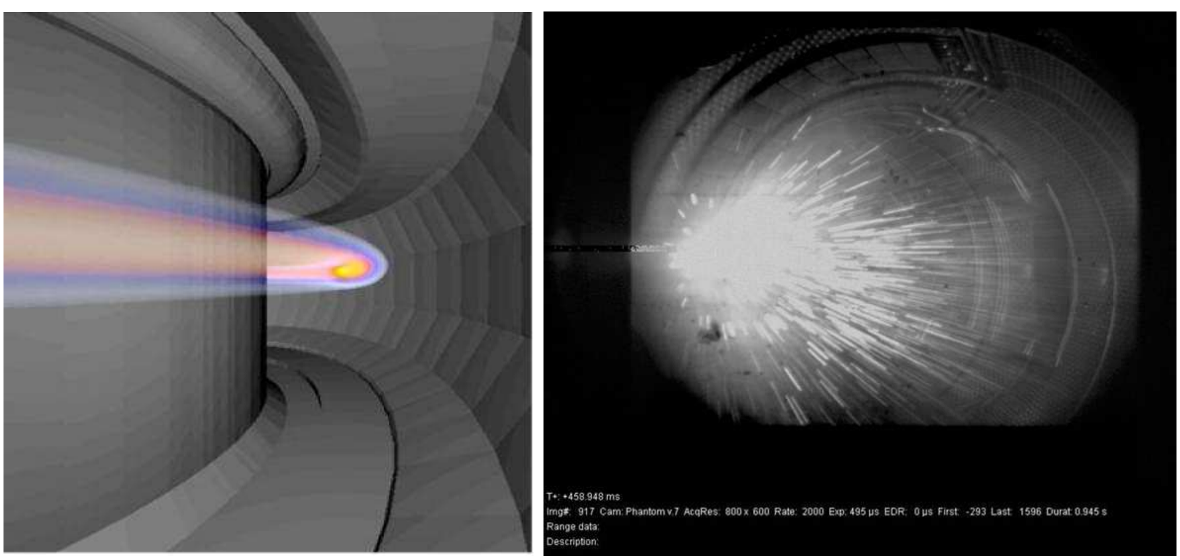
Control of runaway electrons in tokamaks

Contact: Tünde Fülöp, tunde@chalmers.se

Runaway acceleration of charged particles is one of the most interesting phenomena in plasma physics. If the electric field exceeds a critical value, it can detach a fraction of the charged particles from the bulk plasma and accelerate them to very high energies. Usually electrons are detached more easily than the heavier ions and are then referred to as **runaway electrons** (REs). Runaway generation is a candidate mechanism for electron acceleration in solar flares, and is frequently observed in electric discharges associated with thunderstorms.

Runaway also occurs in tokamaks, which is the most promising concept for energy production using fusion reactions. For their operation, tokamaks require a very strong current running through the plasma, which helps confine it inside the device, however when the plasma current is forced to change too quickly, a parallel electric field is induced. This often occurs in so-called disruptions; cataclysmic events where the entire plasma is quickly terminated. REs may then form and damage the plasma-facing components due to their highly localized energy deposition. The potential for detrimental effects increases with plasma current and it is therefore important to understand the processes that may eliminate RE beam formation, in view of future reactor-sclale tokamaks with high currents, such as ITER [`http://www.iter.org`].

The aim of this thesis is to determine the time evolution of the energy spectrum of the runaway electrons in the case when an external electric field is applied and compare it with experimental measurements. The work involves simulations with the numerical tool NORSE (Stahl et al, Comp. Phys. Comm. 2016, `http://arxiv.org/abs/1608.02742`) and will be done in collaborations with experimentalist in Italy and Germany.



The left figure has been obtained by using synchrotron emission to generate a view of the runaway beam in the DIII-D tokamak in San Diego, USA. The right figure shows the carbon dust generated when runaways hit plasma-facing components in the French tokamak Tore Supra.