Filament statistics with imaging techniques and comparison with langmuir probes

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The dynamics of plasma filaments govern the transport of particles in the scrape-off layer (SOL) of tokamak plasmas [D'Ippolito *et. al.*, PoP, 2011] and thus scrape off layer density profiles. A technique has been developed which maps the light emission in fast visible camera images to a midplane grid of field line emission, using camera registration and magnetic equilibrium information. Emission along field lines is used as a proxy for plasma density, facilitating the identification and tracking of SOL plasma filaments. This pseudo-inversion filament analysis technique is described in detail and benchmarked against synthetic camera data in new paper [T Farley *et. al.*, RSI, 2018 (in preparation)].

Here the technique is applied to L-mode fast camera data from the MAST tokamak. Considering individual field lines from within 2D field line emission maps, we construct pseudo-Langmuir probes. These probes are used to calculate probability density functions (PDFs) and time averaged radial profiles and perform conditional averaging and other related statistical techniques. The statistics of the filaments' properties are interpreted using the theoretical ergodic framework described in [F. Militello & J.T. Omotani, PPCF, 2016] in order to better understand how time averaged filament dynamics produce SOL density profiles.

Toroidal filament separation is found to be exponentially distributed, indicating toroidally uniform, independent generation of filaments with no toroidal mode number. Filament waiting times are also seen to be exponentially distributed, indicating filament generation is a Poisson process in agreement with Langmuir probe time series measurements. These findings provide important validation of assumptions in the ergodic framework and give insight into the physics of the filaments.

Finally, the statistics measured with the pseudo-Langmuir probe technique are compared directly with Langmuir probe measurements made in similar discharges and with results from the full 2D pseudo-inversion technique.