Project: **Experimental investigation of ultrafast radiation induced processes in matter and sub-picosecond switching in materials**

Supervisors: **Prof. Brendan Dromey, Dr. Mark Yeung**

Deadline:

Description: This project will focus on the emerging use of ultrafast pulses of laser driven ions to initiate damage cascades in technologically and biologically relevant materials [1]. For decades pulsed ion interactions have been limited to the > 100 ps regime due the inherently long pulse duration from hot cathode radiofrequency cavity ion sources. This prohibits the study of interactions in the critical transition regime from ultrafast free carrier transport to diffusive excited species propagation governed by Fourier dynamics. This requires ~ picosecond (10^{-12} s) ion pulses to observe the resulting excitation dynamics. The recent confirmation of few picosecond proton pulses generated using the Taranis laser system in the Centre for Plasma Physics provides a solid platform to advance these studies to a wide range of materials [1-3].

In an additional stand, recent observations of sub-picosecond switching of the optical properties of opto-electronic crystals will be investigated. This ultrafast switching is a breakthrough observation and opens a new paradigm for the control of optical systems.

The successful applicant will work in tandem with experienced researchers in the Centre for Plasma Physics designing and implementing experiments on the Taranis laser system. New techniques will be developed to study the transient spectroscopic features of ion induced damage in condensed matter as well as working on improving the efficiency and spectral characteristics of the ultrafast ion pulses. This project will also provide exceptional grounding in cutting edge ultrafast laser technology and the opportunity to travel to major large laser facilities around the world (i.e. Jena and Munich in Germany and the Texas Petawatt in Austin, TX, U.S.) with an emphasis on a results driven program. There will also be emphasis on working with cutting edge particle in cell code simulations to develop and theoretical understanding of the mechanisms underlying these processes

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[1] A. Prasselsperger, *Phys. Rev. Lett.* **127**, 186001 (2021) link

[2] M Coughlan *et al* *New J. Phys.* **22** 103023 (2020) link

[1] B. Dromey et al., *Nature Communications* **7**, 10642 (2016) link