

Quantum Parity Detector Fabrication at JPL

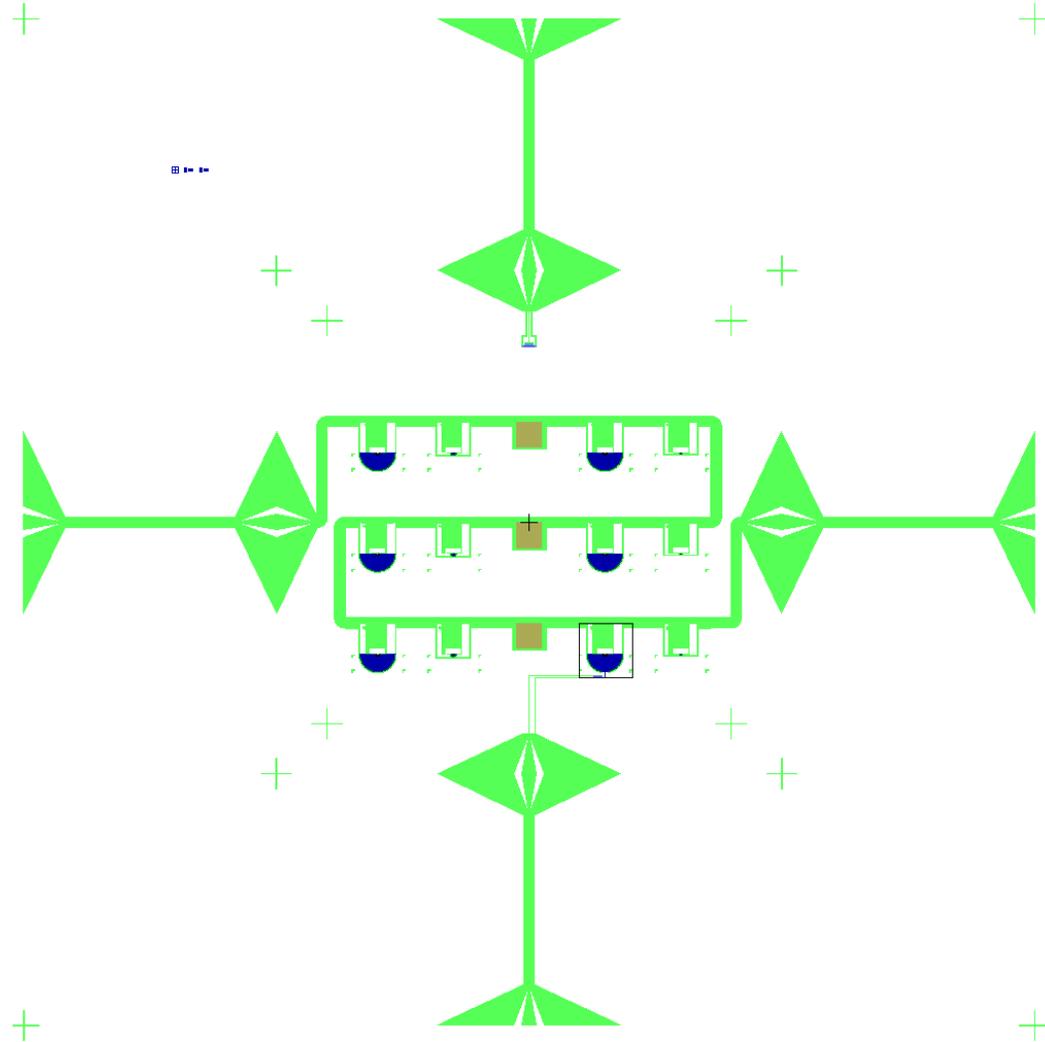
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and M.D. Shaw

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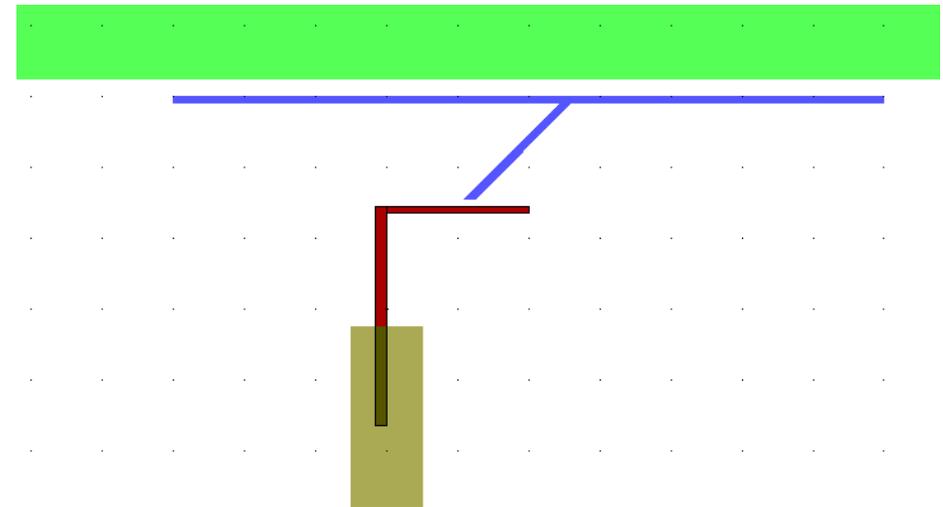
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QPD Fab at JPL



New QPD design

- Niobium feedline and resonators
- Aluminum absorbers
- Lower Tc material for traps – Al/Ti/Au or AlMn
- Three different absorber volumes
- Dolan bridge in a Manhattan geometry for junctions
- KID for lifetime measurement on lower Tc material
- Die can be cut at 1x1 or 2x2 cm



QPD Fab at JPL

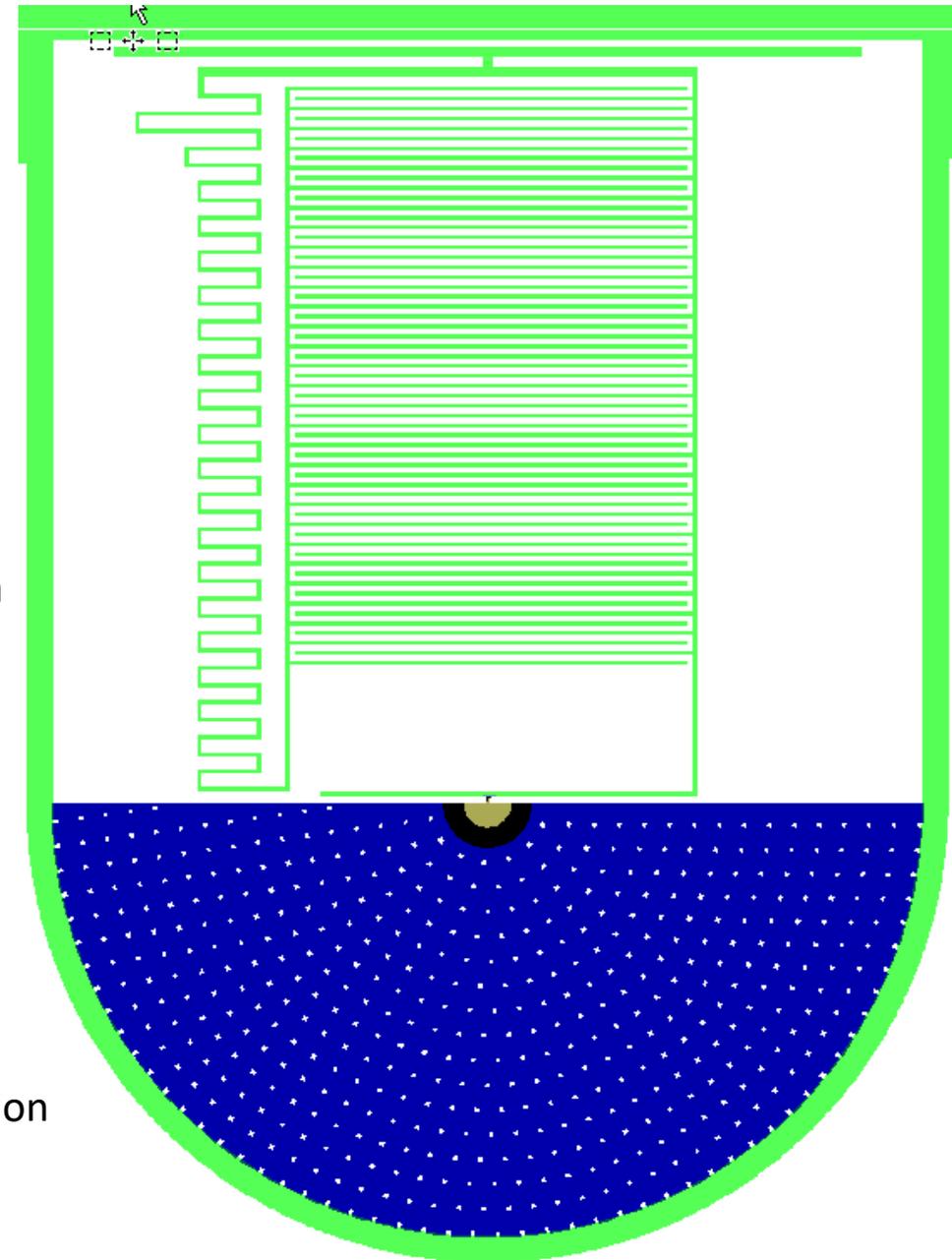


Cannon EX3 stepper

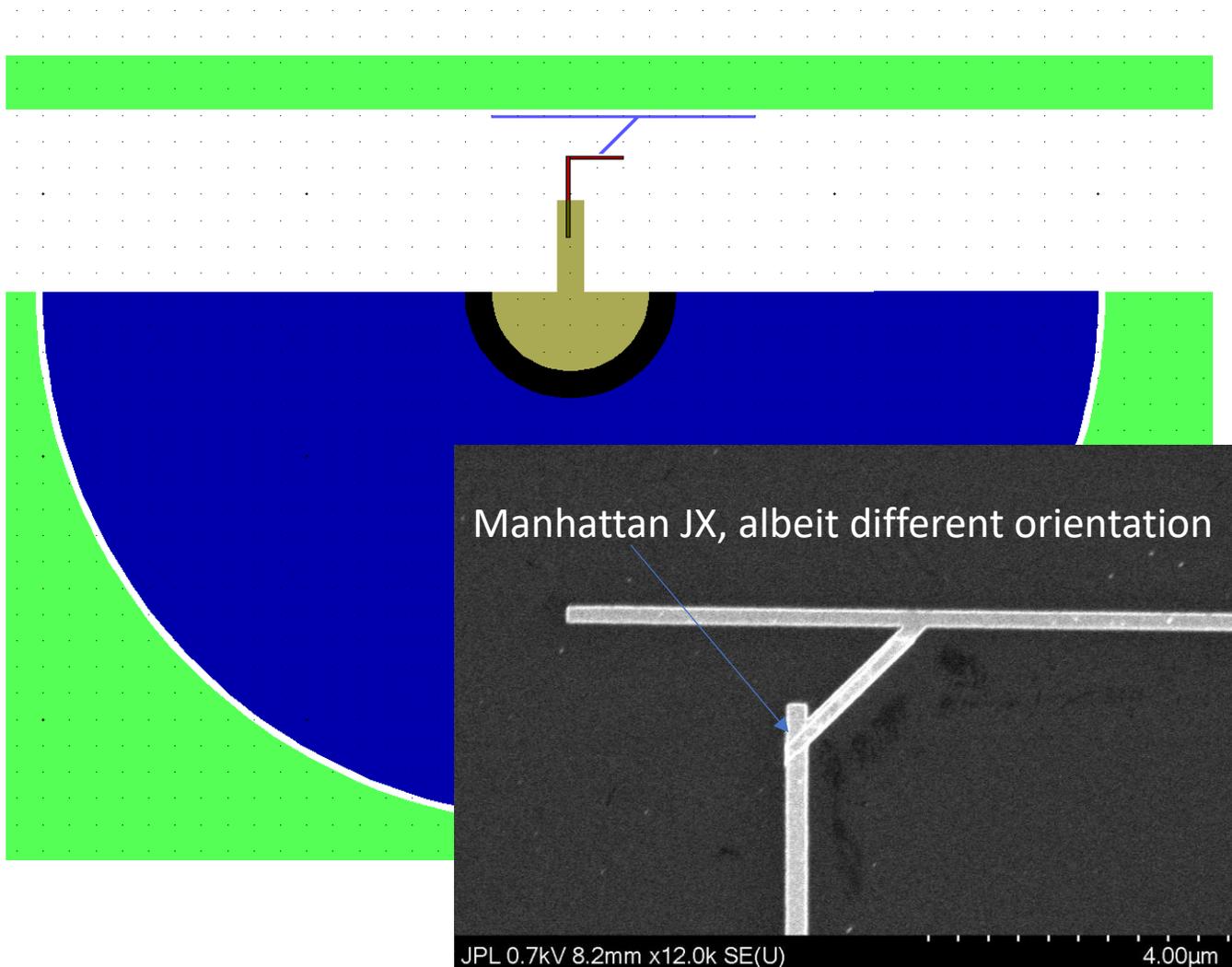


JEOL FX9500 E-beam lithography system

- Float zone high resistivity silicon wafer dipped in BOE, DI water, N2 blow dry
- Aluminum for absorber deposited first via e-beam evaporation
- Patterning by stepper lithography or Maskless Aligner depending on resolution
- Etch in Cl ICP RIE
- Patterning for feedline and resonator by stepper or MLA lithography
- Sputtered Nb deposition and lift off in acetone
- Electron beam lithography to define Dolan bridge in a Manhattan geometry
- Double angle aluminum deposition with intermediate oxidation to define junction
- Patterning of trap material by stepper or MLA
- Ion mill prior to deposition of trap material



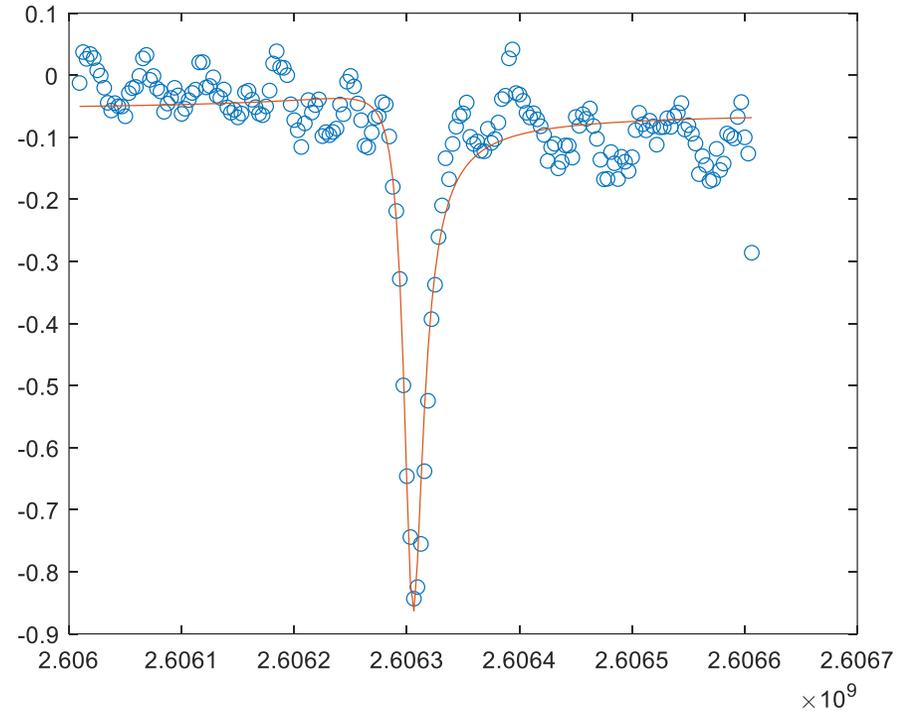
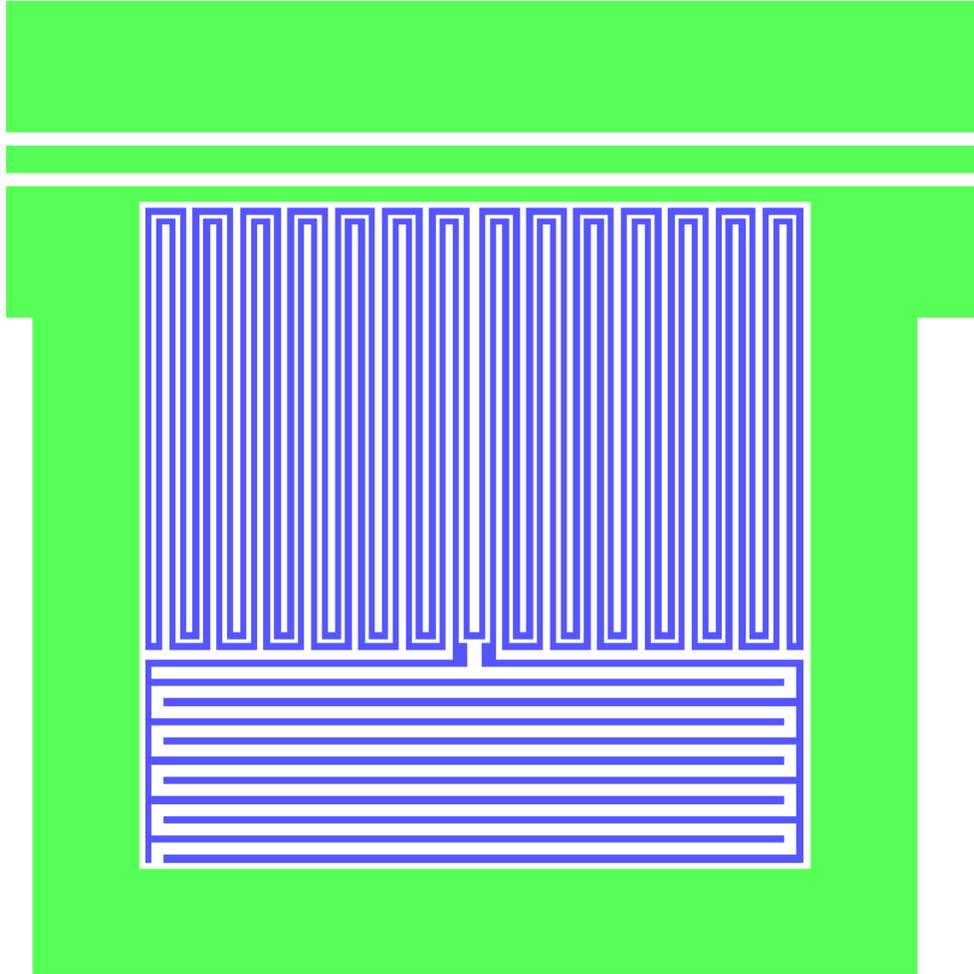
QPD Fab at JPL



- E-beam lithography resist stack:
 - MMA-MAA copolymer/ZEP 150
- Exposure at 48kV
- Development ZEDN50 for ZEP and IPA:MIBK 3:1 for copolymer
- First Aluminum deposition perpendicular to substrate
- Oxidation 100mTorr 15min
- Second evaporation at 45 degree tilt (Dolan bridge up) and 45 degree rotation
- Aluminum will only be deposited on substrate along 45 degree line. Everywhere else deposited on the resist wall and lifted off

QPD Fab at JPL

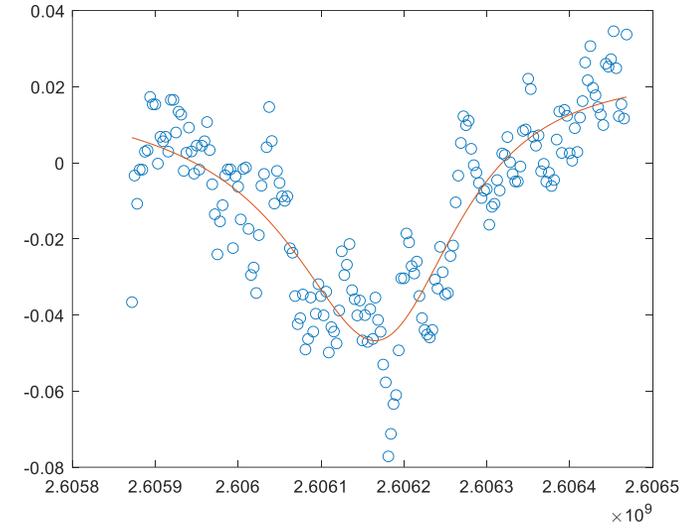
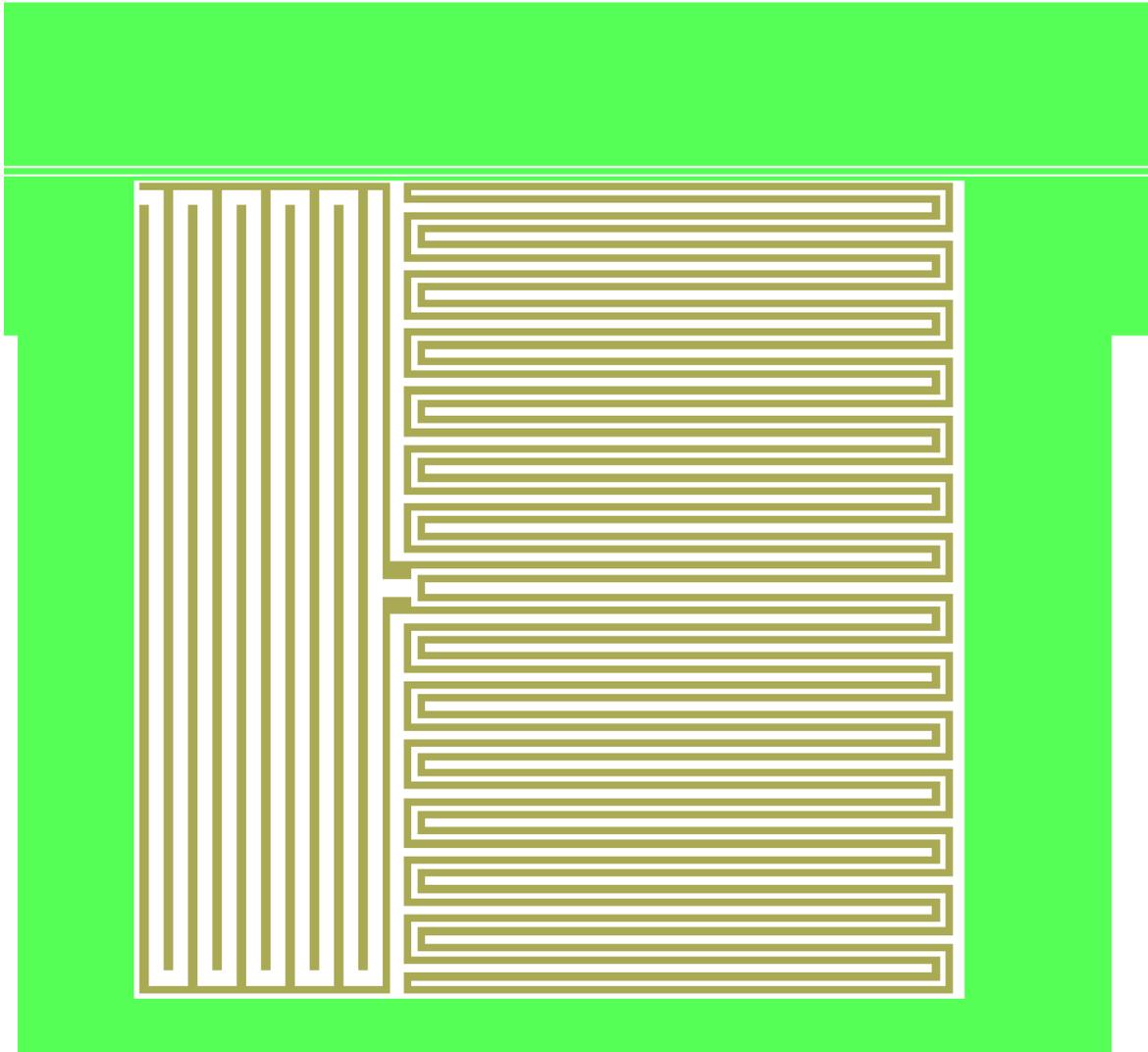
- KID with low Tc material patterned by stepper or MLA and lift off



$Q=1.14e5$
 $Q_c=6.35e5$
 $Q_i=1.38e5$

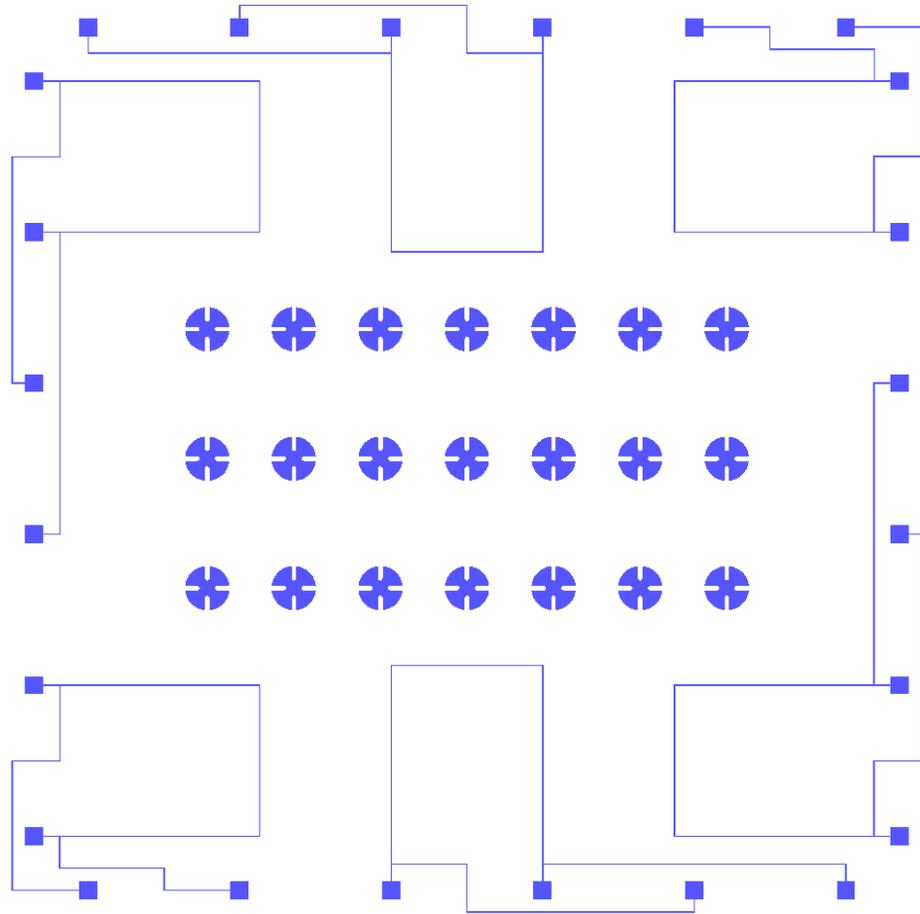
QPD Fab at JPL

- KID with low Tc material patterned by stepper or MLA and lift off

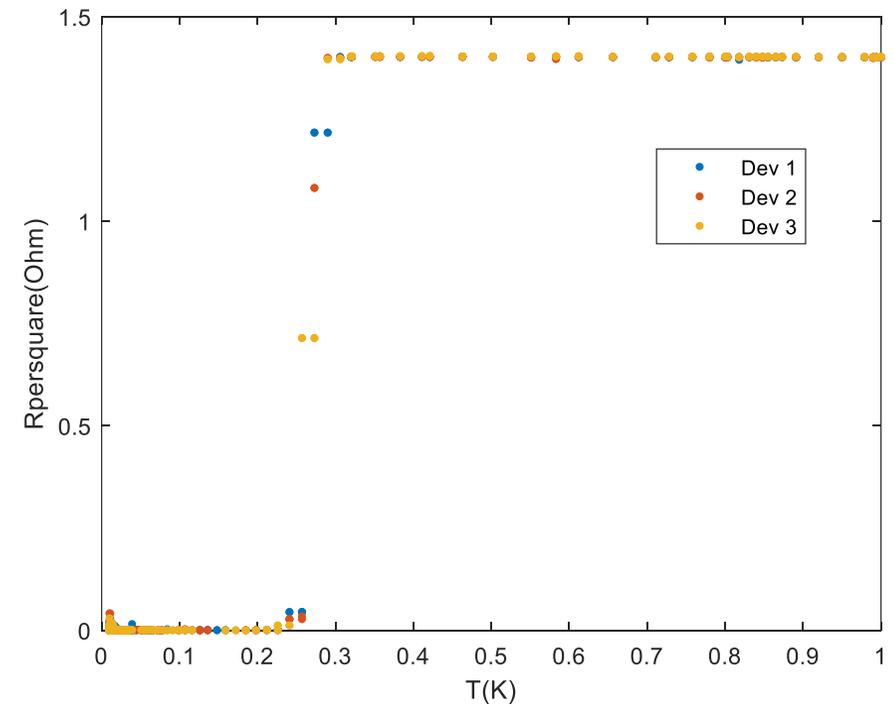


Qt=10465
Qc=6.6e5
Qi=10634

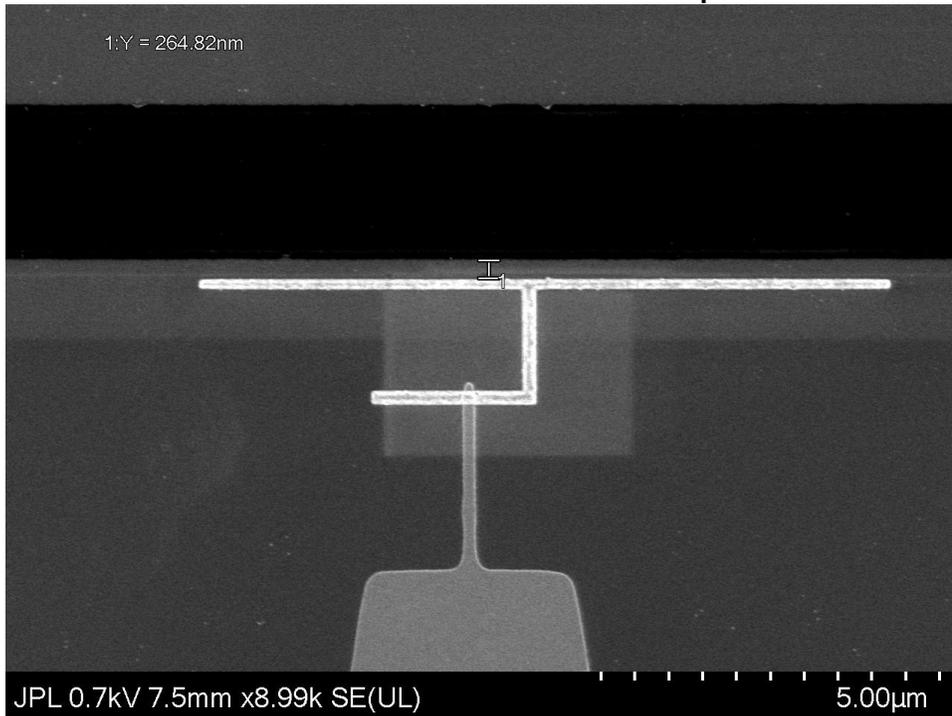
QPD Fab at JPL



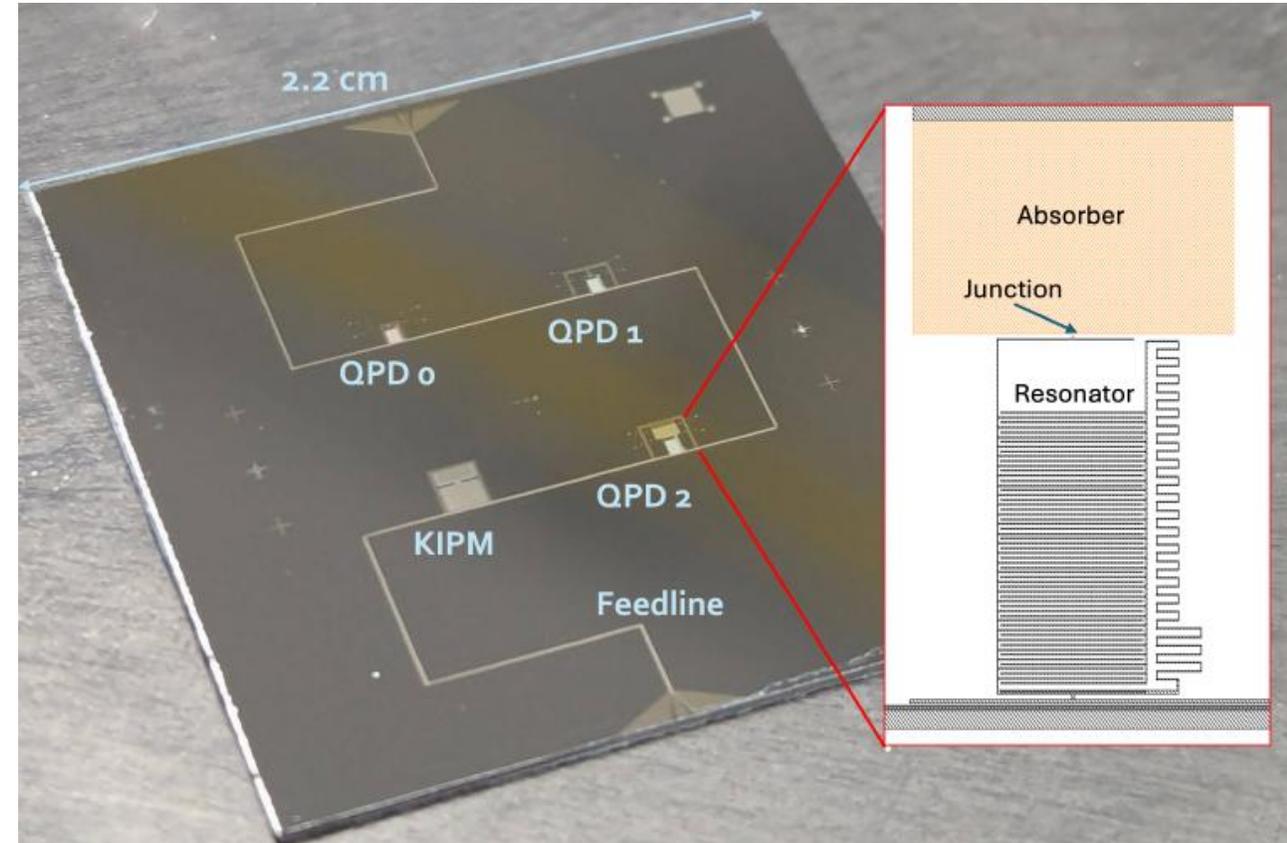
- Tc test patterned by MLA
- 6 four wire resistance measurement sites
- 21 van der PauW cloverleafs
- First measurement of Al/Ti/Au (10/30/30 nm) trilayer
- Tc 257 mK; R per square 1.4 Ohm



JPL Fabricated phonon-sensing QCD with “crossline” process



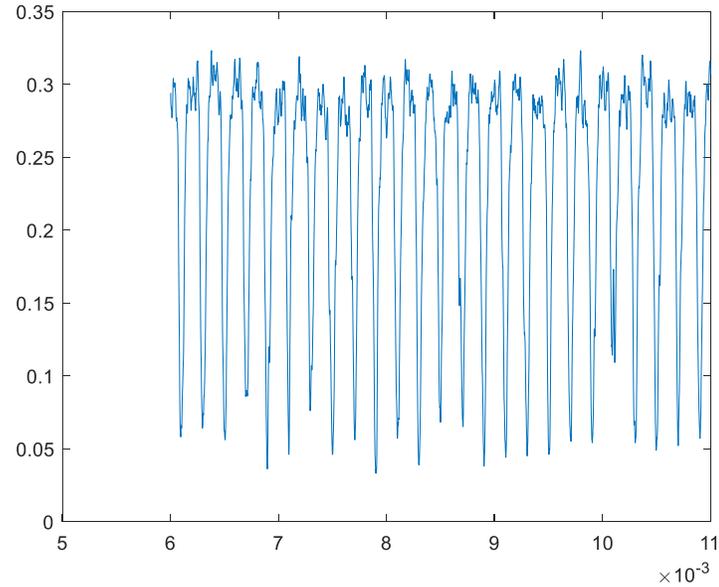
QPD Fab at JPL



- Aluminum film deposited on clean substrate with native oxide removed
- Reactive ion etching through stepper lithography define resist stencil to define base Electrode
- Electron- beam lithography patterned counter-electrode
- In situ ion mil to remove oxide, oxidation of base electrode and aluminum deposition of second electrode through e-beam lithography defined mask

JPL Fabricated phonon-sensing QCD with “crossline” process – measurement results

Channel3 (highest freq)
Acquisition rate 2MHz
Gate freq 5kHz
1 peak per sweep



Histogram of standard deviation
Spanning two gate sweeps

