Experiment Safety Assessment Document (ESAD)
CLAS12 Ring Imaging Cherenkov Counter

June 8, 2016

Contents

Chapter 1

Introduction

This ESAD document describes identified hazards of the Ring Imaging Cherenkov Counter (RICH) detector and the measures taken to eliminate, control, or mitigate them. This document is part of the CEBAF experiment review process as defined in Chapter 3120 of the Jefferson Lab EHS&Q manual, and will start by describing general types of hazards that might be present in any of the JLab experimental halls. The document then addresses the hazards associated with RICH and their mitigation. Responsible personnel for each item is also noted. In case of life threatening emergencies call 911 and then notify the guard house at 5822 so that the guards can help the responders. This document does not attempt to describe the function or operation of the RICH detector. Such information can be found in the specific Operating Manuals.

Chapter 2

General Hazards

2.1 Fire

The experimental halls contain numerous combustible materials and flammable gases. In addition, they contain potential ignition sources, such as electrical wiring and equipment. General fire hazards and procedures for dealing with these are covered by JLab emergency management procedures. The JLab fire protection manager Ed Douberly can be contacted at 269-6638.

2.2 Electrical Systems

Hazards associated with electrical systems are the most common risk in the experimental halls. Almost every sub-system requires AC and/or DC power. Due to the high current and/or high voltage requirements of many of these sub-systems they and their power supplies are potentially lethal electrical sources. In the case of superconducting magnets the stored energy is so large that an uncontrolled electrical discharge can be lethal for a period of time even after the actual power source has been turned off. Anyone working on electrical power in the experimental Halls must comply with Chapter 6200 of the Jefferson Lab EHS&Q manual and must obtain approval of one of the responsible personnel. The JLab electrical safety point-of-contact (Todd Kujawa) can be reached at 269-7006.

2.3 Mechanical Systems

There exist a variety of mechanical hazards in all experimental halls at JLab. Numerous electro-mechanical sub-systems are massive enough to produce potential fall and/or crush hazards. In addition, heavy objects are routinely moved around within the experimental halls during reconfigurations for specific experiments.

Use of ladders and scaffold must comply with Chapter 6231 of the Jefferson Lab EHS&Q manual. Use of cranes, hoists, lifts, etc. must comply with Chapter 6141 of the Jefferson Lab EHS&Q manual. Use of personal protective equipment to mitigate mechanical hazards, such as hard hats, safety harnesses, and safety shoes are mandatory when deemed necessary. The JLab technical point-of-contact (Suresh Chandra) can be contacted at 269-7248.

2.4 Strong Magnetic Fields

Powerful magnets exist in all JLab experimental halls. Metal objects may be attracted by the magnet fringe field, and become airborne, possibly injuring body parts or striking fragile components resulting in a cascading hazard condition. Cardiac pacemakers or other electronic medical devices may no longer function properly in the presence of magnetic fields. Metallic medical implants (non-electronic) may be adversely affected by magnetic fields. Loss of information from magnetic data storage devices such as tapes, disks, and credit cards may also occur. Contact Jennifer Williams at 269-7882, in case of questions or concerns.

2.5 Vacuum and Pressure Vessels

The RICH cooling system consists of two compressors, air tank and three relieve valves. The high pressure section of the system is at 125 psi from the compressor output charging the air tank. Pressure is reduced at the tank outlet to 55 psi or less by a pressure regulator to supply air to the detector air flow control valve. After that, it discharges to the the electronics enclosure inside the detector.

2.6 Hazardous Materials

Hazardous materials in the form of solids, liquids, and gases that may harm people or property exist in the JLab experimental halls. The most common of these materials include lead, beryllium compounds, and various toxic and corrosive chemicals. Material Safety Data Sheets (MSDS) for hazardous materials in use in the Hall are available from the Hall safety warden. These are being replaced by the new standard Safety Data Sheets (SDS) as they become available in compliance with the new OSHA standards. Handling of these materials must follow the guidelines of the EH&S manual. Machining of lead or beryllia, that are highly toxic in powdered form, requires prior approval of the EH&S staff. Lead Worker training is required in order to handle lead in the Hall. In case of questions or concerns, the JLab hazardous materials specialist (Jennifer Williams) can be contacted at 269-7882.

Chapter 3

RICH Specific Equipment

3.1 Overview

The CLAS12 RICH detector is made by a large trapezoidal box of about 5 m^3 volume, containing the aerogel Cherenkov radiator, Multi-Anode PhotoMultiplier Tubes, a missor system and Fron-End electronics. The detector is equipped with a cooling system for the electronics and nitrogen line to keep dry and clean the inner atmosphere.

The material in this chapter is a subset of the material in the full CLAS12 Micromegas Vertex Tracker operations manual and is only intended to familiarize people with the hazards and responsible personnel for these systems. It in no way should be taken as sufficient information to use or operate this equipment.

3.2 RICH components

The Ring Imaging Cherenkov detector (RICH) is designed to improve CLAS12 particle identification in the momentum range 3-8 GeV/c and will replace one sector of the existing LTCC detector. Ring Imaging Cherenkov Counter incorporates

1. Aerogel radiator. Aerogel is very light material, non-toxic and nonflammable but idrophilic.

2. Focusing mirror system.
   Mirrors reduce the detection area instrumented by photon detectors to ~ 1 m^2.

3. Photodetector.
   Photodetector includes 391 Hamamatsu Multianode Photomultipliers (MAPMTs). Each MAPMT has 64 pixels. So in total the detector has 25024 channels.

4. High Voltage.
   High voltage are supplied to each MAPMT. The MAPMT high voltage will be less than 1100 V and the divider current is 225 μA. The power consumption for all MAPMTs is $\sim$ 100 W.

5. Front-end electronics.
   Front-end electronics consists of three types of boards: adapter board, ASIC board and FPGA board. There are two types of the front-end boards: 3 MAPMTs tiles and 2 MAPMTs tiles. Photomatrix has 23 boards with two MAPMTs and 115 boards with three MAPMTs. In total RICH has 138 tiles of both types.

6. Low voltage systems.
   The typical current draw is 0.8A for the FPGA+ASIC boards together (3 MAROC version) from a +5V source. The power used for the 2 MAROC ASIC setup will be slightly less. The total power consumption will be not more than 500 W.

7. Cooling system.
   The RICH detector electronics are sealed inside the detector. The heat generated by HV and LV circuits must be removed in order to prevent damage to the electronics package and the adjacent TOF panels. Air cooling was determined to be the viable method.

8. The Nitrogen Purge System.
   In order to preserve the aerogel optical performance, the RICH box environment must be kept dry by fluxing nitrogen. The nitrogen purge system supplies the amount of gas necessary to fill the box (about 5 cubic meters) and to compensate for the gas leakage. A complete refill of the volume per day is expected under normal operating conditions. A slight overpressure of 0.5 mbar prevents from the contamination from the outside air.

3.3 Hazards

Hazards associated with the RICH detector:

1. Electrical shock from touching exposed wires or damage to the MAPMTs if the detector enclosure is opened with HV on.

2. Heat buildup inside the RICH enclosure if cooling system is not running. This may cause damage to the experimental equipment.

3. The degradation of aerogel properties due to the uncontrolled humidity in the experimental hall.

3.4 Mitigations

1. Whenever any work has to be done on the RICH detector, whether it will be opened or not, HV and LV must be turned off. The cooling system has to be turn off if enclosure will be opened for maintenance.

   The door interlock will turn off HV to prevent touching exposed HV cables or damage of the MAPMTs in case the door will be opened accidentally.

2. The air cooling and nitrogen purge systems monitor key detector parameters. If the monitored signals are outside of pre-programmed limits, the air cooling system shuts off voltage to the electronics.

   The signals monitored for air cooling includes:

   - Air flow
   - Detector internal temperature
   - Pressure inside air tank
   - Air compressor power status

   High capacity air compressors supply clean dry air at room temperature to cool the electronics package inside the detector. The plan is to have 2 compressors in parallel charging a 1000 liter capacity air tank. Air pressure is reduced to supply manual valve flow meters, one per detector. In the case of a power outage, the air tank should contain sufficient air to remove the latent heat of the electronics package.

   Powering up the electronics package inside the RICH without cooling may result in severe damage. Interlocking RICH HV and LV power supply operation to proper cooling circuit operation eliminates this hazard. The interlocks perform two functions in the case of a cooling system fault

- Turn off power to the electronics package.
- Prevent energizing the electronics package.

There are 3 cooling circuit interlocks.

- Air Compressor Operation: minimum one compressor operating.
- Minimum Air Pressure in Tank.
- Minimum Cooling Air Flow.

All three interlocks must be true in order for the electronics package to have power.

3. The aerogel used in the RICH detector requires very dry air in order to perform properly. The nitrogen purge gas system provides gas at low humidity levels.

   The signals monitored for the nitrogen purge system include:

   - Nitrogen flow
   - Detector internal humidity

   If the monitored signals are outside of pre-programmed limits, the nitrogen purge system sets off an alarm.

3.5 Responsible personnel

Individuals responsible for the RICH detector are:

Name	Dept.	Phone	email	Comments
Expert on-call	Hall-B			1 contact
V. Kubarovsky	Hall-B	x5649	mailto:vpk@jlab.org	2 contact
M. Mirazita	INFN	x6273	mailto:mirazita@jlab.org	3 contact
M. Contalbrigo	INFN	x6273	mailto:mcontalb@jlab.org	4 contact
A. Kim	Uconn	x6356	mailto:kenjo@jlab.org	5 contact

Table 3.1: Personnel responsible for the RICH detector.

Bibliography

[1] EPICS Documentation. URL: http://www.epics.org/. See also http://www.aps.anl.gov/asd/controls/epics/EpicsDocumention /WWWPages/EpicsDoc.html

[2] JLAB EH&S Manual. URL: http://www.jlab.org/ehs/ehsmanual/.

[3] JLAB/CEBAF Personal Safety System (PSS) Manual. URL: http://www.jlab.org/accel/ssg/user_info.html

[4] Accelerator Operations Directive. URL: http://www.jlab.org/ops_docs/online_document_files/ACC_online_files/ accel_ops_directive.pdf (URL is available inside JLAB site).