Smaller, Lower-Power Fast-Neutron Scintillation Detectors

There are numerous potential applications in scientific and safety-oriented monitoring of fast neutrons.

**NASA’s Jet Propulsion Laboratory, Pasadena, California**

Several decades ago, scintillation-based fast-neutron detectors were introduced as smaller alternatives to conventional fast-neutron detectors. A scintillation detector of this type includes a photomultiplier tube that monitors a block of a scintillator material (typically, a crystal or a plastic containing a hydrogen rich scintillation dye). A scintillation pulse occurs when a fast neutron knocks a proton in the scintillation material and some of the kinetic energy of the decelerating proton excites luminescence. Although the use of a block of scintillator material is a step toward miniaturization, a photomultiplier tube is still a bulky, high-power device.

The present development of miniature, low-power scintillation-based fast-neutron detectors exploits recent advances in the fabrication of avalanche photodiodes (APDs). Basically, such a detector includes a plastic scintillator, typically between 300 and 400 µm thick with very thin silver mirror coating on all its faces except the one bonded to an APD (see figure). All photons generated from scintillation are thus internally reflected and eventually directed to the APD. This design affords not only compactness but also tight optical coupling for utilization of a relatively large proportion of the scintillation light. The combination of this tight coupling and the avalanche-multiplication gain (typically between 750 and 1,000) of the APD is expected to have enough sensitivity to enable monitoring of a fast-neutron flux as small as 1,000 cm²s⁻¹. Moreover, pulse-height analysis can be expected to provide information on the kinetic energies of incident neutrons. It has been estimated that a complete, fully developed fast-neutron detector of this type, would be characterized by linear dimensions of the order of 10 cm or less, a mass of no more than about 0.5 kg, and a power demand of no more than a few watts.

This work was done by Jagdish Patel and Brent Blaes of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

**Innovative Technology Assets Management**

**JPL**

Mail Stop 202-237

4800 Oak Grove Drive

Pasadena, CA 91109-8099

(818) 354-2240

E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-41345, volume and number of this NASA Tech Briefs issue, and the page number.

Rotationally Vibrating Electric-Field Mill

The disadvantages of rotary couplings in conventional field mills could be avoided.

**NASA’s Jet Propulsion Laboratory, Pasadena, California**

A proposed instrument for measuring a static electric field would be based partly on a conventional rotatings-split-cylinder or rotating-split-sphere electric-field mill. However, the design of the proposed instrument would overcome the difficulty, encountered in conventional rotational field mills, of transferring measurement signals and power via either electrical or fiber-optic rotary couplings that must be aligned and installed in conjunction with rotary bearings. Instead of being made to rotate in one direction at a steady speed as in a conventional rotational field mill, a split-cylinder or split-sphere electrode assembly in the proposed instrument would be set into rotational vibration like that of a metronome. The rotational vibration, synchronized with appropriate rapid electronic switching of electrical connections between electric-current-measuring circuitry and the split-cylinder or split-sphere electrodes, would result in an electrical measurement effect equivalent to that of a conventional rotational field mill.

The figure depicts a version of the proposed instrument, the electrode assembly of which would include a hollow metal hemisphere split into four electrodes. Instead of a conventional rotary