Laser-Driven Fusion with Heavy Water Droplets

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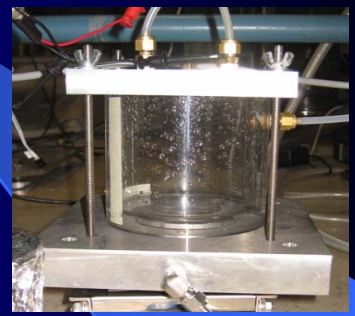
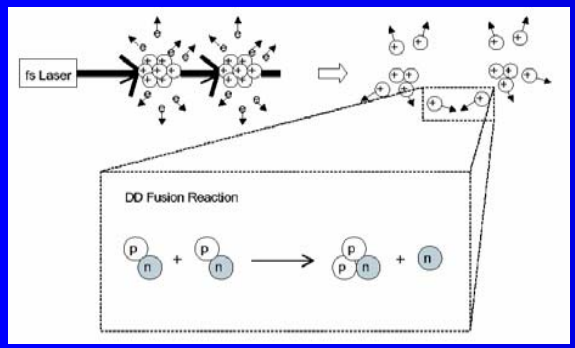
Using a device we have developed at HMC, we can create micron-scale droplets of heavy water. We use these droplets as a target for a laser-driven deuterium-deuterium fusion.

The Droplet Source



An electric oscillator is placed at the bottom of a container of water. When it oscillates at high frequencies, water droplets are created. By changing the frequency of the oscillation, we can change the size of the droplet.

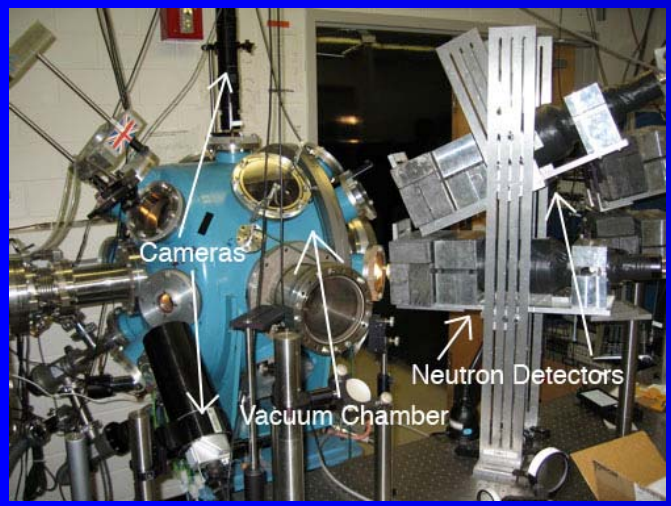


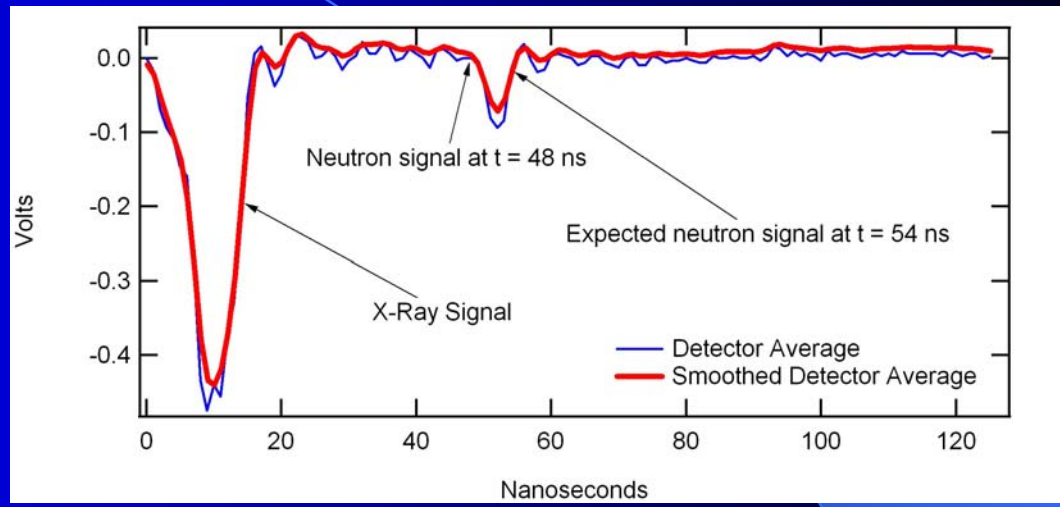
Making Fusion

Theory and experiment suggest that fusion events are most likely for laser-heated droplets of a particular size, and we attempt to find the frequency that creates droplets of this size. For the fusion experiments, we travel to UT Austin to use a laser capable of producing pulses that, while on, produces more power than the United States electrical grid! When we target a deuterium droplet with this laser, it strips the droplet of all its negative charge. The remaining positive nuclei repel each other and explode. The explosion cause the nuclei from neighboring droplets to collide with one another, creating fusion.

Detecting Fusion Events

Neutrons are emitted by a fusion reaction and are the signature of a fusion event. We set up detectors outside of the vacuum chamber where the laser hits our mist to look for neutrons, as well as cameras to capture images of the droplet when it was hit by the laser.





When the laser hits a droplet, we expect it to emit both x-rays and neutrons. Given the speed of light and the expected energy of the neutron emitted from the fusion reaction, we can predict the time between when we see the x-ray signal and the neutron signal. In this case we predicted neutrons at t = 54 ns, which is supported by the above trace.

Further Work

Our results are extremely suggestive, but to be convinced that we have seen fusion we would like to undertake more expansive measurements.