Specifications for MIPP Wire Chamber electronics

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Abstract

This document describes specifications for the electronics to read out wire chambers in MIPP. The existing electronics needs to be replaced for reliability, readout speed, and buffered readout. The new electronics needs to support the specifications given in this document. The number of channels per TDC card is also discussed.

General information on MIPP wire chambers

The MIPP experiment uses three small drift chambers to measure the beam particle (BC1 to BC3) and six large chambers to track reaction particles downstream of the TPC. Four of the six large chambers (DC1 to DC4) are drift chambers similar to the beam chambers in design. The two chambers in front and behind the RICH detector are PWCs (PWC5 and PWC6).

All nine chambers have four planes of sense wires. The Beam Chambers have 160 wires per plane. All BCs are identical. DC1 has 512 wires per plane. DC2, DC3, and DC4 have 512 wires on planes 2 and 3, but only 448 channels on planes 1 and 4 with wires at larger angles. The two PWCs have 640 wires per plane. The total number of wires to read out is 14848.

The 9728 BC/DC channels are read out through 1216 8-channel pre-amps and 304 32-channel discriminators. The two PWCs have 160 32-channel pre-amps. In the first MIPP run the BCs and DCs were read out with LeCroy 4291 TDCs. The PWCs used RMH electronics.

The wire spacing is 1 mm in the Beam Chambers and 3 to 3.5 mm in the DCs and PWCs. The BCs and DCs have wires at angles of +/-7.93 and +/-21.60 degrees to the vertical. The PWCs measure x in plane 1 (vertical wires), y in plane 2 (horizontal wires), and angles of +/-28.07 degrees in planes 3 and 4.

Comments on channel count and new electronics layout

In the new electronics we aim to locate the TDC front end cards close to the pre-amp daughter cards. Pre-amp daughter cards will plug directly into the chambers in the same way that the existing pre-amps connect now. The new pre-amp cards will amplify and discriminate the wire signals so that all analog circuitry is contained on the pre-amp daughter cards. These cards will connect to the TDC front end

cards through twist-n-flat cable carrying LVDS signals. The TDC cards will also provide power to the pre-amp daughter cards so that only one cable connects to the pre-amp cards. This cable should be no longer than 1 meter.

The TDC cards will communicate with the back end readout electronics through a daisy-chain of RJ-45 cables so that each TDC card contains two RJ-45 connectors, one power connector (48V, maximum current to be determined), and several connectors to pre-amp cards.

A cable length of less than 1 meter between pre-amp cards and TDC cards implies that the following groups of wires are read out. (The PWCs have 640 wires per plane with pre-amps on three sides of the chamber.)

Groups of channels	Location	# of 32 channel cards	# of 96 channel cards
3 groups of 640 wires	BCs	60	21
2 groups of 1024 wires	DC1 top and bottom	64	22
6 groups of 960 wires	DC2-4 top and bottom	180	60
2 groups of 2560 wires	PWC5 and PWC6	160	54

If each TDC card serves 32 channels all groups can be read out without leaving empty channels on a TDC card. It may be more economical to build larger TDC cards of 96 channels. In that case some cards would not be fully used. These edge effects would be as follows:

BCs: 7 96 channel cards per chamber with 32 channels unused per chamber

DC1: 11 96 channel cards for top and bottom with 32 channels unused on top and bottom

DC2-4: 10 96 channel cards for each of 6 groups with no unused channels

PWCs: 27 96 channel cards for each of 2 chambers with 32 channels unused on each chamber

Thus in order to read out the total of 14848 channels we will need either 464 32 channel cards or 157 96 channel cards where 224 channels (~1.5%) would serve as spares. **It is clearly preferable to build TDC cards with 96 channels per card.**

TDC specifications

The specifications have been discussed with Jinyuan Wu and Sten Hanson. Jinyuan will provide a full set of specifications with the design. Here the most important specifications are listed. The TDCs must measure multiple wire hits with a timing resolution of ~1 ns. A resolution of 1.2 ns is sufficient. The

TDC should be able to receive a new hit signal within 75 ns of the first hit. The TDC must be able to work with average occupancy of ~5%, meaning that in a typical event 1 out of 20 wires will produce a hit. The occupancy for single events may exceed this limit. In 4 seconds of beam slow spill we expect ~12,000 events on average. The TDC cards need to record and buffer up to 20,000 events in 4 seconds of spill and then ship the data to the readout in less than 60 seconds. The communications protocol for the RG-45 data cables is described in a separate document (MIPP-doc-186).

Pre-amplifier specifications

The pre-amp cards need to mount directly to the chambers. The two types are 8 channel pre-amps on BC1 to DC4 and 32 channel pre-amps on PWC5 and PWC6.

DC1 is located in the remnant magnetic field of the JGG magnet. The pre-amps need to work in a magnetic field of 0.05 T (0.5 kG). The gain and noise specifications are under development and will be added to a future release of this document.

Summary

This document lists the most important specifications for the MIPP wire chamber electronics upgrade. Circuit designs and more detailed specifications will be added to this document over time.