DØ Triggering at High Luminosity

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The DØ Run2b Trigger

Detector (2 MHz)
- Calorimeter
- Pre-shower
- Central Fiber Tracker (CFT)
- Silicon Micro-strip Tracker (SMT)
- Muon

Level 1 (2 kHz)
- L1Cal
- L1PS
- L1CTT
- L1Mu

Level 2 (1 kHz)
- L2Cal
- L2PS
- L2CTT
- L2STT
- L2Mu

Level 3 (250 Hz)
Fast event reconstruction on 300 node PC farm

L2 Global
Trigger Strategy

- **Object oriented**
  - Muons, electrons, taus, jets, MET,…
  - General purpose triggers shared among physics groups, each group gets their “fair share” of the bandwidth
  - High efficiency and redundancy
    - Various combinations of tight and loose conditions
  - Keep High pT “core” triggers unprescaled at all luminosities
    - Some B physics triggers prescaled at high luminosity

- **Rate “guidelines”**
  - Keep L1/L2/L3 rates below their technically allowed values with room to spare
    - L1/L2 < 1800/850 Hz
    - Rate to tape kept at a store average value of 100 Hz (up to 250 Hz at high instantaneous luminosities).
Trigger Status

- Current trigger list (v16) went online in March 2008
  - Meets L1/L2 rate guidelines up to 360E30 with excellent
data taking and physics efficiency - core triggers remain
unprescaled.
  - Rate to tape is above spec for stores starting above
300E30, but well within the data acquisition limit.
  - This is presently an issue as events taken at high
luminosity take longer to reconstruct offline. We are
working on ways to alleviate this
    - Working from both sides: streamlining triggers and
increasing reconstruction resources
A high luminosity store
Data taking efficiency at high luminosity

<table>
<thead>
<tr>
<th>Store</th>
<th>Run number</th>
<th>Initial lumi</th>
<th>efficiency</th>
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<tr>
<td>6625</td>
<td>247857</td>
<td>342E30</td>
<td>92%</td>
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<tr>
<td>6683</td>
<td>248345</td>
<td>338E30</td>
<td>92%</td>
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<td>6715</td>
<td>248672</td>
<td>330E30</td>
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<tr>
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<td>249732</td>
<td>321E30</td>
<td>79%</td>
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<td>338E30</td>
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<td>249901</td>
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</tr>
<tr>
<td>6917</td>
<td>250496</td>
<td>328E30</td>
<td>92%</td>
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</table>

- No drop in efficiency at high luminosity
- Run 249732 had a hardware failure
Triggering above 360E30
Triggers with the highest rates

single electron

multi jet
Some loose triggers are taking off

loose dimuon
Plans for 400E30

- The L1/L2 rates for the core triggers are stable and these can remain unprescaled.

- The L1/L2 rates of several looser versions of core triggers will increase substantially above 370E30. These triggers will be prescaled above this luminosity as needed to keep within the rate limits.

  - This will have a very small effect on the overall efficiency of the trigger list, but the overall trigger efficiency will be a bit more sensitive to hardware failures.
Backup Slides
Level 1 trigger system

- Central Track Trigger (CTT) uses axial layers of the Central Fiber Tracker
  - provides track terms in 4 pT bins, isolation terms, and sends track lists to L1 cal and L1 muon
- Calorimeter
  - coarse 0.2 x 0.2 eta-phi towers
  - Cal-CTT match (L1 tau trigger now!)
- Muon
  - Scintillator and wire hits
  - Muon-CTT match
- No silicon
- Pass rate of 2 kHz set by silicon digitization (no extra event buffer) and muon readout
Level 2 trigger system

- Silicon track trigger
  - Better track pT resolution
  - Primary vertex finding
  - Track impact parameter significance terms
- L1 Muon and Calorimeter (jet and electron) objects are refined
- Global variables allowing combinations of objects
- Provides a factor of 2 rejection to get to output rate limit of 1 kHz, set by precision calorimeter readout
Level 3 trigger system

- Software triggers run on a 300 node pc farm
- Provides fast reconstruction of the event - all physics objects
  - Muons,
  - Electrons,
  - Jets,
  - Tracks,
  - Taus,
  - MET,
  - Isolation,
  - Vertexing,
  - B-tagging,
  - Isolation,
  - Invariant mass,
  - And any combination of the above