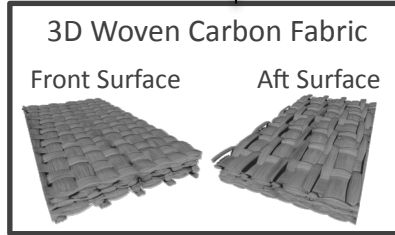
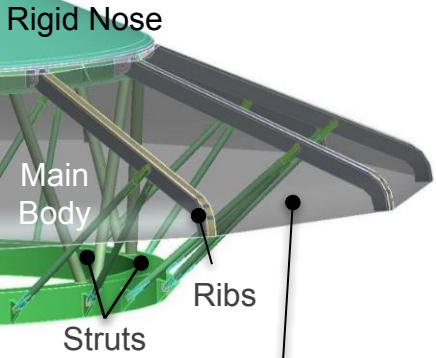




Adaptable, Deployable, Entry and Placement
Technology (ADEPT) Enabling Future Science
Missions

**Paul Wercinski and the ADEPT
Team**
NASA Ames Research Center
January 2023

Adaptable, Deployable Entry and Placement Technology (ADEPT)

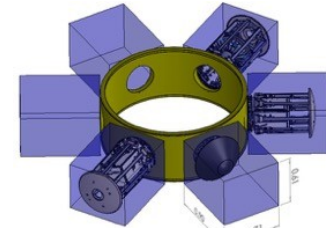


ADEPT's Major Benefits:

- Overcomes entry vehicle packaging and volume constraints in LV shroud or as secondary payload
- Deployed configuration achieves low ballistic coefficient (M/CdA), reducing peak heating and dynamic pressure loads;
- Woven carbon fabric, tested up to 250 W/cm^2 , is suitable for extreme heating conditions including Venus science missions



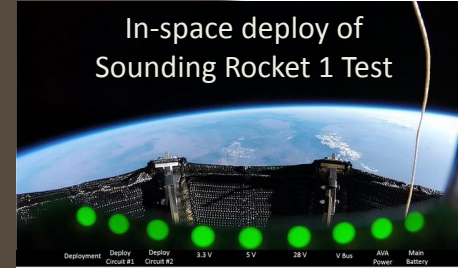
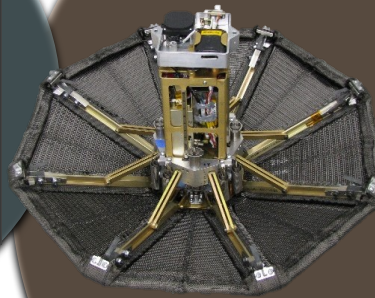
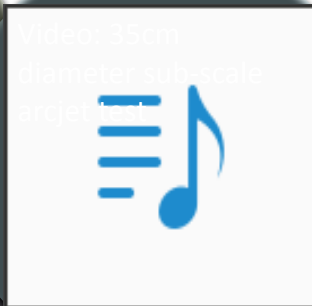
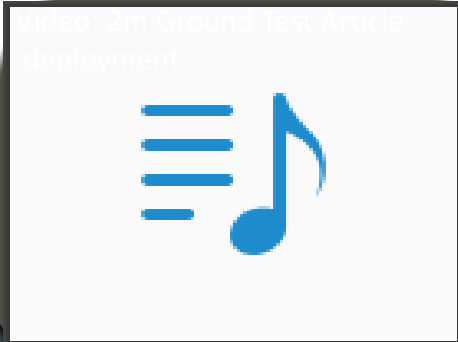
"Umbrella-like" mechanical deployment



ADEPT stowed in ESPA as secondary payload

ADEPT Designs	SmallSat Class (1-3m Diameter) (Tech Demo or Secondary Payload)	Robotic Class (4-12m Diameter) (Discovery, New Frontier, Flagship)	Exploration Class (Human Mars)	
Ballistic and Lifting Entry Vehicle Concepts	<p>SR-1 (2018 Flight Test)</p> <p>1-3m Diameter</p>	<p>Project Pterodactyl</p>	<p>ADEPT VITaL (Venus Lander)</p> <p>6m Dia.</p>	<p>Ice Giant DMA Concept</p> <p>12m Dia.</p>
	<p>Human Exploration 20mt Concept</p> <p>18m Dia.</p>			

ADEPT Technology Maturation FY12-FY19



2012	2013	2014	2015	2016	2017	2018	2019...
<u>Fabric-level</u> arc jet test to 250 W/cm ²	Aeroshell <u>deployment</u> demonstration	<u>Distributed pressure loads</u> (wind tunnel) & SPRITE-C <u>system level</u> <u>aerothermal</u> tests			<u>Develop 0.7m flight system</u> ➤ <u>SR-1 Flight Experiment</u>		Mission concept development — <u>Applications</u>

Component

Subsystems

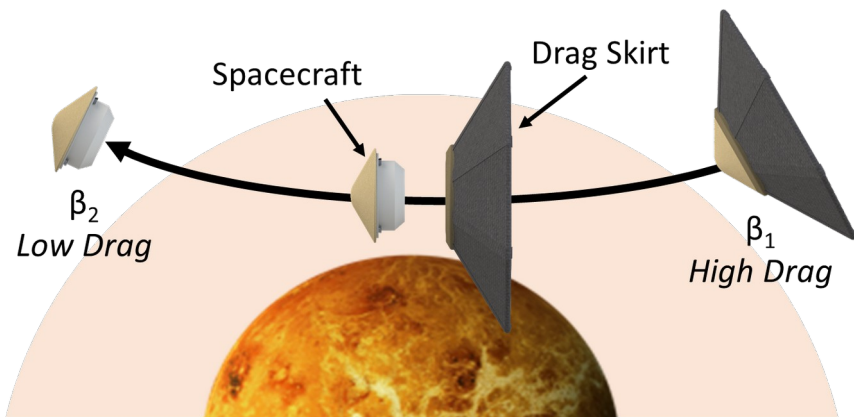
Integrated Systems

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SmallSat Drag Modulation Aerocapture (DMA) for SMD Planetary Orbiter Missions

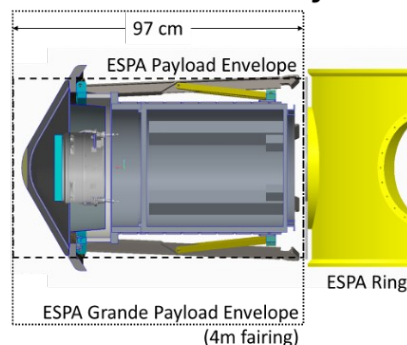


To overcome navigation and atmospheric uncertainties, a form of flight control is needed during the aerocapture pass through the atmosphere

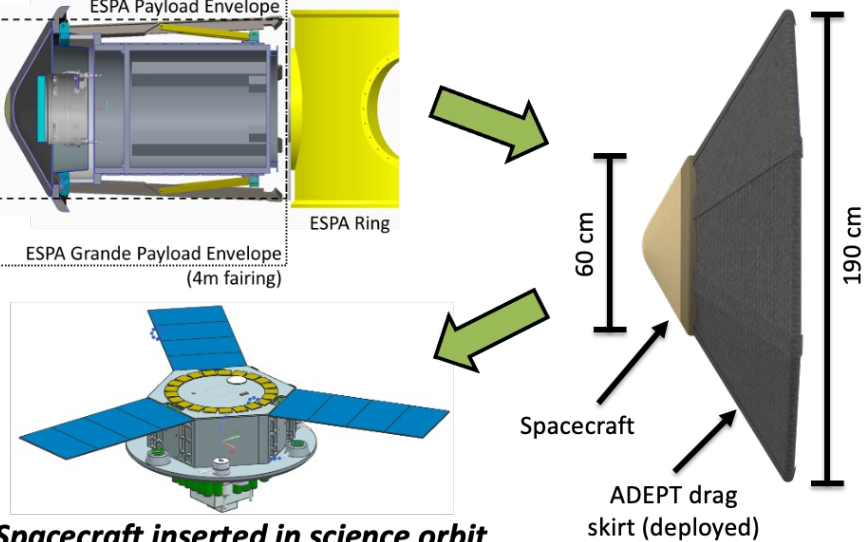


By modulating the time that a drag skirt is jettisoned from the spacecraft, the system can receive more or less delta-V and target a specific orbit

Stowed in ESPA volume for launch



Deployed for cruise & entry



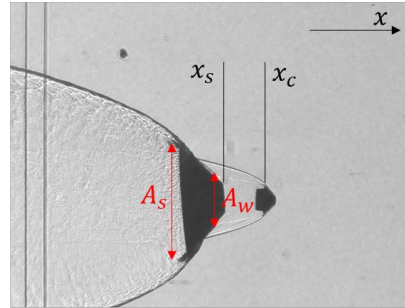
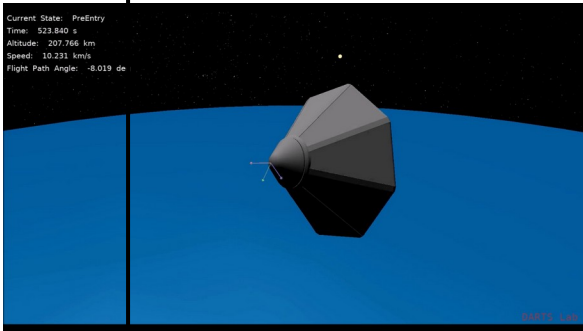
Spacecraft inserted in science orbit

- NASA Ames partnered with JPL (Alex Austin PI) on developing mission concepts and technology development plans (eg. ADEPT Technology Readiness Assessment)
- DMA science mission concepts and potential Earth Technology Demonstration mission recently presented to STMD TDM leadership and SMD sponsored ADRAT

Aerocapture Tech Development Progress



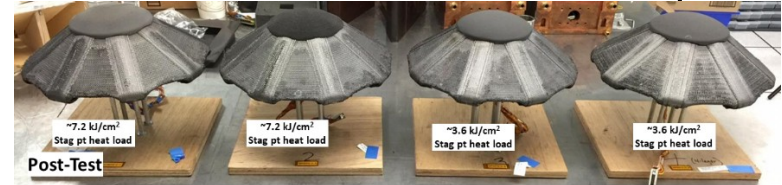
Many years of development progress make drag modulated aerocapture ready for TDM



$$F_c = C_{D,c} A_c q_\infty$$

$$F_s = C_{D,s} (A_s - A_w) q_\infty + C_{D,s} A_w k q_\infty$$

JPL and ARC performed 8 sub-scale ballistic range shots at, giving valuable test data to inform DSENGS modeling

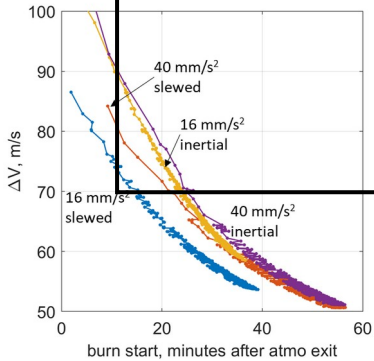


ARC performed arcjet testing of flexible carbon fabric at Mars relevant conditions

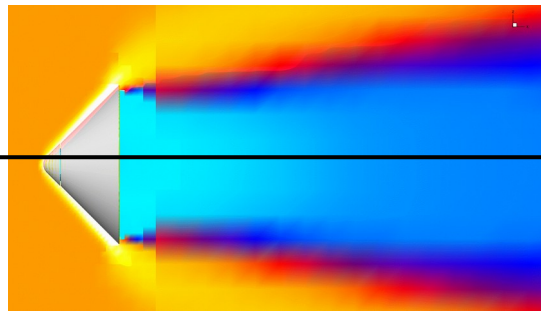


ADEPT vacuum bag and subsonic wind tunnel tests to assess shape change and possibility of flutter

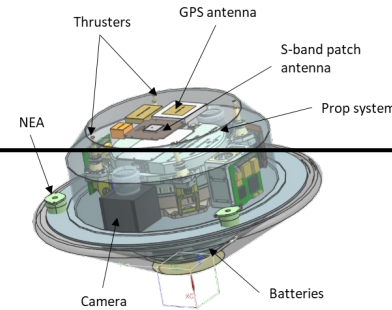
DSENGS 6-DOF simulation toolset provides capability to model the aerocapture maneuver



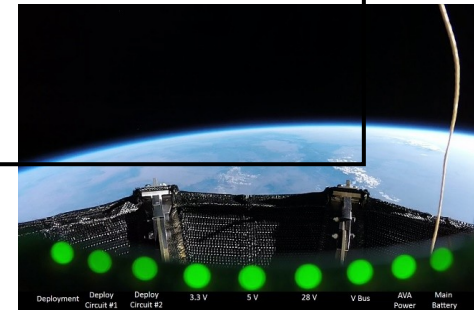
Investigated post-aerocapture PRM delta-v and operations requirements



Cart3D CFD simulations at Venus flight conditions



Extensive trade studies have yielded an integrated flight system design



ARC successfully flew a 70 cm diameter ADEPT skirt on a suborbital sounding rocket

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