

10 PICOSECOND ON-DEMAND OPTICAL PULSES FOR QUANTUM TECH

Optical pulses of the order of 10 ps are crucial for single photon sources. Recently we made 17 ps pulses using our home-built pulse compressor. We think we can push this to 10 ps pulses while improving the on/off contrast by cascading the same electro-optic modulator in a loop.



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An electro-optic modulator (EOM) is a device that can modulate its transmission from an electrical signal. We have multiple extremely high bandwidth (>25GHz) EOMs which we successfully used to create optical pulses from a continuous-wave narrow-linewidth laser (see [arXiv:2408.08213](https://arxiv.org/abs/2408.08213)). To improve the on/off contrast of the optical pulses we cascaded the EOMs, which produced a significantly higher contrast as well as shorter pulses. This is because the pulse shape is Gaussian: multiplication of two Gaussians results in another Gaussian that is a factor $\sqrt{2}$ more narrow.

We would like to cascade more pulsers, but this is not practical because of the insertion loss of the EOM (and because we have a finite number of devices). However, a single EOM can be used in a loop that feeds into itself where the pulse distance is synchronized to the optical path length. The same EOM then modulates the same pulse over and over again into a more narrow pulse. To overcome the insertion loss, we want to put a boost optical amplifier (BOA) in the loop.

We are looking for a master student who wants to figure out if this is possible at all (we are a little worried about dispersion and response time/bandwidth of the BOA), and to then do it (which means solving all of the practical problems which are yet to be run into!). It is for instance possible that such a loop needs to be phase locked or dispersion/bandwidth limitations of the BOA become a limiting factor.

I ran some naïve simulations (neglecting the phase, purely using the intensity) and the results are very promising:

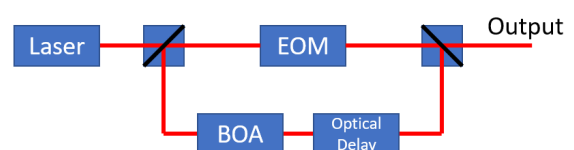


FIGURE 1. OUR EOM LOOP WILL MAKE 10 PS PULSES.

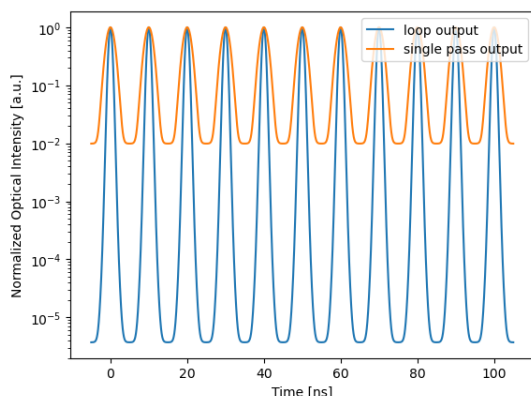


FIGURE 2. THE PULSES PRODUCED BY THE LOOP HAVE A SIGNIFICANTLY HIGHER CONTRAST.

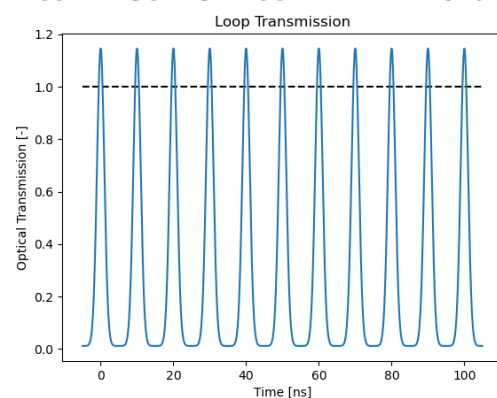
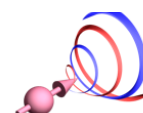


FIGURE 3: THE LOOP GAIN IS VERY SENSITIVE TO WHAT PART OF THE PULSE GETS AMPLIFIED OR EXTINGUISHED.

Interested? Get in touch with poortvliet@physics.leidenuniv.nl!



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