

DEVELOPMENT OF POST-MORTEM VIEWER FOR THE TAIWAN PHOTON SOURCE

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Abstract

The Taiwan Photon Source (TPS) is a 3-GeV third-generation synchrotron light source located in Hsinchu, Taiwan. The post-mortem (PM) system is act as an important tool to diagnostic the cause of trip events caused by beam loss. A MATLAB-based and web-based viewer were developed to plot and view the each event to understand the cause and effect of the event. The post-mortem viewer architecture and implementation were presented in this report.

INTRODUCTION

The TPS is available for user service. During the operation, inevitably there will be unexpected beam trips due to subsystem failure or other abnormal circumstances. Some of the subsystem interlocks, like the BPM orbit (position and angle), vacuum, front-end and beam line interlocks need to shut down the RF system for machine protection. It is possible to find out the reason for such an event by using the beam trip post-mortem (PM) system. The PM system can record the relevant signals from the subsystem when a beam trip occurs. It also can automatically generate beam trip reports and perform a simple analysis of the recorded signals to give possible event identification. So far, typical beam trip events include RF trips, sub-system interlock trips, and spontaneous kicker firings. Several trip scenarios can be found in reference [1]. A MATLAB-based and web-based viewer were developed to plot and view the each event to understand the cause and effect of the event. The MATLAB-based viewer has the full functionality to display the data. The web-based viewer allowing for a quick review of the trip event through the web browser. The post-mortem viewer architecture, plans and implementation were presented in this report

SYSTEM DESCRIPTION

The architecture of the TPS PM system is shown in Fig. 1. The system includes the beam trip detector, EPICS embedded standalone data recorders, data storage server and viewer. The main system features are the following: generate a trigger signal to data recorders when the stored beam current is lost abnormally; record relevant signals to server when a beam trip occurs; view the report from the GUI tool or web browser to analyze each event for cause and effect. The data storage server is used to store PM data and generate report, and provides FTP and HTTP services for PM Viewer and web page access. The report generator process is used to create an html file format report and writes the event description to the database for web page access. The flow char of the save program is shown in Fig. 2. A complete overview can be found in reference [2].

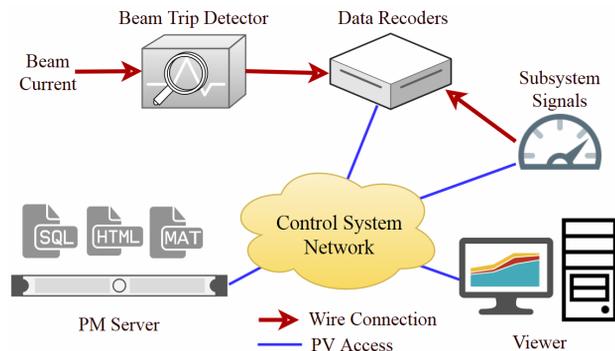


Figure 1: Schematic layout of the TPS PM system.

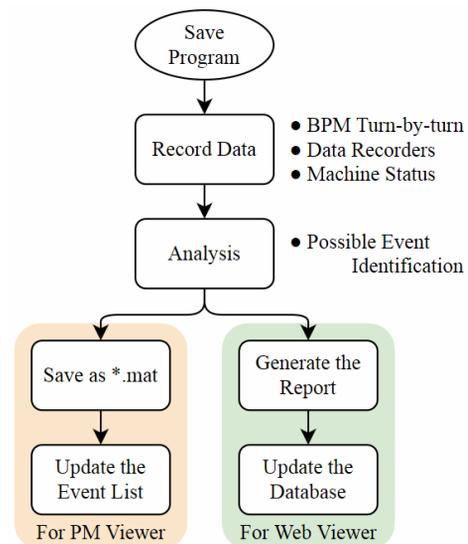


Figure 2: Flow char of the save program.

POST-MORTEM VIEWER GUI

PM Viewer

The PM Viewer GUI is designed to list and plot beam trip events and the graphic user interface is developed with the Matlab's GUI-building tool (Graphical User Interface Development Environment, GUIDE) as shown in Fig. 3. It can list the beam trip event with a simple note and provide a signal list check box to select for display the desired data, which can be downloaded from the server using the FTP protocol. The flow char of the plot function is shown in Fig. 4. Figure 5 shows that the vacuum interlock is active during 400 mA operation. The RF system is shut down within a few milliseconds. Finally, the BPM position interlock is active. Some kickers were unexpectedly fired without system trigger signal, causing an instant loss of the electron beam, as shown in Fig. 6. A customized toolbar can provide simple data adjustment functions as shown in Fig. 7.

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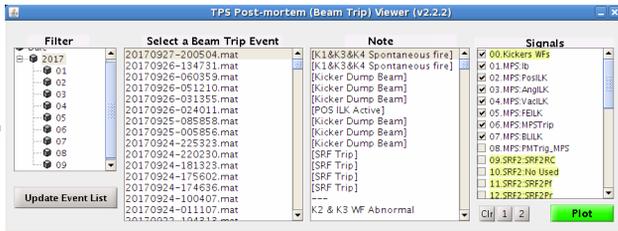


Figure 3: Main page of PM viewer graph user interface.

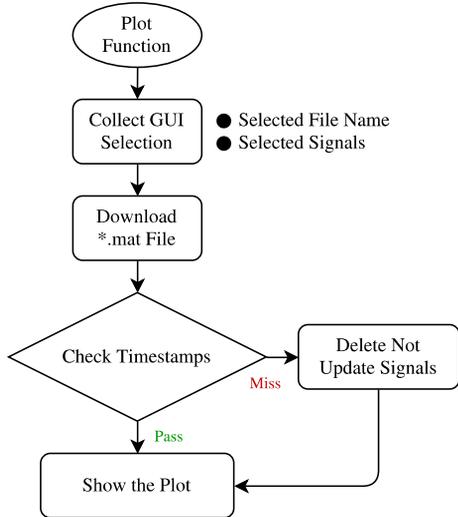


Figure 4: Flow char of the plot function.

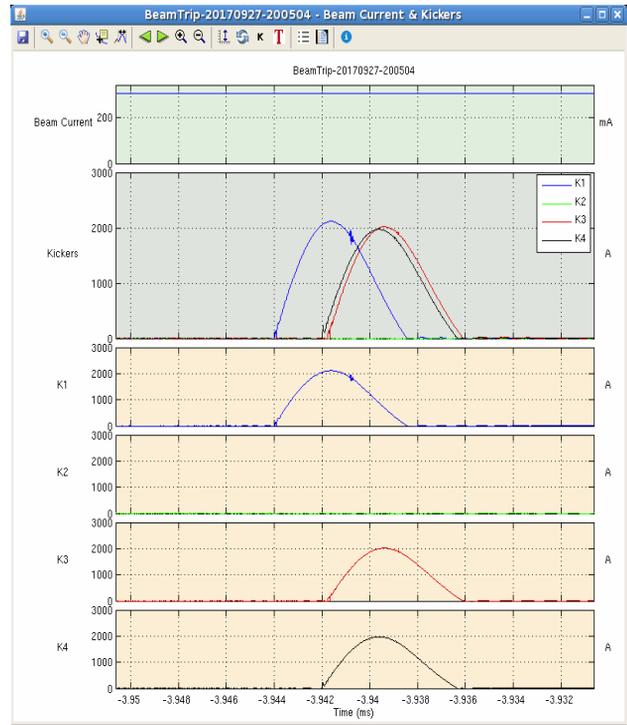


Figure 6: Kicker waveforms during spontaneous fired kickers K1, K3, and K4 while the K2 is misfired causing a beam trip.

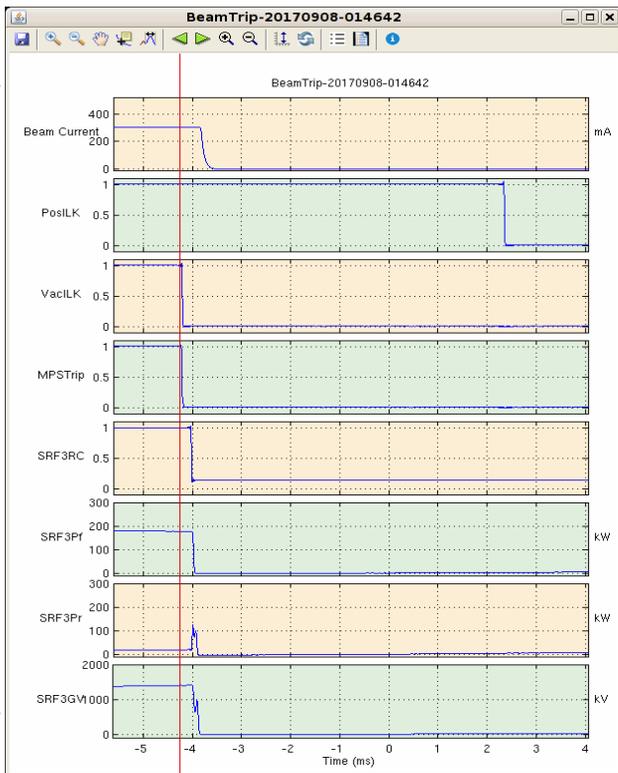
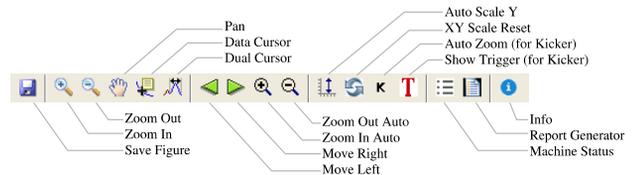


Figure 5: Plot page of vacuum interlock event. PosILK: position interlock, VacILK: vacuum interlock, MPSTrip: machine protection system sum trip, SRF3RC: SRF#3 ready chain signal, Pf: forward power, Pr: reflect power, GV: gap voltage.



(a)



(b)

Figure 7: (a) Text description of the toolbar. (b) Demonstrations of the data cursor and dual cursors functions. The data sampling point will be displayed, when the x-axis is zoom in into a certain level.

Web-based Viewer

The web-based viewer of the beam trip report is designed to list and view beam trip events. The main page is developed by the Python/Django [3] tool with SQLite database as shown in Fig. 8. It can list a beam trip event similar to the PM Viewer GUI, but only the prepared report can be read. As shown in Fig. 9, the report is generated from the report generator immediately or from the PM Viewer GUI later (regenerate).

The report contains the information including the timestamp of the trip event, note, beam current, kicker waveforms, subsystem interlock waveforms, history of the beam current, and machine parameters. This web-based interface is useful to quickly review a trip event by any device through the web browser.

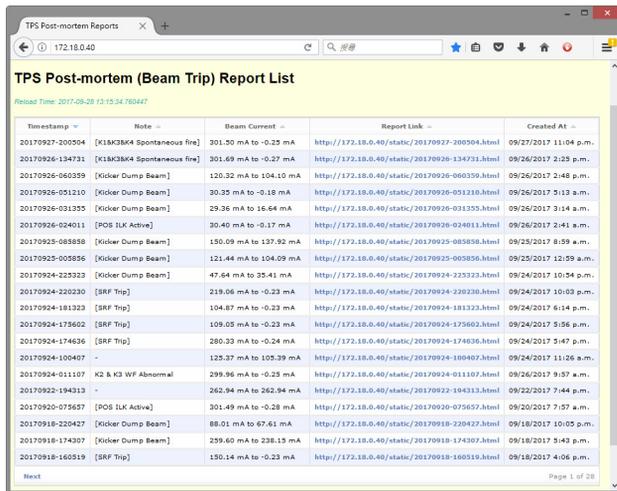


Figure 8: Web interface of TPS beam trip report list.

SUMMARY

The post-mortem (PM) system is act as an important tool during normal operation to diagnostic the cause of beam loss trip events. Reliability and availability of the TPS operation improved significantly with the help of this beam trip diagnostics. A MATLAB-based PM Viewer and web-based viewer were developed for the operators to check the each event. We are considering adding more useful signals. The features of the viewer are also continually being improved and developed with the feedback of the users.

REFERENCES

- [1] C. Y. Liao *et al.*, “Post-Mortem System for the Taiwan Photon Source”, in *Proceedings of IPAC2017 (MOPAB125)*, Copenhagen, Denmark.
- [2] C. Y. Liao *et al.*, “Beam Trip Diagnostics for the TPS”, in *Proceedings of IBIC2017 (WEPWC07)*, Grand Rapids, Michigan, USA.
- [3] Django, <https://www.djangoproject.com/>.

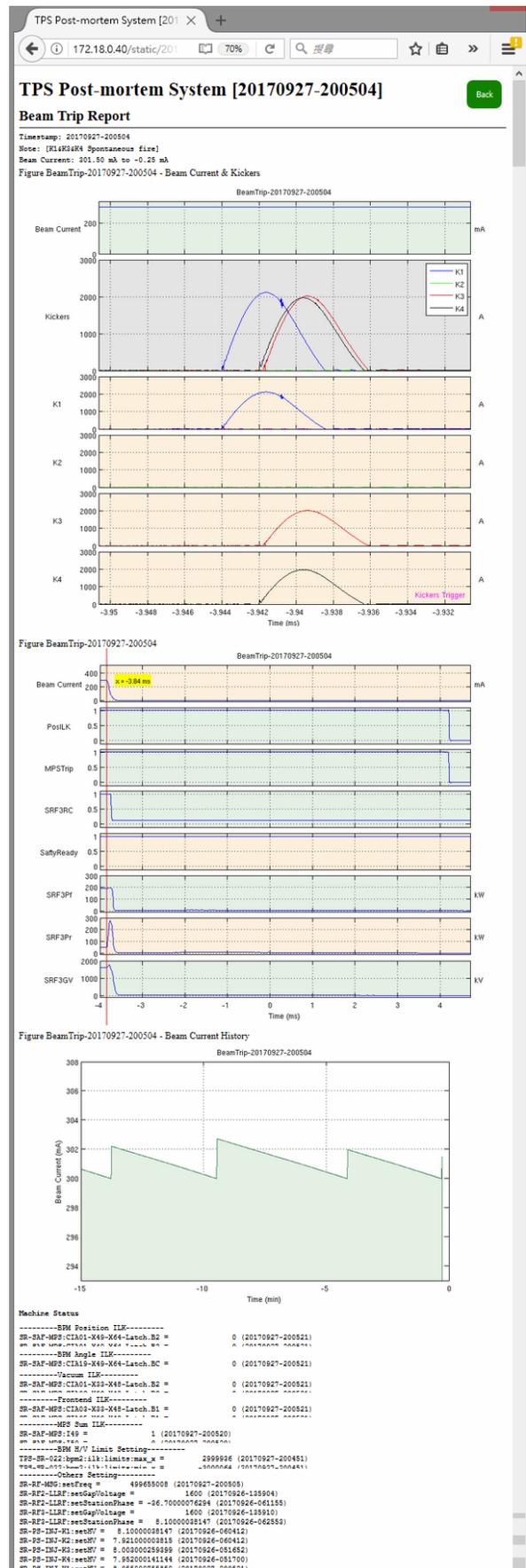


Figure 9: Web page of beam trip report.