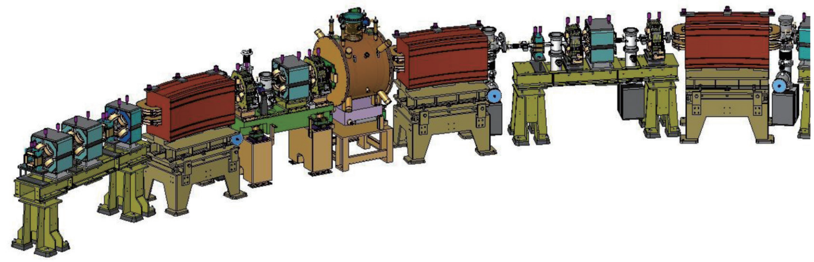
Accelerator Facility



The sketch is a part of TBA cell, which includes dipoles, quadrupoles, sextupoles and IASW6 magnet.

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The Taiwan Light Source has a 1.5 Gev electron storage ring with a circumference of 120 meters and 6-fold symmetry of which every 6-meter long straight sections is occupied by an insertion device. Sitting in between k3 and k4 of the injection section is a superconducting wave length shifter. The downstream of SRF cavity section is stored with superconducting equipments. The remaining sections are equipped with EPU5.6, U5, W20, and W20. To accommodate the increasing demands over beam time and higher brightness by the growing number of NSRRC users. Three identical superconducting wigglers have been built, two are now installed at the location between the first two dipole magnets of second and sixth TBA cell respectively, the third one in the fourth TBA cell, scheduled to be added in February 2010. Maintaining all time availability is a challenging task as the facility becomes more complex with new add-ons and upgrades. Table 1 offers detail information about these insertion devices.

Taiwan light source started 200 mA top-up operation in October 2005 and, subsequently, the stored top-up beam current was raised to 300 mA. Several machine issues were observed and resolved over the past years. The availability experienced a drop in 2006 and had recovery since 2007 as the top-up operation became more mature.

The scheduled user beam time had 575.25 shifts (5,402 hours) in 2009; with 5,288.26 delivered hours and the beam availability scored 97.9%, same level as being maintained in recent years. Nevertheless, the number of beam loss raised to 70 incidents, resulting in the decease

Table 1: The main parameters of the insertion devices in TLS

	W20	U5	U9	EPU5.6	SWLS	SW6	LASWA	LASWB	LASWC
Type	Hybrid	Hybrid	Hybrid	Pure	SC	SC	SC	SC	SC
λ(cm)	20	5	9	5.6	32.56	6	6.1	6.1	6.1
Photon energy (eV)	800~15k	60~1.5k	5-500	80~1.4k	4k~38k	5k~17k	5k~23k	5k~23k	5k~23k
Bmax. (Tesla)	1.8	0.64	1.245	0.67(0.45)	6	3.2	3.1	3.1	3.1
Installation	12/1994	03/1997	04/1999	09/1999	04/2002	01/2004	12/2005	06/2009	02/2010
Location	sec. 5	sec. 3	sec. 6	sec. 2	sec. 1	sec. 4	arc sec. 6	arc sec. 2	arc sec. 4

of mean time between failures to 77.2 hours. Figure 1 presents the summary of machine operation from 2002 to 2009.

According to the data, beam availability in 2009, however, is deviated from the original expectation. The major efforts have been taken to minimize false triggering events from injection kicker power supply or RF arc-detector, occurred randomly in routine top-up operation. The action items in dealing with such situations are described as follows. (a) To change 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. (b) To properly adjust the arc-detection circuit has also improved the false-to-truth alarm a lot. The beam loss events were reduced to about one-tenth of their original record. Unfortunately, the unexpected beam losses followed, due to malfunction of transmitter and SRF interlock triggered from large orbit change. The malfunction of transmitter was identified as cascading effects after klystron tube replacement done in June 2009. The transient of large orbit change was the result of the implementation of the new feedback control algorithm and some bugs of BPM electronics. Figure 2 gives detailed failure analysis since top-up operation. Figure 3 shows an annual downtime statistics.

Analyzing and clarifying the cause of various machine-trip events can help to maintain high availability and to reduce the recovery time required. Proper evaluation of the life time of parts and routine maintenance by replacing the parts beyond its life time, especially in the case of pulse power systems, can ensure good reliability. Various diagnostic tools (e.g., fast digitizer, BPM electronics, 10 kHz orbit recorder and control system archive) were implemented to analyze and clarify the cause of various machine-trip events. High resolution data acquisition system can give detailed trip time sequence of accelerator components, especially for superconducting RF system and superconducting insertion devices, can help determine the cause of the beam trip event and offer a more accurate maintenance schedule for fault prevention. TLS again increased its electron currency to 360 mA in December 29, 2009 and maintained such top-up operation since.

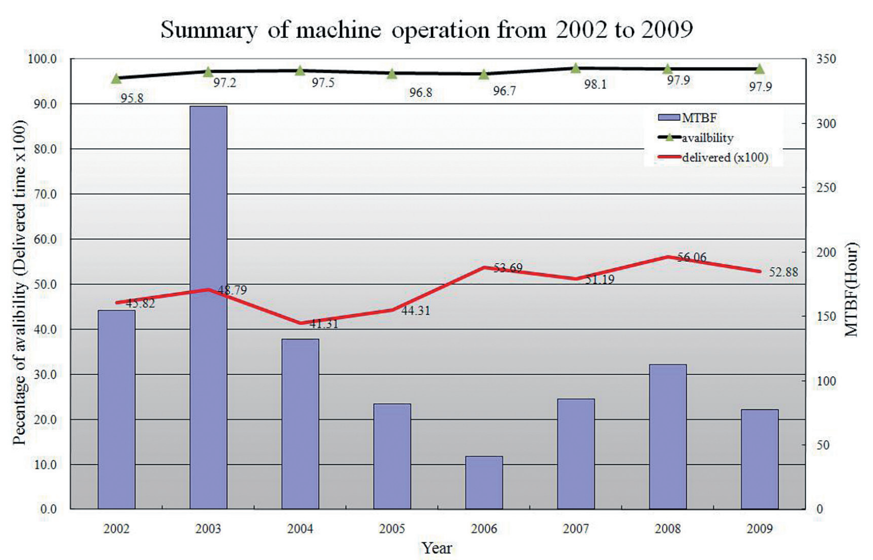

Fig. 1: shows the operation availability, user beam time delivered and mean time between failures form 2002 to 2009.

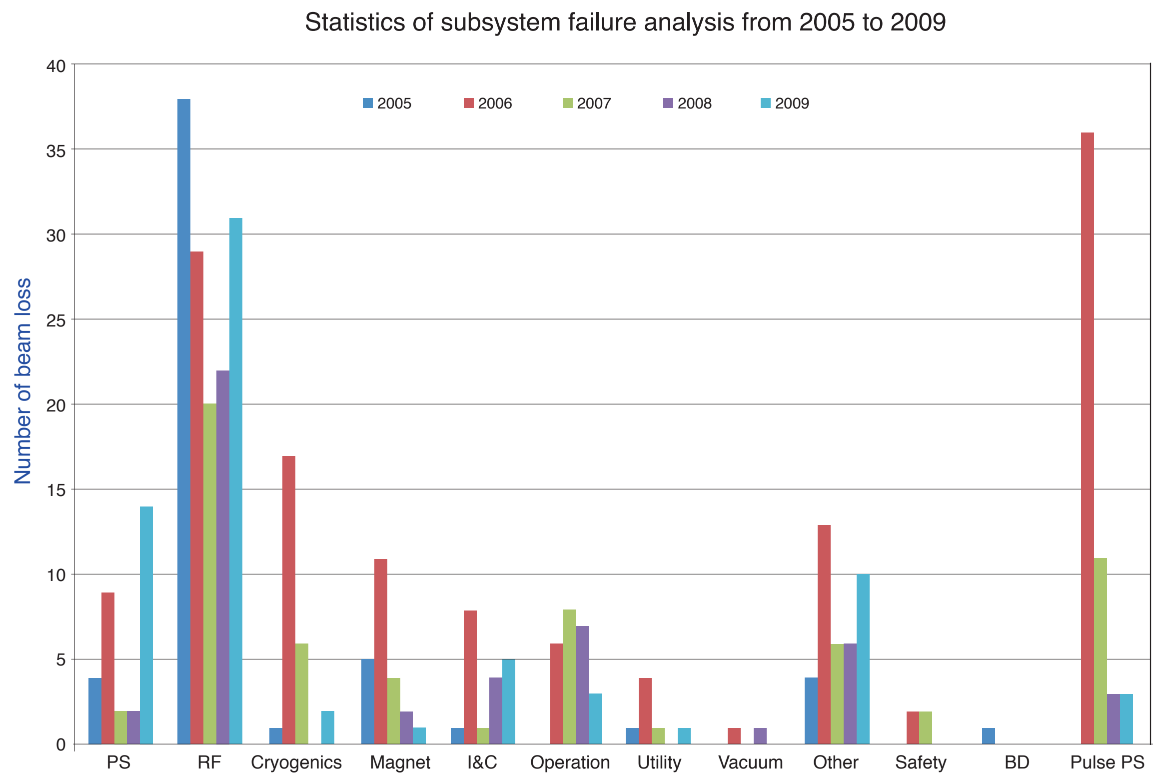

Fig. 2: Detailed failure analysis since top-up operation. There is an increase in failures in both RF and PS. The increase in RF failure is attributed to unexpected malfunction of transmitter, and PS failure of air flow detector or water flow detector.

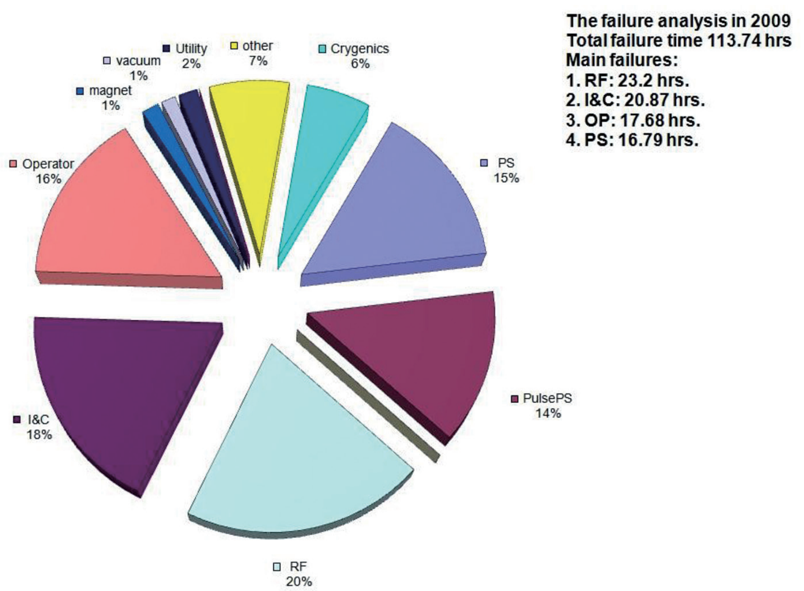

Fig. 3: shows the annual downtime statistics in 2009.

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