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Facility for Dust Mitigation Studies at the University of Glasgow

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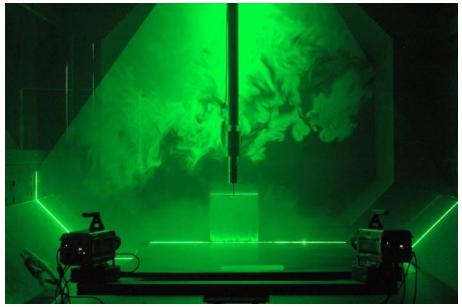
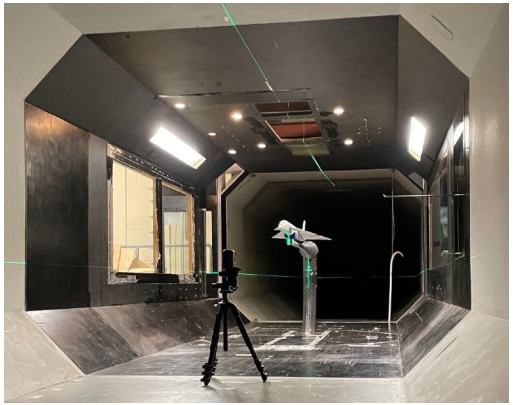
Hub in UK National Wind Tunnel Facility





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Primary Goals

- Build large-volume dirty vacuum facility at to investigate:
  - Plume ground interaction
  - Plume spacecraft contamination
  - Plume-plume interaction
- Directly Support ESA Exploration for soft landing and comet rendezvous
- Two regimes of interest
  - Hard Vacuum (Lunar landing)
  - Mars Environment

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Cross-cutting applications

- Exploration and Robotics
  - Autonomous vehicles: Testing of autonomous vehicles in simulated planetary conditions
  - Robotic manipulators: Testing of sampling devices
  - Dust resilience

- Access to Space
  - Space propulsion systems: Testing of propulsion systems in simulated planetary conditions
  - Clean space environment: The execution of fragmentation studies to understand debris production and its control

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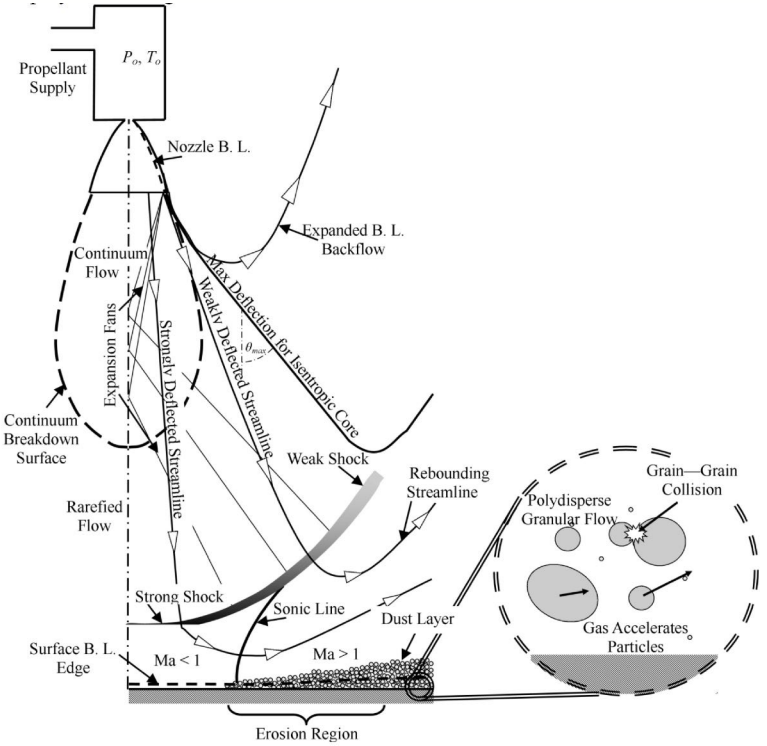
ESA ongoing investigation: The Moon

- Flow field of plume impinging on airless body is complex
- As nozzle lowers altitude the flow/shock structures change
- Surface topography changes with nozzle stand-off height



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ESA ongoing investigation: Mars

- Similitude analysis criterion:
  - Mass flow rate 18.9g/s N2
  - Martian background pressure 6mbar (600 Pa) to be maintained throughout testing

- Vacuum pumps playing greater role.

Artist's conception of sky crane lowering Mars rover (Curiosity) to mitigate dust cloud damage to instruments

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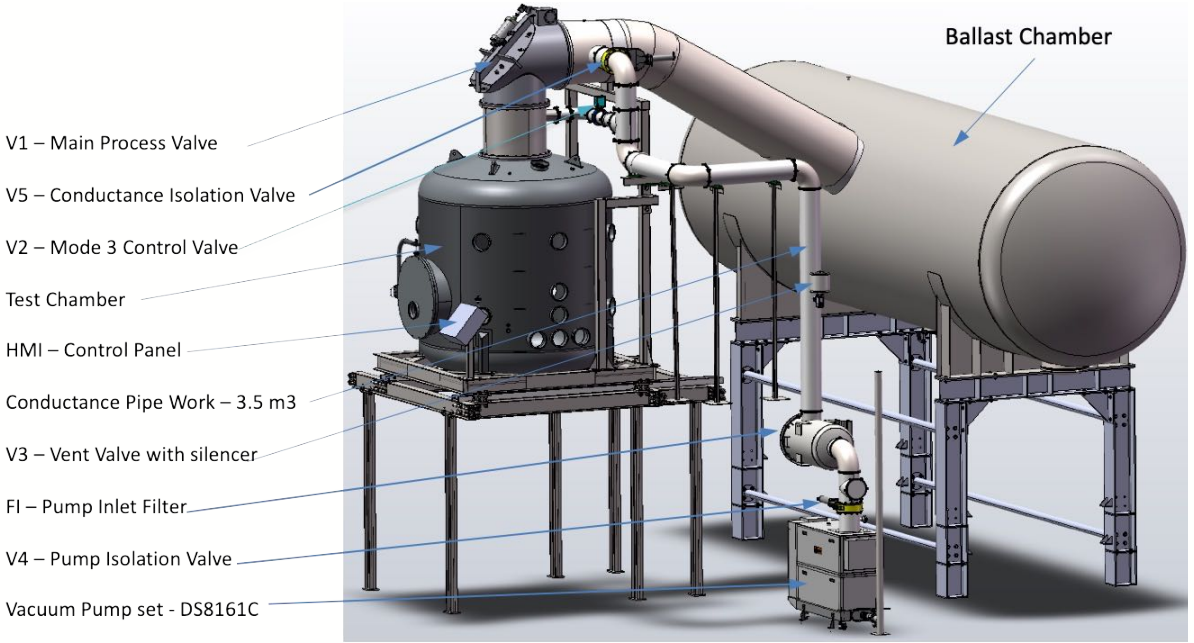
Design Solution

- Test section volume $\sim 12\ m^3$
- Buffer tank volume $\sim 60\ m^3$
- Conductance pipe volume $\sim 3\ m^3$
- Ultimate vacuum level $\sim 1\ Pa\ (0.01 mbar)$
- Time to reach ultimate vacuum level ~ 3.5 hr



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Buffer Tank and Test Chamber

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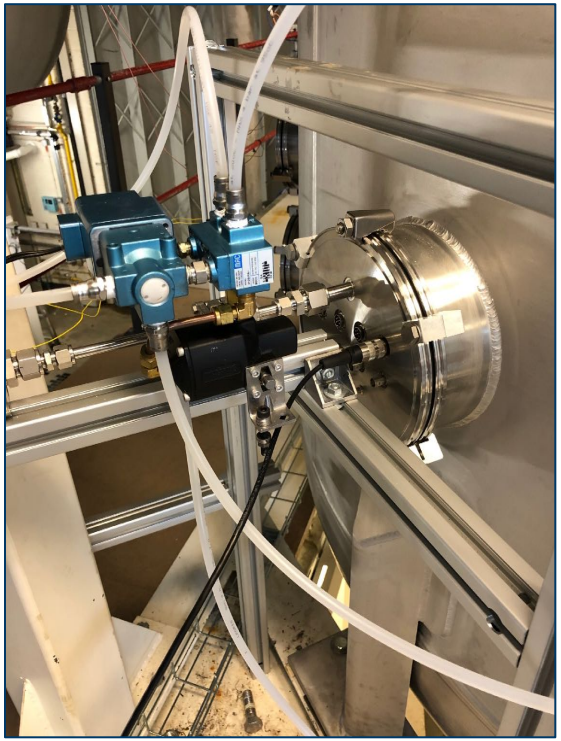
Inside the chamber and external flanges



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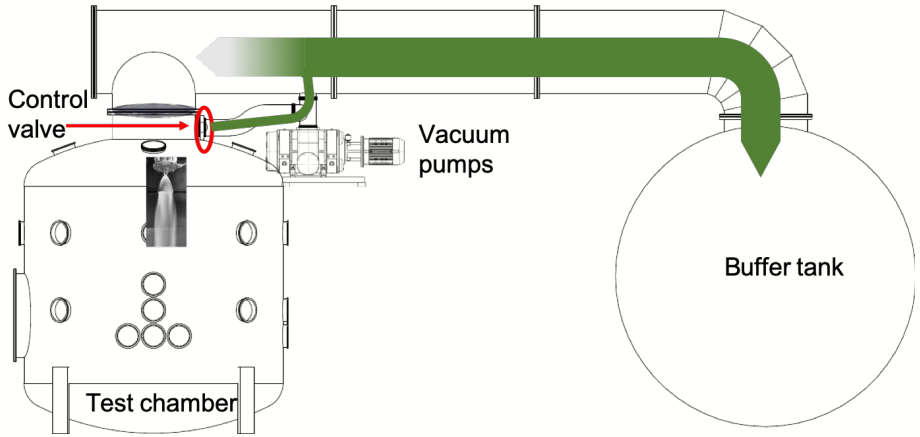
Mars Scenario Operation

- Pressure control valve on test chamber.
- Capacitance manometer used to meter the opening of butterfly valve to maintain desired pressure in test chamber.
- Three stages of valve operation:
  - ***Closed*** – vacuum level in test chamber high (low pressure) allowing pressure in test chamber to rise to 600Pa.
  - ***Control*** – at 600Pa valve begins to open and its rate of opening is metered to maintain target pressure.
  - ***Open*** – valve fully open, no longer sufficient pressure difference between buffer tank and test chamber to maintain 600Pa.



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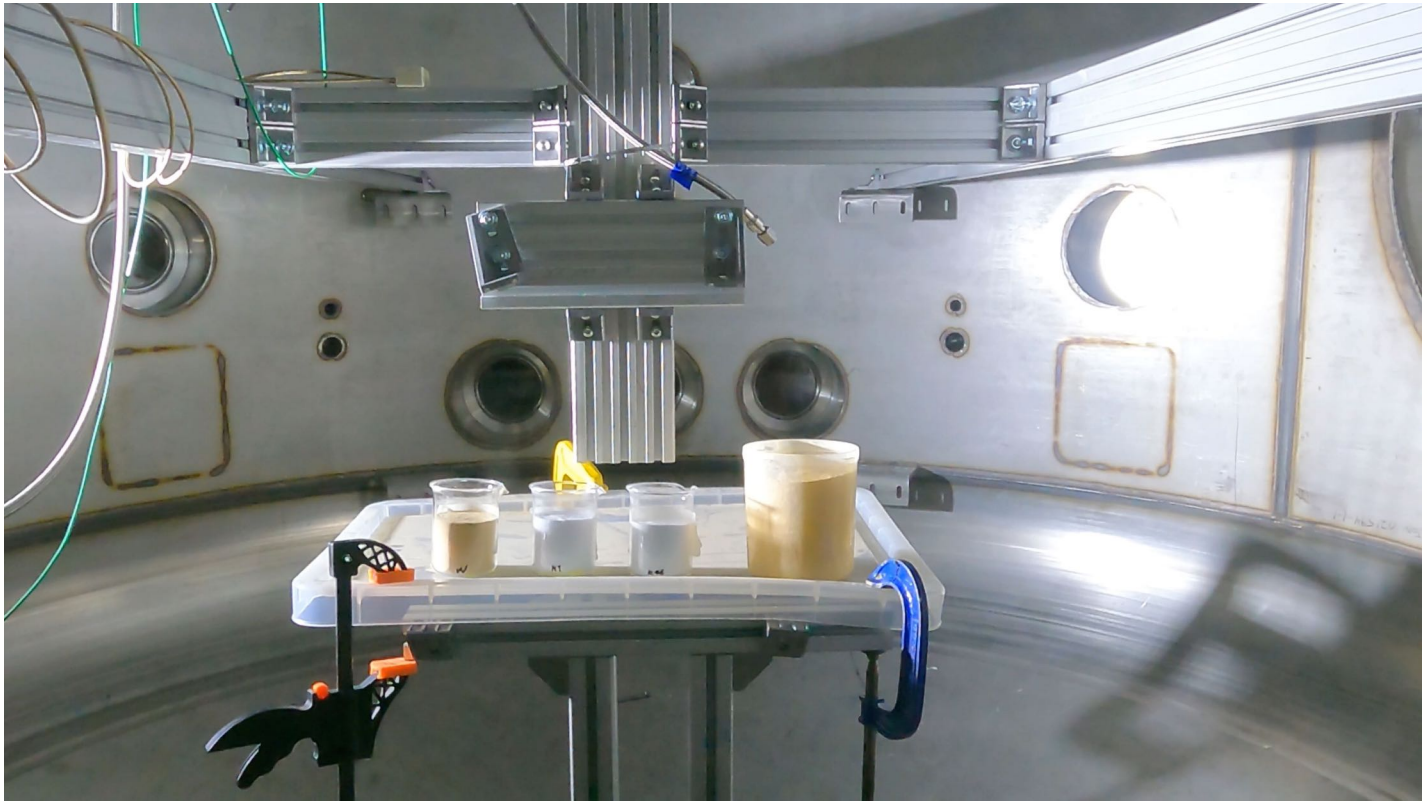
Simulants: Glass Spheres and Walnut Shells



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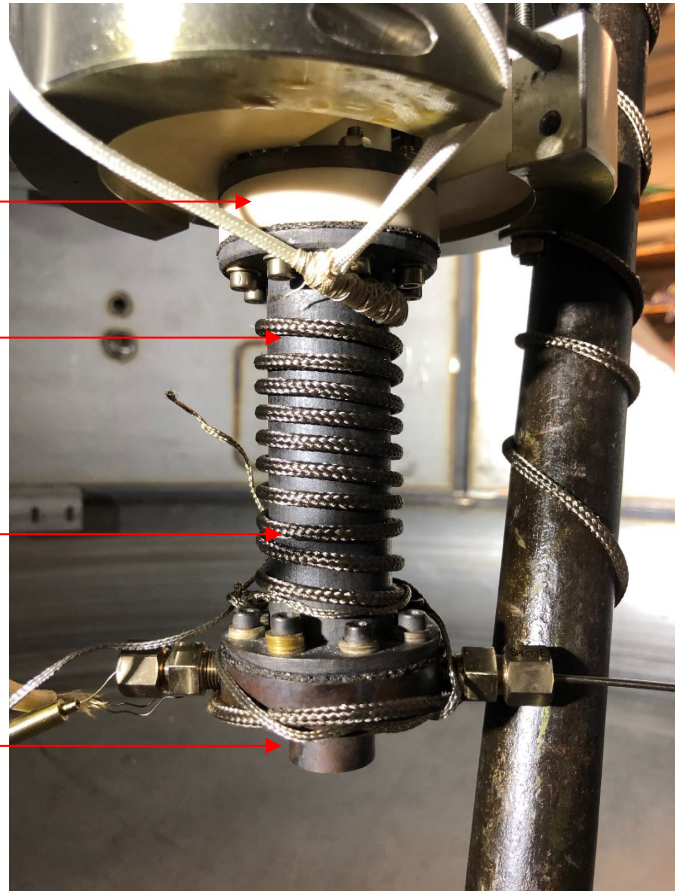
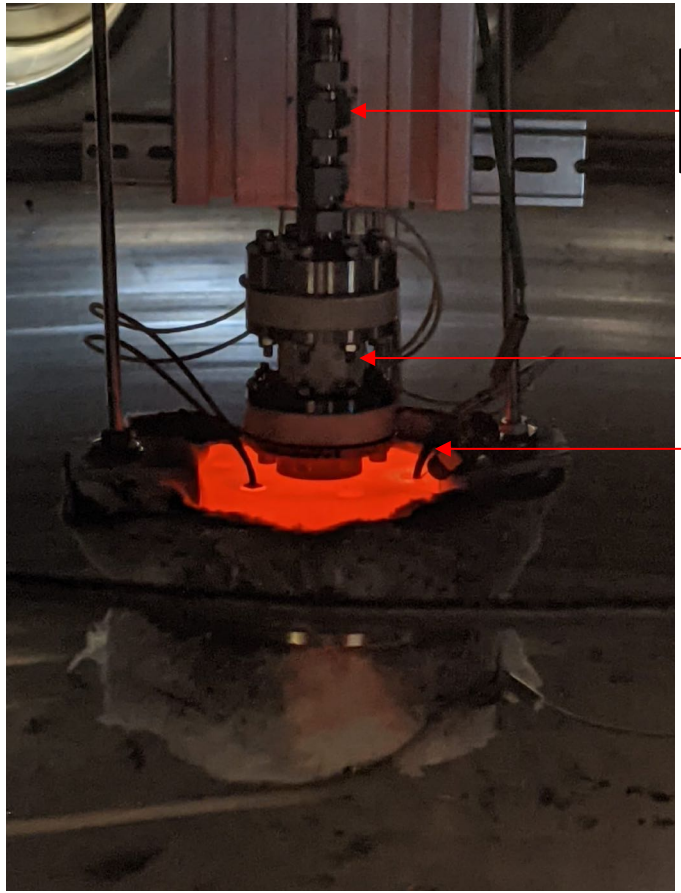
Heating under vacuum





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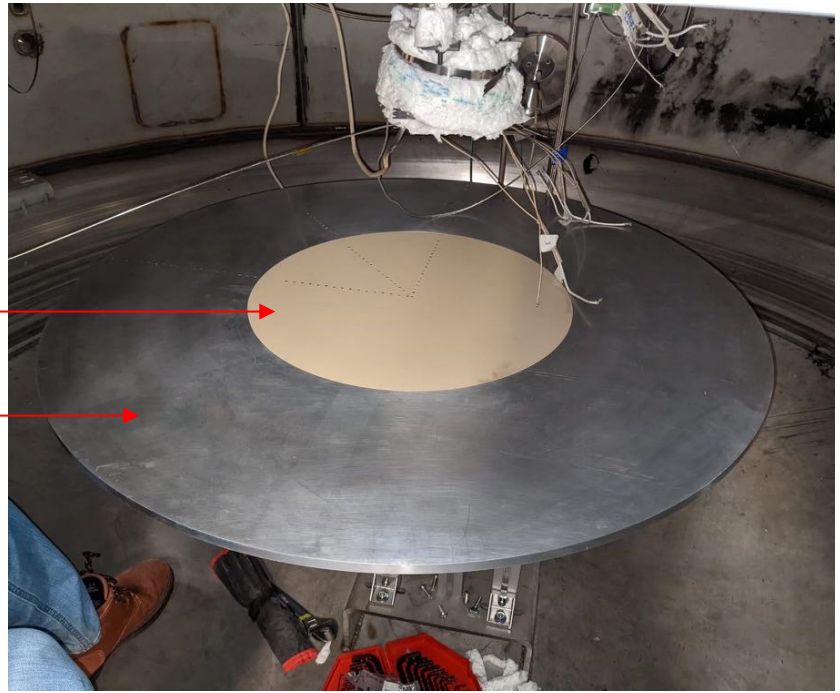
Heat Transfer Measurements



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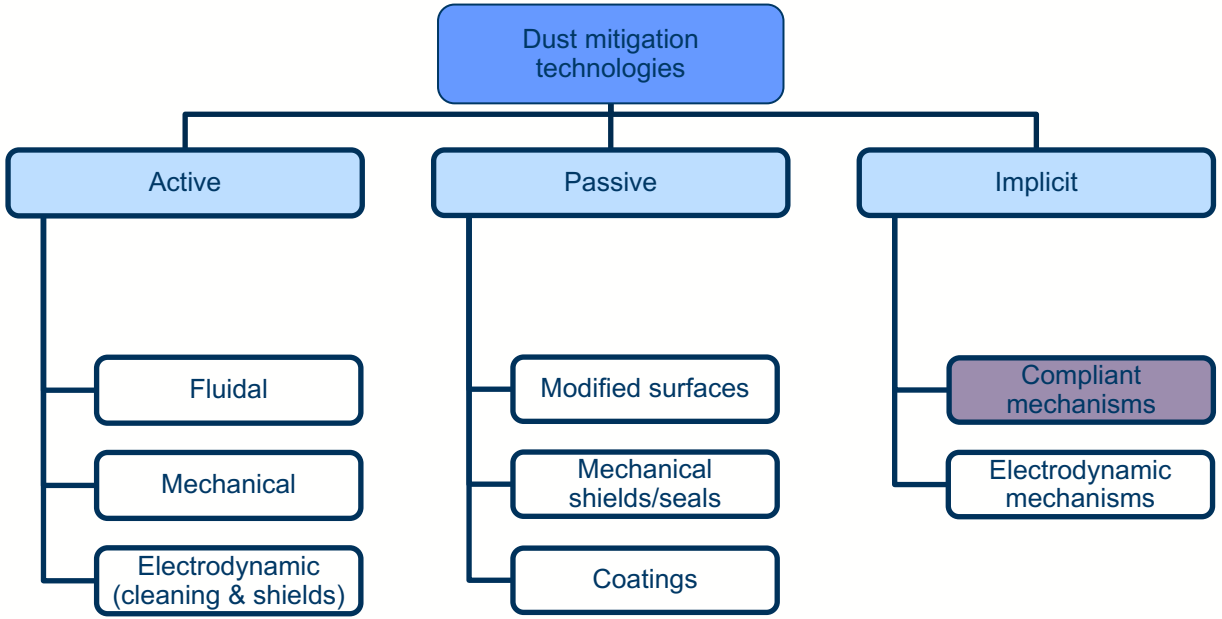
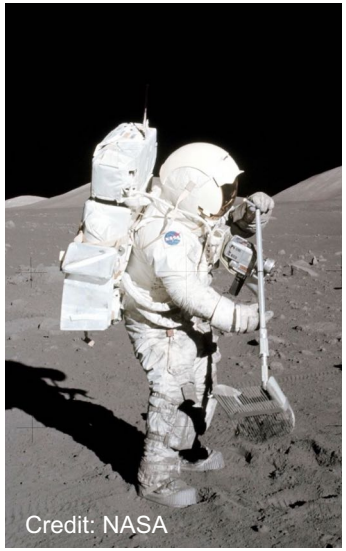
Dust Resilient Mechanisms



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Thank you