Construction of a Forward Electro-magnetic Calorimeter SCISSORS Ⅲ

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A new electro-magnetic calorimeter complex FOREST with a solid angle of about 4π in total is under construction. It consists of three calorimeters: a forward one with CsI crystals, a middle one with lead scintillating fiber modules, and a backward one with lead glass Čerenkov counters. Recently, the forward calorimeter SCISSORS Ⅲ takes shape.

§1. An Electro-magnetic Calorimeter Complex FOREST

Nucleon resonances were experimentally studied via π^0 and η photo-production by using an electro-magnetic calorimeter SCISSORS Ⅱ in the GeV-γ experimental hall. The π^0 and η mesons were identified in $\gamma\gamma$ invariant mass distributions. When more than one neutral mesons were produced and each of these decays into $\gamma\gamma$, the possible choice of two γ's is not unique. Thus the events were contaminated in these distributions that two γ's were detected which different neutral mesons decay into and the others were not detected. Since a solid angle of SCISSORS Ⅱ is only 12.6% of 4π, a fraction of these events was large.

To suppress the contamination, a large solid angle calorimeter is required so that a fraction of undetected γ should decrease. A new electro-magnetic calorimeter complex with a solid angle of about 4π in total has been planned [1]. The complex is called Four-pi Omnidirectional Response Extended Spectrometer Trio (FOREST). It consists of three calorimeters: a forward one with CsI crystals 'SCISSORS Ⅲ,' a middle one with lead scintillating fiber modules 'LEPS Backward Gamma,' and a backward one with lead glass Čerenkov counters. Figure 1 a) shows a slant view of FOREST.

The SCISSORS Ⅲ consists of pure CsI crystals which had composed SCISSORS Ⅱ. The shape of CsI crystal modules is a truncated regular hexagonal pyramid. Among these modules, thickness of 144 crystals is 300 mm (LNS type) and that of 48 ones are 250 mm (INS type). Central units of SCISSORS Ⅲ are the LNS type, and peripheral ones are the INS type. Figure 1 b) shows the arrangement of modules in SCISSORS Ⅲ [2,3].

§2. Arrangement of CsI Crystal Modules

Because an equilateral hexagon has an interior angle of 120°, it can be used to tile the plane without holes like a honeycomb. Neither front nor rear faces of a truncated hexagonal pyramid compose

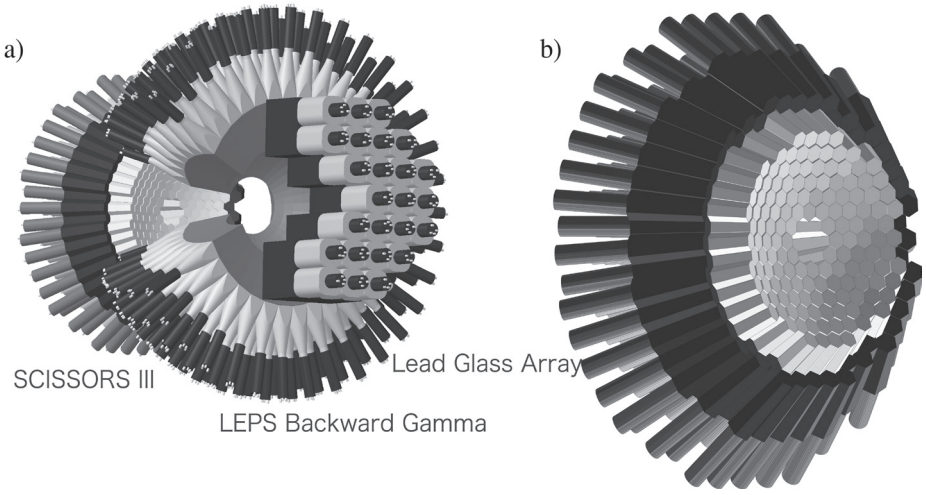

Fig.1. a) Slant view of the new electro-magnetic calorimeter complex FOREST. Polar angles of 4°-27°, 30°-100°, and 106°-170° are covered with CsI crystal array 'SCISSORS Ⅲ,' with lead scintillating fiber module array 'LEPS Backward Gamma,' and with lead glass Čerenkov counter array, respectively. b) Schematic view of the module arrangement in SCISSORS Ⅲ. Central units are the LNS type, and peripheral ones are the INS type.

a segment of a regular solid without overlap. It is required to array truncated regular hexagonal pyramids tight.

Let's consider a crystal is laid out adjacent to the central one. When two crystals are arranged so that the contact side face of the central one is identical with that of the adjacent one as shown in Fig.2(a), the volume of the adjacent one exceeds the angle formed by two vectors to the vertices of the front face of the central one sharing the center of the central one as an endpoint. Hence, another one cannot be laid out similarly adjacent to each of the two without overlap. If the adjacent one is slid rearward so that side faces contact, the adjacent one can be set that does not exceed the allowed region as shown in Fig.2 (b). Numerically, the step of rear LNS type crystal faces should be larger than 4 mm and that of two different type crystal faces should be larger than 40 mm [2].

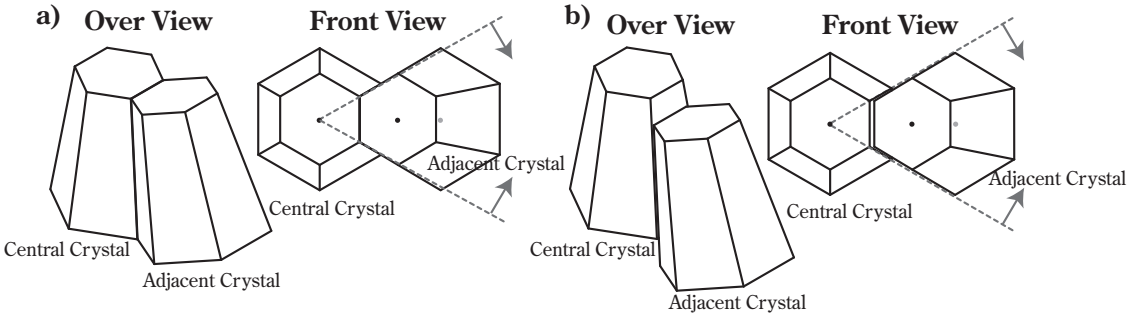

Fig.2. The arrangement of two CsI crystal modules. a) Two crystals are arranged so that the contact side face of the central one is identical with that of the adjacent one. b) The adjacent crystal is slid rearward. In the front view, the volume of the adjacent one should not exceed the angle formed by two vectors to the vertices of the front face of the central one sharing the center of the central one as an endpoint.

§3. Constructed SCISSORS Ⅲ

The crystal arrangement was made from 24th April to 13th May in 2006. Figure 3 shows the constructed SCISSORS Ⅲ. Since individual differences in the module shape exist, crystals are not laid out ideally. The step of rear LNS type crystal faces is about 10 mm at maximum. The front crystal faces cover from 60-460 mm in radius from z-axis. The position and direction of each crystal shall be measured in the near future.

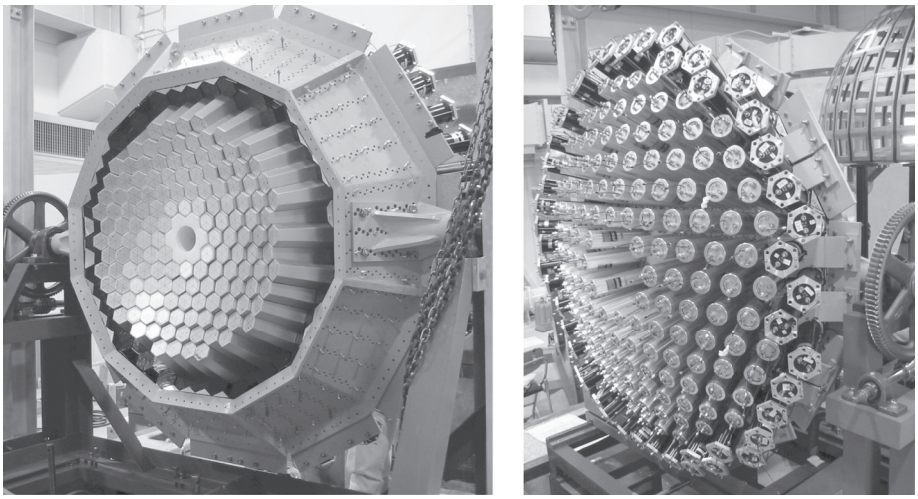

Fig.3. Constructed SCISSORS Ⅲ. The left panel shows a front view, and the right shows a rear one.

References

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

[2] T. Ishikawa: Internal GeV- γ analysis note No.37 (2006).

[3] H. Fukasawa: Internal GeV- γ analysis note No.09 (2005).