Temporal aspects of laser-driven particle sources and application to radiation biology.

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Laser-driven acceleration is a versatile source of short and intense particle bunches, which can be used to produce novel irradiation conditions in matter. Owing to the extremely short bunch duration, from the picosecond to the nanosecond scale, instantaneous dose rates exceeding 10^9 Gy/s can be easily produced. The temporal structure of the driving laser pulse reflects on the temporal radiation pattern, producing a fractionated dose deposition of high dose-rate fractions.

The application of laser-driven particles (proton and electrons alike) sources to living matter is now studied in many laboratories worldwide in order to assess its biological toxicity and with the ultimate goal of defining novel, potentially advantageous, therapeutic schemes. The discovery of the FLASH effect shed new light on the potential role of the temporal structure of the radiation source and motivates deeper research on the combined effect of irradiation time and dose-rate. In this perspective, laser-driven particle sources can be an unprecedented tool for the exploration of fundamental aspects in radiation toxicity.

In this contribution I will review radiation biology experiments we performed with varying temporal modalities, spanning from quasi-continuous irradiation to single-pulse, laser-driven FLASH invivo. Biological models and dosimetry strategies will be presented and discussed, as well as perspectives and future experiments.