Commissioning With Beam of the CLAS12 Spectrometer to Demonstrate the JLab 12 GeV Project Key Performance Parameters Version 4.0

October 31, 2016

Abstract

This document describes the procedures that will be followed for the commissioning of the CLAS12 spectrometer using electron beam induced reactions in order to demonstrate that the system meets the Key Performance Parameters (KPPs) as defined by the JLab 12 GeV Upgrade Project. The commissioning will consist of different phases, starting from low luminosity operation for the initial detector turn-on and functionality checks, to optimizing the detector settings, to data acquisition studies of the basic system response to charged and neutral particles coming from beam-target interactions.

This document is structured as follows: In Sections 1 and 2 the specific KPP parameters are detailed and the objectives of the CLAS12 KPP commissioning beam period are discussed. In Sections 3 and 4 the specific assumptions regarding which elements of Hall B and CLAS12 will have been commissioned and tested prior to the start of the KPP beam time are discussed along with the beamline and detector configurations. Section 5 provides an overview of the expected rates in the detectors for the KPP conditions based on Monte Carlo simulation studies. Sections 6 and 7 describe the different phases of the KPP run and the specific commissioning tasks to be completed along with the associated task timelines. Finally, Section 8 details the CLAS12 subsystem contacts, as well as the management and organization details for Hall B during the KPP beam commissioning period.

Contents

1 Key Performance Parameters (KPP)

The overall objective of the KPP commissioning with beam run is to verify that the new CLAS12 spectrometer is operational. The metrics toward this verification have been set by the JLab 12 GeV Project Management in accordance with U.S. Department of Energy requirements.

The beam conditions to demonstrate that the CLAS12 system is operational require recording events with an incident electron beam on the CLAS12 target of current $>$2 nA and with beam energy $>$6 GeV and at least 3-passes around the accelerator.

The demonstration of the CLAS12 KPPs requires meeting the following six requirements:

1. Detector running for 8 hours recording data for all subsystems.
2. Screenshots of beam status and/or accelerator e-log entries.
3. Plots showing relative timing of calorimetry, time-of-flight, and Cherenkov detectors.
4. Event displays showing correlated particle hits in the forward detectors.
5. Plots of particle trajectories showing the target position.
6. Particle identification plots using signals from calorimetry and Cherenkov detectors.

This list of six requirements must be met in order to officially meet the Hall B milestones for CD-4B and to close out the project. Because of the importance of this KPP run to Hall B and to JLab, this KPP commissioning with beam (CWB) plan has been developed to provide all necessary steps and requirements to demonstrate each of the KPPs.

Note that the list of studies necessary to fully commission the CLAS12 spectrometer before the start of the physics program is much more extensive than the KPP requirements listed above. To meet the needs to complete this more extensive set of studies to fully commission the new CLAS12 spectrometer, the KPP commissioning period will be followed at a later date by a longer and more extensive Engineering Run. The plans for the Engineering Run will be covered in a separate document.

As the six KPP requirements do not provide for rigid guidance as to exactly what will fully satisfy them, this document provides more explicit details on what plots, screen captures, and log entries are expected to be provided to the 12 GeV Project shortly after the completion of the CLAS12 KPP run. It is expected that with the data acquired during the KPP run, significant advances in understanding the CLAS12 detector will be possible. This includes a more detailed determination of the responses of the different detector subsystems in a realistic RF and beam environment.

2 Objectives

In general, the objectives of the Hall B and CLAS12 KPP commissioning procedures are 1) to verify the basic functionality of the CLAS12 subsystems and 2) to study the basic operational performance of the CLAS12 spectrometer, the data acquisition system, and the calibration and reconstruction software using beam interactions. These studies will allow checks of noise and background levels, as well as channel occupancies, in a realistic operating environment that can be compared against our simulation study results. A loose electron trigger configuration will be used to accumulate data with minimal bias. The data collected during these studies will be used to check initial calibrations of the CLAS12 detector systems to allow for charged particle tracking, as well as charged and neutral particle identification in order to satisfy the KPP requirements as detailed in Section 1.

After completion of the KPP commissioning with beam run, the functionality of the Hall B instrumentation, including the beamline, CLAS12 detectors, the trigger and data acquisition systems, as well as the CLAS12 online and offline software, will have been verified at a basic operational level. In addition, the collected data will ultimately allow for a complete calibration plan to be developed for the later CLAS12 Engineering Run.

3 Assumptions

The KPP commissioning plan was developed based on a given schedule for beam delivery to Hall B, on a specific configuration of the CLAS12 detector, and on assumptions concerning the accelerator and CLAS12 operation efficiency. The KPP run itself is planned for 2 calendar days in early 2017 and is to be preceded by a period of beamline commissioning. There have already been several non-CLAS12 experiments carried out in Hall B over the past several years that have allowed for commissioning of the beamline optics and instrumentation. During the beamline commissioning period before the start of the KPP run, it is assumed that all remaining procedures and studies necessary to tune the electron beam upstream of CLAS12 and to send it through the target location to the Faraday Cup will have been fully completed. These studies must be carried out with the torus magnet energized and the nominal CLAS12 requirements for beam transmission, beam spot size, and beam-related backgrounds must be met. Because of the beamline studies already completed and those planned during the beamline commissioning period, no time is included in the KPP plan for beamline commissioning or instrumentation calibrations, and only minimal time is allocated for final beam diagnostics related to demonstrating the KPP requirements.

Prior to the start of the KPP run we assume that the correct functioning and initial calibrations of the CLAS12 detectors will have already been established based on the calibration procedures performed before beam delivery and involving, for example, cosmic ray data taking. These studies have been fully detailed in the CLAS12 Commissioning Document [1]. Completion of the initial detector calibrations before the start of the KPP run necessarily assumes the data acquisition and trigger systems have been tested at a basic level and that the Slow Controls system, the alarm handler, and the detector monitoring software are operational. We also assume that the testing and commissioning of the CLAS12 torus will have already been completed. Finally, it is assumed that the Hall B subsystem hot checkout list will be fully signed off before the start of the KPP run period [2].

Due to delays in the solenoid delivery schedule, this KPP commissioning period has been designed to take place without the solenoid installed in Hall B and without the nominal configuration of the Central Detector subsystems. Of course, as the solenoid is the primary shielding system to reduce the low energy Möller background created during interaction of the beam with the target, the beam commissioning procedures during the KPP run will therefore be fully focused on verifying the capability of operating the detectors with beam at low luminosity of $\leq 1 \times 10^{33}$ cm^{-2}s^{-1}. The CWB plan is designed to optimize the detector configuration, to test the data acquisition system, to determine initial subsystem calibrations based on electron beam data, and to evaluate the detector performance to meet the KPP requirements as detailed in Section 1. The beam time allocated for the completion of the different commissioning tasks is estimated based on completing the minimal necessary steps to complete the KPP objectives assuming a combined accelerator and CLAS12 operation efficiency of 50%.

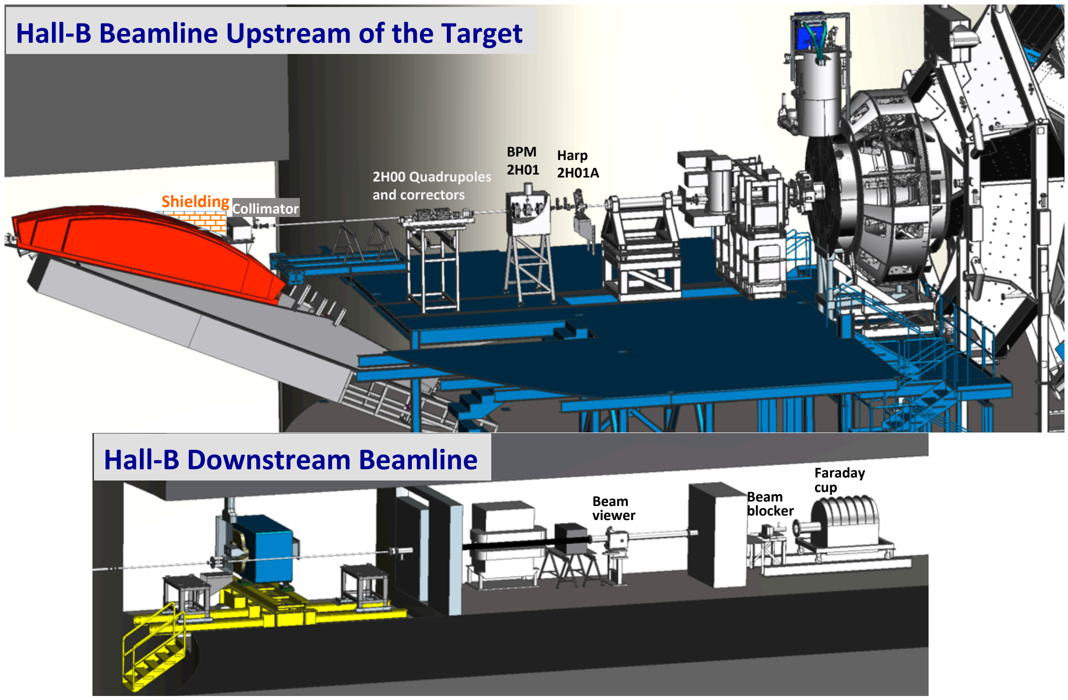

Figure 1: Schematic of the beamline configuration.

4 Beam and Detector Configuration

As mentioned in Section 1, the electron beam during the KPP run should be extracted from CEBAF after 3 passes and have energy greater than 6 GeV. With the planned LINAC configuration for the early 2017 running, the 3-pass beam energy is expected to be 6.4 GeV, therefore satisfying the first requirement on the beam configuration. This energy is above the 6.2 GeV limit for which the Hall B photon tagger magnet can bend electrons into the tagger dump. Therefore the procedure used with CLAS of sending beam to the tagger dump for the initial beam tuning will not be possible. For this reason a new beamline setup and procedure have been developed that make use of a novel configuration shown schematically in Fig. 1. Initial beam tuning will include the following steps:

- the tagger magnet will be ramped up and the set point current will be selected based on the exact beam energy in order to dump beam electrons in the magnet yoke;
- additional movable shielding (*beam blocker*) will be inserted after the magnet yoke and before the collimator to absorb particles escaping from the magnet.

This configuration is designed for operations at 11 GeV and therefore is expected to be applicable for lower beam energies. Optimization of the setup (beam spot position, tagger magnet current, ...)

will be performed during the beamline commissioning period that will precede the KPP run. After the initial beam tuning, the beam blocker will be removed and beam through the target location to the Faraday Cup will be established.

The target that will be used during the KPP run is a thin carbon wire mounted on a harp at the nominal CLAS12 target position. This will provide a well defined interaction point along the z axis, from which we expect to have an inclusive electron rate of $\sim$50-100 Hz at a beam current of 5 nA and luminosity of 10^{33} cm^{-2}s^{-1}. This rate is adequate to perform the commissioning tasks foreseen during the KPP run.

The CLAS12 detector configuration for the KPP run will include all the baseline equipment in the Forward Detector, i.e. HTCC, DC, LTCC, FTOF, PCAL, and EC. In addition, the FT will be mounted in its nominal configuration including the Möller shield that was designed and optimized for the 11 GeV running. As the solenoid magnet will not be available for the KPP run, the Central Detector components (CTOF, SVT, MM, and CND) will not be part of this KPP commissioning plan. However, depending on input from the 12 GeV Project, the baseline equipment elements of the Central Detector (CTOF, SVT) may be installed in Hall B upstream of the target location.

5 Expected Rates

Detector rates due to beam-target interactions and beam-related backgrounds were evaluated with Monte Carlo simulations to provide guidance for the planning of the commissioning tasks and the corresponding beam-time allocation.

5.1 Inclusive Electron Rates

Inclusive electron scattering will be a key process during the commissioning phase of the CLAS12 detector. A good estimation for the rate for this process, as reconstructed through the CLAS12 detector with its acceptance effects and efficiencies, is essential to properly plan the commissioning stage of the operations. To this end, inclusive rates were estimated for a beam energy of 6 GeV. The procedure consisted of two steps. First, inclusive electrons were generated through the code in Ref. [3], which accurately describes the inclusive electron-proton cross section. Secondly, the generated events were reconstructed to account for the CLAS12 acceptance and the detected electron rates were estimated. The second step was performed both using the CLAS12 FastMC [4] and the full CLAS12 simulation-reconstruction chain based on the GEANT-4 simulation package GEMC [5] and the CLAS12 reconstruction package based on COATJAVA [6]. The results obtained with these two approaches were found to be consistent within 20-30%. The results reported here are based on the second approach using GEMC.

Figure 2 shows the differential cross section for inclusive electron scattering as a function of the polar angle and energy of the scattered electrons for a beam energy of 6 GeV. On average the cross section ranges from 10 μb/GeV/sr for θ=5° to 10^{-3} μb/GeV/sr for θ=35° in the energy range reconstructed with CLAS12. The resulting inclusive electron rates for different values of the torus magnetic field intensity are found to be 50 Hz and 100 Hz at $\mathcal{L} = 1 \times 10^{33}$ cm^{-2}s^{-1} for 100% and 50% field, respectively. As expected, the rates decrease for increasing magnetic field strength because of the loss of low momentum electrons at small angles. As a comparison, the empty target electron rate in CLAS during the E1-6 run was of the order of 50 Hz for a luminosity of $\mathcal{L} = 1 \times 10^{33}$ cm^{-2}s^{-1}.

5.2 Background Rates

In addition to particle rates arising from interactions of the beam electrons with the target nucleons, background rates due to electromagnetic interactions were estimated. This was performed via GEANT-4 simulations of the electron beam passing through the target with the GEMC package. The full CLAS12 geometry as presently implemented in GEMC was used together with the latest versions of

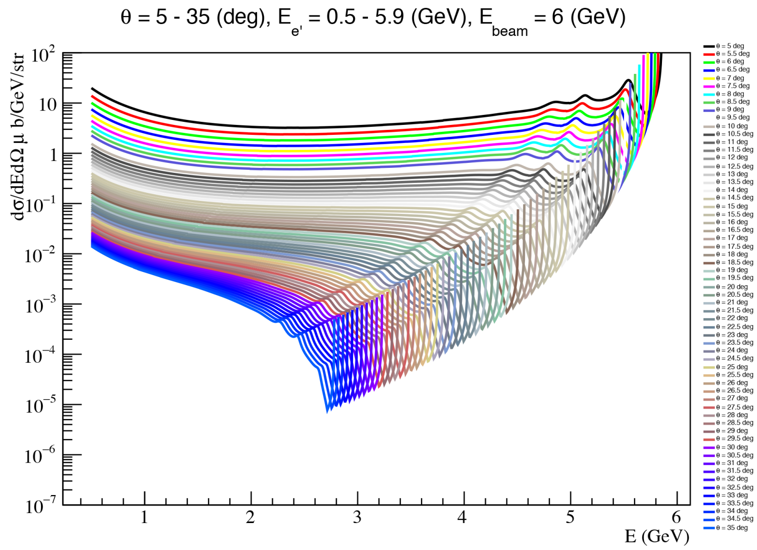

Figure 2: Inclusive cross section dependence on the polar angle and energy of the scattered electrons for a beam energy of 6 GeV. The cross section values are based on the model of Ref. [3].

the GEMC digitization routines that effectively simulate the response of the individual detectors. The electron beam energy was fixed at 6.4 GeV and 7,800 electrons in a 250 ns window (5 nA beam current) were simulated for each event, corresponding to an instantaneous luminosity of $\mathcal{L} = 1 \times 10^{33}$ cm^{-2}s^{-1} for the KPP target configuration (^{12}C target of 260 μm thickness). The simulations were run without the solenoid present and with the torus at full field. The results for DC occupancies and FTOF rates and PMT currents are shown in Figs. 3 and 4, respectively. Similar studies were extended to the other CLAS12 subsystems and will be used for guidance and comparison during the detector commissioning.

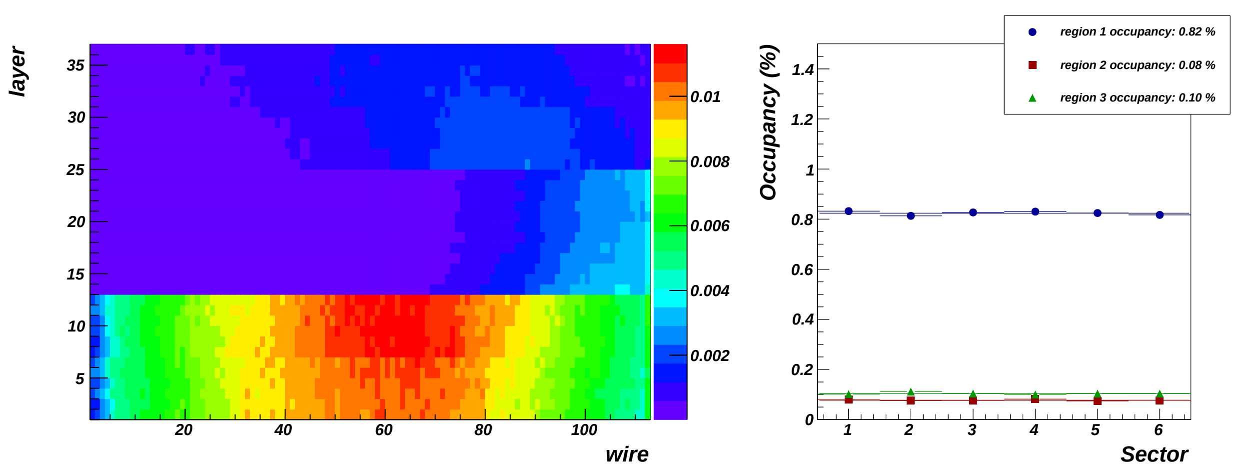

Figure 3: Drift chamber occupancy map in terms of layer vs. wire number (left) and average drift chamber region occupancy vs. sector number (right) for $\mathcal{L} = 1 \times 10^{33}$ cm^{-2}s^{-1} for the KPP target configuration with no solenoid and with the torus at full field.

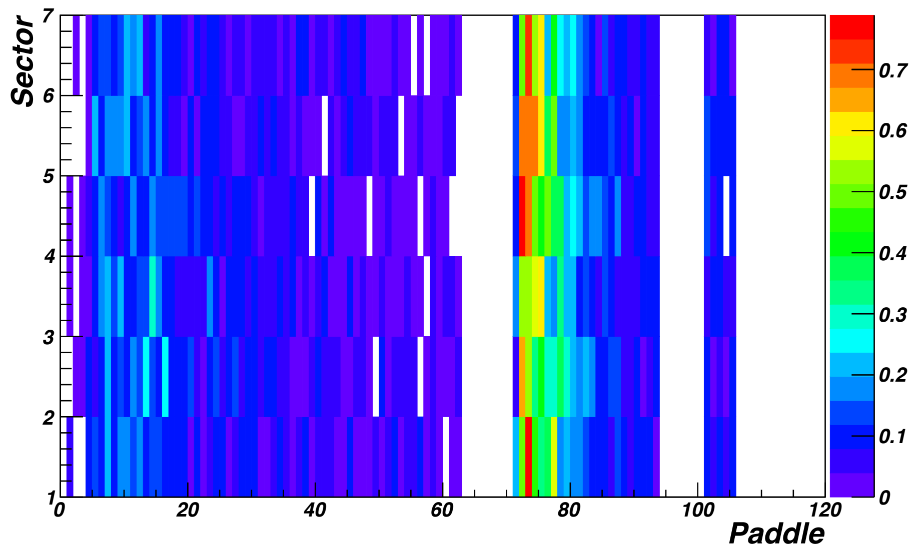

Figure 4: FTOF background rates in kHz. The plot shows values per sector and counter for panel 1b (left group of 62 paddles), panel-1a (middle group of 23 paddles), and panel-2 (right group of 5 paddles), for particle hits with energy deposition larger than 5 MeV for $\mathcal{L} = 1 \times 10^{33}$ cm^{-2}s^{-1} for the KPP target configuration with no solenoid and with the torus at full field.

6 KPP Commissioning Run Phases

The development of the KPP commissioning run plan has been driven by the requirement to be complete in a minimal amount of time in order to minimize the impact on the Hall B installation schedule. As such it has been designed solely to meet the minimal KPP requirements. The full commissioning of the CLAS12 detector before the start of the physics program will take place during the Engineering Run that is scheduled to take place at the end of 2017.

Based on these considerations, the CLAS12 KPP commissioning period has been organized in three different phases:

1. detector turn on and system functionality checks,

2. detector setting and run condition optimization (thresholds, timing studies, trigger optimization),

3. detector performance evaluation.

These phases are described in the remainder of this section.

6.1 Phase 1: Detector Turn on and System Functionality Checks

The first phase of the KPP beam commissioning run for the detectors will use a very low intensity electron beam, of the order of 10^{-3} to 10^{-2} of the nominal luminosity of $\mathcal{L} = 1 \times 10^{35}$ cm^{-2}s^{-1}, to check the basic functionality and operation of the CLAS12 subsystems. After establishing stable beam, the detectors will be turned on, following the predefined sequence:

1. EC and PCAL
2. FTOF, LTCC
3. HTCC (if possible)
4. DC and the FT

Note that due to the Möller electron background present at the location of the HTCC without the solenoid in place, the HTCC PMT rates are likely to be too high to allow the HTCC to identify scattered beam electrons. This is based on Monte Carlo studies of the HTCC rates in the operating configuration of the KPP run. However, these results will be checked during HTCC turn on. It may turn out that at least the large angle HTCC PMTs may allow for identification of scattered electrons with a suitable signal threshold.

Each detector system group will check rates and detector occupancies and to confirm the correct basic functioning of their systems. This period of detector functionality checks is not designed to be reliant on the DAQ system and is not meant to be exhaustive and complete. Isolated problematic or non-functioning channels will not be investigated in detail when the beam is available in an effort to ensure the KPP commissioning run schedule is maintained.

The detector rates and occupancies will be studied through the available scalers associated with the FADCs, discriminators, and DCRBs (Drift Chamber Readout Boards for the DC) and values for beam-on and beam-off conditions will be compared. The low-voltage and high-voltage power supply currents will also be monitored from the CLAS12 Slow Controls system to identify potential problem and beam-related effects. It can be expected that during this commissioning phase there will be need for occasional access to Hall B to deal with any of the issues that will arise. The number and duration of accesses will be carefully managed to be most efficient and to limit downtime.

In parallel with the detector turn on and functionality checks, the initial functionality checks of the DAQ and trigger systems will proceed. An important tool during the checkout phase of these systems will be the scaler information provided by the DAQ Trigger Board. DAQ functionality checks will include verifying that all crates are responding correctly and are read out, that the data that are being readout are correct, and that the information received from the different crates is properly synchronized. Each of these checks, which we assume were already performed before the beginning of the KPP commissioning run, will be performed with beam on to test the correct functioning of the DAQ as a function of rate. The main trigger used during the KPP run will be a loose electron trigger, defined based on the energy deposited in the EC-PCAL. The trigger purity using information from the LTCC and HTCC systems will be improved where possible during offline data analysis.

Once basic functionality of the computer and electronic systems has been established, proper operation of the detector monitoring software suites will be verified, and check out of the CLAS12 alarm handler and EPICS monitoring tools will be completed. After completion of these procedures, the CLAS12 detector will be operational at a sufficient level to proceed to the next commissioning phase.

6.2 Phase 2: Detector Settings and Run Condition Optimization

Once the functionality checks have been completed, the commissioning will proceed with the optimization of the detector settings and readout parameters. For the detector subsystems, the parameters to be adjusted include pedestals, readout and discriminator thresholds, trigger thresholds if applicable, and readout gate widths and offsets. The initial parameters will be based on pre-KPP commissioning work but further adjustment may be necessary based on the response during beam-on conditions. In particular, new pedestal values determined with beam on will be loaded for subsystems used for triggering. Hot channels will be investigated and diagnosed. If necessary, adjustments of supply voltages, for instance HV settings for PMT-based detectors, will be performed or readout thresholds will be increased.

This work will be performed in parallel by the detector subsystem experts. Maximum priority will be given to the EC-PCAL, being the system used for establishing the electron trigger for data taking. Second priority will be given to the DC and FTOF subsystems, being critical for the fulfillment of the KPP requirements. Third priority will be given to the other detector subsystems.

Data recorded by the CLAS12 DAQ will be processed in real time via the CLAS12 monitoring system and the specific subsystem calibration and monitoring suites. The CLAS12 event display, CED, will be used to visually check the consistency of the measured events and verify the presence of typical hit patterns, such as clusters in the calorimeters, matching hits in FTOF panels 1b and 1a, track segments in the DC, etc.. The measured rates for the individual subsystems will be compared to expectations based on Monte Carlo simulations. During this work, optimization of the trigger and DAQ setups will also be performed by the system experts. The results of the studies performed on the EC-PCAL will be used to refine the trigger algorithms and cuts. The DAQ expert will optimize the relevant settings to ensure stable and reliable data taking. Once adequate settings for the critical detector subsystems, including the trigger and DAQ, are achieved, the CLAS12 detector will be ready to move to the final commissioning phase.

6.3 Phase 3: Detector Performance Evaluation

The final phase of the KPP commissioning run with CLAS12 will focus on a series of data acquisition runs over the period of several shifts. This data will be calibrated during the parallel offline shifts in order to study the particle identification and tracking capabilities that are part of the KPP requirements. They will also be used to demonstrate the capability of the CLAS12 system, including the detector subsystems and the data acquisition system, to acquire data in a stable configuration. This commissioning phase is expected to be the longest in duration due to the KPP requirements to take data for extended times and the need to acquire sufficient statistics in a low-luminosity running condition to be able to demonstrate the KPP requirements for tracking and particle identification.

7 KPP Commissioning Plan

The nominal KPP commissioning plan has been designed to be completed in five 8-hour shifts. An additional 8-hour shift has been included beyond this for contingency. With the very short duration and the requirement to ensure that the KPP requirements are met, it is essential that the plan is carried out efficiently and safely. This will require a high degree of coordination between the online and offline teams, including the Run Coordinator, Hall B leadership, subsystem experts on the hardware and software teams, shift workers, and Hall B technical staff. Details on the manpower organization and responsibilities for the KPP run are provided in Section 8.

The different phases of the KPP commissioning run have been compressed into as short a period as possible in order to meet the minimal sets of conditions before moving on to the next phase of the schedule. The planned duration of the three phases of the run outlined in Section 6 are as follows:

- Detector turn on and system functionality checks - 1 shift
- Detector settings and run condition optimization - 1 shift
- Detector performance evaluation - 3 to 4 shifts

The organization of the KPP run has been broken down into 4-hour-long segments. A high-level

KPP CWB Daily Schedule

Shift #1		Shift #2	
Shift 1A: - Final beam tune verifications - Detector turn-on A - DAQ studies	**Shift 1B:** - Detector turn-on B - DAQ studies - Trigger studies - Hall B access	**Shift 2A:** - Detector readout optimization - DAQ studies - Trigger studies	**Shift 2B:** - Detector readout optimization - DAQ studies - Trigger studies - Hall B access
Shift #3		**Shift #4**	
Shift 3A: - DAQ run #1	**Shift 3B:** - DAQ run #2 - Hall B access	**Shift 4A:** - DAQ run #3	**Shift 4B:** - DAQ run #4 - Hall B access
Shift #5		**Shift #6**	
Shift 5A: - DAQ run #5 (if necessary)	**Shift 5B:** - DAQ run #6 (if necessary)	**Shift 6A:** - Contingency (if necessary)	**Shift 6B:** - Contingency (if necessary)

Figure 5: Shift by shift schedule for the CLAS12 KPP commissioning with beam run.

overview of the KPP commissioning run is shown in Fig. 5. The run plan has been organized with two main things in mind:

1. Developing a plan to turn the detector subsystems on and to get the data acquisition system functional in as efficient and safe a manner as possible in order to collect the data necessary to demonstrate achievement of the KPP requirements within the planned commissioning run duration.

2. Organizing the necessary manpower both in terms of the online subsystem hardware experts and the offline subsystem software and analysis experts to demonstrate the specific KPP requirements as soon as possible after the appropriate data has been collected.

In order to ensure full understanding as to what exactly is to be demonstrated from this beam commissioning run period based on the specific KPP requirements detailed in Section 1, a pre-defined set of plots has been prepared and agreed upon with the 12 GeV Project Management. These plots, referred to as the KPP demonstration slides, are provided in Figs. 6 and 7.

The KPP demonstration slides of Figs. 6 and 7 have presently been constructed using legacy data from CLAS, from CLAS12 Monte Carlo simulation data, and from cosmic ray calibration data. The goal of the KPP commissioning run is to remake each of the plots on these slides using information

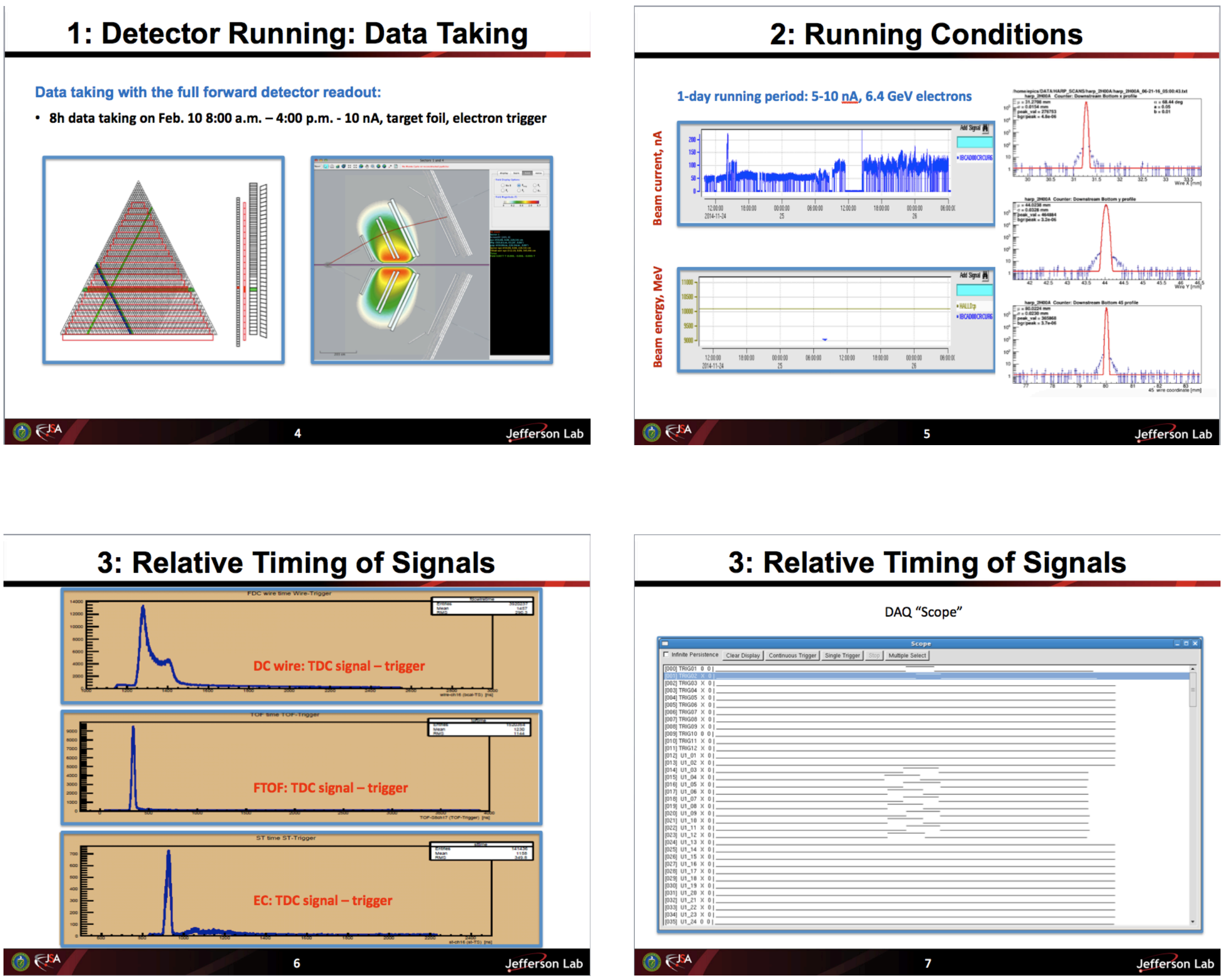

Figure 6: Demonstration slides to be made during the KPP commissioning beam run to satisfy the first three KPP requirements detailed in Section 1.

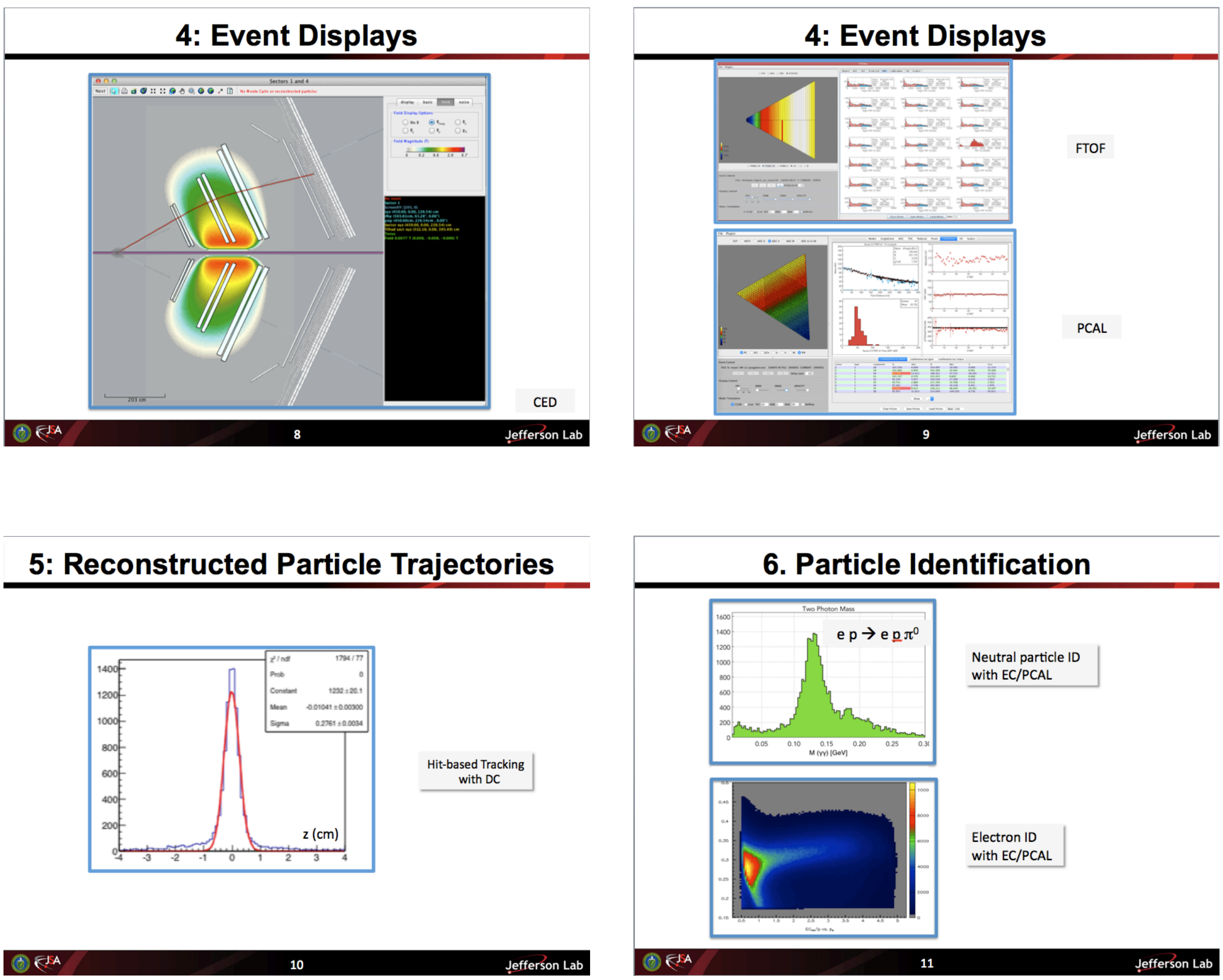

Figure 7: Demonstration slides to be made during the KPP commissioning beam run to satisfy the last three KPP requirements detailed in Section 1.

and data from the KPP beam run. With this set of slides produced as a result of the commissioning run, we will officially have satisfied the KPP requirements for the CLAS12 system.

Table 1 provides a listing of when the various plots for the KPP demonstration slides can be made during the commissioning run. Some of the plots, such as the results from harp scans, EPICS time histories, and CED and system monitoring displays, will be made during the online shifts in the Hall B Counting House. Other plots related to tracking and particle identification will be made after the necessary calibration and reconstruction efforts are carried out during the parallel offline analysis shifts. The goal is to complete the work to generate all of the required KPP demonstration slides within several days after the completion of the beam run.

Shift	KPP Demonstration Plot
1A	Harp scans of Fig. 6 UR, *"2: Running Conditions"*
1B	FTOF and PCAL event displays of Fig. 7 UR, *"4: Event Displays"*
2A	Relative timing of signals of Fig. 6 LL,LR, *"3: Relative Timing of Signals"* CED event display of Fig. 6 UL, *"1: Detector Running: Data Taking"* CED event display of Fig. 7 UL, *"4: Event Displays"*
2B	–
3A	–
3B	Detector running and data taking of Fig. 6 UL, *"1: Detector Running: Data Taking"* EPICS timing histories of Fig. 6 UR, *"2: Running Conditions"*
4A	Reconstructed particle trajectories of Fig. 7 LL, *"5: Reconstructed Particle Trajectories"*
4B	Particle identification of Fig. 7 LR, *"6: Particle Identification"*
5A	–
5B	–
6A	–
6B	–

Table 1: Timeline showing when the required plots for the KPP demonstration slides can be produced. The KPP commissioning run is divided into five shifts with one shift for contingency. The shifts are divided into 4-hour blocks "A" for the first half and "B" for the second half of the shift.

8 Responsibilities, Management, and Organization

8.1 Personnel Responsibilities

The Hall B Organizational Chart that will be in effect during the KPP commissioning beam run is shown in Fig. 8. This chart is somewhat different than that used during normal production data running. Due to the limited duration of the KPP run and the critical importance to the 12 GeV Project of ensuring that each KPP specification has been fully satisfied, an additional set of roles and responsibilities has been included.

The role represented by the purple boxes in Fig. 8 (i.e. to the left of the vertical dashed line) include the usual roles, responsibilities, and information flow for Hall B beam operations. What has been added are the roles shown by the green boxes in Fig. 8 (i.e. to the right of vertical dashed line). The additional inclusions are through the leadership of the Hall B Calibration and Commissioning (CALCOM) group that will be monitoring the progress and planning of the KPP run, and will be working directly with the Hall B Run Coordinator and the Offline Analysis Coordinator. The CALCOM group will be responsible for ensuring that all required aspects of the KPP requirements are met and communicate to the Run Coordinator the required shift plans and progress steps required. The personnel roles for the KPP beam time are as follows:

- CALCOM Group: Monitor the shift by shift progress of the KPP beam time to be sure that each KPP requirement is satisfactorily met. Provide the Run Coordinator with their shift instructions and interact with the Offline Analysis Coordinator leading the offline data analysis shifts.

- Run Coordinator: Immediate on-site manager and coordinator of the KPP beam time. Ensure that the plan provided by the CALCOM group is followed, that systems are working properly, that communication with MCC is clear, that beam tuning by MCC is monitored, and that accesses to Hall B are efficiently scheduled.

- Offline Analysis Coordinator: Oversee the offline analysis shifts. Responsible for the offline data cooking and analysis, interacting with the software experts, and working with the subsystem calibration teams.

- Physics Division Liaison: Oversee all aspects of safety, as well as worker training and staffing issues during the KPP run.

- Hall B Work Coordinator: Single point of contact for all work in Hall B.

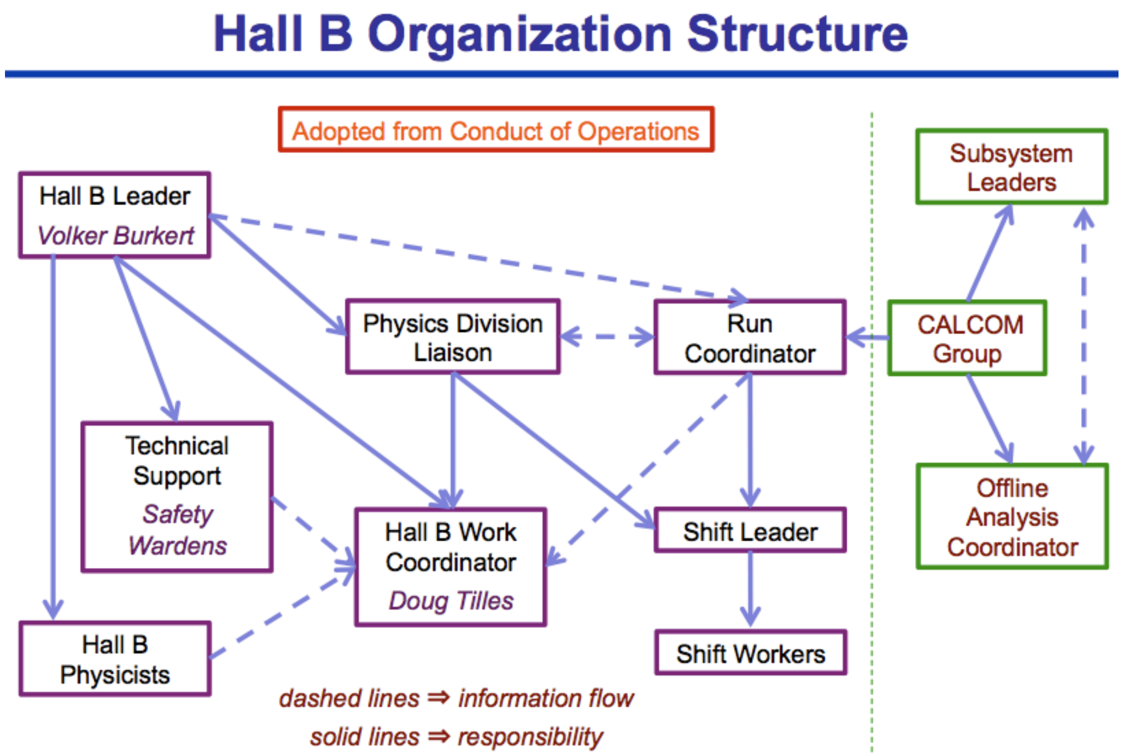

Figure 8: Hall B organization chart for the CLAS12 KPP commissioning run.

- Shift Leader: Responsible for carrying out the program defined by the Run Coordinator, completing the shift check lists, shift summaries, and beam time accounting. Responsible for maintaining the logbook for the experiment. The primary contact with MCC from the Counting House.

- Shift Worker: Responsible for monitoring the detector subsystems and carrying out the shift plans under the direction of the Shift Leader.

- Experts-on-call: Assigned for each CLAS12 subsystem and responsible to provide support to shift personnel and resolve problems that may arise.

Due to the limited beam time for the KPP run, the shift schedules will be prepared in conjunction with the detector subsystem experts to be sure that they are available for all efforts regarding their specific detectors. Their presence in the Counting House will be required during detector turn on, functionality checks, and detailed tuning and monitoring of their subsystems. All subsystems will have assigned experts on call 24 hours a day for the full duration of the KPP beam run. A list of contact numbers will be provided in the Counting House for the Shift Leader to contact the relevant experts whenever they are required to answer questions or address any problems that have arisen. Further details regarding manpower roles and responsibilities are detailed in the Hall B Conduct of Operations document [7] for commissioning.

8.2 CLAS12 Subsystem Contacts

The full list of the CLAS12 subsystem contacts for both hardware and software components is given in Tables 2 and 3.

System	Subsystem	Contact Person	Area of Responsibility
Beamline Instrumentation	Beamline	F.X. Girod (JLab)	Hardware
		S. Stepanyan (JLab)	Hardware
Magnets	Solenoid Magnet	D. Kashy (JLab)	Hardware
	Toroidal Magnet	D. Kashy (JLab)	Hardware
Central Detector	SVT	Y. Gotra (JLab)	Hardware
		V. Ziegler (JLab)	Software
	MM	M. Defurne (CEA)	Hardware
		V. Ziegler (JLab)	Software
	CTOF	D.S. Carman (JLab)	Hardware and Software
	CND	S. Niccolai (IPN)	Hardware and Software
Forward Detector	HTCC	Y. Sharabian (JLab)	Hardware
		N. Markov (UConn)	Software
	DC	M. Mestayer (JLab)	Hardware
		V. Ziegler (JLab)	Software
	LTCC	M. Ungaro (JLab)	Hardware and Software
	FTOF	D.S. Carman (JLab)	Hardware and Software
	EC & PCAL	C. Smith	Hardware and Software
		S. Stepanyan (JLab)	Hardware
	FT	M. Battaglieri (INFN)	Calorimeter
		G. Smith (Edinburgh)	Hodoscope Hardware
		M. Defurne (CEA)	Tracker Hardware
		R. De Vita (INFN)	Software

Table 2: List of hardware and software contacts for each CLAS12 subsystem.

System	Subsystem	Contact Person	Area of Responsibility
Online	FEE, DAQ & Trigger	S. Boyarinov (JLab)	DAQ/Trigger
		C. Cuevas (JLab)	Hardware
		V. Kubarovsky (JLab)	Trigger
		B. Raydo (JLab)	Hardware
		M. Ungaro (JLab)	Trigger Simulations
	Monitoring	N. Harrison (JLab)	Software
	Slow Controls	K. Livingston (Glasgow)	Hardware and Software
		N. Baltzell (JLab)	Hardware and Software
Offline	Architecture	G. Gavalian (JLab)	Software
	Database	H. Avakian (JLab)	Software
	Reconstruction	V. Ziegler (JLab)	Software
	Calibration	R. De Vita (INFN)	Oversight
		D.S. Carman (JLab)	Oversight

Table 3: List of online and offline contacts for CLAS12.

8.3 Documentation

In the Counting House and on the Hall B run webpage [8], a standard set of documents will be available for the KPP commissioning run to provide guidance to all personnel involved in the KPP run. This documentation includes:

- Conduct of Operations (COO): Required reading list, management overview, standard operating procedures
- Experiment Safety Assessment Document (ESAD): Hall B hazards, subsystem hazards, issue mitigation, expert personnel lists
- Radiation Safety Assessment Document (RSAD): General beam conditions in the hall, radiological control details
- JLab Emergency Response Guidelines: Details on safety hazards and protection systems in the Counting House and Hall B

- Subsystem Operations Manuals: Detailed instructions for shift workers and experts to deal with subsystem problems/issues
- Counting House Whiteboard: Lists special instructions for shift workers, shift plans, contact information for key personnel, Hall B access plans
- Logbook: Electronic logbook detailing all shift progress, issues, screen captures, run start/stop information, and beam time accounting for the shift

During the KPP beam run two daily meetings will be organized. In the morning the Run Coordinator will lead a meeting regarding organization and planning for the next 24 hours. This meeting will be open to all interested parties and should be attended by representatives of the CALCOM group, the detector experts, technicians, and the Physics Division Liaison. In the afternoon, the Offline Analysis Coordinator will lead a meeting related to progress with the data processing, the data quality, the ongoing detector calibrations, event reconstruction, and preparation of the required plots to demonstrate the KPP requirements. The CALCOM group will interact with both the Run Coordinator and the Offline Analysis Coordinator before each meeting (and throughout the KPP run period) to be sure of efficient communication and information transfer.

8.4 Hall B Shifts

The online shift worker assignments for the KPP commissioning run will be listed on the Hall B shift page [9]. Here the personnel assignments for the Shift Leaders and Shift Workers will be listed. All shift workers are required to have current JLab training (RW-1, ODH, Hall B safety). The online shift personnel assignments will be defined by the CALCOM group and the Physics Division Liaison, selecting CLAS Collaboration members that are available during the scheduled KPP beam time with appropriate experience and knowledge of Hall B, CLAS12, and shift operations. The offline shift workers will be assigned by the Offline Analysis Coordinator. Note that the Hall B Engineering Group is on-call 24 hours a day to cover any issues with vacuum systems, hall conditions, chilled water, power, and configuration changes.

References

[1] CLAS12 Commissioning Plan, June 2014: https://www.jlab.org/Hall-B/calcom/commission.pdf

[2] Hall B Hot Checkout System: https:accweb.acc.jlab.org/hco/readiness

[3] M. Sargsyan, *"Computer Code for Inclusive* (e, e') *Electro-production Reactions and Radiative Corrections"*, CLAS-NOTE 90-007 (1990).

[4] CLAS12 parametric fast Monte Carlo code FastMC.

[5] GEMC CLAS12 GEANT-4 implementation, http://gemc.jlab.org.

[6] CLAS12 COATJAVA documentation, http://clasweb.jlab.org/clas12offline/docs/software/html/

[7] Hall B KPP Conduct of Operations Document: https://www.jlab.org/Hall-B/run-web/

[8] Hall B Run Information Page: https://www.jlab.org/Hall-B/run-web/

[9] Hall B Shift Scheduling: https://www.jlab.org/Hall-B/shifts/