7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Feasibility study on using Doppler backscattering measurements to infer the magnetic pitch angle

Valerian H. Hall-Chen[1], Q.T. Pratt[2], A.K. Yeoh[1], J. Damba[2], T.L. Rhodes[2], N.A. Crocker[2], J.C. Hillesheim[3], F.I. Parra[4], J. Ruiz Ruiz[5]

[1] Institute of High Performance Computing, Agency for Science, Technology, and Research (A*STAR)
[2] Department of Physics and Astronomy, University of California, Los Angeles
[3] Commonwealth Fusion Systems
[4] Princeton Plasma Physics Laboratory
[5] Rudolf Peierls Centre for Theoretical Physics, University of Oxford

e-mail (speaker): valerian_hall-chen@ihpc.a-star.edu.sg

The Doppler backscattering (DBS) diagnostic is typically used to measure flows and turbulent density fluctuations in magnetic confinement fusion plasmas. In this talk, we will show how DBS can be used to measure the magnetic pitch angle in both the core and edge of tokamak plasmas. This is achieved by changing the toroidal launch angle, such that the probe beam reaches the cut-off at the approximately same poloidal location, but at different toroidal angles. As the toroidal injection angle varies, the returned DBS signal also varies. Since the flows and turbulent density fluctuations are expected to be similar for different toroidal injection angles, the dominant variation of the backscattered signal comes from the probe beams' wavevectors matching to the magnetic pitch angle instead. By measuring these variations and modelling them with Scotty [Hall-Chen, Parra, Hillesheim. PPCF 2022], the local magnetic pitch angle can be extracted. We show an example using DBS measurements of DIII-D. Since DBS is a microwave diagnostic, this technique can be applied to burning plasmas of future fusion reactors where optical approaches like the motional Stark effect diagnostic might be unsuitable. Such DBS measurements of the core magnetic pitch angle could be important for reconstructing the equilibrium, especially in devices without neutral beams, and for quantifying fast ion instabilities. The latter then paves the way for better understanding of fast ion transport.

Acknowledgements: This work was funded by the Urban and Green Tech Office, A*STAR, Green Seed Fund C231718014. This material is also based upon work supported by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences, using the DIII-D National Fusion Facility, a DOE Office of Science user facility, under Awards DEFC02-04ER54698 and DE-SC0019352. This work was also in part supported by a grant from the Engineering and Physical Sciences Research Council (EPSRC) [EP/R034737/1].