ArcaLux – a novel mass-producible flat-panel photon detector for high-energy astrophysics, homeland security and medical imaging

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The presented ArcaLux invention (patent protected) is a photon detector that is suitable for applications where low cost, industrial mass-production, extremely large quantities, high sensitivity, reliability and durability are essential. The photon detector is particularly useful for photon detection in dense media like water, liquid scintillator, plastic scintillator, or ice. It provides excellent optical coupling in dense media, has low buoyancy, simple mounting, unique robustness, unprecedented stability in high ambient pressures (e.g. deep ocean deployment), virtual insensitivity to accidental exposure to high levels of light, and insensitivity to the geomagnetic field. This invention combines three existing mass-production technologies: flat-panel field-emission and plasma TV screens, Geiger-mode APDs, and photocathode evaporation. The production facility will be very similar to a modern flat-panel TV screen factory, and the panel cost shuld be similar to the cost of a TV screen. The invention is therefore ideally suited for nuclear detection in homeland security, as well as for numerous applications in high-energy astrophysics and medical imaging.

The preferred embodiment of the invention is a monolithic flat-panel vacuum enclosure with a transparent front plate having a matrix of hollow hemispherical cells cast into the vacuum side of the window plate. The back plate may have matching hemispherical cells or may be a plain flat plate forming the second part of the evacuated enclosure. The interior of the hemispherical cells is coated with a material to form a photocathode. An electron detector or a scintillator is disposed at the center of the hemisphere preferably equidistant from all of the edges of the hemisphere.

Hollow reflectors are placed between the active hemispherical cells in the plane of the top plate to direct the light from dead regions between the hemispheres to the active hemispherical area, which leads to full area coverage. In addition, each of the reflectors preferably provides space for placement of getter vacuum pumps to remove residual gasses. The panel preferably includes a voltage plate in the middle that simultaneously distributes the anode and the cathode potentials to all pixels in the panel, creating an optimal electron lens in each pixel, together with the hemispherical cavities.

In use, the ‘vacuum part’ of the detector transforms incoming photons into electrons in the photocathode layer, and compresses the signal to such a small area that a very small and inexpensive semiconductor sensor may be used for the electron detection. Alternatively, the sensor may detect photoelectrons through the detection of scintillation light that the photoelectron creates in a small scintillator.