RF and Propagation of Vortex Beams

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Motivation

It has been shown that when a ultra-short pulse laser has a certain power, a process called filamentation occurs. This process causes the beam to self-focus, and then defocus in a cyclic manner. The filamentation creates a plasma that emits RF. The process also causes the beam to lose energy through ionization. These characteristics have been studied for a gaussian beam, but not for different order vortex beams.

RF Emission

- First the placement of the plasma relative to the horn was looked at.
- The RF was measured by using a broadband horn (1Ghz – 14Ghz).
- Measurements were taken every 5 degrees from 0 to 180
- The resulting voltages were then used to find the frequency of the RF.

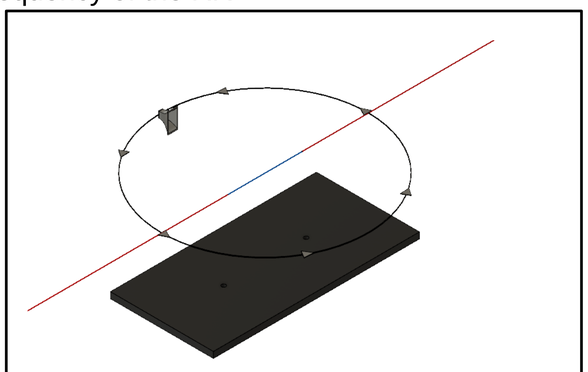

Figure 1: Experimental setup to measure RF

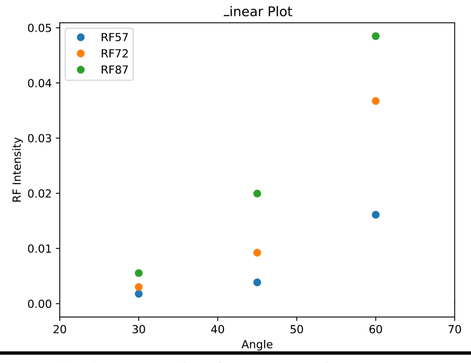

Figure 2: RF signal relative to plasma position

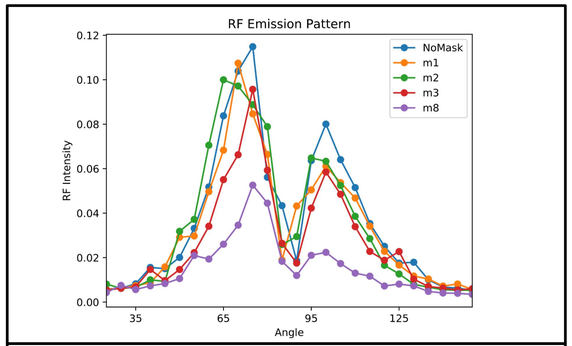

Figure 3: RF emission for each beam profile

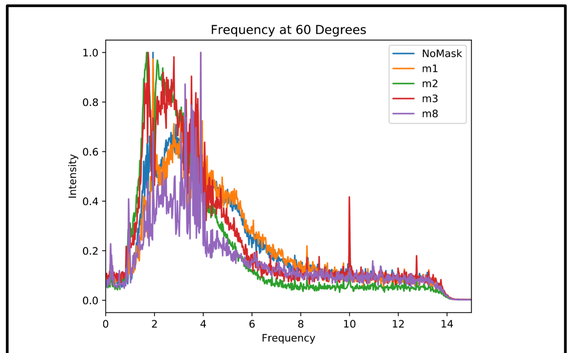

Figure 4: Frequency spectrum for each beam profile

Microscope Images

- CD's were put into the plasma and then examined under a microscope to see the filamentation.

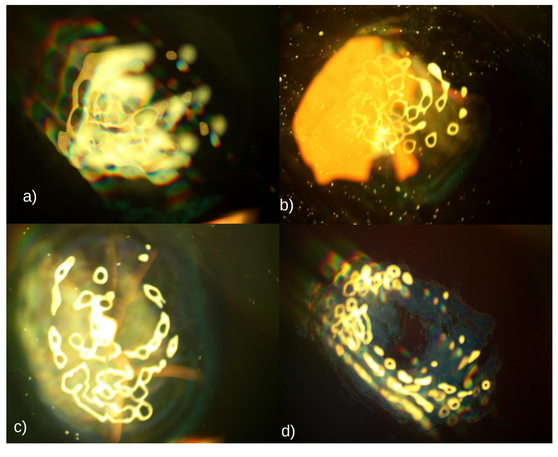

Figure 5: Filamentation for a) gaussian b) 1st order c) 3rd order d) 8th order

Beam Propagation

- The propagation of different beam profiles was looked at over 180 meters.
- Measurements were taken by taking an image of the beam using a ccd.
- Measurements were taken every 10 meters for three different beam profiles.

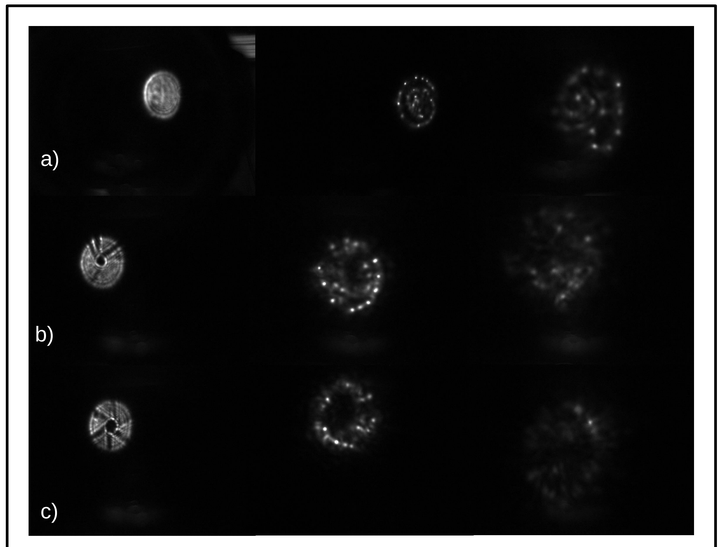

Figure 6: Beam profile at 10m, 90m, 180m (left to right) for a) gaussian b) 3rd order c) 6th order

Summary

The emission pattern for the RF was measured and compared between beam types. As well as the distribution of frequencies emitted. The propagation over 180 meters was studied, along with how each profile behaves in turbulence. The emission data has been analyzed and gave promising results. The data collected for long distance propagation and how the beam behaves in turbulence is still being analyzed and is ongoing.

References

- Polynkin, P., et al. "Self-Focusing of Ultraintense Femtosecond Optical Vortices in Air." *Physical Review Letters*, vol. 111, no. 2, Oct. 2013, doi:10.1103/physrevlett.111.023901.
- Couairon, A, and A Mysyrowicz. *Femtosecond Filamentation in Transparent Media*. Elsevier, 6 Feb. 2007, www.sciencedirect.com/science/article/pii/S037015730700021X.