THE ALARM AND DOWNTIME ANALYSIS DEVELOPMENT IN THE TLS

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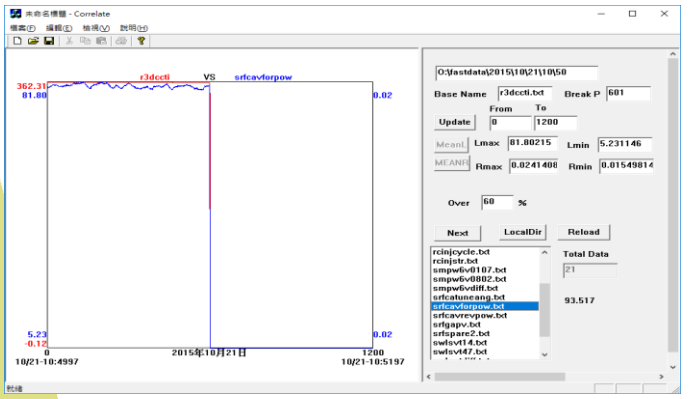
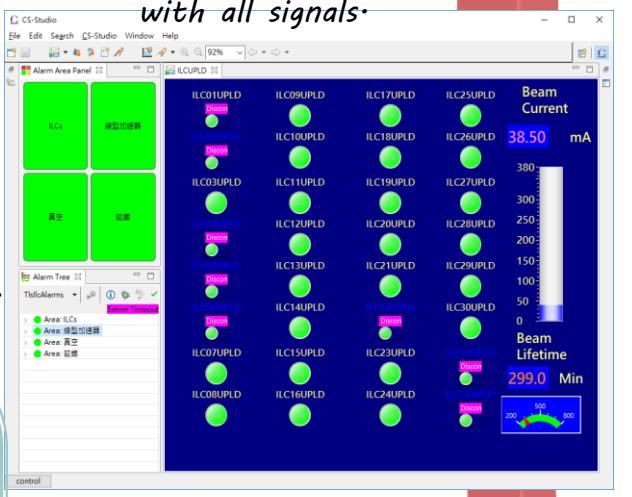
TLS (Taiwan light Source) is a 1.5 GeV synchrotron light source at NSRRC which has been operating for users more than twenty year. There are many toolkits that are delivered to find out downtime responsibility and processing solution. New alarm system with EPICS interface is also applied in these toolkits to keep from machine fail of user time in advance. These toolkits are tested and modified in the TLS and enhance beam availability. The relative operation experiences will be migrated to TPS (Taiwan photon source) in the future after long term operation and big data statistic. These analysis and implement results of system will be reported in this conference.



One of downtime events is recorded with 10Hz post-mortem mode. Several thousands of signals are recorded in the database. After this expert assistance with artificial intelligence processing, the signals number can be reduced to 21. It can help operator to find downtime event and reduce signal number. Checking 21 signals by operator can save much time that compares with all signals.

The alarm toolkit is based on BEAST (Before the using of the Best Ever Alarm System Toolkit). But data interface isn't EPICS in the TLS. One soft IOC is used to bridge data from original control system of TLS. This alarm system of CSS support rich function that includes of alarm handle, acknowledge, event latch, email notification and audio announcement.

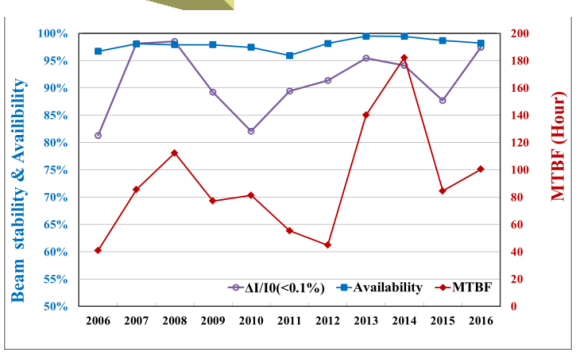


Year	Schedule user time (hours)	Availability	MTBF (hours)	Operation mode	Beam stability ΔI/I0 < 0.1%
2003	5017	97.2%	313.6	Decay	86%
2004	4235	97.5%	132.3	Decay	85%
2005	4576	96.8%	81.7	Decay/ Top-up	76%
2006	5552	96.7%	40.8	Top-up	81.3%
2007	5219	98.1%	85.6	Top-up	98.1%
2008	5726	97.9%	112.3	Top-up	98.5%
2009	5402	97.9%	77.2	Top-up	89.2%
2010	5286	97.4%	81.3	Top-up	82.1%
2011	5818	95.9%	55.4	Top-up	89.4%
2012	5197	98.1%	44.8	Top-up	91.4%
2013	5178	99.5%	140	Top-up	95.5%
2014	5645	99.4%	182.1	Top-up	94.1%
2015	5327	98.7%	84.6	Top-up	87.7%
2016	5526	98.2%	100.5	Top-up	97.46

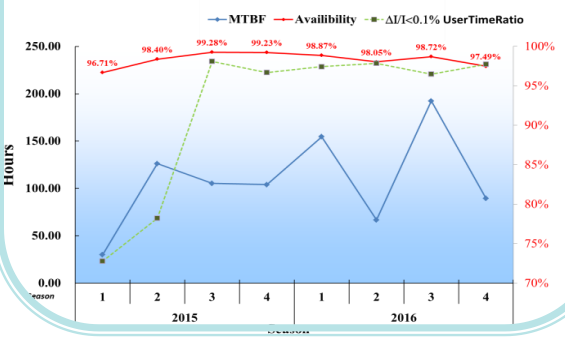
Summary of performance indicators for TLS history operation.

Month	< 0.1%	< 0.2%	Month	< 0.1%	< 0.2%
1	95.3%	99.9%	7	97.0%	99.9%
2	98.0%	99.9%	8	95.9%	99.8%
3	99.0%	99.9%	9	NA	NA
4	99.5%	99.9%	10	98.1%	99.8%
5	97.1%	100%	11	97.5%	99.8%
6	97.0%	99.9%	12	97.7%	99.8%

Annual operation statistic.

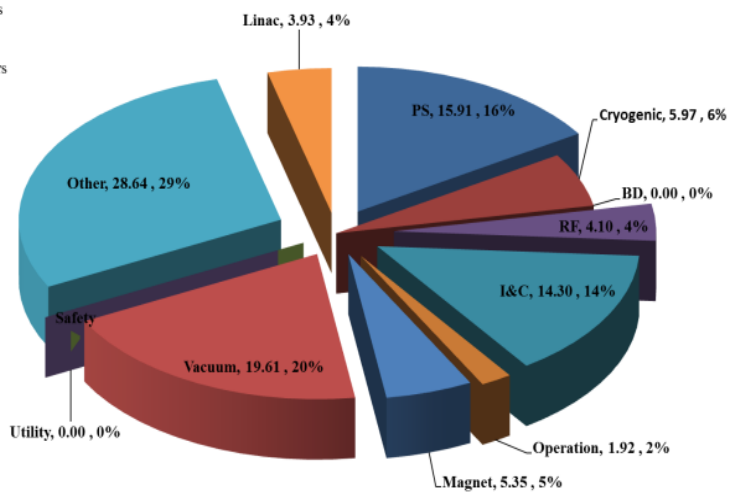


Season user time and beam performance indicators of TLS in 2016.

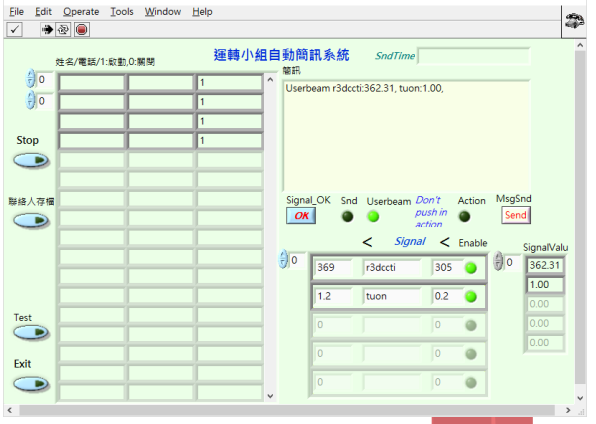


The downtime analysis in 2016
The downtime is 99.73 hours.
Major failures are
*Other: 28.64 hours
*Vacuum: 19.61 hours
*PS: 15.91 hours
*I&C: 14.30 hours
*Cryogenic: 5.97 hours
*Magnet: 5.35 hours
*RF: 4.10 hours
*Linac: 3.93 hours

Downtime analysis in 2016.



Notification system



The Short Message Service (SMS) information is still necessary to send to relative staffs from sub-system event. Especially, the WIFI of mobile phone is turned off. This toolkit GUI is developed by labview tool. It can be also compatible with EPICS and TLS original control system.

Summary

With the beam energy of 1.5 GeV, the storage ring of Taiwan Light Source (TLS) in National Synchrotron Radiation Research Center (NSRRC) has provided research service to users for more than twenty years. It takes a lot of efforts to keep this accelerator reliable and to improve its stability. NSRRC has finished the construction and commissioning of the new 3-GeV accelerator Taiwan Photon Source (TPS) which will be opened to users with limited beam lines in 2016. On the other hand, TLS has 25 beamlines and still serves users very well as being benefited by its mature operation skills and continuous efforts on maintenance and system improvement. High reliability operation is very important to users in the modern light source. 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. Main challenges and corresponding solutions on TLS operation in these recent years are presented herein, together with the statistics on operation performance.