CDF Run II Muon Trigger Project

Eric James
U. of Michigan
Run II Muon Level 1 Trigger

COT Signals → XFT → XTRP →
CMU/CMX Chamber Signals →
Hadron Calorimeter Signals →
CSX Scintillator Signals →
BMU Chamber Signals →
BMS,TMS Scintillator Signals →
CSP Scintillator Signals →

Projective Wire Timing → Signal Gating →
Muon Matchbox Card →
L1 Trigger Bits →
2.5 deg Matches →
L2 Trigger Data →
1.25 deg Bins →
DAQ Output Inputs & Matches →

BMS,TMS Scintillator Signals →
CSP Scintillator Signals →
Muon Matchbox Card →
Pattern Finding →
CMP Chamber Signals →
Muon Trigger Front-End Hardware

A. Delta-T Mezzanine Card

CMU, CMX, BMU

Performs a differential timing measurement for projective wire pairs.

Three momentum thresholds are applied to observed coincidences:

- High Pt : 8ns -> 132ns (programmable)
- Medium Pt : 8ns -> 396ns (programmable)
- Low Pt : 396ns (fixed)

B. CMP Mezzanine Card

Pattern Finding in four layers of drift tubes.

Programmable for hits in 2/4 or 3/4 layers.
Muon Trigger Front-End Hardware

C. Scintillator Mezzanine Card

CSP, CSX, BSU, TSU, WSU, HAD

Accepts signals within a programmable window of the CDF crossing clock.

Front and back edges of the gate are programmable in 7.5ns steps.

D. HOTLink/Optical Transition Module

Transmits trigger primitive data formed on TDC mezzanine card to the muon trigger crate over up to six optical fiber serial connections.
Muon Trigger Crate Hardware

A. Muon Matchbox Card

Performs track matching to muon stubs over an entire 30 degree azimuthal wedge of the detector.

Processes 740 bits of input data and produces up to 30 L1 trigger bits each 132ns crossing interval.

B. Muon Pre-Match Card

Matches CMP and CSP primitives in their natural rectangular geometry.

Converts matches into azimuthal map for track matching at Matchbox card.

C. Muon Trigger Summation Card (MTSC)

Combines trigger bits from each 30 degree Matchbox card to form final muon trigger bits.
<table>
<thead>
<tr>
<th>Card Type</th>
<th>Boards Required</th>
<th>Conceptual Design</th>
<th>Schematic Entry</th>
<th>Board Layout</th>
<th>Prototype Assembly</th>
<th>Prototype Testing</th>
<th>Production Run</th>
<th>Board Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TDC Mezzanine Cards</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delta-T Mezz. Card</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMP Mezz. Card</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scintillator Mezz. Card</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight-Thru Mezz. Card</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VME Transition Cards</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOTLink Tran. Card</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matchbox Tran. Card</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>J3 Crate Backplanes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDC J3 Backplane</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matchbox J3 Backplane</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full-Size VME Cards</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matchbox Card</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Match Card</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summation Card</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VME Pulser Card</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matchbox Testcard</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Muon Trigger Organization in $\eta$

- CMU
- CMP/CSP
- IMU
- Central
- CMX
- Map #1
- Extension
- CSX
- Map #2
- XTRP
- Map #3
- WMS
- IMU
- 1.0 < $|\eta|$ < 1.2
- BMS(F)
- IMU
- $|\eta|$ > 1.2
- BMU
- TMS
- SPARE
Muon Trigger Bits

Each 30 degree Matchbox Card

- 52 bits of L1 match data from eight eta regions of trigger
- 18 bits via dedicated lines on J3 backplane
- 12 bits via bussed, open-collector lines on J2 backplane

Muon Trigger Summation Card

- 216 bits via dedicated lines on J3 backplane
- 12 bits via bussed, open-collector lines on J2 backplane
- 20 (40) bits to Pre-FRED
L2 Muon Trigger

All primitive and trigger data available at L1 is passed into the L2 Muon Interface Card via optical fiber serial connections from each Matchbox and Pre-Match Card (16 total).

Prior to the beginning of event processing, the L2 processor boards will receive a set of flag bits from the interface card which mark the locations of non-zero muon data for the given event.

The L2 processor will retrieve this information as necessary during event processing.

The full azimuthal resolution of the muon chamber trigger primitives (1.25 degrees) will utilized in L2 processing.
Project Status

Testing of front-end trigger hardware is nearing completion, and full production quantities of these boards should be available for installation along with TDC modules this summer.

Matchbox card prototype is due from assembly house in mid-March with testing at Michigan to continue through the beginning of the summer.

Integration testing of muon trigger crate hardware is planned for B0 during June and July.

Production of muon trigger crate hardware will take place in the fall. Installation should be complete in time for November cosmic running.