Preliminary test of a new system for the on-line verification of the dose distribution in scanned ion beam therapy

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Topic of interest: Physics → 4D treatment and delivery

Title: Preliminary test of a new system for the on-line verification of the dose distribution in scanned ion beam therapy

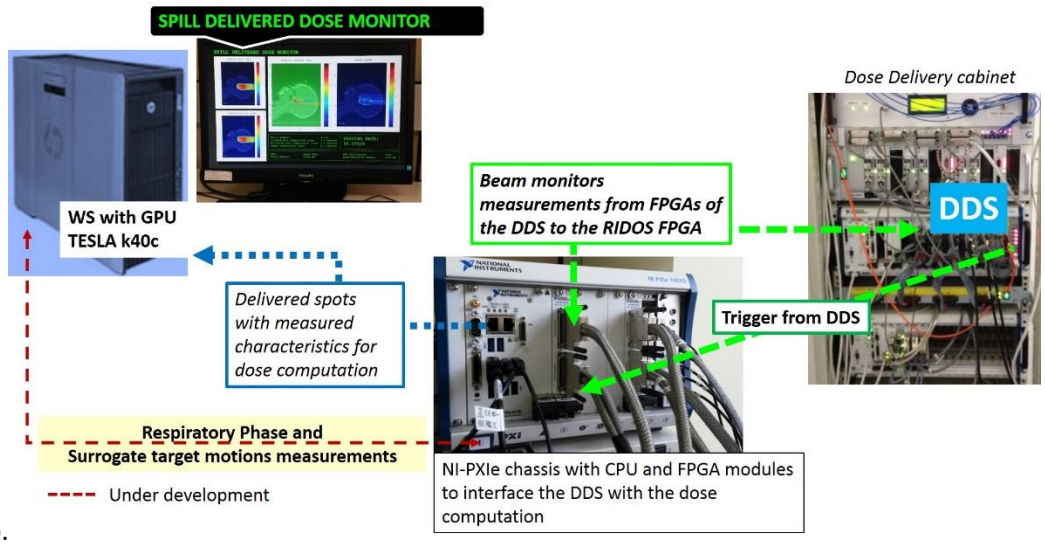
A new system (RIDOS, Real-time Ion DOse delivery and planning System) has been developed to evaluate intra-fraction dose distributions during ion beam treatments by means of fast dose computations.

A validated forward-planning (FP) for the reconstruction of the physical and biological dose distributions has been parallelized on GPU architecture and integrated into a dose delivery system (DDS) for synchrotron-based pencil beam scanning. Two FPs run in parallel to compute the cumulative dose distributions at the end of each spill within a hundred of milliseconds each: one using the planned spot characteristics and the second one the beam parameters measured on-line by the beam monitors. The spill-by-spill partial doses are shown and compared on-line through a fast Gamma-Index computation.

The code runs on a dedicated Workstation with a NVIDIA-TeslaK40c and it is interfaced with the DDS through a transparent connection using Xilinx-FPGA on National Instruments module (Picture1).

The RIDOS preliminary tests have been done with simulated deliveries based on real patient treatment plans. These have shown the capability of the system to quantify the effects on dose distributions of beam uncertainties during synchrotron-based dose deliveries without prolonging the delivery time.

The interface to receive the patient motions measurements is under development and will be used by the fast-FP to select the 3D image of a 4D-CT corresponding to the actual respiratory phase. The effect of intra-fraction organ movements is estimated by mapping the spill dose distributions back to the reference image using deformation vector maps obtained with non-rigid image registration methods.



Picture1. RIDOS setup.