Contribution ID: **561** Type: **Poster**

Basic studies of the interaction of blobs with suprathermal ions and millimetre-wave beams in the TORPEX device

Tuesday 23 October 2018 08:30 (20 minutes)

The fundamental interactions between turbulent structures or blobs and suprathermal ions, injected by Li6+ beams in plasmas created by microwaves at 2.45GHz with ne~1015-1017m-3 and Te~2-10eV, are extensively investigated on the TORPEX toroidal device. Comparisons between fully validated numerical simulations and experimental 3D time-averaged suprathermal ion profiles reveal an entire spectrum of non-diffusive suprathermal ion transport: super-diffusive, diffusive, or sub diffusive, depending on particle energy and turbulence amplitude. 3D time-resolved measurements of 30eV and 70eV ions, exhibiting super- and sub-diffusive transport respectively, show that in all cases the ions are subject to bursty displacement events and that intermittency, quantified by the skewness of the time-traces, is present to some degree in all profiles, also for intermediate energies, including in the sub-diffusive cases. We develop an analytical model that links the time averaged-profile of the ion current and the profile of the statistical moments of the fluctuations. In fusion devices, externally injected beams in the electron cyclotron (EC) frequency range are employed for heating and current drive, and to stabilize neoclassical tearing modes. EC beams must propagate through the Scrape-Off Layer where blobs may scatter the incoming wave by locally modifying the plasma permittivity. This may lead to a loss of efficiency in EC heating and mode stabilization. To understand the effect of plasma turbulence and its structures on the propagation of millimeter waves (mmw), we measure wave scattering in TORPEX by blobs of size comparable to the wavelength. A low-power beam is launched at 29.7GHz in the X-mode from the top of the device using a pyramidal horn antenna. The X-mode component of the transmitted power is detected at the bottom using a pyramidal horn antenna and a Schottky diode, whose position can be radially adjusted. A conditional sampling technique averages the effect of several thousand individual blobs. Combining these scattering measurements with first principle full-wave simulations using COMSOL, we show that density fluctuations associated with plasma blobs, with δne as small as ~10-3 of the critical density, can significantly defocus the mmw-beam in the wake of the blobs, resulting in mmw-power fluctuations that increase monotonically with the blob amplitude.

Country or International Organization

Switzerland

Paper Number

EX/P1-21

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Session Classification: P1 Posters