

# Real Time Monitor on the Internet for the Experimental Apparatus

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## Abstract

The control and monitor of the experimental apparatus by Personal Computers (PCs)[1][2] become very common. Recently, we have developed a simple program to capture the PC screen and save it as GIF or JPEG files periodically. The experiment E-248 (AIDA) "Search for H-particle in the reaction of  $pp \rightarrow K^+ + K^+ + X$ "[3][4] at KEK-12GeV-PS used the super conducting spectrometer magnet "BENKEI"[5] and the liquid hydrogen target [6][7][8][9]. These low temperature devices were controlled and monitored by the PCs. Microsoft Windows95 was used as an operating system (OS) and Personal Web Server (PWS) was installed for the use of the Web server. The PCs were connected to the LAN and the Internet by TCP/IP. The numerical data of the instruments were stored to the FTP root-directory \webshare\ftproot\ on the hard disk drive (HDD) in every 1 minute. These data were monitored on the Internet using auto-reload mode by the WWW browser. The stored data were transferred by the FTP to the other computers. The PC graphic data were captured as a BMP file, were changed to a GIF file and transferred to the WWW root-directory \webshare\wwwroot\ in every 5 minutes. The GIF files were monitored on the Internet by the HTTP and the WWW browser with the auto reload mode. This real time monitor on the Internet can be used for wide fields using PCs.

## 1. APPARATUS AND PC MONITORING SYSTEMS

### 1.1 Super Conducting Magnet BENKEI

BENKEI is a S.C.-Magnet with a large aperture and an iron return yoke. It has an accumulated energy of 3.15 MJ, a cold mass of 5.64 t, a total weight of 16.3 t, a LHe tank of 300 l and a LN<sub>2</sub> tank of 120 l.

In the time of the AIDA experiment, we had to operate BENKEI safely at maximum current of 610 A without a quenching. The LHe of about 200 l was transferred to the magnet, twice in a day. During the LHe transfer, we had to operate it without a thermal oscillation nor a large differential pressure of two current ports which makes a quenching because the LHe level becomes low.

A schematic sheet of the BENKEI control system is shown in Fig. 1. Input/output devices were ADC, DAC and DIO boards that were inserted to the expansion-bus of PC (NEC PC-9821Xa: Intel Pentium 200 MHz). The PC controlled the following items.

- (A) Monitoring of the temperature, pressure, LHe/LN<sub>2</sub> levels and vacuum etc.
- (B) Monitoring of the GHe flow-rate which cools the main current leads, and operation of the emergency valves that open to the air when the GHe recovery line was blocked.
- (C) Set and automatic control of the pressure difference between the LHe Dewar and the BENKEI, during the LHe transfer.
- (D) Automatic LN<sub>2</sub> supply
- (E) Alarm of the devices and some logical alarms (ex. LN<sub>2</sub> empty).

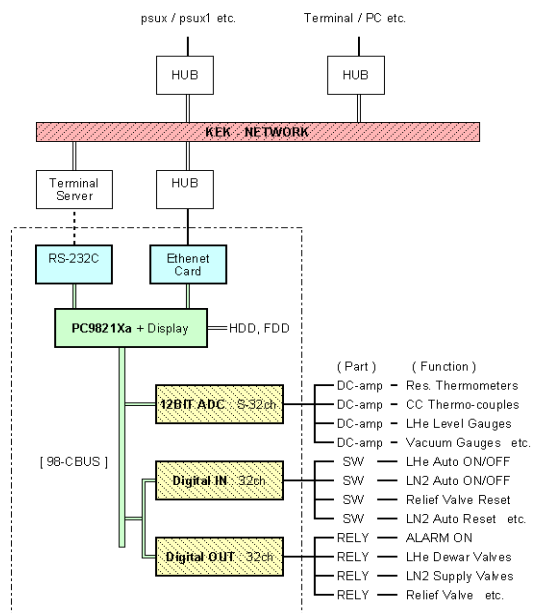


Fig. 1 The super BENKEI control system

### 1.2 Liquid Hydrogen Target

The target cell is a cylinder made of a thin stainless steel and its dimensions are 0.05 mm of thickness, 50 mm of diameter and 250 mm of length.

The H<sub>2</sub> vapour pressure and the temperature should be controlled precisely as much as possible to keep the liquid density and the shape of the cell constant, and also to prevent a fatigue of the metal. For this purpose, we used a high-precision pressure transducer "Baratron" with a thermal stabiliser. A heater at the condenser was PID controlled by the PC to be at the pressure of 1.05 kg/cm<sup>2</sup>.

A schematic view of the LH<sub>2</sub> target control system by the PC (NEC PC-9801BX4: Intel 486DX4-100 MHz) are shown in Fig. 2.

The acquired data by a data-logger are transferred to the PC. The control signals from the PC are sent to DC power supplies and a relay unit etc. via GPIB-bus.

The distance between the PC and the control-rack was extended to about 30 m with a pair of GPIB bus-extenders and a coaxial cable.

The PC controlled the following items.

- (A) Monitoring of the temperature, pressure, liquid-level, vacuum and leak of GH<sub>2</sub>. Calculating of the heater power from measured DC-current and DC-voltage. Conversion of the temperature from Pt-Co resistance thermometers and C-C thermocouples using the calibrated data.
- (B) Automatic pressure/temperature control for the LH<sub>2</sub>-condenser as mentioned above.
- (C) Alarm control for the monitoring values and some logical alarms. Logical alarms will turn off the refrigerator, the compressor, and the heater, and turn on the warning buzzer. In addition, digital voltmeters with relays were used to make the hardware protection circuits when the PC hang up.
- (D) Remote on/off operation of the devices from PC-keyboard. Graphics and status-display of the past and present data of the refrigerator and the compressor.

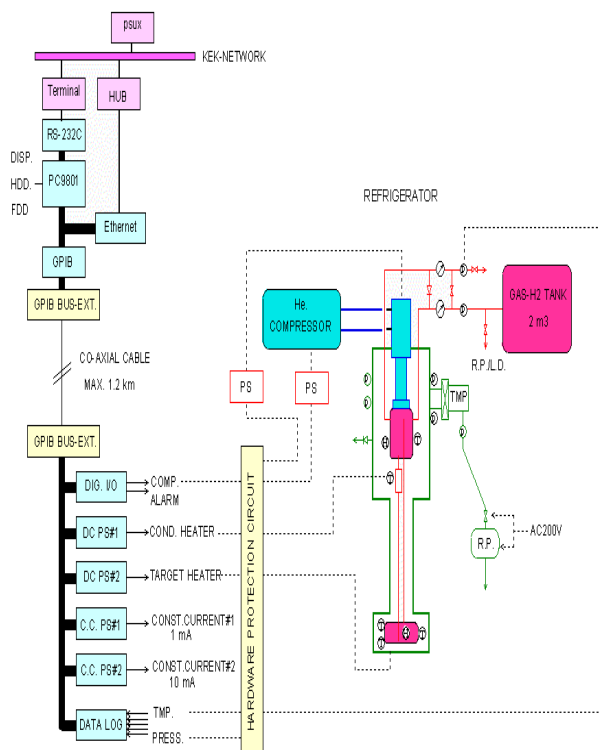


Fig. 2 The LH<sub>2</sub> target control system

## 2. NUMERICAL DATA ON THE INTERNET

### 2.1 Upload to UNIX Host by MS-DOS (BASIC)

First, we uploaded the text data periodically to the UNIX host (psux1.kek.jp) by the monitoring program made by NEC N88-BASIC on MS-DOS via RS-232C port and KEK-LAN. The latest data are visible from any remote login terminals by using a simply shell-scripts in UNIX host for periodical display. To watch the data from the WWW browsers (anonymous access), we wrote the data in the HTML format by the monitoring program and put it to \$HOME/public\_html/ directory in the UNIX host.

In the HTML text data, we described <META HTTP-EQUIV="REFRESH" CONTENT=60>. This command will auto reload the data in every 60 second.

### 2.2 Use WWW Service under MS-Windows95

Second, we used the Personal Web Server under MS-Windows95 (the Peer Web Services or the IIS if using MS-WindowsNT 4.0) in the same PC for control and monitor, in order to shorten the upload time and reduce the CPU load.

#### 2.2.1 WWW Service

In the monitoring program, numerical data are directly saved to \webshare\wwwroot\ on the HDD in almost 0.1 second without loss of the transfer time to the network. This saving time to the HDD is negligible in the condition that the data taking intervals are 10 to 16 sec.

If it is necessary, we can reduce the interval time to one tenth, but it was enough to monitor our cryogenic apparatus. The method to save the data in HTML format to the directory of PC Web service, are very easy way to publish the experimental live data on the Web.

#### 2.2.2 FTP Service

In every 20-30 monitoring cycle, the logging data are saved to \webshare\ftproot\ as a text file aside from the data saving for WWW browsing.

The data size and logging times are followings. BENKEI: 1 file 20 data, 5541 bytes/file and 3.3 min /file, LH<sub>2</sub> Target: 1 file 30 data, 23958 bytes/file and 8.4 min /file (1 data = acquired data from all channels in 1 cycle).

These stored data were manually transferred and saved to other PC by the FTP service.

If the monitoring program has a subroutine to read a setting file from the FTP directory, we can remotely control the apparatus via the Internet. In this case, in order to avoid the security problem, we can set an access limitation for the Internet service, for example password set.

### 3. GRAPHIC DATA ON THE INTERNET

#### 3.1 Capture and Save the PC Display

Resolution of the display on the MS-Windows95 was 800\_600 dots, 256 colours and the MS-DOS window for the monitoring program was 640\_480 dots. Manual way to capture the screen is to push "COPY-key" on NEC PC-9801 or "Print Screen-key" on the IBM-PC/AT compatible. The captured graphic data have to be converted to GIF or JPG format to use in the Web.

#### 3.2 Batch Process under MS-Windows95

For the automatic operation of this process, we used a batch program, a capture program and a graphic converter program. These programs can be operated in the Win32 native mode. The batch program runs aside from the monitoring program under the multitask mode and performs the jobs, capture the screen, convert the BMP file to the GIF file, delete the BMP file and wait interval time. We used "WinBatchEh ver1.27"[10] as the batch program, "CliPlu ver1.0"[11] to capture and save the BMP file and "RASTRN ver1.6"[12] to convert the file into GIF format.

These 3 programs are shareware or freeware.

#### 3.3 Views through the WWW Browser

Fig. 3 and Fig. 4 are examples of graphic data on the Netscape Navigator Gold 3.0. The upper part of graphic window is for numerical data obtained from ADC/DI or data-logger, the lower part are the graph of the numerical data. Time axes are in full scale of 24 hours, and after 1 day the old data will be erased.

It took about 2 sec to capture the screen, convert the format and save the data to the HDD by the PC of 486DX2-100 MHz, and it took about 1 sec in case of the Pentium 200 MHz.

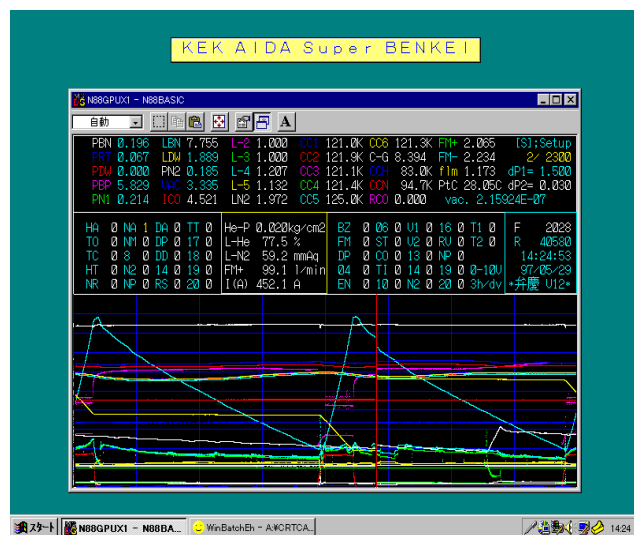


Fig. 3 PC-desktop view of the super BENKEI

### 4. RESULTS AND CONCLUSION

We have performed a real-time monitor by using the WWW browser via the Internet for the acquired numerical data and the desktop view on a controller PC. We also obtained capability to transfer the logging data by using the FTP from remote machines.

These monitor and control systems were successfully operated through total about 1 year. This method had a great advantage for the view of safety and also for the view of easier experimental monitor and control.

When we need higher speed system, it will be possible by using powerful PC or using better programming languages. Recently, we have developed and successfully tested a new program by Visual Basic on Windows95/NT to capture the PC (IBM-PC/AT or NEC PC9801) screen, and transfer to the Internet. This simple method to monitor the apparatus on the WWW can be applied to wide area of the experiment using PC system.

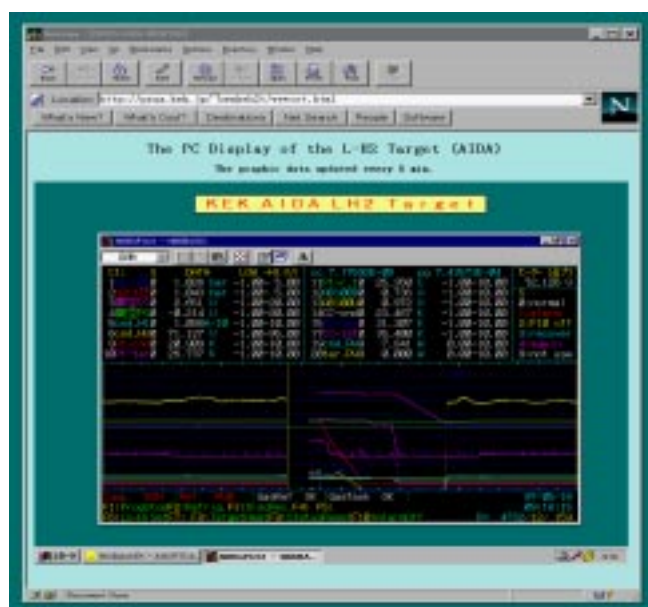


Fig. 4 PC-desktop view of the LH<sub>2</sub> target

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