Array-Fed Radiometer

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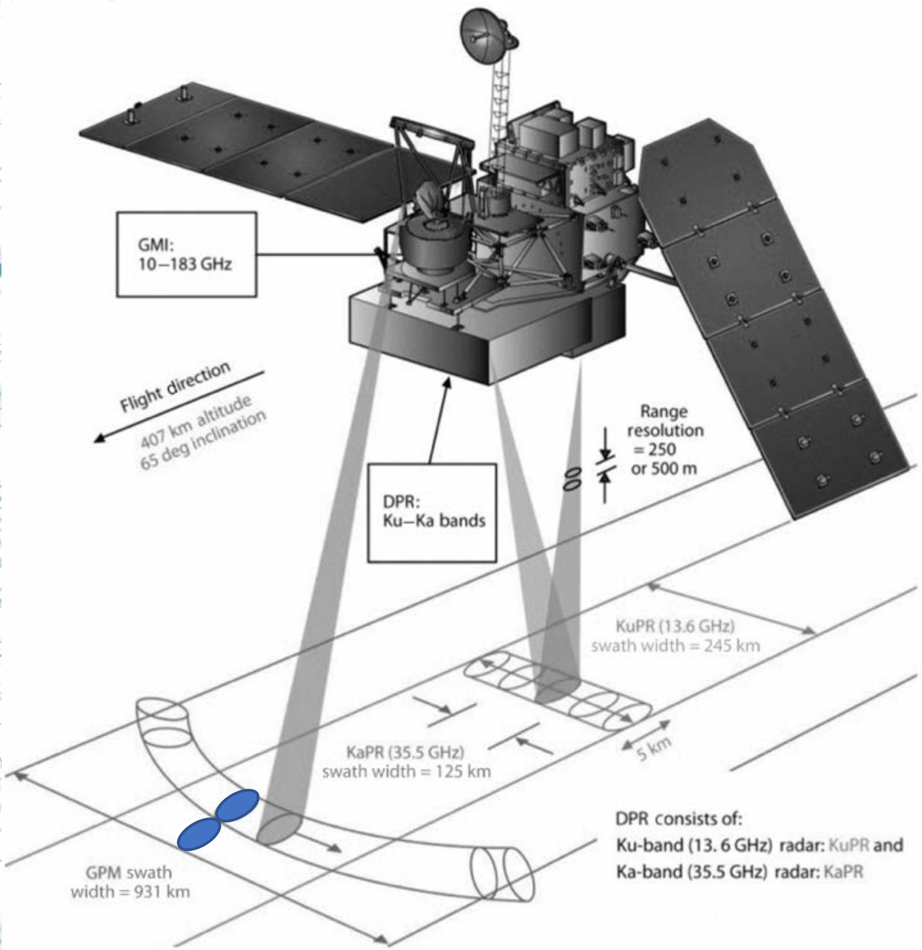
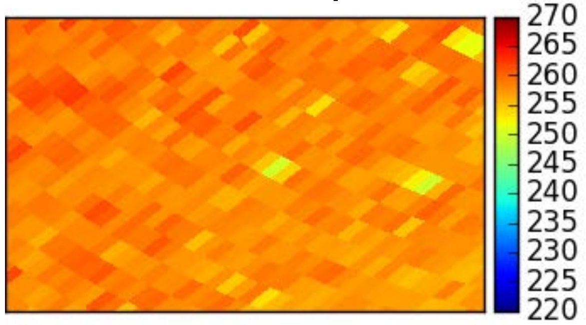
Program: ACT-17

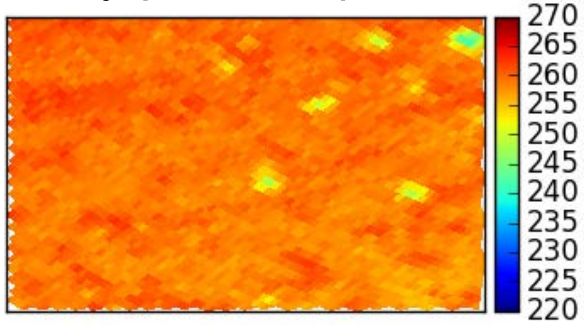
Problem to Solve: Spatial Aliasing



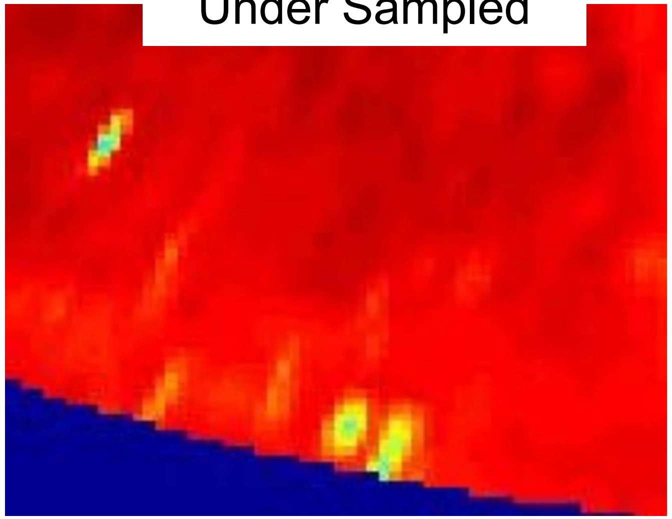
166 GHz @ 1 meter
Under Sampled



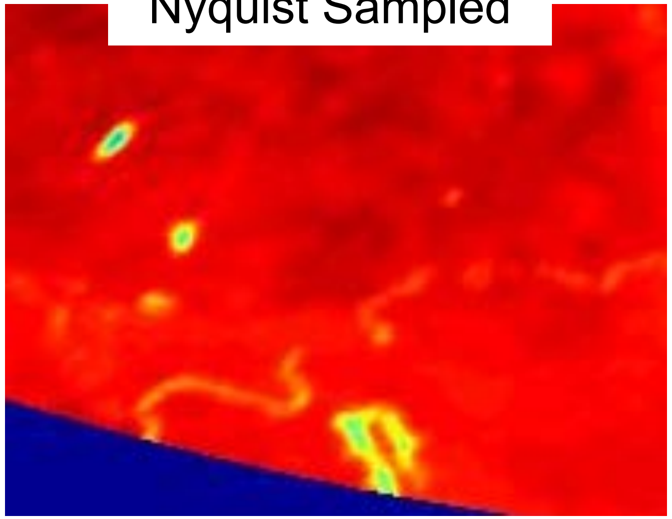
166 GHz @ 0.5 meter
Nyquist Sampled



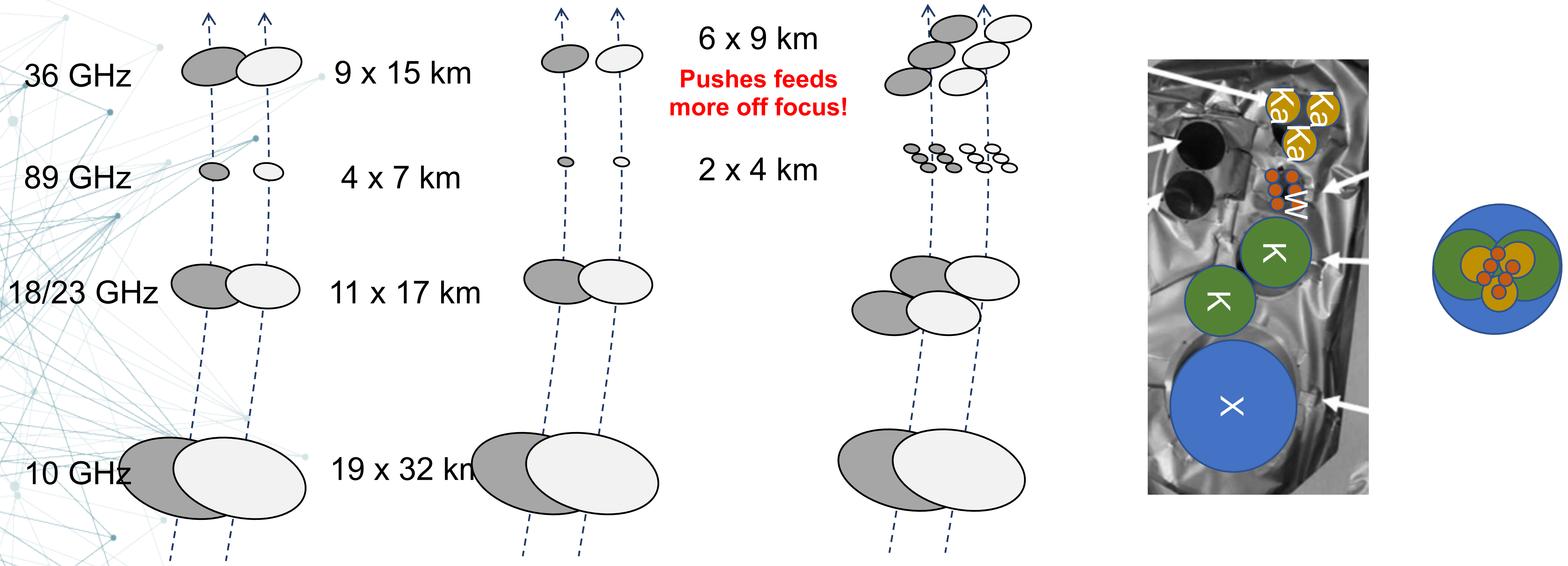
37 GHz @ 2 meter
Under Sampled



37 GHz @ 2 meter
Nyquist Sampled



Improving Conventional Sampling Approach



Scan N, N+1

s/c motion
12.7 km/scan

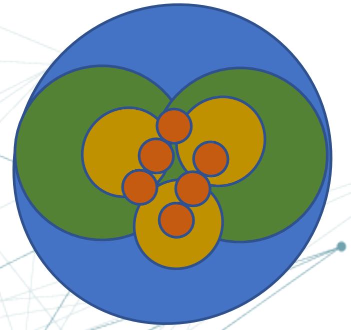
Use full aperture, but still under sampled

Add more beams for Nyquist Sampling

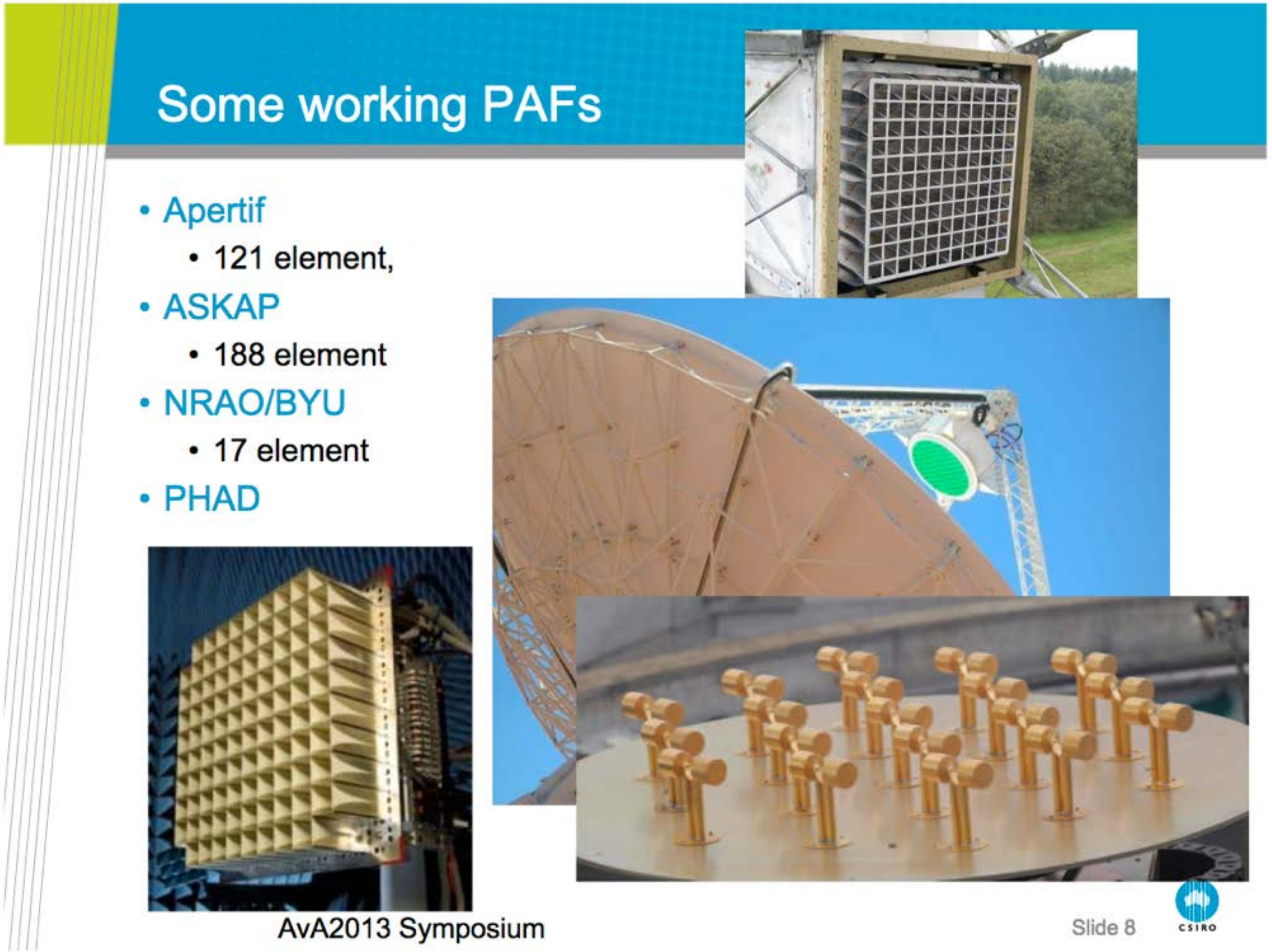
Notional Feed Cluster for Nyquist Sampling

What if ?

How: Borrow (steal) from Radio Astronomy



Overlapping feed apertures at multiple frequencies -> broadband phased array feed



- Possibilities
  - Multiple beams
  - Beam steering
  - Beam shaping
  - RFI nulling

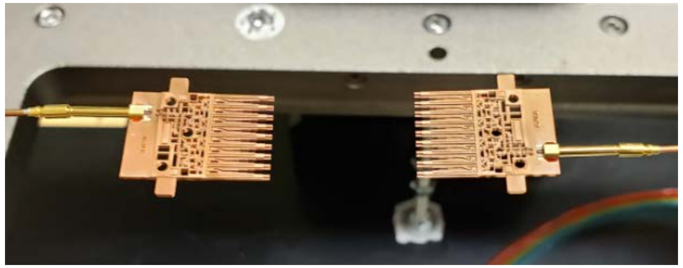
Reinventing Radio Astronomy – PAF Technology
John O'Sullivan
Centre for Astronomy and Space Science
CSIRO
2 April 2013

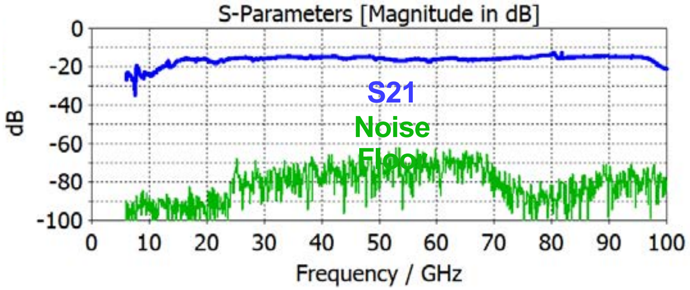
http://www.astron.nl/ava2013/documents/John_O_Sullivan.pdf

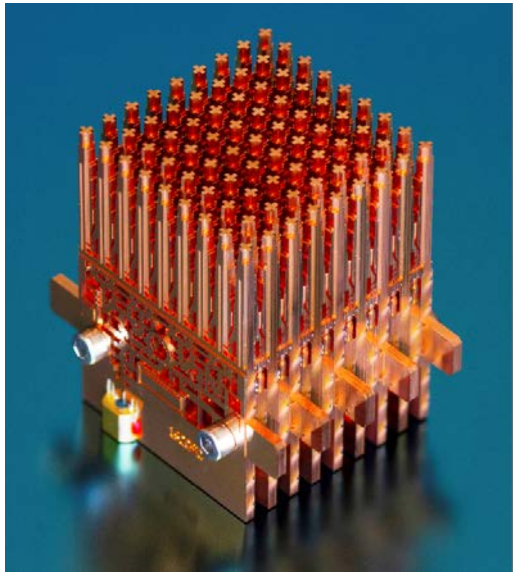
Technical Details

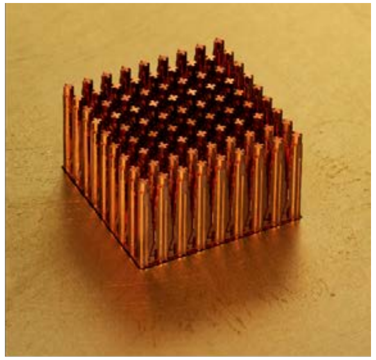
- Dual-Polarized 8X9 Vivaldi array constructed on a 2 mm pitch.
- Targeting operation at 5 radiometer bands spanning 10.6-92 GHz within a single aperture.
- Assembled from 17 pieces of stacked PolyStrata® radiator/array processing cards.
- Column combiners used to perform analog beamforming in elevation.
- Boresight and azimuth steered patterns formed by digitally combining card patterns in post-processing.
- Excellent correlation between simulated and measured radiation patterns is achieved across all radiometer bands.
- Elimination of traditional connector interface between dual-polarized array and array processing.

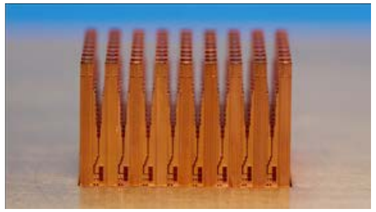
X-W band PolyStrata® Array Demonstrator

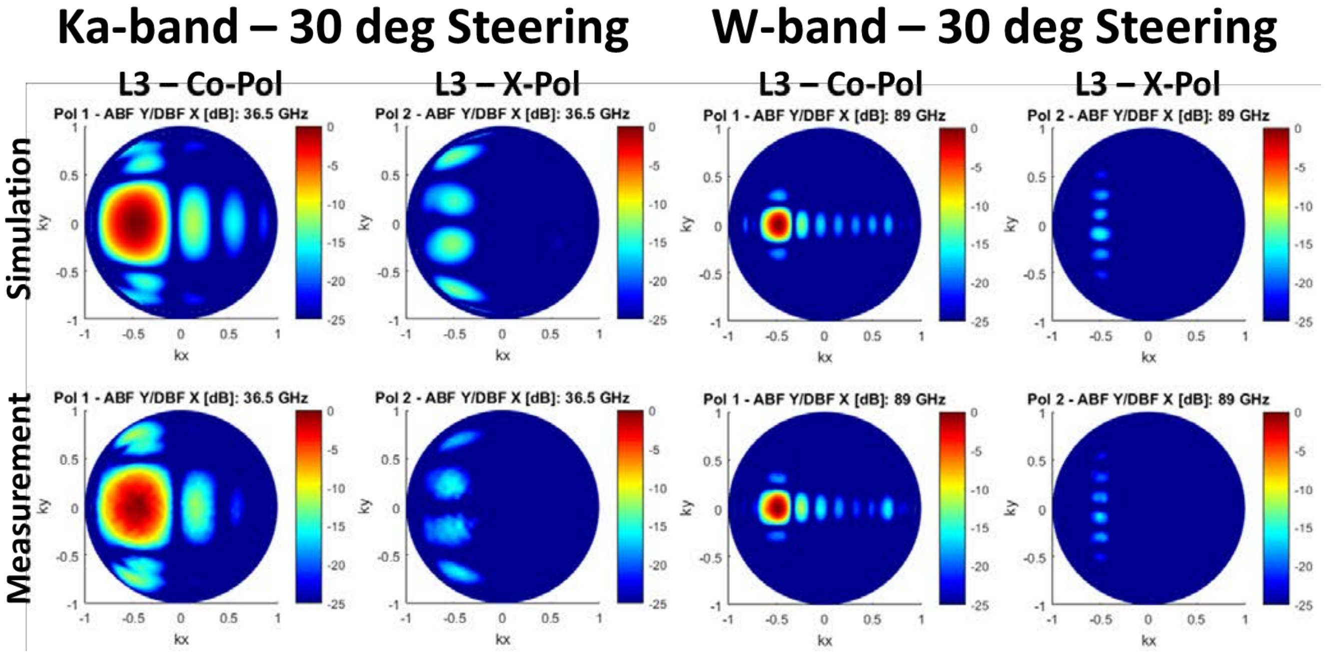




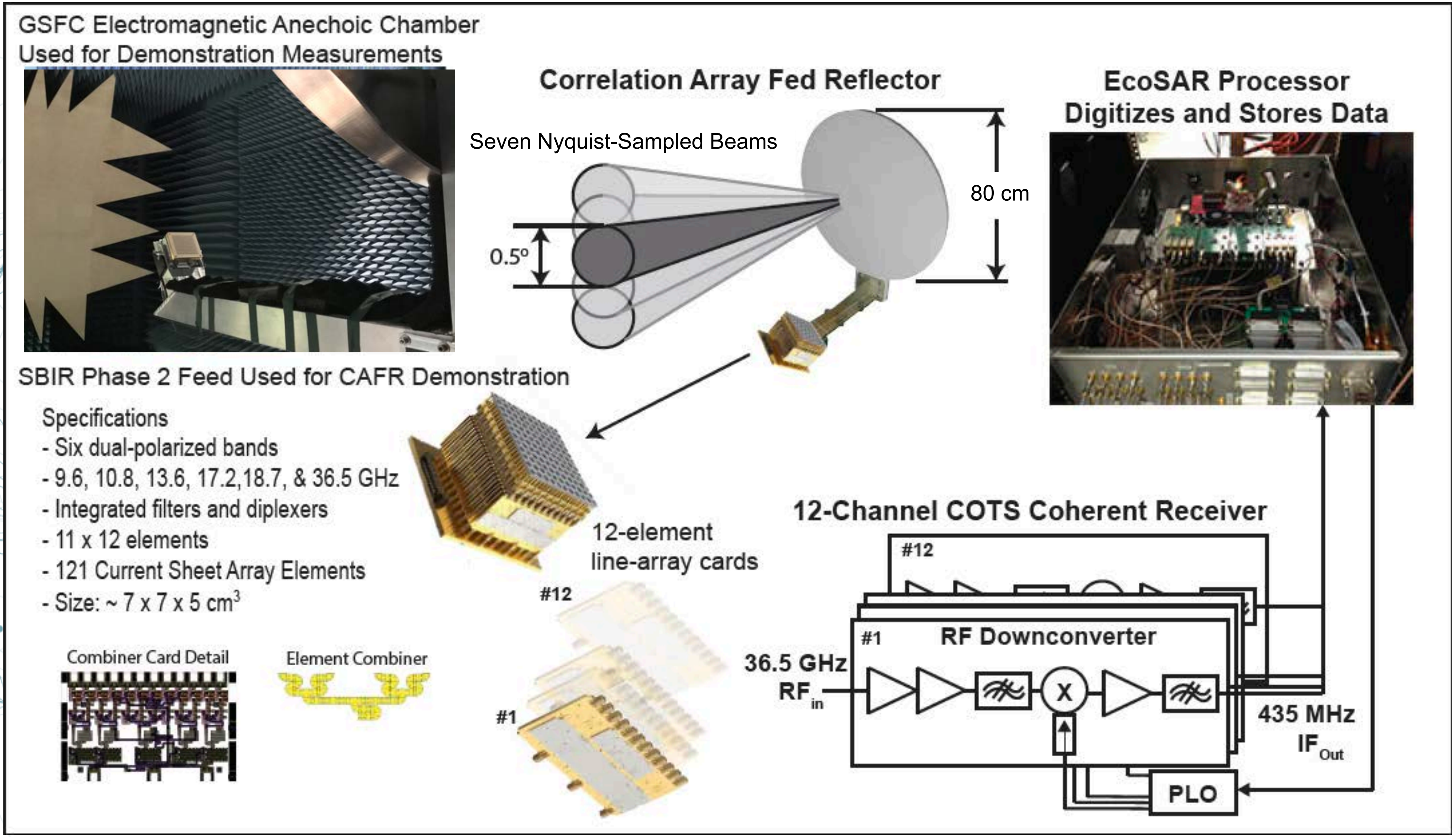








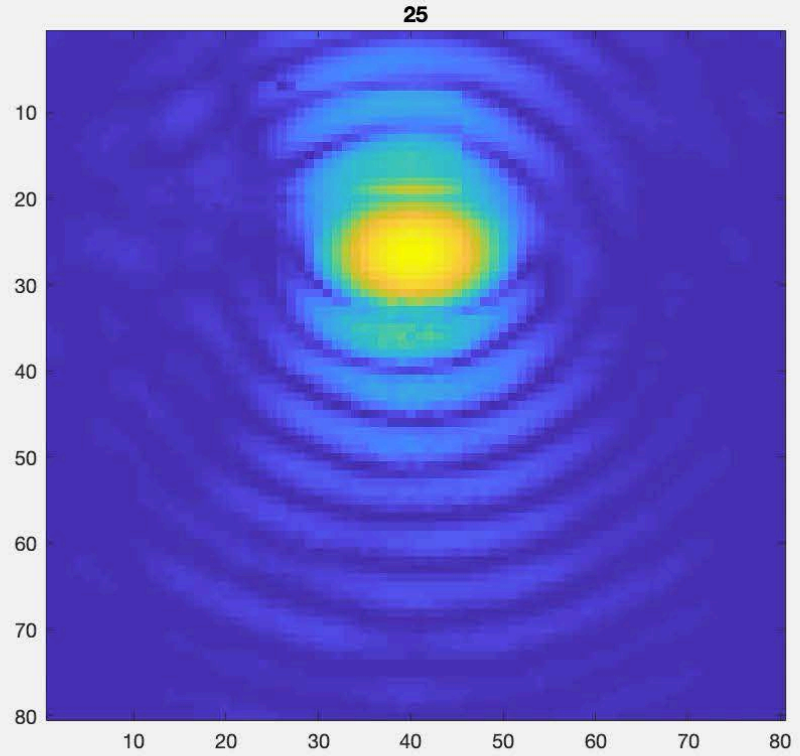
Laboratory Demonstration

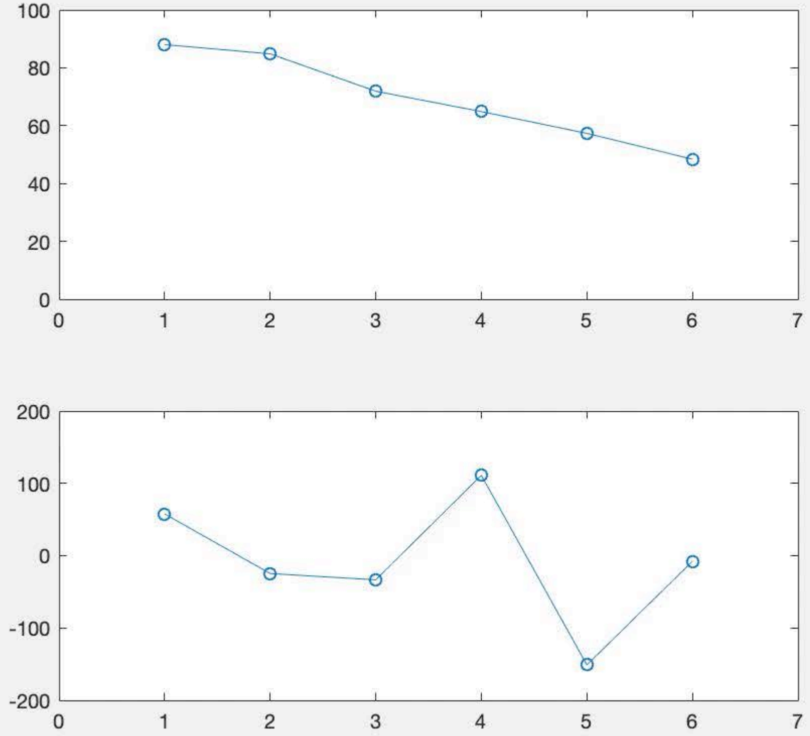


Agile Beamforming in Reprocessing

“Max SNR” beamformer used in radio astronomy

Weights (dB, degrees)





Next Steps

Accomplishments:

- Development of broadband (4:1 & 10:1) **dual-polarized apertures spanning X-band to W-band**.

- **Low-loss (< 0.5 dB) element-level diplexing** to finely control frequency-dependent aperture radiation at the "pixel" level with low-loss (e.g. 0.04 dB/mm @ 89 GHz) analog beamforming networks.

- Modular, multi-band, coaxial-based, passive front-end hardware to enable multi-function instrumentation (i.e. radiometer, radar, fixed & scannable apertures)

Where we are headed:

- Elimination of traditional lossy and bulky RF connector interfaces & cabling and tighter **integration of active devices** (i.e. LNAs, diode detectors, ADCs, etc.) with passive front-end hardware to form tile-able instrumentation.

- *Near-term:* Trade **fewer frequency bands for a lower SWAP** instrument and faster deployment within a small satellite payload.

- *Long-term:* Continue the technology development to further enable **multi-frequency, multi-beam instrumentation** from a common aperture.