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New Scintillator detectors for nuclear physics experiments

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Summary

There is an intense R&D work on scintillator detectors as new high performing scintillating materials are being developed. Since some years ago the best scintillator detector was the NaI:Tl with an energy resolution of 6-7% at 662 keV. Nowadays several scintillator detectors, with energy resolution better that 5% are available. The most used is the LaBr3:Ce due to its excellent properties in term of energy (3 % at 662 keV), time (< 500 ps) resolution and efficiency (density of 5.1 g/cm3) for gamma ray detection. New materials are appearing, such as SrI2:Eu and CeBr3, they could compete with LaBr3:Ce. The development of new ceramic scintillator materials (such as GYGAG:Ce) offers the possibility to perform gamma-ray spectroscopy at low cost.
In nuclear physics experiments, especially when using radioactive beams, there is a great interest in the possibility to identify gamma rays and neutrons and measure their energies.
The scintillator Cs2LiYCl6:Ce (CLYC), that belong to the Elpasolite family, it is a new and important material for radiation detection because of its capability to measure gamma rays and neutrons simultaneously. CLYC scintillators are suitable for thermal neutrons detection, due to 6Li ions and they can also be used as a fast neutron spectrometers, due to 35Cl ions. The gamma rays and neutrons can be discriminated by the pulse shape discrimination.

In this work the performances of different scintillators detectors will be presented, pointing out the advantages and the disadvantages for nuclear physics experiments. The result of characterization measurements on a 2" x2"tapered SrI2:Eu sample, of a 2"x 3"CeBr3 sample, and of a 2"x 0.3"GYGAG:Ce sample will be discussed. In addition the properties of CLYC crystals(a 1"x 1"sample of a CLYC scintillator enriched by 6Li at 95%, a 1"x 1"and a 2"x 2"CLYC enriched with more than 99% of 7Li) will be presented together with the response to fast monochromatic neutrons measured from 1.9 MeV up to 3.8 MeV at LNL (Italy). Moreover the possibility to measure continuous neutron spectra will be shown.

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