The DØ Forward Proton Detector

Andrew Brandt(DØ Collaboration)[a]

[a]University of Texas at Arlington, P.O. Box 19059, Arlington, TX 76019

The Run II DØ Forward Proton Detector is described.

1. Hard Diffraction

One of the most interesting new results from Tevatron Run I was the existence of large rapidity gaps in events with a hard scattering. CDF and DØ published several papers on events with a central rapidity gap between jets [1,2] and have several more papers either published or in preparation on related topics, including diffractive production of jets [3,4], W and Z bosons [5,6], and b quarks [7]. Improved understanding of the new field of hard diffraction, which probes otherwise inaccessible details of the strong force and vacuum excitation, requires new detectors for tagging and measuring scattered protons.

2. The Forward Proton Detector

The DØ Forward Proton Detector (FPD) [8] consists of momentum spectrometers which make use of accelerator magnets along with points measured on the track of the scattered proton to calculate the proton's momentum and scattering angle. Tracks are measured using scintillating fiber detectors (a prototype detector is shown in Fig. 1) located in vacuum chambers positioned in the Tevatron tunnel 20–60 meters upstream and downstream of the central DØ detector. The vacuum chambers were built in Brazil and will be installed in the Tevatron in August 2000. One of the completed Roman pot castles is shown in Figure 2. The scintillating fiber detectors will be assembled at the University of Texas at Arlington.

Figure 1. A photograph of the prototype scintillating fiber detector.

Figure 3 shows the layout of the FPD. In the center of the diagram is the DØ detector (not to scale). The dipole spectrometer consists of two scintillating fiber detectors located after the Tevatron dipole magnets (D) about 57 meters downstream of the interaction point on the outgoing $\bar{p}$ arm, and measures antiprotons that have lost a few per cent of the beam momentum (and are thus deflected out of the beam envelope and into the detector located on the radial inside of the Tevatron ring). The detectors comprising the quadrupole spectrometers are located adjacent to the electrostatic beam separators (S) on both the proton (P) and anti-proton (A) sides and use the low beta quadrupole magnets (Q) as the primary analyzing magnets. They have acceptance for a large range of proton (anti-proton) momenta and angles.

Each of the nine independent spectrometers consists of a pair of detectors, both in the same plane: above, below, to the right, or to the left of the beam. This combination of spectrometers maximizes the acceptance for protons and anti-protons given the available space for locating the detectors. Particles traverse thin steel windows at the entrance and exit of each Roman pot (the stainless steel vessel that houses the detector). The pots are remotely controlled and can be moved close to the beam (within a few mm) during stable beam conditions and retracted otherwise. The scintillating fiber detectors are read out by multi-anode photomultiplier tubes and are incorporated into the standard DØ triggering and data acquisition system.

The FPD project has proceeded well and is expected to be ready for the start of Run II, although final funding for the phototubes and trigger electronics has not yet been secured. The FPD will allow new insight into an intriguing class of events that are not currently un-

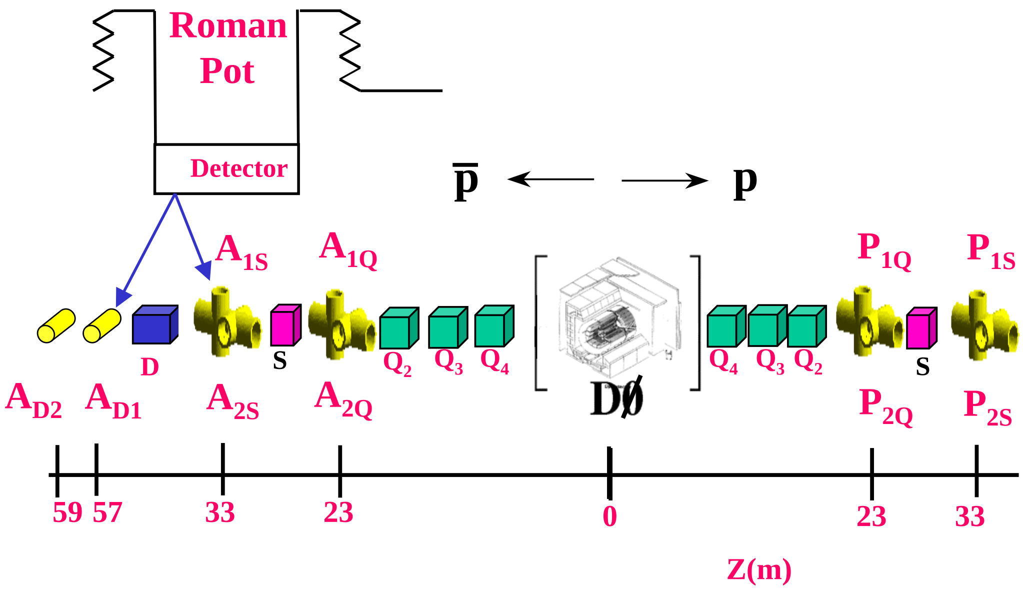

Figure 3. The layout of the Roman pot stations and Tevatron components comprising the Forward Proton Detector as described in the text (not drawn to scale).

Figure 2. A completed Roman pot castle at Fermilab along with project leaders Alberto Santoro (left) and Andrew Brandt.

derstood within the Standard Model. It allows us to trigger directly on events with a scattered proton, anti-proton, or both, along with activity in the DØ detector. In addition to improved studies of recently discovered hard diffractive processes, the new detector will allow a search for glueballs and exotic phenomena. The FPD will also provide improved luminosity measurements, which are an important component to all DØ analyses.

REFERENCES

1. S. Abachi *et al.* (DØ Collaboration), Phys. Rev. Lett. **72**, 2332 (1994);
   Phys. Rev. Lett. **76**, 734 (1996);
   B. Abbott *et al.* (DØ Collaboration), Phys. Lett. B **440** 189 (1998).
2. F. Abe *et al.* (CDF Collaboration), Phys. Rev. Lett. **74**, 855 (1995);
   Phys. Rev. Lett. **80**, 1156 (1998);
   Phys. Rev. Lett. **81**, 5278 (1998).
3. F. Abe *et al.* (CDF Collaboration), Phys. Rev. Lett. **79**, 2636 (1997); K. Hatakeyama (CDF Collaboration), *Proceedings of the XXXVth Rencontres de Moriond* (2000).
4. B. Abbott *et al.* (DØ Collaboration), Hep-ex 9912061, Submitted to Phys. Rev. Lett.
5. F. Abe *et al.* (CDF Collaboration), Phys. Rev. Lett. **78**, 2698 (1997).
6. L. Coney (DØ Collaboration), "Observation of Diffractive *W* Boson Production at DØ," APS Meeting, Atlanta, Georgia, March 1999.
7. T. Affolder *et al.* (CDF Collaboration), Phys. Rev. Lett. **84**, 232 (2000).
8. DØ Collaboration, "Proposal for a Forward Proton Detector at DØ" (presented by A. Brandt to the Fermilab PAC, 1997); A. Brandt *et al*, Fermilab PUB–97–377.