CMS plans for p-Pb data taking

Ferenc Siklér
Wigner RCP, Budapest

for the CMS Collaboration

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Introduction

- 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

This year, pp @ 8 TeV
The detector

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

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p-Pb as reference – bulk physics

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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

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 $p_T$

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
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**

\[ W^\pm \]

\[ Z \]

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
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

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

Looks very interesting

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

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p-Pb physics – low-x QCD dynamics

Sensitive to various CGC model ingredients and initial conditions

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

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

**p-Pb**: of relevance for cosmic-ray MCs

d’Enterria et al, arXiv:0806.0944
How much data? Which data?

- **p-Pb reference**
  - Need for a run corresponding to the binary-scaled statistics of PbPb (150 $\mu$b$^{-1}$)
  - $\Rightarrow$ 30 nb$^{-1}$, that is, 60 billion p-Pb events
  - We prefer a **shorter but higher lumi run**, to accomodate 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$^{-1}$, $\approx$ 20 billion pp events
  - $\Rightarrow$ 6.4 pb$^{-1}$ @ 2.76 TeV pp events (factor 30), last chance before 2015
  - $\Rightarrow$ 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 $\rightarrow$ Pb in CASTOR, to probe lower $x_{Bj}$ in the Pb
    (same side as ALICE muons)
Event centrality

- Number of collisions ($\nu$) of the projectile
  - Glauber calculation? What happens to the projectile?
  - Correlate with number of slow nucleons?
    This way, do we measure $\nu$ 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