MAST UPGRADE CLOSED PUMPED DIVERTOR DESIGN AND ANALYSIS

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The design of the Mega Amp Spherical Tokamak (MAST) Upgrade project provides an excellent opportunity for advancements in tokamak physics in support of ITER and DEMO as well as CTF. One of the main areas of contribution is the divertor, and demonstrating reduced heat loads. MAST Upgrade will be capable of operating with the outer leg of the divertor being either conventional or with the novel Super eXpanded Divertor (SXD) [1] configuration, in which additional shaping of the magnetic field considerably increases the connection length. A region of low poloidal field in the main volume of the divertor allows the outer leg to traverse a considerable distance toroidally, before reaching a large major radius. This increases the volumetric losses from the plasma (through radiation and charge exchange). The wetted target area is also increased through the increase in major radius. Cryogenic pumps behind baffles outboard of the divertor targets will provide density control.
This paper describes the current design and layout of the closed pumped divertor geometry to meet the configurations envisaged. The assembly supports symmetrical double null plasmas – with both the upper and lower divertor assemblies able to accommodate either the conventional or SXD. Each consists of the coil sets, the strike target surfaces including armour tiles, the cryopump, divertor-specific diagnostics and all the associated support structures. The divertor assembly is fully compatible with the anticipated heat loads and protects all surrounding structures.
A set of seven new coils per divertor provides shaping and control for physic studies. The strike targets along with the coil locations define the divertor volume and consist of stainless steel carriers onto which graphite tiles are mounted. Tight assembly tolerances are required to obviate imbricated tiles and this translates to adjustable supports that can be easily aligned. Ceramic thin-film heaters are attached on the rear of the strike target tiles to bake them locally to 320˚C. Armour tiles have attachments to allow sliding into position and interlocking with the next tile in the toroidal direction. Thermal and structural analyses have demonstrated the structure's performance. The targets are capable of a peak power density of 10 MW//m^2 for 5s in the conventional configuration. Analyses will be presented to demonstrate that the peak temperatures in the SXD strike target drop significantly.
The concept for the cryopump has been taken, as a start point, from the design of the General Atomics DIIID divertor cryopump. The configuration for the supply of cryogens, to and from the pump, assumes two semi-circular cryopumps, stacked on top of each other at both ends of the machine. Each cryopump half will have a hairpin bend return loop for both cold gaseous (supercritical) helium and liquid nitrogen. Results from the cryopump performance analysis will be presented.

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[1] M. Kotschenreuther et.al., *Physics of Plasmas,* 14, 2007, 072502