Exclusive Pion Pair Production at √s = 7 TeV

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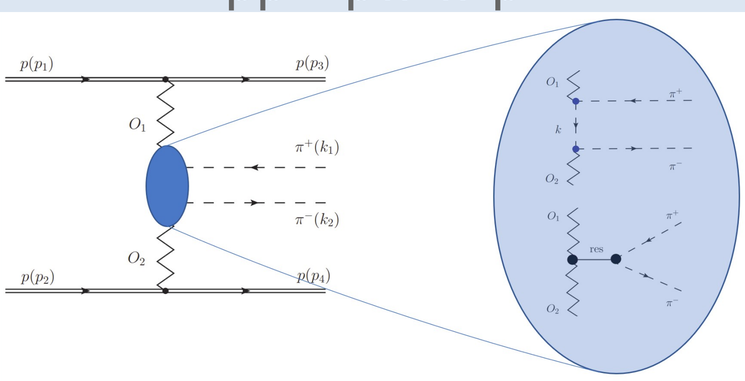
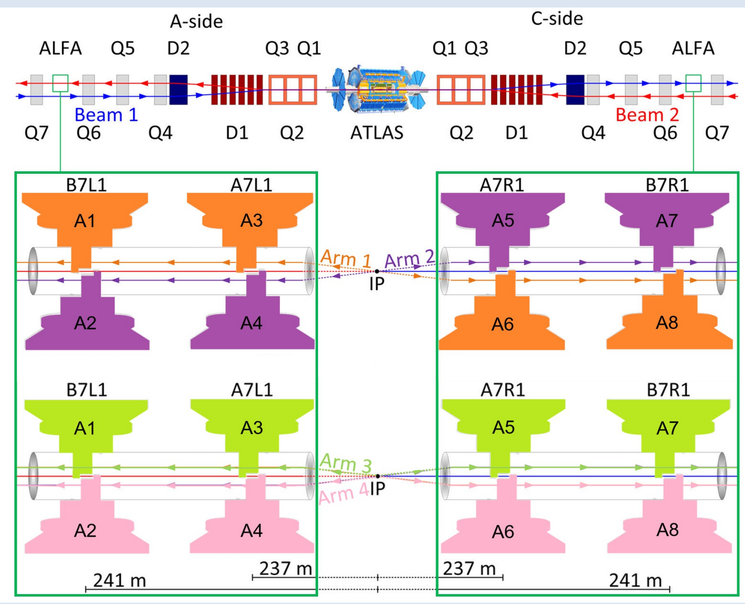
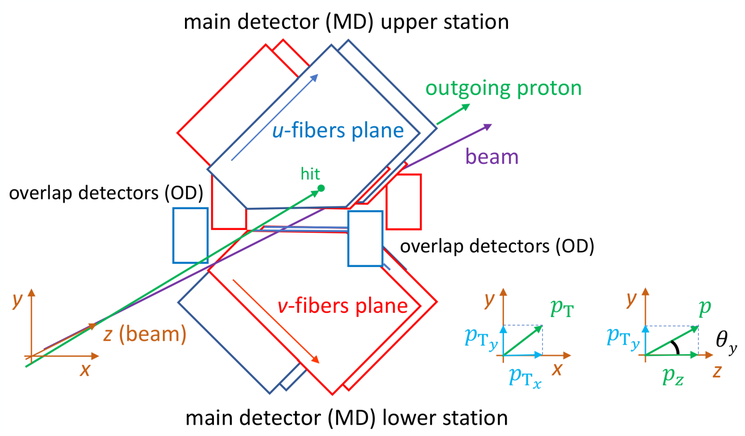
Exclusive Pion Production

$pp \to p\pi^+\pi^-p$



ALFA Detector





Data & Monte Carlo

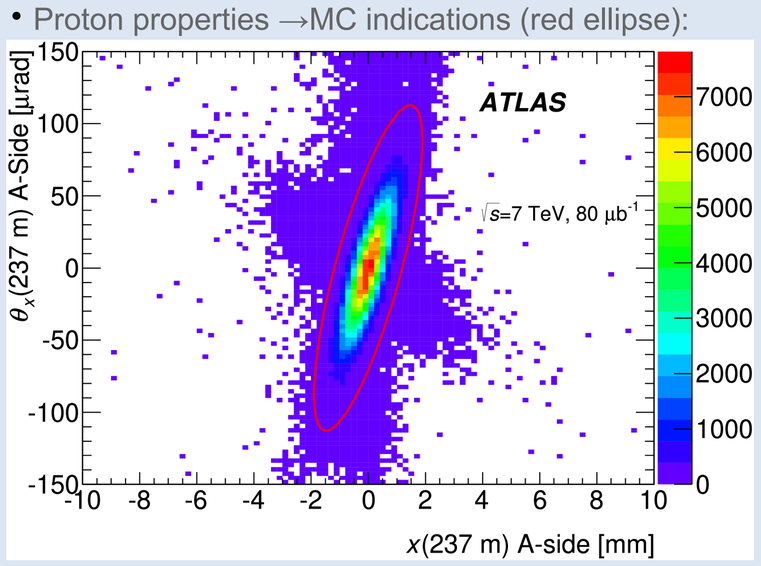
- √s = 7 TeV, β* = 90 m, pile-up μ = 0.035
- integrated lumi.: 78.7 ± 0.1 (stat) ± 1.9 (syst) μb^{-1}
- GenEx and DIME to generate continuum production of $\pi^+\pi^-$ and K^+K^-.
- Pythia8 to estimate diffractive backgrounds.

Event Selection

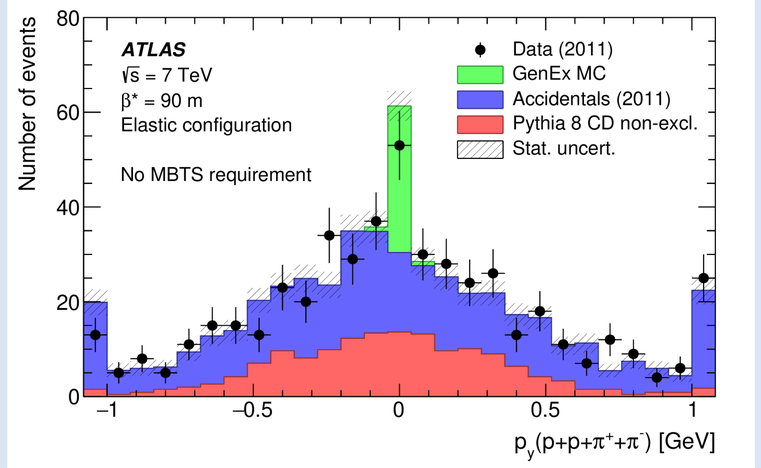
- Elastic configuration: Arm 1 or Arm 2.
- Anti-elastic configuration: Arm 3 or Arm 4.
- Before selection: 6 620 953 recorded events.
- Data quality and trigger preselection.
- Pion pair selection (ATLAS inner detector).
- Veto on ATLAS MBTS (forward activity).
- ALFA: detector geometry and reconstructed tracks.
- System momentum balance (in x and y).
- Fiducial region.
- After selection:
  - 28 candidates in elastic configuration,
  - 3 candidates in anti-elastic configuration.

Analysis

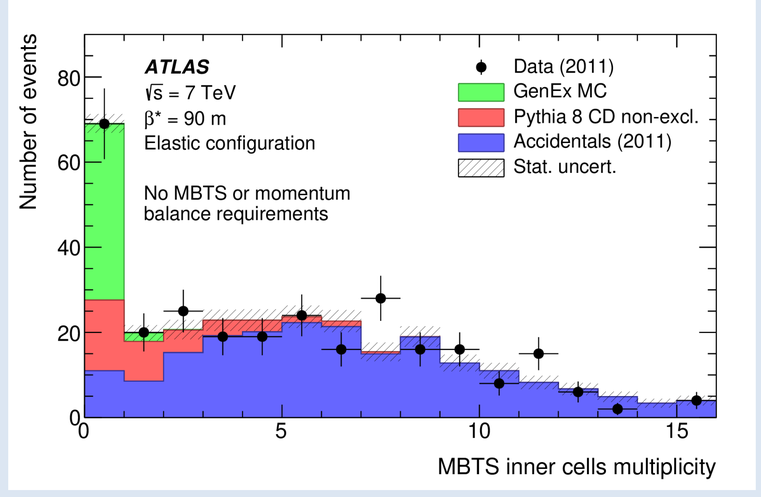
- Proton properties →MC indications (red ellipse):



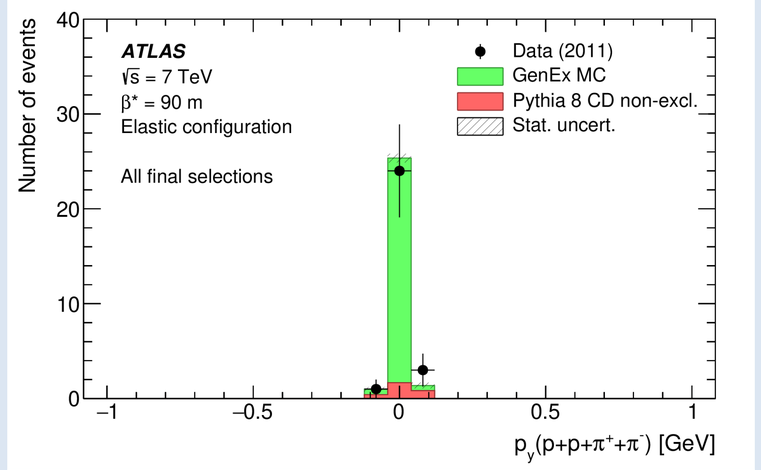
- Exclusivity → momentum balance:



- Exclusivity → veto on activity in MBTS detector:



- Final selection:

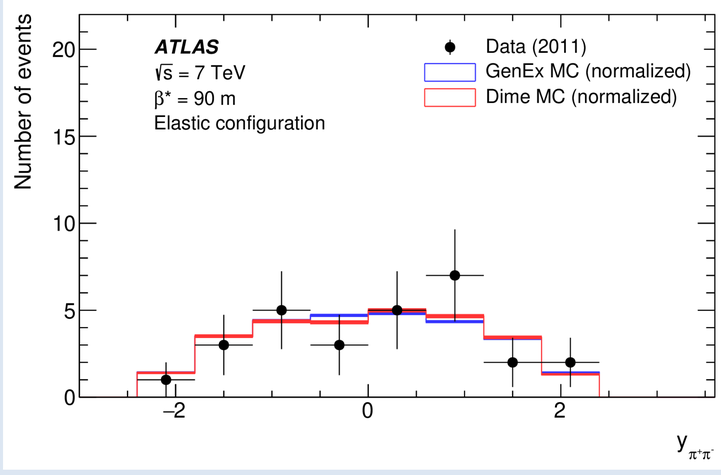


- Measurement uncertainties:

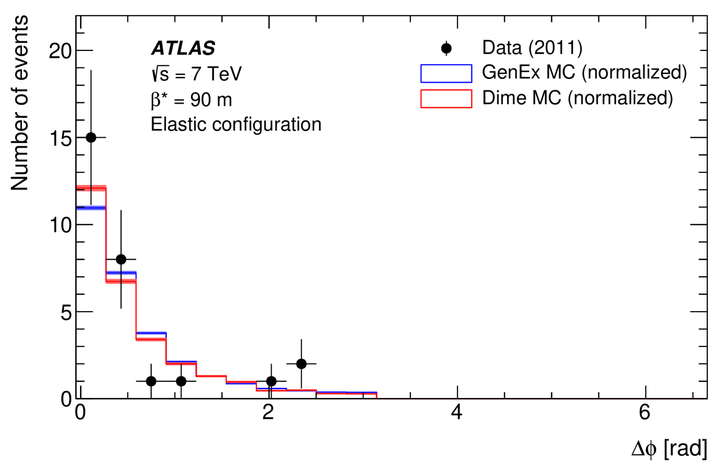
Source of uncertainty	Uncertainty [%] elastic	anti-elastic
Trigger efficiency ϵ_{trig}	±0.1	±0.3
Background determination	±3.5	±3.5
Signal and background corrections:		
Beam energy	±0.1	±0.1
ID material	+4.8	+4.1
Veto on MBTS signal	±1.3	±2.0
ALFA single-track selection	±0.9	±0.9
ALFA reconstruction efficiency	±0.9	±0.8
ALFA geometry selection	±0.5	±0.5
Optics	±1.1	±1.0
Overall systematic uncertainty	+6.4 −4.2	+6.0 −4.4
Statistical uncertainty	±21.2	±61.6
Theoretical modelling	±2.8	±8.0
Luminosity	±1.2	±1.2

Kinematic Distributions

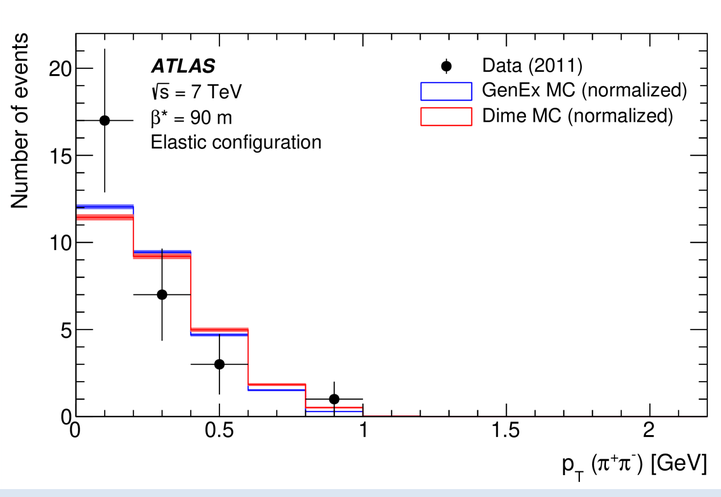
- Pion pair rapidity:



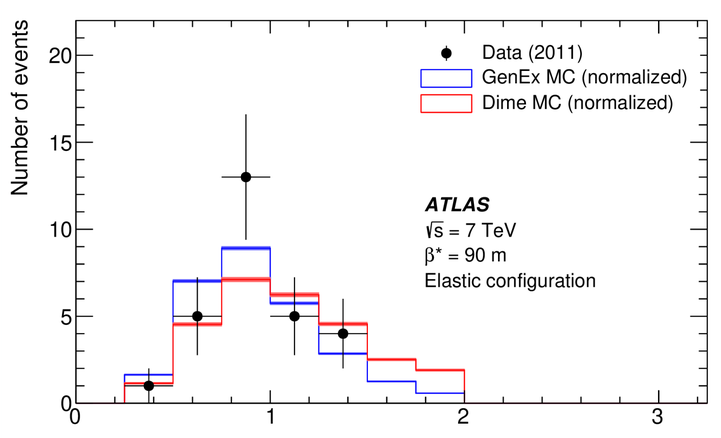
- Pion pair acoplanarity:



- Pion pair transverse momentum:



- Pion pair invariant mass:



Cross-section

- Elastic configuration:
  4.8 ± 1.0 (stat) $^{+0.3}_{-0.2}$ (syst) ± 0.1 (lumi) ± 0.1 (model) μb
  - GenEx: 1.5 μb (absorptive correction)
  - DIME: 1.6 μb
- Anti-elastic configuration:
  9 ± 6 (stat) $^{+1}_{-1}$ (syst) ± 1 (lumi) ± 1 (model) μb
  - GenEx: 2 μb (absorptive correction)
  - DIME: 3 μb
- This measurement demonstrates the potential to measure exclusive diffractive hadronic processes using forward sub-detectors in combination with the ATLAS central detector.

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