AIR²
Access to INFRASTRUCTURES for Radiation protection Research

Special Issue 4
February 2019

Editorial

I warmly welcome this Special Issue dedicated to NASA's infrastructures. I recall with emotion my encounter with Walter Schimmerling, former chief scientist on the NASA Space Radiation Health Program, during my first GSI congress in Darmstadt in the late 1980s. We spoke of "Saturne", an exposure platform in Saclay, France, which allowed cells and animals to be exposed to high-energy heavy ions. Walter had spent a year there and still spoke impeccable French, and I had just done my first thesis experiments there. I bitterly regretted that this fabulous tool for studying the biological effects of heavy ions was no longer available as physicists had lost interest in it. "Saturne" being closed at the end of the 80s, the radiobiologists had to wait many years before being able to work again on this topic. The SIS in Darmstadt and the NASA Space Radiation Biology Laboratory in Brookhaven (described in this issue) now simulate the space radiation environment and provide access to biological laboratories adapted to their experimental needs.

Today, we must ensure that great care is taken to sustain infrastructures essential to radiation protection research.

Dr Laure Sabatier, CEA

The floor to...

The NASA Human Research Program Space Radiation Element

With missions to Mars on the horizon, NASA is developing capabilities to send humans into interplanetary space to live and work for extended periods.

These missions will push the boundaries of the human system, exacting a toll on physical and mental health, and will require careful controls to ensure crew safety and mission success. Crew will be at a greater risk of exposure to solar flares and will receive higher levels of galactic cosmic rays (GCR) exposure, made up of high energy protons and high charge and energy (HZE) ions and secondary particles produced in spacecraft shielding and human tissues. HZE ions differ from terrestrial radiation such as X- or gamma-rays, imparting unique biological damage as they traverse tissue and cells.

NASA's Space Radiation Element (SRE) focuses on characterization and mitigation of health risks associated with space radiation exposure and interaction with other spaceflight stressors (www.nasa.gov/hrp/elements/radiation). Cancer (lung, breast, stomach, colon, bladder, leukemias) is a key health risk and a major factor restricting how many "safe days" an astronaut can spend in space. Risks to the central nervous system may result in early, in-flight cognitive or behavioral impairments, and late degenerative effects include cardiovascular disease, accelerated aging, neurodegeneration, and chronic immune dysfunction.

SRE research strives to decipher quantitative as well as qualitative differences in biological responses produced by GCR compared to terrestrial radiation. Understanding the impact of individual susceptibility, identification of biomarkers, risk surveillance and assessment, and research on medical countermeasures are significant interests. SRE conducts research at the NASA Space Radiation Laboratory (NSRL) at Brookhaven National Laboratory where a beamline is dedicated to the radiobiology and physics of HZE ions. Exciting new capabilities for GCR simulation at the NSRL are under development.

To increase synergy in this humankind endeavor to travel to the stars, SRE invites collaborations from interested groups.

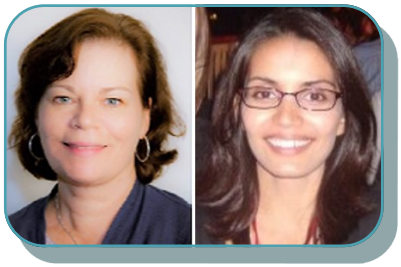

Photo: NASA

Dr Janice Huff (left)
Deputy Element Scientist for Space Radiation

Dr Zarana Patel (right)
Cardiovascular/Degenerative Tissue Lead Scientist for Space Radiation

CONCERT CORNER

Future events:

26-27 March 2019
CONCERT review meeting by the EC, Brussels

Call for Travel Grants
Next deadline: 31st March 2019
Information

14-18 October ERPW 2019
14th October: MB & ExB/ESAB

WP 6 News:

The first version of CONCERT's Web-handbook (D6.4) is now online!

AIR²D²:
- Please complete the online form(s) to register your infrastructure(s) in the database.

Follow STORE on Twitter: @STOREDatabase

Follow the TERRITORIES PROJECT BLOG https://territoriesweb.wordpress.com/

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March 2019

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287

NASA Space Radiation Laboratory (NSRL)

GCR simulations and Solar Particle Event simulations

The NASA Space Radiation Laboratory irradiation facility was commissioned in 2003 to simulate the space radiation environment for biological experiments as well as physics, dosimetry and electronics testing. The facility is owned by NASA and managed by Brookhaven National Laboratory (BNL) for the US Department of Energy. NSRL operates ~1,200 hours per year in three cycles (spring, early summer and autumn).

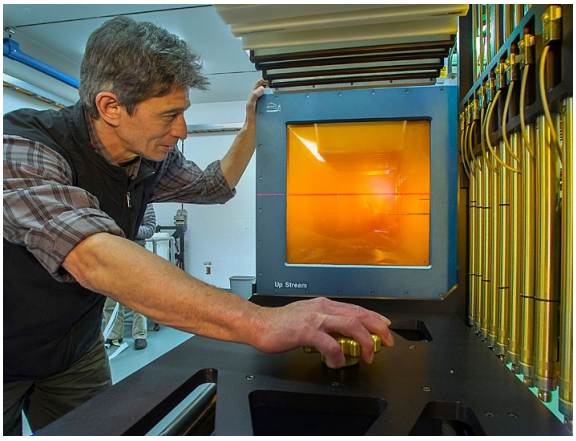

Photo: BNL

NSRL principal investigator Dr Adam Rusek checks the beam alignment

Beams of ions from protons to gold are extracted from the Booster Accelerator and transported to a shielded target area. The 400-ft^2 target area houses a 10-ft long optical bench, beam handling and sample changing equipment, and dosimetry. Beam energy ranges are 50-2500 MeV for protons and 50-1500 MeV/n for ions between He and Fe. Heavier ions from Z=27-79 are limited to ~350-500 MeV/n.

Beam spots with dimensions up to 20 x 20 cm^2 and 95% - 99% uniformity are typical, with a maximum dose rate of 10 Gy/min. For low fluence studies, rates as low as 100 and 2000 particles/cm^2 per spill for HZE ions and protons, respectively, are possible. A "large-beam" configuration of 60 x 60 cm^2 and 90% - 95% uniformity also exists, with a maximum dose rate of ~0.5 Gy/min.

The target area connects to a 4,560- ft^2 support facility with biological experiment stations for cell culture and a short-term animal facility, as well as an area for physics/run-control use. Long-term laboratory space and an accredited animal facility is available in an adjacent building. On-site housing accommodations for users are also available.

Photo: BNL

Dr Peter Guida & Dr Adam Rusek

The NSRL can generate a spectrum of ion beams to approximate the primary and secondary GCR field experienced at human organ locations within a deep-space vehicle. The majority of the dose is delivered from protons (~60-70%) and alpha particles (~10-20%) with heavier ions (Z>3) contributing the remainder. The "NSRL GCR Simulator" consists of 33 beams including 4 proton energies plus degrader, 4 helium energies plus degrader, and the five heavy ions of C, O, Si, Ti, and Fe. A polyethylene degrader is used with the 100 MeV/n H and He beams to provide a distribution of low energy particles. A 500 mGy simulation, delivering doses from each of the 33 beams, requires 75-90 mins.

To more closely simulate the low dose rates found in space, sequential field exposures can be divided into daily fractions over 2-4 weeks, with individual fractions as low as 0.1-0.2 mGy. In the large beam, 54 special housing cages can accommodate 2-3 mice each for a 90 min duration or ~20-36 individually housed rats (depending on age, species, and orientation).

The NSRL Building

Photo: BNL

BROOKHAVEN NATIONAL LABORATORY

ID Card:

Exposure type:
External

Source:
Accelerator

Dose rate:
<10 Gy/min

Irradiation type:
Proton, Helium and heavy ions

Irradiated organism type:
Cells, animals (rodents, fish, invertebrates), plants

Address:
NASA Space Radiation Laboratory
at Brookhaven National Lab
Bldg. 958
Upton, New York 11973

Access:
NASA and non-NASA funded research

Supporting lab:
Cell/molecular biology, animal procedures

Internet link:
https://www.bnl.gov/nsrl/

Contact:
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guida@bnl.gov
+1-631-344-2913

Reference field specification and preliminary beam selection strategy for accelerator-based GCR simulation, Slaba T. C., Blattnig S. R., Norbury J. W., Rusek A., La Tessa C. (2016), Life Sci Space Res (Amst), 8, 52-67

Overview of the NASA space radiation laboratory, La Tessa C., Sivertz M., Chiang I. H., Lowenstein D., Rusek A. (2016), Life Sci Space Res (Amst), 11, 18-23

NASA's LSAH and LSDA repositories

Enabling use of archived data

Jessica A. Keune, PhD & Diedre M. Thomas

The Human Health and Performance Directorate (HH&P) at Johnson Space Center (JSC) is charged with optimizing astronaut crew health and performance and mitigating spaceflight risks through countermeasures, habitability, environmental factors research, medical operations, and directorate support functions that enable mission success.

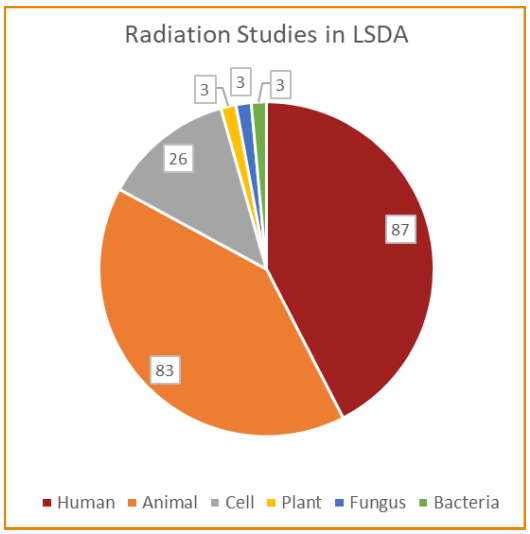


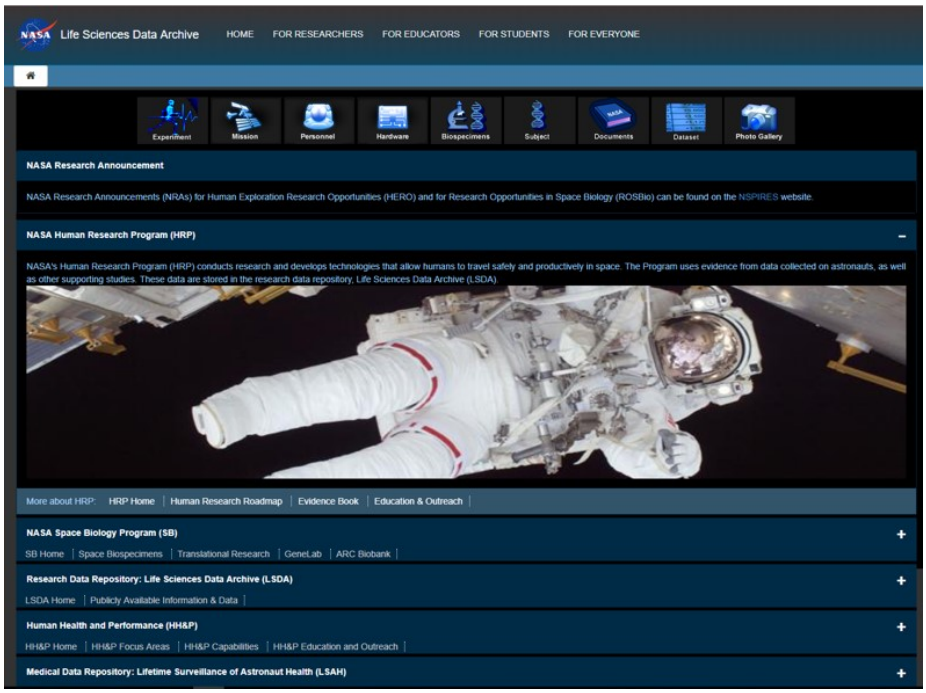
Photo: NASA

The HH&P houses over 50 years of records, archives, and databases of NASA's human spaceflight experience. Two groups within HH&P are working together to implement processes outlined in the HH&P Data Sharing Policy: the Lifetime Surveillance of Astronaut Health (LSAH) program and the Life Sciences Data Archive (LSDA). These groups have made great strides in sharing astronaut data with the spaceflight operational, clinical, and research communities.

Medical and research life sciences data are housed in two separate systems of LSAH and LSDA. The LSAH data system holds all ground and flight medical data for astronauts, vehicle environmental data, and data from non-flight assignable former astronauts who return to JSC annually for occupational health surveillance monitoring. The LSDA holds all research data collected through NASA-funded life sciences investigations, including data collected on astronauts, control and ground analog subjects, plants, animals, and cells. The human data held in both systems are subject to the Privacy Act of 1974, and the agency also voluntarily adheres to the applicable elements of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Data from both LSAH and LSDA systems are accessible by request through a single, integrated web-based process. The access point for all data is through the public website.

With regard to space radiation, LSAH primarily contains effective doses of radiation exposure reported from dosimeters and medical devices. LSDA contains records of over 200 radiation-related studies addressing these risks to not only humans, but also to a variety of animals, bacteria, and plants. Additionally, the LSDA enables access to over 7,000 irradiated animal specimens that are available by request to approved researchers. More information on the specimens can be found through the listed biobank link (https://lsda.jsc.nasa.gov/Home/).

LSDA website interface



ID Card:

Database topic:
LSAH: Astronaut Health Information

LSDA: NASA-sponsored life sciences experiments

Information available type:
NASA Medical and Research Data, with supporting information

Data type:
LSAH: Medical record numeric and image data

LSDA: Experiment descriptions with results, numeric and image data, and animal biospecimens

Link with a biobank:
Yes - https://lsda.jsc.nasa.gov/Biospecimen

Exportable:
No

Species:
Various – human, animal, bacteria, fungus, cells

Internet link:
https://lsda.jsc.nasa.gov/MRID

https://lsda.jsc.nasa.gov

https://www.nasa.gov/ames/research/space-biosciences/alsda

Access:
Publicly accessible

Contact:
https://lsda.jsc.nasa.gov/Common/Feedback

LSAH
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LSDA
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jsc-lsda-archive@mail.nasa.gov

NASCA report 2: Longitudinal study of relationship of exposure to space radiation and risk of lens opacity, Chylack L. T. Jr., Feiveson A. H., Peterson L. E., Tung W. H., Wear M. L., Marak L. J., Hardy D. S., Chappell L. J., Cucinotta F. A. (2012), Radiat Res, 178 (1), 25-32

LSAH and LSDA Repositories: Enabling use of archived NASA data, Lee L. PowerPoint presentation

NASA GeneLab

Open Science for Life in Space

GeneLab (http://genelab.nasa.gov) is a NASA initiative designed to accelerate open-science biomedical research, to support human exploration of space and to help improve life on Earth. The initiative includes a core staff of space biologists, data scientists with expertise in omics (genomics, transcriptomics, proteomics, metabolomics) data, and computer scientists. The GeneLab Data System (GLDS) architecture is illustrated below.

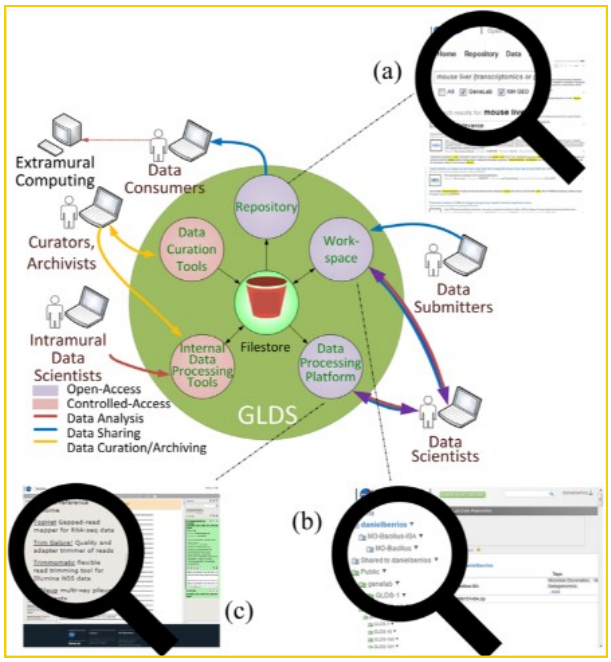

Photo: D. Berrios/NASA Ames Research Center

Schematic representation of the GLDS. Web interfaces for the GeneLab Data Repository (a), Collaborative Workspace (b), and Analysis Platform (c) are also shown.

Phase I of the three-phase GeneLab project emphasized key capabilities for submission, curation, search, and retrieval of omics data from biomedical research experiments conducted in space, or from space-related studies (i.e. radiation and simulated microgravity studies).

The development focus for Phase II included federated search and retrieval of space-related omics data across other open-access systems, so that users are able to conduct biological meta-investigations. Such meta-investigations aim to corroborate findings from many kinds of assays and translate them into systems biology knowledge and, eventually, therapeutics, including countermeasures to support life in space. Phase II development also included a Collaborative Workspace for users to upload, store, and share space-related omics data to promote scientific collaboration.

Phase III introduced a free, open-access *in silico* analysis platform for omics data, based on the open-source Galaxy platform. The GeneLab Analysis Platform provides a tool-shed that includes many widely used bioinformatics tools, a simplified list of tools and workflows, and some tools customized for meta-analysis of spaceflight experiments or for spaceflight data visualization (visualization of microarray illustrated below). A dedicated visualization portal is currently under development for customized browsing of spaceflight omics data with the ability to filter for various experimental factors specific to space (e.g. space radiation doses and radiation quality, environmental conditions like carbon dioxide levels on the International Space Station, species, and strains).

Photo: NASA

Dr Sylvain V. Costes

In addition, GeneLab has expertise in preparing bio-samples from model organisms for omics assays using a state-of-the-art Sample Processing Lab (SPL). GeneLab requests any unused tissues and samples from biological experiments conducted in space through the NASA Life Sciences Data Archive. The SPL uses specialized protocols to process the unused spaceflight (and respective ground control) samples to generate omics data. All of the protocols used for nucleic acid (and protein) extraction, library preparation, and sequencing were established in collaboration with the scientific community and are setting standards for the entire Space Biology community. In an effort to better control variation between experiments due to differences in methodology, the SPL has also become a state-of-the-art sequencing facility with automated sample processing and nucleotide sequencing equipment.

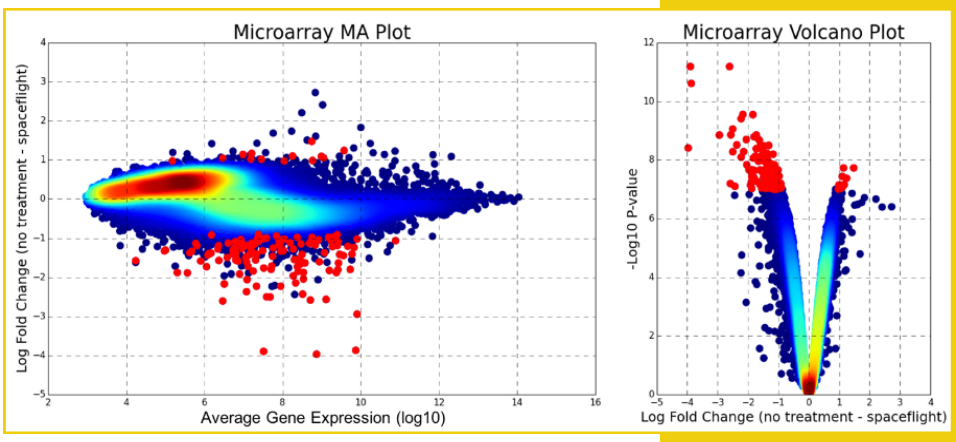

Photo: J. Rubin, D. Mattox/NASA Ames Research Center

Microarray analysis of GLDS-21 samples. MA (left) and Volcano (right) plots comparing gene expression of gastrocnemius muscles from mice flown on the STS-108 shuttle flight (11 days, 19 hours) (spaceflight) *versus* mice maintained on Earth (no treatment) for the same period were generated using the Microarray Analysis tool on the GeneLab Analysis Platform. Dots are colored based on kernel density estimate and differentially expressed genes are colored in red.

ID Card:

Analytical platform type:
Open source, web-based platform for spaceflight-relevant data (genomic, proteomic, metabolomic, epigenomic)

Main techniques proposed:
Nucleotide sequencing computational analysis (e.g. differential gene expression, genome methylation analysis, informatics for mass spectrometry-based proteomic)

Capacity:
Default configuration: 256 GB of storage – CPU and RAM provided for running pipelines are adapted based on user load

Training proposed:
GeneLab provides online tutorials:
- RNA-Seq Analysis pdf tutorial
- GeneLab RNA-Seq Analysis video tutorial

Address:
NASA Ames Research Center
Moffett Field
CA 94035, USA

Access:
Free, open

Internet link:
http://genelab.nasa.gov

Contact:
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sylvain.v.costes@nasa.gov
+1-650-604-5353

GeneLab: Omics database for spaceflight experiments, Ray S., Gebre S., Fogle H., Berrios D. C., Tran P. B., Galazka J. M., Costes S. V. (2018), Bioinformatics, doi:10.1093/bioinformatics/bty884
NASA GeneLab project: Bridging space radiation omics with ground studies, Beheshti A., Miller J., Kidane Y., Berrios D., Gebre S. G., Costes S. V. (2018), Radiat Res, 189 (6), 553-559, doi:10.1667/RR15062.1

AIR2

Access to INFRASTRUCTURES for Radiation protection Research

Issue	Exposure platforms	Databases, Sample banks, Cohorts	Analytical platforms, Models & Tools
Published to date:			
Oct 2015, #1	FIGARO	FREDERICA	RENEB
Nov 2015, #2	B3, Animal Contamination Facility	The Wismut Cohort and Biobank	The Hungarian Genomics Research Network
Dec 2015, #3	Pulex Cosmic Silence	STORE	METABOHUB
Feb 2016, #4	SNAKE	French Haemangioma Cohort and Biobank	Dose Estimate, CABAS, NETA
Mar 2016, #5	Radon exposure chamber	3-Generations exposure study	PROFI
Apr 2016, #6	Biological Irradiation Facility	Wildlife TransferDatabase	Radiobiology and immunology platform (CTU-FBME)
May2016, #7	CIRIL	Portuguese Tinea Capitis Cohort	LDRadStatsNet
Jun 2016, #8	Mixed alpha and X-ray exposure facility	Elfe Cohort	ERICA Tool
Jul 2016, #9	SCRS-GIG	RES^{3}T	CROM-8
Sep 2016, #10	Facility radionuclides availability, transfer and migration	INWORKS cohort	France Génomique
Oct 2016 #11	LIBIS gamma low dose rate facility ISS	JANUS	Transcriptomics platform SCKCEN
Nov 2016, #12	Microtron laboratory	EPI-CT Scan cohort	CATI
Dec 2016, #13	Nanoparticle Inhalation Facility	UEF Biobanking	The Analytical Platform of the PREPARE project
Feb 2017, #14	Infrastructure for retrospective radon & thoron dosimetry	Chernobyl Tissue Bank	HZDR Radioanalytical Laboratories
Special Issue 1	1st CONCERT Call: CONFIDENCE, LDLensRad, TERRITORIES	1st CONCERT Call: CONFIDENCE, LDLensRad, TERRITORIES	1st CONCERT Call: CONFIDENCE, LDLensRad, TERRITORIES
Mar 2017, #15	Alpha Particles Irradiator Calibration Laboratory at KIT		SYMBIOSE
Apr 2017, #16	Changing Dose rate (SU) Low dose rate (SU)		Advanced Technologies Network Center
May 2017, #17	Chernobyl Exclusion Zone	Chernobyl clean-up workers from Latvia	BfS whole and partial body Counting
Jun 2017, #18	MELAF	Belgian Soil Collection	INFRAFONTIER
Jul 2017, #19	MICADO'LAB	Estchern Cohort	ECORITME
Sep 2017, #20	DOS NDS		CERES

Future events:

CONCERT Short Courses

18-22 February 2019

Emergency and recovery preparedness and response. National Center of Radiobiology and Radiation Protection, Bulgaria

Contact:
Nina Chobanova
n.chobanova@ncrrp.org

Registration deadline:
20 January 2019

11-15 March 2019

Radiation Protection: Basics and Applications. Forschungszentrum Jülich, Germany

Contact:
Ralf Kriehuber
r.kriehuber@fz-juelich.de

Registration deadline:
11 December 2018

15-19 April 2019

EURADOS-CONCERT School on uncertainty in biological, physical, and internal dosimetry following a single exposure. Institut de radioprotection et de sûreté nucléaire (IRSN), France

Contact:
Sophie Ancelet
sophie.ancelet@irsn.fr

Registration deadline:
15 February 2019

23 April-3 May 2019

Assessment of long-term radiological risks from environmental releases. Technical University of Denmark, Risø Campus, Denmark

Contact:
Kasper Andersson
kgan@dtu.dk

Registration deadline:
15 January 2019

29 April-10 May 2019

Cellular effects of ionising radiation – introduction to radiation biology Acronym: CELOD, Stockholm University, Sweden

Contact:
Andrzej Wojcik
andrzej.wojcik@su.se

Registration deadline:
24 February 2019

See also on CONCERT website

Editorial Committee: Maria Panagiotopoulou, Jean-Michel Dolo, Elisabeth May, Laure Sabatier

Special Issue 4
February 2019

AIR²

Access to INFRASTRUCTURES for Radiation protection Research

Issue	Exposure platforms	Databases, Sample banks, Cohorts	Analytical platforms, Models & Tools
Published to date:			
Oct 2017, #21	CALLAB Radon Calibration Laboratory		CORIF
Nov 2017, #22	Calibration and Dosimetry Laboratory (INTE-UPC)	German airline crew cohort	Centre for Omic Sciences (COS)
Dec 2017, #23	NMG	Techa River Cohort (TRC)	iGE3
Special Issue 2	MEDIRAD	MEDIRAD	MEDIRAD
Feb 2018, #24	UNIPI-AmBe	Greek interventional cardiologists cohort	SNAP
Special Issue 3	2nd CONCERT Call: LEU-TRACK, PODIUM, SEPARATE, VERIDIC, ENGAGE, SHAMISEN-SINGS	2nd CONCERT Call: LEU-TRACK, PODIUM, SEPARATE, VERIDIC, ENGAGE, SHAMISEN-SINGS	2nd CONCERT Call: LEU-TRACK, PODIUM, SEPARATE, VERIDIC, ENGAGE, SHAMISEN-SINGS
Mar 2018, #25	IRRAD	MARiS	BIANCA
Apr 2018, #26	Forest observatory site in Yamakiya	BBM	OEDIPE
May 2018, #27	Belgian NORM Observatory Site	The German Thorotrast Cohort Study	VIB Proteomics Core
Jun 2018, #28	CERF	Mayak PA worker cohort	Geant4-DNA
Jul 2018, #29	TIFPA	RHRTR	D-DAT
Sep 2018, #30	HIT	The TRACY cohort	COOLER
Oct 2018, #31	PTB Microbeam	The BRIDE platform	BRENDA
Nov 2018, #32	AGOR Facility at KVI-CART LNK		MARS beamline at SOLEIL
Dec 2018, #33	PARISII	The ISIBELa cohort	CIEMAT WBC
Feb 2019, #34	The MIRCOM microbeam	The ISE cohort	EFFTRAN
Special Issue 4	NSRL	LSAH & LSDA	GeneLab

Future events:

Other Events

21-22 February 2019
Environmental Epigenetics Workshop - From Mechanisms to Regulation, Örebro, Sweden

5-6 March 2019
NUCL-EU 2020 EURATOM – Horizon 2020 Training on Proposal preparation, Technology Centre CAS, Prague, Czech Republic

25-28 March 2019
TRANSAT:
First Tritium School, Ljubljana, Slovenia

25-29 March 2019
EURADOS Training Course on Technical Recommendations for Monitoring Individuals for Occupational Intakes of Radionuclides, IAEA, Vienna, Austria
Contact:
Bastian Breustedt
Bastian.breustedt@kit.edu

3-5 April 2019
5th NERIS Workshop & 10th General Assembly, Roskilde, Denmark

10-12 April 2019
8th EUTERP Workshop 2019 : Optimizing radiation protection training, Qawra, St. Paul's Bay, Malta

10-12 April 2019
MELODI Workshop on non-cancer effects of ionizing radiation, Sitges, Spain

13-16 May 2019
ConRad 2019, Munich, Germany

13-16 May 2019
Confidence training course
Use of uncertain information by decision makers at the various levels within the decision making process and its Communication, VUJE, Trnava, Slovak Republic

27-31 May 2019
ICDA-3:
3rd International Conference on Dosimetry, Lisbon, Portugal

10-14 June 2019
Seventh International Conference on Radiation in Various Fields of Research (RAD 2019), Herceg Novi, Montenegro

1-3 July 2019
RICOMET 2019, **Barcelona**, Spain

25-29 August 2019
ICRR 2019: 16th International Congress of Radiation Research, Manchester, UK

Editorial Committee: Maria Panagiotopoulou, Jean-Michel Dolo, Elisabeth May, Laure Sabatier