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Letter to the Editor

Sir,

Measurements in an Aircraft during an Intense Solar Flare, Ground Level Event 60, on the 15th of April 2001

Cosmic radiation is one of the contributors to the natural radiation environment, and the level of exposure from it increases with altitude. At sea level, the annual exposure level is about 0.3 mSv, whereas at air transport altitudes it can reach several µSv per hour. In 1990, the International Commission on Radiological Protection recommended that the radiation exposure due to cosmic rays at high altitudes be taken into account where appropriate as part of occupational exposure to radiation[1]. Cosmic radiation in aircraft is composed mostly of secondary particles created during the transport of primary cosmic rays in the Earth's atmosphere. These particles originate mostly (more than 90%) from galactic cosmic radiation. One can estimate the exposure level onboard aircraft experimentally or by calculation[2,3]. Experimental measurements are rather difficult to undertake when a large-scale series has to be organised. Calculations can provide an estimation of the influence of different parameters much more completely and easily, within a reasonable time. There are now several transport codes available which give reasonable estimations of onboard aircraft exposure levels. However, all of them calculate only the contribution due to the galactic component of cosmic radiation. This exposure level is predictable. When a rare giant solar flare occurs it has to be treated independently. Therefore, measurements onboard an aircraft during a solar event of that type would be highly valuable.

The present set of measurements made use of a variety of dosemeters, including a semiconductor spectrometer. An MDU[4] spectrometer, originally developed and extensively tested onboard cosmic vehicles, was used. Its sensitive element is a silicon diode, and a 256-channel spectrum analyser measures the energy deposited in the detector by individual particles, enabling it to distinguish the contributions from different types of radiation to integral dosimetric quantities. This spectrometer has been calibrated in photon, neutron and high-energy reference radiation fields. MDU units have been tested since the spring of 2000 during two calibration runs in the CEC-EC high-energy reference radiation field at CERN[2]. It was observed that the event spectra in the reference field do not depend on the field intensity and that there are clearly different spectra in the case of photon (low LET) exposures. In addition, it was observed that these spectra are very similar to the spectra registered in aircraft and/or balloon flights. To interpret the data measured onboard aircraft in terms of dose to silicon, (D(Si)), it was decided to use the CERN reference field results.

Since April 2000, the spectrometer has been used aboard aircraft during more than 130 commercial flights. All necessary flight parameters were acquired, and the spectrometer permitted the calculation of the rates of effective energy, E, that were then compared with the directly measured energy deposition rates in Si. In a collaboration with Czech Airlines and also in the frame of EC project FI5P/00/0068, the MDU module was installed on the 22nd of March 2001 on board a Czech Airlines A310-300 Airbus. The data acquisition time was chosen to be 10 minutes. The aircraft was flying mostly above the North Atlantic (96% of effective dose as calculated by the code CARI 6). On the 16th of April, we were informed that an important solar flare, designated Ground Level Event (GLE) 60, was observed on the 15th of April. The MDU module continued to acquire the data until the 7th of May because passive neutron dosemeters and LET spectrometers were also being exposed. After the flight, when the data were transferred from the flash memory of the spectrometer to the computer, a clear excess in the exposure level during the 15th of April flight from Prague to New York was observed. First, the results of the measurements were compared with independent data on GLE 60. Such a comparison is presented in Figure 1. It can be seen that the correlation of the times and shapes of between onboard measured results and the data from the Oulu (Finland) cosmic radiation monitor, as well as with the GOESS-measured high energy proton fluxes, is evident.

Using navigation data, the effective dose rate due to the galactic cosmic ray component during the flight was calculated. The code CARI 6 was used for this purpose. The results obtained are shown in Figure 2 and are compared with the results of onboard measurements. One can see that the solar event produced an excess in the 'normal' exposure level due to the galactic

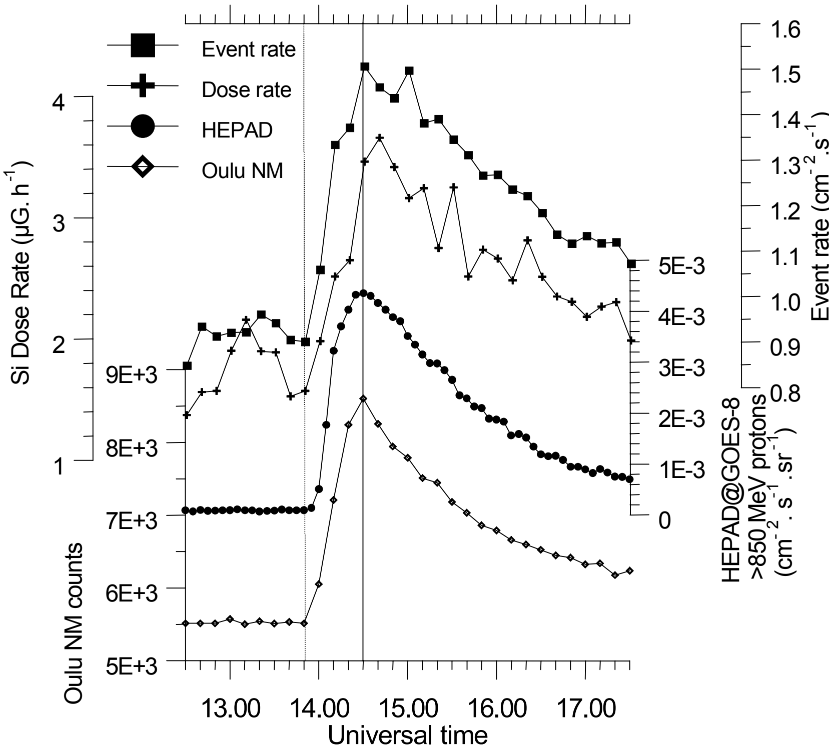

Figure 1. Comparison of onboard measured results with the data of the cosmic ray monitor (Oulu) and the GOESS high-energy proton fluxes.

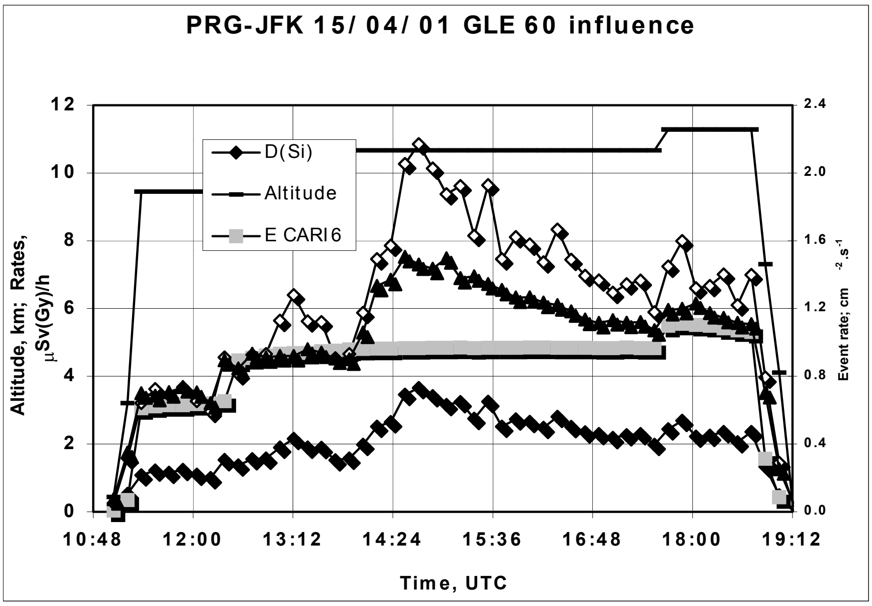

Figure 2. Flight data and experimental results from the Prague-New York flight on the 15th of April 2001.

component (as given by CARI 6) that was a little more than twice the dose rate in the silicon diode, and the apparent effective dose, recalculated on the basis of the CERN calibration, was about 80%, for the event rate. This also means that the event spectra are different for the galactic cosmic ray component and for the solar flare. The authors are now working on more detailed and deeper interpretation of these data in collaboration with other participants in the EC project and other colleagues. It was already estimated that the increase in exposure level for event GLE 60, based on cosmic ray monitor data and a specially developed code, would be about 2.06[5].

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