The CDF 1988-1989 Run

by Hans B. Jensen

In the afternoon of May 31, 1989, when a thunderstorm abruptly ended the last $\bar{p}p$ store of the 1988-1989 Tevatron Collider run, a small party took place in the CDF control room to celebrate the completion of a very successful data taking period.

The run had started almost a full year earlier, in June of 1988, with the goal of collecting 1 inverse picobarn (10^{36} per cm^2) of integrated luminosity on tape. Reality turned out even better than expectations, and about 4.7 inverse picobarns had been collected by the time the run ended.

A friendly competition between shift crews to see who could write the most data to tape in a single 8-hour shift resulted in a record of 26 inverse nanobarns, almost as much as was collected during the entire 1987 run. The record accumulation for a single week was about 0.3 inverse picobarn to tape.

To cope with the high luminosity delivered by the accelerator during this run, a trigger system with four levels was used. Levels 0, 1, and 2 were debugged during the summer months, and were fully operational by September 1, 1988. The Level 3 trigger system, consisting of about 50 Advanced Computer Program (ACP) nodes, running further event-filtering algorithms, was originally planned to be used in a test mode only. However, as the luminosity steadily increased during the run, portions of the Level 3 trigger were gradually turned on. Towards the end, an event rejection from Level 3 of about a factor three was reached.

The utility of this highly sophisticated trigger system is illustrated by the fact that an overall trigger rejection factor of about 50,000 was achieved while maintaining low trigger thresholds (and thereby good acceptance for interesting physics processes). The transverse energy thresholds for single muons and electrons, for instance, were in the 9- to 12-GeV range, while the thresholds for pair triggers were in the 3- to 5-GeV range (on each lepton). Tau lepton thresholds were somewhat higher. Altogether, about 25 different triggers were operated in parallel in standard data taking mode.

Events passing the Level 3 trigger were written to magnetic tape for offline analysis. A total of about 5500 9-track tapes, containing about 6 million events, were written. Offline event reconstruction on a large scale (''production'') began

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on two 65-node ACP systems operated by the Fermilab Computing Department around the first of the year. A "farm" of 20 VAX 3100's was added later on to increase the rate of production. Event processing includes full track reconstruction, and takes about 250 seconds per event on an ACP node. By the time the run ended, about 45 percent of the total data had passed through production. The projected date for completion is December 31, 1989.

In the interest of getting an early look at some of the more interesting physics processes, certain event types were selected for full reconstruction in the course of the run in what was called a "spin" production cycle. Based on such a preliminary event selection, about 600 $Z \rightarrow ee$ and about 5000 $W \rightarrow e\,\nu$ events were identified, and the search for the elusive top quark was begun.

The first result to emerge from analysis of data from this run concerns the mass of the Z^0 particle, discovered at the CERN Collider, and measured by the UA1 and UA2 experiments to be $93.1 \pm 1.0 \pm 3.1$ GeV/c^2 (UA1) and $91.5 \pm 1.2 \pm 1.7$ GeV/c^2 (UA2). The new CDF result, based on $Z \rightarrow \mu\mu$ and $Z \rightarrow ee$ decay events, is $90.9 \pm 0.3 \pm 0.2$ GeV/c^2, consistent with the earlier measurements by UA1 and UA2, but with much improved measurement uncertainties.

Accurate measurement of the Z mass and width is now a very topical subject. A measurement with the MARK II detector at the SLAC Linear Collider yields a mass of 91.11 ± 0.23 GeV/c^2, and results from LEP at CERN are expected soon.

For CDF, a next step is to finish the data analysis for the W mass measurement. Accurate Z and W masses can then be used, within the Standard Model, to get mass limits for the top quark. Combined with other measurements, they can also be used for precision tests of the Standard Model.

At Tevatron Collider energies (1.8 TeV in the $\bar{p}$-p center-of-mass) the dominant production mechanism of top quarks is believed to be the associated production of a $t\,\bar{t}$ pair. Final states containing either an electron, a neutrino and jets, or an electron and a muon provide good signatures for top quarks, and have up to now been the primary focus of the CDF search for the top. The result so far has been negative: no signal has been found, indicating that the mass of the top quark must be larger than 77 GeV/c^2. (Earlier results by other experiments exclude a top mass below about 41 GeV/c^2. The new CDF results extend the limit to 77 GeV/c^2.)

Work is now under way to upgrade the detector and to make it ready for the higher luminosities expected next run (a luminosity increase of about a factor of five is anticipated). Detector upgrades include the addition of a Silicon Vertex Detector, a new set of high-luminosity Vertex Time Projection Chambers, and added muon coverage provided by additional steel plus chambers surrounding

the Central Muon Detector. The higher luminosities will also require modifications to some of the front-end electronics (shorter signal integration times and a faster Level 1 trigger).

In summary, between working on detector upgrades for the next run in 1991 and continuing the analysis of the rich data collected in the last run, the members of the CDF Collaboration have a busy program planned for the next couple of years.