Forward Proton Detector at D0
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1 - Forward Proton Detector Layout

D2 D1 D A₂ S A₁ DØ Q₄ Q₃ Q₂ P1D S P2I
59 57 33 23 0 23 33 Z(m)
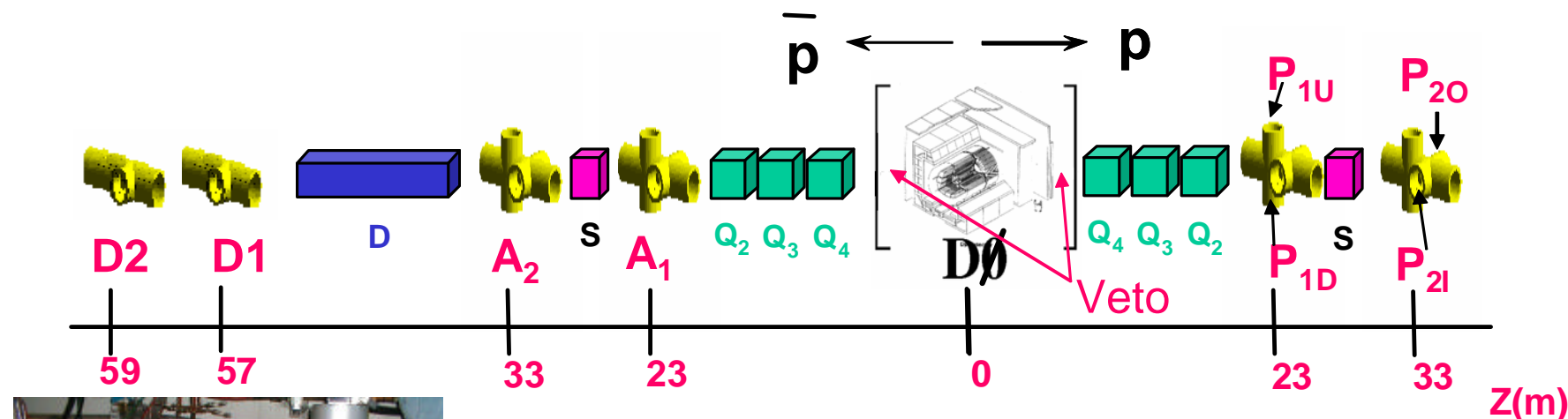
- 9 momentum spectrometers composed of 18 Roman Pots
- Scintillating fiber detectors can be brought close (~6 mm) to the beam to track scattered protons and anti-protons
- Reconstructed track is used to calculate momentum fraction and scattering angle
  - Much better resolution than available with gaps alone
- Cover a t region ($0 < t < 3$ GeV^2) never before explored at Tevatron energies
- Allows combination of tracks with high-p_T scattering in the central detector

2 - FPD Detector Setup
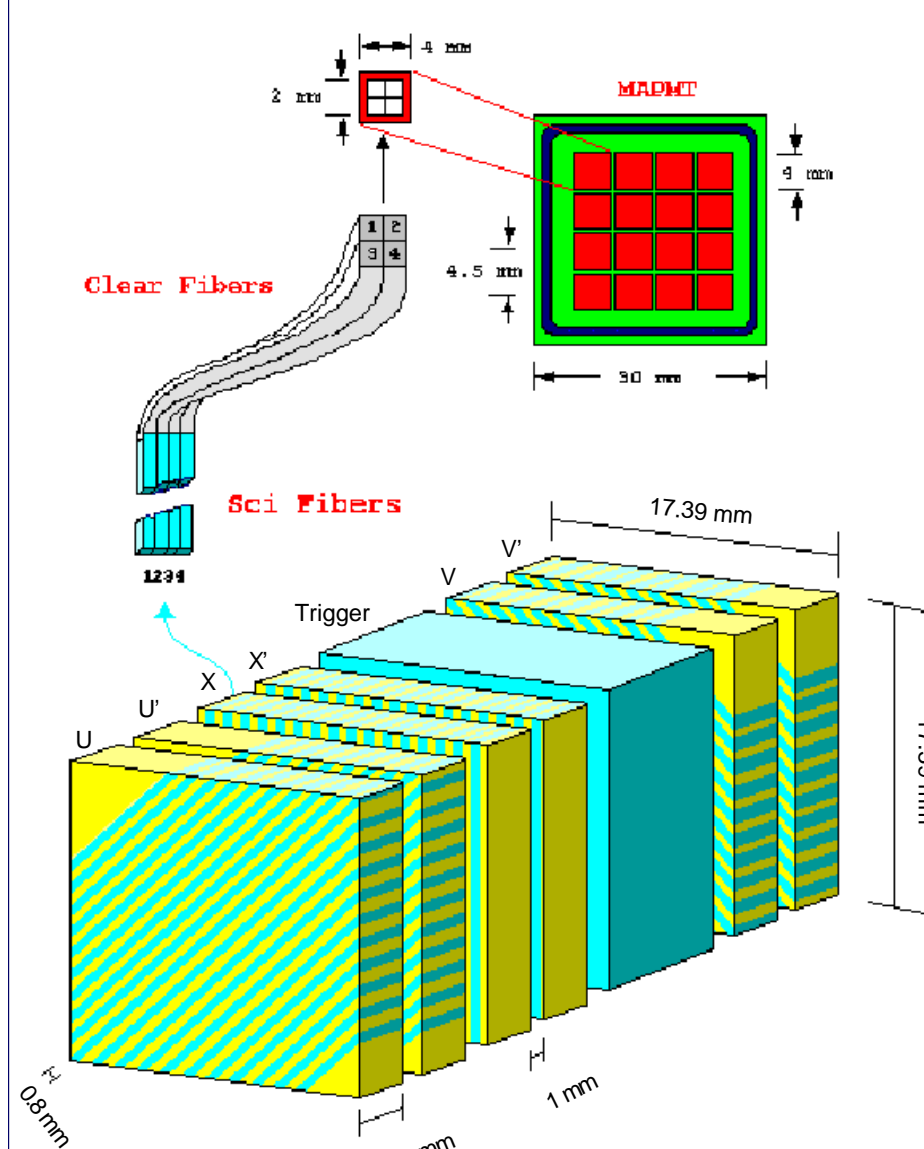
- 6 planes per detector in 3 frames and a trigger scintillator
- U and V at 45 degrees to X, 90 degrees to each other
- U and V planes have 20 fibers, X planes have 16 fibers
- Planes in a frame offset by ~2/3 fiber
- Each channel filled with four fibers
- 2 detectors in a spectrometer

3 - Tagged Elastic Trigger

A1U A2U
Halo Early Hits
Pbar
P
P1D P2D
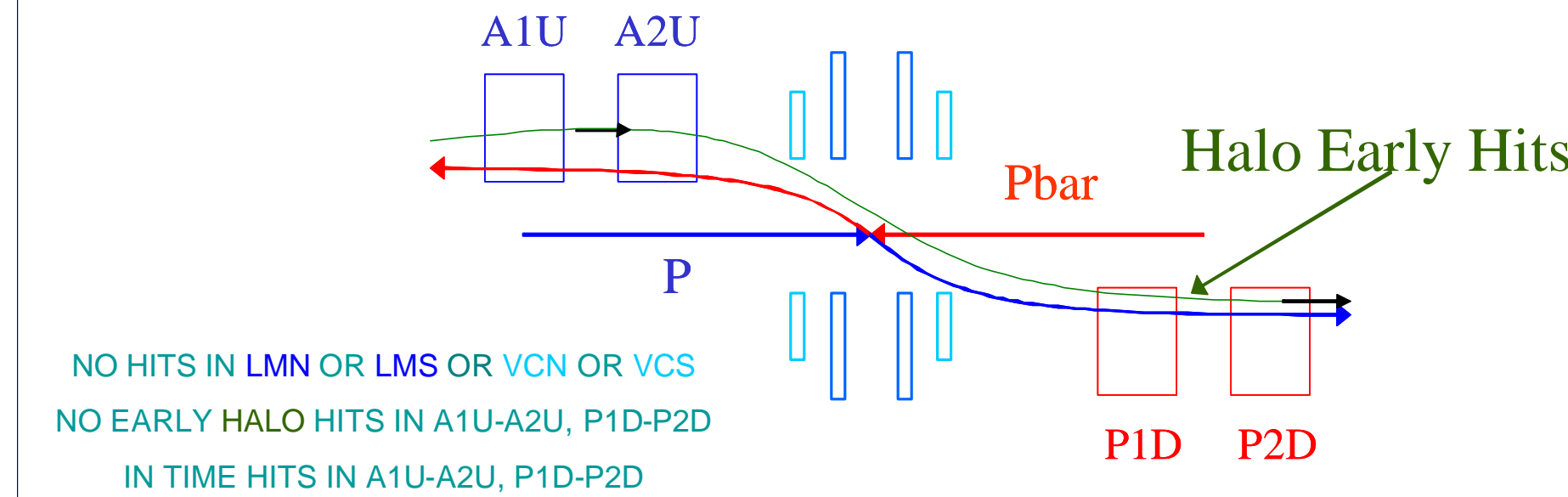
NO HITS IN LMN OR LMS OR VCN OR VCS
NO EARLY HALO HITS IN A1U-A2U, P1D-P2D
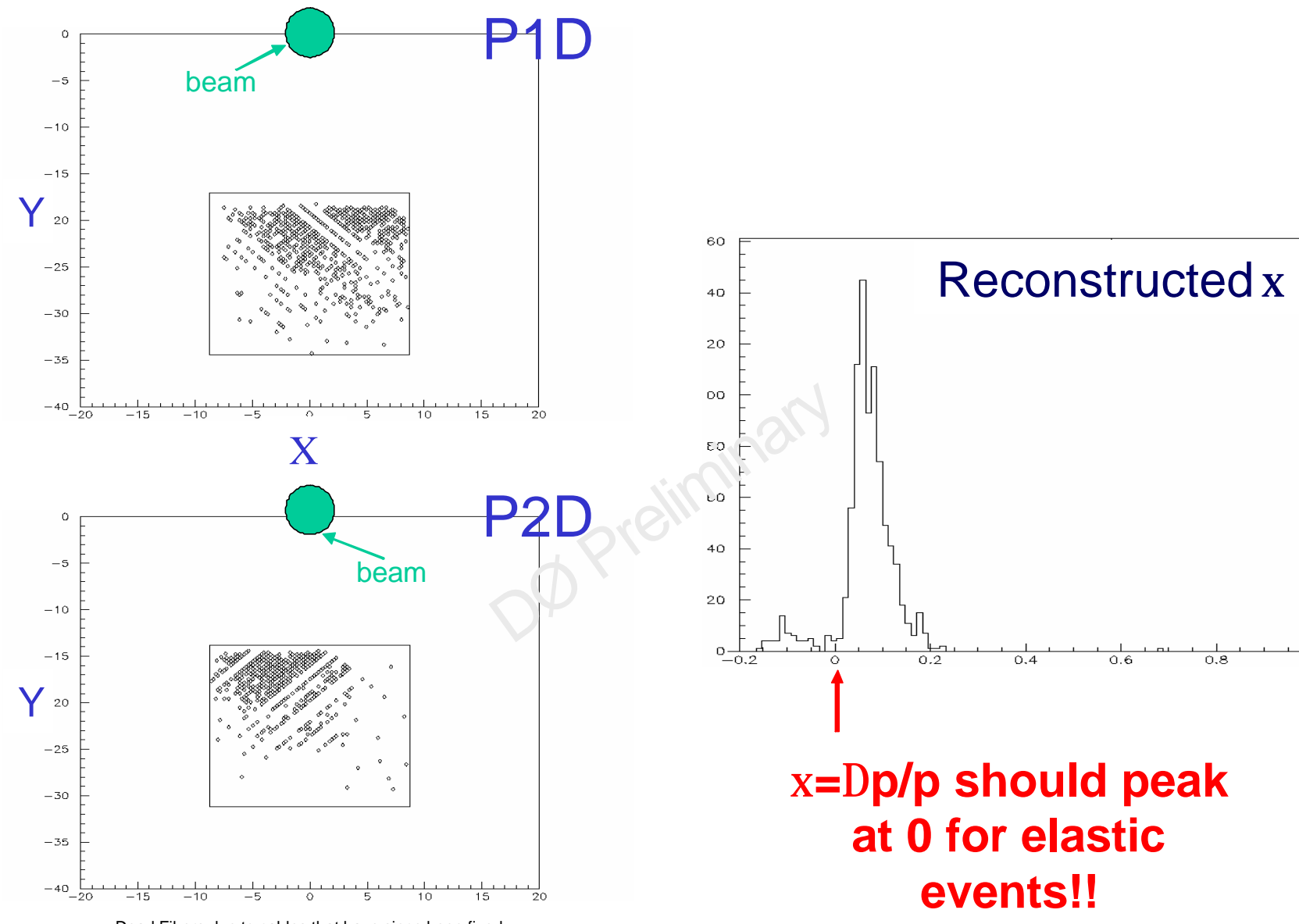IN TIME HITS IN A1U-A2U, P1D-P2D

- Approximately 3 million raw elastic events
- About 1% (30 thousand) pass multiplicity cuts
  - Multiplicity cuts used for ease of reconstruction and to try to handle high halo background from Tevatron
    - 1 or 0 hits in each of 12 planes of the PD spectrometer
    - Each frame of both PD detectors needs a valid segment (i.e. 6 segments total)
    - Segments turned into hits and then reconstructed into tracks

4 - Segments to Hits

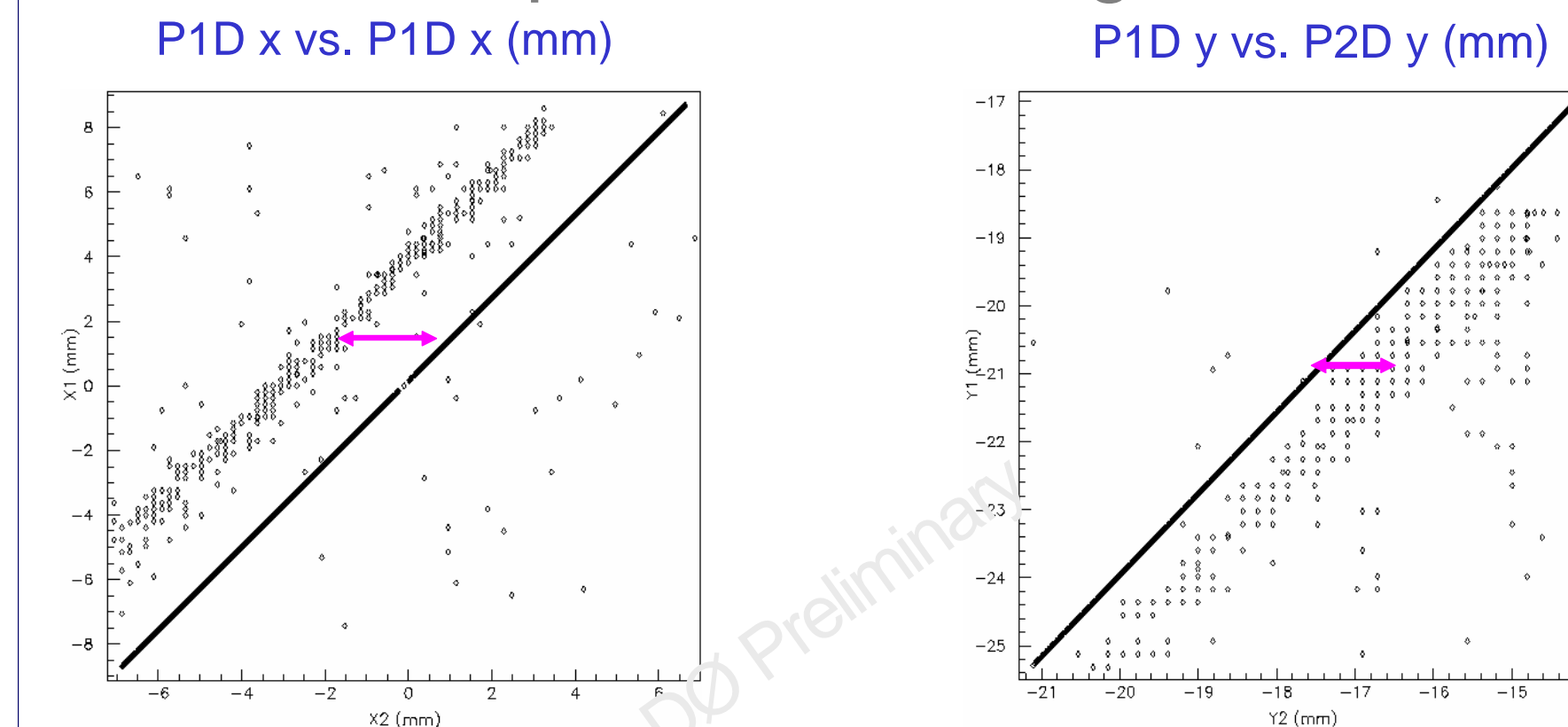Segments (270 μm)

$8\sigma_y$
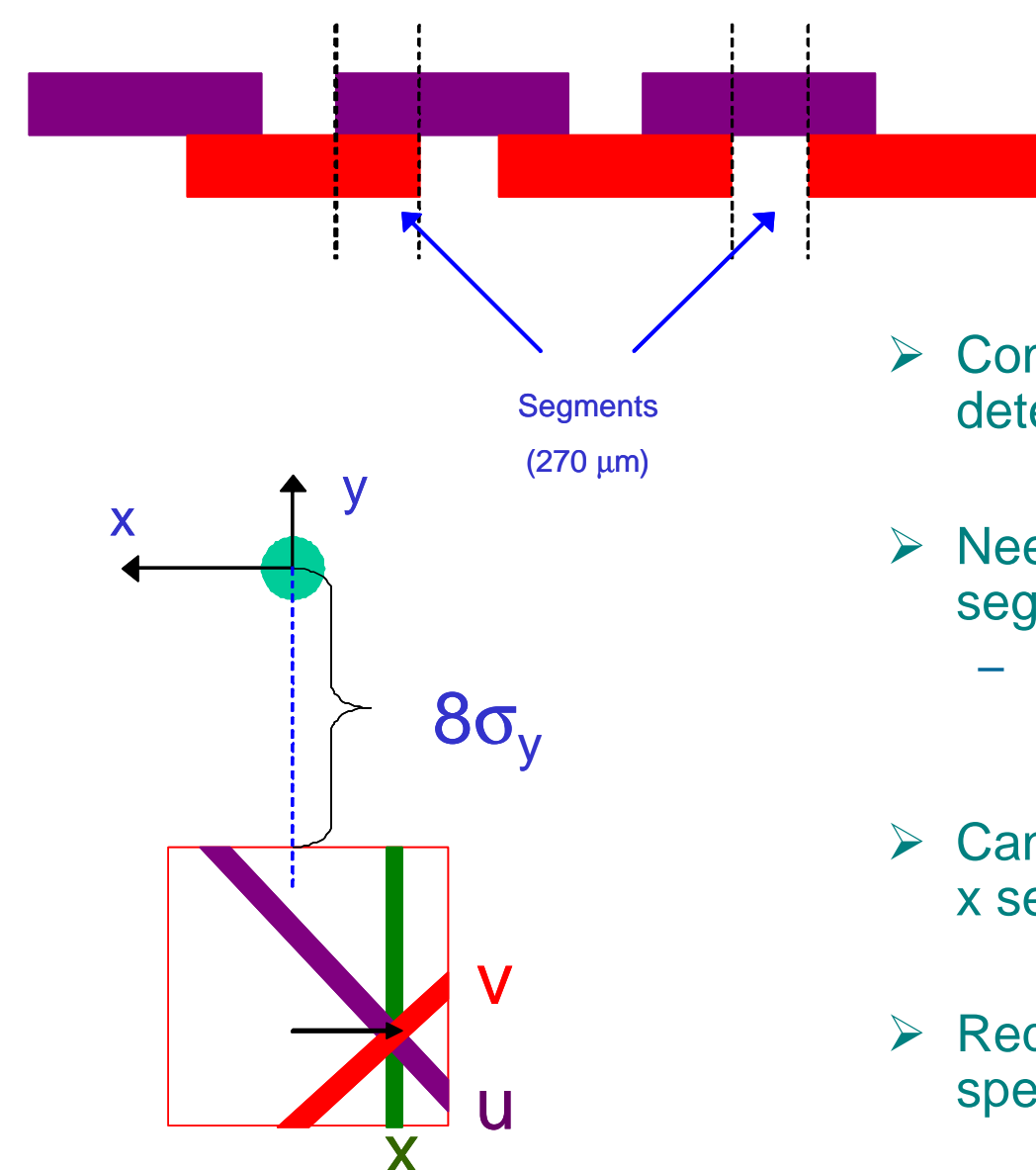
- Combination of fibers in a frame determine a segment
- Need two out of three possible segments to get a hit
  - U/V, U/X, V/X
    - Can reconstruct an x and y
- Can also get an x directly from the x segment
- Require a hit in both detectors of spectrometer

5 – Initial Reconstruction

P1D
beam

P2D
beam

Reconstructed x

x=Dp/p should peak at 0 for elastic events!!

Dead Fibers due to cables that have since been fixed

6 - Spectrometer Alignment

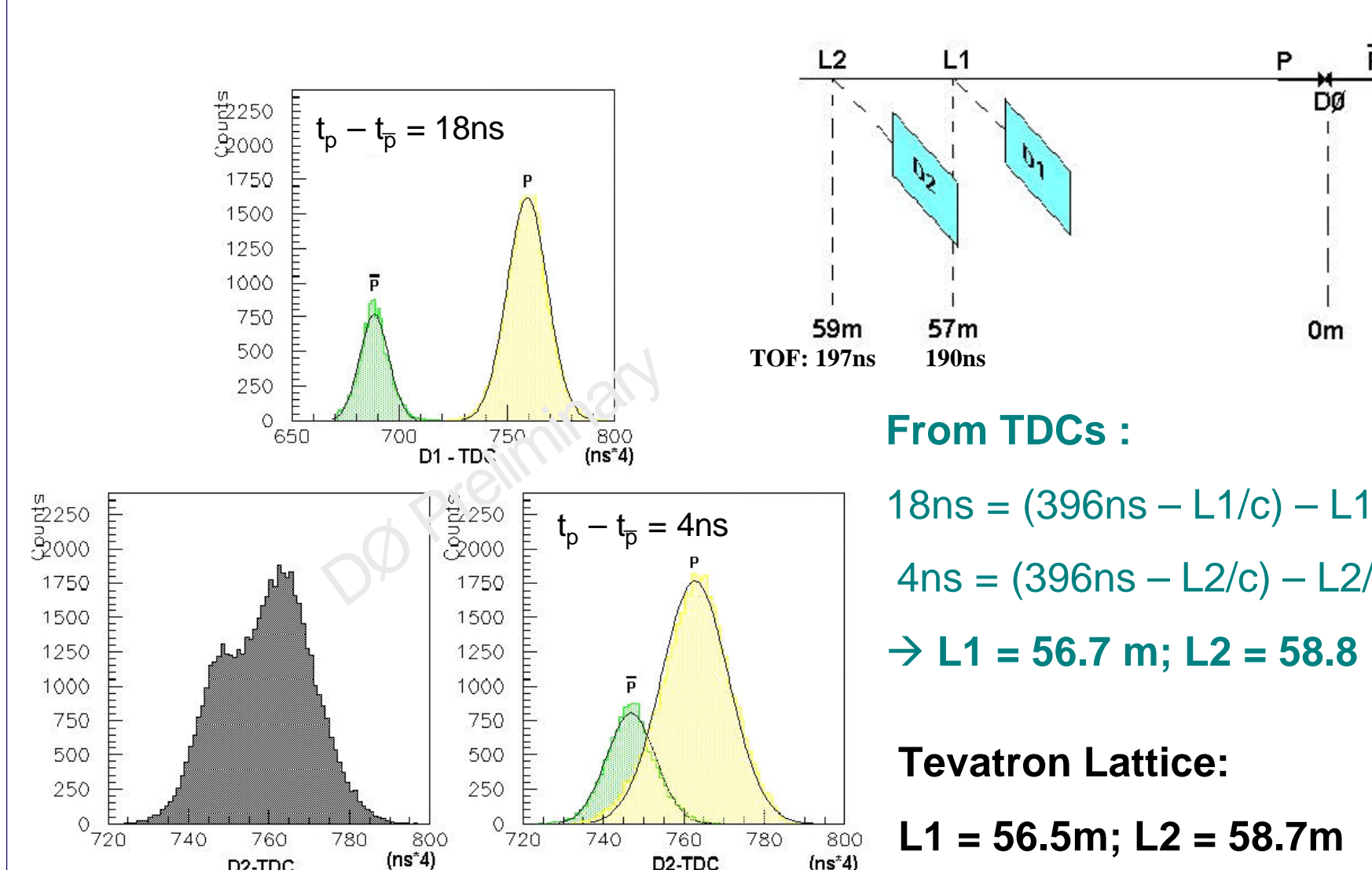P1D x vs. P1D x (mm)   P1D y vs. P2D y (mm)

DØ Preliminary

- Good correlation in hits between detectors of the same spectrometer but shifted from kinematic expectations
  - 3mm in x and 1 mm in y

7 - Distributions after Alignment Correction

x_reco |t| (GeV²)
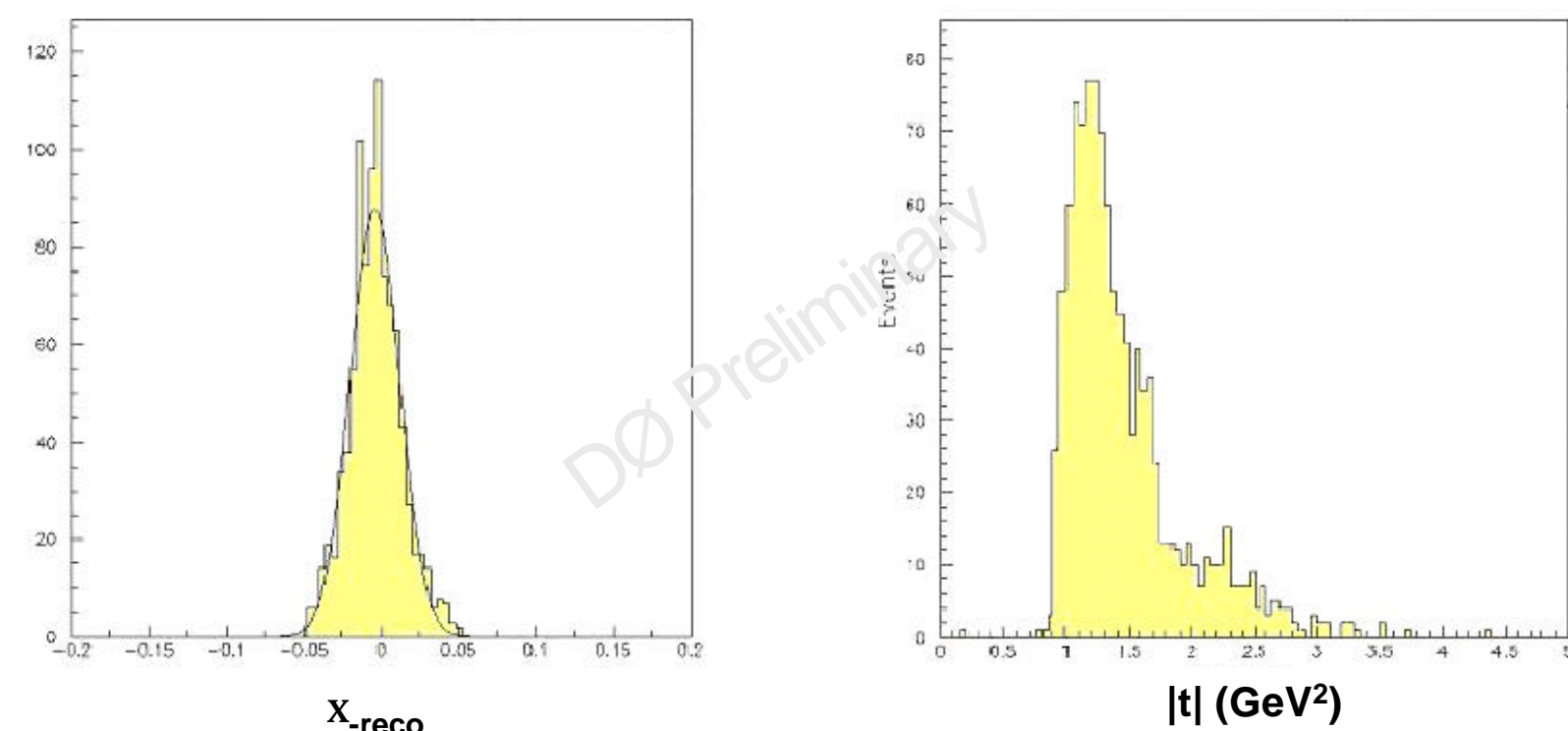
- After correction, ξ now peaks at 0
  - MC ξ resolution is 0.013 (including z smearing and dead channels), data is 0.015, 1.15 times larger
- The t distribution has a minimum of 0.8 GeV². t_{min} is determined by how close the pots are from the beam (would expect 0.5 GeV² with clean beam). Shape is in agreement with expected angular acceptance from MC.

8 - TDC Timing from Trigger Tubes

$t_p - t_{\bar{p}} = 18$ns

L2 L1 P P̄
DØ
59m 57m 0m
TOF: 197ns 190ns

$t_p - t_{\bar{p}} = 4$ns

D1-TDC   D2-TDC   D2-TDC

From TDCs :
18ns = (396ns – L1/c) – L1/c
4ns = (396ns – L2/c) – L2/c
→ L1 = 56.7 m; L2 = 58.8 m

Tevatron Lattice:
L1 = 56.5m; L2 = 58.7m

9 - TDC Resolution

pbar
p
D1 TDC / D2 TDC

DØ Preliminary

- Can see bunch structure of both proton and antiproton beam
- Can reject proton halo at dipoles using TDC timing