Report Oct 15, 2021

Summary:

- **New FF-2B Experiments, Switch Adjustments Start, Erosion Down, Current Up**
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- **Researcher Needed!**
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New FF-2B Experiments, Switch Adjustments Start, Erosion Down, Current Up

LPPFusion's research team started our long-awaited new set of experiments August 4th, successfully firing FF-2B, our fusion experimental device, with its 16 new switches and newly-redesigned anode. While we are still adjusting and optimizing the new switches, we have already demonstrated **a 6-fold decrease in erosion** from the anode and an **8% increase in peak electrical current**.

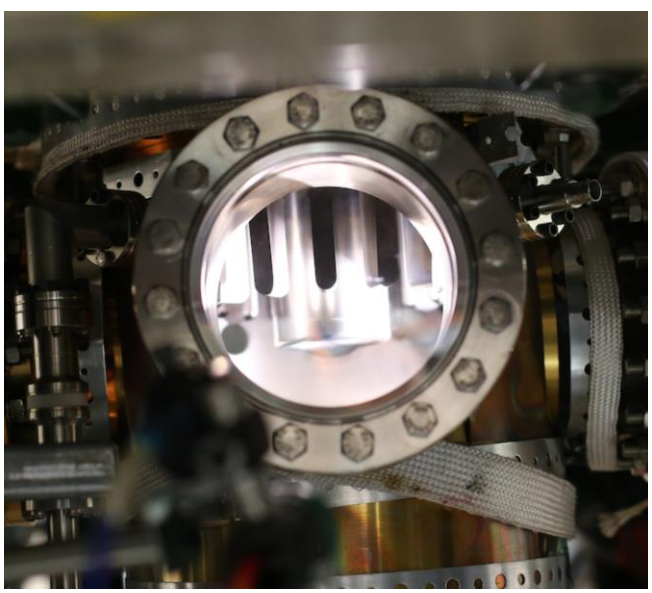


Figure 1. *Our new polished anode (left) still shines mirror-bright after three shots. It is viewed through a window on our vacuum chamber. The anode is a bit more than two inches in diameter. The colors on the anode seen here are the result of lighting and camera response. The true color of the anode is still silver. In contrast, our first beryllium anode after one shot in 2019 (right) was covered with a dark "snow" of beryllium oxide dust, which was*

vaporized and redeposited by FF-2B's powerful electric currents. This is what we avoided by our new polishing procedure.

We devoted July to the tough task of reinforcing the **insulation on the new switches** so they could hold off 40 kV during the few seconds it takes us to fire the device, releasing the current into the central electrodes. The new switches are half the size of the old ones, and twice as numerous, which enables them to carry more current. But the smaller size increases the electric fields, which makes arcing easier. After some trial and error, Research Scientist Syed Hassan devised a **multilayer defense in depth**, using a combination of insulators to seal the metal parts on the bottom of the switch from contact with air. It is the contact of metal with air that leads to ionization - the stripping off of electrons - and in turn to arcing.

Once the switches were arc-proofed, we started firing the whole device on **August 4**. Each "shot" consists of charging a bank of energy-storing capacitors to 40 kV and then "firing" them in a microsecond-long surge of million-amp current. These initial set of shots are aimed at **optimizing the performance** of the new switches and getting them to fire synchronously and with minimum oscillations in current. We immediately noticed a **major improvement** over our first shots in 2019 with the first beryllium anode: **greatly reduced erosion**. Back in 2019, a thin oxide layer had vaporized, covering our electrodes with dark dust that interfered with functioning and took many shots to burn off. For this upgrade, we had hand-polished the anode - our central electrode - to remove the thin layer of oxides on the beryllium. The polishing worked well: after the first few shots, the anode remained mirror-bright. (Figure 1).

In subsequent shots - we have now fired 29 - erosion continued very low. While the anode has lost some of its mirror sheen, and there is roughening on the surface of its inner hole, measurements indicate that **erosion is at least six time less than the best achieved with the old anode**. We can estimate erosion by measuring the amount of material deposited on the vacuum chamber windows. Our spectrometer can do this with high sensitivity, since even a very thin layer of beryllium reduces short-wavelength (blue) light more than long wavelength (red) light. By this method we measured only about 10 nm (billionths of a meter) of beryllium is eroding from the inner anode with each shot. If erosion was the only concern, an anode would last 100,000 shots - a lot longer than we intend to experiment with this anode! Equally important, **low erosion** allows us to get high repeatability in our experiments, since the anode itself is not changing significantly.

Our first ICCD image, a photo taken with a 5ns exposure time, showed unsurprisingly a similar disruption of filaments as in 2020. We don't expect this to improve until we optimize the functioning of the switches, among other steps we intend to take.

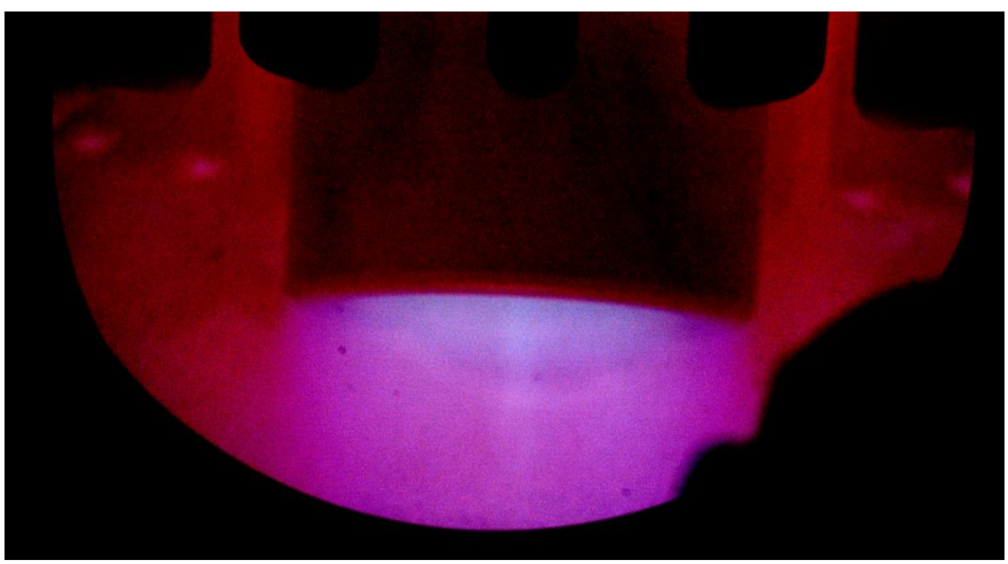


***Figure 2**. A film image of our first fusion shot of the 2021 series (August 13, shot 2) . This is a time-integrated image, but nearly all the light is generated at the time of the pinch. In this contrast-enhanced, true-color version, the pinch column of dense, hot plasma is seen as the bright blue column in the center of the anode hole. It is about 1 mm in radius, indicating only a relatively poor compression (not surprising in a first pinch). The dark semi-circle behind the*

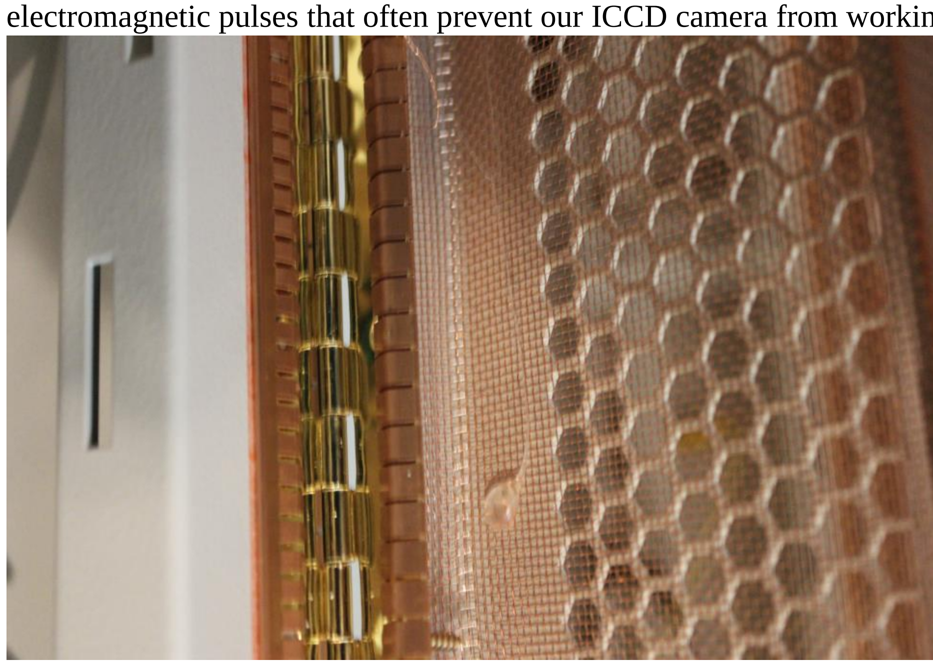
pinch region is the bottom of the window on the opposite side of the vacuum chamber.

By **August 13, we had achieved our first fusion shot** - one with high enough temperature to produce fusion reactions. We also took a good image of the pinch region on film. (Fig.2) The image shows the **relatively large (1 mm radius) plasmoid** formed by the poorly-coordinated filaments. As we get better performance, we expect that plasmoid size will shrink dramatically. After that, we took a well-earned break for two weeks.

September got off to a rocky start with **minor flooding** of the lab by **Hurricane Ida** (a non-functional sump pump was at fault). No damage was done and the lab is on high-enough ground to avoid inundation by nearby Ambrose Brook (Figure 3). Within 2 weeks we resumed firing. We rapidly demonstrated that the **new spark plugs** with ceramic insulators were superior to the old ones with Lexan insulators. Importantly, we also showed that, as we adjusted the switches, we were able to **increase the peak current by about 8%.** This is not yet the full 20 % increase that we expect from the new switches, but is a significant advance. We were also able to rapidly **optimize the switch gas mixture in the switches and the voltage of the trigger spark** that fires the switches.

Figure 3*. All LPPFusion staff and all our lab equipment remained safe and dry, even though our Middlesex, NJ lab was in the center of Ida's path, receiving over 8 inches of rain on Sept. 1. Here's the highest flood level of Ambrose Brook, with water stopping 100 meters from our lab Sept. 2.*

However, adjustment of the switches, still continuing, has been slowed by a number of factors. We found that **too small O-rings** (which seal with switches) allowed the spark plugs to move too much, so the rings were replaced. **Resistors in the trigger heads** also had to be replaced to allow faster firing. In addition, significant time was consumed on seemingly small, but important tasks like improving the **mounting of the doors on our oscilloscope racks**. The doors are vital in sealing out electromagnetic pulses that often prevent our ICCD camera from working. The new mounting has reduced the noise entering the racks by a factor of 10. This now allows the **ICCD to work on most shots**, a big step for our most expensive instrument, one that gives us invaluable insights.



Details matter! This newly installed hinge on the doors of our oscilloscope racks helps to seal out intense radio waves from our FF-2B fusion device. These waves can interfere with the functioning of our instruments, like our ultrafast ICCD camera. By connecting to the copper mesh on the doors and to the copper "fingers" on *each side of the hinge, the new mounting forms a continuous electrical shield, protecting the instrument controls inside the rack.*

The biggest hold-up has been the slow delivery of critical new parts. To observe the firing of all 16 light detectors, we planned to delay one signal for each pair of switches by sending it though a 100-meter coil of optical fiber. The delayed signal and a direct signal from the other switch in the pair would then be sent over a single optical fiber to our oscilloscopes, allowing us to easily distinguish when each switch fired. Unfortunately, no US supplier could sell us the correct Y-connector to join two fibers into one. **The Chinese-supplied connectors, delayed by global shipping shortages, just arrived October 12**. In the meantime, we could only observe 8 switches at a time, considerably slowing adjustment. We have now just started **using the new connectors to monitor all 16 switches**. Completing the adjustment of the switches will allow us to start increasing fusion yield.

Wefunder Capital Drive Raises $683,000

Two days after this year's first fusion shot, LPPFusion successfully concluded out third Wefunder crowdfunding investment campaign. **Thanks to all who invested!** We raised $683,000 from **816 investors** in a whopping **48 countrie**s. We welcome all new investors to the effort to build a fusion energy future. We greatly appreciate repeat investments from our previous investors. All of you will be receiving our newsletter by email, starting with this one. **We'll be in touch next month with those of you who earned virtual group tours**.

Thanks to changes in SEC regulations, we will be able to start a new Wefunder campaign in the relatively near future, so stay tuned for announcements. In the meantime, we are still accepting investments from accredited investors, with a $6,000 (40-share) minimum investment. If interested, email us at invest@lppfusion.com.

Researcher Needed!

LPPFusion is still urgently seeking another laboratory researcher. This will be a full-time permanent position in one of the most exciting fusion energy research efforts in the world. We seek a researcher who will assist in all aspects of our experiments including carrying out experiments, data analysis, equipment maintenance and repair and the design of new parts. We provide competitive pay, full health insurance, and a stock option plan. Requirements: the type of degree is not important but we need someone with **solid experience** in an experimental lab and with high-voltage equipment. Programming ability with Java is a plus as is experience with SolidWorks. We very much regret that due to the awful immigration policies in the US we can't consider applications from those who lack US working papers. We are an Equal Opportunity Employer. **We encourage qualified women and men of all backgrounds to apply.** Please send resumes to fusionfan@lppfusion.com

We can't clone Dr. Syed Hassan, so we need to hire another researcher to move our research forward faster.

Energy Prices, Shortages Show Need for Fusion Energy

Media headlines are filled with news of shortages, energy price increases and inflationary threats. The processes leading to these headlines have multiple causes, but they all have one thing in common. They could be ended with the development of fusion energy, especially LPPFusion's Focus Fusion.

There is no mystery why oil prices are rising, more than doubling in the past year. Oil production is controlled by the governments who are members of **OPEC Plus**, led by **Saudi Arabia**, and by a handful of giant oil and gas companies (**Shell, BP, Exxon-Mobil, Total and Chevron**). Right now, OPEC Plus has **reduced production** by 8 million barrels a day, nearly 10% of total world production. That restriction began in November 2018, well before the pandemic, but ratcheted up hugely in March of last year, when producers panicked over pandemic-induced drops in demand and prices.

MARKET INSIDER

Sharp surge in energy prices threatens economic recovery and is already slowing growth

PUBLISHED TUE, OCT 12 2021-12:18 PM EDT | UPDATED TUE, OCT 12 2021-6:57 PM EDT

Patti Domm

This **artificial shortage could not happen with fusion** energy. Focus Fusion generators will produce energy that is ten time cheaper than any available now, and it would be **impossible to monopolize**. Instead of most energy coming from a handful of energy giants, it would come from millions of fusion generators. **Boron fuel** can be refined from **sea salt.**

Woman pumps gas outside of Wawa storefront

Saul loeb

In Europe, these artificially-created energy shortages have been compounded by an unusual lack of wind, cutting back on wind-generated electricity. Fusion generators will be available all the time.

British motorists are being driven to distraction by endless lines at gas stations caused not by a shortage of gasoline, but a shortage of truckers to deliver the fuel. Again, since fusion fuel has **a million times the energy density of gasoline, an electric-vehicle recharge station will need 5 kg of fuel a year, not 5,000 tons**. A few truck drivers could supply fuel for fusion generators at all the UK's "gas" stations, once they are converted to electric re-charging.

THE WALL STREET JOURNAL.

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ECONOMY

Soaring Energy Prices Raise Concerns About U.S. Inflation, Economy

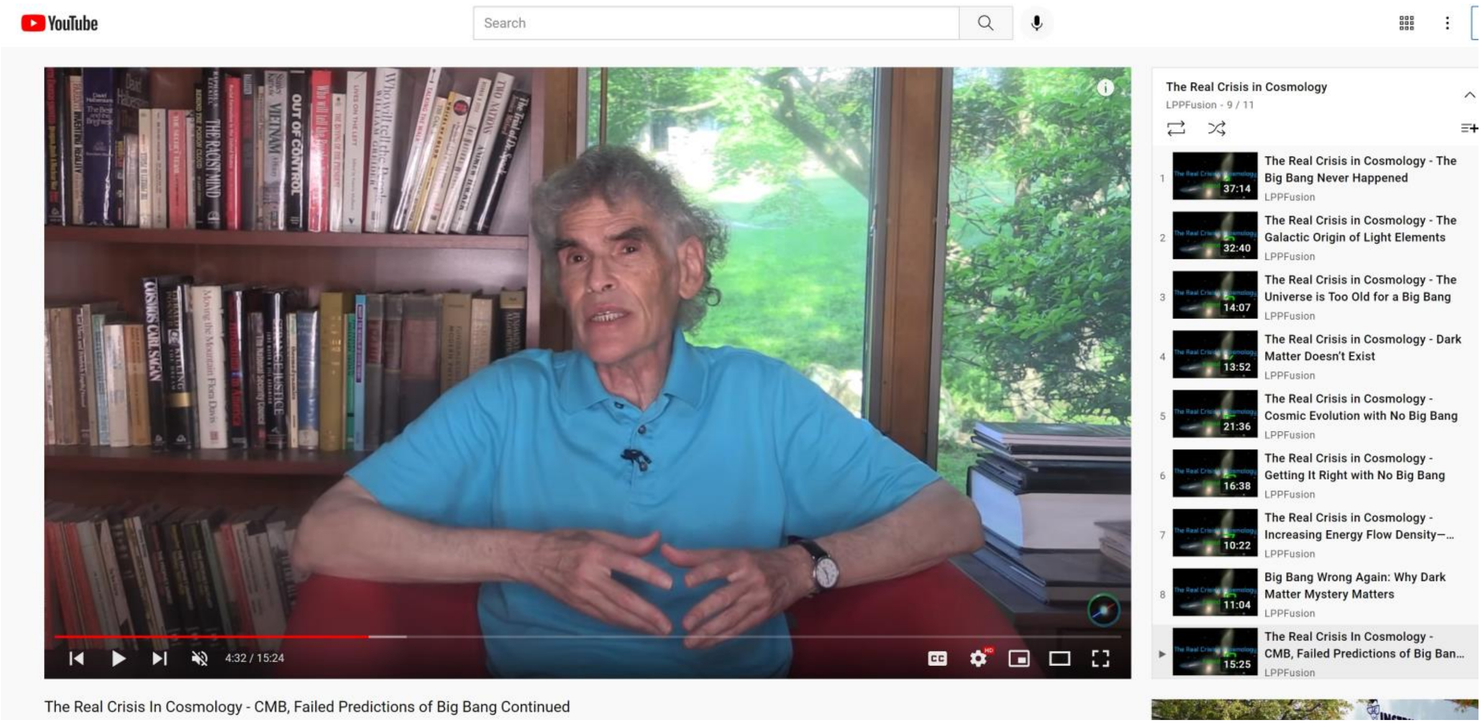
Factories and service providers require energy to boost production, but oil and natural-gas supplies are tight

Investors are urging energy companies to resist significantly expanding production.

PHOTO: MATTHEW BROWN/ASSOCIATED PRESS

Energy, of course, is not the only thing in short supply. The pandemic has stopped factories around the globe for months at a time; these goods simply were not produced. But that only created shortages, and resulting **inflation**, because **"just-in-time" supply policies, introduced 30 years ago to maximize profit**, had eliminated vital inventories. Over the same period, financial demands created massive transportation inefficiencies, shipping bulky goods thousands of miles to take advantage of low wages or cheap currencies. The **giant savings that fusion energy could produce by eliminating trillions in energy costs could free up the resources needed to build up inventories and to rationalize supply networks.** Bulky low-value products, like steel for example. could be produced regionally while the global division of labor and long-distance shipping concentrates on compact, high-value products like machinery and electronics. Even more important, **fusion energy savings can also finance the expanded global medical infrastructure that could have stopped the pandemic in the first place**. Forward to Fusion!

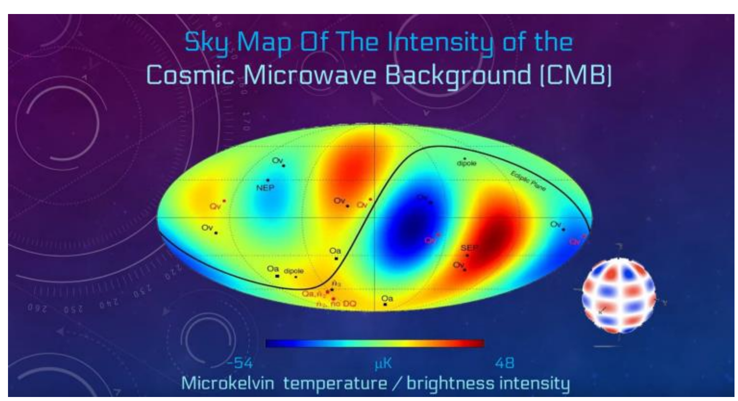
New Videos Released on Fusion and Cosmology



Snip 1. from The Real Crises In Cosmology – Episode 9

LPPFusion has released two new major educational videos and a series of short videos on our progress in the lab. A summary of our fusion research project up to the start of our new experiments is in a new video of the June 14 presentation that LPPFusion President and Chief Scientist Eric Lerner gave to a panel of fusion energy experts reviewing the company's progress. As we recently reported, including in these updates, the committee, chaired by **Dr. Robert L. Hirsch**, former director of fusion research for the United States government's Atomic Energy Commission and Energy Research and Development Administration, concluded that "LPPFusion has made an impressive effort to address DPF physics and engineering issues" and that the "program is vastly underfunded and **merits a much higher funding level**."

Understanding how plasma, electrically conducting gas, behaves in the cosmos has paved the way to understanding how to use plasma to develop fusion energy sources on Earth. Our Crisis in Cosmology series describes how the Big Bang hypothesis fails to predict observations that can be explained with plasma theory. The latest episode, Episode 9 , continues the discussion of the **failed predictions of the Big Bang theory of the Cosmic Microwave Background.**



Snip 2. from The Real Crises In Cosmology – Episode 9