Impact of NASA'S Entry Systems Modeling Project on Planetary Mission Design: OPAG

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Rationale: Every mission that enters an atmosphere relies on specialized expertise and tools for entry system design.
We are the only cross-cutting Agency project serving this critical and NASA-unique function.

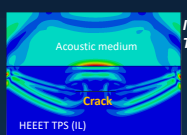
What is the Entry Systems Modeling Project?

Our mission is to develop high-impact computational models and conduct validation testing, driven by mission requirements, that can be delivered in 2-4 years to reduce mission risk and improve performance for Entry, Descent and Landing.

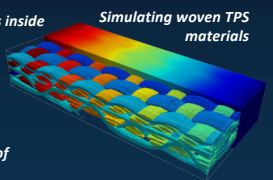
Focused research in four elements:

Predictive Materials Modeling

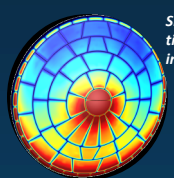
- Micro- to engineering-scale analysis tools
- Full 3-D material response and TPS sizing
- TPS reliability: How flaws and features turn into failures



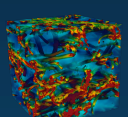
Identifying flaws inside TPS materials



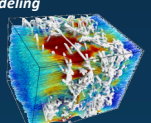
Simulating woven TPS materials



Simulated recession of tiled MSL heat shield including gap fillers

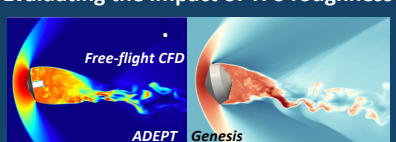


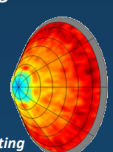
Microscale modeling of material properties and performance



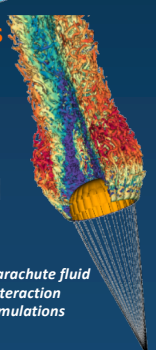
Computational and Experimental Aerosciences

- Simulate parachute inflation & dynamics
- Investigating vehicle dynamics using Free-Flight CFD and Magnetic Suspension Wind Tunnel
- Evaluating the impact of TPS roughness





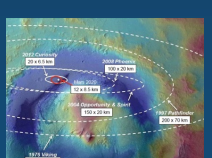
Heating augmentation from rough surfaces



Parachute fluid interaction simulations

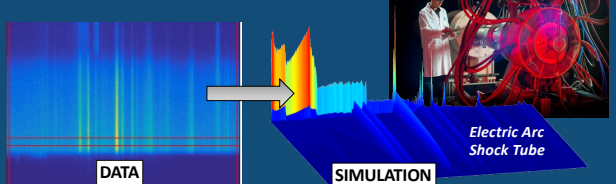
Guidance, Navigation, and Control

- Improving tools and developing advanced guidance and control algorithms



Shock Layer Kinetics and Radiation

- Shock layer radiation databases and models for all solar system destinations
- Reduced TPS margins and mission risk

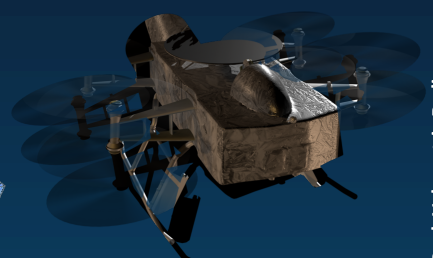


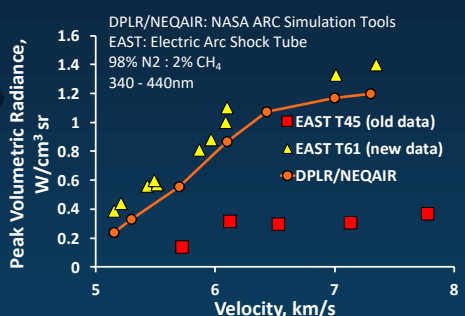
Infusion into missions:

Titan

ESM helps Dragonfly retire risk through analysis and providing state-of-the-art tools:

- Benchmark radiative heating data & codes
- Capsule dynamic stability assessment
- 3-D material response of complicated geometry

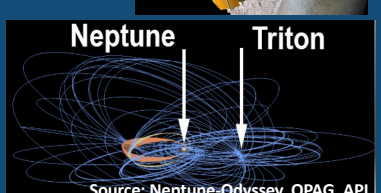


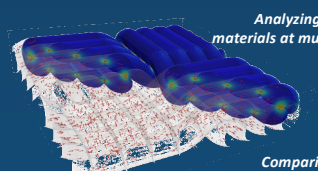


Outer Planets Exploration

- Radiative heating & kinetic rate studies to reduce mission relevant uncertainty
- Launch-to-Landing GNC capability through development of a coupled interplanetary and descent trajectory tool
- Advancing thermostructural and woven TPS models, including fracture and failure
- Examining the Galileo probe entry heating with coupled radiation and ablation

Neptune Odyssey: Neptune orbiter & Triton lander





Analyzing woven TPS materials at multiple scales

Comparing SoA tools against Galileo recession data