Ion Acceleration from ultra thin foils on the Astra GEMINI facility

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Laser driven ion acceleration is an area receiving increasing interest in fundamental research due to the continuous progression in high power laser technology and to its possible applications, including proton radiography, production of warm dense matter, fast ignition of fusion targets, biomedical applications and nuclear and particle physics. Among a number of emerging mechanisms, Radiation Pressure Acceleration of ions in the Light Sail (LS) mode holds high promise for the future delivery of dense, high energy ion beams at over 200 MeV /nucleon energies, as required by application in particle therapy of cancer. Investigating optimising this mechanism in order to meet the demands of future healthcare applications is one of the aims of the UK-wide A-SAIL consortium funded by EPSRC.

Two experiments were carried out on the Astra GEMINI laser system at the Rutherford Appleton Laboratory, STFC, United Kingdom. The ion beams were generated by focusing a single beam of Astra GEMINI with an *f*/2 parabola onto ultra-thin amorphous carbon, formvar, diamond-like carbon and foam targets (thicknesses ranging from 2.5nm to 100nm). A quarter waveplate controlled whether the polarisation of the laser pulse was circular or linear. Several Thomson parabola (TP) spectrometers with image plate detection and MCP detection, radiochromic film (RCF) stacks and CR-39 stacks were used to gather information on the quantity, type, energy and distribution of ions produced.

The effect of the laser light polarisation on the acceleration of ions from ultrathin foils was investigated. The ion beam was characterised, obtaining information on the quantity, type, energy and distribution of ions produced to determine the optimum configuration for the acceleration process for use in future investigations. Steps were also taken to characterise the dynamic transparency / opacity of the foil during ion acceleration using a PTFE screen and to calibrate the MCP detectors for proton and carbon ion flux and energy.