Tile characterization measurements in Heidelberg

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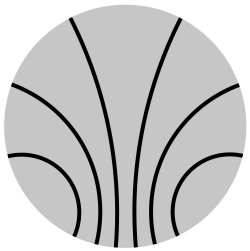


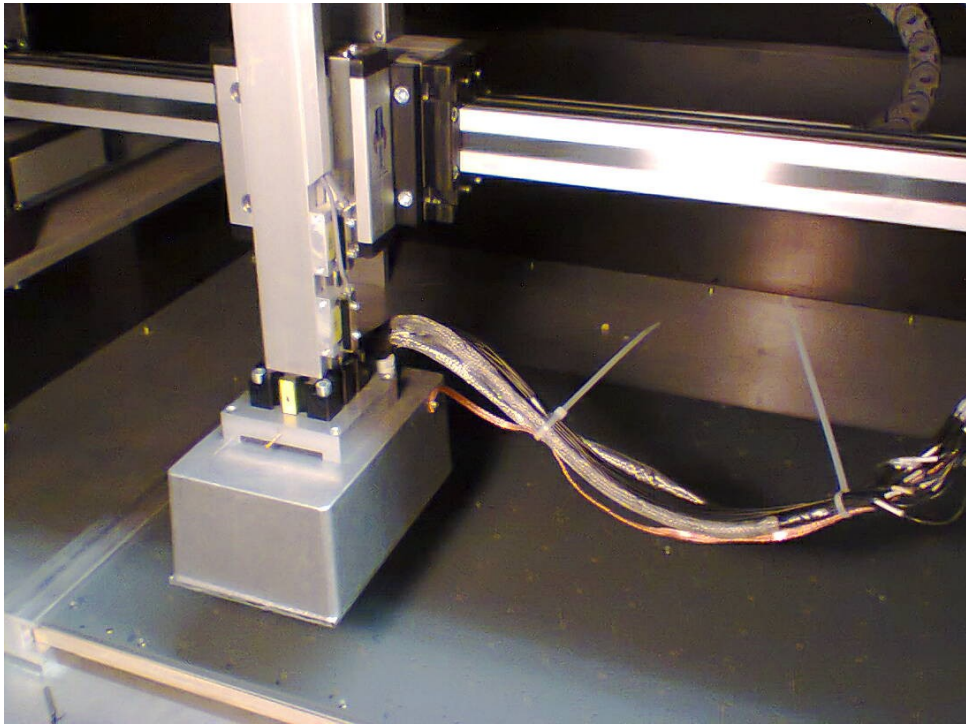
Outline

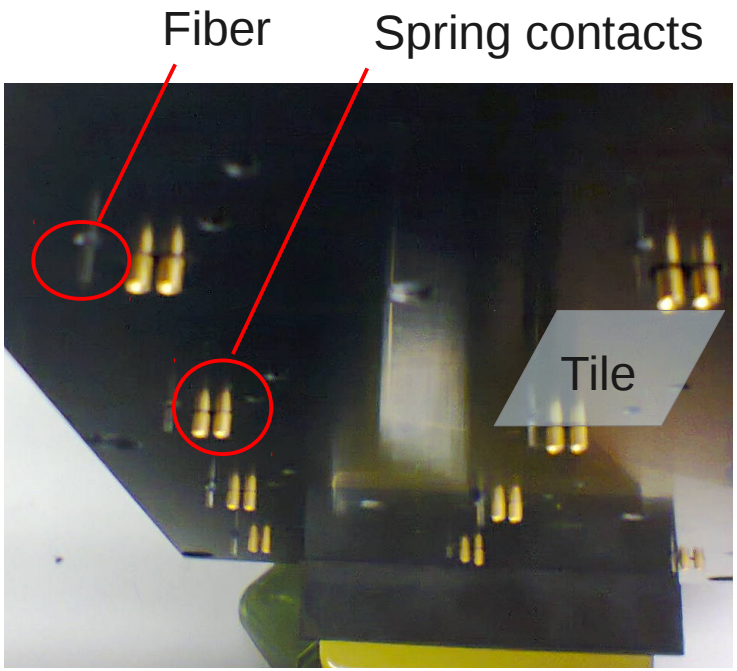
- Large Tile Testing System
- Characterization Measurements
- Future Plans

Reminder - Tile Testing System

Setup:

- 216 tiles can be inserted in a tile holder plate
- Readout electronics and fiber system (12 channels) inside
  Positioning head moved to 18 measurement stations
- Tiles lit by 375nm pico-second laser, pulse with ≈30ps
- Laser intensity fixed, common HV





Measurement procedure

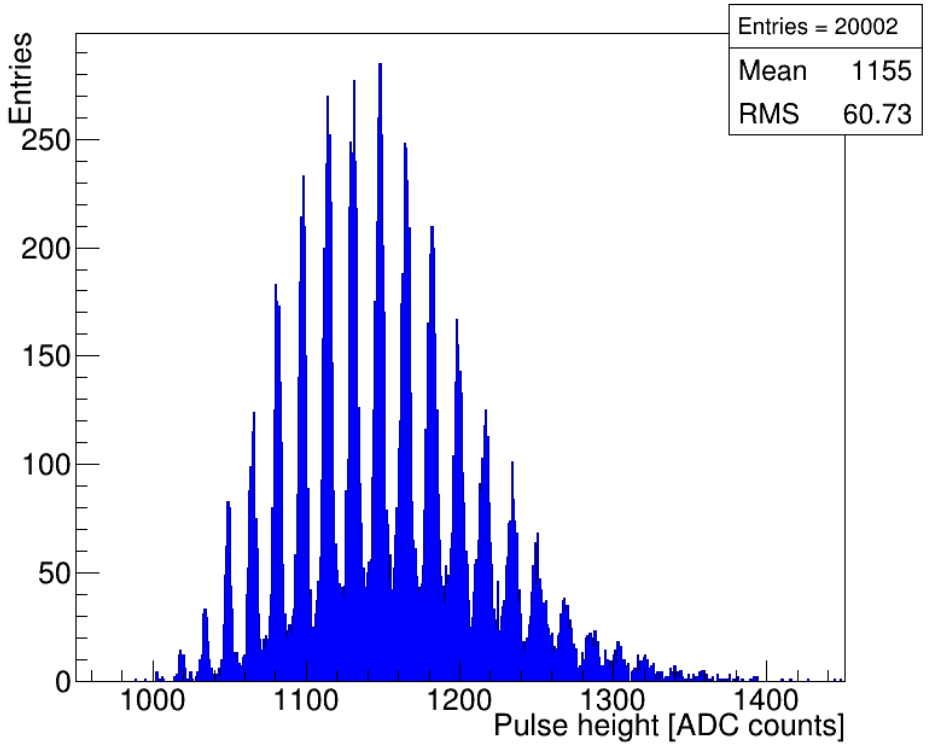
- Voltage scan of 15 Points, measured up to ≈3V over-voltage
- Dark rate spectrum (5kEvents) and Single photon spectrum (20kEvents) taken
- About 2 minutes per measurement (12 tiles in parallel)
- Full measurement of 216 tiles takes about 45 minutes

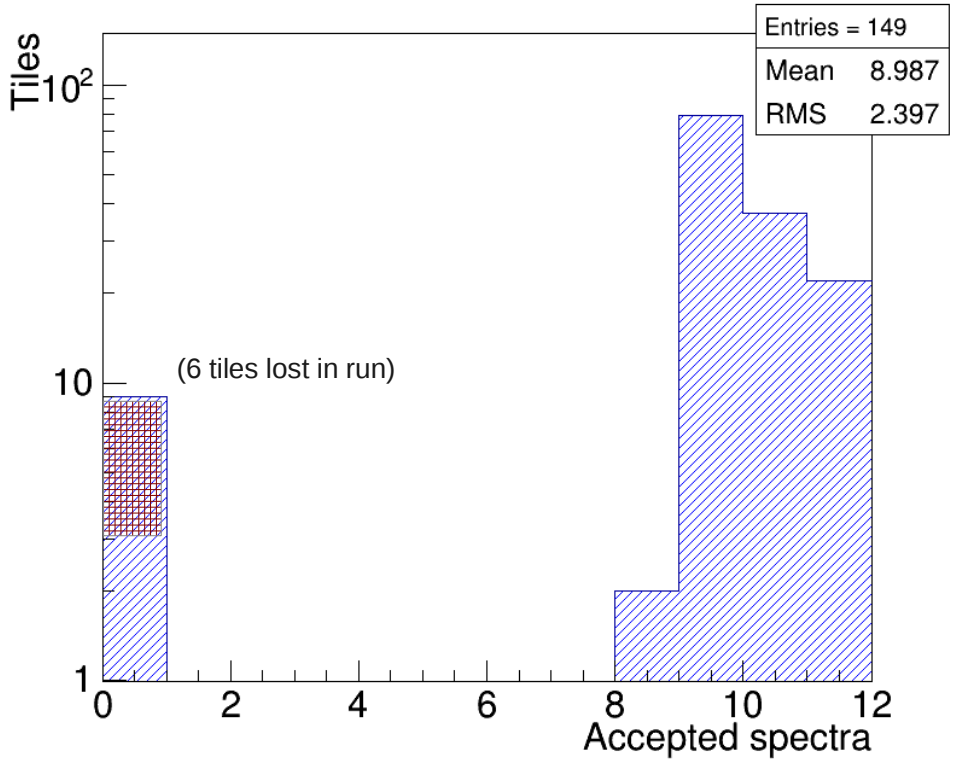
Characterization of 149 Uni HH Tiles

- 149 wrapped tiles measured
  in Heidelberg end of November
- Runs with 50ns and 100ns integration time
- Fiber calibration runs (5h)
- No repeated runs for error estimations
- 100ns runs show lower χ^2 in preliminary analysis, these results are shown here.
  (6 tiles missing in this dataset)

SiPM quality

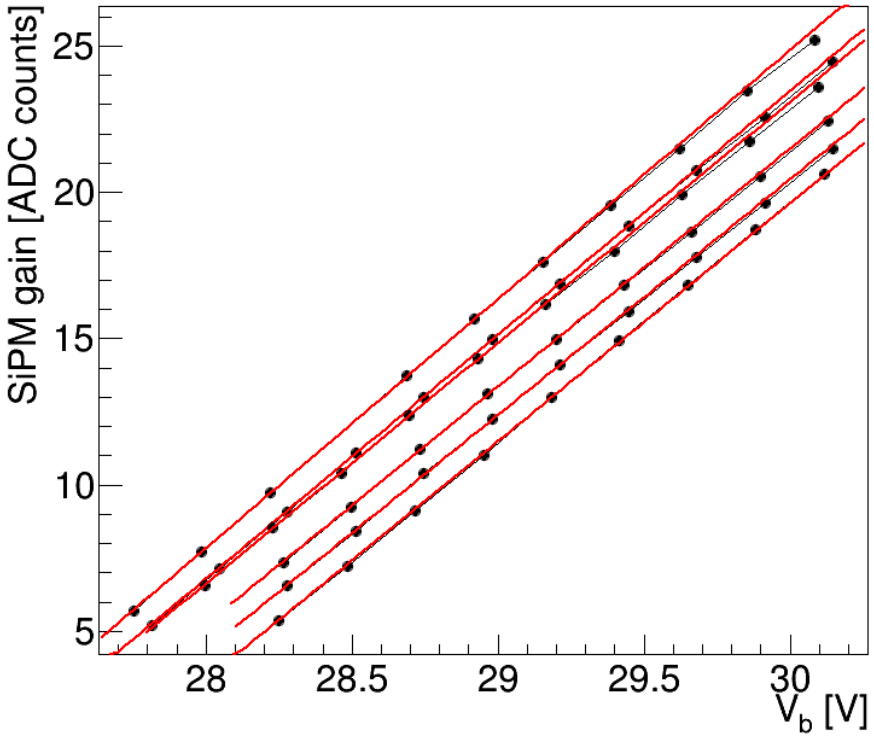
- Spectra show good peak separation from 0.7V above breakdown
- Noise levels about 20% higher compared to small system (Noise from Positioning Stage)
- Out of 149 tiles, 3 do not show any acceptable spectrum

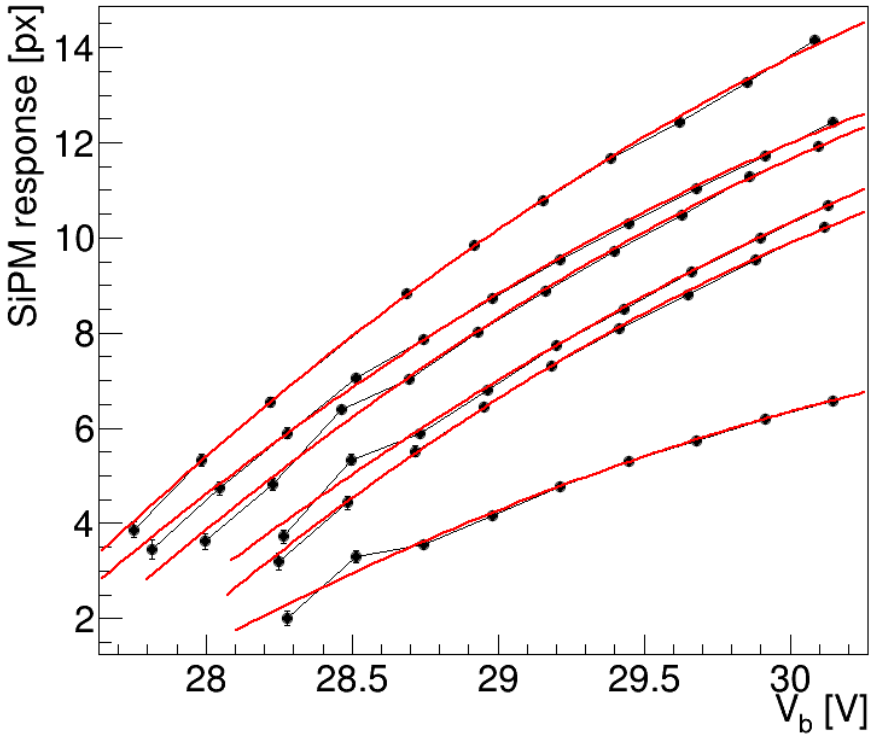




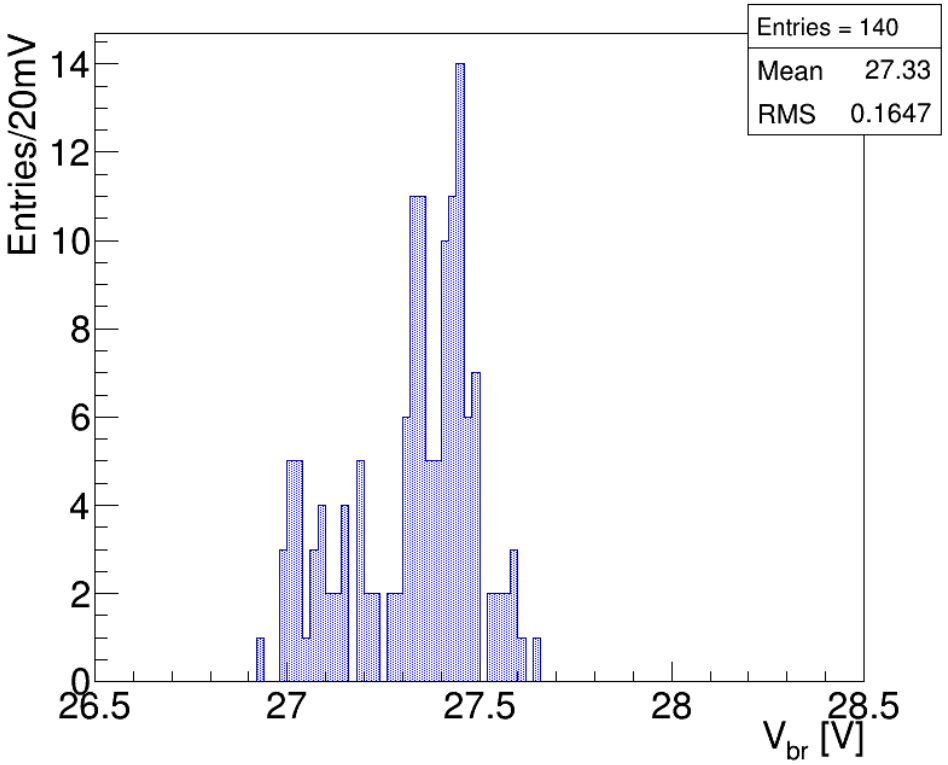
Parameter extraction

- In order to improve fit results, some work on gain error estimation and spectrum quality cuts necessary
- Mean signal in expected bias region ≈10px
- Measured Npx points fitted with a pol(2) function





SiPM breakdown voltage

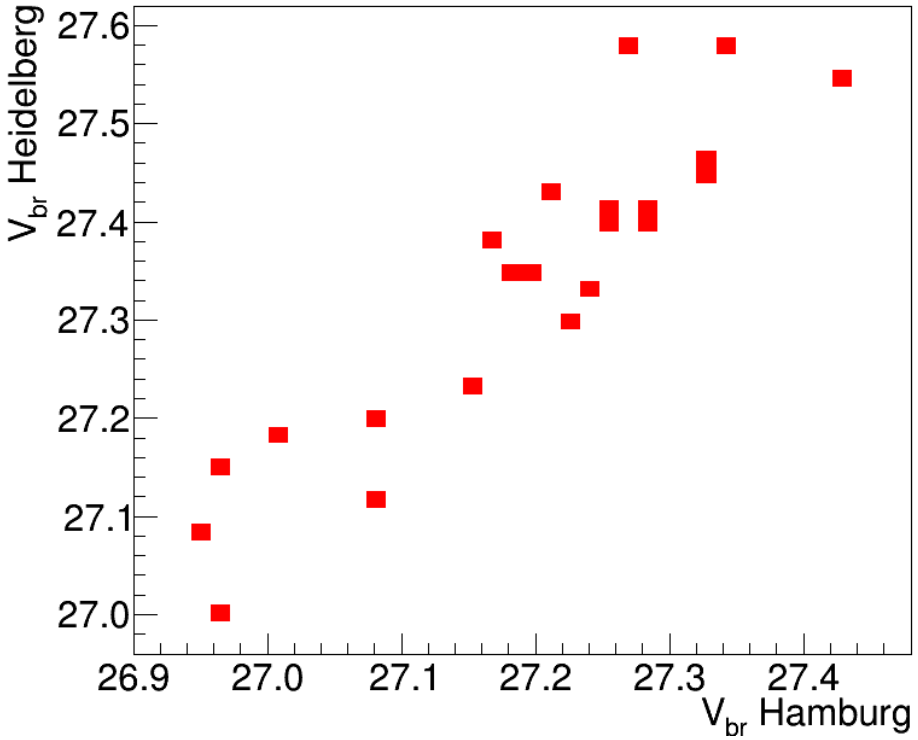


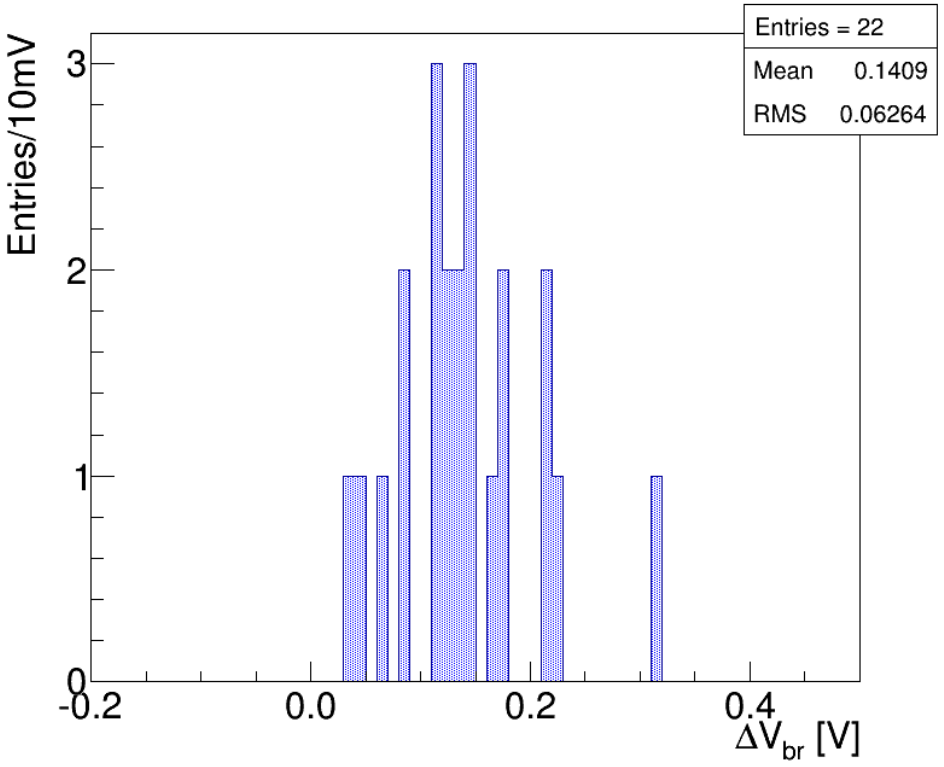
- Distribution shows similar structure as seen in Hamburg measurements.
- Mean errors from fits: 100mV

Preliminary results!

SiPM breakdown Voltage

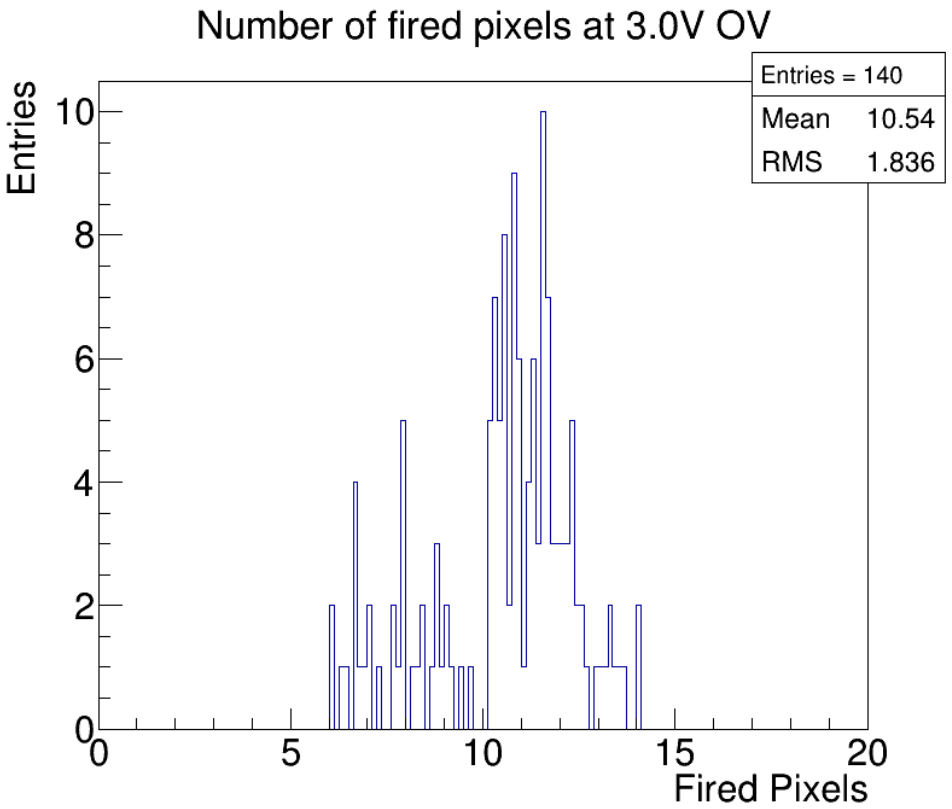
- 22 tiles have also been characterized by Uni Hamburg
- Differences: 300mVpp + Offset, RMS(Δ)~64mV

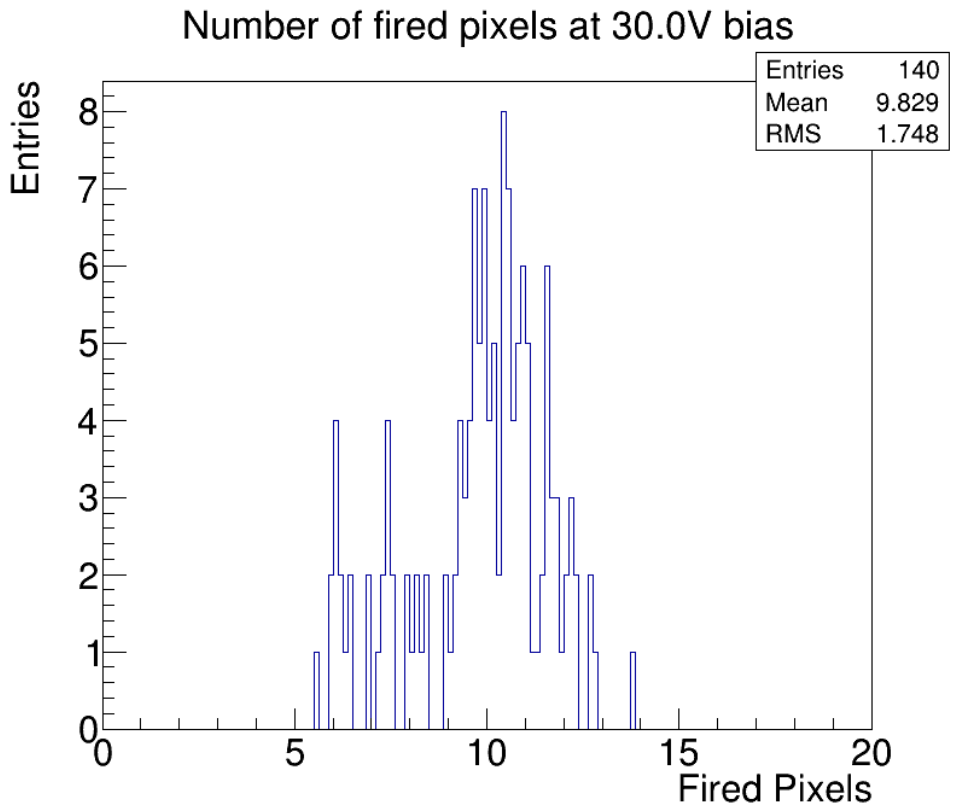




Tile signal response

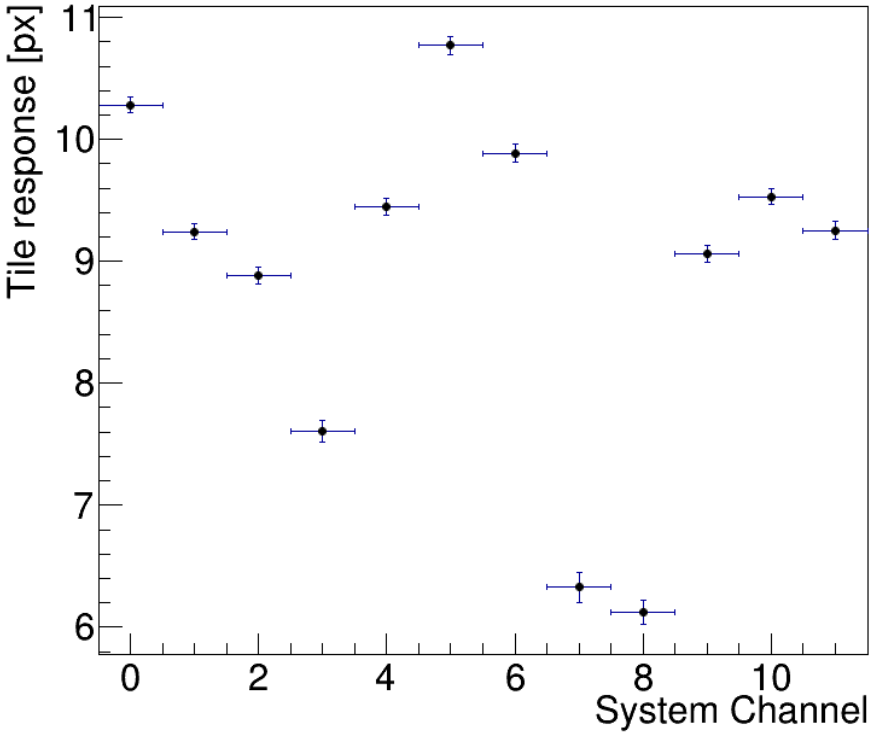
- Light yield not corrected for fiber system non-uniformity here.
- Laser intensity not tuned to actual MIP response (≈20px/MIP at this operating region)





Fiber system intercalibration

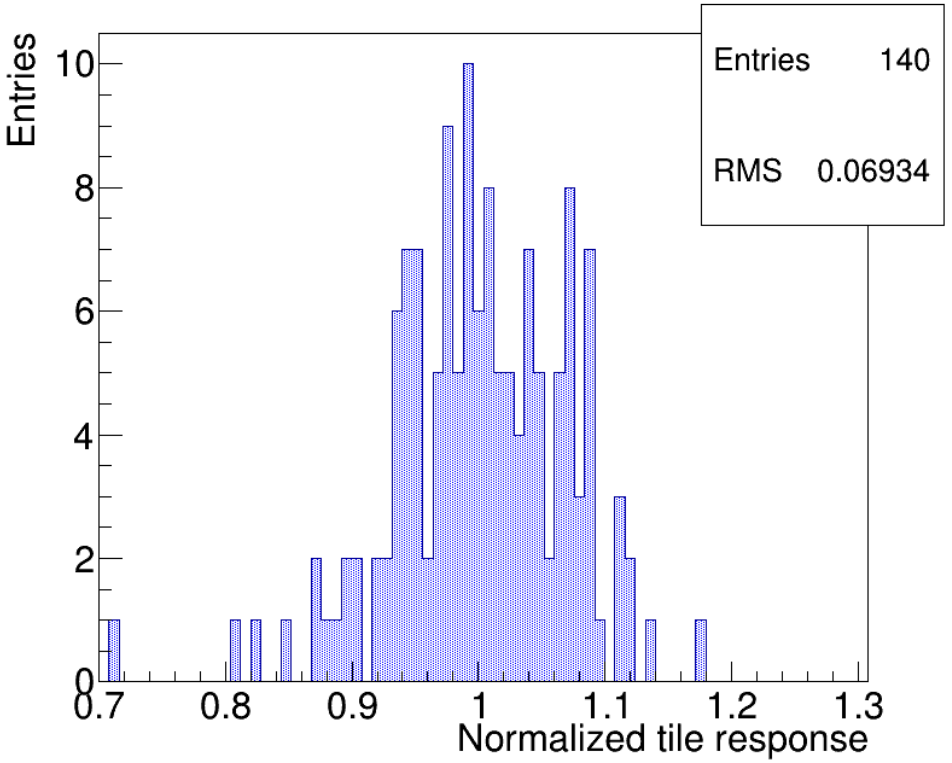
- Positioning head is moved in steps of 1x1 tiles.
- Most of the tiles are measured with each channel.
- Full measurement consists of ≈1500 individual measurements



Mean signal for each channel at constant over-voltage

Fired Pixels – Relative spread

Signal for each tile scaled by mean signal from fiber calibration runs



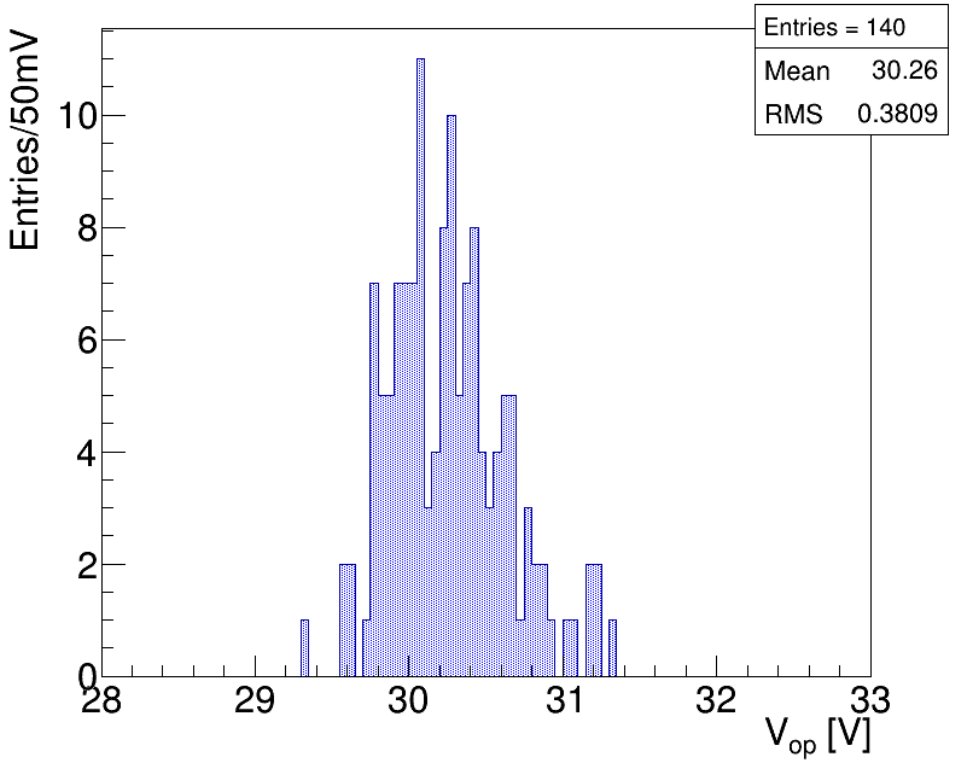
Relative Signal spread for detector operated at constant over-voltage

Allows crosscheck with other measurements and first estimation of measurement uncertainties.

Light yield equalisation

Reading of Uni Hamburg light yield characterization database not yet implemented

→ Absolute light yield per MIP not accessible.



Light yield equalization can be performed on the basis of a voltage operation point.

Mean pixel response is equalized around e.g. $\langle V_{ov} \rangle$ = 3V

Estimation by solving the $N_{px}/N_{px,channel} = 1$ functions in Taylor expansion up to 2nd order

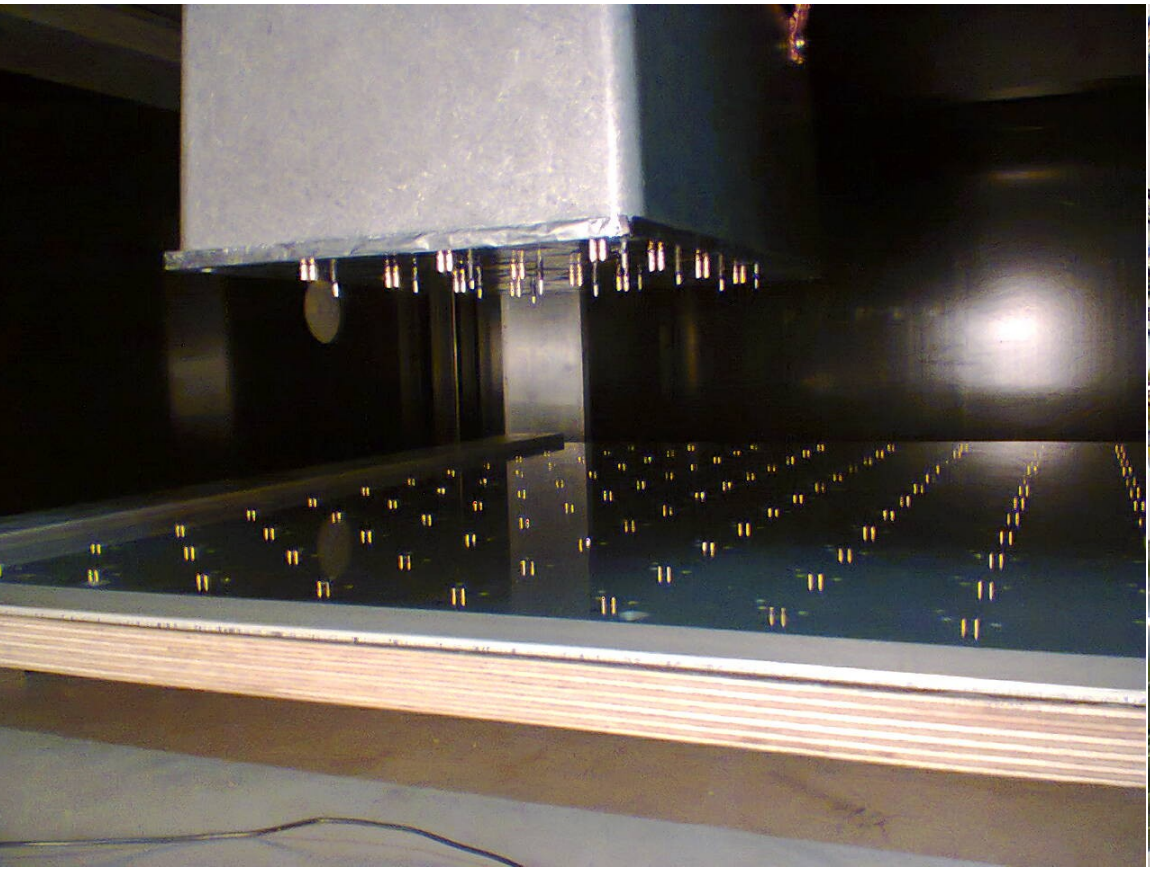
Summary and Outlook

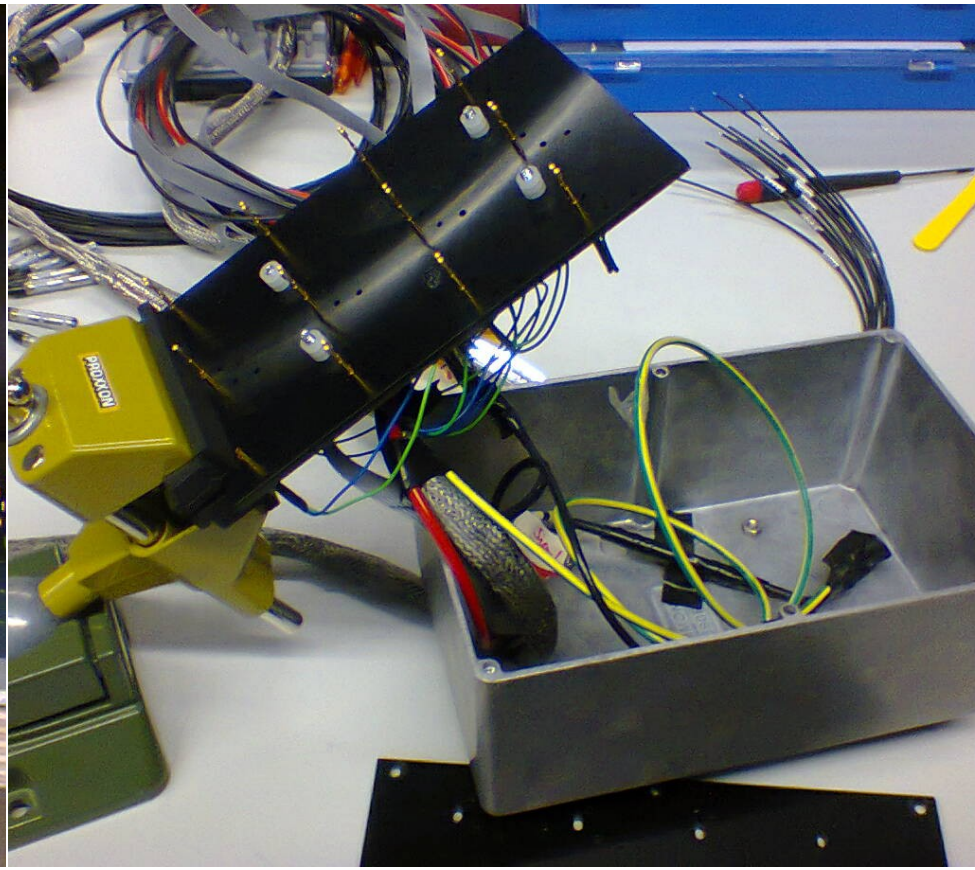
- Large scale system successfully operated with a larger number of tiles
- Good spectrum quality, noise from positioning stage under control
- Significant differences in comparison with prior Uni Hamburg characterizations
- Careful analysis of systematics to be done, some system parameters will have to be tuned
- Tile response equalisation can be performed using a mean operating point.

- 300 tiles will be measured for the test-beam in January
- Repeated measurements to determine system stability and systematics planned

Backup

Detailed pictures of the system





Detailed pictures of the system