# Venus Environmental Test Facility Capability List

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March 9, 2012

# Selection Criteria

- Previous Venus missions were primarily tested in only a Nitrogen environment notwithstanding Goddard's $CO_2$ instrumentation test rig (circa 1974). Future missions will be tested with Venus in-situ chemical species composition, temperatures, and pressures to some level of fidelity at various altitudes.
- The following matrix only includes such in-situ test facilities that support a Venus atmosphere:

| Location | Volume ($ft^3$) | Dimensions (ft by ft) | Pressure (bar) | Temperature (°C) | Species | Notes | Public/ROSES Availability |
|---|---|---|---|---|---|---|---|
| NASA JPL | 0.0009 | .049 by .49 | 1 to 1000 | 20 to 1000 | $CO_2$, $N_2$, $SO_2$ | Accelerated Weathering | Yes |
| MIT | 0.001 | 0.04 by 1 | 1 to 200 | 20 to 700 | $CO_2$ | Pressure or temperature | No |
| LANL | 0.005 | 0.04 by 1 | 1 to 10,000 | 20 to 150 | $CO_2$ | LIBS/RAMAN | No |
| Univ. of Wisconsin | 0.008 | 0.05 by 1 | 1 to 270 | 20 to 650 | $CO_2$ | DOE Reactor Corrosion | No |
| MIT | 0.02 | 0.08 by 4 | 1 to 200 | 20 to 700 | $CO_2$ | Pressure or temperature | No |
| NASA GSFC | 0.13 | 0.41 by 1 | 1 to 95.6 | 20 to 500 | $CO_2$, $N_2$, $SO_2$ | Materials | Yes |
| NASA JPL | 0.45 | 0.33 by 5.25 | 1 to103 | 20 to 500 | $CO_2$, $N_2$,$H_20$, $SO_2$, CO, He, Ne, Ar | RLVT, Optical Access | Yes |
| NASA JPL | 0.5 | .59 by 1.83 | 1 to 103 | 20 to 500 | $CO_2$, $N_2$,$H_20$, $SO_2$, CO, He, Ne, Ar | VMTF, Materials and Small Systems | Yes |
| Georgia Inst of Technology | 1.05 | 1.16 by 1 | 1 to 100 | 20 to 343 | $CO_2$, $N_2$ | Higher altitude only | No |
| NASA Glenn | 5.30 | 1.5 by 3 | 1 to 100 | 20 to 500 | $CO_2$, $N_2$, $SO_2$ | Any altitude, Under Construction | Yes (Fall 2012) |
| NASA Glenn | 28.3 | 3 by 4 | $10^{-3}$ to 103 | 20 to 537 | $CO_2$, $N_2$, $SO_2$, Ar, $H_2O$, CO, He, Ne, OCS, HCl, HF | Any altitude, Optical Access, Under Construction | Yes (Fall 2012) |

# Additional Venus Related Facilities

- Atmospheric entry arc jet facilities are being modified to include $CO_2$ at NASA JSC and Ames to support Mars and potentially Venus thermal ablation testing
- ESA also has entry simulation facilities
- Other facilities exist that simulate viscosity, temperature, and pressure but not in a Venus atmosphere.

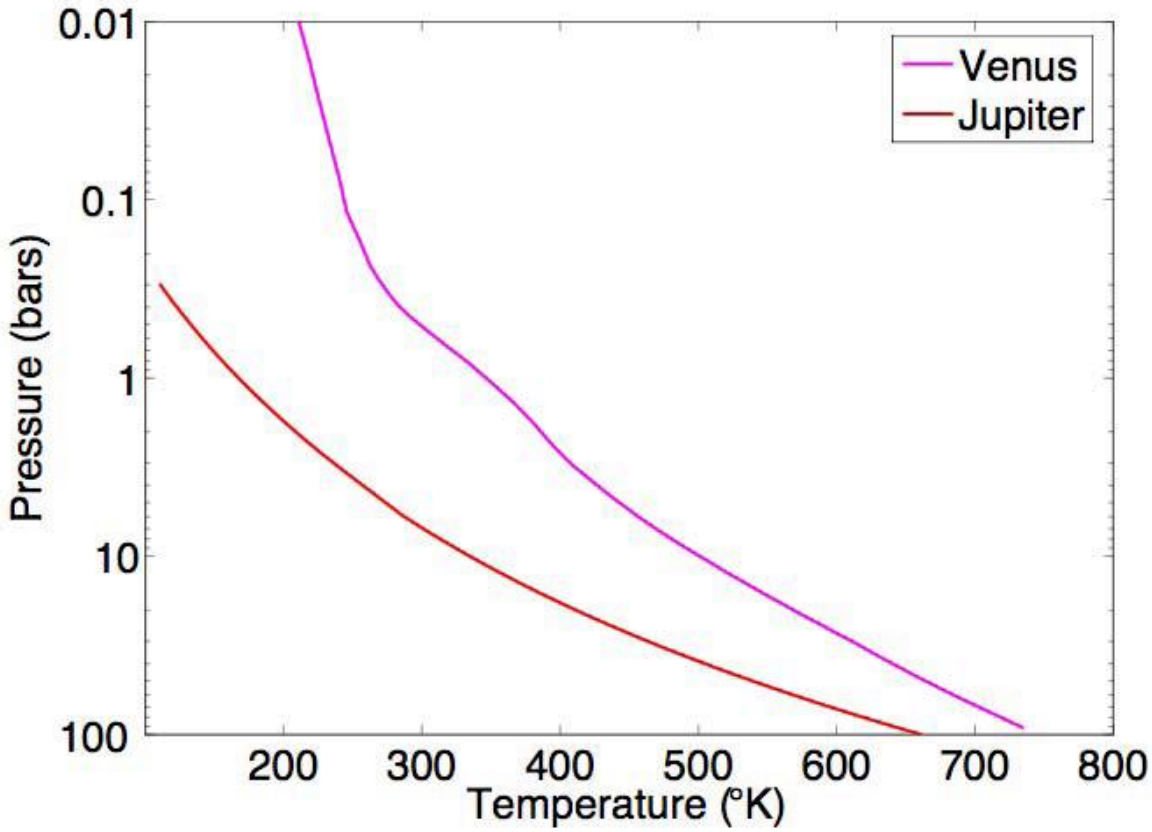
# International

- Proposed University College London, Mullard Space Science Laboratory, Ward & Muller
- VENERA-D needs one (Vega version fell in disrepair), proposing partnering with China
- No other facility known

# Capability Gaps

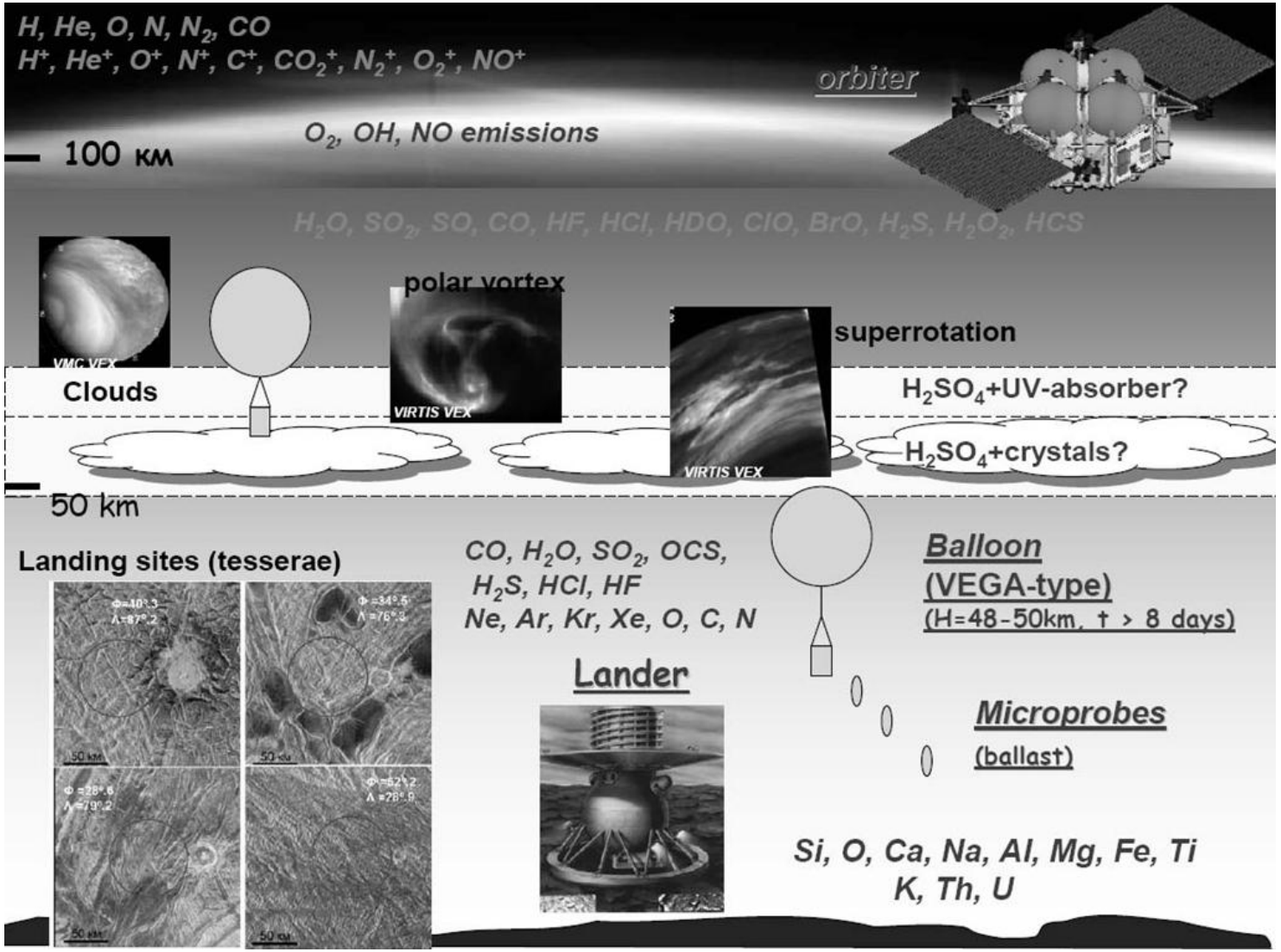
- High speed atmospheric wind and aeolian dust entrapment at surface (limited to 30 bar, 30°C at Ames)
- Vehicles larger than 3’ diameter by 4’ length
- Time-accurate Entry, Descent, Landing
- Cosmic radiation effects (i.e. lightning or other anomalies)
- Full atmospheric entry heating/velocity conditions

# Time Accurate Entry Conditions




Ref. Bryan M. Karpowicz*, Paul G. Steffes+, and Thomas R. Hanley+

# Atmospheric and Dust Composition



# Background Slides

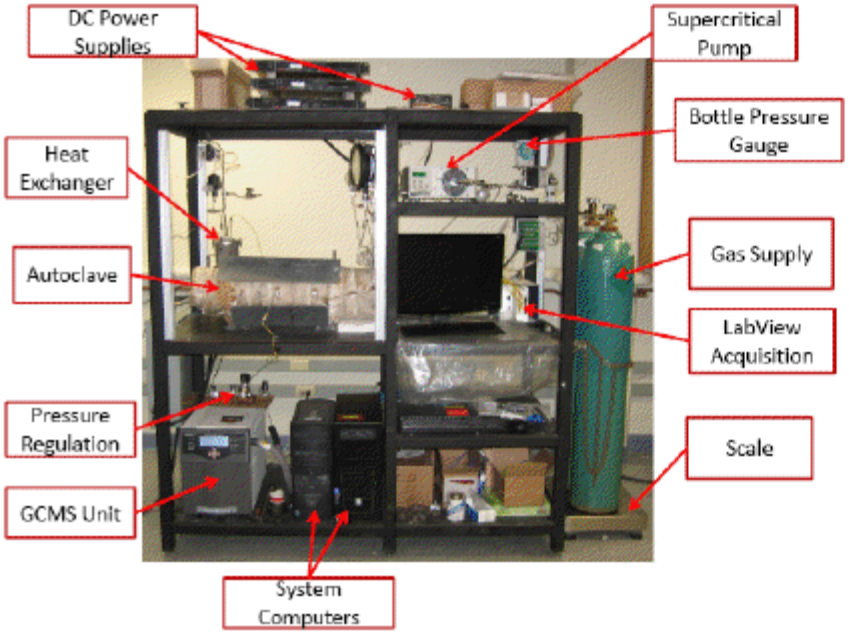
# MIT

.04 ft by 1 ft

.08 ft by 4 ft

# University of Wisconsin

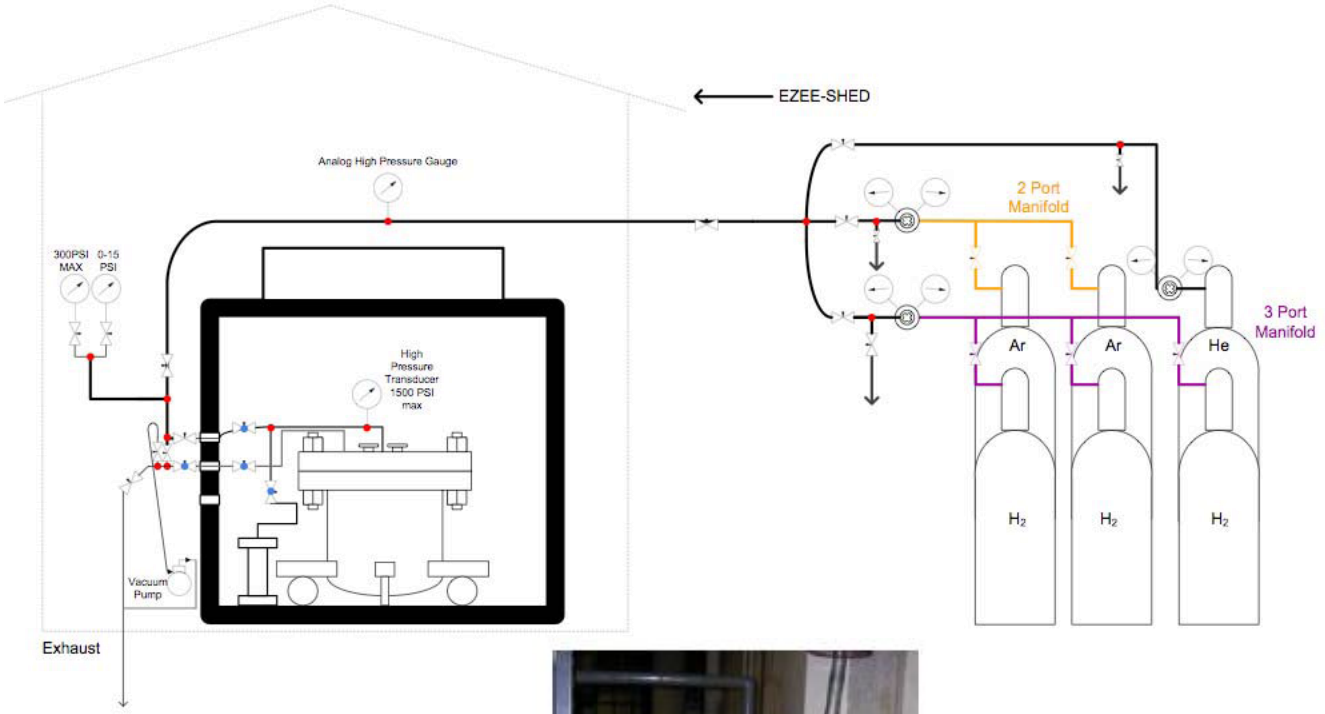
- DoE-NEUP project for Nuclear Reactor



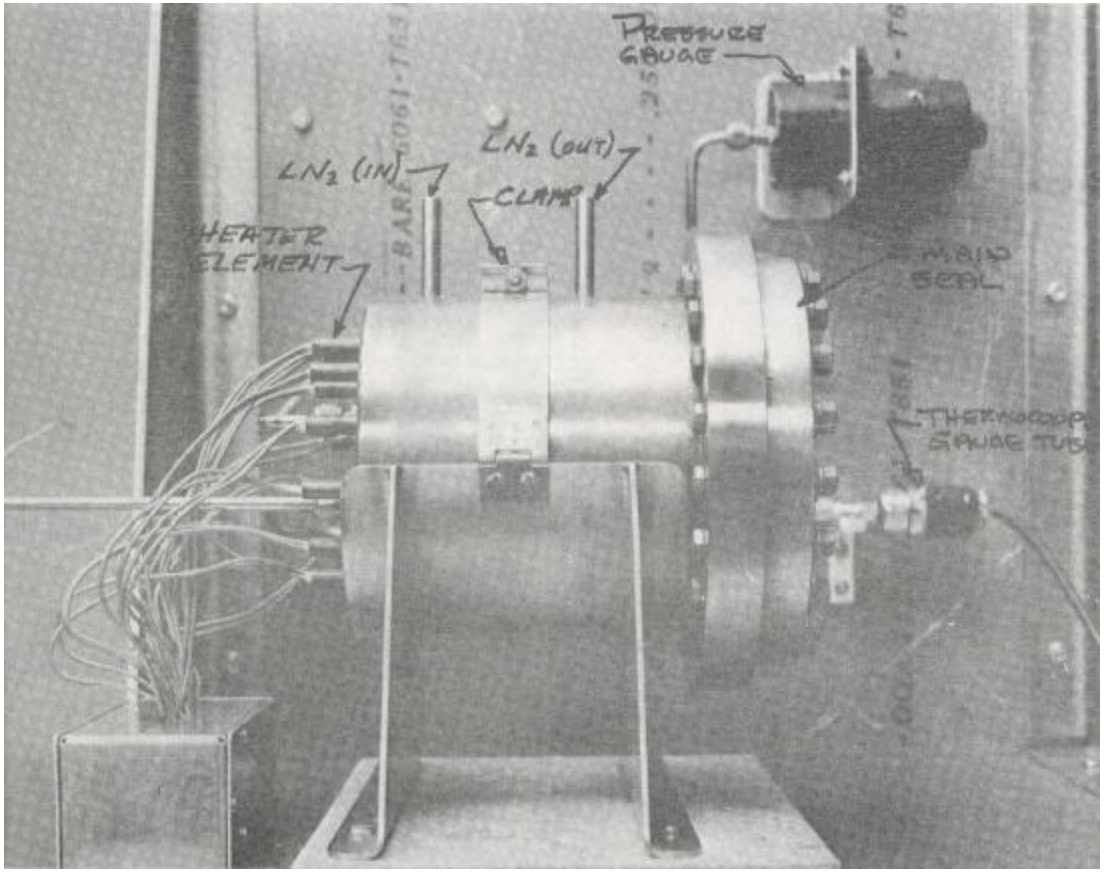

- Constant temperature within 1°
- Constant Pressure within 2%
- Flow rate ~ 2 grams/min

**IN 625 Sample Holder:**
Alumina for avoiding galvanic corrosion

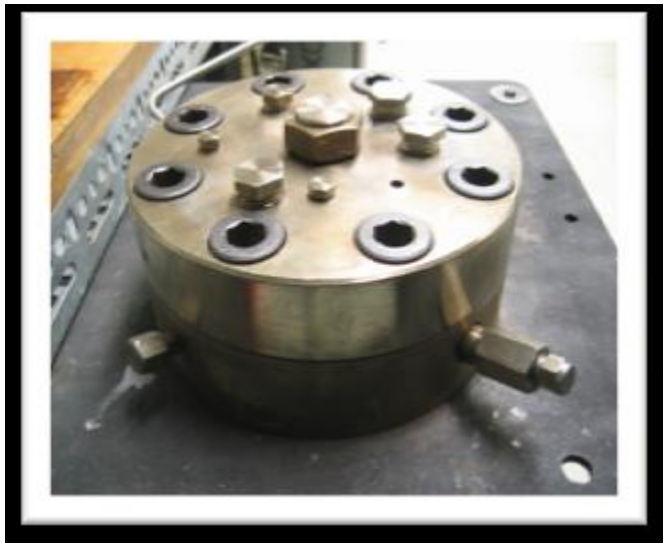
# Georgia Tech




# Goddard



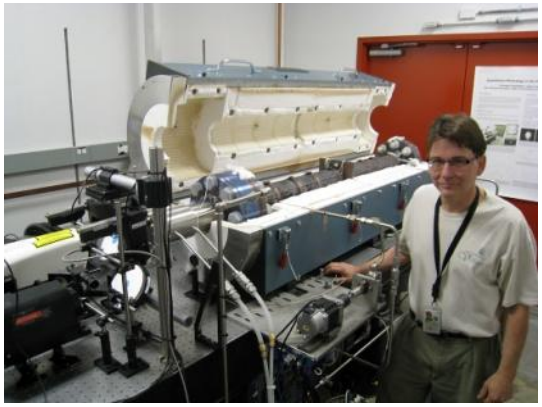

Ref. Cridlin and Munford, CO2, Time Accurate for Pioneer-Venus



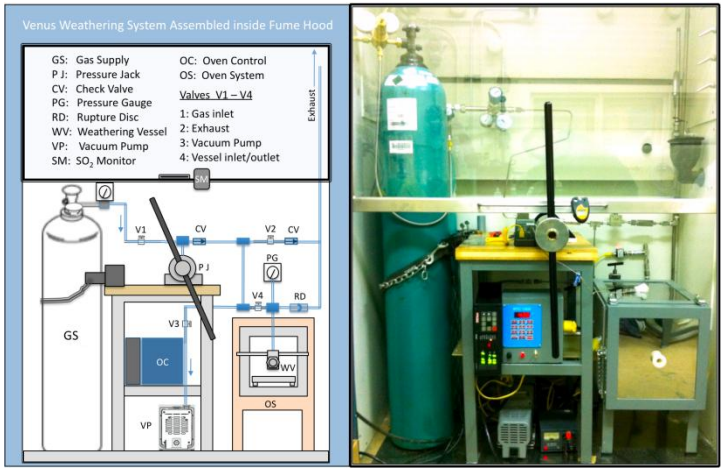
Ref. Johnson, CO2, N2, Steady-state

# JPL

Venus Materials Test Facility (VMTF)

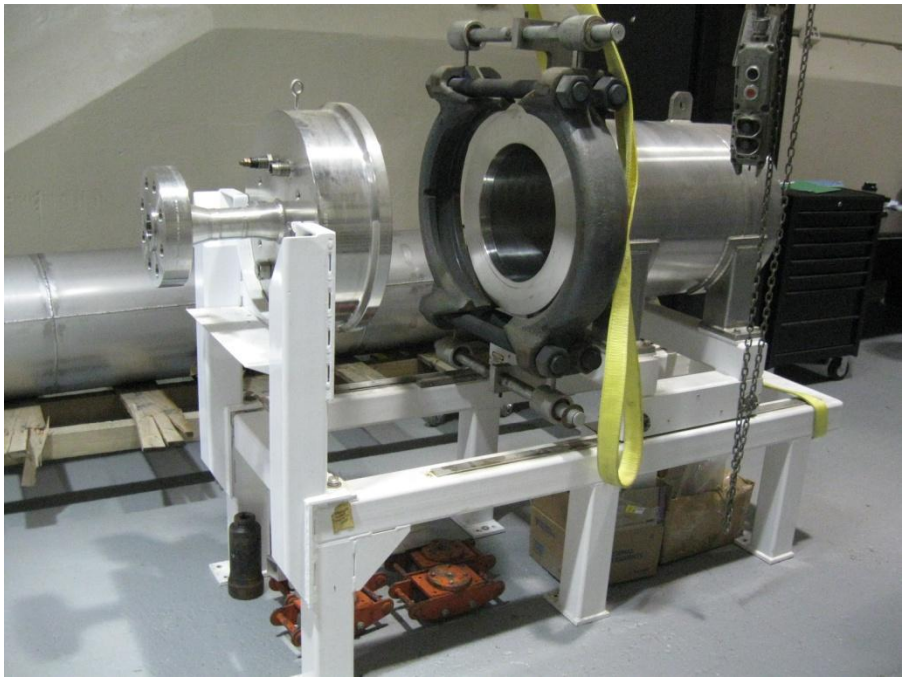


Venus Testbed for Raman and LIBS (VTRL)




Venus Weathering Facility (VWF)

# Glenn



1.5 ft by 3 ft

3 ft by 4 ft

# Defunct Facilities

- LT-HP Venus Wind Tunnel at NASA Ames
- Wichita, Kansas -- Small diameter pipe
- VEGA Chamber in Russia
- Pioneer-Venus Chamber at Goddard

# References


- http://www.planetaryprobe.org/SessionFiles/Session4/Presentations/9_Del_Papa_ARMSEF_CO2.pdf
- http://www.hindawi.com/journals/ijae/2011/937629/
- http://vfm.jpl.nasa.gov/files/EE-Report_FINAL.pdf
- https://docs.google.com/file/d/1Vw9uBB0OMtaODUjd4LgQ8B88oYFURu7PzrADAIVSGG7oo4LLLlsL2G3MPCF/edit?pli=1

- Personal communication and online sources.