Evidence for high mass exclusive dijet production in the D0 experiment

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Outline

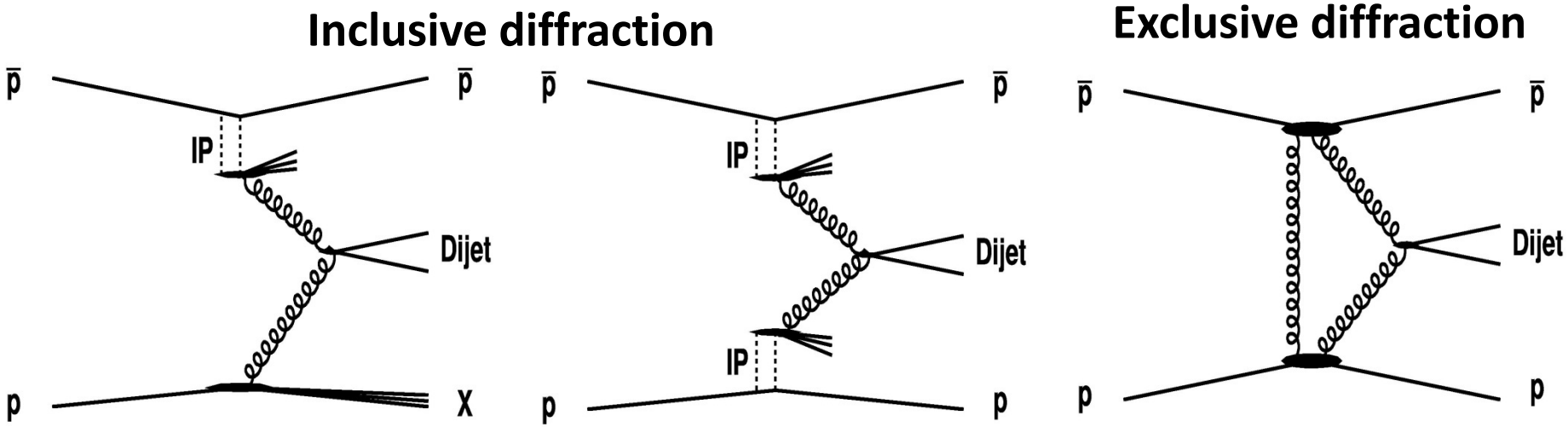
- What is exclusive diffractive production
- D0 Detector
- Data selection
- Signal and background separation
- Evidence for high mass exclusive dijet production
- Conclusions

Diffractive production

- $pp \rightarrow p + X + p$ proposed as a search channel for a new physics and the Higgs boson at the LHC – colorless (Pomeron) exchange
- Kinematic properties of the new channel X can be measured from the (anti)proton energy loss
- Rapidity gaps signal diffractive processes
- The cross section for Higgs in this channel is too low at the Tevatron, but it is important to check if this class of events exists

Event classification

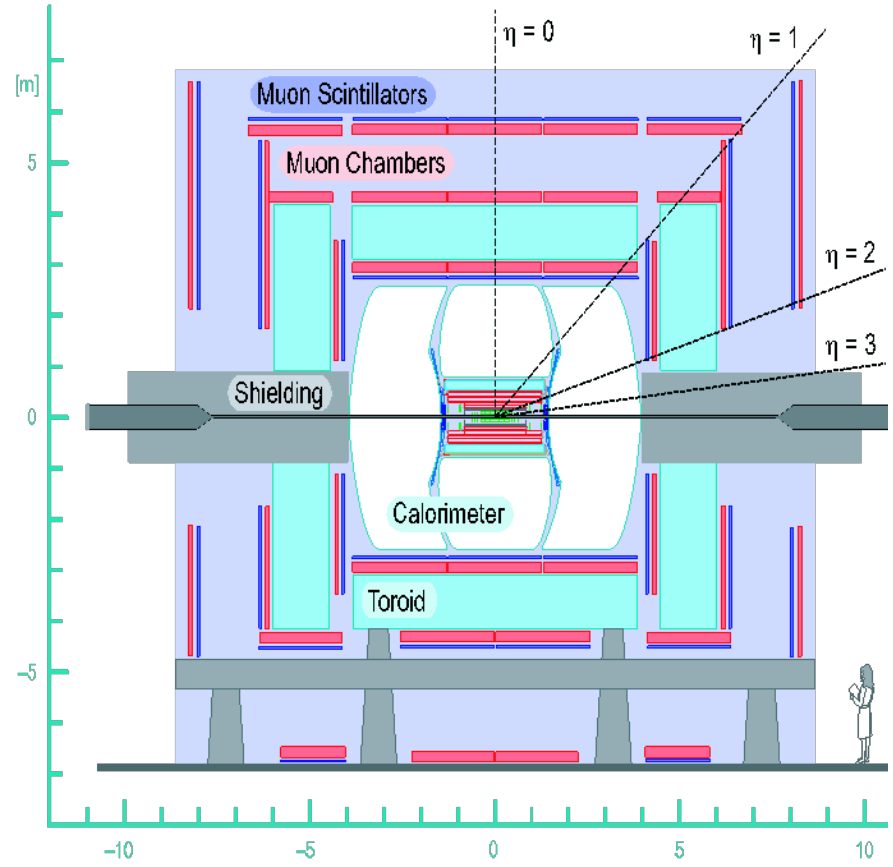
- Classify scattering results into distinct cases
  - Non-diffractive (NDF)
  - Inclusive diffraction (IDF) – single or double
  - Exclusive diffraction (EDF)



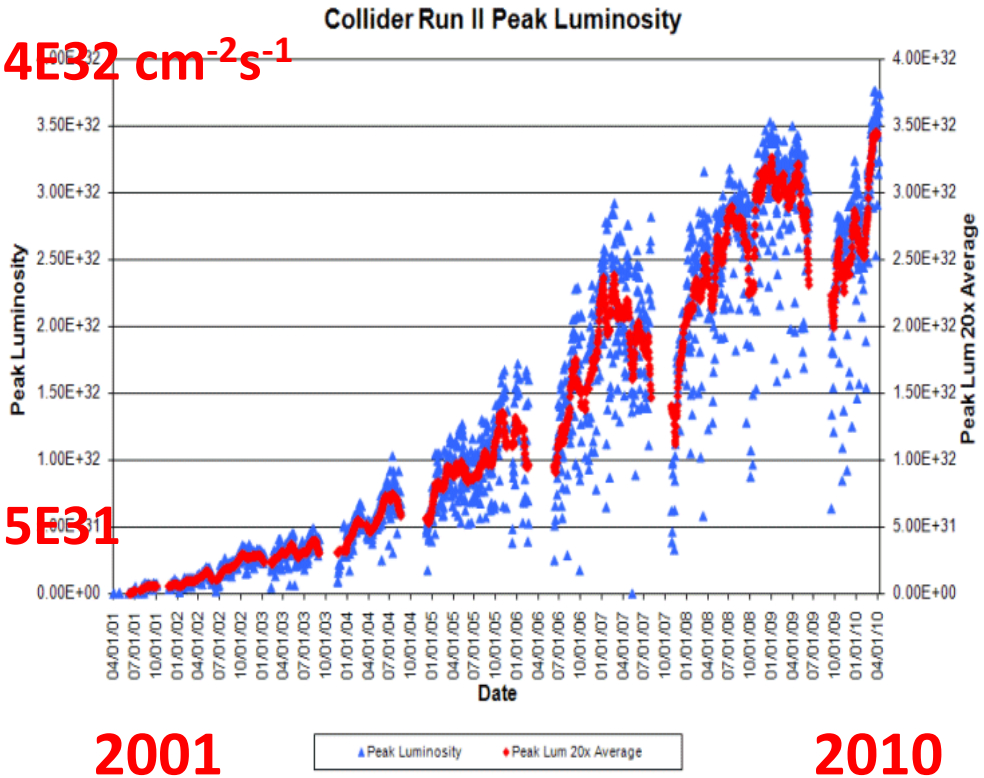
Exclusive diffraction

- Whole energy of the Pomeron transferred in the final state + no additional radiation = the final state reflects the Pomeron properties
- CDF has shown exclusive diffractive production with dijet, dielectron, diphoton and charmonium channels but generally for low mass objects (PRL98, 112001 (2007), PRL99, 242002 (2007), PRD77, 052004 (2008), PRL102, 222002 (2009), PRL102, 242001 (2009))

D0 Experiment



Tevatron peak luminosity



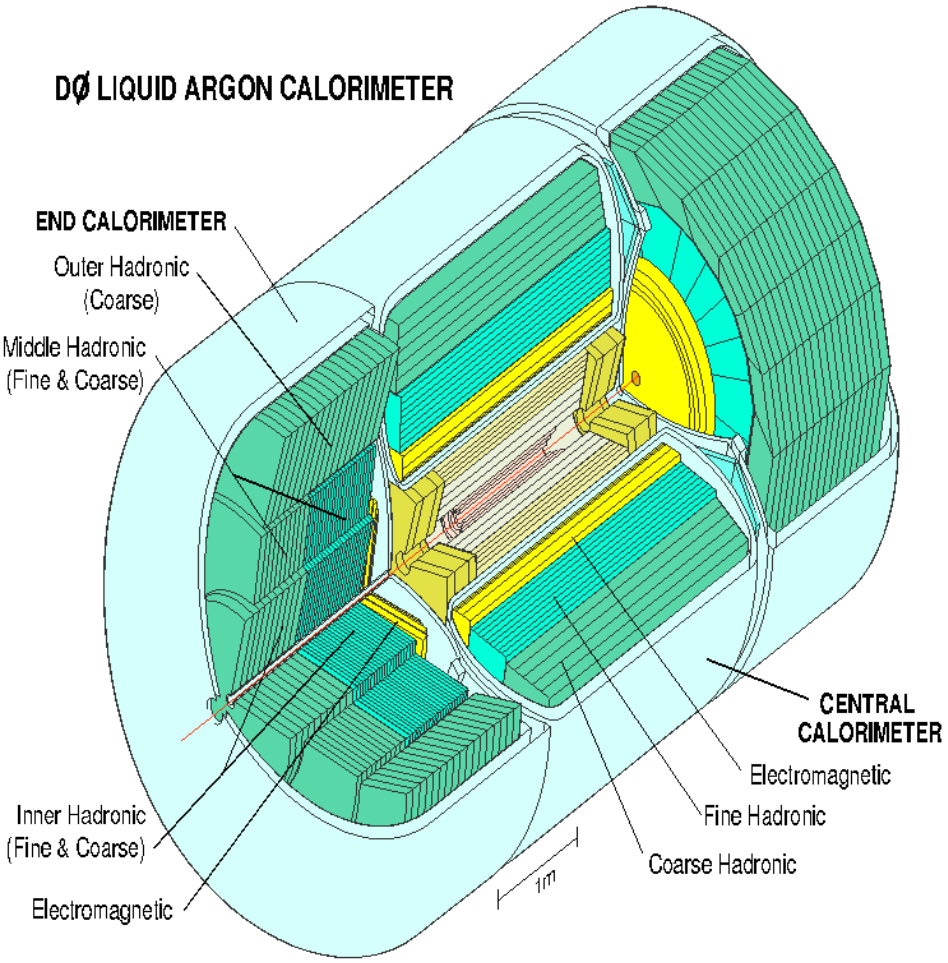
4E32 cm^{-2}s^{-1}

5E31

2001 **2010**

1E30 ≈70000ppbar collisions/s!!

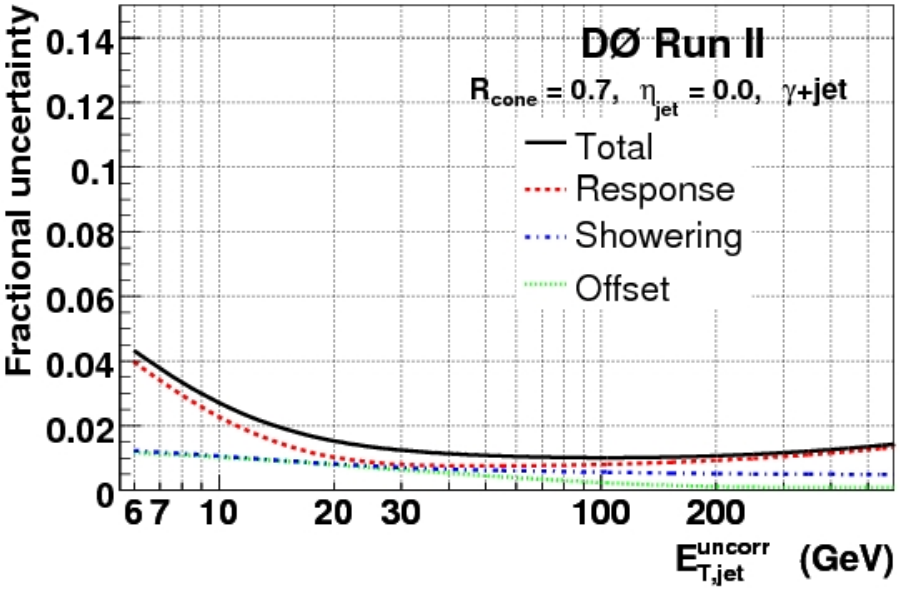
D0 Calorimeter



Coverage up to $|\eta|<4.2$

Finely segmented in η x ϕ (0.1x0.1)

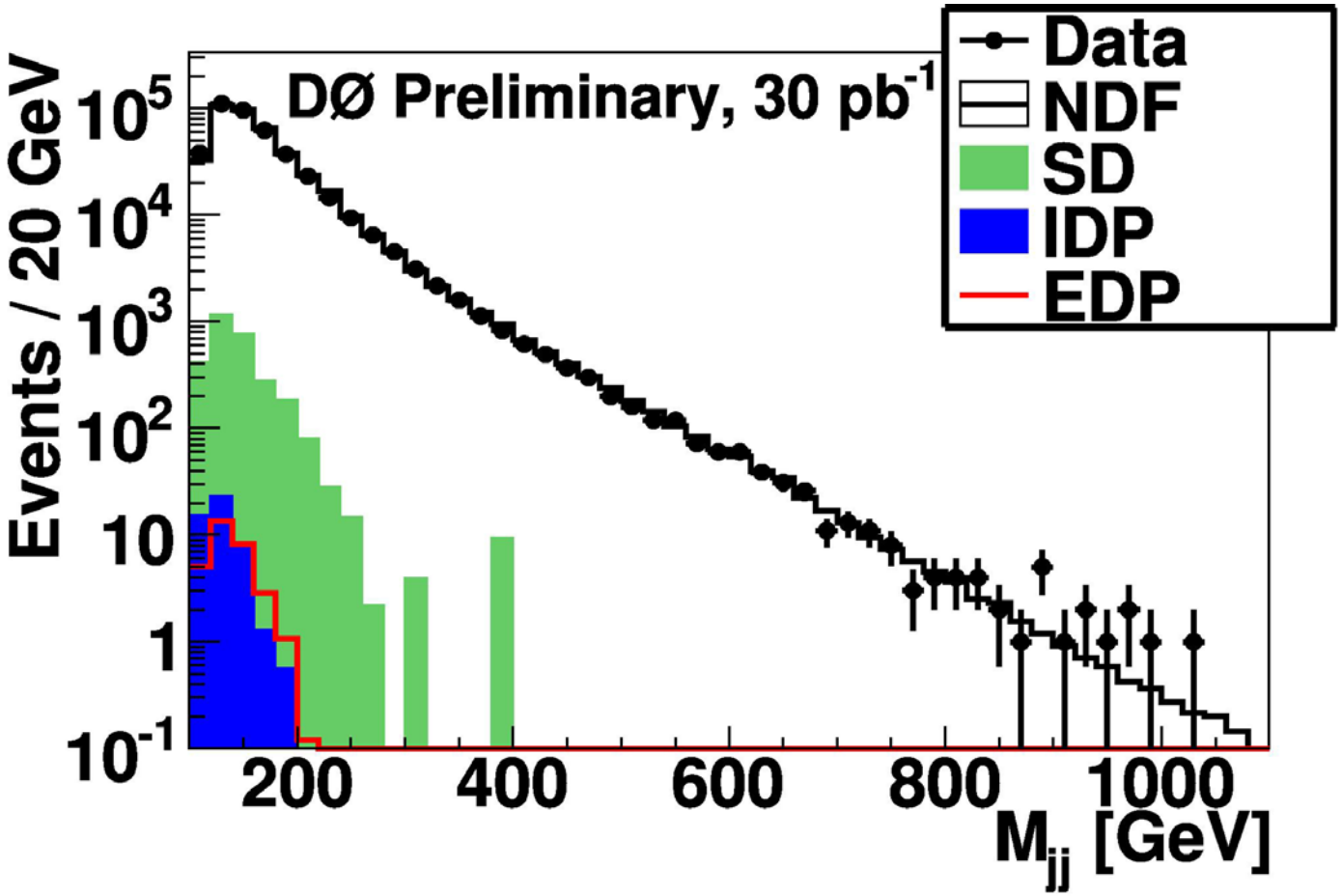
Jet energy scale uncertainty



Data selection

- Inclusive jet trigger with pT threshold of 45 GeV
- Restrict instantaneous luminosity to (5-100)x10^{30} $cm^{-2}s^{-1}$ to limit number of multiple interaction in the same bunch crossing
- Integrated luminosity of the sample ~30 pb^{-1}
- Two jets, $|y_{1,2}|<0.8$, $pT_1>60$ GeV, $pT_2>40$ GeV, $M_{jj}>100$ GeV, $\Delta\phi>3.1$

Dijet invariant mass distribution in Data and MC



MC models:

NDF = Pythia

SD = Pomwig

IDP = FPMC

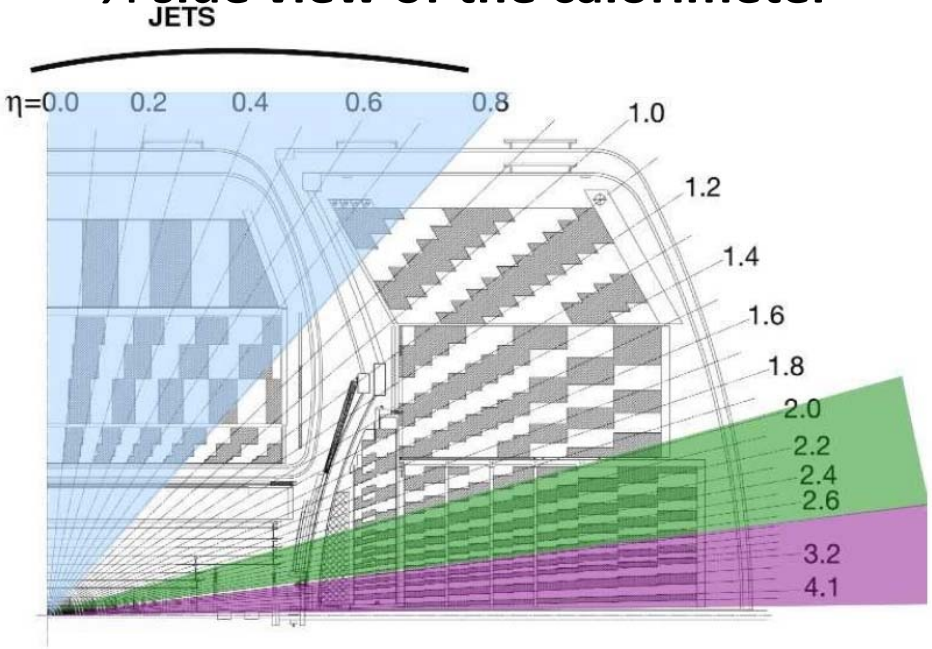
EDP = FPMC

EDP and background separation

Separation variable: sum of energy of calorimeter cells

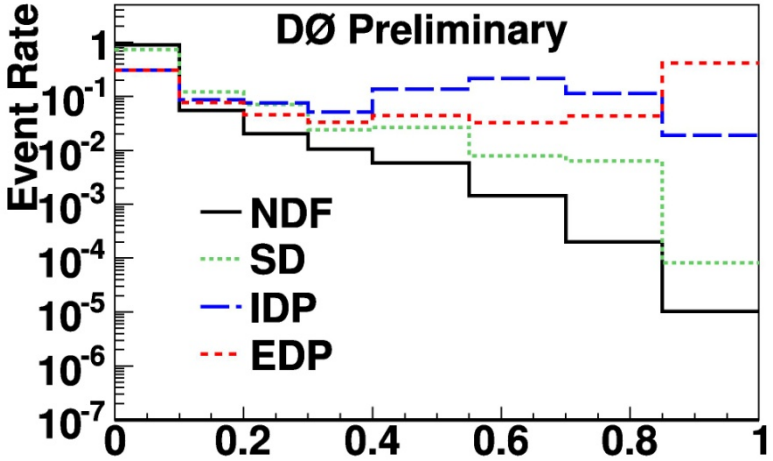
$$\Delta = \frac{1}{2}\exp\left(-\sum_{2.0<|\eta|\leq 3.0} E_T\right) + \frac{1}{2}\exp\left(-\sum_{3.0<|\eta|\leq 4.2} E_T\right)$$

¼ side view of the calorimeter

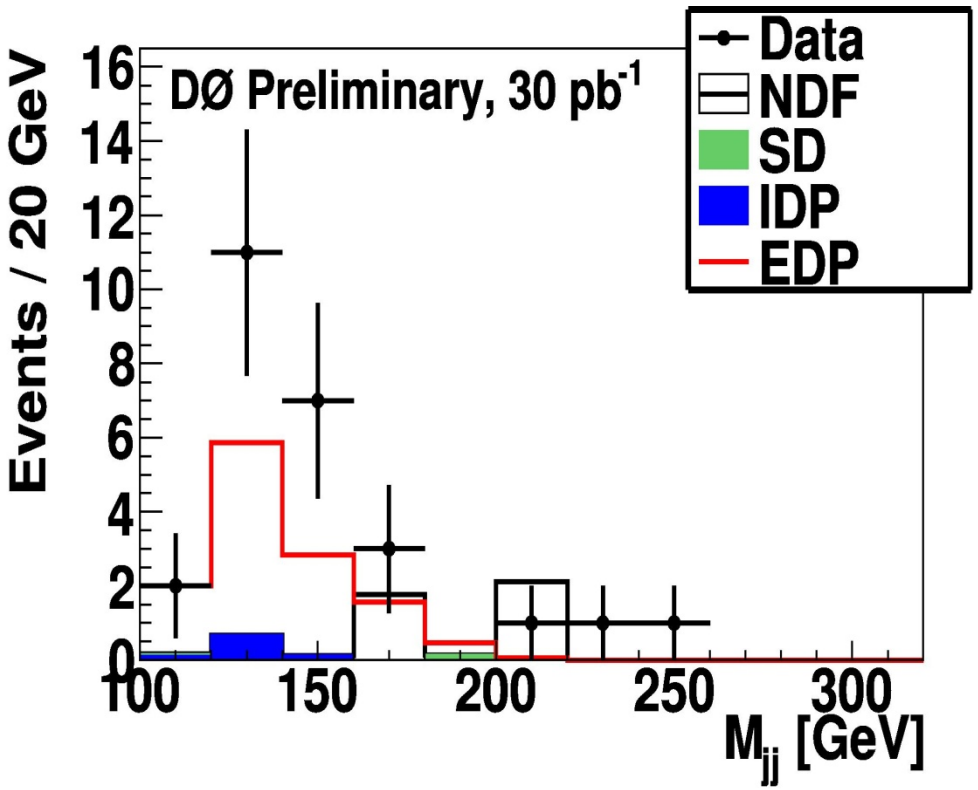


Dijet in the central part of the calorimeter

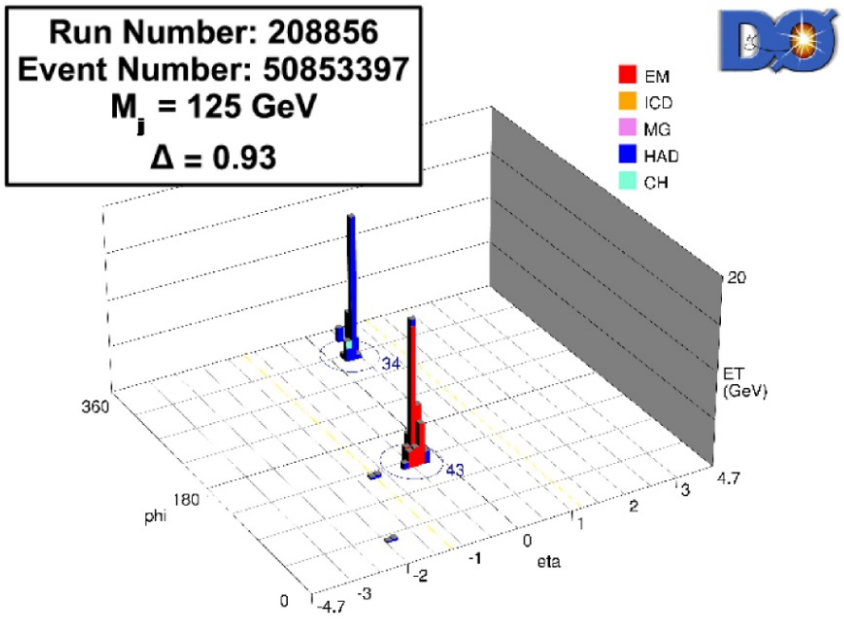
Rapidity gap – minimum energy in the forward -



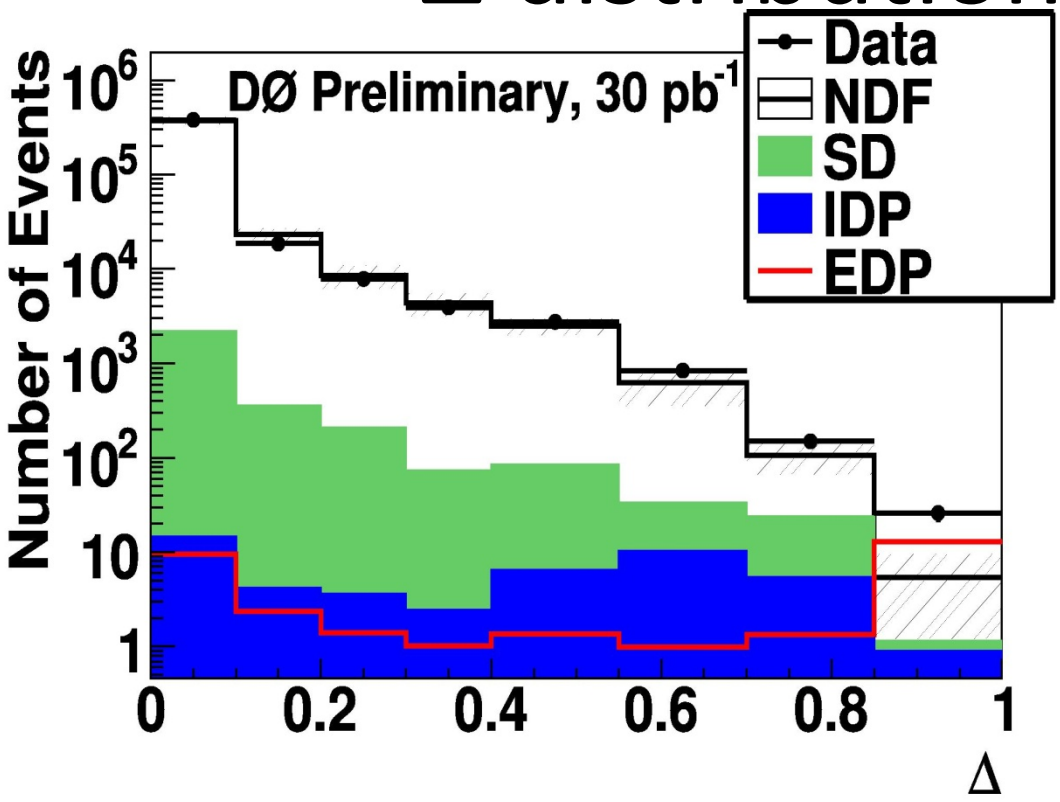
Dijet invariant mass for Δ>0.85



EDP event candidate



Δ distribution for data



Modified frequentist method to estimate the significance of the excess:

Form pseudoexperiments with s+b and b-only hypotheses – count how many times b-only produces cross section seen in data – $2*10^{-3}$% => 4.1σ

Sample	Non-diffractive (NDF)	Single diffraction (SD)	Inclusive diffraction (IDP)	Exclusive Diffraction (EDP)	Data
No Δ cut	409527±24056	48.3±24.3	2930±1474	30.9±1.8	412505
Δ>0.85	4.2±1.6	0.9±0.4	0.2±0.2	12±0.9	26

Systematic uncertainties

- Taken into account in estimating the significance:
- Cell calibration – 25%
- Jet energy scale uncertainty – 12%
- Trigger&luminosity reweighting – 3%
- MC to data normalization – 5%
- Additional uncertainty on SD&IDP MC normalization – 50%

Conclusions

- Presented the first evidence for high mass exclusive dijet production (dijet mass M_{jj}>100 GeV) at 4.1σ
- This event signature might play significant role in future studies at the Tevatron & LHC (for example exclusive Higgs production)