Performance and Optics Robustness of the ATLAS Tile hadronic calorimeter

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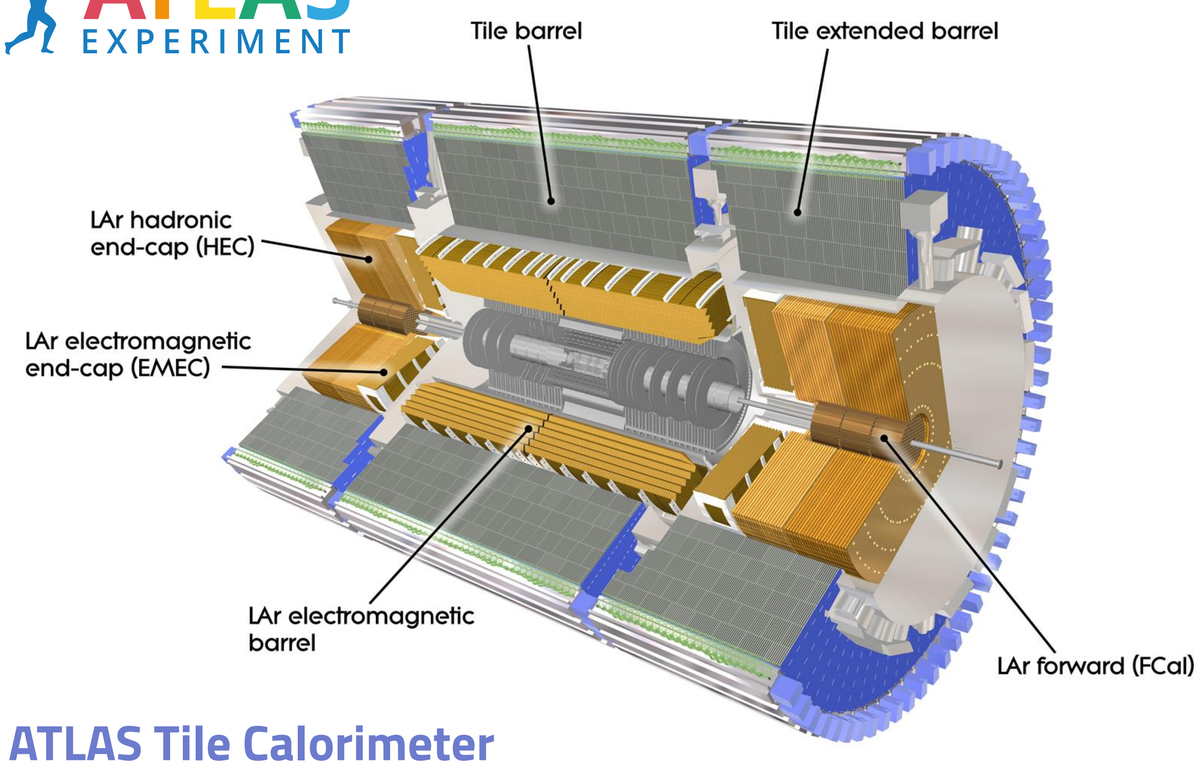


ATLAS Tile Calorimeter

Central hadronic calorimeter of the ATLAS experiment at the LHC, covering $|\eta|<1.7$:

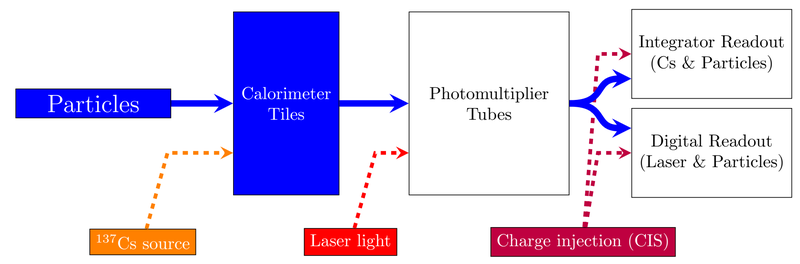
- Sampling calorimeter featuring plastic scintillators interleaved with steel;
- Measures hadrons, jets, hadronic decays of τ -leptons, missing transverse energy;
- Provides analog input to the Level 1 hardware calorimeter trigger.

Double photomultiplier (PMT) readout through wavelength-shifting optical fibres:

- 64 wedged modules, 3 radial layers: A, B(C) and D;
- 9852 readout channels, 5182 unit cells;
- 0.1/0.2 x 0.1 cell granularity in (η, ϕ).

Calibration

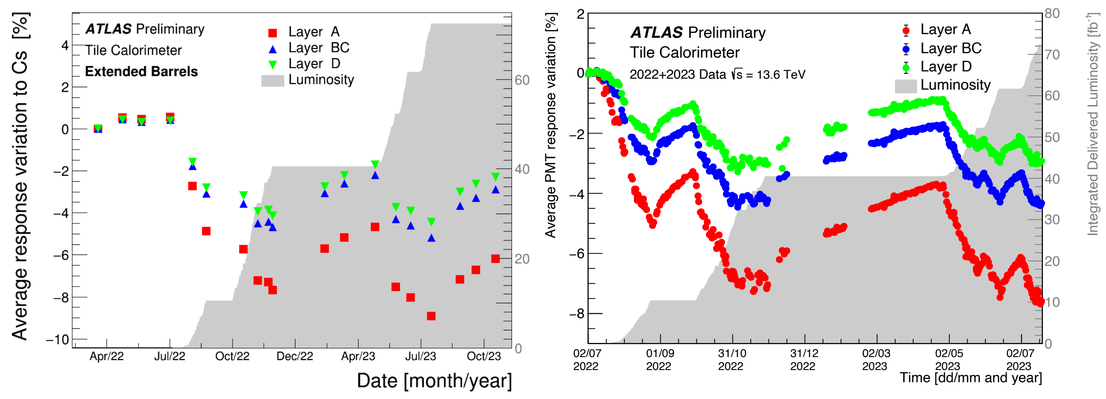
Dedicated systems monitor and calibrate each step of the readout chain.



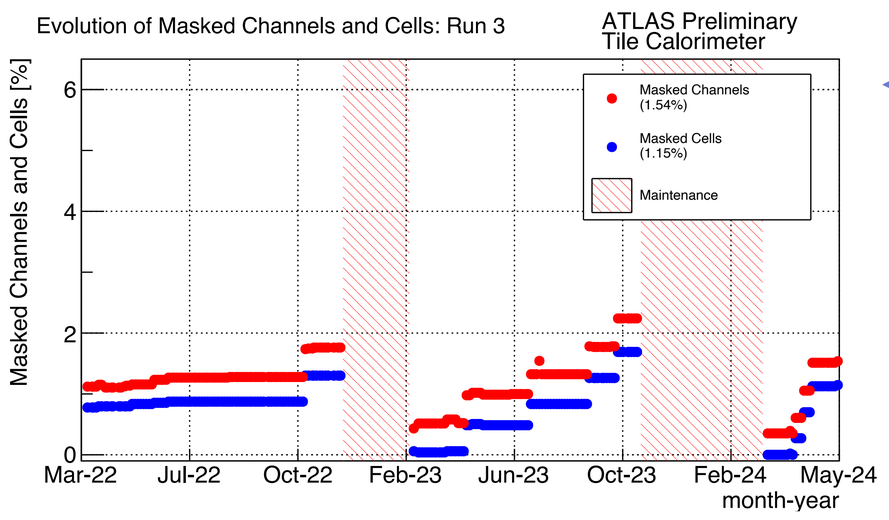
Charge-injection calibrates the readout electronics.

^{137}Cs source scans the whole detector probing scintillation, light transport and photodetection. Detector response decreases with operation, more significantly in high particle fluence regions, but recovers during stops.

Laser system dispatches short light pulses into each PMT using a chain of clear optical fibres. Calibration runs taken daily.

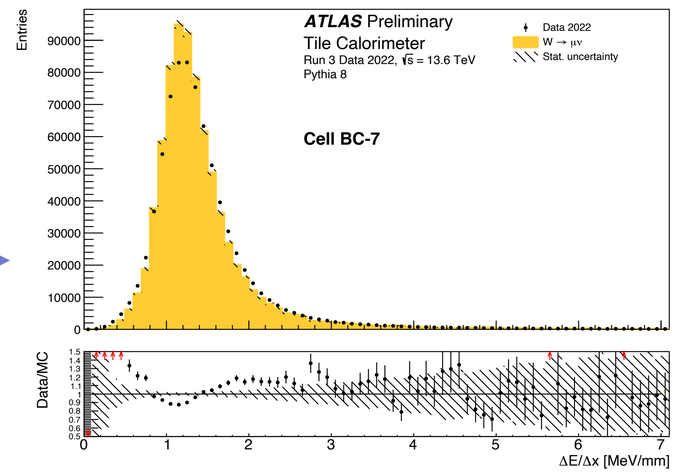


Operation and Performance

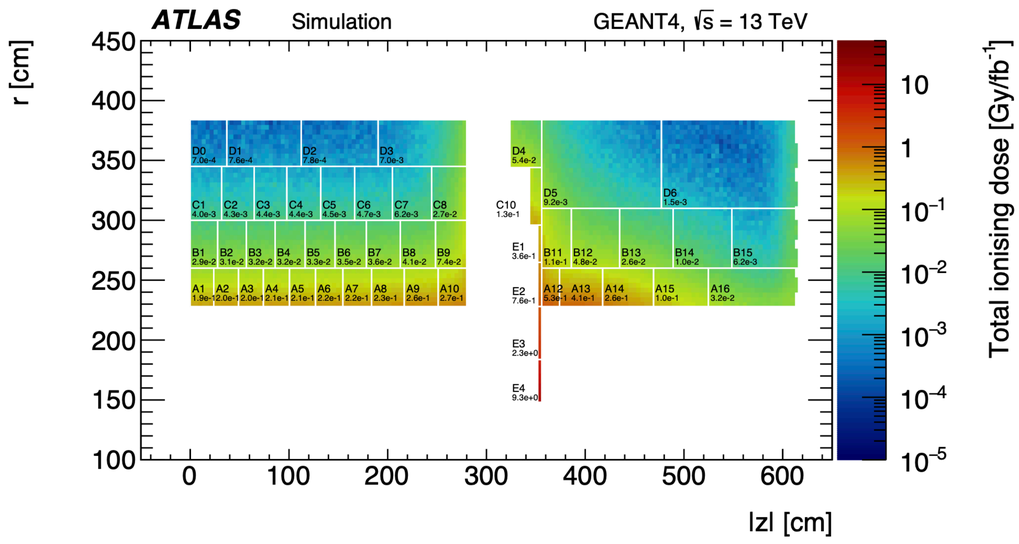


Continuous data quality activities and maintenance campaigns keep the fraction of non-functional readout channels below 2%.

Events with isolated muons from W boson decays used to probe data calibration and simulation accuracy.



Optics Robustness

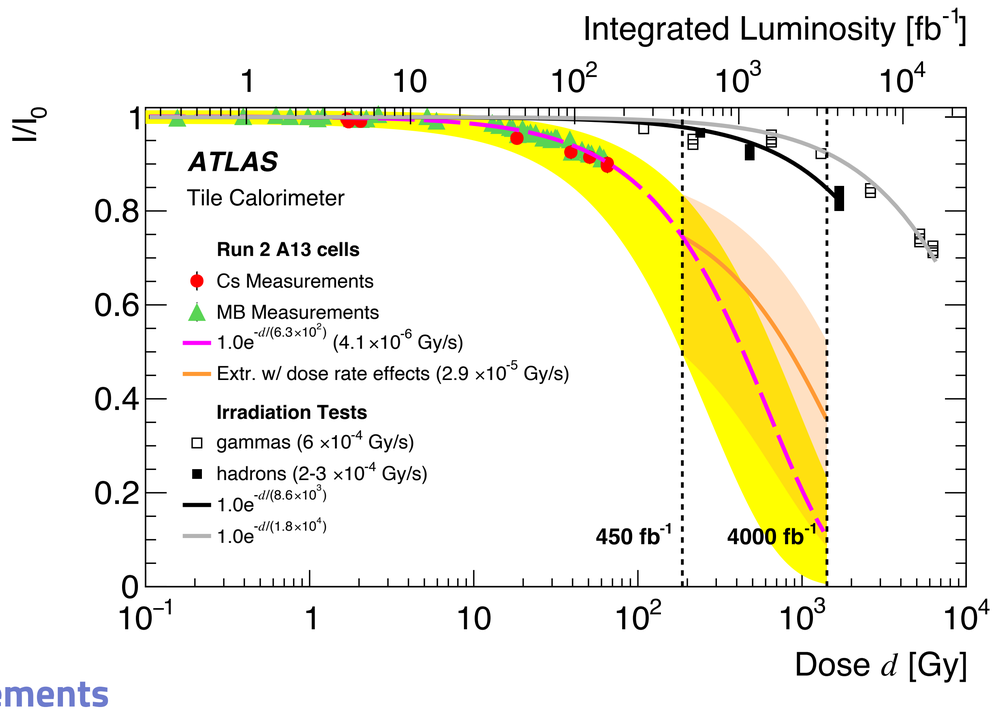


Plastic scintillators known to suffer from radiation damage.

- Dose deposited in the active material simulated with Geant 4;
- Average cell light response I/I_0 measured with data from the calibration systems;
- Light response loss from 2015 to 2018 up to 10%, correlated with dose exposure.

High-Luminosity (HL) upgrade plan for LHC is a challenge to the detector's optics.

- Extended operation leads to much higher doses than design requirements;
- Current light response measurements modelled as a function of dose and dose rate;
- Expected dose rate larger by a factor up to 7 reduces degradation rate;
- Extrapolation to the end of HL-LHC: most exposed cells will maintain 40% light response.



References

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JINST 8 P01005 (2023) / arXiv:2401.16034 (sub. to EPJC)

Acknowledgements

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