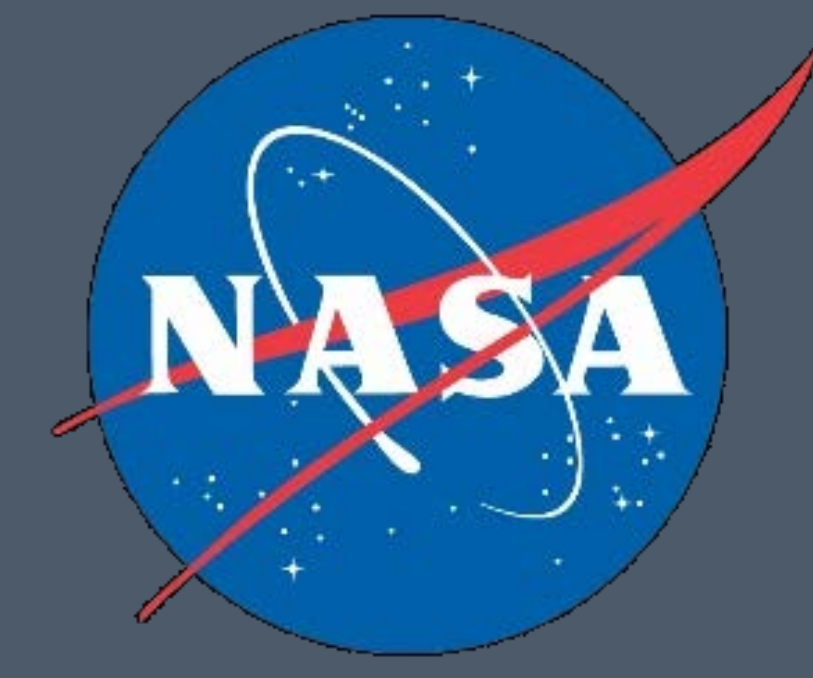


Direct-Write Printing on Three-Dimensional Geometries for Miniaturized Detector and Electronic Assemblies

Beth Paquette, Peng Chen, NASA's Goddard Space Flight Center (GSFC)



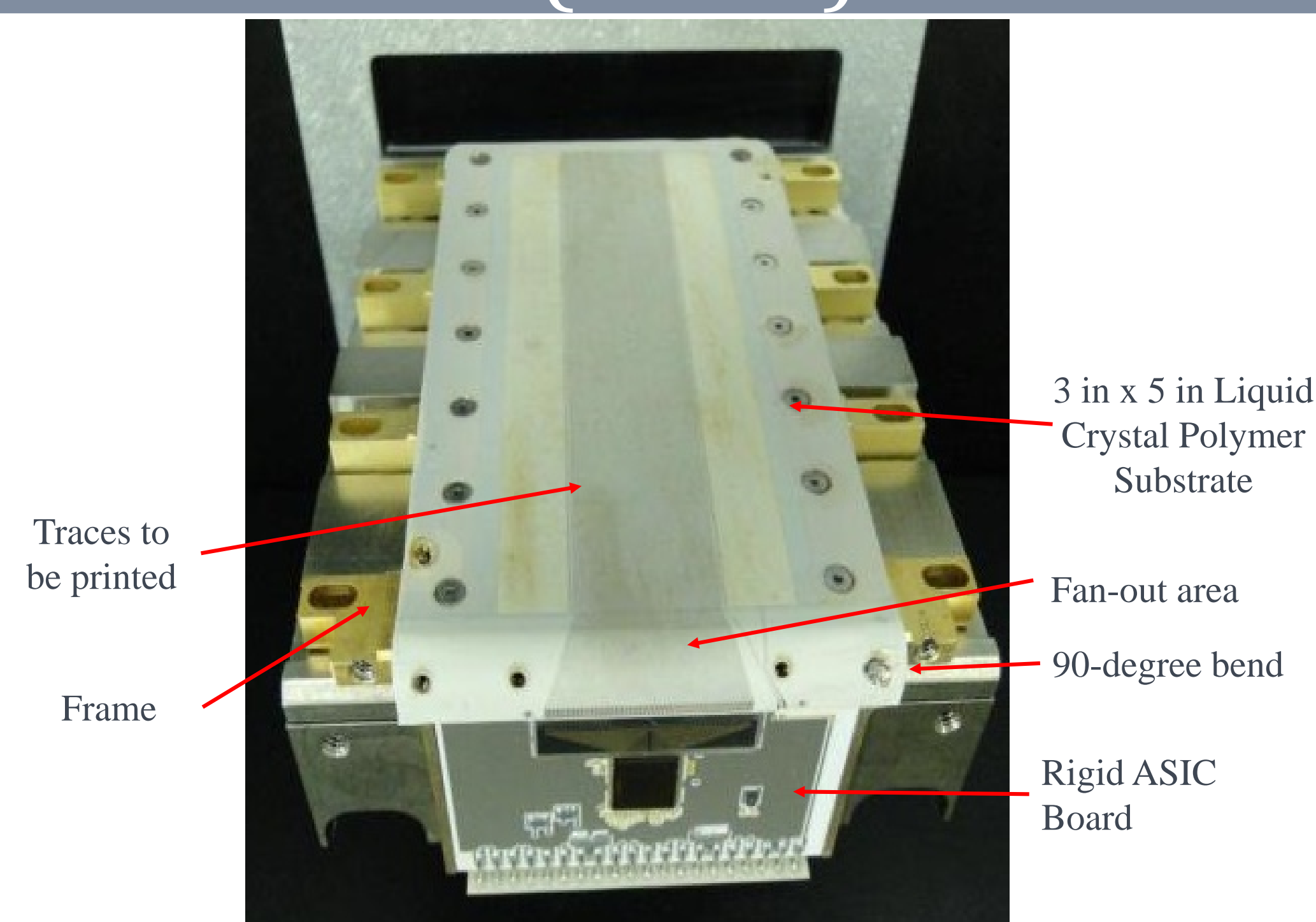
OBJECTIVES

- Analyze repeatability, performance and robustness of Aerosol Jet Printing (AJP).
 - Define a repeatable process for printing the following applications:
 - Next Generation X-Ray Polarimeter (NGXP) Detector Strips
 - Next Generation Microshutter Arrays (NGMSA)
 - MicroWell Detectors (MWD)
 - Magnetometer Bobbin Wires (MBW)

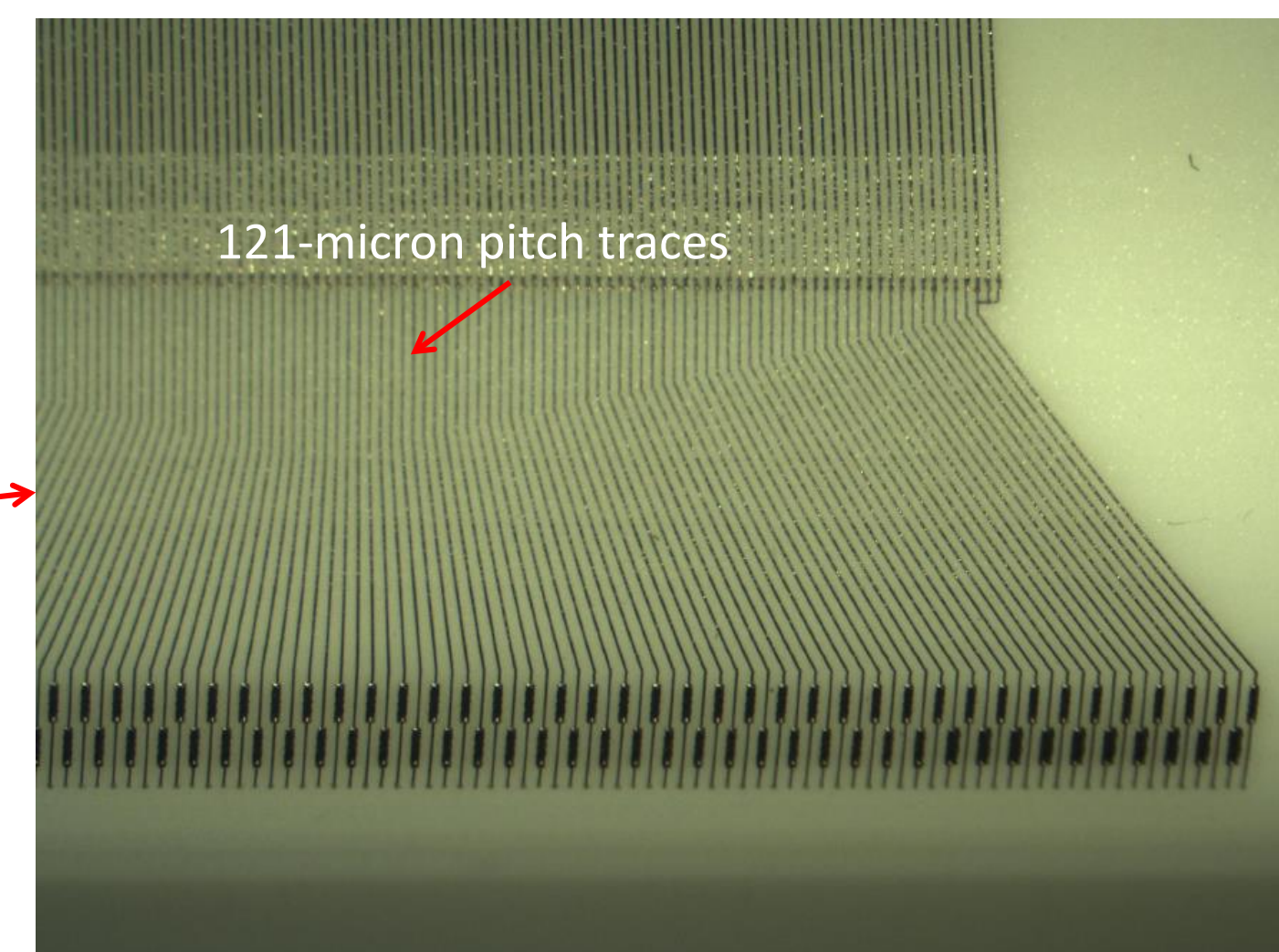
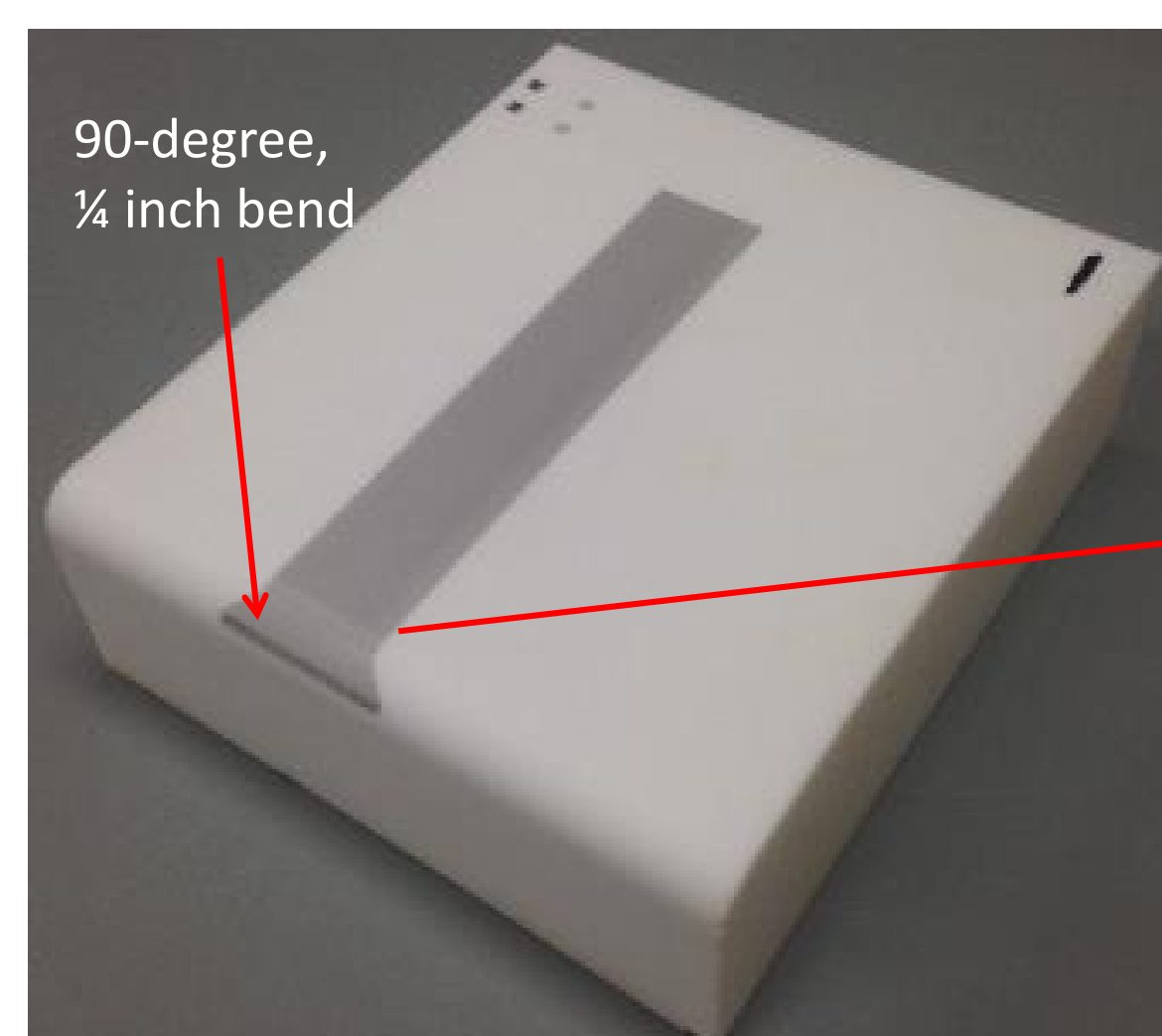
KEY CHALLENGES

- Enable new detector and electronic assemblies:
 - Reduces trace widths and other feature sizes to 10 microns from the current trace sizes, which increases sensitivity by an order of magnitude;
 - Enables dense assemblies - require trace spacing of 121 microns or less;
 - Permits very complex geometries on flexible and three-dimensional substrates.
 - Reduces Assembly Time – MWDs for example require thousands of interconnects that would typically be wire bonded.

NEXT GENERATION X-RAY POLARIMETER (NGXP)



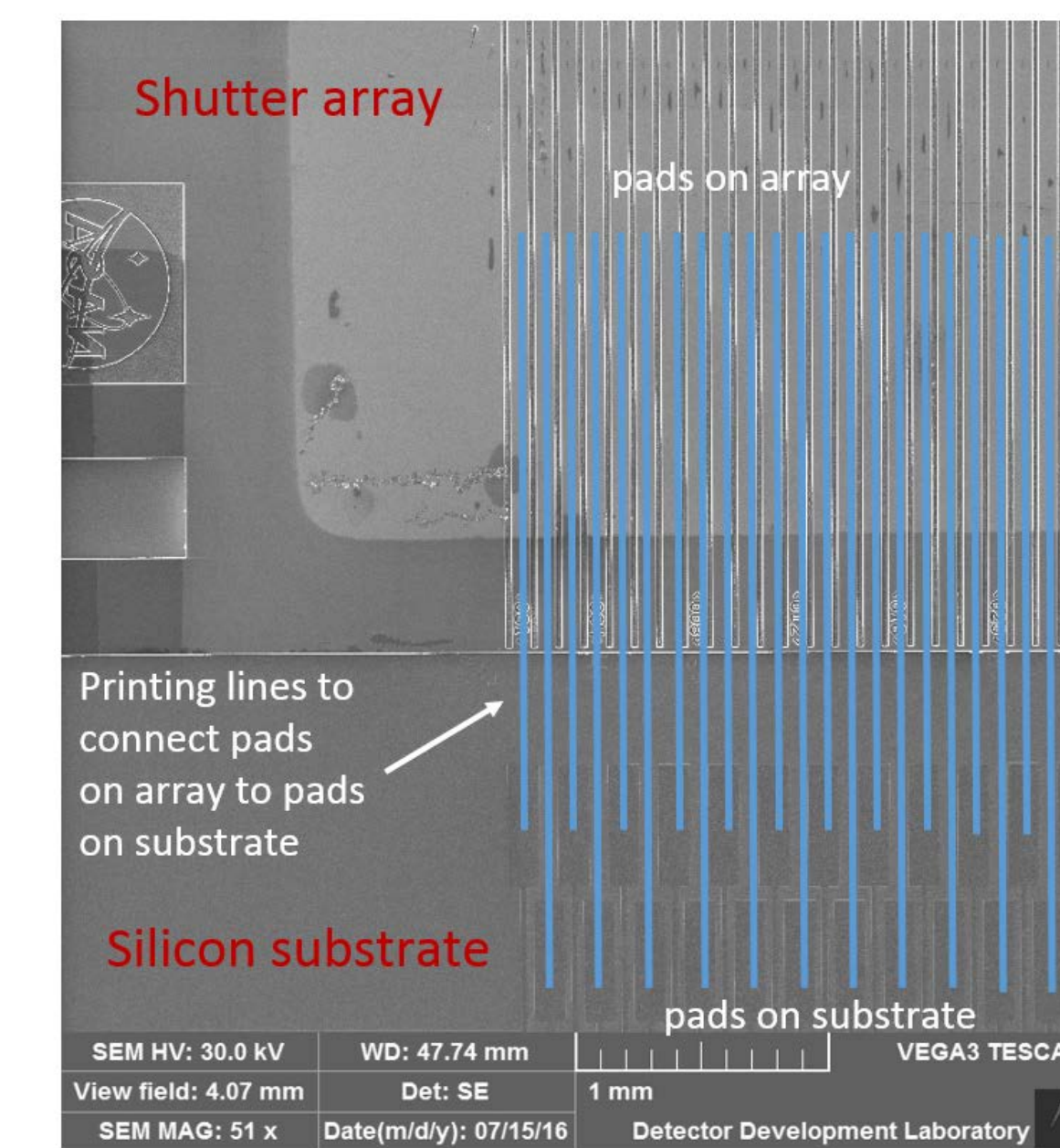
Detector Strip: Original Design 60µm width traces with 121µm pitch
Detector Strip Pattern on 3D Surface using AJP



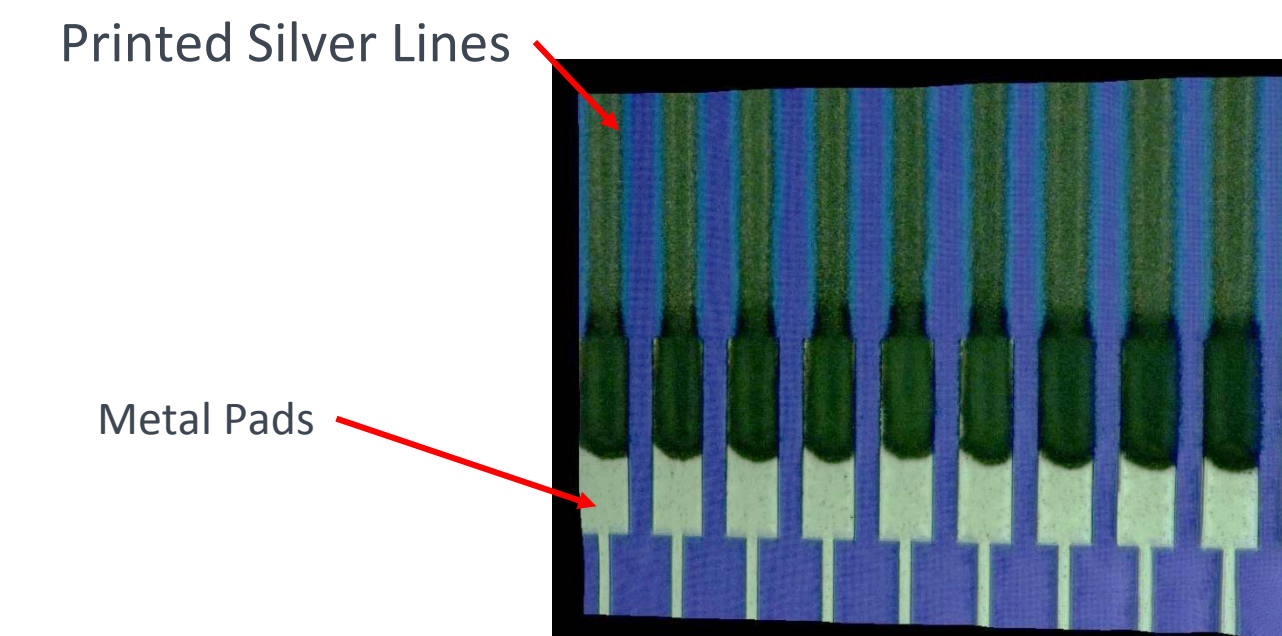
Silver Traces Printed onto Rigid Block around a 90-Degree Bend, Optomec

NEXT GENERATION MICROSHUTTER ARRAYS

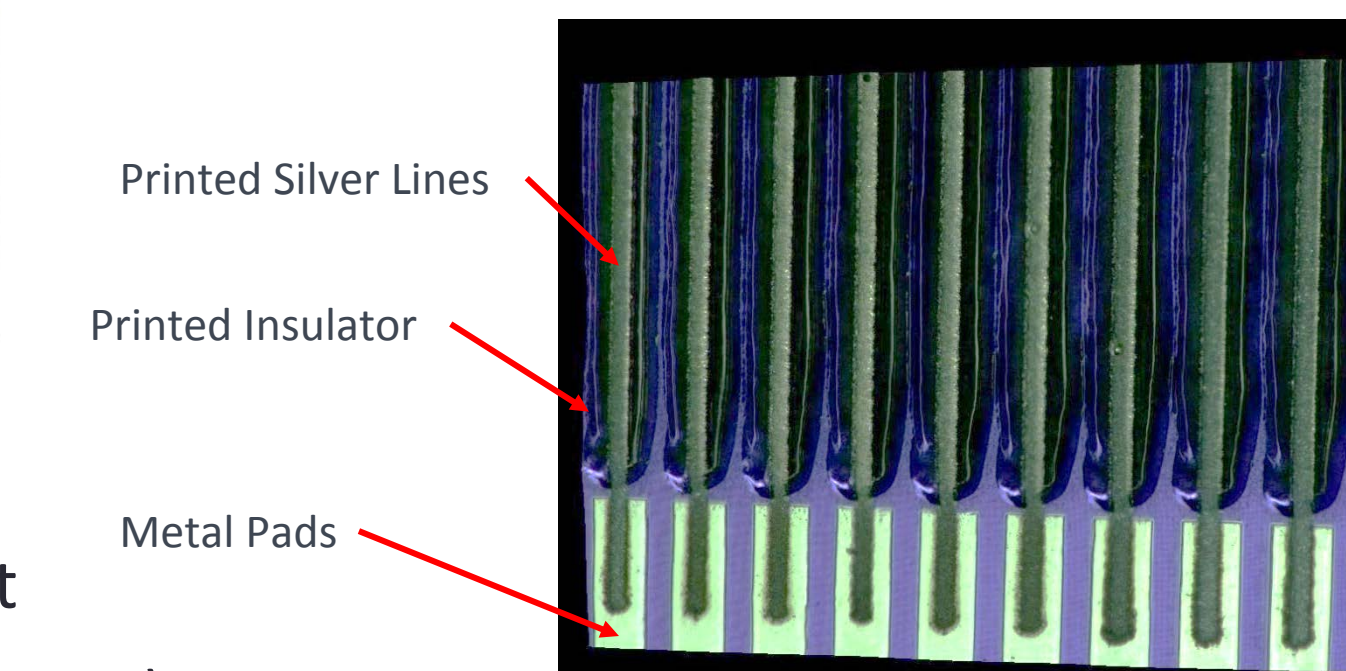
Next Generation Micro Shutter Arrays (NGMSAs)



MSA Original Design
80µm pitch Pads, 100µm MSA height
(from substrate surface to top surface of array)



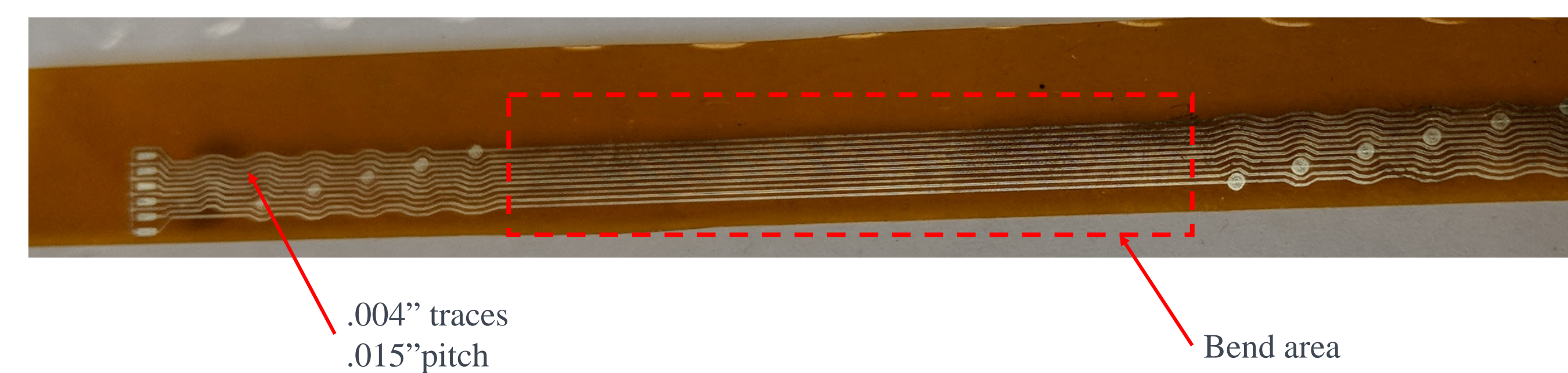
Test print: Silver Traces Printed onto MSA Substrate and Metal Pads



Test print: Silver Traces Printed onto MSA Substrate and Metal Pads with insulator in between

FLEXCIRCUITS

- Flexcircuit for Cubesat
 - Need 180-degree bend
 - Printed silver ink on Kapton
 - In progress: adhesion tests and bend tests

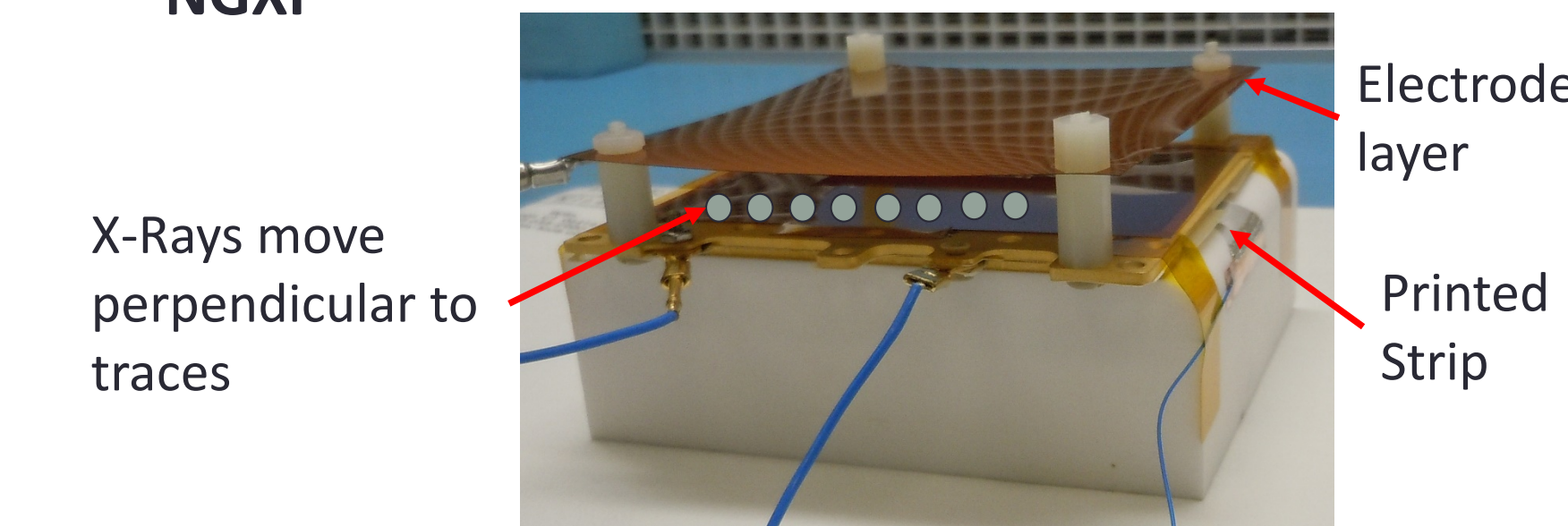


MATERIALS TESTING

- Adhesion
 - Determine ASTM Adhesion ratings of printed materials on different substrates.
- Wire Bonding:
 - Determine if printed materials can be wire bonded to
- Outgassing:
 - Determine printed traces' Total Mass Loss and Collected Volatile Condensable Material values
- Trace Measurements:
 - Determine size tolerances of printed traces
 - Determine conductivity of traces

FINDINGS AND STATUS

NGXP



X-Rays move perpendicular to traces

Printed Detector Strip in Test Fixture

Strip survived 16 hours of testing. No damage to traces observed, and was able to get data

MSA - Conductivity tests were successful on printed samples on MSA substrate

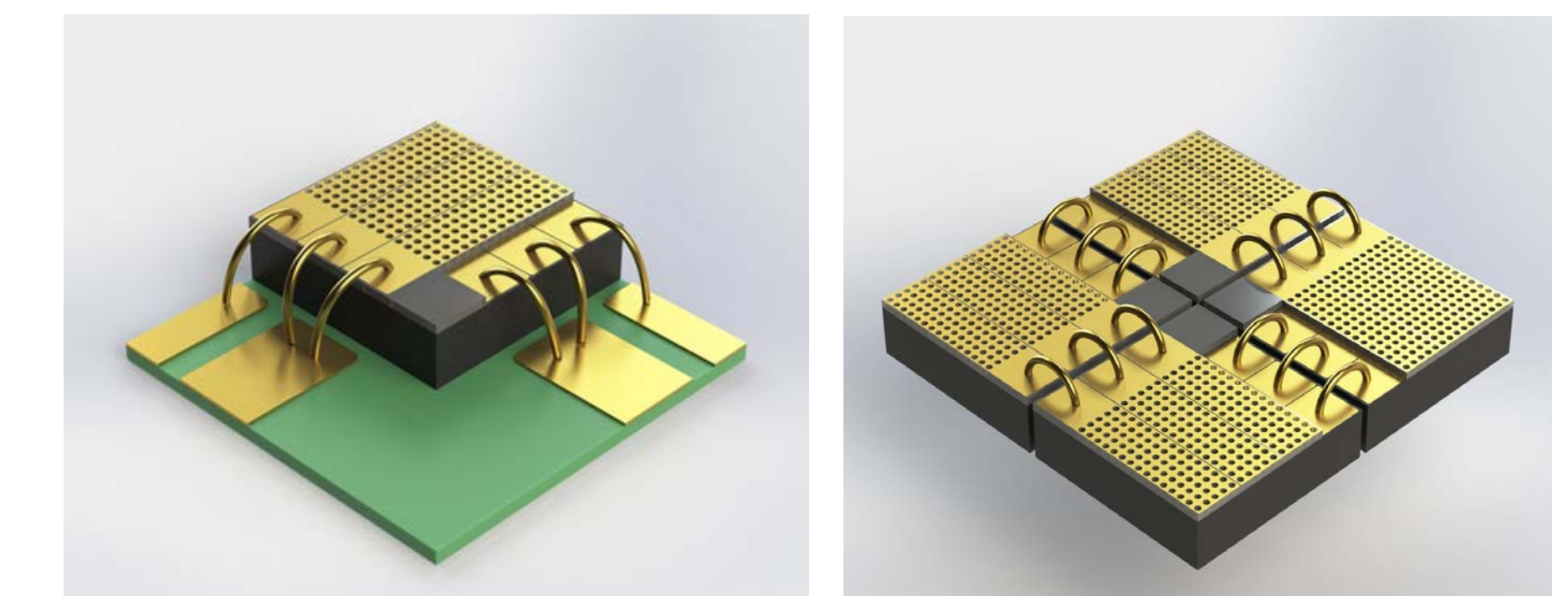
Mechanical Tests - Conductive inks on Macor were shown to have class 5 and class 4B adhesion per ASTM adhesion test standard D3359

Wire Bonding - Initial testing conducted using printed silver pads. Aluminum did not bond to the pads. Gold did bond to the pads, but 50% of samples tested failed to meet 3g minimum pull requirement.

Outgassing - Silver inks tested were well below typical limits of 1.0% Total Mass Loss and 0.1% Collected Volatile Condensable Materials

FUTURE WORK

- Print fillets and interconnects onto MSA
- Print ASIC pattern onto detector strip block, attach ASIC and print fillets and interconnects to the ASIC
- Refine NGXP print using substrates with smoother finish for tighter trace size tolerance
- Conduct bend and adhesion tests on flexcircuit samples
- Print insulating fillets around chips and print interconnects to those chips using defined alignment and CAD adjustment procedures for Silicon Microwell detector (SiMWD) assemblies.
- Print spiral pattern using silver ink onto magnetometer bobbin



(left) MWD interconnects from the tile edges to substrate, (right) interconnects between MWD tiles. The goals of this program are to add insulating fillets (not shown) between the tiles and substrate and possibly also between tiles, and to replace the wire bonds illustrated here with 3D printed conductive traces

ACKNOWLEDGEMENTS

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CONTACT

For further information, please contact Beth Paquette at 301-286-8647 or Beth.M.Paquette@nasa.gov.