# NectarCAM MC meeting

Thomas Tavernier

IRFU / CEA

*thomas.tavernier@cea.fr*

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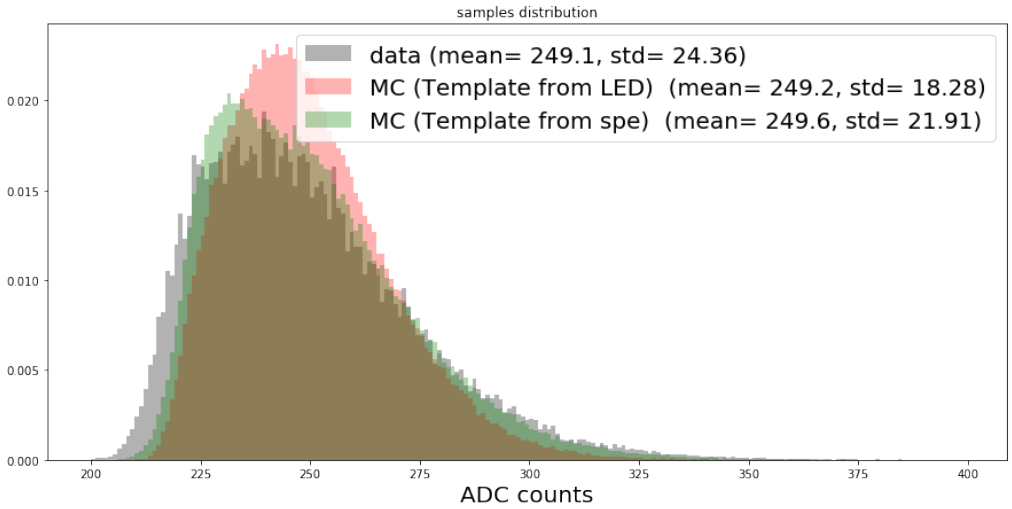
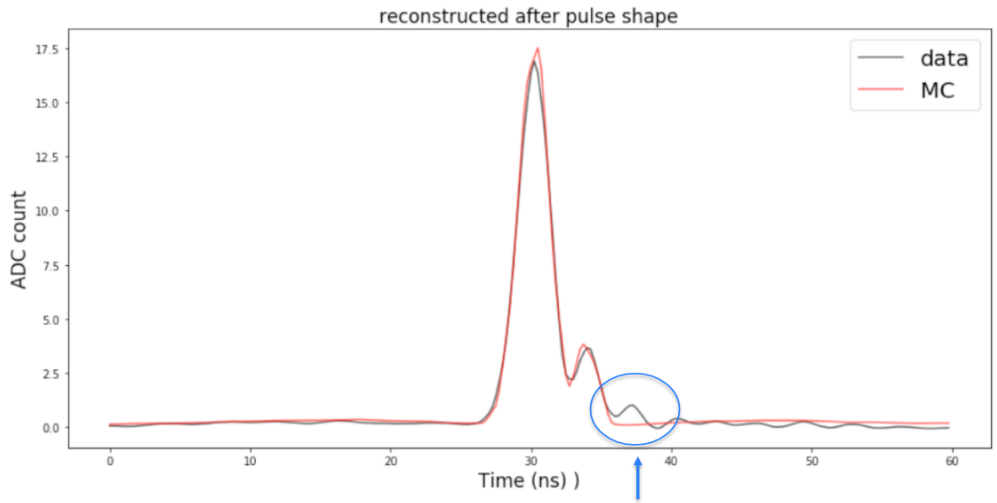
# reminder

- We had non negligible disagreement for the noise induced by NSB
- Pulse shape was estimated neglecting time spread from the LED and the TTS.



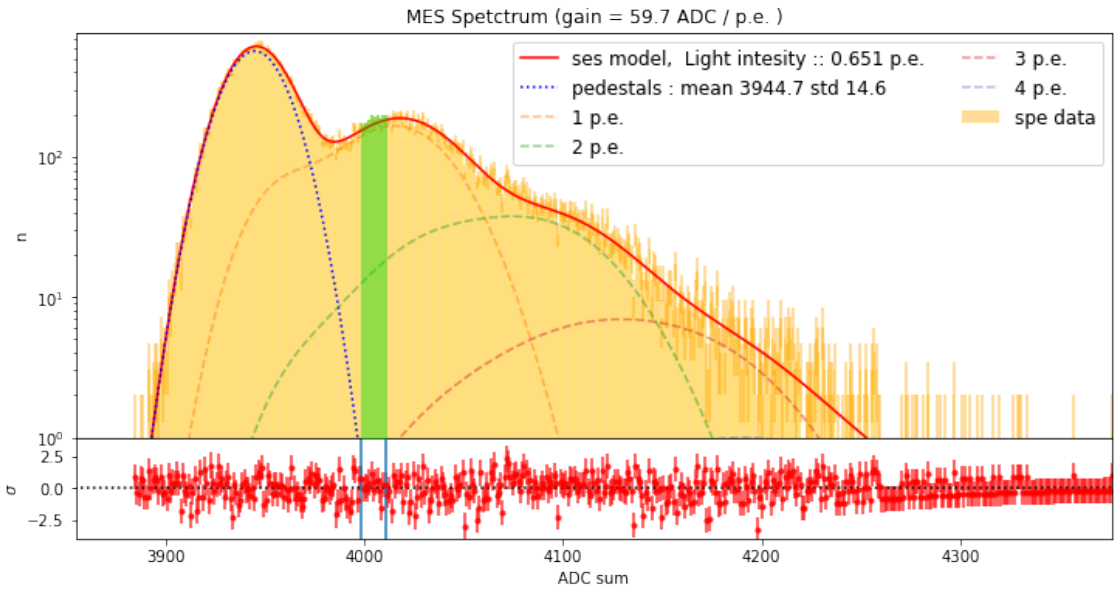

- new pulse shape from spe run
- changes go to the good direction
- remaining disagreement is maybe understood



# pulse shape events selection

## Charge selection

- 1 p.e. +/- 10 %
- $<$ 1% of pedestal evt
- $<$ 1% of 3 p.e. evt
- $\sim$ 10 % of 2 p.e. evt

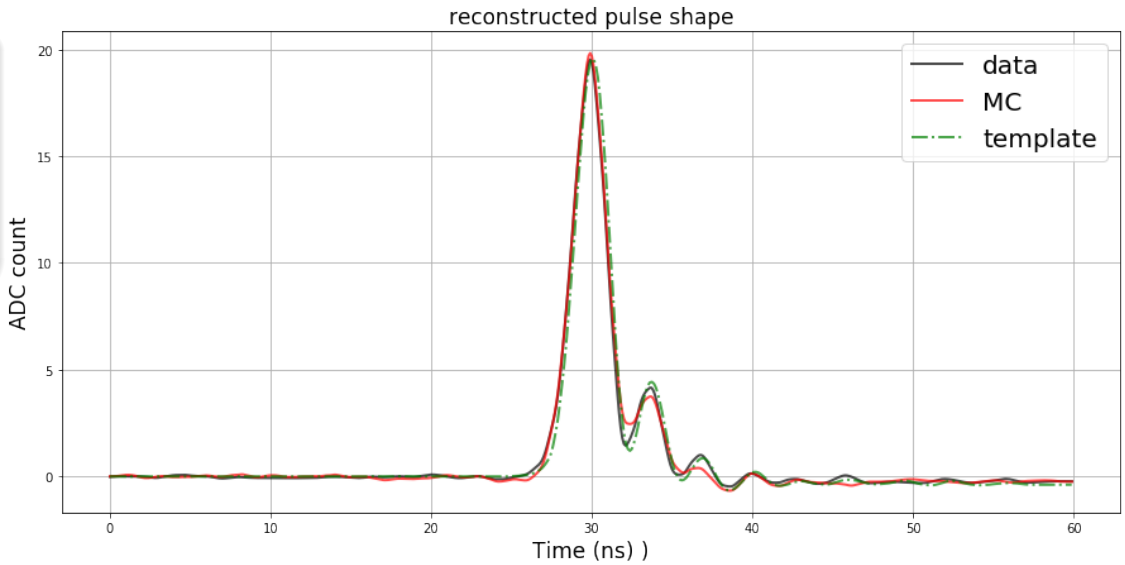



5000 events from all pixels
-> rescaled in time

# SPE pulse shape comparison

- 1 p.e. +/- 10 %
- Good agreement between MC and NectarCAM data.

5000 events from all pixels

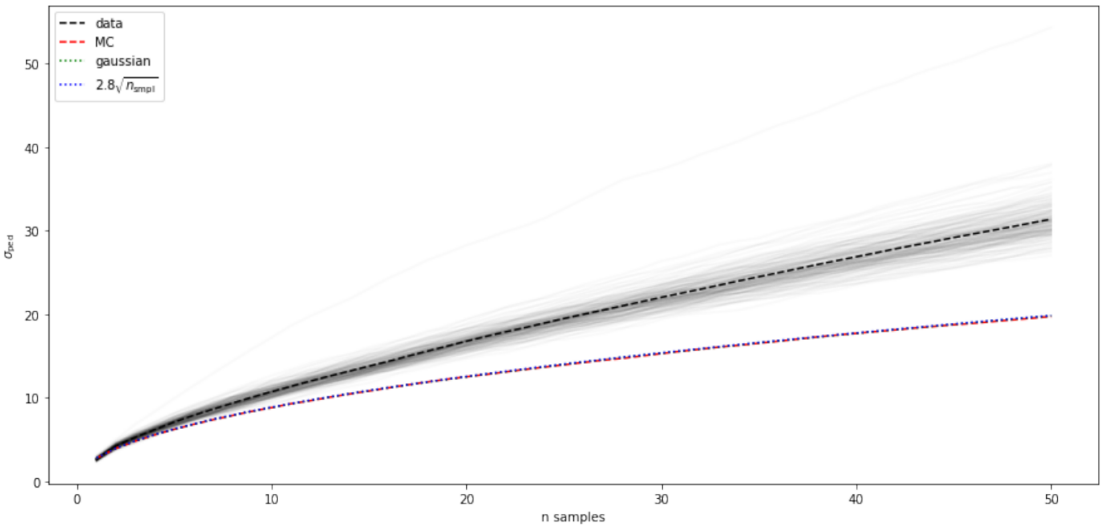


# electronic noise

- Electronic noise in not poissonian in the Camera.
- according to Konrad's suggestion, we defined it in a way it match the integrated std (on 16 samples)

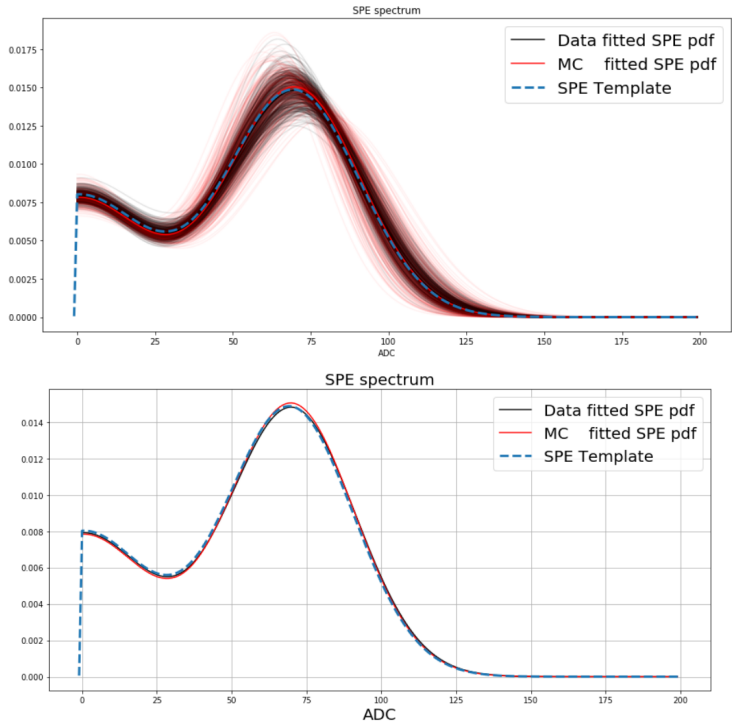
FADC_NOISE : 2.8 $\rightarrow$ 3.6

$\sigma_{\mathrm{ADC}}$(intergated samples)

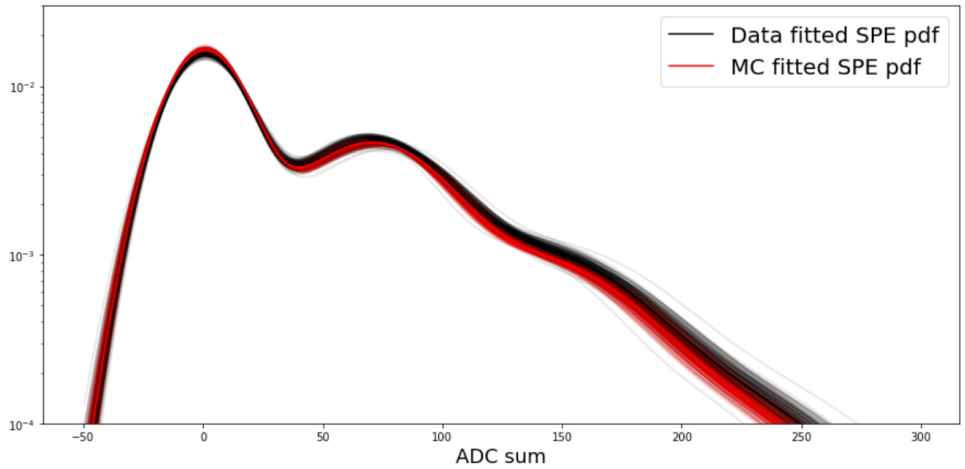


# SPE comparison

New spe pdf parameters (Taken from Sami's work)



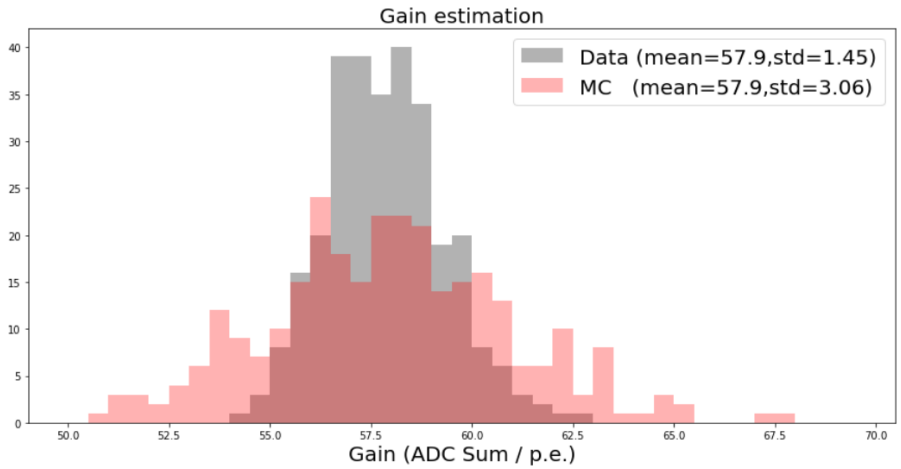

SES spectrum




- Good agreement between MC and NectarCAM data.

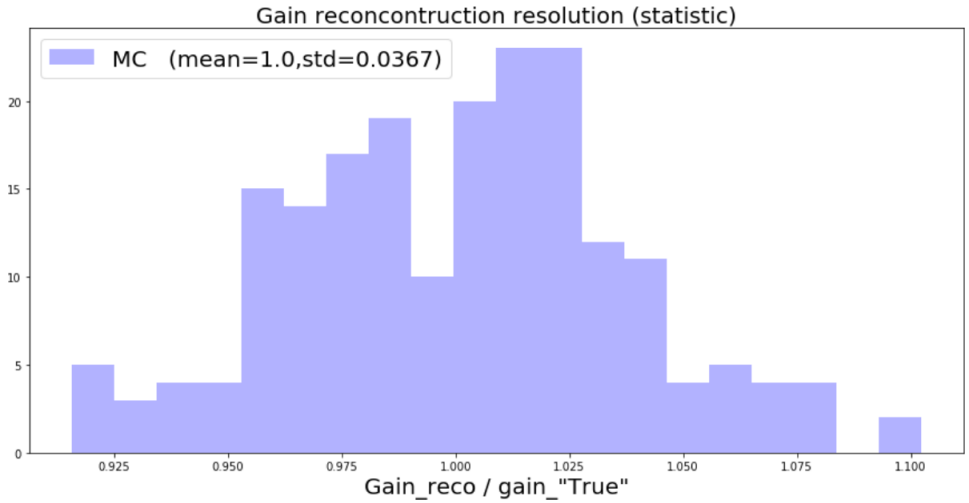
# Ses comparison

- Good agreement for the mean reconstructed gain
- wider dispersion in the gain distribution in the MC gain distribution

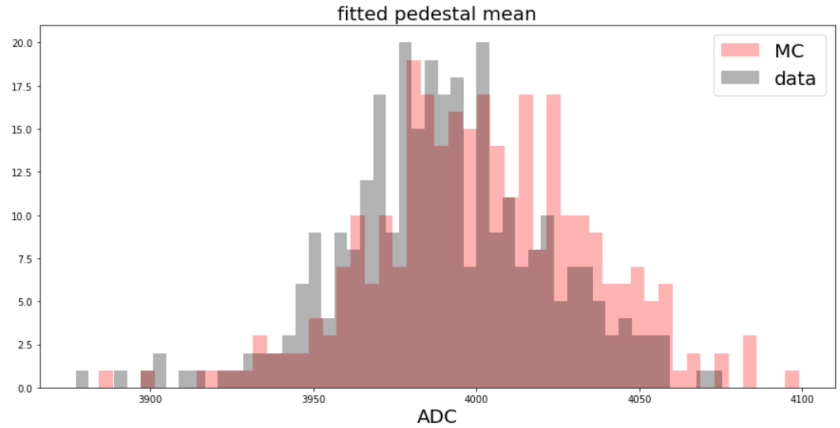


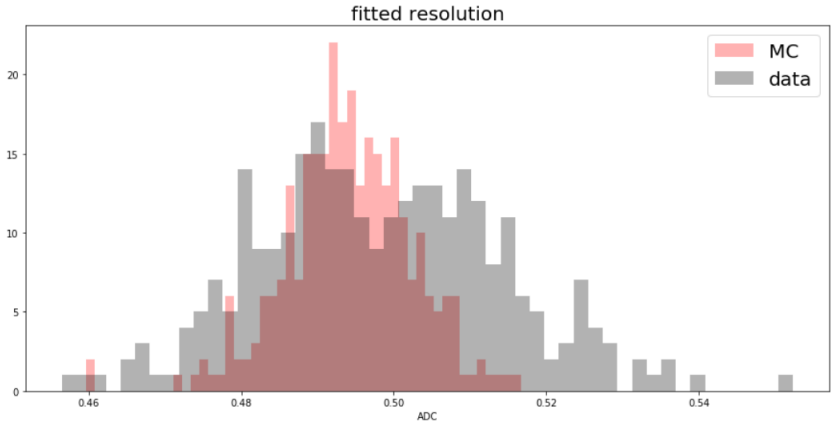

## $\frac{G_{\text{reco}}}{G_{\text{sim}}}$ distribution ( ?)

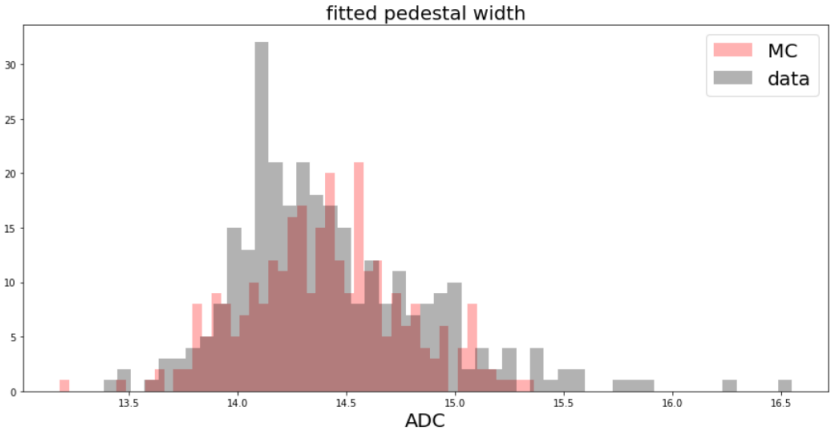
- how one ca recover the "True" gain in the simulation files ?
- what does the parameter gain_variation exactly refer to ?
- statistic error $\sigma \sim 3.7$ % ( ?)

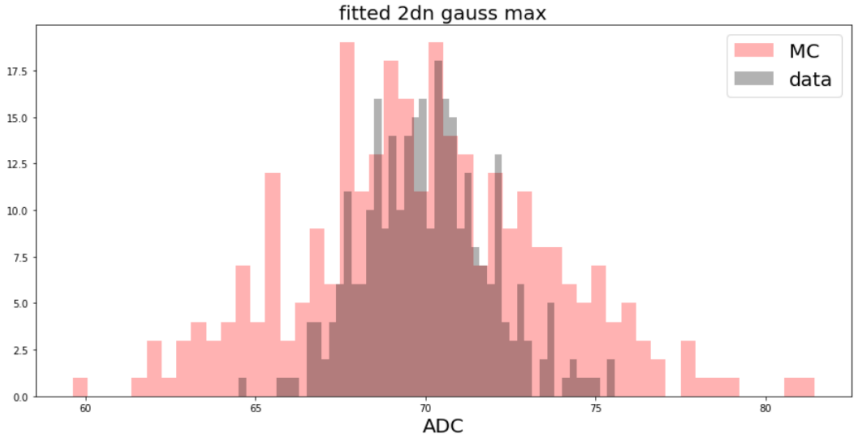


# MES fitted parameters



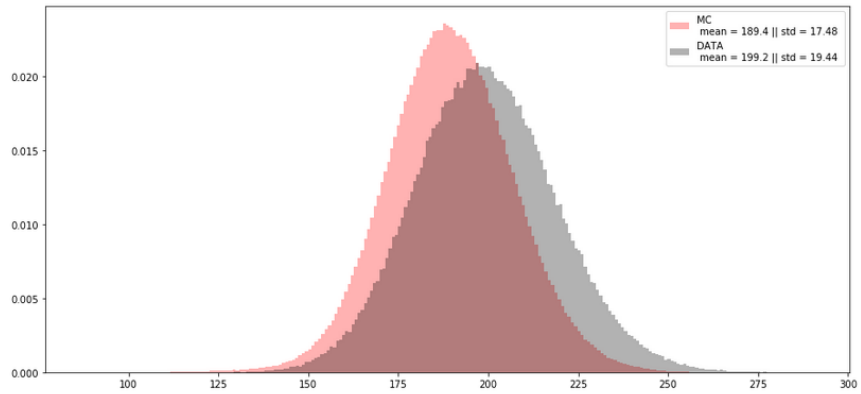



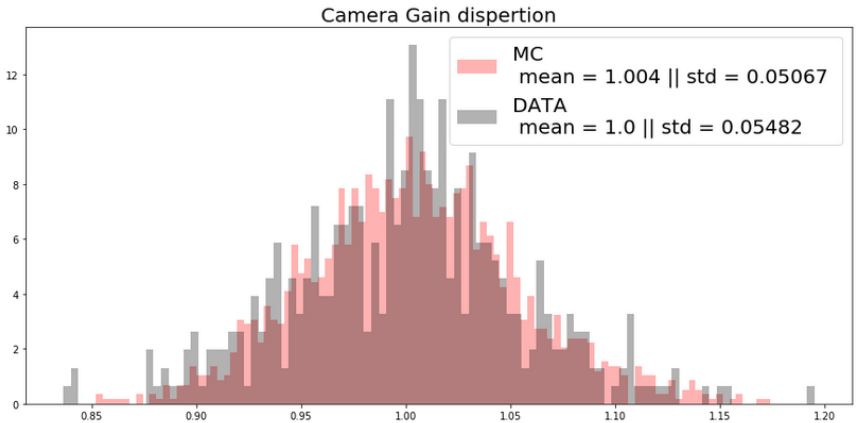



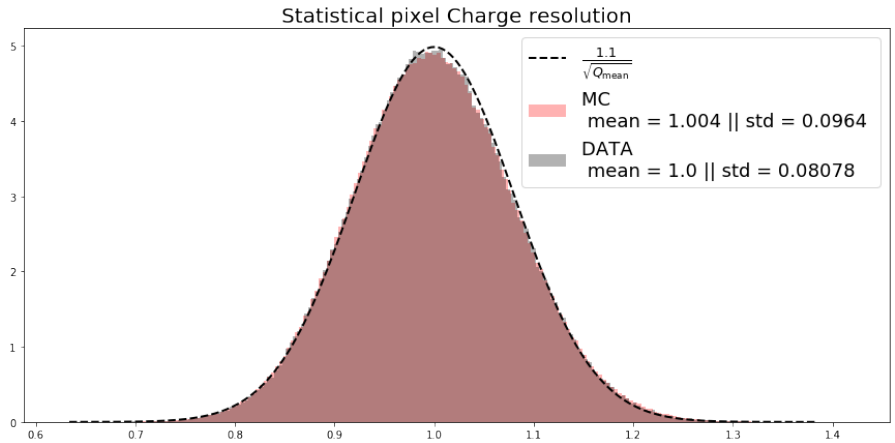



# results from the MC Flat fields run

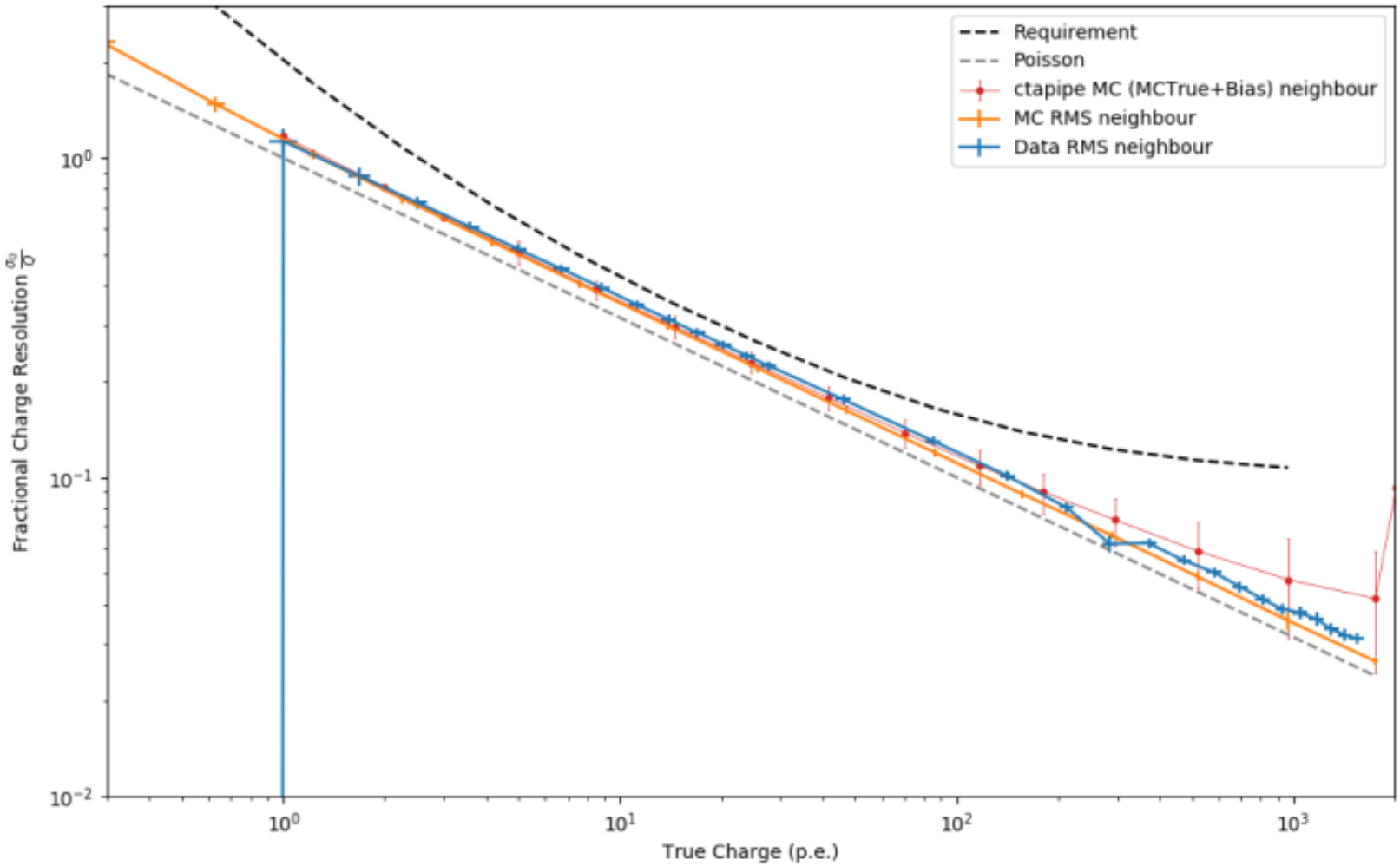
- comparing the MC FF run and a FF run at similar intensity :
  - statistical dispersion seems to agree very well
  - as well as the channel to channel dispersion.



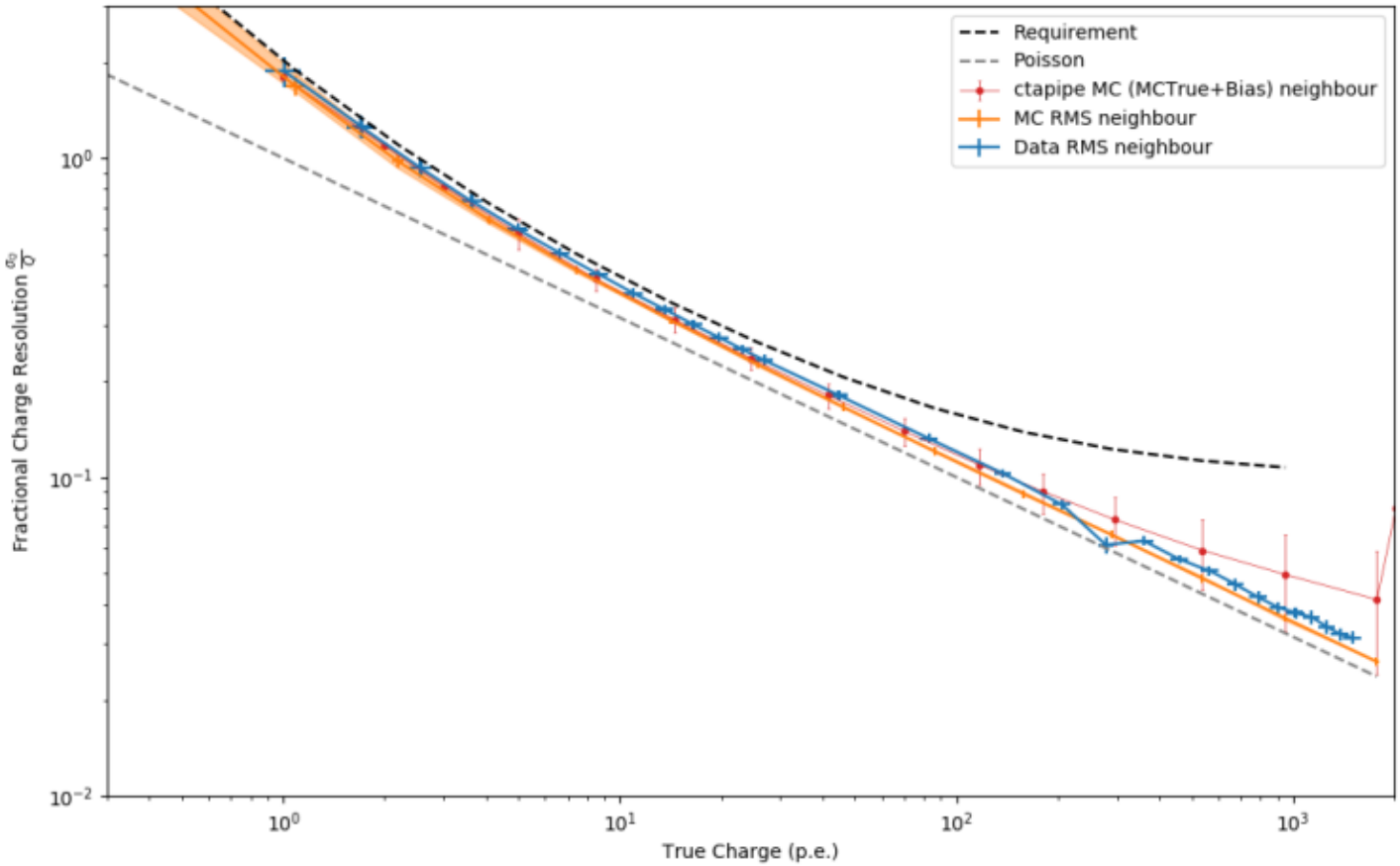



# charge resolution 0 NSB



# charge resolution $\sim$ 100 MHz NSB

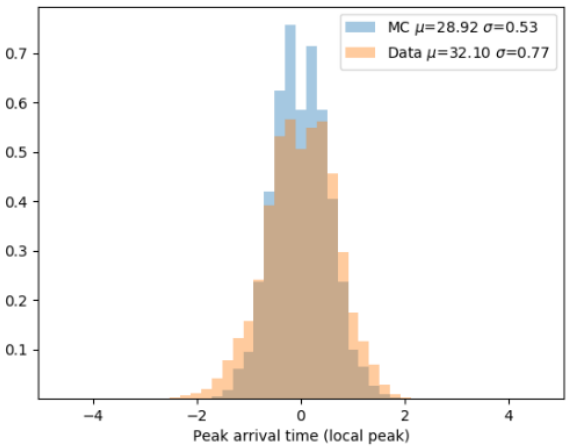
Simulations are performed for 80-120 MHz NSB
due to the uncertainty of the NSB in the lab



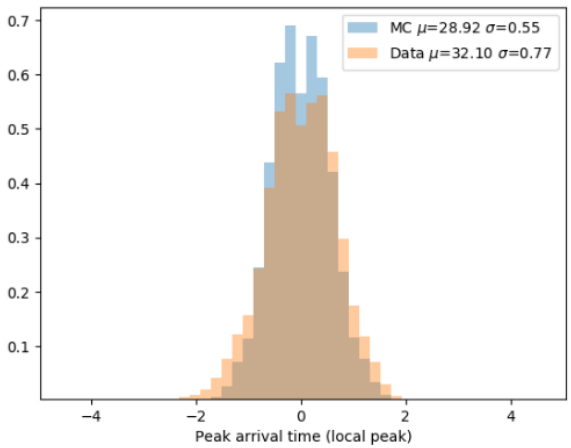
# timing resolution

Initial config:

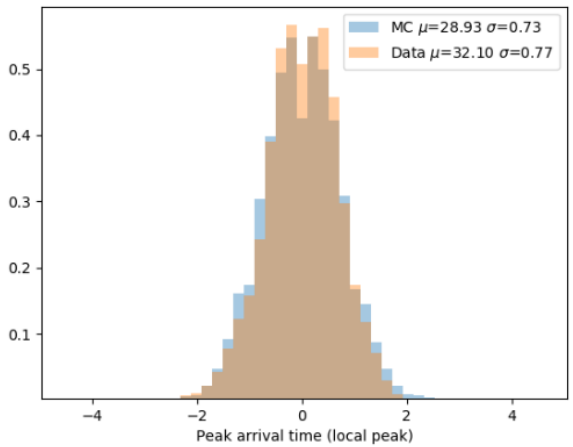
Transit time jitter = 0.64 ns




Transit time jitter = 0.93 ns




Transit time jitter = 0.64 ns
Transit time error = 0.5




Not much change

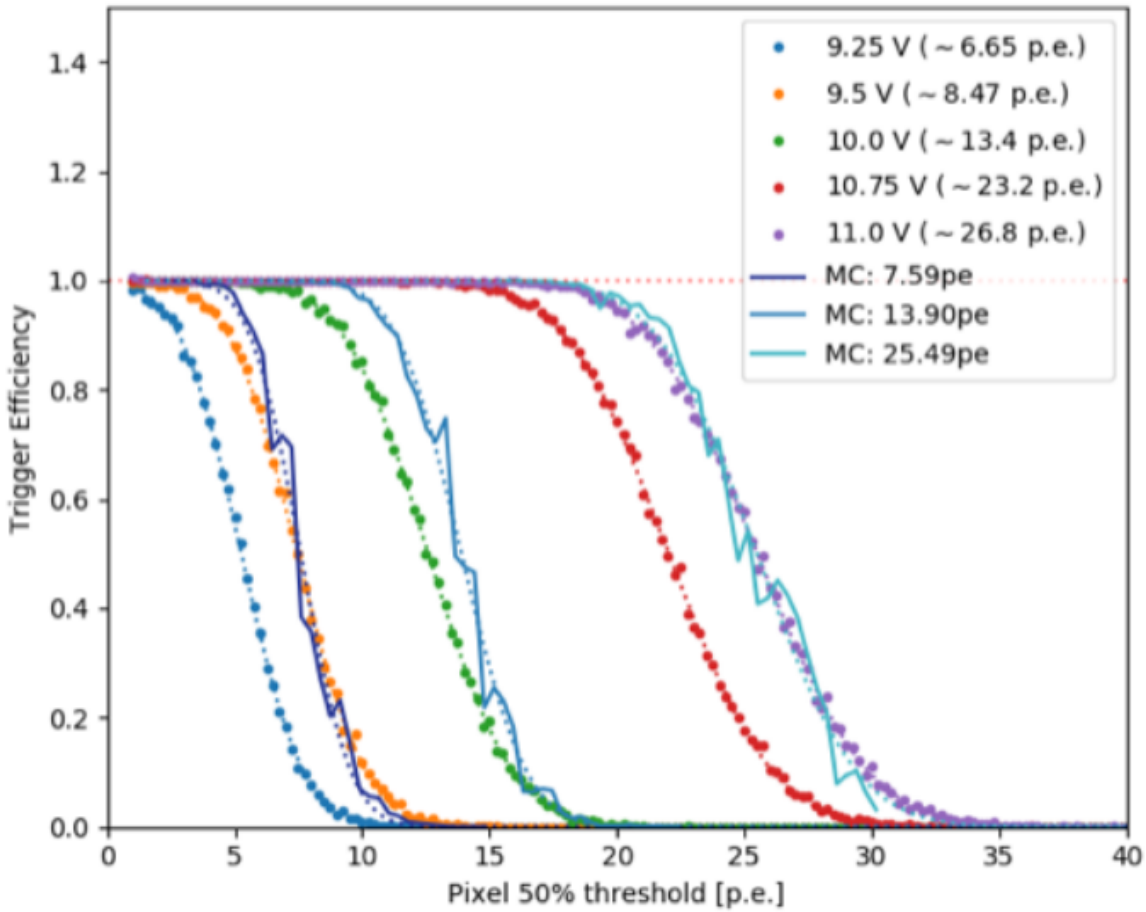
# Trigger efficiency

Strategy here was to start the comparison between the MC and the Camera data with one module

- Well describe by a normal cumulative distribution.
- Agreement is rather good

Still ongoing work

L1 scaler of only one module (6 pixels)



# Overview

- Updates since last call :
  - electronic noise
  - pulse shape
  - pulse amplitude
  - spe pdf
  - ...
- Freezing most of the parameters in the actual state seems reasonable.
- We should provide an official list of the updated parameters to the MC team as soon as possible
- Few more iterations might be needed to fine tune some parameters.

# Summary

| ID | Parameter/Algorithm | Value | MC description | Hardware description | Specification | Status |
|---|---|---|---|---|---|---|
| 7.P-CAM.11 | pm_photoelectron_spectrum | spe_afterpulse_pdf_NectarCam_14032019.dat | File name for single p.e. response distribution. | spe_afterpulse_pdf_NectarCam_18122019.dat | | In WP review |
| 7.P-CAM.12 | pm_average_gain | 40000 | Photodetector average gain, used only for DC currents from NSB pixel rates. | | | Agreed |
| 7.P-CAM.13 | pm_gain_index | 5.8 | Gain rises as given power to the photodetector voltage. | | | Agreed |
| 7.P-CAM.14 | gain_variation | 0.03 | Fractional gain variation between different photodetectors after adjusting the voltage to have approximately the same gain in all channels. | 0.02 | | Agreed |
| 7.P-CAM.15 | pm_voltage_variation | 0.04 | Fractional high voltage variation, used to adjust the transit times ($\propto 1/\sqrt{(V)}$). | | | Agreed |
| 7.P-CAM.16 | pm_transit_time | 20 [ns] | Total transit time of the photodetector at the average voltage. | | | Agreed |
| 7.P-CAM.17 | transit_time_jitter | 0.64 [ns] | Jitter (Gaussian r.m.s. spread of random fluctuations) of individual photo-electrons in nanoseconds. | + transit_error = 0.5 | | Agreed |
| 7.P-CAM.18 | quantum_efficiency | qe_R12992-100-05.dat | File name for the quantum efficiency curve. | | | In WP review |
| 7.P-CAM.19 | qe_variation | 0.035 | Photoelectron collection efficiency variation (Gaussian r.m.s. spread of random fluctuations) between photodetectors. | | | In WP review |

# Summary

| ID | Parameter/Algorithm | Value | MC description | Hardware description | Specification | Status |
|---|---|---|---|---|---|---|
| 7.P-MIX.20 | disc_bins | 100 [Time bins] | Number of time bins used for the discriminator simulation. | | | In WP review |
| 7.P-MIX.21 | disc_start | 5 [Time bins] | Number of time bins by which the discriminator simulation is ahead of the FADC readout. | | | In WP review |
| 7.P-MIX.22 | default_trigger | Majority | Parameter to set the trigger algorithm used. | | | In WP review |
| 7.P-MIX.23 | discriminator_-pulse_shape | Pulse_template_-nectarCam_-22112018.dat | File name for pule shape at the discriminator of an individual pixel. | PTSPE.dat | | In WP review |
| 7.P-MIX.24 | discriminator_-amplitude | 20 | Signal amplitude after amplifier per mean p.e. at the input of the discriminators. | | | Agreed |
| 7.P-MIX.25 | discriminator_-threshold | 146 | Discriminator threshold. | | | In WP review |
| 7.P-MIX.26 | trigger_pixels | 3 | Number of pixels required for single telescope trigger. | | | In WP review |
| 7.P-MIX.27 | teltrig_min_time | 1 [ns] | Minimum time of sector trigger over threshold. Used before telescope trigger. | | | Agreed |
| 7.P-MIX.28 | teltrig_min_sigsum | 0 | Minimum signal sum at sector trigger over threshold. | | | Agreed |
| 7.P-MIX.29 | discriminator_-sigsum_over_-threshold | 0 | Integrated signal required over threshold. | | | Agreed |
| 7.P-MIX.30 | discriminator_var_-sigsum_over_-threshold | 0 | Gaussian r.m.s. spread of discriminator_sigsum_over_-threshold (Pixel-to-pixel variation). | | | Agreed |

# Summary

| ID | Parameter/Algorithm | Value | MC description | Hardware description | Specification | Status |
|---|---|---|---|---|---|---|
| 7.P-MIX.42 | fadc_mhz | 1024 [MHz] | FADC sampling rate. | | | In WP review |
| 7.P-MIX.43 | fadc_bins | 90 [Time bins] | Typically the number of FADC bins to be simulated. | | | Agreed |
| 7.P-MIX.44 | fadc_sum_bins | 64 [Time bins] | Number of bins read out in sampled data, corresponding to the experimental length of the readout window. | 60 | | Agreed |
| 7.P-MIX.45 | fadc_sum_offset | 8 [Time bins] | Number of bins before telescope trigger where summing/reading of sampled data starts. | | | Agreed |
| 7.P-MIX.46 | fadc_pedestal | 250 | Nominal (F)ADC pedestal value per time slice. | | | Agreed |
| 7.P-MIX.47 | fadc_amplitude | 14 | Maximum amplitude above pedestal for a photo-electron with average signal. | 19.56 | | In WP review |
| 7.P-MIX.48 | fadc_noise | 2.8 | Gaussian r.m.s. spread of white noise per time bin in digitisation. | 3.6 | | In WP review |
| 7.P-MIX.49 | fadc_max_signal | 4095 | The maximum value of the digitized signal per sample. | | | Agreed |
| 7.P-MIX.50 | fadc_pulse_shape | Pulse_template_-nectarCam_-22112018.dat | File name for (F)ADC pulse shape (amplitude vs time). | PTSPE.dat | | In WP review |
| 7.P-MIX.51 | num_gains | 2 | Number of different gains the input signal gets digitized. | | | Agreed |
| 7.P-MIX.52 | fadc_lg_pedestal | 250 | Nominal (F)ADC pedestal value per time slice for low-gain channels. | | | Agreed |

| ID | Parameter/Algorithm | Value | MC description | Hardware description | Specification | Status |
|---|---|---|---|---|---|---|
| 7.P-MIX.53 | fadc_lg_amplitude | 1 | Maximum amplitude for low-gain channels above pedestal for a photo-electron with average signal. | 1.41 | | In WP review |
| 7.P-MIX.54 | fadc_lg_noise | 2.5 | Gaussian r.m.s. spread of white noise per time bin in digitisation for low-gain channels. | 3.62 | | In WP review |