The GENESIS platform

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Platform description

The GENESIS (**GE**nerator of **NE**utrons for **S**cience and **I**rradiation**S**) platform consists of an electrostatic accelerator of 220 kV called GENEPI2, delivering neutrons thanks to fusion reactions (Fig. 1).
The deuteron ions are created by an ECR compact source, designed and made at LPSC (accelerator and ion source division). Installed at the 220 kV HV terminal, it produces a continuous beam injected into an electrostatic column, analysed by a magnet and guided onto a deuterated or tritiated target. Subsequent $D(d,n)^3He$ or $T(d,n)^4He$ reactions produce fast neutrons of 3.1 MeV or 15.2 MeV respectively (at 0° for 220 keV incident neutrons). The beam intensity ranges from 10 µA to 150 µA. The typical neutron production via $T(d,n)^4He$ reaction is $8x10^9$ n/s ($5x10^7$ n/cm^2/s at 1 cm).

Figure 1: The HV head of the GENEPI2 accelerator (left) and the experimental area of the GENESIS platform with the XY table in front of the target foreground (right).

The platform can provide users with an X-Y table, remotely controlled, in order to position or withdraw the samples to be irradiated without approaching the activated target. For the needs of the platform exploitation a continuous monitoring of the neutron production is performed thanks to two in-situ monitors, and this information can be provided to users. The absolute neutron production of the target is also regularly checked thanks to foil activation technique with analysis at the low activity laboratory (LBA) of LPSC.

At present the two main fields addressed by the facility users are nuclear physics (mainly detector testing) and microelectronics. The platform is particularly well suited for irradiations in the field of micro-electronics thanks to its high flux, especially since the ECR source was installed. The GENESIS platform offers now the highest 14 MeV neutron flux in France. It is an IN2P3 platform since 2017.

Platform access

The platform activity is shared between academic research ("science") and commercial activity ("irradiations"). Users coming from public laboratories or private companies can make a beam request (by mean of a form) at genesis@lpsc.in2p3.fr at any time of the year as the facility has no PAC. The easy access to the platform is one of its major asset. However the beam is given to academic research in priority. The facility schedule is made over a period of 6 months, taking into account the constraints of the platform exploitation (shut-down periods, maintenance, operation manpower…) or the ones of the user (availability, neutron energy, intensity or fluence required,…). Operation is limited to office hours (8 am-6 pm, Monday-Friday), with an offer of about 130 days/year.
The platform has to be quoted in scientific publications reporting about results obtained at the facility.

Networking

The GENESIS Platform joined the IRT (Institut de Recherche Technologique) Nanoélec in 2016 within the characterization program. In particular it belongs to the Platform for Advanced Characterization Grenoble (PAC-G), gathering ILL, ESRF, CEA/Leti and LPSC, which offers a common entry point for commercial services of material characterization dedicated to micro- and nano-electronics industry (https://pac-grenoble.eu/). It is also a partner of the European training network RADSAGA (RADiation and Reliability Challenges for Electronics used in Space, Aviation Ground and Accelerators) managed by CERN (https://radsaga.web.cern.ch/) and is applying to join the following program RADNEXT as a Transnational Access. Finally, GENESIS is included in the world wide irradiation facilities data base managed by CERN (https://irradiation-facilities.web.cern.ch/).
Regarding the nuclear physics community, GENESIS is a part of the EURATOM project ARIEL (Accelerator and Research reactor Infrastructures for Education and Learning, 2019-2022) as a Transnational Access for the nuclear data community. It is also listed in the NUPIA (Nuclear Physics Innovation) network of the ENSAR2 program.

Some Publications/Communications :

- J.A. Clemente, G. Hubert, F. Franco, F. Villa, M. Baylac et al., *Evaluation of the Sensitive of a COTS 90-nm Memory at Low Bias Voltage Radiation and its Effects on Components and Systems*, RADECS'16, Sep 2016, Bremen, Germany.

- F. Franco, J.A. Clemente, M. Baylac, S. Rey, F. Villa et al., *Some Properties of only-SBUs Scenarios in SRAMs Applied to the Detection of MCUs, Radiation and its Effects on Components and Systems*, RADECS'16, Sep 2016, Bremen, Germany.

- Pabo Ramos, Vanessa Vargas, M. Baylac, F. Villa, S. Rey et al., *Evaluating the SEE sensitivity of a 45nm SOI Multi-core Processor due to 14 MeV Neutrons*, IEEE Transactions on Nuclear Science, Institute of Electrical and Electronics Engineers, 2016, 63 (4), pp.2193 - 2200.

- J.A. Clemente, F.J. Franco, F. Villa, M. Baylac, P. Ramos et al., *Single Events in a COTS Soft-Error Free SRAM at Low Bias Voltage Induced by 15-MeV Neutrons*, IEEE Transactions on Nuclear Science, Institute of Electrical and Electronics Engineers, 2016, 63 (4), pp.2072 - 2079. 〈10.1109/TNS.2016.2522819〉

- J.A. Clemente, F.J. Franco, F. Villa, M. Baylac, S. Rey et al., *Statistical Anomalies of Bitflips in SRAMs to Discriminate SBUs From MCUs*, IEEE Transactions on Nuclear Science, Institute of Electrical and Electronics Engineers, 2016, 63 (4), pp.2087 - 2094.

- J.A. Clemente, G. Hubert, F. Franco, F. Villa, M. Baylac et al., *Sensitivity Characterization of a COTS 90-nm SRAM at Ultra Low Bias Voltage*, IEEE Transactions on Nuclear Science, Institute of Electrical and Electronics Engineers, 2017, PP (99), <10.1109/TNS.2017.2682984>

- M. Cecchetto et al., *Impact of thermal and intermediate energy neutrons on SRAM SEE rates in the LHC accelerator*, to be published in RADECS2017 proceedings.

- M. Le Guillou, A. Billebaud, A. Gruel, G. Kessedjian, O. Méplan, C. Destouches, P. Blaise, *The CANDELLE experiment for characterization of neutron sensitivity of LiF TLDs*, IEEE Transactions on Nuclear Science, (2018) *Vol 65, Issue 9, 2426*.

- G. Lehaut, M. Bourgeot, B. Galhaut, D. Goupillière, M. Henri, F.R. Lecolley, X. Ledoux, J. Lory, L. Manduci, N. Marie, J. Perronnel and Ch. Vandamme, *SCALP: a detector for (n,α) cross-section measurements, ANIMMA conference*, 17-21 juin 2019, Portoroz, Slovénie, EPJ Web of Conferences 225, 01001 (2020).

Publications related to the facility :

- F. Villa *et al., Multipurpose applications of the accelerator-based neutron source GENEPI2*, 5th International Meeting of Union for Compact Accelerator-Driven Neutron Sources (UCANS V), Padova, Italy, May 2015, Il Nuovo Cimento C, 2015 - Issue 6, DOI:10.1393/ncc/i2015-15182-2

- J. Beaucour *et al., Grenoble Large Scale Facilities for Advanced Characterisation of Microelectronics Devices*, *15th European Conference on Radiation and Its Effects on Components and Systems (RADECS),* IEEE Transactions on Nuclear Science, Moscow, Russia, 2015, DOI: 10.1109/RADECS.2015.7365616

- F. Villa *et al., Accelerator-based neutron irradiation of integrated circuits at GENEPI2 (France),* 2014 IEEE Nuclear and Space Radiation Effects Conference (NSREC2014), July 2014, Paris, France, DOI : 10.1109/REDW.2014.7004511