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Non-linearity correction of SiPMs in the MEG˜II liquid xenon detector

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The MEG II experiment is being carried out in the PSI, piE5 area in the experimental hall west. The MEG II aims to search for the charged lepton flavor violation process, $\mu^+ \to e^+\gamma$. The physics run started in 2021 and will be planned by the end of 2026 with the target sensitivity of branching ratio of 6×10^{-14}). In 2025, we published the result with the data collected in 2021and 2022. No signal excess was observed and we set the most strict limit, Br $< 1.5 \times 10^{-13}$ (90% C.L.) [1].
Gamma-rays are detected by the liquid xenon detector to reconstruct their energy, timing, and position. In the latest result [1], the energy resolution was $2.4\%/1.9\%$ ($w < 2$ cm/2 cm$< w$) in the 2022 data. The resolution in the shallow region ($w < 2$ cm) is worse than that in the 2021 data (2.1%). A possible cause is non-linear response of the MPPC used as a photo-sensor. In the shutdown period between 2021 and 2022 an annealing campaign was conducted to recover the detection efficiency [2]. The detected number of photon in an MPPC in the 2022 run was much larger than the 2021 data and this may cause the non-linear response of the MPPCs. In this presentation, I will report ideas to improve the energy resolution by correcting the non-linear response and its result.

[1] K. Afanaciev, et. al, arXiv:2504.15711 (2025)
[2] S. Ban, PSI2022, https://indico.psi.ch/event/11742/contributions/38752/ (2022)

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