Progress Towards the Development of a Long-Lived Venus Lander Duplex System

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Stirling Triad of Enabled Missions Overview

- ASRG
- ASD
- FSP

Radiator, Heat Pipe, Heat Source, Stirling Convertor, Two-Stage Cooler, Pressure Vessel, Radiator Fin, Gas Valve, Stirling, 2X Pressure Relief, Spacecraft Interface, 4X, Heat Source, 2X Insulation, 2X, Radiator Drive Motors (4), Main Radiator Wings (2), in stowed Configuration, Radiator Pumps (4), Stirling, 4X Reactor Control Drum Drive Motors (6), Cavity Radiators (6), Gas Valve, Spacecraft Interface, 4X, Radiator, Supports, Motors, Pumps, Reactor Pumps, Motors, 6X, Plug Shield, Reactor

GRC COMPASS REP Study

ASRG

Stirling Systems

ASD

FSP
Schedule, Cost, and Milestones

- 2009: ProjectBegan Dec. 3
- 2010:
  - SpacecraftStudy
  - Thermophoto-voltaicStudy
  - ChamberDesign
  - CoolerConcept
  - Controller
- 2011:
  - PowerPrototype
  - ChamberPrototype
- 2012:
  - HighPowerTASHE
  - FreeDisplacer
  - ChamberFabrication
  - StirlingCooler
  - Pulse-tubeCooler
- 2013:
  - Duplex
  - ChamberPhaseII
- 2014:
  - LanderIntegration
  - SystemTest
- 2015:
  - TRL 6
  - LanderDemo
  - DeliverDuplexTRL 6
Venus Mission Testing Facilities

Phase III: >10’ x >10’ Mission Testing
Phase II: 7’ x 7’ Lander Testing
Phase I: 3’ x 4’ Prototype Testing

30% Design Review Completed

All mission phases can be tested once proposed facility is completed. Note some small facilities currently exist at some universities and Goddard.

<table>
<thead>
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<th>Location</th>
<th>Size (in.)</th>
<th>Pressure (bar)</th>
<th>Temp. (°C)</th>
<th>Gas</th>
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<td>343</td>
<td>Variable</td>
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<td>Goddard</td>
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<td>500</td>
<td>CO₂</td>
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<td>M.I.T.</td>
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<td>200</td>
<td>700</td>
<td>CO₂</td>
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Concluding Technical Challenges

To combine a Stirling heat engine and refrigerator into a long-lived duplex machine with at least two cooling stages.

To achieve a high thermodynamic efficiency that will keep the GPHS module requirements manageable.

To create a complete system design with the multi-stage refrigerator integrated into the Venus platform.

To mitigate potential electromagnetic or mechanical vibration effects.

Long-lived Venus Lander mission is possible with Stirling duplex technology.