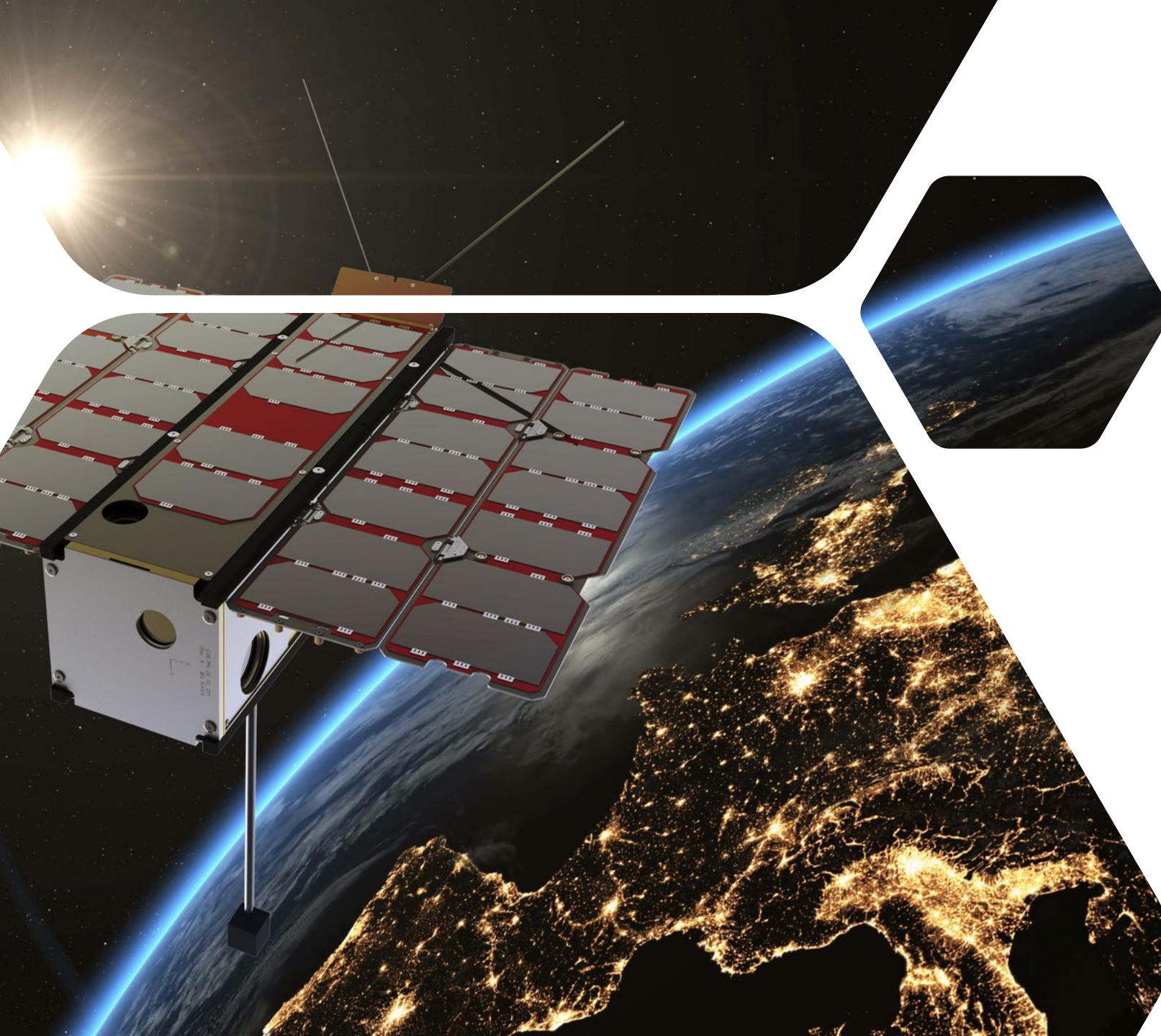


Boost Radiation Hardness Assurance in your Space Mission with Machine Learning

Amor Romero Maestre



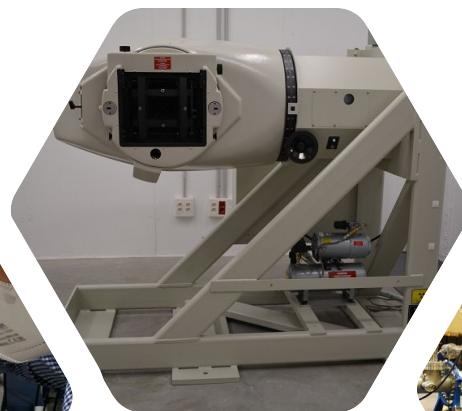
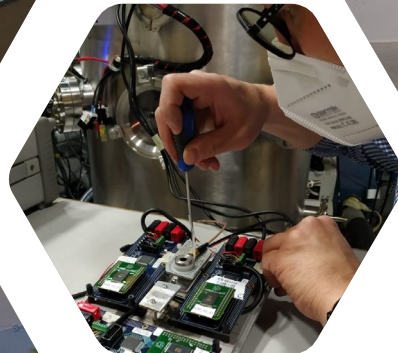
@FlipPhysics
21 - 25 March 2022, Valencia, Spain



PRECEDER (Prediction of the Electrical Behavior of Electronic Devices under Radiation, Spanish acronym) is a **new concept** in the strategy of ensuring the radiation hardness in electronics developed by our group.

The idea is based on the use of **archival data** to assess the risk associated to radiation environments without testing through **Machine Learning methodology**.

Radiation testing is the most decisive way of studying the radiation degradation. However, the increasing use of **COTS** (Commercial Off-The-Shelf) devices and the **New Space** challenges are pushing the need of finding new approaches to assess the risk associated to the radiation environment.

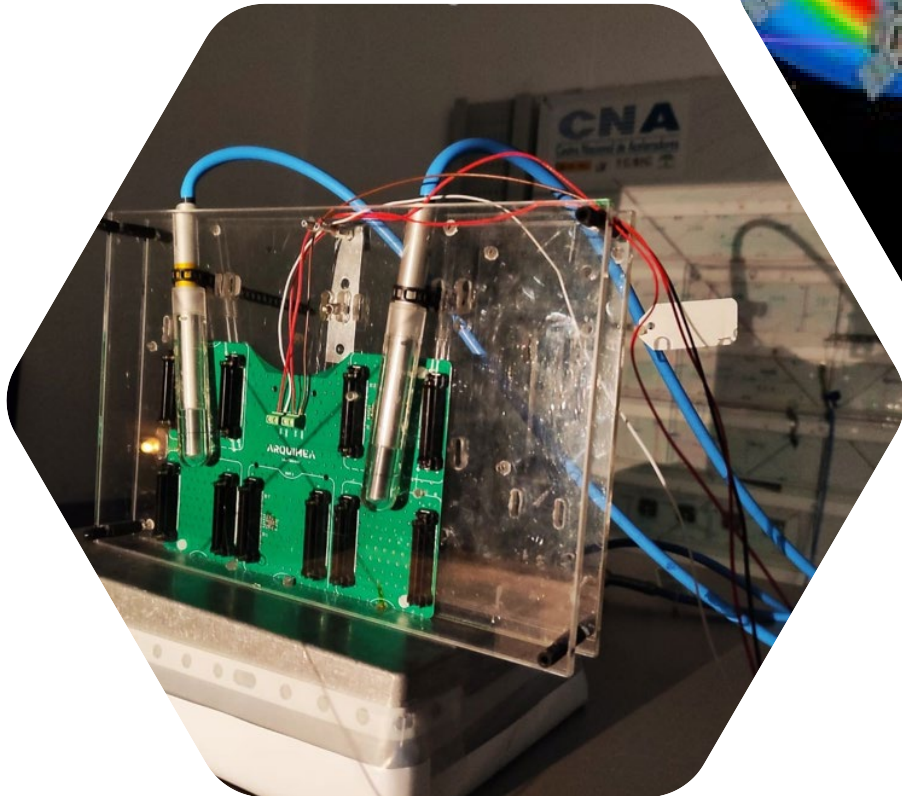
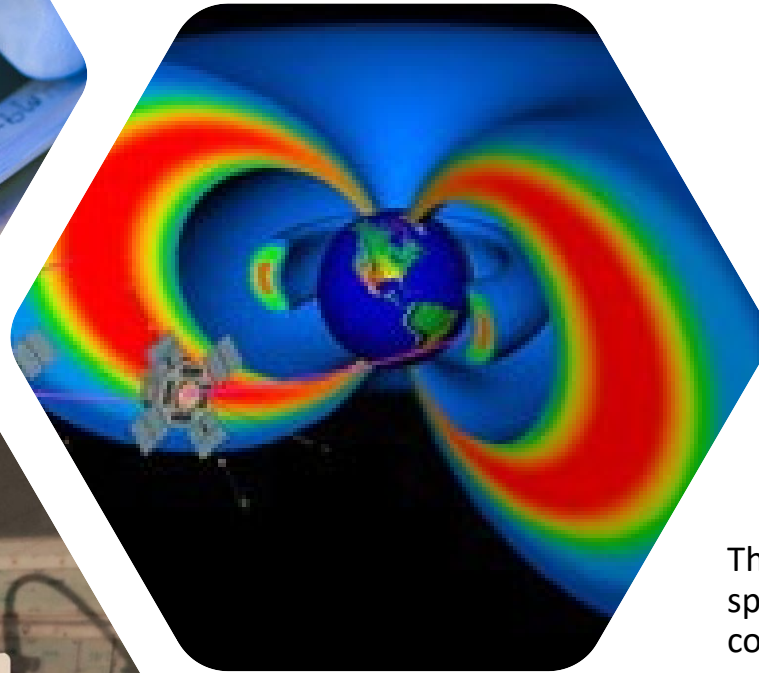
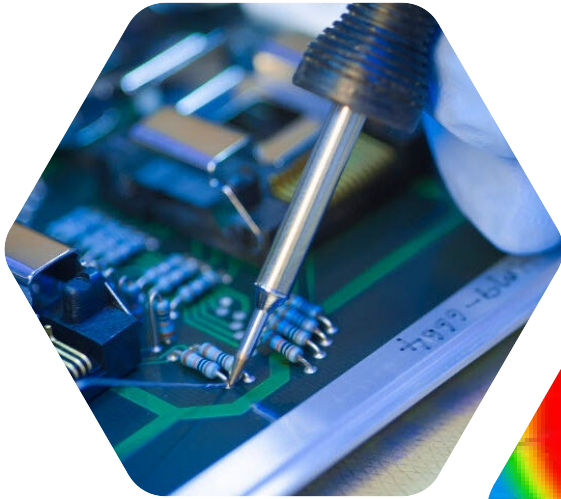


CNA is a mixed investigation center from the University of Seville, CSIC and Junta de Andalucía. It is one of the **ICTS - Singular Scientific-Technical Facilities** in our country, dedicated to interdisciplinary research in the field of applications of particle accelerators and ionizing radiation.



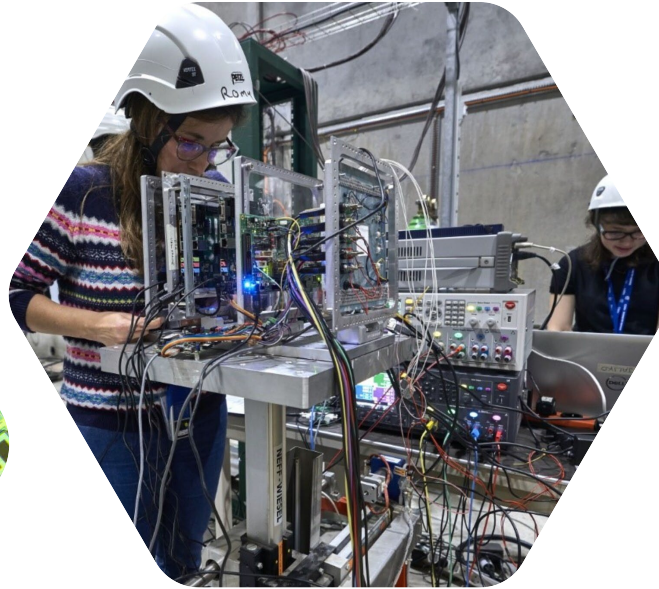
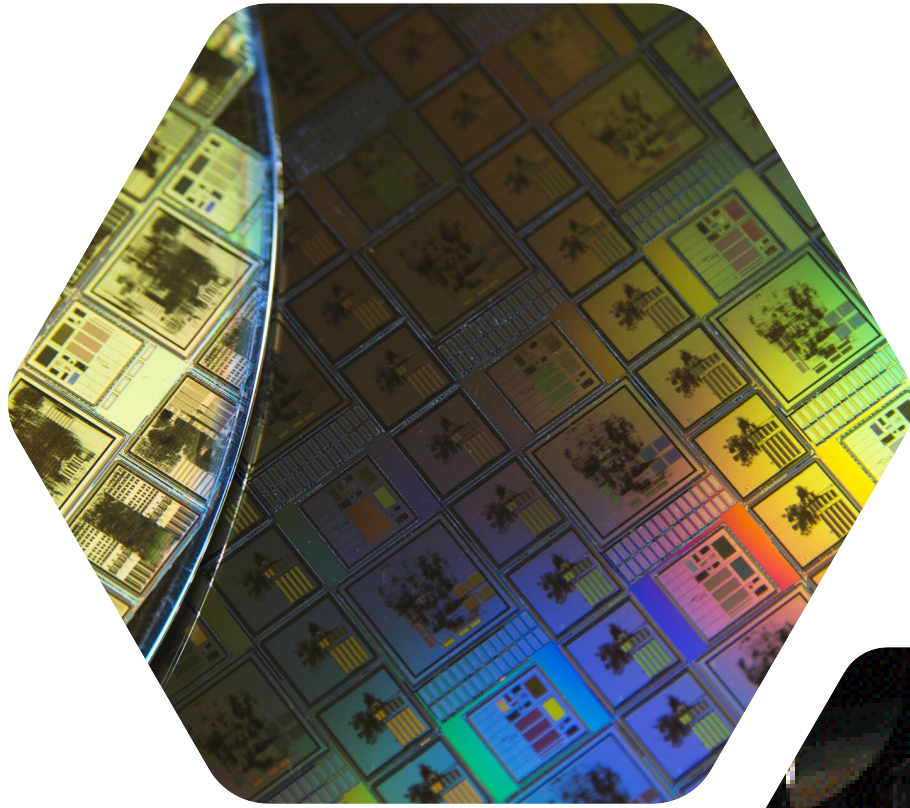
ALTER TECHNOLOGY

Alter Technology, a member of the TÜV NORD group, is a leading company in **engineering, procurement and testing** of electronic equipment and components for the space, military and aeronautical sectors, among others.



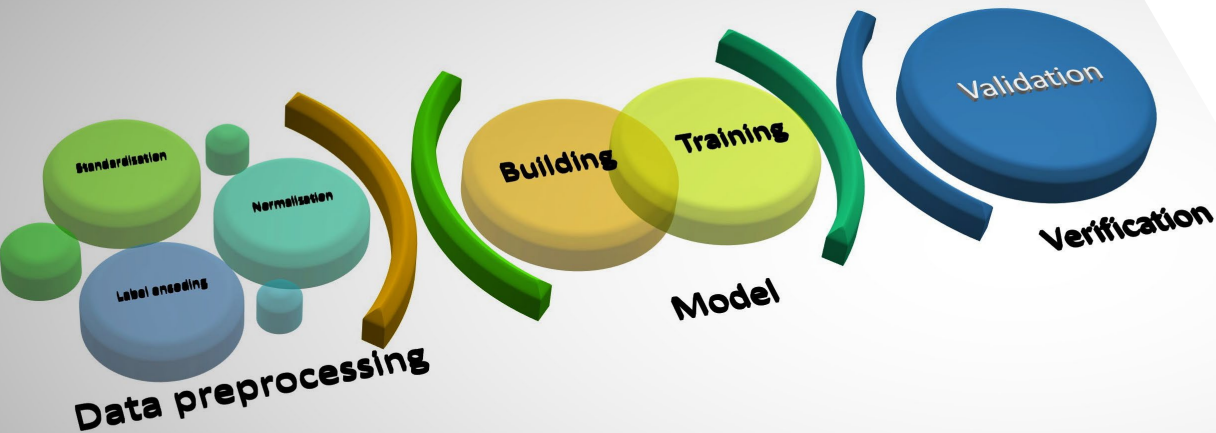
The effects on the **space radiation environment** on spacecraft systems and instruments are significant design considerations for a space mission. The kind of **radiation environment**, that affects in the satellite during the mission depends on many factors, for example the type of orbits or the solar cycle between others.

A critical step of **Radiation Hardness Assurance (RHA)** for space systems is given by the parts selection in concordance with the expected radiation effects. **Radiation testing** is the most decisive way of studying the radiation degradation.



PRECEDER consists of analyzing the structure of the set of results available from **irradiation tests** performed on electronic devices, mainly those used for space or high energy projects. To do this, the data must be **classified**, and the **structure** of each group must be homogenized in order to extract useful information to feed the **Machine Learning software**.

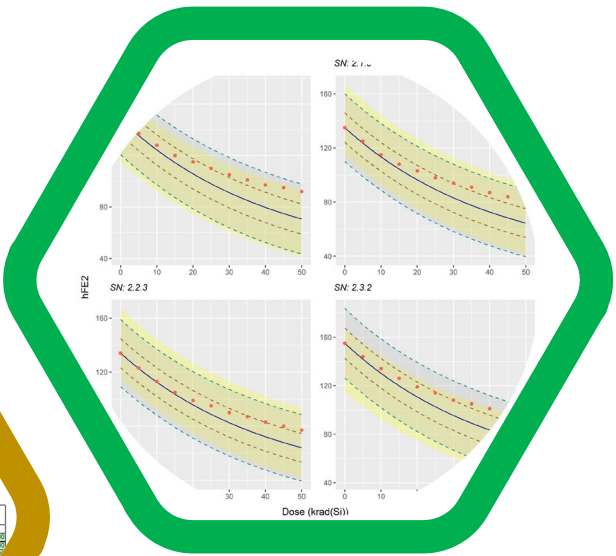
The aim of our proposal is to **extract useful information** from **experimental data**, available in a multitude of test reports previously carried out on different types of devices. And that, based on this previous experience, we can **predict** what will be the **behavior** of similar **components** without the need to test them under radiation.

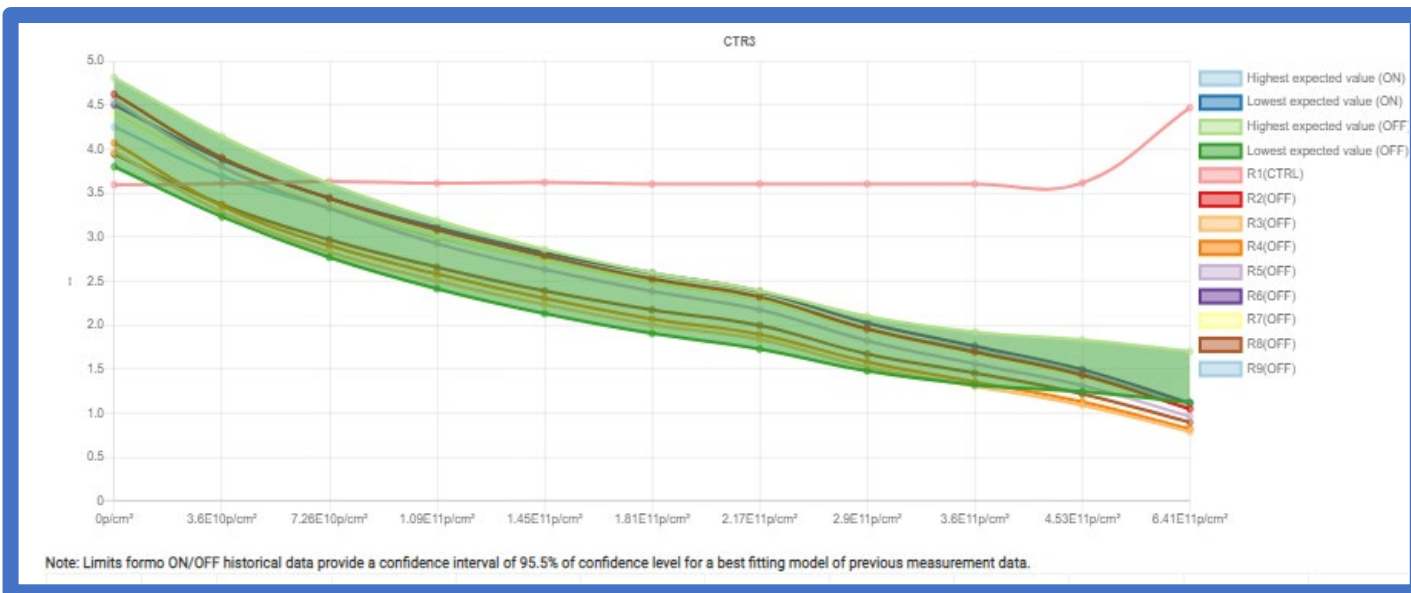
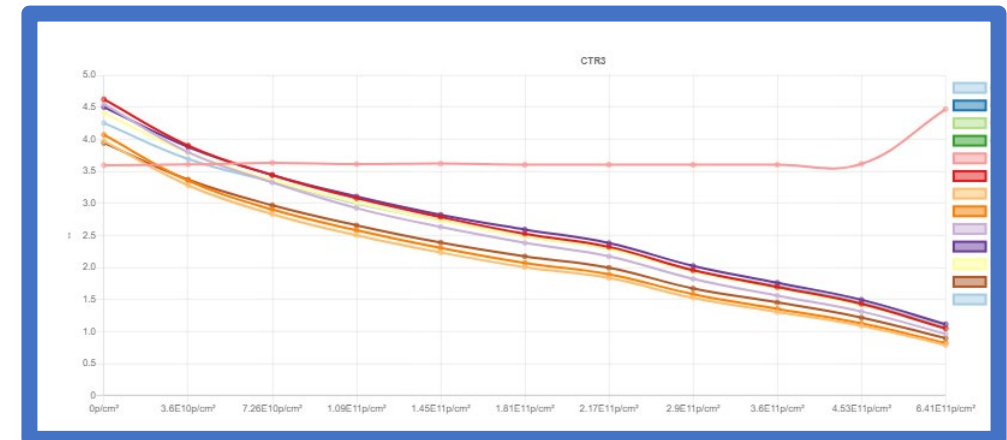
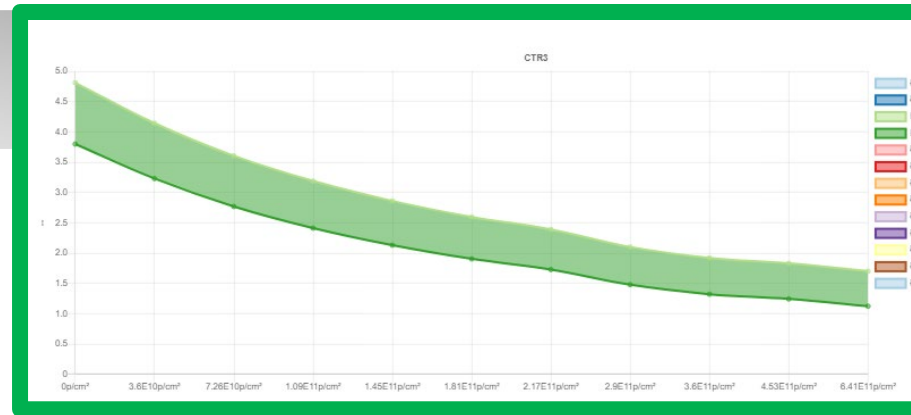
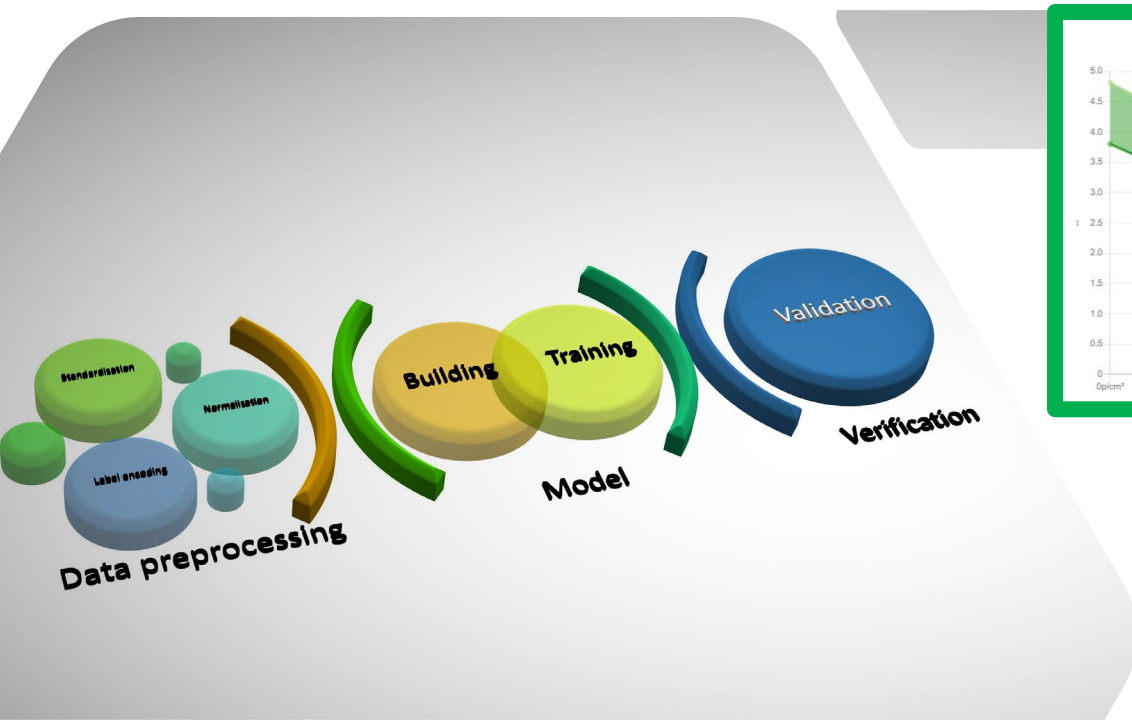


		mA		T# 2		+IB		nA	
100K	24Hr	S/N	OK	100K	24Hr	S/N	OK	100K	24Hr
3.409	3.408	1	-1.460	-1.460	-1.460				
3.363	2.361	2.820	2	-0.487	438.490	145.184			
3.439	2.400	2.825	3	0.730	409.618	141.533			
3.457	2.366	2.818	4	-0.122	418.640	141.777			
3.418	2.365	2.808	5	2.799	409.016	147.740			
3.312	2.321	2.722	22	-1.217	348.266	121.088			
3.290									

		KRAD LEVEL		Limits				
Serial #	0	30	50	100	200	Min	Max	UM
CONTROL	2.500	2.512	2.505	2.509	2.513	2.375	2.625	V
75	2.498	2.509	2.523	2.552	2.593	2.375	2.625	V

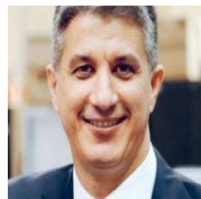
		Reference Voltage VDIFF_SV (L=10mA IV)		Total Dose (rad/Si)		Min		Max	
Serial #	0	30	50	100	200	Min	Max	UM	UM
CONTROL	2.500	2.512	2.505	2.509	2.513	2.375	2.625	V	V
75	2.498	2.509	2.523	2.552	2.593	2.375	2.625	V	V





Once the data is structured, **Machine Learning techniques** are applied to the available data to **identify the models** and patterns that allow to obtain predictions of the behavior of electronic devices.

Finally, the behavior of a small sample of devices is analyzed to **validate the predictions** against **experimental results**.



Manuel Domínguez
Responsable del proyecto



Dr. Aintzane Lujambio
Head of the Microwave Laboratory

ALTER TECHNOLOGY



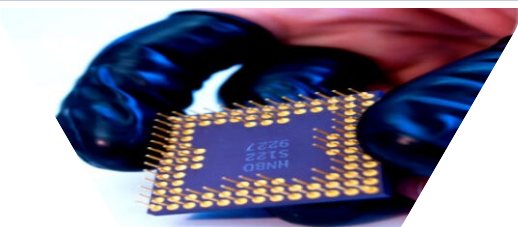
JL García
SW Developer



Jose de Martín
Data Scientist



Jose Manuel Ramirez
Data Scientist

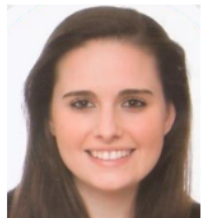


Centro Nacional de Aceleradores

Dr. Yolanda Morilla García
Responsable del proyecto



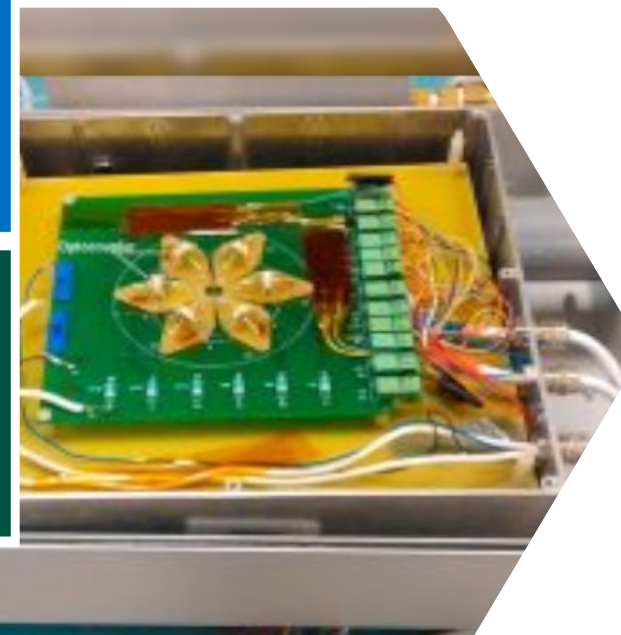
Pedro Martin Holgado
Irradiation Unit



Amor Romero Maestre
Irradiation Unit



Fernando Morilla
University Professor



• Publications

- **“How the Analysis of Archival Data Could Provide Helpful Information about TID Degradation”**
 - Pedro Martín-Holgado, Amor Romero-Maestre, José de-Martín-Hernández, José J. González-Luján, Iván Illera-Gómez, Yolanda Jiménez-de-Luna, Fernando Morilla, Mario Sacristan Barbero, Rubén García Alía, Manuel Domínguez, and Yolanda Morilla
 - Accepted in IEEE Proceedings Radiation and its effects on components and systems RADECS 2021
- **“How the Analysis of Archival Data Could Provide Helpful Information about TID Degradation. Case study: Bipolar Transistors”**
 - Pedro Martín-Holgado, Amor Romero-Maestre, José de-Martín-Hernández, José J. González-Luján, Iván Illera-Gómez, Yolanda Jiménez-de-Luna, Fernando Morilla, Mario Sacristan Barbero, Rubén García Alía, Manuel Domínguez, and Yolanda Morilla
 - In revision. IEEE Transactions on Nuclear Science
- **“A Novelty Approach of Radiation Hardness Assurance for Aerospace Applications based on Machine Learning”.**
 - Yolanda Morilla and Pedro Martín-Holgado
 - In press. Chapter of book ARTIFICIAL INTELLIGENCE: THE NEW PARADIGM TO BOOST SOCIETY 5.0, CRC Press – Taylor & Francis Group, 2021.
- **“Study of the performance characteristics degradation of optocouplers combining TID-DD effects with gamma and protons”**
 - Pedro Martín-Holgado, Amor Romero-Maestre, José de-Martín-Hernández, José M. Ramírez García, José J. González-Luján, Álvaro Ricca Soaje, Mario Sacristan Barbero, Rudy Ferraro, Rubén García Alía, Manuel Domínguez, and Yolanda Morilla
 - Sending to IEEE Nuclear and Space Radiation Effects Conference NSREC 2022, July 18-22, Provo, Utah – USA.
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 - CNA
 - Alter technology



Thank you



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Application of Micro/Nanometric Systems Student

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