PROGRESS OF THE NSRL PHASE II PROJECT

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Abstract

The NSRL Phase II Project is now going at full steam ahead.

A few machine-upgrading tasks have been fulfilled and proven quite effective in improving the operation conditions. They are briefly described in this paper. Among them are: utilization of solid state microwave amplifiers in the linac; re-alignment of the transport line; implementation of new power supplies, a new control system and new beam diagnostics devices in the storage ring; Beam-Based Alignment measurements and test of a Beam Loss Monitoring system.

In the spring of 2001, the performance of NSRL light source is much better than one year ago. New progresses are being reported from the manufacturers. The project has a promising future. Next year will witness its commissioning and dedication.

1 INTRODUCTION

The NSRL Phase II Project, which is described elsewhere[1], is now going on at full steam ahead. In addition to its plan to equip 8 more photon beamlines and experimental stations, the main purpose of its machine upgrading part is to enhance the quality, stability and reliability of the light source. Among its goals are to significantly increase regularly stored beam current, to realize a new configuration with a low beam emittance of 27 nm-rad, to insert a new undulator, etc.

For the first two goals, the ring's RF cavity and the injection kickers with the vacuum chambers have to be reconstructed. The installations of those key devices are scheduled later this year, so a lot of machine study work will be conducted thereafter.

However, quite a few machine-upgrading tasks have been fulfilled and, combined with some machine studies, proven effective in improving the operation conditions.

In the spring of year 2001, the performance of NSRL light source is much better than one year ago, with more reliable user time and more productive machine studies. The stored beam is typically from 160 to 180 mA at the end of ramping, with about 8 hours' lifetime, as shown in Figure1. Unscheduled machine shutdown time due to the new components was almost zero. A few sub-systems of the civil utilities are also upgraded, providing better support to the operation. In addition to the long-existing experimental stations, a newly constructed LIGA station along with its beamline was tested and adjusted, yielding its preliminary results as one of the first achievements of the Phase II Project of NSRL.

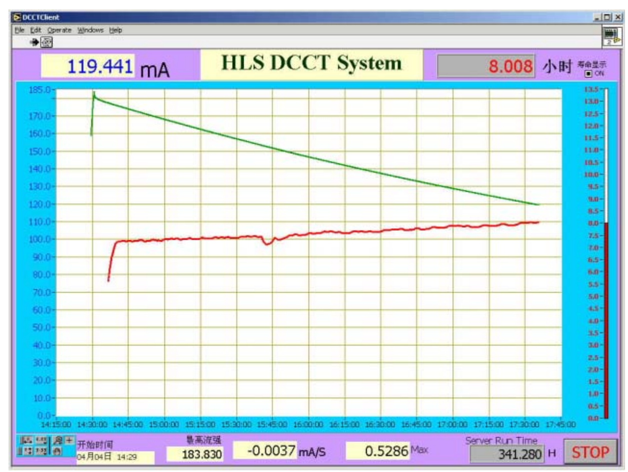

Figure 1: Typical Current Curve in this year's operation.

2 MACHINE UPGRADING TASKS FULFILLED

1) The microwave trigger system of the linac has been rebuilt and put into service. As an important part, solid state (transistor) microwave amplifiers are used in the new system as signal relay device to replace somehow obsolescent low power klystrons. The system works satisfactorily.

2) Due to over ten years' unequal descent of the ground of the tunnel, the electron beam transport line was found inclined seriously, the switch magnet being 9 mm lower than the beam-turning-up point, and had to be re-aligned in the summer of 2000. As the result, the transport line is now lying well within 200 microns of a horizontal plane and injection of the beam becomes smoother than before.

3) Power supplies of the ring's main magnets (dipoles, quadrupoles and sextupoles) are all replaced with new ones. Thyratron-type pulse current power supplies are used for the injection system instead of old gap-switch triggers. In the meantime, the control system, as well as beam diagnostics system, is largely upgraded with more "standardized" commercially-available products and with the software totally developed in the frame of EPICS, to facilitate data acquisition, sharing and archive and to leave room for future extension[2][3]. Following is the entrance page of the control program, called as the main interface page.

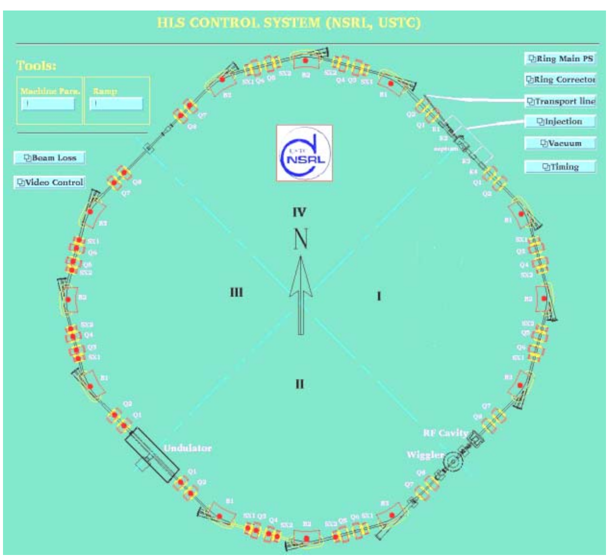

Figure 2: The main interface page of the new control program.

4) With the help of a new Beam Position Monitoring system, the new control system and existing trim coils in the ring's quadrupoles, Beam-Based Alignment (BBA) measurements were carried out in May of 2001[4].

To measure the closed orbit displacements from the magnetic center of the quadrupole in question, 3 nearby correctors are used to make local bumps and move the beam in/out or up/down. With a certain current added to the quad trim coils, BPM data are collected along the ring to calculate the "Merit Functions" and see how they vary with the beam positions. Then the beam-based "center of the quad", where the Merit Function should be minimized, is found by parabola fitting. For example, as shown in Figure 3, the horizontal and vertical offsets of quad Q7W are determined as 0.05 mm and –1.813 mm, respectively, with fitting rms errors around ±0.04 mm.

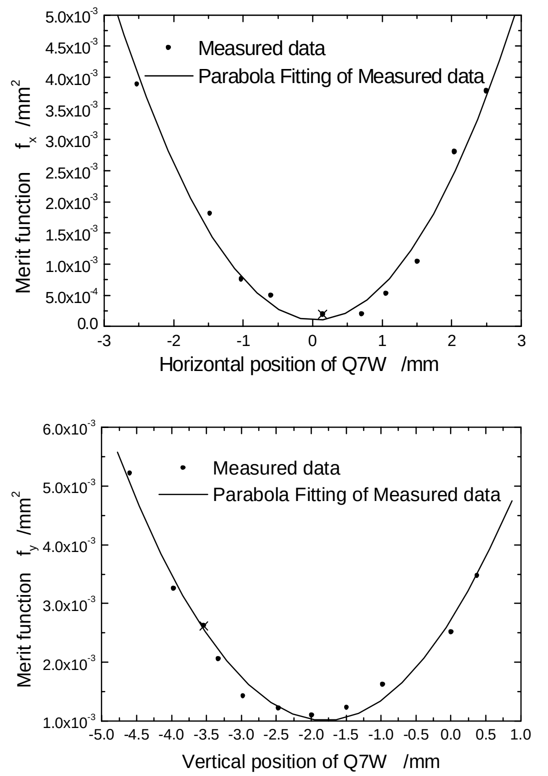

Figure 3: BBA measurement data for Q7W, showing its horizontal and vertical offsets, in the upper and lower figures, respectively.

The vertical closed orbit was found badly deviated from the centers of the magnets, with offsets up to 3 mm (See Figure 4 on next page). This problem is presumably caused, again, by unequal descent of the ground, the largest descending taking place near the transport line tunnel. A test correction, with quadrupole trim coils in the region excited as correctors, decreases the orbit deviation quite effectively, in a good agreement with theoretical analysis[5].

A magnet re-alignment is planned, followed by more BBA work to assure a good orbit for the beam.

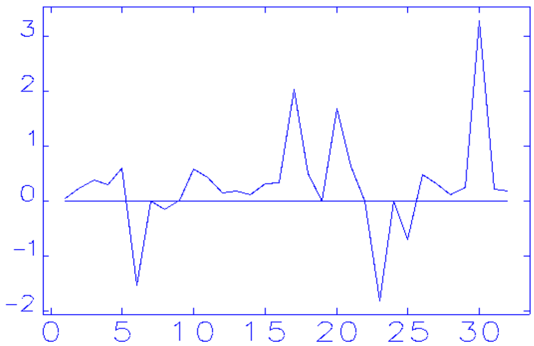

Figure 4: BBA measured vertical orbit offsets (in mm) along the ring's 32 quadruples.

5) A Beam Loss Monitoring (BLM) system is put into service and turns out to be a useful trouble-spotting tool. The measured data, radioactive dose counts, are displayed on time, as shown in Figure 5.

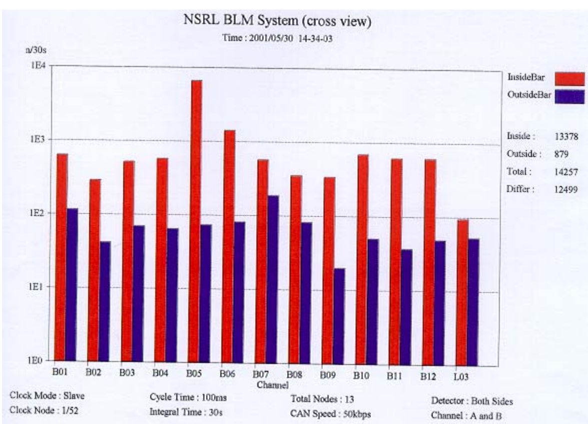

Figure 5: Beam losses measured along the ring.

As analyzed elsewhere[6], a big orbit distortion will of course have counter rates jump up at a few positions; counter rates of the detectors fixed outward of the ring reflect beam elastic collision losses, including Touschek scattering losses; and a big difference between a pair of outer and inner detectors is a symptom that local vacuum somewhere upstream is bad. The counter rate of every detector versus time can also be shown in curves.

The BLM system contributes to solutions of a few problems, such as local vacuum defects, an excessive beam loss at the start of ramping due to failure to full stop of the injection kickers, etc.

For example, at some photon beamline front-ends there exists a vacuum dead end when the gate valve is closed and gas is accumulated there. Once the valve is open, however, the gas rushes into the ring and strongly impacts the beam. The beam is scattered seriously and can be detected in every direction. Figure 6 shows the beam losses at the inner and outer of vacuum chamber, both revealing a sharp increase of beam loss. This problem has been taken care of by installation of pumps near the water-cooling masks.

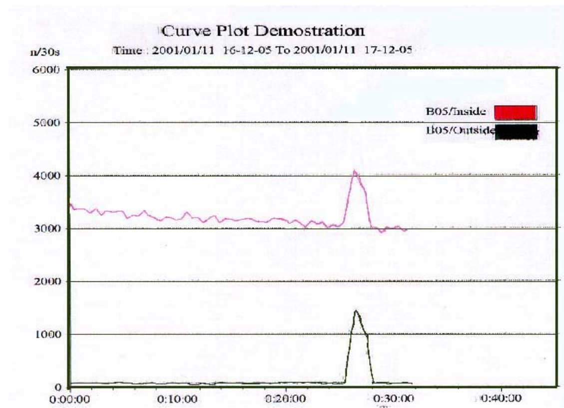

Figure 6: Beam loss at downstream of a certain photon beam port when the gate valve is opeen.

3 FUTURE OF THE PROJECT

Several key components such as the new RF cavity, the ceramic vacuum sections for ferrite kickers, and optic elements (gratings/mirrors) in a few photon beamlines are yet to be completed, not to mention subsequent quality checking and characteristics measurements. In a sense, they are the most technically demanding or troublesome pieces during the construction period, but will be the brightest stars afterwards. Recently, new progresses are continuously being reported from their manufacturers. The cavity, just coming out of machining, is to be welded in a few days. As to the ceramic sections for kickers, the toughest problem of their breaking due to residual strains after welding is solved, and we have got sufficient parts to go further. At present, the undulator is under magnetic field measurements and adjustments, while most photon beamlines are already over or under off-line mechanical and vacuum tests.

The future of the Phase II Project is quite promising. Next year will witness its commissioning and dedication. NSRL will put on a new appearance to greet its users in a more brilliant century.

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