Lattice Confinement Fusion & Fast Fission for Space

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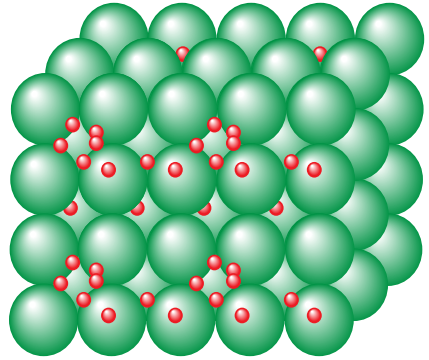
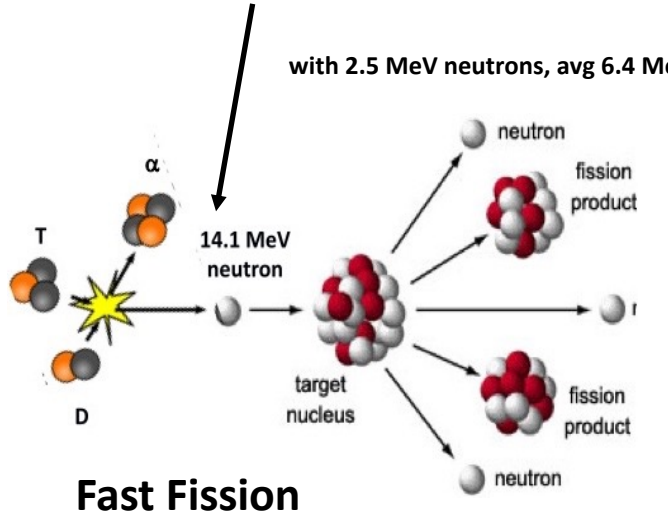
Overview

- **Lattice Confinement Fusion (LCF)[1]**
  - Fusion of hydrogen isotopes into helium isotopes
  - *No tokamak magnets or laser power supplies*
  - Nuclear fuel is confined and triggered within lattice
  - *Nuclear reactions enhanced by electron screening*
  - *Extended Electrodynamics (EED) role*
  - NASA published results in *Physical Review C* [2,3]
  - *Locally hot but globally cold*
  - Commercialized in 2025 to produce medical radioisotopes[4]
- **Lattice Confinement Fusion Fast-Fission Hybrid Reactor**
  - *Fusion neutrons fission uranium, spent fuel rods or thorium*
  - *No enriched uranium, cleaner fission!*
  - Demonstrated with US Navy and GEC
  - Supported by NASA STMD (NIAC) and NSF
- **Application**
  - LEO, Deep Space Power and High I_{sp} Propulsion
  - (Terrestrial)



Green: electron screened lattice
Red: deuterium nuclear fuel

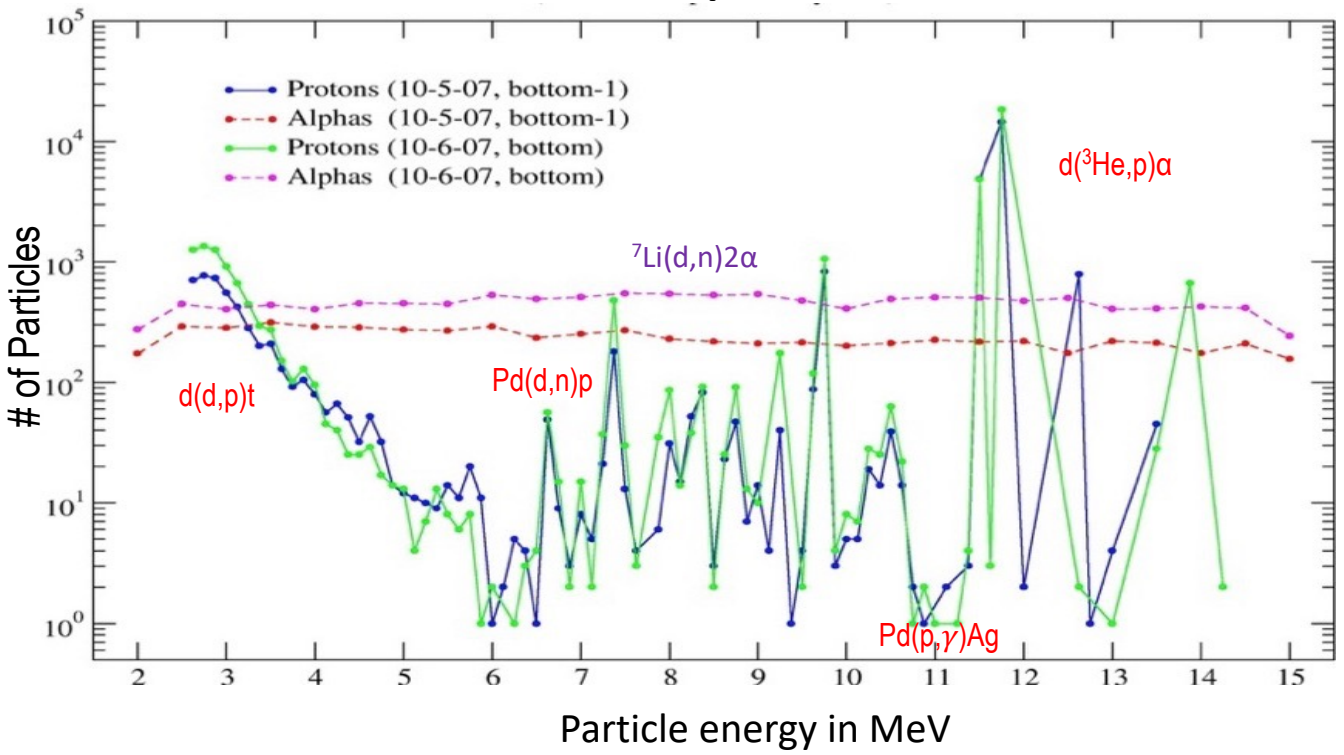
Lattice Confinement Fusion



Fast Fission

1. US Patent 8,419,919, "System and Method to Generate Particles"
2. V. Pines, *et al*, "Nuclear Fusion Reactions in Deuterated Metals", *Phys Rev C*, **101**, (20Apr2020) 044609.
3. B. M. Steinetz, *et al*, "Novel Nuclear Reactions Observed in Bremsstrahlung-Irradiated Deuterated Metals", *Phys Rev C*, **101**, (20Apr2020) 044610.
4. Astral Systems, Ltd.
5. P.A. Mosier-Boss, L.P.G. Forsley, P.K. McDaniel, 'Investigation of Nano-Nuclear Reactions in Condensed Matter: Final Report", *DTRA*, (June 2016) p 44.

Lattice Confinement Fusion (LCF)[1] Products



Replicated in two SRI experiments[2]

Measured Nuclear Reactions[2,3]

- $D(d,n)^3He$ fusion
- $D(d,p)T$ fusion
- $D(T,n)\alpha$ secondary fusion
- $D(^3He,p)\alpha$ secondary fusion
- $^6Li(d,)2\alpha$ 3-body nuclear reaction
- Neutrons and neutron capture reactions

Application:

Neutrons: *medical radioisotopes[4]*

6.4 MeV average neutron energy > fast fission[5]

Charged Particles: *high I_{sp} propulsion:*

- $D(^3He,p)\alpha$ > 14.8 MeV proton, 3.4 MeV α
- $^7Li(p,\alpha)\alpha$ > two >6 MeV α

LCF: Triggered fusion in electron-screened, high-density deuterated metal lattices.

[1] Baramsai, *et. al.*, "NASA's New Shortcut to Fusion Power: Lattice Confinement Fusion Eliminates Massive Magnets and Powerful Lasers", *IEEE Spectrum* (March 2022). https://spectrum.ieee.org/lattice-confinement-fusion

[2] P.A. Mosier-Boss, *et al.*,"Detection of high energy particles using CR-39 detectors part 1: Results of microscopic examination, scanning, and LET analysis", *Int. J. of Hydrogen Energy,* **42**, 1(2017) pp 416-428.

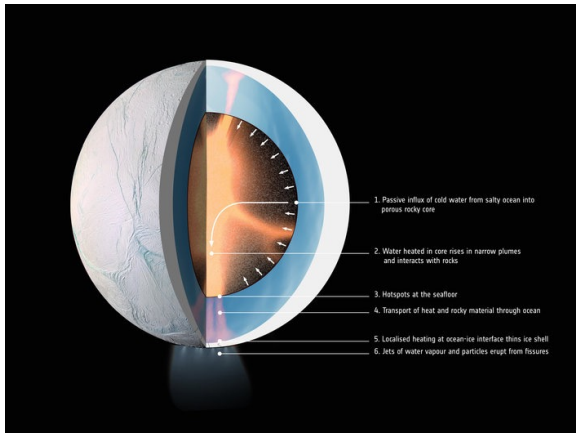
[3] US Patent #8,419,919, "System and Method for Generating Particles", (2013).

[4] Astral Systems, Ltd.

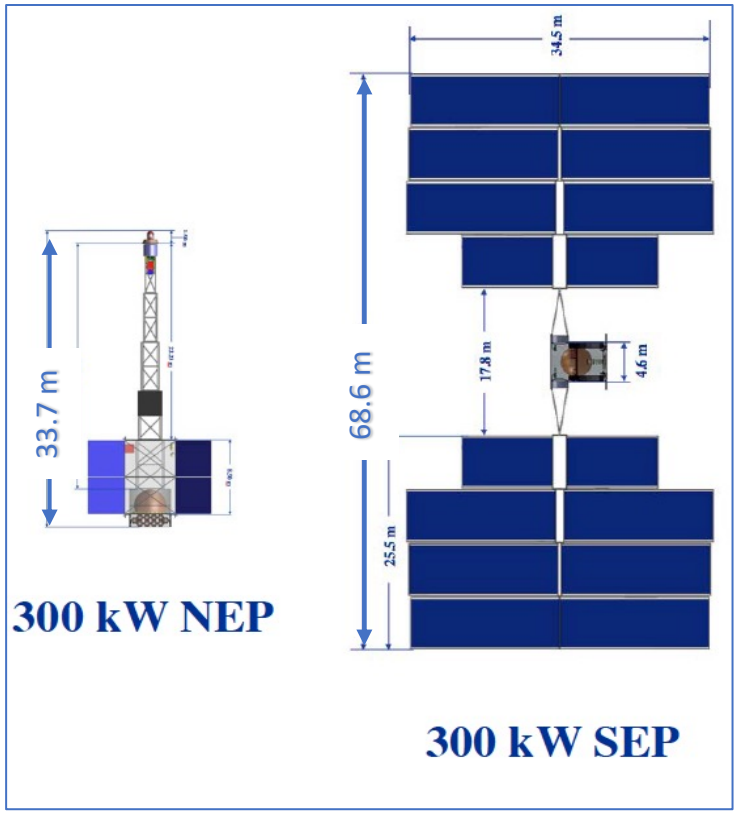
[5] P.A. Mosier-Boss, L.P.G.Forsley, P.K. McDaniel, 'Investigation of Nano-Nuclear Reactions in Condensed Matter: Final Report", *DTRA*, (June 2016) p 44.

Space Applications

- **LEO and beyond**
  - **Power**
    - *Untended operation 5+ years*
    - *Advanced Acoustic Stirling Power conversion*
  - **Nuclear Electric Propulsion**
    - *Save years crossing outer solar system*
    - *Fast transit to Mars*
  - **LCF propulsion** *(1,000 times NTP[2] efficiency)*
    - *LCF 6 MeV alphas >1.5 x 10^4 km/s*
    - *Chemical V_e < 5km/s or Nuclear V_e < 10km/s* [3]
  - **Planetary Surface Power**
    - *10 – 100 kWe Lunar and Martian Power*
    - *Living off the land: fabricate U or Th fuel rods in situ*
- **Past and Present Partners and Programs**
  - US Navy SPAWAR/NSWC, DTRA/DoE/LANL, DoE/NNSA
  - NASA SMD/RPS: *Advanced Energy Conversion*
  - NASA SMD/PSD/PESTO*: Lattice Confinement Fusion*
  - NASA STMD/NIAC: LANL MCNP *Modeling for Icy Worlds LCF Fast Fission Power*
  - NSF SBIR: *Fusion-Fast-Fission Scaling*



Melt through 45 km of Icy shell on Enceladus seeking extraterrestrial life![1]



Nuclear Electric Propulsion (NEP) heat dissipation panels as compared to Solar Electric Propulsion (SEP)[4] solar panels.

Mass, volume, lifetime matter!

If It's safe enough to launch from Florida, its safe enough to use in Florida! [tm]

[1] T. L. Benyo, L P. Forsley, R. Dyson, M. Becks, "Accessing Icy Worlds using Lattice Confinement Fusion (LCF) Fast Fission", *NIAC 2023*
[2] NTP: Nuclear Thermal Propulsion
[3] V_e is the propellant escape velocity
[4] L. Mason, "High Power NEP Power Concepts", *NASA GRC*, (2017) where the 300 kW NEP was for JIMO/Project Prometheus.

Lattice Confinement Fusion