Testing and calibrating analogue inputs to the ATLAS Level-1 Calorimeter Trigger

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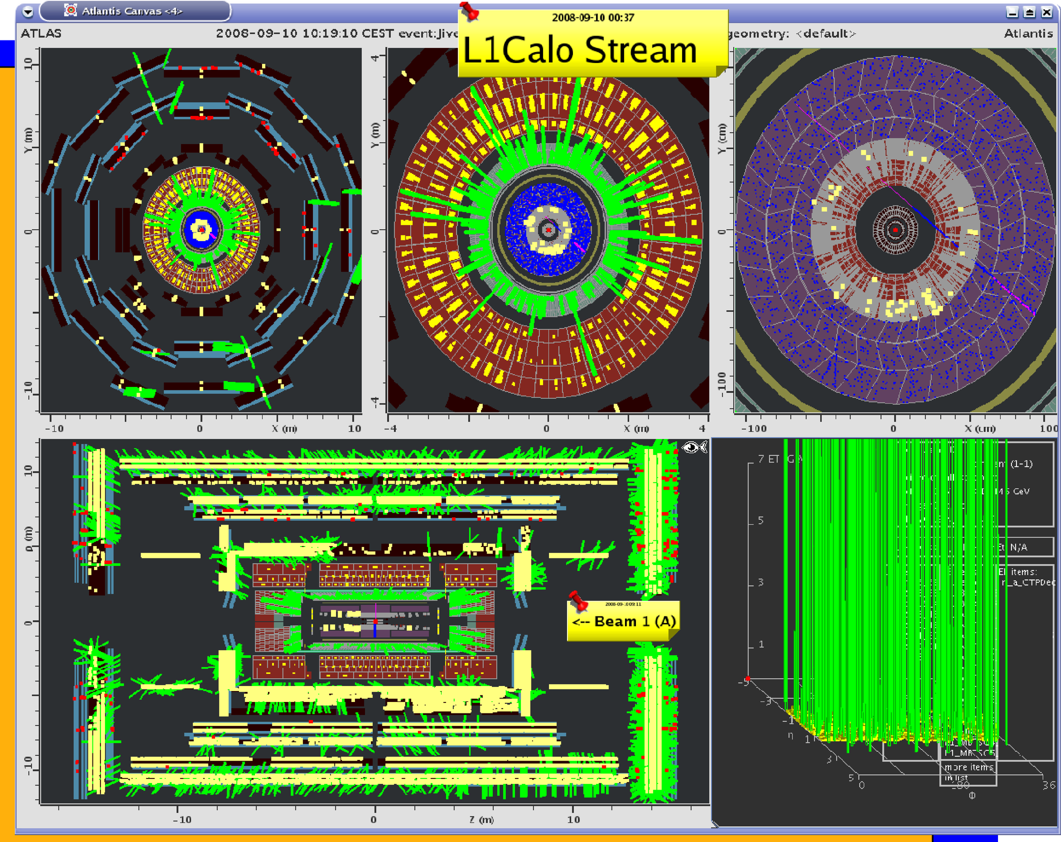
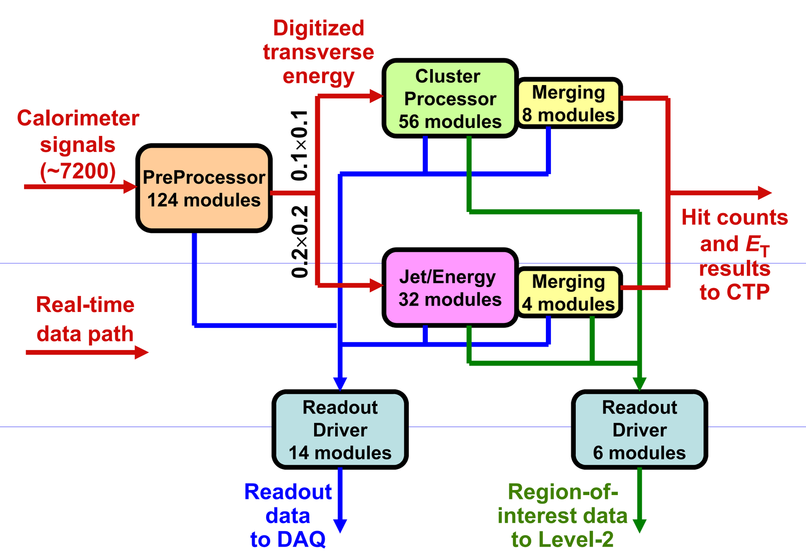
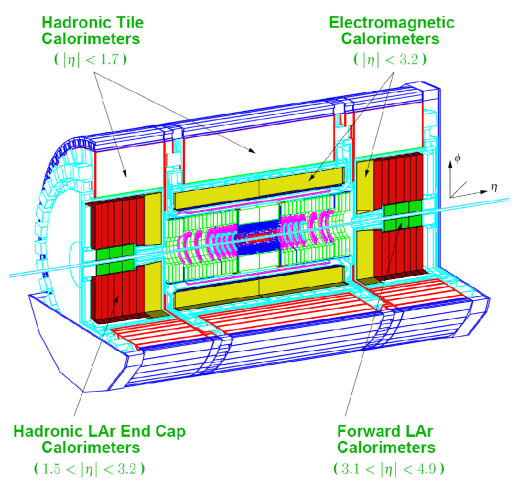


The ATLAS Level-1 Calorimeter Trigger

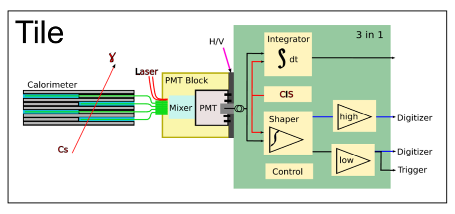


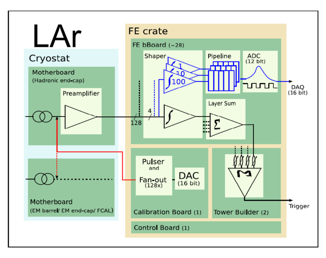
- Identify potentially interesting events
- Exclusive Objects: Electrons, Jets, Taus
- Inclusive Quantities: Missing E_T, SumE_T
- Based on Trigger Towers
  i.e. presummed Calorimeter signals
- Two step system
  - Preprocessing (Digitisation and Bunch Crossing Identification)
  - Processing (search for electron, jet and tau candidates, determination of Missing E_T and SumE_T)

Calorimeter Signals and Analogue Signal chain

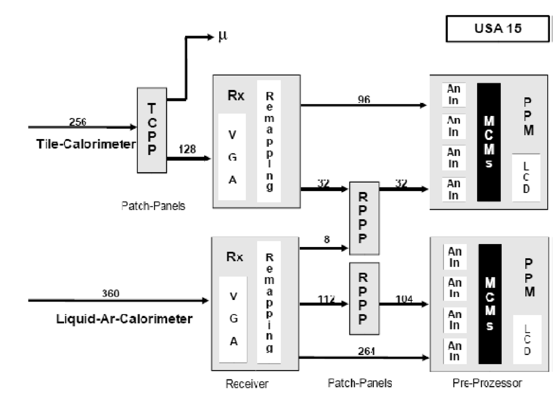


Calorimeters





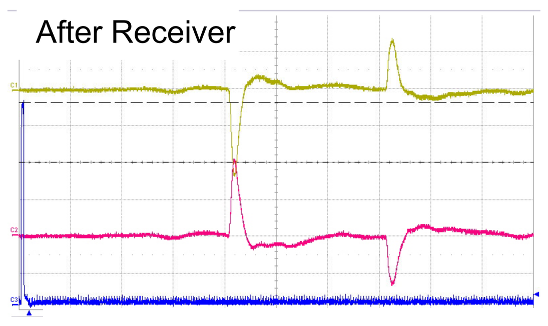
Front End electronics

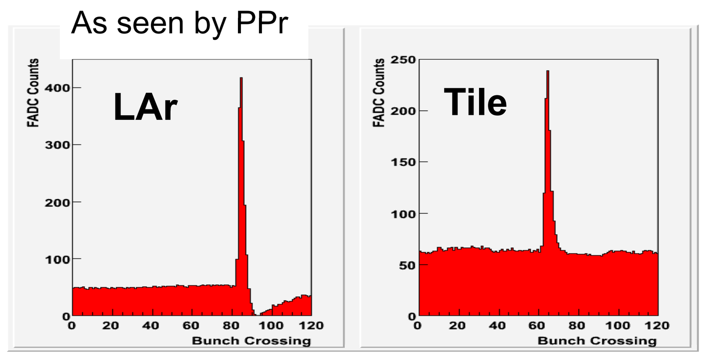


Cabling/Receiver/PreProcessor

Signal chain

- 250k calorimeter cells
- Summed up to 7200 Trigger Towers
- Routed with 70m analogue cables (differential signal)
- Calibration and E_T-conversion in Receiver system
- Routed through remapping boards
- Digitised in Preprocessor





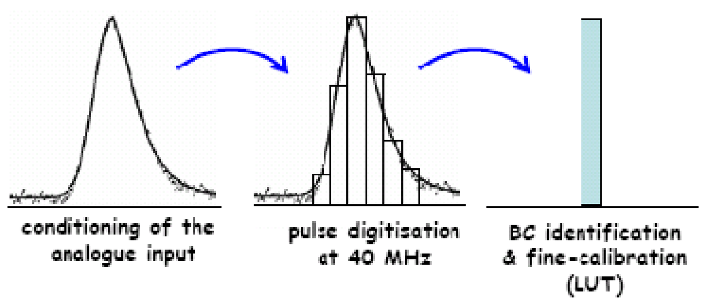
Pulser systems

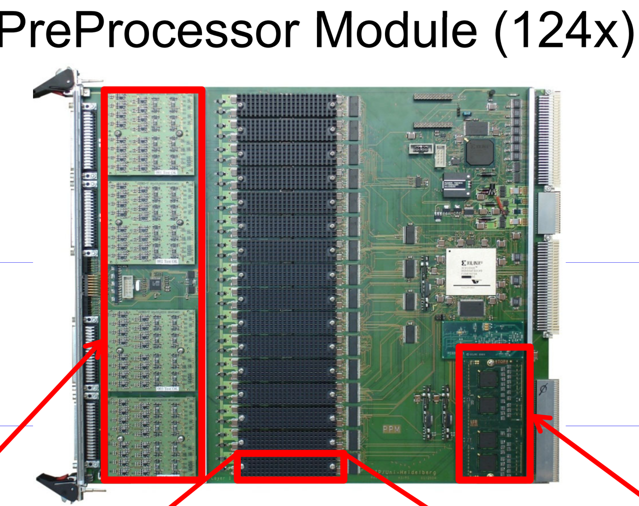
- LAr: electronic Pulser system
- Tile: Laser, Charge Injection System

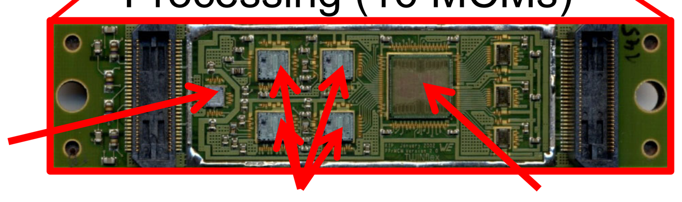
The PreProcessor System

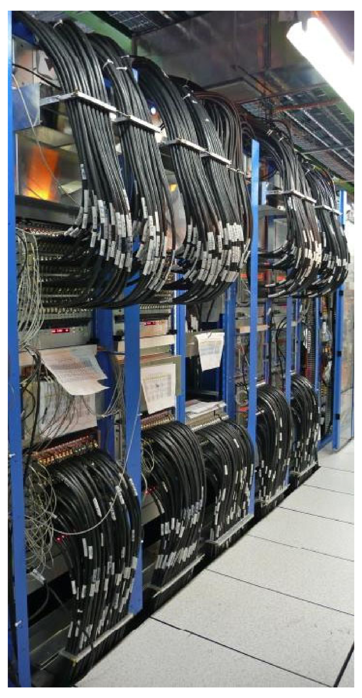
Objectives

- Conditioning of analogue input
- Digitisation of analogue signals
- Bunch Crossing Identification
- Noise Filtering
- Fine Calibration









Installed System

Signal Conditioning

- Pedestal level is set on the Analogue Input Boards using a 8 bit DAC

Processing

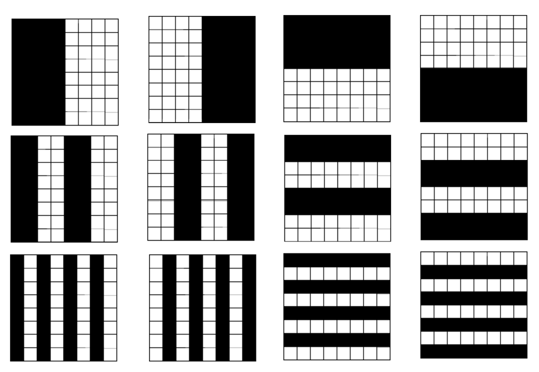
- Performed on a Multi Chip Module
- 4 FADCs controlled by timing chip with ns accuracy
- Finite Impulse Response (FIR) Filter for noise suppression
- Peak finder for Bunch Crossing Identifcation
- Look Up Table for noise cut and fine calibration

Output

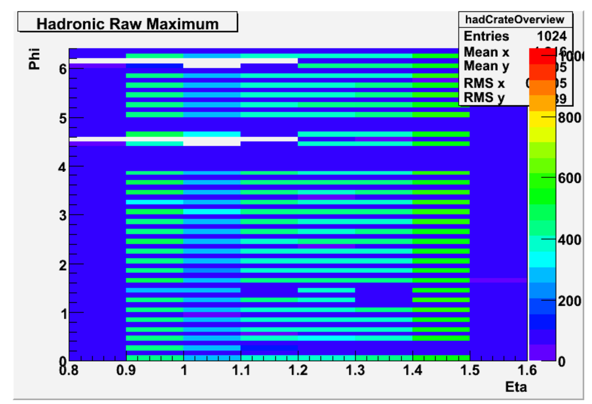
- Serializer chips and LVDS drivers

Connectivity tests

- Testing 7200 channels individually would be too time intensive to be checked unambiguously
- use special pulse patterns
- Reduced time needed substantially



Special pulse patterns



Signal test (indicating faulty channels)

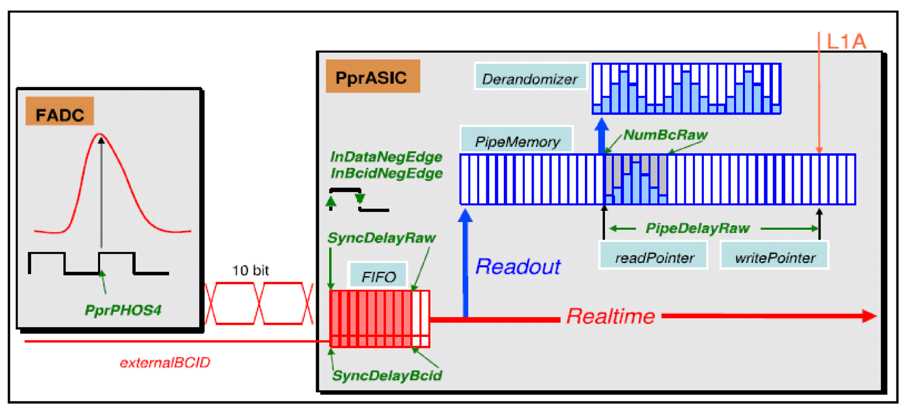
Timing Calibration

Readout- and Coarse input timing

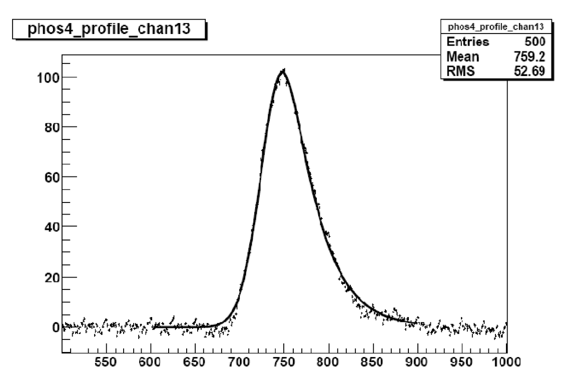
- Determined using a pulser run
- Input delay for adjustment of different cable lengths
- Determine point for pipeline R/O

Fine timing

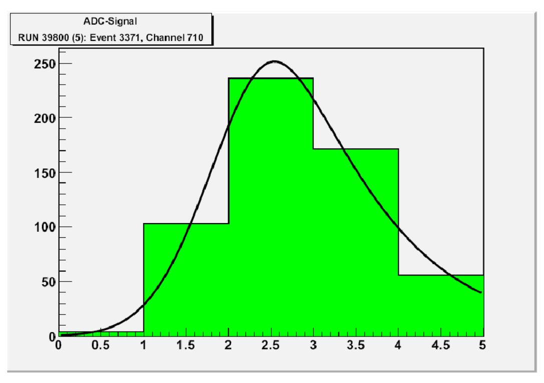
- Pulsers using a timing scan
- Data: fitting ADC slices



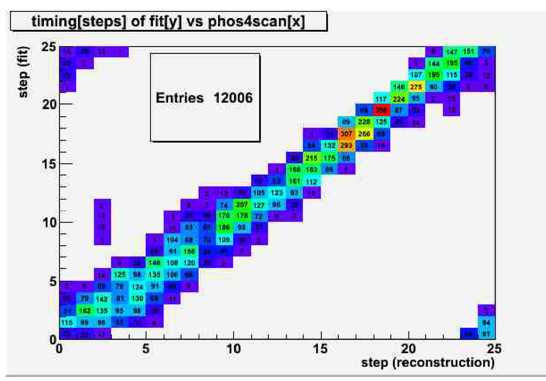
Data Flow Scheme



Timing scan (ns accuracy)



Signal pulse (fit overlayed)



Correlation (fit vs. scan)

Calibration Parameters and Strategy

Timing Calibration

- Input timing
  - coarse timing
  - fine timing
- Readout timing

Energy Calibration

- Receiver gain
- Pedestals
- FIR Filter settings
- Saturation settings
- noise cut
- Final ET determination

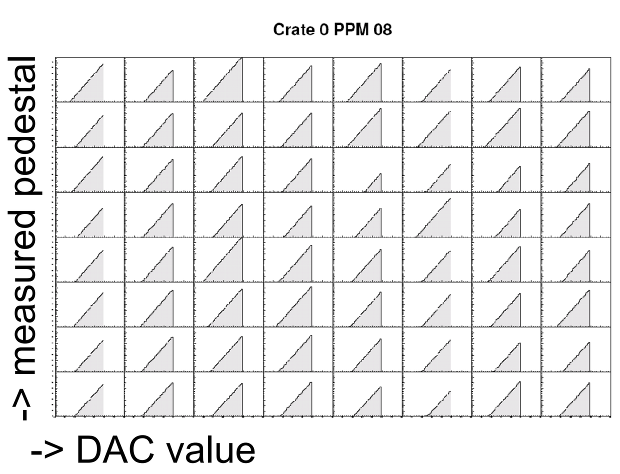
Strategy: stepwise procedure

1. Readout timing (R/O scan)
2. Coarse input timing (pulser runs, collision data)
3. Fine input timing (Fitting)
4. FIR settings (pulse shape ana.)
5. Noise cut (pedestal runs)
6. Energy calibration (pulser runs, collision data)

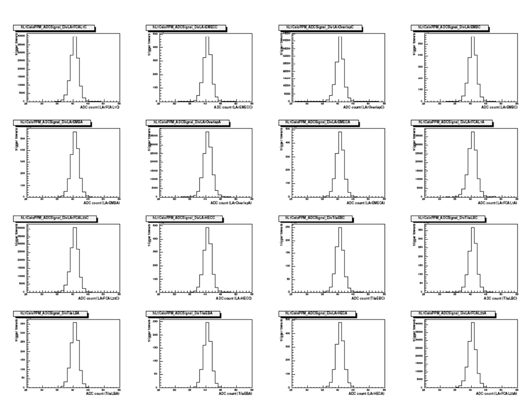
Pedestal Calibration and noise measurement

First step in energy Calibration

- Scan DAC values which condition the input signal
- measure pedestal (for each channel)
- Adjust pedestal to desired value



DAC-scan



Pedestal distributions

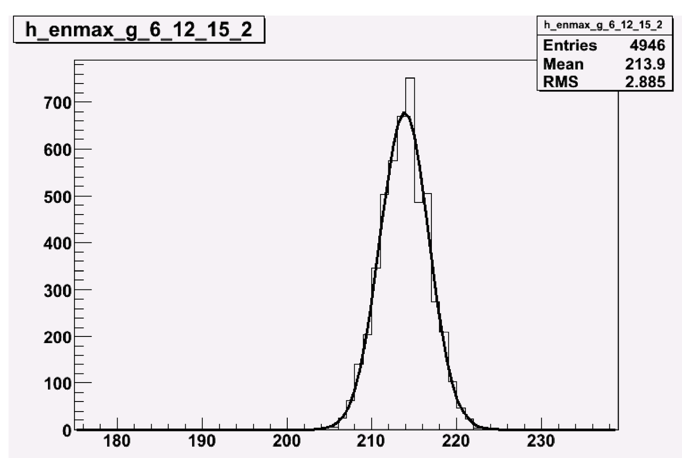
Energy Calibration

Initial Calibration

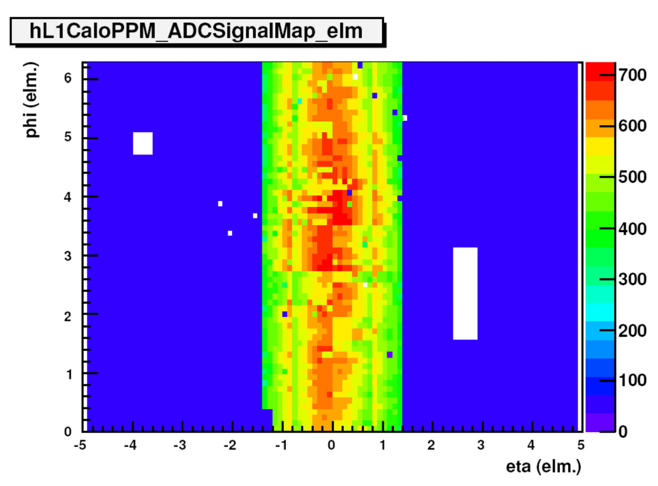
- Electronics calibration
- Pulser runs
- Take Calo R/0 as baseline
- Determine calibration constants
- Not sensitive to Calorimeter properties (HV settings, Impurities, Rad. damage)

Calibration with data

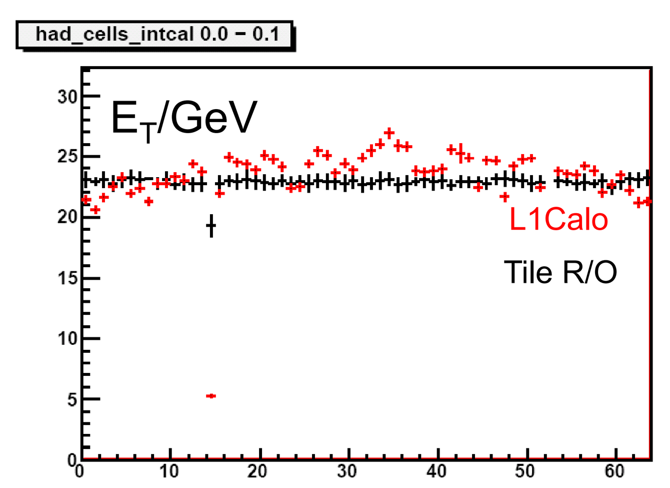
- after first collisions
- off-line data analysis



ADC-distribution for Tile Pulses



Pulse height or Lar Pulses (η – weighted)



Φ-sector