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2020 / 2021

Master training proposal

Topic(s) :

- ☐ Electromagnetism
- ☐ Materials
- ☐ Applied mathematics
- ☒ Plasmas
- ☐ Electrical systems
- ☐ Other(s) :

Title: Modeling of a plasma ion source with highly charged ions for accelerator applications

Framework

The GANIL laboratory, at Caen, is one of the few laboratories in the world delivering stable and radioactive ion beams to worldwide physicists, notably at the SPIRAL1 and the new SPIRAL2 installations. Stable ion beams as well as radioactive ion beams are the tools of physicists to probe nuclear matter and its organization at the atomic nucleus scale. The understanding of the physical properties of the atomic nuclei is essential to give elements of answer to the formation of our universe and the stars composing it.
GANIL has a long tradition in the use and development of low-pressure off-balance ion sources based on the Electron Cyclotron Resonance (ECR) process feeding the GANIL accelerators with highly charged ions. One of the challenge of this type of sources used upstream of the accelerator is to deliver high charge state ions at high intensity specifically for the production of metal ions. A first simulation tool (PhD Thesis of Alexandre Leduc) has been developed to better understand how the ECR Phoenix V3 source works. In that study the transport of heavy particles are considered but the dynamic of electrons has been prescribed. The LAPLACE laboratory, at the University of Toulouse, is recognized worldwide for its work on plasmas and especially for the development of PIC codes that have demonstrated their ability to model the operation of positive ion sources for propulsion (thrusters) and negative ion sources for the ITER neutral injector. To go further previous studies and to reach a self-consistent simulation of the ECR plasma source, the electron transport and the electric field profile solution of the Poisson's equation have to be treated.

Work to be done during the training

The topic will be focused on an axisymmetric ion source developed at GANIL called PK-GANESA delivering low charge state ions. The trainee will begin with an extensive literature review on the topic. One of the major work will be to determine the electron energy distribution function before experiencing collisions by using the TrapCad code. Depending on the studies progress, the trainee will train himself with the simulation tools developed by the LAPLACE Laboratory in the context of modeling the full ion source with a complete PIC code.

Expected skills

Great interest for programming (Fortran, C/C++), Basic of plasma Physics

Supervisors

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Site

GANIL, Bd Henri Becquerel, Caen
LAPLACE, Université Paul Sabatier, Toulouse (few weeks)

PhD extension

A PhD is proposed to go on working on this topic