Neutron Engine

We have plans and intellectual property on fusion powered rockets. When Apollo went to the moon, it's rocket burned at about 9 g's of acceleration for approximately 10 minutes to push it out of Earth orbit. The craft coasted to the Moon. The craft continuously decelerated until reaching the equal gravitational point between the Earth and the Moon. Once under Lunar gravitational pull, the craft then accelerated as it approached the Moon. At the proper point, its engine re ignited, decelerating the craft to a velocity allowing it to enter Lunar orbit. This trip took about 3 days to get to the Moon. It is not possible to carry sufficient fuel for chemical rockets to continuously operate all the way to the Moon.

Fusion rocket engines could continuously power a craft to the moon with pounds of fuel rather than of tons of fuel. Such engines allow a constant rate of 1g acceleration and deceleration all the way to the Moon. Such a trip would be about 4 hours rather than 76 hours. A trip to Mars would be in about 2 days rather than 80 to 333 days. A trip to Pluto in about 16 days rather than about 10 years. A constant 1g acceleration and deceleration flight path allows spacecraft entry into planetary orbits and subsequent return to Earth.

Fuel consumption for a constant 1g acceleration and deceleration flight path depends on their mass. Possible combinations follow. A 1 MW reactor with 1,000 # thrust will propel 827# for about 74 days with 1 # fusion fuel. A 15 MW reactor with 15,000 # thrust will propel 12,250 # (about the weight of the Apollo Command Module) for about 90 days with 15 # fusion fuel. A 50 MW reactor with 50,000 # thrust will propel 41,350 # (about 20 tons) for about 89 days with 50 # fusion fuel. A 300 MW reactor with 300,000 # thrust will propel 233,000 # (approximately the mass of the space shuttle) for about 95 days with 300 # fusion fuel.

The only existing alternative to chemical rocket propulsion is gravity assist and ion engines. With gravity assist, the craft must be launched within critical time periods when various planets are properly aligned. If the craft is to orbit a body, it must carry sufficient chemical propellant to decelerate into orbit. With outer Solar System bodies, the approach velocities are too high to carry sufficient fuel to enter into orbit, permitting a fast flyby with no opportunity to return.

Ion engines have been in development since the 1960's. They require very large amounts of electricity for proportionality very small amounts of thrust. NASA's X3 thruster, see below, requires 102kW of electricity, most likely by heavy thermal nuclear decay source, for only 1.2 pounds of thrust.

Heavy lift chemical rockets will get you to orbit, but are not appropriate for fast Solar System flight. A larger version of our POC reactor can be modified to produce 372 pounds of thrust with 10-20kW DC power output from waste heat using off the shelf parts for the reactor core. It is estimated to be 36" diameter, 96" long, 2-4 tons of mass for complete package. A similarly sized phase II reactor variant (having a virtual target) would produce approximately 50,000 pounds of thrust. With advanced reactors, the engine can be scaled up to very heavy lift (1 M # thrust) long running Solar System spaceflight engines impossible with chemical propulsion. Additionally, these engines do not need a high vacuum environment for operation making development simpler and cheaper and allows landing on bodies without atmospheres. Continuous running, high thrust, low specific fuel consumption engines will change all the dynamic parameters of Solar System spaceflight. Rough preliminary specification follow and as a comparison, included is information on NASA's X3 thruster. This FESH designed fusion powered neutron engine is in a state of development where it's ready to have patents applied defining the intellectual priority foundation of this new art.

NASA X3 Thruster.

36" diameter, 500 pounds of mass just for the thruster, not including 102kW power supply and accessories.
Maximum thrust 1.21 pounds or 5.4 Newtons for 1.44kW power output.
84kW drive power required per pound of thrust output.
102kW drive power for maximum thrust of 1.21 pounds or 5.4 Newtons output.
Efficiency at max power 1.41%.

FESH 372 kW Neutron Engine.

36" diameter, 96" long, 2-4 tons of mass for complete package.
Maximum thrust 372 pounds or 1395 Newtons for 372kW power output.
7.1 e^{17} neutrons per second ejection at about 10.4 MeV near the speed of light.

Fuel consumption. One pound of fuel operates for 3.84 e^{8} seconds, 1.06 e^{5} or 106,666 hours, 74.1 days.
Fuel: Presently 50% Deuterium and 50% Tritium. Research likely will make 100% Deuterium fuel possible. Neutrons will then be at about 2.45 MeV near the speed of light.

Electric drive requirements.
Less than 1 watt drive power to reactor for full output of 372kW.
Less than 1.2 e^{-2} watts drive power per pound of thrust output.
Total system power requirement at full output less than 400 watts.
Efficiency at maximum thrust greater than 93,000%. Gain due to fusion reactions.
System able to thermoelectrically generate 10-20kW DC while producing full thrust.

It's possible to make a 1,000 pound thrust unit with no more than 4 tons of mass for complete package. Above estimate was using "off the shelf" parts for the reactor shell. More advanced technologies will make the 1000 pounds of thrust seem small. Large thrust growth potential with this technology. Half a million pounds of thrust and larger are possible. Does not need a vacuum environment for operation or testing. One kW power of reactor power output equals 0.84 pounds or 4.45 Newtons of thrust. Technology ready for patent applications to establish intellectual priority in this art.