Supermodule Prototype

Sebastian Zimmermann
On behalf of the Panda SciTil group

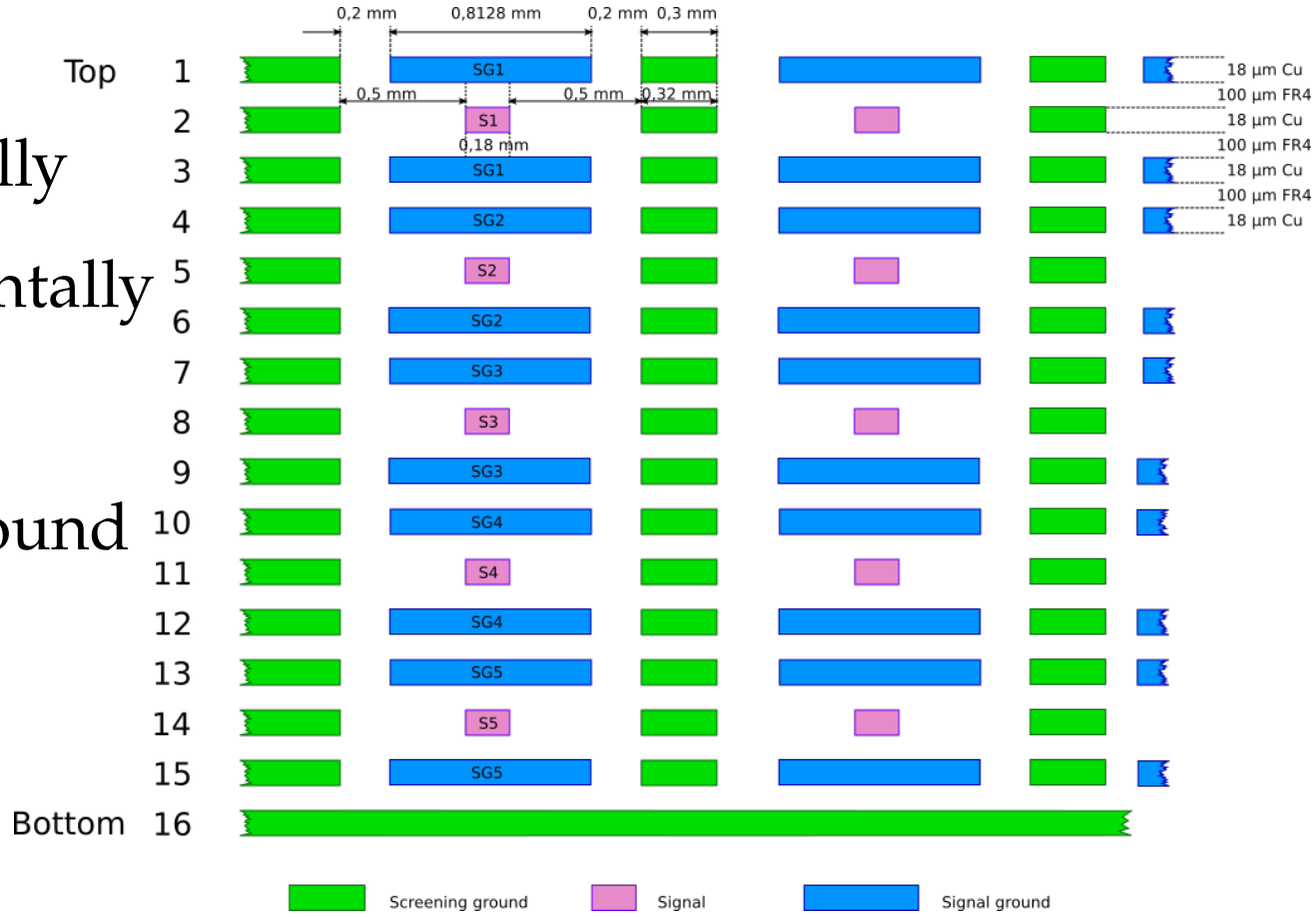
Mainz, 13.9.2016

Railboard Prototype

- This prototype is half the ~~size~~ of the envisioned supermodule
- Dimensions:
  - 110 cm x 17.5 cm x 2.5 mm
- Channels for 30 “dual-modules”
  - Each with ~~dual~~ readout of 4 connected SiPMs (hybrid or serial concetion)

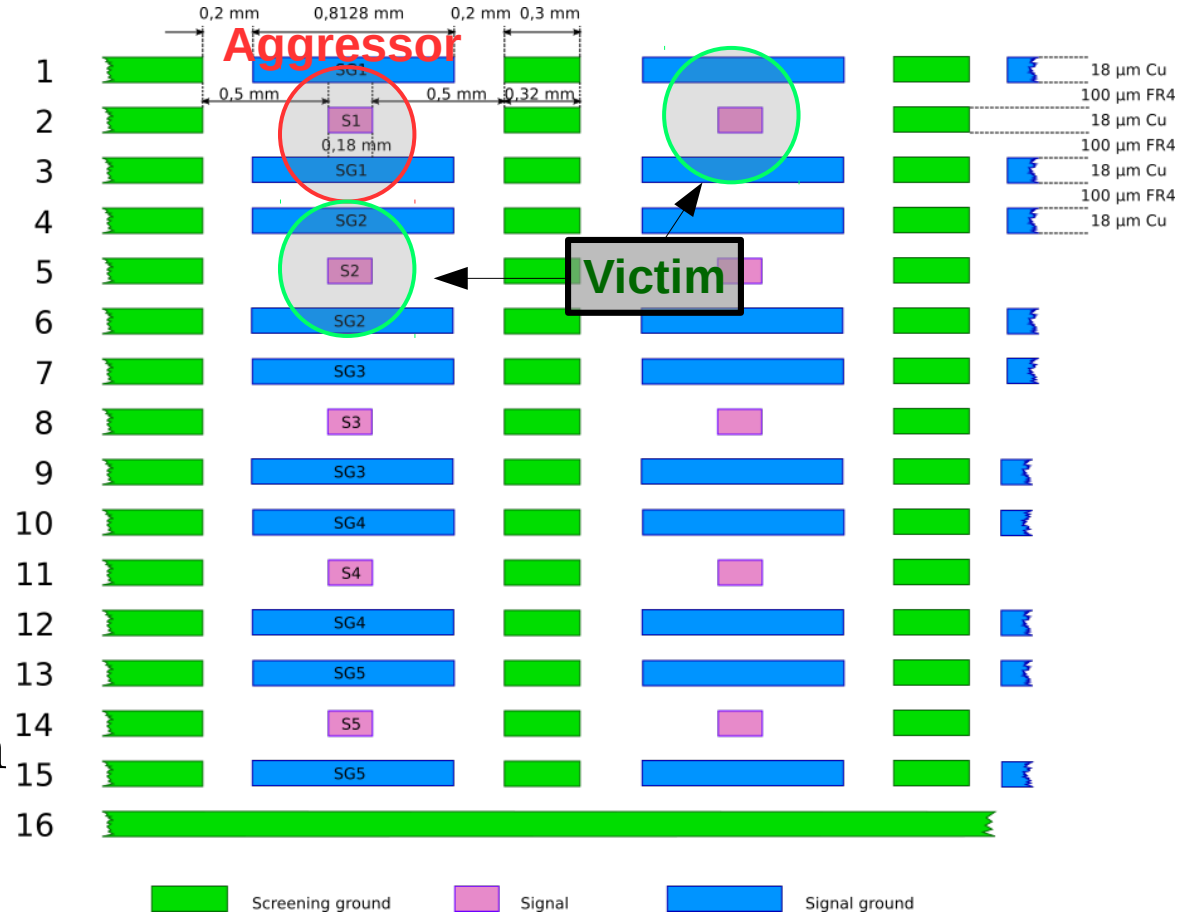
Schematic of the Railboard

- 16 layers
- 5 signal lines vertically
- 6 signal lines horizontally
- Shielded by ground layers and signal ground



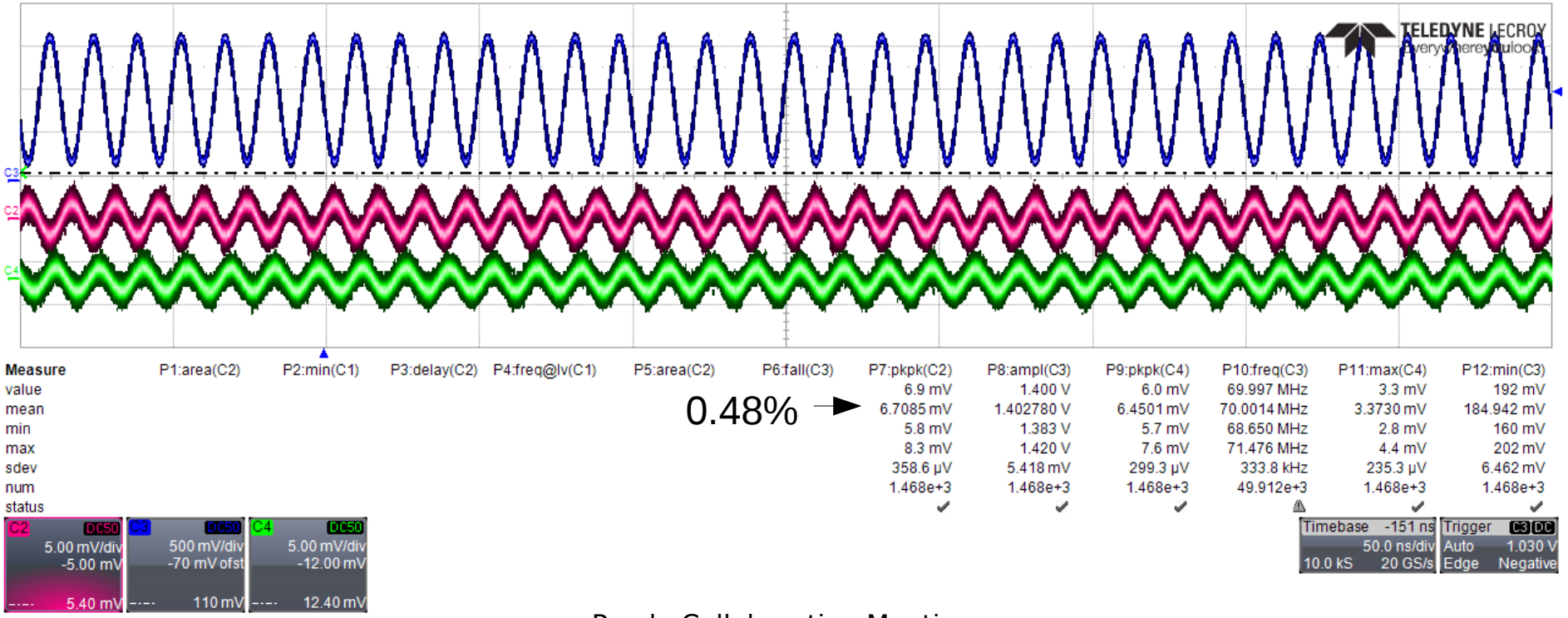
Crosstalk measurement

- Crosstalk to horizontal and vertical neighbors measured
- Aggressor signal (sine curve) induced at the sensor side & measured at the FEE side
- Victim measured on both sides by an Oszilloscope



Crosstalk measurement

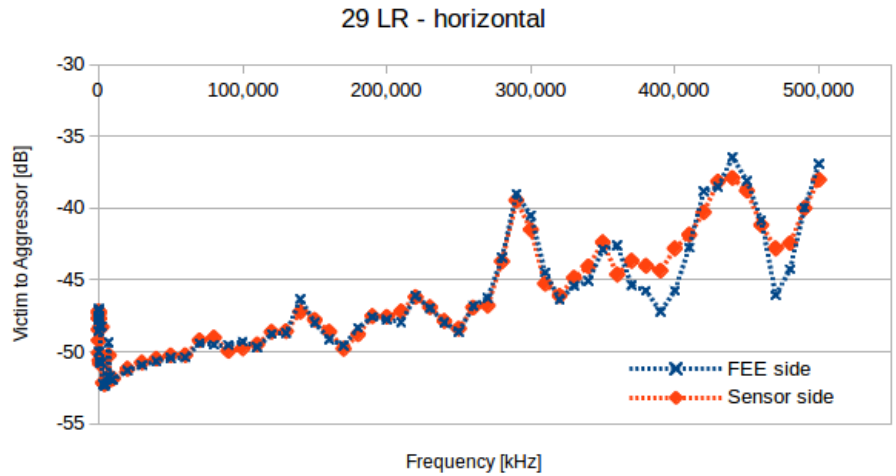
- Blue: Aggressor, red: victim sensor side, green: victim FEE side

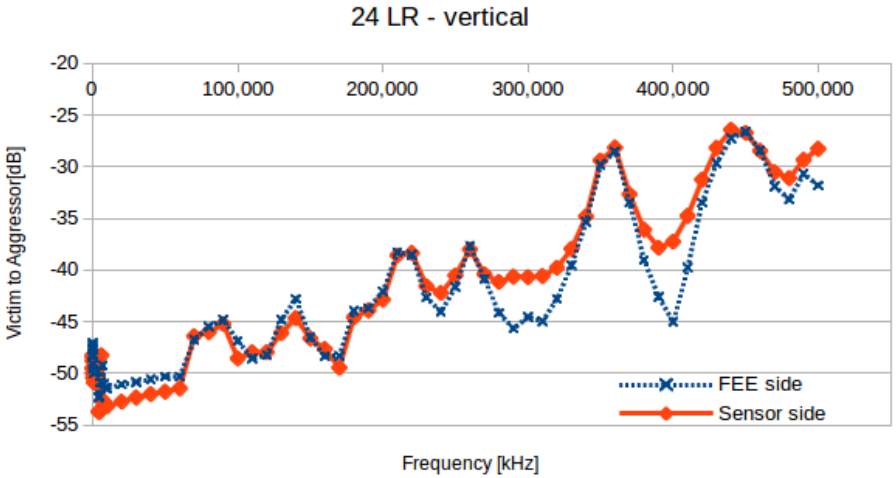


Crosstalk Measurements

- Measured as aggressor amplitude (F_0) vs victim amplitude (F)
  - Measured as mean of peak to peak for >1k events
- Plotted in decibels against the aggressor frequency:

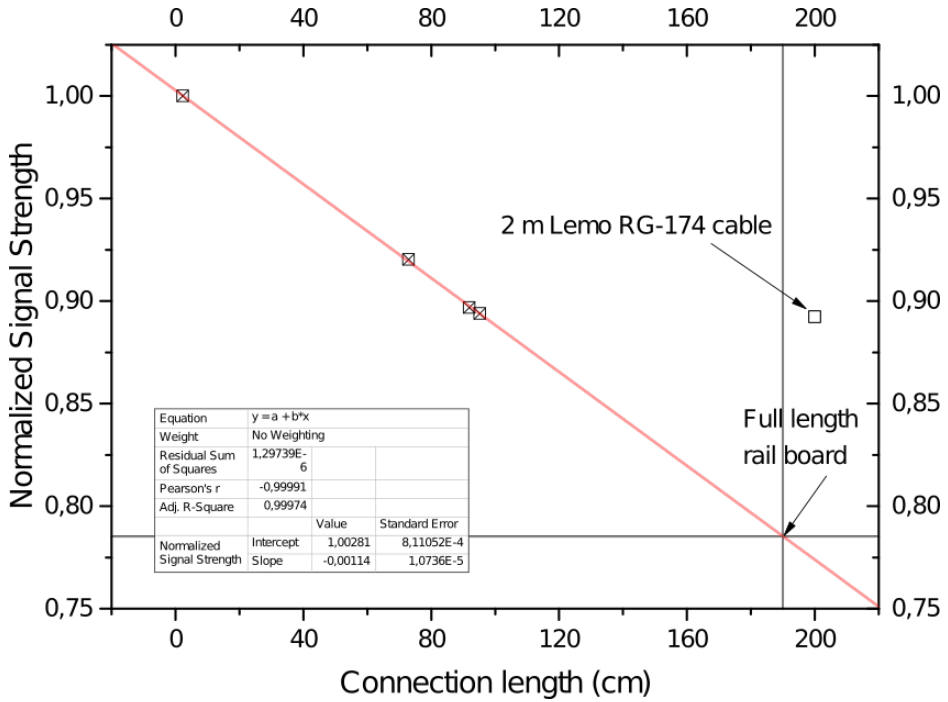
$$20 \log_{10}\left(\frac{F}{F_0}\right) \text{dB}$$





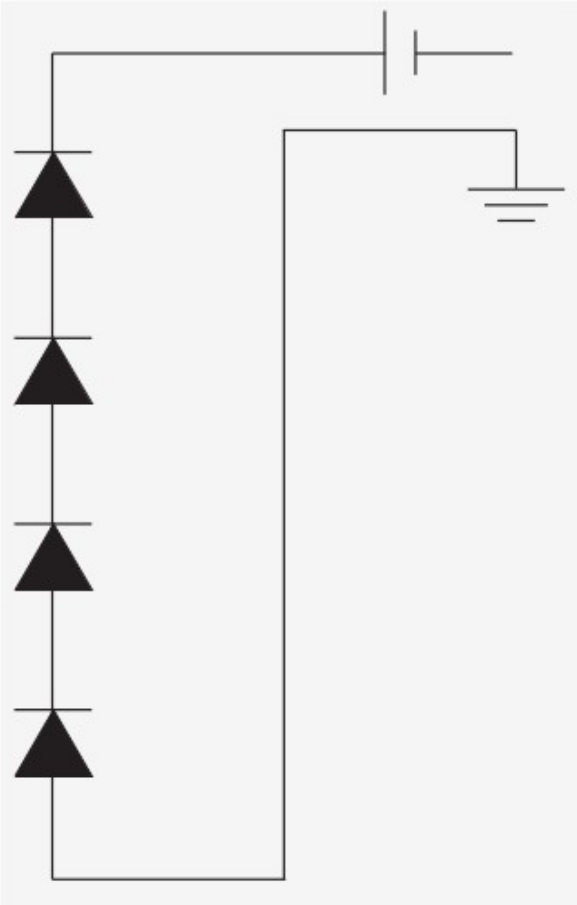
Signal Attenuation

- Measured with a pulse of about 3.4 V and a rise time of 10 ns and a falloff over 40 ns
- Multiple connections measured
- Extrapolated to full length railboard (190 cm)
  - Loss of ~23%

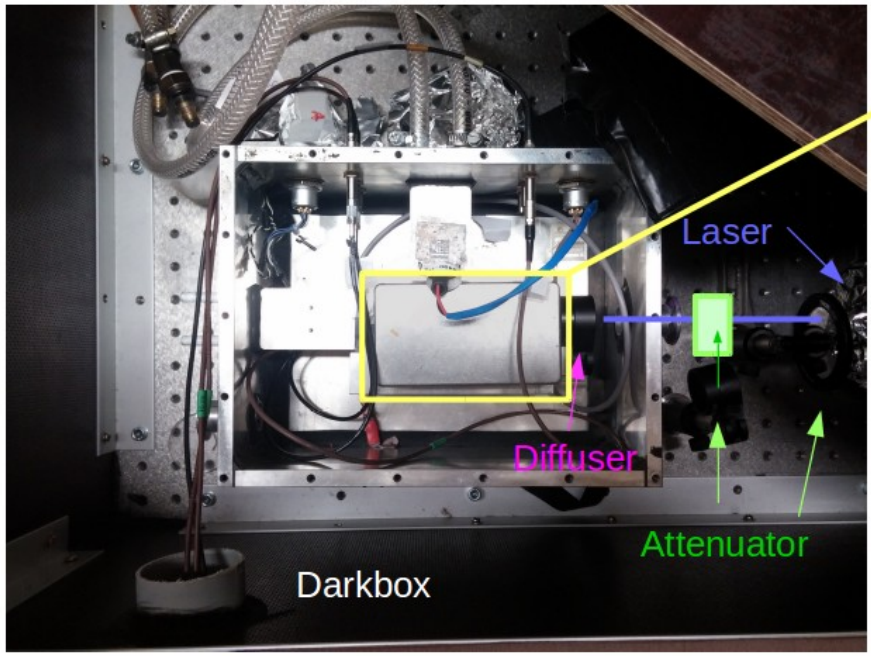


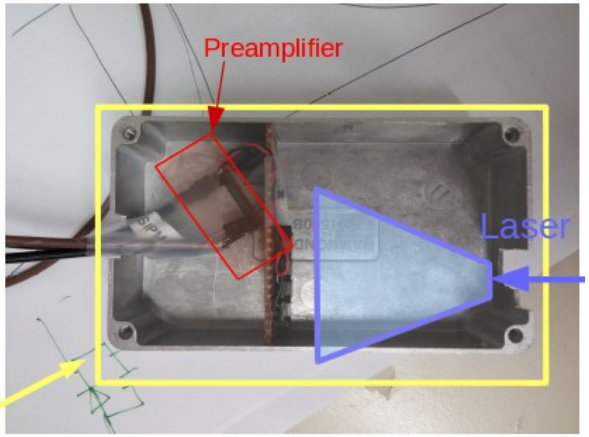
SiPM rate capability

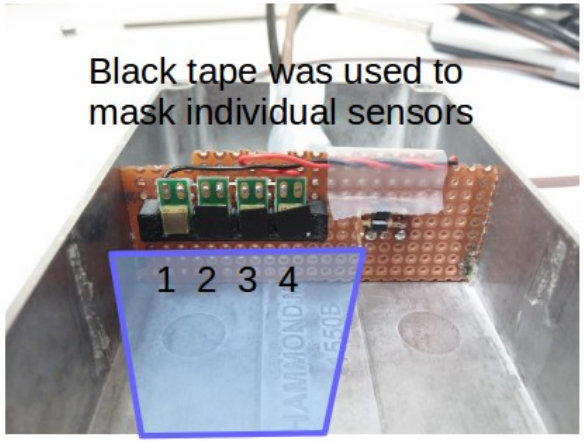
- Possible readout is with a serial connection of SiPMs
  - Improves risetime
  - Simplyfies readout
- Different behaviour than a single SiPM



SiPM rate capability measurement

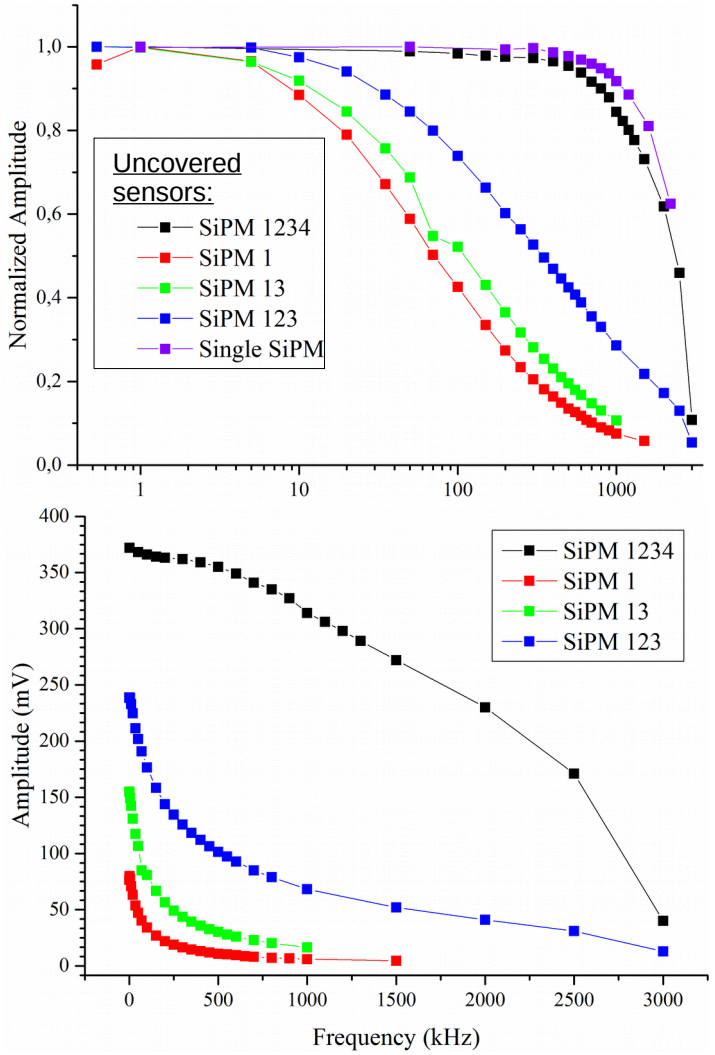






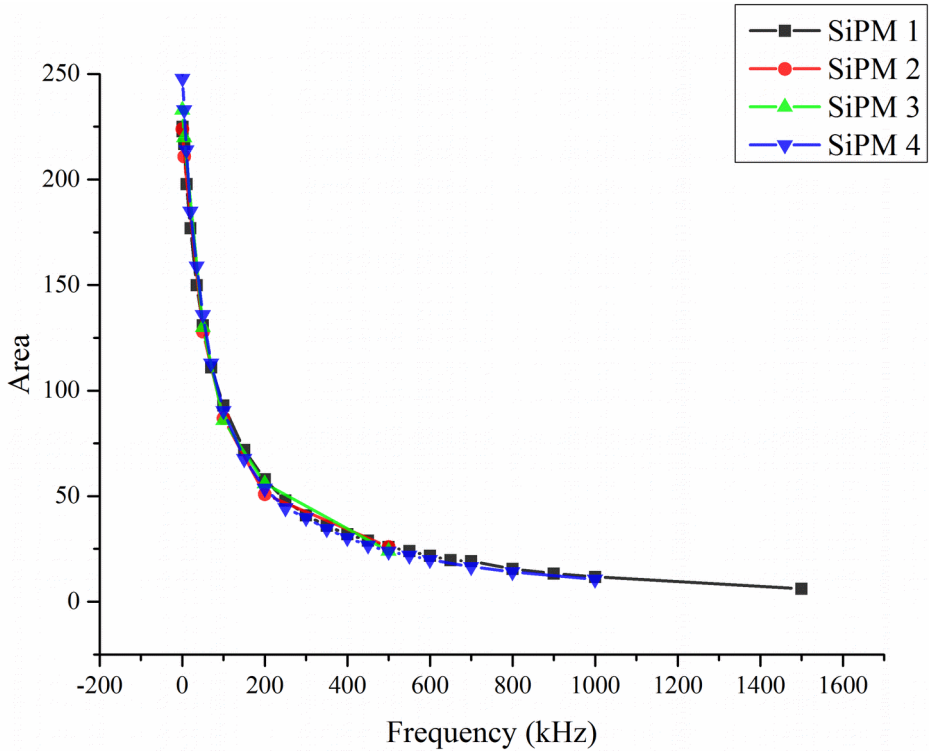
SiPM rate capability – serial connection

- If not all SiPMs are irradiated the rate capability drops
  - Behaviour if all sensors are irradiated equal to a stand-alone SiPM
  - rapid drop-off if at least one sensor is covered
- ~~Limited applicability to the experiment~~
  - All 4 sensors should be irradiated by the scintillator
  - Expected ~~rate at~~ 40 kHz



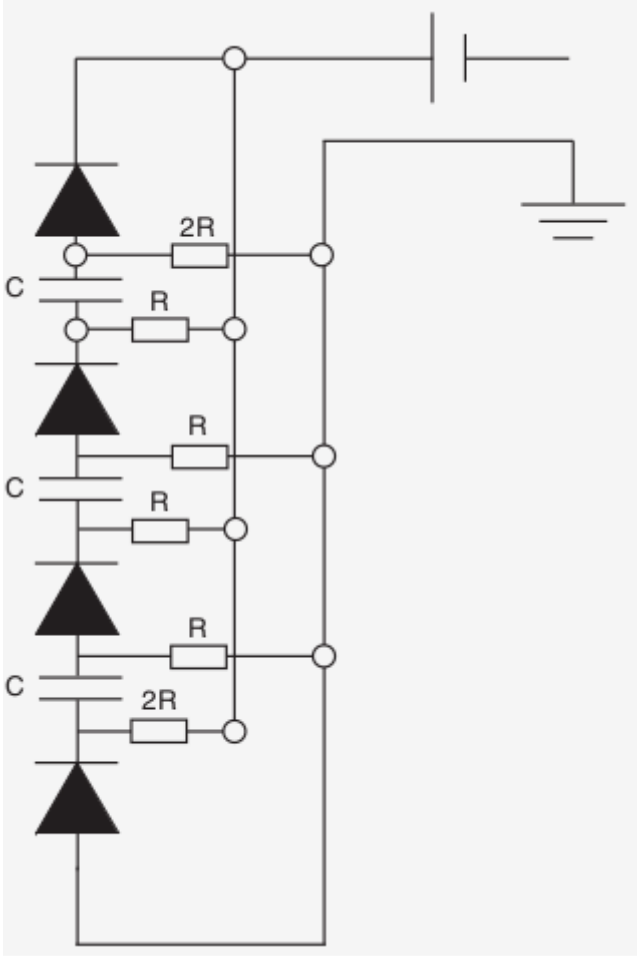
SiPM rate capability – serial connection

- No position dependece of the covered sensor for the SiPM response
- Same for 2 and 3 irradiated SiPMs



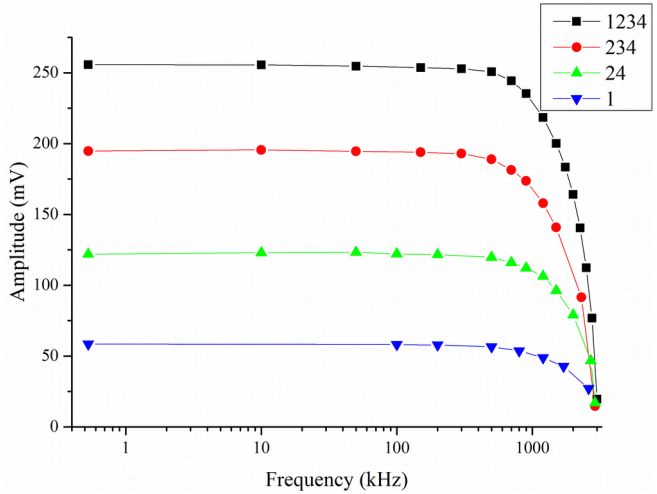
SiPM rate capability – hybrid connection

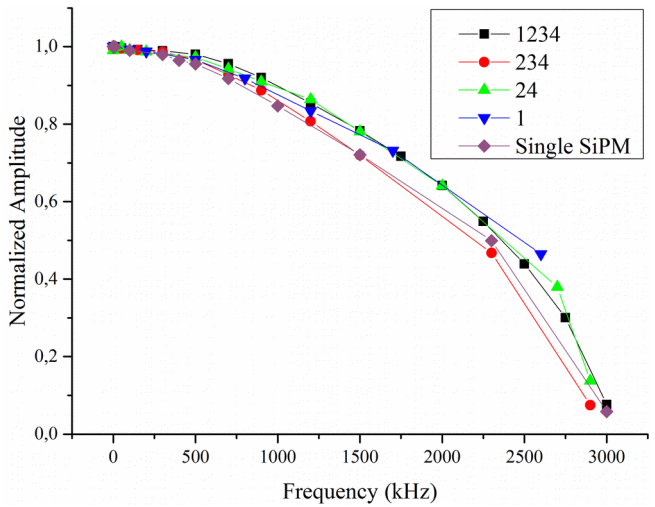
- Transmitts signal in series
- Has individual voltage supply
  - ~~Lower supply voltage necessary~~
  - Potential gain and radiation hardness problems



SiPM rate capability – hybrid connection

- Response independent of position of the irradiated sensor and amount of covered sensors
- Same behaiour for all confiugurations even for a stand-alone SiPM



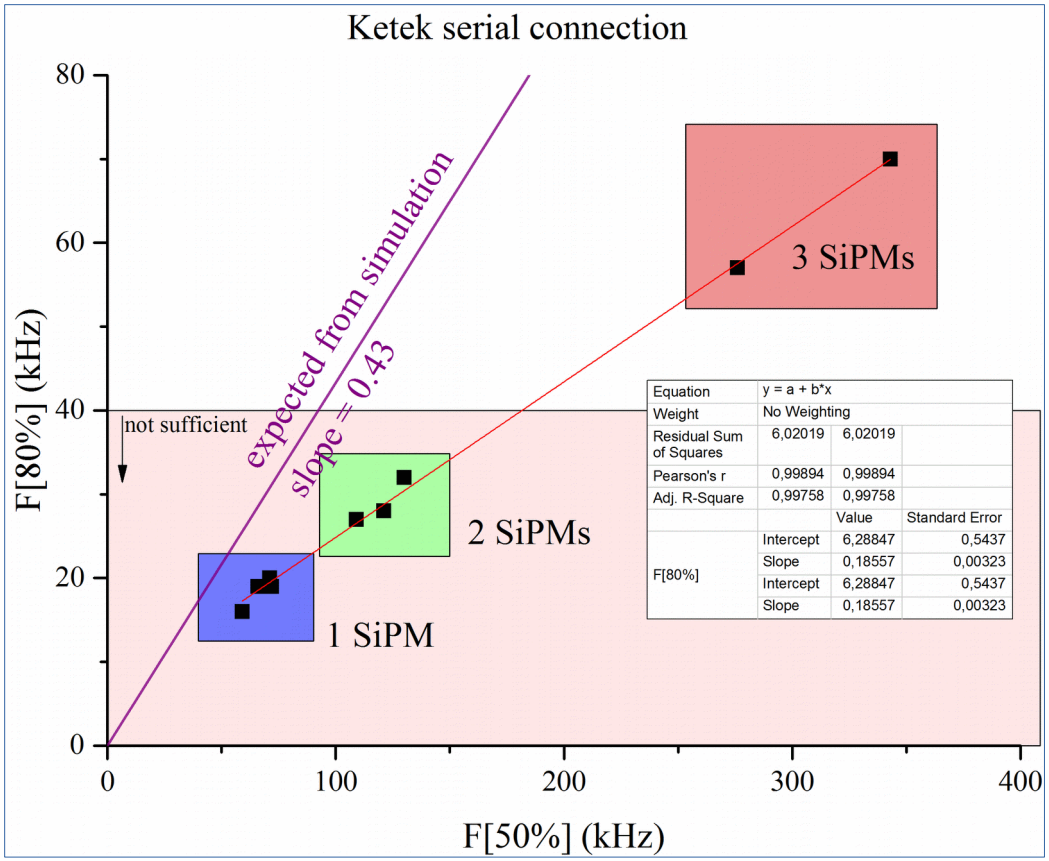


Filter bahaviour

- Linear correlation of the frequency at the 80% and 50% level
- Similar to a low-pass-filter
  - Simulated with:

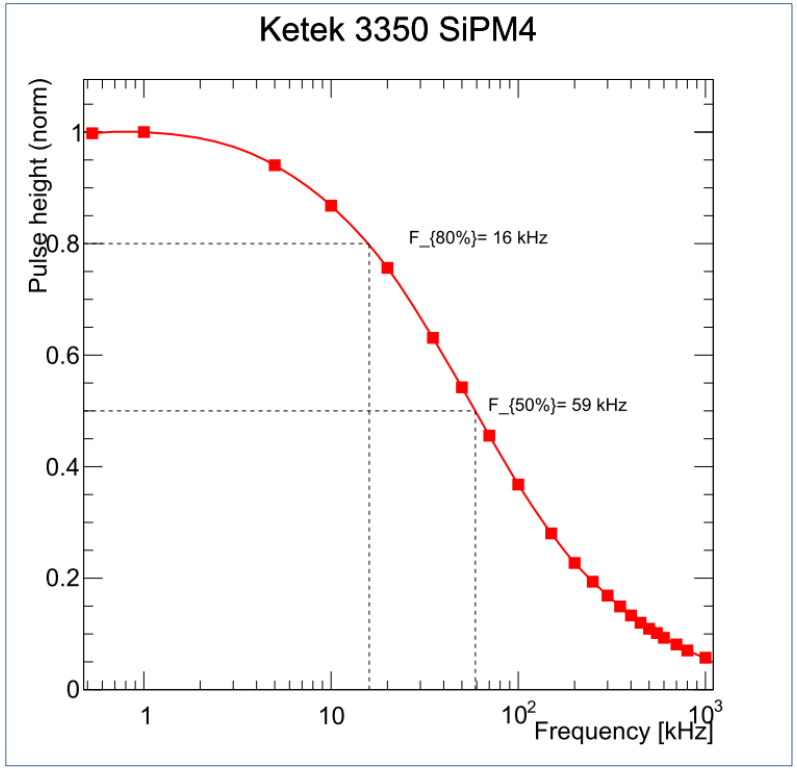
$$V_{out} = V_{in} \times \frac{X_C}{\sqrt{R^2 + X_C^2}} \qquad X_C = \frac{1}{2\pi f C}$$

  - Not a simple RC-filter

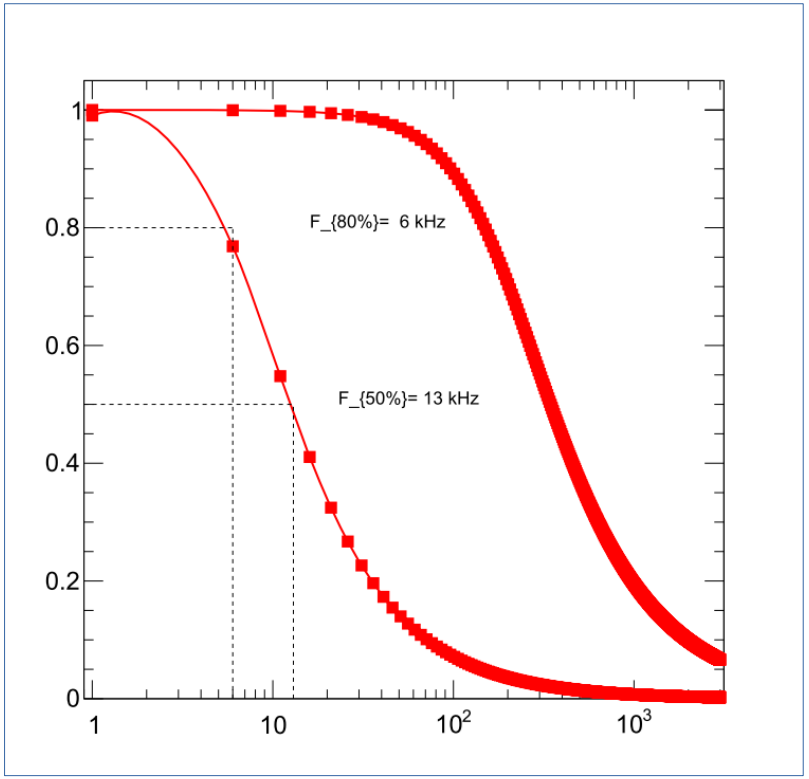


Comparison of measured data to a simulated RC-filter

- Measurement



- Simulated RC low-pass-filter



Work in progess

- Setup of the readout electronics chip
- Further charactarization of the railboard and further improvements
- Test of dual-module functionality

Summary

- Railboard prototype was studied
  - Crosstalk stronger for vertical than for horizontal neighbors
    - Crosstalk of up to 4.7 % at respectively 1.5 % at 440 MHz
  - Linear attenuation of ~11 % for half length railboard
    - Expectation of ~23 % loss for full length
- Drop of rate capability if one or more sensors are covered in a serial setup
  - No such phenomena for a hybrid connection

Thank you for your attention