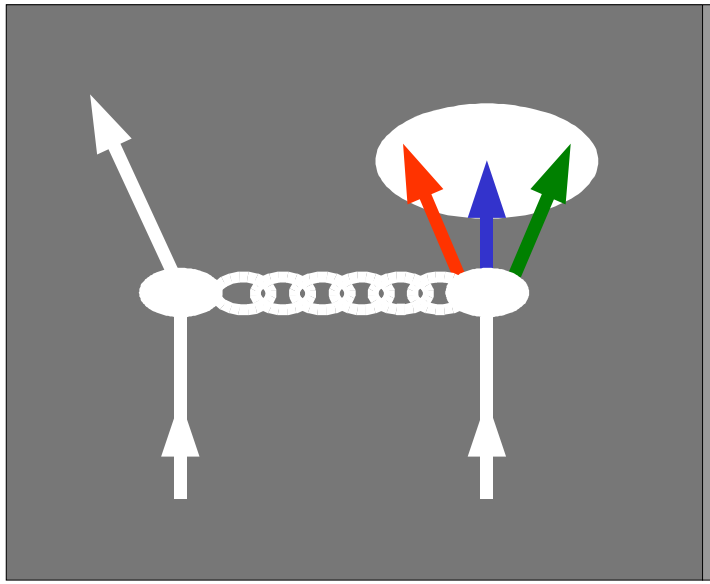
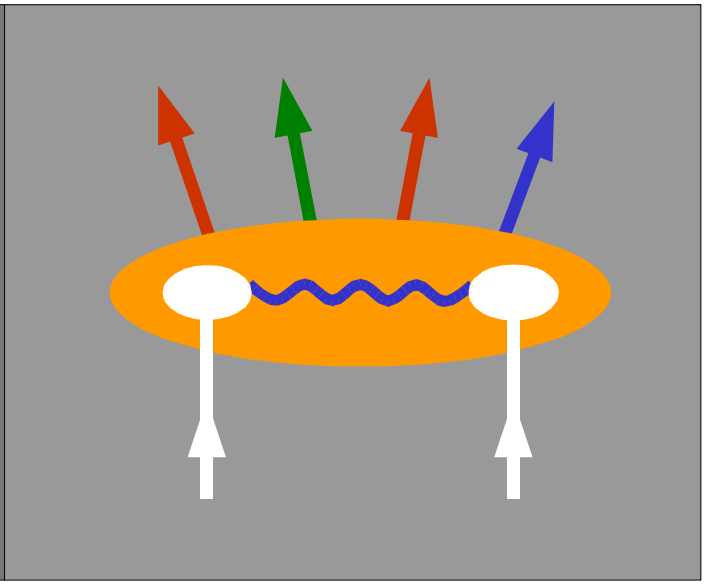
New Diffraction Results from the Tevatron

Koji Terashi
The Rockefeller University

On behalf of the CDF and DØ* Collaborations

*** No new results from DØ**

$\bar{p}$-p Interactions

Diffractive: vacuum exchange	Non-diffractive: color exchange
	
Protons retain their quantum numbers	Protons acquire color and break apart

GOAL :

understand the nature of colorless exchange

Outline

Diffractive Structure Function

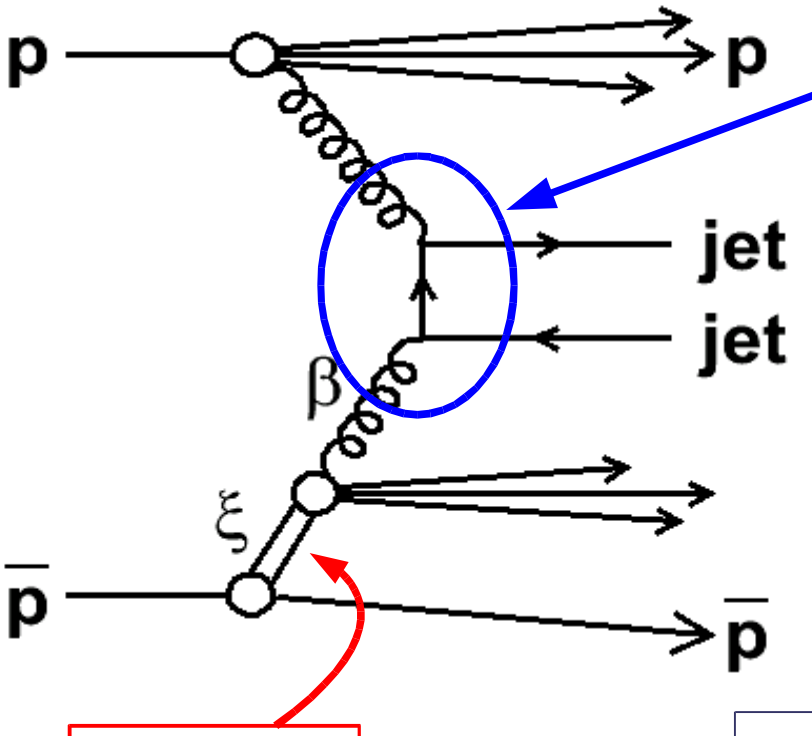
- Ratio SD/ND dijets vs $x_{Bjorken}$
- Q^2 dependence of SD/ND ratio
- Q^2 dependence of t in SD dijets

Exclusive Production

- Exclusive di-jet
  - ➔ Inclusive+Exclusive di-jet Monte Carlo
  - ➔ Heavy flavor jet fraction
- Exclusive di-electron and di-photon

Summary

Diffractive Structure Function



Pomeron

$\xi = P_{Pomeron} / P_{proton}$

Use high p_T jets as a probe

➔ ***Hard Diffraction***

Diffractive Di-Jets :

$$\sigma(\bar{p}p \to \bar{p}X) \approx F_{jj} \otimes F_{jj}^{D} \otimes \hat{\sigma}(ab \to jj)$$

$$F_{jj}^{D} = F_{jj}^{D}(\xi, t, x_{Bj}, Q^2)$$

Diffractive Structure Function

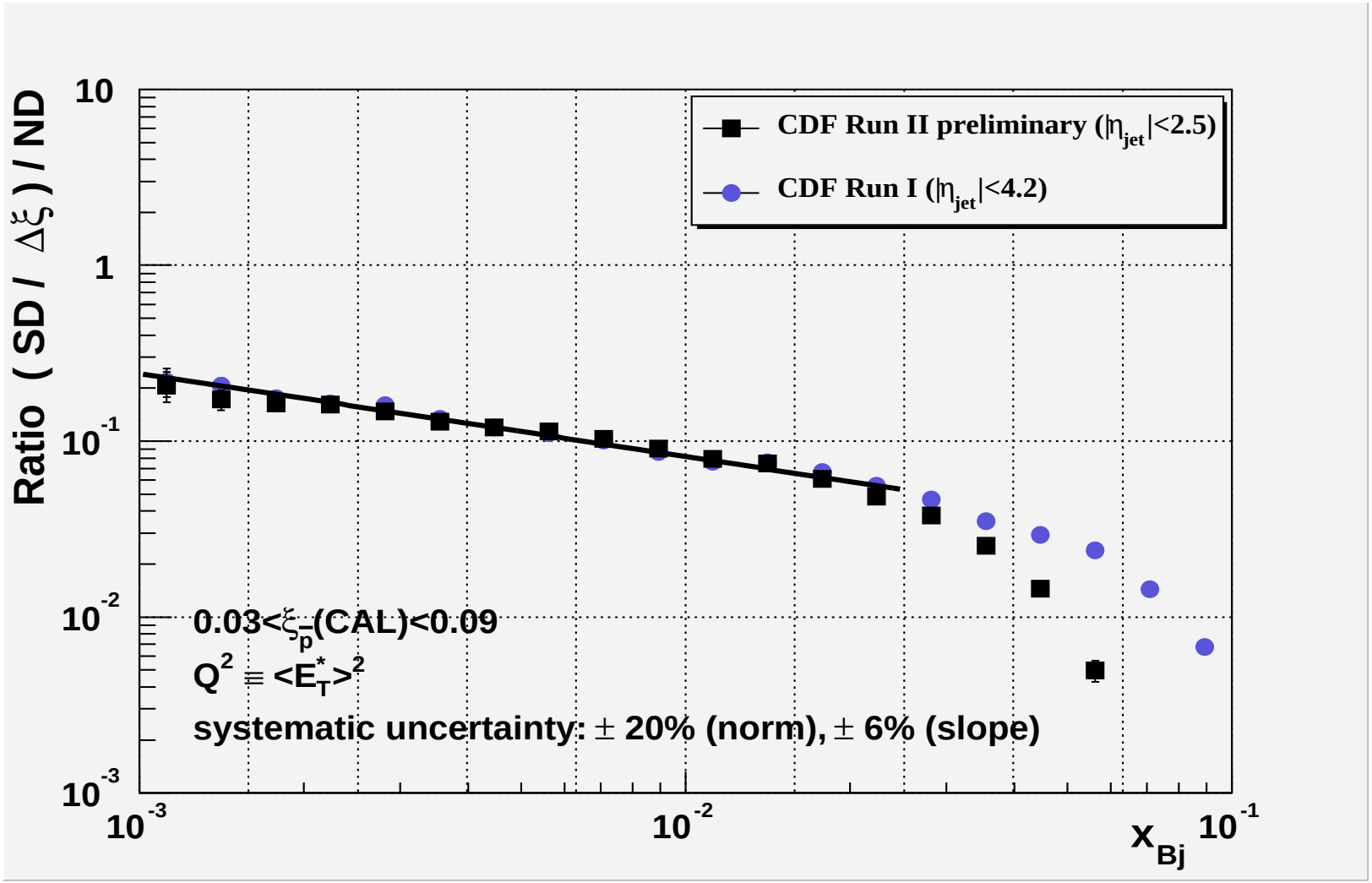
Experimental Determination of F_{jj}^{D}

$$R(x_{Bj}) \text{ of } \frac{\sigma_{jj}(SD)}{\sigma_{jj}(ND)} = \frac{F_{jj}^{D}(x_{Bj}, Q^2)}{F_{jj}(x_{Bj}, Q^2)} \text{ (LO QCD)}$$

Data

Known Proton PDF

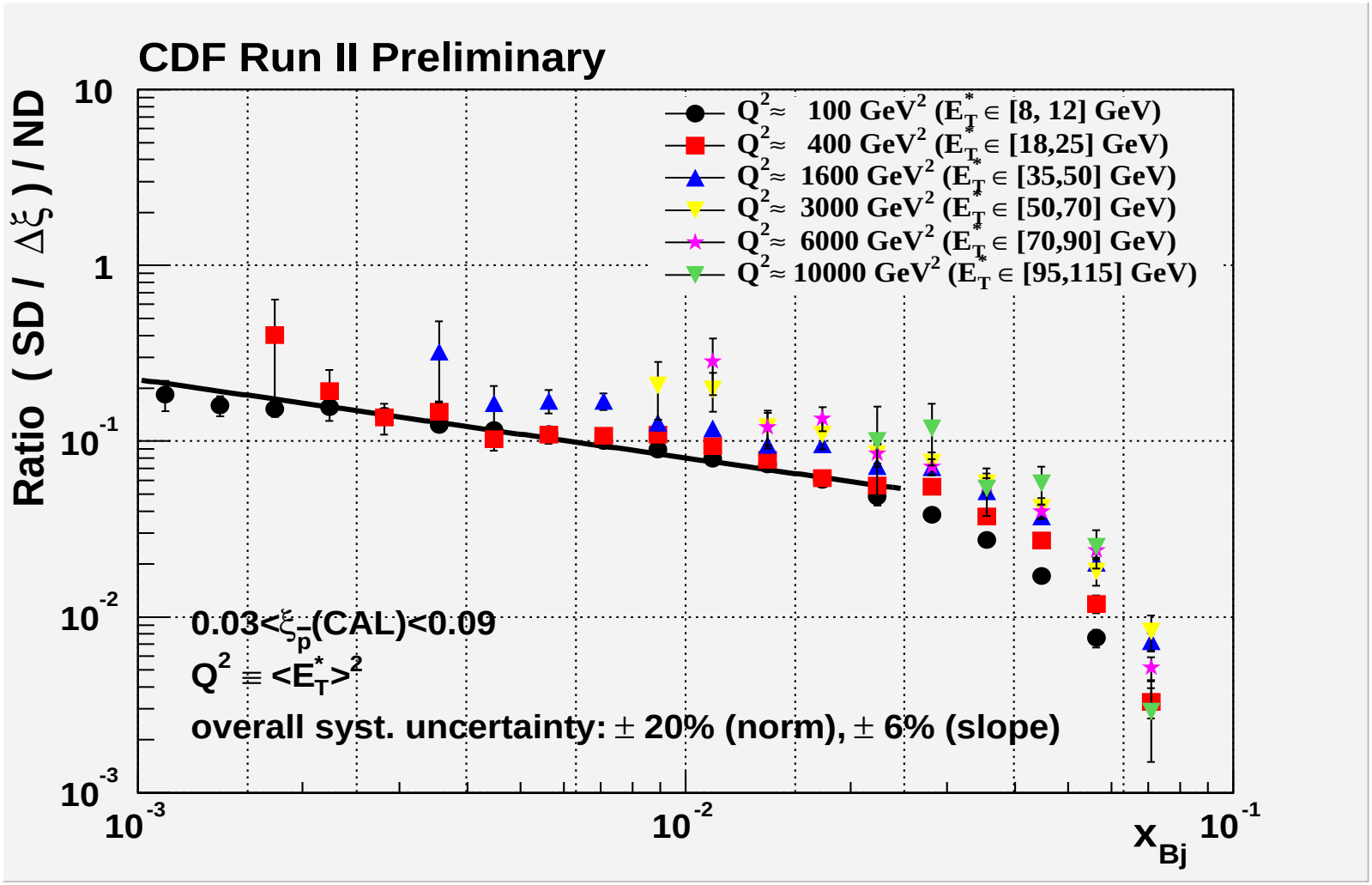
Ratio SD/ND Dijets vs $x_{Bjorken}$



- agreement with Run I result
- no ξ dependence in 0.03<ξ<0.09

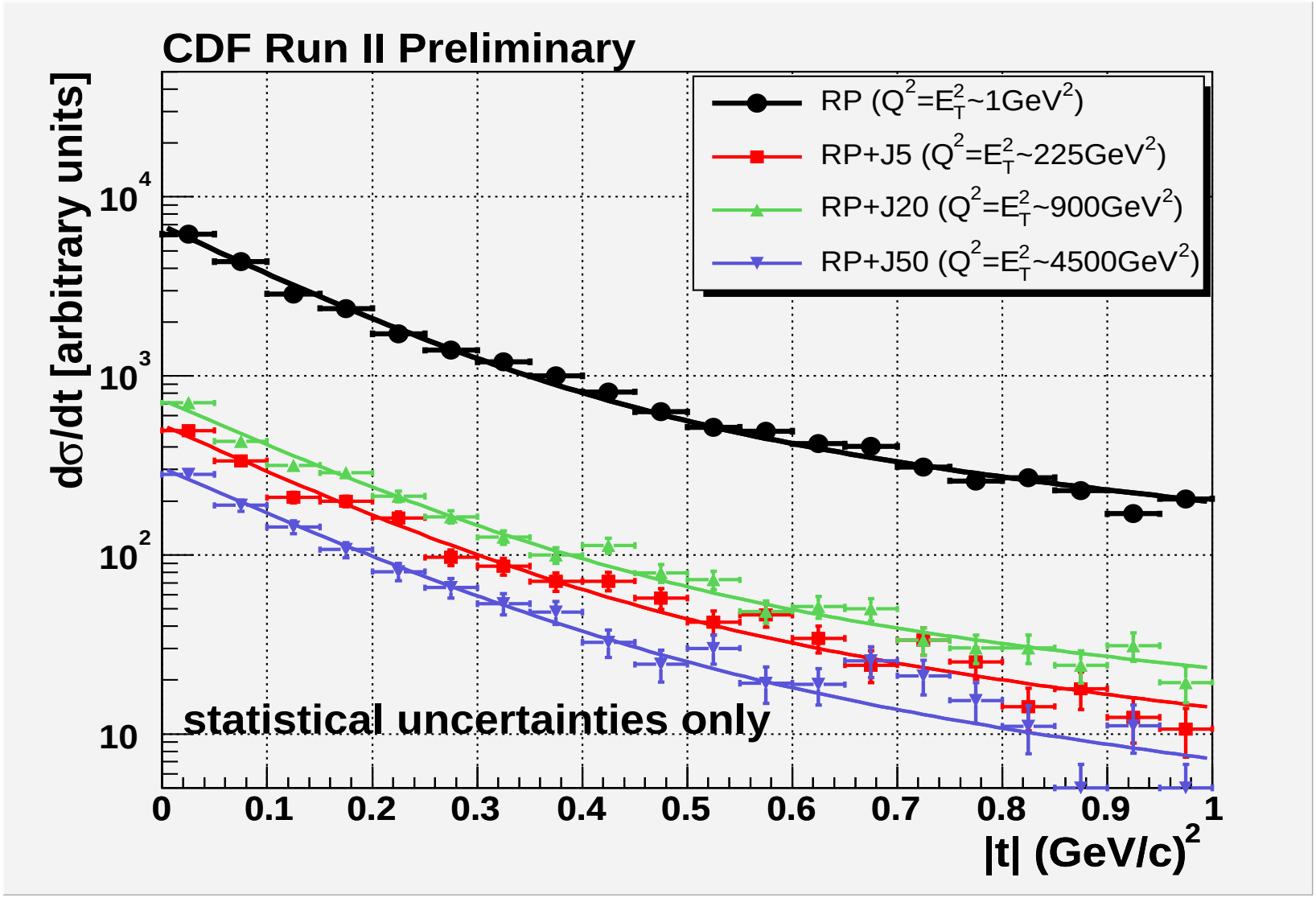
➔ confirms Run I results

Q^2 Dependence of SD/ND Ratio



No appreciable Q^2 dependence in region $100 < Q^2 < 10000$ GeV^2 → Pomeron evolves similarly to proton

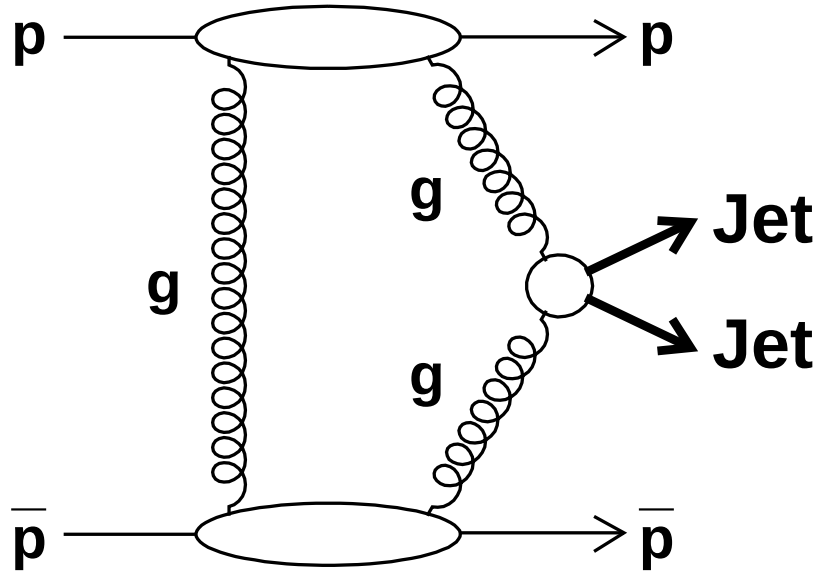
Q^2 Dependence of t in SD Dijets



Slope at $t = 0$ is independent of Q^2

Exclusive Production

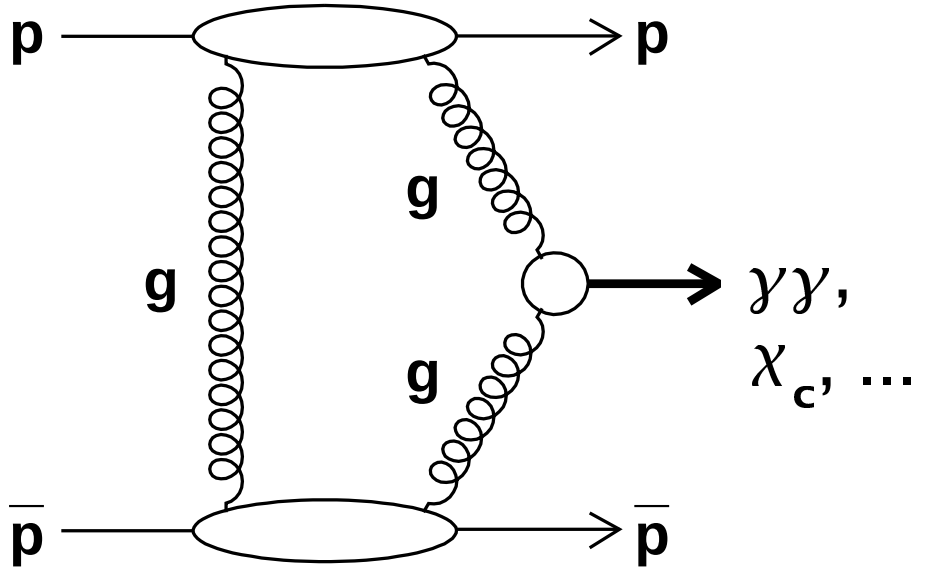
Exclusive Dijet



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

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

Exclusive $\gamma\gamma$, χ_c



$gg \rightarrow \gamma\gamma$, $gg \rightarrow \chi_c$, …

clean signatures

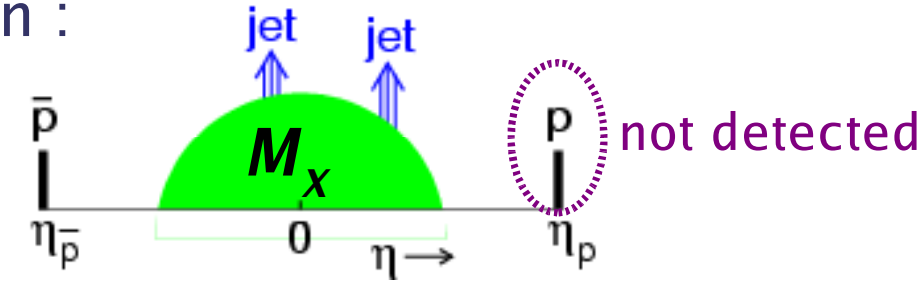
Measure exclusive dijet and $\gamma\gamma$ cross sections to calibrate predictions for exclusive Higgs production at the LHC

Search for Exclusive Dijets

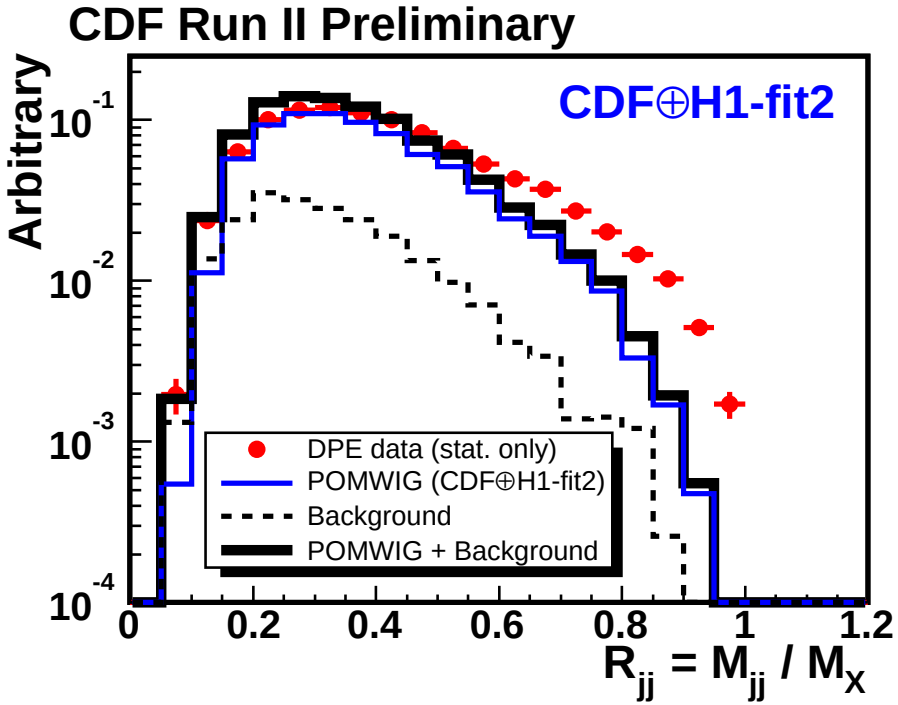
Strategy

- Select inclusive DPE dijets : $\bar{p} + p \rightarrow \bar{p} + X$ ($\geq$2jets, ...) + gap
- Reconstruct dijet mass fraction :

$$R_{jj} = \frac{M_{jj}}{M_X}$$



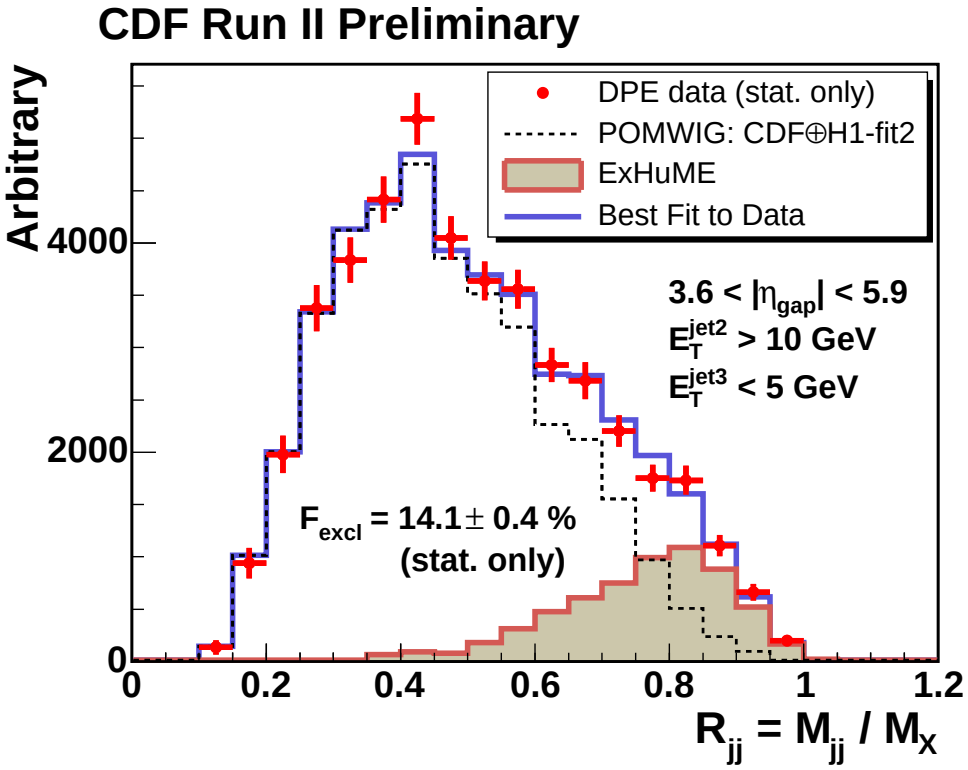
- Look for excess in data over inclusive DPE dijet MC (POMWIG)

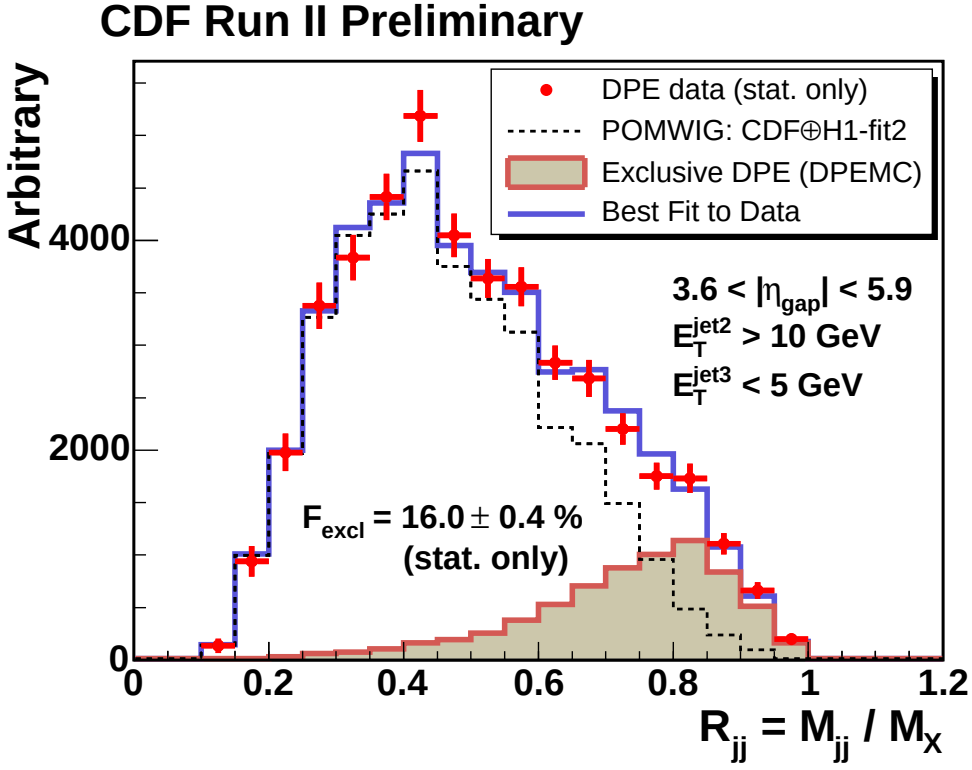


Excess of events in data observed at high R_{jj}

Is this exclusive signal?

Inclusive+Exclusive Dijet Monte Carlo vs Data





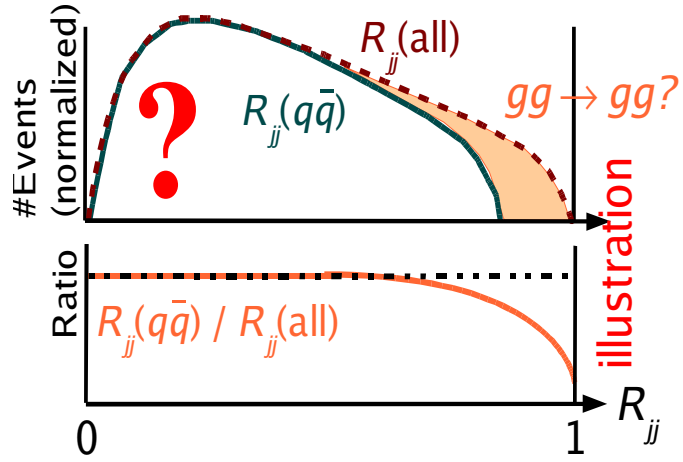
ExHuME (KMR) : ***gg → gg***

Exclusive DPE (in DPEMC) : ***IP IP → 2 jets***

The excess at high R_{jj} is well described by the two exclusive dijet production models

Heavy Flavor Jet Fraction vs R_{jj}

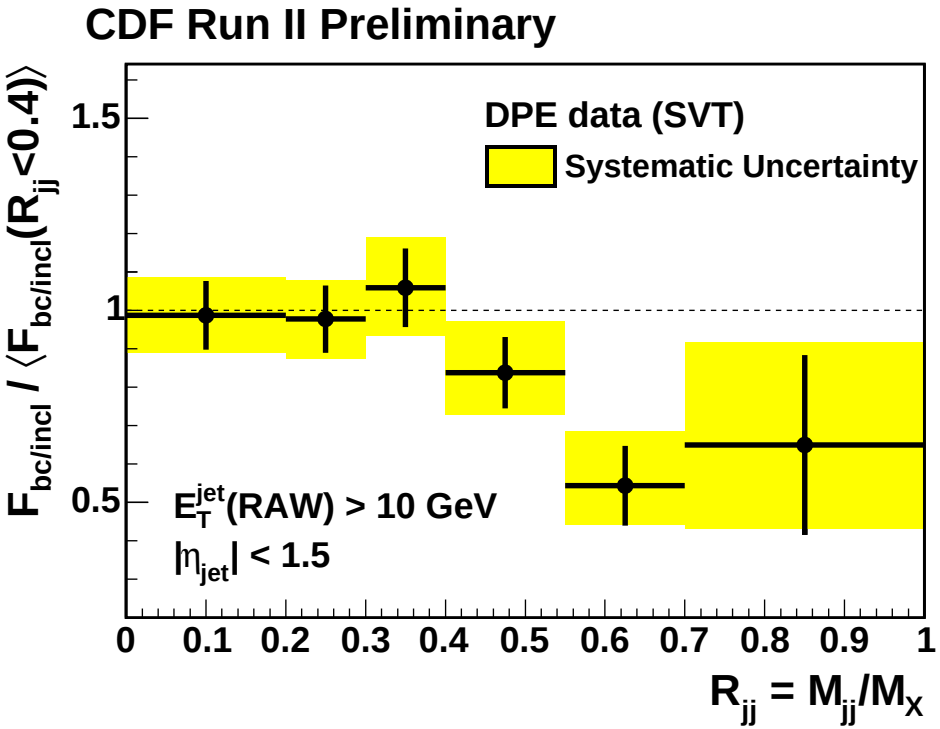
Exclusive $gg \to q\bar{q}$ Jz=0 suppression is expected



Use b/c-quark Jet Data

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

- many exp. systematics cancel in ratio
- *b/c*-quarks identified event-by-event

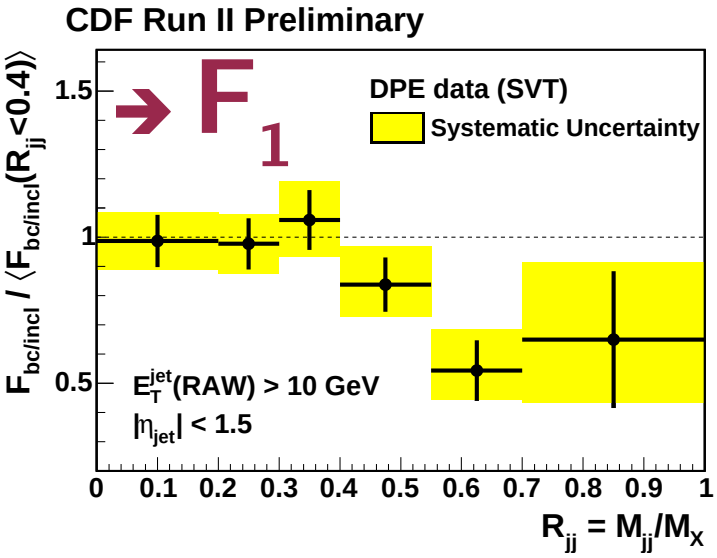


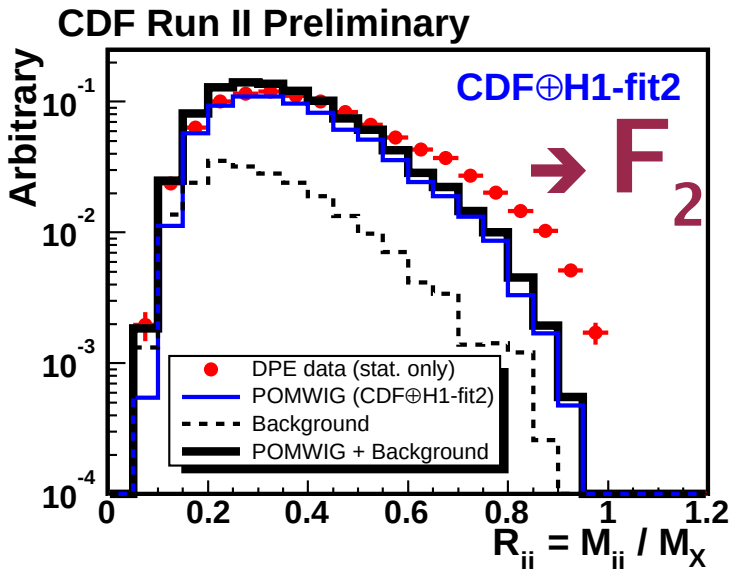
Ratio of *b/c*-jets to all jets (normalized to the mean in R_{jj}<0.4)

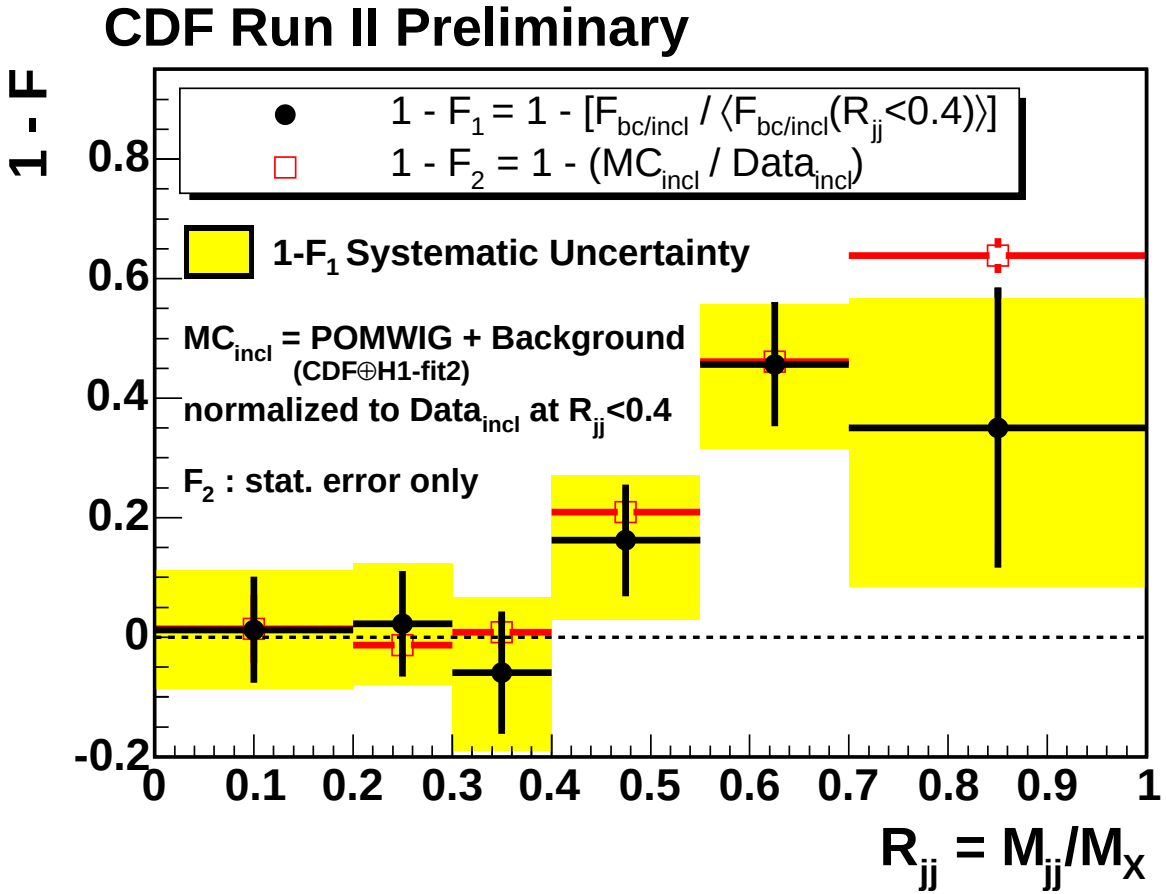
⇩

Decreasing trend observed at high R_{jj}

Comparing Inclusive Jet and Heavy Flavor Jet Results

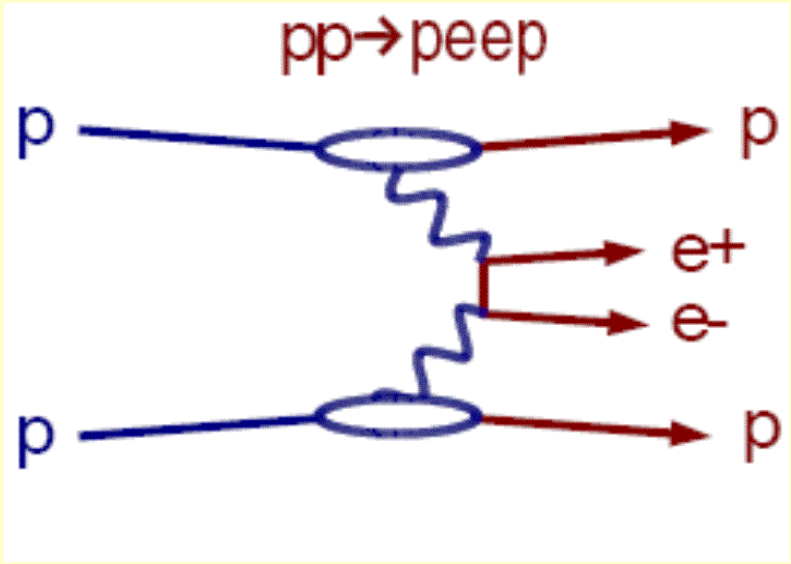




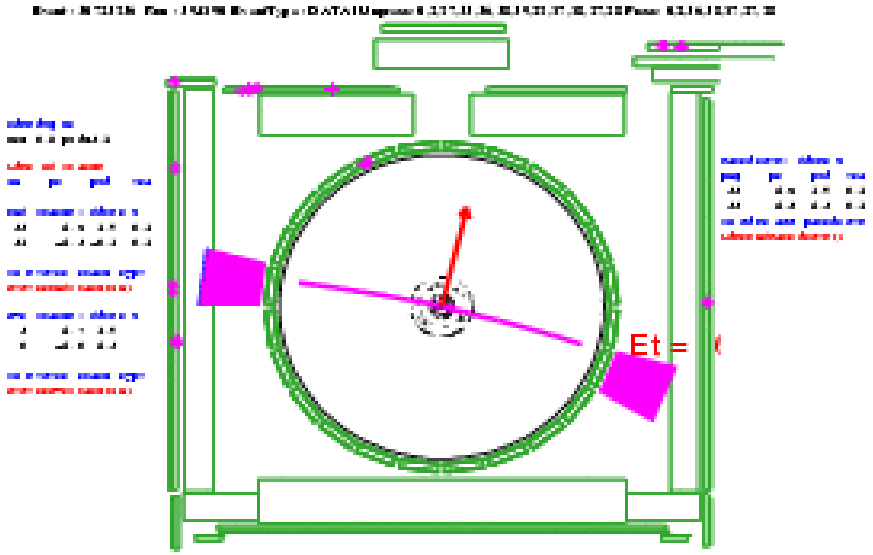


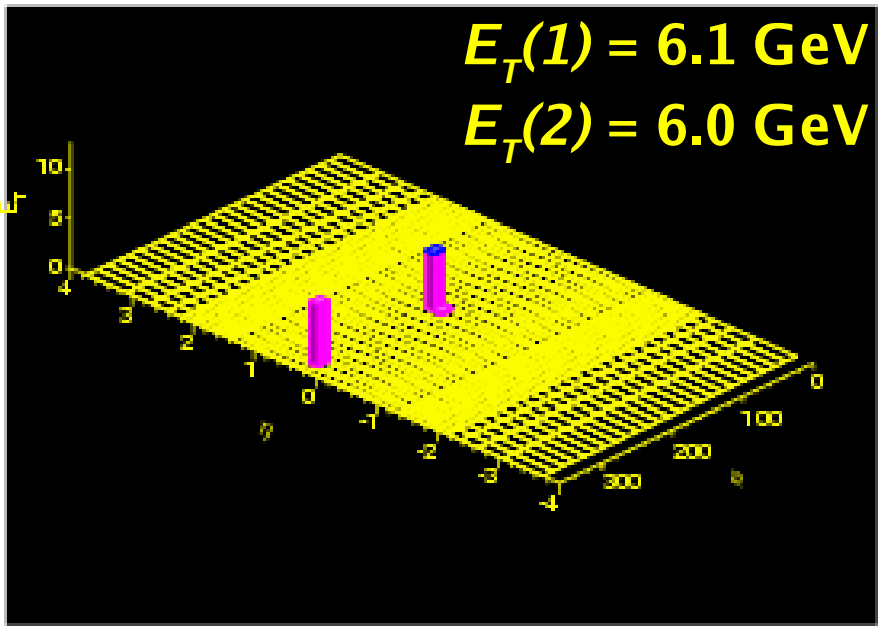
The two results are consistent with each other

Exclusive ee Candidates



Good control sample
for $\bar{p}p \to \bar{p}\gamma\gamma p$ search

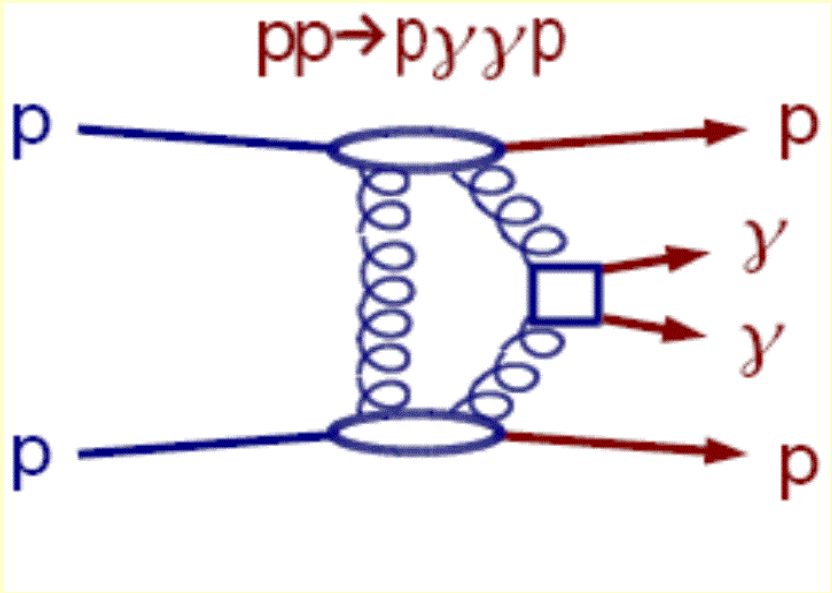


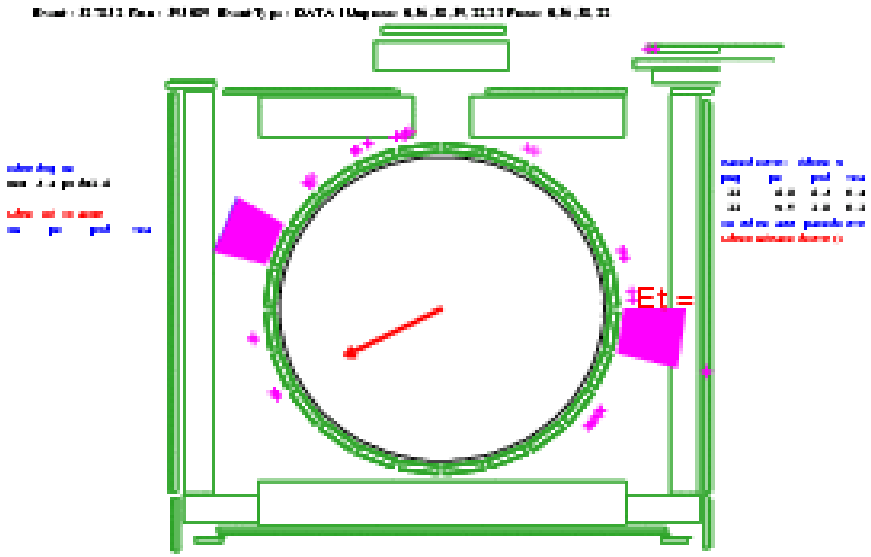


10 candidate events observed
no background estimate yet

9 ± 3 events predicted by LPAIR Monte Carlo

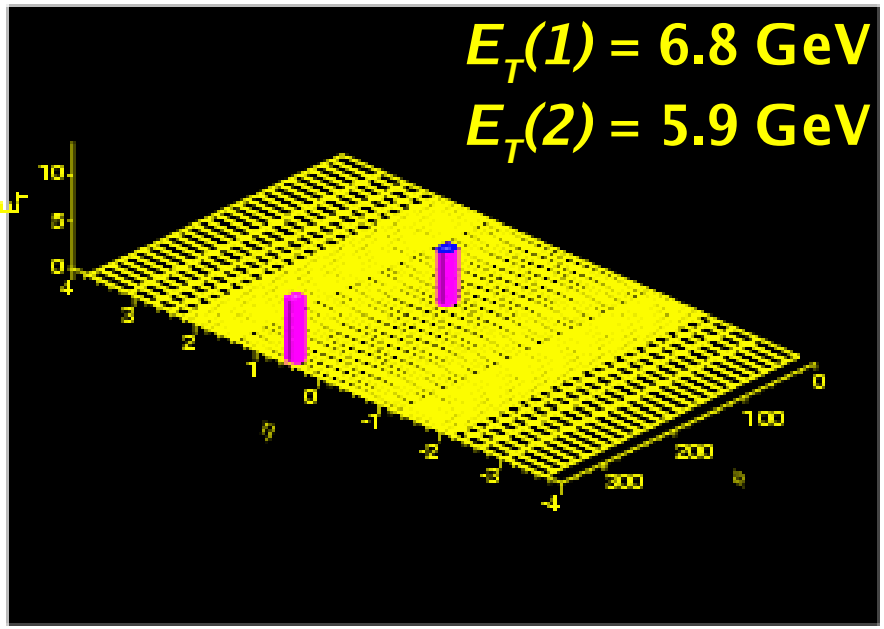
Exclusive $\gamma\gamma$ Candidates





3 candidate events observed
no background estimate yet

1^{+3}_{-1} events predicted by ExHuME Monte Carlo
(based on Khoze, Martin, Ryskin, Ref: Eur. Phys. J. C38, 475-482, 2005)



Summary

Diffractive Structure Function F^D :

- Confirmed and extended Run I results using single diffractive dijets
  - ✔ Q^2 dependence of F_{jj}^D → **Pomeron evolves like proton?**
  - ✔ Slope at $t = 0$ is independent of Q^2

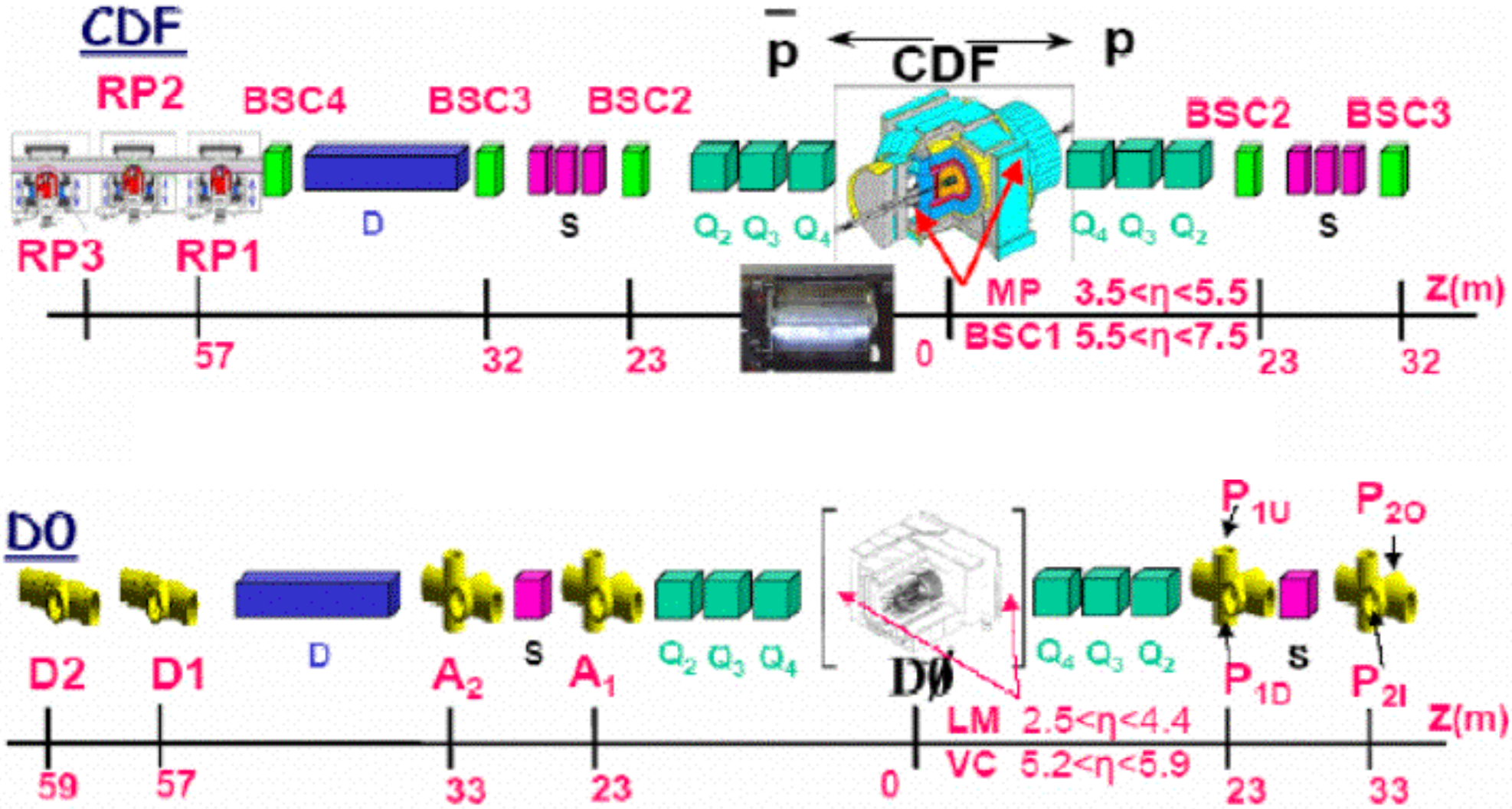
Exclusive Production :

- Observed excess events in data at high R_{jj}, being consistent with the presence of exclusive dijets
- Heavy flavor jet yield relative to inclusive jets appears to be decreased at high R_{jj} → **manifestation of $Jz = 0$ suppression?**
- Observed events which appear to be consistent with $\bar{p}p \to \bar{p}\gamma\gamma p$
  - ✔ $\bar{p}p \to \bar{p}eep$: nice cross check for di-photon
- Exclusive $\gamma\gamma$ and dijet cross sections measured soon

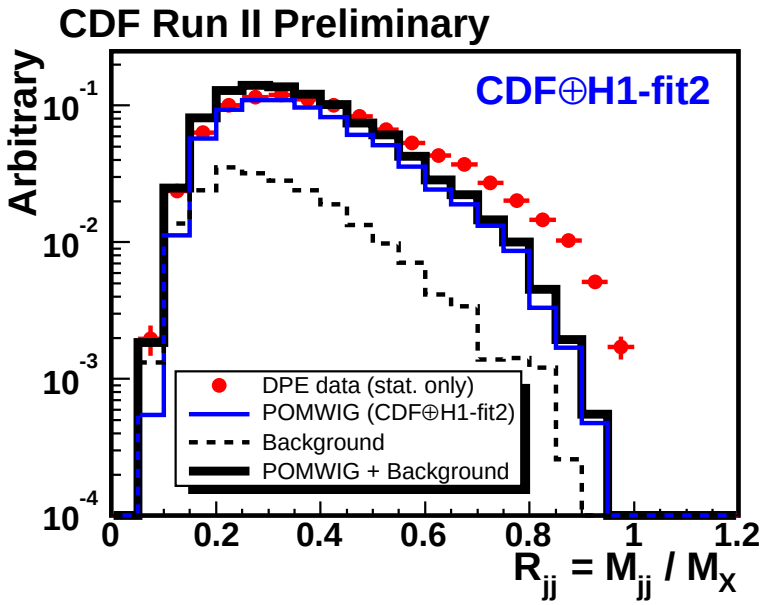
Important inputs to $pp \to pHp$ at LHC

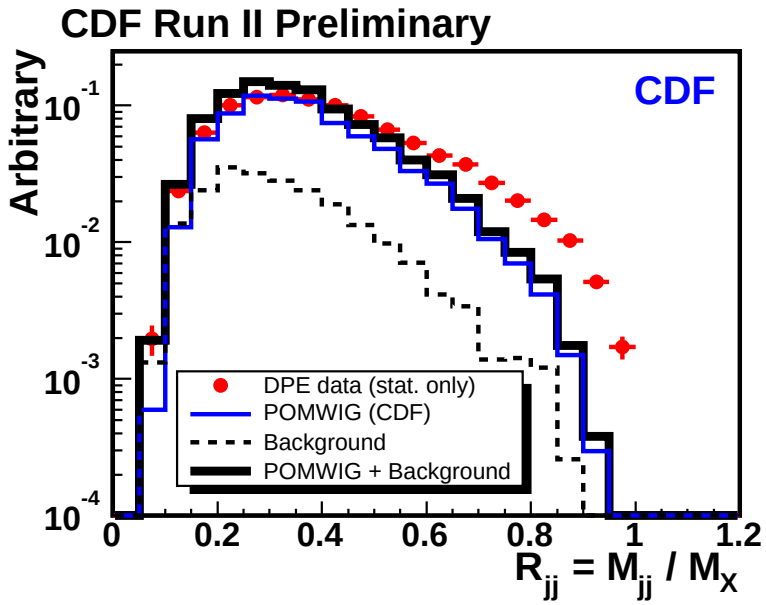
Backup

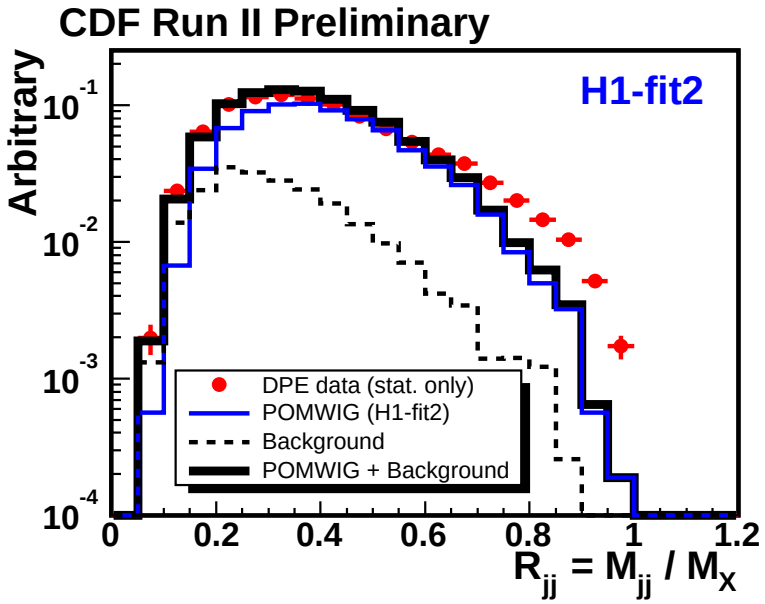
Run II Detectors



DPE Dijet Events : $R_{jj} = M_{jj}/M_X(CAL)$

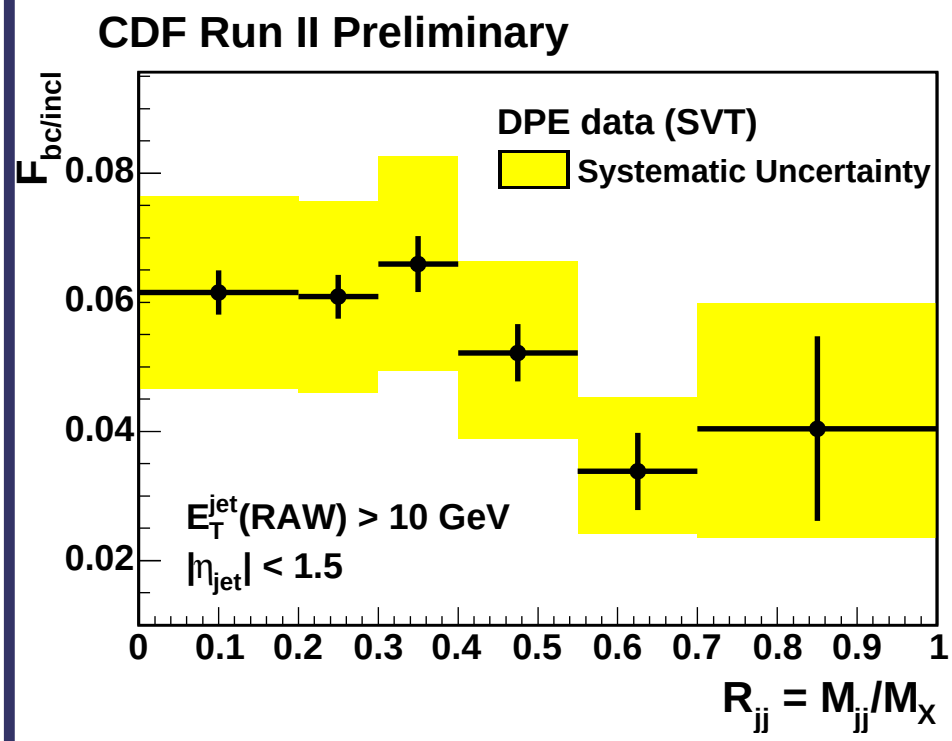


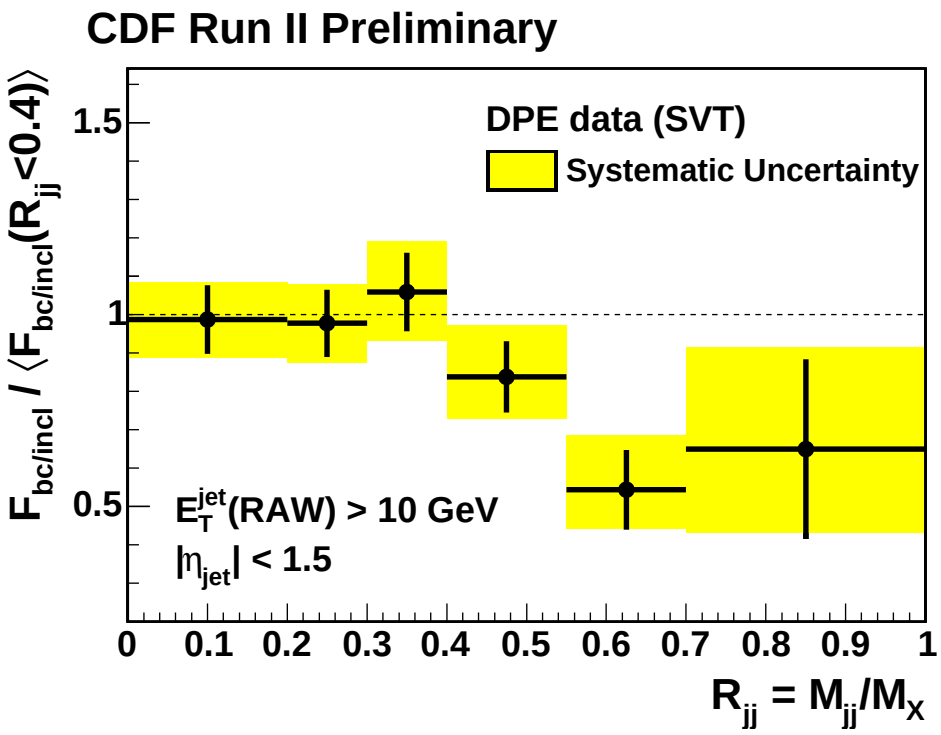




CDF⊕H1-fit2	$F_{jj}^{D} \sim 1/\beta$ (f_g=0.54, f_q=0.46) on one side, H1-fit2 on the other side
CDF	$F_{jj}^{D} \sim 1/\beta$ (f_g=0.54, f_q=0.46) on both sides
H1-fit2	H1-fit2 on both sides

HF-Jet Fraction vs R_{jj}

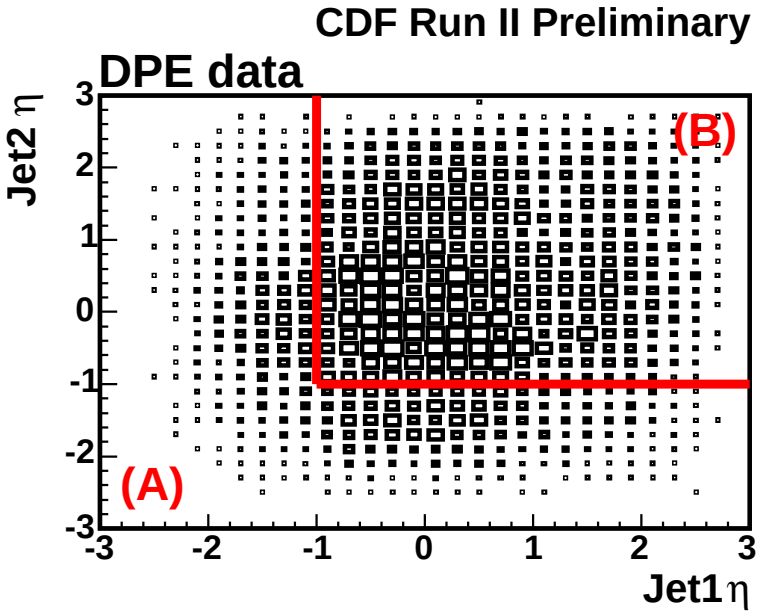


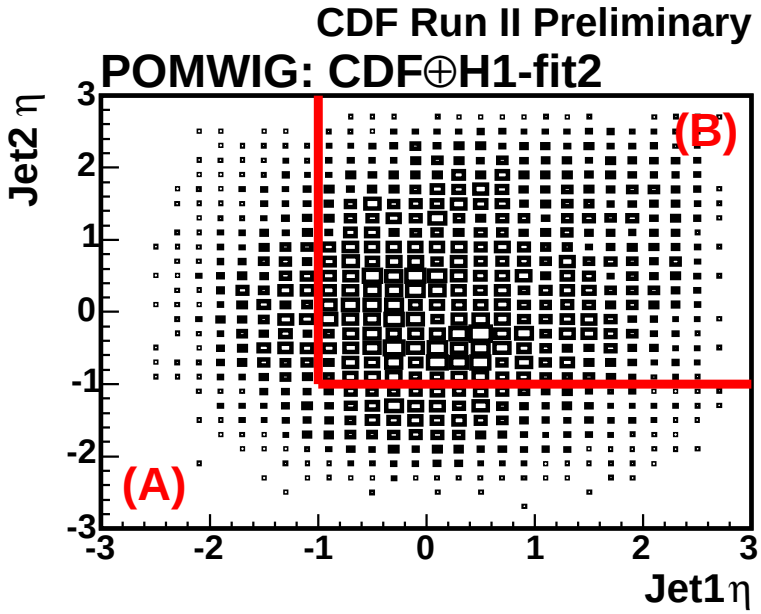


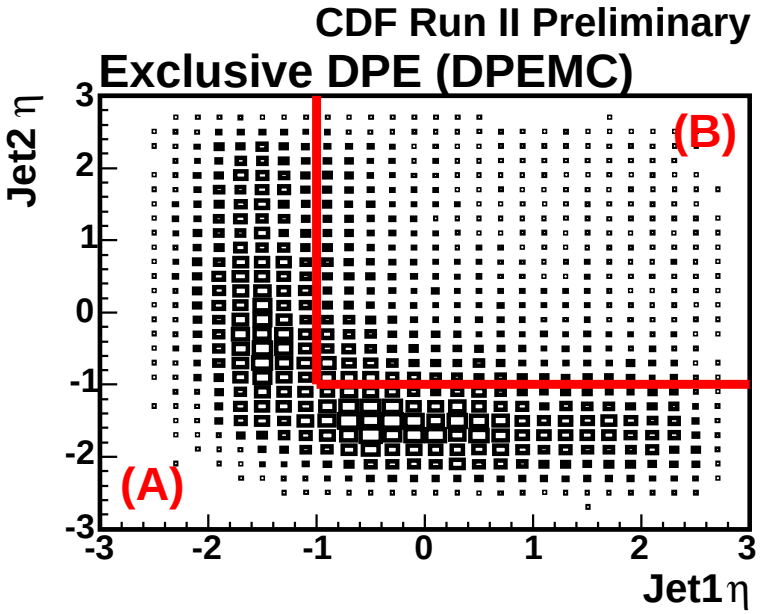
All systematic uncertainties added in quadrature

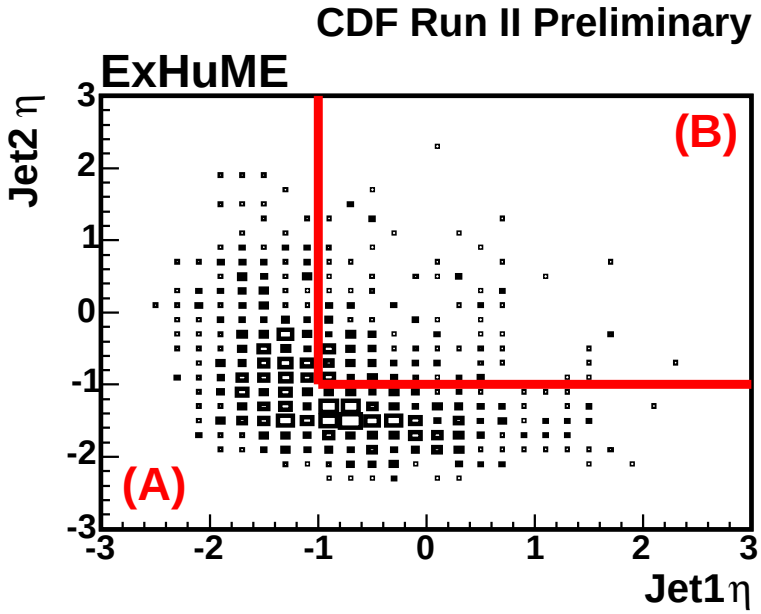
Normalized to the mean in R_{jj}<0.4

Jet Pseudorapidity Cuts

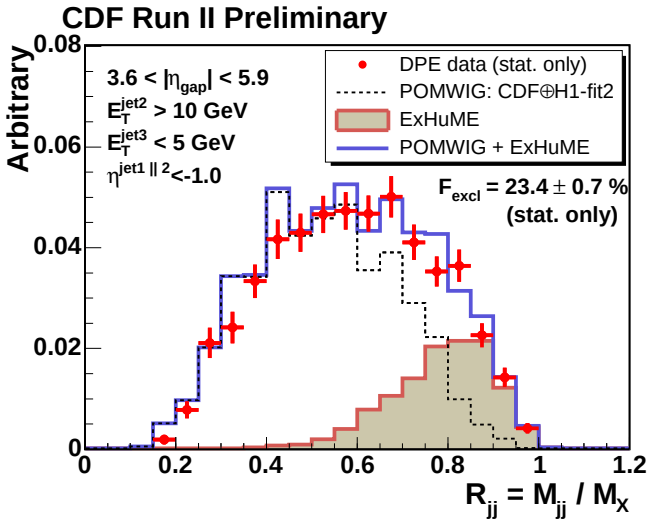


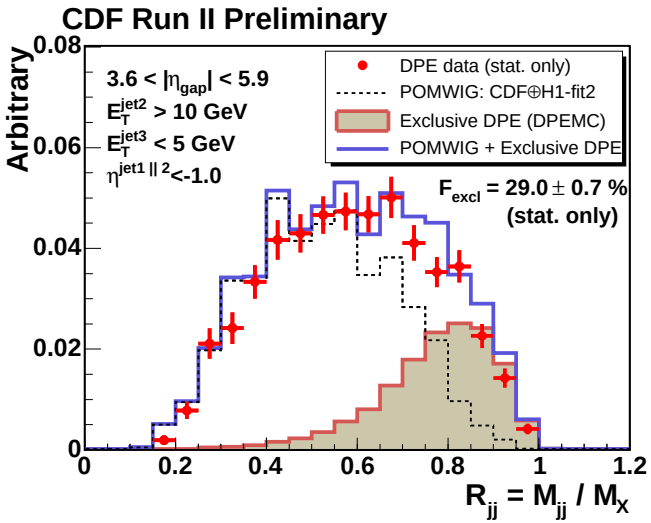




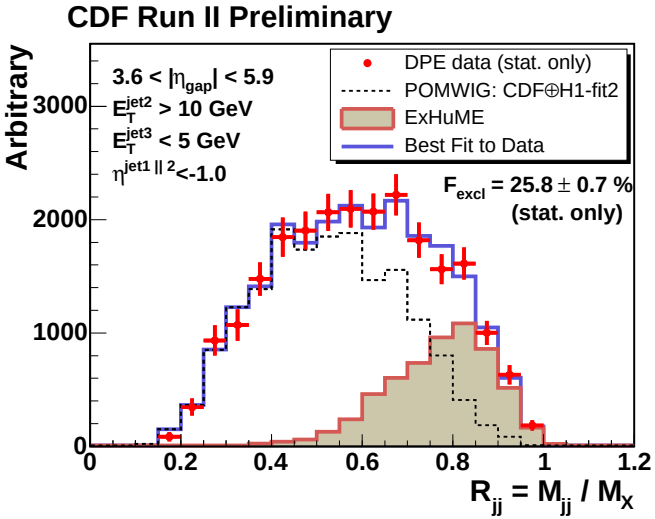


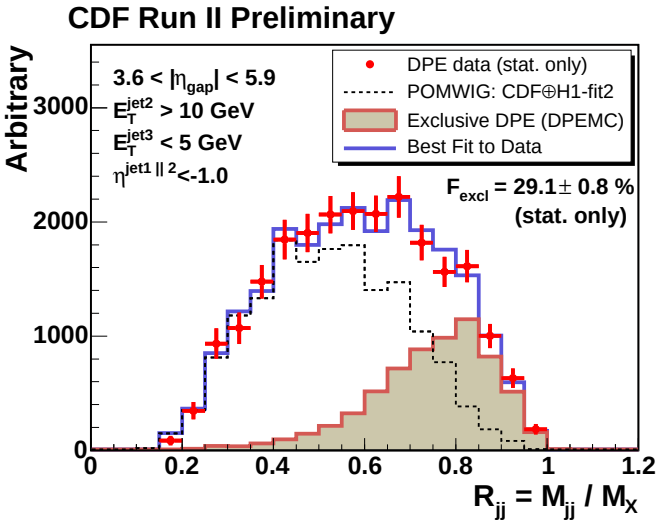
Dijet Mass Fraction : 3rd Jet Veto + (A)





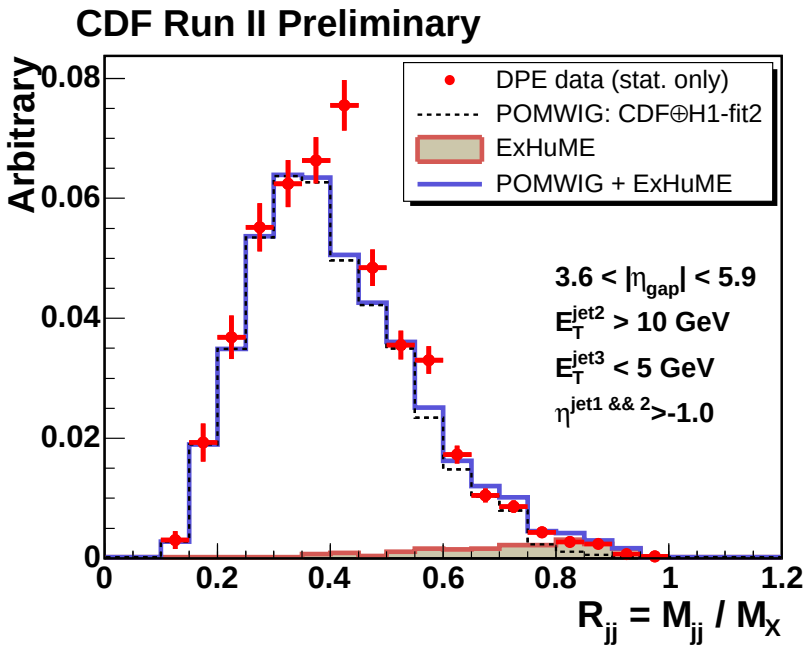
Normalizations fixed to the ones obtained in the fits to 3rd jet veto only
Distributions scaled using #events falling into (A)

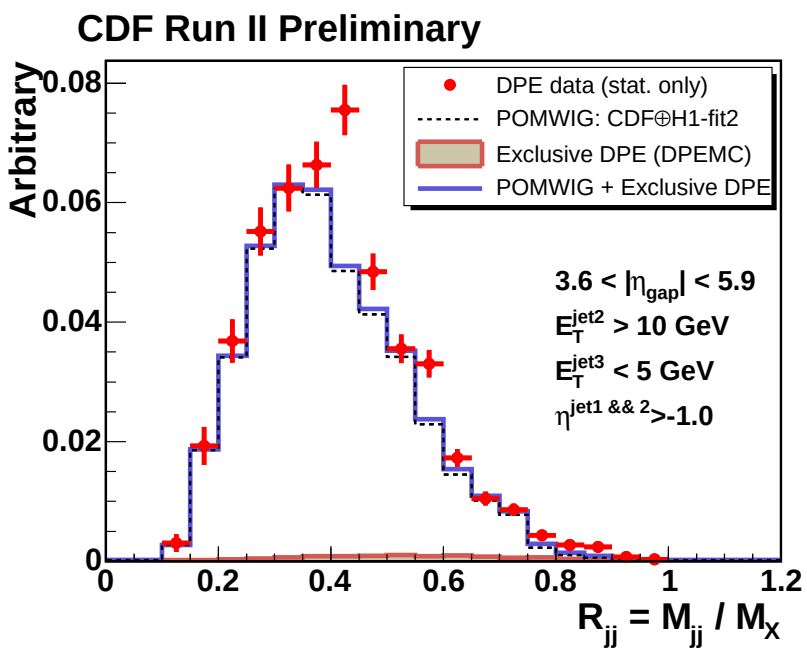




Fit POMWIG + ExHuME/DPEMC to data

Dijet Mass Fraction : 3rd Jet Veto + (B)





Normalizations fixed to the ones obtained in the fits to 3rd jet veto only
Distributions scaled using #events falling into (B)