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Picosecond metrology of laser driven ion bursts

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Over the last decade research into laser driven ion acceleration has led to the development of a new generation of ultra-compact accelerators. While this high flux source has been exploited for applications [1], the direct observation of ultrafast processes initiated by laser-driven ion bunches has yet to be realised. Here we report on the absolute metrology of proton bursts as short as 3.5 ± 0.7 ps from laser solid target interactions for this purpose. Our methodology relies on observing prompt ionisation dynamics [2] in high purity SiO2 irradiated by protons which permits single-shot temporal characterisation of the proton pulse. This new class of ultrafast detector (< 0.5 ps) takes advantage of the high degree of synchronicity between the ion source and optical probe laser pulses. We demonstrate how this metrology can allow near jitter-free tracking of ultrafast ion induced dynamics/radiolysis in condensed matter using optical probing and, in the future, laser-driven ultraviolet/X-ray sources [3].

[1] Macchi, A., et al. Rev. Mod. Phys., 85, 751 (2013)
[2] Audebert, P., et al., Phys. Rev. Lett., 73, 1990–1993 (1994)
[3] Dromey, B. et al. Nature Physics, 8, 804 (2012)

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