

Newsletter #3

September 2020 – December 2020



ELICSIR: Enhancement of Scientific Excellence and Innovation Potential in Electronic Instrumentation for Ionizing Radiation Environments

Welcome to the third ELICSIR project newsletter!

After doing some research and conducting experiments, this was the period for presenting and publishing some of the findings.



Project website: elicsir-project.eu

Type of action: Coordination and Support

Topic: H2020-WIDESPREAD-2018-2020

Call: WIDESPREAD-3-2018-TWINNING



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857558.



ENHANCEMENT OF SCIENTIFIC EXCELLENCE AND INNOVATION POTENTIAL
IN ELECTRONIC INSTRUMENTATION FOR IONIZING RADIATION ENVIRONMENTS
WIDESPREAD-3-2019-TWIRING

18-20 SEPTEMBER 2020



The first joint experiment at Vinča Institute was conducted by our team. Prof. Goran Ristić and student Stefan Ilić from EF-UNINIS and Aleksandar Jaksic from Tyndall National Institute took part in the first joint experiment within the ELICSIR project. The experiment involved irradiation of commercial floating gate transistors and Tyndall stacked RADFET samples at the Vinča Institute of Nuclear Sciences, Belgrade. The results of the experiment will be used in joint research work in the project.



OCTOBER 2020

Luka Spahić, a master student at EF-UNINIS and a member of the ELICSIR project defended his master's thesis.



UNIVERZITET U NIŠU
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Luka Spahić

PROJEKTOVANJE I REALIZACIJA ELEKTRONSKOG SKLOPA ZA
MERENJE NISKIH STRUJA NA BAZI TRANSIMPEDANSNOG
POJAČANJA

MASTER RAD

Studijski program: Elektronika i mikrosistemi

Kandidat:

Mentor:

Luka Spahić, br. ind. 984

Prof. dr Goran Ristić

Design and implementation of an electronic circuit for measuring low currents based on transimpedance amplification

ABSTRACT

In order to successfully measure a given current quantity (current level of nA), it must be applied a certain measurement method. The master's thesis presents a solution based on the concept of transimpedance amplification and which is designed to ensure high as possible measurement accuracy with maximum immunity to external electromagnetic interference.

At the beginning of the thesis, a brief historical description of the development of the method of measuring electric current is given. Furthermore, the idea of the electronic circuit realization is presented and an overview of its key parts is given. As part of the thesis, the electrical circuit design method and its individual parts, simulation of the electrical circuit, as well as detailed design of the printed circuit board of the electronic circuit are presented in details.

After that, the measurements of the electric current were done by realized prototype and the discussion of the measurement results was presented.

At the end, a proposal for the electronic circuit application for measuring low current levels, improvement of functionality, as well as potential omissions and their elimination are given. Also, the electronic circuit enables amplification and conversion of generated photocurrents into voltage due to PIN diode irradiation. Based on the measured current, it is possible to calculate the absorbed dose of ionizing radiation.



Ovaj master rad urađen je u okviru ELICSIR projekta koji je financiran od strane Horizont 2020 programa za istraživanja i inovacije Evropske Unije prema sporazumu o grantu broj 857558

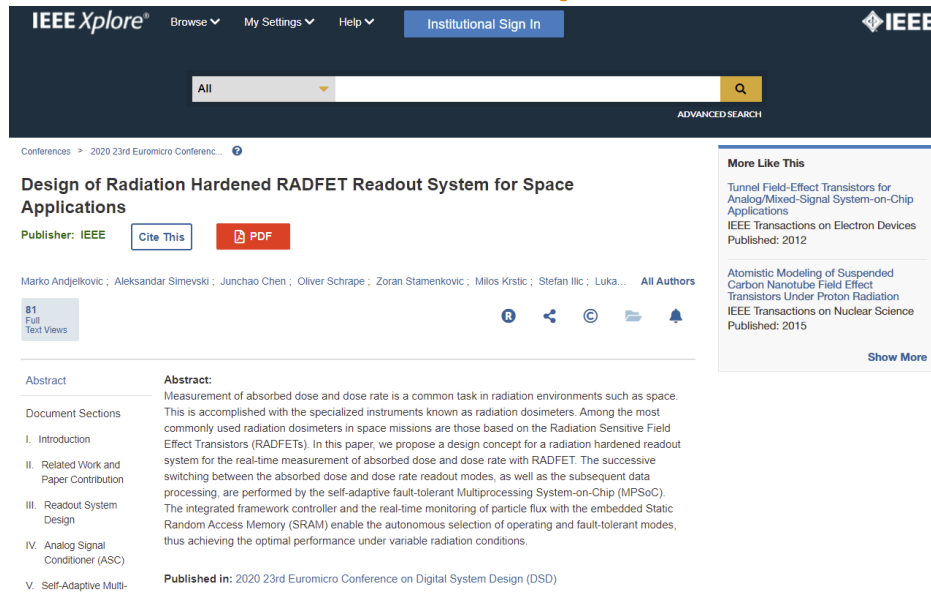


www.elicir.efak.rs

Niš, septembar 2020. god.



Joint scientific paper presented at the 23rd DSD 2020 Conference and published in the Proceedings



The screenshot shows the IEEE Xplore article page for the paper "Design of Radiation Hardened RADFET Readout System for Space Applications". The page includes the IEEE logo, search bar, and navigation options. The article title is "Design of Radiation Hardened RADFET Readout System for Space Applications". The publisher is IEEE. The authors listed are Marko Andjelkovic, Aleksandar Simevski, Junchao Chen, Oliver Schrape, Zoran Stamenkovic, Milos Krstic, Stefan Ilic, and Luka Spahic. The abstract is visible, starting with "Measurement of absorbed dose and dose rate is a common task in radiation environments such as space. This is accomplished with the specialized instruments known as radiation dosimeters. Among the most commonly used radiation dosimeters in space missions are those based on the Radiation Sensitive Field Effect Transistors (RADFETs). In this paper, we propose a design concept for a radiation hardened readout system for the real-time measurement of absorbed dose and dose rate with RADFET. The successive switching between the absorbed dose and dose rate readout modes, as well as the subsequent data processing, are performed by the self-adaptive fault-tolerant Multiprocessing System-on-Chip (MPSoC). The integrated framework controller and the real-time monitoring of particle flux with the embedded Static Random Access Memory (SRAM) enable the autonomous selection of operating and fault-tolerant modes, thus achieving the optimal performance under variable radiation conditions." The paper was published in the 2020 23rd Euromicro Conference on Digital System Design (DSD).

A scientific paper written by **Marko Andjelkovic, Aleksandar Simevski, Junchao Chen, Oliver Schrape, Zoran Stamenkovic, Milos Krstic, Stefan Ilic, Luka Spahic, Laza Kostic, Goran Ristic, Aleksandar Jaksic, Alberto J. Palma, Antonio Lallena, Miguel Angel Carvajal** titled *Design of Radiation Hardened RADFET Readout System for Space Applications* was published in the [Proceedings of the 23rd Euromicro Conference on Digital System Design \(DSD\)](#).

<https://doi.org/10.1109/DSD51259.2020.00082>

A part of this research was
conducted within the ELICSIR
project.

Abstract

Measurement of absorbed dose and dose rate is a common task in radiation environments such as space. This is accomplished with the specialized instruments known as radiation dosimeters. Among the most commonly used radiation dosimeters in space missions are those based on the Radiation Sensitive Field Effect Transistors (RADFETs). In this paper, we propose a design concept for a radiation hardened readout system for the real-time measurement of absorbed dose and dose rate with RADFET. The successive switching between the absorbed dose and dose rate readout modes, as well as the subsequent data processing, are performed by the self-adaptive fault-tolerant Multiprocessing System-on-Chip (MPSoC). The integrated framework controller and the real-time monitoring of particle flux with the embedded Static Random Access Memory (SRAM) enable the autonomous selection of operating and fault-tolerant modes, thus achieving the optimal performance under variable radiation conditions.

Stefan Ilić, a master student at EF-UNINIS and a member of the ELICSIR project defended his master's thesis.

Investigation of the possibility of using a commercial floating gate transistor as an ionizing radiation detector in high sensitivity mode

ABSTRACT

This paper presents the use of a commercial MOS transistor with a floating gate, the so-called EPAD (Electrically Programmable Analog Device), for ionizing radiation detectors in a special high-sensitivity mode (HIGHSENS). The idea is to design a linear sensor with a constant value of sensitivity to ionizing radiation. Floating gate technology provides a semiconductor detector with a much thinner oxide and thus eliminates side effects such as fading, CMOS incompatibility, high-temperature sensitivity, etc. Earlier observation shows that sensitivity decrease because the amount of electrons at the floating gate decreases. The high sensitivity mode is designed to increase the sensitivity of the detector by cyclically charging the floating gate with electrons during operation in the radiation field and thus constantly maintaining a charged floating gate and thus higher sensitivity. Also, the dependence of the threshold voltage shift on the dose is not linear, but this mode can constantly maintain linearity if a sufficiently small linear area is selected where the value of the threshold voltage oscillates.

This process is controlled by auxiliary electronics located next to the detector. The experiment contained two variants of the high-sensitivity regime: with zero and positive bias, where zero bias gives higher sensitivity. The results show a significantly higher sensitivity of EPAD in the mode of high sensitivity and zero bias during irradiation than without such mode of operation. Also, all EPADs in the high-sensitivity mode show a linear dose-dependence. The problem exists in the repeatability of the experiment, it is assumed that the cause is the tunnel oxide through which the floating gate is charged with the electrons, which does not have a satisfactory quality for this kind of work. Also, the operation of the system is quite complex and requires extensive calibration of the software.

Keywords: Floating gate; MOS transistor; ionizing radiation; detector.



Univerzitet u Nišu
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Stefan Ilić

ISPITIVANJE MOGUĆNOSTI KORIŠĆENJA KOMERCIJALNOG
TRANZISTORA SA PLIVAJUĆIM GEJTMOM KAO DETEKTORA
JONIZUJUĆEG ZRAČENJA U REŽIMU VISOKE OSETLJIVOSTI

MASTER RAD

Studijski program: Elektronika i mikrosistemi

Kandidat:
Stefan Ilić, br. ind. 929

Mentor:
prof. dr Goran Ristić



Ovaj master rad urađen je u okviru projekta
ELICSIR koji je finansiran od strane Horizont 2020
programa za istraživanja i inovacije Evropske Unije
prema sporazumu o grantu broj 857558



*Laza Kostić, a master student at EF-UNINIS and
a member of the ELICSIR project defended his master's thesis.*



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PROJEKTOVANJE I REALIZACIJA
SAMOODRŽIVOG AUTONOMNOG
ELEKTRONSKOG SISTEMA SA NISKOM
POTROŠNJOM ENERGIJE ZA MERENJE
APSORBOVANE DOZE JONIZUJUĆEG ZRAČENJA

MASTER RAD

Studijski program: Elektronika i mikrosistemi

Student:

Mentor:

Laza Kostić, br. indeksa: 1007

Prof. dr Goran Ristić



Ovaj master rad urađen je u okviru projekta ELICSIR koji je finansiran od strane Horizont 2020 programa za istraživanja i inovacije Evropske Unije prema sporazumu o grantu broj 857558



www.elicsir-project.eu

Self-sustaining, low-power embedded system for measuring the absorbed dose of ionizing radiation

ABSTRACT

The last century brought mankind a huge technological leap forward. One technological discovery that changed the world forever was the discovery of nuclear energy. Nuclear energy is used, among other things, in the production of electrical energy. Nuclear power plants are one of the cleanest energy sources that we have, and are a great step forward towards a cleaner tomorrow. Nuclear energy doesn't exist only as a product of mankind, it is prevalent everywhere in space. It's affects in space are well known by astronauts and space-engineers alike.

As the possibilities of nuclear energy are tested for the task of a better future here on Earth and elsewhere in space, the need for measuring nuclear energy arises. The way this can be done is by using sensors for ionizing radiation. These sensors normally generate an electrical current or voltage potential on their output, in accordance to the ionizing radiation they absorb.

One application of this kind of sensor is in a system for measuring the absorbed dose of ionizing radiation, for where this kind of system is needed or wanted. For example, inside of and around a nuclear power plant, or inside of and around a mine or quarry where radioactive materials are being resourced, or in an area where using multiple sensing units the statistics of absorbed ionizing radiation are calculated.

In this master thesis, the flow and procedures of designing and realization of a prototype system for this purpose, that uses sensors for sensing doses of absorbed ionizing radiation, uses a GPS module in order to gather information about its location and uses a GSM module to send all the information to a base station is shown. The system is powered by a lithium battery, which is charged by a solar cell via a lithium battery charger circuit. The total power consumption of the system is reduced by using a power management circuit. The system as a whole is very compact and modular, hence it is easy to conform to multiple use cases and conditions.

NOVEMBER 2020



Project team members continue their education

After completing their master's theses resulting from their research conducted within the ELICSIR

project, Stefan Ilić, Luka Spahić, and Laza Kostić, enrolled in the doctoral studies, thus continuing their education and their work on the project.



Stefan Ilić received the award for the best master's thesis at the Faculty of Electronic Engineering for the 2019/2020 school year.

DECEMBER 2020

Visit to the DMV company

Goran Ristić, project coordinator, Laza Kostić, PhD student, and Aleksandar Jevtić, MSc student, visited the [DMV company](#) and presented the ELICSIR project. Together with the owner of the company, Mr. Dušan Šarković, they visited the company's laboratories and considered the possibility of mutual cooperation. It is [one of the most successful companies](#) in this part of Serbia.

