Measurements of charged particle spectra and nuclear modification factor in p+Pb collisions with the ATLAS detector

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introduction

- why to study charged particle spectra?
  - to understand properties of cold nuclear matter
  - to understand the mechanism of energy loss of partons
  - check behaviour at high p_{T}

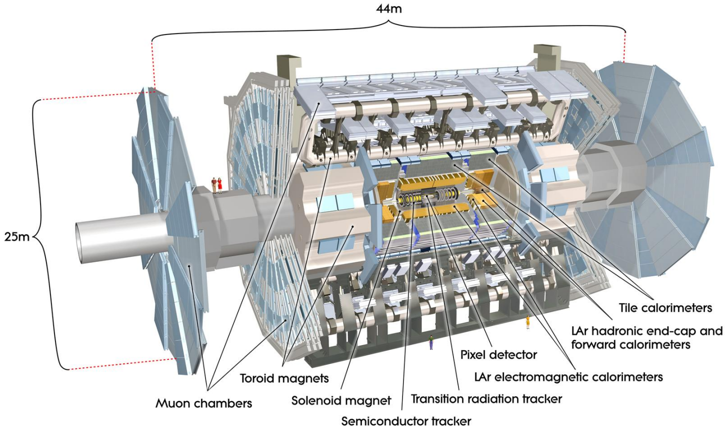
- study ratio of pPb spectra vs. pp reference:

$$R_{\mathrm{pPb}} = \frac{\mathrm{d}^2 N_{\mathrm{Pb}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}{\langle T_{\mathrm{Pb}} \rangle \; \mathrm{d}^2\sigma_{pp}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}$$

- study ratio of <u>c</u>entral vs. <u>p</u>eripheral pPb spectra:

$$R_{\mathrm{CP}} = \frac{\langle T_{\mathrm{Pb}}^{P} \rangle \; \mathrm{d}^2 N_{\mathrm{Pb}}^{\mathrm{C}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}{\langle T_{\mathrm{Pb}}^{C} \rangle \; \mathrm{d}^2 N_{\mathrm{Pb}}^{\mathrm{P}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}$$

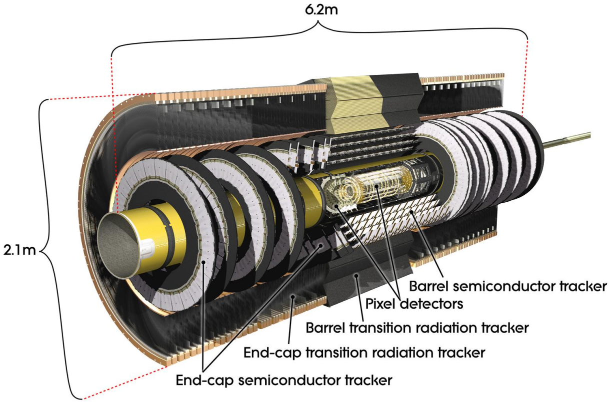
ATLAS detector



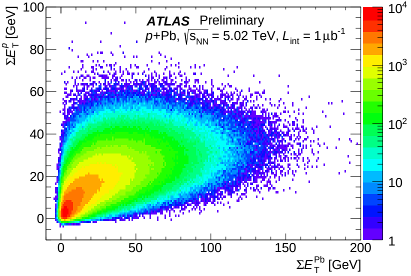
- Inner detector – 2 T magnetic field
- Forward calorimeter – used for determination of centrality

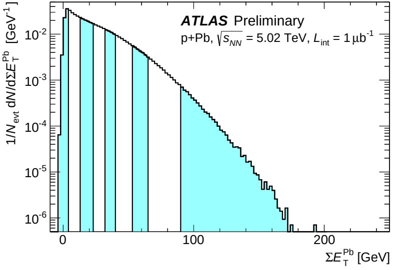
ATLAS detector – Inner detector

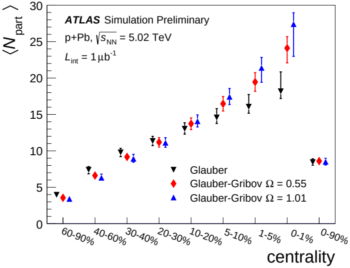
- $p_{\mathrm{T}} > 0.1\,\mathrm{GeV}$
- $|\eta| < 2.5$
- full ϕ coverage



- centrality based on energy deposited in Forward Calorimeter ($3.1 < |\eta| < 4.9$)
- only in the Pb-going side, as pp-going side saturates much faster
- nuclear thickness function $\langle T_{\mathrm{Pb}} \rangle = (\langle N_{\mathrm{part}} \rangle - 1)/\sigma_{\mathrm{NN}}$







collected luminosity & event selection

- pPb 2013 (5.02 TeV): 30 nb^{-1}
  - both p+Pb and Pb+p
  - remove pile-up, diffractive events
  - MB trigger: MBTS signal
  - jet trigger: anti-k_{T} (R=0.4) jet $E_{\mathrm{T}} > 20$ GeV
- pp 2013 (2.76 TeV): 4.0 pb^{-1}
  - MB trigger: MBTS signal
  - jet trigger: anti-k_{T} (R=0.2) jet $E_{\mathrm{T}} > 10$ GeV
- pp 2010+2011 (7 TeV): 0.16 fb^{-1}
  - MB trigger: MBTS signal
  - jet trigger: anti-k_{T} (R=0.2) jet $E_{\mathrm{T}} > 15$ GeV

corrections & y^*

applied several correction to get back on the particle level:

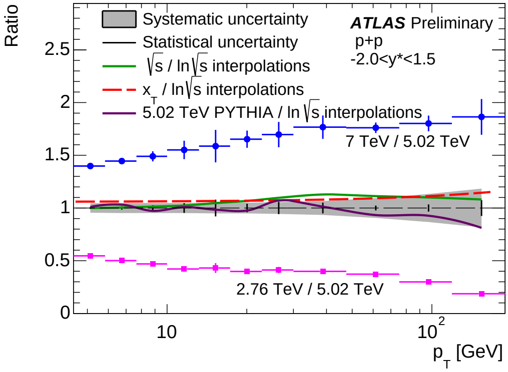
- rejecting fake and secondary tracks
- correct for finite momentum resolution (Bayesian unfolding)
- track reconstruction efficiency

measurement is done in rapidity:

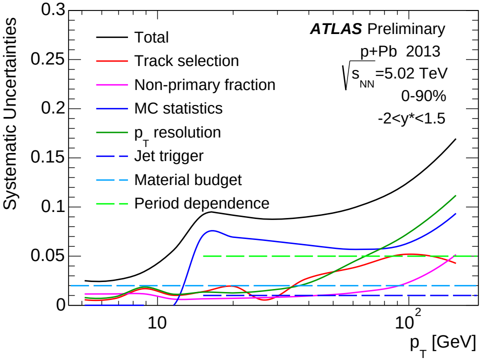
- pp collisions are symmetric
- pPb collisions are asymmetric:
  $\sqrt{s_{\mathrm{NN}}} = 1.57\,\mathrm{TeV}\ (Pb) \longrightarrow \sqrt{s_{\mathrm{NN}}} = 5.02\,\mathrm{TeV} \ \longleftarrow \sqrt{s} = 4\,\mathrm{TeV}\ \ (p)$
- $y* = y - y_{CM};\ \ y_{CM} = -0.465$
- for y^*, all tracks are assumed to be $\pi^{\pm}$ – difference less then 1% with respect to the truth y^* for $p_{\mathrm{T}} > 4\,\mathrm{GeV}$, so we don't need to correct for truth y^*

pp interpolation to 5.02 TeV

- fully corrected pp spectra are interpolated to 5.02 TeV
- pp 2.76 TeV and 7 TeV are used for logarithmic interpolation ($\ln\sqrt{s}$) of 5.02 TeV pp baseline
- linear ($\sqrt{s}$) and x_{T} interpolation for comparison

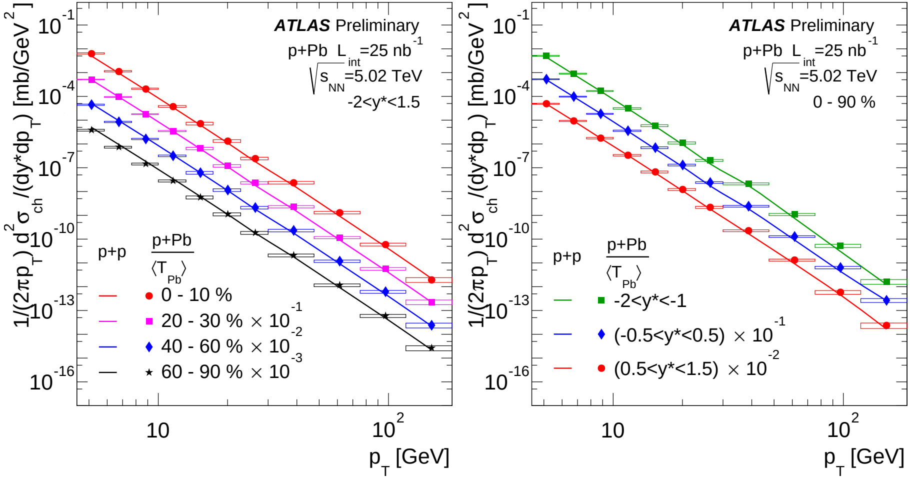


systematic uncertainties



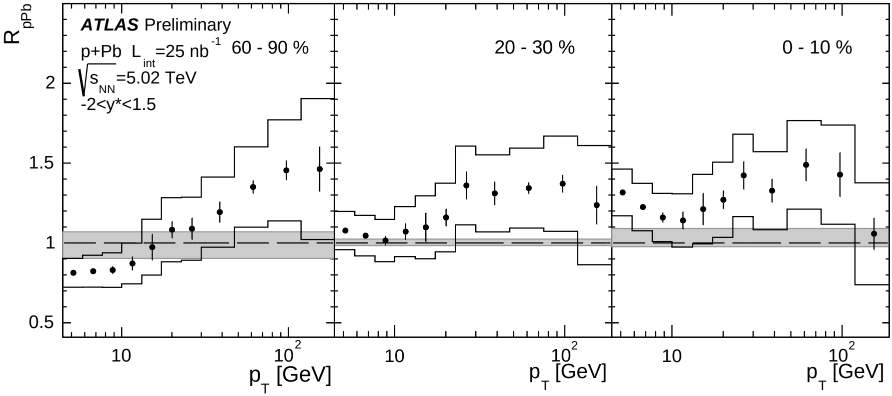
- for R_{pPb} correlated systematic uncertainties are taken out, however y^* describes different areas of the detector in pp and pPb collisions, and thus many of the uncertainties do not cancel out
- difference between linear and logarithmic interpolation is taken as the uncertainty of the interpolation

pPb spectra



- by dividing pPb (points) and pp (lines) we are able to get R_{pPb}

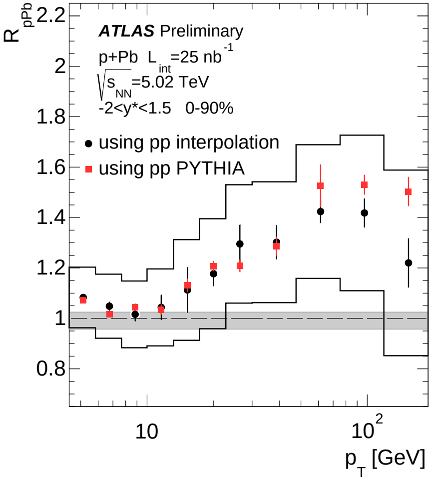
R_{pPb}



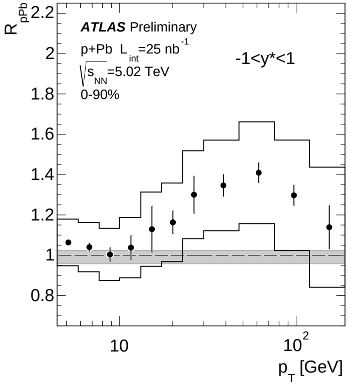
- at lower p_{T} R_{pPb} depends on centrality
- at higher p_{T} R_{pPb} enhanced

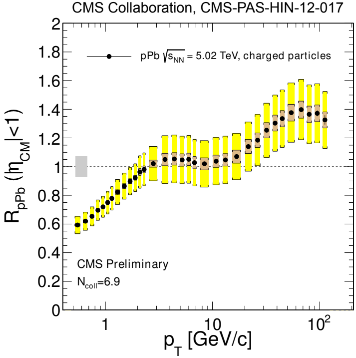
R_{pPb} – with PYTHIA

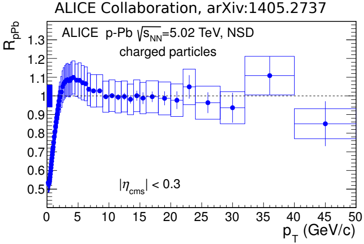
- used PYTHIA generated cross section instead of the pp interpolation as a baseline
- similar trend for both distributions



R_{pPb} – comparison with CMS and ALICE

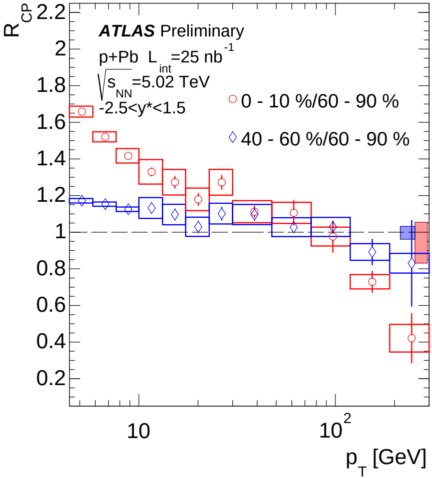






- compatible with CMS measurement
- different trend than ALICE

R_{CP}



- decrease at very high p_{T}, however we have very limited statistics
- R_{CP} in jets → see talk by Dennis Perepelitsa (3 talks later)

conclusion

- measured spectra and nuclear modification factor in pPb
- at lower p_{T} the suppression/enhancement depends on centrality
- enhancement at higher p_{T}
- seen similar trend as CMS