THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY
MANAGED & OPERATED BY:
JEFFERSON SCIENCE ASSOCIATES, LLC

PREPARED BY:
Bob Miller
Hall B Lead Detector Engineer

INFN
RICH Detector for Hall B

MECHANICAL REVIEW
REPORT

RICH DETECTOR MECHANICAL REVIEW
REPORT

BACKGROUND OVERVIEW & COMMITTEE CHARGE

At the request of the Physics Division, a review committee was assembled to conduct a review of the RICH detector mechanical design.

Review Team Committee Members

NAME	PHONE	DISCIPLINE
Patrizia Rossi	7740	Physics Deputy and Division Safety Officer
Bob Miller	7867	Hall B Lead Detector Engineer
Bert Manzlak	7556	Physics EH&S Liaison
Paul Collins	5981	12 GeV Safety Manager
Joe Guerra	7260	Hall B Mechanical Designer

REVIEW SCHEDULE

Date: June 20, 2014
Location: CEBAF B207
Time: 8:30AM – 11:00AM

SUPPLIED REFERENCE MATERIALS

Presentations Located at:
https://clasweb.jlab.org/wiki/index.php/2014_June_18_RICH_Mechanical_Review

M. Contalbrigo: The RICH Project

D. Orecchini: RICH Mechanical Shell Design

S. Tomassini: FEA Model Weight Analysis

R. Perrino: Gas System Design Parameters

RICH DETECTOR MECHANICAL REVIEW REPORT

Charge 1: Is the proposed RICH mechanical design well integrated into the CLAS12 detector? I.e. are all the mechanical constraints imposed by the CLAS12 detector taken into account?

Findings:

1. The INFN team provided a 3D model of the RICH detector and the LTCC. The model was placed in the Hall model at the final LTCC location. As shown in Figure 1, the minimum distance from the target to the most upstream portion of the RICH detector is 5444 mm. The maximum distance from the target to the most downstream portion of the RICH detector is 6613 mm.

2. The clearances were checked to the forward carriage structure and the adjacent detectors and the 3D model shows that the RICH detector fits in the space allotted; see Figure 2. Jlab will provide a 3D file of the final location of the RICH detector and the mount locations, as well as a file showing the Torus cryostat shadow on the RICH detector by July 11, 2014.

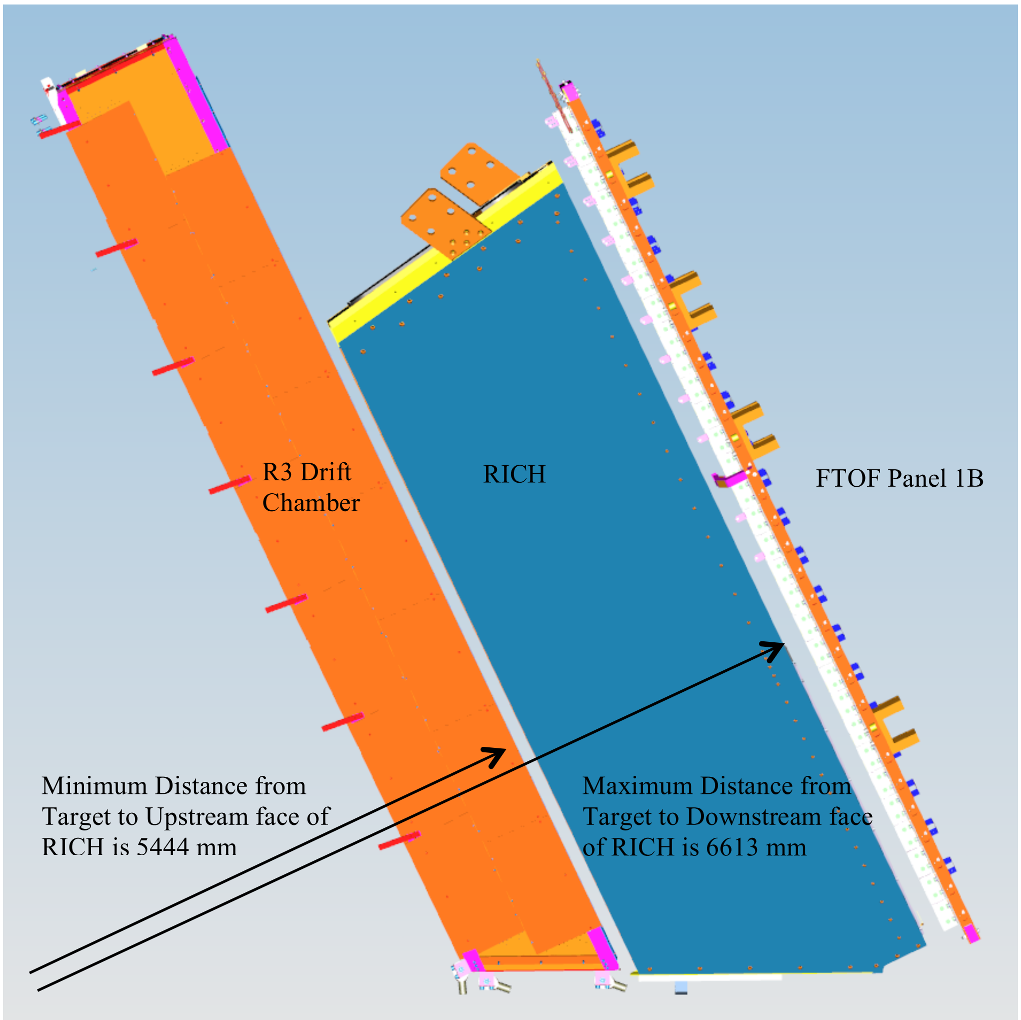

Figure 1: View Showing Clearance Between RICH, R3, and FTOF

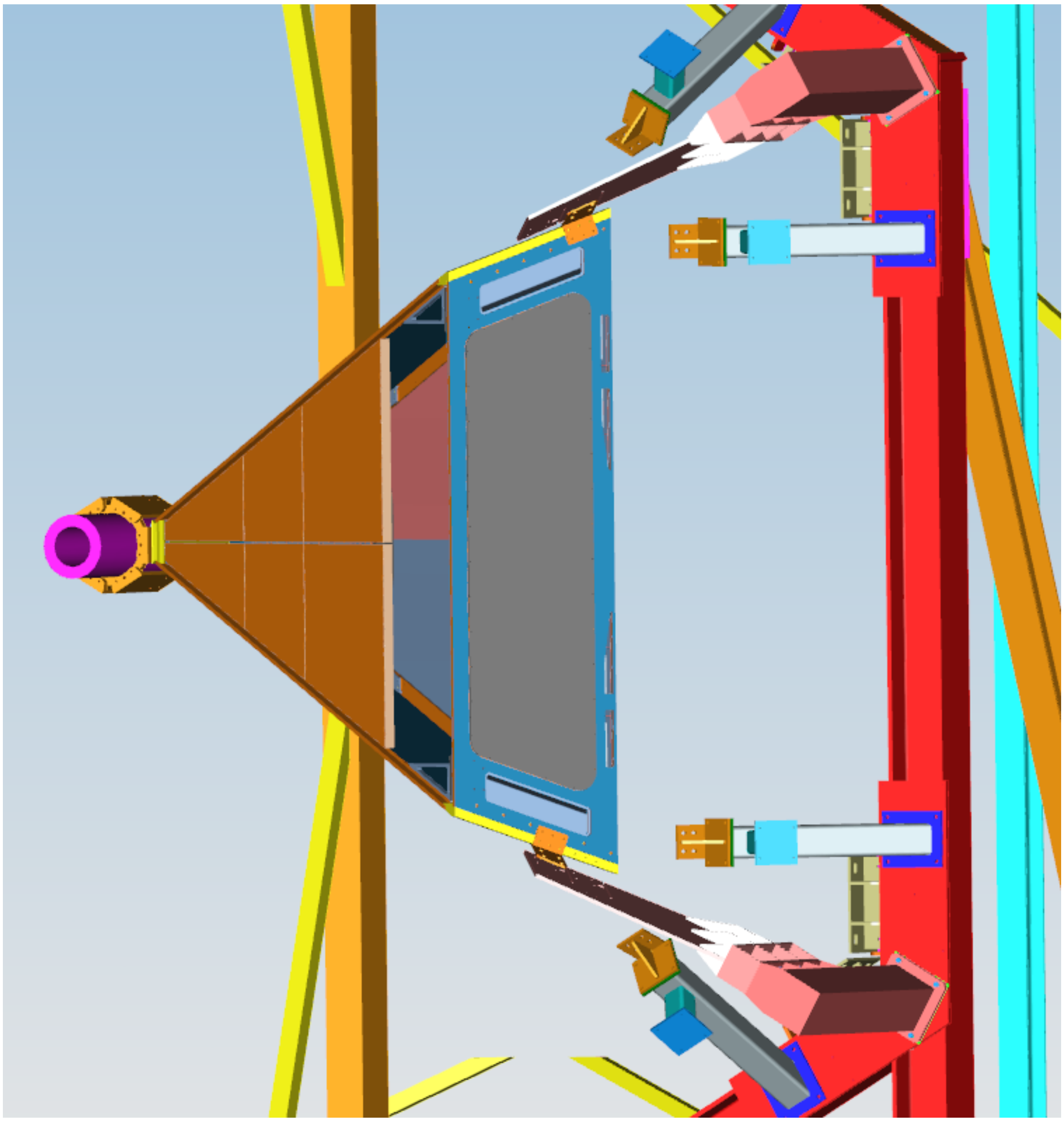
Figure 2: RICH Detector Attached to Forward Carriage Mounting Brackets

Comments:

1. The RICH detector will fit through the truck ramp horizontal if one of the mounting stirrups are removed. The LTCCs were removed using this method and since then, the door width has been increased by 4 inches. See Figure 3.

Figure 3: LTCC Removal from the Hall

2. Jlab will conduct an engineering review of the final lifting fixture design and follow the JLab lift plan guidance.

3. The composite entrance and exit panels add substantial stiffness to the mechanical shell. If these panels are included in the FEA analysis, the deflection of the side walls will be reduced.

4. The maximum steady state temperature for the time of flight system has been studied by Dan Carman. The results are:

    There are four issues related to temperature effects on the FTOF:

    1). Temperature-dependence of scintillation material

    According to the manufacturer's data sheets for BC-404 and BC-408, the light output is independent of temperature from -60C to 20C. However, as the temperature increases about 20C, there is a slight decrease in light output such that at 60C, the light output has dropped by about

5% compared to that at 20C.

Conclusion: The material is reasonable temperature stable in terms of light output within a reasonable range about "room temperature", however temperatures in the vicinity of 60C will have an slight impact on timing resolution.

2). Temperature-dependence of construction materials

The construction materials of the FTOF detector system (Tedlar, epoxy, Al foil, fiberglass tape, Mylar tape) are known to be quite stable at room temperatures (~24C). Certainly temperatures within 10C might be still considered within the bounds of the definition of "room temperature" and as such, we would not expect any issues in such temperatures.

3). Temperature-dependence of PMT/divider assemblies

There is a known temperature coefficient of the PMT/divider assemblies that gives rise to an increase of dark current with temperature. This increased dark current could, in principle, lead to noise on the leading edge of the PMT signals that would negatively impact the timing resolution. Also, the PMT/divider assembly lifetime depends on the integrated current. Thus as the dark current increases at the elevated temperatures, it would lead to a shorter operating life of these units. However, the increase of temperatures from ~24C (normal Hall B temperature) within about 10C would not be expected to have any significant impacts on performance.

4). Temperature-dependent of scintillator mechanical stability

There is a known affect that leads to softening of plastic scintillator with increasing temperature. With materials like BC-404 and BC-408 they are known to have definite "softening points" at temperatures of 70C. However, softening effects, which cause the material to flow like a viscous liquid over time, have been seen in scintillators stored in temperatures at about 40C. The flow time constant becomes longer with decreasing temperatures. This mechanical stability effect is perhaps the biggest concern associated with temperatures elevated above room temperatures.

It is recommended for the mechanical stability of the materials to keep them in temperatures no higher than 30C at steady state.

Recommendations:

1. The RICH detector group should show by analysis that the steady state temperature of the FTOF panel 1B will not exceed 30C. It is acceptable to extend the RICH detector 1 inch downstream at the electronics box location to install insulation to reduce the heat load on the FTOF. The insulation must not interfere with the FTOF panel 1B cables. Contact Joe Guerra for dimensions of the cable locations if insulation is used.

Charge 2: Are the external envelope frame and closing panel materials in accordance with the Jlab safety rules and regulations?

Findings:

1. The RICH detector is consists of an aluminum frame, aluminum honeycomb panels for the sides, and composite carbon fiber with foam core entrance and exit panels. These materials are used in other applications in Hall B and they are in accordance with the Jlab safety rules and regulations.

Comments:

1. None

Recommendations:

1. Cabling, PMTs and electronics were mentioned, so ensure the procurements of these items are acceptable per JLab electrical and fire protection guidance.

Charge 3: Are the gas systems proposed to keep the aerogel dried and the electronics thermal power dissipation system following the Jlab safety rules and regulations?

Findings:

1. The flow diagram for the N_2 dry gas system has been reviewed by the Hall B gas system expert, George Jacobs.

2. The electronics thermal power dissipation system is in the conceptual stage right now and there is not enough information to determine if it meets the Jlab safety rules and regulations.

Comments:

1. The design pressure for the N_2 system is much higher than a typical purge system used on Hall B detectors. The RICH group is encouraged to study the Jlab systems and discuss the pressure with George Jacobs.

2. The heat load from the electronics should be measured to determine the design load of the cooling system including a factor of safety.

Recommendations:

1. The internal pressure of the RICH detector from the N_2 dry gas system shall be included in the FEA analysis of the detector. The statement: "pressure: wanted levels of ~30-40 mbar are not expected to affect mechanics significantly" must be confirmed via analysis.

2. A properly sized relief valve will be required after the pressure regulator, preferably a properly sized 15 psig relief to eliminate pressure system requirements downstream. The pressure regulator used must be for pure gas and have the proper outlet pressure range of 0-15psig.

3. The controller for the N_2 system shall be an Allen Bradley CompactLogix to match the other Hall B gas system controllers for ease of programming and maintenance.

4. The dry nitrogen volume, all be it relatively small, shall have an approved oxygen deficiency hazard safety review per JLab ODH guidance.

5. The final design of the dry nitrogen piping and ventilation systems shall be reviewed by a Jlab engineering subject matter expert(s).