Inclusive jet and charged particle R_{AA} in PbPb collisions at 2.76 TeV with CMS

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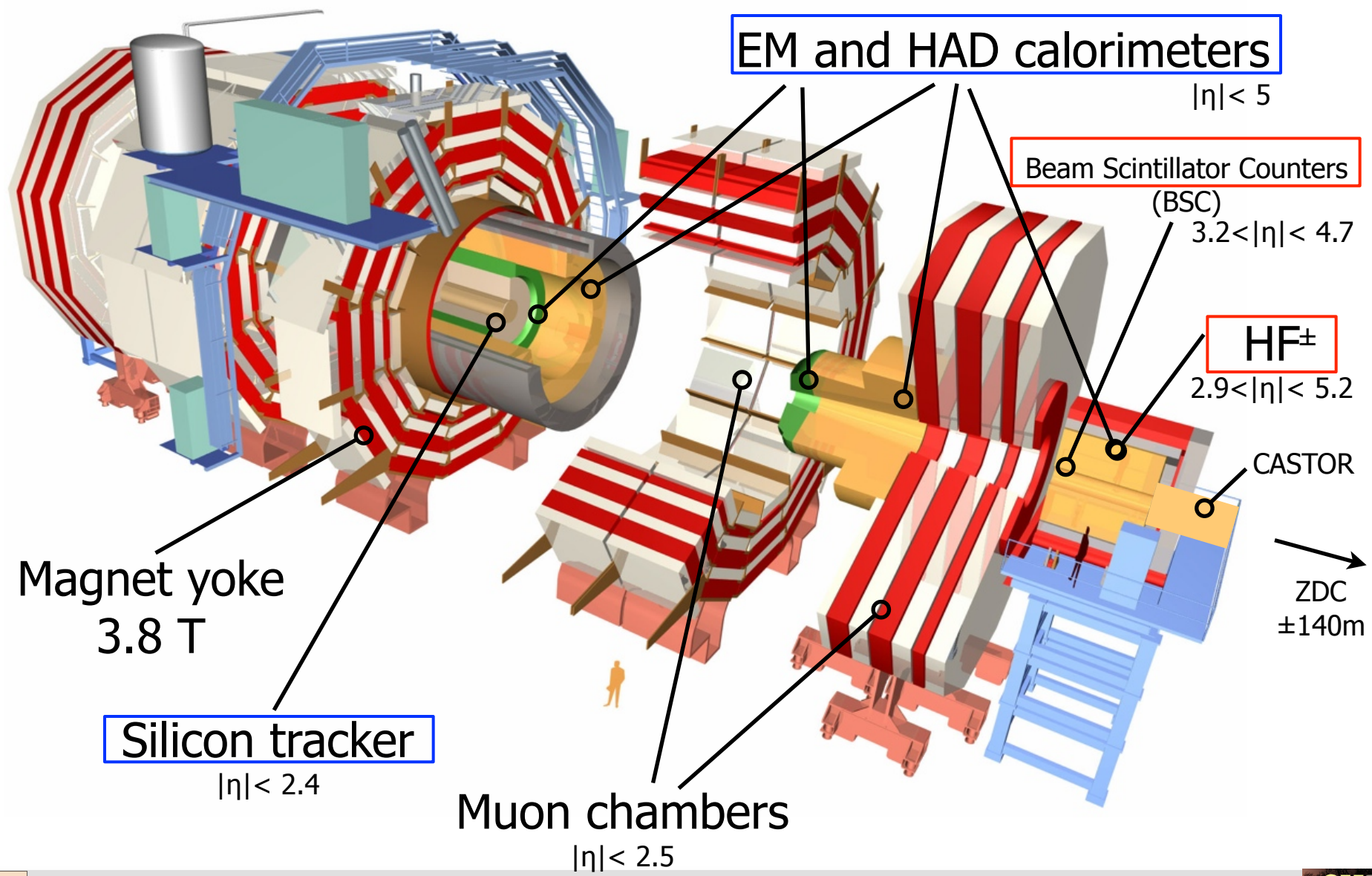
Quark Matter conference, Washington DC
14 August, 2012

Compact Muon Solenoid (CMS)



Charged particle analysis

- Triggering:
  - Min. bias: coincidence triggers
    - BSC (3.2<|η|<4.7) or HF (2.9<|η|<5.2)
  - 2011 jet triggers extend statistical reach of track p_T
  - Jets: Iterative cone + background subtraction
    - Thresholds: 65 and 80 GeV
- Event Selection:
  - Beam Halo veto
  - Beam-scraping cleaning
  - ECAL, HCAL noise cleaning
  - Vertex with at least 2 tracks
  - 3 towers (E>3 GeV) in HF±

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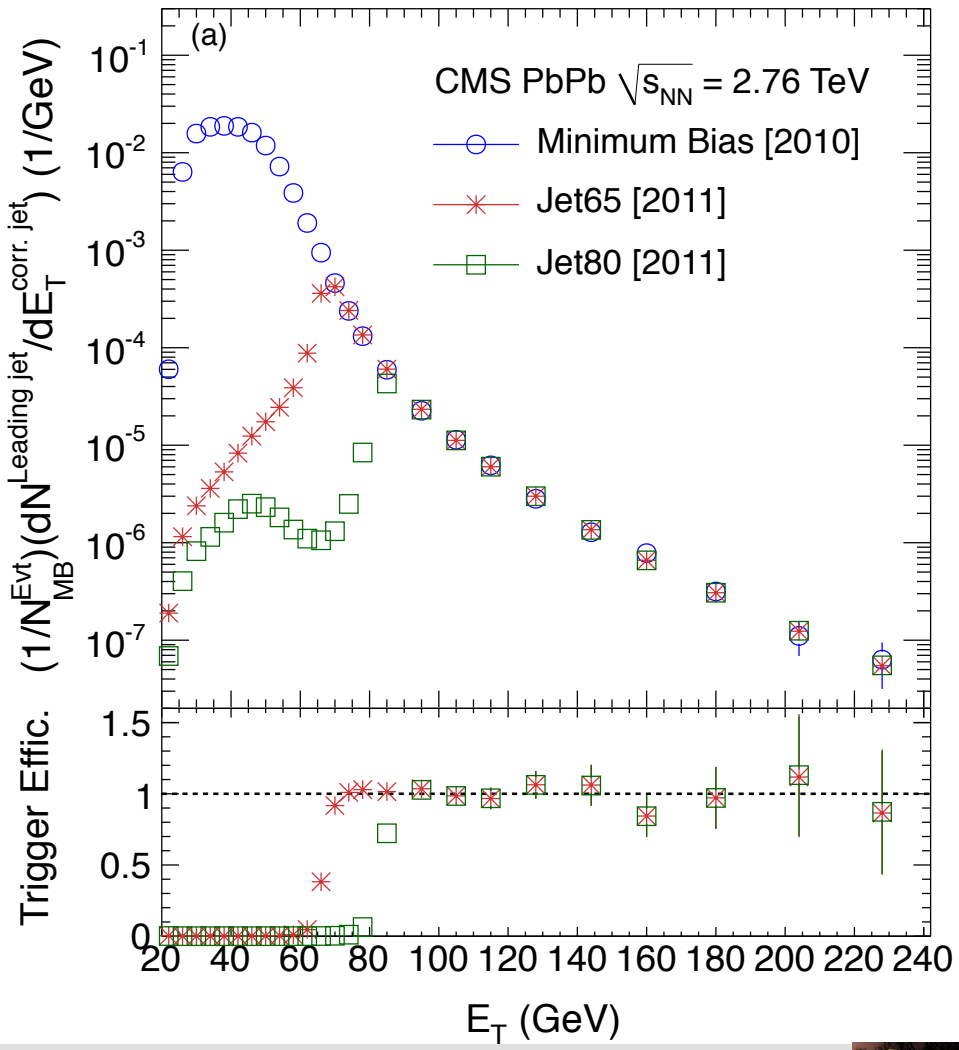

Track reconstruction

- Track reconstruction: iterative algorithm
  - Find tracks in consecutive steps
  - Remove hits belonging to tracks in each step
  - Merge tracks based on the fraction of shared hits
  - "Calorimeter compatibility": tracks are matched to closest calorimeter cells (for track $p_T \gtrsim 30$ GeV/c)

→ High efficiency, low fake track rate at high-p_T

PbPb charged particle spectra

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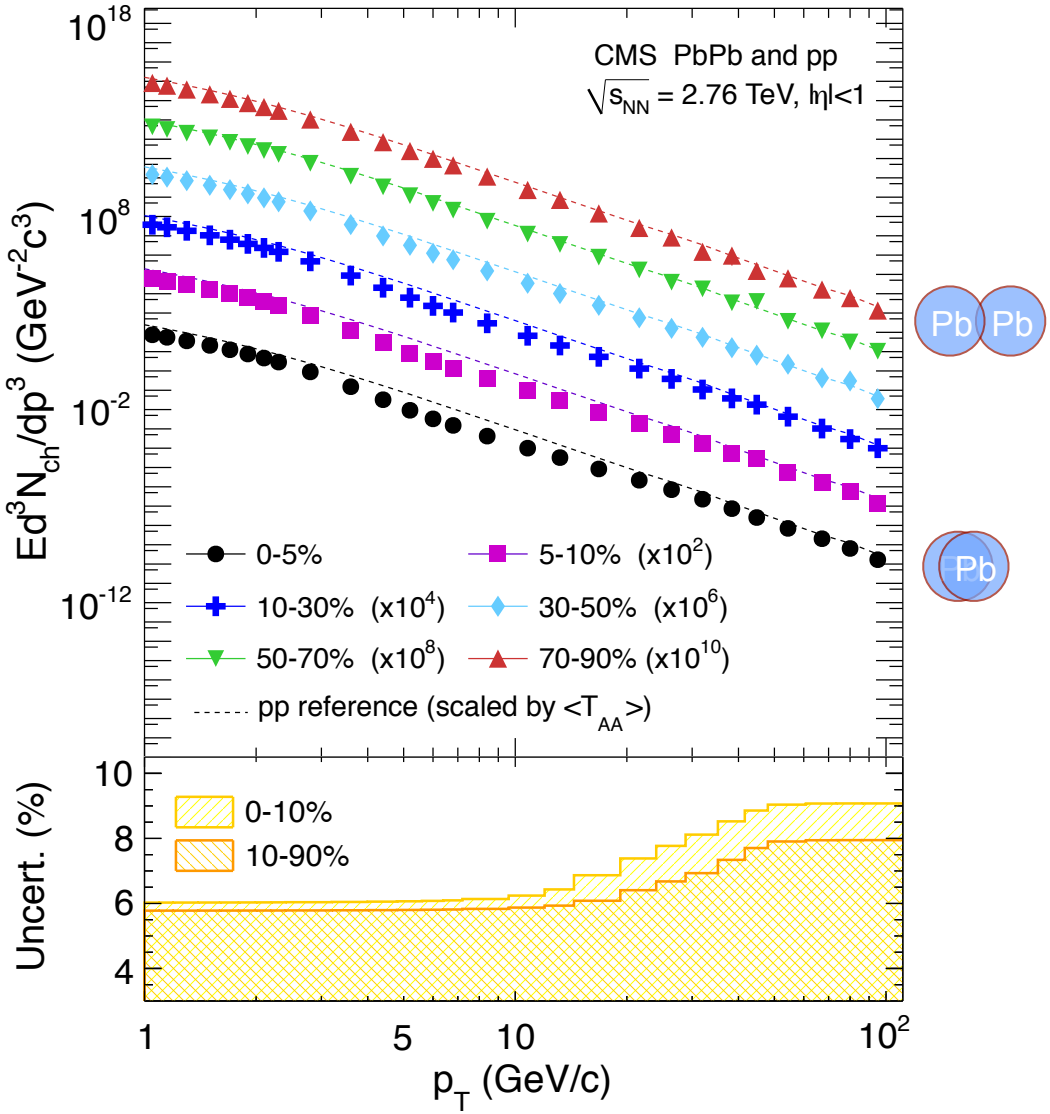
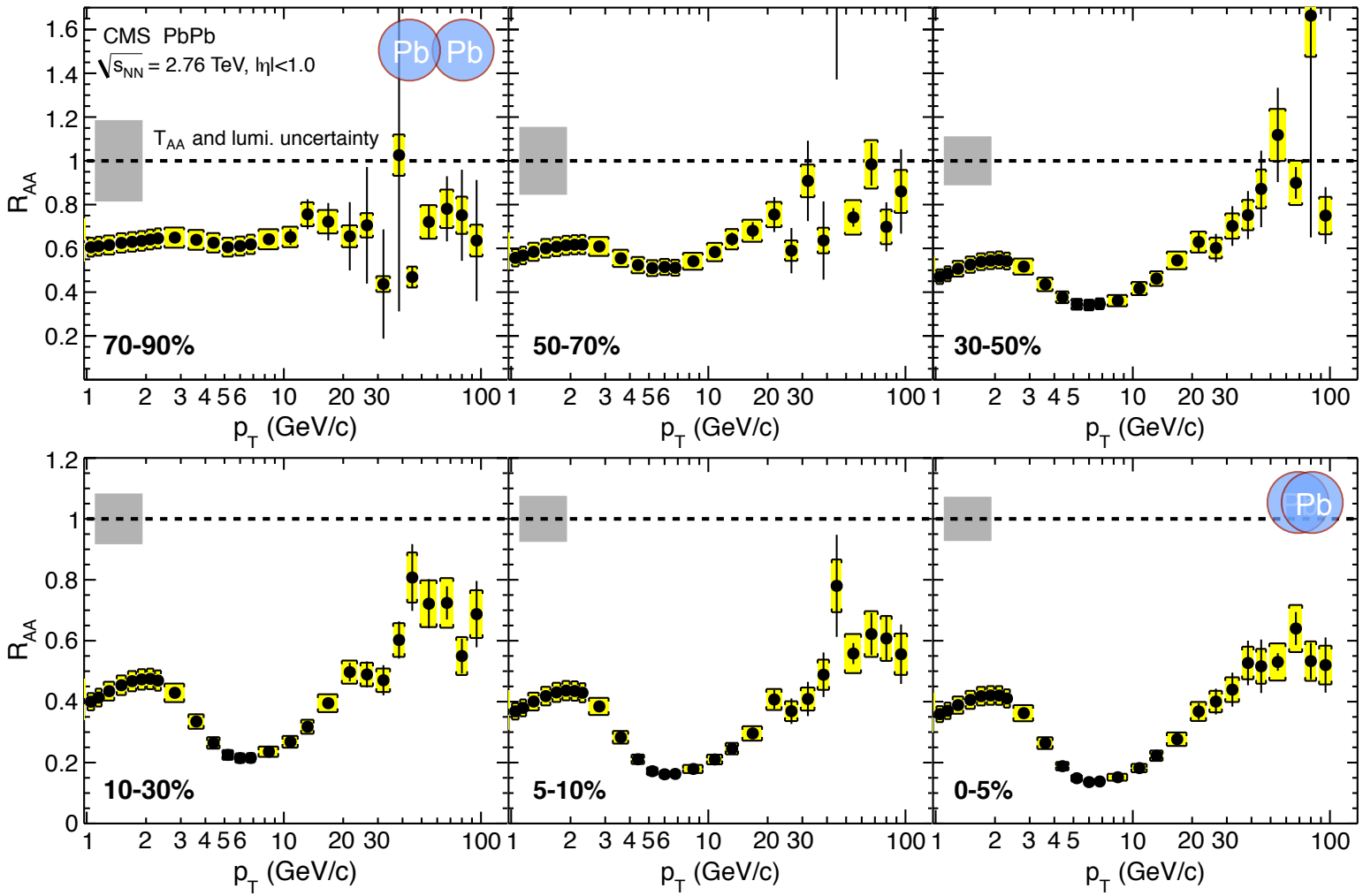
- Measured up to 100 GeV/c in six centrality bins
- Uses full 2011 run statistics at high p_T
  - 150 μb^{-1}
- Use to make R_{AA}

$$R_{AA} = \frac{dN^{AA}/dp_T}{\langle T_{AA}\rangle \, d\sigma^{pp}/dp_T}$$

$$\langle T_{AA}\rangle = \frac{\langle N_{coll}\rangle}{\sigma_{inel}^{NN}}$$



Charged particle R_{AA}



- Dip structure develops as a function of centrality
- R_{AA} increases at high p_T

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Charged particle R_{AA} evolution

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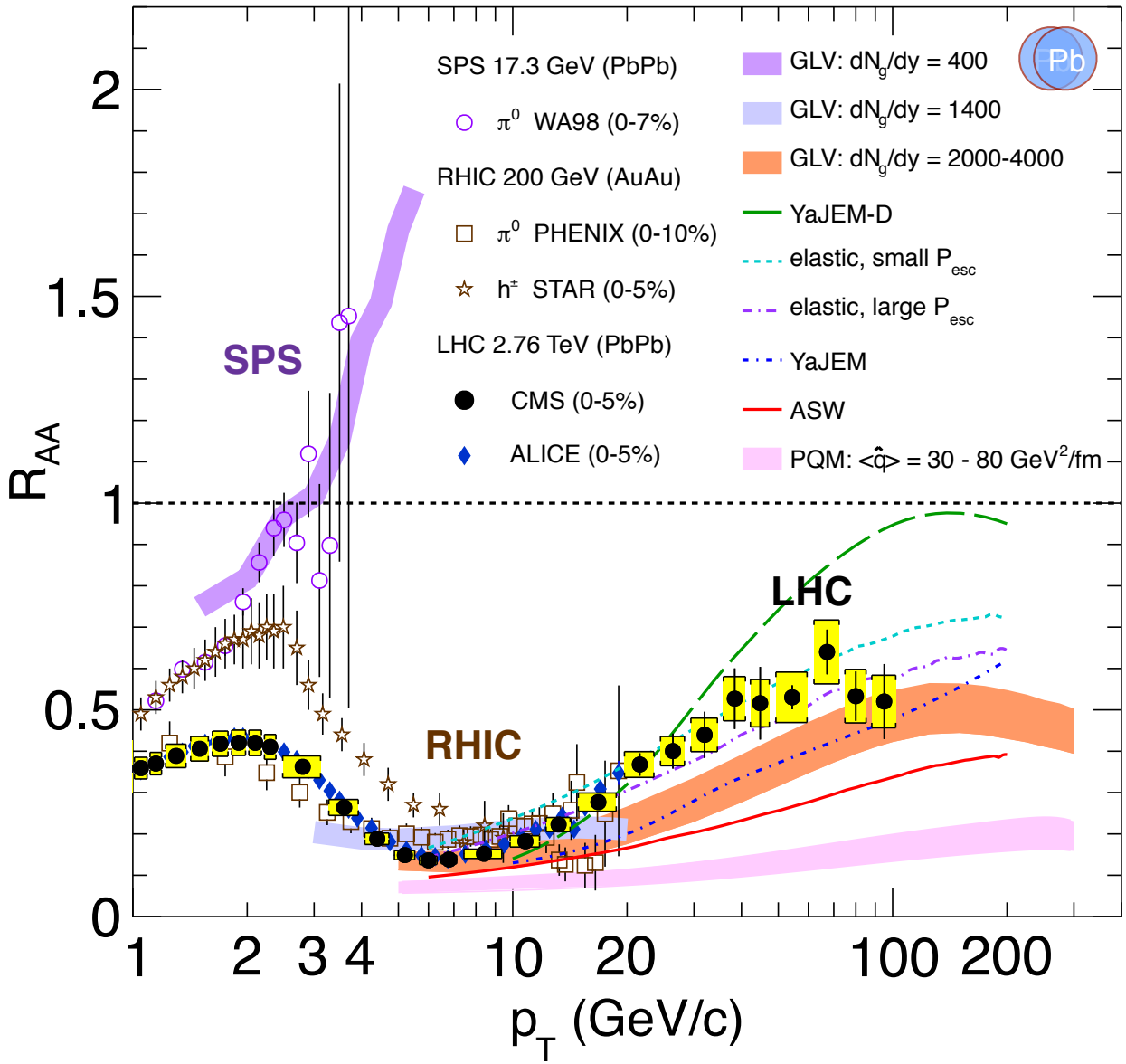
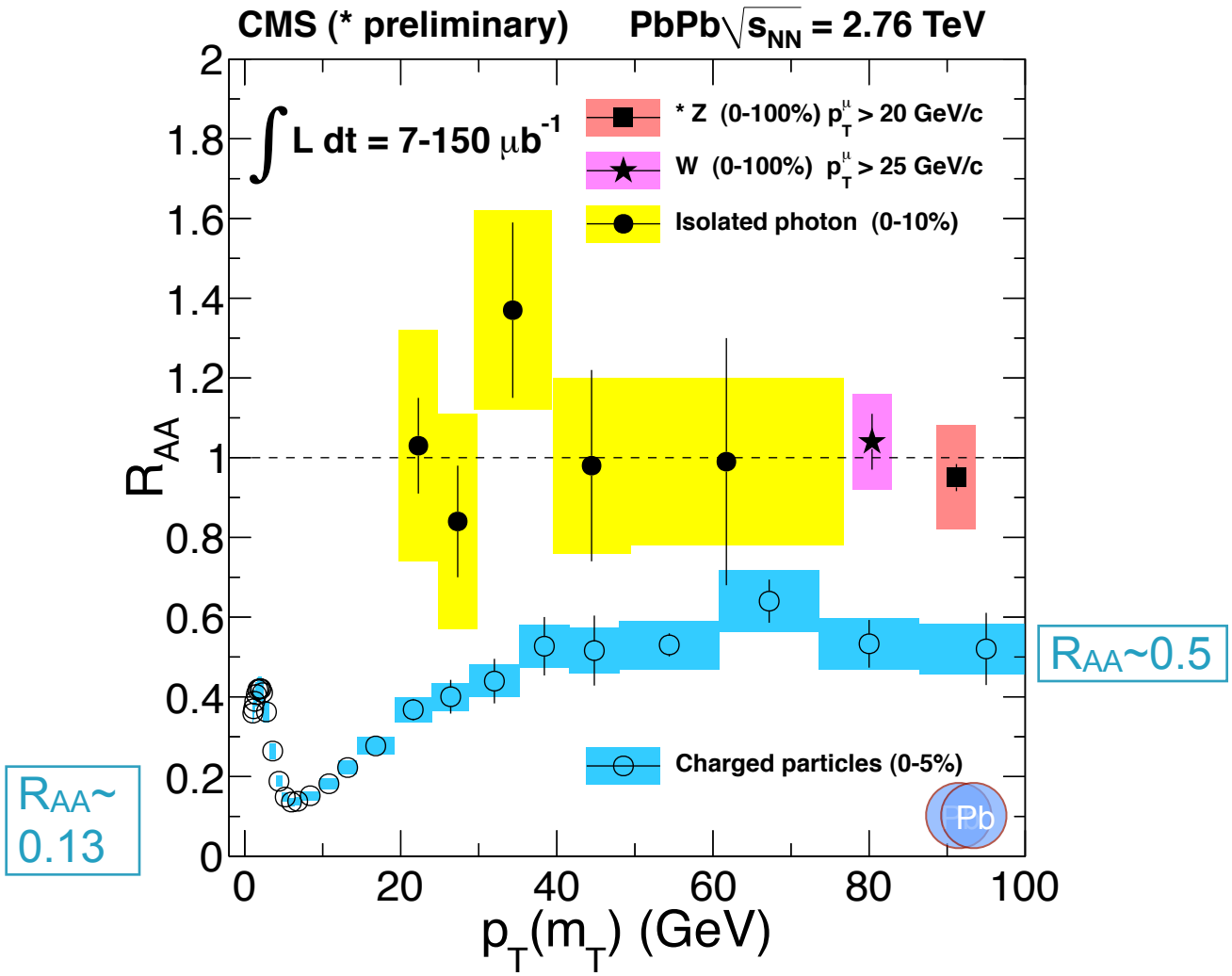


- Below 10 GeV/c, LHC is 50% more suppressed than RHIC
- Most models predict the rise at LHC, but the slope varies

Charged particle R_{AA}

https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsHIN

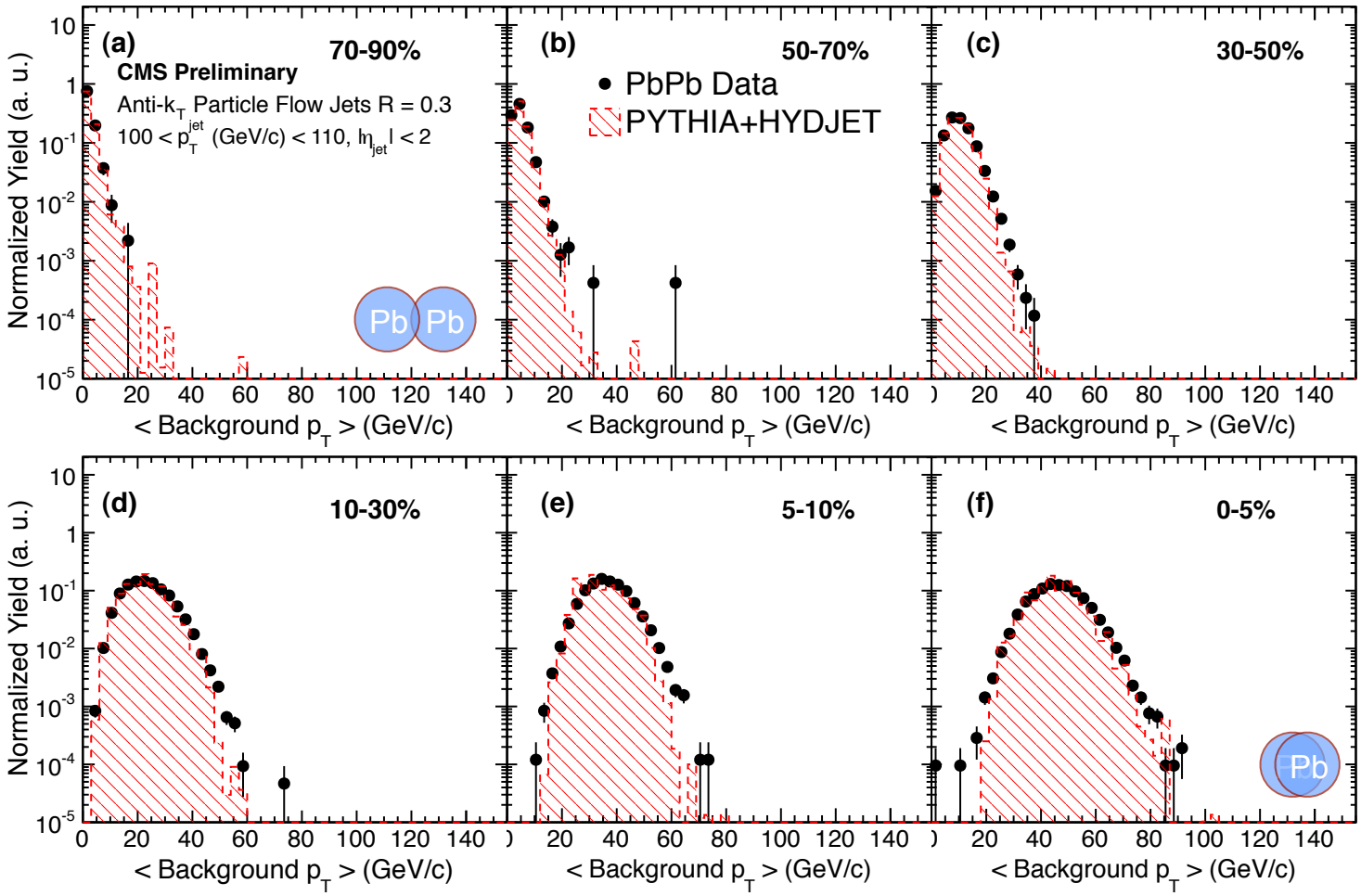


- Central charged particle R_{AA} shows suppression up to high p_T

Jet R_{AA} analysis

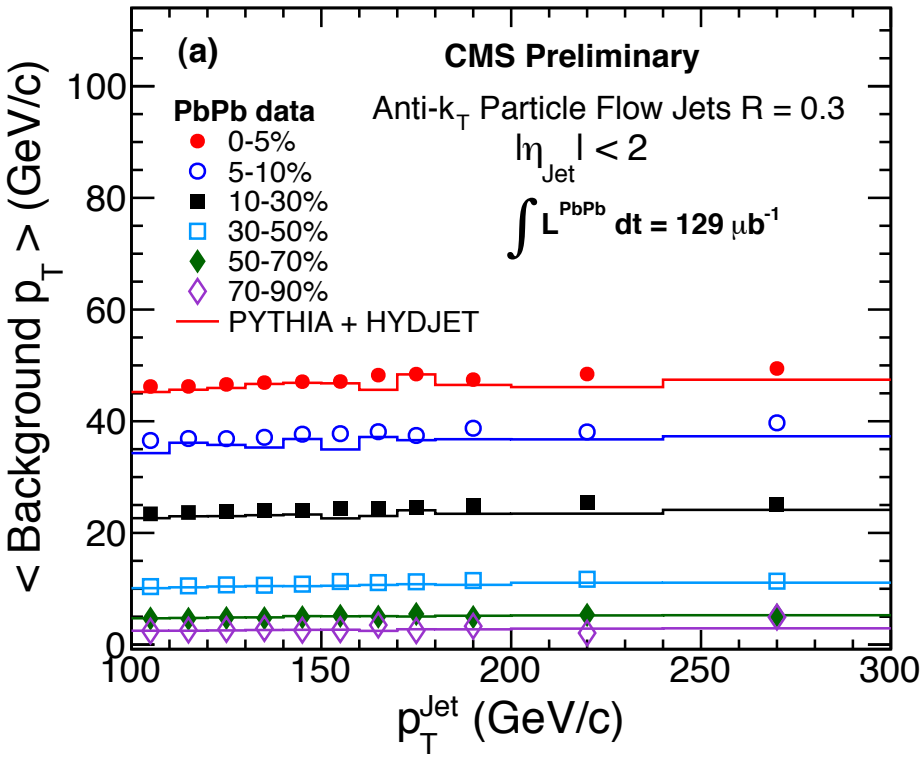
- Make measured jet spectra
  - Jet triggered events E>80 GeV
  - Inclusive jets p_T>100 GeV/c, |η|<2
  - Anti-kT particle flow jets, iterative background subtraction(PbPb)
- Remove detector effects in both PbPb and pp (jet p_T resolution and jet p_T scale):
  - Main technique: unfold jet spectrum based on performance of PbPb MC (Bayesian unfolding)
    - Cross-checks:
      - Generalized Singular Value Decomposition (GSVD) unfolding
      - Bin-by-bin unfolding
      - Smear pp data based on jet resolution & scale from PbPb MC (different jet p_T, centrality bins)
- Construct ratio of jet spectra: unfolded PbPb to unfolded pp
- Also analyzed with calorimeter jets instead of particle flow

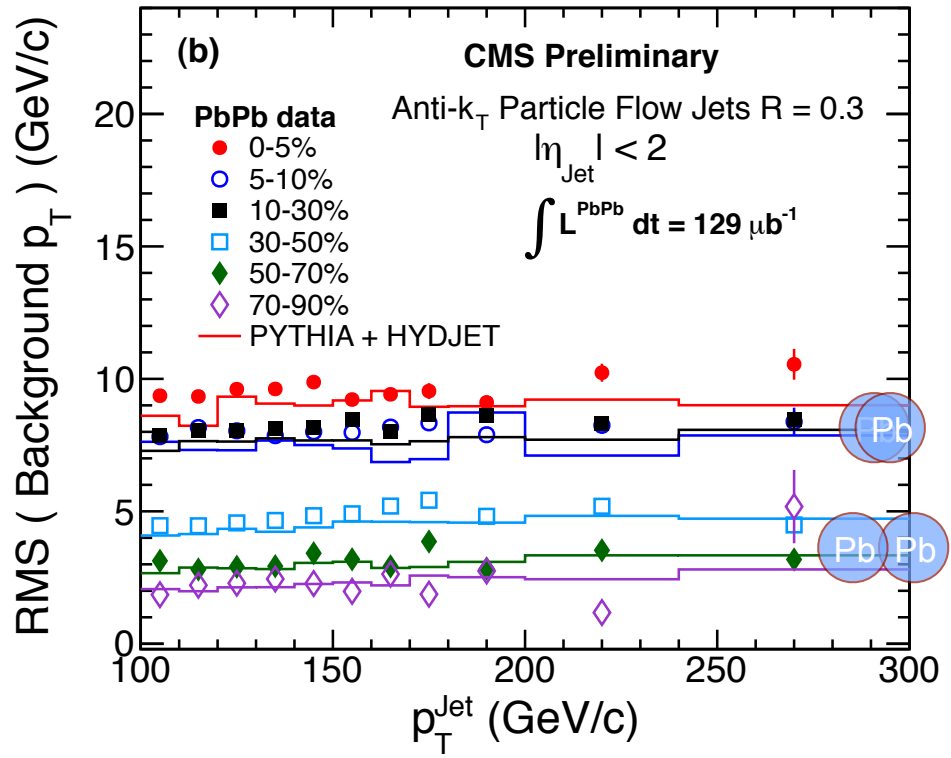
Jet background from PbPb



- Average background p_T subtracted from each jet
  - Example: 100 < jet p_T < 110 GeV/c
- Remaining jet bins have similar agreement for data & MC

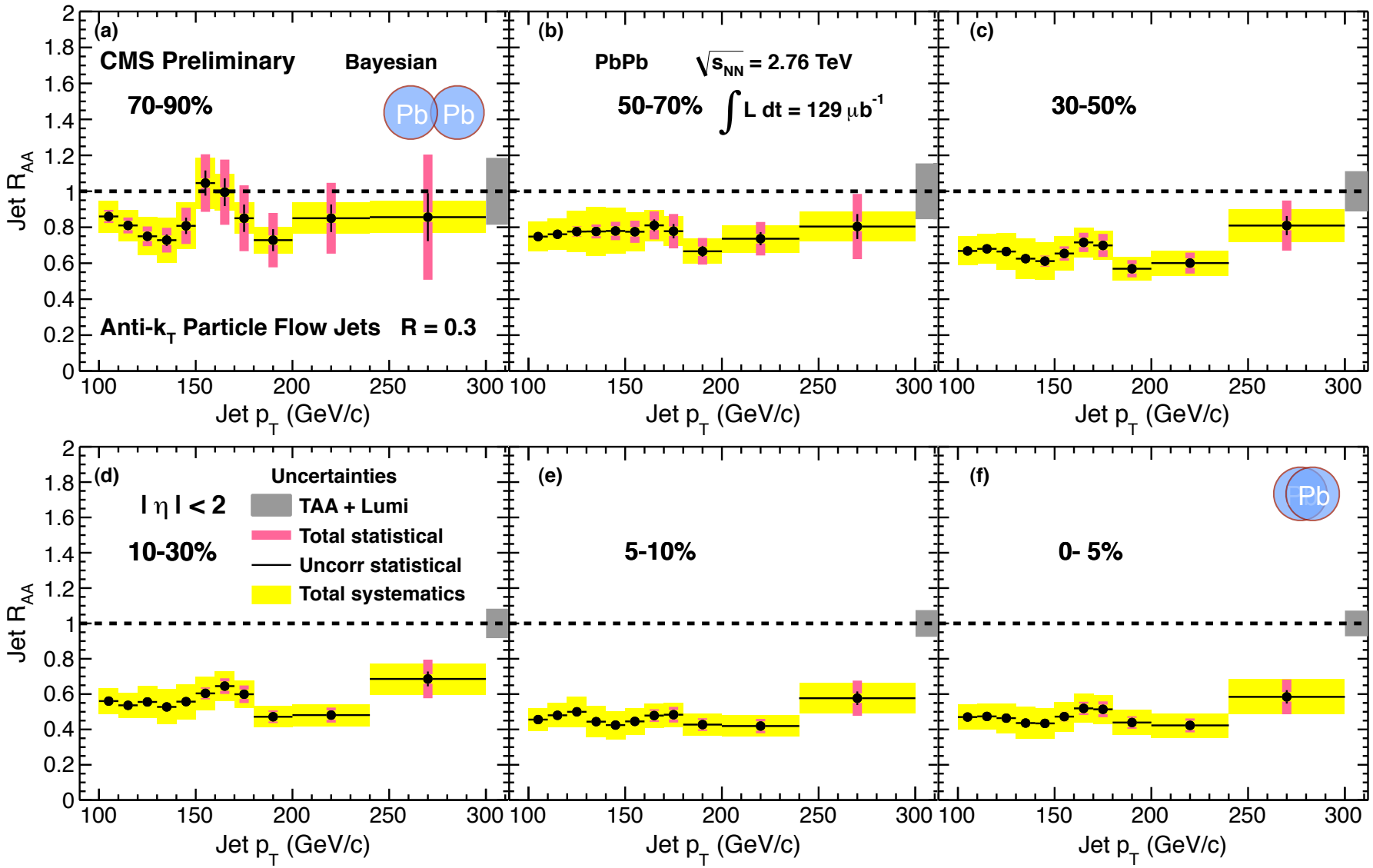
Jet background in PbPb



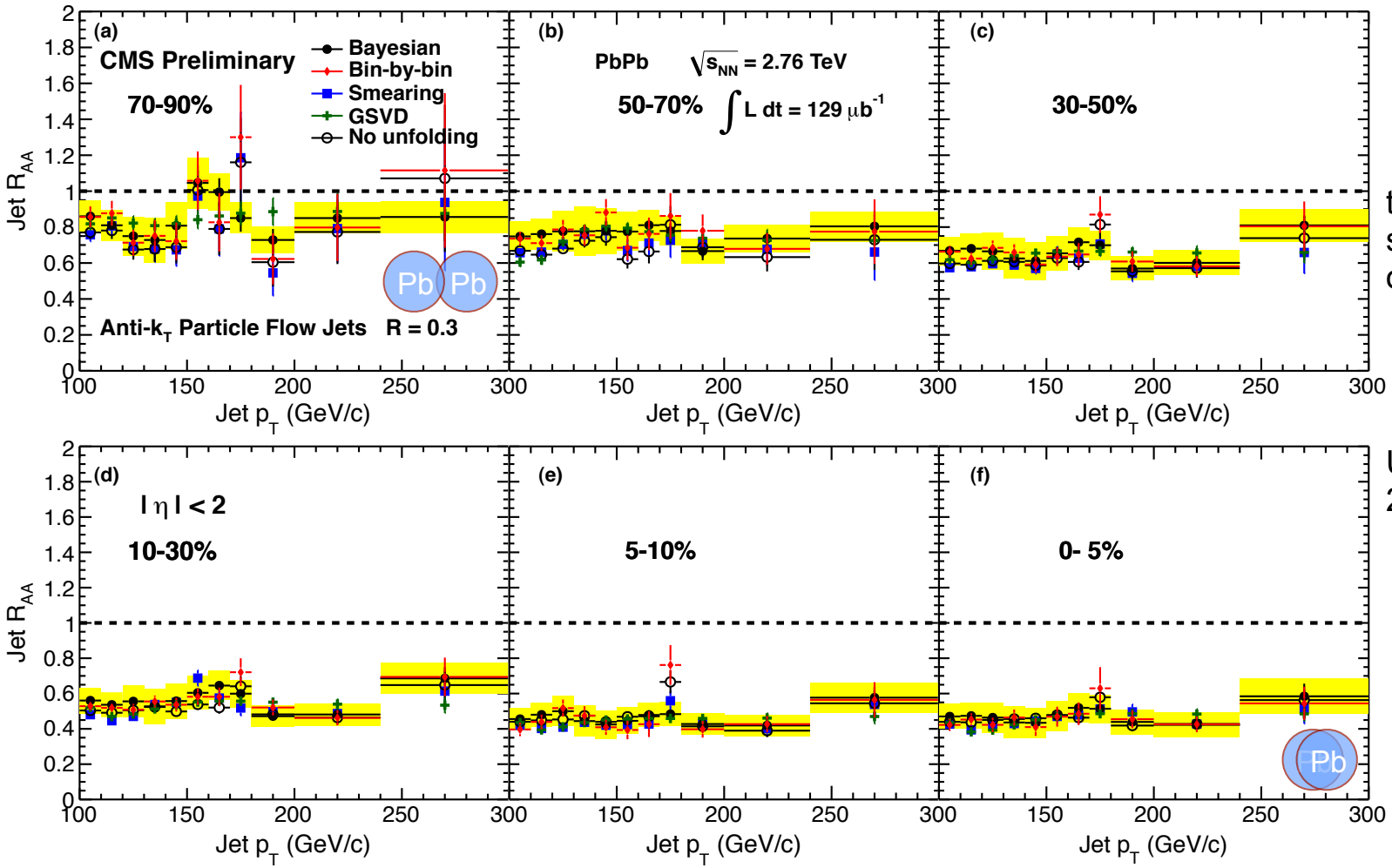


- Mean and width for background p_T subtracted from jets
- Not detector η & p_T energy corrected (factor ~10-25%)
  - ➡Be careful when comparing directly to jet p_T

R_{AA} from unfolded jet spectra



Jet R_{AA} methods comparison

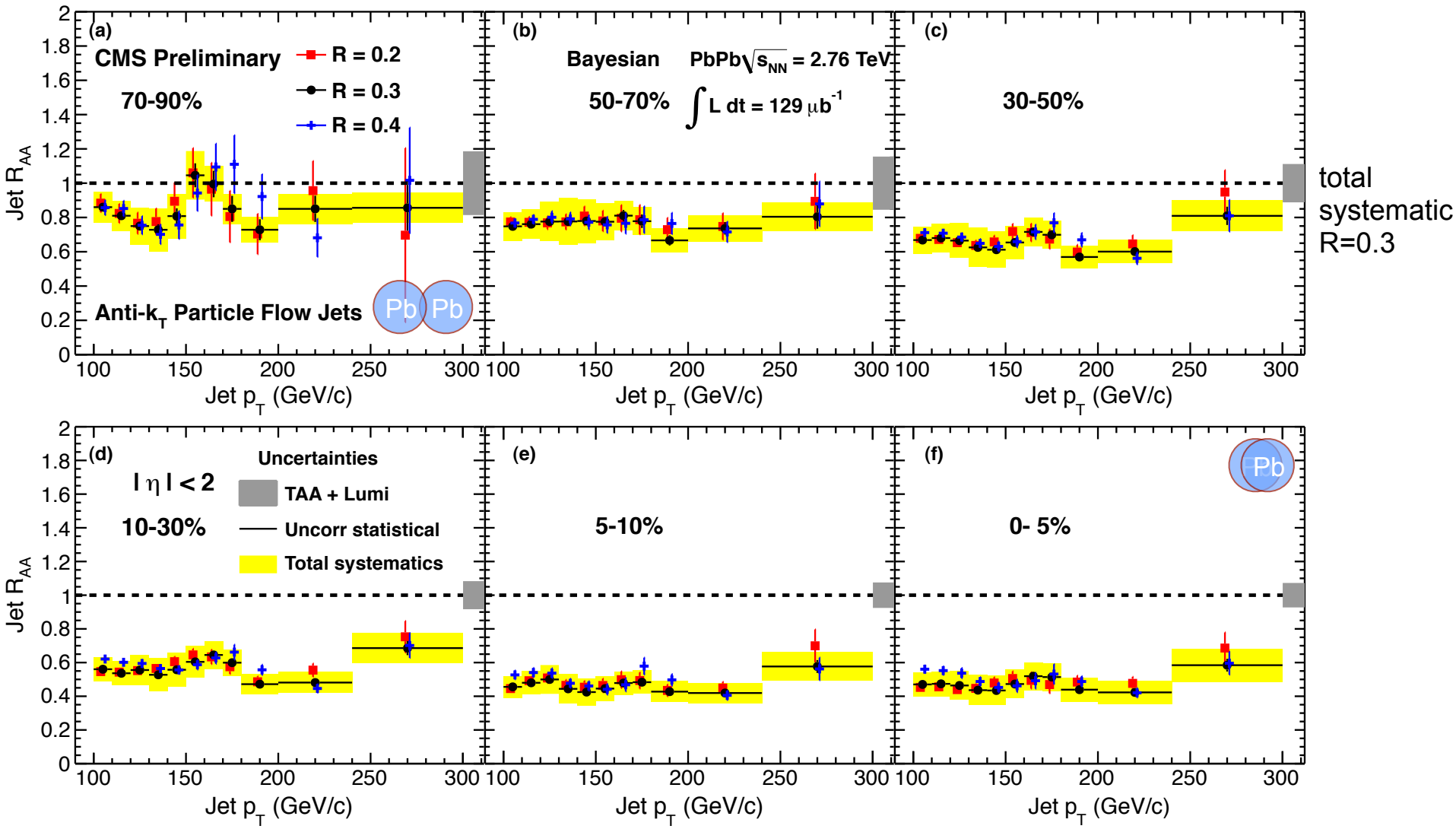


total systematic only Bayesian

Uses 90% 2011 statistics

- Good agreement between 4 different methods
- Unfolding only makes a small difference in the jet R_{AA}

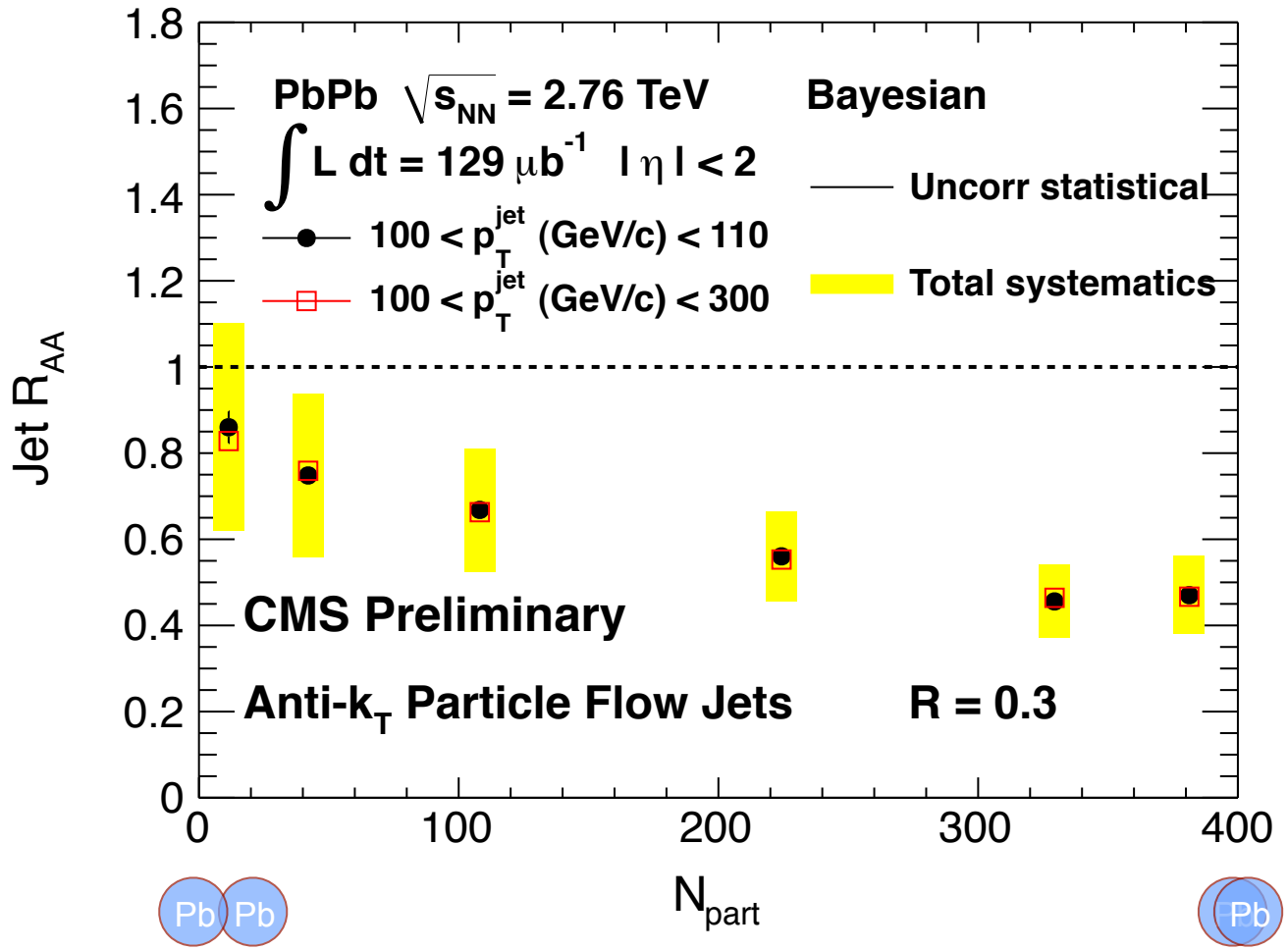
Different jet cone size



total systematic R=0.3

- No strong dependence on jet radius

Jet R_{AA}

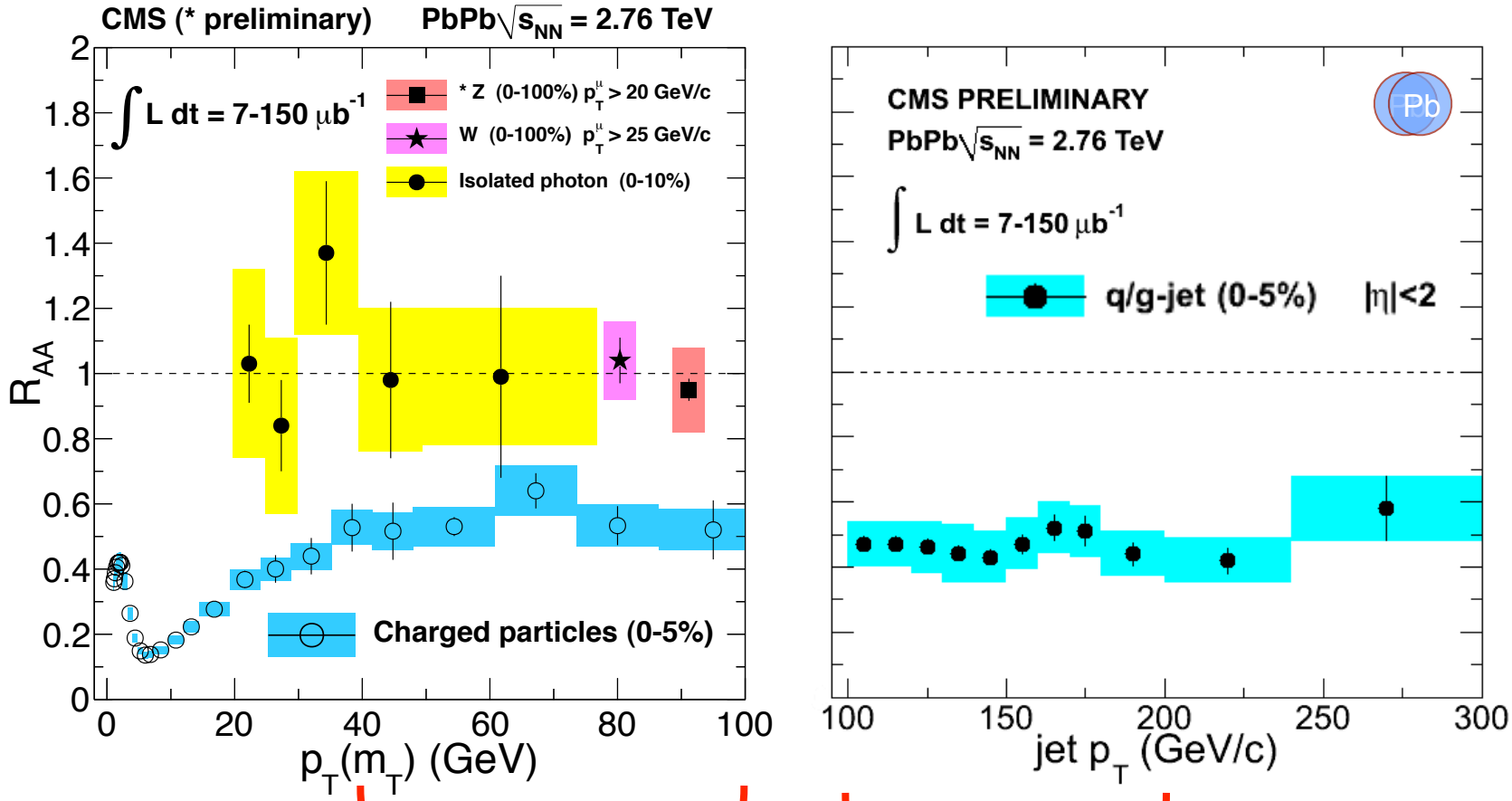


Systematics includes T_{AA} uncertainty

- Jet R_{AA} decreases with increasing number of participants

Central R_{AA}

https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsHIN



Looking at the same parton p_T range

Charged particles from p_T =20-100 GeV/c:
$z = p_T(\text{track})/p_T(\text{jet}) = 0.5$

Summary

In central PbPb collisions:

- Charged particle R_{AA}: minimum of 0.13 at low p_T
  - Dip structure increases from peripheral to central
- Charged particle $R_{AA} \approx 0.5$ at high p_T
- Jet $R_{AA} \approx 0.5$ for jets from p_T of 100 to 300 GeV/c
- Jet R_{AA} is independent of cone size for jets from p_T of 100 to 300 GeV/c

Charged particle and jet R_{AA} decrease from peripheral to central PbPb collisions at 2.76 TeV