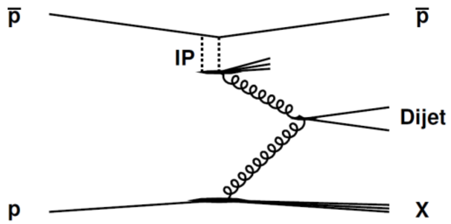
DIFRACTION ON DØ

Carlos Avila, UNIANDES, Colombia
On behalf of the D0 Collaboration.

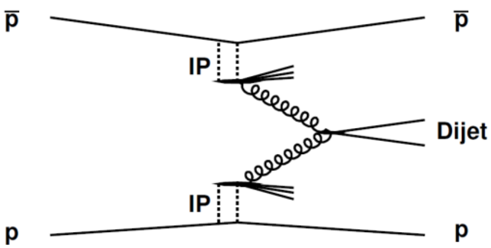
1. High mass exclusive diffractive dijet production at E_{CM}=1.96 TeV.
2. Measurement of p-pbar elastic $d\sigma/dt$ at E_{CM}=1.96 TeV .

High mass exclusive diffractive dijet production at E_{CM}=1.96 TeV.

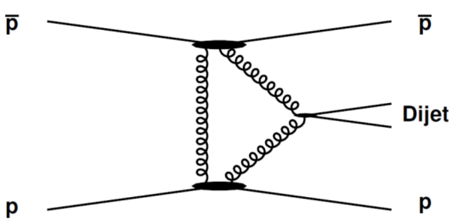
Single Diffraction Production:



Inclusive Diffraction Production (IDP):



Exclusive Diffraction Production (EDP):



- p + p → p +X + p proposed as a search channel for the Higgs boson at the LHC.
- Kinematic properties of new channel X can be measured from the proton (pbar) momentum loss.
- The cross section for Higgs in this channel is too low at the Tevatron but is important to check if this class of events exists.
- Study based on rapidity gaps.
- Backgrounds: single diff. + IDP + NDF.

Data vs MC

Data Selection

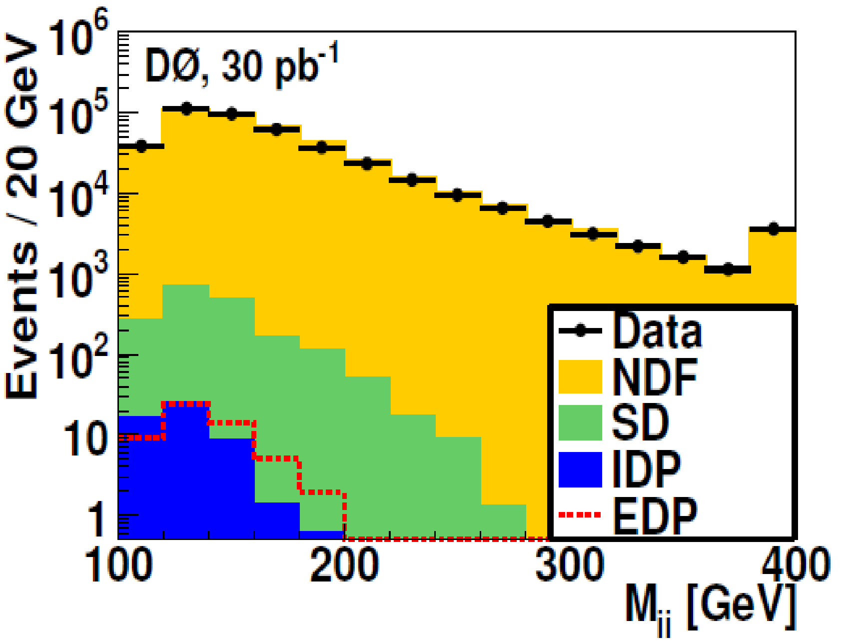
-Inclusive jet trigger with P_T>45 GeV.

- Restrict instantaneous luminosity (5-100)x 10^{30} $cm^{-2}s^{-1}$ to limit number of multiple interactions in same BX.

-Integrated luminosity of the sample ~ 30 pb^{-1}.

- Two jets $|y_{1,2}|<0.8$, $p_{T1}>$ 60 GeV, $p_{T2}>$40 GeV, $M_{jj}>$ 100 GeV, $\Delta\phi>3.1$.

Dijet invariant mass in data and MC



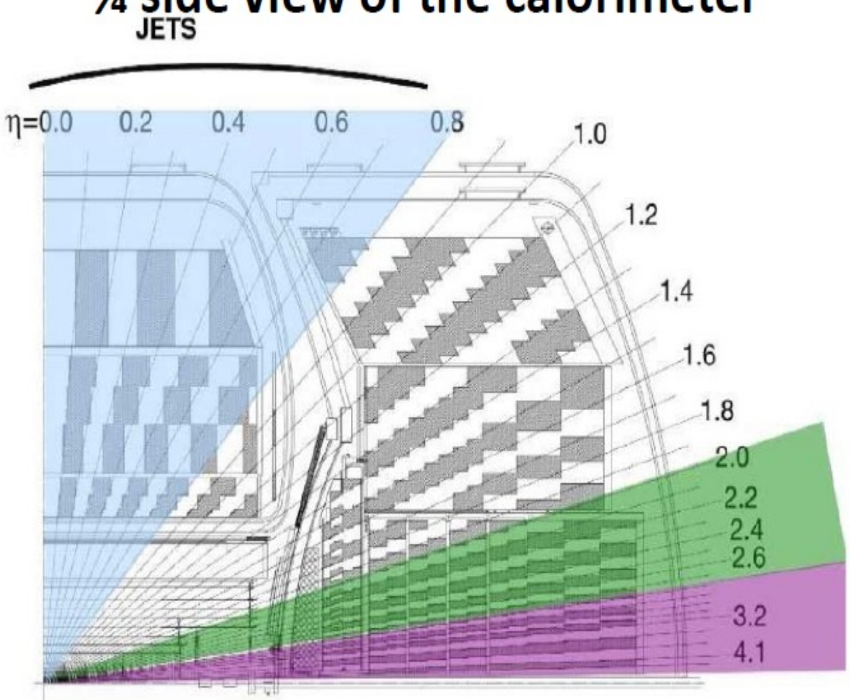
MC Models:
NDF = Pythia, SD = POMWIG
IDP = FPMC, EDP = FPMC

EDP and background separation

Separation variable: Sum of energy in the calorimeter cells.

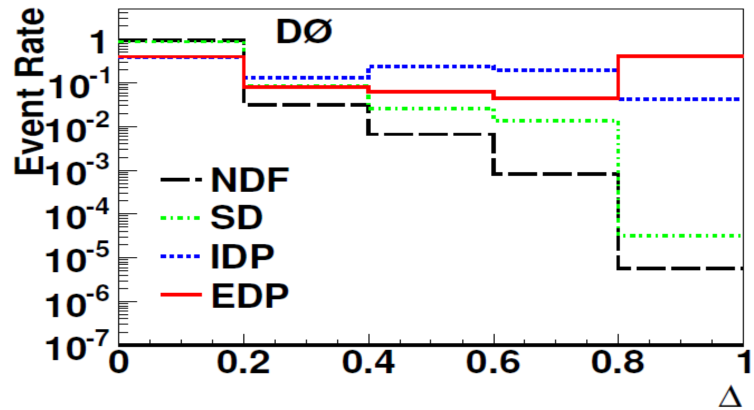
$$\Delta = \frac{1}{2}\exp\left(-\sum_{2.0<|\eta|\leq 3.0} E_T\right) + \frac{1}{2}\exp\left(-\sum_{3.0<|\eta|\leq 4.2} E_T\right)$$

¼ side view of the calorimeter

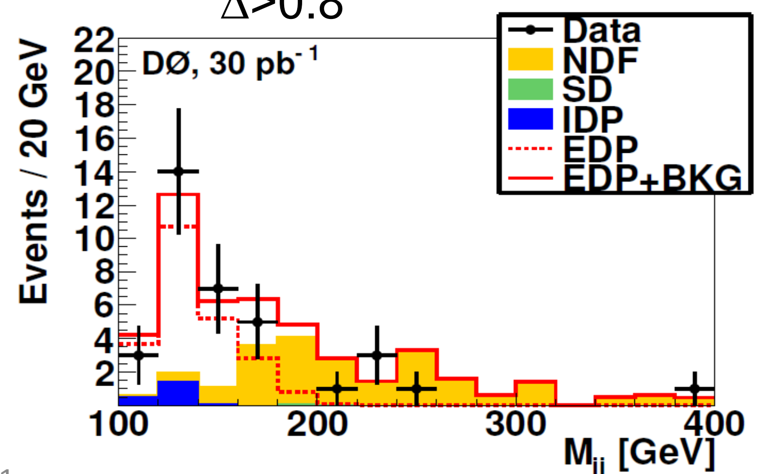


-Dijet in the central part of the calorimeter

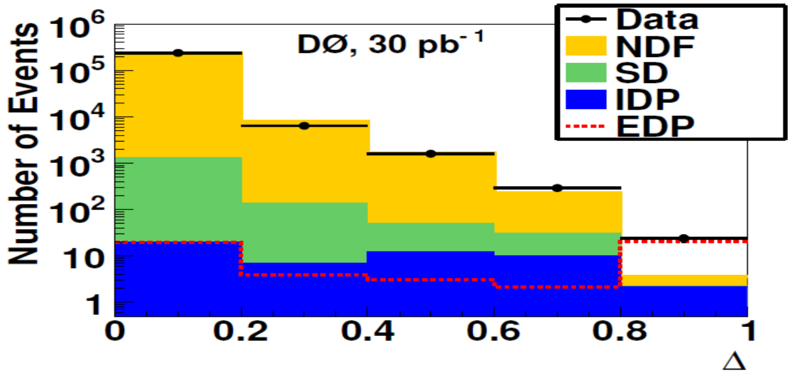
- No energy deposition in the forward part: Rapidity gap.



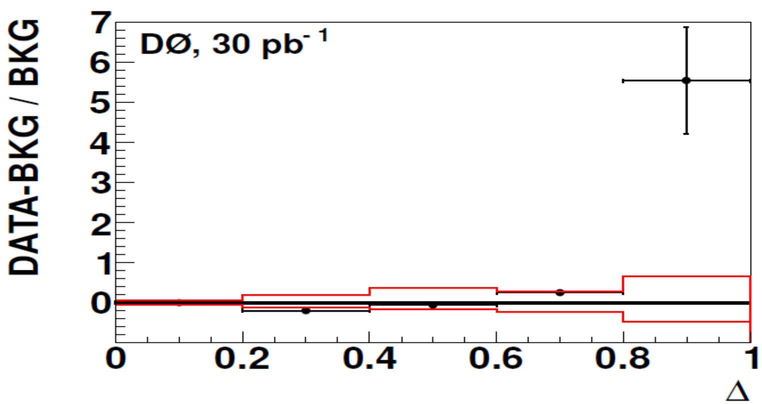
Δ>0.8



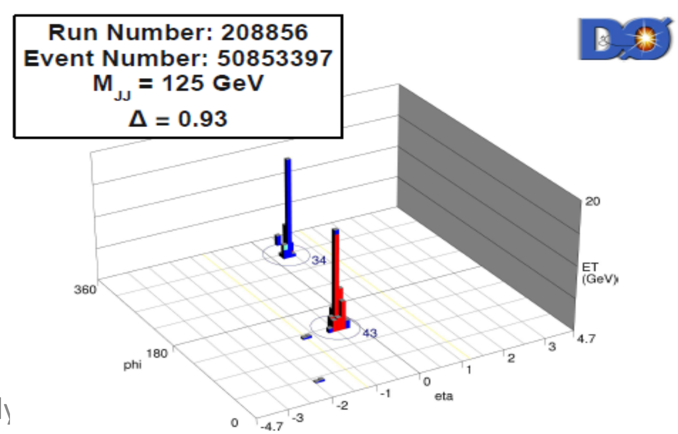
SIGNIFICANCE OF THE EXCESS



Systematic uncertainties:
- Cell calibration : 25%
- Jet energy scale uncertainty: 12%
-Trigger efficiency: 3%
- MC to data normalization: 5%
- Uncertainty of SD & IDP MC norm.: 50%

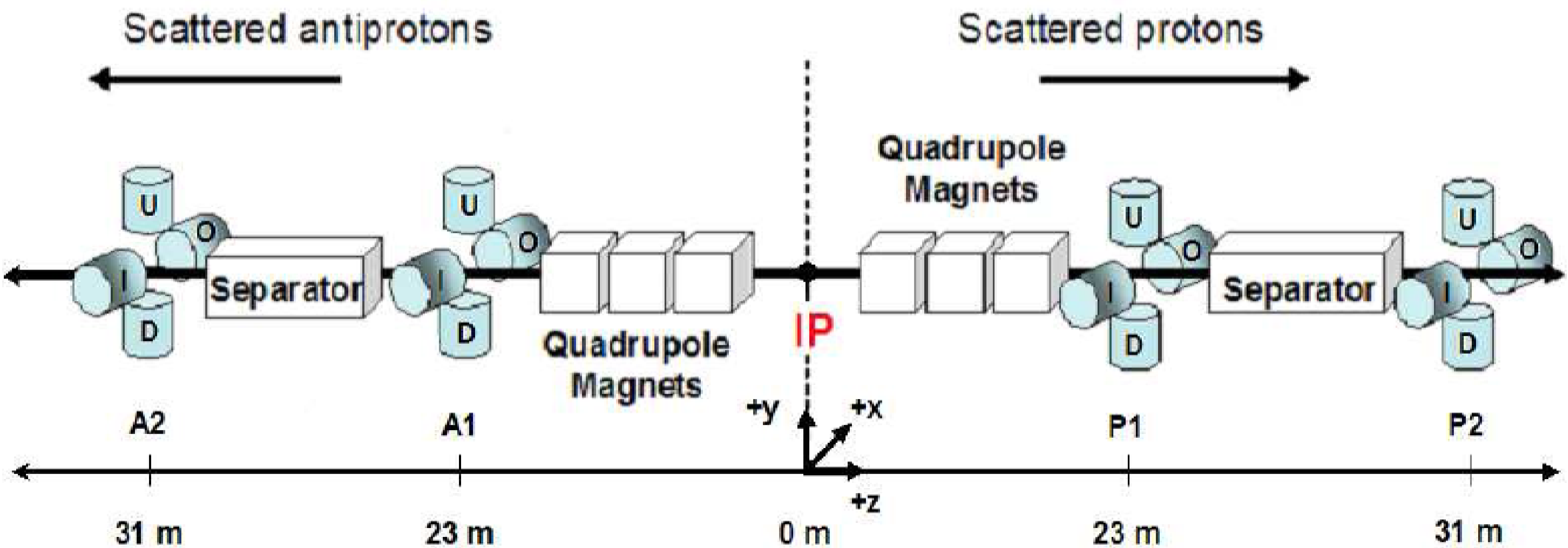


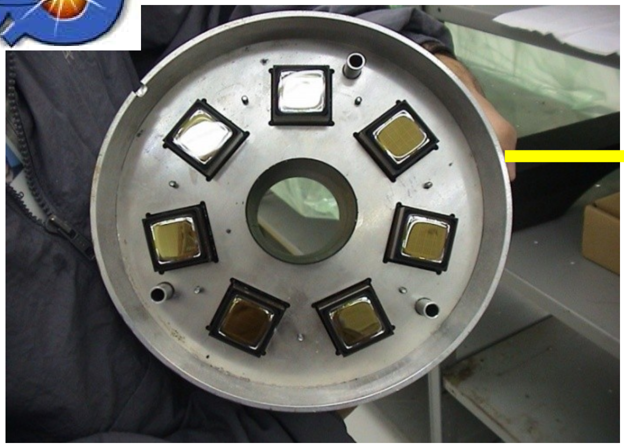
Estimation of the significance of the excess:
Form seudoexperiments with signal+back and back only hypotheses, count how many times back produces cross section seen in data:
2.0×10^{-4} % → 4.7σ.

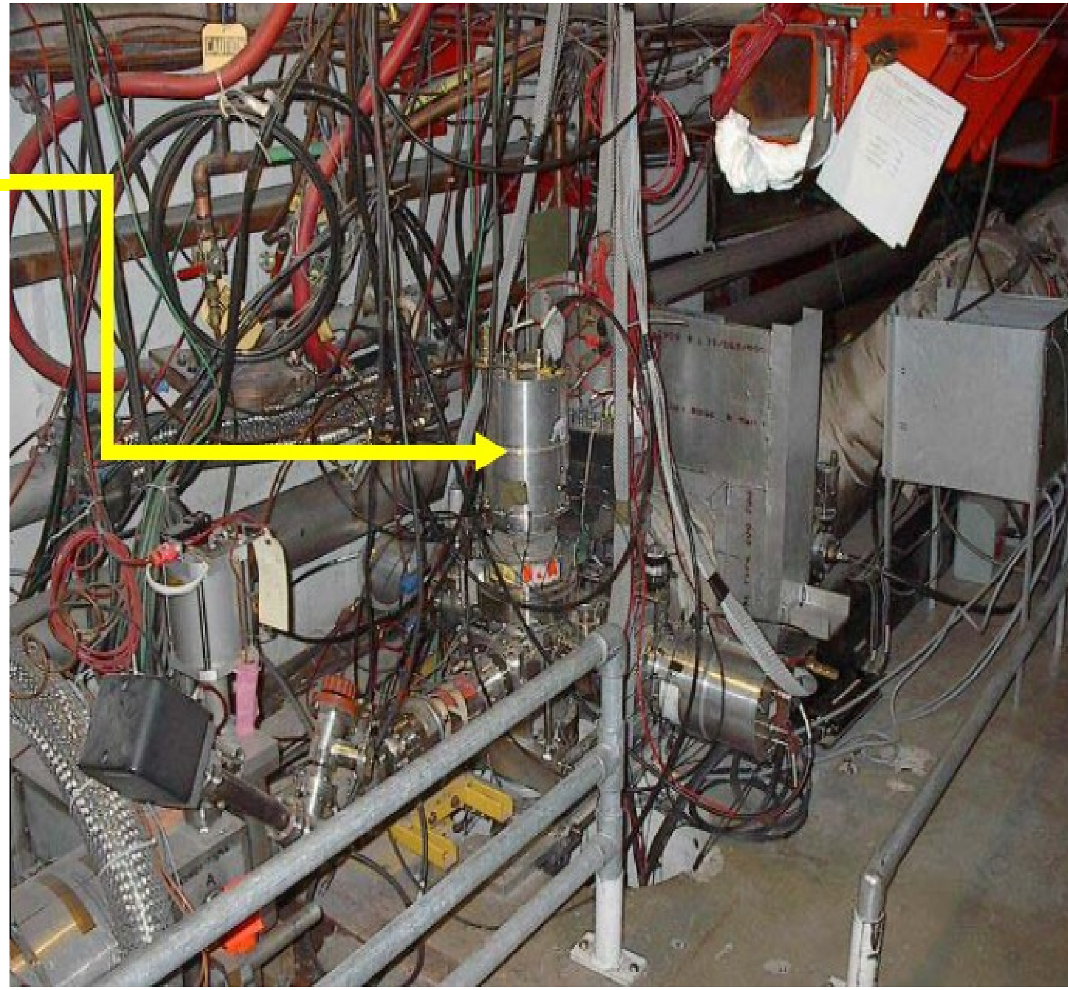


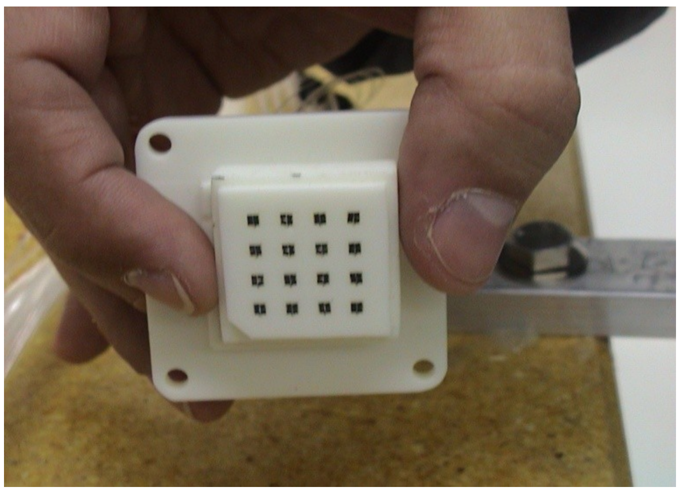
Sample	NDF	IDP	SD	EDP	DATA
All Δ	243145	52.2	1484.9	49	244682
Δ>0.8	$1.4^{+1.0}_{-0.8}$	$2.2^{+1.8}_{-1.5}$	$0.05^{+0.04}_{-0.03}$	$20.4^{+1.8}_{-1.7}$	24

2. Measurement of the p-pbar elastic $d\sigma/dt$ at E_{CM}=1.96 TeV



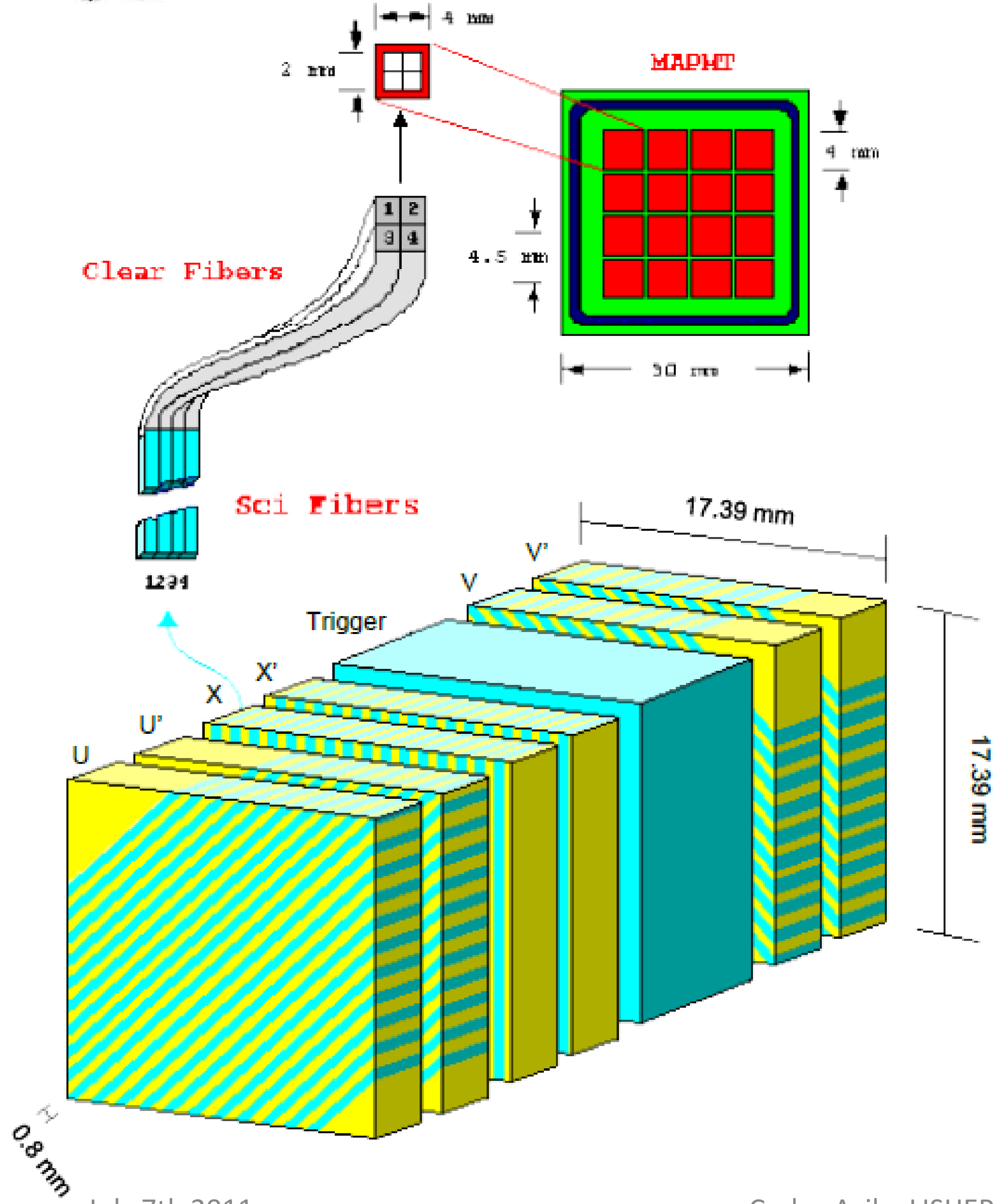






FPD POT STATION WITH 4 DETECTORS INSTALLED

FPD DETECTORS



- 3 planes of 0.8 mm Scintillating fibers with different rotations: U = 45°, X=90°, V=135°
- Each plane with 2 fiber layers (prime and unprimed) offset by 2/3 fiber.
- Each channel filled with 4 fibers.
- 112 channels per detector
- 7 MAPMts readout one detector.
- Trigger scintillator provides timing information.

Data Sample

- Special store:
  - Tevatron injection tune lattice : $\beta^*=1.6$ m
  - Only 1 proton and 1 antiproton bunch colliding.
  - Electrostatic separators turned OFF
  - Heavy scraping to reduce halo.

- Two sets of data taken with detectors at different positions with respect to the beam.

- Total integrated Luminosity recorded : $L = 30 \pm 4$ nb^{-1}, obtained by comparing the number of jets from run IIA to number of jets from high β store.

- A total of 20 million triggers recorded with a special FPD trigger list. About 25% of the triggers were elastics.

Track Finding

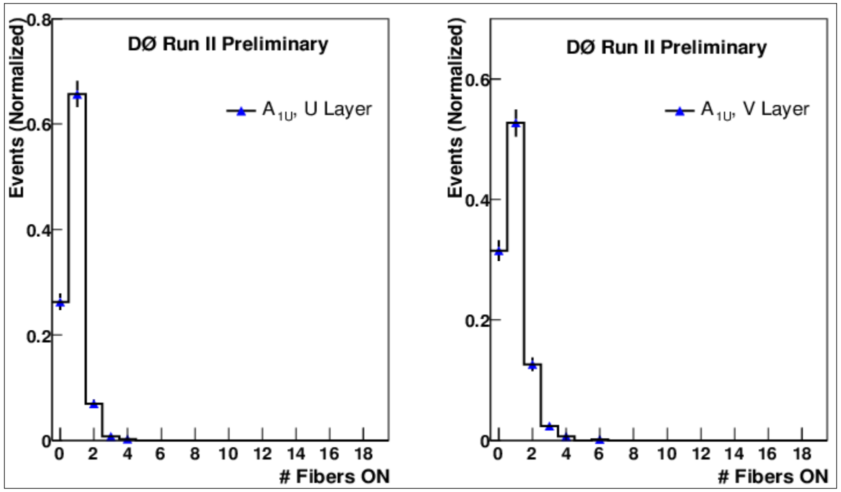
1. **HIT FINDING**
   - Require less than 5 fibers/layer ON (To reject beam background).
   - Use intersection of fiber layers to determine hit position.

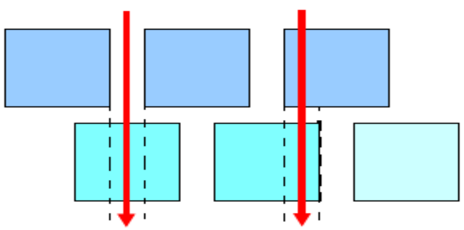
2. **ALIGNMENT**
   - Over constrained tracks that pass through horizontal and vertical detectors in same pot station allow relative alignment of detectors.
   - Hit distributions are used to align detectors with respect to particle beam.

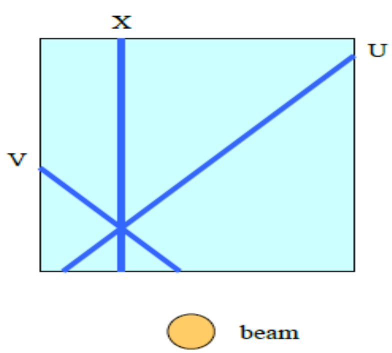
3. **TRACK RECONSTRUCTION**
   - Require hits in both detectors of a spectrometer.
   - Use aligned hit coordinates and Tevatron transport equations to reconstruct scattering angle and offset at the interaction point.

Hit Finding

Fiber Multiplicity

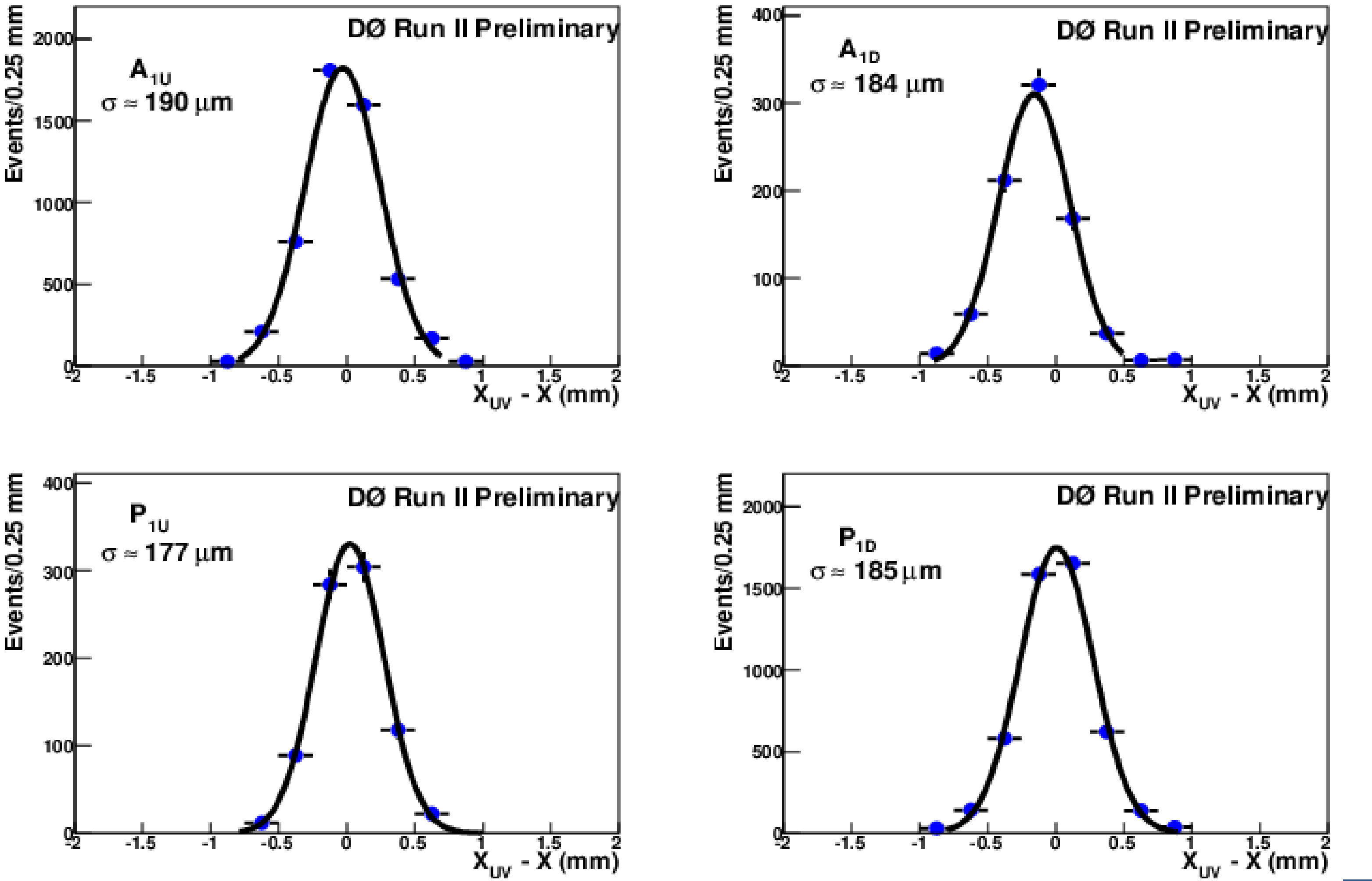






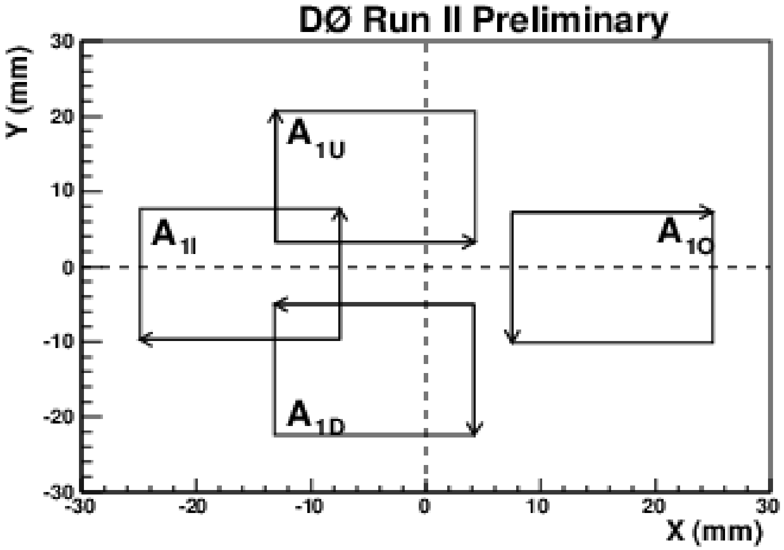
- Combining the two layers from a plane define a fiber segment.
- Need two out of three fiber segments (UV, UX, XV or UVX) to determine the hit coordinates.
- *Use alignment to get coordinates with respect to the beam.*
- *X can be gotten directly from X fiber segment. Resolution is determined by comparing x measurements.*

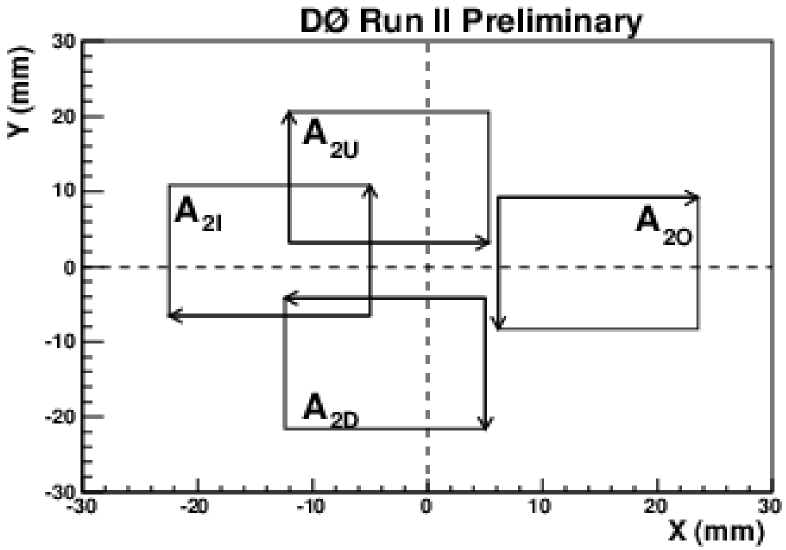
Detector resolution

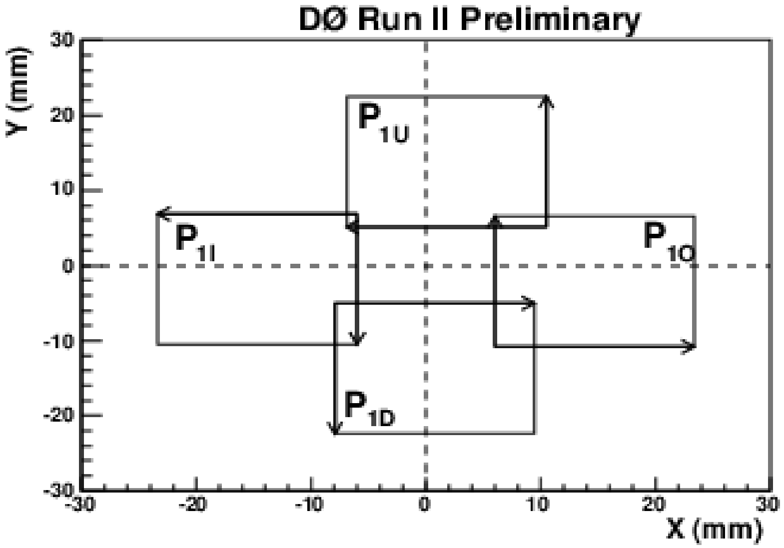


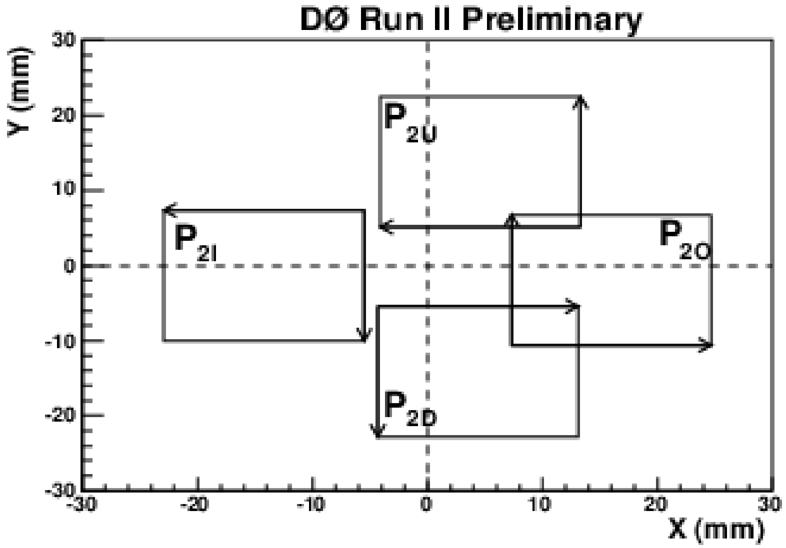
$$\sigma_{xUV-X} = \sqrt{2}\sigma$$

Detector positions after alignment



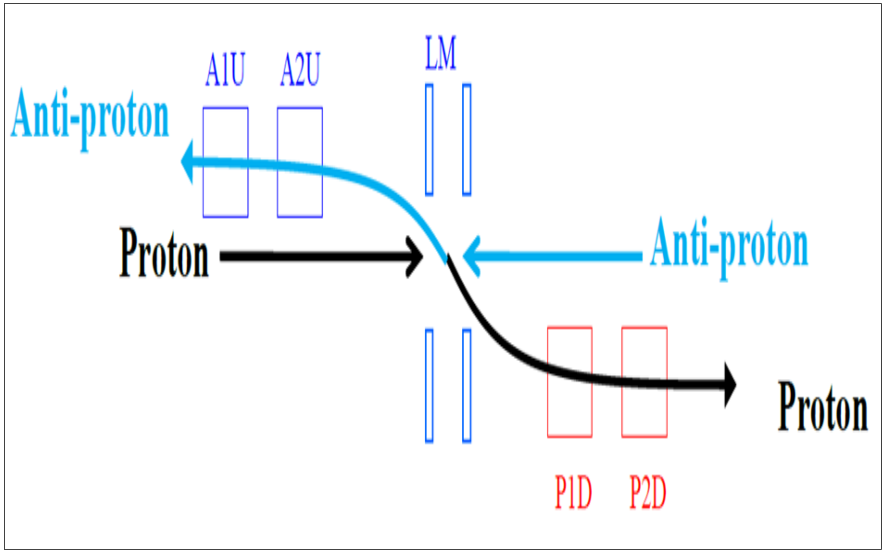




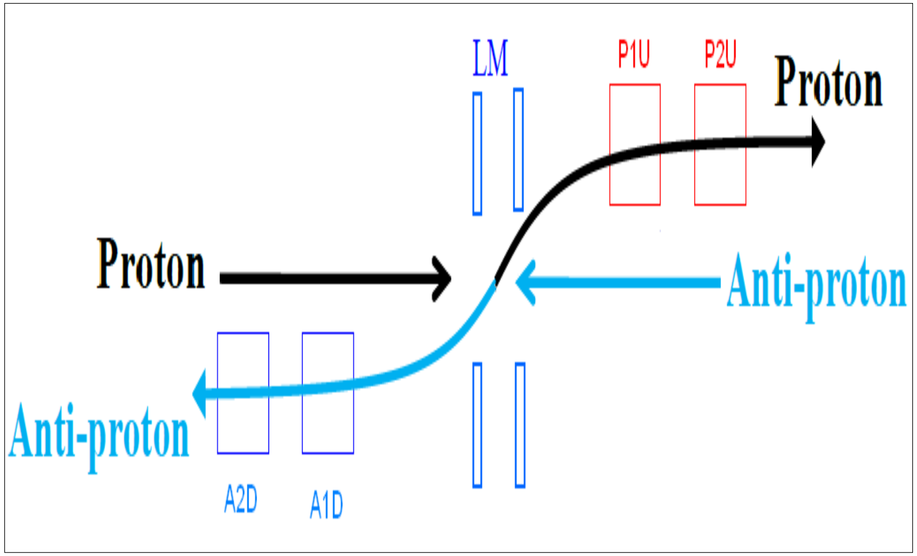


Elastic Combinations

AU-PD



AD-PU

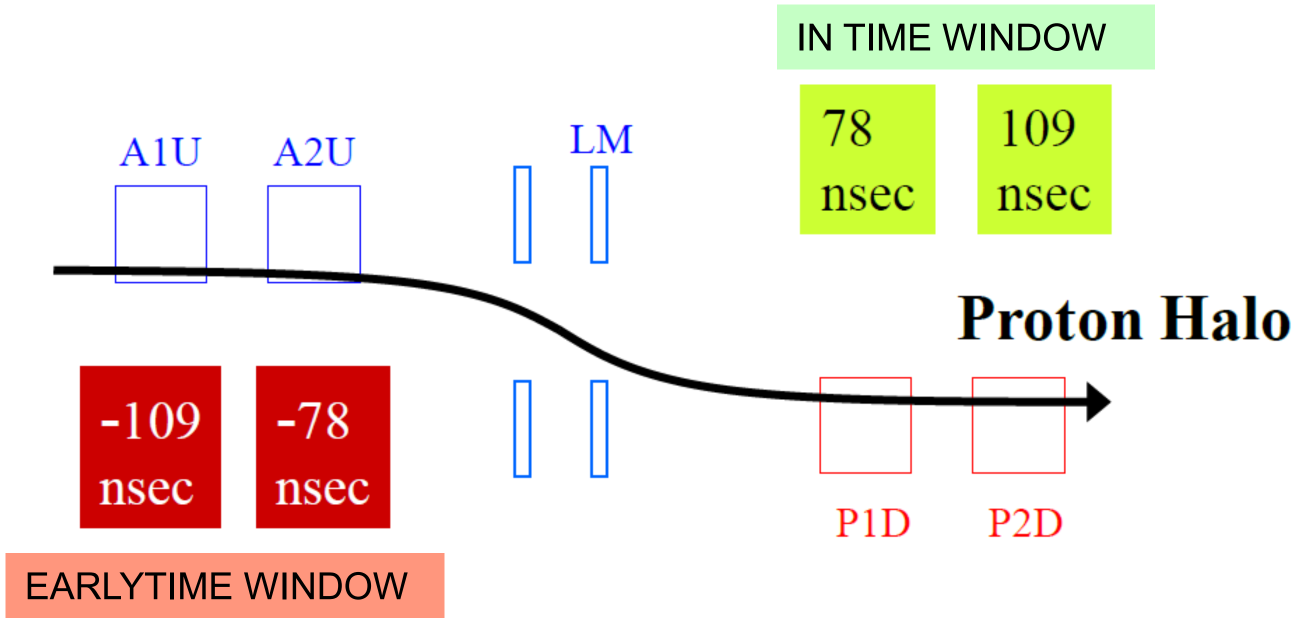


Elastic events with tracks in opposite side spectrometers

- AU-PD with the best acceptance

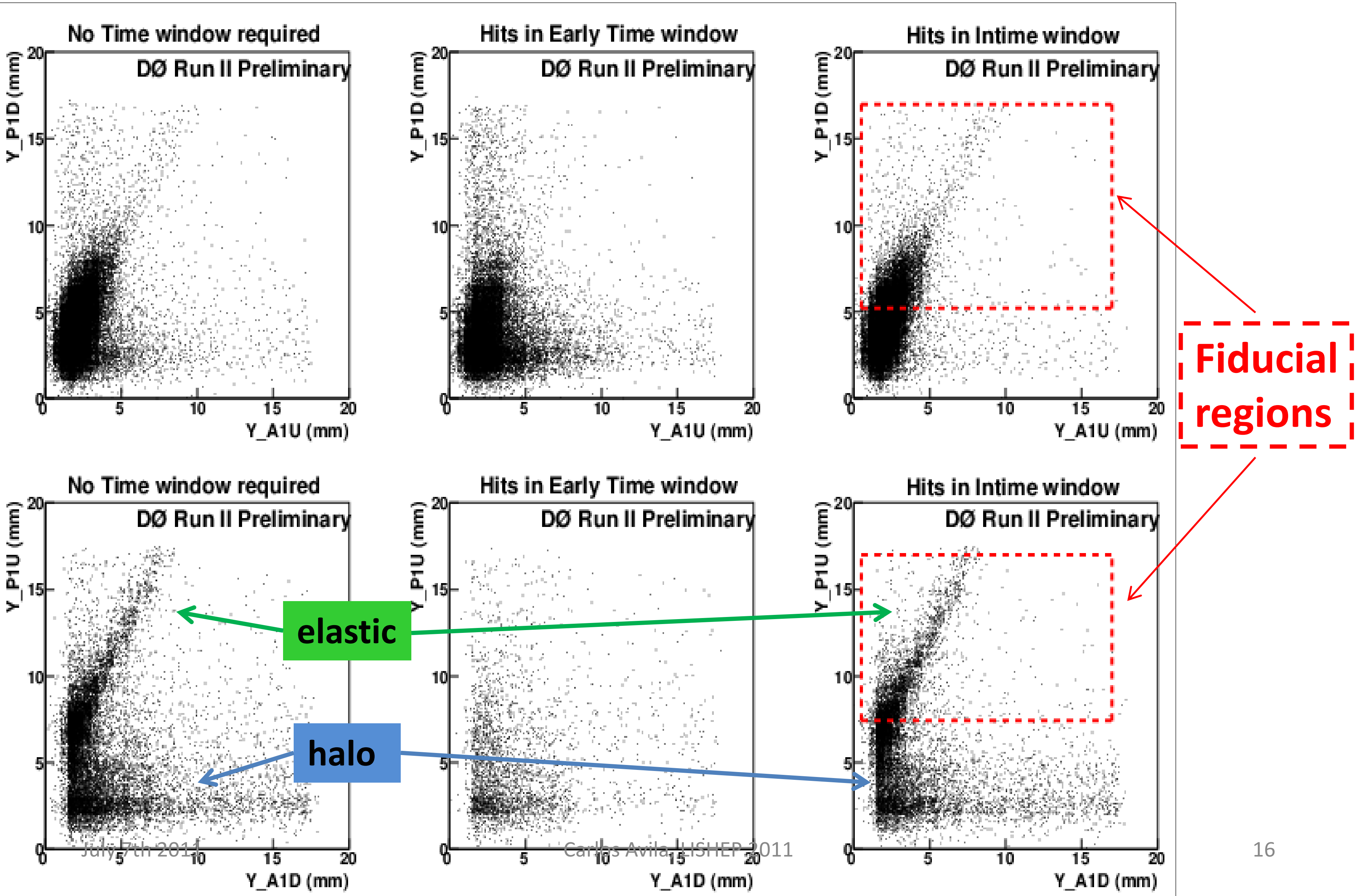
- Momentum dispersion in horizontal plane produces more halo in horizontal detectors, we have based our analyis on the vertical detectors.

Halo Rejection

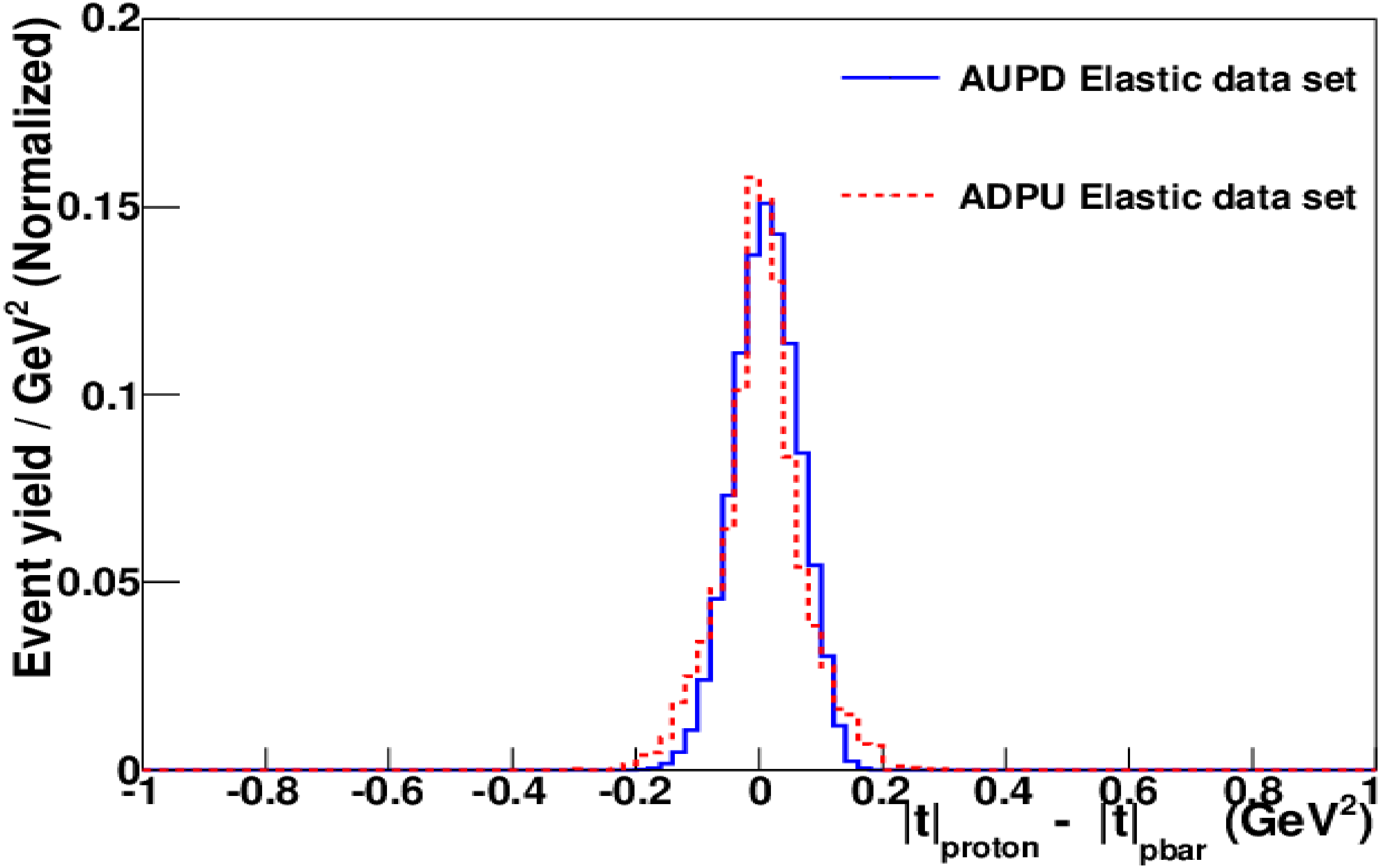


- The in-time bit is set with a pulse detected in the in time window (consistent with proton TOF from IP).
- The halo bit is set with a pulse detected in the early time window (consistent with a halo proton).
- We reject a large fraction of halo events with the timming info from the scintillator counters in each detector.

COORDINATE CORRELATIONS BETWEEN DETECTORS



Δ|t|



Good colinearity between p and pbar detectors

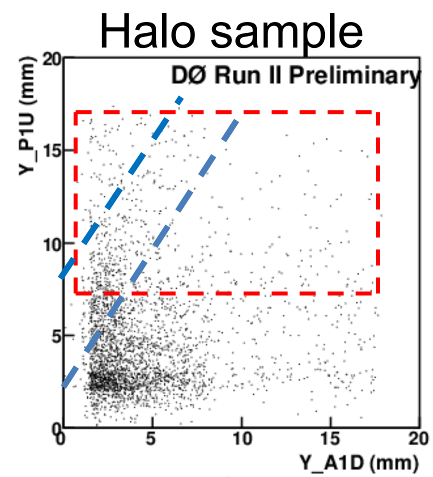
Measurement of dσ/d|t|

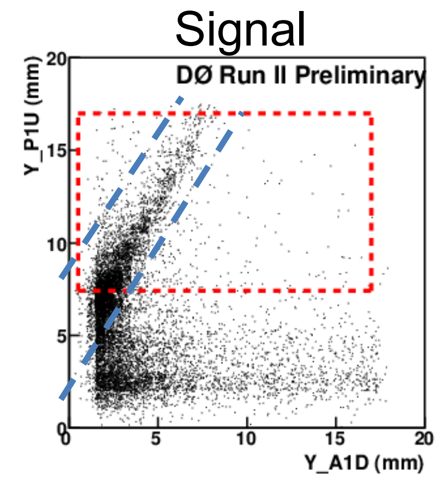
1. Count number of elastic events as a function of t.
2. Subtract residual background.
3. Divide by Luminosity
4. Correct for acceptance and efficiencies
5. Correct for beam smearing
6. Take weighted average over 4 measurements:
   2 elastic combinations (AUPD, ADPU) X 2 detector positions.

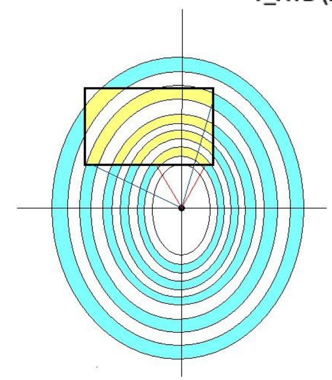
$$\frac{d\sigma}{dt} = \frac{1}{L}\frac{1}{Acc}\frac{1}{\varepsilon}\frac{1}{smearing}\frac{dN}{dt}$$

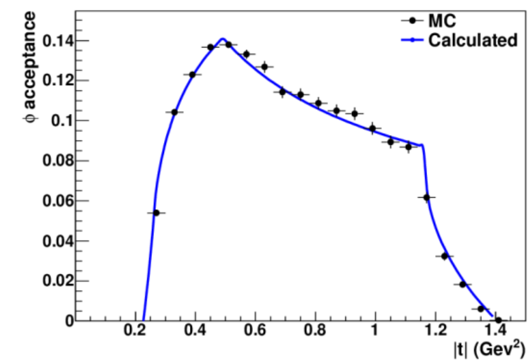
Corrections to obtain $d\sigma/d|t|$

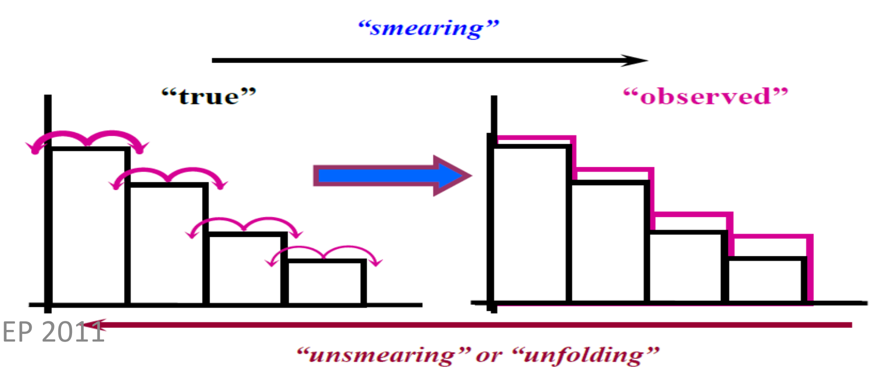
1. Use side bands to subtract background.
2. ϕ acceptance: A detector geometry correction.
3. Unsmearing correction: dN/dt distribution gets smeared by beam divergence and |t| resolution.
4. Efficiency: Use looser triggers, reconstruct elastic event in 3 detectors and measure efficiency of 4th detector.



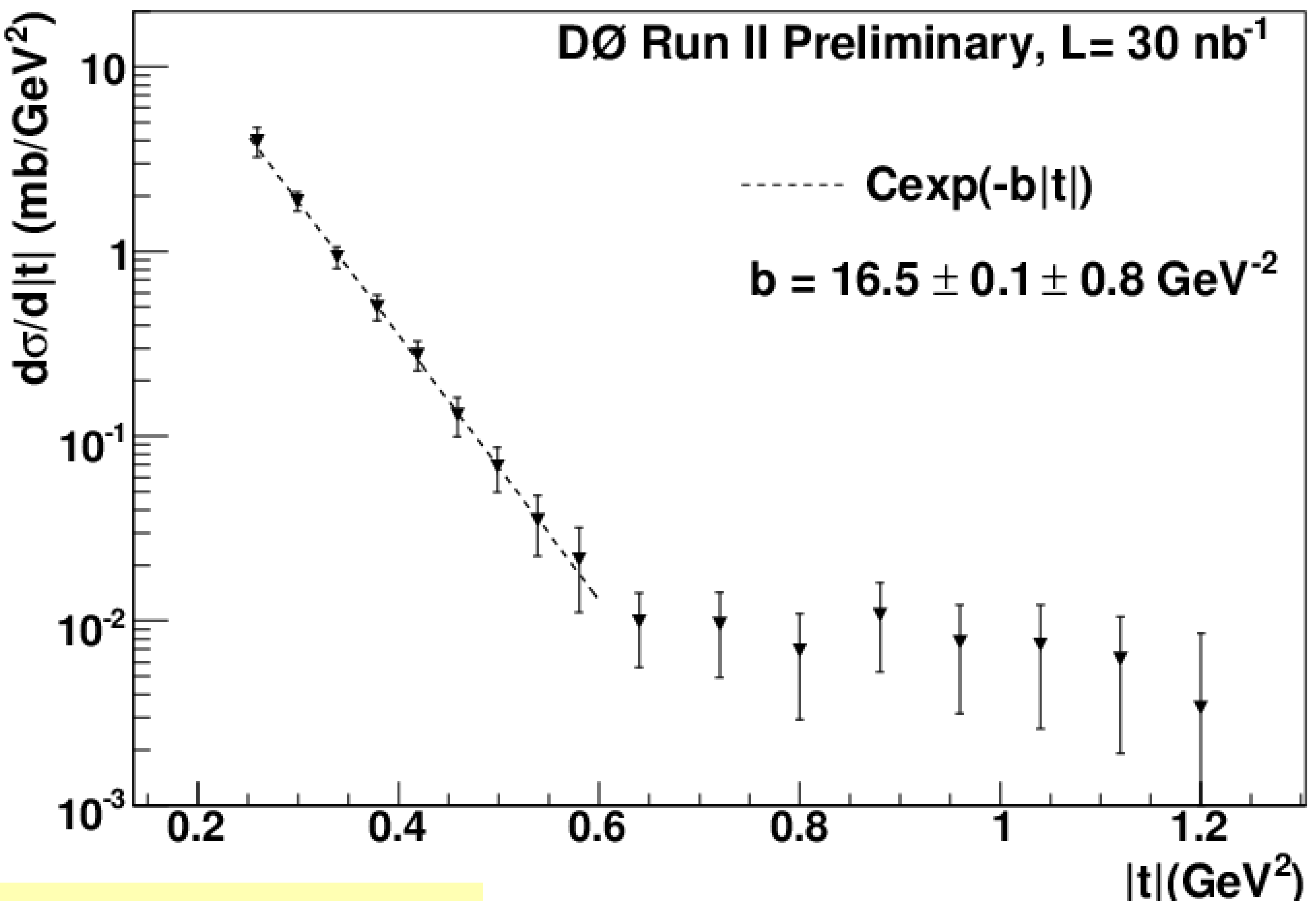








Measured $d\sigma/d|t|$

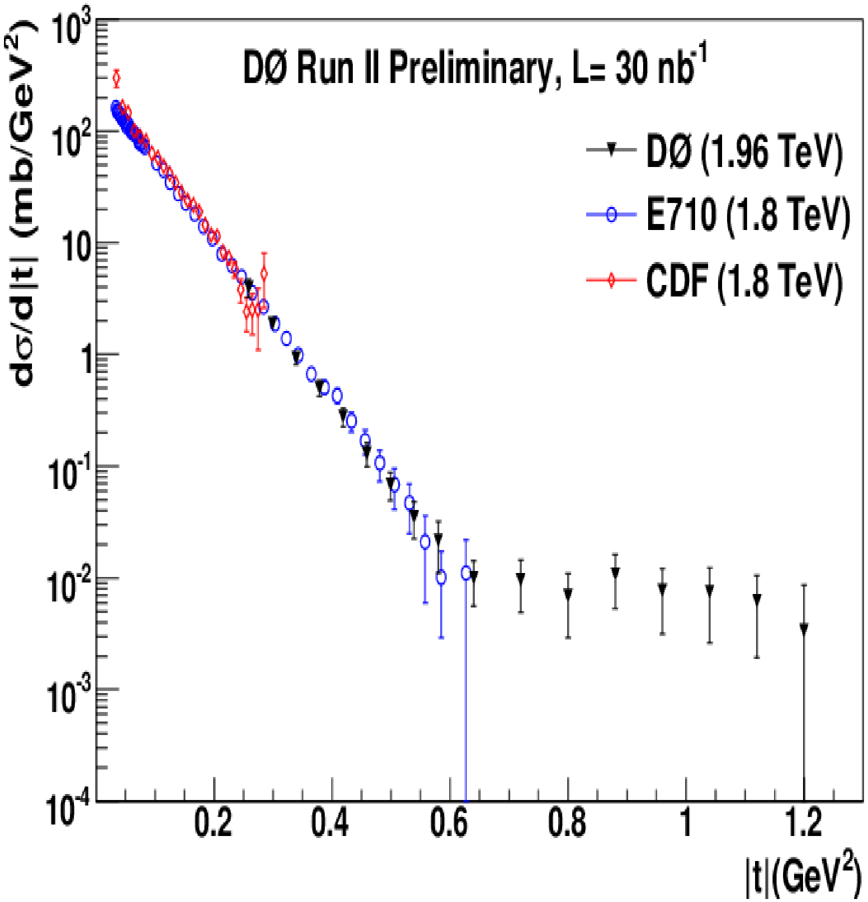


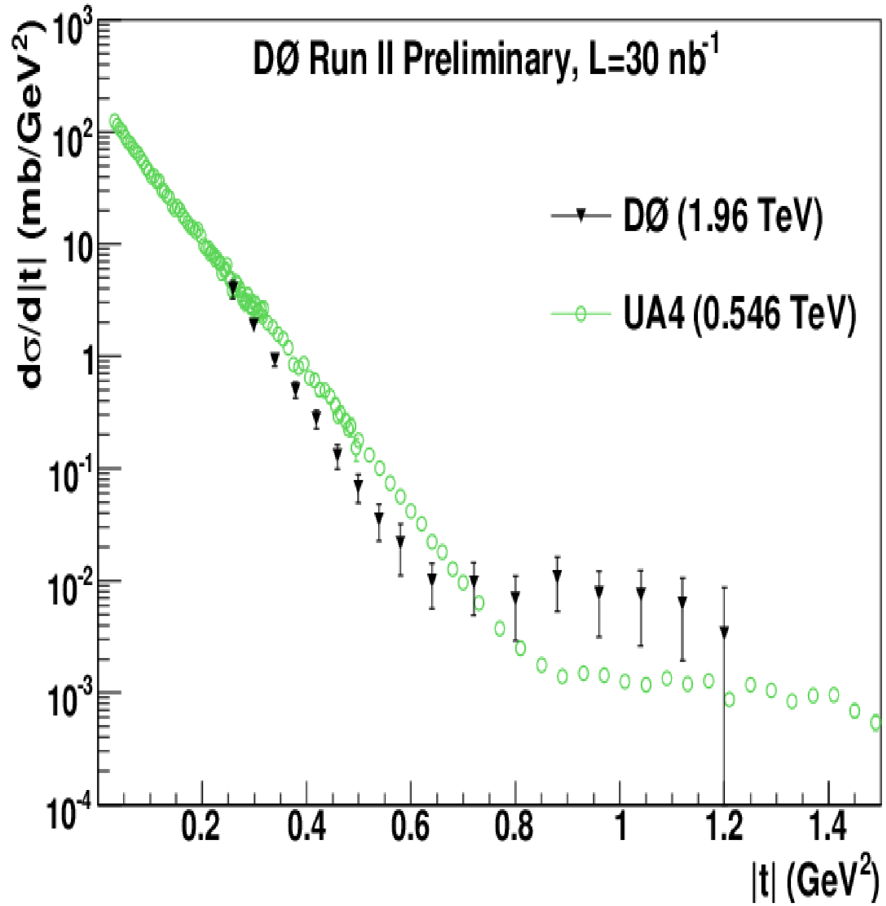
Systematic error dominated by efficiency correction.

We observe the first diffraction minimum.

Working in reducing systematic uncertainties to ~1/3.

Comparison to other experiments





First observation of the first diffraction minimum at Tevatron energies

As energy increases:
- Steeper slope
-Drastic change of slope moves towards lower |t| values.

Conclusions

1. We have presented first evidence of high mass diffractive dijet production (4.7 σ). This event signature might play a significant role in future studies at LHC (for example exclusive Higss diffractive production).

2. We have measured $d\sigma/dt$ for p-pbar elastic scattering at E_{CM}=1.96 TeV, in the range $0.26<|t|<1.2$ Gev^2.

3. In the range $0.26<|t|<0.6$, the logarithmic slope has the value:
   $b = 16.5 \pm 0.1\ (stat) \pm 0.8\ (syst)$

4. We observe the first diffraction minimum at the Tevatron energy.

5. The systematic   uncertainties have been reduced to ~1/3. Under approval stage for publication.