Imaging performance dependence on crystal absorption properties: the CRY018 and CRY019 comparison

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AIM
The purpose of this work is a quantitative comparison of two recently released scintillation crystals named CRY018 and CRY019, in terms of detected light distributions, position linearity, uniformity, energy and spatial resolution. They are non hygroscopic, have similar short decay time (45 ns), high light yield (28 kph/MeV leading to a good energy resolution) and low refraction index (1.8). CRY018 and CRY019 show similar responses, in terms of radiation absorption, to those of YSO and LYSO respectively.

MATERIALS
* CRY018 and CRY019, released by Crytur Company, have been studied. They have a round shape (52.0±0.1 mm diameter and 6.25±0.05 mm thickness), both coated with a 0.2 mm TiO₂ white paint (full reflective treatment);
* Crystals are optically coupled to a Hamatsu multi anode PMT (MA-PMT) series H10966A-100 with metal channel dynodes structure, a segmented anode pad of 8×8 array (6.05 mm pitch), a gain of 3×10⁵, 60% first dynode efficiency and 35% of Q.E. @400 nm and an anodic gain variability 1:2.

METHODS AND MEASUREMENTS
* 6mm-step scanning on crystals surface was performed with 2.5 mm ²⁵⁴Am and ²⁰⁸Ba collimated sources for CRY018 and 2.5 mm ²⁰⁸Tc and ¹²⁴Cs collimated sources for CRY019, in order to irradiate each anode center;
* 1.5mm-step scanning on both crystals along a maximum diameter with 1 mm ⁶⁰Co collimated source;
* 6mm-step scanning on CRY018 crystal surface was performed with 1 mm ²⁴¹Am collimated source;
* Pulse height uniformity response, ER, position linearity and SR were investigated;
* A new position method for image construction (RTP method) was used to correctly strong position non linearities generated by the wider scintillation light distribution of full reflective coating:

\[
X_{\text{centroid}} = \frac{\sum_j n_j x_j}{\sum_j n_j} = \left( \frac{\sum_k n_k y_k}{\sum_k n_k} \right)^a \quad a = 1.2, 3, ...
\]

REFERENCES

RESULTS

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<th>Energy (keV)</th>
<th>PMT</th>
<th>Single Spot</th>
<th>Single Spot</th>
<th>64 Spots</th>
<th>Sum</th>
<th>Anodic gain correction</th>
<th>Flood</th>
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<tbody>
<tr>
<td>CRY018 CRY019 CRY018 CRY019 CRY018 CRY019 CRY018 CRY019 CRY018 CRY019</td>
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Scintillation light PSF Profile.

CRY018 and CRY019 position linearity for ²⁰⁸Am and ²⁰⁸Ba respectively evaluated with the standard Anger logic and corrected with the RTP method with α=3 compared with the theoretical curve.

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Scintillation light PSF Profile.

CONCLUSIONS
* All ER values measured by MA-PMT are worse than the ones by standard PMT. ER values from flood irradiation are worse in agreement with the MA-PMT anodic gain standard deviation of 3%.
* Thanks to crystals coating and optical treatment, the pulse height uniformity response is close within 6%. It allows the selection of a reasonable narrow energy window without any look-up-table gain correction.
* Mean scintillation light PSF profile seams mainly dependent on crystals coating, optical treatment and size.
* All ISR values are dependent on attenuation length and are confined within 2mm after RTP position linearity correction.

15th Topical Seminar on Innovative Particle and Radiation Detectors (IPRD19)
Siena, 14-17 October 2019