

Prototype of a rasterscan control system for BIOMAT@FAIR

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Introduction

The pencil beam scanning method (rasterscan) developed in the framework of ion beam therapy at GSI has proven to be extremely valuable not only in medical applications, but also for experimental applications in radiobiology and materials research. It allows to adapt the field size exactly to the needs of the individual experiments without collimating the beam and thus makes optimal use of the ions delivered by the accelerator. It is thus planned to use this method also in the future BIOMAT facility at FAIR. However, the currently used rasterscan control system in Cave A is based on technologies available in the 1990s and includes many features which are particularly relevant for patient safety, like e.g. redundancy and interlock systems. For many radiobiological experiments, though, less sophisticated techniques still allow to achieve a dose delivery with sufficient accuracy. The goal of the project described here was thus a redesign of the control system on a different hardware- and software platform, focusing on the core functions required in any scanning system.

Methods

At present the system is limited to 2D-scanning in x- and y-direction. The basic functions of the system comprise the automatic control of the scanning magnets, of the beam request and of the fast stop of extraction (Fig. 1). An ionization chamber signal is used to measure the beam intensity, which represents the input information required to control the scanning speed.

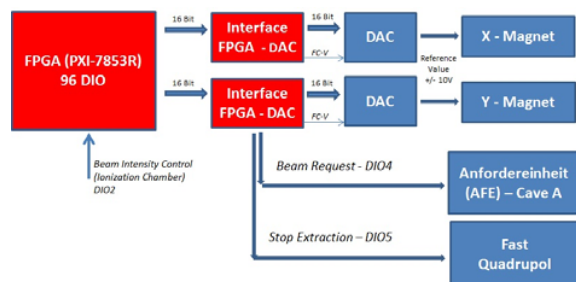


Figure 1: Block diagram of the rasterscan control system

The system is implemented on a real-time field-programmable gate array (FPGA) system (PXI-7853R from National Instruments) that is programmable in a LabView-FPGA environment.

The only in-house hardware developments that were re-

quired were the FPGA-DAC interface cards allowing to connect to the magnet power supplies, the beam request, the extraction control system and the signal input from the ionization chamber. The major advantages of such a system are:

- All functions that required dedicated hardware developments for the currently used system in Cave M and Cave A can now be implemented in software, which makes the system highly flexible.
- The flexibility makes the system future-proof, it can be easily adapted to the specific features of the accelerator control system that will be implemented within the FAIR project.
- All hardware components are commercially available components with widespread use, allowing to implement the system at comparably low costs and to facilitate the maintenance.

Results

After extensive testing of the system using a simulation environment first tests in Cave A have been performed. Dosimetric measurements as well as tests of the field homogeneity have been successfully performed. Fig. 2 shows an example of a field irradiated with 2 Gy of 1 GeV/u Fe-ions. Further tests will be done within the beamtime in 2014, so that it is expected that the system is ready for routine applications at the end of 2014.

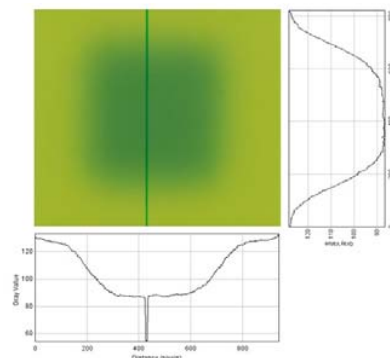


Figure 2: First test of the new rasterscan control system. A GafChromic film was irradiated with a dose of 2 Gy using 1 GeV/u Fe-ions (Field size: 40 mm x 40 mm). Histograms show the density profiles along the x- and y-axis. The vertical line is an artificial line used as position reference.