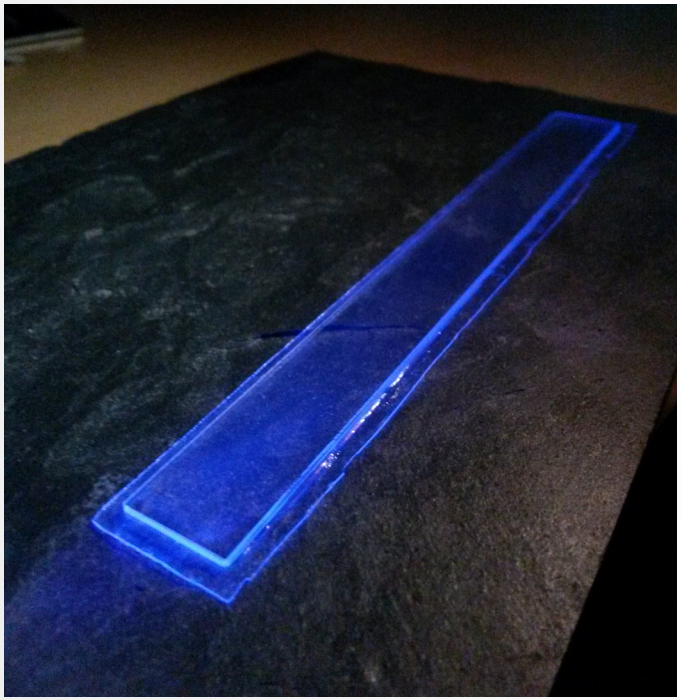
Entwicklung eines Szintillationstriggers auf Basis von SiPMs für einen Neutronendetektor

Fabian Schmidt, Markus Köhli, Tim Wagner,
Jochen Kaminski und Klaus Desch



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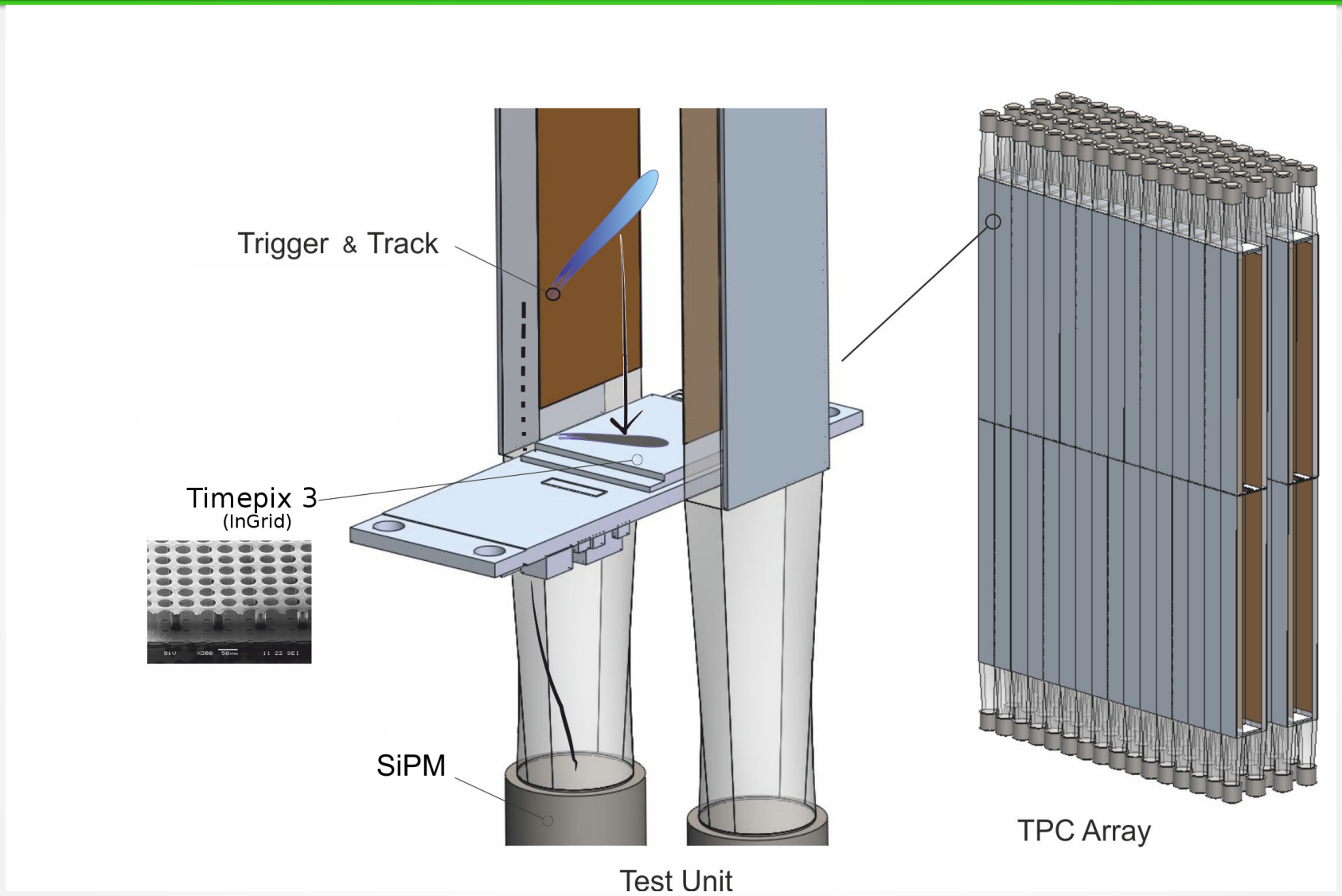
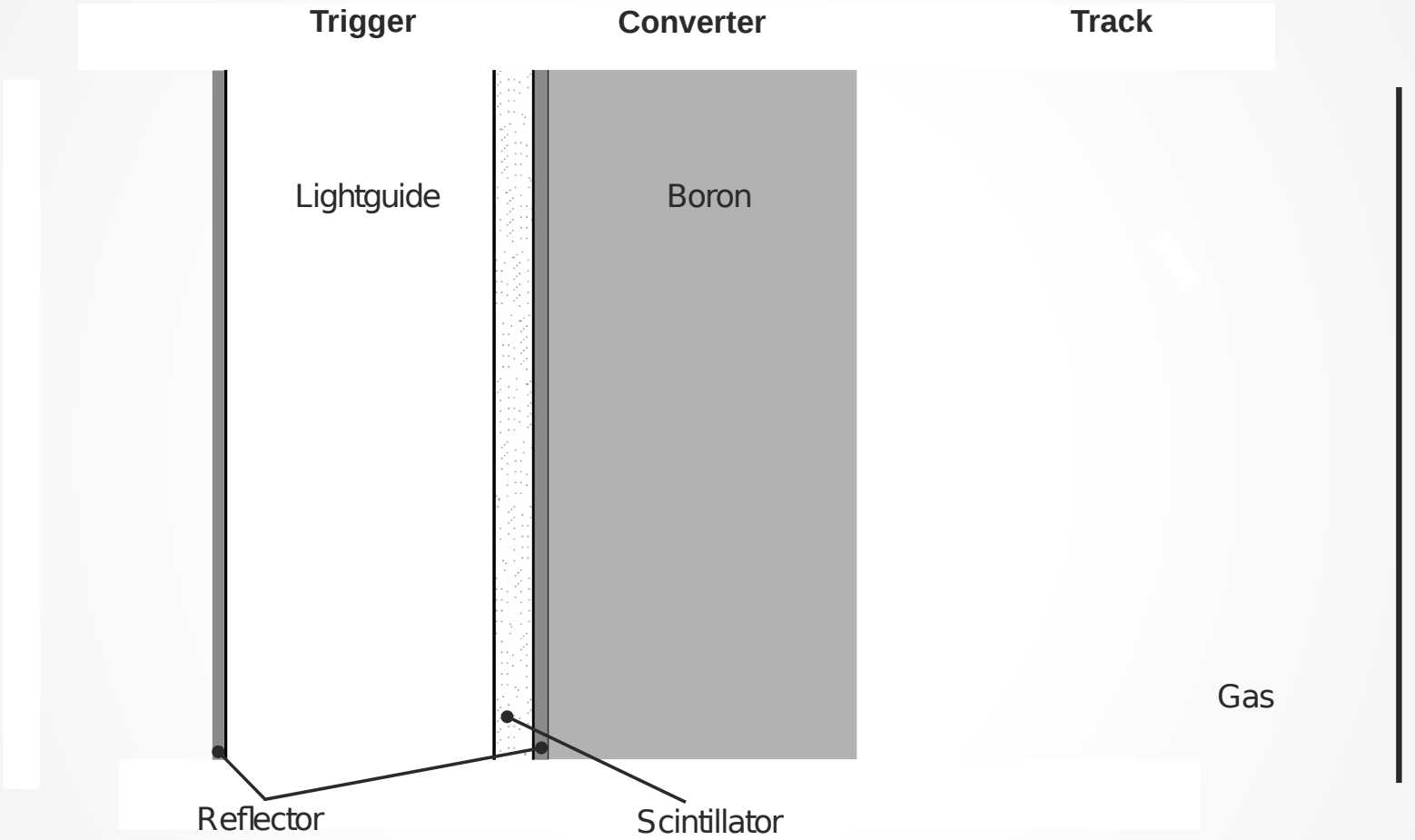
Design of the BODELAIRE detector



The scintillation trigger



$$^{10}\mathrm{B} + \mathrm{n} \rightarrow {}^{7}\mathrm{Li} + \alpha + 2.79\,\mathrm{MeV}\ (6\%)$$
$$\rightarrow {}^{7}\mathrm{Li}^{*} + \alpha + 2.31\,\mathrm{MeV}\ (94\%)$$

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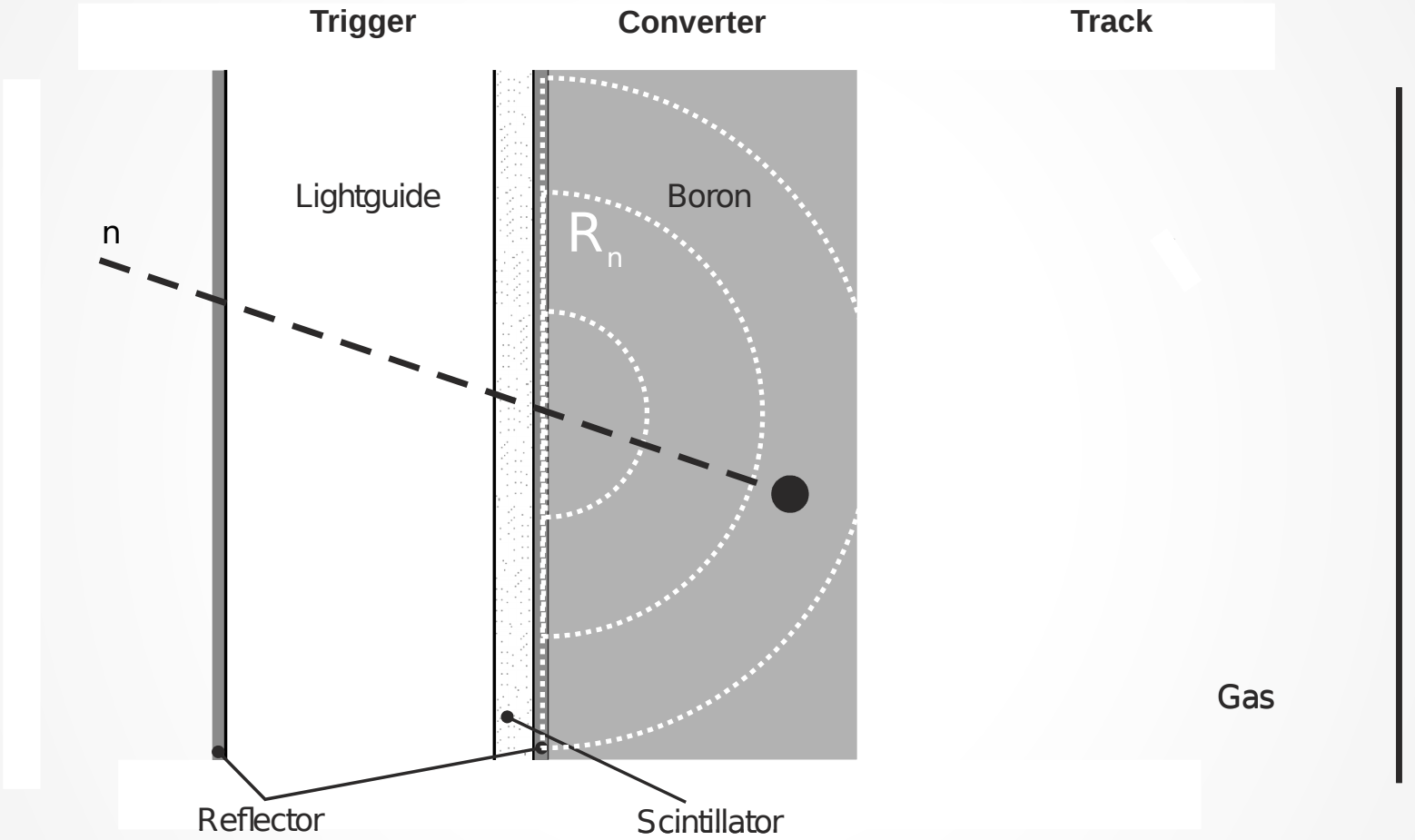

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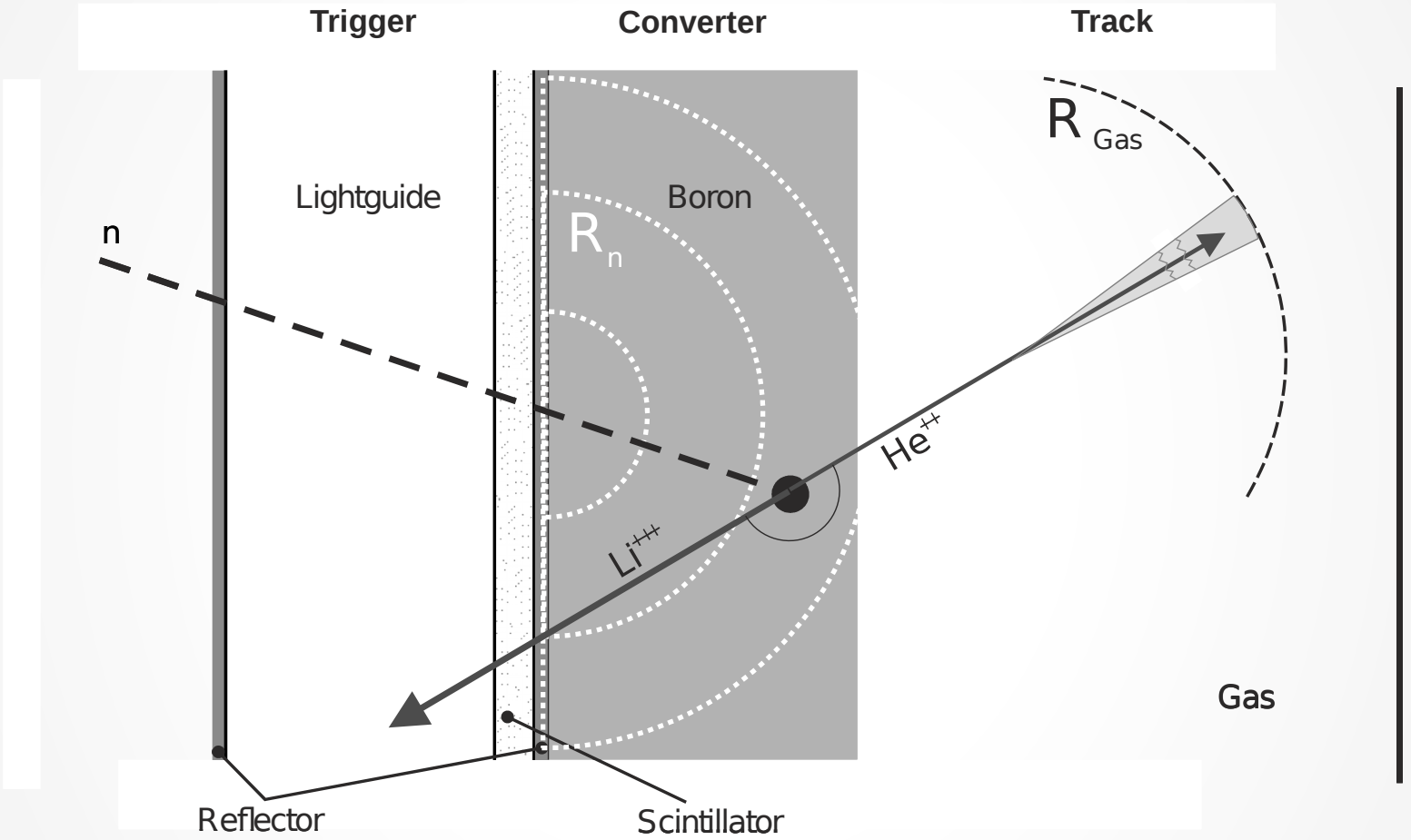

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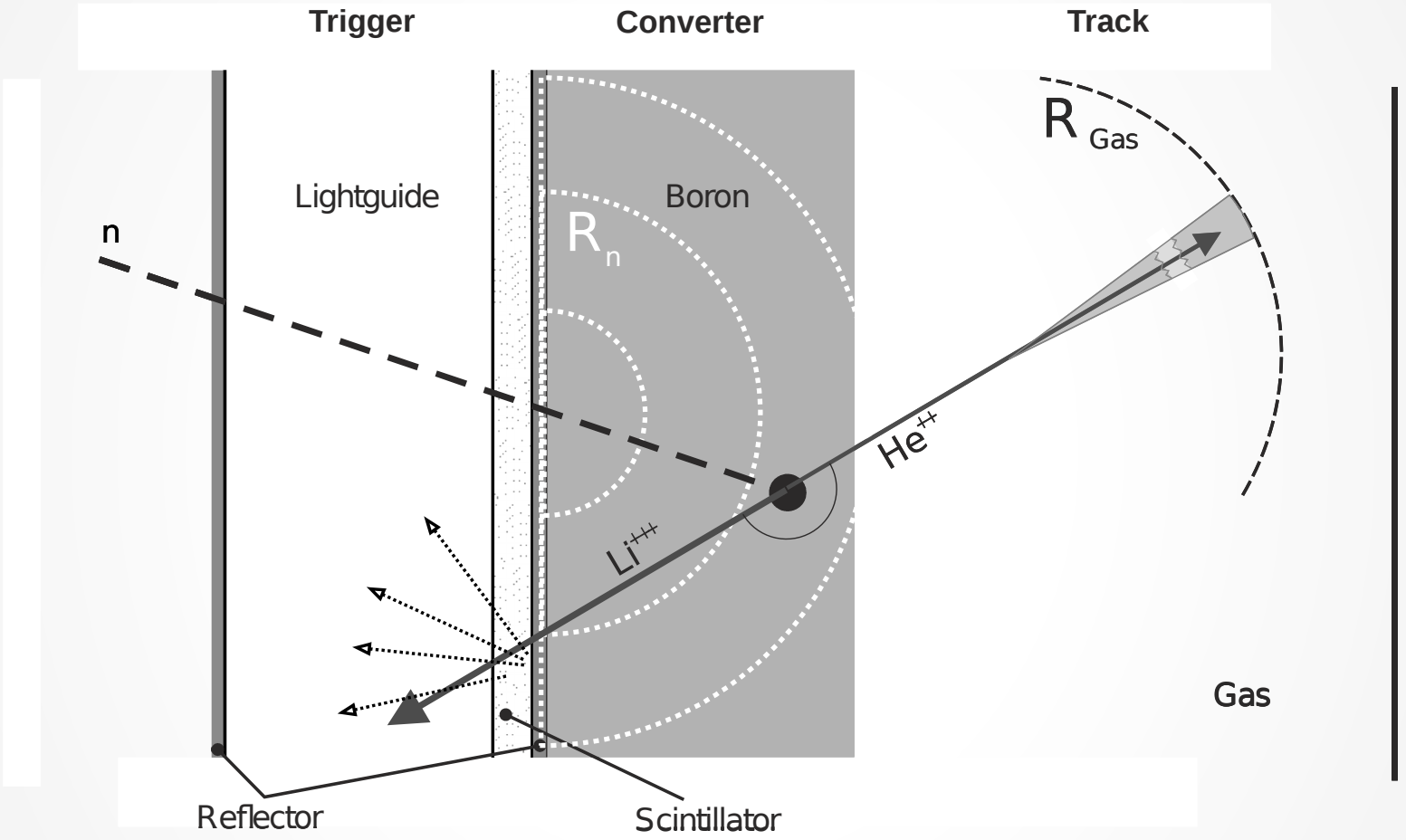

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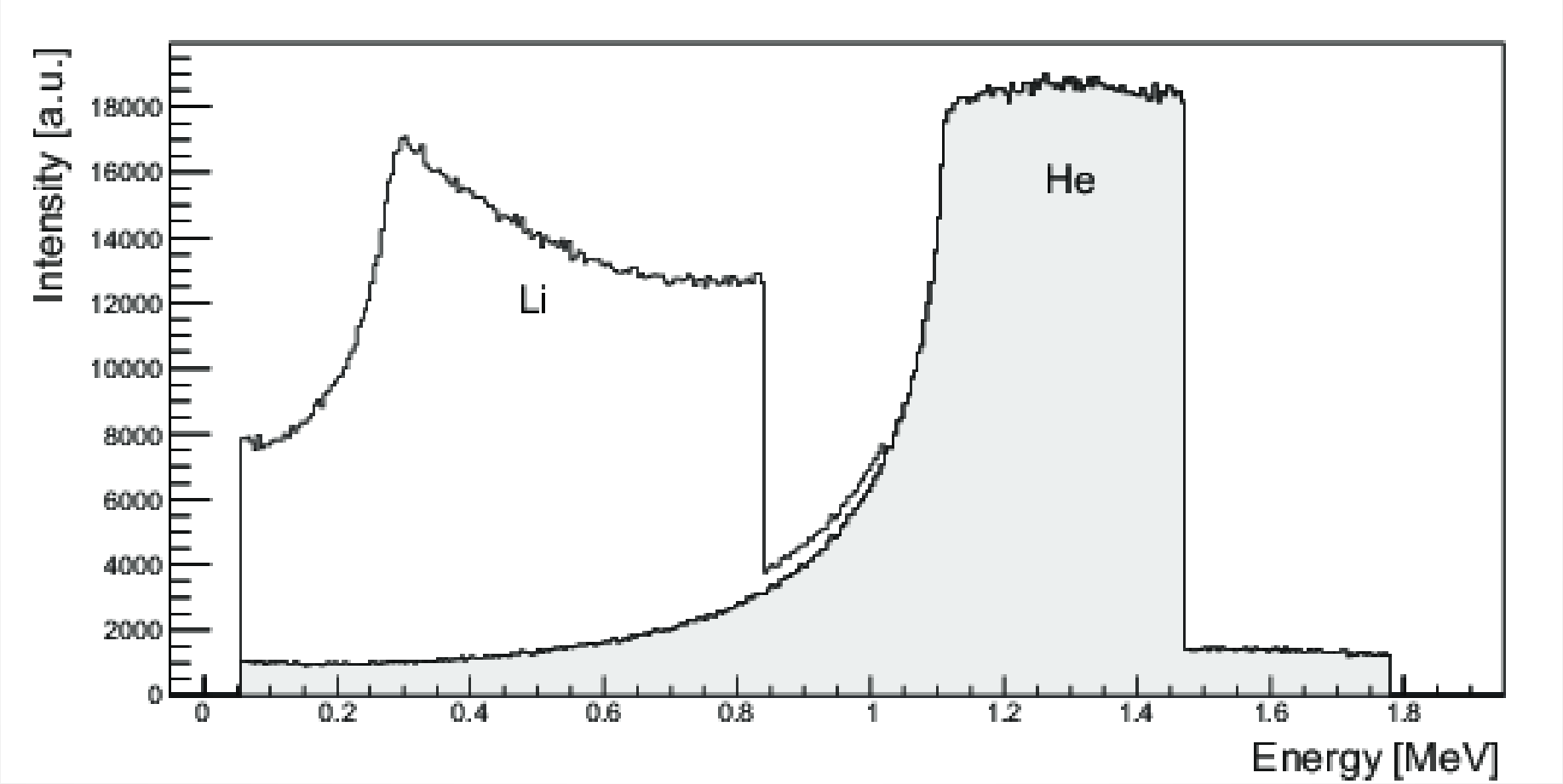
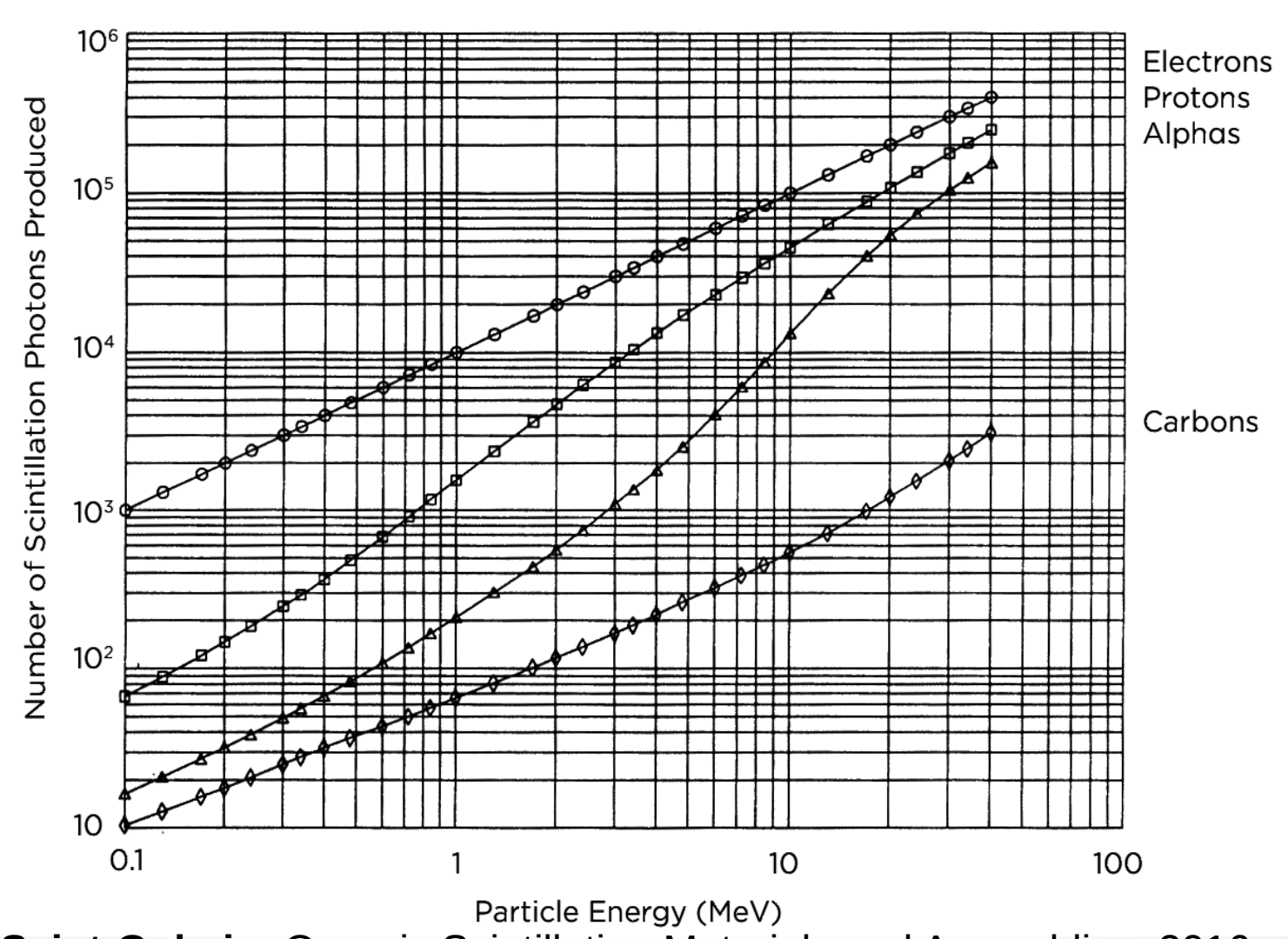
Energy spectrum of conversion ions

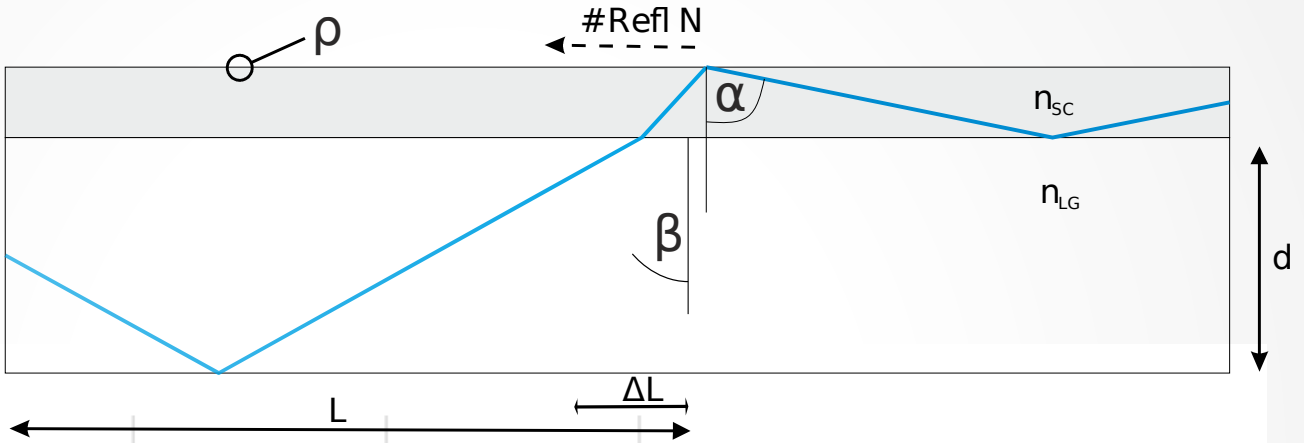


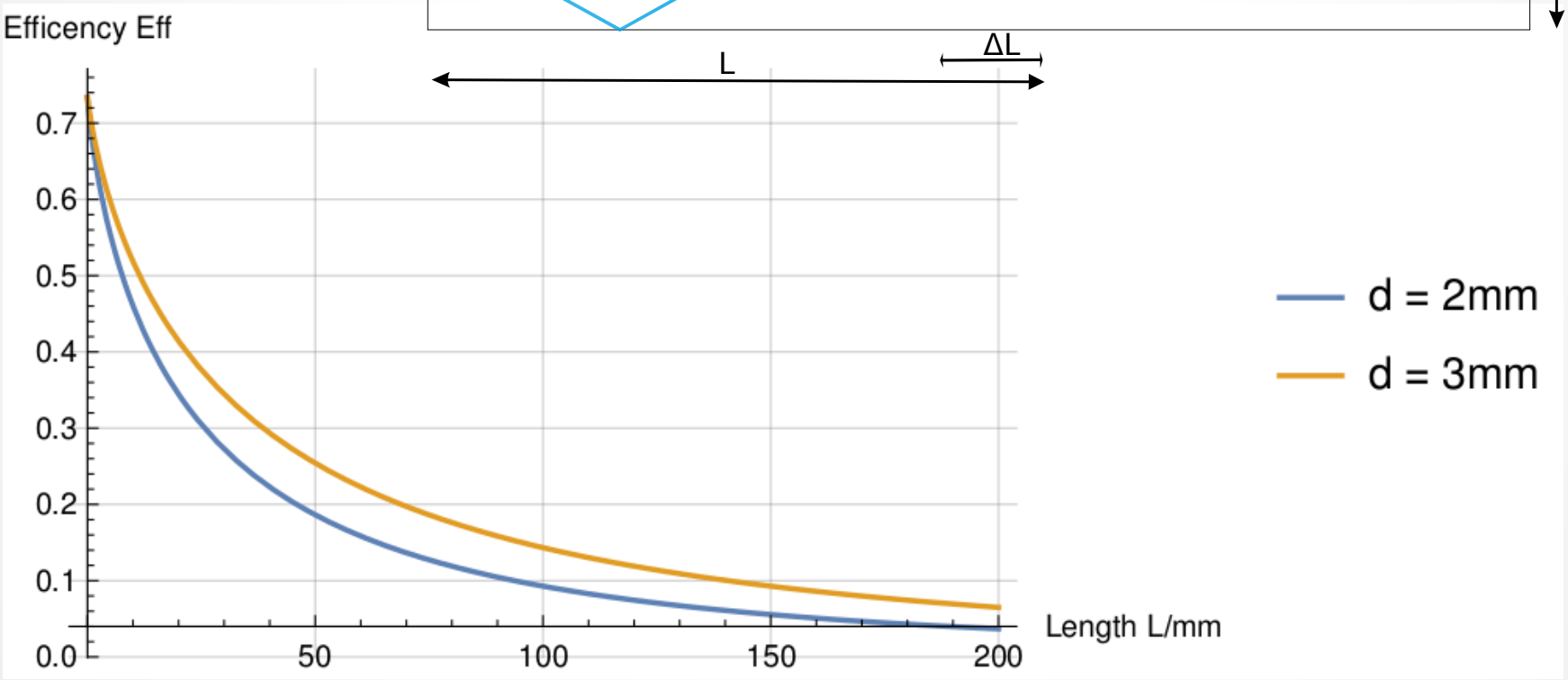
Photon production by BC400 scintillator



Saint-Gobain, Organic Scintillation Materials and Assemblies, 2016

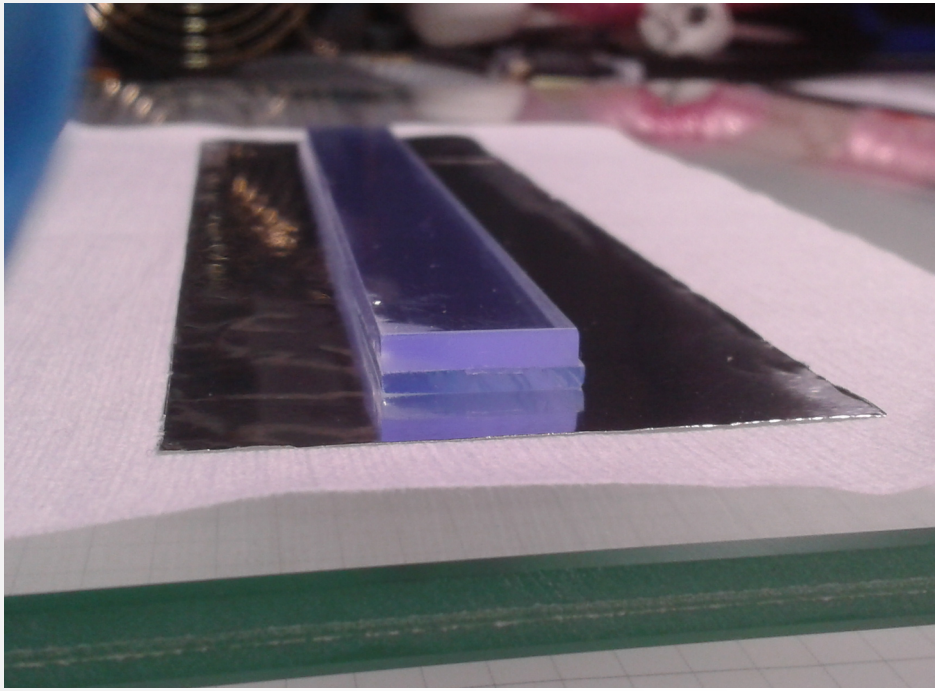
Photon transmission in light guide



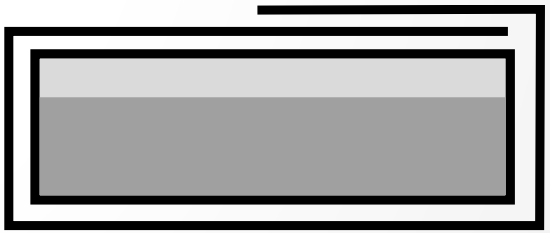


The trigger prototypes

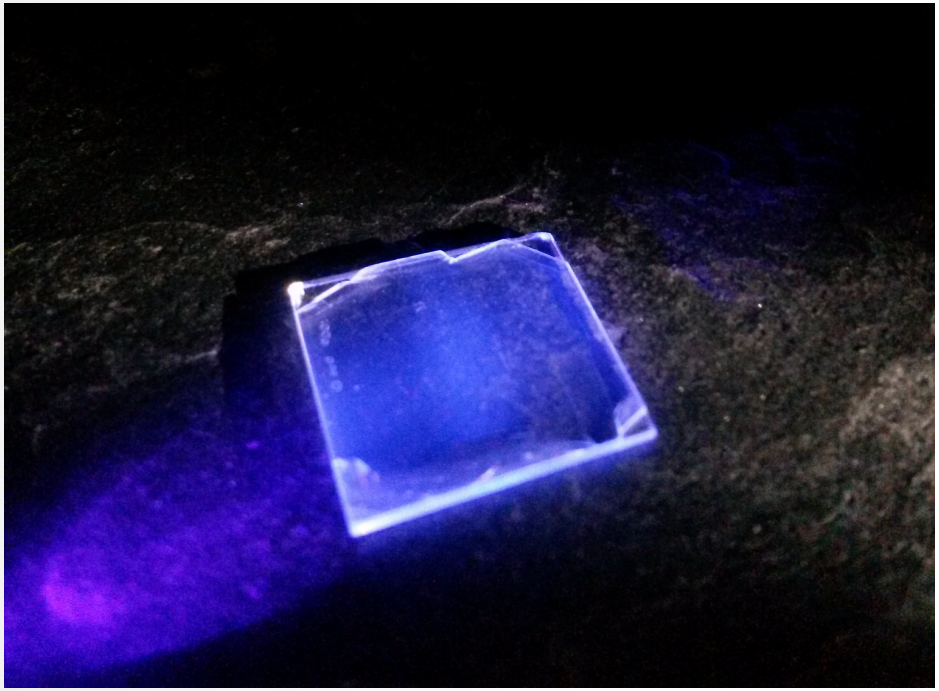
The 1st trigger prototype



- 150x15x4.7 mm³
- 2.8 mm BC408
- 1.9 mm float glass
- covered in aluminium foil

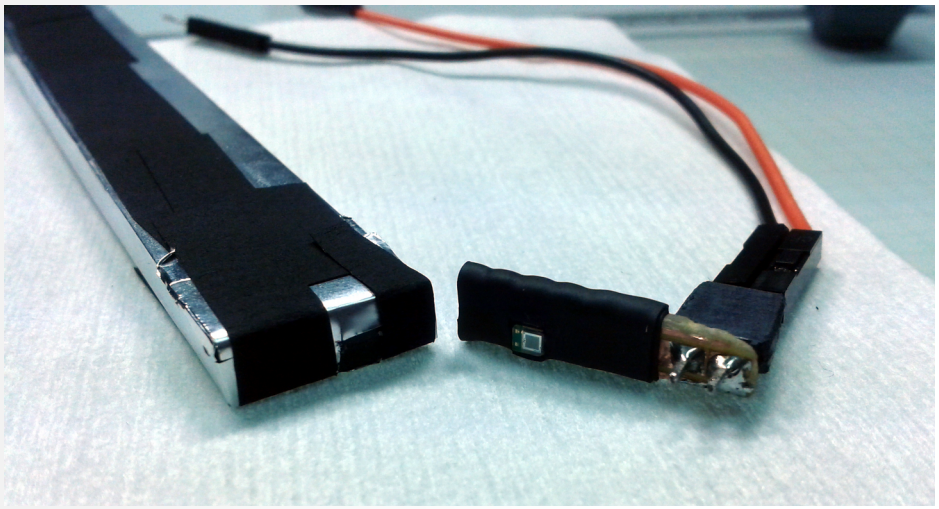


The 2nd trigger prototype

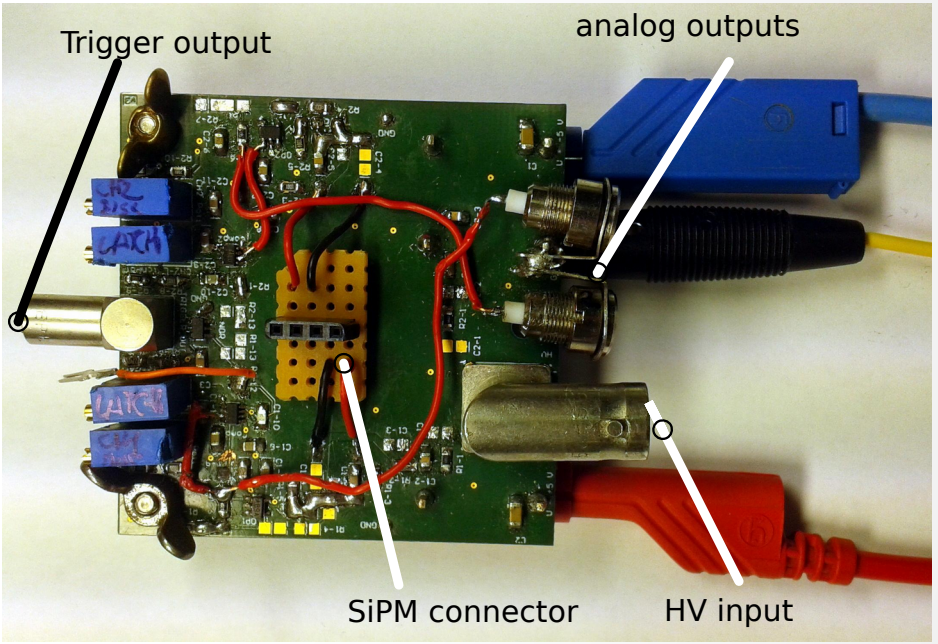


- 15x15x 1.2 mm
- 0.2 mm BC400
- 1 mm JGS1 glass

Scintillator readout with SiPM

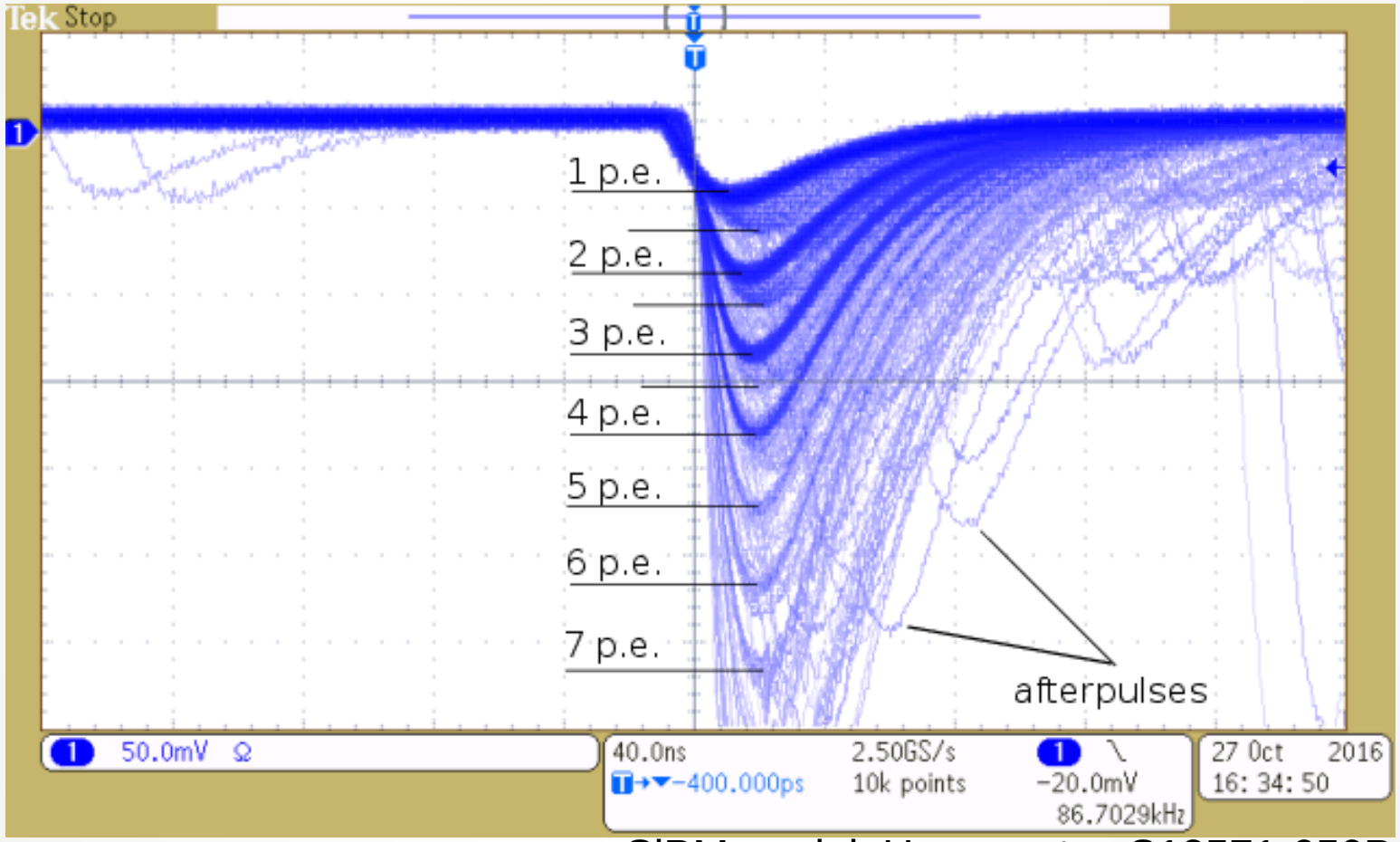


Scintillation strip and SiPM mount



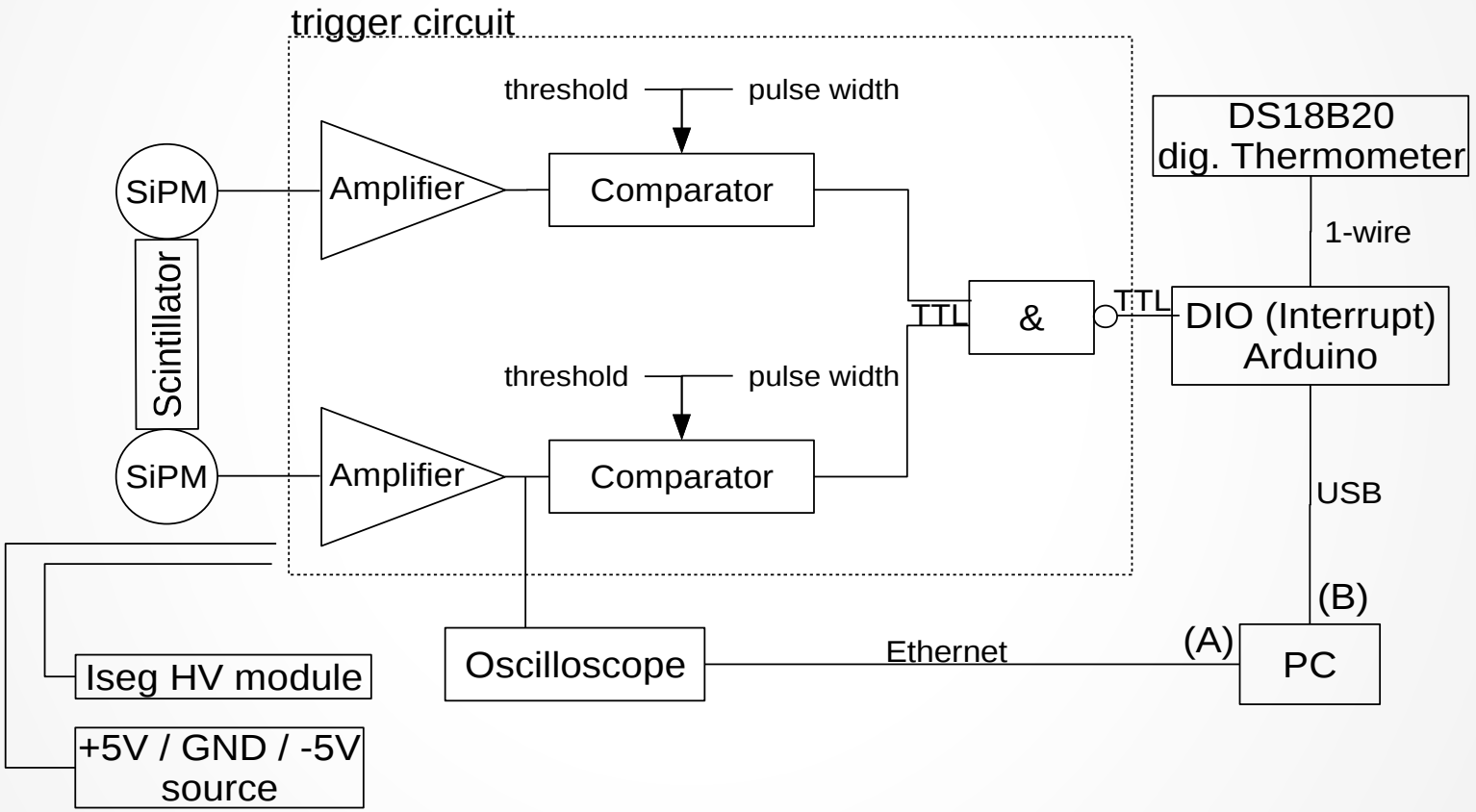
Coincidence unit with two SiPM channels

SiPM dark count rate

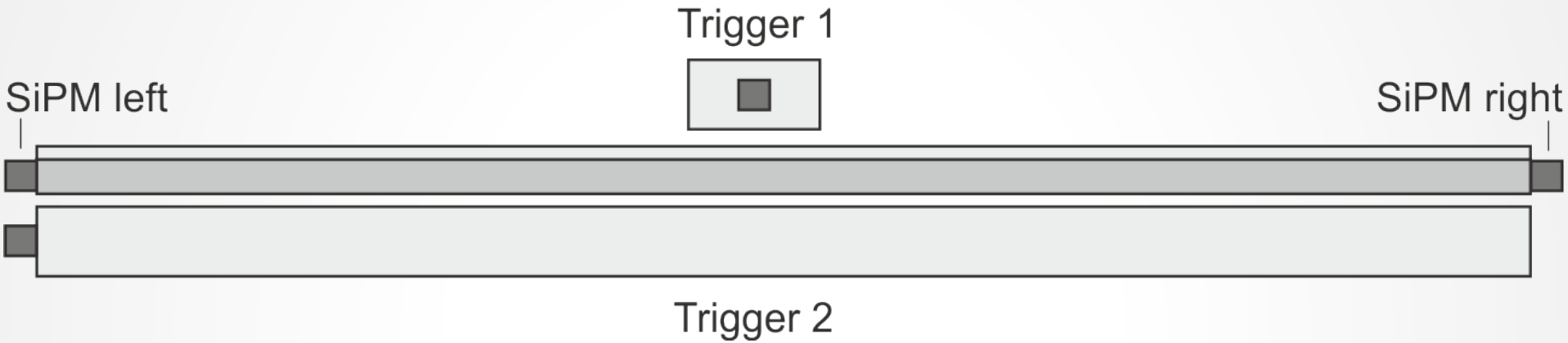


SiPM model: Hamamatsu S12571-050P

Measurement setup

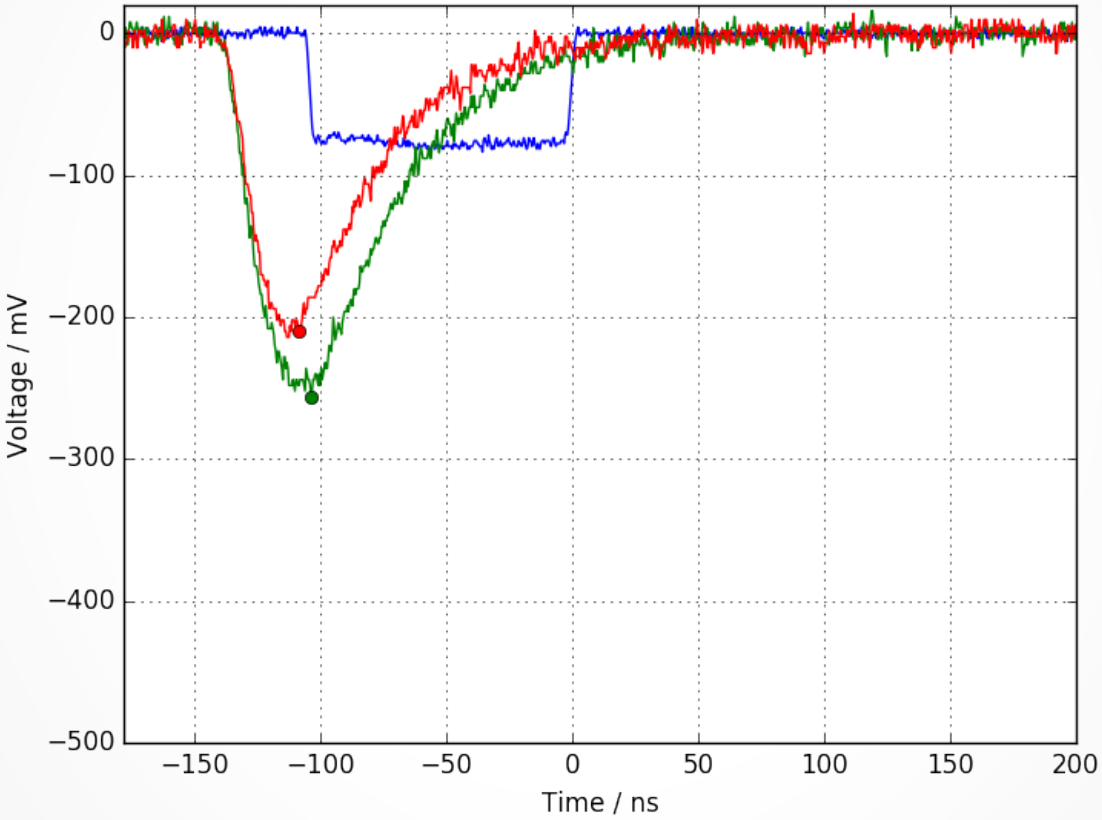


Testing with MIPs – The hodoscope

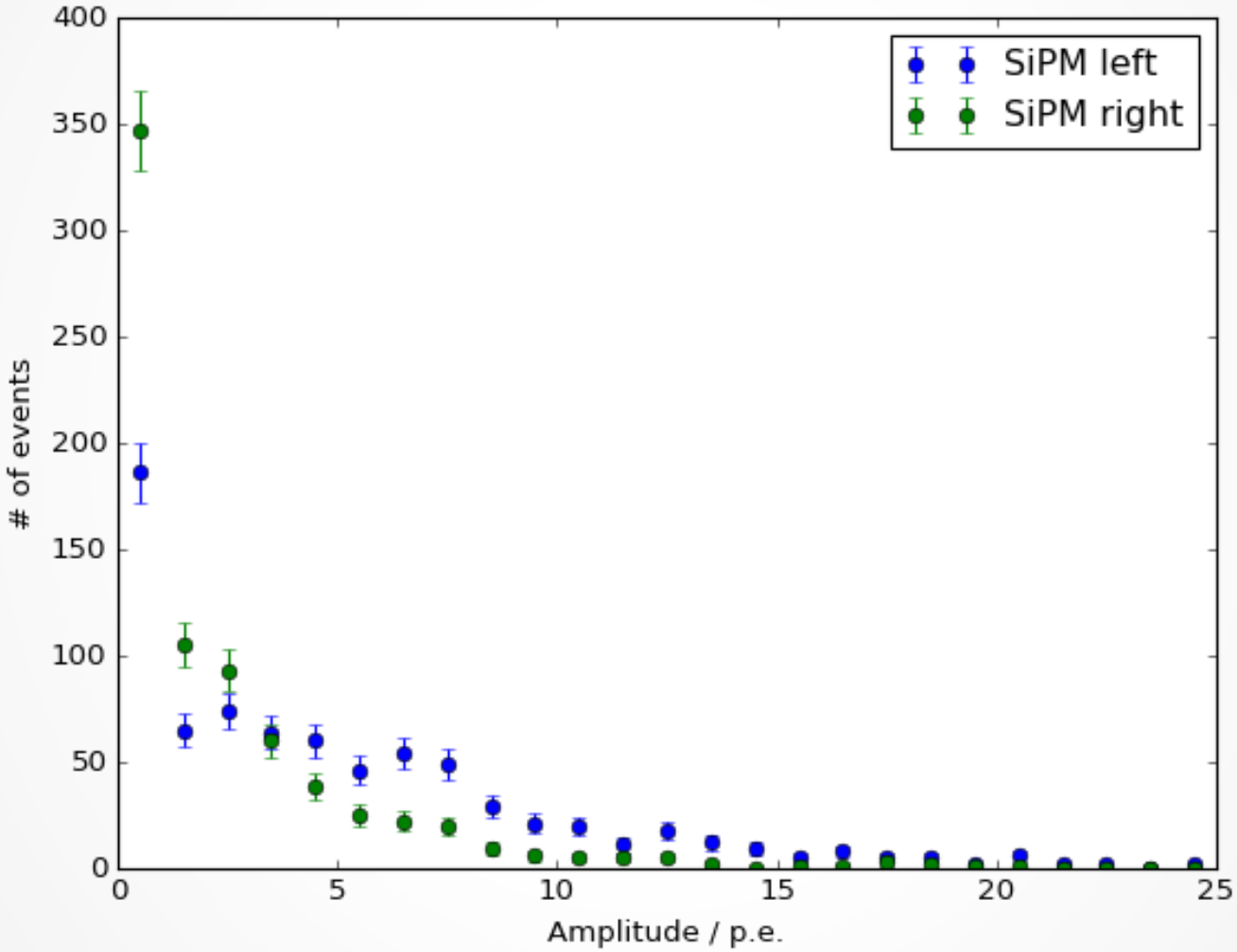


- external scintillation trigger
- based on PMTs
- Trigger1: 7 x 1cm²
- Trigger2: 22 x 1 cm²
- Rate of coincident events (90° crossed): (0.54 +- 0.02) /min

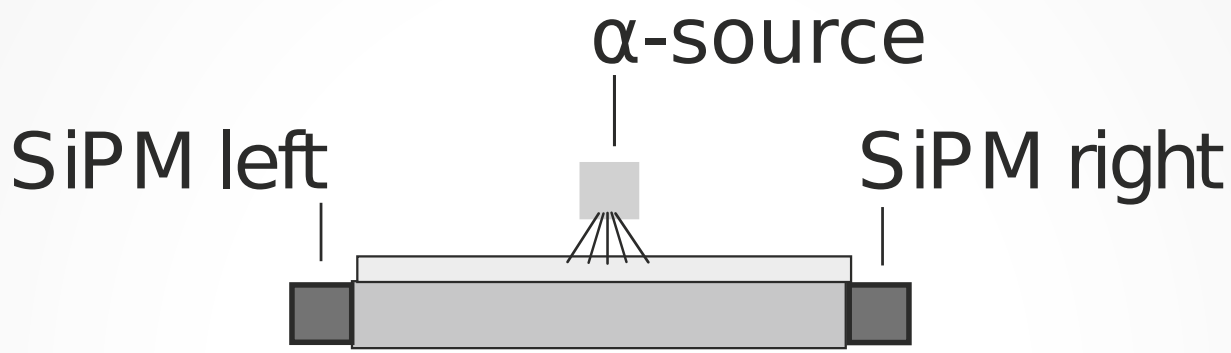
signal waveforms



Light yield per MIP

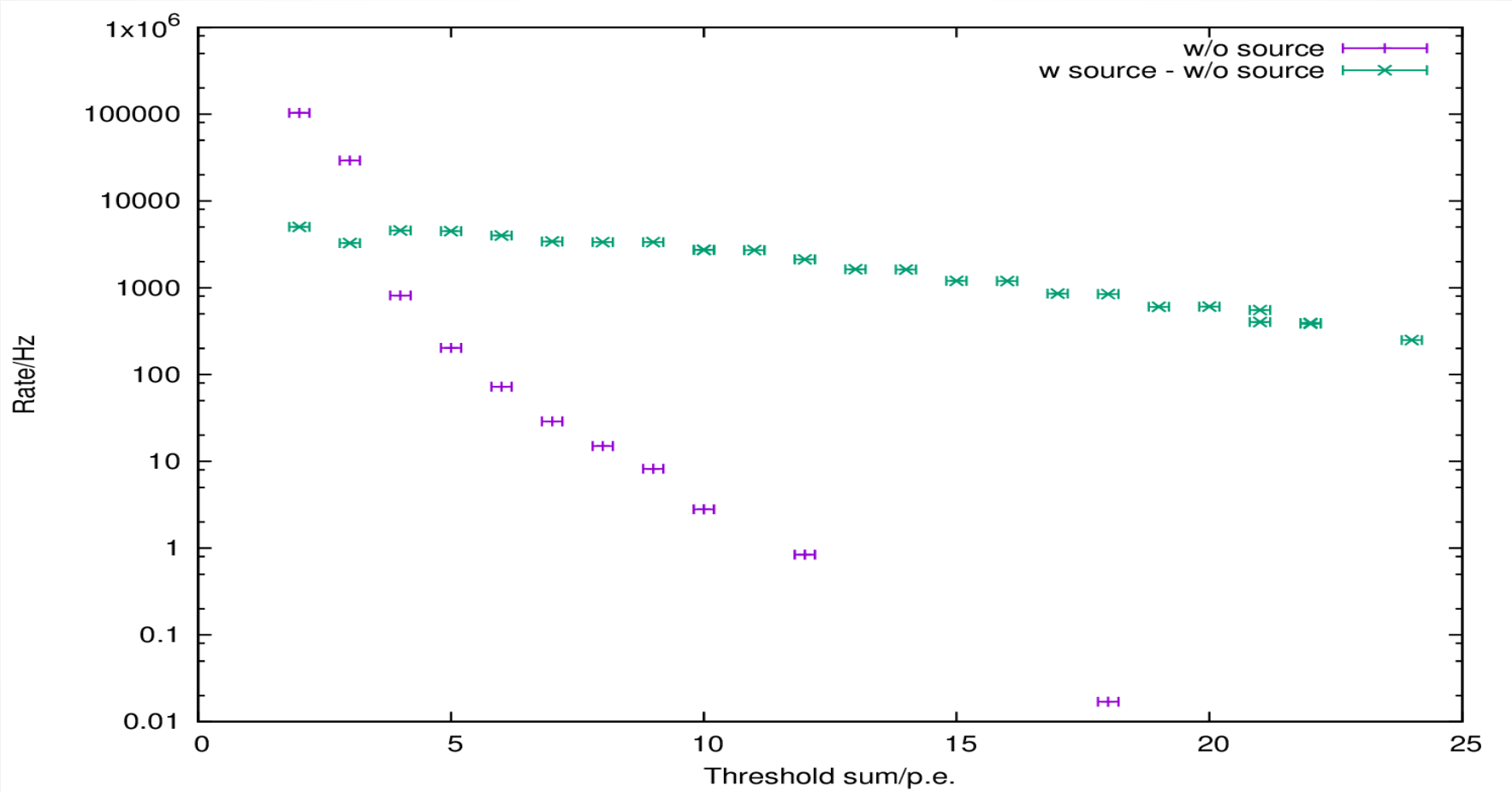


Testing with α-particles



- self-triggered using the coincidence unit
- Threshold individually adjustable
- ^{241}Am source with 33 kBq

Integrated Spectrum of ^{241}Am-source



Summary & Outlook

- Development of the analog SiPM readout
- SiPM readout & coincidence unit for the neutron TPC trigger
- Characterisation of the trigger prototypes

Next steps:

- Characterisation of the scintillation trigger with design dimensions & boron coating
- Microcontroller-based threshold setting of the coincidence unit for threshold scans

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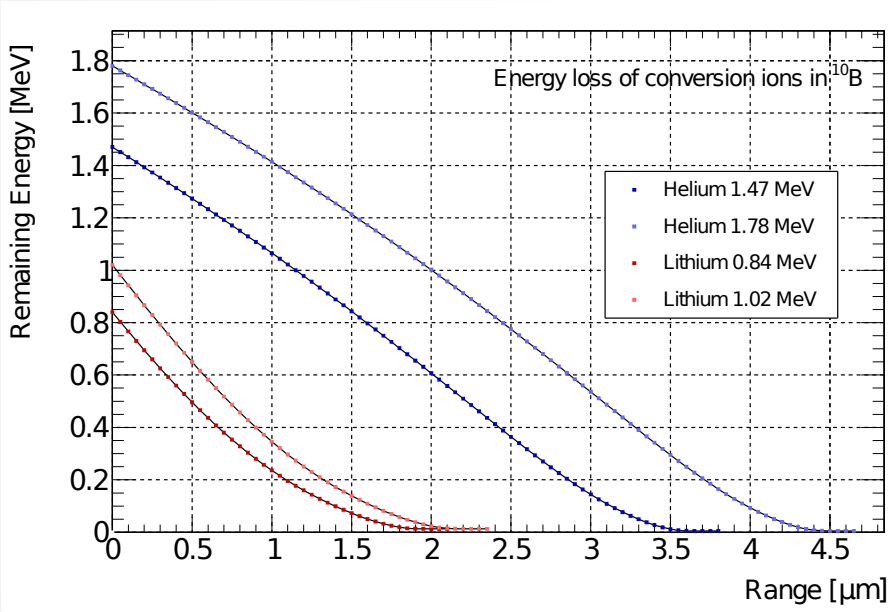
Thank you!

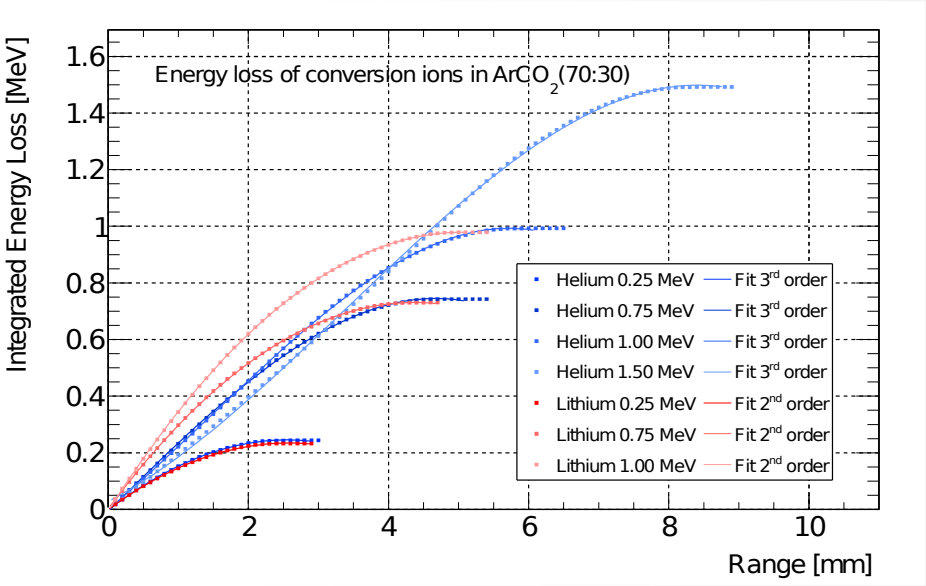
Backup slides

Range of the conversion ions

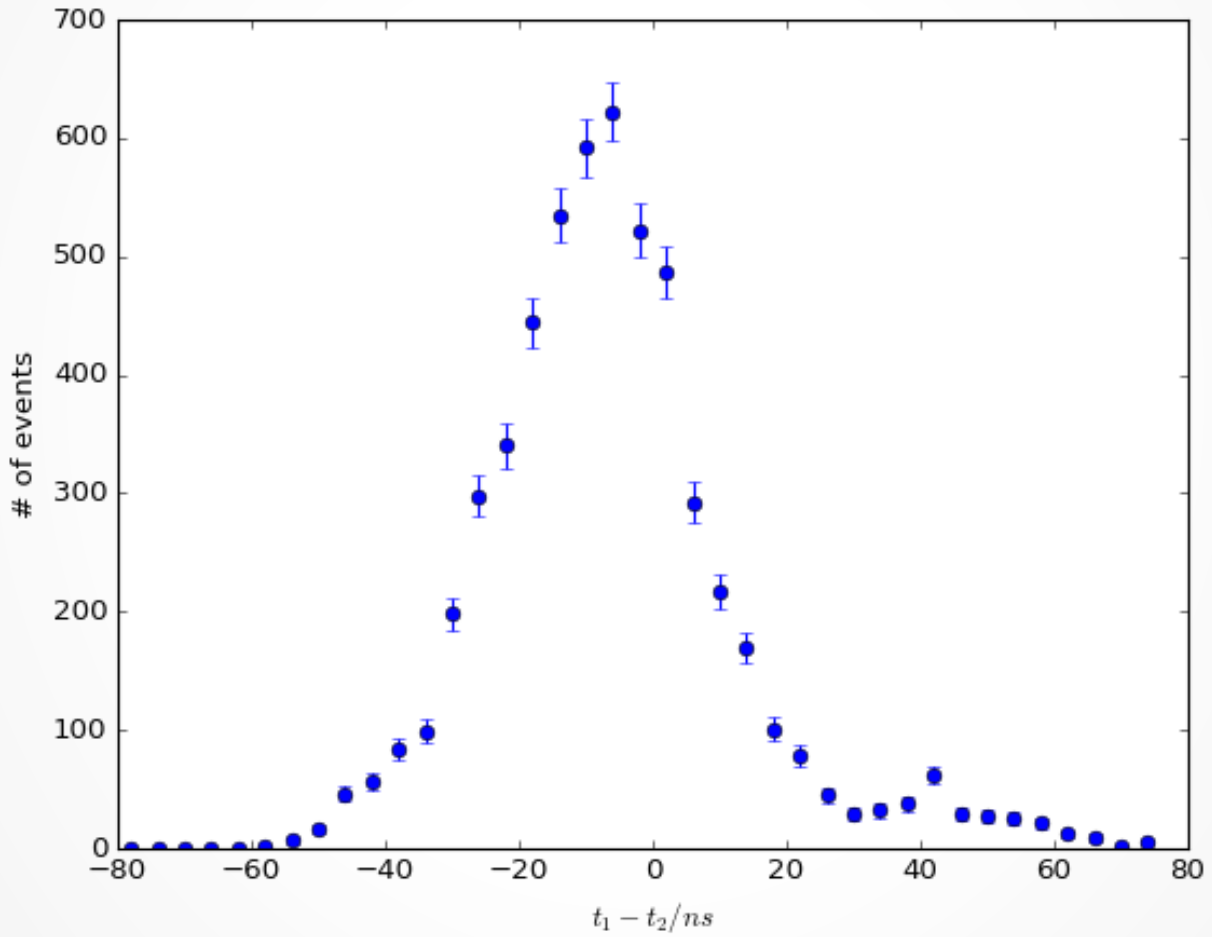
In the Boron layer



In the gas volume



Coincidence time in self-triggered mode



Dual SiPM signal map (zoomed out)