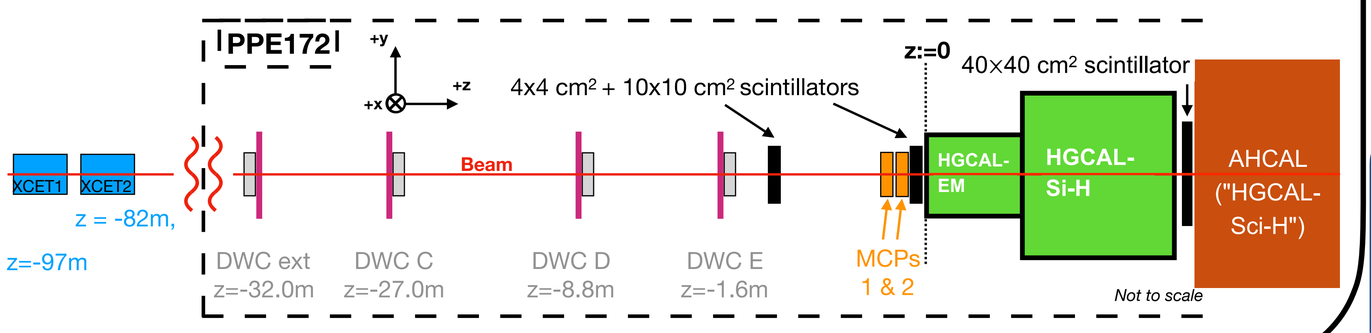
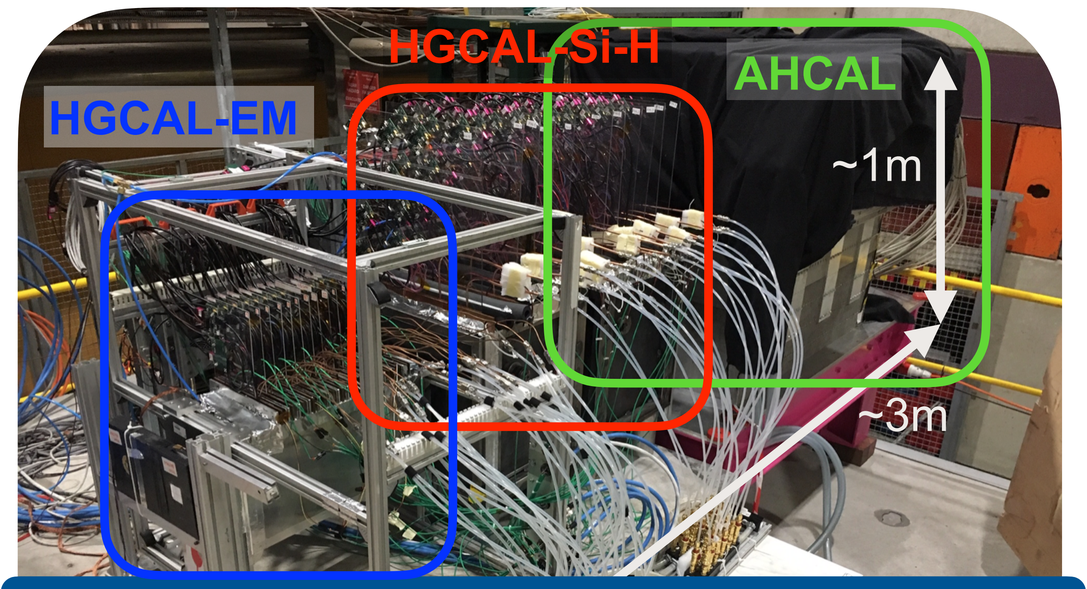
Performance of CMS high granularity calorimeter prototypes in testbeam experiments

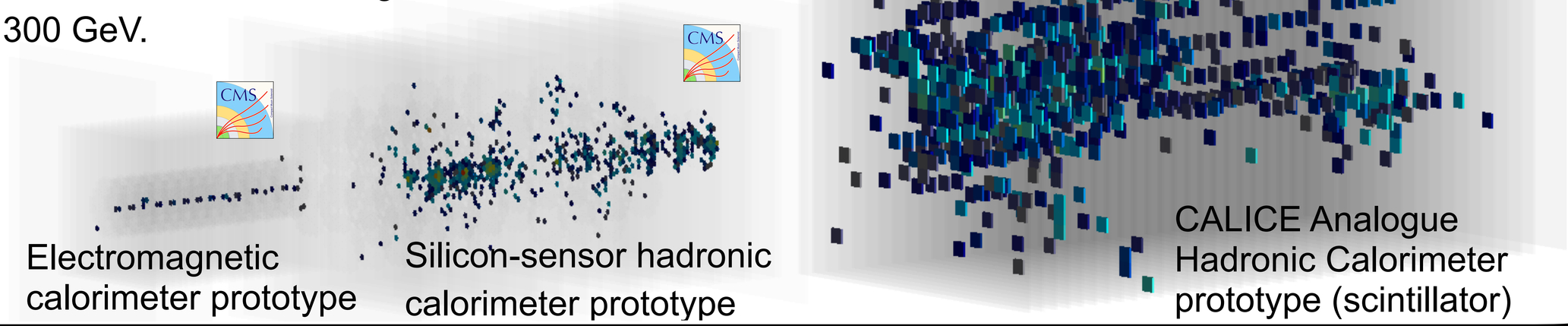
The High Luminosity-LHC (HL-LHC) is expected to commence operations in 2027. The CMS Collaboration will replace the existing endcap calorimeter with a new High Granularity Calorimeter (HGCAL). Prototypes of this calorimeter have been operated in beam tests. Results of the **2018 campaign at the CERN H2 beam line** are presented.





HGCAL-EM: 28 sampling layers (Cu/CuW/Pb absorbers), 28 X_0/1.5 λ_{int}
HGCAL-Si-H: 12 sampling layers (steel absorbers), 3.5 λ_{int}
AHCAL: scintillator tiles, 39 layers (steel absorbers), 4 λ_{int}

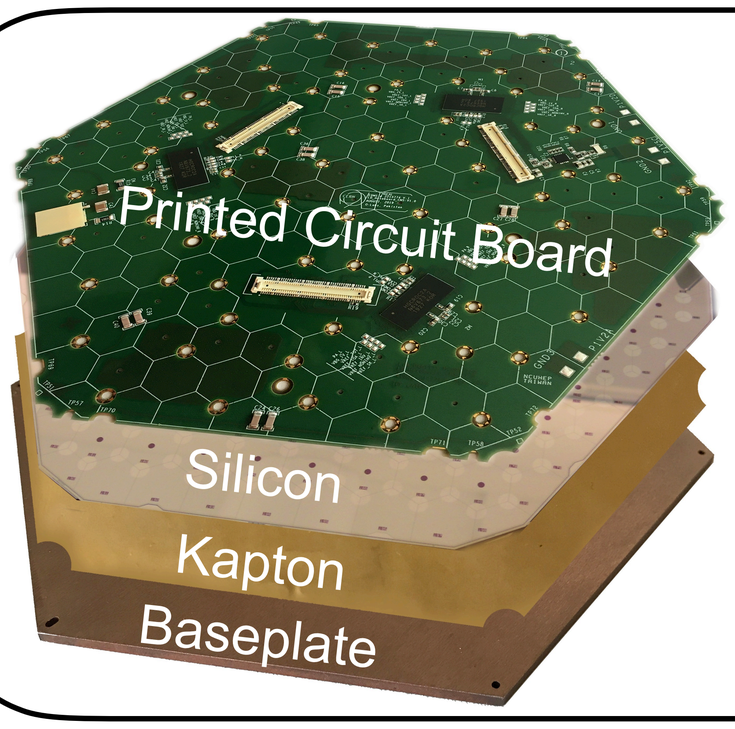
Different kinds of particles (e^+, π^+, μ^+, ...) with energies between 20 and 300 GeV were shot at the detector. Shown here is the shower resulting from a π^+ with an energy of 300 GeV.



Electromagnetic calorimeter prototype

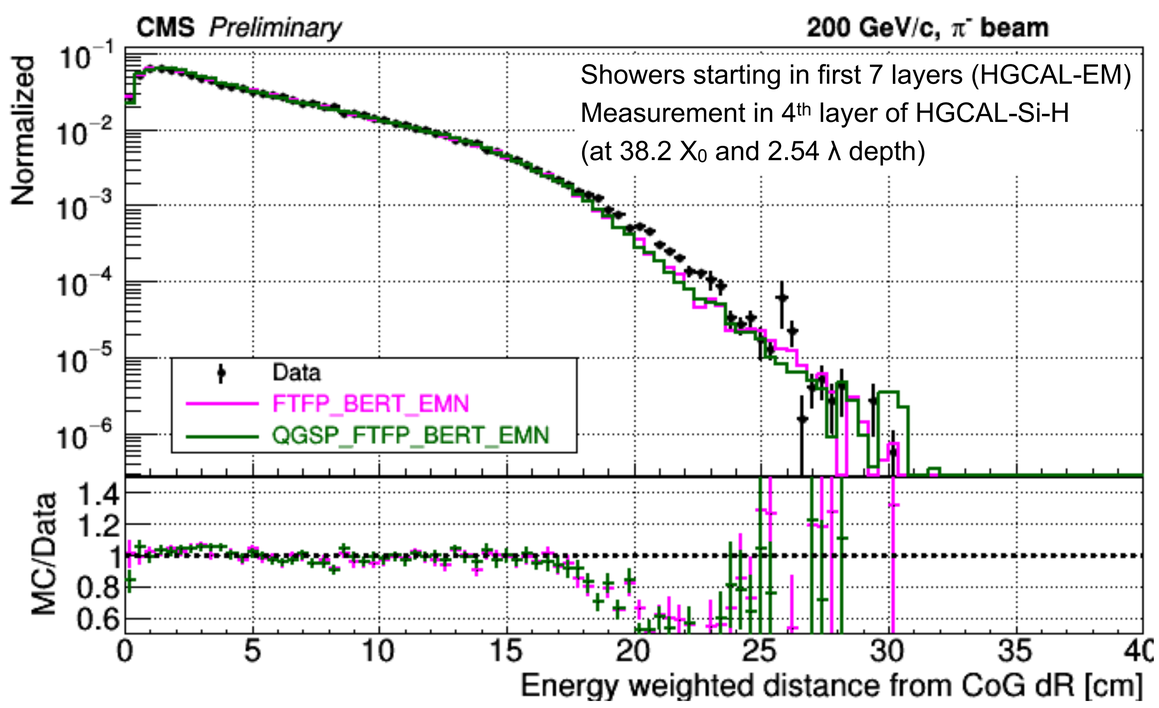
Silicon-sensor hadronic calorimeter prototype

CALICE Analogue Hadronic Calorimeter prototype (scintillator)

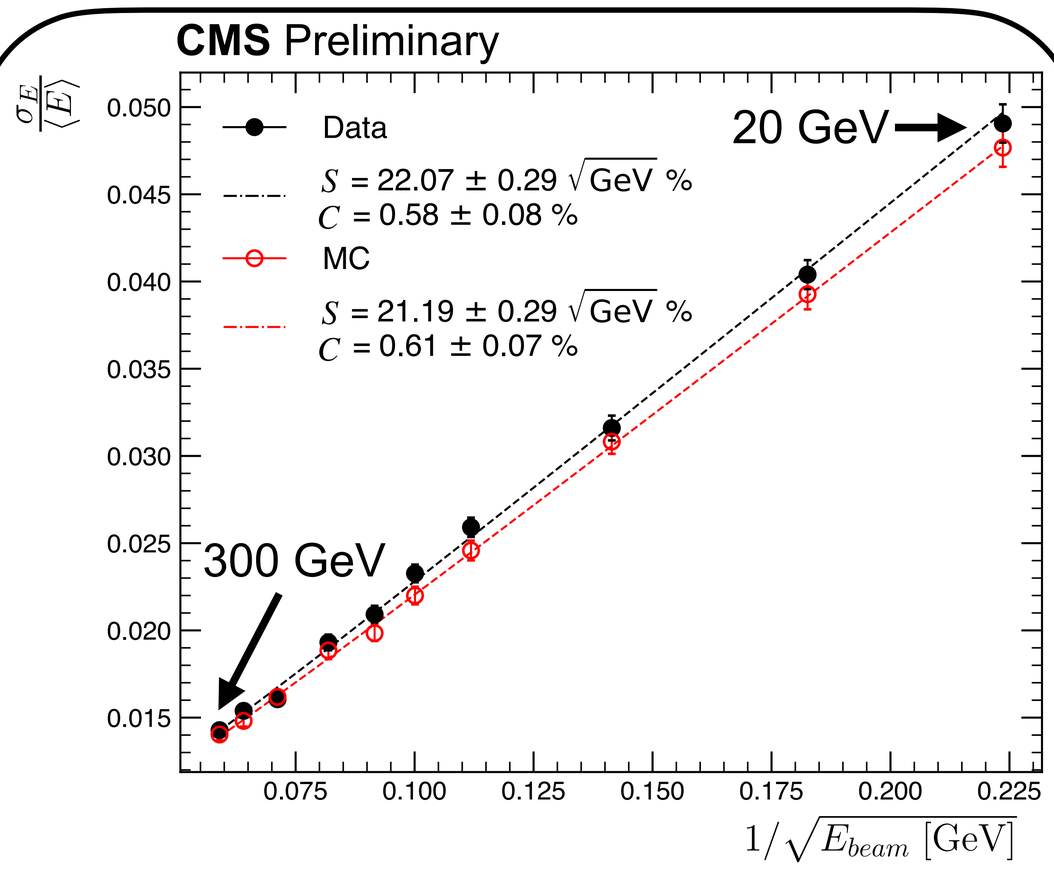


Large parts of the HGCAL consist of characteristic hexagonal modules with hexagonal silicon pads.

The single-channel MIP response calibration for the O(100) modules comprising O(12k) channels was performed using μ beams.



Transverse shower shape example: The energy-weighted distance from the centre-of-gravity in one of the first HGCAL-Si-H layers for pions of 200 GeV energy starting to shower in the first layers of the HGCAL prototype.



Positron energy resolution as a function of the beam energy. Good agreement between data and simulation is found.

Summary: The 2018 testbeam campaign was the first large-scale systems test of the HGCAL. Data analysis is almost completed. The good agreement between data and simulation confirms the expected performance for the detector.

Further reading:
- HGCAL Technical Design Report (CMS-TDR-019)
- HGCAL prototype DAQ system (JINST 16 T04001)
- HGCAL module construction/commissioning (arXiv:2012.06336)

Clemens Lange (CERN) on behalf of the CMS Collaboration