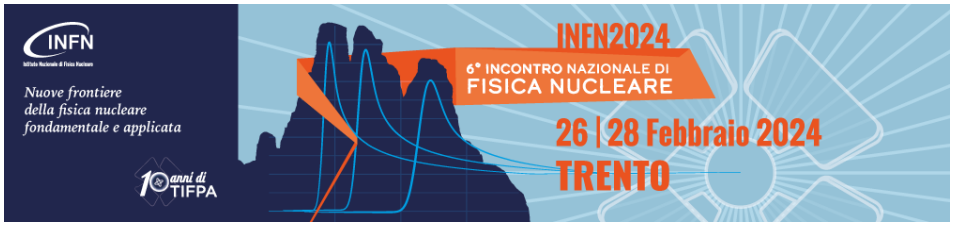

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A method to predict space radiation biological effectiveness for Galactic Cosmic Rays and intense Solar Particle Events

Wednesday, 28 February 2024 12:00 (20 minutes)

Space research is object of a renewed interest, also considering that human missions to the Moon, and possibly Mars, are being planned. Astronauts'exposure to space radiation is one the highest-priority problems. In the framework of the ARES project funded by INFN, we developed and applied the BIANCA biophysical model to calculate absorbed, equivalent and effective doses following astronauts'exposure to Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE) under different shielding conditions. More specifically, BIANCA allowed calculating the relative biological effectiveness (RBE) both for cell killing, which is related to non-cancer effects, and for chromosome aberrations, which are related to the induction of stochastic effects
including cancer. The calculations were performed first in a water phantom and then in the reference male and female computational phantoms recommended by ICRP.
The results were then compared with astronauts'dose limits for cancer and non-cancer effects. Concerning GCR exposure, the equivalent doses calculated multiplying the absorbed dose by the chromosome-aberration RBE were similar to those calculated using the Q-values recommended by ICRP. For a typical 650-day Mars mission at solar minimum, the obtained values were lower than the 1-Sv career limit recommended by ICRP, but higher than the 600-mSv limit recently adopted by NASA. More generally, both at solar minimum and at solar maximum, a 10 g/cm 2 Al
shielding resulted to be a better choice than 20 g/cm 2 . For the August 1972 SPE, a 10 g/cm 2 Al shield was sufficient to respect the 30-day limit for skin and blood forming organs (BFO). For the October 2003 SPE ("Halloween event"), a 5 g/cm 2 Al shield was sufficient to respect these limits. Smaller shielding values were sufficient for the January 2005 event, which had a harder spectrum (i.e., with higher-energy particles) but lower fluence and thus lower dose.
This work showed that BIANCA, interfaced with a radiation transport code, allows predicting GCR and SPE equivalent and effective doses based on the mechanisms underlying cell death and chromosome aberrations.

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