A new approach for a near-term compact, ultralight nuclear thermal propulsion engine, termed MITEE (MINiature Reactor Engine) is described. MITEE enables a wide range of new and unique planetary science missions that are not possible with chemical rockets. With U-235 nuclear fuel and hydrogen propellant the baseline MITEE engine achieves a specific impulse of ~1000 seconds, a thrust of 28,000 newtons, and a total mass of only 140 kilograms, including reactor, controls, and turbo-pump. Using higher performance nuclear fuels like U-233, engine mass can be reduced to as little as 80 kilograms. Using MITEE, V additions of 20 km/sec for missions to outer planets are possible compared to only 10 km/sec for H2/O2 engines.

The much greater V with MITEE enables much faster trips to the outer planets, e.g., 2 years to Jupiter, 3 years to Saturn, and 5 years to Pluto, without needing multiple planetary gravity assists. Moreover, MITEE can utilize in-situ resources to further extend mission V. One example of a very attractive, unique mission enabled by MITEE is the exploration of a possible subsurface ocean on Europa and the return of samples to Earth. Using MITEE, a spacecraft would land on Europa after a 2-year trip from Earth orbit and deploy a small nuclear heated probe that would melt down through its ice sheet. The probe would then convert to a submersible and travel through the ocean collecting samples. After a few months, the probe would melt its way back up to the MITEE lander, which would have replenished its hydrogen propellant by melting and electrolyzing Europa surface ice. The spacecraft would then return to Earth. Total mission time is only 5 years, starting from departure from Earth orbit. Other unique missions include Neptune and Pluto orbiter, and even a Pluto sample return.

MITEE uses the cermet Tungsten-UO2 fuel developed in the 1960’s for the 710 reactor program. The W-UO2 fuel has demonstrated capability to operate in 3000 K hydrogen for many hours - a much longer period than the ~1 hour burn time for MITEE. Using this cermet fuel, and technology available from other nuclear propulsion programs, MITEE could be developed and ready for implementation in a relatively short time, i.e., approximately 7 years. An overview description of the MITEE engine and its performance capabilities is provided.