The Future of Forward Physics at the LHC
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Exclusive Dijet Production at CDF

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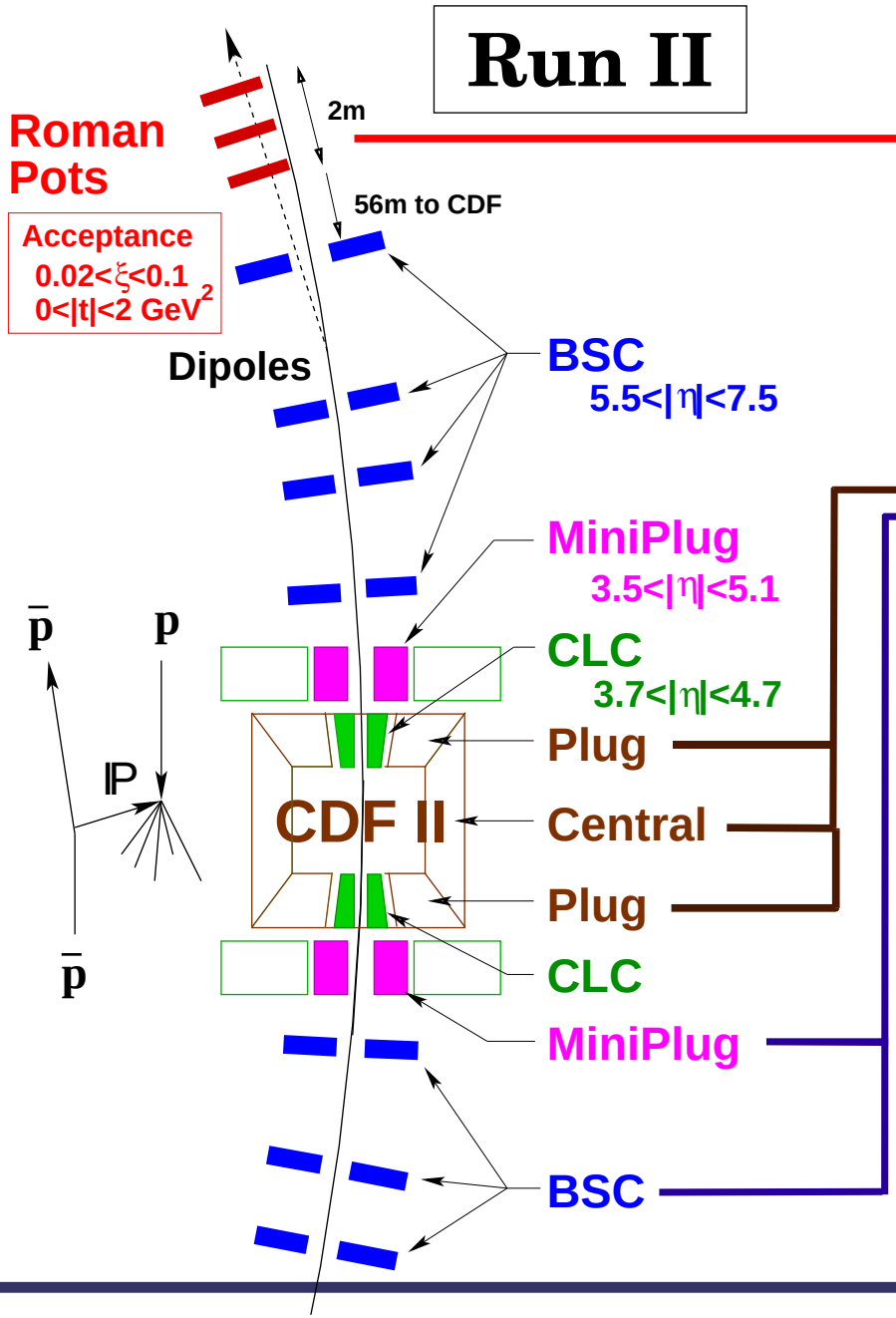
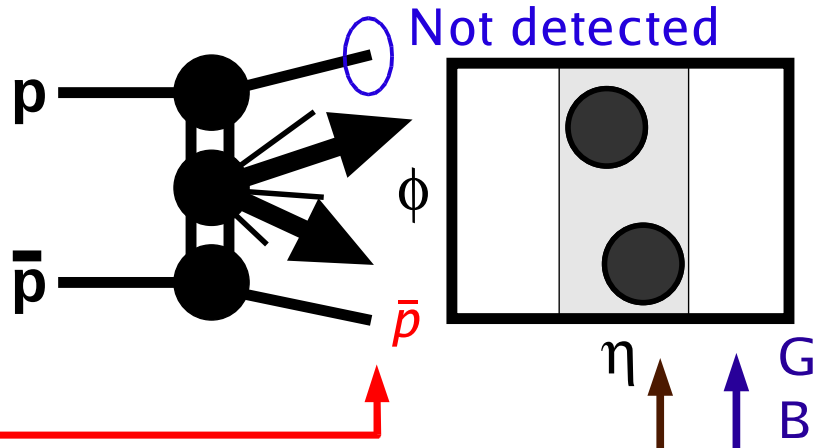
- Introduction
- Data
- Monte Carlo Studies
- Prospects

DPE Dijets in Run II





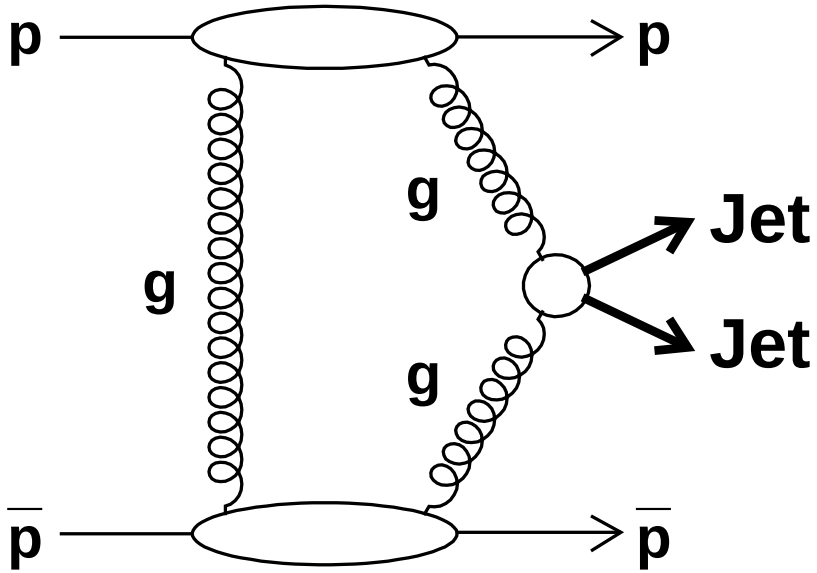
GAP$_p$ in BSC & MiniPlug

DPE dijet signature :

- leading antiproton in RPS
- rapidity gap on the *p* side
- ≥ 2 jets

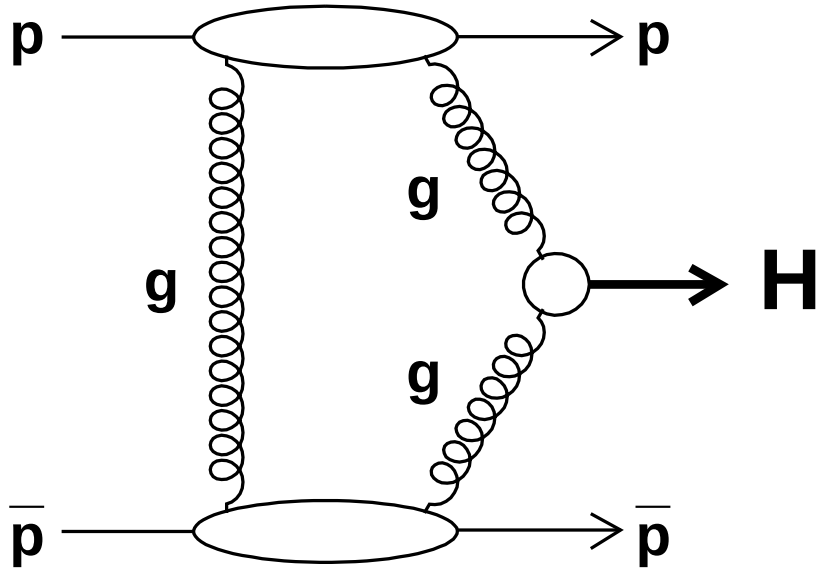
DPE dijets = dominant background in exclusive dijet search

Exclusive Production



$gg \rightarrow gg, q\bar{q}g, \ldots$

$gg \rightarrow q\bar{q}$ $J_z=0$ suppressed



$gg \rightarrow H \rightarrow b\bar{b} + \ldots$

Khoze, Martin, Ryskin :

σ_H^{excl} ~ 3 fb, S/B ~ 3 @ LHC

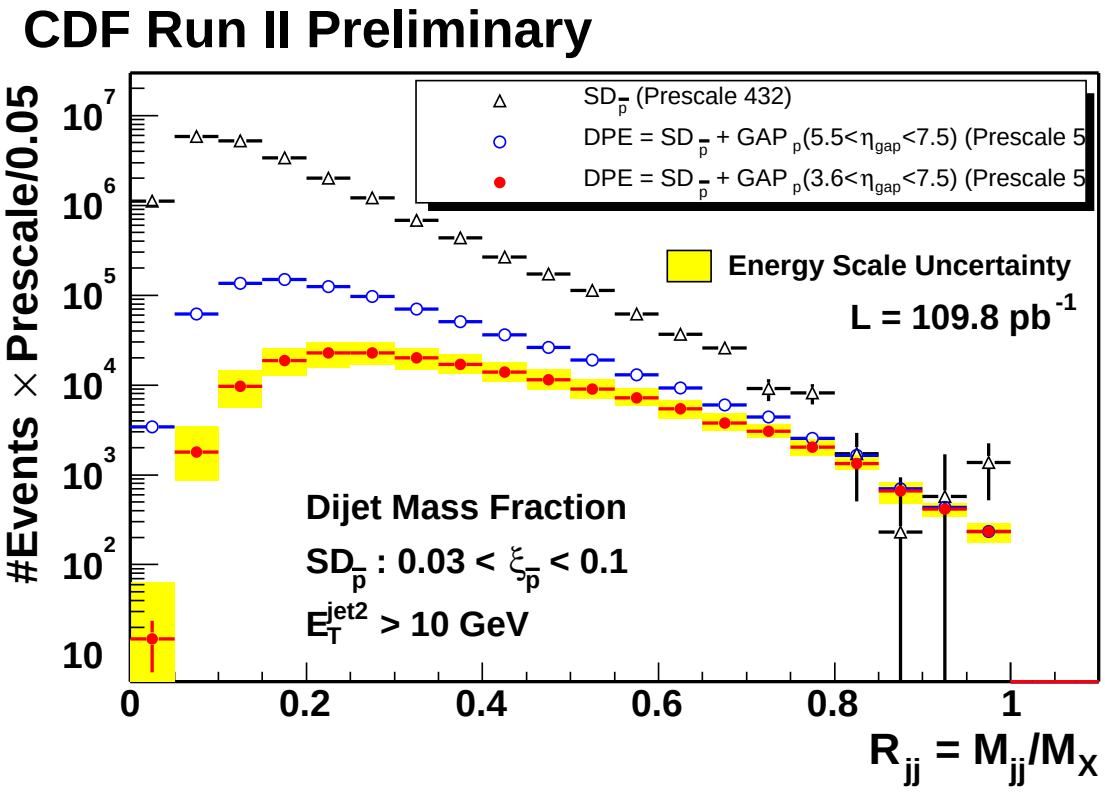
Measure exclusive JJ cross section to calibrate predictions for exclusive Higgs production at the LHC

Search for Exclusive Jets in CDF

Strategy

- Select inclusive DPE dijets : $\bar{p} + p \rightarrow \bar{p} + \geq 2\text{jets} + X + \text{gap}$
- Search for exclusive dijet signature using dijet mass fraction :

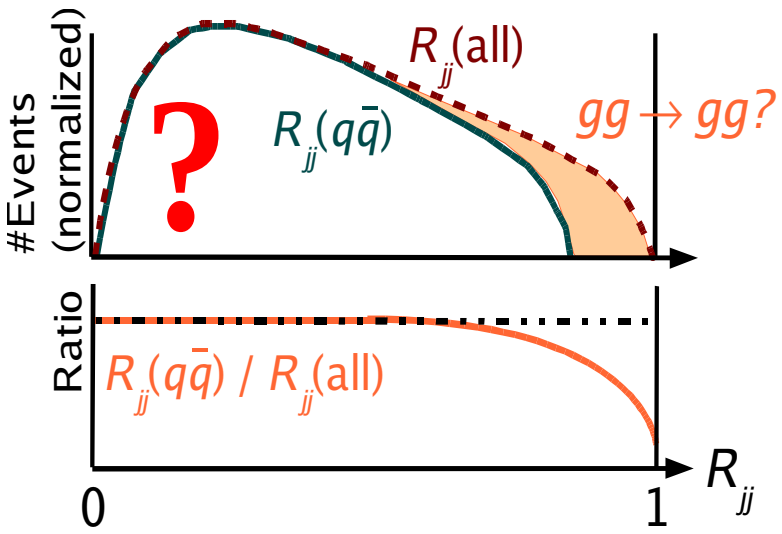
$$R_{jj} = \frac{M_{jj}^{cone}}{M_X} \qquad \begin{cases} M_{jj}^{cone} = \text{dijet mass} \\ M_X = (\text{dijet} + X)\ \text{mass} \end{cases}$$



- Understanding the tail of inclusive DPE dijets at high R_{jj} is essential
- **How can we extract the exclusive dijet signal from a smoothly falling spectrum?**

Extracting Exclusive Jets

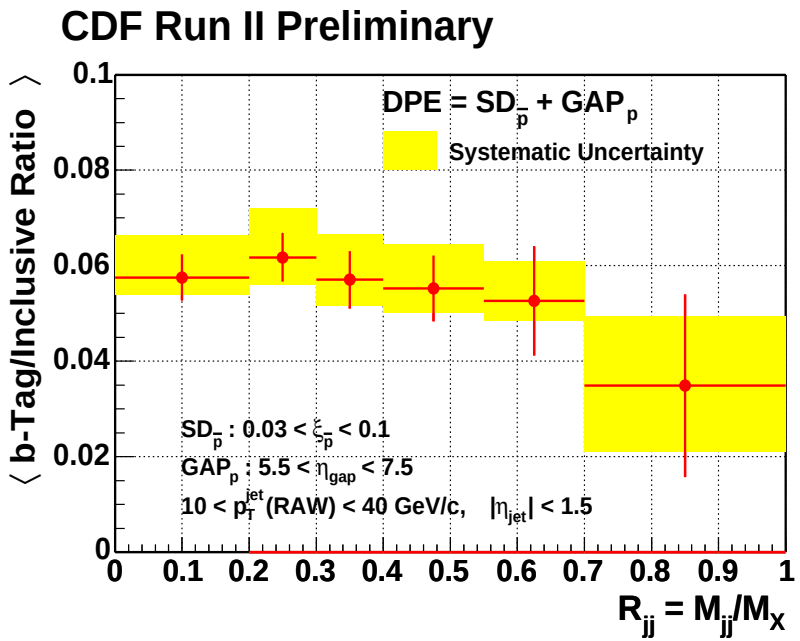
Analysis based on expected exclusive $q\bar{q}$ suppression



Using b-Quark Jet Data

Look for suppression of the *b*-quark jet fraction in the high R_{jj} region

- many exp. systematics cancel out in ratio
- *b*-quarks well identified: mistags @ $O(1\%)$



CDF Run II Preliminary

$$R_{btag}(R_{jj}>0.7) / R_{btag}(R_{jj}<0.4) = 0.59 \pm 0.40 \text{ (stat}\oplus\text{syst)}$$

Statistics limited

➔ Install new DPE *b*-jet trigger

Data and Corrections

Run II Data

Inclusive DPE jets :

RPS + Single Tower 5 GeV + GAP_p(BSC) w/ PS=5

- ~110 pb^{-1} in FY03 (analyzed)
- >500 pb^{-1} in FY04-05

DPE b-jets :

Inclusive DPE jets + ≥1 displaced SVT track w/ PS=1

- Implemented since April '05
- Expect ~30-fold increase in data

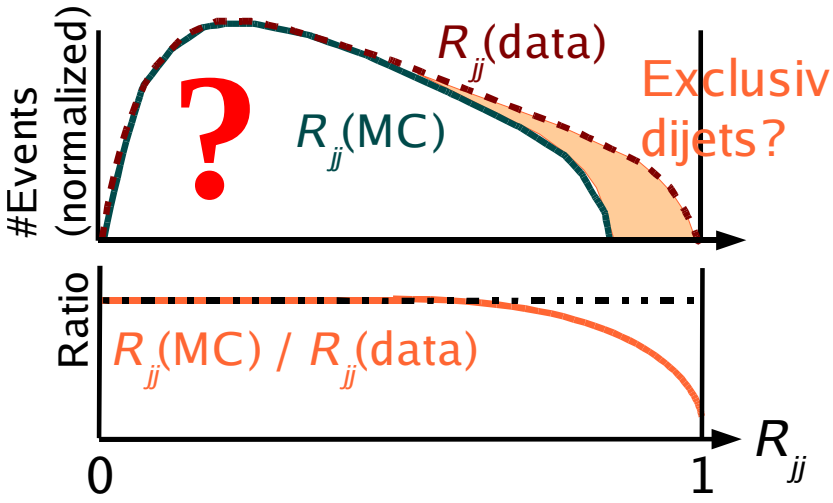
Data Corrections

Splash : large number of hits in RP detectors ➔ low mass $\bar{p}$ dissociation and/or high ξ diffraction with the $\bar{p}$ hitting the beampipe near the RP detectors

Radiation damage : gain degradation of RP trigger counters

Monte Carlo Studies

Extracting Exclusive Jets :



Using Inclusive Dijet MC

Look for enhancement in data relative to MC in the high R_{jj} region

- requires understanding of calorimeter simulation, backgrounds, and **MC input parameters**

Basic Tool : POMWIG v1.3β (Cox and Forshaw, CPC 144 (2002), 104) is used as an event generator of inclusive dijets

- ✔ Pomeron flux : $\propto 1/\xi^{2\alpha_{IP}(t)-1}$
- ✔ Pomeron PDF : 1997 H1 QCD fits

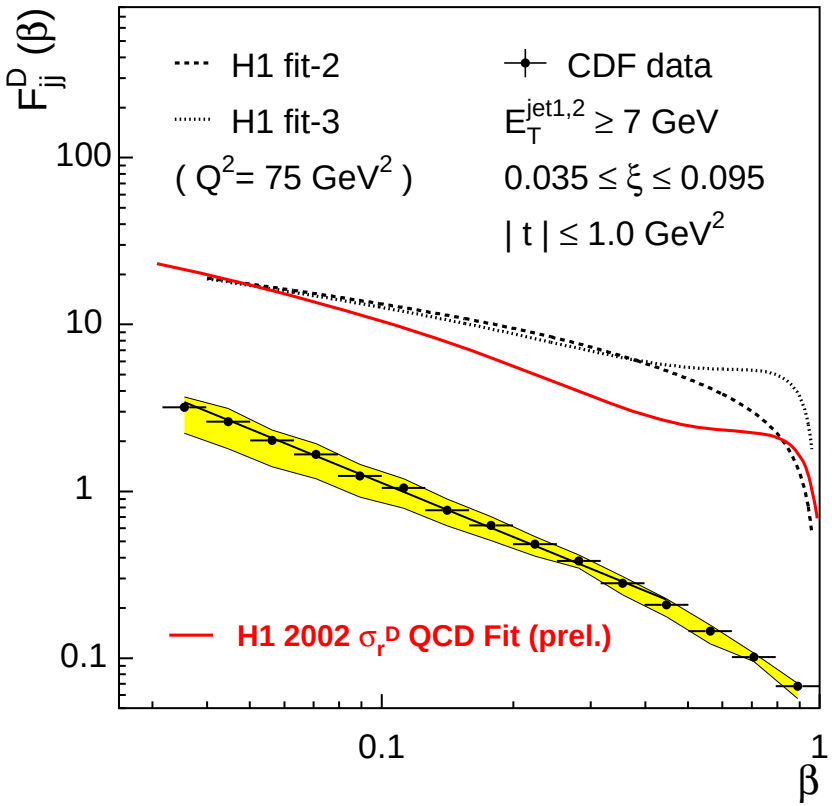
This Study : modifications to structure functions and underlying event

Structure Functions used in this Study

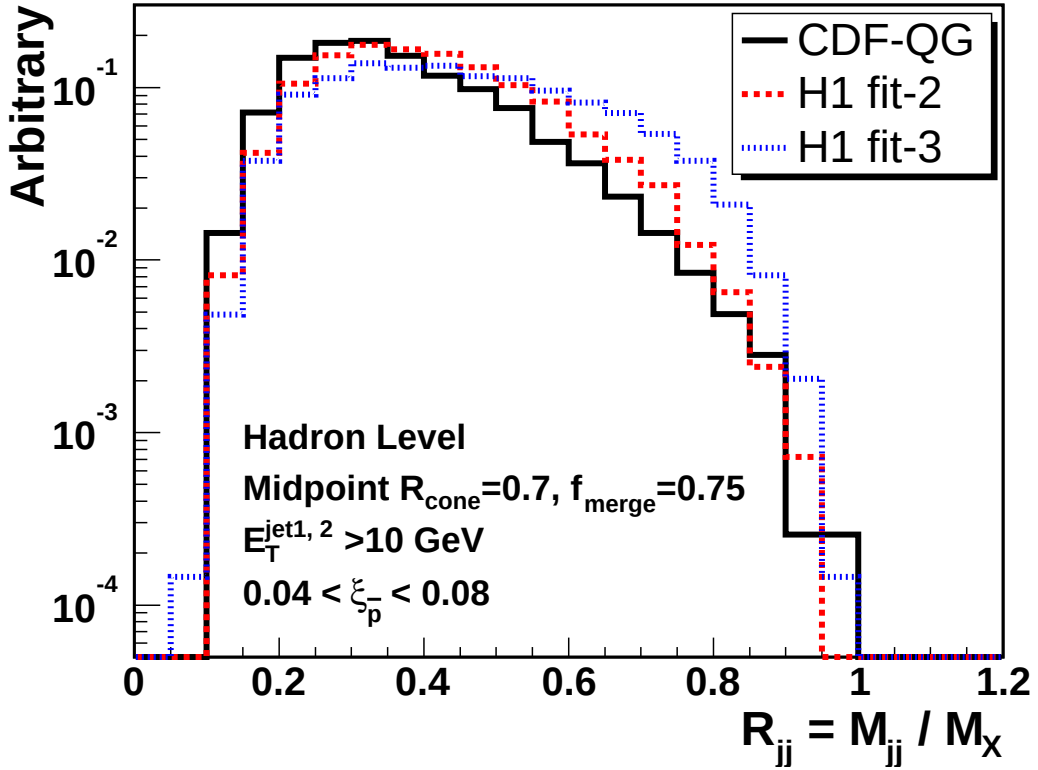
H1 fit-2	
H1 fit-3	
CDF-QG	**CDF $F_{jj}^{D} \sim 1/\beta$ on both sides**
Renormalized CDF-QG	**CDF $F_{jj}^{D} \sim 1/\beta$ on one side, H1 fit-2 on the other side**

CDF F_{jj}^{D} vs H1 fit-2 and fit-3

Factorization Breakdown

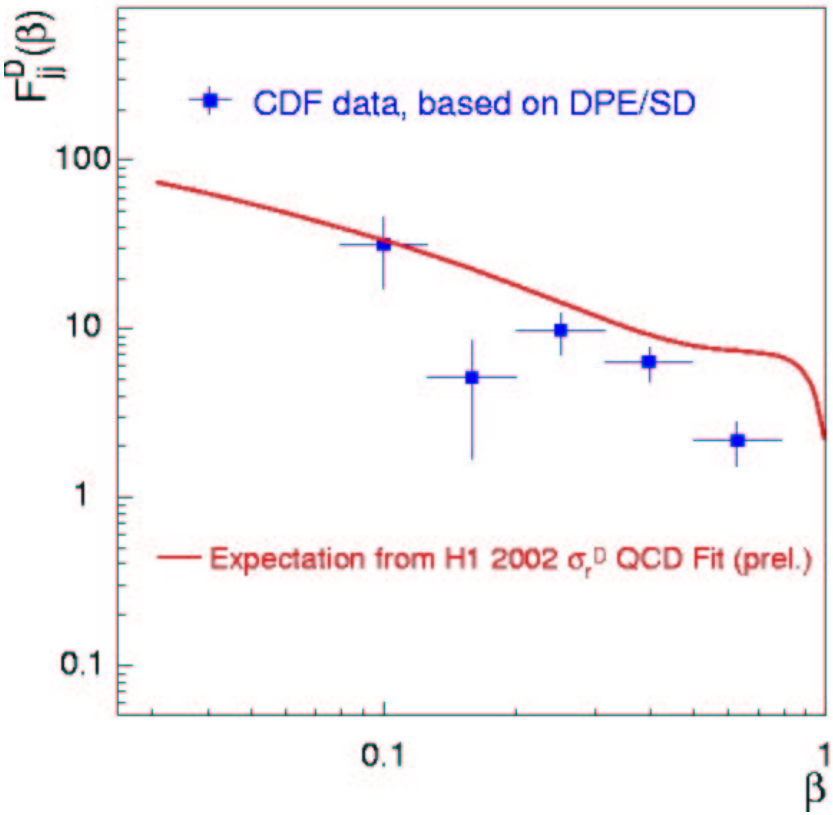


Dijet Mass Fraction

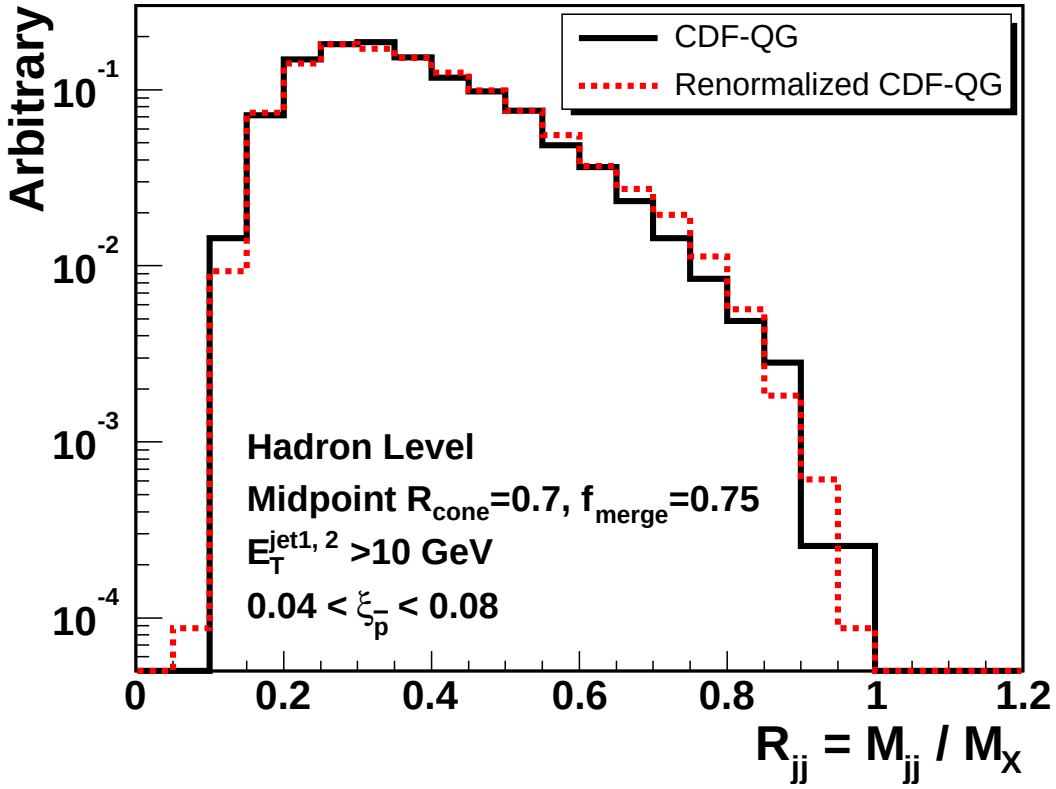


Renormalized CDF-QG

Restoration of factorization

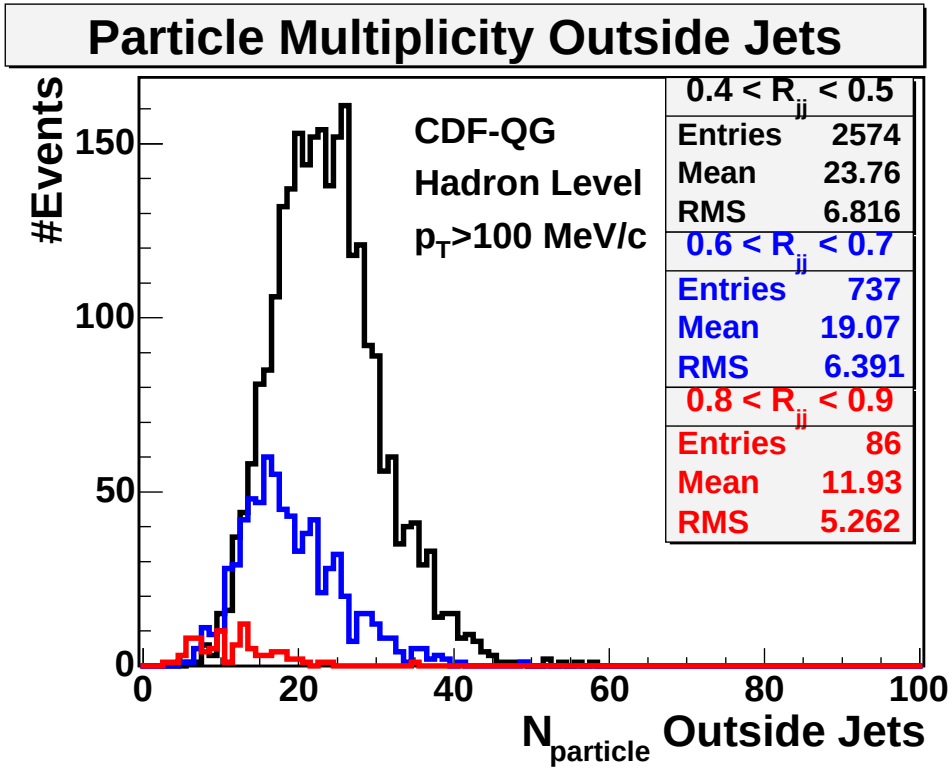


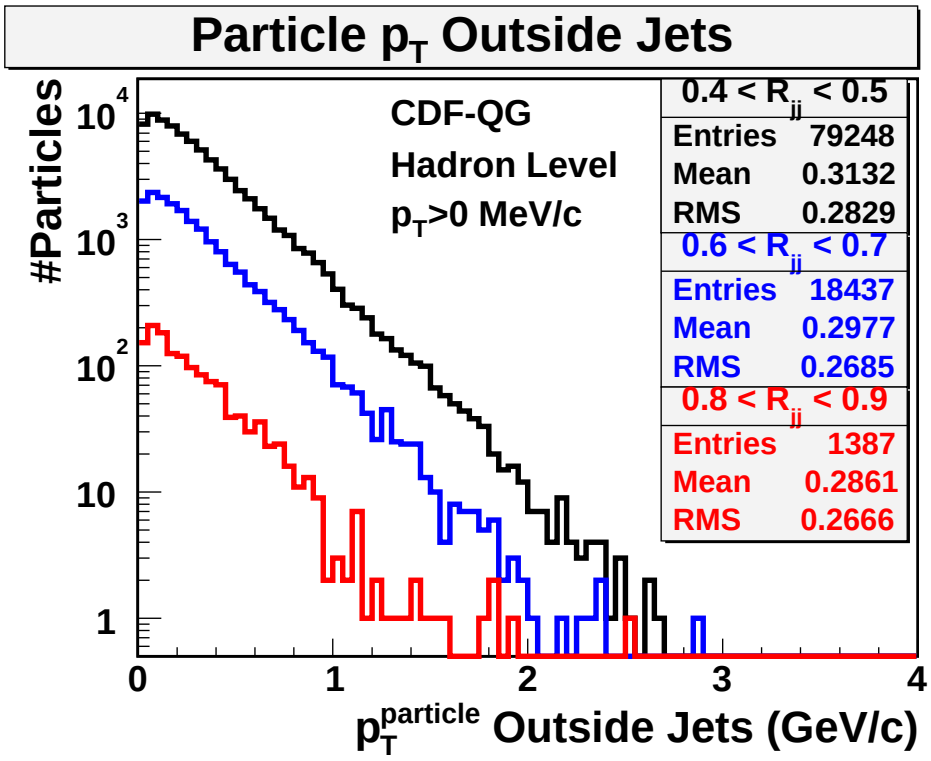
Dijet Mass Fraction



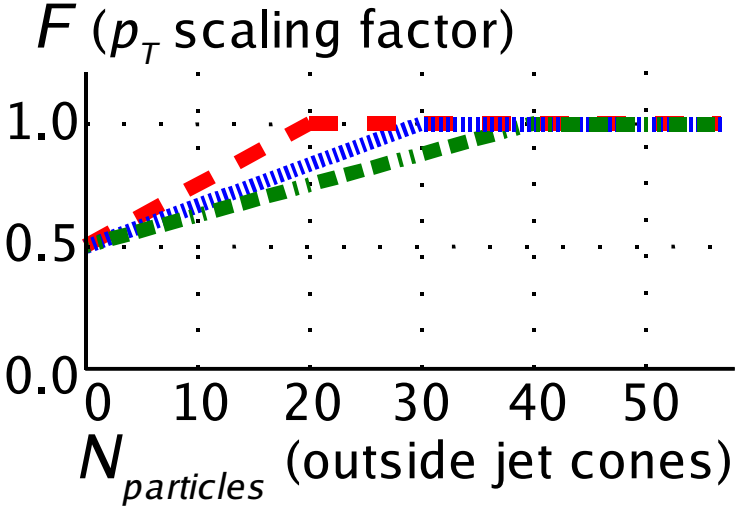
Underlying Event

MC modeling of underlying event at low multiplicity



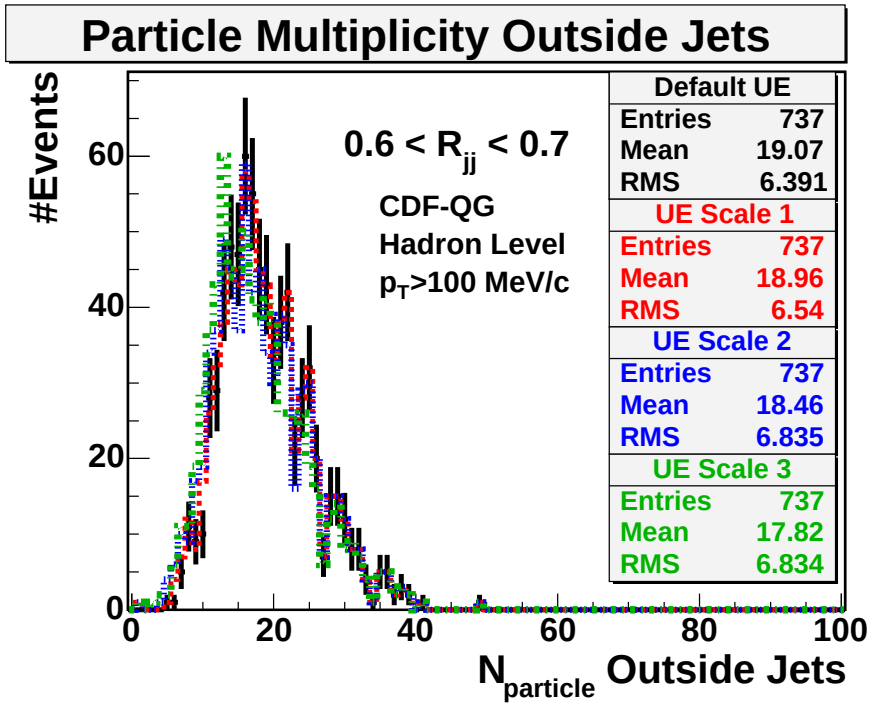


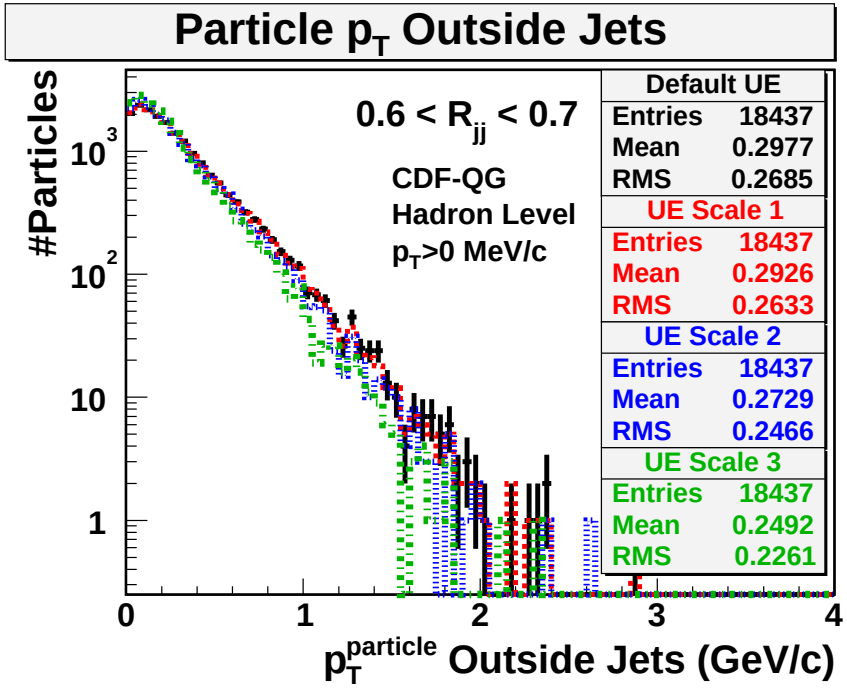
p_T Scaling Studies



Scale Type 1 2 3

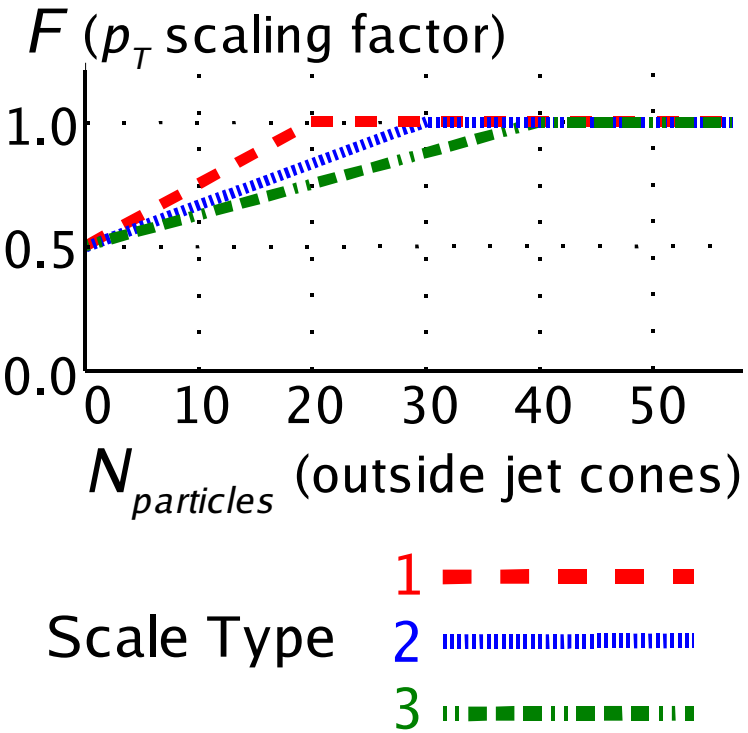
Particle $p_T \rightarrow p_T \cdot F(N_{particles})$

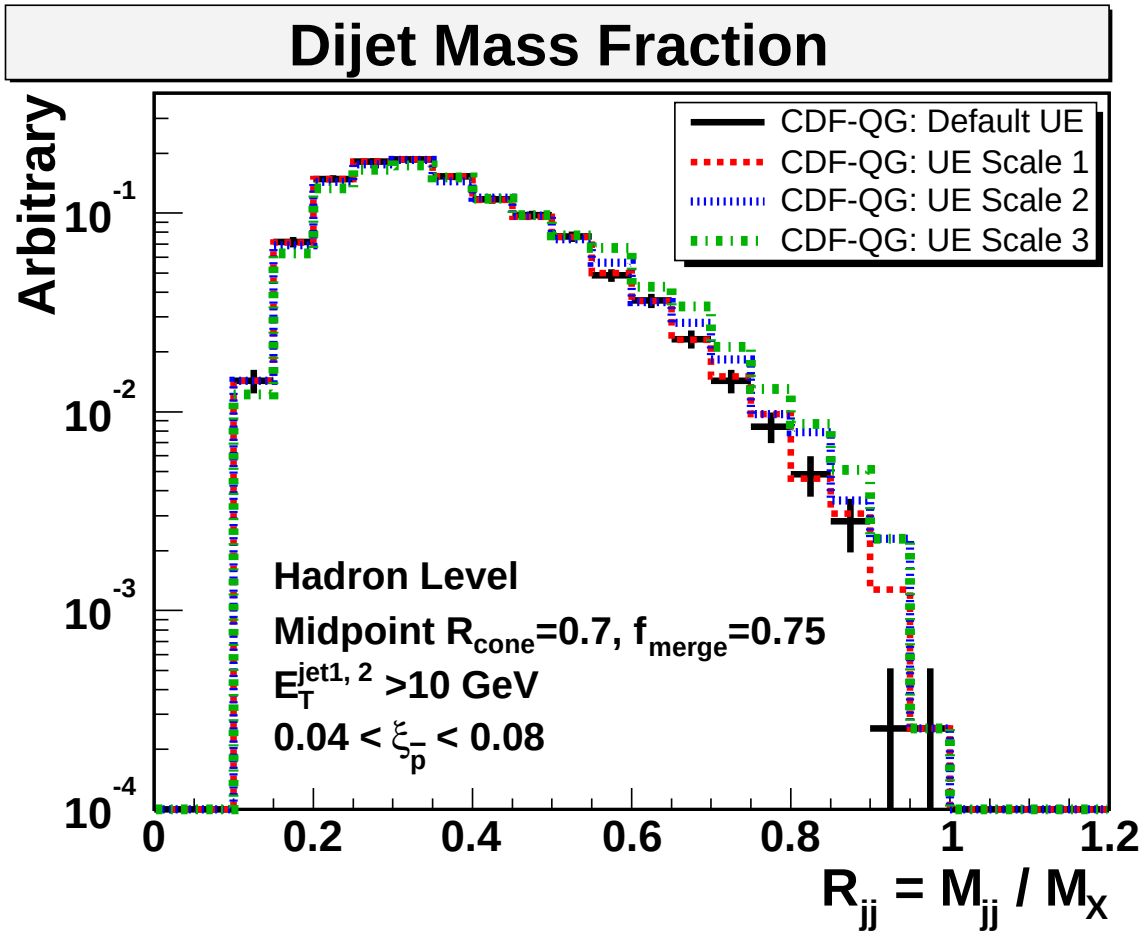




No significant impact on the particle level distributions

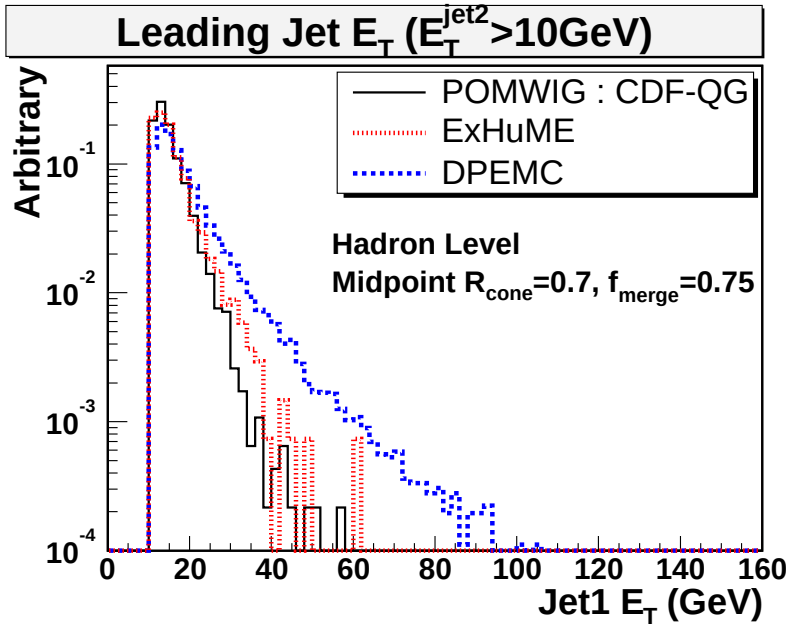
p_T Scaling Effect on R_{jj}

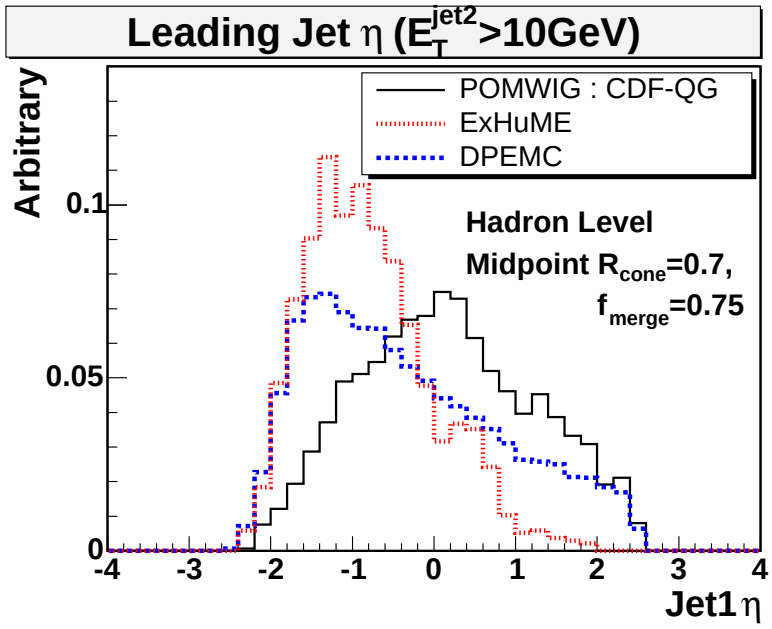




p_T scaling at low multiplicity (dashed line) does not produce significant effect

MC Generated Dijet Distributions





ExHuME v1.3.1? (hep-ph/0502077)

- Based on KMR
- LO matrix element

DPEMC v2.5 (hep-ph/0312273)

- Based on BL
- LO (HERWIG add-on)

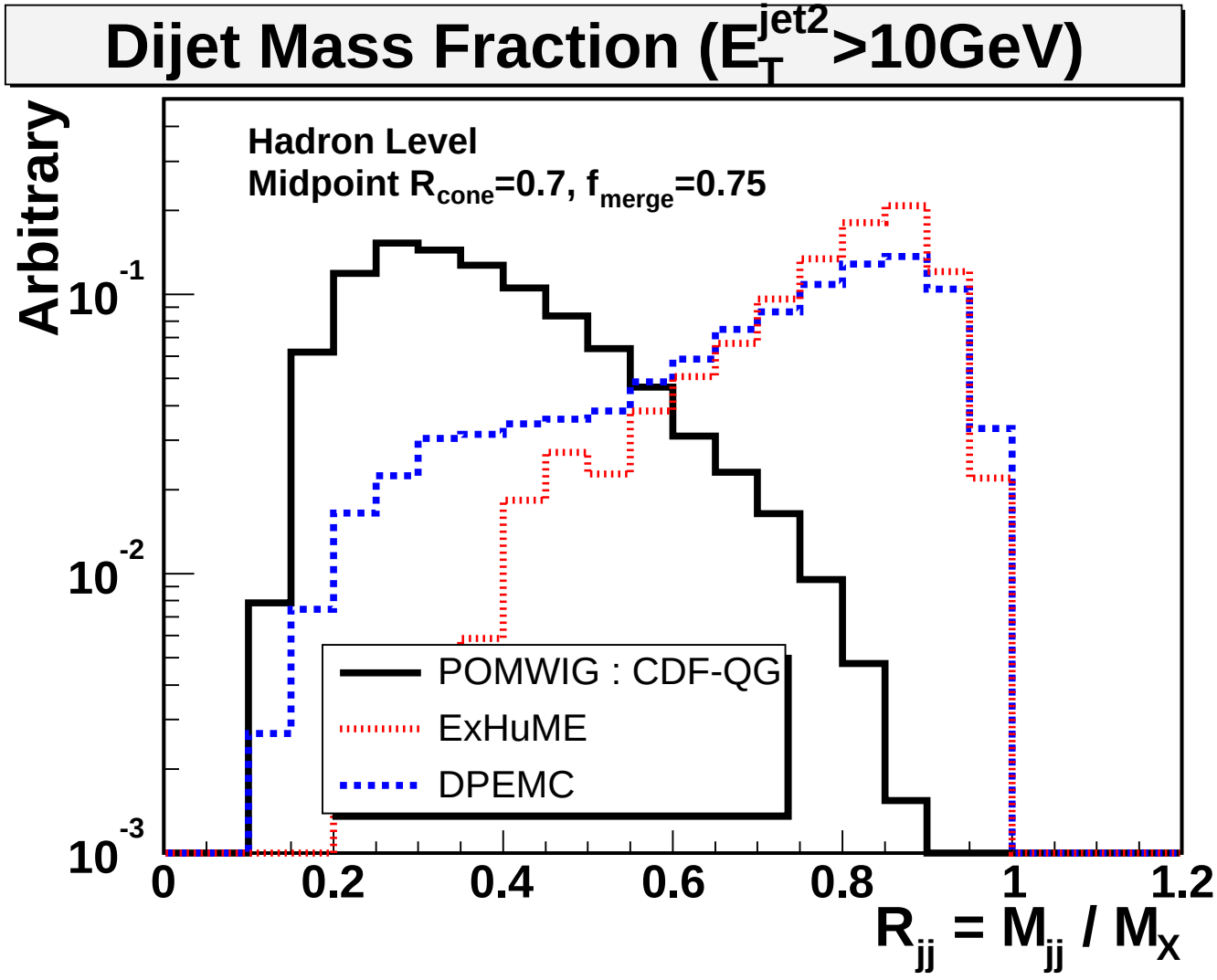
Diffractive PDF	
DPEMC	$\propto 1/x^{1+\epsilon}$
ExHuME	$\propto 1/x^{1+\lambda}$
POMWIG	$\propto 1/x^{1+\lambda+0.45}$

$$\lambda = \lambda(Q^2) = 0.2 \sim 0.4$$

Run I Dijet:

$$R_{\frac{SD}{ND}}(x) \propto x^{-0.45}$$

MC Generated R_{jj} Distributions



- ✔ R_{jj} peak position ~ 0.8 (leakage from jet cones)
- ✔ Long tail towards small R_{jj} due to FSR

Prospects

- Complete studies of systematic uncertainties
- Obtain results in early 2006
- Check results using DPE *b*-jet data