Temperature screening and moderation of neoclassical impurity accumulation in high-temperature plasmas of non-axisymmetric devices

J.L. Velasco\textsuperscript{1}, S. Satake\textsuperscript{2,3}, J.M. García-Regaña\textsuperscript{1}, I. Calvo\textsuperscript{1}, F. I. Parra\textsuperscript{4,5}, A. Alonso\textsuperscript{1}, M. Nunami\textsuperscript{2,3}, the LHD experimental team, the TJ-II team

\textsuperscript{1} Laboratorio Nacional de Fusión, CIEMAT, Madrid, Spain
\textsuperscript{2} National Institute for Fusion Science, Toki, Japan
\textsuperscript{3} The Graduate School for Advanced Studies (SOKENDAI), Toki, Japan
\textsuperscript{4} Rudolf Peierls Centre for Theoretical Physics, University of Oxford, Oxford, UK
\textsuperscript{5} Culham Centre for Fusion Energy, Abingdon, UK

Achieving impurity control is a crucial issue in the path towards fusion-grade magnetic confinement devices, and this is particularly the case of helical reactors, whose low-collisionality ion-root operation scenarios usually display a negative radial electric field which is expected to cause inwards impurity pinch. In this work we discuss, based on experimental measurements and standard predictions of neoclassical theory, how plasmas of very low ion collisionality, similar to those observed in the impurity hole of the Large Helical Device \cite{1}, can be an exception to this general rule, and how a negative radial electric field can coexist with an outward impurity flux \cite{2}. This interpretation is supported by comparison with documented discharges available in the International Stellarator-Heliotron Profile Database, and it can be extrapolated to show that achievement of high ion temperature in the core of helical devices is not fundamentally incompatible with low core impurity content. We will show that, in order to describe accurately this regime of good impurity behaviour and to be able to extend it to higher densities, additional contributions to impurity transport have yet to be understood. In the last part of the talk, we will address in detail one of them: the impurity flux caused by variations of the electrostatic potential within the flux-surface of non-axisymmetric devices \cite{3,4}.

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

References

\cite{1} K. Ida \textit{et al.}, Phys. Plasmas \textbf{16}, 056111 (2009)
\cite{2} J. L. Velasco \textit{et al.}, Nucl. Fusion \textbf{57}, 016016 (2017)