Commissioning document of the CLAS12 RICH

M. Contalbrigo, V. Kubarovsky, M. Mirazita

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Abstract

This is an integration to the CLAS12 Commissioning Document describing the Commissioning procedure for the RICH detector.

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2 Quality Assurance and System Checkout

2.1 Quality Assurance

RICH Mechanic structure survey (EEL124)	
Description	Check of the relative position of the panels forming the RICH structure. The target points installed on the RICH mechanics will be used for the survey. The measured positions must match the ones measured during the assembly test performed at the company.
Special equipments	Laser tracker. Faro-arm.
Softwares	NA
Manpower and time needed	2 days
Information to be saved in database	NA

RICH Mirrors (EEL-121)	
Description	Check of the accuracy of the spherical mirror surface with spot size and Shack-Hartmann measurements. 1. Alignment of the Shack-Hartmann sensor axis. 2. Alignment of the mirror axis with respect to the Shack-Hartmann axis. 3. Alignment of the light source and photocamera for the spot size measurement. 4. Measure the spot size as a function of the distance from the mirror. 5. Wave-front measurement with the Shack-Hartmann sensor at the minimum spot size distance. 6. Shape of the surface with a CMM.
Special equipments	Two optical tables. Shack-Hartmann sensor. Point-like source with LED and optical fiber. CCD photocamera. Remotely controlled motors for the alignment of the system. Coordinate Measuring Machine (CMM)
Softwares	Linux software for the remote control of the motors and CCD. Root analysis software for the spot size measurements. Shack-Hartmann reconstruction software.
Manpower and time needed	About 2 days per mirror, based on previous experience
Status	First 4 mirrors tested in June
Information to be saved in database	Radius of the mirrors

RICH Mirror alignment (EEL124)	
Description	Verify the relative alignment of the RICH mirrors. Four mirror systems must be aligned: 1. the frontal planar panel. 2. the lateral planar panel. 3. the bottom planar panel. 4. the spherical panel. The relative alignment of the mirrors composing each panel will be checked first. Then the panel will be installed in the RICH and its alignment with respect to the others will be checked with optical methods. The position of the panel can be optimized by acting on the adjusting screws of the three attaching points on the RICH structure.
Special equipments	Laser tracker. Faro-arm.
Softwares	NA
Manpower and time needed	one week
Information to be saved in database	NA

RICH Aerogel: Catholic University (Washington)	
Description	Check of the optical quality of the aerogel tiles
Special equipments	Spectrophotometer
Manpower and time needed	About 1 day per 10 tiles, based on previous experience The work is performed at the Catholic University (Washington).
Status	10 tiles already tested
Information to be saved in database	Average transparency and refractive index of the tiles

RICH Aerogel (Ferrara)	
Description	Check of the optical quality of the aerogel on a subsample of tiles
Special equipments	Laser. CCD photocamera. Remotely controlled motors to scan the surface of the tile.
Manpower and time needed	About 1 day per tile, based on previous experience The work is performed in Ferrara.
Status	Started in October 2015
Information to be saved in database	NA

RICH Multi-Anode PMT	
Description	Characterization of the MAPMT
Special equipments	Laser source. Flash-ADC. Remote-controlled motors to scan the MAPMT entrance window.
Status	Completed
Results	Measurement of the Single-photon spectrum per each pixel of all the MAPMTs.
Information to be saved in database	Gain and single photon resolution of each channel

RICH Electronics: EEL-121	
Description	
Special equipments	
Manpower and time needed	
Information to be saved in database	

2.2 System Checkout

Checkout of High Voltage system	
Description	Connect the detector to HV supply, verify cable map, switch on, check of current monitor.
Manpower and time needed	
Software	CLAS12 slow control
Computing resources	NA
Dependencies from other systems	Cooling system must be checked out prior to HV system.
Information to be saved in database	HV distribution map

Checkout of Low Voltage system	
Description	Connect the detector to LV supply, verify cable map, switch on, check of current and voltage monitor.
Manpower and time needed	
Software	CLAS12 slow control
Computing resources	NA
Dependencies from other systems	Cooling system must be checked out prior to HV system.
Information to be saved in database	LV distribution map

Checkout of the Gas systems	
Description	1. Nitrogen lines: gas flow, humidity, leak tests. 2. Cooling air lines: gas flow, temperature, humidity, leak tests.
Manpower and time needed	two weeks
Software	CLAS12 slow control
Computing resources	NA
Dependencies from other systems	HV and LV must be checked out prior to gas systems.
Information to be saved in database	Flow, pressure, humidity and temperature data

Checkout of the Safety System	
Description	Checkout and test of the interlocks between HV, LV, cooling, gas systems
Manpower and time needed	one week
Software	CLAS12 slow control and safety system
Computing resources	None
Dependencies from other systems	All interlocked systems
Information to be saved in database	Minimum pressures, temperatures and flows for the interlocks

Checkout of the Front-End electronics	
Description	ASIC and FPGA configuration, calibration, channel mapping, noise level, etc
Manpower and time needed	
Software	CLAS12 DAQ and slow control, calibration software
Computing resources	
Dependencies from other systems	Cooling system, HV and LV must be checked out prior to HV system.
Information to be saved in database	Channel map, calibration data

Checkout of the DAQ and trigger	
Description	Test of different DAQ and trigger configurations
Manpower and time needed	1 week
Software	CLAS12 slow control and DAQ
Computing resources	Computer farm
Dependencies from other systems	Need DC information
Information to be saved in database	RICH electronics configuration data

Cosmic runs with the electronic panel (EEL124)	
Description	Check of the full electronic system. Data will be acquired with the electronic panel put in horizontal position, with the MAPMT entrance window up. A simple tracking system could be setup for determining the cosmic trajectories.
DAQ configuration and trigger	RICH DAQ software, dedicated trigger
Manpower and time needed	two weeks
Software for analysis of results	RICH analsys software
Computing resources	Access to batch computing farm
Dependencies from other systems	Cooling system and interlocks must be on.
Information to be saved in database	NA

Cosmic runs with the whole RICH (EEL-124)	
Description	Check of the RICH with cosmics. Data will be acquired with the RICH put in horizontal position on its transportation trolley, with the aerogel panel down. Cherenkov photons will be produced in the aerogel, then reflected back by the frontal mirror toward the photodetectors. A simple tracking system could be setup for determining the cosmic trajectories.
DAQ configuration and trigger	RICH DAQ software, dedicated trigger
Manpower and time needed	two weeks
Software for analysis of results	RICH analisys software
Computing resources	Access to batch computing farm
Dependencies from other systems	Cooling system and interlocks must be on.
Information to be saved in database	NA

3 Commissioning Without Beam

3.1 Special Calibration Procedures

Pedestal runs	
Description	Determine the baseline of the Front-End electronics
DAQ configuration and trigger	Clock trigger
Manpower and time needed	
Software for analysis of results	
Computing resources	
Dependencies from other systems	HV on/off to compare noise levels
Information to be saved in database	Pedestals

Dark runs	
Description	Calibration of the Front-End electronics using thermal noise.
DAQ configuration and trigger	Internal trigger
Manpower and time needed	
Software for analysis of results	
Computing resources	
Dependencies from other systems	
Information to be saved in database	Single p.e. level and resolution

Charge injector runs	
Description	Calibration of the Front-End electronics using the internal charge injector
DAQ configuration and trigger	Internal trigger
Manpower and time needed	
Software for analysis of results	
Computing resources	
Dependencies from other systems	
Information to be saved in database	Single p.e. level and resolution

3.2 Calibration with Cosmic Rays

Cosmic runs in Hall B	
Description	Check of the RICH with cosmics.
DAQ configuration and trigger	CLAS12 DAQ and trigger for cosmics
Manpower and time needed	two weeks
Software for analysis of results	CLAS12 analysis software
Computing resources	Access to batch computing farm
Dependencies from other systems	RICH fully operating, CLAS12 tracking system
Information to be saved in database	NA

3.3 Commissioning With Beam

RICH detector reconstruction calibration	
Description	After initial system checkout, a series of runs with different conditions will be performed. 1. Runs at different beam current to study the noise level. 2. Runs with torus off to check the detector geometry. 3. Runs with different torus magnetic field, including reverse field, to study the performance of the detector.
DAQ configuration and trigger	CLAS12 electron trigger
Manpower and time needed	one day of CLAS12 data taking
Software for analysis of results	CLAS12 tracking and RICH reconstruction software
Computing resources	Access to batch computing farm
Dependencies from other systems	All the CLAS12 detector on
Information to be saved in database	Several tuning parameters for the RICH reconstruction (background level, tracking resolution, single photon resolution, etc.).

RICH detector PID in the direct light case	
Description	Study the Kaon/Pion and Kaon/Proton rejection powers in the case of direct detection of the Cherenkov photons. Production data taken with liquid hydrogen target. Narrow resonances will be used to verify the RICH PID, for example: 1. K_S for pions. 2. ϕ for kaons. 3. Λ for protons.
DAQ configuration and trigger	CLAS12 electron trigger
Manpower and time needed	few hours of CLAS12 data taking
Software for analysis of results	CLAS12 and RICH reconstruction and PID software
Computing resources	Access to batch computing farm
Dependencies from other systems	All the CLAS12 detector calibrated
Information to be saved in database	Kaon detection efficiency vs pion and proton contamination.

4 Contact Persons

RICH contac persons			
Name	Affiliation	email	Area of responsibility
V. Kubarovsky	JLab	vpk@jlab.org	Hardware/Software
M. Contalbrigo	INFN-Fe	mcontalb@fe.infn.it	Hardware/Software
M. Mirazita	INFN-LNF	mirazita@lnf.infn.it	Hardware/Software