ATLAS Tile Calorimeter Visualisation needs

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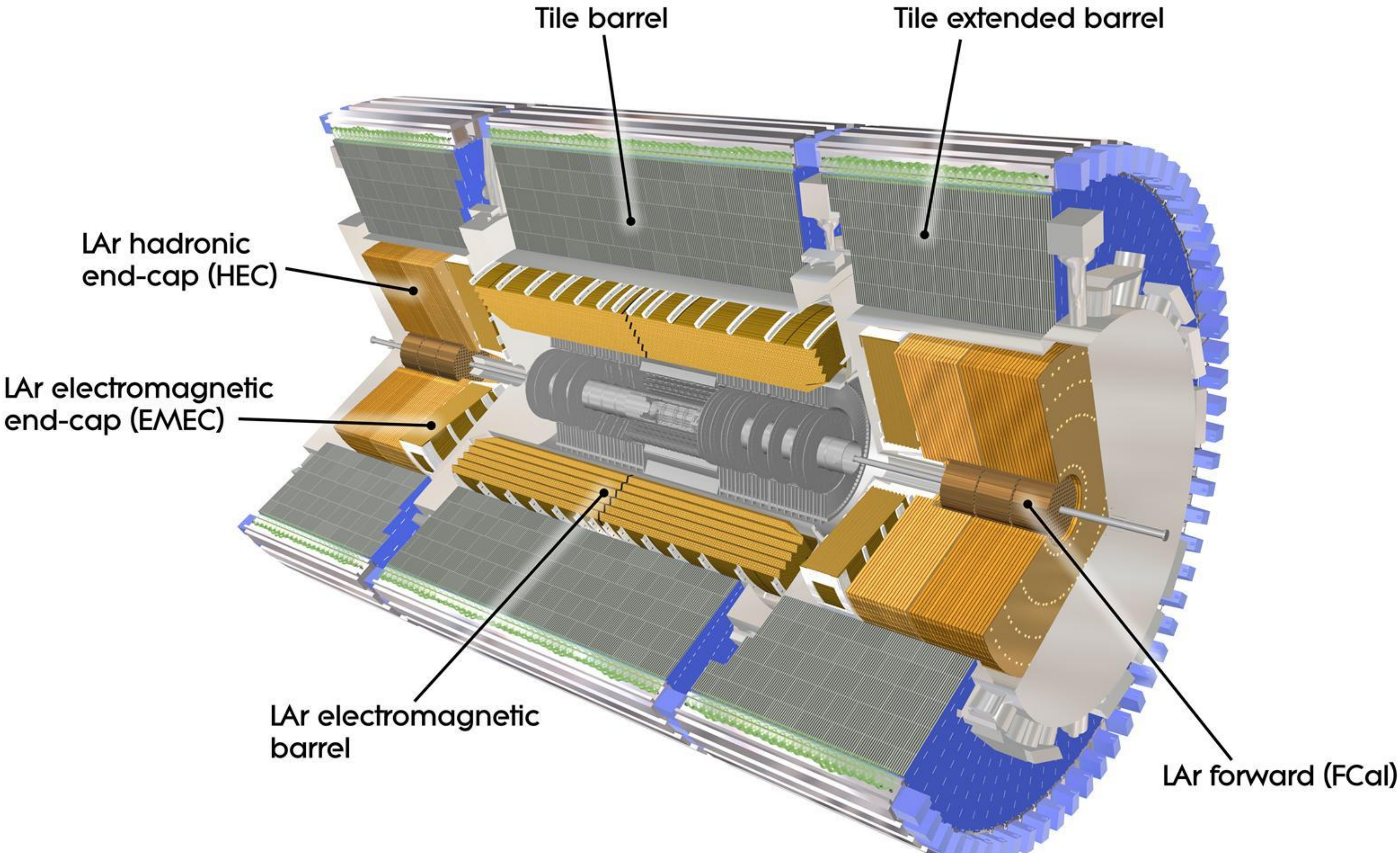
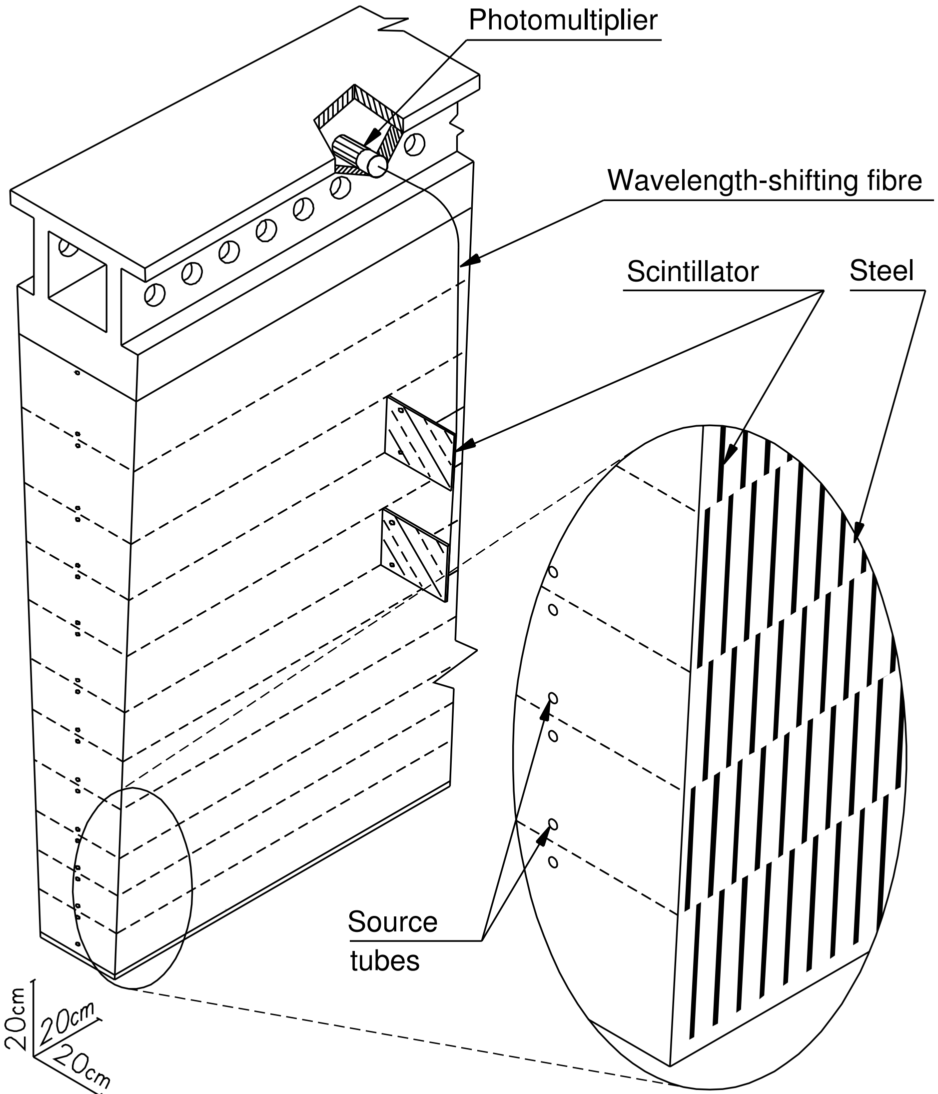
ATLAS Calorimeters



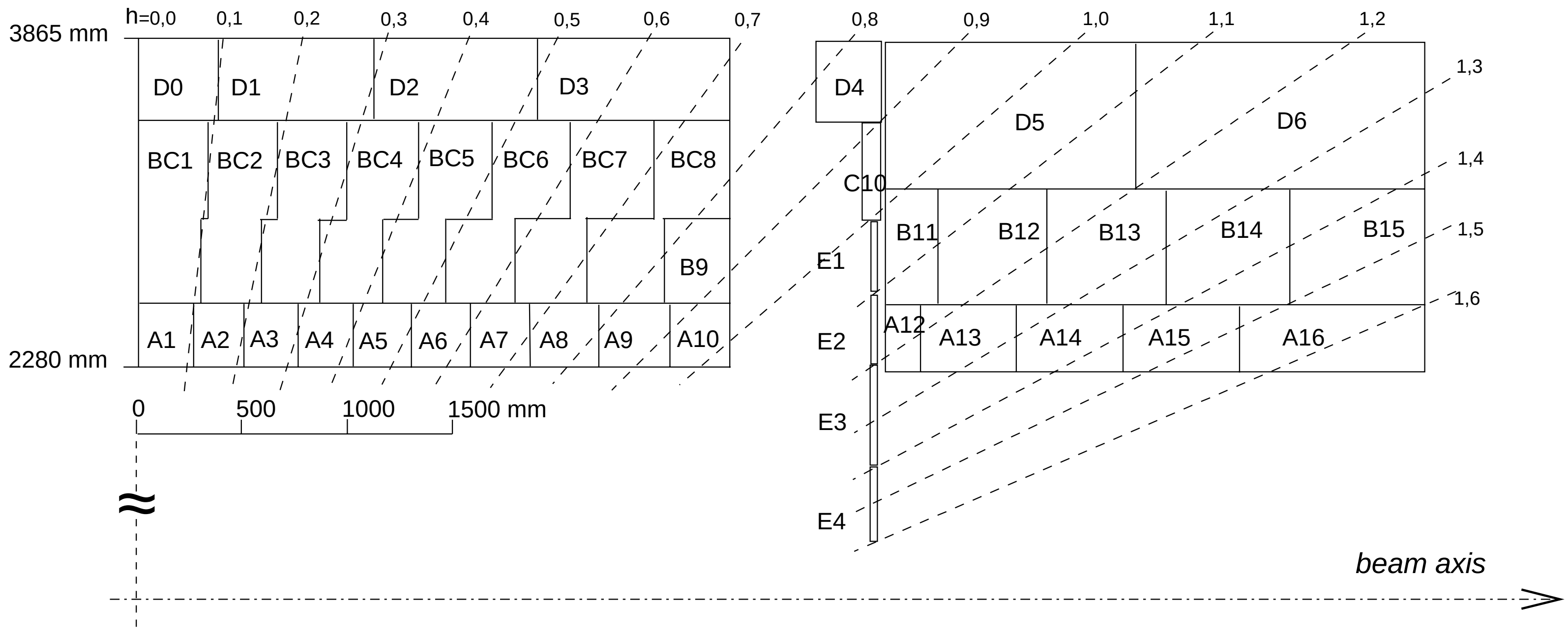
Tile Hadron Calorimeter



Tile Calorimeter module design drawing

- Hadron non-compensating sampling calorimeter
  - Steel as radiator
  - Scintillating tiles as active medium
- 3 mm thick scintillating tiles (PSM, BASF polystyrene + dopants) oriented perpendicular to beam axis, wrapped in Tyvek paper
- Readout via green WLS fibres (Kuraray Y11) connected to both short edges of scintillating tiles
- Hamamatsu R7877 PMTs, located in a module’s girder, collect light from the fibre bundles
- 3 cylinders: EB-A, LB, EB-C
- 64 modules in a cylinder

Calorimeter cell layout

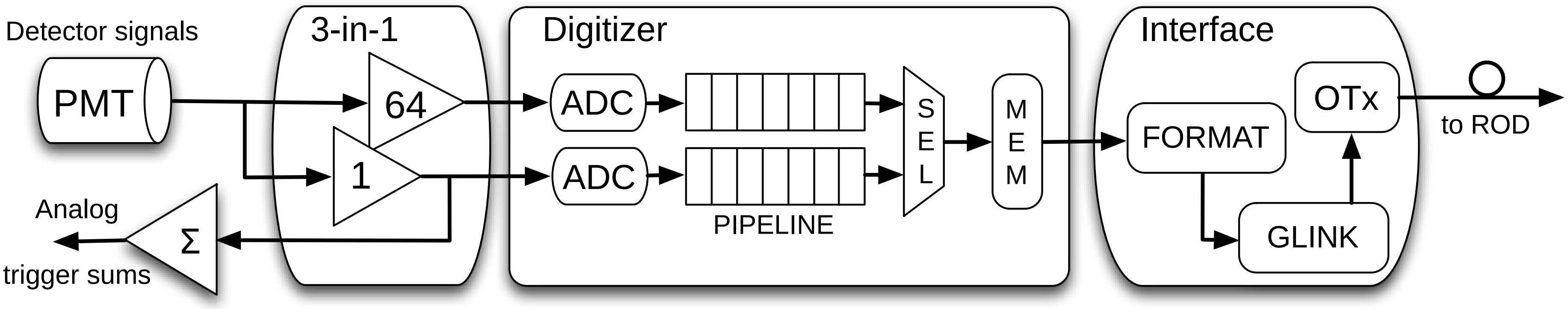


- Long barrel $|\eta|<1.0$, extended barrel $0.8 < |\eta| < 1.7$
- WLS fibre routing defines calorimeter cells
- 0.1x0.1 $\Delta\eta \mathrm{x} \Delta\phi$ cell granularity (0.2x0.1 for D layer cells)
- Three longitudinal layers, total thickness of about 7λ
- Pseudo-projective towers for first level trigger
- Design resolution for jets $\Delta E/E = 50\%/\ E \oplus 3\%$

Calorimeter module

Instrumentation of the Tile Calorimeter barrel modules

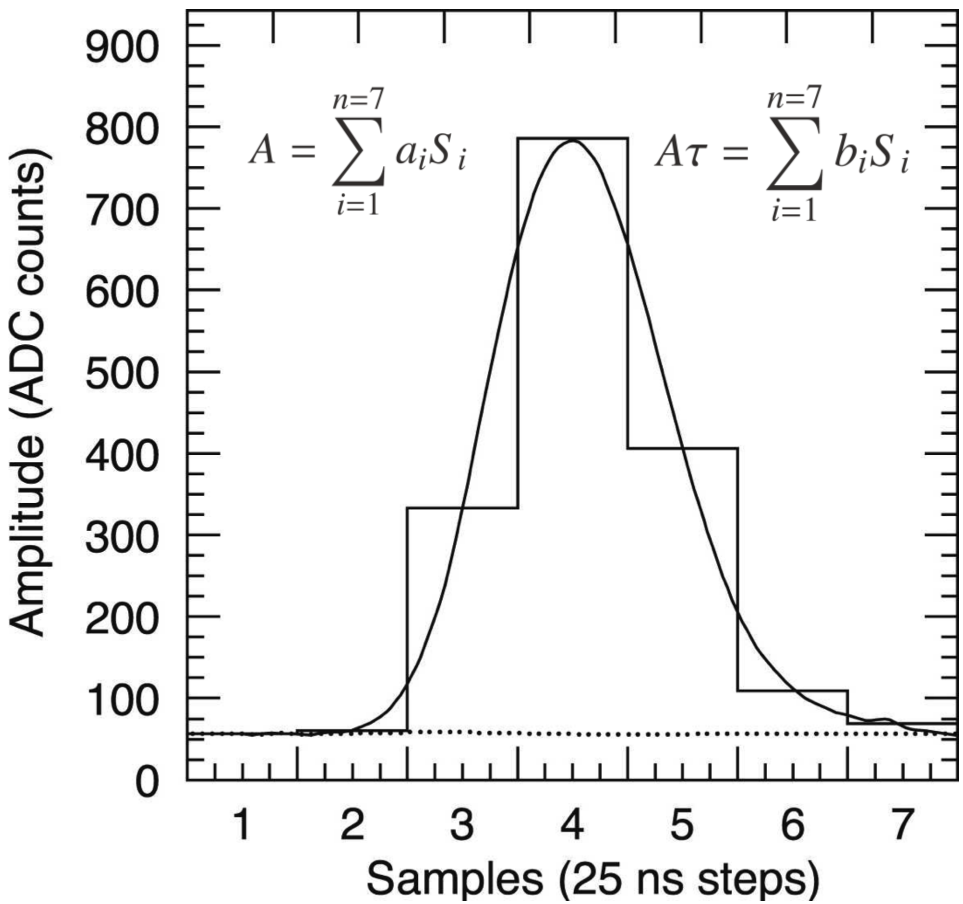
Front-end electronics



- PMTs signals are shaped and amplified with two gains (1:64)
- Analogue tower sums are provided for level one trigger
- Both gains are digitized in parallel by 40 MHz sampling 10-bit ADCs
- Digitised samples are temporary stored in pipeline memory
- Upon first level trigger decision the data of one of the gains are transferred to de-randomiser memory and then to the back-end electronics via readout fibres

Signal reconstruction

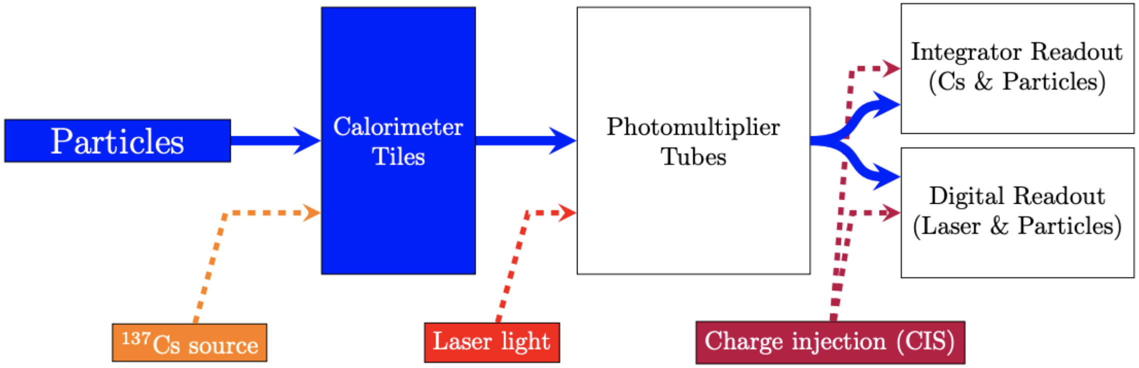
- Signal is reconstructed from 7 samples using optimal filtering (OF) algorithm
- Energy, time and quality factor are extracted from the sampled signal
- Amplitude of the signal is proportional to the energy (shaping)
- OF uses weighted sum of samples in order to minimise noise
- Calibration allows to reconstruct the energy in GeV



$$E[\mathrm{MeV}] = A[\mathrm{ADC}] \times C_{CIS}\left[\frac{\mathrm{pC}}{\mathrm{ADC}}\right] \times C_{TB}\left[\frac{\mathrm{MeV}}{\mathrm{pC}}\right] \times C_{LASER} \times C_{Cs}$$

Calibration systems

TileCal Energy Reconstruction and Calibration



$$E\ [\mathrm{GeV}] = \frac{A\ [\mathrm{ADC}]}{f_{\mathrm{pC}\to\mathrm{GeV}} \cdot f_{\mathrm{Cs}} \cdot f_{\mathrm{Las}} \cdot f_{\mathrm{ADC}\to\mathrm{pC}}}$$

Energy reconstruction

- From **signal amplitude** A using a set of calibration factors to keep constant the energy response
- $f_{pC\to GeV}$ is the **EM energy scale constant** measured during test beam (2001-2003)

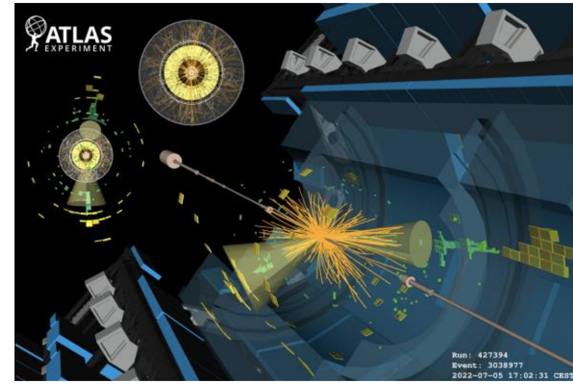
Calibration Systems

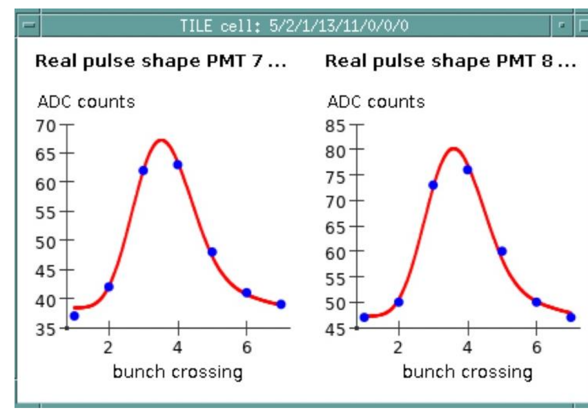
- **Cesium** source calibrates optical components and PMTs responses: f_{Cs}
- **Laser** light calibrates the response of PMTs and readout electronics: f_{Laser}
- **Charge Injection** System (CIS) calibrates the response of ADCs: $f_{ADC\to pC}$

- **Integrator readout** (10 ms) of Physics events to **monitor** the full detector response

Visualisation needs 0

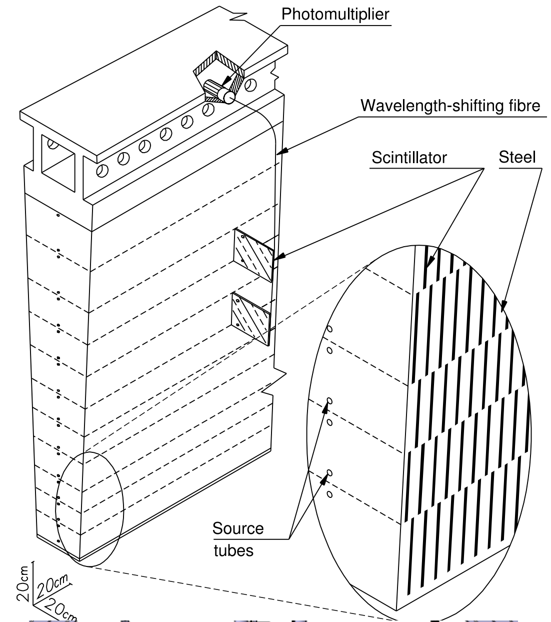
- Event display
  - Enhanced detector information
    - Module numbers, eta-phi, …
  - Enhanced reconstruction information
    - Energy, time, quality factor
    - Pulse shape

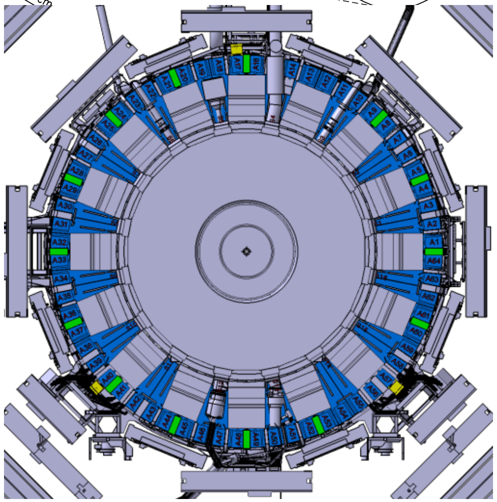




Visualisation needs 1

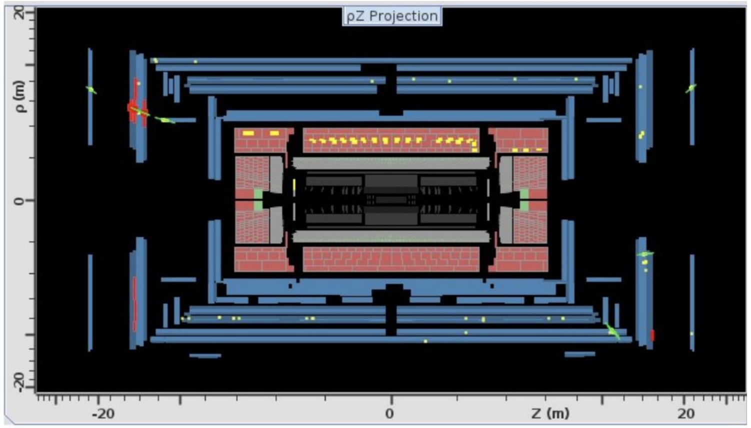
- Detector geometry
  - As designed
  - As constructed
  - As simulated
  - Simplified
  - Materials
  - Geometry and material conflicts
  - Envelopes

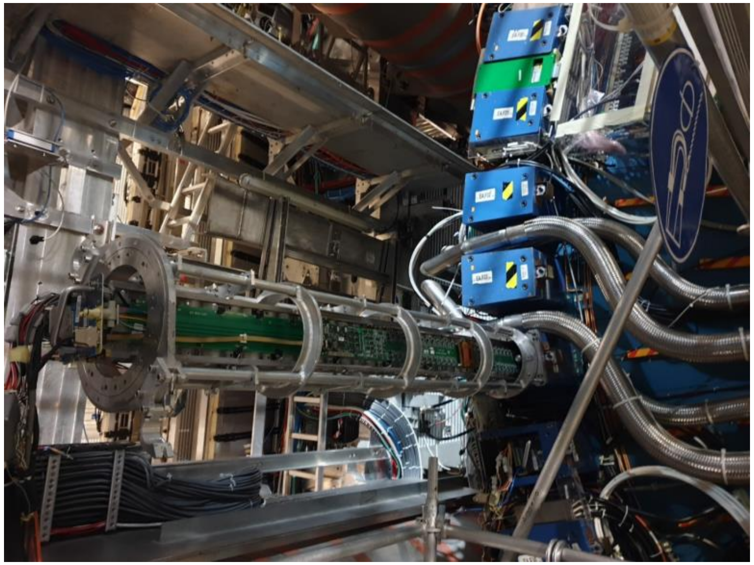




Visualisation needs 2

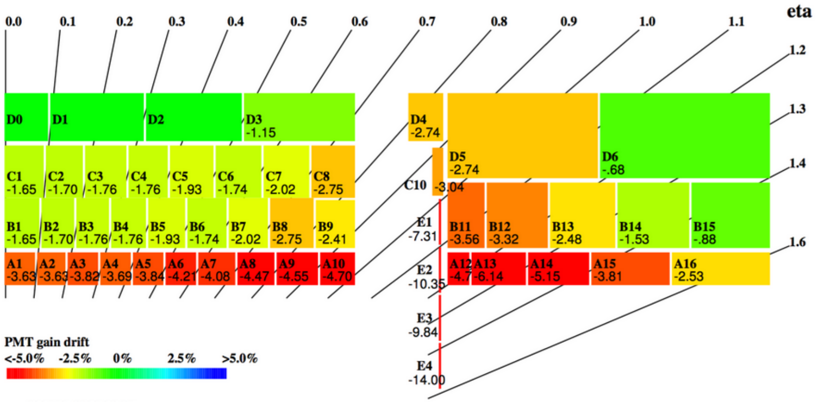
- Detector components
  - Calorimeter modules
  - Cell structure
  - Calorimeter electronics
    - Location
    - Serial numbers
    - Cabling





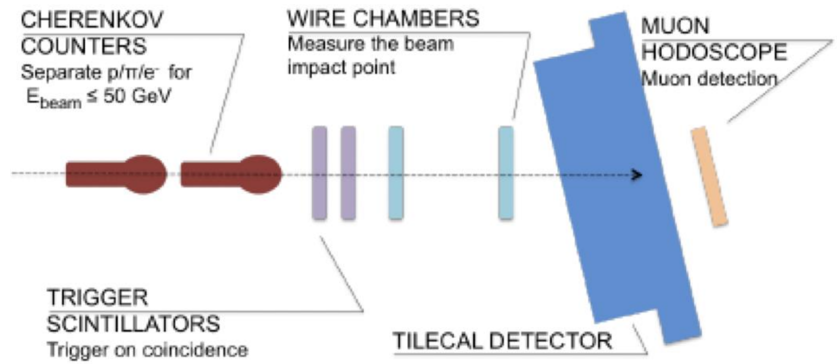
Visualisation needs 3

- Calibration constants
  - Timing, Charge injection, Laser, Cesium, Min.Bias, Pedestal, Noise, …
- Detector control system
  - Power consumption, temperature, problems, …
- Time interval
  - Latest
  - Difference to last update
  - Behaviour in time



Visualisation needs 4

- Test Beam
  - Geometry
  - Simulation
  - Reconstructed data



Visualisation needs 5

- Phase-II Upgrade
  - Simulation
  - Assembly
  - Installation
  - Operation