Internship in accelerator physics

Modelling the transport and acceleration of electrons inside the plasma confined by the magnetic-field structure of an electron-cyclotron resonance ion source within the GEANT4 framework

Electron-cyclotron resonance ion source (ECRIS) works on a multi-step mechanism to produce highly-charged ions, which can then be injected into an accelerator beam line:

1) Absorption of the heating high-frequency electromagnetic wave injected into the ECRIS inner volume, which accelerates the electrons and realises first ionisations of the atoms
2) The obtained high-temperature electrons are partially confined by the magnetic field of the source in order to maximise the absorption of the electromagnetic wave as well as the probability for the accelerated electrons to ionise further the gas
3) The obtained ions are extracted from the ECRIS plasma with the help of dedicated electrostatic fields

The modelling of the transport of electrons and ions is necessary in order to design sources as well as to understand their performances or the measurements performed with precise plasma diagnostics. Such a modelling is handled in two regimes:

- The first instants of the ECRIS heating by the electromagnetic wave, where the plasma is sufficiently cold to reduce drastically the probability of electron or ion collisions;
- the constant regime where the hot plasma is present inside the ECRIS. We propose here to develop a code for calculating the charged-particle transport of the first instants, using Monte-Carlo methods of particle tracking inside both the confining magnetic field map and the electric field of the electromagnetic wave within the CERN/GEANT4 libraries. This C++ environment has proven to be accurate over decades of particle kinetic energies and is widely used.

The internship will have as a goal the development of the C++ model and the different classes and methods necessary for the calculation, the numerical tests and the prediction of spectra (ions and electrons) at the locations of ECRIS diagnostics to be mounted for planned experiments. A minimum time of four months is required.

Expected skills

plasma, nuclear or particle physics, Monte-Carlo simulations, C++

This work cannot be pursued by a PhD-thesis

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