Development of a pop-up Langmuir probe array for the W7-X high-heat-flux divertor

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Divertor target-mounted Langmuir probes are foreseen as a crucial diagnostic during Operational Phase 2 (OP 2) of the W7-X experiment to aid our understanding of detachment, edge fueling, strike patterns, and other scrape-off layer phenomena. The high-heat-flux divertor [1], to be used during this period, will be water-cooled to withstand the sustained power flux from continuous discharges lasting up to 30 minutes. Since it is not forseen to actively cool the probes, however, they must periodically withdraw from the plasma to avoid damage from overheating. Finite-element modeling indicates that, in the worst case, the graphite-tipped probes must stay retracted for 10 s after 200 ms of plasma exposure.

The system currently under design will consist of poloidal arrays of probes in two of the ten island divertors. The arrays will span up to 400 mm of their respective horizontal target elements with 25 to 50 mm of separation between each probe. Both the probes and the mechanisms driving the reciprocation will be integrated into the targets. The driving mechanism consists of a rigid, current-carrying loop which moves in response to the Lorentz force from the W7-X magnetic field. Although most of the instrumentation will be mounted on the back sides of divertor target modules and therefore not accessible during the operational phase, the interface between the probes and the drive units will permit the probes to be periodically removed and replaced from the plasma-facing side. The in-vessel cabling system is designed for compatibility with high-speed measurements using the "Mirror Langmuir probe" technique [2].

Here we present the current status of the project. Topics to be addressed include the technical challenges which had to be overcome to realize the system, solutions developed for those challenges, and the results of simulations and prototype testing to predict and qualify the performance of the probes.

References

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[2] B. LaBombard and L. Lyons, *Rev. Sci. Instrum.* **78**, 7 (2007)