Meeting Genova

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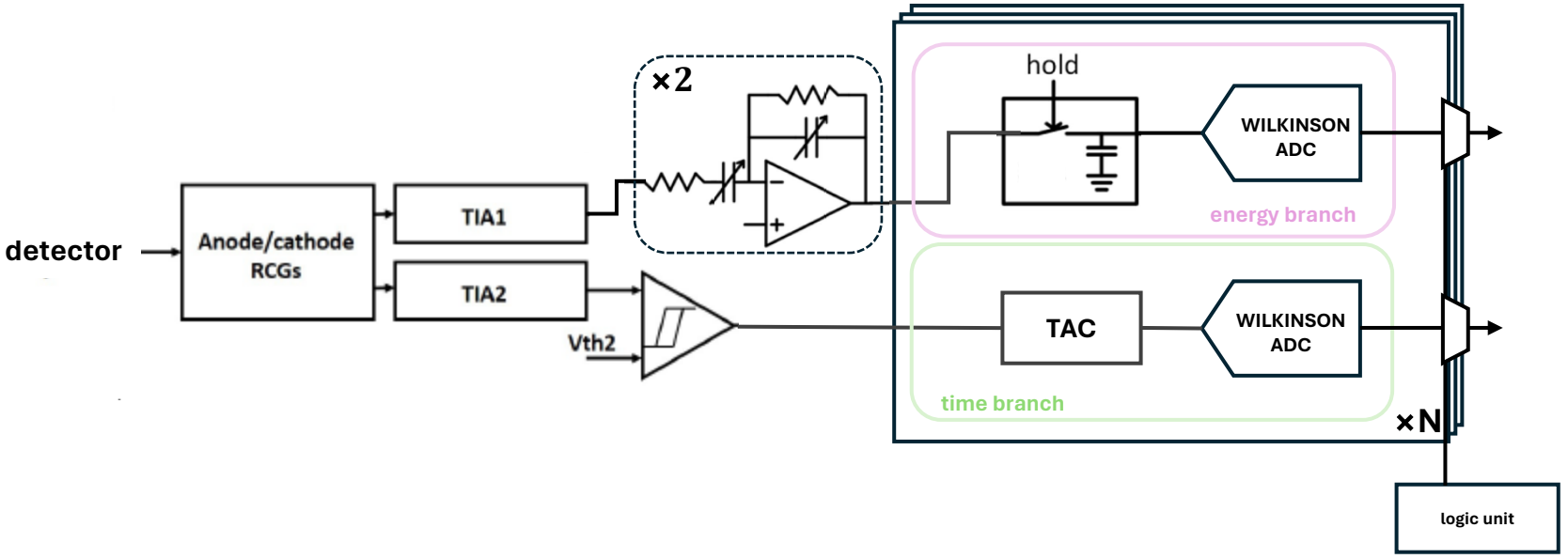
ALCOR – preliminar FE

- TDCs substituted with pairs of capacitors for T and E measurements
- How many pairs?



Detector response

Input: OptMen GEANT4 simulation output file

Detector response

- Compute interacting photons + noise (AP, CT, DC)
- Assign photons to SiPM pixel
- SiPM Waveform simulation -> sum of 1pe waveform from CADENCE simulation
- ASIC response simulation (depending on architecture)

Output : root Tree with vector of DAQHit struct

Output for spill studies:

```
struct DAQHit {
    int pixelId;
    int capacitorId;
    float TDCrise;
    float TDCfall;
    float ADCCharge;
    float ADCCharge_tail;
    float timeDiff;
    char cameraId[20];
};
```

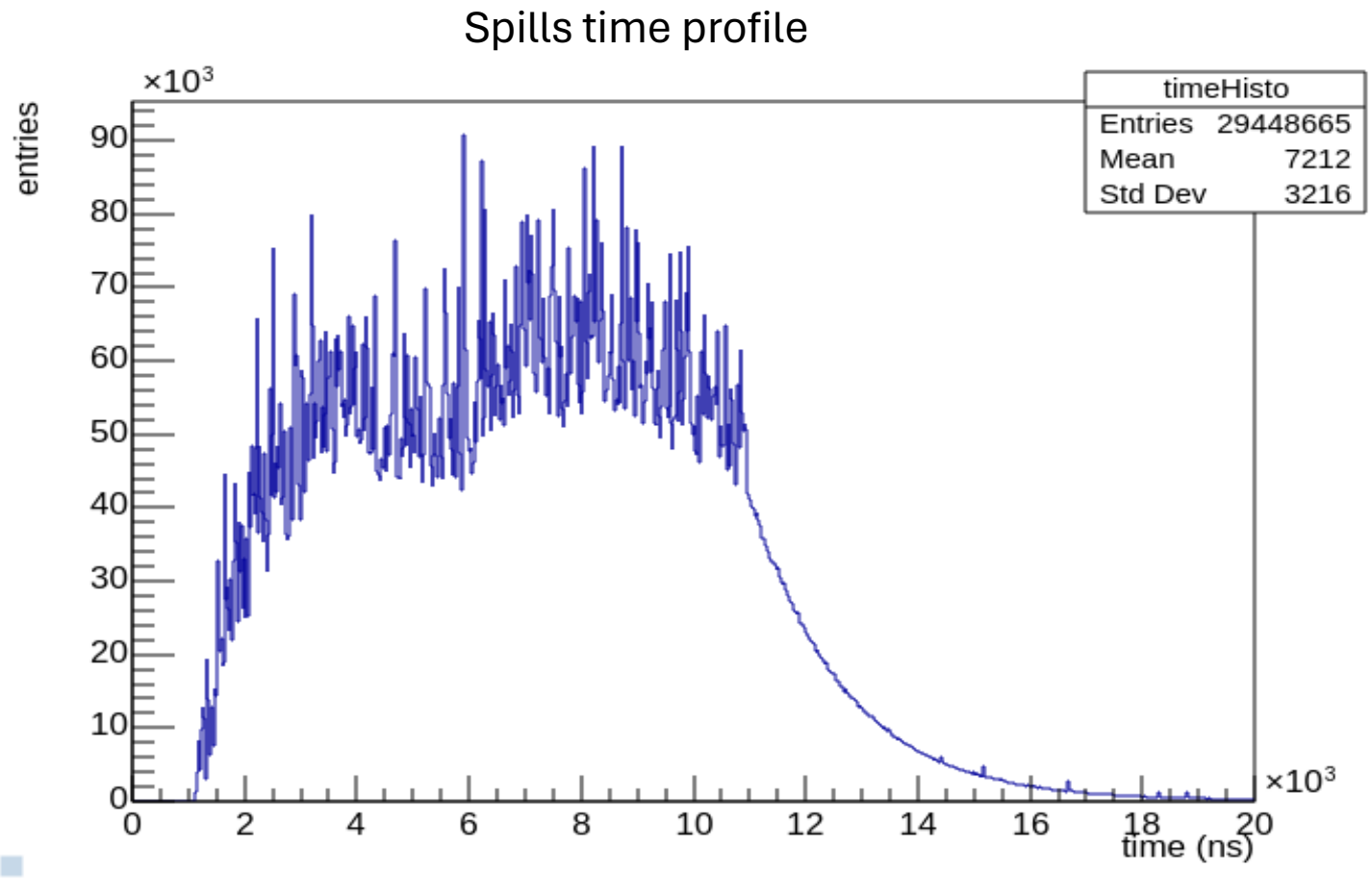
Output for reconstruction chain:

```
struct DAQHit {
    int pixelId;
    int capacitorId;
    int TDCcoarse;
    int TDCfine;
    int ADCCharge;
    char cameraId[20];
};
```

https://baltig.infn.it/dune/sand-optical/detector-response-gpu/ (branch : develop)

Simulated spills

- 600 spill
- GRAIN con 60 camere con maschere, SiPM 3x3 mm^2



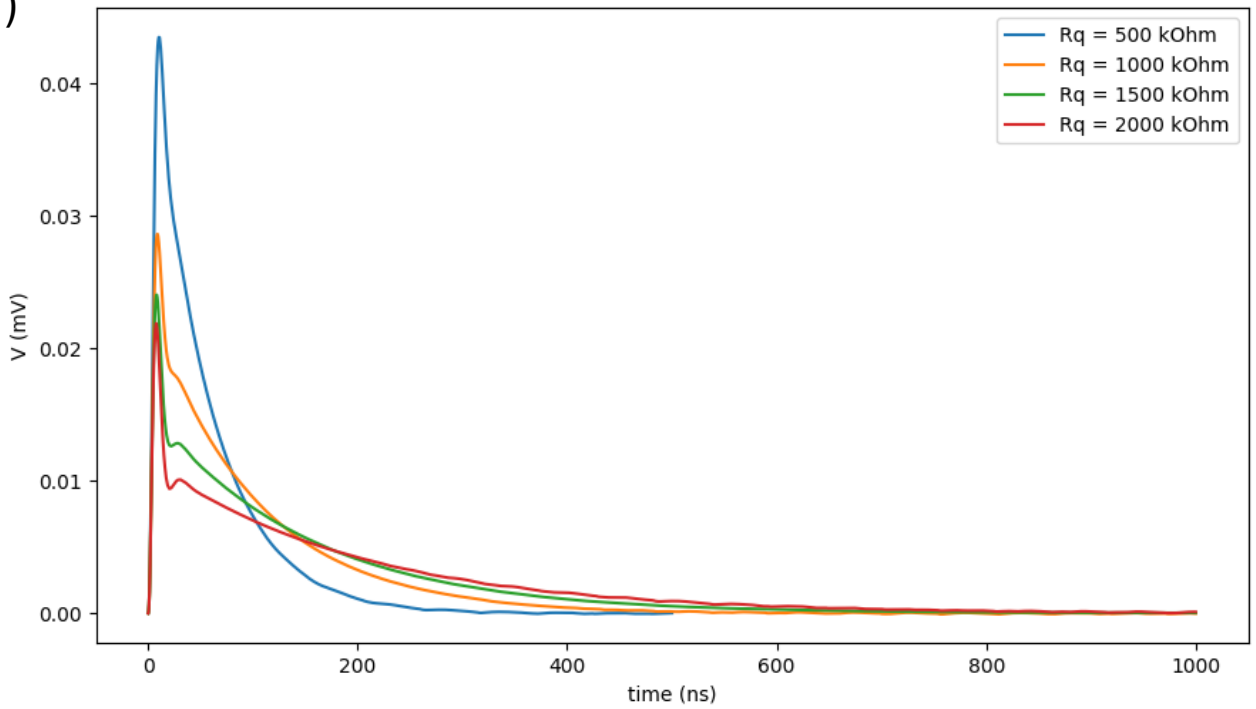
Simulation parameters

SiPM characterization:
- PDE = 0.2
- DC rate = 0.2 Hz/mm^2
- P_crosstalk = 0.05
- P_afterpulse = 0.05
- Rq = 500 kOhm

waveform:
- Tmax = 20 μs
- sampling period = 0.25 ns
- No saturation / limits on waveform amplitude

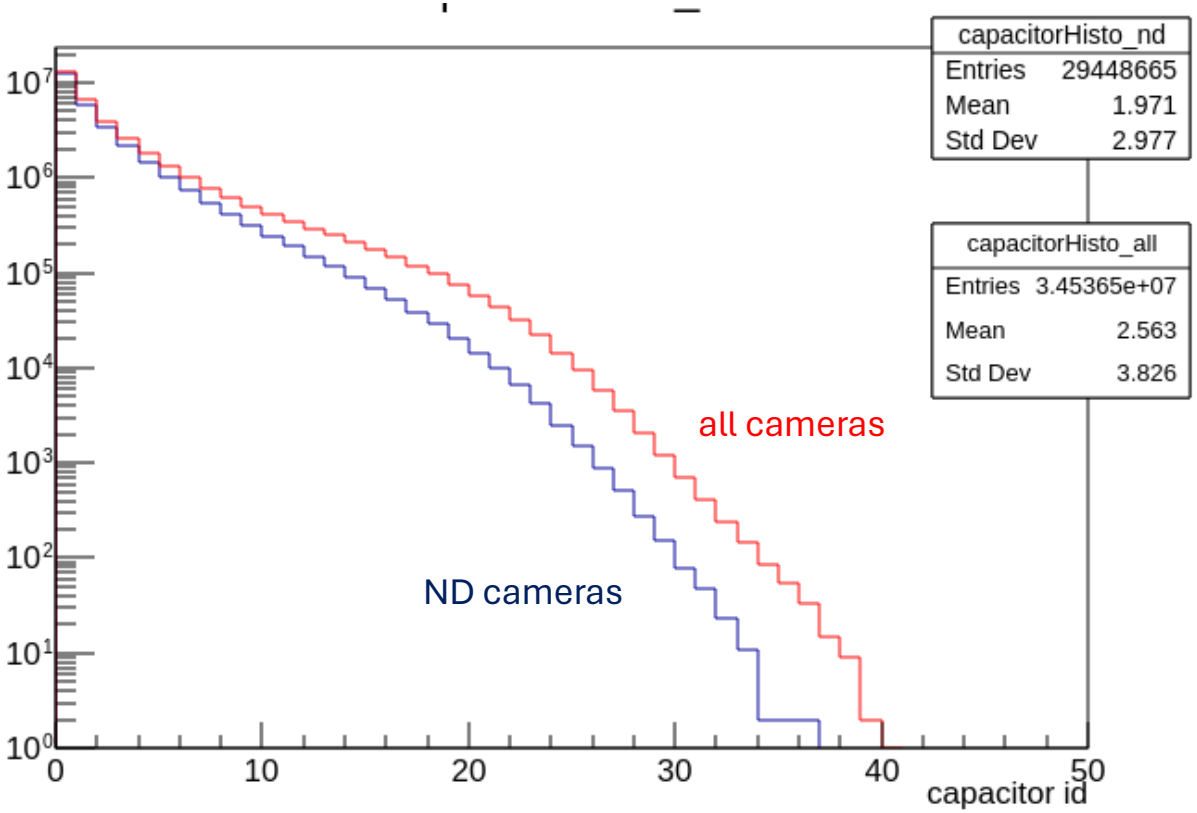
- Discriminator threshold = 0.5 photoelectrons
- N Capacitors = 50

1 photoelectron waveform (CADENCE simulation + ALCOR transfer function)



capacitor number

Rq = 500 kOhm

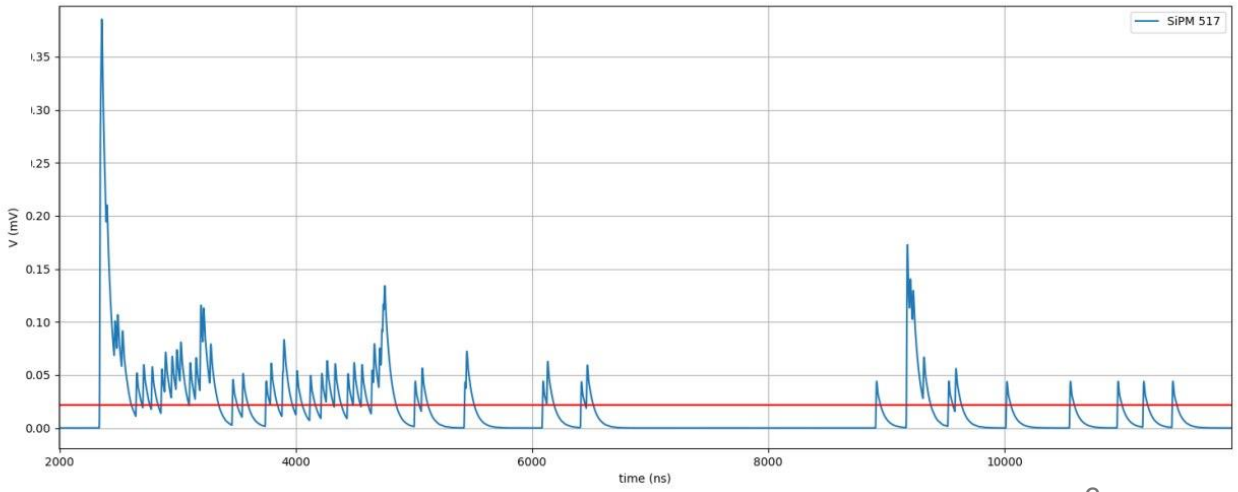


All_cams(capacitorId = 10) / All_cams(capacitorId = 0) = 0.025

ND_cams(capacitorId = 10) /ND_cams(capacitorId = 0) = 0.013

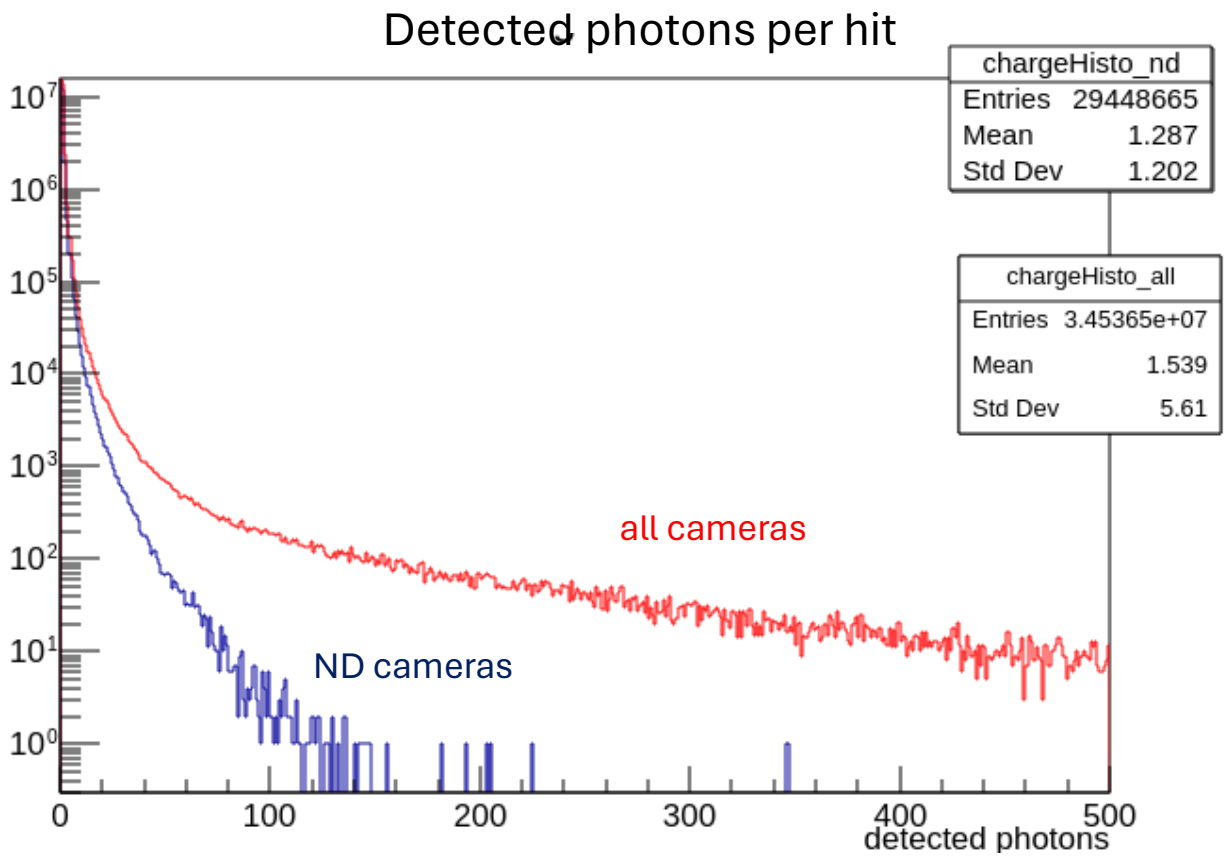
Non-Dazzled (ND) camera :
inner photons / total photons < 0.1

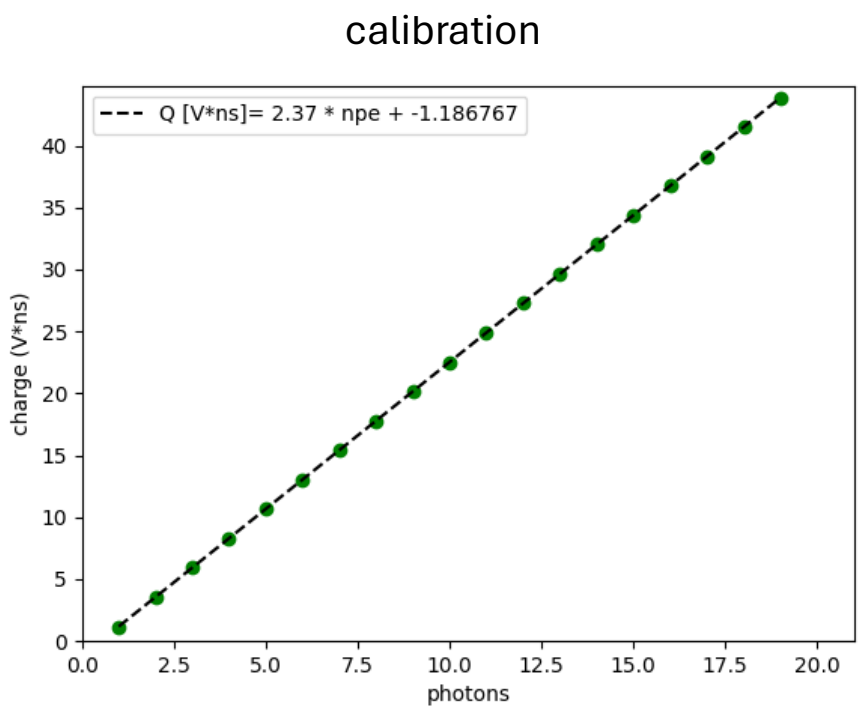
Spill SiPM signal example



Detected photons distribution

Rq = 500 kOhm

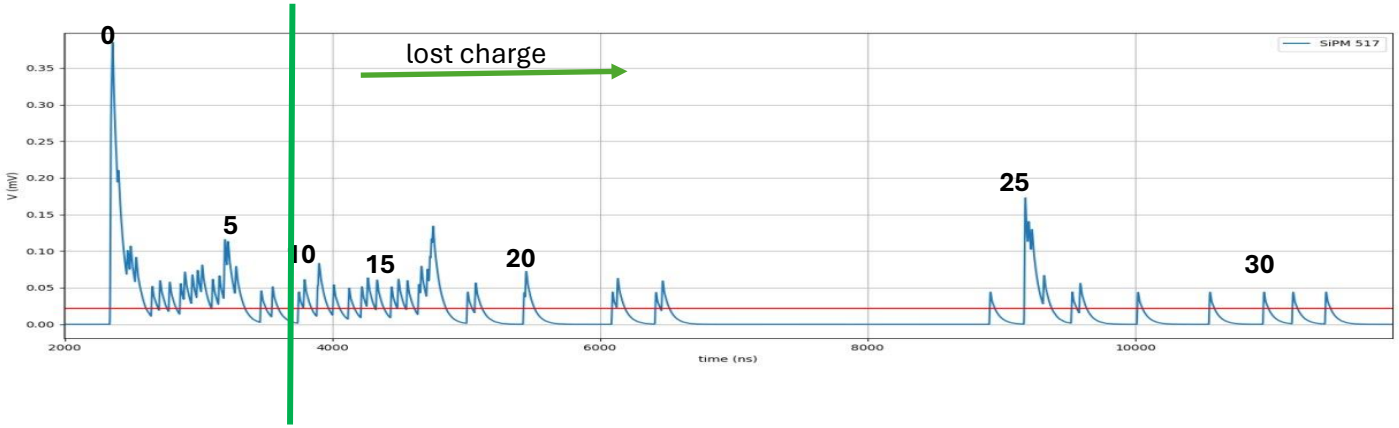




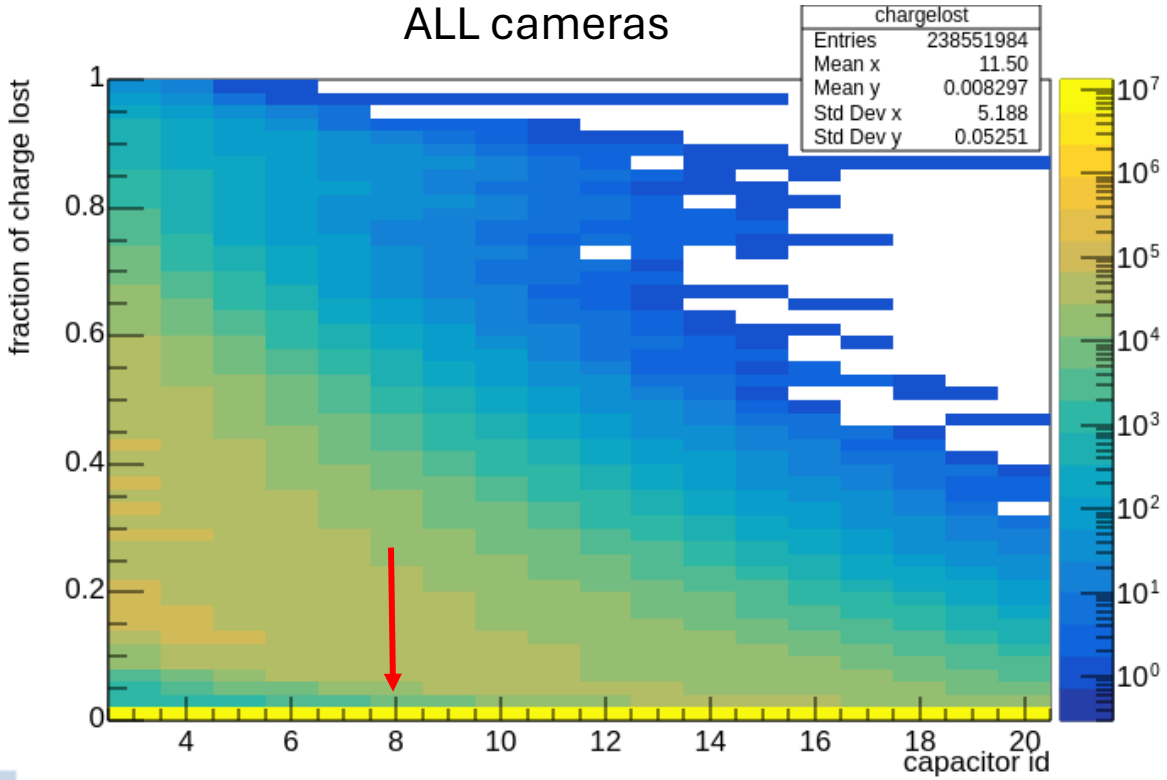
Rq = 500 kOhm

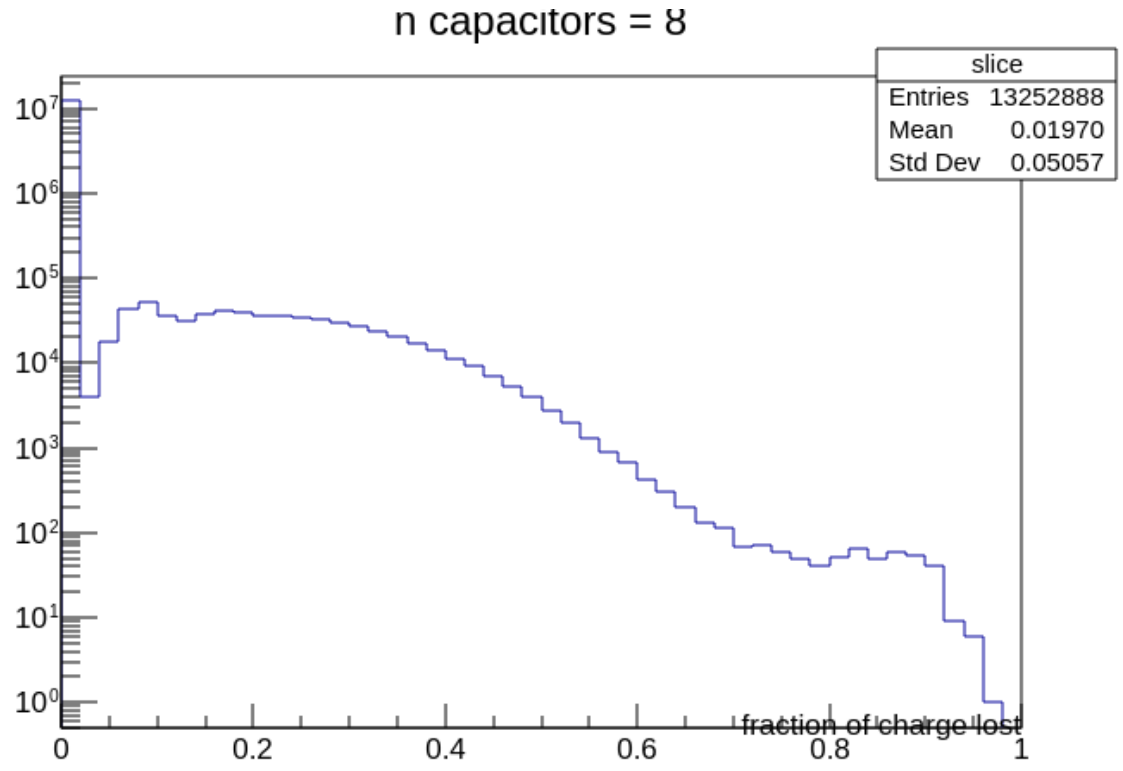
Fraction of lost charge per number of capacitors

$$Q_{lost} = \frac{\sum_{c>n} (\text{n integrated photons})_c}{\text{total integrated photons}}$$



ALL cameras

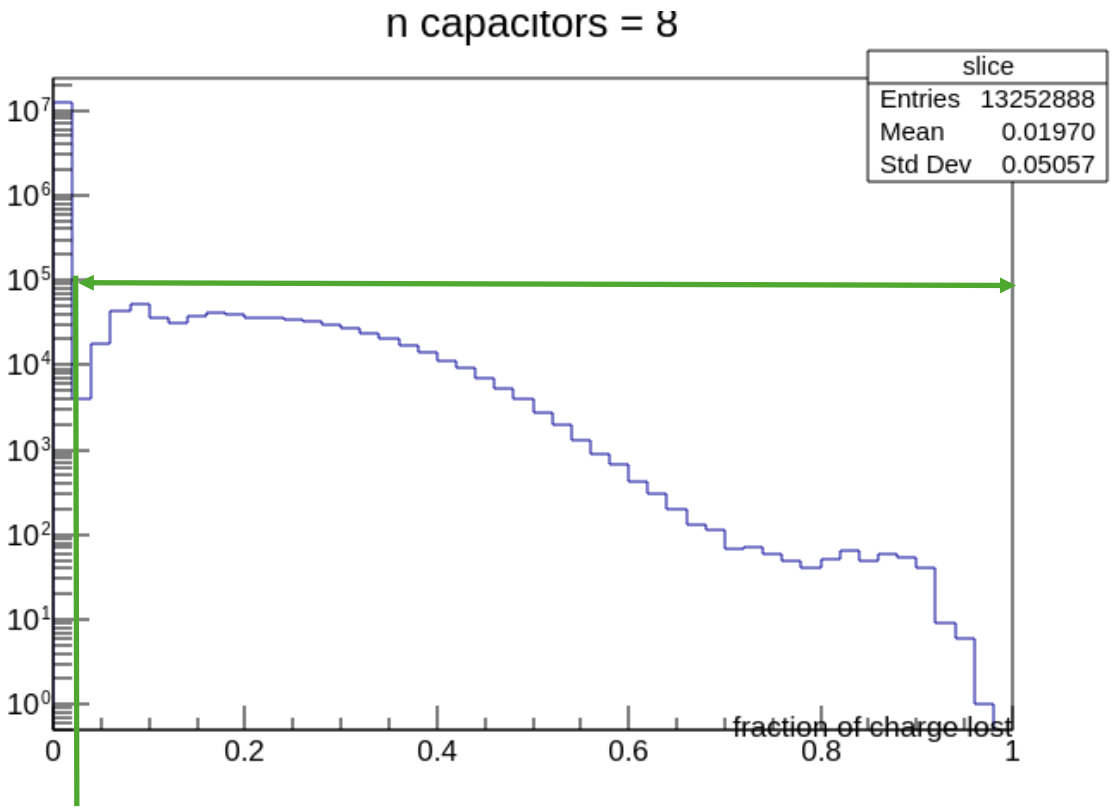


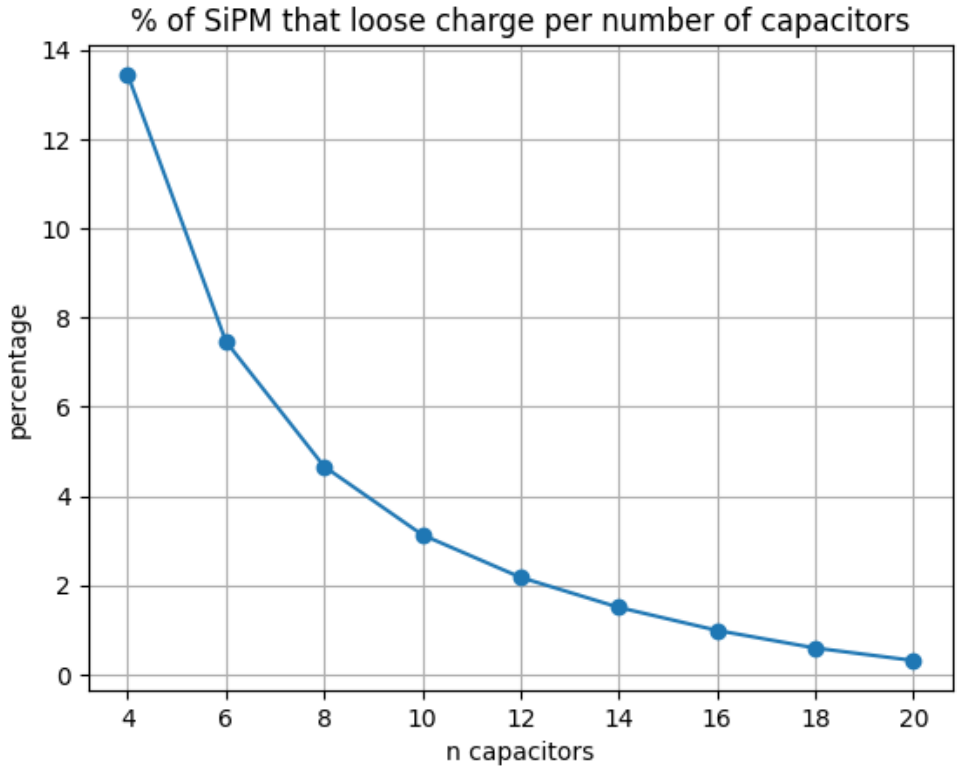


Fraction of lost charge per number of capacitors

Rq = 500 kOhm

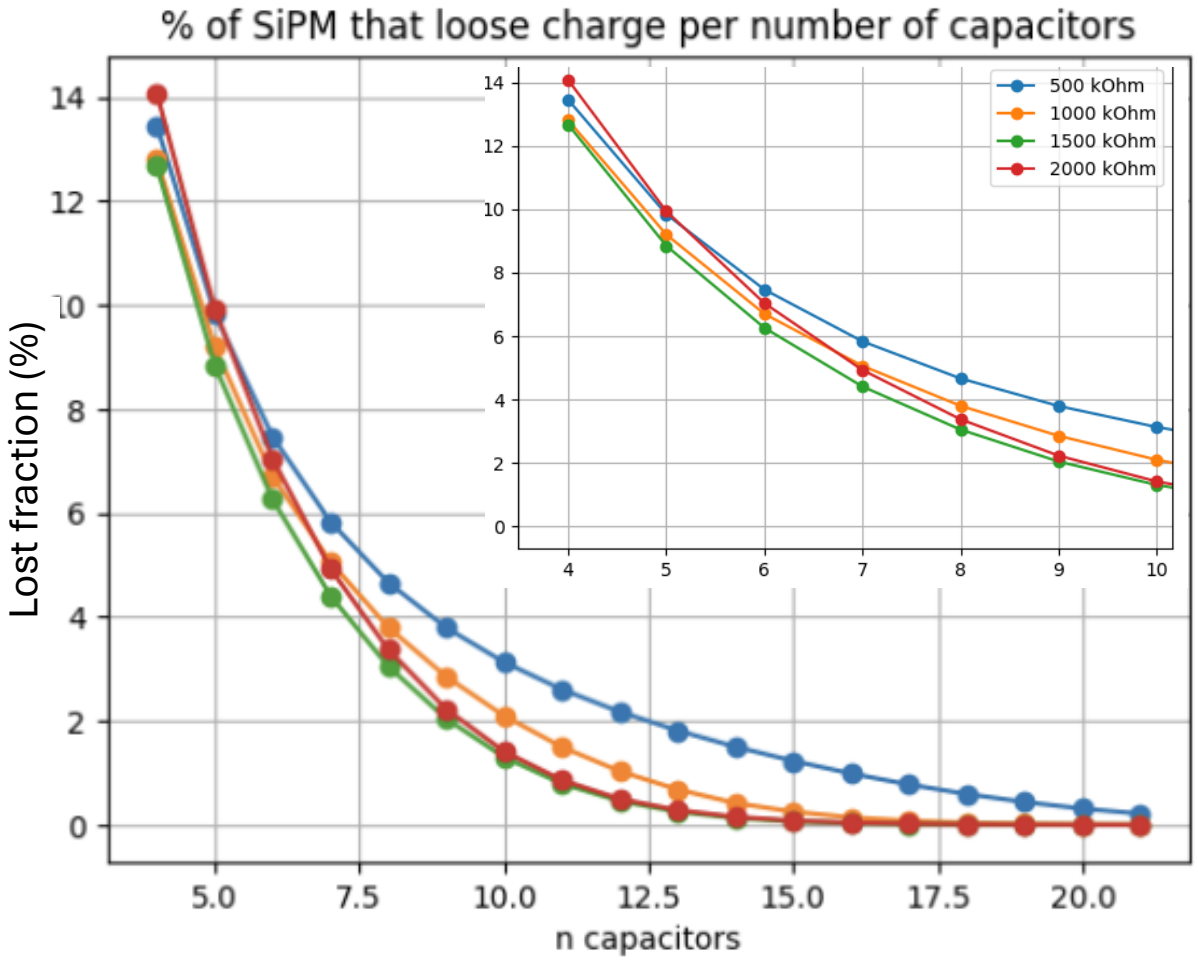
Lost fraction = SiPM that loose > 2 % photons / all

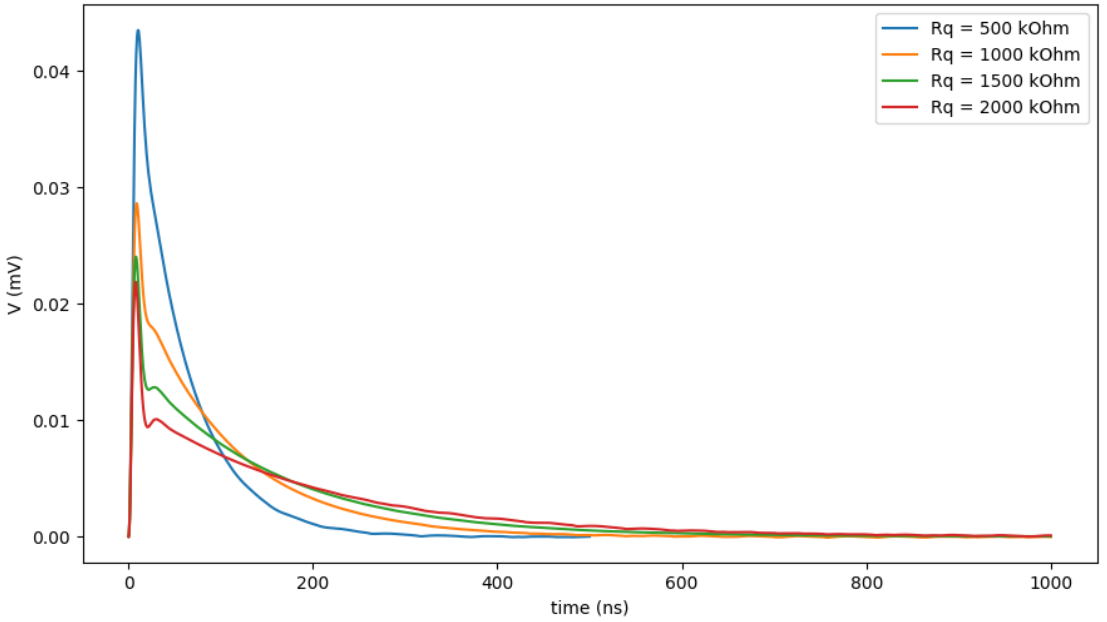




Fraction of lost charge per number of capacitors

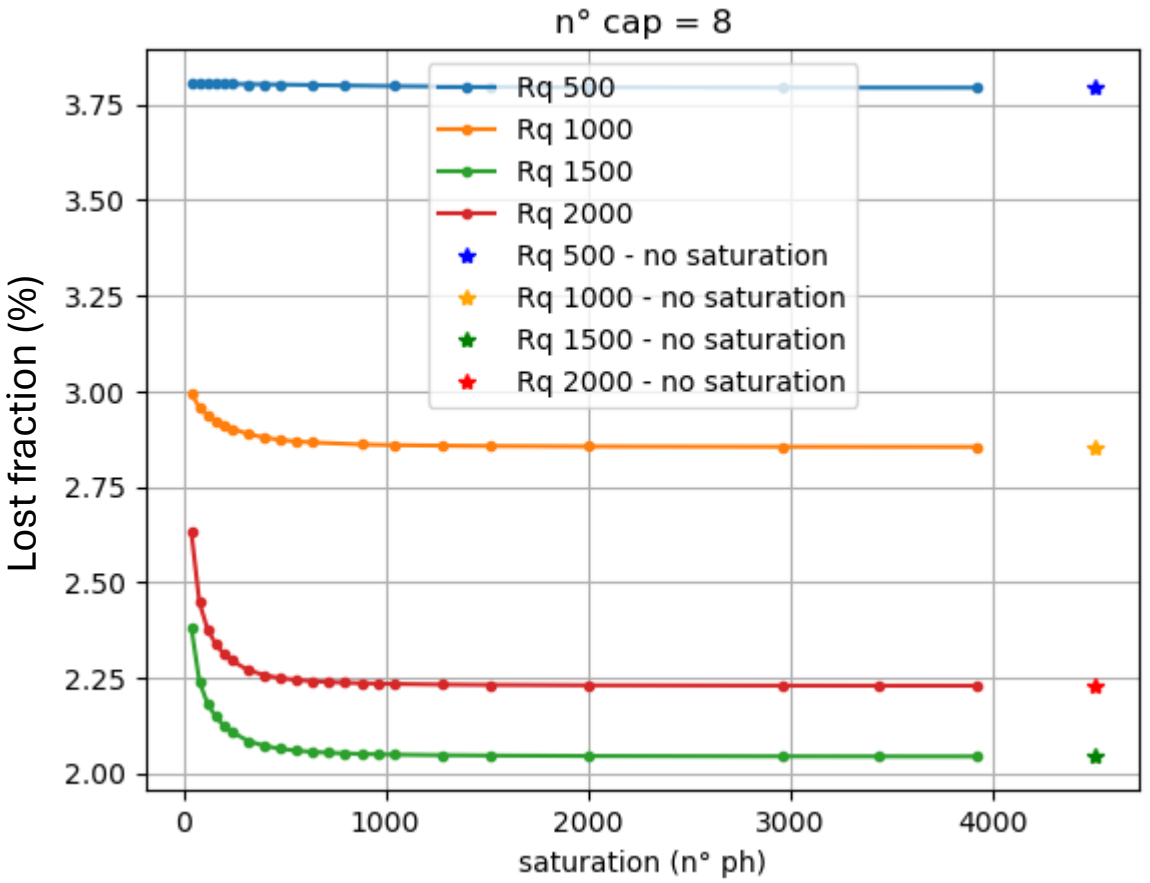
Lost fraction = SiPM that loose > 2 % photons / all

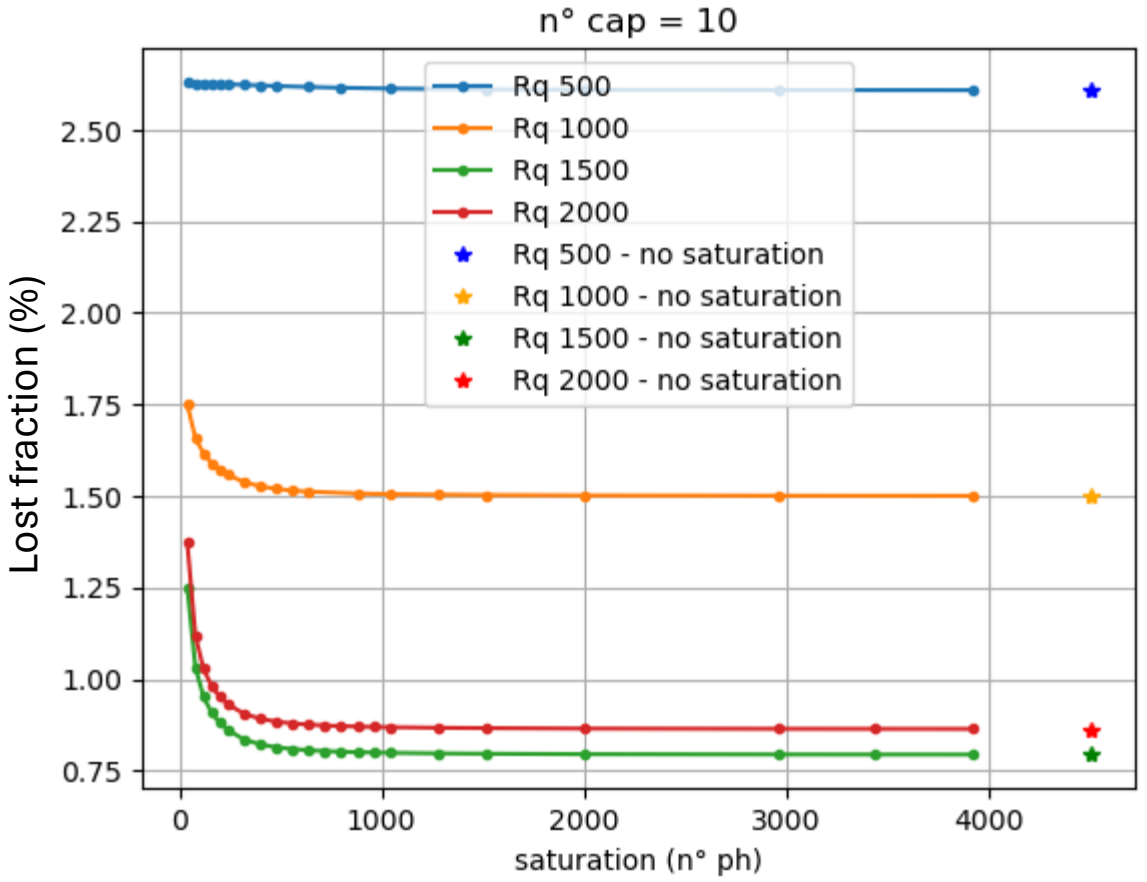




Fraction of lost charge per number of capacitors

- Introduced capacitor **saturation**
- Lost fraction = SiPM that loose > 2 % photons / all

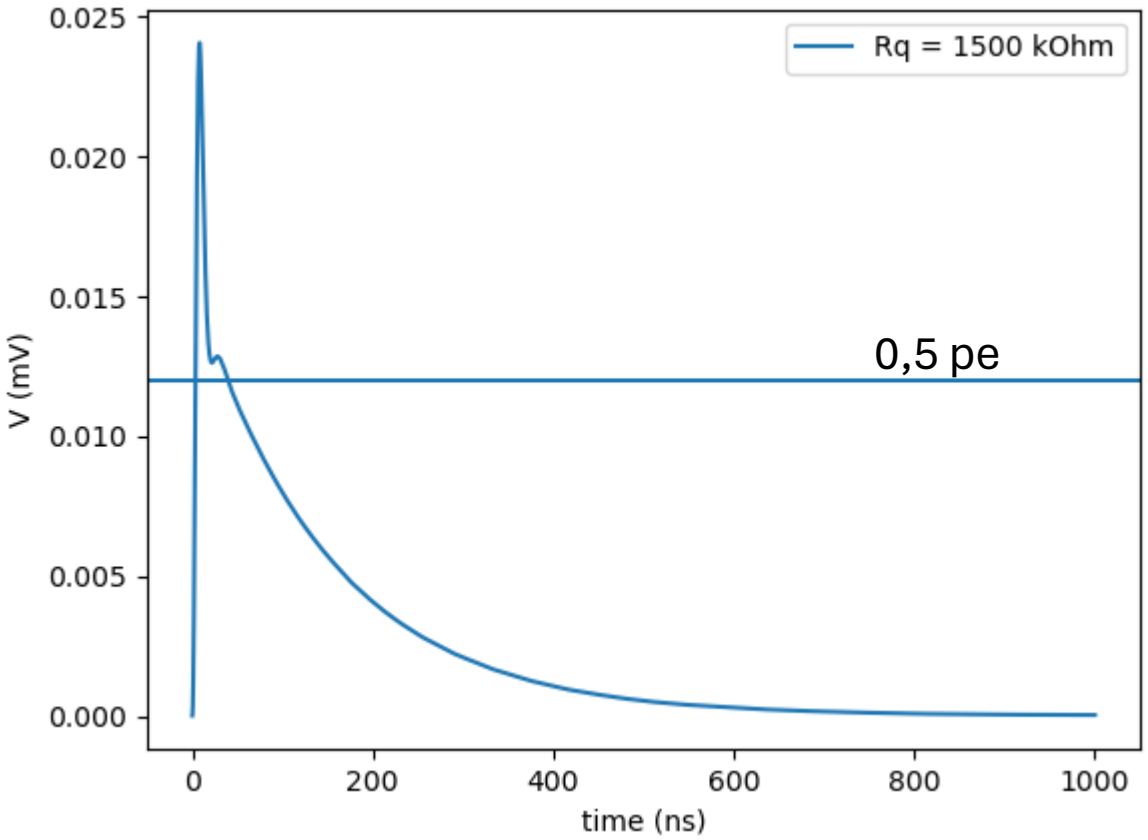


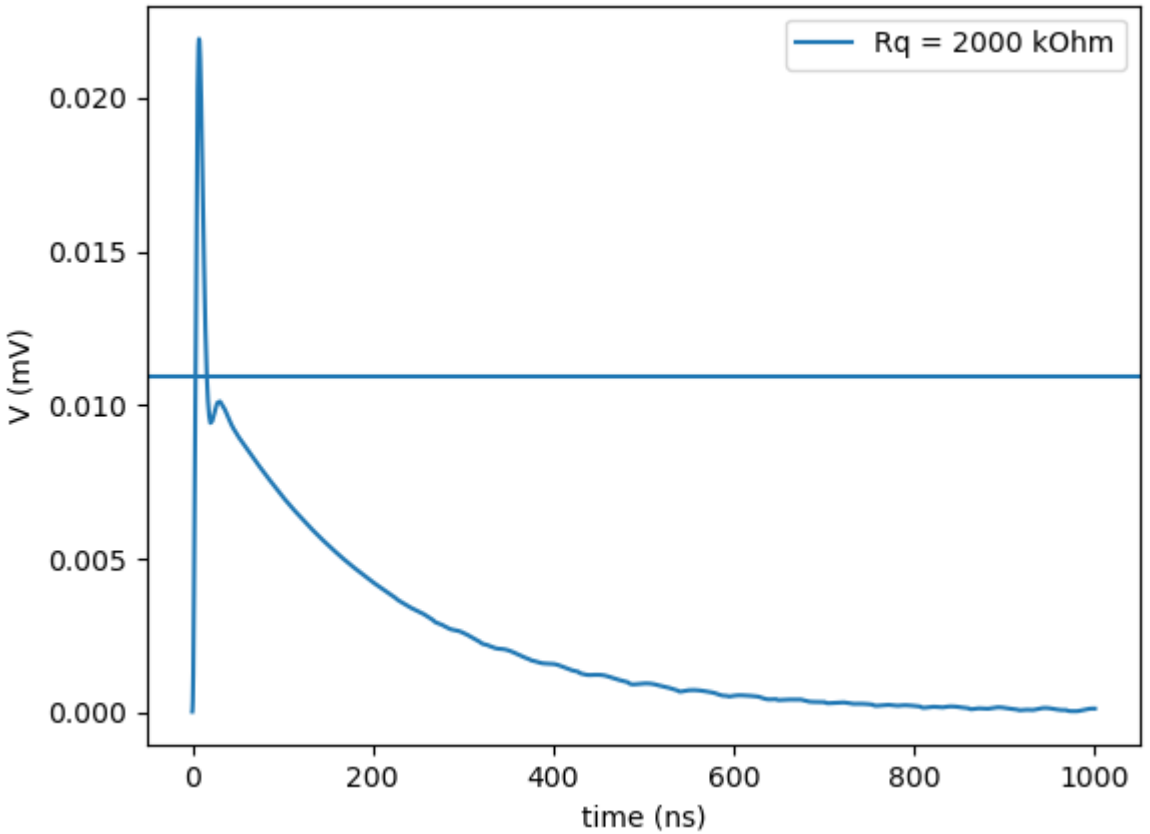


Conclusions

- FE design not yet finalised
  - How many capacitors?
  - Implement discriminator hysteresis?
- Rq between 1000 and 1500 kΩ are preferable
- Study capacitor saturation effects on track reconstruction and calorimetry

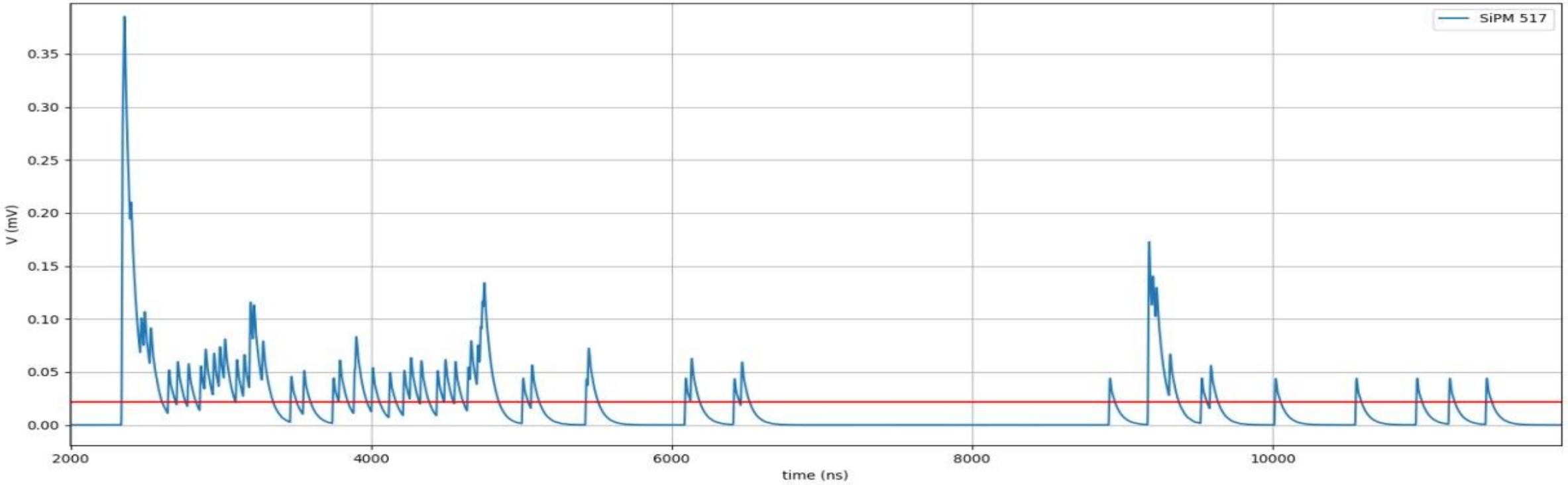
1pe waveform





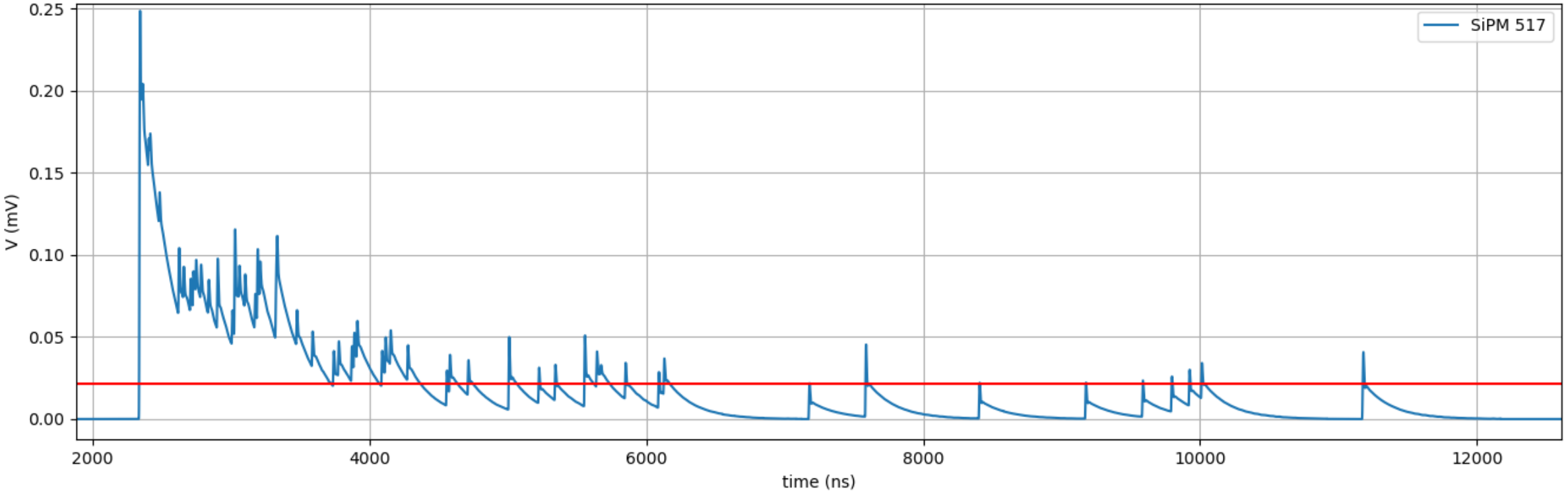
Sample waveform

Rq = 500 kΩ

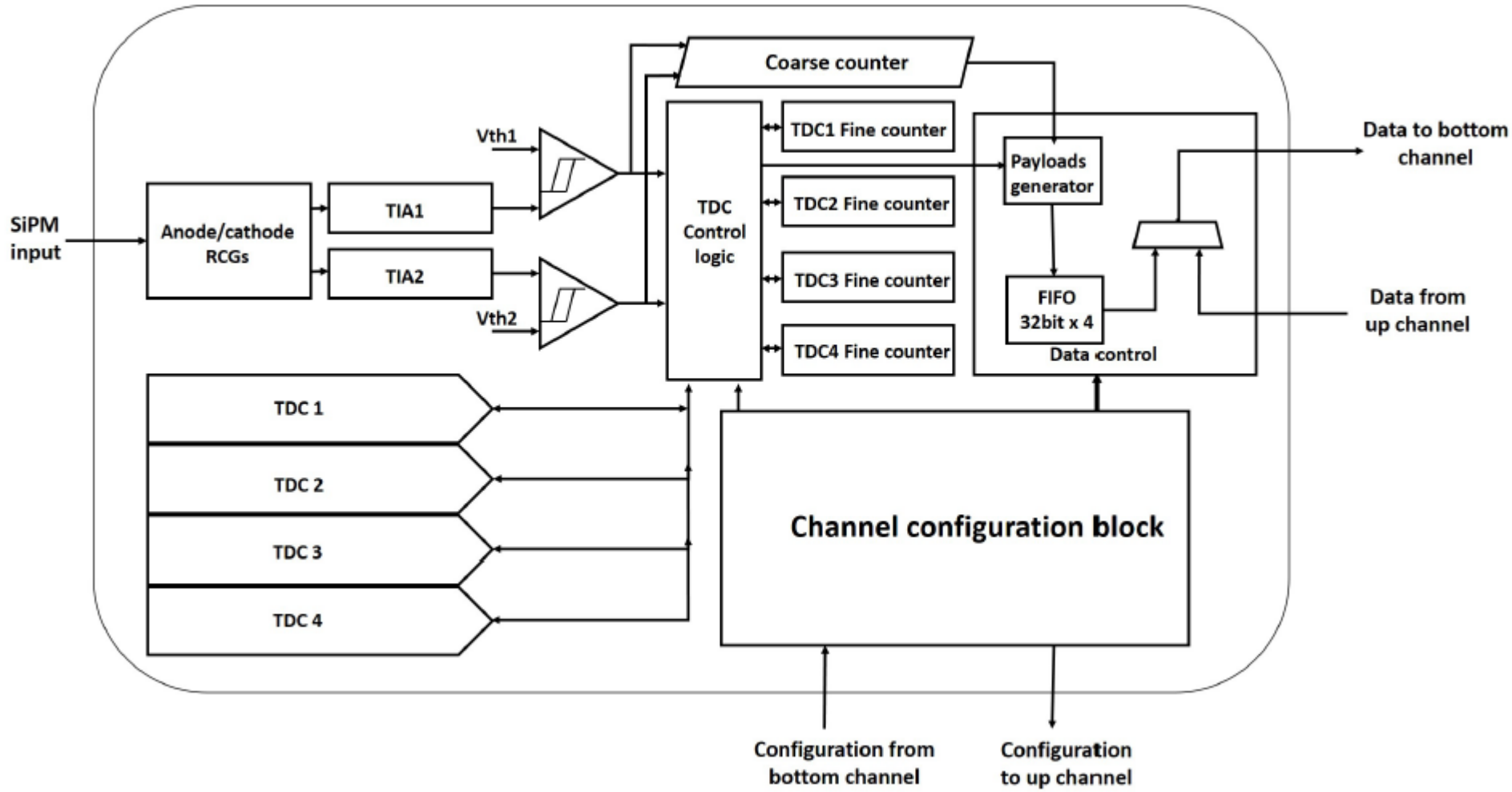


Sample waveform

Rq = 2000 kΩ



ALCOR FE


Coarse counter
Vth1
SiPM input
Anode/cathode RCGs
TIA1
TIA2
Vth2
TDC Control logic
TDC1 Fine counter
TDC2 Fine counter
TDC3 Fine counter
TDC4 Fine counter
Payloads generator
FIFO 32bit x 4
Data control
Data to bottom channel
Data from up channel
TDC 1
TDC 2
TDC 3
TDC 4
Channel configuration block
Configuration from bottom channel
Configuration to up channel