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Liquid metal experiments on FTU

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The experiments on FTU with a cooled liquid lithium limiter (CLL) (2014&2015) and subsequently with a cooled liquid tin limiter (TLL) (2016) aim at testing liquid metals (LM) under reactor relevant thermal loads of up to 10 MW/m2 in stationary conditions. In preparation of this program, improvements of the FTU facility started in 2014 with: 1) the extension of the pulse duration from 1.5 s up to 5s and 2) feasibility studies to achieve diverted plasmas with the X-point near the CLL. The additional aim is to get the H-mode in plasmas heated by Electron Cyclotron Resonance Heating (ECRH) to study the impact of Edge Localized Modes (ELMs) on the CLL used as main target. The first CLL dedicated discharges were both ohmic and with auxiliary heating power (PECRH=500 kW). Circular and elongated shape (k~1.2) were tested as well as different CLL positions under the TZM toroidal limiter shadow up to 1.8 cm inside the last closed magnetic surface in elongated plasmas. Heat loads up to 2.3 MW/m2 had been withstood by the limiter surface for all the duration of the plasma discharge (1.5s) with temperatures below the threshold for acceptable Li evaporation (~500 ℃). Unfortunately, experiments with higher heat load values were prevented by the onset of hot spots on the joint points of the strips of CPS structure and by the poor control of the Li temperature that displayed large oscillations. To solve these problems, a new active CLL refrigeration head in Red Star Labs has been realized with a larger curvature radius and the CLL control system has been successfully implemented in ENEA in order to optimize the temperature monitoring and the control of the water circulation. An other important upgrade was the extension of FTU pulses to 4.5 s and BT=2.5–4 T. In the European framework of coordinated actions, a cooled sample of Sn CPS type envisaged for the TLL in FTU has been tested on Pilot-PSI linear device. A power handling of 26 MW m-2 has been demonstrated under stationary conditions and without apparent damage of Sn sample, giving early indications the TLL will be effective. In this paper an overview of the main activities of the last two years will be presented followed by the experimental results obtained on FTU with the new CLL system. Then, the preliminary work with the tin liquid limiter (TLL) and the results on Pilot-PSI with liquid tin samples will be described.

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