RICH Detector Design Review
Committee Report
STAR Note #0390

Introduction:

A Design Review of the STAR RICH was held on January 28th, 1999. A committee consisting of R. Brown, A. Pendzick, H. Wieman, B. Christie, H. Matis, Y. Makdisi and B. Edwards (chair) participated in this review which took place Brookhaven National Laboratory.

The review covered design requirements, analyses, hardware design, installation tooling and plans and overall schedule. A secondary purpose of the review was to communicate the RHIC and STAR standards and requirements for drawings and documentation, procedures, safety analysis documents, and safety and operational readiness reviews.

The review agenda, presentation materials and action items can be found in the RICH Design Review binder in the STAR Project Office. The action items are considered an appendix to this report.

Summary & Conclusions:

Technical progress to date has been impressive and no "show stoppers" or significant issues were discovered during the course of the review. The combination of the Yale and CERN/Bari groups and facilities involved are a good match to the needs of the STAR RICH project.

The committee agrees with the technical arguments and plans for installing the TIC (Test Ionization Chamber) before the June/July run; however it also worries about the lack of time and number of other tasks that have to be completed between now and then. If push comes to shove, the RICH TIC will have low priority. By minimizing the quantity of hardware items involved and by planning the installation well in advance, the chance of success increases.

It is the opinion of the committee that while the RICH schedule may be realistic from the perspective of the RICH group completing their tasks, there are a number of outside influences that may reduce the chance for completing the RICH installation by the end of October, 1999 (stated goal). Some of these items are listed below:

a) Priorities conflict with the baseline or Barrel EMC installation efforts this summer
b) Too many people scheduled to be in the same place at the same time.
c) Lack of sufficient installation equipment (manlifts, scaffolding) due to the above
d) RHIC safety and Lab ORR reviews
e) Procedures review and sign-off
f) The interface with STAR Global Interlocks
g) Safety Analysis Document (SAD) & Design Basis Accident (DBA) review & approval by RHIC

There are a few issues that need attention by the RICH group in the coming months if they are to be successful in integrating their detector into STAR. These issues will be discussed in some detail in the body of this report, however a summary is presented here:

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Integration issues:

- Modeling of RICH feedthrough plumbing with respect to existing cable tray at that same approximate location
- Integrating radiator liquid, gas, electronics and cooling lines into STAR
- Electrically isolating "breaks" in the utility lines (for detector grounding)
- Electrically isolating the RICH from the Magnet in mounting system

Detector Enclosure, Support & Feedthroughs:

A three point kinematic support of the enclosure to the BEMC rails at 5 o'clock south location in the STAR Detector was presented. The intention was to use three bearing blocks, the same as used for BEMC Modules; two on one rail straddling eta=0 and the single on another rail at eta=0, and connect the enclosure to these bearing by way of swivel ball joints. The ball joints are a satisfactory solution to the kinematic support of the RICH but it is recommended that the single bearing block be changed to a follower style that offers less constraint and rolling friction to the system as a whole (perhaps an eccentric grooved cam follower). A suggestion was made during the review that the channel that forms the exterior sides of the enclosure could be flipped with the legs of the channel facing out which would enhance the gas seal of the enclosure. This may be worth some investigation. It is also recommended that the aluminum welding performed in the fabrication of the enclosure be either performed by or inspected by an ASME or AWS certified operator or inspector. A documented (STAR Note) engineering stress analysis of the enclosure and its support is required.

The containment box provides the isolation needed to solve many safety concerns. The proposed design utilized the RHIC SEAPPM requirements for design pressure and maximum allowed leak rate. The calculated deflection of 0.25 inches at 0.5 inches water pressure for the front cover is adequate, but should be checked when the box is proof tested. The use of standard feed-throughs and final proof testing should eliminate any remaining safety issues.

The gas piping, radiator liquid plumbing and electronics cables that enter/exit the RICH via a feedthrough on the West end appears to interfere with the existing cable tray, LV power, HV and signal cables as well as cooling water for the TPC, FTPC, SVT and CTB. This needs to be modeled to determine the extent of interference. A significant interference with the existing tray, water and cables would be a major problem to overcome. The sooner this is understood, the sooner we can begin working on a solution.

Gas System:

While the addition of the RICH adds only a small percentage to the total flammable gas volume within the STAR detector, the RICH is the only detector with pure flammable gas. It will be STAR's only possible explosion hazard and therefore efforts to mitigate this are very important. A simple, reliable, fail-safe gas system is one of these measures.

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The gas system presented was a once through system, using premixed gas, flow limited to 1 ft^3/hr. with a normal flow of .7 ft^3/hr. Many of the design details, including the interlock logic for this system were taken from the TPC gas system. This has the advantage of already being approved, greatly reducing the effort of getting approval for the RICH system. In case of an emergency, the time to purge the RICH to below the LEL may be an issue. The RICH group should insure this time is as small as possible. The detector methane leak rate should be measured at operating pressure so it can be tracked over time. A failure of the liquid radiator containment in the counter may result in an interaction between the methane gas and the nitrogen blanket system for the radiator. This should be looked at for failure modes and effects (FMEA) and be mitigated if necessary.

Liquid Radiator System:

The plans presented for the liquid radiator system appear to be in good order. The system is designed following an existing system that has been successfully used at CERN. Questions of space were raised about the part that will reside on the first platform level, but there appears to be adequate room next to the laser power supply. There were questions about the availability of an air supply and the use of glass for the bubbler, but there does not appear to be a problem. There was discussion about whether dirty power would be adequate for the pressure sensors and whether this system would be suitable on clean power. This can be resolved after the system is built and tested.

The committee agreed with the RICH group that the pump portion of the liquid radiator should be located in the assembly hall where it would be available for service and maintenance during beam time.

Installation Plans & Tooling:

The installation concept shown required that installation and maintenance of the RICH could only take place in the Assembly Building after the STAR Detector has been rolled out of the WAH. It is strongly recommended that a solution be found that allows for installation and/or maintenance of the RICH while the STAR Detector is on the beam line in the WAH with the pole tips retracted. This concept should allow for the rigging of the 500 lb. RICH from a roll around floor support frame to an installation fixture attached to the magnet end rings and existing BEMC rails in the STAR Detector. It is recommended that all rigging gear provided for installation of the RICH be that which is commercially available, certified, and stamped with proof load capacity.

RICH utilities were shown to be a combination of rigid gas/liquid piping and cable tray supporting electrical cable, all exiting from the STAR Detector to the west in the annular pole tip gap. It appears that these utilities may interfere with existing STAR Detector Systems such as Pole Tip Radial Support, Cable Tray, and TPC Laser System, and need to be resolved (see discussion above). It is also recommended that a means of controlling and supporting these utilities be provided by the addition of a bearing to be used to support this utility bundle from an existing BEMC rail. Keep in mind that if the cable tray is to provide

support for all utilities, then tray dividers may be a good idea between control cable, HV cable, and gas/liquid piping.

An engineering stress analysis of all installation fixtures is required, along with installation and rigging procedures. Some of these documents will require review and approval from the RHIC Experimental Safety Committee (RESC).

Integration:

The RICH group has made excellent progress in specifying the requirements of their detector since their proposal was accepted by STAR. They understand the STAR environment and are proceeding to make their detector "STAR-compatible." At the review they presented their qualitative utility and footprint requirements.

Now, it is time to specify a more complete description, so that we can provide the proper electrical and space assignments. They need to specify the AC plugs, the current required, type of power, and the number and sizes of their cables. (We suggest that they use conventional power for the liquid system.) This information should include the connections (slow controls) needed to monitor the detector. The fiber cable should be procured as soon as possible; it would be best for it to arrive at BNL by February 19. This cable as well as others must meet the RHIC flammability and electrical (for copper) requirements.

The space for the RICH gas rack in the gas mixing room has been approved (ECN #SIM025). Upon examining the STAR Assembly Hall after the review, a place was found for the liquid rack. However, routing the lines from the liquid storage vessel to this rack it may be very difficult to satisfy the requirements for the slope of those lines. Routing that line seems very difficult because the path is very complicated as it goes through the Assembly Building South wall. The liquid lines that go on the detector have a conflict with an existing cable tray. This area needs a careful design to minimize loss of space for routing new cables.

It is suggested that the group put a mock-up of the detector in the magnet to ascertain that the rails and the space needed to insert the detector are well understood. This mock-up can be a very simple item.

The RICH detector interlock system will need to interface with the STAR Global Interlock system. The interface is minimal but necessary: receive, enable, and shut down inputs as well as send a ready signal. The first step is to modify the Global Interlock system requirements documentation to account for this.

Safety:

It is recommended that the RICH group go before the RHIC Experimental Safety Committee for a formal review soon. As part of this review it is recommended that the RICH group present as detailed a plan as possible of the "fall-back" plan for testing. the Test Ionization Chamber (TIC) this June and July. This "fall-

back" plan appeared to include the use of a gas system that consisted of a premixed bottle of gas, piped to the TIC location, with a bubbler on the output to regulate the pressure in the detector.

It was also recommended that the RICH group spend time soon detailing exactly what will be required to implement the "fall-back" TIC testing plan. The rationale for this suggestion is to identify the various elements of the Fall-back plan and make sure that these items can be implemented by late May, 1999.

Both in order to meet the RHIC Safety requirements and as RICH impacts the STAR Safety Envelope, the group will be required to write/revise and submit the following documents for Safety Committee approval prior to implementation in STAR:

a) Appendix to the Safety Assessment Document (SAD)
b) Design Basis Accident (DBA)
c) Failure Modes and Effects Analysis (FMEA) of the gas system