

CMS plans for p-Pb data taking

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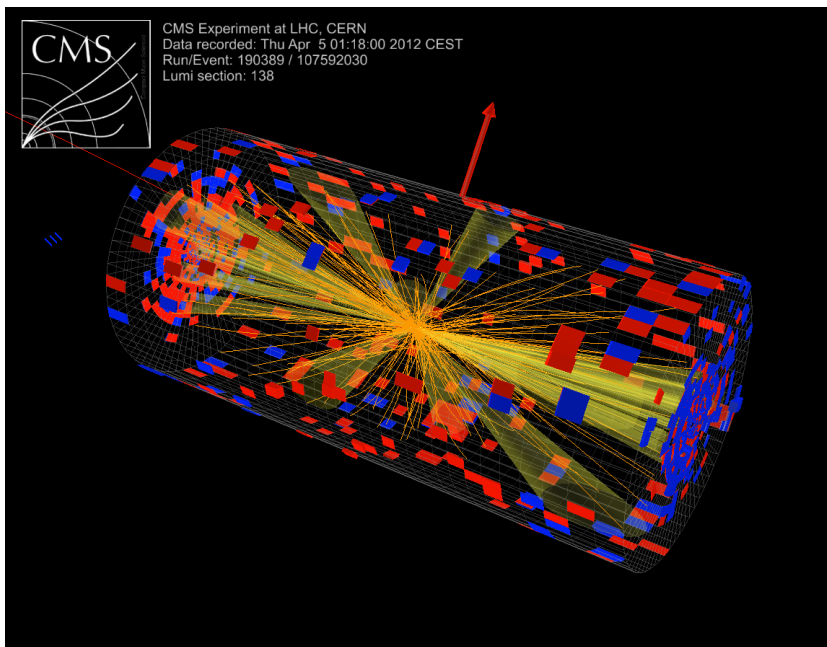
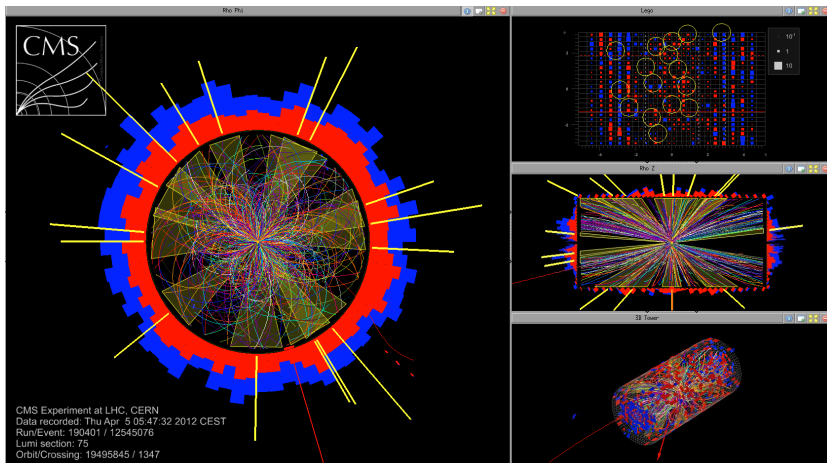
for the CMS Collaboration



pA@LHC Workshop

4 June 2012

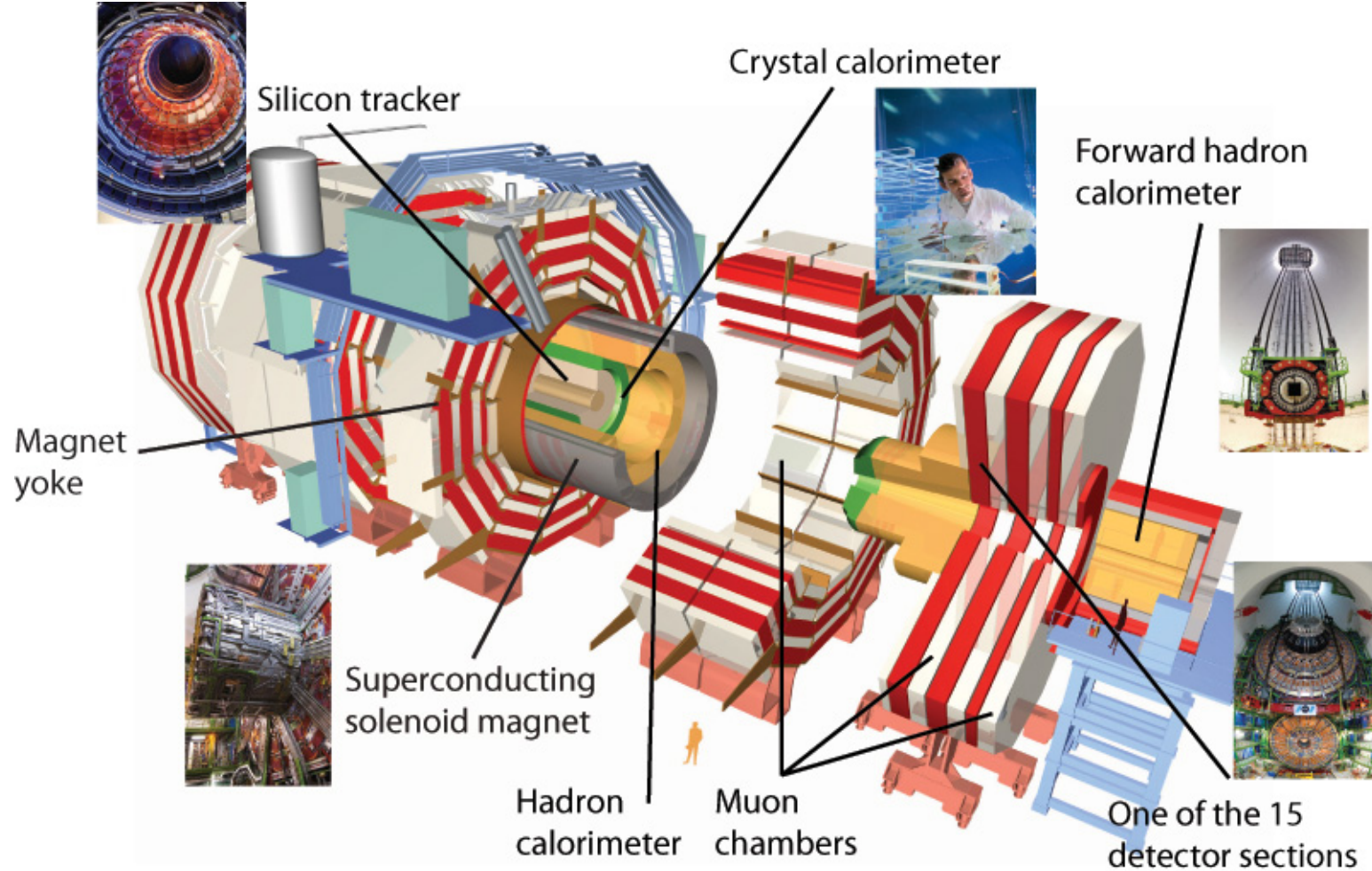
Introduction



This year, pp @ 8 TeV

- p-Pb as reference for PbPb
 - Bulk physics, two-particle correlations
 - High p_T , jets
 - W and Z, onia
- p-Pb physics
 - Low-x QCD dynamics
 - Forward particle production
 - Gamma-induced processes in UPCs
- How much data? Which data?
- Event centrality
- Summary

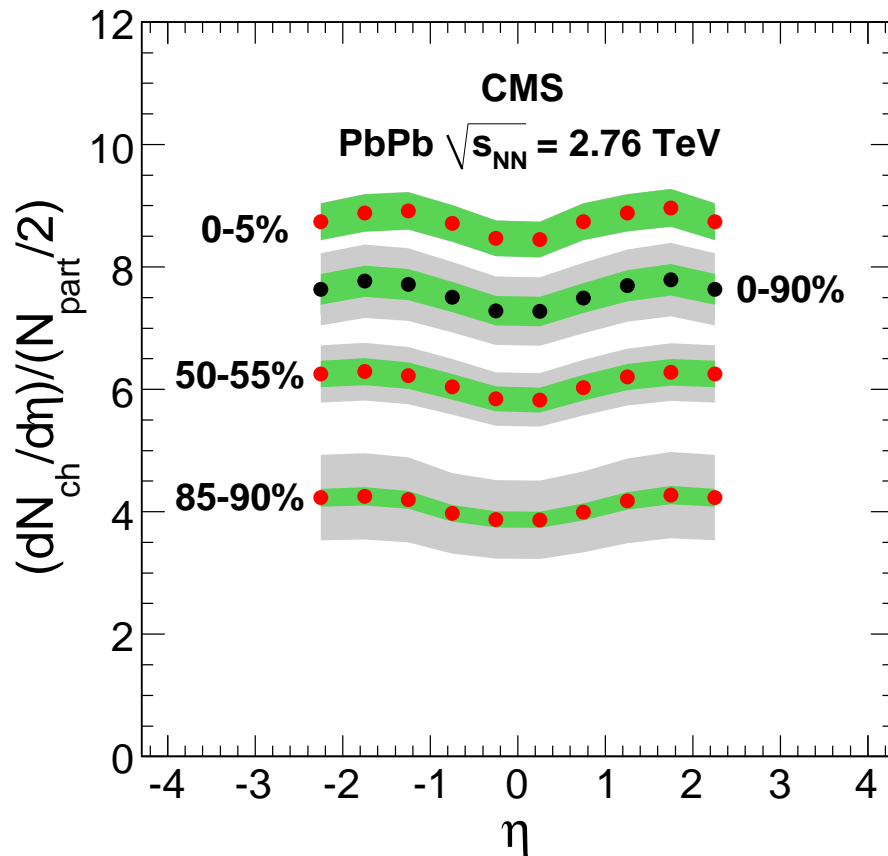
The detector



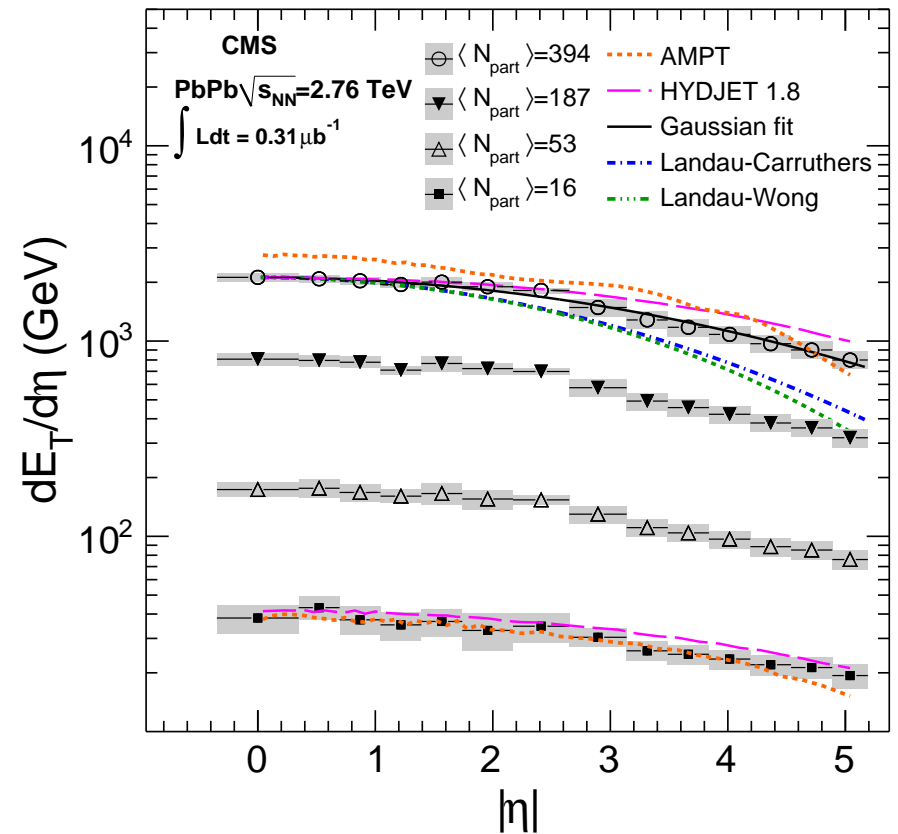
Muon	$ \eta < 2.4$
HCAL	$ \eta < 5.2$
ECAL	$ \eta < 3.0$
Tracker	$ \eta < 2.5$

Wide acceptance, to high and low p_T
 Also forward calorimetry
 CASTOR ($5.2 < |\eta| < 6.6$), ZDC

p-Pb as reference – bulk physics



JHEP 08 (2011) 101



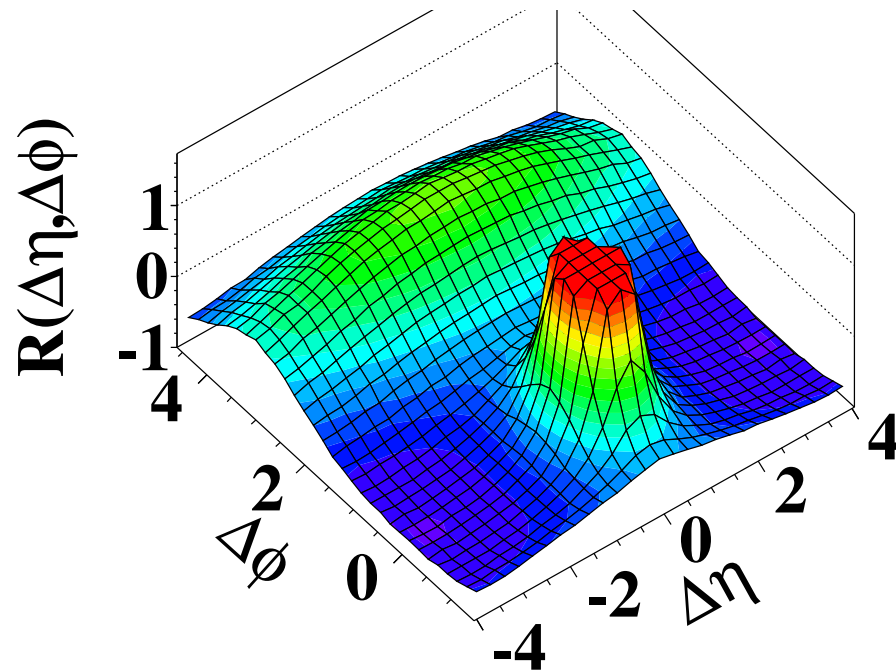
arXiv:1205.2488

Multiplicity and energy flow on a wide pseudorapidity range
Important input for saturation physics

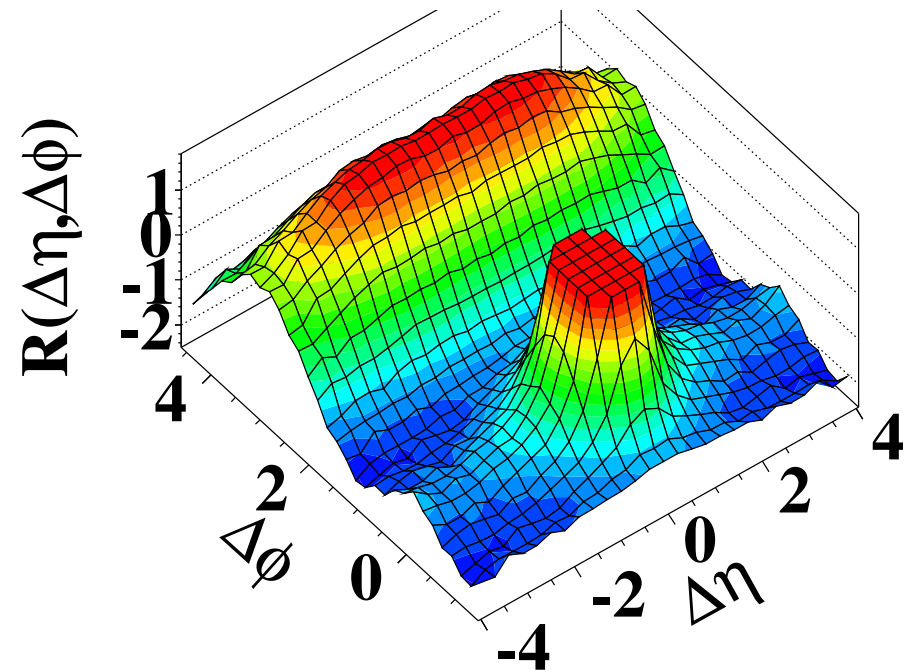
p-Pb: for this physics some hundred thousand events would be enough, but

p-Pb as reference – two-particle correlations

(b) CMS MinBias, $1.0\text{GeV}/c < p_T < 3.0\text{GeV}/c$



(d) CMS $N \geq 110$, $1.0\text{GeV}/c < p_T < 3.0\text{GeV}/c$

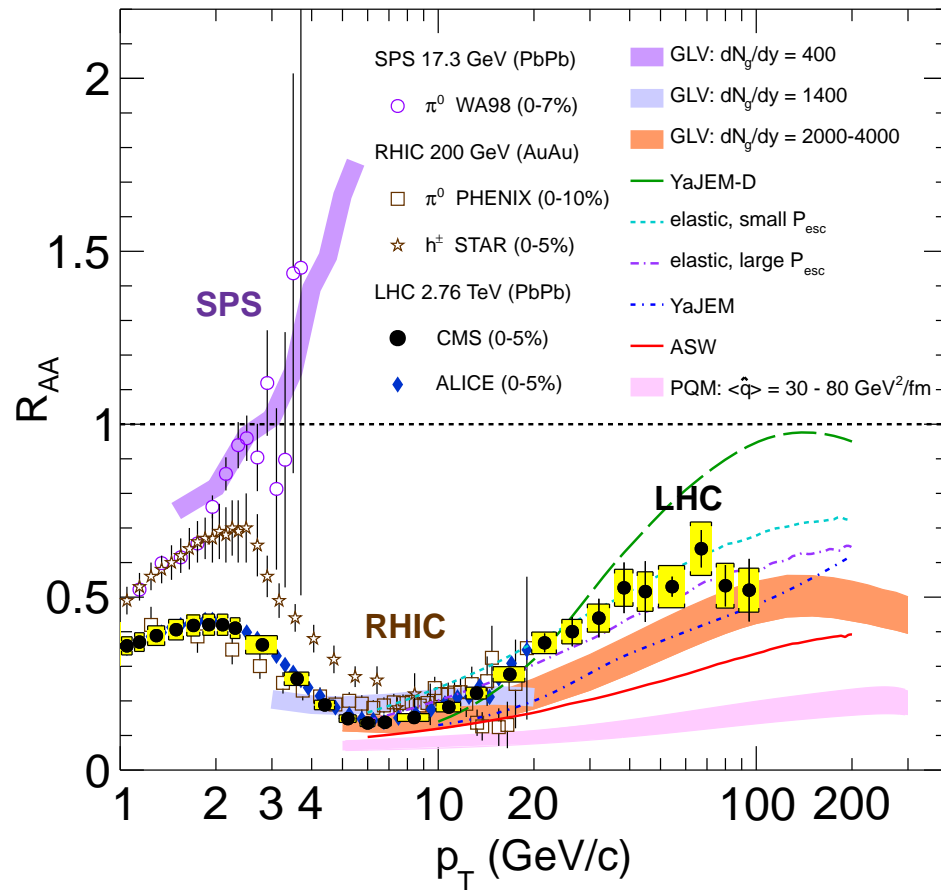


JHEP 09 (2010) 091 JHEP 07 (2011) 076

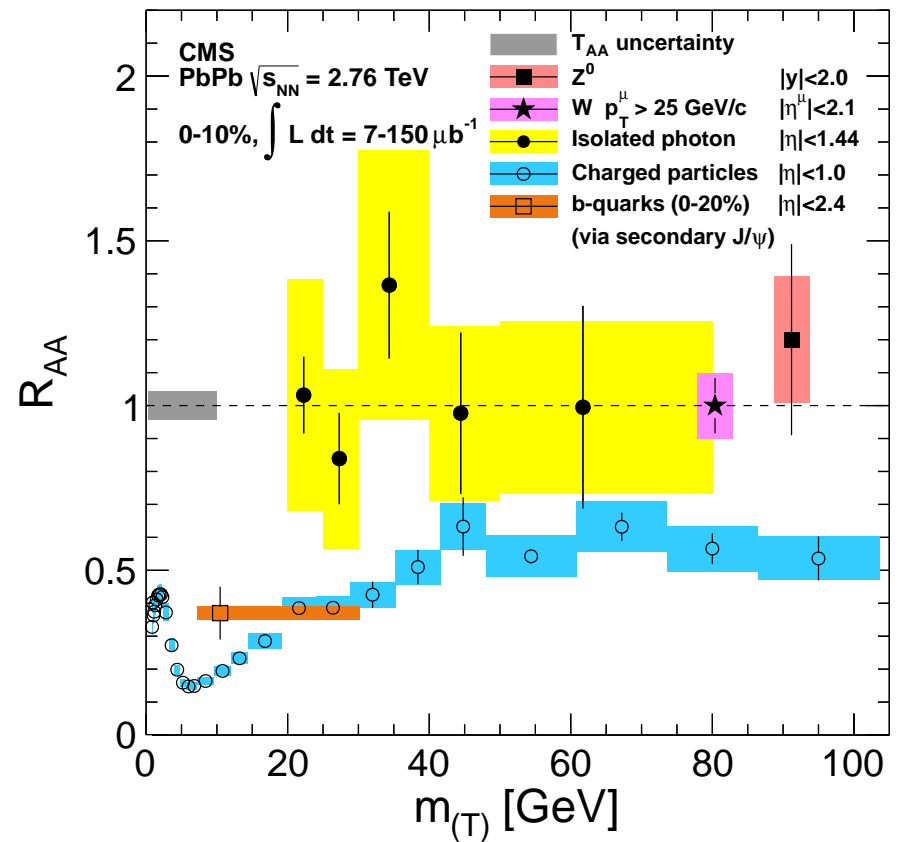
We saw the ridge in pp and PbPb

p-Pb: look, as a function of centrality
but also all phase space, back-to-back in forward

p-Pb as reference – high p_T



EPJC 72 (2012) 1945

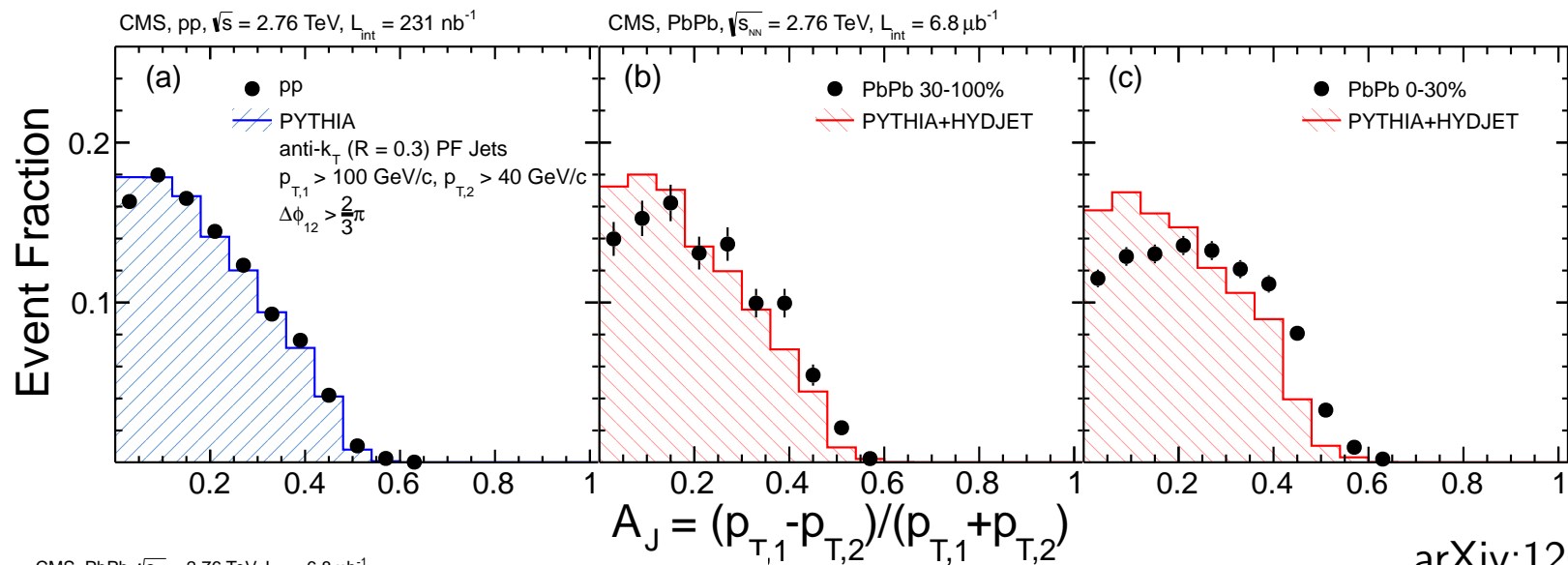


PRL 106 (2011) 212301, PLB 710 (2012) 256,
 EPJC 72 (2012) 1945, JHEP 05 (2012) 063,
 arXiv:1205.6334

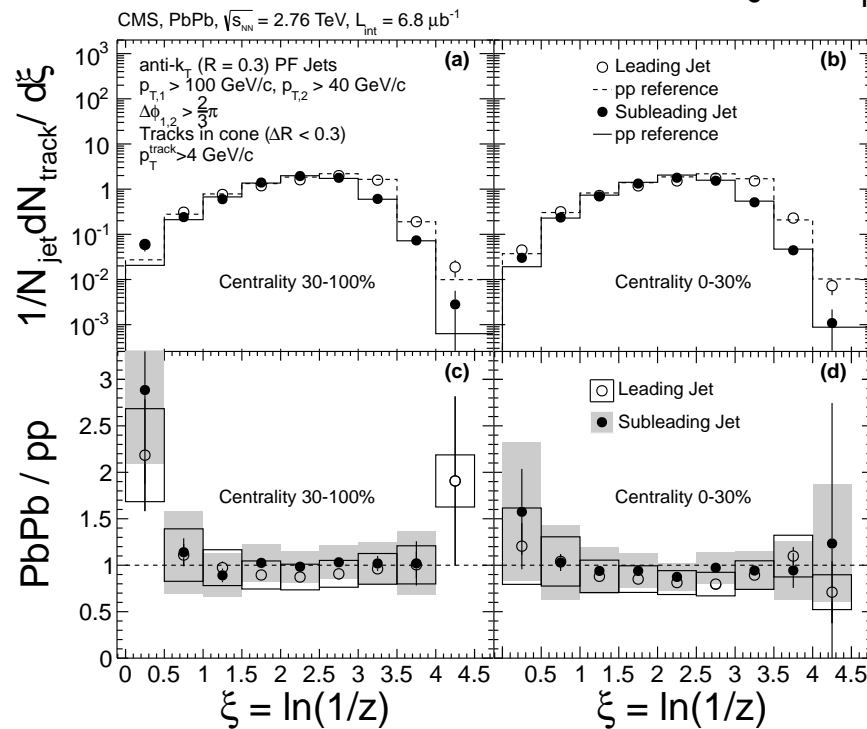
Nuclear modification factor up to 100 GeV/c
 Isolated photons, W^\pm , Z are unmodified

p-Pb: check suppression or enhancement (Cronin); photons could constrain nPDF

p-Pb as reference – jets

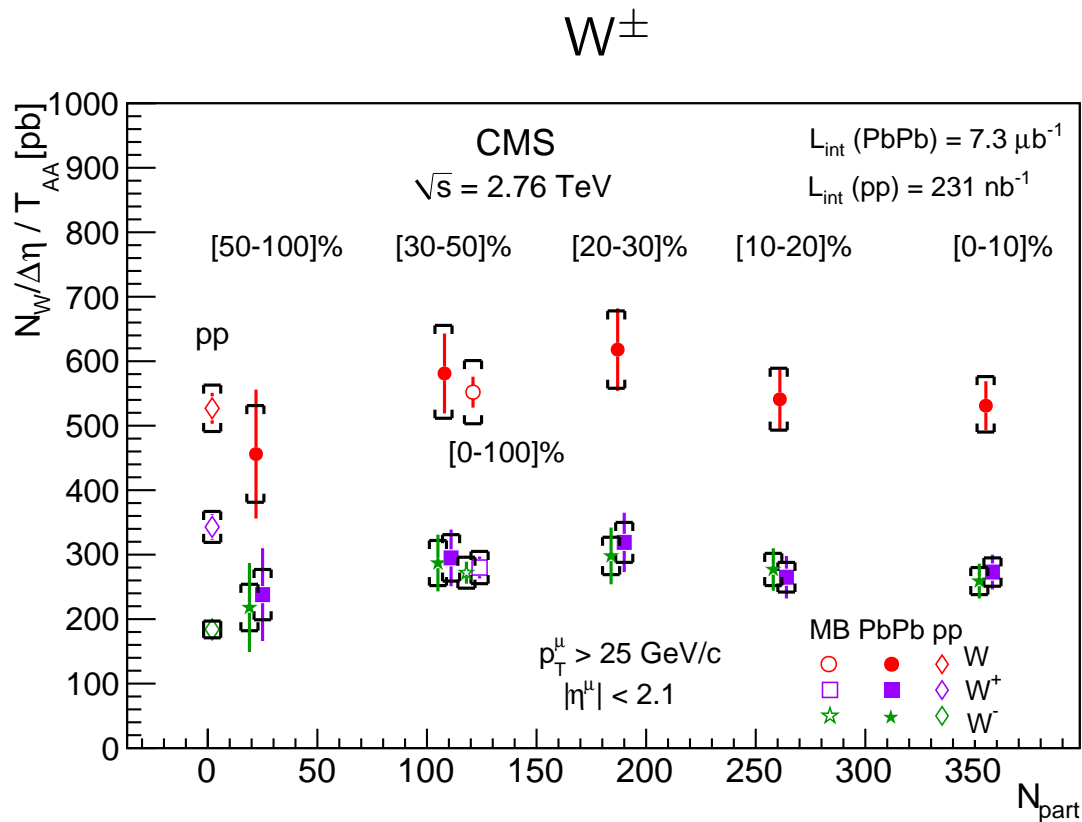


arXiv:1205.5872

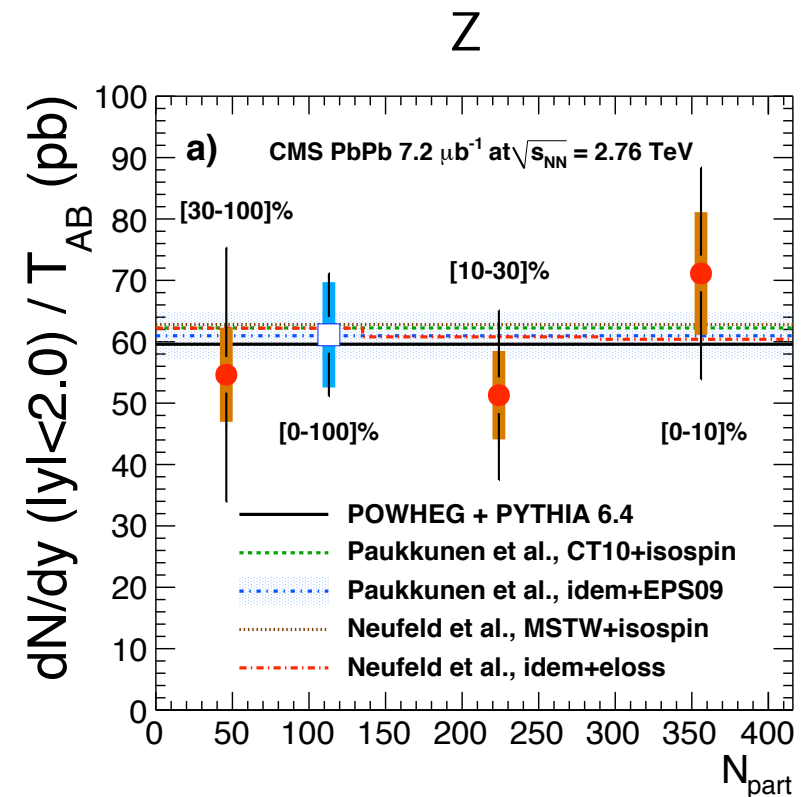


Jets are extremely quenched,
 but leftover hard component of the
 fragmentation function is unmodified
 p-Pb: check the same observables

p-Pb as reference – W and Z



arXiv:1205.6334



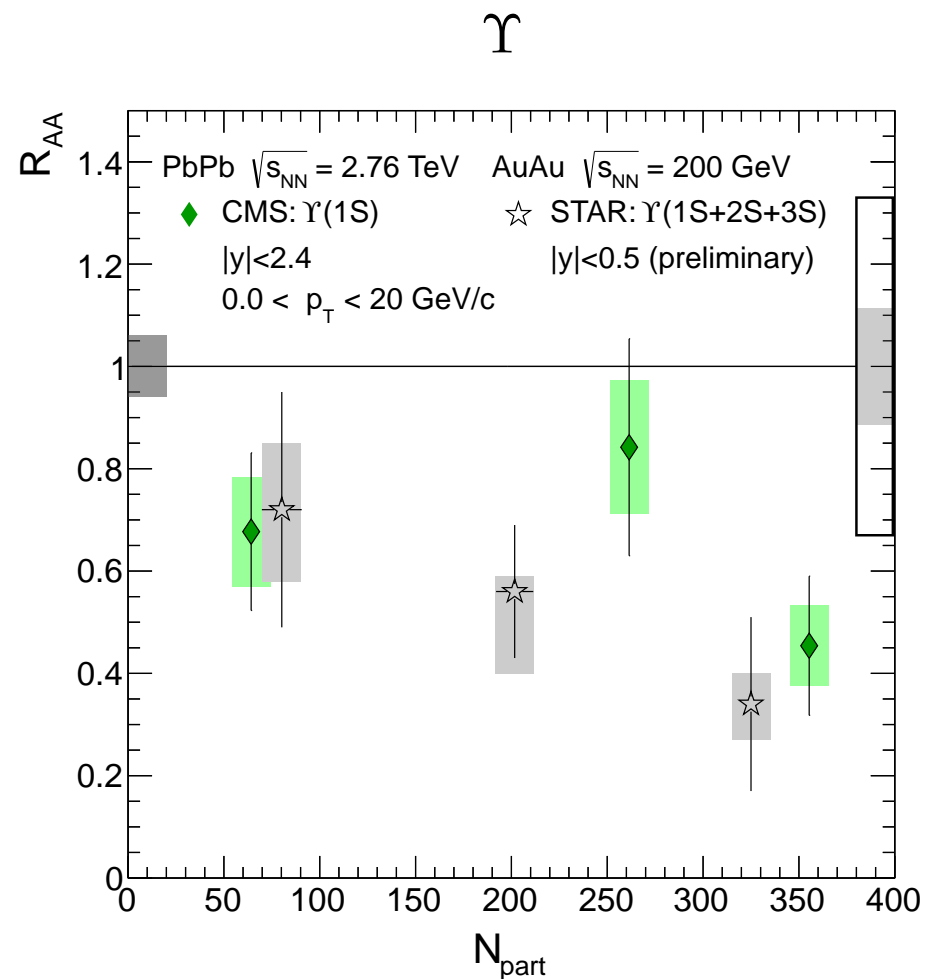
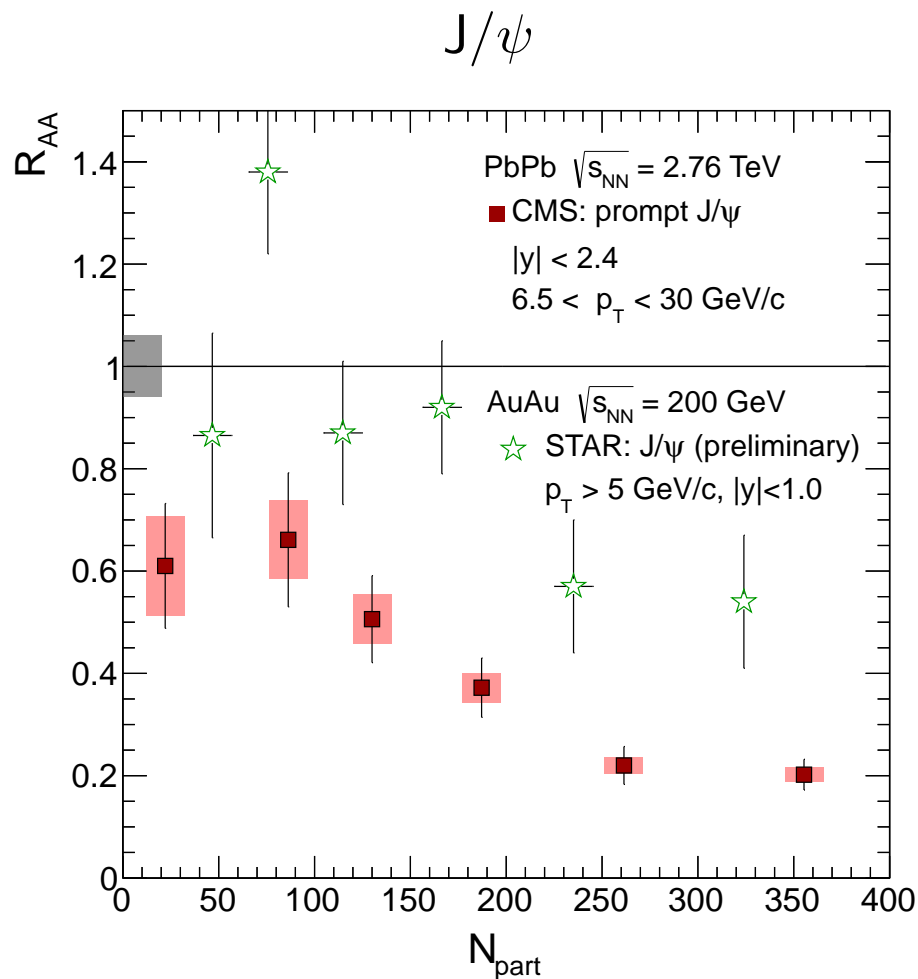
PRL 106 (2011) 212301

They are not modified

Need much more W and Z in pp @ 2.76 TeV, pp reference

p-Pb: interesting in itself to constrain nPDF

p-Pb as reference – onia

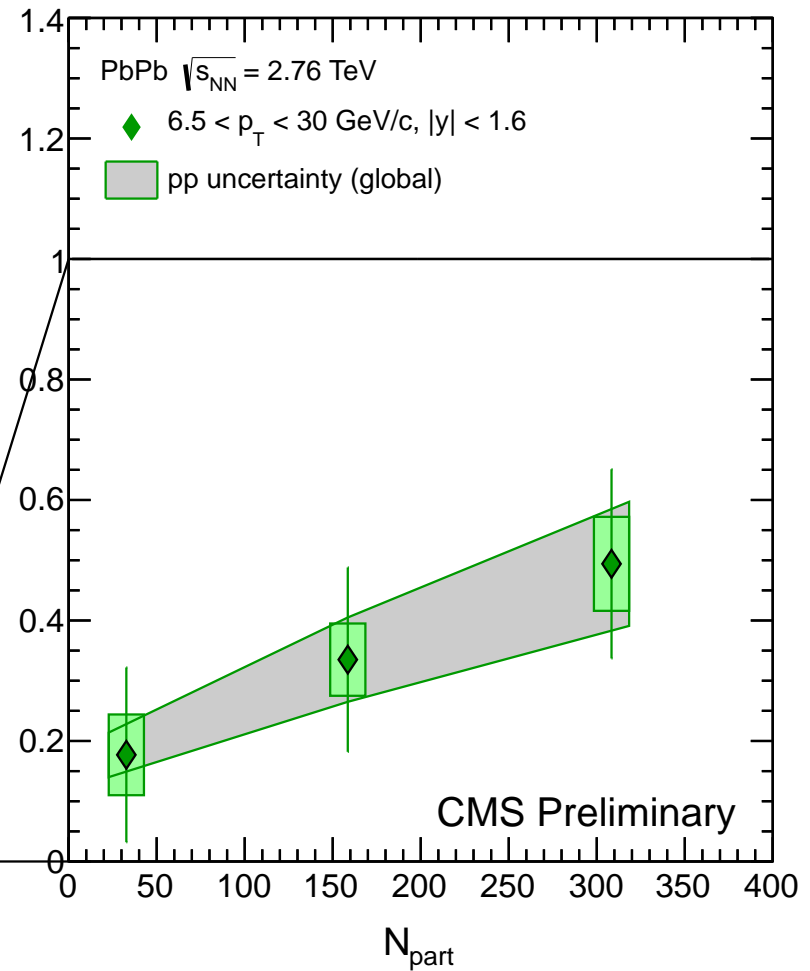
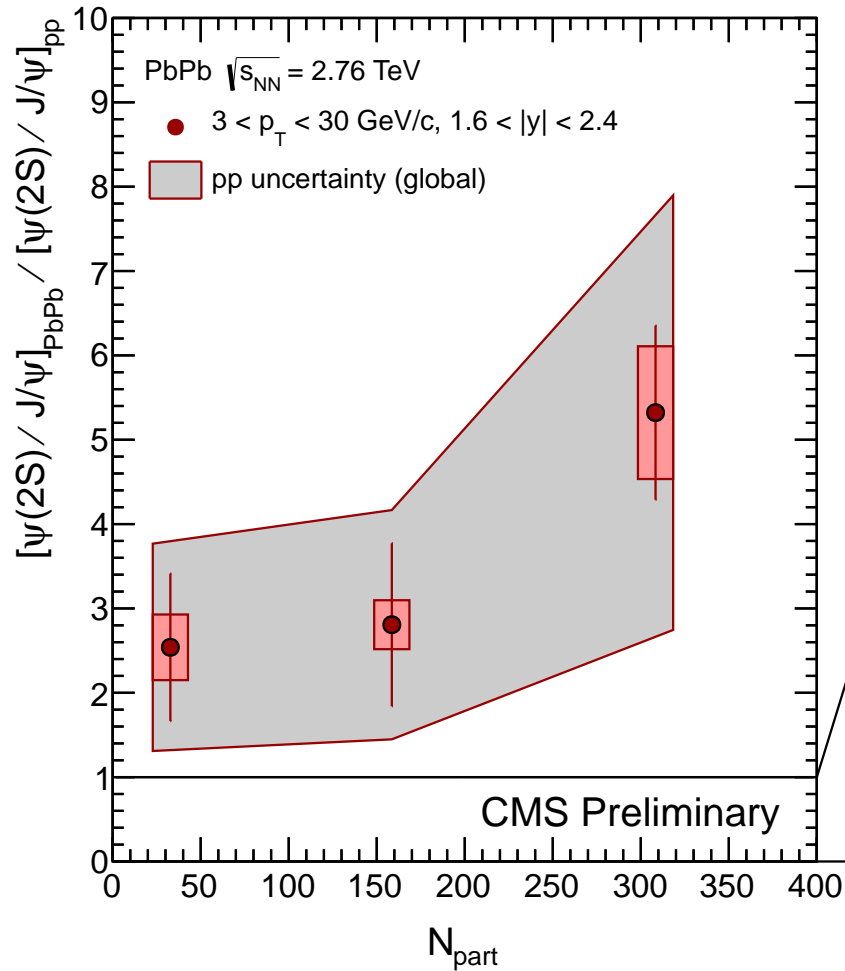


JHEP 05 (2012) 063

Charmonia: strongly suppressed, prompt, non-prompt reflecting b-quark energy loss
 Bottomonia: if excited/ground unmodified, could be strong case for deconfinement

p-Pb: check suppression, maybe enhanced (Cronin), regeneration

p-Pb as reference – $\psi(2S)$ wrt J/ψ

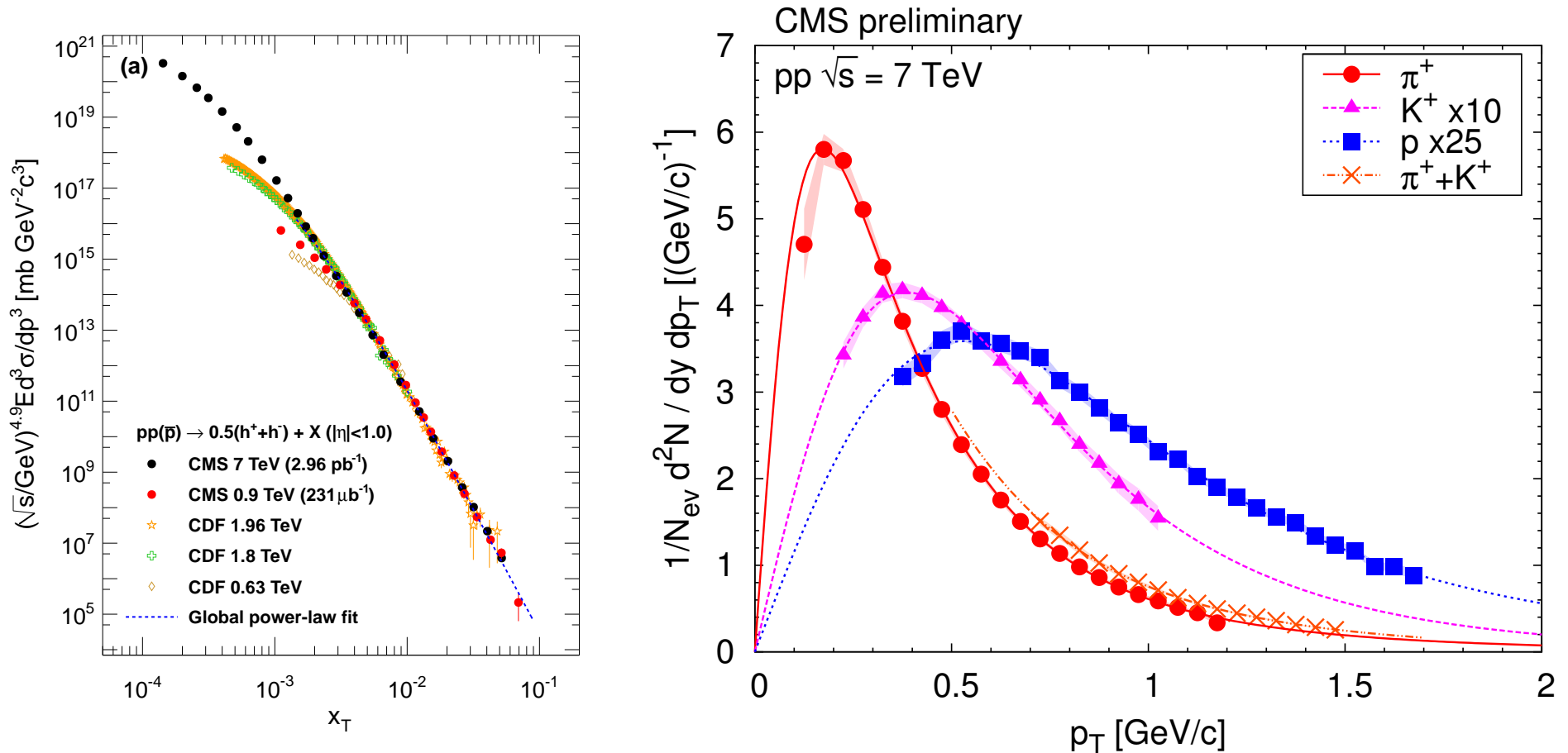


CMS-HIN-12-007

Looks very interesting

pp @ 2.76 TeV, some numbers: 310 W^+ , 165 W^- , 30 Z, 20 $\psi(2S)$

p-Pb physics – low-x QCD dynamics



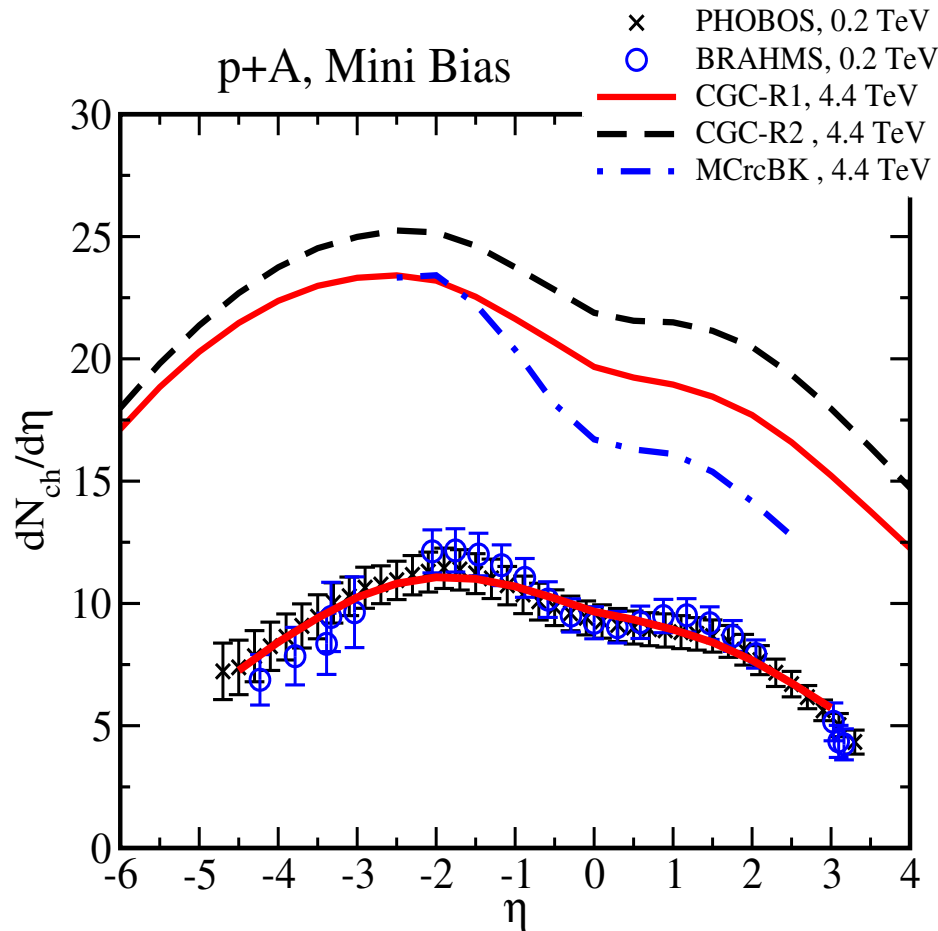
JHEP 08 (2011) 086

CMS-PAS-FSQ-12-014

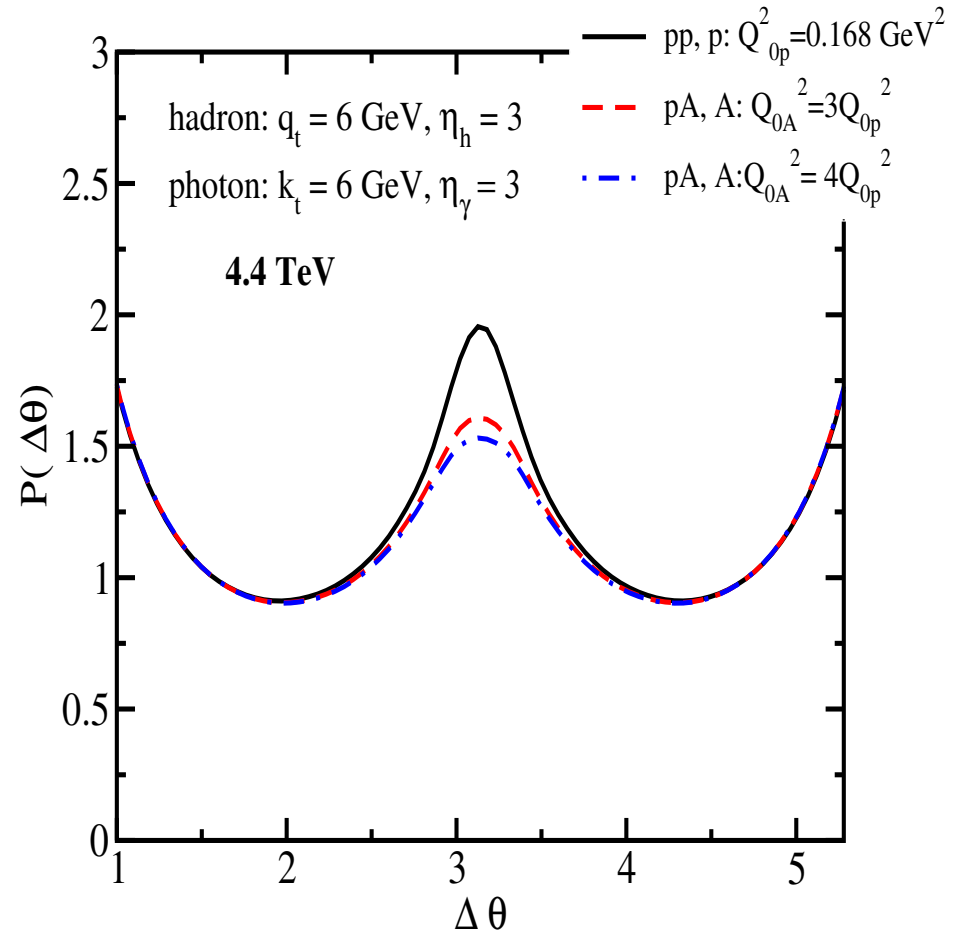
Sensitive to various CGC model ingredients and initial conditions

p-Pb: inclusive hadron production (dN_{ch}/dy and dN/dp_T) at $y \approx 0$
 High p_T , but also low p_T identified particles

p-Pb physics – low-x QCD dynamics



Rezaeian, arXiv:1111.2312

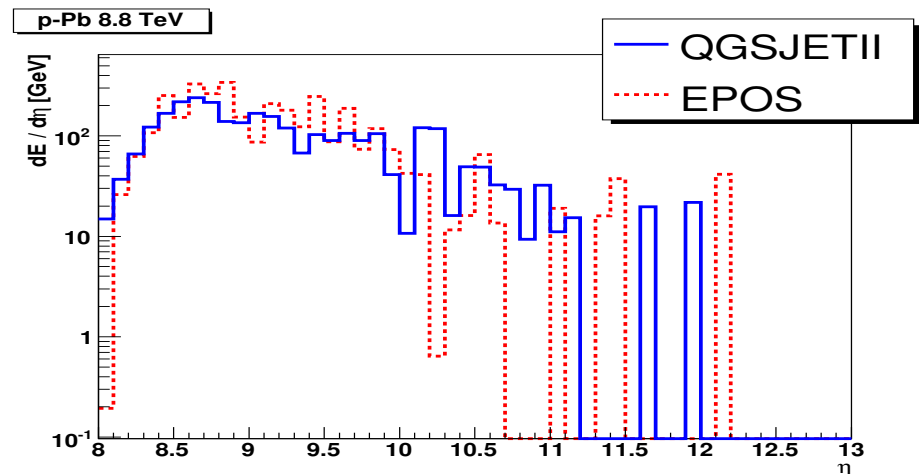
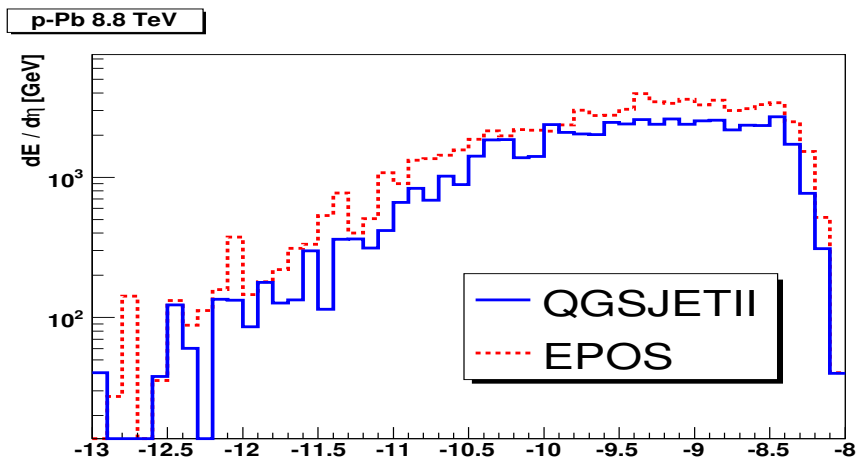
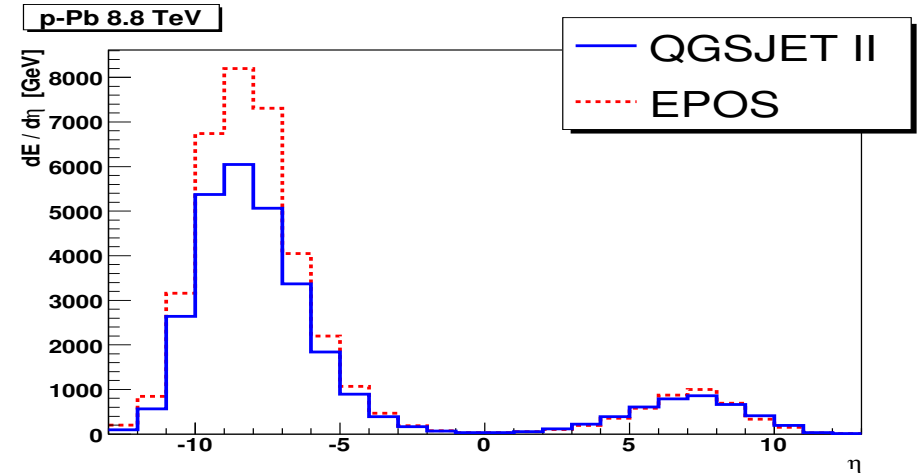
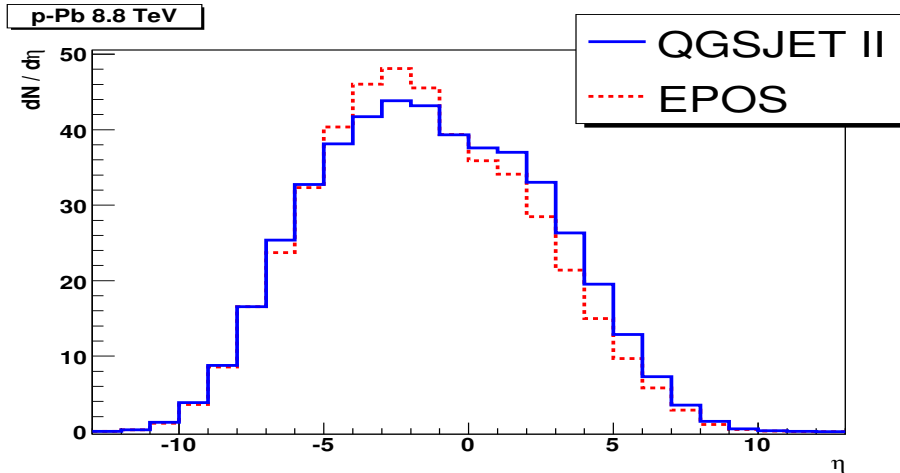


Jalilian-Marian and Rezaeian, arXiv:1204.1319

Sensitive to various CGC model ingredients and initial conditions

p-Pb: inclusive hadron production ($dN_{ch}/d\eta$ and dN/dp_T) at $y \approx 0$
 p-Pb: azimuthal decorrelations of forward-backward dijets (dihadrons)

p-Pb physics – forward particle production



d'Enterria et al, arXiv:0806.0944

Inclusive hadron production: $dN_{ch}/d\eta$ and dN/dE_T in HF/CASTOR/ZDC

p-Pb: of relevance for cosmic-ray MCs

How much data? Which data?

- p-Pb reference

- Need for a run corresponding to the binary-scaled statistics of PbPb ($150 \mu\text{b}^{-1}$)
- ⇒ **30 nb⁻¹**, that is, 60 billion p-Pb events
- We prefer **a shorter but higher lumi run**, to accommodate pp
- CMS could take the needed p-Pb, with few percent pile-up, in a week

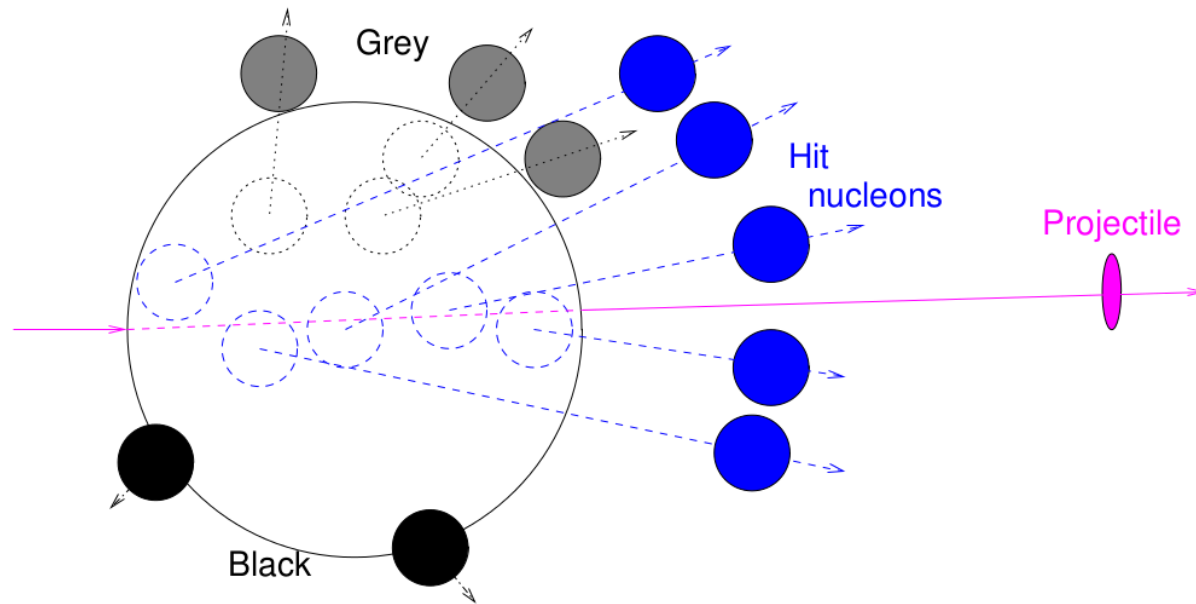
- pp reference

- Now in PbPb we have 30 times more effective lumi than in pp
- Need for a high luminosity pp run, “conditional strategy”
- Current pp statistics limits the 2011 PbPb analyses, so far we have only 225 nb^{-1} , ≈ 20 billion pp events
- ⇒ **6.4 pb⁻¹** @ 2.76 TeV pp events (factor 30), last chance before 2015
- ⇒ and similar amount of pp @ 5 TeV, for p-Pb reference

- p-Pb and Pb-p?

- Both settings are interesting for systematic study
- If only one, then $p \rightarrow \leftarrow$ Pb in CASTOR, to probe lower x_{Bj} in the Pb (same side as ALICE muons)

Event centrality



- Number of collisions (ν) of the projectile
 - Glauber calculation? What happens to the projectile?
 - Correlate with number of slow nucleons?
This way, do we measure ν or impact parameter (b)?
 - Correlate with event properties?
Do they result in a bias?

ZDC black/grey neutrons, track multiplicity, calorimetric energy

Summary

- What to measure?
 - p-Pb as reference for PbPb
 - p-Pb physics
 - Event centrality
- How much and which data?
 - Get equivalent-statistics reference data
 - A **p-Pb run** with at least 60 billion events ($> 30 \text{ nb}^{-1}$)
5 TeV is good
 - Much more **pp data**
 - * pp @ 2.76 TeV for PbPb reference ($> 6 \text{ pb}^{-1}$)
 - * pp @ 5 TeV for p-Pb reference ($> 6 \text{ pb}^{-1}$),
this will also be used as reference for PbPb @ 13 TeV

Thank you for your attention