Doppler Shift Spectroscopy Diagnostic for Indian Test Facility (INTF).

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Abstract

India Test facility (INTF) is being commissioned in Institute for Plasma Research (IPR) to test ITER Diagnostic Neutral Beam (DNB) with full specification. Neutral beam system for INTF is based on a negative hydrogen ion source. The ion source is expected to deliver 60A negative hydrogen ion beam current of energy 100keV. The source will be operated with 5Hz modulation having 3s ON/20s OFF duty cycle for 3600s. To characterize the beam parameters several diagnostics will be used. One of them will be the Doppler shift spectroscopy (DSS), which will be used to measure the beam energy, line integrated beam uniformity, beam divergence, and neutralization losses inside the accelerator (stripping losses). The red shifted Doppler radiation emitted by the beam particles can be spectrally discriminated from background neutrals and then used for determining the beam energy and divergence of the beam itself and also the stripping losses. DNB ion beam is made of 1280 beamlets arranged in 4×4 beamlet groups each having matrix of 5×16 beamlets of diameter ~14mm. Total 36 LOS both from horizontal and vertical directions has been provisioned in the INTF system to map the beam of size ~ (0.6m×1.6m) completely. Port view angle with respect to the beam has been optimized to 60 degree for clear peak resolution from the background H-alpha radiation (~ 656nm). Due to the conductance limitation inside the extractor system of the ion source, pressure is relatively higher at that location and collision induced negative ion stripping (losing loosely bound electrons from the negative ion) is expected to be more at that region. As a result a fraction of negative ions will unable to get full energy before it gets neutralized by the stripping collisions. Therefore, a separate broad Doppler shifted peak corresponds to the extraction potential is expected along with the full energy peak corresponds to acceleration potential. The system is designed to resolve peak due to stripping losses from the full energy peak. Accuracy of about 9-10% is expected in the measurements of beam divergence from the present DSS design. The radiation collected by collimation lenses through viewports on the INTF vacuum vessel will be transmitted through optical fibers to the instruments, which are in air Czerny Turner (CT) spectrometers coupled to 2D CCD cameras. Optical throughout/etandue (light collection cone) and its propagation along the light transmitting path has been maintained as close as possible for the light collection optics and that of the spectrometer. A CT spectrometer coupled to a 2D CCD camera is a cheap and compact solution when dealing with acquisition of multiple lines of sights. To improve read out time defining some macro pixel (binning technique) is proposed. The design of the present DSS system is reported with background design considerations and calculations.