Commissioning of 360 mA Top-up Operation

The TPS site construction is scheduled to be started at the beginning of 2010. Some crucial construction work will create unavoidable disturbance to the TLS user operation. Consequently, the available user time in 2010 will be decreased from 650 shifts to 550 shifts, about 84% of them provided in 2009. In order to compensate for the loss of user shifts, increasing the routine stored beam current from 300 mA (in 2009) to 360 mA (in 2010) will provide an alternative arrangement to improve the situation. Feasibility study concerning 360 mA, top-up mode, user operation has been carried out for this purpose during June ~ December 2009. This report summarizes the results of this accelerator commissioning and its overall impact on beam lines and end stations.

Top-up mode operation in user shifts preserves constant heat load to beam line elements and therefore, provides a steady photon source for end stations. The stored beam current is constantly filled, about 0.9 mA/per injection for 300 mA top-up operation, once per minute. During the refilling, the stored beam orbit is unchanged by using the orbit feedback system. One can also optimize the data acquisition, if needed, by utilizing the gating signal provided in the top-up operation. Moreover, the beam line shutter is left open during the refilling; the radiation leak-out concern has been eliminated by greatly improving the injection efficiency and enforced shielding arrangement since October, 2005. Figure 1 gives statistics of beam trips during user shifts in the past few years. It indicates that the TLS is a mature light source for user operation.

In order to minimize any possible changes of the present top-up mode operation procedure, while shifting from 300 mA to 360 mA, the booster beam current is increased by a factor of 1.33, i.e. 1.2 mA, to meet the criterion of refilling once per minute. It has been experimentally verified that the overall top-up mode performance at 360 mA was as good as 300 mA[1]. Figure 2 shows the difference of

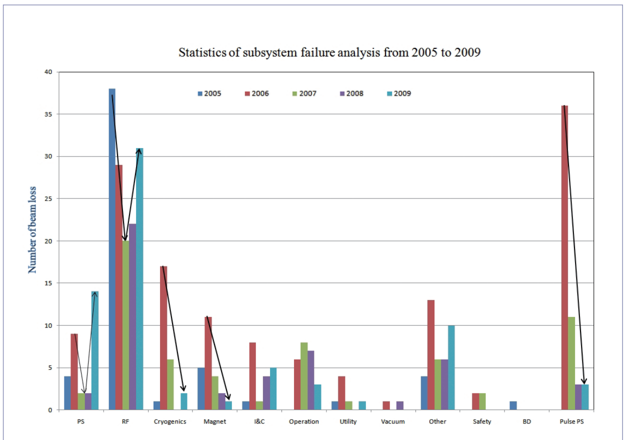

Fig. 1: A stably declined trend in the beam loss rate caused by the failure of accelerator subsystems.

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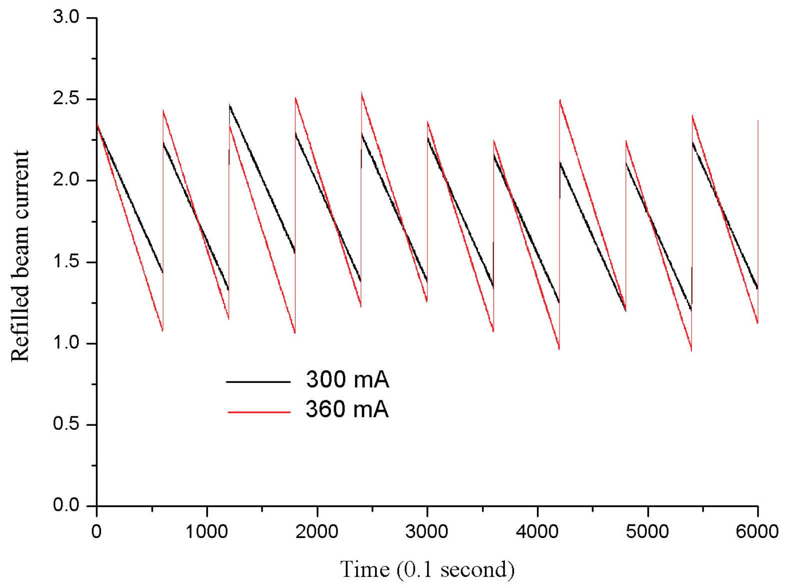

Fig. 2: The difference of refilled beam current between 300 mA and 360 mA operation. The average refilled current for 300 mA and 360 mA are 0.9 mA and 1.2 mA respectively.

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The capability of all accelerator subsystems has been upgraded in order to provide substantial margin for 360 mA top-up operation. As a matter of fact, the cooling capacity of both vacuum chambers and magnets have been proved to be adequate under a test-run at 400 mA. The temperature of both systems became stable within a few hours. Both well-tuned transverse and longitudinal feedback systems gave excellent performance at 400 mA test-run[2]. The orbit feedback system has been upgraded by implementing new digital BPM electronics and fast corrector switching power supplies in late 2008[3]. The overall bandwidth of orbit feedback system has been improved from several Hz to 100 Hz in vertical plane and 50 Hz in horizontal plane.

Long-term observation shows that false triggering of injection kicker power supply and RF arc-detector occurred randomly in routine top-up operation. The counteract in dealing with this situation is as follow: a) The charging voltage of the kicker power supplies are applied only at a few seconds before injection take place. This arrangement greatly prevents the possible miss-trigger from happening; b) Properly adjusting the arc-detection circuit has also improved the false-to-truth alarm a lot. The corresponding beam loss events were reduced to about one-tenth of their original statistics.

The radiation loss at 300 mA stored beam current is 63.5 kW. It will be increased to 73 kW at 360 mA including those the insertion device to be installed in 2010. The solution to this extra RF power consumption was implemented in May 2009 by installing a 100 kW klystron for this purpose and enhancing the reliability of RF system.

The beam injection efficiency has been constantly improved and optimized whenever new insertion devices are installed for user operation[4]. The result shown in Fig. 3 indicates the improvement of injection efficiency in the past several years. It has successfully met the radiation safety requirements for 360 mA, top-up operation. The comparison of observed photon intensities at end stations between 300 mA and 360 mA indicates that its increase is proportional to the stored beam current. The BL17A beamline is the only ex-

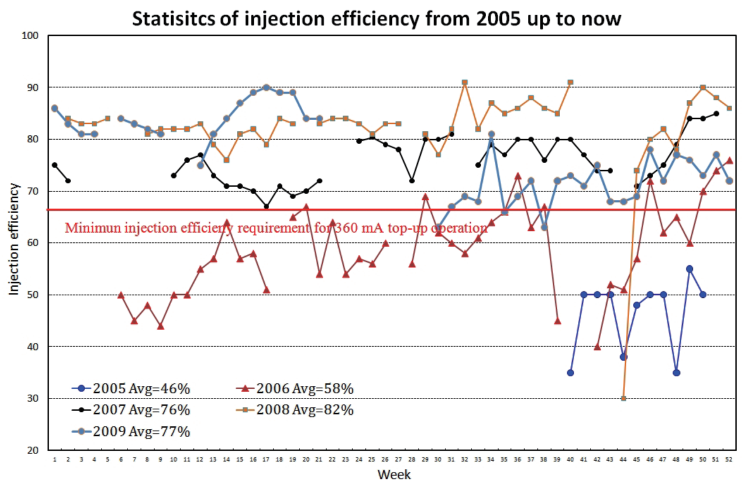

Fig. 3: Average injection efficiency fulfills the radiation safety requirement.

ception. The focus mirror of BL17A is continuously heated by scattered light from upstream optics. This problem could be cured by installing an attenuator in front of the collimator of BL17.

Several unsolved issues remain to be improved: a) the stored beam was disturbed by the septum leakage field; b) Partial beam loss occurred during injection when EPU gap was smaller than 24 mm. An effort to improve the septum leakage field and beam loss study have scheduled in 2010 in order to further improve the performance of top-up operation.

Thanks to all the efforts contributed from colleagues in the accelerator division and the beamline division, the 360 mA top-up mode operation was made possible.

References

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