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Ultrashort Pulse Reflectometry (USPR) Diagnostic for EAST

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Ultrashort Pulse Reflectometry (USPR) is a plasma diagnostic technique involving the propagation of ultrashort duration (~few nsec) chirps which contain frequency components spanning large portions of the plasma density profile [1]. Upon reflection, each frequency component reflects from a distinct density layer. The reflected wave packet is down-converted and passed through a multi-channel filter bank, with time-of-flight (TOF) measurements made on each of the filtered wave packets which are then used to reconstruct the electron density profile. One key advantage of USPR is that measurements take place during such a short time that fluctuations are essentially "frozen" in place, thereby reducing their effect on the reconstructed profile.

This technique was applied in the past to the Sustained Spheromak Physics Experiment (SSPX), where a 24-channel system operated spanning a frequency range of 33 to 75 GHz [2]. UC Davis is now updating this technique with higher power (>10X) sources, enhanced channel counts and high speed customized TOF electronics [3]. A 32 channel USPR system is being developed for EAST with frequencies spanning 52 to 92 GHz, reflecting from the right-hand plasma cutoff layer. The system will employ three monostatic transmit/receive horns each covering a different waveguide band. Each of the two higher frequency bands will have 8 distinct frequency channels, with the lowest frequency band, spanning 52 to 65 GHz, to have 16 receiver channels to better resolve the EAST scrape-off layer. With a pulse repetition rate of 1 MHz and simultaneous acquisition of all 32 TOF signals, electron density profiles may be obtained with time resolutions of as short as 3-6 μsec.

Details of the EAST USPR system design and laboratory testing will be provided.

References

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