RIDER and SPIDR: Open-Access Complementary Facilities for Planetary Terramechanics Investigations

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Introduction

- Human permanence off Earth depends on efficient, safe, and reliable transportation capabilities
- Need to test wheel-regolith interactions experimentally and be able to predict computationally
  - RIDER offers full-scale, automated rover wheel testing in relevant simulants
  - SPIDR offers realistic simulation of rover wheels in the lunar environment

RIDER Description

- 3.8 x 0.9 x 0.5 m deep simulant bin with custom compaction capabilities
- Gravity offload / load application system
  - ≤200 kg single-wheel loads
- Air filtration, dust containment, dehumidification
- Interchangeable BLDC motors (10:1, 50:1, 100:1, 225:1 reduction ratios)
- Custom wheel mounting system
  - Wheels from 26 to 82 cm diameter
- Control system logs data to ASCII text files for later analysis
- Video recording from multiple angles

SPIDR Description

- Discrete element modeling (DEM) of CAD-based wheel geometries interacting with the lunar environment (e.g., surface, electric fields, and gravity)
  - Focuses on <2 µm fraction of regolith
- Calibrated to experiments with returned Apollo samples (15071 and 61141)
  - Currently undergoing recalibration
- Predicts dust plume trajectories and velocities
  - LRV wheel and Apollo 16 Grand Prix

RIDER

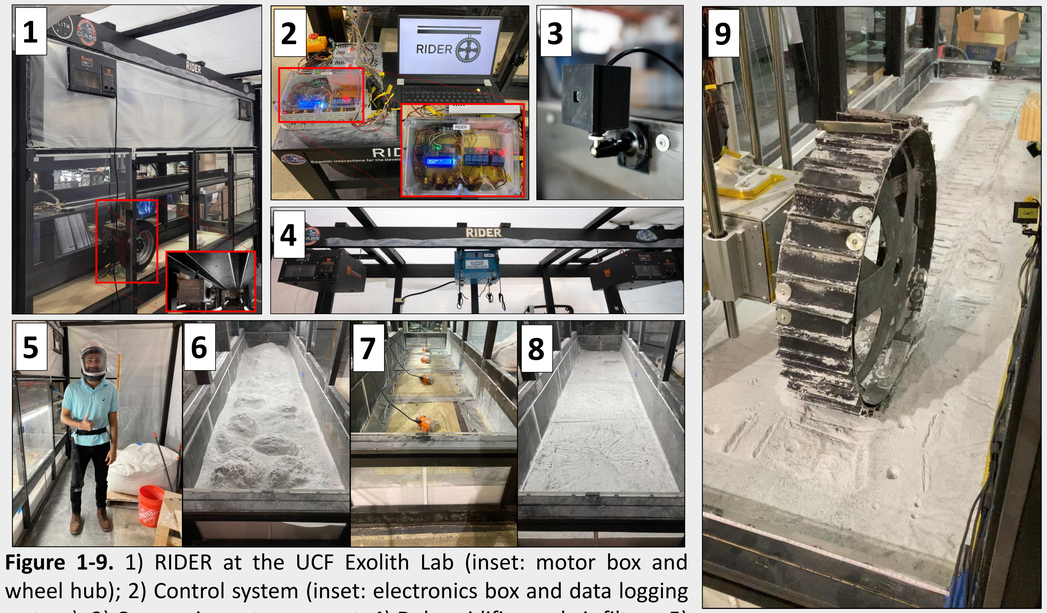

Figure 1-9. 1) RIDER at the UCF Exolith Lab (inset: motor box and wheel hub); 2) Control system (inset: electronics box and data logging system); 3) Camera in custom mount; 4) Dehumidifier and air filters; 5) G. Blandin in PAPR respirator; 5-8) Simplified LHS-1 in RIDER before (6), during (7) and after (8) compaction; 9) Testing Astrobotic Polaris prototype wheel in illuminated, dust mitigated, dehumidified bin.

SPIDR

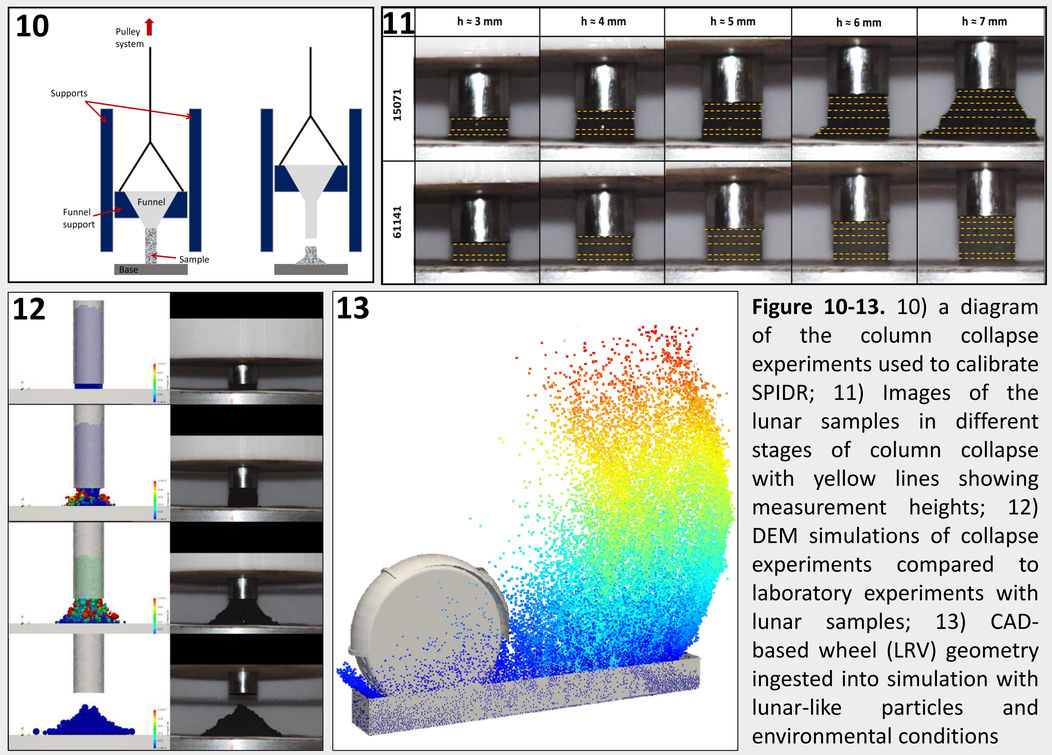

Figure 10-13. 10) a diagram of the column collapse experiments used to calibrate SPIDR; 11) Images of the lunar samples in different stages of column collapse with yellow lines showing measurement heights; 12) DEM simulations of collapse experiments compared to laboratory experiments with lunar samples; 13) CAD-based wheel (LRV) geometry ingested into simulation with lunar-like particles and environmental conditions

RIDER and SPIDR as Services

- RIDER and SPIDR offer unparalleled planetary terramechanics testing capabilities and serve to cross-validate each other's findings
- RIDER provides:
  - Experimental evaluation of rover wheel performance (e.g., longevity, slip, sinkage) in high-fidelity, customizable simulants
  - Testing of rover wheels customer-specified speeds and loads
  - Capabilities to analyze traffic-induced effects on the regolith
- SPIDR provides:
  - Computational evaluation of rover wheel performance and optimal drive speed (travel efficiency and dust mitigation)
  - Ability to simulate rover traffic on any planetary body
    - Upcoming calibrations for Mars
- RIDER and SPIDR teams can comply with any privacy measures (nondisclosure agreements, visual barriers, etc.)
- Reach out to jared.long-fox@ucf.edu or dbritt@ucf.edu for more information, logistics, and scheduling

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