National Aeronautics and Space Administration

Planar Multi-Pixel Heterodyne Array Architecture Suitable for Large Arrays

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Program: FY23 R&TD Strategic Initiative **Strategic Focus Area: Long-Wavelength Detectors**

Objective:

To develop a novel submillimeter-wave heterodyne detection architecture, suitable to realize large-format arrays that contain hundreds of pixels integrated in a highly compact and efficient instrument package. By:

(1) Using a quasi-optical distribution of LO power, without making use of lossy beam splitters or waveguide networks

(2) Developing an modular and low-loss planar integration architecture.

Approach and Results:

- Planar HEB mixer array integrated on **silicon micromachined packaging.** Allows for a dense integration of pixels & short RF WG path.
- **Two arrays of lenses** couple the RF and LO signal from the front and back respectively. No beamsplitter necessary (that typically throws away 90% of LO power)
- **Balanced HEB architecture** gives improved common mode and spectral image rejection.

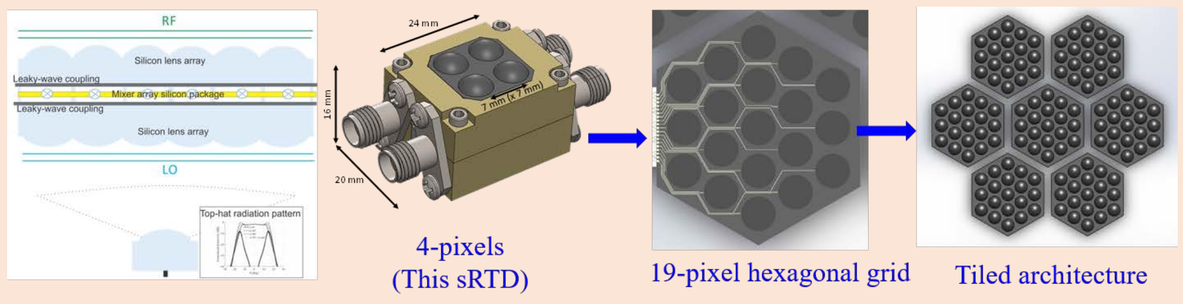

Figure 1. Schematic of the basic architecture of the multi-pixel planar terahertz heterodyne receiver array and the way forward to large-format arrays.

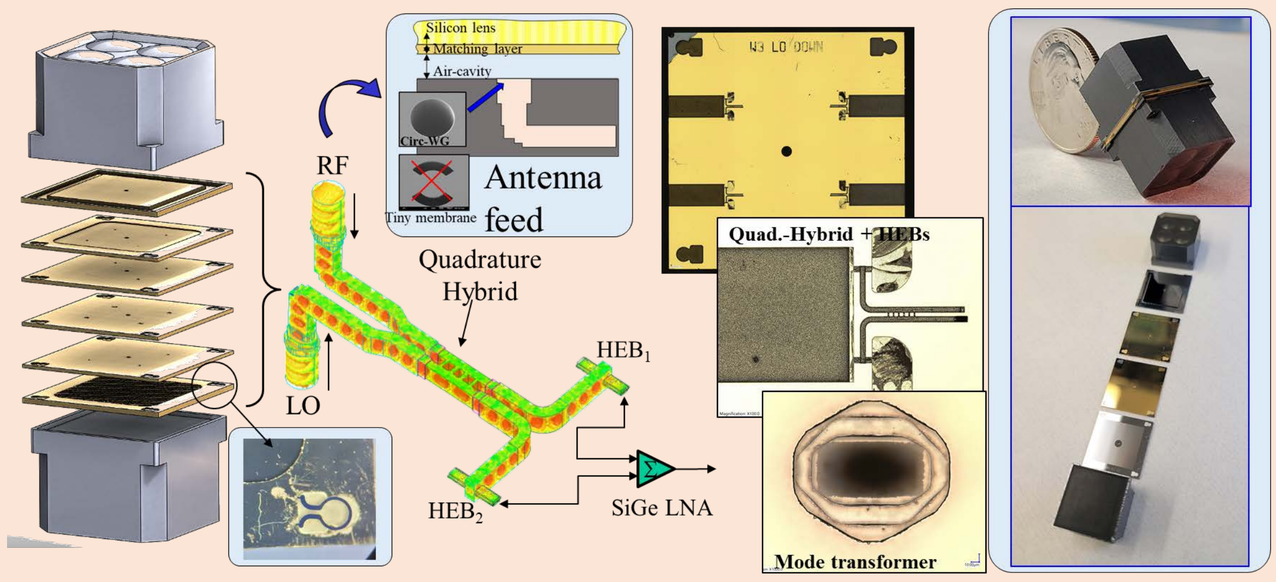

Figure 2. Planar integration of receiver front-end, fabricated using silicon micromachining technology. The wafer stack contains the lens antenna feeds, hybrid coupler and balanced HEB mixers.

- 1.95 THz LO chain assembled providing 40uW output power
- Transmit array configuration assembled for LO coupling validation
- Lens patterns and power measured with LHe-cooled bolometer

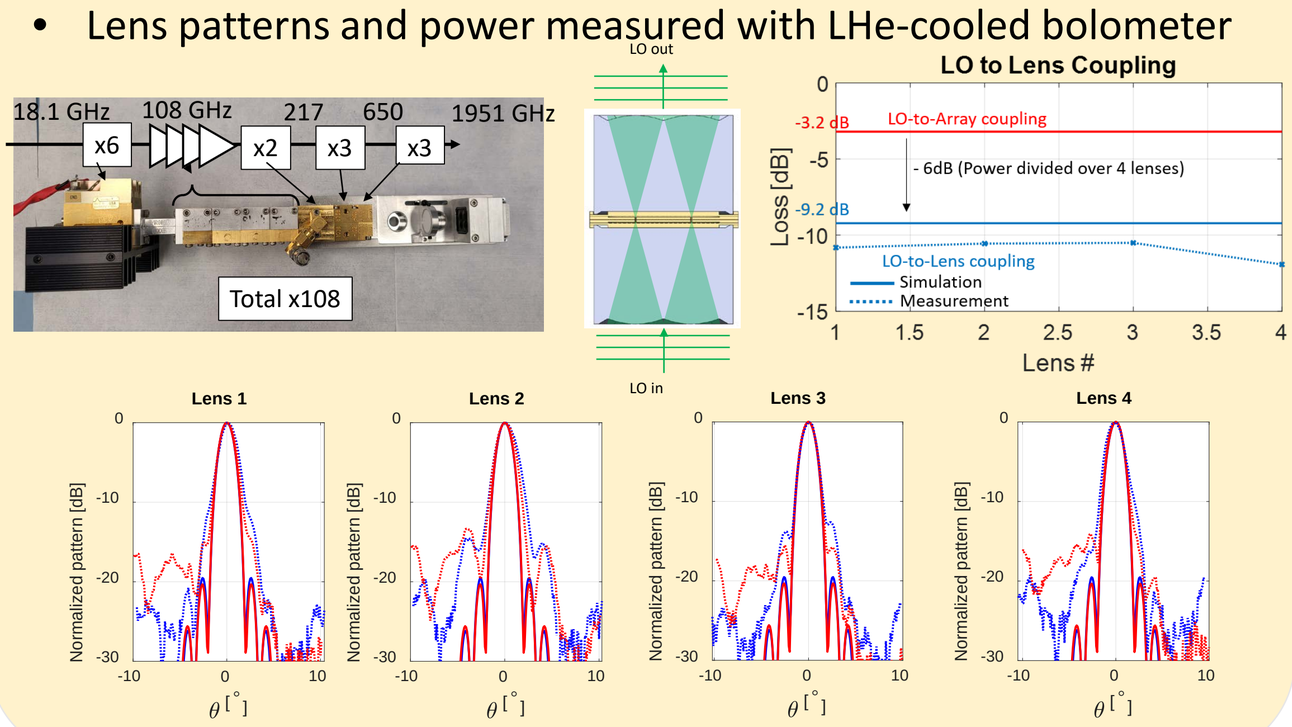

Figure 3. 1.9THz LO chian and LO coupling validation using a transmit-array configuration

- Custom SiGe cryo-LNA designed and tested that can be integrated in large format arrays.
- HEBs, designed and fabricated at MDL, are carefully selected based on normal resistance and critical current.
- Spring-loaded design for CTE mismatch mitigation.

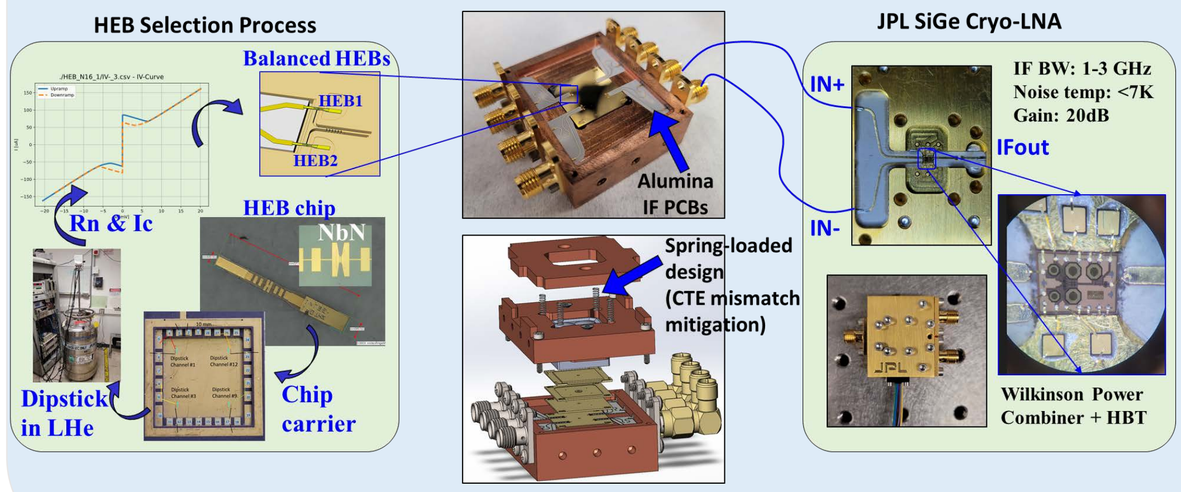

Figure 4. Assembly status of 2x2 Array; Custom SiGe Cryo-LNA with Wilkinson Power Combiner

Significant Benefit to JPL and NASA: Large-format heterodyne arrays would facilitate more and better science in future planetary and astrophysics missions, thanks to a potentially orders of magnitude improvement in sensitivity and/or mapping speed. The emphasis under initiative is to mature existing technologies to a stage where they can help bridge gaps in technological needs for instruments that can be proposed for future flight missions.

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