WS101-9: Studying nascent proton-driven radiation chemistry in H_2O in real time using laser-based sources

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Beams of energetic ions are finding application in multiple cutting edge technologies ranging from hadrontherapy to semiconductor device manufacture/metrology. To date, however, ion interactions in matter have been dealt with in a manner similar to those of electrons/photons, with attention primarily being paid to the energy, E, lost over path length, dx, giving the stopping power S(E) = - dE/dx. The obvious distinction is of course that ion stopping in matter exhibits a Bragg peak. In both scenarios the expected cell death or material damage are then generally extrapolated from empirical studies of dose deposition. For ions it is not immediately clear that this is the correct approach as it masks a critical phase of the interaction. When ions are incident on matter they generate dense tracks of ionisation that rapidly evolve. Exactly how this evolution, which occurs on femtosecond and picosecond timescales, determines the nascent radiation chemistry is still largely unknown.

Recently we have demonstrated that laser driven ion accelerators can provide an ultrafast tool for studying this inherently multiscale regime with temporal resolution < 0.5 ps [1,2]. Here we present novel results that show a marked difference in the solvation dynamics for electrons generated due to the passage of fast electrons/X-rays and protons (>10 MeV) in water. We discuss the role of nano-cavitation during ion radiolysis in H_2O and the potential for modified dose-depth curves on ultrafast timescales.

References

[1] B. Dromey, et al., *Nat.Comms.*, (2013) **4**, 1763

[2] L. Senje, et al., App. Phys. Letts., (2017) 110, 104102