CPS Liquid Metal Divertor cooled by 'low' temperature water

Selanna Roccella[*,a], Riccardo De Luca[b], Giacomo Dose[c], Matteo Iafrati[a], Andrea Mancini[a], and Giuseppe Mazzitelli[a]

[a]*ENEA, Fusion and Technologies for Nuclear Safety Department, C.R. Frascati, Italy*

[b]*University.of Tuscia, Departiment DEIm, Viterbo, Italy*

[c]*Università di Roma "Tor Vergata", Dipartimento di Ingegneria Industriale, Rome, Italy*

*corresponding author selanna.roccella@enea.it

In a magnetic confinement fusion reactor, the heating power absorbed by the plasma is mainly exhausted through the divertor, where the magnetic surfaces intersect the chamber wall. From a technological point of view, the efforts are directed to the design of plasma facing components and new materials capable of increasing the life-time and thermal performance. The liquid metal plasma facing components represent a potential divertor solution due to the their power handling capability and resistance to permanent surface damaging. Among other liquid metals, Lithium and Tin represents the most promising candidates. Tin is, unlike lithium, a high Z element (Z=50) and shows overall better operational conditions, at the expenses of worsening the plasma performance due to higher radiated power at the temperature of the main plasma. It has a larger operational window due to its low vapor pressure (300<T<1300 °C), low or negligible activation, low H retention and no safety problems in combination with water cooling. Nevertheless, for Tin, it is crucial to prove that plasma operations are possible at a tolerable Zeff value without significant plasma performance degradation. A Tin based conceptual design of liquid metal divertor has been developed in ENEA: a tungsten fibre Capillary Pore System (CPS) keeps the liquid Tin on the plasma facing surface, while a helium heated tank ensures the necessary refilling due to evaporation. Water at 140°C flowing below the CPS maintains the surface temperature lower than 1300 °C with a heat load up to 20 MW/m^2, maintaining good operational margins in terms of critical heat flux. The simple design and the compatibility with standard body cassette make possible a faster prototyping for testing in an integrated environment inside a tokamak machine.