VISIT TO THE NASA SPACE RADIATION LABORATORY TO TEST RADIATION SHIELDING FOR SPACECRAFT

Activity report by Eszter Gulacsi, Astro SpArch

It will be critical for human space exploration to develop space radiation protection for the crew, for the crop and for the sensitive equipment on board. I'm working on different architectural space radiation shieldings using fungi that have a long history with Gamma rays but in deep space, Galactic Cosmic Rays and Solar Energetic Particle (SEP) events are the lethal radiations that need to be shielded against.

Galactic Cosmic Rays (GCRs) are isotropic and a constant threat therefore I wanted to do a GCR simulation. As GCR is 98-99% proton and helium, and 1-2% heavier elements, it was decided to simulate GCRs with protons in order to decrease the necessary radiation beam time significantly, from 70 min to 5 min. Most of the 70 min full GCR simulation is made up by the computer changing settings to change the particle beam.

The samples were made at the Institute of Pathology and Tropical Deceases Laboratory in Strasbourg (France) on the 12th of May as previous tests suggested that the fungi cover the 5.5cm Petri dishes and still have nutrition to grow 5 days after inoculation. The scheduled radiation beam time at the NASA Space Radiation Laboratory (NSRL) at the Brookhaven National Laboratory (BNL) in Upton, New York (US) was on the 17th of May, 2024.

I arrived in Strasbourg on the 10th of May and flew to JFK New York from Paris CDG on the 13th of May. From JFK, I had to drive to BNL, where I booked on-site accommodation, in the dormitory for 9 days. My check-in at the Guest/Visitor Centre (GUV Center), the iris scan and dispersible training were scheduled for the 14th of May. I received my BNL badge and TLD (personal dosimeter) from the GUV Center. After the iris scan, I went to get the key to my allocated biology laboratory at the Environment, Biology, Nuclear Science and Nonproliferation Directorate (NASA Support Facilities).

On the 15th of May, I went to NSRL to introduce myself and talk to the nuclear and particle physicists to learn about the radiation dose they would suggest and to discuss the radiation experiment. As NASA's mission-relevant space radiation dose is 0.25-0.75 Gy, my intentions upon arrival were to irradiate 2 of each type of fungi, ARMOR samples and control with 0.5 Gy radiation dose and later 0.75 Gy, both with 1000 MeV energy. NASA has measured 77μSV/hour radiation during the transit to Mars and considers 250 mSv for 180 days. That 250mSV is 0.25 Gy. However, after discussing the particle physics and the available

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equipment at the lab, several times before the beam time, we decided on having 2 separate sets of all 5 samples (including 1 control sample).

Both sets were irradiated on the 17th of May (Friday) with 1Gy at 100 MeV but one set had a 0.367 cm aluminium sheet in front to slow the protons and create a secondary radiation shower. We tried to shield the detector from background radiation but it was a crude structure.

I wanted to measure temperature before, during and after radiation behind the samples and on the surface, unfortunately, thanks to a software update the day before, the laboratory's cameras did not work so we had no way of taking note of the measured temperature at this time.

After irradiation, both sets of samples were pretty hot. A Facility Support Technician measured 180 μR/hour on one set, and 250 μR/hour on the other set, therefore I had to wait hours before the samples could leave the building of NSRL. While waiting, I had the honour to meet the Director of BNL and the Associate Director of Nuclear and Particle Physics. Both of them came to visit NSRL and I was asked to talk about my experiment and experience at the lab. By the evening, my samples were cleared and I could take them to my lab at the Medical Building and left them in the incubator for the night. The next day I re-plated the fungi from all 6 plates and took spore samples.

On the 20th of May, I cut thin sections from an irradiated sample and its non-irradiated pair (inoculated on the 12th of May with the same fungi liquid culture), and placed them onto microscope slides with lactophenol blue. I took some photos under the inverted microscope.

Later, I went to NSRL to meet with the physicists to get help analysing the data during the irradiation. 21st of May (Tuesday) was spent packing, cleaning the lab, and a 2-mile walk with hundreds of BNL employees.

I drove back to the rental car agency, Hertz at JFK on the 22nd of May and flew back to Turin (Italy) through Madrid (Spain). I landed in Turin on the 23rd of May.

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