New evidence and impact of electron transport non-linearities based on new perturbative inter-modulation analysis applied at the Large Helical Device

M. van Berkel\textsuperscript{1,2}, H. Igami\textsuperscript{3}, G. Vandersteen\textsuperscript{1}, G.M.D. Hogeweij\textsuperscript{2}, K. Tanaka\textsuperscript{3}, N. Tamura\textsuperscript{3}, M.R. de Baar\textsuperscript{2,4}, H.J. Zwart\textsuperscript{4}, S. Kubo\textsuperscript{3}, S. Ito\textsuperscript{3}, H. Tsuchiya\textsuperscript{3}, and the LHD Experiment Group

\textsuperscript{1}Vrije Universiteit Brussel (VUB), Dept. of Fundamental Electricity and Instrumentation, Pleinlaan 2, 1050 Brussels, Belgium
\textsuperscript{2}DIFFER, PO Box 6336, 5600HH Eindhoven, The Netherlands
\textsuperscript{3}National Institute for Fusion Science, 322-6 Oroshi-cho, Toki-city, Gifu, 509-5292, Japan
\textsuperscript{4}Eindhoven University of Technology, Mechanical Engineering, PO Box 513, 5600MB Eindhoven, The Netherlands

Plasma turbulence or anomalous transport deteriorates energy confinement in contemporary magnetically confined fusion devices. Therefore, with the view to improve and understand energy confinement a number of methodologies have been developed to analyze electron heat transport [1, 2]. In this presentation, a new methodology to analyze perturbative transport experiments based on frequency inter-modulation [3, 4] in combination with a newly developed experimental analysis method based on Volterra series [5] is introduced. This allows for the unambiguous detection of non-linearities in the electron thermal transport within a single experiment. The spatial dependency of the non-linearity is estimated in dedicated experiments at the Large Helical Device showing some coherence with the measured turbulence level. Moreover, the linear profiles of phase and amplitude are reconstructed, which are significantly different from the measured profiles.

References