Experimental studies on fast electron transport in relativistic laser-matter interactions

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A detailed knowledge of the physical phenomena underlying the generation and the transport of fast electrons generated in high-intensity laser-matter interactions is of a great interest both for fundamental research, e.g. laboratory astrophysics and for applications such as the development of ultra-fast X-ray and particle sources and the Fast Ignition approach to Inertial Confinement Fusion, where a laser-generated fast electron beam is envisaged to deposit its energy in a precompressed fuel capsule heating it to the point of ignition.

Typically a few tens of percent of the laser energy is converted into kinetic energy of the fast electrons, which are injected into the target material, generating huge currents, largely exceeding the Alfvèn limit. Therefore, the transport of the fast electrons in the dense target material, in addition to collisions of the electrons with the target atoms, is affected by the onset of self-generated electric and magnetic fields and a neutralizing return current. Such a system of counter-streaming electron beams is unstable to beam-plasma instabilities, leading to modifications in the energy deposition and the dynamics of the fast electron beam.

Recent results from experimental campaigns dedicated to the investigation of some fundamental aspects of fast electron transport phenomena, including the role of beam-plasma instabilities and polarization dependent measurements, are reported. We focus our attention to the spatial and spectral characterization of the Kα emission, generated through inner-shell ionization by collisions of the fast electrons with the target atoms and subsequent radiative decay, as one of the main diagnostic tools employed to get information on the fast electron beam dynamics.