

# RF DATA ACQUISITION AND SOFT ALARM SYSTEM FOR THE TAIWAN PHOTON SOURCE

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## Abstract

The Taiwan Photon Source (TPS) is a modern, high brightness 3 GeV light source. A data acquisition program for the radio frequency (RF) system, including a transient data recorder, a long term data archiver and real time data monitoring, has been developed for the analysis of RF trips and RF system debugging. A soft alarm system is implemented as well utilizing EPICS and python packages. The hardware architecture and the functionality of the RF data acquisition and soft alarm system will be discussed in this article.

## INTRODUCTION

The Taiwan Photon Source (TPS) at the NSRRC is a third generation light source operating at 3 GeV electron energy. In order to provide high quality light for users, the reliability of the RF system is of great importance. The data acquisition (DAQ) systems, including post-mortem system, long term data archiver and real time data monitoring, are powerful tools for beam trip analysis and system debugging. Transient data recorder, archive viewer, and trend plots are the three main application programs that can be used to analyse weak points of the RF system and thus improve the reliability of the TPS [1, 2].

A soft alarm chatbot system, based on LINE's Message API [3], is implemented to inform personnel of abnormal operating conditions. This system can prevent RF trips caused by the gradual change of operating parameters, such as the temperature of cooling units, water flow rate, etc. For convenience, notification and query functions are included in this chatbot system as well. When an RF trip occurs, RF personnel will receive a trip alert with its related signals and first trip diagnostics information from this soft alarm chatbot. Further specific information can be obtained through an interactive user interface.

The hardware architecture of the RF DAQ system, the design and the implementation of the soft alarm system are reported in the following sections.

## HARDWARE ARCHITECTURE

The hardware architecture of the RF DAQ system for the TPS uses the same structure that was used for the SRF horizontal tests [1]. There are three TPS RF stations: the RF for the booster ring and the storage ring SRF stations 2 and 3. There is a DAQ rack at each RF station. Figure 1 shows the hardware layout for the DAQ rack. All analog signals are collected in the junction box and distributed to the digitizers. Signal buffers are placed between the junction box and digitizers to avoid any impedance mis-

match. Four digitizers are used for the EPICS IOC to collect historic data at a slow sampling rate of up to 1 kHz and one digitizer is used for the transient recorder with a sampling rate of up to 250 kHz.

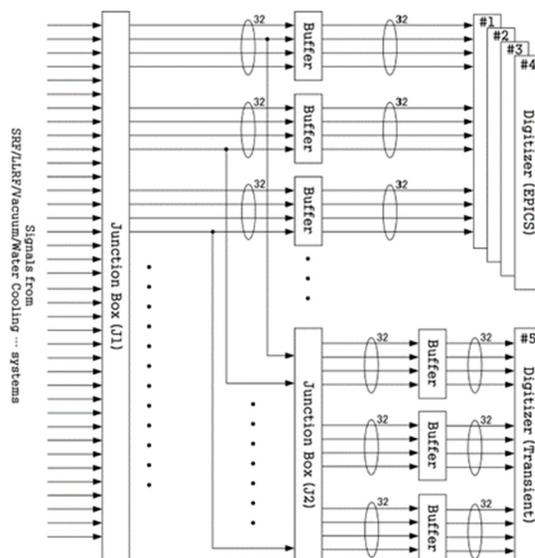


Figure 1: Hardware architecture of the DAQ rack.

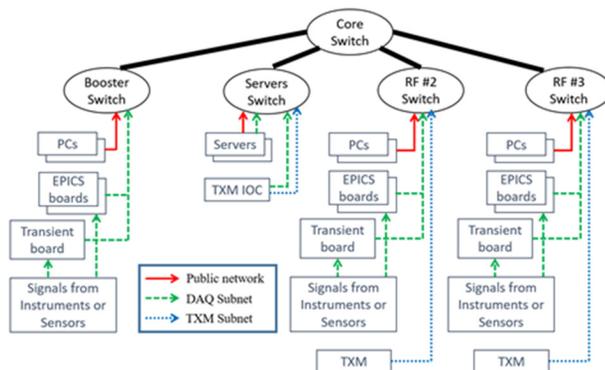


Figure 2: Network topology of the RF area.

Figure 2 shows the network topology of the RF area, including three RF stations and the server room. There are three categories in the RF area network: public area network, DAQ local area subnet and transmitter (TXM) control subnet. Most of the EPICS IOCs send the processing variable (PV) information to the DAQ subnet and users from the public network can obtain these PVs from the servers which are connected to both DAQ subnets and the public network. There is a local network switch in each station and all of them are connected to a core switch.

The information of the transmitter status can be connected to an EPICS IOC via the S7PLC EPICS driver [4].

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Interlock status signals for the SRF system are collected from Fatek programmable logic controllers and are sent to the network by an EPICS soft IOC [1]. All PVs on the DAQ network are available for many application functions such as post-mortem, long term data archiver and real time data monitoring as well as the soft alarm system.

### APPLICATION FUNCTIONS

There are three main application functions for the TPS RF DAQ system: transient data recorder, archive viewer and trend plots. Figure 3 shows the information from the transient data recorder. It can display important signals with a high sampling rate of up to 250 kHz for a trip event and diagnostic information for the trip source. Figure 4 shows information from the archive viewer recording long term data with a 1 to 10 Hz sampling rate. The trend plots as shown in Figure 5, are used to monitor real time data like those obtained during the slow cool down process of SRF modules. Design details for these functions can be found in [1, 2].

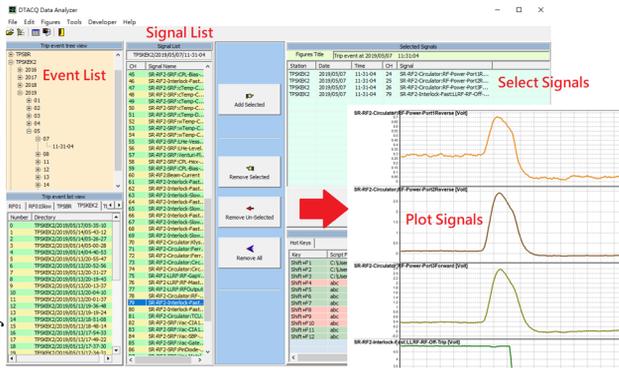


Figure 3: Display from the transient data recorder.

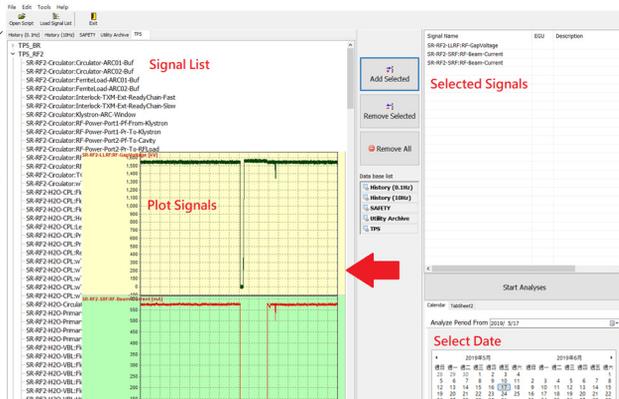


Figure 4: Display from the archive viewer.

### SOFT ALARM SYSTEM

Figure 6 shows the architecture of the chatbot based soft alarm system, which has three functions: machine status warning, trip alert and signals inquiry. This system is developed by python, pyepics and the LINE message API. It uses a similar architecture that is used at TPS frond-end systems [5] and the details of the chatbot application can be found there as well.

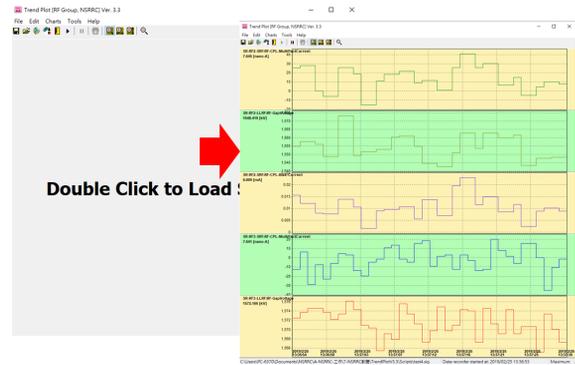


Figure 5: Example of trend plots.

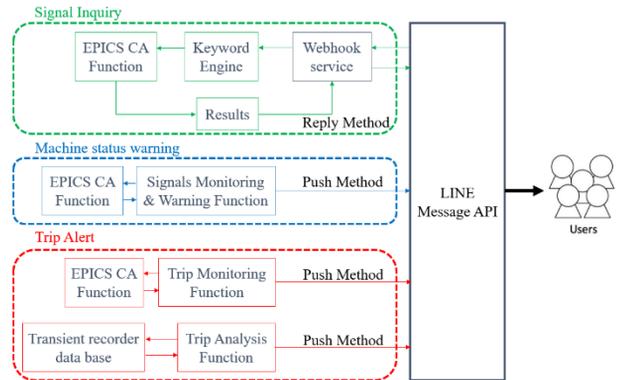


Figure 6: Chatbot architecture.

For the RF soft alarm chatbot warning function, some important signals can be monitored via the EPICS channel access and can sent out warning messages to users by the LINE message API push method when these signals become abnormal. Users can inquire for more information about these signals by sending keywords to the soft alarm chatbot. The chatbot will get the signal values for these inquiries through the EPICS channel access and sends the results back to users through the LINE message reply method. Figure 7 shows a screen shot of the chatbot for warning and inquiry functions. For more convenience, a rich menu, button and carousel templates are used for the inquiry system [6]. Users only need to click buttons to obtain signal parameters.

The RF system can be tripped for many reasons, such as SRF ready chain (due to SRF related signals), beam dump signal (due to accelerator machine protection), RF power reflection trip signals etc. To get quick RF trip diagnostics results, a trip alert function is included in the soft alarm chatbot system as well. The PVs of the SRF interlock status are monitored by the trip alert function. If one of the SRF ready chain interlocks was triggered, the alert function would send out the trip summary to users, including all the triggered signals from the SRF ready chain modules and the indicator signals from the first trip module. The status of the transmitter is also checked when an SRF trip occurs. If the status of a transmitter is not in the correct state, the soft alarm chatbot would send out the status of the transmitter as well.

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To cross-check for the trip reason, the status of the transient data recorder is also monitored by the trip alert function. If there is a new trip event found in the data base of the recorder, a simple trip analysis process based on the signal time sequence will be applied to the new trip event and the results will be sent to users.

Figure 8 shows two trip messages sent out by the alert function. For the plot on the right side of Figure 8, the RF system is tripped by a beam dump signal and there is no SRF ready chain triggered. Only trip analysis results from the transient data recorder are sent. Machine learning techniques will be applied to this function in the future.

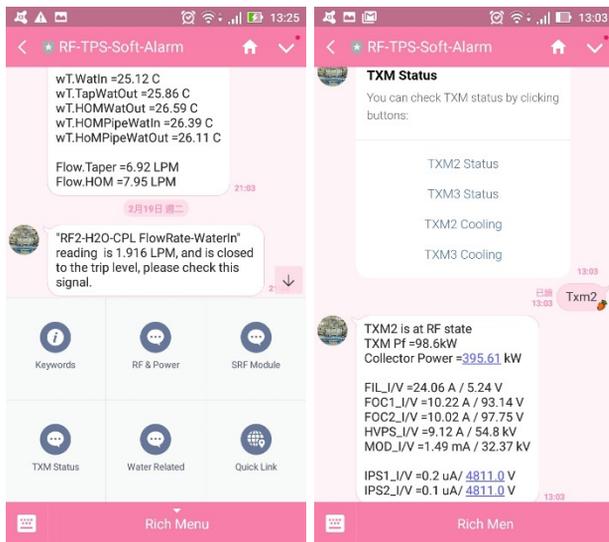


Figure 7: Screen shot of the chatbot for warning (left) and inquiry (right) functions.

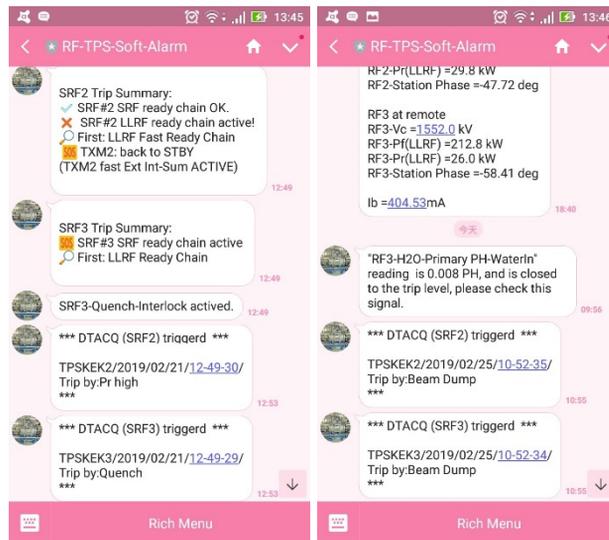


Figure 8: Screen shot of the chatbot for the trip alert function.

## CONCLUSION

The data acquisition and its applications of the RF system are developed to analyze weak points of the RF system and to improve the reliability of the TPS. A chatbot

based soft alarm system, including machine status warning, trip alert and signal inquiries are implemented as well. Through this soft alarm chatbot, users can easily receive information and warning about the RF system on their smart phone. Other advanced functions such as machine learning based trip analysis, dashboard functions can be applied in this soft alarm chatbot in the future.

## ACKNOWLEDGE

We thank the NSRRC vacuum group for useful information about the LINE chatbot.

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