More tests for the laser wire scanner detector in PETRA:

Test of a $PbWO_4$ Crystal ; with Cosmics, high bandwidth readout

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Internal Note DESY MDI-04-01
5-Dec-01

Introduction

The response of a $PbWO_4$ Crystal (2 x 2 x18cm^3) to Cosmics is studied with a high bandwidth readout system.

Setup and measurements

The main setup is described in a previous note Internal Note DESY MDI-03-01. Two fast plastic scintillators (NE110 + PMT type 56AVP) were positioned above and below the crystal. The two coincident scintillator signals created the clock for the ADC. The timing was adjusted that the maximum of the Photomultiplier (PMT) signal came simultaneously with the clock for a proper AD conversion. Two different treatments of the PMT signal were studied:

1) Direct connection to the ADC Board (Fig. 1a).
2) Smoothing of the PMT signal by a filter with a time constant of 35 ns (see Fig. 2), witch is still faster than the bunch distance in PETRA, but makes the timing a little less critical. It avoids clock sitting on the fast rising or falling edge of the PMT signal. The smoothed signal is connected to the ADC board (Fig. 1b).

A new ADC board (Type: GAGE 2125) was used, which has an input bandwidth of 125 MHz and an arbitrary and very low frequent external clock capability.

The amplitude spectrum of >#5000 cosmic triggers is displayed in Fig. 3a and 3b, together with a fit to the peak.

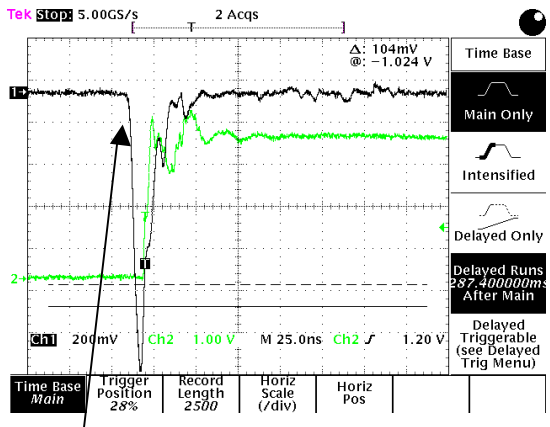
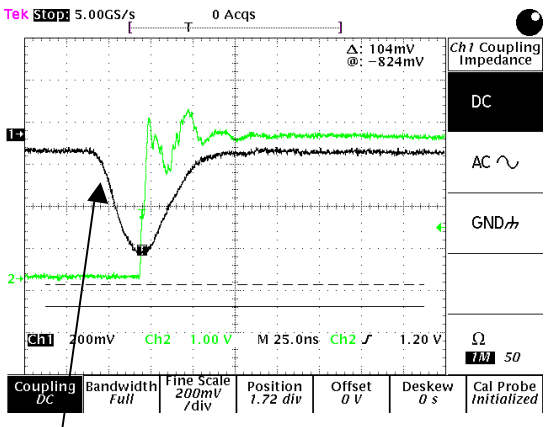


Fig. 1a: PMT signal and clock (TTL)



1b: PMT signal after filter and clock (TTL)

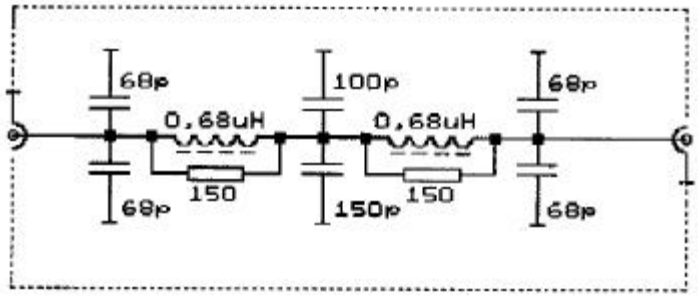


Fig. 2: Filter; rise and fall time: 35 ns

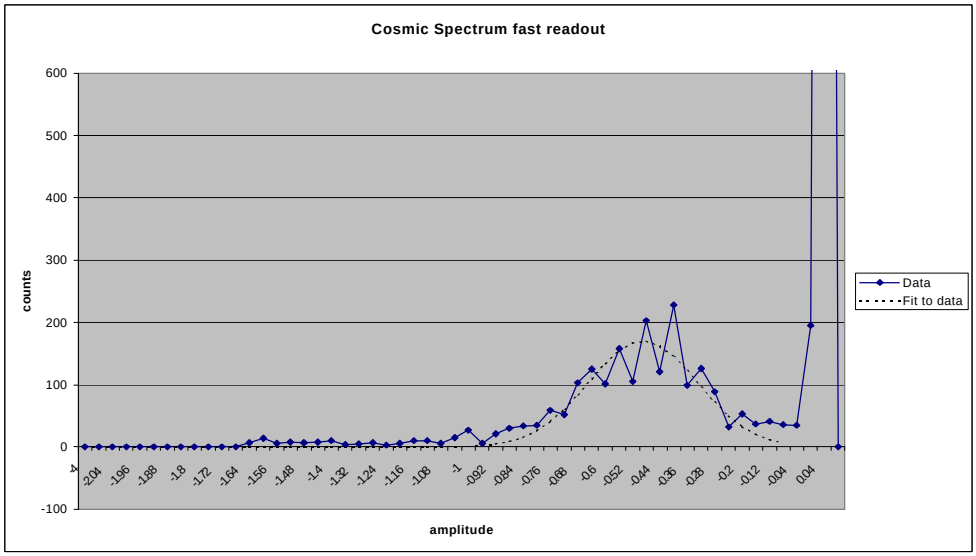


Fig. 3a: Amplitude spectrum of cosmics triggered by the two scintillators, without filter. The dashed line is a gaussian fit to the cosmic peak.

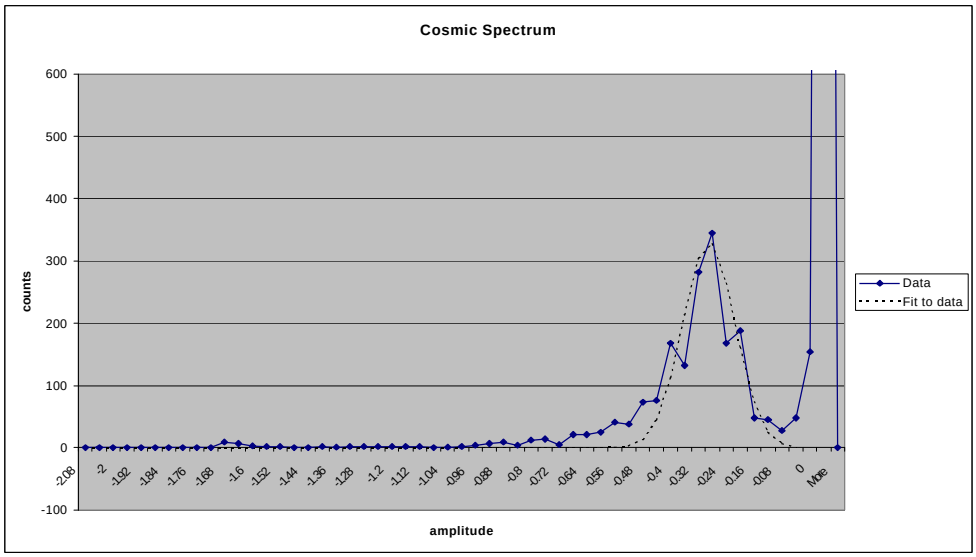


Fig. 3b: Amplitude spectrum of cosmics triggered by the two scintillators, with filter. The dashed line is a gaussian fit to the cosmic peak.

Observations:

A typical Landau distribution for minimum ionizing particles (cosmics) can be observed, too (Fig. 3). The width of the cosmics peak and therefore the resolution was calculated by a gaussian fit to the cosmic peak (see Fig. 3a,b). The resolution was determined to $\sigma = 35\%$ for the raw signal and $\sigma = 26\%$ for the smoothed signal. This compares with the resolution of $\sigma = 18.6\%$ from previous measurements (Ref. 1) with the preamplifier/shaping amplifier combination with a rise time of 3 μs (ca. 160 kHz bandwidth).
The resolution depends on the readout bandwidth, which was expected. Especially the timing of the clock signal becomes critical for the PMT pulse. One might sit on the fast edges of the signal and small jitters of the signal and/or the clock will result in large changes of the measured amplitude. The smoothing of the signal helps a lot to get rid of this problem, even with a time constant shorter than the bunch distance.
However, note that the resolution is $\sim 1/\sqrt{E_{dep}}$ so that the measured resolution is still sufficient for the laser wire scanner detector.
A new compactPCI ADC card with a bandwidth > 100 MHz is under development at DESY MDI and will be tested soon. A new integrate-and-hold circuit with an integration time of min. 10 ns and a frequency of max. 40 MHz will be available in the near future and might replace the filter circuit. It will be tested as soon as possible.

Conclusions

The sensitivity and the resolution of a high bandwidth readout system are sufficient for the laser wire scanner detector and offer a bunch by bunch resolution.

References

Ref. 1: Internal Note DESY MDI-03-01