Fundamental experiments of jet impingement on granular surfaces

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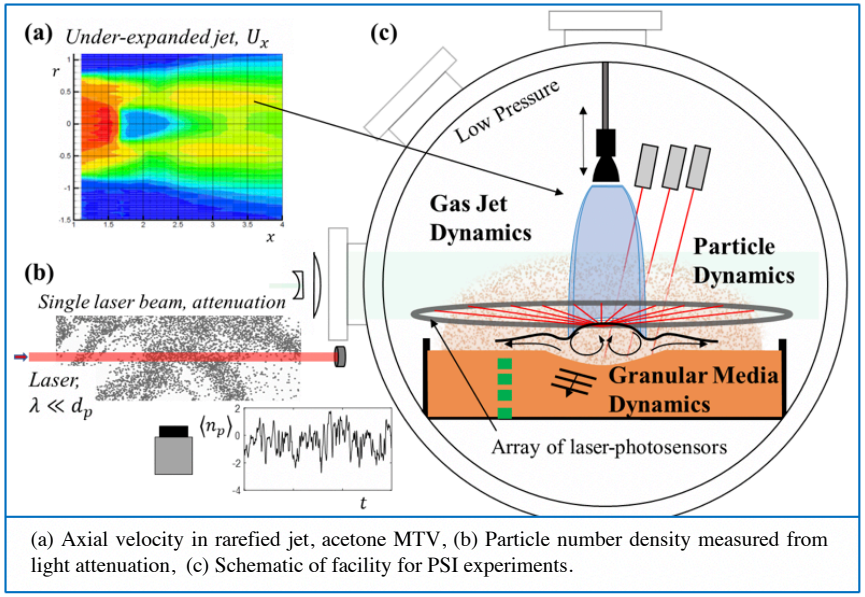
Research Objectives

- **Goal:** Develop a suite of diagnostic techniques for gas, particulate, and soil bed dynamics, and provide a benchmark dataset for plume-surface-interactions in regimes representative of landings on extraterrestrial atmospheres.
- **Innovation:** Enable and provide correlated measurements of fluid and particle velocities, ejecta evolution and cratering in rarefied sub-atmospheric environments.
- **SOA**: Current predictive models do not incorporate all relevant physics/ lack validation. Fluid-soil interaction is not well understood. Data is scarce, not representative/qualitative.
- TRL of measurement techniques applied to this environment expected to rise from 1-2, to 5. Techniques ready for use in other/more complex setups.



(a) Axial velocity in rarefied jet, acetone MTV, (b) Particle number density measured from light attenuation, (c) Schematic of facility for PSI experiments.

Approach

- Reproduce in a ground facility non-dimensional aerodynamic parameters representative of Mars/Moon landings.
- Develop/tailor diagnostic techniques to measure:
  - *jet dynamics at low-ambient pressures in unladen and laden conditions: PLIF/MTV,*
  - *particulate concentration and dynamics: laser attenuation tomography and high-speed streak imaging,*
  - *granular dynamics and cratering: embedded pressure sensors and accelerometers, and laser range sensors.*
- Apply diagnostics to a range of well-controlled conditions.
- Perform uncertainty quantification analysis of all collected data and study the sensitivity to the most relevant parameters.

Potential Impact

- Diagnostic techniques can be extended to flight sensors and real scale experiments.
- Well-characterized experimental data is key to **understand** flow-particle/granular material interactions, **develop** physics-based models and **validate predictive codes.**
- Outcomes can be directly translated in **design guidelines**, e.g., protection against most probable particle size and impact energy.
- Others: Diagnostic developments benefit other areas of research dealing with supersonic or multiphase-flows. Optically-thick environments are a challenge shared across disciplines.