

ASD Quarterly Bulletin **January – March 2015**

At the time of writing (April 3, 2015) the operational statistics is 90 hours of the Mean Time Between Faults and 98% of the Machine Availability. Beam stability issues were raised by users from Sector 19 and Sector 20 and were investigated. Data analysis is ongoing. Meantime, Diagnostic Group added sector 19 ID XBPM into datapool feedback after analysis showed that the noise on the XBPM was acceptable at the larger undulator gap. Also a working group with the representatives from the ASD and user community was established. Several other developments and events took place in the first quarter of 2015 and are highlighted here.

The Diagnostic Group

Continued testing of Libera Brilliance Plus (B+) BPM electronics both in the lab and in Sector 27. A test stand in the diagnostics lab has been built and automated testing of the B+ unit has been developed. Continued to work on implementing/simulating the Aurora receiver interface used to transmit data from the B+ unit to the Real Time Feedback (RTFB) double sector controller. Continued development of Brookhaven National Laboratory (BNL) NSLS-II double cell controller bpm as alternative to Libera BPM units. Continued design and simulation for the MBA integrated BPM electrodes and vacuum chamber in Microwave Studio. Continued simulation of present APS bpm buttons to resolve discrepancies between the various configuration sensitivities and calibration factors. XBPM alignment was performed on a number of sectors. A new XBPM motor controller was priced and initial assembly begun.

The RTFB development accelerated per the updated plan during this reporting period. The Schroff uTCA.4 chassis was received and the power supply and μ TCA Carrier Hub (MCH) were installed. The CommAgility AMC-V7-2C6678 was ordered during this reporting period. The AMC-V7-2C6678 is a high performance digital signal processor/field programmable gate array DSP/FPGA card. The new uTCA hardware represents the new direction for the RTFB upgrade development. Started development of a data traffic generator for the FPGA part of the uTCA development.

Developed a simple vacuum chamber feedback system using the Mechanical Motion Sensor position as the readback and a heater tape wrapped around the vacuum chamber stand as the actuator. Sub-micron control of the chamber position was demonstrated.

In Sectors 27 and 28 (27ID) changed measurement locations to allow us to see temperature of the chamber supports on the girders. In Sectors 19 and 20 (19ID) we are working to understand relationship of outside air temperature to 19ID and 19BM beam position. Worked with ASD/Diag technicians to remove rack temperature regulation system from SR BPM rack 38 and move this to SR BPM rack 19 and tuned the system.

A good progress has been made in commissioning the Sector 27 and Sector 35 XBPM system including data analysis to obtain gap dependent calibration factors that were implemented in the IOC as feedforward parameters. Proposed new design options for saving money in canted undulator Compton XBPMs. Performed R&D for various MBA beam diagnostics including design work for modifying 35-BMB front end for testing new absolute and relative beam size monitors. Performed preliminary synchrotron radiation and bremsstrahlung ray-tracing for the modified beamline. Worked on the simulation of x-ray interferometer and specified a program sdds fresnel (H. Shang of ASD/AOP) to generate x-ray diffraction patterns in 2-D space from a set of apertures specified by the user.

Continued work on a precision current source for MBA power supply DCCT calibration. Made improvements to the BESOCM and injector current monitor test set-ups, and continued investigation of BESOCM modifications for MBA injector high charge injector studies. Started analyzing surrogate stripline signals to function as a back-up for the Storage Ring DCCT.

Finished the re-engineering of APS thermionic RF gun. Based on the physical design and outside geometry, the side-coupled RF gun is optimized through the re-engineering. Simulation results are close to the measurement of the existing gun.

The Magnetic Devices Group

During the installation of the SCU1 at Sector 1 during last shutdown a vacuum leak in the vacuum chamber has developed. The device has been removed from the straight section and its original configuration was restored. The SCU1 storage ring vacuum chamber has been inspected and very noticeable cracks in both bimetallic flanges have been detected. The repair of the vacuum chamber has been completed with both flanges replaced. The device has been reassembled and tested cryogenically and magnetically. SCU1 will be ready for the installation on the ring in April-May shutdown.

The revolver undulator for the Dynamic Compression Beamline in Sector 35 is under assembly. It will be ready for the installation in the forthcoming shutdown.

The prototype 1.5-m long SCU is under construction within a framework of joint efforts with SLAC and LBNL to develop the SCU suitable for the Free Electron Lasers. All magnetic cores have been wound and are ready for the epoxy impregnation. Both high and low current leads systems have been assembled and successfully tested. The project is staying on schedule for completion in July, 2015.

The contract to design and build a 3.4-m long permanent magnet undulator for the LCLS-II with the horizontal magnetic field and spring compensation of the field has been awarded. The procurement of long lead components has been authorized and is ongoing. The next important step is the undulator construction that is planned to be completed in summer. After that the extensive testing tuning of the device will follow.

MDG plans to rebuild the existing 1.8-cm period ID in order to install it in the future at Sector 29.

The Power Systems Group

Completed the planned maintenance work for the December/January shutdown; measured the water flow rate and cleaned the water filters for all storage ring raw DC power supplies; replaced the failed thyatron for the RG2 kicker, which failed on filament open circuit. The new thyatron has a faster turn-on time, resulting in the shorter kicker pulse and reduced electron beam charge passing through the kicker. The kicker pulse was increased by approximately 5 ns after the 14 foot long HV cable was replaced with an 18 foot long cable. Besides, PSG continued replacement of the old IGBTs in the SR quad converters utilizing the machine intervention periods on Tuesdays and continued to work on a new Booster kicker power supply. To date, the pulse shape has been tuned to meet the requirement by the Booster operation and the power supply has been pulsed up to 20 kHz on the test stand.

PSG continued evaluation of the stability of two commercial power supplies Danfysik 9100 and TDK-Lambda Genesys for the APS-U. The Danfysik 9100 is a current-regulated power supply while TDK-Lambda Genesys runs in the voltage mode and maintains the constant current with an external regulator. Both power supplies and configurations achieved a current stability of less than

1 ppm RMS of 200A during a 7-day run test. The FID fast pulser, a prime candidate for the injector kicker power supply, accumulated more than 60 million pulses at 20 kV before it failed, which is equivalent to more than 11 years in operation. The failure was caused by an under rated capacitor and the manufacturer replaced it with a more reliable capacitor from a different supplier.

The Accelerator and Operations Group

The Accelerator Operations and Physics group dealt with several operational issues during this run. First, the newly installed ID4 small-gap vacuum chamber was measured to have smaller gap than expected by about one millimeter. This resulted in lower injection efficiency and difficulties with top-up operation. A special optimization of sextupoles performed by M. Borland around ID4 allowed to recover the injection efficiency and lifetime. After that, various measurements were performed that confirmed the reduction of the gap of the ID4 chamber. The reason for a reduced gap was not understood and will be investigated during the next shutdown.

Besides, AOP assisted the DIAG group in investigation of the beam orbit motion at 19ID and its improvement. Extensive work was done in supporting injector operations. The operation of the spare gun RG1 was optimized and improved. As a test, the RG1 gun was used for operation during the last week. Also, a 30 microsecond jitter was identified and corrected in the booster main ramp current digitizer trigger, which resulted in 20% reduction in booster dipole ramp errors and significant improvement in booster beam stability. The drive laser alignment was completed for the photocathode gun and this gun can now be used to generate high-quality electron beam.

AOP members continued working on APS Upgrade project. Injection simulations were completed and added to the CDR, work is ongoing on Touschek beam loss simulation and analysis to identify locations of the particle losses. To understand possible high-current limitations in the Booster, an impedance model of the booster cavity was built to use in simulations and for comparison with experiment.

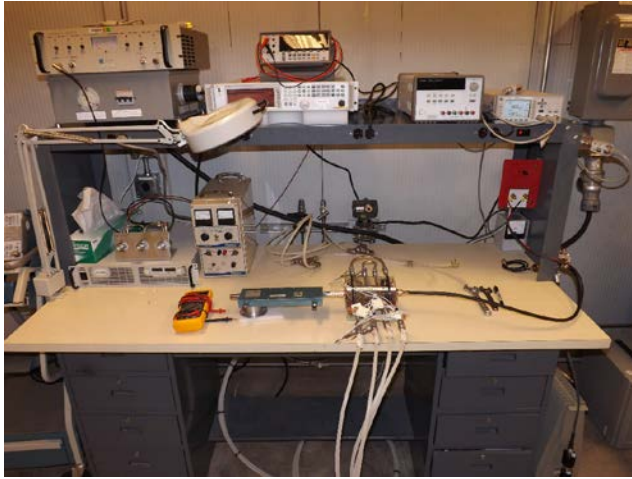
U.S. Patent 8,951,671 was awarded for ternary acetylides as alkali-metal intercalation electrodes for batteries with K. Harkay as co-inventor.

The RF Group

Dealt with several operation issues including L2 and L4 modulator failure, RF4 mod-anode regulation problem and RF sideband instability at RF2 which caused a beam loss. The group investigated that cause of a 1.8 kHz noise line seen on the storage ring beam DCCT output. This investigation included measurements on RF3m RF4, and RF5 to determine if the rf systems were the source of this noise. Measurements indicated that they were nor the source of this noise. The group conducted PAR RF systems studies to track down an apparent gain loss in the Harmonic PAR amplifier #2 chain. Investigation on RF1 trip on Crowbar was traced to an open resistor which was replaced.

Several in-house repairs on malfunctioning RF Group test equipment were completed, including a network analyzer, the IFR Service Monitor, a Wavetek pulse generator, an HP arbitrary function generator, and a Tektronix TDS3054B oscilloscope. One rf generator was sent to Agilent for factory repair and calibration.

A solid state rf laboratory was set up in Building 400A. Dedicated kilowatt-level calibrated test systems were assembled for 9.77MHz and 352MHz testing.



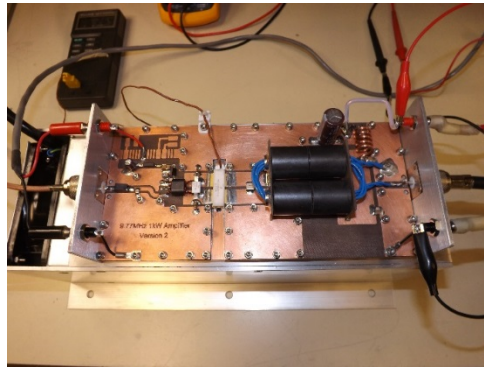
Calibrated solid state rf power test bench
in Building 400A.

Progress has been made on development of an in-house design for a prototype single-device 352 MHz solid state amplifier with a target output power of 2 kW cw. Simulation tools were used to complete the in-house circuit design, and hardware has been ordered to build the first prototype for testing.

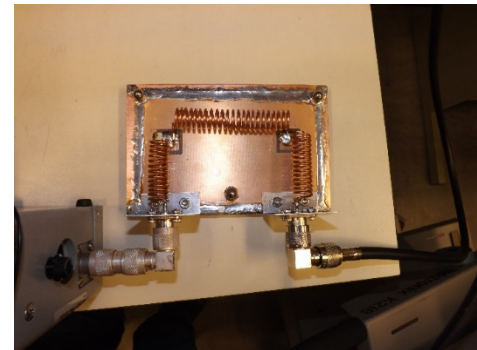
Significant progress has been made on a new in-house design for a driver amplifier that will replace the existing obsolete amplifiers presently in use in the Fundamental PAR rf systems. The new amplifier utilizes the Freescale MRFE6VP61K25HSR5 LDMOS field effect transistor, which can also be used as a kilowatt cw device at the two other APS

frequencies, 117.3MHz and 351.93MHz. Two prototype 9.77MHz amplifiers have been built and tested, and both have demonstrated performance that will be acceptable for the Fundamental PAR application. The highest power output achieved was 1,170 watts cw at an efficiency of 75.4%, which required an rf drive level of only 1.9 watts. The second prototype was also tested with an output harmonic filter, demonstrating an efficiency exceeding 80% at an rf output level of 411 watts cw and a drain voltage of 30 V. The very high efficiency makes it possible to utilize air cooling for the PAR application up to a power output of 400 watts cw.

APS-U work has been started to convert the Multi-Purpose Amplifier (MPA) to L-band operation by fitting it with a CPI L-band IOT. The MPA will be utilized to provide a nominal 20 kW cw of rf power for testing the



9.77MHz/1kW prototype
amplifier #2



9.77MHz output Harmonic
Filter

Bunch-Lengthening Harmonic Cavity coupler. The input cavity/cover assembly for the CPI L-band IOT has been sent to CPI for replacement of a damaged high-voltage blocking capacitor. Modification of the MPA itself to accept the L-band IOT has been started.