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A miniaturized radiation detection system for spacecraft

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It has long been clear that a major problem in the study of the Earth's magnetosphere is the limited number of observation points, that is, of satellites containing radiation detectors. Furthermore those few satellites that exist are not optimally distributed within the magnetosphere for scientific studies. It has long been a dream to put at least a simple particle-detector system on all spacecraft; however the cost of doing so has remained prohibitive.

We decided to try another approach. All spacecraft have state-of-health sensors such as thermistors, which monitor temperatures at many locations in the vehicle. Therefore a particle sensor that required only the same resources as a state-of-health sensor could be integrated in spacecraft for minimal cost, using only those already existing interfaces. We began with a sensor to measure total dose, as such a measurement would furnish valuable space-weather engineering information and thus appeal to a wider audience. The Advanced Dosimeter System (ADS) is a hybrid microcircuit which directly measures total ionizing dose in a silicon test mass. The ADS has a size of 2.5 cm X 2 cm X 1 cm, and weighs 20 g. It requires 13 milliamps from the satellite's unregulated bus, and can operate over input voltage ranges from 12 to 40 volts. The dosimeter output consists of 5 analog outputs of 0-5 volts, providing 20 u-Rad resolution for a measurement range from 0 to 21.9 MRad. A logarithmic output is provided also. Many such dosimeters, placed throughout a satellite, will provide the radiation depth-dose profile in the vehicle and which can be directly compared with calculations using environmental models and radiation transfer computer codes. The space weather applications are obvious.

The ADS capabilities are to be expanded to include the separation of low-LET and

high-LET doses, and to make particle measurements. It is planned to reduce power and package by 30%. The present state of development will be described, sample calibration results shown, and future developments described in some detail.