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Hydrogen-Boron Fusion Conference Marks Big Advances

Hydrogen-Boron (pB11) fusion had a sort of coming-out party in Prague the first week of October. Over 100 researchers gathered Oct 2-Oct 6 at the 3rd International Workshop on Proton-Boron Fusion to discuss the latest results in the rapidly moving field and plans for the next round of experiments. Not only did the number of participants double from the event last year, but the presence of fusion industry corporate giants like General Atomics signified the "mainstreaming" of the pB11 fusion field. This is a big change from even a few years ago, when the use of this fuel to achieve practical fusion (pioneered by LPPFusion, among others) was widely dismissed by government funding agencies. We expect the new credibility of pB11 fusion coming out of the conference to help LPPFusion's fundraising efforts and to make collaboration with other researchers easier. (See the second news item).

Driving much of the excitement at the conference was an ongoing series of results with laser-driven pB11 fusion that far exceeded expectations based on theory and simulations. With deuterium and deuterium-tritium fuels, fusion yield has almost always fallen short of predictions from simulations, so having fusion that are tens or hundreds of times more than simulations with hydrogen-boron fuel is a big change for the better.

The laser results have continued to improve, leading to a series of records. The latest, announced at the conference was from the Institute of Physics, of the Chinese Academy of Sciences in Beijing. Dr. Yihang Zhang presented new experiments that led to a PB11 fusion yield of 7 mJ for a laser input to a solid target of 270 J. While in itself this result was comparable to those already achieved by the HB11 start-up in Australia, Dr. Zhang explained that the reaction resulted from a laser-produce proton beam, containing only 7 times more energy input to the target than the fusion output. While the energy input to the entire laser device is several million times more than the energy in proton beam, the record efficiency of the proton beam in producing fusion reactions is remarkable and at least 10 times larger than theoretical predictions.

Dr. Zhang attributed part of the good results to the foam nature of the boron/plastic target. The tiny threads of material between the foam voids concentrate the electric fields and may reaccelerate the protons after they have been slowed down by collisions with other nuclei in the foam. This process can extend the time that the protons are energetic enough to fuse with the boron nuclei in the foam.

The 3rd Proton-Boron Fusion Workshop at the ornate Italian Cultural Institute Hall in Prague

At the conference, a new organization promoting the development of proton-boron fusion was publicized. The organization, PROBONO, which LPPFusion has joined, is funded by the European Union. Unfortunately, the name, which is legal jargon for “for free”, is apt as the amount of the funding is at the moment very small and is limited to travel and administrative costs, not research. However, the existence of the organization just as an official network will make setting up collaborations among pB11 fusion researchers much easier.

LPPFusion Gives Invited Presentation at Prague Conference

LPPFusion's Chief Scientist Eric Lerner gave one of only eight invited presentations to the Prague conference, a recognition of our work as among the leaders in the field. While we had hoped to present the earliest results from firing our experimental fusion device, FF-2B with pB11 fuel, Lerner reported that we were not quite ready yet. We have completed installation of the bubbler that allows safe emissions form the vacuum chamber. As reported earlier, we are using the compound decaborane, which is toxic, as the source of hydrogen and boron for our experiments. Fortunately, when bubbled through water, decaborane breaks down into harmless boric acid and hydrogen gas. But decaborane needs to be somewhat heated to produce the vapor needed to fill the chamber, and the heating system is not yet complete.

Lerner's report on the use of decaborane stirred considerable interest at the conference. Decaborane is one of a class of compounds (the boranes) that consist of only hydrogen and boron. This makes them efficient fuel for pB11 fuel, since all the gas consists of nuclei that can participate in the fusion reactions. Other researchers at the conference had been avoiding the boranes due to their toxicity and using other compounds, such as plastics, which contain many non-reacting elements like carbon and nitrogen. However, Lerner explained that the toxicity level of the boranes was quite modest and easy to neutralize, provoking excitement over these compounds as superior alternatives. By the end of the conference, questions about the possible use of boranes had become so common after many presentations that a chairman jokingly asked a presenter—and "of course, what are your plans for using boranes?"

LPPFusion has just begun preliminary tests with gas mixes, Lerner explained, aiming to find the optimal conditions that can lead to hydrogen-boron fusion. The idea is to first find gas mixes that lead to high temperature and density in the plasmoids and then introduce a small amount of decaborane into the mix. In this way, initial experiments will not be using large amounts of our 100-gm supply of decaborane and we will have more flexibility in choosing initial conditions. To get the correct conditions, the hydrodynamic (fluid-flow) forces that help form current filaments must exceed the electrical resistance forces that disperse the filaments. The current filaments are an essential step toward compressing the fuel gases into the dense hot plasmoids where fusion reactions take place.

LPPFusion's Lerner with TAE's Dr. Robert Magee, another invited speaker, at the 3rd Proton-Boron Fusion Workshop

Lerner outlined LPPFusion's plans for detecting the proton-boron reactions once we get them to occur. The products of each proton-boron fusion reaction are three helium nuclei, also called alpha particles (because they were the first nuclear particles identified). The problem for detection is that alpha particles, being charged, can't penetrate through more than a thin layer of material. But in the DPF the plasma is sufficiently energetic that an electronic alpha particle detector inside the vacuum chamber will likely be rapidly destroyed.

Instead of detecting alpha particles directly, the LPPFusion team will rely on neutrons and short-lived radioactive material produced by two side reactions, even though these side reactions only involve a few tenths of a percent of the energy of the main reactions. One side reaction occurs when alpha particles produced by the main reaction undergo a second reactions with the boron nuclei, producing a neutron and a nitrogen nucleus. These neutrons easily penetrate the chamber walls and can be detected by our instruments. A second reaction occurs relatively rarely between the highest-energy protons and boron nuclei producing radioactive carbon-11 and a neutron. The radioactivity from the carbon 11 which has a half-life of only 20 minutes, can easily be detected from the gamma rays it emits, which again can travel through the chamber walls as can the neutrons from this reaction. The combination of the two measurements can unequivocally measure both the number of main fusion reactions and the temperature of the plasma. (Fig.1)

At the end of the presentation, Lerner invited other researchers to join in two new simulation collaborations. One aims at simulating the [quantum magnetic field effect]() that LPPFusion has shown is of great importance in pB11 fusion, including in laser-driven fusion. A second is for simulating plasmoids at all scales, from the sub-atomic to astrophysical, including the tiny plasmoids produced by dense plasma focus devices. At the conference, a researcher from a new fusion company, Marvel Fusion, expressed interest in the first collaboration and we expect more researchers to join in both efforts.

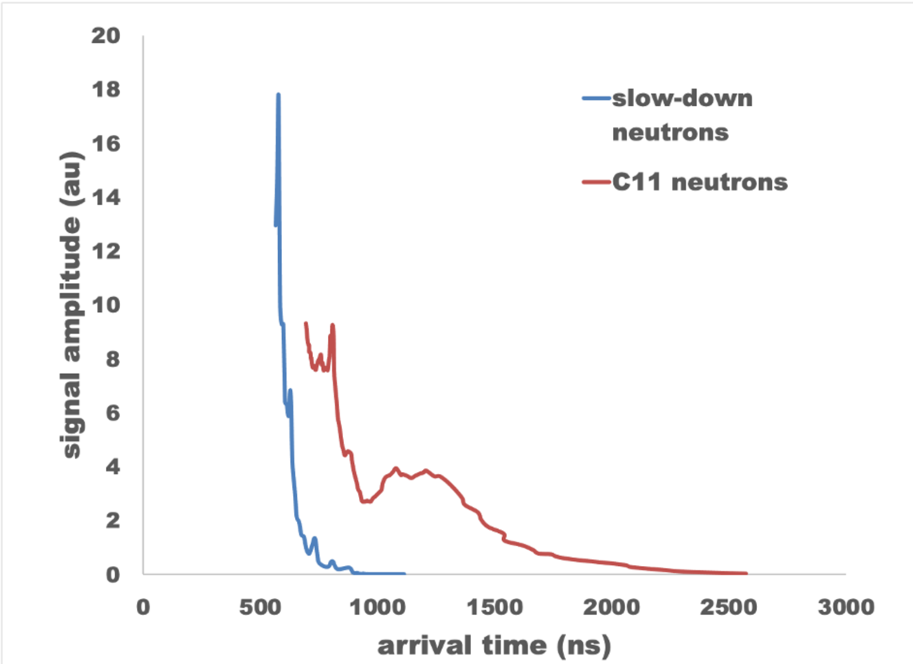

Figure 1. Simulated signals show what we expect from our sensitive PMTs (photomultiplier tubes) when we get pB11 reactions. The signal amplitude is plotted against the arrival time of the signal, the smaller the arrival time, the faster the neutron and the higher its energy. The blue line plots the neutrons arriving from alpha particle slowing down in the plasma and reacting with boron nuclei. The red line shows neutrons from the production of carbon-11. Both sources only amount to a fraction of a percent of the main reactions, so are not a safety concern. But together they allow calculation of the number of main fusion reactions and of the temperature of the plasma.

Wefunder Campaign Passes $300,000—Next Goal $600,000

Our 2023 Wefunder campaign has passed $300,000 and is entering a final month before closing November 15. In that final month, we need to get in another $300,000 to meet our minimum goal of $600,000. Investors tend to invest in the first and last month of the campaign, but our goal will require about twice as much money at the end as at the start in May. We think this is possible, as we expect considerable new publicity and new advances in our laboratory work to spur investment. If you have not invested this round, please do at https://wefunder.com/lppfusion. If you have, please let others know about our campaign in any way you can.

New Board of Advisors Elected

To help guide us in our business decisions this year, our investors have elected a new Board of Advisors. We congratulate incumbent Board members Rudy Fritsch, Dr. Charles Lewis and Jeff Maier and congratulate and welcome to the Board new members Raju Mathew, Dr. Patrick J O'Neill, Jeffrey Parkin and Robert Woodward. The election meetings themselves, held online Sept. 28, led to new ideas for more rapidly raising the capital we need. More about these coming soon.

New Videos on Cosmology and Physics

In the eighth episode of "JWST and the Big Bang Never Happened Debate" , LPPFusion Chief Scientist replies to New York Times Opinion piece, "The Story of Our Universe May Be Starting to Unravel" by Dr. Adam Frank and Dr. Marcelo Gleiser. What the authors don't actually say is that there already is an alternative "story of the universe" that is being widely debated among researchers: the story of an evolving universe without a Big Bang or the expansion of space. It looks like Dr. Frank and Dr. Gleisel have put on their life jackets on board the sinking cosmic ship "Big Bang" but are not yet ready to enter the lifeboats. They should not hesitate further. A rescue ship - "No Big Bang"- is standing close by at the ready. Time to get on board and chart a new course for the science of the cosmos.

In the third study group on the Evolution of Physics, LPPFusion's Eric Lerner and the group discuss the efforts by James Clerk Maxwell and others to use vortices to unite the newly-developed concept of fields with the observations of particles, especially atoms. These efforts encountered difficulties and then were superseded by J. J. Thompson's surprising discovery of the electron, a particle thousands of times less massive than atoms.

Reminder: On October 17, Lerner will talk with Dr. Francesco Sylos-Labini, Research Director at the Enrico Fermi Research Center (Rome, Italy). Dr. Sylos-Labini has been a leader in the mapping of large-scale structures in the universe. On the largest scales, these structures are too big to have formed in the time since the hypothetical Big Bang. There will be an open Q and A from the zoom chat at the end of each event.