Performance and Development of the DIII–D Tokamak Core*

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Abstract

The DIII–D tokamak is an upgrade of the Doublet III configuration and has operated since early 1986. This paper presents recent advances in operation of the vacuum vessel, first wall, upper divertor, and coil systems.

Good vacuum quality and low leak rates are essential to high performance operation. In order to maximize leak checking productivity while operating in deuterium, a palladium filter method was developed to remove deuterium from the gas mix in the sample stream. This restored maximum sensitivity to the helium mass-spectrometer leak detector which allowed the detection of smaller leaks and eliminated the time previously required for vessel conditioning prior to leak checking.

Operation with the new upper divertor baffle and pump has allowed density control in high-triangularity plasma discharges. Previously using the lower divertor cryopump, which was designed for low triangularity single null plasma shapes, we were able to obtain values of the figure of merit I_p/n_e=2.5–3. Recent operation with the new pump for high-triangularity plasmas has achieved similar results in single null operation. The pumping speed of the baffle/cryopump combination agrees reasonably with design estimates. We are currently testing these two pumps applied simultaneously to double null plasmas, in preparation for installation of divertor hardware for double null high-triangularity operation in the lower divertor in 2001. The graphite tile and in-vessel structures, comprising the upper divertor and cryogenic pump, are designed to withstand halo currents based on criteria derived from arrays of in-vessel tile current monitors. Present in-vessel components have experienced no structural and thermal failures. As part of these divertor modifications, we have developed joining and welding techniques of low-activation vanadium alloys specifically developed fusion use.

The DIII–D cryogenic system supplies liquid helium to four neutral beams, two in-vessel cryo pumps and batch filled dewars for magnets and the ORNL pellet injector. The helium cooled surface of the two in-vessel cryo pumps is regenerated between shots within the 10 minute shot repetition rate. Sequential defrosting of the pumps is accomplished using either gaseous helium to displace the liquid helium from the pump or increased heat load during glow discharge cleaning to evaporate the helium within the pump. Plans include up to two more in-vessel cryo pumps for the inner leg of the upper and lower divertors.

The water cooled copper coil systems originate mostly from Doublet III (1978) with some poloidal coils replaced for DIII–D. These coils have proven reliable with the exception of a water leak due to a cracked conductor in the lead to the coil comprising one half of the ohmic heating coil solenoid. Remote operations were performed in situ to: (1) install a mechanical clamp to restrain the lead deflection arresting crack growth and (2) bypass the crack to allow for reduced water flow in the cracked conductor. Instrumentation monitors the clamp and cooling circuit parameters to evaluate the performance of the re

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