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Nd:YAGトムソン散乱計測装置に最適なデータ処理システムによる測定精度の改善

Improvement of measurement accuracy by optimum data acquisition system for Nd:YAG Thomson scattering system

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Precise time evolution information of plasma profiles is indispensable to improve a plasma performance. An Nd:YAG Thomson scattering method has advantages for the profile measurement, because it can measure local values of plasma electron density and temperature, in addition, it provides a precise time evolution of the plasma profile due to the high repetition rate of the Nd:YAG laser. However, the Nd:YAG Thomson measurement requires higher speed data processing, because the short laser pulse width ($\sim 10ns$) is required for improvement of S/N ratio. Therefore, we have developed a new high speed analog to digital convertor for data processing of the Nd:YAG Thomson scattering measurement (High speed YAG Thomson scattering AD Convertor: HYADC). Until now, a charge integrating type AD convertor was mainly utilized for the Nd:YAG Thomson scattering, because there has been no high speed and high resolution AD converter chip. Recently, the high speed AD converter of 12 bits resolution and 500MHz sample rate (AD5463, Texas Instruments inc.) is developed, then we are developing the HYADC that can directly convert the scattered light signal to the digital signal. The direct conversion method of the HYADC has several advantages as follows.

1. An increased number of the sampled data compared to the charge integrating type AD convertor improve a signal to noise ratio by over 10 times.
2. A precise background light reduction can be performed using the digitized data of which signal is detected just after a laser injection.
3. The HYADC can analyze a short pulse interval laser injection of the multi-pulse Nd:YAG Thomson scattering measurement. Even if the signal is overlapped, The HYADC can separate both signals.

The HYADC has a ring buffer memory and a stop trigger due to sampling only a short period in which the scattered light is detected. Consequently, an amount of the total data that is stored in data storages is reduced to below 0.01% compared to a full data conversion. The data transfer to the analysis computer is executed by SiTCP[1] which has developed by KEK. The SiTCP can transfer the data by the TCP protocol using a wire logic circuit without CPU. Then the real time data acquisitions are realized, which is required for a real time feedback plasma control of the fusion plasma. Because the AD converter control unit, the data memory unit, and the data transfer unit are consolidated on one FPGA chip, the system has scalability, expandability, and affordable cost to construct the multi channel data acquisition system for the Nd:YAG Thomson scattering measurement.

In this talk, we report the structure and the estimated performance of the measurement accuracy of the HYADC, and the present status of the development.

[1] Tomohisa Uchida , IEEE Transactions on Nuclear Science. vol. 55, no. 3, 2008.6, pp. 1631-1637