Extreme Environments Capabilities at Glenn Research Center

Venus and Beyond

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Extreme Environments Capabilities at Glenn Research Center

_Venus and Beyond_

1. Venus atmospheric and surface investigations
   - A (brief) introduction to GEER
   - GEER status
   - Upgrades in progress

2. Other extreme environments capabilities
Venus in a Bottle:
The Glenn Extreme Environment Rig (GEER)

Two facilities combined:

A. 10 ton pressure vessel
   • Certified to 100 bar at 500° C
   • Corrosion resistant 304 SS
   • Many user ports
   • ~ 1 m$^3$ volume

B. Programmable gas bank
   • Configurable via visual interface
   • Controlled to PPM (or better)
   • 9 independent gas streams
GEER simulates atmospheres

Current capability

- Temperature: ambient to 500 degree C
- Virtually any chemistry – accurately
- Large physical size (3’ dia. x 4’ long inside)
- Pressure: .001 to 100 bar
- Indefinite duration

Science, technology and/or mission applications

Venus (environment and chemistry – surface to above clouds)
Saturn, Jupiter, Uranus, moons (chemistry and temp / pressure within rig limits)
Exoplanets – Chemistry for science and model inputs

Venus Flagship STDT Report
NRC 2013 Planetary Decadal Survey
Super-Earth exoplanet GJ 1214b (Image from ESA VLT)

Direct applications for ROSES science, instrument and technology development, Discovery, New Frontiers, and Flagship missions
Recent Accomplishments

- Over 90 days of operation at Venus surface conditions
- Extensive catalog of performance of engineering materials created
- Geological science investigation for atmosphere-surface interaction
- Successful operation of data feedthroughs
- Initial journal publications in preparation
New Capabilities and Upgrades in Progress

- General purpose interior probe
- Optical window
- Co-located mass spectrometer
- In-line gas chromatograph
- In-line FTIR
- Improved thermal control
- More precise control over gas injection
GEER available for users

• Science and engineering investigations
• GEER team will work with users to meet schedule and technical requirements and provide cost estimates
• Customization of vessel will require proposal-supplied funds
• All test runs are coordinated to maximize science and technical return
  – Can support several experiments at the same time
GEER available for users

- Customer interface document being finalized
- Website: [https://geer.grc.nasa.gov/](https://geer.grc.nasa.gov/)
- Primary contact is Dan Vento at: daniel.m.vento@nasa.gov

Currently seeking volunteers for science advisory board
contact Jeff Balcerski (jeffrey.balcerski@nasa.gov)
Extreme Environments at Glenn Research Center

Out of the Frying Pan… And Into the Freezer

Cryogenics Facilities at GRC

- Maintain $1 \times 10^{-6}$ torr
- Liquid He, H$_2$, N$_2$, Ar, O$_2$, CH$_4$
- Can accommodate a 1.1 x 1.6 m test article
- Ascent profiling: 760 to $1 \times 10^{-2}$ torr in 2 min.
- Programmable thermal shroud: 100 to 390 K to simulate diurnal cycles
- Can emulate conditions of Titan’s lakes
Cryogenics Facilities at GRC

Numerous pressure vessels ranging from 0.2 ft³ (0.006 m³) to 58 ft³ (1.6 m³) with pressures up to 500 psi (34.5 bar)

• Primary contact is Lori Arnett at: lori.arnett@nasa.gov
Backup Slides
Glenn Extreme Environment Rig (GEER) Specs

- 304SS vessel - 3’ dia x 4’ long inside dimensions (28.3 ft³ or .8 m³)
- Max conditions pressure 103 bar at 500 degree C
- Eight ports - including a couple at opposing ends
- Nine separate gas streams
  - Each of these can handle pure or mixed gases
  - Ppm accuracy or better
- Re-boost pumping system
- Supporting infrastructure sized to handle multiple or a much larger chamber if ever needed
- Currently verify chemistry through mass spectroscopy (regular sample)

Tested with predicted chemistry near Venus surface

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<th>Gas</th>
<th>Moles</th>
<th>Grams</th>
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<td>H₂O</td>
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</tbody>
</table>

Operating Details

- Temperature ramp rate 7 degree C /hour
- Average temperature controlled to 1 degree C
- Pressure can be boosted
- Large volume may offer opportunity to explore stratification