Source Group Status

12/8/15

**CEBAF-related**

5 MeV Mott: Much progress on what we’ve been calling Campaign#1, “assigning an uncertainty to our beam polarization measurement”. To date, we have collected two full sets of Asymmetry versus Foil Thickness measurements, where “two” relates to measurements made using beam from two different photocathodes, and therefore different beam polarization. Both measurement sets were made with nominally similar beam energy, although measurement set2 was performed with a more thorough evaluation of beam properties. Extensive systematic studies were performed: asymmetry versus beam position on foil, beam energy, beam size, beam current and dead time. Detailed assessment of where to apply energy cuts has been performed. The thickness of sibling target foils was studied using AFM. Marty has made great progress on the GEANT4 model including single and double scattering required to model the polarimeter analyzing power. An excellent test of the model will be to predict asymmetry versus energy cut. Joe and Charlie are now working to write this up for PRST-AB or Phys. Rev. B. This will conclude a 3 year effort to upgrade the Mott polarimeter and test its precision using an integrated model. Anticipated completion date is early March.

PEPPo: All of the positron data has now been analyzed with preliminary estimates of positron polarization above 70%. The final effort is to refine the GEANT4 model of the apparatus to improve the simulation of the Compton transmission polarimeter analyzing power for positrons. Maurizio Ungaro of Hall B stepped in to help incorporate the refined magnetic and polarization field maps and Riad beta-tested a recent CERN update of GEANT4. Once completed Leke should be performing start-to-end simulations on the JLab computing farm of positron production/collection and polarimeter response over the next 1-2 months. The Nature pre-submission was rejected, Joe and Eric now working on a paper to PRL anticipating submission in February.

Bubble Chamber: An engineering run was successfully completed. Learned many things, including:

The chamber operated as expected with Bremsstrahlung beam, measured 18O(γ,α)14C cross section at five energies, found sensitivity as expected to 14N(γ,p)13C when lowering operational pressure and measured cosmic background in fiducial volume of about 1 bubble every 15 minutes inside the JLab tunnel, which is one order of magnitude smaller than measured at Duke or Argonne due to 15 ft of soil and water shielding at injector (which is good). Data analysis is ongoing.

By the end of test, we noticed the background rates increasing very rapidly due to oxidation of mercury. When we vented N2O gas and filled with a fresh sample, background rates went down but for only few hours and then started to rise again. We hypothesized that x-ray radiation was causing mercury to oxidize and dissolve into the N2O causing bubbles. We removed the chamber from the injector and shipped back to Argonne. We are planning to get rid of mercury and use only N2O as both the active target material and the buffer liquid. We have a few other modifications and improvements to implement before bringing the chamber to JLab for the next test in June 2016.

One other problem we are facing is how to reliably measure the beam energy after the ¼ cryounit. In October we developed and tested a procedure and now Joe needs to write it up - measuring and setting the beam energy at the CEBAF MeV injector. This should be reviewed by Kazimi and CASA and submitted as a TechNote

Brock cavity bunchlength monitor: We are wrapping up the assessment of the cavity at location immediately downstream of aperture A1. The cavity can resolve bunches as short at 60ps at 130kV beam energy, and ~ 38 ps at 500kV. Wes Moore is going to evolve the existing data acquisition software so that the off-line analysis presently performed by Mahmound can instead be done on-line to show a real-time plot of the electron bunch length for the Operations Department. The installed Schottky diode is sensitive to two beams and provides a simple means to phase up the lasers, even showing when two beams are coincident in time, which is a nice Ops feature when using 249.5 MHz lasers. We want to test the two-beam cross correlation method at MeV energy, where maybe this provides a means to measure sub-picosecond bunches. The paper is nearly complete, to be submitted to PRST-AB before end of calendar year 2015. We are interested in using this cavity to measure beam charge asymmetry for parity violation experiments, although it will still see all beams. We are also interested in seeing if this cavity provides a means to implement Slava’s resonant polarimeter idea. Perhaps at start up during January/February 2016 we can make parity measurements versus Wien angle and with pockel cell ON/OFF, this could be interesting.

SVT photocathodes: Two new photocathode samples from sbir-partner SVT were installed inside the gun2 preparation chamber. One sample - GaAsSb/AlGaAs - is supposed to provide longer operating lifetime. Inside the miniMott, at 780nm (our CEBAF laser wavelength), it yielded ~ 80% polarization and QE ~ 1.5%. Sample#2 is a GaAs/GaAsP strained-superlattice photocathode grown atop a distributed Bragg reflector mirror. It provided 90% polarization QE 0.7% at the miniMott. This QE value is lower than expected, because the photocathode parameters where not optimized for our 780nm wavelength. New material will be arriving soon, hopefully with enhanced QE at 780nm. Regardless, testing these new samples is an important step for us, cross comparing miniMott results to accurate 5 MeV mott. And of course, seeing 90% polarization at CEBAF represents a huge milestone, the highest polarization to date. Maybe an opportunity to evaluate these new photocathodes during machine start-up January/February 2016? We would also want to take the tunable white light laser to tunnel to map QE spectral response, inside the prep chamber. I think we need to push to make this happen, as Wei needs sufficiently interesting material to support his thesis.

CEBAF operations and shutdown schedule: There’s a posted CEBAF schedule on the web and it is ambitious. Following the holiday shutdown, Machine restoration begins January 28, 2016. WE enjoy about three months of 2 and 3-hall operation through April 13 (Hall A, D round the clock, and Hall B during weekends). There’s a two week down at the end of April for Cryo work and PSS recertification (maybe Bubble can be installed during this down time?). Then 1GeV PRad happens at Hall B during May. Then Bubble Chamber starts a test run which lasts through June 19. The formal summer shutdown starts June 20 through August 14. During this period the 4-laser installation occurs – John will need to add 4th laser and reconfigure the laser table, and Tomasz Plawski and RF group will need to provide 4 spigots of 250/499 MHz, Roger Flood will need to deploy SCAM-II module which allows for beam modes for 4-lasers, and Henry Robertson will need to verify PSS controls to lasers. At the end of August, Bubble gets two more weeks of beam and then CEBAF start up to resume physics experiments at three halls with tentative plans for four hall operation December 2016.

**LERF Related**

The 350 kV vent/bake gun and drive laser at the LERF performed well enough to support the recent LERF re-commissioning run, although photocathode QE fell from nominal 2.5% to 0.4% while in tune mode. Everyone agrees we need to perform a photocathode heat clean before the next run to get better QE and lifetime. And it will probably help to operate the ¼ cryomodule booster at a lower gradient to reduce the field emission, which poisons vacuum and enhance QE decay via ion bombardment. The drive laser lost lock to the machine typically X times per day.

The next run will be in early May and most of the time in tune mode, with just a few hours of CW operation. After that, the Dark Light physics run happens in the summer. The first part will be a low energy scattering experiment, which only requires about 10-100 uA CW. The second part with internal target requires CW for long periods of time. The plan is to restore gun operation to 2012 performance (4.5mA/8hrs, 30% DL power), cesiate the photocathode every day and perform a heat clean once a week. We need to deliver ~ one to two kilo-Coulombs per week. This will require lots of CIS manpower.

Long term, we want a load locked gun with alkali-antimonide photocathode. We hope the gun can be a clone of the UITF gun. And we would like to replace the modelocked TimeBandwidth master oscillator laser with a gain-switched diode laser and fiber preamp.

**GTS**

GTS - new 350kV high voltage gun with inverted insulator: Since summarizing the insulators and electrode configurations for the IEEE paper, Yan, Bubba, John and Phil have tested four more insulator configurations. a) white R30 insulator coated with black material by SCT, b) the same coated insulator from SCT but with coating removed in a spiral geometry in an attempt to increase the resistance, c) a black bulk conductivity R30 insulator that seems to have been made with the wrong recipe because it was too conductive, and d) the black bulk conductivity R30 insulator we wanted SCT to fabricate for us originally. All of these tests were performed with the dummy ball and no shed. The first three tests were disappointing, namely because the coating and bulk material were too conductive. This lead to excessive current across the insulator and heating of the plastic HV cable connector. The fourth test with new black bulk conductivity insulator was deemed a success although Yan and I pushed it too hard, resulting in a puncture of the insulator wall. However, because we reached 360kV with new insulator, and because the current draw was acceptably small, we asked SCT to make four more insulators, and these are now in our possession.

Carlos, Yan, Phil and Bubba constructed a DPP-d stainless steel electrode + shed, with internal components that hold a GaAs photocathode puck, all mounted to a white R30 insulator. And the large anode with five holes was added to the gun at the GTS. This represents our first high voltage test with a spherical electrode and anode that could actually be used to make beam. The gun bakeout went smoothly and they are now high voltage conditioning the gun. Field emission has been problematic, but they have reached 330 kV with krypton. We would like to shift our focus from high voltage conditioning, to making beam. As such, we are willing to stop high voltage conditioning and content ourselves with gun operation at ~ 320 kV or even lower.

More parts have arrived for the CsK2Sb deposition chamber. Joe Meyers is wrapping up the solenoid field mapping. Soon we will bolt the gun to the floor, attach the beamline, and start making CsK2Sb photocathodes.

GTS - Magnetized Beam: Riad was awarded LDRD funding to study magnetized beam. In order to get continued funding, we need to be making beam at GTS with new gun and CsK2Sb photocathode by ~ June 2016, and we need to have characterized the GTS gun/photocathode lifetime and we need to purchase the gun solenoid/Helmoltz coil pair by October 2016. The Plan: wrap up gun high voltage conditioning soon, settle on a gun voltage without field emission, attach the simple VA beamline to gun, start building the CsK2Sb depo chamber, bolt everything to the floor. Make cathodes in depo chamber, connect beamline components to epics, deliver dc beam to the dump. Measure gun lifetime, measure thermal emittance vs gun voltage and other relevant parameters. Then if possible, setup our second gun chamber and build a second electrode + shed, attached to black R30 insulator, use GP500 pump in place of anode, condition this gun in the evenings when not making beam.

**UITF**

New money has arrived, priorities have been assigned, troops are marching again. Top priority, apply high power RF to a cold ¼ cryomodule. For this to happen we need Cryo Group to plumb in the ¼ cryomodule to the CTF, we need facilities to provide electricity to racks, we need klystrons and rf control, we need network connections and software, we need an ODH system, we need a PSS. Groups are making progress. In addition, we want cable trays and we want to build the keV beamline.

Of note, the new ¼ cryomodule will be complete during January 2016. It seems more and more appealing to commission UITF with this cryomodule, which means the gun voltage only needs to be 200kV (we have a gun that provides this beam). HDIce has determined it will be better to flip the orientation of the target, so that beam hits the backside of the target first. This development comes from GEANT studies by Charles Hanretty, spurred by our 5 MeV Mott experience. John is working to package the 400kV power supply inside the SF6 tank.

**Global R&D**

Photocathode studies: Wei has evaluated two new GaAs/GaAsP photocathodes and measured very high polarization via miniMott, 90% at 780nm. One photocathode sample was supposed to have a DBR, however there was no observed QE enhancement. Both samples were returned to SVT for x-ray diffraction measurements, to see if indeed the DBR is missing. Wei has also measured QE and polarization from a bulk GaAs sample with 111 cleave plane. And he has measured QE of three bulk GaAs samples inside the H1 chamber: cleave planes 100, 110, and 111. The goal of this work is to identify bulk GaAs cleave plane that provides highest QE, highest polarization and to investigage if one cleave plane provides longer operating lifetime as a result of ion “channeling”. H ion implantation will be performed using hydrogen dissociator.

Mamun and Edgar Morales successfully grew CsK2Sb photocathodes on niobium substrates and evaluated QE spectral response at room temperature and 77 K. It appears QE decreases when substrate and photocathode are cooled due to bandgap shift (expected) and also due to adsorption of contaminant gasses on photocathode surface (bad). A good summer project that should be revisited.

Vacuum Studies: Marcy and Phil built a cryopump using boron nitride nanotubes obtained from BNNT and Kevin Jordan. Initial tests are very promising, indicating BNNT offers good pump speed, and a means to eliminate water from the cryopump via bakeout (no epoxy + charcoal). Marcy is working with Kevin to install more BNNT material (more pump speed, better pump capacity) and with retaining material that will cool material to lower temps.

**Papers**

1. Carlos’ paper on high voltage studies of insulators and electrode configurations was accepted for publication, scheduled for the February 2016 issue. IEEE Transactions on Dielectrics and Electrical Insulation.
2. Mamun’s long paper on alkali-antimonide photocathode fabrication using an effusion source was approved “with mandatory revisions”. He is nearly done with revisions and will send back to JVST-A for re-evaluation
3. A draft paper describing CEBAF characterization of the harmonically resonant cavity as bunchlength monitor has been written and distributed for comments. Fine tuning figures and some final proofing required. Hope to submit for publication by end of 2015. PRST-AB.
4. Marcy has sent out a vacuum shop note for editing, to be submitted to JVST.