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A fast - Monte Carlo toolkit on GPU for treatment plan dose recalculation in proton therapy

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Abstract content
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An innovative cancer treatment technique called particle therapy is emerging. It consists of irradiating solid tumors with beams of protons or ions. Thanks to the peaked shape, called Bragg Peak, of charged particles energy deposition in matter it is possible to concentrate the dose on the tumor and to reduce the damage to healthy tissues. This selectivity in energy release involves the necessity of an high level of accuracy in the calculation and optimization of the beams to be sent to the patient. This computation is performed by Treatment Planning System (TPS).
Nowadays one of the major issues related to the TPS in particle therapy is the large CPU time needed. We developed a software toolkit (FRED) for reducing dose recalculation time by exploiting Graphics Processing Units (GPU) hardware. Thanks to their high parallelization capability, GPUs significantly reduce the computation time, up to factor ˜100 respect to a standard CPU running software. The transport of proton beams in the patient is accurately described through Monte Carlo methods. Physical processes reproduced are: Multiple Coulomb Scattering (double and triple Gaussian models), energy straggling and nuclear interactions of protons with the main nuclei composing the biological tissues. FRED toolkit does not rely on the water equivalent translation of tissues, but exploits the Computed Tomography anatomical information by reconstructing and simulating the atomic composition of each crossed tissue. FRED can be used as an efficient tool for dose recalculation, on the day of the treatment. In fact it can provide in about one minute on standard hardware the dose map obtained combining the treatment plan, earlier computed by the TPS, and the current patient anatomic arrangement.
Assessment results of FRED performance in terms of accuracy and calculation time in comparison to commercial TPS and the full MC approach (Fluka) will be presented.

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