Aerothermal Analysis and Thermal Protection System (TPS) Design of the Mars Sample Retrieval Lander (SRL) Concept.

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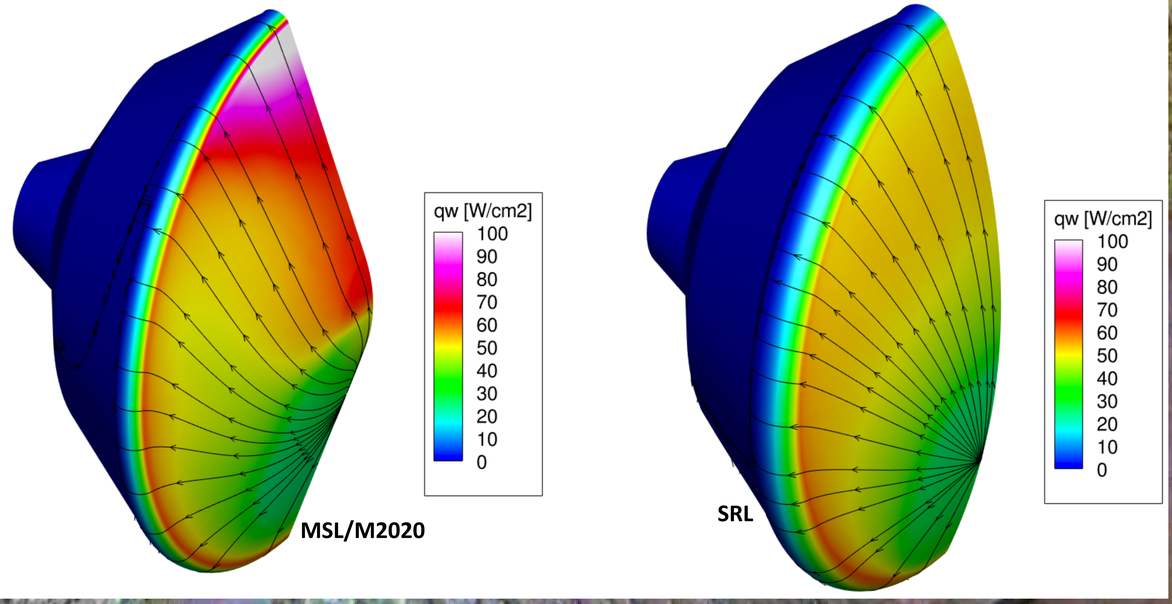
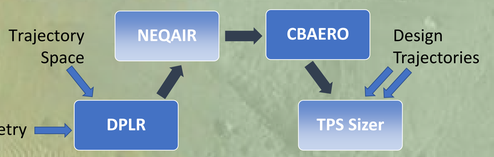
Introduction

- Mars Sample Return (MSR) is a mission to bring Martian samples back to Earth.
- Sample Retrieval Lander (SRL) is the part of MSR architecture that lands a fetch rover and an ascent vehicle on Mars.
- SRL EDL is desired to be as close as possible to MSL/M2020.
- Entry capsule features a 4.7m diameter spherical heatshield, *a first at Mars* (all previous Mars entries used a 70° sphere cone).
- Aerothermal analysis is focused on developing the intuition for aerothermal environments on this new geometry at Mars.

Differences in surface heating distribution and magnitude at the same freestream conditions



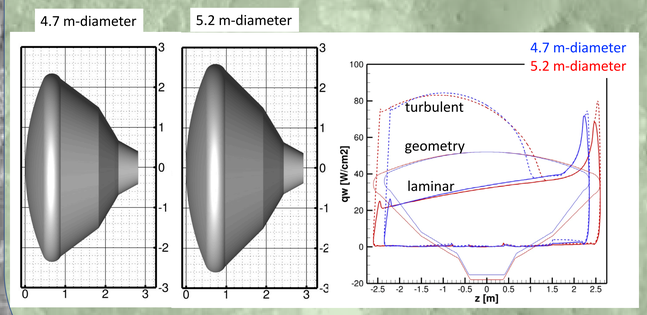
Aerothermal Analysis, and TPS Design

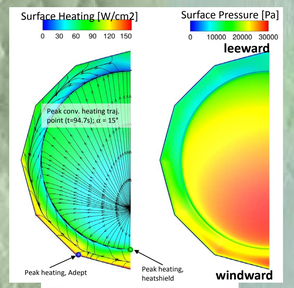


- Design leverages MSL/M2020 and Orion experience
- Analysis includes radiative environment (similar to Mars Insight and M2020).
- **CBAERO** and **TPSSizer** enable efficient evaluation of environments and material response across the entire surface for multiple trajectories.
- Enables optimization based on local aerothermal environment and sub-structure, facilitates trade studies (materials, constraints, margins etc).

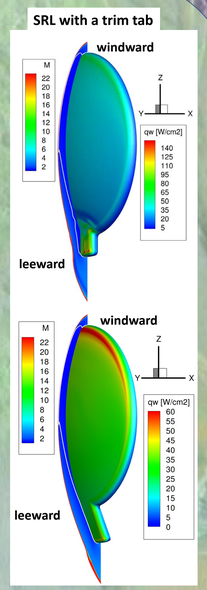
EDL Augmentations, Aerothermal Concerns

- Consideration of EDL augmentations for increased payload capability; augmentations include larger heatshields, trim tabs and an ADEPT drag-skirt.
- CFD simulations used to help assess the aerodynamic/aerothermal impacts
- TPS Sizing used to estimate mass impacts of these enhancements





SRL with an ADEPT Drag-skirt



TPS Mass Optimization

- Alternate TPS Materials
  - Using Conformal PICA (instead of PICA) reduces heatshield mass by about 30%.
- Contoured Thickness
  - MSL and M2020 feature uniform thickness heatshields
  - Orion features a heatshield of varying thickness.
  - Tailoring the SRL TPS thickness to the environment reduces heatshield mass by 15%.
- Sharper Shoulder
  - Sharpening the shoulder radius reduces the heatshield mass by about 20%
  - Affects the aerothermal environment (increased convective heating and shear), but well within the operational regime for PICA