Report August 8, 2023

Summary:

- **Hydrogen Boron(pB11) Tests to Start in September**
- **Wefunder Campaign Passes $200,000**
- **Progress with Pre-Pulses**
- **DZP 2023 Conference—LPPFusion Still Ahead**

Hydrogen Boron (pB11) Tests to Start in September

After the successful upgrade of the switches, we've decided that the time has come to move forward to experimenting with pB11 (hydrogen-boron). On July 11, LPPFusion Chief Scientist Eric Lerner announced at the Dense Z- Pinch Conference (DZP 2023) in Ann Arbor Michigan that **we plan to start experimenting with pB11 in September.** This will be the first time anyone has tested the Focus Fusion approach of pB11 fuel in a dense plasma focus device. The experiments will be the first in a months-long series of tests aiming at net energy before the end of 2024. If successful, such experiments will pave the way for cheap, clean, safe and unlimited energy for the entire world.

Until now, the LPPFusion team has been using deuterium as the fusion fuel in their tests. But with the successful upgrade of the switching system and the achievement of higher currents, the FF-2B device is now ready for the transition to pB11, the target fuel for Focus Fusion. Fusion with pB11 fuel produces no radioactive waste and allows direct conversion of energy to electricity, making feasible a great reduction in the cost of energy.

To prepare for firing with pB11, LPPFusion Research Scientist Dr. Syed Hassan is taking a number of steps. For one, to operate with pB11, we need 100% reliable remote functioning. While the main reaction of hydrogen- boron produces no radioactivity at all, a side reaction produces the very short-lived radioactive isotope carbon-11. The decay time of C-11 of 20 minutes means it does not constitute radioactive waste, but it also means a high level of radioactivity in the short term, so we will need to operate our device remotely during the day. Overnight, the radioactivity will drop to background, so we can do maintenance or make changes to the machine the next morning.

Dr. Hassan has been working to upgrade our current remote control system, which is not reliable enough. While we expected that commercial products suitable to our needs were available, it turns out they are not. So, Syed has had to modify the circuits to get the switching we needed and is in the process of installing the new controls.

In addition, we have to install a simple chemical conversion system on the exhaust, which will convert the toxic boron compounds to harmless boric acid by bubbling the exhaust through water.

Wefunder Campaign Passes $200,000

LPPFusion's new Wefunder crowdfunding camping got underway on May 11. **In under three months, we've raised $216,000 from 311 investors.** That's a great start, it's only about half the rate we need to raise to get $2 million a year, which is what we really need to accelerate our fast path to fusion energy. We realize that many of you have invested what you can already and we greatly appreciate it. The problem is that not enough people know about LPPFusion. We are working to fix that—but you can help!

One way is to get LPPFusion's Lerner on platforms that have lots of viewers or to get information of Focus Fusion to influencers who have lots of followers. It's hard getting through to the influencers. If only one of us contacts them, we probably won't get through. But if lots do, we might. Here are a few examples of prominent people concerned with our energy future who need to know about Focus Fusion and let their followers on social media know:

Greta Thunberg info@fridaysforfutureusa.org
Arnold Schwarzenegger office@schwarzeneggerclimate.com
Susan Sarandon Twitter: @SusanSarandon

Let them know about LPPFusion and the solutions we offer to the crisis facing world society. Give them the links to find out more. https://youtu.be/Ouwrzn7rnH4 https://wefunder.com/lppfusion

If you have your own idea of a platform to spread the news about LPPFusion, please go ahead and contact them. If you do contact any of these platforms or people, shoot us a short email at fusionfan@lppfusion.com to let us know, so we can see how this effort is going.

Also, we've updated our LinkedIn profiles. You can now find some updates there if you're not on FB. Please share our LPPFusion link with other you know on LinkedIn.

Eric: https://www.linkedin.com/in/ericjlerner/
Ivy: https://www.linkedin.com/in/ivanakaramitsos/
LPPFusion: https://www.linkedin.com/company/lpp-fusion/

Progress with Pre-Pulses

As Lerner reported to the DZP 2023 conference, in May our new switches allowed LPPFusion's FF-2B device to reach a peak current of 1.5 MA (million amps). Since our device is powered by a capacitor bank storing only 60 kJ, our energy efficiency, producing the most current for the least energy, **is now better than that of any other operational DPF device.** (For comparison, 60 kJ is the caloric energy delivered by eating three pistachio nuts. Eating pistachios does give you a boost—but not 1.5 MA's worth!)

However, we also encountered a problem. To increase the density of our plasma—which increases fusion yield—we have increased the density and pressure of our fill gas, deuterium, to 40 torr (5% of atmospheric pressure). We efficiently transferred energy to the higher-pressure gas (see Fig.1). But that higher pressure makes the gas more difficult to "break down"—to convert into a plasma that carries electricity. Harder breakdown makes for a less symmetric breakdown, and less symmetry means less compression and less final density in the fusion-producing plasmoid. To make breakdown easier, Lerner decided to greatly increase the current we use to pre-ionize the gas right before each shot. Instead of a 60-microamp current, creating what is called a “dark discharge” we would go to 2 A current creating what researchers call an “anomalous glow discharge” or AGD.

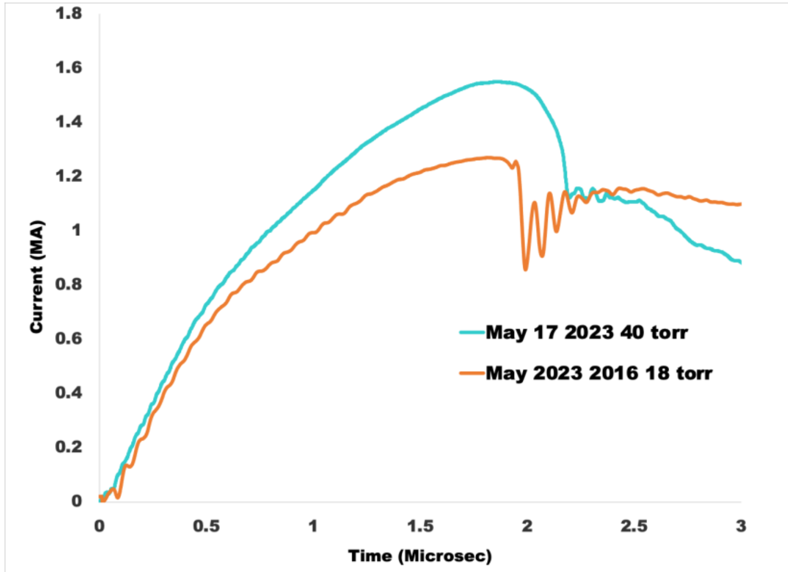

Figure 1 The blue curve shows clearly the increase in current achieved in FF-2B as compared with FF-1 (red curve with old switches and tungsten electrodes). The big drop in current is a measure of the efficient transfer of energy from the circuit to the plasmoid. However, the much slowed current drop in the blue curve as compared with our record yield shot back in 2016 shows that compression was unsymmetrical, leading to lower fusion yield. This is what we are now trying to fix.

This upgrade required a switching circuit to release the prepulse of higher current. This circuit turned out to be more complicated than we thought. A circuit that Lerner designed did not work, nor did two circuits designed by a contractor, Timothy Klein. But in July a fourth circuit designed by Jon Williams, an electronics expert with local supplier Greenbrook Electronics did work.

Before we test the new pre-pulse system with our main bank, we are doing preliminary tests with the trigger pulse that triggers our spark gap switches. When we use the trigger pulse without charging our big capacitors, we get a much smaller discharge that we can repeat rapidly for testing. Instead of a 40 kV, 1.5 MA main pulse, a whopping 60 GW for the 2 microseconds that our machine fires, the trigger gives us a 6 kV, 30 kA pulse, still a respectable 180 MW of power for 0.4 microseconds. We can use the trigger pulse to see how symmetric the breakdown is, taking an image with an ordinary camera from a window at the bottom of the vacuum chamber. We can’t use this window with the main shots as it would get coated swiftly with a thin layer of beryllium from the anode.

Our immediate goal is to get a symmetrical breakdown at 40 torr pressure like the trigger shot on the left in Fig. 2 , which we got at 24 torr pressure, not like the one at the right, which was obtained without any pre-pulse at 40 torr. Once we optimize the pre-pulse with the trigger-tests, we’ll try it out later this month with deuterium fill gas and the main bank firing.

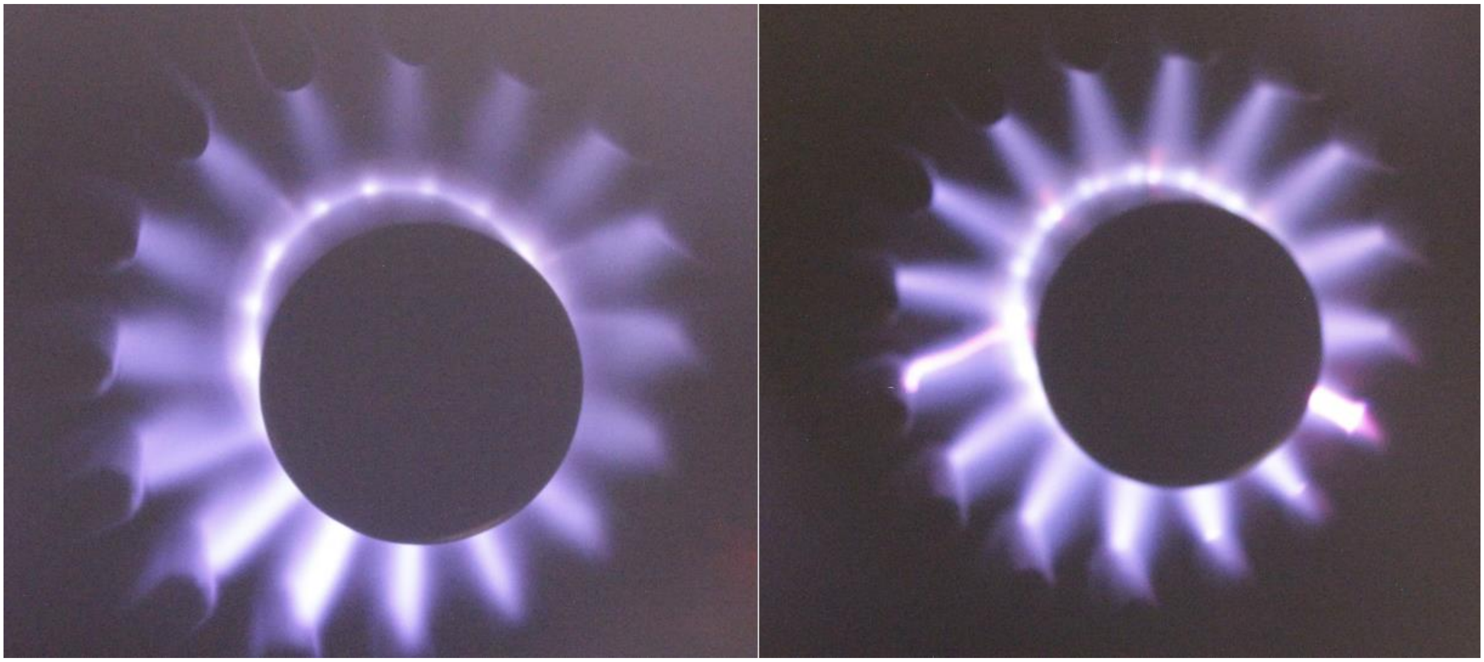

Fig. 2 Our trigger tests allow us to image the breakdown with an ordinary camera pointed upwards towards the electrodes. Here the anode is the black central circle, that cathode vanes are on the outside circle and the breakdown region is between the insulator and anode. At 24 torr (left) we get good symmetry, but not at 40 torr(right). We are testing the enhanced pre-pulse to get high symmetry at high pressure and mass density.

DZP 2023 Conference—LPPFusion Still Ahead

The DZP 2023 conference brings together researchers working on the type of fusion device that we use—the dense plasma focus—and a related device, the z-pinch. Chief Scientist Lerner went to share our results and learn from others' work. While most of the other presentations were from researchers at universities and US national laboratories, a few other private fusion companies participated. Zap Energy released for the first time information on their fusion yields, reporting 1 mJ fusion yield for 100 kJ input. By comparison, LPPFusion has published a ratio of fusion energy yield to input energy that is 400 times higher. **LPPFusion still leads all other private fusion efforts in this critical measure**.

We made useful contacts who provided us with tips on solving some of the problems we see ahead. One graduate student , Carolina Vazquez of the University of Michigan, sent us a Chinese patent on a method removing boron from a vacuum chamber surface—something we will need to do when we start testing with pB11.

Not all was work at the DZP. In keeping with tradition, some of the participants also played a 2-hour long soccer game. "The team I played on lost 7-8, " says Lerner, "but considering that the winning team was mostly grad students, we thought we did pretty well!"

Kudos to Conference Chair Dr. Ryan McBride and colleagues for organizing a pleasant and successful conference.

At DZP 2023, researchers, including Lerner (upper right) chat together between sessions or (bottom) pose after playing soceer (Lerner is standing behind the ball, with conference chair Dr. Ryan Mc Bride kneeling to left of ball.)