

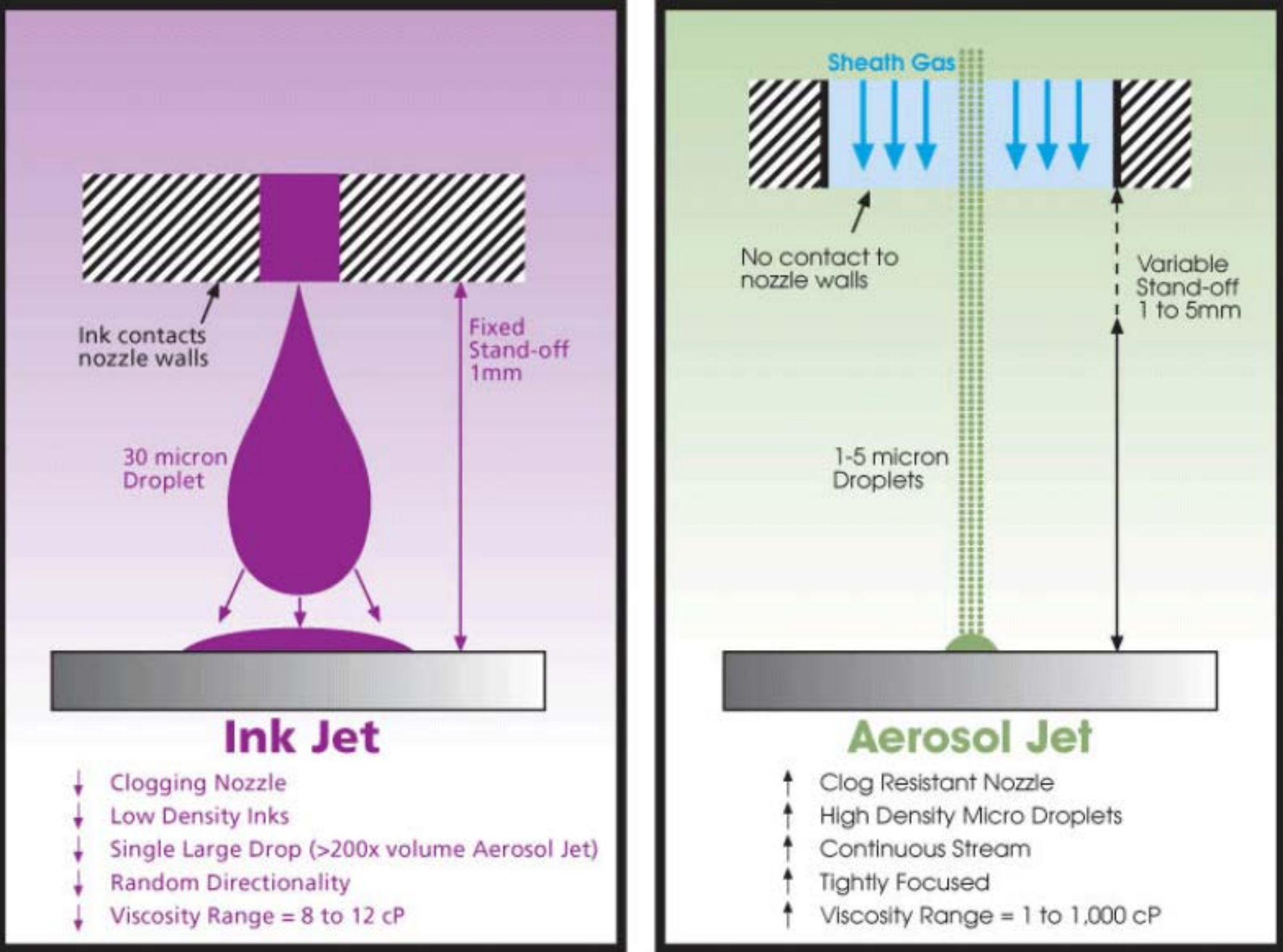
# Direct-Write Printing on Three-Dimensional Geometries for Miniaturized Detector and Electronic Assemblies

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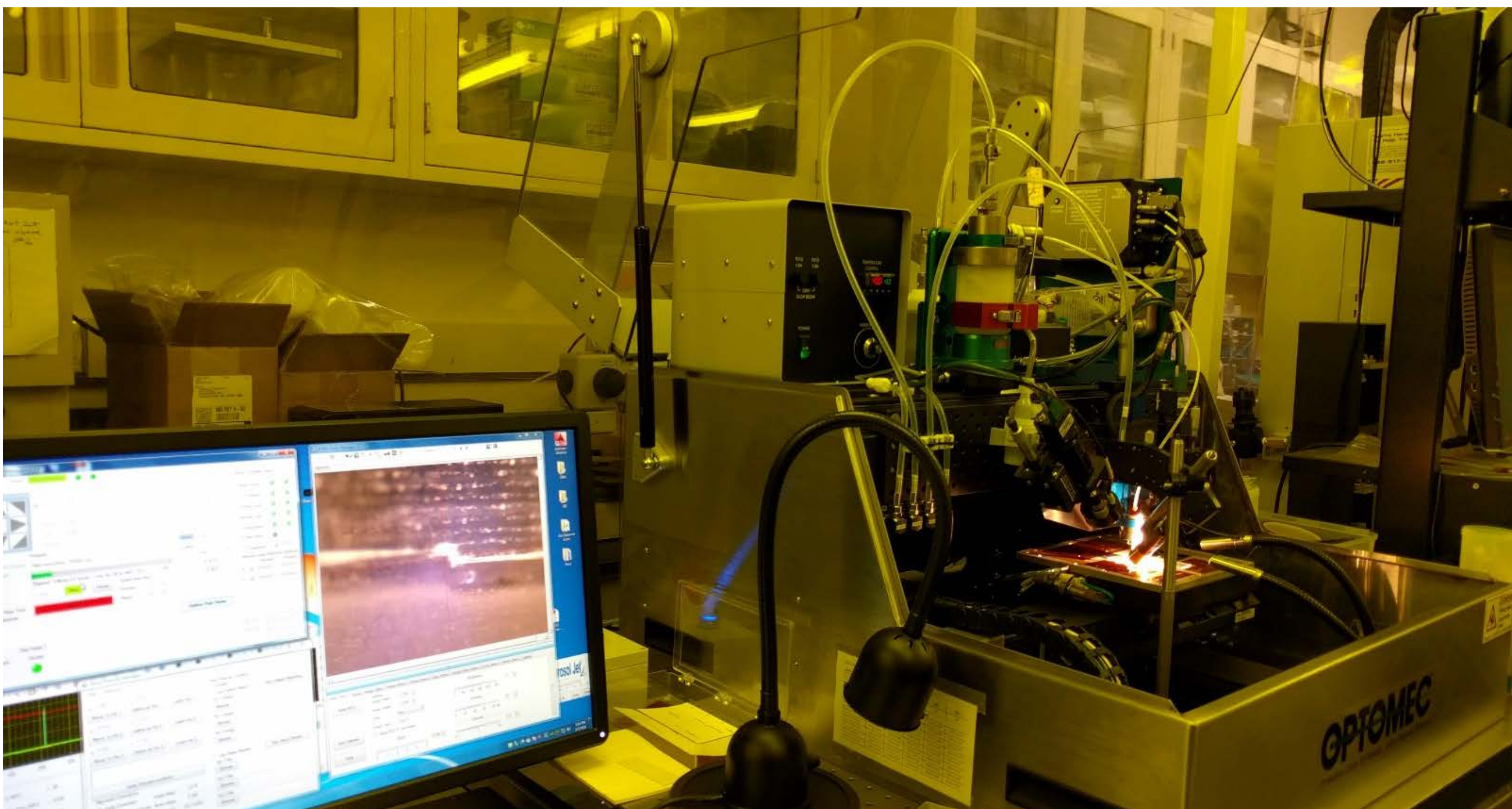


## OBJECTIVES

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



Ink Jet vs Aerosol Jet Printing



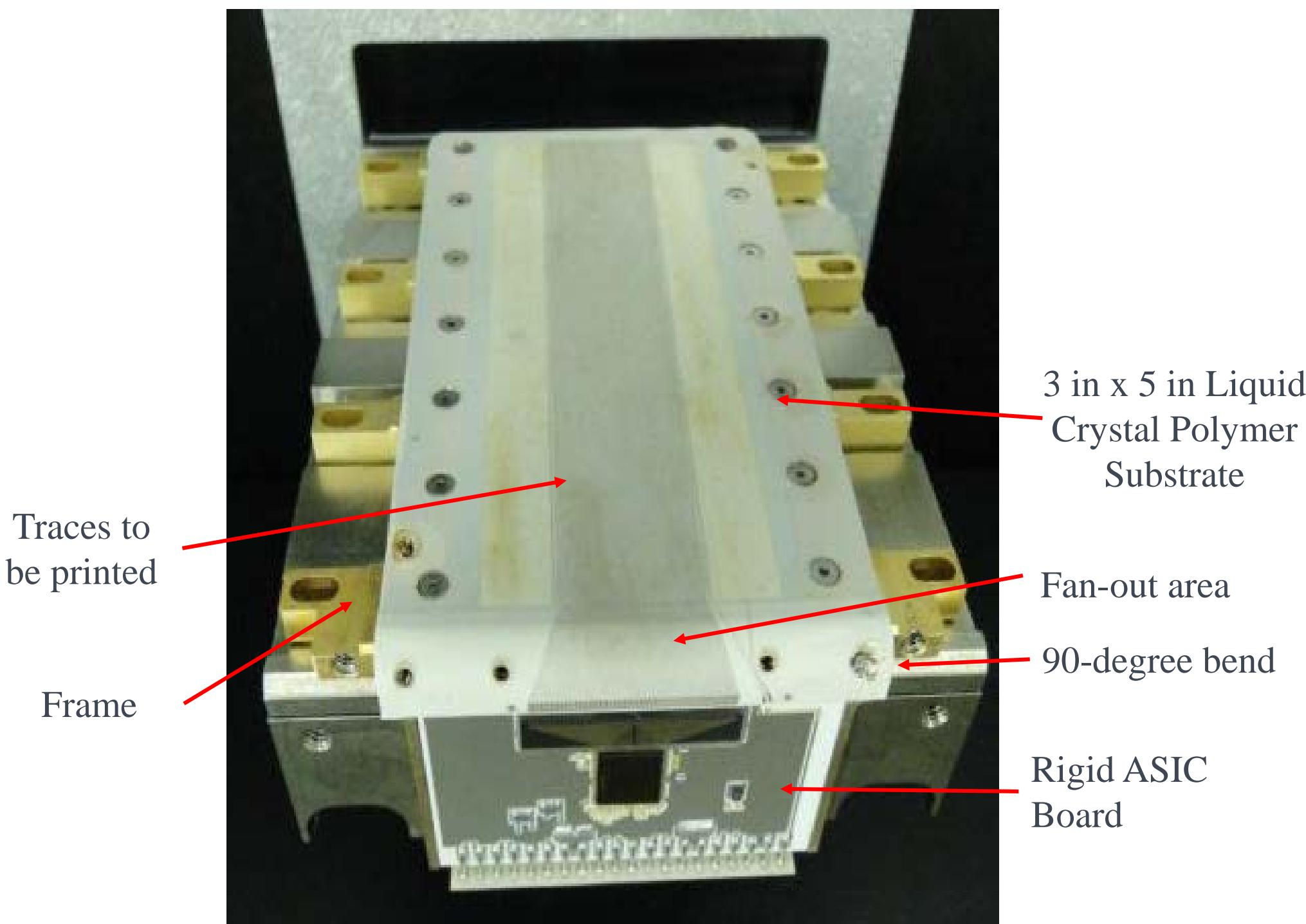
Optomec Aerosol Jet Printer AJ200

## 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.

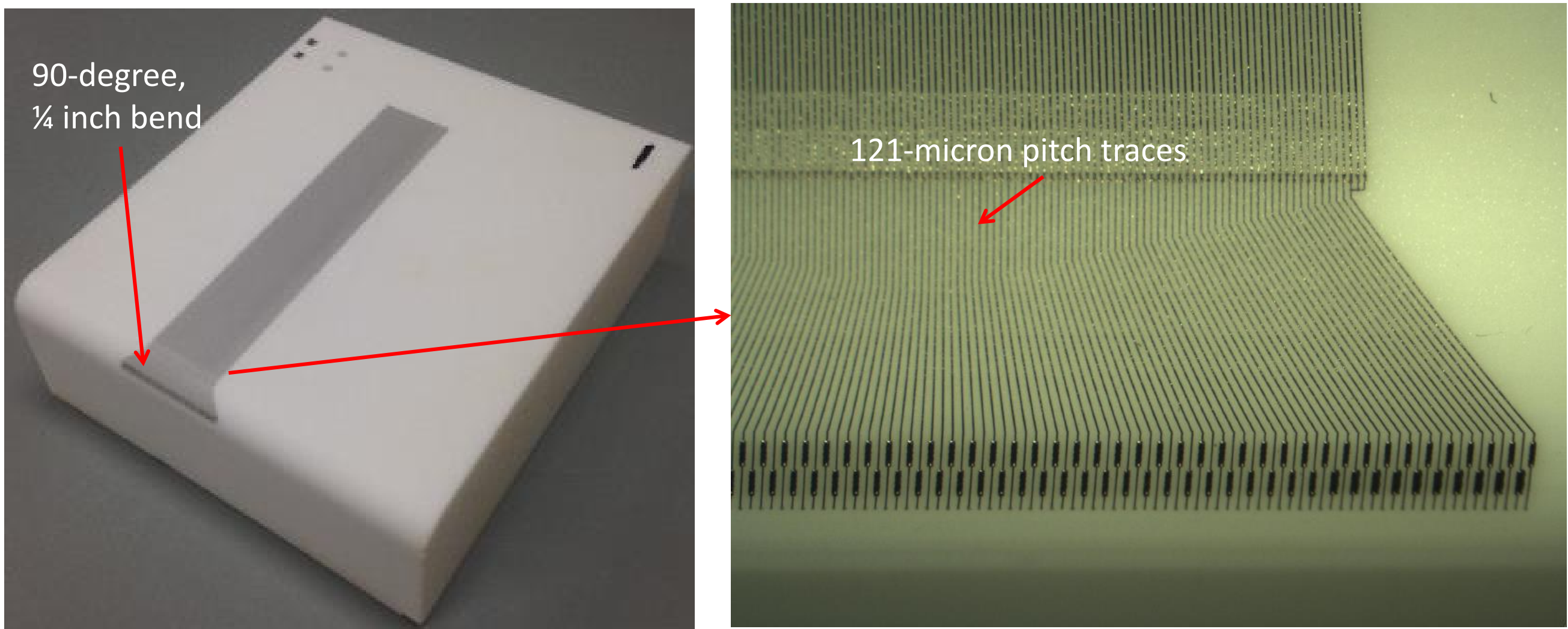
## APPLICATIONS

### Next Generation X-Ray Polarimeter:



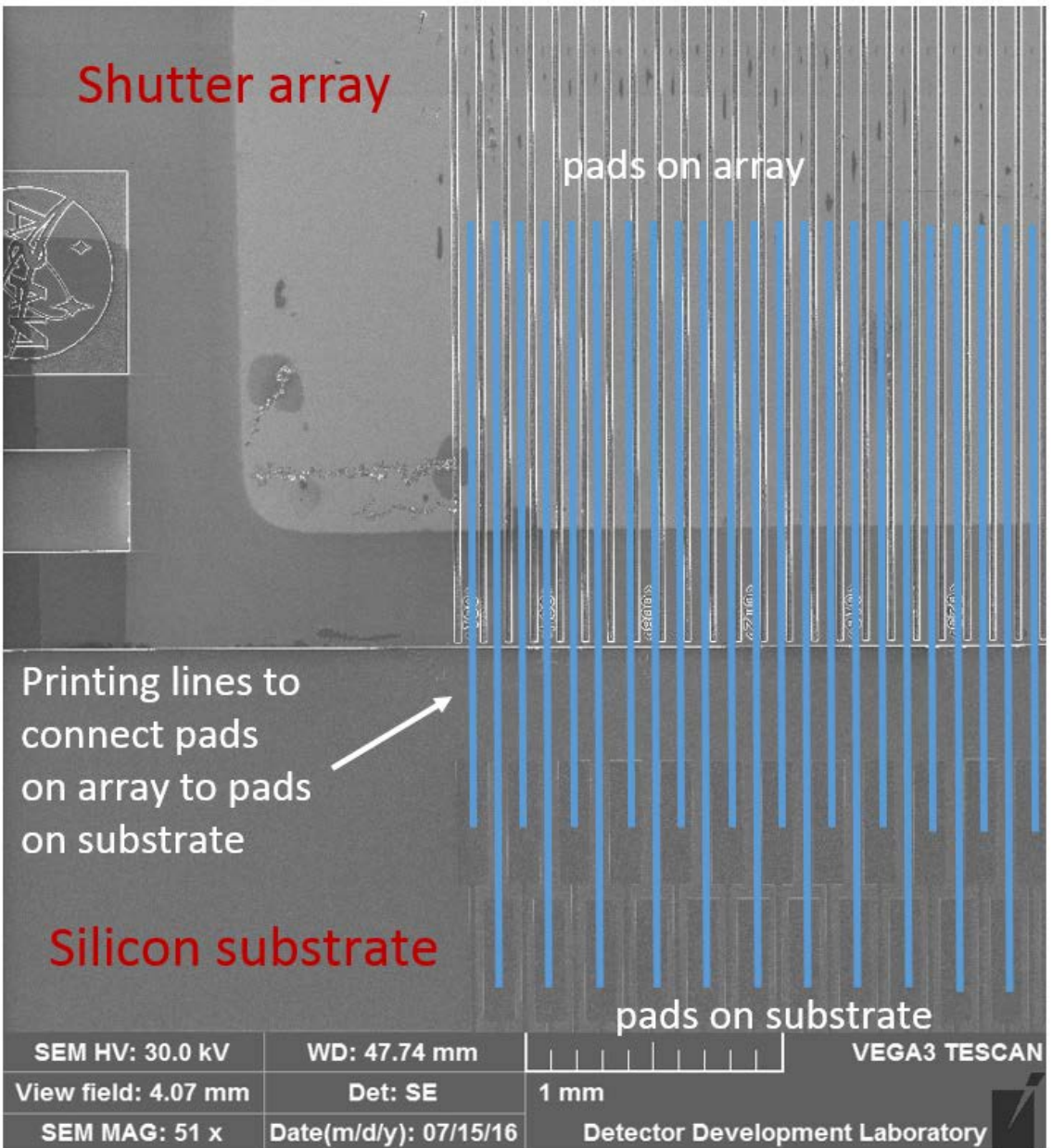
Detector Strip: Original Design 60µm width traces with 121µm pitch

### Detector Strip Pattern on 3D Surface using AJP

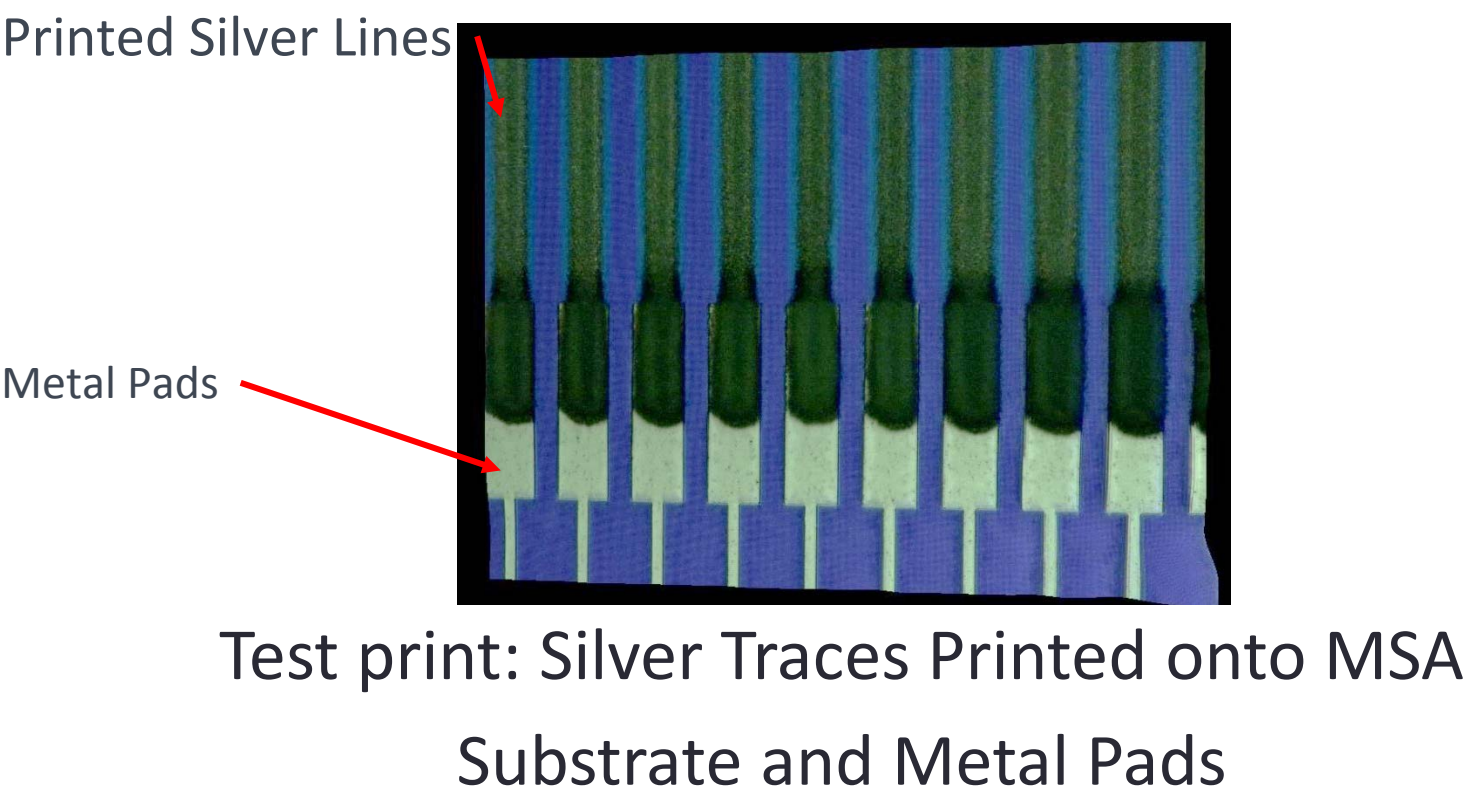


Silver Traces Printed onto Rigid Block around a 90-Degree Bend, Optomec

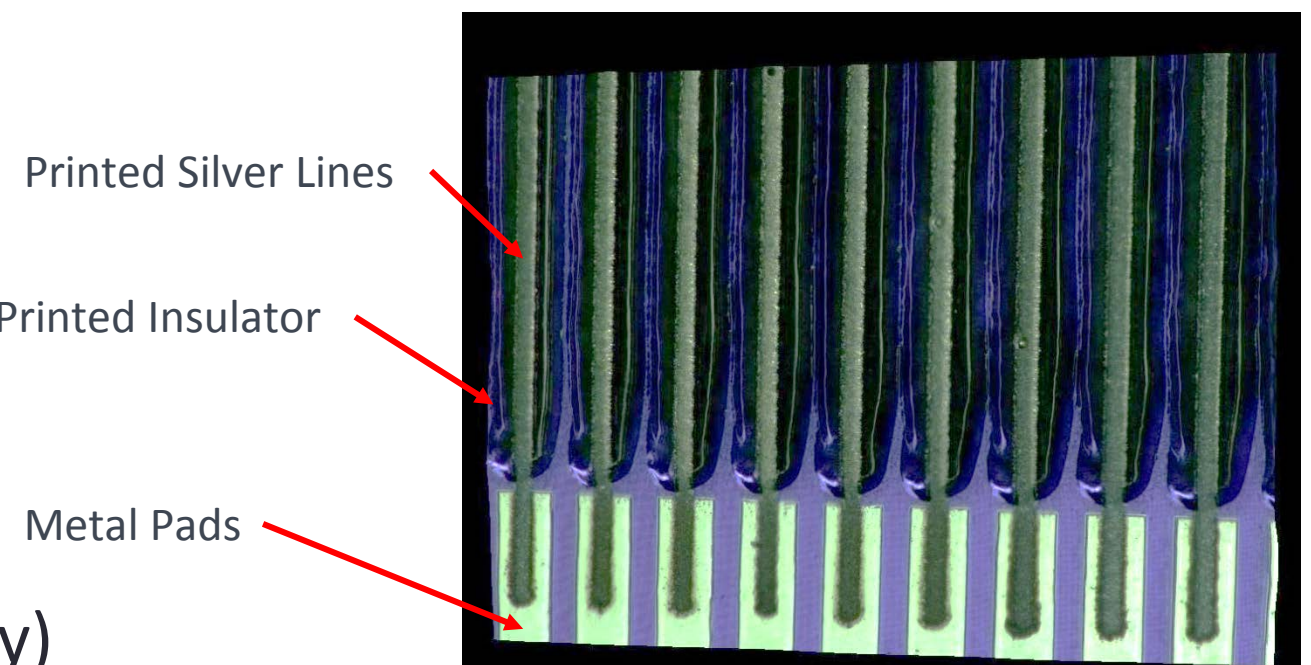
### Next Generation Micro Shutter Arrays (NGMSAs)



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



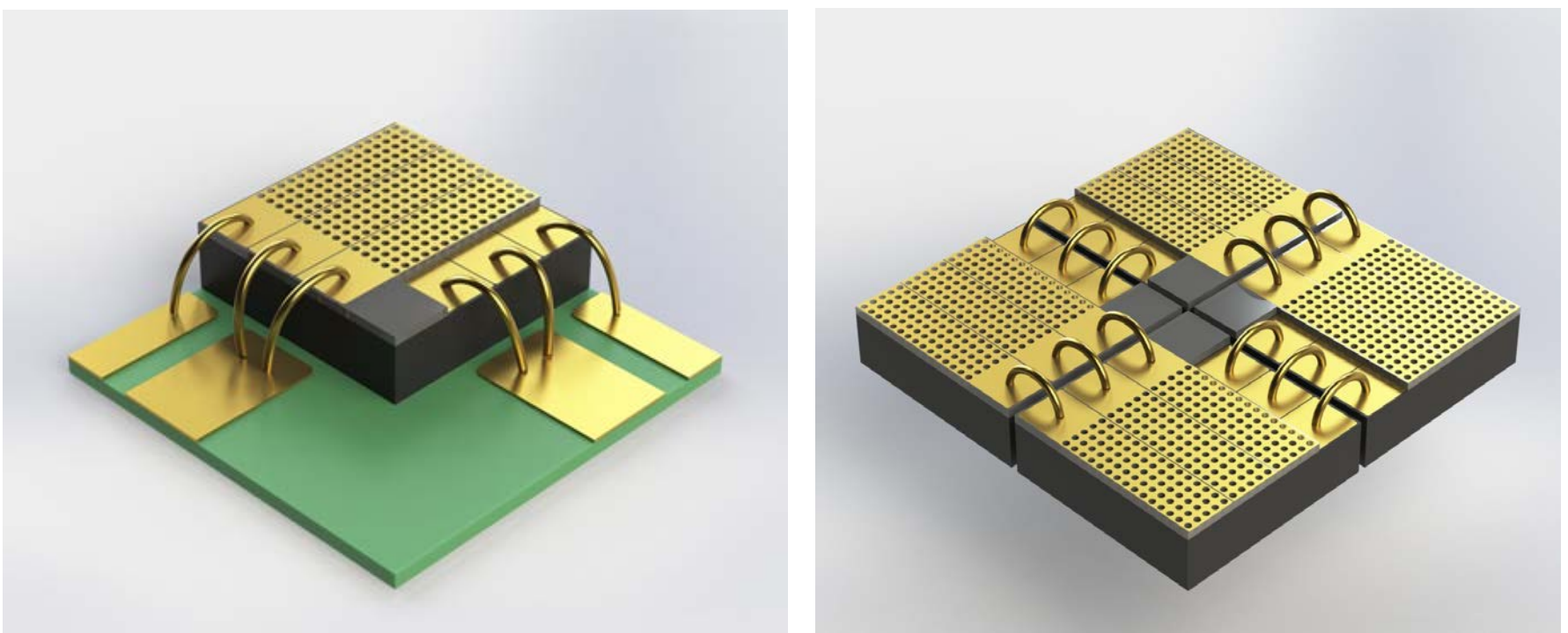
Test print: Silver Traces Printed onto MSA Substrate and Metal Pads with insulator in between

## FINDINGS AND STATUS

- Completed Repeatability Plans for all 4 applications.
- Completed Material Selection for all 4 applications.
- Designed rigid substrates for 3D rigid detector strip and magnetometer bobbin. Defined 3D printing paths.
- Additional application of superconducting traces identified.
- Additional application of flex cable for CubeSat identified.
- Received all substrates.
- Prints of detector strip pattern on rigid and flexible materials completed.
- Microshutter array (MSA) test prints completed. Conductivity tests showed promising results.
- Wire bond tests on the detector strip prints on PEEK showed that gold bonds adhere better.

## FUTURE WORK

- Test printed detector strip patterns on rigid pre-formed material.
- Print wires around magnetometer bobbins.
- Print traces for CubeSat flex circuitry.
- 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 ASIC board pattern onto detector strip block, attach ASIC and print its interconnects.



(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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