ASD Quarterly Bulletin
July – August 2014

During this quarter, we finished Run 2014-2 with 97.6% Machine Availability and 69.3 hours of the Mean Time between Faults (MTBF). This is a good performance, but the numbers are lower than we typically deliver. Why is that? Think about it and come with suggestions for improvements.

In the past quarter:

The Diagnostic Group calibrated Sector 27 grazing incidence x-ray beam position monitor (GRID XBPM), tested and integrated into the APS control system Libera Brilliance plus BPM electronics and demonstrated GRID XBPM in feedback operation. Fabricated, installed and commissioned a new imaging diagnostic, transverse loss monitor (TLM), in Sector 10. During the shutdown performed calibration, repair and installation of diagnostic hardware, provided the oversight of "snubber" installation in Sector 13 and Sector 14, measured mechanical vibrations at Sector 27 ID vacuum chamber. Tested a new temperature monitoring system for Sectors 27 and 28. Managed RG2 operations gun replacement and re-commissioning of a new gun. Tested 3G1 gun in the injector test stand (ITS) in preparation for a RadiaBeam experiment for generation of short THz pulses. Completed firmware modifications required to make BSP100 to work with the Booster BPMs. Designed and optimized a NEG coated copper coaxial tube to measure the impedance of MBA chamber in a frequency range up to 40 GHz. Optimized the transition and feedthrough of the strip line kicker for Sector 31. Designed a 25-kV feedthrough for MBA kicker. Installed and tested two new photocathode electron gun (PCgun) BPMs and an old PCgun BPM. Installed PCgun current monitor and Faraday cup. Installed and tested PCgun optics and cameras.

The Magnetic Devices Group built two new permanent magnet undulators with the period of 17.2-mm and installed them in Sector 30. Thus, the important milestone for the RIXS project has been met. New undulators replaced two 30-mm long period IDs that were moved in Sector 27 where they replaced two Undulator-As. The operation of the prototype superconducting undulator SCU0 was flawless through the entire quarter. The assembly of a new 1-m long superconducting undulator SCU1 proceeded according to the plan. The only delayed component was the vacuum chamber where one transition section exhibited unexpected strong vacuum leak and had to be re-fabricated. The magnetic structure of the SCU1, which consists of two superconducting magnets, has been tested and successfully quench-trained in a vertical liquid-helium Dewar. It can operate well above the maximum design current. The preliminary magnetic measurements show that SCU1 meets and exceeds all performance requirements. There was a steady progress in the development of a horizontal-gap, vertical-polarizing undulator (HGVPU). Although, the undulator mechanical design is far from the optimal, it is expected to perform close to the required specifications. The 3D magnetic modeling of realistic undulator end sections in conjunction with a phase shifter progressed well. The results are going to be benchmarked with the magnetic measurements performed at SLAC.

The Power Systems Group continued the R&D for the MBA upgrade. The modeling and simulation of the fast corrector power supply circuit and control loop are close to completion. With the latest estimate of the fast corrector parameters, a simple high-frequency, 100-kHz switching circuit can achieve 10-kHz bandwidth for an AC current up to 0.5% of 15A full range, which exceeds the requirements. The evaluation of the communication speed of Danfysik 9100

power supply is complete. The evaluation result is that the SPI communication interface used in the Danfysik power supply meets the proposed requirements for the MBA unipolar DC power supplies. Completed the installation of the new PC gun power supplies for the most part. The remaining work is outside the tunnel and will soon be completed.

The Accelerator and Operations Group completed commissioning of the new photo-cathode electron gun (PCGun) in the ITS. Projected beam energy, energy spread, emittance, and quantum efficiency of photon conversion to electrons were achieved. At a 25-pC bunch charge, a normalized emittance of ~0.8μm was measured, which is comparable to other state-of-the-art high-brightness S-band photocathode guns in the world. The beam energy exceeded 6 MeV and a maximum dark current was less than 100 pC per RF pulse. During the shutdown, the PCGun was installed in the linac tunnel. Studies were performed to find the best option to protect superconducting undulators from quenching induced by stray electrons during sudden beam loss, validating the concept of using a beam-abort kicker to protect the SCU. A working concept was identified and it is under further development now. An option for a simulation of electron intrabeam scattering for non-Gaussian beams was added to *elegant* code and will be used to improve simulation of beam lifetime in the MBA ring in operation with the harmonic cavity. During beam studies, a single bunch with 31 mA was stored using higher chromaticity and lower rf voltage. Though this is not a desirable operational condition, this experiment demonstrates some operational flexibility. New Booster power supply ramp correction programs allowing for an arbitrary current reference waveforms were prepared. After implementing the new software, a significant improvement in beam stability was observed for the 92-nm emittance lattice, which is critical for high charge injector beam development of the MBA upgrade.

The RF Group performed several equipment maintenances. A high voltage power supply filter capacitor failed in Harmonic PAR power amplifier #2. This capacitor failure also caused a ground bounce condition that resulted in multiple failures in the PLC control system hardware. Repairs were completed while the system was off-line. The tuner motor on Sector 40/cavity #4 began sticking in position, causing the cavity tuning loop to rail. Subsequent inspection after the run ended revealed that the motor had severely worn bearings. The motor was replaced with a spare over the shutdown. Evidence of a water leak was found on the front gun magnet of the klystron at RF3. Photographs were taken and forwarded to Thales for comment. A subsequent check at the end of the shutdown after water flow was restored indicated no active leaks from the magnet. The RF group also completed a successful Work for Others project for Nokomis, Inc. This work involved high-power testing of waveguide windows that were treated by a proprietary process to suppress electron multipactor effects. The RF group provided high-power S-band rf test stand facilities to test the windows at nominal rf power levels and collected operating data. The project was completed in time to meet all project deadlines.