# Front End Electronic for the Monolith Experiment

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**Abstract**

We describe a possible solution for the readout electronics of the Glass Spark Counter (Glass RPC) of the Monolith apparatus. In the proposed scheme we integrate the Front End Electronics (FEE) on the readout strips taking advantage of the strip thickness. To test this solution we are producing about 100 cards with a 16 channels modularity to instrument a test set-up that will be run at the Frascati National Laboratory of INFN.

## 1 Introduction

The Monolith [1] [2] is a massive magnetized iron apparatus to study the atmospheric neutrino oscillation. The baseline option is a 34 kton detector based on the use of about $50,000\ m^2$ of Glass RPC [3] [4]. The Glass RPC equipped with 3 cm wide strips allows to reconstruct the track with a spatial resolution (in both X-Y views) of $\sim 1$ cm and a timing resolution less than 2 ns. The FEE must allow the tracking of the particles crossing the Glass RPC without smearing the performances of the detector.

One of the requirements in the construction of such a large area apparatus is the capability to assemble the structure and the detector in an independent

way. Moreover, to simplify the experiment assembling, the detector should be modular and each part should be completely tested before its insertion in the apparatus itself. Therefore, we have developed a FEE that can be fully integrated on the detector readout strips.

This solution allows the test of the produced modules at the same time with the iron structure assembling. On the other hand, the FEE must be very reliable because it is difficult to fix failures when the modules have been inserted in the iron gap.

In addition, since no cooling system has been foreseen, FEE must have low power dissipation to avoid the heating of the detector.

# 2 Front End Electronics

A minimum ionizing particle crossing a Glass RPC induces a prompt signal of about 200 mV on the 3 cm wide readout strip.

From the physics requirements, each strip signal must be used for both timing information and particle track reconstruction. Therefore to reduce the power dissipation and the costs per channel, a hybrid solution has been developed that uses different signal path to get the two informations (see Fig.1).

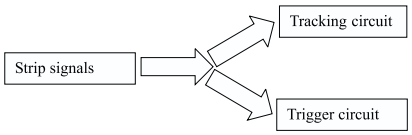


Figure 1: The Front End Electronic basic scheme.

In the scheme the fast timing information is carried out with a single low-walk discriminator, while slow and low-power discriminators have been used together with serial output readout for particle tracking purpose (see Fig.2).

The serial strips readout has already been used successfully by other experiments [1]. Unfortunately those experiments did not require the use of strip signals to generate the trigger, therefore no prompt output trigger signal has been foreseen in the electronics. Moreover the FEE cards developed for those experiments make use of digital shapers to increase the width of the discriminated signals [2]. As a consequence several frequency components of the main clock are injected on the strips-detector system worsening the S/N ratio.

To overcome these problems the FEE card developed for the Monolith experiment makes use of analog shapers and provides also both trigger and analog sum signal outputs. The Fig.2 shows the block diagram of the card developed.

[1] Aleph, MACRO, LVD

[2] Discriminated strip signals must be enough wide to allow the generation of the trigger signal

has been checked with a CAEN STAS module up to a transfer rate frequency of 4 MHz. About 100 cards will be produced to instrument the Monolith prototype. The main features of this cards are:

| | | |
|---|---|---|
| N. | 16 | Input channels; |
| N. | 1 | Analog Sum output signal for energy measurement purpose with a dynamic of 2 Volts; |
| N. | 1 | Fast Digital output signal with an intrinsic walk of $\sim$ 300 ps for time of flight measurements; |
| N. | 1 | Fast Digital signal for trigger; |
| N. | 1 | 16-Bits shift registers readable by a commercial CAEN STAS module for tracking; |

In Table 1 are shown in more detail the technical characteristics of the FEE card.

| | |
|---|---|
| **Output :** | |
| Analog sum dynamic range | 1.5 V (50 $\Omega$ load) |
| Trigger output width | 100 ns |
| Trigger output walk | 700 ps (standard NIM) |
| Digital shaper width | 5 $\mu$s |
| Data serial output frequency (max) | 4 MHz |
| Digital output signal standard | LVDS |
| **Input :** | |
| Strip signal adapting for $Z_{in} > 5\ \Omega$ | |
| Input channel polarity selection capability | |
| Input stage gain selection capability ($A_v$ max = 5) | |
| **Threshold :** | |
| Timing Discriminator | 0$\div$100 mV |
| Tracking Discriminator | 0$\div$50 mV |
| **Power Supply :** | |
| Vcc | + 7V |
| Vee | - 7V |
| Icc | 250 mA |
| Iee | 300 mA |

# 3 Future Development

Future developments of this card for the Monolith final design includes:

- A new design of the PCB layout to match the final strip pitch

- A strip-card interface that allow a fast mechanical insertion of the electronic inside the strip honeycomb support
- The implementation of the remote control of thresholds.

# References


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