Research Networking Programmes

Short Visit Grant ☒ or Exchange Visit Grant ☐

(please tick the relevant box)

Scientific Report

The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.

***Proposal Title**:* Ultrafast studies of ion induced damage in matter

Application Reference N°: 6435

1) Purpose of the visit

Participation in experiment at Queen's University, Belfast, UK

2) Description of the work carried out during the visit

The visit took place during seven consecutive weeks from 01/02/2014 to 23/03/2014 of which funding from SILMI was approved for 15 days. The aim of the experiment was to study how laser-accelerated protons interact with different materials on a pico-second time-scale. While ion-induced opacity has been studied before, the use of laser-driven ions allows for the first time to study these effect on the ps-time scale and promises to advance this field significantly. This was carried out by looking at opacacity changes caused by the high-energy protons in the materials. Protons were accelerated from a thin metal foil with a laser pulse from a high intensity laser (Taranis). The protons propagated into a transparent sample material where an optical probe pulse was used to study the damage in the samples. The probe pulse could both be used in with a chirp (to get time resolution) or in a compressed version.

The first two weeks were spent building the experimental set-up and diagnostics (such as cameras and spectrometer looking at the transmitted and reflected light from the laser probe). The following weeks were used to collect data from different sample materials, both solids, in amorphous and crystal forms, and liquid. Images both with spatial and temporal evolution of the ion induced damage were recorded.

3) Description of the main results obtained

Opacity induced by laser accelerated protons (with energies above 10-15 MeV) was observed for several materials, as a function of both penetration depth, on the mm scale, and of time, on the ps time scale. The transmission of the optical probe beam (with a wavelength centered around 1053 nm), through the region of proton induced damage in the sample materials dropped by different factors in different samples, but always by an amount that was significantly larger than any shot to shot fluctuations in the intensity of the probe. The propagation velocity and penetration depth of the opacity fronts into the target have been recorded.

It was confirmed that the change in opacity in the sample materials was caused by protons and not by the electrons accelerated or x-rays produced in the interaction between the main high energy laser beam and the target foil.

The method to study ion induced damage by using an optical probe pulse was proven successful both for solid and liquid sample materials. It was further shown that the characteristics of the opacity are depending not only on the atomic composition of the sample material but also on the structure of it, such as density and whether it is in amorphous form or a crystal.

The experiment has just ended and the analysis of the experimental data has just started. It is therefore too early to draw any firm conclusion but the clear difference observed as function of material properties makes us optimistic that much can be learnt from the data.

4) Future collaboration with host institution (if applicable)

None planned at present

5) Projected publications / articles resulting or to result from the grant *(ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)*

It is difficult to specify any publications, but the prediction is that the experiment will result in publications where SILMI support will be acknowledged.

6) Other comments (if any)