2015 Beginning-of-Year Report

January 27, 2015

Lawrenceville Plasma Physics, Inc

High technology research, development and consulting in plasma physics, X-ray sources, and Focus Fusion

2014 Summary:

- **Our successful Indiegogo crowdfunding and increased investment together brought in almost $1 million, greatly improving our financial resources for our research. Two thousand people around the world supported our efforts.**
- **The campaign led to global press coverage in *Nature, Science, IEEE Spectrum, Gizmag* and other publications. LPPFusion is now widely recognized as one of the leading companies in alternative fusion.**
- **We identified runaway electrons as a second source of impurities and found ways to eliminate this source in future experiments.**
- **We launched a redesigned website that greatly increased our ability to communicate our work to a wide audience. We used the site to share our data with our worldwide network of colleagues.**
- **We increased our full and part-time staff. The staff now includes leading plasma physicists Dr. Hamid Reza Yousefi and Dr. Robert E. Terry.**
- **However, the long delay in acquiring our tungsten cathode postponed further experiments into 2015.**

In 2015:

In the first quarter we will complete our upgrade of both our experimental device and our computer network, including our advanced Processed Data Base. We will start the experiments, originally planned for last year, with tungsten electrodes, expecting a nearly 100-fold increase in plasmoid density and fusion yield. With these experiments we expect to confirm in the course of the first half of the year the predicted improvement in fusion yield with the axial field coil and with heavier mix gases. We will then proceed in the summer to test shorter electrodes, which will give higher current. Finally, we will move in the fall to begin tests with hydrogen-boron fuel.

Looking back on 2014:

LPPFusion succeeded in achieving many of the goals we set for ourselves at the beginning of 2014. We needed to greatly increase our financial resources, and aimed to raise $1million through a crowdfunding effort. Between the $180,000 raised by the crowdfunding itself and the close to $780,000 raised from new investments, much of that due to the crowdfunding publicity, we came very close with total funds of $958,000. We were greatly aided in this work by the Focus Fusion society board of directors and volunteers, our temporary crowdfunding staffers and Chief Financial Officer Robert Fitzgerald.

We needed that money in part to expand our too-small staff and we have succeeded in that as well. We hired Dr. Hamid Reza Yousefi as full time Chief Research Officer, brought in Dr. Robert E. Terry to strengthen our simulation effort and hired on part-time Tony Ellis and Jonathan Klabacha as consulting mechanical engineers and John Harhai as Administrative Assistant. We still need another full-time researcher, but we are getting close to the staff we need.

As planned, we launched a completely redesigned website, the work of Chief Information Officer Ivy Karamitsos. This site aided us immensely during the Indiegogo crowdfunding campaign and in explaining our work generally. Based on Electrical Engineer Fred van Roessel's JavaFusion program, we were able to put our processed data from all our shots on this website, and make it available to everyone. We are sure that the open sharing of data will help speed the advance of plasma focus research.

While we did not plan this, we succeeded in making a major advance in our understanding of the generation of the impurities that have prevented FF-1 from achieving the plasma density needed for net energy production. In a paper we published in *Physics of Plasmas*, we showed that runaway electrons, accelerated during the very first nanoseconds of the current pulse, were the source of vaporization of the copper anode and a major source of impurities in the plasma. Pre-ionization (smoothing the way for the big current pulse with a tiny current pulse) and high pressure (to slow the runaways down) are possible cures for this problem.

Where we clearly did not succeed is with restarting the experiment itself. The tungsten cathode, expected in May, proved impossible to produce for one supplier and very difficult for a second one, leading to delays of about ten months in total. We did use much of that time for improvements in the FF-1 device, including a tungsten anode, but for the first year since FF-1 was completed in 2009, we fired no shots in 2014.

Plans for 2015:

As in previous years we emphasize that our plans require adequate financing. They also depend on critical suppliers coming through on time and within specifications. However we are confident that the tungsten cathode will arrive soon, and we are planning a backup monolithic copper cathode as well. Our main goal for this year remains to increase the density of the plasmoid, the tiny ball of plasma where reactions take place, the third and last condition needed to achieve net energy production.

January-March:

1. We will complete our computer upgrade and the creation of our Processed Data Base, a powerful tool for analyzing our data.

2. We will install our new tungsten electrode and perform experiments that we expect will

a) Increase density about 100-fold to around 40 milligrams/ cm^3
b) Increase yield more than 100- fold to above 15 J
c) Demonstrate the effect of the axial field coil
d) Demonstrate the positive effects of mixing in somewhat heavier gases, such as nitrogen

April-June:

1. Move to shorter electrodes

July-September

1. Implement our improved connections and demonstrate peak currents above 2 MA
2. Increase density to over 0.1 grams/cm^3

October-December

1. Move to beryllium electrodes, or at least beryllium anode, which will be needed as x-ray emission increases so much that tungsten electrodes would be cracked by the heat absorbed. Beryllium is far more transparent to x-rays.
2. Demonstrate density over 1 gram/ cm^3
3. Demonstrate billion-Gauss magnetic fields
4. Demonstrate the quantum magnetic field effect with these billion-Gauss magnetic fields; show its ability to prevent plasmoid cooling caused by x-rays, making possible the net energy burning of pB11 fuel.
5. Install new equipment and begin running with pB11 mixes