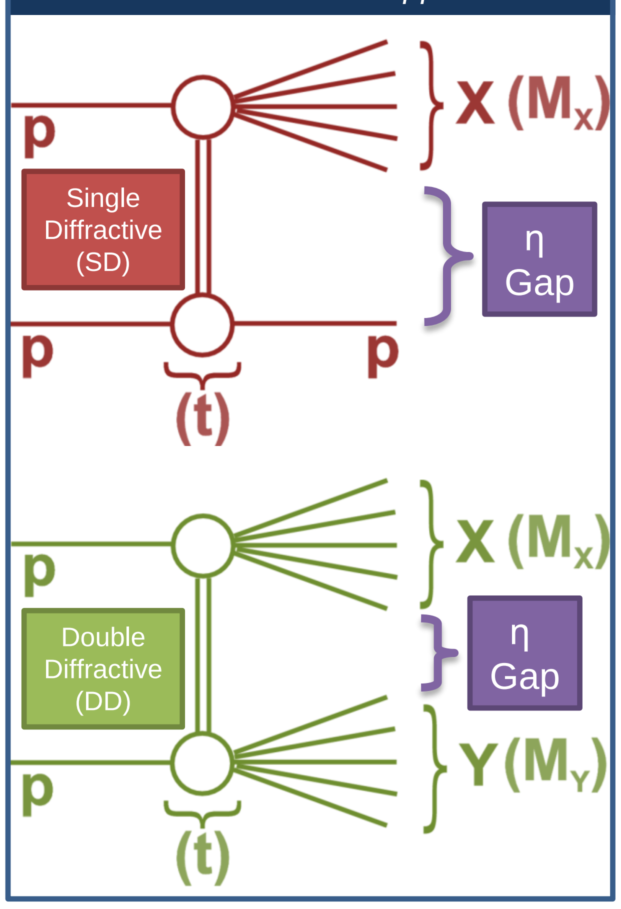
LHCC Poster Session - CERN, 21 March 2012

Diffractive Dissociation of Protons in 7 TeV Collisions at the ATLAS Detector

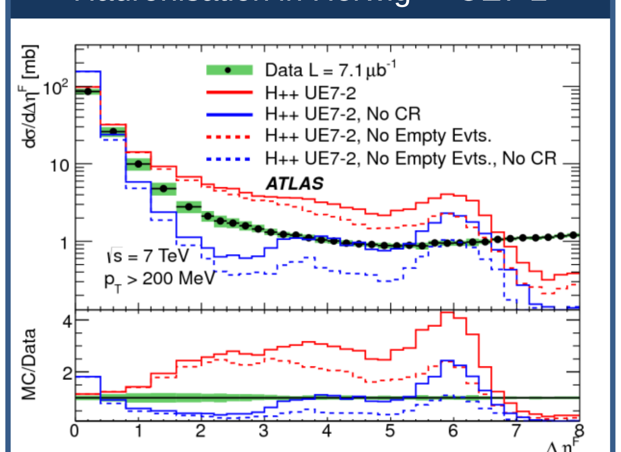
Diffraction in Minimum Bias Events

- Approximately 25% of all interactions at the LHC are *soft inelastic diffractive*.
- In the limit $s \gg M_X \gg t$ the cross section is best modelled by the exchange of a strongly interacting colour singlet, know as the Pomeron ($\mathbb{P}$) in Regge theory.
- Colour singlet exchange results in *large pseudorapidity gaps* in the final state.
- We apply *gap finding techniques* to minimum bias events to isolate and study the *diffractive* component of the inelastic cross section with *high precision*.
- The measurement is *unfolded* to the *hadron level* to allow for comparison with MC.

Diffractive Dissociation in *pp* Collisions

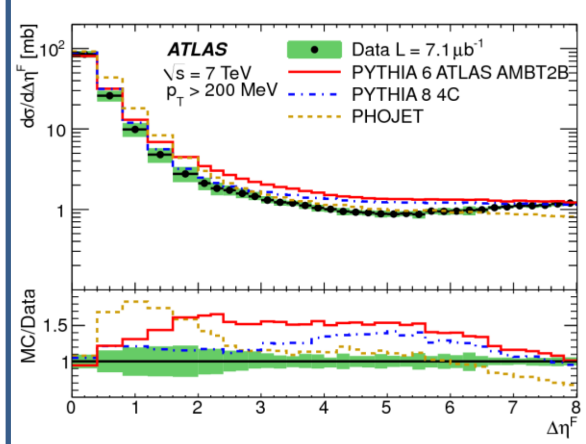


Rapidity Gaps with Cluster Hadronisation in Herwig++ UE7-2



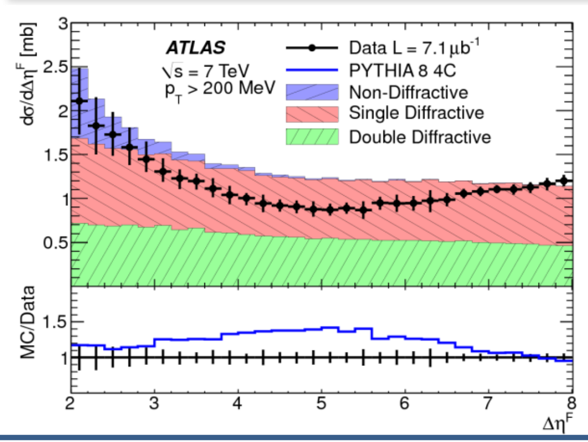
- Unexpected structure in H++ UE7-2 tune including bump at gap size $\Delta\eta^F = 6$.
- Model contains *no* explicit diffraction.
- Disabling Colour Reconnection and removing events with 0 scatters both reduce the large gap cross section.

The Inelastic Cross Section Differential in Gap Size

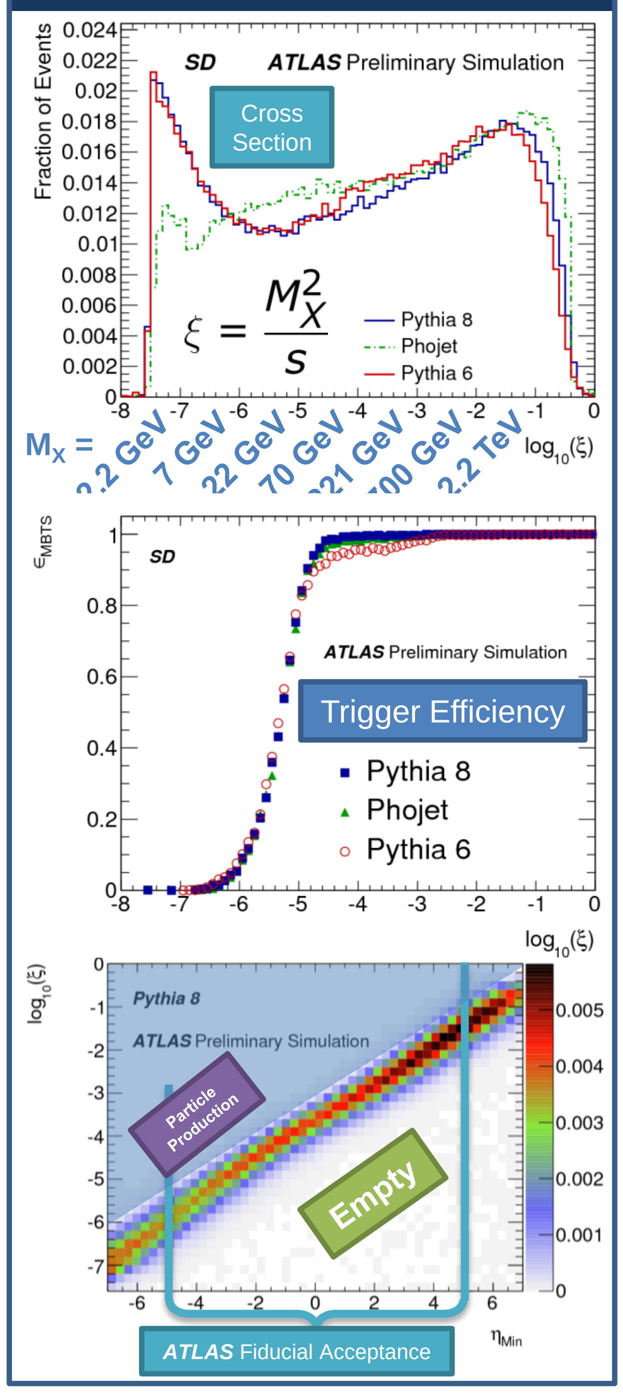


- Measure the *inelastic cross section* differential in *forward gap size*.
- Forward gap size, $\Delta\eta^F$, is the largest gap per event containing no particles with $p_T > 200$ MeV that stretches from the detector edge at $\eta = \pm 4.9$.
- Most of the cross section is contained at small $\Delta\eta^F$.
- Exponential fall in differential cross section for gaps of size $0 < \Delta\eta^F < 2$.

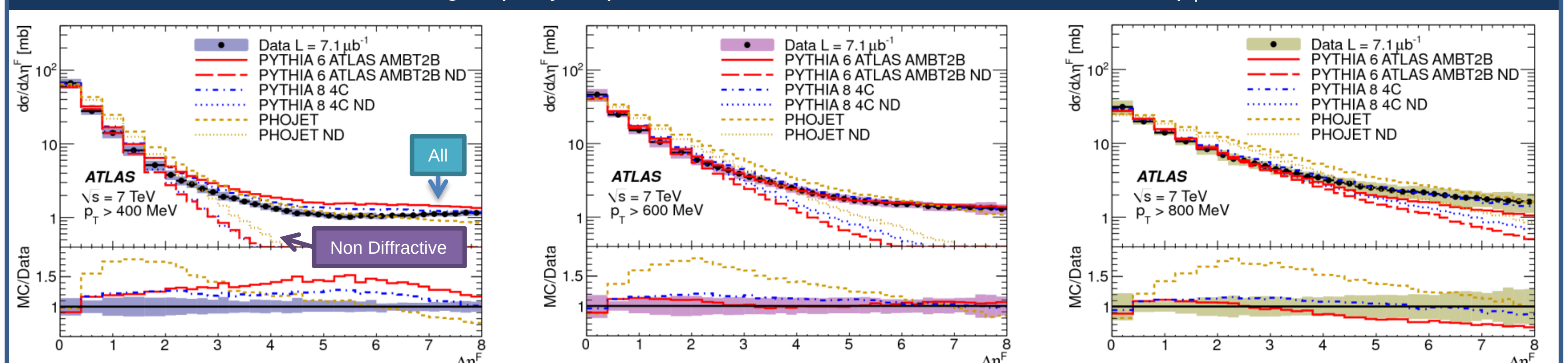
- Diffractive interactions are *isolated at large gap sizes*.
- Manifests as a *plateau* of the differential cross section for events with $\Delta\eta^F > 3$.
- *ATLAS* spans 9.8 units of η, though we only measure gaps up to 8 units of pseudorapidity due to trigger.
- None of the default models match the *rise in cross section observed* in data at large gaps.



ATLAS Diffractive Acceptance

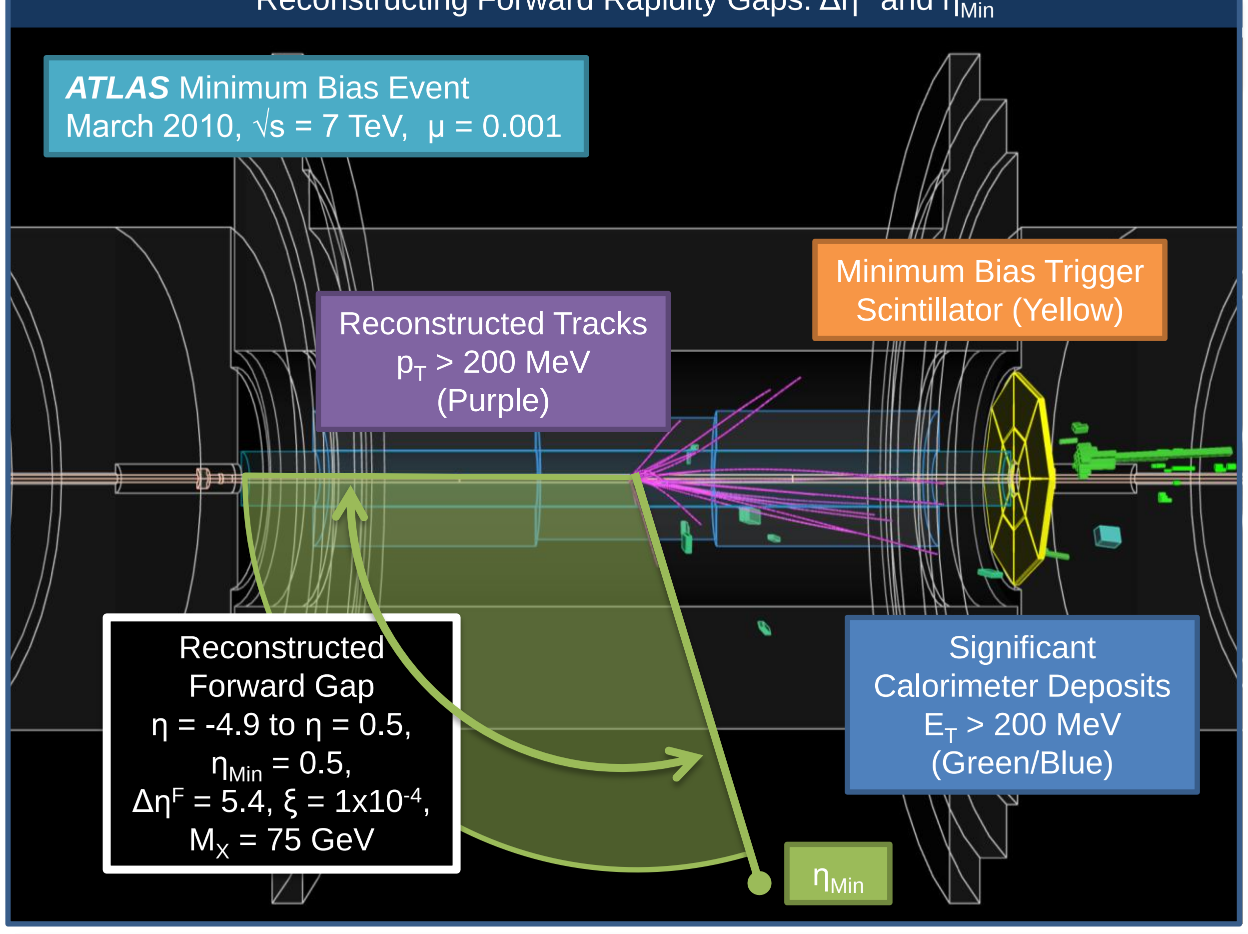


Probing Rapidity Gap Fluctuations in Hadronisation as a Function of p_T

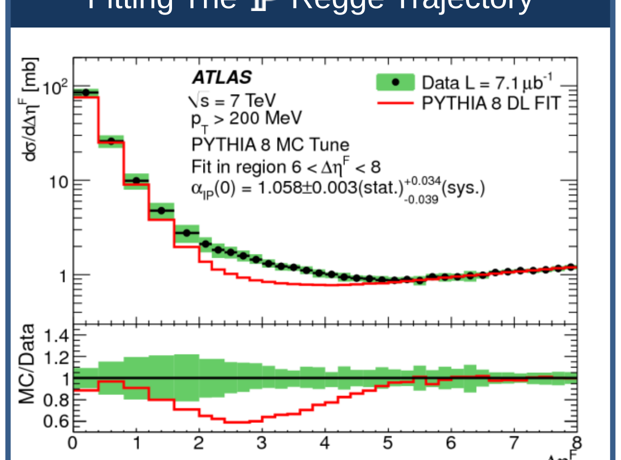


- By increasing the p_T cut used to define the gap, the probability of a large gap arising out of *hadronisation fluctuations* increases.
- Pythia 8 is best able to recreate the gap spectrum as a function of particle p_T cut.

Reconstructing Forward Rapidity Gaps: $\Delta\eta^F$ and η_{Min}



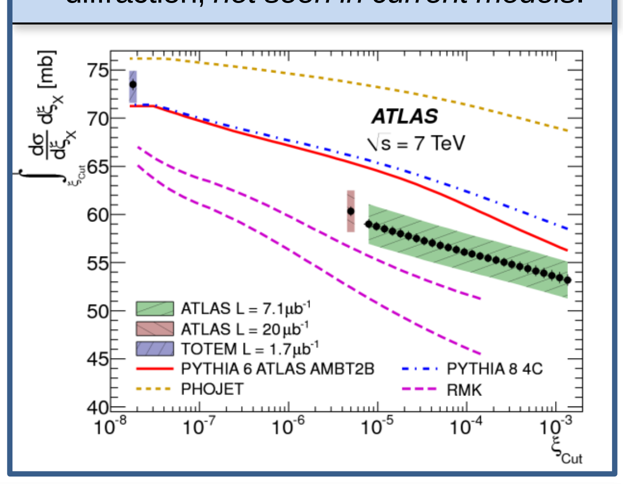
Fitting The $\mathbb{P}$ Regge Trajectory



- The rise in cross section at large gap size is attributed to the *super-criticality* of the Pomeron *Regge trajectory intercept*.
- The intercept for the *Donnachie and Landshoff* Pomeron in Pythia 8 is fitted using a templated χ^2 minimisation method in the region $6 < \Delta\eta^F < 8$.
- The normalisation is allowed to float as a free parameter.

The Running of σ_{Tot} with ξ_{Cut}

- Probe the dependence of the *inelastic cross section* by taking the *integral* of the gap spectrum from $\Delta\eta^F = 0$ up to variable maximum $\Delta\eta^F_{Cut} = 3 - 8$.
- As the endpoint, $\Delta\eta^F_{Cut}$, is diffraction dominant, can convert to integral in ξ.
- $\Delta\eta^F_{Cut}$ to ξ_{Cut} MC derived correction is at most $1.3 \pm 0.6\%$.
- The dominant uncertainty is lumi.
- We see an excess of low mass diffraction, *not seen in current models*.



Based on: Rapidity gap cross sections measured with the ATLAS detector in pp collisions at sqrt(s) = 7 TeV, *arXiv:1201.2808 [hep-ex]*.
Notable References: *RMK Eur. Phys. J. C71 (2011) 1617 | TOTEM Europhys. Lett. 96 (2011) 21002 | ATLAS Nature Comm. 2 (2011) 463 | ATLAS-CONF-2011-002*

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ATLAS EXPERIMENT