The Level-2 Forward-Muon Trigger at the DØ Experiment

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The trigger system of the DØ experiment at the $p\bar{p}$-Collider TeVatron [1] consists of three successive levels of rejection. The second level, the Level 2 trigger [2,3], is the first level that forms trigger decisions based upon physics objects. It incorporates information from *all* detector systems. This trigger level is designed to reduce the incoming event rate of up to 10 kHz by a factor of 10, before a further rejection in the third trigger level takes place in order to reduce the event rate to a level that can be recorded.

The muon section of the Level 2 trigger is made of two parts: First, the tracking algorithms form *muon candidates* from hit patterns in the muon detectors (see figure 1) for the layers A and B+C separately. Then these candidates from the different layers, before and after the muon toroid, are matched to L2-muon objects in order to measure the momentum of the muons. In a third not yet existing part, information from other detectors (e.g. the central tracking system) will be added to those muon objects.

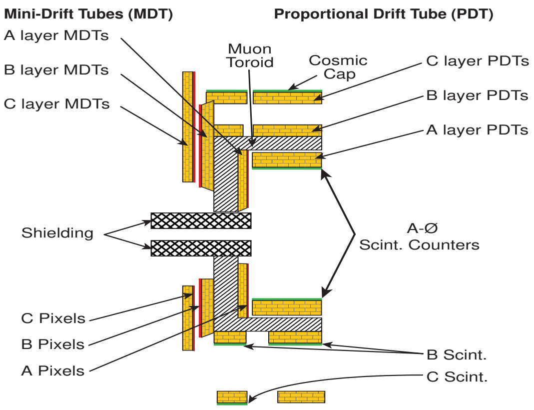

Fig. 1: The end-cap region of the DØ muon detectors as seen from the side. In the forward system, layer A (B,C) itself consists of 4 (3) successive planes of drift tubes and one additional plane of plastic scintillators.

In the forward system, the tracking algorithms search for *valid hit patterns* in the drift tubes (without using drift time information) and scintillator counters for the three layers of muon detectors separately (see Mini-Drift Tubes and Pixel Counters in fig. 1). Combining these patterns from the three layers A, B and C, the direction, charge and momentum of the muons can be obtained by measuring their deflection within the magnetised toroid (~1.9 T) between the layers A and B.

Figure 2 shows the deflection of simulated muons in the magnetic field as measured by the L2 forward-muon tracking: The red triangles denote muons that are bent outwards (these are muons in the north-forward region of the detector and anti-muons in south); the green circles are bent inwards, i.e. into the direction of the beam pipe. Figure 2 shows that the Level 2 muon trigger is able to measure muon momenta. The momentum resolution even improves when adding the direction to the calculation of the transverse momentum, mostly because the *transverse* momentum $P_t = |\vec{p}| \cdot \sin\theta$ (θ denotes the angle between the muon direction and the beam pipe) depends on the muon direction and because muons with smaller angles θ penetrate less material of the magnetised toroid.

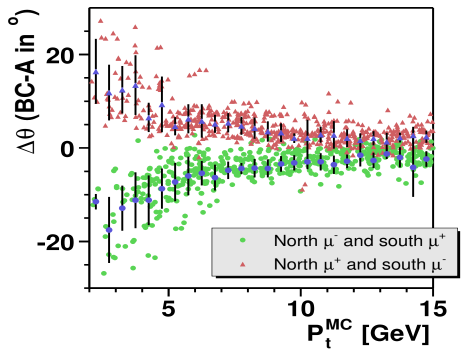

Fig. 2: Deflection of Monte Carlo muons in the forward toroid as seen by the Level 2 tracking versus transverse momentum.

The rejection and efficiency of the Level 2 muon trigger can be seen in figure 3: the left plot, which is the distribution of the number of L2-μ objects (i.e. ABC matches with momentum information, or unmatched A(BC)-only candidates), indicates, that L2 rejects about 40% of L1-single-muon triggered[1] events. On the right one can see that the L2-muon trigger detects muons in more than 99% of the events for which the DØ offline analysis reconstructs 'medium' and/or 'tight' muons. In order to reach the planned rejection factor of 10, the measured muon momentum will be used in global L2 decisions.

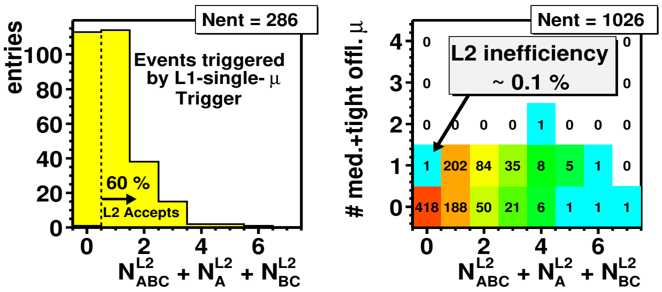

Fig. 3: Left: the number of muon objects as found by the Level 2 muon triggers for all events that were triggered by the L1 all-η-single-μ trigger, a trigger based on scintillator coincidences in 2 of the 3 layers. Right: the number of offline-reconstructed muons versus the number of L2 muon-objects. There is only 1 event with an offline muon that was not found by Level 2.

References

[1] R. Ströhmer, T. Christiansen, D. Schaile and T. Trefzger, this report, p.43
[2] T. Christiansen, D. Schaile, R. Ströhmer and T. Trefzger, Annual report 2000, p. 34
[3] The DØ Collaboration, S. Abachi *et al.*, The DØ Upgrade: Forward Preshower, Muon System and Level 2 Trigger, Fermilab-FN-641 DØ, 1996

[1]The Level 1 muon triggers are based on scintillator coincidences. They do not use any signals from the drift tubes.