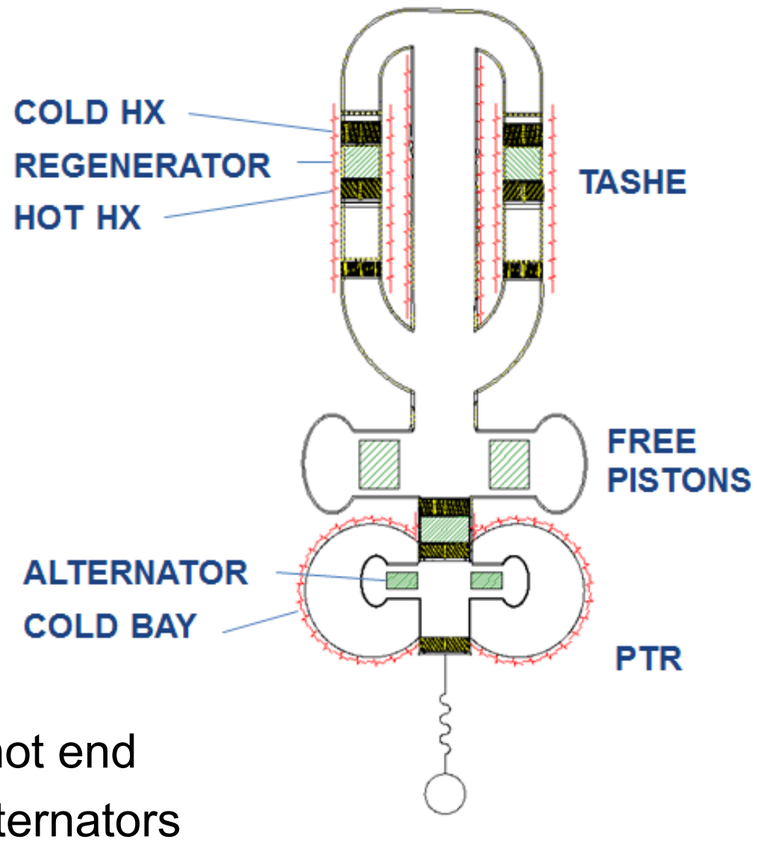
Venus Thermoacoustic Duplex

Cooling and Powering Long-Lived Venus Lander Instrumentation

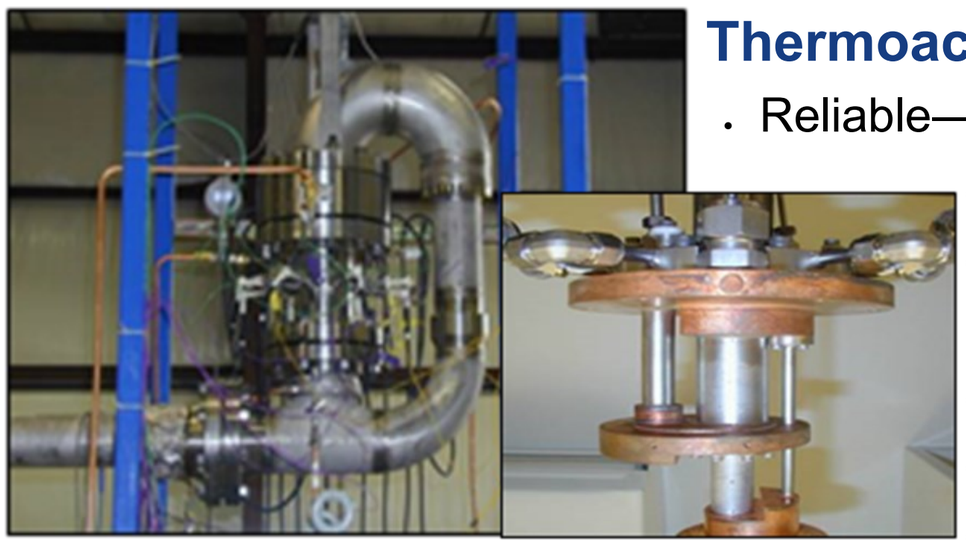
Thermoacoustic Duplex Concept

- Thermoacoustic Stirling Heat Engine (TASHE) generates acoustic power
- TASHE uses heat from General Purpose Heat Source (GPHS) modules
- Free-Piston Resonators tune thermoacoustic oscillations
- Pulse Tube Refrigerator (PTR) converts acoustic power to cooling power
- PTR cools the cold bay for science instrumentation and electronics
- Linear alternators, located in the cold bay, produce electrical power



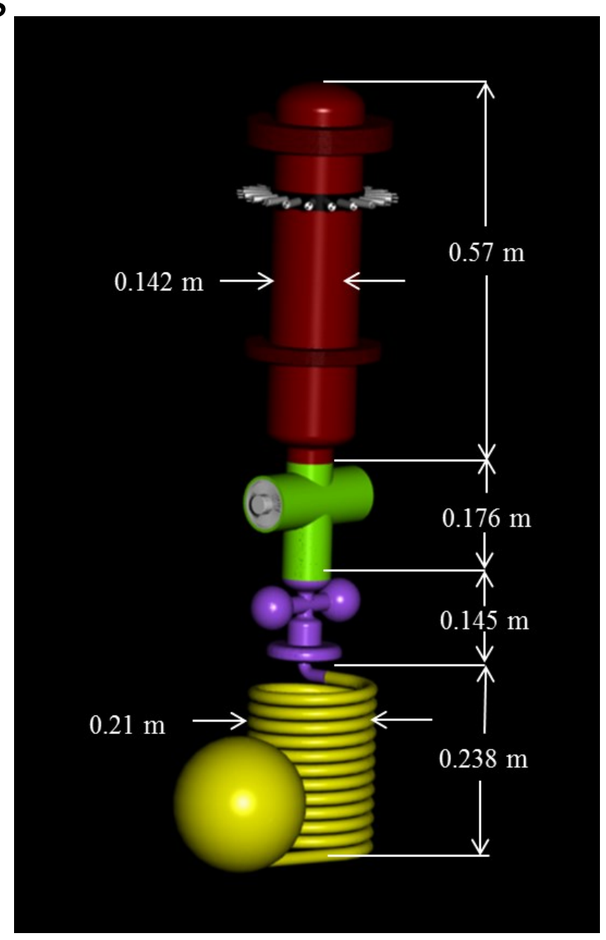
Thermoacoustic Duplex Advantages

- Reliable—contains no moving parts in the hot end
- Low vibration—dual opposed alternators
- Uses CO_2 from Venus atmosphere as the working fluid to reduce spacecraft mass
- High Efficiency
  - TASHE: 23% (48% Carnot)
  - PTR + Alternators: 24% of Ideal



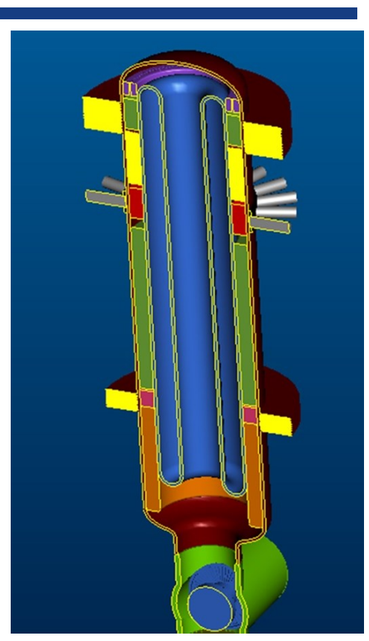
TASHE

PTR

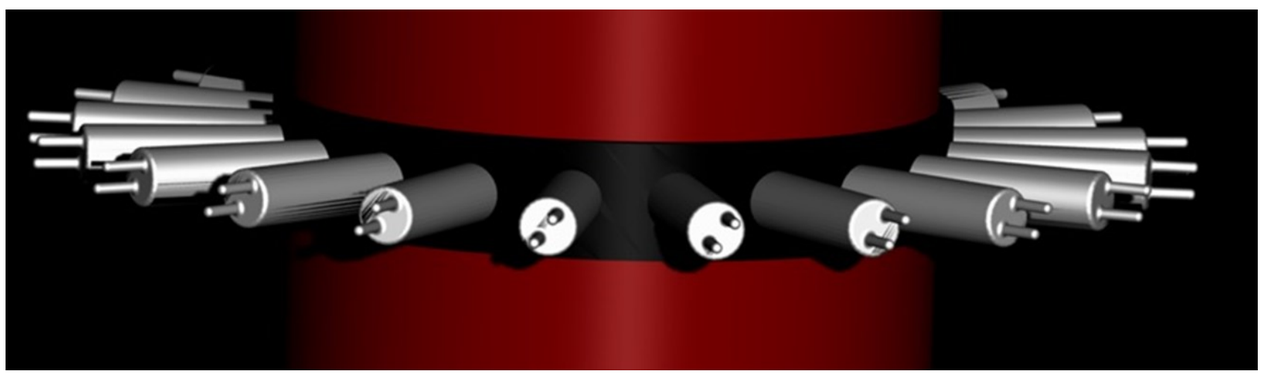


Venus Duplex Design

- 500°C, 92 bar CO_2 ambient conditions
- 1200°C TASHE hot heat exchanger temperature
- 77°C cold bay temperature
- 152 Watts cooling power
- 20 Watts electrical power



Electrical Heaters Simulating GPHS Modules



Similitude Duplex System

- Allows testing near Earth ambient temperatures
- Reduces development risk of near-critical-temperature PTR
- Validates thermoacoustic models
- Uses N_2 as the working fluid
- 27°C, 42 bar N_2 ambient conditions
- 395°C TASHE hot heat exchanger temperature
- -130°C cold bay temperature
- Powers scale by about 0.4
- Size scaling is approximately 1:1

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