Global fluid turbulence simulations in the edge and SOL of Wendelstein 7-X

B. Shanahan[1], D. Bold[1], B. D. Dudson[2], S. B. Ballinger[3], S.G. Baek[3], C. Killer[1], A. von Stechow[1], J. L. Terry[3], O. Grulke[1,4], and the W7-X team[5]

[1]*Max-Planck-Institut für Plasmaphysik, Wendelsteinstr 1, 17491 Greifswald, Germany*

[2]*Lawrence Livermore National Laboratory, 7000 East Avenue, Livermore, 94550, CA, USA*

[3]*Massachusetts Institute of Technology Plasma Science and Fusion Center, Cambridge, Massachusetts 02139*

[4]*Department of Physics, Technical University of Denmark, Lyngby, Denmark*

[5]*See T Sunn Pedersen et al., Nuclear Fusion 62 042022 (2022) for the W7-X Team members*

Neoclassical optimization in Wendelstein 7-X (W7-X) has successfully reduced the neoclassical transport in the core [1], but understanding of edge and Scrape-Off-Layer (SOL) phenomena is still in its infancy. To understand the nature of transport in the SOL of stellarators, the BSTING project [2] has developed the BOUT++ framework for stellarator geometries [3]. Here, we present results from the first turbulence simulations in the W7-X SOL. The initial fluctuation amplitude distribution exhibits a structure reminiscent of previous gyrokinetic results [4], see Figure 1. The influence of the magnetic island geometry on the fluctuations in the W7-X SOL is investigated. Shear flow patterns are observed in the SOL and a correlation is seen with the connection length profile, which has implications for filament generation and turbulent transport in the SOL. A comparison with experimental measurements in several magnetic configurations is presented.

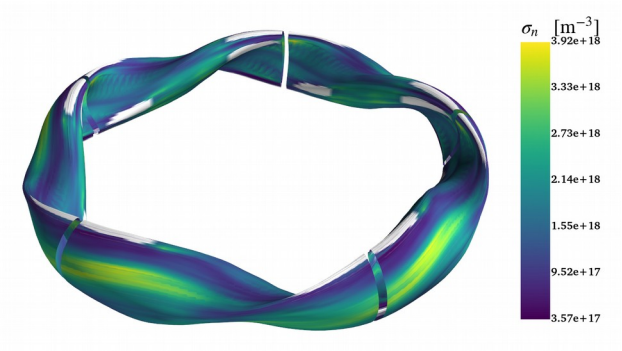

Figure 1: Simulated fluctuation amplitude on a flux surface in the SOL of the W7-X standard configuration. The white contours indicate intersections with the boundary.

[1] C Beidler et al., *Nature* **596**, 221–226, (2021)

[2] B Shanahan et al., *Plasma Physics and Controlled Fusion*, **61** 0250007 (2019)

[3] B Shanahan et al., *Submitted to Journal of Plasma Physics*, (2024)

[4] P Xanthopoulos et al., *Physical Review Letters*, **113**, 155001 (2014)

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