AIDA 2020

Advanced European Infrastructures for Detectors at Accelerators

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

CALICE

PRISMA Cluster of Excellence

Task 14.2.2

TEST BENCHES FOR THE CHARACTERISATION OF HIGHLY GRANULAR CALORIMETER ELEMENTS WITH SCINTILLATOR AND SIPM READOUT

Lucia Masetti

Johannes Gutenberg University Mainz

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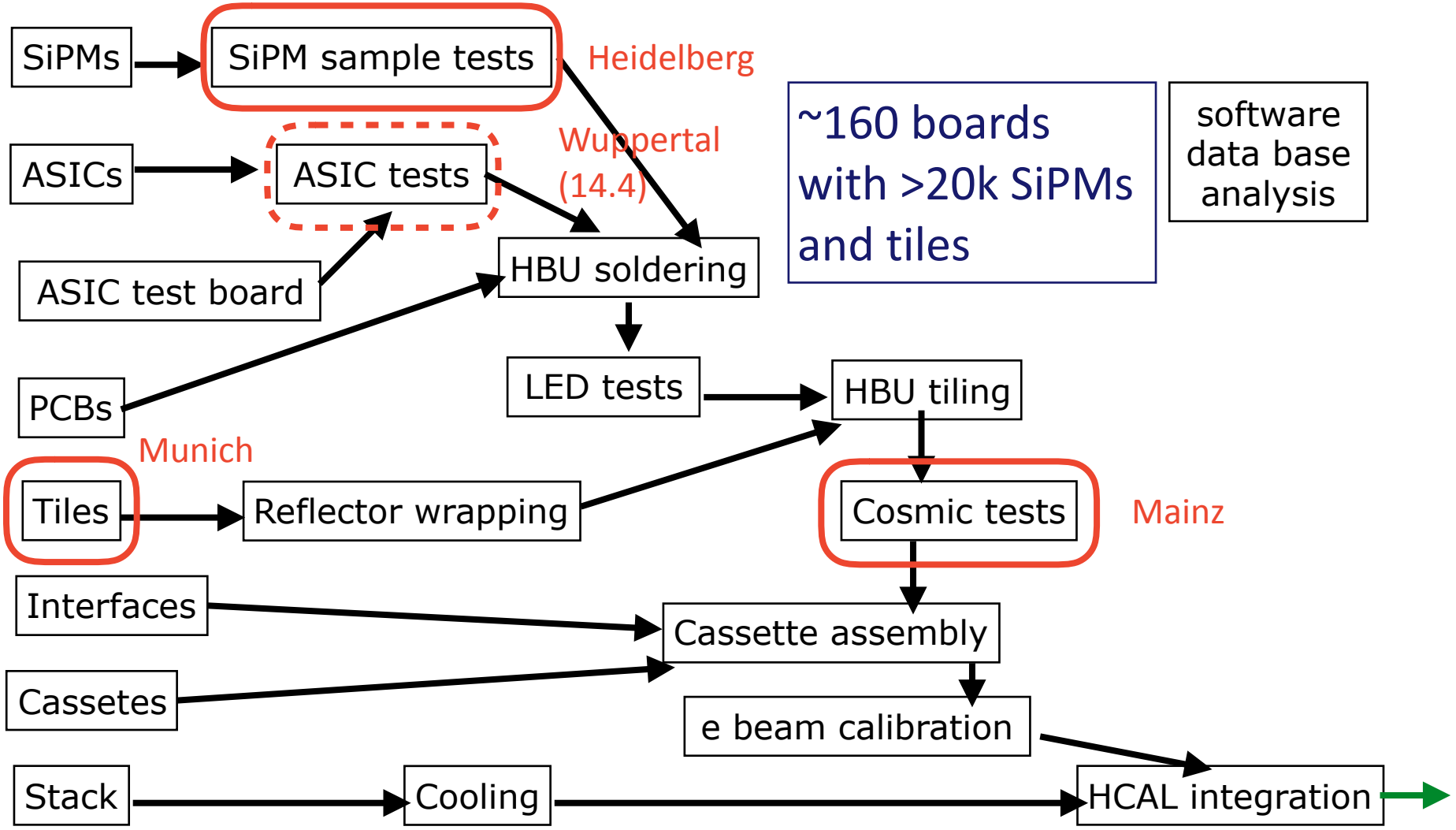
Goals and Milestones

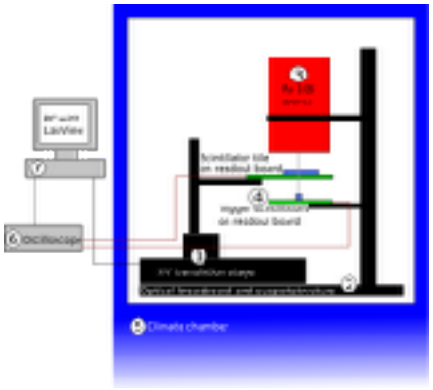
- **Goals:**
  - Precision test of single cells with a radioactive source (Munich)
  - Mass tests of photon sensors (Heidelberg, as partner of DESY)
  - Large area tests with cosmic ray muons (Mainz)
  - Temperature stabilisation of bias voltage (Prague, Bergen)
    -> Talk by Gerald
- **Milestone:**
  - MS14.2: M12 (04/2016) - Specification of setup -> **DONE**
- **Deliverable:**
  - D14.2: M40 (08/2018) - Report on commissioning and usage of setup -> commissioning and usage: ongoing!

AHCAL prototype production



Munich: reminder

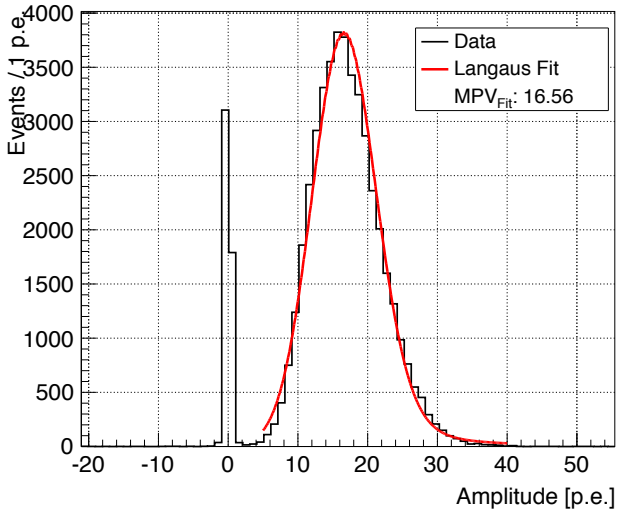
- To evaluate the uniformity of response of scintillator tile and SiPM systems
- **Design:**
  - In AIDA2020 WP14.2 Specification document (Milestone 12)
  - Electron source
  - Tile under test mounted on on x-y stage (range 19.5 cm, typical scan steps 1 mm)
  - Trigger cube or trigger fibres underneath the tile aligned with the source
  - Inside a climate chamber
  - Readout of up to 3 channels with Picoscoop and LabView controlled DAQ
- **Improvements wrt. previous version:**
  - Temperature controlled for stable and repeatable measurements
  - Increased range for crosstalk studies with single tiles and mega-tiles
  - Low noise SiPM in the trigger
  - Higher energy electrons for larger penetration depth and higher rate
  - Simplified LabView based control and readout system
  - Analysis in Root

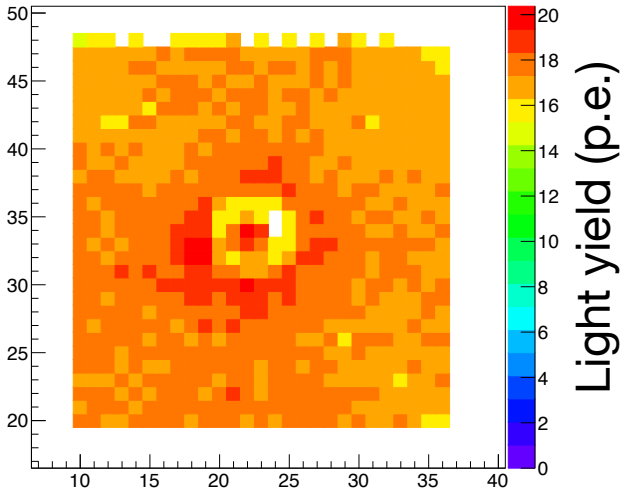


15 cm range translation stages inside the climate chamber

Munich: commissioning

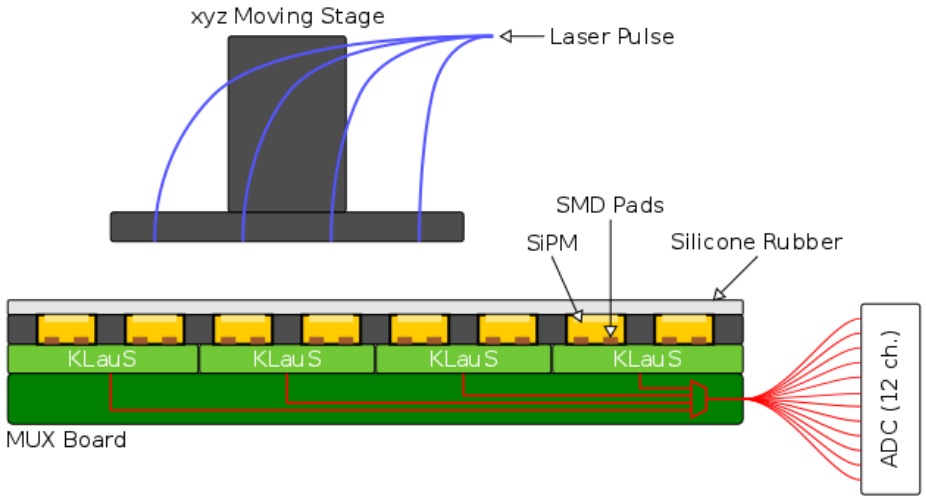
- Climate chamber, ^{106}Ru source and translation stages available
- Design of trigger cube/fibres and support structure ongoing
- Data taking steered via Labview
  - Motor control
  - Picoscope control and readout (4 channels)
  - Ongoing: climate chamber control, power supply control
- Record signal integrals but also (optionally) the complete waveforms for detailed analysis
- Analysis in Root determines the light yield at each position from a Gaussian fit to the peak region of the recorded energy deposition





Heidelberg: SiPM QA

- **Requirements:**
  - DCR < 500KHz
  - Cross-talk < 3%
  - PDE (@420nm) >20%
  - Gain >3x105
  - dV/dT < 1% of excess bias voltage (~50mv/k)
  - V_{bd} spread min-max within a batch 200 mV
- From each batch of 600 SiPMs 24 are tested
- Batch rejection if fails > 1/24



SMD SiPM schematic view

Default settings: 25°C, 5V overvoltage

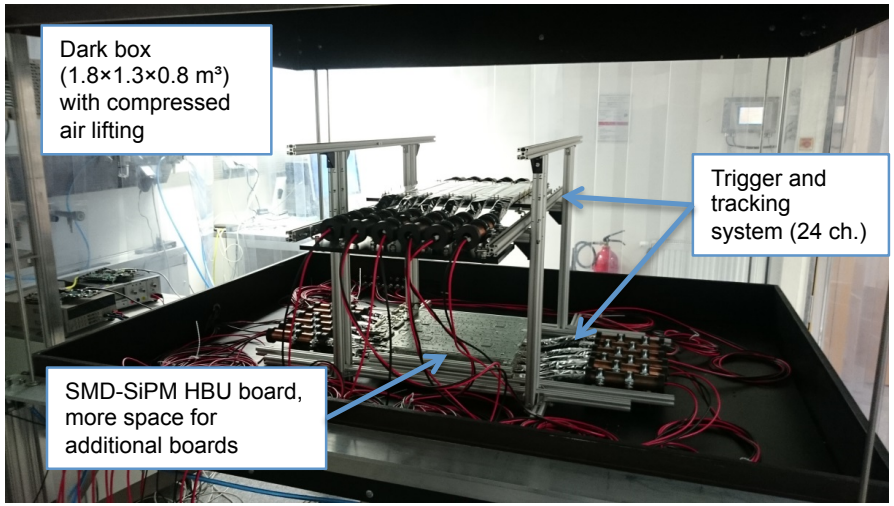
Heidelberg: SiPM test results

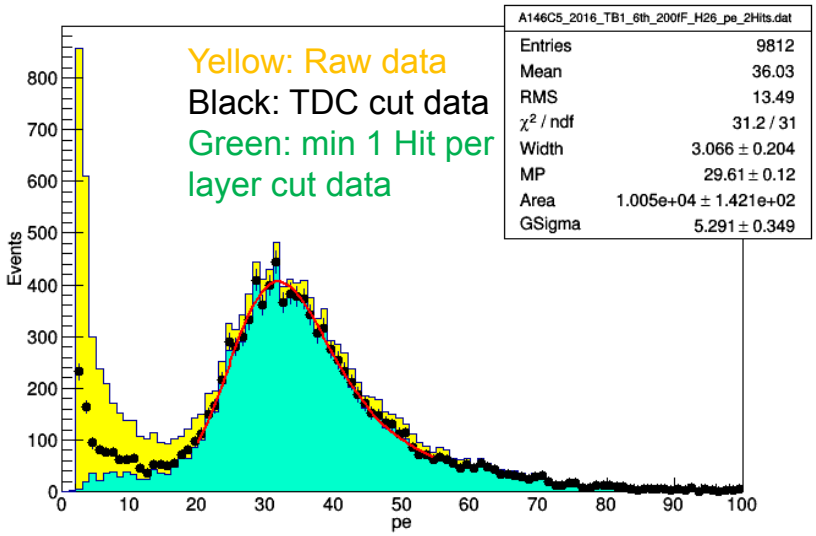
- DCR ~70K< 500KHz **ok!**
- Cross-talk + after pulse ~ 5% **ok?** Cross-talk measured for similar SiPM < 3%
- PDE (@420nm) >20% - **test bench being commissioned, could sample few SiPMs per batch**
- Gain 6x105 > 3x105 **ok!**
- dV/dT 56 mv/k of ~50 mv/k **ok!**
- V_{bd} spread min-max within a batch 200 mV **ok!**
- **First tested batch was accepted**

- Expecting more SiPMs in the next two months (~1000 SiPM to test)
  - Full temperature analysis only for the last batch of the day (over night)
  - Rest will be measured at 25°C

Mainz: current status

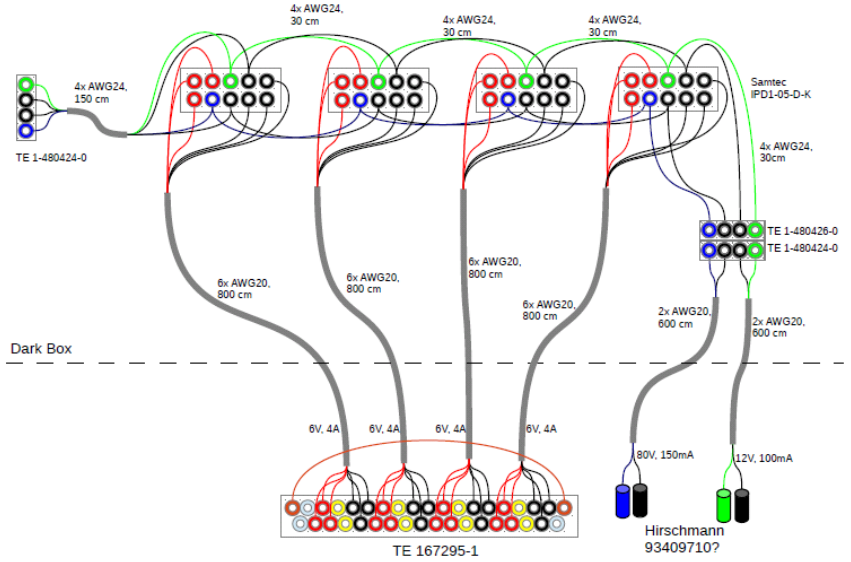
- Cosmic ray test stand was used to measure the performance of the 6 HBUs assembled last year
- 2 HBUs were measured in parallel
- Cosmic ray test stand and the HBUs show very good performances
- Cosmic ray test stand is scalable to mass production needs
- For the final calibration ~60 HBUs have to be measured in parallel
- This Year: 160 new HBU boards have to be measured → 8-10 boards in parallel





Mainz: plans

- Stack structure to align maximum 10 HBU Boards vertically
  - HBU with individual interface board (no slabs)
- Design of HBU stack plates based on single HBU design
- Air circulation system with fans is planned
- New parallelised powering scheme for LV and SiPM bias



Summary and conclusions

- **Infrastructure already under regular use**
- Only few upgrades missing to completely meet all specifications
- Stress test with big AHCAL prototype production is starting
- Additional features being implemented and tested as necessary
- We are well in time for our deliverable
- Users from other communities are very welcome to use our facilities!