AIR²
Access to INFRASTRUCTURES for Radiation protection Research

Issue 28
June 2018

Editorial

The first draft of the infrastructure web handbook is in preparation, and will provide a more panoramic view of the RPR infrastructures than our monthly newsletter AIR². The wealth and diversity of these infrastructures at European level and beyond is exceptional. However some are seldom used, as researchers all too often favour the facilities at the end of their bench!

With the goal of open access, data sharing and retrospective studies, the reliability of data is prerequisite. The use of these infrastructures should enable researchers to optimise the quality of their results, as well as the integration, interoperability and management of their data.

Thus these RPR infrastructures - always at the cutting edge of the art - are essential partners for future research projects.

Details of the contact person(s) for each infrastructure are available *via* the links in the AIR² Bulletin and directly in the AIR²D² database.

Dr Laure Sabatier, CEA

The floor to...

University of Latvia's role in nuclear and radiation research and training

The University of Latvia (UL) is one of the largest comprehensive and leading research universities in the Baltic States. It conducts research in over 50 fields representing four main areas of inquiry: the humanities, sciences, social sciences and educational sciences. UL is also the leading organisation in Latvia for nuclear and radiation research and training.

Radiation protection research focuses on:

- Development of new materials for TLD dosimetry, implemented by the Institute of Chemical Physics (ICP) and the Institute of Solid State Physics (ISSP). The irradiation device used is a linear electron accelerator (ELU- 4, energy of electrons 5 MeV) hosted by ICP. To assess dosimetric properties, ISSP hosts TSL equipment including an Andor Shamrock B-303i with a CCD camera (Andor DU-401A-BV), cryostat with closed cycle refrigerator, temperature controller and software for different TSL regimes.
- Development of analytical methods for biodosimetry services and emergency response methods is undertaken by the Faculty of Biology using automated, cost-efficient and highly sensitive technological solutions based on rt-PCR (real time Polymerase Chain Reaction) detection in human blood samples. The infrastructure used includes: a real-time PCR instrument – Rotor-Gene Q 5plex + HRM Platform, liquid handling instrument – QIAgility System HEPA/UV and nucleic acid extraction instrument – QIAcube.
- Studies on the radiation safety of the future nuclear energy source - nuclear fusion. Studies on tritium, a radioactive isotope of hydrogen, accumulation and behaviour under different conditions in the reactor materials, is being conducted at ICP in the context of the EUROFusion consortium (EURATOM). The infrastructure includes tritium monitors (TEM 2100A), Liquid Scintillation Analyzer (Tri-Carb 2900TR), Multi Gas Analyser with Thermal Desorption QMS (Hositrad MGT 6-300).

Notably, UL's strategic plan for the next five years includes development of the Technology Centre which hosts a cyclotron and a linear accelerator.

In CONCERT, UL contributes to WP2 and WP3, in collaboration with the Latvian Ministry of Environmental Protection and Regional Development, by identifying and working on problems of radiation safety in relation to both the general and specific research needs of the region. UL has also contributed to WP5 and WP6.

Dr Elina Pajuste
University of Latvia
CONCERT
WP2, WP3, WP5 & WP6

Photo: Institute of Chemistry

CONCERT CORNER

Future events:

October 3rd 2018
ExB/ESAB

October 4th 2018
MB meeting

Call for Travel Grants
Next deadline: 30th June 2018
Information

WP 6 News:

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/

Contents:

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July 2018

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

CERF

The CERN-EU high-energy Reference Field facility

Neutron calibrations and instrumentation tests often need to be performed at neutron energies or spectra very different from those generated by radioactive sources. The CERN-EU high-energy Reference Field (CERF) facility is a workplace field, unique in its kind, which reproduces the mixed radiation field encountered in the vicinity of high-energy particle accelerators and at commercial flight altitudes. Located in the North Experimental Area of CERN, CERF is served by a secondary beam from the Super Proton Synchrotron (SPS), which consists of a 120 GeV/c positively charged hadron beam (about 2/3 pions and 1/3 protons), impinging on a copper target 50 cm thick.

Photo: CERF

Dr Marco Silari

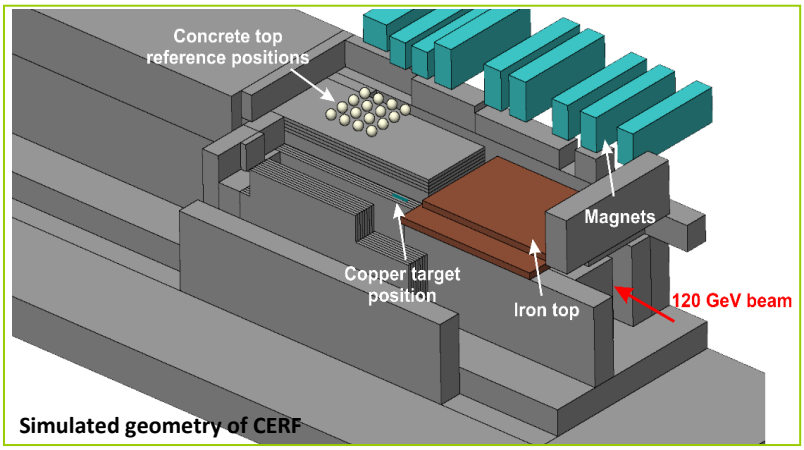

Photo: CERF

Simulated geometry of CERF

The target can be placed below either an 80 cm thick concrete roof shield or a 40 cm thick iron roof shield (see figure above). Sixteen reference exposure locations (50 x 50 cm^2 each) are provided on the top of the two roofs. Eight additional exposure locations are available outside an 80 cm thick lateral concrete shield.

The beam is delivered to CERF with a typical intensity in the range 10^6 to 10^8 particles per SPS beam extraction (spill), with two to three beam extractions of about 5 s duration over an SPS cycle (the duration of which varies in the range 30-45 s). The beam monitoring, on which the normalisation of all measurements relies, is provided by an air-filled, parallel-plate, transmission-type ionisation chamber (IC), calibrated with the multi-foil activation technique. Typical values of ambient dose equivalent rates are 0.2-0.3 nSv per IC-count on the concrete roof and 1-1.5 nSv per IC-count on the iron roof. By assuming an average of three spills per minute and adjusting the beam intensity on the target, ambient dose equivalent rates can be obtained from approximately 5 µSv/h (30 nSv per spill) to 250 µSv/h (1.5 µSv per spill) on the concrete roof, and from 18 µSv/h (100 nSv per spill) to 360 µSv/h (2 µSv per spill) on the iron roof. The uncertainty on the reference values of ambient dose equivalent rate is about 15%.

CERF is primarily a simulated workplace field for testing radiation protection instrumentation (active monitors and passive dosimeters) used at high-energy accelerators and/or for aircrew dosimetry. In addition, the Linear Energy Transfer (LET) distribution of dose equivalent makes CERF a suitable facility for space dosimetry.

Other applications of the CERF radiation field are: radiobiology studies; spallation cross section measurements (in the hadron beam); investigation of activation of accelerator materials (by exposing them next to the target); intercomparison of individual dosimeters; benchmarking Monte Carlo codes against experimental data. For a more exhaustive list of possible applications, see the references cited below.

Photo: CERF

Typical set-up of radiation detectors and dosimeters exposed on the concrete roof.

The CERN-EU high-energy Reference Field (CERF) facility: applications and latest developments, Silari M., Pozzi F. (2017), Eur. Phys. J. Web of Conf., 153, 03001

The CERN-EU high-energy Reference Field (CERF) facility for dosimetry at commercial flight altitudes and in space, Mitaroff A., Silari M. (2002), Radiat. Prot. Dosimetry, 102 (1), 7-22

ID Card:

Exposure type:
External

Source:
120 GeV/c proton and pion beam
Simulated workplace mixed radiation field

Dose rate:
5 µSv/h to 250 µSv/h (concrete roof)
18 µSv/h to 360 µSv/h (iron roof)

Irradiation type:
Neutron, proton, pion, gamma

Irradiated organism type:
None

Address:
CERN
1211 Geneva 23
Switzerland

Access:
One or two beam periods of one week per year, subject to acceptance by the facility manager

Supporting lab:
Radiation calibration laboratory

Internet link:
http://cerf-dev.web.cern.ch/

Contact:
Dr Marco Silari
Marco.Silari@cern.ch

Related to:
EURADOS

Mayak PA worker cohort (MWC)

Cohort study of workers employed at the Mayak Production Association

The Mayak Production Association (PA) is a large-scale, Russian nuclear enterprise set up to produce weapon-grade plutonium and located in the Southern Urals (Russian Federation), close to the city of Ozyorsk. When it commenced operations in June 1948, the Mayak PA consisted of a main production facility with industrial reactors, radiochemical and plutonium production plants, as well as auxiliary facilities.

Table 1 – Characteristics of the cohort of Mayak PA workers employed between 1948 – 1982 (first employment) – data as of 31.12.2017

Cohort size	22,377
Known vital status	95 %
Deceased workers	63 %
Autopsy performed	34 %
Alive (Ozyorsk residents)	32 (19) %
Cumulative dose from external gamma-rays (Hp10)	0 – 8.4 Sv
Cumulative lung absorbed dose from internally deposited alpha-particles	0 – 26.3 Gy
Cumulative liver absorbed dose from internally deposited alpha-particles	0 – 38.0 Gy
Available data on initial health status	90 %
Medical history data on disease incidence	96 %
Available data on non-radiation factors (smoking, alcohol consumption, body mass index, blood pressure, etc.)	80 – 90 %
Available data on family members (offspring)	59 %
Available biological material	13 %

Once the first reactor came into operation, all Mayak PA workers were monitored for individual doses of external gamma-rays, however regular monitoring of internal alpha-activity in workers exposed to alpha-active aerosols containing transuranium radionuclides did not begin until the 1960s. Individual organ-absorbed doses from external gamma-rays and internally deposited alpha particles were estimated based on the improved and updated dosimetry and biokinetics models used in the Mayak Workers Dosimetry Systems of 2008 and 2013 (MWDS-2008 and MWDS-2013).

Workers of the Mayak PA were subjected to special health supervision following standard protocols, which included mandatory pre-employment and annual medical health examinations throughout the entire follow-up period.

The raw data collected enabled the creation of a unique resource, the "Clinic" medical dosimetry database of Mayak PA workers and their family members. These data provide the basis for numerous studies aimed at assessing tissue reactions (deterministic effects) and stochastic events following external and internal radiation exposure (cancer and non-cancer effects).

Photo: SUBI

Dr Tamara V. Azizova

The Mayak Worker Cohort (MWC) includes 22,377 workers (25% female) whose first employment was at one of the main facilities during the period 1948-1982. Table 1 summarises the cohort characteristics as of the end of 2017.

The MWC has a number of strengths including its large size, long follow-up period (70 years), individually measured doses from external and internal radiation exposure, heterogeneity by sex, age, ethnicity and pre-employment health status, completeness of information on health effects and vital status, and available data on non-radiation factors as well as stored biological samples.

Tissue reactions, such as acute radiation sickness, chronic radiation syndrome, plutonium-induced pulmonary fibrosis, radiation-induced cataracts and local radiation injuries, were recorded in MWC members during 1948–1960, and evidence was reported of increased radiation-induced risks for leukemia, lung, liver and bone cancers, circulatory diseases, chronic obstructive pulmonary disease and senile cataract as well as cataract subtypes.

Table 2 – Dose-response for non-cancer incidence in MWC

Outcome (number of cases)	ERR per Gy of external gamma-rays (95% CI)	ERRper Gy of internal alpha-radiation (95% CI)
Cardiovascular diseases (7225)	0.10 (0.04, 0.17)	0.02 (n/a, 0.10)
Cerebrovascular diseases (8717)	0.46 (0.37, 0.57)	0.28 (0.16, 0.42)
Lower extremities diseases (938)	0.19 (0.05, 0.39)	0.16 (n/a, 0.50)
Chronic obstructive pulmonary diseases (2135)	0.14 (0.02, 0.28)	1.19 (0.32, 2.53)
Senile cataracts (4159)	0.28 (0.20, 0.37)	–
posterior subcapsular	0.91 (0.67, 1.20)	–
cortical	0.63 (0.49, 0.70)	–
nuclear	0.47 (0.35, 0.60)	–
Hypertension (8425)	0.14 (0.09, 0.20)	-0.10 (n/a, 0.05)

The "Clinic" medical-dosimetric database of Mayak production association workers: structure, characteristics and prospects of utilization, Azizova T. V., Day R. D., Wald N., Muirhead C. R., O'Hagan J. A., Sumina M. V., Belyaeva Z. D., Druzhinina M. B. et al. (2008), Health Phys, 94 (5), 449–458
Risk of cataract incidence in a cohort of Mayak PA workers following chronic occupational radiation exposure, Azizova T. V., Bragin E. V., Hamada N., Bannikova M. V. (2016), PLoS One, 11 (10):e0164357

ID Card:

Cohort type:
Individual data on Mayak PA workers occupationally exposed to external gamma- and internal alpha-radiation at wide dose ranges over prolonged periods.

Age/Follow-up:
Age at exposure (first employment): 15–65 years
Mean age at the end of the follow-up: 66 years
Mean duration of follow-up: 42 years; 939,811 person-years

Biobank available:
Yes

Sample type:
Tumour and non-tumour tissues (formalin-fixed, paraffin-embedded tissues blocks, histology slides), peripheral blood and its components, DNA

Sample storage conditions:
18 - 20°C, -20°C, -80°C, liquid nitrogen

Access:
MWC database is owned by SUBI. Access to anonymous data is restricted and subject to approval by the SUBI Institutional Review Board.

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Involved in:
- "Epidemiological Studies of Exposed Southern Urals Populations" (SOLO, FP7)
- "Combining epidemiology and radiobiology to assess cancer risks in the breast, lung, thyroid and digestive tract after exposures to ionizing radiation with total doses in the order of 100 mSv or below" (EpiRadBio, FP7)
- "Cardiovascular Risk from Exposure to Low-dose and Low-dose-rate Ionizing Radiation" (PROCARDIO, FP7)

Related to:
MELODI

Geant4-DNA

An extension of Geant4 for simulations in radiobiology

Accurate modelling of biological damage induced by ionising radiation at the scale of the DNA molecule remains a major challenge for radiobiology research today. In order to provide the community with an easily accessible mechanistic simulation platform, it was decided to extend the usage of the general purpose, open source "Geant4" Monte Carlo simulation toolkit, developed under the "Geant4-DNA" project initiated by the European Space Agency.

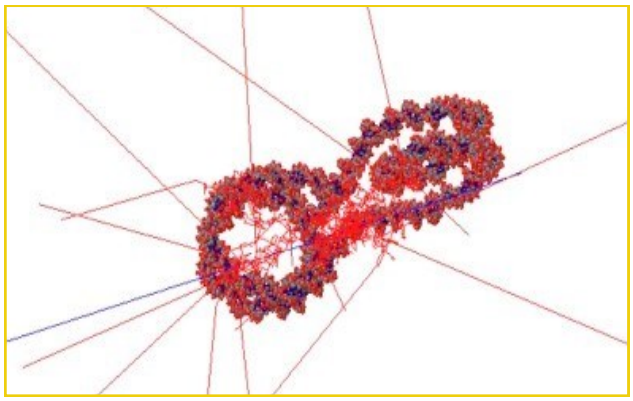

Photo: Geant4-DNA Collaboration

Geant4-DNA simulation of the irradiation of a dinucleosome with a single 100 keV proton

Geant4-DNA offers Geant4 users a set of functionalities which allow detailed simulation of particle-matter interactions in biological media. These functionalities include physical, physico-chemical and chemical processes that can be combined with nanometer-size geometries of biological targets in order to predict early DNA damage.

The key developments currently being undertaken by the Geant4-DNA Collaboration cover three main areas:

- Physical processes: Several sets of physical processes are available to describe the dominant step-by-step physical interactions of electrons, protons, hydrogen atoms, alpha particles and their charged states in liquid water, the main component of biological media. They can be combined with existing Geant4 physical processes in order to describe other processes such as photon interactions.
- Physico-chemical and chemical processes: These processes can simulate water radiolysis from physical interactions, that is, the creation, diffusion and mutual reactions of molecular species in liquid water, up to 1 microsecond after irradiation. An illustration of water radiolysis around a single electron track, simulated using Geant4-DNA, is shown in the figure on the right.
- Detailed geometries of biological targets: Given the benefits of Geant4 geometry modelling capabilities, it is now possible to simulate accurate geometries of biological targets such as the DNA molecule and even neurons.

Photo: Personal archive

Dr Sébastien Incerti

The figure in the left panel illustrates the implementation of a dinucleosome geometry extracted from the Protein Data Bank™ database.

These developments can be combined to predict early DNA damage. In particular, we have recently demonstrated that it is possible to predict early direct and indirect DNA damage in bacteria and cells.

Most of the features described above are already fully accessible through the Geant4 simulation toolkit and can also be run using a freely downloadable Geant4 virtual machine. Their inclusion in Geant4 makes them accessible to other Geant4-based simulation platforms such as GATE and TOPAS. Several application examples are also provided in Geant4. We hope that this simulation platform and its future developments will be useful for the further mechanistic understanding of ionising radiation effects in biological targets, especially when high spatial resolution (nanometer) and low energy (tens of electronVolts) track structure simulations are required.

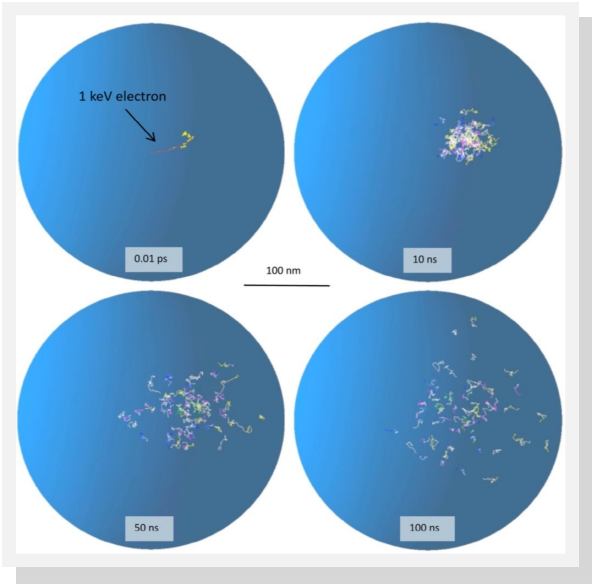

Photo: Geant4-DNA Collaboration

Molecular species diffusing in liquid water around a single electron track of 1 keV

ID Card:

Purpose:
Open access toolkit for the simulation of 3D track structures, water radiolysis, geometrical models of biological targets, and early biological damage.

Use:
Anyone familiar with the Geant4 Monte Carlo simulation toolkit.

Housed at:
Software repository at CERN, coordinated by CNRS/IN2P3, France, and developed by an international Collaboration.

Training proposed on the software:
http://geant4-dna.org

Access:
Open access, fully included in Geant4 (http://geant4.org) and also available through a virtual machine (http://geant4.in2p3.fr).

Internet link:
http://geant4-dna.org

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(Geant4-DNA Collaboration spokesperson)

Involved in:
GATE and TOPAS Monte Carlo simulation platforms

Related to:
MELODI

Track structure modeling in liquid water: A review of the Geant4-DNA very low energy extension of the Geant4 Monte Carlo simulation toolkit, Bernal M. A., Bordage M. C., Brown J.M.C., Davídková M., Delage E., El Bitar Z., Enger S. A. et al. (2015), Phys. Med., 31 (8), 861-874
Comparison of Geant4 very low energy cross section models with experimental data in water, Incerti S., Ivanchenko A., Karamitros M., Mantero A., Moretto P., Tran H. N., Mascialino B., Champion C., Ivanchenko V. N., Bernal M. A., Francis Z., Villagrasa C., Baldacchino G. et al. (2010), Med. Phys., 37 (9), 4692-4708

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	RES³T	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
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
Coming soon:			
Jul 2018, #29	To Be Announced	To Be Announced	To Be Announced

Future events:

CONCERT Short Courses

28 May-8 June 2018

Modelling radiation effects from initial physical events, University of Pavia, Italy

Contact:
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11-29 June 2018

NORM (Naturally Occurring Radioactive Material) in work and natural environment: identification, exposure assessment and decision making process, Central Mining Institute, Katowice, Poland

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25 June-6 July 2018

Space Summer School (space radiation, medicine and life sciences) , SCK•CEN , Belgium

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Other Events

11-15 June 2018

EPRBioDose 2018, Munich, Germany

13-15 June 2018

RICOMET 2018, Antwerp, Belgium

15 June 2018

MELODI Award Call 2018 deadline

20-24 August 2018

NEA International Radiological Protection School (IRPS), Stockholm, Sweden

22-25 August 2018

ERR 2018, Pecz, Hungary

1-5 October 2018

3rd ERPW, Rovinj Rovigno, Croatia

8-11 October 2018

HEIR 2018, Fontenay-aux-roses, France

29-31 October 2018

3rd Geant4 International User Conference at the Physics-Medicine-Biology frontier, Bordeaux, France

See also on CONCERT website

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

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