Inexpensive gamma-ray spectrometers for education and outreach

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Abstract. This 90 minute workshop will provide participants with hands on experience assembling and using an extremely low cost (approximately €100) gamma ray spectrometer. Results from our teaching and outreach labs will be discussed.

1 Introduction

Many commercial systems are available for detecting gamma radiation. These are often, but not exclusively, based on NaI(Tl) crystal scintillators coupled to photomuliplier tubes (PMT). Such detectors are typically read out either via a multichannel analyzer or via proprietary electronics and software. Niether of these invites student understanding of what is going on in the detector, how the pulses are generated, or how they are processed. With the advent of inexpensive and easy to use electronics made possible via the "maker movement" systems of much lower cost and much higher transparency are within reach of most physicists.

2 The NBI BiGS

In order to provide all our first year students with the experience of measuring the results of matter antimatter annihilation (resulting from the beta+ decay of ^{22}Na.), we have developed the Niels Bohr Institute "Billig Gamma-ray Spectrometer " (BiGS), and found an inexpensive and highly open data acquisition system. The BiGS is a LYSO crystal from an old PET scanner coupled to a Silicon Photomulier (SiPM). One advantage of SiPMs compared to traditional PMTs is that their operating voltage is typically less than 30 V, compared to approximately 1000V PMTs, making them both more forgiving of the mistakes of inexperienced students and substantially less expensive.

3 The workshop

In this 90 minute workshop, participants will learn to assemble a gamma ray detector, connect it to a voltage supply and connect it to the acquisition system. Once the detector is operational, participants will begin to take data, both from the slightly radioactive LYSO scintillation crystal as well as available gamma ray sources. We estimate that it should take roughly an hour to assemble, test, and take data with the BiGS. The final half hour will be devoted to discussing details of the detector design, possible improvements, and to a discussion of how such a tool might be useful in teaching and outreach activities. Finally, we will demonstrate our toy PET scanner consisting of two BiGS operatining in coincidence.

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