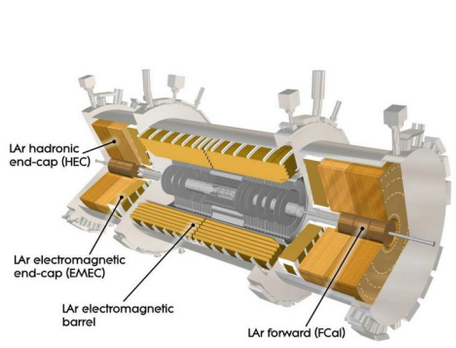
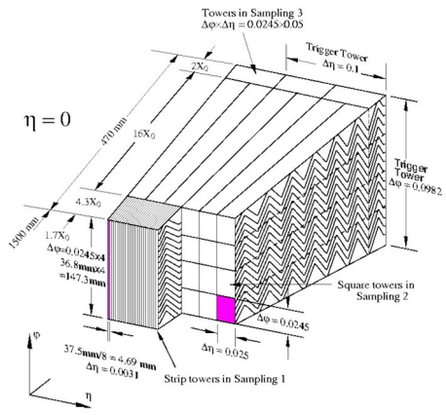
OPERATION AND PERFORMANCE OF THE NEW ATLAS LAR CALORIMETER TRIGGER
EPS-HEP in Marseille

Liquid Argon Calorimeter

Liquid **Ar**gon Calorimeter (LAr) is composed of
- Electromagnetic barrel (**EMB**)
- Electromagnetic end-cap (**EMEC**)
- Hadronic end-cap (**HEC**)
- Forward (**FCAL**)

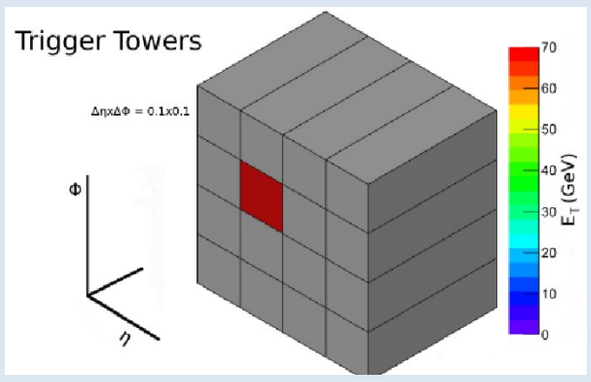
with a total of over 180K LAr cells in $|\eta| < 4.9$, which measure the energy of electrons, photons, and jets.

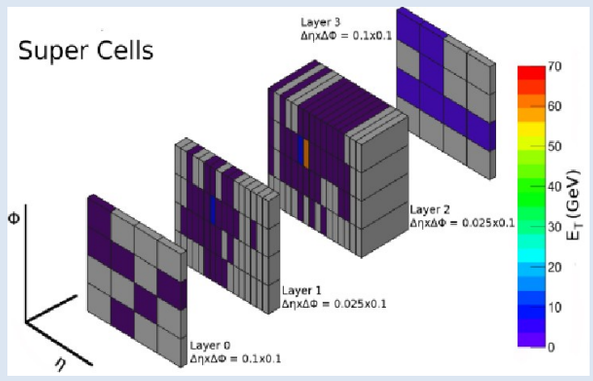




Super Cell (SC)

34000 **Super Cells** are used in the new trigger system to cope with the higher pileup environment in LHC Run3.
The following are the main features of super cells:
- Finer granularity with a factor up to 10 than the legacy trigger
- system (trigger towers).
- Better shower information to identify the physics objects.
- Better energy resolution

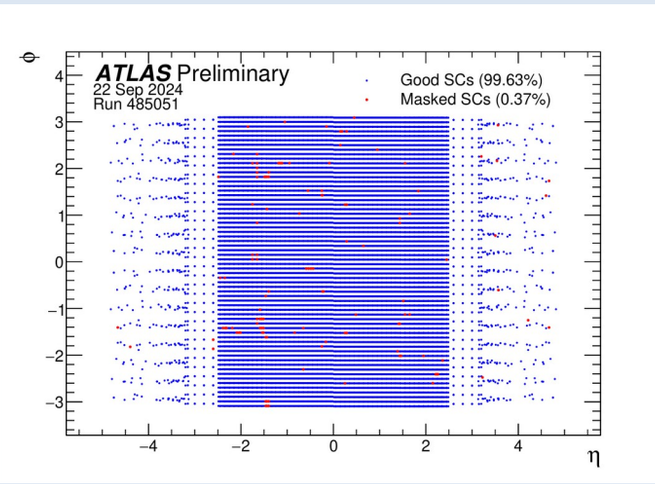




Coverage

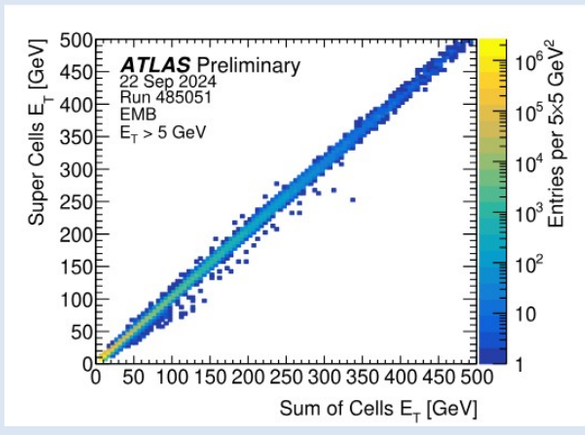
Supercell which are causing issues when included in the trigger decision are masked.

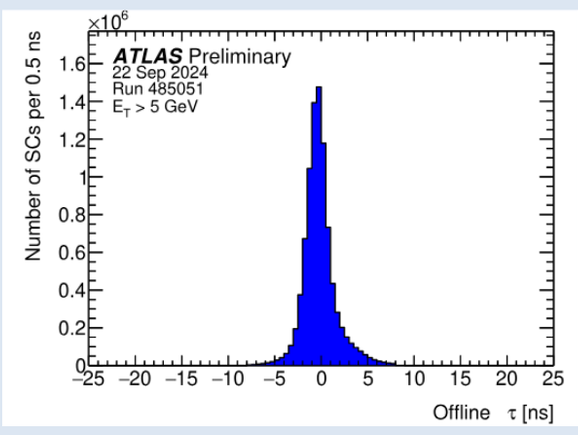
In total 126 Scs are permanently mask and additional noisy cells are masked on-the-fly by the online software.



Performance on energy and timing

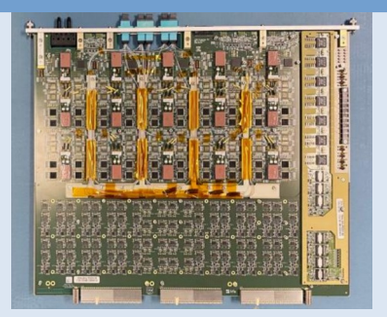
- The energy from the SCs is compared to the sum of energy from corresponding cells, which shows good linearity.
- The distribution of the reconstructed timing is centered at 0, which shows good alignment with the arrival of physics pulses.

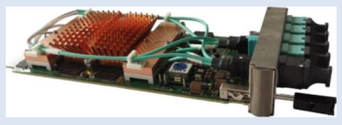




New boards

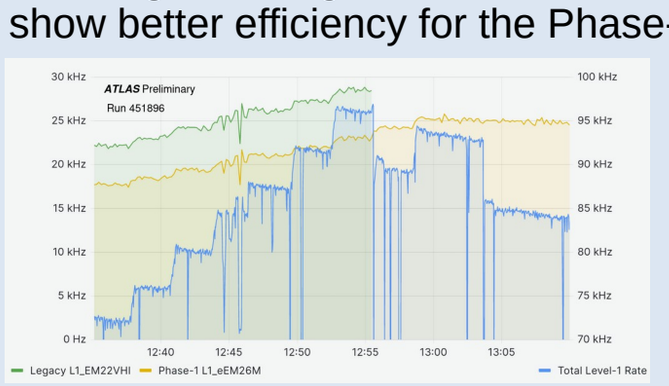
New electronics on the front-end and back-end were installed during long shutdown 2 (LS2, 2018-2022).
- 124 **LAr Trigger Digital Boards (LTDBs)** on the front-end provide digital signals for the Super Cells.
- 116 **LAr Trigger processing MEzzanines (LATOMEs)** compute the energy and timing of the pulses for each Super Cell. LATOMEs inserted in LAr carriers are installed in three ATCA crates on the back-end.

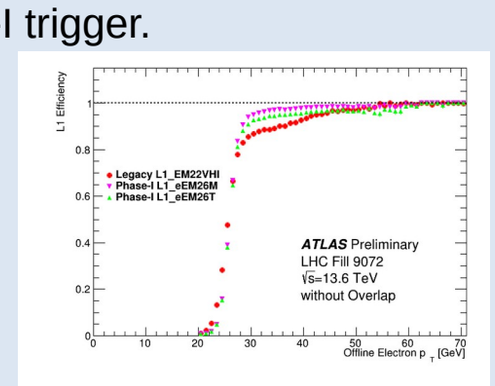




Trigger performance

On 11th May 2023, the primary electron trigger (L1_EM22VHI) was switched to the new Phase-I trigger (L1_eEM26M), resulting in savings in the L1 rate of 5 kHz. The turn-on curves show better efficiency for the Phase-I trigger.





New boards

Optimal filtering coefficients (OFCs) are used for the reconstruction of the pulse amplitude and peaking time from four samples of the bipolar LAr pulses.
- Signals of sampling points

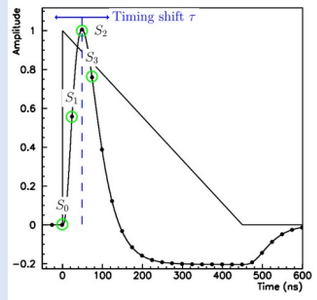
$$S_i = ADC_{raw} - ADC_{ped} - ADC_{bas}$$

- OFC A for energy estimation

$$E_T = \Sigma_{i=0}^{N-1} A_i . S_i$$

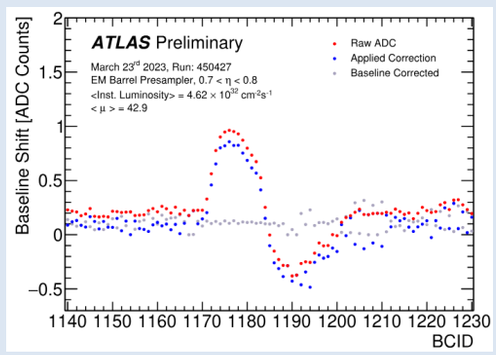
- OFC B for energy multiplied by timing

$$E_T . \tau = \Sigma_{i=0}^{N-1} B_i . S_i$$



Baseline Correction

The bunch structure in the LHC can cause a baseline shift that varies depending on the position within an LHC train. To correct this, a **baseline correction** dependent on the bunch-crossing identifier is calculated on the fly for each SC by the LATOME.



2025 Challenges

- Low efficiency of low pT electrons in ultra-peripheral collisions
  - Issue in Pb-Pb collision
- PO,OO collisions with digital trigger
- Comissioning of a HLS based LATOME firmware
  - To improve performance/ ressource usage
  - First version show same performance with reduced power usage

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