DØ Run 2a Status Report

Prepared for the Fermilab PAC meeting, Aspen, June 2002

Detector and Computing

The detector is fully installed and being read out (except for the forward preshower detector which is 72% instrumented). The silicon tracker, calorimeter and muon systems are fully commissioned and running with high efficiency. The fiber tracker is operating well, its readout is running smoothly, and tracks are being found, using stereo and axial fibers combined, with good efficiency. We are working to improve our offline tracking and vertexing algorithms and alignment, and to move the operation of the fiber tracker readout to a mode where experts are no longer needed. The preshower detectors are still being commissioned and the roman pots need to be integrated into data taking.

Data are being written to tape at the design rate (up to 50 Hz). The offline reconstruction farm is processing all data with a latency of about one week. Physics and reconstruction software is being refined. The tape robot data storage system and the SAM data access system are performing well.

Trigger and DAQ

DØ is now operating, as planned, with a three-level trigger system.

Level 1 *(nominal output rate ~ 5kHz)*

We are selecting events based on calorimeter energy deposition and on muon detector hits. The calorimeter trigger energy scale is being adjusted to the correct settings based on data we have taken so far, and the trigger is being extended to the end calorimeters, during the June shutdown.

The major missing component at Level 1 is the fiber track trigger (CTT). Until the CTT is operational, the major impact is that the single inclusive muon trigger must be prescaled, since the fiber tracker provides the trigger-level muon p_T threshold. (Because the rate is much lower, we can run an unprescaled dimuon trigger). The CTT trigger hardware and connections are all installed. Firmware programming is making good progress (~90% complete). By the end of June we anticipate being able to generate L1 muon and L1 track triggers. We will then commission by comparing the L1 muon trigger patterns with offline muons, and similarly for the L1 track patterns and offline tracks. Commissioning of pathways to the L2 silicon track trigger is also proceeding. Though the hardware is all in place, we have decided that commissioning the preshower triggers will wait until the tracking triggers are operational.

Level 2 *(nominal input rate ~ 5kHz; nominal output rate ~ 1kHz)*

The L2muon and L2Global alpha processors are running, and rejecting events. L2Cal has been approved for rejection, and will be doing so as soon as beam comes back after the shutdown.

With the current number of L2 alpha processors, our L1 accept rate can reach 2kHz, though some fine tuning is going to be required over the summer to solve known alpha problems around ~ 1 kHz.

The replacement cpu ("L2Beta") prototypes have passed their functional tests and we have finalized the modifications needed for pre-production boards which will be tested later this summer. The L2beta system will allow us to reach 5kHz.

The Silicon Track Trigger will be commissioned during the fall of 2002.

Level 3 *(nominal input rate ~ 1kHz; nominal output rate ~ 50Hz to tape)*

A 48-node Level 3 linux farm is installed and rejecting events. We are selecting electrons, muons and jets. The track-finding code is installed and being certified for rejection. Additional farm nodes will be added over the summer.

DAQ

At the end of 2001, we made a decision to convert from the custom designed Run 2a baseline DAQ system to an entirely new system. The new system uses commercial components: single board computers (SBC's) in the VME crates, read out over ethernet using Cisco switches. A strong team has made rapid progress specifying the system, procuring and installing the hardware, and implementing the necessary control software. We switched to new data-flow control software at the end of March, and it has been running stably since then. The new software allowed an adiabatic changeover of VME crates to the SBC readout. As of June 4th, all of the readout crates have been converted to SBC's, which is six weeks ahead of schedule.

For the past two months, the partially upgraded system has boosted our Level 2 accept rate to ~ 100 Hz. (This is 1/10 of the design value, but this has not been a severe handicap, since the luminosity has been ~ 1/20 of its design value). Rate tests with the components of the new system have demonstrated that all individual components can be read out at the design rate of 1 kHz. Coming out of the June shutdown with all the hardware installed, we will start to ramp up the Level 2 accept rate to this level, and commission the readout for high rate operation (this requires some firmware upgrades to readout crates that have not so far been run at such high rates).

The successful design, procurement, and implementation of this new DAQ system is a very significant achievement, and we particularly acknowledge the strong support of the Fermilab Computing Division in this project.

Summary of Trigger and DAQ

- The DØ Trigger and readout has made great progress over the last six months. Level 2 is now rejecting events. We have installed a completely new DAQ system during this period: all hardware is now in place, the major rate limitations are now removed and it is a matter of commissioning high rate readout.

- The significant missing component of the system is the CTT trigger. Until this is online, the biggest physics impact is the high bandwidth at L1 that is needed for a single inclusive muon trigger (which meant we had to prescale it while the DAQ rate was limited). It also limits our ability to trigger on isolated charged tracks (taus for example).

Data Analysis

We are on the road to physics. About $24 pb^{-1}$ has been delivered to DØ in 2002, with roughly $10 pb^{-1}$ of recorded physics runs. The first Ph.D. students to use Run 2 data have recently defended their theses. A wide variety of progress reports were shown at the recent DPF meeting. As an illustration of some recent analysis progress, figure 1 presents a variety of results from the full global tracking system (silicon, fiber tracker and muon system). Figure 2 shows the E/p ratio for the electron calorimeter cluster and the corresponding reconstructed track, in $W \rightarrow e\nu$ decays. Figure 3 shows the number of events as a function of jet multiplicity *n*, for $Z(\rightarrow \mu\mu) + n$ jet events. Figure 4 shows impact parameter signals for b-jet production using the silicon detector.

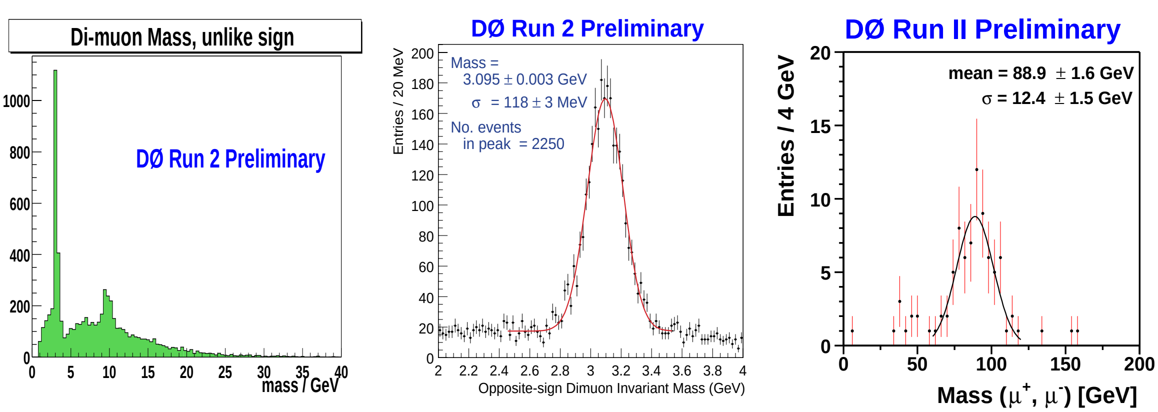

Figure 1. Invariant mass distributions for opposite sign dimuon samples obtained using globally reconstructed tracks (silicon, axial plus stereo fiber tracker, and muon system). The psi, upsilon and Z signals are clearly visible.

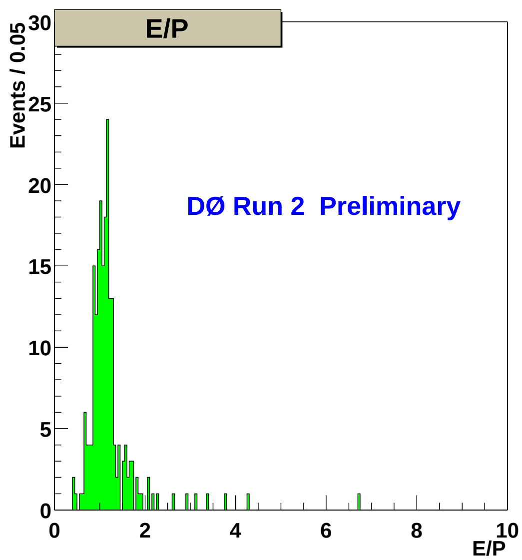

Figure 2. E/p ratio in W → eν sample.

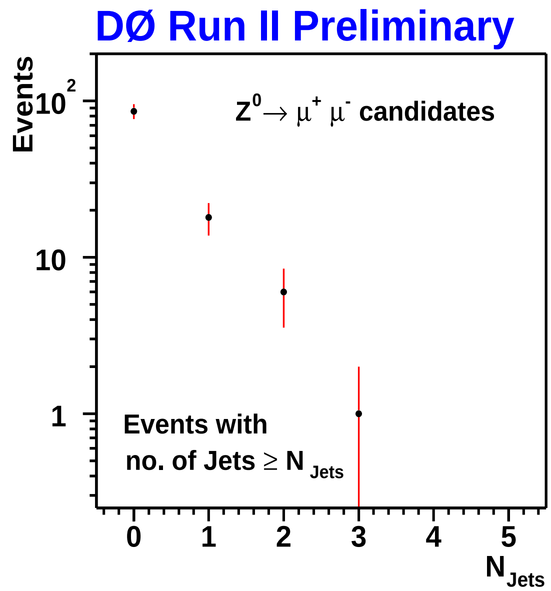

Figure 3. Number of vector boson + jet events, as a function of jet multiplicity, for Z → μμ signal.

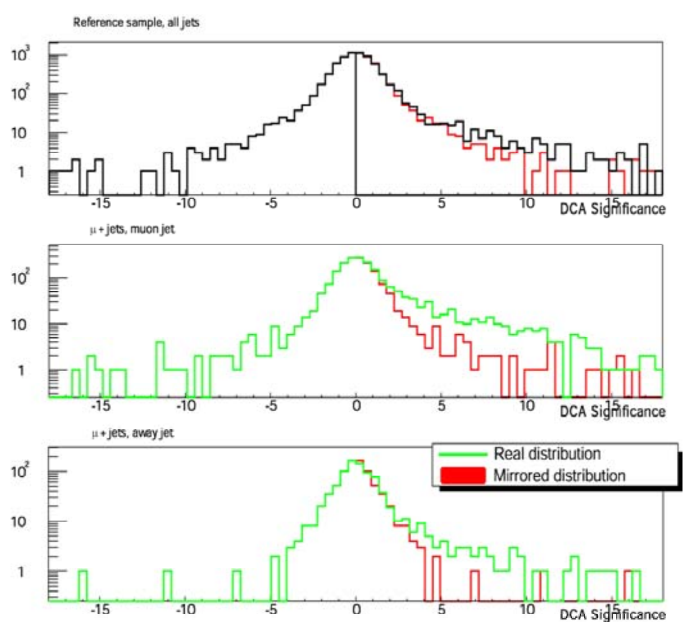

Figure 4. Impact parameter significance distributions from Run 2 data. The upper plot is a reference sample of unbiased jets; the center plot shows a b-enhanced sample (muon tagged jets); the bottom plot shows the away-side jets in the muon tagged sample (expected to have an intermediate b content).

Conclusion

There is still work to be done on commissioning the fiber tracker trigger, but all the hardware is in place. The new DAQ system is fully installed, six weeks ahead of schedule and only six months since the decision was made to implement it. With this system, our DAQ rate bottlenecks are eliminated. While it will take some time yet to ramp up the readout rate and to bring the fiber trigger into physics operation, DØ is ready now to take significantly higher luminosities than have so far been delivered, and our ramp-up will keep us ahead of the accelerator.