THERMAL EFFECTS AND COOLING OF COMPONENTS WITH HIGH HEAT LOAD IN THE MAGNUM-PSI TEST FACILITY

O.G. Kruijt[1], P.H.M. Smeets[1], J. Scholten[1], S. Brons[1], H.J.N. van Eck[1], R.S. Al[1], M.A. van den Berg[1], H.J. van der Meiden[1], J. Rapp[1], G.J. van Rooij[1], B. Schweer[2] and P.A. Zeijlmans van Emmichoven[1]

[1] FOM-Institute for Plasma Physics Rijnhuizen, Association EURATOM-FOM, Trilateral Euregio Cluster, www.rijnh.nl
[2] Forschungszentrum Juelich GmbH, IEF-4, Euratom association, Trilateral Euregio Cluster, 52425 Juelich, Germany.

Corresponding author: kruijt@rijnhuizen.nl

The FOM-Institute for Plasma Physics Rijnhuizen is constructing Magnum-PSI; a magnetized (3 T), steady-state, large area (80 cm^2) high-flux (up to 10^{24} H^+ ions $m^{-2}s^{-1}$) linear plasma generator. Magnum-PSI is a highly accessible laboratory experiment in which the interaction of magnetized plasma with different surfaces can be studied. This experiment will provide new insights in the complex physics and chemistry that will occur in the divertor region of the future experimental fusion reactor ITER. Here, high power- and particle flux densities are foreseen at relatively low plasma temperatures. Magnum-PSI will be able to simulate these conditions in detail. In addition, conditions can be varied over a wide range, such as target material, plasma temperature, beam diameter, particle flux, inclination angle of target, background pressure, magnetic field, etc.

For realization of plasma-surface research in the magnum-PSI device by means of an adequate plasma beam a cooling capacity of total of 1 MW is foreseen. The construction of the plasma source, skimmers (diaphragms for differential pumping), anode ring, beam dump and target are prepared to handle heat fluxes up to10 MW/m^2; in the plasma source probably higher. Vacuum chambers and components receive heat load from the plasma source, from an additional plasma heating system and from hot target radiation. All vacuum chamber walls are water cooled. Source- and target chamber are therefore built with a cooled double wall. Optical windows are equipped with cooling and water cooled shutters. Windows and shutters in the target chamber are prepared to handle heat radiation up to 30 kW/m^2 . In-vacuum mirror units for target surface diagnostics are foreseen with cooling and dedicated shutters as well. (For more specific data on thermal effects in source- and target is referred to separate congress contributions).
All sub-circuits are supplied with temperature- and flow sensors for calorimetry.
Every separate vacuum chamber has water leak detection, where in case of emergency will be acted upon by automatic switch-off of valves in water- and vacuum pump circuits.

The cooling system consists of 4 separate circuits to supply sufficient cooling to each subsystem. Heat is transferred to secondary circuits, with a cooling tower and with temperature fine tuning by means of a separated cold water circuit to facilitate easier calorimetry. An emergency cooling circuit guarantees cooling of components of the superconducting magnet.