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Lawrenceville Plasma Physics, Inc

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

LPP Focus Fusion Report
January 22, 2016

Summary:

- **Beryllium for New Electrodes Arrives**
- **New Fundraising Drives: Take Your Best Shot, Fund-a-Video**
- **LPPF Awarded Canadian Patent**
- **FF-1 Moves Toward "Goldilocks" Bake-Out**
- **Dr. Syed Hassan gets "Extraordinary Ability" Immigrant Status**

Beryllium Arrives for New Electrodes

Two cylinders of nearly pure beryllium metal were delivered to LPPFusion's Middlesex, NJ lab on January 14. The cylinders, weighing together 35 kg, are to be machined over the next five months into two anodes and a cathode for experiments in the second half of 2016. They were fabricated from 97.8% pure beryllium at the Ulba Metallurgical Plant in Kazakhstan. The two anodes will be machined in California and the cathode in Massachusetts, after acceptance testing for purity and strength, which were guaranteed by Ulba.

While the LPPF research team is still working with the tungsten electrodes, we know the beryllium electrodes will be needed soon. Tungsten is being used now because of its extreme resistance to the heat generated by runaway electrons during the early stages of FF-1's pulse. We are combining that thermal resistance with a technique called "pre-ionization" to prevent vaporization of the electrodes and the resulting impurities in the plasma (see earlier report here.) This, we expect, will greatly increase the density of the tiny plasmoid the device produces and thus the fusion energy yield.

However, as the plasma density increases, so will the intensity of the x-ray pulse emitted by the plasmoid. In tungsten, the x-rays will be absorbed in the outermost micron of the metal. When they are strong enough, the x-rays will start to vaporize even tungsten. Before we reach that point, we want to switch to beryllium. Beryllium, a far lighter metal with only four electrons per atom, is almost transparent to x-rays. What x-rays beryllium does absorb will be spread out harmlessly throughout the bulk of the electrodes.

We did not want to use beryllium first because we need to test and perfect the pre-ionization technique on the tougher tungsten. Beryllium is much less resistant to the runaway electrons than tungsten. Once we get the pre-ionization to work well, we'll test it further using a silver-coated electrode to simulate the less thermally resistant beryllium. Then we can switch to beryllium.

We have to be sure that the beryllium will not significantly erode because vaporized beryllium could recondense as beryllium dust. While bulk beryllium is harmless, beryllium dust is dangerous. If inhaled in air at above 0.1

parts per billion, it can set off an immune reaction that leads to serious or fatal lung disease. By comparison, the decaborane fuel we will be using later this year is harmful only at concentrations in air of 50 ppb, 500 times as much as beryllium dust. As a result, the beryllium is being machined at specialized facilities with high levels of safety protections. Because of this safety hazard LPPFusion will have to use special precautions, including a sealed glove box, if we do anything to the electrodes that could create dust. However, with tests to ensure no dust is produced, careful monitoring and careful safety procedures, we will be able to ensure our own safety around the beryllium.

Since only 400 tons of beryllium is currently produced world-wide, some of our newsletter readers have asked if supplies will be adequate for production of millions of focus fusion generators. In fact, beryllium is as abundant in the Earth's crust as lead, whose global production is 4 million tons per year. Beryllium production at the moment is limited by low demand, and strict regulations relating to its use in fission reactors and nuclear weapons. As focus fusion production gears up, it will be technically easy to ramp beryllium production up to the roughly 40,000 tons per year needed. Changes to regulations should also be possible, as focus fusion generators would make fission power obsolete and could lead to the cessation of uranium production, firmly closing the door to more nuclear weapons and obviating the need for controlling beryllium.

Figure 1. The new beryllium cylinders in their sturdy packing box at LPPFusion's Middlesex, NJ lab. The one on the left will go to making two anodes, of different lengths, and the one on the right will go to making a single cathode.

LPPFusion and Focus Fusion Society Announce New Fundraising Drives

The purchase of the beryllium was made possible by money that LPPFusion raised in an Indiegogo crowdfunding campaign in 2014. However, Focus Fusion still needs contributions. The Focus Fusion Society, in cooperation with LPPFusion, Inc. is making a set of new videos explaining the physics behind Focus Fusion. Everyone can help fund these videos (and be credited in them if you donate $75 or more) with a tax-deductible donation to Focus Fusion Society. Please do it here.

Focus Fusion Society has just uploaded a new set of videos, which together show the whole sequence of how the tungsten electrodes were repaired and mounted on the FF-1 device.

Everyone can also help fund the research here at LPPFusion directly. While most of our operation is funded by investors, if we had additional funding from contributors we could hire more staff and move faster towards fusion. The key to our progress is taking shots with our machine, Focus Fusion-1 or FF-1 for short, which gives us the experimental data to test our theories and demonstrate progress towards net energy. We estimate that to accomplish net energy demonstration we have to do 1,500 more shots. So far we have carried out 1,900 shots. Each shot costs us about $900. So we want you to help—take your best shot!

For $75 you can fund the charging of one of our 12 capacitors for one shot, for $150, two capacitors and so on up to $900 for a full shot. Everyone who funds a given shot will be recognized in a list kept permanently on the website. People will be assigned to a given shot in the order that we receive your money. If we cite "your" shot in a scientific paper, we'll include your name in the acknowledgements of the paper. Your shot may make history! You can contribute (not tax-deductible) here.

LPPFusion gets Canadian Patent

At the end of December, 2015 LPPFusion was notified that it was awarded Canadian Patent 2,642,749. The patent is essentially identical to the basic patent already awarded in the US, Australia and China and extends to the year 2027. The only pending foreign patent applications are for the European Union and India. LPPF's research team expects that new patent applications will emerge from the next round of experiments.

FF-1 Moves Toward "Goldilocks" Bake-Out

LPPF Research Physicist Dr. Syed Hassan and Chief Scientist Eric J. Lerner continue to prepare FF-1 for the next set of experiments, which aim to rid the device of oxygen that has caused continued high impurity levels. A key step to doing this is a "bake-out" that heats the vacuum chamber and electrodes to drive off oxygen and water molecules that cling tightly to all metal parts. Right now, the scientists are looking for the right temperature to perform the bake-out. An initial attempt to do the bake-out at 150° C was unsuccessful in December, 2015, when several plastic parts overheated and were damaged. Subsequent oven tests showed that the Mylar sheets that separate the top and bottom plates of the device, providing the main electrical insulation, are not, as the manufacturer claimed, good to use at 150° C. At even 140° C the Mylar has shrunk so much as to be permanently distorted and weakened. The shrinking was reported in the data sheets provided by DuPont but were not indicated as a cause of failure. According to DuPont the heat-induced shrinkage is caused by the relaxation of stresses imposed during manufacture.

Abundant reports in the literature indicate that 100° C is too low a temperature for adequate bake out. So LPPF scientists are looking at 120°-130° C as a possible Goldilocks bake-out temperature: not too hot, not too cold. This temperature was considerably exceeded during the last effort, so the team is installing additional thermocouples to control the temperature. In addition, with the help of volunteer thermal engineer Marc-Antoine LeGault of Quebec, we are carrying out a thermal simulation of the heat flow during the bake-out.

Replacement of the damaged Mylar and other plastic insulators is going ahead rapidly and we expect to attempt another bake-out in late January or early February, leading to oxygen elimination and renewed firing of FF-1.

Dr. Syed Hassan Gets "Extraordinary Ability" EB-1 Immigrant Status

The United States Citizenship and Immigration Service has granted LPPF's Dr. Syed Hassan an EB-1 immigrant status. This is a status reserved for immigrants of "extraordinary ability" who intend to immigrate permanently to the United States. The status is also a step towards permanent residency. Since Dr. Hassan and his wife Nur have been living in the US for several years, this step assures their residence here for the next few years and ends immigration uncertainties for LPPFusion for the foreseeable future. We congratulate Syed and Nur on their new status—and we at LPPFusion agree with CIS's assessment of Syed's "extraordinary ability"!

Fig. 2 Dr. Syed Hassan demonstrates some extraordinary ability in cutting Mylar to replace damaged pieces. Cutting precision will help insure no currents can arc through the gaps between Mylar pieces.