

Pulse duration and power

TCT requires for applications focused to signal formation laser pulses shorter than the response time of the electronic response time. The contributions to the latter (limiting the response in the frequency domain) sorted by importance are mainly: capacitance of the detector (together with input impedance of the amplifier forms a RC circuit), oscilloscope bandwidth, amplifier and Bias-T bandwidths. Any additional contribution may appear depending on the application and additional circuitry used.

Typically RC contributions amount to time constants of 500-1000 ps, which requires the laser pulse to be narrower than that. Particulars lasers have variable pulse duration ranging from <350 ps to around 4 ns. In many cases even shorter pulses than nominal can be obtained by driving the laser to the edge (for threshold setting see next section), but the user should pay attention in this case on time stability of the laser and potentially larger variation of light amplitude between pulses.

Particulars lasers have symmetrical pulses without any low intensity tail, which is often the case for many commercial lasers. The tails can spoil the measurements particularly for measurements where low level sensitivity is crucial.

The driver providing the short current pulses to the laser diodes implemented in the Particulars lasers correlates pulse power with light duration. The shorter the pulse the less powerful it is and vice versa. The Particulars lasers usually provide more than enough light for silicon TCT and may even require attenuation for most efficient use. This can be easily achieved by neutral density filter put in front of the fibre (diode hole) output. If focusing system is used such filters can be simply mounted in front of the iris which is itself mounted on the beam-expander. The impact of the neutral density filter on focus finding (beam spot) was found to be negligible for all present studies.

Setting pulse duration

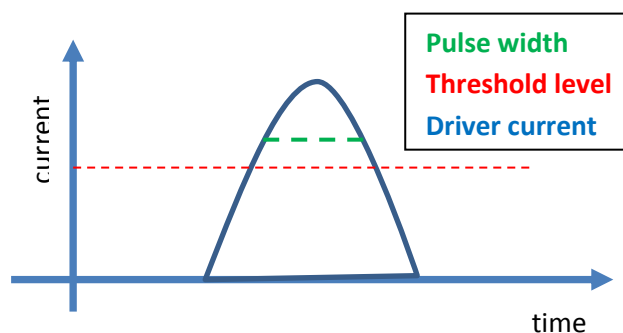


Figure 1: Schematic view of the pulse width/power regulation with treshold.

The duration of the pulses is set by restricting the current pulse from the driver. The current passed to the diode is required to pass certain threshold before it is fed to the laser diode. As the threshold increases the width of the current above threshold narrows (see figure 1). At the same time smaller



amount of the total current pulse integral (pulse power) is left through. The current pulse are power are therefore clearly correlated. The threshold setting is realized with DAC controlled via USB by a user. The max. range of the DAC is at the rail voltage of 3.3 V, which corresponds in the default configuration of the software to 100% ¹ and means that threshold is set as high as possible (3300 mV = 100%). There are different laser diodes used with the same driver, hence the DAC setting should be set for each diode separately (see laser control instructions for details on how to set the scale for an individual diode). If the threshold is set to high for the specific diode the pulses are not produced. As soon as the threshold is low enough the diode produces light pulses. Reduction of threshold for additional few 10 mV-100 mV from the onset of the light pulses has no impact on measurable pulse duration/width, but has an impact on pulse height. Further reduction of threshold results in increase of power and pulse width. It is important to note that reduction of power doesn't scale linearly with threshold voltage.

The current pulse is also fed to the buffer responsible for producing the trigger pulse (driver trigger). This is produced regardless of the threshold. At high values of threshold therefore the trigger is produced although no light comes out of the laser diode. The trigger pulse can be either positive or negative (+/-5V) depending on the type of the laser diode.

What is the right value od DAC?

It is difficult to give a straight answer to the question. A general rule would be: use the threshold setting as close to the maximum tolerable threshold by the diode that gives you stable pulse of appropriate height for your application. Usually this is few 10 mV from the threshold.

¹ The operation at this point is unpredictable, but mostly the laser doesn't produce and light pulse.