Preliminary tests for the background measurements for the laser wire scanner detector in PETRA

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## Introduction

For the use of the laser wire scanner in Petra, the background conditions at the detector are of interest, mainly the energy deposition in the detector from synchrotron radiation as well as from beam losses. Therefore test are foreseen to determine the background in terms of deposed energy in the detector. A fully absorption shower counter is the adequate detector to observe the energy of the background produced from each bunch. The calibration and the foreseen measurements are described in this note.

## Setup and measurements

A CsI(Tl) crystal will be used to measure the amount of background. The crystal comes from radiation tests made in 1985 (Refs. 1. and 2.) and has the dimensions 1.5x1.5x10cm3. It is glued to the photomultiplier (Hamamatsu R268, Ref. 6) window. The photomultiplier was connected via a charge sensitive preamplifier (Canberra 2005, Ref 3) and a shaping spectroscopy amplifier (Ortec model 451, Ref. 4). The shaping constant was 0.5 µs. The bipolar output of the shaping amplifier was used to generate a clock signal via a discriminator and a gate/delay unit while the unipolar output was connected to the AD board (Datel PCI-416K2, Ref. 5).

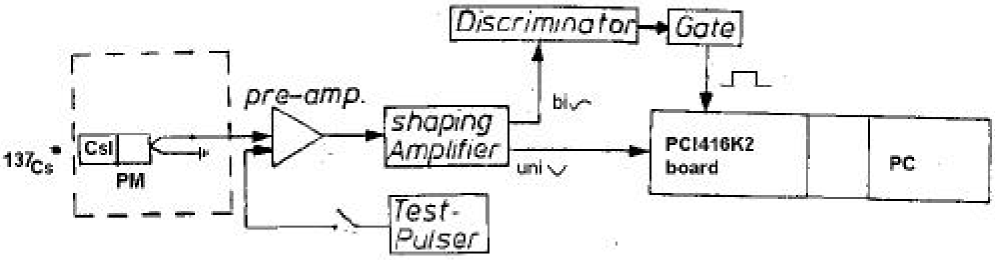


Fig. Readout Electronics

This AD board was used because it has the capability for an arbitrary external clock, which is important for the self-trigger mode when using a radioactive source and it is fast enough for the measurements in PETRA. The rising edge of the clock signal starts the A/D conversion (with an internal delay of 20 ns).

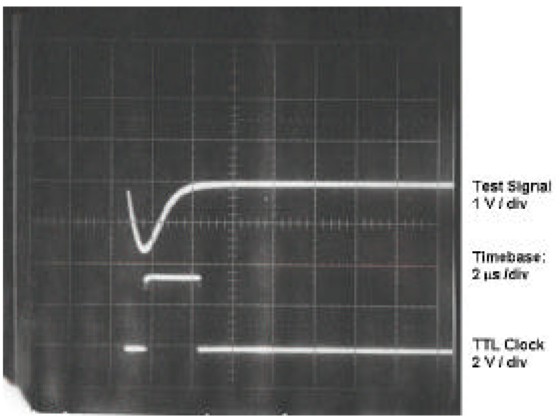


Fig: Test signal and self-triggered clock signal (after delay of clock signal).

A radioactive source (137Cs, 660 keV photons) was used to check the response of the setup. The result is shown in the next figure:

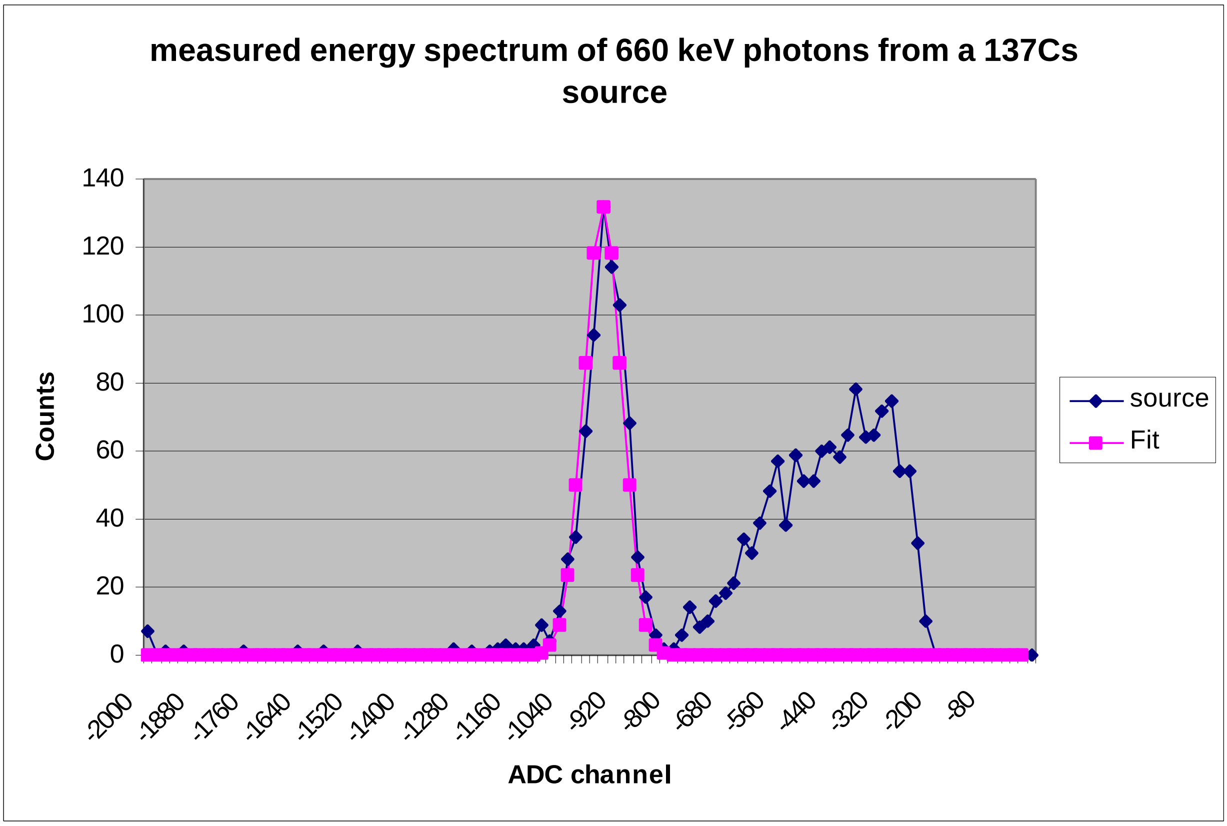


Fig: Energy spectrum. The threshold of the discriminator suppresses the lower end of the spectrum (self triggered mode).

It shows the typical 660 keV peak and the Compton background. The resolution of the peak (energy resolution) is about 4.4%.

## Perspectives

This method provides a nice way to calibrate the background in terms of deposed energy. The source line gives the reference-value, which calibrates the whole spectrum that will be measured in PETRA. But note that very high energy particles (beam losses or so) will depose only a fraction of the total energy in the crystal, because of the relative small dimensions of the crystal. This has to be taken into account when interpreting the future results from the background measurements. The crystal is adequate for photons (and particles) up to the 10 MeV region. However, the expected energy of the Synchrotron radiation photons will be much less.

The technical realization for the readout in the Tunnel will be a little different. After calibration of the setup, as described above, the clock will be synchronized with the bunch clock of PETRA in that way, that the clock signal starts at the maximum signal amplitude of the amplifier. Only one bunch has to be in the accelerator because of the long integration time of the amplifiers. The revolution frequency is 130 kHz or 7.7 µs, which is a little longer than the signal length and the decay time of CsI(Tl). Nevertheless it is adequate for this background measurements but of course not for the laser scanner.

As discussed during our last meeting, we will use a fast PWO4 crystal array and a fast AD board to resolve 96 ns bunch distances. The AD board will be clocked by the bunch clock and the conversions will be enabled by a “scan” trigger gate. Note that the fast AD boards do not have the capability of a random clock because of their ADC (pipe-) structure, they need always a constant frequency. This can easily provided by the bunch clock but an energy calibration by a source (as above) will not work. However, we want to measure a beam profile and therefore an absolute and calibrated energy measurement is not necessary.

The last Fig. shows the prepared box for the measurements in PETRA.

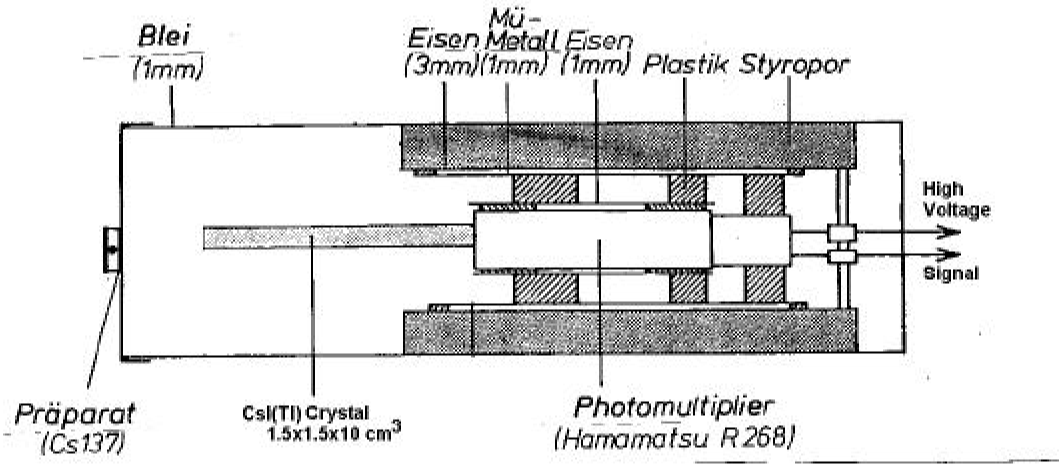


Fig: Light-tight box including the crystal and the photomultiplier

## References

1) Ch. Bieler, D. Burkhard, J. Marks, M. Riebesell, H. Spitzer, K. Wittenburg
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2) S. Schlögl, H. Spitzer, K. Wittenburg
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**Radiation Damage of CsI(Tl) Crystals in a long Term Exposure at PETRA**
Nuclear Instruments & Methods A242 (1985), p. 89 - 94

3) Attached file: Canberra 2005.pdf or http://ww2.canberra.com/pcatalog.nsf/productcatalog?openview

4) Attached file: ORTEC 671.pdf or http://www.ortec-online.com/electronics/amp/671.htm (not the same type, it seems ours is too old)

5) Attached file: pci416.pdf or http://www.datel.com/index.htm

6) Attached file: Hamamatsu R268.pdf