Current Status of ATLAS Endcap Muon Trigger System

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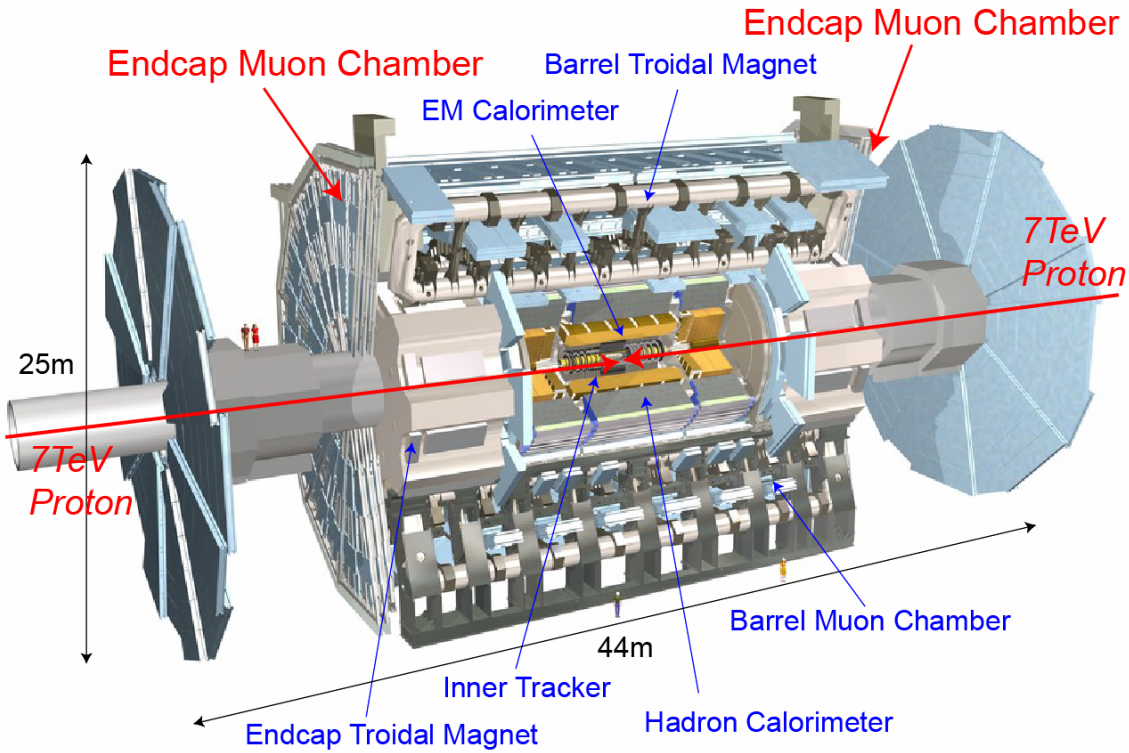
On behalf of ATLAS Japan TGC Group

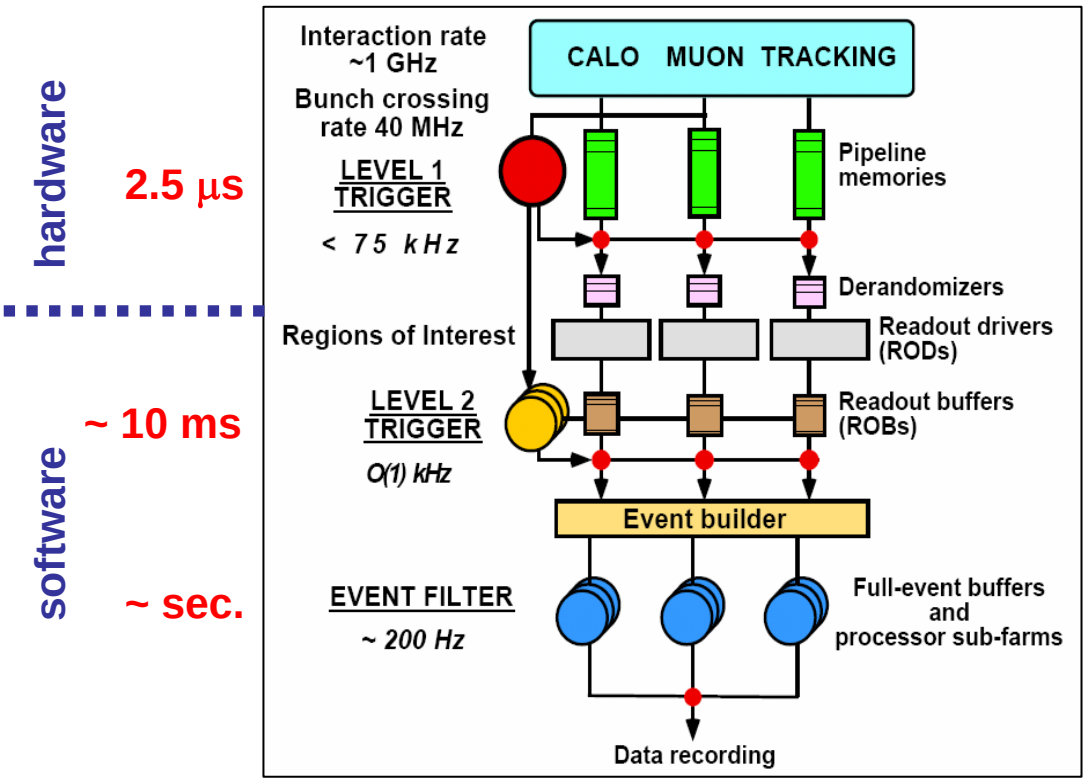
Contents

Introduction

- ATLAS Detector
  - General purpose detector for LHC
    - Length:44m
    - Diameter:25m
    - Weight: 7000t
  - Data taking will be started from September 07.



ATLAS Trigger System

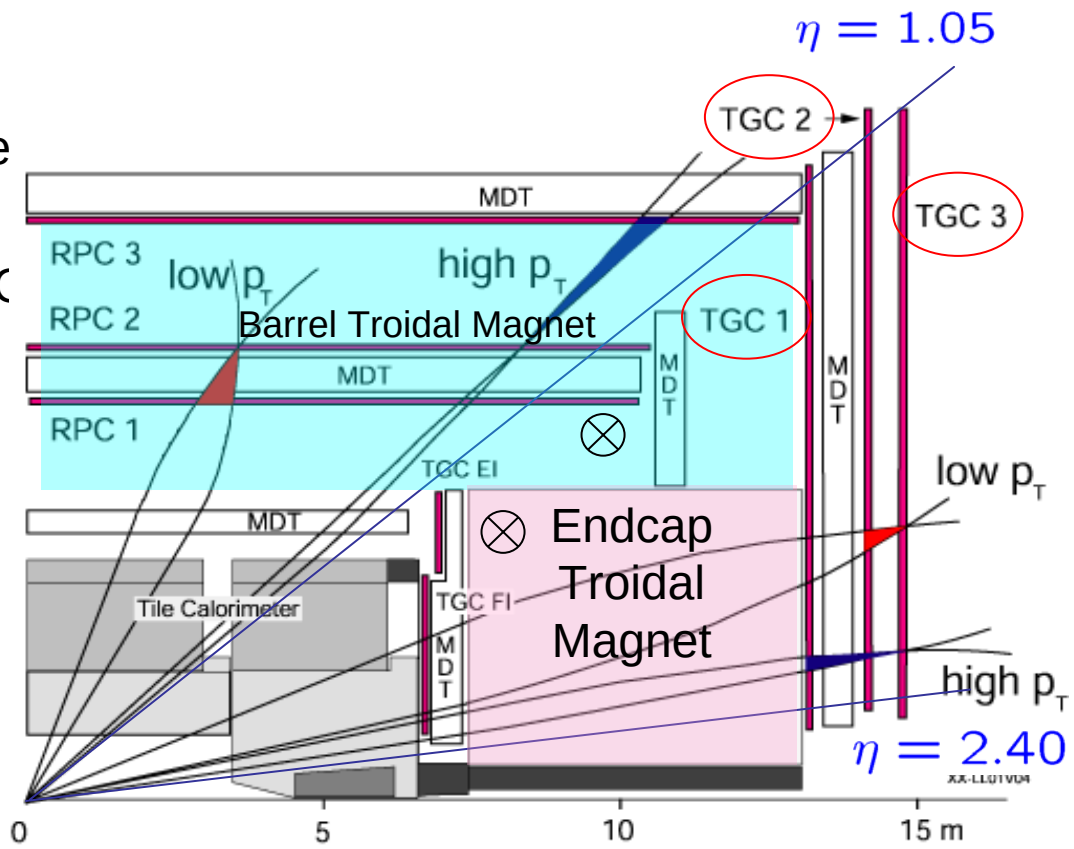


- 3 level trigger system

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

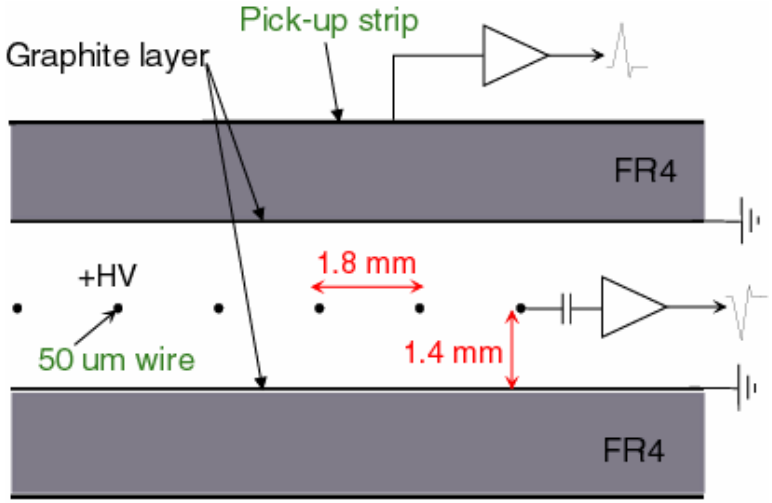
Level1 Muon Trigger System

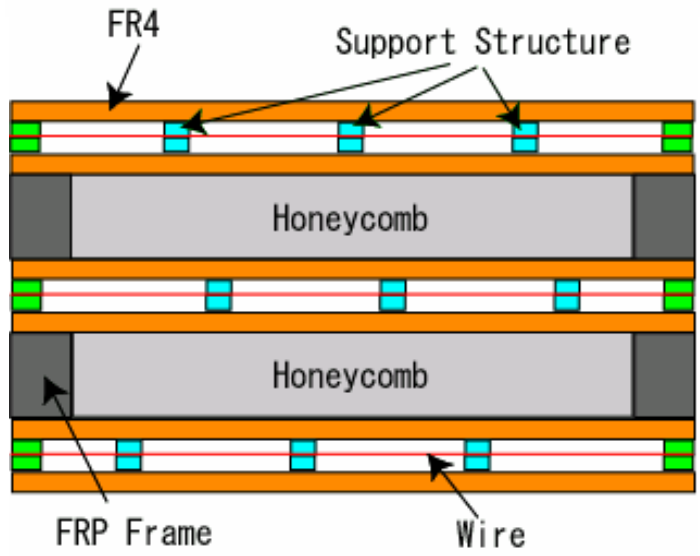
- TGC provides
  - Bunch ID
  - muon hit position
  - Pt of muon
    - EC toroidal magnet
    - 2 station coinc.
      - → low Pt trigger (>6Ge
    - 3 station coinc.
      - → high Pt trigger (>20(



Thin Gap Chamber

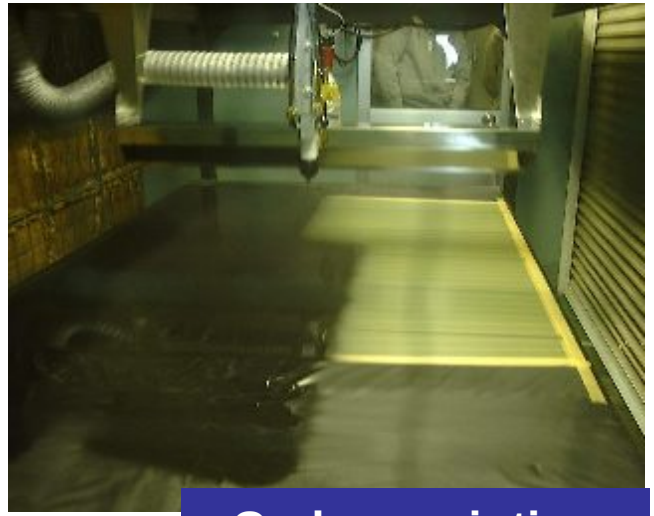
- Performance requirements
  - ① **Detection efficiency > 99% → Trigger**
  - ② **Signal response time ~ 25nsec → BC ID**
  - ③ Stable operation for more than 10 years under high rate environment (~kHz/cm^2)
  - ④ Radiation Tolerance (~0.6C/cm)
- Structure of TGC
  - Similar to MWPC
    - Wire : 50μm gold-plated W
    - Anode-Cathode Gap : 1.4mm
    - Wire-Wire Gap : 1.8mm
    - 2-dimentional readout (wire, strip)
    - Cathode plane: carbon (~MΩ/cm^2)
    - Trapezoidal shape (~2m^2)
  - Operation condition
    - Gas : CO_2 + n-Pentane (55:45)
    - High Voltage : +3.0kV
    - Operation Mode : Limited Proportional
    - Gas Gain : ~10^6





Production of TGC

- Mass production of chambers
  - Total:3,600 chambers (11 types)
    - Produced in Japan, Israel and China.
    - Total channel:~ 320,000 channels
    - Covered area:~ 2,700m^2
  - Japanese contribution
    - Total : 3 types, 1,224 chambers (inc. spare)
    - Period : Apr. 2001~Feb. 2005 (48 months)
    - Site : KEK (Fuji experimental hall)



Carbon painting

Wire winding

Close chamber

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
    - **<u>12 chambers</u>** with locally inefficient region.
      - Not transported to CERN
  - Transportation from Kobe to CERN by ship
    - All good chambers were already transport to CERN

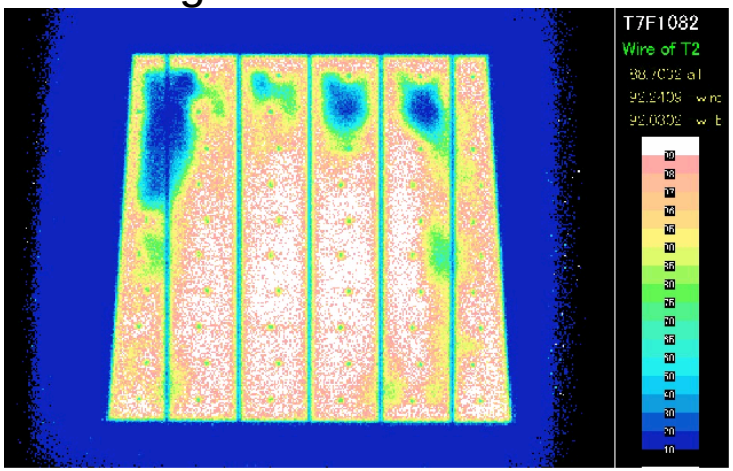
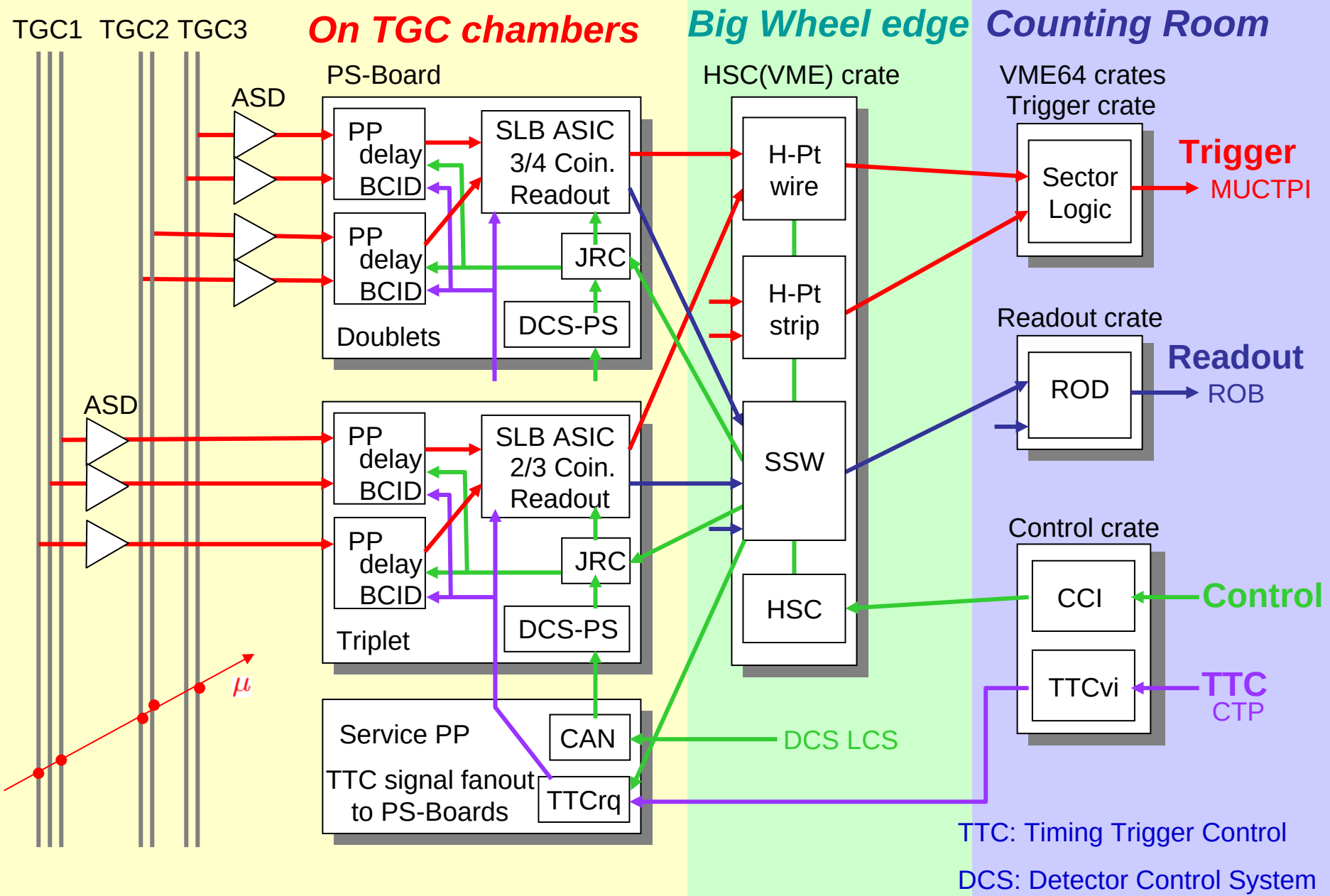
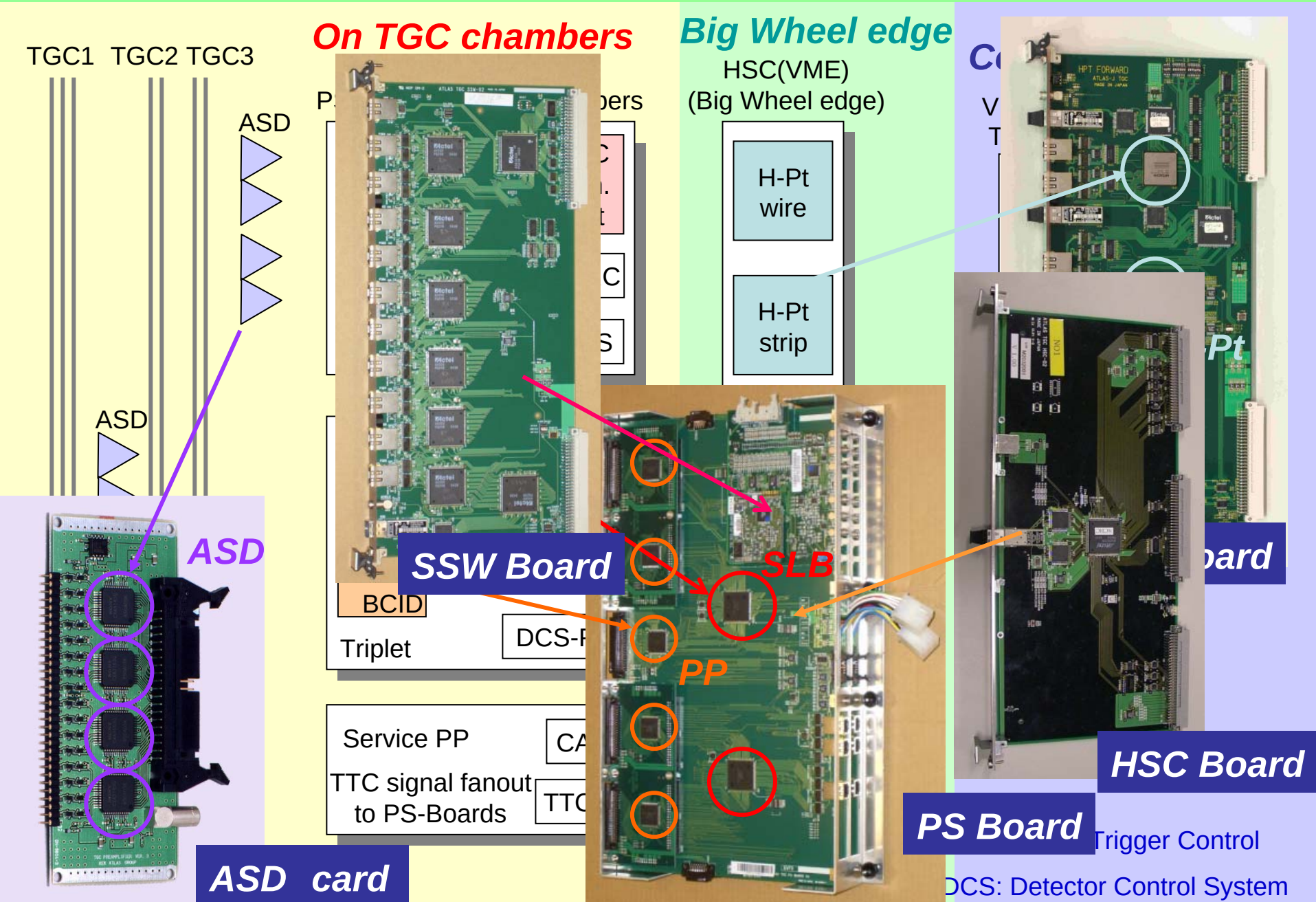


Diagram of TGC Electronics



TGC Electronics Modules made in Japan

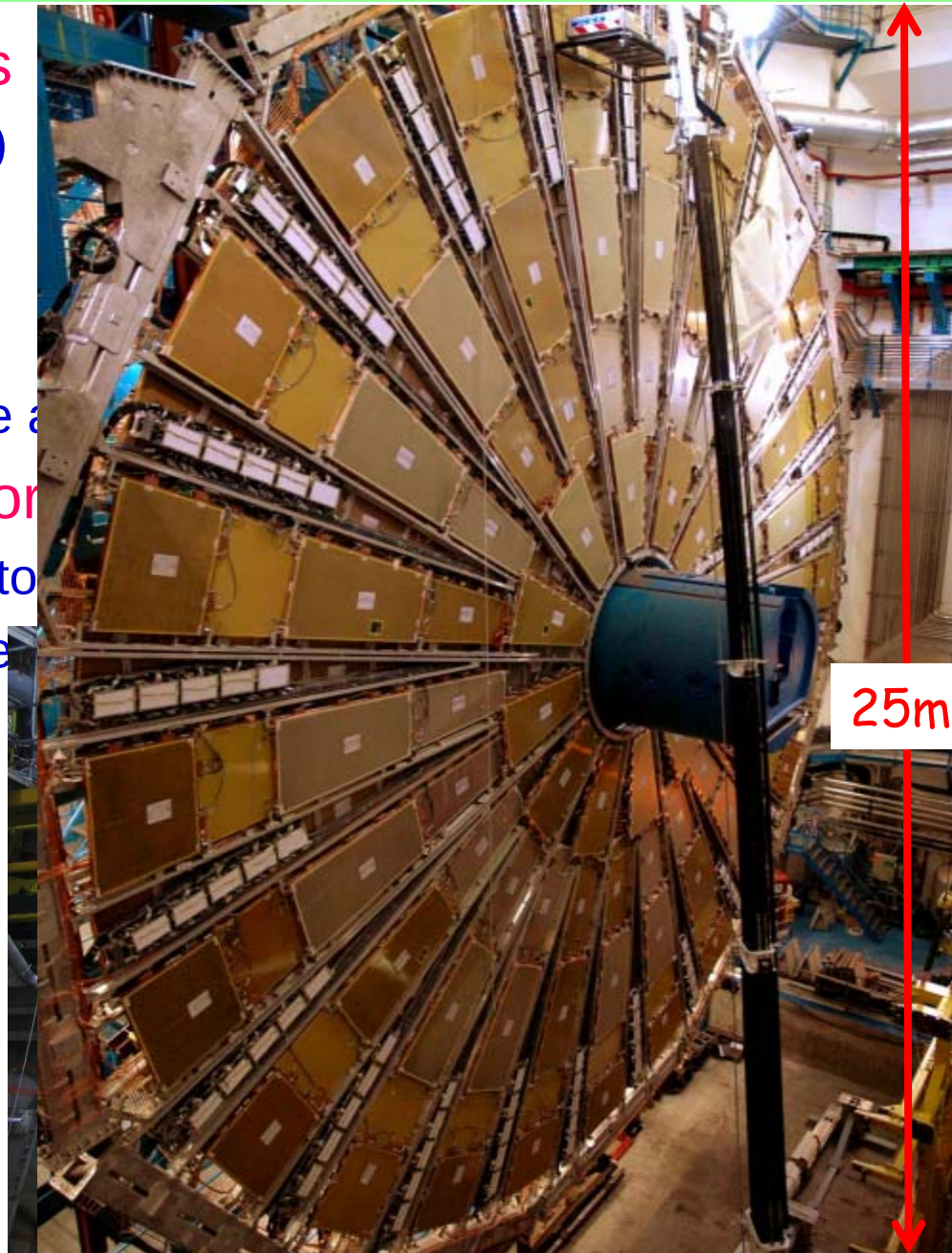


Assembly and Installation of TGC

Assembly unit

- 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 a
- Each BW consists of 12 sector
  - TGC1: 18 triplet modules/secto
  - TGC2,3: 22 doublet modules/se

  → 1488 modules in total.



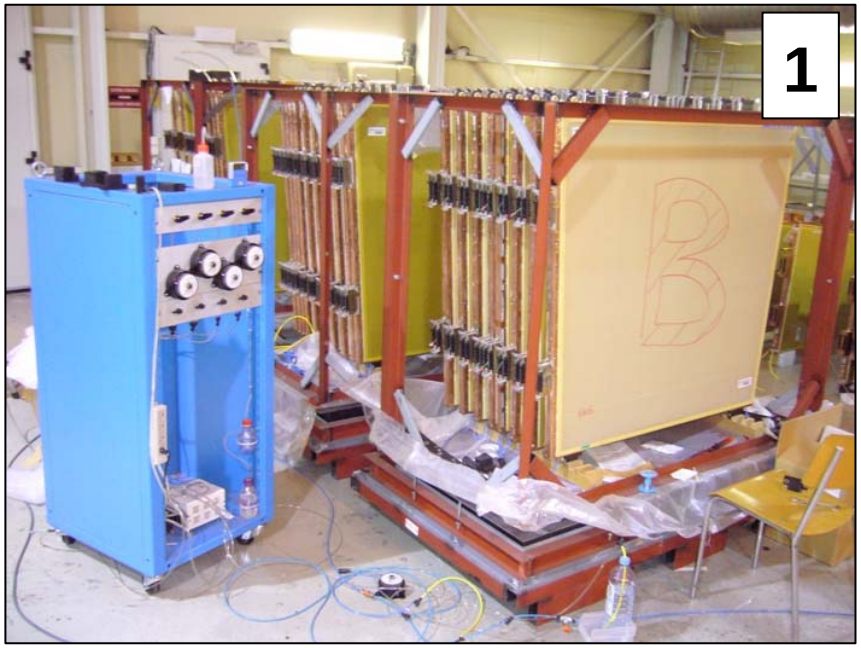
Two Working Areas @ CERN

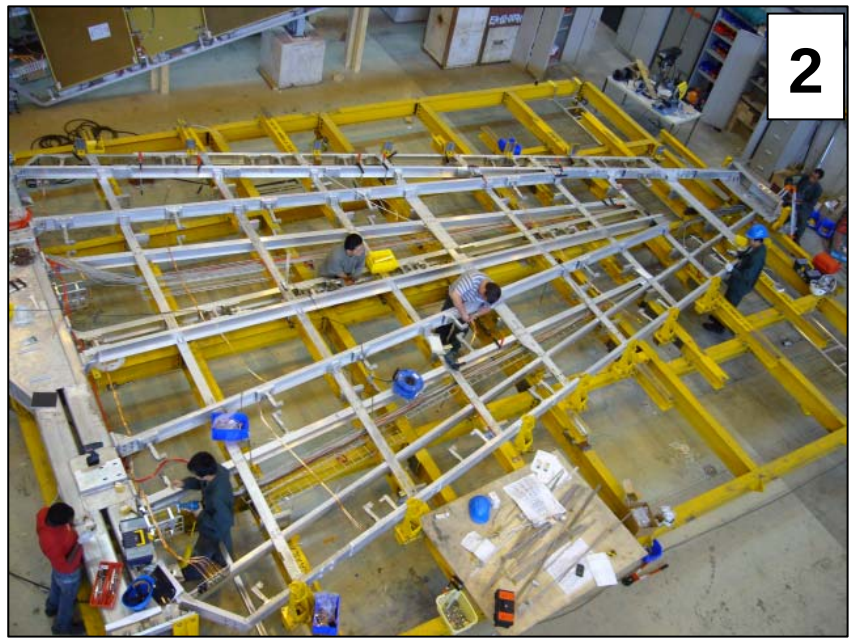
Storage of 1/12 sector

ATLAS pit

Sector Assembly Procedure

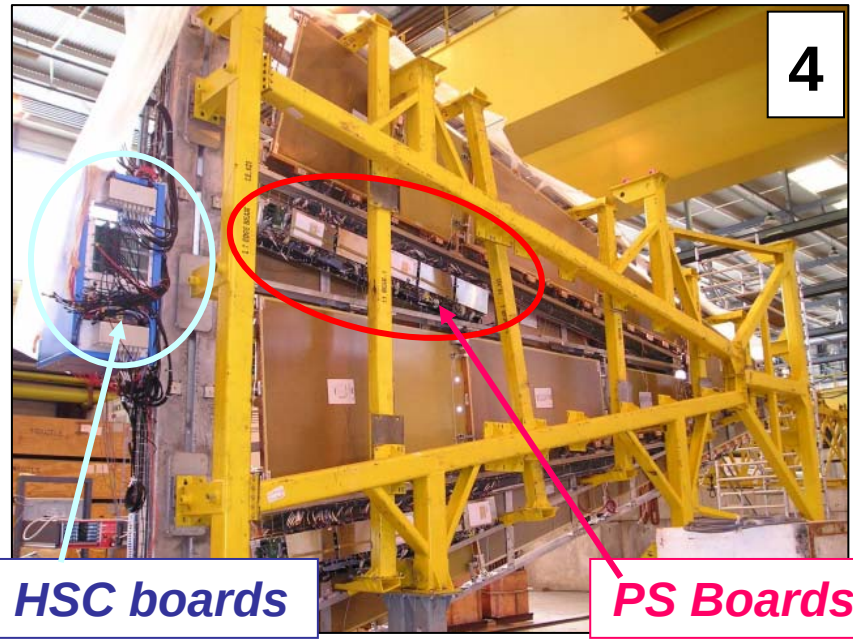
1. Chamber preparation before installation
   - Check gas tightness of chamber
2. Assembly in horizontal position
   - Assembly of Al frame for sector
   - Arrangement of cables (signal and LV/HV)
   - Arrangement of gas pipe





Sector Assembly Procedure (cont)

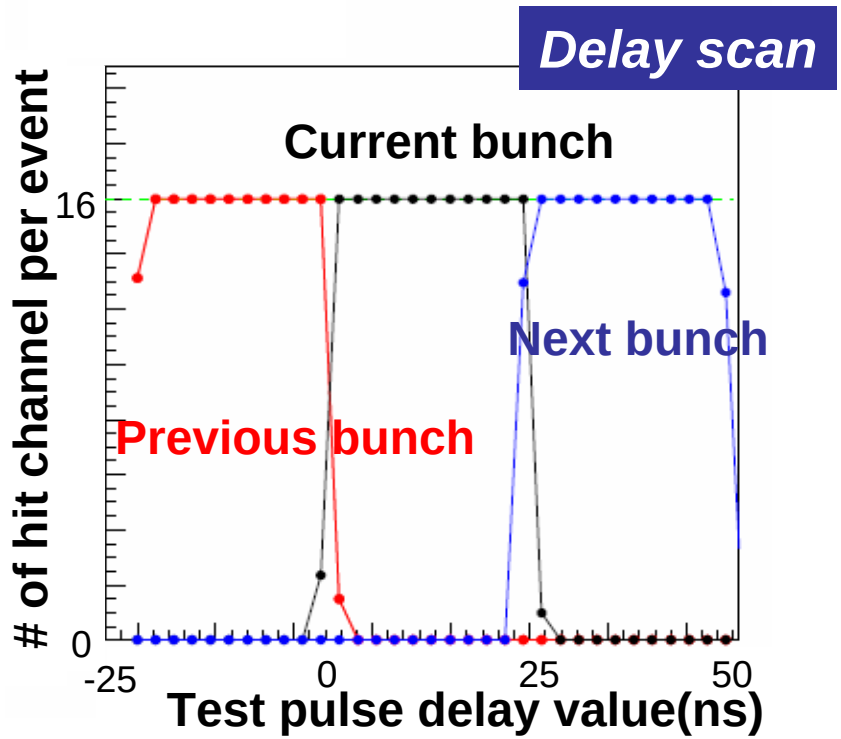
3. Assembly in vertical position
   - Chamber installation
4. Install on-detector electronics
5. Test of sector
   - Check cabling and electronics health
     - Send test pulse to ASD card
   - Apply high voltage to chambers with CO_2 gas flow
   - Test with RI source & cosmic ray



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
- In TGC1 test, all electronics channels (~30k channels) were checked.
- Only five channels on chambers were found to be dead (0.017%).

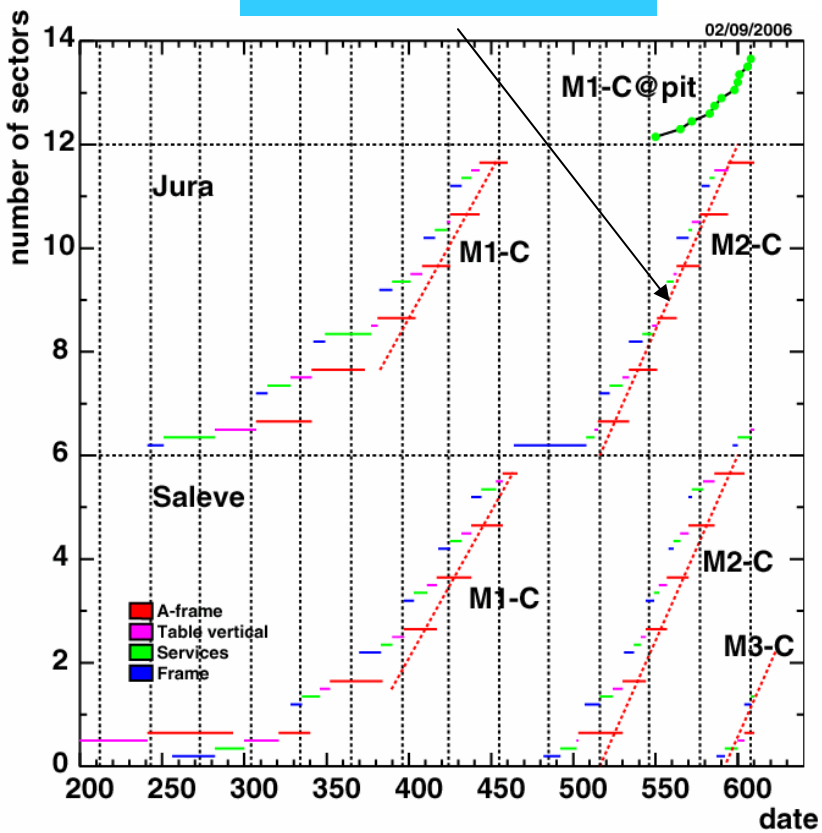
- Delay scan method
  - To confirm timing adjustment functionality
  - Take data with changing test pulse delay values with accuracy of sub-nano second



Progress of sector assembly

- 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.

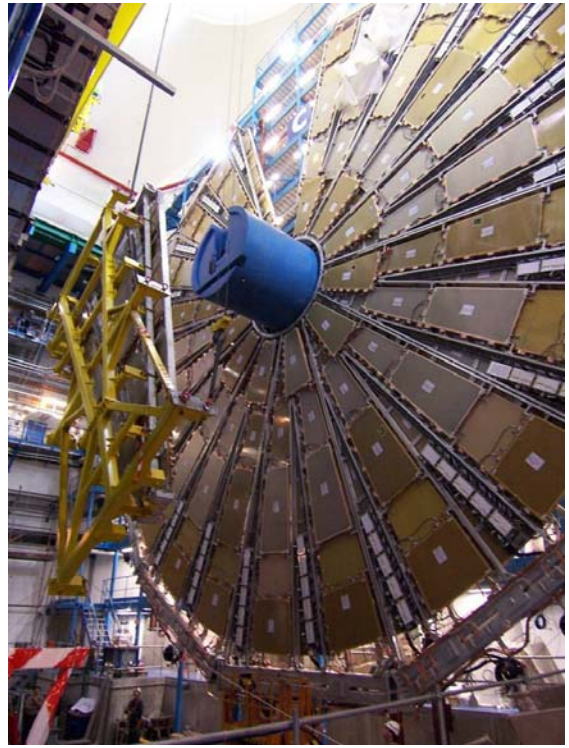
1 sector/week



Installation to ATLAS pit

Transport to the pit

Lower down to the pit



Built up to a BW

Schedule

	station	Assembly	Installation
C-side	TGC1	Done	Done
	TGC2	Done	Jan.07 -
	TGC3	In progress	Feb.07 -
A-side		Nov.06 -	Jan.07 -

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

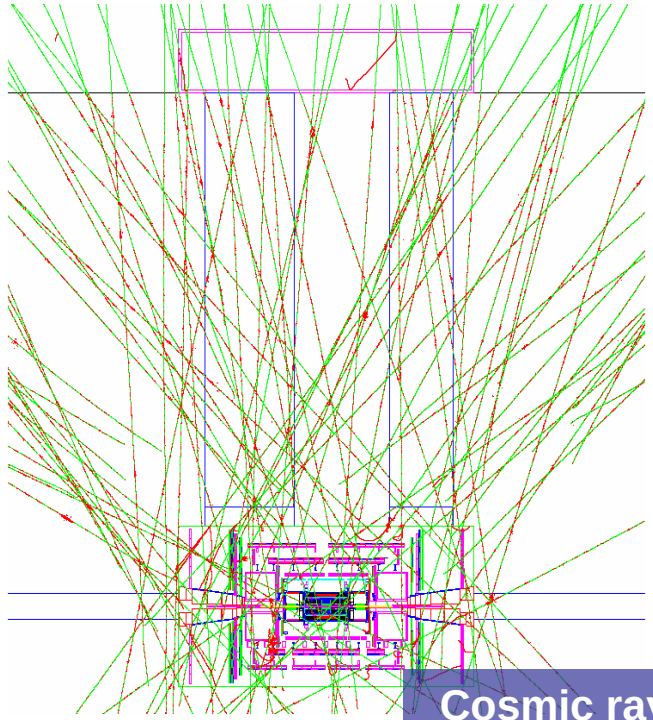
Future test programs foreseen in the pit

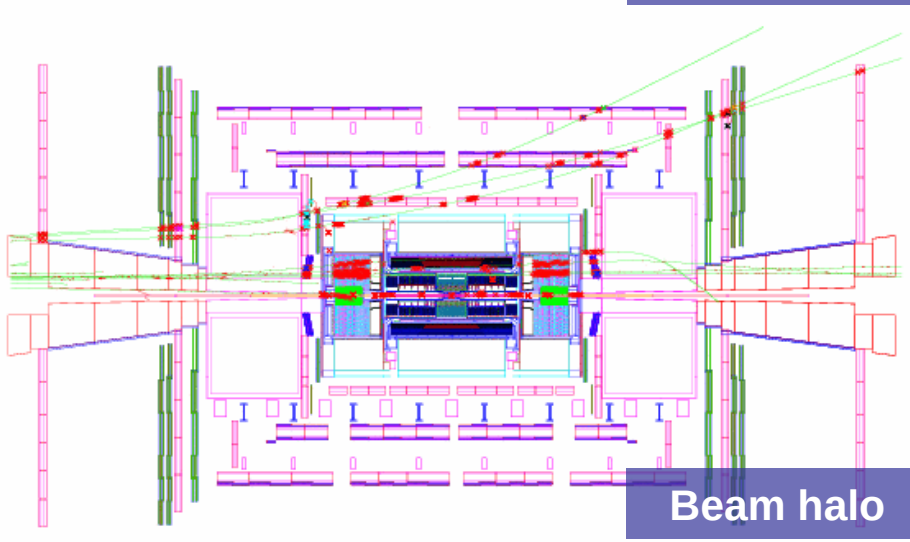
Preparation for the beam collision

- 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

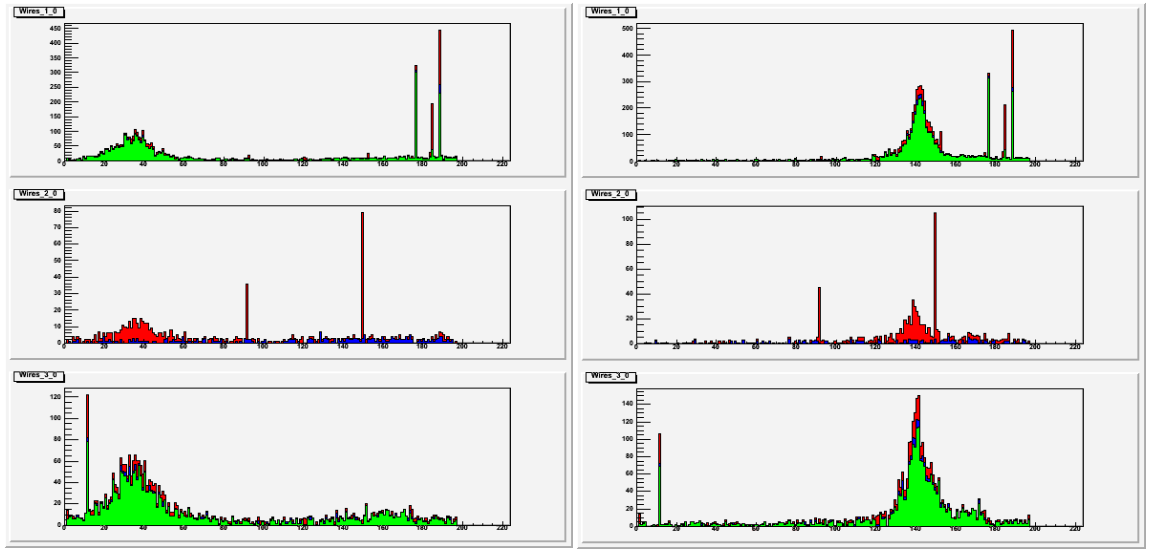
- Thin Gap Chamber
  - Used as ATLAS Level1 endcap muon trigger chamber
  - Almost chambers were produced and tested their performance.
- Assembly and Installation
  - TGC modules are assembled to 1/12 sectors.
    - TGC1 and TGC2 for side-C have been assembled.
    - TGC3 are assembled now.
    - TGC1 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 cablings.
    - 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

	station	Assembly	Installation
C-side	TGC1	Done	Done
	TGC2	Done	Jan.07 -
	TGC3	In progress	Feb.07 -
A-side		Nov.06 -	Jan.07 -

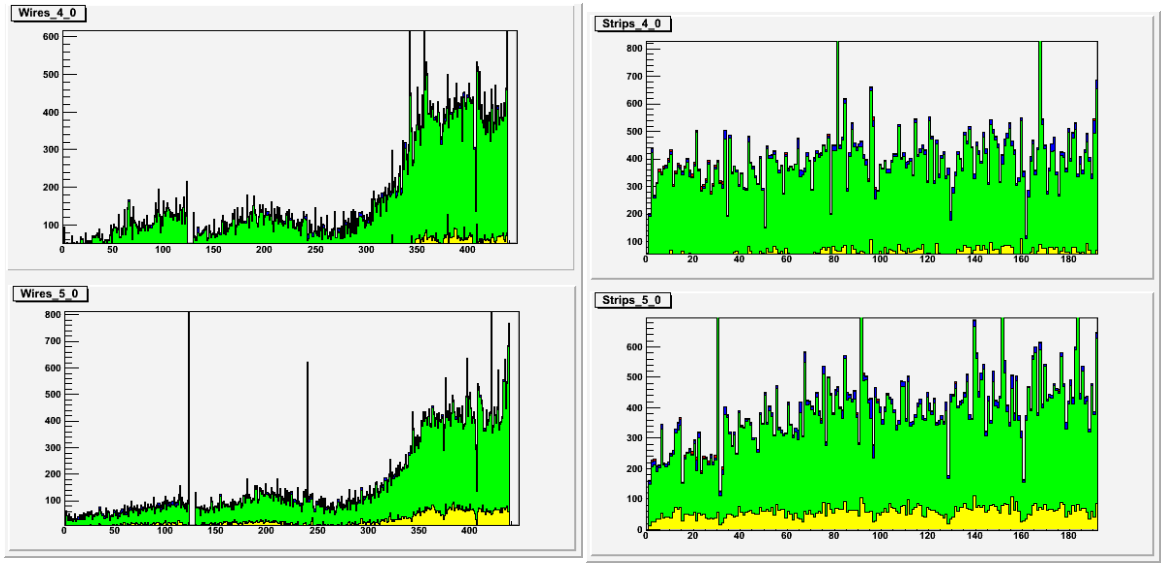
Backup slide

Result for RI source & cosmic ray test

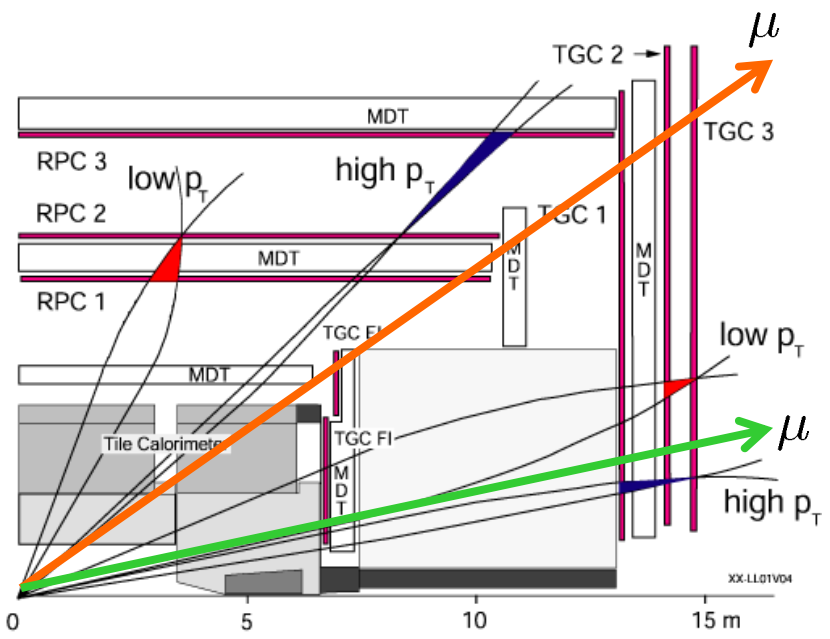
- RI source test
  - 1MBq ^{60}CO was used.
  - CO_2 flow, 2.8kV?
  - Only very few hot channel was found.

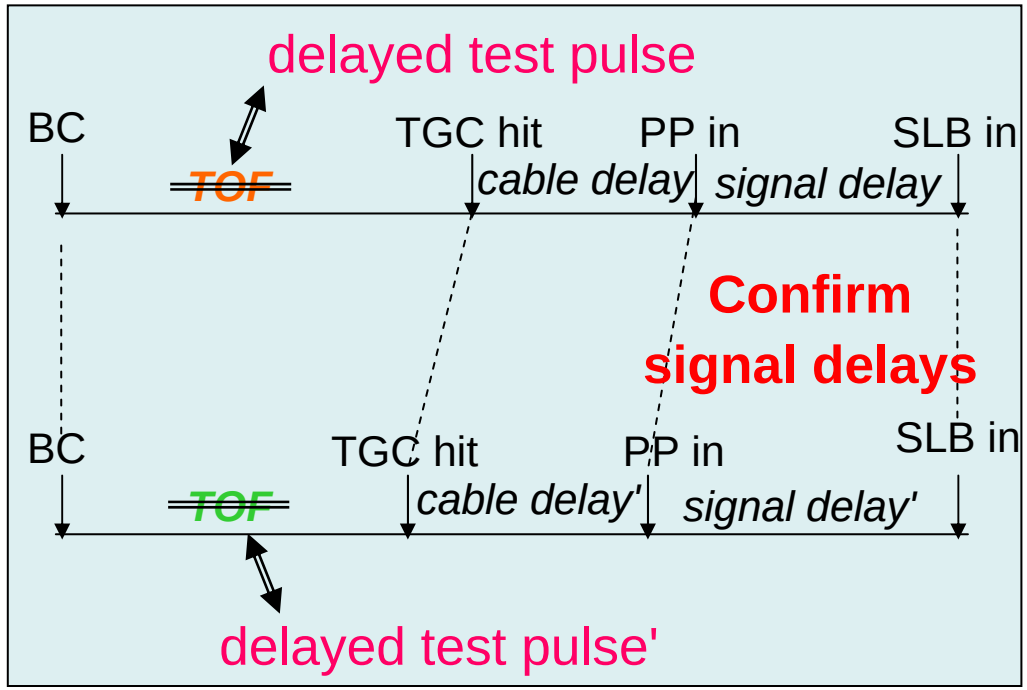


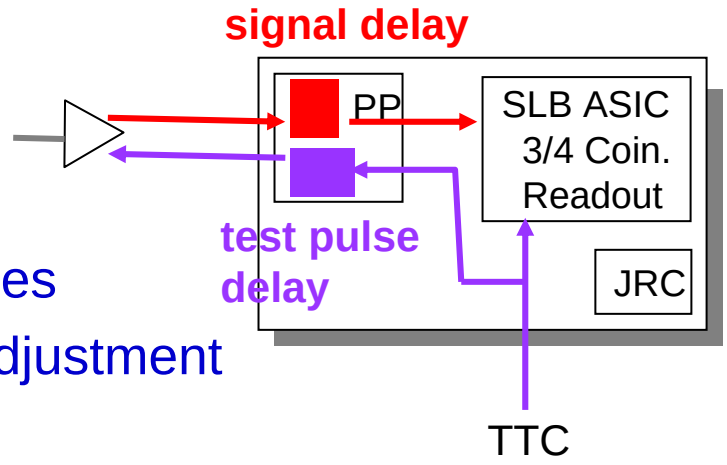
- Cosmic ray test
  - Random trigger
    - 100kHz clock



Before beam collision

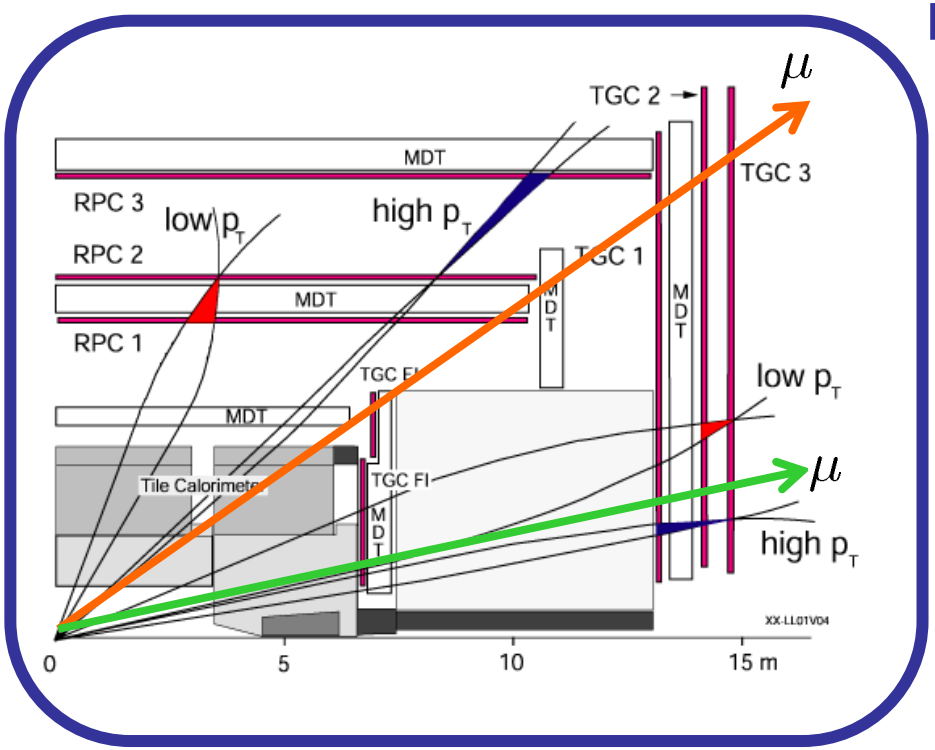


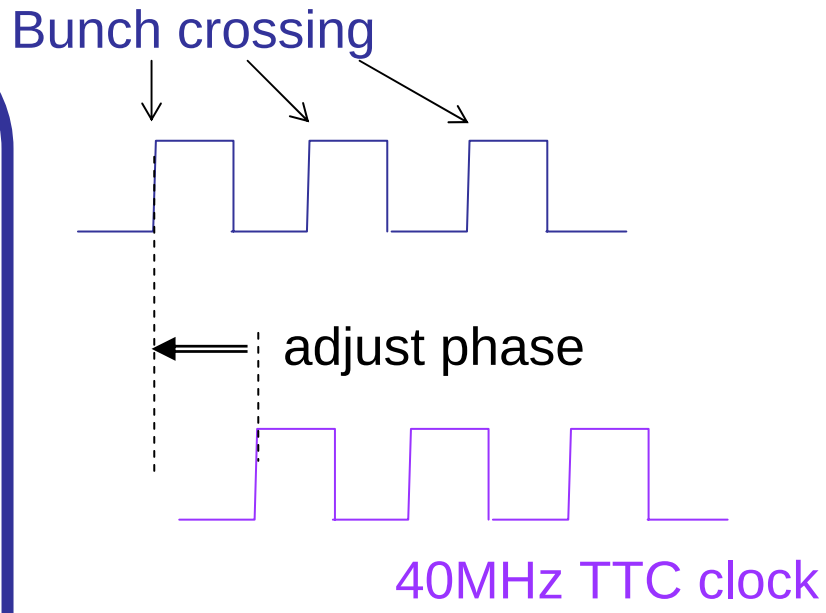


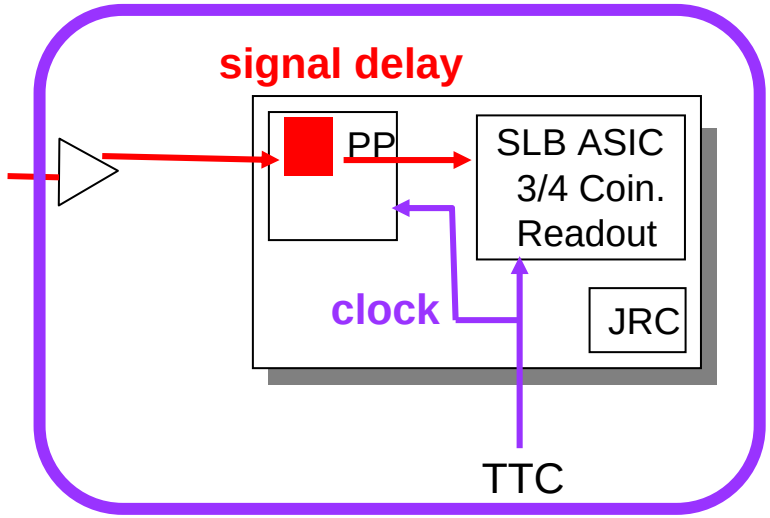


- Procedure
  1. Set test pulse delays properly.
  2. Confirm necessary signal delay values by checking test pulse data timing adjustment is synchronized to 40MHz clock

After beam collision







Procedure

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