D0 Results in Diffraction

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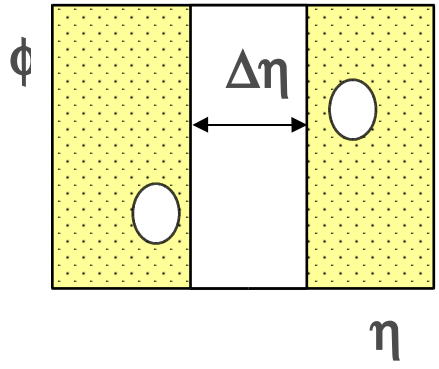
On Behalf of the D0 Collaboration

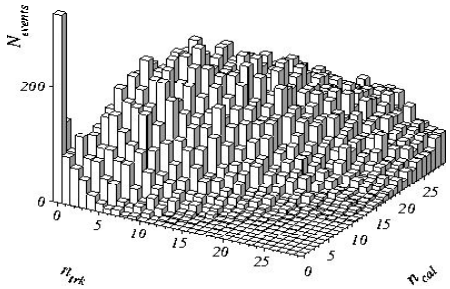
- Diffraction at Run I
- Run II
  - Diffractive topics
  - Preliminary results
  - Forward Proton Detector
- Summary

Run I Results

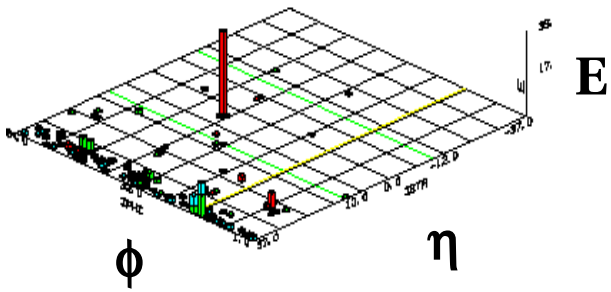
•**Central gaps between jets:** Color-Singlet fractions at $\sqrt{s}$ = 630 & 1800 GeV; Color-Singlet Dependence on $\Delta\eta$, E_T, $\sqrt{s}$ (parton-x). **PRL 72, 2332(1994); PRL 76, 734 (1996); PLB 440, 189 (1998)**



•**Observed forward gaps in jet events at $\sqrt{s}$ = 630 & 1800 GeV.** Rates much smaller than expected from naïve Ingelman-Schlein model. Require a different normalization and significant soft component to describe data. Large fraction of proton momentum frequently involved in collision. **PLB 531, 52 (2002)**



• **Observed jet events with forward/backward gaps at $\sqrt{s}$ = 630 and 1800 GeV**



•**Observed W and Z boson events with gaps:** measured fractions, properties first observation of diffractive Z. **PLB 574, 169 (2003)**

Run II Improvements

- ✔ Larger luminosity allows search for rare processes
- ✔ Higher E_T jets allow smaller systematic errors
- ✔ Integrated Forward Proton Detector (FPD) allows accumulation of large hard diffractive data samples
- ✔ Measure ξ, t over large kinematic range

Diffractive topics

10 PhD Students

- **Diffractive Z (gap)**
- **Diffractive W,Z**
- **Diffractive forward jets**
- **Diffractive heavy flavor**
- **Diffractive structure function**
- **Double pomeron+jets**
- **Diffractive pomeron+jets**
- **Inclusive double pomeron**
- **Diffractive jets**

Current diffractive triggers

Jet +Gap(s):
15 GeV jet + 1 or 2 gaps; 2 gap trigger has low prescale up to intermediate lums

45 GeV jet + 1 or 2 gaps; prescale of 2 for single gap up to 60E30, double gap unprescaled at all lum

J/ Ψ +Gap(s):
2 low p_T muons+1 or 2 gaps; unprescaled at all luminosity

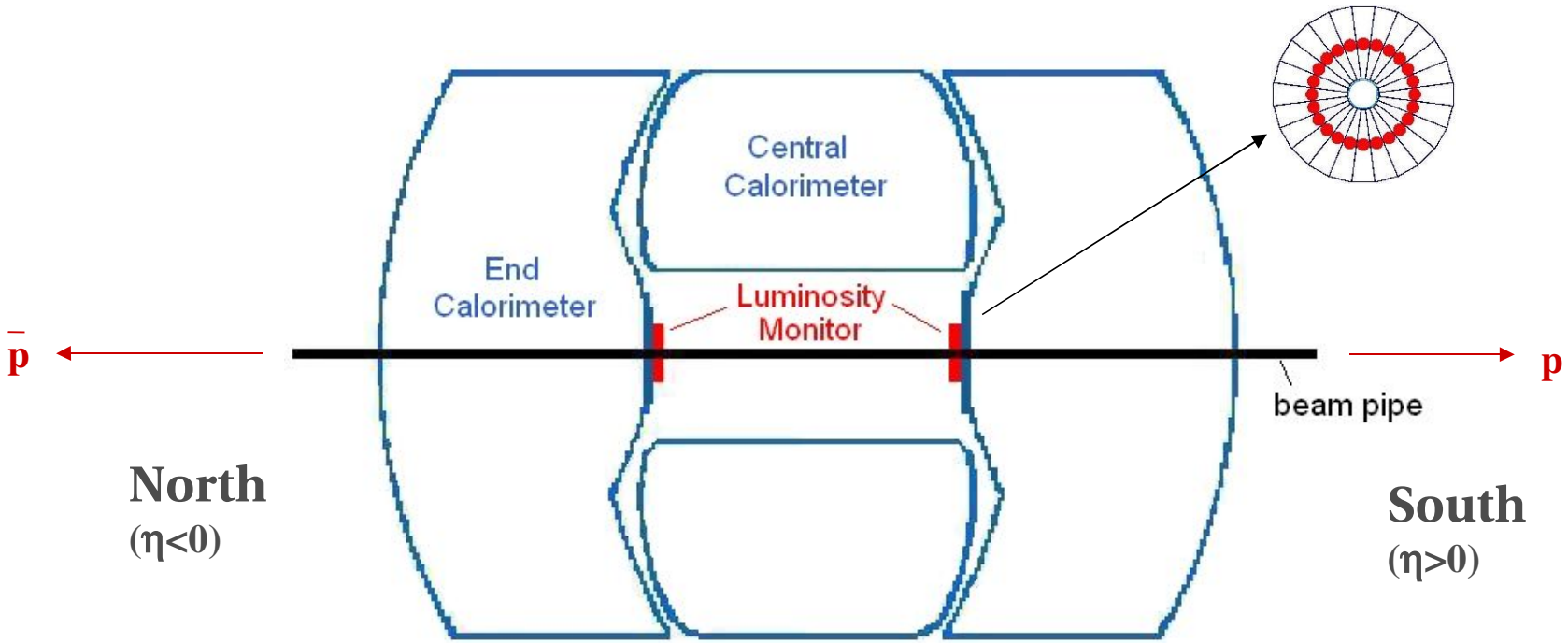
Elastic and double pomeron triggers (FPD):
Recently added elastic global list trigger, previously restricted to special runs

These triggers are being used to search for exclusive dijets and exclusive χc (along with many other diffractive topics), a key step towards validating diffractive Higgs models.

Rapidity Gap Trigger

Luminosity Monitor (LM)

- Scintillating detector
- $2.7 < |\eta| < 4.4$
- Charge from wedges on one side are summed:
  Detector is **on**/**off** on each side, North and South



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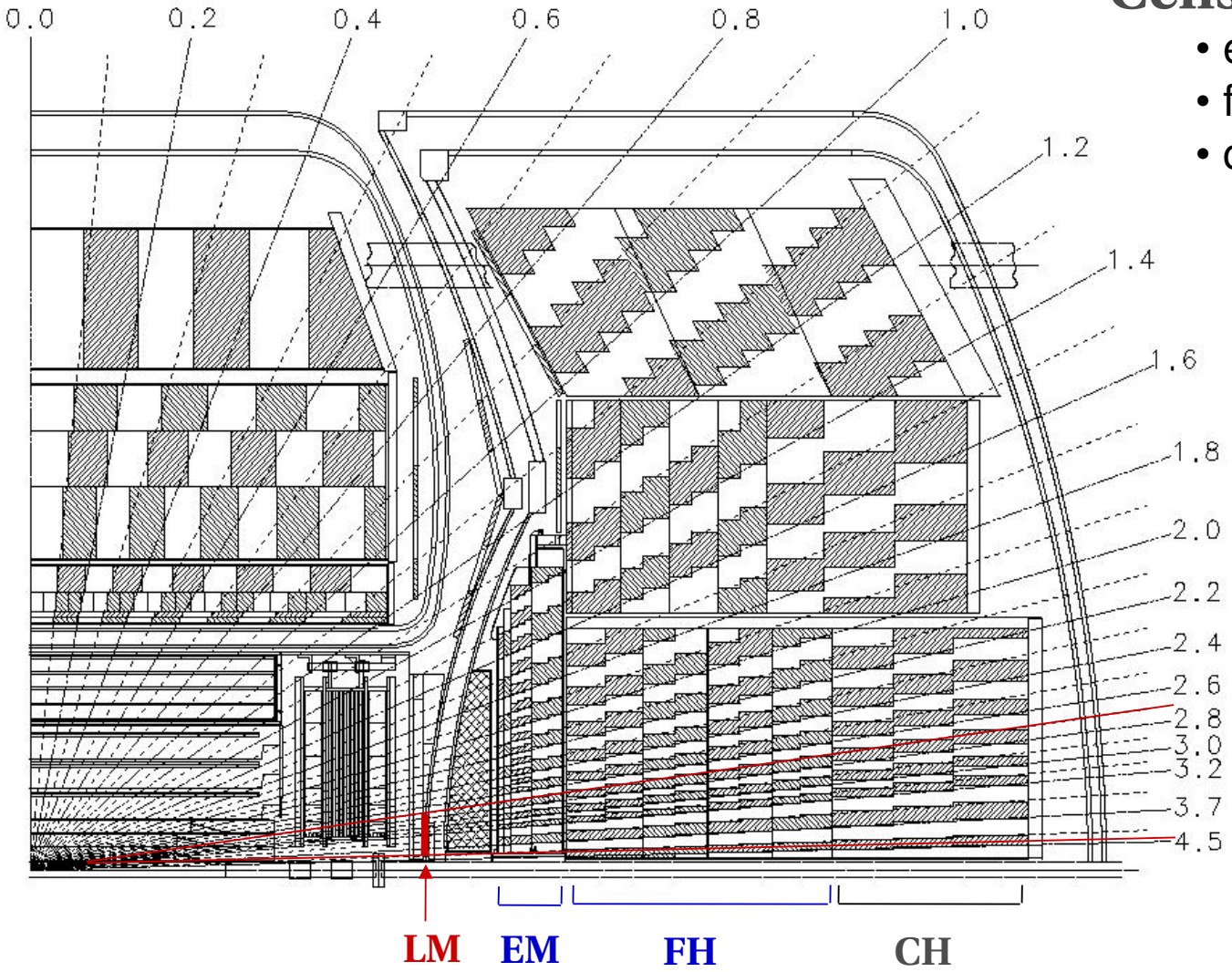
Rapidity Gap Selection

Liquid argon/uranium calorimeter



Cells arranged in layers:

- electromagnetic (EM)
- fine hadronic (FH)
- coarse hadronic (CH)

- **Sum E of Cells in EM and FH layers above threshold:**

  $E_{EM} > 100$ MeV

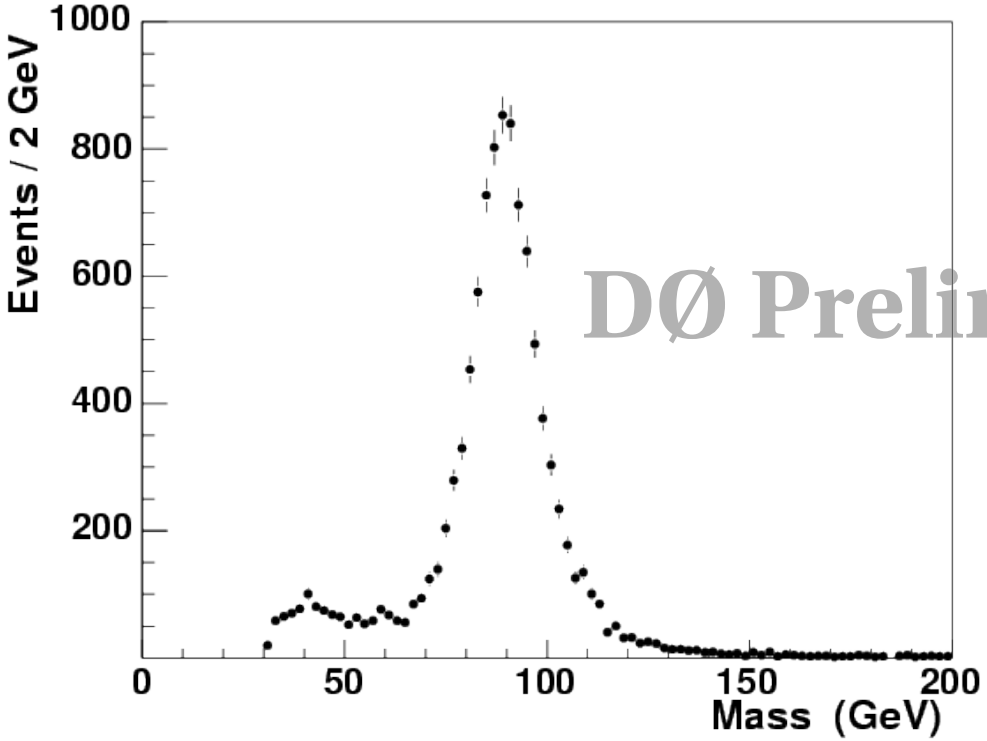
  $E_{FH} > 200$ MeV

	LM range	Esum range
	2.7	2.6
	4.4	4.1 - 5.3

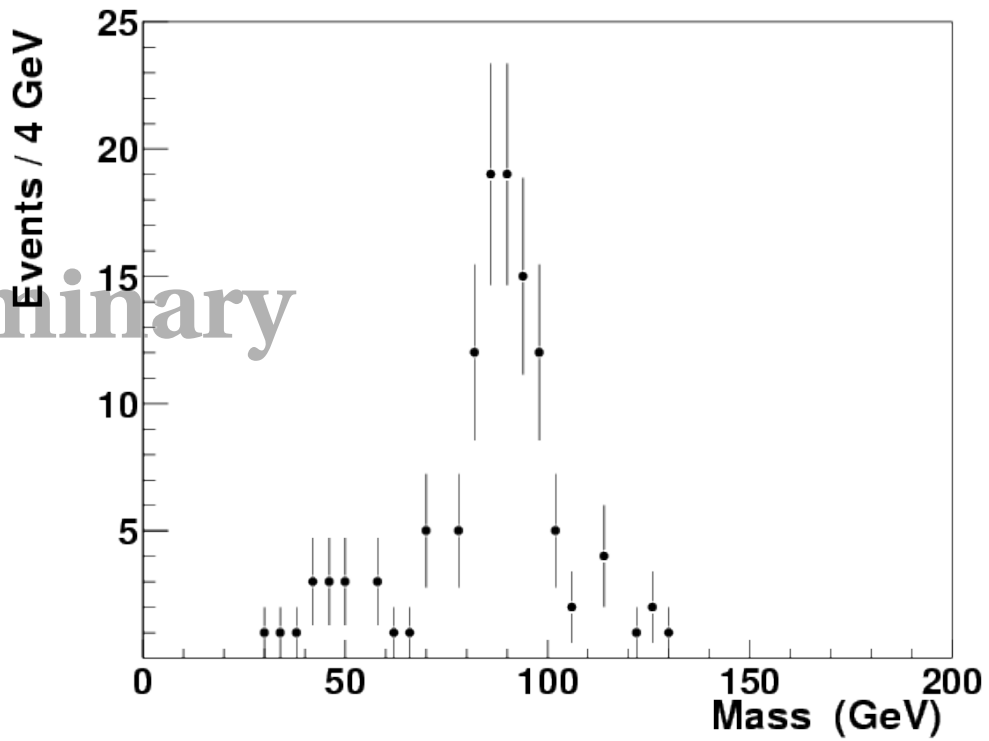
Diffractive Z (gap tag)

Event Selection: **Z→μ+μ- Events** from 2003 data sample
Two good (P_T > 15GeV) oppositely charged muons (at least one isolated), cosmic ray rejection

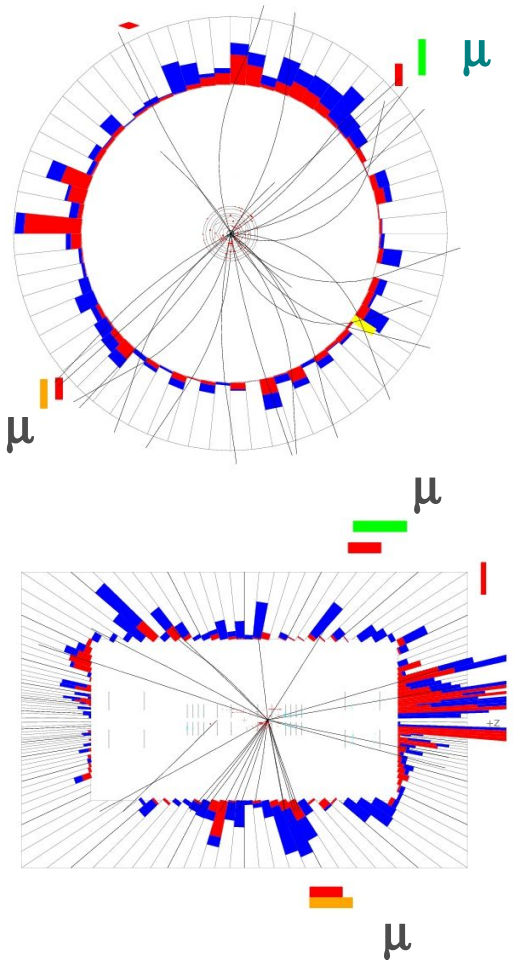
Demand Activity North and South



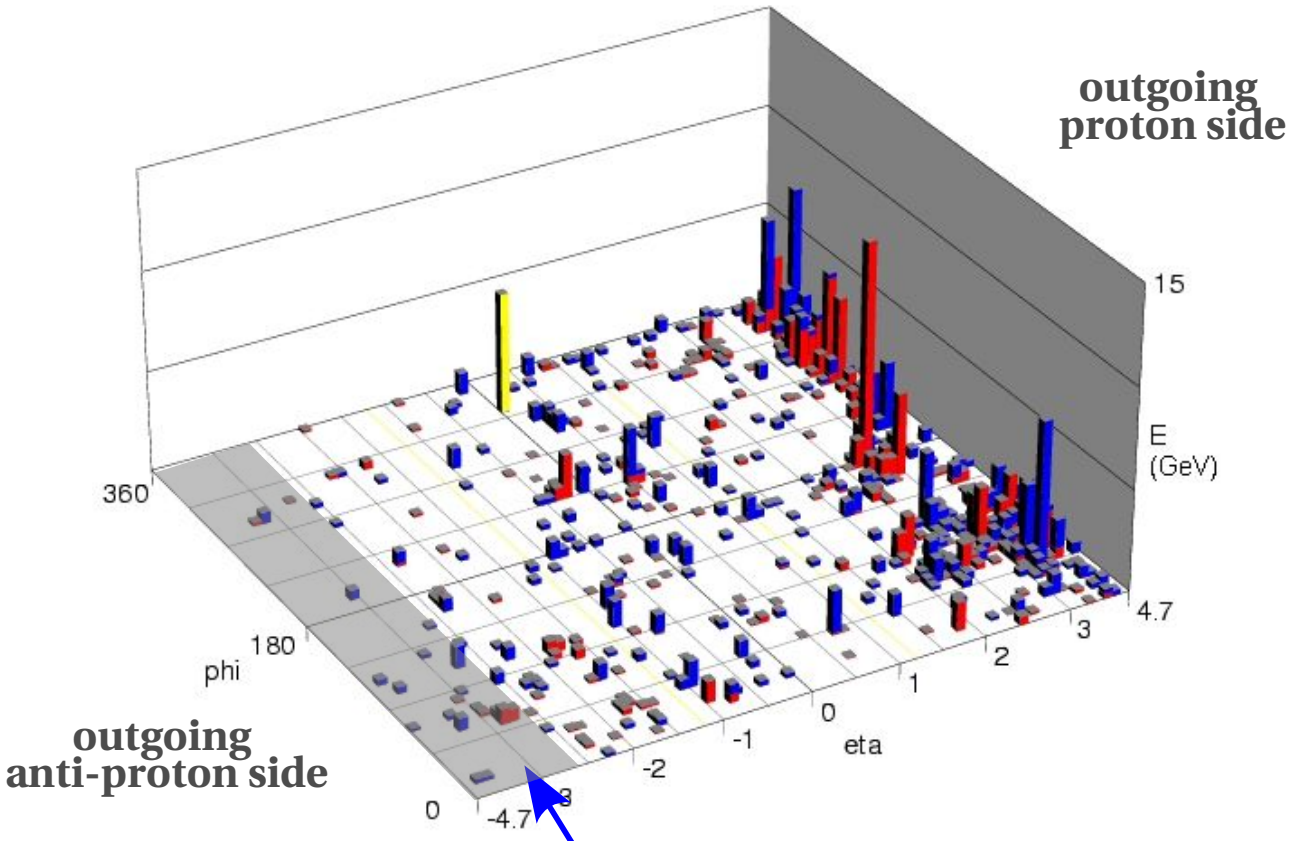
Forward Gap (North or South)



Diffractive Z candidate

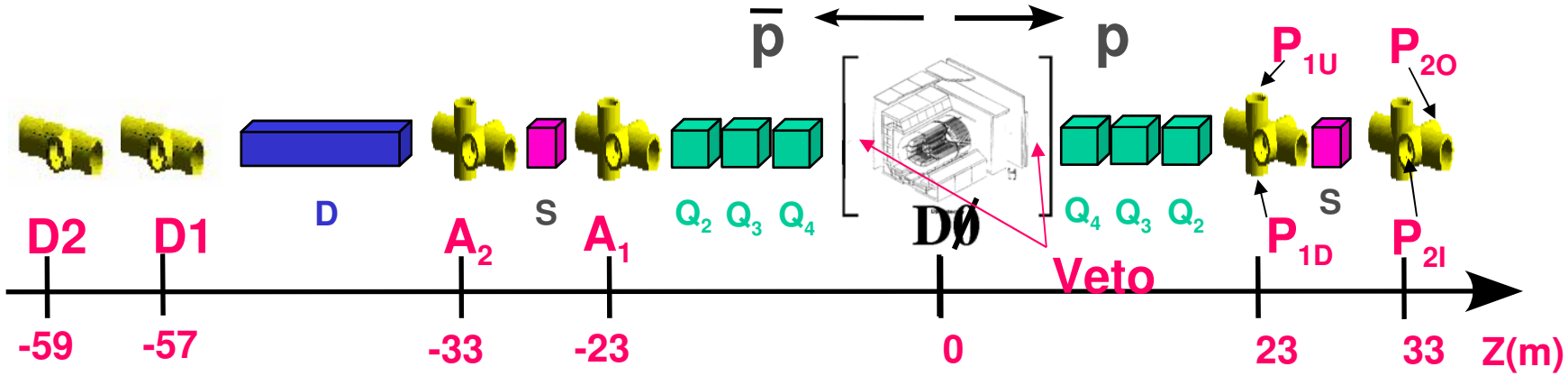


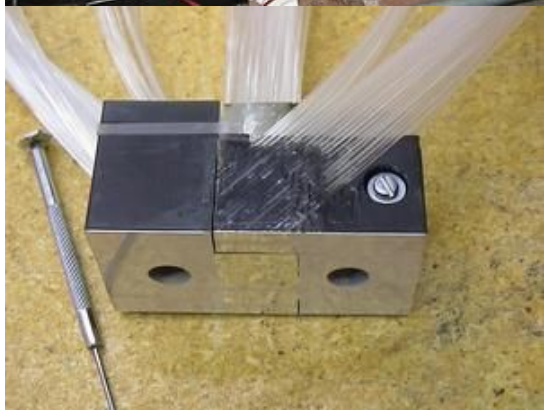
$Z \rightarrow \mu\mu$ event



... with rapidity gap

Forward Proton Detector (FPD)

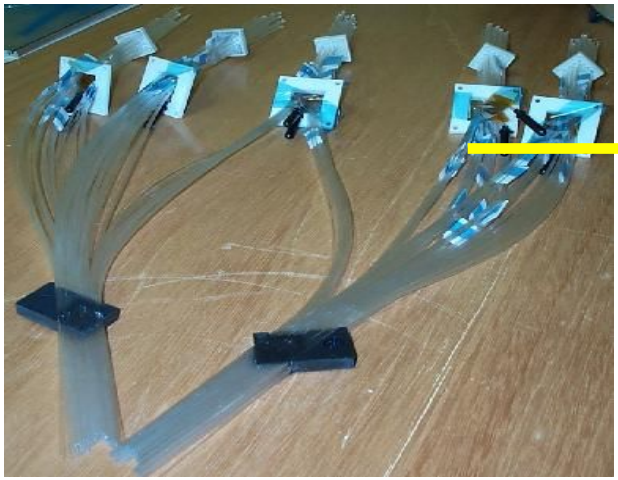


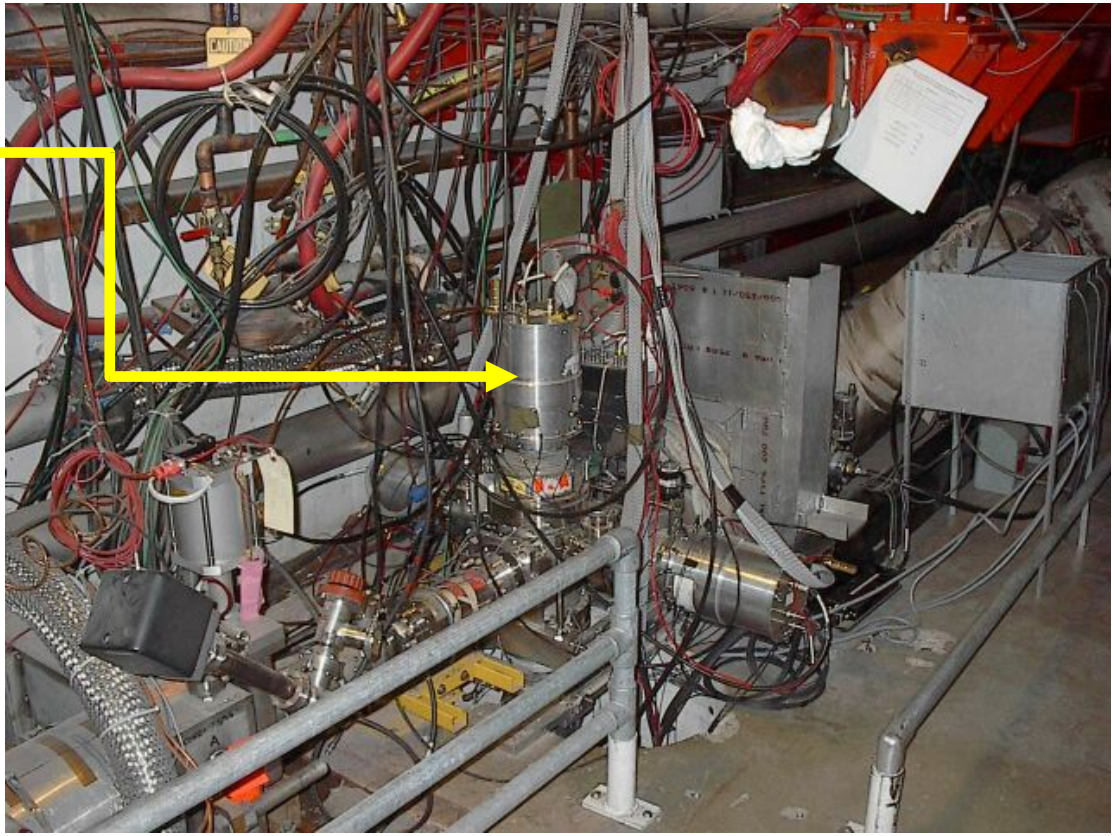


- 9 momentum spectrometers comprised of 18 Roman Pots
- Scintillating fiber detectors can be brought close (~6 mm) to the beam to track scattered protons and anti-protons
- Reconstructed track is used to calculate momentum fraction and scattering angle
- Much better resolution than available with gaps alone
- Extend measuments to low values of *t* never before explored at Tevatron energies
- Allows combination of tracks with high-p_T scattering in the central detector

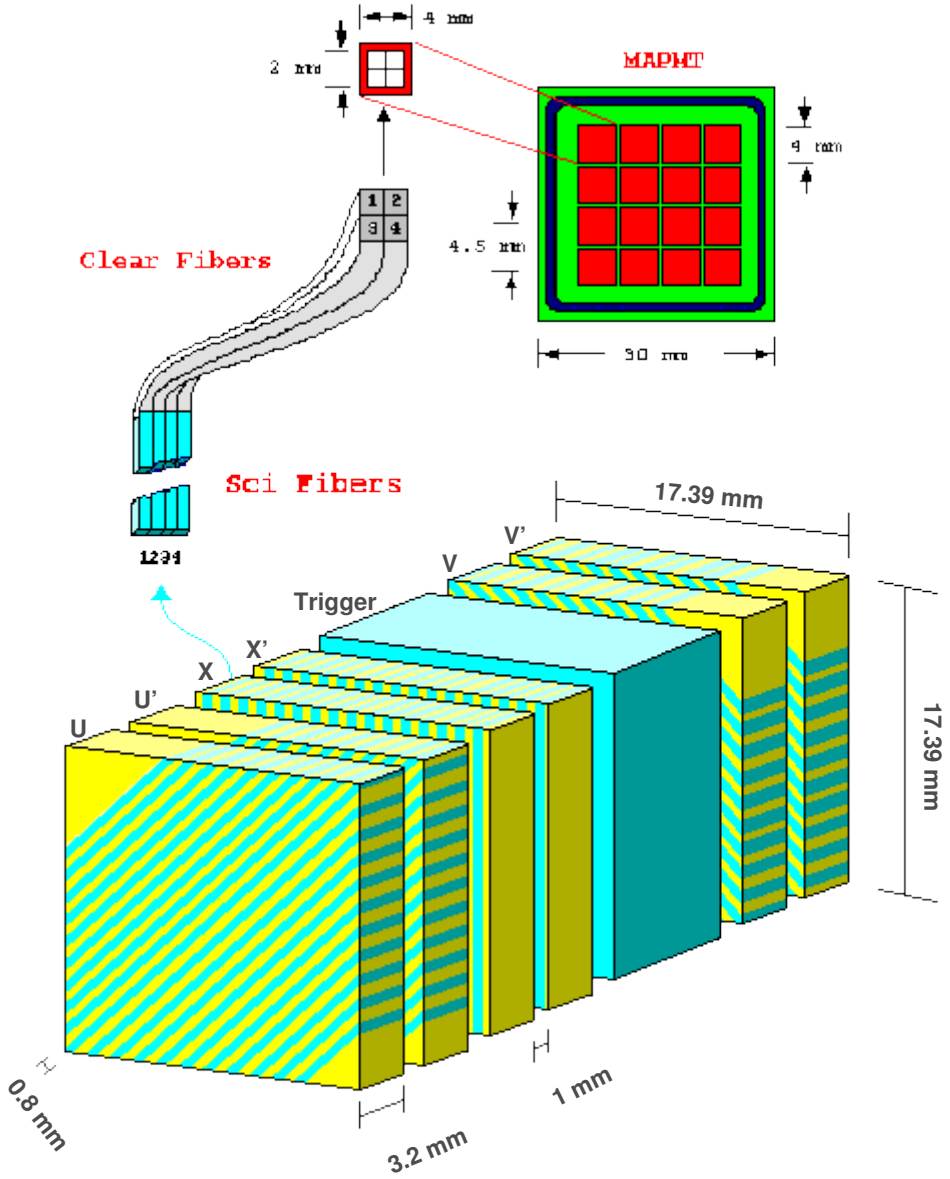
Forward Proton Detector

- All 6 castles with 18 Roman pots comprising the FPD were constructed in Brazil, installed in the Tevatron in fall of 2000, and have been functioning as designed.
- 20 detectors built over a 2+ year period at UTA
- In 2001-2002, 10 of the 18 Roman pots were instrumented with detectors. During the fall 2003 shutdown the final eight detectors and associated readout electronics were installed.



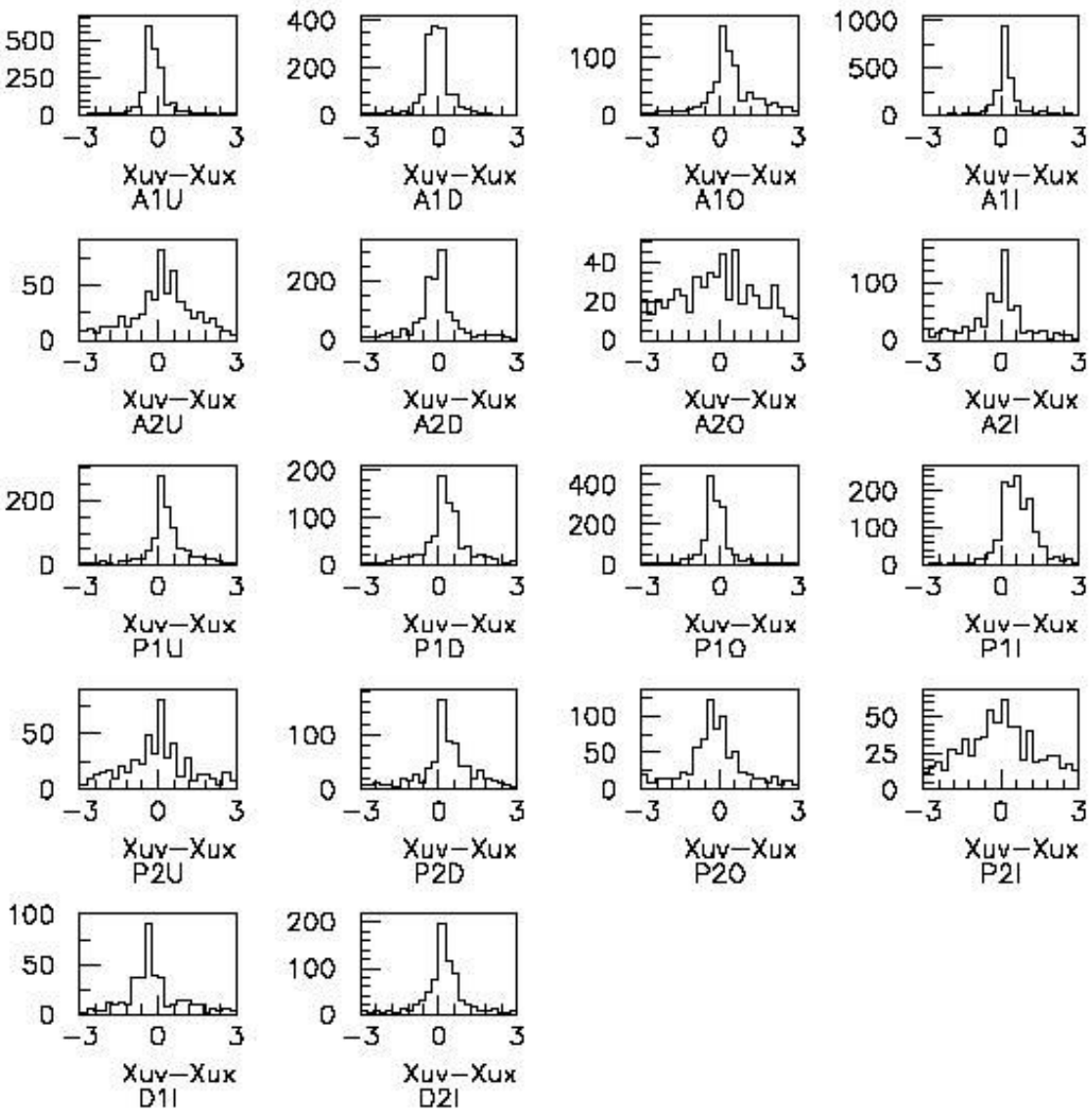


Forward Proton Detector



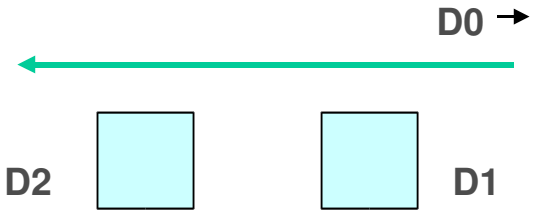
- 6 layers per detector in 3 planes and a trigger scintillator
- U and V at 45 degrees to X, 90 degrees to each other
- U and V planes have 20 fibers, X planes have 16 fibers
- Each channel filled with four fibers
- Layers in a plane offset by ~2/3 fiber. Fibers in each layer of a plane taken together define a segment.
- 2 detectors in a spectrometer. Segments are used to reconstruct hits.

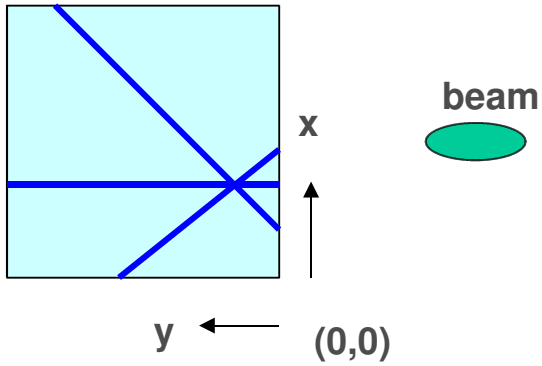
Detector hit resolution

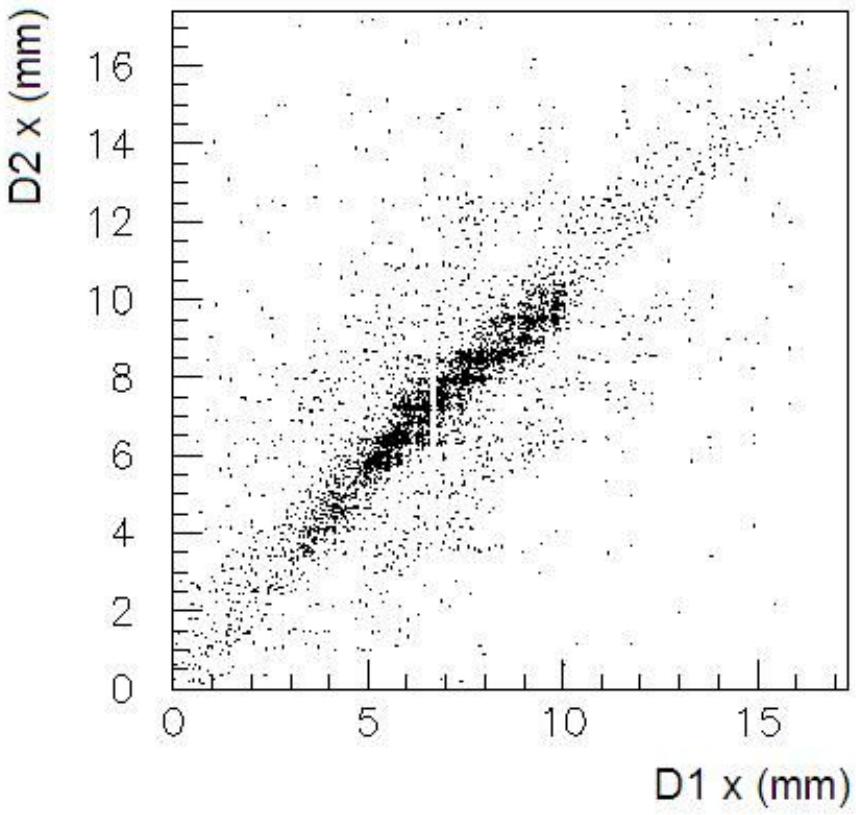


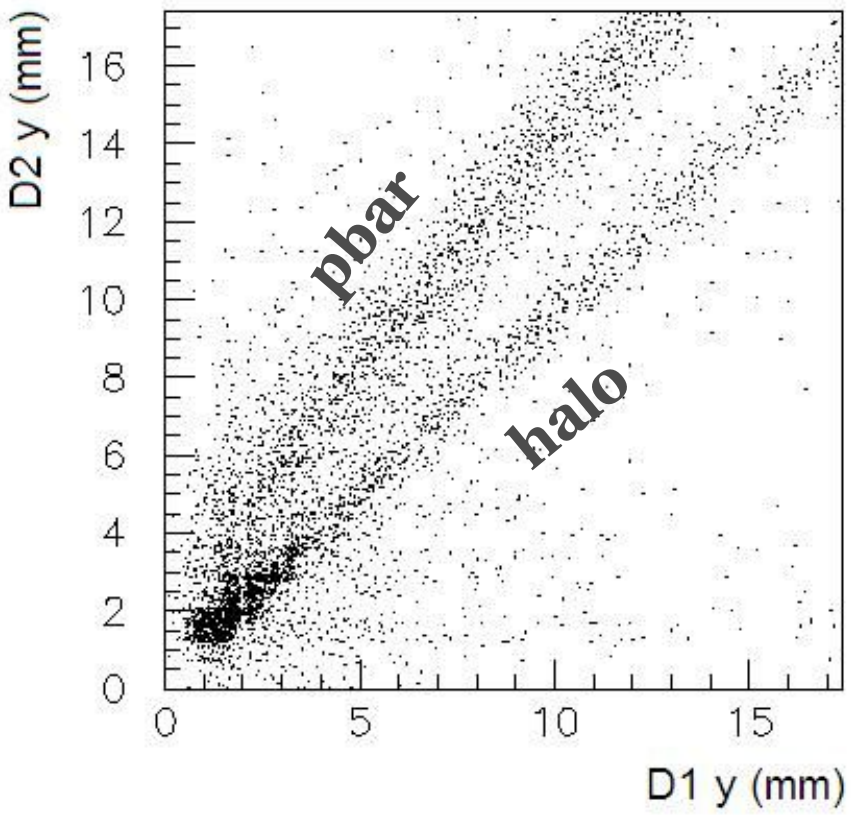
- Starting in January 2004, all 18 detectors regularly inserted (dipoles since February 2003)
- Resolutions calculated by the difference of the x value of a hit calculated from u/v segments compared to the x value of the x segment show that most of the detectors are working as expected

FPD dipole data









Summary

- FPD being calibrated and working as planned.
- Level 1 FPD triggers being commissioned (new data samples).
- Comparing measurements with FPD tag vs. Gap tag yields new insight into processes

- Many diffractive physics measurements already in progress.

- Get your predictions of if/where the dip(s) will be for Single Diffraction, Double Pomeron Exchange + Elastic.