Conformal Ablative Thermal Protection System for Small and Large Scale Missions: Approaching TRL 6 for Planetary and Human Exploration Missions and TRL 9 for Small Probe Missions

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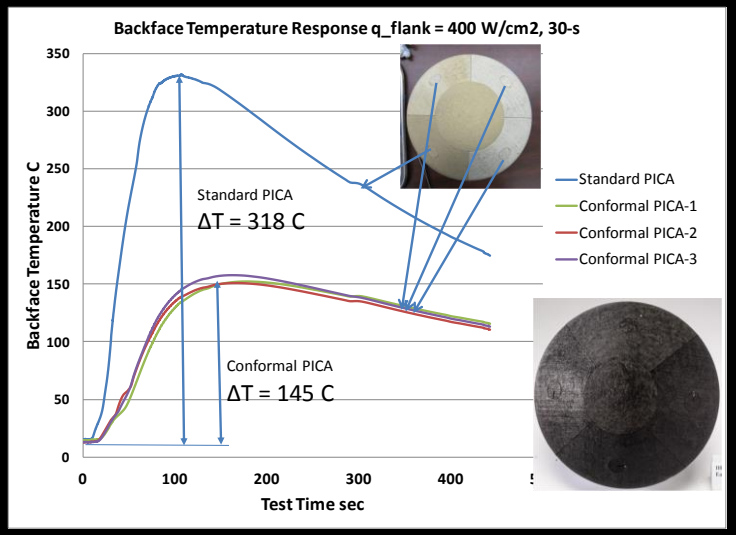
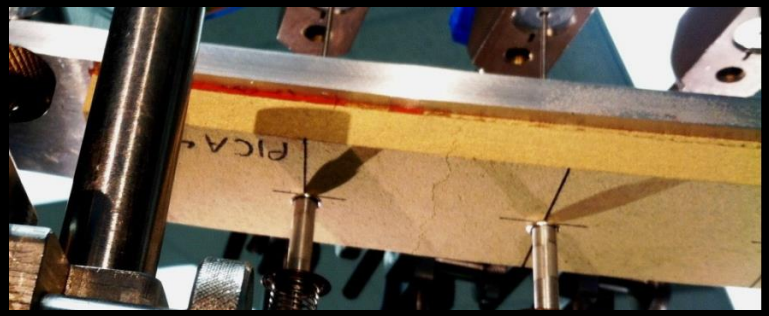
CA-TPS: The Problem – The Solution

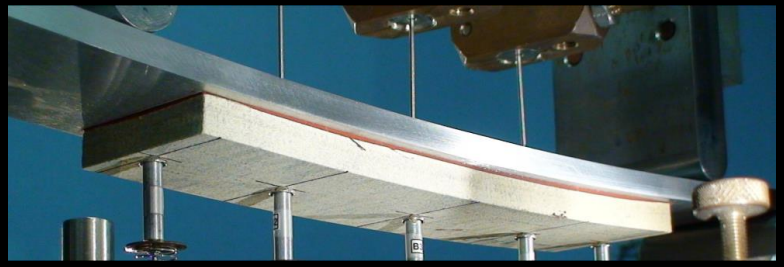
Problem: Current SOA materials require complicated installation techniques and/or high touch labor costs (PICA, Avcoat, SLA) and with adequate thermal and poor-to-moderate mechanical performance

Solution: Develop a conformal TPS ablator with a significantly lower areal mass and more compliant for ease of integration (direct bonding, no gap fill)

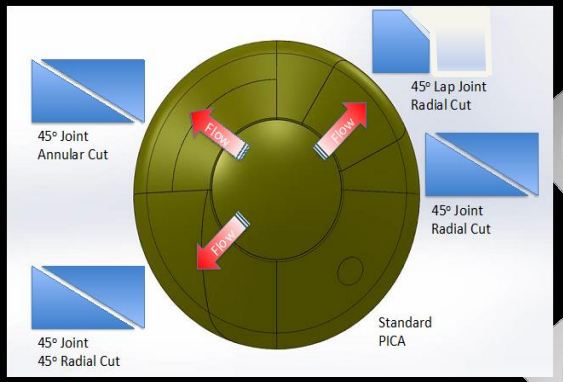


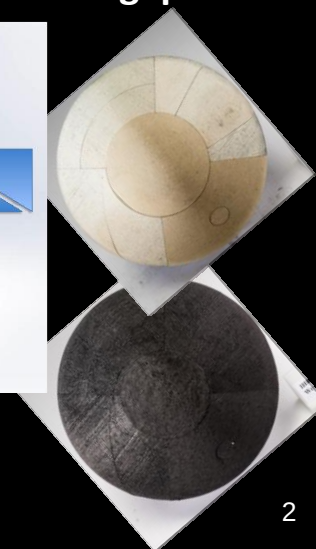


PICA failure <750 lb, ROC ~145”
C-PICA no failure at 1500 lb, ROC <65”

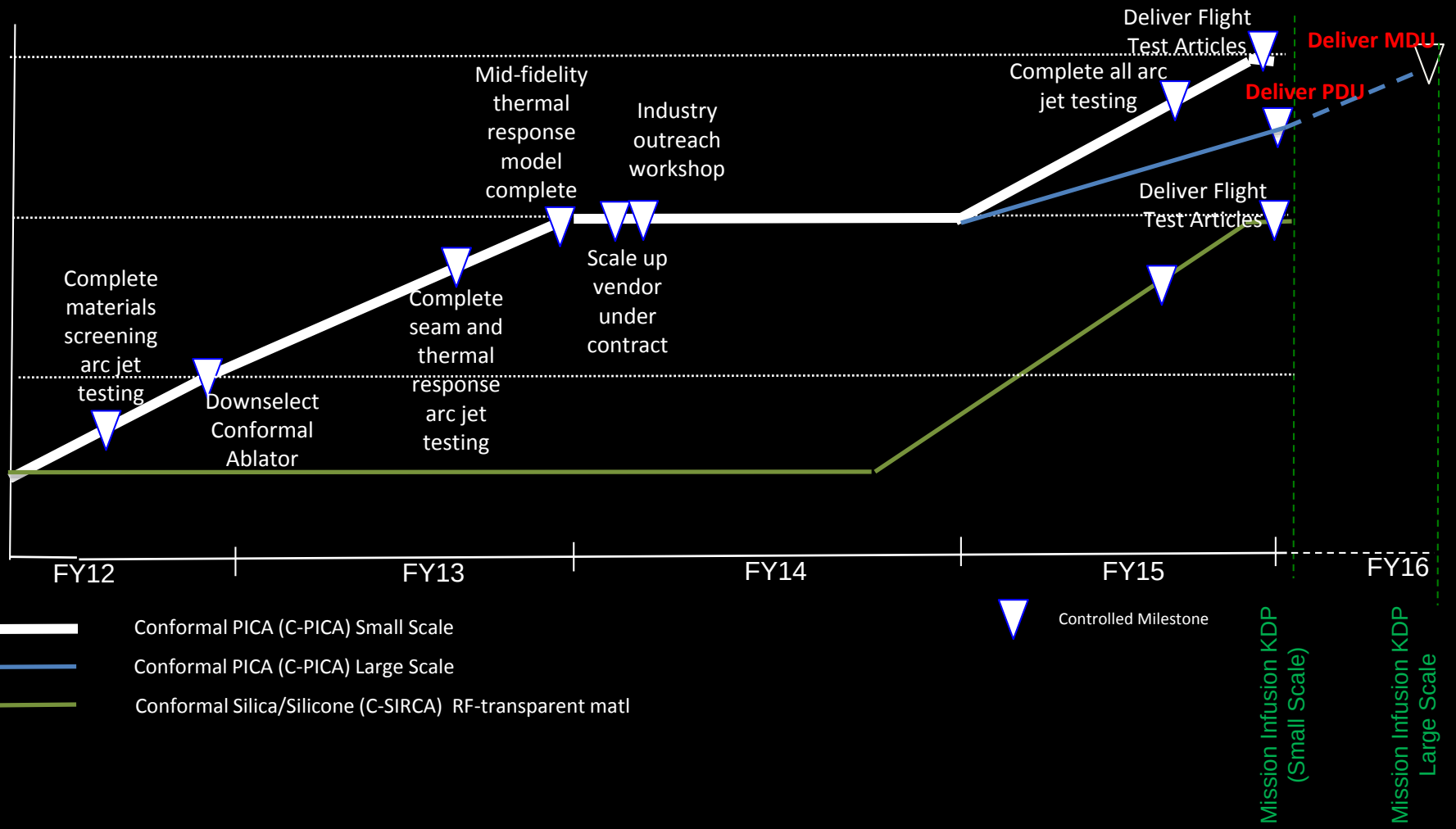


Materials response models tested – $\Delta T = \Delta T_{PICA}/2$
Seam development models tested – no gap filler





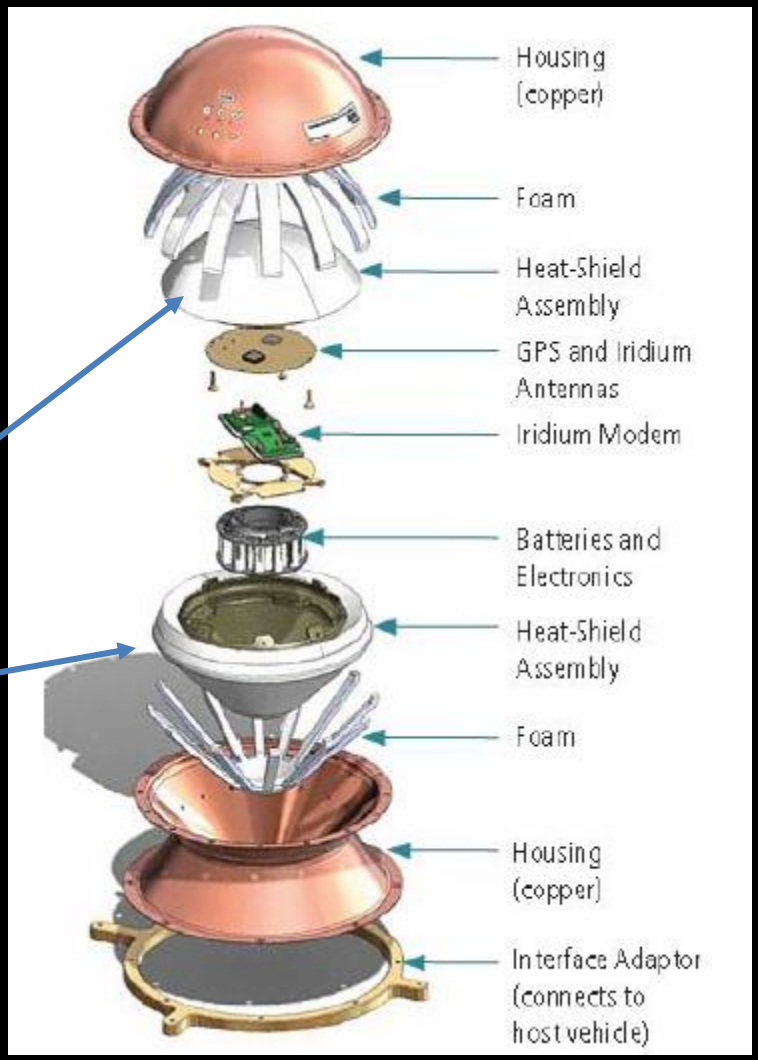
CA-TPS TRL Progression



CA-TPS Mission Infusion Efforts

Small Probe Development with Terminal Velocity Aerospace Design and Hardware Roles and Responsibilities

- Small probe vehicle designed for break-up evaluation
- TVA responsible for entire design
  - Ames responsible for TPS selection and sizing
- Ames hardware
  - Backshell TPS bonded to carrier structure
    - RF transparent Silica/silicone (C-SIRCA)
    - In-depth instrumentation included
  - Heatshield TPS bonded to carrier structure
    - C-PICA
    - In-depth instrumentation included
- Remaining hardware is TVA's responsibility

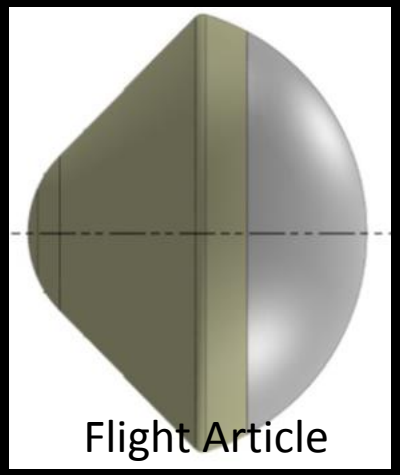


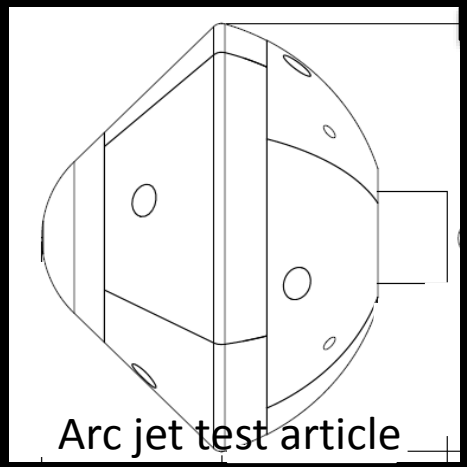
CA-TPS Mission Infusion Efforts

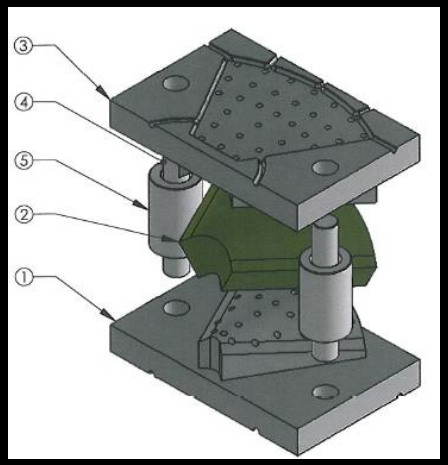
Small Probe Development with Terminal Velocity Aerospace

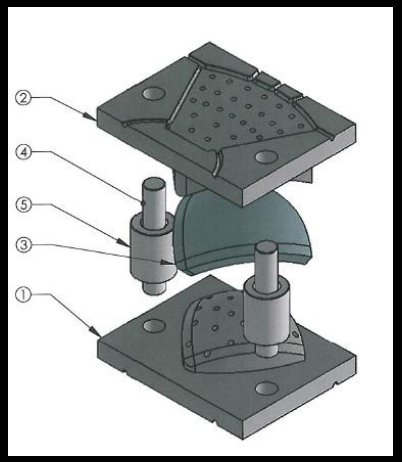
Arc Jet Test Article Design and Build

- **Vehicle and arc jet test article configuration iterations completed**
  - Trajectory analyses performed, environments defined, TPS sizing completed
- **TPS parts designed**
- **TPS processing molds designed and manufactured**
- **Segments processed and machined**









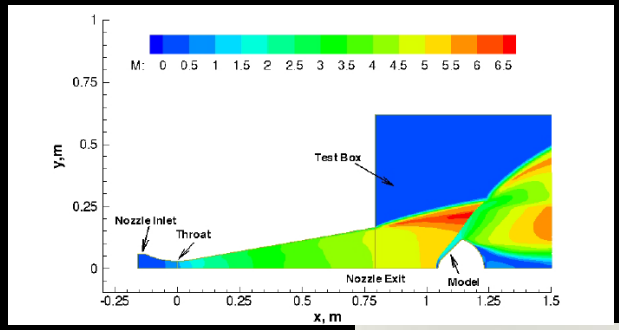
- **TVA tested their mock-up in balloon-drop out of Tillamook, Oregon**
  - Charred RF transparent conformal ablator flew

CA-TPS Mission Infusion Efforts

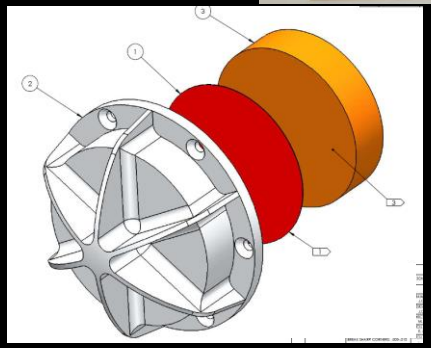
Small Probe Development with Terminal Velocity Aerospace

Arc Jet and Vibe Testing Efforts

- Arc jet test planning completed
  - Arc jet environments defined
  - Arc jet aeroshells received from TVA
  - Test article assembly nearly complete
  - Testing scheduled Aug 3-7



- Vibe test planning underway
  - Testing PICA, C-PICA and C-SIRCA
  - Test fixture
  - Fixtures and specimens in manufacturing
  - Testing scheduled in July

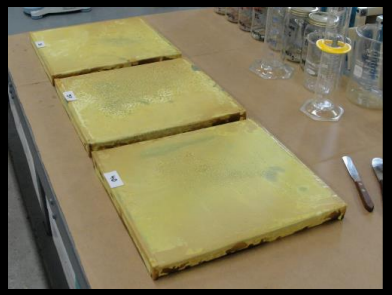


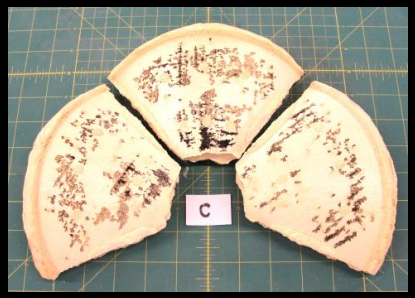
TVA RED-Data2 has a flight manifest – late CY17

CA-TPS Scale-Up – Step 1

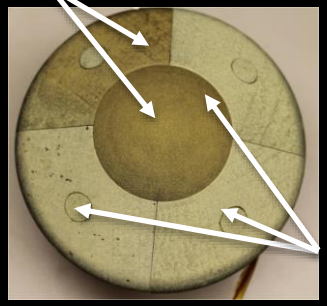
Vendor Demonstration of C-PICA Processing (Small articles)

- Material processing duplicated on small scale by Applied Research Associates, Ablative Laboratory (ARA-ABL)
- NASA provided molds and process descriptions used and first parts produced
  - Flat panels for characterization
  - Molded parts for use on arc jet test models
- NASA process duplicated with no changes provided delivered parts
- Testing to occur June 24-25





NASA C-PICA



Vendor

CA-TPS Scale-Up – Step 2

C-PICA Pathfinder Unit Leading to a MDU

- Pathfinder Demonstration Unit for delivery this year
  - Design new metallic molds for large-scale parts
  - Infiltrate thin and thick felt to demonstrate uniform infiltration and evaluate extent of warping (parts ~0.6m x 0.7m)
  - Install on foam “body”
- Manufacturing Demonstration Unit for delivery mid FY16 (if funded)
  - ~1-m length mid L/D vehicle design
  - Build 3-4 panels
  - Side panel(s) demonstrates complex curvature
  - Install on foam “body”