

MultiRad: Evaluation of Space-to-Ground **Radiation** Effects in **Multicore** Computing Systems for Safety-Critical Applications

Computing systems with powerful multicore engines progressively assume key autonomous functions in safety-critical artificial intelligence applications such as new generations of industrial automation robots, electric/hybrid self-driving cars, drones, aircraft, and satellites. MultiRad project aims to study, evaluate, and improve the reliability of forthcoming multicore computing systems running complex algorithms under common impacts of single energetic particles provoked in space, aviation altitudes, and also ground levels as results of sun and cosmic ray radiation effects from space. In addition to set a related scientific research synergy, MultiRad project will train PhD and master-level international students through advanced research experimental activities at accelerated radiation test facilities, putting young students very early in contact with practical experiences and advanced technologies.

Consortium

MultiRad consortium is an international scientific partnership of 6 universities from France, Brazil, Spain, and United Kingdom within the disciplines of computer engineering, computer science, and physics. The scientific interactions are based on the rich complementary of the consortium composed of Université Grenoble Alpes (UGA) contributing with accelerated radiation testing aspects of computing systems, Loughborough University (LU, United Kingdom) with virtual platforms for simulating multicore systems, Universidad de Alicante (UA, Spain) with software-level radiation-hardening techniques, Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS, Brazil) with design of multicore systems, Universidade Federal do Rio Grande do Sul (UFRGS, Brazil) with hardware design in programmable logic for radiation-hardened applications, and Universidade Federal de Santa Maria (UFSM, Brazil) with processor design for aerospace applications.



Project information

- Start: July 2020
- End: December 2023
- **General coordination:**
 - Rodrigo POSSAMAI BASTOS
- **Principal investigators:**
 - Université Grenoble Alpes (UGA):
 - Rodrigo POSSAMAI BASTOS
 - Loughborough University (LU):
 - Luciano OST
 - Universidad de Alicante (UA):
 - Sergio CUENCA ASENSI
 - Universidade Católica do Rio Grande do Sul (PUCRS):
 - Rafael GARIBOTTI
 - Universidade Federal do Rio Grande do Sul (UFRGS):
 - José Rodrigo AZAMBUJA
 - Universidade Federal de Santa Maria (UFSM):
 - João BAPTISTA MARTINS
- **Current and former PhD students:**
 - UGA:
 - Tarso KRAEMER SARZI SARTORI
 - Matheus GARAY TRINDADE
- **Current and former interns:**

- UGA:
 - 2022:
 - Guilherme AKIRA ALVES DOS SANTOS
 - Luiz HENRIQUE LAURINI
 - 2021:
 - Marcelo CORREA CUETO
 - Joao Paolo SALES BRUM
 - Jiaru LIN
- **Consortium funding:**
 - Agency: Région Auvergne-Rhône-Alpes
 - Call: International Ambition Pack (PAI)
 - Grant: 45 k€
- **Official website:**
 - <https://sourcesup.renater.fr/wiki/multirad/public>
- **Institutional website:**
 - <https://tima.univ-grenoble-alpes.fr/multirad>
- **Related projects:**
 - stAte:
 - <https://tima.univ-grenoble-alpes.fr/state>
 - <https://sourcesup.renater.fr/wiki/state/public>
 - PERSYVAL-Lab:
 - <https://persyval-lab.org/en>
 - Nanoelec
 - <https://irtnanoelec.fr/en/>

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Project scientific production

International journals

1. Rodrigo Possamai Bastos, Matheus Garay Trindade, Rafael Garibotti, Jonas Gava, Ricardo Reis, and Luciano Ost, Assessment of Tiny Machine-Learning Computing Systems under Neutron-Induced Radiation Effects, IEEE Transactions on Nuclear Science, 2022;
2. Tarso Kraemer Sarzi Sartori, Hassen Fourati, Manon Letiche, and Rodrigo Possamai Bastos. Assessment of Radiation Effects on Attitude Estimation Processing for Autonomous Things, IEEE Transactions on Nuclear Science, 2022;
3. Fabio Benevenuti, Marcio Goncalves, Evaldo Carlos F. Pereira Jr, Rafael G. Vaz, Odair L. Gonzalez, Odair L.; Rodrigo Possamai Bastos, Manon Letiche, Fernanda L. Kastensmidt, Jose Rodrigo Azambuja. Investigating the Reliability Impacts of Neutron-induced Soft Errors in Aerial Image Classification CNNs Implemented in a Softcore SRAM-based FPGA GPU, Journal Microelectronics Reliability, Elsevier, 2022;
4. Vitor Bandeira, Jack Sampford, Rafael Garibotti, Matheus Garay Trindade, Rodrigo Possamai Bastos, Ricardo Reis, and Luciano Ost, Impact of radiation-induced soft error on embedded cryptography algorithms, Journal Microelectronics Reliability, Elsevier, 2021;
5. Matheus Garay Trindade, Fabio Benevenuti, M. Letiche, J. Beaucour, F. Kastensmidt, and Rodrigo Possamai Bastos, Effects of thermal neutron radiation on a hardware-implemented machine learning algorithm, Journal Microelectronics Reliability, Elsevier, 2021, 116 (114022);

International conferences

1. A. Serrano-Cases, A. Martínez-Álvarez, R. Possamai Bastos, and S. Cuenca-Asensi, Redundant Portable Multi-Threading for Soft Error Mitigation on Multicore Systems on Chip, Conference on Radiation Effects on Components and Systems (RADECS), Oct 2022, Venice, Italy;
2. J. Gava, G. Abich, R. Garibotti, S. Cuenca-Asensi, R. Possamai Bastos, R. Reis and L. Ost, A Lightweight Mitigation Technique for Resource-constrained Devices under Neutron Radiation, Conference on Radiation Effects on Components and Systems (RADECS), Oct 2022, Venice, Italy;
3. J. Gava, N. Moura, V. da Rocha, R. Garibotti, S. Cuenca-Asensi, R. Possamai Bastos, R. Reis and L. Ost, Assessment of Radiation-Induced Soft Error on Lightweight Cryptography Algorithms, Conference on Radiation Effects on Components and Systems (RADECS), Oct 2022, Venice, Italy;
4. T. Kraemer Sarzi Sartori, H. Fourati, A. Justus Rajappa, P. Reiter, and R. Possamai Bastos, Effectiveness of Attitude Estimation Processing Approaches in Tolerating Radiation Soft Errors, Conference on Radiation Effects on Components and Systems (RADECS), Oct 2022, Venice, Italy;
5. Rodrigo Possamai Bastos, Martí Gorchs Picas, Marcelo Correa Cueto, and Raoul Velazco, MEO Spaceflight Results of Radiation Effects in COTS FPGA-implemented Triple Modular System, Conference on Radiation Effects on Components and Systems (RADECS), Oct 2022, Venice, Italy;
6. Fabio Benevenuti, Marcio Goncalves, Evaldo Carlos F. Pereira Jr, Rafael G. Vaz, Odair L. Gonçalez, Odair L.; Rodrigo Possamai Bastos, Manon Letiche, Fernanda L. Kastensmidt, Jose Rodrigo Azambuja. Investigating the Reliability Impacts of Neutron-induced Soft Errors in Aerial Image Classification CNNs Implemented in a Softcore SRAM-based FPGA GPU, European Symposium on Reliability of Electron Devices, Failure Physics and Analysis (ESREF), Sep 2022, Berlin, Germany;
7. Rodrigo Possamai Bastos. Radiation effects in tiny machine learning systems and attitude estimation processing modules for autonomous things, 17th International School on the Effects of Radiation on Embedded Systems for Space Applications (SERESSA), Nov 2021, Virtual event;
8. Joao Paolo Sales Brum, Tarso Kraemer Sarzi Sartori, Jiaru Lin, Matheus Garay Trindade, Hassen Fourati, Raoul Velazco, Rodrigo Possamai Bastos, Evaluation of Attitude Estimation Algorithm under Soft Error Effects, IEEE Latin-American Test Symposium (LATS), Oct 2021, Virtual event;
9. Vitor Bandeira, Jack Sampford, Rafael Garibotti, Matheus Garay Trindade, Rodrigo Possamai Bastos, Ricardo Reis, and Luciano Ost, Impact of radiation-induced soft error on embedded cryptography algorithms, European Symposium on Reliability of Electron Devices, Failure Physics and Analysis (ESREF), Oct 2021, Bordeaux, France;
10. Matheus Garay Trindade, Joao Paolo Sales Brum, Liège Maldaner, Rafael Garibotti, Luciano Ost, and Rodrigo Possamai Bastos, Assessment of Machine Learning Models in Computing System under Neutron Radiation, Conference on Radiation Effects on Components and Systems (RADECS), Sep 2021, Vienna, Austria;
11. Tarso Kraemer Sarzi Sartori, Hassen Fourati, Matheus Garay Trindade, and Rodrigo Possamai Bastos, Assessment of Attitude Estimation Processing System under Neutron Radiation Effects, Conference on Radiation Effects on Components and Systems (RADECS), Sep 2021, Vienna, Austria;
12. Matheus Garay Trindade, Rafael Garibotti, Luciano Ost, M. Letiche, J. Beaucour, and Rodrigo Possamai Bastos, Assessment of Machine Learning Algorithms for Near-Sensor Computing Under Radiation Soft Errors, 16th International School on the Effects of Radiation on Embedded Systems for Space Applications (SERESSA), Dec 2020, Virtual edition;
13. Matheus Garay Trindade, Rafael Garibotti, Luciano Ost, M. Letiche, J. Beaucour, and Rodrigo Possamai Bastos, Assessment of Machine Learning Algorithms for Near-Sensor Computing Under Radiation Soft Errors, IEEE International conference on electronics, circuits & systems (ICECS), Nov 2020, Glasgow, SCOTLAND, United Kingdom;