E907 RICH Status

Earl C. Swallow

9/28/2001

We now have a reasonably clear picture of the status of the SELEX RICH for use in E907. A basic summary is that there are no "show stoppers," but a significant amount of detailed work remains to be done on the various subsystems after the move to Meson Center. The effort to achieve this understanding was helped tremendously when Ben Blaiszik and Earl Swallow were joined for a month during the past summer by Alexander Kozhevnikov who has extensive experience operating and maintaining the RICH in SELEX. This enabled us to carry out comprehensive testing and evaluation of the detector's electronic systems in Proton Center.

Photomultiplier Tubes

The LED test and monitoring system was checked and brought into operation. With it, the signals from each of the 2484 photomultiplier tubes (organized in 89 columns each containing 32 tubes) were examined. In the process, 6 columns which drew excess HV current were identified. For each of these columns, the affected tube and base combination was isolated so that the remainder of the column was made operational. Two tubes were replaced as demonstrations of the necessary techniques.

In the end, only 58 tubes failed to produce acceptable signals. Given its high granularity, the RICH could operate quite successfully with many times this number of dead tubes (as long as they are spread throughout the ring image plane). We will test the tubes again after the RICH is moved to Meson Center, and then make a decision if or when to replace those which are not operating properly. The fact that replacement of tube/base assemblies is a delicate process must be included in the decision-making.

Front-end Electronics

The SELEX front-end electronics consists of hybrid chips containing a preamplifier, a discriminator, and an ECL line driver. Each hybrid chip plugs into a socket on a custom card mounted directly on the RICH near the ring image plane – one chip per PMT, 32 chips per card, and one card for each PMT column.

All of the existing front-end electronics units were tested showing that the preponderance of the original Russian-made hybrid chips used on the detector are no longer operational. These failed at a rate of ~1-2% per month during the SELEX experiment, and that rate of failure appears to have continued since the experiment. Only 916 of the ~1800 Russian-made chips in use at the end of SELEX were operational at the time of the test. Some additional hybrid chips were purchased from a US company (Hybrids International, Ltd.) as replacements during the SELEX experiment. Of the 556 tested, only 4 failed. Unfortunately, this company, which had the negatives and masks for the chips, is no longer in business. Additional makeshift replacement boards, based on a Nanometrics N277 discriminator, were also used for SELEX. All 30 of these

are in working order, but they can only be used in non-adjacent card slots.

For initial test and commissioning purposes, we could instrument about 75 of the 89 RICH columns at any time. For stable data taking, **at least** 2000 new front-end circuits are needed (if we also use the existing US-made hybrids). Both Tom Droege and Sten Hansen recommend constructing circuits based on modern surface-mount technology rather than repeating the hybrid development process. These could be a variant of the RICH electronics which S. H. is currently building for CKM. He estimates $15-20 per channel and 5-6 months to build them. For comparison, Hybrids International quoted $25.60 pre hybrid chip (quantity 1000) in1995.

Readout Electronics

To read RICH data into the E907 DAQ system, one ECL delay and latch channel is required for each front-end discriminator output (2484 total channel). LeCroy PCOSIII modules are available and appropriate for this.

The LeCroy Model 2731A is used in a dedicated CAMAC crate with the Model 2738 in the controller station. In this configuration, the 2731A can be read out at 10x CAMAC speed, 100 nsec per 32-bit word. Data may then be cluster-compacted by the Model 2738. The concentrated data are then transferred through a LeCroy standard DATABUS for readout via a Model 4299 DATABUS Interface in a CAMAC crate with a standard controller. Up to 16 Model 2738 controllers can be connected to a single 4299.

The 2371A is a 32-channel delay and latch, so each module can read out the data from one column of RICH phototubes, and a total of 89 modules are required. Allowing reasonable power margins, an appropriate readout configuration would be as follows (not including spares):

89	LeCroy Model 2371A modules
6	CAMAC Crates
6	LeCroy Model 2738 modules
1	LeCroy Model 4299 module.

These are all available from presently unused PREP electronics inventories at Fermilab.

Gas Selection

Using Neon gas, SELEX achieved a ring radius resolution of 1.7 mm, dictated primarily by the PMT size and the number of PMT hits. For our lower momentum range, a gas with at least 6 times higher refractivity is needed. Since the RICH operates only near atmospheric pressure, this suggests CO_2 as an appropriate gas for our use. It provides a 6.1 times larger photon yield and a 2.5 times increase in ring radius. The larger ring radius will necessitate analysis of partial rings for many particles. Given that we determine the location of each ring center from tracking in the drift chambers, and that we will have more detected photons in the partial rings, this should not pose a problem. Even if we are very conservative and use a poorer 2mm resolution for CO_2, we will have K/pi separation (at 3 standard deviations) up to 80 GeV/c and K/p separation up to 134

GeV/c. While CO_2 does exhibit somewhat higher dispersion than Neon, the estimated contribution of dispersion to the ring resolution remains small. So CO_2 remains the gas of choice.

Miscellaneous Issues

1. I don't know the present status of the acquisition of the Russian FEU60 PMTs.

2. As I understand it, the HV power supplies were built and provided to SELEX by Moscow State University. It is not clear what, if anything, we need to do to be assured that we can have them for E907.

3. We need budget $$ for the design and construction of the front-end electronics to replace the Russian hybrids.

4. To align the RICH mirrors, we need to be able to move it our of the beam line (as on rails in Proton Center) to have another open 10 meters upstream from the counter. This also requires enough vertical space for the cable hanging rails that are now in Proton Center.

5. A CO_2 gas system is needed. I have been unable to give this any attention thus far.

6. Given the extent of my teaching and institutional responsibilities, and the present uncertainties regarding my health, we need at least one additional person involved in the details of the RICH.

7. The assistance of a careful, skillful technician (with small hands, and often with a helper) will be needed for at least several weeks after the RICH is moved to Meson Center. The integrity of electronics will have to be checked in some detail, PMT bleeder resistors will need to be tested and replaced, PMTs will need to be tested, "dead" PMTs will need to be replaced (if /when we decide to do that), etc.

8. The air handling manifold on top of the RICH needs to be modified so that the lifting fixture can be used to support and remove the electronics access panel.