Data Analysis and Performance Aspects of the New DIII-D Monostatic Profile Reflectometer System*

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Abstract. The DIII-D FM profile reflectometer system has been completely renewed. The new system features a monostatic antenna geometry (using one microwave antenna for both launch and receive), as compared with the previous bistatic arrangement (separate launch and receive antennas). The new system provides a first experimental test of a monostatic measurement approach for profile reflectometry. Use of a monostatic arrangement offers significant advantages, such as a simplified and improved antenna geometry, and a reduced numbers of antennas and transmission lines, e.g. the new DIII-D system uses just two antennas, as compared with six previously. The new microwave transmission system features use of reactor-relevant, low-loss, circular corrugated waveguides. No special launch/receive antennas are used, instead the circular waveguides are used to directly launch beams with a Gaussian profile. The two antennas are located on the machine midplane, recessed 28 cm behind the plasma facing wall, with transmission line runs consisting of ~13 m lengths of 89 mm diameter corrugated waveguide, with 6 miter bends per run, while the vacuum interfaces consist of angled fused silica windows located in gaps in the waveguide. At the end of V-band launch, the 89 mm waveguide is tapered to 63.5 mm diameter. The frequency coverage of the system is maintained at 32-75 GHz, with one waveguide and antenna used for 32-50 GHz measurements (Q-band), and the second for 50-75 GHz (V-band). The systems are operated in both O- and X-mode allowing acquisition of simultaneous phase data for both polarizations in both Q and V-band. In each sub-system the two polarizations are combined and demultiplexed from a single microwave source using an orthomode transducer. Individual profile measurements are made with 25 μs time resolution, i.e. the full-band frequency sweep period is 25 μs. In addition to briefly describing the new hardware system, this paper will also discuss the data analysis aspects and in-service performance of the new monostatic profile reflectometer system. Multiple aspects of the data processing and analysis approach have been modified and improved for the upgraded system. With regard to in-service performance, scans of the plasma vertical position were made in order to measure the range of operation of the new antenna system. With such scans we have successfully demonstrated an ability to measure the electron density profile with L-mode plasmas shifted up to ±20 cm off the machine midplane. For plasma offsets above ~10 cm we utilize information from ray tracing (GENRAY) to determine the approximate propagation trajectory of the probe beam. The reflectometer density profiles are then reconstructed along the angled propagation path indicated by the ray tracing. Using this approach, the measured density profiles were invariant when mapped to ρ-space during the ±20 cm vertical plasma position scans. Examples will be presented of accurate, high time and spatial resolution density profile measurements made over a wide range of DIII-D conditions, e.g. the measured temporal evolution of the density profile during L-H and H-L transitions, ITB formation, ELM and sawtooth events.

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