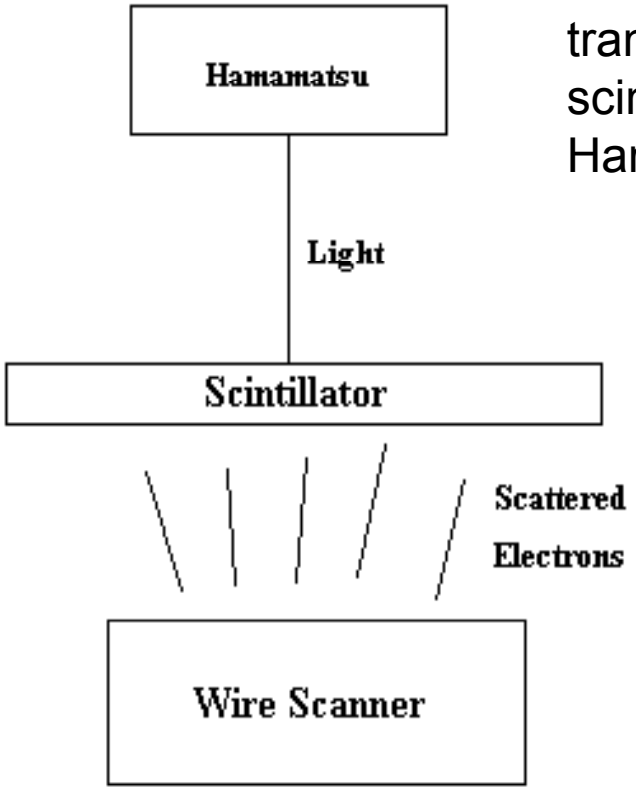
Optimization of the Hamamatsu

Saturation of the Hamamatsu of the Undulator
Wire Scanner -
Investigation with a LED

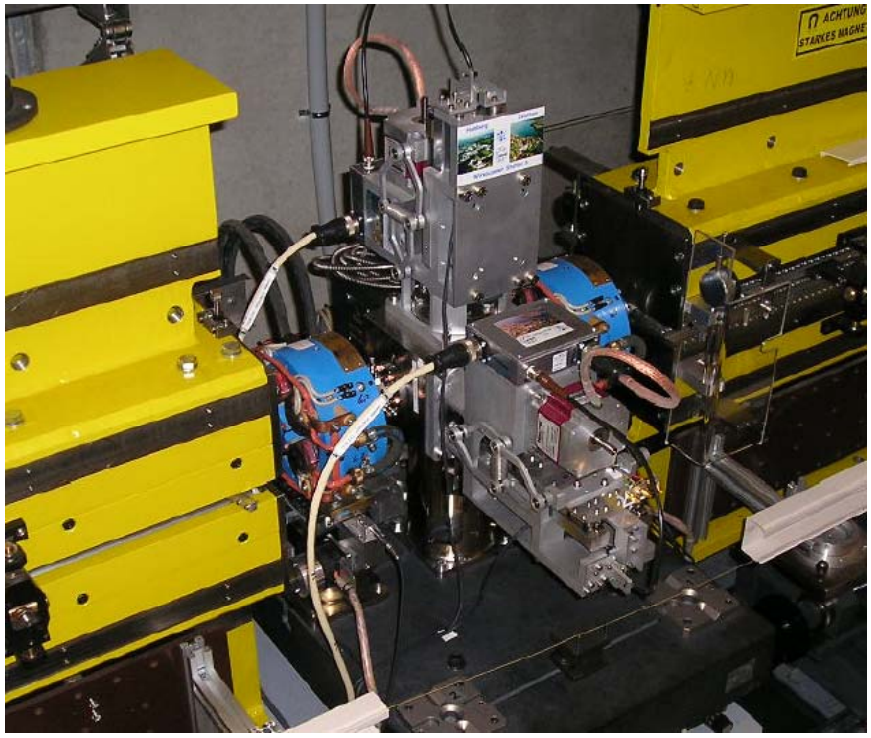
By Annika Wipprecht

The Principle

Sketch:



Scattered radiation is transformed by a scintillator and sent to a Hamamatsu (PMT).

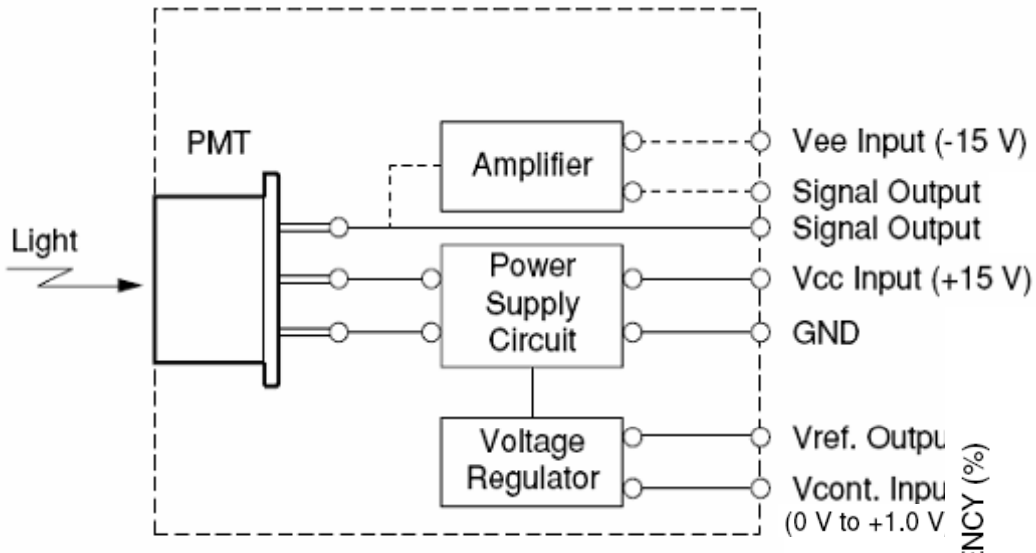


"Wire Scanner system for undulator section of VUV FEL at DESY" –M. Sachwitz, U. Hahn, N.v.Bargen, H.Thom

Table of Contents

Hamamatsu H6780 - 04

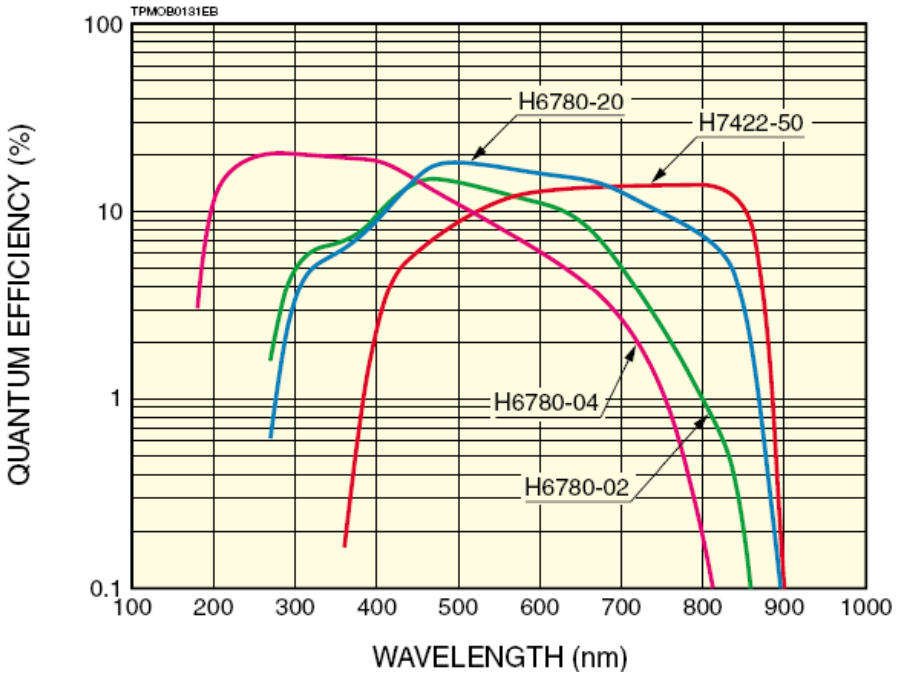
Block Diagram



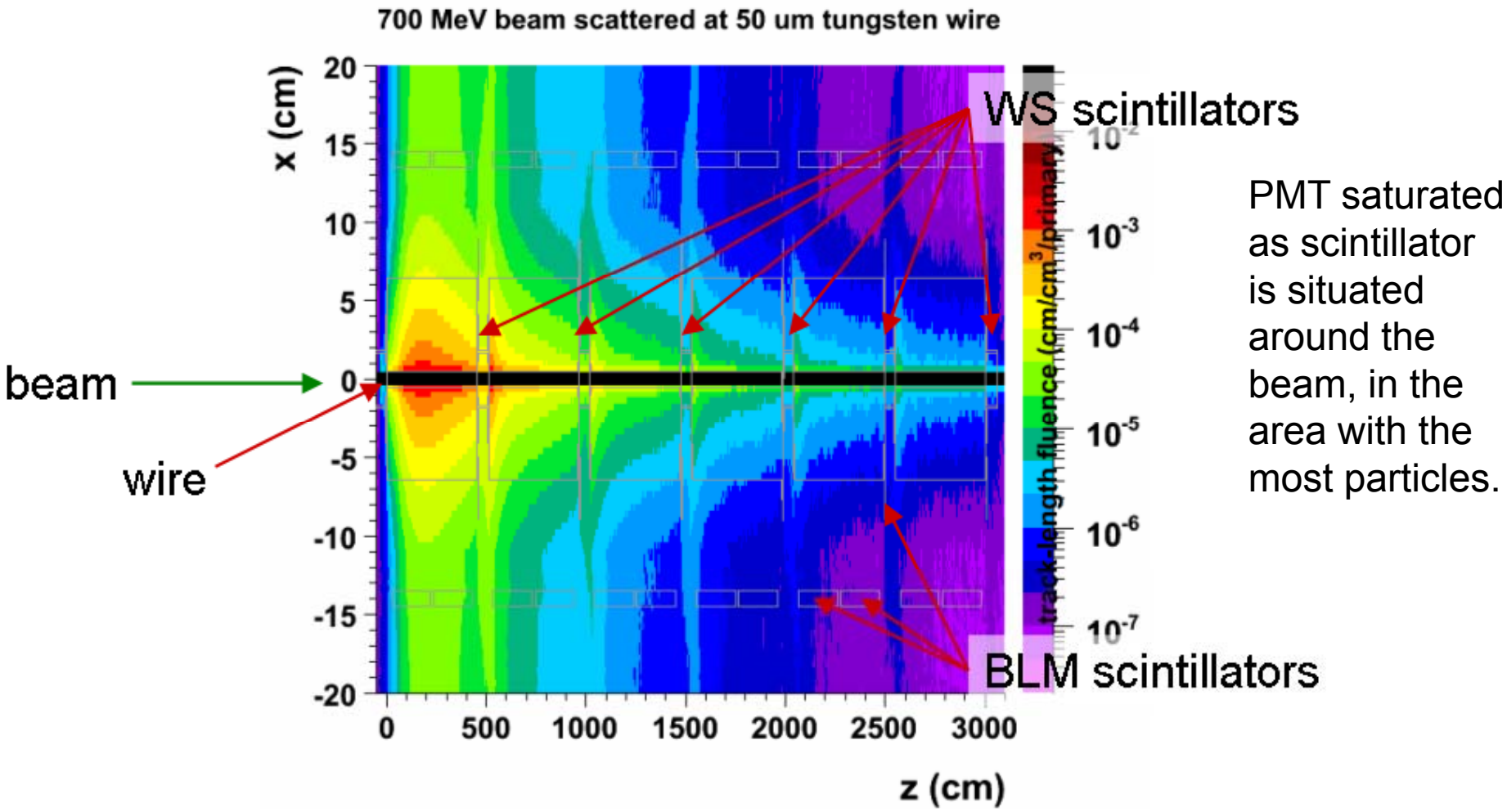
- Hamamatsu needs 15V.

- For fine tuning, you can regulate between 0V and 1V .

Efficiency against Wavelength



Saturation of the Hamamatsu



PMT saturated as scintillator is situated around the beam, in the area with the most particles.

Beam dynamics meeting, 2007/02/12
Lars Fröhlich/Eduard Prat, MPY

Dissolvability of small signal pauses of a PMT

- Gaps between packages (30ns) shell become smaller (from 1 µs to 110ns)

- Question: Can the Hamamatsu still “see” the bunches and detect the amplitude?

Table of Contents

Neutral Density Filters

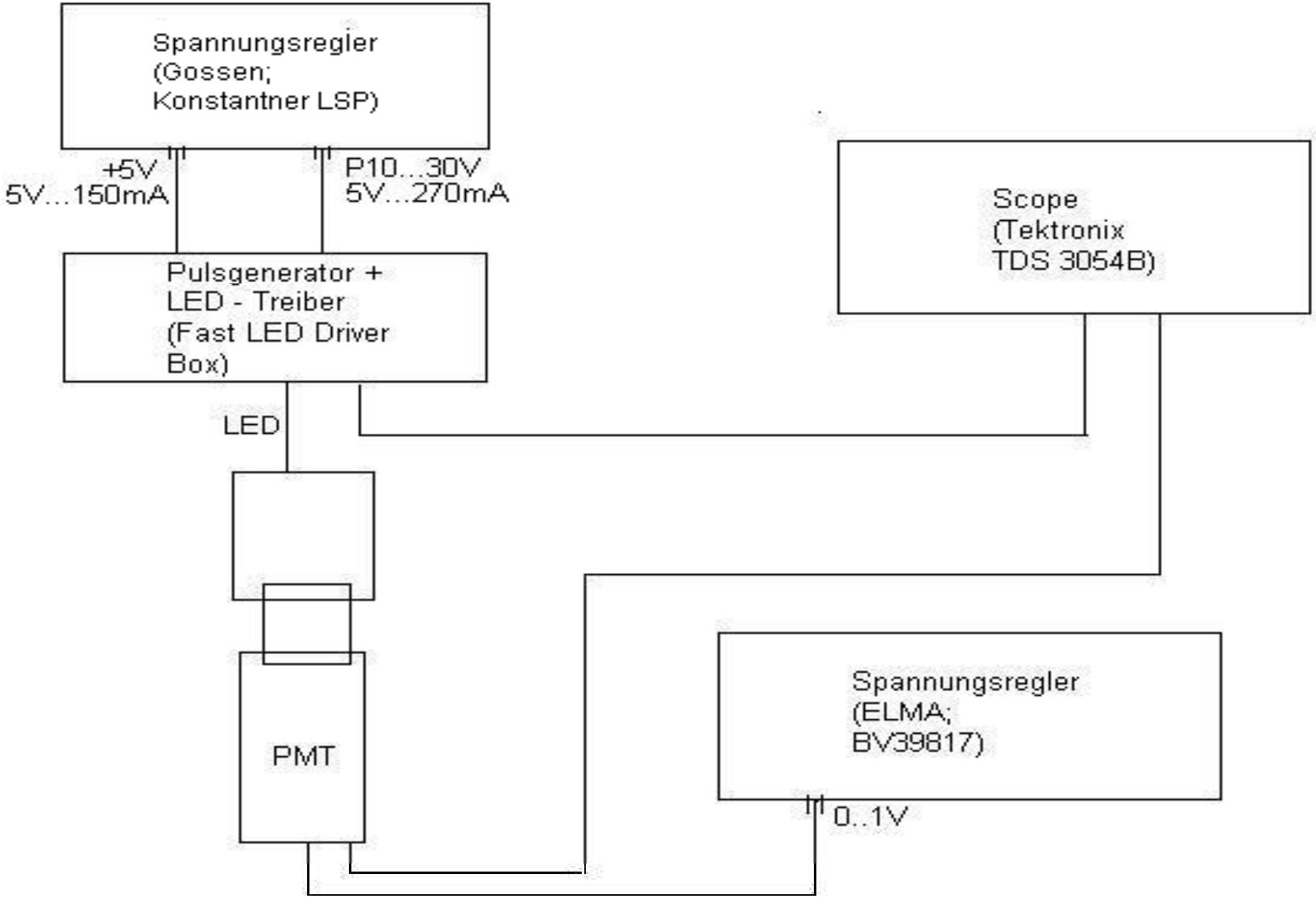
- Filters as a solution to lower light output
- Filter:
- Pentax
- ND2, ND4, ND8

Fixed Neutral Density Filters (UV, VIS, NIR)

Specifications, Quartz Glass

- **Size:** 25 mm diameter and 50 mm x 50 mm +/- 0.2
- **Thickness:** 2.2 mm +/- 0.2
- **Substrate material:** Quartz glass
- **Surface quality:** 80 - 50 scratch-dig
- **Flatness:** < 2 waves per inch
- **Parallelism:** <3 arc min.
- **Density tolerance:** +/- 5% of maximum density
- **Type of coating:** Metallic film
- **Construction:** Single surface coated on quartz glass
- **Usable wavelength:** 200 nm to 2500 nm
- **Calibrated wavelength:** 510 nm

Assembly


Spannungsregler
(Gossen;
Konstantner LSP)
+5V
5V...150mA
P10...30V
5V...270mA
Pulsgenerator +
LED - Treiber
(Fast LED Driver
Box)
Scope
(Tektronix
TDS 3054B)
LED
PMT
Spannungsregler
(ELMA;
BV39817)
0..1V

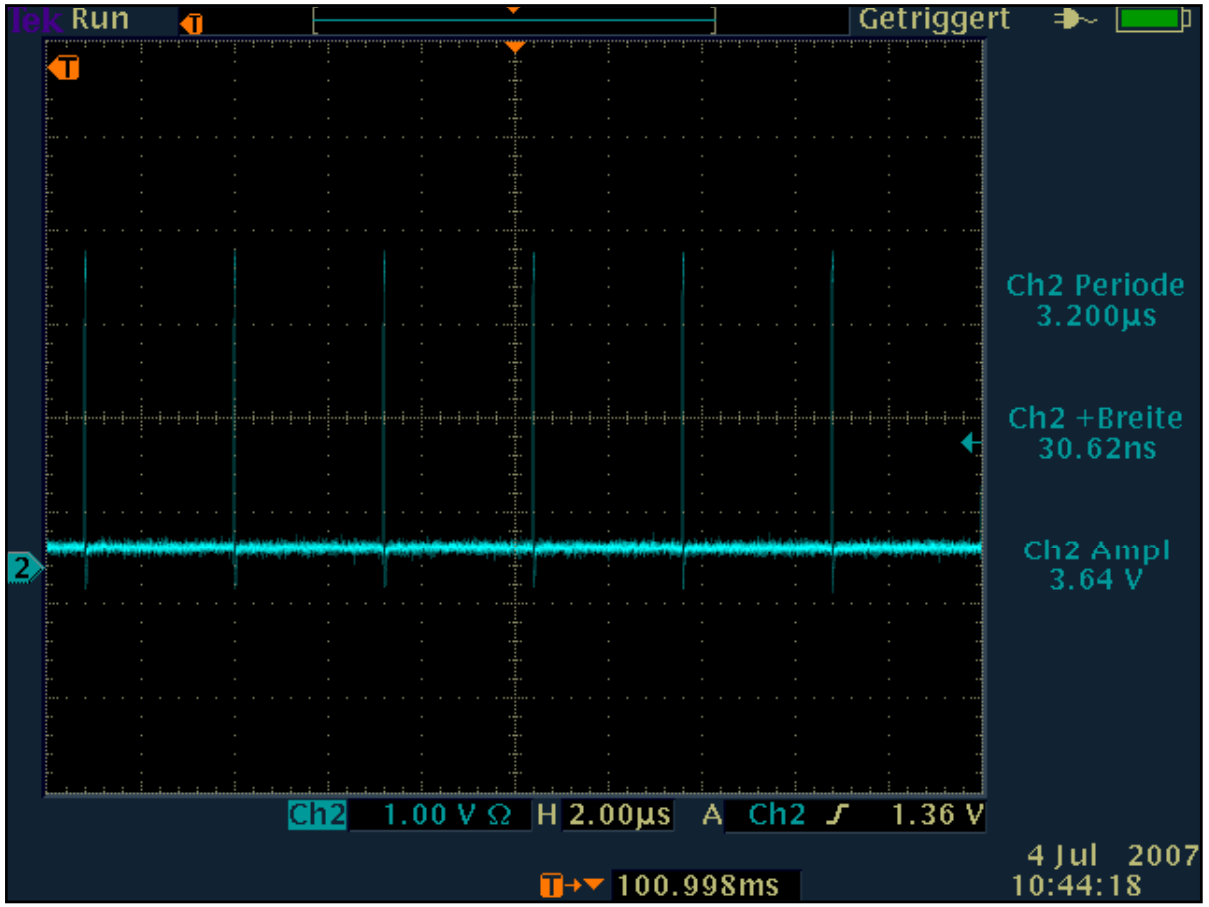
Values of the LED

LED (blue) Control:

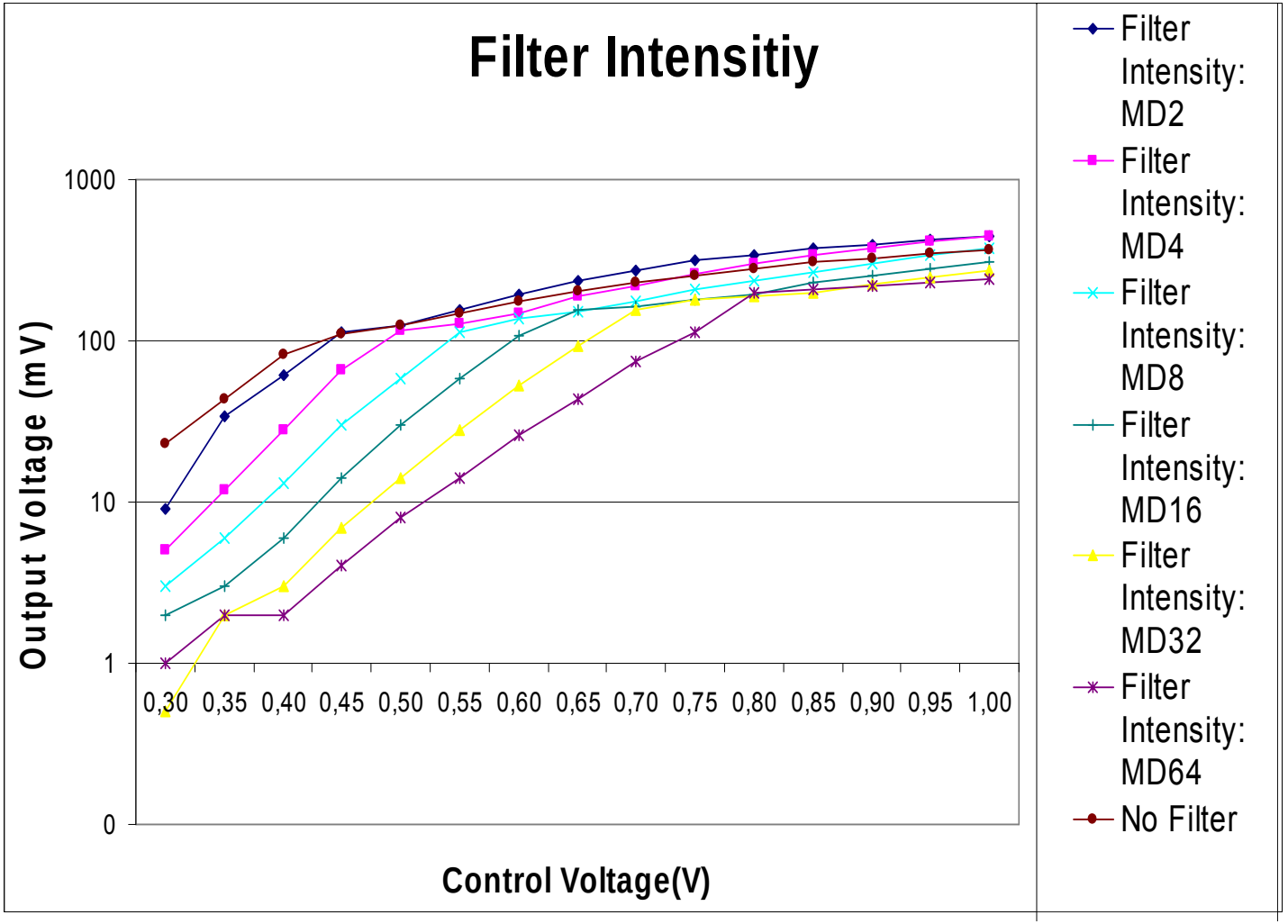
Voltage: 3.6V

Period: 3.2µs

Width: 34ns



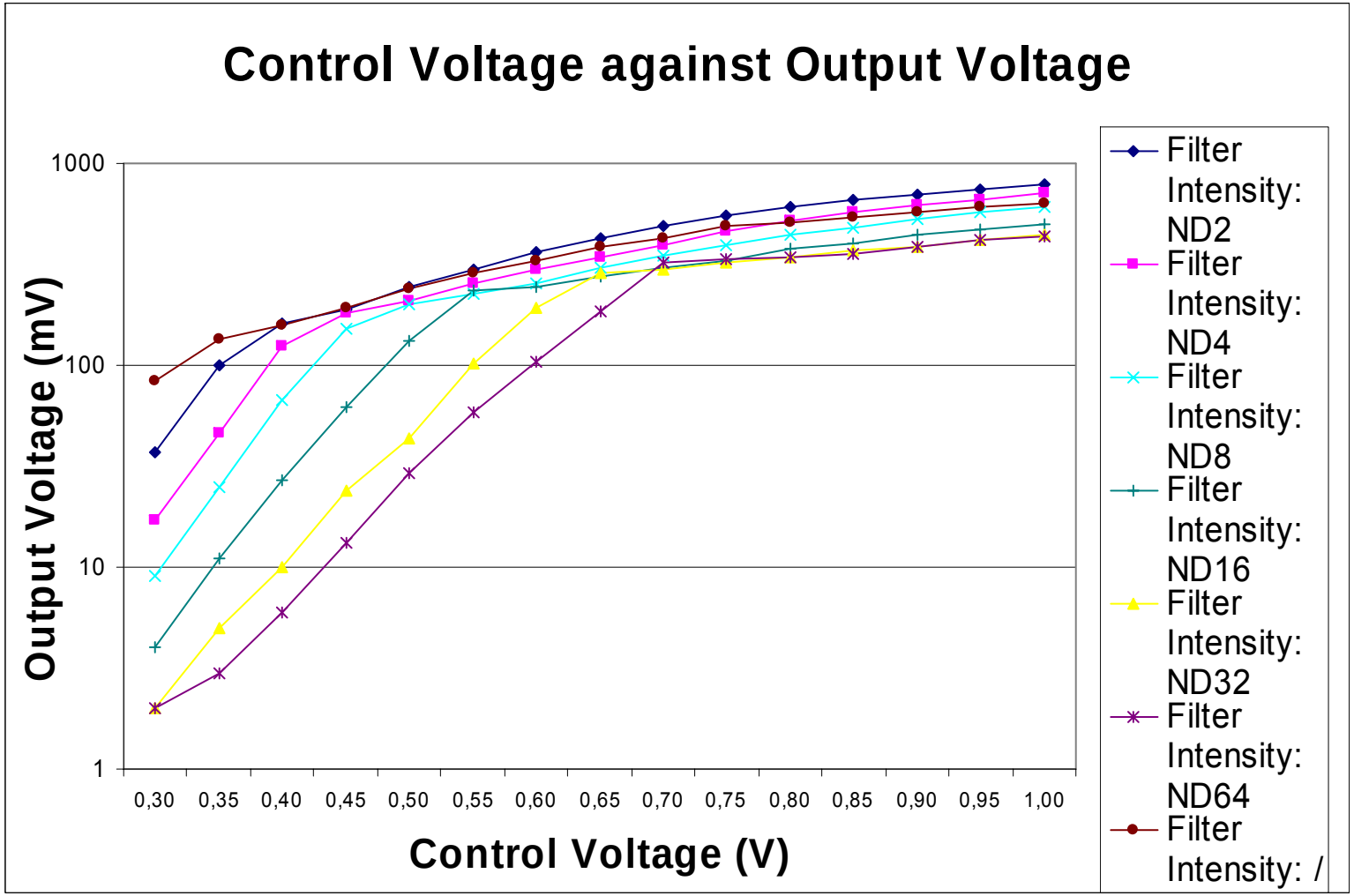
Measurements of a PMT without Electronics



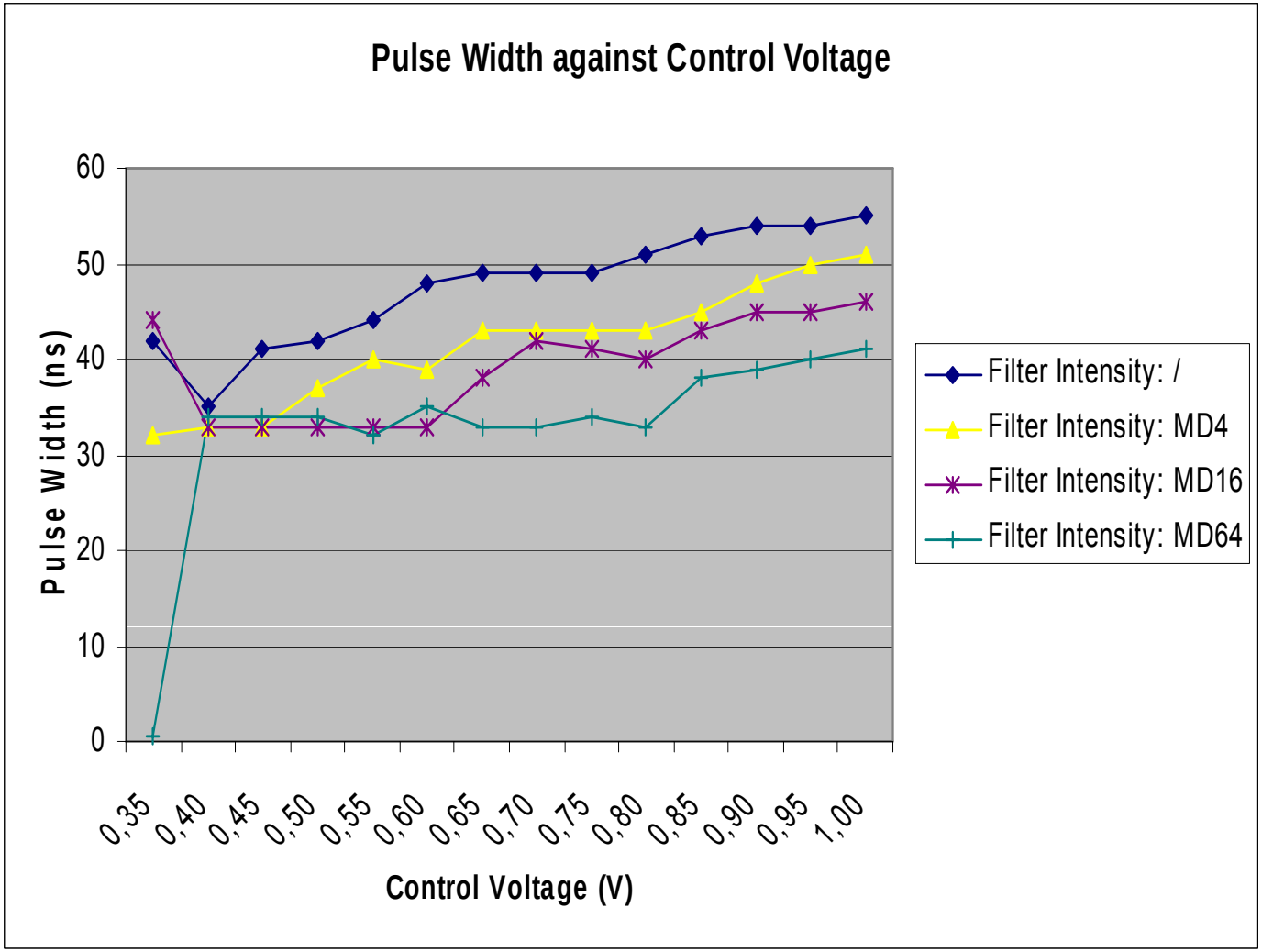
Without a Filter, the PMT is already saturated.

The filters expand the linear region by reducing the values of the rays.

Measurements of a PMT with Electronics



Measurements of a PMT without Electronics – Bunch Width



The bunch width of the PMT-output changes when the PMT is saturated.

Table of Contents

Replication of the Bunches

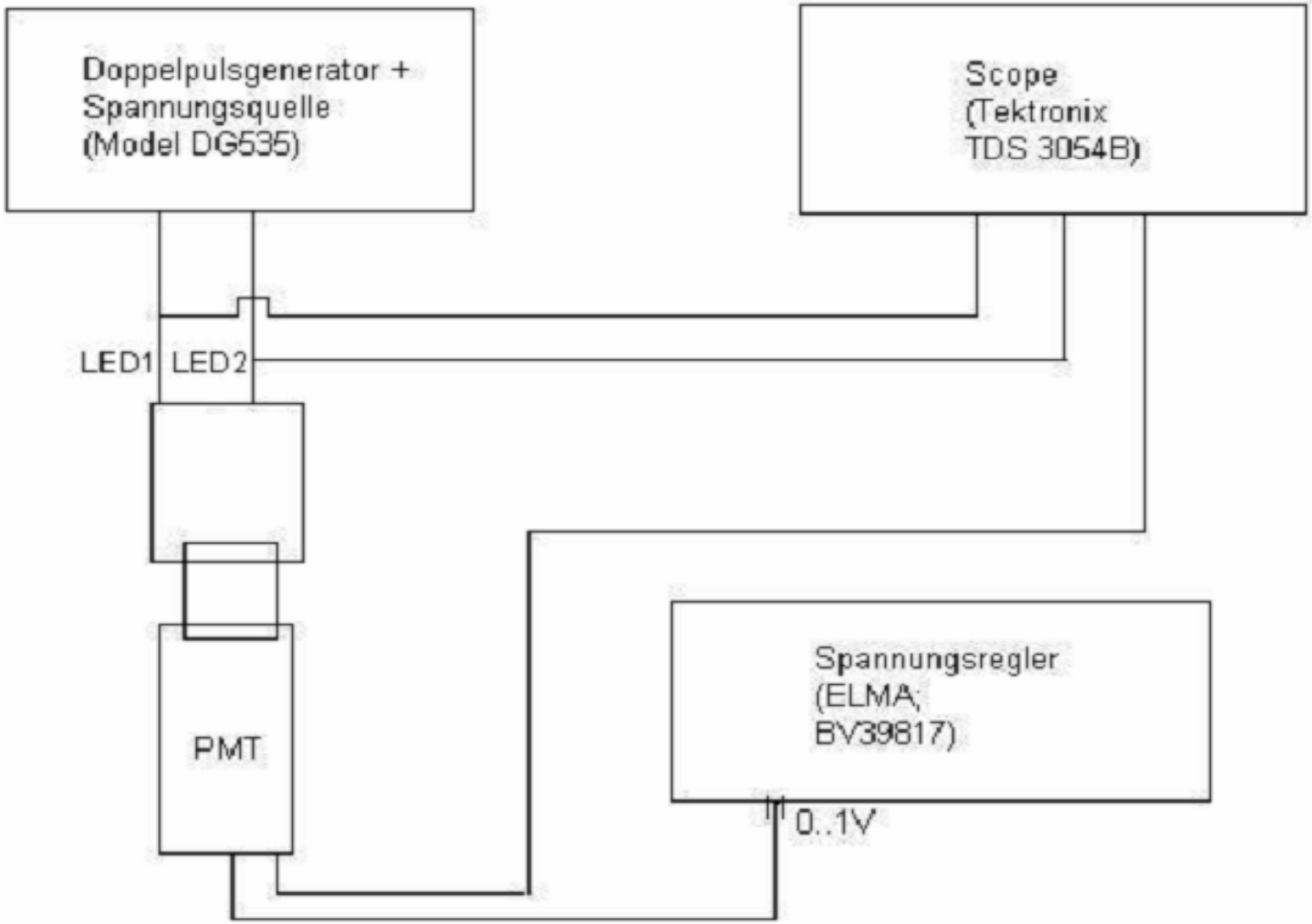
A replication of individual bunches with gaps in µs tests the behavior of the PMT to detect the last bunch.
Therefore, I use a 1ms long bunch to imitate the individual bunches and one bunch with the length: 30ns following after 1µs.

Another way of testing the saturation: generating a sinus curve

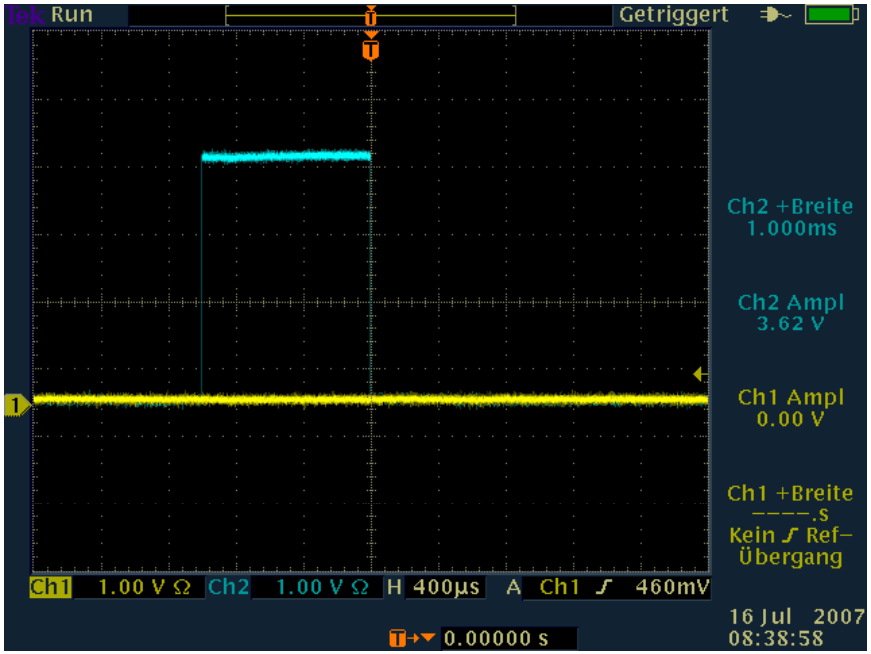
In the third test, a pulse generator produces 35ns long bunches with a frequency of 9MHz.

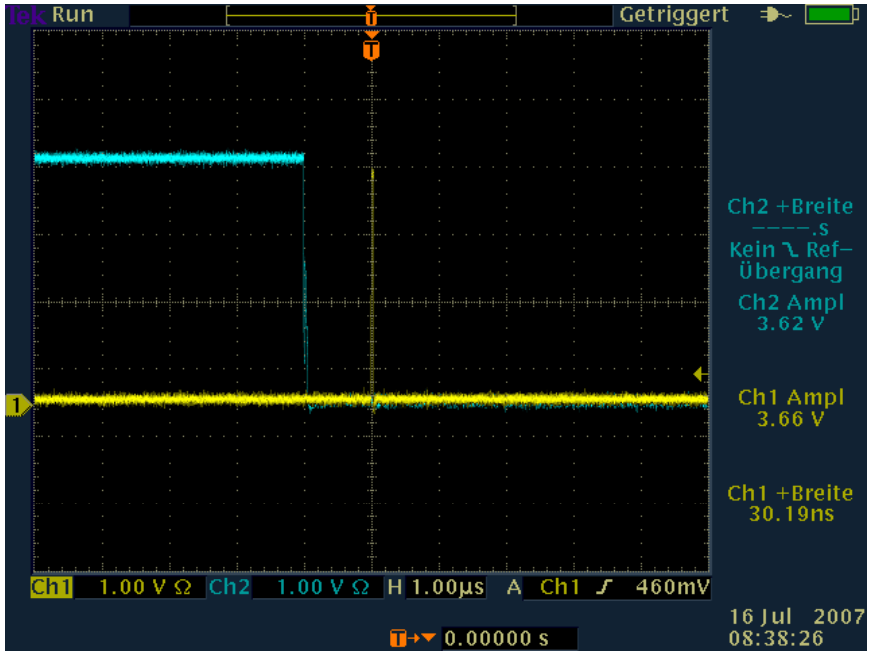
Question: Can the Hamamatsu still “see” the bunches and detect the amplitude ?

Assembly of the first Test



Values of the LEDs





LED1

Voltage: 3.6V

Width: 1ms

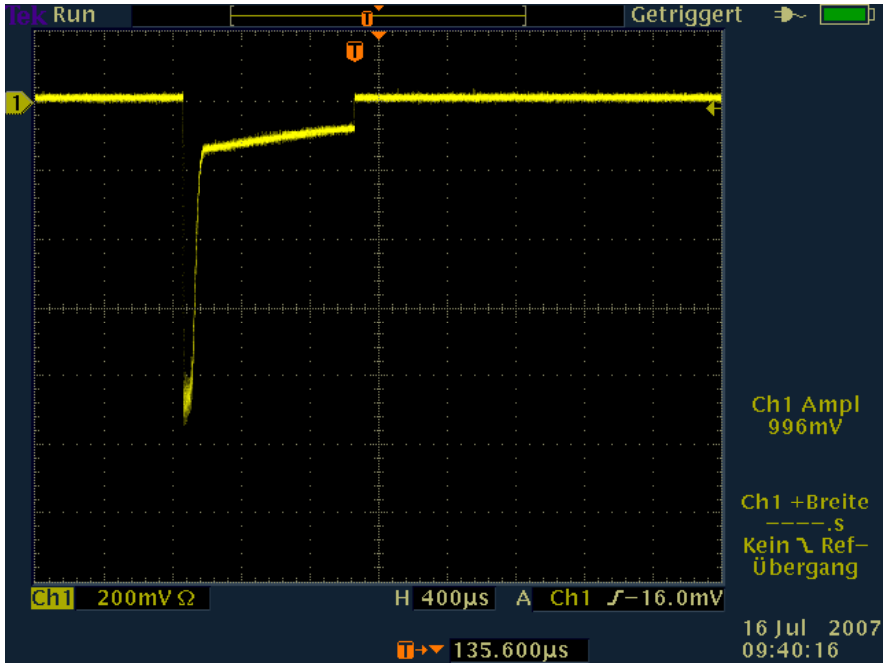
LED2

Voltage: 3.6V

Width:30ns

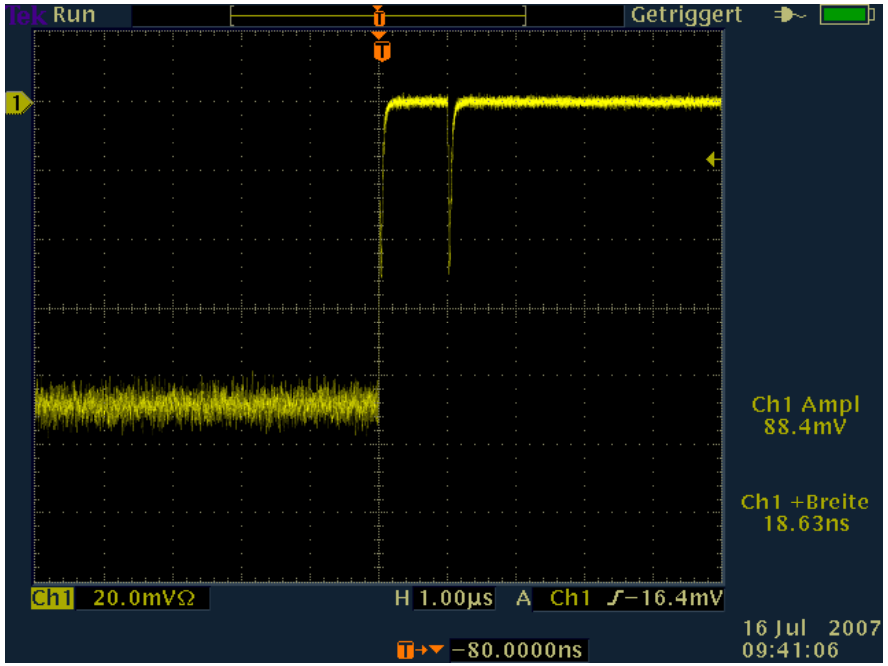
Distance to LED1: 1µs

Measurement of the Output Voltage



Big output bunch at a control voltage at 0.7V without a filter.

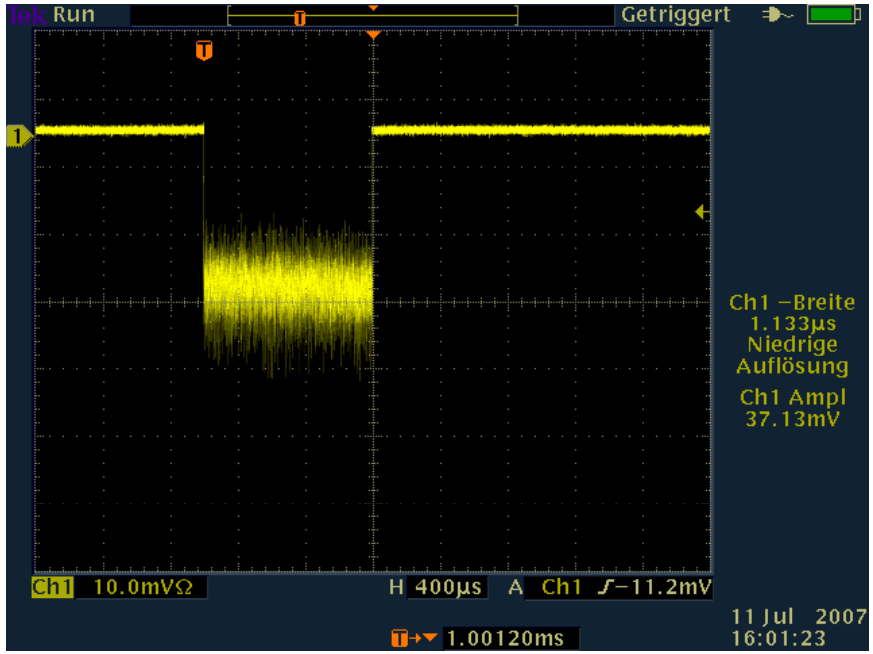
The PMT output for the long bunch is saturated.



The 30ns output bunch.

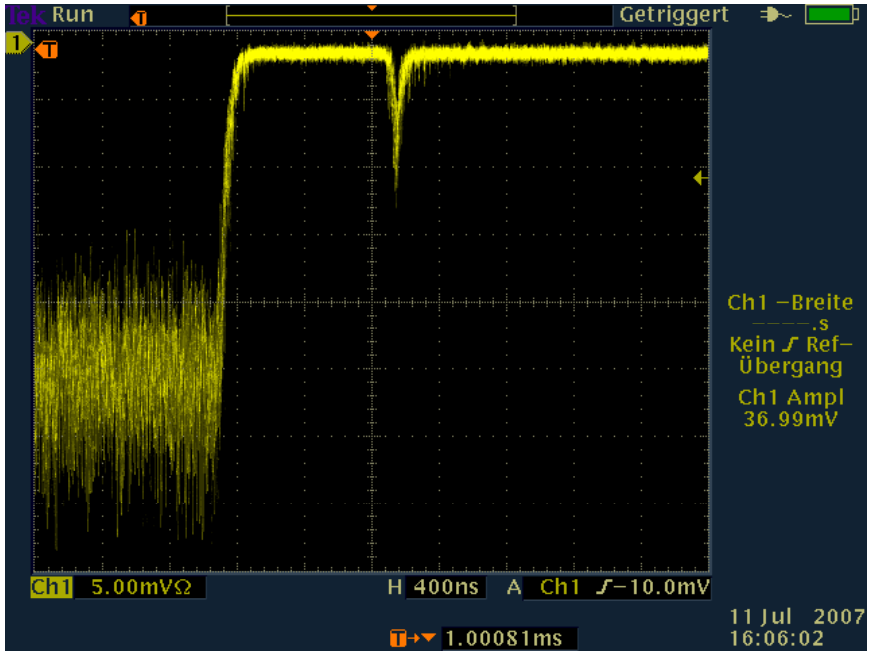
Although the first bunch is saturated, the PMT can measure the small bunch. The distance between the 2 bunches is 1 µs.

Measurement of the Output Voltage with a ND32 Filter



Big implied bunch at a control voltage at 0.7V with a ND32 filter.

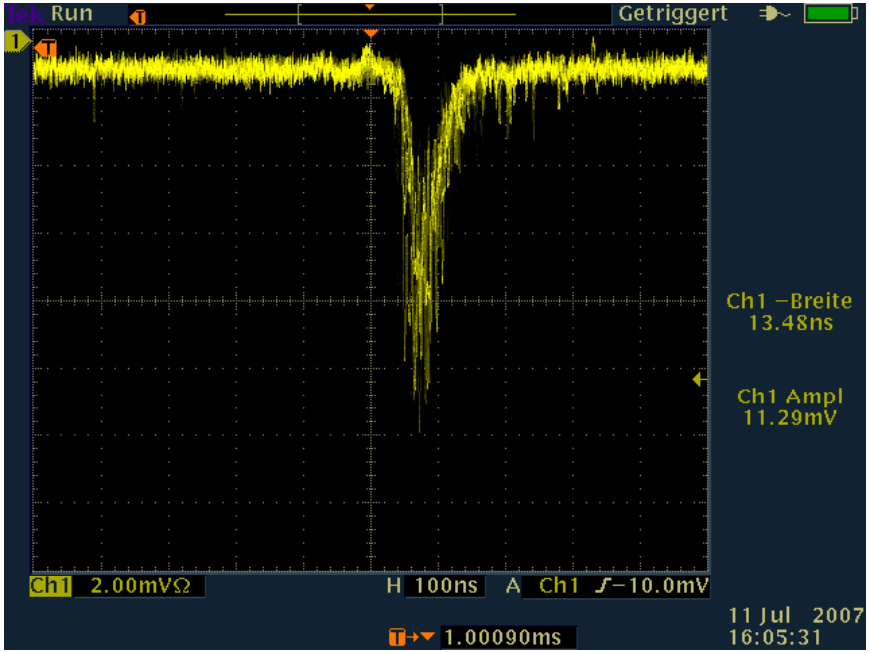
The bunch is in the linear region of the PMT. If you multiply by the amplitude with 32 you will get the implied voltage.



The distance between the 2 bunches is 1µs again.

Modification of the Amplitude

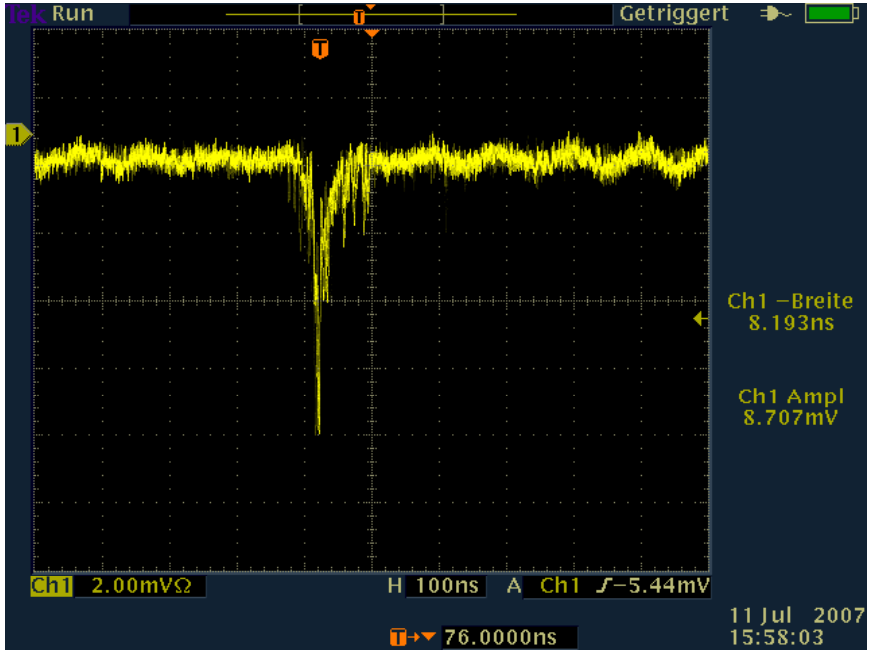
Single small Bunch



Amplitude: 13mV

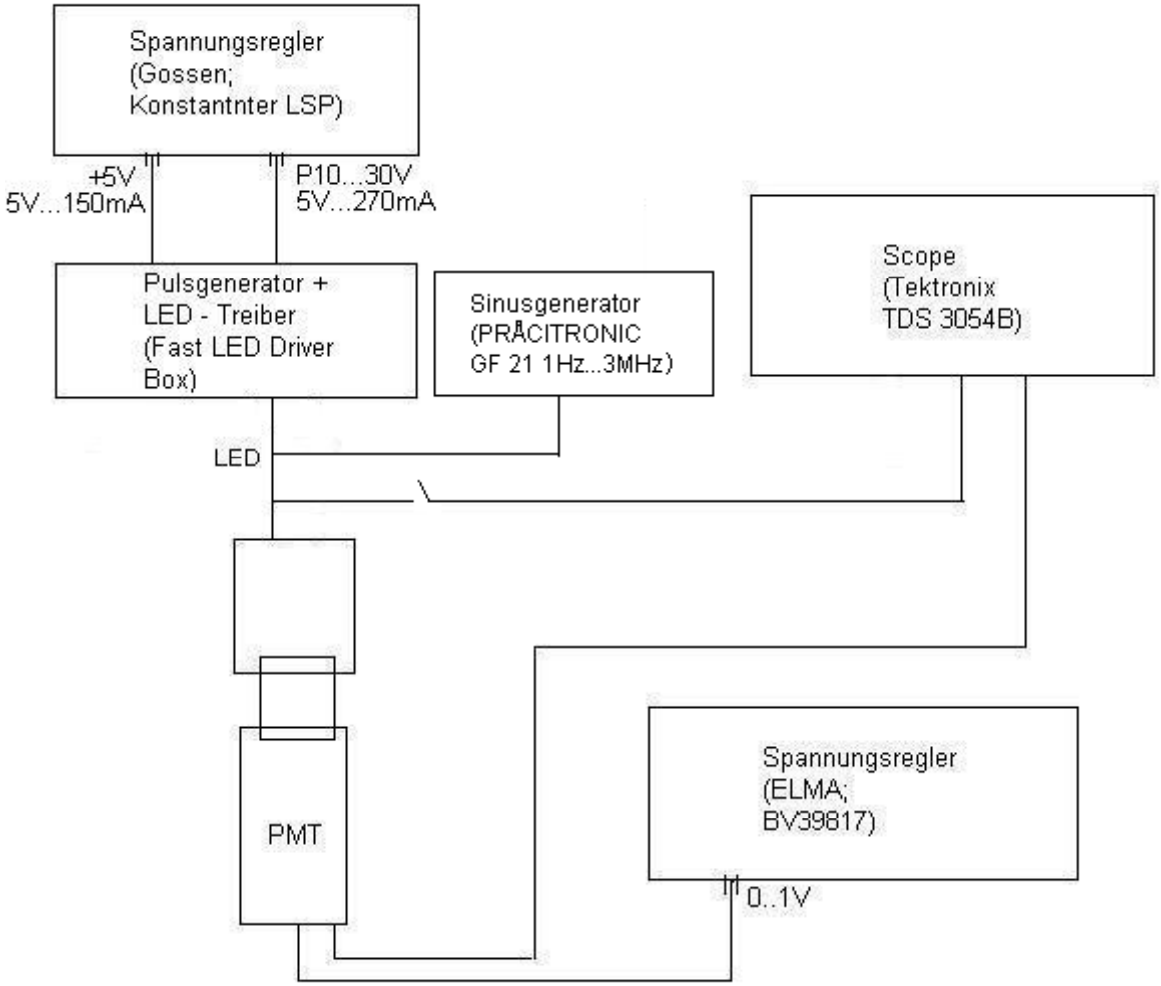
The implied pulse after the 1ms bunch is 38% smaller than the single measured bunch.

Small Bunch after a big one

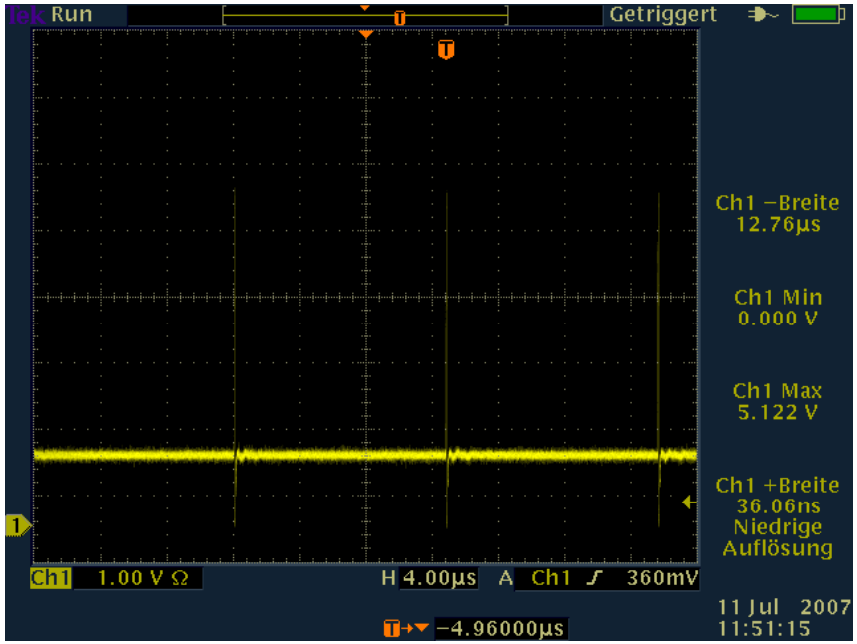


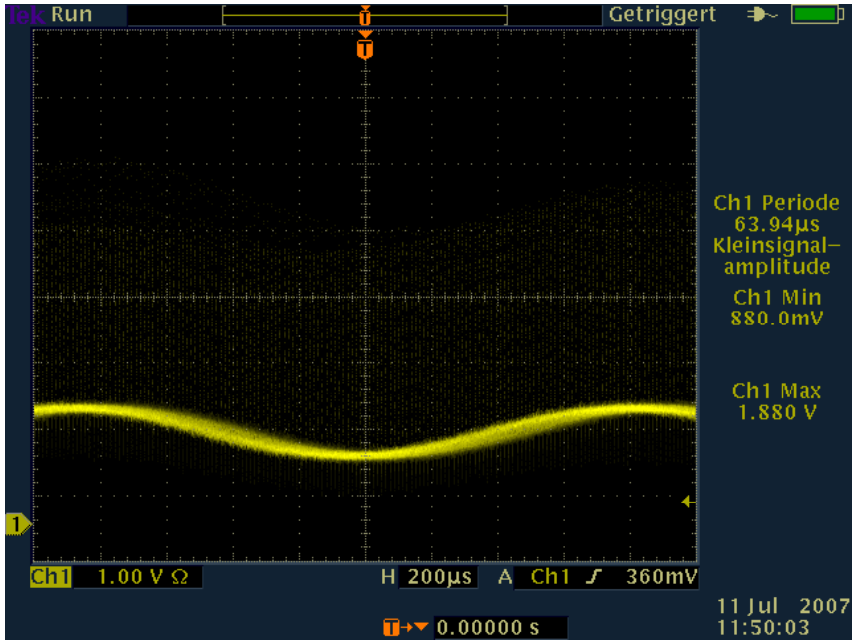
Amplitude: 8mV

Application of the Packages with a Sinus Curve



Settings

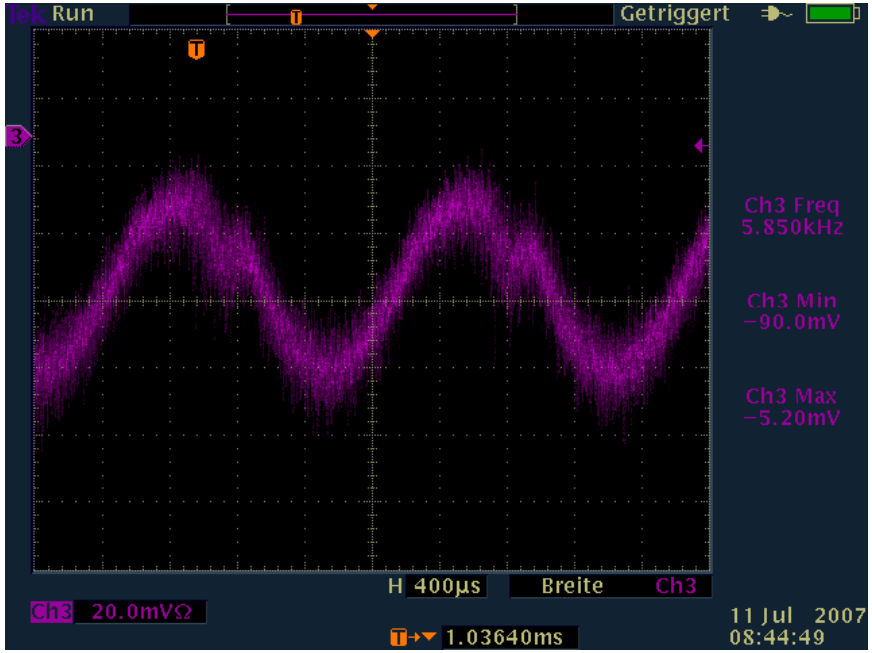




Bunches: Width: 37ns
Amplitude: 5.1V
Interval: 13µs

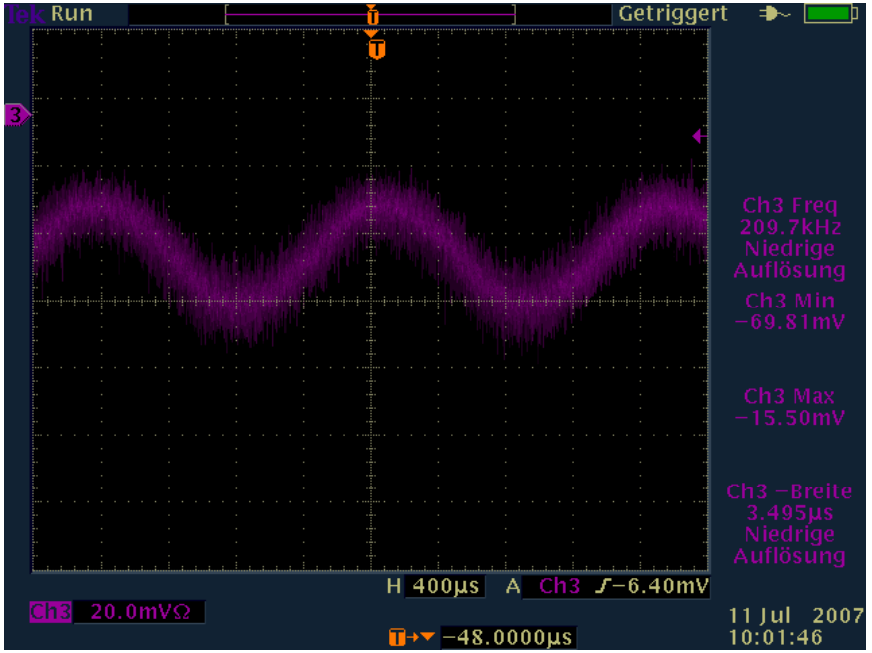
Sinus curve: Frequency: 0.6kHz
Offset: 1.4V
Max. Voltage: 1.9V

Measured Sinus Curve



Sinus curve without a filter.

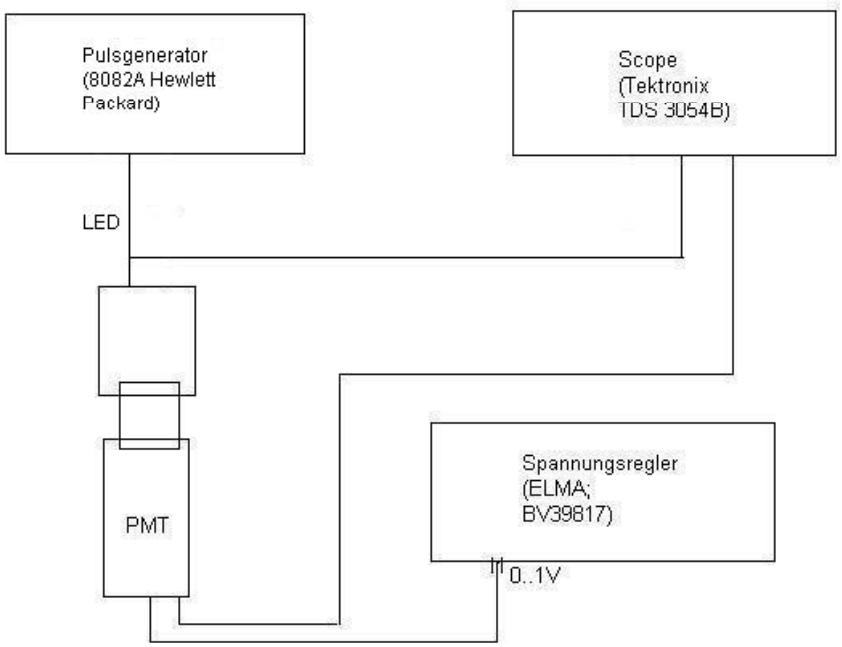
At the fall, a quality fall-off is visible.



With a ND2 the intensity is lowered and the PMT is not saturated anymore.

The last Method

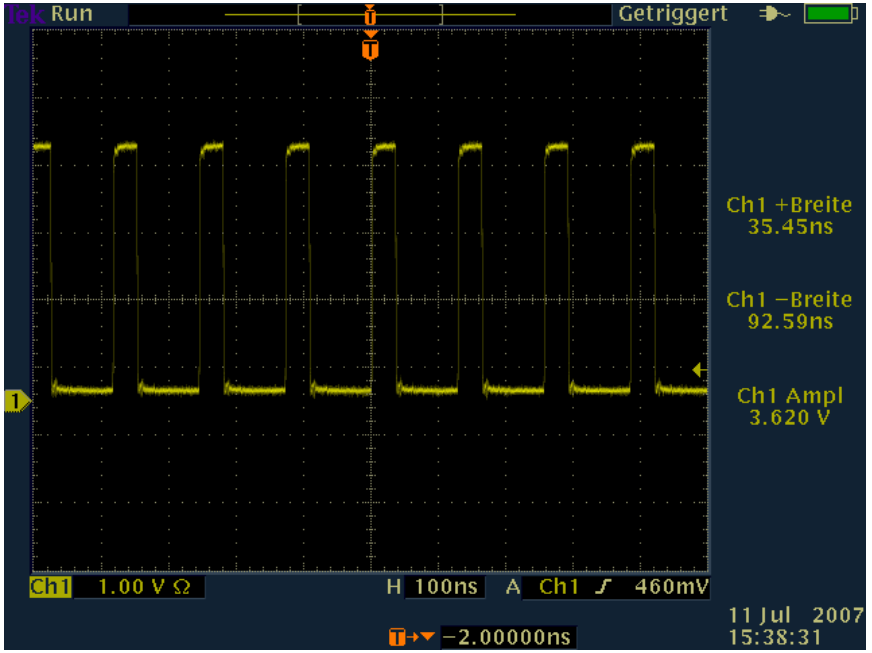
Assembly



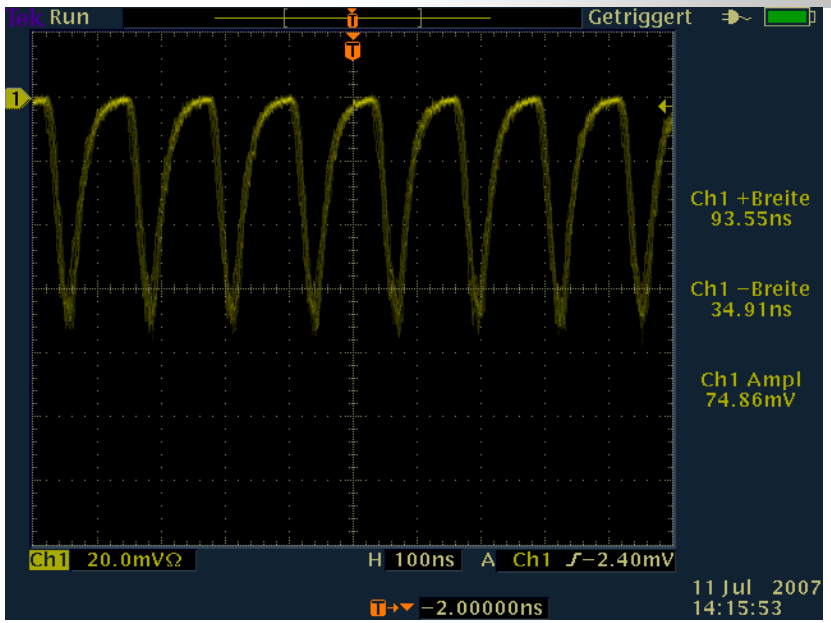
Output signal of the generator:

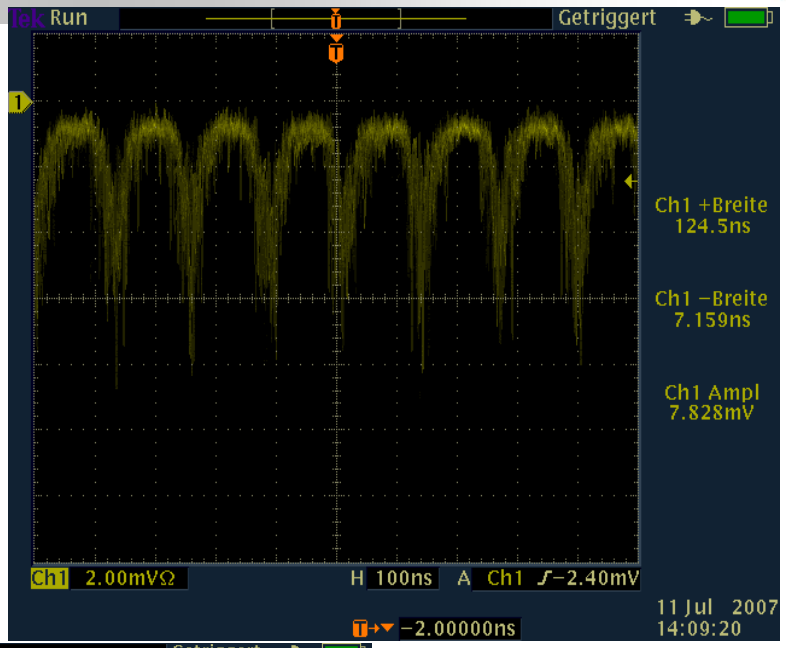
- Small bunches in a frequency of 9MHz
- Width: 35ns
- Voltage: 3.6V

Signal of the Generator



Measurement of the Output Voltage

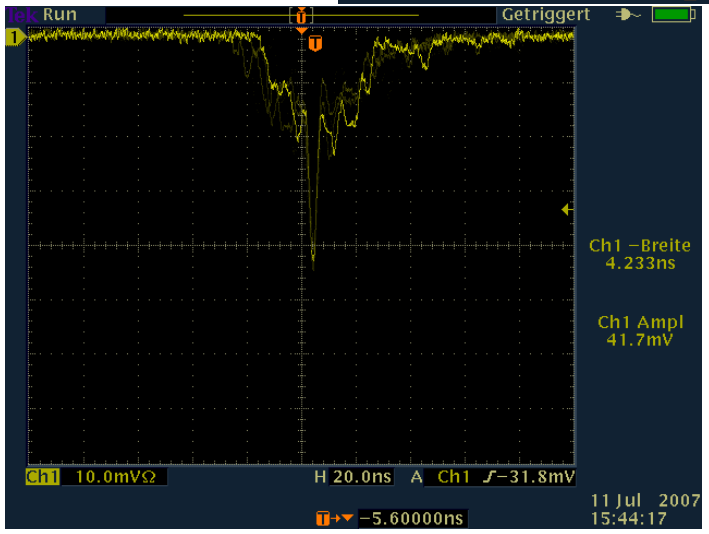




←Detected bunches (control voltage: 0,7V) with a ND8. Amplitude: 8mV

Width:~30ns

↑ Implied pulses at a control voltage at 0,7V without a filter.



→ Measurement of a single bunch.

Amplitude: 41mV

Width: ~30ns

The PMT still detects the pulses. However, they are 80% smaller than they should be.

Conclusion

- Measurements verify that the filters minimize the intensity of the ray by their factors.
- The linear region of the Hamamatsu expands.
- At a filter factor of 16 or 32, you can measure in the linear range. If you use a higher filter the photon statistic will be too low. Therefore, the signal is mixed with the noise.

- The Hamamatsu still detects the bunches with a frequency of 9MHz and can measure the bunches with a width of 30ns .
- However, there will be a change in the height of the amplitude.