

## OPERATION EXPERIENCE AT TAIWAN LIGHT SOURCE

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### Abstract

A matrix structure has been implemented for the purpose of successful operation of TLS and continuous progress of Taiwan Photon Source (TPS) construction. A dedicated and flexible manpower distribution has proven it could keep as same performance of TLS operation as possible. We will summarize the machine operation experience at TLS during TPS civil construction period.

### INTRODUCTION

Figure 1 presents the statistics of beam trip from 2002 to 2012. The SRF cavity was installed and subsequent commissioning took place in the end of 2004. The top-up operation @ 200 mA started in October 2005. The stored beam current was raised to 300 mA after implementing both transverse and longitudinal bunch-by-bunch feedback systems in 2006. Again, the stored beam current was raised to 360 mA after installation of in achromatic superconducting wiggler in arc section 4 in 2010.

The TPS civil construction started on February 7, 2010. Since the TPS storage ring just located beside TLS storage ring. (Fig. 2) The impacts of ground vibration of the TPS civil construction were unavoidable to TLS operation. As we predicted, there were 19 faults related to ground vibration of TPS civil construction in past three year. Moreover, several kind unexpected faults occurred. 70 hours downtime was due to additional vacuum cleaning for vacuum chamber and mirrors of beam lines, in response to a vacuum leak caused by beam line valve flange deformation. Such deformation occurred during the machine commissioning after installation of in achromatic superconducting wiggler in arc section 4, the first beam line valve located in the downstream of superconducting wiggler was closed, and the flange was heated and deformed under the exposure to the X-ray. This human error was, of course, due to unfamiliar with matrix structure. In 2011, the major event was that the klystron tube of Linac modulator had reached its end of lifetime and, as a result, caused 128.3 hours downtime. In 2012, several kinds of faults that should be prevented or could be cured early, which included: wrong synchronized rate of BPM electronics caused malfunction of global orbit feedback system (11 faults) for testing the commissioning tools, LHe pressure interlock triggered by offset of zero point of LHe supply valve (12 faults) after a large voltage sag event, and insufficient margin of transverse bunch-by-bunch feedback system for beam instability excited by mismatched injection scheme. The situation was deteriorated after the replacement of injection kicker1 and kicker3 pulser (39 faults) in January and September respectively.

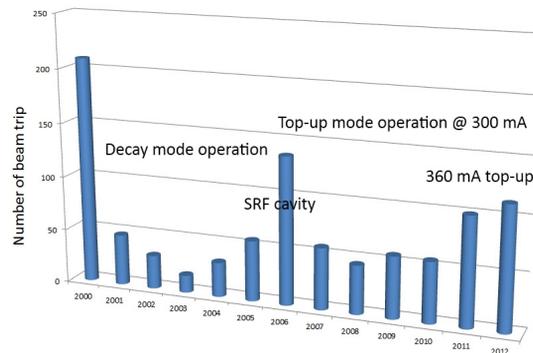


Figure 1: The statistics of beam trip from 2002 to 2012.

### STRATEGY AND METHODS

The operators were assigned to the dedicated manpower for TLS operation; they should prepare weekly operational report and analyze the failures. The machine operational weekly meeting takes place on Tuesday morning and Friday morning respectively. Several diagnostic tools have been developed for analyzing and classifying the failure causes. According to the occurrence time sequence of machine parameters, operator could classify which kind of the fault was attributed. First, the faults are roughly distinguished in RF and others. If the fault is attributed to RF group, a dedicated manpower of RF group should find out and solve the problem. Operators should be responsible for analyzing and classifying the others. Once operator finds out the failure cause, detailed failure report will send to the corresponding subsystem. These will help us far away from unneeded argument and ambiguous suspicion. Linac also has dedicated manpower due to the heavy workload. That were, poor lifetime issue of thermionic cathode due to water leak problem of booster septum chamber, and arcing problem of aging high-voltage cable.

The diagnostic tools will be illustrated with a standard failure analysis procedure. The DTACQ data analyzer could be used to preliminarily determine the fault attribute from a commercial data acquisition system in first step, which collects some machine parameters and all SRF parameters. Then a post-mortem diagnostic tool [1] with MATLAB based interface is composed a 96 channels 16 bits digitizer, and could be used to identify the fault related to superconducting insertion devices. In addition, 10 Hz control system archive could be used to identify the trivial faults resulted from magnet power supplies and from malfunction of conventional insertion devices. All of the faulty events could be analyzed and classified by the diagnostic tools. Most of the faulty events have causality between interlock signal and beam

trip, and could be explained well. The rest did not have enough evidence to find out related failure mechanism of the components, but these still could be classified by similarity. Furthermore, the booster performance and

waveform of kickers have been monitored every minute accompanied top-up injection.



Figure 2: The satellite pictures show TPS civil construction progress in past years. The shortest distance between two circles across the intersecting point and SRF cavity, that is why the SRF cavity is so sensitive to the ground vibration of TPS civil construction.

## RESULTS AND DISCUSSION

Table 1 gives a summary of the efforts that make to improve the accelerator reliability. Those efforts significantly reduced the early life failure rate of SRF cavity and cryogenics system. By carefully maintaining and monitoring the kickers' behaviour, a stable and reliable top-up operation could be achieved. The fail to switch concept has been implemented to a faulty event of power supply, and the mean time to recovery of faulty power supply reduced to less than half hour.

Table 1: Summary of major efforts for accelerator reliability

Subsystem	
RF	Adjusted properly the arc-detection circuit to improve the false-to-truth alarm.
Cryogenics	Installed a phase separator in the upstream of SRF cavity to suppress the pressure fluctuations during refilling liquid nitrogen into LN2 storage Dewar.
	Installed DC UPS for the variable speed driver to protect compressors of cryogenic system from voltage sag event.

Pulse PS	The voltage of the kicker power supplies is applied only at a few seconds before injection takes place. This arrangement greatly prevents the possible false-trigger from happening. Performed the kicker performance check procedure every week.
PS	Installed UPS for power supply of superconducting insertion devices. Replaced the water flow meter every year. Established fail to switch strategy for reducing the mean time to recovery.

Analyzing and clarifying the cause of various faults can help to maintain high availability and to reduce the recovery time required. Proper evaluation of the lifetime of parts and routine maintenance by replacing the parts beyond its lifetime, especially in the case of pulse power systems, can ensure good reliability.

## REFERENCES

- [1] K. H. Hu et al., "Post-mortem diagnostic for the Taiwan Light Source", EPAC 08, Genoa, 2008.