Plasma-wall interactions at the breeding blanket first-wall

Abstract

Fusion reactions between deuterium and tritium ions are being prospected for generation of fusion electricity. Magnetically confined hot plasmas utilizing the tokamak approach seems to be very successful in achieving the breakeven conditions. However, in such plasmas the temperature often exceeds 106 K to 107K (10-100 eV) near the metallic wall. Furthermore, electromagnetic radiation and energetic neutrons are also incident on the plasma-facing wall. One of the most crucial components of the tokamak reactor is the breeding blanket, that generates tritium and acts like a heat exchanger between the plasma and the primary coolant. Plasma-wall interactions (PWI) play a crucial role in tokamak based fusion devices. These interactions include sputtering, erosion, creation of melt-layer, creation of impurities, excessive radiation loss and sometimes disrupt the plasma itself.
This project aims to analyse the PWI in both steady-state and transient conditions for a fusion reactor blanket so that constraints on design and operational/maintenance scenarios can be systematically assessed. The impact of these conditions on the blanket first-wall be self-consistently evaluated for different power plant configurations.
Specifically, the student shall,
• Identify various projectiles incident on FW (ions, energetic neutrals, photons, neutrons, etc.) and their broad energy spectrum
• for each of the projectiles, the processes (such as sputtering, erosion) shall be identified and their yield will be estimated by writing/using computer program
• Estimation of heat load on First Wall (surface heat flux and neutronic heat)
• Well-known FW materials shall be assessed.
• An assessment of the pulse length and total number of pulses will be made to define the frequency with which new coating must be restored.
• A computational model to estimate the transient loads under a few extreme conditions (during VDE) shall be created using data from the published papers/ experiments data worldwide.

Academic Project Requirements:

1) Required No. of student(s) for academic project: 1

2) Name of course with branch/discipline: M.Sc. Physics

3) Academic Project duration:

(a) Total academic project duration: 10 Weeks
(b) Student's presence at IPR for academic project work: 2 Full working Days per week

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