FUSION INDUSTRY ASSOCIATION

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Fusion Energy for Space Propulsion

Making Fusion Space Propulsion A Reality by 2030

The next space race is not simply into orbit; it is to the Moon, Mars, and beyond. The global competition is fierce, and the stakes are high—from landing the first humans on Mars to harvesting the limitless wealth of asteroids, and much more. **Fusion propulsion is the best path to winning this "Deep Space Race."** It is the only technology that can take cargo and people to Mars and beyond and then return them home quickly.

Fortunately, fusion propulsion technology has advanced considerably in recent years, and **new concepts are ready today to move towards flight**. A targeted $40 million funding program, taking from successful aspects of the DARPA and ARPA-E experiences, can drive transformative growth in this game-changing industry.

The Stakes of the Deep Space Race

U.S. innovation in chemical propulsion and satellite technology has allowed it to maintain a clear but fragile lead in space exploration. This lead can be a springboard to even greater opportunities. Our explorers—in both the public and private sectors—want to go beyond Earth orbit (i) to colonize the Moon and Mars, (ii) mine asteroids for trillions of dollars in resources, (iii) defend Earth from comets & asteroids, and (iv) search for extraterrestrial life within our solar system on the moons of Jupiter and Saturn.

A global competition

The Chinese government claims it will be the first to colonize Mars and reach asteroids. It is funding those ambitions accordingly, making heavy investments into nuclear and advanced propulsion technologies that reportedly dwarf current U.S. efforts. The Chinese and Russian governments have announced plans to build a lunar base by as early as 2031, and from there to move into the rest of the solar system.

The Deep Space Race will impact the balance of power on Earth

Nations that can build significant space outposts and unlock the resources of asteroids will have access to unparalleled economic might. The first nation to bring back materials (or even life) from the moons of Saturn or Jupiter will dominate scientific progress. Those nations with the technology to win the Deep Space Race will have a sustained advantage in national security matters.

Fusion Propulsion Will Decide the Deep Space Race

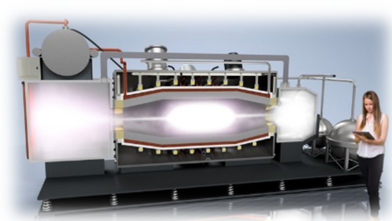
Sample Mission	Estimates - Chemical Propulsion	Estimates - Fusion Propulsion
Colonizing Mars	• 7-9 months • Very limited flight windows • Small payloads	• 3 months • Fly nearly anytime, there and back • Colony-level payloads
Mining the Asteroid Belt	• 10+ years • Visits and sample extraction only	• ~4 years • Return trip with commercial payloads
Planetary Defense	• Not usable for deflecting comets or reaching distant objects	• Able to deflect asteroids and comets, even within limited time windows • Able to reach unknown passing objects
Exploring the Moons of Jupiter & Saturn	• 3.5 – 7 years • Small probes only	• 0.5 – 2 years • Round trips, bringing back samples • Human trips eventually possible

Chemical propulsion cannot compete in the Deep Space Race

While effective for transporting people and material into low Earth orbit since the 1950s, repeat lunar transits and trips to Mars and beyond are severely constrained. Travel to Mars on a chemical rocket takes nearly a year, and can only happen at limited intervals, one-way, with marginally sized payloads. Chemical propulsion is limited to sending modestly sized robotic probes on one-way missions beyond Mars, leaving the broader Solar System inaccessible to human-led exploration.

Fusion propulsion technologies will determine the winner

Fusion propulsion systems are now under development by an array of private-sector startups. Fusion will make it possible for heavier payloads—and eventually humans—to venture to Mars and beyond, while returning home quickly with plenty of safety margin. Fusion propulsion is up to 100 times more fuel-efficient than chemical propulsion, while still maintaining large thrusts—making it the best option for transporting large payloads to distant destinations or ferrying cargo to and from the Moon.



Fusion spacecraft propulsion is on the launchpad

Recent advancements in fusion technology are accelerating the viability of fusion power on Earth. Yet fusion propulsion could progress even faster towards demonstration than terrestrial fusion power. A fusion spacecraft does not need to maintain the same high-intensity operating conditions as a terrestrial fusion power plant, nor does it require complex engineering to capture energy. A variety of private-sector fusion propulsion technologies are now under development, each of which is seeking to leverage recent breakthroughs in fusion plasma physics, materials, modeling, and simulation, to create a spacecraft propulsion prototype this decade.

Leveraging the "ARPA" Model to Drive Development

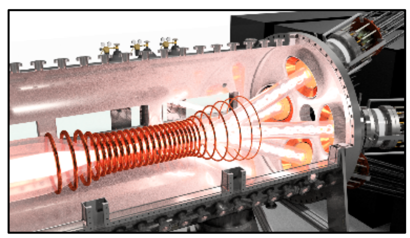
The "ARPA" model brings new technologies to commercial reality

The Advanced Research Projects Agency or "ARPA" concept—whether it be DARPA for defense applications, ARPA-E for energy applications, or elsewhere—has proven one of the most successful government programs in the history of U.S. science funding. For pennies on the dollar, the ARPA concept *accelerates* the billions of dollars otherwise invested in basic R&D, by identifying and transforming the good ideas that result into commercialize-able innovations. This happens because ARPA programs focus on bringing in innovators to lead milestone-based programs, that aim to move technologies beyond government support and into the private sector. Fusion propulsion innovators and researchers have reached the threshold of where they would benefit from an ARPA model to take their concepts from the drawing board to the test stand—and eventually into space itself.

Spacecraft fusion propulsion needs its own ARPA-style program

Such a program can transform U.S. exploration and beneficial use of the solar system. This program could be based within NASA—the NASA Innovative Advanced Concepts (NIAC) program funds disruptive propulsion technologies for example, but at a small fraction of even a *single* ARPA-E funding program. It could also exist as a separate "ARPA-S," with NASA and the Space Force as potential anchor tenants, and with technical support from DOE.

Even modest funding programs can have transformational impacts



An initial $40 million program would directly support experiments of fusion propulsion concepts and the development of critical supporting systems (such as shielding & power electronics). Funds can also support the development of prototype machines that reach operational conditions on Earth. These would bridge the "valley of death" that plagues innovative technologies and help ready the field for private sector investment—just as ARPA-E has done for terrestrial fusion power, and DARPA has done for many other technologies.

FIA Recommendation

An ARPA-style fusion propulsion funding program, appropriated **just $40 million**, would be a low-cost effort with transformative applications. For less than the cost of a *single* Falcon 9 rocket launch (and 1/20th the cost of a Mars rover), a successful program has the potential to transform the way we look at the universe and ourselves, unlock potentially trillions of dollars in scientific and economic innovation, and secure American interests for this century and the next.

Read More:

New Space Age Hampered by Old Technology (Baltimore Sun)
China and Russia Are Teaming Up in the New Space Race (Bloomberg)
Space Mining Could Become a Real Thing — and It Could Be Worth Trillions (CNBC)
The Direct Fusion Drive That Could Get Us to Saturn in Just 2 Years (Popular Mechanics)
Scientist Develops New Fusion Rocket that Could Take Humans to Mars in Short Time (IBT)

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