Development of a multifunctional real-time data processing system for interferometers on EAST

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Due to the disadvantages of the old interferometer with high voltage drive, such as instability during long-pulse discharge and unsafety of personnel operation, interferometers for electron density measurements are gradually being replaced by interferometers built with smaller, more stable sources.

In the latest campaign of EAST experiments, two new interferometers were installed, a dispersion interferometer (DI) based on a Carbon Dioxide laser and a solid source interferometer (SSI) based on microwave multiplier sources. In order to make them available for the Plasma Control System (PCS) system, each of them needs to be provided with a real-time processing system to extract the detector output signal and afterward obtain the electron density information through signal processing.

To obtain interferometer data quickly and reliably, a unified hardware template was applied to both interferometers. Three main parts are included in this hardware template - digitization, digital signal processing, and output modules. In particular, the digitization section uses a multi-channel Analog-to-Digital Convertor (ADC) to acquire the signals that need to be calculated. The digital signal processing part is implemented by an FPGA, which is the hardware basis of this multifunctional template that can be used for multiple interferometers. This section includes two main parts, wrapped density signal extraction and signal unwrapping. For DI it is a phase calculation based on the intensity ratio, while for SSI it is a phase calculation by means of FFT or phase demodulation. Both computational approaches form independent IP cores to build systems quickly, while these IP cores provide parameter interfaces to adapt to different application scenarios. The output module provides a variety of data transmission methods, including fiber optic transmission and Digital-Analog-Convertor based analog transmission, to interface with PCS or other subsequent systems.

This data processing system template has been applied to each of the above two interferometers and valid data were obtained in a recent EAST experiment campaign. It demonstrates the usefulness of the template and provides a reference for the design of data processing systems on future devices.

[1] Y. Yao *et al.,* J. Instrum. **12** C12043 (2017)

[2] Y. Yao *et al*., Rev Sci Instrum 93, 034705 (2022)

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