MIPP RICH Safety Review

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1 Overview

The MIPP experiment (Main Injector Particle Production experiment, Fermilab E907) is a fixed target experiment being mounted at Fermilab MC7 to measure proton, pion, and kaon interactions on nuclear targets between 10 and 120 GeV/c. Below 120 GeV/c, the proton, pion, and kaon beams are secondary beams derived from a primary beam extracted from the Main Injector at 120 GeV/c. MIPP also plans to take data using 120 GeV/c protons directly from the Main Injector. This data will have direct applications to the MINOS neutrino experiment.

Most of the detector systems in use by the MIPP experiment were originally built for fixed target experiments which ran at Fermilab and have been recycled and refurbished for use my MIPP. The Rich Imaging Cherenkov detector (RICH) is no exception; it was originally built and operated for the SELEX experiment (FNAL E871).

This section provides a quick overview of the entire detector systems. Details of each system are provided in later sections of this document.

1.1 Physical Layout

The RICH detector consists of a cylindrical low carbon steel tank 93 in in diameter, 10.22 m in length, with 1/2" thick outer walls. As used by MIPP, this volume is filled with CO_2 at atmospheric pressure. Cherenkov light from particles traversing the gas volume is reflected by 16 mirrors mounted inside the tank at the downstream end. This light is detected by photomultiplier tubes located on the upstream face of the tank.

The tank stand is supported by four wheels which rest on iron plates attached to the experiment floor. The wheels on the beam-right side are grooved and ride on a $\sim$1.5"-high guide rail. During normal operation the

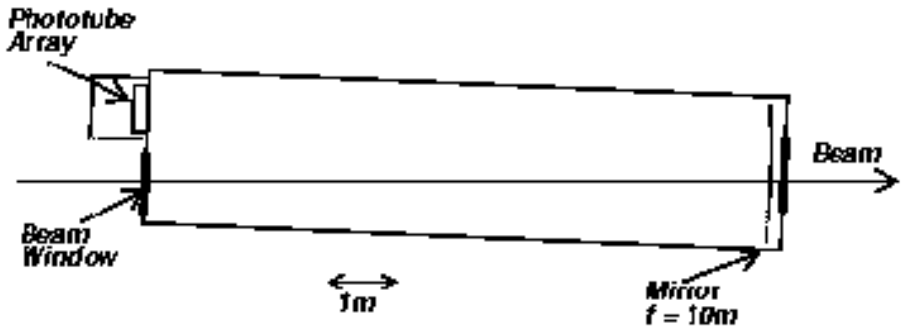

Figure 1: Schematic layout of the RICH detector

detector in braked in place, but can be moved during installation of other experiment components and for laser alignments of the reflecting mirrors. The RICH stand supports the tank at an angle of at an angle of 2.4° with respect to the beam direction.

1.2 PMT Array, HV, and Electronics

The physical layout of the RICH detector is shown in Figure 1. Figure 2 shows the basic HV and front-end electronics wiring.

The upstream end of the tank is instrumented with 2848 1/2" diameter PMT's mounted above the beam window. The PMT array is organized into a hexagonal grid 89 columns wide and 32 channels high. The PMT array in enclosed in a light-tight box which is welded to the face of the tank. This box also contains all the high voltage and anode cables for the PMT's.

The high voltage is supplied by 6 cables and distributed to each of the 2848 PMT's by a Zener divider box located on the beam-left face of the light-tight box. The box also contains an interlock circuit which becomes open when either the front access panel to the box is removed or when temperature sensors hidden inside between the PMT's trip. This interlock circuit is connected to the HV supplies and disables the HV when the circuit is opened.

The anode signals are fed through the top of the light-tight box to 3 front crates mounted on the top face of the light-tight box. Each crate

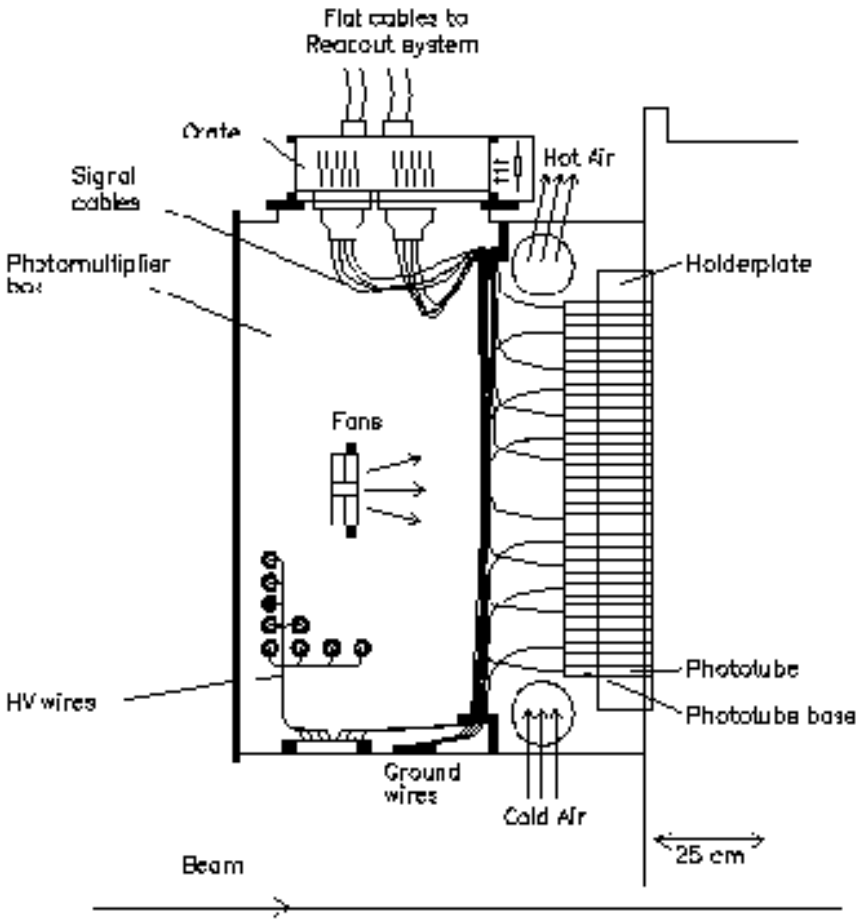

Figure 2: Schematic layout of the RICH PMT array

contains 29 or 30 front end board and supplies the boards with $+5\ V$ power. Communication with the boards is done via serial line. Adjacent boards are daisy-chained together; the last board in the crate is connected via a serial cable to a VME read out controller board located adjacted to the RICH in a VME crate on beam-left. In total, the cables running to the detector are:

#	Type	Purpose	Length	Max. V	Max. I
6	RG-58	PMT high-voltage	40 feet	2000 V	100 mA
3	10-gauge	low-voltage power	30 feet	5 V	10 A
3	serial	read out	30 feet	(small)	(small)
6	32-channel ribbon	HV monitoring	35 feet	10 V	(small)
1	co-axial	HV interlock	20 feet	0	0

1.3 Gas

For MIPP running, the detector will be filled with CO_2 at atmospheric pressure. Past experience with the detector is that the volume is very leak tight and so we expect to fill the tank once, just before running.

2 Front end and readout electronics

2.1 Front end

Figure 3 shows the basic layout of the RICH front-end electronics. The electronics was newly developed at Fermilab for the E907 RICH detector. The 89 front end cards are housed in 3 crates (30 boards/crate) located on the top of the PMT box. Each crate takes 5 V low voltage and draws roughly 10 A. Within each crate, the front-end boards are connected via a serial data line (slow controls) and 37-connector ribbon cable (data readout). Both cables return to a VME controller board.

2.2 Read out

Readout of VME boards is done through Motorola MVME processor which lives in the same crate as controller boards. The boards will be strobed by a $\sim$ 100 ns gate, and readout a few tens of nanoseconds after the end of the gate.

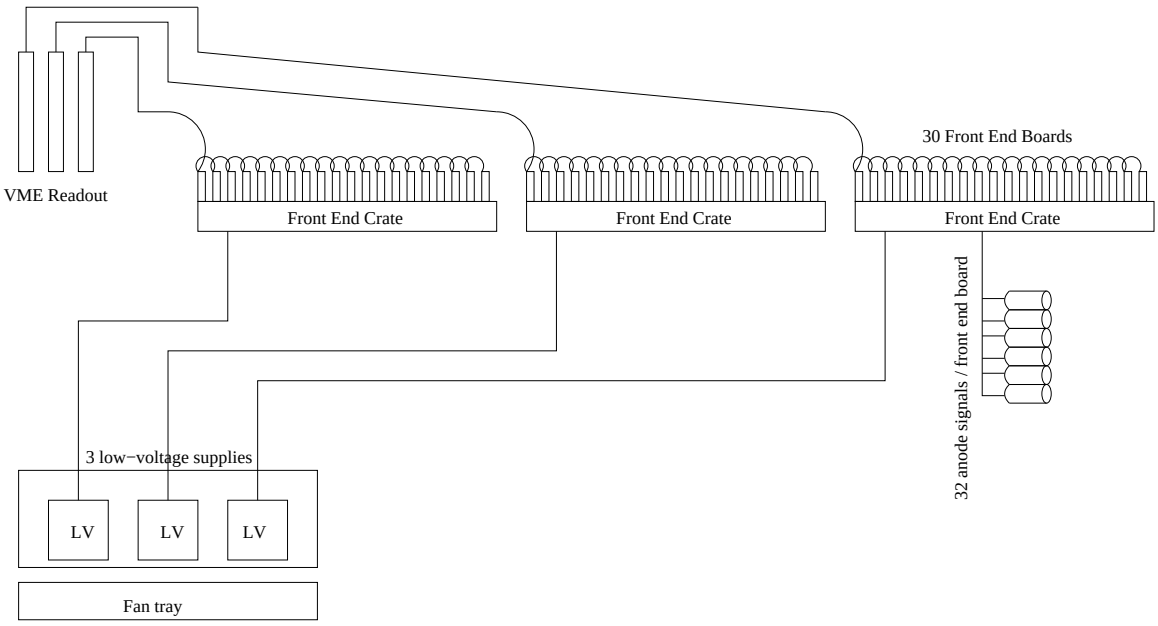

Figure 3: Block diagram of the RICH front-end electronics

3 High Voltage

The high voltage for the RICH detector is supplied by 6 Glassman EK-series supplies. The supplies provide HV between 0 and 3 kV with currents up to 200 mA (600 Watts). During operation, each supply provides roughly 100 mA of current. The supplies are operated in current-limit mode, with a typical trip point set at 120 mA.

A block diagram of the HV system is shown in Figure 5. The 6 HV cables are routed to a distribution box on the side of the RICH light-tight box. The distribution box contains 6 diode chains. Each stage of the chain drops the voltage by 20 volts. HV for the PMT's are picked off the appropriate point in the divider chain for the PMT voltage required. At each location in the diode chain there is a resistor divider which provides a voltage proportional to the high voltage, but in a range between 0 and 10 volts which can be used to monitor the voltages. These monitoring voltages are routed back to the crate on 6, 32-channel ribbon cables.

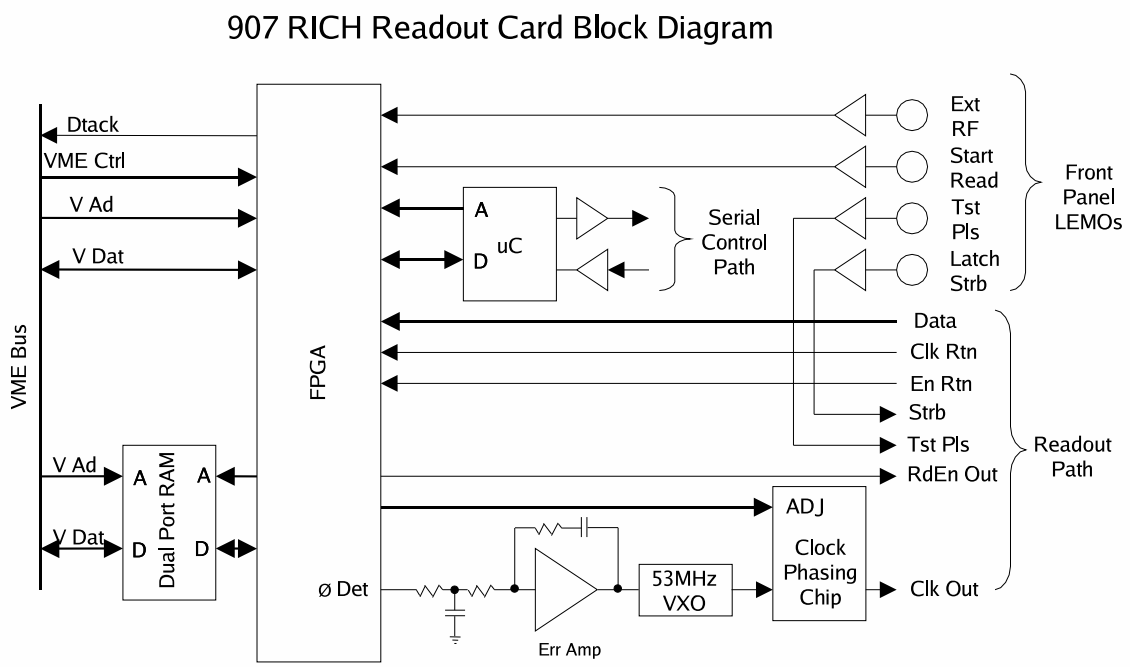

Figure 4: Block diagram of the RICH readout electronics

The HV supplies are connected to an interlock system which trips the supplies off if the light-tight box is openned or if heat sensors indicate an excessive temperature inside the light-box.

Air flow to the light-tight box is provided by a large blower located under the box. Two crate fans are mounted on the side of the voltage divider box to keep air flowing through it.

4 Gas

to do: Describe the $C0_2$ gas system

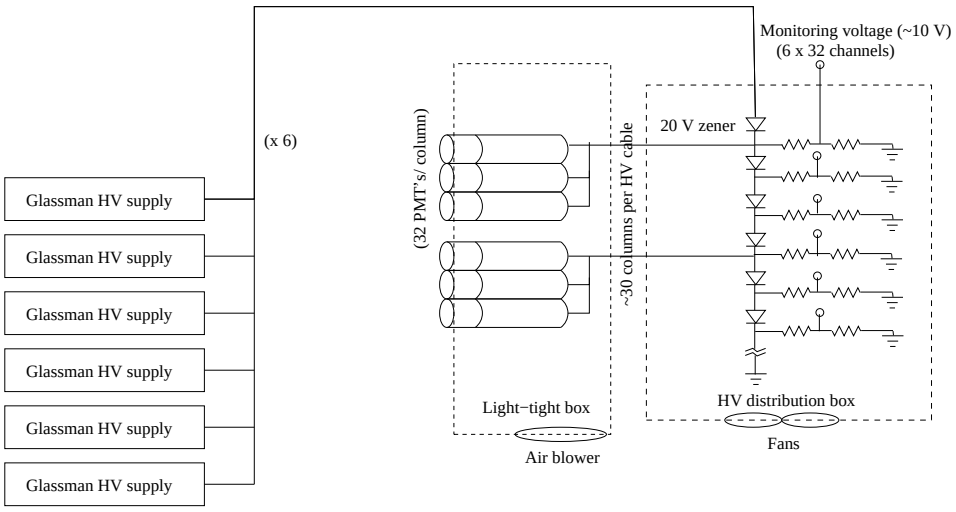

Figure 5: Block diagram of the RICH HV system

5 Monitoring

Provisions have been made to monitor the detector high voltage, temperatures, gas oxegen content... *(to do)*