RECENT DEVELOPMENTS OF THE MEG LIQUID XENON PHOTON DETECTOR

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The Large Prototype liquid xenon photon detector was extensively tested to evaluate the detector performance and to gain the necessary experience required for operation. In 2003, two kinds of beam tests were conducted after a purification scheme was implemented as reported previously[1]. This was essential in order to achieve the best performance of the detector. The first test was performed using a γ-beam produced via inverse-Compton scattering, while the second test was carried out using γ's from π^0-decays produced in the charge exchange process (CEX).

The initial test was performed at the electron storage ring, TERAS, in AIST, Tsukuba in Japan. In this facility a pure γ-beam is available, produced through head-on collisions of laser light with electrons in the storage ring. The γ-beam energy can be selected up to 40 MeV by adjusting the laser wavelength and electron energy in the storage ring. A schematic view of the setup is shown in Figure 1. We used a 10 MeV,

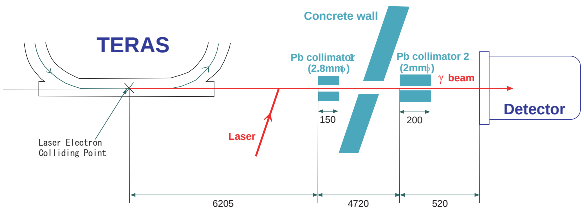

Figure 1: TERAS beam test setup.

20 MeV and 40 MeV inverse-Compton γ-beam. The energy resolution was evaluated by fitting the shape of the Compton edge, while the position resolution was evaluated by placing a lead collimator in front of the detector to define the beam size on the entrance window. Figure 2 (left) shows an energy spectrum measured by the large prototype for a 40 MeV inverse-Compton γ-beam. Overlaid is a fit to the data using a convoluted function of an approximated inverse-Compton spectrum and the detector response, described by a logarithmic Gaussian function. We conclude from this result that the detector has an energy resolution of less than 2% in sigma for 40 MeV γ's. Figure 2 (right) shows a distribution of the reconstructed position of incident γ's, yielding a detector position reconstruction resolution of between 2$\rightarrow$4 mm in sigma, depending on the incident beam position.

The second test in 2003 was carried out at the πE1 beam line by utilizing the charge exchange process:

$$\pi^- + \mathrm{p} \rightarrow \pi^0 + \mathrm{n} \qquad (1)$$

Almost all produced π^0's decay to $\gamma\gamma$. Since a π^0 has a momentum of 28 MeV/c in the CM frame, there is a strong correlation between the opening angle(θ) and the energy of the two γ's in the lab frame. If we select events with $\theta \sim 180^o$, the energy of the two γ's are 55 MeV and 83 MeV respectively. Hence an almost monochromatic γ-beam of 55 MeV incident on the large prototype could be obtained, with an accuracy determined by the θ-resolution of the setup (0.3 MeV in FWHM when we select $\theta \geq 175^o$), by selecting 83 MeV

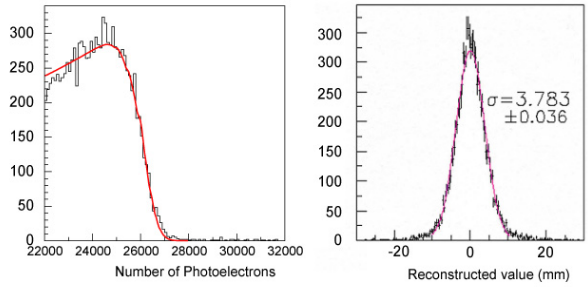

Figure 2: (left) 40 MeV inverse-compton γ beam spectrum measured by the large prototype. (right) Distribution of the reconstructed positions with a collimator (ϕ1mm).

γ's on the opposite side. A picture of the setup including the NaI detector[2] used to select the 83 MeV γ's is shown in Figure 3.

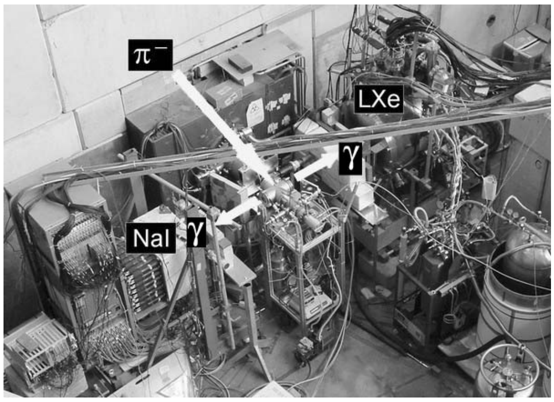

Figure 3: πE1 Setup, showing the NaI detector on the left and the Large Prototype LXe detector opposite.

The purpose of this test was to investigate the detector performance using a different process from that of the first test. The two methods complement each other when evaluating detector performance. On the one hand the CEX-process has a well defined spectrum but has an induced background from electrons and neutrons, whereas the inverse-Compton beam is very clean, but has a less well defined spectrum. In addition, the CEX-process is thought to be a realistic channel for the final detector calibration. It is also possible to evaluate the timing resolution from this channel by measuring the arrival time of the 83 MeV γ's on the opposite side.

As a preliminary result, we obtained an energy resolution of (4.5$\pm$0.3)% FWHM for 55MeV γ's, by rejecting events in which the γ interaction occurred near to the front face of the detector. A detailed analysis is in progress and will be published in 2004.

REFERENCES

[1] PSI-Scientific Report 2002/Volume 1.

[2] Nucl. Instr. and Meth, **A271**, 497(1988).