

# LNA Systems at JPL

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Remote Sensing Group 382F

Technology Concepts

for the

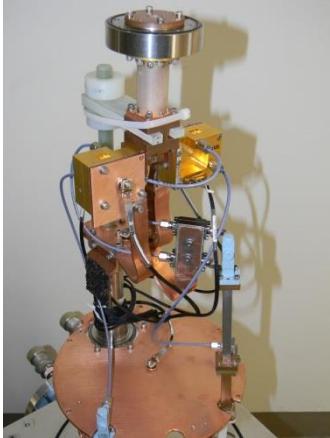
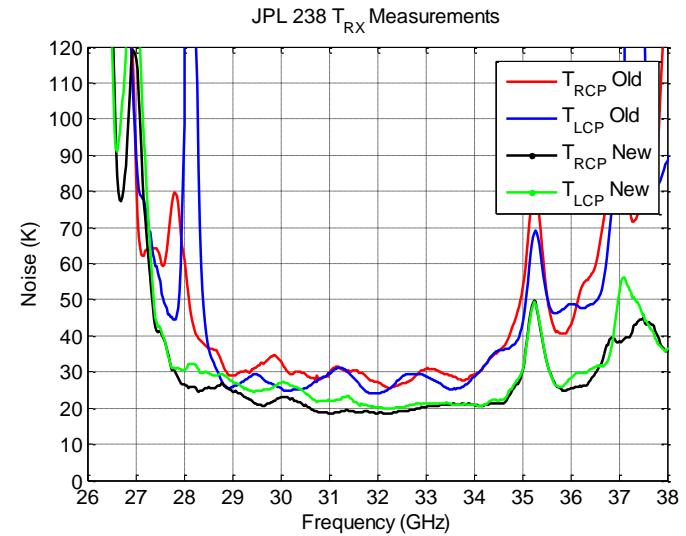
Next Generation VLA

4.09.2015

**DSN LNAS**

# DSN LNA Systems Overview

- Cryogenic receivers at S, X, and Ka DSN communication bands
- InP based LNAs with 3-9 K noise temperature
- Receiver systems include OMTs, noise sources, and calibration loads, cooled by CTI-350 and Sumitomo 4K Cyro-coolers
- Prototype systems fielded at DSS 13, a 34 m Beam Waveguide Antenna, Goldstone CA.



Ka Development  
Rx Cartridge



Rx Testing at JPL

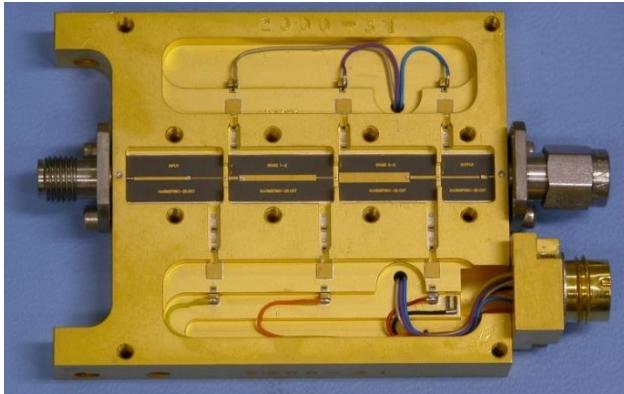


34 m Beam Waveguide  
Antenna DSS 13

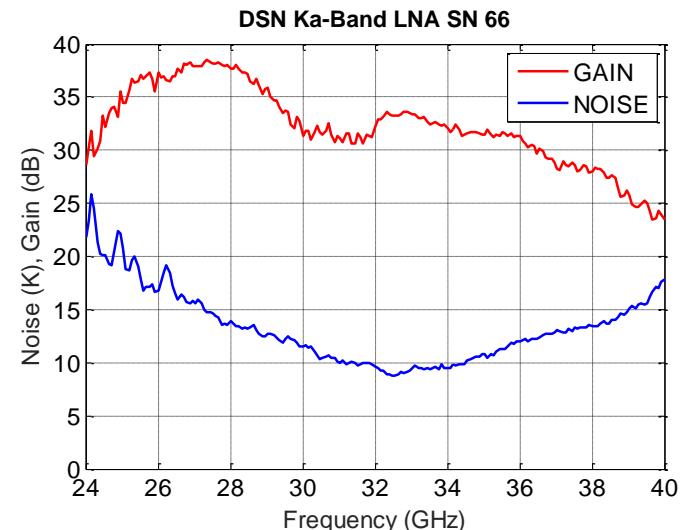
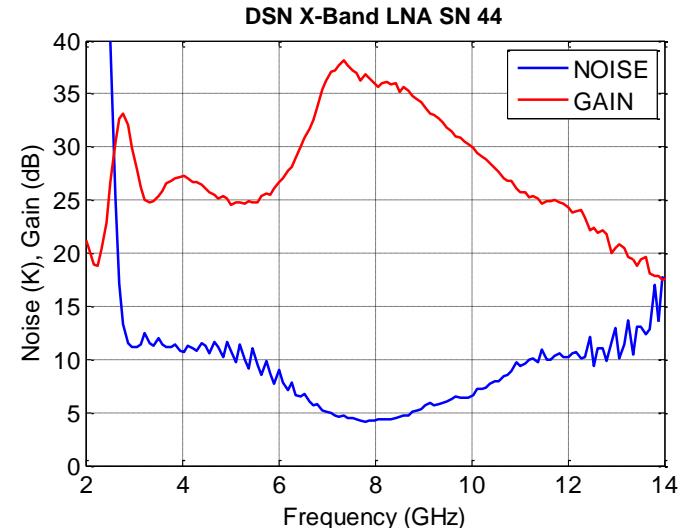
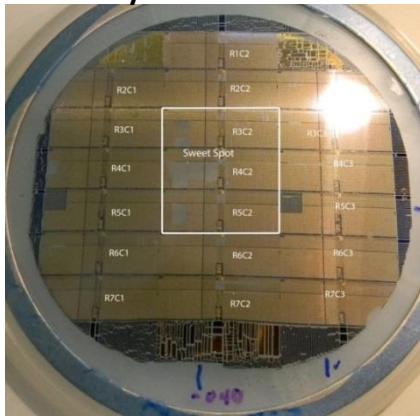
## Current DSN X and Ka Band Amplifiers

- Discrete “chip and wire” designs based on “Cryo-3” InP devices
- 3-4.5 K noise at 8.2 GHz, 9 K at 32 GHz
- Increasingly challenging to tune, as best portions of Cryo-3 wafers have been depleted.

X-Band LNA Module



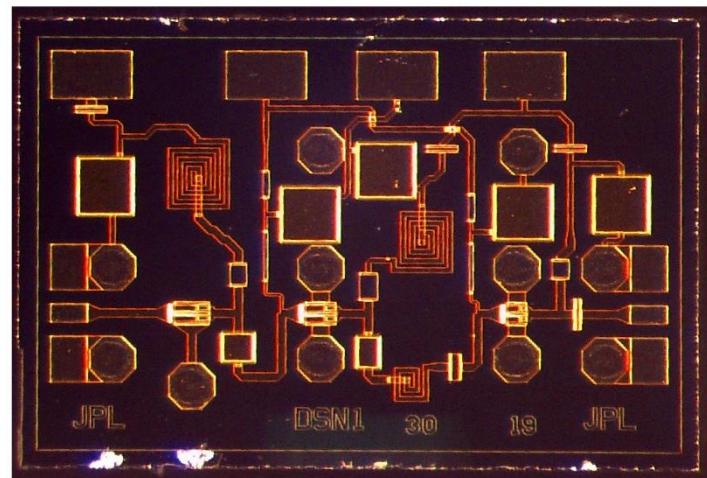
Cryo-3 Wafer



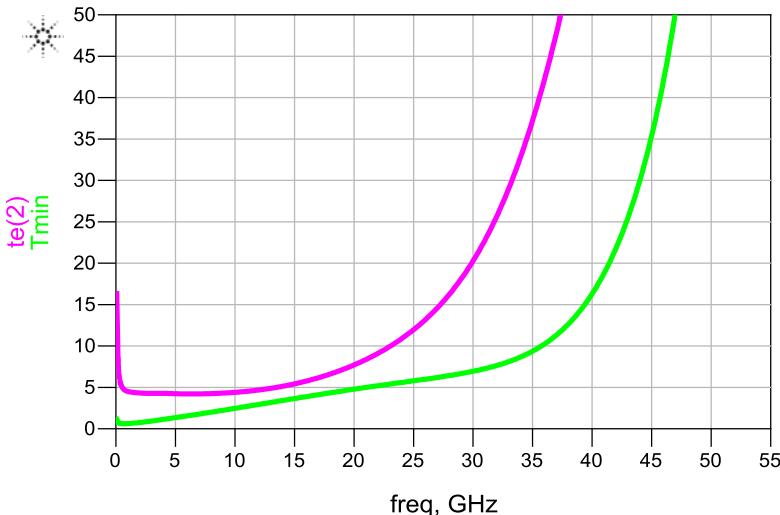
# Next Generation X Band Amplifiers

- OMMIC D007IH 70 nm process
- $T_{50}=4.4$  K, 3-4 K with external matching network.
- Gain = 37 dB
- Unconditionally stable
- Tape-out also includes 50, 80, 120, 200, 400, and 600  $\mu\text{m}$  discrete devices for characterization purposes

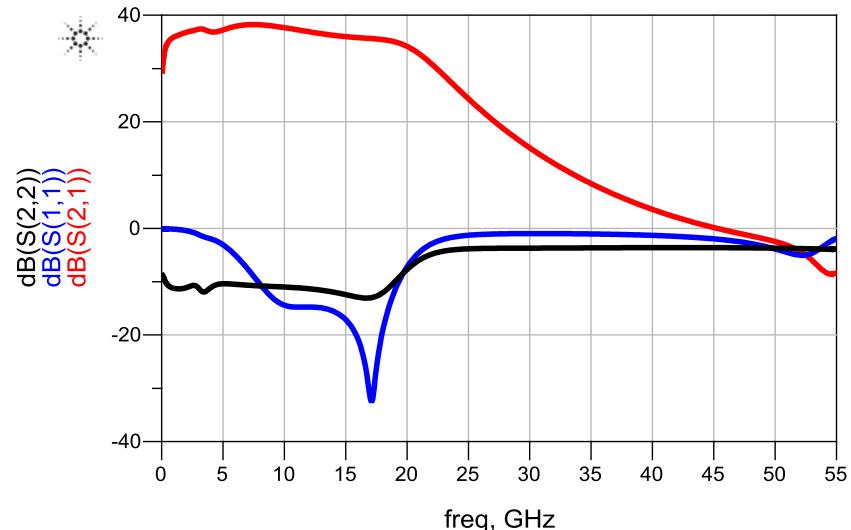
X-Band MMIC 1.5 x 1 mm



MMIC  $T_{50}$  and  $T_{\min}$  @ 15 K

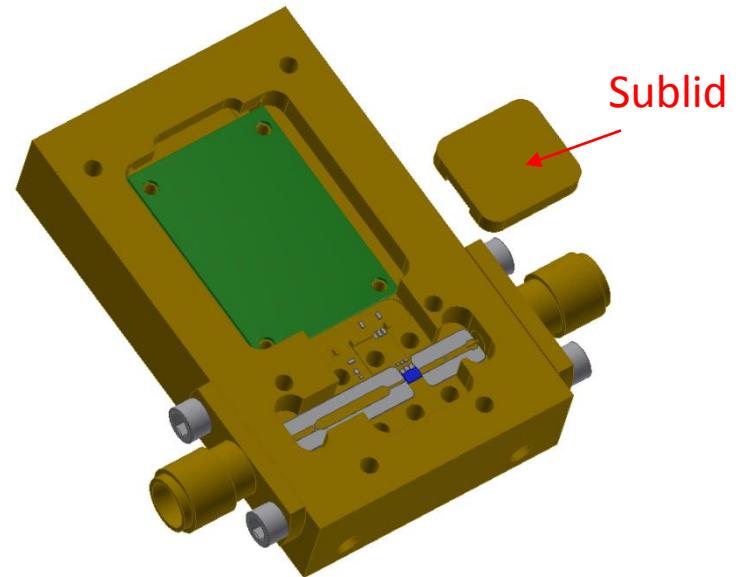


MMIC [S] Parameters

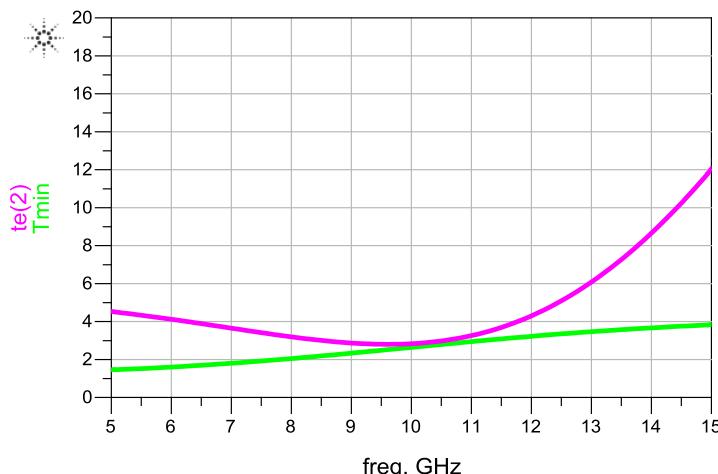


# X-Band LNA Module

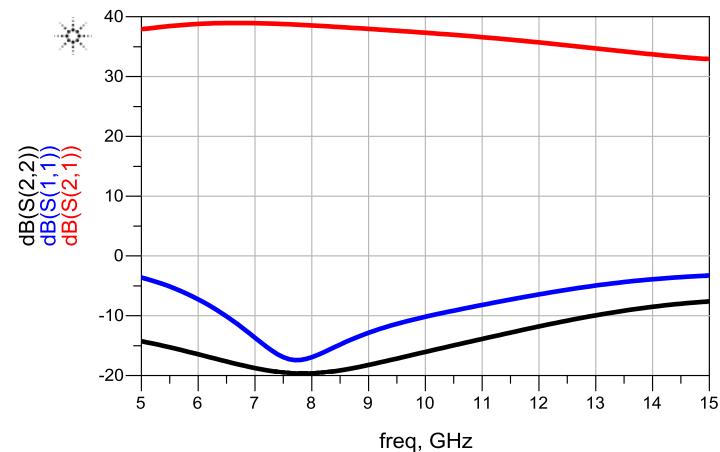
- 1.1 x 1.8 x .4 inch, SMA connectorized package
- Integrated bias protection network, micro-D connector
- $T_{50}=3.5$  K
- Gain = 37 dB
- S11, S22 better than 15 dB



Module  $T_{50}$  and  $T_{\min}$  @ 15 K

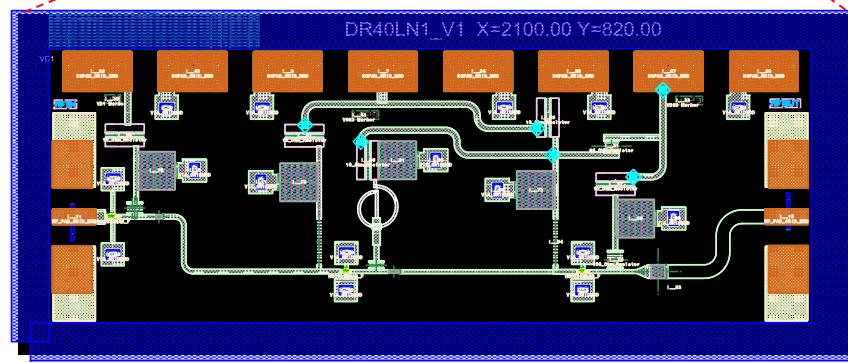
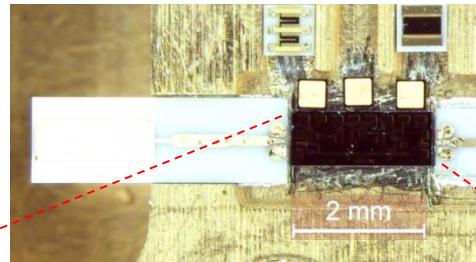


Module [S] Parameters

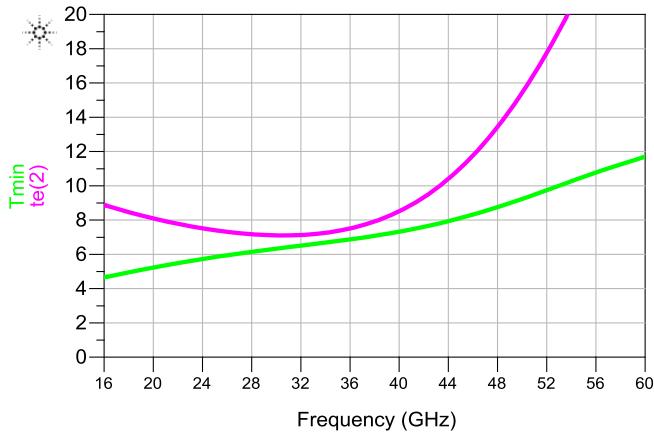


# Ka-Band InP MMIC

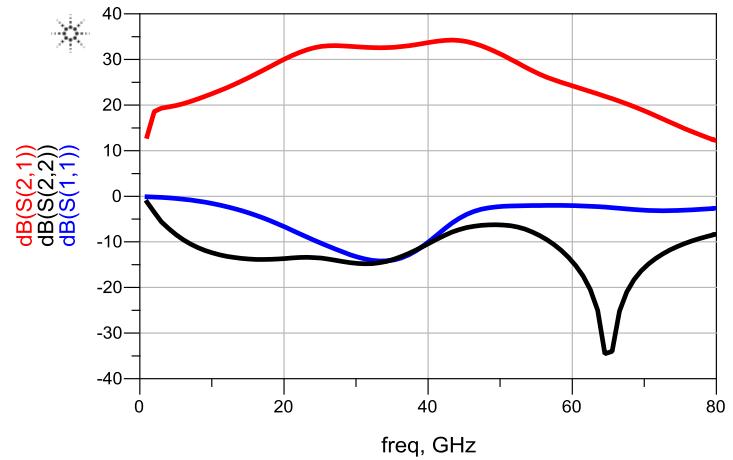
- Ka Band MMIC fabricated on NGST 35 nm InP process.
- $T_{50}=7.2$  K
- Gain = 33 dB
- S11, S22 better than 12 dB.
- Unconditionally stable.



MMIC  $T_{50}$  and  $T_{\min}$  @ 15 K



MMIC [S] Parameters

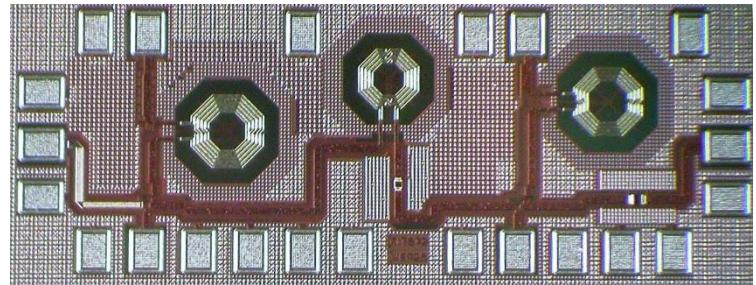


\*Assembly photo courtesy S. Montanez, JPL.

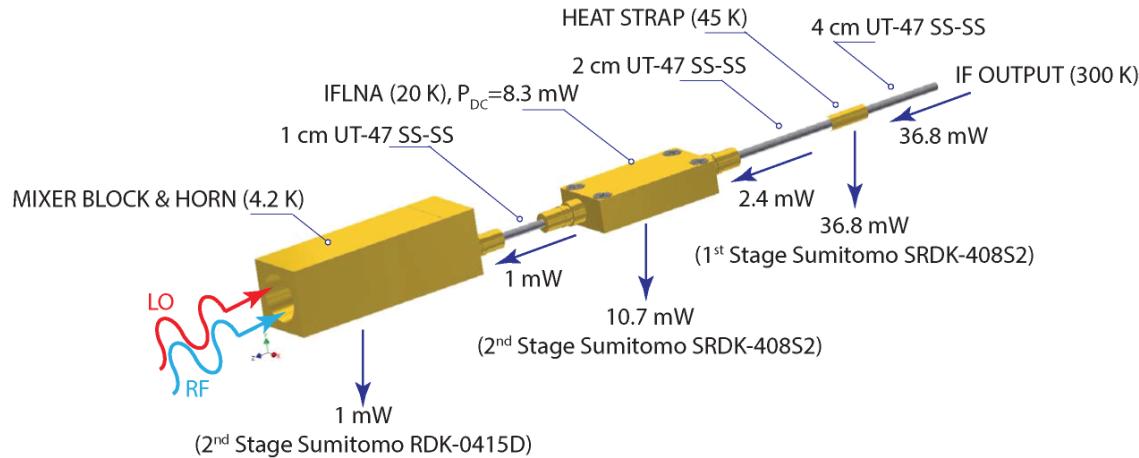
# **SIGE IF LNAS FOR TERAHERTZ MIXER ARRAYS**

# REQUIREMENTS

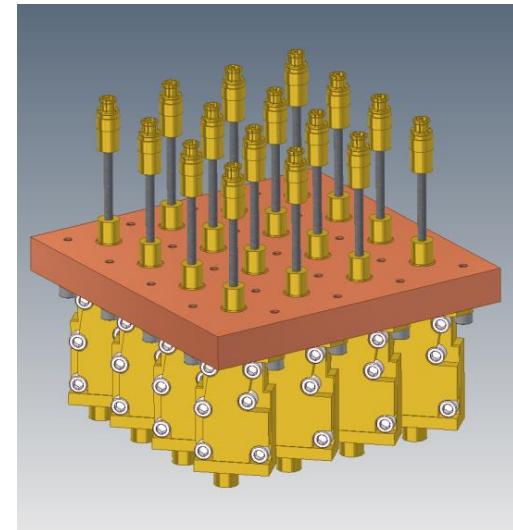
- Small size → # of pixels
- Low power consumption → burden on cryogenics, # of pixels
- Minimum number of connectors → ease of packaging, service
- Low input return loss → minimize effect of standing waves between mixer and LNA



SiGe MMIC,  $570 \times 1500 \mu\text{m}$



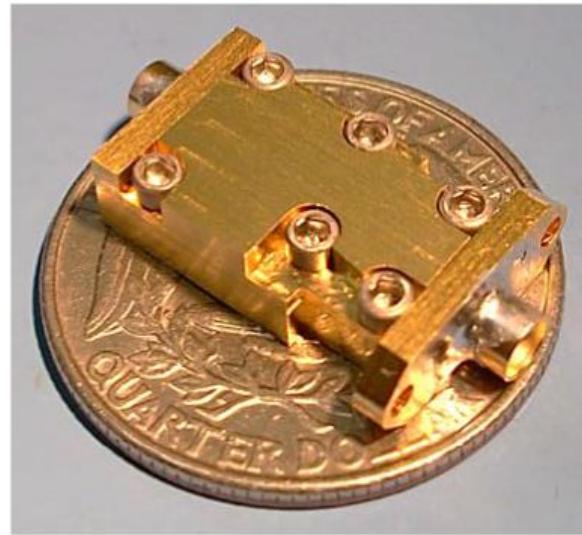
System Concept



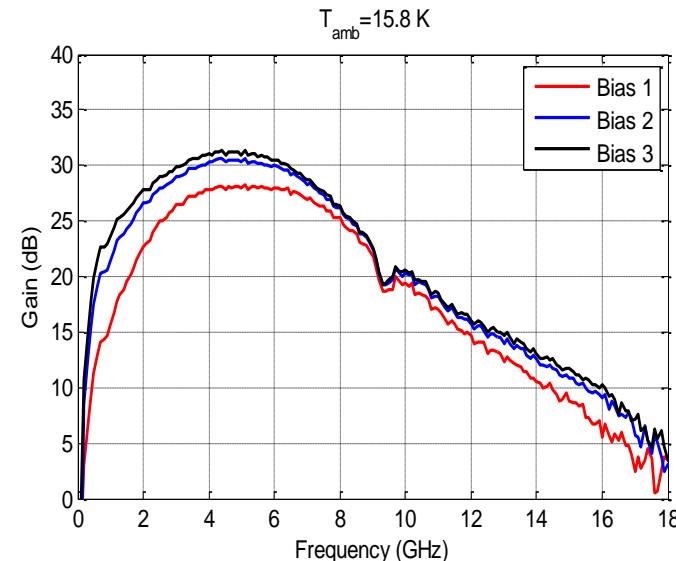
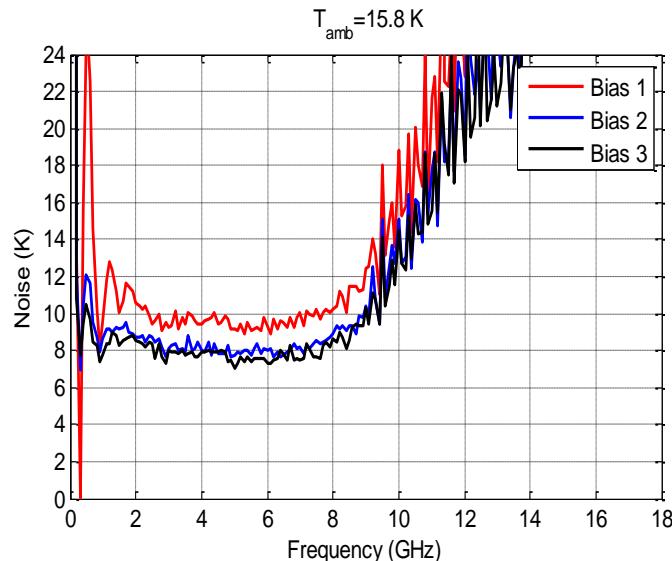
4 x 4 Array Example

# SiGe IF LNA Developed for CHAI/GUSSTO

- 2-8 GHz
- 8 K noise with 10 mW DC power
- Integrated bias-tee in output line, no separate DC connector required.
- Resistive feedback for low S11.
- 13.7 x 5 x 22.5 mm package with GPPO connectors.



LNA Performance at 5, 10, and 16 mW DC Power



\*Assembly courtesy S. Montanez & M. Soria, JPL.