RADECS 2015

RUSSIA MOSCOW SEPTEMBER 14/18

RADECS 2015
CONFERENCE
PROGRAM

MOSCOW // RUSSIA // 14 - 18 // SEPTEMBER // 2015

ROSCOSMOS

URSC

TL ISDE

JINR

MEPhI

SPELS

RISI

CERN

JSC "KBO" ROSCOSMOS

中国航天宇航元器件工程中心
China Aerospace Components Engineering Center

CONTENT

MOSCOW DEPARTMENT OF SCIENCE AND INDUSTRIAL POLICY GREETING

ПРАВИТЕЛЬСТВО МОСКВЫ

ДЕПАРТАМЕНТ НАУКИ, ПРОМЫШЛЕННОЙ ПОЛИТИКИ И ПРЕДПРИНИМАТЕЛЬСТВА ГОРОДА МОСКВЫ

Участникам, гостям и организаторам Международной конференции по радиационным эффектам в компонентах и системах RADECS-2015

От имени Департамента науки, промышленной политики и предпринимательства города Москвы приветствую участников, гостей и организаторов Международной конференции по радиационным эффектам в компонентах и системах – RADECS-2015.

За 25 лет своего проведения конференция RADECS зарекомендовала себя в качестве авторитетной площадки для обмена опытом и информацией в области контроля и обеспечения стойкости радиоэлектронной аппаратуры к воздействию излучений космического пространства. Мероприятия конференции создают плодотворную почву для активного взаимодействия представителей ракетно-космической отрасли – научно-исследовательских организаций, производителей специализированного оборудования, профессиональных образовательных учреждений и национальных космических агентств.

Проведение конференции в Москве еще раз подчеркнет роль столицы России как крупнейшего мирового научного центра, продемонстрирует значимость одного из основных направлений развития науки и техники – космического приборостроения, а также высокий уровень организации и проведения международных мероприятий на московских площадках.

Убежден, что конференция RADECS-2015 пройдет в конструктивном ключе, запомнится ее участникам и гостям интересными, содержательными дискуссиями.

Желаю вам успешной и результативной работы!

Руководитель Департамента науки, промышленной политики и предпринимательства города Москвы **О.Е.Бочаров**

To the participants, hosts and organizers of the International Conference on Radiation Effects on Components and Systems - RADECS-2015

Head of the Moscow Department of Science, Industrial Policy and Entrepreneurship

O.E. Bocharov

Moscow, I welcome the participants, guests and hosts of the International Conference on Radiation Effects on Components and Systems – RADECS-2015.

For more than 25 years, the RADECS conference recommended itself as an authoritative platform for exchange of experience and information in the field of hardness control and assurance of electronic components and systems to space ionizing radiation influence. The conference events offer a significant opportunity for dynamic cooperation for representatives of the rocket – and – space industry– research organizations, specialized equipment manufacturers, professional educational institutions and national space agencies.

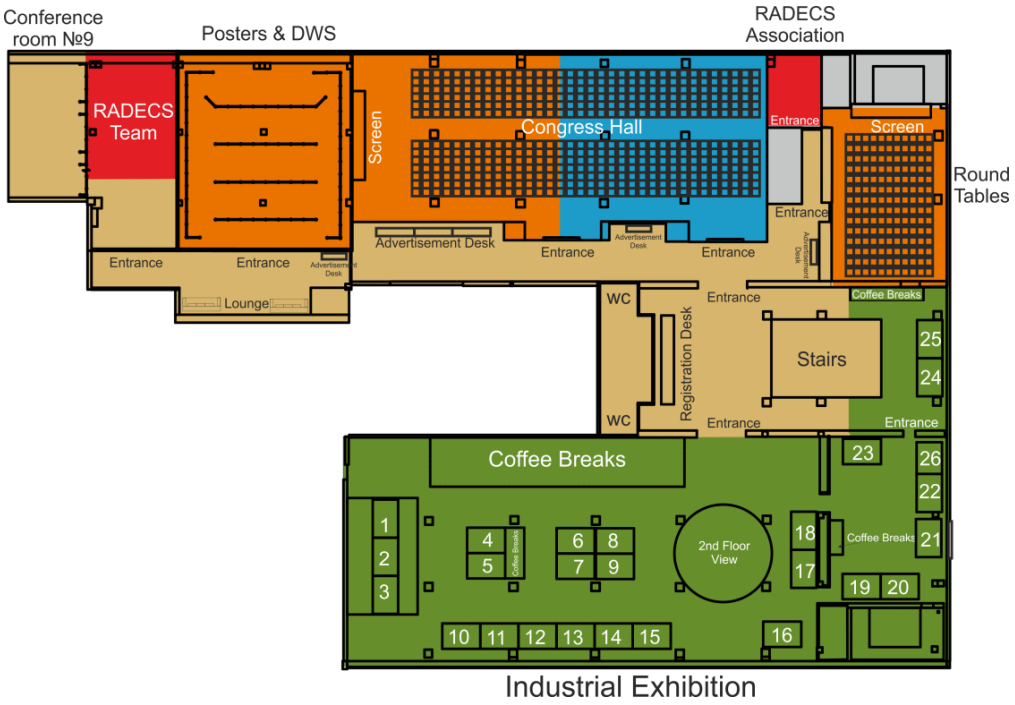
Holding the conference in Moscow once more will bring into focus the role of Russian capital as one of the largest global scientific centers, and it will also demonstrate the importance of principal directions for the science and technology development (space device engineering), as well as the high level of holding international events in Moscow.

I am convinced that the RADECS – 2015 conference will be productive and it will also be remembered by its participants and guests for interesting and informative discussions.

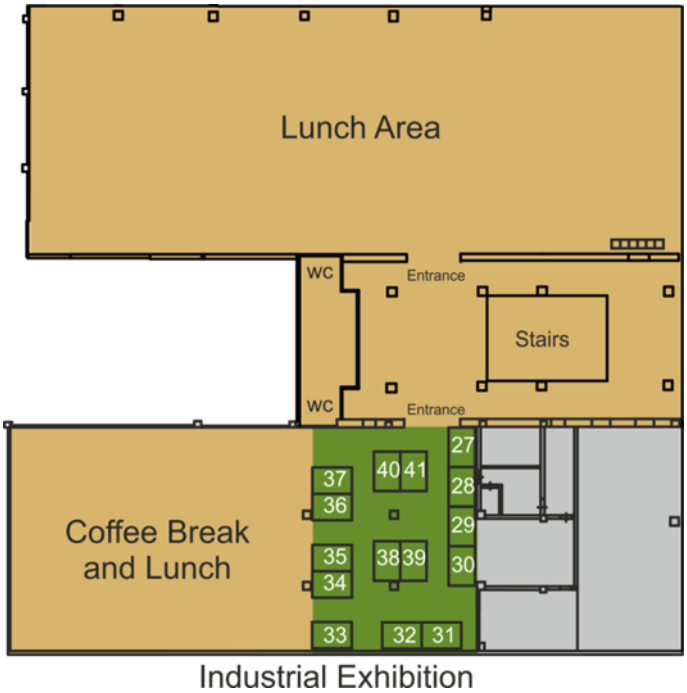
I wish you a successful and fruitful cooperation!

CONFERENCE VENUE
FLOOR PLAN

3rd Floor



2nd Floor



RADECS Association members' places
Short Course area
Technical sessions area
Exhibition area

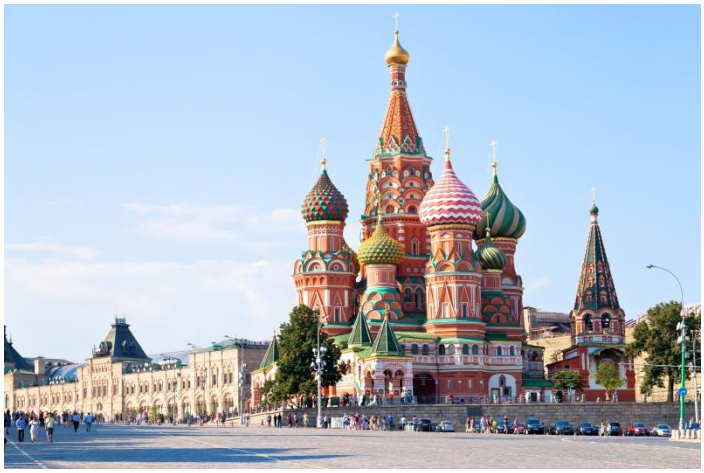
CONFERENCE AGENDA

SHORT COURSE AGENDA

SEPTEMBER 13 (SUNDAY)		*SEPTEMBER 14 (MONDAY)*	
		08h00-16h30	Registration
		09h00-09h15	Introduction by RADECS-2015 General Chairman
		09h15-09h30	Introduction by the Short Course Chairs
		09h30-10h30	Spacecraft radiation environment specification procedure
		10h30-11h00	**Coffee Break**
		11h00-12h00	Space radiation effects in modern and advanced electronics devices
		12h00-13h00	Radhard by design methods and approaches
		13h00-14h30	**Lunch**
		14h30-15h30	Total dose radiation hardness confirmation procedure of electronic components and systems in Europe/USA
		15h30-16h00	Total dose radiation hardness confirmation procedure of electronic components and systems in Russia
16h00-18h00	Registration	**16h00-16h30**	**Coffee Break**
		16h30-17h30	SEE radiation hardness confirmation procedure of electronic components and systems in Europe/USA
		17h30-18h00	SEE radiation hardness confirmation procedure of electronic components and systems in Russia
		18h00-18h15	Conclusion by the Short Course Chairs

TECHNICAL PROGRAM

SEPTEMBER 15 (TUESDAY)		*SEPTEMBER 16 (WEDNESDAY)*		*SEPTEMBER 17 (THURSDAY)*		*SEPTEMBER 18 (FRIDAY)*	
08h00-16h30	Registration	08h00-16h30	Registration	08h00-16h30	Registration	08h00-10h00	Registration
09h00-09h20	**Conference Opening**	9h00-10h00	**Session E.** Radiation Environments	9h00-11h00	**Session G.** Photonic and Optoelectronic Devices	9h00-11h00	**Session I.** Hardening by Technology, Design and System
09h20-10h30	**Session A.** Dose Effects In Devices and Integrated Circuits						
10h30	**Exhibition opening**	10h00-11h00	**Session F.** Single Event Transients	11h00-11h30	**Coffee Break**	11h00-11h30	**Coffee Break**
10h30-11h00	**Coffee Break**			11h30-13h00	**Session H.** Facilities and Dosimetry	11h30-12h40	**Session J.** Single Event Effects Mechanisms and Modeling
11h00-11h55	**Session B.** Basic Mechanisms of Radiation Effects	11h00-11h30	**Coffee Break**				
		11h30-13h00	**Round Table #2.** Micro and Milli Beams	13h00-14h30	**Lunch**	12h40-13h00	**End of Conference**
11h55-13h00	**Session C.** Hardness Assurance	13h00-14h30	**Lunch**	14h30-15h30	**Invited Talk.** Regarding Genuine Russian		
		14h30-15h30	**Invited Talk.** History of Russian Cosmonautics from the 19th to the 21st Century	15h30-17h30	**Radiation Effects Data Workshop**		
13h00-14h30	**Lunch**	15h30-18h00	**Poster Session**	16h30-17h00	**Coffee-Break**		
14h30-15h30	**Invited Talk.** A Russian cosmonaut's work experience	16h30-17h00	**Coffee Break**	17h30-19h00	**RADECS Association General Assembly**		
15h30-16h40	**Session D.** Single Event Effects in Devices & Integrated Circuits	17h00-18h30	**Round Table #3.** Spacecraft On-board Radiation Control				
16h40-17h00	**Coffee Break**						
17h00-18h30	**Round Table #1.** Simulation Methods						
10h30-18h30	**Industrial Exhibition**	9h00-18h30	**Industrial Exhibition**	9h00-13h00	**Industrial Exhibition**		
19h00-21h00	**Welcome Reception**	19h00-21h00	**Exhibition Cocktails**	20h00-22h00	**Gala Dinner**		



Moscow is the capital of Russia and the country's main political, economic, financial, educational and transportation center, located on the Moscow River. The city is more than eight and a half centuries old. Moscow is one of the most beautiful cities in Russia and in the world. With its parks, museums, monuments, great buildings, Moscow is a city of contrasts. This is the "third Rome" and "big village", and a place for the elite and for everybody. Moscow has a vibrant nightlife and idyllic residential areas. We could talk about Moscow and its sights, but it is better to see it for yourself.

The venue of the conference is **Izmailovo Alfa Hotel**. After a 15-minute drive from the historical city-center, the visitors are immersed in an atmosphere of serenity which contributes to both recreation and serious business meetings.

Izmailovo Alfa Hotel is conveniently located in the green area of Izmailovo Park. It is situated close to the Silver-Grape Pond, Pokrovsky Cathedral, and the "Vernissage". You will need only 15 minutes to drive to the city center. The Partizanskaya metro station is located 50 meters away. All these features attract both tourists and businessmen.

The address of Izmailovo Alfa Hotel is 71 A, Izmailovskoe shosse, 105613, Moscow, www.alfa-hotel.ru/en.

CONFERENCE CHAIRMAN'S INVITATION

Vasily Anashin received his PhD in Technical Sciences in 2008. From 2014 he has been working as the deputy head of Branch of Joint Stock Company "United Rocket and Space Corporation" – "Institute of Space Device Engineering".

He is a well-known specialist in the field of electronic components radiation hardness control methods and facilities development, especially in the research of single event latch-up cross-section and linear energy transfer thresholds dependence on the operational temperature range for digital integrated circuits during heavy ions irradiation.

He has authored and co-authored more than 120 published works on information system of electronic components hardness to space ionizing radiation, testing facilities for SEE control in electronic components, avionics and ionizing radiation dose exposure calculation.

He was a SERESSA (International School on the Effects of Radiation on Embedded Systems for Space Applications) Chair in 2013.

He has been a member of IEEE since 2011 and in 2014 he became a senior member of IEEE.

This is the first time Russia is hosting the RADECS Conference, and on behalf of the RADECS-2015 organizing committee, it is a great pleasure to invite you to participate in the RADECS-2015 Conference, that will be held from September 14 to September 18, 2015 at the Izmailovo Alfa Hotel, in Moscow.

The week begins on Monday September 14, 2015 with a one-day Short Course held by Alexander Chumakov and Robert Ecoffet and titled "The specifying requirements, electronic components and systems radiation hardness assurance providing".

The Short Course is intended for designers, radiation engineers, component specialists, and other technical and management personnel who are involved in developing reliable systems designed to operate in radiation environments. The Short Course will offer an opportunity for newcomers to get familiar with the radiation effects and for experts to review their knowledge and to focus on unexplored areas.

The conference week continues with the Technical program, which includes oral presentations divided into 10 sessions, poster session, radiation effects data workshop and round tables. In addition to the technical sessions, three invited talks will take place during the conference.

The RADECS-2015 organizing committee decided to seamlessly combine the technical program with the industrial exhibition. The industrial exhibition, which will run from Tuesday to Thursday, provides the opportunity for exhibitors to showcase the products and services which support the radiation effects industry.

In addition to managing the organization aspects of the conference, we have also prepared exciting and varied social programs for both delegates and their guests.

Finally, The RADECS-2015 organizing committee would like to thank all our sponsors, whose support has enabled us to host the conference and make proof of the famous Russian hospitality.

On behalf of the RADECS-2015 organizing committee, I believe the RADECS-2015 Conference will provide participants with an active scientific exchange and an opportunity to promote future scientific cooperation and friendship. I am certain that your involvement will contribute to the overall success of the conference.

We are looking forward to seeing you in Moscow this September.

RADECS-2015 Chairman

Vasily Anashin

CONFERENCE COMMITTEE

The RADECS-2015 conference committee consists of two parts: Russian and international, which makes the conference unique.

Conference Chair

Vasily Anashin, URSC-ISDE

Conference Vice-Chair

Ronan Marec, TAS

Technical Chair & Vice-Chair

Dmitry Boychenko, NRNU MEPhI/SPELS

Philippe Paillet, CEA

Short Course Chair & Vice-Chair

Alexander Chumakov, NRNU MEPhI/SPELS

Robert Ecoffet, CNES

Industrial Exhibition Chair & Vice-Chairs

Irina Tuzhikova, URSC-ISDE

Teresa Farris, Aeroflex

Christian Chatry, TRAD

Local Chair &Vice-Chair

Tatiana Barataeva, URSC- ISDE

Olga Ponourina-Paillet, Galactic Flow

Treasure Chairs

Zhanna Simonova, URSC-ISDE

Yulia Rybalchenko, URSC-ISDE

Honor and Advisory Chairs & Vice-Chairs

Kirill Borisov, Roscosmos

Vitaly Telets, NRNU MEPhI

Jean Gasiot, IES

Steve McClure, NASA – JPL

Awards Chair & Vice-Chair

Victor Ulimov, RISI

Christian Poivey, ESA

Web Support Chair & Vice-Chair

Anton Pankov, URSC- ISDE

Ksenia Buldygerova, URSC-ISDE

Guest editor for IEEE TNS

Dan Fleetwood, Vanderbilt University

RADECS Liaison

Michel Labrunee, CNES

SPONSORS

We would like to give many thanks to our sponsors, who have helped us organize the RADECS-2015. Without their financial support, the conference wouldn't be so successful and fruitful.

Our team appreciates your contribution and will be glad to see your representatives in Moscow at the Izmailovo Alfa Hotel.

We would like to present our sponsors

United Rocket and Space Corporation – Institute of Space Device Engineering (URSC – ISDE)

Joint Institute for Nuclear Research (JINR)

China Aerospace Components Engineering Center (CACEC)

Specialized Electronic Systems (SPELS)

Research Institute of Scientific Instruments (RISI)

Scientific production center «GRANAT»

Scientific production center «ElTest»

Vostok Company

Aerospace Scientific Research Test and Manufacturing Association (AKNIIPO)

RNII «Electronstandart»

Conseil Européen pour la Recherche Nucléaire (CERN)

EHO

SUPPORT

We would also like to thank the companies who supported the RADECS-2015 conference and helped us engage ministries, agencies, industries and universities, that supported us in organizing the conference and focused on the problems in the field.

Our team appreciates your contribution and will be glad to see your representatives in Moscow at the Izmailovo Alfa Hotel.

We would like to present the support organizations

Russian Space Agency (ROSCOSMOS)

United Rocket and Space Corporation (URSC)

Ministry of Industry and Trade of the Russian Federation (MINPROMTORG)

Russian Federation National Nuclear Corporation (ROSATOM)

National Research Nuclear University MEPhI (NRNU MEPhI)

Institute of Electrical and Electronics Engineers (IEEE)

Centre National d'Études Spatiales (CNES)

National Aeronautics and Space Administration (NASA)

European Space Agency (ESA)

Department of Science, Industrial Policy and Entrepreneurship of Moscow

International Association of Space Activities participants (IASP)

SHORT COURSE GENERAL INFORMATION

Sponsored by

Scientific production center «GRANAT»

Scientific production center «ElTest»

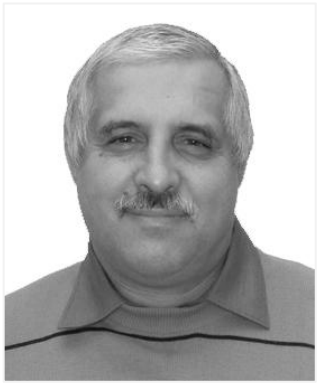
Vostok Company

RNII «Electronstandart»

AKNIIPO

In addition to the main conference, the 2015 Conference on Radiation Effects on Components and Systems (RADECS-2015) will also feature a Short Course. This one-day event is organized as a seminar around a specific theme, with several lectures providing their expert training. This course provides a unique opportunity to RADECS attendees to benefit from the expertise of the lecturers, their in-depth coverage and application-oriented perspective. The RADECS Short Course format makes it possible to cover topics more deeply than in a technical paper, to provide a way to introduce tutorial material and to place older work in a revised perspective. The Short Course will provide a perfect introduction to the conference.

RADECS-2015 Short Course Chair



Alexander Chumakov *received his M.S., Ph.D and Technical Doctor degrees in Electronics from the Moscow Engineering Physical Institute in 1976, 1982 and 1999, respectively. He works now as a professor of the Electronics Department at The National Research Nuclear University MEPhI. He joined the Specialized Electronic Systems (SPELS) in 1989. He is involved in simulation and investigation of radiation effects in IC. He was involved in the organization of different Russian conferences and he organized three Russian schools on Radiation Hardness of electronic devices. He has authored and co-authored more than 200 publications. He has been an IEEE Member since 1996.*

RADECS-2015 Short Course Vice-Chair

Robert Ecoffet *is an engineer at the French Space Agency CNES (Centre National d'Etudes Spatiales). For 25 years, he has been working for CNES in the field of space environment and radiation effects. He co-authored more than 100 papers, mainly published in the IEEE Transactions on Nuclear Sciences. He is a member of the RADECS Association (Radiation Effects on Components and Systems) steering board, and had the honor to serve as General Chairman of the 2014 IEEE Nuclear and Space Radiation Effects Conference. His position in CNES is senior expert in space environment and radiation effects, and he is responsible for the CNES "space environment" R&D axis.*

THE SPECIFYING REQUIREMENTS, ELECTRONIC COMPONENTS AND SYSTEMS RADIATION HARDNESS ASSURENCE PROVIDING

8h00 – 9h00	**Registration**
9h00 – 9h15	**Introduction by RADECS-2015 General Chairman** Vasily Anashin, *Conference Chair*
9h15 – 9h30	**Introduction by Short Course Chairs** Alexander Chumakov, *Short Course Chair* Robert Ecoffet, *Short Course Vice-Chair*
9h30 – 10h30	**Spacecraft radiation environment specification procedure** Athina Varotsou, *TRAD*
10h30 – 11h00	**Coffee Break**
11h00 – 12h00	**Space radiation effects in modern and advanced electronics devices** Simone Gerardin, *University of Padova*
12h00 – 13h00	**Radhard by design methods and approaches** Maxim Gorbunov, *Scientific Research Institute of System Analysis*
13h00 – 14h30	**Lunch**
14h30 – 15h30	**Total dose radiation hardness confirmation procedure of electronic components and systems in Europe/USA** Ronan Marec, *TAS*
15h30 – 16h00	**Total dose radiation hardness confirmation procedure of electronic components and systems in Russia** Alexey Akhmetov, *NRNU MEPhI/SPELS*
16h00 – 16h30	**Coffee Break**
16h30 – 17h30	**SEE radiation hardness confirmation procedure of electronic components and systems in Europe/USA** Renaud Mangeret, *Airbus Defence & Space*
17h30 – 18h00	**SEE radiation hardness assurance procedure electronic components and systems in Russia** Alexander Pechenkin, *NRNU MEPhI/SPELS*
18h00 – 18h15	**Conclusion by Short Course Chairs**

The Short Course printed book is available if you paid the Short Course registration fee.

September 15-18, 2015 (Tuesday-Friday)

The aim of RADECS conferences is to provide an annual European forum for the presentation and discussion of the latest advances in the field of radiation effects on electronic and photonic materials, devices, circuits, sensors, and systems. The scope of the conference encompasses technological processes and design techniques for producing radiation tolerant systems for space, aeronautical or terrestrial applications, as well as relevant methodologies for their characterization and qualification. The conference features a technical program, an Industrial Exhibit, and a one day tutorial or 'short course' on radiation effects. The technical program includes oral and poster sessions, radiation effects data workshop, round tables and three invited talks.

RADECS-2015 Technical Chair

Dmitry Boychenko *received his PhD degree in Electronics from the Moscow Engineering Physics Institute in 2009. He is general director of the Specialized Electronic Systems (SPELS) – leading Russian radiation hardness assurance test center majored in radiation hardness research, development and testing of microelectronic devices and circuits (microelectronics, RF and microwave units, semiconductor devices, sensors, MEMS). Dmitry also works as an associate professor of the Electronics Department at The National Research Nuclear University MEPhI. He wrote co-authored and himself more than 150 (20 originally in English) publications about radiation effects in electronic components and systems. IEEE member.*

RADECS-2015 Technical Vice-Chair

Philippe Paillet *received his PhD degree in Electrical Engineering from the Université Montpellier II, France, in 1995, and then joined the Commissariat à l'Energie Atomique (CEA) in Arpajon, France, where he is a senior expert of radiation effects in electronic and optoelectronic devices, developing radiation-hardened technologies and hardness assurance approaches. Philippe has served the radiation effects community as reviewer and Session Chairman for the IEEE Nuclear and Space Radiation Effects Conference (NSREC) and the RADiation Effects in Components and Systems (RADECS) European conference. He served as Guest Editor from 2004 to 2007 for the journal IEEE TRANSACTIONS ON NUCLEAR SCIENCE. He has authored and co-authored more than 150 publications, articles, short courses and book chapters, including two Best Papers at RADECS, one Best Paper Award at HEART, two Meritorious Paper Awards and five Outstanding Conference Paper Awards at NSREC.*

TECHNICAL SESSION CHAIRS & VICE-CHAIRS

Sessions	Chairs	Vice-Chairs
Session A: Dose Effects in Devices and Integrated Circuits	**Oleg Kalashnikov** *NRNU MEPhI/SPELS*	**Vincent Goiffon** *ISAE*
Session B: Basic Mechanisms Of Radiation Effects	**Viacheslav Pershenkov** *NRNU MEPhI*	**Laurent Dusseau** *University Montpellier*
Session C: Hardness Assurance	**Vladimir Emelianov** *RISI*	**Hugh Barnaby** *Arizona State University*
Session D: Single Event Effects in Devices and Integrated Circuits	**Andrey Yanenko** *NRNU MEPhI/SPELS*	**Philippe Adell** *JPL*
Session E: Radiation Environments	**Vladimir Kalegaev** *SINP MSU*	**Markus Brugger** *CERN*
Session F: Single Event Transients	**Vladimir Steshenko** *Russian Space Systems*	**Dale McMorrow** *NRL*
Session G: Photonic and Optoelectronic Devices	**Konstantin Tapero** *RISI*	**Marco Van Uffelen** *F4E*
Session H: Facilities and Dosimetry	**Vladimir Skuratov** *JINR*	**Mathieu Boutillier** *CNES*
Session I: Hardening by Technology, Design and Systems	**Maxim Gorbunov** *SRISA*	**Fernanda Lima – Kastensmidt** *University Rio Grande do Soul*
Session J: Single Event Effects Mechanisms and Modeling	**Gennady Zebrev** *NRNU MEPhI*	**Marta Bagatin** *University Padova*
Poster Session	**Petr Skorobogatov** *NRNU MEPhI/SPELS*	**Sylvain Girard** *University St. Etienne*
Radiation Effects Data Workshop	**Pavel Chubunov** *URSC – ISDE*	**Renaud Mangeret** *Airbus D&S*
Round Table #1: Simulation Methods	**Anastasia Ulanova** *NRNU MEPhI/SPELS*	**Dale MacMorrow** *NRL*
Round Tables #2: Micro and Milli beams	**Aleksandr Koziukov** *URSC-ISDE* **Semen Mitrofanov** *JINR*	---
Round Tables #3: Spacecraft On-board Radiation Control	**Grigory Protopopov** *URSC-ISDE*	**Robert Ecoffet** *CNES*

RADIATION EFFECTS DATA WORKSHOP

The Radiation Effects Data Workshop is a forum for papers on radiation effects data on electronic devices and systems. Workshop papers are intended to provide radiation response data to scientists and engineers who use electronic devices in a radiation environment, and for designers of radiation-hardened systems. Papers describing new simulation or radiation facilities are also welcome.

Authors will be available on Thursday to discuss their work from 15h30 to 17h30.

POSTER SESSION

The Poster Session will be held on Wednesday from 15h30 to 18h00 and the authors will be available at that time to discuss their work.

ROUND TABLES

The scope of the Round Tables encompasses a wide set of radiation hardness assurance techniques and their comparison, the performance of different facilities and their design features for deep ICs SEE sensitivity research and description of the special sensors, detectors and systems for the space radiation on-board control and measurements consideration. The Round Tables will be organized as presentations (up to 4 from different countries: Russia, Europe, the USA and Asia and questions with discussions after each report. The Round Tables will be held from Tuesday to Thursday.

INVITED TALKS

1. **A Russian Cosmonaut's Work Experience**

Sergei Krikalev, Russian cosmonaut

2. **History of Russian Cosmonautics from the 19th to the 21st Century**

Irina Golovkina, Museum of Cosmonauts

3. **Regarding Genuine Russian**

Maria Sukhorukova, private speaker

LATE NEWS PAPERS

Late News papers will be accepted and included in the Poster Session and the Radiation Effects Data Workshop.

9h00

CONFERENCE OPENING
V. Anashin (URSC- ISDE), General Chair
R. Marec, (Thalès Alenia Space), General co-Chair
P. Calvel, (Thalès Alenia Space), President of RADECS Association
Roscosmos representative

TECHNICAL SESSION OPENING REMARKS
D. Boychenko, (NRNU MEPhI/SPELS) Technical Program Chair
P. Paillet (CEA) Technical Program co-Chair

SESSION A **DOSE EFFECTS IN DEVICES AND INTEGRATED CIRCUITS**

Session Chairs

Oleg Kalashnikov *is a National Research Nuclear University MEPhI assistant professor. The subject of his research is radiation hardness of VLSI, like microprocessors, FPGA, SoC, ADC, DAC, memories. The subject of his interest is related to radiation testing of Ics and units, radiation facilities and dosimetry, hardness assurance. He is the author of more than 100 publications.*

Vincent Goiffon *(MSEE 2005, Ph.D. EE 2008) has been an Associate Professor at ISAE-SUPAERO since 2008. His research interests focus on solid-state image sensors and include CMOS IC design, pixel/device modeling/characterization, leakage/dark current, RTS, radiation effects and hardening techniques. He is regularly involved in scientific image sensor R&D projects. He has co-authored more than 30 journal papers, including one Outstanding Conference Paper Award and one Outstanding Student Paper Award (both at IEEE NSREC).*

9h20 **SESSION INTRODUCTION**
Chairs: O. Kalashnikov, (NRNU MEPhI/SPELS) & V. Goiffon (ISAE-SUPAERO)

ORAL PAPERS

A-1 9h30 **Radiation Hardening by Process of CBRAM Resistance Switching Cells**

Y. Gonzalez-Velo[1], A. Mahmud[1], H. J. Barnaby[1], M. N. Kozicki[1], W. Chen[1], J. Taggart[1], M. Ailavajhala[2], K. Holbert[1], M. Mitkova[2]
[1]Arizona State University, [2]Boise State University

It is discovered that Conductive Bridging Random Access Memory (CBRAM) is sensitive to high values of TID, and it is demonstrated that this novel technology could be radiation hardened by process.

A-2 9h45 **A 1 MGy TID Radiation-Tolerant 56 µW CMOS Temperature Sensor with ±1.7°C accuracy**

Y. Cao[1], J. Verbeeck[1], M. Van Uffelen[2], L. Mont Casellas[2], C. Damiani[2], E. Ruiz Morales[2], R. Ranz Santana[2], R. Meek[3], B. Haist[3], W. De Cock[1], L. Vermeeren[1], M. Steyaert[1], P. Leroux[1]
[1]Catholic University of Leuven, [2]Fusion for Energy, [3]Oxford Technology Ltd

The 1 MGy TID radiation-tolerant temperature sensor with dynamic base leakage compensation achieves an accuracy of ±1.7°C from -40°C to 125°C, while the power and area consumption are only 56 µW and 0.07 mm², respectively.

A-3 10h00 **SiGe HBT TCAD Simulation Taking into Account Impact of Proton Radiation**

K. O. Petrosyants, M. V. Kozhukhov
Moscow Institute of Electronics and Mathematics

Performance degradation of SiGe HBT after proton radiation impact is investigated using Synopsys Sentaurus tool. The method to account for the impact of proton radiation is based on additivity of the ionization and displacement effects.

A-4 10h15 **Total Ionizing Dose Effects in Carbon Nanotube Network Transistors**

S. Ishii[1], D. Yabe[1], S. Enomoto[1,2], S. Koshio[3], T. Konishi[4], T. Hamono[4], T. Hirao[3]
[1]Tokyo Denki University, [2]University of Tusukuba, [3]National Institute of Radiological Sciences, [4]Ryoei Technica Corporation

Total ionizing dose (TID) effects on carbon nanotube network transistors were experimentally evaluated using 60Co gamma-ray irradiation up to 50 kGy(Si). The electrical characteristics of the devices after irradiation are reported for future space applications.

POSTER PAPERS

PA-1 Dose Effects in CMOS Operational Amplifiers with Bipolar and CMOS Input Stage at Different Dose Rates and Temperatures

K. I. Tapero[1], A. S. Petrov[1], V. N. Ulimov[1], P. A. Chubunov[2], V. S. Anashin[2]
[1]Research Institute of Scientific Instruments (RISI), [2]Branch of JSC URSC – ISDE

It is shown that CMOS operational amplifiers with bipolar and CMOS input stage can be susceptible to both enhanced low dose rate sensitivity and time-dependent effects that should be taken into account during radiation testing.

PA-2 Evaluation of the post-irradiation temperature dependence of operational amplifier input bias current

A.S. Rodin, A.S. Bakerenkov, V.S. Pershenkov, V.A. Felitsyn, A.G. Miroshnichenko, N.S. Glukhov
National Research Nuclear University MEPhI

The Evaluation technique for radiation degradation of temperature dependences of operational amplifier input bias currents was developed. The technique can improve the accuracy of prediction of radiation hardness of operational amplifiers in full operation temperature range.

PA-3 Rad-Hard Versions of SPICE MOSFET Models for Effective Simulation of SOI/SOS CMOS Circuits Taking into Account Radiation Effects

K. O. Petrosyants, I. A. Kharitonov, L. M. Sambursky, A. S. Mokeev
Moscow Institute of Electronics and Mathematics

SPICE modeling of SOI/SOS MOSFETs with account for static (TID) and dynamic (SEU and transient ionizing radiation) radiation-induced effects including SPICE models, model parameter extraction and applications for circuit simulation, is described for radhard SOI/SOS technologies.

PA-4 TCAD Simulation of Total Ionization Dose Response of 45nm High-K MOSFETs on Bulk Silicon and SOI Substrate

K. O. Petrosyants, D. A. Popov
Moscow Institute of Electronics and Mathematics

Semi-empirical model accounting for TID dependences of oxide and HfO_2/Si interface trap densities, carrier mobilities, lifetime of device material was developed and introduced into TCAD tool. TID response of 45 nm high-k bulk/SOI MOSFETs was simulated.

PA-5 Flash-Based FPGA TID and Long-Term Retention Reliability through VT Shift Investigation

J.J. Wang, N. Rezzak, D. Dsilva, F. Hawley, E. Hamdy
Microsemi SOC

FPGA configuration flash's V_T shift is modeled for TID and long-term retention effects by nature decay equations. The combined effects are proposed as a decay equation with the coefficient being TID adding to retention.

PA-6 Connection of the parametric and functional control for TID testing of complex VLSI circuits

V. A. Marfin[1], P. V. Nekrasov[1], I. O. Loskutov[2]
[1]National Research Nuclear University MEPhI, [2] Specialized Electronic Systems (SPELS)

The article describes an original technique for TID testing of complex VLSI circuits (microprocessors) based on combined use of parametric and functional control. The resulting dependences obtained in radiation experiment are qualitatively confirmed by circuit simulation.

PA-7 Effect of electron irradiation on MISFET integrated hydrogen sensors

B. Podlepetsky
National Research Nuclear University MEPhI

The electron irradiation effect on hydrogen sensitivity of the integrated sensors based on MISFET has been investigated. The estimation of critical doses has been done according to developed models of hydrogen and radiation sensitivities.

PA-8 The TID effects of RRAM based oxide material

W. Yan, J. Bi, J. Liu, Q. Liu, H. Lv, S. Long, M. Liu
Institute of Microelectronics, Chinese Academy of Sciences

RRAM exhibit highly stable characteristics under TID radiation. But different radiation effects are shown in the RRAM based different oxide. The radiation effects in RRAM based HfO_2 and SiO_2 are tested and analyzed.

PA-9 The Impact of Plane-Polarized Unfocused Laser Radiation on Bulk Ionization in Deep-Submicron Modern ICs

P.K. Skorobogatov, G.G. Davydov, A.V. Sogoyan, A.Y. Nikiforov, A.N. Egorov
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

Manifestation of the dose rate effects is strongly depends on the laser polarization direction for the ICs with design rules less the laser wavelength. There are several approaches to reduce this influence in deep-submicron ICs.

PA-10 Long-Term Transient Radiation Effects in SOI CMOS RF ICs

G. N. Nazarova, V. V. Elesin, G. V. Chukov, D. M. Amburkin, A. Y. Nikiforov
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

This paper presents the study of transient radiation effects in SOI CMOS RF IC's and discrete MOS transistors. Experiments show that the sensitivity of SOI RF IC's (gain blocks, mixers, VCO etc.) to transient irradiations (dose rate) is mainly determined by the transient response of RF characteristics i.e. output power, output frequency, power / conversion gain, rather than supply transient photocurrent.

10h30–11h00 COFFEE BREAK

SESSION B BASIC MECHANISMS OF RADIATION EFFECTS

Session Chairs

Viacheslav Pershenkov *received his PhD in Technical Science in 1968. He became a Senior research associate in 1971, Associate professor in 1977, Doctor of Engineering Science in 1988 and Professor in 1991. He has been working as a Head of the Micro and Nanoelectronics department since 1997. He has been a Department Chair of Automatic Equipment and Electronics since 2007. Mr. Pershenkov is an author of more than 200 scientific articles 1 monograph, has 12 author's certificates including the license of the USA. He is a member of the editorial board of the international journal "Microelectronics Reliability".*

Prof ***Laurent Dusseau*** *graduated with a Ph.D. from University of Montpellier 2 in 1995. He was appointed full professor in 2004 and became Head of the electrical engineering department in 2005, position he held until 2011. Vice president of the RADECS association since 2012, he was also Géneral Chair of the RADECS 2005 conference. He is currently head of the University Space Center and conference.*

11h00

SESSION INTRODUCTION
Chairs: V. Pershenkov (NRNU MEPhI) & L. Dusseau (Univ. Montpellier)

ORAL PAPERS

B-1 11h10 **Radiation vulnerability in 65 nm CMOS I/O transistors after exposure to Grad dose**

L. Ding[1,2], S. Gerardin[1,2], M. Bagatin[1], S. Mattiazzo[1], D. Bisello[2,3], A. Paccagnella[1,2]
[1]University of Padova - Dept. of Information Engineering, [2]INFN, [3]University of Padova - Dept. of Physics and Astronomy

We studied the TID response of I/O 65-nm MOSFETs, which are strong candidates for LHC upgrade. Enhanced radiation vulnerability in I/O transistors compared to core transistor appeared, due to radiation-induced interface states and charge accumulation

B-2 11h25 **Physical Mechanisms of Radiation Response in Thick Isolation Oxides for Different Temperatures and Dose Rates**

M. G. Drosdetsky[1], G. I. Zebrev[1], A. M. Galimov[1], R. G. Useinov[1,2]
[1]National Research Nuclear University MEPhI, [2]Research Institute of Scientific Instruments

Temperature behavior of the charge yield and degradation saturation due to the interface precursor depletion has been modeled and simulated. Competition between the time-dependent and true dose rate (ELDRS) effects has been simulated and discussed.

B-3 11h40 **Modeling charge buildup in deposited oxides under x-ray and gamma irradiation**

A. A. Smolin[1], A. V. Sogoyan[2], A. V. Ulanova[2], A. A. Demidov[2]
[1]National Research Nuclear University MEPhI, [2]Specialized Electronic Systems (SPELS)

Analysis of TID degradation differences for MOS-structures under x-ray and gamma irradiations is provided. Correlation between spatial distribution of hole traps in the oxide and TID degradation kinetics is determined.

POSTER PAPERS

PB-1 **Research on Interaction between Oxide Charge and Displacement Defects in NPN Transistors Based on Deep Level Transient Spectroscopy**

X. Li, C. Liu, J. Yang, and G. Ma
Harbin Institute of Technology

Based on DLTS, the interaction mechanisms between oxide charge and displacement defects in NPN transistors caused by the combined irradiations of 70 keV, 170 keV protons together with 5 MeV protons are revealed.

PB-2 **Radiation Damage and Defects in NPN Bipolar Junction Transistors Irradiated by Silicon Ions with Various Energies**

C. Liu, X. Li, J. Yang, and G. Ma
Harbin Institute of Technology

Radiation effects in bipolar junction transistors are examined under the irradiation with 10, 24 and 40 MeV Si ions. The incident particle energy affects the concentration of displacement defects in irradiated NPN BJTs.

PB-3 **Application of isotope radiation sources for radiation effects simulation in semiconductor devices**

E. N. Vologdin, F. S. Pudovikov, D. V. Sidorov, V. F. Sinkevich
JSC "S&PE "Pulsar"

Radionuclide sources of alpha radiation are used to simulate neutron irradiation on silicon semiconductor devices and integrated circuits. A general approach is formulated to use these sources to simulate space radiation.

SESSION C HARDNESS ASSURANCE

Session Chairs

Vladimir V. Emelianov *graduated from The National Research Nuclear University MEPhI (Moscow Engineering Physical Institute) in 1988. For 27 years, he has been working for the Research Institute of Scientific Instruments (Radiation test center of ROSATOM, Russia) in the field of radiation testing of electronic devices. His position in RISI is head of department, and he is responsible for RISI's single event direction. He is the co-author of more than 20 papers, published in the IEEE Transactions on Nuclear Science and RADECS Proceedings.*

Hugh J. Barnaby *is an associate professor of Electrical Engineering at Arizona State University, where his primary research focuses on the analysis, modeling, and experimental characterization of extreme environment effects in semiconductor materials, devices and integrated circuits. He has served as an active researcher in the radiation effects field for over 22 years in both industry and academics, presenting and publishing more than 200 papers during this time. He is a senior member of IEEE and has been involved in the NSREC and RADECS community since 1996.*

11h55 **SESSION INTRODUCTION**
Chairs: V. Emeliyanov (RISI) & H. Barnaby (Arizona State Univ.)

ORAL PAPERS

C-1 12h05 **Dose Rate Switching Technique to Estimate the Low Dose Rate Response of Bipolar Technologies**
J. Boch[1], A. Michez[1], M. Rousselet[1], S. Dhombres[1], L. Dusseau[1], E. Lorfèvre[2], N. Chatry[3], N. Sukhaseum[3], and F. Saigné[1]
[1]Université Montpellier, [2]CNES, [3]TRAD

The Switched Dose Rate technique is investigated when devices do not exhibit ELDRS. Experimental data and modeling results are presented and discussed in terms of hardness assurance.

C-2 12h20 **Comparison of Irradiation at Low Dose Rate and Irradiation at Elevated Temperature to Reveal ELDRS in Bipolar Linear Circuits**
K. I. Tapero[1,2], A. S. Petrov[1], Vi. N. Ulimov[1], P. A. Chubunov[3], V. S. Anashin[3]
[1]Research Institute of Scientific Instruments (RISI), [2]National University of Science and Technology MISIS, [3]Branch of JSC URSC – ISDE

The degradation of LM124J operational amplifier under gamma-irradiation is studied for different dose rates and temperatures. The paper shows how to take into account such effects during radiation testing and ELDRS characterization.

C-3 12h35 **Method of SEU-hardness assurance for SRAM with error correction using focused laser sources**

A. B. Boruzdina[1,2], A. A. Pechenkin[1,2], I. B. Yashanin[3], A. V. Ulanova[1,2], A. V. Yanenko[1,2], A. I. Chumakov[1,2]
[1] National Research Nuclear University MEPhI, 2Specialized Electronic Systems (SPELS), 3 FSUE FRPC "NIIIS named after Yu. Ye. Sedakov"

In this work an analysis of approaches for testing SEU-hardness in SRAM with error correction is presented. The results of experiments on 16 Mbit SRAM under heavy ion and focused laser exposures are provided.

POSTER PAPERS

PC-1 **The issue of using test dose rate 10 mrad (Si)/s for ELDRS prediction in MIL-STD-883-H**

A.T. Yastrebov, V.S. Pershenkov, A.S. Bakerenkov, V.A. Felitsyn, A.S. Rodin, V.V. Belyakov, V.V. Shurenkov
National Research Nuclear University MEPhI

The validity of MIL-STD-883-H test method at dose rate less than 10 mrad(Si)/s is discussed. The prediction capability of a conversion model is evaluated at ultra-low dose rates and compared with current test standard.

PC-2 **Experimental technique for determination of ELDRS-free devices**

V.S. Anashin[1], V.S. Pershenkov[2], A.S. Bakerenkov, P.A. Chubunov[1,2], A.V. Solomatin, A.S. Rodin, V.A. Felitsyn
[1]Branch of JSC URSC – ISDE, [2] National Research Nuclear University MEPhI

A technique for identifying of ELDRS-free devices is described. The technique is based on a conversion model for low dose rate effects in bipolar transistors.

PC-3 **The technique for estimation of the chip temperature of integrated circuits during irradiation**

V.A. Felitsyn, A.S. Bakerenkov, V.S. Pershenkov, A.S. Rodin, V.V. Belyakov, V.V. Shurenkov, N.S. Glukhov
National Research Nuclear University MEPhI

The technique for estimation of the chip temperature of integrated circuits during irradiation is described. The technique is based on the experimental determination of the actual value of junction-to-ambient thermal resistance.

13h00–14h30 ***LUNCH***

INVITED TALK 14h30 – 15h30 **A Russian cosmonaut's work experience**

Sergei Krikalev, Russian cosmonaut

Space flight is a very dangerous and complicated job and only the strongest and bravest men can achieve the title of Hero and cosmonaut. We are proud that the first cosmonaut was born in Russia – Yury Gagarin, and we know that his footsteps are taken by the bravest people in Russia.

SESSION D — SINGLE EVENT EFFECTS IN DEVICES & INTEGRATED CIRCUITS

Session Chairs

Andrey Yanenko *graduated from The National Research Nuclear University MEPhI (Moscow Engineering Physical Institute) in 1993. Then he carried out research work on radiation hardness assurance of SRAMs and received his Ph.D in 2009. Since 1998 he has been working as an associate professor at NRNU MEPhI.*

Since 1993 he has been working as a research engineer in Specialized Electronic Systems (SPELS). Since 2009 he has been head of SEE research and testing department and since 2014 he has been working as CTO. Since 2012 he has been working as a Leading Researcher in the Institute of Extreme and Applied Electronics of the National Research Nuclear University MEPhI. His field of scientific interest is SEE in electronic devices. He is author and co-author of more than 160 scientific publications, including more than 20 in English.

Philippe Adell *started working at the NASA-Jet Propulsion Laboratory, California Institute of Technology in Feb. 2007 after completing his MS (2003) and PhD (2006) in Electrical Engineering at Vanderbilt University. He graduated from the polytechnic institute of the University of Montpellier (France), with a MS (1999) in material science and technologies In the past couple of years, he has been involved with the CubeSat community at JPL and was appointed by Charles Elachi, JPL director, to be the JPL liaison for future international collaboration on interplanetary CubeSats with the French space agency and the Montpellier's Van Allen Consortium. Philippe has more than 60 international publications in the field of radiation effects in micro-electronics and systems.*

He has served as session chair and short course instructor in previous major US and European radiation effect conferences.

15h30 **SESSION INTRODUCTION**
Chairs: A. Yanenko (NRNU MEPhI) & P. Adell (NASA-JPL)

ORAL PAPERS

D-1 **15h40** **CARMEN1 and CARMEN2 Experiments: Comparison between In-flight Measured SEE Rates and Predictions**
A. Samaras[1], A. Varotsou[1], N. Chatry[1], E. Lorfevre[2], F. Bezerra[2], R. Ecoffet[2]
[1]TRAD, [2]CNES

SEU rates evaluated with standard method and accurate method (flux measurement, sectored shielding and experimental data) are compared to in-flight results for trapped protons and solar flare protons.

D-2 15h55 **Experimental Characterization and In-flight Observation of Weakened Cells in SDRAM**

A. Samaras[1], B. Vandevelde[1], N. Sukhaseum, N. Chatry[1], A. Rodriguez, F. Wrobel[3], F. Bezerra[2], E. Lorfevre[2] and R. Ecoffet[2]
[1]TRAD, [2]CNES, [3]Université Montpellier

In-flight observations and test results present higher SEU occurrence on some addresses of the SDRAM memories. This effect is observed as weakened cells generated by energetic particles on several addresses on the memory array.

D-3 16h10 **Heavy-ion radiation impact on a 4Mb FRAM under Different Test Conditions**

V. Gupta[1,3], A. Bosser[1,2], G. Tsiligiannis[1,3], A. Zadeh[4], A. Javanainen[2], A. Virtanen[2], H. Puchner[5], F. Saigné[3], F. Wrobel[3] and L. Dilillo[1]
[1]Université Montpellier-LIRMM, [2]University of Jyvaskyla,
[3]Université Montpellier-IES, [4]ESA,
[5]Cypress Semiconductor

The impact of heavy ions on commercial Ferroelectric Memories (FRAMs) is analyzed. Moreover, the influence of different test modes and stimuli on their error rate is investigated.

D-4 16h25 **Reliability Analysis of Operating Systems for Embedded SoC**

T. Santini, L. Carro, F. Rech Wagner, and P. Rech
Universitade Federal do Rio Grande do Sul

We experimentally and analytically evaluate the reliability of Linux in modern SoCs and show that cache conflicts reduce the Linux-induced SEFI rate increase. We prove that the OS software stack significantly reduces the neutron-induced SDCs.

POSTER PAPERS

PD-1 **On the Characterization of Embedded Memories of Zynq-7000 All Programmable SoC under Heavy Ions and Protons Induced Single Event Upsets**

L. Antunes Tambara[1], A. Akhmetov[2], D. V. Bobrovskiy[2], Lima Kastensmidt[1]
[1]Universidade Federal do Rio Grande do Sul,
[2]National Research Nuclear University MEPhI/ Specialized Electronic Systems (SPELS)

This work presents static tests performed with heavy ions and protons irradiations on the Zynq-7000 to measure the sensitivity of its FPGA and memories under Soft Errors.

PD-2 **Analyzing the Failure Impact of Using Hard- and Soft-cores in All Programmable SoC under Neutron-induced Upsets**

L. Antunes Tambara, P. Rech and F. Lima Kastensmidt
Universidade Federal do Rio Grande do Sul

We investigate the impact of using different system architectures on an APSoC, such as memory organization, communication schemes and by using hard- and soft-cores in the same context, in the final system failure rate.

PD-3 Sensitivity to Neutron Radiation of a 45 nm SOI Multi-core Processor

R. Velazco[1], P. Ramos[1,2], V. Vargas[1,2], M. Baylac[3], F. Villa[3], S. Rey[3], J. A. Clemente[4], N-E. Zergainoh[1]
[1]TIMA Labs, [2]Universidad de las Fuerzas Armadas,
[3]University of Grenoble-Alpes, [4]Universidad Complutense de Madrid

SEU sensitivity of a multi-core architecture working in two different multi-processing modes was evaluated. Radiation ground tests were performed with 14MeV neutrons. The case study was a 45nm SOI multi-core processor having implemented ECC and parity.

PD-4 Investigation of Single Event Functional Interrupts in Microcontroller with PIC17 Architecture

P. V. Nekrasov, D. V. Bobrovskiy, A. B. Karakozov, V. A. Marfin
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

The article is devoted to the study of Single Event Functional Interrupts in microprocessors. SEFI detection method is discussed. The new simplified method of SEFI cross-section calculation based on critical memory space estimation is presented.

PD-5 A Methodology for the Analysis of Memory Response to Radiation through Bitmap Superposition and Slicing

A. Bosser[1,2], V. Gupta[1,3], G. Tsiligiannis[1,3], R. Ferraro[3], C. Frost[6], A. Zadeh[4], A. Javanainen[2], H. Puchner[5], M. Rossi, F. Saigné[3], A. Virtanen[2], F. Wrobel[3] and L. Dilillo[1]
[1]Université Montpellier-LIRMM, [2]University of Jyvaskyla,
[3]Université Montpellier-IES, [4]ESA,
[5]Cypress Semiconductor, [6]Rutherford Appleton Laboratory

A methodology is proposed to perform statistical analysis of radiation test data of memories searching for trends in the error distribution. The treated case study is a 65nm SRAM irradiated with neutrons, protons and heavy-ions.

PD-6 Non-uniform Optical Losses in Laser SEE Tests

D. V. Savchenkov, A. I. Chumakov, O. V. Merkushin, G. G. Davydov, V. A. Marfin
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

The non-uniformity of the metallization of any integrated circuit hinders the correct determination of SEE cross-section vs. LET when using laser techniques. A new method is discussed in this article taking this non-uniformity into account.

PD-7 SEE Laser Testing at Different Temperatures

A. A. Novikov, A. A. Pechenkin, A. I. Chumakov, A. O. Akhmetov, O. B. Mavritskii
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

IC's SEE sensitivity may depend on temperature. Traditional ion irradiation methods have some limitations, which laser SEE technique can overcome. In this work, SEE laser results for various temperatures are discussed.

PD-8 Investigation of SEGR cross-section in power MOSFETs under Proton Irradiation

E. V. Mitin, V. G. Malinin
Russian Scientific Research Institute "Electronstandart"

The cross-section of single-event gate rupture effect caused by 1 GeV protons is measured in several types of power MOSFETs. The influence of drain-source voltage is observed.

PD-9 Experimental Study of 0.18μm and 65nm SRAM SEUs Induced by Heavy Ions, High Energy Protons and Low Energy Protons on Orbits

Q. Yu, L. Luo, M. Tang, Y. Sun, Z. Wei, Z. Li, M. Zhu
China Academy of Space Technology

SEUs of 0.18μm and 65nm SRAMs are tested by using heavy ions and protons. SEU rates on orbits induced by heavy ions, high energy protons and low energy protons are studied.

16h40–17h00 ***COFFEE BREAK***

ROUND TABLE #1 **Simulation Methods**
17h00 – 18h30

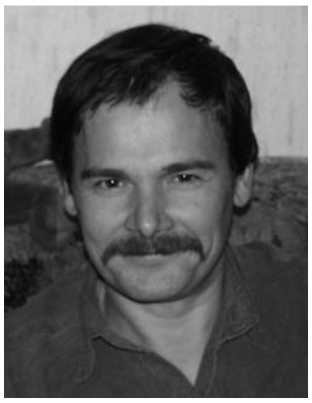
Anastasia Ulanova, NRNU MEPhI/SPELS, Russia (chair)
Dale McMorrow, NRL, USA (chair and also presenter)
Savchenkov Dmitry, NRNU MEPhI/SPELS, Russia (presenter)
Smolin Anatoly, NRNU MEPhI/SPELS, Russia (presenter)

Round table devoted to the discussion of test simulation methods. The round table is divided into two parts. The first part discusses the features of laser SEE testing technique: differences between ion and laser ionization tracks, SEE cross-section depends on laser spot size, optical losses nonuniformity over chip area, what design scales can be tested via lasers and etc. The second part of round table considered to using of X-ray facilities for TID testing: main advantages and problems compared to gamma-facilities.

18h30 ***End of Tuesday Sessions***

SESSION E RADIATION ENVIRONMENTS

Session Chairs



Vladimir Kalegaev *is a senior researcher working in Skobeltsyn Institute of Nuclear Physics (SINP) of Moscow State University (MSU). He has been the head of the Department of Space Monitoring of SINP since 2006. He was awarded his PhD (Physics and Mathematics) in 1992 and D.Sc. in 2010. In 1992 he joined the American Geophysical Union. Vladimir Kalegaev has been vice chairman of the COSPAR PRBEM (2006-2014). His research interests are in sophisticated modeling of the magnetic field in the disturbed magnetosphere of the Earth to develop a general understanding of the various dynamical processes taking place during magnetic storms in the Earth's environment. Vladimir Kalegaev has published more than 70 papers mentioned in WoS.*

Markus Brugger *is project leader of the 'Radiation To Electronics' (R2E) project for the CERN Accelerator and Technology (A&T) Sector, with work spanning from shielding and relocation measures, radiation monitoring, construction of new test facilities and radiation tolerant developments of various critical LHC systems. He teaches FLUKA in dedicated schools, supervises regularly master and PhD students, as well as post-docs, has authored and co-authored more than 50 papers in various journals, conferences and workshops and is also regular reviewer for several journals. He will also chair the 2017 RADECS conference to be held in Geneva.*

9h00 **SESSION INTRODUCTION**
Chairs: V. Kalegaev (MSU) & M. Brugger (CERN)

ORAL PAPERS

E-1 **Simulation and Optimization for Space Low Energy Charged Particle**
9h10 **Detector**
B. De-dong, Y. Sheng-sheng, X. Yu-xiong, A. Heng
Lanzhou Institute of Physics

In order to measure electron and proton in space with the range of 0.1～1.0 MeV, a permanent magnet with field strength of 1kGs, and one dimension position-sensitive silicon micro-strip detector (PSSMSD) is used.

E-2 **Comparison of the models of charged particle fluxes in space**
9h25 *N.V. Kuznetsov[1], N.I. Nikolaeva[1], R.A. Nymmik[1], M.I. Panasyuk[1], V.M. Uzhegov[2], M.V. Yakovlev[2]*
[1]Lomonosov Moscow State University, [2]Central Research Institute of Machine Building

The energy spectra of the particle fluxes of radiation environment in space predicted by SPENVIS and COSRAD codes are compared. The ERB, GCR and SEP models used in these codes are discussed.

E-3 9h40 **Correction of in-flight dose sensors measurements results in a middle-Earth orbit taking the fading effect into account**

V. S. Anashin[1], G. A. Protopopov[1], O. S. Kozyukova[1], I. A. Lyakhov[1], S. V. Balashov[2], N. N. Sitnikova[2], S. V. Tasenko[3], P. V. Shatov[3], V. D. Popov[4]
[1] Branch of JSC URSC – ISDE, [2]Information Satellite Systems, [3]Fedorov Institute of Applied Geophysics, [4]National Research Nuclear University MEPhI

Fading effect analysis using in-flight dose sensors data was presented. The dose sensor measurements correction method was proposed and implemented. Corrected data were compared with space models. Last dose rate abrupt increasing events were presented.

POSTER PAPERS

PE-1 **Monte-Carlo Simulation of The Fast Neutron Detectors with Gradient-sized Scintillation Fibers**

Xue Y. X.[1], Zhuang K. [2], Qin X. B. [2], Wei C. F. [2], Yang S. S. [1], An H[1]., Wei L. [2], Li Y. J. [1]
[1]Lanzhou Institute of Physics, [2]Beijing Engineering Research Center of Radiographic Techniques and Equipment

Scintillation proton recoil detectors have been another main categories for fast neutron spectrometers. Nowadays, it is the researching hotspot for neutron detector. The simulations are carried out using Monte Carlo based computer code FLUKA. Finally gradient-sized scintillation fibers are designed to achieve the fast neutron detector.

PE-2 **Monte Carlo Tools Accuracy for High Energetic Electron Radiation Environment**

J. Cueto[1], S. Ibarmia[2], P. Calvel[3], J. Eck[4], G. Santin[5]
[1]Thales Alenia Space Spain (TAS-E), [2]INTA, [3]Thales Alenia Space France (TAS-F), [4]TRAD, [5]ESA

A valuable set of dosimetric data for high energy electrons propagated through typical space multi-layer materials has been obtained in order to validate the main radiation simulation tools used by the space industry and to improve our knowledge of the uncertainties and margins in the space radiation analysis. The experimental dataset has been intensively compared with GEANT4, PENELOPE, ITS, EGSnrc and NOVICE codes.

SESSION F SINGLE EVENT TRANSIENTS

Session Chairs

Vladimir Steshenko *received his PhD in Technical Science in 1997. He works now as a deputy chief designer of electronic components in the JSC "Russian Space Systems". He is one of the leading experts working in the development, production and application of electronic components and CAD systems during the synthesis, calculation and design of the radio-electronic equipment; he has applied up-to-date information technology in the development and design of specialized VLSI and equipment. The designed components developed by Vladimir are embedded in the advanced on-board and ground equipment. He has worked in the scientific community for about 5 years, and in education for about 8 years. He is a member of the organizing committee of the "Digital Signal Processing and its Applications" International Conference, a member of the program committee of the Russian scientific conference "Problems of development of advanced micro- and nanoelectronic systems", and is also a member of the organizing committee of the conference "Practical aspects of the development of the domestic VLSI of the System-on-the chip type». Vladimir has published more than 77 scientific, educational papers.*

Dale McMorrow *received the B.S. Degree in Chemistry from Spring Hill College, Mobile, and the Ph.D. degree in Physical Chemistry from The Florida State University, Tallahassee, FL. His graduate studies focused on the role of intermolecular structure and dynamics in shaping the excitation and relaxation processes of molecular species, with an emphasis on excited-state intramolecular proton transfer processes. Following a postdoctoral fellowship at the University of Toronto he joined the technical staff at the Naval Research Laboratory in December 1988, and presently is head of the Radiation Effects Section. His current research interests include use of ultrafast nonlinear-optical spectroscopic techniques to probe the details of intermolecular dynamics and excited-state photophysical processes of liquids, solutions, and glasses, and the development, characterization and application of laser-based methodologies for simulating single-event phenomena in microelectronic devices and complex integrated circuits. Recent emphasis has been on characterization of the physical mechanisms responsible for the single-event response of III-V semiconductor devices, and the development of two-photon absorption as a tool for interrogating single-event phenomena. He has authored over 200 papers in refereed journals and has served as Technical Chair for the Single-Event Effects Symposium, session chair multiple times for the IEEE Nuclear and Space Radiation Effects Conference (NSREC), the Radiation and its Effects on Components and Systems (RADECS) Conference, and the Single-Event Effects Symposium, and has received three NRL Berman Awards for best paper. He is a member of the IEEE, the American Chemical Society, the Optical Society of America, and the Association for the Advancement of Science.*

10h00 **SESSION INTRODUCTION**
Chairs: V. Steshenko (Russian Space Systems) & D. McMorrow (NRL)

ORAL PAPERS

F-1 10h10 **Measurement and Analysis of Multiple Output Transient Propagation in BJT Analog Circuits**
N. J-H. Roche[1,2], A. Khachatrian[2,3], J. H. Warner[2], S. P. Buchner[2], D. McMorrow[2], D. Clymer[4]
[1]George Washington University, [2]U.S. Naval Research Laboratory, [3]Sotera Defense Group, [4]Lockheed Martin

The propagation of multiple-output transients (MOTs) in BJT ICs is reported. Laser experiments, SPICE simulations, and analysis of the SET propagation in s-domain explain how MOTs are generated and propagate in the device.

F-2 10h25 **UV Single-Photon Absorption Single-Event Transient Testing of Pristine and Irradiated AlGaN/GaN HEMTs**
A. Khachatrian[1,2], N. J-H. Roche[2,3], S. P. Buchner[2], A. D. Koehler[2], T. J. Anderson[2], J. H. Warner[2], D. McMorrow[2]
[1]Sotera Defense Group, [2]U. S. Naval Research Laboratory, [3]George Washington University

Carrier generation by single-photon absorption using ultraviolet optical pulses is used to investigate charge-collection dynamics in pristine and irradiated AlGaN/GaN HEMTs. The results depend strongly on position and gate and drain bias conditions.

F-3 10h40 **A Novel 'S-like' Inverter Chain (SIC) Test Structure for the Separation Measurement of P-hit and N-hit Charge Sharing**
P. Huang, S. Chen, J. Chen, Y. Chi, R. Song
National University of Defense Technology China

An 'S-like' inverter chain test structure is proposed for separating P-hit and N-hit charge sharing for the first time; the magnitude of the P-hit and N-hit average pulse quenching is attained by heavy-ion experiment.

POSTER PAPERS

PF-1 **Simulation of Proton-Induced SETs in Linear Devices and Assessment of Sensitive Thicknesses**
C. Weulersse[1], S. Morand[1], F. Miller[1], T. Carrière[2], R. Mangeret[2]
[1]Airbus Group Innovations, [2]Airbus Defence and Space

This study aims to accurately determine analog SET proton cross sections derived from heavy ion data using the gateway tool METIS. Especially, METIS could be used to determine the sensitive thickness based on proton data.

PF-2 **Measurement of SET Injected Charge from a Californium-252 source in 340 nm Straight and Enclosed Layout NMOS and PMOS transistors**
D. Englisch, M. Horstmann, S. Athanasiou, R.J.E Jansen, B. Glass
ESA ESTEC

The amount of SET injected charge into both the straight and enclosed-layout 340 nm NMOS and PMOS transistor of a 180 nm mixed-mode CMOS technology has been measured. The maximum injected charge and charge-collection depth is found to vary between the PMOS and NMOS devices.

PF-3 **Impact of Radiation-Induced Single-Event Transients on High Resolution Time to Digital Converter**
S. Balaji[1], S. Ramaswamy[2]
[1]LICET, [2]RMK

This paper presents an analysis of single-event transients (SETs) in the timing generator of a delay lock loop based time-to-digital converter (TDC) and its impact in the digital output of TDC.

PF-4 **Single Event Transient Pulse Width Measurement of 65nm Bulk CMOS Circuits**
S. Yue, X. Zhao, Y. Zhao, X. Zhang, L. Wang, D. Wang, Y. Sun, D. Li, F. Wang, X. Yang, H. Zheng, J. Ma, L. Fan
Beijing Microelectronics Technology Institute

Heavy-ion results of a 65 nm CMOS SET pulse width test chip are presented. The influence of device threshold voltage, temperature, and well separation on pulse width and multiple peaks in pulse-width distribution are discussed.

11h00–11h30 ***COFFEE BREAK***

ROUND TABLE #2 **Micro and Milli Beams**
11h30 – 13h00
Aleksandr Koziukov, URSC-ISDE, Russia (chair)
Semion Mitrofanov, Joint Institute for Nuclear Research, Russia (chair and also presenter)
Luca Silvestrin, University of Padova, Italy (presenter)

The scope of the Round table encompasses performing of different test facilities and its design features for deep ICs SEE sensitivity research such as micro- and milli- ion and proton beams, lasers, electronic microscopy of the charged particles interaction with electronic components and its materials.

13h00–14h30 ***LUNCH***

INVITED TALK **History of Russian Cosmonautics from the 19th to the 21st Century**
14h30 – 15h30
Irina Golovkina, Museum of Cosmonautics

For centuries, humans have dreamed about space exploration. Nowadays the dream comes true. Space exploration is the ongoing discovery and exploration of celestial structures in outer space by means of continuously evolving and growing space technology. From this invited talk you will learn information about the experts working in the space industry and the achievements of Russia in the space field.

15h30 – 18h00 **POSTER SESSION**

Session Chairs

Dr. Petr Skorobogatov *received the PhD of Technical Science in 1980. He became associate Professor in 1985, Doctor of Technical Science in 2000, Professor in 2003. Currently he is working in* ***National Research Nuclear University MEPhI*** *in the Department of Electronics. He is an expert in the field of radiation resistance of microelectronics, pulse electric strength of electronic products.He holds the honorary title "Honored test engineer of space-system engineering" of the Russian Cosmonautics Federation. He is author of more than 250 scientific works. He holds 2 author's certificates and 3 licenses.*

Dr. Sylvain Girard *received his PhD degree from the Université Saint-Etienne, France, in 2003. From 2004 to 2012, he was Research Engineer at CEA, DAM, in France. Since Sept. 2012 he has been Full Professor at the* ***University of Saint-Etienne****, France. His research domains cover the radiation vulnerability and hardening studies of optical fibers, fiber-based sensors and cameras for integration in the harsh environments associated with space, nuclear industry and high energy physics applications. He received the 2014 IEEE/SEE Léon-Nicolas Brillouin Award and the 2013 IEEE NPSS Early Achievement Award. S. Girard is a Senior Member of IEEE NPSS.*

16h30–17h00 ***COFFEE BREAK***

ROUND TABLE #3 **Spacecraft On-board Radiation Control**
17h00 – 18h30 *Grigory Protopopov, URSC-ISDE, Russia (chair and also presenter)*
Robert Ecoffet, CNES, France (chair and also presenter)

Advantages and disadvantages of different methods of spacecraft on-board radiation control for different task (MOS, MNOS, SRAM, ionizing chamber, optically stimulated dosimeter and spectrometer).

18h30 ***End of Wednesday Sessions***

SESSION G **PHOTONIC AND OPTOELECTRONIC DEVICES**

Session Chairs

Konstantin Tapero *graduated from the National University of Science and Technology "MISIS" (former Moscow Institute of Steel and Alloys – Technological University) in 1993 in microelectronics and semiconductor devices. He received a PhD in the Physics of Semiconductors and Dielectrics in 1997. Currently he is a scientific affairs advisor of the Research Institute of Scientific Instruments (RISI), Lytkarino, Moscow region, Russia. In addition, he is an associate professor of the Department of Semiconductor Electronics and Physics of Semiconductors of the National University of Science and Technology "MISIS", Moscow, Russia. His field of scientific interest is radiation effects on materials, semiconductor devices and integrated circuits, radiation hardness assurance and reliability of semiconductor devices, integrated circuits and electronic equipment. He has more than 20 years' experience in this field. He was a member of the developing team of Roscosmos' guidelines for total ionizing dose testing, displacement damage dose testing and single event effects testing of electronic components intended for space. He is a member of IEEE Nuclear and Plasma Science Society, IEEE Electron Devices Society, ISROS (International Society on Reliability of Optoelectronics for Systems). In 2013, he was elected to RADECS Council Board.*

After more than 3 years with the French Atomic Energy Commission (CEA) near Paris, where he obtained his PhD in the field of photonics exposed to nuclear environments in 2001, ***M. Van Uffelen*** *joined the Belgian Nuclear research Centre SCK-CEN, where he conducted research for more than 10 years within the advanced nuclear instrumentation group. His main topics of interest dealt with the characterization of fibre-optic and opto-electronic components, finally also addressing the associated driving and read-out electronics, for their application and qualification in conventional power plants, the high energy physics installation of CERN, and also for fusion. Since early 2010, Marco Van Uffelen joined the European agency Fusion for Energy (F4E) in Barcelona, Spain. Since 2003 he also joined IEEE standards association and the IEC Committee for "Instrumentation and control (and electrical) systems for nuclear facilities", reviewing qualification standards for safety related electrical equipment in NPPs.*

9h00 **SESSION INTRODUCTION**

Chairs: K. Tapero (RISI) & M. Van Uffelen (Fusion for Energy)

ORAL PAPERS

G-1 9h10 **Dark Current Spectroscopy in CMOS Image Sensors Irradiated with Alpha Particles**

J-M Belloir[1], V. Goiffon[1], P. Magnan[1], C. Virmontois[2], O. Gilard[2], M. Raine[3], P. Paillet[3]
[1]ISAE, [2]CNES, [3]CEA

Dark Current Spectroscopy of radiation-induced defects is tested for the first time in CMOS Image Sensors. Several dark current peaks are observed and their evolution with fluence, particle energy and temperature is studied.

G-2 9h25 **Dose Effects on CMOS Active Pixel Sensors**

S. Dhombres[1,2], A. Michez[1], J. Boch[1], S. Beauvivre[2], J-R. Vaillé[1], A. D. Touboul[1], P. C. Adell[3], F. Bezerra[4], E. Lorfèvre[4], D. Kraehenbuehl[2] and F. Saigné
[1]Université Montpellier, [2]Systheia, [3]Jet Propulsion Laboratory, [4]CNES

A thermal annealing approach is applied on irradiated CMOS active pixel sensors to investigate total dose effects and improve device lifetime. Results are discussed and help identify the sensor's sensitive areas.

G-3 9h40 **Investigation of nonuniform degradation of CMOS-Sensor light-sensitive surface under gamma-irradiation**

M. E. Cherniak[1,2], A. A. Smolin[1,2], A. V. Ulanova[1,2], A. Y. Nikiforov[1,2]
[1]National Research Nuclear University MEPhI, [2]Specialized Electronic Systems (SPELS)

The paper discusses non-uniform degradation effect for peripheral and central elements of CMOS-sensor light-sensitive surface under γ-irradiation. Spatial dependence of individual pixels' radiation hardness was investigated. The paper also assesses the possible causes of this phenomenon.

G-4 9h55 **Proton Irradiation Effects on Commercial Laser Diodes**

G. Marcello[1], G. Mura[1], M. Vanzi[1], M. Bagatin[2], S. Gerardin[2], A. Paccagnella[2]
[1]University of Cagliari, [2]University of Padova

Damage recovery after 3 MeV proton irradiation has been observed in commercial laser diodes for telecom applications. The peculiar setup of the experiment allows to attribute the observed time evolution to a proton diffusion mechanism.

G-5 10h10 **Cerium Codoping Effect on the Radiation Response of Germanosilicate and Phosphosilicate Multimode Optical Fibers**

D. Di Francesca[1], S. Girard[1], S. Agnello[2], A. Alessi[1], C. Marcandella[3], P. Paillet[3], N. Richard[3], A. Boukenter[1], Y. Ouerdane[1], F. M. Gelardi[2]
[1]Université de Saint-Etienne, [2]Università di Palermo, [3]CEA

We investigate the effects of cerium codoping on the radiation response of germanosilicate and phosphosilicate optical fibers in the UV-Visible spectral range. The samples were irradiated by X-rays and γ-rays up to 10 MGy dose level.

G-6 10h25 **Radiation induced attenuation kinetics in pure silica-core optical fibers during successive irradiation**

A. Alessi[1], S. Girard[1], D. Di Francesca[1], C. Marcandella[2], P. Paillet[2], A. Boukenter[1], and Y. Ouerdane[1]
[1]Université de Saint-Etienne, [2]CEA

We provide evidence for the differences in the UV-visible response of a radiation-hardened optical fiber submitted to successive irradiation runs and discuss the impact of the observed complex behavior on the prediction of its lifetime.

G-7 10h40 **Radiation Response of OFDR Distributed Sensors Based on Microstructured Pure Silica Optical Fibers**

S. Rizzolo[1], A. Boukenter[1], J. Périsse[2], G. Bouwmans[3], H. El Hamzaoui[3], L. Bigot[3], Y. Ouerdane[1], M. Cannas[4], M. Bouazaoui[3], J-R Macé[5], S. Bauer[6], and S. Girard[1]
[1]Université de Saint-Etienne, [2]AREVA-Lyon, [3]Université de Lille 1, [4]Università di Palermo, [5]AREVA-Paris, [6]AREVA-Le Creusot

OFDR-based radiation tolerant sensors are tested during irradiation up to 100kGy level to investigate potentialities of microstructured optical fibers. Rayleigh based sensors radiation responses reveal promising performances for their employment in harsh environment.

POSTER PAPERS

PG-1 **Performance Degradation after Proton Irradiation in Charge-Coupled Devices: a Cross-device Comparison**

T. Prod'homme, P. Verhoeve, L. Duvet
ESA, ESTEC

In the context of the technology validation of Charge-Coupled Devices for three different European Space Agency missions dedicated to Astronomy, we present a comparison between the performance degradation (dark current and charge transfer inefficiency) after proton irradiation of three types of device manufactured by e2v.

PG-2 Total Ionizing Dose and Displacement Damage Effects in a Tunable Laser Diode Based Fiber Optic Sensing System

M. Roner[1], P. Putzer[1,2], A. Hurni[1], S. Schweyer[2], N. Lemke[1]
[1]OHB System AG, [2]Technical University of Munich

A temperature measurement system for space applications is developed on the basis of a radiation-tested modulated grating Y-branch tunable laser diode and fiber Bragg gratings, inscribed in radiation tolerant optical fiber.

PG-3 Impact of the border crossing effects on the DCNU for pixels arrays irradiated with high energy protons

M.C. Ursule, C. Inguimbert, T. Nuns
ONERA-DESP

A 3D Monte Carlo model has been used to simulate the Dark Current Non Uniformity of image sensors. The consequences of the border crossing effects on the DCNU has been analysed through different pixel geometries.

PG-4 Raman based distributed fiber optic temperature sensors for structural health monitoring in radiation environment

C. Cangialosi[1,2], S. Girard[1], M. Cannas[2], A. Boukenter[1], E. Marin[1], S. Delepine-Lesoille[3], C. Marcandella[4], P. Paillet[4], Y. Ouerdane[1]
[1]Université de Saint-Etienne, [2]Università di Palermo, [3]ANDRA, [4]CEA

The radiation tolerance of different distributed Raman based sensor classes and/or their responses evolution during gamma-ray exposure at 1 kGy/h dose rate (to reach ~0.1 MGy) was investigated to monitor radioactive waste deep geological repository.

PG-5 Distributed Optical Fiber Radiation Sensing at CERN High Energy AcceleRator Mixed Field Facility (CHARM)

I.Toccafondo[1,2], A.Thornton[1], E.Guillermain[1], J.Kuhnhenn[3], J.Mekki[1], M.Brugger[1], F. Di Pasquale[2]
[1]CERN, [2]Scuola Superiore Sant'Anna, [3]Fraunhofer-Institut Naturwissenschaftlich-Technische Trendanalysen (INT)

The first results of distributed optical fiber radiation sensing measurements based on radiation induced attenuation (RIA) at the new mixed-field irradiation facility CHARM are presented.

PG-6 The Influence of the 21 MeV Protons on Heterolaser Optical Capacity Based on Gallium-Arsenide with Fiber Resonator

V.V. Alekseev[1], I.I. Dolgov[2], P.I. Dolgov[2], A.V. Ivanov[3], V.M. Isaev[1], V.T. Semenov[4], V.D. Kurnosov[3], M.V. Kozhukhov[4]
[1]FSUE "MNIIRIN",, [2]"Ivan Dolgov Laboratory" ("IDL" LLC), [3]"Polus", JSC, [4]"«VNIIEM» Corporation" JSC

The measurement results of output optical power (Pt) of double-heterojunction laser (DHL) based on the Ga-As and fiber optic Bragg grating are presented before and after the influence of protons (p^+) with an energy of 21 MeV and fluence level of $5 \cdot 10^{14}$ p^+/cm^2. The Pt degradation at 850 nm wavelength is no more than 15%. The Pt degradation occurs due to the secondary particles produced by proton braking in a heterolaser enclosure and determined by the Ga-As radiation hardness.

PG-7 Kinetics of Radiation-Induced Optical Losses in Undoped Fiber for different temperatures. Experiment and Modeling

R.G.Useinov[1], I.I.Dolgov[2]
[1]Research Institute of Scientific Instruments, [2]"Ivan Dolgov Laboratory" ("IDL" LLC)

An analytical model of the radiation-induced optical absorption in undoped optical fiber has been developed, based on self-trapped holes light absorption. The model correctly describes the dependences obtained in our investigation of gamma-radiation induced fiber absorption for different temperatures in the 1450 ~ 1600 nm wavelength range.

PG-8 Dose-rate dependence of fiber Bragg gratings' responses

A. Morana[1], E. Marin[1], S. Girard[1], C. Marcandella[2], P. Paillet[2], A. Boukenter[1] and Y. Ouerdane[1]
[1]Université de Saint-Etienne, [2]CEA

We present a study on dose-rate dependence of classical UV-FBGs and propose an empirical model to extrapolate the induced wavelength shift, on the basis of a similar one for the RIA.

11h00–11h30 COFFEE BREAK

SESSION H FACILITIES AND DOSIMETRY

Session Chairs

***Vladimir Skuratov**, Dr. of Sciences, head of research sector "Ion implantation nanotechnology and radiation materials science" of Flerov Laboratory of Nuclear Reactions, Joint Institute for Nuclear Research, Dubna. Current research and main research interests: microstructural phenomena in tracks of high energy heavy ions in insulators and semiconductors, design of experimental set-up for "in situ" studies of radiation effects induced by swift heavy ions in solids and electronic components for space applications.*

***Mathieu Boutillier** got his PhD in 2007 from Toulouse University on the effect of radiations on laser diodes. Since then, he has been in CNES in charge of evaluation and qualification of opto-electronic devices, including radiations testing of such devices. He actively contributes to several radiations campaigns in both ionizing dose, displacement damage and SEE facilities, and has contributed to many technical communications particularly at RADECS and NSREC conferences*

11h30 **SESSION INTRODUCTION**
Chairs: V. Skuratov (JINR) & M. Boutillier (CNES)

ORAL PAPERS

H-1 11h40 **Using the FLNR Accelerator Complex for SEE Testing. State of Art and Future Development**
I. V. Kalagin[1], G. G. Gulbekyan[1], B. N. Gikal[1], S. V. Mitrofanov[1], V. A. Skuratov[1], Y. G. Teterev[1] and V. S. Anashin[2]
[1]Joint Institute for Nuclear Research, [2]Branch of JSC URSC – ISDE

Since 2010 the Russian Federal Space Agency (Roscosmos) has been utilizing SEE testing facilities at the Flerov Laboratory of Nuclear Reactions (FLNR) of the Joint Institute for Nuclear Research (JINR) in Dubna. The future FLNR plans of SEE testing development are presented.

H-2 11h55 **CHARM: a new mixed field facility at CERN for radiation test in ground, atmospheric, space and accelerator representative environments**
J. Mekki, M. Brugger, R.G. Alia, A. Thornton, N. C. Dos Santos Mota, S. Danzeca
CERN

A new mixed-field radiation test facility called CHARM is available at CERN since end of 2014. Its radiation environment is not only representative for accelerators, but also for atmospheric, ground level and space applications.

H-3 12h10 **ISNP/GNEIS Facility in Gatchina for Neutron Testing With Atmospheric-Like Spectrum**

O. A. Shcherbakov[1], A. S. Vorobyev[1], A. M. Gagarski[1], L. A. Vaishnene[1], E. M. Ivanov[1], V. S. Anashin[2], L. R. Bakirov[2], A. E. Koziukov[2]
[1]PNPI of RSC "KI", Gatchina, [2]Branch of JSC URSC-ISDE, Moscow

A description of the testing facility ISNP with spectrum resembling that of terrestrial neutron radiation developed at the PNPI is given. The results of the tests carried out by the Branch of JSC "URSC"-"ISDE" (Moscow) at ISNP are presented.

H-4 12h25 **Comparison of a Readout Chain Dedicated to the Signal Conditioning of a Particle Detector and an Innovative Chain Based on a VCO Concept**

S. Ben Krit[1], K. Coulié-Castellani[1], W. Rahajandraibe[1], G. Micolau[2], H. Aziza[1], J-M. Portal[1]
[1]Aix Marseille Université, [2]Université d'Avignon

This paper presents a comparison of two different chains, used for the processing of the signal generated by an ionizing particle crossing a detection cell. The results of the two chains are discussed.

H-5 12h40 **Optimization of Flexible Ag-Chalcogenide Glass Sensors for Radiation Detection**

A. Mahmud, Y. Gonzalez-Velo, H. J. Barnaby, M. N. Kozicki, K. E. Holbert, M. Mitkova, T. L. Alford, M. Goryll, M. Saremi, W. Yu, D. Mahalanabis, W. Chen and J. Taggart
Arizona State University

We demonstrate how the radiation response and performance of Ag-chalcogenide radiation sensors fabricated on a flexible substrate can be optimized by modifications in electrode size and spacing between electrodes.

POSTER PAPERS

PH-1 **High energy (20-60 AMeV) ion beam-line for SEE Testing at U400M FLNR JINR Cyclotron**

S.L.Bogomolov[1], G.G.Gulbekyan[1], V.A.Skuratov[1], I.V.Kalagin[1], S.V.Mitrofanov[1], Yu.G.Teterev[1], A.S.Fomichev[1], V.S.Anashin[2]
[1]Joint Institute for Nuclear Research, [2] Branch of JSC URSC – ISDE

The detailed overview of the Roscosmos new high energy (20-60 AMeV) ion beam line based on U400M cyclotron and the features of diagnostic set-up used for ion beam parameters evaluation and control during SEE tests are presented.

PH-2 The "Livio Scarsi" X-ray Facility at University of Palermo for device testing

F. Principato, G. Gerardi, A. A. Turturici, M. Quartararo, F. Pintacuda and L. Abbene
Università di Palermo

We report on the characteristics of the Livio Scarsi X-ray facility in Palermo, able to produce X rays within the energy range of 0.1–60 keV and with fluence rates ranging from 10^5-10^8 ph/mm^2 s.

PH-3 Grenoble Large Scale Facilities for advanced characterization of microelectronics devices

J. Beaucour[1], J. Segura-Ruiz[1], R. Cubitt[1], B. Giroud[1], E Capria[2], E Mitchell[2], C Curfs[3], JC Royer[3], M Baylac[4], F Villa[4], S Rey[4]
[1]Institut LAUE-LANGEVIN, [2]ESRF, [3]CEA, LETI, [4]University of Grenoble-Alpes

The French IRT-nanoelec consortium in collaboration with GENEPI2 accelerator is offering world unique and complementary techniques for Hirel components characterization. Part of this capability is the high and low (thermal) energy neutron testing of devices.

PH-4 Small-size High-performance ARSA Accelerators for On-line Testing for ECB Radiation Hardness

S. L. Elyash, S. P. Pukhov, A. V. Rodigin, A. L. Yuryev
Russian Federal Nuclear Center

A high-performance small-size pulse accelerator ARSA with voltage up to 1.3 MeV was developed. The accelerator differs in stability of characteristics (scatter not more than ±10 %), high dose rate of bremsstrahlung (up to $1.5 \cdot 10^{10}$ R/s in a spot 1 cm in diameter), potentiality of intense operation (hundreds of shots a day), and electro-magnetic compatibility with radio electronics.

PH-5 Dosimetry inter-laboratory comparison between ESTEC, CNA-ALTER/RADLAB, and UCL

A. Costantino[1], M. Muschitiello[1], G. Fernandez Romero[2], P. Martín Holgado[2], Y. Morilla[3], G. Muñiz[3], L. Standaert[4], J. Vanhees[4]
[1]ESA-ESTEC, [2]Alter TUV, [3]Universidad de Sevilla,, [4]UCL-CRC

Following the ISO ISO17025 recommendations, a total dose and dose rate inter-comparison measurements have been designed and carried out between three Co60 laboratories: ESA/ESTEC, CNA-ALTER/RADLAB, and UCL, assessing the process and the obtained results.

PH-6 Detailed Geant4 simulations of the ANITA and ANITA-CUP neutron facilities

Q. Hong[1], S. P. Platt[1], A. V. Prokofiev[2] and E. Passoth[2]
[1]University of Central Lancashire, [2]University of Uppsala

Simulations of the ANITA spallation neutron source at The Svedberg Laboratory (TSL) are described. Neutron radiation calculations show close agreement with measurements at both standard and close user positions. Gamma radiation characteristics are also predicted.

PH-7 A Fast Neutron Detector Using ^{10}B-Lined Ionization Chamber for mixed field dosimetry

Z. Zhang, Z. Wei, M. Fang, L. Zhu, G. Chen, P. Qiang, Q. Ni
Nanjing University of Aeronautics and Astronautics

Boron-lined ionization chamber was developed by introducing twin structures within the sensitive volume, wrapped in a set of 5 high density polyethylene cylinders. The best sensitivity of all is 8.702×10^{-15}A/(cm^{-2}·s^{-1}) in ^{241}Am-Be radiation field.

PH-8 Sample Temperature Measurement and Control System Developed for Accelerator-based Single Event Effects Experiments

L. Cai, J. Liu, H. Fan, G. Guo, S. Shi, H. Wang, G. Wang, D. Shen
China Institute of Atomic Energy

In order to meet domestic demands of studying temperature dependence of single event effects cross-section, a device under test temperature measurement and control system was developed based on Beijing HI-13 tandem accelerator SEE irradiation facility, DUT temperature could be measured and controlled within the range of 90-450 K, and control accuracy better than ±1K.

13h00–14h30 LUNCH

INVITED TALK **Regarding Genuine Russian**
14h30 – 15h30 *Maria Sukhorukova, private speaker*

What is usually associated with Russia? For most foreigners, Russia is a cold country where you can see beautiful women and in which the traditional drink is vodka. This Russian traditional drink is included as a component of many cocktails. But not many people know about its history.

15h30 – 17h30 **RADIATION EFFECT DATA WORKSHOP**

Session Chairs

Pavel Chubunov *(**Branch of JSC URSC - ISDE**) graduated from the National Research Nuclear University MEPhI (Moscow Engineering Physical Institute), and is an Engineer-Physicist (2006).*

His scientific activity is related to the development of the methods and control facilities of hardness of silicon integrated circuits to the influence of space ionizing radiation, and also the research of impact space ionizing radiation on the reliability characteristics of integrated circuits.

Mr. Chubunov is the author and co-author of more than 60 works in Russian and international published works, and collected papers of conference materials.

Renaud Mangeret *received his PhD in electronics from the Paul Sabatier University, Toulouse (France) in the Materials and Components for Electronics Department in 1992. Since 1995 Renaud has been the radiation specialist at Matra Marconi Space/EADS Astrium/**Airbus Defence and Space**, Toulouse, and since 2006 he has been Astrium/Airbus Defence and Space's Transnational Radiation Expert. He is responsible for all aspects of radiation hardness assurance solutions for use of sensitive devices in space programmes (telecommunications, Earth observation, interplanetary scientific and launchers). Renaud is a Member of the IEEE and currently serves as Treasurer for the RADECS Association Steering Committee.*

DW-1 Total Dose and SEE Testing of the Intersil ISL75052SEH Low Dropout Regulator

N. W. van Vonno, J. S. Gill, L. G. Pearce and E. J. Thomson
Intersil Corporation

We report the results of SEE and low and high dose rate total dose testing of the Intersil ISL75052SEH hardened low dropout regulator (LDO) together with a discussion of electrical specifications and fabrication process.

DW-2 TID Response of Various Field Programmable Gate Arrays and Memory Devices

J. M. Armani[1], J. L. Leray[2], R. Gaillard[3] and V. Iluta[4]
[1] CEA-LIST, [2] CEA-DIF, [3] Consultant, [4] ERMES

The Total Ionizing Dose (TID) tolerance of some FPGAs and memory devices has been evaluated. Two FPGAs and five memories of various types and technologies have been irradiated. Results show that the total dose tolerance of the tested FPGAs is around 200 Gy. The SRAM is the most tolerant device with a failure dose level over 2.4 kGy. Two Flash memories were still well-functioning after 1 kGy.

DW-3 ELDRS Characterization to 300 krad of Texas Instruments High Speed Amplifier LMH6702

Kirby Kruckmeyer
Texas Instruments

The LMH6702 was tested to 300 krad at 10 mrad/s. Testing to 300 krad took one year. The LMH6702 was found to be ELDRS-free.

DW-4 Enhanced Low Dose Rate Sensitivity Analysis of Vertical BJT-STM

F. Pintacuda, M. Poizat, M. Muschitiello
STMicroeletronics

Enhanced Low Dose Rate Sensitivity of many BJT- STM transistors have been studied. The devices 2N2222AHR, 2N2907AHR, 2N5401HR, 2N5551HR, 2N3810HR and 2ST3360HR have been tested getting up to TID: 100 krad according to ESCC22900 specification.

DW-5 Investigation of Equivalent LET on SEL by Laser Backside Testing

G. Feng, J. Han, Y. Ma, S. Shangguan, X. Zhu, R. Chen
National Space Science Center, Chinese Academy of Sciences

This summary presents the equivalent LET study on single event latch-up by laser backside testing, which is dedicated to deal with the increasing metal layers on the front side of the integrated circuits.

DW-6 SEL Sensitivity Differences in IC's with Same Crystals Marking

A. A. Pechenkin, P. V. Nekrasov, A. B. Boruzdina, D.E. Protasov
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

Several cases differences SEL sensitivity in IC's with same crystals marking are presented and discussed. The crystals are compared visually and identical crystal markings confirmed.

DW-7 Different chips at identical marking on the example of OP1177

A. V. Demidova, A. A. Pechenkin, A. Y. Borisov, L. N. Kessarinskiy,
A. V. Yanenko, D. V. Boychenko, A. Y. Nikiforov
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

Four parts of opamp OP1177ARZ manufactured by Analog Devices have been tested. The chips have been compared visually and with specialized software. It has been determined, that crystals samples are different, despite identical crystals marking. A different TID behavior has been observed for the various samples.

DW-8 Identification of authenticity of microelectronic devices using radiation simulation modeling

D.V. Boychenko[1,2], A.Yu. Nikiforov[2], Yu.A. Ozhegin[1,2], V.A. Telets[1]
[1]National Research Nuclear University MEPhI, [2]Specialized Electronic Systems (SPELS)

The article outlines a methodological approach, core specifics and capabilities of radiation identification of microelectronic devices at a specified exposure to ionizing radiation.

DW-9 The critical elements of the modern transceiver ICs upon space radiation exposure

G.G. Davydov, A.S. Kolosova, D.V. Boychenko, A.A. Pechenkin
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

As a result of analyzing more than 60 types of modern transceivers ICs, the most sensitive functional units and the critical operation modes upon exposure the space radiation (specifically, TID and SEE effects) were identified.

DW-10 Total Ionizing Dose Effects in Phase-Locked Loop ICs and Frequency Synthesizers

D. I. Sotskov, V. V. Elesin, A. G. Kuznetsov, G. N. Nazarova,
G. V. Chukov, D. V. Boychenko, V. A. Telets, N. A. Usachev
National Research Nuclear University MEPhI/Specialized Electronic Systems (SPELS)

This paper presents a brief overview of total ionizing dose effects for a variety of PLL ICs and PLL-based synthesizer implemented in commercial bulk CMOS, silicon-on-insulator CMOS, BiCMOS and SiGe BiCMOS processes with frequency range up to 8 GHz. Total dose sensitivity data of PLL ICs have been obtained at the SPELS test center, based on comprehensive parametric and functional control.

DW-11 The Features of Radiation-Hardening-By-Design of Bulk SRAM Cells

Y. M. Gerasimov[1], N. G. Grigoryev[1], A. V. Kobylyatskiy[2],
Y. Ya. Petrichkovich[2] and T. V. Solokhina[2]
[1]National Research Nuclear University MEPhI, [2]Electronic VLSI Engineering & Embedded Systems

The main circuit design and constructive-topological SRAM cells Radiation-Hardening-By-Design (RHBD) methods applied in 250 ... 90 nm bulk CMOS processes were analyzed. The test chip research results show that an increase of the 6T-memory cell area by 1.5 times can significantly improve the tolerance to all the radiation factors.

DW-12 Design and SEE testing of high capacity high speed radhard synchronous SRAM

V. S.Anashin[1], P. A.Chubunov[1], S. A.Yakovlev[1], A. V.Perebeynos[1], A. V.Rutkevich[2], D. I.Voronkov[2], Y. S.Gubin[2], B. A.Novikov[2], D. A.Skaryukin[3], A. S.Popova[3]
[1]Branch of Joint Stock Company «United Rocket and Space Corporation»-«Institute of Space Device Engineering», [2]Design Center «Digital Solutions», [3]Joint Stock Company «Russian Space Systems»

Two types of synchronous SRAM bitcells were designed and tested for SEL and SEU single-event effects with heavy ions. Experimental results and abilities of development high capacity high speed SSRAM were discussed.

DW-13 SEE test results of 256k RAM with preliminary TID irradiation

V. S. Anashin, P. A. Chubunov, S. A. Yakovlev
Branch of Joint Stock Company «United Rocket and Space Corporation»-«Institute of Space Device Engineering»

This paper presents SEE test results of 256k RAM with preliminary □-ray irradiation and comparison with previous not irradiated samples tests. Difference between irradiated and not irradiated samples test results for SEL is shown.

DW-14 Typical Facilities and Procedure for Single Event Effects Testing in Roscosmos

V. S. Anashin[1], P. A. Chubunov[1], S. A. Yakovlev[1], A. E. Kozyukov[1], G. G.Gulbekyan[2], V. A.Skuratov[2], S. V. Mitrofanov[2]
[1]Branch of Joint Stock Company «United Rocket and Space Corporation» - «Institute of Space Device Engineering», [2]Flerov Laboratory of Nuclear Reactions, Joint Institute for Nuclear Research

In this work we overviewed Roscosmos test facilities which are available for single event effects testing and are in developing and producing nowadays. Typical test procedure and admissible methods are also presented.

DW-15 Analysis results of in-flight measurements in geostationary and polar orbits in 2014-2015

V. S. Anashin[1], G. A. Protopopov[1], O. S. Kozyukova[1], I. A. Lyakhov[1], P. V. Shatov[2], S. V. Tasenko[2], V. D. Popov[3]
[1]Branch of Joint Stock Company «United Rocket and Space Corporation» - «Institute of Space Device Engineering», [2]FSBI "Fedorov Institute of Applied Geophysics", [3]National Research Nuclear University MEPhI

Analysis of flight data from spectrometers in geostationary and polar orbits is presented. Flight data are compared with other in-flight measurements and with trapped and solar particles models including AX8, AX9, CRRESELE, JPL, Nymmik.

DW-16 TID and SEGR Radiation Characterisation of European COTS Power MOSFETS with respect to Space Application Electronics

M. Wind[1], J. Bagalkote[1], P. Beck[1], M. Latocha[1], M. Poizat[2]
[1]Seibersdorf Laboratories, [2]European Space Agency

We investigated TID radiation response and SEGR susceptibility of two COTS power MOSFETs by exposing them to Co-60 photons with 100 krad(Si) and various heavy ion fields of LET between 18.5 and 60 MeV $mg^{-1}cm^{-2}$.

DW-17 X-ray-induced Upsets in a Xilinx Spartan 3E FPGA

M. A. G. da Silveira[1], R. B. B. Santos[1], N. H. Medina[2], B. C. Porcher[3], V. A. P. Aguiar[2], N. Added[2], F. Vargas[3]
[1]Centro Universitário da FEI, [2]Instituto de Física da Universidade de São Paulo, [3]Catholic University of Rio Grande do Sul

As the use of Field Programmable Gate Arrays (FPGAs) in space and in other strategic areas increases, concerns about their tolerance to radiation also increases. This work reports the observation of soft and hard errors in a Xilinx Spartan-3E commercial off-the-shelf FPGA when exposed to low- dose rate, low energy X-rays during a dynamic test in which a LEON 3 soft core processor was mapped in the FPGA.

DW-18 Radiation Tolerance of Programmable Voltage Supply and High Galvanic Insulation Readout Electronics used by CERN's LHC Cryogenics

J. Casas, N. Trikoupis, and J. Mekki
CERN

Two different types of electronic cards have been tested in CERN's CHARM irradiation facility. The cards are capable to sustain 900 to over 1000 Gy and confirmed the appropriate selection of the integrated circuits.

DW-19 MGy radiation assessment of a space-graded amplifier and ADC

Y. Cao[1], J. Verbeeck[1], M. Van Uffelen[2], L. Mont Casellas[2], C. Damiani[2], E. Ruiz Morales[2], R. Ranz Santana[2], R. Meek[3], B. Haist[3], W. De Cock, L. Vermeeren, M. Steyaert[1], P. Leroux[1]
[1]KU Leuven (KUL), [2]Fusion for Energy (F4E), [3]Oxford Technologies Ltd.(OTL)

This paper shows a high total dose radiation assessment on a set of space qualified components. Two space graded COTS components were selected and monitored under 60Co gamma radiation, namely an instrumentation amplifier and a 14 bit analogue-to-digital- converter (ADC). The specifications of these COTS components were monitored on-line with a customized test bed, up-to a total ionizing dose larger than 1 MGy and are presented in this paper.

DW-20 **Radiation effects on high-resolution linear InGaAs arrays**
S.Herftijd[1], P. Deroo[1], R. Vinella[1], A. Kondrashina[2], J. Vermeiren[1]
[1]Xenics nv, [2]Xenics

The recent radiation experiments on 12.5 and 25 um pitch InGaAs array for SWIR imaging will be discussed. The main focus will be on displacement damage by low energy protons.

DW-21 **Displacement Damage Test on COST Laser Diodes Embedded in Satellite**
H. Liu[1], H. Jiang[2], Y. Shen[2], S. Liao[3,4], J. Yin[3,4], Y. Cao[3,4], Y. Liu[5], R. Zhu[5]
[1]National Space Science Center, [2]Shanghai Institute of Technology Physics, [3]Shanhhai Branch, University of Science and Technology of China, [4]Shanhhai Branch, CAS Center for Excellence and Synergetic Innovation Center in Quantum Information and Quantum Physics [5]Shanghai Institute of Optics and Fine Mechanics

Five types of COST Laser Diodes were under 50 MeV proton irradiation test up to 10^{12} accumulative fluence, the test results show all the LDs can sustain the displacement damage radiation effect throughout mission lifetime.

16h30–17h00 ***COFFEE BREAK***

17h30 ***End of Thursday Sessions***

17h30 – 19h00 **RADECS ASSOCIATION GENERAL ASSEMBLY**
P. Calvel, President of RADECS ASSOCIATION
RADECS Bureau

SESSION I HARDENING BY TECHNOLOGY, DESIGN AND SYSTEM

Session Chairs

Maxim Gorbunov *graduated from the Micro- and Nanoelectronics Department of The National Research Nuclear University MEPhI (Moscow Engineering Physical Institute) in 2008 (summa cum laude), and he received his Ph.D. in 2010. He ~~is~~ has been with the Scientific Research Institute of System Analysis, Russian Academy of Sciences (SRISA) since 2008. His main scientific interests are radiation effects in CMOS microelectronics and radiation hardening by design. He is co-author of the add-on for SPICE simulators for modeling of stationary ionizing radiation "TIDESim". The Russian Academy of Sciences gave him the Young Scientists Best Paper Award for the work "Multi-level modeling of the effects of ionizing radiation for design of long-functioning analog and digital ICs for space systems" in 2011. He ~~is~~ has also been a lecturer in National Research Nuclear University MEPhI since 2013. Maxim has taken part in the RADECS Conference since 2008 and has presented 7 papers there.*

Professor ***Fernanda Lima Kastensmidt*** *joined the Instituto de Informática faculty in 2005. She received a PhD in 2003 and MSE in 1999 both in Computer Science from Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre, RS, Brazil. Dr. Fernanda's current research focuses on soft error mitigation techniques for SRAM-based FPGAs and integrated circuits, such as microprocessors, memories and network-on-chips (NoCs), and the analysis and modeling of radiation effects in those circuits. She currently advises the MSE and PhD thesis at the Computer Science Graduation Program http://ppgc.inf.ufrgs.br/ (PPGC) and at the Microelectronics Program http://www.inf.ufrgs.br/pgmicro/ (PGMICRO). She has published more than 80 papers in Scientific conferences and journals, she wrote many books such as Fault-Tolerance Techniques for SRAM-based FPGAs in 2006, and she has been participating in payload projects on nano satellites. She is currently the coordinator of the Microelectronics Program PGMICRO at UFRGS and she is an IEEE member.*

9h00 **SESSION INTRODUCTION**
Chairs: M. Gorbunov (SRISA) & F. Lima-Kastensmidt (Univ. Rio Grande do Sul)

ORAL PAPERS

I-1
9h10 **A Radiation-Hardened Non-redundant Flip-Flop, Stacked Leveling Critical Charge Flip-Flop in a 65 nm Thin BOX FD-SOI Process**
J. Yamaguchi, J. Furuta, K. Kobayashi
Kyoto Institute of Technology

We propose a radiation hardened non-redundant flip-flop named SLCCFF in a 65-nm FD-SOI process. Accelerated test shows that proposed flip-flop has 27x higher neutron-induced SEU reliance than the standard DFF.

I-2 9h25 **A MGy, low-offset programmable instrumentation amplifier IC for nuclear applications**

J. Verbeeck[1], Y. Cao[1], M. Van Uffelen[2], L. Mont Casellas[2], C. Damiani[2], E. Ruiz Morales[2], R. Ranz Santana[2], R. Meek[3], B. Haist[3], W. De Cock[4], L. Vermeeren[4], M. Steyaert[1], P. Leroux[1]
[1]KU Leuven, [2]Fusion for Energy, [3]Oxford Technologies Ltd., [4]SCK·CEN

This paper shows a customized MGy radiation tolerant instrumentation amplifier. The 65 nm CMOS-based ASIC amplifier has an offset smaller than 1 μV and a noise level below 50 nV/√Hz from DC.

I-3 9h40 **Partial TMR in FPGAs using Approximate Logic Circuits**

A. Sánchez-Clemente, L. Entrena, M. García-Valderas
Universidad Carlos III

In this work we propose a new approach to build Partial TMR circuits for FPGAs using approximate logic circuits. This approach is scalable, with a low granularity, and can provide an optimal balance between reliability and overheads. The proposed approach has been validated using proton irradiation.

I-4 9h55 **Redundant Skewed Clocking of Pulse-clocked Latches for Low Power Soft Error Mitigation**

A. Gujja, S. Chellappa, C. Ramamurthy and L. T. Clark
Arizona State University

A soft-error hardening approach combining redundant clock trees and pulse-clocked latches mitigates both SEU and SET. An AES implemented with the proposed approach reduces energy per operation by 20% over using non-redundant clocks.

I-5 10h10 **Validation of FDIR Strategy for Spaceborne SRAM-based FPGAs Using Proton Radiation Testing**

F. Siegle[1,2], T. Vladimirova[1], C. Poivey[2], and O. Emam[3]
[1]University of Leicester, [2]European Space Agency, [3]Airbus Defence and Space

A FDIR strategy for SRAM based FPGAs has been developed, which comprises a hardware framework and an availability prediction model. Proton radiation test results validating both the hardware framework and the prediction model will be presented.

I-6 10h25 **Architectural and Micro-architectural Techniques for Software Controlled Microprocessor Soft-error Mitigation**

A. R. Gogulamudi, L. T. Clark, C. Farnsworth, S. Chellappa, and V. Vashishtha
Arizona State University

A MIPS embedded microprocessor core design that incorporates architectural features for software aware radiation upset recovery is presented. The design uses multiple fault tolerance techniques and the prototype operates at up to 336 MHz.

I-7 10h40 **Reliability on ARM Processors against Soft Errors by a Purely Software Approach**

E. Chielle[1], F. Rosa[1], G. Rodrigues[1], F. Kastensmidt[1], R. Reis[1], and S. Cuenca-Asensi[2]
[1]Instituto de Informática, UFRGS, [2]University of Alicante

A set of software-based techniques to detect soft errors in embedded ARM processors at low costs is presented. Fault injection results show high fault coverage at performance and memory overheads inferior to state-of-the-art techniques.

POSTER PAPERS

PI-1 **Multiple Cell Upset Mitigation in a Triple Modular Redundancy Architecture**

F. Smith
Nelson Mandela Metropolitan University

A modification of the multi-input Muller C-Element is proposed as a multiple cell upset mitigation circuit. Proton tests suggest its efficiency in eliminating single and multiple cell upsets compared to TMR and unmitigated designs.

PI-2 **Physical Design Methodologies for Soft Error Mitigation Using Redundancy**

C. Ramamurthy, L. T. Clark and S. Chellappa
Arizona State University

Three physical design methodologies for soft error mitigation using redundancy are presented. The first offers SEU mitigation only, but only uses unhardened cells and non-redundant logic; the others provide both SEU and SET mitigation.

PI-3 **A Family of Rad-Hard ADC with Flash Architecture**

U. Gatti, C. Calligaro
RedCat Devices

This work presents a family of rad-hard ADCs with flash architecture for space applications. The 4-Bit ADC has been integrated in two standard CMOS 0.18-µm technologies by TowerJazz and XFAB. The prototypes have been tested under Co-60 and showed same radiation immunities up to 300krad(Si)

PI-4 **Semi-Empirical Method for Estimation of Single- Event Upset Cross-Section for SRAM DICE Cells**

M. S. Gorbunov[1,2], A. B. Boruzdina[2], P. S. Dolotov[1]
[1]Scientific Research Institute of System Analysis (SRISA), [2]National Research Nuclear University MEPhI

We propose a new method for estimation of SEU cross-section for DICE SRAM cells with known distance between neighboring sensitive volumes. The method is based on experimental analysis of SEU maps in 6T SRAM cells.

PI-5 The experimental and simulation study of specialized thermal control coating application for radiation shielding of electronic components

V. S. Anashin[1], G. A. Protopopov[1], O. S. Kozyukova[1], I. A. Lyakhov[1], V. F. Zinchenko[2], A. V. Grigorevskiy[3], R. H. Khasanshin[3], A. V. Sogoyan[4]
[1]Branch of JSC "United Rocket and Space Corporation"-"Institute of Space Device Engineering", [2]FSUE "Research Institute of Scientific Instruments", [3]JSC "Kompozit", [4]Specialized Electronic Systems (SPELS)

Experimental and simulation study results of radiation shielding properties of multilayer thermal control coating with the adding element with high atomic number are presented.

PI-6 The experimental and simulation study of radiation shielding properties of multilayer shielding cases with tantalum carbide extender pigment

V. S. Anashin[1], G. A. Protopopov[1], O. S. Kozyukova[1], I. A. Lyakhov[1], P. A. Chubunov[1], A. V. Perebeynos[1], A. V. Grigorevskiy[1], L. V.Kiseleva[2], S. V. Tokar[2]
[1]Branch of JSC "United Rocket and Space Corporation"-"Institute of Space Device Engineering", [2]JSC "Kompozit"

Experimental and simulation study results of radiation shielding properties of multilayer shielding cases with tantalum carbide extender pigment are presented

PI-7 The Radiation-Hardened Differential Stages and Op Amps without Classical Reference Current Source

N. N. Prokopenko[1], O. V. Dvornikov[2], I. V. Pakhomov[1] and N. V. Butyrlagin[1]
[1]Don State Technical University, [2]Minsk Research Instrument Making Institute

The paper reviews the circuitry of differential stages (DSs) based on the elements of radiation-hardened bipolar and field effect analog gate-array master chip "AGAMC-1.3" (OJSC "Integral", Minsk city, Belarus).

PI-8 Verifying Hardening Techniques for Distributed Electronic Systems in Critical Applications

A. Vaskova[1], C. López-Ongil[1], M. García-Valderas[1], M. Portela-García[1], Y. Morilla[2], Gema Muñiz[2]
[1]Carlos III University of Madrid, [2]National Centre for Accelerators, Seville

Robustness of distributed electronic systems against ionizing radiation is often estimated based upon single nodes reliabilities. In this paper a proposal is presented for on-line reporting the SEU/SEFI appearance on these systems, while checking the self-recovery capability of the system and its components.

11h00–11h30 COFFEE BREAK

SESSION J **SINGLE EVENT EFFECTS MECHANISMS AND MODELING**

Session Chairs

Gennady Ivanovich Zebrev *(Ph. D. from 2003, Doct. of Sci. from 2009) is currently a full professor at the National Research Nuclear University MEPhI, Moscow. Gennady Zebrev was born in Tambov Province, Russia, he graduated from the Department of Theoretical Physics of Moscow Engineering Physics Institute in 1984. Gennady Zebrev worked as a senior researcher at the Research Institute of Science Instruments, Lytkarino, Moscow, from 1984 to 1999. Since 1999 he has been teaching Device Physics, Electrical Engineering and Radiation Physics at the Department of Micro- and Nanoelectronics of National Research Nuclear University MEPhI. He has authored over 80 papers on various topics in the radiation effects area, device modeling and physics of nonequilibrium processes. Achievements include researches in microelectronic device modeling and the diffusion-drift MOSFET model; physical mechanisms of radiation degradation in thick isolation oxides and the ELDRS model; radiation-induced leakage current in CMOS modeling; single event effect basic mechanisms including the role of the fluctuation of energy deposition (straggling) and multiple cell upset description and characterization, the heavy ion induced SEU simulator OSOT (PRIVET) development; graphene physics and graphene device modeling and characterization methods development; Keldysh technique for nanoscale devices. He was awarded in 2007 the M.V. Keldysh medal of merit of the Russian Space Federation. G.I. Zebrev is author of several books and chapters in Russian and international publishing houses, including "Physical Basics of Silicon Nanoelectronics" (Binom, 2011, Moscow, in Russian) and a chapter in "Physics and Application of Graphene: Theory," InTech, 2011. Married, has a daughter, his hobby is history.*

Marta Bagatin *received the Laurea degree (cum laude) in Electronic Engineering in 2006, and a Ph.D. in Information Science and Technology in 2010, both from the University of Padova, Italy. She is currently a Post Doc at the Department of Information Engineering, University of Padova. Her research interests concern reliability and radiation effects on electronic devices, especially non-volatile memories. She authored and co-authored about 40 papers published in peer-reviewed journals in the field of radiation effects in electronics.*

11h30

SESSION INTRODUCTION
Chairs: G. Zebrev (NRNU MEPhI) & M. Bagatin (Univ. di Padova)

ORAL PAPERS

J-1 **New Insight into Heavy Ion Induced SEGR: Impact of Charge Yield**
11h40
V. V. Emeliyanov, A. S. Vatuev, R. G. Useinov
Research Institute of Scientific Instruments (RISI)

An experimental evidence of a crucial role of the charge yield in the heavy ion induced single-event gate rupture (SEGR) process in SiO_2 is reported.

J-2 **Analysis of BOX Layer Thickness on SERs of 65 and 28nm FD-SOI**
11h55 **Processes by a Monte-Carlo Based Simulation Tool**
K. Zhang, S. Kanda, J. Yamaguchi, J. Furuta, K. Kobayashi
Kyoto Institute of Technology

We estimate the SERs of FD-SOI structures according to the thicknesses of BOX (Buried OXide) layer on 65-nm and 28-nm processes by reducing the supply voltage. The simulation results are consistent with the measurement results.

J-3 **Proton-Induced SDRAM Cell Degradation**
12h10
A. Rodriguez [1], F. Wrobel [1,2], A. Samaras [3], F. Bezerra [4], B. Vandevelde [3], R. Ecoffet [4], A. Touboul [1], N. Chatry [3], L. Dilillo [5], F. Saigné [1]
[1] IES - Université de Montpellier, [2] Institut Universitaire de France, [3] TRAD, [4] Centre National d'Etudes Spatiales, [5] LIRMM - Université de Montpellier

Retention time degradation and cell functionality under proton irradiation is studied for two SDRAM references that exhibit in-flight faulty behavior. Elements that may be used for physical interpretation of the phenomenon are given.

J-4 **Analysis of SRAM-Based FPGA SEU Sensitivity to Combined Effects of**
12h25 **Conducted EMI and TID**
J. Benfica [1], B. Green [1], B. C. Porcher [1], L. Bolzani Poehls [1], F. Vargas [1], N. H. Medina [2], N. Added [2], V. A. P. de Aguiar [2], E. L. A. Macchione [2], F. Aguirre [2], M. A. G. da Silva [3], E. A. Bezerra [4]
[1] Electrical Engineering Faculty – PUCRS, [2] Instituto de Física, Sao Paulo University, [3] Depto. de Física, Centro Universitário – FEI, [4] Federal University of Santa Catarina

Methodology to evaluate SRAM-Based FPGA SEU susceptibility to noise on VDD power pins (IEC61.000-4-29) and TID. Procedure was demonstrated for a Xilinx Spartan3E FPGA operating in an 8MV Pelletron accelerator and a Shimadzu X-ray diffractometer.

POSTER PAPERS

PJ-1 Multiple Cell Upset Cross-Section Uncertainty in Nanoscale Memories: Microdosimetric Approach

G. I. Zebrev [1], K. S. Zemtsov [1], R. G. Useinov [1,2], M. S. Gorbunov [1,3], V. V. Emeliyanov [2], A. I. Ozerov [2]
[1] National Research Nuclear University MEPhI, [2] Research Institute of Scientific Instruments (RISI), [3] Scientific Research Institute of System Analysis, Russian Academy of Sciences (SRISA)

We found that the energy deposition fluctuations in the sensitive volumes may cause multiplicity scatters in the multiple cell upsets in the nanoscale (with feature sizes less than 100 nm) memories.

PJ-2 Body Bias Effects on the Single-Event-Transient Response of PDSOI Devices

J. Bi [1], L. Chen [2], Z. Han [1], Y. Wang [1], M. Liu [1]
[1] Institute of Microelectronics, Chinese Academy of Sciences, [2] University of Saskatchewan

Body bias effects on the laser-induced transient current peak, duration, collected charge and amplification factor are experimentally evaluated. The results are promising for radiation-hardened circuit design.

12h40 End of Friday Sessions

12h40 - 13h00 Conference Closing Remarks

V. Anashin, (URSC-ISDE) General Chair
R. Marec, (TAS-France), General co-Chair
P. Calvel, (TAS-France), President of RADECS Association

YURI GAGARIN AWARD

We are glad to present you the «Yuri Gagarin» Award! The organizers together with the representatives of the RADECS Association decided to introduce the tradition of annual awards, which for the first time will be awarded at RADECS-2015 in Moscow.

This award will be given annually to a selected person working in the radiation effects community.

It can be given to a person from any organization from this community.

The candidate for the award must meet the following criteria:

- **at least 20 years of experience in the radiation effects community;**
- **must be a well-known professional with recognized scientific or technical expertise;**
- **a special individual involvement in building relationships between countries;**
- **a significant individual contribution to the work of the RADECS conferences organization (including important chair positions).**

Nominations for this award were accepted from any member of the community by filling the form on the website.

The winner of the award is selected by the General Chair of the RADECS-2015 Conference and the RADECS bureau from the 3 finalists, who were first selected by the General Chair. The award will be presented by the President of the RADECS Association at the gala dinner of the RADECS-2015 conference in Moscow.

INDUSTRIAL EXHIBITION GENERAL INFORMATION

The RADECS-2015 Industrial Exhibition will start on Tuesday morning, September 15, 2015 and will continue until Thursday afternoon, September 17, 2015. It will be held on the 2nd and 3rd floor of Izmailovo Alfa Hotel (Moscow, Russia).

Exhibiting at RADECS-2015 is a cost-effective way to interact with those involved in the radiation effects industry.

Conference breaks will be hosted in the Exhibit Area (2nd & 3rd floor) on Tuesday, Wednesday and Thursday along with lunches which will be on the 2nd floor (for registered attendees only). RADECS badges must be worn at all times.

On Tuesday evening, the exhibitors will host the Exhibitor Cocktails featuring complimentary drinks in the Exhibit Area along with light hors d'oeuvres in the Exhibit Area. The Exhibitor Cocktails is open to all RADECS attendees and guests.

On Wednesday, 16 September, exhibitors can invite guests or partners for a one day exhibition at the cost of 100 EUR per visitor. Exhibitors or guests will pay the registration fee on site. This cost includes access to coffee breaks, lunch and Exhibitor Cocktails.

NOTE: Children under 16 must be accompanied by an adult in the Exhibit Area.

For more information, contact:

Industrial Exhibition
RADECS-2015 Chair
Irina Tuzhikova
URSC - ISDE
E-mail info@radecs2015.org

Industrial Exhibition
RADECS-2015 Vice-Chair
Teresa Farris
Cobham/Aeroflex
E-mail teresa.farris@aeroflex.com

Christian Chatry
TRAD
E-mail christian.chatry@trad.fr

On the RADECS-2015 website you can find following information:

- RADECS-2015 Exhibitor Manual
- RADECS-2015 Exhibitor Floor Plan
- RADECS-2015 Exhibitors list
- Additional services for exhibitors
- Request for additional services
- Customs Guide
- Price-list for custom clearance services

Detailed information is presented in the printed copy of the Exhibitor Manual (for exhibitors only).

INDUSTRIAL EXHIBITION CHAIR & VICE-CHAIRS

RADECS-2015 Industrial Exhibition Chair

Irina Tuzhikova *graduated from the National Research Nuclear University MEPhI, Micro- and Nano-electronics Department, the Automatics and Electronics faculty (Electronics and Automation of Physical Facilities specialty) in 2011. She is currently working as an engineer at the Branch of JSC "United Rocket and Space Corporation" – "Institute of Space Device Engineering" (Moscow, Russia). She actively participated in the Industrial Exhibitions (RADECS 2012, RADECS 2013, NSREC 2014, NSREC 2015) and has co-authored several publications in Russian conferences.*

RADECS-2015 Industrial Exhibition Vice-Chairs

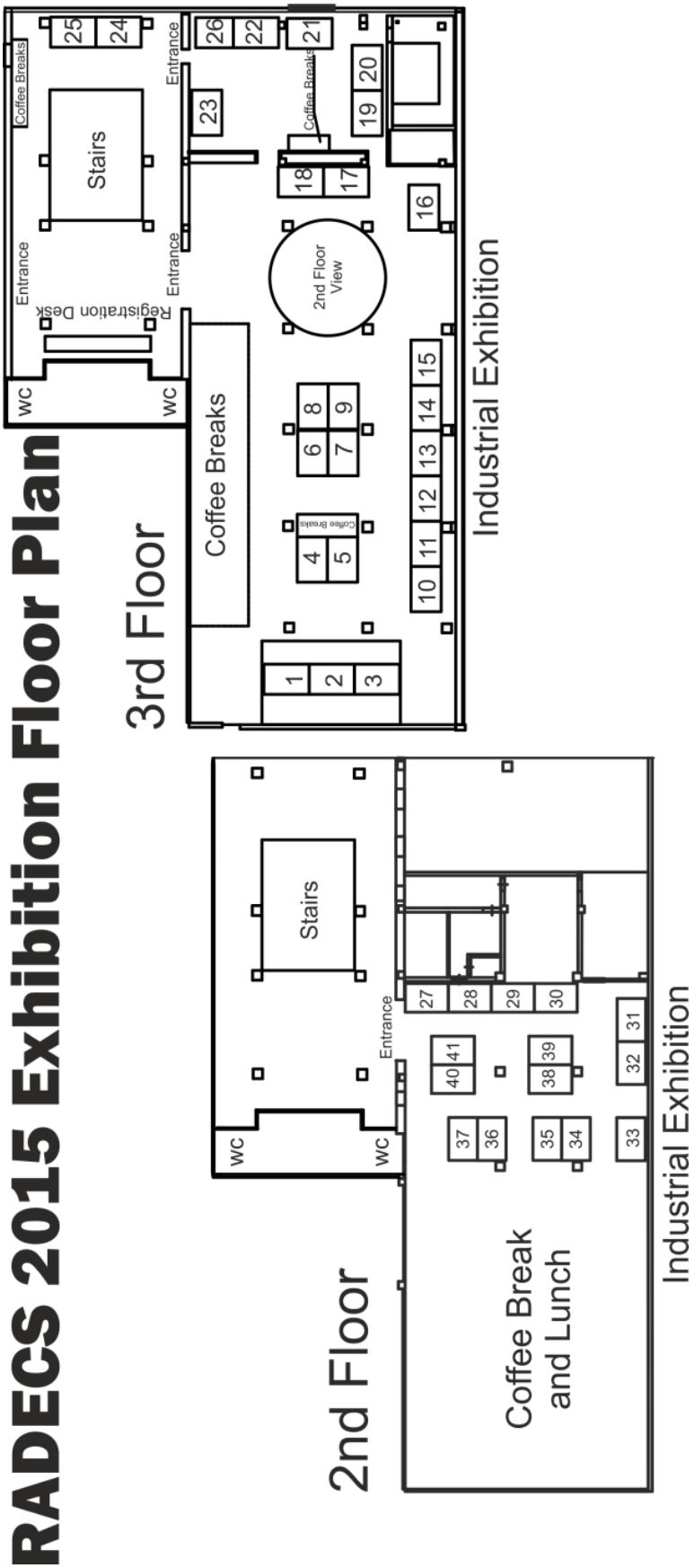
Christian Chatry *received his PhD in neutron-matter interaction and MSc in Electronics (both obtained from Montpellier University in 1991). Christian Chatry started his career at Thomson CsF Paris (now Thales). From 1991 to 1994, he was the head of Thomson CsF's test department.*

Building on this successful experience, he created TRAD Tests & Radiations in July 1994. Initially specialized in the radiations effects on electronic components and materials, TRAD further expanded towards engineering services and simulation software edition in the early 2000's.

With more than 21 years of experience in the field of particles interaction, design and testing of electronic components in space environment, he is now the general director of TRAD which counts over 40 employees today.

He co-authored several papers, mainly published in the IEEE Transactions on Nuclear Sciences, and is a member of the RADECS Association (Radiation Effects on Components and Systems) steering board.

Teresa Farris*, MARCOM Manager, Cobham Semiconductor Solutions, (Formerly Aeroflex) has been the Marketing Communications Manager, since RADECS was born and has been on the RADECS Steering Committee and US Exhibit Chair for 10 years. She handles Cobham's press, trade shows, contributed articles and marketing collateral. She has served on the IEEE NSREC Steering Committee as Vice Chair of Publicity since 1999 as well as Local Arrangements Chairman since 1997 and has also been exhibit chair twice. Teresa has also served as Exhibit Chair for NASA's SEE/MAPLD Workshop since 2010. Teresa is very dedicated to the European, International and US Radiation Hardened and Extreme Environment Communities.*


RADECS 2015 Exhibition Floor Plan
3rd Floor
Coffee Breaks
Industrial Exhibition
Stairs
Entrance
Registration Desk
wc
2nd Floor View
1 2 3
4 5
6 7 8 9
10 11 12 13 14 15
16
17 18
19 20
21 22 26
23
24 25
2nd Floor
Coffee Break and Lunch
27 28 29 30
31 32
33
34 35
36 37
38 39
40 41

EXHIBITORS LIST

Please check our website (www.radecs2015.org) for a current listing of companies exhibiting at RADECS-2015

EXHIBIT SCHEDULE

Sunday, 13 September
16:00-18:00 Registration

Monday, 14 September
08:00-16:30 Registration
14:30-17:00 Set-up time

Tuesday, 15 September
08:00-10:30 Registration/ set-up times
10:30-18:30 Exhibition time
10:30 Opening of exhibition
10:30-11:00 Coffee Break
13:00-14:30 Lunch
16:40-17:00 Coffee Break
19:00-21:00 Welcome Reception

Wednesday, 16 September
09:00-18:30 Exhibition time
11:00-11:30 Coffee Break
13:00-14:30 Lunch
16:30-17:00 Coffee Break
19:00-21:00 Exhibitor Cocktails
(in the exhibit area)

Thursday, 17 September
09:00-13:00 Exhibition time
11:00-11:30 Coffee Break
11:00-13:00 Closing of exhibition
13:00-15:30 Booth dismantling
20:00-22:00 Gala Diner

A prize raffle will be held in the last break (16:30 - 17:00) on Wednesday, September 16, 2015.
To be in with a chance to win, make sure you hand in your business cards to the following participating exhibitors:

- TL ISDE
- HiLevel Technology, Inc.
- PetroInTrade
- NRNU MEPhI/SPELS

Company	Booth
ChipIR	1
International Rectifier	2
ALTER TECHNOLOGY TÜV NORD	3
China Academy of Space Technology	4
Anaren/MS Kennedy	5
Digital Solutions	6
INTEGRAL	7
NRNU MEPhI/SPELS	8
HILEVEL Technology, Inc.	9
R&D Center «ELVEES», OJSC	10
3D PLUS	11
INTERSIL	12
PetroInTrade	13,14
Isocom	15
Maxwell Technologies	16
Microsemi	17
TRAD	18
Crane Interpoint Products	19
STMicroelectronics	20
ROSCOSMOS	21
Texas Instruments	22
Institute of Isotopes Co. Ltd	23
ELCOEX Inc. & Q-Tech Corporation	24
NKT	25
TL ISDE	26
ATMEL	34,35
ARUAL-Tech	36
CERN	37
SMC «Technological Centre»	38
PULSAR	39
AO «IZHEVSKIY RADIOZAVOD»	40
IHP and ARQUIMEA	41

We are really happy to offer you this unique opportunity to visit Moscow - the most beautiful city in Russia

RADECS-2015 Local Chair

Tatiana Barataeva graduated from The State University of Management in Moscow, Russia in 2010. She is currently working as a head of group at the Branch of JSC "United Rocket and Space Corporation" – "Institute of Space Device Engineering" (Moscow, Russia) and is in charge of organizing different kinds of events, such as seminars, workshops, conferences, meetings, etc. Also, she is a head of the Galactic Flow LLC, which is in charge of the RADECS-2015 conference organization. She has participated in the RADECS and NSREC conferences since 2012.

RADECS-2015 Local Vice-Chair

Olga PONOURINA-PAILLET graduated from the Medical School and the University of Sports and Health in Saint-Petersburg, Russia in 1997 and 1999 respectively. After moving to the USA, then to France, she graduated from the Medical School and the University of Sports in Paris, in 2011 and 2014. She is currently working as a physical trainer and nutritionist at the Headquarters of the French military police. Olga has a great experience in building international relationships and collaborations in various fields, such as science, medicine, health, sports, and arts. She has been involved in the organization of many international events: sports championships, concerts and art events, workshops and conferences, in Russia (1991-1999), the USA (1999-2001) and France (2001-2015). She actively participated in the organization of NSREC 2014 in Paris, acting as co-Local Arrangements Chair.

The RADECS-2015 is held at the Izmailovo Alfa Hotel and has a highly technical program. For your accommodation we present the overview of the conference halls where the Short Course and Technical Program will take place.

The registration desk will be on the 3rd floor in the hall area. You won't miss it when you come to the conference. All the information will be made available to you here.

In the hall you will also find tables with information about future conferences and our partners.

The Short Course, as well as the Technical program, which includes oral Technical Sessions and Invited Talks, will be held in the conference hall number 1-4 from Monday to Friday.

The opening and closing ceremonies will also be held in the same conference halls.

Another part of the Technical Program, which is called Round Tables, will be held in conference hall number 7 from Tuesday to Thursday.

The Round Tables go in parallel with the Invited Talks and sessions.

There are also two extra parts of the Technical Program. They are the Radiation Effects Data Workshop, which will be held on Tuesday, September 15, and the Poster session, which will be held on Wednesday, September 16.

Both parts of the Technical Program will be held in conference hall number 8.

Another interesting part of the conference is the Industrial Exhibition, which will be held in conference halls numbers 5 and 6 on the 3rd floor and in the green hall on the 2nd floor.

The RADECS-2015 will provide refreshments in the breaks during the RADECS Short Course and Technical Sessions. Coffee breaks are included for Short Course attendees on Monday, September 14, in the Industrial Exhibition area.

For registered Technical Session attendees, coffee breaks will be also available in the Industrial Exhibition area.

A light lunch is included for both Short Course and Technical Session attendees on the 2nd floor in the restaurant.

HOW TO GET TO THE VENUE

There are 3 main international airports in Moscow:

Sheremetyevo (SVO) Airport is located 44 km from Izmailovo Alfa Hotel. The airport has 5 terminals: Sheremetyevo B and Sheremetyevo C, Sheremetyevo D, Sheremetyevo E and Sheremetyevo F. Regular comfortable buses run between these terminals.

Domodedovo (DME) Airport is located 56 km from Izmailovo Alfa Hotel. The airport is the largest and the most promising Russian airport. It holds the leading position among Moscow area airports in terms of passenger traffic.

Vnukovo (VKO) Airport is located 48 km from Izmailovo Alfa Hotel. The airport was recently renovated and is now one of the most modern ones in Moscow.

No matter which airport you arrive at, you can take **a taxi**. The minimum trip time from any airport to the Izmailovo Alfa Hotel if you take a taxi will be 1h- 1h30.

For your comfort, we would like you to use a **transfer** from and to any airport. You can make a reservation through your personal page after the full process of the registration on the website registration page.

Upon arrival at the airport or railway station, a representative of the International Agency of Congress Management «MAKO» will meet you with the greeting sign «RADECS-2015 Conference», first name and last name.

The contact e-mail address is radecs2015@makongress.ru.

Another way to get from the airport to the Izmailovo Alfa Hotel is by **«Aeroexpress»**.

The fastest and the best way to get to and from the city is taking the comfortable high-speed «Aeroexpress»- the fast train service to the center of Moscow. After that you should take the metro.

The whole trip from any airport to the Izmailovo Alfa Hotel if you take «Aeroexpress» will be 1h-1h30.

Detailed information is presented on the website www.radecs2015.org.

ACCOMMODATION

We are glad to offer you accommodation in the following hotels. You can make a reservation through your personal page after the full process of the registration on the website registration page. All the hotels are located in the same area.

Izmailovo Complex consists of 5 hotels, which are situated in the adjacent buildings: Alfa ****, Gamma ***, Delta ****. We recommend three of them.

Izmailovo Alfa Hotel**** – the venue of RADECS-2015

Hotel address: Moscow, Izmailovskoe shosse, 71, building A

The nearest metro station: «Partizanskaya». It is located 50 meters from the hotel.

The Izmailovo Alfa Hotel is a modern four-star hotel, which offers its guests a high level of service, based on a developed infrastructure, perfectly organized technology of servicing guests and professionalism of the staff. Izmailovo Alfa Hotel is conveniently located in a green area of the Izmailovo park.

Izmailovo Gamma Hotel***

Hotel address: Moscow, Izmailovskoe shosse, 71, building 4G-D

The nearest metro station: «Partizanskaya». It is located 50 meters from the hotel.

The Izmailovo Gamma Hotel is a modern three-star hotel offering its guests a high level of service, based on ~~a~~ the developed infrastructure of services «City-within-the-city», perfectly organized technology of guest serving and professionalism of the staff. Izmailovo Gamma Hotel is conveniently located in a green area of the Izmailovo park.

Izmailovo Gamma Hotel***

You have to finish the process of registration

Hotel address: Moscow, Izmailovskoe shosse, 71, building 4G-D

The nearest metro station: «Partizanskaya». It is located 50 meters from the hotel.

The Izmailovo Gamma Hotel is a modern three-star hotel offering its guests a high level of service, based on the developed infrastructure of services «City-within-the-city», perfectly organized technology of guest serving and professionalism of the staff. Izmailovo Gamma Hotel is conveniently located in a green area of the Izmailovo park.



You can find additional information on the website www.radecs2015.com.

VISA SUPPORT

All foreign participants* of **RADECS-2015** should obtain a visa to enter the Russian Federation.

You can get a Russian visa **only** through a Russian General Consulate in your country of residence.

To apply for a Russian visa, you need to submit the appropriate necessary documents (**support documents**), which depend on the rules of the General Russian Consulate in your country.

The organizing committee of RADECS 2015 can provide the **support documents** for two types of visa: **TOURIST** or **BUSINESS.**

***Support documents for Tourist visa*:**

The International Agency of Congress Management «MAKO», partner of the RADECS 2015 organizing committee, will provide participants with the documents necessary for their **Russian «Aim Tourist» Visa** application.

Supporting documents will be issued based on your personal information submitted during **the on-line registration process.**

The deadline for all visa requests is the **August 14, 2015.** The International Agency of Congress Management «MAKO» has a reference number in the Russian Federal Migration.

NOTICE! The Conference Secretariat will send the visa support documents to the participant only after receiving the Registration and Accommodation fees for your entire stay.

***Support documents for Business visa*:**

Obtaining a **Russian Business Visa** will probably require an **official invitation letter** from the RADECS 2015 organizing committee.

An invitation letter will be issued based on your personal information, which you will need to send to us.

In order to get your visa in time, please contact the RADECS 2015 Organizing Committee by mail (info@radecs2015.org).

The deadline for all visa requests is the **August 14, 2015.** After that date, the Invitation Letter can still be provided, but getting the visa may not be guaranteed.

NOTICE! The Conference Secretariat will send the visa support documents to the participant only after receiving the Conference Registration fee.

NOTICE! Please be sure to check your passport beforehand. It must be valid 6 months after the last day of your visa, and it must have 2 adjacent empty pages to put the visa.

IMPORTANT! All foreign citizens arriving in Russia will be given an immigration card (printed sheet of paper, the size of a passport page) while passing through immigration. Please be careful and keep this card secure until your departure from the Russian Federation, as it will be requested when leaving by the immigration officer.

For further information please contact:
Olga Potapova
Telephone: +7 (499) 705-79-25
E-mail: radecs2015@makongress.ru

REGISTRATION

RADECS-2015 is offering a preferential rate to delegates who register before June 19, 2015.

Categories	Early Registration until June 19, 2015	Late Registration until September 1, 2015	On-site registration
Short Course	300 €	360 €	420 €
Short Course (student)*	150 €	240 €	300 €
Technical Sessions	750 €	870 €	990 €
Technical Sessions (student)*	500 €	550 €	600 €
Short Course and Technical Sessions	1 050 €	1 230 €	1 410 €
Short Course and Technical Sessions (student)*	650 €	790 €	900 €
Accompanying person (only social program)**	130 €	160 €	190 €

*****students have to provide a proof of status from their university.

**social program includes: Welcome Reception, Exhibitor Cocktails and Gala-Dinner

The registration fee for the Short Course on Monday September 14, 2015 includes:

- Pass to Short Course
- CD Disc / memory stick and book with Short Course materials
- Coffee Breaks and Lunches on Monday – 14th September 2015

The registration fee for the Technical Sessions from Tuesday to Friday September 14-18, 2015 includes:

- Pass to Technical Sessions, Round Tables and Industrial Exhibition
- Handout materials
- Coffee Breaks and Lunches from Tuesday 15th September – Friday 18th September 2015
- Pass to the social program: Welcome Reception, Exhibitor Cocktails and Gala-Dinner

The registration fee for the Short Course and Technical sessions from Monday to Friday September 14-18, 2015 offers access to all events in both categories.

If you would like to invite a guest to join you in the RADECS-2015 social program (Welcome Reception, Exhibitor Cocktails and Gala-Dinner), you (or they) have to fill in the on-line registration form as accompanying person.

CANCELATION POLICY

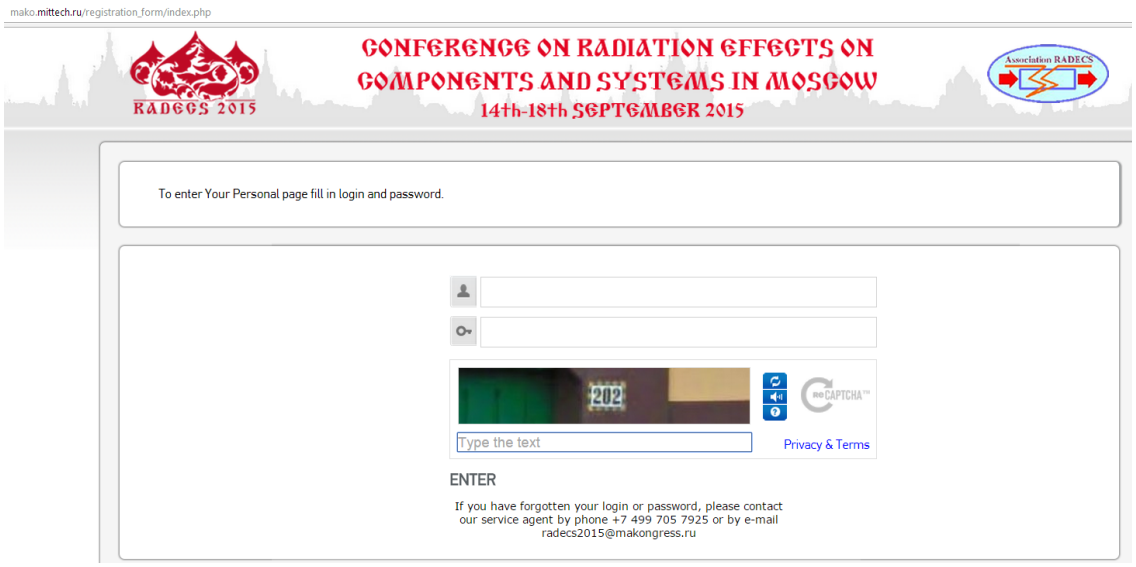
- until 15th of June 2015 you can get a refund 90% of your registration fee
- from 15th of June to 15th of July 2015 you can get a refund 50% of your registration fee
- after 15th of July 2015 the registration fee is non-refundable

REGISTRATION

All participants are required to submit their details through the online registration site by August 25, 2015 and pay the registration fee.

http://radecs2015.org/conference/?pm=6&m=1

The booking of accommodation and social activities can also be done through this site. You can book the hotel and choose the social program there. Information from your personal account (name, company name) is going to be used for the badge.



The conference registration will take place in the Izmailovo Alfa Hotel hall (3rd floor). If you have not registered yet, go to the «ON-SITE REGISTRATION» desk. If you have already registered, go to the «REGISTRATION» desk to pick your handout materials.

ON-SITE REGISTRATION HOURS

Sunday, September 13, 2015	16:00 – 18:00
Monday, September 14, 2015	08:00 – 16:30
Tuesday, September 15, 2015	08:00 – 16:30
Wednesday, September 16, 2015	08:00 – 16:30
Thursday, September 17, 2015	08:00 – 16:30
Friday, September 18, 2015	08:00 – 10:00

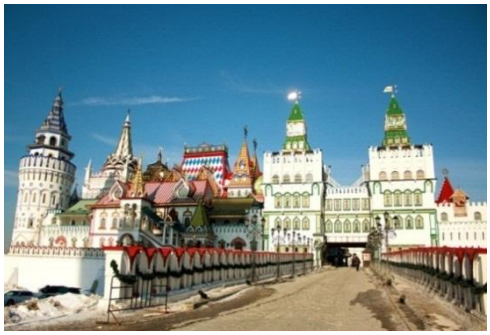
All the participants can collect closing documents from Tuesday to Thursday after 14:00.

For further information please contact:
Olga Potapova
Telephone: +7 (499) 705-79-25
E-mail: radecs2015@makongress.ru

SOCIAL PROGRAM

The Social Program is included in the Technical Session and the guest registration fee

WELCOME RECEPTION



Date: September 15, 2015 (Tuesday)
Time: 19.00 – 21.00
Place: Izmailovo Kremlin
Address: Izmailovskoe shosse, 73-zh
Dress code: Smart casual

The Izmailovo Kremlin is a cultural-entertaining complex which includes different museums and manufacture-artistic workshops

The performance will be on the street at first and after that in one of the halls with walls and columns painted in khokhloma style

EXHIBITOR COCKTAILS

Date: September 16, 2015 (Wednesday)
Time: 19.00 – 21.00
Place: Izmailovo Alfa Hotel
Address: Izmailovskoe shosse, 71 A
Dress code: Smart casual

The venue is the Izmailovo Alfa Hotel Exhibition area (3rd and 2nd floors)

About 40 leading international and Russian companies will participate in the Exhibition

GALA – DINNER

Date: September 17, 2015 (Thursday)
Time: 20.00 – 22.00 (buses leave at 19.00)
Place: Surikov Hall
Address: Viatskaya st., 41A
Dress code: Festival attire

Surikov Hall is located in the building of the former Culture Centre of «Svoboda» Factory, built by a world famous constructivist architect - Konstantin Melnikov, in 1929

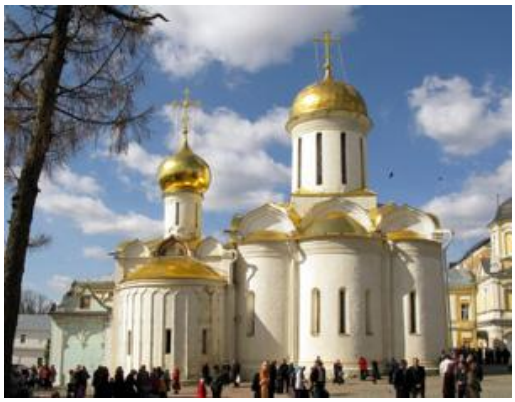
After renovation, this historical site under UNESCO protection renewed its original constructivist facade and got its new classic interior

CULTURAL AND TECHNICAL PROGRAM

We would like to offer you some cultural and technical excursions. You can choose your favorite ones on your personal page after the conference registration

http://radecs2015.org/conference/?pm=6&m=1

CULTURAL PROGRAM



Tour to Sergiev Posad (lunch included)

Date: September 14, 2015, Monday

Time: 9 a.m.-5 p.m. (6 p.m.)

Duration: 8-9 hours, it depends on traffic jam (including transfer time)

Starting point / Tour end: Hotel "Alfa", Moscow, Izmailovskoe shosse, 71, building A

Visit to Roscosmos Test Facilities (Dubna town near to Volga river), JINR (lunch included)

Date: September 14, 2015, Monday

Time: 8 a.m. - 5 p.m. (6 p.m.)

Duration: 9-10 hours, it depends on traffic jam (including transfer time)

Starting point / Tour end: Hotel "Alfa", Moscow, Izmailovskoe shosse, 71, building A

Bus tour around Moscow

Time: 2 a.m. – 6 p.m. (7 p.m.)

Date: September 15, 2015 Tuesday

Duration: 4-5 hours, it depends on traffic jam (including transfer time)

Starting point / Tour end: Hotel "Alfa", Moscow, Izmailovskoe shosse, 71, building A

You can also find additional excursions on our website and book them individually http://radecs2015.org/leisure_activities/?pm=34&m=6.

For further information please contact:
Olga Potapova
Telephone: +7 (499) 705-79-25
E-mail: radecs2015@makongress.ru

For more information, please contact:
info@radecs2015.org
www.radecs2015.org