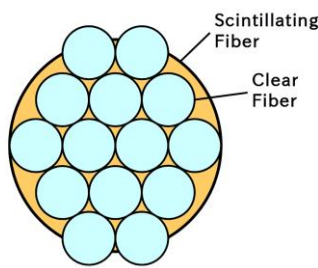


Development of Large-Area Charged Particle Detectors with High Position Resolution and Low Cost

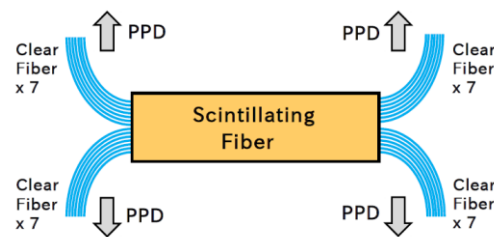
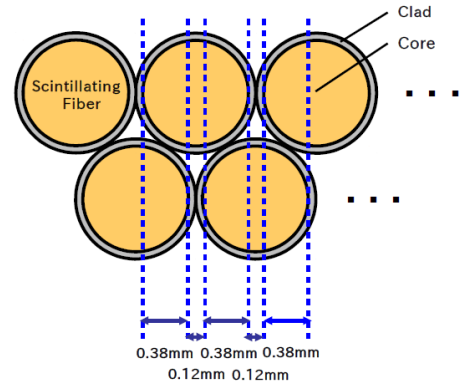
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We have developed two types of large-area charged particle detectors. The position resolution and cost are much excellent than those of drift chambers or other gas detectors.



One is a scintillation fiber detector with an effective area of 2 m x 2 m. A detector is composed of 2 layers and a layer is composed of 2000 scintillating fibers of 1 mm in diameters and double cladding. Since the width of the cladding is 0.06 mm, there are 0.38 mm of band in which a charged particle passes cores of two fibers and 0.12 mm of band in which a charged particle passes a core of up or down fiber, alternately. The position resolution is 0.13 mm (RMS).

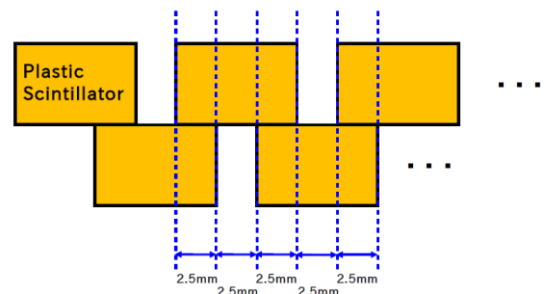


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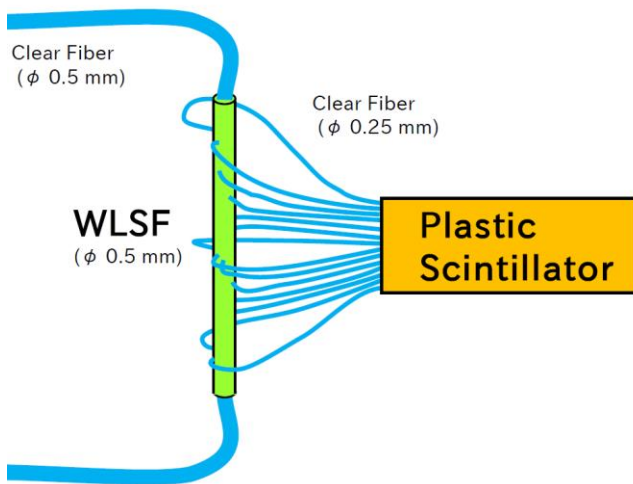
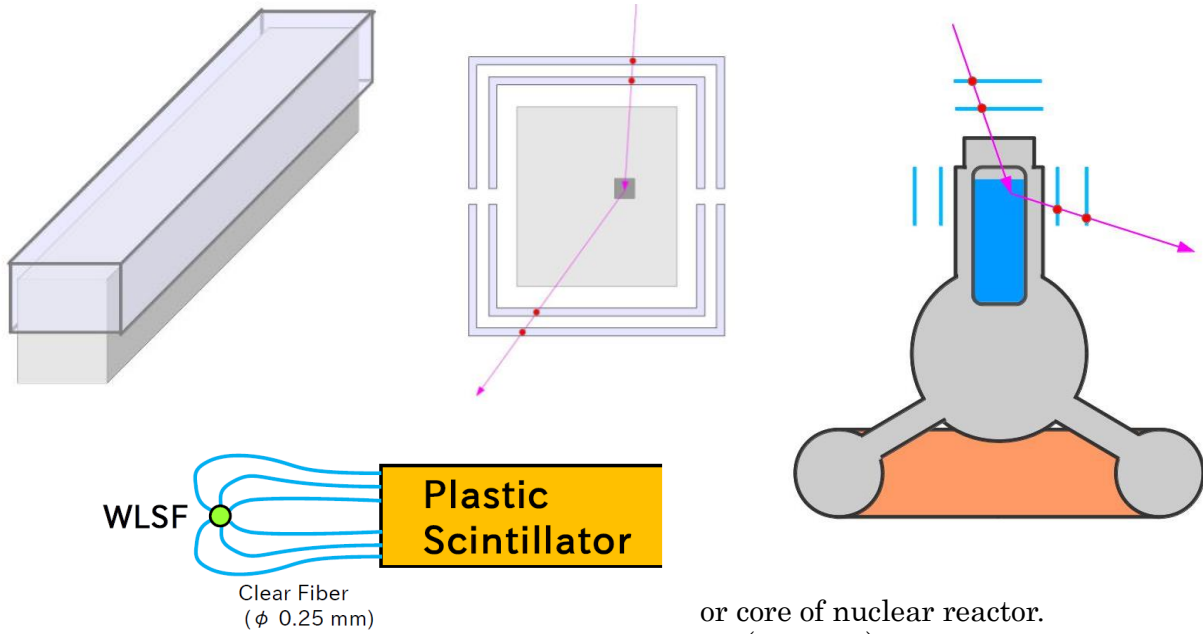
14 clear fibers of 0.25 mm in diameter are attached to each end surface of a scintillating fiber and 7 clear fibers are bundled. Thus, each scintillating fiber has 4 bundles. A four-digit octal number is assigned to each scintillating fiber. First bundle of 512 fibers of which the first digit are same number are gathered and attached to a photo detector. Second bundle of 512 fibers of which the second digit are same number are gathered and so on. The fired fibers are identified by only 32 photo-detectors.

The total length of the scintillation fiber is (2 m x 2000 x 2 sheets =) 8 km. The price of the scintillation fiber is about 5 dollars per meter. Since the average length of the clear fibers is 1 m, the total length of the clear fiber is (1 m x 28 x 2000 x 2 sheets =) 112 km. The clear fiber ESKA produced by MITSUBISHI Rayon Co. ltd. is widely used. The price of ESKA 0.25 mm is only 10 dollars per 1 km. Pixelated Photo Detector is a candidate for a photo-detector. The price is about 100 dollars including a read-out electronics. There are high rate of thermal noise. Another candidate is a 1/2" PMT.

The other is a scintillating plate detector with an effective area of 50~100 m². It contains about 20,000 ~28,000 plastic scintillator of which the cross section is 5 mm x 7.5 mm and the length is 620~700 mm. The reflecting film ESR produced by SUMITOMO 3M Co. ltd. is attached on the four side surfaces of the scintillating plate. The reflection efficiency of ESR is more than 99.7%. The gap between each plate is 2.5 mm and the position resolution is obviously 2.5 mm (FWHM) or 1 mm (RMS).



This detector is suitable for muon measurements and can be used for inspection of container



or core of nuclear reactor.

(30×20=) 600 clear fibers of 0.25 mm in diameters and 50 mm of average length ESKA 0.25 mm are attached on each end surface of a plastic scintillator. At the other end of the clear fivers, 6 sheets with 100 fibers are attached on the side surface of a wave length shifting fiber of which the diameter is 0.5 mm and the length is 30 mm. The full reflection on the outer surface of clear fiber of 50 mm transport almost all light which is transported inside the scintillating plate. More than 95% of scintillation light is absorbed in the core of WLSF and about 60% of light are re-emitted isotropically. On each end of the

WLSF, a clear fiber ESKA of which the diameter is 0.5 mm and the length is 10 m are attached. Full reflection occurred at the boundary surface between core and cladding of a clear fiber. The full reflection angle is 20 degree and 6% of re-emitted light satisfy the full reflection condition. The attenuation length inside ESKA 0.5 mm is about 30 m. About 10,000 photons are emitted inside the scintillating plate and 1,000 photons arrives on the end surface of plate. The number of re-emitted photons is about 500 and it of arrived photons at the end of ESKA 0.5 mm is about 10. It is not so many but enough to recognize that the connecting scintillating plate is fired or not. Thus each scintillating plate connects 4 clear fibers. A four-digit base-13 number is assigned to each scintillating plate and the fired plates are identified by only 52 photo-detectors.

The price of scintillating plate is a thousand dollars per 1 m². The price of ESLA 0.5 mm is 40 dollars per 1 km. It is expected that the total cost of this detector is 200 or 300 thousand dollars.

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