DEVELOPMENT OF INTELLIGENT ALARM MESSAGE SYSTEM AT TPS

C.C. Liang†,T.C. Yu, C.S. Huang, T.Y. Lee, Sam Fann, C.H. Chang, Y.C. Liu, Y.S. Cheng, Jenny Chen, I.C. Yang, Y.C. Lin, C.H. Chen, M.S. Chiu, F.H.Tseng, J.Y. Chen, C.C. Kuo, and H.J. Tsai
National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan, R.O.C.

Abstract

The traditional alarm systems usually set high/low limit for various signals. When the acquired values exceed the limits, the alarm system would be activated. The proposed system in this article can focus on various possible events with their corresponding signals for response judgments. During alarm calling period, data can also be announced and recorded. The system can also monitor various events according to different time shifts. Integrating LabVIEW, mobile phone, AT-command and Bluetooth communication, the system can handle factory broadcast, sending E-mail and SMS message. The above sound and text messages can be set directly at the home-made software interface. The new intelligent alarm system can eliminate the procedure made by man with the added event recording, system stability improvement and debugging function in wider application fields.

INTRODUCTION

Taiwan Photon Source (TPS) has achieved its phase-I commission of stored 100mA beam current in May, 2015. After the installation of SRF cavities and 10 sets of Insertion Devices before Sep., 2015, the phase-II commission started. During phase-II commission, there was a vacuum problem happened at No.2 cell of vacuum chambers. After replacing with a new vacuum chamber, the goal of 520mA stored beam is achieved. In March, 2016, beam line starts open to the invited users [1].

During system commissioning, various alarm systems, interlock systems and feedback systems for each sub-system was built by each group, such as the TPS radiation accumulation dose is limited to be under 2μSv/4hrs. Once the accumulated dose exceeds this limit, the E-gun of Linac would be locked till next operation shift. Separate interlocks are also provided by each group, like Instrumentation and Control Group, Magnet Group, Utility Group and Vacuum Group etc. Before running the accelerator, the operator needs to check and unlock each sub-system. When a trip or fault happens, finding out which sub-system trips first and how many events are affected is thus necessary to know the actual faulty source. Therefore, an Intelligent Alarm Message System is proposed and implemented and the network architecture of the system is shown in Fig. 1. The system is expected to be helpful for operators to manage the system much better.

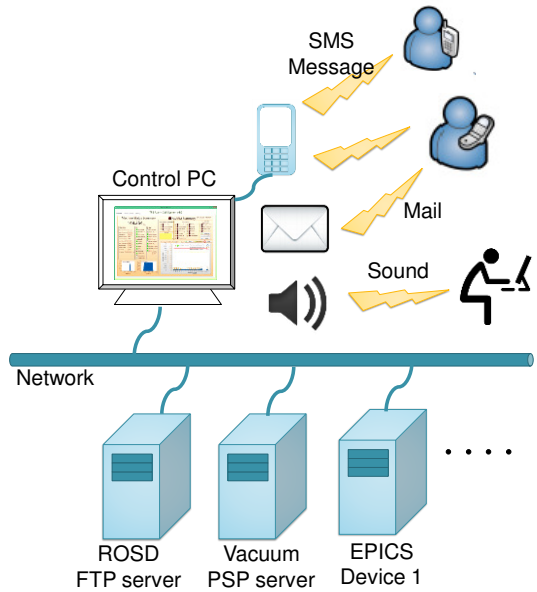

Figure 1: Network architecture of the proposed Intelligent Alarm Message System.

TPS OPERATION SUMMERY

TPS is a larger accelerator with several times of components quantity than those in Taiwan Light Source (TLS). The system is also more complex. For operator to master the system status faster, picking up proper parameters and signals as key information is quite important. The GUI of the program is shown in Fig. 2. The picked signals are as following:

1. The key status of TPS: including time, operation mode, storage ring current, beam lifetime, beam size, RF frequency, tune, mode of E-gun etc.
2. The status of SRF system: TPS storage ring has two sets of SRF module. One or two would be in operation depending on the required beam current. When switching the SRF system in remote mode, the SRF system would be in operation. If the SRF is in off-state for beam, it must be switched to local mode and detune the resonant frequency of the cavity.
3. The status of IDs: There are 10 IDs (insertion devices) in TPS at present. Since the synchrotron light radiated by the ID has strong power as the gap of IDs are closed. Before dumping beam current, operator and control system must check if all the gap of IDs are opened, especially those In-vacuum Undulators.

† changeliang@nsrrc.org.tw

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4. The status of feedback system: The present on duty feedback system in TPS is fast orbit feedback (FOFB) with independent and separate beam control in horizontal and vertical directions to stabilize beam orbit in high current. Another bunch-by-bunch feedback system is used for suppressing instability resulting from any perturbation. This feedback must be turned on during user time shift.
5. Interlock (ILK) System: The interlock of beam orbit can be divided as position and angle types. This must be activated as beam current high than 30mA. This interlock has passed functional test and the position type orbit interlock is used in user time shift. The activation of this kind of interlock can be determined by operator. Other system protection interlocks, such as vacuum, radiation dose and temperature, are work in routine operation.
6. Radiation dose distribution: The restriction of radiation dose in TPS is under 2μSv accumulation in 4 hrs. Once the dose rate exceeds this limit, safety would disable the usage of E-gun till next machine shift. There are 19 detection points outside shielding wall for measuring gamma and neutron respectively. These two kinds of radiation dose would be sum together and displayed in blue bar as instant radiation dose rate and red bar as accumulation radiation dose rate at their pick up points. There is also a map with detectors distribution on it. By the map and the corresponding dose rate, the operators can decide the machine operation mode as well as adjustment of parameters accordingly.
7. Filling pattern: The operation status of booster and storage ring can be clearly known by filling pattern graphs.

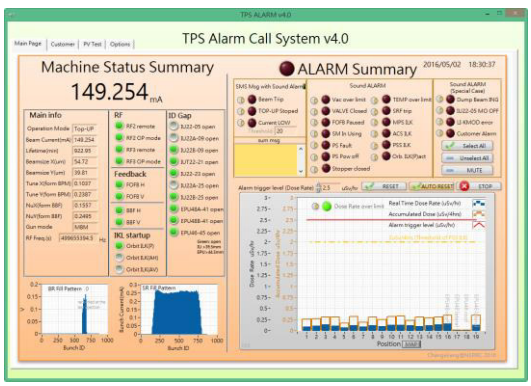

Figure 2: TPS alarm call system.

TPS ALARM SUMMERY SYSTEM

This system integrates the alarm messages of each TPS sub-systems and the frequent used messages. The signals can also be added manually. The integrated alarm messages are shown in Fig. 3. The signals source can be divided in three types:

1. EPICS protocol
2. NI PSP protocol
3. FTP protocol

Most signals can be acquired from the EPICS system built by Instrumentation and Control Group. Which signal would activate alarm is decided by this alarm system.

Since the vacuum and temperature of vacuum chamber is quite important, this system can also receive the data of the shared database from Vacuum Group which is also built by Labview.

The radiation dose relating signals are acquired directly through FTP protocol from Radiation and Operation Safety Group.

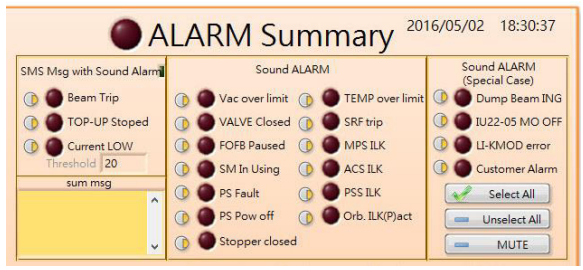

Figure 3: The integrated Alarm messages by Alarm Summary System.

The classification and function of Alarms

The classification of Alarm can be divided in three types according to its notifying methods.

1. The critical and important messages: can notify people by SMS messages as well as on-site broadcasting and E-mail messages.
2. General messages: having on-site broadcasting voice and E-mail messages.
3. Special messages: set for special purpose and have on-site audio and E-mail messages.

All alarms can be disabled by pressing corresponding button. The scan period is about 2 seconds.

The items are explained below:

1. Beam trip: Once the reading value of storage ring beam current drops by 20mA for twice, it would be seen as beam trip.
2. The termination of TOP-UP: Send messages when TOP-UP is terminated. Several machine status would terminate TOP-UP, such as the trip of SR PS.
3. Current Low: When the stored beam current lower than the setting value
4. Vac. over limit: When the vacuum condition becomes higher than the settings
5. VALVE closed: Vacuum gate valve is closed
6. FOFB Paused: FOFB (fast orbit feedback) is normal in ON or OFF states. The paused state is abnormal.
7. SM in Using: The Screen monitors did not pull up at LTB (Linac to booster), BR (booster), SR (storage ring) BTS (booster to storage ring) or beam line.
8. PS fault: when there is any error message by any power supply.
9. PS Pow. off: When there is any power supply is turned off.
10. Stopper closed: the beam stopper located at LTB is not pulled up

11. TEMP over limit: The temperature of vacuum chamber gets higher than warning value. Keeping 15 minutes would turn off SRF system.
12. SRF trip: when SRF system is in remote control status but not in operation mode.
13. MPS ILK (machine protection system interlock): includes orbit interlock, front-end emergency button pressed, poor vacuum pressure
14. ACS ILK: Access control system is activated
15. PSS ILK: radiation dose higher than 2μSv/4hrs
16. Orbit ILK (P) act.: when the running orbit interlock is triggered, the SRF system would be turn off.
17. Dump Beam ING: As SR kicker is triggering and SR septum is turned off, this would be seen as dumping beam. ID gap needs to be opened and checked immediately when there is warning.
18. IU22-05 MO OFF: The motor of IU22-05 was frequently and unexpectedly turned off recently. The reason is still under inspection. This alarm would notify operator to help the user to turn on the motor.
19. LI-KMOD error: The modulator HVPS would trip accidently. This message can remind operator to reboot it.
20. Customer Alarm: The alarm to be custom set. The main setting is shown in another page.

The setting of Custom Alarm

The setting of Custom Alarm is to satisfy the temporary and emergent requirement. The type of alarm can be numerical or true/false status as shown in Fig. 4.

Numerical type is using high/low limit as judgment; the status type can be divided in two types

a: correct status. Once the reading status is not the same as correct status, the system will alarm

b: wrong status. As the reading status is the same as the wrong status, the system will alarm.

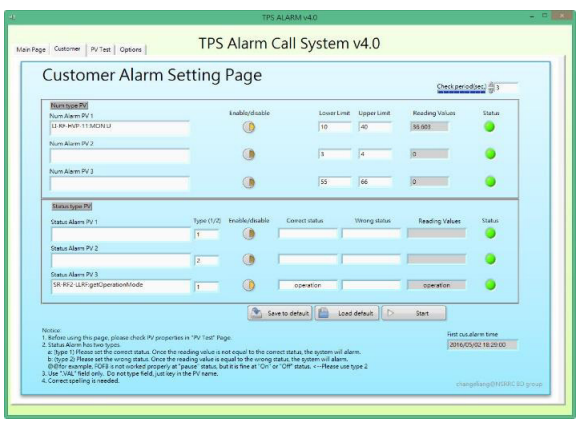

Figure 4: Custom alarm setting page.

The setting and feature of SMS message

This system adopts general and commercial available mobile phone (NOKIA 2730) as telecommunication media by the AT-command executed on PC which is low cost and easy to setup. The transmission interface could be general USB cable or Bluetooth interface. Since there is text length limitation for SMS message, text stream would be checked first before sending out. If the text length is too long, briefer description will be preceded. The message would contain the time of first triggered event and the relating signals. Multiple receivers can be set. The alarm message will be sent immediately, 5 minutes later and 10 minutes later, respectively. When system is recovered, the machine recovered message will also be sent. The program can also detect the status of data base network. When the data base network is abnormal and cannot acquire signals, SMS message would also notify system administrator. Sending test messages by user at any time is also applicable.

SUMMARY

Intelligent Alarm Message System has completely integrated various sub-system interlocks with the corresponding alarm messages accompanying the notification methods such as SMS messages, audio/voice and Email. The usage is also quite flexible and can record the triggered time and signal name of that event. The recovering of the system can also have notification and recording. With such smart feature of the program, the abnormal status of TPS can be easily identified by operators.

ACKNOWLEDGEMENT

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REFERENCES

[1] C. C. Kuo et al., “Commissioning of the Taiwan Photon Source” , Proc. IPAC. 2015, TUXC3, p.1314.

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