Report October 15, 2024

Summary:

- **Million-Dollar Syndicate Succeeds!**
- **New Beryllium Electrodes: Stronger Filaments, Almost to Boron**
- **Proton-Boron Workshop: Many Encouraging Results**
- **On Line Conference to Discuss Cosmology Melt-Down**

Million-Dollar Syndicate Succeeds!

LPPFusion has received almost $1 million in new investments from the investor syndicate we established at the beginning of the year. To be exact, we got in $990,000, including pledges to be invested before year-end. Together with the money raised from crowdfunding and what we expect to raise in a new crowdfunding round this fall, we are heading towards a record year for investments. This new money will allow us to hire another full-time research scientist.

We want to thank our syndicate members who made this financial breakthrough possible (in order of investment size, largest first): James Elam, Dennis Peterson, Walter Rowntree, Yang Bin Kwok, David Marcus, Hany Agami, Warren Upham, Paul Dorger, Ben Ferris, Loren Brichter, Martin Aavik, Dave Bright, Vincent Tabone, Timothy Eastman, Fletcher James, Richard Kandarian, Gary Wade and Carolyn Brown.

We'll be starting a new round of crowdfunding very soon and will announce it to everyone.

New Beryllium Electrodes: Stronger Filaments, Almost to Boron

We started firing with a new insulator and the new beryllium anode and reprofiled cathode on Sept.10. These initial test shots were still with deuterium fuel, the last ones before our long-awaited hydrogen-boron shots. A key goal of these tests was to use the reprofiled cathode to reduce the number of filaments from 128 to 64. This would increase the current in each filament, allowing them to better compress the plasma and surive until the end of the rundown phase.

Sure enough, images taken by LPPFusion Research Scientist Dr. Syed Hasan with our ultra-fast ICCD camera clearly showed a reduction in the number of filaments between each pair of cathode vanes from eight to four. (Fig.1) Since there are 16 vanes, the total number of filaments is now at the targeted 64.

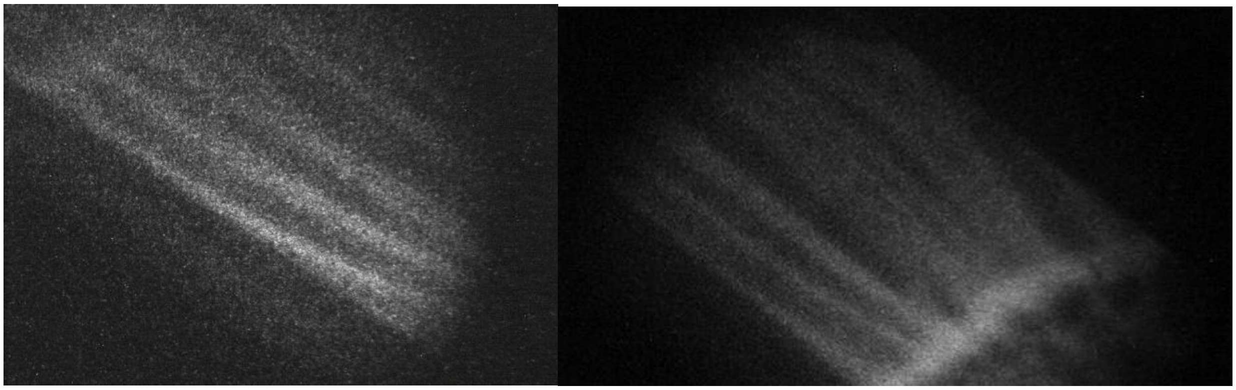


Figure 1. The new beryllium cathode produces 4 filaments between each set of cathode vanes (left) as opposed to 8 filaments with older electrodes (right.) This reduction in the number of filaments means each filament carries more electrical current and thus better compresses the plasma.

Images taken at the time of the pinch (maximum compression) showed that the plasmoid, where the fusion reactions take place, was about 1 mm in radius (Fig.2). This is much greater than the optimum radius, leading to lower than optimum density and fusion yield. Fusion yield average 0.12 J in the best five shots, four times better than with the last beryllium electrodes but still 30% less than the best five shots back in 2016.

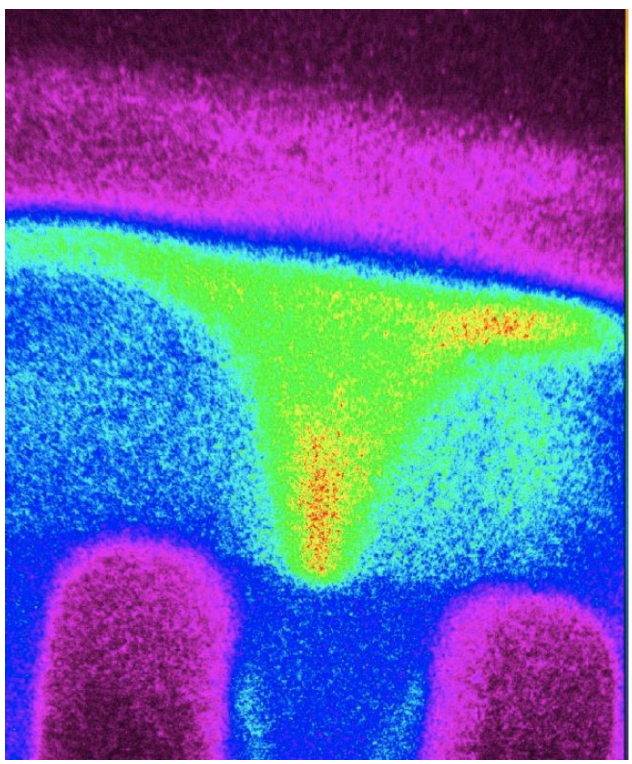


Figure 2. This false color image of the plasmoid from shot 4, Sept.12, shows the brightest plasma in red, with some filamentation within the plasmoid visible. The purple objects at the bottom are the tips of the cathode vanes, which are black in the original image. The entire image is 3 cm across. The exposure time was 5 ns.

There are two reasons for this. First, the filaments are not yet strong enough to survive all the way to the end and compress into the plasmoid. Fortunately, with boron the magnetic forces on the nuclei will be stronger, due to boron's five electrical charges, allowing the filaments to maintain themselves. Second, a tiny fragment of plastic accidentally got stuck inside the insulator. The volatile gases created as the plasma destroyed the plastic were still interfering with optimum pinching, creating multiple current sheaths that drained energy from the plasmoid. We expect that these remnant gases will be burned off in a few more shots.

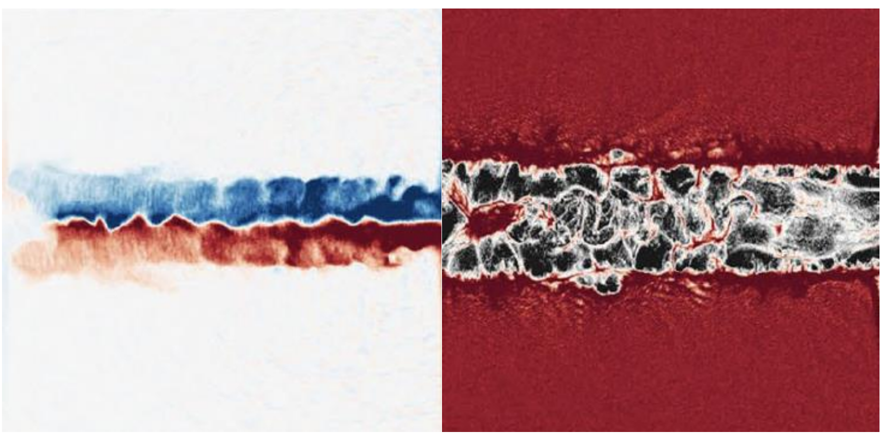
We’ve now completed the deuterium shots and are very close to starting the boron shots. Dr. Hassan and Lerner have been tweaking the heating system and the filters needed to protect our pumps from any stray chemicals. We expect to burn boron very soon!

Proton-Boron Workshop: Many Encouraging Results

LPPFusion Chief Scientist Eric Lerner joined more than 100 other researchers in the Fourth International Workshop on Proton-Boron Fusion held in Frascati, Italy (near Rome) Sept. 30-Oct.3. This conference was even more encouraging than the previous one held last year in Prague. Most significantly, nearly all the experimental results showed fusion yields above simulations, which is the opposite of what has been true for years for deuterium and deuterium-tritium reactions in nearly all machines.

For example, a Czech-based group got about 1.5 J of hydrogen-boron fusion energy by bombarding a solid target with a 7 J proton beam, an amazing ratio of energy out to energy in. Of course, the input proton beam was generated by a much larger laser beam, which in turn required 1.2 MJ of electric input energy. This is very far from net energy, where more energy is produced than is fed into the machine. But such a ratio of particle energy in to fusion energy out is very encouraging for LPPFusion’s own FF-2B machine, which produces accelerated and heated particles far more efficiently than a laser.

Some insight into how such great yields are produced was provided by simulations of lasers interacting with plasmas, as they do in the nano-second-pulse lasers. I. Tazes and colleagues in Crete showed in these simulations that the plasma is confined in magnetic vortices, as the LPPFusion team has long theorized, with magnetic fields up to the gigagauss levels that we are aiming for. Confined densities were about $10^{21}/cm^3$. These simulations lend a great deal of credibility to LPPFusion’s calculations.



In simulation by I. Tazes and colleagues, a proton beam generated by a laser generates a powerful magnetic field on left. The blue color indicates the field direction towards the viewer and the red color away, showing that a magnetic vortex or filament is created. The density image on right, for the same simulation at the same time, which reflects what would be seen in optical images, looks like some our best plasmoid images. It shows how a fairly tangled density map can be reflective of a very ordered magnetic field as at left.

Lerner presented LPPFusion’s recent progress towards pB11 shots, including our revised predictions for pB11. He reported that if we just achieve the same plasma conditions that we had with deuterium, we’ll get a respectable 1.5 J in fusion yield and will jump to the front of the race for wall plug efficiency with pB11—25 part per million

(PPM) vs about 1 PPM for the best previous results. If we meet our latest theoretical predictions, we'll get something in the range of 10 -100 J. That approaches, but is actually less than, what we would get from just scaling up the other pB11 results to our beam power. Lerner offered to use FF-2B's powerful ion beam to test anyone's targets. There was a lot of interest in that and several other opportunities for collaboration, which we will report on as they develop.

LPPFusion Chief Scientist Eric Lerner presenting our results at the 4th Fourth International Workshop on Proton-Boron Fusion

Online Conference to Discuss Cosmology Melt-Down

An online workshop this week will examine the growing contradictions between observations and the "concordance cosmology" based on the Big Bang and the expansion of the universe. The Challenges of Modern Cosmology -2 workshop will be held Oct17-18. Details are available here. At the conference, LPPFusion's Lerner will present his and colleagues Riccardo Scarpa, (Instituto de Astrofisica de Canarias, Spain) and Renato Falomo, (INAF – Osservatorio Astronomico di Padova, Italy) latest results on JWST and other data that rule out expansion.

In other presentations, Martín López-Corredoira (Instituto de Astrofísica de Canarias) will report on galaxies that are older than the Big Bang and Dr Sebastian Von Hausegger (University of Oxford) will survey the wide variety of observations in conflict with the dark-matter dark-energy Big Bang hypothesis. The link for streaming is here.