Solutions for the absolute dosimetry of pulsed, high-rate proton beams

GAP Cirrone (1), R Catalano (1), G. Cuttone (1), D Margarone (2) and G Petringa (1)

(1) - Laboratori Nazionali del Sud-INFN, Via S Sofia 63, Catania, Italy
(2) - Institute of Physics ASCR, v.v.i. (FZU), ELI-Beamlines Project, Na Slovance 2, Prague, 18221, Czech Republic

It is becoming evident, supported by many in-vivo and in-vitro experiments, that very high dose rate (> 40 Gy/sec) ionising radiation beams, are able to strongly improve the efficiency in radiotherapeutic tumours treatment.
Experimental pieces of evidence have been, in fact, collected by many authors, using electron and photon beams. Similar studies are ongoing with proton beams, as well.
In addition, the new opportunities opened by the high power laser-matter interaction, able to accelerate electron and ion beams with unprecedented fluences (10E8 particles in 100 nsec, corresponding to dose rate of the order of 10E7 Gy/sec!) could give an even greater impulse to the flash-radiotherapy approach.

If the clinical capabilities of flash-radiotherapy will be definitively proven, and laser-accelerated beams will enter in the clinical practice, it will become mandatory to start, in the next years, a well-defined action to define, design, realise and test specific detectors able to measure the relative and absolute dose generated from these extreme radiation sources.
Conventional approaches, indeed, will be not applicable as strong recombination effects will affect the results of the absolute and relative ionisation chambers commonly used in the standard dosimetric practice.

In this work, we will discuss the actual status of dosimetric approach investigated for high dose-rate beams. The use of dose-rate independent detectors (Faraday cup, Gafchromic, CR39) coupled to specially designed multi-gaps transmission ionisation chambers (where recombination effects can be somehow corrected), will be discussed.
The practical case of the application of 300 Gy/sec pulsed proton beams, available at the Laboratori Nazionali del Sud (INFN) in Catania and of the proton-beams from the ELIMED beamline installed at ELI-beamlines (CZ) will be discussed.