Study of Exclusive Dijet Events Using DPE Trigger Data

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- Trigger and Data
- Event Kinematics
- Dijet Mass Fraction
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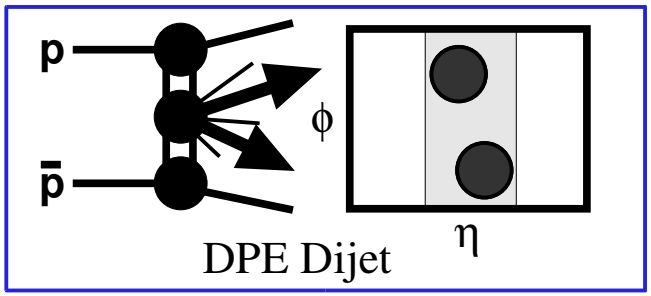
- Summary

Introduction



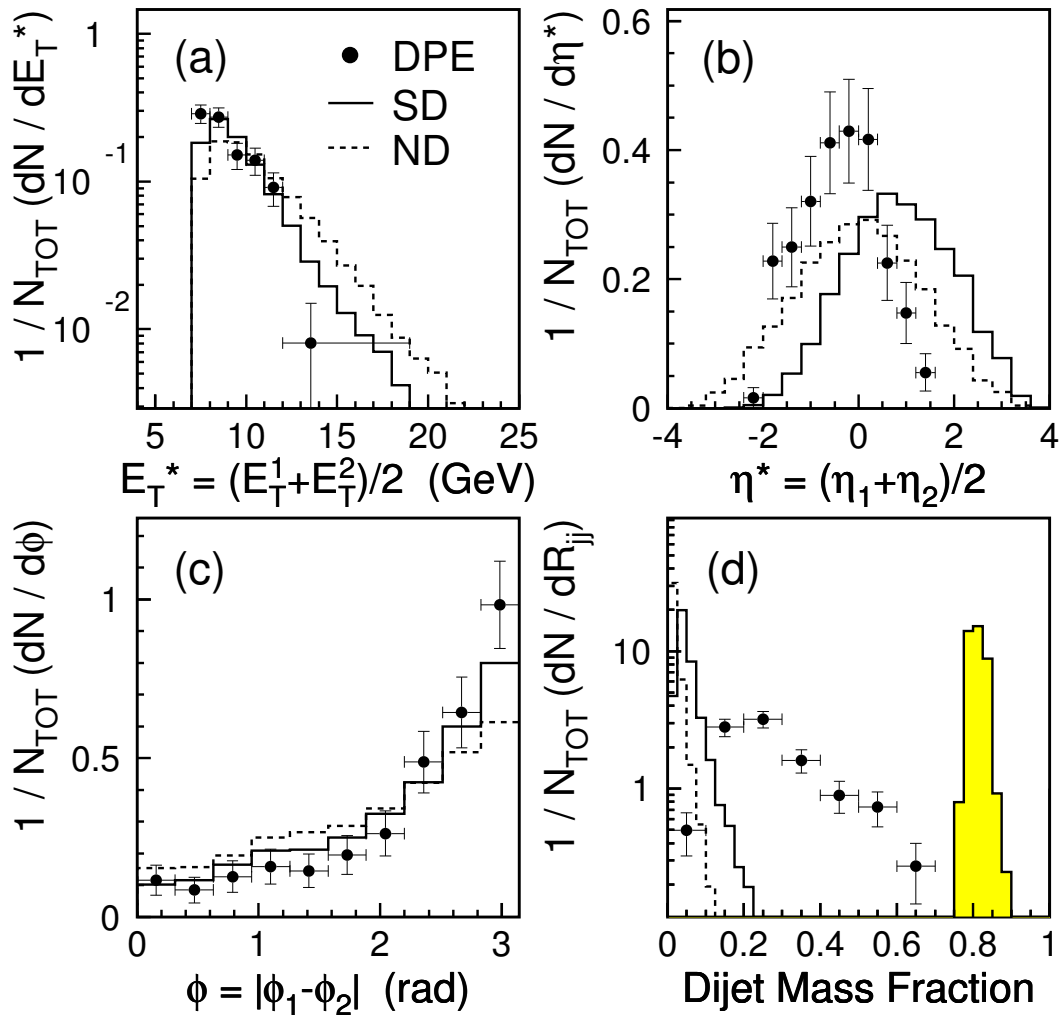
Observed ~100 DPE dijets in Run I

- $0.035<\xi<0.095$
- dijets $E_T > 7$GeV,
- rapidity gap in $2.4<\eta<5.9$

Dijet Mass Fraction $R_{jj} = \frac{M_{jj}}{M_X}$

Exclusive dijet in DPE: $0.7<R_{jj}<0.9$

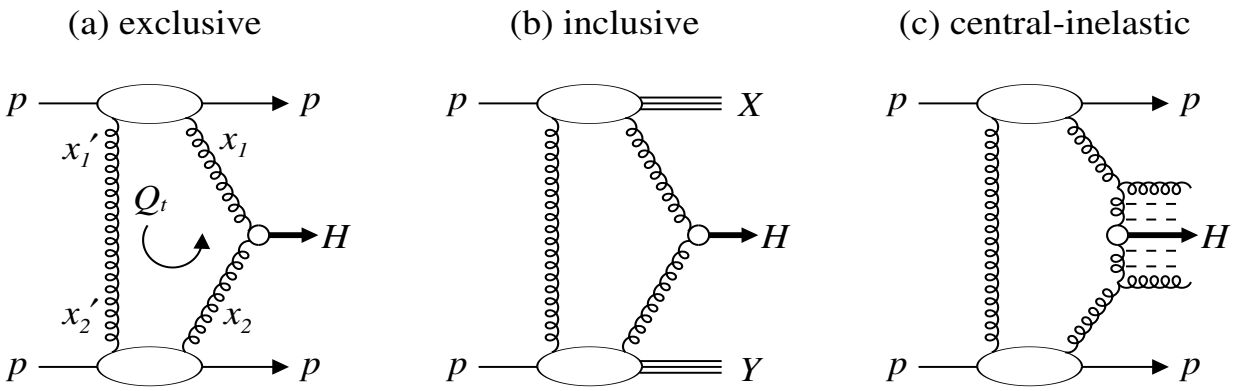
$\bar{p}p \rightarrow [\bar{p}' + IP] + [p' + IP] \rightarrow \bar{p}' + j + j + p'$



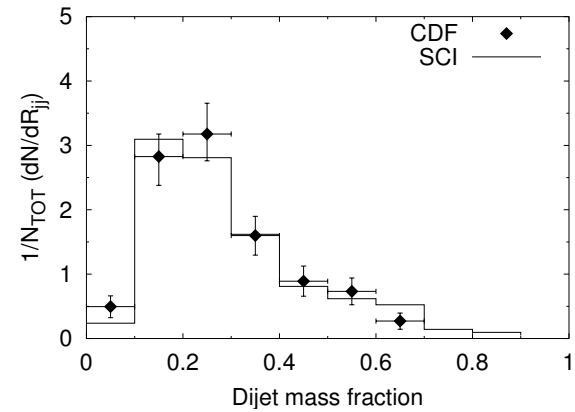
Inclusive DPE dijet: $\sigma = 43.6 \pm 4.4(\text{stat}) \pm 21.6(\text{syst})$ nb

Exclusive DPE dijet: $\sigma < 3.7$ nb (95% C.L.)

Inclusive/Exclusive Dijet in DPE



Khoze, Martin, Ryskin
Eur. Phys. J. C23, 211 (2001), C26, 229 (2002)

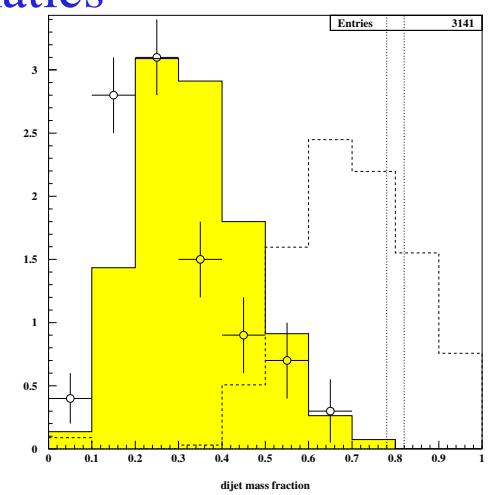


Enberg, Ingelman, Timneanu
Acta. Phys. Polon. B33, 3479 (2002)

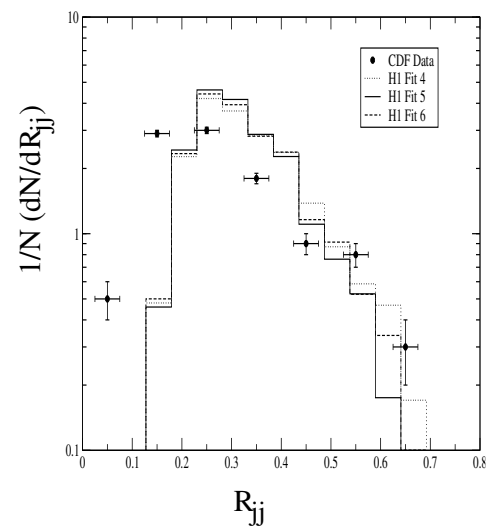
Exclusive dijets in Run I CDF kinematics
~ 1nb (factor 2 uncertainty)

Recent Calculation: ~ 60pb
($25<E_T^{jet}<35$ GeV, $|\eta_1-\eta_2|<2$)

Used to normalize calculations to predict e.g, diffractive Higgs production

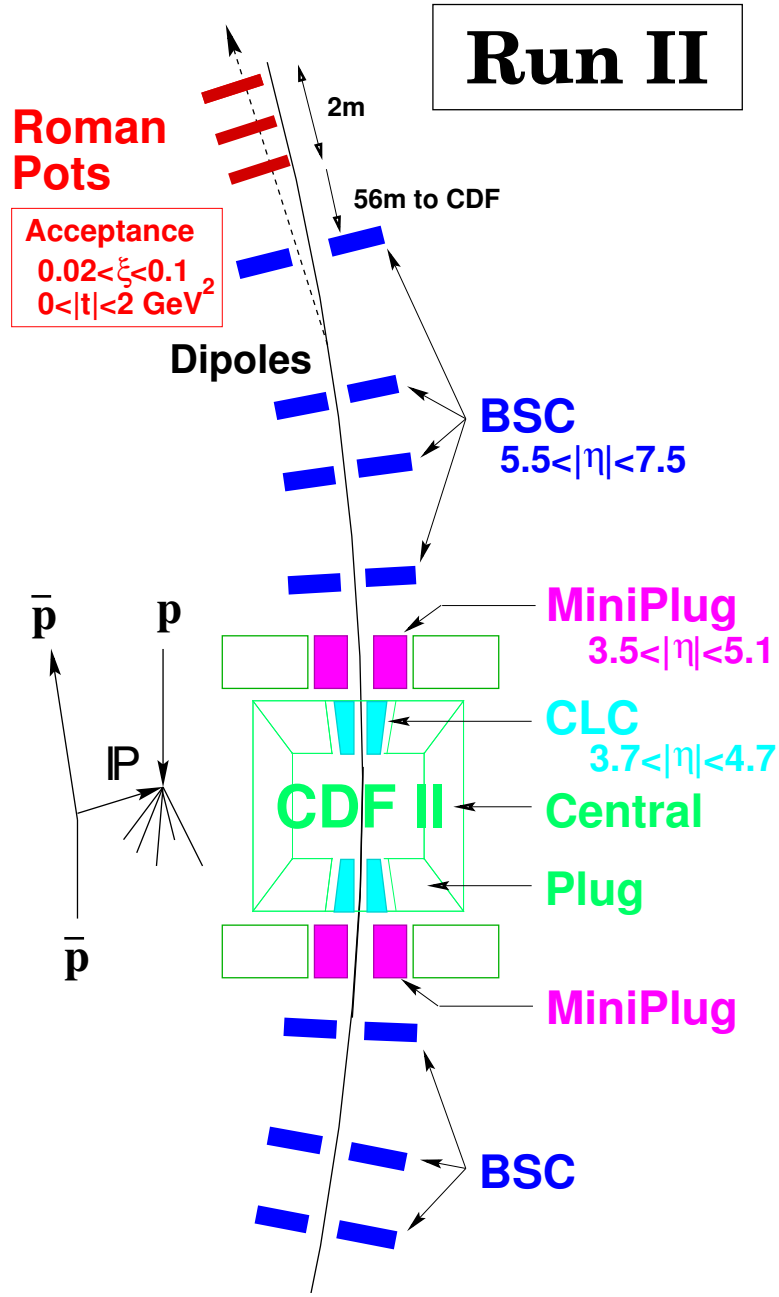


Boonekamp, Peschanski, Royon
Phys. Rev. Lett. 87, 251806 (2001)



Appleby, Forshaw
Phys. Lett. B541, 108 (2002)

Trigger



Used in main analysis:
"Dedicated DPE" trigger
- DPE = RP + SingleTower 5GeV + BSC-East Gap

Control Sample:
- SD = RP + SingleTower 5GeV
- ND = SingleTower 5GeV

Run 151683~155821 (DPE, SD)
Run 152123~152949 (ND)

Data	L1	L2	L3
DPE	RP+ST5+Egap: PS1	PS5	AUTO
SD	RP+ST5: PS1	PS100*	AUTO
ND	ST5: PS20	PS300	AUTO

*100 (~1_03-v1) ⟶ 1000 (1_03-v2~)

Data Sample - I

Diffractive Triggers (v1) put in default table on 4/27/02 (Run 143938~)

- ✓ All MP hardware electronics instrumented and calibrated (8/5/02)
- ✓ RP trigger timing adjusted to pick up only outgoing antiproton
- ✓ HV of MP adjusted for expected higher luminosity

→ Started taking "good" data (except RP-fiber) from Run 151648

<u>Good Run Selection:</u>

- taken with PHYSICS_1_* trigger table
- integrated luminosity > 10 nb^{-1}
- run checked by CO
- run marked "good" in RC, Analysis and Offline
- run marked "good" for online CAL/CLC/Trig/MP/BSC
- not CAL/FwdDet offline bad runs

Data Sample - II

DPE and SD data were ntuplized using StNtuple from master DIFFRACTIVE-08 dataset, then split into diffractive trigger path according to L3 bit

- Stntuple/offline version : tag239/4.9.1hpt1
- Run 151683~155821 (25.7±1.5 pb^{-1} by *lumsum.pl*)

ND data were also stntuplized from JET_CALIB-08 dataset

- Stntuple/offline version : tag239/4.9.1hpt1
- Run 152123~152949 (6.1±0.4 pb^{-1} by *lumsum.pl*)

Data Selection

Cuts	DPE	SD	ND
Triggered Events	397K	356K	278K
$N_{vertex}(Q12) \leq 1$	365K	205K	196K
$\lvert Z_{vertex} \rvert < 60cm$	347K	195K	186K
MET significance < 6	347K	195K	186K
BSC offline cut (GAP)	317K	N/A	N/A
RP offline cut (RP-Hit)	309K	193K	N/A
Njets (R=0.7) ≥ 2	204K	158K	160K
$\lvert \eta_{det}^{jet1,2} \rvert < 2.5$	163K	122K	123K
$E_T^{jet2}(corr) > 10$ GeV	116,473	93,567	85,038
$0.01 < \xi_{pbar} < 0.1$	54,547	14,956	N/A
MP-East Nhit = 0	17,093	N/A	N/A

UE correction of jets: DPE (0.37GeV), SD (0.54GeV) = Run I values (CDF-4716)
ND (1.56 GeV) = default Run II value

Measurement of ξ

Fractional Momentum Loss of Antiproton :

$$\xi^X = \frac{M_X^2}{s} \approx \frac{\Sigma_i E_T^i e^{-\eta_i}}{\sqrt{s}}$$

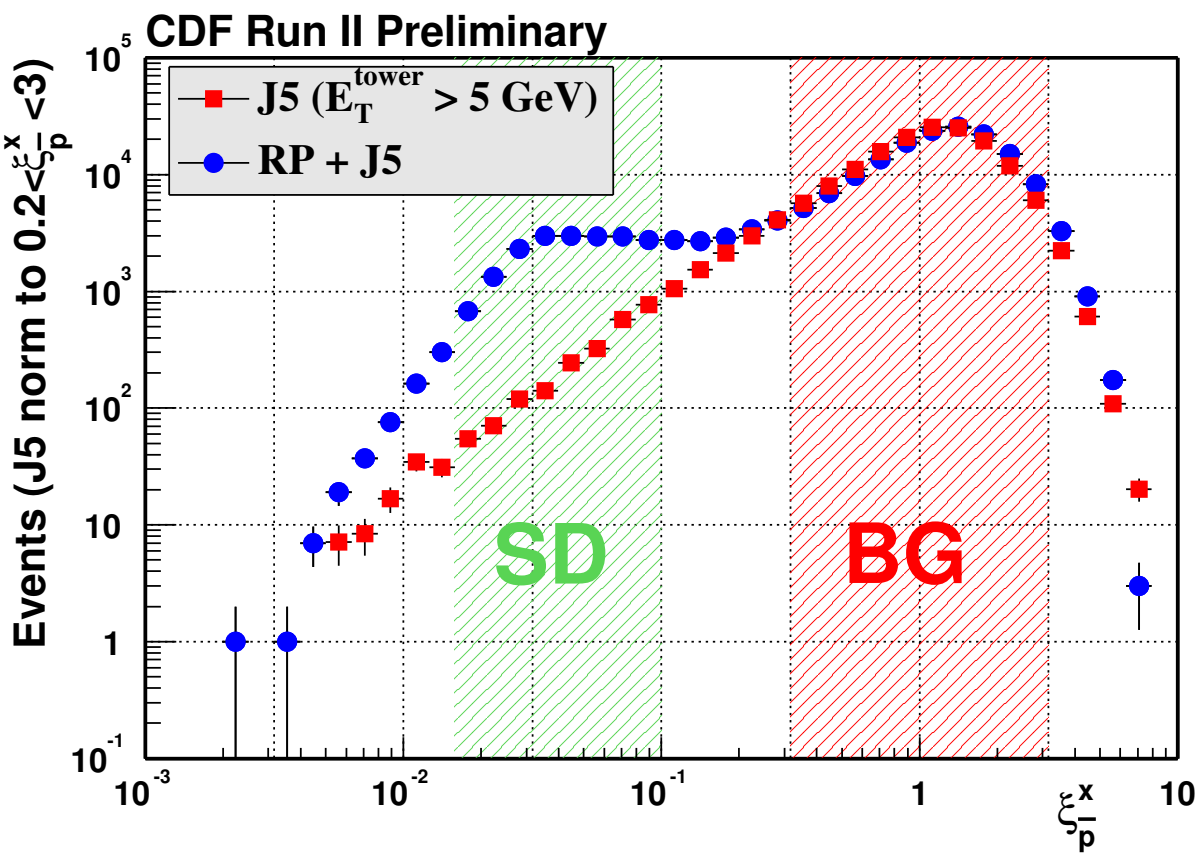
- sum over all particles except antiproton
- use calorimeter towers of E_T >100 MeV
- miniplug energy scale: ±25% ⟶ Δlogξ = ±0.1

Flat part at ξ < 0.1:

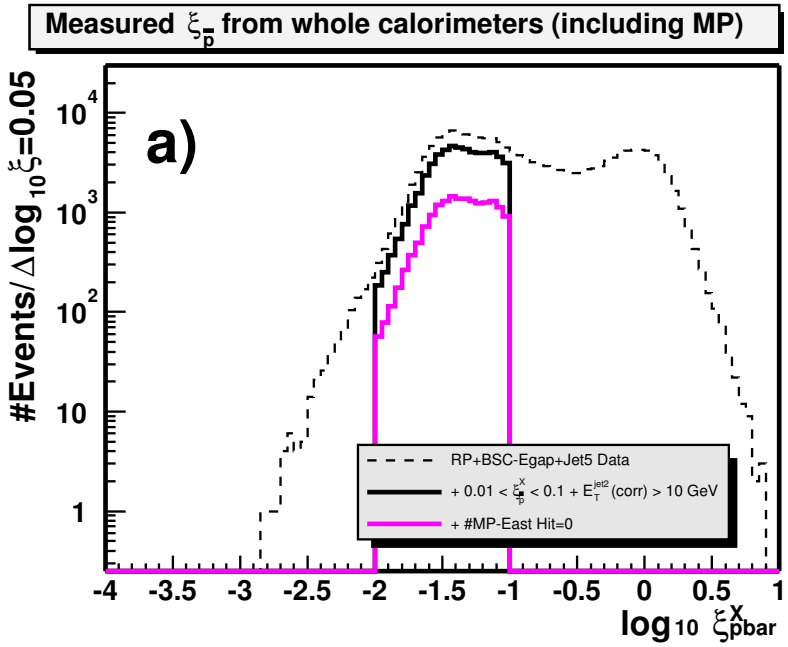
$$\frac{d\sigma}{d\xi} \propto \frac{1}{\xi} \rightarrow \frac{d\sigma}{d(\log\xi)} = Constant$$

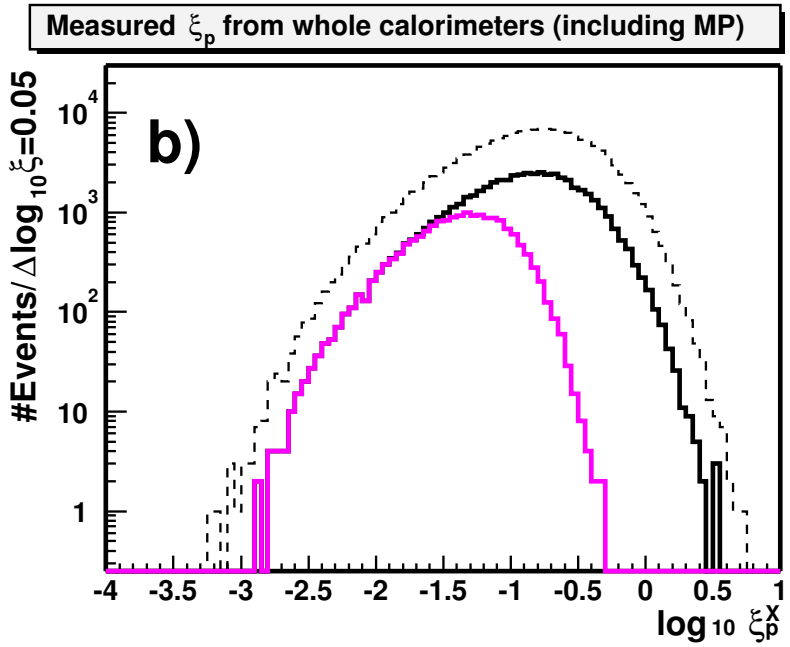
Peak at ξ ~ 1:

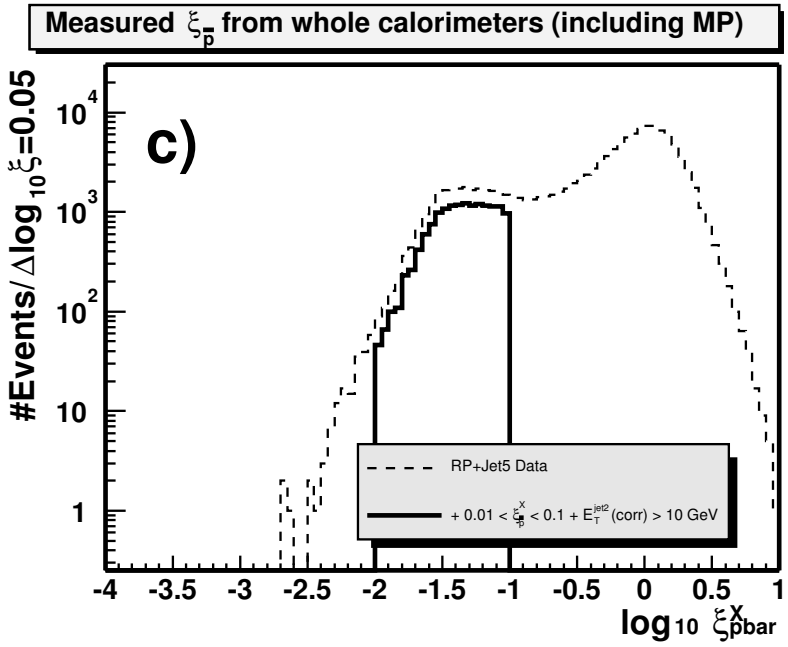
⟶ overlap of ≥1 ND events

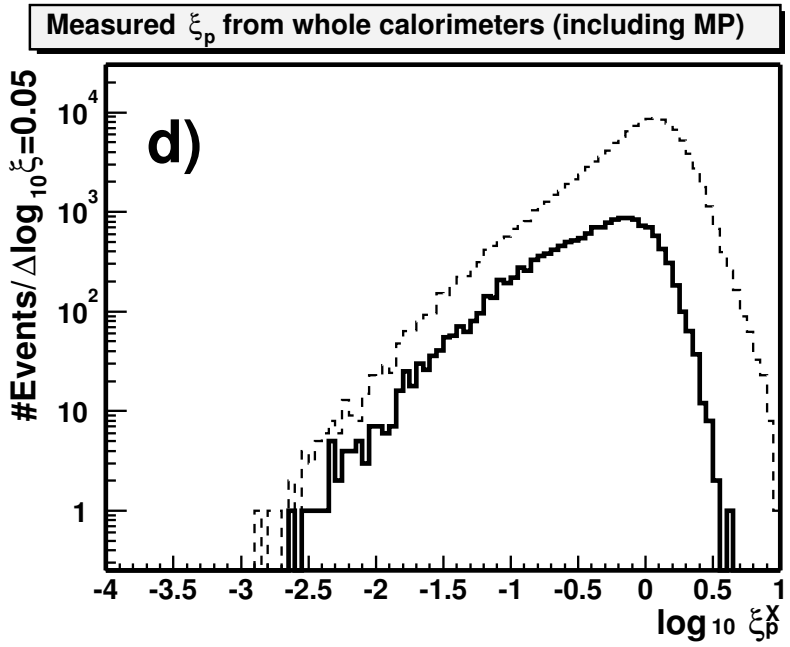


Measured ξ

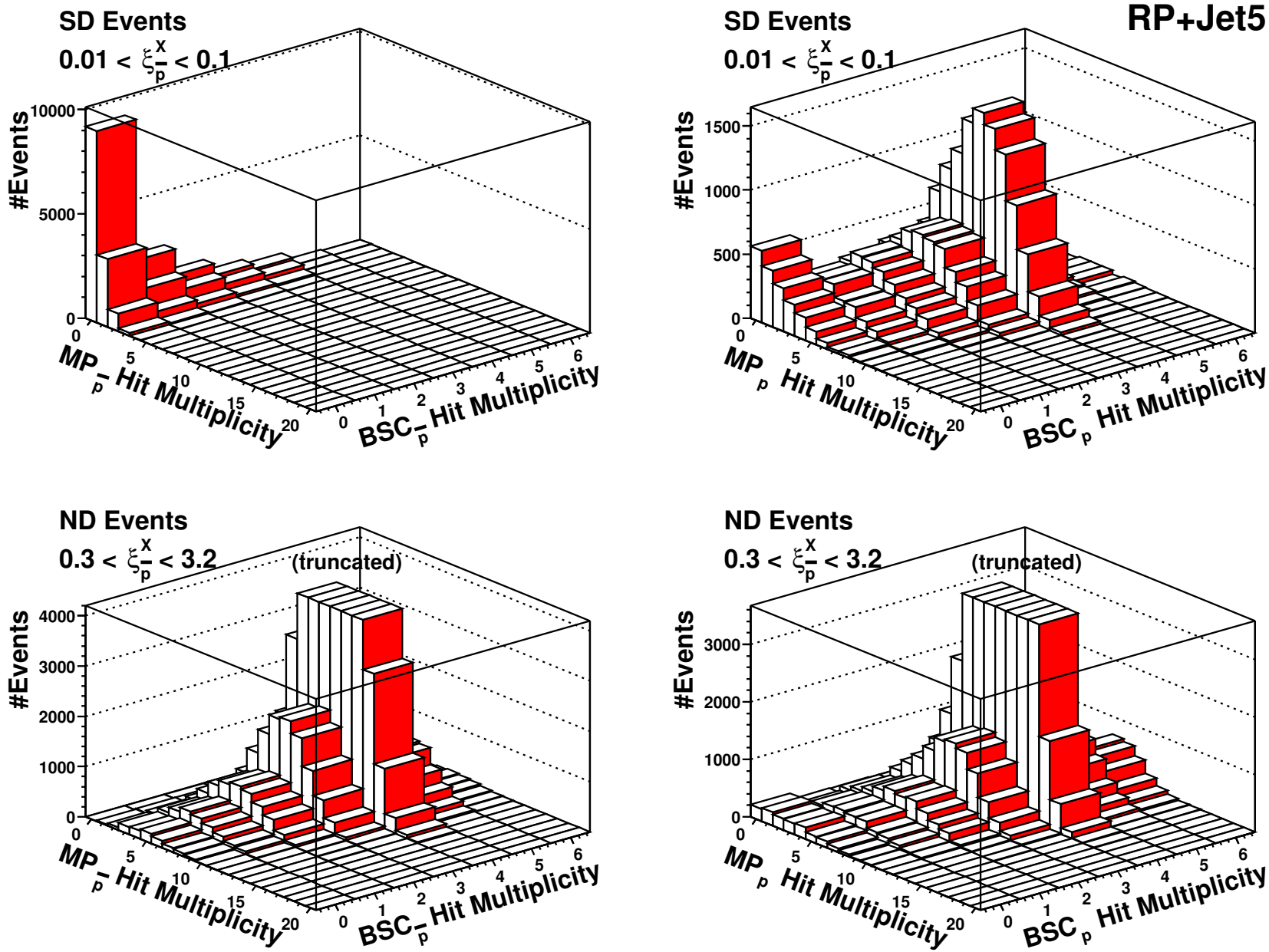

Measured $\xi_{\bar{p}}$ from whole calorimeters (including MP)
a)
#Events/Δlog10ξ=0.05
RP+BSC-Egap+Jet5 Data
+ 0.01 < $\xi^{x}_{\bar{p}}$ < 0.1 + E_T^{jet2}(corr) > 10 GeV
+ #MP-East Hit=0
log10 ξ^{x}_{pbar}


Measured ξ_p from whole calorimeters (including MP)
b)
#Events/Δlog10ξ=0.05
log10 ξ^{x}_{p}

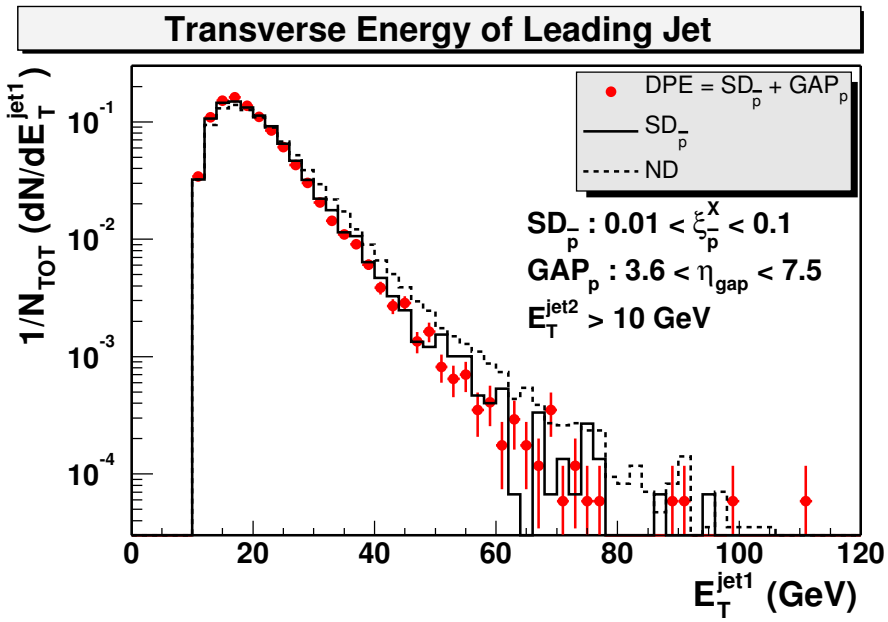

Measured $\xi_{\bar{p}}$ from whole calorimeters (including MP)
c)
#Events/Δlog10ξ=0.05
RP+Jet5 Data
+ 0.01 < $\xi^{x}_{\bar{p}}$ < 0.1 + E_T^{jet2}(corr) > 10 GeV
log10 ξ^{x}_{pbar}

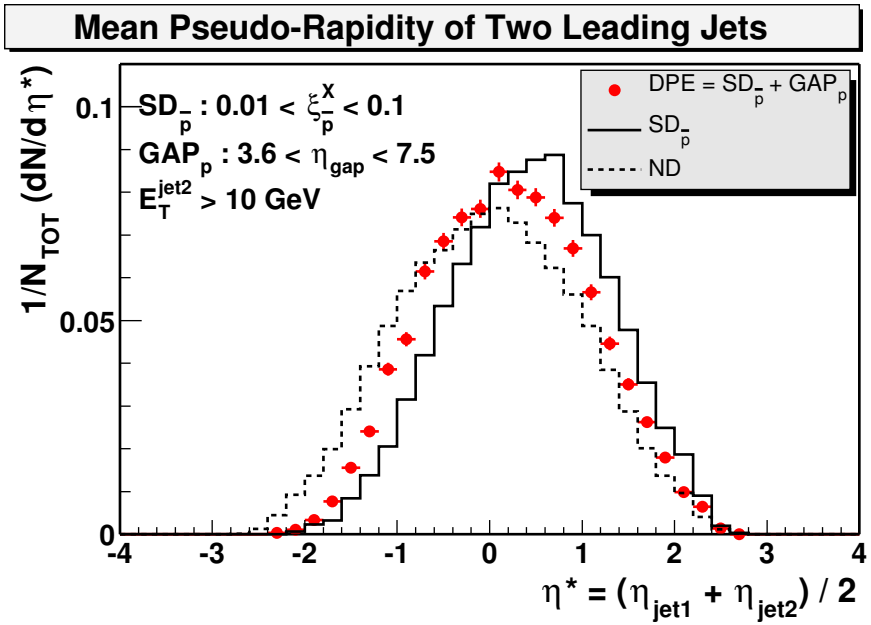

Measured ξ_p from whole calorimeters (including MP)
d)
#Events/Δlog10ξ=0.05
log10 ξ^{x}_{p}

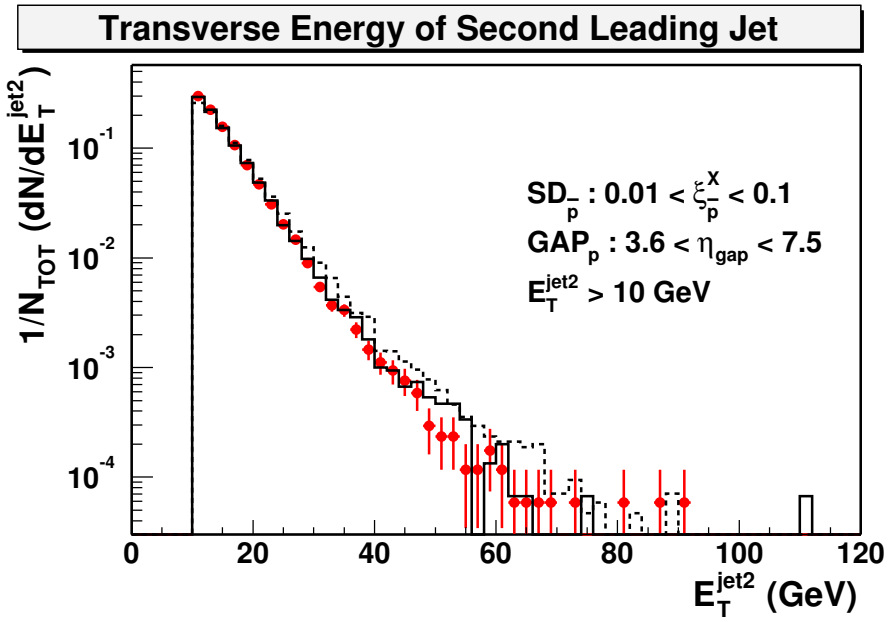
DPE Signal in SD Data

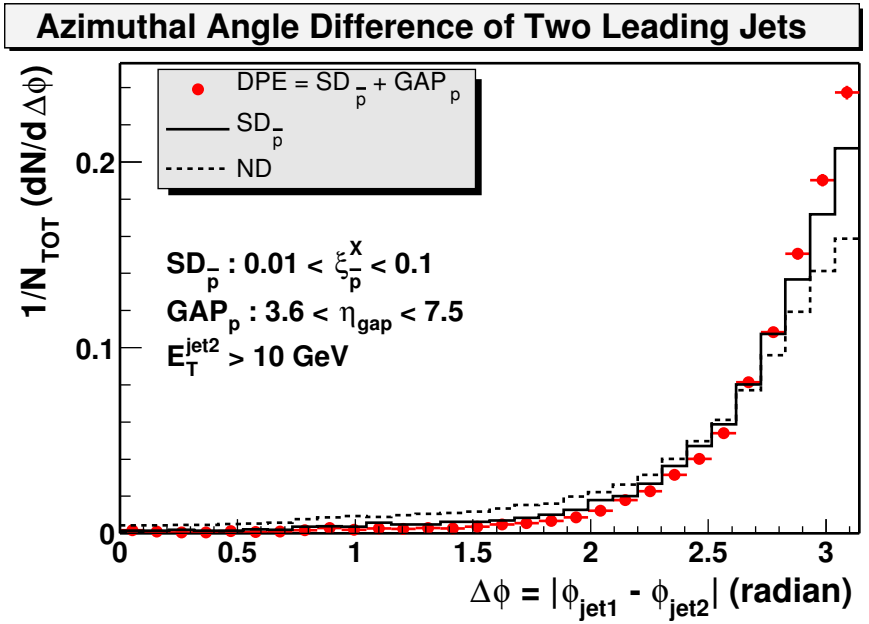


Kinematic Distribution of Jets

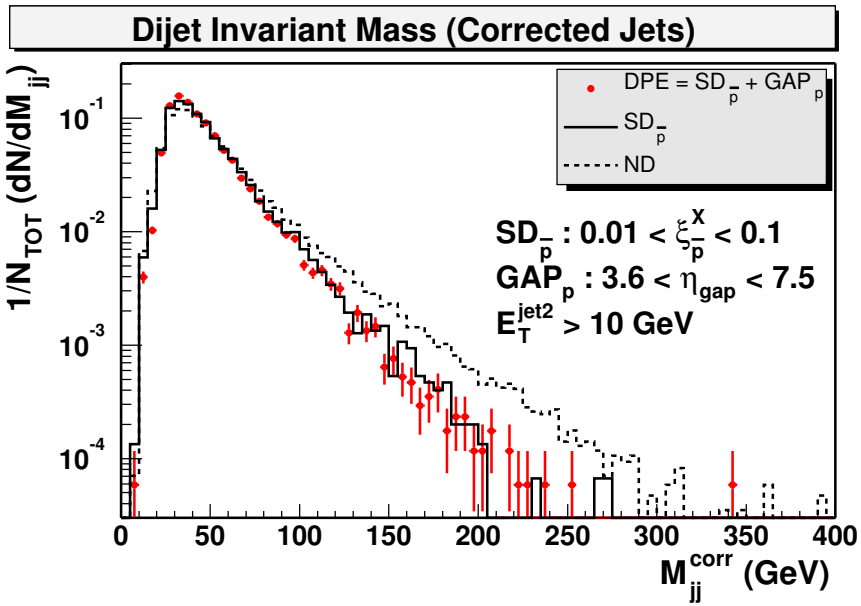


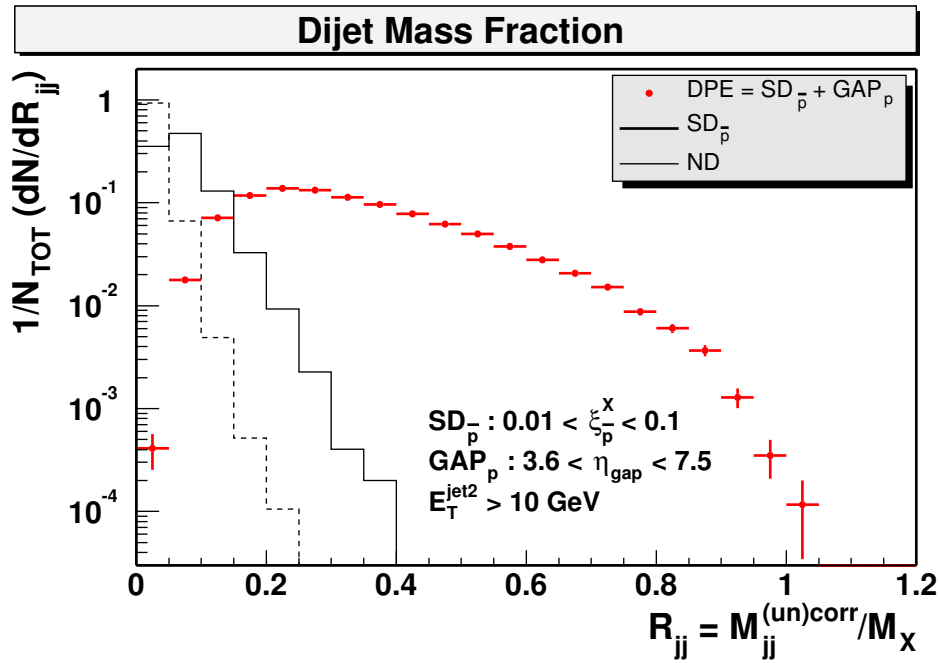


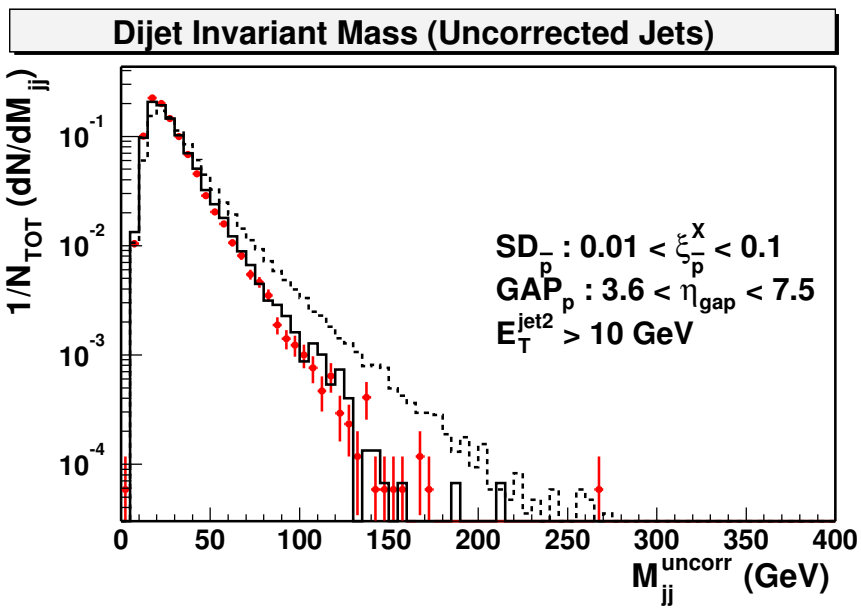




Dijet Mass and Mass Fraction



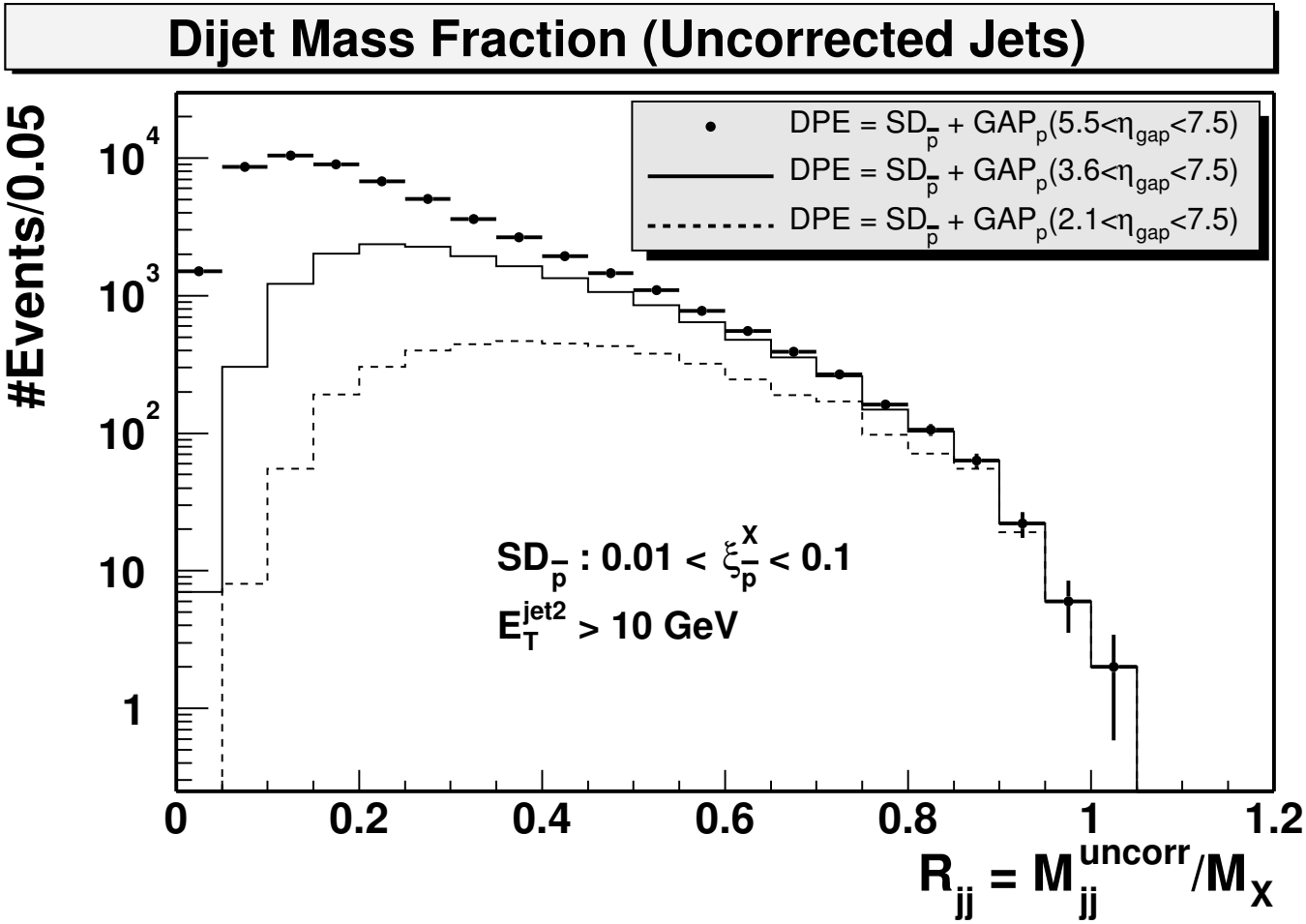




Dijet Mass Fraction: $R_{jj} = \dfrac{M_{jj}}{M_X}$

$$M_X = \sqrt{\xi_p \cdot \xi_{\bar{p}} \cdot s} \quad : \text{DPE}$$
$$= \sqrt{\xi_{\bar{p}} \cdot s} \quad : \text{SD}$$
$$= \sqrt{s} \quad : \text{ND}$$

Dijet Mass Fraction



$E_T^{jet1,2}$>10GeV, 0.01<ξ_{pbar} < 0.1, R=0.7:

GAP (p side)	5.5<η<7.5	3.6<η<7.5	2.1<η<7.5
All	54,547	17,098	4,305
R_{jj}>0.8	199	196	153

Cross Section

Goal: Set upper limit on exclusive dijet production cross section

$$\sigma_{DPE}^{excl.\ jj} = \frac{N_{DPE}(R_{jj} > 0.8)}{N_{DPE}(All)} \times \frac{N_{DPE}^{PS}}{L \cdot \epsilon \cdot A}$$

N_{DPE}^{PS} : # of observed DPE events corrected for PS → PS eff. Study
corrected for multiple interactions (weighted by e^{n_i}, $n_i = (L_i \sigma_{inel}) / f_{Tev}$)

L : integrated luminosity

ϵ : total selection efficiency (including trigger efficiency) of DPE events*

A : total acceptance of DPE events*

* Under study

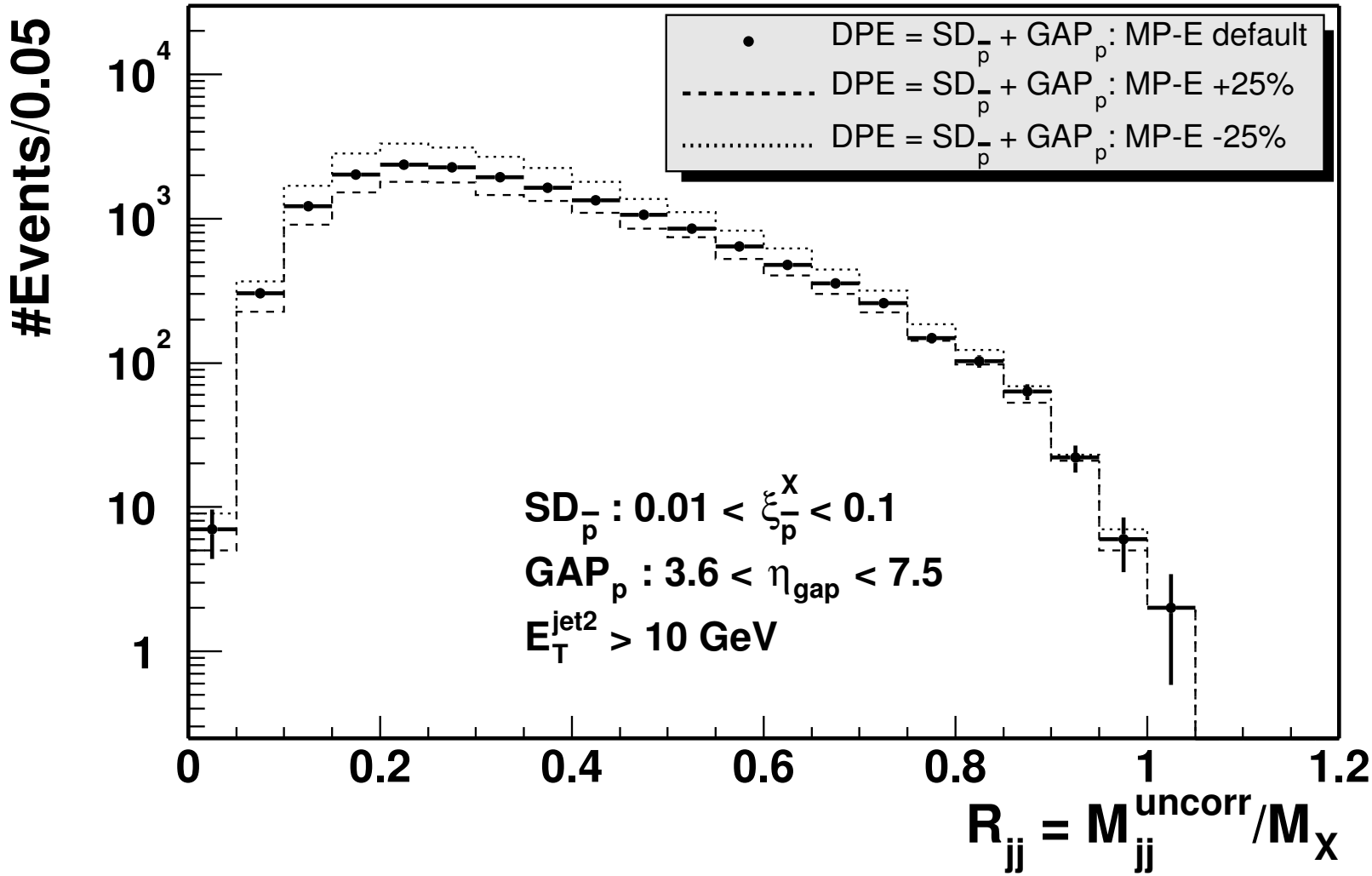
$E_t^{jet1,2} > 10$GeV, $0.01 < \xi_{pbar} < 0.1$, $R = 0.7$ (stat. error only)

GAP (p side)	$5.5<\eta<7.5$	$3.6<\eta<7.5$	$2.1<\eta<7.5$
$R_{jj}>0.8$	69.9±0.2 pb	67.7±0.4 pb	53.5±0.6 pb

Change of cross section by different gap size < 20%

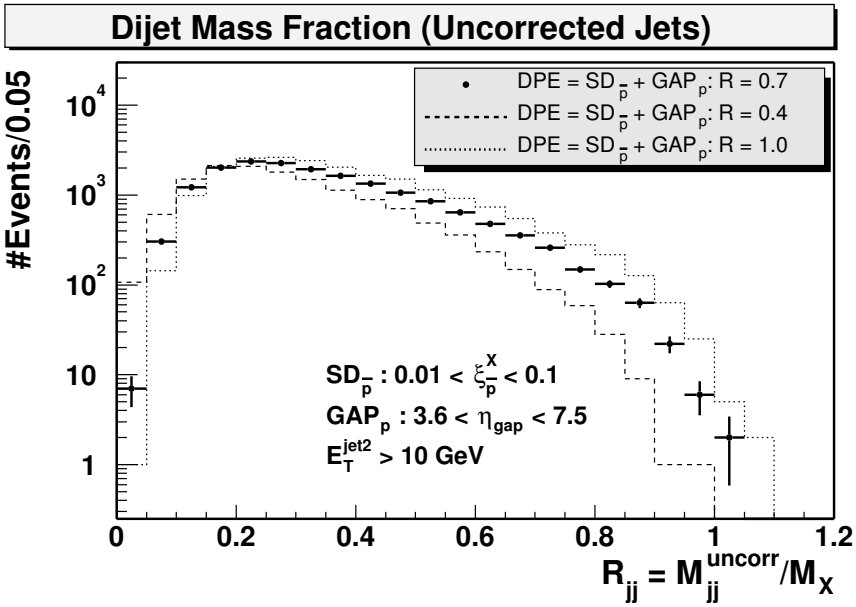
Systemtic Uncertainty: MP Energy Scale

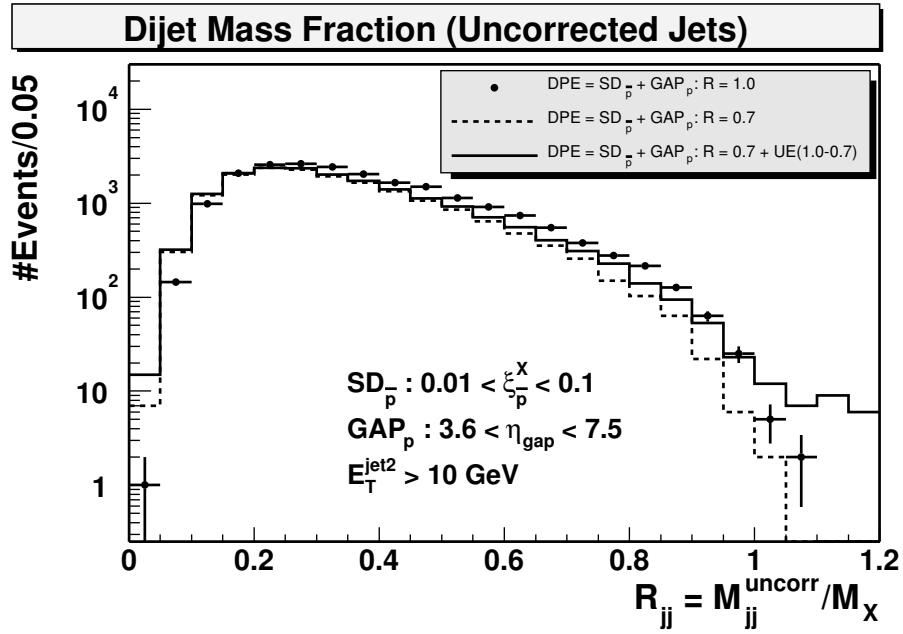
Dijet Mass Fraction (Uncorrected Jets)



25% change of MP energy scale ⟶ variation of $\sigma(R_{jj}>0.8) < \pm 14\%$

Systemtic Uncertainty: Cone Size



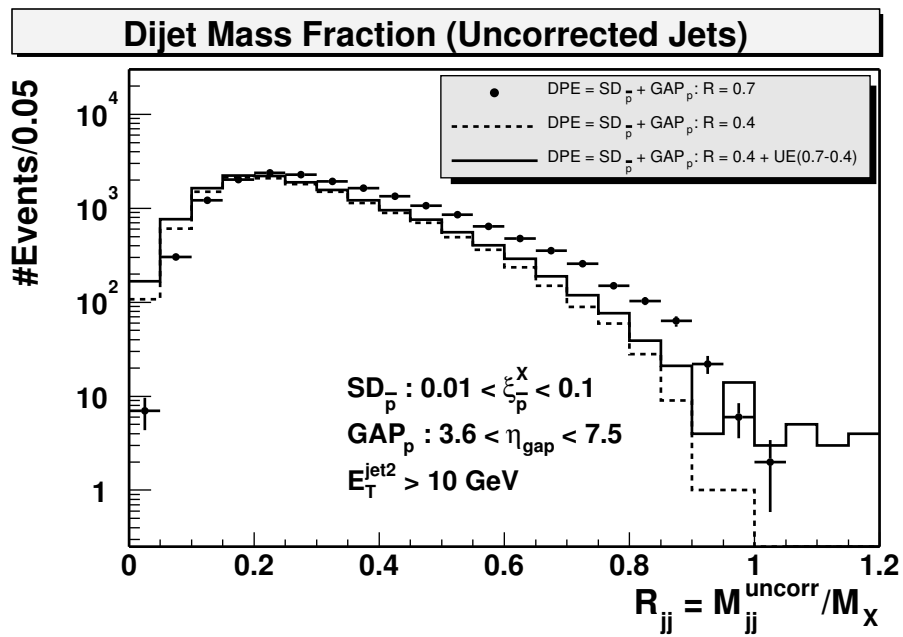


Hadronization Effect:

R_{jj} depends on cone size (unless no out-of-cone and no underlying energy)

Exclusive dijet (no UE) depends only cone size

- ✔ R_{jj} with $R=0,4,\ 0.7$ (default) and 1.0
- ✔ R_{jj} with $R=0.7 + UE_{annulus}(1.0 - 0.7)$



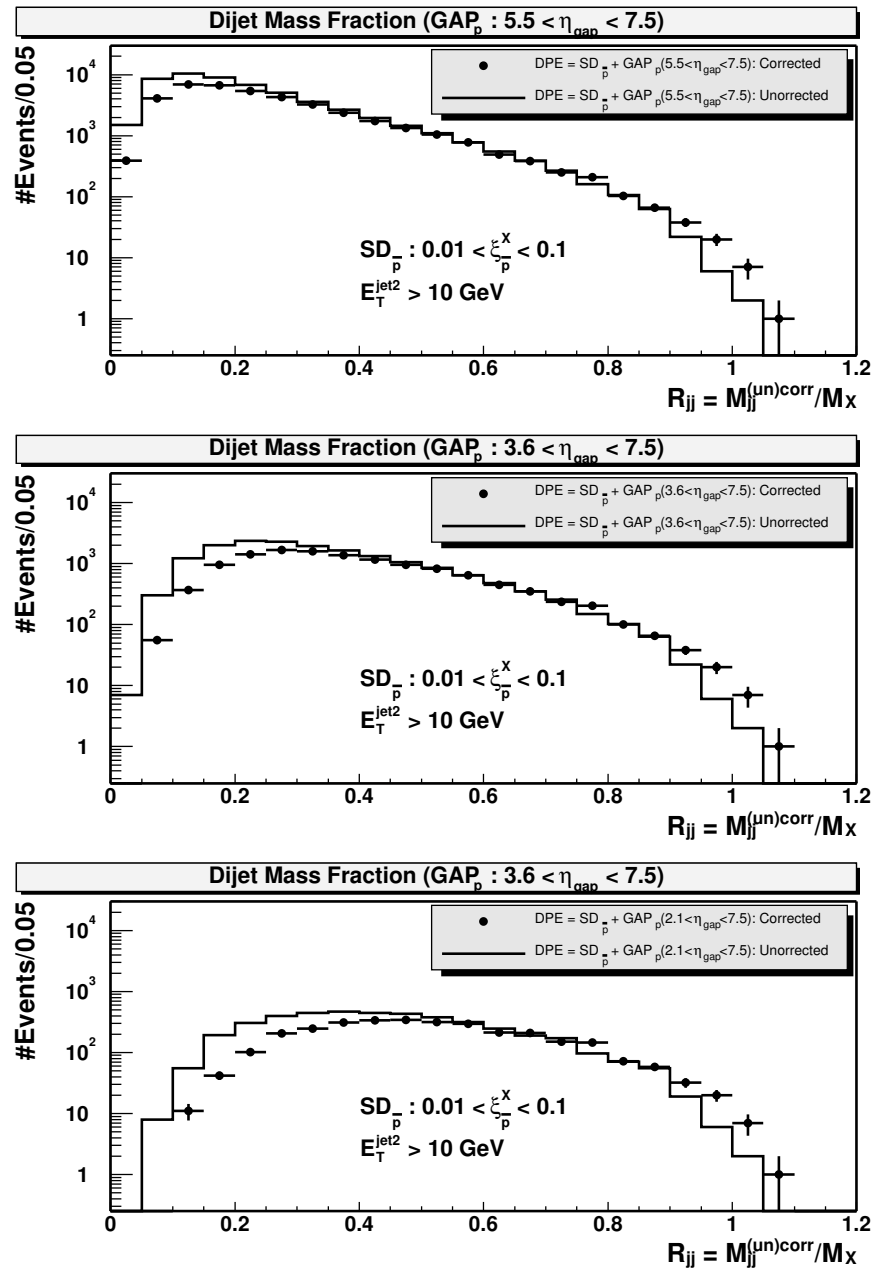
Systemtic Uncertainty: Corrected R_{jj}

Multiplication by 1.6 of the tower energy (Run I absolute correction)

→ a good approximation to get corrected system mass from calorimeter ξ values

↓

Corrected R_{jj} shapes in rather good agreement with uncorrected R_{jj} shapes though slightly off at low and high R_{jj} edges



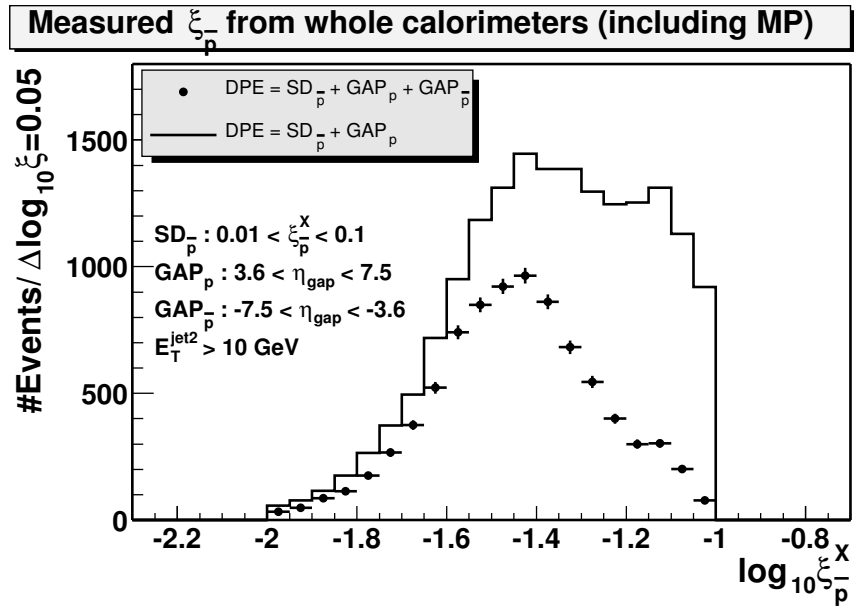
Systemtic Uncertainty: Gap on Antiproton Side

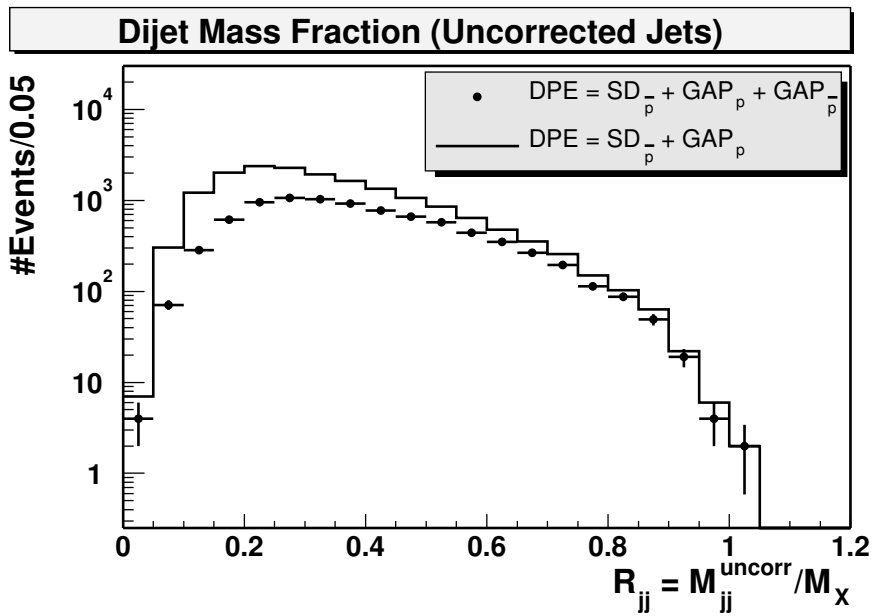
Rapidity gap width:

$$\Delta\eta_{gap} \approx -\ln\xi$$

Gap in BSC and MP on the antiproton side $(\Delta\eta_{gap} \sim 4.0)$

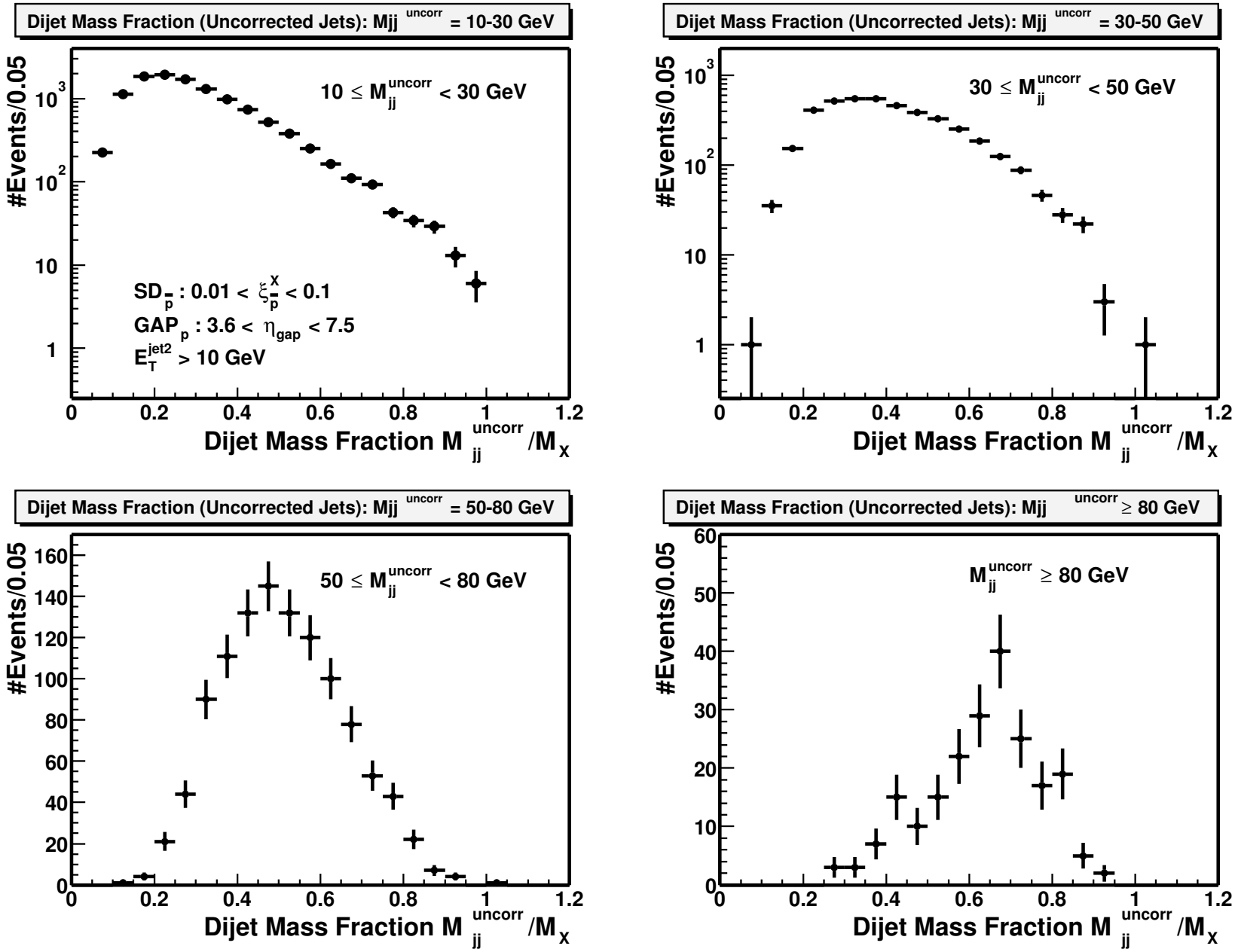
$\longrightarrow$ enhance events at lower ξ_{pbar}





18% decrease of $\sigma(R_{jj}>0.8)$ due to gap requirement on the antiproton side

Systemtic Uncertainty: Dijet Mass Dependence



Summary

Preliminary cross sections for exclusive dijet production with DPE event topology were obtained, though they are not corrected for efficiencies and acceptances, yet.

Trying to get upper limit on exclusive dijet production cross section, which is our primary interest in this analysis

Some systematic studies are done

A draft CDF note is almost ready

Will ask preblessing in 2 weeks

Prescale Efficiency

Check effective prescaling by looking at events in different trigger paths from target triggers, then counting events with unprescaled and prescaled trigger bits fired at each trigger level

#Events with prescaled bit / #Events with unprescaled bit

Data	Level-1	Level-2
DPE	-	0.201±0.003 (0.2)
SD	-	0.0106±0.0002 (0.01)
ND	0.0502±0.0002 (0.05)	0.00344±0.00015 (0.00333)