ASD Quarterly Bulletin
April - July, 2016

This bulletin is one month late and thus covers the four-month period. In the reporting period many of ASD employees were busy with the APS-U Director's review and DOE CD-3B review. Both reviews were very successful. On the operation side, the machine performance has been very good resulting in the 99.1% Machine Availability and 140.4 hours of the Mean Time Between Faults (MTBF) at the time of writing, July 28. Several other developments and events took place in the last four months and are highlighted here.

The Accelerator and Operations Group

AOP group members completed development of fully automated user steering. Presently, APS users can execute orbit steering without interaction with the MCR. APS became the first light source in the world that allows automated user steering.

AOP members participated in several APS-U related reviews: Injector Beam Physics Review, Machine Advisory Committee meeting, and Insertion Devices Preliminary Design Review. They gave over 10 talks and contributed to other talks. Group members also participated in helical SCU Physics Requirement review and SCU18-2 Installation Readiness Review. Physics Requirements Document was developed for SCU18-2.

In other developments, it was found that the old Booster lattice (132 nm emittance) allows for much more stable operation with high beam charge. This lattice is presently the most promising lattice for achieving high-charge operation required for APS-U. Work on APS-U design is also ongoing. New lattices are being studied. Injection simulations were improved and tolerances on the pulsed magnets were updated. Magnet error and vibration tolerances for storage ring were also refined. Simulations of the Booster injection were developed that confirmed better injection for the old Booster lattice.

A lattice with reduced horizontal beta function at Sector 7 for installation of the helical SCU was developed and tested in studies. Several software programs were developed and updated to support hardware modifications in the injector and future interleaving operation. A new program for providing SCU operational statistics was written.

The Magnetic Devices Group

During May shutdown preparations at Sector 4 to accommodate larger canted angle have been made. At the same time the CPU has been taken to Bldg.314 where its mechanical systems have been thoroughly cleaned. The SCU18-2 has been comprehensively tested and prepared for the installation on the ring. The SCU18-2 Installation Readiness Review is scheduled for July 8. The short, 0.3-m HSCU prototype has been fabricated: it includes the machining of the core, winding and epoxy impregnation. The cryogenic testing is scheduled for July. All major procurements for the APS HSCU are in progress: the core is in the production at the Hi-Tech, order for cryocoolers is in place with Sumitomo and the cryostat fabrication has been awarded to Anderson Dahlen, MN. The design of the eXLEAP wiggler for LCLS has started.

The Power Systems Group

Operations

There have been several storage ring power supply failures. Two of them were counted for beam losses and others only contributed to down times. One of the failures was caused by a partially failed 5V control power supply in a corrector power converter. We have experiences a few converter control power supply failures recently. This could be a sign of the end of lifetime for those commercial power supplies.

We have made a lot progress in the project to upgrade the IGBT in the quad power converters. We expect to complete the project before the end of this fiscal year.

APS-U
We completed the first prototype bipolar power supply controller. The controller was tested with a fast corrector power supply.

Prototype fast corrector power supply
and power supply controller

A power supply preliminary design review was conducted in May with external reviewers from SLAC, BNL, and FNAL. Also presented the power supply designs and R&D in the APS-U Advisory Committee Meeting in June.

We have been busy with constructing eight fast corrector power supplies, four power supply controllers, and four relay racks for the Beam Stability R&D. All these components are schedule to install in sectors 27 and 28 during August/September shutdown.

The RF Group

General RF System Operation
As of 6/30/16, the rf systems have experienced four trips since April 1st.

Linac-PAR
Linac accelerating structure #016 was successfully straightened and installed in L2:AS2. Accelerating structure #018, which was removed from L2:AS2, has been fitted with supports and straightened, and is ready for bead-pull measurements and tuning. A performance issue that has developed with accelerating structure #016, or the associated waveguide windows, is presently under investigation. Support parts for Linac accelerating structure IHEP-01 are in production.

The HGS cavity was successfully tested and the test system was dismantled.

Work cable installation and hardware assembly necessary for additional rf envelope detector measurement capabilities at L2 was completed. Similar installation and construction activity is underway at the remaining Linac rf stations. BPM signal tap-off hardware was assembled and installed to provide timing reference signals to facilitate timing studies and enhance operations support.

New klystron focus power supplies were installed at L1 and L2. Preparations are underway to complete the installation of new focus power supplies at the last two remaining rf stations, L4 and L5, during the upcoming shutdown. Two new Linac klystrons are in production at the vendor, with expected delivery in September 2016 and mid-FY2017.

Response time measurements were performed on both PAR rf cavity tuner systems and LLRF feedback cards to gather performance data for the APS Upgrade effort. The PLC upgrade to the second Harmonic PAR rf amplifier was completed.

Booster-Storage Ring

Proof of principle tests with the new stepper motor hardware necessary to replace obsolete motors used in the 352-MHz rf systems were successfully completed at the RF Test Stand. Ongoing work on pc board layout and chassis design for support electronics is underway.

Thales klystron s/n 089036 failed in service at RF2 due to severe arcing damage to the output cavity coupling loop center conductor. It was replaced by rebuilt spare klystron s/n 089033.

Thales klystron s/n 089043 failed in service at RF1 due to a shorted cathode heater. It was replaced by rebuilt spare klystron s/n 089024.

The RF3 circulator load failed due to internal defects and was replaced with a spare.

350-MHz RF Test Stand

The first of three EEV klystrons received from Los Alamos, s/n 02, was installed in the rf test stand and initially operated at 350.0MHz to a power output of 125kW to confirm operational status prior to re-tuning. One storage ring tuner was successfully conditioned to 100kW cw in the rf test stand.

Solid State RF Development

Production drawings for the 12kW cavity combiner were completed, and a P.O. was issued to a vendor to fabricate the hardware.

Multi-Purpose Amplifier Conversion to L-Band

The conversion of the Multi-Purpose Amplifier (MPA) to L-band operation was completed, and the system produced 12kW of cw rf power into a load. The MPA was then dismantled, shipped to the Physics Division test stand, and reassembled to provide rf power to test the harmonic cavity input coupler for the APS Upgrade. Testing of the coupler is presently underway.

The Diagnostic Group

We have completed initial testing of the MBA feedback controller in spring of 2016 with assistance from controls and power supply groups. Figure 1 shows the layout of the so-called 4x4 test in sectors 27 and 28 of the SR. In green are shown the new orbit feedback hardware including the feedback controller at the heart of the test. Four insertion device "P0" bpms are connected to commercial Libera Brilliance+ bpm electronics from Instrumentation Technologies Solkan, Slovenia to obtain beam position for processing in the feedback controller. The feedback controller receives the turn-by-turn or 271 kHz beam position data, decimates it by twelve to 22.6 kHz and processes it to obtain corrector set points. The corrector set points are then applied using a new "CMPSI-II" interface between feedback controller and the existing fast corrector power supplies. The fast correctors used are the A:H3's and B:H4's in sectors 27 and 28. In addition the feedback controller is able to send its bpm and corrector data to a data acquisition system (DAQ) which allows the data to be captured and provides a convenient interface to perform step response measurements (at the 22.6 kHz sample rate). Additional diagnostics includes the mechanical motion control system (MMS) and GRID XBPM.

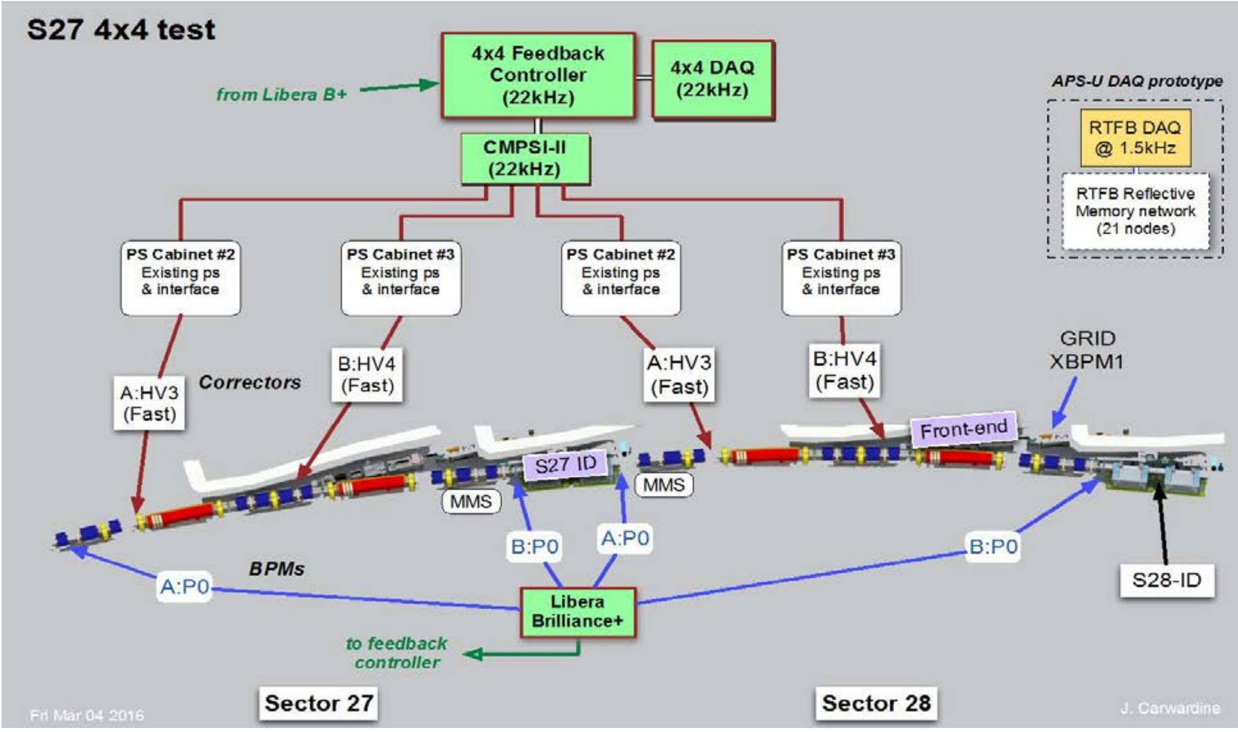

Figure12: Layout of the 4x4 test in sectors 27 and 28 of the SR. Shown in green is new prototype orbit feedback hardware used to perform the test.

The main goals for the test were demonstrating a proper function of all hardware and a higher sampling rate than in the existing real time feedback (RTBF) system. At the four test P0 bpms we achieved ~450 Hz closed loop bandwidth and an rms motion from ~0.1 to 450 Hz of 1.8 microns (see, Figure 2). This is a factor of 5 above the closed loop bandwidth of the existing RTFB system. These initial test results will inform design of the full integrated test planned for fall of 2016 as well as aid in refining the design of the system as a whole.

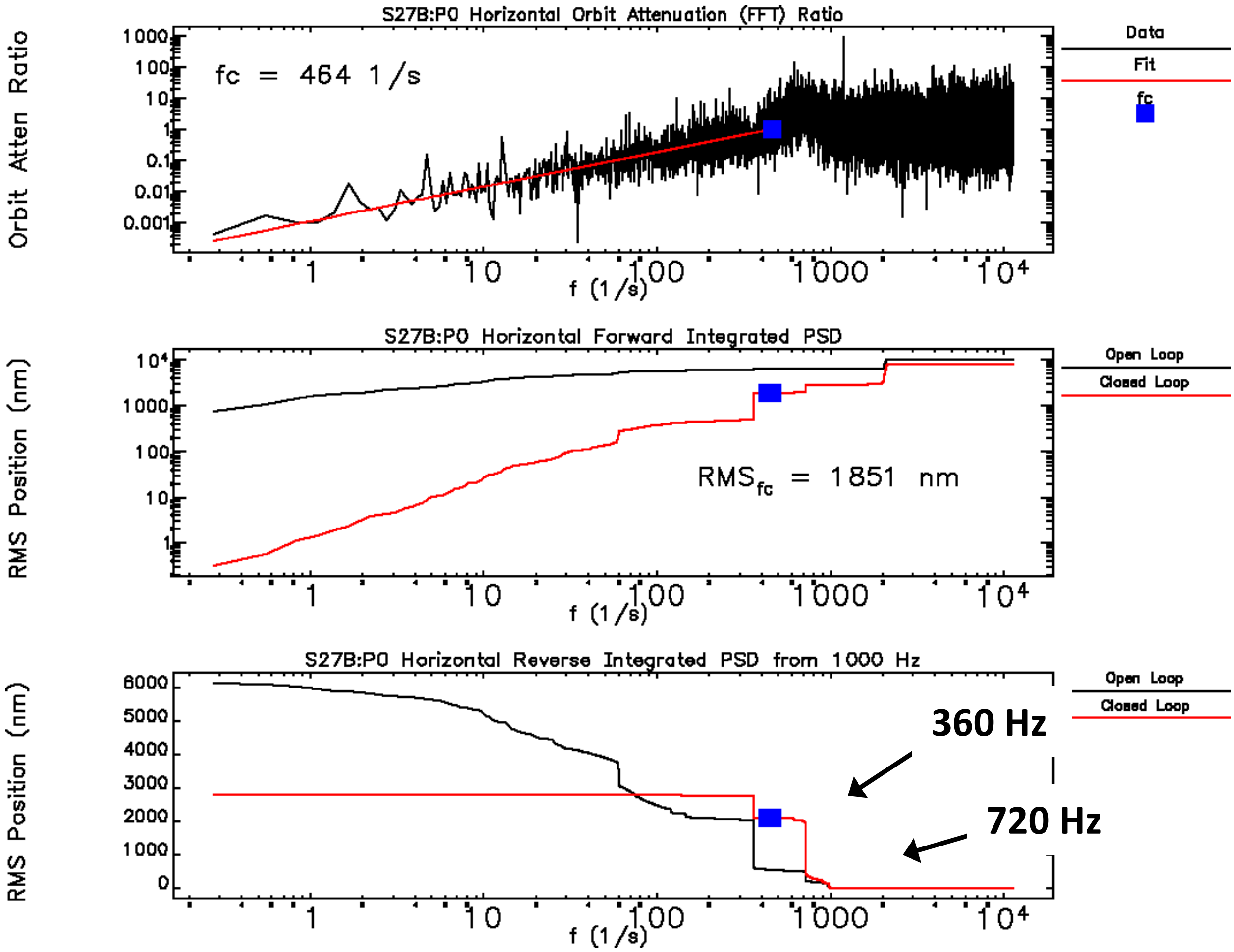

Figure 2. Orbit attenuation and closed loop bandwidth plot. for S27B:P0 (upstream ID P0 bpm). Top plot: Orbit attenuation showing closed loop bandwidth cutoff frequency of 464 Hz. Middle plot: forward integrated PSD indicating 1851 nm rms motion to the closed loop bandwidth cutoff frequency. Bottom plot: reverse integrated PSD starting at 1000 Hz showing amplification at 720 Hz and attenuation at 360 Hz.