Experimental Validation of the FLASHGuard Prototype

LIP Internship Program 2026

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4 September 2026; Lisbon, Portugal

Introduction

FLASH-Radiotherapy:

- alternative to conventional radiotherapy
- delivery of **ultra-high dose rate** (UHDR) radiation
- requirement for a **real-time beam monitoring device:** time and spatial resolution

FLASHGuard:

- **Cherenkov**-based detector
- **in-beam radiator** optically coupled with a **fast photodetector**

Silicon Photomultiplier

General composition:

- microcells connected in parallel
- each consisting of an avalanche photodiode
- they work as a photon-triggered switch

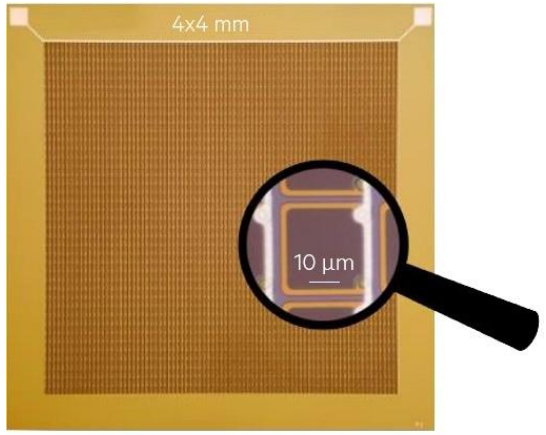


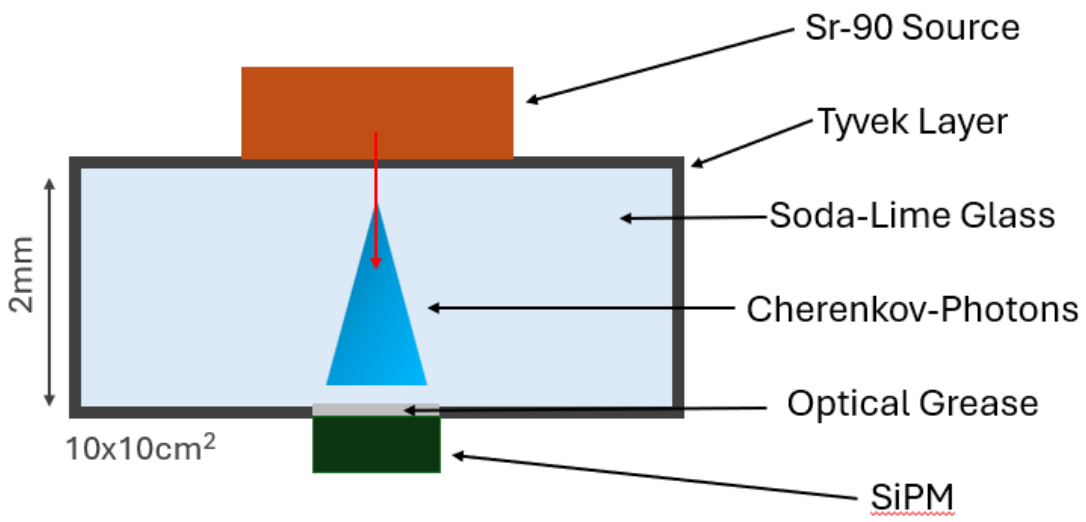
Illustration of microcells' arrangement

Specific properties:

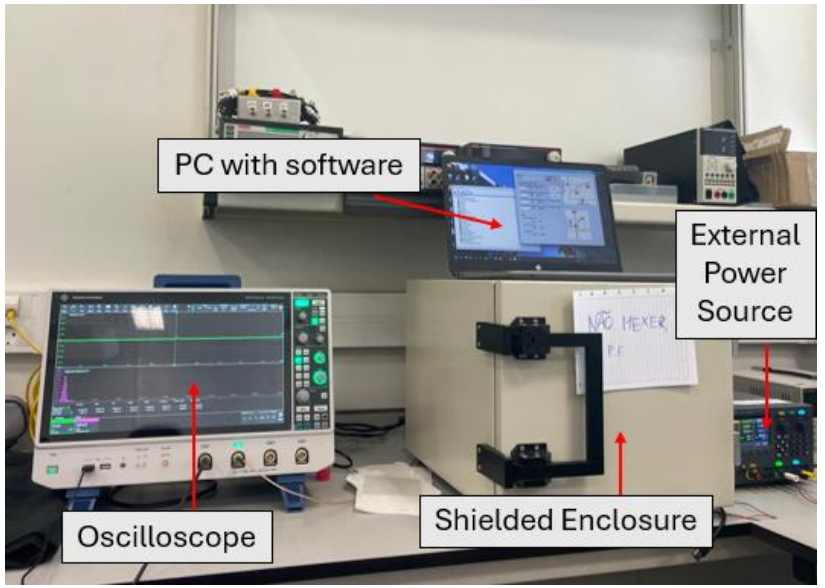
- 1,3 x 1,3 mm^2 active area, 667 microcells
- high gain
- random thermal noise – Dark Counts

Hamamatsu S13360-1350CS-01

Experimental Setup



Scheme of the prototype (not to scale)

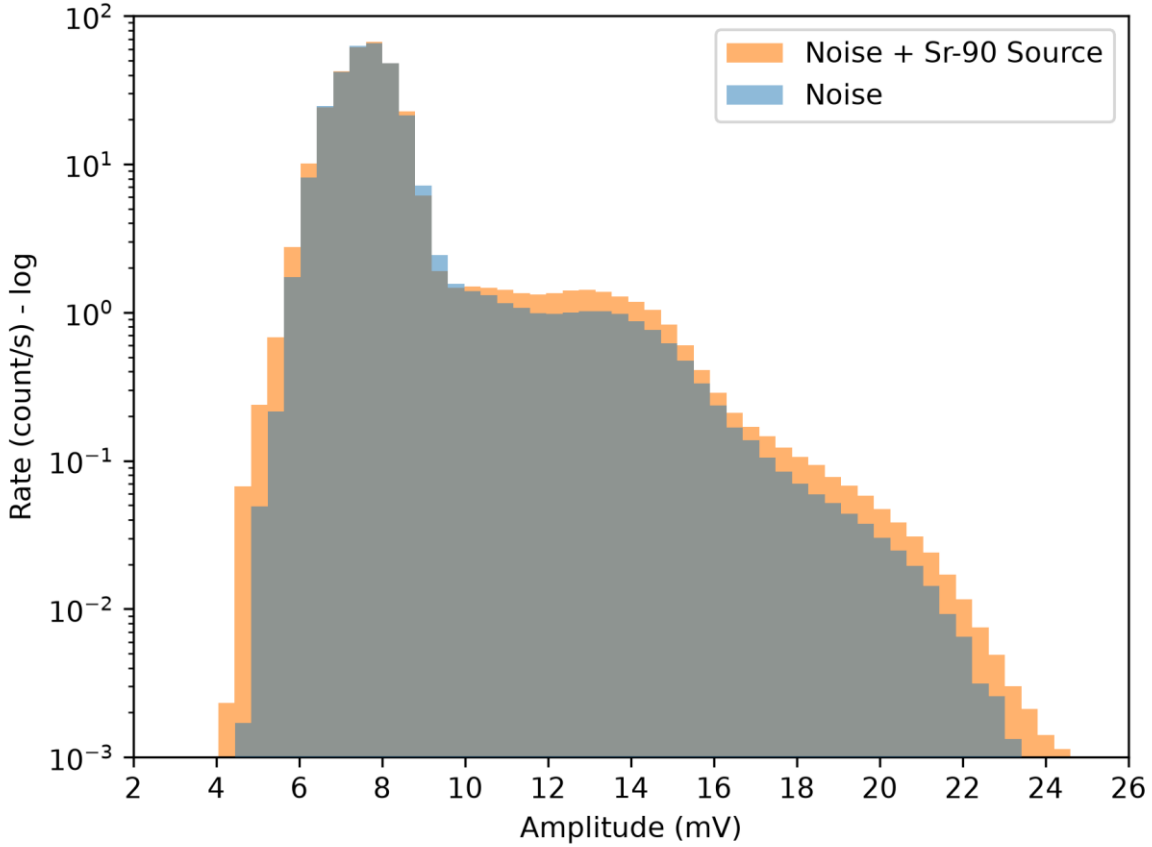


Overview of the setup

Setup adaptions throughout the work to test some variables:

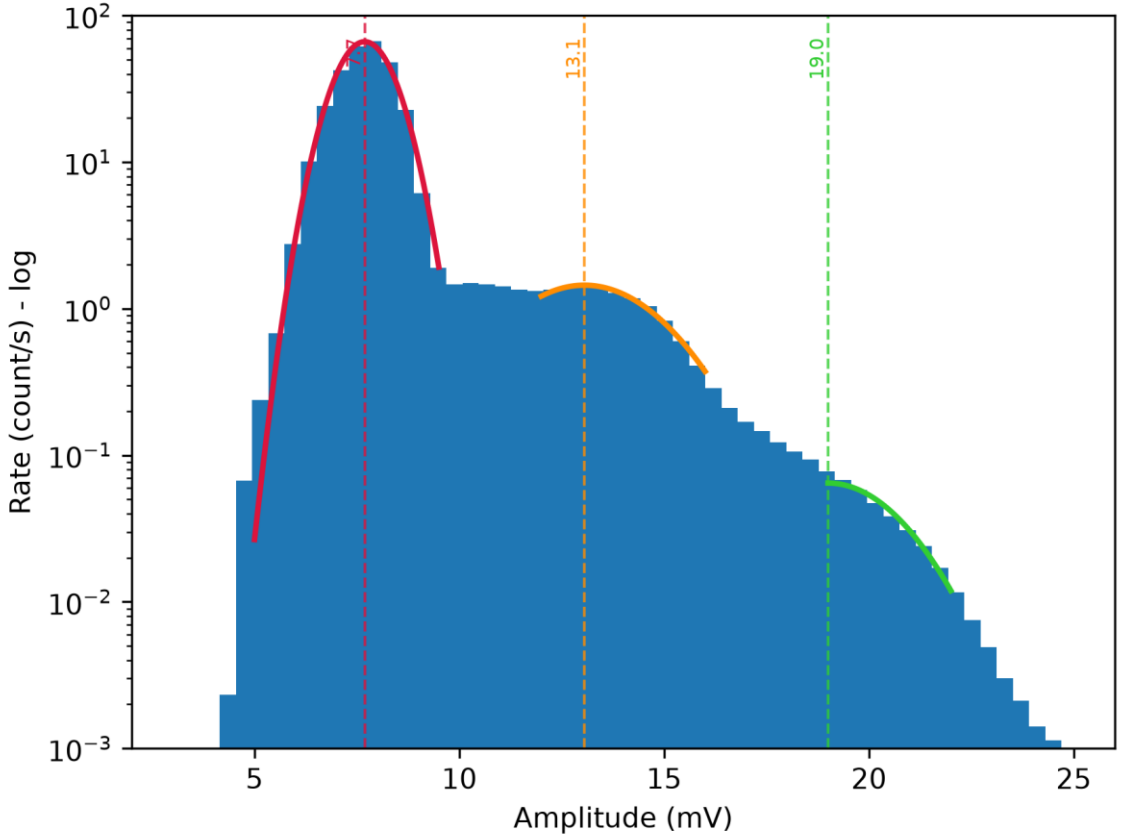
- with vs. without radiation source
- 2mm vs. 0.4mm thick radiator
- with vs. without Tyvek enclosure

Results and Analysis - Noise



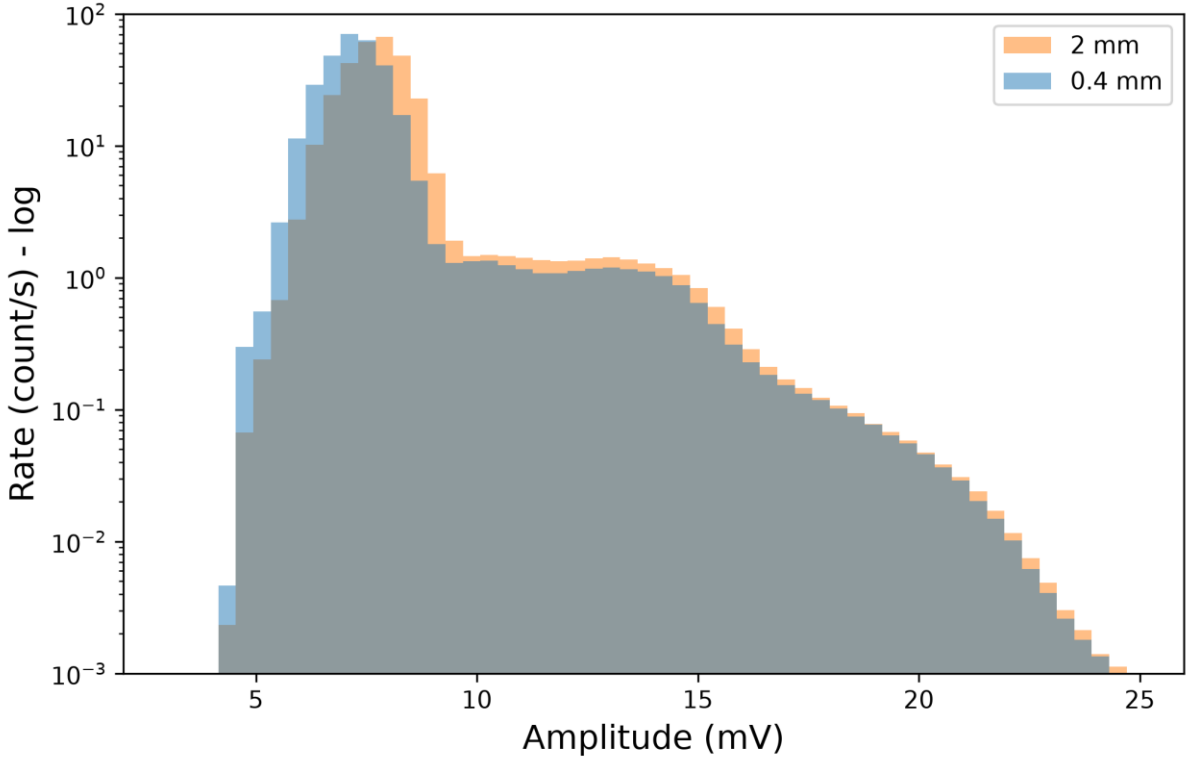
- higher count rate with source
- may be attributed to the relatively low activity of the available 90Sr source
- Cherenkov-photons were detected

Results and Analysis - Peaks



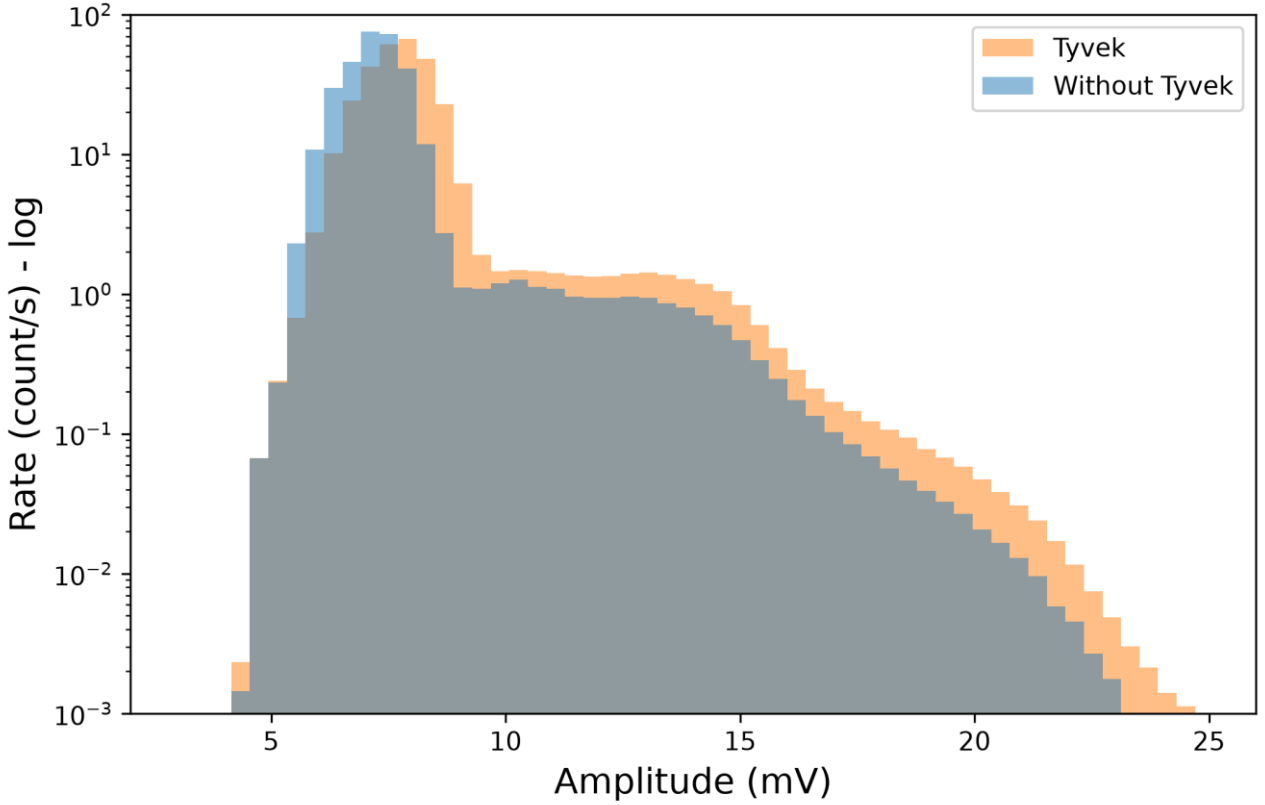
- fitting of gaussian curves to identifiable peaks
- centroids at 7.7mV, 13.1mV and 19.0mV
- spacing of 6mV corresponds to 1 p.e., 2 p.e. and 3 p.e.
- peaks exhibit lower resolution than expected
- possible temperature fluctuations during the acquisition runs

Results and Analysis - Thickness



- both spectra have nearly identical event rates across all amplitude bins
- radiation is fully absorbed in 2mm thick radiator
- decrease of Cherenkov yield through the path

Results and Analysis - Tyvek



- higher count with Tyvek-enclosed radiator
- more photons detected
- Tyvek redirects escaping photons back into the radiator

Conclusions and Future Work

→ identified peaks consistently evenly spaced:
- consistent response across acquisitions

→ peaks resolution was lower than expected:
- temperature variation during acquisition process

→ higher count rate observed when source was present:
- difference corresponds to light-triggered signals
- Cherenkov-Photons were detected

→ higher count rate observed with Tyvek enclosure:
- more photons detected by the SiPM
- decrease of photons lost through surrounding surfaces

→ no relevant difference in comparison of two radiators

Future Work

→ repetition of acquisitions with **more active and higher-energy source**

→ development of **temperature-control** system for experimental setup could be beneficial

→ **simulation** (Geant4) to find optimal source positioning

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