First Measurements with the ATLAS Level-1 Calorimeter Trigger PreProcessor System

The ATLAS Level-1 Calorimeter Trigger Collaboration

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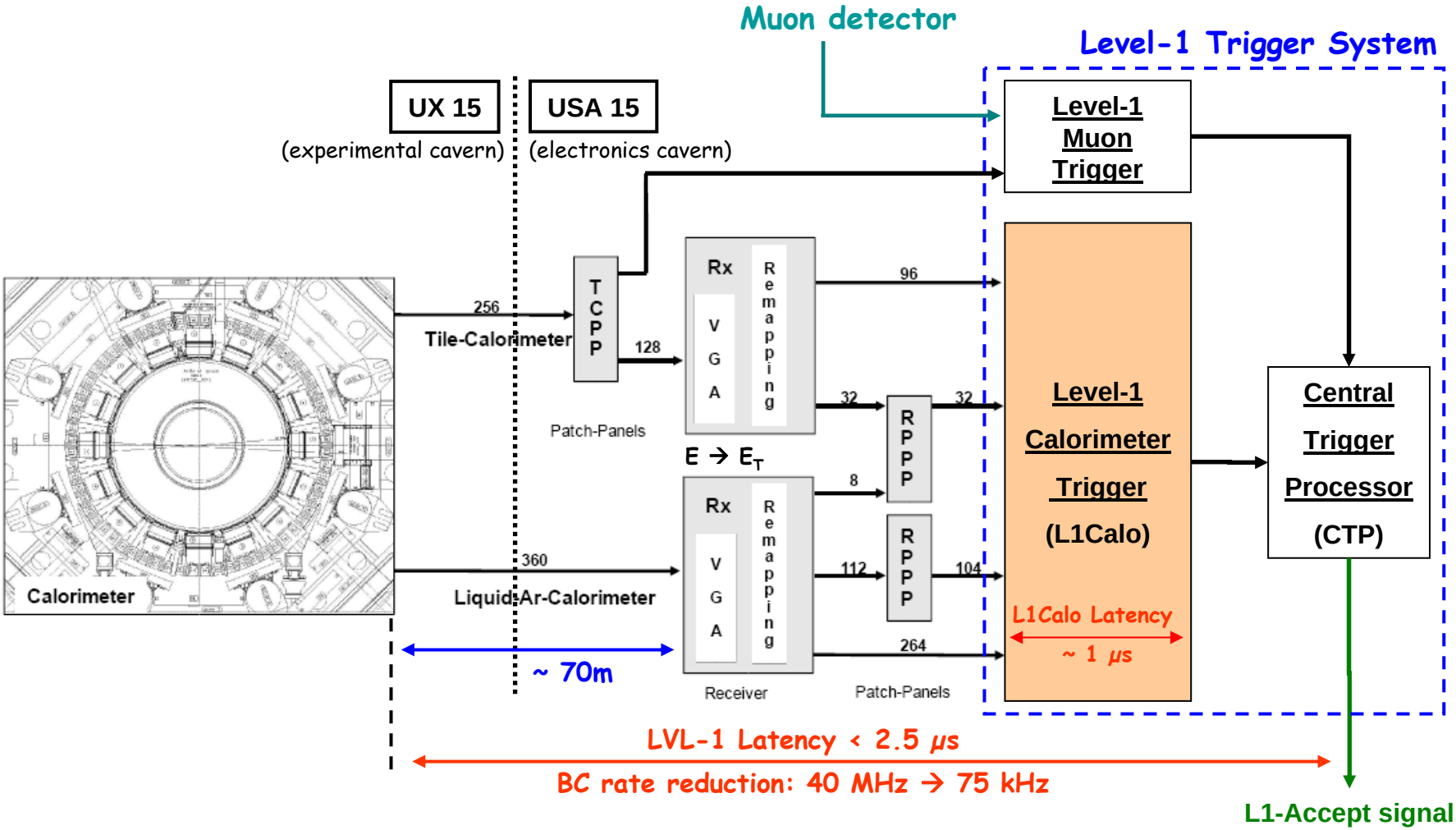
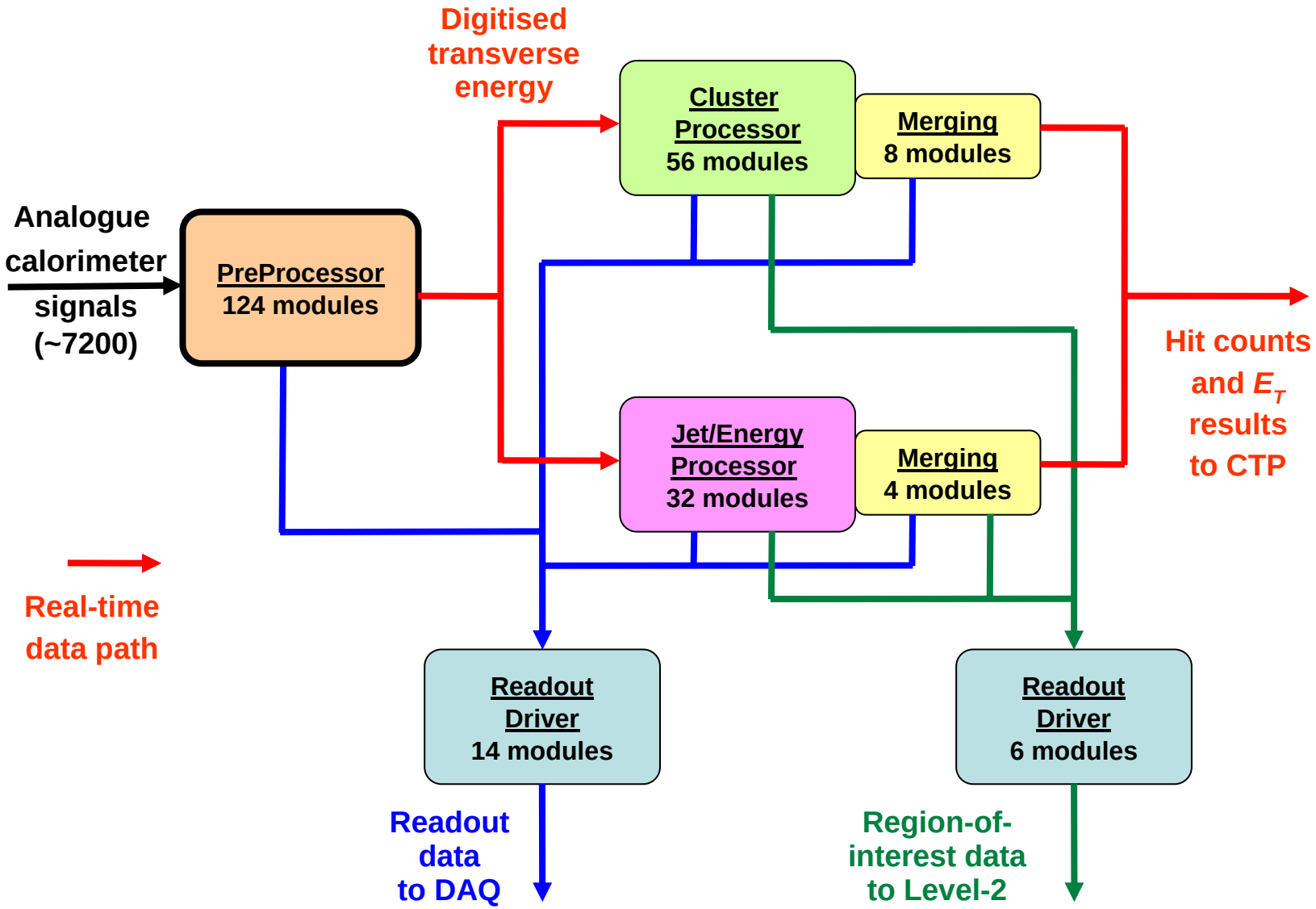
Overview

- Introduction
  - Level-1 Trigger & Level-1 Calorimeter Trigger
  - PreProcessor System
- PPM Production Tests @KIP Heidelberg
- Installation Status & Integration Tests & System Tests @CERN (in situ in the ATLAS experiment)

The Level-1 Trigger System



The L1Calo Trigger: Architecture

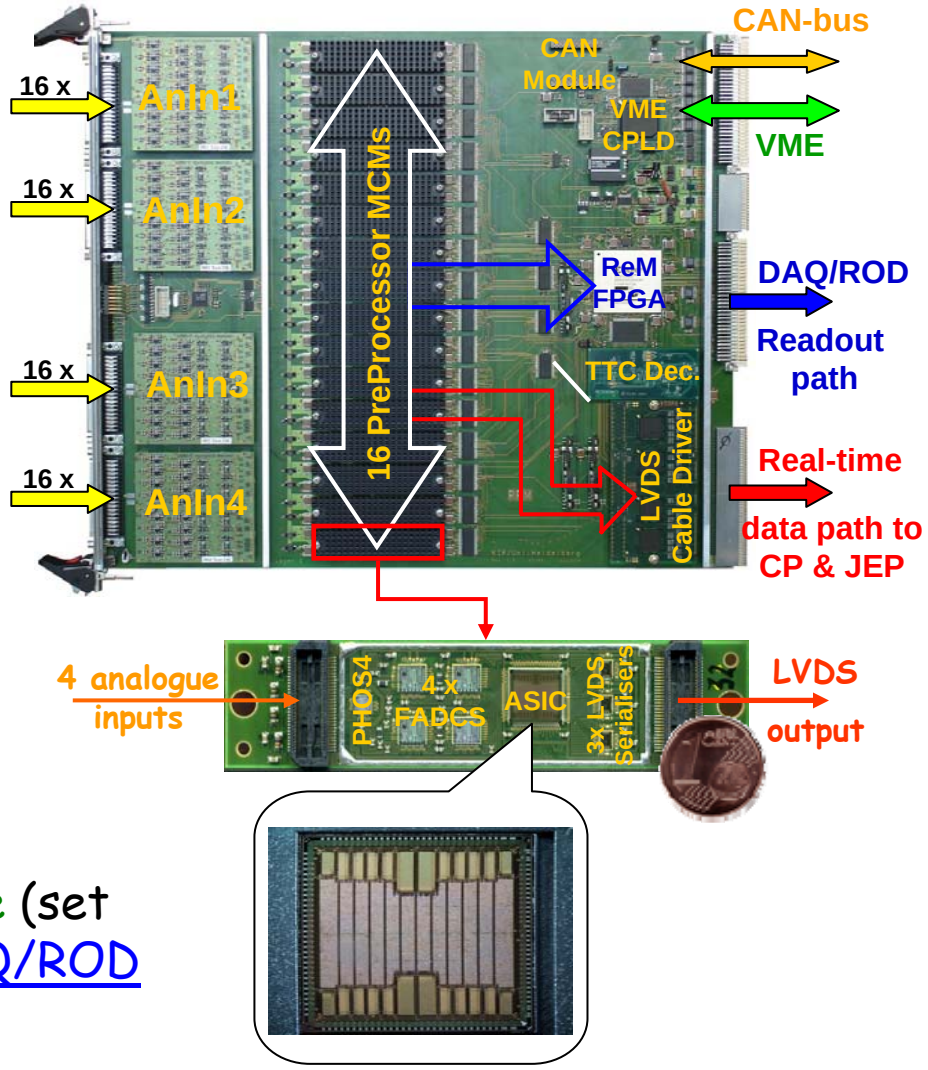


Five main types of custom 9U modules

- PPM
- CPM
- JEM
- CMM
- ROD

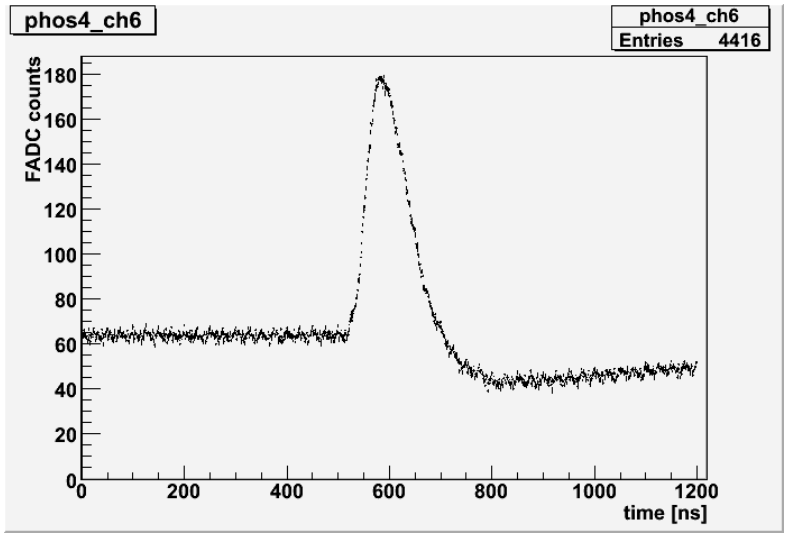
The PreProcessor Module (PPM) (1/2)

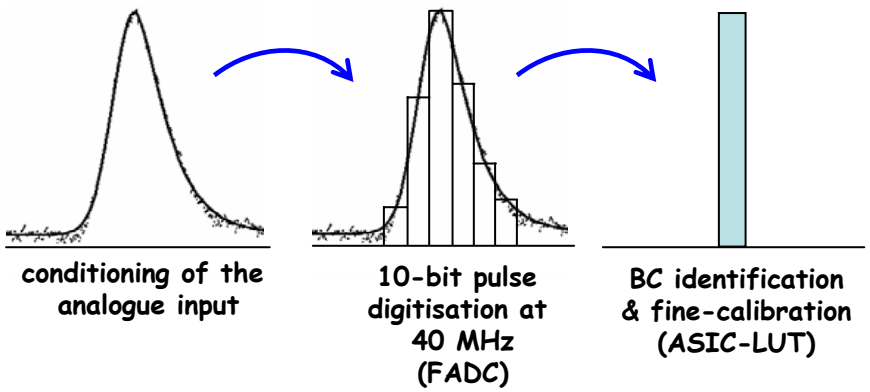
- main component of PreProcessor (PPr) System
- **124** hardware identical PPMs accommodated in 8 crates
- each PPM receives and processes **64** analogue calorimeter trigger signals
- processing of data in **custom ASIC** (developed in Heidelberg)
- serial transmission of the digital energy values to CP and JEP (*real-time path*)
- provides bidirectional VME interface (set control data, local monitoring) and DAQ/ROD interface (monitoring of the system)



The PreProcessor Module (PPM) (2/2)

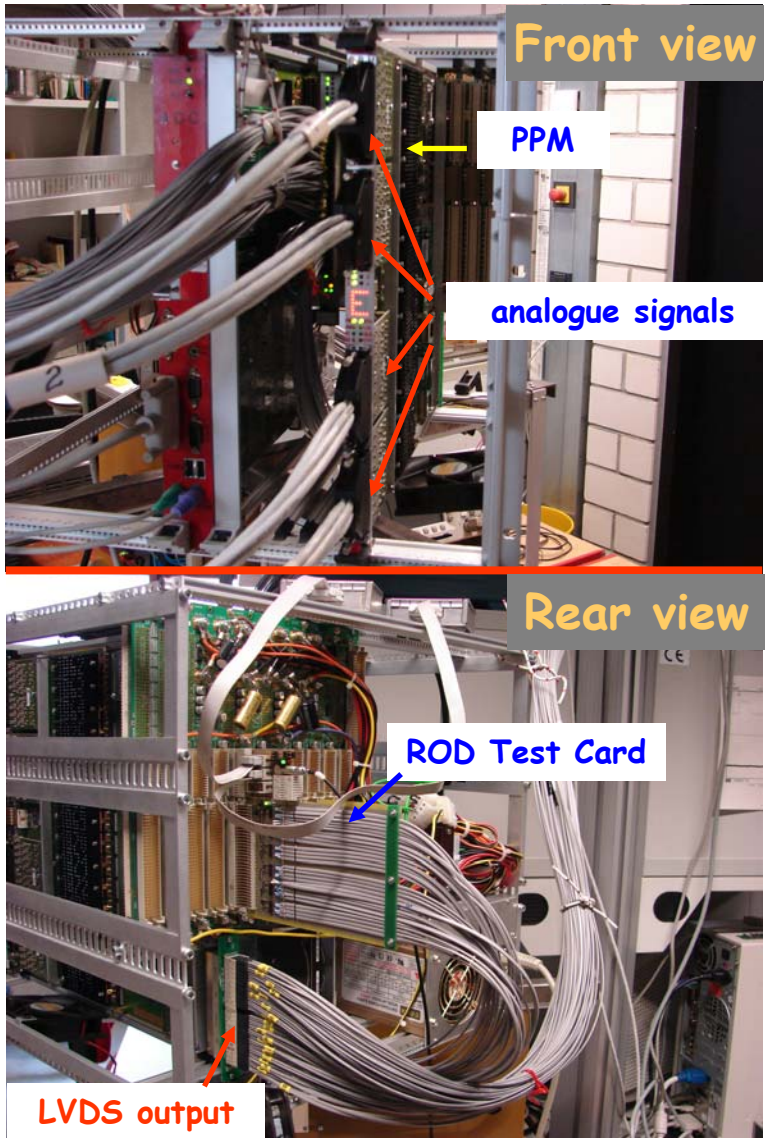
- 10-bit digitisation (40 MHz) with exact sampling on the signal's peak (25 ns delay, in steps of 1 ns → PHOS4)
- experiment specific algorithms put into **ASIC**
  - synchronisation of pulses originating from the same event to the same *bunch-crossing* clock tick
  - BC identification of the E_T deposition per trigger channel and of the corresponding bunch-crossing, for all pulses in the linear range & saturated region (FIR Filter, PeakFinder)
  - noise suppression, pedestal subtraction, fine-calibration of extracted E_T using lookup table
  - data preparation for transmission to L1Calo processors (jet-element formation, multiplexing)





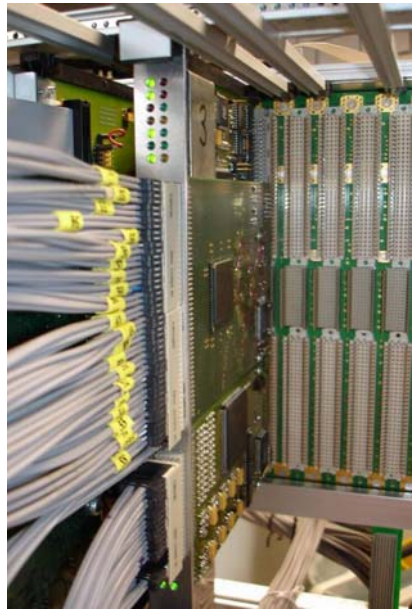
Production Tests @KIP Heidelberg (1/2)

- PPM production is completed
  - 124 modules needed by the full-coverage of the experiment
  - 36 spare modules
- all modules are tested in Heidelberg before sending to CERN
- Single Board Tests (bring each module into operation)
  - **Initial preparation** (optical inspection, power up tests w/o daughterboards, etc)
  - **Operational tests** (check conditioning & digitisation of the analogue input signal, verify ASIC algorithms, etc)

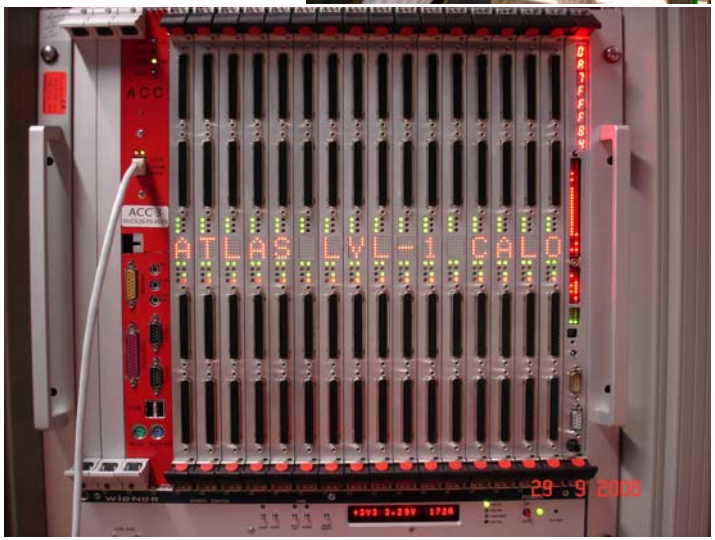


Production Tests @KIP Heidelberg (2/2)

- Single Board Tests (cont'd)
  - **ROD Readout data tests** verify the ROD buffer formation & content using both the VME & DAQ readout interfaces
  - **Real-time (LVDS) data tests** check quality of LVDS data after transmission over 15m long cables → LVDS cables in USA15 are 11m long



- Full Crate Tests ("burn-in" of a week or more with 16 PPMs in a standard PPr crate)
  - repeat all functional tests performed during the Single Board Tests

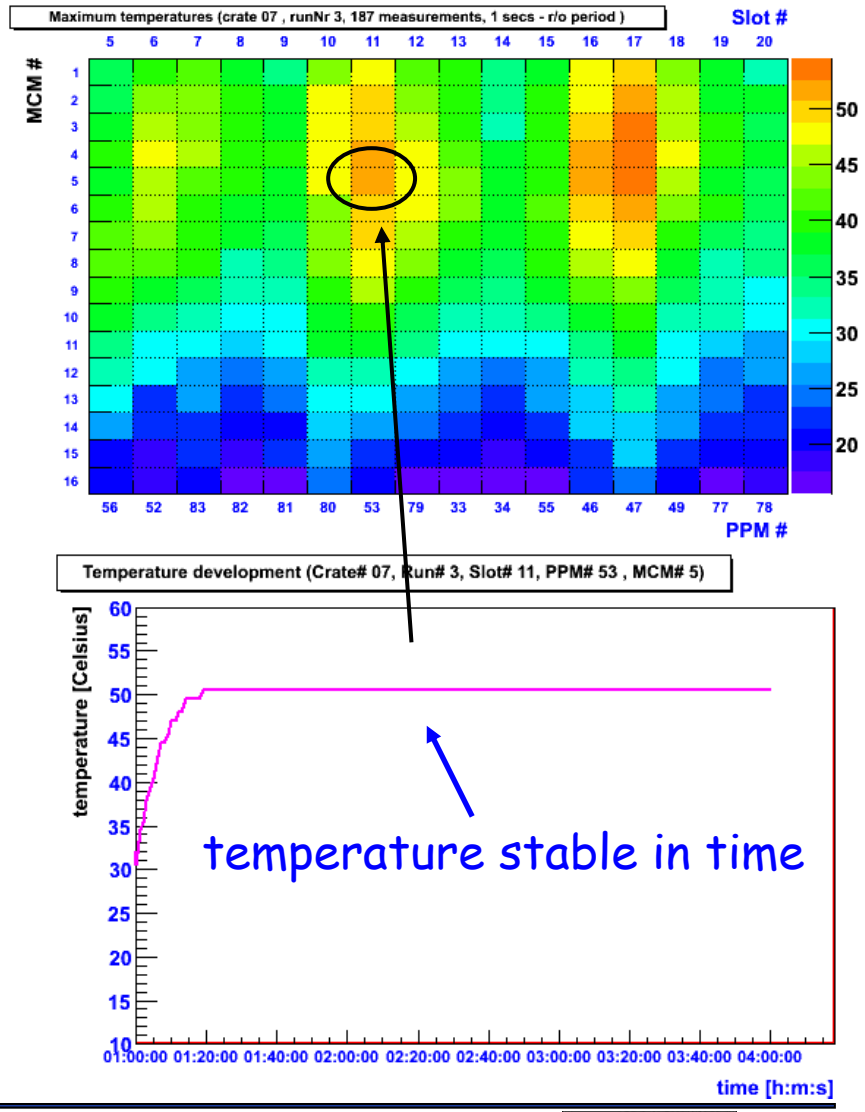


PPr Installation Status in USA15

- so far 2/3 of the PPr system installed
- will be completed during autumn 2007
- installation of analogue cables from receiver stations to the PPr system is completed
- installation of LVDS cables from PPr system to the L1Calo Processors (CP, JEP) nearly completed

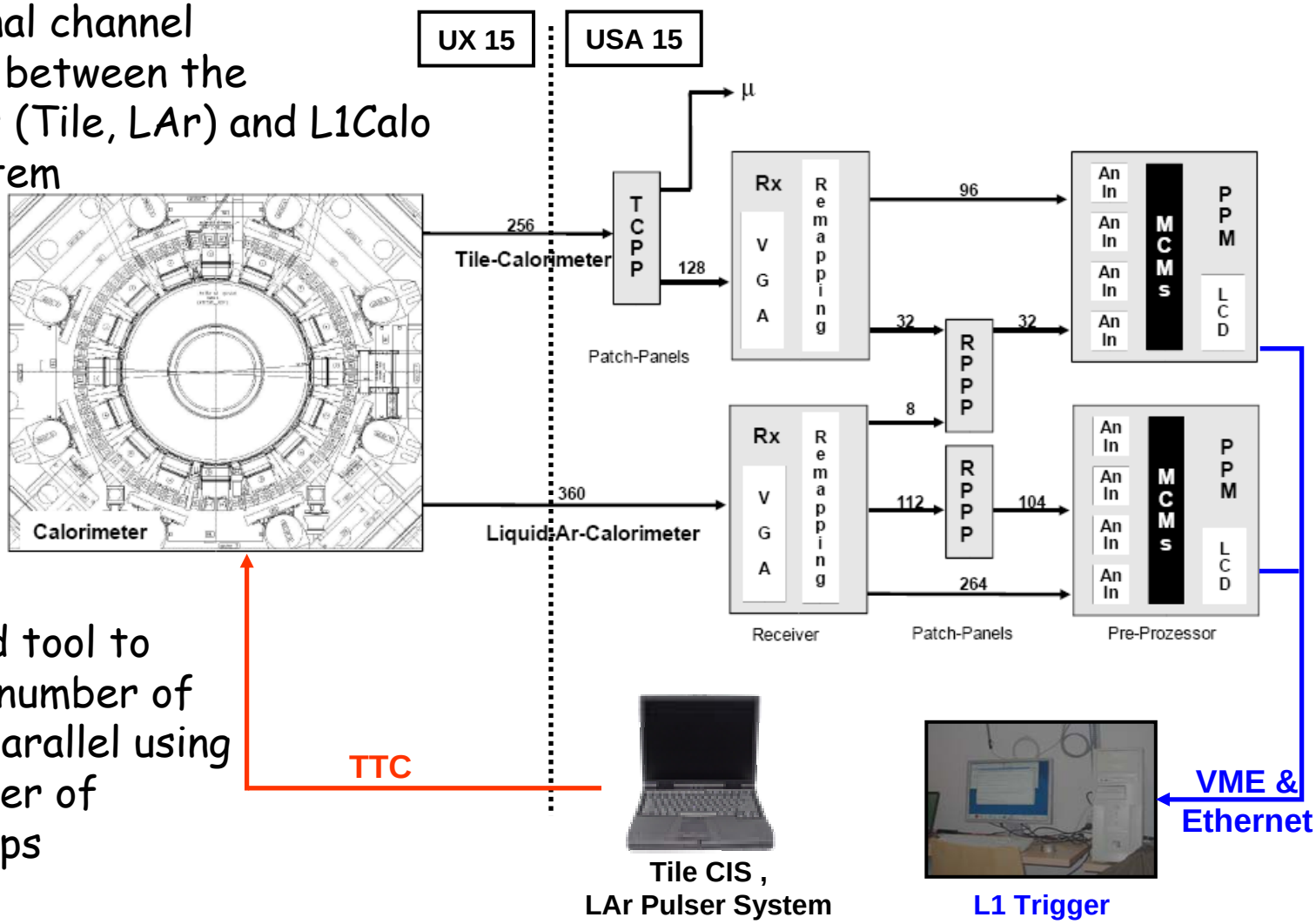
Tests In Situ in the ATLAS Experiment: PPM Temperature Monitoring

- monitor the MCM temperature of each PPM mounted in each crate
- used digital stress patterns to define *high-activity* in ASIC
- very dense assembly, air flowing is not completely homogeneous
- in general temperatures on chip are even in the worst case below 60°C (safe operating condition)



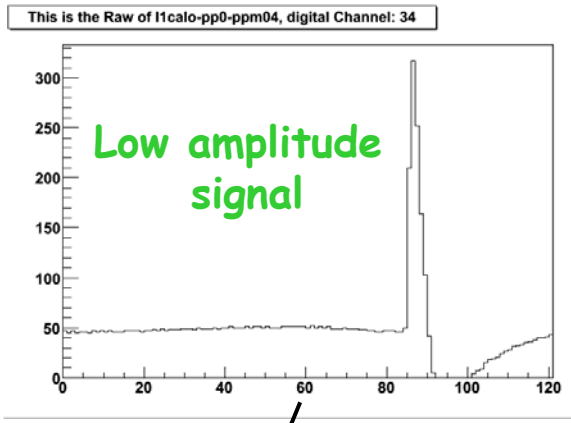
Tests In Situ in the ATLAS Experiment: Connectivity (1/4)

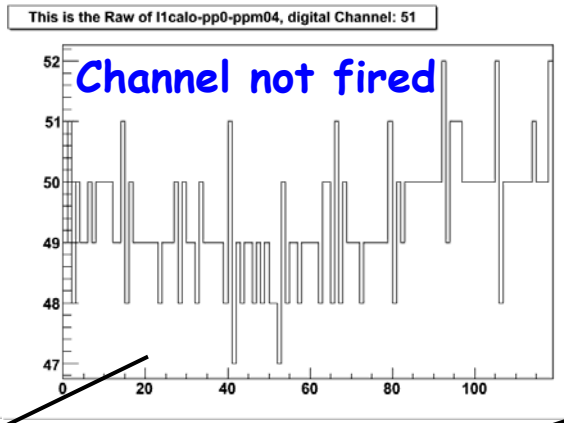
- check signal channel connectivity between the calorimeters (Tile, LAr) and L1Calo Trigger System

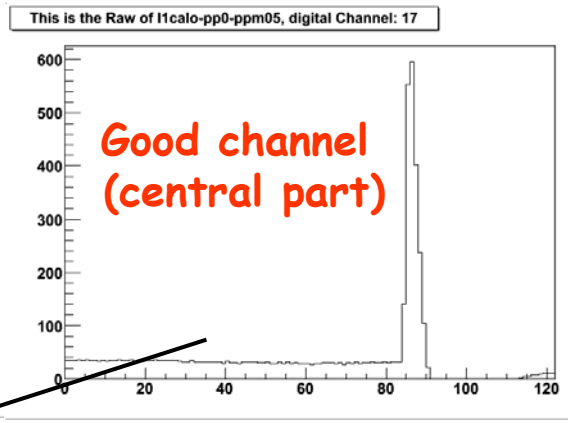


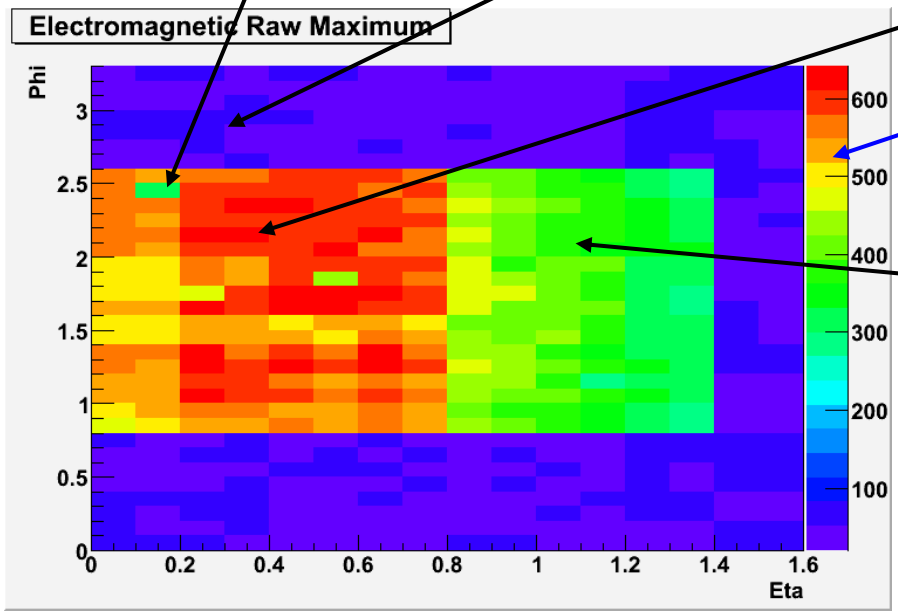
- automated tool to test a large number of channels in parallel using a small number of checking steps

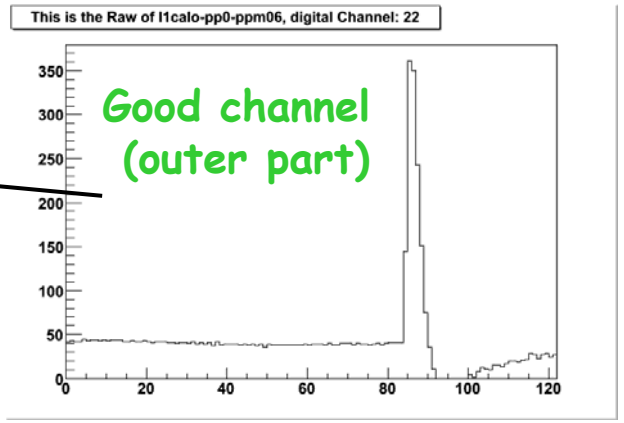
Tests In Situ in the ATLAS Experiment: Connectivity (2/4)









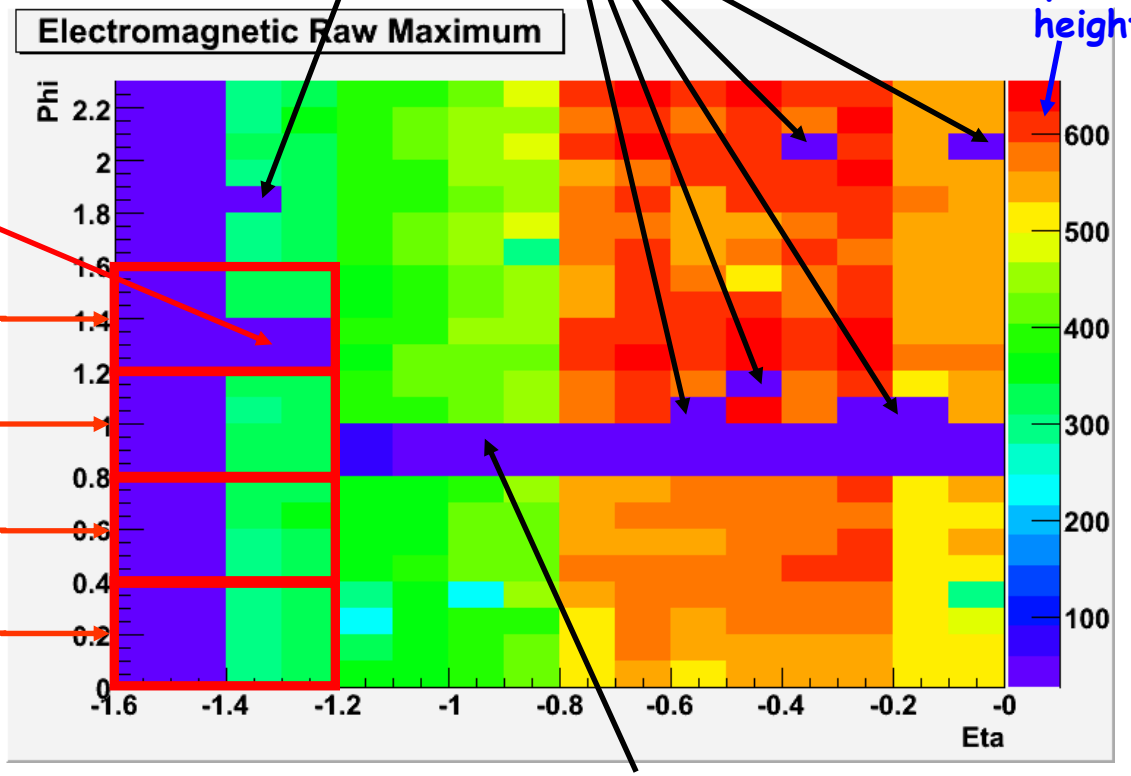


Tests In Situ in the ATLAS Experiment: Connectivity (3/4)

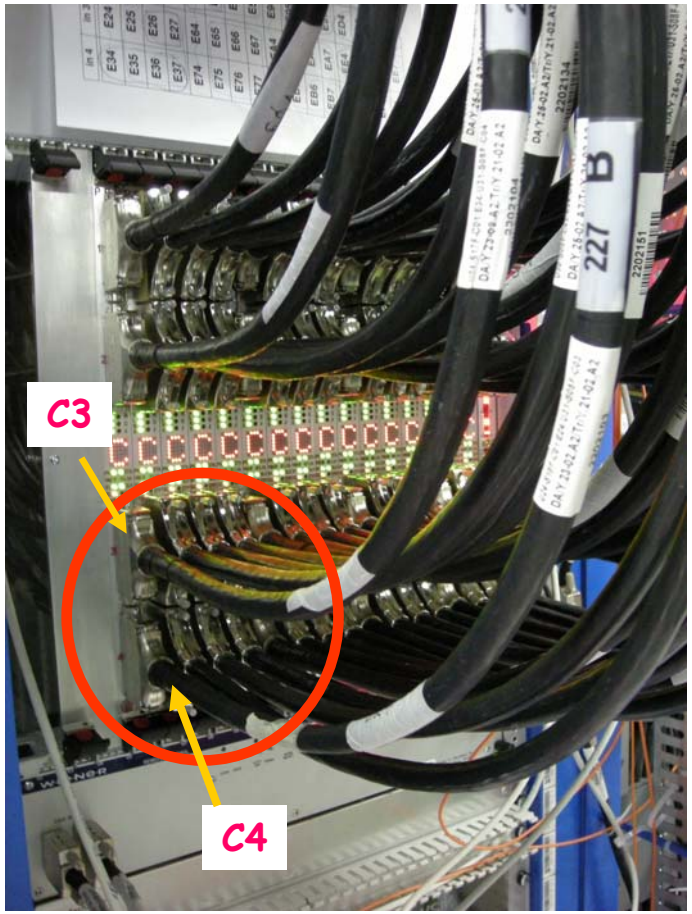
Typical minor problems seen in tests

Dead channels upstream of PPM (to be repaired)

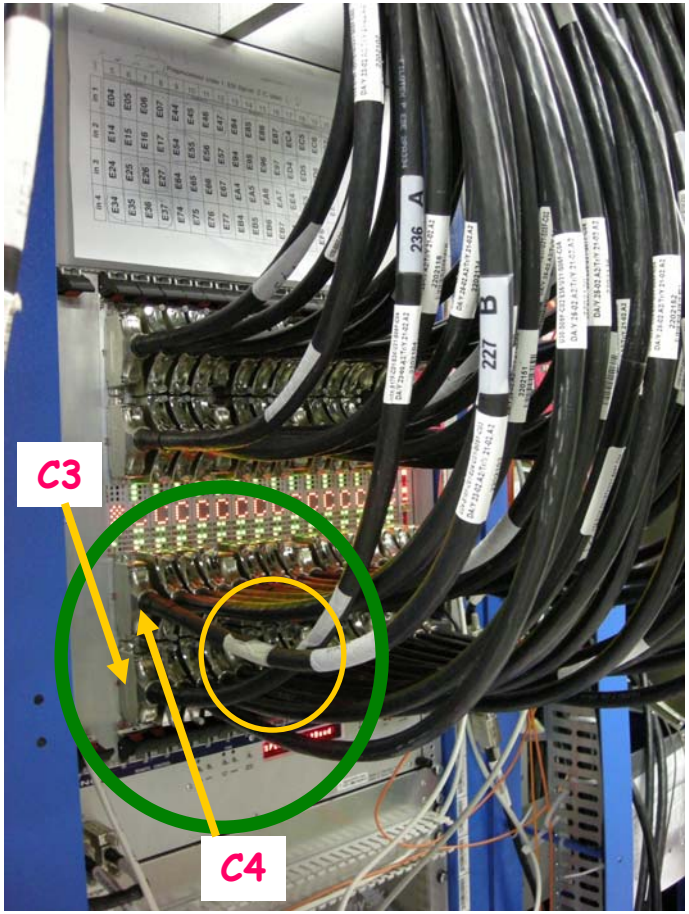
Cables 3 & 4 were found to be interchanged at the output of the receiver system



Tests In Situ in the ATLAS Experiment: Connectivity (4/4)



Mistake was corrected by swapping the cables at PPM input



BEFORE

AFTER

More Tests In Situ in the ATLAS Experiment

- Digital connectivity
  - LVDS cable transmission (400 MBit/s) from PPMs to JEP tested for half of the PPr system
  - no error observed
- Signal quality tests at different energies (including saturation), with different patterns from Tile & LAr calorimeters
  - to be done as soon as the integration of the system is completed
- Participation to ATLAS System Integration Run (M4)
  - 4/8 Ppr crates were integrated in the run

Conclusions

- PPM production is completed (160 modules)
- More than half of the PPr system is already installed in USA15 → to be completed during autumn 2007
- Installation of analogue cables is completed and installation of LVDS cables is nearly completed
- Connectivity tests: ok, so far only done for large parts of the barrel region, no serious problem seen
- More tests are foreseen during and after the installation of the system