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LEPS Backward Gamma Detector Reassembled

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A new electro-magnetic (EM) calorimeter complex FOREST covering a solid angle of about 4π sr is under construction. It consists of three calorimeters: the EPS forward one made up of pure CsI crystals, the middle one of lead scintillating fiber (Lead/SciFi) modules, and the backward one of lead glass Čerenkov counters. We have reassembled the middle calorimeter, comprised of 252 Lead/SciFi modules, which used to be the LEPS Backward Gamma detector system utilized in a LEPS experiment at SPring-8. A performance test for the gamma detector system has been made with a photon beam in the GeV γ experimental hall. The π^0 peak is clearly observed in the $\gamma\gamma$ invariant mass distribution.

§1. Electro-Magnetic Calorimeter Complex FOREST

Nucleon resonances were experimentally studied via π^0 and η photo-production by using an electromagnetic (EM) calorimeter SCISSORS II in the GeV-γ experimental hall at Laboratory of Nuclear Science (LNS), Tohoku University. The π^0 and η mesons are identified as a peak at specific places in the $\gamma\gamma$ invariant mass distribution. It was difficult, however, to detect all the γ's coming from π^0 or η decay since the solid angle of SCISSORS II was only 12.6% in total. In addition to that the process of multi-π production is dominant in the GeV energy region. There is a huge background made up with wrong combinations of γ's, which do not form a peak of π^0 nor η in the $\gamma\gamma$ invariant mass distribution. To suppress the background due to the wrong combinations, a large solid angle calorimeter is required so that a fraction of undetected γ's decreases.

A new EM calorimeter complex called Four-pi Omnidirectional Response Extended Spectrometer Trio (FOREST) with a solid angle of about 4π sr has been planed [1]. It consists of three calorimeters. The most forward region is covered with pure CsI crystals 'SCISSORS III' [2]. The detector system called 'Backward Gamma' is placed at the central region. And a set of lead glass Čerenkov counters covers the backward region. Figure 1 shows a schematic view of FOREST and a side view of Backward Gamma. The Backward Gamma detector system covers 30°–100° in the polar angle and 0°–360° in the azimuthal angle, consisting of 252 Lead/SciFi modules. Each module has a 10° coverage both in the polar and azimuthal angles. Backward Gamma was originally used at the Laser Electron Photon beam facility at SPring-8 (LEPS).

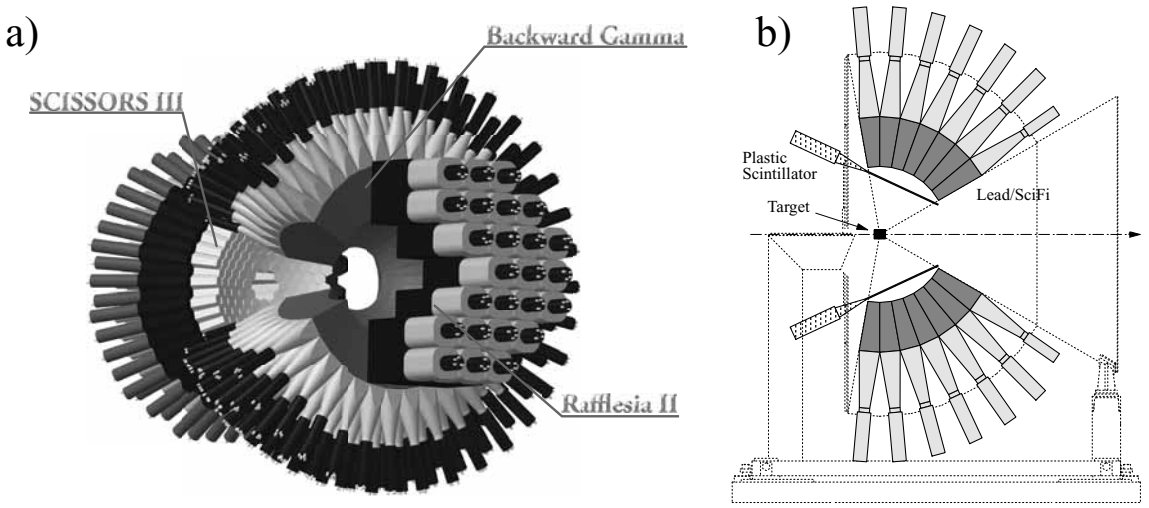

Fig.1. a) Slant view of the new EM calorimeter complex FOREST. b) Side view of the LEPS Backward Gamma detector. Backward Gamma consists of 252 Lead/SciFi modules. Each module covers 10° both in the polar and azimuthal angles.

§2. Rebuilding of LEPS Backward Gamma Detector

The LEPS Backward Gamma system was reassembled from 9th to 23rd Nov. in 2006. The frame of Backward Gamma was rotated first of all so that the plane corresponding to the polar angle of 90°

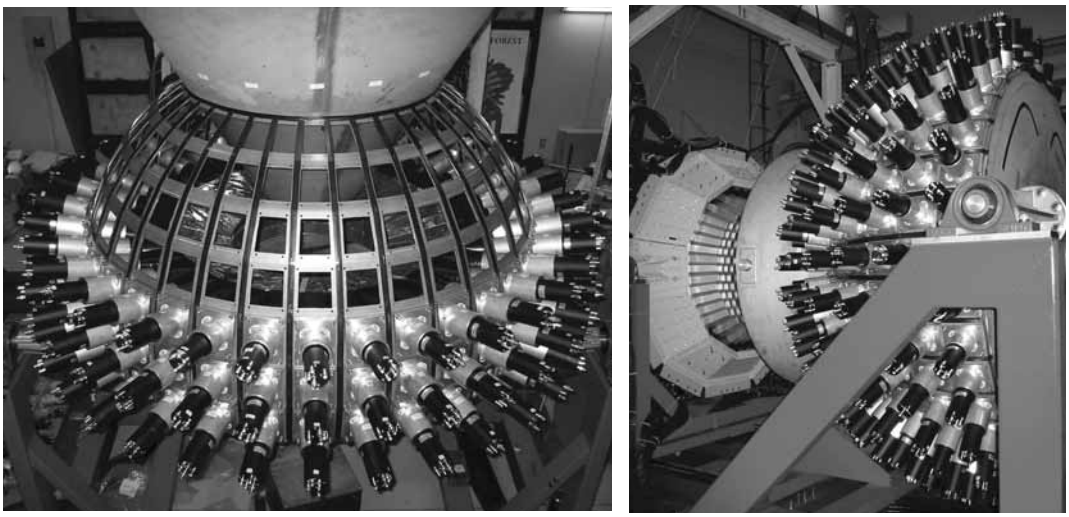

Fig.2. LEPS Backward Gamma. The left panel shows a photo of the LEPS Backward Gamma when the 90°–100°, 80°–90°, and 70°–80° Lead/SciFi modules were stacked. The right panel shows a photo of the constructed Backward Gamma together with SCISSORS III.

became horizontal. The largest Lead/SciFi modules covering a polar angle of 90°–100° were installed into the frame at first. Then 80°–90° modules were stacked on the 90°–100° ones. The 70°–80° and 60°–70° modules were installed in the same way. The left panel of Fig. 2 shows the middle stage of stacking procedure. The 50°–60°, 40°–50°, and 30°–40° modules of the same azimuthal angle were stacked at once so that the modules could not drop inside the frame during installation. The frame was rotated

back by 90°, after the installation of all Lead/SciFi modules was completed. Then the symmetry axis of Backward Gamma was aligned to the axis of the GeV-γ beamline.

§3. Beam Test for Backward Gamma Detector

A beam test of Backward Gamma was performed from 5th to 7th June in 2007. A data acquisition system for Backward Gamma was developed independently of that for the SCISSORS III. The energy deposited in each module was digitized with a LeCroy 4300B Fast Encoding and Readout ADC (FERA) in a CAMAC system. The data were collected and stored with a universal I/O (UIO) module [3] in a VME system through a LeCroy 4301 FERA driver in the CAMAC system. The timing signals were measured with CAEN V1190A TDC modules in the VME system. All the digitized data were finally accumulated in a personal computer (PC) through the VME-bus. The trigger signals are made under the condition

$$[\text{TotalSigmaTagger}] \otimes [N_{\text{BG}} \geq 2], \tag{1}$$

where TotalSigmaTagger stands for an OR signal of STB-Tagger II, and $N_{\text{BG}} \geq 2$ denotes the signal which is generated when more than two modules are responded.

The energy calibration was made in such a way that the position of the peak corresponding to π^0 events in the $\gamma\gamma$ invariant mass distribution should be at the π^0 mass. Figure 3b) shows the $\gamma\gamma$ invariant mass distribution measured with Backward Gamma. The π^0 peak is clearly observed.

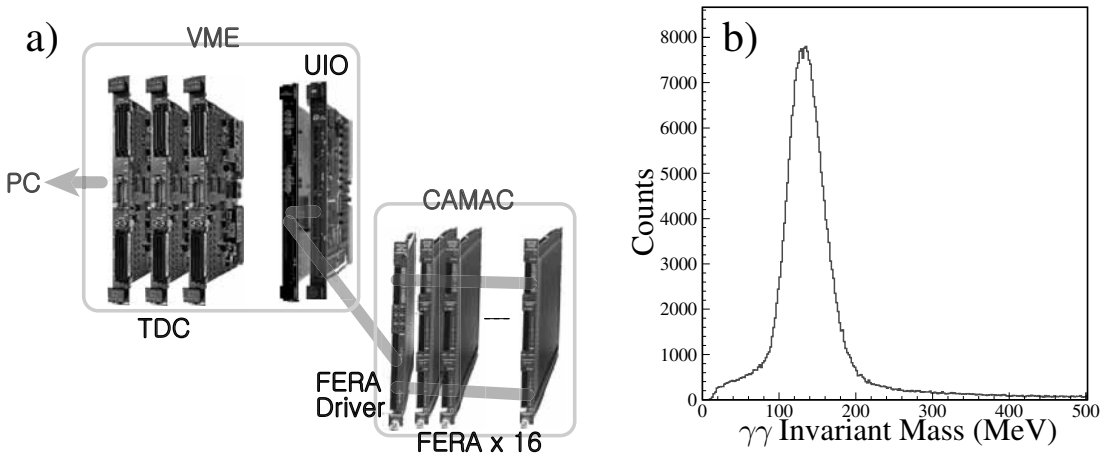

Fig.3. a) Dataflow of the data acquisition system for Backward Gamma. The digitized data of energies in FERA modules in a CAMAC system are collected in a UIO module through FERA driver. Those of timing signals are obtained with TDC modules in a VME system. b) The $\gamma\gamma$ invariant mass distribution measured with Backward Gamma. The π^0 peak is clearly observed.

Acknowledgment

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References

[1] T. Ishikawa: LNS Experiment #2536 (2005).

[2] T. Ishikawa *et al.*: Research Report of LNS, Tohoku University **39** (2006) 35.

[3] Y. Sugaya and M. Nomachi: Nucl. Instrum. Methods Phys. Res., Sect. **A437** (1999) 68.