Radiation hardness tests on electronic components for CBM/STS low voltage power supply.

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Electronic components installed in the field of reaction products in future experiments at FAIR have to be radiation hard. At present, selected parts like DC/DC converters and LDO voltage stabilisers undergo exhaustive tests with use of intense minimum ionising particles' beams, mostly 3 GeV protons at Jülich sychrotron facility.

Testing setup

For components like DC/DC converters or LDO voltage stabilisers the output voltage level as well as expected transient voltage spikes rate due to the Single Event Upsets has to be monitored during irradiation. Voltage level monitoring (input and output) requires relatively low readout frequency below 1 Hz and can be implemented on inexpensive ARDUINO-Nano system [1]. Fast transients have been investigated on 4 trace digital oscilloscope Rhode-Schwarz RTO1044 [2] (triggering threshold has been setup to 15 mV). Measurement results have been recorded in nonvolatile memory and analysed.

Selected ASICs

For the radiation hardness tests several DC/DC converters have been chosen. Selection criteria like circuit efficiency, chip size, low coil inductivity, apropriate output voltage and sufficient output power as well as voltage setting flexibility have been applied. Only one model

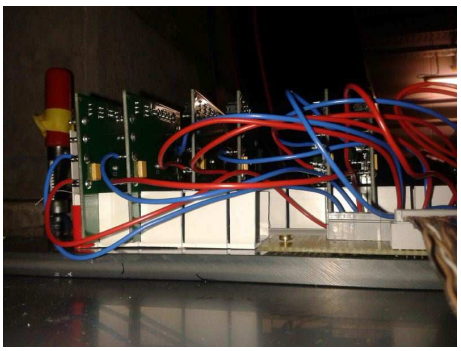

Figure 1: Base plate with PCB card holder and wiring.

of the LDO stabilizer produced in rad hard technology has been examined until now. Alltogether 10 test boards with LTC3605 and 3 Boards with LTC3610 (Linear Technology) and 4 boards containing LM2596S (Texas Instruments) have been tested in two beam times. A GaN based ISL75051SRH has been abandoned according to producer information on radiation hardness of only 100 krad. All tested ASICs have been powered on during irradiation runs. Test boards have been placed in a holder which assured their position with respect to the proton beam during the measurement as shown in Fig.1.

Test results

PCBs with tested chips have been placed in a row along the beam axis such that the irradiating beam punched through all of them. A small ionisation chamber placed on the beam axis behind tested chips has been used to monitor the beam intensity. The beam profile has been investigated

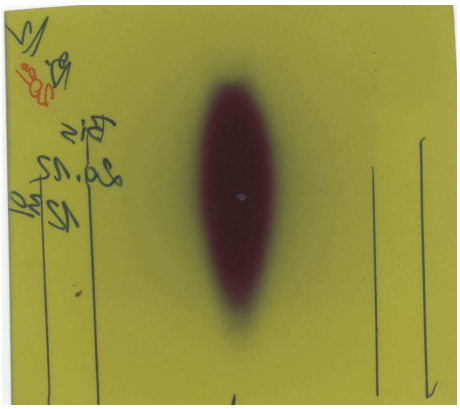

Figure 2: Beam spot on Gafchromic self-developing dosimetric film.

with Gafchromic dosimetric film [3]. In course of irradiation the film developes a spot corresponding to the shape of the proton beam with optical density corresponding to the integrated beam intensity (Fig.2). The total dose is known from the measurement with the ionisation chamber. Using film densitometry precise beam intensity distribution can be estimated and - consequently - the dose at ASIC chips.

Neither of tested DC/DC converters survived more than $4.3*10^9$ protons. No fast transients have been observed on LDO voltage stabilisers which have absorbed only 10^8 protons (measurement was stopped for technical reasons before planned dose was reached).

References

[1] S. Löchner and P. Koczoń GSI Annual Report 2014

[2] http://www.rohde-schwarz.de/de/Produkte/messtechnik-testsysteme/aerospace-and-defense/messtechnik/oszilloskope-fuer-ad/RTO.html

[3] http://www.ashland.com/products/gafchromic-radiotherapy-films

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