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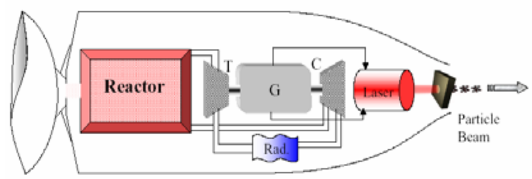
Ultrafast Laser-Driven Plasma for Space Propulsion



Laser-Accelerated Plasma Propulsion Systems (LAPPS)

Analytical and experimental investigations based on the findings of the Phase I study are proposed to accelerate the development of "LAPPS," the (ultra-fast) Laser Accelerated Plasma Propulsion System that could meet NASA's needs for space exploration in the next few decades. Preliminary examination of the underlying physics reveals that intense lasers are capable of accelerating charged particles to relativistic energies when focused on small focal spots in very thin targets. Experiments at the University of Michigan and other world-wide laboratories have demonstrated dramatically the production of nearly collimated beams of protons at mean energies of several MeV when lasers of intensities of $\geq 10^{18}$ W/cm^2, at about one micron wavelengths, are made to impinge on focal spots of several microns in radius in solid targets with few microns thickness. When viewed from the propulsion standpoint, these present-day experiments are capable of producing specific impulses that exceed million seconds albeit are very modest thrusts. If employed as propulsion devices, they can achieve interstellar fly-by robotic missions in a human's lifetime, but they fail to do manned interplanetary missions in acceptable times due to the smallness of thrust that results in a sizable imbalance with the specific impulse as required for optimum travel time. This Phase II proposal is aimed at enhancing the thrust that can be generated by LAPPS without seriously degrading the specified impulse. This can be accomplished in several ways:1) by increasing the number of particles in the beam, (2) by increasing the rep rate, and 3) by increasing the velocity of the ejected charged particles. The first approach will be tested by increasing the size of the focal spot while maintaining the same intensity; the second will be addressed by achieving kilohertz rep rates on the target side to match that on the laser side which has already been achieved; and the last by increasing the power of the laser. The current laser at the University of Michigan delivers 10 TW, but is expected to be upgraded to 100 TW and a petawatt in the time frame of this proposal so that these issues can be addressed. Jet targets, rather than solid ones, will also be investigated in order to establish their feasibility for large rep rates that match those of the laser.