Seminar

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Institute for Plasma Research

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Title: Stable, small plasmas in Wendelstein 7-X

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Date: 27th December 2022 (Tuesday)

Time: 10:30 AM

Venue: Seminar Hall, IPR

Abstract

Recent operation phases of Wendelstein 7-X have witnessed several discharges where the plasma shrank down to nearly 60% of its original size as a result of intense edge radiation from a several cm thick, visibly radiating mantle at the edge. This behavior was observed with as well as without boronized walls [1] although with different edge plasma densities. In such discharges, the plasma remained stable in the shrunken state, completely decoupled from the plasma facing components, for many confinement times. An analysis of such a discharge, which exemplifies a small and stable plasma with a radiating mantle, is presented. The intense edge radiation is triggered by a strong hydrogen puff. The SOL density rises sharply after the gas injection and the SOL electron temperature decreases below 10 eV as seen from the Langmuir probe data. The conditions in the edge become conducive to higher level of low-Z impurity radiation. This creates a strong energy loss channel and makes the plasma shrink down to 62% of its original size, which in turn reduces the confinement time of the plasma as expected from the empirical scaling [2]. The plasma stays in this state for nearly 100 confinement times until the programmed termination of the discharge. During the stable, small state of the plasma, the particle and heat load on the plasma facing components are extremely small while the density and temperature in the core are $n_e \sim 4\ to\ 6 \times 10^{19}\ m^{-3}\ and\ T_e \sim 2.5\ keV$ respectively. A power balance model can broadly explain the observed behavior. The radius of the plasma cross-section is shown to scale inversely with the plasma density in the center as expected from the empirical scaling, which proposes a density limit for stellarators [3] and specifically for W7-X [4].

References:

1. Pedersen, T.S., et al. Small, stable plasmas, fully decoupled from the PFCs in W7-X, Proceedings of the 62nd Annual Meeting of the APS Division of Plasma Physics, Nov. 2020.

2. H. Yamada et al Nucl. Fusion **45** 1684 (2005).

3. S. Sudo. et al., Nuclear Fusion, **30**, 11, (1990).

4. Fuchert et al, Nuclear Fusion 60, 036020 (2020).