Report May 2, 2023

Summary:

- **Assembly Completed, Switches Work on FF-2B**
- **Our March Capital Drive Succeeds with $112,000**
- **US Approves Separate Regulation for Fusion**
- **New Course: Evolution of Physics**
- **Focus Fusion Society Annual Meeting**

Assembly Completed, Switches Work on FF-2B

The redesigned dual switches are now working on LPPFusion FF-2B experimental fusion device. As our test-bed experiments had indicated, the 16 redesigned switches are firing together and providing more electrical current than any earlier designs. With the initial switch testing complete, our next step is optimizing the conditions for much higher fusion yield.

The new switches provide more current mainly because there are two switches for each capacitor, rather than one switch, as in the design used prior to 2021. Doubling the number of switches reduces the amount of energy tied up in the magnetic field and thus allows more current to flow. The redesigned switches correct design errors that were made with the initial dual switches in 2021.

Painstaking assembly of the 16 switches took all of March. While the parts of the switches were all machine-made, assembly was by hand and had to be kept to tolerances of about 25 microns (one thousandth of an inch). This was not easy but was achieved mainly by LPPFusion Research Scientist Dr. Syed Hassan. Inevitably a few assembly errors (some by Chief Scientist Eric Lerner) were uncovered in initial switch testing during April. However, by the end of the month, good switch functioning was achieved, with all 16 switches firing and with almost all firing within 20 ns of each other.

The first big goal of the switch effort was to achieve higher current. We compared the current produced by the dual switches with control shots taken in February with the old single switches, using identical conditions with the vacuum chamber. As seen in Fig. 1, **the peak current increased by almost 25% with the new dual switches, almost exactly the design goal.**

This increase is quite significant as the optimal amount of gas in the vacuum chamber increases roughly as the square of the peak current. This denser gas is then compressed during the operation of the plasm focus, leading to higher plasma densities in the tiny plasmoid where fusion reactions take place. Higher density in turn leads to higher fusion yield. Preliminary experiments have already confirmed that optimal fill pressure has at least doubled with the new switches, although we have not yet begun to optimize conditions to achieve higher fusion yield.

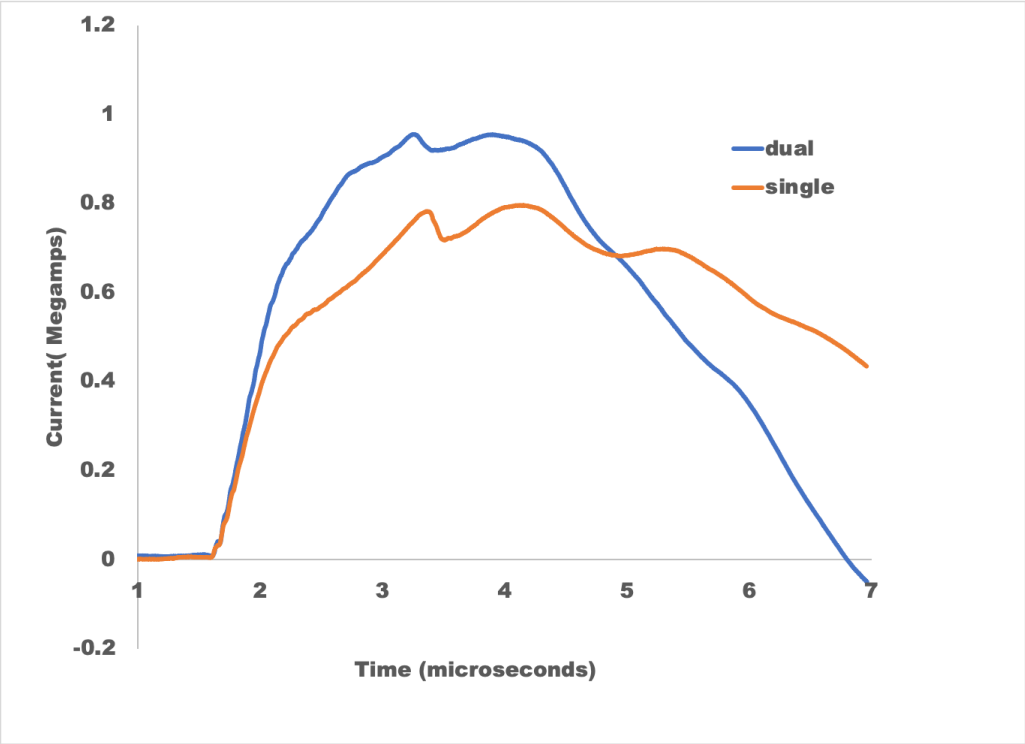

Figure 1. The dual switches (blue line) are producing almost 25% more current than the older single switches (orange line) with similar conditions in the vacuum chamber.

A second major goal was to reduce the oscillations in the current supplied by the switches. These oscillations were likely a main contributor to the disruptions of filaments in the current sheath of FF-2B. This disruption in turn reduced density in the plasmoid and thus fusion yield. The **oscillations have in fact decreased** to the lowest levels yet seen in our experiments (fig.2). In particular, the dip in current that occurs early in the pulse has almost entirely disappeared.

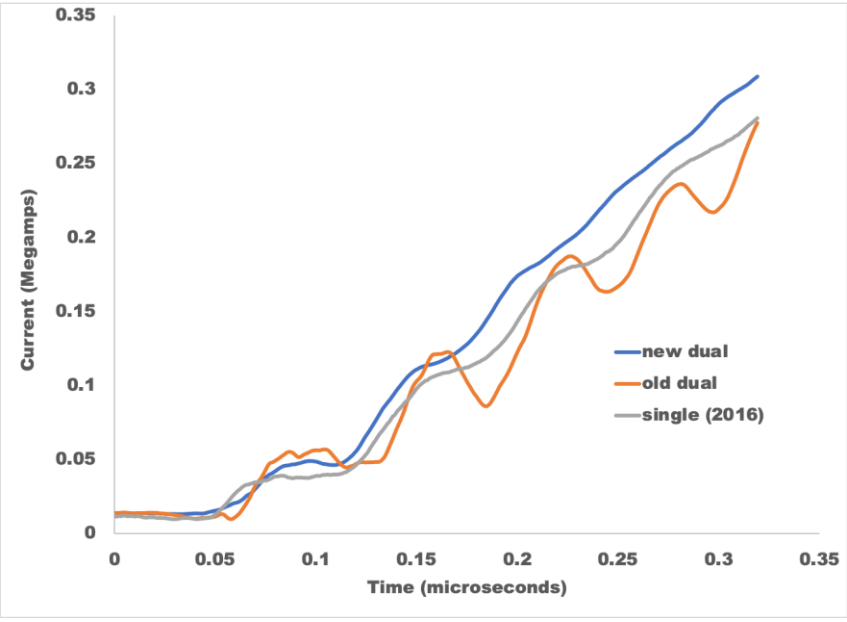

Figure 2. Oscillations in the current early in the pulse have dramatically decreased with the new, redesigned dual switches (blue) compared with the earlier version (orange) with the dips in current almost disappearing. Oscillations also decrease more quickly than in the old single switches(grey). The zero current is displaced from the axis for clarity.

Closely connected with the reduction in oscillations is the goal of turning on the current quicker. This is measured by the time to achieve a maximum rate of increase of current. Again, the turn-on time has improved considerably compared with the earlier dual switch design. Finally, **we eliminated entirely the negative pulse of current** at the start of the much large positive current pulse.

Our immediate next steps, to be taken in May, are to optimize the functioning of the device at the much higher fill pressure. This higher pressure alters how the gas in the chamber ionizes during the first nanosecond of the pulse. (Ionization is the process by which electrons are stripped from atoms, allowing the gas to carry current.) This ionization has to be extremely symmetrical if the sheath is going to compress to high densities. We can adjust the preionization current and added nitrogen to optimize "breakdown"—the time of rapid ionization. If we can at the same time achieve a quicker, as well as more symmetrical breakdown, we may be able to further reduce the oscillations, entirely eliminating the small dip in current that remains. We may also be able to further speed up the turn-on time.

Once breakdown is optimized, we can adjust the amount of angular momentum fed into the sheath by our axial field coil, which changes the magnetic field at the start of the pulse.

We expect that this optimization process will lead to yields much higher than those achieved previously with either our current beryllium or the earlier tungsten electrodes. Specifically, we anticipate that we will be able in this process to prevent the disruption of the filaments that interfere with high fusion yields. We have not yet been able to observe the filaments, as our 14-year-old ultrafast ICCD camera is reaching the end of its life and is not functioning reliably. (We need more money to replace it!) But we expect to get some good images during May.

Our March Capital Drive Succeeds with $112,000

LPPFusion has successfully reached its March fundraising goal of $100,000! We did take one day into April, (April 3) to do it, but **as of now we have $112,000 in new investments**. Thanks to James, of the USA, who put us over the top, and our other investors for this success!

If you did not get around to investing, but still want to—you are in luck. We certainly will continue to accept investments at the same terms from accredited investors. (By the way, we do accept cryptocurrency, although we convert it immediately.) Just email us at invest@lppfusion.com.

For non-accredited investors, **we still expect our new crowdfunding to start very soon** and will let everyone know when it happens.

US Approves Separate Regulation for Fusion

On Friday, April 14, the five Commissioners of the US Nuclear Regulatory Commission (NRC) announced in a unanimous vote that fusion energy would be regulated in the United States under the same regulatory regime as

particle accelerators, not as some variant of nuclear fission. This is an important victory for all fusion efforts, as it means both fusion research facilities and eventual fusion energy generators will not be burdened with irrelevant regulations from the existing fission energy industry, which is referred to as “nuclear energy”.

The decision was, in part, the result of patient education work for the Fusion Industry Association (FIA), which LPPFusion is a member of. In a statement, the FIA said: “The FIA’s position has maintained that the case is clear: fusion energy is not nuclear fission, and therefore should not be regulated as such. Today’s decision affirms that principle, and the five NRC Commissioners deserve commendation for making this decision. “

The NRC decision to regulate fusion by entirely separate rules(which the NRC staff will develop) will also help assure the public that fusion energy does not have the disadvantages of fission energy, such as the possibility of meltdowns, and the production of large amounts of radioactive waste—long-lived radioactive material at dangerous levels. In particular, LPPFusion is confident that its generators, once developed, will produce no radioactive waste at all.

In the process of formulating new regulations, we at LPPFusion hope the NRC will carve out exceptions for fusion use for beryllium. Currently, beryllium is regulated for international trade as a nuclear-related material, which can cause long paperwork delays in supply. Beryllium is the material LPPFusion uses for its electrodes, and it is also widely used in other fusion devices.

New Course: Evolution of Physics

Physics from Michael Faraday(left) to Hannes Alfven (right) will be covered in LPPFusion new online seminar

LPPFusion is initiating an online seminar course in the history of physics;” The Evolution of Physics”. In explaining our fusion efforts to many people without technical backgrounds, we’ve long ago come to realize that most people don’t have the basic concepts of physics that are needed to fully understand fusion—or for that matter most of modern technology. Many people have told us that they would really like to learn the basics of physics not

only to understand emerging new technologies like fusion but also to better judge the wide variety of ideas circulating on the web: from debates around the Big Bang, to quantum paradoxes, to the physical nature of consciousness.

To meet this need, LPPFusion's Lerner is initiating this seminar course. This will be an active participation course, as for most people it would be very difficult to get good understanding strictly from lectures or their online equivalents. To understand new concepts, people generally have to be able to freely discuss them, ask questions and reformulate ideas in their own words.

The study group would **not** at all be about math, or problem solving, unlike any college course. Math will be very much kept to a minimum. **The study group will be about how physics ideas developed over the last two centuries, how different views of the scientific method, philosophy and of society influenced these ideas, and how in turn the technologies arising from physics changed how people live. We'll be covering physics from Faraday and Maxwell, through Planck and Einstein to Alfven and Prigogine, the basic ideas of electromagnetism, quantum mechanics and relativity, plasma physics and thermodynamics.**

This will be a video-recorded study group, so that many others can share the experience. There will not be any requirements that participants have their video turned on when they speak. Participants will be people with no (or little) formal physics background, but who want to learn. We will have required readings, so the course will take some time in addition to the study group sessions.

To have good discussions, we will keep participation down to a couple of dozen, but the group could work with as few as ten. So far, we have six participants signed up, so we will start as soon as we get four more.

If you want to participate in such a study group, please contact us with the subject line study group at fusionfan (at) lppfusion.com.

In addition, LPPFusion plans to start a new video series, "The Physics of Evolution", which will describe how physic concepts developed over the past half century have altered how we view the basic process of evolution, from the evolution of the cosmos, to the evolution of life and consciousness on earth, to the social evolution of human society. We'll be announcing the first installment as soon as it is ready.

Focus Fusion Society Annual Meeting

We are passing along the invitation to the Focus Fusion Society's Annual meeting. The Focus Fusion Society, an independent tax-exempt non-profit organization, has been funding aneutronic fusion efforts, including LPPFusion, for nearly 20 years. The Society will be discussing new ideas of small-scale funding projects, including encouraging collaboration among various research groups. FFS needs **your** help in publicizing aneutronic fusion and educating the public about its advantages. Here's the invitation:

Get ready for an electrifying experience at the Focus Fusion Society's Annual Meeting on May 12, 2023, at 10 PM UK time (2 PM PDT, 3 PM MDT, 4 PM CDT, 5 PM EDT)! We'll be meeting virtually via Google Meetup to bring together passionate individuals like you who are eager to make a difference in the world of aneutronic fusion research.
The link for Joining the meeting will be:
https://meet.google.com/sdm-tmjb-bgg

As we unite to propel the development of affordable, secure, and eco-friendly energy, the Focus Fusion Society is committed to championing the groundbreaking Focus Fusion approach. This year's meeting will address crucial topics such as:

- Discussion on organizational plan suggestions
- Establishing a robust network of fusion supporters
- Electing a dedicated Board of Directors to steer our efforts for the coming year.

We need YOUR innovative ideas and valuable input to help us accelerate towards a fusion-powered future! Share your thoughts on what should be included in the board plan by filling out our feedback form: https://forms.gle/CejbngFDjFn1av8J9

To become a dues-paying member, contribute $30 for regular membership or $10 for student membership. As a member, you'll have the privilege of voting at our annual meeting. You can become a member at the following link:
https://focusfusion.org/donate

Don't miss this opportunity to ignite change and contribute to a world powered by clean, abundant energy. We can't wait to see you there!