Exclusive Jet Production and Diffractive Dijets with Gap

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AFP Meeting

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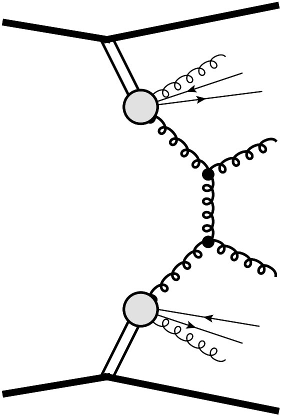
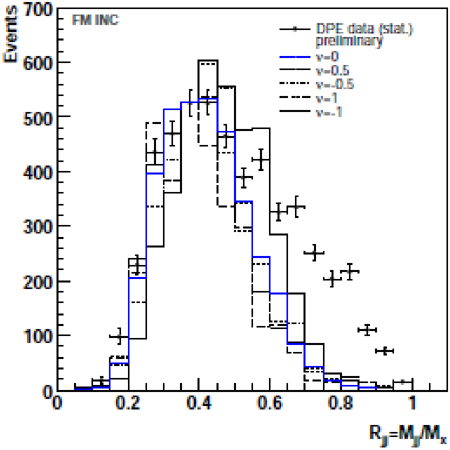
Exclusive Jet Production

Tevatron Analysis of the DPE Jet Production

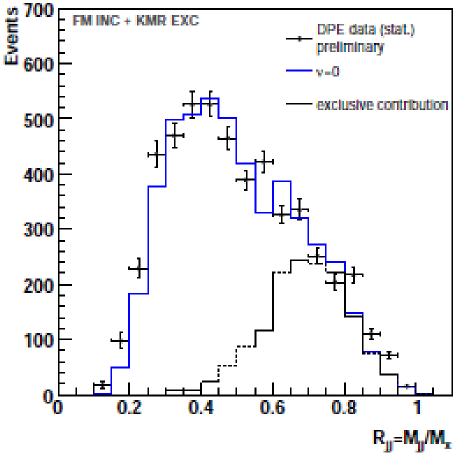
DPE – Double Pomeron Exchange
Signature: two jets in central region + two intact protons.

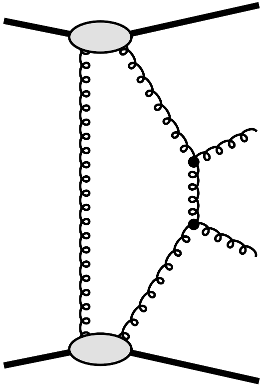




Goal: to probe the Pomeron Density Function.
Too much events in the high mass ratio region.

Signature: two jets in central region + two intact protons
+ gap in rapidity between jet and proton.

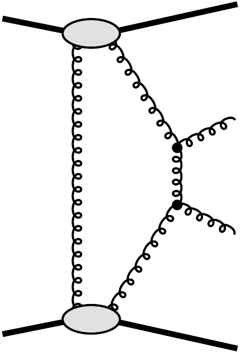




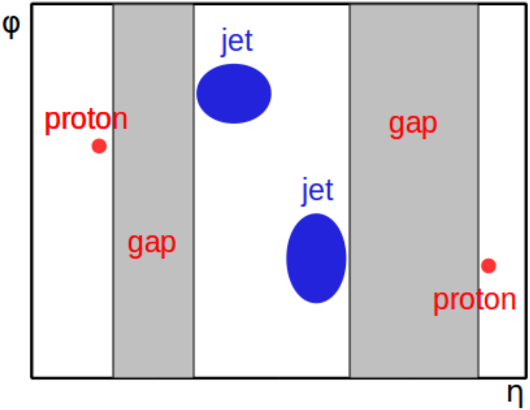
Exclusive Production

KMR model explains additional contribution.

Detection Methods

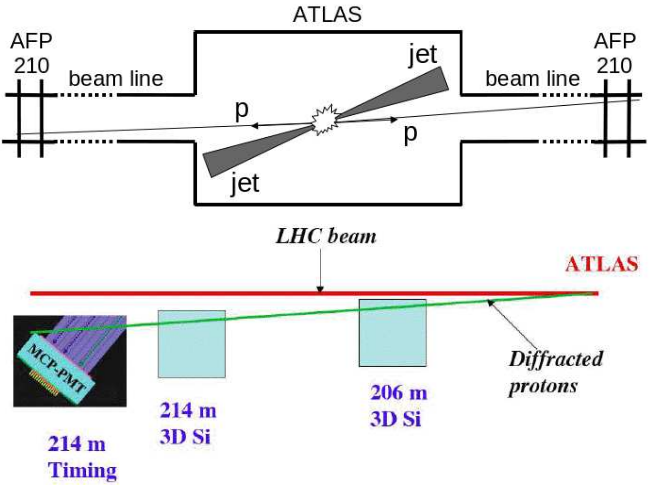


Exclusive Production



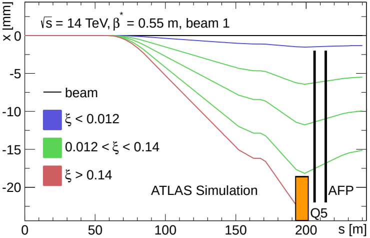
1. Gaps between jets and outgoing protons.
2. Intact proton tagging.

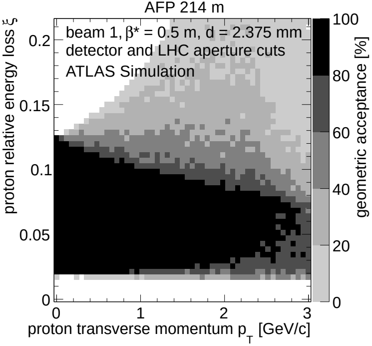
ATLAS Experiment

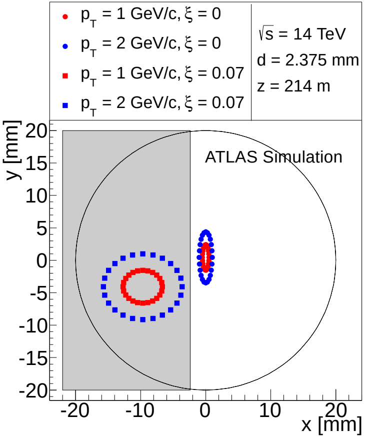


Jets measured in the ATLAS central detector.
Protons tagged in the AFP stations (position + time of flight).

Forward Protons

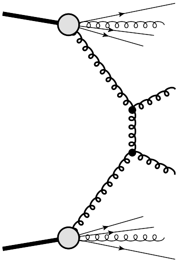




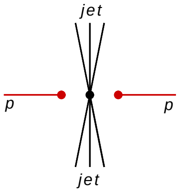


Acceptance above 80% for $0.012 < \xi < 0.14$ and $p_T < 3$ GeV.

Non-diffractive jets
+ pile-up.

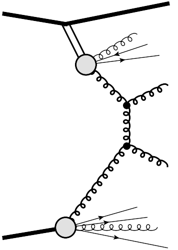


Non−difftactive Production

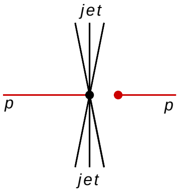


CS ($p_T > 150$ GeV):
645 nb

Single-diffractive jets
+ pile-up.

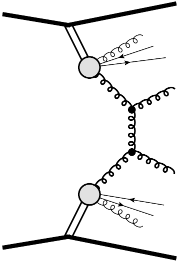


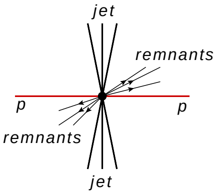
Single Diffractive Production



CS ($p_T > 150$ GeV):
2.26 nb

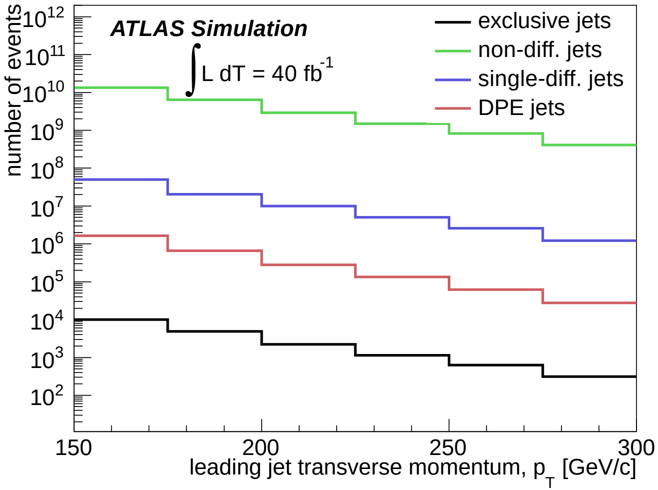
DPE jets
+ pile-up.





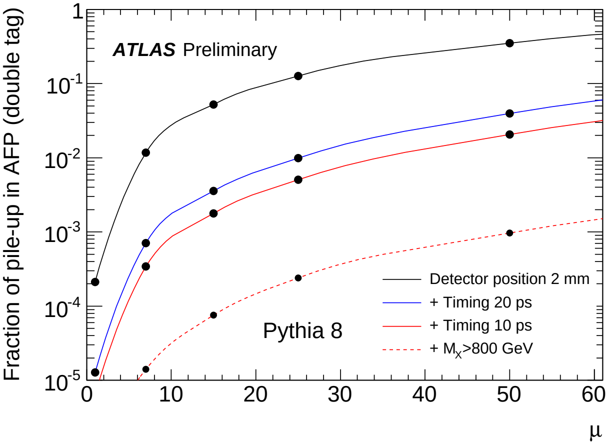
CS ($p_T > 150$ GeV):
40 pb

Initial Cross-Section



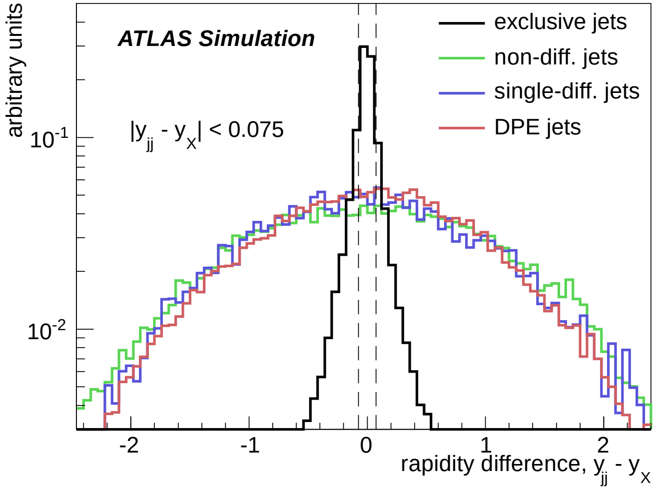
Six orders of magnitude to gain!

Cuts – AFP Acceptance



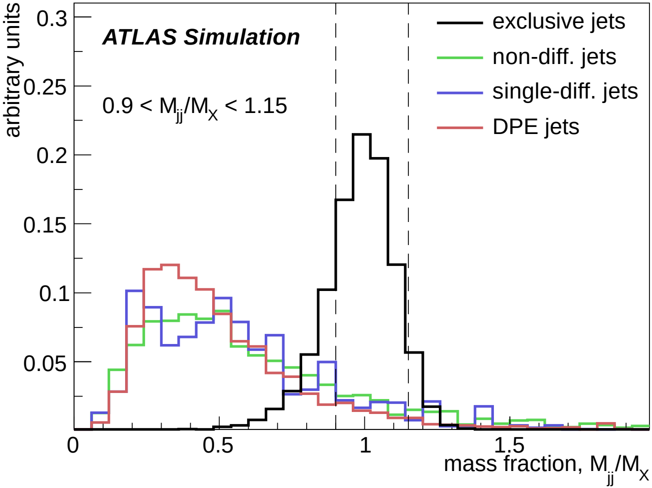
Studies for $<\mu>= 23$ end $<\mu>= 46$.

Cuts – Rapidity Fraction



$$0.85 < \frac{y_{jj}}{y_x} < 1.15$$

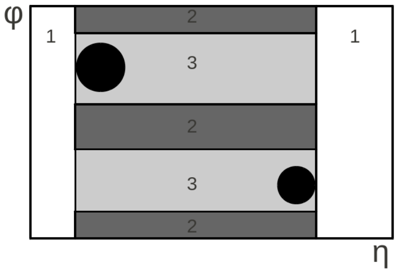
Rapidity of the proton system is defined as $y_x = 0.5 \cdot \ln\left(\frac{\xi_1}{\xi_2}\right)$.

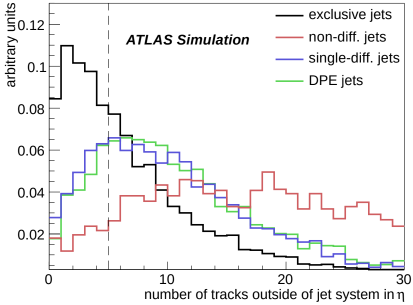


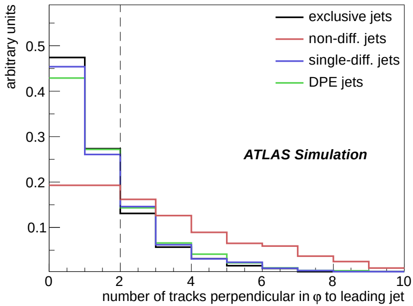
$$0.9 < \frac{M_{jj}}{M_x} < 1.15$$

Missing mass is defined as $M_X = \sqrt{s \cdot \xi_1 \cdot \xi_2}$.

Cuts – Tracks Outside Jets

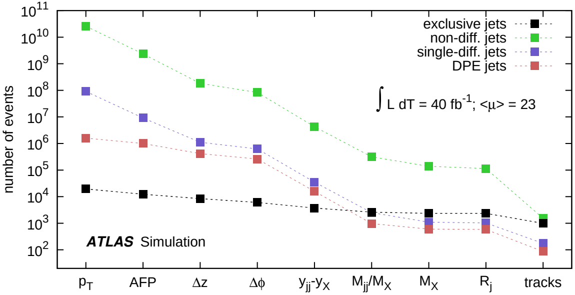


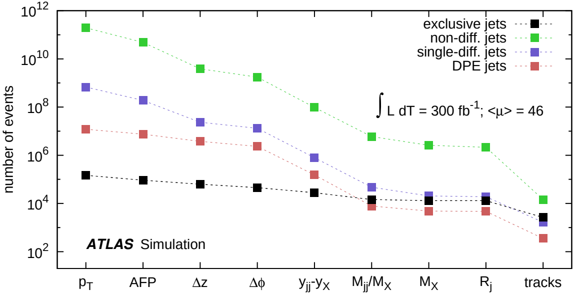




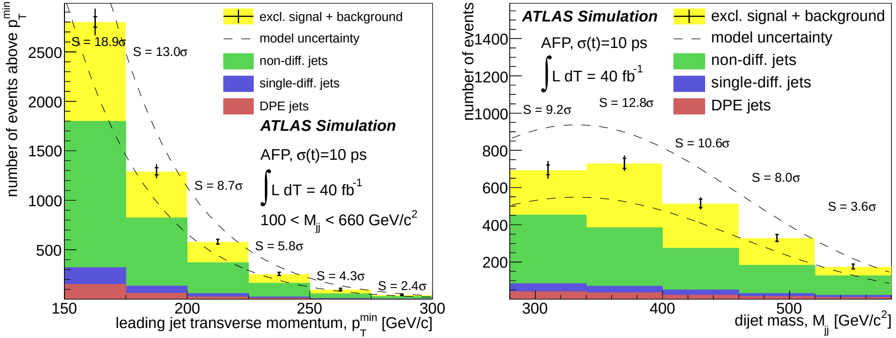
Number of tracks outside of jet system (in η) – region 1.
Number of tracks perpendicular to leading jet (in ϕ) – region 2.

Discriminating Power



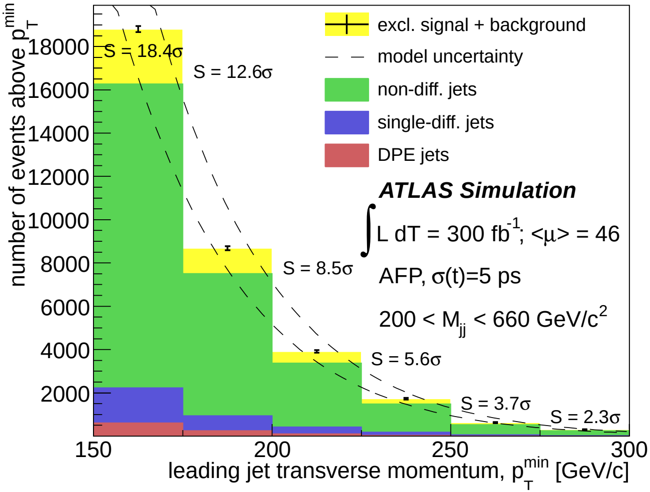


Number of Events ($<\mu>=23$)



The error bars show the statistical and systematic uncertainties.
The dashed line represents the theoretical model uncertainty (best constraints on parameters from the Tevtatron data).
For each bin the significance (S) is presented.

Number of Events ($<\mu>=46$)

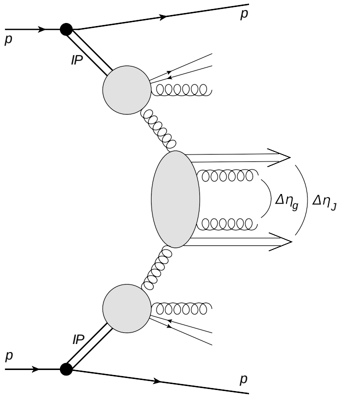


Summary

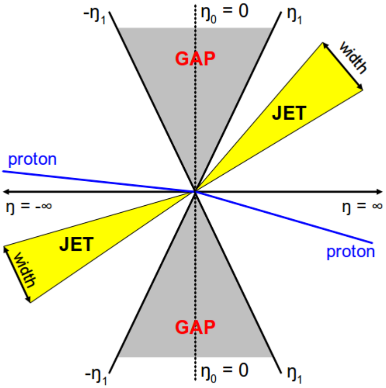
- Measurement possible in ATLAS during normal (low beta, high pile-up) runs using AFP detectors.
- Up to 18.9σ significance for the exclusive signal.
- Improvement of uncertainties coming from Tevatron CDF measurements using pbar tagging by about one order of magnitude.

Diffractive Dijets with Gap

Diffractive jet-gap-jet event



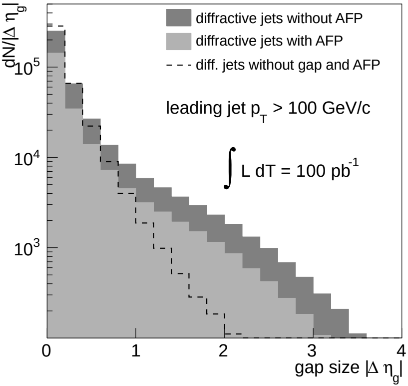
Feynman diagram of
pp $\rightarrow$ *p-jet-gap-jet-p* process.



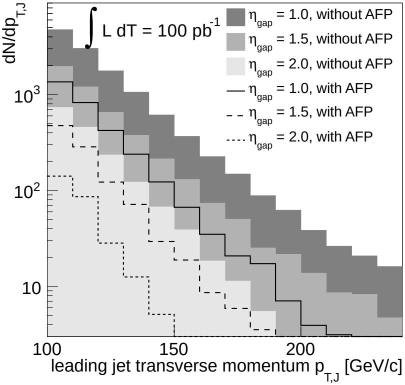
Event signature:

- two outgoing protons,
- two jets in opposite hemispheres,
- gap (symmetric in η) between jets.

Central jets



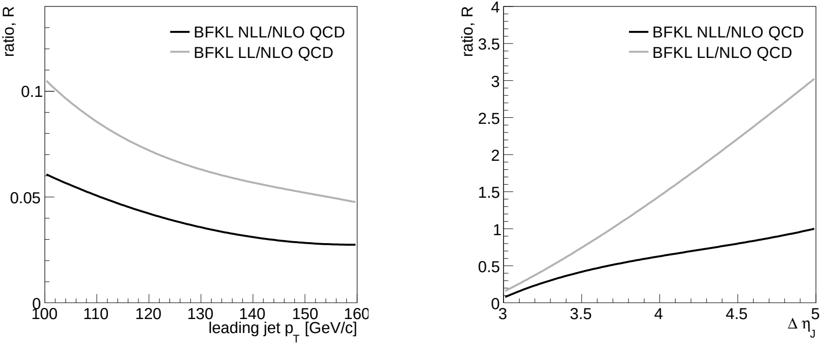
The gap size distribution for non-diffractive jets and diffractive jet-gap-jet events.



The jet transverse momentum distribution for different gap sizes with and without AFP tag requirement.

Ratio BFKL NLL/QCD NLO

$$R = \frac{\sigma(NLL\ BFKL\ FPMC)}{\sigma(Jet\ FPMC)}$$



Predictions for the ratio of the cross section for the diffractive jet-gap-jet to the inclusive jet cross section at the LHC as a function of the leading jet transverse momentum p_T (left) and the rapidity difference between the two leading jets $|\Delta\eta_J|$ (right).

Summary

- Diffractive jet-gap-jet measurement allows to test the BFKL model in very clean experimental environment.
- The HERWIG parton-level NLL-BFKL calculation was implemented into the FPMC Monte Carlo program, in order to obtain hadron-level results for the diffractive jet-gap-jet cross-section in hadron-hadron collisions, corresponding to the production of two high-pT jets around a large rapidity gap.
- Predictions for the ratio of the diffractive jet-gap-jet to the inclusive-jet cross section at the LHC, as a function of the second-leading-jet transverse momentum, and the rapidity difference between the two leading jets $\Delta\eta_J$ were presented.
- Diffractive jet-gap-jet measurement will be possible with help of the AFP detectors in special LHC runs.