

Small Active Radiation Monitor

This is a significant advancement over the passive dosimeters that presently monitor astronaut exposure to radiation.

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A device, named small active radiation monitor, allows on-orbit evaluations during periods of increased radiation, after extravehicular activities, or at predesignated times for crews on such long-duration space missions as on the International Space Station. It also permits direct evaluation of biological doses, a task now performed using a combination of measurements and potentially inaccurate simulations. Indeed the new monitor can measure a full array of radiation levels, from “soft” x-rays to “hard” galactic cosmic-ray particles. With refinement, it will benefit commercial (nuclear power-plant workers, airline pilots, medical technicians, physicians/dentists, and others) and military personnel as well as the astronauts for whom thermoluminescent dosimeters are inadequate.

Civilian and military personnel have long since graduated from film badges to thermoluminescent dosimeters. Once used, most dosimeters must be returned to a central facility for processing, a step that can take days or even weeks. While this suffices for radiation workers for whom exposure levels are typically very low and of brief duration, it does not work for astronauts. Even in emergencies and using express mail, the results can often be delayed by as much as 24 hours. Electronic dosimeters, which are the size of electronic oral thermometers, and tatters, small electronic dosimeters

that sound an alarm when the dose/dose rate exceeds preset values, are also used but suffer disadvantages similar to those of thermoluminescent dosimeters. None of these devices fully answers the need of rapid monitoring during the space missions. Instead, radiation is monitored by passive detectors, which are read out after the missions. Unfortunately, these detectors measure only the absorbed dose and not the biologically relevant dose equivalent.

The new monitor provides a real-time readout, a time history of radiation exposures (both absorbed dose and biologically relevant dose equivalent), and a count of the number of particles passing through a unit area. Better still, the monitor can be used anywhere. It is compact, measuring 8.3 by 4.8 by 1.9 cm, and has a solid-state diode and a thin protective coating that satisfy operational requirements — even at room temperature. Its preamplifier is a custom-made integrated circuit that has a range of approximately $(6 \text{ to } 12,000) \times 10^{-15}$ coulombs, and the monitor can provide charge amplification, signal shaping, peak stretching, and adjustable discrimination. Its analog-to-digital converter is an 8-bit, tri-state output device that converts data in less than 1 μ s. Finally, it has a power-down mode capability and selectable lower and upper reference discrimination.

Eighty pins enable the small active radiation monitor to have multiple inputs and outputs, two clocks (one for timing and one for display), power-saving features (including standby and halt modes), and selectable instruction cycles (1 to 122 μ s). Each monitor is capable of running continuously, performing data dumps from the microprocessor to memory once every minute. Each data point includes the calendar time of measurement, the dose, and an estimated quality factor. Weighted quality factors are determined from a look-up table that has been programmed into the microprocessor's read-only memory. The new monitor is a sophisticated and vastly improved tool that is capable of supporting extended-duration stays on the Space Station as well as long-distance space explorations.

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