AIR²
Access to INFRASTRUCTURES for Radiation protection Research

Issue 38
June 2019

Editorial

As a result of recommendations in the interim evaluation report of the Euratom Research and Training Programme 2014 – 2018, published on December 1, 2017, the EC decided to proceed to a mid-term review of the CONCERT EJP by independent external experts. This review took place in Brussels on the 27th of March and aimed to evaluate the proper use of resources and overall management and progress of the project work plan (click here to access the presentations of the participants).

The obtained feedback was immensely positive. At approximately three quarters of the project's term: the number of beneficiaries has significantly increased, R&D priorities have been clearly set and joint roadmaps planned, two R&D Calls for proposals have been successfully implemented, a stakeholder group has been established comprising members from NGOs, international organizations, operators, regulators, and universities, access to infrastructures for radiation protection research has been reinforced through the success of AIR², AIR²D², and the upcoming publication of the web-handbook, STORE has been considerably enlarged, and education and training has been included in all research projects and complemented by courses, summer schools, and travel grants.

Congratulations to all!

Dr Laure Sabatier, CEA

The floor to...

The Science in Space Environment (SciSpacE) programme is the European Space Agency's (ESA) research programme to advance and enable exploration of the Solar system while bringing knowledge and expertise back to Earth.

The programme offers a wide variety of ground and space-based research platforms, each simulating or reproducing certain characteristics of the space environment in the areas of physics, biology, and human research.

ESA supports ground-based radiobiology research for space radiation protection

Cosmic radiation risk is a cross-cutting topic, spanning all three disciplines and including both spaceflight experiments and ground-based simulations. For ground-based experiments, the ESA identified the GSI in 2006 as the European accelerator facility capable of simulating the high-energy particle radiation spectrum encountered in deep-space travel and launched the Investigations on Biological Effects of Space Radiation programme (IBER). The programme works similarly to the approach of NASA at the beginning of this century, which led to the construction of a dedicated beamline at the Brookhaven National Laboratory in Upton, NY (see: AIR² - Special Issue 4 - February 2019).

The IBER programme has been on hold since 2012 because of construction at the GSI in preparation for the new Facility for Antiprotons and Ion Research (FAIR) but was resumed in 2018 with the start of the so-called FAIR phase-0 at GSI.

The ESA maintains a special interest in FAIR, because the production of very high energy heavy ions creates unique opportunities that cannot be provided by any other accelerator worldwide. To this end, the ESA and FAIR signed a Memorandum of Understanding in March 2018 for future cooperation in the field of space radiation research. During the same year, the ESA released an Announcement of Opportunity (AO-2017-IBER) for experiments to make use of GSI's beamtime, resulting in the selection of 11 experiments of investigators throughout Europe.

The ESA will release another dedicated Announcement of Opportunity in 2019 for proposals investigating the biological effects of space radiation to be implemented during the upcoming SciSpacE programme period 2 (2020-2023).

Dr Jennifer Ngo-Anh
SciSpacE Team Leader
Directorate of Human and Robotic Exploration Programmes (HRE-RS)
European Space Agency

Photo: J. Ngo-Anh/ESA

CONCERT CORNER

Future events:

Call for Travel Grants
Next deadline: 30th June
Information

14-18 October
ERPW 2019
Stockholm, Sweden
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/

Contents:

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

FAIR

FAIR phase-0 at GSI in Darmstadt, Germany started in 2019

The Facility for Antiprotons and Ion Research (FAIR) is the most ambitious infrastructure for nuclear physics under construction worldwide. FAIR is based at GSI, the Helmholtz Research Institute in Darmstadt (Germany), well known for the discovery of six new heavy elements in the periodic table (107<Z<112) and for having started cancer therapy with high-energy carbon ions in Europe (1997-2007).

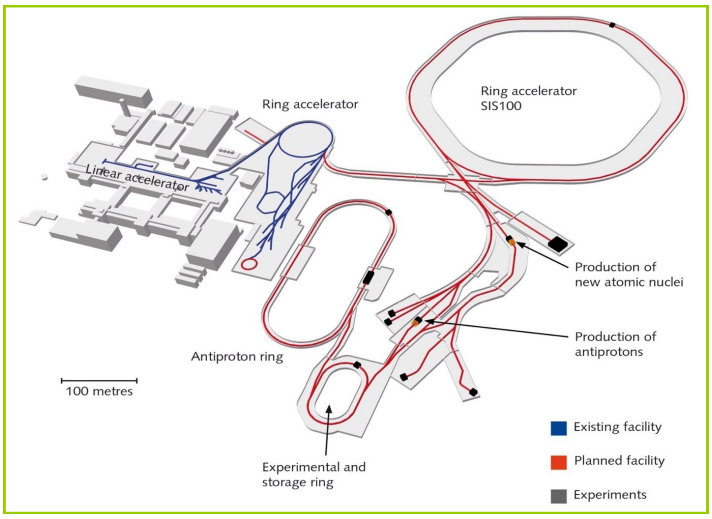

Photo: GSI/FAIR

The current GSI complex and design of the future FAIR complex

GSI operates the SIS18 synchrotron (18 Tm rigidity), an impressive heavy-ion facility that can accelerate ions from H to U up to energies of approximately 1 GeV/n. The new FAIR synchrotron, SIS100 (100 Tm rigidity), will be characterized by higher energies (up to 10 GeV/n) and 100-1000-fold higher beam intensities. This unique facility provides new exciting opportunities in nuclear physics in the four main experiments in nuclear astrophysics (NuSTAR), compressed baryonic matter (CBM), antiproton annihilation (PANDA), and applied physics (APPA, including atomic and plasma physics, materials research, and biophysics).

The biomedical program is highly diverse and run by the GSI Biophysics Department, directed by Marco Durante, Professor of Physics at the Technische Universität Darmstadt. A large, international biophysics collaboration met in May at GSI to discuss the biomedical applications of FAIR (https://indico.gsi.de/event/7796/). This collaboration will exploit both characteristics of the new FAIR facility.

Photo: Brinner/GSI

Dr Marco Durante

The higher energy is especially useful for space radiation research, because FAIR will be able to simulate the full spectrum of galactic cosmic radiation. It can also be useful for biomedical studies, especially particle radiography. The high intensity has far-reaching applications in cancer therapy, e.g. for ultra-fast beam delivery (FLASH radiotherapy), minibeam therapy (using grids), acceleration of radioactive ion beams (especially positron-emitting nuclides, which can be visualized online by PET), and the production of heavy radioisotopes for targeted alpha-particle therapy.

The construction of SIS100 will be completed in 2025, but FAIR phase-0 already started in 2019 at SIS18, with the increased beam current necessary for FAIR. Approximately 20 radiobiology experiments have been implemented, using either C-ions (for pre-clinical therapy research) or Fe-ions (for space radiation protection; supported by the ESA within the IBER program). FAIR-phase-0 is now accepting applications *via* the GSI Program Advisory Committee (for therapy or radiation protection studies) and the ESA for space radiation research.

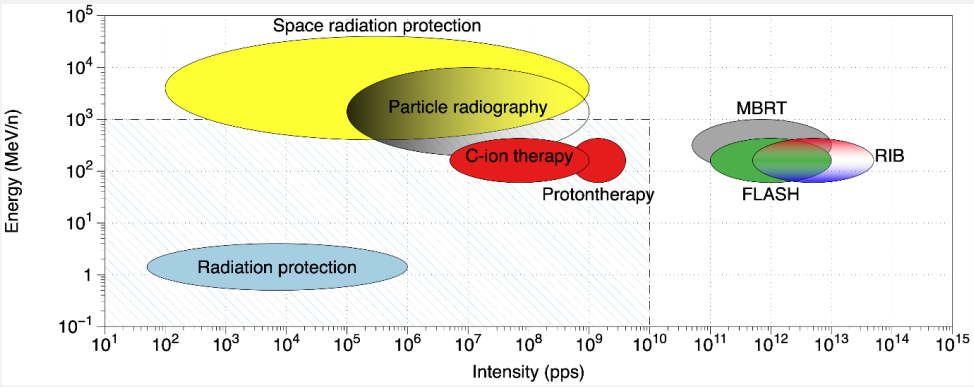

Photo: M. Durante /GSI

Radiation research at the accelerators. The energy (in MeV/n) and intensity (in particles per second) define the phase space in which different applications can be performed. The shaded region includes energy values and intensities covered by the present accelerators, whereas the other regions will be covered by FAIR. MBRT, minibeam radiotherapy; RIB, radioactive ion beams; FLASH, high dose-rate radiotherapy.

ID Card:

Exposure type:
External

Source:
Accelerator

Dose rate:
0.01-1000 Gy/min

Irradiation type:
All ions from H to U

Irradiated organism type:
Cells, Tissues, Animals, Plants

Address:
GSI Helmholtzzentrum für Schwerionenforschung
Biophysics Department
Planckstraße 1
64291 Darmstadt - Germany

Access:
Free after scientific evaluation by a program advisory committee. Space-related projects are evaluated by ESA.

Supporting lab:
Cell/molecular biology/animal facility/electronics/workshop

Internet link:
www.gsi.de/biophysik

Contact:
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Related to:
ESA

All the fun of the FAIR: fundamental physics at the facility for antiproton and ion research, Durante M., Indelicato P., Jonson B., Koch V., Langanke K., Meißner Ulf-G., Nappi E., Nilsson T., Stöhlker Th., Widmann E., Wiescher M. (2019), Phys Scr, 94 (3), DOI: 10.1088/1402-4896/aaf93f

Applied nuclear physics at the new high-energy particle accelerator facilities, Durante M., Golubev A., Park W. Y., Trautmann C. (2019), Phys Rep, 800, 1-37

The BACCARAT study

Early cardiotoxicity after radiotherapy for breast cancer

Radiotherapy (RT) for breast cancer can lead to secondary effects to the heart due to the presence of neighbouring normal cardiac tissue within the irradiation field and is associated with long-term radiation-induced cardiovascular diseases. Little is yet known concerning early cardiotoxicity, which can appear long before the onset of clinically significant cardiac events.

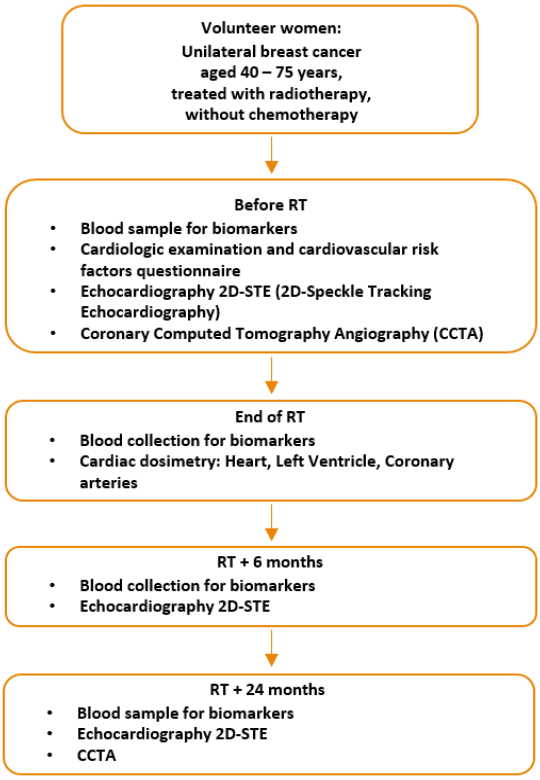


Photo: IRSN

BACCARAT Study flowchart

The BACCARAT study (BreAst Cancer and Cardiotoxicity induced by RAdioTherapy) is based on a two-year follow-up prospective cohort of breast cancer patients treated with RT. It aims to improve our knowledge on the early detection and prediction of RT-induced subclinical cardiac dysfunction and lesions and the biological mechanisms that are potentially involved through functional and anatomical cardiac imaging combined with the simultaneous assessment of multiple circulating biomarkers and precise cardiac dosimetry.

The study includes 114 female patients, aged 40 to 75 years old, treated with 3D-conformal radiotherapy RT for left or right unilateral breast cancer, without chemotherapy, in the Pasteur Clinic of Toulouse, France. Exclusion criteria were a history of coronary artery disease, myocardial infarction or a major cardiac event, or prior cancer treated with chemotherapy or RT. The inclusion period lasted from October 2015 to December 2017. The two-year follow-up of patients is still ongoing, the end is foreseen for early 2020.

Once included, the women's follow-up protocol was implemented (see Figure Flowchart):

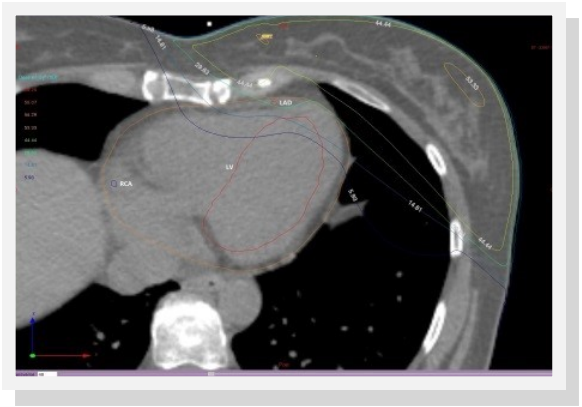
- Two-dimensional speckle tracking echocardiography (2DSTE) performed at baseline before RT, RT+6 months, and RT+24 months: to evaluate myocardial dysfunction (in particular, the left ventricular ejection fraction) and assess myocardial deformation (with longitudinal myocardial strain).
- CT coronary angiography (CTCA) performed at baseline and RT+24 months: to evaluate coronary artery lesions by assessing morphological information, including plaques and stenosis of the arteries, and determination of the coronary artery calcium score.
- Plasma sampling (PLASMA) performed at baseline, the end of RT, RT+6 months, and RT+24 months: for the analysis of circulating biomarkers, including classical biomarkers of cardiac injury, inflammatory cytokines, markers of endothelial activation and dysfunction, microparticles, and microRNAs.
- Collection of information on traditional risk factors of cardiac diseases (e.g. systolic and diastolic blood pressure, hypertension, diabetes, cholesterol, tobacco use, and body mass index) performed at each visit of the follow-up.
- Individually-determined cardiac dosimetric evaluation performed at the end of RT: dose distributions (dose-volume histogram) were generated for the whole heart, left ventricle, left main coronary artery, left anterior descending artery, left circumflex artery, and right coronary artery.

Photo: IRSN

Dr Sophie Jacob

BACCARAT is the result of a multidisciplinary collaboration to enhance knowledge on early breast RT-induced cardiotoxicity.

Photo: IRSN



CT-based dose-planning scan for left tangential breast irradiation, showing isodoses and delineated structures: heart (orange circle), left ventricle (LV), left anterior descending coronary artery (LAD), and right coronary artery (RCA).

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

ID Card:

Cohort type:
Prospective observational cohort study of 114 breast-cancer patients treated with RT without chemotherapy. Inclusion before RT, follow-up of 2 years, including 3 time points: end of RT, end of RT+6 months, end of RT+24 months. Blood samples are collected and cardiac imaging examinations performed at baseline and during follow-up. Cardiac dosimetry is available for the whole heart, left ventricle, and coronary arteries.

Age:
- at exposure: 40-75 years
- follow-up: 2 years

Biobank available:
Yes

Sample type:
Plasma

Sample storage conditions:
-80°C

Access:
Due to data protection, access to the data is restricted. S. Jacob can be contacted to explore opportunities for scientific collaboration.

Internet link:
https://clinicaltrials.gov/ct2/show/NCT02605512

Contact:
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sophie.jacob@irsn.fr
+33 5 61 14 56 08

Involved in:
MEDIRAD EARLY-HEART study

Related to:
MEDIRAD

Is mean heart dose a relevant surrogate parameter of left ventricle and coronary arteries exposure during breast cancer radiotherapy: a dosimetric evaluation based on individually-determined radiation dose (BACCARAT study), Jacob S., Camilleri J., Derreumaux S. et al. (2019), Radiat Oncol, 14 (1), 29
Early detection and prediction of cardiotoxicity after radiation therapy for breast cancer: the BACCARAT prospective cohort study, Jacob S., Pathak A., Franck D., Latorzeff I., Jimenez G., Fondard O., Lapeyre M., Colombier D. et al. (2016), Radiat Oncol, 11 (54), doi: 10.1186/s13014-016-0627-5 231-248

CIEMAT *In Vitro* Internal Dosimetry Laboratories

Spanish reference laboratories for *in vitro* monitoring

The CIEMAT *In Vitro* Internal Dosimetry Laboratories consist of the Bioelimination Laboratory and the Mass Spectrometry Laboratory, both reference facilities in Spain for *in vitro* bioassay of internal emitters. They can monitor alpha and beta emitters in urine and faecal samples that have been incorporated into the body through inhalation, ingestion, injection, or a wound. The activity measured in the excreta (mBq/d or Bq/L) is interpreted in terms of the committed effective dose E(50) mSv. Approximately 140 internally exposed workers are monitored per year at CIEMAT using *in vitro* bioassay techniques.

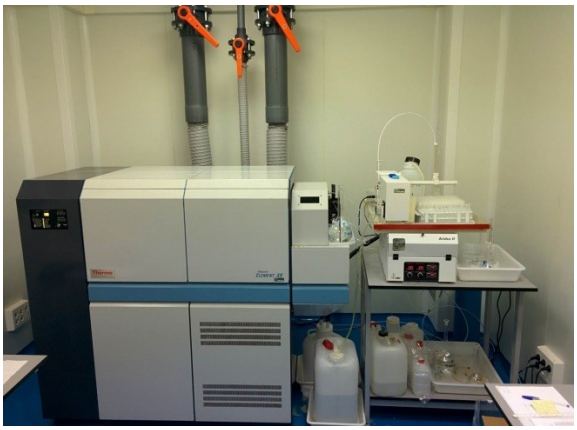

Photo: CIEMAT (Madrid, Spain)

Inductively Coupled Plasma Sector Field Mass Spectrometer (ICP-SF-MS). Element XR (Thermo Finnigan).

The Bioelimination Laboratory (BIO) has been accredited according to the ISO 17025 Standard since 2012 (ENAC 144/LE1836). Alpha emitters (Pu, Am, Th, Cm, U) in urine and faecal samples are analysed by alpha spectrometry after radiochemical separation. The uranium content in urine can also be determined by mass measurement by kinetic phosphorescence analysis (KPA). Beta emitters in urine samples can be measured by liquid scintillation counting (LSC) by direct measurement (H-3, C-14, S-35) or by performing radiochemical separation procedures (Sr-90).

The most recent research activities of the CIEMAT Bioelimination Laboratory have been focused on developing rapid methods for the determination of Pu, Am, Th, Cm, U, and/or Sr-90 in an emergency scenario. Future challenges of the laboratory are the implementation of the gamma spectrometry technique for the determination of gamma emitters in urine samples and the analysis of alpha emitters in nasal swabs.

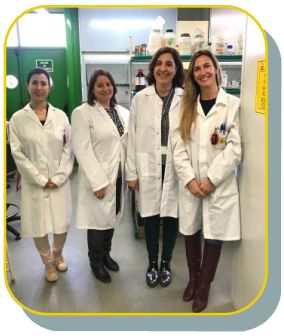

Photo: CIEMAT (Madrid, Spain)

P. Lorente, C. Hernández, I. Sierra, A. I. Barrado

The Mass Spectrometry Laboratory (ICP) consists of a measurement laboratory, containing a high-resolution mass spectrometer with an inductive coupling plasma source, magnetic sector, and double focus (XR Element, Thermo Finnigan), and a laboratory for the preparation and treatment of samples, in which measurements of various radioisotopes are carried out.

The ICP Laboratory is in the process of being accredited and is currently authorized by the CSN (Nuclear Safety Council) for the determination of activity in urine samples. Due to the high sensitivity of the XR Element, U and Th measurements are performed directly after dilution. Pu-239 analysis requires radiochemical separation and a special nebulization chamber to increase the sensitivity of the analysis (ARIDUS II).

The CIEMAT *In Vitro* Internal Dosimetry Laboratories participate in national and international R&D programs (e.g. ICP lab in the DARK MATTER Project), European initiatives (e.g. BIO Lab in EURADOS Emergency Intercomparisons), technological and/or knowledge transfers, and education & training activities. In addition, the Bioelimination Laboratory has coordinated and prepared several proficiency tests for public and private Spanish laboratories. The CIEMAT *In Vitro* Internal Dosimetry Laboratories also participated in the elaboration of the document "Technical Recommendations for Monitoring Individuals for Occupational Intake of Radionuclides" - EC Radiation Protection Report 188 (2018).

Photo: CIEMAT (Madrid, Spain)

CIEMAT Bioelimination Laboratory facilities and equipment

Rapid procedure for actinides and ^{90}Sr analysis in emergency urine spot samples applied in the GHSI-RNWG emergency intercomparison exercise, Hernández C., Sierra I. (2019), Appl Radiat Isotopes, 144, 19-23

Retrospective method validation and uncertainty estimation for actinides determination in excreta by alpha spectrometry, Hernández C., Sierra I. (2016), Radiat Prot Dosim, 170 (1-4), 39-44

ID Card:

Analytical platform type:
Internal dosimetry *in vitro* laboratories

Main techniques proposed:
In vitro monitoring of alpha and beta emitters in urine and faecal samples using:
- Alpha Spectrometry
- Liquid Scintillation Counting
- Kinetic Phosphorescence Analysis
- Inductively Coupled Plasma Sector Field Mass Spectrometry
- Rapid emergency methods

Capacity:
300-600 samples per year, depending on the required analysis

Duration of experiment:
From 1 hour to 2-3 weeks, depending on the sample type and analytical procedure

Intercomparison exercise proposed:
- PROCORAD intercomparisons
- BfS intercomparisons
- Emergency intercomparisons

Training proposed:
Technical Recommendations for Monitoring Individuals for Occupational Intake of Radionuclides. European Commission Radiation Protection Report 188 (2018)

Address:
CIEMAT, Internal Dosimetry.
Avda. Complutense 40.
E36. 28040 – Madrid, Spain

Access:
The analytical facility is open to joint research collaborations

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Related to:
EURADOS

Issue 38
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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

Future events:

CONCERT Short Courses

24 June-5 July 2019

ADORE - Application of cytogenetic and EPR/OSL techniques for biological dosimetry and physical retrospective dosimetry. Bundesamt für Strahlenschutz, Germany

Contact:
Ulrike Kulka
ukulka@bfs.de

24 June-5 July 2019

Space summer school. SCK•CEN, Mol, Belgium

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Bjorn Baselet
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9-11 September 2019

CONFIDENCE WORKSHOP: Do Process-Based Models have a role in human food chain assessments? CIEMAT, Madrid, Spain

Contact:
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4-7 November 2019

LEU-TRACK course "Essentials of Radiation Leukaemogenesis", Centre for Radiation, Chemical & Environmental Hazards, PHE, Didcot, Oxfordshire, UK

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See also on CONCERT website

Editorial Committee: Maria Panagiotopoulou, Jean-Michel Dolo, William Hempel, Laure Sabatier

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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
Mar 2019, #35	IRSE Experimental Farm	The MWF database	DSA Environmental Laboratory
Apr 2019, #36	PG stack at Barreiro, Portugal	CONSTANCES	The MCDA Tool
May 2019, #37	LERF	IMMO-LDRT01 cohort	Radiochemical and Radioactive Analysis Laboratory (INTE-UPC)
Jun 2019, #38	FAIR	The BACCARAT study	CIEMAT *In Vitro* Internal Dosimetry Laboratories

Future events:

Other Events

10-14 June 2019
RAD 2019: Seventh International Conference on Radiation in Various Fields of Research, 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

8-13 September 2019
ENVIRA 2019: 5th International Conference on Environmental Radioactivity, Prague, Czech Republic

11-13 September 2019
ENGAGE final project workshop:
Enhancing stakeholder participation in the governance of radiological risks for improved radiation protection and informed decision making, Bratislava, Slovak Republic
Registration here
Contact:
Tatiana Duranova
tatiana.duranova@vuje.sk

16-20 September 2019
RADECS 2019: Radiation and its Effects on Components and Systems, Montpellier, France

23-27 September 2019
9th International Symposium on NORM, Denver, USA

28-30 October 2019
ICRA 2019: International Conference on Radiations and Applications 2019, Algiers, Algeria

4-7 November 2019
International Conference on Effective Regulatory Systems for Nuclear and Radiation Safety 2019, Vienna, Austria

12-14 November 2019
TERRITORIES final event,
Aix en Provence, France
Open to TERRITORIES scientists and stakeholders
Pre-register your interest here

26-29 November 2019
19th EAN WORKSHOP jointly organised with the PODIUM project: Innovative ALARA tools, Athens, Greece
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Editorial Committee: Maria Panagiotopoulou, Jean-Michel Dolo, William Hempel, Laure Sabatier

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