Ministry of Human Resources and Social Security

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

2019 Helmholtz – OCPC – Program

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Improvements in the global Plasma-Wall-Interaction modelling with the ERO2.0 code and application to EAST

Helmholtz Centre and institute:

Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research, Plasmaphysics (IEK-4)

Project leader: Dr. Sebastijan Brezinsek

Web-address: https://www.fz-juelich.de/iek/iek-4/EN/Home/home_node.html

Description of the project:

The candidate will be working with the code ERO2.0 [Rom19], which is the recently developed new version of the original ERO code for 3D Monte-Carlo modelling of erosion and deposition in fusion devices [Kir00]. Among the improvements of the new version are the massive parallelisation and the possibility to include the entire 3D geometry of a tokamak in the model for global migration modelling. The task of the candidate is to implement specific new physical processes into the code that will improve the model accuracy, and apply the updated code to modelling of experiments at the EAST tokamak and possibly further devices like ITER, JET-ILW or W7-X.

The model improvements to be implemented are

- Dropping the trace impurity approximation: ERO/ERO2.0 calculates impurity transport using a constant input plasma background, and assumes that the impurity concentration is low enough to neglect the influence on the plasma. However, in the presence of strong impurity sources due to erosion or external injection, effects such as cooling and Coulomb collisions with impurities will change the plasma background. In the frame of a collaboration between FZJ and ASIPP Hefei, these effects were demonstrated in a reduced simulation volume by coupling ERO to a 1D fluid model in an iterative scheme [Din11]. The candidate's task is to extend this model to the global simulations in ERO2.0 and validate it using an appropriate plasma scenario at EAST.
- Core impurity transport in ERO2.0: While it is possible to simulate the core plasma region with effective plasma radius rho < ~0.8 in ERO2.0, it is usually neglected for performance reasons and replaced with an appropriate boundary condition. While such approach still allows to simulate global PWI, it is not possible to predict the precise core impurity concentration and compare it e.g. with VUV or X-ray diagnostics. The candidate's task is to implement a reduced 1D fluid model for core impurity

transport in ERO2.0. Alternatively, ERO2.0 can be coupled to another code that offers 1D core impurity transport, such as COREDIV [Sta03] or JINTRAC [Rom14]. The model should be validated in EAST with respect to carbon and tungsten impurity penetration into the core plasma.

- Material mixing model in ERO2.0: In ERO, mixing was described using either the simple homogeneous mixing model or by coupling to the SDTrimSP code [Dro08]. These models should be incorporated by the candidate to global PWI in ERO2.0. Furthermore, improvements of the approaches should be envisaged, such as including diffusion, trapping/de-trapping and outgassing which are crucial e.g. for the description of fuel surface content and retention.

Description of existing or sought Chinese collaboration partner institute:
There has been a strong connection between ASIPP and FZJ (IEK-4) for more than a decade. Both institutes are working in the same research area of plasma-wall interactions (PWI) in fusion-relevant experiments. Several bilateral workshops on PWI studies have been hold since 2009, two in China and two in Germany. Based on the workshops, three joint research projects supported by the Sino-German center have been successfully conducted and led to a number of joint publications and joint presentations at conferences. There were specific co-operations in the area of basic PWI modelling with different sandwich PhD students and long-term visitors at FZJ to address questions within the field of PSI modelling like transport and resulting deposition of externally injected impurities, surface roughness effects or material mixing. Also, various co-operations on experimental PWI topics were established and most recently an Agreement on Joint Research between FZJ and ASIPP about ”Plasma-Wall Interaction Diagnostics for Steady-State Fusion Plasmas” supported by the DFG has been approved.
We also welcome collaboration with any Chinese institution that deals with the same subjects and shares our scientific interests.

Required qualification of the post-doc:

- PhD in Physics, Chemistry or Engineering
- Experience in fusion research, plasma physics and plasma-wall interaction
- Additional skills in C++ programming and numerical modelling

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team