Current Status of ATLAS Endcap Muon Trigger System

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Introduction

ATLAS Detector

- General purpose detector for LHC
  - Length: 44m
  - Diameter: 25m
  - Weight: 7000t

- Data taking will be started from September 07.
3 level trigger system

1. **LVL1** decision based on data from calorimeters and muon trigger chambers; synchronous at 40 MHz; bunch crossing identification (BCID)

2. **LVL2** uses Regions of Interest (identified by LVL1) data (ca. 2%) with full granularity from all detectors

3. **Event Filter** has access to full event and can perform more refined event reconstruction
Level1 Muon Trigger System

- **TGC provides**
  - Bunch ID
  - muon hit position
  - Pt of muon
    - EC toroidal magnet
    - 2 station coinc. → low Pt trigger (>6 GeV)
    - 3 station coinc. → high Pt trigger (>20 GeV)
Thin Gap Chamber

Performance requirements

① Detection efficiency > 99% → Trigger
② Signal response time ~ 25nsec → BC ID
③ Stable operation for more than 10 years under high rate environment (~kHz/cm²)
④ Radiation Tolerance (~0.6C/cm)

Structure of TGC

- Similar to MWPC
  - Wire: 50μm gold-plated W
  - Anode-Cathode Gap: 1.4mm
  - Wire-Wire Gap: 1.8mm
  - 2-dimensional readout (wire, strip)
  - Cathode plane: carbon (~MΩ/cm²)
  - Trapezoidal shape (~2m²)

- Operation condition
  - Gas: CO₂ + n-Pentane (55:45)
  - High Voltage: +3.0kV
  - Operation Mode: Limited Proportional
  - Gas Gain: ~10⁶
Mass production of chambers

- Total: 3,600 chambers (11 types)
  - Produced in Japan, Israel and China.
  - Total channel: ~320,000 channels
  - Covered area: ~2,700m²

Japanese contribution

- Total: 3 types, 1,224 chambers (inc. spare)
- Period: Apr. 2001~Feb. 2005 (48 months)
- Site: KEK (Fuji experimental hall)
Inspection of TGC

- Chamber performance test in Japan
  - Test Stand at Kobe University
    - Period: May 2001 ~ July 2005 (40 months)
  - Check following items using cosmic ray
    - Detection efficiency (5mm x 5mm)
    - Timing distribution
  - Result for Japanese chambers
    - 12 chambers with locally inefficient region.
      - Not transported to CERN
  - Transportation from Kobe to CERN by ship
    - All good chambers were already transport to CERN
TGC Electronics Modules made in Japan

On TGC chambers

- TGC1
- TGC2
- TGC3
- ASD

Big Wheel edge

- HSC(VME) (Big Wheel edge)
- H-Pt wire
- H-Pt strip

Service PP
- TTC signal fanout to PS-Boards

Triplet
- DCS-PP

H-Pt
- SSW Board
- SLB
- PP

ASD card

H-Pt Board

HSC Board

PS Board

Trigger Control

DCS: Detector Control System
Assembly and Installation of TGC
TGC consists of three wheels
- We call this “Big Wheels” (BW)
  - Triplet (TGC1)
  - middle doublet (TGC2)
  - pivot doublet (TGC3)
- located at each end-cap (A-side and C-side)

Each BW consists of 12 sectors
- TGC1: 18 triplet modules/sector
- TGC2,3: 22 doublet modules/sector
  \[ \Rightarrow 1488 \text{ modules in total.} \]
Two Working Areas @ CERN

Site de Meyrin

Storage of 1/12 sector

ATLAS pit
1. Chamber preparation before installation
   - Check gas tightness of chamber
2. Assembly in horizontal position
   - Assembly of Al frame for sector
   - Arrangement of cables (signal and LV/HV)
   - Arrangement of gas pipe
Sector Assembly Procedure (cont)

3. Assembly in vertical position
   - Chamber installation

4. Install on-detector electronics

5. Test of sector
   - Check cabling and electronics health
     - Send test pulse to ASD card
   - Apply high voltage to chambers with CO$_2$ gas flow
   - Test with RI source & cosmic ray
Test Result

- We have checked cabling before installation
  - 12 x TGC1 sectors and 12 x TGC2 ones were tested.
    - TGC3 is tested now.
  - Have found some problems and fixed them.
    - insufficient connection
    - cable swapping
    - broken cables
    - electronics failure
    - dead channels on chamber

- Delay scan method
  - To confirm timing adjustment functionality
  - Take data with changing test pulse delay values with accuracy of sub-nano second

- In TGC1 test, all electronics channels (~30k channels) were checked.
  - Only five channels on chambers were found to be dead (0.017%).
Assembly work is performed in parallel on 2 sites at assembly site.

- We have already tested 12 x M1-C sectors and 12 x M2-C ones.
- Now we are assembling M3-C
  - 4 sectors were already installed.
- M1-A will be assembled from this November using 3rd site.

1 sector/week
### Installation to ATLAS pit

#### Schedule

<table>
<thead>
<tr>
<th>Side</th>
<th>Station</th>
<th>Assembly</th>
<th>Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-side</td>
<td>TGC1</td>
<td>Done</td>
<td>Done</td>
</tr>
<tr>
<td></td>
<td>TGC2</td>
<td>Done</td>
<td>Jan.07 -</td>
</tr>
<tr>
<td></td>
<td>TGC3</td>
<td>In progress</td>
<td>Feb.07 -</td>
</tr>
<tr>
<td>A-side</td>
<td></td>
<td>Nov.06 -</td>
<td>Jan.07 -</td>
</tr>
</tbody>
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- **Transport to the pit**
- **Lower down to the pit**
- **Built up to a BW**
Current Status @ pit

- Assembly and installation of C-side TGC is in progress
  - 1st BW has been fully installed in the pit
  - 2nd BW is ready for installation
    - Stocked in assembly site
- Services to be performed in the pit
  - Check distortion of BW
  - Check electronics and DCS
  - Gas, LV/HV and optical fiber
- Installation of A-side TGC will be started from Jan. 07
Future test programs foreseen in the pit
Preparation for the beam collision

- **Timing adjustment**
  - TGC must make level1 trigger decision at each 40MHz bunch.

- **Strategy**
  1. Before beam collision
     - Timing adjustment is synchronized to 40MHz clock
  2. After beam collision
     - Adjust phase between bunch crossing timing and L1A signal.

- **Pre-run**
  - Cosmic run
  - Single beam halo run
    - provide trigger signal
    - need special configuration (1 station coincidence)
Summary & Plan

Thin Gap Chamber
- Used as ATLAS Level1 endcap muon trigger chamber
- Almost chambers were produced and tested their performance.

Assembly and Installation
- TGC modules are assembled to 1/12 sectors.
  - TGC1 and TGC2 for side-C have been assembled.
  - TGC3 are assembled now.
  - TGC1 for side-A will start to be assembled from this November.
- The first Big Wheel station (TGC1) was installed on this September.
  - TGC2 will be installed in Jan. 07.

Sector Test
- To check on-detector electronics and cabling.
- TGC1 and TGC2 for side-C have been checked.
- We continue sector tests for remaining sectors in cooperation with sector assembly.

Future Plan
- We will start full big wheels test from Mar.07
  - Timing adjustment
  - Cosmic & beam halo run

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Result for RI source & cosmic ray test

- **RI source test**
  - 1MBq $^{60}$CO was used.
  - CO$_2$ flow, 2.8kV?
  - Only very few hot channel was found.

- **Cosmic ray test**
  - Random trigger
    - 100kHz clock
**Procedure**

1. Set test pulse delays properly.
2. Confirm necessary signal delay values by checking test pulse data timing adjustment is synchronized to 40MHz clock.
After beam collision

**Procedure**

1. Take data with changing TTC clock skew.
2. Confirm signal delays with synchronized to beam collision by checking data.