Jefferson Lab
Thomas Jefferson National Accelerator Facility
Exploring the Nature of Matter

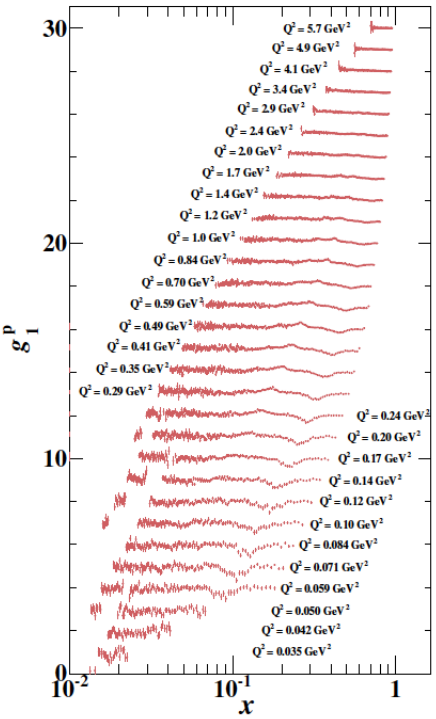
December 30, 2017

Dear Hall B collaborators

2017 has been a very successful year for Hall B. As we are about to enter a new year I like to take a look back at some of the highlights of 2017. Before I do this I like to welcome all new members who have recently joined one of the Hall B experiment collaborations (CLAS, HPS, PRad). Most importantly, with the approval by DOE of the Critical Decision CD4B, the JLab 12 GeV project, including CLAS12 are officially complete; a major accomplishment! Our reach in science continues to broaden with results from the 6 GeV era coming out unabated, while at the same time we have continued analyses of two high impact experiments searching for evidence of dark matter and trying to solve the proton radius puzzle

The 6 GeV science program

The Hall B collaborations continued the excellent harvest of science published in refereed journals with a record number of 20 publications as collaboration or as high-level analysis results. They include data with strong evidence for undiscovered or poorly known excited nucleon states, as a result of including many polarization observables in the search for new baryon states. Polarized electrons were also essential for the first exclusive DVCS results on Helium-4, and polarized deuterium and hydrogen target targets let to the final results of the study of the proton and deuteron and neutron spin-structures in and beyond the nucleon resonance region shown in the textbook-worthy results of the g_1^p spin structure function (graph).



Another measure of the collaboration's productivity is seen in the large number of talks given on results from CLAS, and preliminary data from HPS and PRad at international conferences and workshops. As education of young scientists is one of our missions, we can be proud that six PhD students graduated this year and over 30 PhD projects are currently in progress. Last but not least, the 2017 JSA Thesis Price was awarded to Priyashree Roy (FSU) with work on the FROST double polarization measurements in omega photoproduction with CLAS.

The 12 GeV Upgrade

PAC45 - Broadening of the science program

A new CLAS12 run group RG-L "Partonic Structure of Light Nuclei" consisting of 4 experiments were approved with 55 additional beam days. It represents a significant broadening of the science program by extending the nuclear structure studies on deuterons with BONUS to heavier nuclei. It requires design and construction of a new tracker (ALERT) for the CLAS12 Central Detector. Another proposal on J/ψ production and the search for hidden-charm pentaquark states was added to RG-A.

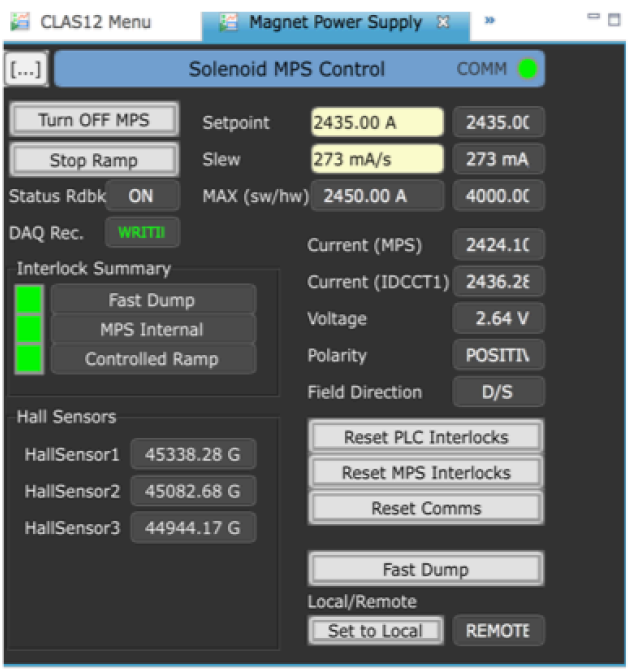
Base equipment

The main activity during the year was the completion and the commissioning of the entire CLAS12 detection system and of both superconducting magnets. In early February a short weekend beam run was carried out that demonstrated to DOE the achievement of the key performance parameter for the CLAS12 base detectors. The run was followed by the approval of the results by DOE just two days later. For the fall engineering run all base detector systems have been completed with the installation of the full Central Detector systems and the HTCC. Other, ancillary detectors, provided by CLAS collaboration institutions, have since been installed, and the forward carriage was moved into the final operating position. What is not visible in the photo though critical for the success of CLAS12 is the tremendous effort that went into the development and implementation of the entire data acquisition hardware and complex event selection programming software.

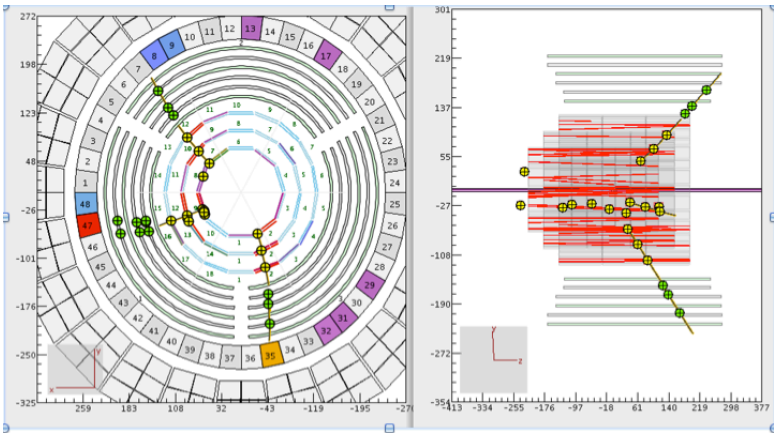
Superconducting magnets

The year 2017 also saw the completion, commissioning, and field mapping of the superconducting Solenoid magnet. A significant effort was needed, involving many groups across the Lab, to successfully complete the assembly, to carry out the pump out and cool down, and to finally energize the magnet to its full design current of 2416 A, and slightly beyond. This last step occurred on the 27 September 2017. With this both superconducting have reached and exceeded design specifications. It also completed officially the CLAS12 project and the entire JLab12 GeV Upgrade project. The magnet was then field mapped showing excellent agreement with the model projects. The photo shows the solenoid after full assembly, just before the cool down began. The right panel shows the maximum current achieved at the

current ramp up. With this successful ramp, the CLAS12 superconducting magnetic system has been fully validated.



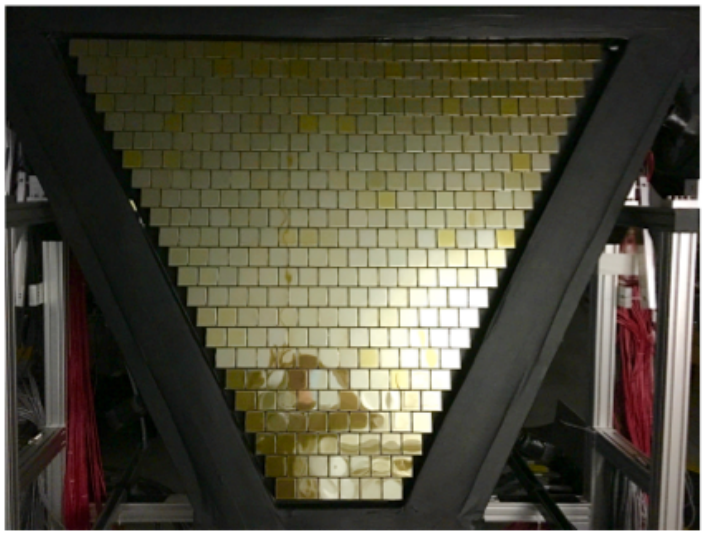
CLAS12 Engineering Run



The first beam run at 10.6 GeV occurred just before the holiday break, with the full CLAS12 base detectors and most ancillary detectors installed and operational. The graph shows one of the early multi-prong events as seen in the central tracker with tracks reconstructed in the SVT and the barrel MicroMegas tracker (BMT) taking with empty target, i.e. at low luminosity. Although good beam delivery was limited to a few days, the first part of the engineering run (second part to begin in January) allowed collection of data for the detector calibration, the study of luminosity dependence of tracking efficiency, magnetic field dependence, and other important tests. Data were taken up to the full projected luminosity of L = 10^{35}cm^{-2}s^{-1} with close to the expected occupancies in the drift chamber systems, excellent DAQ and trigger performance. The data are now being used for detector calibrations and to for possible adjustments in operational parameters,

such as high voltages, discriminator thresholds, time windows, etc., in preparation for the first CLAS12 experiment.

Extending the CLAS12 science reach



Many CLAS12 experiments require additions to the base equipment, such as the central neutron detector (CND) for neutron detection at large angles, two different sets of micromesh gas detectors (Micromegas) to improve resolution and efficiency of charged particle tracking at forward and at large scattering angles, the forward tagger (FT) for quasi-real photoproduction experiments at high rates. All of them have seen beam during the short engineering run. The RICH detector has been fully assembled and is currently being prepared for installation in CLAS12 early January. It will provide improved charged kaon identification in one sector. The photo shows the RICH multi-anode PMT plane of 25,088 readout channels.

Looking forward to 2018 and beyond

For the January 2018 engineering run CLAS12 will be fully operational, with both magnets and the detection system instrumented including all the ancillary equipment and the beam line components, including the Moller polarimeter and the cryogenic target. The software development for the detector calibration will continue to be at the forefront with a focused effort on completing a suite of fully tested calibration and analysis tools for the spring 1st experiment physics run in February/March.

Besides preparing for the first CLAS12 experiment, we have many exciting analysis projects ongoing that will continue in full strength and involve many students and senior researchers. We can expect first publications of the dark matter search with HPS, and perhaps a solution of the proton radius puzzle with PRad. In the coming years we may also expect new results in baryon spectroscopy, meson decays, nucleon structure studies, and for the first the pressure distribution of the quarks in the proton. Beyond the ongoing analyses, the data accumulated with CLAS are still rich with unexplored physics and provide great opportunities for new analysis projects for years to come.

As we are leaving behind the year 2017 that saw excellent science emerging, the completion of CLAS12, and first data taken at energies near 11 GeV, we are looking forward to the successful exploitation by the collaboration of the great potentials provided by CLAS12 for discovery physics. This is where the leadership, scientific curiosity, and energy of the collaboration

members are needed to enter a new era of hadronic and nuclear science towards addressing the intricate problems and challenges of strong interaction physics and the science beyond.

With all the best wishes for

Volker Burkert