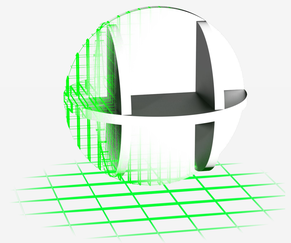
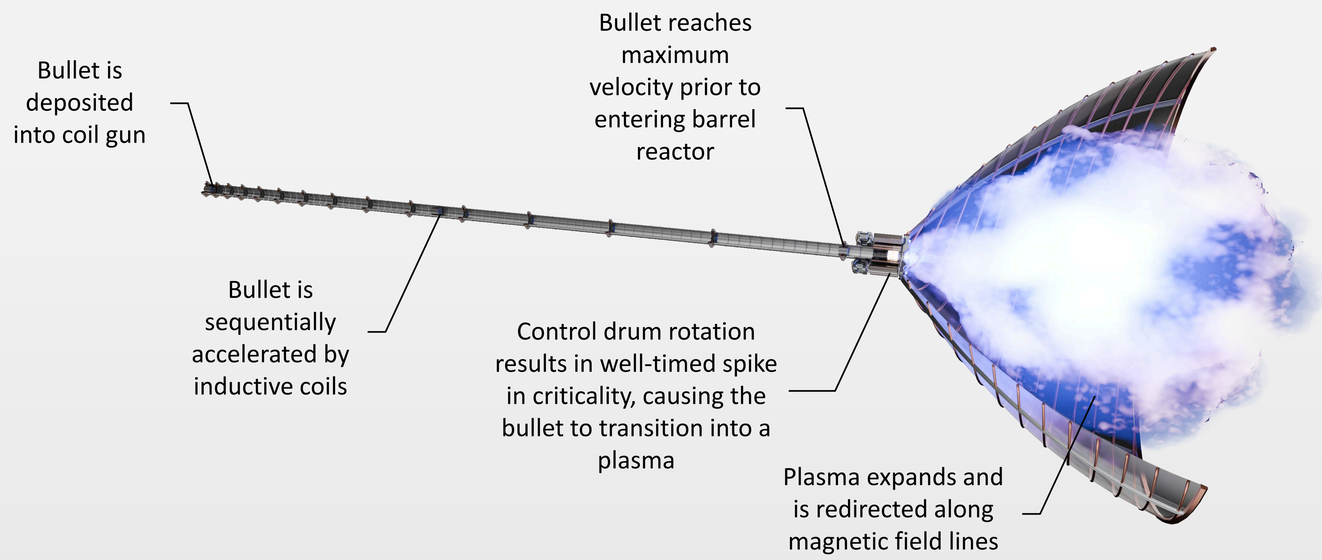
Pulsed Plasma Rocket (PPR): *Shielded, Fast Transit for Humans to Mars*

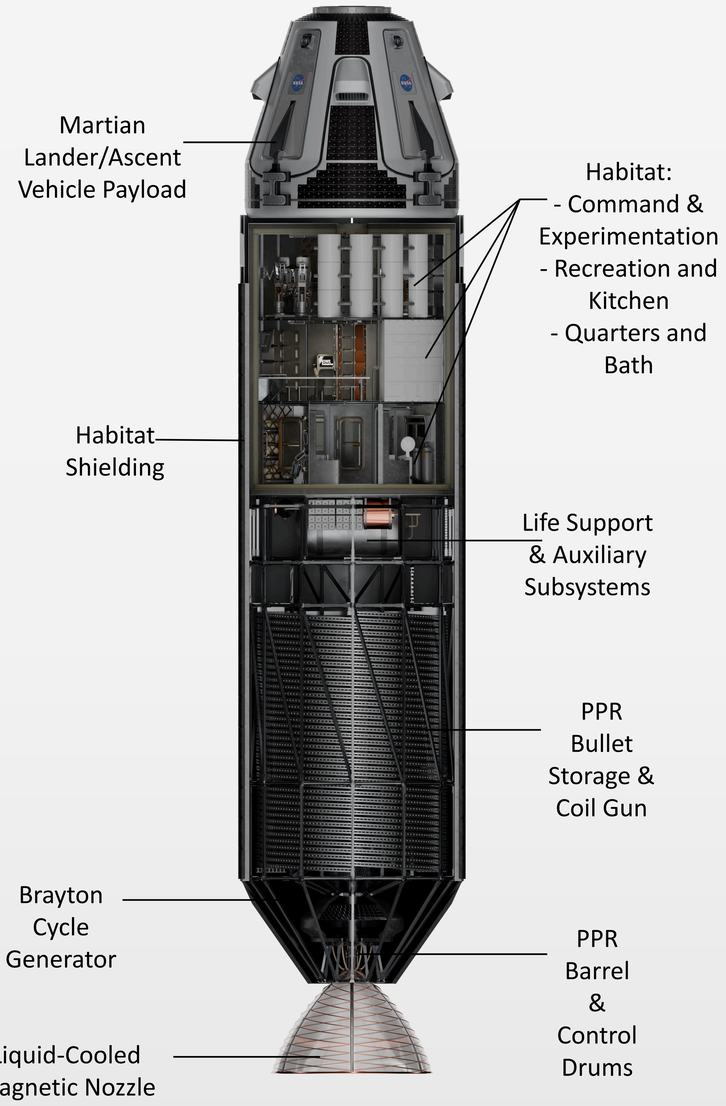
PI: Dr. Troy Howe, Dr. Steven Howe, Brianna Clements, Soyasha Pandey, Matisse De Roo, Nathan Blaylock, Hayden Rheinfielder
Howe Industries LLC
Troy@howeindustries.net, (480) 478-8799
www.howeindustries.net



PPR Concept

- Can be used for **any mission** requiring transit from Low Earth Orbit (LEO) to any destination in the Solar System
- Delivers **100,000 Newtons of thrust** with an **ISP of 5,000 seconds**
- Builds on the Orion thermonuclear propulsion concept and the Pulsed Fission Fusion (PuFF) NIAC Phase II headed by Dr. Rob Adams
- PPR uses a **fissile mass** injected into a transient critical assembly to generate a high-temperature plasma for propulsion
- Barrel/bullet configuration is a hybrid thermal-fast reactor for power concentration
    - **Barrel**: A subcritical High-Assay Low-Enriched Uranium (HALEU) assembly with a small High-Enriched Uranium (HEU) ring, functioning as a fast reactor
    - **Bullet**: Comprised of HALEU/ice material encased in a conductive iron shell, acting as a moderated reactor
- **Criticality control** is achieved with **control drums** and **fissionable material** in the projectile, maintaining criticality above **keff = 1** when the bullet is in the barrel

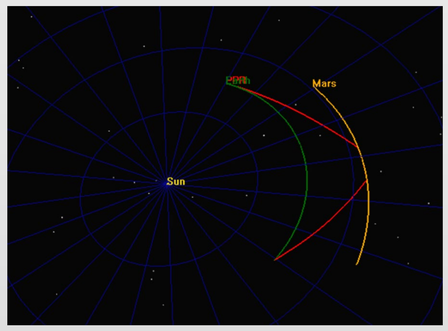


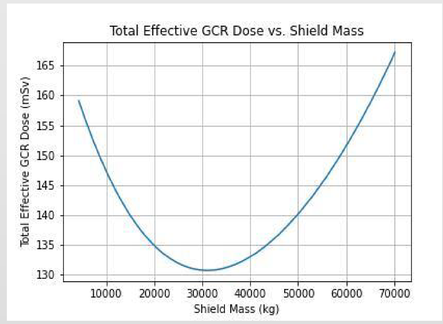


Key Phase 2 Developments

PPR Mission

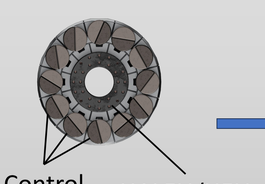
- Transports **200 metric tons** to Mars and back in **120-160 days**
    - Includes 20-day stay on Mars
- Protects astronauts from GCRs and limits exposure to ~ 116.54 mSv – 155.39 mSv using polyethylene shielding (NASA's Total Career Radiation Limit is 600mSv)
- Has dV budget of 39km/s to perform novel trajectory and minimize transit time

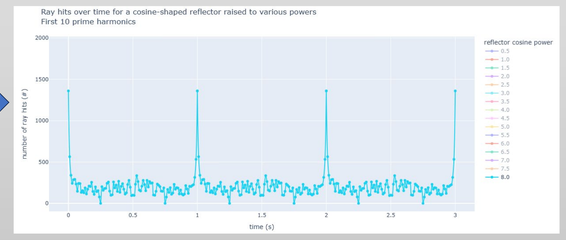




Control Drums

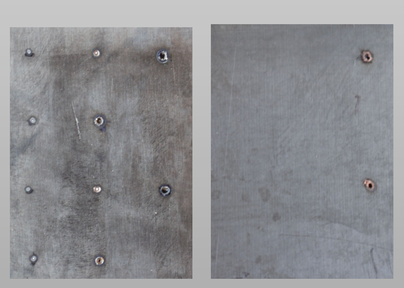
- Control drum system shown to produce exceptional criticality control
- Physical system demonstrated using light reflecting off drums back to a PV cell
- Test article used to validate computational models, then extrapolated for PPR control
- Spinning drum concept may provide extremely high fidelity controls for nuclear systems, including nuclear thermal rockets or power reactors



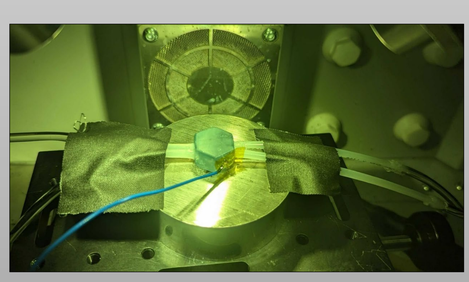


Photonic Shielding

- Tungsten shield was penetrated at 250W/mm2 intensity after 30s
- Translucent shield survived for 5 minutes under 500W/mm2 intensity
- Using a cooled translucent material to protect against intense light may provide increased lifetimes and better performance



Front Back



Key Terms/Phrases: Pulsed Plasma Rocket (PPR), Nuclear Propulsion, Plasma Propulsion, Manned Mission to Mars