Air-Breathing Magnetoplasmadynamic (MPD) Thrusters

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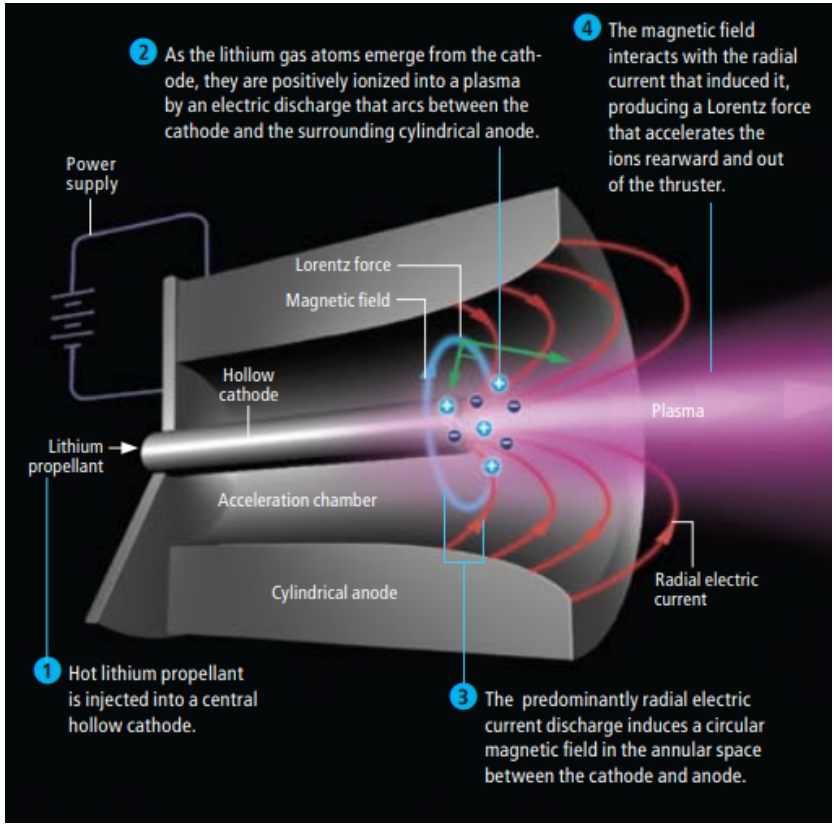
Background

- An MPD thruster takes advantage of plasma's properties as an ionized gas as well as the process used to ionize it to produce thrust.
- As gas flows through a sufficiently powerful electric field, it becomes ionized.
- This electric field drives a current through the plasma which induces an azimuthal magnetic field.
- The magnetic field produces a Lorentz force on the ionized gas, shooting it out of the thruster.

Background



Choueiri, Edgar.
"New Dawn for Electric Rockets."
Scientific American, 2009.

Background

Advantages of an MPD thruster:

- Can utilize more electric power than other means of electric propulsion
- Electricity is easier to store and lighter than chemical fuel
  - While chemical fuel is still necessary to escape Earth's gravity, electric propulsion is significantly more efficient in most other scenarios
- When the current is pulsed, exhaust speed and thrust are more easily adjusted

Air-Breathing MPD Thrusters

- Problem: Low-Earth orbit satellit
- Solution: Use the atmosphere as
  - Air (mostly N_2) would be collected this project
  - Would then be ionized utilizing an

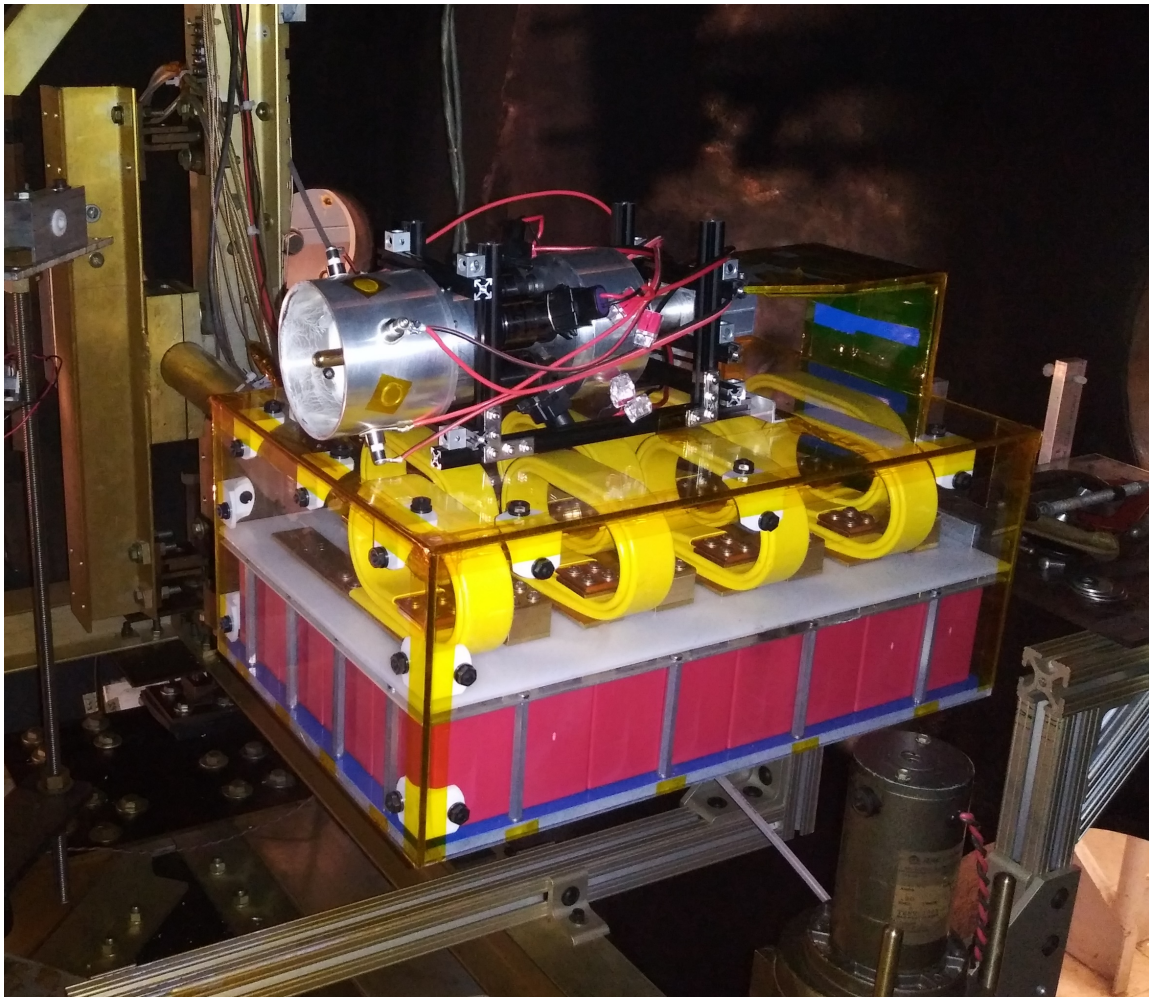
Air as Fuel

- Advantages:
  - Plentiful – fuel is not a limiting factor
  - Makes the satellite lighter
  - Does not need to refuel conventionally
- Disadvantages:
  - Nitrogen is inefficient to ionize
  - More than likely would not be used in a different context

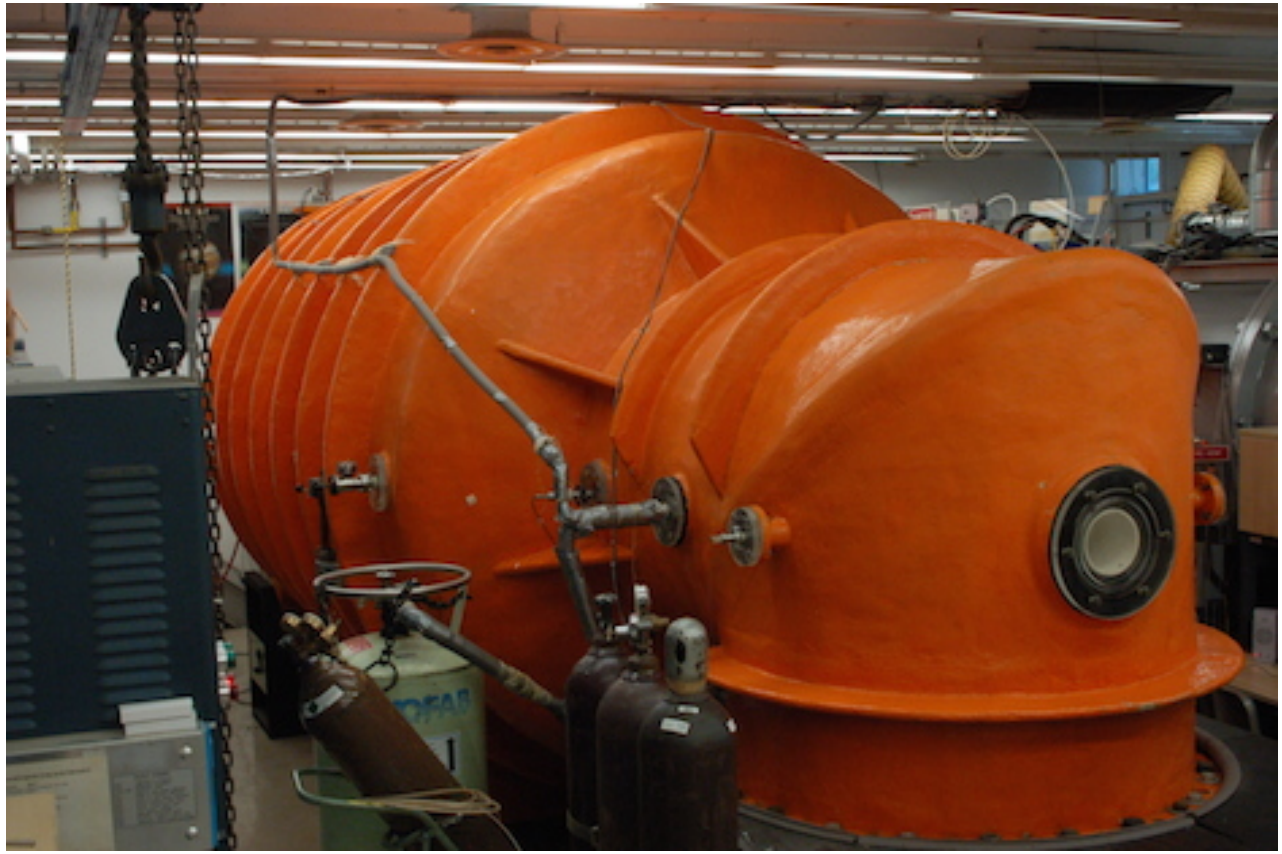
Setup

- Similar setup to that shown previously, except with a central anode and fuel being released through the gap
- Igniters initially ionize the gas
- A pulse-forming network (PFN) – an array of inductors and capacitors – sustains the plasma for a short period of time
- This thruster is placed atop a thrust stand that is allowed to move freely
- An LVDT measures the displacement of the thrust stand

Setup



Setup



Results

- The impulse produced by the PFN-sustained plasma is clearly much higher than that of cold nitrogen gas
- There is clearly a relationship between voltage supplied and resultant impulse