Name of research institute or organization:

Project SPAESRANE (Solutions for the Preservation of Aerospace Electronic Systems Reliability in the Atmospheric Neutron Environment)

Title of project:

SPAESRANE environmental experiments

Project leader and team:

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Project description:

A range of detectors to monitor cosmic-ray effects in electronics has been deployed at the Jungfraujoch Sphinx over the period from January 2006. These detectors are as follows:

1. An Imaging Single-Event Effects Monitor (ISEEM, University of Central Lancashire). This is a novel monitor based upon the a commercial charge-coupled device (CCD) sensor directly to image charge packets resulting from nuclear interactions in semiconductor devices. ISEEM was deployed on 17 January 2006 and remains in situ at the time of writing (January 2007).

2. A Cosmic Radiation Effects and Activation Monitor (CREAM, QinetiQ). CREAM is a multichannel dosimeter providing time-resolved deposited energy measurements and calibrated against reference fields to provide radiobiological equivalent dose. CREAM has previously been deployed in a wide range or aircraft and spacecraft environments. CREAM was deployed at Jungfraujoch between 25 January and August 2006.

3. An experiment comprising five Unibrain Fire-i scientific webcams (MBDA UK). This experiment was deployed at Jungfraujoch between 30 January and 16 May 2006.

4. A portable cosmic ray three-band neutron detector (Lancaster University). The spectrometer was deployed on 23 November 2006 and remains in situ at the time of writing (January 2007)

The aims of the experiments are to

- Measure single-event effect (SEE)-inducing phenomena in the natural cosmic-ray field and compare with effects in accelerated test facilities.
- Gather data for validation of atmospheric radiation models.
- Reduce risk in the development of future advanced flight experiments for monitoring SEE-inducing phenomena in flight.

Example results from the UCLan ISEEM experiment are given below. Figure 1 is a montage of two events observed in the detector. In this image the grey scale represents the charge deposited in the CCD by the ionising products of nuclear reactions between cosmic ray particles and the constituent atoms of the CCD. The pixel resolution is 9 μm. Both events shown in Figure 1 show evaporation particles travelling in the plane of the CCD. To the left, two light evaporation particles, probably protons, are emitted. Together with the residual heavy ion (probably magnesium), this event deposits 832 fC in the body of the detector. The right hand event is similar but in this case an α particle is emitted and travels about 40 μm in the plane of the array. The charge collected from in this event is 534 fC.

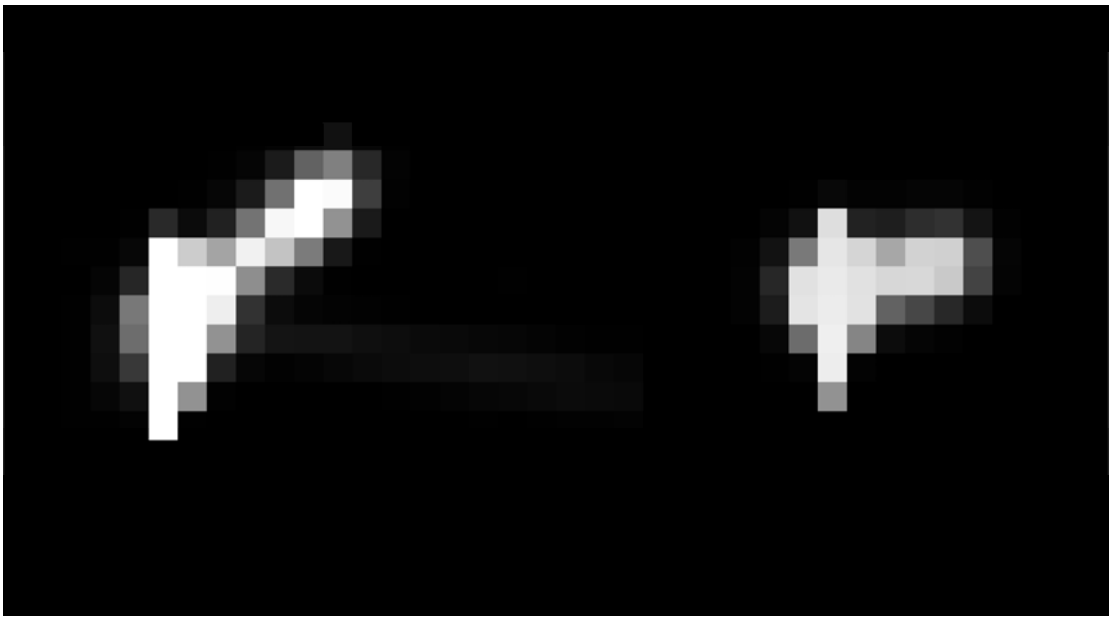

Figure 1 Example events occuring in ISEEM at Jungfrauoch

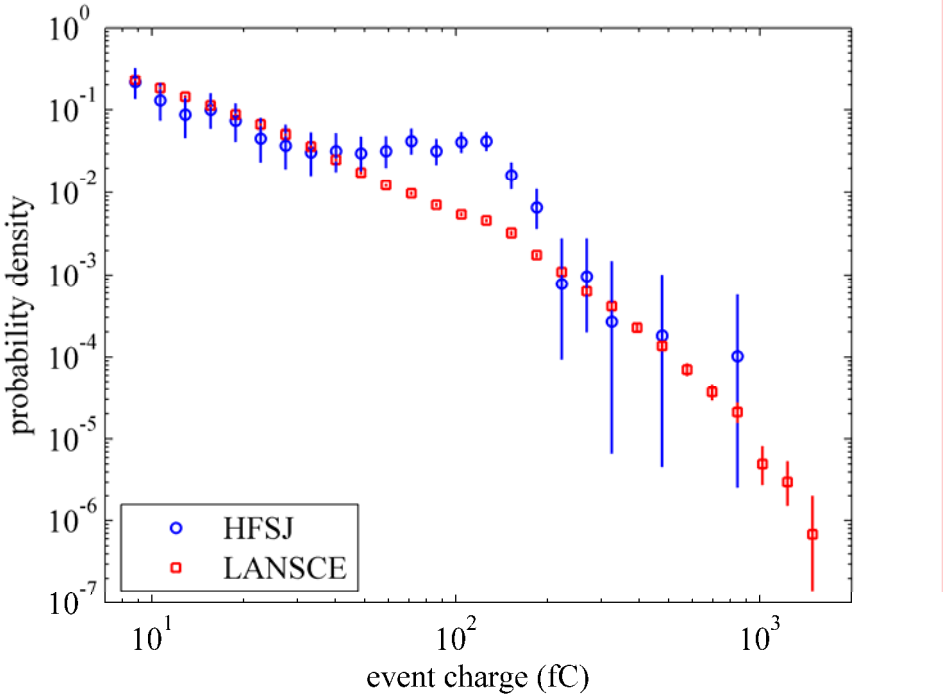

Figure 2 ISEEM charge collection spectra: Jungfraujoch and LANSCE compared

Figure 2 illustrates a differential charge-collection spectrum for events observed at HFSJ between 17 January and 12 September 2006. These data are compared with similar data gathered with ISEEM at the Los Alamos Neutron Science Center (LANSCE) ICE House, a high-intensity broadband neutron field used for accelerated testing of electronic components for susceptibility to upsets caused by cosmic ray neutrons. The peak in the HFSJ spectrum around 100 fC appears to be consistent with radioactive contamination of the ISEEM detector. Apart from that feature, charge collection spectra at Jungfraujoch and LANSCE are consistent. Exposure at Jungfraujoch is continuing to improve statistics. We are not aware of any previous work comparing charge-collection measurements in accelerated neutron fields with those in the natural cosmic-ray environment. We expect this work to contribute significantly to the validation of accelerated test facilities.

At the time of writing, the Imaging SEE Monitor and cosmic-ray neutron spectrometer remain deployed at Jungfraujoch. Data analysis and reporting are in progress.

Key words:

Cosmic rays, neutrons, electronic system reliability, single-event effects

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http://www.spaesrane.com

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