BEAMED ENERGY PROPULSION:
A CRITICAL ANALYSIS USING SOLID ROCKET MOTORS

Introduction
• Chemical efficiency in launch vehicles has reached a limit (SSME ~ 96% efficient)
• Only about 4% of total vehicle mass makes it to orbit
• Advanced Concepts are required to improve payload mass fraction
• Beamed microwave energy is absorbed by alumina particles (droplets) coming from the motor
• Collisions increase the temperature, energy, and velocity of the expanding plume

Microwave System
• 529 antenna elements with a 9 m diameter would be needed to produce a nominal 1 GW at 50 km (3.13 GW produced on the ground)
• An optimized frequency of 140 GHz was used based on antenna element size, atmospheric attenuation and breakdown, and free space loss.

Experiment
• Particles were irradiated with microwave energy a 2.45 GHz to a steady state temperature and compared to results from a resistive heater
• A coupling efficiency of 57.1% was corresponding to 0.57 GW of absorbed microwave energy and a 10% increase in thrust

Computational Study
• For the purposes of this analysis the performance of a notional Castor 120 solid rocket booster was studied
• A NASA/AF model was used to show that a thrust multiplication factor of 1.4 would increase the vehicle velocity to 2.587 km/s at 50 km and increase the Isp from 280 seconds to 402 seconds

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The derived total power for the launch vehicle with respect to percent increase of thrust augmentation.

Change in velocity seen at 50 km in relation to an absolute change and a relative change velocity.