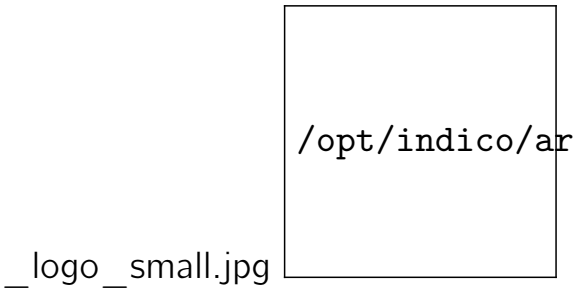

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Pulse-shape discrimination with Cs2HfCl6 crystal scintillator

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Content

Very recently, significant interest in crystal scintillators with $KPtCl_6$ structure has been renewed since they possess a high light yield, linear response at low energies, and good energy resolution. Cs_2HfCl_6 (CHC), in particular, a crystal belonging to the same structure group, is one of the most promising scintillator for gamma spectroscopy giving almost 54000 ph/MeV light yield and 3.3% energy resolution at 662 keV. In addition, the CHC crystal is the first scintillating material containing a high fraction of Hf in mass (of about 25%). This opens new opportunities to search for a rare nuclear processes occurring in Hf isotopes applying the "source = detector" experimental approach with high sensitivity.

Here we report the results of our investigation into a 3 cm^3 CHC crystal as a promising detector of search for rare nuclear processes occurring in Hf isotopes. For this reason, the response of the crystal to irradiation by alpha particle was studied. The quenching factor for 5 MeV alpha particles is 0.28, showing that alpha particles produce almost a third of the light produced by gamma quanta. This crystal has also shown the ability to discriminate between different types of radiation by applying pulse-shape discrimination techniques. For example, using the optimal filter method we determined the separation between signals with a Factor of Merit (FOM) = 6.08 for energy at 1 MeV. This means we can fully separate signals induced by alpha particles from those of gamma quanta. Similar results were obtained using the mean time method.

The internal radioactive contamination of our 3 cm^3 CHC was also studied. Using low-background measurements with germanium gamma-spectrometer at Gran Sasso Underground Laboratory (Italy). The resulting analysis concluded that the crystal is free from nuclides of U/Th natural decay chains, only limits were set of their activities at the level of few mBq/kg were seen after 500 hours of measurements. However, the crystal contains artificial ^{137}Cs nuclide (0.8 Bq/kg) and ^{134}Cs at levels of tens of mBq/kg. Also observed nuclides produced by cosmic ray irradiation ^{132}Cs and ^{181}Hf with activities at the level of tens of mBq/Kg.

The prospects of the CHC scintillating crystal as a detector to search for rare nuclear decay of Hf isotopes is discussed.

Summary

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