AUGERINFOCUS

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PIERRE AUGER OBSERVATORY

SCINTILLATION DETECTORS

Scintillator detectors take advantage of certain materials that, when exposed to ionizing radiation, generate a flash of light, known as scintillation. This phenomenon is triggered when radiation interacts with matter, causing the excitation and ionization of numerous atoms and molecules. By returning electrons to their ground state, these materials emit photons in or near the visible energy range.

A scintillator detector incorporates a scintillator material as its first transducer (a device that transforms one form of energy into another), responsible for converting ionizing radiation into visible photons. In organic scintillators, fluorine is used, the element responsible for fluorescence. A photodetector (another transducer) transforms the scintillation light into an electrical signal.

A photomultiplier consists of a photocathode and an electron multiplier. The photocathode releases electrons by absorbing photons, which are called photoelectrons. On the other hand, the electron multiplier is a set of interconnected electrodes at high voltage, designed to amplify the final signal with respect to the original signal and be able to measure it.

For cost reasons, in most cases photodetectors tend to have a smaller surface area than scintillators. To ensure that the photodetector captures the maximum amount of scintillation light, light guides are used, which consist of a set of optical fibers.

OPERATING PRINCIPLE

The particles in the cascade of secondary particles produced by cosmic rays interact with the scintillator material, transferring a fraction or all of their energy to the latter. A part of the absorbed energy is converted into visible photons through scintillation processes. The emitted light is guided to the photodetector through optical fibers. The photocathode of the photomultiplier absorbs photons and emits photoelectrons

The photoelectrons experiment a multiplication of approximately one million times in the photomultiplier tube, generating a current pulse that is processed electronically to analyze and count these pulses, with the purpose of obtaining information about the incident radiation.

Figure 1 shows the schematic of a scintillator detector, such as the Surface Scintillation Detectors (SSD) and those that are part of the Underground Muon Detectors (UMD).

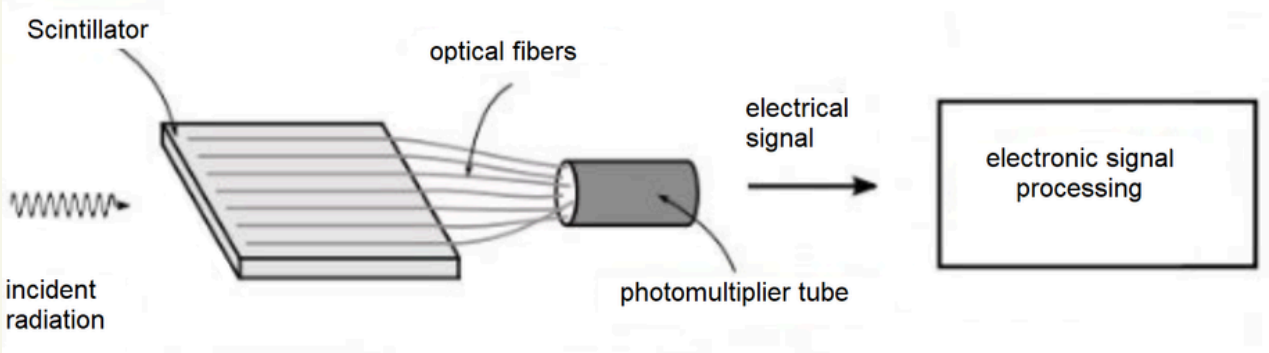

FIGURE 1. SCHEMATIC OF A SCINTILLATOR DETECTOR, COUPLED TO A PHOTOMULTIPLIER.

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