Fourth International Conference on
SUPERSTRONG FIELDS IN PLASMAS

October 2010, Sunday 3 to Saturday 9
Villa Monastero, Varenna, Italy

# Hollow Microspheres – A Novel Target for Staged Laser-Driven Proton Acceleration

M. Burza[1], A. Gonoskov[2,3], G. Genoud[1], A. Persson[1], K. Svensson[1], M. Quinn[4], P. McKenna[4], M. Marklund[2], C.-G. Wahlström[1]

[1]*Department of Physics, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden*
[2]*Department of Physics, Umeå University, SE-901 87 Umeå, Sweden*
[3]*Institute of Applied Physics, Russian Academy of Sciences, 46 Ulyanov Street, Nizhny Novgorod 603950, Russia*
[4]*SUPA, Department of Physics, University of Strathclyde, Glasgow, G4 0NG, United Kingdom*

claes-goran.wahlstrom@fysik.lth.se

Laser-driven proton acceleration generates particle beams with interesting properties such as multi MeV energies and a very low longitudinal and transverse emittance. Its potential future applications range from proton imaging to proton cancer treatment and fast ignition in inertial confinement fusion.

When a high intensity laser pulse strikes a thin foil target, a population of hot electrons is produced. Some of the electrons traverse the target and form an electrostatic sheath at the target rear side, which field ionizes surface contaminants such as hydrocarbons. Free protons are produced and accelerated along the target normal. This mechanism is known as Target Normal Sheath Acceleration (TNSA). However, the maximum proton kinetic energy obtained through TNSA is still insufficient for some applications, such as proton therapy. This is due to a poor energy coupling between the hot electrons and protons, partly as only a fraction of the hot electron population contributes to the quasi-static field at the rear side, and partly because this field enables acceleration during only a very short time.

In a recent TNSA experiment McKenna *et al.* observed protons emitted from the edges of a flat foil target [Phys. Rev. Lett. **98**, 145001 (2007)]. The electrons responsible for that were part of the primary population of hot electrons, not contributing to the quasi-static field at the rear target surface. Instead they spread laterally with a speed close to the speed of light and set up a delayed sheath at the target edges, promoting proton emission there. We explore the possibility to use these laterally spreading hot electrons to set up a spatially separate and temporally delayed field for post acceleration of protons following TNSA. For this we irradiate hollow microspheres of ~50 µm diameter and sub-micron wall thickness. Laterally spreading hot electrons are guided along the spherical surface to the opposite side of the sphere, where protons accelerated to MeV energies through TNSA inside the sphere are passing through a micro machined exit hole and become post accelerated.

We will present our first experiments with hollow microspheres, conducted at the Lund High Power Laser Facility. The results show spatial and spectral features in the proton beam parameters that are different to those encountered in standard TNSA experiments with flat foil targets. The experimental results are compared with the outcome of PIC simulations.