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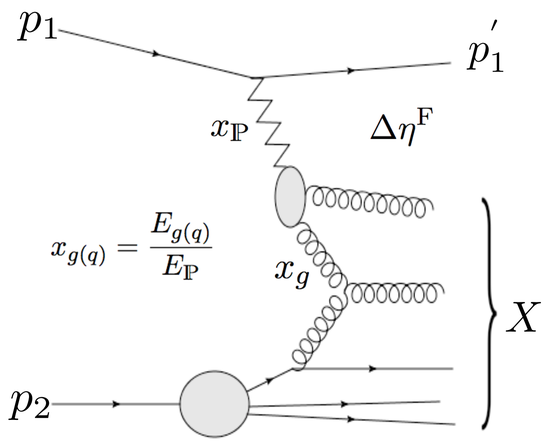
Soft Diffraction Dissociation at the LHC

The soft diffractive processes at the Large Hadron Collider, LHC, are important for understanding non-perturbative QCD effects and they also constitute a significant fraction of the total proton-proton cross-section.



Single Diffractive Dissociation

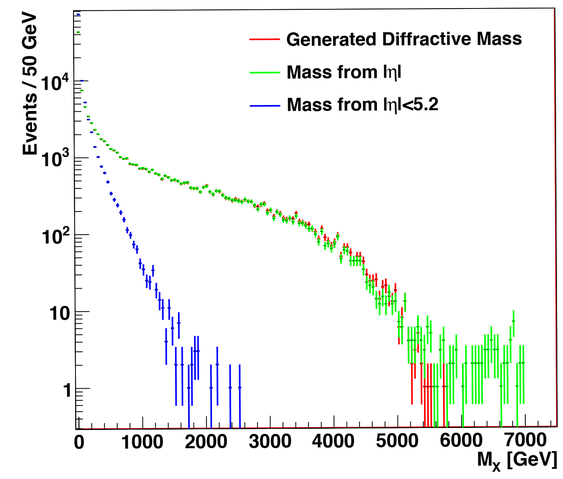
$$\frac{d\sigma(pp \to pX)}{dx_{\mathbb{P}} dx_1 dx_2 d\hat{t}} = f_{\mathbb{P}/p}(x_{\mathbb{P}}, Q^2) \frac{d\sigma(p\mathbb{P} \to X)}{dx_1 dx_2 d\hat{t}}$$

$$\frac{d\sigma(p\mathbb{P} \to X)}{dx_1 dx_2 d\hat{t}} = f_{p_1/p}(x_1, Q^2) f_{p_2/\mathbb{P}}(x_2, Q^2) \frac{d\hat{\sigma}}{d\hat{t}}$$

$$\xi_X = 1 - \left(\frac{p_1'}{p_1}\right) \qquad \xi_X = \left(\frac{M_X}{\sqrt{s}}\right)^2$$

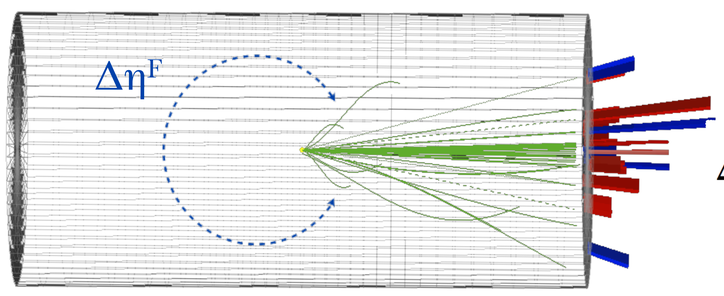
The larger the rapidity covered, the more precisely measurements for diffractive dissociated events can be done.

$$M_X = \sum_i m_i$$

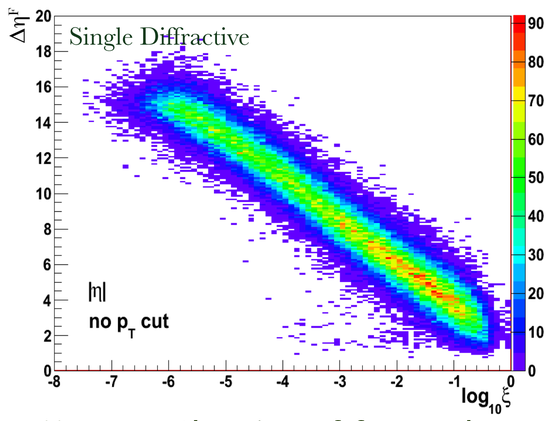


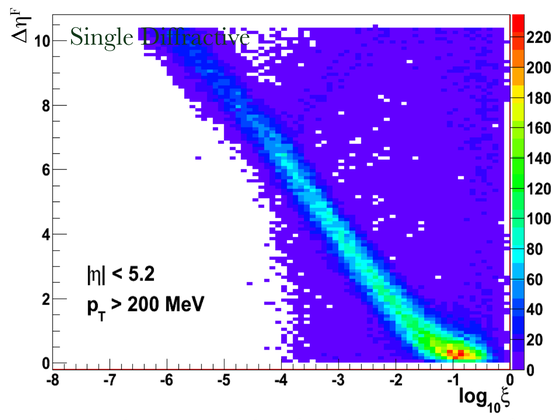
Not possible to measure the actual mass of the diffractive system within the detector pseudo-rapidity range, $|\eta| < 5.2$.

Large Rapidity Gap Method



$$\Delta\eta^F \sim -\ln \xi_X$$

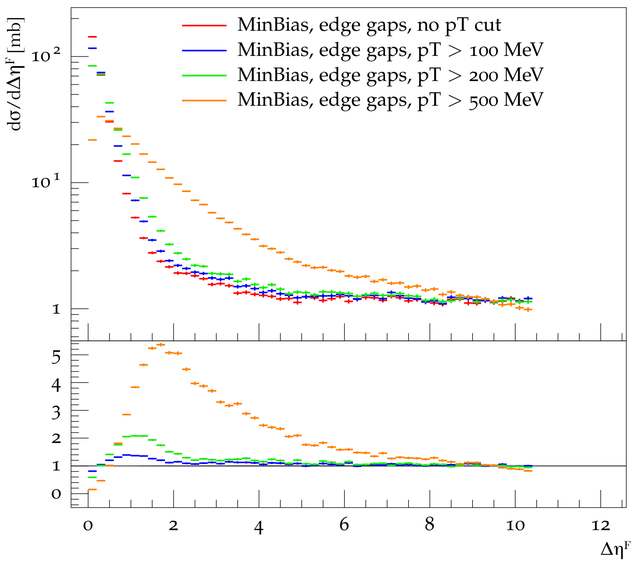




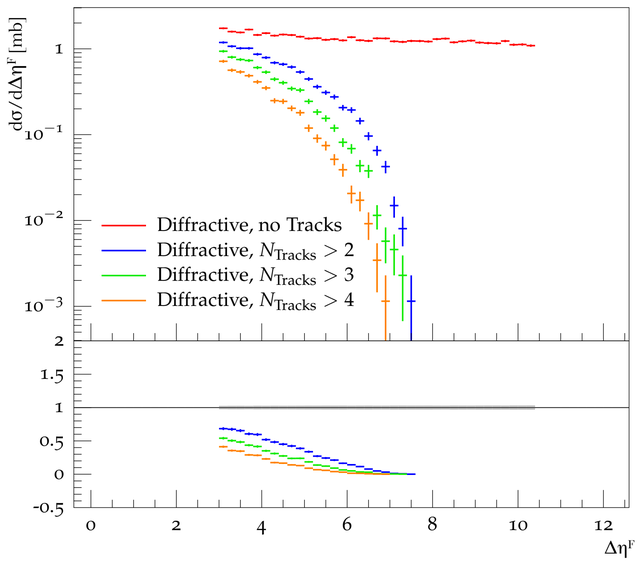
Diffractive events at hadron colliders are typically characterized by a region of the detector without particles, known as a rapidity gap.

Measure the size of forward gap and use the correlation to determine ξ. Study the observables in the detector limits with Rivet !

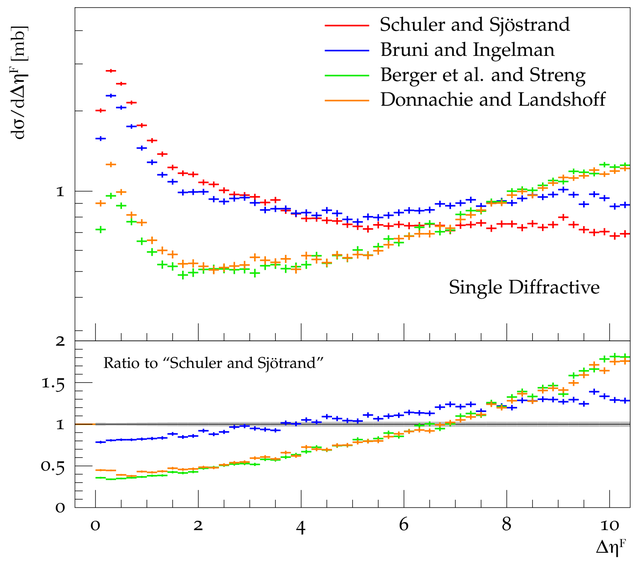
Low-p_T Threshold



Vertex Contribution



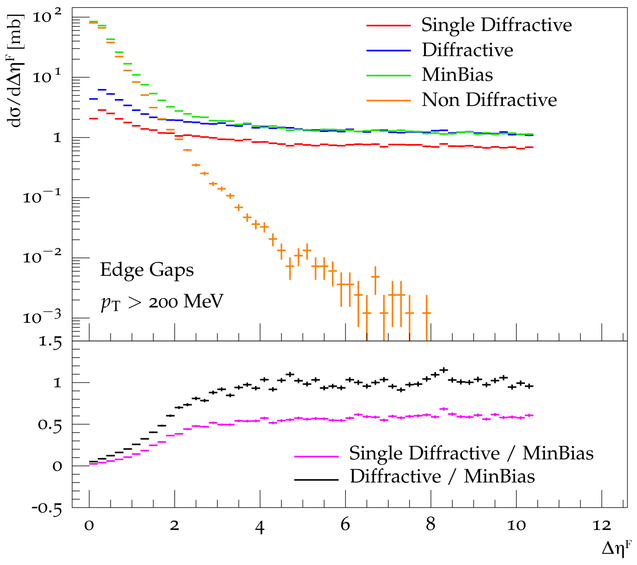
It's Model Dependent !

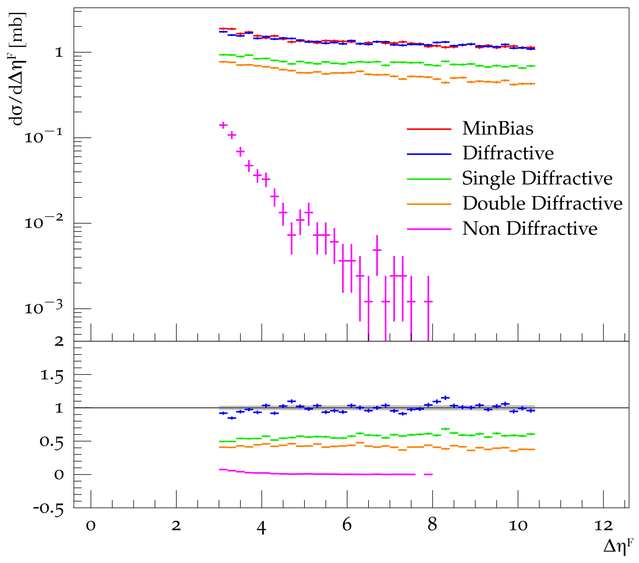


The size of the gap is very sensitive to the low-p_T threshold. When the threshold is increased, the gap size becomes larger. A primary vertex requirement suppresses the distribution for values lower than $\Delta\eta^F$ of 8.

Model parameters need to be tuned, particularly to reproduce the differential cross section as a function of gap size at the largest $\Delta\eta^F$ values.

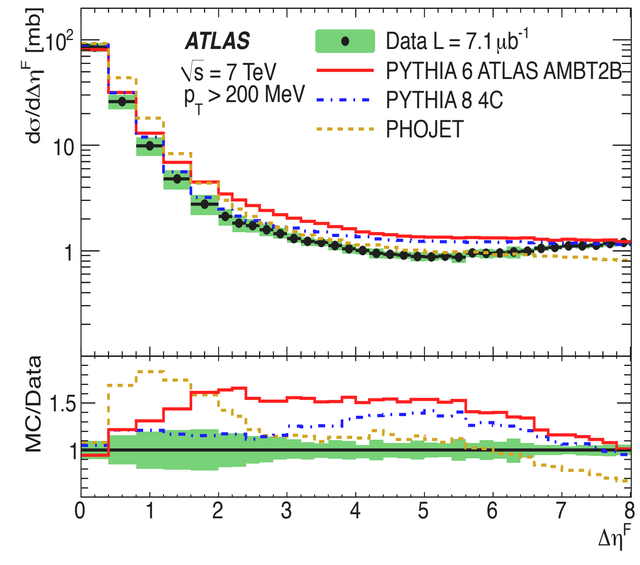
Gap Cut to Select Diffractive Events





In $|\eta| < 5.2$, diffractive dissociated events can be selected with a cut of $\Delta\eta^F > 3$ for particles $p_T > 200$ MeV. However with this event selection, it is not possible to make an unambiguous distinction between single and double diffractive dissociated events due to the limited pseudo-rapidity coverage of the detector.

ATLAS Measurement



ATLAS measured the inelastic cross section differential in forward gap size $\Delta\eta^F$ for particles with pT > 200 MeV. The shaded bands represent the total uncertainties.

[1] Emily Nurse, Sercan Sen, "Methods to Select Soft Diffraction Dissociation at the LHC", arXiv:1107.2688 [hep-ph].

[2] T. Sjöstrand, S. Mrenna and P. Z. Skands, "A Brief Introduction to PYTHIA 8.1", Com- put. Phys. Commun. 178 (2008) 852867 [arXiv:0710.3820 [hep-ph]].

[3] The ATLAS Collaboration, "Rapidity Gap Cross Sections measured with the ATLAS Detector in *pp* Collisions at √s = 7 TeV", Eur. Phys. J. C72 (2012) 1926 [arXiv:1201.2808 [hep-ex]].

[4] A. Buckley et al., "Rivet User Manual", arXiv:1003.0694 [hep-ph].

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CERN (Geneva) Switzerland, July 23-27 2012