Monitoring the PPM

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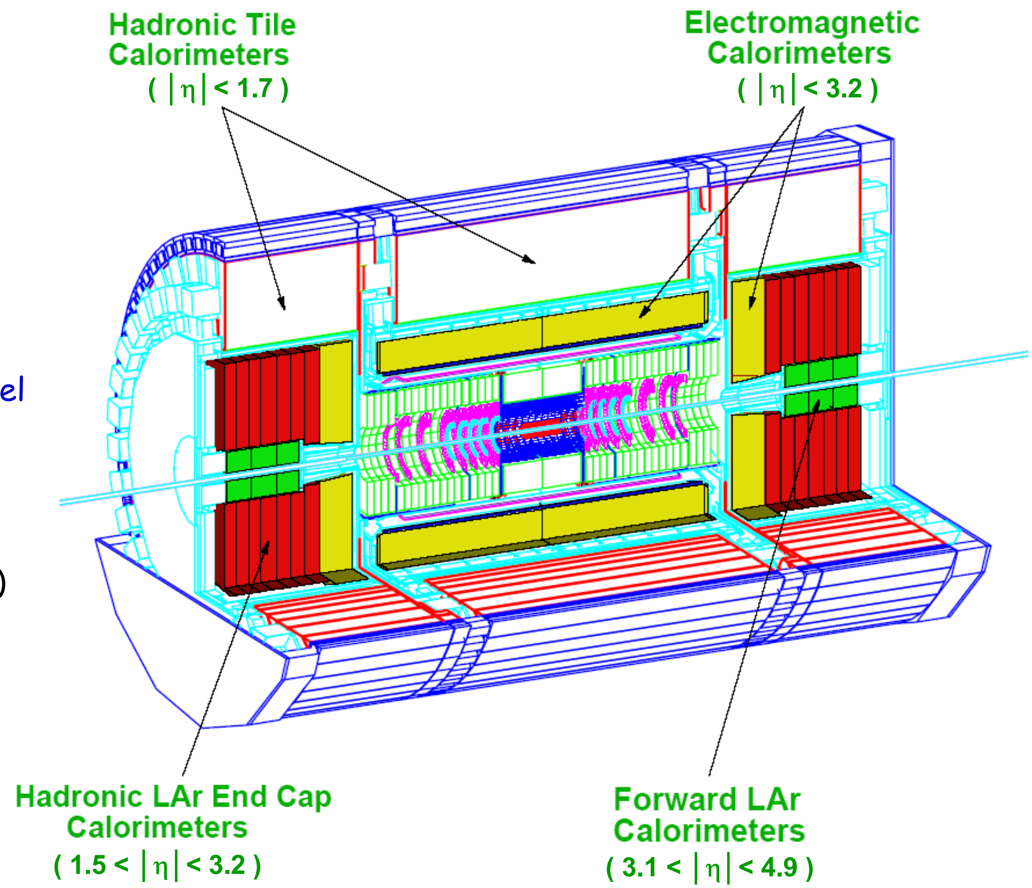
Overview

- ATLAS Calorimetry and Trigger System
- PreProcessor System/Module
- Monitoring the Cable Test Runs
- Event and Non-Event Monitoring

ATLAS Calorimetry

- **EM Calorimeters** (Barrel + Endcap)
  - accordion geometry
  - LAr (sensitive material) + Pb (absorber)
  - ~ 200,000 readout channels
- **Hadronic Calorimeters**
  - TileCal Barrel + 2x TileCal Extended Barrel (scintilating tiles embeded in iron absorber matrix)
  - EndCap (HEC) (LAr + copper)
  - ~ 21,000 readout channels (TileCal + HEC)
- **Forward Calorimeters**
  - integrated in Endcap cryostat
  - 1 EM layer (copper)
  - 2 Had layers (tungsten)
  - ~ 11,000 readout channels



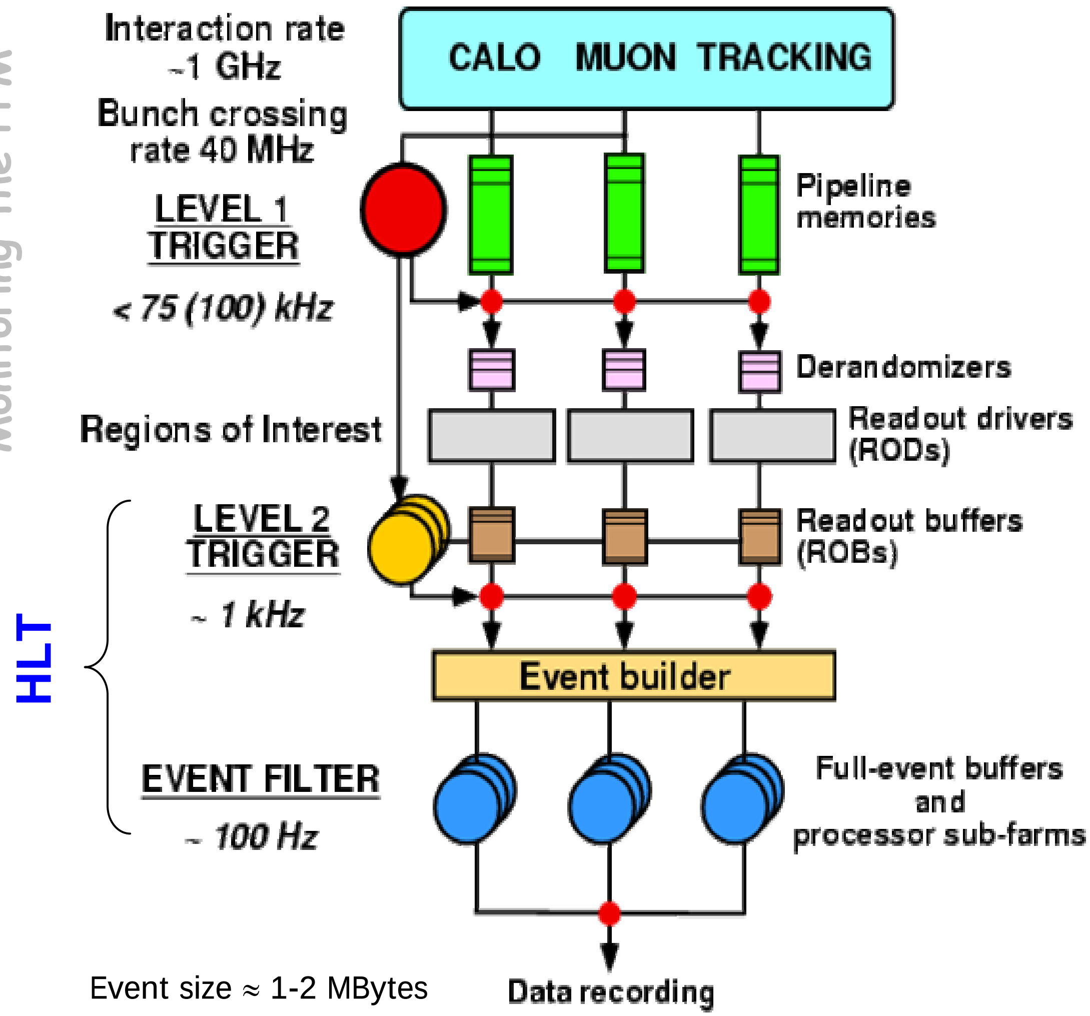
- rotational symmetry
- seamless e.m. ϕ-coverage and full hadronic coverage

Trigger Towers

- fine segmentation of the e.m. and hadronic calorimeters (over 230,000 cells)
- analogue summation over calorimeter cells (calorimeter front-end electronics)
- granularity of $\Delta\eta \times \Delta\Phi = 0.1 \times 0.1$ (for $|\eta| < 2.5$)
- variations up to $|\eta| < 4.9$
- separate sets of trigger towers for the e.m. and had. calorimeters
- ~ 7200 triger tower signals
- solely used as inputs for the LVL1 Calorimeter Trigger

ATLAS Trigger System

Monitoring the PPM



LVL1

- fixed latency 2.5 μs
- hardware-based (ASIC, FPGA)
- coarse granularity calorimeter and muon p_T

LVL2

- latency ~ 10 ms
- special algorithms
- uses ROI as identified by LVL1
- access to all sub-detectors
- full granularity and fast rejection

EF

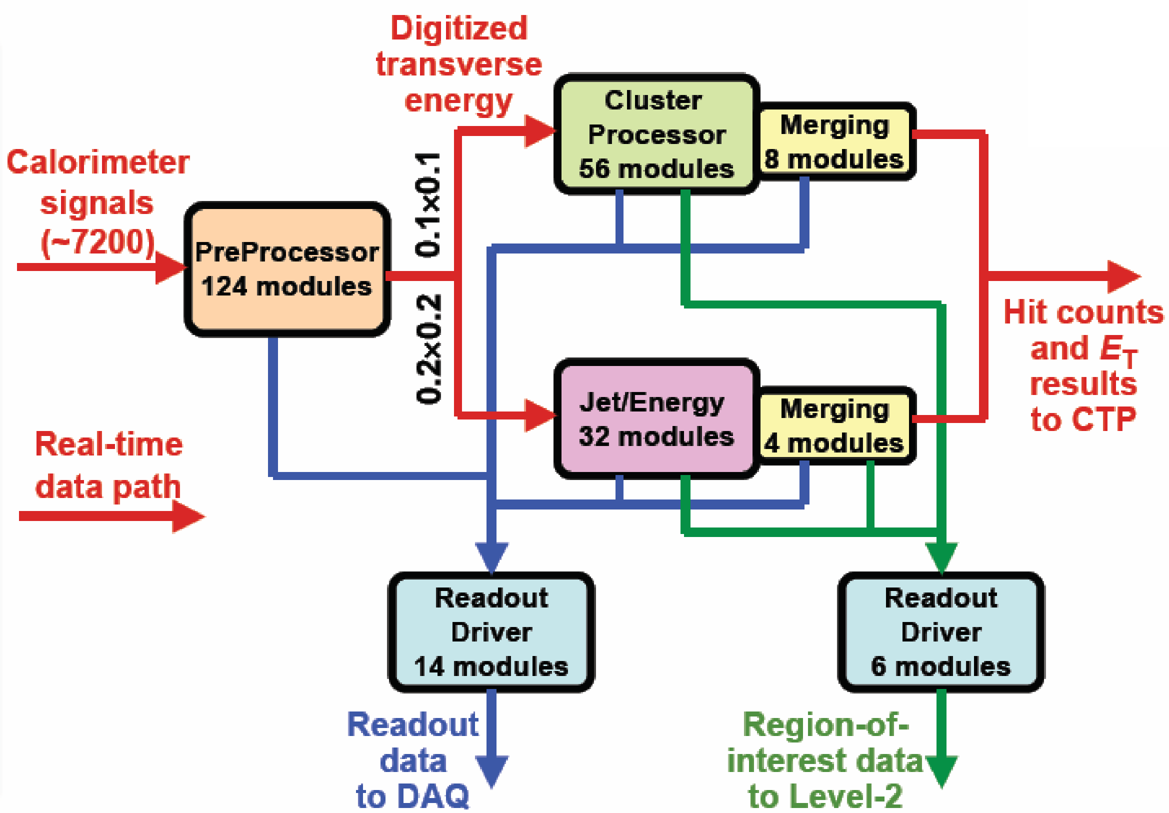
- latency ~ 1 s
- off-line algorithms
- access to full event data

L1 Calo Trigger

Monitoring the PPM

Features

- Real-time data path: <1 μs fixed-latency pipeline
- Many processing stages
- Massive parallelism: ~300 Gbyte/s input
- Complex connectivity: sliding-window algorithms
- Multi-purpose modules (CMM, ROD, backplane)
- Heavily FPGA-based, only one ASIC
- Algorithms specified in ATL-DAQ-2004-011



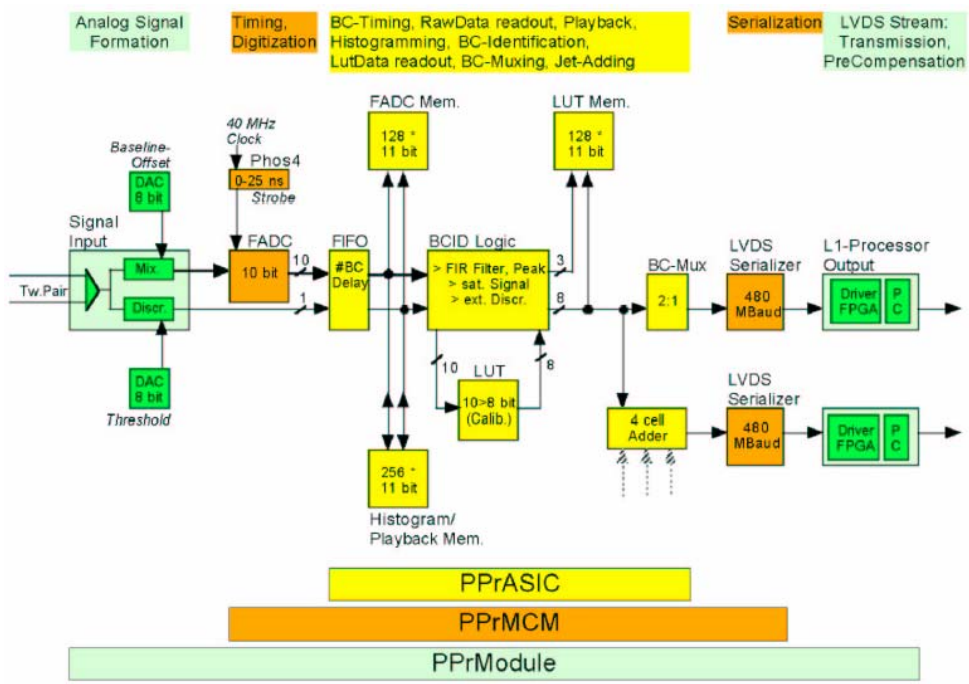
Five main types of custom 9U modules	PPM	CPM	JEM	CMM	ROD
	Heidelberg	UK	Mainz/ Stockholm	UK	UK

Taken from *Level-1 Calorimeter Trigger Status*, Eric Eisenhandler, ATLAS Overview Week, Stockholm, 12 July 2006

PreProcessor System

Monitoring the PPM

- consists of **8 crates**, each of which equipped with **16 PreProcessor Modules** (PPM), that can each receive and process **64 analogue inputs (trigger towers)**
- **real-time path**
  - analogue signal conditioning and digitisation
  - time alignment (1ns resolution)
  - bunch-crossing identification
  - energy calibration (using LUT)
  - providing input to subsequent processors (CP, JEP)
  - data serialisation

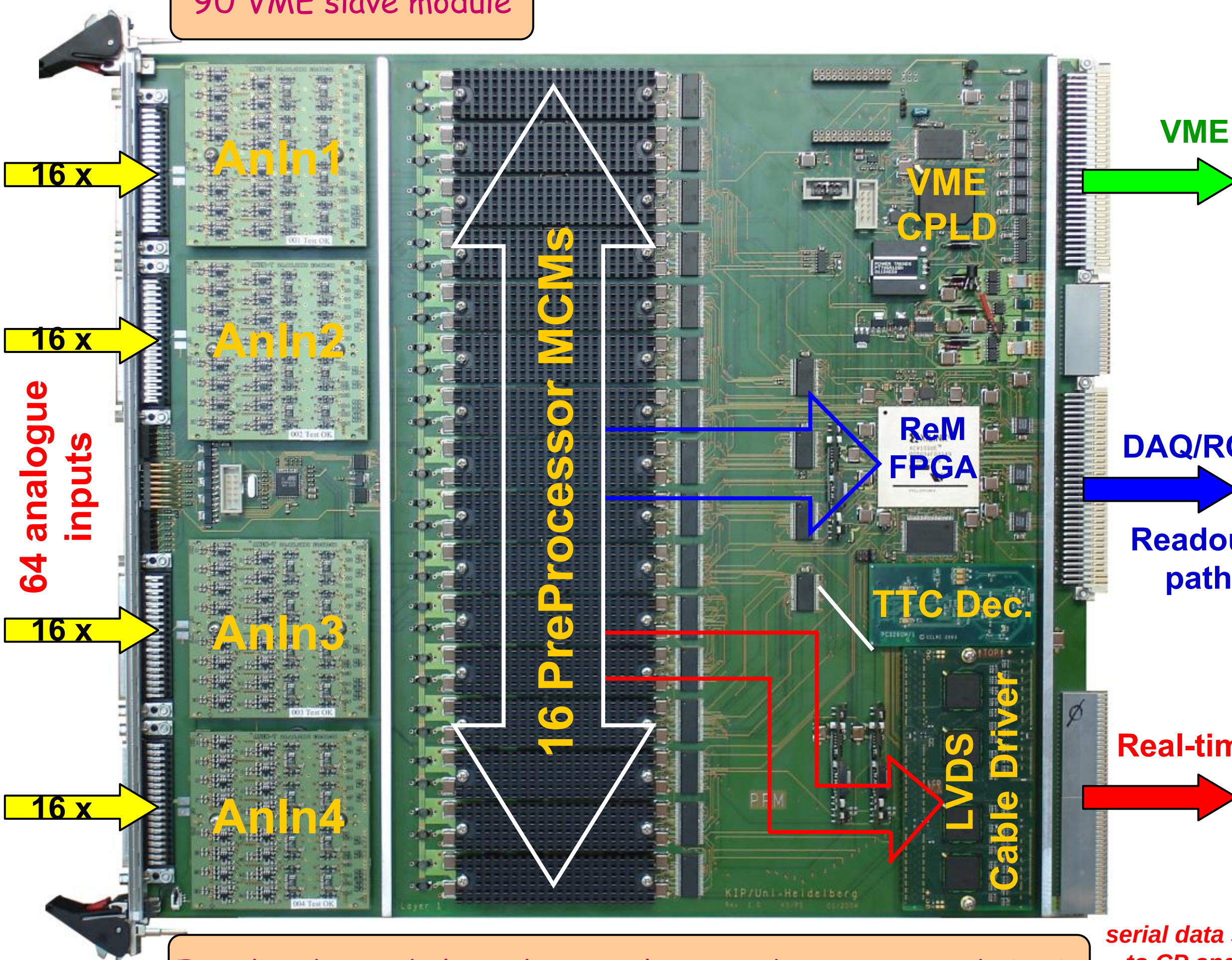


Block-diagram of the pre-processing for one trigger channel

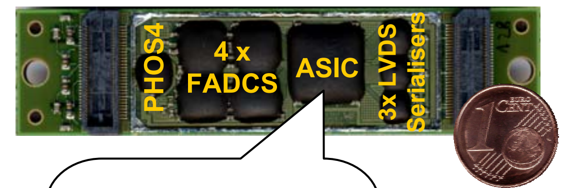
- **readout path**
  - pipelined readout of monitoring data to document the trigger decission
  - extra features:
    - data playback for technical tests of the Level-1 Trigger System
    - real-time histogramming and rate-metering

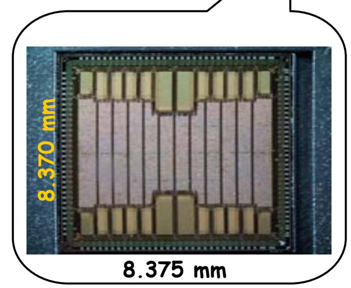
PreProcessor Module

9U VME slave module

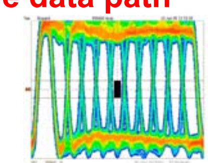


MCM • mini PCB, contains 9 dice





PPM • total latency contribution to the L1 pipelined system is 15 LHC clock cycles (17 estimated in TDR, 1998)



serial data stream to CP and JEP processors

Fast hard-wired algorithms implemented in ASICs and MCMs

PPM Readout

- PPM provides two readout interfaces (from software point of view):
  - VME → crate controller CPU
  - G-Link → DAQ system via RODs
- both interface to ReM FPGA → collection, formatting and transmission of PPM data
- **VME Readout**
  - event based and non-event based
  - readout buffer depth
    - 128 (FADC + BCID) samples per PPM channel
- **G-Link Readout**
  - event based
  - bandwidth limitation for high L1A rate:
    - 5 FADC plus 1 LUT/BCID samples per PPM channel

Monitoring the PPM

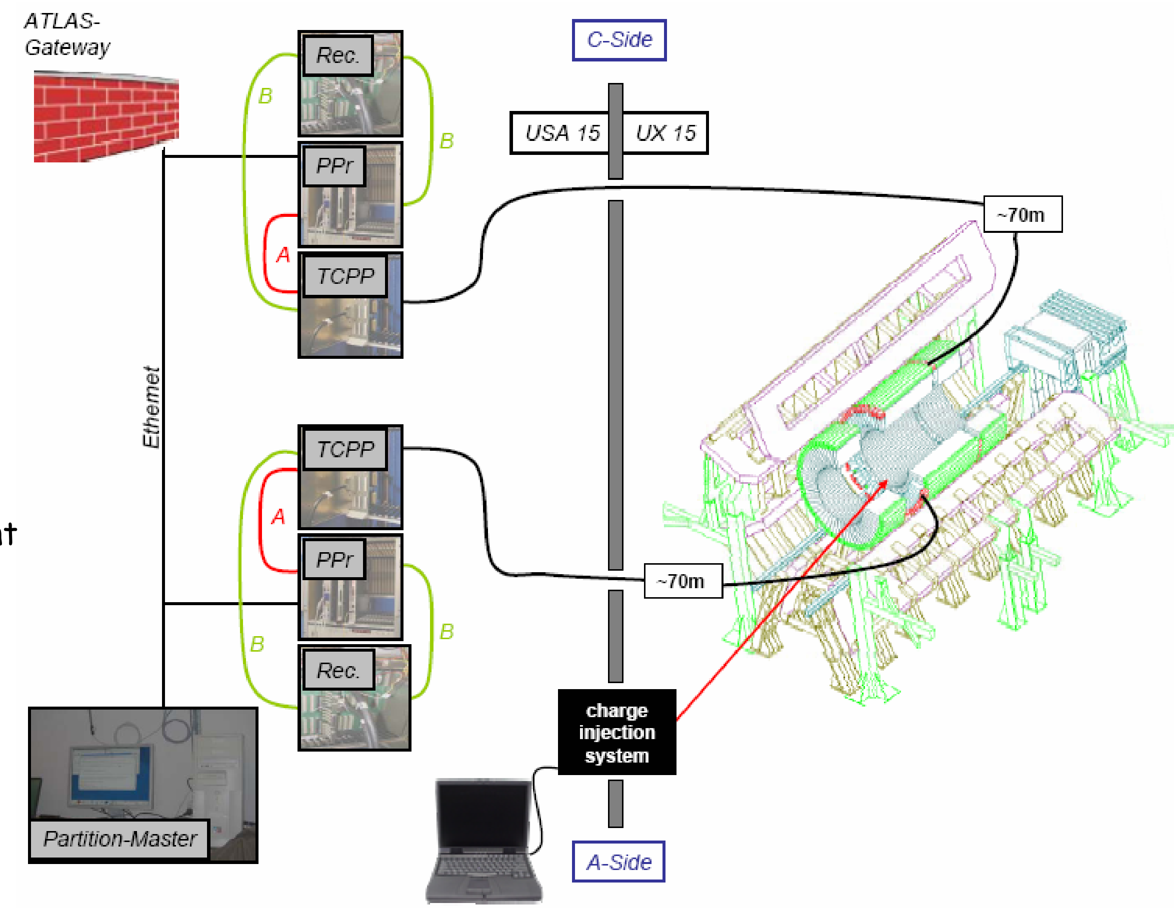
- **physical aspects of the hardware**: module temperatures, supply voltages, etc (to be handled by DCS)
- **non-event based data** (read out periodically)
  - e.g. rate metering and histogramming
- **event based data** (accepted events)
  - e.g. performance of the trigger, data taking quality check, etc.

- *sources* of monitoring data
  - non-event based readout → rate maps
  - event based readout → FADC raw data, LUT/BCID

- first monitoring application → *cable tests runs*
  - PPM readout used only in VME mode

Monitoring the Cable Test Runs (1/2)

- test connectivity, cable pin mappings, trigger timing, s/w
- pedestal/noise studies, signal reconstruction
- **Hardware setup:**
  - calibration signal + trigger received from Tile or LAr calorimeters (barrel region)
  - analogue cables through TCPP and/or Receiver Statations
  - 2 *PPMs* installed in two different crates/racks
- **Software:**
  - standard TDAQ system (e.g. read events from PPM)
  - data stored in appropriate files (*formatted VME buffers*) after each run



Taken from *CERN PPM Status: Tests and Software*, Florian Föhlisch, L1Calo Meeting, Heidelberg, 15 March 2006

Monitoring the Cable Test Runs (2/2)

- two general purpose packages available in the L1Calo Online Software to monitor the PPM data during the cable test runs

PPM Decoder

- decodes the VME readout buffer and provides *bytestreamDecoder-like objects* (Rdos), and the original PPM VME data for output
- current development considers only event based data

PPM Monitoring

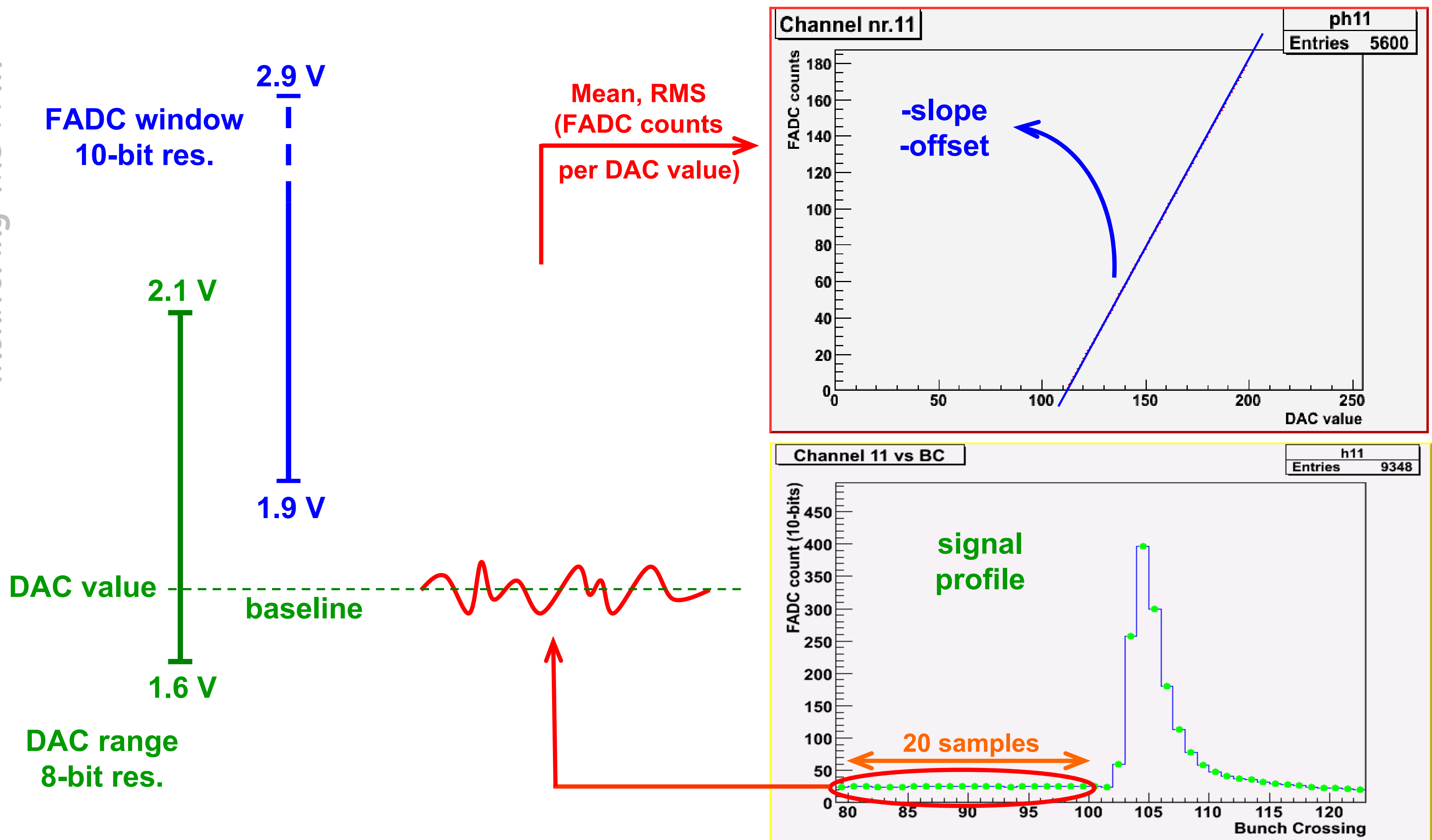
- creates and fills a collection of histograms based on the decoded VME data (PPM Decoder)
- run types: DAC scan, FIFO scan (pedestal) and PHOS4 scan (1ns time adjustment)
- application to collect and export the histograms to the OH server and display them with a dedicated tool (PMPpresenter)
- Documentation: ***Monitoring the Cable Test Runs***, V. Andrei, Software Note 019, May 2006

  (http://hepwww.ph.qmul.ac.uk/l1calo/sweb/documents/doclist.html)

Data Content of PPM Readout

- event data (scan parameter and the corresponding FADC counts) stored in files
- these files are used as input by PPM Monitoring
- **DAC Scan**
  - determines and sets a programmable pedestal for PPM channels (same pedestal)
  - DAC setting (scan parameter) on all PPM channels is ramped (1 LSB step) while reading out the scan parameter and the corresponding raw data (FADC counts)
  - check linearity of the system (DAC value vs. FADC counts) → determine DAC setting corresponding to the desired pedestal value (40 FADC counts, on next slides)
- **FIFO Scan**
  - estimates the pedestal value in each PPM channel (using the DAC setting previously determined)
  - data: scan parameter (PHOS4 delay, set to 12) and FADC counts corresponding to each channel
- **PHOS4 Scan**
  - determines the optimal PHOS4 delay for each PPM channel
  - the run scans through all PHOS4 delay (from 0 to 24 ns, in steps of 1 ns) to find the precise timing of each PPM channel
  - data: scan parameter (PHOS4 setting) and FADC counts corresponding to each channel
- characteristic information to each run is extracted, histogrammed and displayed

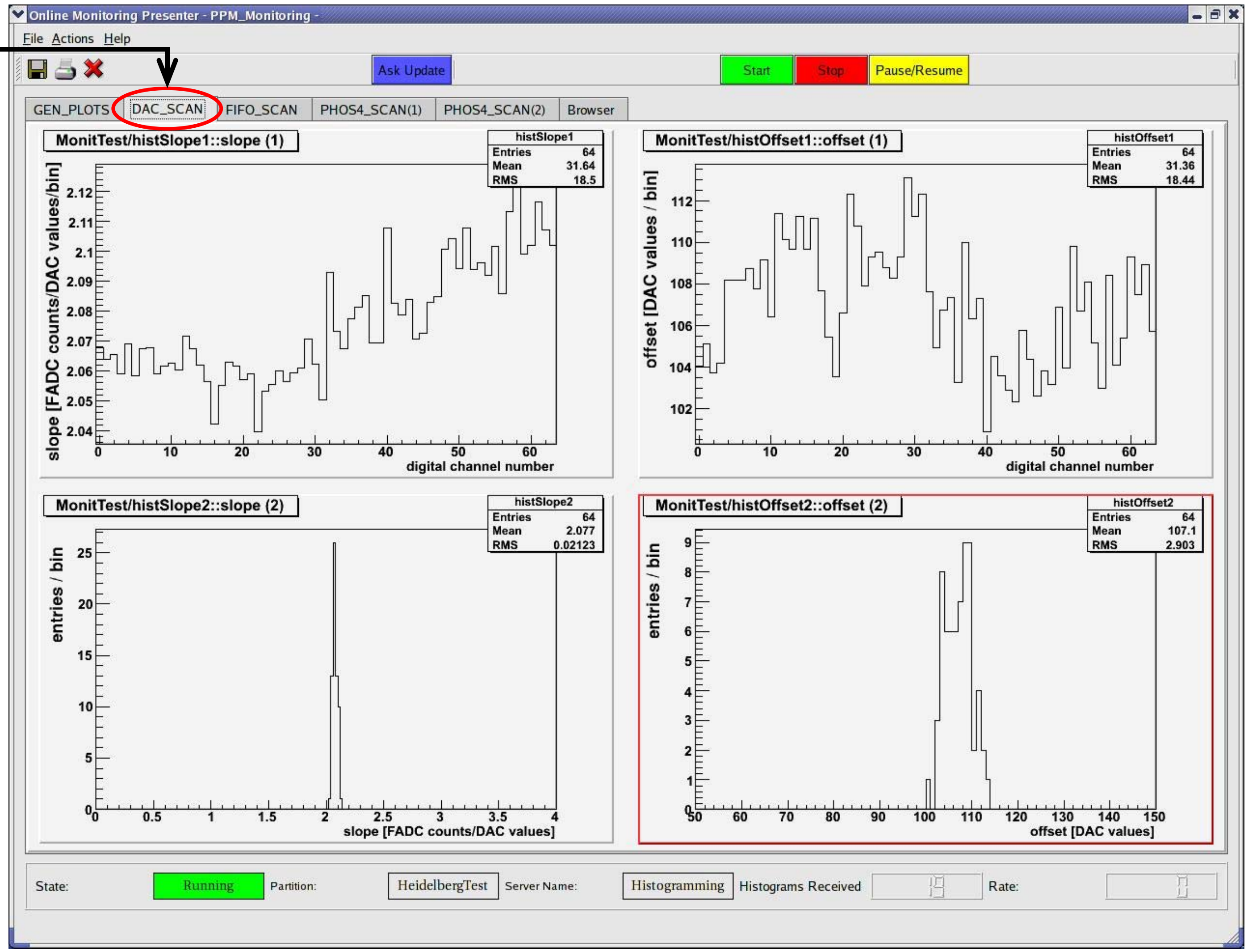
PPM DAC Scan Runs



Results (1/5)

Monitoring the PPM

DAC Scan

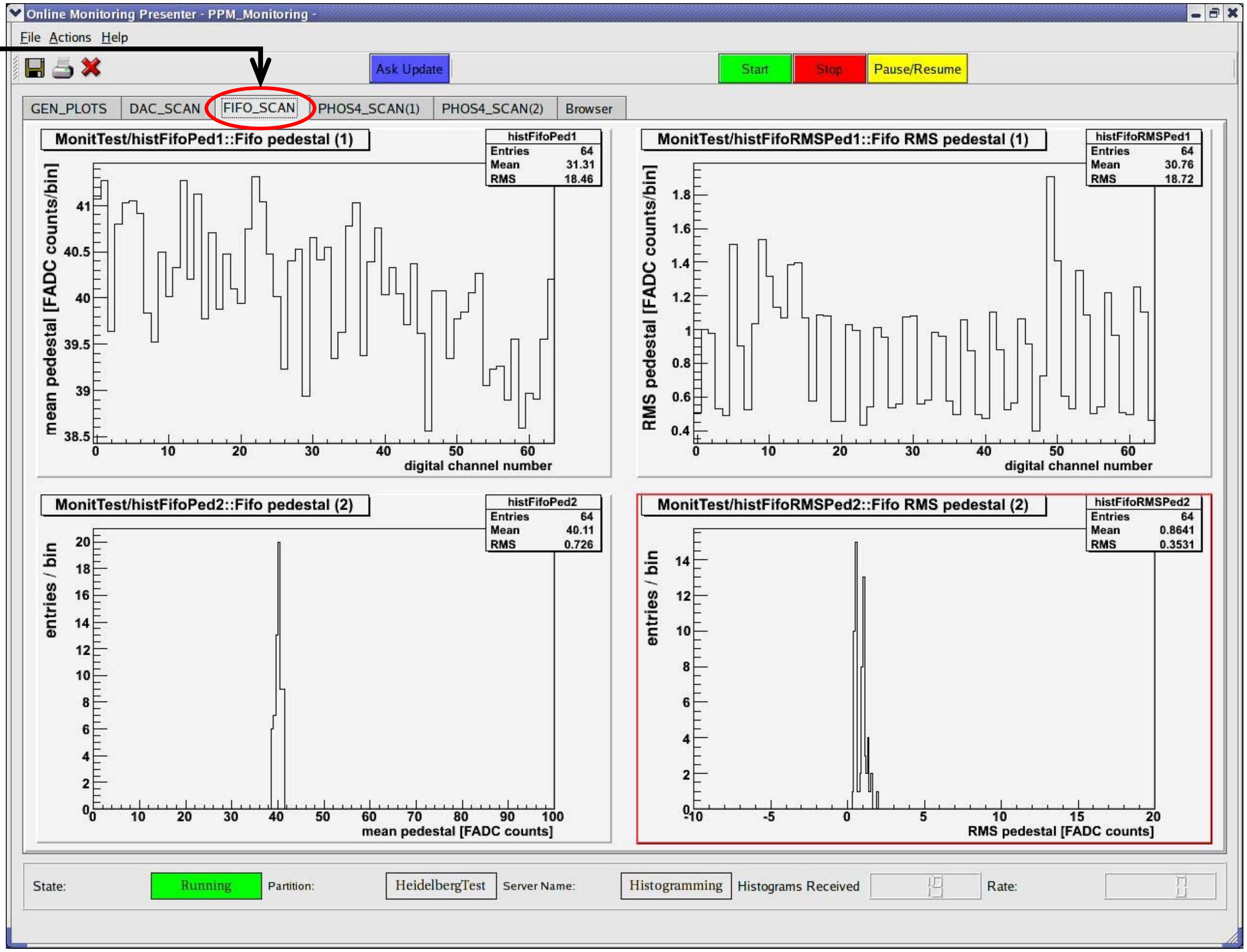


- plots using real PPM event data (taken during tile cable tests at CERN)
- displayed with PMPpresenter (Online Monitoring Presenter)
- check linearity of the system (slope and offset)

Results (2/5)

FIFO Scan

- estimate the pedestal (mean and rms) in each PPM channel (noise determination)

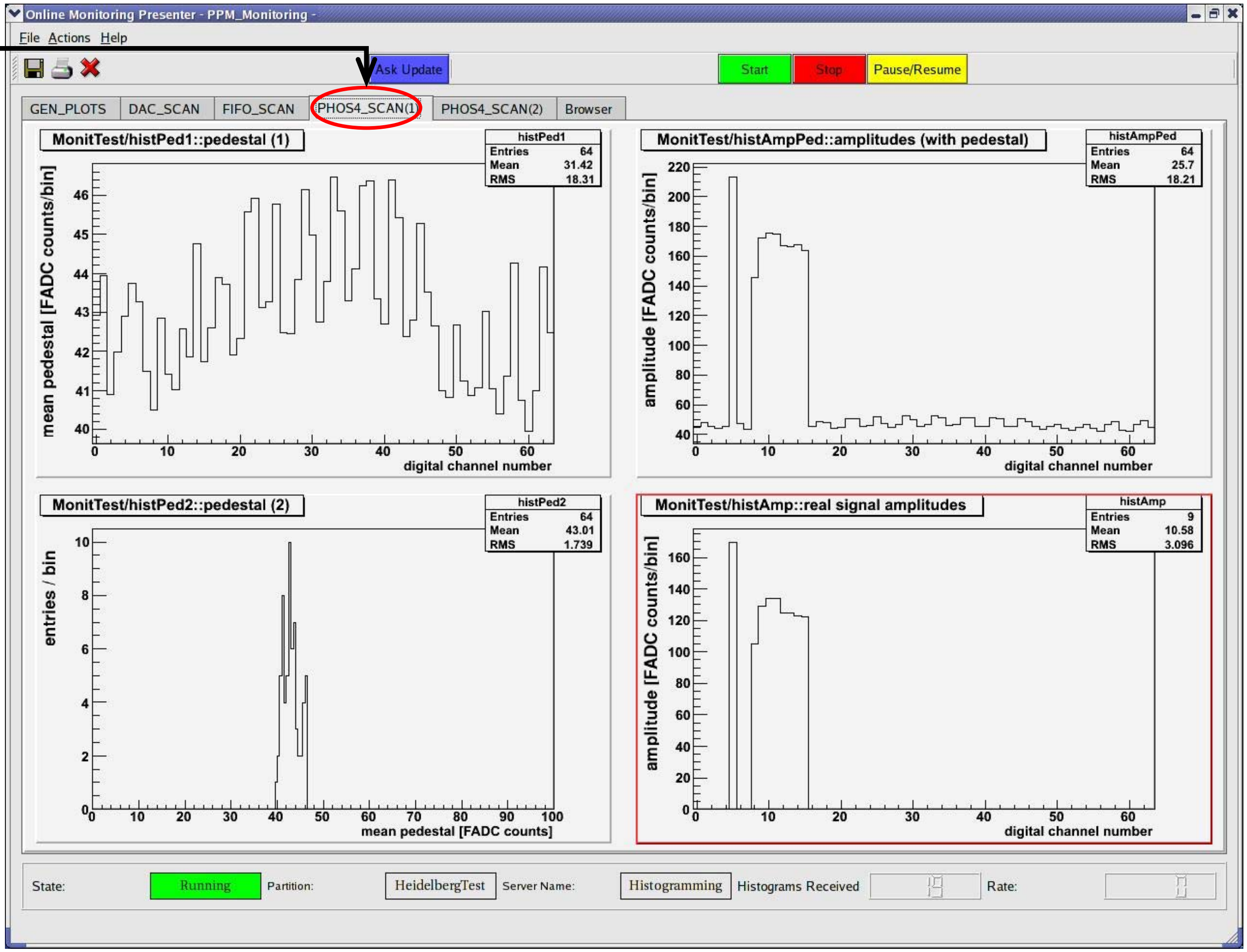


Results (3/5)

Monitoring the PPM

PHOS4 Scan (1st panel)

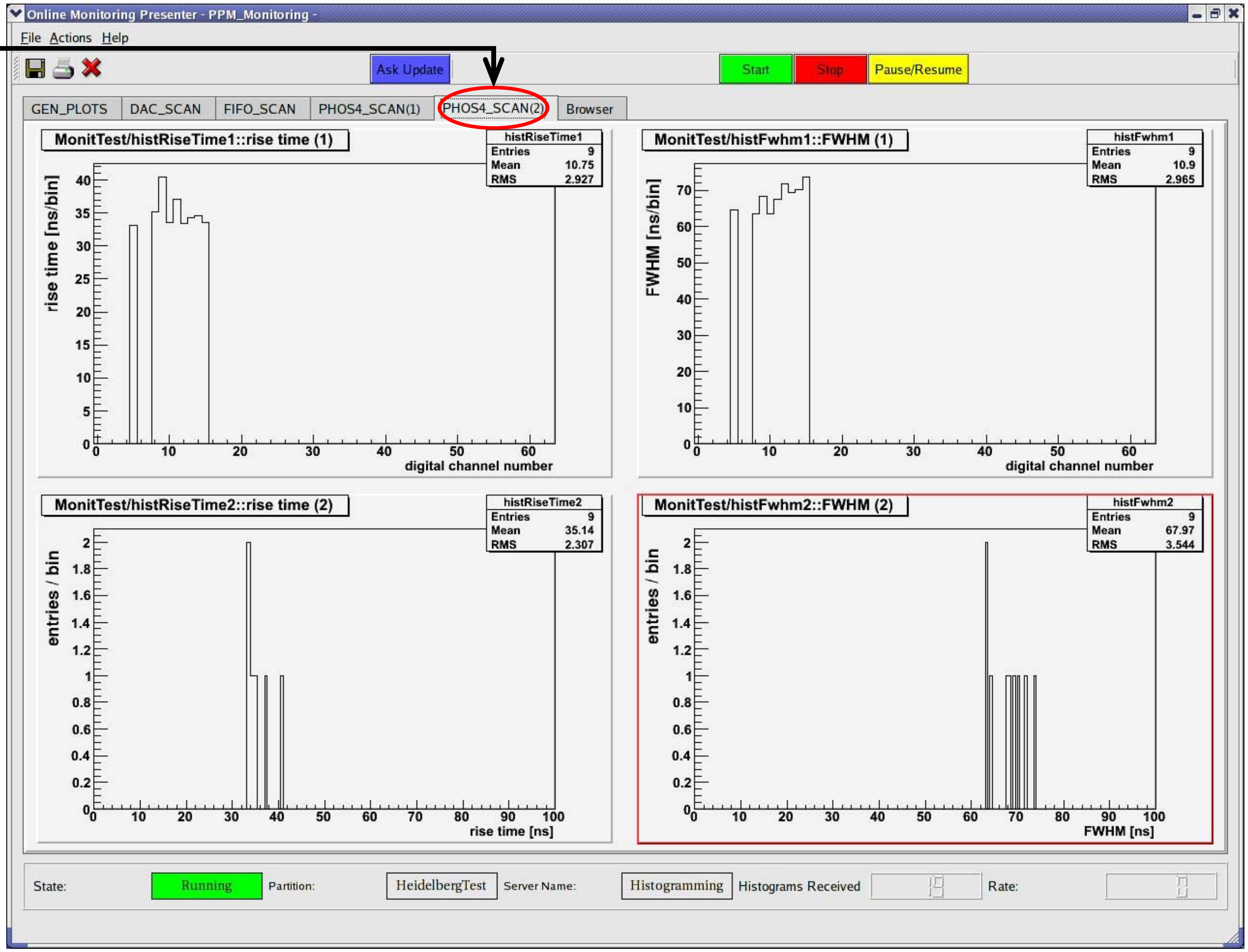
- 1ns sampling of the pulse
- pedestal determination (using the first 500 samples)
- find the signal amplitude and subtract the determined pedestal



Results (4/5)

PHOS4 Scan (2nd panel)

- rise time
- full width at half maximum (FWHM)



Results (5/5)

Readout Statistics

- number of times a PPM channel was read out during the run

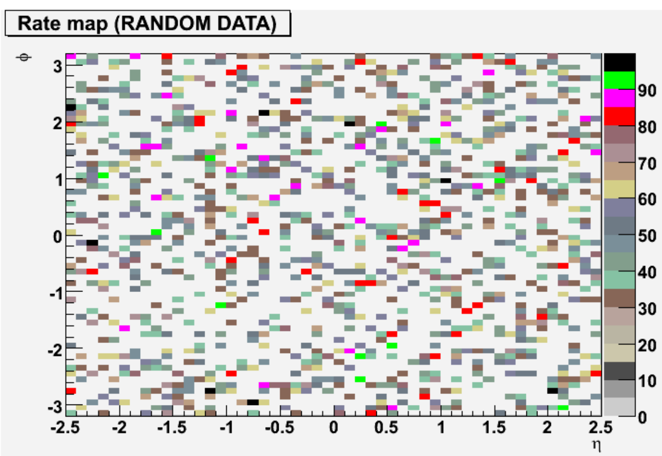
Non-event based readout

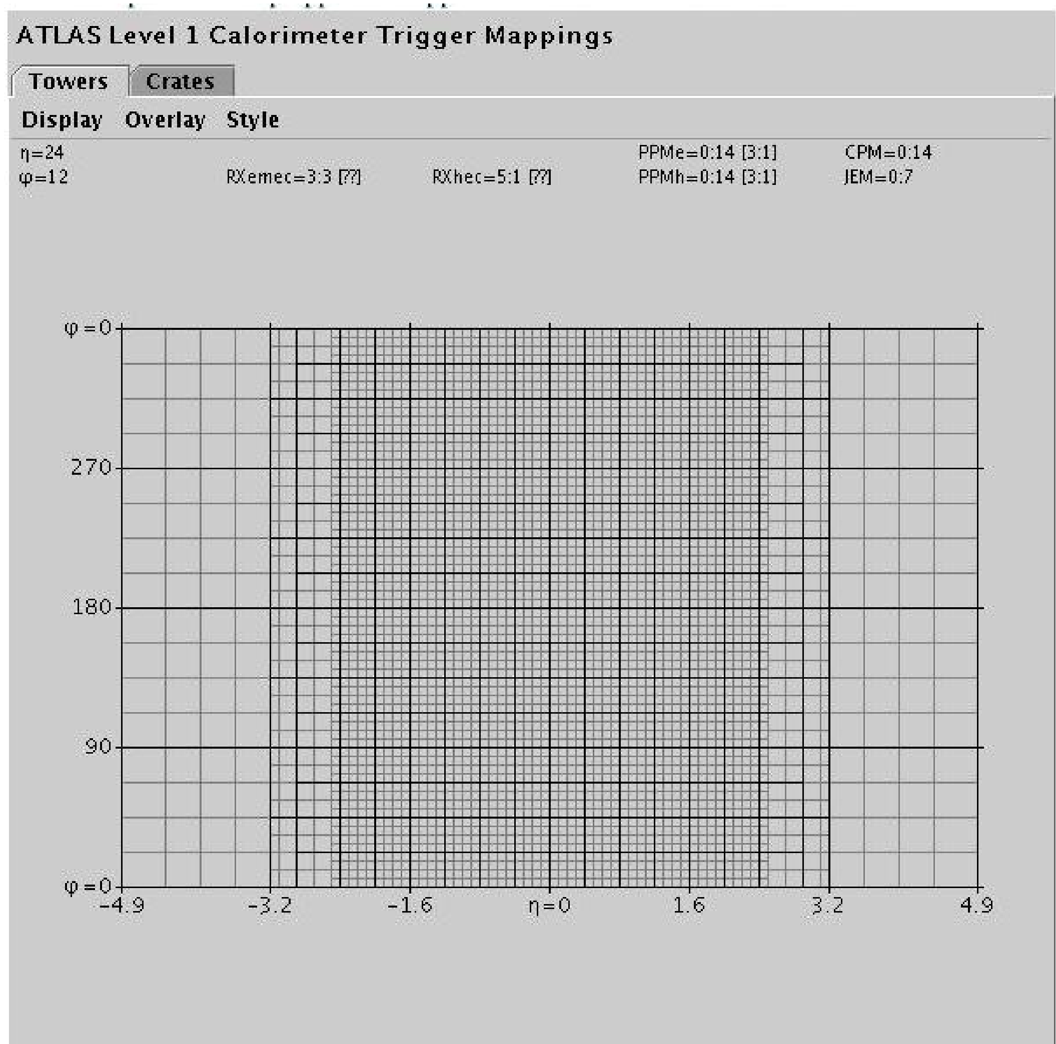
- available only via VME (not accessible through standard ATLAS DAQ)
- periodic readout with programmable frequency
- PreProcessor has diagnostic features implemented in PprASIC
- rate maps and energy spectra (per trigger tower)
  - with programmable thresholds

- low threshold to analyse noise characteristics
- high threshold to analyse energy flow/activity

Rate Metering (e.g.)

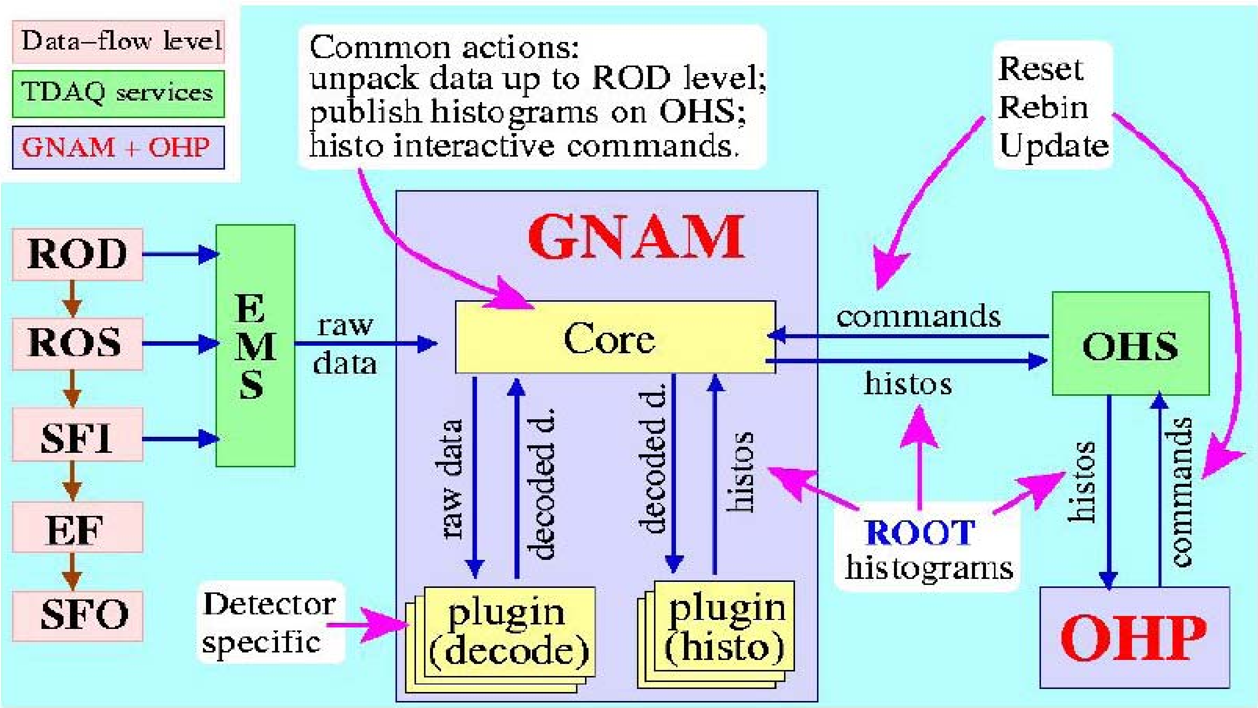
- number of times a certain energy threshold is passed in a given time interval (per trigger tower)
- every bunch-crossing taken into account
- java tool to display mappings of trigger towers to the modules of L1Calo trigger (M.Landon,2001)
- needs some modifications (crates, modules) but can be used as web application for rate metering





Event based readout (GNAM)

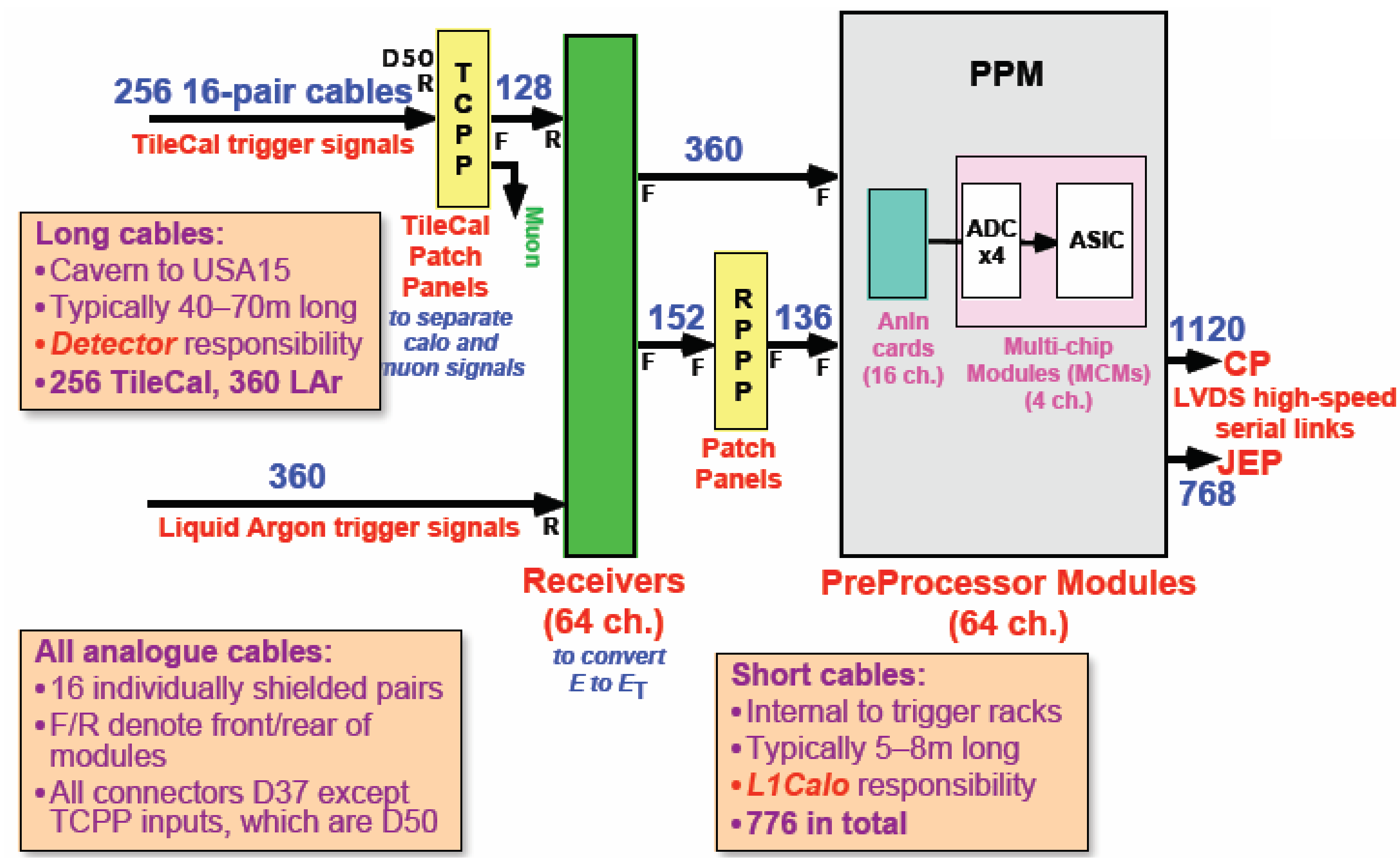
- **GNAM**
  - Online Monitoring structure developed to monitor the ATLAS detectors at all data flow levels
  - modular framework based on FSM Core
  - detector specific code implemented in dynamic libraries
- **OHP** →application to display the histograms
- L1Calo GNAM monitoring meeting → 19 – 22.07 (CERN)



BackUp Slides

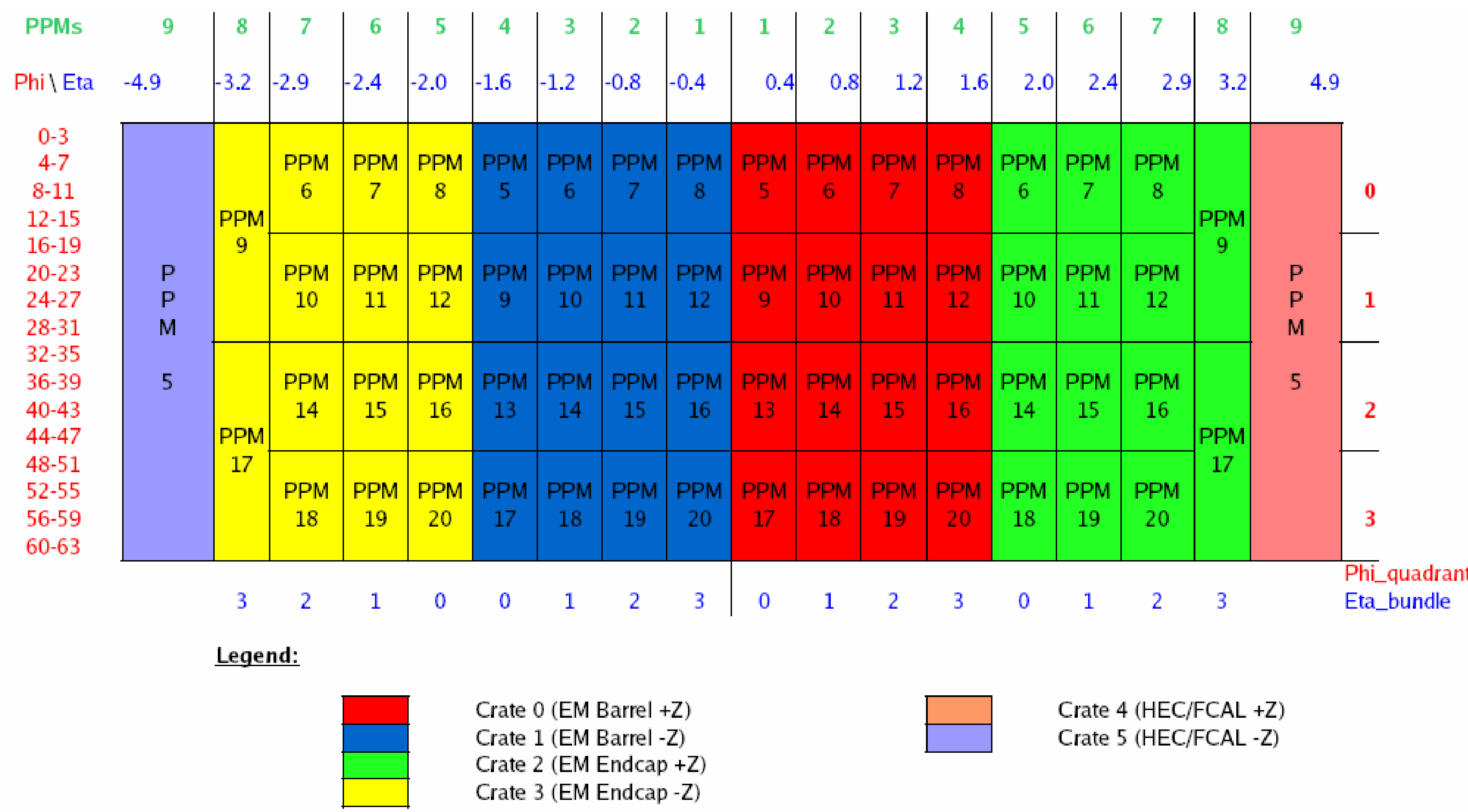
L1 Calo Trigger (front-end)

Monitoring the PPM

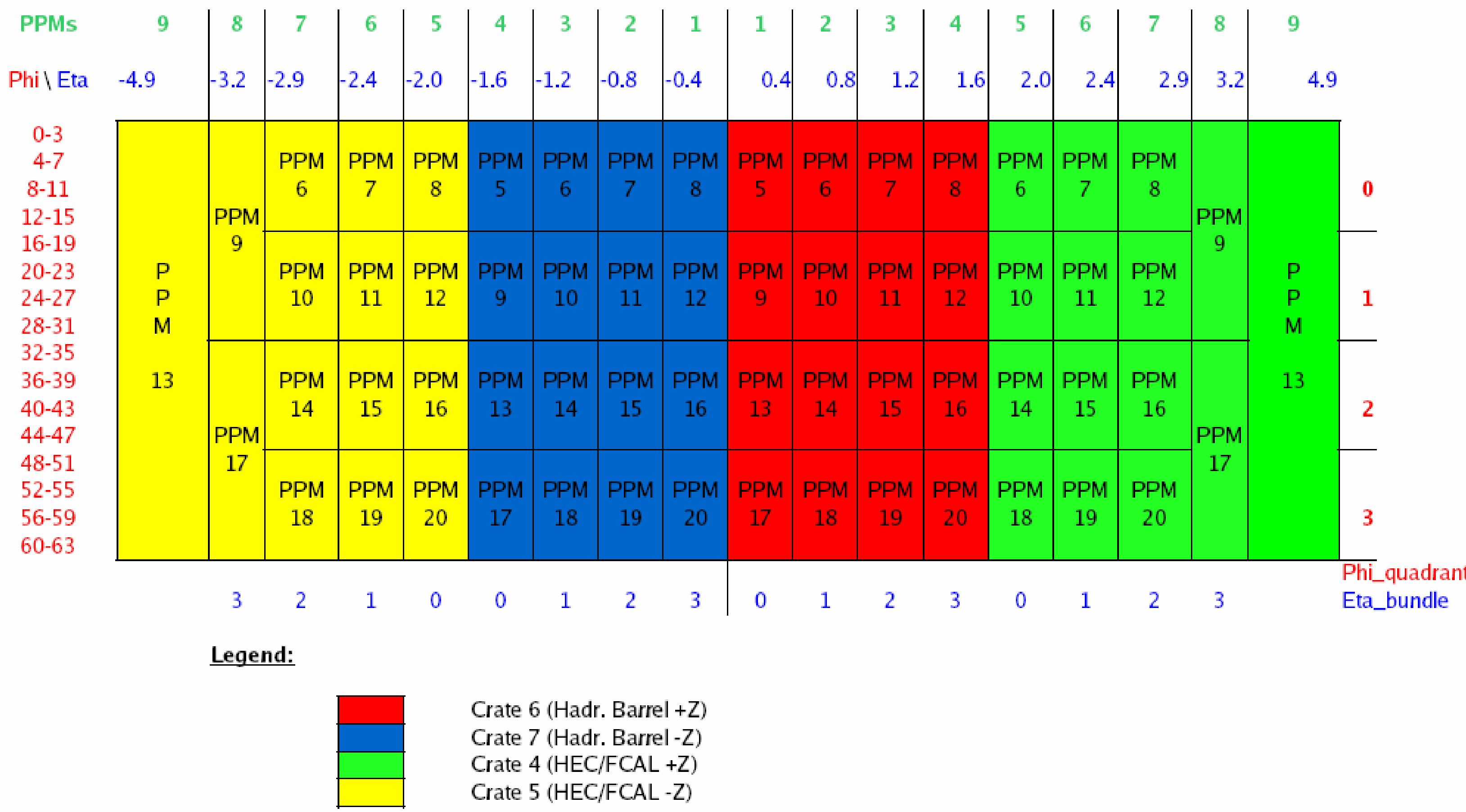


Taken from *Level-1 Calorimeter Trigger Status*, Eric Eisenhandler, ATLAS Overview Week, Stockholm, 12 July 2006

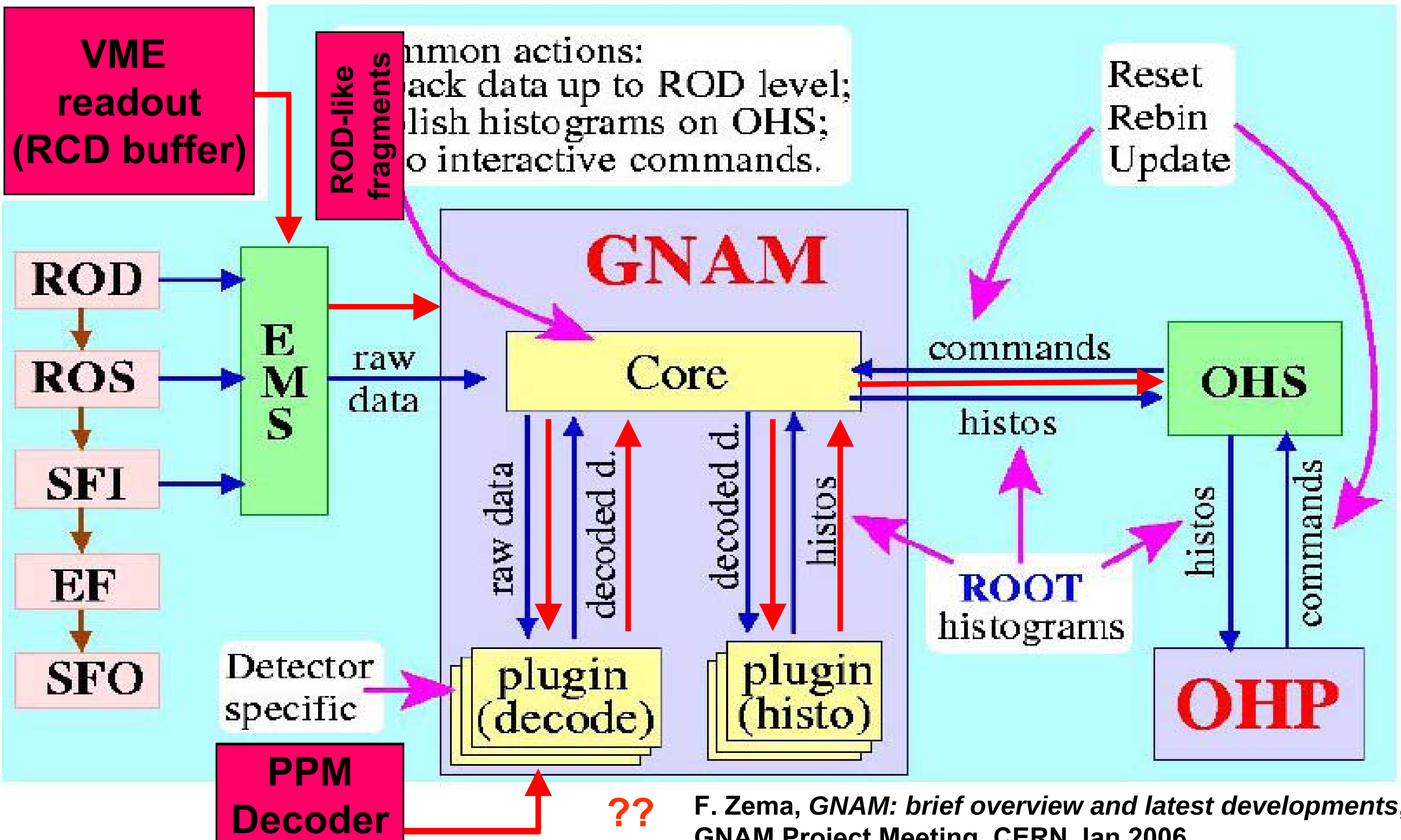
EM Crates


PPMs 9 8 7 6 5 4 3 2 1 1 2 3 4 5 6 7 8 9
Phi \ Eta -4.9 -3.2 -2.9 -2.4 -2.0 -1.6 -1.2 -0.8 -0.4 0.4 0.8 1.2 1.6 2.0 2.4 2.9 3.2 4.9
0-3
4-7
8-11
12-15
16-19
20-23
24-27
28-31
32-35
36-39
40-43
44-47
48-51
52-55
56-59
60-63
PPM 5
PPM 9
PPM 17
PPM 6 PPM 7 PPM 8 PPM 5 PPM 6 PPM 7 PPM 8 PPM 5 PPM 6 PPM 7 PPM 8 PPM 6 PPM 7 PPM 8
PPM 10 PPM 11 PPM 12 PPM 9 PPM 10 PPM 11 PPM 12 PPM 9 PPM 10 PPM 11 PPM 12 PPM 10 PPM 11 PPM 12
PPM 14 PPM 15 PPM 16 PPM 13 PPM 14 PPM 15 PPM 16 PPM 13 PPM 14 PPM 15 PPM 16 PPM 14 PPM 15 PPM 16
PPM 18 PPM 19 PPM 20 PPM 17 PPM 18 PPM 19 PPM 20 PPM 17 PPM 18 PPM 19 PPM 20 PPM 18 PPM 19 PPM 20
PPM 9
PPM 17
PPM 5
0
1
2
3
Phi_quadrant
3 2 1 0 0 1 2 3 0 1 2 3 0 1 2 3
Eta_bundle
Legend:
Crate 0 (EM Barrel +Z)
Crate 1 (EM Barrel -Z)
Crate 2 (EM Endcap +Z)
Crate 3 (EM Endcap -Z)
Crate 4 (HEC/FCAL +Z)
Crate 5 (HEC/FCAL -Z)

Hadronic Crates



PPM Decoder in GNAM



F. Zema, *GNAM: brief overview and latest developments*, GNAM Project Meeting, CERN Jan 2006