PhD Thesis

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Abstract

Zusammenfassung

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0.1 Detector Design and Construction

0.1.0.1 Light Yield Measurement

The light yield of all $PbWO_4$ scintillator crystals and of one EJ200 scintillator sample was measured to estimate the amount of incident photons on an SiPM.

The measurements were conducted using the process described in Section **??** and the setup shown in Figure **??**. The PMT used is an R2059 from Hamamatsu (serial number BA3200) with a quantum efficiency of 23.16 % [7] (cf. Appendix **??**) for the luminescence peak of 420 nm of $PbWO_4$ [1] and EJ_{200}.

All $PbWO_4$ crystals were measured in a flat and vertical position, where all non PMT-facing scintillator sides were enveloped in highly reflective PTFE foil in order to not lose any photons. Two additional measurements were performed, where one 3 mm- and 2 mm crystal were fully wrapped with an SiPM sized window cutout in the center of a side. The $PbWO_4$ crystals were optimounted onto the PMT's optical window next to a ^{22}Na γ-source inside a climate chamber and optically coupled using glycerin, as shown in Figure **??**. Glycerin which used as a substitute for the commonly used Baysilone® Fluid M optical grease, due to its less-adhesive characteristic. The Baysilone® Fluid M with its high adhesion might have lead to damaging the fragile crystals during the removal process.

The optical grease used is Baysilone® Fluid M with a viscosity of 300 000 mm^2/s at 20 °C and refractive index $n_{og} \approx 1.404$ [8]. The refractive index of $PbWO_4$ and the SiO_2 glass window of the **P**hoto**M**ultiplier **T**ube (PMT) are $n_{PbWO_4} \approx 2.3$ [1] and $n_{SiO_2} \approx 1.459$ [9], respectively. Additionally to the climate chamber's light-tightness, the setup is enclosed, ensuring perfect light tightness, as shown in Figure **??**.

5 min measurements per crystal were taken at 20 °C after an acclimation time of 1 h each. An exemplary light yield measurement of crystal number 0 is shown in Figure **??**. The measured light yields for all crystals are tabulated in the Appendix Table **??** and plotted in Figure **??**. The average light yield of the $PbWO_4$ crystals is $\approx$64.83 ph/MeV, with a relatively high standard deviation of $\approx$30.99 ph/MeV. The high standard deviation is expected due to the defects in the crystals and the relatively high measurement temperature of 20 °C. Nevertheless, all the crystals exhibit a sufficient light yield suitable for the

Figure 1: Open light yield measurement setup for $PbWO_4$ crystals using a ^{137}Cs γ-source.

Figure 2: Encased light yield measurement setup for $PbWO_4$ crystals using a ^{137}Cs γ-source.

detector use.

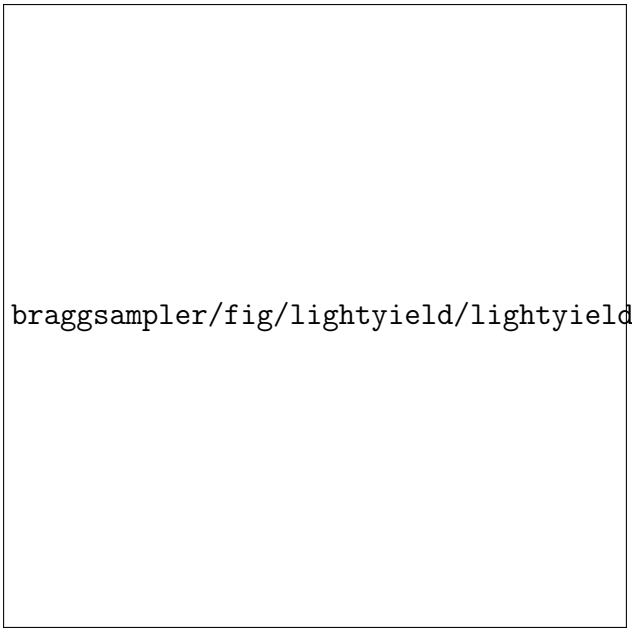

Figure 3: Exemplary light yield measurement of crystal number 0 with Gaus fitted ^{137}Cs source peak.

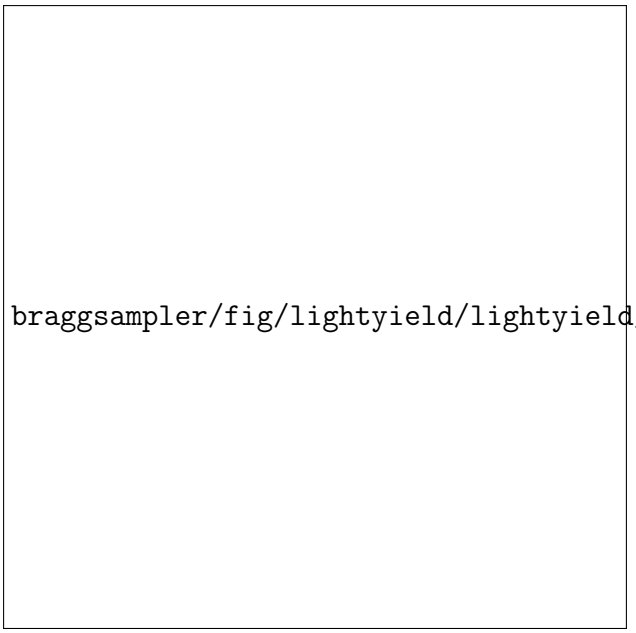

Figure 4: Plotted light yield measurements of the Braggpeak Sampler's crystals.

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Selbstständigkeitserklärung

Hiermit versichere ich, die vorgelegte Thesis selbstständig und ohne unerlaubte fremde Hilfe und nur mit den Hilfen angefertigt zu haben, die ich in der Thesis angegeben habe. Alle Textstellen, die wörtlich oder sinngemäß aus veröffentlichten Schriften entnommen sind, und alle Angaben die auf mündlichen Auskünften beruhen, sind als solche kenntlich gemacht. Bei den von mir durchgeführten und in der Thesis erwähnten Untersuchungen habe ich die Grundsätze gute wissenschaftlicher Praxis, wie sie in der ‚Satzung der Justus-Liebig-Universität zur Sicherung guter wissenschaftlicher Praxis' niedergelegt sind, eingehalten. Entsprechend § 22 Abs. 2 der Allgemeinen Bestimmungen für modularisierte Studiengänge dulde ich eine Überprüfung der Thesis mittels Anti-Plagiatssoftware.

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