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TlCl:Be,I: a high sensitivity scintillation and Cherenkov emitter for TOF-PET

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The material requirements for gamma-ray detectors for medical imaging applications are multi-fold and sensitivity is often overlooked when aiming for the best timing performance. High effective atomic number (Z_{eff}) Cherenkov radiators have raised the attention in the community due to their potential for harvesting prompt photons. A material with one of the highest (Z_{eff}) and thus short gamma-ray attenuation length is thallium chloride (TlCl, Z_{eff} = 76).

By doping TlCl with beryllium (Be) or iodine (I), scintillation photons are produced upon gamma-ray interaction on top of the prompt Cherenkov luminescence. The scintillation response of TlCl:Be,I is investigated in terms of intensity, energy resolution, kinetics, and timing capability with and without energy discrimination. The scintillation light yield of 0.9 ph/keV is sufficient to discriminate events with low energy deposition in the crystal which is used to improve the measured coincidence time resolution from 360 ps (580 ps) FWHM without energy selection down to 235 ps (402 ps) FWHM after energy discrimination and time walk correction for 2.8 mm (15.2 mm) thick TlCl:Be,I crystals.

Already with the first generation of doped TlCl encouraging timing capability close to other materials with lower effective atomic number has been achieved. Improvements in the crystal surface finishing and doping optimization to increase the energy resolution will broaden possible applications.

Field

Detectors and electronics

Primary author: KRATOCHWIL, Nicolaus (UC Davis, Department of Biomedical Engineering)

Co-authors: SCHOTT, Jared (RMD); VAN LOEF, Edgar (RMD); SOUNDARA PANDIAN, Lakshmi (RMD); RONCALI, Emilie (UC Davis, Department of Biomedical Engineering and Department of Radiology); GLODO, Jaroslaw (RMD); ARINO-ESTRADA, Gerard (UC Davis, Department of Biomedical Engineering)

Presenter: KRATOCHWIL, Nicolaus (UC Davis, Department of Biomedical Engineering)

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