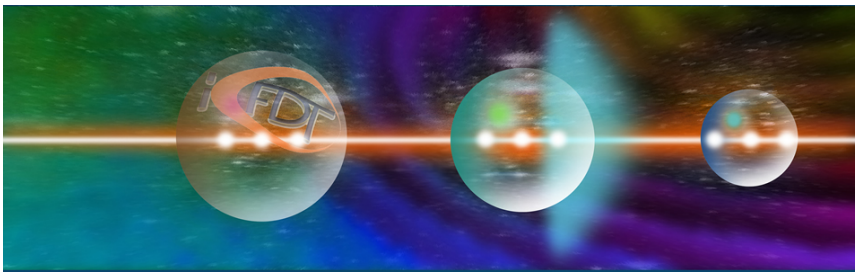

Contribution ID: **14** Type: **Poster**

Absolute Calibration of Thomson Parabola-Micro Channel Plate (MCP) for multi-MeV laser driven carbon ions

Thursday, October 4, 2018 2:30 PM (1h 30m)

Laser driven ions have gained significant attention due some of their unique properties making them a potential source of high energy radiation for a range of applications including particle therapy. Current facilities produce particles up to ~100 MeV with an ultra-short duration (~1ps at the source)1. Some of these facilities, typically the ones based on Ti:Sapphire, ultra-short pulse lasers, have a high repetition rate which makes the use of some diagnostics the limiting factor for data collection during experiments. Future facilities such as the Extreme Light Infrastructure will operate at 1 shot per minute or less2. The Thomson Parabola Spectrometer (TPS) is a widely used diagnostic for determining the maximum energy and the spectrum of each species generated in the interaction. Image Plates (IP) are typically used as the detector in TPSs since they are well calibrated for high energy particles3,4 and are easy to set up. However, IPs are slow to process and typically require breaking the vacuum of the interaction chamber in order to do so.

These disadvantages can be overcome by using MicroChannel Plates (MCPs) which act as an electron multiplier to incident ionizing radiation. The electrons are accelerated by a potential difference towards a phosphor screen which fluoresces and an image is collected onto a CCD. This allows for an on-shot ion energy diagnostic, when used with a TPS, which can be collected remotely and can be used again instantly thus not limiting the frequency of laser shots.

The particle spectrum is an important measurement as spectral features can indicate the acceleration process occurring and particle numbers are important, e.g. when looking to use the ion beams for radiobiological purposes. Thus, it is important to calibrate the detector in absolute terms, and we present here a calibration procedure for high energy Carbon ions. The MCP calibration was done for C6+, the dominant species generated in the interaction, up to 21MeV/u (252MeV) using the Gemini laser at RAL (U.K.), focused at an intensity of ~5x1020W/cm2 onto a 15nm amorphous carbon target. The calibration, which can be extended to higher energies by using a fit to the calibration data, was obtained by using slotted CR-39 so that the pixel value from the detector can be directly compared to the absolute number of particles counted on the CR-39 at a number of different energies. A calibration can then be built up by measuring the response of the MCP to these ions of varying energy. Previous calibrations have been done at much lower energies5,6 thus our work extends significantly these previous efforts.

This calibration is of particular importance in the perspective of developing diagnostic approaches capable of performing at high repetition rate on the next generation of lasers where high energy ions will be readily generated and a reliable online measurement of their spectra will be required.

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Session Classification: POSTER SESSION