Accelerator Systems Division provided excellent support for APS operation and finished Run 2016-2 with 105 hours of the Mean Time Between Faults (MTBF) and 98.5% of the Machine Availability. Several other developments and events took place in the third quarter of 2016 and are highlighted here.

The Accelerator and Operations Group

AOP group members worked on the design of various ASP-U systems: a) performed simulation of particle losses that informed the design of the beam collimation, b) started analysis of the effects of insertion devices on the beam dynamics, c) completed realistic simulation of MBA lattice commissioning, d) simulation of ion effects that showed that the ion instability in long bunch trains can be suppressed by using short gaps.

The work on achieving high charge in injectors continues. A running average PV for beamline current monitor was developed (with Controls group) to allow the PAR to operate at high charge without exceeding the safety envelope. Then, the approval for injector operation with increased charge was secured. The work on studying the beam loss patterns in PAR using fast beam loss monitor continues. 10-nC bunch was extracted from the Booster after switching to 132-nm lattice. Simulation of the booster injection with up to 20 nC is ongoing.

Group members actively participated in DOE CD-3B review of APS Upgrade and in other APS-U related reviews.

A software protocol for reporting problems with the quality of the x-ray beam experiencing by the beamlines was developed. This software will facilitate the MCR response and resolution of the problem. It will go in operation in October.

The extensive investigation of the SR kicker timing jitter was conducted to pinpoint the misbehaving power supplies.

Among other things, the group members participated in installation and commissioning readiness review of Sector 6 SCU. The device was commissioned with beam without any issues. More information about this SCU is in the next section. AOP group also has started commissioning the transverse deflecting cavity in APS linac. The first vertically streaked beam was observed.

The Magnetic Devices Group

During the September shutdown, a new 1.1-m long APS superconducting undulator SCU18-2 was installed in Sector 6 successfully, replacing the first APS superconducting undulator SCU0. Undulator SCU18-2 was cooled down, filled up with LHe and then trained. The commissioning with the beam is in progress. Undulator SCU0 was removed from the Sector 6 after serving the APS users for 3.5 years. The second operational superconducting undulator, SCU1, in Sector 1 completed its regular maintenance of two top cryocoolers. The device has been cooled down and filled with LHe. The magnet has been trained to above the operating current.

Two short magnet helical SCU (HSCU) prototypes with 2-cm period length and winding diameter of 15 mm have been fabricated and tested in a vertical LHe cryostat. The designed on axis field of 0.6 T has been achieved. The two 300-mm helical cores with the final period of 3.15-cm have been delivered. Superconducting wire winding is in progress. Four cryocoolers for the HSCU have been received. The cryostat for the HSCU is being fabricated.

ANL director's CD-3B review and DOE CD-3B review for both the conventional magnets and IDs have been completed successfully. The final design review for the Q1 and Q2 magnets has

been completed. The FODO magnet weights have been ordered. DMM measurement and testing is in progress. Results show that the crosstalk between the magnet components is negligible. DC magnetic measurement on the 8-pole corrector has been completed and agrees well with the calculated result at BNL. The corrector magnet has been received for verification.

MD group began working on the modification of the decommissioning APS wiggler A for the xLeap project at LCLS/SLAC. Design review has been completed successfully. Final design has been completed and approved. The magnet/pole keeper and other mechanical components is being fabricated. Magnets from APS wiggler A has been removed, sorted, and re-grouped. Gap separation mechanism preparation is in progress.

The Power Systems Group

There were eight beam losses in the last run caused by power supply failures, very untypical and resulting only with 209.8 MTBF hours for power supplies. Two of the power supply failures were due to excessive time jitters in the storage ring injection kickers. The cause of the jitter was the thyratron in the kicker. The thyratrons in IK2 and IK4 kickers were replaced during the shutdown. Other six beam losses were caused by failures in the quadrupole, sextupole, and corrector power converters.

PS group have completed upgrading the IGBTs and related hardware components in the quadrupole power converters. This upgrade must eliminate the IGBT related failures in these power converters.

It had been notices that the frequency of failures of control power supplies in the SR converters began to increase. The failures were likely caused by the equipment aging. The group replaces the failed control power supply as it happens. A more proactive approach may be necessary if the same type failures will persist.

PS group completed the R&D for the fast corrector power supplies and the bipolar power supply controllers for APS-U. Eight power supplies and four controllers were constructed for the Beam Stability R&D. Those power supplies and controllers were installed in four relay racks with A/B select switches to switch the magnet loads between the existing corrector power converters for the normal operation and the new fast corrector power supplies for the stability studies. Those relay racks are installed in sector 27 and sector 28.

The RF Group

The rf systems experienced one trip in Run 2016-2, ending on August 23rd, completing the run with 0.15% downtime and 511 hours mean-time-between-faults.

Linac-PAR

Linac accelerating structure #016 was damaged during start-up for Run 2016-2, but remained in service until the end of the run. Accelerating structure #018 was straightened and tuned during run 2016-2, and was used to replace the damaged structure #016 during the August-September 2016 maintenance shutdown.

The fabrication of spare waveguide pieces for the test stand and general spares is underway. Two new WR284 waveguide switches were received from the vendor.

The first new low-level rf power supply chassis prototype was designed and built, and is undergoing tests. A phase measurement, readback, and control system was implemented at L6 to aid in operation of the T-cavity. Twenty VXI D10 daughter cards were received and made

available as spares. Testing and calibration of the VSWR module at L2 was started, and parts were ordered to build one spare vector detector card.

The L5 klystron was replaced due to end-of-life issues at 61,500 operating hours. Replacement of all original klystron focus power supplies with new units was completed.

The second Harmonic PAR amplifier was upgraded to PLC control and installed during the August-September 2016 maintenance shutdown. Assembly of five new Fundamental PAR driver amplifiers is underway, and design of the first prototype replacement driver amplifier for the Harmonic PAR rf systems is underway.

Measurements were made on the Fundamental PAR amplifiers and cavity in support of high-charge injector studies.

Booster-Storage Ring

The original RF5 Matching Transformer was replaced with a new spare unit, and one complete matching transformer and enclosure was received. The installation of intelligent transformer monitors has been completed at all five rf systems. Concrete maintenance patching was completed on the T-R Set catch basins at RF1, RF2, and RF3.

Testing of the new stepper motors and drive electronics hardware necessary to replace obsolete motors used in the 352-MHz rf cavity tuning systems was successfully completed at the RF Test Stand. Production of boards for the first system installation has been started. One new stepper motor was temporarily placed at the Sector 36 rf cavity location in the storage ring tunnel for a radiation tolerance test.

Thales klystron s/n 089043 failed in service at RF1 at 40,594 filament hours due to a shorted cathode heater, and was shipped back to Thales for a failure evaluation and quotation for rebuild. It was replaced by rebuilt spare klystron s/n 089024.

Construction of one spare storage ring tuner was completed, and two storage ring couplers are in the last stage of assembly prior to conditioning. Parts necessary to build one spare HOM e-probe damper have been received from the vendor.

HOM measurements from 800 MHz to 1.6 GHz were made on all four cavities in Sector 37, and two rf cavities in Sector 40 to inform studies for the APS Upgrade.

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 new storage ring tuner, ANL-27, was installed on the test stand cavity and is awaiting conditioning.

Solid State RF Development

Hardware pieces necessary to build the 12kW cavity combiner have been received. An assembly area is being prepared in Building 400A. A FY2017 work plan for the Solid State LDRD Project has been developed.

Multi-Purpose Amplifier Conversion to L-Band

The conversion of the Multi-Purpose Amplifier (MPA) to L-band operation was completed, and the system successfully produced 17kW of cw rf power to test the harmonic cavity input coupler for the APS Upgrade. Testing of the coupler was completed, and the MPA was dismantled and returned to Building 400A.

The Diagnostic Group

The booster beam dump Transverse Profile Monitor (pictured) was upgraded in support of the MBA injector kicker development R&D program. This electron beam imaging system will help to characterize the beam displacement produced by the newly installed BTX Kicker; providing higher resolution centroid tracking of the electron beam. A large format single crystal YAG:Ce beam conversion target replaced the original fluorescent screen material that inherently has the limitations of large grain size, saturation effects at high charge and a long decay time. The single crystal YAG and associated renewed imaging hardware will enhance our ability to resolve and measure nominal machine operations based electron beam profiles and the much smaller beam spot sizes at high charge as exhibited during MBA kicker studies. The hardware platform produced here is a first round prototype design that will eventually replace similar APS injector beam imaging stations addressing the needs and goals of the MBA project.

Booster beam dump (BTX) Transverse Profile Monitor prototype imaging hardware located under the electron beam vacuum pipe just upstream of the dump shielding wall.