BEYOND THE MONTE CARLOS

Konstantin Goulianos
The Rockefeller University
New York, NY 10021, U.S.A.

Diffractive Monte Carlo Workshop
18-20 July 2001, Fermilab

- Introduction
- Jet-Gap-Jet Events
- The diffractive Structure Function
- Double Pomeron Exchange
- Conclusion

CDF Run I Results on Diffraction

SOFT DIFFRACTION

1) Soft single diffraction	PRD 50 (1994) 5535	
2) Soft double diffraction	NEW RESULT	

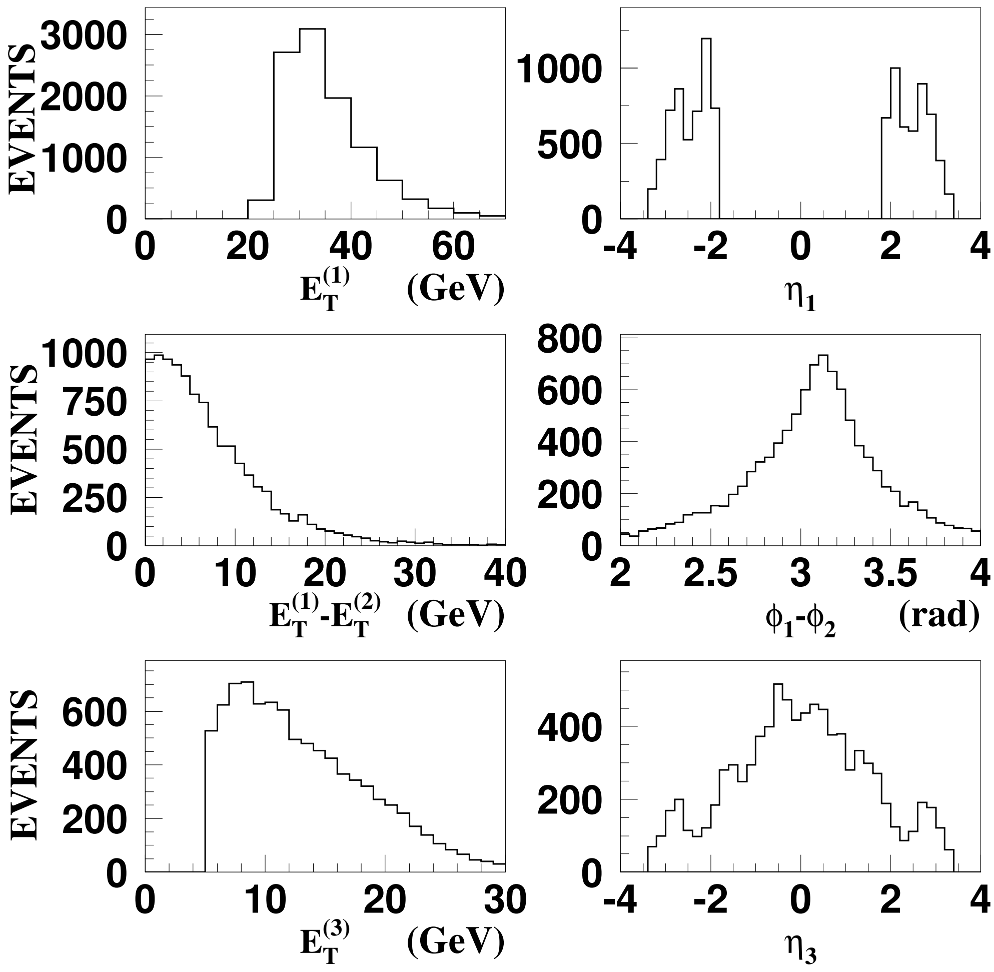
RAPIDITY GAP RESULTS

3) Diffractive W	PRL 78 (1997) 2698	Ph.D. Thesis
4) Diffractive Dijets	PRL 79 (1997) 2636	
5) Diffractive Beauty	PRL 84 (2000) 232	Ph.D. Thesis
6) Diffractive J/ψ	NEW RESULT	Ph.D. Thesis
7) Jet-Gap-Jet 1800	PRL 74 (1995) 855	
8) Jet-Gap-Jet 1800	PRL 80 (1998) 1156	
9) Jet-Gap-Jet 630	PRL 81 (1998) 5278	

ROMAN POT RESULTS

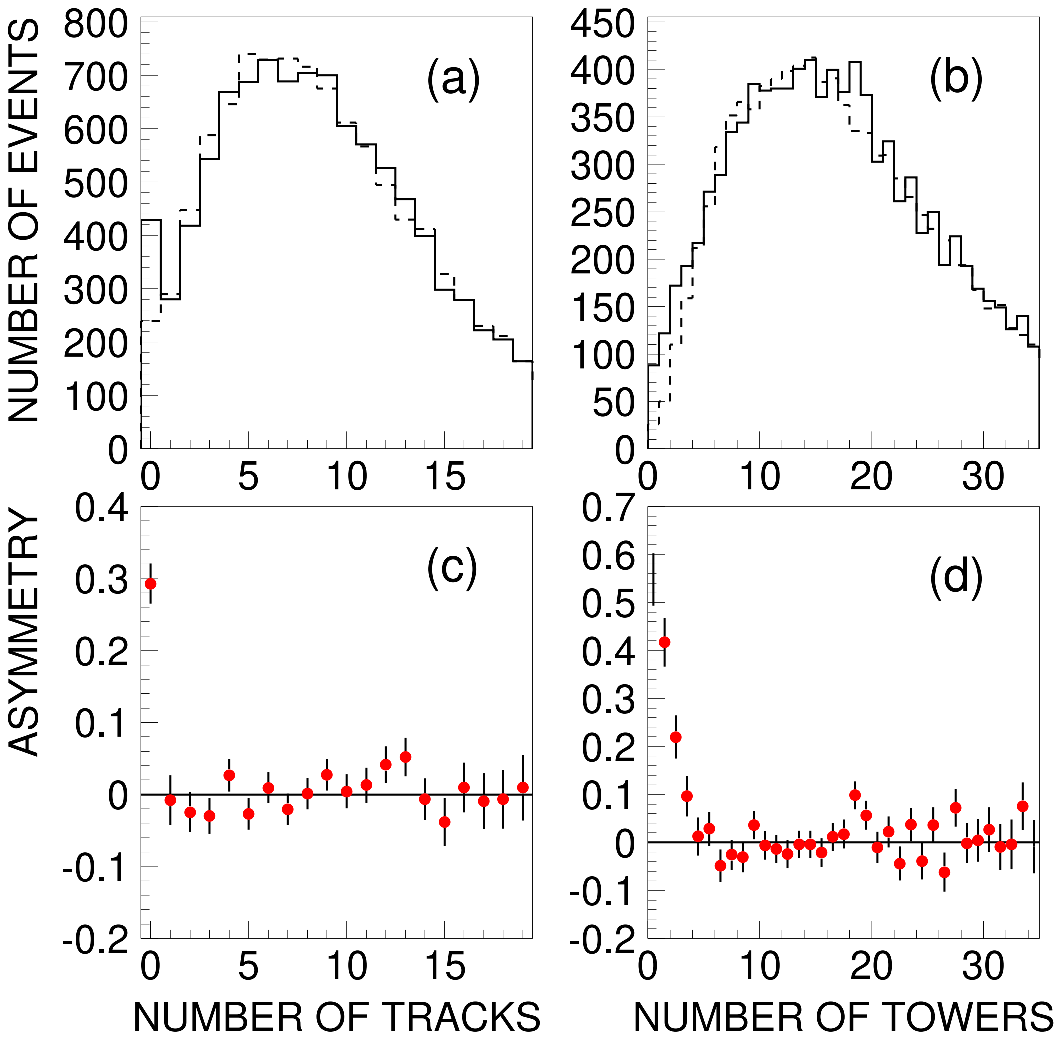
10) Diffractive Dijets 1800	PRL 84 (2000) 5043	Ph.D. Thesis
11) Diffractive Dijets 630	COMING SOON!	Ph.D. Thesis
12) Double Pomeron Dijets	PRL 85 (2000) 4215	Ph.D. Thesis

Jet-Gap-Jet 1800 GeV



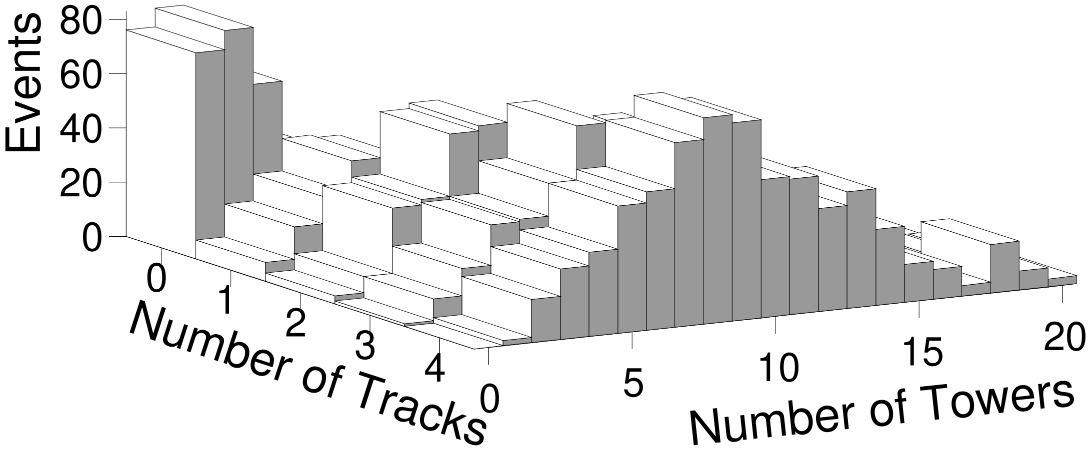
(*top*) Leading jet transverse energy and pseudorapidity (the structure at $|\eta| \sim 2.2 - 2.4$ is instrumental); (*middle*) difference between the transverse energies and azimuthal angles of the two leading jets; (*bottom*) third jet ($E_T^{(3)} > 5$ GeV) transverse energy and pseudorapidity.

Jet-Gap-Jet 1800 GeV



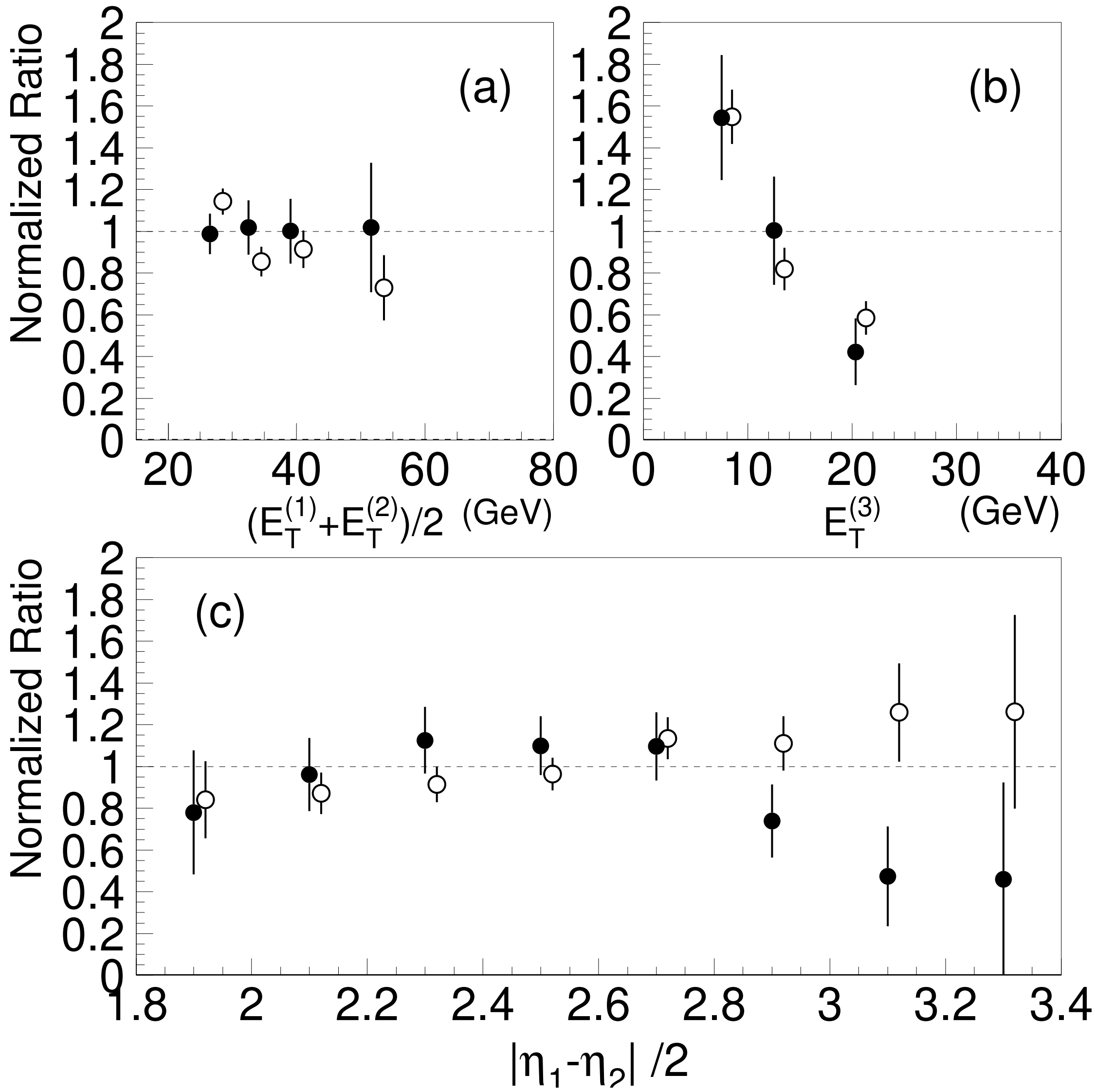
Multiplicity distributions (a) for tracks with $P_T > 300$ MeV and (b) for calorimeter towers with measured $E_T > 200$ MeV in the regions $|\eta| < 1.0$ for opposite-side ($\eta_1\eta_2 < 0$) dijet events (solid lines), and $|\eta| < 1.2$ ($|\eta| < 1.25$) for tracks (towers) of same-side ($\eta_1\eta_2 > 0$) dijet events (dashed lines); (c,d) The bin-by-bin asymmetry, defined as the ratio of the difference over the sum of the opposite-side and same-side multiplicity distributions of (a) and (b).

Jet-Gap-Jet 1800 GeV



Track versus tower multiplicity distribution for events in the $N_{\mathrm{vertex}} \leq 1$ opposite-side dijet sample with $N_{\mathrm{track}} < 5$ and $N_{\mathrm{tower}} < 20$ within $|\eta| < 1.0$. The bins with zero tracks and 0, 1 or 2 towers contain an excess of events above the expectation from an extrapolation from the bins with $N_{\mathrm{track}} > 1$. This excess is attributed to events from color-singlet exchange.

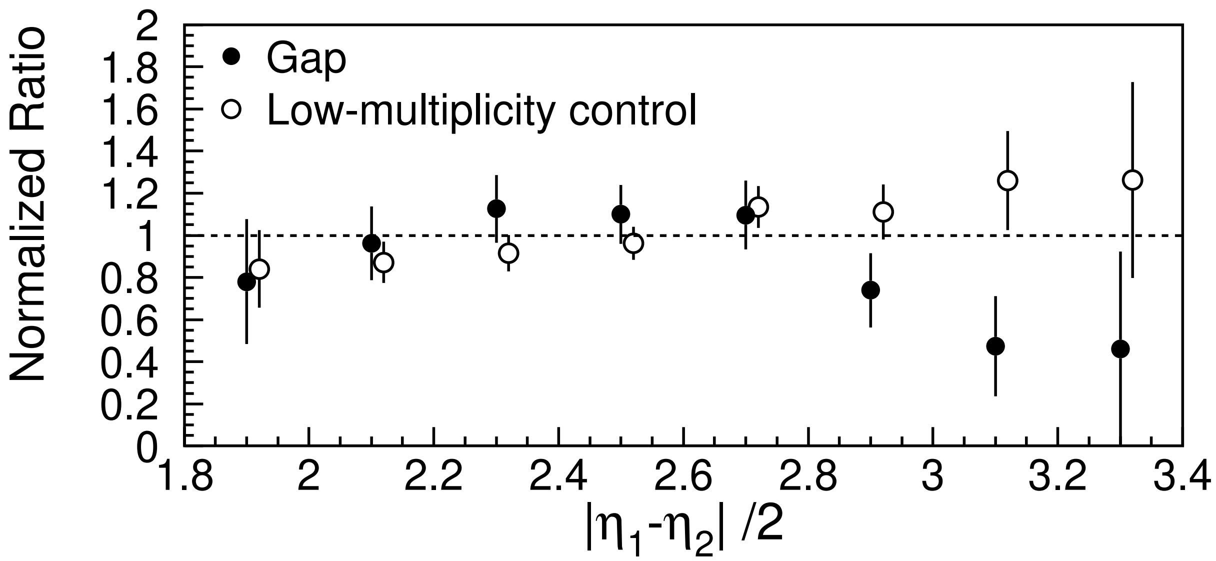
Jet-Gap-Jet 1800 GeV

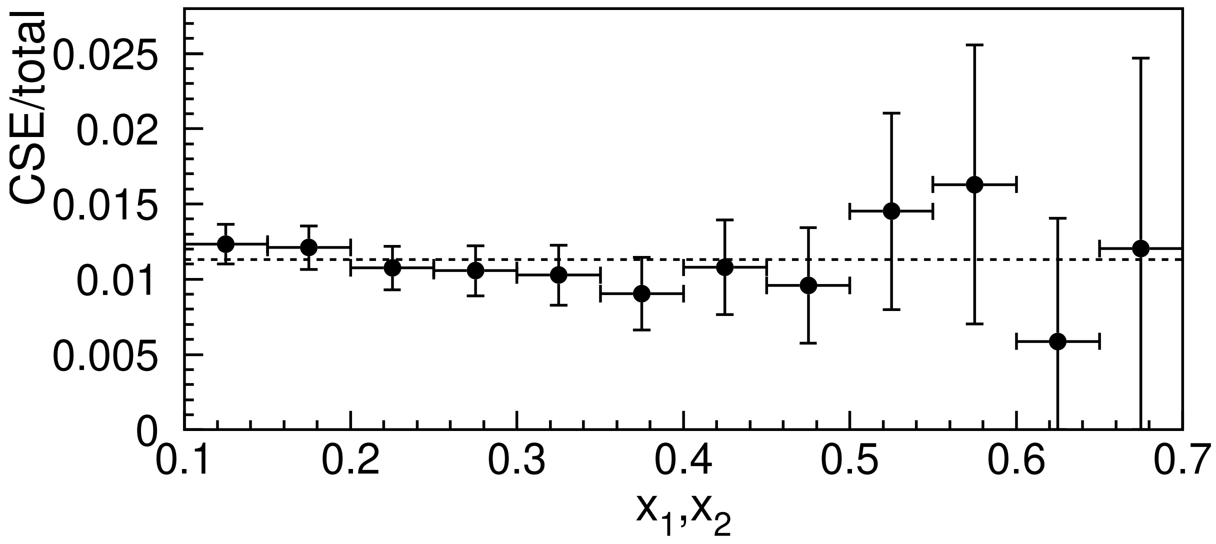


Normalized (to be unity on average) ratios of gap (solid points) and control sample events (open circles) over all events versus: (a) the average E_T of the two leading jets, (b) the E_T of the third jet, and (c) half the η separation between the two leading jets.

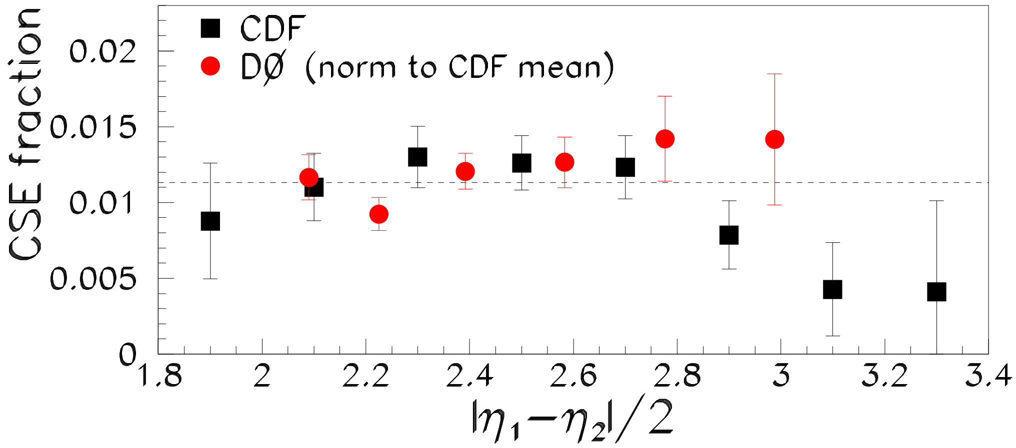
Jet-Gap-Jet 1800 GeV

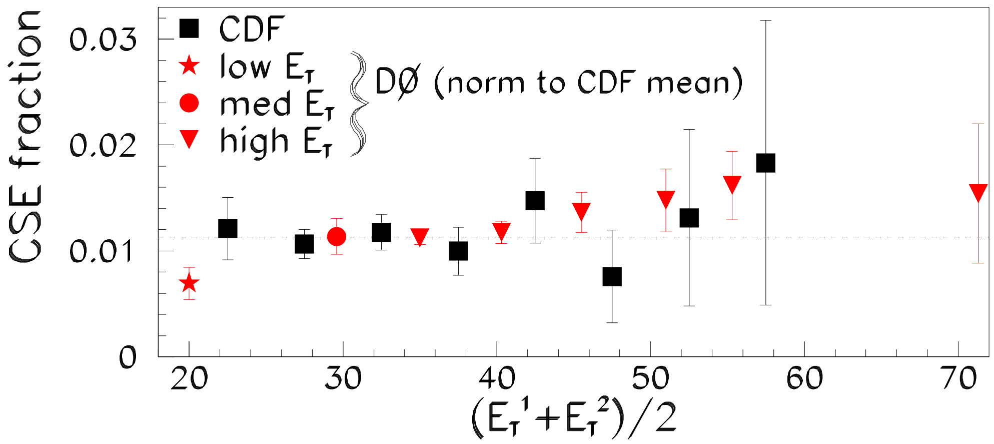
CDF Results: PRL 80, 1156 (1998)





Jet-Gap-Jet Events
$\sqrt{s}$ =1800 GeV





Roman Pot Dijet Data

Structure Function Measurement

- $$x_{\bar{p}} = p_{g,q}/p_{\bar{p}} = \frac{\sum_{i=1,2(3)} E_T^{(i)} \cdot e^{-\eta_{(i)}}}{\sqrt{s}}$$
  (if $E_T^{(3)} > 5$ GeV, include the 3rd jet)

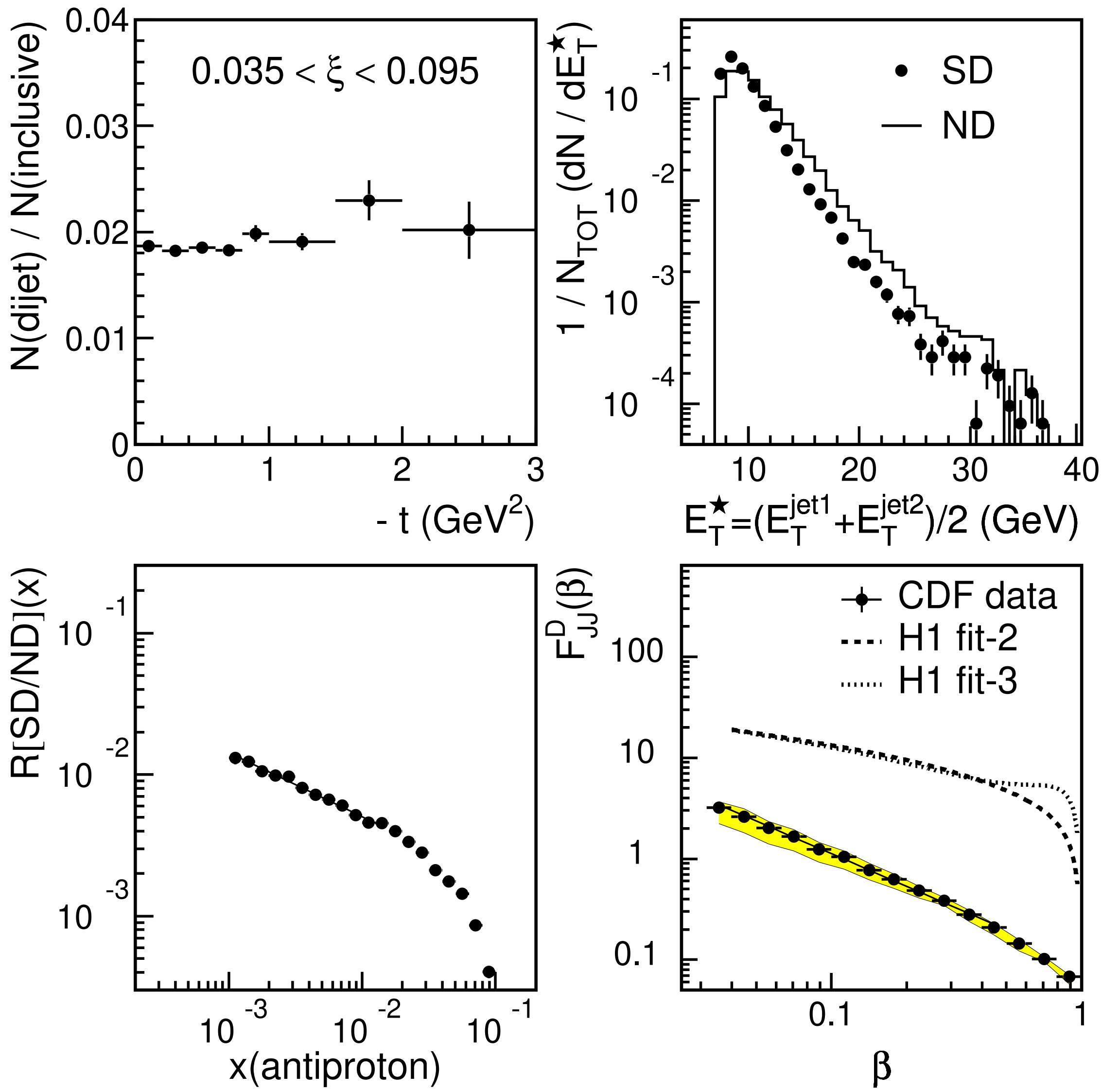
- $$R_{\frac{SD}{ND}}(x_{\bar{p}}, \xi) = F_{jj}^D(x_{\bar{p}}, \xi)/F_{jj}(x_{\bar{p}})$$
  $$\left(F_{jj}^{(D)}(x_{\bar{p}}) = x_{\bar{p}}\left[g^{(D)}(x_{\bar{p}}) + \frac{4}{9}\sum(q_i^{(D)}(x_{\bar{p}}) + \bar{q}_i^{(D)}(x_{\bar{p}}))\right]\right)$$

- $$F_{jj}^D(x_{\bar{p}}, \xi) = R_{\frac{SD}{ND}}(x_{\bar{p}}, \xi) \times F_{jj}(x_{\bar{p}})$$

- $$F_{jj}^D(x_{\bar{p}}, \xi) \longrightarrow F_{jj}^D(\beta, \xi)$$
  $$\beta = x_{\bar{p}}/\xi$$

Roman pot dijets

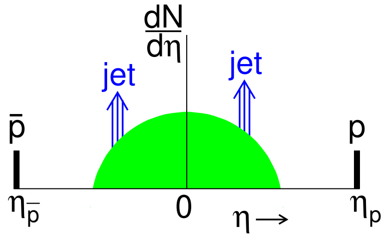
<u>diffractive structure function</u>

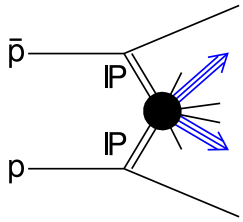


- Dijet to inclusive production ratio is t-independent
- Regge factorization for $\beta < 0.5$

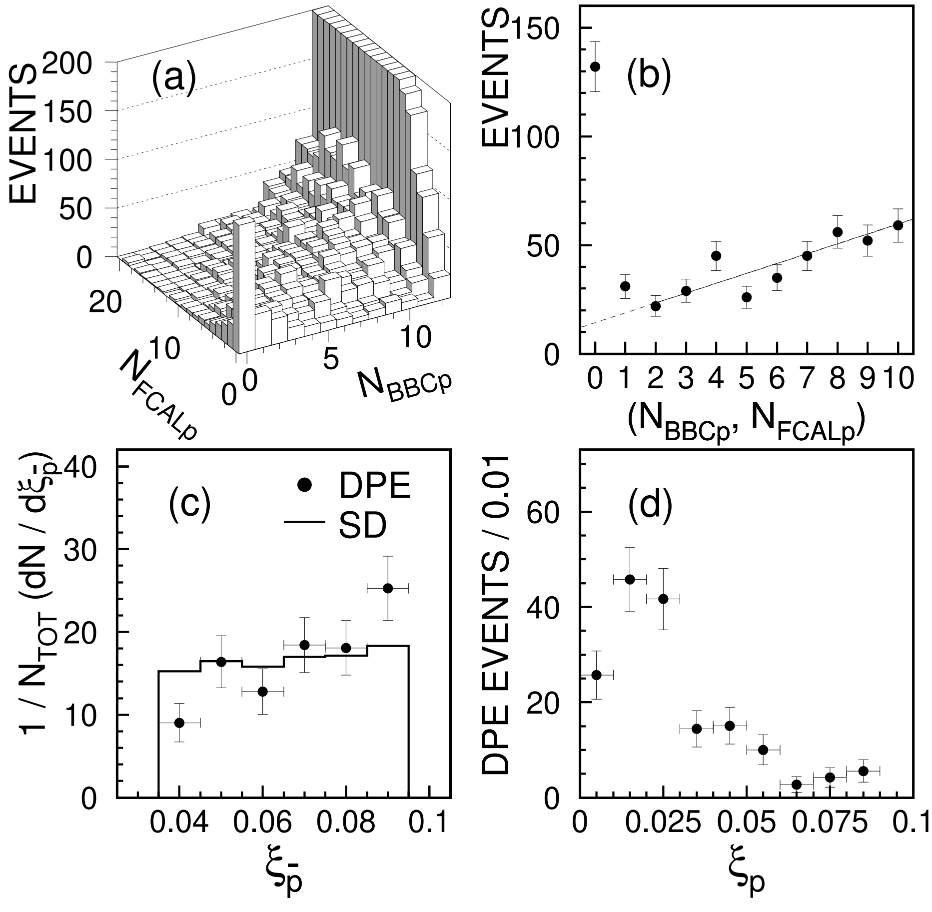
$$F_{jj}^{D}(\xi,\beta) \propto \frac{1}{\xi^m} \cdot \frac{1}{\beta^n} \quad (m \approx n \approx 1)$$

Double Pomeron Event Sample





$0.035 < \xi_{pbar} < 0.095$
$E_T^{jet1,2} > 7$ GeV

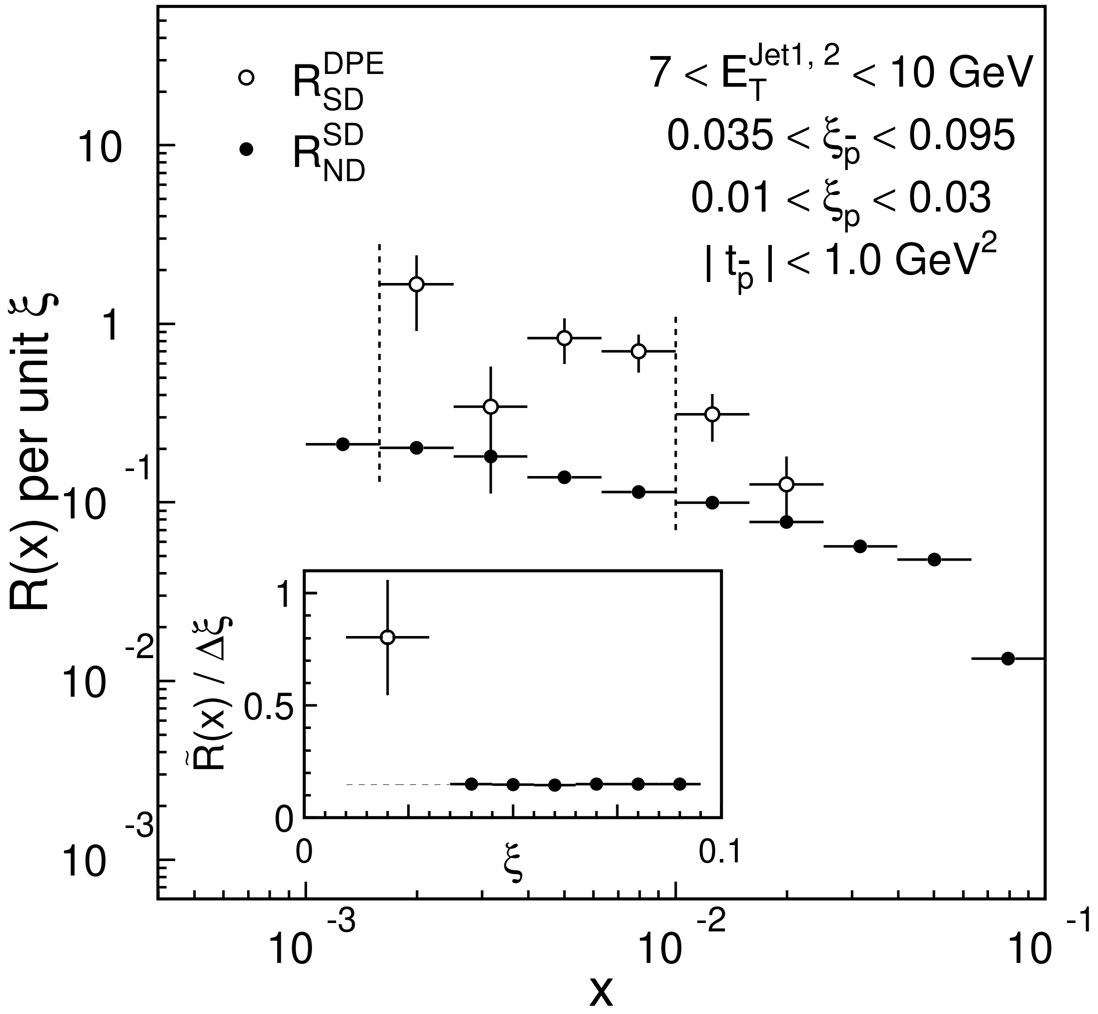


(a) Forward detector multiplicities: FCAL vs. BBC
(b) Diagonal multiplicity distribution
(c) ξ_{pbar} distribution for SD and DPE events
(d) $\xi_p = f_{cal} \times \frac{1}{\sqrt{s}} \Sigma_{i=1}^{N}$ (all particles) $E_T^i e^{+\eta_i}$

$f_{cal} = 1.7$, obtained from $\xi_{\bar{p}}^{RPS}$ vs $\xi_{\bar{p}}^{X} = \frac{1}{\sqrt{s}} \Sigma_{i=1}^{N} E_T^i e^{-\eta_i}$

Factorization test

Compare ratios $R_{SD}^{DPE}(x_p, \xi_p)$ and $R_{ND}^{SD}(x_{pbar}, \xi_{pbar})$
(per unit ξ)



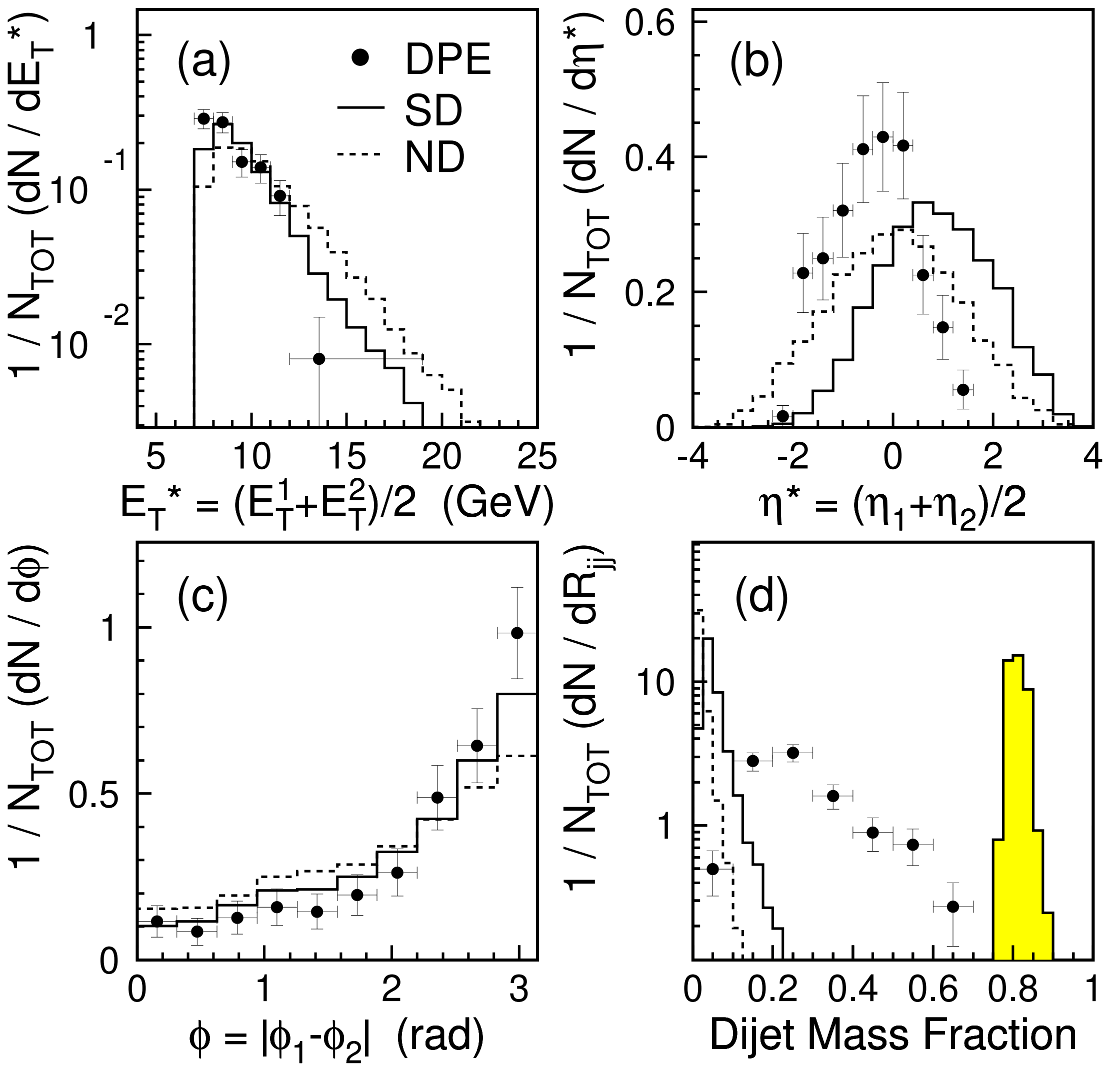
INSET: $\tilde{R}$ = weighted average of R per unit ξ in the region $1.5 \times 10^{-3} < x < \xi_p^{min}$ as a function of ξ.

$\tilde{R}_{SD}^{DPE}(\xi_p) = 0.80 \pm 0.26$ $\qquad$ $\tilde{R}_{ND}^{SD}(\xi_{pbar}) = 0.15 \pm 0.02$

$$\boxed{D = \tilde{R}_{ND}^{SD} / \tilde{R}_{SD}^{DPE} = 0.19 \pm 0.07}$$

$D \neq 1 \Rightarrow$ Breakdown of factorization

Double Pomeron Dijet Kinematics



(a) Average dijet E_T
(b) Average dijet pseudorapidity
(c) $\phi \equiv |\phi^{jet1} - \phi^{jet2}|$
(d) Dijet mass fraction: $R_X^{JJ} = M_{JJ}(cone)/M_X$
$M_{JJ}(cone)$ $\Rightarrow$ dijet mass from $E_T^{jet1,2}$ within cone of 0.7
$M_X = \sqrt{\xi_{\bar{p}}^{RPS} \cdot \xi_p^X \cdot s}$ $\Rightarrow$ total DPE c.m.s. energy

$\boxed{\text{CONCLUSIONS}}$

$\boxed{???}$