



Contribution ID: 5

Type: **Poster**

EVALUATIONS OF COMMON SOLID-STATE DETECTORS WITH MULTI-CRITERIA DECISION-MAKING THEORY FUZZY PROMETHEE

Monday 25 June 2018 16:00 (1 hour)

Solid-state detectors are radiation detectors which employ semiconductor crystals as the detecting medium. These detectors produce a pulse of electric current, by means of pairs of charge carriers, electrons and holes generated when the detectors come in contact with ionizing radiation. The type of semiconducting material used in the detectors determines the the number of paired charge carriers generated, which is a very important parameter that affects the performance of the device. Other parameters to be considered in determining the performance of the solid-state detectors include energy resolution, atomic number, density, and electron/hole mobility. The trend in development of new cameras for nuclear medicine applications is the principal reason behind the extensive research into detectors with superb spatial resolution and energy resolution. Semiconductor based detectors have received much attention due to their high energy and intrinsic spatial resolution. Although various types of such detectors exist, to our knowledge no study has categorically provided the best amongst the existing detectors. Fuzzy PROMETHEE is a multi-criterion decision-making method (MCDM) that has been applied in many fields to solve selection problems involving multiple criteria. We applied the MCDM technique in order to evaluate the various semiconductor materials using their distinct physical parameters including density, bandgap, energy resolution and electron/hole mobility. Evaluation results showed that Germanium is the best detector, mainly due to relatively very high electron/hole mobility, for use in fast nuclear medicine applications, on the ranking followed by Gallium Arsenide, then Cadmium Telluride and Cadmium Zinc Telluride based on the selected weights. Results also showed that Silicon and Thallium Bromide came last on the ranking, having a low performance value from the most important parameters. By using fuzzy PROMETHEE, one can determine the most suitable crystal based on the selected criteria and defined weight according to desired application.

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Session Classification: Poster session

Track Classification: general