Report June 20, 2022

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LPPFusion Launches 2022 Wefunder Capital Campaign

The sun, our local fusion generator, is on high June 21, the Summer Solstice, (at least in the Northern Hemisphere!) so it's a good day to launch LPPFusion's 2022 Wefunder campaign, to further fund bringing fusion to earth. **As of June 21, once again anyone in the world can invest in our research, with a minimum investment of $200 for one share.** Our minimum goal is $200,000 and our maximum $5 million.

Based especially on our new purity record (see April 29 report) the LPPFusion Board of Advisors on June 11, 2022 decided, without dissent, to increase LPPFusion's share price from $150 to $200 per share. With 324,000 shares outstanding, this increases the LPPFusion valuation to $64.8 million.

This means that since our first sales of shares in 2003, LPPFusion's shares have now increased 10-fold in price. By comparison, the S&P 500 chare price index has increased 3.6-fold. Of course, we readily admit that our shares are not liquid assets while the S&P500 shares are. They have no guaranteed resale market until we become a publicly traded company. Also, as in all investments, past performance is not a guarantee of future performance.

We look forward to seeing many of our newsletter readers on the Wefunder site and will be bringing them regular reports of our progress.

Switch Redesign—the 45 Degree Solution

Starting at the end of April, the LPPFusion team began testing our switches with the ceramic insulators replaced by Teflon ones. We had previously determined that Teflon is better at resisting the surface breakdown that had prevented the proper functioning of our switches. In surface breakdown, electric current travels from one conductor to another along the surface of an insulator.

We rapidly learned that the good news was that surface flashover within the sparkplug that fires the switches did indeed decrease and the switches became as hard to fire as we expected. The bad news was that when the switch gas mix was reduced enough to fire the switches (reducing the insulating SF6 gas relative to the argon) the switches prefired before charging to 40kV was complete. Visual inspection made clear that this was still due to surface breakdown, even with the Teflon parts.

Fortunately we were able to swiftly learn the cause and probable cure of this continued surface breakdown (also called "flashover") . Since the beginning of the pandemic, our research efforts have been hampered by our lack of access to the resources of a major university library. For a long time, we had used Princeton University Library, which allowed aces to powerful technical search engines like INPSEC and thousands of technical journals to anyone physically present on campus. But with the pandemic, Princeton locked down and , to date, has not allowed non-University individuals back on campus. No other local university provided access.

But in May we hired a student intern, Alexandra Calabro, who is entering her sophomore year as a Mechanical Engineering student at University of Connecticut. Not only did Ms. Calabro have access to the University of Connecticut's library resources, but she is a very efficient library researcher, with a great interest in all things fusion. She rapidly tracked down papers that showed a critical improvement was needed to stop surface breakdowns.

The papers from several research groups showed that a key parameter in surface breakdown is **the triple-point angle**—the angle between the insulator and the conductor at the point where the insulator, conductor and gas meet. If this angle is small, electrons released from the conductor can impact the insulator, breaking off a few electrons that travel back to the conductor in an amplification cycle that can lead to breakdown—the ionization of the gas and a large current flow (see Fig.1). But if the angle is large, more than 90 degrees measured through the gas, electrons moving from the conductor won't bump into the insulator. The ideal angle turns out to be 135 degrees measured through the gas, or 45 degrees as measured thorough the insulator.

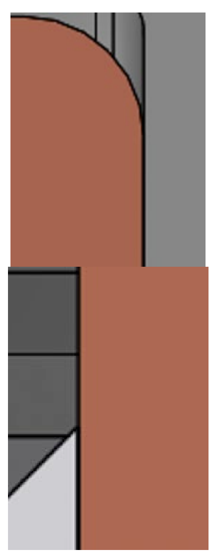


Figure 1. (Top) In the wrong angle between the conductor (red) and insulator (grey) electrons can bounce back and forth, amplifying a tiny number into a surface flashover current. (Bottom) In the correct angle between the conductor(red) and the insulator (light grey) no such multiplication can occur. In both diagrams the conductor is assumed to be negatively charged(cathode) and the field would be in the upward direction toward the positive anode.

We have had to redesign the switch parts to achieve this triple point angle. We've taken the opportunity to remedy mechanical weakness in the parts as well. We expect our redesign to be complete by the end of June and new tests to start in early August.

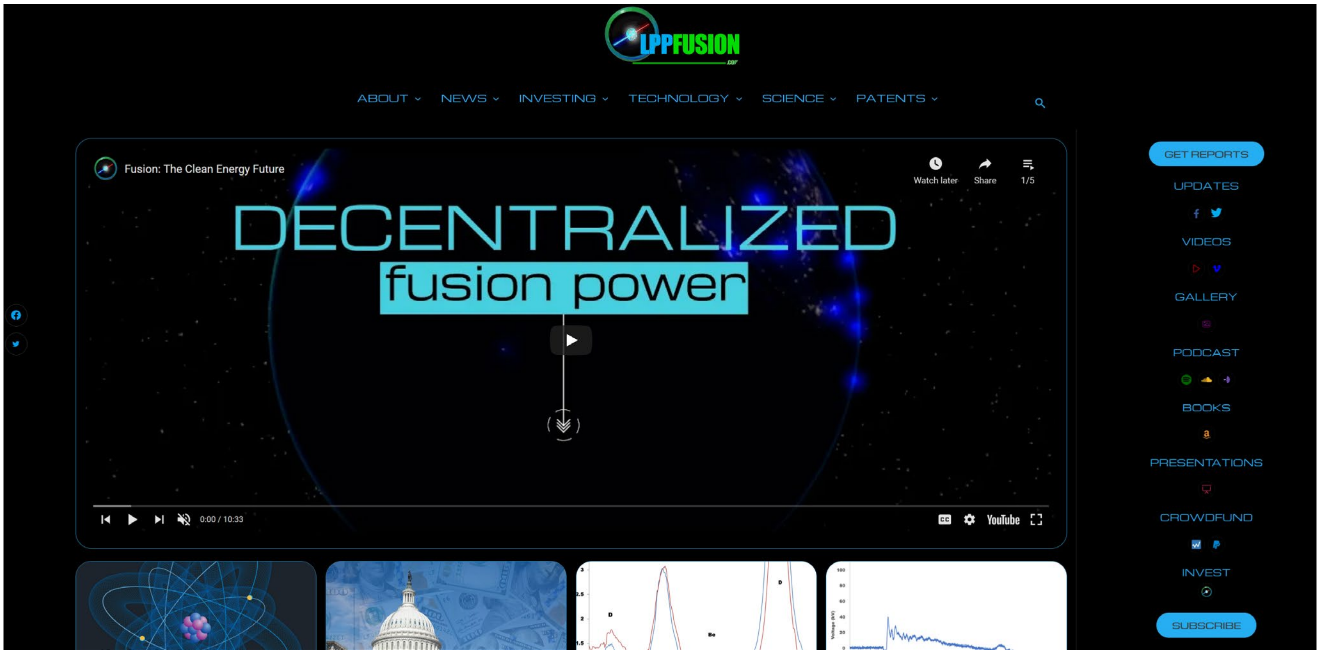
To avoid having to rebuild and fire all 16 switches, **Research Scientist Dr. Syed Hassan is preparing a test stand that will allow us to test just two switches,** firing into an electrical dump, without affecting our plasma focus electrodes at all. This will greatly speed up testing the new switch design and arriving at the best conditions for firing the switches.

While waiting for the new parts, the LPPFusion research team is continuing preparation for remote operation during pB11 experiments planned for later this year and is writing up for publication our new plasma purity record.

Website Upgrade Underway

Our IT team has reconfigured and migrated our website onto a new server with the latest plugins, and increased security. In the process, we've made numerous content updates, rewriting many pages to address new developments. We've moved our image gallery onto a professional photography site, LPPFusion gallery, where we can continue to upload images showing our research and development progress in high resolution, thus allowing greater detail for your understanding of our work. We now have most of our video content on our Youtube channel and all our media content is easily findable and shareable via the updated social links on both sides of each webpage.

LPPFusion's website is large, covering not only the core Focus Fusion experimental R&D information from our lab and relevant fusion related news around the world, but also connecting the science and the history of fusion energy research with the impact of fusion energy on the environment and with its positive social benefits to humanity. Keeping a website with over 600 pages continually updated with the latest content is like continuously editing a book. Creating relevant PR, video and image content for the website and various media outlets is too much for our small team. To keep this job manageable, over the last six months LPPFusion Chief Information Officer and Director of Communications **Ivy Karamitsos-Zivkovic** has built a small group of collaborators to keep the site up-to-date and maintain the PR. We'd like to thank our fan investors **Alex Loseman** and **Josh Brimdyr** for their support and help with finding talent. And we'd like to thank Dejan Simurdic for his help regarding the PR outreach as well. Please note, we are still adding more pages back onto the site, as we are updating them, so feel free to report any mistakes, or non-working links that may have escaped us.



Fusion vs Inflation

The acceleration in inflation world-wide has made the need for fusion energy even more urgent. By far the largest factor in present inflation is the more than doubling in the price of energy since before the pandemic. In January, 2020, oil was $60 a barrel—today it is $120 a barrel. The price of natural gas is up by a factor more than 2.6. The increase in prices at the gas station and in heating bills , while painful, tells only a small part of the story. Taking into account all costs of energy, (including oil, gas and coal) each increase in the price of oil by $20 a barrel costs $1 trillion a year. Almost all of these costs travel through the economy, elevating the prices of nearly all goods and are eventually paid by wage-earners, farmers, and small business people worldwide, who consume these goods. For comparison, total wage and small business income is around $32 trillion a year, so the $60 a barrel increase in oil has by itself contributed more than 9% to total inflation.

In the United States, inflation since the beginning of the pandemic has totaled 13%, so energy costs—including those filtered thought the rest of the economy—constitute nearly 70% of total inflation.

Why has the price of energy shot up? It’s not the war in Ukraine—the price run-up started long before February. It is simple—less is being produced. Worldwide, oil production is 6% less today than in January 2020. Don’t entirely blame OPEC-plus, although that Saudi-led coalition has cut production. Here in the US, production has dropped by a whopping 10%! With supplies artificially tightened by global production cutbacks, prices naturally shot up.

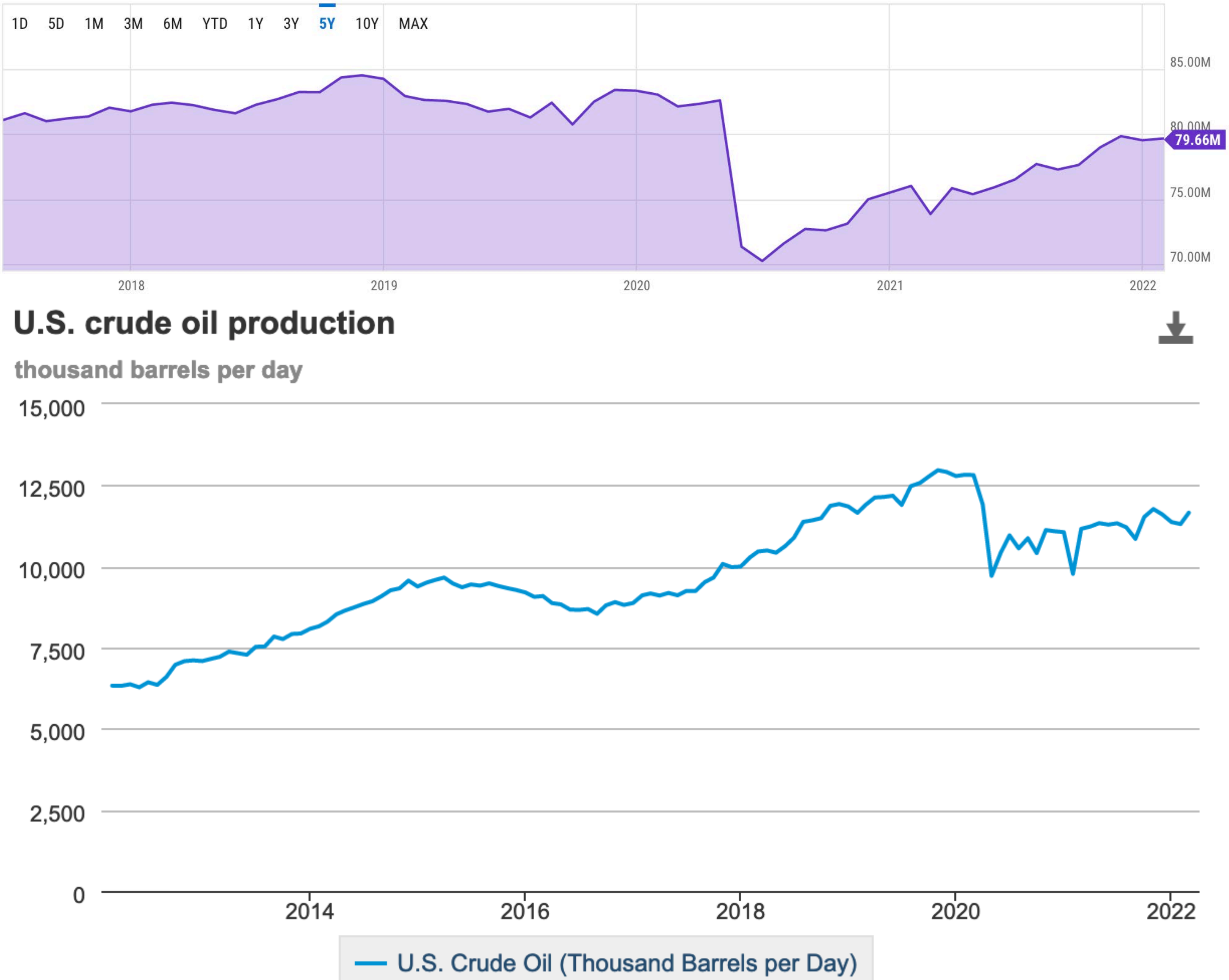


Figure 2. Reductions in the production of oil, deliberately aimed at higher prices, have occurred both worldwide (top graph) and in the US (bottom graph) Source: US Energy Information Agency.

As explained in LPPFusion's video Pandemic, *Economic Crises and the Energy Density Solution,* the basis for these production cuts were laid back in March, 2020, when the price of oil collapsed as Covid-19 shutdowns spread. With the strong help of the US government, the Saudis and Russia patched up differences and organized a sharp reduction in production. Combined with support for the US oil industry, these sharp reductions were easy to maintain as consumption ramped back up to pre-pandemic levels. Reductions that would have been impossible to impose pre-pandemic emerged from the international effort to stave off the severe financial threat of low prices.

The only way to prevent these repeated episodes of energy price strangulation of the world economy, which funnel trillions of dollars from all of us into the pockets of a handful of oil, gas and financial corporations, is to break the fossil fuel monopoly. Fusion energy, especially Focus Fusion, can do this by providing safe, clean, unlimited energy that is far cheaper than oil and gas. Of course, we are still at least 4-5 years off from even demonstrating a working prototype generator, so fusion can't yet help with the immediate crisis. But simply the existence of a cheap alternative will prevent future crises, long before fusion actually displaces oil and gas. Once it is clear this will happen, all the oil and gas producers will try to sell as much product as they can before it become next to worthless, eliminating the possibility of any future production cuts and resulting price gouging.

Of course, energy prices are not the only reason for the current inflation. Another huge reason is the trillions the US, European, Japanese and Chinese governments have given to financial institutions. While most of this largess went into the stock market bubble, now deflating without government support, a large share went to real estate speculation, with huge financial institutions bidding up the price of housing everywhere. Millions of US homebuyers have been outbid by speculators paying cash. Money that governments could have directed into actually building housing and ending the very real worldwide shortage of housing instead ended up driving up the prices of existing housing.

By vastly reducing the trillions paid for energy, fusion will free up money for greatly expanded infrastructure, including far more housing. Without housing shortages, speculation will not be possible, so this source of inflation could be combatted as well.

Confirmation of the Growth of Cosmic Plasma Filaments

Filaments consisting of electrical current, magnetic fields and spinning plasma are central to the operation of the dense plasma focus. They constitute the critical first step in concentrating energy that leads to the formation of dense, hot plasmoids where fusion reactions take place. The theoretical and experimental understanding of such filaments was first pioneered by Nobel Laureate Hannes Alfvén and his collaborator Carl-Gunne Falthammar in the early 1980's. These researchers connected phenomenon observed in laboratory experiments with those observed on the astrophysical scales of stars and galaxies. LPP Fusion Chief Scientist Eric Lerner elaborated this work in 1986 into a quantitative theory of how such filaments originated in the evolution of the cosmos and interacted with gravitation to form the structure of planets, stars, galaxies, cluster of galaxies and superclusters that we see today.

These theories were and remain controversial because the time required to from the largest-scale filaments is trillions of years, hundreds of times longer than the time since the hypothesized Big Bang. We will be reporting on new developments in the debate over the Big Bang hypothesis in coming months.

But now new research and detailed supercomputer simulations have confirmed the idea that large scale magnetic filaments can arise from cosmic plasma—without needing either a Big Bang or any pre-existing magnetic fields. A team of researchers at MIT, Princeton, the University of Colorado and the Flatiron Institute in New York City have published in the Proceedings of the National Academy of Science on May 5 a paper showing that magnetic fields form at all scales through the filamentation instability (also called the Weibel instability) in any plasma that has shear. Shear simply means any sort of internal motion in which particles are not all moving in exactly the same direction—something that is inevitable in any real plasma.

The team first showed analytically (by exact equations) that a magnetic field will build up quickly on time scales similar to the "crossing time" of the plasma—the time it takes particle to move from one side to another of the plasma. Then they used a particle-in-cell simulation to verify their calculations. Such PIC simulations trace a sample of charged particles through a grid of cells and can be very accurate, although they require big supercomputers. The simulations did indeed show filaments appearing from a previously unmagnetized plasma (see Fig. 3)

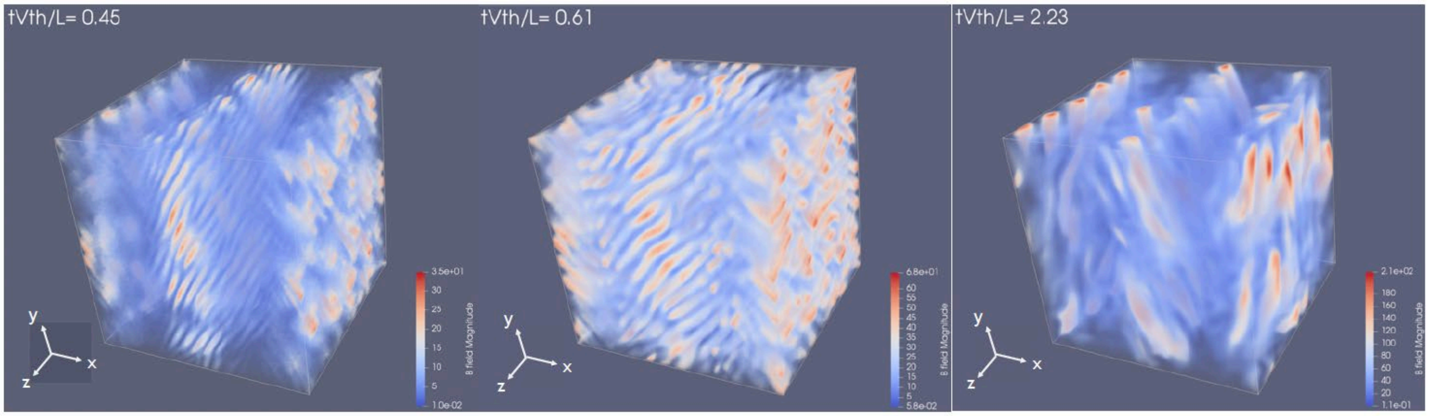


Figure 3. These images from the new simulations show the growth of filaments, already underway in the image at left, continues at later times. The times are fractions of the crossing time.

This is yet another dramatic confirmation of the general model for structure formation laid out decades ago by Alfvén and Falthammar. The study did not contain any gravitation, so the full process of structure formation could not be studied, but it did show the initial stages, before the magnetic filament had grown to the size where gravitation would become important.

The authors also did not note that the timescales indicated in their studies would only allow for the formation of magnetic fields on the scale of about 15 Mpc during the 14 billion years since the hypothetical Big Bang. But filamentary structures on far larger scales—up to 3Gpc—have already been observed, adding to the evidence that object in the universe exist that are hundreds of times older than the Big Bang hypothesis allows.

The published article is here, but a free version is here.