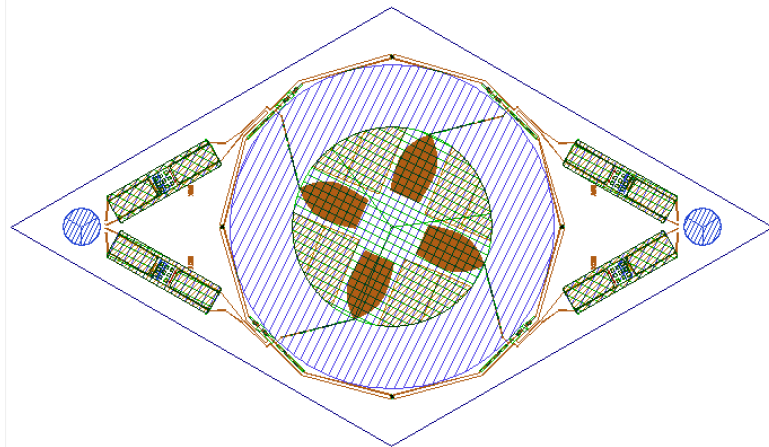# Argonne CMB-S4 Detector R&D update

Clarence Chang
HEP Division
Argonne National Lab

Tom Cecil
HEP Division
Argonne National Lab

April 28, 2021

FY21 R&D
CDFG RFI

- Delivered array design
  - Identified that TES positions need adjustment to match NIST coupling wafer posts

- Delivered wiring array

- To deliver: R(T) arrays
  - Wiring array + TES films
  - Can be mounted and cooled down. Operated using SQUID readout.

- To deliver: CDFG RFI arrays
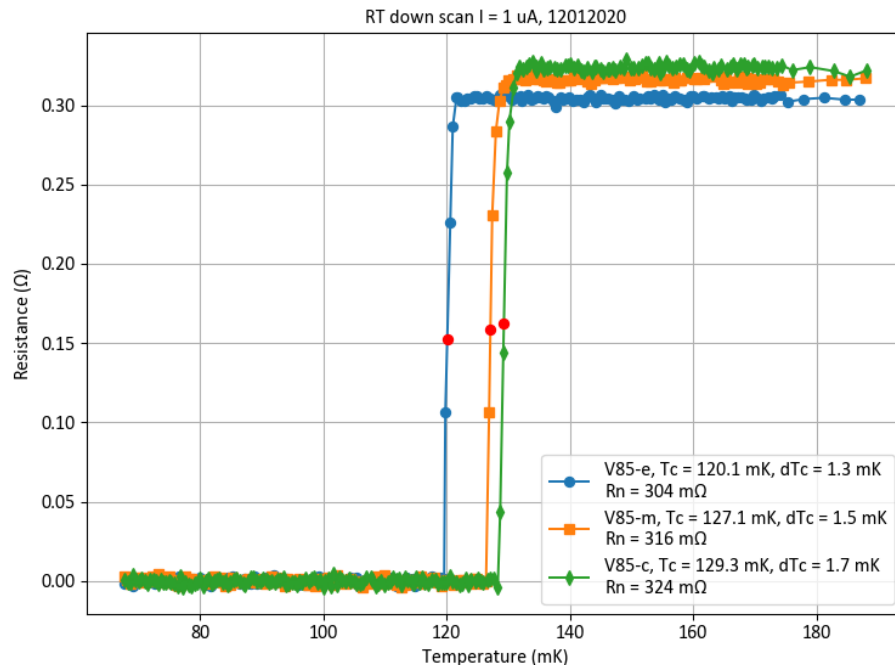
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In Pixel changes

- Canted TES to make room for contact pads for interface wafers

- Added in-pixel 'bondpads'

- Updates to TES dimensions are underway
  - Adjust Tc of high-Tc TES
 - Soften transition of high-Tc TES

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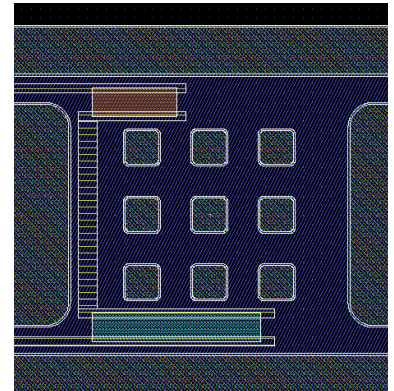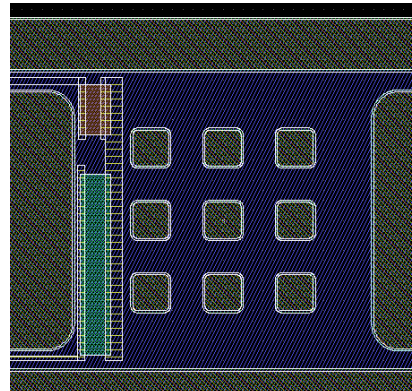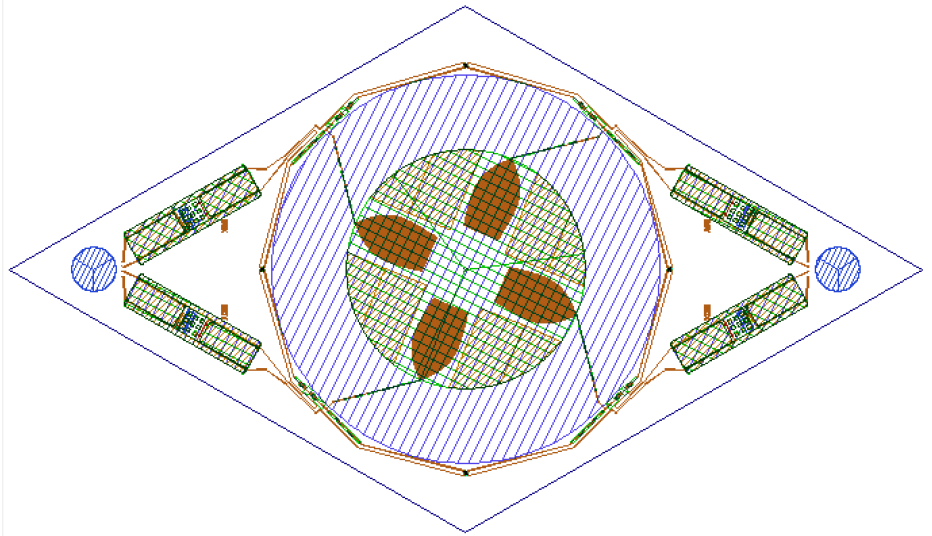
Low Tc TES

- Used test structures to measure Tc uniformity
    - Tc varies across wafer, primarily near outer edge
    - Measurements show variation of film thickness as well

RT down scan I = 1 uA, 12012020

V85-e, Tc = 120.1 mK, dTc = 1.3 mK
Rn = 304 mΩ

V85-m, Tc = 127.1 mK, dTc = 1.5 mK
Rn = 316 mΩ

V85-c, Tc = 129.3 mK, dTc = 1.7 mK
Rn = 324 mΩ

Low Tc TES

- Adjust sputtering dep for improved thickness uniformity

- Resulting Tc distribution measured to be more uniform. Though shifted down.

- Increase post-dep baking to increase Tc.
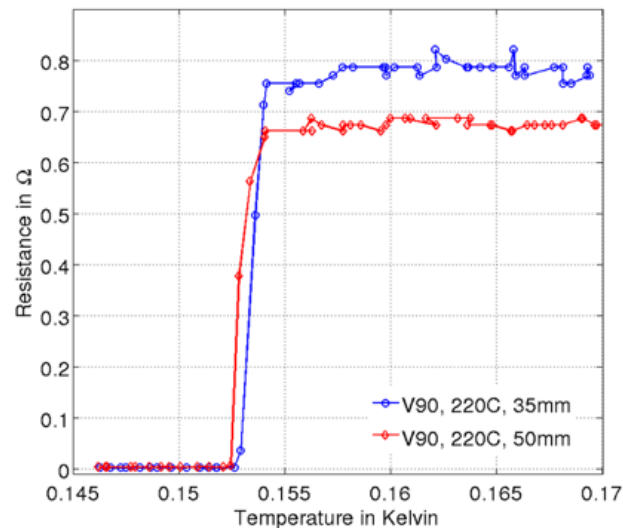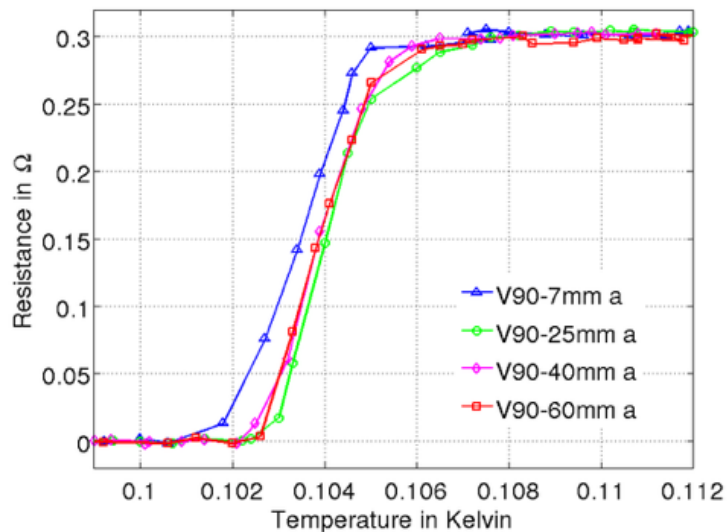
High Tc TES

- Psat_hi/Psat_lo = (54/7.5) = 7.2
  - Tc_lo = 150 mK
  - for n=3, means Tc_hi = 300 mK
- Stability wants G_int/G_ext > loop gain
  - G_ext scales as T^3 for phonons
  - G_int scales as T for electrons
  - Ratio scales as T^{-2}, decreases by 4x between low and high Tc.
    - Try to offset by softening high Tc transition

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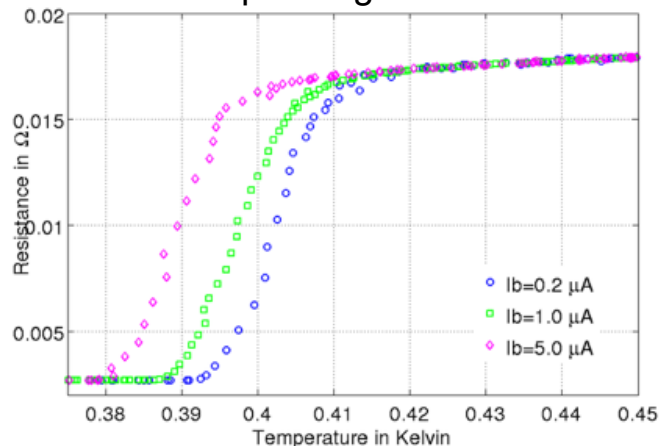
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High Tc TES
Two adjustments

- Increase Mn doping for high Tc TES
  - Reduces Tc from 450 mK to 365 mK
- Shorten spacing between Nb leads
  - Softens transition by ~4x
  - Also increases Tc to 400 mK
- Can further increase Mn concentration to bring Tc down further
  - Takes some time
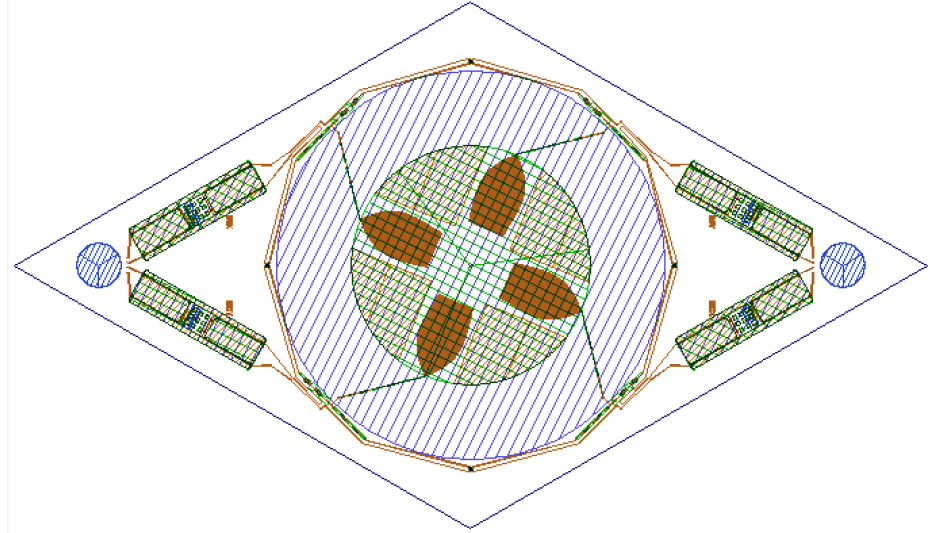 - Shorter leads shows some current dependence

20 µm long
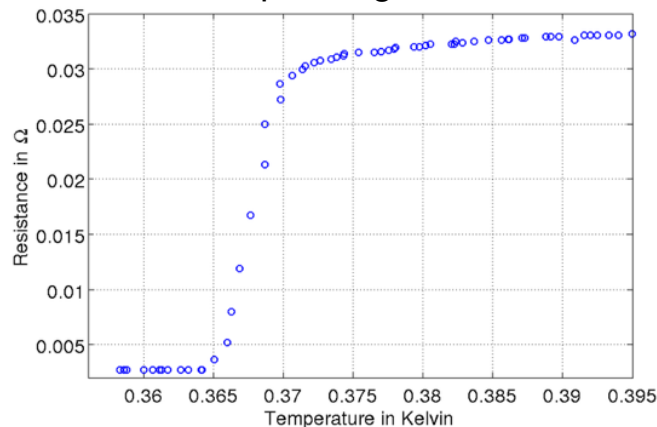
10 µm long

Status

- Using opportunity to make adjustments based on ongoing discussions and test structure results

- Updates nearly finalized.

- Will start R(T) wafers after adjustments are complete

FIN

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