RADECS 2013
CONFERENCE PROGRAMME

RADECS 2013
Oxford, UK
23rd - 27th September 2013

RADECS
AWE
intersil
Peregrine Semiconductor
synergyhealth
our work protects your world

CHAIRMAN'S WELCOME PAGE

It is my genuine pleasure to welcome you to RADECS 2013, the 22nd edition of the RADECS conference. Hosted by Synergy Health plc in Oxford, the week begins on Monday 23rd September with a short course entitled, "Radiation effects: understanding the evolving risk for new technologies and new environments". Organised by Peter Truscott (Kallisto Consultancy Limited), this short course will provide delegates with a thorough review on the hazards and effects of the space environment on both electronics and humans.

Commencing on Tuesday 24th September, the main technical programme features a collection of exceptional paper contributions. Technical chairman, Andrew Chugg (MBDA) and his team have critically reviewed a large number of international paper submissions to bring you the latest developments in the form of oral and poster presentations and a data workshop. The oral presentations have been partitioned by topic into ten sessions over the week, with the posters having a dedicated session on Thursday and the data workshop on Tuesday.

In addition to the technical presentations, three invited talks will take place during the conference. Two technical talks will be provided by internationally renowned industry experts: Clive Dyer on space weather and Paul O'Brien on new electron and proton belt models. The third talk is a cultural introduction to the city of Oxford and its surroundings and will be given by Brian Murray, Oxford's leading Blue Badge tour guide. We are also delighted to announce that our local expert, Andrew Holmes-Siedle, will be presenting a technical paper on RADFET dosimeters as part of session B.

The RADECS 2013 organising committee has created a multifaceted conference that seamlessly combines technical sessions with an industrial exhibition, providing the opportunity for exhibitors to demonstrate the products and services which support the radiation effects industry. I am grateful to Teresa Farris (Aeroflex) and Shlomo Manheim (Peregrine Semiconductor) for co-ordinating the industrial exhibition, which will run from Tuesday to Thursday, including a reception on Tuesday evening.

The 2013 organising committee chose Oxford as the location of this year's conference due to its rich cultural history and scientific links. You will see some of the former in the venues selected for the conference, the welcome reception and the gala dinner. Our conference will take advantage of Oxford's close proximity to the emerging 'science hub' in south Oxfordshire to offer a choice of two technical tours to STFC's Rutherford Appleton Laboratory (ISIS / Diamond, including the ChipIR facility) and the Culham Science Centre (Joint European Torus nuclear fusion experiment).

In addition to managing the organisational aspects of the conference, Rebecca Lomax (Synergy Health plc), the RADECS 2013 Event Organiser, has also assembled an exciting and varied social programme for both delegates and their accompanying partners. Selected to showcase the best of Oxford and the surrounding county, the social programme includes a trip to the world famous Blenheim Palace, birthplace of Sir Winston Churchill, and tours of Oxford landmarks Christ Church and the Ashmolean museum, not to mention the famous Sunday Tour, gala dinner and golf and football tournaments.

Finally, the RADECS 2013 organising committee would like to thank all our sponsors whose support has enabled us to host what we hope will be a highly enjoyable and successful conference. On behalf of the RADECS 2013 organising committee, I hope you enjoy your time with us in Oxford and that you will leave with happy memories of a high class technical conference in impressive and friendly surroundings.

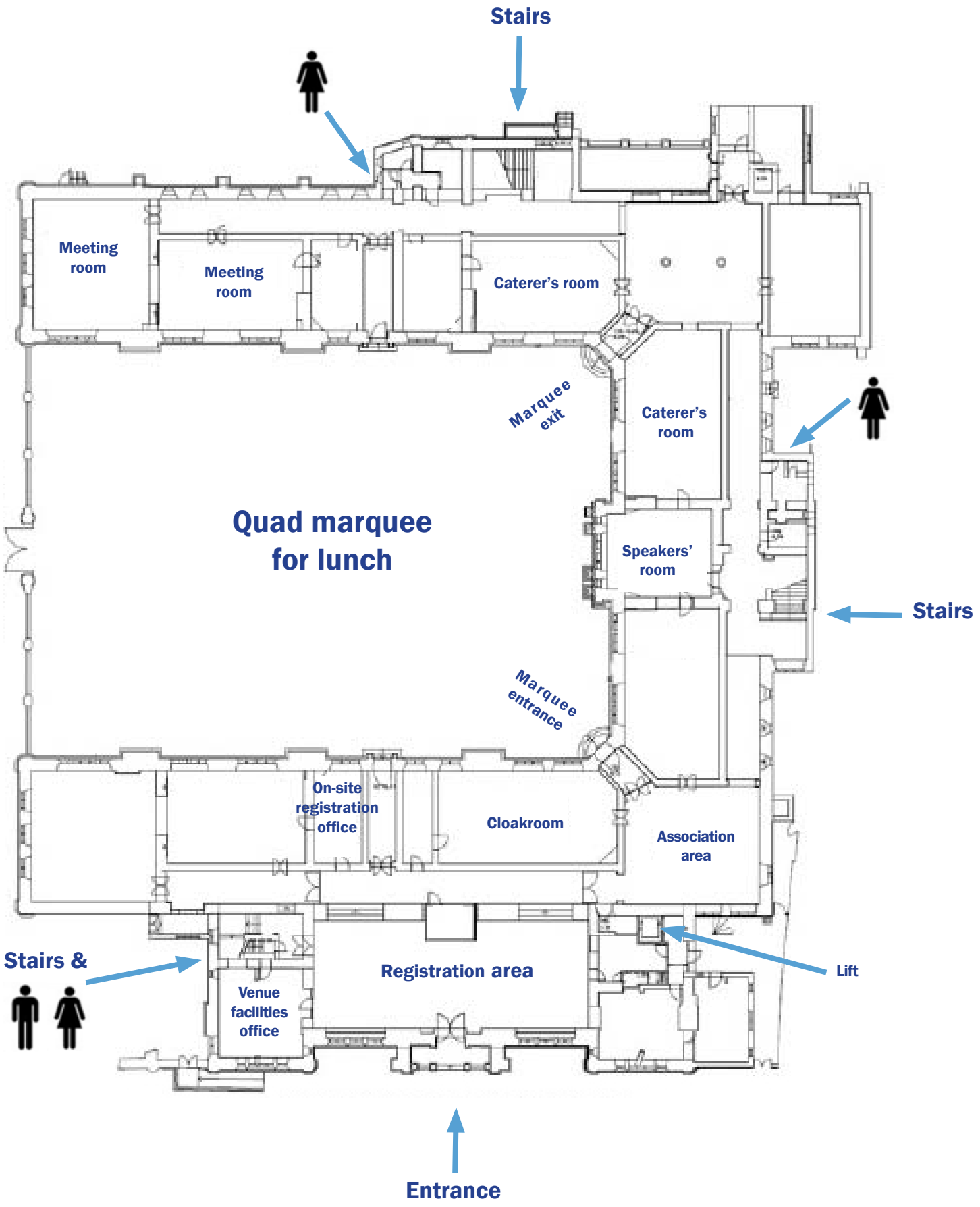
RADECS

Dr Richard Sharp
Conference Chairman, RADECS 2013

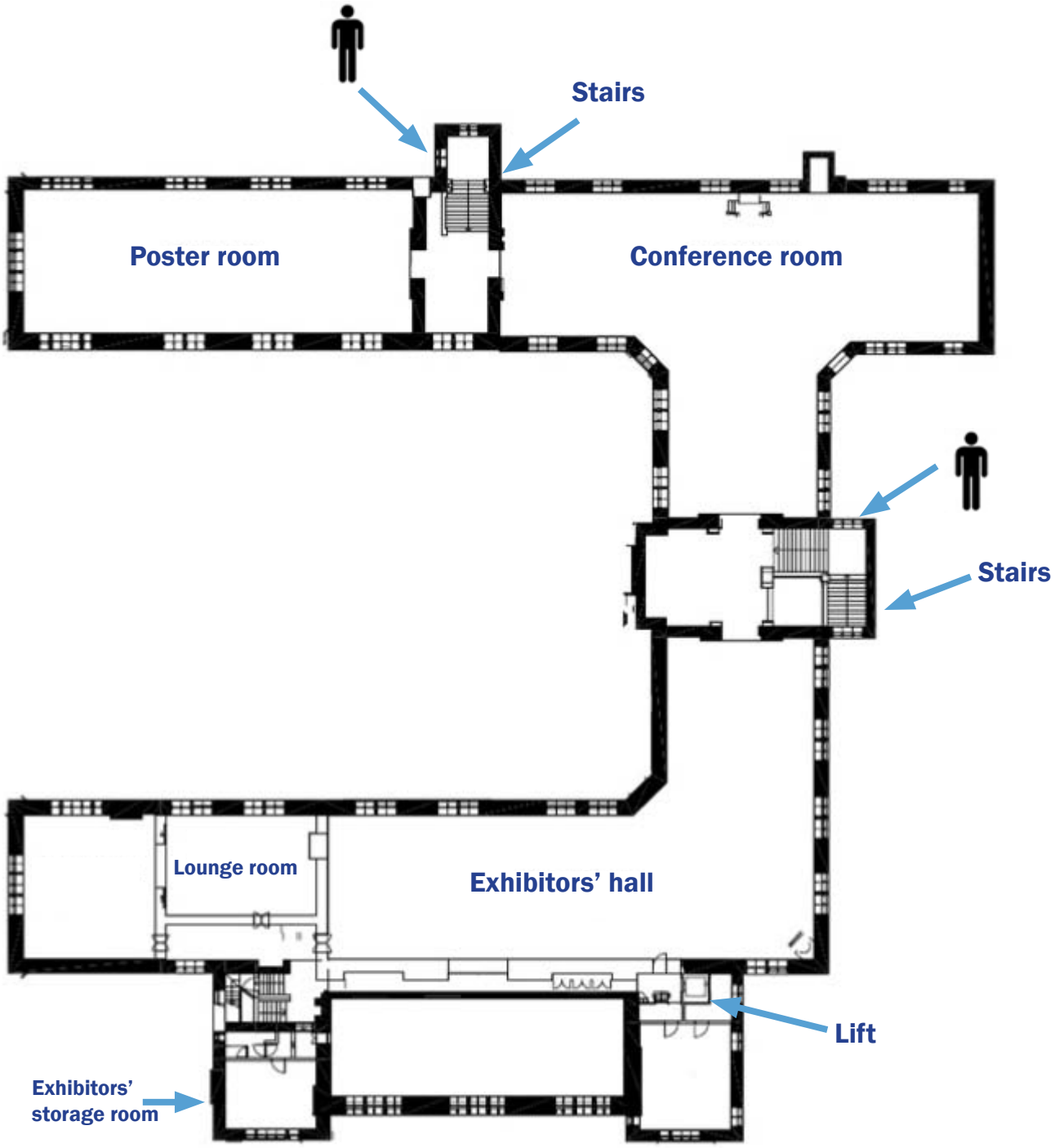
synergyhealth
our work protects your world

CONTENTS PAGE

CONFERENCE VENUE: GROUND FLOOR



CONFERENCE VENUE: FIRST FLOOR



PROGRAMME OVERVIEW

Short course | **Conference** | **Industrial exhibition**

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
07:30		**Short course registration**	**Conference registration**	**Conference registration**	**Conference registration**	
08:00						
08:30		**Introduction**				[08:30] Invited talk: Paul O'Brien
09:00	**Sunday tour to Stratford-upon-Avon**	[08:55] The Space Radiation & Plasma Environment	**Opening ceremony**	[09:00] Session C: Hardness by Design	[09:00] Session G: Radiation Effects in Electronic Devices	
09:30		[09:45] Radiation Interaction Physics and Simulation	[09:30] Session A: Basic Mechanisms			[09:30] Session I: Photonic Devices
10:00			**[10:20 - 10:50] Break**		**[10:20 - 10:50] Break**	
10:30		**Break**		**[10:50 - 11:20] Break**		**[10:35 - 11:05] Break**
11:00		[11:00] Total Ionizing Dose and Displacement Damage Effects	[10:55] Session B: Radiation Facilities and Dosimetry		Session G: Radiation Effects in Electronic Devices	[11:10] Session J: Hardness Assurance
11:30				[11:25] Session D: SEE Transients		
12:00		[11:50] Understanding Evolving Risks of Single Event Effects			[11:45] Session H: SEE Modelling	**[12:15] Closing ceremony**
12:30			**[12:30 - 14:00] Lunch**			
13:00		**[12:40 - 13:55] Lunch**		**[12:45 - 14:15] Lunch**	**[12:35 - 14:05] Lunch**	
13:30						
14:00		[14:00] Radiation Induced Charging Effects	[14:05] Invited talk: Brian Murray	[14:20] Session E: Laser SEE	[14:10] Invited talk: Clive Dyer	**Technical tours: RAL (Diamond/ISIS) or Culham (JET)**
14:30		[14:40] Radiation Testing and the Radiation Hardness Assurance Process				
15:00			**[15:05 - 15:30] Break**	**[15:05 - 15:35] Break**	**[15:10 - 15:40] Break**	
15:30		**Break**	[15:35] Data workshop	[15:40] Session F: Radiation Environments	[15:45] Poster session	
16:00		[15:55] Radiobiological Effects in the Aerospace Environment				
16:30		[16:35] Spacecraft Anomalies Associated with Radiation				
17:00						
17:30		**Closing remarks**	**Exhibitors' reception**		[17:30] RADECS association AGM	
18:00		**Welcome reception: Oxford Town Hall**		**Olde English pub crawl and walking tour**		
19:00					**Gala dinner: Balliol College**	
19:30						
20:00				**Bangers and mash meal**		
20:30						

RADECS 2013 ORGANISING COMMITTEE

Richard Sharp

Conference Chairman
Synergy Health plc

Rebecca Lomax

Event Organiser
Synergy Health plc

Andrew Chugg

Technical Chair
MBDA UK Ltd

Peter Truscott

Short Course Chair
Kallisto Consultancy Ltd

Awards chair
Jason Gow, Open University

Guest editor for IEEE TNS
Dan Fleetwood, Vanderbilt University

Guest editor for proceedings
Simon Platt, University of Central Lancashire

Technical visits
Chris Frost, ISIS Facility, STFC Rutherford Appleton Laboratory

Exhibition co-ordinators
Teresa Farris, Aeroflex
Shlomo Manheim, Peregrine Semiconductor

Honorary and advisory committee:

Honorary vice-chairman: Pascal Fouillat, RADECS 2012
Honorary vice-chairman: Vasily Anashin, RADECS 2015
RADECS Association liaison: Renaud Mangeret, Astrium
IEEE RESG liaison: Véronique Ferlet-Cavrois, ESA
IEEE TNS liaison: Paul Dressendorfer, IEEE and Sandia National Laboratories
IEEE/NPSS liaison: Harold Flescher, IEEE
Conference advisor: E.G. Stassinopoulos, NASA GSFC
Conference advisor: Ken Galloway, Vanderbilt University
Conference advisor: Jean Gasiot, IES/Université Montpellier 2
Conference advisor: Ron Schrimpf, Vanderbilt University

GENERAL CONFERENCE INFORMATION

Security

Please note that delegates are required to wear their RADECS 2013 name badges at all times. Badges will be inspected and any delegate who fails to produce their badge will be asked to leave the conference.

RADECS 2013 delegate badges are coloured coded to display the following categories:

Short course delegate:	**blue**
Short course presenter:	**beige**
Conference delegate:	**orange**
Session chair:	**gold**
Presenter (oral):	**silver**
Presenter (poster):	**dark grey**
Presenter (workshop):	**black**
Invited speaker / VIP:	**red**
Exhibitor:	**green**
Day exhibitor:	**yellow** (excluded from technical sessions, lunches and the gala dinner)
Organising committee:	**purple**
Conference volunteers:	**pink**

If you have registered for more than one category, your badge will display a colour coded sticker for the secondary category.

Registration desk

Registration is mandatory to access the RADECS 2013 conference and industrial exhibition.

Delegate registration times:

Sunday 22nd September:	**15:00 - 18:00**
Monday 23rd September:	**07:30 - 11:00 (short course delegates only)** **13:00 - 17:45**
Tuesday 24th September:	**07:30 - 17:00**
Wednesday 25th September:	**08:00 - 11:00**
Thursday 26th September:	**08:30 - 11:00**

Registered delegates

Delegates who have completed the online registration process are required to sign-in to collect their delegate bags and supporting material. Please have your booking confirmation details to hand and upon arrival, proceed to the corresponding alphabetical stand.

On-site registration

Those who have not pre-registered should go to the on-site registration office within the registration area. Please note that payment can be made by credit / debit card (excluding American Express) only and some of the included activities may be full.

Break-time refreshments

All break-time refreshments will be served in the exhibitors' room. A secondary serving station will also be available outside of the poster room.

Lunch

Lunch will be served in the quad marquee. Delegates are required to show their badges to gain entry to the marquee. Delegates who are not able to show their badge will be refused entry. Please note that due to capacity limitations we are unable to accommodate partners at lunch.

No seating plan will be enforced at RADECS 2013. However, there will be a reserved section each day for the exhibitors.

Dietary requirements

All those who entered a dietary requirement through the registration site will be provided with a colour coded card. Please ensure this is placed on the placeholder upon arrival at lunch and the gala dinner.

No-smoking policy

It is against the law to smoke inside venues in the UK and this is rigorously enforced in all RADECS 2013 venues.

Oral presenters

A downstairs meeting room has been assigned as an AV room for all oral presenters. Please ensure the final version of your presentation is provided to the AV technician by the following times:

Morning speakers: **last break of the day before presentation**
Afternoon speakers: **first break of the day**

Poster set-up times

Posters should be affixed in the poster room between 16:00 on Monday 23rd September and 15:30 on Tuesday 24th September.

Poster dismantling times

Posters must be removed by 14:00 on Friday 27th September. If not dismantled by this time they will be disposed of.

Internet access

Exhibitors will be provided with 2 complimentary Wi-Fi codes for the duration of the conference. A limited number of 24 hour Wi-Fi codes will be made available to delegates on a first come, first served basis. Wi-Fi codes can be collected from the on-site registration office after 10:30 each day.

Message board

A message board will be located near in the registration area. In the case of an emergency, please contact Rebecca Lomax, Event Organiser.

Meeting rooms

A limited number of meeting rooms are available for exhibitors and sponsors. Pre-booking is essential and can be arranged through the Event Organiser, located in the on-site registration office.

Social programme

All social activities will depart from the registration area in the Examination School (with the exception of the Sunday tour which will depart from the front of the building). Please ensure you are in the registration area at least 10 minutes before the departure time. Coach trips will depart promptly and refunds are not available for late arrivals. Drop-off times may vary due to tour end times and local traffic conditions.

Complimentary guided walk

For guests who have pre-registered we invite you to join us for a guided walk with Oxford's Town Crier. The guided walk will depart from the registration area at the following times:

Welcome reception: Monday 23rd September
Departure time: 17:45

Gala dinner: Thursday 26th September
Departure time: 18:40

Please ensure you are located in the registration area at least 5 minutes before the departure time.

Tourist information

A representative from the Oxford Visitor Information Centre will be based in the registration area at the following times:

Monday 23rd September: 10:30 - 13:00

Tuesday 24th September: 10:30 - 13:00

Wednesday 25th September: 10:30 - 13:00

Feedback forms

The RADECS 2013 organising committee sincerely hope you enjoy the conference. In order to obtain your thoughts and opinions, we would be grateful if you could complete the short survey included in your delegate bag and return to the survey collection box in the registration area.

Transport

Oxford is approximately 60 miles (90 km) northwest of London. This historical city is served by excellent transport links, with regular road, rail and coach services linking Heathrow, Gatwick, Luton and Birmingham airports.

Train

Oxford train station is regularly served by the main rail networks. Journey information can be accessed through National Rail Enquiries (www.nationalrail.co.uk) or by calling National Rail Enquiries on +44 08457 48 49 50.

Coaches

Oxford can be accessed by London Heathrow and Gatwick airport by The Airline Coach Service (www.oxfordbus.co.uk). National Express also provides regional transportation (www.nationalexpress.com). The Oxford Tube is a frequent coach service running from the London Victoria coach station to Oxford's Gloucester Green coach station, which is within walking distance of the Examination Schools and many of our hotels. Further details can be found at www.oxfordtube.com.

Driving

Travelling by car is not recommended in Oxford due to the lack of car parking spaces and expensive parking fees. However, as Oxford has some of the UK's best public transport (affordable and frequent) travelling around the city and beyond is pleasurable. Those wishing to drive are encouraged to use Oxford's park and ride (www.oxfordshire.gov.uk/cms/public-site/park-and-ride) which provides convenient travel into the centre of Oxford.

Taxi

Taxi ranks are located at Oxford train station, Gloucester Green coach station and St Giles' in the city centre:

ABC Taxis: +44 (0)1865 770077
City Taxis: +44 (0)1865 201201
Euro Taxis: +44 (0)1865 430430
Radio Taxis: +44 (0)1865 249743 or 242424

Cycling

As the UK's most cycle-friendly city, there are a range of companies providing bicycle hire throughout the city. The Oxford Tourist Information Centre recommends Bainton Bikes (www.baintonbikes.com) who are offering an exclusive 12% discount to RADECS 2013 delegates. To benefit from this, please quote '**RADECS 2013**' at the time of ordering.

Walking

Walking is a great way to experience Oxford and the Examination Schools, along with many of Oxford's main attractions are easily accessible on foot. Please note that Oxford is a historic city, with paved cobbles, therefore, walking in stiletto heals is not advised.

IMPORTANT CONTACT DETAILS

University of Oxford Examination Schools
75-81 High Street
Oxford
OX1 4BG

+44 (0)1865 276903

Emergency services (police, ambulance, fire):	999
John Radcliffe hospital:	+44 (0)1865 741166
Eastgate hotel:	+44 (0)1865 248332
Randolph hotel:	+44 (0)1865 256400
St. Edmund Hall college rooms:	+44 (0)1865 279000
Pembroke college rooms:	+44 (0)1865 276444
Oxford Town Hall:	+44 (0)1865 252195
Balliol College:	+44 (0)1865 277777
Rebecca Lomax, Event Organiser:	+44 (0)7720 497600

USEFUL INFORMATION

The currency for the UK is GBP (Great British Pounds, also known as Pound Sterling).

Banks and currency exchange

Banks open between the hours of 09:00 and 17:00 Monday to Friday. On Saturdays, banks usually close around 13:00. Banks do not open on Sundays. Some banks will 'price match' competitors' rates for currency, so it is wise to shop around.

Tipping

Tipping in the UK is more casual than in other countries and is usually only expected if you receive good service (legally, all UK staff must be paid at least a minimum wage, rendering tips as a welcomed extra rather than a necessity).

Restaurants

Tipping is optional, but expected in restaurants with table service. A 10% tip is the average. If a service charge is included in the bill, you do not need to tip, but can instead request for the charge to be removed and given to the waiting staff directly. You are not expected to tip if you order food at the counter (e.g. fast-food establishments etc), even if food is subsequently brought to your table.

Hotels

The tipping of around £2.00 is appreciated if a porter carries luggage for you. Hotel staff usually only receive a tip if they have provided exceptional service.

Taxis

Although tipping is not required, it is often custom practice to 'round' up the fare to the nearest whole amount.

Public transport

Tipping is not expected for public transport.

Guided tours

If you have been well looked after, a £1.00 - £2.00 tip per person is often appreciated.

Electrical sockets

Residential voltage in the UK is generally 230V. Most sockets will offer an 'on/off switch'. Sockets in bathrooms are sometimes used for the connection of shavers and toothbrushes only. The shaver unit may also have a 'type A' 115 V socket. Overseas visitors are reminded that they should bring the necessary plug adapters to be able to use their electrical equipment whilst in the UK and should seek professional assistance if they are unsure.

SPONSORS' SECTION

"The support provided by our sponsors has significantly contributed to your RADECS 2013 experience."

synergyhealth

Proud hosts of RADECS 2013

RADIATION EFFECTS SPECIALIST

INDUSTRY EXPERTS FOR OVER 30 YEARS

The assessment of radiation effects on materials and components normally considers several aspects of the radiation environment. **Synergy Health** offers test facilities for total dose, electrons and solar protons as follows:

- Total integrated dose: gamma radiation from cobalt-60 sources; dose rates from background to several kGy/hr, depending on sample size; in-situ monitoring, temperature control.
- Electron irradiation: from 1 to 20 MeV; doses from tens of Gy to MGy; in-situ monitoring; temperature control; sample handling by conveyor or static positioning under the beam (forced cooling required).
- Proton irradiation: from 0.5 to 10 MeV; irradiation in vacuum or air; in-situ monitoring, temperature control; ISO Class 7 (class 10,000) clean room available.

synergyhealthplc.com

Call now to talk to one of our in-house experts

+ 44 (0) 8456 88 99 70

Call now to talk to one of our in-house experts

+ 44 (0) 8456 88 99 70

Radiation is found in a wide range of applications, from nuclear and space, through to numerous industrial processes. Synergy Health specialist application service offers a range of tests for space radiation, including:

- Proton, Electron and Gamma irradiation facilities
- TID,SEE and planetary protection irradiation
- Mission planning assessments
- Other environmental factors (Vacuum, gases, heating, cooling)
- Comprehensive service and support

Visit us for more infomation at Booth 28

Applied Sterilisation Technologies sites can be located in:

GERMANY · UK · SWITZERLAND · HOLLAND · FRANCE
IRELAND · COSTA RICA · THAILAND · SOUTH AFRICA
USA · MALAYSIA

Visit us at Booth 6

Samples Available

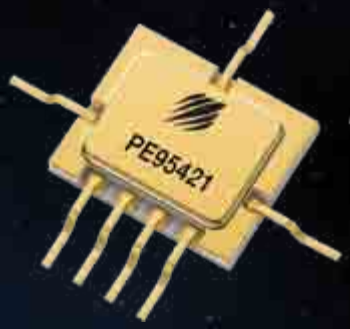
Ultra-Low Phase Noise Integer-N PLL

- Normalized phase noise floor figure of merit: -230 dBc/Hz
- Dual modulus prescaler: 10/11 to 5 GHz and 5/6 to 4 GHz
- Low power consumption of 80 mA @ 2.8 V

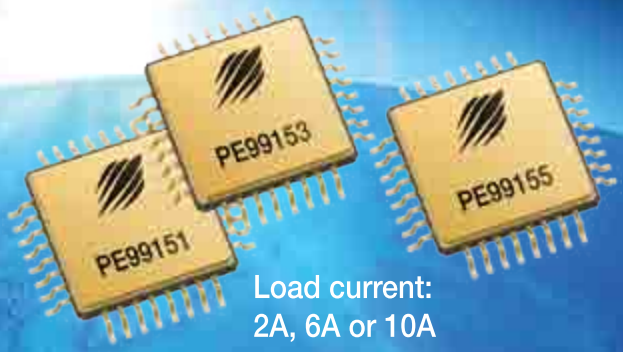
NEW

SPDT RF Switch

- Operates up to 8500 MHz
- 60 dBm IIP3, HaRP™ Technology enhanced
- 1.38 dB IL @ 8500 MHz
- 28 dB Isolation @ 8500 MHz

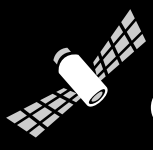


Monolithic Point-of-Load DC-DC Buck Regulators



Load current:
2A, 6A or 10A

- SEE tolerant to LET >90 MeV•cm²/mg
- 93% peak efficiency
- Input voltage: 4.6 - 6V
- Output voltage: 3.6 - 1V



Contact Us

Pricing and samples: SalesHiRel-EU@psemi.com
Marketing and applications assistance: hi-rel@psemi.com

PeregrineSemiconductor

About AWE

AWE is a centre of scientific and technological excellence, with some of the most advanced research, design and production facilities in the world and we play a crucial role in the defence of the UK. AWE is home to the UK's nuclear deterrent where we build and maintain warheads for Trident, a submarine-launched ballistic missile. The company has been at the forefront of the UK nuclear deterrence programme for more than 60 years, delivering to UK Government, providing innovative solutions to national nuclear security and supporting Continuous At Sea Deterrence (CASD).

Delivering excellence
Shaping the future

AWE Aldermaston

AWE Burghfield

AWE is contracted to the Ministry of Defence (MOD) through a Government-Owned-Contractor-Operated (GOCO) arrangement. While our sites and facilities remain in government ownership, their management, day-to-day operations and the maintenance of Britain's nuclear stockpile is contracted to a private company: AWE Management Limited (AWE ML). AWE ML is a consortium comprising three equal partners: Jacobs Engineering Group, Lockheed Martin Corporation & Serco Group plc.

AWE is an exciting place to work, with many opportunities across science, engineering and technology. Building on our international recognition, we employ scientists and engineers of world renown, and achieving the highest standards in everything that we do is at the very heart of our vision.

Our Strategic Goals

Delivering excellence
Shaping the future

Unique opportunities in a truly unique environment

Science | Engineering | Technology

Competitive package & benefits, including final salary pension, nr Reading, Berks

Tasked with supporting the UK's nuclear deterrent and protecting national nuclear security, AWE is a unique working environment. As one of Britain's largest high technology research and development facilities, our expertise, our people and the work we do are truly innovative and world class.

With exacting standards to maintain, we employ only the brightest minds across various disciplines. So if you're a recently qualified or experienced scientist, engineer or technologist looking for your next challenge, you need not look any further.

As well as the opportunity to continually develop your career, you can expect a superb benefits package that includes 28 days' holiday and a final salary pension.

Ours is a committed approach to excellence. If it's one you share, find out more about the roles on offer at www.awe.co.uk. AWE promotes diversity in employment. We welcome applications from women and men, regardless of disability, sexual orientation, racial or ethnic origin, or age. Applications from women and ethnic minorities are particularly encouraged. Successful candidates will be selected solely on their ability to carry out the duties of the post.

Because of the nature of work associated with these posts, they are subject to special nationality rules and are open only to British citizens. All selected candidates will be required to undergo security clearance.

awe.co.uk

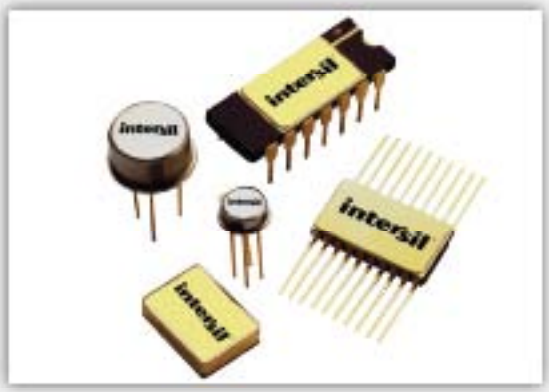
Intersil Corporation

Intersil Corporation is a leading provider of innovative power management and precision analog solutions.

1001 Murphy Ranch Road
Milpitas, CA 95035
tel: 408-432-8888
1-888-INTERSIL
fax: 408-434-5351

Who is Intersil?

- 40+ years supplying high-reliability ICs into space and defense applications
- Experts in high-efficiency power management
- Over 40 diverse product families
- Headquartered in Milpitas, CA
- Design centers in N.A. and U.K.
- Sales locations around the globe



Intersil's Space Solutions

- ~300 space-qualified radiation hardened products available.
- Consistent design and manufacturing in Intersil's MIL-PRF-38535-qualified facility located in Palm Bay, Florida.
- Intersil is one of only 15 RHA Defense Logistics Agency (Land and Maritime) QML suppliers.
- All products are fully Class V (space level) compliant.
- All products are on individual DLA SMD drawings.

Intersil's Approach to Radiation Environments in Space

TID (Total Ionizing Dose)

TID is the progressive, long-term ionizing radiation damage caused by protons, electrons and other sources. Total ionizing dose testing of semiconductor components has historically been performed at 'qualification' dose rates in the 50 - 300rad(Si)/s. Modern sub-micron technologies tend to be more resistant to total dose effects.

Intersil's approach: TID hardness is tested and guaranteed on a wafer by wafer basis to MIL-STD-883 Method 1019 using an in-house Gammacell 220™ ^{60}Co irradiator. This is now done at both high dose rates (50rad(Si)/s) and low dose rates (0.01rad(Si)/s).

SEE (Single-Event Effects)

The intense heavy ion environment encountered in space applications can cause a variety of effects in electronic circuitry, including Single-Event Transient (SET), Single-Event Latchup (SEL) and Single-Event Burnout (SEB). These Single-Event Effects (SEE) can lead to system-level performance issues including disruption, degradation and destruction.

Intersil's approach: SEE characterizations are performed at Texas A&M and complete reports can be found at **www.intersil.com** Rad Test Reports

Rad Hard Linear Regulation
ISL75052SEH

Eval Board Available! SPICE MODEL Available!

1.5A, Rad Hard, Positive, High Voltage LDO

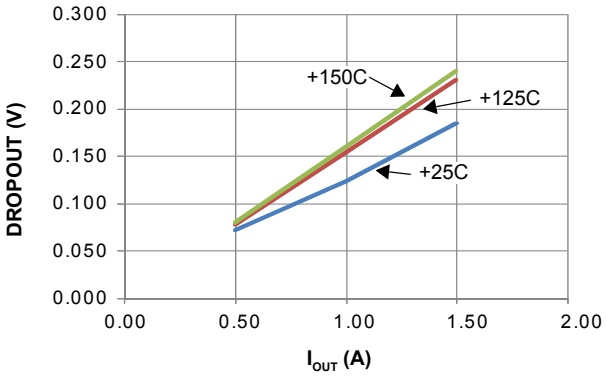
The ISL75052SEH is a radiation hardened, single output LDO specified for an output current of 1.5A. The device operates from an input voltage range of 4.0V to 13.2V and provides for output voltages of 0.6V to 12.7V. The output is adjustable based on a resistor divider setting. Dropout voltages as low as 75mV (at 0.5A) typical can be realized using the device. This allows the user to improve the system efficiency by lowering V_{IN} to nearly V_{OUT}.

Key Features

- Radiation Environment
  - High Dose Rate (50-300rad(Si)/s) ..... 100krad(Si)
  - Low Dose Rate (0.01rad(Si)/s) ..... 100krad(Si)*
  - SET/SEL/SEB ..... 86MeV.cm^2/mg
- Input Supply Range 4V to 13.2V
- Best in Class Accuracy ±1.5%
- Ultra Low Dropout:
  - 75mV Dropout (typ) @ 0.5A
  - 225mV Dropout (typ) @ 1.5A
- Noise of 100µV_{RMS} (typ) between 300Hz to 300kHz
- SET Mitigation with No Added Filtering/Diodes
- Shutdown Current of 165µA (typ)

*Level guaranteed by characterization; "EH" version is production tested to 50 krad(Si).

Ultra Low Dropout



DROPOUT vs I_{OUT}

Rad Hard Op Amp
ISL70444SEH

Eval Board Available! SPICE MODEL Available!

19MHz Rad Hard 40V Quad Rail-to-Rail Input - Output, Low-Power Op Amps

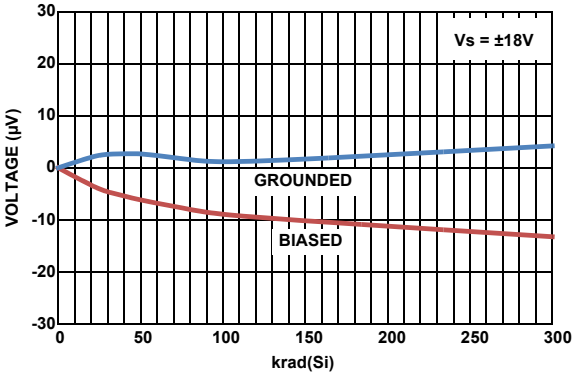
The ISL70444SEH features four low-power amplifiers optimized to provide maximum dynamic range. These op amps feature a unique combination of rail to rail operation on the input and output as well as a slew enhanced front end that provides ultra fast slew rates positively proportional to a given step size; thereby increasing accuracy under transient conditions, whether it's periodic or momentary. They also offer low power, low offset voltage, and low temperature drift, making it ideal for applications requiring both high DC accuracy and AC performance.

Key Features

- Radiation Effects
  - High Dose Rate (50-300rad(Si)/s) ..... 100krad(Si)
  - Low Dose Rate (0.01rad(Si)/s) ..... 100krad(Si)*
  - SEL/SEB LET_{TH} ..... 86.4 MeV•cm^2/mg
- Acceptance Tested to 50krad(Si) (LDR) Wafer-by-wafer
- <5µs Recovery from SEE (LET_{TH} = 86.4MeV•cm2/mg)
- Unity Gain Stable
- Rail-to-rail Input and Output
- Wide Gain·Bandwidth Product.....19MHz
- Wide Single and Dual Supply Range.....2.7V to 40V Max
- Low Input Offset Voltage 300µV

*Level guaranteed by characterization; "EH" version is production tested to 50 krad(Si).

Offset Voltage Over Radiation



V_{OS} vs HIGH DOSE RATE RADIATION

intersil™

TECHNICAL PROGRAMME

“The 2013 technical programme aims to bring you the latest radiation effects developments.”

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE)

Radiation Effects: Understanding the Evolving Risk for New Technologies and New Environments

08:45 **Short Course introduction**
Pete Truscott (Kallisto Consultancy Limited, UK)

08:55 **Session 1: The Space Radiation and Plasma Environment**
Paul O'Brien & Joe Mazur (Aerospace Corporation, USA)

09:45 **Session 2: Radiation Interaction Physics and Simulation**
Giovanni Santin (ESA/ESTEC, The Netherlands and Rhea Tech Ltd)

10:35 **Break**

11:00 **Session 3: Total Ionizing Dose and Displacement Damage Effects in Embedded Memory Technologies**
Hugh Barnaby (Arizona State University, USA) & Matt Marinella (Sandia National Laboratories, USA)

11:50 **Session 4: Understanding Evolving Risks of Single Event Effects**
Jean-Luc Autran & Daniela Munteanu (Aix-Marseille University & CNRS, IM2NP Laboratory, France)

12:40 **Lunch**

14:00 **Session 5: Radiation Induced Charging Effects on Spacecraft**
Keith Ryden (Surrey Space Centre, University of Surrey, UK)

14:40 **Session 6: Radiation Testing and the Radiation Hardness Assurance Process**
Renaud Mangeret (Astrium SAS, France)

15:30 **Break**

15:55 **Session 7: Radiobiological Effects in the Aerospace Environment**
Christine E Hellweg, Günther Reitz & Christa Baumstark-Khan (German Aerospace Center (DLR), Germany)

16:35 **Session 8: Spacecraft Anomalies Associated with Radiation**
Robert Ecoffet (Centre National d'Etudes Spatiales (CNES), France)

17:25 **Closing remarks**
Pete Truscott (Kallisto Consultancy Limited, UK)

17:35 **Short Course ends**

Welcome reception, Oxford Town Hall 18:00 - 20:00

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE SUMMARY)

This one day course provides an overview of our understanding of the radiation and plasma environments and their effects on spacecraft and humans. The material is aimed at newcomers who want to learn about space radiation/plasma effects, as well as established experts within the field wishing to acquaint themselves with topics they are less familiar with.

The year's short course addresses the particular challenges of using state-of-the-art (SOTA) microelectronics and instruments in space, and also treating the more severe environments expected, including within Earth MEO and at Jupiter. The material, presented by highly experienced instructors and experts, includes reviews of our basic understanding of the phenomena and physical processes, relevant models and practical experience on the primary environment, treatment of radiation interactions and shielding, cumulative (ionising and non-ionising) damage in SOTA memories and single event effects. Charging phenomena and radiobiological effects are topics not usually treated by RADECS, but are highly important and covered here in separate talks. The radiation hardness assurance process is described from the industry perspective, and historic evidence of spacecraft radiation- and plasma-induced anomalies reviewed.

Attendees will be provided with a short course notebook to accompany and expand upon the presentation material, and which is intended to act as a practical reference for attendees.

Pete Truscott, Short Course Chairman

Pete Truscott received his BSc in physics from the University of Bristol in 1985, and joined the Radiation Environment and Effects team at the Royal Aircraft Establishment, Farnborough (later becoming DERA and then QinetiQ). From the beginning, his work included the development and application of 3D energetic particle simulation models (e.g. HETC, EGS) to shielding analysis for spacecraft, and particularly the study of induced radioactivity in sensors during spaceflight. In 1997, he received his PhD from the University of London for his work on induced radioactivity in space-borne BGO detectors. He has led numerous radiation model-development and analysis projects, mainly applying Geant4 and other detailed models to simulate spacecraft radiation effects, planetary radiation environments (e.g. for Mars, Earth, Ganymede) and micro-dosimetry effects in semiconductors. In 2012, Pete set up Kallisto Consultancy and continues to lead and support research and software development projects on radiation modelling.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 1: The Space Radiation and Plasma Environment

Paul O'Brien & Joe Mazur (Aerospace Corporation, USA)

This first course covers the space radiation environment, with emphasis on topics relevant to space system design and operation for near-Earth missions. The particle environments covered include energetic plasmas, trapped electrons, trapped protons, solar energetic particles, and galactic cosmic rays. For each topic we describe the location, phenomenology, effects, design specification approaches, operational considerations, and areas of active research. We also discuss small sensors designed to provide situational awareness and support further improvement of design specifications. We show that new orbits, new materials, and new technologies drive a need for continued improvement in models and sensors to support space system design and operation. We also discuss concerns about a growing mismatch between the priorities of scientific researchers and the satellite design and operations communities.

Paul O'Brien is a research scientist in the Space Sciences Department at The Aerospace Corporation. He holds a BA degree in Physics and Classics from Rice University, and MS and PhD degrees in Earth and Space Science from the University of California, Los Angeles. He has over 15 years of experience in space science and the effects of the charged particle environment on space systems. His research experience includes magnetospheric physics, with special emphasis on radiation belts and empirical analysis of in situ particle data. He is one of the lead developers of the AE9/AP9 radiation specification models. He is the chair of the COSPAR Panel on Radiation Belt Environment Modeling (PRBEM).

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 2: Radiation Interaction Physics and Simulation

Giovanni Santin (ESA/ESTEC, The Netherlands and Rhea Tech Ltd)

A review will be provided of modelling techniques for transporting the external radiation through a spacecraft's structure and systems up to the sensitive components (e.g. sensors or microelectronic circuits) and for the interactions therein. The first portion will be devoted to describing the relevant physical interaction processes and related basic terminology. Methods of modelling for rapid engineering assessment purposes as well as detailed analyses will then be described, by providing an overview of current techniques and tools for simulation that are available for transport modelling and radiation effect calculation. These include 1-D approximations, classic and advanced algorithms for ray tracing, and forward and adjoint full 3-D Monte Carlo simulations. The discussions will include uncertainties and their implications on engineering margins. In addition, potential mitigation strategies will be described, especially in MEO and Jupiter environments, and for interplanetary exploration missions.

Giovanni Santin received his Bachelor's and his PhD degrees in physics from the University of Trieste, Italy. He worked at CERN (for the University of Geneva) and the University of Lausanne, before joining the European Space Agency in 2002 as a consultant from RHEA Tech Ltd, and is currently an analyst in the Space Environments and Effects Analysis section of ESA/ESTEC. Giovanni's current research interests are in the development and use of radiation environment models, radiation effects modelling for manned and unmanned missions, radiation effects analysis engineering tools and monitors. He is a specialist in radiation transport codes for Monte-Carlo simulations. His work has supported the ESA Cosmic Vision mission to Jupiter, including radiation assessments and countermeasures against the harsh particle environment. He is responsible also for several contracts aimed at improved spacecraft radiation effects predictions, and at making advanced Geant4-based physics and analysis techniques available and viable in engineering environments.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 3: Total Ionizing Dose and Displacement Damage Effects in Embedded Memory Technologies

Hugh Barnaby (Arizona State University, USA)
& Matt Marinella (Sandia National Laboratories, USA)

This course reviews the fundamental threats posed by cumulative radiation damage to solid state materials and devices used in embedded memory. The technologies considered include traditional volatile memory (SRAM and DRAM), non-volatile flash, as well as new non-volatile memories such as phase change (PCRAM), spin transfer torque magnetic RAM (STT-MRAM), and resistance switching RAM (ReRAM). For traditional memory, which is based on charge-based MOS devices, the fundamental mechanisms of ionizing radiation effects from radiation absorption to defect buildup in gate and isolation dielectrics are described. An overview is provided of the mechanisms of displacement damage and vacancy generation in semiconductors and new ion transport materials. The effects of ionising radiation on charge-based devices and memory architectures are then discussed. In the final section, we review much of what is known today regarding the effects of both TID and displacement damage in resistance change memory.

Hugh J Barnaby has served as an active researcher in radiation effects for over 20 years in both industry and academia. He received a BA in Mathematics and Philosophy from UC Berkeley in 1992. In 1996, Hugh entered the graduate program in electrical engineering at Vanderbilt University, specializing in device physics and radiation effects. He received his MSE and PhD in 1999 and 2001 and joined Arizona State University, becoming a member of the university faculty in 2004. His primary research focuses on the analysis, modelling, and experimental characterization of extreme environment effects in semiconductor materials, devices and integrated circuits. Hugh also has on-going research activities in wireless (RF and optical) IC and data converter design, radiation- and reliability-enabled compact modelling, and memory technologies and applications. Hugh is a Senior Member of IEEE and has presented and published more than 100 papers.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 4: Understanding Evolving Risks of Single Event Effects

Jean-Luc Autran & Daniela Munteanu (Aix-Marseille University & CNRS, IM2NP Laboratory, France)

This short-course surveys the status of recent research work in the domain of single event effects (SEE) in advanced CMOS technologies, such as fully depleted silicon-on-insulator (FD-SOI), FinFET, tri-gate or multi-gate configurations based on ultra-thin films or nanowire channels. This review primarily focusses on our understanding of the evolving risks related to SEE in such a “More Moore” roadmapping effort. Some important key-points are presented and discussed, including: the critical charge and ion-track spatial structure vs. device feature sizes, the impact of variability on SEE, the increasing sensitivity to background radiation (including the emerging issues of cosmic-ray-induced terrestrial muons, and alpha-particles from contamination), the emergence of new physical mechanisms in advanced technologies (e.g. bipolar amplification). Finally, the review briefly discusses the SEE sensitivity of a few “More than Moore” CMOS solutions envisaged for 3D integration of future circuits.

Jean-Luc Autran received a MS degree in Materials Science and Engineering and a PhD degree in Electrical Engineering from the Institut National des Sciences Appliquées de Lyon (INSA-Lyon) in 1992 and 1994, respectively, and the HDR Diploma from the Université Claude Bernard Lyon-1 in 1999. After working at CEA, he was an Assistant Professor at INSA-Lyon from 1996 to 2000, and from 2000, has been a Professor with Aix-Marseille Université. In 2003, he was appointed a Member of the Institut Universitaire de France (IUF). He is currently the Principal Investigator of the Altitude SEE Test European Platform (ASTEP) platform and his research interests include the characterization, modelling, and numerical simulation of Single Event Effects (SEE) in advanced CMOS technologies and particularly the physics of soft errors. Jean-Luc is the author or co-author of more than 250 papers, 15 invited conference papers, and 11 book chapters. He is a Senior Member of the IEEE and Fellow of the SEE.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 5: Radiation Induced Charging Effects on Spacecraft

Keith Ryden (Surrey Space Centre, University of Surrey, UK)

The interactions of space plasmas and radiation with spacecraft materials can give rise to significant electrostatic charging effects. Such processes occur on external surfaces due to low energy plasma particles and also within the interior of satellites due to higher energy radiation particles. In this course a review is provided of the underlying physical interactions leading to surface and internal charging and the historical development of the discipline illustrated by in-orbit experiences. For internal charging a more detailed review is provided of the mechanisms, the applicable environments, conductivity processes, thermal effects, electrostatic breakdowns, in-orbit measurements, test facilities and mitigation approaches. Radiation-induced charging effects for Jupiter missions are also introduced and, finally, future challenges in the field are described. This presentation includes a live demonstration of a 'deep dielectric discharge'.

Keith Ryden obtained a First Class Honours Degree from the University of Bath in 1986 and started work at the Royal Aircraft Establishment (RAE), Farnborough, in 1986. He completed an MSc Degree at the University of Surrey in 1988. Keith transferred to the partially- and later fully-privatised bodies which succeeded RAE, namely DERA and QinetiQ and became Leader of the Radiation Environment and Effects group, and later in 2007, was appointed a QinetiQ Fellow. Keith is currently a Reader in Space Engineering at the University of Surrey Space Centre. His work has focussed on the engineering effects of radiation environments on satellites (and aircraft) and on radiation-induced charging effects in particular. He has led several satellite anomaly investigations and the development of radiation monitors (SURF, Merlin, etc). Amongst several committee responsibilities, Keith has recently been a member of the Royal Academy of Engineering study on the possible impact of a 'Carrington Event' solar storm on UK infrastructure.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 6: Radiation Testing and the Radiation Hardness Assurance Process
Renaud Mangeret (Astrium SAS, France)

The Radiation Hardness Assurance (RHA) process for a spacecraft project has to adequately address: the approach to follow for calculating radiation levels; the radiation design margins (RDM) to apply for the different effects; determination of radiation sensitivities of components, and where existing test data may be used; and the requirements for conducting radiation tests. This course discusses the RHA process and looks at the activities and decisions to be taken from the proposal phase through to preliminary and detailed design phases. The material presented is both from the prime contractor and equipment supplier perspectives, and also discusses the differing approaches which may be taken for "one-of-a-kind" satellite projects compared to recurring satellite production lines. The close relationship between the RHA process and the need for test data is highlighted, and this course will discuss the approaches to (and challenges associated with) TID, displacement damage and SEE testing.

Renaud Mangeret received his PhD in electronics from the Paul Sabatier University, Toulouse (France) in the Materials and Components for Electronics Department in 1992. He then worked at the IBM Almaden Research Center, California, as a visiting scientist working on non-linear optics (NLO) polymers. From 1993-1995 Renaud worked at Giat Industries, Toulouse as a research and development engineer. Since 1995 Renaud has been the radiation specialist at Matra Marconi Space/EADS Astrium SAS, Toulouse, and since 2010 has been the Head of Radiation for Astrium France and Astrium'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.

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 7: Radiobiological Effects in the Aerospace Environment

Christine E Hellweg, Günther Reitz, & Christa Baumstark-Khan
(German Aerospace Center (DLR), Germany)

Human spaceflight carries with it the risk of acute radiation syndrome (including gastrointestinal effects, suppression of haematopoiesis, and neurological damage) due to a large solar particle event, and the risk of cancer and cataracts from long-term (chronic) radiation exposure in orbit or interplanetary space. Energetic GCR heavy ions are of major consideration for cancer risk because of their high relative biological effectiveness, and these cause complex DNA damage that is difficult to repair by the cell's enzyme machinery. This course will review our current understanding of radiobiological effects for astronauts. Discussions will include the methods of routine dosimetry to more complex analysis of depth-dose distribution in humans by means of the human phantoms (MATROSHKA). The challenges for future interplanetary spaceflight compared to flights on International Space Station are discussed, as well as radiation mitigation measures which might be employed. Synergistic effects, from the combined radiation field and other aspects of the artificial environment on spacecraft, are also discussed.

Christine Hellweg (2001 PhD in veterinary medicine, 2012 Habilitation at the "Freie Universität Berlin", Germany) is research scientist in the department of Radiation Biology of the Institute of Aerospace Medicine at the DLR in Cologne, Germany. She is the Principal Investigator of several experiments at the French heavy ion accelerator GANIL in Caen, and is currently involved in the preparation of the space experiment CELLRAD. Her major research interests are the biological effects of radiation and other environmental stressors at the cellular and molecular level: gene expression and signal transduction in mammalian cells, DNA damage and repair, apoptosis and cell cycle control, and molecular bone metabolism under conditions of space flight. Since 2009, Christine has coordinated the Helmholtz Space Life Sciences Research School (SpaceLife) which offers up to 25 students per generation an interdisciplinary doctoral training programme. Since 2011, she is "Corresponding Member" of the International Academy of Astronautics (IAA).

TECHNICAL PROGRAMME - MONDAY (SHORT COURSE PRESENTERS)

Session 8: **Spacecraft Anomalies Associated with Radiation Effects**
Robert Ecoffet (Centre National d'Etudes Spatiales (CNES), France)

Spacecraft anomalies due to radiation effects on electronic devices have been observed since the very beginning of the space era. Today, they represent a major portion of the observed on-board anomalies, mission outages and unexpected operational workload on mission ground controllers. Within this course, we will first describe a sample of known cases of cumulative or transient effects in both Earth or planetary environments. Then, we will discuss investigation methodologies, and issues such as the statistical aspects of probabilistic anomalies in the assessment of cause-to-effects relationships, and the necessity of multi-field experts group root cause analysis, from radiation effects to satellite fault determination, identification and reconfiguration strategy. A focus on some practical cases of anomaly analysis will be made. Finally, brief considerations on the helpfulness of on-board environment and radiation effects monitoring will be provided.

Robert Ecoffet received his degree in electrical engineering from the Ecole Supérieure d'Electricité engineering school, Paris, France, in 1987 and a MS degree in electronic properties of materials from the University of Paris-VI, in 1987. He joined the Centre National d'Etudes Spatiales (CNES), French space agency, in 1989 and worked for ten years in radiation testing, radiation effects R&D, development of radiation facilities, and development of in-flight radiation monitors and technology experiments. In 1999 he became head of the radiation effects department at CNES. Since 2003, he has been a senior expert in space environment and effects at CNES, where he coordinates the space environment (radiation, charging, materials, contamination, debris) R&D axis, gives training courses, participates in European working groups and international collaborations. He has authored or co-authored over 100 papers in radiation effects and on the radiation environment. He is also currently Secretary of the RADECS Association Steering Group.

TECHNICAL PROGRAMME - TUESDAY

08:00 **Registration**

09:00 **Opening ceremony**

- **Dr Richard Sharp, RADECS 2013 Conference Chairman, Synergy Health plc**
- **Dr Adrian Coward, CEO, UK and Ireland, Synergy Health plc**
- **Professor Andrew Hamilton, Vice Chancellor, University of Oxford**
- **Andrew Chugg, RADECS 2013 Technical Chair, MBDA UK Ltd**
- **Philippe Calvel, President, RADECS Association, Thales Alenia Space**

Session A: Basic Mechanisms of Radiation Effects

Chairs:

- **Ron Schrimpf, Vanderbilt University**
- **V S (Slava) Pershenkov, National Nuclear Research University MEPHI**

09:30 **Session A introduction**

A-1 **Ion-Induced Charge-Collection Transients in p-channel AlGaSb/InGaSb Field Effect Transistors**

09:35 J. Warner [1], D. McMorrow [1], S. Buchner [1], J.B. Boos [1], B. Bennett [1], C. Cress [1], J. Champlain [1], P. Paillet [2], M. Gaillardin [2]

[1] Naval Research Laboratory, [2] CEA

Ion-induced, time-resolved charge-collection measurements for p-channel AlGaSb/InGaSb field-effect transistors are reported. The data reveal charge enhancement processes, the dynamics of which are associated with the trapping and de-trapping of electrons.

A-2 **Follow-up Multicenter Alpha Counting Comparison**

09:50 J. Wilkinson[1], C. Brett, R.Wong [3], C. Slayman [3], B. Carroll [4], M.Gordon [5], Y. He [6], K. Lepla [7], J. Marckmann [8], B. McNally [9], T. Wu [10]

[1] Medtronic, Inc., [2] Honeywell, [3] Cisco Systems, [4] Freescale Semiconductor, [5] IBM, [6] Intel, [7] Teck Metals, Ltd, [8] Medtronic, Inc, [9] XIA LLC, [10] SGS

A follow-up alpha emissivity study to examine causes of previously reported errors demonstrates a small effect from discriminator threshold and substantial systematic errors. Accurate alpha metrology continues as a concern for electronics reliability.

A-3 **Influence of X-ray radiation on standard and uniaxial strained triple-gate SOI FinFETs**

10:05 C. Bordallo [1], M. Silveira [2] , P. Agopian [2]

[1] Centro Universitario da FEI, [2] University of Sao Paulo & Centro Unive

In this work, X-ray radiation influence on the digital and analog parameters of triple gate FinFETs was studied, considering two different splits: unstrained and uniaxial strained.

Break 10:20 - 10:50 in the exhibitors' hall

Poster session: Thursday 26th September 15:40 - 17:30

PA-1 **Neutron irradiation effects on the structural properties of KU1, KS-4V and I301 silica glasses: coupling ab initio simulation and experiments**

M. Leon [1], L. Giacomazzi [2], S. Girard [3], N. Richard [4], P. Martin [5], L. Martin-Samos [6], A. Ibarra [5], P. Paillet [4], A. Boukenter [7], Y. Ouerdane [7]

[1] Laboratoire Hubert Curien, [2] CNR-ION DEMOCRITOS, [3] Laboratoire Hubert Curien, [4] CEA, DAM, DIF, [5] CIEMAT, [6] Materials Research Laboratory, University of Nova Gorica, [7] Laboratoire Hubert Curien

In this work we have studied the effects of high neutron fluences and gamma doses on the structural properties of KU1, KS-4V and I301 silica glasses, comparing experimental results and *Ab initio* simulations.

PA-2 **Temperature Dependence of Single Event Upset in Bulk and SOI Technologies**

L. Tianqi [1], L. Jie [1], Z. Zhangang [1], G. Chao [1]

[1] Institute of Modern Physics, Chinese Academy of Sciences

Under the different deposited energy, the SEU sensitivity both in bulk and SOI technologies displays a different temperature dependence. This phenomenon is attributed to the temperature dependence of the transient pulse shape.

PA-3 **Microdose Induced Drain Leakage Effects in Power Trench MOSFETs: Experiment and Modelling**

G. Zebrev [1], R. Useinov [2], A. Vatuev [2], V. Emeliyanov [2], V. Anashin [3], M. Gorbunov [4], V. Turin [5]

[1] NRNU MEPHI, [2] Research Institute of Scientific Instruments, [3] JSC Institute of Space Device Engineering, [4] Scientific Research Institute of System Analysis, [5] Orel State University

Analytic quantitative model and experimental results are presented and applied to the problem of microdose-induced current leakage in trench power MOSFETs aimed at calculation of survival probability in space heavy ion environment with high LETs.

Session B: Radiation Facilities & Dosimetry

Chairs:

- **Simon Platt, University of Central Lancashire**
- **Chris Frost, ISIS Facility, STFC Rutherford Appleton Laboratory**

10.55 **Session B introduction**

B-1 **Use of Laser-Plasma-Accelerators for Advanced Reproduction of Space Radiation in the Laboratory**

11:00 B. Hidding [1], O.Karger [1], T. Königstein [2] , G. Pretzler [2], Q. Chen [1], N. Alexander [1], S. Schiller [1], J.Rosenzweig [3], V. Ferlet-Cavrois [4], A. Costantino [4], M. Muschitiello [4], E. Daly [4]

[1] Institute of Experimental Physics, [2] Institute of Laser and Plasma Physics, [3] Department of Physics and Astrophysics, [4] ESA ESTEC

For the first time, a laser-plasma-accelerator has been used for reproduction of space radiation and radiation effects testing. The results of proof-of-concept experiments and the strategy to establish this novel radiation source are presented.

B-2 **Characterization of a floating-gate radiation sensor for X-ray dose detection**

11:15 E. Isern [1], M. Roca [1], E. Garcia-Moreno [1] , J.C. Font [2], A. Pineda [3]

[1] Universitat de les Illes Balears, [2] Son Espases Hospital, [3] IC-Málaga

An ionizing radiation sensor based on a floating-gate capacitor with output in current mode has been tested as X-ray dose monitor for radiotherapy applications. Sensor sensitivity to ambient temperature and supply voltage has been measured.

B-3 **HMRM: A Highly Miniaturised Radiation Monitor as engineering tool supporting satellite design**

11:30 S. Gunes-Lasnet [1], D. Griffin [1], R. Turchetta [1], N. Guerrini [1], S. Woodward [1], H. Araujo [2], E. Mitchell [2], A. Menicucci [3], E. Daly [3]

[1] RAL Space , [2] Imperial College London, [3] ESA

The availability of reliable housekeeping data on the radiation environment in and around spacecraft is a desirable tool for their efficient design and operation, but the engineering/ economic costs of integrating such sensors into flight systems is a barrier to adoption.

B-4 **ESA Next Generation Radiation Monitor**

11:45 L. Desorgher [1], W. Hajdas [1], I. Britvitch [1], K. Egli [1], F. Chastellain [2], C. Perreira [2], R. Muff [2], D. Boscher [3], G. Maehlum [4], D. Meier [4], P. Nieminen [5]

[1] Paul Scherrer Institute, [2] RUAG Space, [3] ONERA, [4] IDEAS, [5] ESA/ESTEC

The ESA Next Generation Radiation Monitor (NGRM) will measure protons from 2 MeV up to 200 MeV, and e- from 100 keV up to 7MeV. We describe the NGRM and present the status of its development.

TECHNICAL PROGRAMME - TUESDAY

B-5 **3D Radiation Detectors: Charge Collection Characterisation and Applicability of Technology for Microdosimetry**

12:00 L. Tran [1], D. Prokopovich [2], M. Petasecca [1], M. Lerch [1], A. Kok [3], A. Summanwar [3], C. Da via [4], M. Reinhard [2], A. Rosenfeld [1]

[1] University of Wollongong, [2] Australian Nuclear Science and Technology Organisation, [3] SINTEF MiNaLab, [4] University of Manchester

The charge collection image in 3D active edge Si detectors using IBIC technique utilizing 5.5MeV He^{2+} microbeam has been studied. The effect of 1MeV eq. neutrons and 10 MRad gamma will be presented.

B-6 **RADFET Dosimeters in the Belt: the Van Allen Probes on Day 365**

12:15 A. Holmes-Siedle [1], J. Goldsten [2], R. Maurer [2], P. Peplowski [2]

[1] REM Oxford, [2] The Applied Physics Laboratory of Johns Hopkins University

Scientific satellites VAP-A and -B, launched 2012, carried 16 pMOS RADFET dosimeters aboard each spacecraft. The performance of these silicon dosimeters over 365 days shows properties of the turbulent central region of the radiation belt.

Dr Andrew Holmes-Siedle (RADECS 2013 VIP)

Andrew Holmes-Siedle will become 84 years old in 2013. His original training was in organic chemistry including a PhD in oxidation and enzyme chemistry but he altered course when he entered the aerospace industry in 1960, being assigned to handling engineering problems associated with space radiation or vacuum in Earth orbiting, unmanned satellites. He went to the USA in 1962, was Manager, Radiation Effects at RCA Space Centre, later ran a consulting company in the UK and held an Honorary professorship at Brunel University, London, UK. He is still running his own company, REM Oxford Ltd, in 2013, which sells his RADFET dosimeters. He is cited as one of a small group of survivors who attended the first three IEEE NSREC conferences, now celebrating their 50th anniversary and stays active in the field of radiation effects. He received a medal from the University of Montpellier when giving a paper at RADECS in 1991 and received the IEEE Nuclear and Plasma Sciences Society Radiation Effects Award in 2001 with the citation "For contributions to the field of radiation dosimetry and his encouragement of young researchers in the field of radiation effects."

Lunch 12:30 - 14:00 in the quad marquee. Please ensure you have your name badge.

Poster session: Thursday 26th September 15:45 - 17:30

PB-1 **Proton Accelerator with Adjustable Energy for ICs Radiation Test**

A. Akhmetov [1], A. Yanenko [2], A. Bazhan [3]

[1] Department of Electronics of Moscow Engineering Physics Institute (National Research Nuclear University), [2] Specialized Electronic Systems, [3] CJSC PROTOM

The paper discusses the pilot studies of the experimental research on ICs SEE hardness under proton irradiation at the compact proton accelerator complex which was built by JSC PROTOM.

PB-2 **Brazilian Facilities to Study Radiation Effects in Electronic Devices**

N.H. Medina [1], M. Silveira [2], N. Added [1], V. Aguiar [1] , E. Macchione [1], R. Santos [2], L. Seixas Jr. [3]

[1] University of São Paulo, [2] Centro Universitário da FEI, [3] Centro de Tecnologia da Informação Renato Archer

This work presented three facilities prepared to study TID and SEE in electronic devices: a 60 kV X-ray source, a 1.7 MV and an 8 MV Pelletron accelerators to produce protons and heavy ions.

PB-3 **Withdrawn**

PB-4 **The Electron Calibration Facility**

L. Britvitch [1], H. Wojtek [1], E. Ken [1] , L. Desorgher [1]

[1] PSI

This work describes construction and performance of the Electron Calibration Facility - a beta magneto-spectrometer placed in a large volume vacuum chamber. The facility constitutes a versatile tool for testing of electronic components and detector development.

PB-5 **Comprehensive Study of Parameters Influencing the Response of RadFETs**

S. Metzger [1], S. Hoeffgen [1], T. Kuendgen [1], G. Spiezia [2], M. Brugger [2] , S. Danzeca [2], J. Mekki [2], P. Oser [2]

[1] Fraunhofer INT, [2] CERN

Fraunhofer INT together with CERN calibrated different RadFET radiation dosimeters from TRAD and NMRC while studying the influence of dose-rate, reading condition, package and lot on their response.

PB-6 **Tissue Equivalence of a novel diamond microdosimeter for proton and alpha particle Galactic Cosmic Rays and Solar Particle Events**

J. Davis [1], S. Guatelli [1], M. Petasecca [1], M. Lerch [1], M. Reinhard [2], J. Ziegler [3], M. Zaider [4], A. Rosenfeld [1]

[1] Centre For Medical Radiation Physics, University of Wollongong, [2] Australian Nuclear Science and Technology Organisation, [3]United States Naval Academy, [4] Department of Medical Physics, Memorial Sloan-Kettering Cancer Centre

Diamond based radiation detectors are attractive for radiation protection applications in space and aviation. This paper is dedicated to study the tissue equivalence of diamond in Galactic Cosmic Rays and Solar Particle Events fields.

PB-7 **A Novel Silicon Microdosimeter using 3D Sensitive Volume: Modeling the Response in Neutron Field Typical of Aviation**

L. Tran [1], S. Guatelli [1], D. Prokopovich [2], M. Lerch [1] , M. Reinhard [2]

[1] University of Wollongong, [2]Australian Nuclear Science and Technology Organisation (ANSTO)

Geant4 Monte-Carlo modeling of the response of new SOI microdosimeter utilizing 3D sensitive volumes embedded in PMMA in neutron radiation fields is presented. It was demonstrated the improvement of tissue equivalency of new SOI microdosimeter.

TECHNICAL PROGRAMME - TUESDAY

Invited talk: 14:05 - 15:05

How Oxford Became the City of Dreaming Spires

Oxford is one of the UK's oldest cities and is famed for having one of the world's most prestigious universities. This presentation will look briefly at the earliest days of Oxford as a community before moving on to the historic University of Oxford; its foundation, the earliest aspects of education, the colleges, architecture from the 13th century through to the present day, famous alumni, benefactors, scholarships and much more.

Brian will also be present at the afternoon break to informally answer any questions you may have.

Brian Murray, Oxford Tour Guide

Brian's foray into tour guiding began after an 'office emergency' one day required him to leave the desk and escort some visitors during their sightseeing programme. The desk job was gone forever when he discovered the enjoyment to be gained from showing visitors the delights of the UK. In 1988 Brian gained a 'blue badge' guide status; widely recognised around the world as the 'gold standard' in tourist guiding. Since then he has been guiding visitors in Oxford, London, Bath, York, Salisbury and beyond.

Brian's commitment to the tour guiding industry has seen him become a founding member and past chair of the Association of Professional Tourist Guides. He is also a founding member of the Institute of Tourist Guiding as well as a former member of the Oxford Economic Partnership 'Tourism Task Force' which group ultimately brought about today's Visit Oxford and Oxfordshire organisation.

Brian has recently stopped guiding in the palace of Westminster/Houses of Parliament and now guides principally in Oxford for private and corporate clients, several of the university's colleges and the university's business school.

Break 15:05 - 15:30 in the exhibitors' hall

TECHNICAL PROGRAMME - TUESDAY

Data Workshop : Poster room, 15:35 - 17:30

Chairs:

- **Lee Pater, Astrium**
- **Thomas Granlund, SAAB Group**

15:35 **Data workshop introduction**

DW-1 **Compendium of SEE comparative results under ion and laser irradiation**

A. Chumakov [1], A. Pechenkin [1], D. Savchenkov [2], L. Kessarinskiy [2], A. Vasil'ev [1], A. Yanenko [2], V. Anashin [3], P. Chubunov [3]

[1] Specialized Electronic Systems, [2] The Department of Electronics of Moscow Engineering Physics Institute (National Research Nuclear University), [3] JSC Institute of Space Device Engineering

Compendium of SEU, SEL, SET, SEB, SEGR comparative results under ion irradiation and laser beam are presented. The possible sources of discrepancies between ion and laser results and the ways of data correction are discussed.

DW-2 **SRAMs SEL and SEU In-Flight Data From PROBA-II Spacecraft**

M. D'Alessio [1]

[1] ESA ESTEC

This paper presents an analysis of the SEE in-flight data of SRAMs on board Proba-II spacecraft. Proba-II spacecraft has been flying on a LEO orbit for more than 3 years. Observed in-flight error rates are reported.

DW-3 **SEE Characterization of the AMS 0.35 um CMOS Technology**

J. Ramos-Martos [1], A. Arias-Drake [2], J.M. Mora-Gutiérrez [1], M. Muñoz-Díaz [2], A. Ragel-Morales [1], B.R. Piñero-García [2], J. Ceballos-Cáceres [1], L. Carranza-González [2], S. Sordo-Ibáñez [2], M.A. Lagos-Florido [1]

[1] Instituto de Microelectrónica de Sevilla, [2] Departamento de Electrónica y Electromagnetismo - Univ. de Sevilla

Presents experimental results for SEE characterization of AMS 0.35 CMOS technology for the standard and a custom-designed RHBD digital library, including SEU, SET, and latch-up.

DW-4 **Analyzing the Influence of Voltage Scaling for Soft Errors in SRAM-based FPGAs**

J. Tonfat [1], J. Azambuja [1], G. Nazar [1], P. Rech [1], C. Frost [2], F. Kastensmidt [1], L. Carro [1], R. Reis [1], J. Benfica [3], F. Vargas [3], E. Bezerra [4]

[1] UFRGS, [2] ISIS, [3] PUCRS, [4] UFSC

This work presents the actual impact of voltage reductions in the vulnerability of SRAM-based FPGAs to neutron-induced soft errors in terms of static and dynamic cross-sections.

DW-5 **Using Flash-based FPGAs under Radiation Environment**

C. Urbina Ortega [1], G. Furano [1], G. Magistrati [1], D. Merodio Codinachs [1], K. Marinis [1]

[1] ESA

Margins and trade-offs definition for the use of RHBD techniques in space-borne Flash FPGAs as well as the SEE mitigation techniques needed to be applied and their impact.

DW-6 **Measured Single-event Characteristics of the Virtex-5QV RHBD Space-grade 65nm FPGA**

G.M. Swift [1], G.N. Madias [2], Y.C. Wang [2], R.B. Kent[1], M. Shoga [3], E.J. Miller [2], R. M. Monreal [2]

[1] Xilinx Inc, [2] Boeing Satellite Systems, [2] Southwest Research Institute, [3] The Radiation Group, Inc

The hardened features exhibit a small proton susceptibility. Most of the unhardened features have small numbers of bits or sources of transients which, along with the small feature size, yields low on-orbit proton rates, but not proton immunity.

DW-7 **Beamtest results of Lattice LFE2M20E FPGA**

R. Erdmann [1], J. Gebelein [2], U. Kebschull [1]

[1] Cologne University, [2] Goethe University Frankfurt

This paper presents Lattice LFE2M20E SRAM FPGA particle accelerator proton and heavy ion beamtest results focusing on Single Event Effects (SEE) cross-section and maximum Total Ionizing Dose (TID) response.

DW-8 **Radiation Effect in CMOS Microprocessor Exposed to Intense Mixed Neutron and Gamma Radiation Field**

X.M. Jin [1], Q. Ma [1], C. Qi [1], S.C. Yang [1], R.B. Li [1], X.Y. Bai [1], Y. Liu [1], G.Z. Wang [1], D.S. Lin [1], W. Chen [1]

[1] Northwest Institute of Nuclear Technology

Radiation effects of microprocessor in mixed neutron and gamma rays radiation field were researched. The ionizing energy deposited by neutron in Geant4 simulation accords with experimental data. Qualitative correlation is demonstrated between transistors.

DW-9 **Bias conditions and functional test procedure influence on PowerPC7448 microprocessor TID tolerance**

A. Karakozov [1], O. Korneev [2], P. Nekrasov [1], M. Sokolov [2], D. Zagryadsky [2]

[1] Specialized Electronic Systems, [2] RC 'Module'

TID test method and results for CMOS SOI PowerPC7884 microprocessor in gamma-rays are presented. Significant influence of bias conditions and functional test procedure on resulting TID tolerance level is noted.

DW-10 **Aeroflex HiRel Memory Roadmap**

A. Jordan [1], R. Lake [1], C. Hafer [1], M. von Thun [1], T. Farris [1]

[1] Aeroflex

Aeroflex Colorado Springs continues to augment their HiRel memory family with both high density volatile and low power non-volatile additions. This abstract reviews the status and test summaries on mature products and upcoming memory products.

DW-11 **Total Ionizing Dose Effects on I-V and Noise Characteristics of MOS Transistors in a 0.18um CMOS Image Sensor Process**

T. Greig [1], K. Stefanov [1], A. Holland [1], A. Clarke [1], D. Burt [2] , J. Gow [1]

[1] The Open University, [2] e2V

This paper investigates total ionizing dose effects on electrical characteristics of MOS transistors in a 0.18µm CMOS image sensor process. The findings allow assessment of TID effects on sensor designs for space use.

DW-12 **Total Dose and Single Event Effects Testing of the Intersil ISL70003SEH Integrated Point of Load Converter**

N. van Vonno [1], J. White [1], R. Hood [1], M. Reingraber [1], L. Pearce [1], E. Thomson [1], O. Mansilla [1]

[1] Intersil

We report results of destructive and nondestructive SEE testing and total dose testing of the ISL70003SEH integrated Point of Load (POL) converter together with a discussion of the part's electrical specifications and fabrication process.

DW-13 **Verification of SRAM MBUs calculation technique for experiment time optimization**

A. Boruzdina [1], A. Ulanova [2], A. Petrov [1]

[1] Specialized Electronic Systems (SPELS), [2] National Research Nuclear University (NRNU) MEPHI

Analysis of separation methods for SEUs and MBUs caused by single charged particles in adjacent memory cells is provided. Separation technique is considered and results of its practical application are given.

DW-14 **SEE Test Results of the LVDS Driver and Receiver**

P.X. Wang [1]

[1] 3D Plus

We report on results of SEE tests of LVDS Quad Drivers and Receivers. In particular, this report provides a good way to characterize SET and analyzes the SET result and determines if data are lost.

DW-15 **Investigation of Low dose rate effects in DC/DC Converters**

D. Boychenko [1], L. Kessarinskiy [2], A. Nikiforov [2]

[1] National Research Nuclear University, [2] Specialized Electronic Systems (SPELS)

Results of low dose rate DC/DC convertors' behavior are presented. Experiments conducted at LINAC and Co60-sources utilizing various accelerated methods and reduced dose rate for low dose rate effects accounting.

DW-16 **Linear integrated circuit cumulated dose test representativeness for high energy electron environment applications**

N. Sukhaseum [1], A. Samaras [1], J. Abadie [1], B. Renaud [1], N. Chatry [1], F. Bezerra [2], E. Lorfèvre [2], R. Ecoffet [2]

[1] TRAD, [2] CNES

The aim of the test sequences presented in this document is to compare the representativeness of usual cumulated dose test under Cobalt-60 for dose, and neutron for displacement, versus real high energy electron irradiation effects.

DW-17 **In-situ, low dose rate, total ionising dose test of the cooling performance of a thermo-electric module**

J. Hofman [1]

[1] Synergy Health plc

The abstract presents the design and fully automated total ionising dose test of a thermo-electric cooling module including data from an initial low dose rate total ionising dose test.

DW-18 **Application of FAIR for Space Radiation Investigations**

M. Durante [1], C. Trautmann [1], V. Ferlet-Cavrois [2], A. Menicucci [2] , O. Angerer [2] , E. Daly [2]

[1] GSI, [2] ESA

The applications of the very high energy facility for anti-proton and ion research (FAIR), built in Darmstadt (Germany) for single event effects in electronic components, analysis of radiation shielding and space biology are presented.

DW-19 **Advanced Electronics X-ray Dosimetry for Space and Airborne Applications**

L. Quarrie [1]

[1] L3 Telemetry West

It was found that accurately measured dosimetry from real time x-ray machines, shielding, and intended mission radiation design margins must be considered during radiographic inspection of critical active components for space and airborne applications.

DW-20 **The Effects of Radiation on Optical Properties of Spacecraft Solar Array Protective Glasses**

R. Khasanshin [1], A. Galygin [1]

[1] JSC 'Kompozit'

Degradation of optical properties of K-208 glass substrates exposed to electrons, protons and thermally stimulated outgassing products of polymeric composites was studied. Changes of transmittance of substrates irradiated by 30-keV electrons and protons.

Exhibitors' reception 17:30 - 19:30 in the exhibitors' hall

TECHNICAL PROGRAMME - WEDNESDAY

Session C: Radiation Hardness by Design

Chairs:

- **Lew Cohn, Naval Research Laboratory**
- **Heather Quinn, Los Alamos National Laboratory**

09:00 **Session C introduction**

C-1 **FinFET SRAM hardening through design and technology parameters considering process variations**

09:05 H. Villacorta [1], V. Champac [2], S. Bota [1], J. Segura [1]

[1] University of Balearic Islands, [2] National Institute for Astrophysics, Optics and Electronics

FinFET SRAM Cell radiation-hardening considering process variations is analyzed. It is possible to obtain similar improvement in critical charge by increasing cross-coupled transistors fin height instead of the number of fins without area overhead.

C-2 **A Radiation Hardened by Design Charge Pump for Flash Memories**

09:20 G. Bellotti [1], V. Liberali [1], A. Stabile [2], S. Gregori [3]

[1] Università degli Studi di Milano, [2] INFN - Milano, [3] University of Guelph

A charge pump voltage multiplier for programming flash memories for space has been designed in a commercial 180 nm CMOS technology using RHBD techniques.

C-3 **Total Ionizing Dose Radiation Effects between the Wave Layout Style and its Conventional Counterpart focusing on the Digital IC Applications**

09:35 R.Navarenho de Souza [1], M. Silveira [1], S. Pinillos [1], S. Gimenez [1]

[1] FEI University Center

This paper performs an experimental comparative study of the X-ray radiation effects between the Wave layout style (S-shaped gate geometry) and the Conventional (rectangular gate geometry) counterpart, focusing on the digital integrated circuits (IC) applications.

C-4 **Total Ionizing Dose Effects on the Digital Performance of Irradiated OCTO and Conventional Fully Depleted SOI MOSFET**

09:50 L. Fino [1], M. Silveira [1], C. Renaux [2], D. Flandre [2], S. Gimenez [1]

[1] FEI University Center, [2] Université catholique de Louvain

This paper investigates and compares experimentally TID effects in digital parameters of the FD OCTO SOI n-type, that presents an octagonal gate geometry, versus its conventional (rectangular gate geometry) counterpart (CSM).

C-5 10:05 **Angled Flip-Flop Single-Event Cross Sections for Submicron Bulk CMOS Technologies**

N.Gaspard [1], S. Jagannathan [1], Z. Diggins [1], S. Wen [2], R. Wong [2], K. Lilja [3], M. Bounasser [3], D. Loveless [1], T. Holman [1], B. Bhuva [1], L. Massengill [1]

[1] Vanderbilt Univeristy, [2] Cisco Systems Inc., [3] Robust Chip Inc.

Experimental heavy-ion results show that hardened flip-flop single-event cross sections increase at a faster rate with increasing angle of incidence than unhardened flip-flop cross sections for technologies ranging from 28-nm to 130-nm.

C-6 10:20 **Neutron Cross-section of N-Modular Redundancy Technique in SRAM-based FPGAs**

J.Tarrillo [1], P. Rech [1], F. Kastensmidt [1], C. Valderrama [2], C. Frost [3]

[1] UFRGS, [2] UMONS, [3] ISIS Facility, STFC Rutherford Appleton Laboratory

This paper evaluates different trade-offs of N-modular redundancy technique in SRAM-based FPGAs. Redundant design was exposed to neutrons and results in cross-section, area and power were analyzed for 3 up to 7 redundant modules.

C-7 10:35 **Two-Order Increase in Robustness of Partial Redundancy under Radiation Stress Test by Using SDC Prediction**

T. Ahmed [1], J. Yao [1], Y. Nakashima [1]

[1] Nara Institute of Science & Technology

Partial redundancy is an emerging method for cost-effective SEE addressing. We achieved a two-order increase in the robustness for partial redundancy by adding a light-weighted error prediction based on sampled errors under radiation stress tests.

Break 10:50 - 11:20 in the exhibitors' hall

Poster session: Thursday 26th September 15:45 - 17:30

PC-1 **Design of 65 nm CMOS SRAM for Space Applications: a Comparative Study**

M. Gorbunov [1], P. Dolotov [1], A. Antonov [1], G. Zebrev [2], V. Emeliyanov [3], A. Boruzdina[4], A. Petrov [4], A. Ulanova [4]

[1] Scientific Research Institute of System Analysis, Russian Academy of Sciences, [2] Moscow Engineering Physics Institute (National Research Nuclear University), [3] Research Institute of Scientific Instruments, [4] Specialized Electronic Systems (SPELS) and National Research Nuclear University (NRNU) MEPHI

We study the design of different SRAM blocks based on a commercial 65 nm CMOS technology and discuss the experimental results for X-ray, proton and heavy ion irradiation campaigns.

PC-2 **A Low-Power and Area-Efficient Radiation-Hard Redundant Flip-Flop, DICE ACFF, in a 65 nm Thin-BOX FD-SOI**

K. Kubota [1], M. Masuda [1], J. Furuta [1], Y. Manzawa [1], S. Kanda [1], K. Kobayashi [1], H. Onodera [1]

[1] Kyoto Institute of Technology

We propose a low-power area-efficient redundant FFs, called DICE-ACFF implemented in a 65 nm thin-BOX FD-SOI. It achieves lower power at lower data-activity consuming 2x area of DFFs and 1.5x better SER than DICE.

PC-3 **Dependence of Cell Distance and Well-contact Density of MCU Rates by Device Simulations and Neutron Experiments in a 65-nm Bulk Process**

K. Zhang [1], J. Furuta [1], K. Kobayashi [1], H. Onodera [1]

[1] Kyoto Institute of Technology

We analyze contributions of cell distance and well-contact density to suppress MCUs by device-level simulations and neutron experiments. All device models and test chips are constructed in a 65-nm process.

PC-4 **Efficient Mitigation of Data and Control Flow Errors in Microprocessors**

L. Parra [1], A. Lindoso [1], M. Portela-Garcia [1], L. Entrena [1], F. Restrepo-Calle [1], S. Cuenca-Asensi [2], A. Martinez-Alvarez [2],

[1] Universidad Carlos III, [2] Universidad de Alicante

This paper presents a new hybrid technique aimed to protect both data and control-flow in microprocessors. Experimental results show that both SEUs and SETs can be mitigated by two orders of magnitude.

PC-5 **Applying Residue Arithmetic Codes to Combinatorial Logic to Reduce Single Event Upsets**

M. Sika [1], J. Ahlbin [1], M. Bajura [1], M. Fritze [1], J. Damoulakis [1], J. Granacki [1]

[1] Information Sciences Institute, University of Southern California

Residue arithmetic coding (RAC) is embedded in digital arithmetic logic units to detect and correct single-event upsets (SEUs). Simulations and analyses validate that RAC can be implemented in digital arithmetic logic units.

PC-6 **Evaluating the Effectiveness of a Diversity TMR Scheme under Neutrons**

L. Tambara [1] , F. Kastensmidt [1], J. Azambuja [1], E. Chielle [1], F. Almeida [1], G. Nazar [1], L. Carro [1], P. Rech [1], C. Frost [2]

[1] Universidade Federal do Rio Grande do Sul, [2] ISIS Facility, STFC Rutherford Appleton Laboratory

This paper explores the concept of Design Diversity Redundancy applied to digital circuits as a proposal to increase system reliability. The setup was exposed to a neutron source to investigate the occurrence of SEEs.

PC-7 **Comparing Software-Based Fault Detection Techniques Applied at Different Abstraction Levels**

E. Chielle [1], D. H. Grehs [1], J. R. Azambuja [1], F. Kastensmidt [1]

[1] Universidade Federal do Rio Grande do Sul

An analysis of software-based techniques applied in high level language and in assembly language is presented. Partial hardened versions of the applications are created. Results show performance, memory footprint and error coverage of each approach.

TECHNICAL PROGRAMME - WEDNESDAY

Session D: Single Event Effect Transients

Chairs:

- **Véronique Ferlet-Cavrois, ESA ESTEC**
- **Ray Ladbury, NASA**

11:25 **Session D introduction**

D-1 **Accurate Mitigation of Single Event Effects on Flash-based FPGAs: A new Design Flow**

11:30 L. Sterpone [1], D. Boyang [1], D. Merodio Codinachs [2], V. Ferlet-Cavrois [2]

[1] Politecnico di Torino, [2] ESA

We propose a new design flow for implementing circuits hardened against SET effects affecting Flash-based FPGAs. Experimental results on RISC microprocessors show an increase of robustenss of more than 70% wrt traditional mitigation approaches.

D-2 **Real-Time SEU Tolerant Circuits on SRAM-based FPGAs**

11:45 L.Sterpone [1], A. Ullah [1]

[1] Politecnico di Torino

We propose a novel circuit implementation method for probing TMR circuits for error detection and fast run-time reconfiguration for recovery. Experimental results demonstrated full SEU protection and more than 90% recovery improvements on the average.

D-3 **SET Tolerance of 65 nm CMOS Majority Voters: a Comparative Study**

12:00 I. Danilov [1], M. Gorbunov [1], A. Antonov [1]

[1] Scientific Research Institute of System Analysis, Russian Academy of Sciences

We study the design of different majority voters, propose the test system and discuss the experimental results of heavy ion irradiation campaign and the proposed effectiveness criterion.

D-4 **SET Sources of Scan Flip-Flop and An SET-immune Redundant Delay Filter (RDF)**

12:15 Z. Xinyuan [1], W. Liang [1], Y. Suge [1]

[1] Beijing Microelectronics Technology Institute

Heavy ion experimental results indicate the great contribution of SE-SET to soft errors and SET vulnerability of the conventional DF. A novel redundant delay filter is designed and simulated.

D-5 **Study of Manufacturing Discrepancies Impact on TID-ATREEs Synergistic Effect in LM124 Operational Amplifier**

12:30 F. Roig [1], L. Dusseau [2], P. Ribeiro [3], G. Auriel [3], N. Roche [4], A. Privat [2], J. Vaillé [2], J.Boch [2], F. Saigné [2], R. Marec [5], P. Calvel [5], F. Bezerra [6], R. Ecoffet [6]

[1] CEA/DAM Université Montpellier 2, [2] Université Montpellier 2, [3] CEA/DAM Gramat, [4] U.S. Naval Research Laboratory, [5] Thales Alenia Space, [6] CNES

The impact of TID on ATREE responses in the LM124 op-amps from three different manufacturers is investigated . Pulsed-laser mappings, TID and flash X-Ray experiments are conducted. ATREEs are modeled with a previously developed simulation tool.

Lunch 12:45 - 14:15 in the quad marquee. Please ensure you have your name badge.

Poster session: Thursday 26th September 15:45 - 17:30

PD-1 **Modeling of Elevated Temperature Impact on Single Event Transient in Advanced CMOS Logics Beyond the 65-nm Technological Node**

L. Artola [1], G. Hubert [1]

[1] ONERA - The French Aerospace Lab

This paper presents the modeling of elevated temperatures on Single Event Transients in 65-nm CMOS logics. The prediction platform MUSCA SEP3 shows a good agreements with experimental measurements. The die-shrink to 28-nm is also investigated.

PD-2 **Investigating the Impact of Input Patterns, Propagation Paths, and Re-convergent Paths on the Propagation Induced Pulse Broadening**

G. Bany Hamad [1], S. Rafay Hasan [2], O. Ait Mohamed [3], Y. Savaria [1]

[1] Groupe de Recherche en Microelectronique et Microsystemes, Polytechnique Montreal,
[2] Dept. of Electrical & Computer Engineering, Tennessee Technological University,
[3] Dept. of Electrical & Computer Engineering, Concordia University

A new investigation of the dependence of the soft error broadening on the input pattern, propagation paths, soft error pulse polarity and re-convergent paths is presented.

PD-3 **An SET propagation EDA tool based on analytical glitch propagation model**

S. Barceló [1], X. Gili [1], S. Bota [1], J. Segura [1]

[1] University of the Balearic Islands

We develop an EDA tool that quantifies the susceptibility of each combinational circuit node to propagate an SET. It computes the minimum SET starting from each site, ranking circuit nodes considering logical and electrical masking.

PD-4 **C-Element model for SET fault emulation**

K. Zhang [1], J.M Arevalo-Garbayo [1], M. Portela-García [1], M. García-Valderas [1], C. López-Ongil [1], L. Entrena [1]

[1] University Carlos III of Madrid

A C-Element SET filtering cell has been modeled to allow its integration in a FPGA based fault injection system, and it has been used to perform selective SET hardening to a cryptographic circuit.

Session E: Laser SEE Simulation

Chairs:

- **Vincent Pouget, Université Montpellier 2**
- **Dale McMorrow, Naval Research Laboratory**

14:20 **Session E introduction**

E-1 **Analysis of Short-Term NBTI Effect on the Single-Event Upset Sensitivity of a 65nm SRAM using Two-Photon Absorption**

14:25 I. El Moukhtari [1], D. Lewis [1], V. Pouget [2], C. Larue [3], P. Perdu [4]

[1] IMS, [2] IES, [3] Pulscan, [4] CNES

We used two-photon absorption laser testing to characterize the effect of short-term NBTI aging on the SEU sensitivity of 65nm CMOS SRAM cell. Results indicate a fast increase of SEU sensitivity due to aging.

E-2 **Impact of mechanical strain on the charge collection mechanisms of nanometer scaled SOI devices under heavy ion and pulsed laser irradiation**

14:40 M. Gaillardin [1] , M. Raine [1], O. Duhamel [1] , S. Girard [2] , P. Pallet [1], F. Aadrieu [3], S. Barraud [3], O. Faynot [3]

[1] CEA, DAM, DIF , [2] Laboratoire Hubert Curien, [3] CEA, LETI-Minatec

We investigate the impact of mechanical strain on nanometer scaled SOI devices. The charge collection mechanisms are investigated using heavy ion and pulsed laser experiments on dedicated test structures.

E-3 **Mitigation of Single Event Charging in Commercial FPGA Design**

14:55 S. Ramaswamy [1]

[1] BAE Systems, Inc.

Impact of well implant and contact placement on single event charge sharing was investigated using 3D simulations and the information was used to mitigate SEE in commercial design. Results were verified through Laser and SEE testing.

Break 15:05 - 15:35 in the exhibitors' hall (exhibitors' raffle)

Poster session: Thursday 26th September 15:45 - 17:30

PE-1 **Study of SEL and SEU in SRAM Using Different Laser Techniques**

D. Savchenkov [1], A. Chumakov [2], A. Petrov [1], A. Pechenkin [1], A. Egorov [2], O. Mavritskiy [2], A. Yanenko [2]

[1] National Nuclear Research University MEPhI, [2] Specialized Electronic Systems

Single event upset and single event latchup laser testing results of SRAM CY62256 using both focused and local laser techniques are presented. Variable laser wavelength was used for SEE threshold linear energy transfer estimation.

PE-2 **Wavelength Influence on CMOS SOS IC Dose Rate Laser Simulation Efficiency**

P. Skorobogatov [1], A. Nikiforov [1], A. Egorov [1], A. Ulanova [1], G. Davydov [1]

[1] Specialized Electronic Systems

Dose rate effects wavelength dependence under pulsed laser irradiation of typical CMOS thin-film structure is investigated. The optimal wavelength for maximum laser simulation efficiency is defined.

PE-3 **Top-Side Pulsed Laser Induced Single Event Upsets in Highly-Scaled SRAM Devices**

I. Depaul [1], J. L. Merino [1], G. Torrens [1], C. de Benito [1], J. Verd [1], J. Segura [1], S. Bota [1]

[1] Universitat Illes Balears

Pulsed laser has been used to induce SEUs in scaled SRAM from topside. Routing tracks make difficult the measurement of minimum energy to induce SEU. Induced laser off-chip currents are mainly photocurrents generated in well-substrate diode.

Session F: Radiation Environments in Space, within the Atmosphere and from Radiological and Artificial Sources

Chairs:

- **Alex Hands, AWE**
- **Frédéric Wrobel, Université Montpellier 2**

15:40 **Session F introduction**

F-1 **Correlation of in-flight displacement damage on the OSL sensor with space environment on-board Jason-2 spacecraft**

15:45 S. Bourdarie [1], D. Falguere [1], C. Inguimbert [1], C. Deneau [2], J. Vaillé [2], E. Lorfèvre [3], R. Ecoffet [3]

[1] ONERA, [2] Université Montpellier - IES, [3] CNES

Displacement damage doses measured by the ICARE-NG/OSL sensor on board JASON-2 spacecraft are compared to predictions performed with proton measurements available from the spectrometers and proton spectrum predicted by AP8 min model and AP9 models.

F-2 **A new ONERA-CNES Slot Electron Model**

16:00 A. Sicard-Piet [1], D. Boscher [1], D.Lazaro [1], S.Bourdarie [1], G. Rolland [2]

[1] ONERA, [2] CNES

A new model of electron flux in the Slot Region has been developed at ONERA. This model provides electron flux between L=2 and L=4 for energies between 0.1 MeV and 3 MeV.

F-3 **Release of the Electron Slot Region Region Radiation Environment Model**

16:15 I. Sandberg [1], I. Daglis [1], D. Heynderickx [2], P. Truscott [3], A. Hands [4], H. Evans [5], P. Nieminen [5]

[1] Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, National Observatory of Athens, [2] DH Consultancy, [3] Kallisto Consultancy Ltd, [4] AWE, [5] ESA/ESTEC

The first release of the Electron Slot Region Radiation Environment Model (E-SRREM) which characterizes the trapped electron fluxes and their variability in the region between the inner and outer radiation belt is presented.

F-4 **A 3-Dimensional Model of Internal Charging Simulation**

16:30 X. Tang [1], Zhong Yi [2], L.Meng [2], Y. Liu [3], C. Zhang [3], J. Huang [3]

[1] Science and Technology on Reliability and Environmental Engineering Laboratory, and Beijing Institute of Spacecraft Environment Engineering, [2] Science and Technology on Reliability and Environmental Engineering Laboratory, [3] Beijing Institute of Spacecraft Environment Engineering

A 3-dimensional model of internal charging simulation for arbitrary configuration is developed. In this paper, the charging of a PCB partially grounded, which is immersed in high-energy electrons, is simulated to illustrate the 3-dimensional method.

F-5 16:45 **Evaluation of Neutron-Induced Soft Error Effects on CPUs in Automotive Microcontrollers**

T. Uezono [1], S. Yoneki [2], T. Toba [1], K.Shimbo [1], E. Ibe [1]

[1] Yokohama Research Laboratory, Hitachi, Ltd., [2] JASPAR (Japan Automotive Software Platform and Architecture)

Four automotive microcontrollers (MCUs) in an actual operating condition are irradiated with white and quasi-monoenergetic neutron beams. Results showed neutron-induced soft error rates are in the range of 0.1 to 0.2FIT.

F-6 17:00 **Effect of thorium decay chain disequilibrium on alpha emissivity**

A. Kaouache [1], F. Wrobel [1], F. Saigné [1], A. Touboul [1], R. Schrimpf [2], J. Autran [3]

[1] Université Montpellier 2, [2] Vanderbilt University, [3] Aix-Marseille University

An emissivity model generalized to disequilibrium state shows that even if the alpha emissivity has initially an acceptable level, it can be significantly increased, during device lifetime, by the disequilibrium chain of thorium.

F-7 17:15 **SEU Monitoring in Mixed-Field Radiation Environments of Particle Accelerators**

G. Tsiligiannis [1], L. Dilillo [1], A. Bosio [1], P. Girard [1], S. Pravossoudovitch [1], A. Todri [1], A. Virazel [1], J. Mekki [2], M. Brugger [2], F. Wrobel [3], F. Saigné [3]

[1] LIRMM, [2] CERN, [3] IES

We used the H4IRRAD mixed-field radiation area of CERN to test our SRAM based instruments, in order to explore the feasibility of using them as monitoring devices for particle accelerators.

Poster session: Thursday 26th September 15:45 - 17:30

PF-1 **Radiation Belt Activity Indices and Solar Proton Event Alarm on the CRATERRE Project Web Site**

D. Lazaro [1], D. Boscher [1], S. Bourdarie [1], A. Sicard-Piet [1], G. Rolland [2], R. Ecoffet [2], E. Lorfèvre [2]

[1] ONERA, [2] CNES

Two Radiation Belt Activity Indices and one Solar Proton Event Alarm are developed for post event analysis. Both indices and alarm are plotted on the CRATERRE project web site.

PF-2 **In-depth analysis of count rate measurements for future use in data assimilation tool**

S. Bourdarie [1], D. Lazaro [1], P. Nieminen [2], H. Evans [2]

[1] ONERA, [2] ESTEC

An extension to space environment data analysis proposed by COSPAR/PRBEM in 2008 is given. A detailed analysis of count rate data is applied to PROBA-1/SREM: the definition of regions/times when protons/electrons dominate the measurements is given.

PF-3 **Unfolding JASON-2 / ICARE-NG high energy particle measurements using a Singular Value Decomposition approach**

V. Maget [1], S. Bourdarie [1], D. Lazaro [1], D. Boscher [1], G. Rolland [2], R. Ecoffet [2], E. Lorfèvre [2]

[1] ONERA, [2] CNES

This paper presents an enhanced approach to extract as much as possible information from raw measurements of a given solid state detector. Here we focus on the benefits of a Singular Value Decomposition approach.

PF-4 **Studies of correction methods for influences from space environment on observation of radiation dose in space**

S. Dainichi [1]

[1] Kagoshima University

Data sets obtained by semiconductors tend to have errors due to annealing effect and temperature variation. The brief correction by data processing makes temporal variation of dose rate more clear and total dose more accurate.

PF-5 **Long Term Destructive SEE Risk and Calculations Using Multiple 'Worst-Case' Events**

P. Jiggens [1], H. Evans [1], P. Truscott [2], D. Heynderickx [3], F. Lei [4]

[1] ESA/ESTEC, [2] Kallisto Consultancy, [3] DH Consultancy, [4] RadMod Research

Statistical analysis comparing the number of CREME-96 worst-week to a space environment particle flux data analysis and the PSYCHIC model is presented. A direct assessment of SEE using the ESA SEPEM system is also presented.

PF-6 **Atmospheric Radiation Environment Effects on Electronic Balloon Board observed during Polar Vortex and Equatorial Operational Campaigns**

G. Hubert [1], F. Bezerra [2], J.M. Nicot [2], L. Artola [1], A. Cheminet [1], J.N. Valdivia [2], J.M. Mouret [2], J.R. Meyer [2], P. Cocquerez [2]

[1] ONERA, [2] CNES

This paper describes functional anomalies induced by the atmospheric-radiation-environment during balloon flights during polar vortex and equatorial operational campaigns. The objective of this paper is the analysis of in-flight data in order to propose modelling.

Session G: Radiation Effects in Electronic Devices

Chairs:

- **Fred Sexton, Sandia National Laboratory**
- **Reno Harboe-Sørensen, Consultant**

09:00 **Session G introduction**

G-1 **Influence of Heavy Ion Irradiation on Perpendicular-Anisotropy CoFeB-MgO Magnetic Tunnel Junctions**

09:05 D. Kobayashi [1], Y. Kakehashi [1], K. Hirose [1], S. Onoda [2], T. Makino [2], T. Ohshima [2], S. Ikeda [3], M. Yamanouchi [4], H. Sato [4], C. Enobio [4], T. Endoh [4], H. Ohno [4]

[1] Institute of Space and Astronautical Science, JAXA, [2] Japan Atomic Energy Agency, [3] Tohoku University, [4] Center for Spintronics Integrated Systems, Tohoku University

A non-volatile memory element of a perpendicular-anisotropy magnetic tunnel junction is exposed to 15-MeV Si ions in different bias conditions. Stored data, which are written with a current injection switching, remain intact after irradiation.

G-2 **Single Event Induced Upsets in HfO_2/Hf 1T1R RRAM**

09:20 W. Bennett [1], N. Hooten [1], R. Schrimpf [1], B. Jinshun [1], Z. Enxia [1], M. Alles [1], R. Reed [1], D.Linten [2], M. Jurczak [2], A. Fantini [2]

[1] Vanderbilt University, [2] IMEC

Single event upset measurements in 1T1R RRAM structures show that susceptibility is dominated by the access transistor. Two-photon laser induced upsets only occur when the RRAM is in the high resistance state.

G-3 **Total Ionizing Dose Tolerance of the Resistance Switching of Ag-Ge40S60 based Programmable Metallization Cells**

09:35 P. Dandamudi [1], H. Barnaby [1], M. Kozicki [1], Y. Gonzalez-Velo [1], K. Holbert [1]

[1] Arizona State University

The radiation tolerance of Ag-doped-Ge40S60 based PMC elements that were irradiated up to a total ionizing dose (TID) of 10 Mrad(Ge40S60) using 60-Co gamma rays is demonstrated. The irradiated devices show no significant resistance switching degradation.

G-4 **Single Event Effects Induced by Heavy Ion Irradiation in SiC Power MOSFETs**

09:50 C. Abbate [1]

[1] DAEIMI University of Cassino

The results of bromine and iodine irradiation of 1200V silicon carbide power MOSFETs are presented. Damage at the gate dielectric is observed at proportionally lower biasing conditions than what happens in silicon power MOSFET.

G-5 **5MeV Proton and 15MeV Electron Radiation Effects Study on 4H-SiC nMOSFET Electrical Parameters**

10:05 M. Alexandru [1], M.Florentin [1], A. Constant [2], B. Schmidt [3], P. Michel [3], P. Godignon [1]

[1] IMB-CNM CSIC, [2] ON SEMICONDUCTOR, [3] Helmholtz-Zentrum Dresden-Russendorf (HZDR),

The impact of proton and electron irradiation on 4H-SiC MOSFET electrical parameters response was investigated with bias stress instability measurements. Great improvements in the SiO_2/SiC interface quality and key electrical parameters were observed.

Break 10:20 - 10:50 in the exhibitors' hall

G-6 **Gate Voltage Contribution to Neutron-Induced SEB of Trench Gate Fieldstop IGBT**

10:55 L.Foro [1], A.Touboul [1], F. Wrobel [1], P. Rech [2], L. Dillio [3], C. Frost [4], F. Saigné [1]

[1] Université Montpellier 2 - IES, [2] Universidade Federal do Rio Grande do Sul, [3] Université Montpellier 2 - LIRMM, [4] ISIS Facility, STFC Rutherford Appleton Laboratory

Single Event Burnout and Gate Rupture are catastrophic failures due to cosmic rays that can occur simultaneously. It is shown that biasing the gate negatively leads to a substantial increase of SEB cross section.

G-7 **Multiple-Cell-Upsets on a commercial 90nm SRAM in Dynamic Mode**

11:10 G. Tsiligiannis [1], L. Dilillo [1], A. Bosio [1], P. Girard [1], S. Pravossoudovitch [1], A. Todri [1], A. Virazel [1], C. Frost [2], F. Wrobel [3], F. Saigné [3]

[1] LIRMM / UM2, [2] ISIS Facility, STFC Rutherford Appleton Laboratory, [3] IES / UM2

In this paper, we present new types of Multiple Cell Upsets (MCUs) as they were recorded during atmospheric-neutron irradiation experiments on a commercial 90nm SRAM that was tested in dynamic mode.

G-8 **Degree of Parallelism Variation Effects on GPUs Reliability**

11:25 P. Rech [1], C. Frost [2], L. Carro [1]

[1] UFRGS, [2] ISIS Facility, STFC Rutherford Appleton Laboratory

The Degree of Parallelism (DOP) variation effects on GPUs reliability are experimentally evaluated. A higher DOP increases performances but may lower the GPU radiation reliability, as an increased scheduling strain is required to implement the parallelism.

G-9 **Quadruple well CMOS MAPS with time-invariant processor exposed to ionizing radiation and neutrons**

11:40 L. Ratti [1], G. Traversi [2], S. Zucca [3], S. Bettarini [4], F. Morsani [4], G. Rizzo [4], L. Bosisio [5], I. Rashevskaya [5]

[1] University of Pavia, [2] University of Bergamo, [3] INFN, [4] University of Pisa, [5] University of Trieste

Quadruple well CMOS MAPS with time invariant processing channel have been exposed to ionizing radiation from a Co-60 source and to neutrons from a nuclear reactor core to evaluate their limits in applications to particle tracking.

Poster session: Thursday 26th September 15:45 - 17:30

PG-1 **NAND Flash Memory In-Flight Data From PROBA-II Spacecraft**

M. D'Alessio [1]

[1] ESA ESTEC

This paper presents a complete analysis of the in-flight data of the Samsung K9F8G08U0M 8 Gbit NAND Flash memory experiment used as a as a technology demonstrator for the floating-gate technology in radiation environments.

PG-2 **Effects of 3 MeV protons on 4H-SiC bipolar devices and integrated OR-NOR gate**

S. Suvanam [1], L. Luigia [1], C. Zetterling [1], A. Hallen [1], G.M. Bengt [1]

[1] KTH, Royal Institute of Technology

4H-SiC circuits are irradiated with 3 MeV proton and up to doses of the order of the $1x10^{11}cm^{-2}$ the performance of both the devices and circuits appear unaffected, but for higher fluence they degrade rapidly.

PG-3 **Study of the synergistic effect between TID and TREE on the lachup of the MC14573 operational amplifier**

M. Qiang [1], J. Xiao Ming [1], C. Wei [1]

[1] Northwest Institute of Nuclear Technology

The impact of total ionizing dose on the lachup of CMOS operational amplifier under transient irradiation is investigated for the first time.

PG-4 **Failure analysis of TID in SRAM-based FPGA based on gamma-ray and local X-ray irradiation**

L. Ding [1]

[1] Tsinghua University

Failure analysis of Total Ionizing Dose effect in SRAM-based FPGA is studied by means of common gamma ray irradiation and local X-ray irradiation. The corresponding failure principles are observed and compared carefully.

PG-5 **Simulation of Bipolar Transistors Degradation at Various Dose Rates and Electrical Modes for High Dose Conditions**

G. Zebrev [1], A. Petrov [2], R. Ikhsanov [2], R. Useinov [2], V. Ulimov [2], V. Anashin [3], I. Elushov [3]

[1] NRNU MEPHI, [2] RISI, [3] JSC Institute of Space Device Engineering

Radiation response of bipolar transistors irradiated under various electrical modes and dose rates for high doses are experimentally investigated. Simulation accounting for ELDRS and the electric field reducing modelling at high doses agrees well with experiment.

TECHNICAL PROGRAMME - THURSDAY

Session H: SEE Modelling

Chairs:

- **Philippe Paillet, CEA**
- **Alessandro Paccagnella, University of Padua**

11:45 **Session H introduction**

H-1 **Towards a Generic Representation of Heavy Ion Tracks to be Used in Engineering SEE Simulation Tools**

11:50 M.Raine [1], M. Gaillardin [1], P. Paillet [1]

[1] CEA

A methodology is proposed to generate a database implementable in engineering SEE simulation tools that would allow representation of any heavy ion track from a minimal set of proton tracks and a simple scaling formula.

H-2 **From Memory Device Cross Section to Data Integrity Figures of Space Mass Memories**

12:05 D. Walter [1], M. Herrmann [1], K. Grürmann [1], F. Gliem [1]

[1] Technische Universität Braunschweig , Institut f. Datentechnik

The influence of SEU and SEFI events in 4-Gbit DDR3 SDRAM on the data integrity of an example mass memory with a capacity of 4-Tbit and Single Symbol Error Correcting Reed-Solomon Code is investigated.

H-3 **Neutron and Alpha SER in Advanced NAND Flash Memories**

12:20 M. Bagatin [1], S. Gerardin [1], A. Paccagnella [1], V. Ferlet-Cavrois [2], G. Gorini [3], C. Andreani [4], C. Frost [5]

[1] University of Padova, [2] ESA ESTEC, TEC-QEC , [3]Department of Physics - University of Milano - Bicocca, [4]Università di Roma - Tor Vergata, [5] ISIS Facility, Rutherford Appleton Laboratory

We study the response of NAND Flash memories to neutron and alpha particle exposure, with both Single- and Multi-Level Cell architecture devices. We analyze the error rate in the terrestrial environment and discuss scaling trends.

Lunch 12:35 - 14:05 in the quad marquee. Please ensure you have your name badge.

Poster session: Thursday 26th September 15:45 - 17:30

PH-1 **Impact of Nuclear Reaction Models on Neutron-Induced Soft Error Rate Analysis**

S. Abe [1], R. Ogata [1], Y. Watanabe [1]

[1] Kyushu University

We have analyzed terrestrial neutron-induced soft error rate (SER) by multi-scale Monte Carlo simulation using different nuclear reaction models, and clarified that the choice of nuclear reaction models has a great effect on the SER prediction.

PH-2 **Comparison of the Transient Current Shapes Obtained With the Diffusion Model and the Double Exponential Law - Impact on the SER**

F. Wrobel [1], L. Dilillo [2], A. Touboul [1], F. Saigné [1]

[1] Université Montpellier 2, [2] LIRMM

We investigated the effect of the transient current shapes on the Soft Error Rate. The double exponential law gives results comparable to diffusion model if the parameters are well chosen.

PH-3 **A Physical Prediction Model Issued from TCAD Investigations for Single Event Burnout in Power MOSFETs**

S. Siconolfi [1], G. Hubert [1], L. Artola [1], F. Darracq [2], J.P. David [1]

[1] ONERA, [2] IMS

This paper investigates SEB physical/device mechanisms in power MOSFETs, and proposes SEB prediction model. Investigations relied on 2D TCAD simulations. Calculated SEB risk for IRF360 is consistent with ground experimental values and in-flight data.

TECHNICAL PROGRAMME - THURSDAY

Invited talk: 14:10 - 15:10

Space Weather: Past, Present and Future

Space weather is the influence of space environment variability on technology and human health. While our Sun is remarkably constant in the wavelengths that illuminate and warm us, it is extremely variable in other wavelengths and in its emission of plasma and energetic particles. Mankind's increasing dependence on technology is creating new concerns and Space Weather has finally captured the attention of politicians. The question is being asked as to what would be the consequences in today's high technology society of a repeat of the major solar flare event observed in white-light by Richard Carrington in 1859. The lecture will review the history, current status and recommendations for future strategies, particularly with respect to radiation effects.

Professor Clive Dyer

Clive took the Natural Sciences Tripos at Christ's College Cambridge and has since worked in space and radiation research for more than 40 years, authoring more than 200 publications in the field. He studied for his PhD in the Cosmic Ray Group at Imperial College London working on the HEOS-1 and Ariel-5 spacecraft. This was followed by a National Academy of Sciences Research Associateship at NASA Goddard Space Flight Center analyzing data from gamma-ray spectrometers carried on the Apollo 15 to 17 and Apollo-Soyuz missions. Following this he joined the UK Ministry of Defence as Senior Lecturer in the Department of Nuclear Science at the Royal Naval College Greenwich and subsequently transferred to the Space Department at the Royal Aircraft Establishment Farnborough where he founded the Radiation Environments, Effects and Hardening Team. During his time at Farnborough he became a Senior Fellow and Chief Scientist (Space) and received the Geoffrey Pardoe Space Award of the Royal Aeronautical Society. For more than 20 years he led a programme of research into radiation environments and effects. He has flown radiation monitors on a wide range of aircraft (including Concorde), twelve Space Shuttle missions, the MIR Space Station and a variety of spacecraft in orbits from LEO to interplanetary space. He continues to provide consultancy in these areas and is Visiting Professor at the University of Surrey Space Centre. He has been actively involved with IEEE NSREC since 1983 and with RADECS since 1991, serving as a short course lecturer at both. In 2010 he was honoured with the Radiation Effects Prize of the IEEE Nuclear and Plasma Sciences Society. During the last two years he has been actively involved with Royal Academy of Engineering Study on "Extreme Space Weather: impacts on engineered systems and infrastructure," which reported in February 2013.

Break 15:10 - 15:40 in the exhibitors' hall

TECHNICAL PROGRAMME - THURSDAY

Poster Session

Chairs:

- **Vincent Goiffon, ISAE**
- **Julien Mekki, CERN**

15:45	**Poster session introduction (conference room)**
15:50	**Poster session start (poster room)**
17:30	**Poster session end**

17:30 RADECS association AGM

19:00 Gala dinner - Balliol College - please bring name badges and tickets

TECHNICAL PROGRAMME - FRIDAY

Invited talk: 08:30 - 09:30

AE9, AP9, and SPM: New Models for Radiation Belt and Space Plasma Specification

The radiation belts and plasma in the Earth's magnetosphere pose hazards to satellite systems which restrict design and orbit options with a resultant impact on mission performance and cost. For decades the standard space environment specification used for spacecraft design has been provided by the NASA AE8 and AP8 trapped radiation belt models. There are well-known limitations on their performance, however, and the need for a new trapped radiation and plasma model has been recognized by the engineering community for some time. To address this challenge a new set of models, denoted AE9/AP9/SPM, for energetic electrons, energetic protons and space plasma has been developed. The new models offer significant improvements including more detailed spatial resolution and the quantification of uncertainty due to both space weather and instrument errors. Fundamental to the model design, construction and operation are a number of new data sets and a novel statistical approach which captures first order temporal and spatial correlations allowing for the Monte-Carlo estimation of flux thresholds for user-specified percentile levels (e.g., 50th and 95th) over the course of the mission. An overview of the model architecture, data reduction methods, statistics algorithms, user application and initial validation is presented in this paper.

Dr Paul O'Brien

Paul O'Brien is a research scientist in the Space Sciences Department at The Aerospace Corporation. He holds a B.A. degree in physics and classics from Rice University, and M.S. and Ph.D. degrees in Earth and Space Science from the University of California, Los Angeles. He has over 15 years of experience in space science and the effects of the charged particle environment on space systems. His research experience includes magnetospheric physics, with special emphasis on radiation belts and empirical analysis of in situ particle data. He is one of the lead developers of the AE9/AP9 radiation specification models. He is the chair of the COSPAR Panel on Radiation Belt Environment Modeling (PRBEM).

TECHNICAL PROGRAMME - FRIDAY

Session I: Radiation Effects in Photonic Devices

Chairs:

- **Cedric Virmontois, CNES**
- **Jochen Kuhnhenn, Fraunhofer INT**

09:30 **Session I introduction**

I-1 **Coupled theoretical and experimental studies for the radiation hardening of silica-based optical fibers**

09:35 N. Richard [1], S.Girard [2], L. Martin-Samos [3], L. Giacomazzi [4], D. Di Francesca [2], C. Marcandella [1], A. Alessi [5], P. Paillet [1], S. Agnello [5], A. Boukenter [2], Y. Ouerdane [2], M. Cannas [5], R. Boscaino [2]

[1] CEA DAM DIF , [2] Lab. Hubert Curien, [3] University of Nova Gorica, [4] CNR-IOM DEMOCRITOS, [5] Università di palermo

Recent improvements of our approach coupling experiments and theory developed to study radiation effects on silica-based optical fibers are discussed. We focus on the SiE' defect that is observed and quantified through EPR measurements in all canonical samples.

I-2 **Comparison of proton damage effects in standard and enhanced depletion CMOS Image Sensors**

09:50 A. Pike [1], J. Pratlong [1], T. Greig [2]

[1] e2v technologies, [2] The Open University

A comparison of the proton radiation effects in CMOS Image Sensors manufactured with standard and enhanced depletion is presented. Electro-Optical sensitivity to proton damage is described, in particular for dark signal and random telegraph signals.

I-3 **Design and First Tests of a Radiation-Hard Pixel Sensor for the European X-Ray Free-Electron Laser**

10:05 E. Fretwurst [1], R. Klanner [1], I. Kopsalis [2], J. Schwandt [1], J. Zhang [1]

[1] University of Hamburg, [2] National Technical University of Athens

X-ray damage-parameters in MOS-structures on high-ohmic n-silicon have been determined between 10kGy and 1GGy and used in TCAD-simulations to optimize a pixel-sensor. First sensors have been delivered which show that the optimization has been successful.

I-4 **Determination of in situ trap properties in Charge Coupled Devices using a single-trap pumping technique**

10:20 D. Hall [1], N. Murray [1], A. Holland [1], J. Gow [1], D. Burt [2]

[1] The Open University, [2] e2v technologies

Radiation damage to focal plane CCDs in space telescopes can limit science performance. Trap-pumping allows parameters to be determined for single traps, located to the sub-pixel level, providing the essential information for image correction models.

Break 10:35 - 11:05 in the exhibitors' hall

Poster session: Thursday 26th September 15:45 - 17:30

PI-1 **Macro-bending influence on radiation induced attenuation of optical fibres**

E. Guillermain [1], J. Kuhnhenn [1], D. Ricci [2], U. Weinand [2]

[1] CERN, [2] Fraunhofer INT

Radiation induced attenuation of optical fibres shows discrepancies at high dose rate. This phenomenon is related to low bending radius. For irradiation tests of single-mode fibres, the spool radius shall be carefully chosen.

PI-2 **Displacement damage analysis of single-junction and triple-junction GaAs solar cells induced by electron irradiation**

X. Gao [1], S. Yang [1], Z. Feng [1], L. Zhang [1], X. Cui [2]

[1] Lanzhou Institute of Physics, [2] Tianjin Institute of Power Sources

The irradiation experimental results were present about single- and triple-junction GaAs cells. Displacement damage dose method was employed to analyze and predict the behaviors of the cells in typical electron-rich orbit radiation environments.

PI-3 **Initial Proton Damage Comparison of an e2v Technologies N-channel and P-channel CCD204**

J. Gow [1], N. Murray [1], A. Holland [1], D. Burt [2]

[1] The Open University, [2] e2v Technologies plc

A comparison of the experimental data collected using an e2v technologies n-channel and p-channel CCD204s under the same experimental conditions. The effect of different trap species on the devices' operation is also discussed.

TECHNICAL PROGRAMME - FRIDAY

Session J: Hardness Assurance

Chairs:

- **Christian Poivey, ESA, ESTEC**
- **Craig Underwood, University of Surrey**

11:10 **Session J introduction**

J-1 **Alpha-SER determination from Word-line Voltage Margin (WVM) measurements: Design architecture and experimental results**

11:15 G. Torrens [1], I. de Paúl [1], B. Alorda [1], S. Bota [1], J. Segura [1]

[1] Balearic Islands University

Experimental results from a 65nm CMOS commercial technology SRAM test chip reveal high correlation between the word-line voltage margin and the measured circuit alpha-SER. The technique requires minor design modifications with virtually no area impact.

J-2 **Impact of Single Event Gate Rupture and latent defects on Power MOSFETs switching operation**

11:30 A. Privat [1], A. Touboul [1], M. Petit [1], J. Huselstein [1], F. Wrobel [1], J. Vaille [1], S. Bourdarie [2], R. Arinero [1], N. Chatry [3], G. Chaumont [4] , E. Lorfèvre [5], F. Saigné [1]

[1] Université Montpellier 2, [2] ONERA, [3] TRAD, [4] STMicroelectronics SA, [5] CNES

This paper reports on the impact of single event gate rupture and post-irradiation gate stress on Power MOSFETs switching ability.

J-3 **Single Event Effects Characterization of Texas Instruments ADC12D1600CCMLS, 12 bit, 3.2 GSPS Analog-to-Digital Converter with Static and Dynamic Inputs**

11:45 K. Kruckmeyer [1], T. Trinh [1]

[1] Texas Instruments

A 12 bit, gigasample ADC was put through heavy ion testing, using different beam energies and range penetrations and with dynamic and static inputs. The results of the different test conditions are compared.

J-4 **Analysis of a non-destructive Single Event Burnout test methodology**

12:00 P. Oser [1], J. Mekki [1], G. Spiezia [1], E. Fadakis [1], G. Foucard [1], P. Peronnard [1], A. Masi [1], R. Gaillard [2]

[1] European Organization for Nuclear Research (CERN), [2] Atomic Energy Commission

This paper analyzes a non-destructive test circuit which was used for the SEB cross-section evaluation of power MOSFETs. However, it provoked destructive events and modified the initial test conditions which resulted in an incorrect cross-section.

12:15 **Closing ceremony**

12:45 **Conference close**

14:00 **Optional technical tours to RAL (ISIS / Diamond) or Culham (JET)**

Poster session: Thursday 26th September 15:45 - 17:30

PJ-1 **Analysis in the Frame Of Space Radiation Hardness Assurance of Low Dose Rate Results Obtained With MIL and ESCC Test Method**

R. Marec [1], J.F. Carlotti [1], M. Marin [1], P. Calvel [1], C. Barillot [1], R. Mancini [1], M. Sarno [1], M. Mélotte [1], J. Cueto [1]

[1] Thales Alenia Space

We present TID results obtained with dose rates of 10-100 mrad(Si)/s and 10 mrad(Si)/s on different space qualified bipolar part types. The results are analysed in the frame of the Thales Alenia Space RHA.

PJ-2 **A New Accelerated Method for Evaluating the ELDRS of Bipolar Operational Amplifiers: Temperature Switching Approach**

Z. Yuzhan [1], L. Wu [2], R. Diyuan [2]

[1] Institute of Spacecraft System Engineering,CAST, [2] Xinjiang Technical Institute of Phy. & Chem., CAS

An new accelerated evaluation method for the ELDRS in bipolar operational amplifiers is instroduced, that is switching method. The underlying mechanism of this accelerated evaluation method is also discussed.

PJ-3 **The estimation of long time operation bipolar devices in space environment using conversion model of ELDRS**

V. Pershenkov [1], A. Bakerenkov [1], A. Solomatin [1], V. Belyakov [1]

[1] MEPhI

On the basis of the proposed conversion model, the radiation degradation of LM111 comparator input current is considered during dose rate variation corresponding to a 12 hour orbit, cyclic device temperature variation and impact of solar flare.

PJ-4 **Neutron Sensitivity and Hardening Strategies for Fast Fourier Transform on GPUs**

P. Rech [1], L. Pilla [1], F. Silvestri [2], C. Frost [3], P. Navaux, M. Sonza Reorda [1], L. Carro [1]

[1] UFRGS, [2] Università di padova, [3] ISIS Facility, STFC Rutherford Appleton Laboratory, [4] Politecnico di Torino

The neutron sensitivity of FFT executed on GPUs is experimentally measured. Thread and data dependencies cause multiple output errors. As ECC is not sufficient to provide high reliability, software-based hardening strategies are designed and validated.

PJ-5 **Experimental Study of Heavy Ion Flux Impact on Single Event Errors of VLSI for Space**

Q. Yu [1], L. Luo [1], M. Zhu [1], Y. Sun [1], M. Tang [1]

[1] China Academy of Space Technology

The influences of heavy ion flux on single event errors of VLSI are tested. The impact of flux on single event upset errors is related to the interior structural designs of circuits and programs used.

PJ-6 **Hardening Dynamically Reconfigurable Processing Modules Architectures: A Neutron Test Experience**

L. Sterpone [1], D. Sabena [1], A. Ullah [1], M. Porrmann [2], J. Hagemeyer [2], J. Illstand [3]

[1] Politecnico di Torino, [2]University of Bielefeld, [3] ESA

We describe a neutron radiation testing campaigns on a dynamically reconfigurable system hardened with a new design flow on Xilinx Virtex-4 and Virtex-5 SRAM- based FPGAs. Experimental results demonstrate the effectiveness of the proposed method.

LATE NEWS

> The late news section features papers on new developments.

LATE NEWS

Session A: Basic Mechanisms of Radiation Effects

PA-4L **Total Ionizing Dose Effect on Low On/Off Switching Ratio**

Y. Chi [1], R. Liu [1], Z. Tang [1], R. Song [1]

[1] College of Computer, National University of Defense Technology

Total ionizing dose effect is experimentally investigated on the electrical characteristics of low on/off switching ratio TiO_2 memristive memories for the first time. Degradation of parameters have no impact on data storage and reading/writing operations.

Session B: Radiation Facilities & Dosimetry

PB-8L **A Facility for Soft Proton Irradiation of X-Ray Detectors and Instrument Testing for Future Astronomical Space Missions**

S. Diebold [1], J. Jochum [1], E. Kendziorra [1], E. Perinati [1], A. Santangelo [1], C. Tenze [1]

[1] Kepler Center for Astro Particle Physics - Universität Tübingen

Orbital soft protons (tens of keV to few MeV) can seriously degrade the performance of astronomical X-ray detectors. This paper presents a facility with setups for homogeneous irradiation of large detectors and for instrument testing.

PB-9L **Status and prospects of the SIRAD irradiation facility for radiation damage studies at LNL**

L. Silvestrin [1], D. Bisello [1], A. Candelori [2], P. Giubilato [1], S. Mattiazzo [3], D. Pantano [1], M. Tessaro [2], J. Wyss [1]

[1] Department of Physics and Astronomy, University of Padova and INFN Padova, [2] INFN Padova, [3] Department of Physics and Astronomy, University of Padova, [4] DiCEM, University of Cassino and INFN Padova

The SIRAD irradiation facility at LNL is devoted to SEE and bulk damage studies on electronic devices and systems. We describe in detail SIRAD and present SEU cross-section measurements of the ESA SEU monitor.

PB-10L **Neutron and gamma fields at neutron spallation sources for single-event-effects testing**

Q. Hong [1], S. Platt [1], S. Mein [1], L. Zhang [1]

[1] University of Central Lancashire

Monte-Carlo simulations of spallation fields are used to determine neutron and gamma spectra in beams used for single-event-effects testing.

LATE NEWS

PB-11L **CUP - a new high-flux irradiation position at the ANITA neutron facility at TSL**

A. Prokofiev [1], E. Passoth [1], A. Hjalmarsson [2]

[1] The Svedberg Laboratory, Uppsala University, [2] Department of Physics and Astronomy, Uppsala University

A new irradiation position has been characterized and put into operation at the ANITA facility for accelerated neutron SER testing. The neutron flux is the highest among the facilities in the same class.

PB-12L **Modeling the response of the ESAPMOS4 RADFETS for the ALPHASAT CTTB experiment**

P. Gonçalves [1], A. Keating [1], A. Trindade [1], P. Rodrigues [1], M. Ferreira [1], P. Assis [1], M. Muschitiello [2], B. Nickson [2], C. Poivey [2]

[1] LIP, [2] ESA/ESTEC

A model describing the observed ESAPMOS4 RADFETs temperature dependent response during low dose rate irradiation at ESA Co-60 facility is presented, along with an analysis of the RADFET's response during isothermal annealing following irradiation.

Session G: Radiation Effects in Electronic Devices

PG-6L **Investigation of Single-Event Damages on Silicon Carbide (SiC) power MOSFETs**

E. Mizuta [1], S. Kuboyama [1], H. Abe [2], T. Tamura [2]

[1] JAXA, [2] JAEA

It was demonstrated that single-event burnout (SEB) was observed in silicon carbide power MOSFETs caused by heavy ion and proton irradiations. In addition to SEBs, permanent damage was also observed with higher LET ions.

PG-7L **Threshold Voltage Shift in 65nm NOR Flash**

K. Lavery [1]

[1] Texas Instruments

Neutron testing at LANSCE is presented on 65nm NOR flash; the initial threshold voltage (V_T) of the bank plays a role in determining the likelihood of a threshold voltage shift.

LATE NEWS

Session H: SEE Modelling

PH-4L **SEGR in SiO_2–Si_3N_4 stacks**

A. Javanainen [1], V. Ferlet-Cavrois [2], A. Bosser [1], J. Jaatinen [1], H. Kettunen [1], M. Muschitiello [2], F. Pintacuda [3], M. Rossi [1], J. Schwank [4], M.R. Shaneyfelt [4], A. Virtanen [1]

[1] University of Jyväskylä, [2] ESA/ESTEC , [3] STMicroelectronics, [4] Sandia National Labs

This work presents experimental SEGR data for MOS-devices, where the gate dielectrics are formed with stacked SiO_2–Si_3N_4 structures. Also a semi-empirical model for predicting the critical gate voltage in these structures under heavy-ion exposure is proposed.

PH-5L **Single-Event Cluster Multibit Upsets Due to Localized Latch-up in a 90nm COTS SRAM containing SEL Mitigation Design**

L.Yin-Hong [1], Z. Feng-Qi [2], G. Hong-Xia [2], W. Hajdas [1], Z. Hui [2], Z. Li-Sang [3], J. Dong-Mei [3], S. Chen [3], G. Ding [3]

[1] Paul Scherrer Institut, [2] Northwest Institute of Nuclear Technology, [3] Cogenda Co. Ltd

A 90nm low-power SRAM exhibits cluster multibit flips due to a single particle strike. Based on TCAD simulation, we attribute the cluster flips to localized latch-up events that can affect a segment of 32x64 bits.

Session I: Radiation Effects in Photonic Devices

PI-4L **Proton, Electron and Heavy Ion Single Event Effects on the HAS2 CMOS Image Sensor**

M. Beaumel [1], D. Hervé [1], D. Van Aken [2], P. Pourrouquet [3], M. Poizat [4]

[1] EADS SODERN, [2] ON Semiconductor, [3] TRAD, [4] ESA-ESTEC

The Single Event Effects sensitivity of the HAS2 CMOS Image Sensor has been characterized with protons, electrons and heavy ions. Effects in the photosensitive area and in the read-out integrated circuit have been studied.

Session J: Hardness Assurance

PJ-7L **A Study of the Robustness Against SEUs of Digital Circuits Implemented with FPGA DSPs**

F. Serrano [1], J.A. Clemente [1], H. Mecha [1]

[1] Universidad Complutense de Madrid

This paper presents an experimental validation of the reliability increase of digital circuits implemented in Xilinx FPGAs when they are implemented using the DSPs (Digital Signal Processors) that are available in the reconfigurable device.

LATE NEWS

Data Workshop

DW-21L **New SEE and TID Test Results for 2-Gbit and 4-Gbit DDR3 SDRAM Devices**

M. Herrmann [1], K. Grürmann [1], F. Gliem [1], H. Schmidt [2], M. Muschitiello [3], V. Ferlet-Cavrois [3]

[1] IDA, TU Braunschweig, [2] Astrium GmbH, [3] ESA-ESTEC

Different 2-Gbit and 4-Gbit DDR3 SDRAM devices have been tested. Under Cobalt 60, some of them showed a peculiar error pattern. Under heavy ions, none of the tested types displayed any latch-up.

DW-22L **Heavy ion testing of two types of digital step attenuator**

R. Sharp [1], J. Hofman [1], A. Devexhiu [2], P. Denny [2]

[1] Synergy Health plc, [2] Peregrine Semiconductor

This presentation details heavy ion radiation testing of two types of digital step attenuator fabricated in Peregrine Semiconductor's UltraCMOS® process. No single event effects were observed, even at a LET of 120 MeV/mg/sq cm.

DW-23L **Recent Proton and Co60 Radiation Test Data from a newly developed European Optocoupler source for space application**

M. Bregoli [1], S. Hernandez [2]

[1] Optoi, [2] ESA ESTEC

The permanent degradation introduced in the main electrical parameters of a newly developed European optocoupler type is described as a function of proton fluences and Co-60 total ionizing dose.

SESSION CHAIR ACKNOWLEDGEMENT

The RADECS 2013 organising committee would like to thank the following:

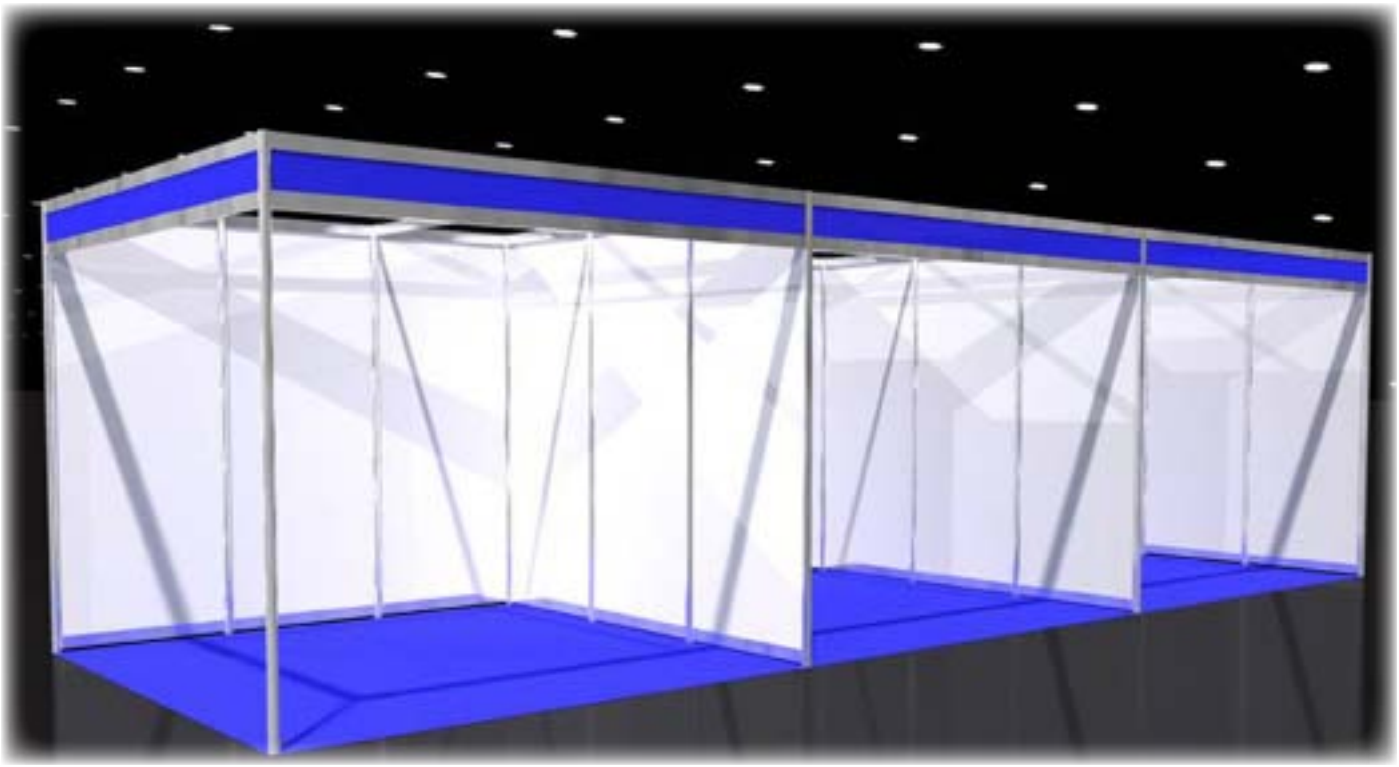
Lew Cohn	Naval Research Laboratory
Véronique Ferlet-Cavrois	ESA ESTEC
Chris Frost	ISIS Facility, STFC Rutherford Appleton Laboratory
Thomas Granlund	SAAB Group
Alex Hands	AWE
Reno Harboe-Sørensen	Consultant (formerly ESA)
Jochen Kuhnhenn	Fraunhofer INT
Ray Ladbury	NASA
Dale McMorrow	Naval Research Laboratory
Alessandro Paccagnella	University of Padua
Lee Pater	Astrium
Philippe Paillet	CEA
Slava Pershenkov	National Nuclear Research University, MEPHI
Simon Platt	University of Central Lancashire
Christian Poivey	ESA
Vincent Pouget	Université Montpellier 2
Heather Quinn	Los Alamos National Laboratory
Ron Schrimpf	Vanderbilt University
Fred Sexton	Sandia National Laboratory
Craig Underwood	University of Surrey
Cedric Virmontois	CNES
Frédéric Wrobel	IES, Université Montpellier 2

REVIEWER ACKNOWLEDGEMENT

The RADECS 2013 organising committee would also like to thank the following:

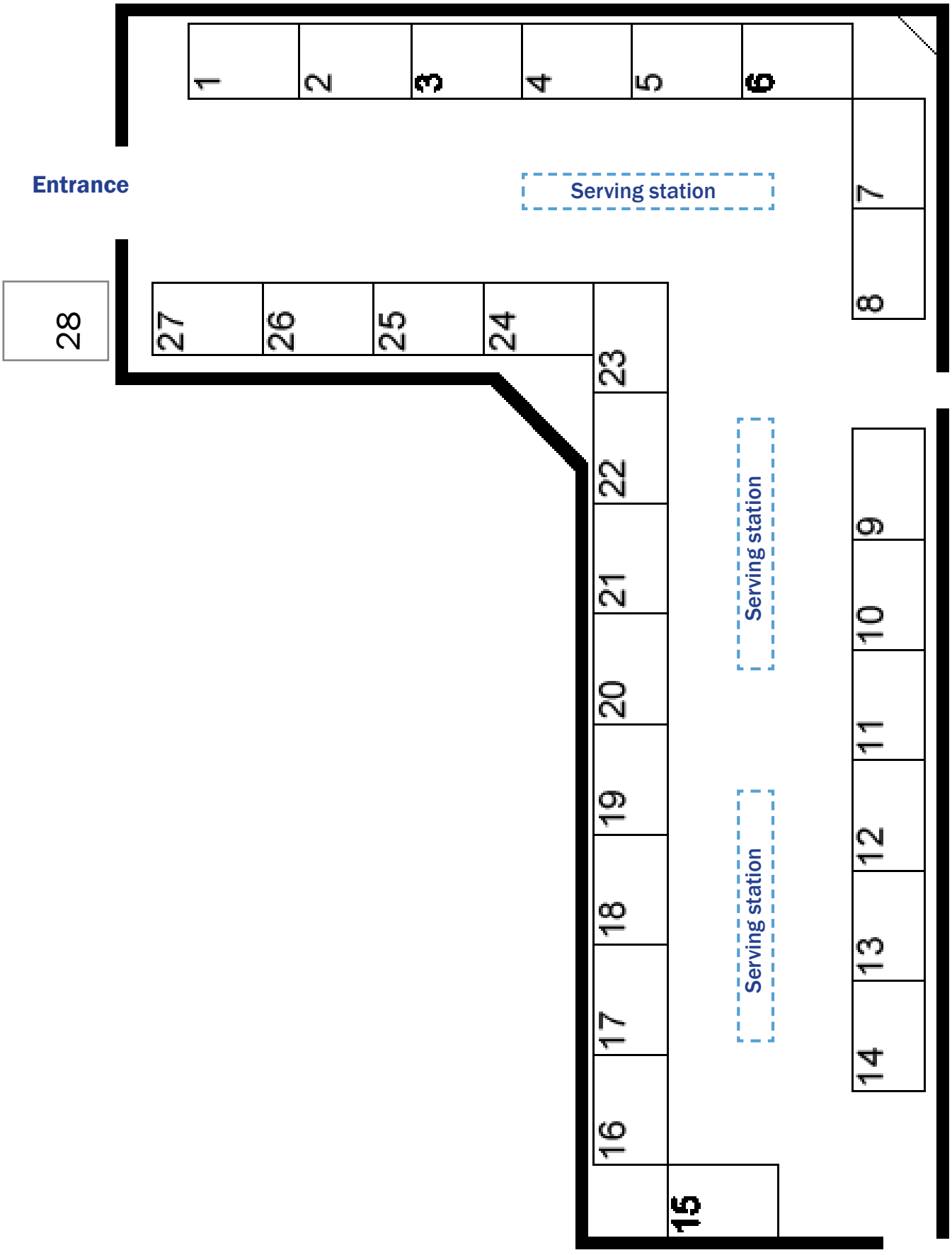
Philippe	Adell	Jet Propulsion Laboratory
Dan	Alexandrescu	iRoC Technologies
Sarah	Armstrong	NSWC Crane
Laurent	Artola	ONERA
Jean-Luc	Autran	AIX-Marseille University
Keith	Avery	AFRL
Marta	Bagatin	DEI - University of Padova
Janet	Barth	NASA
Rob	Baumann	TI
Melanie	Berg	NASA GSFC- MEI Technologies
Francoise	Bezerra	CNES
Ben	Blalock	The University of Tennessee
Cesar	Boatella-Polo	CNES
Jerome	Boch	Université Montpellier 2
Stephen	Buchner	Naval Research Laboratory
Manuel	Cabanas-Holmen	Boeing
Ethan	Cannon	Boeing
Megan	Casey	NASA
Dakai	Chen	NASA
Lawrence	Clark	Arizona State University
Kobayashi	Daisuke	ISAS/JAXA
Eamonn	Daly	ESA
Frédéric	Darracq	IMS laboratory
Paul	Dodd	Sandia National Laboratories
Nathaniel	Dodds	Sandia National Laboratories
Peter	Duncan	MBDA UK
Clive	Dyer	Consultant
Paul	Eaton	Micro-RDC
Robert	Ecoffet	CNES
Robert	Edwards	AEC
Daniel	Fleetwood	Vanderbilt University
Edward	Friebele	Naval Research Laboratory
Adam	Frydland	AWE
Marc	Gaillardin	CEA
Ruben	Garcia Alia	CERN
Gilles	Gasiot	ST
Simone	Gerardin	University of Padova
Giuseppe	Gorini	Universita Milano-Bicocca
Leif	Granholm	SSC
Russell	Graves	Orbital
Andrei	Gusarov	SCK-CEN
Wojtek	Hajdas	PSI
David	Hansen	Maxwell
Stefan	Hoeffgen	Fraunhofer INT
Jiri	Hofman	Synergy Health Plc
Arto	Javanainen	Jyvaskyla University
Allan	Johnston	Jet Propulsion Laboratory
Insoo	Jun	JPL
Kirby	Kruckmeyer	Texas Instruments
S	Kuboyama	JAXA
Ken	Label	NASA
Reed	Lawrence	BAE Systems
Fan	Lei	QINETIQ
Jean-Luc	Leray	CEA
Austin	Lesea	Xilinx
Daniel	Loveless	Vanderbilt University
Gary	Lum	Lockheed-Martin
Akiko	Makihara	HIREC
Wassim	Mansour	TIMA
Ronan	Marec	Thales Alenia Space
Cheryl	Marshall	NASA
Paul	Marshall	GSFC/Consultant
Lloyd	Massengill	Vanderbilt University
Stanley	Mattsson	SAAB
Michel	Mélotte	Thales Alenia Space
Scott	Messenger	NRL
Florent	Miller	EADS IW
Steven	Moss	Aerospace
Daniela	Munteanu	IM2NP-CNRS
Ron	Pease	RLP Research
Jonathan	Pellish	NASA/GSFC
Bruno	Piquet	GANIL
Marc	Poizat	ESA
Alexander	Prokofiev	Svedberg Laboratory of Uppsala University
Mélanie	Raine	CEA
Paolo	Rech	UFRGS
Robert	Reed	Vanderbilt University
Nicolas	Richard	CEA, DAM, DIF
Ken	Rodbell	IBM
Anatoly	Rosenfeld	University of Wollongong
Leif	Scheick	JPL/CIT
Jim	Schwank	Sandia National Laboratories
Marty	Shaneyfelt	Sandia National Laboratories
Joe	Srour	Aerospace Corp
Fredrik	Sturesson	ESA
Jeffrey	Titus	US Navy
David	Truyen	ATMEL
Rustem	Useinov	National Research Nuclear University MEPHI
Ari	Virtanen	RADEF
Robert	Weller	Vanderbilt University
Thijs	Wijnands	CERN
Mike	Xapsos	NASA
Gennady	Zebrev	National Research Nuclear University MEPHI

EXHIBITORS' SECTION



"The 2013 exhibitors have a range of products and expertise to support the radiation effects industry."

EXHIBITION MAP



EXHIBITORS

Booth number	Company
1	TRAD
2	International Rectifier
3	HiLevel Technology Inc
4	Isocom Limited
5	MBDA
6	Peregrine Semiconductor
7	Aeroflex
8	Aeroflex
9	Fraunhofer INT
10	Crane - Interpoint Brand
11	Astrium GmbH
12	Silicon Space Technology
13	Analog Devices
14	Microsemi
15	Atmel
16	STMicroelectronics
17	M.S. Kennedy Corp
18	XIA LLC
19	ISDE & ROSCOSMOS
20	Modular Devices Inc
21	Intersil
22	Texas Instruments
23	Alter Technology Tüv Nord
24	Maxwell Technologies
25	3D Plus
26	SPELS / NRNU MEPHI
27	API Technologies Corp
28	Synergy Health plc

Exhibition hours

Tuesday 24th September: 10:00 - 19:30
Wednesday 25th September: 10:00 - 16:30
Thursday 26th September: 10:00 - 16:00

Exhibitors' reception

Tuesday 24th September: 17:30 - 19:30

Exhibitors' prize raffle

A prize raffle will be held during the last break (15:05 - 15:35) on Wednesday 25th September. To be in with a chance to win, make sure you hand in your business cards to the following participating exhibitors:

- Synergy Health plc
- International Rectifier
- HiLevel Technology
- Aeroflex

International IOR Rectifier
THE POWER MANAGEMENT LEADER

HILEVEL TECHNOLOGY, INC.

AEROFLEX

synergyhealth

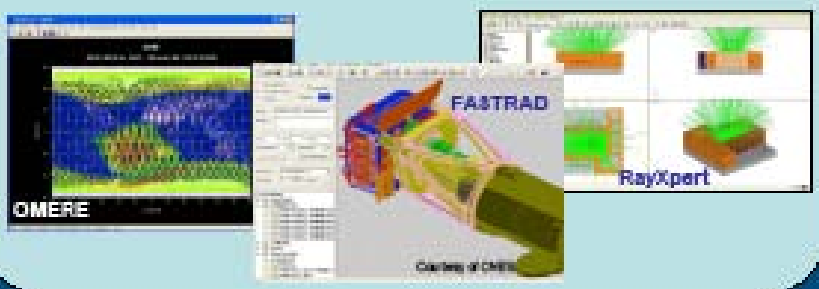
TRAD - Tests & Radiations

Founded in 1994, TRAD, Tests & Radiations is an independent company providing High Reliability electronic services for space, defense, aviation and other harsh environment applications where reliability is critical.

Test and analysis of radiation effects on materials, components and electronic systems.

ENGINEERING

- ✓Environment & dosimetry calculations
- ✓Shielding Analysis & Sizing
- ✓Radiation Training
- ✓OMERE software for space environment & effects
- ✓FASTRAD® software for spatial applications
- ✓RayXpert® software for the nuclear domain

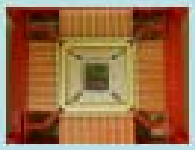


TESTING

- ✓Parametric & Functionality tests
- ✓Test benches development for TID, DD, SEE
- ✓Extensive experience and knowledge in discrete and complex parts (Memories, FPGAs, ASICs,…)

EEE COMPONENTS EXPERTISE

- ✓Quality Assurance
- ✓Radiation Database



IN-HOUSE FACILITIES

- ✓GAMRAY
  - > Co60 source for TID testing
  - > Dose rate: 7rad(Si)/h to 1krad(Si)/h
  - > Operational since October 2012

NEW!!

- ✓Electron accelarator
  - > 1 to 4 MeV
  - > 10^{-6} mbar vacuum
  - > Temperature range -150 to +150°C
  - > Operational early 2014

MATERIALS

- ✓Radiative environment Testing (ECSS-Q-ST-70-06C)
- ✓Thermal cycling: vacuum & atmospheric (ECSS-Q-ST-70-04C)
- ✓UV ageing under vacuum (ECSS-Q-ST-70-06C)

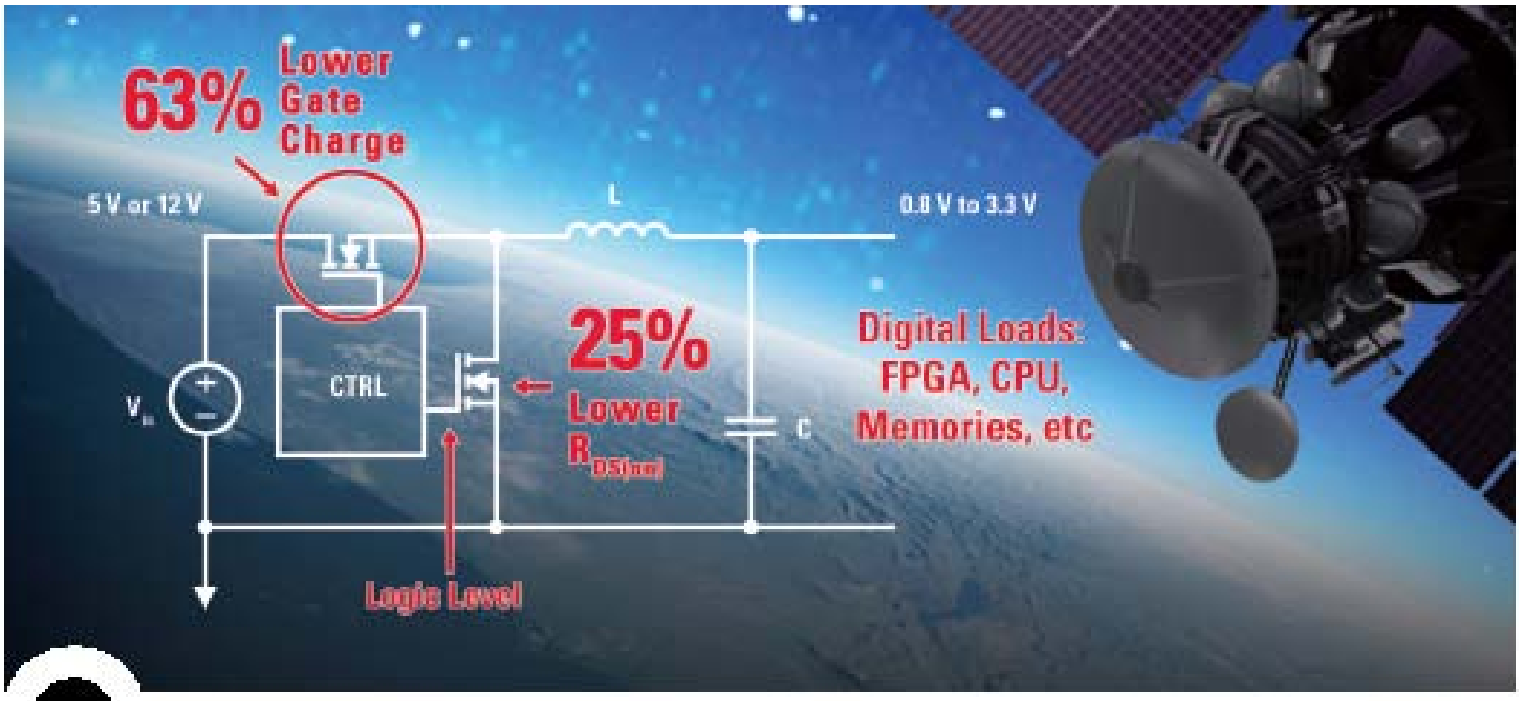
- ✓Characterisation Means & functional Testing

Come see us at Booth N° 1 to discuss your projects and discover our solutions !

907 l'Occitane 31670 Labège Cedex – France
Tel: +33 (0)5 61 00 95 60 – Fax: +33 (0)5 61 00 95 61
E-mail: trad@trad.fr – www.trad.fr
www.fastrad.net

afaq ISO 9001 Qualité AFNOR CERTIFICATION

TRAD Tests & radiations



New $\mathcal{R}_8$ RAD-Hard MOSFETs for POL

Part Number	Package	B_{VDSS}	I_D	$R_{DS(on)}$ Max	Q_G Max	θJC
IRHLNM67260CS	SMD 0.2	20V	17A	15 mΩ	24 nC	3.5 °C/W

Visit us at **Booth 2** for the latest in RAD-Hard MOSFET technology

IR's new $\mathcal{R}_8$ radiation hardened logic level gate drive power MOSFETs set a new industry standard for lowest on-resistance ($R_{DS(on)}$) and switching speed (Q_G) enabling the least in class efficiency performance for point of load voltage regulators.

Features

- 20 V B_{VDSS}
- TID rated to 100 Krads without performance degradation to 300 Krads
- SEE immunity to LET of 81 MeV-cm²/mg
- Logic level gate drive with V_{GS} rating to 12V
- Low $R_{DS(on)}$ 12 milliohms typical (SMD 0.2 package)
- Low total gate charge (Q_G) 18 nC typical
- Available in SMD 0.2, the industry's smallest surface-mount power package yielding 50% space saving and TO-39 package for thru-hole assembly

For more information call +49 (0) 6182 884 311 or visit us at www.irf.com

International
IOR Rectifier
THE POWER MANAGEMENT LEADER

INTRODUCING...

A NEW LOW-COST TESTER FOR SINGLE EVENT EFFECTS TESTING

HILEVEL TECHNOLOGY, INC.

GRIFFIN SEE-RAD Test System

- Optimized for Radiation Effects Test
- Analyze and Save Results While Testing Continues to Run
- APG Memory Test with Bitmapping
- Deep 64M Capture Memory

HiLevel testers are compact, portable, robust, and easy to use. Visit HiLevel in booth 3 at the RADECS conference and expo in Oxford, UK between September 24 – 26 to learn more about HILEVEL.

For more information:
HiLevel Technology, Inc. 1-800-HILEVEL
17805 Sky Park Circle, Suite E, Irvine CA, 92614 USA
hilevel@hilevel.com www.hilevel.com

www.hilevel.com

Radiation hard optoelectronic isolation

31 years experience providing isolation for electronic systems in Aerospace & Defence applications

High Quality

IECQ
(M1077 IECQ)
ISO9001:2008
(SGS GB09/76607)
MIL-883 STD*
MIL-S-38510 STD*
MIL-S-19500 STD*
*Compliant

Radiation Hard

High Speed Optocouplers
TID Tolerant to 1Mrad (Si)
QC 88000 C0002

Neutron Tolerant to
1MeV - 1E-13n/cm2 Max

Proton Tolerant to
200MeV Max

Optical Isolation

Single, Dual & Quad Channels
Darlington
High Speed
Triacs / Zero Crossing Triacs
AC Input
Schmitt Trigger
AC/DC Logic Interface
SCR High Collector-Emitter

Flexibility

Our flexibility helps designers to improve the assembly process and achieve weight and cost reductions.
Dual in line, Surface mount, Metal can, LCC or flatpack packages available.
Custom circuits and packages also available.

Manufacturing Capabilities

Our manufacturing process for high reliability optoelectronic components includes Acceleration Testing, PIND Testing and 100% Screening to MIL Standards

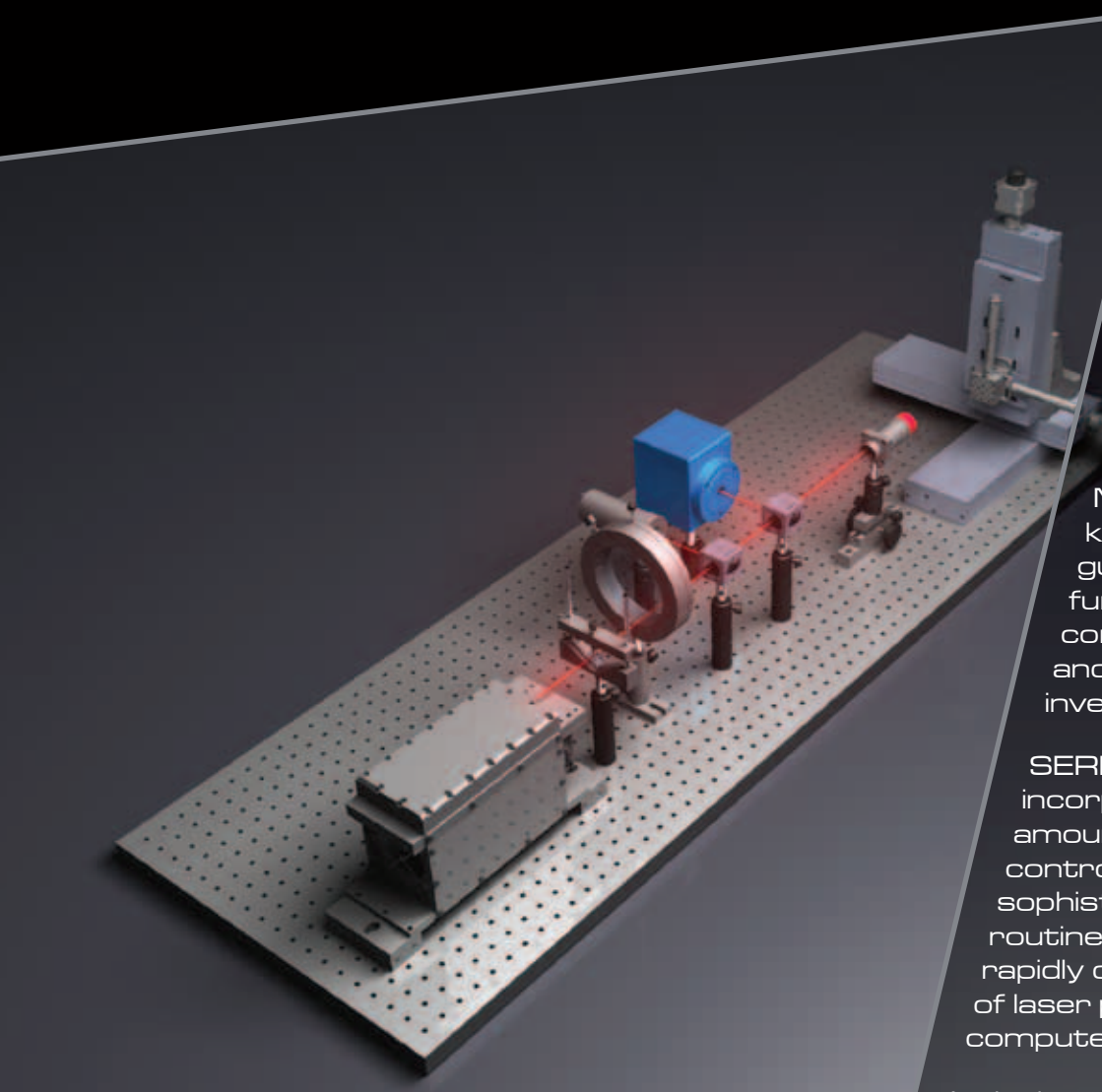
www.isocom.uk.com
0044 (0)191 4166546
sales@isocom.uk.com

ISOCOM® LIMITED

Radiation Effects Group
SEREEL-EXPORT

SEREEL2

MARITIME SUPERIORITY
AIR DOMINANCE
GROUND BASED AIR DEFENCE
BATTLEFIELD ENGAGEMENT



MBDA have designed a powerful clone of MBDA's own Single Event Radiation Effects in Electronics Laser facility (SEREEL2), which is known as:

SEREEL-Export.

MBDA's technical knowledge and expertise guarantee instant functionality, negating considerable research and development investment.

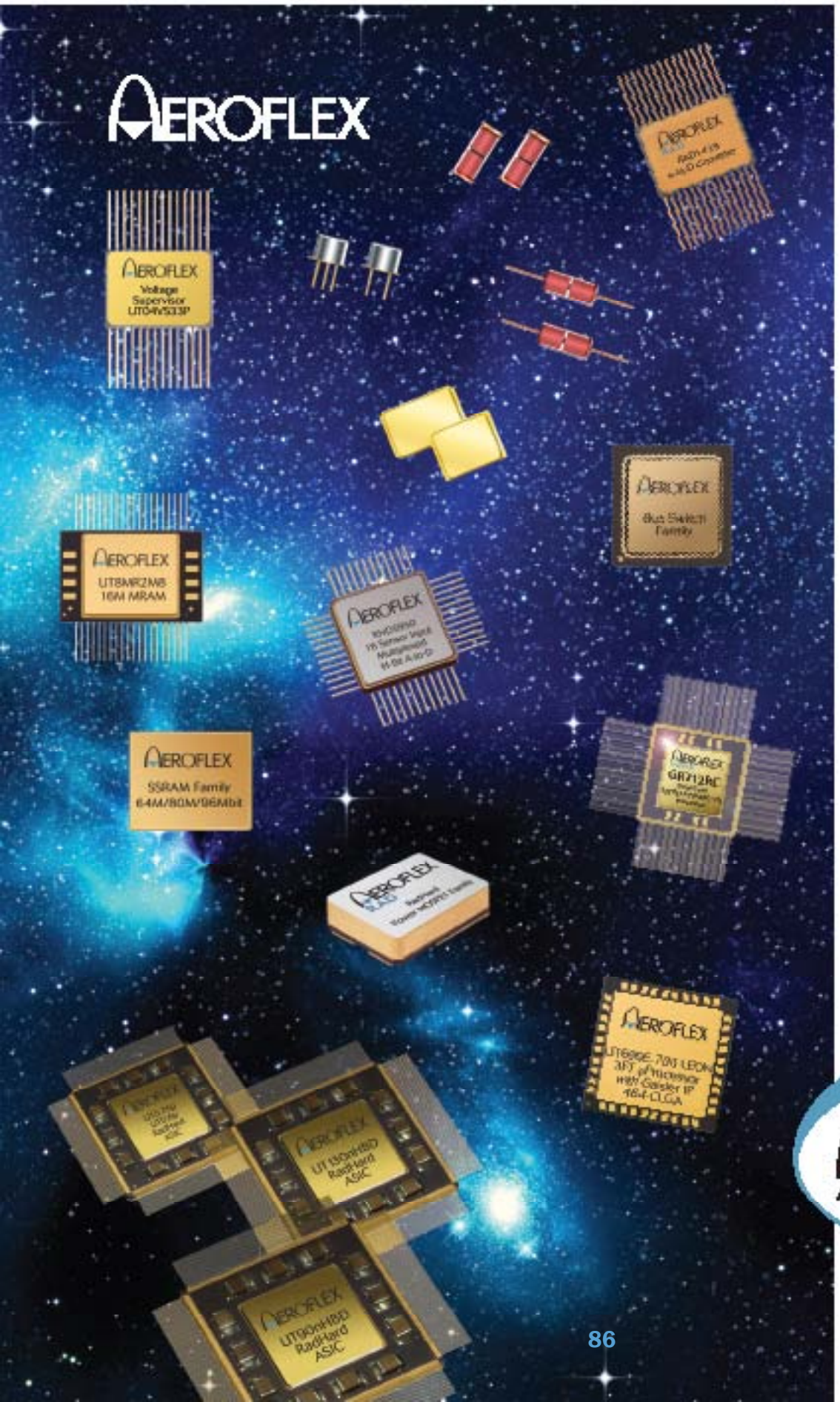
SEREEL-Export incorporates a considerable amount of operational and control software, including sophisticated Labview routines for efficiently and rapidly delivering large arrays of laser pulses to devices under computer control.

Inclusion of backside laser pulsing capability, avoids the metallisation interference normally encountered with frontside microchip lasing.

Precision Solutions
MBDA UK Ltd
Six Hills Way, Stevenage, Hertfordshire SG1 2DA, UK
Tel: +44 (0)1438 754477
Fax: +44 (0)1438 755198
www.mbda-systems.com
precision.solutions@mbda-systems.com
For additional information visit our website: www.mbdaps.com

MBDA

Aeroflex Microelectronic Solutions serves your HiRel requirements



Aeroflex Microelectronic Solutions... Digital, Analog, Power, RFMW, and Motion Solutions for HiRel Applications... serving worldwide customers with HiRel standard products:

- LEON 3FT IP and µProcessors
- Memories, SpaceWire
- LVDS, Logic, FPGAs
- ADCs/DACs
- Diodes, MOSFETs
- Op Amps, Comparators
- Muxes
- Voltage Regulators/ Supervisors
- Bus Switches

Aeroflex custom ASICS – 90 and 130nHBD, 0.25 and 0.6µm technologies and FPGA to ASIC Conversions.

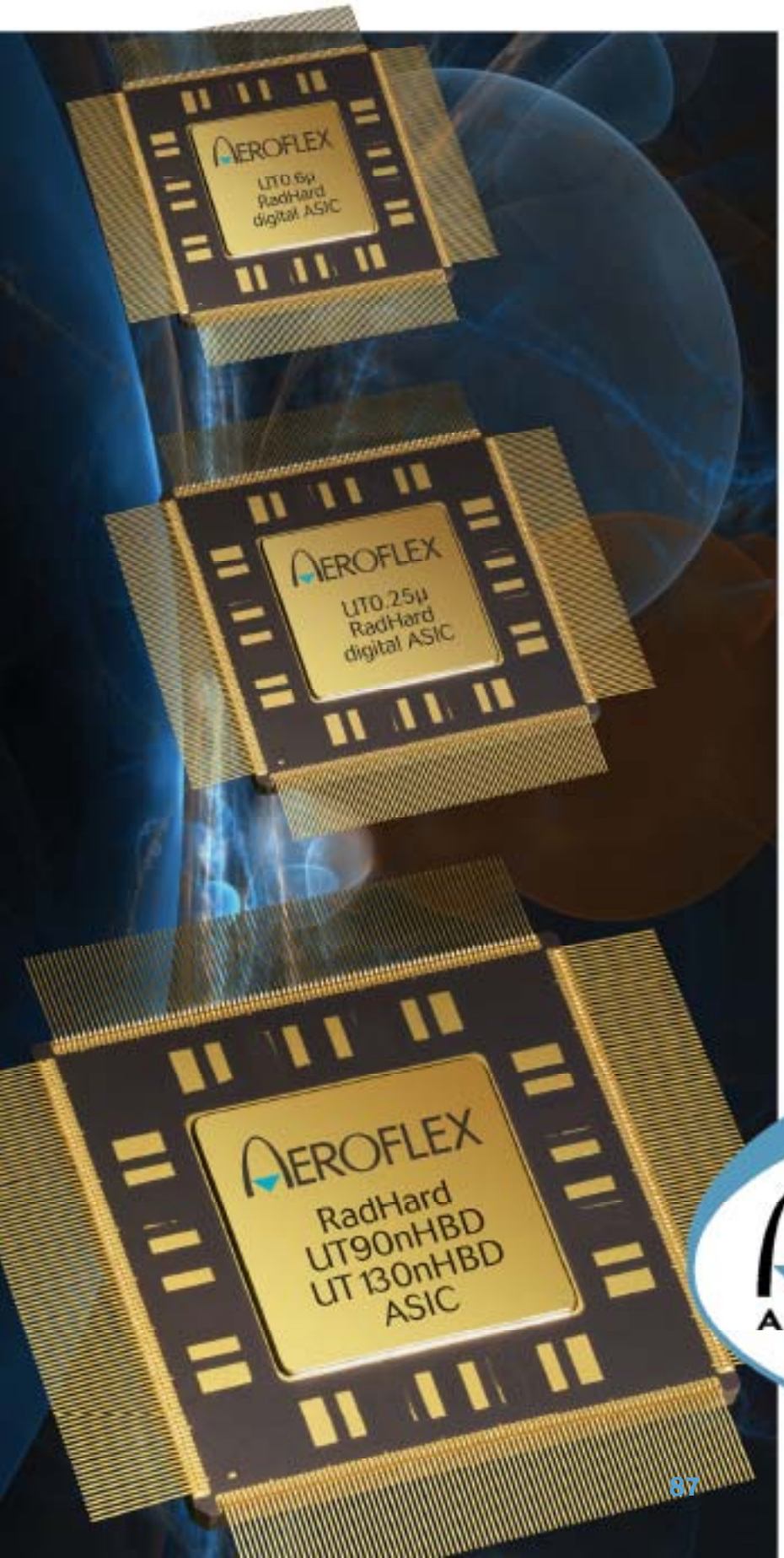
Electronic Manufacturing Services:

- Circuit Card Assembly
- Radiation Testing
- Custom Hybrid, Module and MCM Services

www.aeroflex.com/HiRel
800-645-8862

AEROFLEX
A passion for performance.

Launch with a RadHard ASIC you trust



Aeroflex continues to provide the latest innovations in RadHard digital ASICs, as we have for over 30 years! Our latest 90nHBD and 130nHBD deep-submicron technology allows significant advantages for HiRel applications.

- High speed, low power
- 90nHBD, 130nHBD, 0.25µ, and 0.6µ
- Validated radiation performance
- Trusted CAT1A accreditation
- Aeroflex Gaisler IP options support your ASIC designs

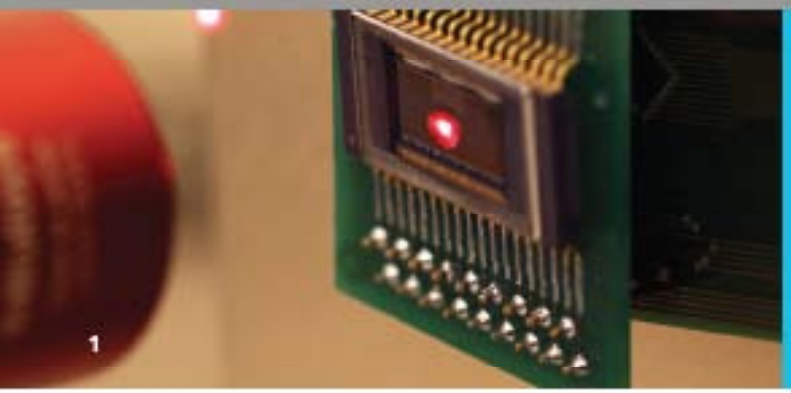
Check out why Aeroflex continues to be the leader in RadHard Mixed-Signal ASICs.

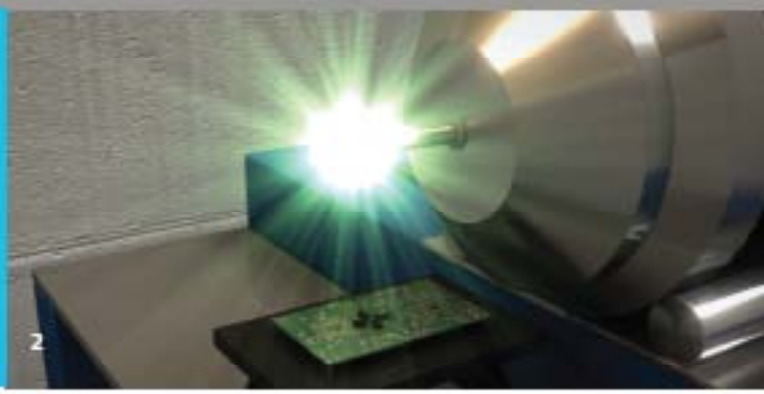
800-645-8862
aeroflex.com/RadHardASIC

AEROFLEX
A passion for performance.

Fraunhofer
INT

FRAUNHOFER-INSTITUTE FOR TECHNOLOGICAL TREND ANALYSIS INT





1 *A Laser focused on an Integrated Circuit.*
2 *A Cobalt-60-Source used for Gamma-Irradiation*

NUCLEAR EFFECTS IN ELECTRONICS AND OPTICS

Profile

- Investigations of the effects of all kinds in radiation environments
- Performance, analysis, and evaluation of irradiations done at Fraunhofer INT and external facilities
- Ensuring the operability of components and systems in typical radiation environments, such as space, nuclear facilities, medicine, or accelerators
- Consulting users and manufacturers on the use of products in radiation environments by selecting, optimizing and hardening
- Measurement of the radiation effects on optical fibers and fiber Bragg gratings (FBG)
- Development of radiation sensors based on optical fibers, FBGs, oscillating crystals, UV-EPROMs, and SRAMs
- Participation in the development of international testing procedures for IEC, IEEE, NATO, and IAEA
- All services ISO-9001 certified

Irradiation Facilities

- 3 Co-60 gamma irradiation facilities (dose rate: 10 µGy/s to 1 Gy/s)
- One exclusive proton irradiation beam line at the FZ Jülich (maximum energy: 35 MeV; proton flux: 10^{8} – 10^{10} p/cm²s)
- Access to high energy heavy ions at GSI (energy: 50 to 2000 MeV/u)
- Two neutron generators (neutron energy: 2.5 and 14 MeV; neutron fluence: up to $4x10^{10}$ n/s)
- One laser for SEE investigations (wavelength: 1064 nm; pulse length: 9 ps; energy: up to 200 µJ/ pulse)
- One X-ray facility (energy: 20 to 450 keV; anode current: up to 20 mA)
- One flash X-ray facility (energy: up to 2.2 MeV; pulse length: 30 ns)
- Possibility for high dose irradiations (MGy), low energy heavy ions (10 MeV/u) and low energy protons (up to 200 keV) at external facilities

QUALITY SYSTEM CERTIFICATION – ISO 9001 DNV

Fraunhofer-Institute for
Technological Trend Analysis INT

Appelsgarten 2
D-53879 Euskirchen
Germany

Contact Person

Dr. Stefan Metzger
Phone +49 2251 18-214
stefan.metzger@int.fraunhofer.de

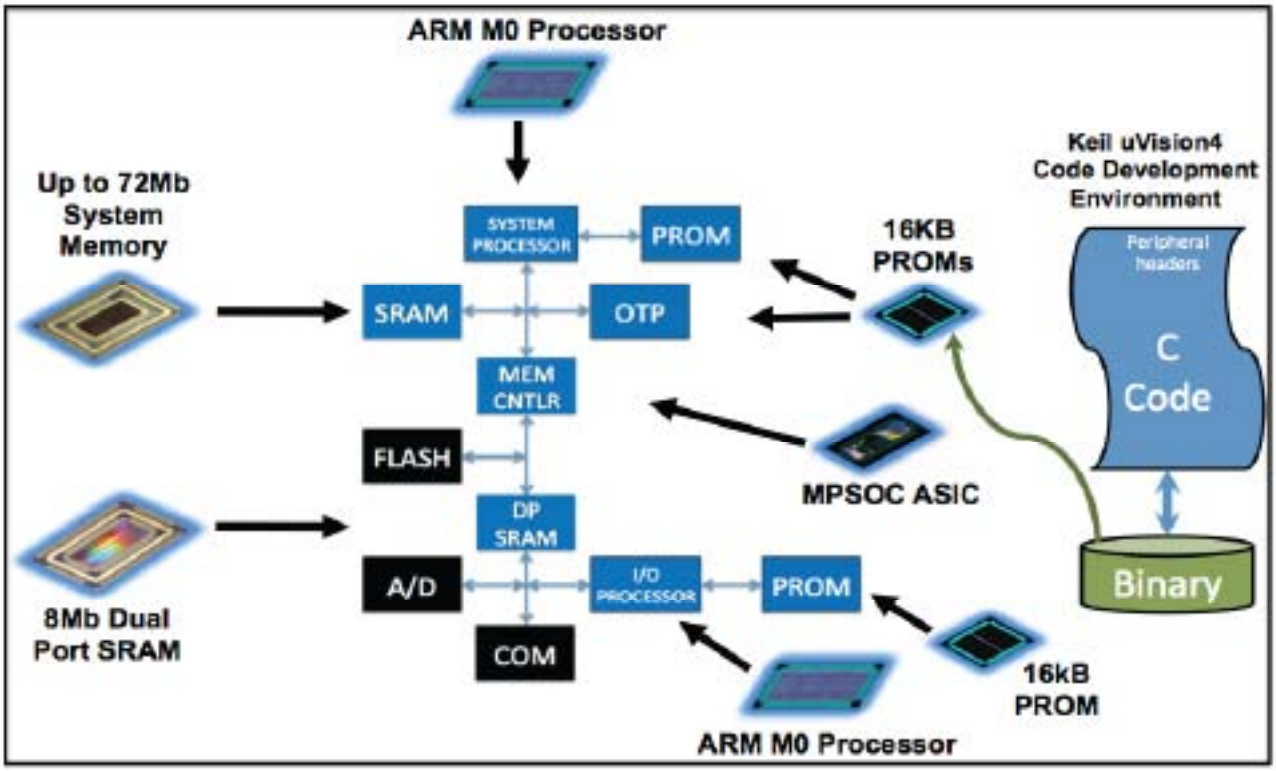
www.int.fraunhofer.de

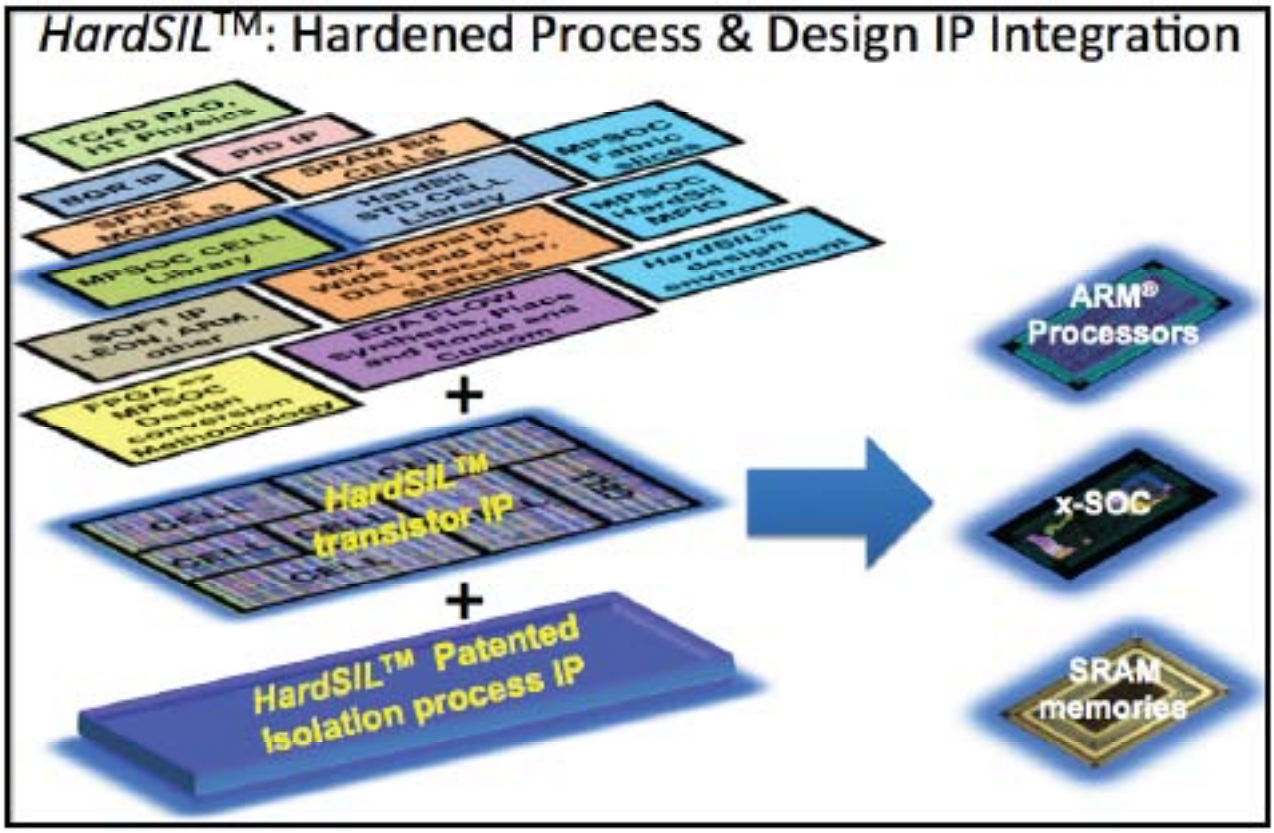
RADECS 2013
Oxford, UK
23rd - 27th September 2013

SST's *HardSIL*™
@ siliconspacetech.com

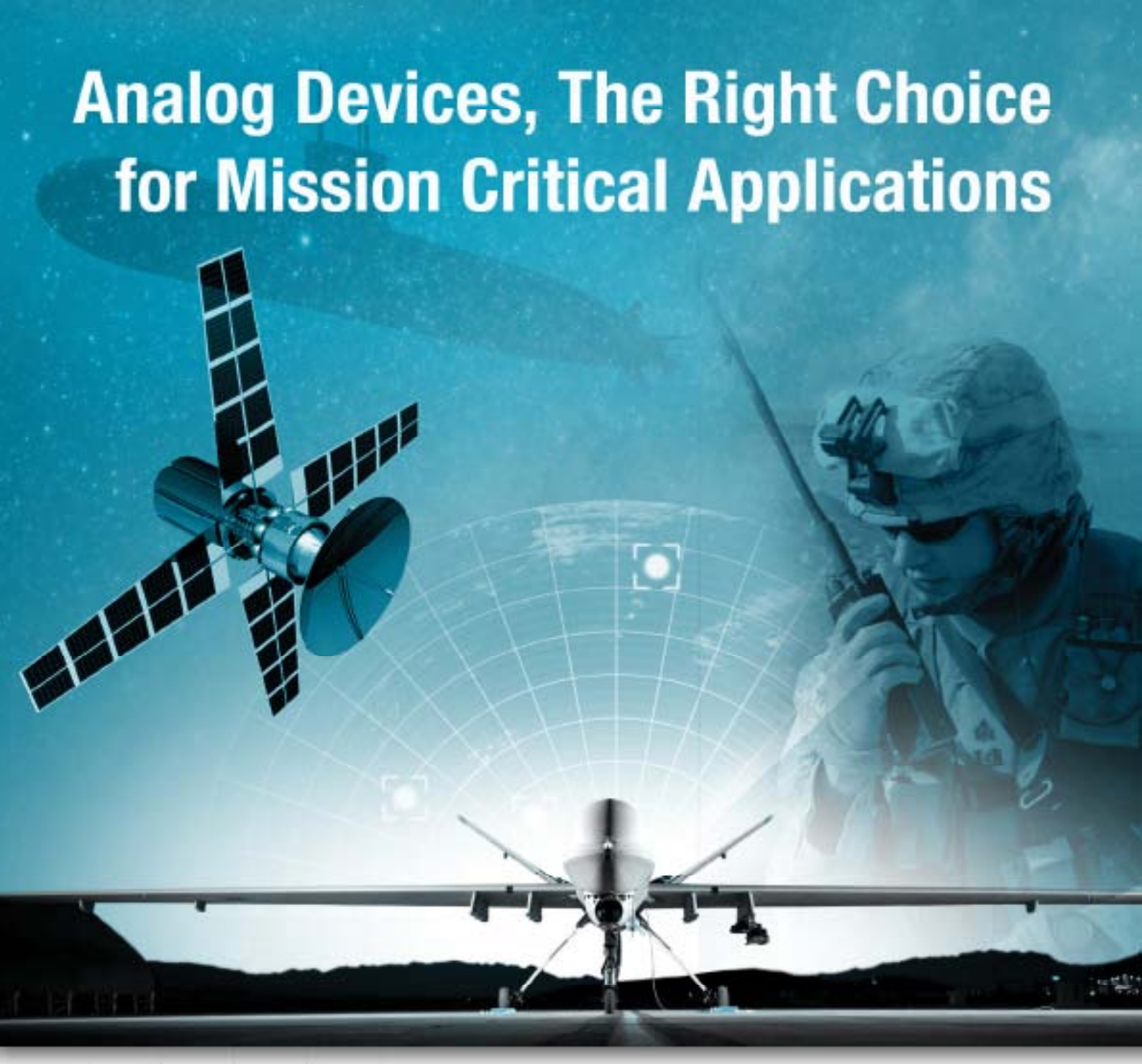
See us @ booth 12

RADIATION HARD COMPONENTS





Analog Devices, The Right Choice for Mission Critical Applications



Analog Devices, a trusted name in the design and manufacture of space based IC solutions

Analog Devices is committed to serving the needs of the world space community by manufacturing the highest quality data conversion and signal processing products. Analog Devices offers state-of-the-art data conversion and linear products to the space marketplace, which were previously only available as commercial or military Class B products.

Visit The Analog Devices Booth #13 at RADECS 2013

www.analog.com/aero-def

ANALOG DEVICES

2012
Cygnus

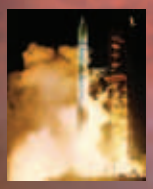
2011
Mars Science Lab

2003
Mars Rovers

1998
Int'l. Space Station

1971
Apollo/Saturn Rover

Surveyor
1966



Centaur
1962

Mercury
1962

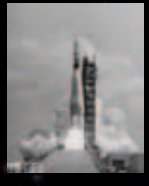
Poseidon
1961

Polaris
1960

Agena
1960

Titan
1959

Delta
1959



Atlas
1957

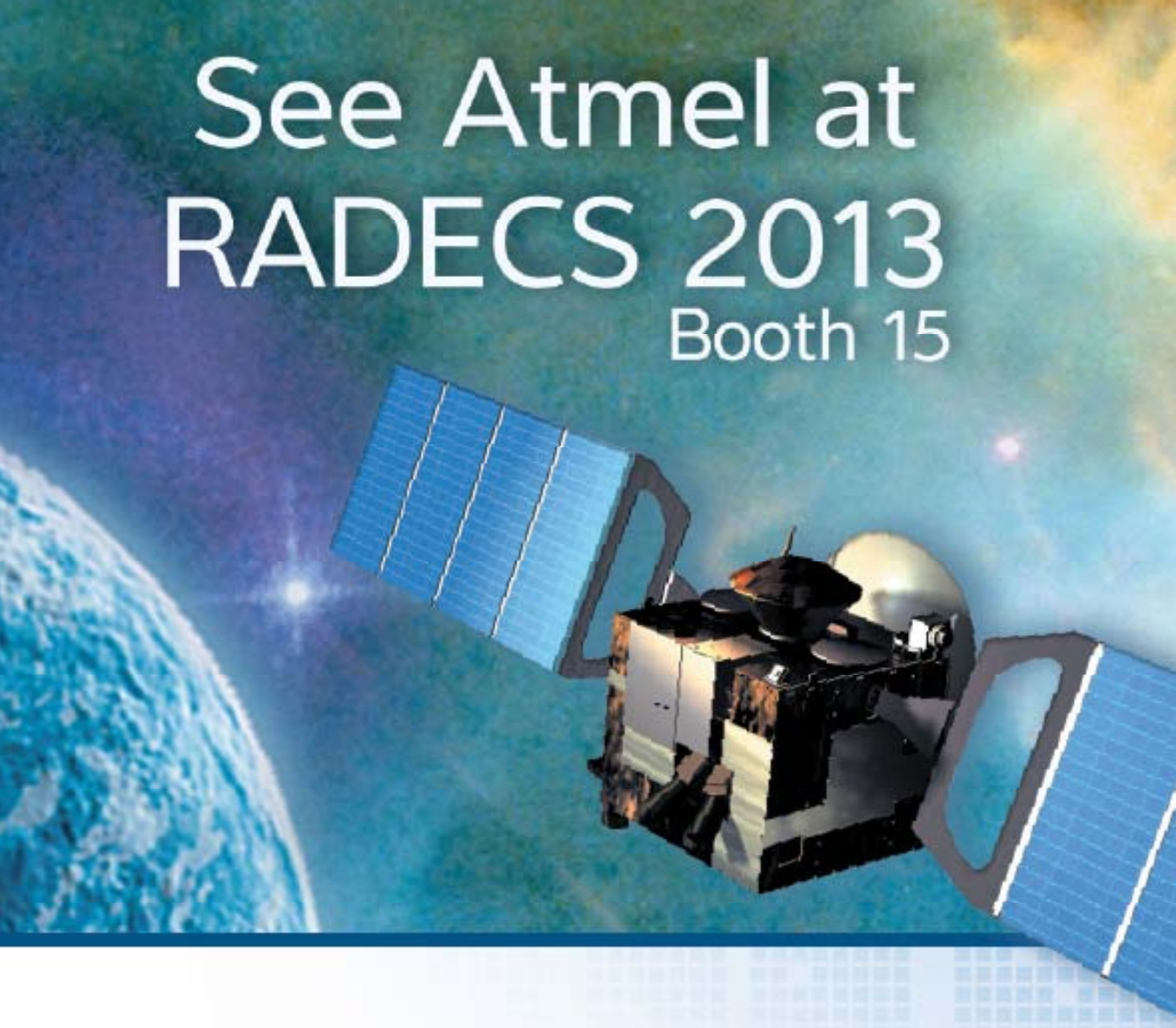
Propelling Space Innovation For More Than A Half Century

With one of the industry's most comprehensive portfolios of space products, Microsemi provides radiation-hardened and radiation-tolerant solutions ranging from diodes, transistors and power converters, to FPGAs, ASICs, RF components, custom semiconductor packaging, and integrated power distribution systems. We are committed to supporting our products throughout the lifetime of our customer programs.

www.microsemi.com

Microsemi

Visit us at Booth #14



Come meet with our Technology Experts and learn about our latest solutions for the Aerospace community.

www.atmel.com

Atmel

Space Agency Qualified

Supplying rad-hard semiconductor products and technologies for over 35 years

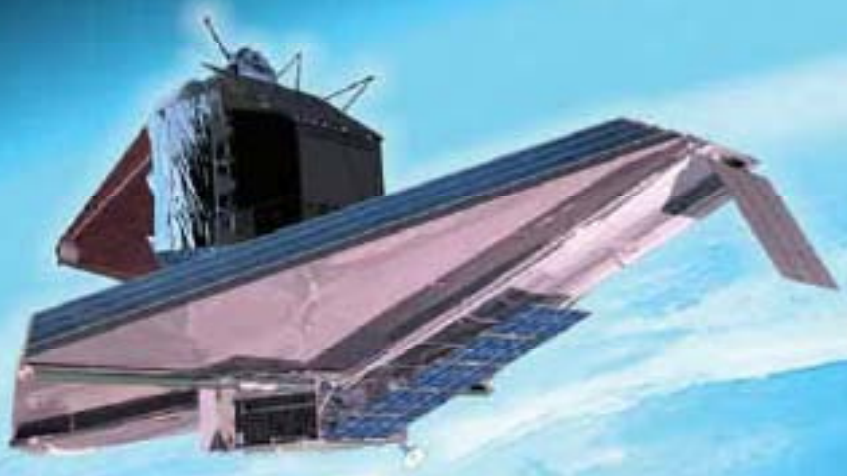
- ESCC – JANS & QML qualified products
- Expanding product portfolio:
  - Bipolar Transistors & MOSFETs
  - Diodes & rectifiers
  - Logic & interfaces: including LVTH & LVDS
  - Analog: Voltage References, Op-amps, ADCs...
  - Power ICs: Voltage regulators, Gate Drivers, PWM...

Find out more on www.st.com

life.augmented

MSK

The New Power in Power Electronics



Custom Hybrids
Power Hybrids
Motor Controls
DC-DC Converters
Amplifiers
Voltage Regulators

MSK

Rad-Hard ICs with LTC's
RH DICE Inside™

LINEAR TECHNOLOGY

QML Listed, RHA Certified

Come see us and our partner, Linear Technology Corp. at Booth 17

www.mskennedy.com

an Anaren Company

UltraLo-1800

Next Generation Alpha Particle Counter

Advanced Alpha Particle Emission Metrology

MATERIALS SCREENING

Monitor your ultra low alpha materials (0.001 $\alpha/cm^2/hr$) with accurate measurements in just one day.

QUALITY CONTROL

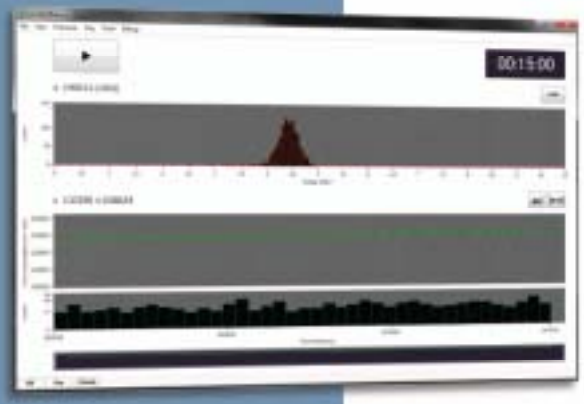
Ensure that your materials satisfy your design requirements by using the most sensitive instrument available.

- **Dramatically reduced counting times.** Count ULA samples in hours or days, not weeks or months.
- **Repeatable and reliable measurement results.**
- **Advanced sample analysis.** Energy information aides for the identification of isotopes on sample surfaces.
- **Robust data management.** Easily access and review both current and historical measurement data.

The UltraLo-1800 is a revolutionary new design for low background alpha particle counters that employs electronic background suppression to drive achievable background rates to 0.0001 alpha/cm²/hr and below. This is a factor of 50 or more better than can be achieved by the conventional proportional counter systems that are currently available.

Through the use of novel, dual channel pulse-shape-analysis techniques, the UltraLo-1800 is able to distinguish between alpha particles emitted from the sample under test, and those emitted from other parts of the counter structure. By rejecting the latter, it achieves background rates approaching 0.0001 alpha/cm²/hr. Under these conditions, it becomes feasible to measure samples having emissivities in the 0.001 to 0.0005 alpha/cm²/hr range in fewer than 10 hours, and to measure emissivities below 0.0005 alpha/cm²/hr in fewer than 100 hours.

CounterMeasure – the interface to the UltraLo-1800 system – is a powerful data analysis and instrument control application, with capabilities including the display of energy spectra, time stamped events, system health metrics, measurement over evolution, and much more. Sophisticated yet intuitive, this tool provides users with unique insights into their alpha particle emission measurements.



CounterMeasure

UltraLo-1800 Interface Software

XIA LLC

www.xia.com

sales@xia.com

Instruments That Advance The Art

ROSCOSMOS

TL ISDE

Test Laboratory of Institute of Space Device Engineering

Test Laboratory for Hardness to Radiation Effects in Electronics and Components

All Radiation Effects Services that you need

Contact us at any time

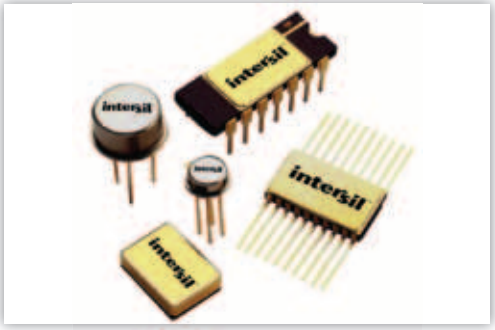
53 Aviamotornaya st., 111250, Moscow, RF
tel./ fax +7-495-673-99-26
e-mail: npk1@niikp.org
www.TLISDE.org

intersil™

Booth # 21

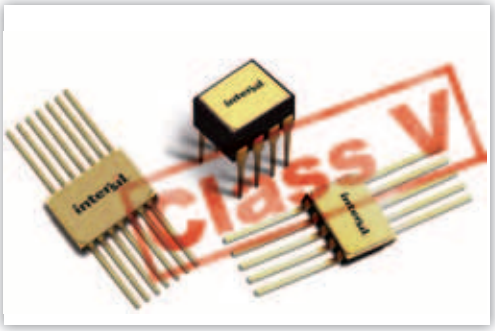
Intersil Corporation

Intersil Corporation is a leading provider of innovative power management and precision analog solutions.



Who is Intersil?

- 40+ years supplying high-reliability ICs into space and defense applications
- Experts in high-efficiency power management
- Over 40 diverse product families
- Headquartered in Milpitas, CA
- Design centers in N.A. and U.K.
- Sales locations around the globe

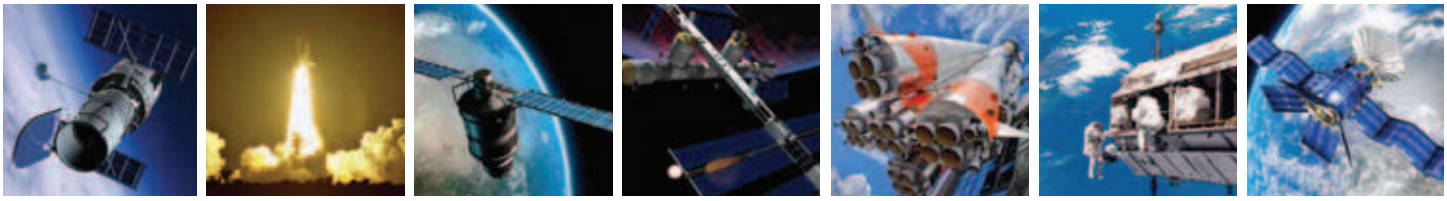


Intersil's Space Solutions

- ~300 space-qualified radiation hardened products available
- Consistent design and manufacturing in Intersil's MIL-PRF-38535-qualified facility located in Palm Bay, Florida
- Intersil is one of only 15 RHA Defense Logistics Agency (Land and Maritime) QML suppliers
- All products are fully Class V (space level) compliant
- All products are on individual DLA SMD drawings

INTERSIL.COM

Texas Instruments High Reliability space products support the demanding nature of space applications



Benefits of TI HiRel QML Class V products:

- Broad product offering
- Designer-driven portfolio
- High-performance devices
- Latest available technology
- Radiation reports available at www.ti.com/radiation
- For more information on TI-HiRel space products, see www.ti.com/space

Potential Applications:

- Commercial and defense space-based systems
- Flight critical control systems
- Gas chromatographs
- Particle detectors
- Photometers
- Space-based imaging and surveillance
- Spectrometers
- Wave analyzers

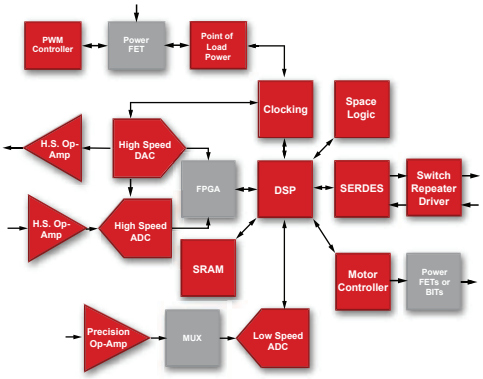
TI HiRel has introduced MILPRF-38535 radiation-tolerant products to our extensive qualified manufacturer listing (QML) Class V family

Radiation Test Services

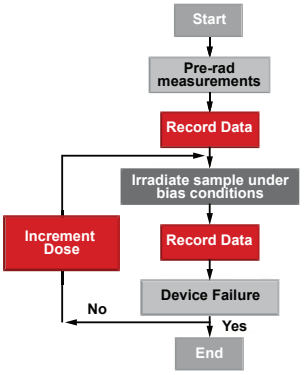
TI now has the ability to test our devices to accommodate specific program requirements including ELDRS, SEE, SEU, SEL, SEGR, and SEB testing. Our (High Dose Rate) HDR Co-60 source allows TI to test devices in a cost effective manner up to a dose rate of 50Rad/s. Additionally this provide TI with the ability to test more commercial products and determine if they are suitable for the space environment. The red blocks in the block diagram below highlight the expansive space portfolio that TI can offer today. All space qualified devices are tested to Method 1019 of MIL-STD-883, described below.

Radiation Test Method

To assure reliable performance under the aforementioned environmental conditions, RHA products from the HiRel space product line are thoroughly tested for radiation performance as part of the qualification process. The flow diagram shown here illustrates the HiRel radiation test procedure. The devices are electrically tested before irradiation, with parametrics recorded and datalogged for later comparison. Devices are electrically biased in specialized fixtures within the radiation chamber and exposed to a predetermined radiation level. They are then electrically tested after irradiation to determine if degradation or device failure has occurred. If no measurable degradation has occurred the devices are irradiated again at a higher dose level and tested once more. This process repeats until the devices fail or reach the maximum predetermined radiation level.



TI space solutions.



Radiation test method.

RADLAB

ALTER TECHNOLOGY TÜV NORD and CNA have established a new total dose radiation laboratory, being now FULLY OPERATIONAL.

Meets or exceeds the requirements for total dose irradiation tests currently demanded by the industry and applicable standards such as ESCC, MIL-STD or ASTM.

Combines more than 12 years of experience on ion beam analysis with over 25 years of experience in EEE component radiation testing, covering a wide range of device functions and technologies, and using multiple test conditions (biasing, annealing, dose rate, accumulated doses, etc...).

radiation

ALTER TECHNOLOGY has a long and wide experience in the design and performance of all radiation test types, from total dose to heavy ions in a wide range of conditions.

For further information please contact:

David Núñez - david.n@altertechnology.com
c/ Tomás Alba Edison, 4 - 41092 Sevilla - Spain
Tel : **+34 95 446 70 50**

www.altertechnology.com

Radiation engineering

- Modelling and evaluation of space radiation environment
- Radiation analysis at satellite, equipment and component level (geometric modelling and sectorial analysis)
- Shielding calculations
- Preparation of radiation test procedures and plans
- Radiation test performance (including test samples preparation, programme and test board development) and reporting
- In-orbit SEU and error rates prediction
- Support to user for radiation risk mitigation

Total ionising dose gamma radiation testing

- Low and high dose rate (from 0 to →100 Krad(si)/h)
- Static and dynamic biasing
- Panoramic, cell and pool Co60 radiation sources
- Coverage of all potential annealing and accelerated aging conditions
- Large available area for multiple simultaneous testing

Heavy ions testing

Single event effects (SEE):

- Single event upset (SEU)
- Single event transient (SET)
- Single event latch-up (SEL), single event snap back (SESB)
- Single event burn-out (SEB), single event gate rupture (SEGR)
- Single event functional interrupt (SEFI), ...

Other types of test

- Proton testing: SEE and displacement damage
- Laser test and pre-qualification activities (Cf252)
- Neutron testing: accelerated soft error test (ASER)

Maxwell TECHNOLOGIES

Enabling Energy's Future™

SUPPLY
RADIATION
PERFORMANCE

RADIATION MITIGATED SOLUTIONS FOR THE GLOBAL SPACE INDUSTRY

HIGH RELIABILITY DESIGNED INTO EVERY PRODUCT

- Start from commercial semiconductor die
- Characterize for electrical and radiation performance
- Integrate with radiation mitigation technology
- Package in a hermetic package
- Assemble and test in a QML certified facility

TECHNOLOGY HARDENED SOLUTIONS FOR YOUR APPLICATION

- Computers
- Memory
- A to D Converters
- D to A Converters
- Op Amps
- MUXes
- Logic

TURNKEY CUSTOM SOLUTIONS ALSO AVAILABLE

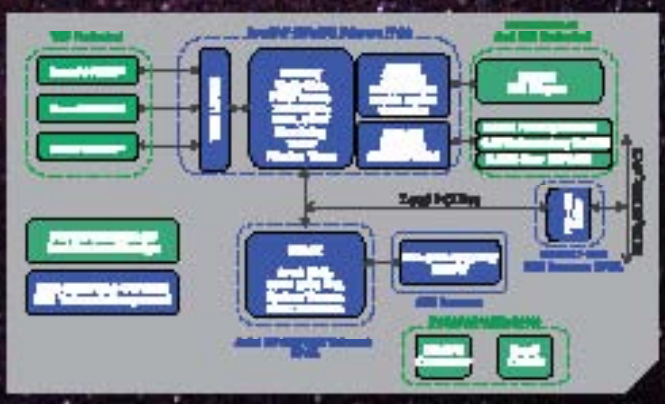
NEW 16-BIT A-TO-D CONVERTER

NEW HIGH DENSITY FLASH MEMORY

- 512 Mb NOR Flash
- 32 to 128 Gb NAND Flash
- Small size and weight
- RAD-PAK® packaging

SCS750® SINGLE BOARD COMPUTER FOR SPACE

- IBM® 750FX PowerPC® processors
- 256 MB SDRAM
- 8 MB EEPROM
- cPCI, 1553, LVDS and RS-422 interfaces
- 100 krad(Si) TID tolerance (typical)
- Once every 80 year board level upset rate
- Coming soon: SpaceWire interface



COME VISIT MAXWELL AT BOOTH 24

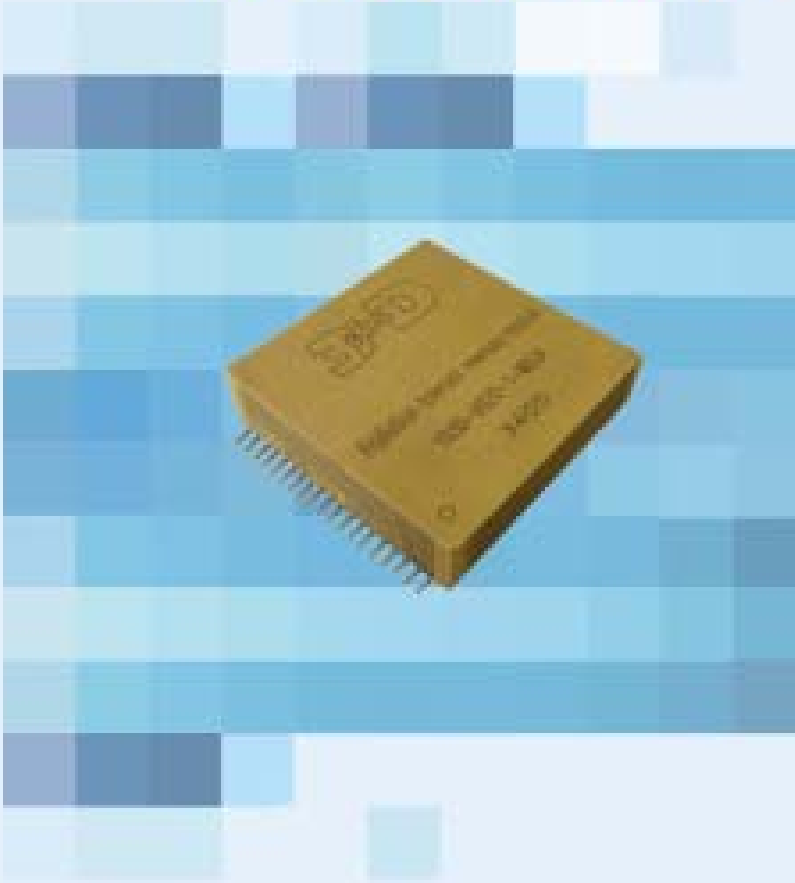
www.maxwell.com
contactus@maxwell.com

Radiation Tolerant Intelligent Memory Stack
RTIMS Flash Module
Radiation Hardened Design

3DSS24G08VS3626

KEY FEATURES

- Single 3.3V Power Supply
- Up to 24 Gb of Space qualified NAND Flash Memory
  - 8 Gb with TMR memory protection
  - 16 Gb with EDAC memory protection
  - 24 Gb with no additional memory protection
- SLC memory technology
- Bad Block Free - continuous logic sectors
- 100 Kcycles Program/Erase endurance
- 15 years data retention
- Standard 8-bit NAND Flash I/F
- Access Time:
  - Write mode at 42 Mbits/s, Read mode at 258 Mbits/s
- Operating Temperature Range: -55°C/+125°C
- Radiation Hardened design:
  - TID: > 60 krad(Si)
  - SEL Immune > 80Mev-cm²/mg
  - SEU Immune by design
  - HC SEFI Immune by design
- ITAR Free Product - Worldwide delivery guaranty
- Space Qualified Technology
- 36-pin SOP pitch 1.27mm
- Dimensions (Lxlxh): 27 x 27 x 11 mm
- Mass: 18 gr.



PRODUCT OVERVIEW

The NAND Flash Radiation Tolerant and Intelligent Memory Stack (NAND Flash RTIMS) is a Users Friendly, Plug-and-Play and Radiation Protected high density NAND Flash Memory. It provides a very high density, radiation hardened by design and non-volatile memory module suitable for all space applications such as commercial or scientific geo-stationary missions, earth observation, navigation, manned space vehicles and deep space scientific exploration.

The Intelligent Memory Module embeds a very high density of non-volatile NAND Flash memory and one Intelligent Flash Memory Controller (FMC). All the basic devices embedded in the RTIMS Flash are SEL Immune. The Protection against high current SEFI is performed by the current detection function and power switch electronics controlled by the FMC. The FMC also provides the module with a full protection against SEU: Error Detection And Correction (EDAC) protection or Triple Modular Redundancy (TMR) protection. The SEU protection can be selected between EDAC and TMR or switched off, and the RTIMS Flash density will be 8Gb in TMR protection, 16Gb in EDAC protection and 24Gb in SEU protection off.

The 3DSS24G08VS3626 offers continuous logic sectors (no bad blocks) and high added value functionalities such as wear leveling, memory self-test, internal registers for telemetry information:

- Error free guaranteed sector 0 for Boot data storage
- Continuous logic sectors - Embedded Bad blocks management
- Embedded dynamic wear leveling function
- Embedded format, fetch failing block, sector logic generation commands for initialization
- Internal registers for configuration, operation status and telemetry information

And all these functionalities are fully configurable thanks to H/W configuration pins and a powerful User Interface Port.

Thanks to its standard NAND FLASH interface, the 3DSS24G08VS3626 can be easily connected to any existing µprocessor and FPGA with an embedded NAND Flash interface. Its embedded high level functions also allow using it as a standalone small local data recorder.

3D PLUS is a world leading supplier of advanced high density 3D microelectronic products and Die and Wafer Level stacking technology meeting the demand for high reliability, high performance and very small size of today's and tomorrow's electronics.

Institute of Extreme Applied Electronics of National Research Nuclear University "MEPhI"

JSC "Specialized Electronic Systems" (SPELS)

Turnkey Smart Radiation Tests and Hardness Assurance

- Smart radiation tests of all kind of analog, digital and mixed microelectronics, Microwave Devices and MST

- Testing capabilities (TID, ELDRS, SEE, TRE)

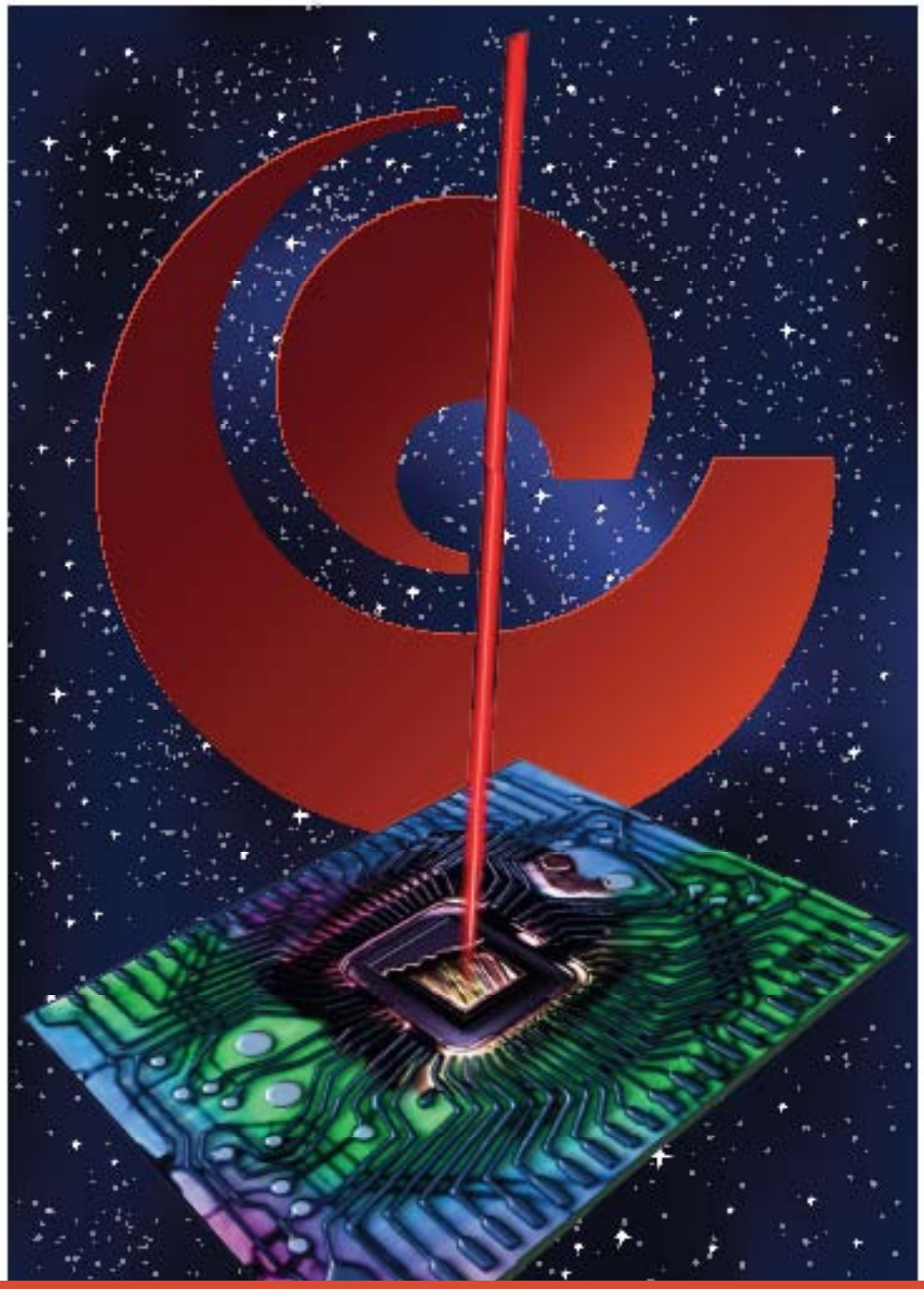
- Turnkey laser and X-ray simulation test and DUT fault diagnostics facilities

- Radiation Effects Calculations, modeling and research

- Radiation Hardness Analysis, Assurance and Consulting

- Complete Microwave Devices testing and development

- DUT decapsulation, identification and other test services



You are welcome to meet our staff at booth 26!

Address: SPELS, 31 Kashirskoe shosse,
115409, Moscow, Russia,
Phone/Fax: +7 (499) 324-04-20

www.spels.ru

api technologies corp.

Low Power Nuclear Event Detector (NED)

High Reliability Electronic Modules for Extreme Environments

European Design and Manufacture to MIL-PRF-38534 Class H

API Technologies, in association with MBDA, introduces
a state-of-the art low power Nuclear Event Detector

Radiation hard to tactical/strategic nuclear environments

- Low power consumption at 2mA from single 5V supply
- Operates within specification over -55°C to +125°C
- Precise radiation detection level with single external resistor
- Accurate monostable pulse duration with single external capacitor
- Built-in self test
- Resettable output, bistable flag

Visit us at booth 27 to discuss our full range of high reliability microelectronic solutions.

API Technologies Corp
RF2M Microelectronics Ltd
Tel: +44 (0)1493 743100
Fax: +44 (0)1493 858536
E-mail: info.rf2m@apitech.com

Website http://micro.apitech.com

RADIATION EFFECTS SPECIALIST

INDUSTRY EXPERTS FOR OVER 30 YEARS

Synergy Health's radiation effects service offers:

- ✓ Pre-irradiation assessments
- ✓ Electronic circuit simulation
- ✓ Ion beam irradiation facilities (0.5 – 10 MeV protons, 0.5 – 15 MeV alphas, etc)
- ✓ Materials selection
- ✓ Component selection
- ✓ Cobalt-60 gamma irradiation facilities
- ✓ Electron beam irradiation facilities (1 – 20 MeV)
- ✓ Database of published data on radiation effects
- ✓ Shielding/penetration calculations
- ✓ Radiation and environmental testing

Synergy Health also offers a range of other species of ion beam irradiation, microbiological testing and validation studies for planetary protection. All Synergy Health facilities are certified to ISO 9001:2008

Visit Synergy Health on booth 28

www.synergyhealthplc.com/specialist-applications

Call now to talk to one of our in-house experts

+ 44 (0) 8456 88 99 70

synergyhealth

our work protects your world

SOCIAL ACTIVITIES







"The organising committee has selected a range of tours and events that will allow you to experience the best of what Oxford has to offer."

SOCIAL ACTIVITIES SCHEDULE

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
08:00						
08:30						
09:00						
09:30	Sunday tour to Stratford-upon-Avon				Blenheim palace tour and lunch	Ashmolean museum tour
10:00						
10:30						
11:00						
11:30						
12:00						
12:30						
13:00						
13:30						
14:00						Technical tours: RAL (Diamond/ISIS) or Culham (JET)
14:30		Christ Church tour with afternoon tea	Christ Church art gallery tour			
15:00						
15:30						
16:00						
16:30						
17:00						
17:30			Exhibitors' reception	Olde English pub crawl and walking tour		
18:00		Welcome reception: Oxford Town Hall				
18:30						
19:00					Gala dinner: Balliol College	
19:30						
20:00				Bangers and mash meal		
20:30						
21:00						
21:30						
22:00						

SOCIAL ACTIVITIES: INCLUDED

The following social activities are included in the delegate rate:

Monday 23rd September

Welcome reception — Oxford Town Hall

The welcome reception is free of charge for registered delegates, however, **pre-registration is mandatory**.

Start time: 18:00 (a free guided walk with Oxford's Town Crier is available, departing at 17:45 from the Examination Schools registration area).
End time: 20:30

Tuesday 24th September

Exhibitors' reception — Exhibitors' hall

The exhibitors' reception is free of charge for registered conference delegates, however, **pre-registration is mandatory**.

Start time: 17:30
End time: 19:30

Thursday 26th September

Gala dinner — Balliol College

Join us for an exquisite evening at Balliol College, Oxford's oldest and most exclusive venues. The gala dinner is free of charge for registered conference delegates, however, **pre-registration is mandatory**.

Please note, the dress code for this dinner is smart:
Ladies: smart dress / trousers and top / skirt and top
Gentleman: suit / shirt and tie

Start time: 19:00 (a free guided walk with Oxford's Town Crier is available, departing at 18:40 from the Examination Schools registration area).
End time: 23:20

SOCIAL ACTIVITIES: PARTNERS

All social activities will depart from the registration area in the Examination School (with the exception of the Sunday tour which will depart from the front of the building).

Please ensure you are in the registration area at least 10 minutes before the departure time. Coach trips will depart promptly and refunds are not available for late arrivals. Drop-off times may vary due to tour end times and local traffic conditions.

Please visit the registration desk if you wish to enquire about availability for any of the social activities.

Sunday 22nd September

Sunday tour: Straford-upon-Avon 09:30 - 17:00

Spend the day visiting the home of Shakespeare and seeing a little of 'The Cotswolds' with some of the prettiest villages and finest scenery in England. The day will include a trip by coach to Stratford upon Avon, a guided walking tour, a visit to Shakespeare's birthplace, lunch and a return journey through some of the beautiful Cotswold villages.

Departure time: 09:30
Return time time: 17.00
£55.00

Monday 23rd September

Christ Church tour with afternoon tea 14:30 - 17:00

Join this afternoon tour to see Christ Church. Learn of the College's history, its architecture, student life, scenes associated with the world of Lewis Carroll and of course, the Harry Potter films. Then enjoy cream scones and tea in the dining hall of Christ Church.

Departure time: 14:15
End time: 17.00
£15.00

Welcome reception 18:00 - 20:30

Join us at the historic Oxford Town Hall for a drinks reception and an official welcome to Oxford by the Deputy Lord Mayor of Oxford. **Pre-registration is mandatory**.

Start time: 18:00 (a free guided walk with Oxford's Town Crier is available, departing at 17:45 from the Examination Schools registration area).
End time: 20:30
£23.50

SOCIAL ACTIVITIES: PARTNERS

Tuesday 24th September

Christ Church art gallery tour — 14:30 - 17:00

Christ Church is unique among the Oxford and Cambridge colleges in possessing an important collection of Old Master paintings and drawings, housed in a purpose-built gallery which is also of considerable architectural interest. You will have the chance to view this beautiful collection guided by the curator of the gallery, followed by cream scones and tea in the dining hall of Christ Church.

Departure time: 14:15
End time: 17.00
£14.75

Wednesday 25th September

Olde English pub crawl and walking tour — 18:00 - 19:30

Join our Blue Badge Guide on a walking tour of some of the oldest pubs of Oxford and learn some of the tales of past patrons of fame and note, whilst savouring a taste of some of the best local ales.

Departure time: 18:00
End time: 19.30
£15.00

Bangers and mash meal — 20:00 - 23:00

The Big Bang is the true gastronomic experience of Great Britain; classic favourites done with a bit of style. Almost everything is sourced from within 20 miles of the city allowing you to taste the authentic flavours of Oxford, not a chain-restaurant version of it. Try the Great British banger (sausages) with a variety of mashed potatoes, onion gravy and a glass of wine, beer or soft drink.

Departure time: 19:40
End time: 23.00
£22.50

SOCIAL ACTIVITIES: PARTNERS

Thursday 26th September

Blenheim Palace tour and lunch — 10:00 - 15:00

This half day tour will take you by coach to visit this UNESCO World Heritage Site and birthplace of Sir Winston Churchill. and the ancestral home of the Dukes of Marlborough. Visit the State Rooms with a private tour guide, before lunch.

Departure time: 10:00
Return time: 15.00
£39.50

Gala dinner

Join us for an exquisite evening at Balliol College, Oxford's oldest and most exclusive venues. The price of the gala dinner is £175 and as capacity is strictly limited, **pre-registration is mandatory**.

Please note, there is a dress code for this dinner:
Ladies: smart dress / trousers and top / skirt and top
Gentleman: suit / shirt and tie

Start time: 19:00 (a free guided walk with Oxford's Town Crier is available, departing at 18:40 from the Examination Schools registration area).
End time: 23:20
£175.00

Friday 27th September

Ashmolean museum tour — 10:00 - 12:00

Founded in 1683, the Ashmolean is Britain's first public museum and home to the University of Oxford's world-class collections of art and archaeology. With a £61 million refurbishment opened by Her Majesty The Queen in December 2009, the new Ashmolean welcomed over one million visitors in its first year. Arranged over five floors with level access throughout, the building provides 39 galleries. Take this tour with a private guide to view some of the treasures it houses.

Departure time: 09:45
End time: 12.00
£15.00

STFC – Rutherford Appleton Laboratory

The Rutherford Appleton Laboratory is based in Oxfordshire and hosts a thriving and multifaceted scientific community. It is home to a cluster of the UK's major scientific facilities including ISIS the pulsed neutron and muon source and the Diamond light source, which provide glowing opportunities for cutting-edge research. Every year about 10,000 scientists and engineers make use of these facilities to advance their research in areas including material science and structures, light sources, astronomy and particle physics. The Rutherford Appleton laboratory is operated by the UK's Science and Technology Facilities Council – one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide.

ISIS – Spallation Neutron and Muon Source

This technical tour will allow you to see the facilities at the Laboratory including a tour of the ISIS Spallation Neutron and Muon Source. ISIS is one of the world's most productive neutron sources. This pioneering research facility emits brilliant beams of neutrons and muons that provide scientists with exciting opportunities to delve deep into the complexity of matter and reveal its microscopic structure and dynamics. ISIS is constantly expanding and welcomes visitors from all corners of the world to come and experience a growing facility at the forefront of modern research. On the recently constructed second target station a highlight of the tour will be a chance to visit the new state-of-the-art neutron irradiation facility for electronic devices, ChipIr, which is nearing completion. Chipir will be used to study how silicon microchips respond to cosmic-ray neutron radiation, offering accelerated testing leading to safer and more reliable electronic systems. Chipir is the newest edition to the extensive suite of neutron and muon instruments at ISIS which are used to unravel the physical, chemical and biological properties of materials at the atomic and molecular scale.

Diamond

Diamond Light Source is the UK's synchrotron; it speeds up electrons to near light speeds so that they give off a light 10 billion times brighter than the sun. Scientists use the light to study a vast range of subject matter, from new medicines and treatments for disease to innovative engineering and cutting-edge technology.

Diamond is a not-for-profit limited company funded as a joint venture by the UK Government through the Science & Technology Facilities Council (STFC) in partnership with the Wellcome Trust. Over 3000 researchers use Diamond to conduct experiments, assisted by approximately 500 staff. Whether it's fragments of ancient paintings or unknown virus structures, at the synchrotron, scientists can study their samples using a machine that is 10,000 times more powerful than a traditional microscope. Diamond is one of the most advanced scientific facilities in the world, and its pioneering capabilities are helping to keep the UK at the forefront of scientific research.

Warning: This tour is unsuitable for people with pacemakers and pregnant women

Departure time: 14:00
Return time: 17.30
£15.00 (this fee covers transport and administration costs)

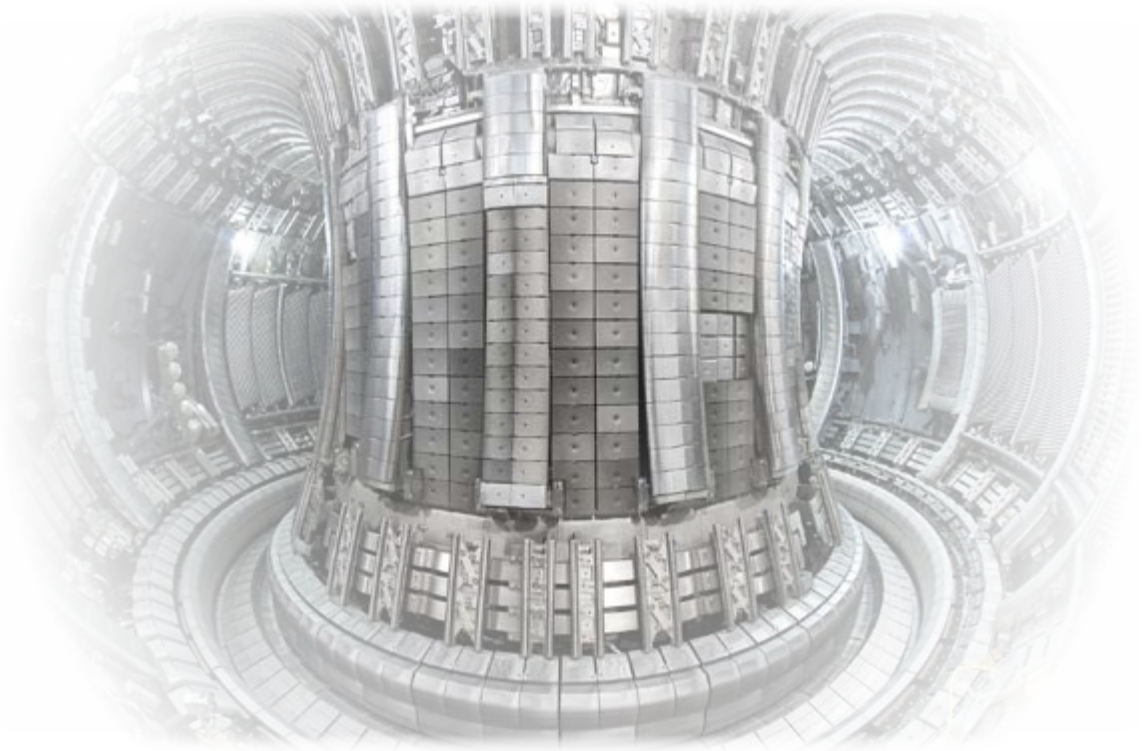
Culham technical tour 14:00 - 17:30

The Culham Centre for Fusion Energy (CCFE) (the research arm of the United Kingdom Atomic Energy Authority) is the UK's national laboratory for fusion research and hosts and operates the world's largest magnetic fusion experiment, JET (Joint European Torus) on behalf of Europe. Designed to study fusion in conditions approaching those needed for a future power plant, JET is the only device currently operating that can use the deuterium-tritium fuel mix that will be used for commercial fusion power. Experiments on JET are answering key issues in the design of the international next step fusion device –ITER – currently being constructed in France. ITER will be the bridge to the first fusion power stations – which are expected to put electricity on the grid around 2050.

Departure time: 14:00
Return time: 17.30
£15.00 (this fee covers transport and administration costs)

Please note:

- Photo ID (passport, driving licence, National ID card etc.) is required to visit Culham
- Please let the Event Organiser know immediately if you have a pacemaker, or an automatic drug dispenser fitted as a medical implant, as this may affect access to some parts of the Culham tour.
- Please also note that open-toe shoes are strictly forbidden; all visitors must wear covered footwear.



The Harwell and Culham technical tours will run at the same time.


AEROFLEX
ALTER TECHNOLOGY
Member of TÜV NORD
CRANE
AEROSPACE & ELECTRONICS
MBDA
Fraunhofer INT
SILICON SPACE TECHNOLOGY
International IOR Rectifier
THE POWER MANAGEMENT LEADER
plusD
a HEICO company
TRAD
Tests & radiations
ISOCOM
LIMITED
SPELS
Modular Devices, Inc.
One Roned Road Shirley, NY 11967
631.345.3100 · sales@mdipower.com
www.mdipower.com
TEXAS INSTRUMENTS
Atmel
Peregrine Semiconductor
intersil
HILEVEL TECHNOLOGY, INC.
MSK
api technologies corp.
ASTRIUM
AN EADS COMPANY
Maxwell TECHNOLOGIES
Enabling Energy's Future™
Microsemi
ANALOG DEVICES
life.augmented
XIA
Instruments That Advance The Art
RADECS
synergyhealth
our work protects your world
NUCLEAR & PLASMA SCIENCES SOCIETY
www.radecs2013.com
IEEE