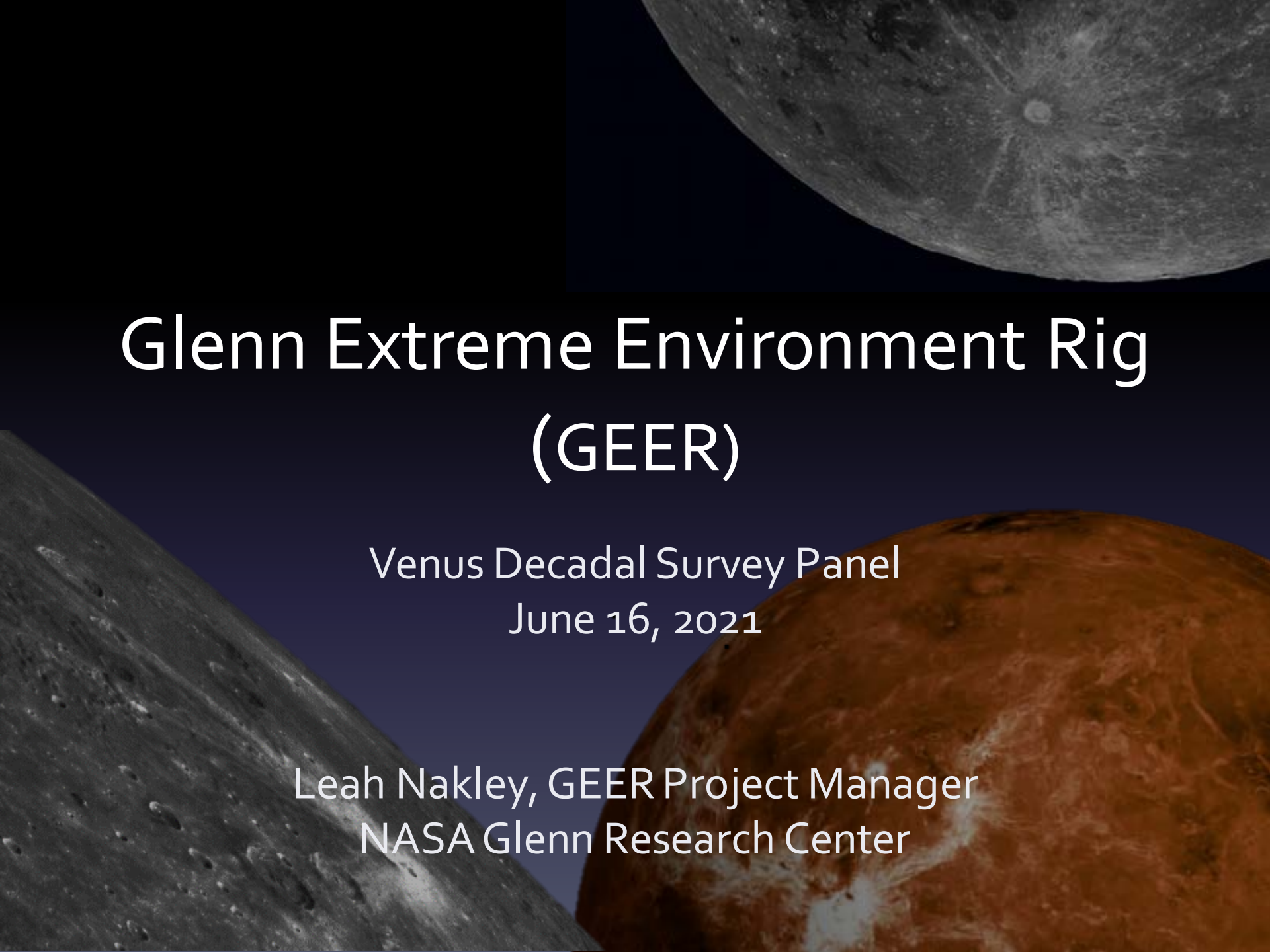


Glenn Extreme Environment Rig (GEER)

Venus Decadal Survey Panel
June 16, 2021

Leah Nakley, GEER Project Manager
NASA Glenn Research Center

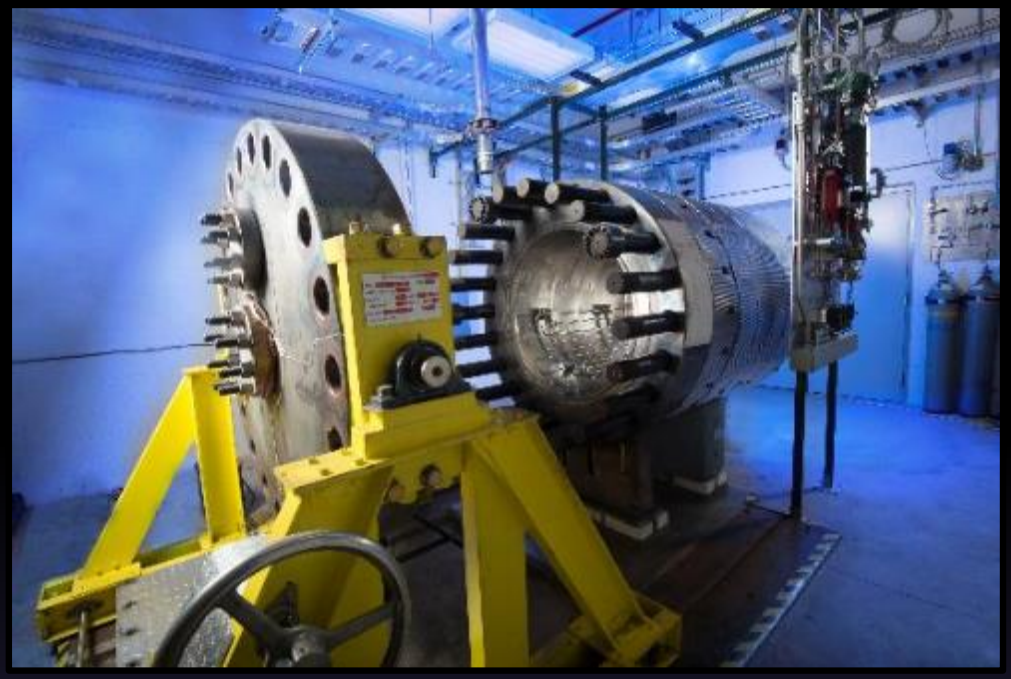
Agenda

- What is GEER?
- Benefits and Applications
- Accomplishments
- Future Plans
- Decadal Survey Final Report
- Questions

What is GEER?

- GEER is the world's most capable facility for simulating extreme and complex planetary conditions in our solar system
  - Most notably Venus
    - Temperature, pressure, gas chemistry lower and upper atmosphere
  - Also used for Jupiter
    - High temperature water vapor and CO_2 experiments
  - Can be used for Mercury
    - Electronics technologies would benefit daytime surface exploration
  - Future possibilities include certain conditions found on Mars, Titan, Europa, and more
- Supports NASA missions
- Critical facility for studying surface mineralogy, atmospheric physics, and atmospheric and surface interactions
- Available to government, academia, and industry

https://www1.grc.nasa.gov/space/geer/



Pressure Vessel

- 3’ x 4’ long
- 811 L internal volume
- Adjustable support stand up to 200lbs

Gas Mixing System

- Up to 9 independent gas streams
  - ppb blend accuracy
- High pressure liquid injection
- Booster pump for maintaining or adjusting gas chemistry throughout test

Analytics

- MicroGC for real-time gas analysis
- Mass Spectrometer
- Gas calibration system

Also Offers

- High temperature electrical feedthroughs for active test articles
- Long duration testing
- Experienced staff for complex and custom experiments

Benefits and Applications

Benefits

- Can accommodate large test hardware and large quantities of samples in a single experiment
  - Integrated testing
- Electrical feedthroughs for active test articles
- Provide and maintain the full Venus surface chemistry
- Ability to adjust conditions and simulate altitude transitions
- Can be reconfigured to simulate other planets/atmospheres

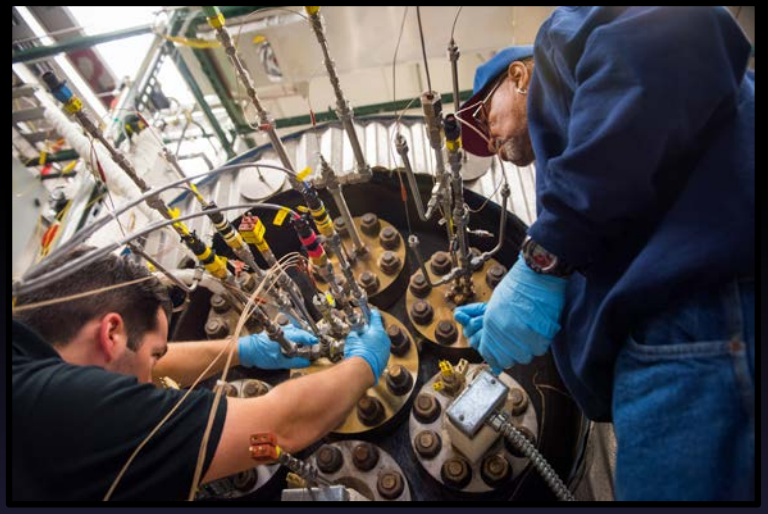
Applications

- Mission risk reduction through ground-based testing
- Planetary research
  - Geology, atmospheric physics, modeling
- Geochemistry/petrological database development
- Material testing and compatibility
- Technology development and demonstration
- Qualification/environmental testing
  - Landers, probes, flight hardware

Accomplishments

Venus weathering of geological samples

- 40 day test and 80 day test



Deep Venus atmosphere investigation

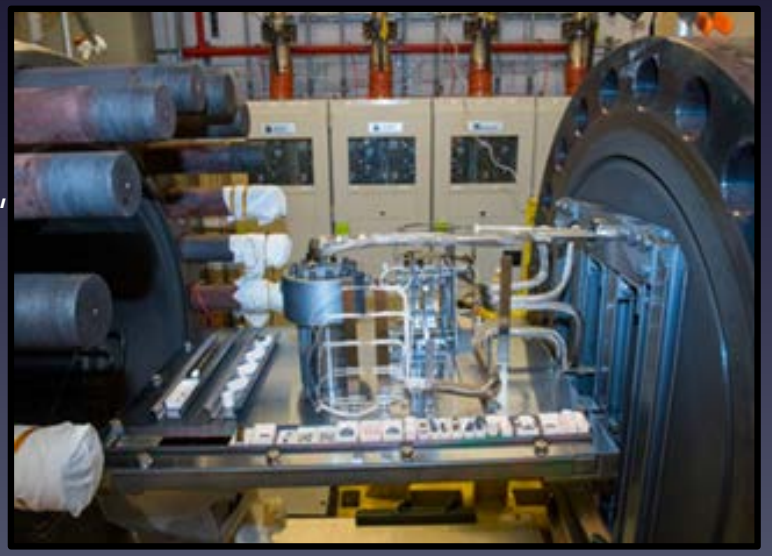
- Stratification of N_2/CO_2
- Various mix

Materials for Venus surface Missions

- Over 20 publications to date
- Structural, electrical, coatings

High temperature SiC electronics & sensors for extreme environments

- 2018 R&D 100 Award: Durable Integrated Circuit (IC) Chips for Extreme Environments
- Led to a complete suite of building blocks needed for a 60-day lander (LLISSE), including electronics, batteries, sensors, and communications technology



Long-Life In-Situ Solar System Explorer (LLISSE)

- Maturation of LLISSE components to TRL 5
- Functionality test with subsystems

Future Plans

- Continue to engage with science community
  - VEXAG, LPSC, and other conferences
  - GEER Science Advisory Council
- Continue to support collaborative research
  - NASA Research Opportunities in Space and Earth Science (ROSES)
  - Established Program to Stimulate Competitive Research (EPSCoR) Rapid Response Research (R3)
- Enhance analytics
  - Mass spectrometer
  - In-situ chemical sensors
- Development of thermodynamic models for Venus
- Simulate other planets/extreme environments
- Expand capabilities
  - miniGEER – available soon!
  - Other needs of the science community

miniGEER

Coming Soon!

miniGEER is a smaller pressure vessel designed for short duration experiments

Size: 4L
Temp: 500 C
Pressure: 1500 psi

Advantages
- Quick turnaround
- Cost effective

Capabilities
- Passive samples
- Tri-gas mix of CO_2, N_2, SO_2
- Gas analysis with GC and MS

Mini Version of Extreme Environments Chamber Extends Planetary Science | NASA

Decadal Survey Final Report

- Weigh in on the importance of this unique facility and maintaining its availability to the science community at large
- Recommend facility enhancements or new capabilities GEER should consider
  - The importance (or not) of adding the capability to simulate mid-atmospheric Venus conditions (i.e. clouds and aerosols)
- Prioritization of science vs. technology investigations


Questions