1. Background – PICA and PICA Sustainability

State of the Art Low Density Carbon Phenolic Ablators

- Lyocell Based PICA (PICA-D) was manufactured and limited testing performed
- Based on successful mission use across destinations
- Phenolic Impregnated Carbon Ablator (PICA) is a low density (~ 0.27g/cc) ablator first used as the forebody heatshield for the Stardust sample return capsule (single piece heatshield)
- Since Stardust:
  - PICA was used on the Mars Science Lab (MSL) in a tiled configuration
  - OSIRIS-REx sample return capsule (single piece)
  - Slated for Mars 2020 (tiled configuration)
- In 2016 NASA ARC learned that the heritage rayon utilized in PICA was stopping production, leading to a flight-qualified PICA sustainability challenge
- In FY16/17, NASA ARC was funded by SMD-PSD to address PICA rayon sustainability
- Lyocell Based PICA (PICA-D) was manufactured and limited testing performed showing it to be a good candidate as a potential replacement for heritage rayon

2. Establishment of PICA-D as a Replacement for Heritage PICA

- In FY17, SMD-PSD funded ARC to manufacture and perform limited property and aerothermal characterization of lyocell-based PICA
  - FY17 task successfully completed limited testing that indicated the viability of PICA-D as a potential replacement for heritage PICA

3. Arc Jet Characterization

- 3 arcjet conditions were tested in FY17:
  - NF proposals provided guidance on test conditions
  - All conditions will be repeated in FY18/19 to demonstrate performance repeatability

4. Exploration of Lyocell PICA (PICA-D) for Future Missions

- Establishing PICA-D as a "drop in replacement" will allow missions to depend on and design missions with PICA without the risks typical of a replacement.
- Establishing the extended capability of PICA-D will allow Sample Return Missions with higher entry speed that were not considered before.

   Task 1: Establish PICA-D as a Drop-in Replacement for Heritage PICA

   - Develop comprehensive material property database
     - Perform comprehensive material property testing (range of temperatures) for thermal and mechanical properties
   - Perform comprehensive arcjet test campaign
     - Test at multiple conditions, including different material lots
     - Testing to include thermal response, instrumented stagnation and wedge shear coupons
   - Develop PICA-D Thermal Response Model utilizing arcjet test data and new material property database

   Task 2: Establish the Expanded Capability (Extensibility) of PICA-D

   - Demonstrate Manufacturing and Scale-Up of a Single Piece Heatshield at a Scale of > 1.2m Diameter
     - Perform comprehensive characterization and evaluation of single piece FiberForm casting
     - Characterize fiber alignment, mechanical properties and non-destructive evaluation (NDE)
   - Establish Expanded Design Space of PICA-D
     - Perform arcjet testing and heat flux / pressure conditions beyond which PICA has previously been tested and/or flown
   - Publish all PICA-D Data for current and future missions

5. PICA-D Project Schedule

- NASA ARC / FMI is working with the Planetary Science Division of the Science Mission Directorate to address PICA rayon sustainability concerns
- In FY16/17, Lyocell Based PICA (PICA-D) was manufactured and limited testing performed showed it to be a good candidate replacement for heritage rayon
- Establishing PICA-D as a "drop in replacement" will allow missions to design with PICA-D without any competitive disadvantage over other competing proposals.
- Establishing the extended capability of PICA-D will allow Sample Return Missions with higher entry speeds not considered before.

6. Summary

- NASA ARC / FMI is working with the Planetary Science Division of the Science Mission Directorate to address PICA rayon sustainability concerns
- In FY16/17, Lyocell Based PICA (PICA-D) was manufactured and limited testing performed showed it to be a good candidate replacement for heritage rayon
- Establishing PICA-D as a "drop in replacement" will allow missions to design with PICA-D without any competitive disadvantage over other competing proposals.
- Establishing the extended capability of PICA-D will allow Sample Return Missions with higher entry speeds not considered before.