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

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Summary:

- **Open letter for fusion funding gains support**
- **LPP and FFS begin planning for crowdfunding effort**
- **Spectra confirm metal impurities in FF-1 plasma**
- **Design of monolithic tungsten cathode finalized—to cure impurities**
- **LPP participates in Plasma 2013 conference, releases database**

Fusion scientists begin circulating open letter urging a broader fusion program

More than 20 scientists from a dozen countries have signed an open letter urging a much broader international fusion program. The letter urges "that the United States, the European Union and Japan fund a much broader fusion energy research effort, expanding the program to include a large number of promising devices and fusion fuels in order to maximize the chances of getting economical fusion power as soon as possible." The new initiative, launched at the Plasma 2013 conference in Warsaw, Poland, at the beginning of September, grew out of initial discussion at the Google "Solve for <X> Fusion Brainstorming" workshop in June. The preliminary goal is to get 100 scientists, especially in the fusion field, to sign the letter. An effort will then be made to publicize it as widely as possible.

"Our idea is to begin a discussion about the direction of the international fusion program," explains LPP Chief Scientist Eric Lerner, one of the letter's initiators. "The current focus exclusively on the ITER tokamak program is not the fastest or surest way to economical fusion energy, and we need to let policy makers and the general public know that there are alternatives."

In terms of concrete action, the letter advocates that the US Congress and the European and Japanese parliaments "immediately hold hearings on the direction of the international fusion program, looking at the wisdom of a much broader-based program. Such hearings could be the first step to legislation allocating an additional at least $300 million per year to research on alternative fusion approaches, devices and fuels."

The letter's initiators are also seeking a separate list of non-scientist signatures that will show broad public support for a new direction for international fusion research.

LPP and FFS begin planning for crowdfunding effort

LPP, in cooperation with the Focus Fusion Society, has begun making plans for a crowdfunding effort for Focus Fusion research. In crowdfunding, small contributions in the range of $10-50, are sought from large numbers of people through websites such as Kickstarter or IndieGoGo. Recently, a company called Planetary Resources raised $1.5 million through Kickstarter for a public access space telescope. LPP and FFS hope that, with adequate preparation, similar amounts can be raised for Focus Fusion research. To succeed, a large number of volunteers will be needed. Videos and other material will have to be prepared. We want to start now to plan for this new potential source of income, to supplement the investment money now funding LPP research. Those who want to help out with this project, especially in publicizing it, are encouraged to use the volunteer sign-up form here, or email us.

Spectra confirm metal impurities in FF-1 plasma

Our research team believes that the main problem impeding higher density and yields in LPP's FF-1 device is metal impurities in the plasma. We have estimated the level of these impurities in various ways, but have not until now actually measured them. Now, thanks to a new optical-UV spectrometer from Ocean Optics, we have measured the impurities and confirmed what they are and their amounts. This important step forward was taken with the able help of summer Research Associate Kyle Lindheimer, a student at Penn State University, under the direction of LPP Lab Director Derek Shannon.

With an optical spectrum, elements can be identified by the characteristic wavelength of light they emit in concentrated "lines" that show up as peaks in the spectrum.

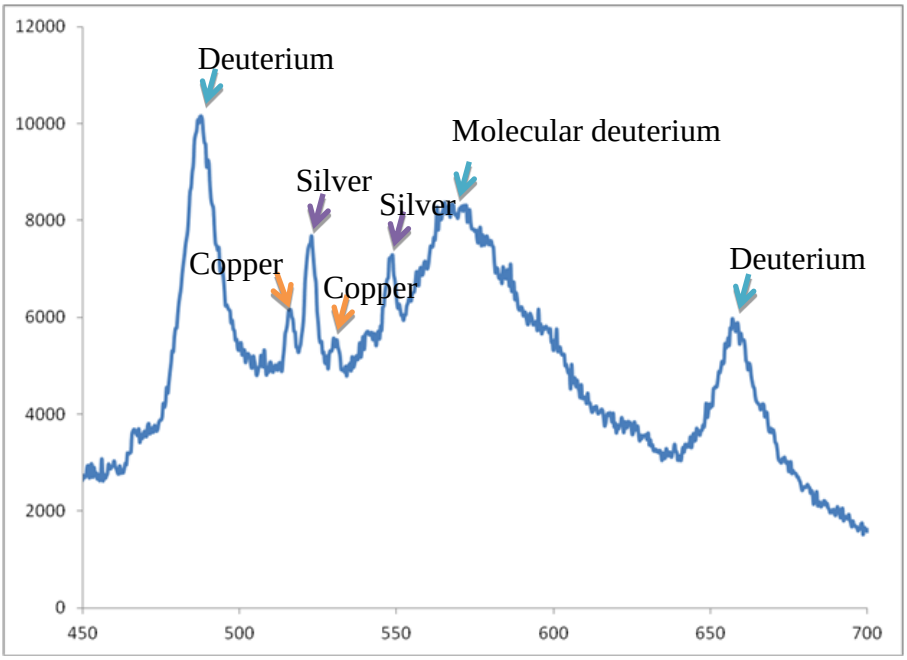

Figure 1. In this spectrum, recorded on September 11, 2013, the X-axis is the wavelength of light in nanometers while the Y-axis shows relative intensity.

In figure 1, the tallest peaks are identified as those of deuterium, the main fill gas. The second largest peaks are silver, and the smallest ones are copper. While we need to and will obtain additional spectra, current calculations from the relative strength of these lines (area under the peaks) indicates that about 2% of the ions in our plasma are silver and perhaps 0.5% are copper. Since silver ions are 54 times as massive as deuterium ions, as much as half the total mass of the plasma may be silver. This is consistent with earlier simulations that showed the plasma sheath moving much slower than anticipated. This is also more than enough silver to disrupt the plasma filaments and prevent higher density plasmoids and more fusion yield. Our solution is to eliminate the silver and copper in the electrodes and replace them with tungsten.

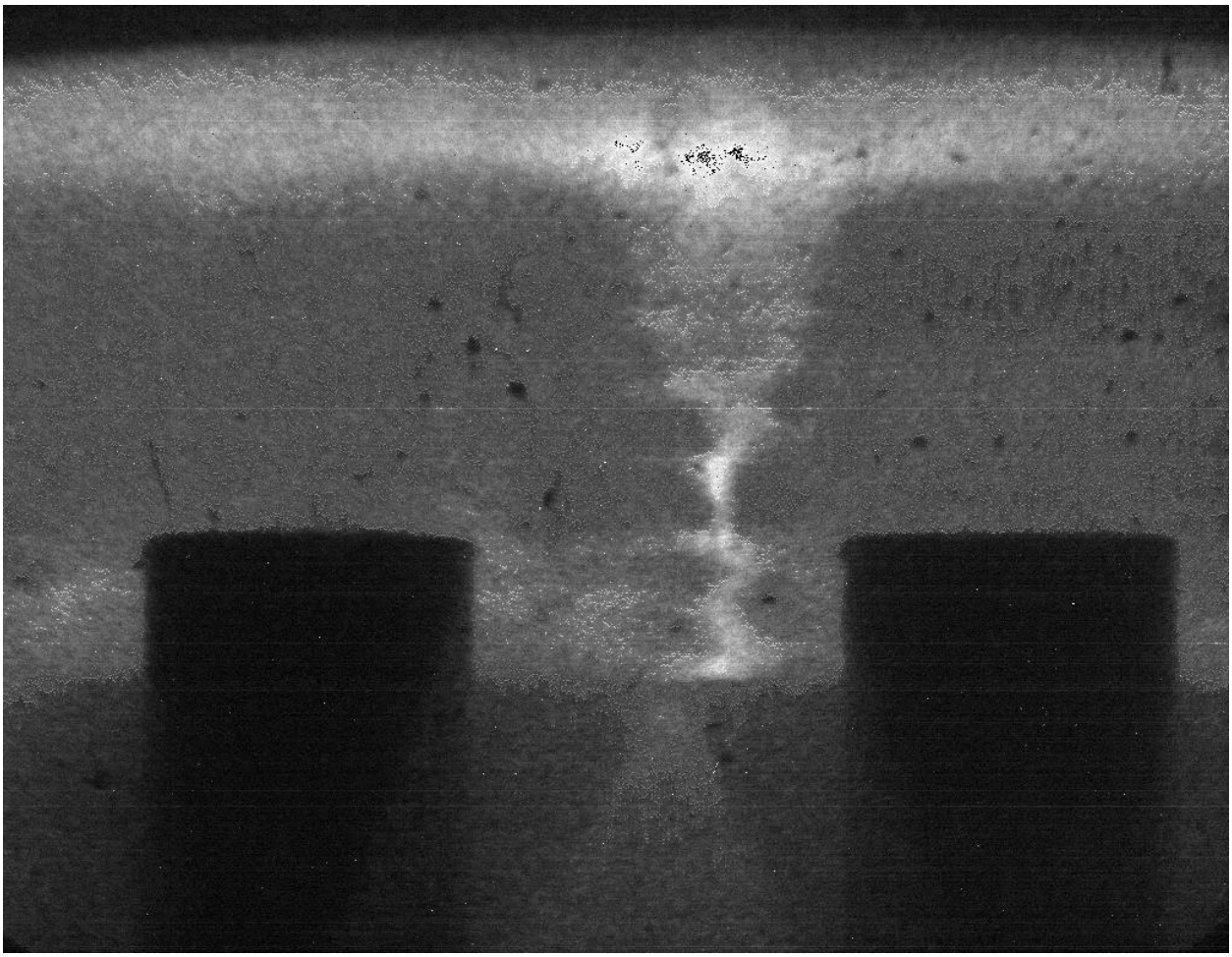

Figure 2. Doing the twist: A recent photo of the pinch in our FF-1 device gives some of the clearest evidence yet for the kinking that forms the plasmoid (bright central spot). See the spiral-staircase (helical) patterns above and below the plasmoid, where the current filaments kink up.

Design of monolithic tungsten cathode finalized—to cure impurities

Thanks to the hard work of LPP's Board of Advisors member Rudy Fritsch, a mechanical engineer, and summer Research Associate Arya Ghaseminejad, now a junior at Rutgers, LPP has finalized the design of its new all-tungsten electrode set and is now seeking a suitable supplier. Pure tungsten

was chosen as the material that will vaporize the least and create the fewest impurities. In addition, the single cathode piece, connected to the circuit only outside the vacuum chamber, will eliminate any chance of micro-arcing. With the CAD modeling done by Fritsch, we are confident that the tungsten will withstand the mechanical stresses imposed on it during FF-1's pulses. To ensure that it will also take the thermal stresses, we will be testing our existing small tungsten plate with the full bank of 12 capacitors in the near future. While we expect the fabrication of these custom pieces to still take a few months, we are looking forward to much improved performance once we get them.

LPP participates in Plasma 2013 conference, releases database

LPP Chief Scientist Eric Lerner participated in the Plasma 2013 conference in Warsaw, Poland, in early September. The conference brings together dense plasma focus researchers from much of Europe as well as plasma physicists working in other areas. In addition to seeing the launch of the open letter on fusion funding, this year's conference also revealed encouraging experimental results from the PF-1000 device, the world's most powerful dense plasma focus, in Warsaw. Researchers showed that when the plasmoid was deliberately contaminated with tungsten ions from a plate inserted in the path of the electron beam, fusion production from the subsequent plasmoid was reduced four fold. This is encouraging news for LPP, since it implies that at least a similar increase in fusion yield will result from getting rid of our metal impurities. There were also lively discussions on the theoretical concepts introduced by Lerner and others.

At the conference and the subsequent workshop on the plasma focus, Lerner announced the release of LPP's database of experimental results and invited other labs to do the same with their databases. Lerner urged the plasma focus researchers to compare and analyze each other's data to speed the program globally. Many researchers promised to take up LPP's initiative.

To request a copy of the roughly 3GB database, which can be accessed with the open source PostgreSQL program pgAdmin, email fusionfan@lppfusion.com.