Modeling of the COMPASS Scrape-off Layer turbulence by GBS code

Petr Macha[1,2], Diego De Oliveira[3], Davide Galassi[3], Jan Horacek[1], Jakub Seidl[1], M. Giacomin[3], Ales Podolnik[1]

1) Institute of Plasma Physics of the CAS, Prague, Czech Rep.

2) Faculty of Nuclear Sciences and Physical Engineering CTU in Prague, Prague, Czech Rep.

3) École Polytechnuque Fédérale de Lausanne (EPFL), Swiss Plasma Center (SCP), CH-1015 Lausanne, Switzerland

Scrape-Off-Layer (SOL) is one of the key areas in tokamak in terms of energy exhaust and plasma-wall interaction. Heat fluxes in large fusion devices passing through separatrix and SOL could, in many situations, be devastating for plasma facing components. Unfortunately, detailed understanding and capability to predict plasma profiles, fluctuations and transport properties of SOL are still limited. These quantities can be determined either by empirical scalings [1] based on experimental measurements, which allow predictions, but there could be limits in accuracy for new tokamaks, or by numerical simulations. Fluid turbulent codes are another tool for obtaining decay length value, which is the key factor for heat flux determination. These codes are also able to simulate and predict fluctuations, blob time traces and more SOL turbulence properties.

Global Braginskii Solver (GBS) [2] is a 3D drift-reduced model of edge plasma turbulence with Braginskii closure for the ion and electron species. This work presents first modeling of the COMPASS tokamak [3] by the GBS code and its comparison with experimental data. The COMPASS tokamak is a compact experimental device with major radius 0.56 m, toroidal magnetic field in the range 0.8-2.1 T and divertor plasma configuration. We aim at validating the code for the COMPASS conditions and assessing its predictive potential for the COMPASS Upgrade tokamak [4]. Most of the used experimental data come from reciprocating probes located at the tokamak midplane and from divertor probes. The reciprocating probes can penetrate inside the separatrix without perturbing the plasma and the used probe head contains several standard Langmuir and ball-pen probes. The analysis of combined ball-pen and Langmuir probe data provides means to simultaneously measure electron temperature, real plasma potential, and ion saturation current in sub-microsecond temporal resolution [5], which is an unique feature of this assembly.

During the model-experiment comparison we assess several key statistics related to turbulent transport and their uncertainty, such as radial profile shape and gradients, distribution function of the fluctuations and its moments, etc. Furthermore, spectral analysis of experimental data and GBS outputs is performed and used for comparison. For the case of plasma potential, this model-experiment comparison is unique. Based on GBS verification on COMPASS experimental data, predictive simulations for COMPASS Upgrade will be performed in the future. The decay length will be determined, which will be then available as an input for 2D transport codes, like SOLPS-ITER.

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