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Development of the collective Thomson scattering diagnostic system on HL-2A tokamak

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Abstract: Collective Thomson Scattering (CTS) diagnostic technique has great potential in measuring velocity distribution of fast ions in magnetically confined fusion devices. Here we report on design of the CTS system for the measurement of ion velocity distribution function in HL-2A tokamak. A 105 GHz 500 kW gyrotron with high power transmission/antenna in ECRH system will be used to generate a highly focused well-defined Gaussian beam. To improve the capacity to focusing the scattering beam and avoid the stray contamination, a Cassegrain antenna is installed ~30 cm below the ECRH antenna in vacuum vessel as the receiver of the scattering beam from the central chord. The receiver system includes a RF box that consists of a heterodyne sweeping system able to sweep the frequency from 102 to 108 GHz in 0.1 ms and an IF box with 120MHz bandwidth. The scattering signal is transmitted to the RF box through an overmoded waveguide. To protect the receiver, a notch filter/attenuator, which provides >35dB attenuation at 105GHz, is used before the RF mixer. A high sensitive IF logarithmic detector with the power limit of -80 dBm and dynamic range of 55 dB is designed in the IF box. Since the background ECE noise is so strong that CTS signal may be masked, a method of gyrotron modulation with 5 ms on-times and 5 ms off-times is adopted, which determines the temporal resolution of 10 ms. We can eliminate the ECE with signals during on-times subtracting signals during off-times. The direction of probing beam is steerable for spatially resolved measurements, and thus the scattering volume can move between the core and the edge of plasma. The spatial resolution varies between 68~260mm, and it's 94mm when the volume located in the core.

References

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