Detector response with simulated spills

GRAIN WG – 19/04

V. Cicero & F. Chiapponi

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];
};
```

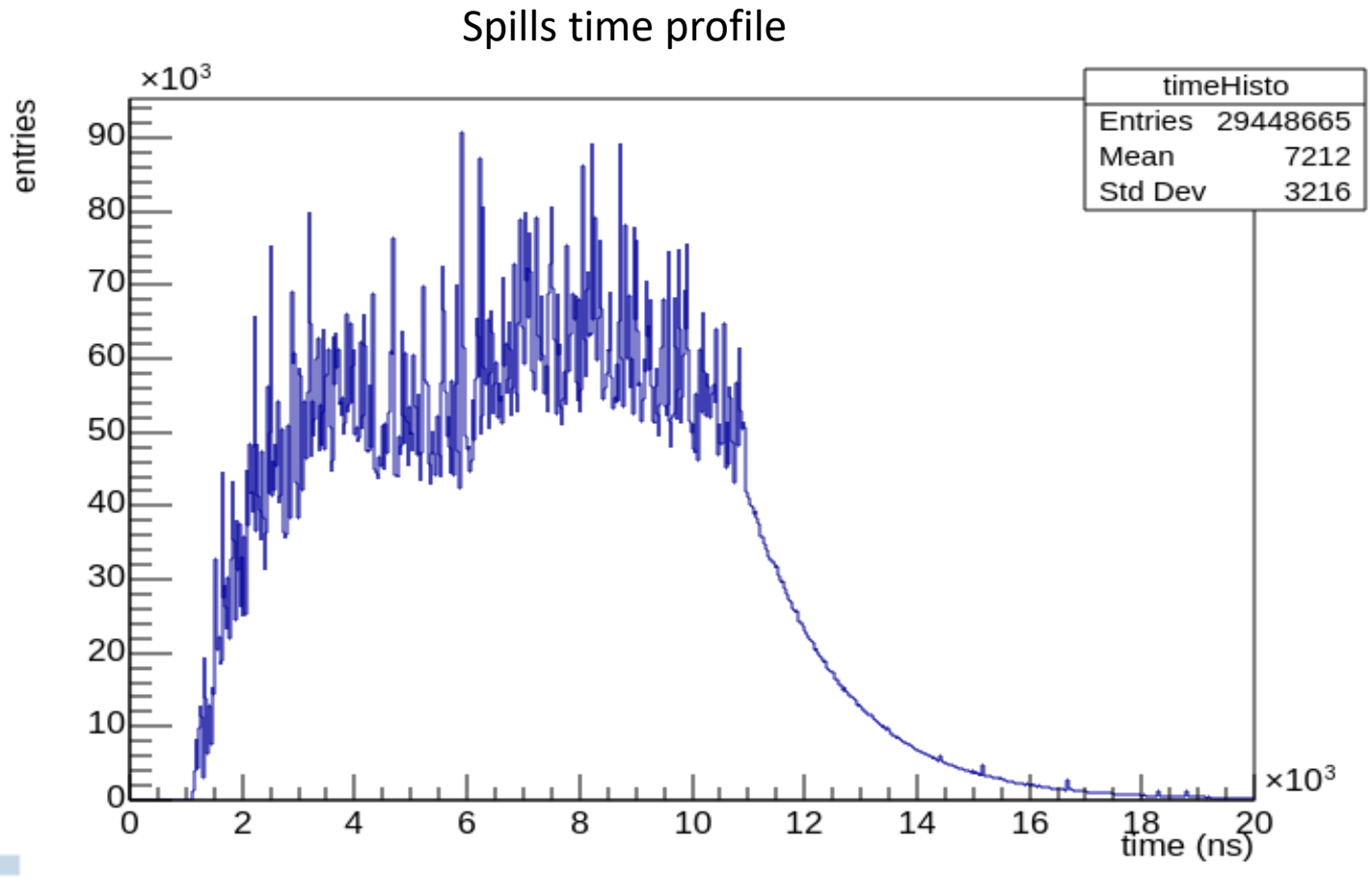
Output for reconstruction chain:

```
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



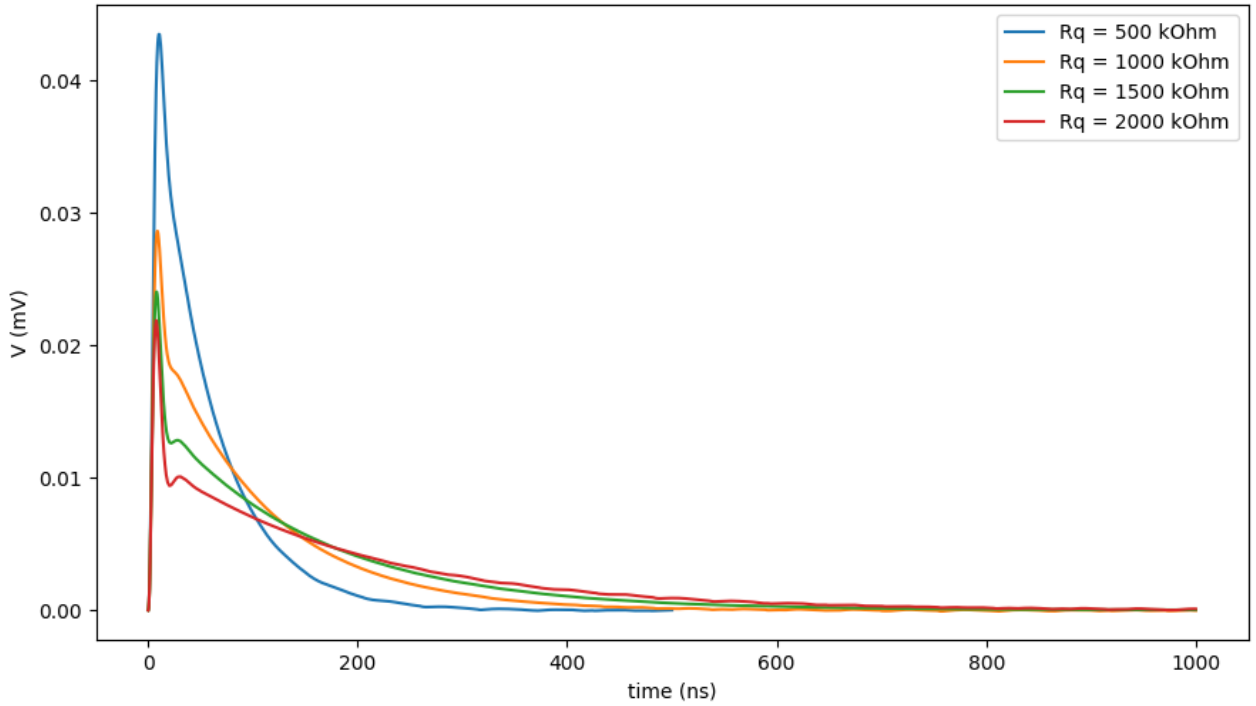
Simulation parameters

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

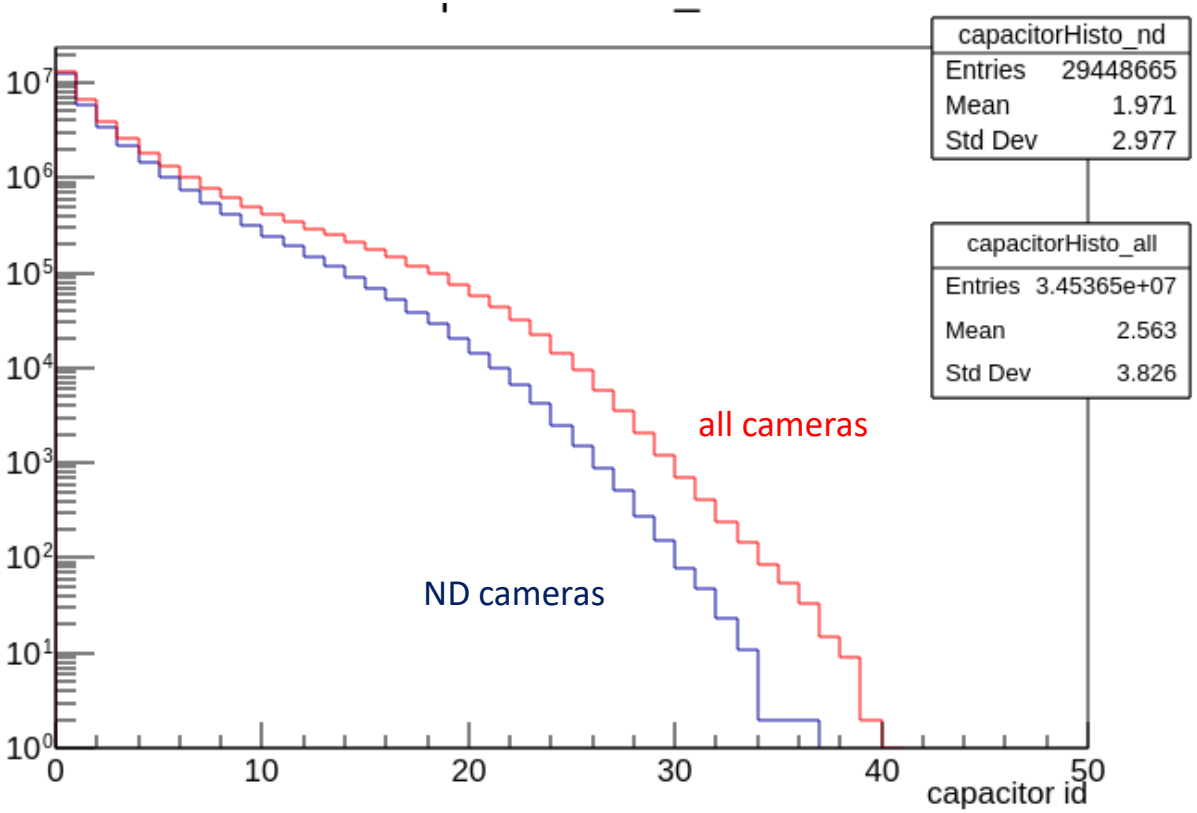
- Discriminator threshold = 0.5 photoelectrons
- N Capacitors = 50

1 photoelectron waveform (CADENCE simulation + ALCOR transfer function)



capacitor number

Rq = 500 kOhm

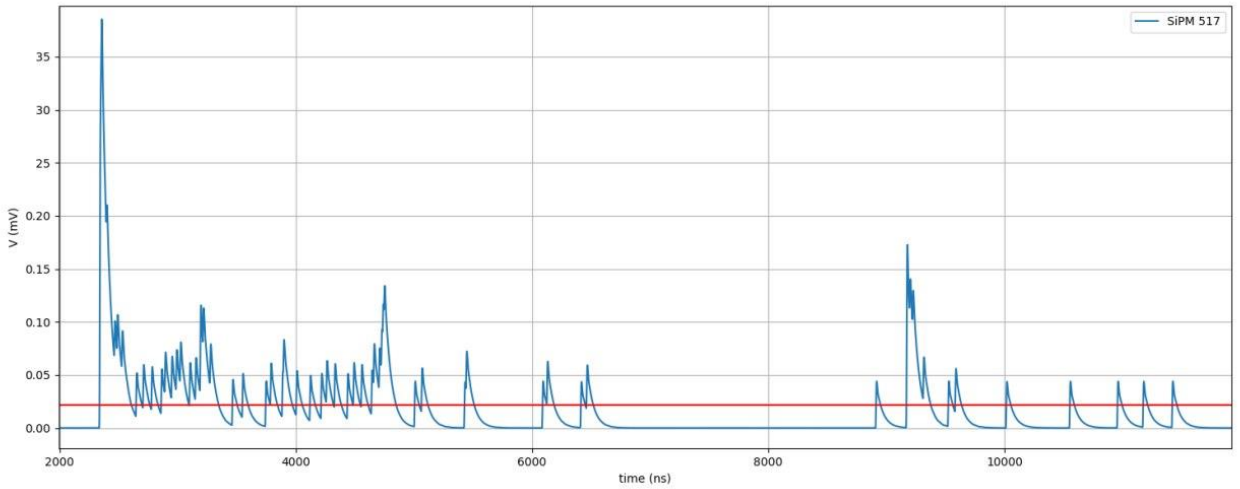


All_cams(capacitorId = 10) / All_cams(capacitorId = 0) = 0.025

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

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

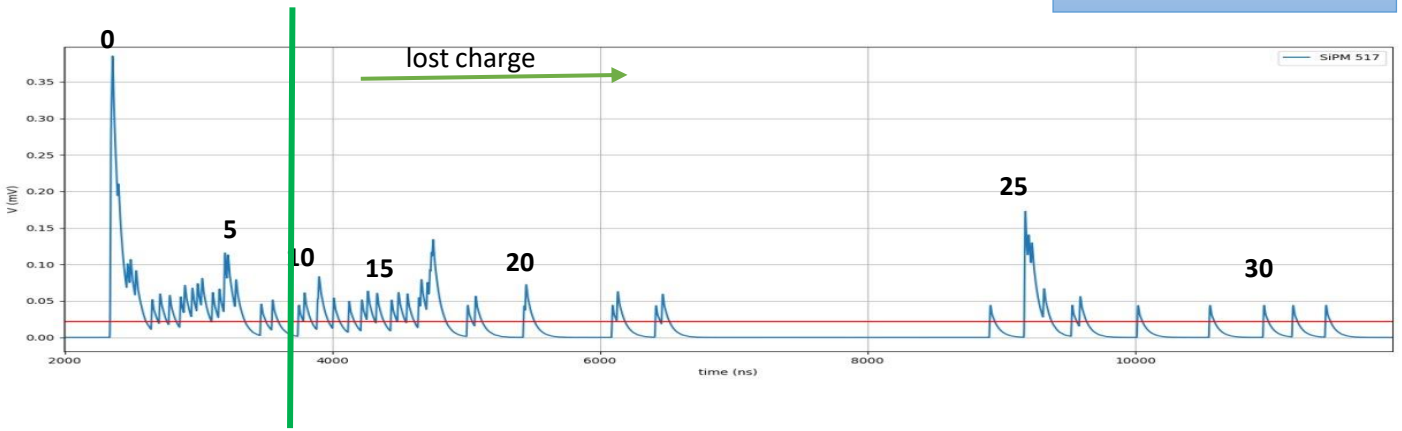
Spill SiPM signal example



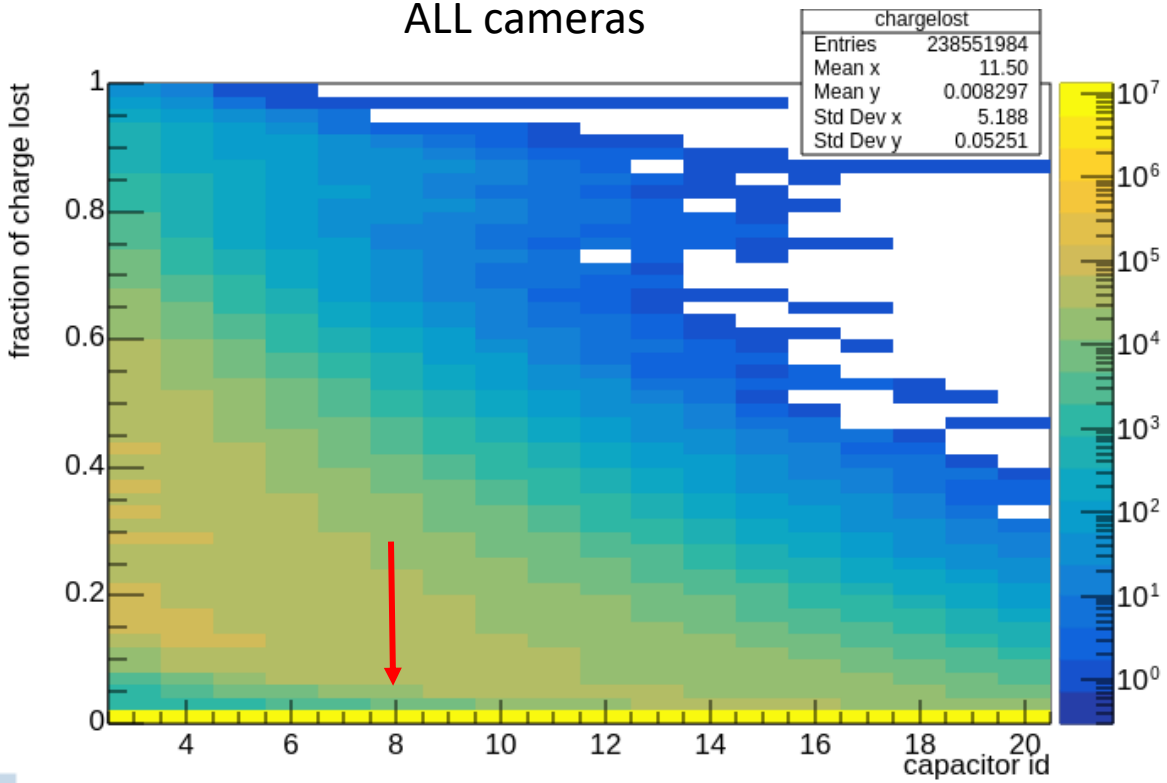
Rq = 500 kOhm

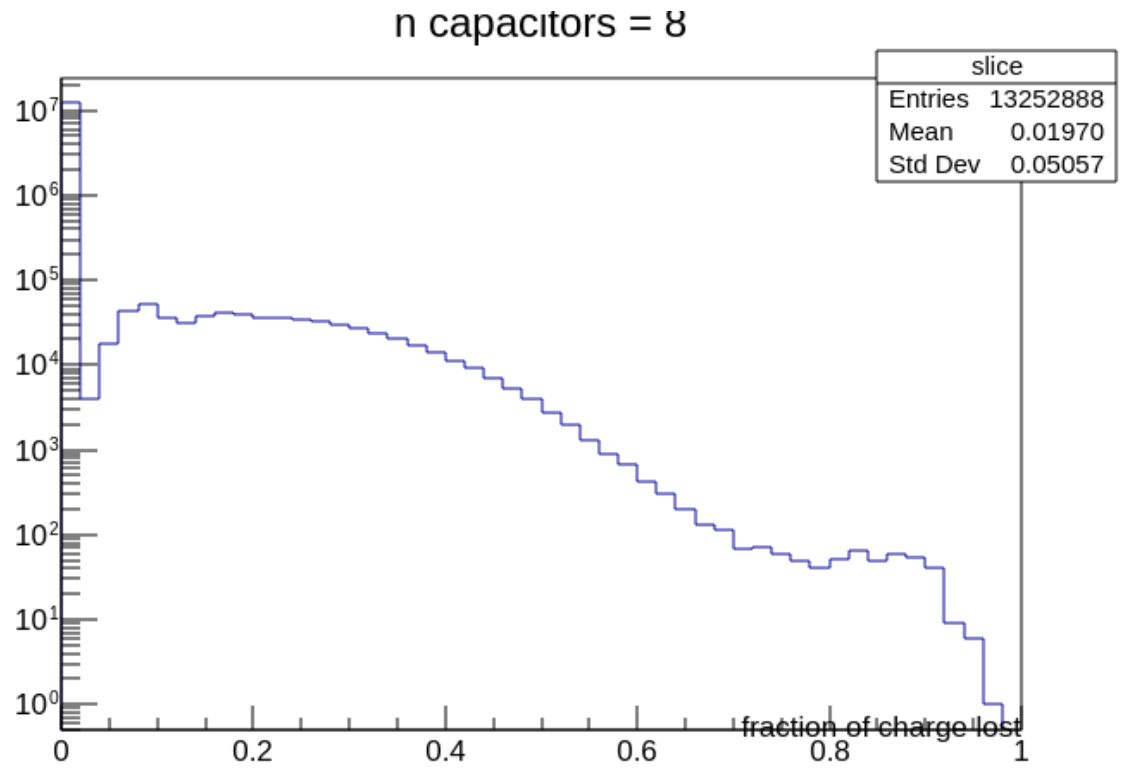
Fraction of lost charge per number of capacitors

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



ALL cameras

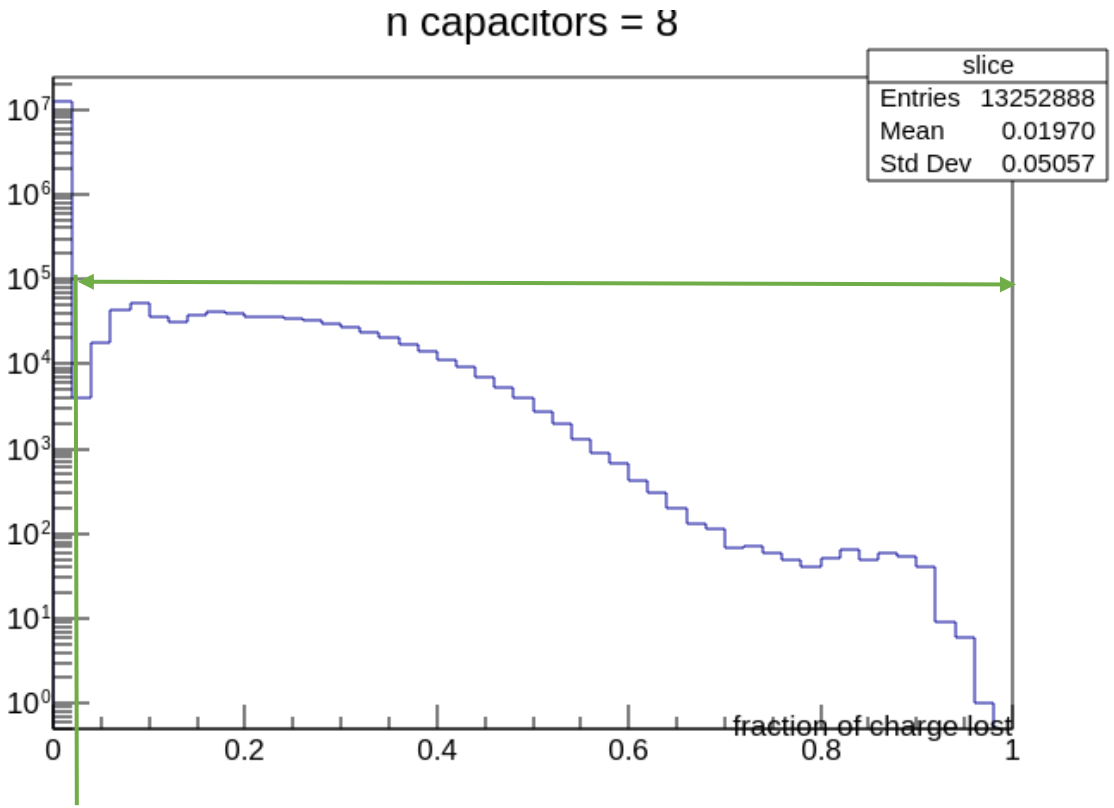


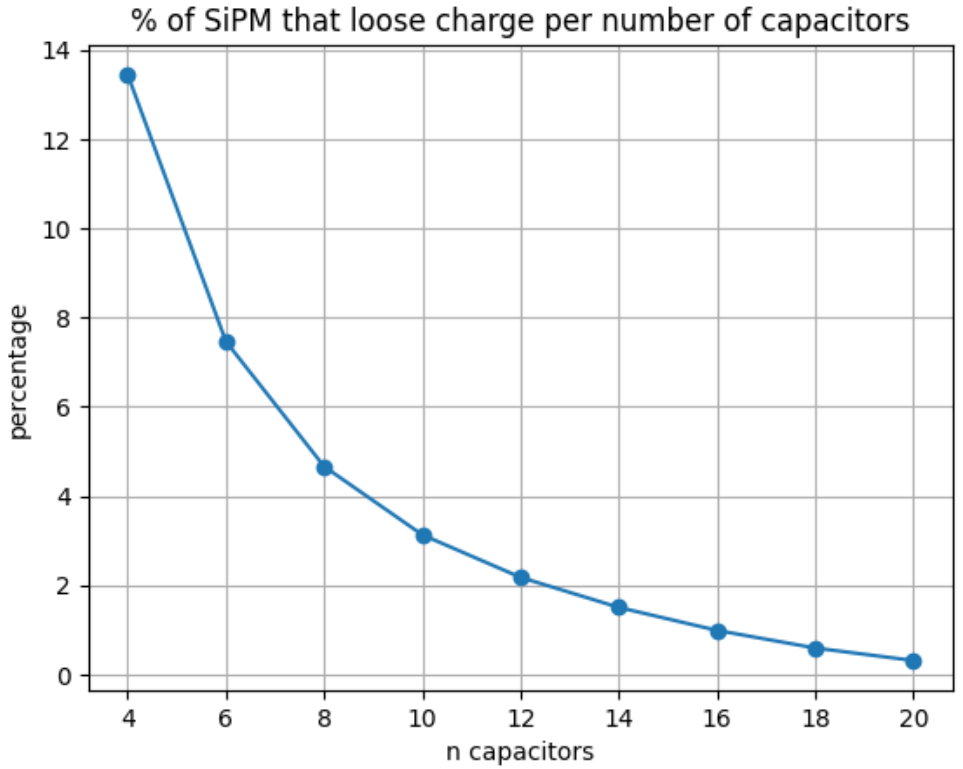


Fraction of lost charge per number of capacitors

Rq = 500 kOhm

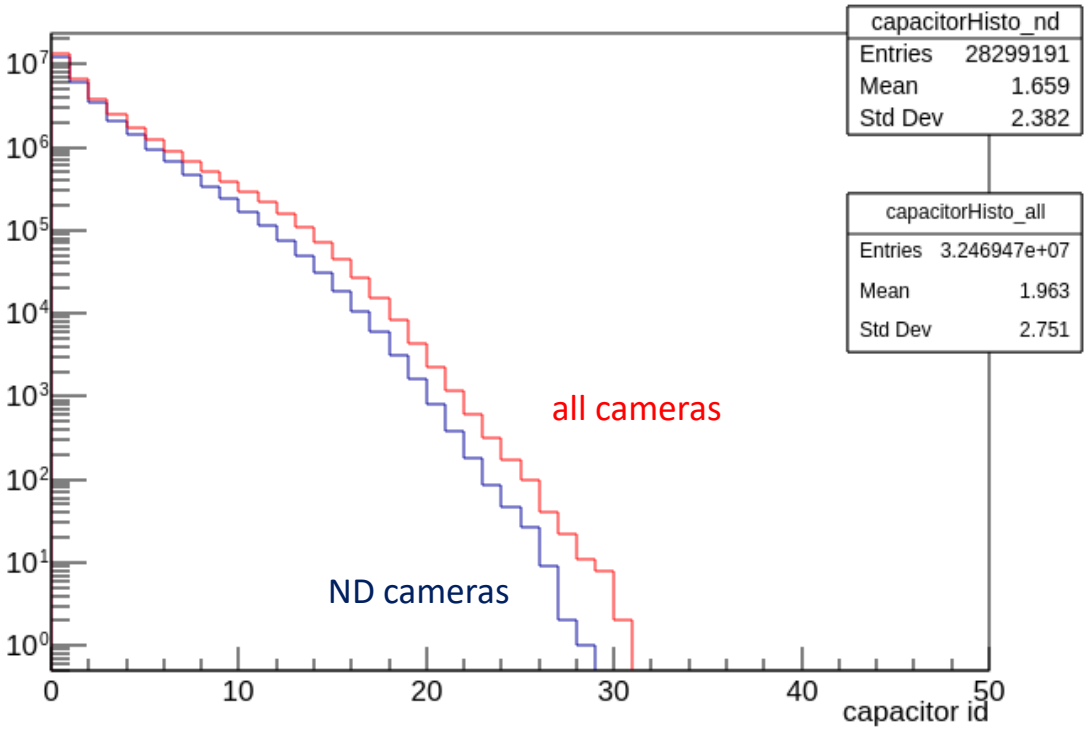
Lost fraction = SiPM that loose > 2 % photons / all



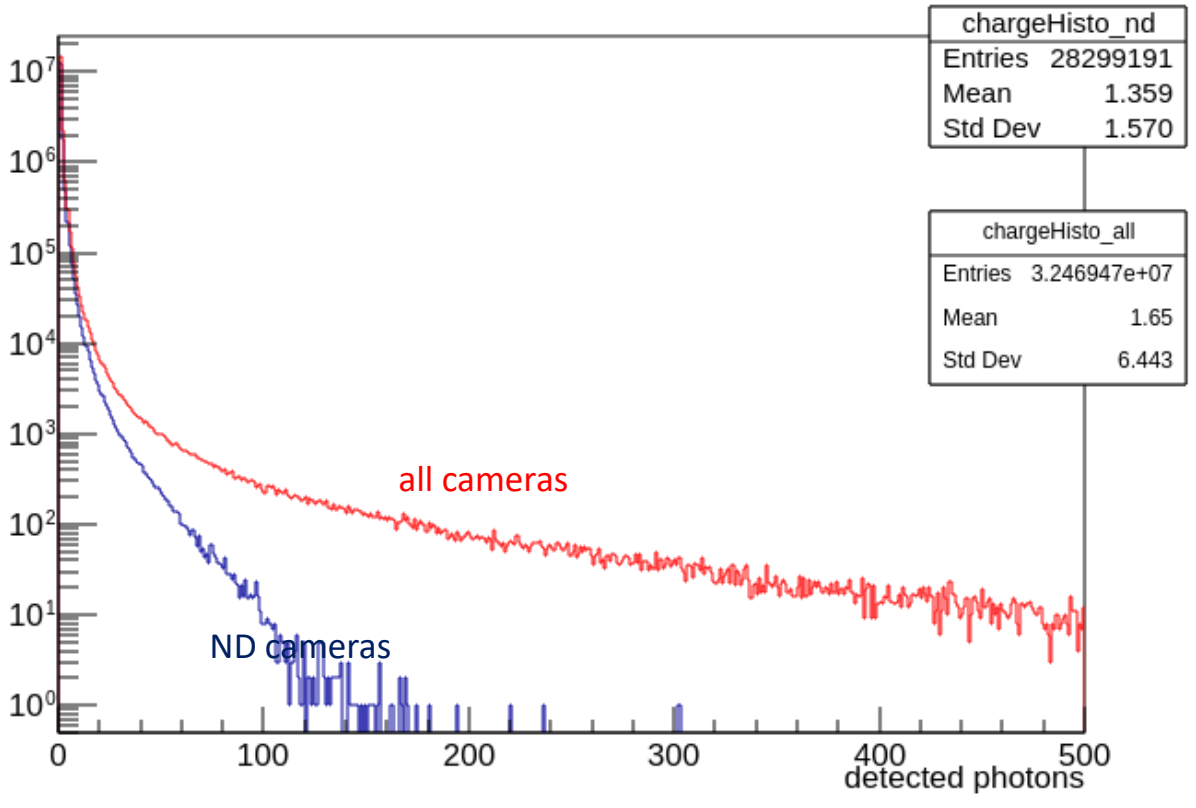


Capacitor and photons per hit

Rq = 1000 kOhm



Detected photons per hit



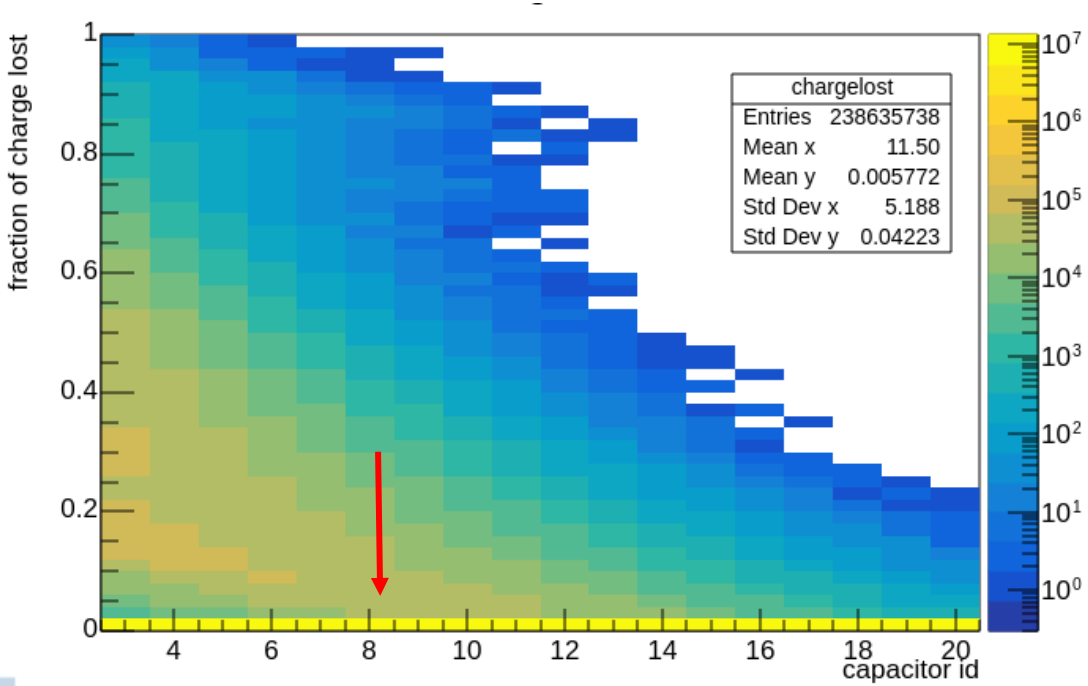
Non-Dazzled (ND) camera :
inner photons / total photons < 0.1

Fraction of lost charge per number of capacitors

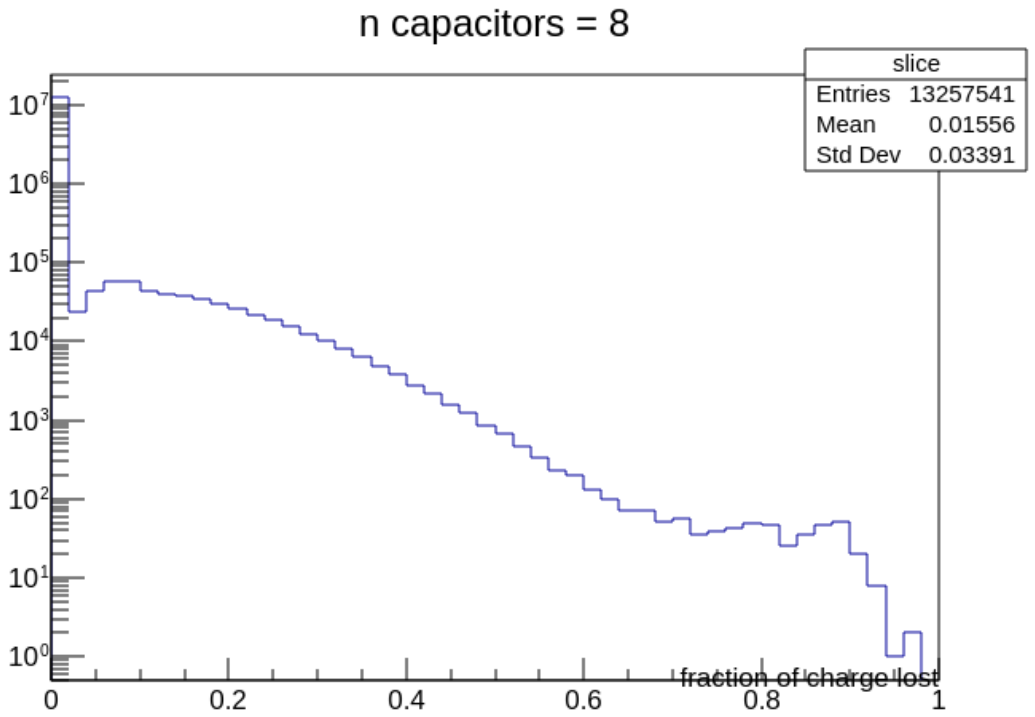
Rq = 1000 kOhm

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

ALL cameras



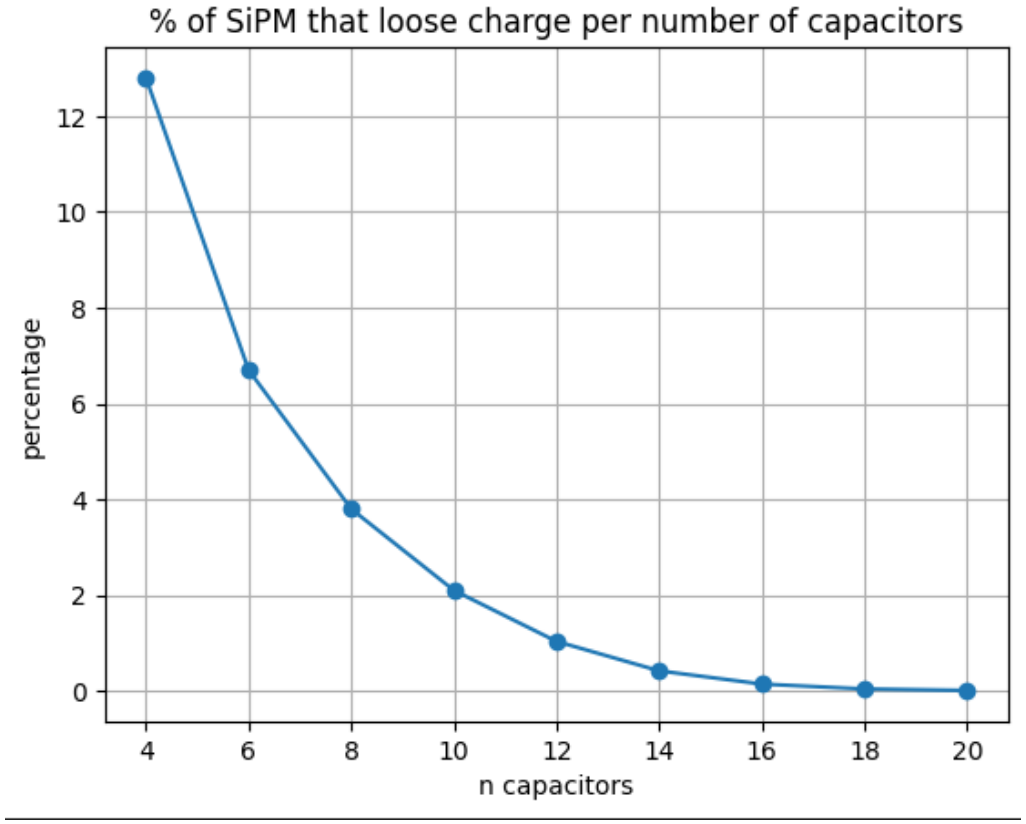
n capacitors = 8

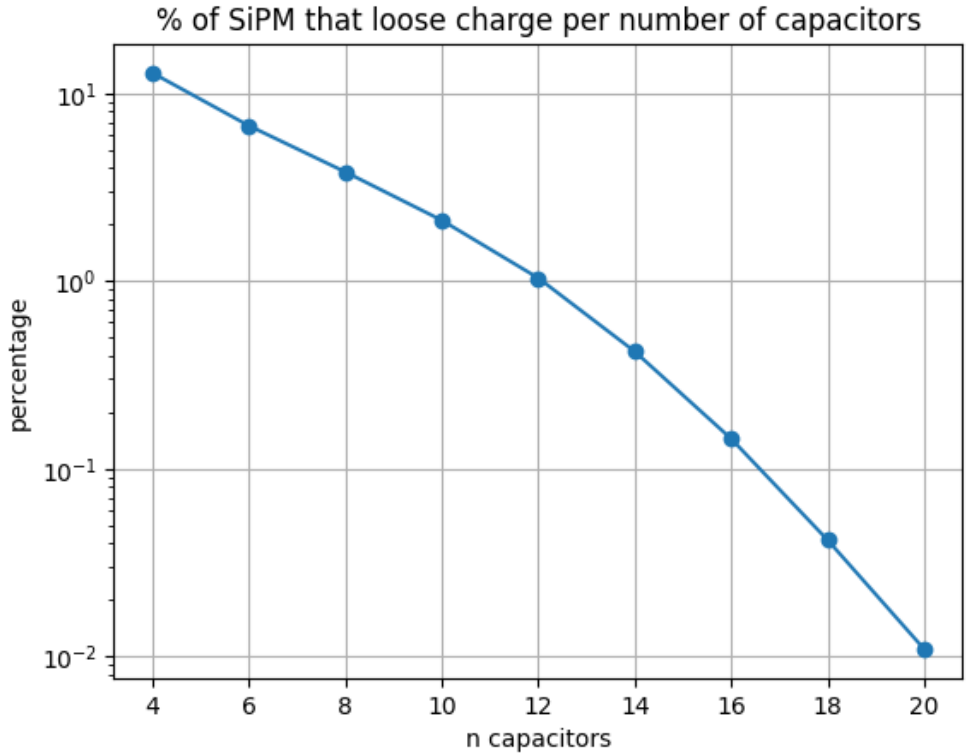


Fraction of lost charge per number of capacitors

Rq = 1000 kOhm

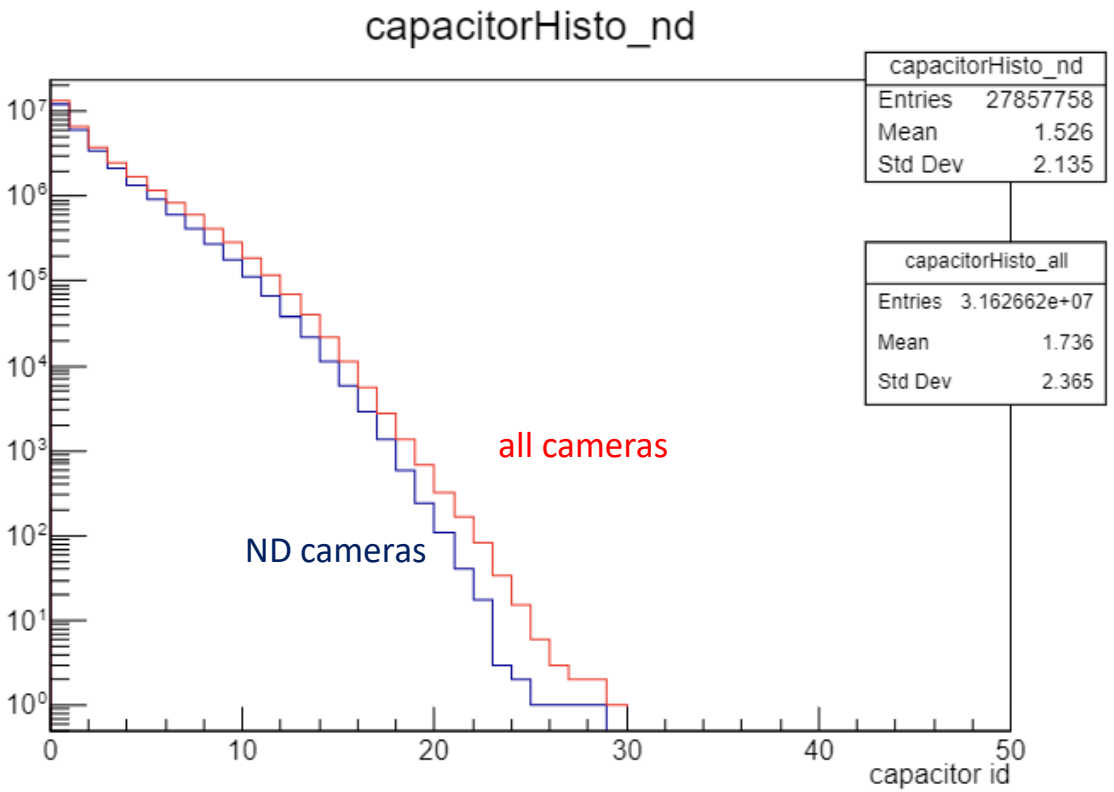
Lost fraction = SiPM that loose > 2 % photons / all



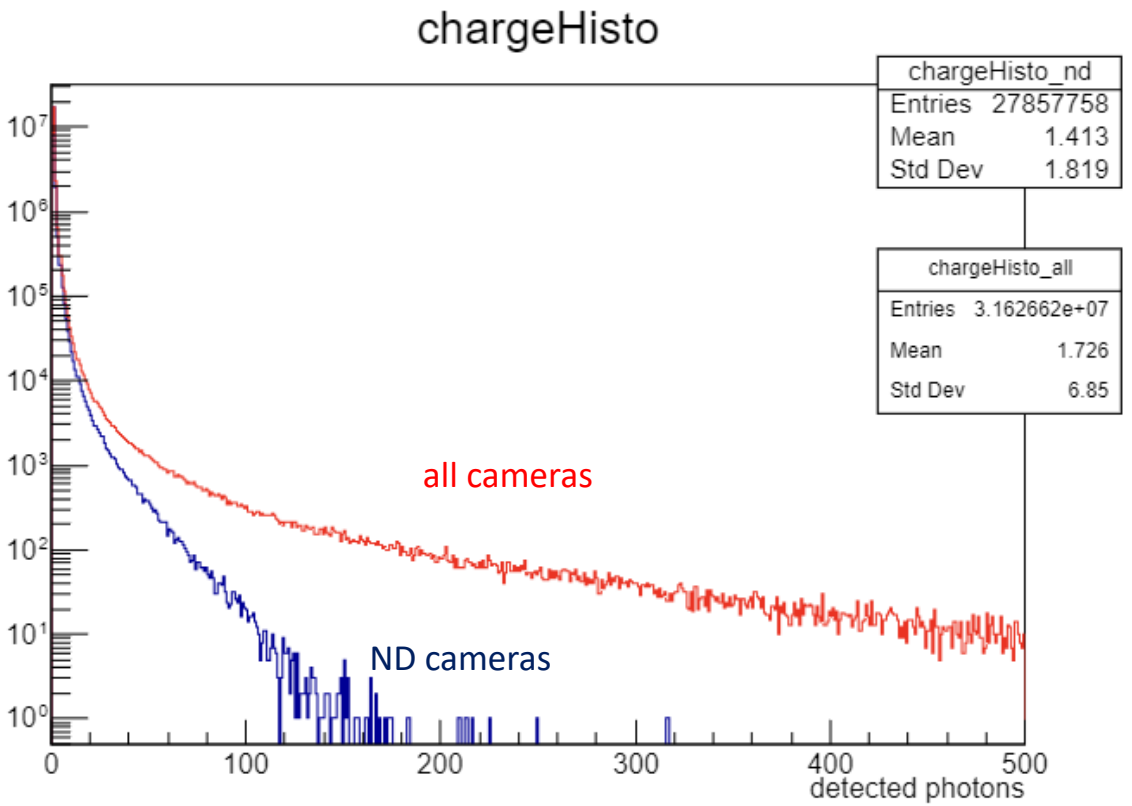


Capacitor and photons per hit

Rq = 1500 kOhm



Detected photons per hit



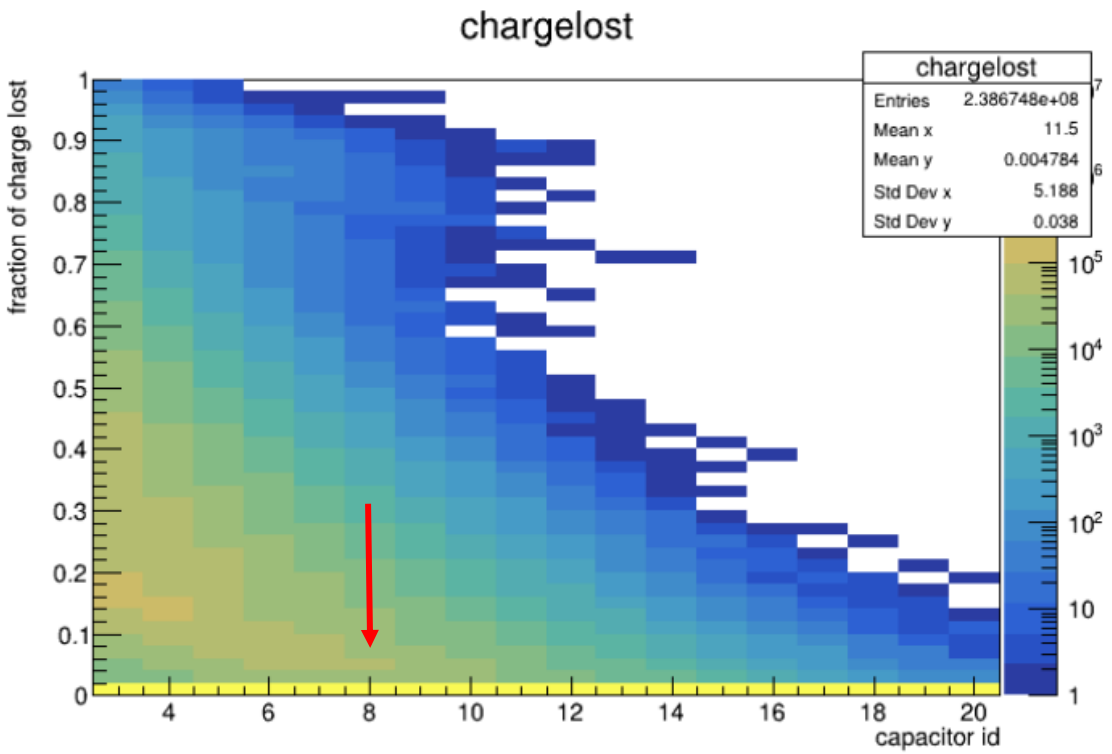
Non-Dazzled (ND) camera :
inner photons / total photons < 0.1

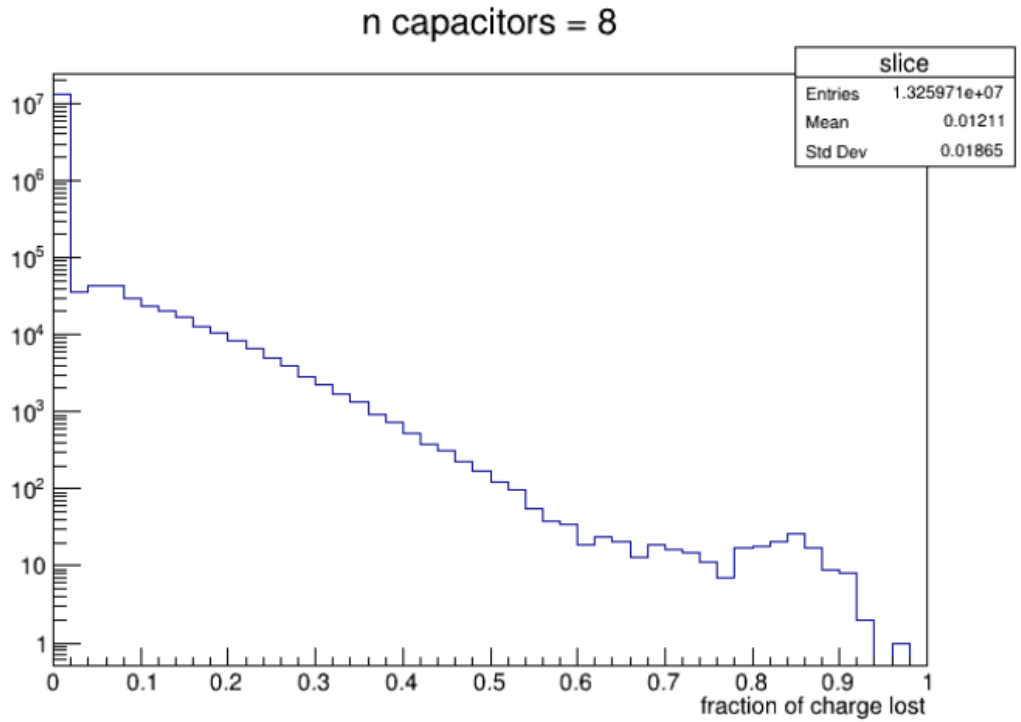
Fraction of lost charge per number of capacitors

Rq = 1500 kOhm

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

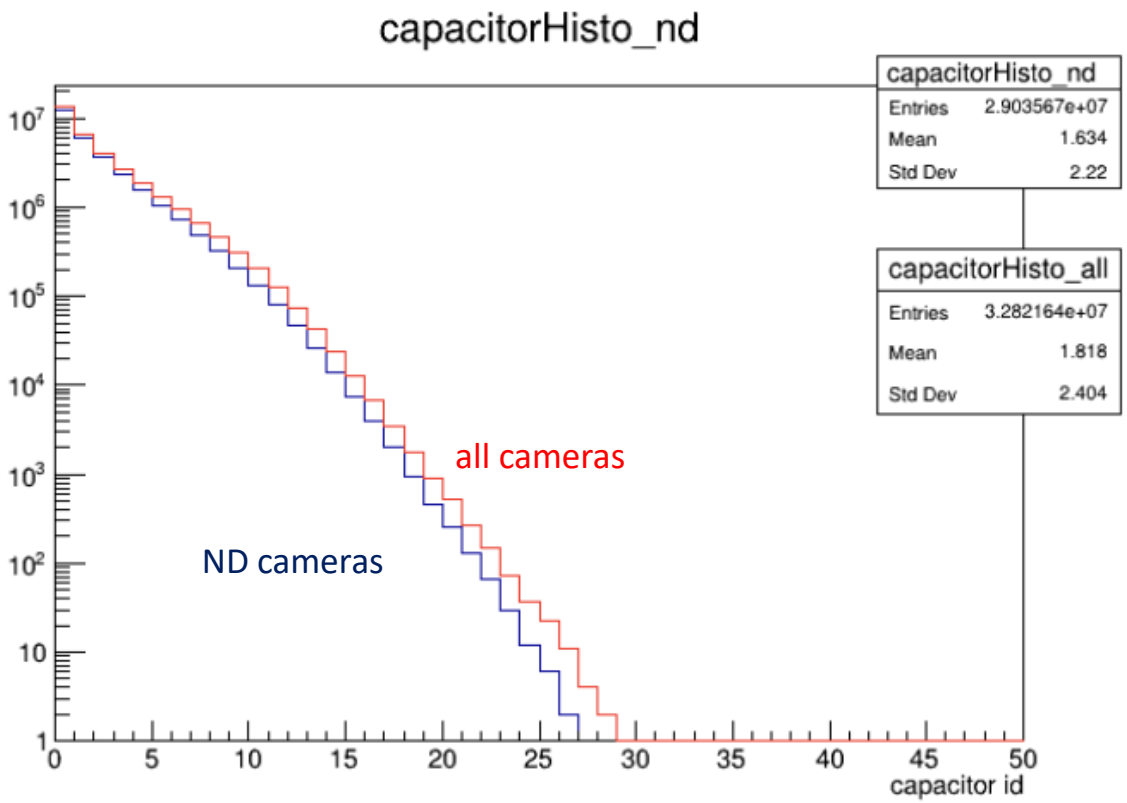
ALL cameras



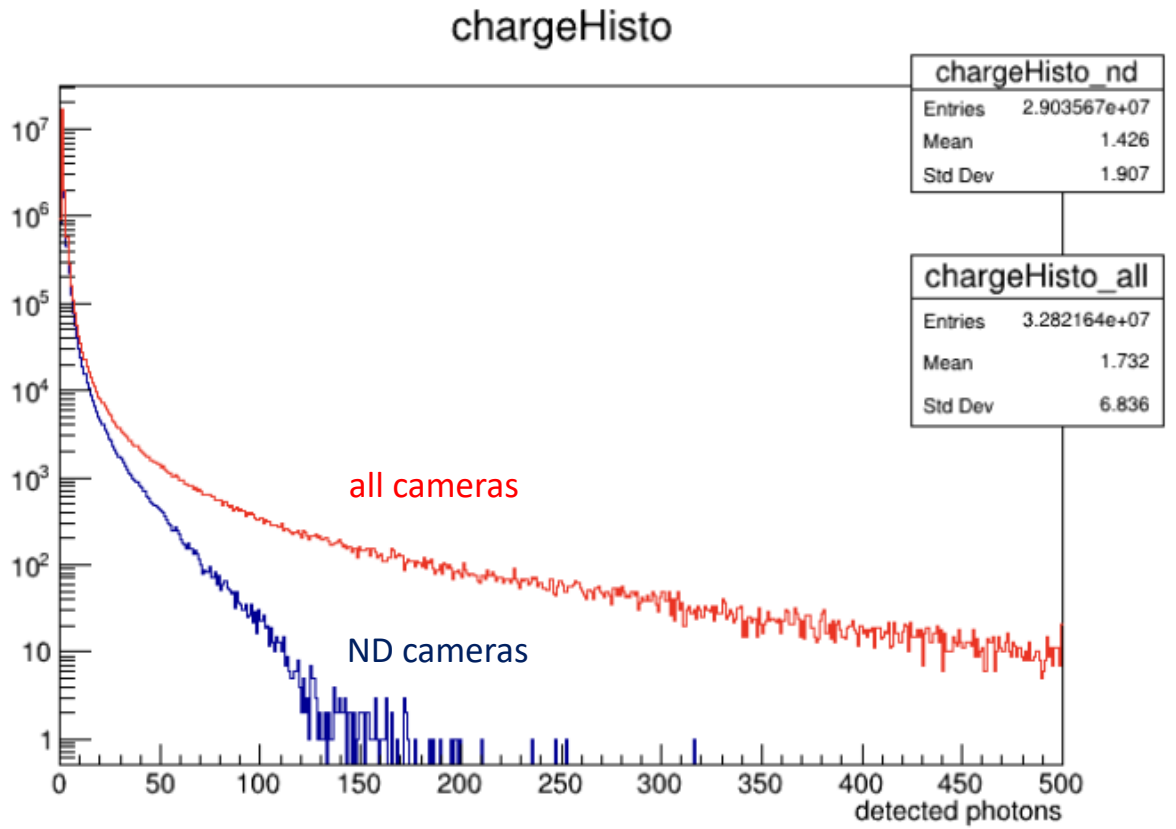


Capacitor and photons per hit

Rq = 2000 kOhm



Detected photons per hit



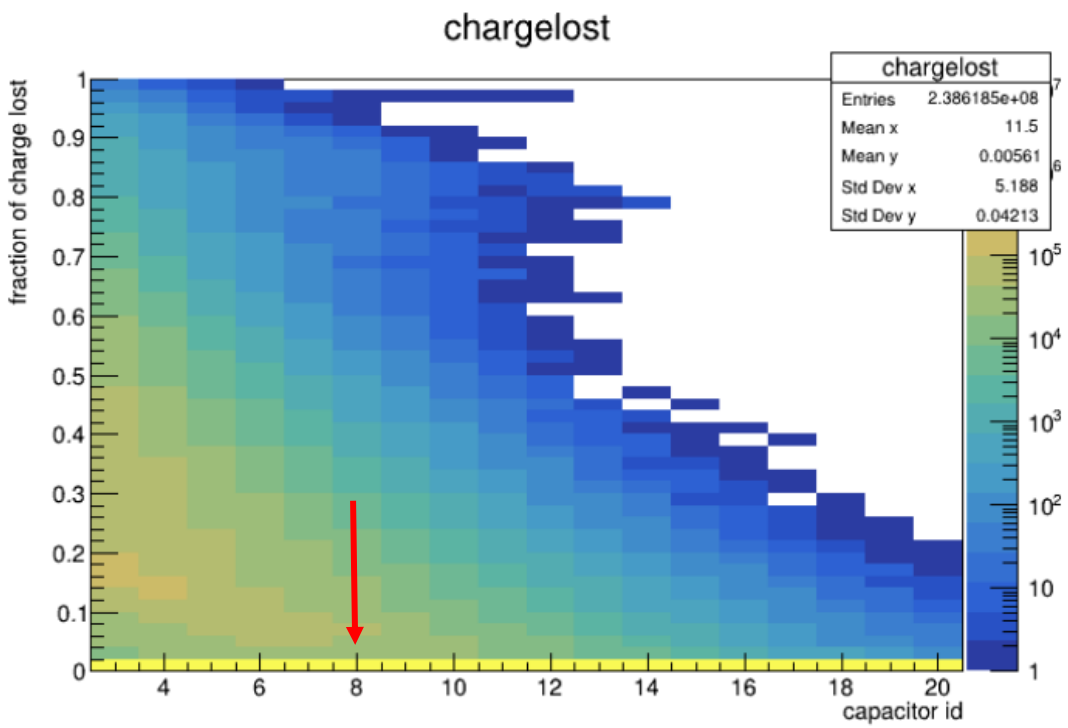
Non-Dazzled (ND) camera :
inner photons / total photons < 0.1

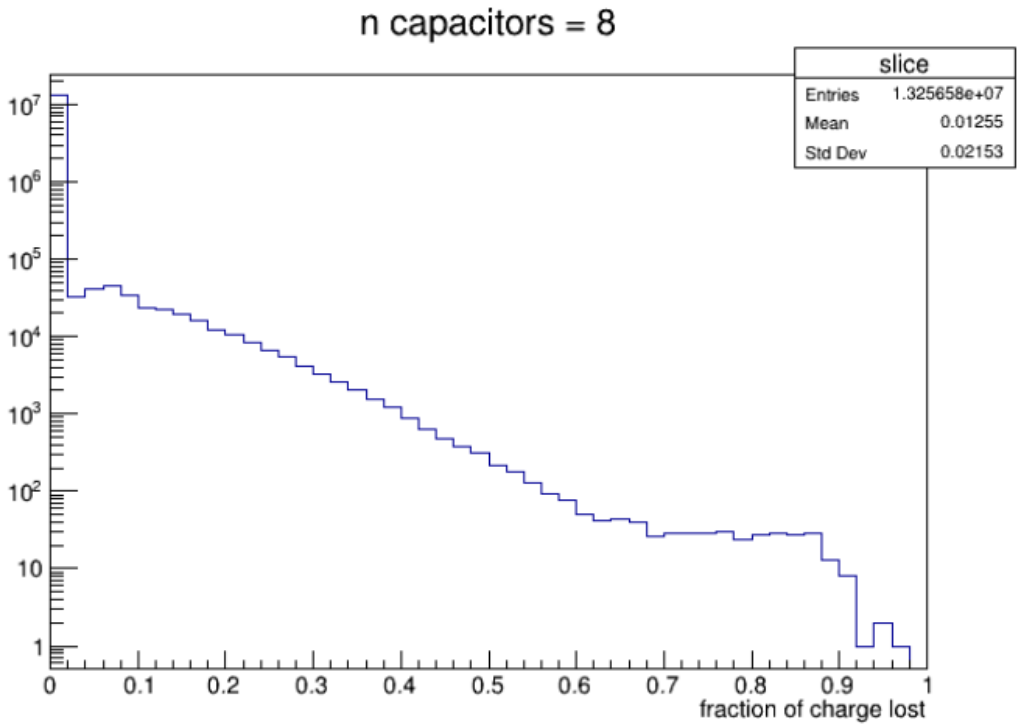
Fraction of lost charge per number of capacitors

Rq = 2000 kOhm

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

ALL cameras





Fraction of lost charge per number of capacitors

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