Plasma-Pulsed Power Generation (P³G)

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Introduction

• Background
• Conceptual Design
  – Power Potential
  – Propulsion Potential
• Program Progress
  – Analysis
  – Experiments
• Summary
Mission Drivers

• Low Cost, Convenient Access to Space
• Rapid, Affordable Space Travel
  – Power --- “…a critical technology…space activities.” (“Space Technology for the New Century”, National Research Council)
  – Interstellar Transport
The P³G Concept

Induction Coils
Excitation Coils
Superconducting Shell
Detonation Chamber

Expanding Plasma (Chemical or Micro-Fusion Detonation)
Compressed Magnetic Field

radial flux compression generator

magnet coil
superconducting shell
generator coil
detonation driven plasma armature

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P³G Power Potential

D-He³
50% coupling efficiency
100 Hz pulse rate

fuel consumption rate (gram/sec)

burnup fraction, \( f_b \)

10 GW
5 GW
Mission Drivers

• Interstellar Transport
  – Propulsion -
    • Pulsed Fusion Thruster
P³G Propulsion Potential

Winterberg / Daedalus
Magnetic Compression Reaction Chamber

- magnetic field
- excitation field coils
- induction generator coil
- superconductor compression wall
- structural shell
- electrical power
- detonation target
- exhaust
P³G Propulsion Potential

specific impulse, $I_{sp} = V_{eff} / g_0 \times 10^6$ (s)

burnup fraction, $f_b$

charged particles only

D-He³

D-T

D-D
Research Drivers

• Plasma Containment

• Efficient Compression of Magnetic Field
  – Minimize Magnetic Diffusion Loss to Plasma or Wall
  – Type II Superconductor
P³G Progress (Analytical)

- Magnetic diffusivity ($m^2/s$)
- Magnetic diffusion time constant ($s$)

Superconductor Tube
- $d_i = 1.6$ cm
- $d_0 = 3.0$ cm

- Flux creep
- Flux flow

- Copper
- Brass
- Stainless steel

- Anticipated range
- Range for typical type-II superconductor

- (3 s)
- (50 ms)
P³G Progress (Experimental)

Test Cylinders:
- superconductor
- stainless steel
- aluminum
- copper
Summary

• P³G Addresses NASA Mission Interests
• P³G has:
  – High Power Potential
  – Possible Propulsion Applications
• P³G Analysis Shows:
  – Power Promise
• P³G Experiments Continuing
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