SiPM Response Correction

Zhiyu Zhao(TDLI/SJTU)

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李政道研究所
TSUNG-DAO LEE INSTITUTE

SiPM Response Functions

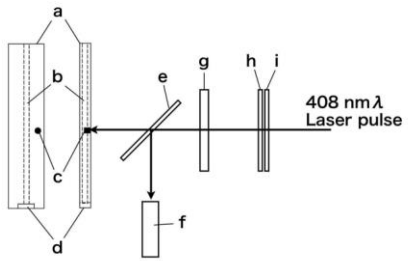


Figure 1: Setup of the $N_{\mathrm{pix}}^{\mathrm{eff}}$ measurement: a) target scintillator enveloped in reflector (left, top view; right, side view); b) WLS fiber; c) irradiation position with a small hole in reflector; d) MPPC; e) half mirror: f) photomultiplier tube; g) lens; h) polaroid (fixed); and i) polaroid (rotatable).

- First order:

$$N_{\mathrm{fire}}^{\mathrm{LO}'} = N_{\mathrm{pix}}^{\mathrm{eff}}\left(1 - \mathrm{e}^{-\epsilon N_{\mathrm{in}}/N_{\mathrm{pix}}^{\mathrm{eff}}}\right).$$

- One pixel receive more than one photon

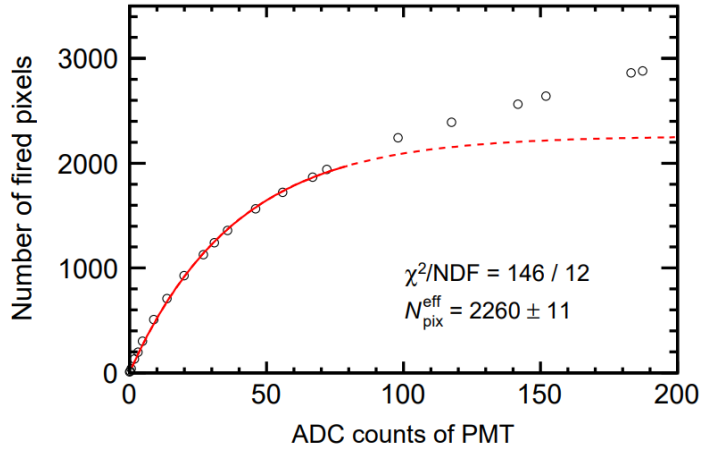
$$N_{\mathrm{fire}}^{\mathrm{NLO}} = N_{\mathrm{fire}}^{\mathrm{LO}} + \alpha N_{\mathrm{R}}.$$

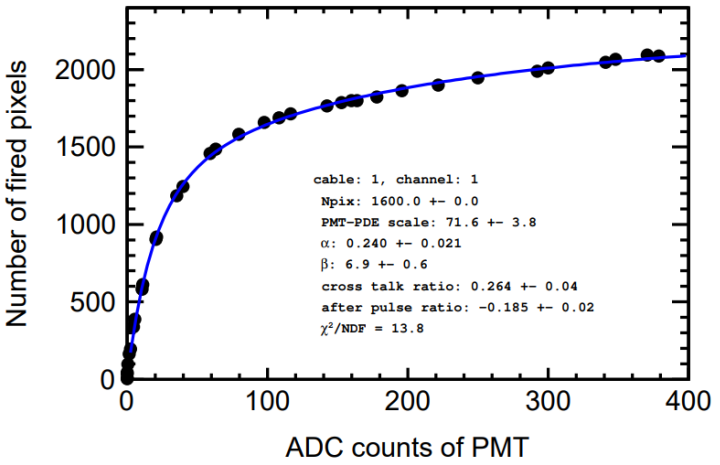
- Charge distribution of a photon: considering pixel recovery and scintillation decay

$$N_{\mathrm{fire}}^{\mathrm{NLO}'} = N_{\mathrm{fire}}^{\mathrm{NLO}} \frac{\beta + 1}{\beta + \epsilon N_{\mathrm{in}}/\mathrm{LO}}.$$

- Crosstalk and afterpulse

$$N_{\mathrm{fire}}^{\mathrm{NLO}'_{\mathrm{C\cdot A}}} = N_{\mathrm{fire}}^{\mathrm{NLO}'}\left(1 + P_{\mathrm{cross}} \cdot \mathrm{e}^{-\epsilon N_{\mathrm{in}}/N_{\mathrm{pix}}}\right) \cdot (1 + P_{\mathrm{after}}),$$





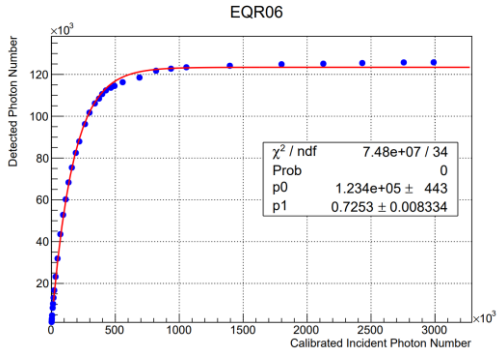
ICASiPM_Krause_final.pdf (gsi.de)

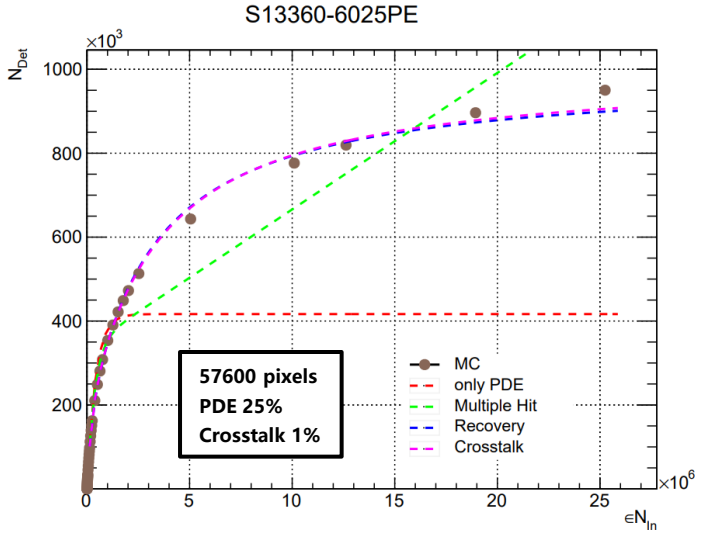
[1510.01102] Describing the response of saturated SiPMs (arxiv.org)

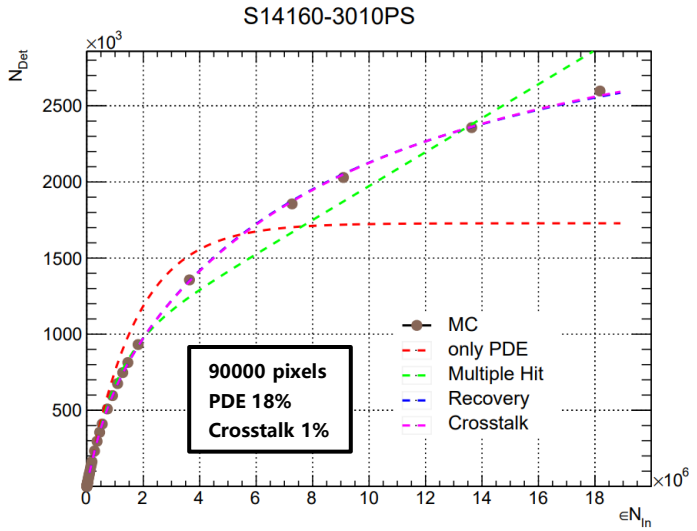
Fitting Results

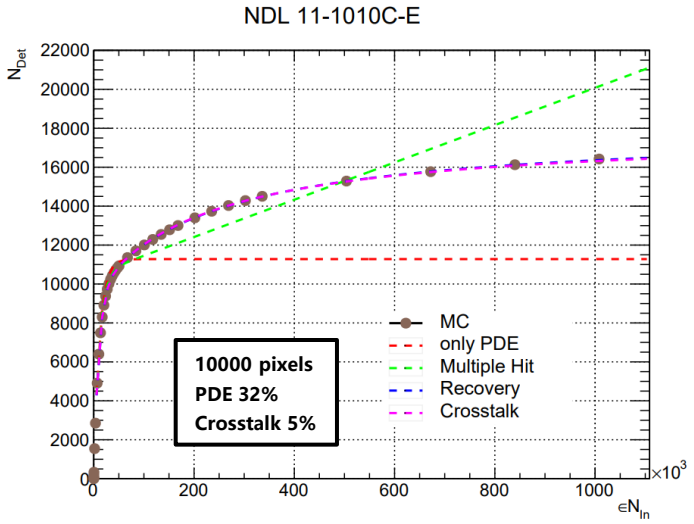
Study on the Dynamic Range of SiPMs with Large Pixel Number

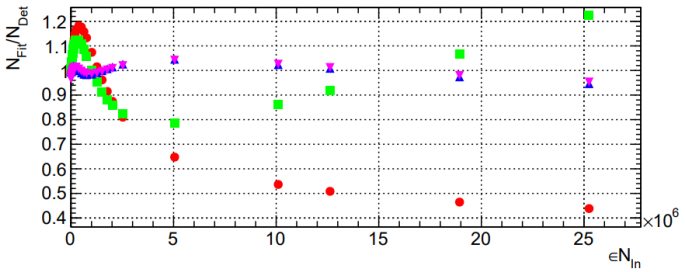
- Toy Monte Carlo
  - PDE, recovery, crosstalk, no afterpulse
  - Up to 100 million incident photons(3 million for NDL 11-1010C-E). For our picosecond laser, the maximum output photon number is about 10 million?

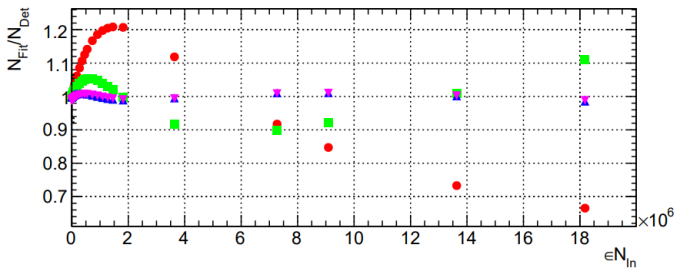


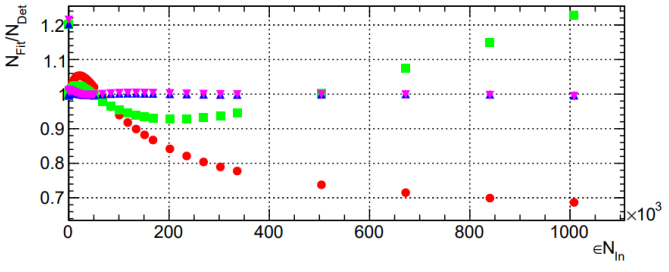












Summary

- When the response of SiPM is close to its saturation region, it is necessary to introduce a formula with high-order correction terms.
- The simulation results are not verified. It can be done by the same method mentioned in the paper.