Signal Processing Techniques for Lithium Beam Polarimetry on DIII-D

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On the DIII-D tokamak the LIBEAM diagnostic provides precise measurements of the local magnetic field direction by combined polarimetry/spectroscopy of the Zeeman-split 2S-2P lithium resonance line. Using these measurements we are able to determine the behavior of the edge toroidal current density $j_\phi(r)$, a parameter of critical interest for edge stability and performance. For a successful measurement, analysis of the polarization state of the spectrally filtered fluorescence must be done with high precision in the presence of non-ideal filtering, beam intensity evolution and dynamically varying background light. This can be accomplished by polarization modulation of the collected emission, followed by digital demodulation at various harmonics of the modulation frequency. Either lock-in or FFT techniques can be used to determine the various Stokes parameters and reconstruct the field directions based on accurate spatial and polarization efficiency calibrations. Details of the specific techniques used to analyze various DIII-D discharges will be described, along with a discussion of the present limitations and some possible avenues towards improving the analysis. Work supported by the U.S. Department of Energy under DE-FC02-04ER54698.

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