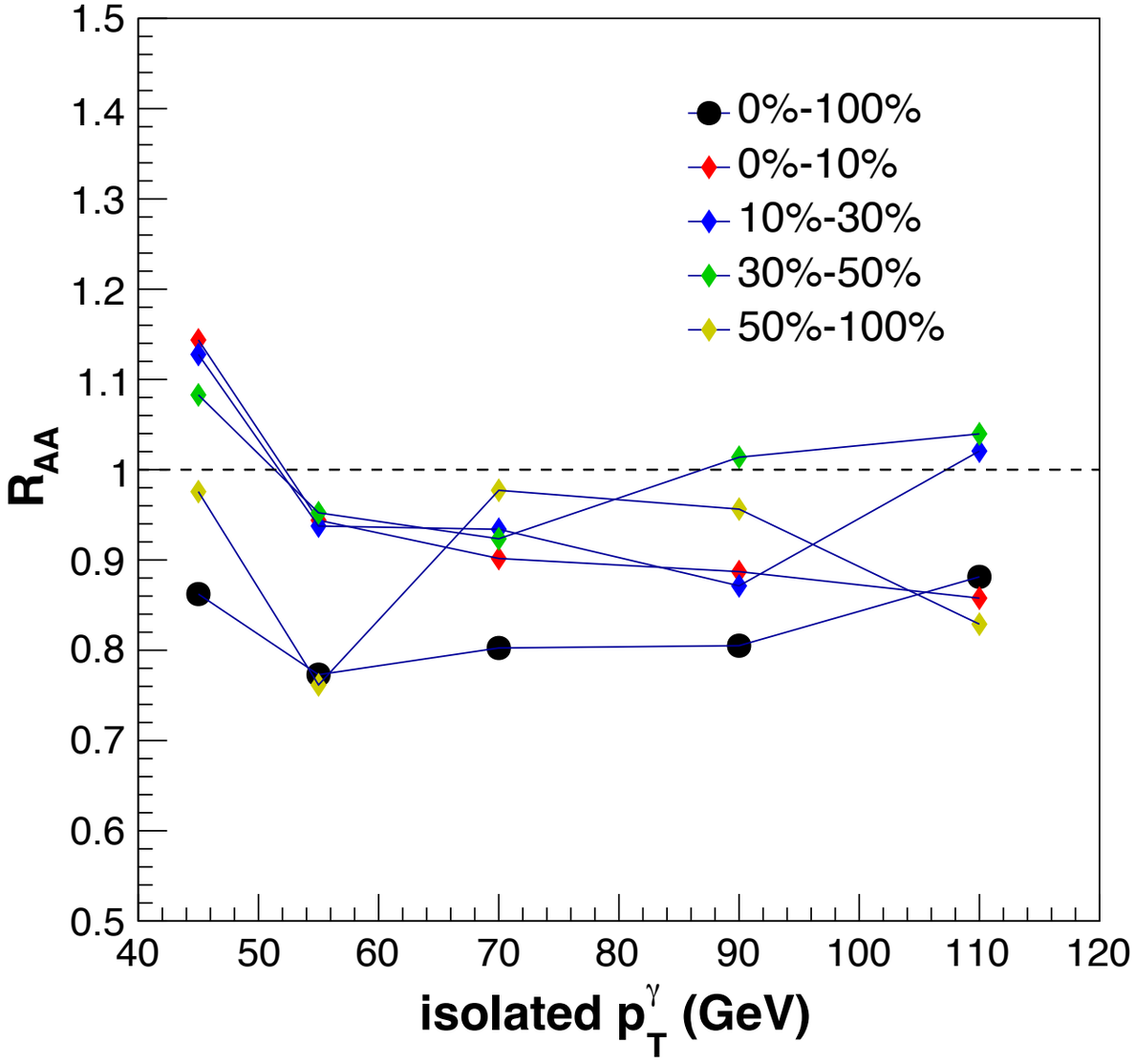
- **Purity values are smaller after sideband weighting**
- **chi2/ndf values are better after sideband weighting**

Purity with sideband weighting (pp)

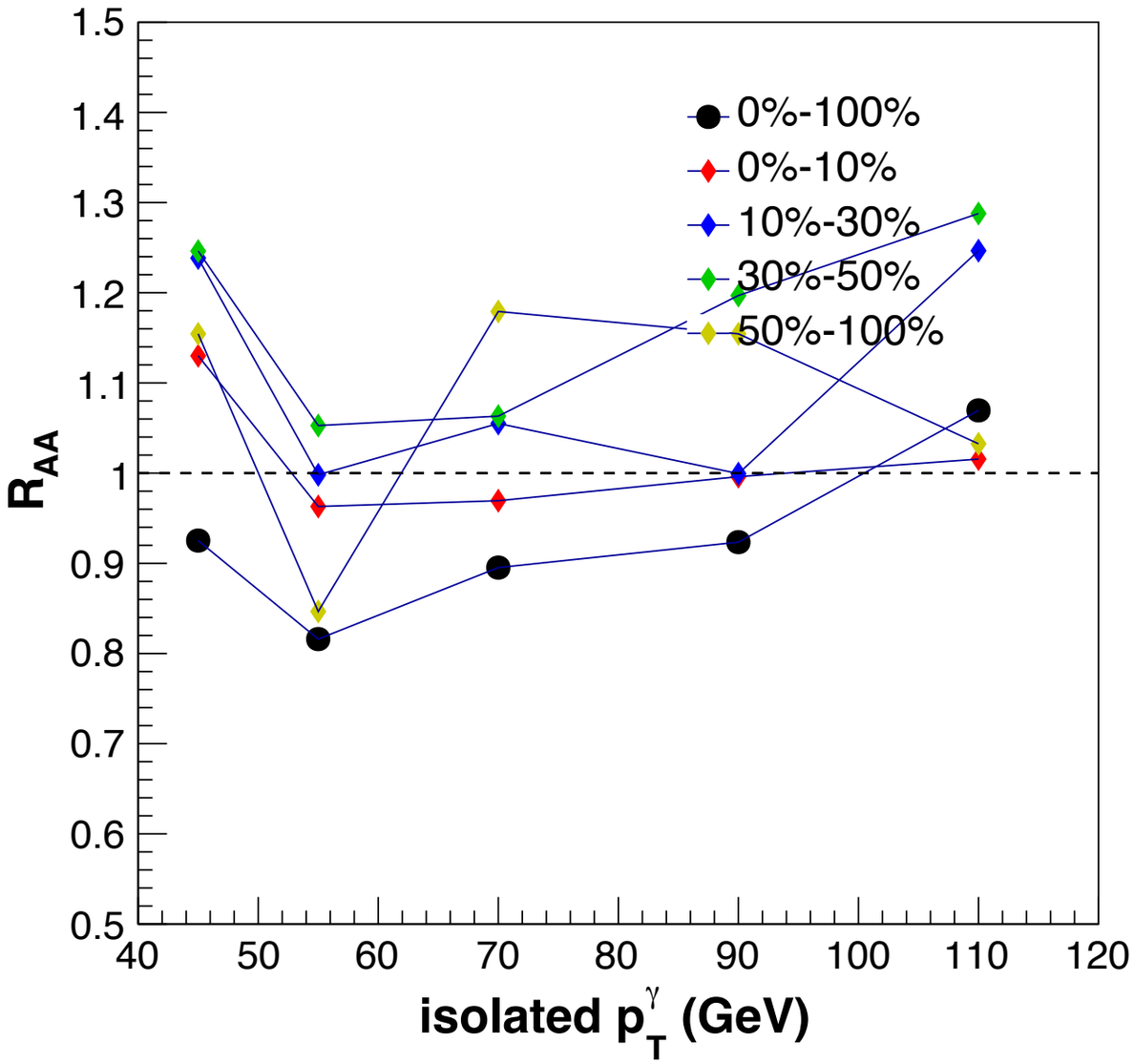


R_AA and cross section with sideband weighting

Before

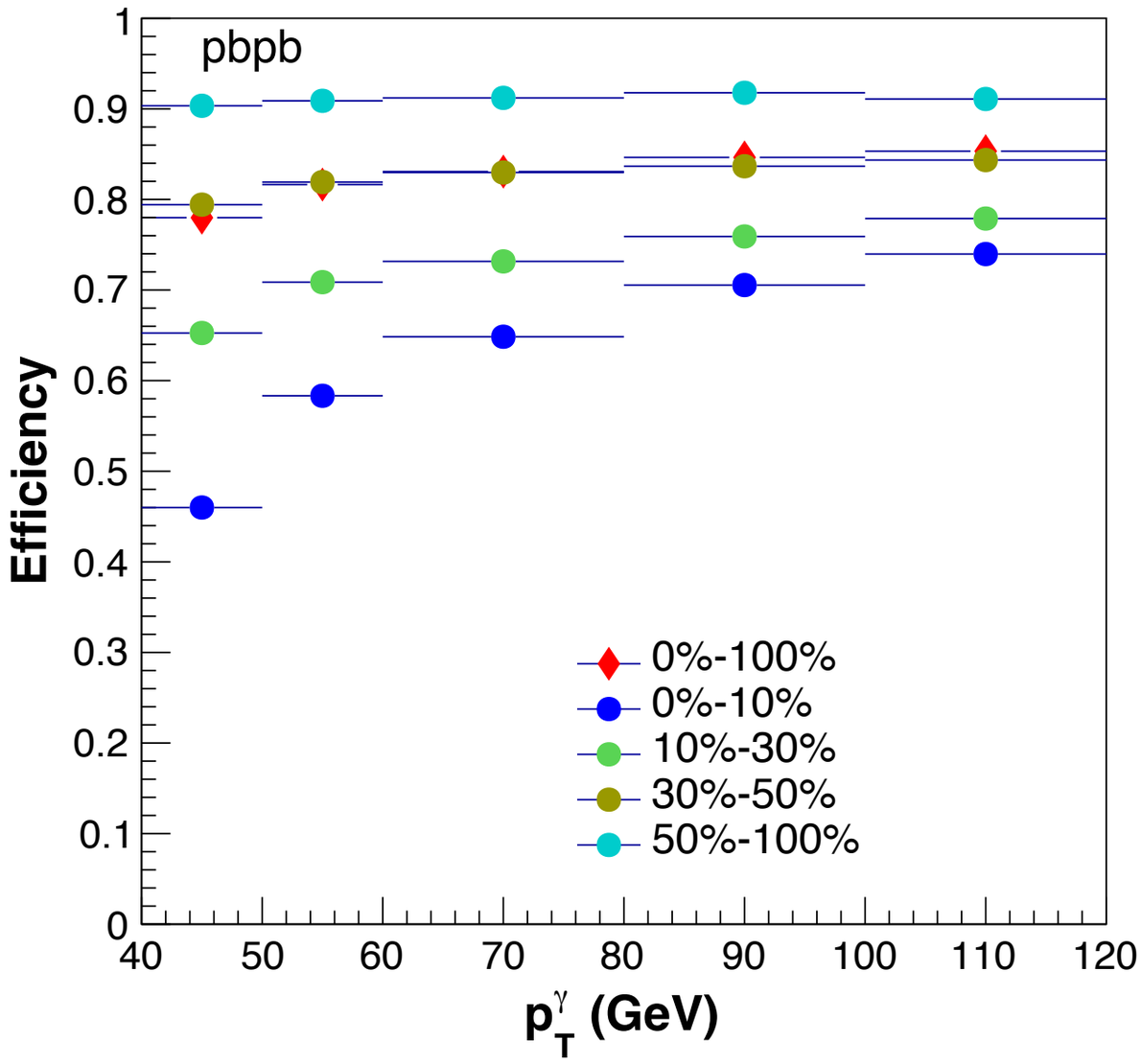


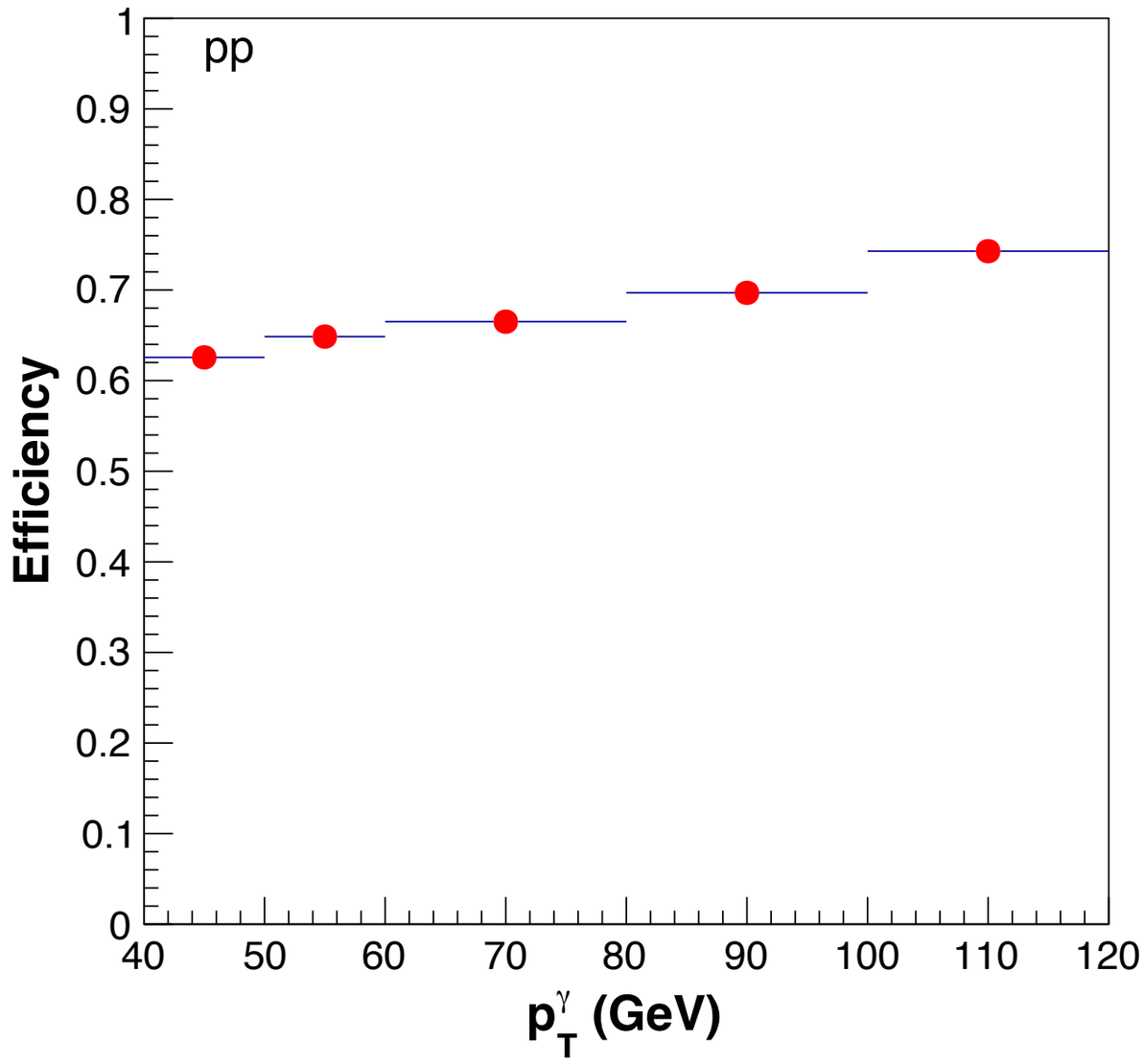
After sideband weighting



- **R_AA is a bit higher after sideband weighting**

Efficiency





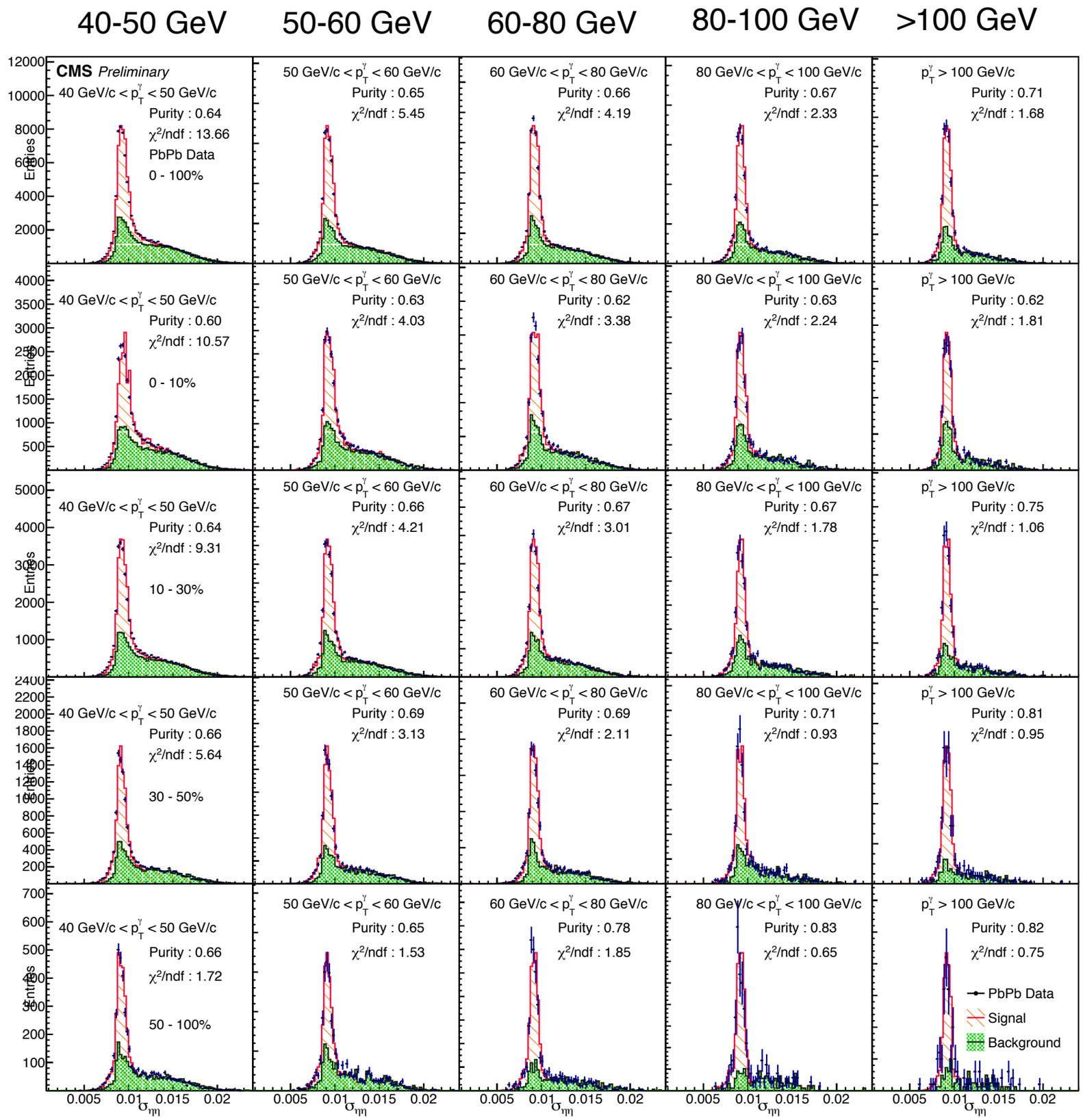
- **Obtained from MC**
- **Total efficiency**
  - Trigger+reconstruction+isolation
  - PbPb Isolation condition
    - phoHoverE < 0.1
    - phoSigmaIEtaIEta_2012 < 0.010
    - sumIso < 5 GeV

- pp Isolation condition (from Egamma POG)

BARREL	Medium (79.9%)
Background Rejection	Medium (86.9%)
HoverE	0.05
$sigma_{ietaieta}$	0.0102
PF charged hadron isolation	1.37
Rho corrected PF neutral hadron isolation	1.06 + 0.014*pho_pt + 0.000019* $(pho\_pt)^2$
Rho corrected PF photon isolation	0.28 + 0.0053*pho_pt

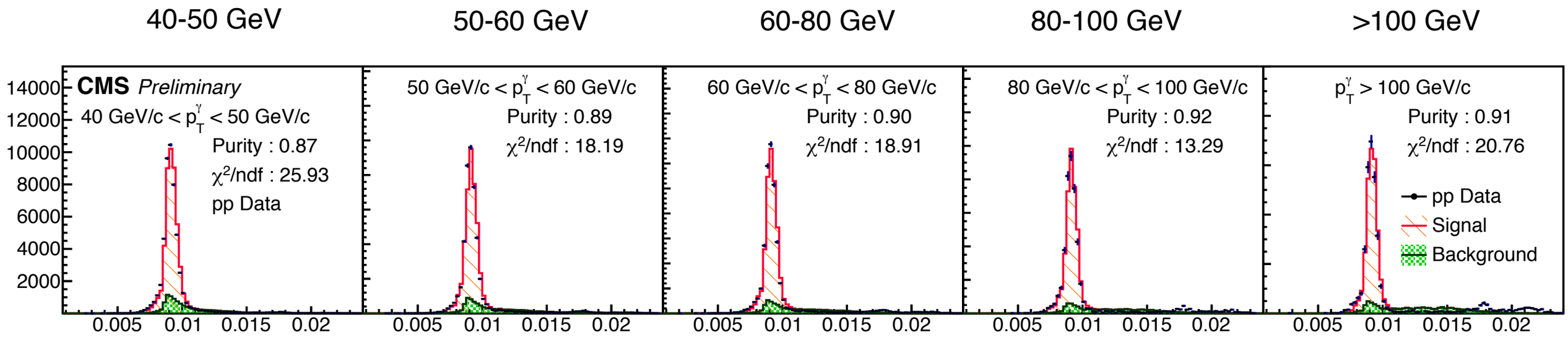
https://twiki.cern.ch/twiki/bin/view/CMS/CutBasedPhotonIdentificationRun2Archive#SPRING15_selections_25_ns

Purity (PbPb)



- **Signal template cut :**
  - genId = 22
  - |genMomId| <= 22
  - genCalIso < 5
  - Signal isolation condition
- **Sideband cut :**
  - 10 < sumIso < 20

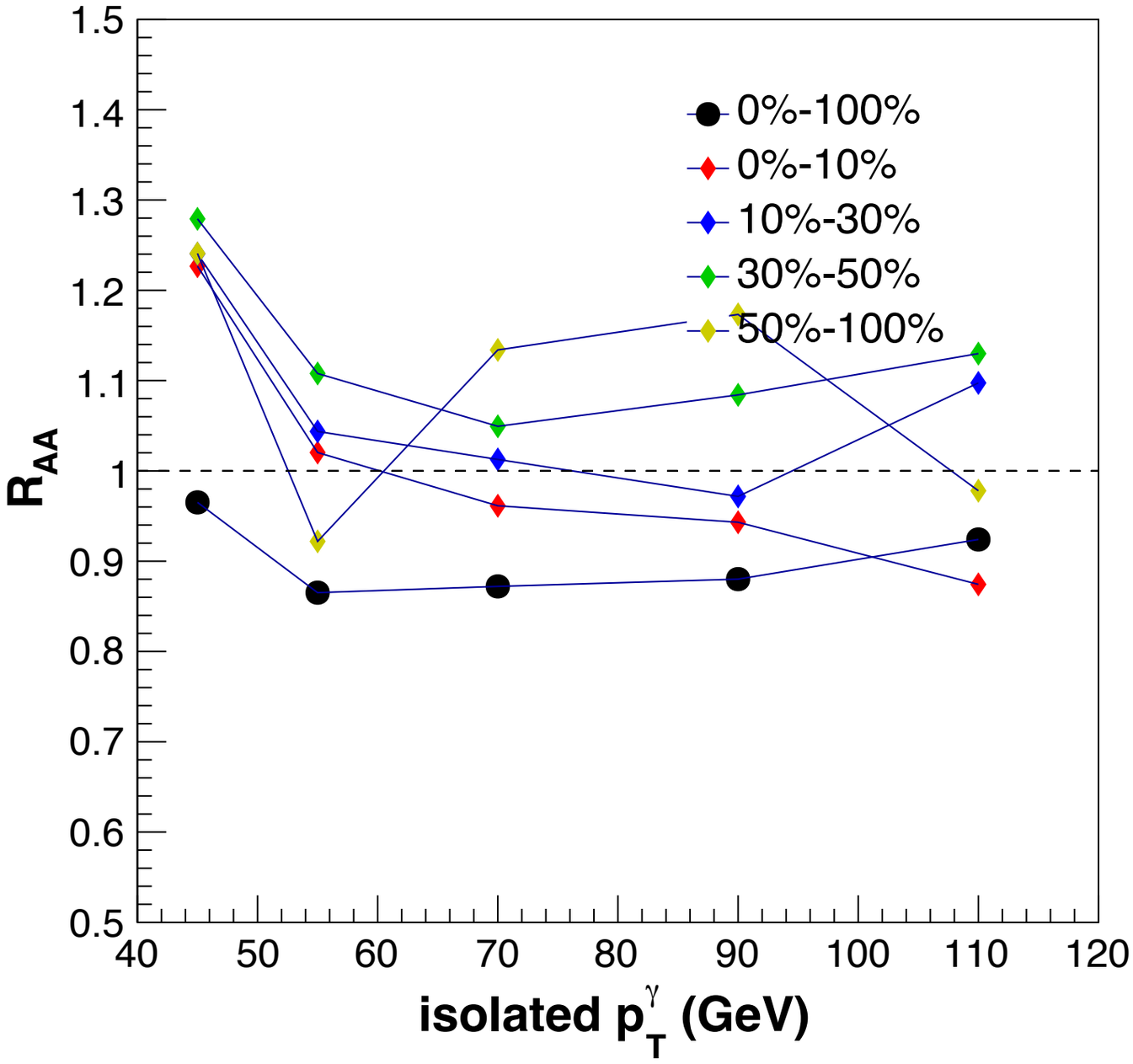
Puity (pp)

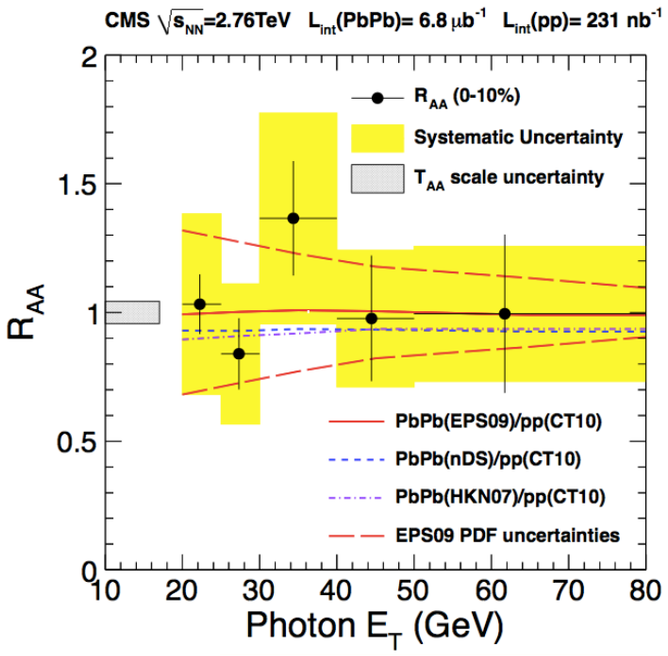


BARREL	Medium (79.9%)
Background Rejection	Medium (86.9%)
HoverE	0.05
$sigma_{ietaieta}$	0.0102
PF charged hadron isolation	1.37
Rho corrected PF neutral hadron isolation	1.06 + 0.014*pho_pt + 0.000019* (pho_pt)^2
Rho corrected PF photon isolation	0.28 + 0.0053*pho_pt

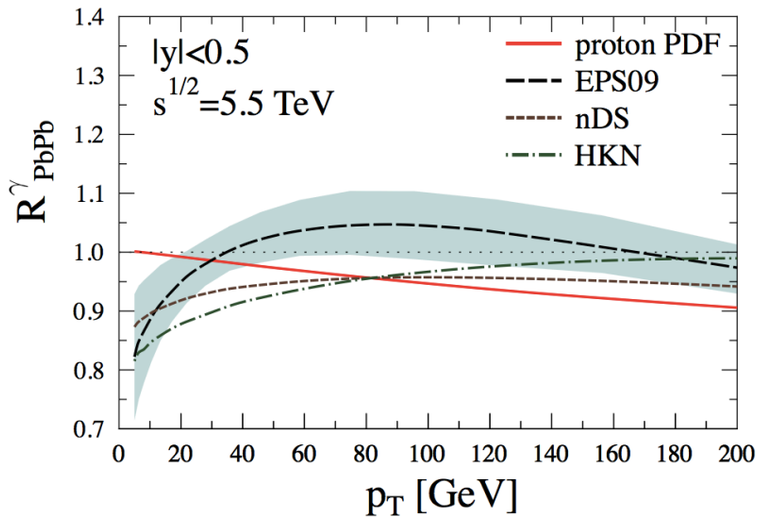
- **Signal template cut :**
  - gen cuts : same as PbPb
  - reco cuts from Egamma POG
- **Sideband cut : 10 < sumIso < 20**
  - same with PbPb sideband cut
  - Q) different variable other than sumIso for sideband cut?

R_AA





PLB 710 (2012) 256



JHEP04(2011)055

- **purity of 0-100 % is reliable?**
- **R_AA at 50-100 % fluctuate because of low statistic**

Cross section