Venus Sample Return Using In-situ Propellant

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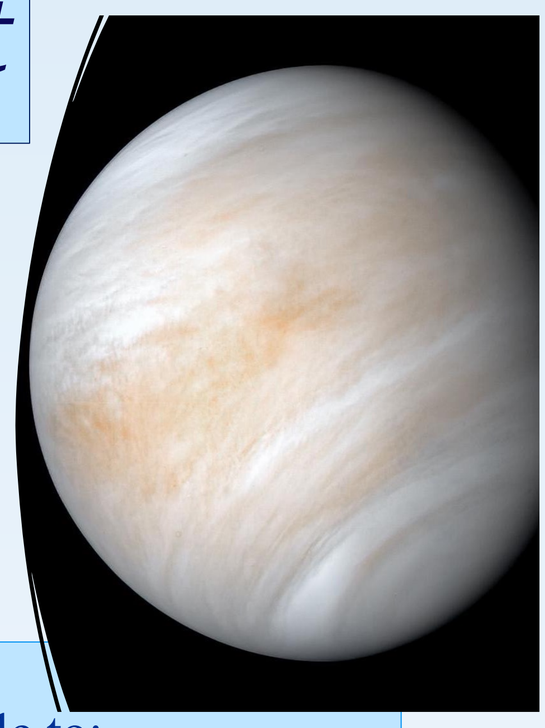


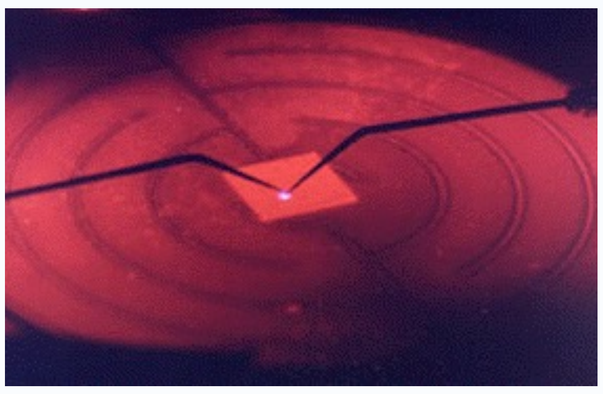
Why Venus?

- Venus is Earth's evil twin: nearly the same size at Earth, yet in many ways very different.

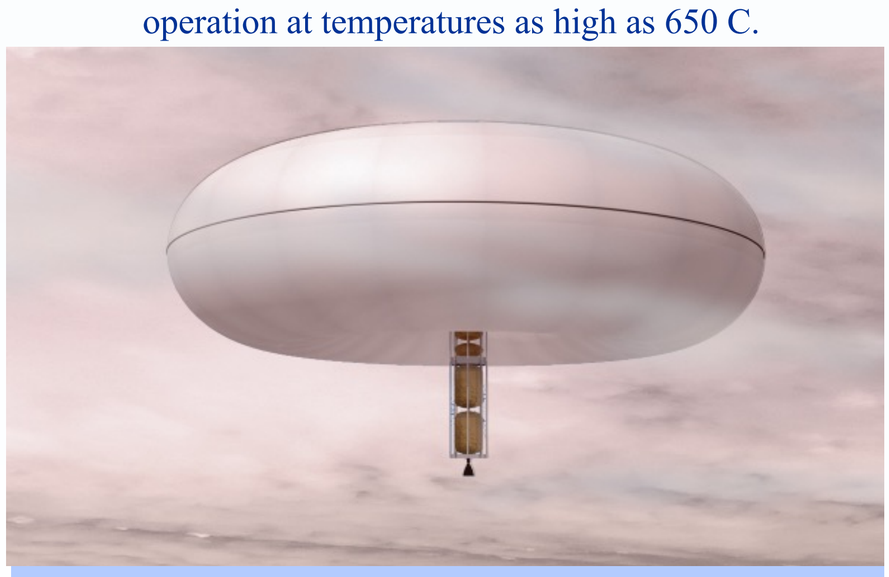
Our knowledge of the geology and mineralogy of the surface of Venus is very slight. Beneath the clouds, the surface of Venus is mostly unknown.

- Only one NASA mission has even entered the atmosphere.
- The Soviet Venera and VeGa missions did slightly better, but the longest-lived Venera transmitting for two hours from the surface
- To really understand geology and minerology of Venus, we need to bring surface samples back to Earth
- But the surface of Venus is one of the most hostile environments in the solar system: fiercely hot, high pressure, and corrosive.

Why Venus? Not because it is easy, but because it is hard



NASA Glenn SiC devices have demonstrated operation at temperatures as high as 650 C.



One conceptual design of the balloon platform is a toroidal balloon, shown here with the launch vehicle suspended beneath the central aperture

At a surface temperature of 450C, we don't want to land the fully-fueled sample return rocket on the surface!

- Solution: Float the rocket high above the surface in a balloon

Solution using multiple technologies

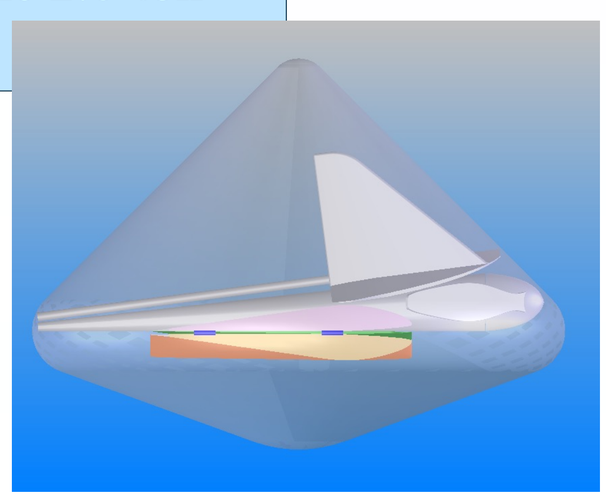
- High-temperature solar airplane with SiC electronics to access surface and bring sample to:
- Orbital launch rocket floats ~60 km above the surface
- Fueled by CO-O_2 propellant manufactured from the Venus atmosphere
- Launch rocket to rendezvous with in-space return vehicle waiting in orbit

To reduce the amount of mass we have to carry to Venus, we use *in-situ propellant production* to make rocket propellant from the Venus atmosphere

- NASA has demonstrated technology to make carbon monoxide and oxygen from carbon dioxide
- We use technology developed by Dianne Linne at NASA Glenn to use carbon monoxide and oxygen as rocket fuel
- Fuel to be produced: 2.35 tons.
- Vehicle based on Japanese SS-520 vehicle
- Use of ISRU fuel production means we need to transport to Venus only the empty weight of the launch vehicle, 250 kg, rather than the 2.6-ton fully-fueled weight of the rocket.

SS-520 orbital booster

Mission design and engineering by the NASA Glenn Compass current engineering team



Solidworks model of solar airplane folded into aeroshell for Venus atmospheric entry