Summer Work Report:

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This summer I spent 5 weeks working in Professor Suckewer's lab as part of the X-Ray Laser Group. My research goal was to develop an axially (~2mm long) and temporally (~1ns) uniform plasma channel of density ~$10^{19}$$cm^{-3}$, which can be used in Raman Backscattering Amplification. The aim is to achieve this by optimising a previous experimental setup consisting of a high-energy (~0.5J) short-pulse (~2ns) IR laser firing into a small gas cell inside a vacuum chambre. The beam enters and leaves the chamber via two pinhole apertures (~200um), the focus of the beam is located between the pinholes. Gas enters the chamber from above and escapes from both pinholes.

Plasma is created when the pulse is fired into the cell. The high intensity of the laser ionizes the gas between the pinholes and ablates the surface of the pinholes, which creates plasma along the laser channel, between the two pinholes. This laser channel is observed by interferometry and the resulting image can be analysed to determine the properties of the laser channel.

There are many factors that alter the properties of the plasma channel that must be explored in order to optimize the uniformity of the plasma. These include pinhole size, laser intensity, focus position, beam quality/shape/crossection/geometry, gas pressure and the type of gas used.

My achievements during the summer include the optimization of the laser system to increase the energy of the pulse to more than 500mJ, development of a method of observing the beam cross-section in different positions along the cell, improvement of the interferometry setup and investigation of effect of focus position on plasma size. Near the end I also discovered that the exact alignment of the pinholes with the beam was crucial, and that they had not been as closely aligned as previously thought. Better alignment showed promise of completely different (and more uniform) plasma formation.

Work Planned for 06-07

I have already begun to make improvements to the experimental setup based on my results of the summer. I have developed a different method of drilling the pinholes that results in much more accurate alignment. I plan to investigate the resulting plasma and make more precise, quantitative measurements of the effects of the previously mentioned variables on the desired plasma.

I would also like to increase the consistency of the plasma provided, this mainly pertains to reducing the jitter and increasing stability in the laser system, but also development of ways to measure and observe the conditions inside the gas cell, including alignment of the beam within the cell and location of the focus.

Hopefully, if these things work out as planned and a uniform reproducible plasma channel is created, this method can be utilized in the Raman Backscattering Amplification experiment, replacing the gas jet plasma method and thereby increasing amplification.