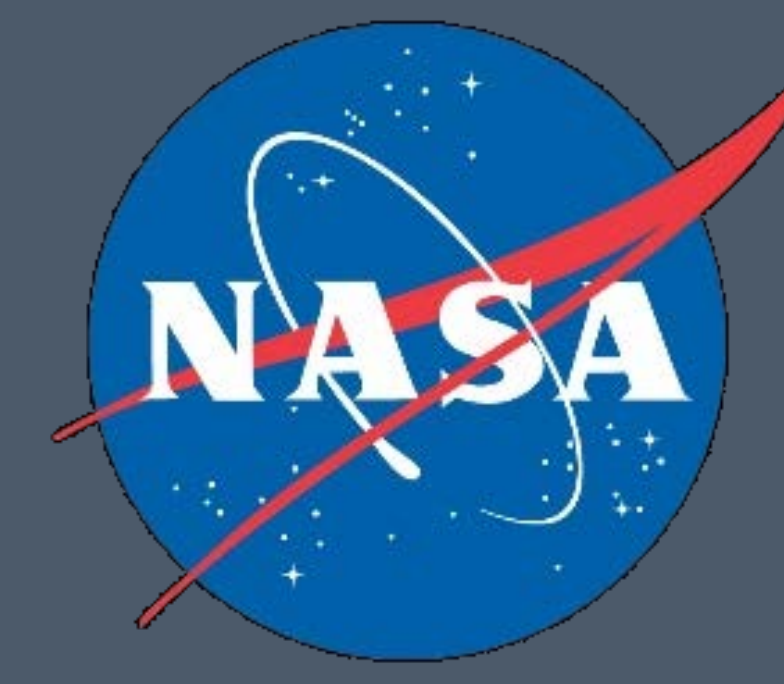


Direct-Write Printing on Three-Dimensional Geometries for Miniaturized Detector and Electronic Assemblies



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OBJECTIVES

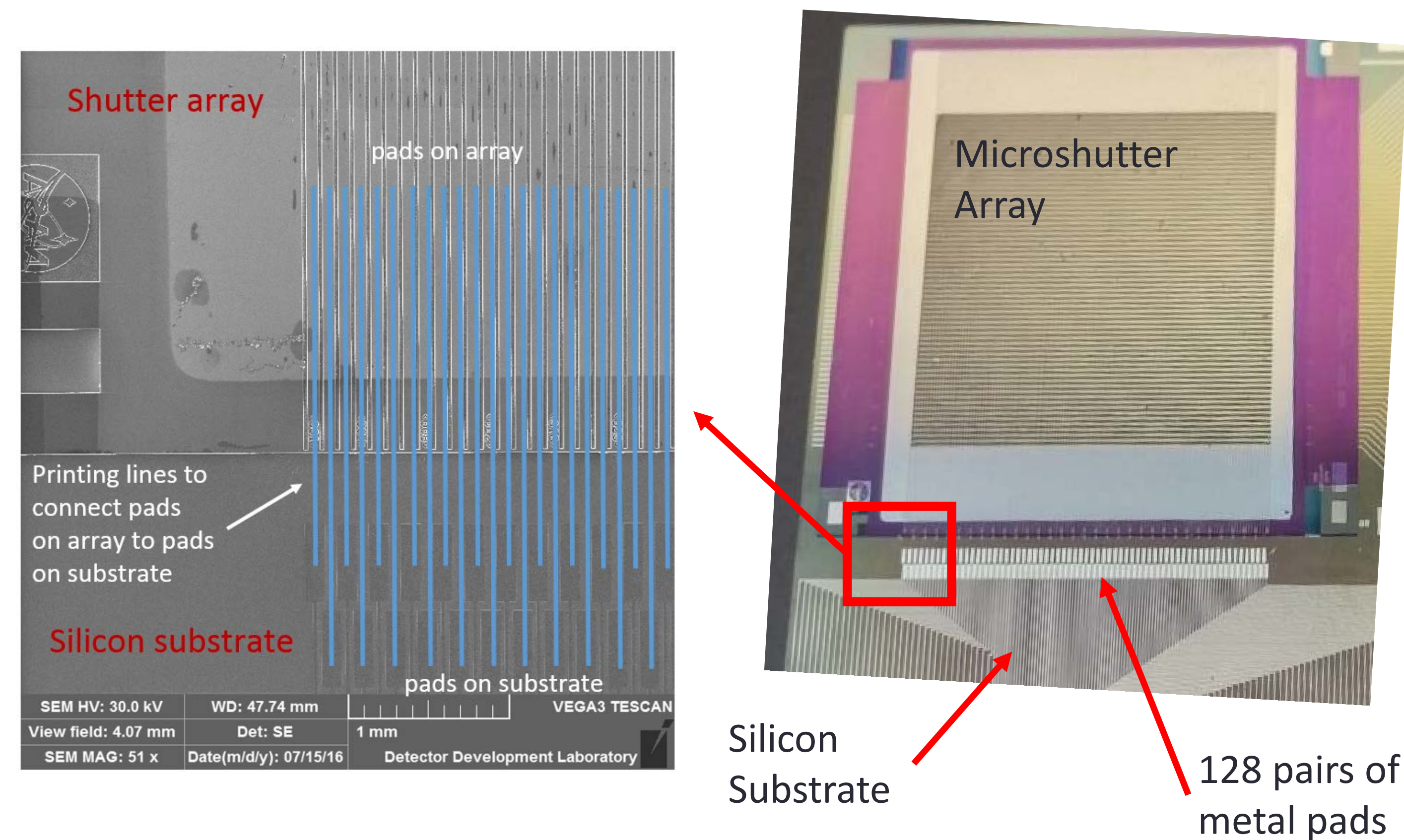
- Define best processes for printing interconnects for Next Generation Microshutter Array (NGMSA) and other electronic assemblies
- Print NGMSA Interconnects

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;
 - Enable dense assemblies - require trace spacing of 100 microns and less;
 - Permit very complex geometries on flexible and three-dimensional substrates.
 - Reduce assembly time, increase productivity.

NEXT GENERATION MICROSHUTTER ARRAYS (NGMSA)

Microshutters select many objects in one viewing for simultaneous observation – High-resolution spectroscopy



MSA Original Design

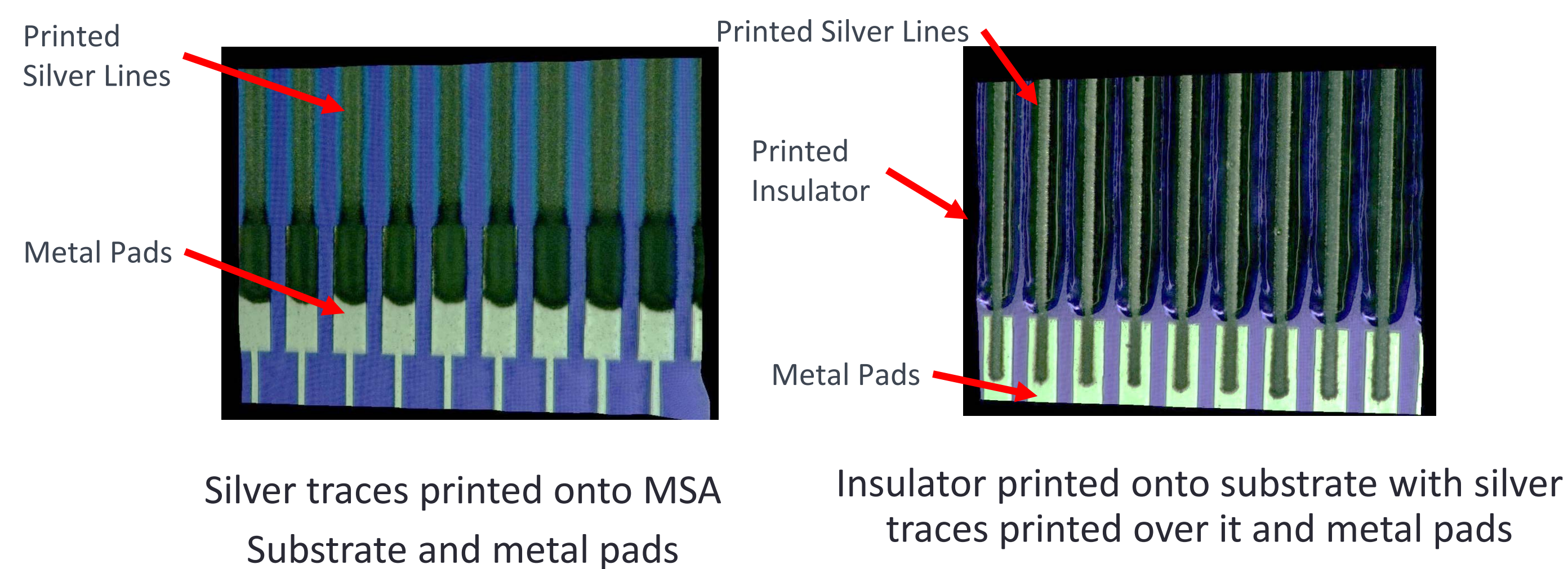
80µm pitch Pads, 100µm MSA height
(from substrate surface to top surface of array)

Requirements:

- At maximum, 20 micron width traces with 100 micron pitch
- Interconnects to be printed from substrate pads to top of MSA pads
- Electrical Requirement: Resistance: $\leq 500\Omega$ per individual interconnect
- Outgassing:
 - Total mass loss $\leq 1\%$
 - Collected Volatile Condensable Material $\leq 0.1\%$

TEST PRINTS – AEROSOL JET

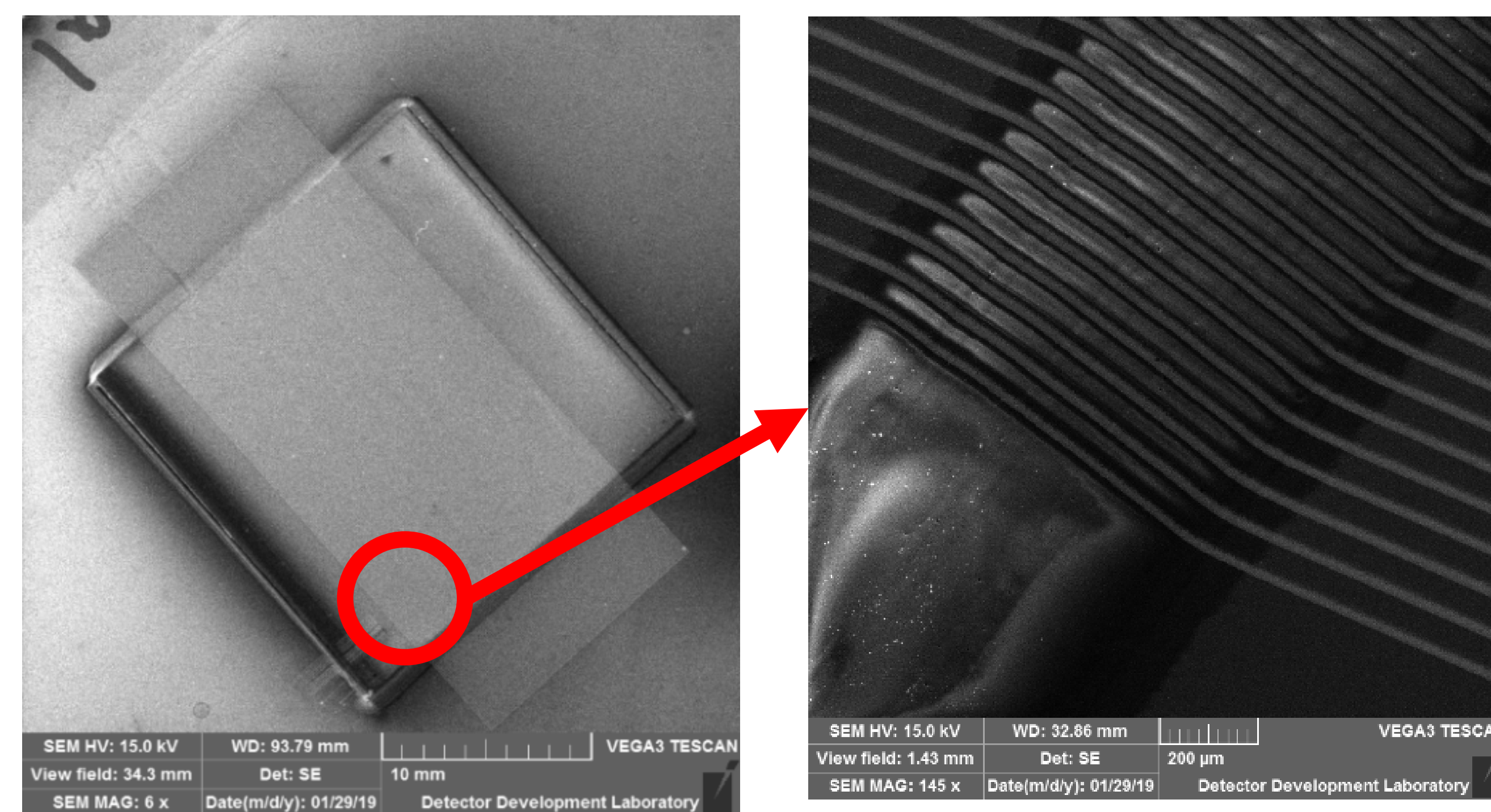
Initial Ink Conductivity Check



Conductivity tests were successful on printed samples on MSA substrate

Fillet prints

Printed Sample on Silicon Squares attached to Wafer



Printed silver lines with 20µm width over insulating fillet/"ramp"

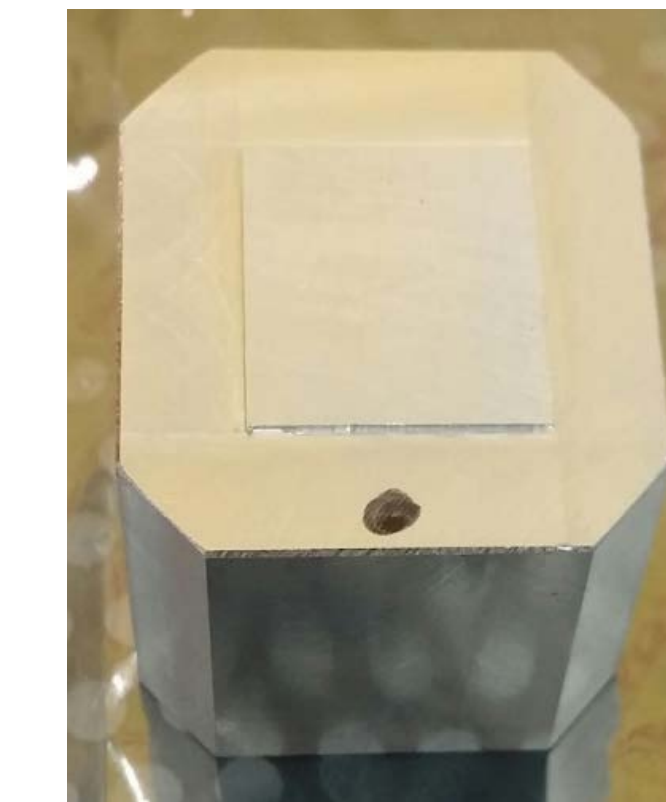
Resistance measured across conductive traces: 12Ω

- **Between traces:**
 - Resistance measures on order of MΩ, but needs to be on order of GΩ between traces
 - Trying plasma treatment to increase resistance

MATERIALS TEST - OUTGASSING

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

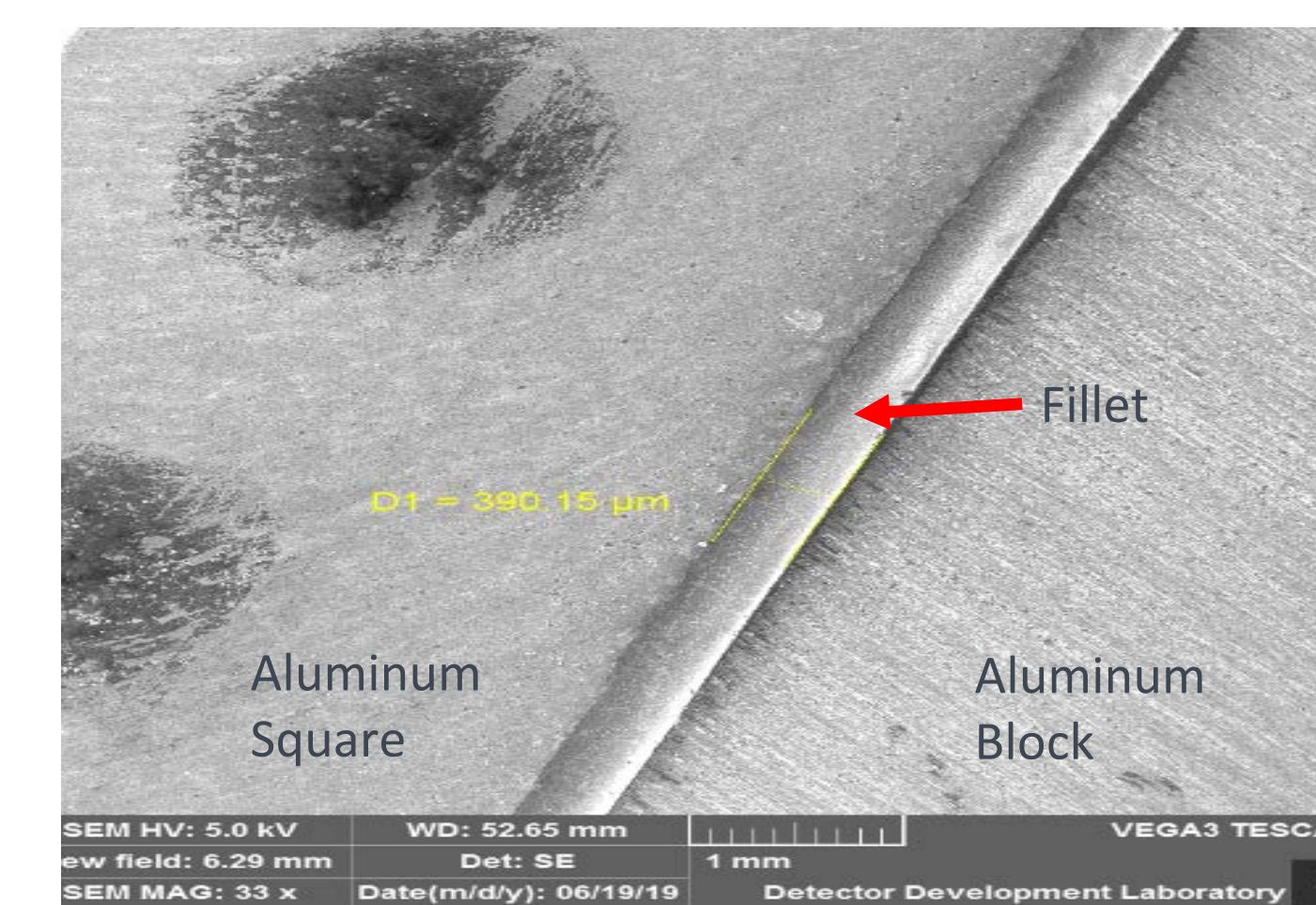
TEST PRINTS – SYRINGE PRINTER



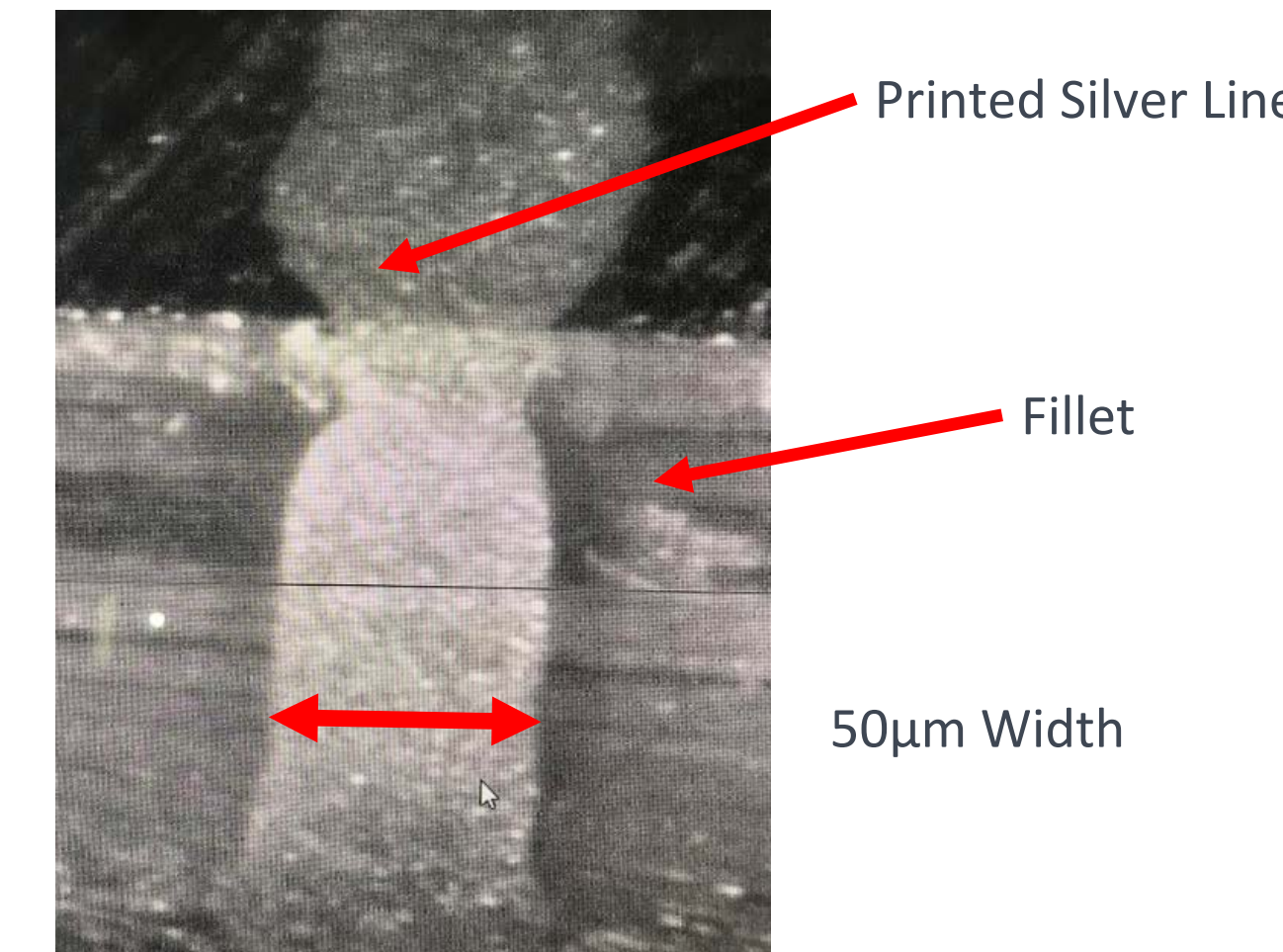
Fillet Test sample – 1" x 1" aluminum square attached to aluminum block
250µm height step



5-Axis Syringe printer
3D Flexible, Inc



Printed Fillet



Silver Traces over Fillet

FUTURE WORK

- Print fillets and traces with different process parameters for aerosol jet to increase resistance between traces
- Improve syringe printer processes to yield consistent conductive trace widths
- Perform electrical continuity tests on syringe printed samples
- Apply improved processes and techniques to printing on MSA assembly and test

MORE APPLICATIONS

- Next Generation X-Ray Polarimeter detector strips and readout boards
- Flexcircuits for CubeSats
- Silicon Microwell detector (SiMWD) assemblies
- Superconducting assemblies
- Magnetometer bobbin wires
- Mass Spectrometer components

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