Evaluation of new scintillator crystals with multi-criteria decision-making methods for brain PET

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In the last decades, brain positron emission tomography (PET) imaging has become highly demanding for better diagnosis and staging in brain cancer and other brain disorders. The performance of a PET system is majorly described by its overall image quality where it depends on many factors including the selection of the radiation detection medium. Previously, we simulated novel transparent optical scintillator crystals for brain PET system [1]. The purpose of this research is to evaluate and compare them using multi-criteria decision-making (MCDM) methods, namely fuzzy Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) and fuzzy Visekriterijumska Optimizacija I Kompromisno Resenje (VIKOR).

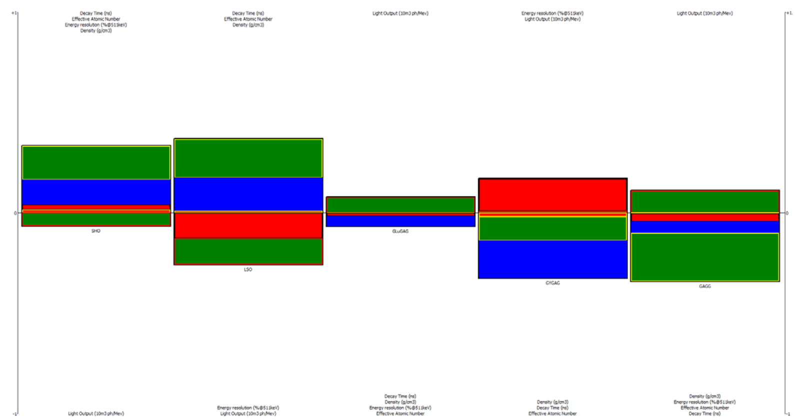

Figure. 1. Positive and negative aspects of each criteria for the selected scinitillator crystals.

The crystals used in this study are Strontium hafnate - SHO ($SrHfO_3$), Gadolinium aluminium gallium garget - GAGG ($Gd_3Al_2Ga_3O_{12}$), Gadolinium yttrium gallium aluminum garget - GYGAG $(Gd,Y,Ce)_3(Ga,Al)_5O_{12}$), Gadolinium lutetium gallium aluminum garget - GLuGAG $(Gd_xLu_{1-x})_3(Ga_yAl_{1-y})_5O_{12}$, and lastly Lutetium Oxyorthosilicate (LSO) for comparison. The density, effective atomic number, energy resolution, light output, and decay time were selected as important criteria. Importance weights of each criteria are then assigned by considering the high resolution and high sensitivity detectors.

With both MCDM methods, the results showed that SHO is outranked the other scintillator materials followed by LSO and GLuGAG (Figure 1). GYGAG, and GAGG are found as the least favorable crystals, in agreement with the previous simulation studies [1]. This study can be extended by including more scintillators as they become available in the future.

[1] I. Ozsahin *et al.*, *JINST* **15** (2020), C05024.