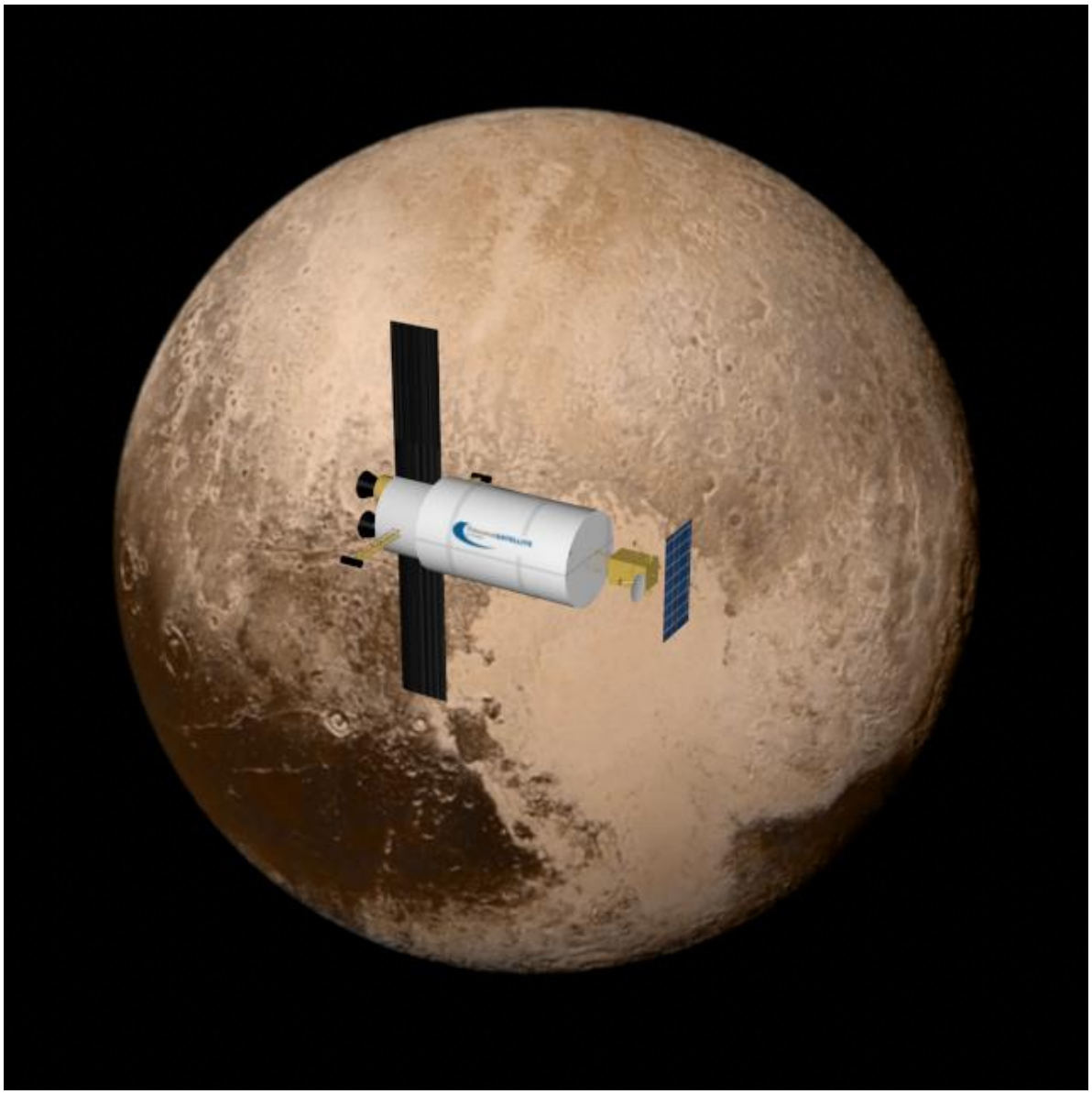
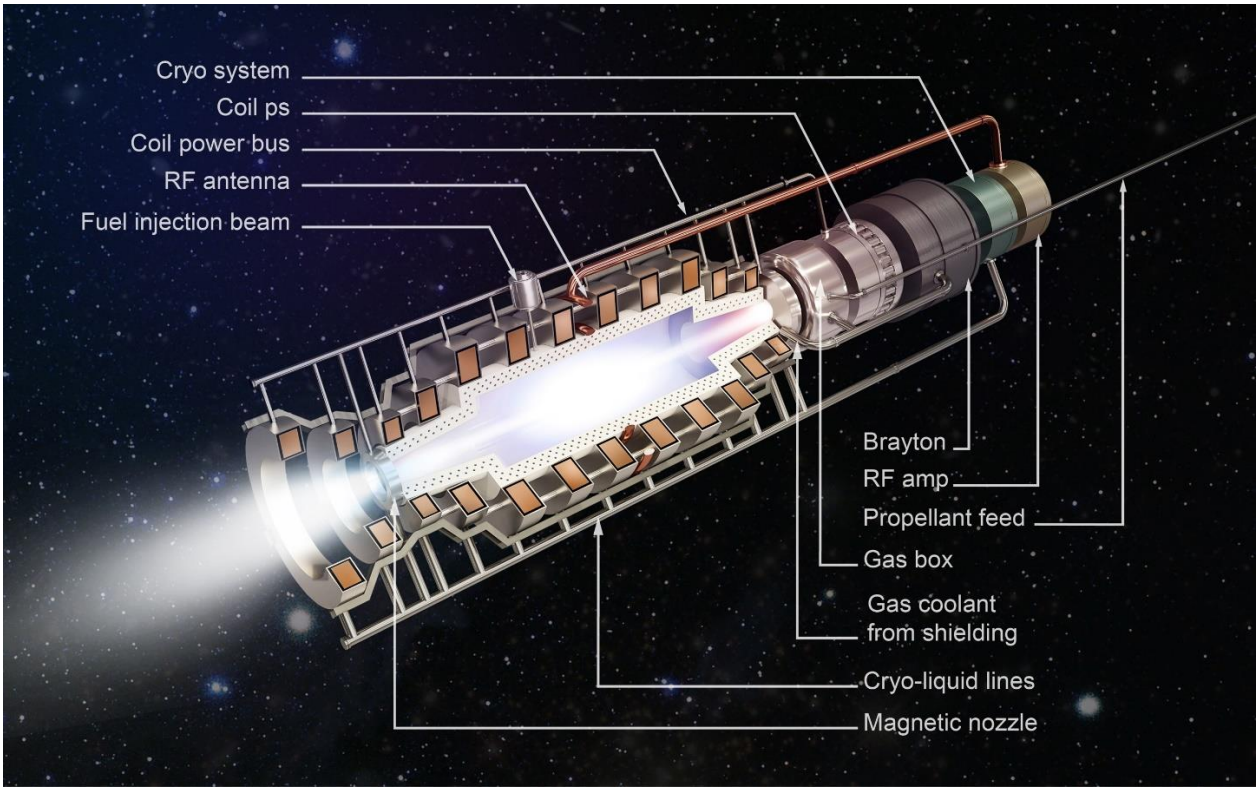
Direct Fusion Drive for Space Propulsion and Power

The Direct Fusion Drive rocket engine (DFD), based on the Princeton Plasma Physics Laboratory's Princeton Field Reversed Configuration machine, will enable human missions to the planets, advanced robotic missions, mission to interstellar space and to nearby solar systems. The same system can be used for propulsion and power. The engine is based on the Princeton Plasma Physics Laboratory Field Reversed Configuration invented by Dr. Samuel Cohen.

A DFD powered Pluto orbiter is shown below. This was developed under a NASA NIAC Phase I grant. The mission includes a laser powered lander.



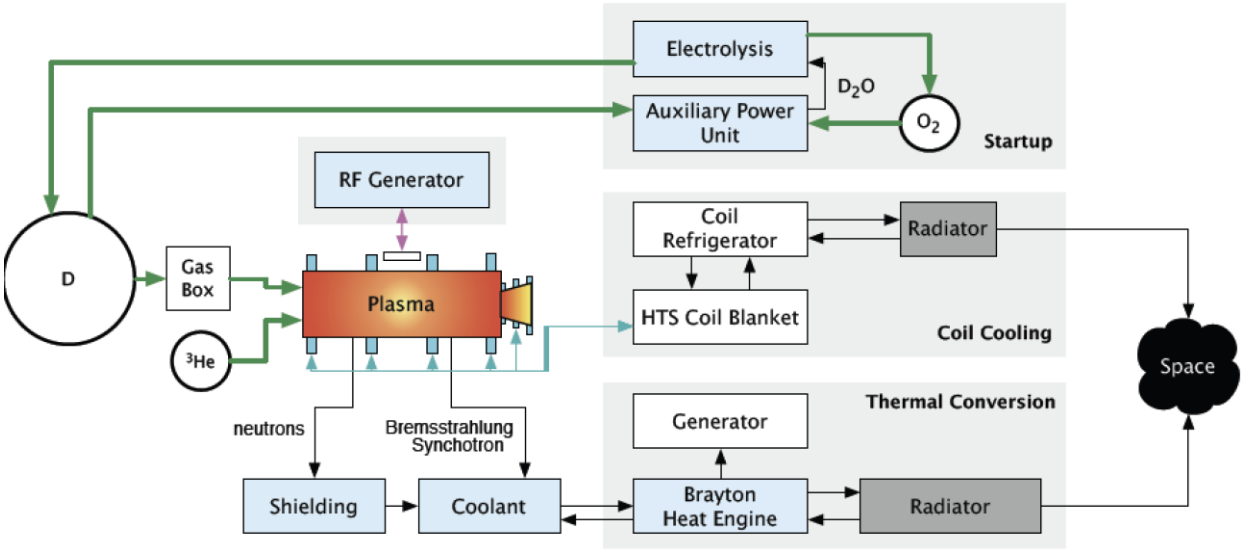
An artist’s conception of the engine. All subsystems are labeled.



DFD uses a radio-frequency drive to heat the plasma to fusion temperatures. The reactants are contained in a toroidal closed magnetic field region within the solenoidal coil. The products escape this region quickly and do not provide any energy to heat the plasma. The drive is powered by waste heat from the reactor. High temperature superconducting coils provide the solenoidal field and the nozzle fields in the engine.

The reactor uses helium-3 and deuterium as fuels. These react at relatively low temperature (compared to other advanced fuels) thus putting a lower demand on energy recycling efficiency. Helium-3 is rare on the Earth but can be obtained by mining the lunar regolith. It is also available from the atmospheres of the gas giants.

The following diagram shows the DFD subsystems. The startup system is for situations in which no fusion power is available for engine startup.



The machine requires shielding to protect the superconducting coils from the neutrons released in the deuterium-deuterium side reactors. More shielding might be needed for vehicles and space stations with crews.

Work is ongoing under three NASA Grants and DOE funding. The following picture shows the experiment in operation.