Virtual Research Presentation Conference

Planar Multi-Pixel Heterodyne Array Architecture Suitable for Large Arrays

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Program: Strategic Initiative

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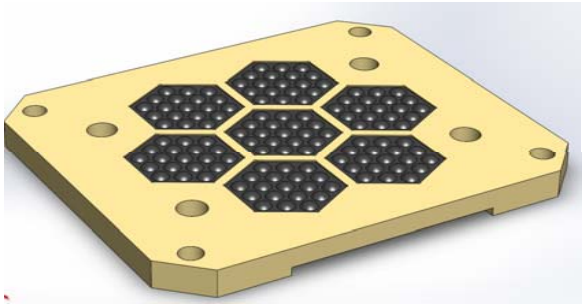
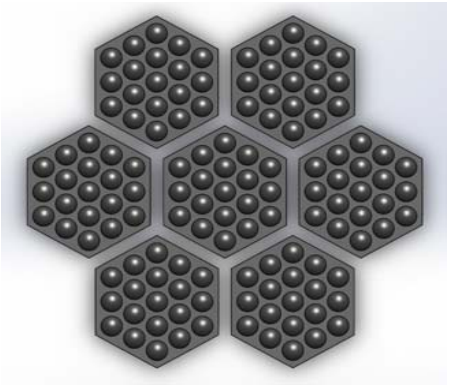
Introduction

We are developing a submillimeter-wave planar heterodyne array architecture leading to hundreds of pixels in a highly compact and efficient instrument package.

- Current generation of multi-pixel heterodyne arrays at submillimeter-waves are limited due to brute-force approach of tiling single-pixel systems.
- Silicon micromachined packaging and planar receiver architecture, coupled with novel leaky-wave lens couple antenna array allows expansion of sub-arrays to multi-pixel system with hundreds of pixels.





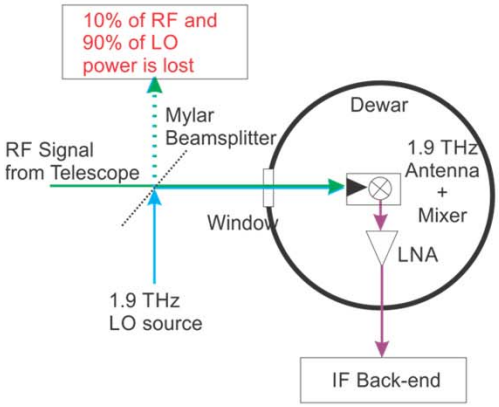
Hexagonal sub-array with 19-pixels in each sub-array and 7-such sub-arrays tiled to have a 119-pixel highly integrated system.

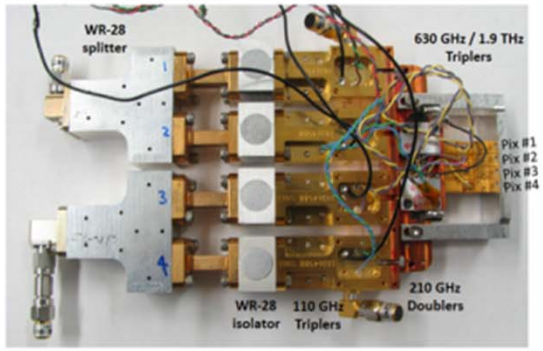
Scientific Motivation

- Mapping of the coolants, such as ionized carbon and atomic oxygen, of the interstellar medium close to massive young stars is very important to study formation of stars and galaxies.
- Velocity-resolved spectra of the fine structure lines of [CII] and [OI] is of prime importance.
- Both these objectives can be achieved through a very high resolution ($\lambda/\Delta\lambda \approx 10^7$) multi-pixel heterodyne array instrument with hundreds of pixels.

Technology Status and Future Need

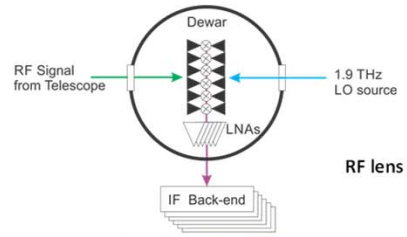
- Current generation of multi-pixel heterodyne receivers use assembly of single-pixel receiver architecture, severely limiting the performance, number of pixels, and ease of fabrication.
- A new, innovative, and bold heterodyne array architecture is needed to overcome the shortcomings mentioned above.

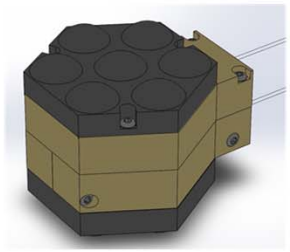




Proposed receiver layout for multi-pixel system

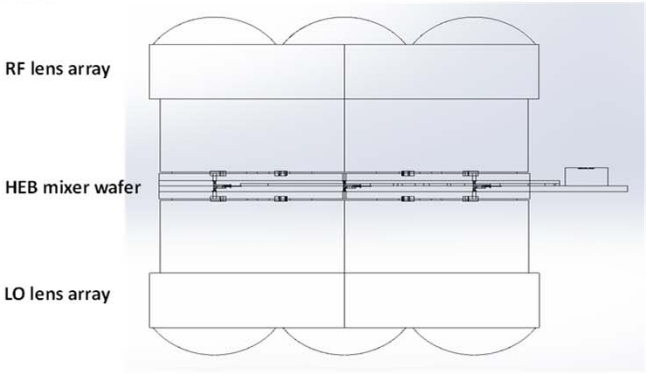
Current state-of-the-art: arraying of single-pixel systems





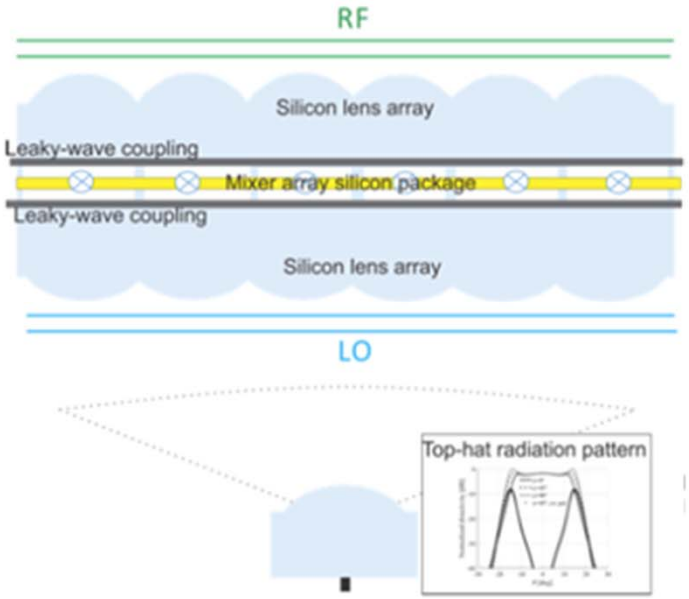
New Approach

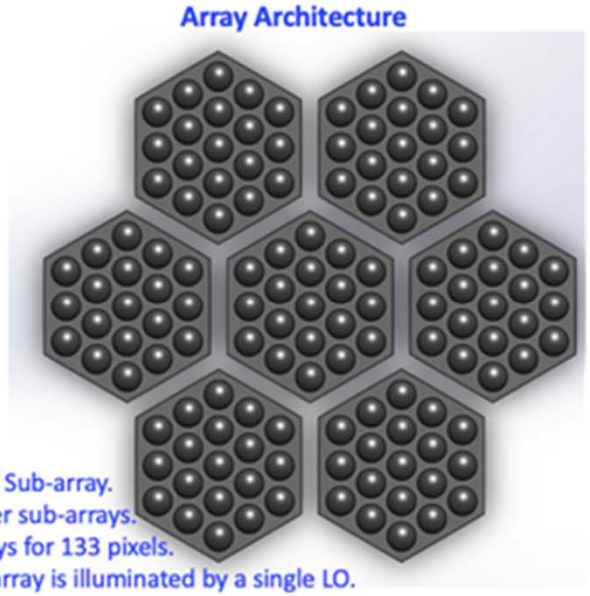
- RF and LO is coupled from two sides
- Planar layer of mixers sandwiched between two arrays of lenses for LO and RF coupling.



Technical Approach

- Planar HEB mixer array fabricated on thin silicon membrane and integrated on silicon micromachined packaging and two array of lenses couple the RF and LO signal from the front and back respectively.
- HEB mixers will not be diced individually and hand assembled: a wafer containing all the HEB mixers and coupling structures will be fabricated photolithographically and integrated with the lens arrays.

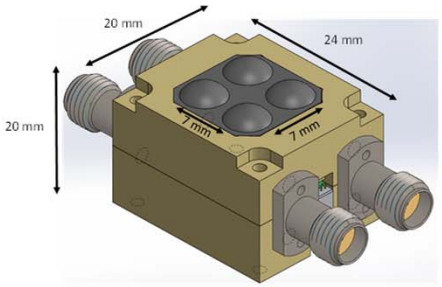


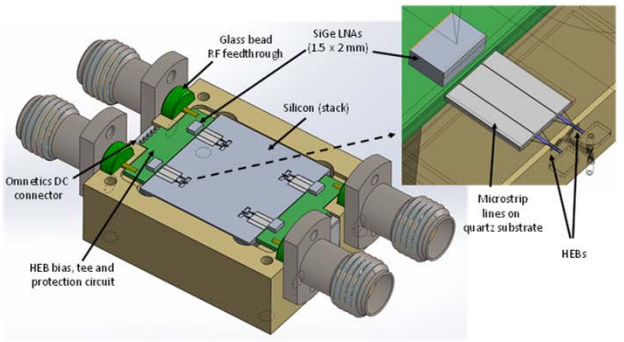


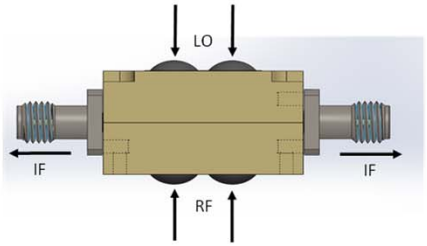
Accomplishments

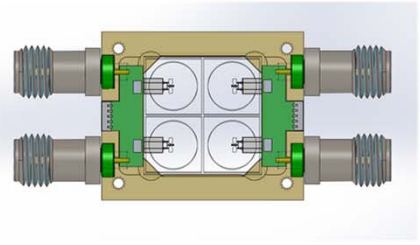
- Completed the array architecture design. We developed a 19-pixel sub-array architecture where each of the sub-arrays is illuminated by a single LO source.

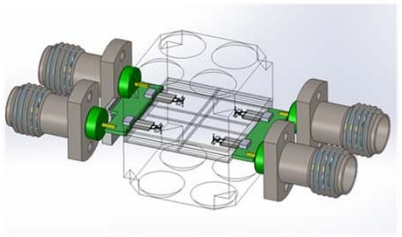
- Completed a proof-of-principle 4-pixel array with integrated IF amplifiers.
- The layout of the designs have been completed.
- Detailed simulations have been done to verify performance.
- In the process of fabricating the array now.











Significance of Results

This work of shows that a planar multi-pixel array design is possible and a modular design approach will enable instruments with many more pixels than the traditional approaches are being currently used.