ICANS XIX,
19th meeting on Collaboration of Advanced Neutron Sources
March 8 – 12, 2010
Grindelwald, Switzerland

IMPROVEMENTS OF J-PARC/MLF CONTROL SYSTEM BASED ON BEAM OPERATION

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ABSTRACT

The Materials and Life Science Experimental Facility (MLF) has been operated nearly for two years since the first neutron beam generation in May 2008. During the beam operations for commissioning and user programs, the MLF control system has been improved step by step to be matched with users' requirements on facility operations and experimental apparatus.

In the MLF building, information displays and pilot lights to indicate facility status were equipped. The MLF WEB server has been improved for useful functions in database system and easy accessibility to MLF operating status. Two types of timing signals are now being supplied for TOF measurements.

1. Intorduction

The Materials and Life Science Experimental Facility (MLF) in J-PARC has experience of almost two years' operation since first neutron generation in May 2008.[1] MLF consists of the high power pulsed neutron facility and the muon facility, aiming at proton beam power of 1 MW. At the beginning of the beam operation, the proton beam power was 4 kW. It has been increased to 120 kW in normal operation. MLF user programs were started and the number of users is expected to increase more and more.

Since MLF is an accelerator driven neutron and muon facilities, beam status relies on the accelerator operation and neutron and muon beams may stop interruptedly with unscheduled events. It is therefore important to inform the users of the beam operation status on demand.

One of the useful experimental methods to observe neutron energy is time of flight (TOF) measurement. The choice of timing signal is important for quality of the measurement.

2. Information system in the MLF

To inform the MLF users of the MLF operating status, several information displays and pilot lights were set up in MLF building. Figure 1 shows the arrangement of information displays and pilot lights.

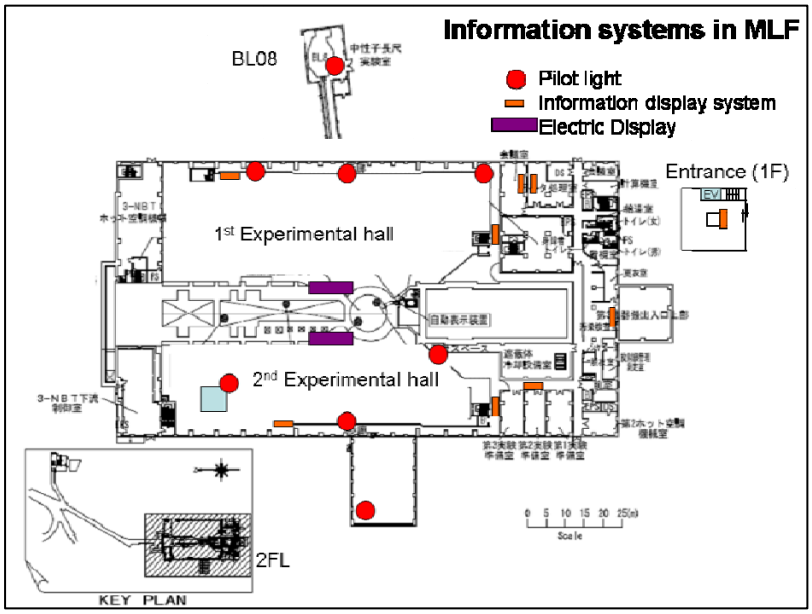

Figure 1 Layout of MLF information system.

2.1. Information Display System (IDS)

The IDS is composed of a server and nine client displays. The IDS client displays are scattered in the MLF building to inform the users of the MLF operating status. The current proton beam power, its trend, the operation status of the facilities, the status of neutron and muon beam lines and the messages from facility operators are sent to the server. This server is also connected to the J-PARC control LAN and receives real time information on the operation parameters of the accelerators.[2][3]

As shown in figure 1, the IDS client displays are located in the MLF entrance hall, the experimental halls and one of the user meeting rooms. Figure 2 shows a sample image of the IDS client display. The proton beam power is always shown on the top of the display. Other information such as beam power record, operation status of facilities, status of neutron and muon beam lines and operation schedule are displayed one after another.

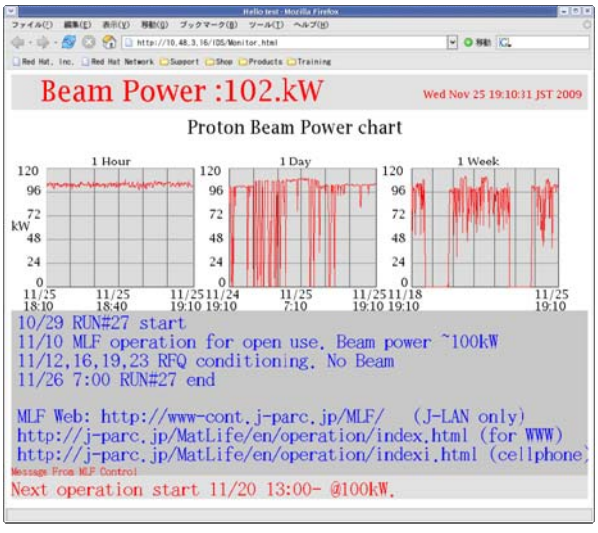

Figure 2. Image of Information Display System (IDS).

2.2. Pilot lights

In the MLF, there are several pilot lights to inform experimental users of the beam-on status. The pilot lights are placed in the MLF experimental halls to be seen from almost

all the places. The pilot lights are controlled with a server in the MLF control room. This server operates the pilot lights according to the states of the MLF and the proton beam operations. The pilot light has three colors of LED lights. A green light means that the MLF is not ready to accept proton beam. A yellow light means that the MLF is ready to accept proton beam but proton beam is off**.** A red light means beam-on. These three states are exclusive and solely one of the LED lights turns on to avoid misidentification. For example, only the green pilot light is on during the maintenance period. In the beam operation period, the red light is on when the proton beam is on and it switch to the yellow light immediately when the proton beam stops.

2.3. Large electric displays

Now MLF building is equipped with the IDS client displays. However, they are not large enough to read from a distance what they say. Then we are planning to introduce a large electric display in the experimental halls. Beam power and other information will be displayed there with very large letters so that they can be read almost everywhere in the experimental hall. The operation of the large electric displays and the messages on the displays will be also controlled from the MLF control room.

3. WEB information

In the MLF, we have several kinds of WEB services to distribute operating status to the users. The accesses to some of the WEB services are limited within the local network in J-PARC site. The others are open to Internet.

In J-PARC, there is a private LAN system called JLAN. JLAN is open to the users in J-PARC site, but can't be accessed from outside of J-PARC site. JLAN can be therefore used for MLF experimental apparatus control and experimental data analysis as well. J-PARC users are able to connect their own PCs to JLAN by applying in the J-PARC USERS office. A distinct and independent LAN is provided for controlling the accelerators and the facilities.

3.1. MLF WEB services for JLAN users

In the MLF, a variety of WEB service was provided for MLF users on JLAN. They can access the MLF WEB page (http://www-cont.j-parc.jp/MLF/) and take MLF operation data into their own PC.

The access to the pages on this WEB server is restricted to PCs on JLAN. Users can see MLF operating status, proton beam current, moderator temperature and J-PARC operation status with a web browser. The trend of proton beam current and moderator temperature record are displayed as a JPEG image. These images can be used as information display on user's PC.

Users can retrieve the proton beam current data and the hydrogen temperature data from the SQL

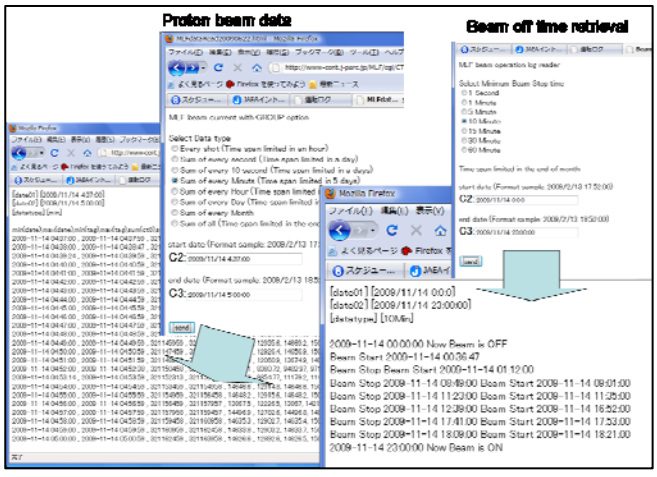

Figure 3. MLF WEB data retrieval system for JLAN.

database. Beam ON/OFF time band search and beam reliability calculation can be also done simply by accessing the page on this WEB server (Figure 3).

These images and numerical data are all accessible with Python API for data analysis system. Neutron and Muon instrument data analysis systems can be connected to this data system.

3.2. MLF WEB service for Internet

A page (http://j-parc.jp/MatLife/en/operation/index.html) that can be accessed via Internet was prepared on the MLF WEB server and J-PARC official WEB page (http://j-parc.jp) has a link to this page. This page shows only proton beam power, facility operating status, schedule and general information. Another style of page was provided mainly for the access from cellphones, showing simplified and small picture of proton beam current information. User can find J-PARC operation status with this service, wherever they are and whenever it is.

4. Timing system

In time of flight (TOF) measurement, the origin of time (T0) is important to know the particle energy precisely. Because J-PARC is an accelerator complex facility, it is driven with common timing system. With this common timing system, several kinds of timing signals are supplied from the Central Control Room (CCR) to all the facilities in J-PARC, such as 12 MHz master clock, 25 Hz clock and Rapid Cycling Synchrotron (RCS) kicker timing signal. The RCS kicker signal can be used as T0 timing of TOF measurements in MLF. Figure 4 shows the outline of the timing. The RCS kicker signal is synchronized with the timing of proton beam to MLF, since it is used to excite the kicker magnets in RCS to extract proton beam pulses for RCS to MLF. The RCS kicker timing is one of the scheduled trigger signals, which is kept running even if the beam operation stops, When the RCS kicker timing is used as T0 for TOF measurements, the measurements may be running without beams. We made therefore another timing signal system with a current transformer (CT), which is used as a proton beam current monitor for proton beam transport line. The CT signal is divided, amplified, shaped with a shaping amplifier and then sent to neutron and muon instruments. The CT timing signal is generated from real proton beam signal and quite useful to use as T0 timing by adding constant delay.

The RCS kicker timing is better for fast event experiment. The CT timing is, on the other hand, better for trigger counting experiment. MLF users can select a timing signal suitable to their measurement.

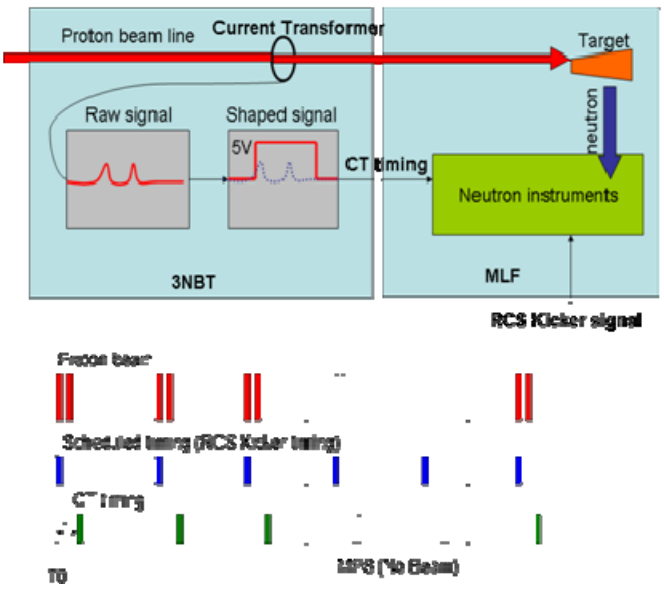

Figure 4. CT timing and Timing signal chart.

5. Summary

We have developed additional functions and services for MLF users. They can now obtain MLF operating information via Internet. From PCs on JLAN, they can even access the SQL database to get the proton beam power data and the hydrogen temperature data. These data can be used for online data analysis. Information displays and pilot lights were provided in the MLF building to indicate proton beam status.

We have started supplying two types of timing signals for T0 of TOF measurements; one is the RCS kicker signal and the other is the CT signal.

6. Reference

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