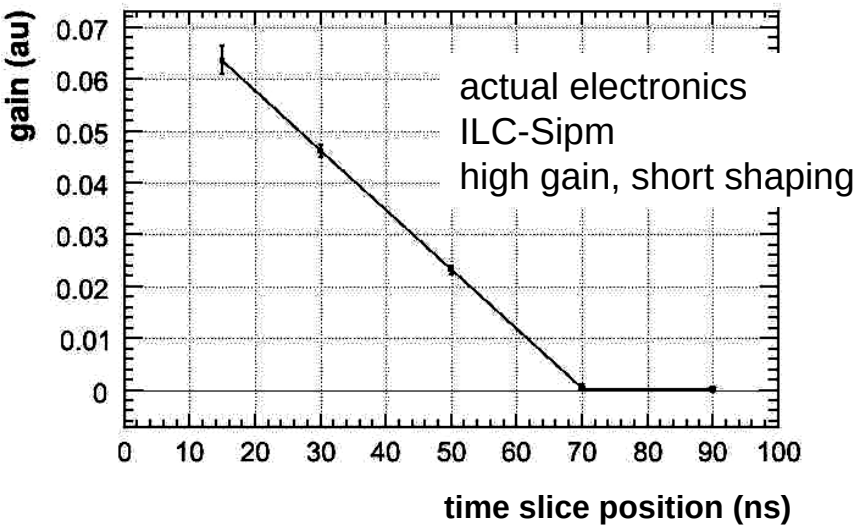
SiPM & MPPC
pulse shapes studies

implications to amplification
and measurement processes

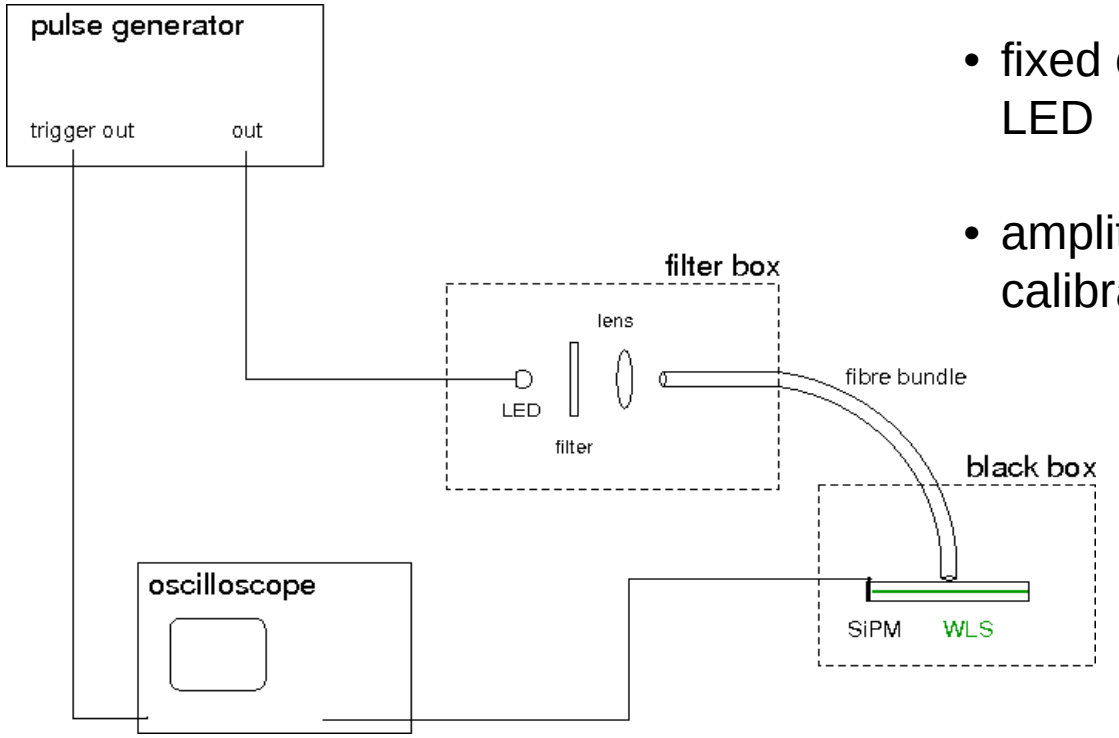
by
Benjamin Lutz

Motivation

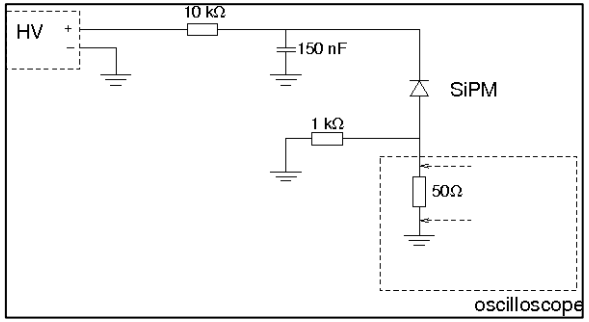
- SiPM from different production series show different signal shape
- SiPM coupled via WLS to scintillator change signal shape during saturation
- actual electronics is sensitive to the signal shape in fast shaping mode (but fine for low signals)
- new electronics will use reduced shaping in low gain mode → need input for simulations
- no data for MPPC



Setup

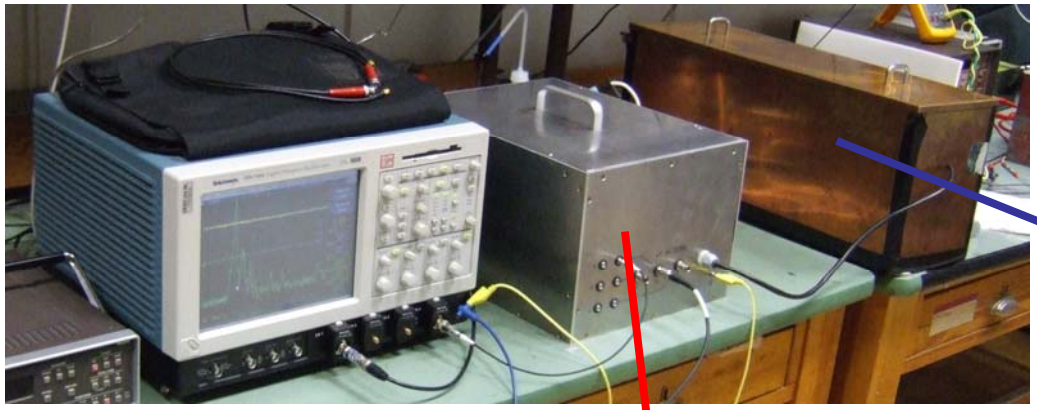


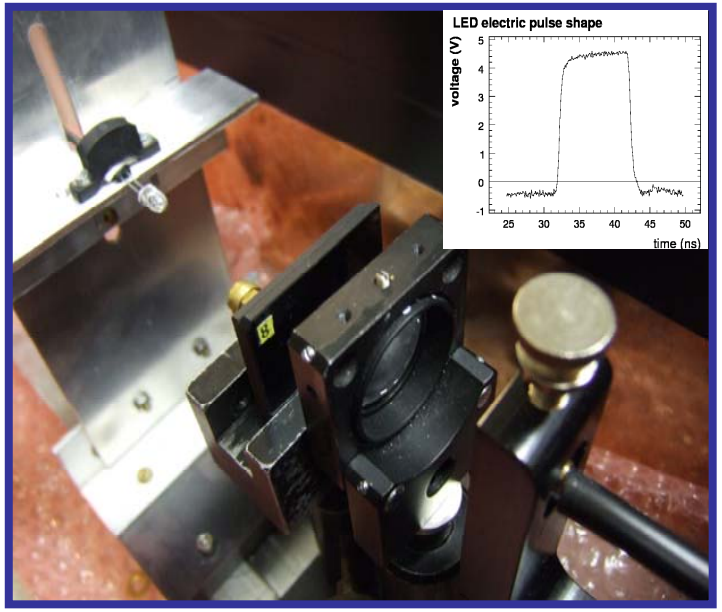
- fixed electrical signal for the LED
- amplitude variation with calibrated filters



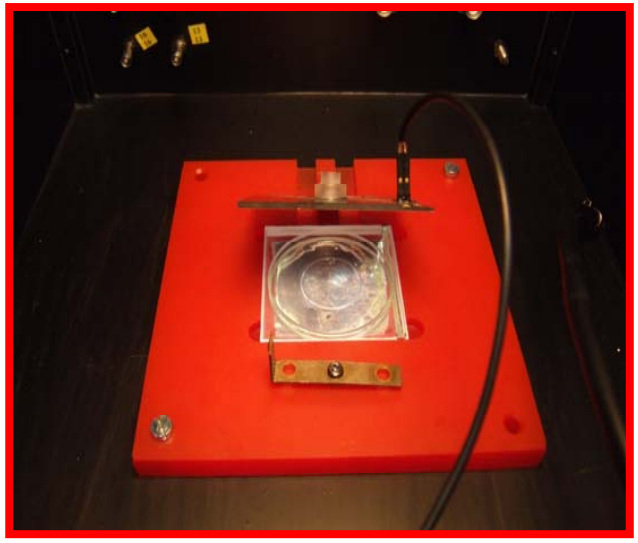
- high bandwidth connection
- high bandwidth and high resolution oscilloscope (4 GHz 20 Gs)

In pictures





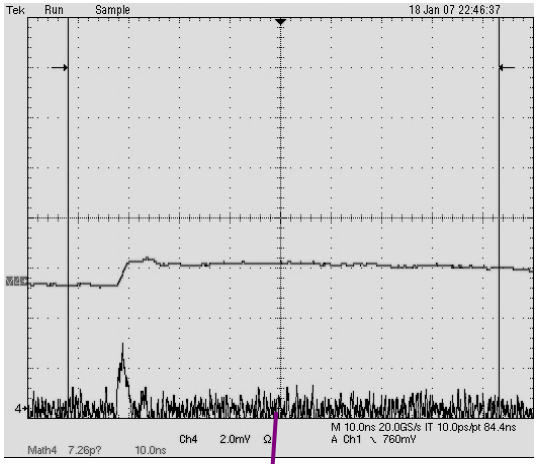
LED & filter

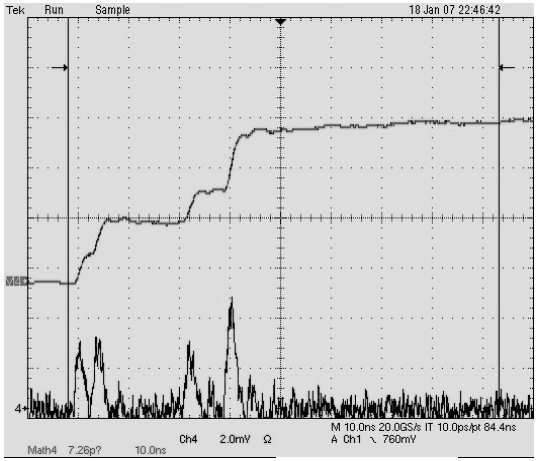


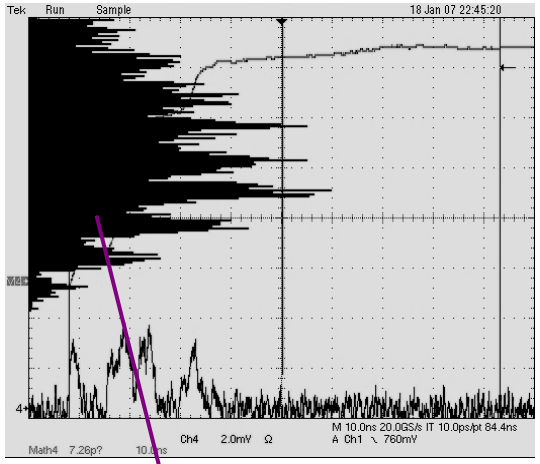
scintillator
WLS
SiPM

fibre bundle

Measurement technique

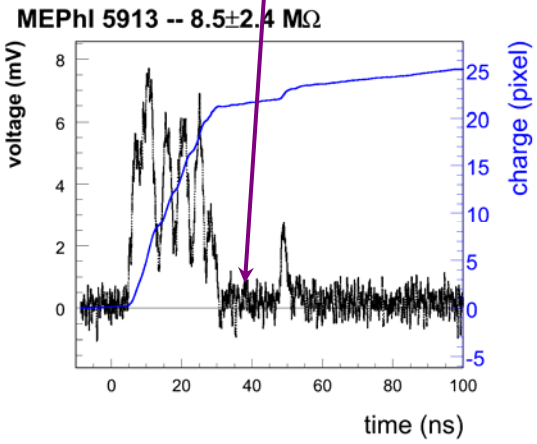


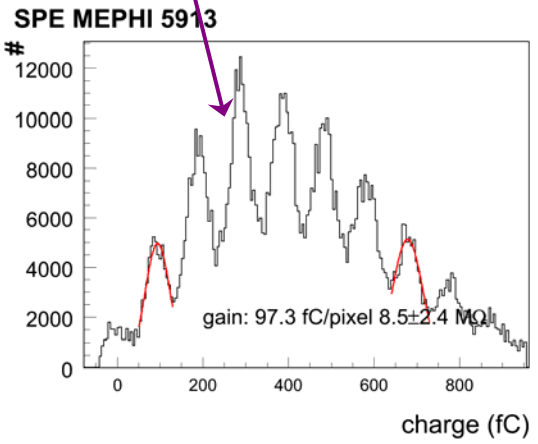




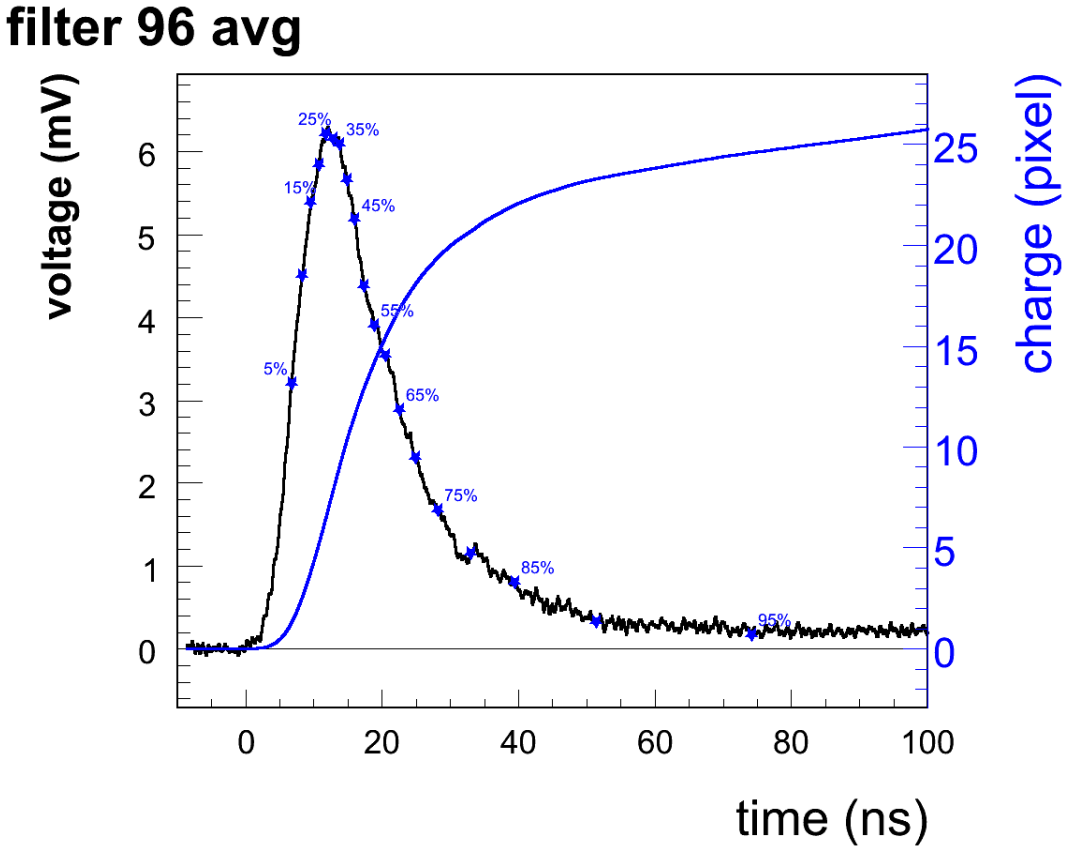
online

offline



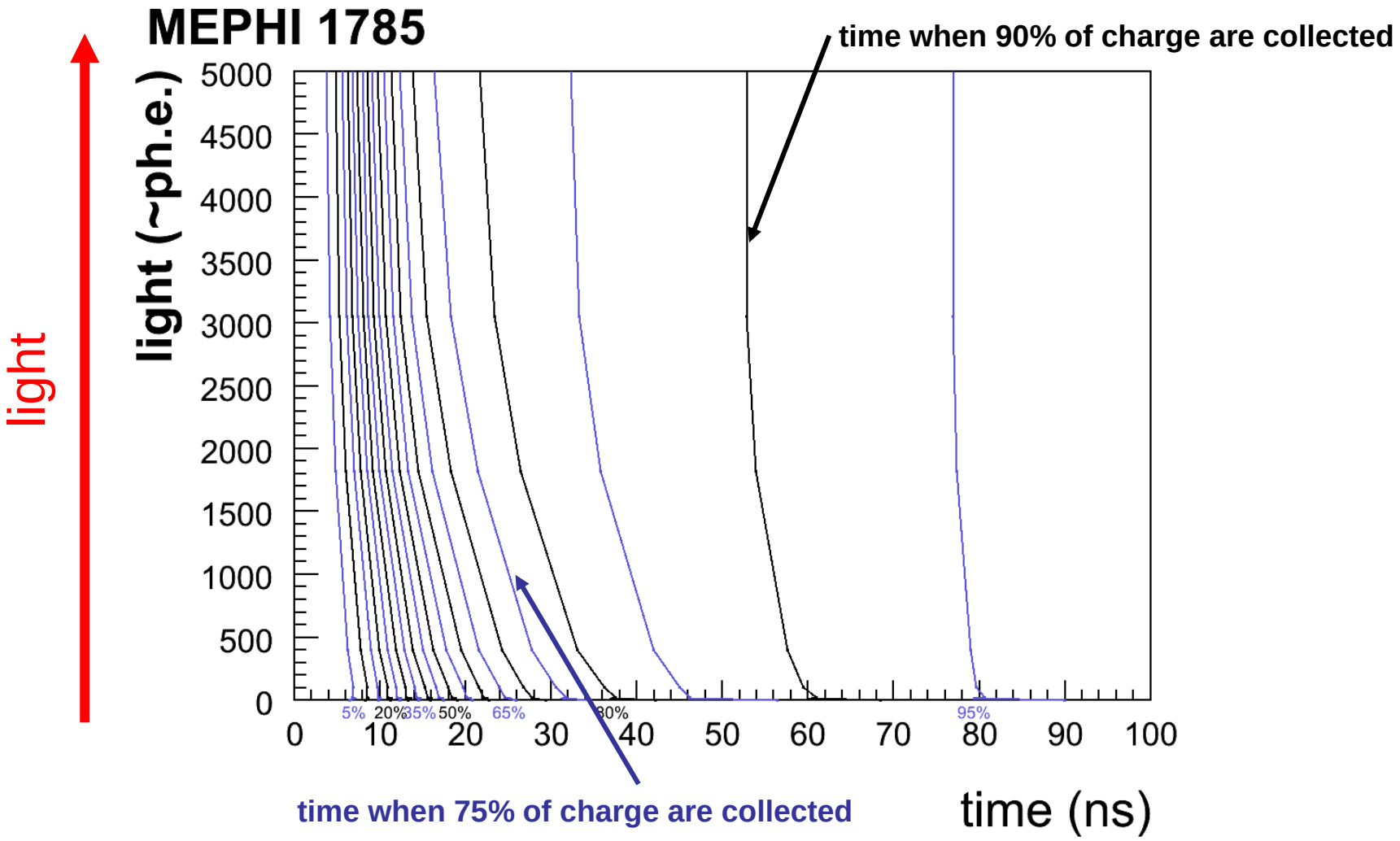


Single measurement

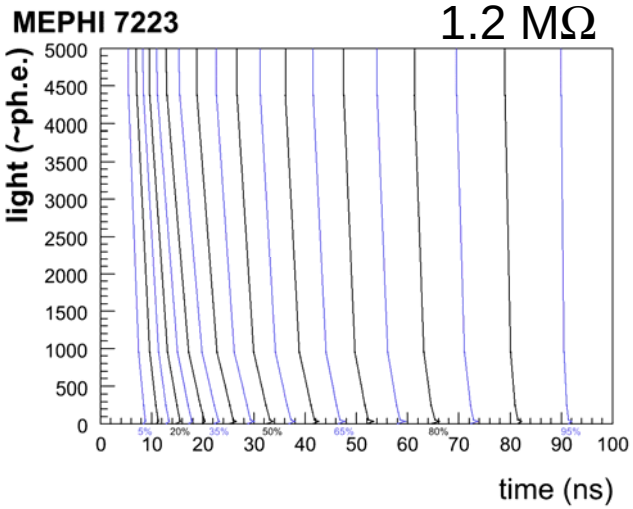


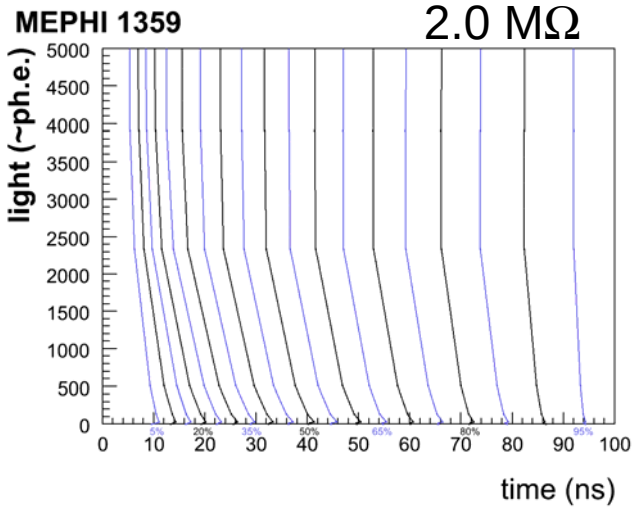
- light intensity (by filters)
- total amount of charge
- charge distribution in time

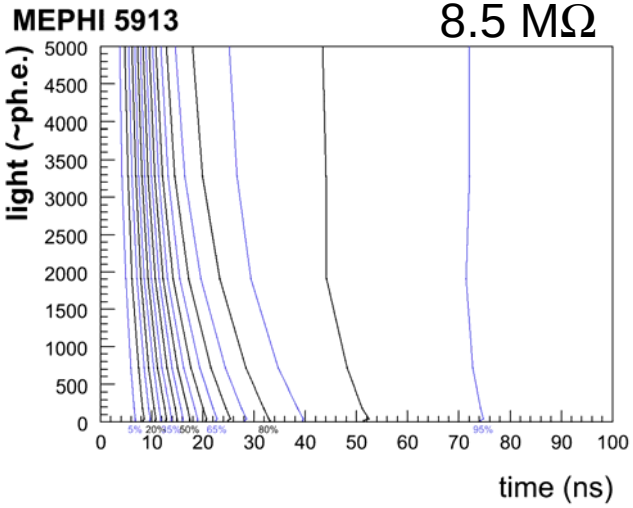
Visualization of result

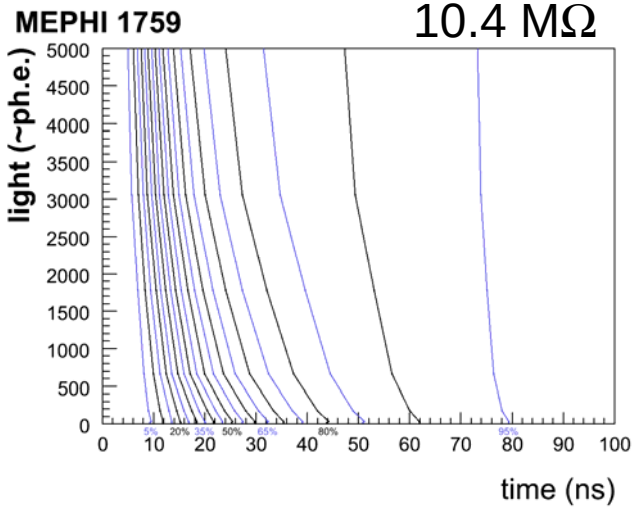


Results for different SiPM series

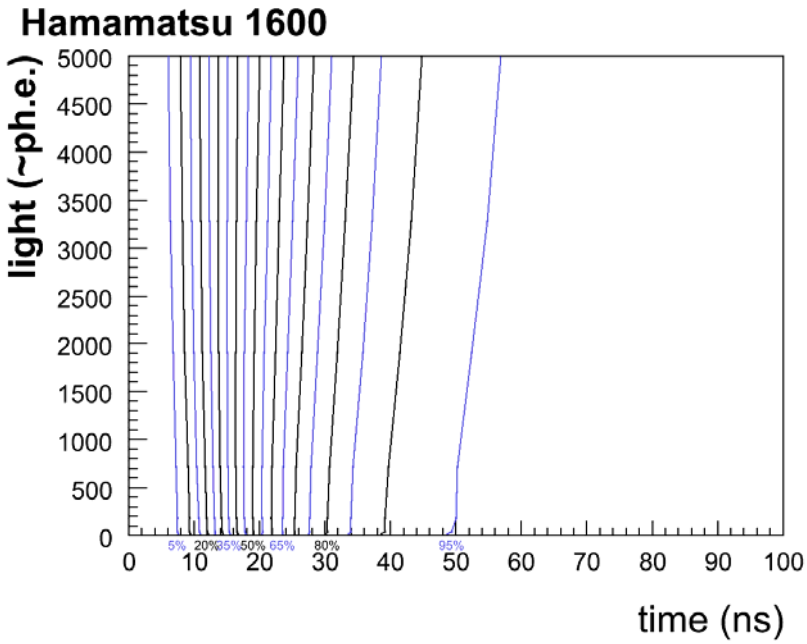


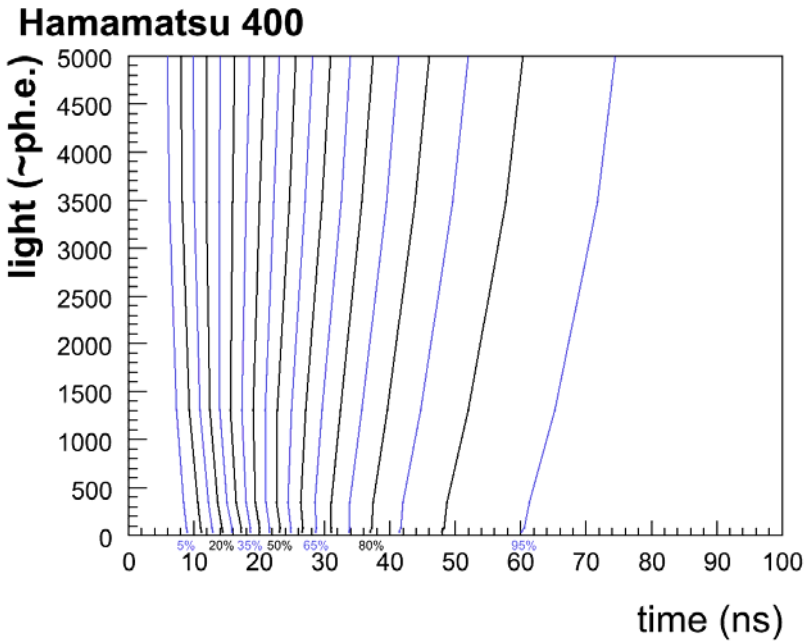




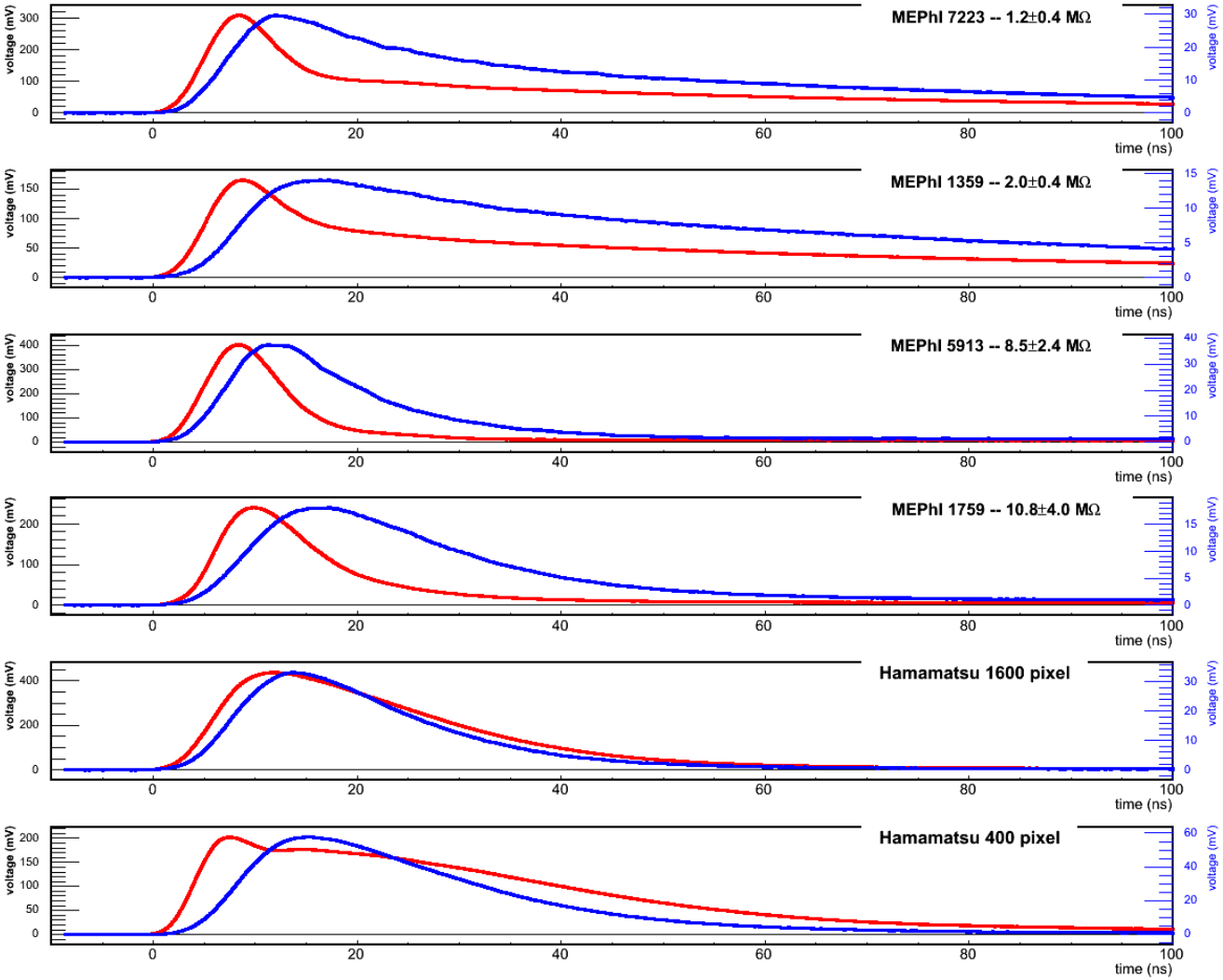


Result for MPPC





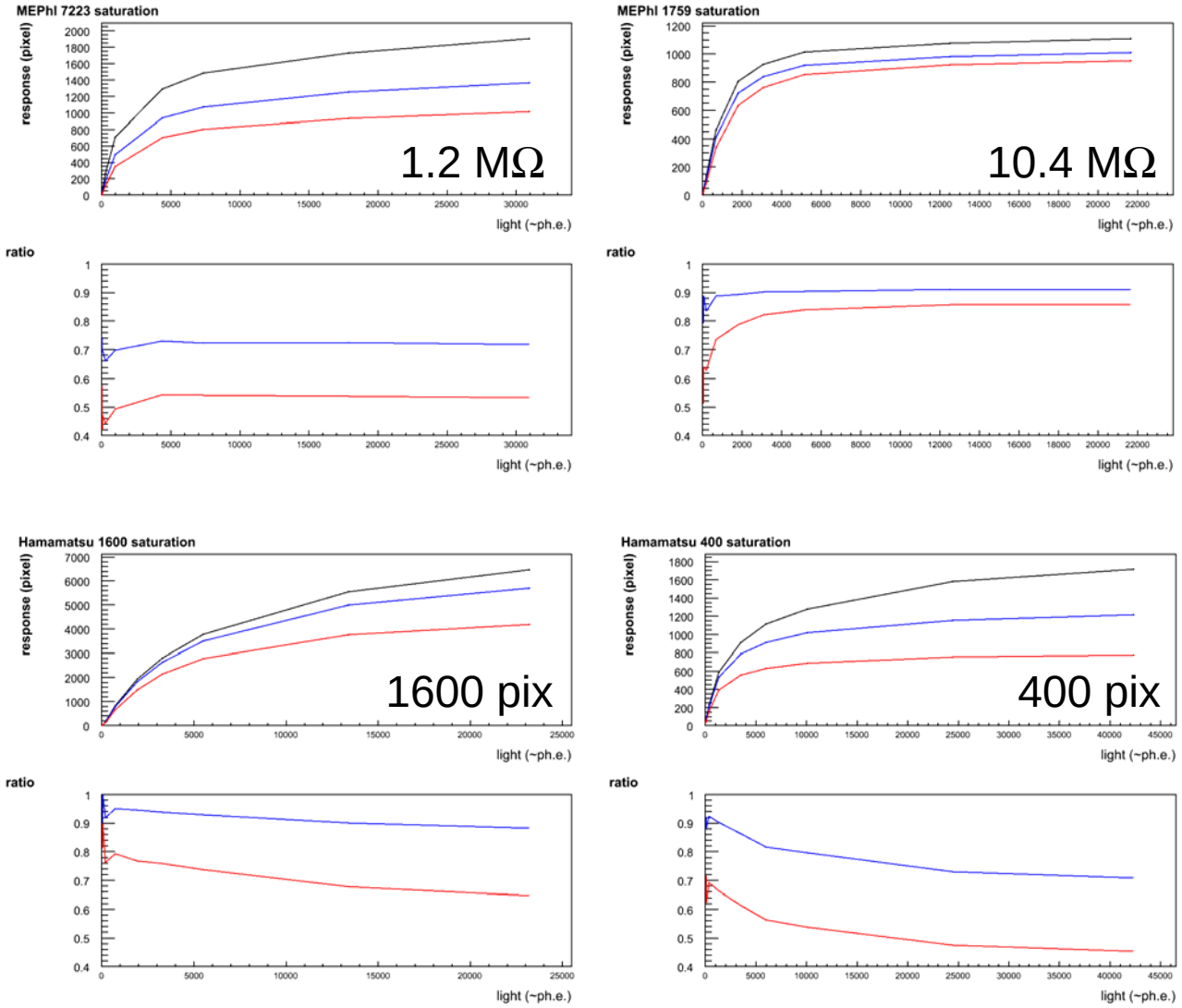
Signal shape for different intensities



medium light intensity

high light intensity

Saturation behavior

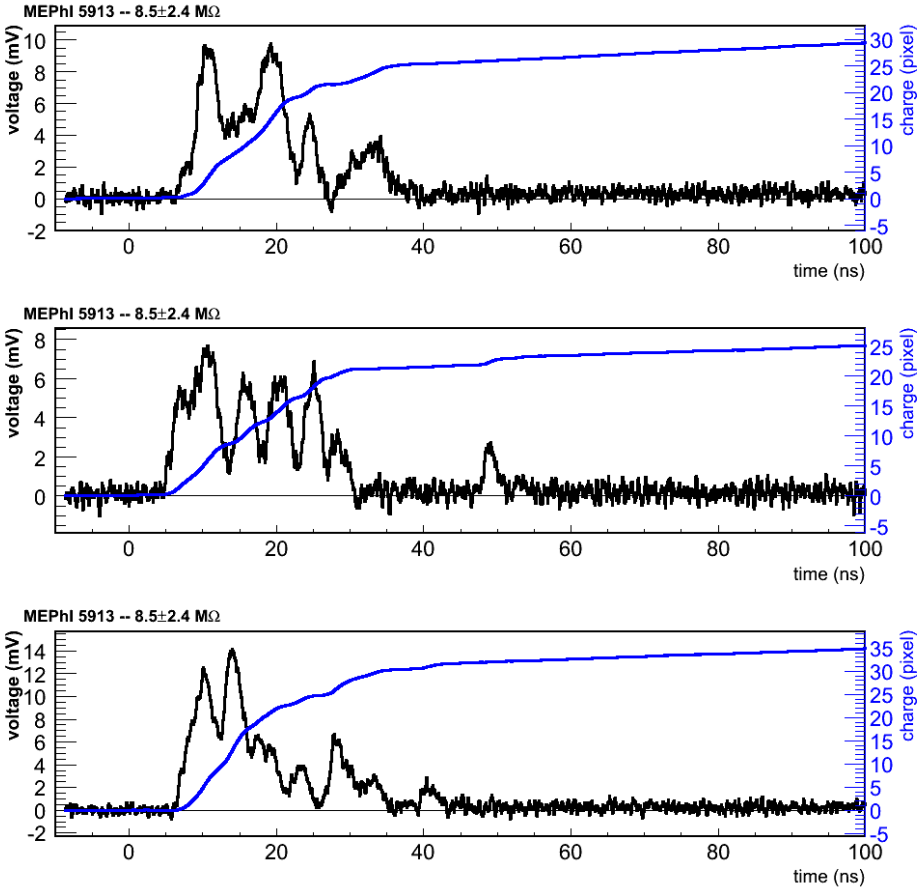


SiPM

100 ns integration
50 ns integration
30 ns integration

MPPC

The low light intensity limit



three triggers with
identical experimental settings

➔ signal shape is defined by statistical effects

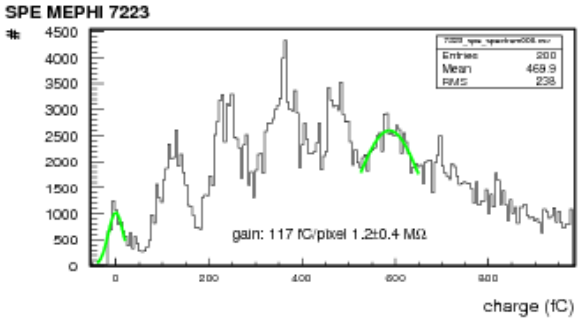
Summary/Outlook

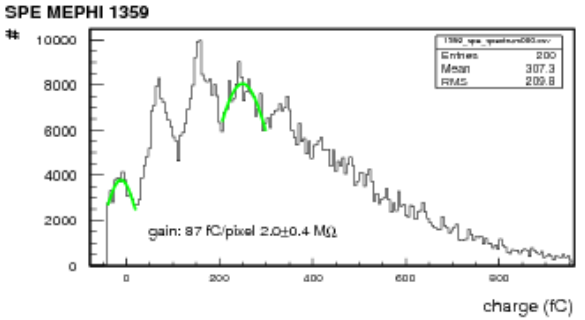
- Scintillator-WLS-SiPM show various signal shapes depending on
  - quenching resistor (production series)
  - signal amplitude
- shortest shaping of new chip with 50 ns may be “on the edge”, but shaping and integrating are not the same
  → studies necessary
- MPPC saturation is quite different compared to SiPM

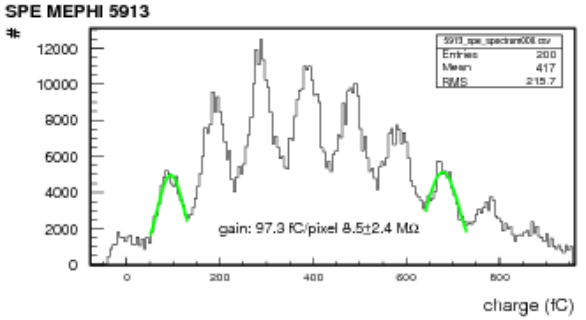
future:

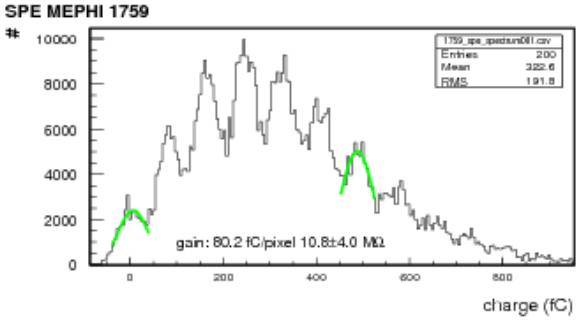
- Coupling without WLS
- Simulation studies of new amplifier design with the recorded signals (LAL)

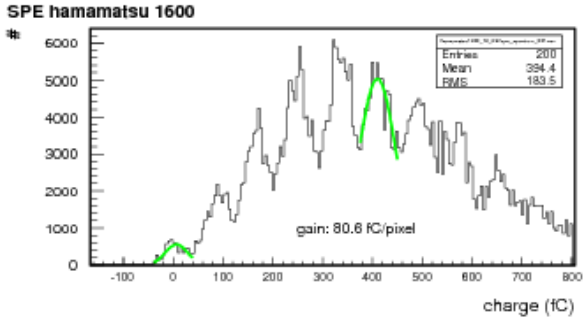
backup

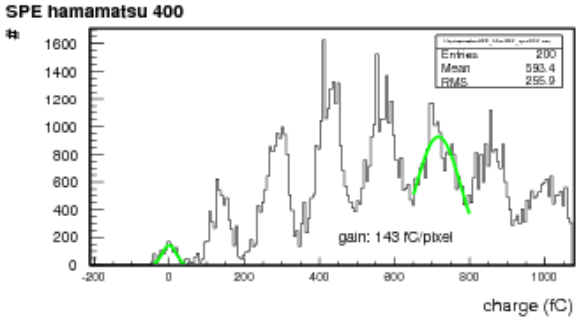

SPE MEPHI 7223
gain: 117 fC/pixel 1.2±0.4 MΩ
charge (fC)


SPE MEPHI 1359
gain: 87 fC/pixel 2.0±0.4 MΩ
charge (fC)


SPE MEPHI 5913
gain: 97.3 fC/pixel 8.5±2.4 MΩ
charge (fC)


SPE MEPHI 1759
gain: 80.2 fC/pixel 10.8±4.0 MΩ
charge (fC)


SPE hamamatsu 1600
gain: 80.6 fC/pixel
charge (fC)


SPE hamamatsu 400
gain: 143 fC/pixel
charge (fC)