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DEVELOPMENT OF OPERATING ALARM SYSTEM AT TPS

C.S. Huang†, H.S. Wang , W.Y. Lin, T.Y. Lee, B.Y. Chen, S.Y. Perng, T.C. Tseng, C.H. Kuo and C.K. Kuan

National Synchrotron Radiation Research Center, Hsinchu, 30076, Taiwan, R.O.C.

Abstract

The Taiwan Photon Source (TPS) has many subsystems which includes magnet, power supply, vacuum, RF system, insertion device, control system, etc. Therefore, the operational and system check procedures are complex. In this paper, we summarize the routine operational procedures and propose an integrated operational alarm system that gathers machine information and sets high/low warning and fault limits for various signals which can help operators to quickly identify abnormal subsystems, thereby reducing machinery down time. The alarm system also has a wide range of applications, such as the event recording that helps the analysis after event. This new alarm system interface clearly indicates the machine status and improves operational efficiency.

INTRODUCTION

The Taiwan Photon Source (TPS) is the latest generation of 3 GeV synchrotron light source which has been under construction at the National Synchrotron Radiation Research Center (NSRRC) in Taiwan. It consists of a 150 MeV Linac, a 0.15 to 3 GeV booster ring, a 3 GeV storage ring, and two transfer lines, LTB and BTS. The TPS storage ring will provide 48 beam lines for users in the future. The storage ring has 24 DBA cells, 18 short straight sections (7m), 6 long straight sections (12m) and 2 SRFs [1]. The IDs, 7 in-vacuum undulators (IU) and 3 elliptically polarized undulators (EPU), are installed in the TPS storage ring to deliver 7 beamlines.

The EPICS (Experimental Physics and Industrial Control System) is a set of open source software tools, libraries and applications developed collaboratively and used to create distributed soft realtime control systems for scientific instruments such as the particle accelerators. The control system infrastructure of TPS is based upon the EPICS framework. [2]. The EPICS toolkit provides standard tools for display creation, archiving, alarm handling and etc.

The CSS is a collection of tools: Alarm handler, archive engine, as well as several operator interface and control system diagnostic tools[3]. Most of them deal with Process Variables (PVs), i.e. named control system data points that have a value, time stamp, alarm state, maybe units and display ranges, but they do this in different ways. One tool displays the value of a PV, one displays details of the PV configuration, while another concentrates on the alarm state of a PV.

The integrated operation of alarm systems is achieved by the use of the Control System Studio (CSS) platform and the Experimental Physics and Industrial Control System (EPICS) channel. This system displays both alarms and associated information. Figure 1 shows the network architecture of the proposed alarm system, in which the alarm triggers are process variables (PVs) in the control system, which are external to the alarm system per se. The alarm system monitors these PVs, and PVs of non-normal will trigger an alarm.

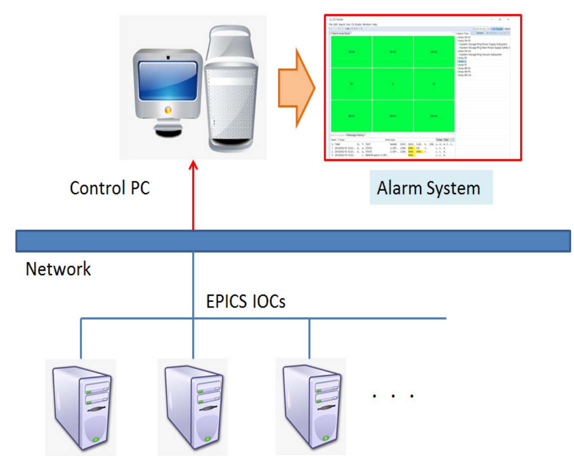

Figure 1: Network architecture of proposed alarm system.

We developed this integrated operation alarm system to help operators better manage their alarm systems. Figure 2 shows the GUI of the program, which has three parts: an alarm area panel, alarm tree, and message history function.

When a warning or a fault occurs, the system can identify any abnormal subsystems in real time. Its usage is also quite flexible and it can record the trigger time and abnormal signal information to a given event. With this program feature, operators are fully informed regarding any abnormal status of the TPS.

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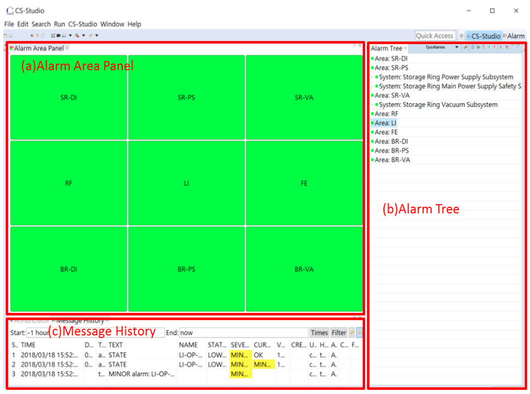

Figure 2: Operationally integrated alarm system. (a)Alarm Area Panel, (b)Alarm Tree, (c) Message History.

OPERATIONAL ALARM SYSTEM SUMMARY

The TPS system comprises a magnet, pulser, power supply, vacuum, RF system, and insertion device, etc. This system, which is more complex than earlier systems, allows operator to identify abnormalities faster by the selection of appropriate parameters as key information.

Because the warning limits and fault limits can be set for the Reading Value of each process variables (PVs) signal, and all signals are scanning once per second. Therefore, when the reading value begins to deviate from the baseline but has not caused a system abnormality, which can help to find problems before event. The old operation alarm system will display an abnormal system item when the system has failed.

Figure 3 shows the alarm area panel of the program, in which PV signals are classified into nine categories. When a warning or a fault occurs in a subsystem, the main area will change color from green to yellow or red, which helps the operator to quickly and accurately identify abnormalities.

Figure 3: The Alarm Area Panel of alarm system.

The program's alarm tree shows details regarding the PV signals, as illustrated in Fig. 4. There are hundreds of possible PV signals in the nine alarmtree categories, each of which have upper and lower warning limits and upper and lower fault limits. As such, the program helps operators to identify abnormalities early in the routine operation. For future operation requests, signal information can be easily modified or new PV signals added to the alarm tree. As such, this program enables easy adaptation to new system settings and modifications.

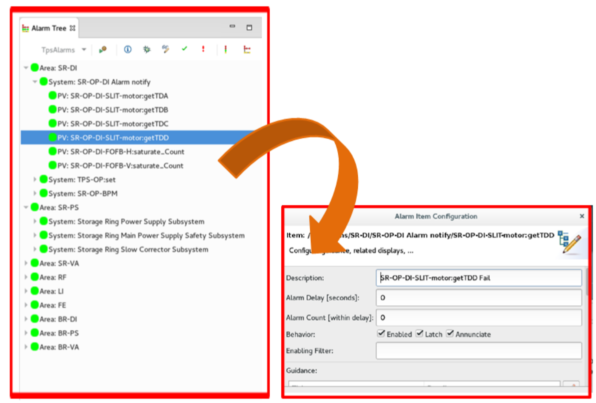

Figure 4: The Alarm tree of alarm system.

Figure 5 shows the message history function of the program. When an event occurs, this function records relevant information, including the triggering value, signal name, and triggering time, which helps operators to quickly to identify abnormal systems. Because the old operation alarm system has no record function and cannot search the history of abnormal events and the new program has a record function, start and end times can be set to help operators search for historical event information, which is also helpful for later analysis.

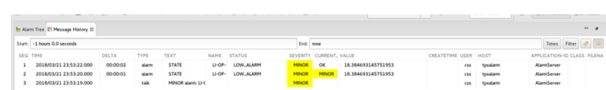

Figure 5: The message history function of alarm system.

When a fault occurs in the old alarm system, the operator need to go through the inquiry to know the abnormal detail of the subsystems. Now the new system can find the abnormal detail directly. As shown in Fig. 6, we can directly find the fault is power supply and the abnormal power supply is S6192 by the new alarm system.

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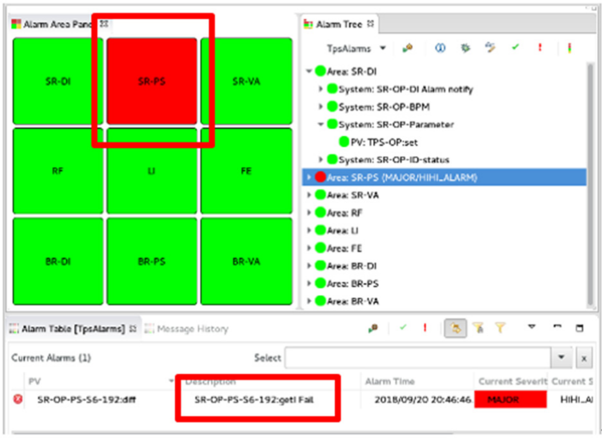

Figure 6: Fault of the alarm system.

The system occurs abnormal in a short time (Reading value exceeds the upper or lower limits) and then return to normal, which is difficult for operator to find the abnormal event. It is now possible to find the abnormal system's name、time and reading value by this alarm system. As shown in Fig. 7, when a warning occurs and then return to normal, we can still find the information that is Linac RF Modulator-3 High voltage dropped to warning limits and the abnormal voltage is 18.22kV.

Figure 7: Warning of the alarm system.

The key program features are as follows:

1. Checking that the currents of the linac to booster (LTB), booster to storage ring (BTS), and storage ring (SR) power supplies are within specification, so that any abnormal power supply can be detected in real time.
2. Checking that the vacuum valves are in the park position.
3. Checking that the electron beam stopper is in the park position.
4. Checking that all screen monitors are in the park position.
5. Checking that the LTB slits and BTS scrapers are in the park position.
6. Checking the readiness of the BR and SR pulsers' high voltage for operation.
7. Checking that the highvoltage power supply (HVPS) of the E-gun and linac modulators are normal.
8. Checking that the vacuum condition is within its limit.
9. Checking that the status of the machine protection system (MPS) interlock, including the orbit interlock, frond-end emergency interlock, and vacuum pressure is ready for operation.
10. Checking the key beam position monitor (BPM) value to identify any abnormal BPM or orbit for the beam orbit interlock.
11. Checking the EPU feed forward tables (CFF、TFF) are ready for operation.
12. Monitoring and display of some key parameters if the parameter changed during the user's time period.

CONCLUSION

In this report, we summarized the routine operation and proposed a new operational alarm system, which completely integrates various PV signals and sets high/low warning limits and high/low fault limits. When a warning or fault occurs, the color of main monitor area changes, thereby advising the operator that a subsystem is functioning abnormally.

The program facilitates the identification of abnormal system statuses. Information regarding an abnormal system status can be recorded by the message history function, which is very helpful in the subsequent analysis of abnormal events.

The proposed operational alarm system can help operators to quickly identify abnormal subsystems prior to the occurrence of an event, thereby reducing machinery down time and increasing operational efficiency.

ACKNOWLEDGE

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[2] EPICS: http://www.aps.anl.gov/epics/index.php.
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