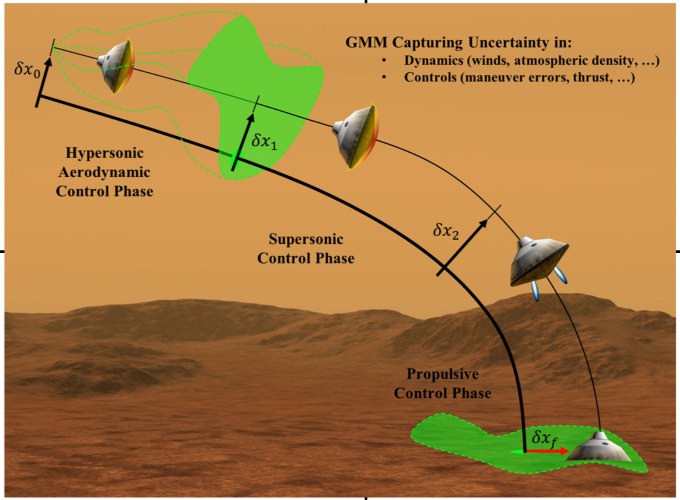
Title and Research Team

- **Robust Entry and Landing Guidance Under Dynamic Uncertainty**
- **PI: Professor Jay McMahon**, CCAR, Smead Aerospace Engineering Sciences department, University of Colorado Boulder
- TBD Post-doctoral researcher
- TBD Graduate Student Research Assistant
- Collaborators
  - Dean/Professor Bobby Braun, College of Engineering and Applied Sciences, Smead Aerospace Engineering Sciences department, University of Colorado Boulder
  - Professor Hanspeter Schaub, CCAR, Smead Aerospace Engineering Sciences department, University of Colorado Boulder

Research Objectives

- <u>What do you hope to accomplish?</u>
  - Design and feasibility testing of a new robust guidance algorithm applied to EDL problems
- <u>What is the innovation?</u>
  - Create and implement a general aerospace guidance algorithm that will robustly deliver a vehicle to a desired target state in the presence of uncertainty
- <u>How does your research compare to the SOA?</u>
  - PredGuid – our algorithm is more general – not for only bank angle guidance and more appropriately accounts for uncertain nature of problem
  - G-FOLD – directly addresses uncertainty for robustness
- <u>What are the start and end TRLs (with justification)?</u>
  - TRL 1 start (since unpublished)
  - TRL 4 target (test algorithms)



Approach

- **Overview description:** use experience in spacecraft GNC to apply new advances in control theory to the problem of EDL in order to create a system that could be implemented in the near future (ie doesn't require a servers worth of computers on- board)
- The new guidance algorithm will be based on advances in stochastic model predictive control, and will consist of three main components
  - Machine learning for prediction of perturbing accelerations
  - Unscented Gaussian Mixture Model for prediction of the effect of uncertainties in the dynamic model
  - Non-linear minimization of stochastic error metrics with controls
- Implementation of high-fidelity simulation in BASILISK

Potential Impact

- <u>Benefits of the proposed space technology research to future space science and exploration needs if the technology is eventually successful</u>
  - Improve performance and capabilities for Mars landing
  - More mass to the ground more robustly
  - New missions to Mars moons enabled by improving aerocapture guidance and propulsive landing
- <u>Other benefits and outcomes from the proposed research</u>
  - Builds a core research competency that will be used in the future to improve guidance for many other aerospace systems, most immediately for lunar and asteroid exploration