§ 18. Digitizer Strategy toward Real-time and Ultra Wide-bandwidth Data Acquisition

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The newest fusion devices applying the super-conducting magnets, such as LHD (Large Helical Device) and W7-X, usually plan to hold a quasi-steady-state experiment with over ten minutes plasma duration. In such cases, the data acquisition system will be requested to continue non-stop real-time operations so that it can display the transient behaviors in accordance with the plasma discharge going on. It is quite a brand-new subject in fusion research experiments, which was not significant in conventional short pulse experiments.

Present Status of CAMAC Data Acquisitions

The LHD diagnostics have over 30 kinds of plasma measurement devices and their total number of CAMAC modules and channels are about 300 and 2000, respectively. In the 2002-2003 campaign, their acquisition data makes up to 740 MB/shot in 150 shot/day usual operation. (See Fig. 1) The growth rate of the raw data slows down comparing to the previous cycles, however it still keeps growing.

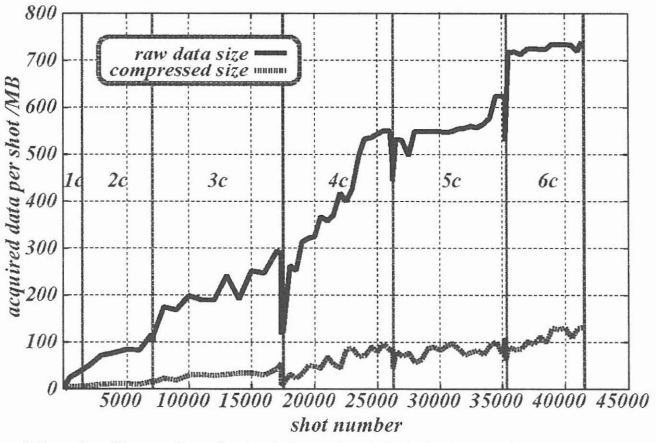

Fig. 1. Growth of shot-by-shot total data size acquired by LABCOM data processing system.

The growth curve shows that in earlier 1st ~ 4th campaigns it continue ascending within the period, however, after 5th one only the sudden growth near the start/end of periods can be seen and in their middle time the growth curve was rather flat. Such the tendency could be understood as that the LHD diagnostics have got out of their start-up period now. In the next 2003-2004 campaign, the total acquisition size will probably reach up to 1 GB/shot because LABCOM system will begin to operate the other two kinds of digitizers: WE7000 and CompactPCI/PXI. Those digitizers have also capabilities to cope with the non-stop data acquisition in quasi-steady-state experiments.

Prototype Evaluation of Ultra Wide-bandwidth Streaming Digitizer

For realizing the wide-bandwidth real-time digitizer [1], the CompactPCI standards can smoothly replace the CAMAC digitizers because of its popularity and low price by the PCI compliance. As a preliminary result, the prototype system has achieved its continuous data acquisition and transfer performance up to 80MB/s in one DFE [2]. Such fast steaming transfer of the massively sized LHD physics data has proved its instrumental wide possibility.

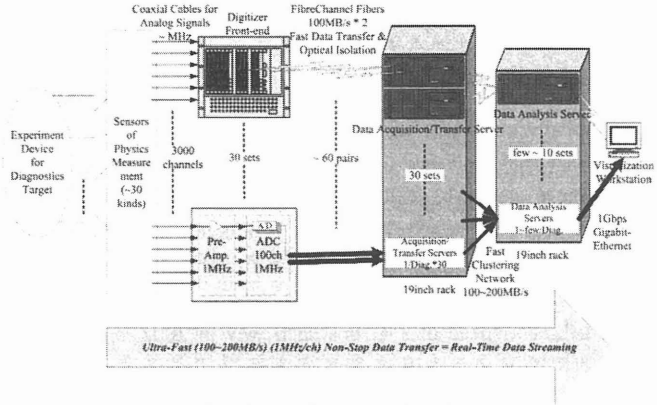

Fig. 2. Schematic view of ultra wide-bandwidth streaming acquisition system.

Another examination to store massive data into the hard-disk array was also done for demonstrating real-time data saving. Fig. 3 shows the performance result achieved by a set of a popular ATA-RAID controller "Promise FASTTRAK TX2000" and four 5400 rpm ATA133 disks "Maxtor 4G160J8" organizing a RAID0 striping volume. In larger I/O size regime, the read/write rates steadily show over 95/85 MB/s, respectively. Such easy PC parts even perform enough high data storing rate for the CompactPCI prototype's output rate of 80 MB/s.

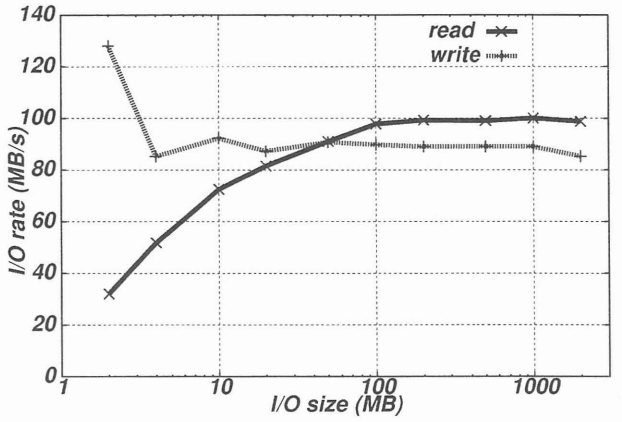

Fig. 3. Performance evaluation for continuous data writing into striping 4*HDD array (FAT32).

To realize 80 MB/s streaming for data clients, Gigabit capable networks must be available. By introducing 10 Gbps backbone of SuperSINET, LHD has powerful network realizing 1 Gbps streaming for remote laboratories.

References

1) Nakanishi, H. et al.: Fusion Eng. Des. **56-57** (2001) 1011
2) Nakanishi, H. et al.: Ann. Rep. NIFS (2001-2002) 159