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Error estimation in filament measurements using a synthetic probe

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Plasma filaments –or blobs –are large, coherent structures in the Scrape-Off-Layer (SOL) of fusion devices which can significantly contribute to heat and particle transport out of the plasma. Electric probe arrangements are a standard tool for investigating plasma filaments in the SOL of magnetic fusion experiments. In the Wendelstein 7-X (W7-X) stellarator, recent work has characterized plasma filaments using reciprocating electric probes and provided a comparison of filament scaling to simulated filaments, showing remarkable agreement. The paper further utilizes such simulations to assess uncertainties inherent to probe measurements by introducing a synthetic probe diagnostic into the simulation. It is determined that filament diameters, and to a smaller degree radial filament velocities, are inherently underestimated in experiment when a filament is not centered on the probe tip. Filament velocity measurements are also sensitive to the alignment of the probes relative to the poloidal direction and the distance between pins. Floating potential pins which are spaced too far apart will underestimate filament velocity, whereas pins which are closely-spaced can overestimate the filament velocity. The sensitivity of the floating potential measurements – from which radial velocity is extracted – to temperature fluctuations is discussed. These investigations apply to measurements of filaments by electric probes in tokamaks as well and may serve as guidance for interpreting probe data and designing probe arrays.

Country or International Organisation

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