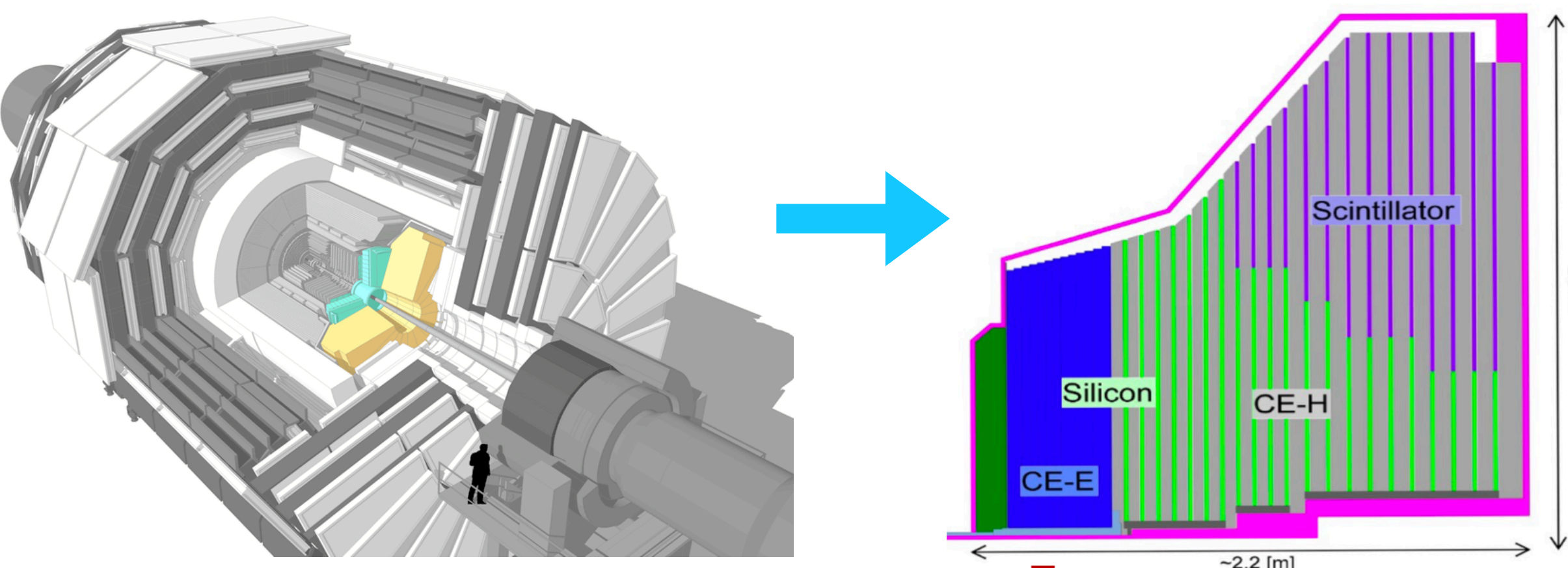


How to build a radiation-hard, high-granularity calorimeter: the CMS HGCAL upgrade

Antoine Laudrain (FH-FTX)

Why do we need the HGCAL?

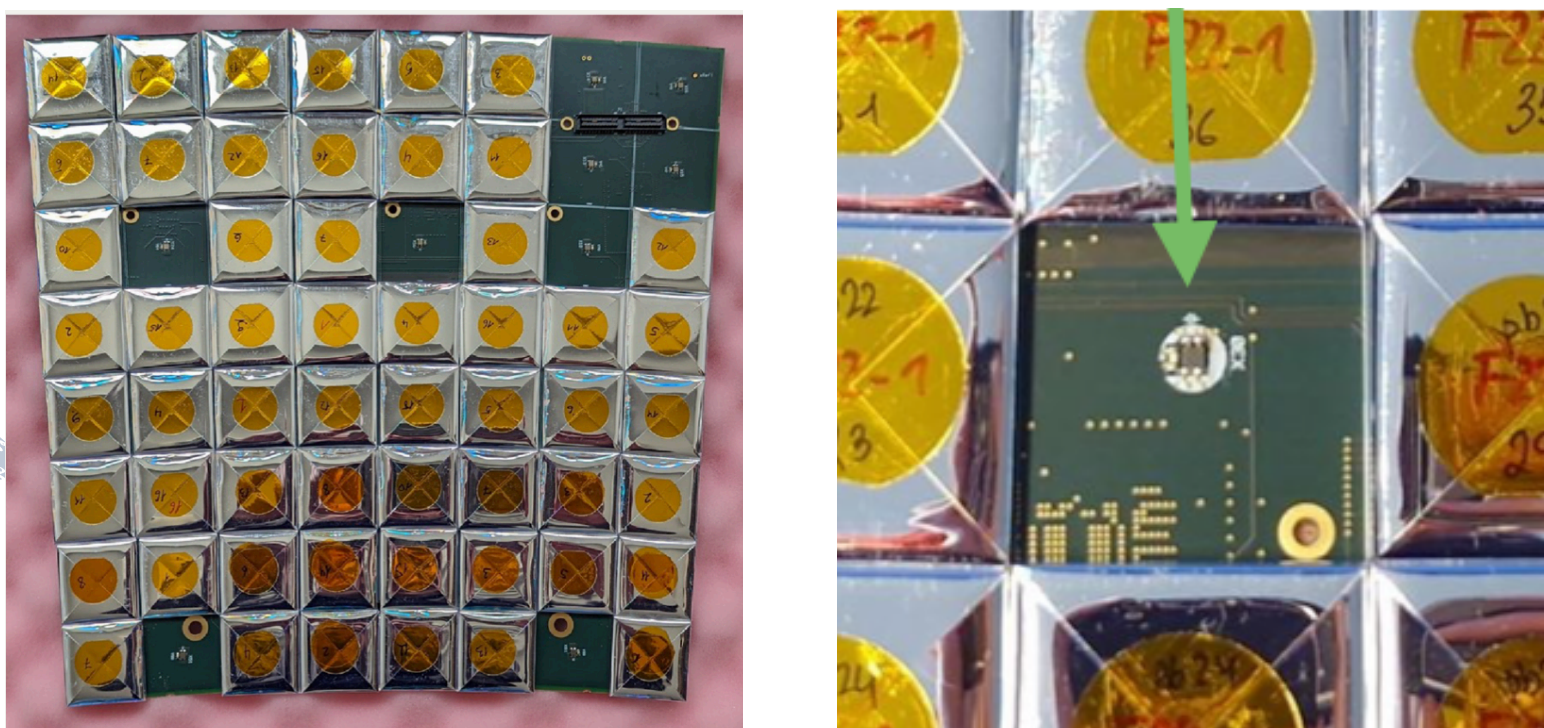
- **High-Luminosity LHC** to start in 2030:
 - 10x more luminosity => crucial phase for LHC physics!
 - 10x more particle rate & radiation damage...
- **Current calorimeter systems will not survive** => replace with:
 - Silicon (620 m2): largest silicon detector
 - Scintillators (370 m2): lower cost } Operated at -30°C
- **High-granularity: discriminate jets & pileup + enable particle flow!**



How is DESY involved?

- **Building and testing** half of the **scintillator** section: **2000 boards**, totalling ~140'000 channels (SiPM + scintillating tiles).
- Design and use automated assembly techniques.

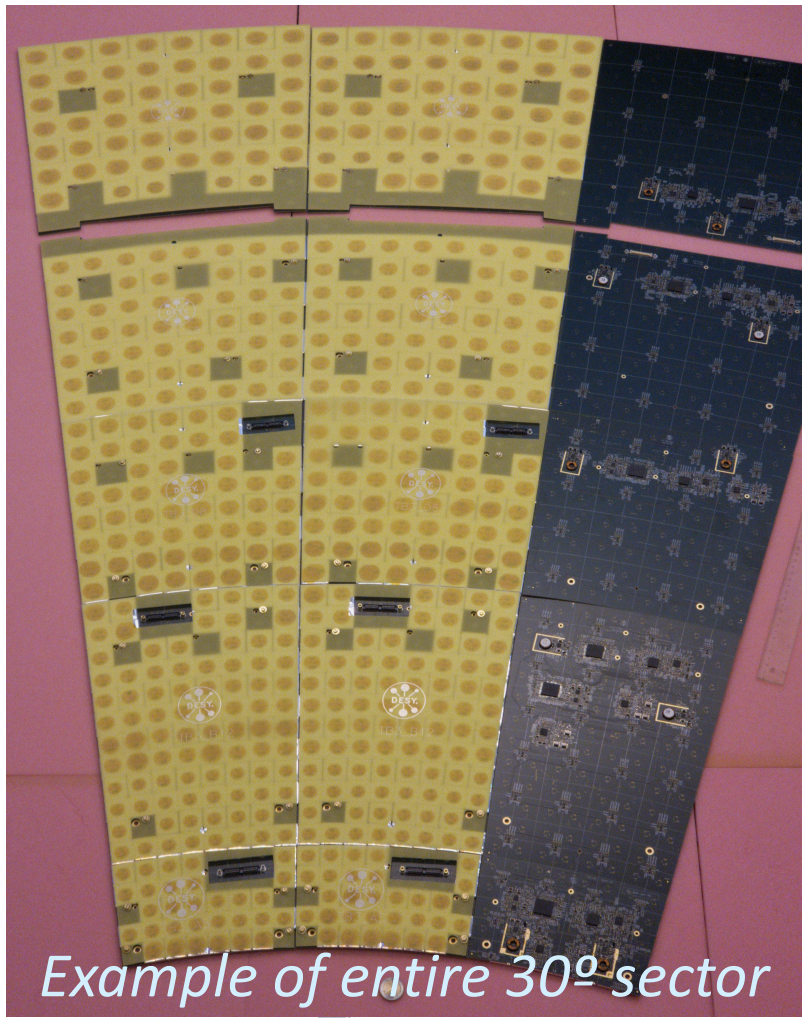
DESY has 15+ years of expertise with SiPM-on-Tile technologie (CALICE)



A "Tilemodule" (PCB + tiles wrapped in reflective foil).

Towards the future!

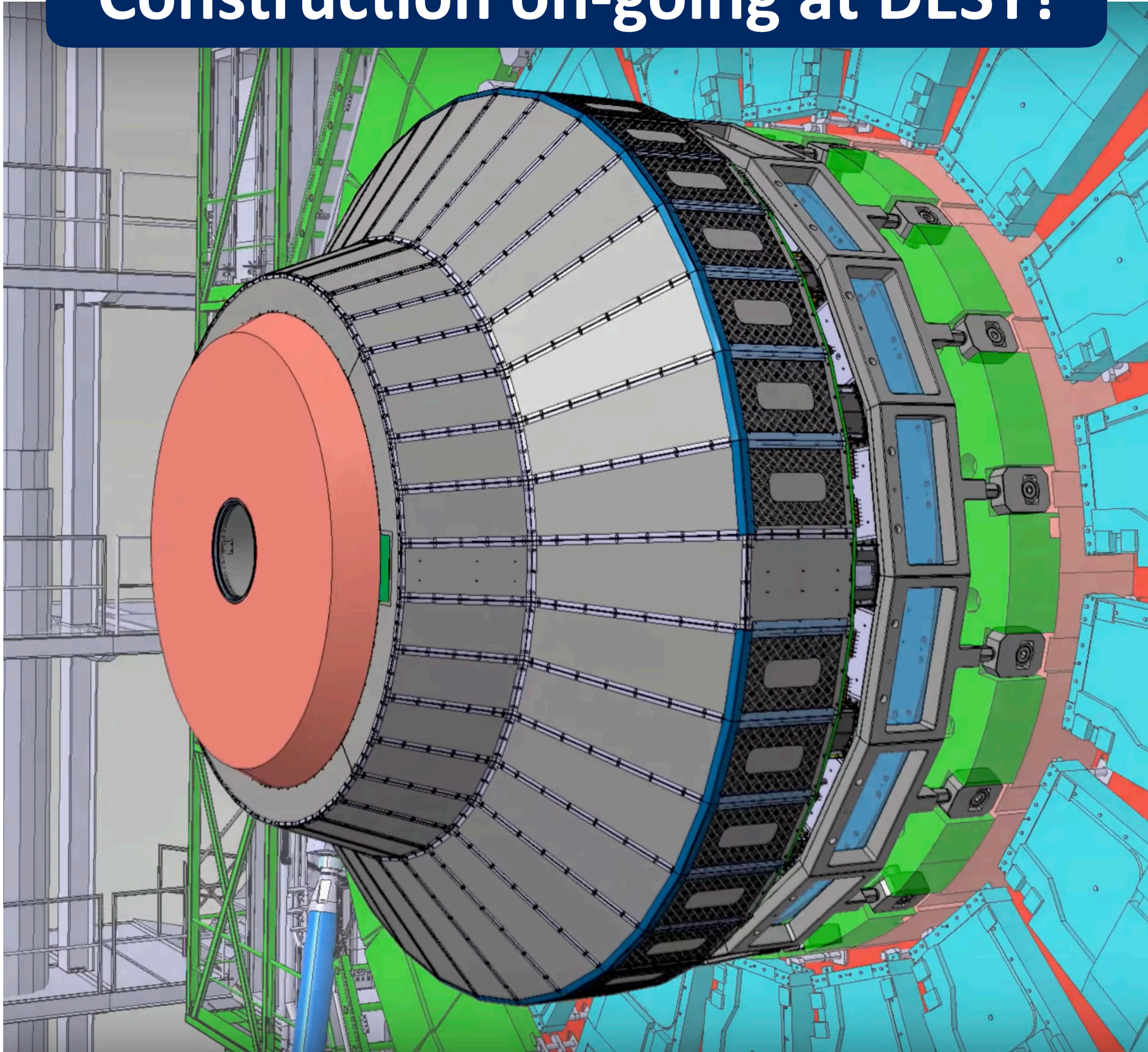
Sent to FNAL/CERN for integration.
Ready for lowering down in CMS in 2027!



Example of entire 30° sector

- Project originated from future colliders...
- ... and is still a **top technology** for ILC, CLIC, FCC, CEPC detectors.
- Also a strong activity at DESY!

Construction on-going at DESY!



How to characterise 150 modules / month?

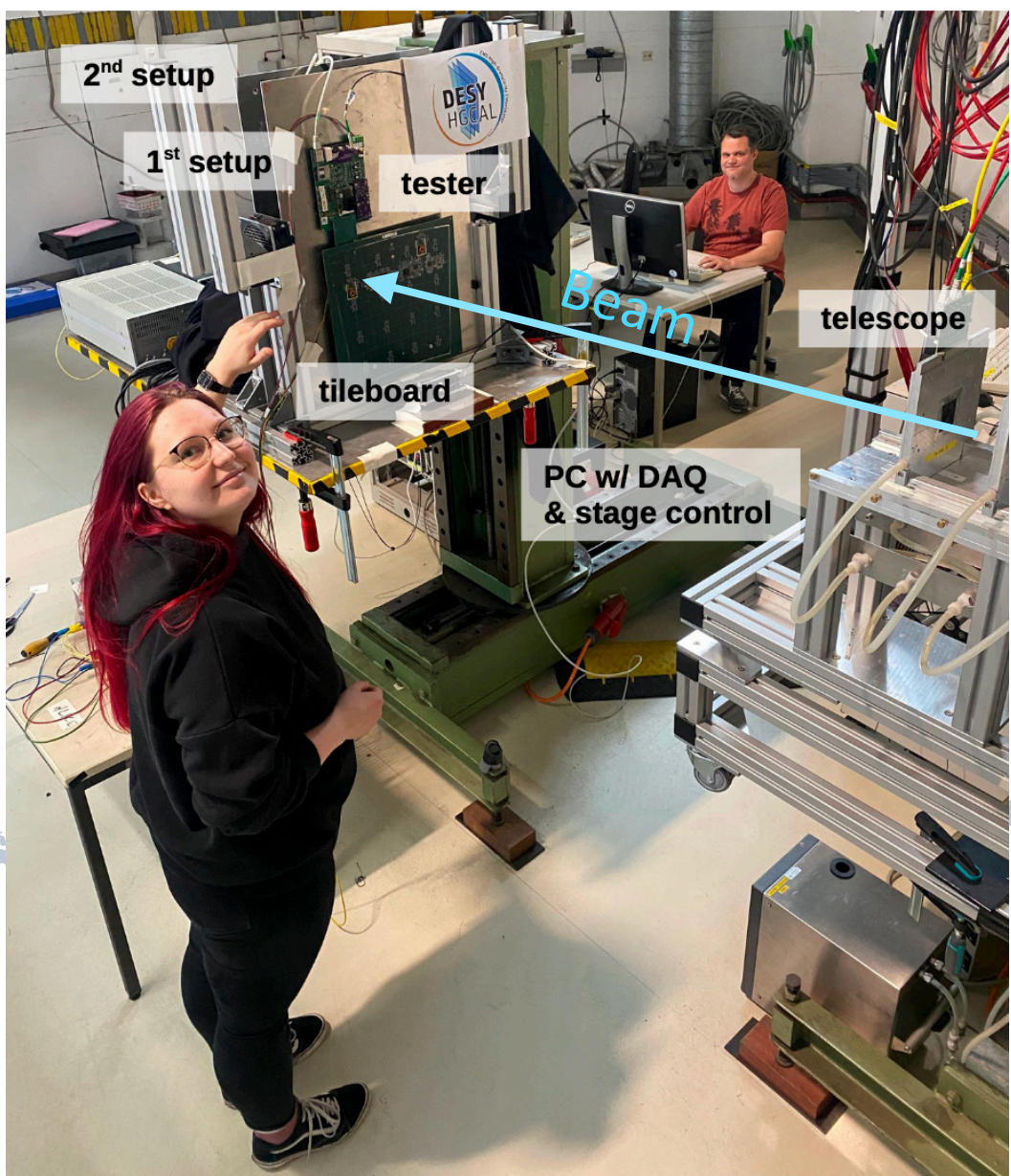
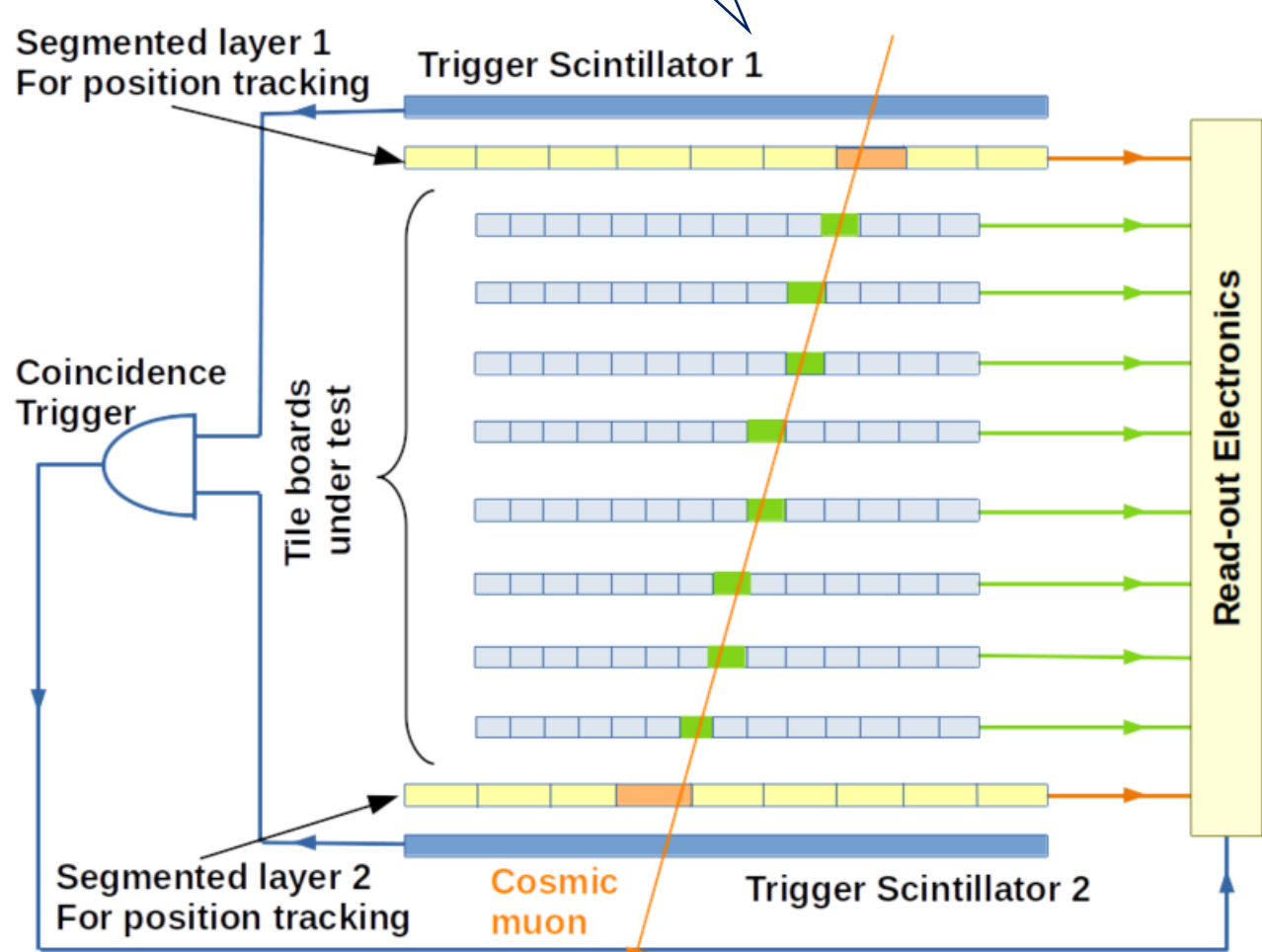
- Design of mapping and calibration software.
- Definition of the quality control procedure.
- Electrical & data-taking tests + initial calibration.



Thermal cycling at -30°C in climate chamber: board QC.

First production boards tested last month!

Cosmic test bench (under construction): initial calibration



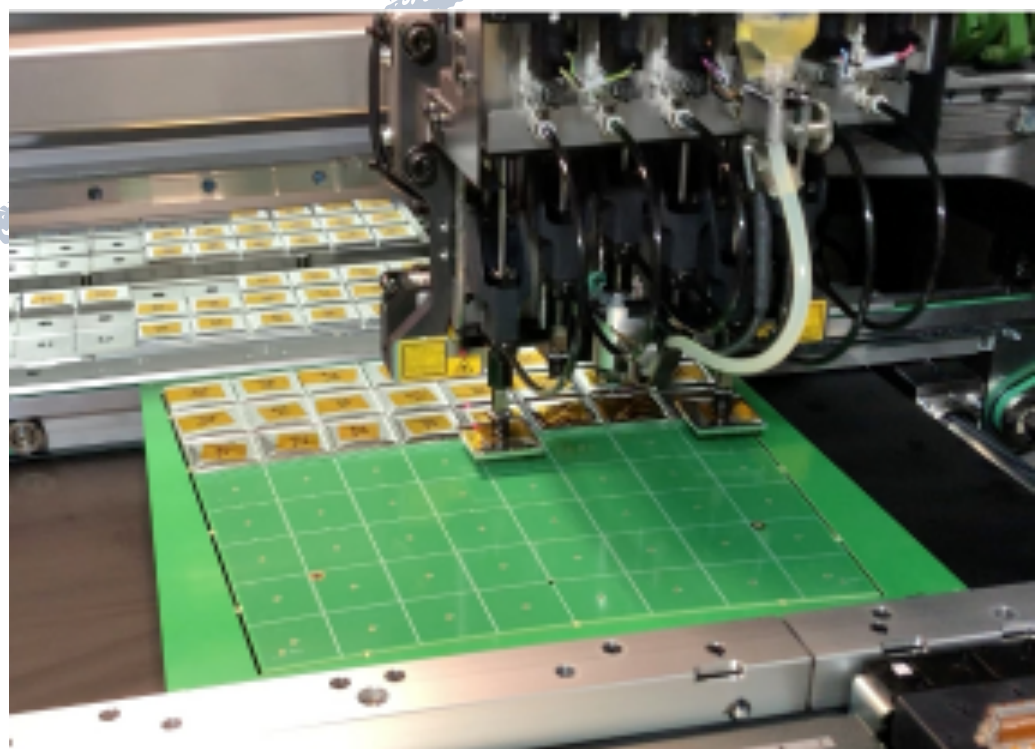
Testbeam: study showers in real conditions.

major DESY facility!

Cooperation with KIT

How to assemble 2000 boards?

- 35 board variants: all designed in DESY
- Use industrial pick-and-place machines for:
 - PCB assembly.
 - Gluing of tiles on the PCB.

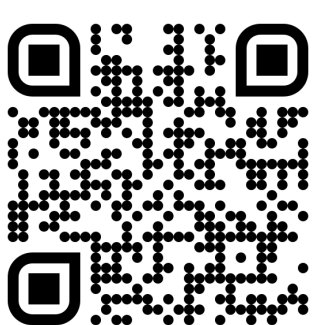


Video!

Placeholder for picture

- ★ PhD at LAL (Orsay) on Higgs physics in ATLAS.
- ★ Postdoc in Mainz: high-granularity calorimeter prototypes in CALICE.
- ★ Postdoc fellow at DESY since 2023, joining the CMS HGCAL construction.

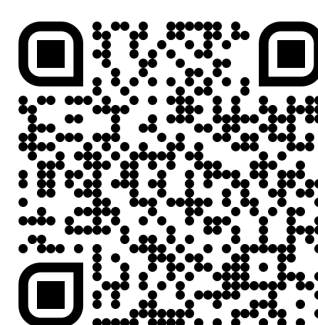
Videos



Integration modelling



Tile wrapping



Tilemodule pick-and-place

