Sidebar 2

eyes for gamma rays

Scintillation detectors mounted in satellites are the eyes that “see” bursts of gamma rays. Currently, our most distant eye, the Pioneer Orbiter circling Venus, contains a detector designed jointly by Los Alamos National Laboratory and Sandia National Laboratories. This detector consists of two scintillation spectrometers, mounted opposite each other at the periphery of the spacecraft, and a logic and data-storage module (see figure).

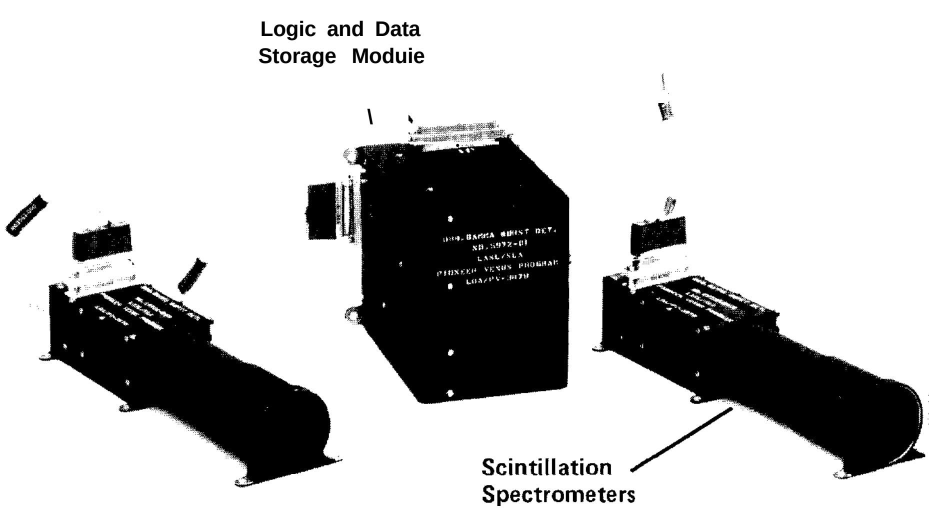
The “retina” in this system is a cylindrical cesium iodide crystal doped with a small amount of thallium. Gamma rays deposit energy in the crystal by kicking electrons from the crystal lattice. As the electrons recombine with positive charges at the thallium impurity sites, photons of visible light are produced; that is, the crystal "scintillates.” The number of photons is proportional to the gamma-ray energy. A photomultiplier tube bonded optically to the crystal detects the light and sends a signal to the logic and data-storage module.

Because the penetrating charged particles of cosmic rays also produce scintillation in the cesium iodide, the crystal is surrounded with a shell of plastic scintillator that is sensitive primarily to these particies. Scintillation in the plastic occurs quickly, and the logic circuits use this signal to reject the accompanying but later signal caused by charged-particle interactions in the crystal.

Energy-level discriminators split the signal into four ranges of gamma-ray energy: 100 to 200, 200 to 500, 500 to 1000, and 1000 to 2000 kiloelectron-volts (keV). A trace of radioactive californium-249 deposited on the scintillator is used for in-flight calibration of the system.

When a significant increase in the signal above the average background signal occurs, the system automatically stores the data and the time of the burst in a dedicated solid-state memory. The detector count-rate history is recorded at a basic interval of 12 milliseconds, but the interval can be shortened when the intensity of the signal warrants more rapid sampling. Because the background signal is being continuously stored in memory, the important initial rise of the burst wavefront is captured (for example, see Fig. 2 of the main article). Also, a set of spectral data is recorded with every set of sixteen 12-millisecond samples. These data are retrieved later upon command from Earth.

At present, this detector, and similar detectors on about seven other satellites, are watching the heavens for bursts of gamma rays. Twenty-nine burst events were recorded by the Venus Orbiter during 1979, including the energetic event of March 5, 1979. ■



The gamma-ray detection system aboard the Pioneer Venus Orbiter spacecraft.