RADECS 09

Outline

- Overview

- Inputs & Ideas

- RADECS future events

- Reserve Slide: Selection of some papers

Conference theme

a) Towards modeling of radiation effects in nano-scale systems.

b)Latest development and experimental observations related to radiation effects on electronics.

Link

- Final program: http://www.radecs2009.com/sites/default/files/FINALPROGRAM.pdf

- Login radecs09, password radecs 09.

http://www.radecs2009.com/?q=node/54

- Some Abstracts are in

  \\cern.ch\dfs\Users\m\mbrugger\Public\Radecs09

Overview

- State-of-art-device

- SEE analysis for design

- Modeling & simulation

- Experimental tests

- Dosimetry

- Facility

State of the art devices

Session A: Devices, Integrated Circuits and MEMS.

Session D: Basic Mechanism

- Radiation effects on state-of-the art devices
  - Multigatefet
  - Silicon On Insulator (SOI)
  - Hybrid technology
  - < 100 nm technology
- No rules
- General trend:
  - TID limit improves
  - SEE gets worse

SEE analysis

Session B: SEE – Devices and Integrated Circuits.

- Analysis of Single Event Transient (SET)
  - Laser techniques (B1, B2)
  - Delays 'ad hoc' along the paths with a careful routing on FPGA (B3)

SEE analysis
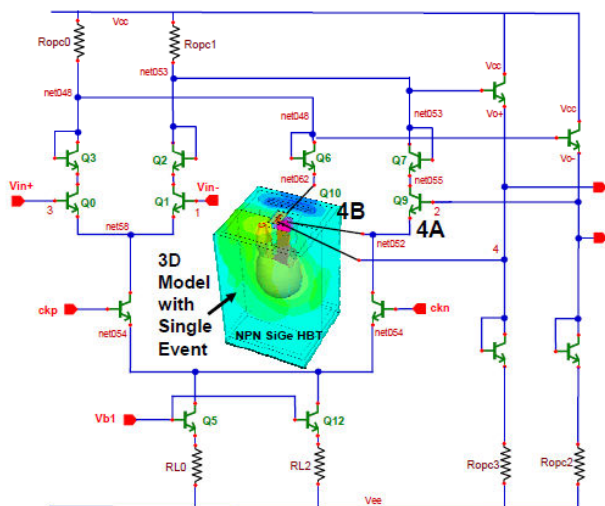
Session B: SEE – Devices and Integrated Circuits.

- Laser technique for hardware assurance againt SEE
  - Results not fully consistent.
  - Difficult to use (open package)
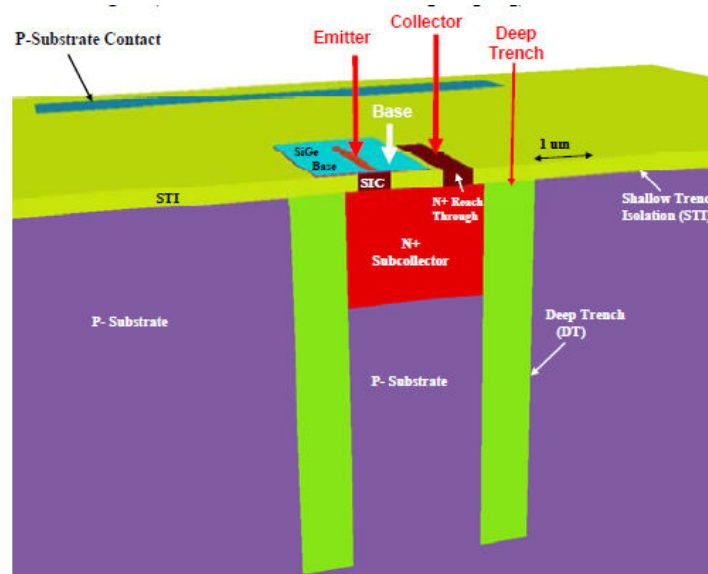
Laser techniques   more suitable as a design tool

Modeling & Simulation
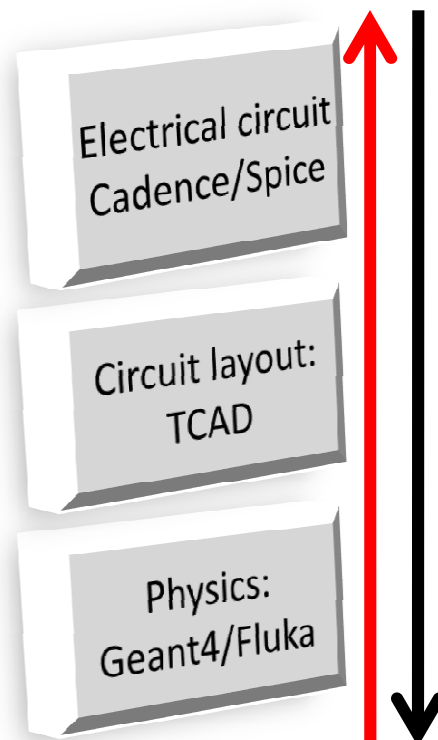
Session C: SEE – Mechanism and Modeling.

- ## General strategy: Mixed simulator (C8)

Mixed simulator

TCAD 3Dmodel

Modeling & Simulation

Session C: SEE – Mechanism and Modeling.

- Detailed analysis of the charge collection phenomena
    - Powerful simulators and analysis tools
    - Useful in the design phase

Paper C5: **Single Event Upset and Multiple Cell Upset Modeling in Commercial Bulk CMOS 65nm SRAMs**

Paper C8: **Enabling Mixed-Mode Analysis of Nano-Scale SiGe BiCMOS Technologies in Extreme Environments**
Complete tool from Physics up to the circuit.

Hardness Assurance: Test

- Single component test

A novel method of dynamic SEE ADC testing is presented. The approach utilizes a FPGA core for processing and has proven to enhance error signature and signal integrity observation verses alternate techniques. (E2)
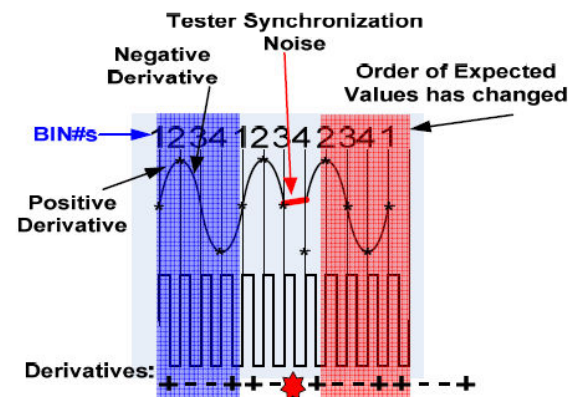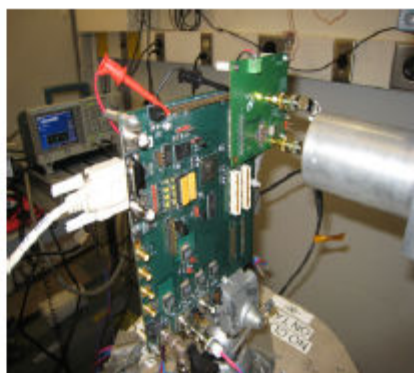
DUT ADS5424 and ADC14155
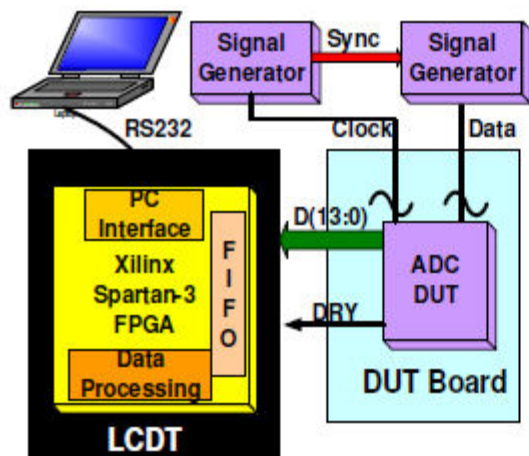
Figure 3: FP Windows. Tester Synchronization Causes Order of Derivatives and Subsequent Expected Values to Change
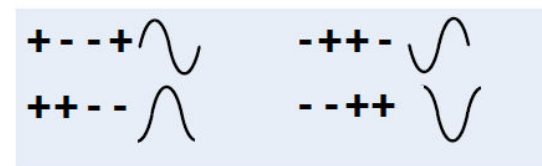
Figure 4: Possible orderings of windowed 4-point Derivatives without error during Normal Operation

Hardness Assurance: tests

DUT LM117 regulator

Failure modes are investigated for linear integrated circuits, including load current effects. (E3)

DUT LM124 LM139 OpAmp

Investigation of the Bias Effect on Total Dose Induced Degradation on Bipolar Linear Microcircuits . A time-saving evaluation procedure based on switching experiments is given. (E2)

Poster sessions PE: Use of fault injection methods.
Data Workshop DW: Memory, FPGA, and processor.

Environment and Dosimetry

Session F: Terrestrial and Radiation Environments.

Session H: Dosimetry

- Useful for RadMon
  - Radiation measurements devices (H1)
  - Neutron effects on SRAM (F1, PB4)
  - Pin diode used at high neutron fluence (6.3×10^{13} neq/cm^2). (H2)

Facility

- GSI: ion and proton beams available
- SCK – CEN: total dose and neutron testing
- CEA 14 MeV neutron (calibration purpose)
- INFN – LNS: SEE test with 2- MeV/nucleon, (PH1)
- AGORFIRM: protons and carbon ions, available for radiation damage and radiobiology studies (PH2)
- Jungfraujoch: study of neutron effect

RESERVE SLIDES

Selection of some papers at the end of the presentation

Inputs & Ideas

Most of the papers are on State of art device
However, always something to learn...

- Test of single components
  - Motivation for a general Database of radHard components for the future developments
  - Dedicated facility at CERN (HiRadMat or NTOF)

- Modeling & Simulation
  - Evaluation of FLUKA in the simulation chain
  - Study of the critical charge for the RADMON SRAM

Inputs & Ideas

- Collaborations with Universities.
  - Environment simulation;
  - Modeling and test;
  - Contacts to follow up.

Future events

- [SERESSA 2009 From 02/12/2009 to 04/12/2009 JAPAN - TAKASAKI](#)

- [RADPRED 2010 From 14/01/2010 to 15/01/2010 ONERA DESP - TOULOUSE](#)

- [RADFAC 2010 26/03/2010 Université Montpellier-2 - IES - Montpellier](#)

- [RADECS 2010 From 20/09/2010 to 24/09/2010 AUSTRIA - LÄNGENFELD](#)

RESERVE SLIDES

Paper overview

Session A: Devices, Integrated Circuits and MEMS.

- Radiation effects on state-of-the art devices
  - Multifet
  - Silicon On Insulator (SOI)
  - Hybrid technology
- Paper A6: **Impact of Neutron Irradiation on Oxidized High-Resistivity Silicon Substrates with and without a Trap-Rich Passivation Layer**

  We investigate the influence of high-energy neutrons on oxidized HR Si-substrates. RF losses are strongly reduced in the case of thin-oxide, while substrates with a polysilicon passivation layer are almost insensitive to the neutron irradiation.

- Paper A8: **The Effect of Proton and Gamma Radiation on Different Type of Temperature Sensors**

  In a study performed to test the effects of proton and gamma radiation on different temperature sensors, Pt RTDs and thermocouples result negligibly sensitive, though IC-based Ad590 and, especially, TMP36, modify significantly their readout signals.

Paper type overview

Session B: SEE – Devices and Integrated Circuits.

- Analysis of Single Event Transient (SET)
  - Laser techniques (B1, B2)
  - Delays 'ad hoc ' with a careful routing on FPGA (B3)

Paper B1: **Total Dose Effects on the Propagation of Single Event Transients in a CMOS Inverter String**

A pulsed laser has been used to reveal how the propagation of single event transients radiation.

Paper B3: **Analysis of SET Propagation in Flash-based FPGAs by means of Electrical Pulse Injection**

A technique based on electrical pulse injection for the analysis of SETs propagation within logic resources of Flash-based FPGAs is developed. Experimental results provide detailed characterization of basic gates and realistic routing and logic paths.

Paper type overview

Session B: SEE – Devices and Integrated Circuits.

- Laser technique to create SEE

  Paper B4: **Estimation of Heavy-Ion LET Thresholds in Advanced SOI IC Technologies from Two-Photon Absorption Laser Measurements**

  The laser energy thresholds for SEU for SOI SRAMs were empirically correlated to heavy-ion LET thresholds for Sandia's 0.35-µm SOI technology. The use of this relationship to estimate LET thresholds in other technologies is discussed.

Comments: Laser techniques more suitable as a design tool

- Single Event Gate Rupture and Single Event Burn-out on Mosfet (B6-B9)

Paper overview

Session C: SEE – Mechanism and Modeling.

- Detailed analysis of the charge collection phenomena
    - Powerful simulators and analysis tools
    - Useful in the design phase

Paper C5: **Single Event Upset and Multiple Cell Upset Modeling in Commercial Bulk CMOS 65nm SRAMs**

Heavy-ion experimental characterizations of three commercial bulk 65nm SRAM bit cells were carried out and compared to simulated values obtained using a proprietary Monte-Carlo simulation code. The contributions of Single Event Upsets and Multiple Cell Upsets are discussed. Comments: Missing angular dependency

Paper C8: **Enabling Mixed-Mode Analysis of Nano-Scale SiGe BiCMOS Technologies in Extreme Environments**

The latest developments combining 3D physics of nano-scale devices, mixed-mode coupling with Cadence Spectre, interface to Geant4 radiation models, and extreme temperature modeling, enable simulations of radiation effects in modern mixed-signal systems which match experiments. Complete tool from Physics up to the circuit.

Paper type overview

Session D: Basic Mechanism.

- Detailed analysis of basic mechanism radiation effects in state-of-the art devices

Paper D2: **Angular and Strain Dependence of Heavy-Ions Induced Degradation in SOI FinFETs**

We studied the short- and long-term effects of heavy-ion strikes on SOI FinFET devices manufactured in a sub 32-nm CMOS process. We analyzed the dependence on the channel strain, incidence angle, and channel type.

Paper D3: **Effects of Halo Doping and Si Capping Layer Thickness on Total-Dose Effects in Ge p-MOSFETs**

The total-dose response of Ge p-MOSFETs is reported. Radiation-induced fall in on-off current ratio increases with halo doping density (to reduce short channel effect). Increasing the number of Si monolayers at the interface reduces total-dose sensitivity.

Paper type overview

Session E: Hardness Assurance

- Useful tips for testing devices
  - Few papers this year…

Paper E1: **Investigation of the Bias Effect on Total Dose Induced Degradation on Bipolar Linear Microcircuits**

Dose experiments are conducted on bipolar microcircuits to analyze the bias effect during irradiation. The worst-case is shown to be dose rate dependent. A time-saving evaluation procedure based on switching experiments is given.

Paper E2: **Enhancing Observability of Signal Composition Response and Error Signatures during Dynamic SEE Analog to Digital Device Testing**

A novel method of dynamic SEE ADC testing is presented. The approach utilizes a FPGA core for processing and has proven to enhance error signature and signal integrity observation verses alternate techniques.

Paper type overview

Session E: Hardness Assurance

Paper E3 **Failure Modes and Hardness Assurance for Linear Integrated Circuits in Space Applications**

Failure modes are investigated for linear integrated circuits, including load current effects. Results for large samples are used to develop a less conservative design approach that can extend their useful range in space environments.

Check also

Poster sessions PE: Use of fault injection methods
Data Workshop DW: Memory, FPGA, and processor

Paper type overview

Session F: Terrestrial and Radiation Environments.

Useful for Radmon

Paper F1: **Altitude and Underground Real-Time SER Tests of Embedded SRAM**

Altitude and underground real-time SER tests have been performed on embedded SRAMs. The results are used to validate the accelerated SER test methodology. Statistical analysis of the real-time SER results has been performed. Fast tests at IRI (Delft), WNC (Los Alamos), CPO (Orsay). Good agreement for neutrons, not for alpha.

Paper F3: **MATSIM: The Development of a Voxel Model of the MATROSHKA Astronaut Dosimetric Phantom Exposed to Cosmic Radiation Onboard the International Space Station ISS**

We developed a high resolution voxel model of the MATROSHKA astronaut dosimetric phantom and investigated the imparted energy within the phantom due to interaction with ionizing radiation. The mathematical model is validated by reference measurements. → Useful for comparison between simulations and Radmon.

Paper type overview

Session G: Photonics

- Radiation effects in charge transfer and dark current at varying manufacturing parameters and temperature

Paper G3: **Effects of Low Temperature Proton Irradiation on a Large Area CCD for Astrometric Applications**

Charge transfer and dark current effects are compared for regions of a large area 4500 x 1966 pixel CCD irradiated with 7.4 MeV protons at -130°C and at room temperature. Post-annealing measurements were also performed.

Paper type overview

Session H: Radiometry and Facilities

- Radiation effects in charge transfer and dark current at varying manufacturing parameters and temperature

Paper H1: **The DIME suite of Dosimeter**

Simple dosimeters are described for single-event effects from cosmic-rays and nuclear-spallation reactions as well total-dose effects and displacement-damage. Measurement of these complex radiation environments is complicated by fluctuating temperature and voltages.

Paper H2: **A new Approach in Characterizing the Response of Silicon p-i-n diodes used as Radiation Monitoring Sensors**

In this work the effect of radiation damage on Silicon p-i-n diodes have been studied. I-V characteristics of unirradiated and irradiated diodes up to 6.3x1013 neq/cm2 have been measured and analyzed to give a more comprehensive understanding of the Si-bulk properties after irradiation. Possible if the current and the temperature are below a threshold values.

Paper H3: **Validation of Geant4 Based Dose Computational Tools with REEF Experiments**

This paper reports on the experiments carried out using the QinetiQs REEF (Realistic Electron Exposure Facility) for the validation of computational tools used in space radiation studies. Importance of calibration for the silicon dosimeters.

Paper type overview

Session H: Radiometry and Facilities
* Two facilities presented in the poster session

Paper PH1: **The Radiation Hardness Assurance Facility at INFN-LNS Catania for the Irradiation of Electronic Components in Air**
This paper describes a beam flux monitoring system used at the Accelerator of INFN-LNS for SEE tests. The relatively high energy of the beam (20 MeV/nucleon) allows the irradiation of components in air.

Paper H2: **AGORFIRM, the AGOR Facility for IRradiations of Materials**
AGORFIRM is a facility for irradiations with protons and carbon ions, available for radiation damage and radiobiology studies. An overview is presented of the various beams and services and of recent characterization measurements and modeling.

Paper type overview

Session I: Technology and Design hardening

- Hardening by desing (I1, I3, and I4) and by logic design (I2).

  Paper I3: **A 90 nm Bulk CMOS Radiation Hardened by Design Cache Memory**

  A RHBD high performance cache fabricated on 90 nm bulk CMOS is presented. Test silicon data arrays can read and write at 1.02 GHz. Radiation hardness was proved through irradiation with Co-60 and ion beams.