Transactions of the Materials Research Society of Japan 26 [2] 561-564 (2001)

Data Acquisition with Computer Network — Improvements on KUR-SANS System —

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We have been investigating mesoscopic structure materials with the small-angle neutron scattering method at several institutions including Kyoto University Reactor(KUR-SANS). KUR-SANS system was developed by one of the authors(M. Su.) and has sufficient performance for experiments. However, in a series of experiments, because the system lacks functions for automating the experiments, the inefficiency caused from disruption becomes a major obstacle. In order to remove this disadvantage, a new data acquisition system with distributed processing through the computer network is proposed in the present paper. This new system is composed of an Ethernet local area network and computers combined together.
Key words: small-angle neutron scattering, data acquisition, computer network, Ethernet, TCP/IP, HTTP

1. INTRODUCTION

We have been investigating various kinds of gels and other mesoscopic materials [1–4]. Small-angle neutron scattering method, is one of the most important experimental techniques for these materials, and instruments for this method are installed at several institutions including Kyoto University Reactor, Kumatori, Japan (KUR-SANS).

Carrying out series of experiments are required for ordinary investigations, however, several difficulties or obstacles have been recognized on the KUR-SANS system, i.e. lack of functions for automating these sequential experiments. ThAis is caused from the data acquisition system based on stand-alone personal computers, which leave no excess capacity to spare. Therefore, we are developing a new data acquisition system with distributed processing over a computer network. This new system is composed of computers attached to an Ethernet local area network and communication software utilizing the internet/intranet technology.

2. KUR-SANS SYSTEM

The KUR-SANS system was developed by one of the authors (M. Su.) [5–8]. Although the neutron intensity is somewhat weak, the system has a fairly high S/N ratio and has sufficient performance for usual experiments.

Figure 1 shows a comparison of obtained profiles of TFEE (Poly-tetrafluoroethylene-co-

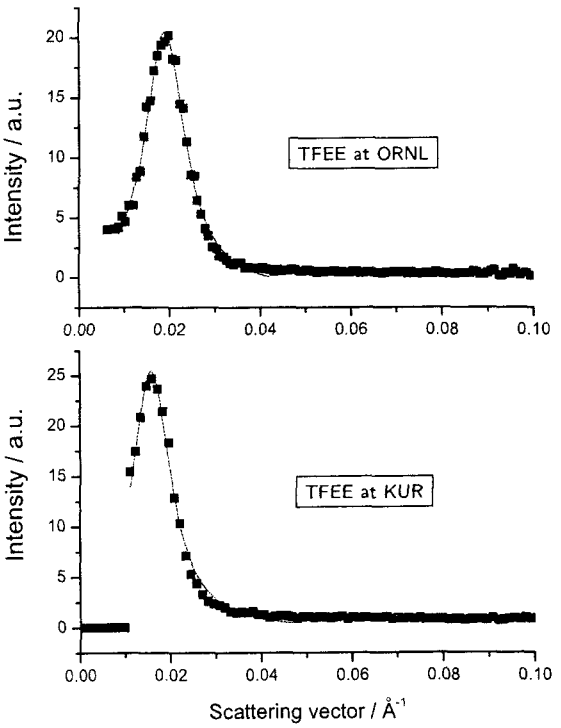

Fig. 1: A comparison of SANS profiles of TFEE (Poly-tetrafluoroethylene-co-ethylene), obtained at ORNL and KUR. Closed squares indicate observed data and dashed-dotted lines are results of fitting to Lorentzian functions. Small difference in peak position between the profiles is due to that of wavelength of incident neutron beams.

ethylene) as functions of scattering vector, observed by the KUR-SANS and a SANS system at Oak Ridge National Laboratory (ORNL), USA. This polymer is rather stable and can be considered as a "standard" sample for SANS experiments.

From the line width in the both profiles, there is no significant difference in resolutions. Thus, the fundamental performance of the KUR-SANS is sufficient for usual investigation.

Figure 2 shows profiles obtained at ORNL and KUR for Ovalbumin 5wt% solution. These line profiles show fair agreement with slight difference in peak positions, which is due to imperfection of compensation. Such compensation will need a sample with sharp peak in a high angle region, and that remains future issue.

In order to improve the performance, an optical layout is also planned to improve neutron flux intensity and to reduce background. This new layout is schematically shown in Fig. 3, and is expected to increase neutron intensity about 20%.

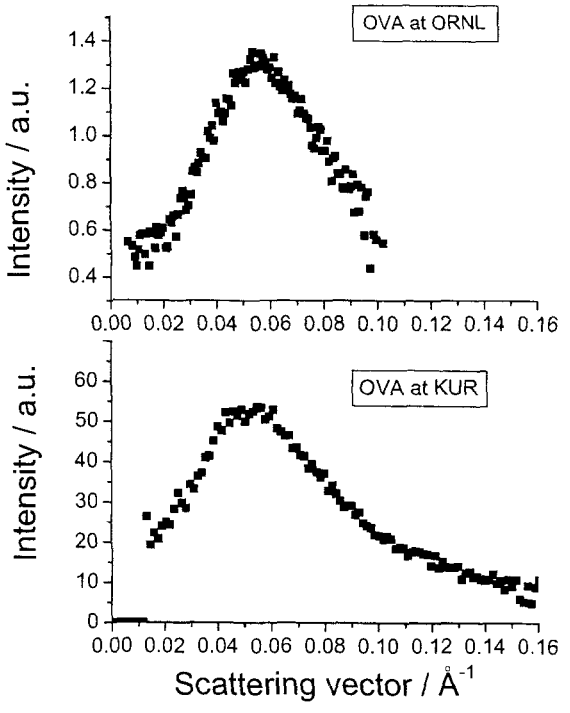

Fig. 2: An example of SANS profiles of Ovalbumin 5wt% solution, obtained at ORNL and KUR.

2.1 Conventional data acquisition system

A schematic diagram of the data acquisition part of the KUR-SANS system is shown in Fig. 4. Other components, such as a 2-dimensional position sensitive detector (2-D PSD), position encoding/decoding circuits, a neutron monochromator, etc., are described in Ref. [5] and omitted here.

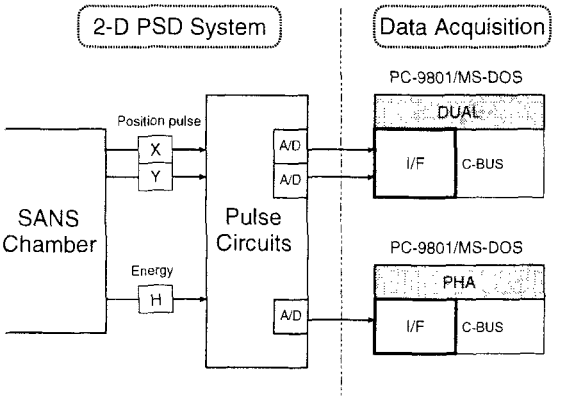

Fig. 4: Conventional data acquisition system of the KUR-SANS.

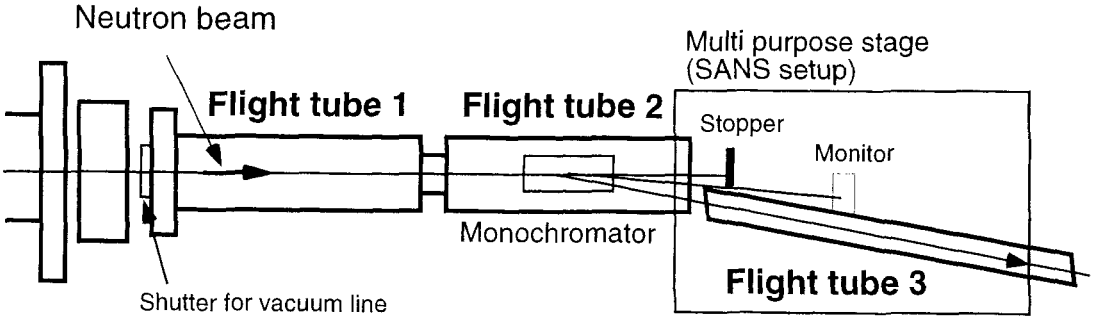

Fig. 3: A new optical layout for the KUR-SANS. Three vacuum flight tubes are introduced for reducing neutron losses by air-molecule scattering.

In the present system, detected neutron pulse signal is processed with pulse circuits, then it is converted into digital data and input to personal computers through specific interface boards. These computers are NEC PC-9801's, which are somewhat obsolete, have so called "C-BUS" interface for extension board connection. A program named "DUAL" for measuring neutron position, and that called "PHA" for neutron energy are running on MS-DOS.

2.2 Problems

Because these data acquisition software are running with no relations each other, all procedures for the experiment require manual operations by human operator(s). For example; beginning scattering experiment, two computers need push both start buttons simultaneously; after finishing data collection, neutron data file name must be input every time; before and after a scattering experiment, monitor counter is need to move into beam line by hand, for detecting transmission rate; etc. The last procedure requires to shut off neutron beam because a human needs to approach the neutron beam line. Though it will be reduced with installing a computer controlled motor, the manual operations still remain without a system integration. This is because computers are running in a stand-alone configuration, due to lack of a capacity to spare.

3. New Data Acquisition System

Figure 5 shows the new data acquisition system with an Ethernet local area network and every computer with an Ethernet interface, internet/intranet protocol or TCP/IP forming "Laboratory Network".

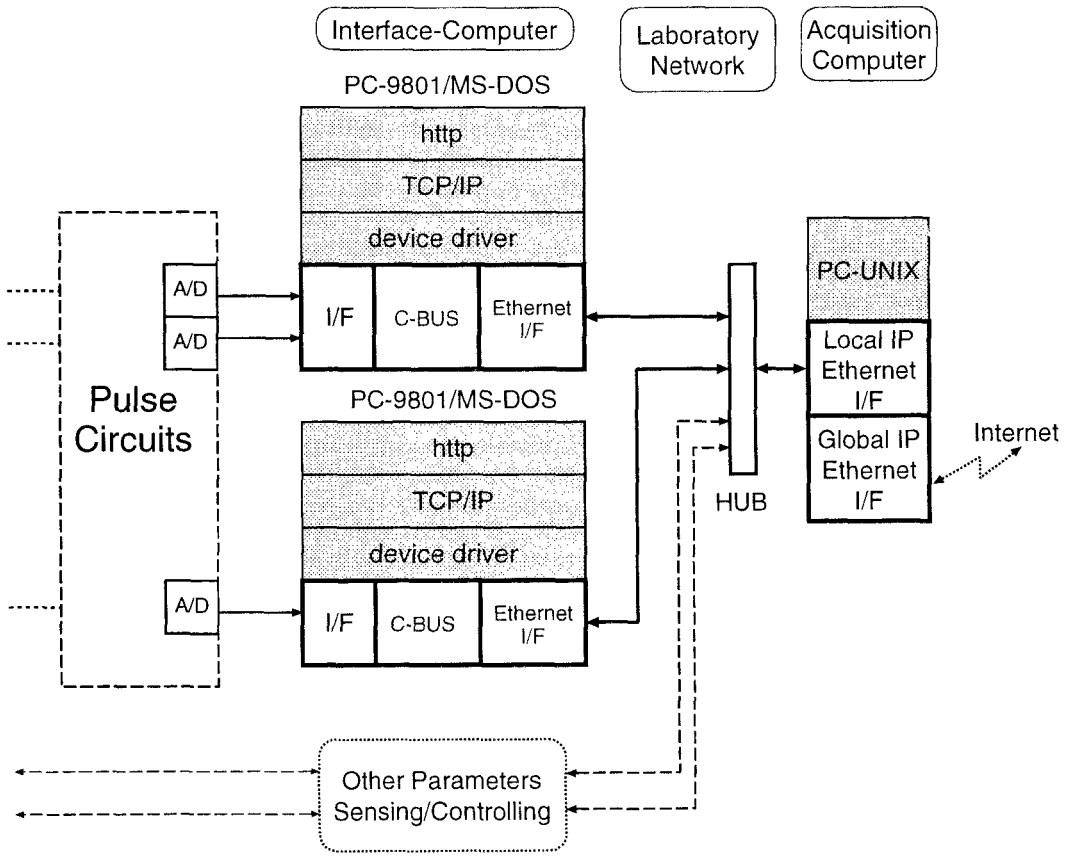

Fig. 5: New data acquisition system of the KUR-SANS. Shaded blocks represent software and others denote hardware. Laboratory Network is formed from a local area network and computers with Ethernet interface hardware. Each Interface-Computer(NEC PC-9801) has another specific interface hardware for the KUR-SANS neutron pulse circuits with the C-BUS, and communicates with Acquisition Computer through the network with TCP/IP and HTTP protocols. Acquisition Computer executes programs which control Interface-Computers to carry out experiments.

Each computer has simple and separate role for data acquisition on experiment: converting scattered neutron position data into network packet, monitoring neutron pulse energy, and controlling other computers to carry out experiment.

Because the specific interface board with the C-BUS is required for the KUR-SANS system, PC-9801 computers must be still used in the new system. Thus, the programs for network protocols are being developed.

On this new system, the flexibility for measuring or changing another parameter according to the requirements of investigation, such as temperature of sample, sample position etc, is available by just adding instruments for the parameter to the network. In other words, "Interface Computer" and corresponding equipment for experiment forms a module, which can be attached or detached to the system as required. The HTTP, known as the protocol for Wold Wide Web, is selected for data transferring protocol. It is because if a new module is made, Web browser program will be able to use on testing the module alone.

The costs of the computer and network equipment are significantly decreased in these few years. Therefore, the most important matter is allocating each computer to a separate task, with which the system shows a high flexibility of modification.

4. SUMMARY

A new data acquisition system utilizing intranet technology(i.e., Ethernet, TCP/IP, and HTTP) is proposed, in order to resolve the inefficiency of the conventional data acquisition system.

ACKNOWLEDGMENT

This work was partly supported by the Grant-in-aid from the Ministry of Education, Science, Culture and Sports, Japan.

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(Received December 8, 2000; Accepted March 16, 2001)