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ANALYSIS AND DIAGNOSTIC TOOLKIT FOR OPERATION EVENT IN THE NSRRC

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Abstract

Taiwan Photon Source (TPS) and Taiwan light source (TLS) have been operated in the same time. TPS is a 3 GeV electron energy, 518 m circumference, low-emittance synchrotron storage ring which will offer one of the synchrotron x-ray sources, provide cutting-edge experimental facilities and novel multidisciplinary scientific research. TLS is a 1.5 Gev electron energy. The control system is difference between two facilities. Amount of instruments and devices these must be monitored and controlled by operator. The difference diagnostic tools will be difficult to operate and analysis between two system. These utility toolkits are effective to reduce operator loading. However, these tools are developed with same concept, combined with two difference machine is effective and reduce maintenance efforts. These applications of software will be reported in this conference.

INTRODUCTION

TLS is a small, state-of-the-art and compact synchrotron radiation facility featuring with adapted energy for users. This machine are still operated and supported with high reliability and stability beam quality. The operation performance is shown in the Fig. 1. The schedule user time is more than five thousand hours. The user availability is 98.7%. The beam time between fail (MTBF) is 365.8 hours. For this operation request, alarm in advance and analysis after event, it must be quickly found out and solved to avoid same event again in the next time [1]. The TPS is opened for users from 2016. The operation time includes of user time, sub-system commission and beamline commission. It isn't only for users. The schedule user time is 4479 hours in the 2018. Thea beam availability is 99.2%. The MTBF is 93 hours. There are many events are processed in the short time. But it still 48 times trips. In the 2019, the statistics are until August. The operation performance is shown in the Fig. 2. Amount of signals analysis follow trip that are heavy duty in the TPS. For specially, large scale signals of TPS are more than TLS. The utility are developed to scan signal automatically and find sub-system problem after event that are necessary in the big data analysis. Following subsystem from beam trip event and statistics are to classify signal that is effective to reduce searching time and CPU loading [2].

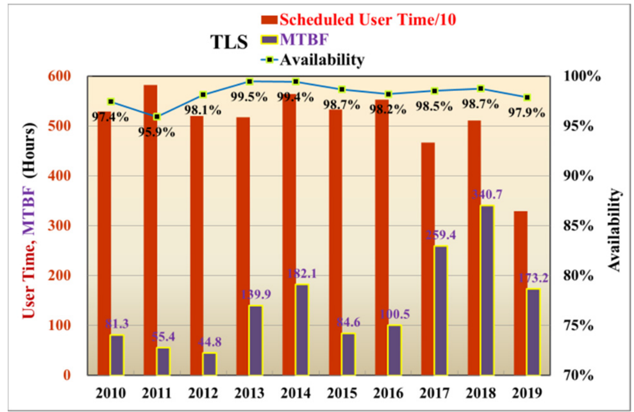

Figure 1: Annual operation statistic of TLS.

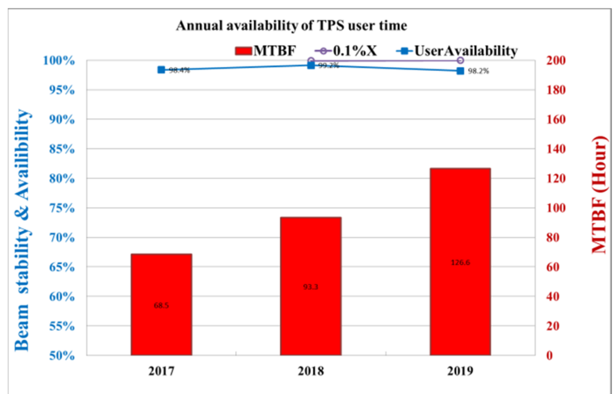

Figure 2: Annual operation statistic of TPS.

TLS BEAM OPERATION EVENT AND ANALYSIS UTILITY

In 2006, the super conductivity RF cavity system is installed in the storage ring. The main trip rate is contributed in the beginning operation of this system. In 2011, TLS is operated in 360mA topup from 200mA. Meanwhile it is always aimed to improve the performance of facility as indicated by availability, mean time between failures (MTBF) and beam stability index. Availability is defined as the ratio of delivered user time to the scheduled user time; MTBF as the ratio of scheduled user time to number of faults. After 2012, digital bunch by-bunch feedback systems were working. There are many instability are reduced. The storage ring reliability is improved to stable status. The annual beam trip statistics are shown in the Fig. 3. In the 2015, there is some new power amplifier configuration problem of bunch-by-bunch feedback system in the beginning operation. After 2016, everything is solved. The MTBF is up very much. However, there are

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some beam trip are noticed in the 2019 with long and stable operation. It is still 14 times beam trips until August. The most events are relative to injection system. The sub-system event statistic is shown in the Fig. 4.

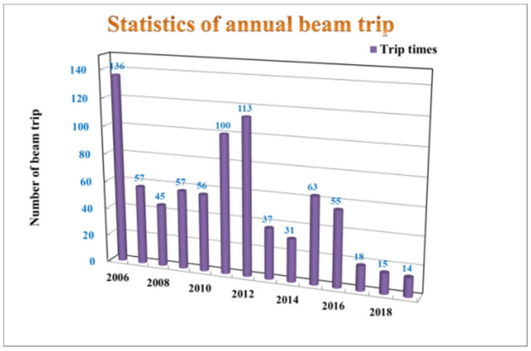

Figure 3: Annual beam trip event statistic of TLS.

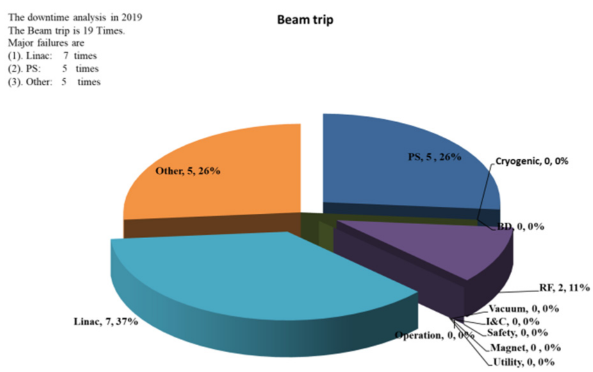

Figure 4: Sub-system event statistics of TLS in the 2019.

In the 2019, Most of the events are from injection sub-system. The injection kicker of storage ring record and analysis is very import for long term operation. The beam trip from injection system is difference from leakage fire and misfire. In the injection period, the injection timing system will send trigger signal to kicker pulse power-supply. If the power-supply isn't acted, is called to misfire. In the normal time, there is no any trigger signals operated, but pulse power-supply is acted. It means that leakage fire. The fast logger system can record this status to analyze after event. This utility is show in the Fig. 5. This utility is based on DTACQ ACQ196 100KSPS, is supported to record multi-channel fast data, to replace oscilloscope wall. For the most transient status, the request is satisfied. It is still disadvantage for pulse power-supply recorder. The pulse width of power-supply is just 2 micro second. The acq196 bandwidth wasn't enough to record full wave in that time. Reconfiguration pulse signal is necessary. In the Fig. 5, this is typical pulse power-supply leakage fire event. The kicker3 is acted in the normal time.

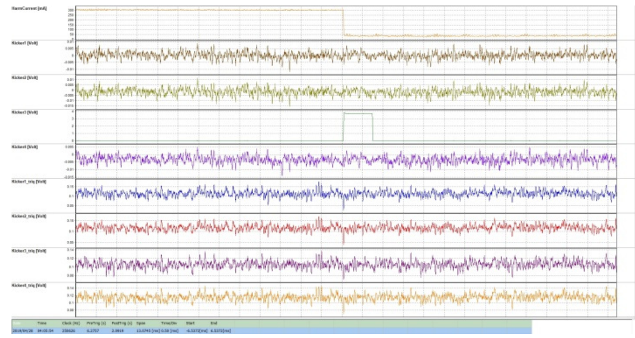

Figure 5: The GUI of Fast data logger.

This record is mistake with incomplete amplitude in the Fig. 6(a). It is typical kicker misfired case. The original utility is hard to find the event. The new EPICS scope can support width bandwidth recoding in the Fig. 6(b). The hardware is shown in the Figure 7, pitaya module with 125MSPS is applied in this request. The waveform record of GUI is based on EPICS. It can support record by event automatically, period record and manual record. These events include of beam current drop and beam trip.

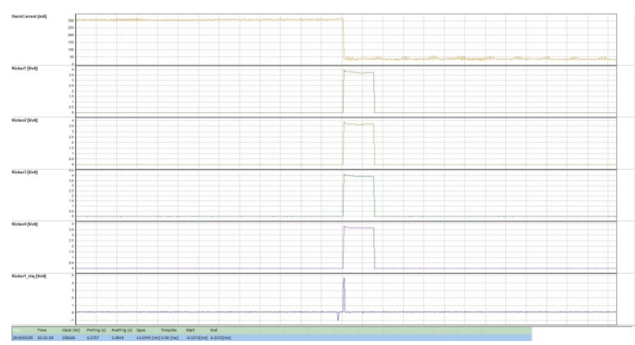

Figure 6(a): Misfired event, record by old utility.

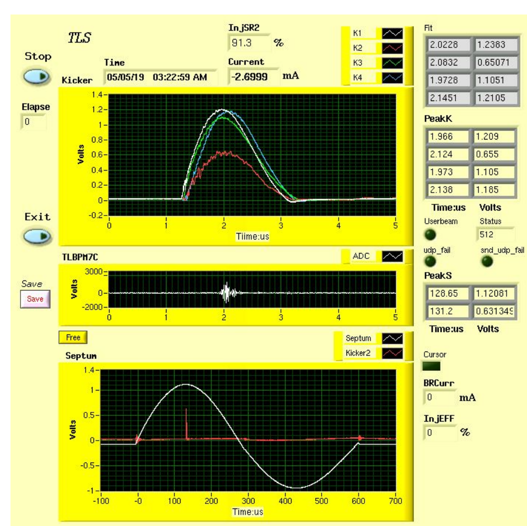

Figure 6(b): Misfired event, records by EPICS scope utility.

Figure 6(a)(b): The same transient event is recorder by difference system. The K2 pulse power-supply is misfired incompletely.

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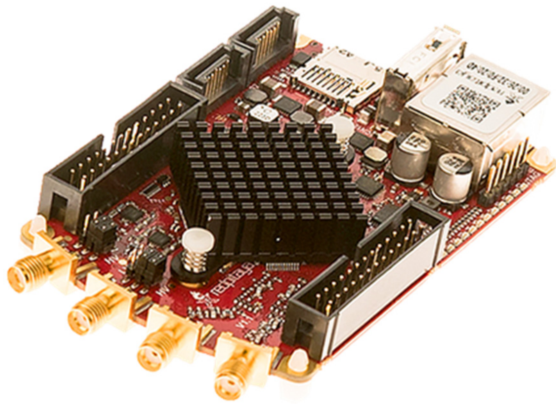

Figure 7: The red pitaya.

TPS BEAM OPERATION EVENT AND ANALYSIS UTILITY

The event analysis utility is gradually merged between TPS and TLS. There are several year operation experience and utility to reduce downtime and enhance reliability in the TLS. These experiences are useful to build tools to analysis and improve TPS availability. The beam trip event statistic is shown in the Fig. 8. The six events are from SRF system in the 2019. The utility for SRF system is first key point. The ACQ196 of D-TACQ with 500KSPS sampling is applied in the SRF event analysis. This hardware is shown in the Fig. 9. The software structure is same as TLS. The downtime statistic is shown in the Fig. 10. To sum up downtime and beam trip analysis, the power-supply and fast orbit feedback of instrument control system take heavy duty. The FOFB event includes of orbit interlock and hardware problem [3]. The BPM post-mortem and power-supply events searching utility automatically is useful. This utility is designed by MATLAB channel access. It can search power-supply fail event and orbit interlock event. The part of GUI software is shown in the Fig. 11.

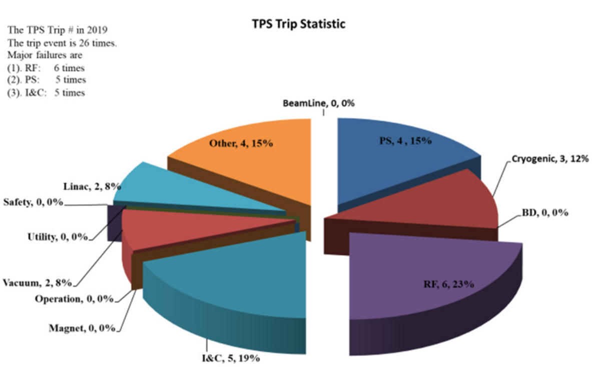

Figure 8: TPS beam trip event statistic in the 2019.

Figure 9: The waveform recording196 of T-TACQ.

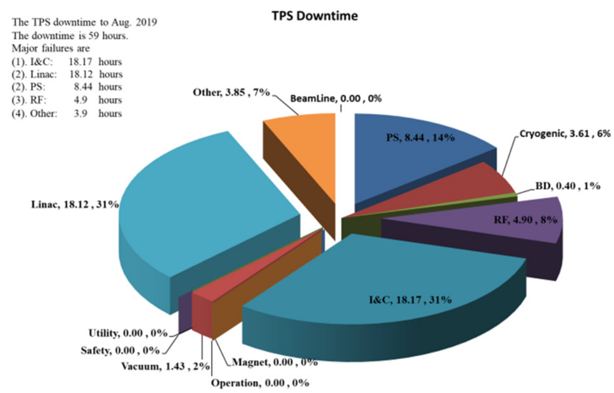

Figure 10: TPS downtime statistic in 2019.

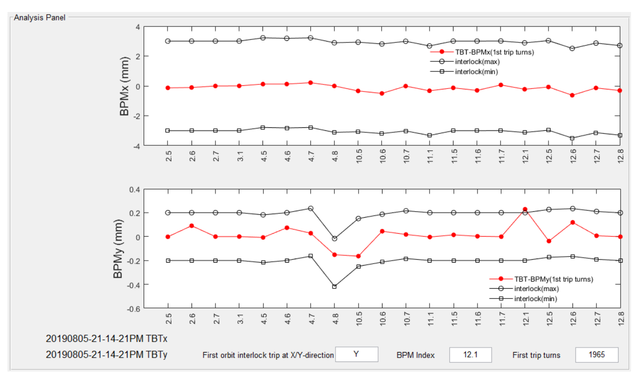

Figure 11: Integrated TPS orbit interlock and power-supply fail analysis tool.

SUMMARY

The TLS and TPS control system are gradually merged together. Analysis tools are recombined to reduce operator overheads. Various toolkit and diagnostic tools are used to check sub-system, look for problem between ten thousands signals and events in each downtime. In the future, this artificial intelligence (AI) toolkit and expert assistance (EA) system for downtime analysis will be developed continuously.

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