

Measuring Transmission for Neutral Density Filters 1/12/2015



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Setup

The laser was set on the table with no fiber optic cabling (the signal was too weak when using the cable). The photodiode was set next to it on the table. Index cards were used to raise the diode up and down small amounts until the signal was maximized for movement on that axis (more cards to raise, fewer to lower). The laser was moved horizontally on the table by hand until the output signal from the diode was maximized.



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ND Filters

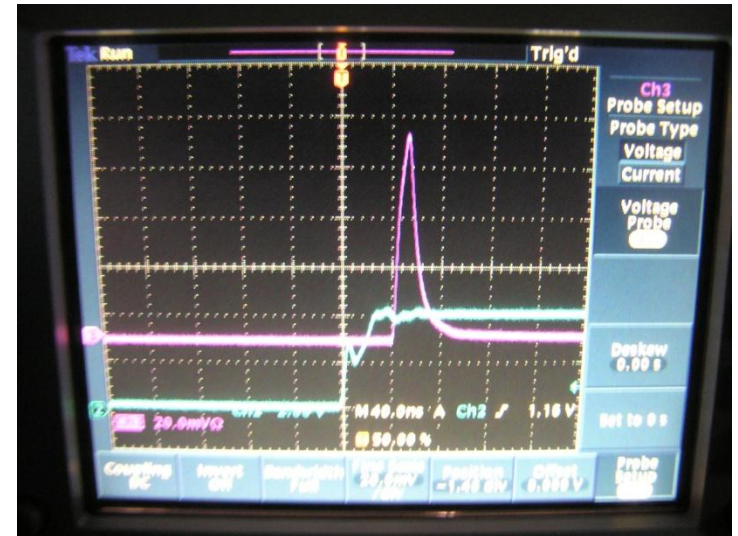
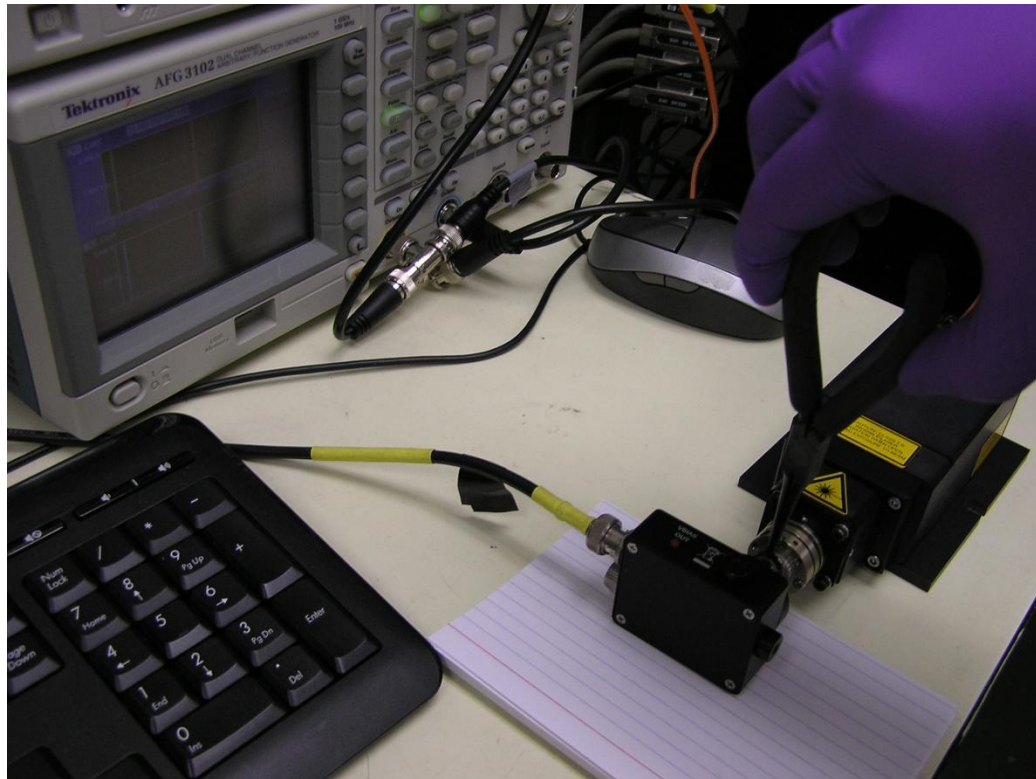
Small pieces of electrical tape were attached to the absorptive Neutral Density (ND) filters so they could be held with needle nose pliers. Gloves were worn during handling so as not to get fingerprints on the filter glass.



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Measurement Procedure

The ND filters were held in place by hand in front of the laser. Care was taken to gently hold the filter flush against the tip of the laser head so that the angle of incidence of the laser was roughly normal. Voltages were read manually off the scope.



Blue Line: Trigger Signal to Laser
Pink Line: Diode Response Pulse

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Expected Transmission Coefficients (T) from Filter Specs

There was a table in the specs for the ND filters that gave expected T at 1060nm. The laser used in this measurement was 1062nm, so those are about the values expected.

Filter	Expected T
1201	0.69
1202	0.43
1203	0.27
1205	0.11
1213	0.04
1220	0.0079





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Measured Transmission

		All Measurements			CW Measurements			100Hz Measurements		
Filter	Expected T	Filter	T	sigma	Filter	T	sigma	Filter	T	sigma
1201	0.69	1201	0.61	0.01	1201	0.61	0.01	1201	0.62	0.02
1202	0.43	1202	0.43	0.01	1202	0.43	0.01	1202	0.44	0.01
1203	0.27	1203	0.27	0.003	1203	0.27	0.003	1203	0.27	0.002
1205	0.11	1205	0.058	0.001	1205	0.056	0.000	1205	0.058	0.001
1213	0.04	1213	0.041	0.001	1213	0.039	0.0005	1213	0.042	0.001
1220	0.0079	1220	0.013	0.002	1220	0.011	0.001	1220	0.014	0.001

Five separate measurements were made for each filter. The first was done on the first day with the laser set to its highest power running in CW mode (no pulses). The second was done on the first day with the laser set for 15ns pulses at a 100Hz repetition rate (rep rate).

Those same two measurements were repeated the second day, along with another measurement made with the laser set to pulsing 15ns pulses at 100Hz but with the power set to about half of its highest output.



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Measured Transmission

		All Measurements			CW Measurements			100Hz Measurements		
Filter	Expected T	Filter	T	sigma	Filter	T	sigma	Filter	T	sigma
1201	0.69	1201	0.61	0.01	1201	0.61	0.01	1201	0.62	0.02
1202	0.43	1202	0.43	0.01	1202	0.43	0.01	1202	0.44	0.01
1203	0.27	1203	0.27	0.003	1203	0.27	0.003	1203	0.27	0.002
1205	0.11	1205	0.058	0.001	1205	0.056	0.000	1205	0.058	0.001
1213	0.04	1213	0.041	0.001	1213	0.039	0.0005	1213	0.042	0.001
1220	0.0079	1220	0.013	0.002	1220	0.011	0.001	1220	0.014	0.001

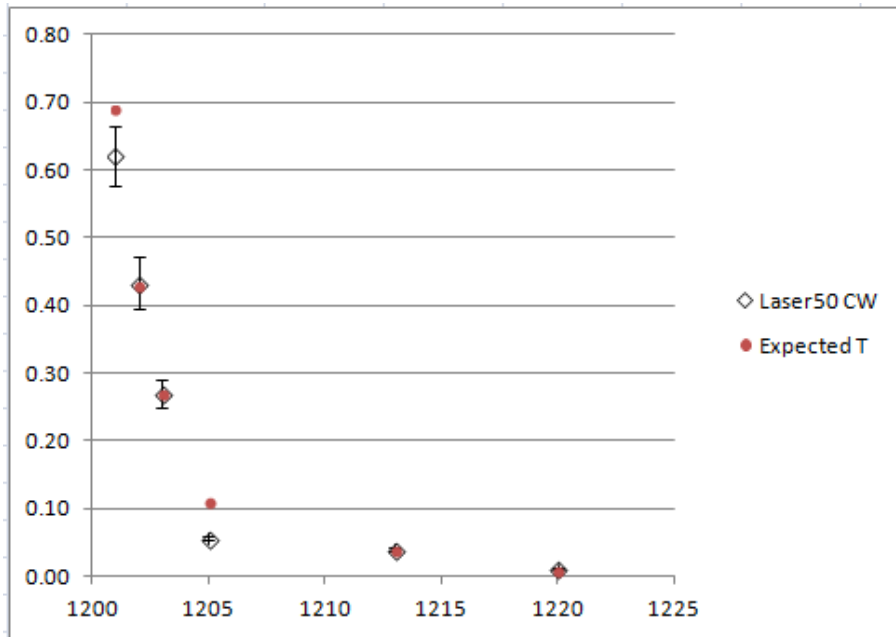
The computation for T is simply the voltage read with the filter in place divided by the voltage read with no filter. There was no detectable difference on the scope with the lights in the room on or off, so they were left on for convenience. The signal with the filter in place decreased by about 5% if the filter was held at an angle from normal of about 30 degrees, presumably due to reflection from the surface of the glass. This effect was ignored since the angle of incidence in the detector experiment should be nearly the same as for this measurement with the filter held carefully against the laser head as it was.

The measured value for 1201 was lower than expected by about 12%. The measured value for 1205 was about half of what was expected, and the value for 1220 was about twice what was expected, but the measurements of those values were quite consistent.

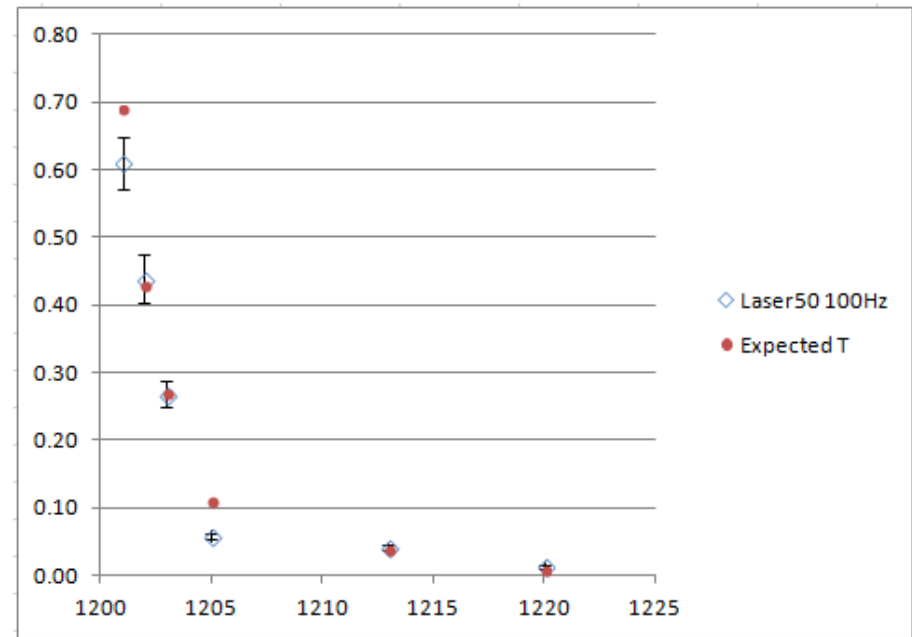
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Measured Transmission

Measured T with laser in CW mode (no pulses)



Measured T with laser pulsing at 100Hz rep rate



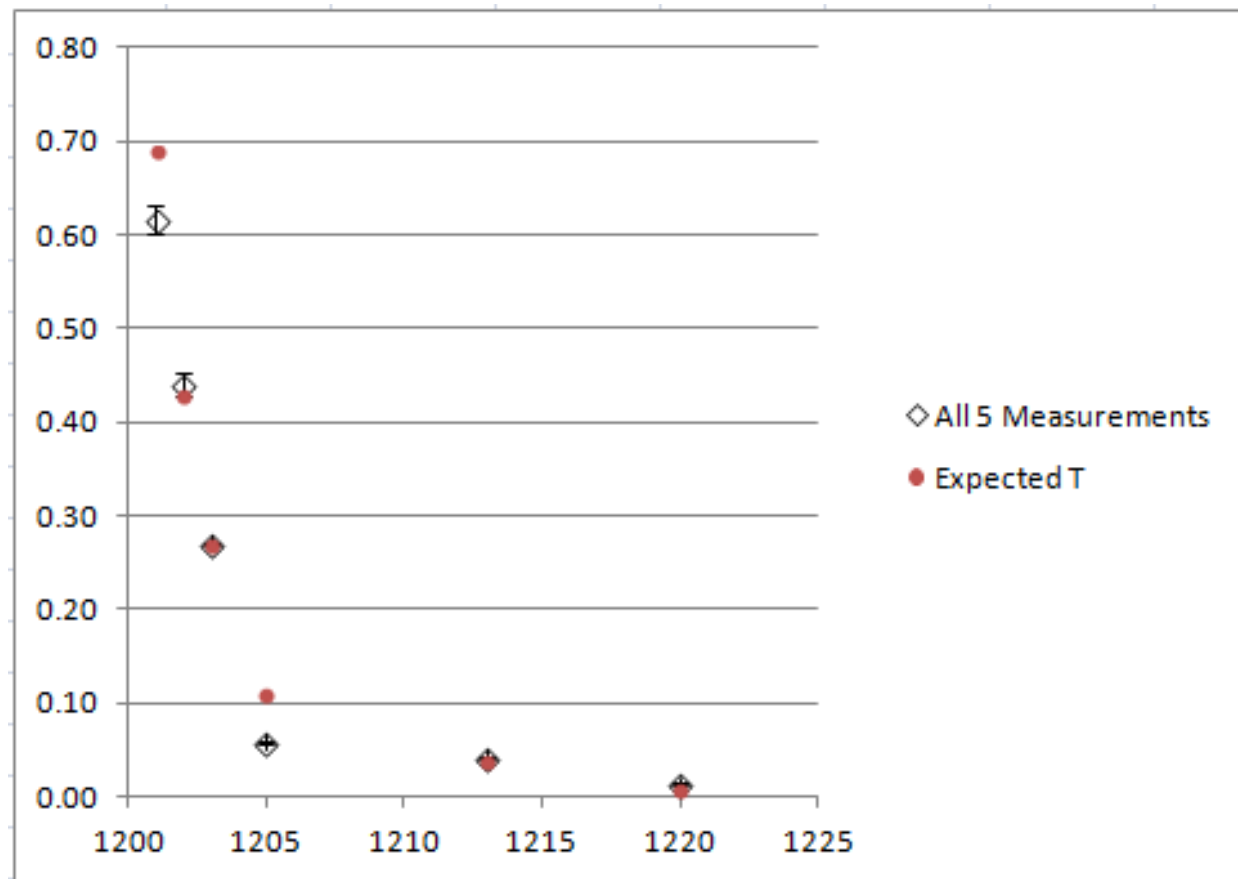
There was a small increase in T with the laser pulsing. This is possibly due to the increased strength of the EM field during a pulse. In CW the laser can achieve about 10mW continuous power, while it can achieve more than 200mW during the short duration (~15ns) of a pulse. So the value at 100Hz will be used during the detector measurement.

These plots are not expected to be linear. The x-values are just the names of the filters.

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Measured Transmission

This plot takes all 5 measurements into account (two in CW, three at 100Hz at two different power levels). The error shown here is sigma for the five measurements.





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END

