Rapidity gaps and ξ in SD processes in ATLAS/CMS

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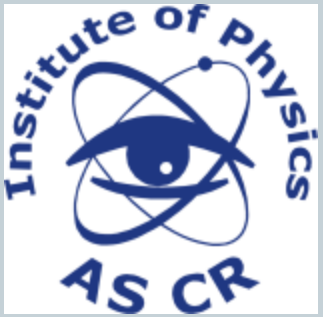


Definitions of diffractive variables

- Fractional momentum loss of scattered proton

$$\xi_{\text{proton}} = (p_Z^{\text{In}} - p_Z^{\text{Out}}) / p_Z^{\text{In}}$$

Detector-level approximation:

summing over detector objects ... $\xi^{\pm} = \Sigma\, p_T e^{\pm y} / \sqrt{s}$ **or** $\xi^{\pm} = \Sigma\, (E \pm p_Z) / \sqrt{s}$

ξ^{+} ... diffractive system going in the $-z$ direction
ξ^{-} ... diffractive system going in the $+z$ direction

- Forward rapidity gaps $\Delta\eta^F$

Region in η devoid of hadronic activity

$\boldsymbol{\Delta\eta \sim -\ln \xi_X}$ ... smaller ξ_X (M_X) => bigger gap

The ATLAS/CMS acceptance and sensitivity

- ATLAS/CMS acceptance & sensitivity:

  $|\eta| < 4.7\text{-}4.9$

  particles with $p^{\text{charged (neutral)}} >$ X (Y) MeV

  (lower-p particles don't reach calorimeters due to mag. field etc.)

- Rapidity gaps:

  Particle-level: region without particles ($p^{\text{ch(n)}} >$ X (Y) MeV) within $|\eta| < 4.7\text{-}4.9$

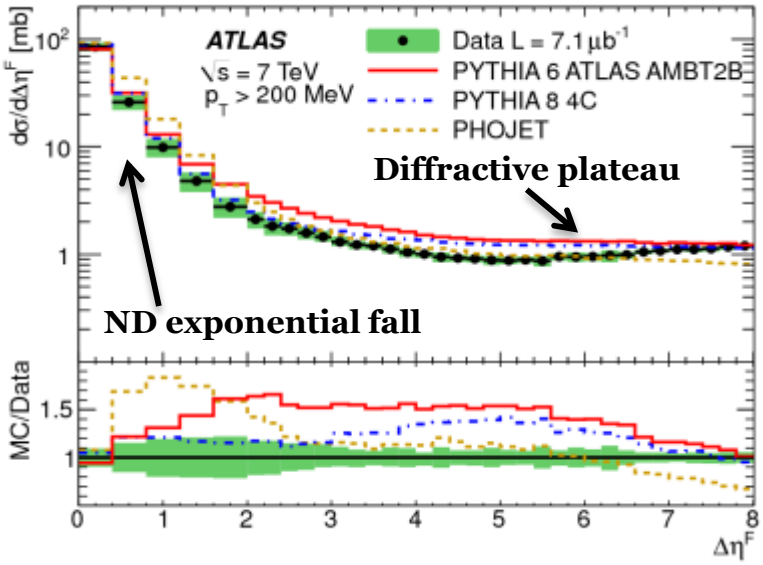
  Reco-level gap: suppression cuts against the electronic noise in calorimeters

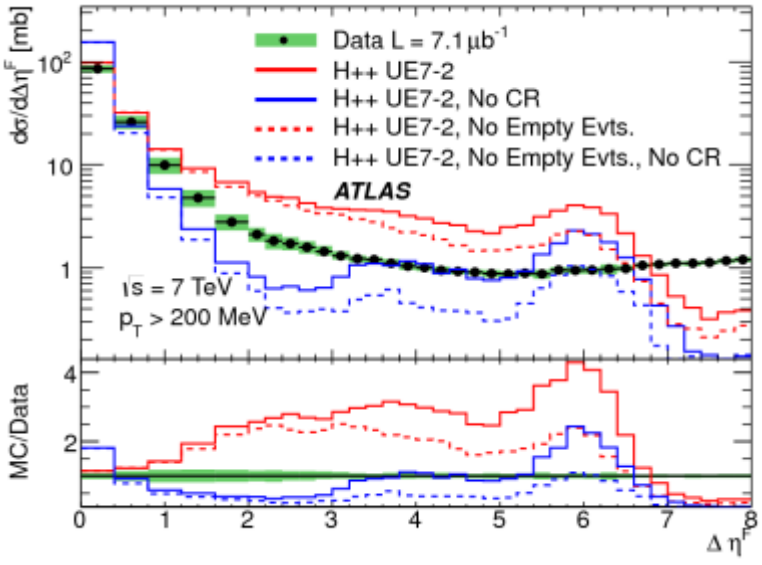
- ξ approximation:

  summing over all clusters as the electronic noise is Gaussian-symmetric around 0 -> noise cancellation

- Key requirement: single interaction per bunch crossing

Soft diffraction by ATLAS





- Small gaps -> hadronization fluctuations of ND events
- Large gaps -> diffractive plateau (SD+DD dominant)
- Model uncertainties -> Herwig++ fails to describe the gap spectrum
  - $\Delta\eta^F$ allows to test hadronization models (cluster-based approach of Herwig++)

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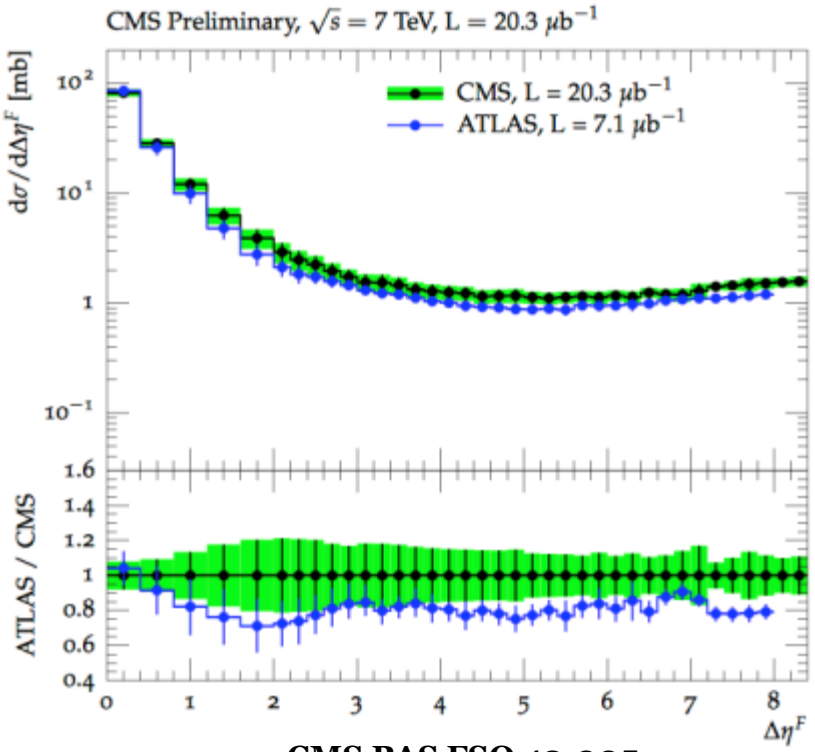
ATLAS vs. CMS: soft diffraction

- ATLAS definition
  - Hadron-level: $p_T > 200$ MeV, $|\eta| < 4.9$
  - Detector-level: $p_T > 200$ MeV, $|\eta| < 4.9$
    $E_{cell}/\sigma_{noise} > S_{th}(\eta)$
- CMS definition
  - Hadron-level: $p_T > 200$ MeV, $|\eta| < 4.7$
  - Detector-level: $E > 0 - 4$ GeV (depending on det. region and object type), $|\eta| < 4.7$
- ATLAS vs. CMS
  - systematic shift of the cross-section
  - difference - η-acceptance
  - CMS extends the ATLAS measurement by 0.4 units of $\Delta\eta^F$

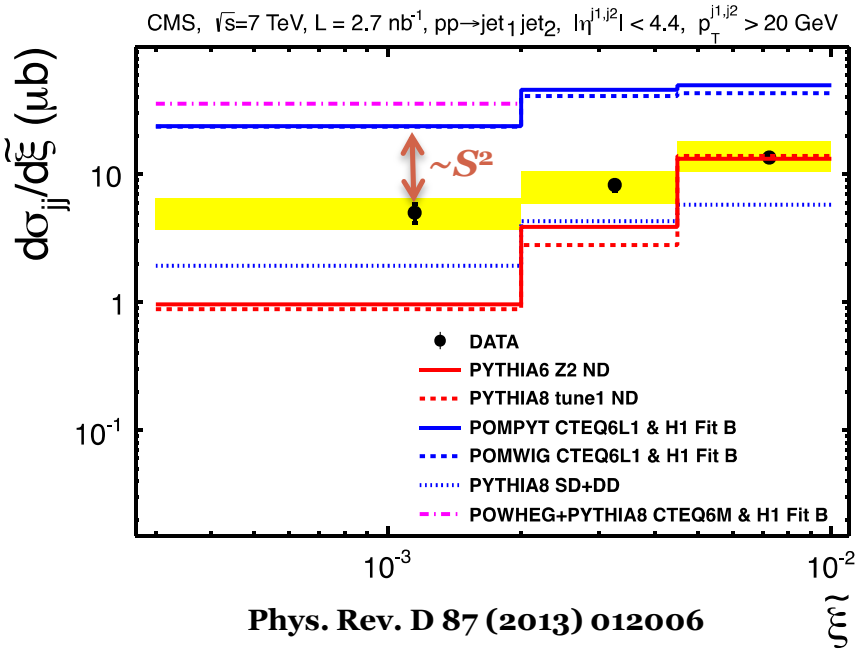


CMS PAS FSQ-12-005

Hard diffraction by the CMS experiment

- CMS published the diffractive contribution to dijet production at the LHC
  - Jets $p_T > 20$ GeV
  - Detector objects: $p_T > 200$ MeV for $|\eta| < 2.4$, $E > 4$ GeV for $|\eta| > 3$
  - Enhancing diff. contribution by $\Delta\eta^F > 1.9$ requirement
- Measurement of $\xi^{\pm}$
  - comparison to different MC models
    - ND (red): Pythia 6 & 8
    - SD (blue): Pythia 8, Pompyt, Pomwig
    - DD: Pythia 8
    - Powheg for NLO comparisons
- Results
  - data also consists of proton dissociative events
    (scattered proton excited into low mass state escaping undetected into the forward region)
  - Gap Survival Probability

$$S^2 = 0.12 \pm 0.05 \text{ (LO)}$$



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