Level 2 Trigger for the Muon Spectrometer in the Forward Region of the DØ Detector at the $p\bar{p}$-Collider TeVatron

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DØ is one of the two experiments at the $p\bar{p}$ collider TeVatron at the Fermi National Accelerator Laboratory near Chicago. After an upgrade, the storage ring with a circumference of 6.3 km produces collisions of protons and anti-protons within the detectors at a centre-of-mass energy of 2 TeV starting in March 2001. Until 2003, DØ is expected to have recorded an integrated luminosity of 2 fb^{-1}.

As opposed to physics at lepton colliders such as LEP, $p\bar{p}$ collisions have a large hadronic background mainly from unwanted processes from spectator quarks and hadronic reactions from simultaneous collisions of other $p\bar{p}$ pairs within the same bunch crossing. This results in a huge hadronic multiplicity lying over the interesting physics events. As a result, the detection and identification of leptons become even more important. Furthermore, high energetic electrons and muons are an indication of interesting physics and therefore play a major role in the trigger system [1].

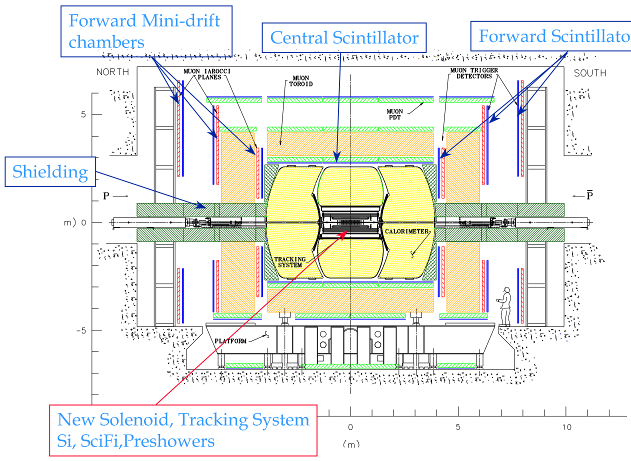

Fig. 1: The DØ detector as seen from the side.

The DØ detector [2] (see figure 1), which has also been substantially upgraded, was given a new muon spectrometer for the forward region ($1 \leq |\eta| \leq 2$) consisting of three super-layers of drift tubes and scintillator pixels. Each of the three layers is made of multiple planes of muon tubes (four planes in the first, three in the second and third super-layer) and an additional plane of plastic scintillators. A azimuthal magnetic field of about 1.9 T in the iron yoke between the first two layers allows the measurement of the momentum of the transversing muons deflected in the magnetic field.

In the level 2 trigger, muon tracks are reconstructed using the binary hit information of the drift tubes and the scintillator pixels in order to estimate the momenta and the directions of the muons. This information is used in the global level 2 trigger decision and it is passed to the level 3 trigger system. The reconstruction has to be accomplished at an event rate of the order of 10 kHz.

Hits in the drift tubes within each layer are combined to tracks by comparing them to look-up tables containing possible hit combinations as seen in studies of Monte Carlo simulated events.

The association with the hit in the plane of scintillator pixels, installed before each of the three layers, provides the azimuthal information ϕ and a correction of angle θ between the direction of the reconstructed track and the beam pipe. Using another set of look-up tables, the track candidates in the second plane are associated to those of the third plane taking into account both the position and the slope of the hit sequence in both layers.

A difference of the directions of the muon tracks as measured by the first plane with the additional constraint of the muon coming from the interaction region and the direction measured in the second and third layer is sensitive to the momentum of the muon. Figure 2 shows the difference of the slopes of the muon tracks before and after the magnet versus the muon momentum as simulated by Monte Carlo. Figure 2 clearly shows that the algorithm allows a discrimination of muon momenta. From timing studies on emulated processor boards [2] one concludes that the algorithm can also cope with the anticipated event rate.

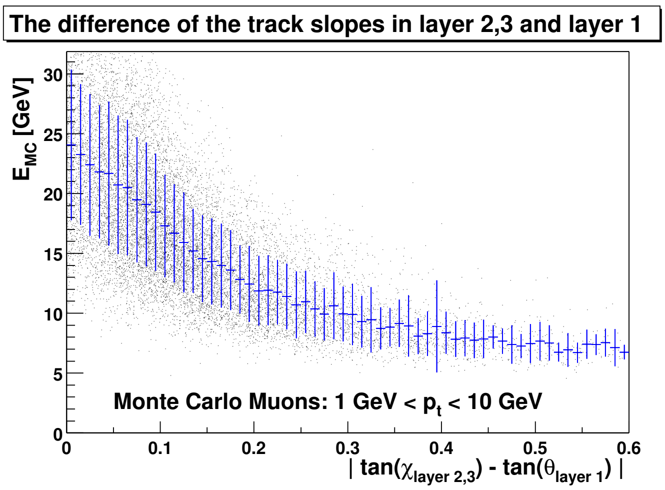

Fig. 2: The difference of the slopes of the muon tracks $|tan(\chi_{\mathrm{layer2,3}}) - tan(\theta_{\mathrm{layer1}})|$ as measured in the first and the other two super-layers as a function of the Monte Carlo momentum. $\chi_{\mathrm{layer2,3}}$ is the slope of the track as measured by the second and third layer while θ_{layer1} is defined by the position of the track in the first layer and the vertex.

References

[1] The DØ Collaboration, S. Abachi et al., *The DØ Upgrade: Forward Preshower, Muon System and Level 2 Trigger*, Fermilab-FN-641 DØ, 1996

[2] The DØ Collaboration, S. Abachi et al., *The DØ Upgrade: The Detector and its Physics*, Fermilab Pub-96/357-E, 1996