Upgrade of NSLS Vacuum for the Research and Development of NSLS-II

Jih-Perng Hu

Photon Sciences Directorate
Brookhaven National Laboratory
Upton, NY 11973-5000 USA

Built in 1982 at the Brookhaven National Laboratory, the 0.8-GeV 51-m Ultra-Violet Ring and the 2.8-GeV 171-m X-ray Ring of the National Synchrotron Light Source (NSLS) are two UHV vacuum electron-storage facilities designed to generate the ultraviolet light and soft X-rays for advanced research at 60 beamlines (13 at UV-ring, 47 at X-ring). Upstream of the two storage rings is a 0.12-0.74 GeV, 28-m HV Booster Ring that energizes and modulates the incoming beam from a Linac and Thermionic Gun. Under normal operational conditions, the beam current and lifetime at the UV-ring are 800 mA and 10 hours, and at the X-ring are 300 mA and 20 hours, respectively. Starting from 2005, upgrade of NSLS vacuum at three synchrotron rings and a dozen of beamline front-ends has begun, to prepare for the R&D of NSLS-II, a DOE-approved and funded 3rd generation light source to be built at Brookhaven site before 2015.

The following are major vacuum upgrades fulfilled by the end of fiscal year 2010:

Facility vacuum - eliminated building-elevation induced moisture accumulation in the pneumatic lines which affected control of vacuum systems; replaced all undocumented brands of weight-bearing bolts and degraded fixtures at overhead cranes to protect beamline chambers and optical devices; repaved the floor of ring tunnel after LEGS dismantling for ease of IVU installation.

Ring vacuum - completed experimenting on the beam scattering through vacuum chamber walls for magnet-epoxy lifetime analysis (data referenced by the NASA Goddard Space Flight Center for epoxy use at space shuttles); redesigned and fabricated ceramic kicker spares to await the test of 3 GeV beam for NSLS-II; upgraded Linac klystrons by incorporating ceramic windows to isolate the waveguide vacuum from the klystron vacuum while allowing the RF to transmit.

Device vacuum - completed design and installation of the 1st cryo-cooled permanent-magnet MGU equipped with an in-vacuum glow-discharge for cleaning, a removable chamber sidewall (1.35-m wide, 0.4-m high) for a direct internal access and a Keyence optical micrometer for magnet gap precision measurement; redesigned and installed a vertical and an horizontal scrapers in two consecutive straight section at the X-ring, for measuring the beam aperture and lifetime and for the testing of blade outgassing (Glidcop vs OFHC-copper) and electron dump (NSLS-II dipole design).

System vacuum – expanded and reformatted the system control on vacuum data logging and history display at CCTV and website; replaced outdated analog units with compact digital modules for most of the gauges/pumps/detectors to quicken the pressure reading and leak detecting.

In order to overcome the ~40% increase of synchrotron radiation since the mid-1990s when X-ring was upgraded from 2.54 to 2.8 GeV, most of the sensitive apparatuses at rings and heat bearing parts at front-ends have been periodically upgraded, and all motion devices at rings and beamlines have been routinely checked and replaced; however, maintenance of appreciable UHV at NSLS will be a continuous effort until the completion of NSLS-II and its associated facilities. To meet annual operation of 5,500-hours for the NSLS users, spares of critical ring parts including beam chambers, magnet coils and ceramic injectors are available for emergency replacement.