

WP2: Update on training activities

Ygor Aguiar (CERN)

RADNEXT 2nd Annual Meeting – 9-10 May 2023

<https://indico.cern.ch/e/radnext-2023>



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Introduction

- ❑ Besides communication, dissemination and exploitation, WP2 also has a focus on training activities in the radiation effects domain with the main goals to :
 - educate people on the fundamentals related to radiation effects in electronics;
 - attract more engineers and scientists to the field.

- ❑ WP2 relies on two important training modalities:
 - I. Online training activities via webinars and a dedicated Massive Online Open Course (MOOC) on radiation effects in electronics, and;
 - II. In-person training opportunities via the organization of international schools and workshops.

In-person training

SERESSA, the Radiation Effects International School

SERESSA 2022 – Geneva, Switzerland

General Chairs

- Ygor AGUIAR (CERN, Switzerland) and Raoul VELAZCO (CNRS-TIMA, France)

Program Chair

- Jaime ESTELA (Spectrum Aerospace, Germany)

Local Chair

- Rubén GARCÍA ALÍA (CERN, Switzerland)

Poster Chairs

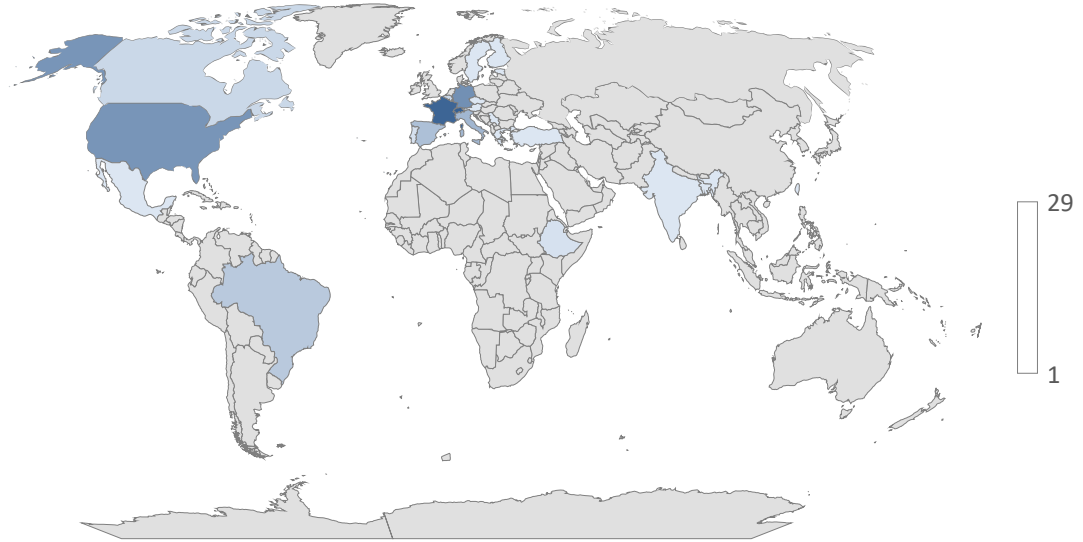
- Ygor AGUIAR (CERN, Switzerland) and Andrea CORONETTI (CERN, Switzerland)

- 24 lectures + 2 software trainings + 1 poster session
 - USA 6, France 5, Germany 5, Switzerland 4, Italy 2, The Netherlands 1, Spain 1, Canada 1 and Brazil 1.
 - Lecture material is available on Indico: <https://indico.cern.ch/e/seressa2022>
- Supported by the **CERN R2E project** and **RADNEXT European project**
 - Grant agreement No 101008126
 - Thanks Pablo and Sabrina for the support from PMO.



Some statistics

- ❑ Total of 152 participants
- ❑ 17% of woman
- ❑ 38% are MSc or PhD students
- ❑ 20+ countries:
 - Switzerland – 29
 - France – 28
 - Germany – 19
 - United States – 18
 - Italy – 11



Technical Program

18th International School on the Effects of Radiation on Embedded Systems for Space Applications

from Monday, 5 December 2022 (07:30) to Friday, 9 December 2022 (19:00)

Monday, 5 December 2022	Tuesday, 6 December 2022	Wednesday, 7 December 2022	Thursday, 8 December 2022	Friday, 9 December 2022
08:00 Registration				
08:30 School Opening				
09:00 Fundamental Mechanisms of Non-Destructive SEEs in Devices and Circuits	09:00 Introduction to G4SEE: a toolkit for simulating radiation effects in electronics I - David Lucsanyi (CERN)	09:00 Introduction to G4SEE: a toolkit for simulating radiation effects in electronics II - David Lucsanyi (CERN)	09:00 Introduction to OMERE: a tool for space environment and radiation effects on electronics devices I	09:00 Introduction to OMERE: a tool for space environment and radiation effects on electronics devices II
09:50 Coffee Break	09:50 Coffee Break	09:50 Coffee Break	09:50 Coffee Break	09:50 Coffee Break
10:10 SEE effects on VLSI devices: challenges and solutions - Luca Sterpone	10:10 Radiation Hardness Assurance (RHA) - Stephen Buchner (Naval Research Laboratory)	10:10 The Value of "Test-As-You-Fly": Modernizing FPGA Experimentation And Data Analysis for Critical Space Missions - Melanie Berg (Founder/CEO of Space R3 LLC)	10:10 Accelerator Radiation Environment and Neutron Effects in Electronics - Matteo Cecchetto (CERN)	10:10 Mitigation of Soft Errors at Circuit Level - Ricardo Reis (UFRGS)
11:00 Sensitivity characterization of SRAM-based FPGA against SEU and SET	11:00 COTS in (Deep) Space - Hans-Juergen Sedlmayr (DLR)	11:10 Radiation Hardening by Software: Advanced FDIR and Redundancy Concepts with COTS in Space	11:00 Introduction to 'Radiation to Materials': methodologies and examples - Matteo Ferrari	11:00 CELESTA project
12:00 Lunch break	12:00 Lunch break	12:00 Lunch break	12:00 Lunch break	12:00 Lunch break
13:30 TID Mechanisms in Nanometer-Scale Microelectronic Technologies - Stefano Bonaldo (University of Padova)	13:30 Radiation Mitigation Techniques for Mixed-Signal Circuits - Daniel Loveless (University of Tennessee Chattanooga)	13:30 System-Level Design and Radiation Test Methodologies based on a novel Software-Defined Radio Architectu...	13:30 Analyzing data extracted from radiation tests in advanced SRAMs	13:30 Exam
14:20 Modeling Cumulative Radiation Effects in Semiconductor Devices and Integrated Circuits - Hugh Barnaby (ASU)	14:20 The RADNEXT irradiation facility network - Andrea Coronetti (CERN - University of Montpellier (FR))	14:20 The Phoenix GPS Receiver for Rocket and Satellite Applications: An Example for the Successful Utilization...	14:20 Accurate Abstraction and High Level Modeling and Validation of SEE in Electronic Systems	14:10 School Closure
15:10 Coffee Break	15:10 Coffee Break	15:10 Coffee Break	15:10 Coffee Break	14:40 Visits to CERN installations
15:30 Error rate prediction for programmable circuits: methodology, tools and studied cases	15:30 The challenges of testing COTS devices at European Irradiation Facilities	15:30 Single-Event Effect Criticality Analysis - Anthony Sanders Jonathan Allen Pellish	15:30 Poster Session	
16:20 Modelling and prediction of Single Event Transient and Single Event Upset - Frédéric Wrobel	16:20 Fundamentals of the Pulsed-Laser Technique for Single-Event Effects Testing			
		19:00 Social Dinner		

SERESSA 2022



Andrea Coronetti presenting RADNEXT during SERESSA.



On-line training

From webinars to a dedicated MOOC

RADNEXT Webinar Series

- Webinar series on present and future irradiation facilities around the world:
 - 7 webinars were organized with an average attendance of 70 participants
 - Recorded videos available on [RADNEXT YouTube Channel](#)
 - More information in Ennio's talk and soon to be released in the Deliverable Report D2.3
 - Stay tuned via our [RADNEXT page on LinkedIn](#) for the upcoming webinars.



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48:48
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43:06
Boron 10 and All That Jazz: The Impact of Thermal Neutrons on...
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Politics as well... the Brussels case
35:49
Thermal Neutrons Effects on Supercomputers and Autonomous...
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MOOC: RadiationX

Radiation Effects in Electronics: from accelerators to space

What is a MOOC?

Massive Open Online Course

The diagram shows the acronym 'MOOC' expanded into 'Massive Open Online Course'. Each word is underlined with a blue line. Three blue arrows point downwards from each underlined word to its corresponding definition below.

Thousands of students

For anyone and free of charge!

Web-based course using online platforms such **EdX**, **Coursera**, ...

RADNEXT MOOC

Radiation Effects in Electronics: from Accelerators to Space

- ❑ Very first MOOC on the topic
- ❑ Duration: 5 weeks (*self-paced*), 5-7 hours per week
- ❑ Target audience: undergraduate and graduate students in Physics or Engineering
- ❑ Expected launch date: **03/2024**

- ❑ Support from MOOC design team of the **KU Leuven Learning Lab**
 - Multimedia and design support
 - 30+ MOOCs developed or in development
 - 190+ countries reached
 - More than 300k enrolments
 - Average of **1000 participants per run**



Preliminary proposed program

Module 1: Radiation Environment

- Space radiation
- Atmospheric radiation
- Artificial radiation environment (particle accelerators...)

Module 2: Particle Interaction

- Ionization (Direct and Indirect)
- Displacement
- Modelling codes I

Module 3: Radiation effects on electronics

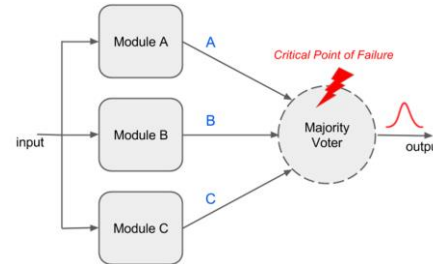
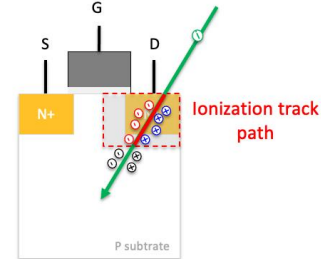
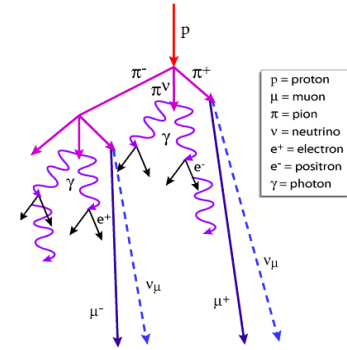
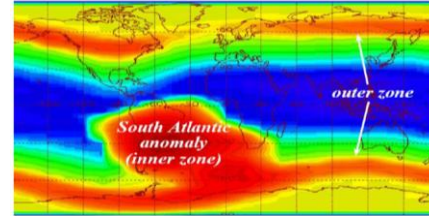
- SEE
- TID and DD
- Modelling codes II

Module 4: Mitigation techniques







- Hardening by Process
- Hardening by Design

Module 5: Testing methodologies

- European Standards for Space Missions
- Guideline of best practices beyond standards



Learning activities

 Acquisition Learning by listening, reading or watching	 Inquiry Learning by finding out	 Collaboration 1 + 1 = 3
Learners read, watch or listen to an explanation or demonstration by the teacher. This does not require any observable action from them.	Learners explore, compare and critique resources that reflect the concepts and ideas being taught. They modify their conceptual organization by questioning, investigating, <u>analyzing</u> , interpreting, synthesizing, ...	Building on inquiry and acquisition, learners create joint reference and take part in the process of knowledge building itself. Therefore they collaborate through discussion, practice or production.
 Discussion Learning by discussing	 Production Learning by creating	 Practice Learning by doing
Learners articulate their ideas and questions, and challenge and respond to the ideas and questions from the teacher and their peers.	Learners consolidate what they have learned by producing an output, which generates a representation of this learning.	Learners apply their conceptual understanding to the task at hand, put the theory into practice, and improve their understanding.



EdX platform

- ❑ Launched in 2012 by **Harvard** and **MIT**
- ❑ Several universities with proven reputation (MIT, Harvard, Berkeley, ...)
- ❑ 4000+ courses and more than 110 million enrolments to this date
- ❑ Two training modalities:
 - ❑ Audit track (*Free*)
 - ❑ Verified track (*Paid*)

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MOOC Example

The screenshot shows a web browser displaying the course page for 'Circuits and Electronics 1: Basic Circuit Analysis' on the edX platform. The browser's address bar shows the URL: `edx.org/course/circuits-and-electronics-1-basic-circuit-analysis-2?index=product&queryID=a90bf7ac7bdabb4eb95bc59e1d64e1...`. The page features the MIT logo and the course title 'Circuits and Electronics 1: Basic Circuit Analysis'. A description states: 'Learn techniques that are foundational to the design of microchips used in smartphones, self-driving cars, computers, and the Internet.' A video thumbnail with a 'Play Video' button is visible. Course details include a duration of '5 weeks' (5-7 hours per week) and a 'Self-paced' format. A notification indicates that there is one session available, starting on May 4, with 109,797 already enrolled. An 'Enroll' button is prominently displayed. At the bottom, there are navigation links for 'About', 'What you'll learn', 'Syllabus', 'Instructors', 'FAQs', and 'Ways to enroll'.

Circuits and Electronics 1: Basic Circuit Analysis

Learn techniques that are foundational to the design of microchips used in smartphones, self-driving cars, computers, and the Internet.

5 weeks
5-7 hours per week

Self-paced
Progress at your own speed

There is one session available:
109,797 already enrolled! After a course session ends, it will be [archived](#).

Starts May 4

Enroll

I would like to receive email from MITx and learn about other offerings related to Circuits and Electronics 1: Basic Circuit Analysis.

About **What you'll learn** Syllabus Instructors FAQs Ways to enroll

Learning material

Several types of content:

Video lectures

- Screencast and talking head
- Short videos up to 7min max

Interactive quizzes

- Multi-select, drag and drop, word cloud, text input...

Discussion forums

The screenshot shows a web browser window displaying a course page on learning.edx.org. The course is 'Circuits and Electronics 1: Basic Circuit Analysis' (MITx 6.002.1x). The page is titled 'S1V4: Lumped element abstraction'. A video player is embedded, showing a slide with the text 'We could do it the Hard Way... Apply Maxwell's' and a diagram of a battery and light bulb. The slide lists Maxwell's equations in differential and integral forms:

	Differential form	Integral form
Faraday's	$\nabla \times E = -\frac{\partial B}{\partial t}$	$\oint E \cdot dl = -\frac{\partial \phi_B}{\partial t}$
Continuity	$\nabla \cdot J = -\frac{\partial \rho}{\partial t}$	$\oint J \cdot dS = -\frac{\partial q}{\partial t}$
Others	$\nabla \cdot E = \frac{\rho}{\epsilon_0}$	$\oint E \cdot dS = \frac{q}{\epsilon_0}$

The video player shows a progress bar at 0:00 / 2:51 and a volume icon. A transcript sidebar is visible on the right, with the text: 'Start of transcript. Skip to the end. None SPEAKER 1: OK, we are ready to begin. So, as I said earlier, 6.002x will represent a big jump from physics to EECS. And let's just dive right into it and take a look at an example of the kind of problems that we'.

Learning material

The screenshot shows a web browser window displaying a course page. The page title is "Circuits and Electronics 1: Basic Circuit Analysis". The user is logged in as "YgorAguiar". The page is titled "ST1E1.5: Simple Power". Below the title, there is a circuit diagram showing a voltage source V_S in series with a resistor R . The text below the diagram states: "the strength of the source is $V_S = 10\text{ V}$, and the resistance of the resistor is $R = 50\Omega$ ". There are two questions: "What is the power dissipated in the resistor (in Watts)?" and "What is the power entering the source (in Watts)?" with input fields for answers. A "Calculator" button and "Hide Notes" option are visible at the bottom right.

Quiz

Discussion Forum

The screenshot shows a discussion forum page for the same course. The page title is "Circuits and Electronics 1: Basic Circuit Analysis". The user is logged in as "YgorAguiar". The page is titled "Discussion Forum". There is a search bar and an "Add a post" button. The forum shows a list of posts sorted by recent activity. The first post is an introduction post by a staff member named "aa".

Post Title	Author	Replies	Time
[Introduction] Introduce yourselves	aa Staff	52	3y
The 6.002 Circuit Sandbox – some notes	Grove TA	6	1y
Course extended to May 26 2025	MIT_Lover_UA Staff	7	1y
Lab 2 - some notes	markyangcal Staff	3	3y
Make your forum posts more readable! Using M...	markyangcal Staff	2	3y

The introduction post content is as follows:

[Introduction] Introduce yourselves
Hello everyone! I am Anant Agarwal (username aa). I am joined by Dr. Fei Hu (username MIT_Lover_UA) who will be helping as a staff member in this course.

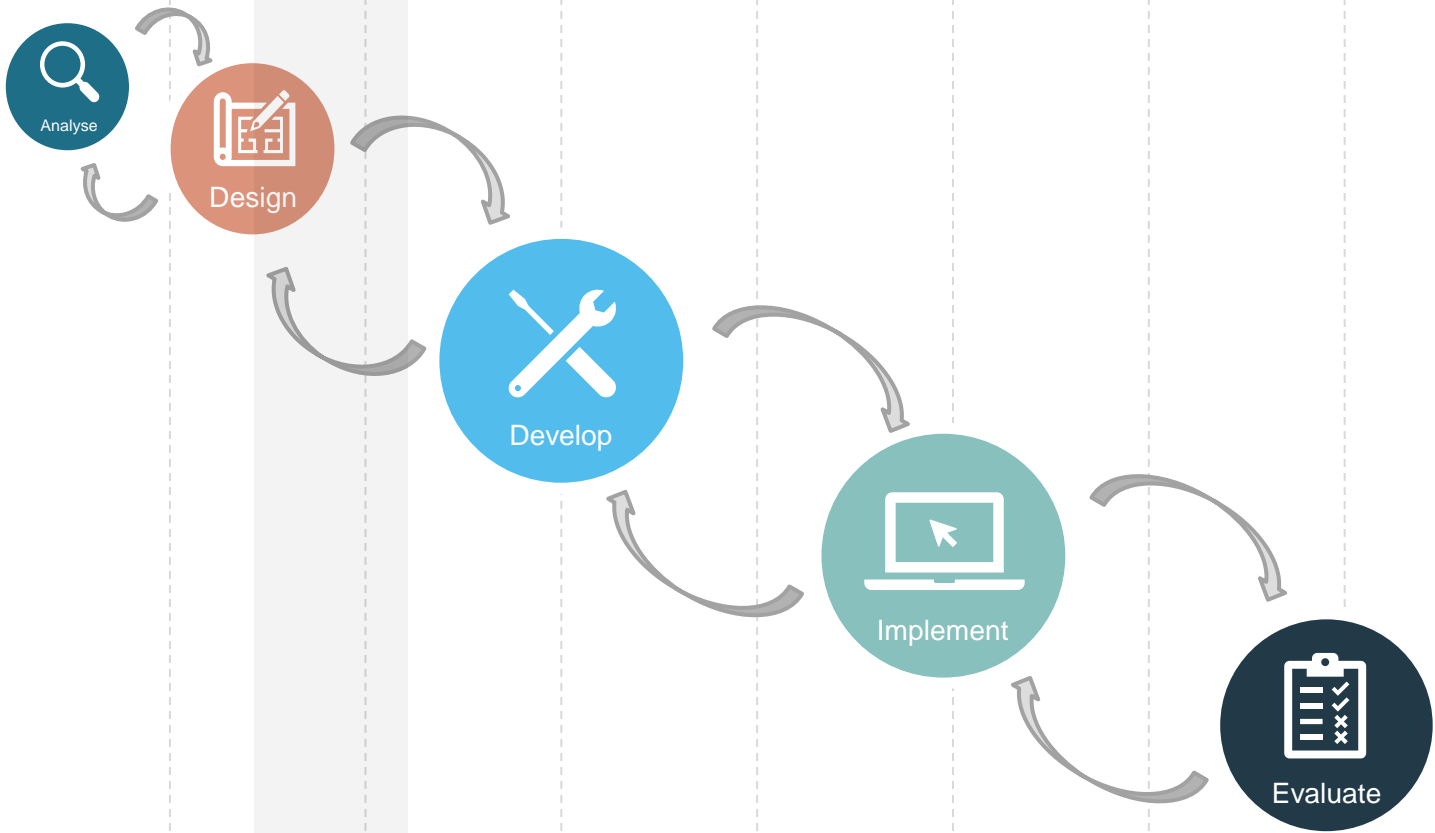
We are excited to have you join us for the course. Please introduce yourselves and get to know one another. As a guideline, you may want to share:

- Who you are
- Where you are from
- Why you are taking this course
- We hope you enjoy the course!

Related to Introductions / Welcome to 6.002x

Showing 10 responses

DESIGN
TRAIN
BUILD
TEST



Conclusion

- ❑ Training opportunities have been organized for on-line and in-person participation.
- ❑ An international school on radiation effects was organized at CERN with more than 150 participants from more than 20 countries.
- ❑ Webinar series exploring present and future facilities around the world has been proposed, recorded and uploaded on RADNEXT Youtube channel.
- ❑ A Massive Open Online Course (MOOC) is under development for the EdX platform with the support of KU Leuven team.

Thanks for your attention!



RADNEXT, Sevilla, España