J. Haeberle[1], A. Krille[1], M. Jungmann[1], K. Kosev[2], A. Wagner[2], R. Krause-Rehberg[1]

Poster A.60

Investigation of the timing behavior of fast photomultiplier tubes with short laser pulses

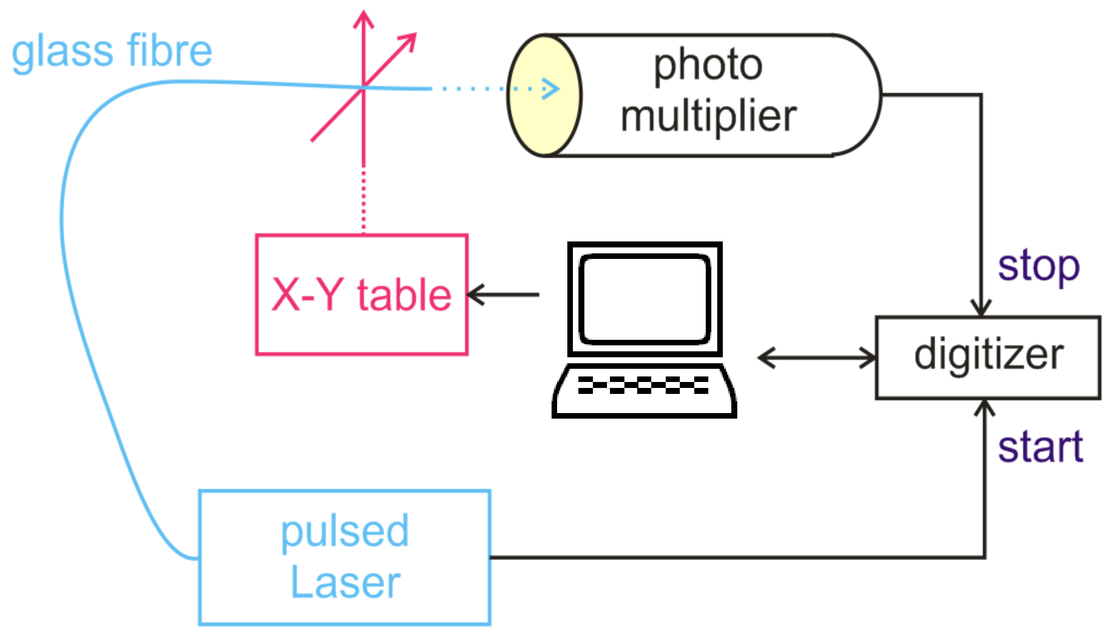
1 University Halle-Wittenberg, Inst. of Physics, 06099 Halle/Germany
2 HZDR, Inst for Radiation Physics, Box 510119, 01314 Dresden/Germany

The time resolution is the most important parameter of a positron lifetime spectrometer. It is determined by the timing behavior of the photomultiplier tubes and the scintillators. In order to measure the timing behavior of the PMT's independently, we placed a remote controlled X-Y-table into a lightproof box and attached there the output of a fiber-optic light guide. Light pulses with a repetition frequency of 1 kHz from a short-time laser are thus scanned across the photocathode of different PMT's typically in use in PALS systems. A digital PALS setup was used to collect the timing data. We determined the transition time (TT) and the time resolution (FWHM) with a lateral resolution of 2.5 mm (each dot in the X-Y scans below).

Properties of the pulsed Picosecond Injection Laser (PiLas):
- Wavelength λ = 375 nm
- Repetition frequency: 1 kHz
- Pulse width: 36 ps
- Pulse jitter: < 3 ps

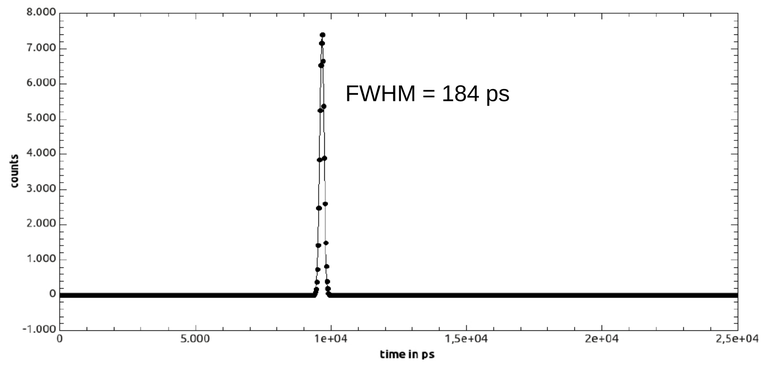
X-Y-Table:
- Two Nanotec stepper motors
- Two stepper motor positioning controllers SMCI33-1
- System operated by LabView automation
- 35 × 35 = 1225 spots analyzed
- Laser spot size: 2.5 mm²
- Time per spectrum 60 s ⇨ 6×10⁴ counts/spectrum

Digitizer:
- Two coupled Acqiris DC211 from digital PALS setup
- 4 GS/s
- analog Bandwidth: 1 GHz
- Electronic time resolution ≈ 5 ps

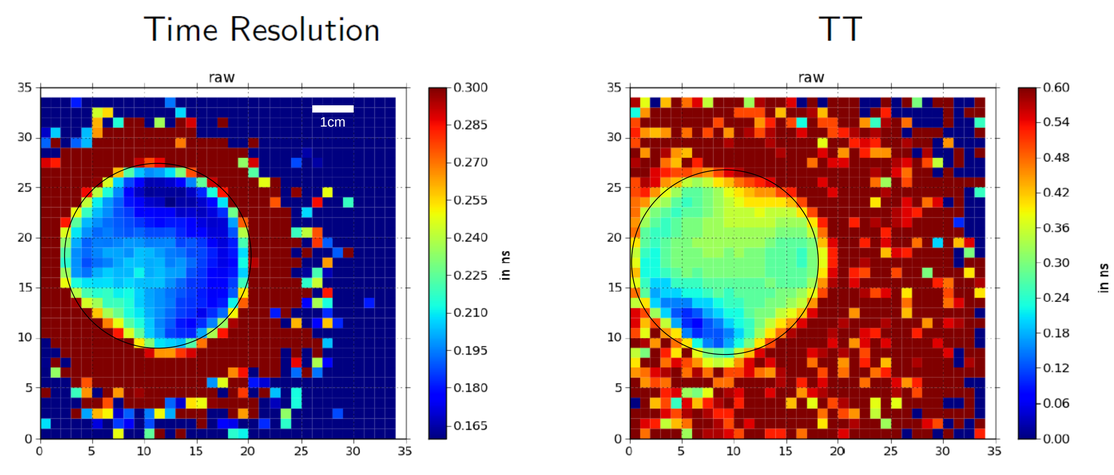


The setup: The glass fibre tip scans the photocathode of the PMT. 35 × 35 time spectra are recorded in order to determine the FWHM of the time resolution function and the transition time (TT) locally resolved.

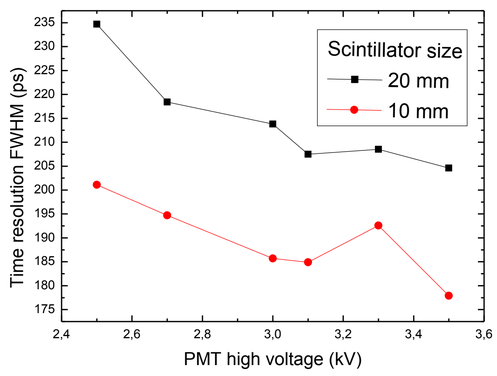
First experiment: The first test was performed as one-dimensional scan along the center line of the photocathode of an XP2020Q (not any more in production). The transition time is plotted as function of the position along this line. It is obvious that this particular tube can only be used with a small scintillator of 20 mm diameter, avoiding thus the area at r > 10mm. In that case TTS ≈ 150 ps is acceptable.



Single lifetime spectrum of the X-Y scan: The spectrum was obtained for one spot (2.5×2.5 mm²) for the Hamamatsu PMT 3370-50. The resolution and the position on the time axis is recorded for all spots to obtain the X-Y plots across the whole photocathode of the PMT.



X-Y-Scans: The figure shows a scan across a Hamamatsu PMT H3378-50. The locally resolved time resolution (FWHM) and also the transition time (TT) is shown. The photocathode is seen as inner circle of about 45 mm. The outer brownish ring is due to stray light.



Time resolution as function of high voltage and scintillator size: The results of the above X-Y scans were averaged in an area of 10 and 20 mm diameter to see the possible effect of a smaller scintillator size. The high voltage increase will not significantly improve the time resolution when U_{HV}> 3.1 kV.

X-Y scan of the new Hamamatsu H5320: This is a 10 dynode PMT with a 20mm photo-cathode and a nominal very short TTS=160 ps (H3370-50: TTS=300ps). The scan shows that the time behavior is very good.

Poster is available at http://positron.physik.uni-halle.de

Martin-Luther-University Halle-Wittenberg