Status of the Level-2 Muon Trigger at the DØ Experiment

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1. The DØ Detector and Trigger System

The DØ experiment [1] measures $p\overline{p}$ collisions at 1.96 TeV at the Fermilab TeVatron. The physics programme includes measurements of the strong and electroweak interactions, bottom and top production, and searches for the Higgs boson and physics beyond the Standard Model.

The inner part of the detector consists of a silicon microvertex detector and a scintillating fiber tracker and is located inside a 2 T solenoid. The tracking detectors are surrounded by preshower detectors and the calorimeter, followed by muon chambers before and after a toroidal magnetic field, which is used for standalone momentum determination.

The trigger scheme for the upgraded DØ detector is divided into three levels. The Level-2 trigger (L2) first checks the Level-1 decision, currently formed from calorimeter and muon information at $\mathcal{O}(1\,\mathrm{kHz})$. It then also forms correlations between signals in different detector components and reduces the event rate by a factor of ~ 2. Level-3 uses full event reconstruction to reduce the rate to $\mathcal{O}(50\,\mathrm{Hz})$.

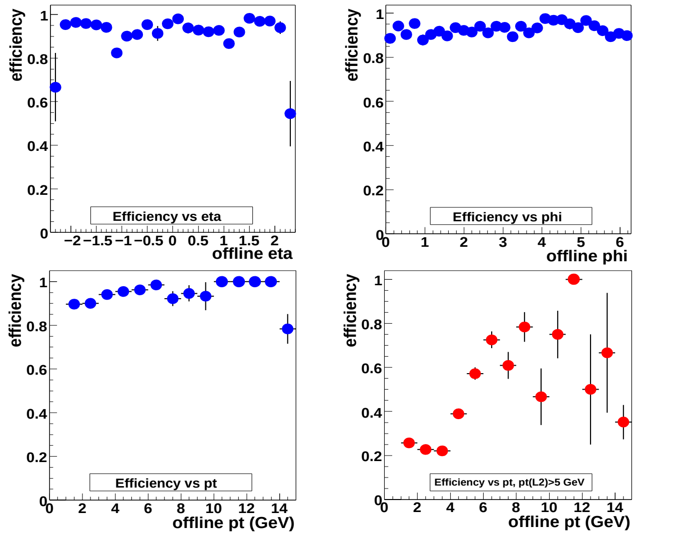

Fig. 2: The Level-2 muon efficiency without p_t cut at Level-2 for Level-1 triggered, offline reconstructed muons as a function of (a) pseudorapidity, (b) azimuthal angle, and (c) transverse momentum. In (d), the efficiency with a $p_t > 5\,\mathrm{GeV}$ cut at Level-2 is shown.

2. The Level-2 Muon Trigger Performance

The Level-2 muon trigger [2] reconstructs muon tracks in the three layers of muon detectors before and after the toroid. The deflection angle in the toroid is a measure of the muon momentum.

The momentum measurement is limited by the muon chamber resolution, see figure 1. Still, where rate reduction is more important than efficiency, a $p_t > 5\,\mathrm{GeV}$ cut can be applied at Level-2 to optimize the event yield.

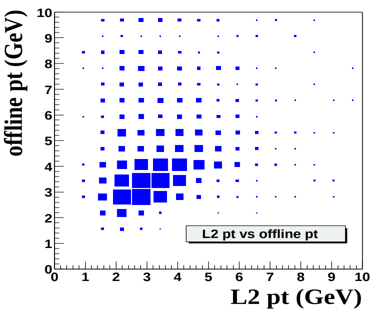

Fig. 1: The correlation between the transverse momentum p_t relative to the beam axis as obtained in the standalone muon reconstruction at Level-2 and the measurement obtained from the tracking detectors in the offline reconstruction.

The overall Level-2 muon efficiency without p_t cut at Level-2 is 93%, cf. figure 2. The actual value is larger due to small impurities in the base sample. For a single muon trigger at Level-1, the rate reduction factor is 2.6 (7.7) without Level-2 p_t cut (requiring $p_t > 5\,\mathrm{GeV}$).

3. Complementary Triggers at Level-2

The ability to form event-wide correlations at Level-2 allows a comparison of the azimuthal angles of the leading calorimeter jets. A small opening angle may indicate the presence of an energetic muon or neutrino.

This signature is useful to monitor the Level-2 muon trigger, and as a trigger e.g. for leptoquark searches in the $\mathrm{LQ}\,\overline{\mathrm{LQ}} \to (\mathrm{q}\nu)(\overline{\mathrm{q}}\nu)$ channel or for $\mathrm{t}\overline{\mathrm{t}} \to (\mathrm{b}\mu\nu)(\overline{\mathrm{b}}\tau\nu)$ events. With the trigger indicated in figure 3, a rate reduction factor of 6.5 is obtained at Level-2 at an efficiency of above 80 % for pair production of leptoquarks of 160 GeV mass.

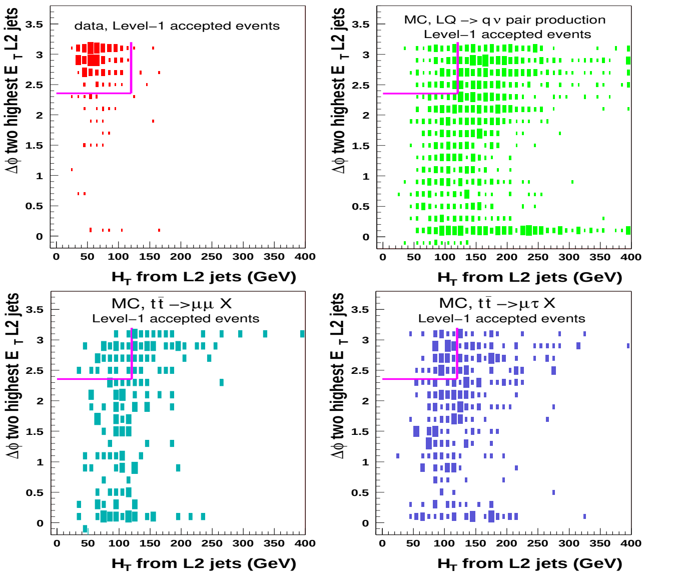

Fig. 3: The ϕ difference of the two highest-E_t jets vs. the total calorimetric transverse energy, H_t, at Level-2 for data (upper left histogram), leptoquark production (upper right), and $\mathrm{t}\overline{\mathrm{t}}$ dilepton events (lower histograms). Events in the upper left corner, indicated by the line, are rejected by the trigger.

References

[1] R. Ströhmer, T. Christiansen, D. Schaile, and T. Trefzger, Annual report 2001, p. 43

[2] T. Christiansen, D. Schaile, R. Ströhmer, and T. Trefzger, Annual report 2001, p. 44