Lattice Confinement Fusion (LCF) Technology Utilized by Astral Systems Ltd

Lattice Confinement Fusion, the method developed by a GRC research team, accomplishes fusion reactions in a metal solid. Deuterium fuel is confined to the space between metal atoms and with electrons in the metal lattice and a trigger such as a gamma beam, fusion reactions are produced. The team (Fig 1) is currently led by LMN/Dr. Theresa Benyo, LCF Principal Investigator (PI), and Lawrence Forsley, LCF Deputy PI, from Global Energy Corporation and HX5/LMN. Fusion products were observed (Fig 2) in an electron-screened, deuterated metal lattice by reacting cold deuterons (d) with hot deuterons (D) produced by elastically scattered neutrons originating from bremsstrahlung photodissociation resulting in d-D fusion. Previously, the worldwide fusion research community has used deuterium-tritium (DT) fuel for two types of fusion: inertial confinement fusion (ICF) and magnetic confinement fusion (MCF). ICF compresses DT fuel to extremely high levels but for only a few nanoseconds when fusion can occur. In MCF, the DT fuel is heated in a plasma to temperatures much higher than those at the center of the Sun.

Figure 1: Lattice Confinement Fusion Experimental Team and IBA Industrial Team at the site of experiments featured in the pivotal Physical Review C journal paper. Left to right: Dr. Bruce Steinetz, Lawrence Forsley, Dr. Marshall Cleland (IBA Technical Advisor), Dr. Philip Ugorowski, James Lavender, Dr. Theresa Benyo, Richard Martin, James Scheid (IBA Dynamitron Operator), and Dr. Bayarbadrakh Baramsai.

Alternatively, LCF indefinitely maintains fusion deuterium fuel in a metal lattice at a billion times the density of magnetic confinement fusion. Yet, LCF fusion occurs in a lattice at ambient temperature. While initially at room temperature, LCF creates an energetic quantum mechanical environment inside the lattice where individual atoms achieve fusion-level kinetic energies.

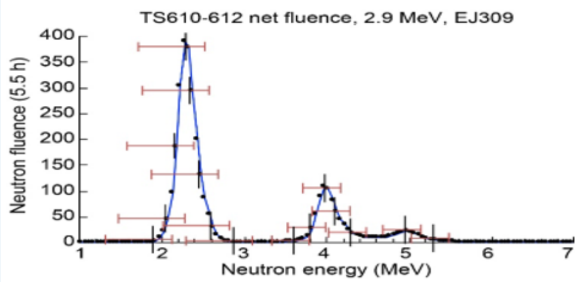

Figure 2: Neutron spectra for TiD_2 (TS610 to 612) (5.5-h EJ-309) net neutron counts (beam: 2.9 MeV, 15 mA), showing evidence of (1) fusion neutron production (2.45MeV) and (2) neutrons with greater than fusion energies. Notes: (i) Uncertainty bars represent 3σ. (ii) Fusion energy neutron counts scaled to sample location 1.8×10^3 neutron counts per second using EJ-309 liquid scintillator.

NASA researchers are seeking new energy sources for deep-space exploration missions. The energy created by LCF could be harnessed to power various NASA missions requiring small, compact, controllable power reactors. With more study and LCF development, future applications could include power systems for long-duration space exploration missions, in-space propulsion, or space-based nuclear medicine. LCF could also enable both Earth-based electrical power and produce medical radioisotopes. LCF research has been funded by HQ's Planetary Science Division (PSD) and the NASA Innovative Advanced Concepts (NIAC) Program. At the last NIAC User Symposium, Lawrence Forsley and Leonard Dudzinski from NASA PSD met with two Astral System Ltd team members to discuss how using the LCF technology improved their neutron generator.

Utilizing the principles outlined in the two *Physical Review C* papers published in 2020 by the LCF research team at GRC, Astral Systems Ltd., has been able to boost d-D fusion neutron output by at least 50 times compared to a commercially available neutron generator predecessor. Astral Systems Ltd., reports that 99 percent of the fusion reactions are produced by LCF within their Electrostatic Confinement plasma-based fusion in a single device. Their LCF-infused operating prototype fits on a desktop (Fig 3). LCF makes their devices significantly more effective at generating practical neutrons than any other devices on the market. With their devices, LCF initiated d-D fusion neutrons and anticipated DT fusion neutrons will be generated in significant quantities, enabling new classes of conventional and short-lived radioisotopes to be locally produced serving important new medical and industrial applications. Astral Systems Ltd., visited GRC in September (Fig 4), and noted they plan to deliver their devices using Lattice Confinement Fusion technology in 2025. These devices will serve the global medical radioisotope market.

Figure 3: Tom Haywood (left) and Dr. Tom Wallace-Smith (right) from Astral Systems Ltd, together with their Gen2 research reactor. This reactor has the same internal geometry as their commercial systems but is easy to open and close at the bottom so that they can swap their many deuterium-loaded plasma-facing sleeves as they complete their own LCF experiments, searching for the best materials and manufacturing processes to maximize performance.

Figure 4: The Astral Systems Ltd team visited the LCF Team at GRC on September 18–19, 2024, to share information about how LCF has improved the performance of their neutron generators. Left to right: Talmon Firestone, Eytan Cerasi, and Dr. Robert Annewandter from Astral Systems Ltd, Dr. Theresa Benyo (GRC LCF PI), Dr. Tom Wallace-Smith and Dr. Erin Holland from Astral Systems Ltd, and Lawrence Forsley (GRC LCF Deputy PI).