Review of Recent CDF Diffraction Results

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Nov 4, 1999

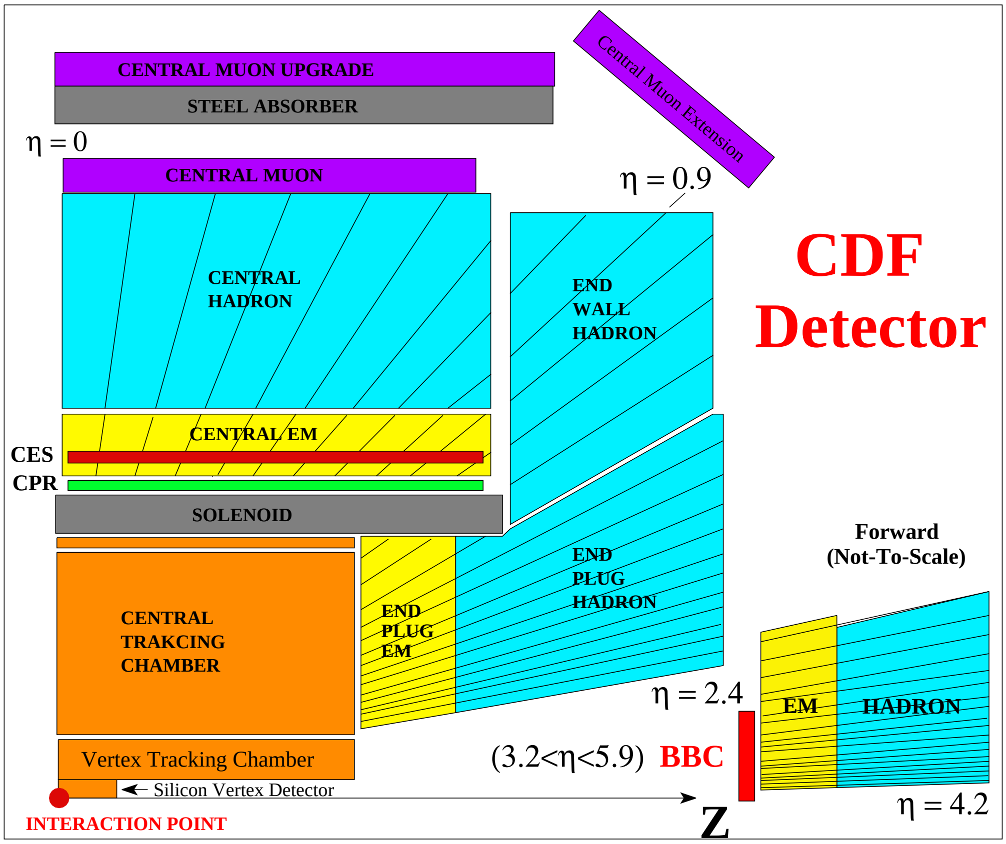
I. Rapidity gaps in hard single diffraction:
   b and J/ψ production

II. Diffractive dijets with Roman pots

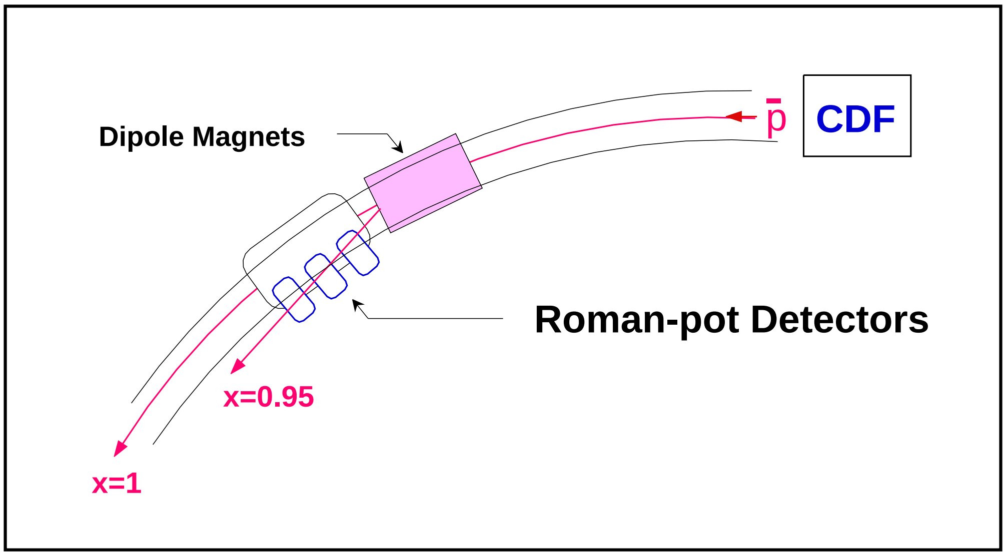
III. Double Pomeron exchange

IV. Soft double diffraction

Apparatus

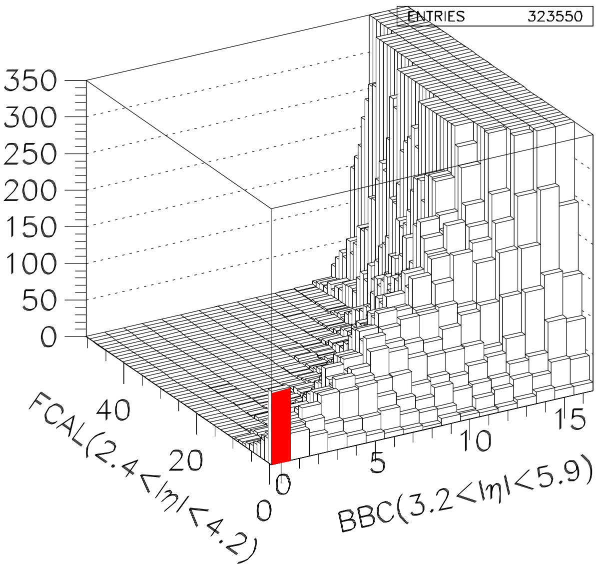


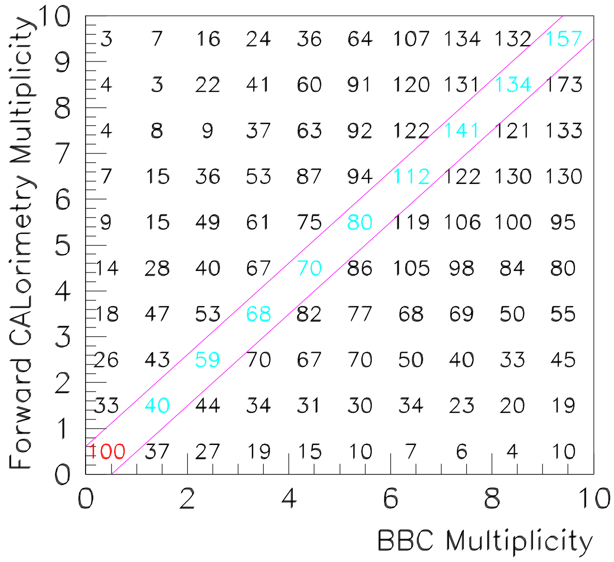
In Run 1C ('95-'96)

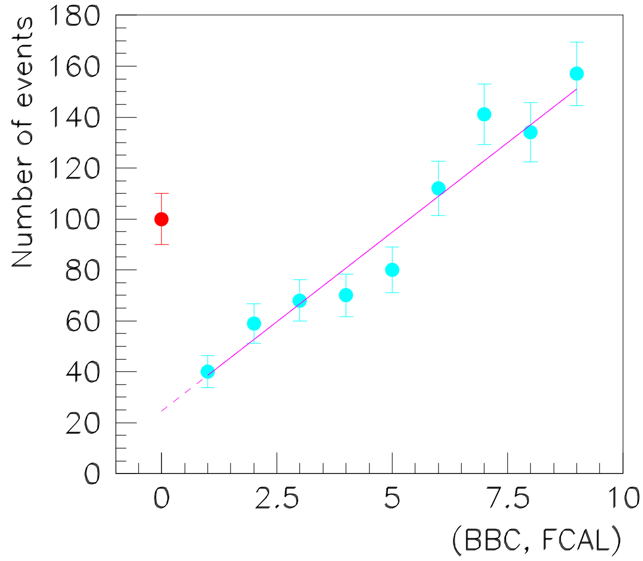


Diffractive b-quark production at $\sqrt{s} = 1800$ GeV

CDF Preliminary







Diffractive/Non–Diffractive Ratio

$R_{bb} \times A = [0.26 \pm 0.08(\text{stat.})]\%$

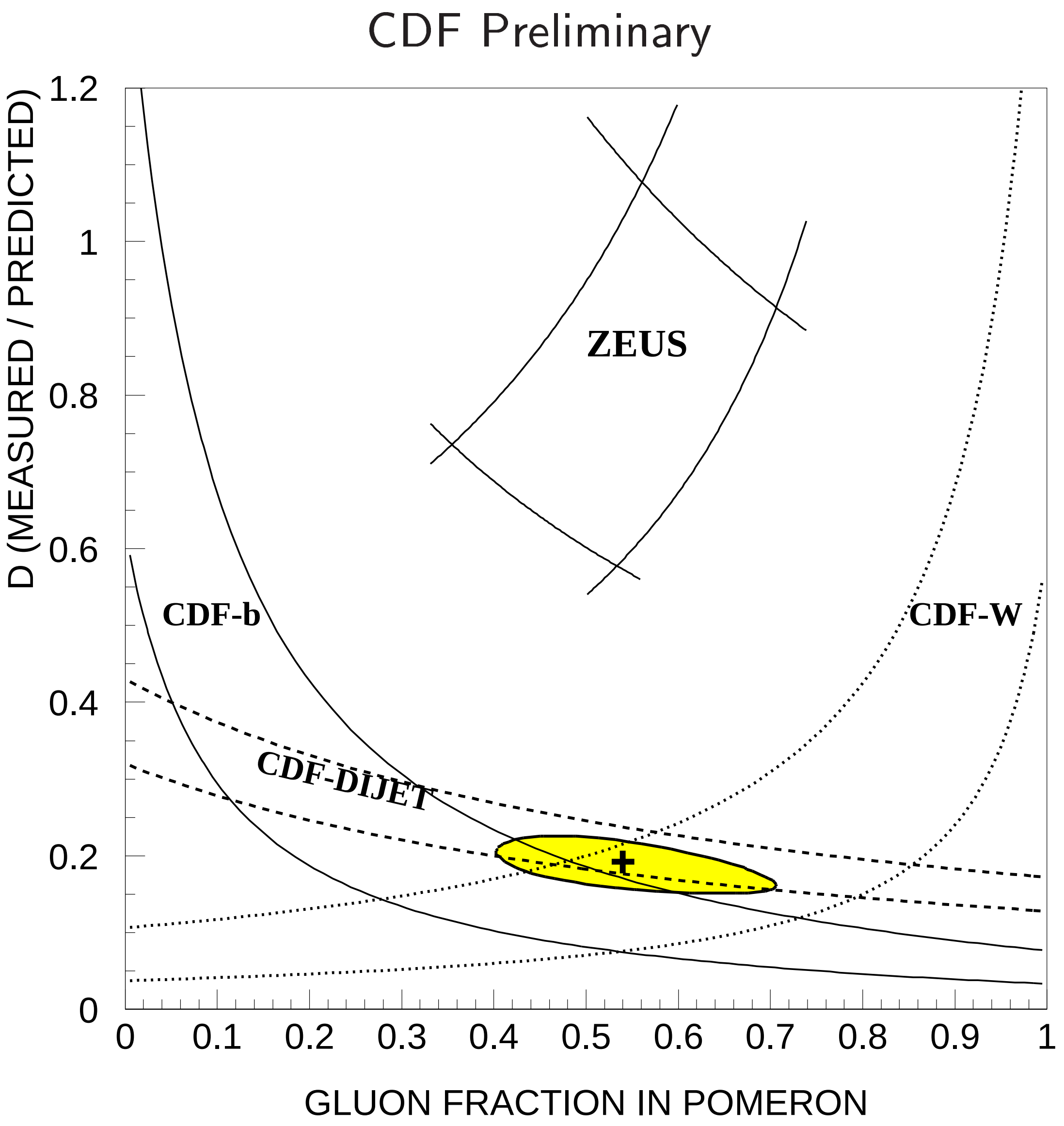
where A is the GAP Acceptance

GAP definition:

- $-5.9 \leqq \eta \leqq -3.2$ or $3.2 \leqq \eta \leqq 5.9$
  No charged particles
- $-4.2 \leqq \eta \leqq -2.4$ or $2.4 \leqq \eta \leqq 4.2$
  No charged or neutral particles of $E \geqq 1.5$GeV

$$R_{\bar{b}b} = [0.62 \pm 0.19(stat) \pm 0.14(syst)]\%$$

Gluon Content



$$f_g = 0.54^{+0.16}_{-0.14}$$

CDF Hard Diffractive Rapidity Gap Results

Diffractive W

$R_W \left(\frac{SD}{ND}\right) = (1.15 \pm 0.55)\%$

PRL 78, 2698 (1997)

Diffractive dijets

$R_{JJG} \left(\frac{SD}{ND}\right) = (0.75 \pm 0.10)\%$

$E_T^{jet} > 20$ GeV, $\eta^{jet} > 1.8$, $\eta_1 \cdot \eta_2 > 0$

PRL 79, 2636 (1997)

b-quark production

$R_b \left(\frac{SD}{ND}\right) \times A = (0.26 \pm 0.08)\%$

$E_T^e > 9.5$ GeV, $\eta^e < 1.1$

$A \approx 0.4 \ (2.4 \leq |\eta^{gap}| \leq 5.9)$

submitted to PRL

J/ψ production

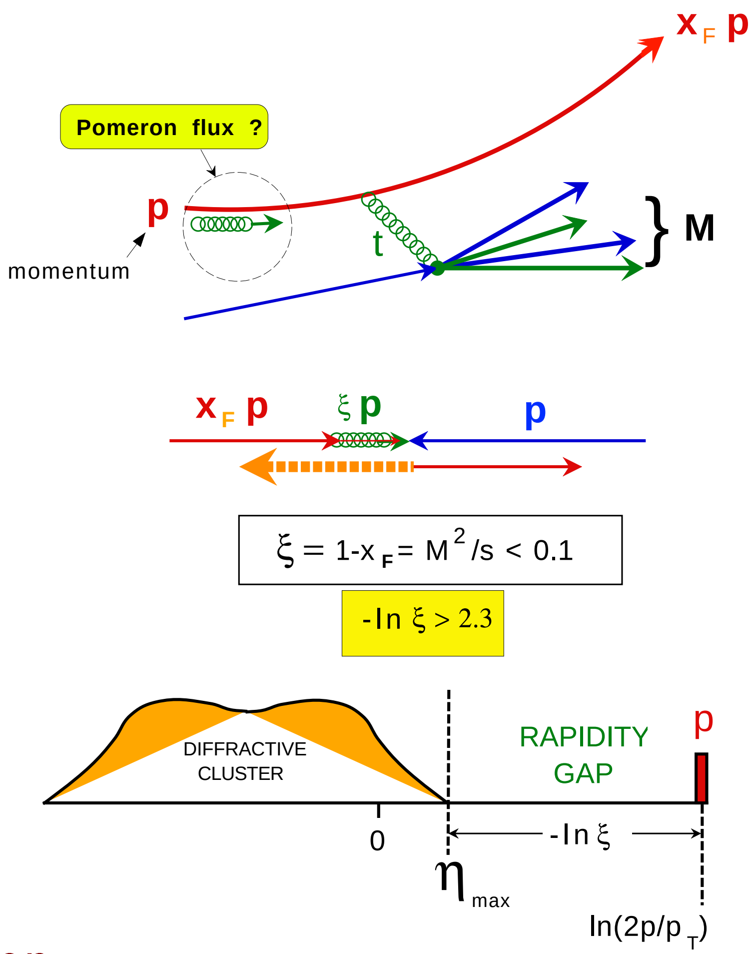
results similar to b

preliminary

all ratios $\sim 1\%$

Hard Diffraction in $\bar{p}p$ Collisions

Diffraction Dissociation



Factorization

$$\frac{d\sigma(\bar{p}\,p \;\to\; \bar{p} \,+\, X)}{d\xi\ dt\ dx_{\bar{p}}\ dx_p} = f_{I\!P/\bar{p}}(\xi,t)\,\frac{d\sigma(p\ I\!P \;\to\; X)}{d\beta\ dx_p}, \quad (x_{\bar{p}} = \beta\cdot\xi)$$

t : *Four Momentum Transfer Squared*

$$x_{\bar{p}} = p_{g,q}/p_{\bar{p}}, \qquad\qquad x_p = p_{g,q}/p_p$$

$$\xi = 1 - x_F = p_{I\!P}/p_{\bar{p}}, \qquad \beta = p_{g,q}/p_{I\!P}$$

Diffractive Structure Functions

$$x_{\bar{p}} = \sum_i^{N_{jets}} \frac{E_T^i e^{-\eta_i}}{\sqrt{s}}$$

- measure SD/ND ratio as function of $x_{\bar{p}}$
  (SD, ND jets have $\sim$ same η, E_T at fixed $x_{\bar{p}}$)

$\rightarrow$ ratio of SD to ND structure functions

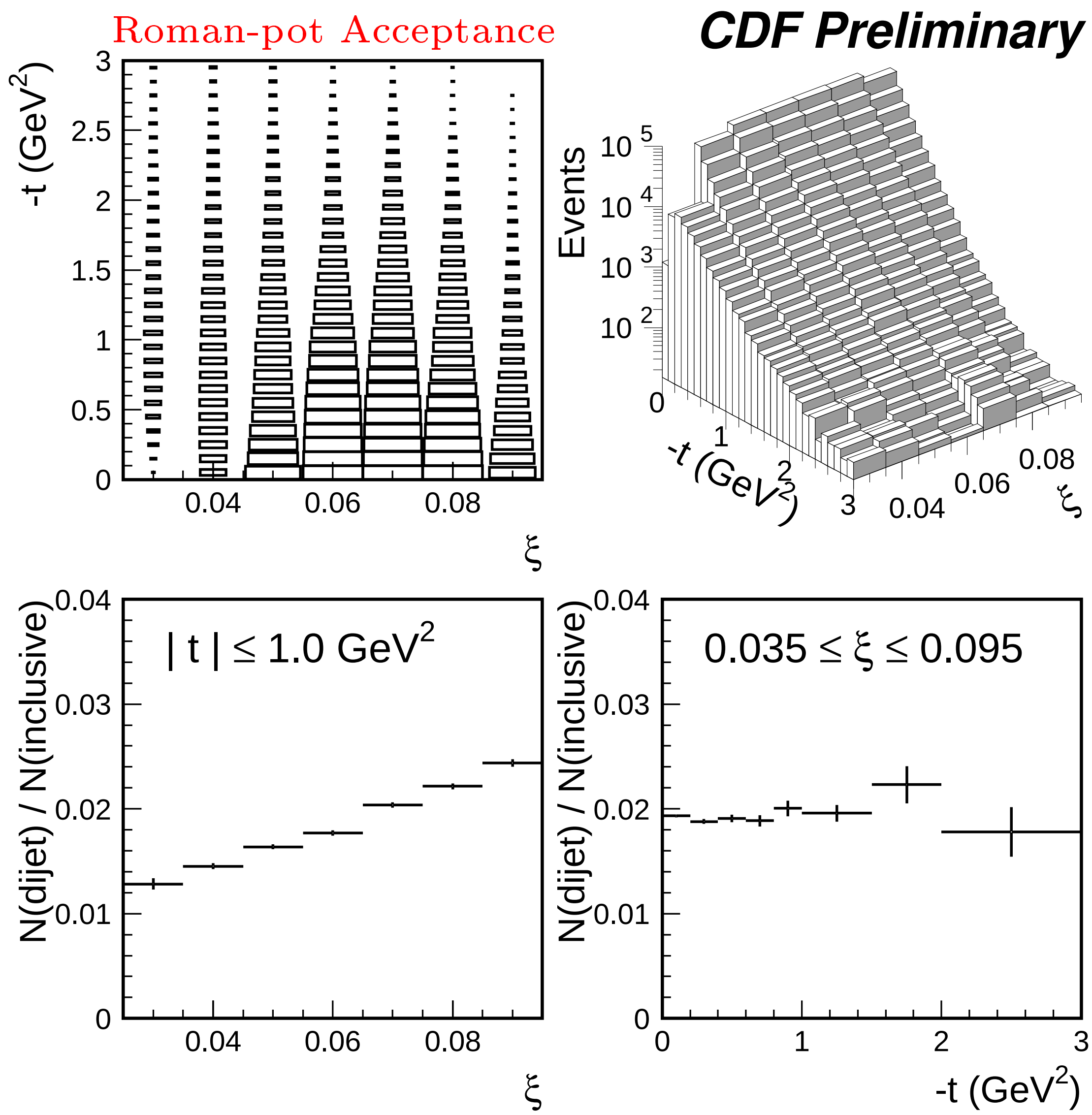
$$R_{\frac{SD}{ND}}(x_{\bar{p}}) = \frac{F_{JJ}^{D}(x_{\bar{p}})}{F_{JJ}(x_{\bar{p}})}$$

- multiply by known ND structure function

$$F_{JJ}^{(D)}(x_{\bar{p}}) = x_{\bar{p}} \left[g^{(D)}(x_{\bar{p}}) + \frac{4}{9} \sum_i \left(q_i^{(D)}(x_{\bar{p}}) + \bar{q}_i^{(D)}(x_{\bar{p}}) \right) \right]$$

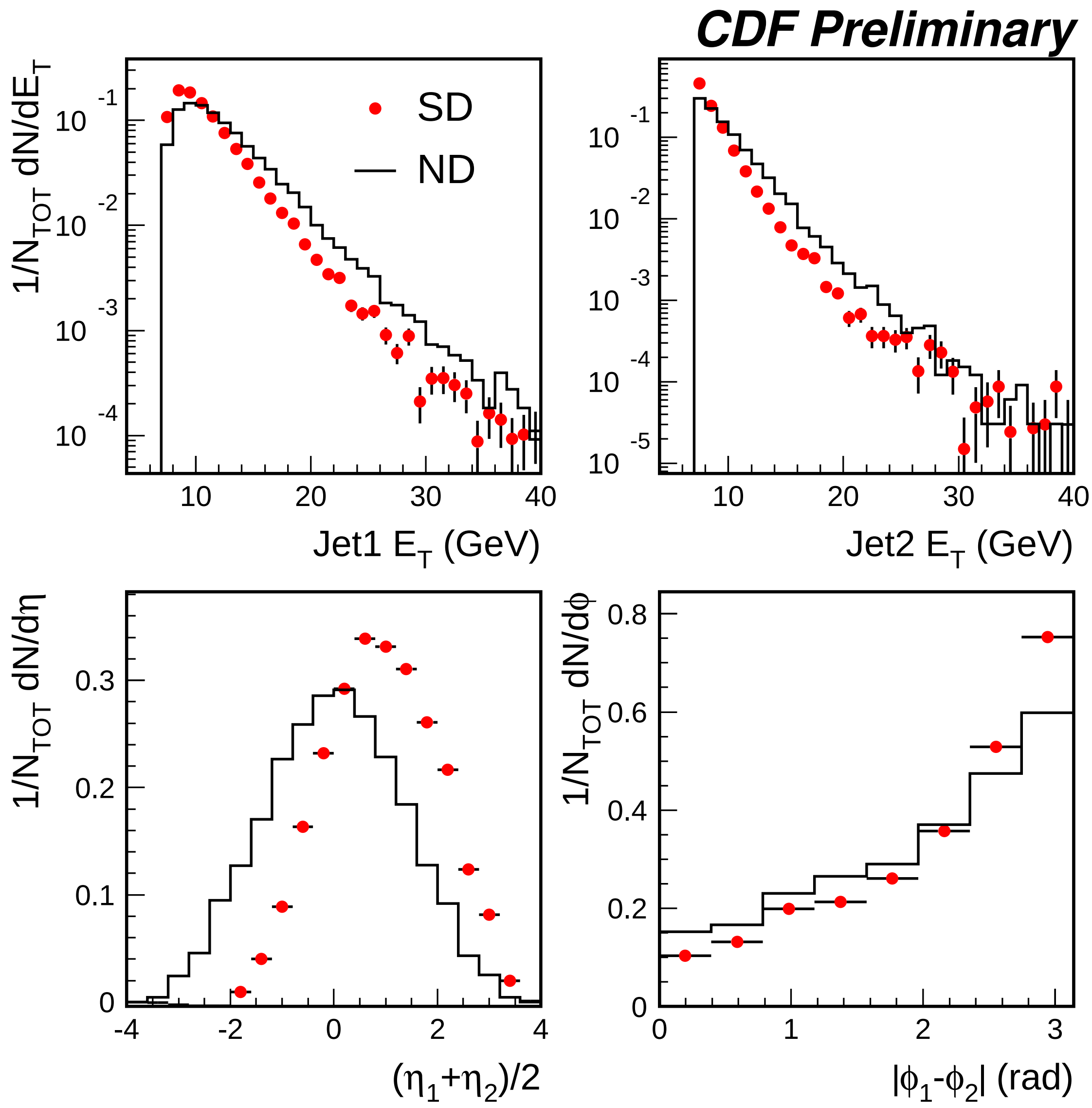
$\rightarrow$ structure function for events with gaps
independent of MC, $I\!\!P$

Roman-pot Acceptance, $R_{\frac{dijet}{incl}}$ vs ξ, t



- R(Dijet/Inclusive) increases with increasing ξ.
- R(Dijet/Inclusive) is approximately flat in the measured t region.

E_T, η and $\Delta\phi$ of Diffractive Dijets

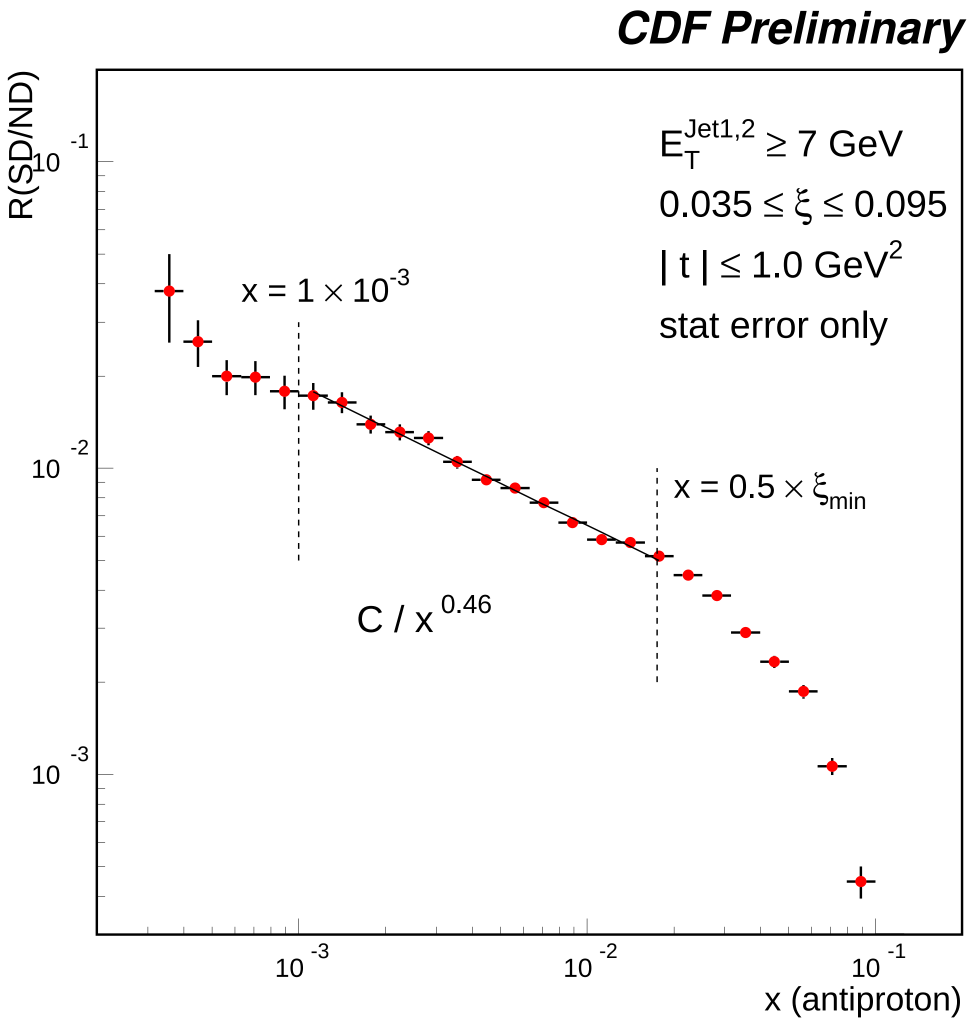


- Diffractive dijet boosted to the $p-$beam direction
- Diffractive dijets are more back-to-back $\Rightarrow$ less radiation

Diffr. to Non-diffr. Ratio as a Function of $x_{\bar{p}}$

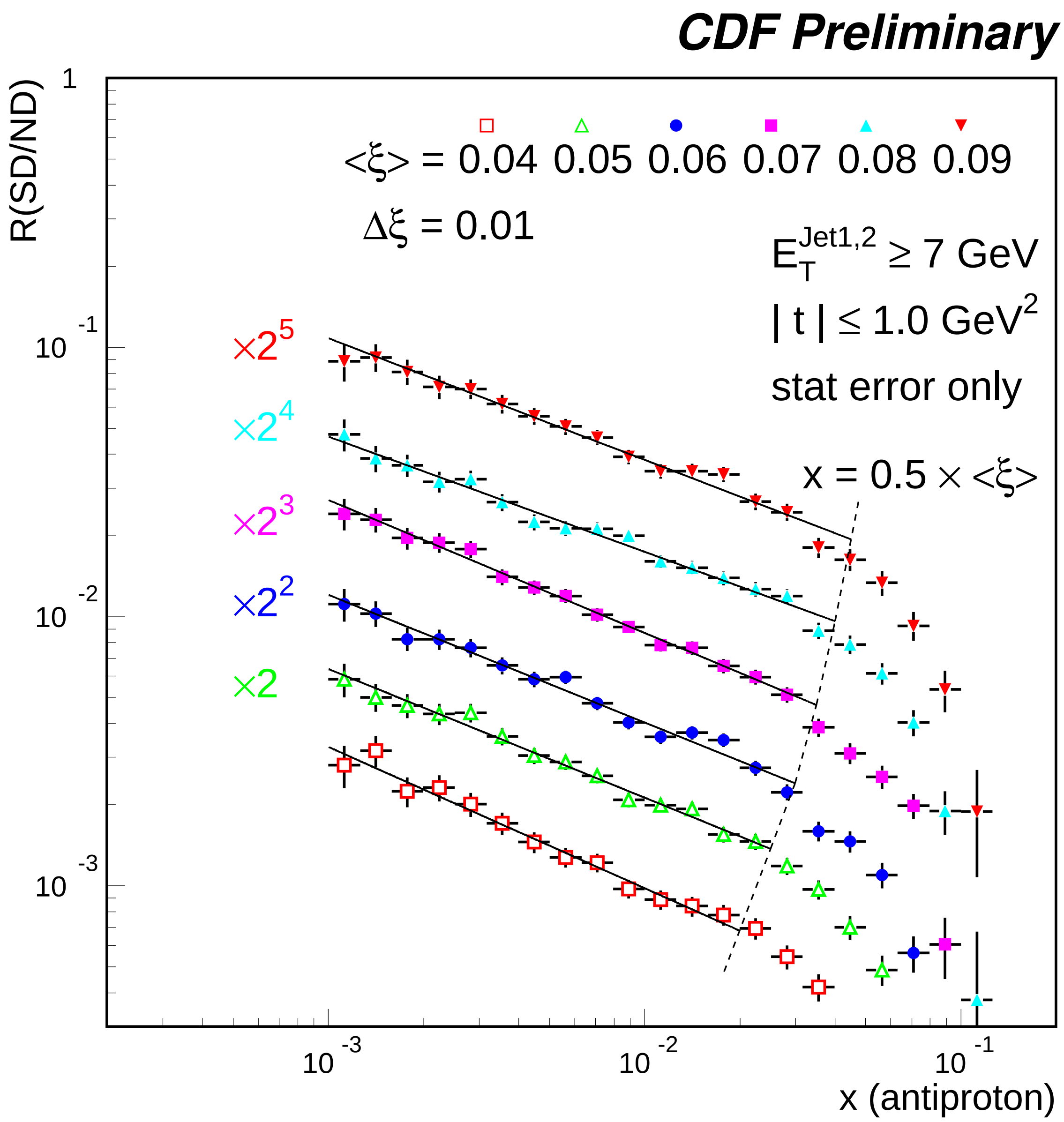
$$R_{\frac{SD}{ND}}(x_{\bar{p}}) = \frac{F_{JJ}^{D}(x_{\bar{p}})}{F_{JJ}(x_{\bar{p}})}$$

$$F_{JJ}^{(D)}(x_{\bar{p}}) = x_{\bar{p}} \left[g^{(D)}(x_{\bar{p}}) + \frac{4}{9}\Sigma(q_i^{(D)}(x_{\bar{p}}) + \bar{q}_i^{(D)}(x_{\bar{p}})) \right]$$



The distribution fits to $C/{x_{\bar{p}}}^n$ in the range of $10^{-3} < x_{\bar{p}} < 0.5 \times \xi_{min}$.

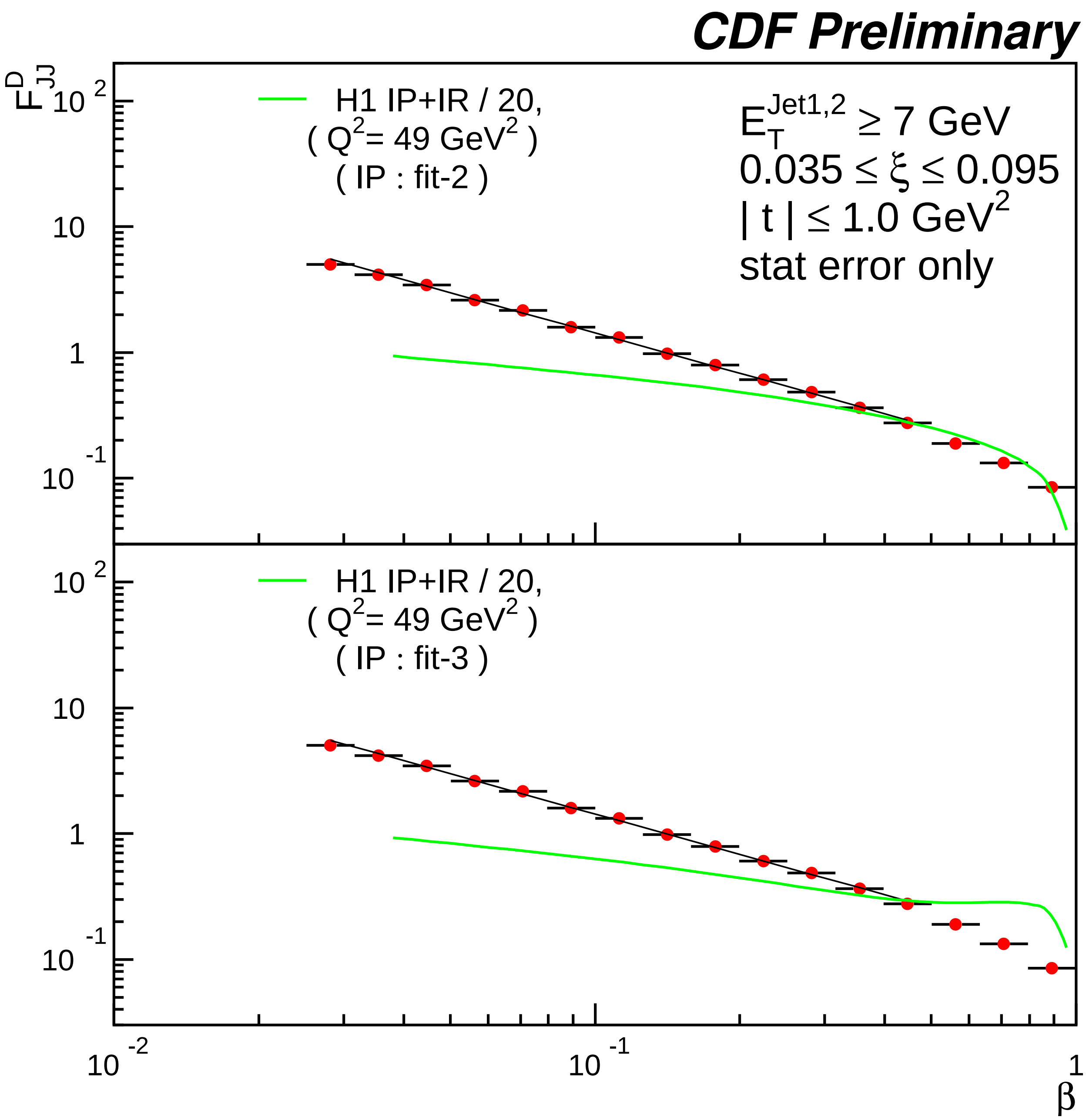
ξ-dependence of $R_{\frac{SD}{ND}}(x_{\bar{p}})$



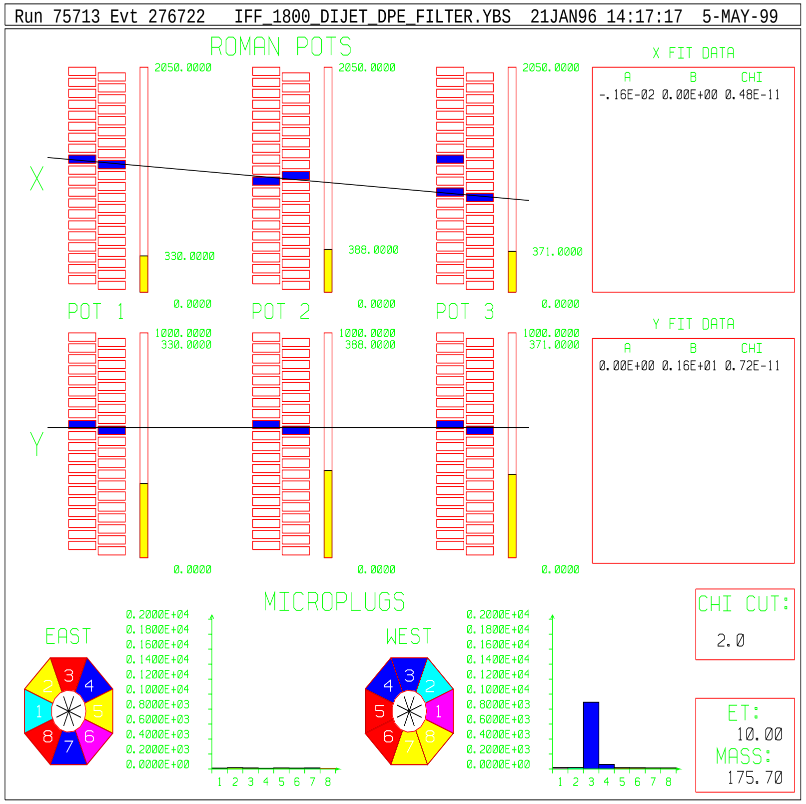
The slope is approximately the same over the measured ξ range.

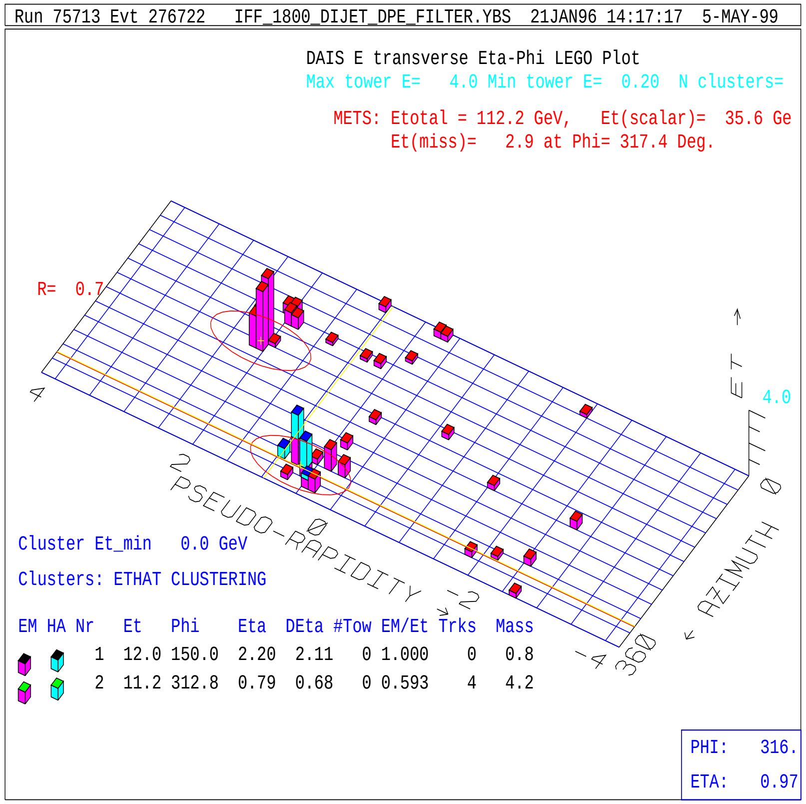
Comparison with H1

$$\beta = x_{\bar{p}}/\xi$$



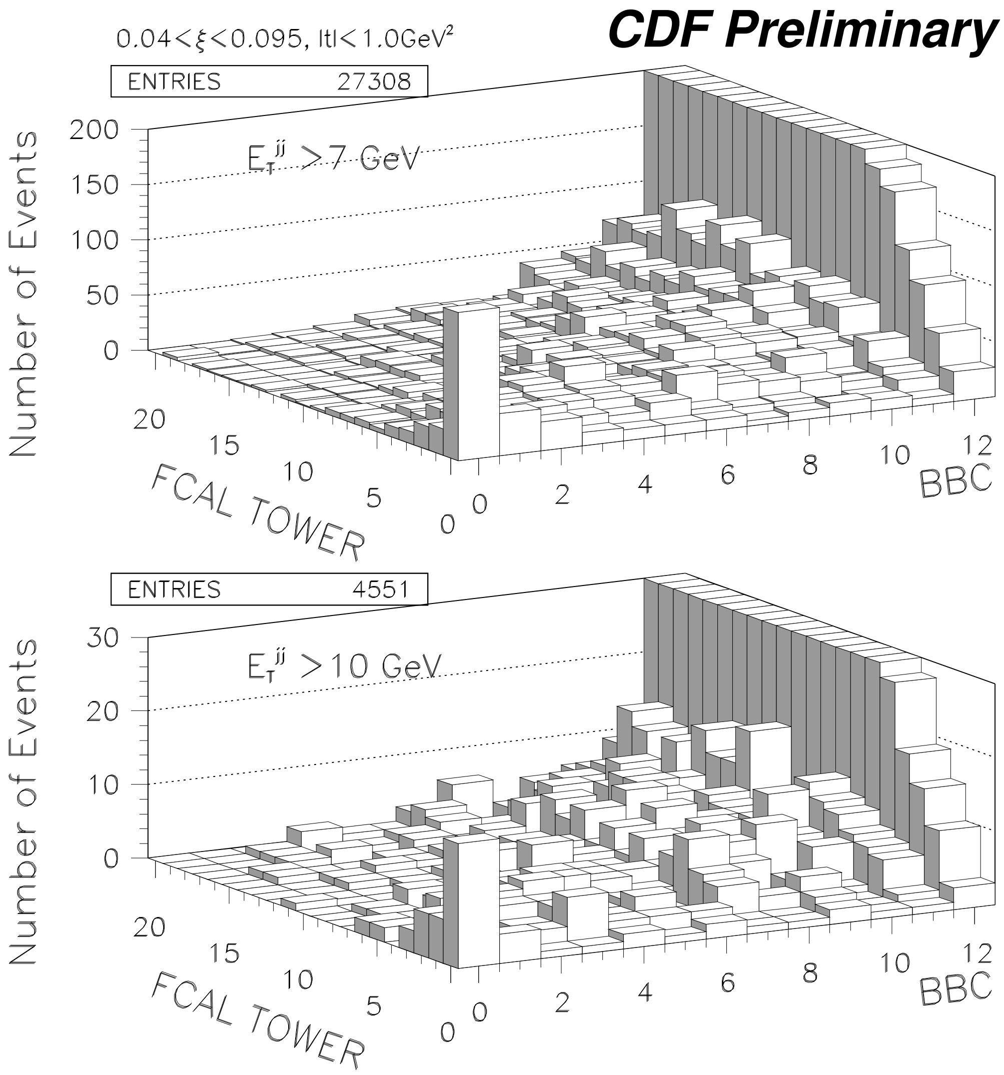
Candidate of Double Pomeron Exchange Dijet





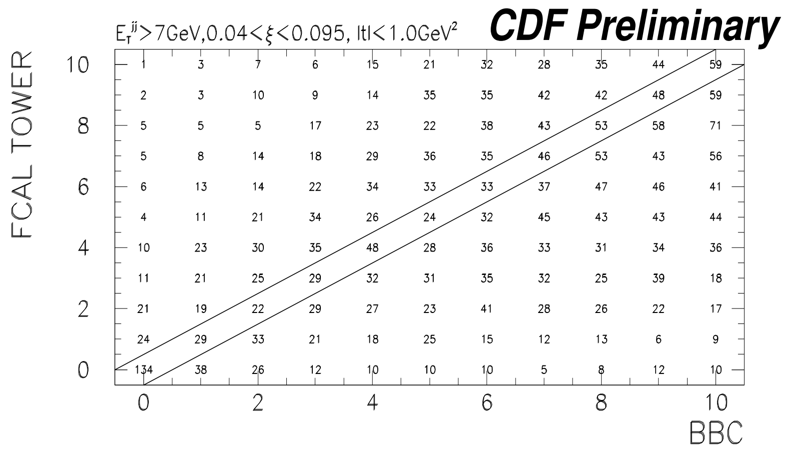
Jet 1	$E_T = 19.0$ GeV, $\eta = 2.2$	Proton Side	$N_{BBC}(2.4 < \eta < 4.2) = 0$
Jet 2	$E_T = 18.1$ GeV, $\eta = 0.79$		$N_{FCAL}(2.4 < \eta < 4.2) = 0$
Pot	$\xi = 0.070$, $\lvert t \rvert = 0.0097$ GeV^2		

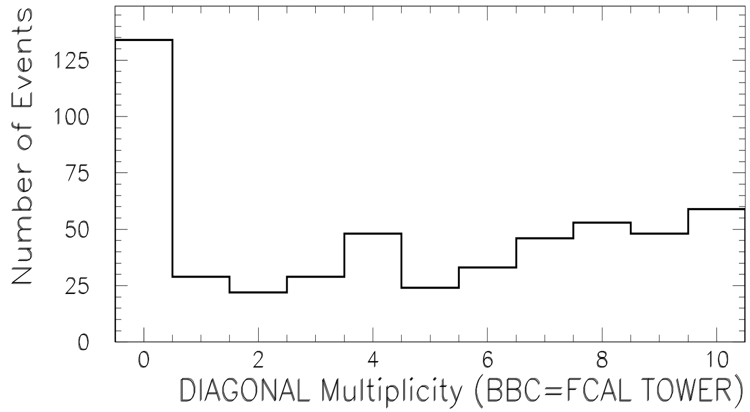
Search for Double Pomeron Dijets



Diagonal BBC($3.2 < \eta < 5.9$) vs FCAL($2.4 < \eta < 4.2$)

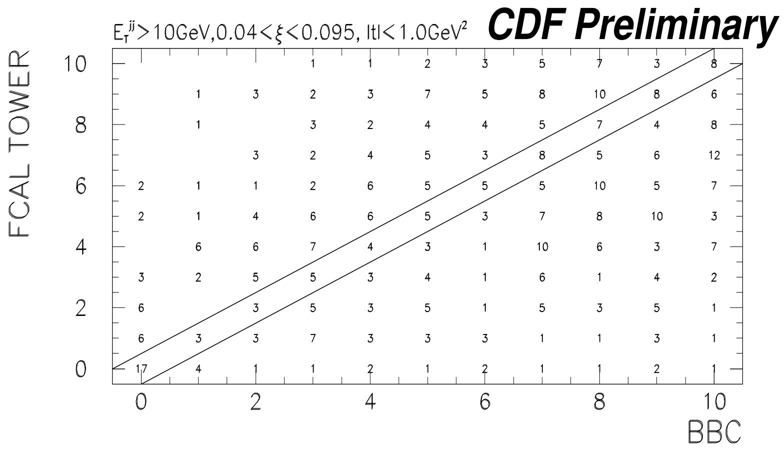
$E_T > 7$ GeV

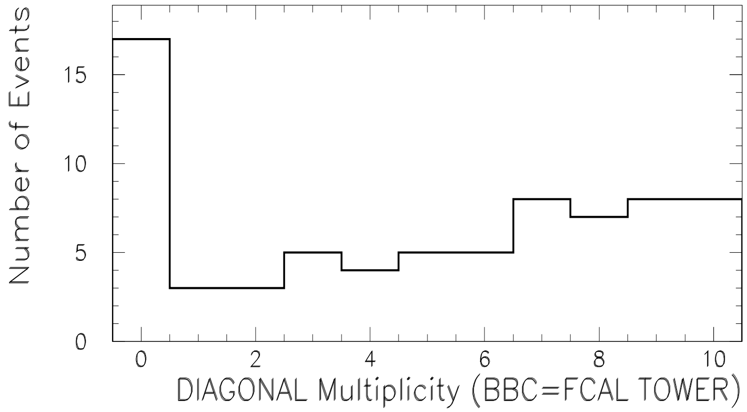




$$R\left(\frac{DPE}{SD}\right) = (0.39 \pm 0.07)\%$$

$E_T > 10$ GeV

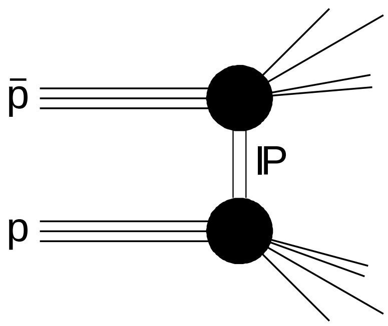


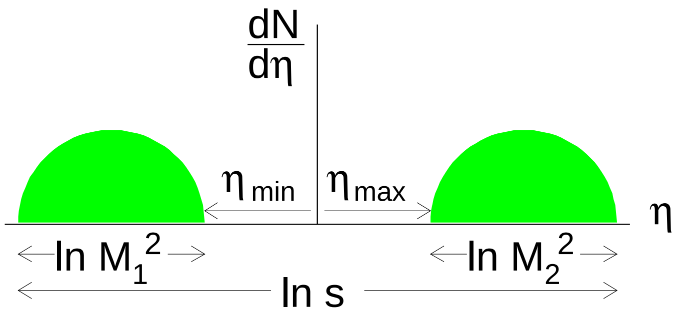


$$R\left(\frac{DPE}{SD}\right) = (0.28 \pm 0.09)\%$$

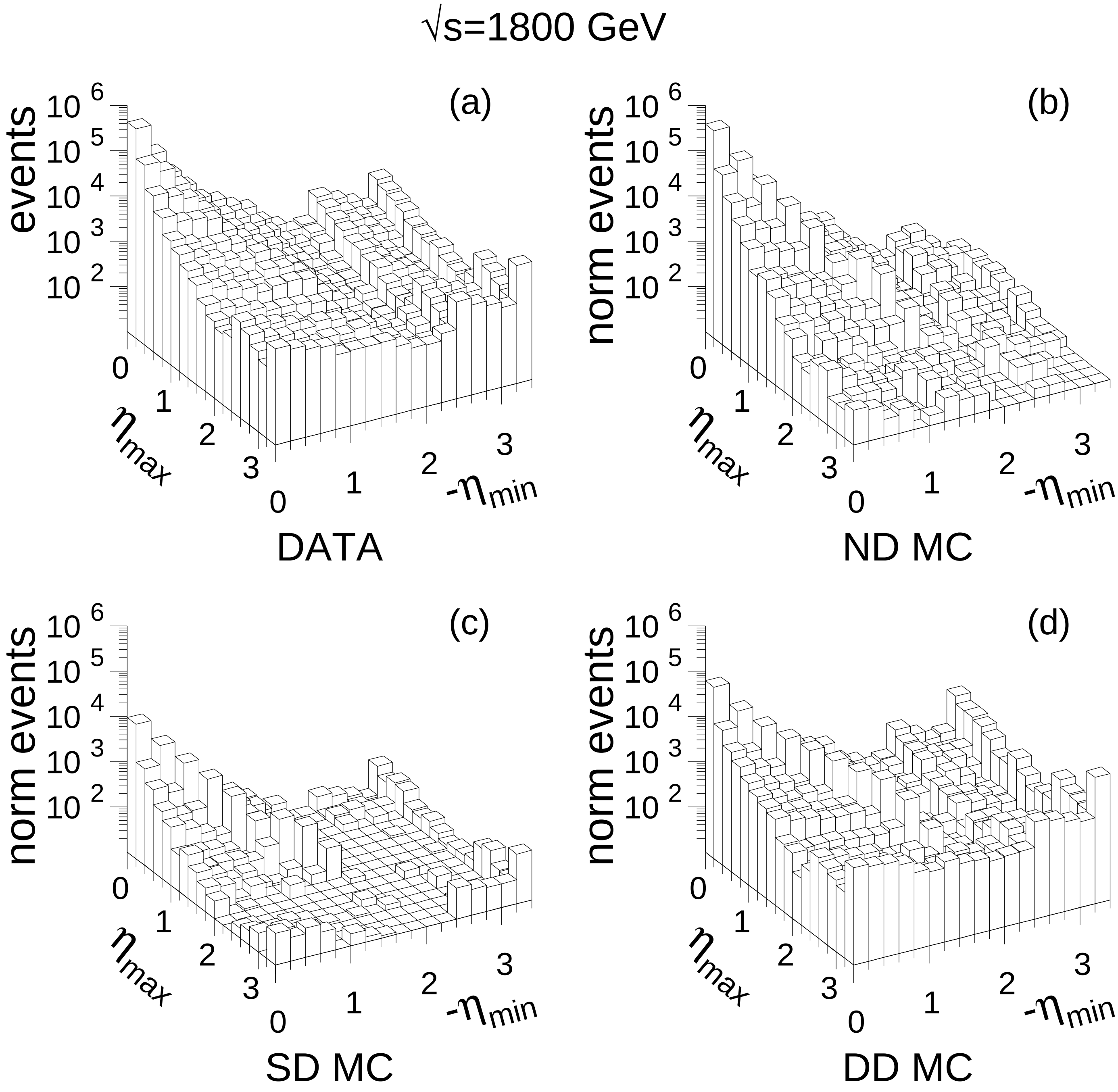
(sketch of DPE x_{bj})

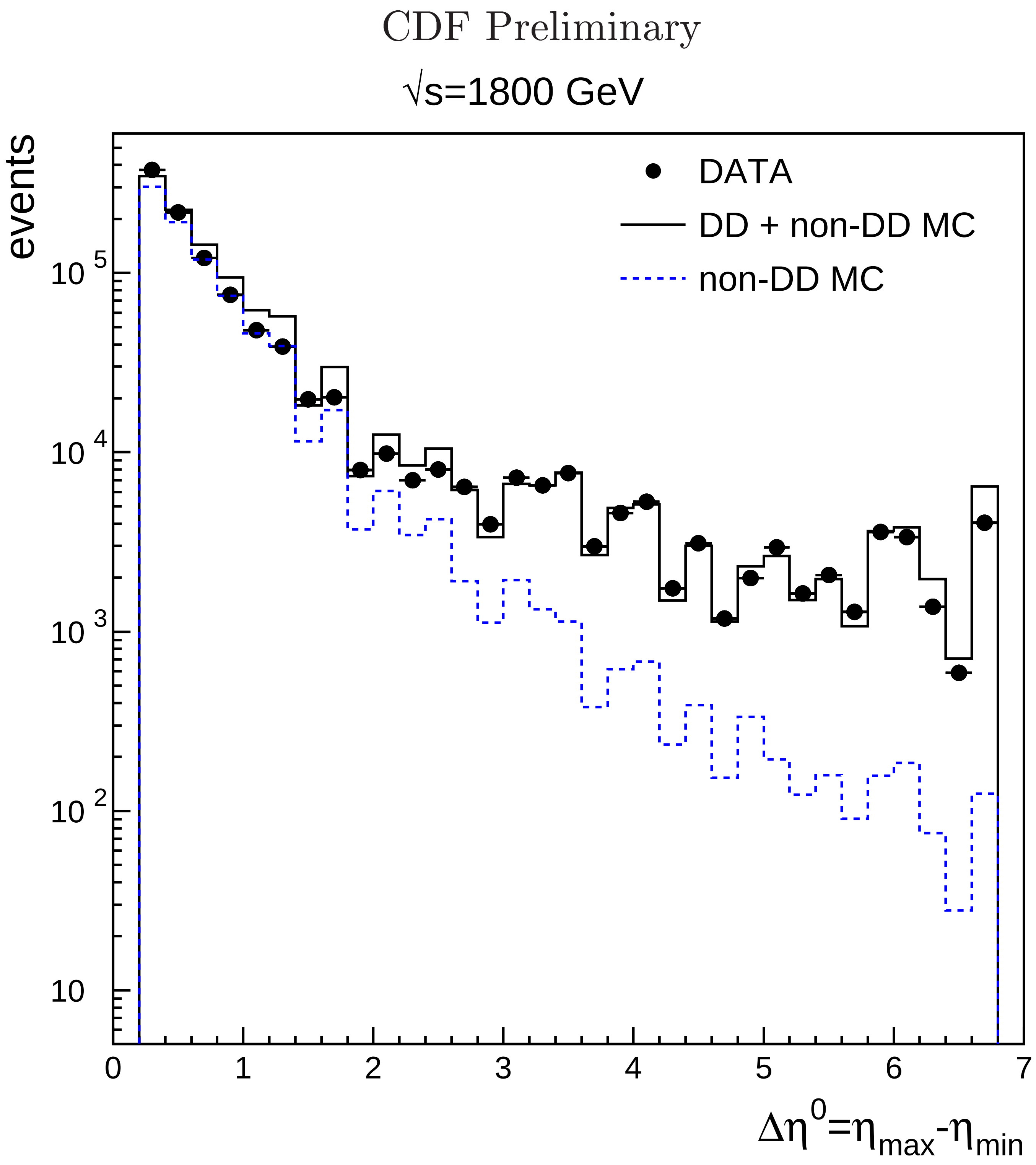
Soft double diffraction





CDF Preliminary




CDF Preliminary
√s=1800 GeV
events
DATA
DD + non-DD MC
non-DD MC
10
10 2
10 3
10 4
10 5
0
1
2
3
4
5
6
7
Δη0=ηmax-ηmin

CDF Preliminary

DD cross section for central gaps $\Delta\eta^0 > 3$

$\sqrt{s} = 1800$ GeV

$$\sigma_{DD}(\Delta\eta^0 > 3) = [2.29 \pm 0.01(\mathrm{stat})^{+0.20}_{-0.19}(\mathrm{syst})\ \mathrm{mb}]/A$$

detector acceptance $A = (48.7 \pm 8.4)\%$

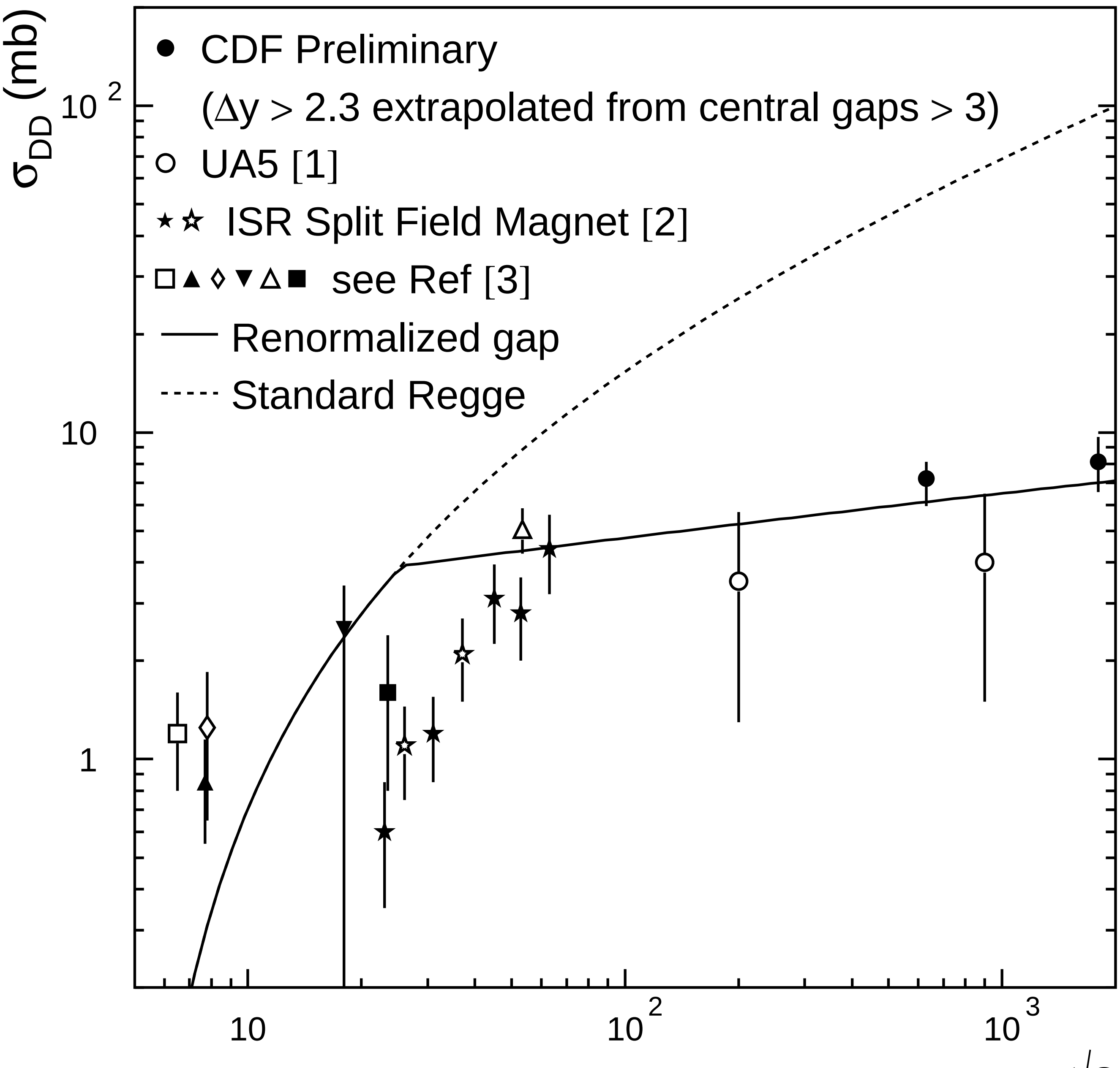
$$\sigma_{DD}(\Delta\eta^0 > 3) = 4.71 \pm 0.02(\mathrm{stat})^{+0.92}_{-0.90}(\mathrm{syst})\ \mathrm{mb}$$

$\sqrt{s} = 630$ GeV

$$\sigma_{DD}(\Delta\eta^0 > 3) = [2.65 \pm 0.01(\mathrm{stat})^{+0.15}_{-0.36}(\mathrm{syst})\ \mathrm{mb}]/A$$

$$A = (61.4 \pm 6.8)\%$$

$$\sigma_{DD}(\Delta\eta^0 > 3) = 4.32 \pm 0.01(\mathrm{stat})^{+0.54}_{-0.76}(\mathrm{syst})\ \mathrm{mb}$$



[1] R. E. Ansorge *et al.*, Z. Phys. C **33**, 175 (1986).

[2] C. Conta *et al.*, Nucl. Phys. B **175**, 97 (1980).

[3] A. Givernaud *et al.*, Nucl. Phys. B **152**, 189 (1979) and references therein.