NEWSLETTER

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Content

BIOSPHERE Training course and 1st stakeholder workshop.

The BIOSPHERE training course and the 1st stakeholder workshop on "*New methodologies and developments to investigate the influence of extraterrestrial radiation in the biosphere*" was organized by UJF CAS, CMI, and PTB on October 1-2, 2024, in Prague and at the Milešovka observatory, Czech Republic. The event attracted over 50 participants, including both in-person and online attendees.

The course focused on new methods and techniques developed within the project, specifically on methods capable of identifying and establishing correlations between cosmic rays, solar UV radiation, and the thickness of the ozone layer, as well as assessing their mutual effects on biological systems.

Taking advantage of the ongoing third measurement campaign at the Milešovka Observatory (running from mid-August 2024 to mid-November 2024), participants were provided with a unique opportunity to see the instruments in action.

The first day featured lectures introducing key topics, including an invited presentation by Prof. Ashot Chilingarian, head of Cosmic Ray Division (CRD) at the A.I. Alikhanyan National Laboratory (Yerevan Physics Institute), titled "*Modulation of Cosmic Rays in the Earth's Atmosphere*". On the second day, participants joined an excursion to the Milešovka Observatory, where they observed the instruments in operation and received on-site explanations of their functionality. Prof. Chilingarian also presented the SEVAN detector installed at the observatory, part of the SEVAN network (http://crd.yerphi.am/space_environmental_viewing_and_analysis_network).

Excursion to the Milešovka observatory (October 2, 2024).

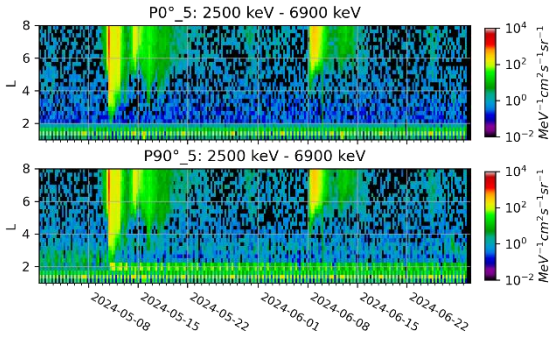
On-site explanations of the functionality of the cosmic ray detectors participating in the third measurement campaign at the Milešovka Observatory.

The topic of the project and the third measurement campaign captured significant media interest. Coverage included a report aired on Czech Television News and broadcasts on Czech Radio.

Iva Ambrožová with a journalist from Czech Television (Photo: D. Šebek).

Mother's Day solar storm of 11 May 2024 and its effect on Earth's radiation belts

The strongest geomagnetic storm of the last 20 years occurred on May 11, 2024, caused by a large solar eruption that produced beautiful auroras in many European countries at unusually low latitudes. It has been called the Mother's Day event due to its date. This geomagnetic storm had important consequences on the terrestrial environment of the Earth, and especially on the radiation belts as explained in this new publication (Pierrard et al., 2024, https://doi.org/10.3390/universe10100391). Indeed, for the first time since the launch in 2013 of the PROBA-V satellite with the Energetic Particle Telescope (EPT) detector on board, an injection of energetic protons in the South part of the South Atlantic Anomaly was observed. Moreover, four electron belts were observed after the storm instead of the usual inner and outer belts, which was never seen before.



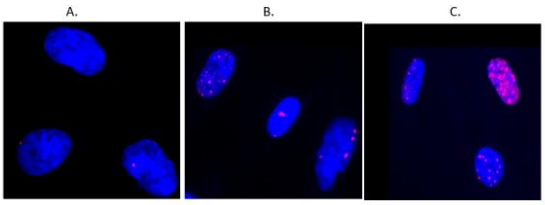
The figure above shows proton differential fluxes injected at high radial distances (here L in Earth radii Re) on 11 May and 27 days later after a full solar rotation on itself. The METOP/MEPED 0° telescope (top panel) observes the precipitating protons, while the MEPED 90° telescope (bottom panel) shows the rare injection of protons in the trapped radiation belt below 2.3 Re on 11 May 2024.

Registry and database for radiobiological experiments

There is a tremendous need to obtain and share knowledge on biological studies for humans exposed to various irradiation scenarios, especially ones that mimic normal or extreme environmental exposures. In response to this challenge, BIOSPHERE announces that a 'good practice' guide

(REGISTRY) on the major methods, protocols and reagents, used under the framework of BIOSPHERE to assess the response of skin and blood cells exposed to relatively low doses of energetic protons/gamma rays and UVB, either as single or combined radiation, has been issued as open access at https://doi.org/10.5281/zenodo.12547395. In addition, Metadata for the already published radiobiological database 'Metadata for RadPhysBio: A Radiobiological Database for the Prediction of Cell Survival upon Exposure to Ionizing Radiation' is available at https://doi.org/10.5281/zenodo.12582566. A holistic perspective was applied, combining various components of the stress response of cells under irradiation, comprising geno- and proteotoxicity, oxidative and hypoxic stress as well as inflammation. The guide that will be continuously updated is addressed to the radiobiology community as a means for sharing expertise and research tools.

In the frame of WP4 "Effects of combined SCR and UV radiation fields on biological systems", DNA damage and repair was assessed by performing γH2AX immunofluorescence in human normal fibroblasts (HS27) following exposure to protons, gamma rays, UVB and their combination.

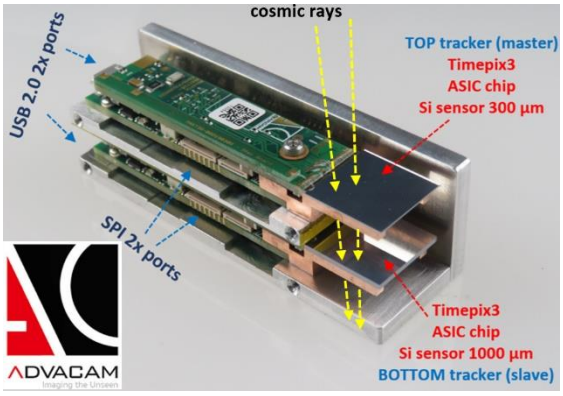


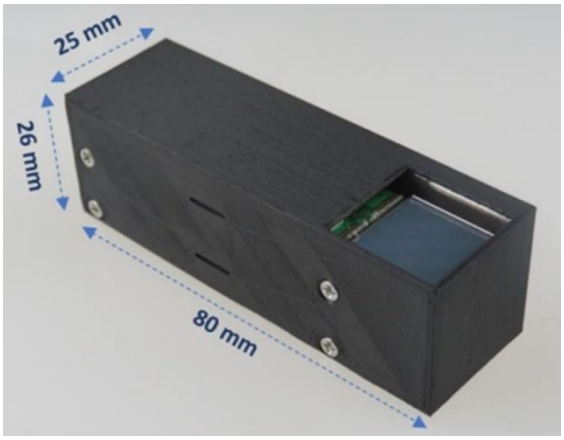
Images above were obtained through application of fluorescence microscopy: (A) unirradiated cells, (B) cells exposed to 0.5 Gy protons and (C) cells co-exposed to 100 J/m^2 UVB and 0.5 Gy protons, all 24 h post-irradiation (nucleus: blue color, DNA damages-double strand breaks: red color foci). Pan-nuclear staining of the cell in the upper right corner with many foci indicates very high levels of stress.

The increased signal of γH2AX repair protein (DNA double strand breaks) following co-exposure to gamma rays and UVB was also validated by Transmission Electron Microscopy (TEM) by applying the immunogold labeling technique.

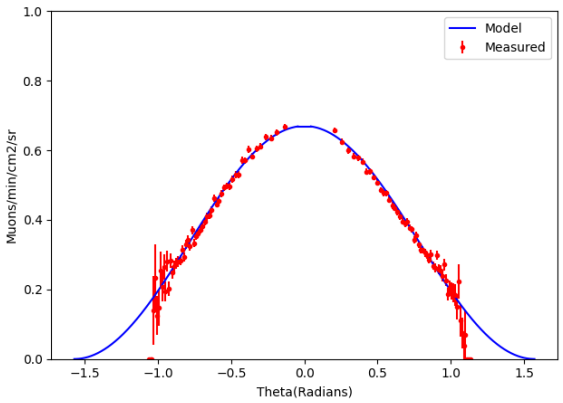
Muon tracking with miniaturized 2× stack Timepix3 telescope

The secondary cosmic radiation field during the 3rd measurement campaign at the Milešovka Observatory is measured in high resolution and enhanced resolving power with a miniaturized particle telescope 2× stack Timepix3 (https://advacam.com/camera/minipix-tpx3/) – see photo of the stacked pixel detectors (top) and assembled radiation camera (bottom).





Data is processed with previous calibration database, AI and pattern recognition algorithms using an integrated database and SW tool DPE-TraX (https://advacam.com/camera/trax-engine/). The composition and spectral characterization of the mixed-radiation field is resolved into particle species. The resulting angular flux of muons measured in the atmosphere is shown below.



For further details, see: C. Granja, J. Jakubek, P. Soukup, *et. al*., Spectral tracking of energetic charged particles in wide field-of-view with miniaturized telescope MiniPIX Timepix3 1×2 Stack, J. of Instrum. JINST 17 (2022) C03028 https://doi.org/10.1088/1748-0221/17/03/C03028.

Total Ozone Column (TOC) and UV index measurement: BTS-Solar, BTS2048-UV-S-WP and GUV

Two BTS high-end weatherproof array spectroradiometers operated by Gigahertz Optik GmbH (GGO) and DWD (Deutscher Wetterdienst: German Meteorological Service) are running at different measurement campaigns in this project [Athens (Greece), Brussels (Belgium), Milešovka (Czech Republic), Lindenberg (Germany)]. One for TOC measurements by direct sun tracking and one for global spectral irradiance in the UV (to compute the UV index). More information can be found here: BTS-Solar (https://www.gigahertz-optik.com/en-us/product/bts-solar/), BTS2048-UV-S-WP (https://www.gigahertz-optik.com/en-us/product/bts2048-uv-s-wp/).

The Royal Belgian Institute for Space Aeronomy (BIRA-IASB) contributed to UV index measurements during all campaigns using absolute calibrated radiometers (UVB pyranometer, multichannel filter radiometer) and a double monochromator.

The picture below shows the UV and TOC measurements instruments on the platform of Milešovka Observatory (third campaign: August-November 2024). From left to right: GUV and UV pyranometer (UV index, from BIRA-IASB), BTS2048-UV-S-WP (UV spectral irradiance, UV index from DWD), BTS-Solar (TOC, from GGO).

Upcoming events until May 2025

Conference/ Workshop	Date/Location	Reason for attending
PHITS Workshop and Intermediate Course at Japan Atomic Energy Agency in Tokai	February 2025/ Tokai, Japan	Presentation on the use of PHITS in BIOSPHERE measurement campaigns.
EURADOS Annual Meeting 2025, WG11 meeting	February 2025/ Bucharest, Romania	Update on the BIOSPHERE project and measurement campaigns
EURADOS Annual Meeting 2025, WG 3 meeting	February 2025/ Bucharest, Romania	Update on the BIOSPHERE project and measurement campaigns with a focus on charged component of

		secondary cosmic radiation
Annual International Astrophysics Conference (AIAC)	April 2025/ Compostela, Spain	Presentation of Biosphere solar wind events
EGU 2025	April 2025/ Vienna, Austria	Presentation of evolution of the South Atlantic Anomaly during solar events, min and max activity
ConRad 2025 (26th Nuclear Medical Defence Conference)	May 2025/ Munich, Germany	Presentation on the achievements of BIOSPHERE/ Radiobiology experiments

Past events

Please visit our homepage:

https://euramet-biosphere.eu/index.php/conferences-and-meetings

Our publications

1) **Solar Wind Density and Core Temperature Derived From the PSP Quasi-Thermal Noise Measurements**, Xianming Zheng, Kaijun Liu, Mihailo M. Martinović, Viviane Pierrard, Mingzhe Liu, Qingbao He, Kun Cheng , Yuqi Liu, and Yan Wang, The Astrophysical Journal, 963:154, 2024, https://doi.org/10.3847/1538-4357/ad236d
2) **Computer-Aided Identification and Design of Ligands for Multi-Targeting Inhibition of a Molecular Acute Myeloid Leukemia Network**. Asfa SS, Arshinchi Bonab R, Önder O, Uça Apaydın M, Döşeme H, Küçük C, Georgakilas AG, Stadler BM, Logotheti S, Kale S, Pavlopoulou A. Cancers (Basel). 2024 Oct 25;16(21):3607. doi: 10.3390/cancers16213607. PMID: 39518047; PMCID: PMC11544916.
3) **RadPhysBio: A Radiobiological Database for the Prediction of Cell Survival upon Exposure to Ionizing Radiation**. V. Zanni, D. Papakonstantinou, S.A. Kalospyros, D. Karaoulanis, G.M. Biz, A. Adamopoulos, A. Pavlopoulou, A.G. Georgakilas, Physica Medica, Volume 127, Supplement 1, 2024, 104568, ISSN 1120-1797, https://doi.org/10.1016/j.ejmp.2024.104568.
4) **Induction of complex DNA damage after proton therapy beam irradiation to plasmid DNA and human prostate cancer cells**. Souli, M. P., Nikitaki, Z., Spyratou, E., Efstathopoulos, E. P., Sihver, L., & Georgakilas, A. G. (2024). PP. 7.2 Physica Medica, 127, 104613.
5) **Radiobiological effects of protons or gamma rays and UVB radiation on human cells**. Gkikoudi, A., Vasilopoulos, S. N., Beinke, C., Al-Qaaod, A., Giesen, U., Krasniqi, F. & Georgakilas, A. G. (2024). O. Physica Medica, 127, 104567.
6) **Development and evaluation of a proton irradiation experimental setup for use in human cells**. Zonitsas, S., Gkikoudi, A., Vasilopoulos, S. N., Georgakopoulou, A., Chasapoglou, S., Diakaki, M. & Georgakilas, A. G. (2024). P. Physica Medica, 127, 104707.
7) **Flash radiation therapy: a review on the ultra-high dose rate paradigm of radiotherapy**. Koutsostathis, A., Rangos, V., Adamopoulou, A., Koumenis, C., & Georgakilas, A. G. (2024). P. 1.19 Physica Medica, 127, 104641.
8) **The Mother's Day solar storm of 11 May 2024 and its effect on Earth's radiation belts**. Viviane Pierrard, Alexandre Winant, Edith Botek, and Maximilien Péters de Bonhome, Universe, 10, 10, 391, 10 October 2024, https://doi.org/10.3390/universe1010

0391 (data DOI: 10.5281/zenodo.13626553)

9) **Statistics and models of the electron plasma density from the Van Allen Probes**. Ripoll, J.-F., S. Thaller, D. Hartley, D. Malaspina, W. Kurth, G. S. Cunningham, V. Pierrard, J. Wygant, Journal of Geophys. Res.: Space Physics, 129, e2024JA032528. https://doi.org/10.1029/2024JA032528.
10) **Radial Evolution of Non-Maxwellian Electron Populations Derived from Quasi-Thermal Noise Spectroscopy: Parker Solar Probe Observations**, December 2024. Zheng X., Mihailo M. Martinović, Kaijun Liu, Viviane Pierrard, Mingzhe Liu, Kun Cheng, https://doi.org/10.3847/1538-4357/ad236d.
11) **High-resolution mapping of secondary cosmic rays by miniaturized stacked pixel telescope**. Carlos Granja, Herve Chanalb et al., journal of the Czech TU Prague, Acta Polytechnica.
12) **Dual Targeting of DNA Damage Response Proteins Implicated in Cancer Radioresistance**. Vasilopoulos, S.N.; Güner, H.; Uça Apaydın, M.; Pavlopoulou, A.; Georgakilas, A.G. Genes 2023, 14, 2227. https://doi.org/10.3390/genes14122227
13) **DExplore: An Online Tool for Detecting Differentially Expressed Genes from mRNA Microarray Experiments**, Katsiki, A.D.; Karatzas, P.E.; De Lastic, H.-X.; Georgakilas, A.G.; Tsitsilonis, O.; Vorgias, C.E. Biology 2024, 13, 351. https://doi.org/10.3390/biology13050351
14) **RadPhysBio: A Radiobiological Database for the Prediction of Cell Survival upon Exposure to Ionizing Radiation**, Zanni, V.; Papakonstantinou, D.; Kalospyros, S.A.; Karaoulanis, D.; Biz, G.M.; Manti, L.; Adamopoulos, A.; Pavlopoulou, A.; Georgakilas, A.G., Int. J. Mol. Sci. 2024, 25, 4729. (https://doi.org/10.3390/ijms25094729) Link to the database: (http://radbiodb.physics.ntua.gr/radphysbio/)
15) **Effects of the Sun on the space environment of the Earth**, Pierrard V., Book at Presses Universitaires de Louvain, ISBN: 978-2-39061-442-5, 208 p., 2024. (https://i6doc.com/en/book/?gcoi=28001100628290)
16) **Geomagnetic Storm Effects on the LEO Proton Flux during Solar Energetic Particle Events**, Kirolosse M. Girgis, Tohru Hada, Akimasa Yoshikawa, Shuichi Matsukiyo, Viviane Pierrard, Susan W. Samwel, Space weather, 21, 12, e2023SW003664, doi: 10.1029/2023SW003664, 2023. (https://doi.org/10.1029/2023SW003664)
17) **The Role of Plasmasphere in the Formation of Electron Heat Fluxes**, Khazanov G. V., Pierrard V., Ma Q., Botek E., Journal of Geophys. Res.: Space Physics, Vol.128, Issue 11, November 2023, e2023JA032013 (https://doi.org/10.1029/2023JA032013)
18) **The atmospheric influence on cosmic ray induced ionization and absorbed dose rates**, Alexandre Winant, Viviane Pierrard, Edith Botek, Konstantin Herbst, Universe, 9, 502, 1-17, 2023. https://doi.org/10.3390/universe9120500
19) **Exospheric Solar Wind Model Based on Regularized Kappa Distributions for the Electrons Constrained by Parker Solar Probe Observations**, Pierrard V., Halekas J.,

Audoor C., and M. Péters de Bonhome, P. Whittlesey and R. Livi, Plasma, 6, 518-540, 2023. https://doi.org/10.3390/plasma6030036

20) **Comparison of radiation belts electron fluxes simultaneously measured with PROBA-V/EPT and RBSP/MagEIS instruments**. Winant, A., Pierrard, V. & Botek, E., Ann. Geophysicae, 41, 313–325, 2023. https://doi.org/10.5194/angeo-41-313-2023
21) **Prediction of radiation belts electron fluxes at a Low Earth Orbit using neural networks with PROBA-V/EPT data**. Botek, E., Pierrard, V., & Winant, A., Space Weather, 21, e2023SW003466, 2023. https://doi.org/10.1029/2023SW003466
22) **Combined experimental and theoretical study on the elastic electron scattering cross sections of ethanol**. Dinger, M., Park, Y., Hepperle, P. and Baek W.-Y., Eur. Phys. J. D 77, 52, 2023. https://doi.org/10.1140/epjd/s10053-023-00632-6
23) **More than Meets the Eye: Integration of Radiomics with Transcriptomics for Reconstructing the Tumor Microenvironment and Predicting Response to Therapy**. Logotheti, S., Georgakilas, A.G., Cancers, 15, 1634, 2023. https://doi.org/10.3390/cancers15061634
24) **Proton flux variations during Solar Energetic Particle Events, minimum and maximum solar activity and splitting of the proton belt in the South Atlantic Anomaly**, Pierrard V., S. Benck, E. Botek, S. Borisov, A. Winant, Journal of Geophysical Research: Space Physics, 128, e2022JA031202, 2023. https://doi.org/10.1029/2022JA031202
25) **Intense Storm at Low Earth Orbit and Geostationary Transfer Orbit**. Viviane Pierrard, Alexandre Winant, Edith Botek, Jean-François Ripoll, Mélanie Cosmides, David M. Malaspina, Geoffrey D. Reeves and Scott A. Thaller, Simultaneous Observations of the 23 June 2015 Intense Storm at Low Earth Orbit and Geostationary Transfer Orbit, URSI Radio Science Letters, Vol. 4, 2022. doi: 10.46620/22-0016
26) **Modeling of the cold electron plasma density for radiation belt physics**. Ripoll J-F, Pierrard V., Cunningham G.S., Chu X., Sorathia K.A., Hartley D.P., Thaller S.A., Merkin V.G., Delzanno G.L., De Pascuale S. and Ukhorskiy A.Y., Front. Astron. Space Sci. 10:1096595, 2023. doi: 10.3389/fspas.2023.1096595
27) **Radiation Type- and Dose-Specific Transcriptional Responses across Healthy and Diseased Mammalian Tissues**. Sagkrioti, E.; Biz, G.M.; Takan, I.; Asfa, S.; Nikitaki, Z.; Zanni, V.; Kars, R.H.; Hellweg, C.E.; Azzam, E.I.; Logotheti, S.; Pavlopoulou, A.; Georgakilas, A.G., Antioxidants, 11, 2286, 2022. https://doi.org/10.3390/antiox11112286
28) **Clustered DNA Damage Patterns after Proton Therapy Beam Irradiation Using Plasmid DNA**. Souli, M.P.; Nikitaki, Z.; Puchalska, M.; Brabcová, K.P.; Spyratou, E.; Kote, P.; Efstathopoulos, E.P.; Hada, M.; Georgakilas, A.G.; Sihver, L. Int. J. Mol. Sci., 23, 15606, 2022. https://doi.org/10.3390/ijms232415606
Dual Targeting of DNA Damage Response Proteins Implicated in Cancer Radioresistance

29) Vasilopoulos, S.N.; Güner, H.; Uça Apaydın, M.; Pavlopoulou, A.; Georgakilas, A.G.., Genes 2023, 14, 2227. https://doi.org/10.3390/genes14122227

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For the time being, the project BIOSPHERE has established the following collaborations by a Letter of Agreement (in the order of signature date): Collaborators by signed letters of agreement:

1. Bundeswehr Institute of Radiobiology, Germany,
2. UK Health Security Agency (Radiation Effects Department), United Kingdom,
3. University of Naples Federico II (Radiation Biophysics Laboratory), Italy,
4. Biomedical Research Foundation of the Academy of Athens, Greece.