Diffractive Dijet Production in Run II

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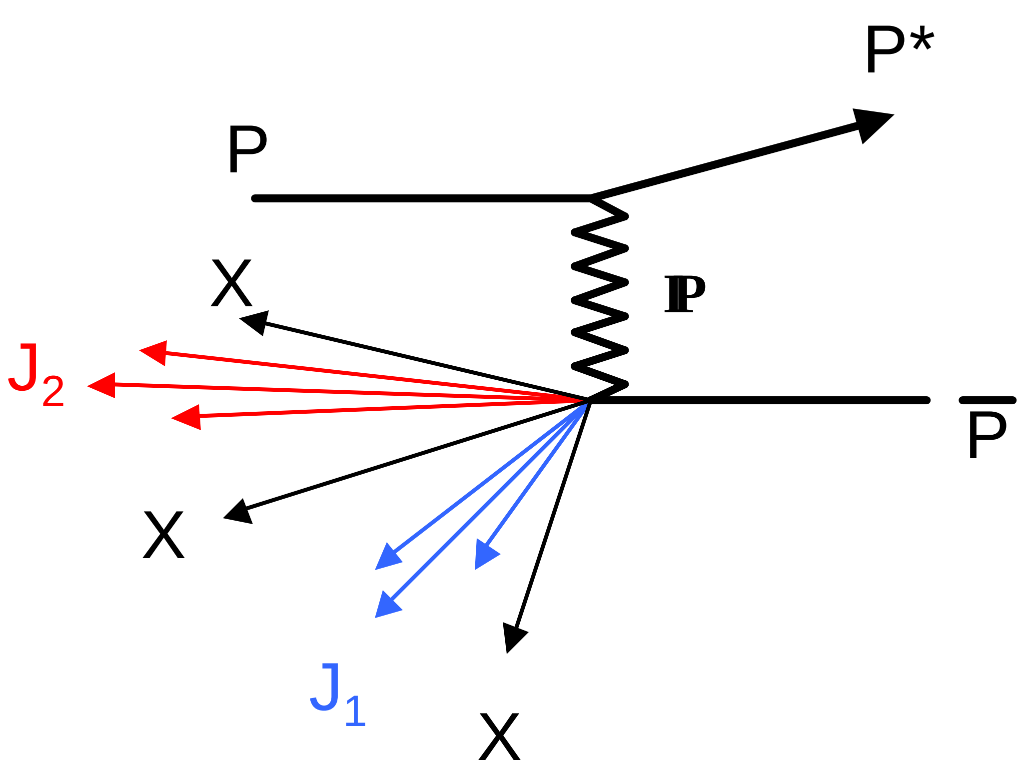


Diffractive Dijets

- Definition of hard diffraction
  - One incoming particle survives interaction (scattered), other disassociates to form hard objects (jets)
- Seen in detector through rapidity gaps…
  - Region of detector with no deposit of energy
- …or by tagging the particle that survives
  - Track from interaction region through detector near the beam far from interaction point
- Occurs in about 1% of standard dijet events
- Run I at DØ used rapidity gap tag
- Run II at DØ can tag the scattered proton as well

Physics Motivation

- Diffraction occurs when quanta of the vacuum is exchanged (Pomeron) between the incoming particles
  - Scattered particle has same quantum numbers as incident particle

- Various theories to describe how this happens and our goal is to try to differentiate between them with data
  - Ingelman-Schlein Model
  - BFKL Theory
  - Soft Color Evaporation

Ingelman-Schlein Model

- Attempt to blend Regge theory with perturbative QCD

- Factorize the cross section

$$\frac{d^2 s\,(AB \rightarrow AX)}{dxdt} = F_{P/A}(x,t)\,s\,(PB \rightarrow X)$$

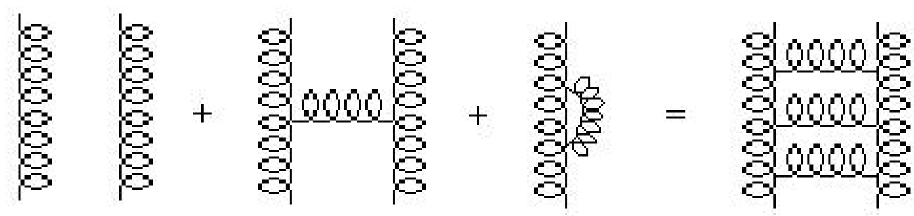
- Use the variables $x = 1 - p_A/p_{A^*}$, (diffraction dominates for $x < 0.05$) and t, the standard momentum transfer.

- Flux factor given by a global fit found by Donnachie and Landshoff and remaining part of cross section can be factorized leaving as the only unknown the structure function of the Pomeron

- Hard scattering probes structure of Pomeron (jet production --> gluon structure, W production --> quark structure)

BFKL Theory

- Proposes a more involved gluon structure of the Pomeron
- Add perturbative corrections to two reggeized gluons to form a gluon ladder

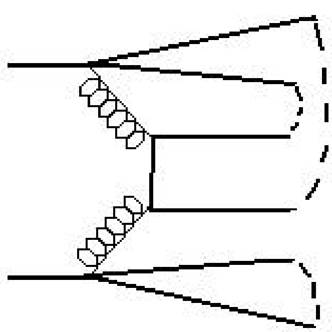


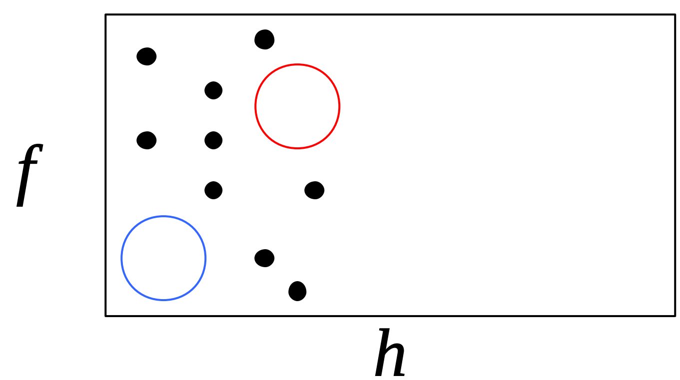
- Use leading logarithmic approximation as the resummation scheme using the BFKL equation
- Resummed amplitude has a cut in the complex angular momentum plane called the BFKL Pomeron
- Causes a different jet topology than I-S

Soft Color Evaporation

- Account for rapidity gaps without need of a Pomeron

- Allow soft color interactions to change the hadronization process such that color lines are canceled and rapidity gaps appear (non-perturbative, color topology of event changes)





- Look at difference in gap production of gluon processes vs. quark processes to find evidence

Measurements using the FPD

- Observation of hard diffractive processes.
- Measure cross sections

$$\frac{d^2 s\left(SD \to jets\right)}{dt dM^2} \qquad \frac{s\left(SD \to jets\right)}{s\left(SD \to all\right)} \qquad \frac{s\left(SD \to jets\right)}{s\left(p\bar{p} \to jets\right)}$$

$$dM = dx/2x \qquad 6\% \text{ for } M_x = 200 \text{ GeV } \left(x = 0.01\right)$$

$$dx = 0.0012 \qquad 3\% \text{ for } M_x = 280 \text{ GeV } \left(x = 0.02\right)$$

$dt = 0.12\sqrt{|t|}$ Dominated by angular dispersion 15% error for $|t| > 0.5 \text{ GeV}^2$ (reduced with unsmearing)

- Measure kinematical variables with sensitivity to pomeron structure (η, E_T, …) Use Monte Carlo to compare to different pomeron structures and derive pomeron structure
- Combine different processes to extract quark and gluon content.

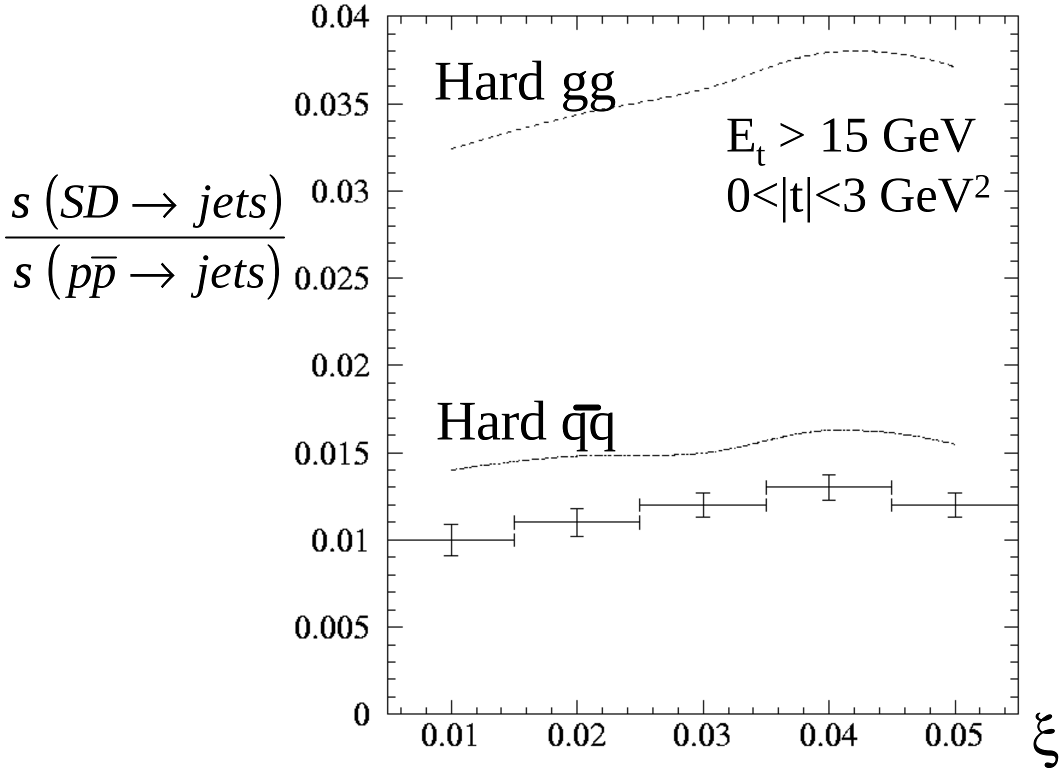
Jet Definition

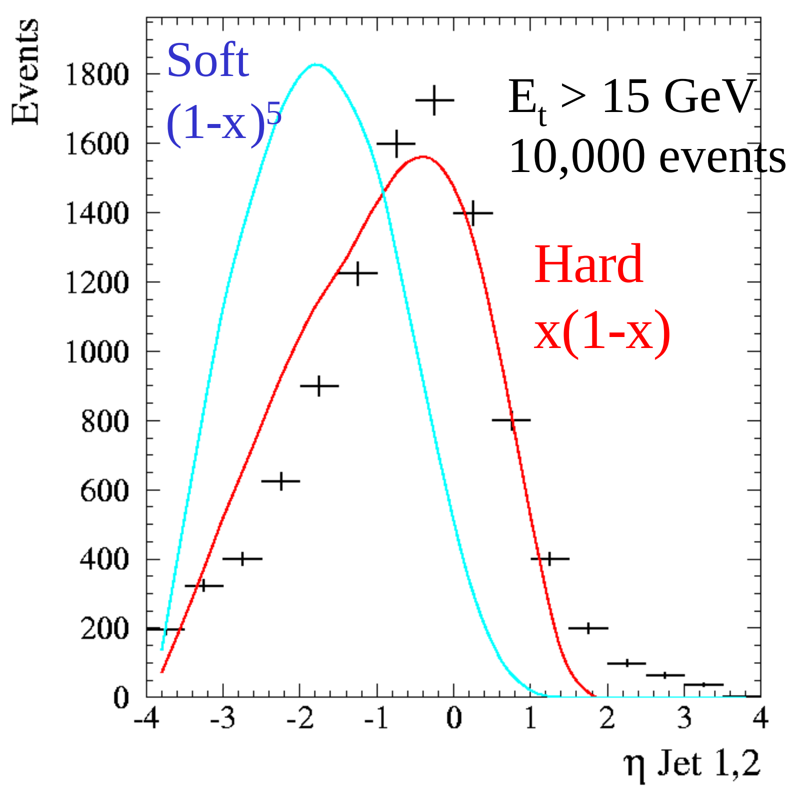
- When looking for dijets start with a loose definition (hard deposition of energy)
- Start with low Et and some tracks →blobs
- As detector matures, refine the definition for better jets
- Use different jet algorithms

Approach

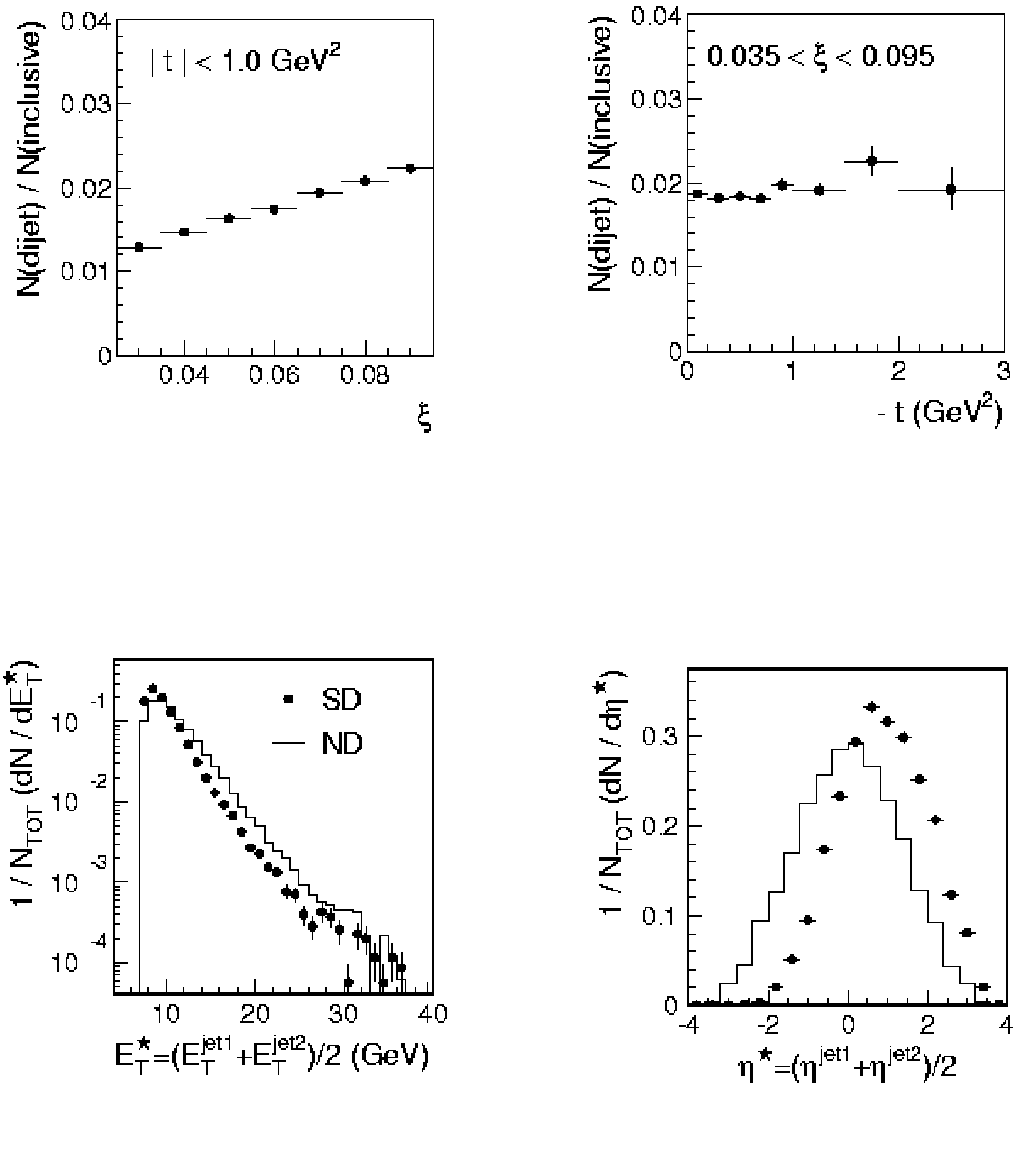
- Read out Roman Pots for all events
- Some dedicated Global triggers for particular processes
- Reject fakes from multiple interactions (SD + dijet) and perform halo rejection
- For 1 fb^{-1} obtain ~ 500K diffractive dijets
- Derive a Pomeron structure function
  - Compare to HERA and CDF functions
- Study jet properties for various ranges of x and t as well as diffractive variables for various jet energies
- Compare to rapidity gap measurements and CDF anti-proton tag measurements from Run Ic

FPD Measurements (1 fb^{-1})





CDF Measurements (Run Ic)



Early Results

- Hit patterns in detectors
- Reconstructed tracks
- Raw t distributions for diffractive and elastic events
- t distributions with and w/o jets
- Jet Et distributions with and w/o protons
- Et and t distributions for two different x (diffractive mass bins)
- fraction of SD events with jets above some threshold
- fraction of jet events with tracks
- double pom candidate events

Conclusion

- FPD adds new ability for DØ to tag scattered particle in diffractive events
- Better coverage than CDF had in Run I
- Compare results from Run I using rapidity gaps to results using tagging
- Derive Pomeron structure function to compare to HERA and CDF
- Try to differentiate between various models of diffraction
- Produce initial paper with new data
- Follow with detailed paper as detector matures