Effect of ultra-short laser-accelerated particle pulses pace on cells survival

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Radiation therapy is a cornerstone of cancer management in which particle and radiation beams deliver their energies in the cancer tumor. Improving the spatial dose deposition in the target by minimizing the dose delivery in the safe tissues and organs was the major concern during the last decades. Temporal aspects of dose delivery is a novel axe of research that, thanks to the recent developments of laser-plasma based particle accelerators make possible the production of pulsed particle beams with unprecedent values of peak dose rate (10^9 Gy/s) deliver in nanosecond time scale and opens new horizons. The impact of such extremely high proton dose rates was investigated. We showed by varying the repetition rate of proton bunches an oscillation of the radio-induced cell susceptibility. This oscillation was related to the presence of the PARP1 protein and an efficient parylation process and seemed to recall the W-effect firstly shown with electrons. Interestingly, applying laser-driven proton bunches with a time lapse of 3 s, cell survival of the radioresistant HCT116 $p53^{-/-}$ cells joined that of its radiosensitive counterpart HCT116 WT, which was also similar as cells treated with the PARP1 inhibitor Olaparib. Finally, we showed that the normal human fibroblast MRC5 cells, positive for PARP1 detection and harboring efficient parylation process, were not sensitized by variation of proton bunches cadency. All together, these results suggested that the application modality of ultrashort bunches of particles could provide a great therapeutic potential in radiotherapy.