Radiation Effects Facility RADEF

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Abstract

Since the first days of the space conquest, electronic components have changed remarkably. In the seventies, Single Event Effects (SEE), caused by heavy ions and protons, were unknown. The increase in integration density led first to Single Event Upsets and later, with the CMOS technology, Single Event Latchups etc... The end of the cold war crashed the military market and, since that, the growing acceptance of Commercial Off-The-Shelf (COTS) components in space systems has encouraged the major manufacturers to withdraw from the RadHard component production. Therefore, one had to start testing of the SEE durability of COTS components with particle accelerators.

1. Introduction

This was our motivation to start the construction of the RADiation Effects Facility, RADEF, at the accelerator laboratory of the University of Jyväskylä (JYFL). Daimler-Benz Aerospace (currently Astrium Space) performed the first test of ISS electronics in spring 1998. Since that several test-campaigns with different users have been carried out and, recently, European Space Agency, ESA, has evaluated the RADEF facility for its coming purposes.

2. The JYFL accelerator

The JYFL accelerator is a sector-focused K-130 cyclotron of beams from hydrogen to xenon equipped with two ECR-ion sources for high-charge-state heavy ions and an H-minus ion source for intense protons. In conjuction with the ECR, the cyclotron can run "ion cocktails" which are mixtures of ions with near-identical charge-to-mass ratios. This property allows a fast swap of ions. Our ion selection provides linear energy transfer values in silicon up to 62 MeV/(mg/cm²). Also, MIVOC technique [1] allows one to use metallic ions in cocktails.

3. The RADEF facility

The RADEF facility includes a special beam line dedicated to irradiation studies. It consists of a vacuum chamber (H=81cm, D=75cm) including component movement apparatus and the necessary equipment for beam quality control and dosimetry [2]. The position of the components can be adjusted in X, Y and Z directions and the possibility of tilting around the Y-axis is provided by a round table. The assembly is equipped with a standard mounting fixture [3] where the free movement area reserved for the DUT-board is 25x25cm².

4. ESA-evaluation

By using the same devices at both RADEF and ESA coordinated test site, HIF, in Belgium, ESA evaluated the RADEF-station. As can be seen in a comparison of figure below, a fairly good agreement between the two preliminary SEU curves exists [4].

The aim of ESA is to use our capability to accelerate high-penetration cocktails, needed for the backward irradiations of the modern advanced components, where a part of sensitive area of the silicon die is shielded. As an example, the penetration depths of nitrogen and krypton ions can reach up to 200 and 100 microns in silicon, respectively.