

Supercam: A 64-Beam Heterodyne Array for the 870-micron Atmospheric Window

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And many collaborators from many institutions...



Supercam Team

University of Arizona

- Chris Walker (PI)
- Craig Kulesa (DPI, science team lead)
- Chris Groppi (Co-I, Instrument Scientist)
- Christian Drouet d'Aubigny
- Robert Stickney
- Dathon Golish
- Paul Gensheimer
- Jenna Kloosterman
- Shane Bussmann

University of Cologne

- Patrick Puetz

Harvard Smithsonian Center for Astrophysics

- Abby Hedden

Jet Propulsion Lab

- Tom Kuiper

California Institute of Technology

- Sander Weinreb (Co-I, IF system)
- Jacob Kooi
- Hamdi Mani
- Glenn Jones
- Joe Bardin

University of Massachusetts

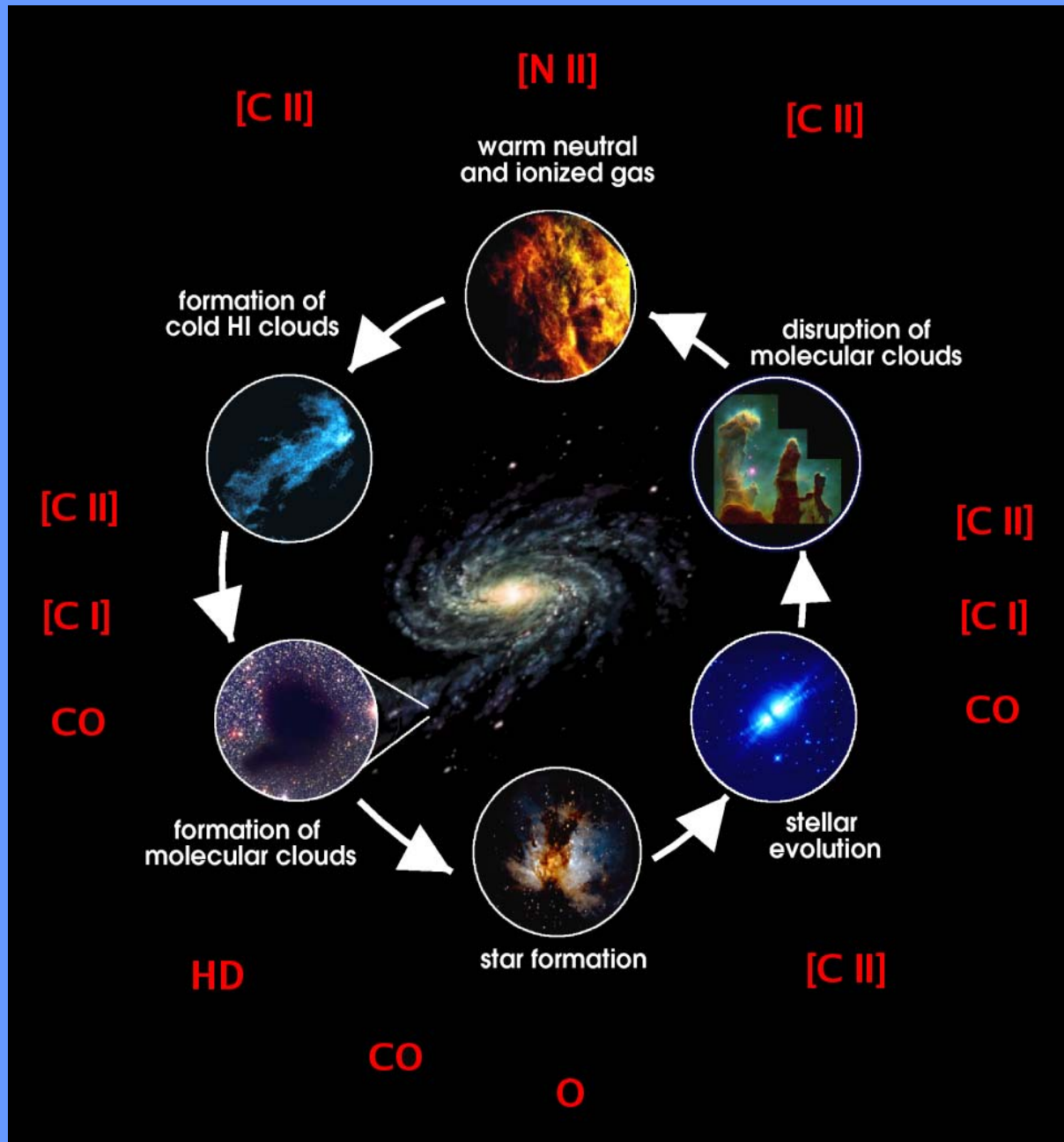
- Gopal Narayanan
- Ron Grosslein

University of Virginia

- Art Lichtenberger (Co-I SIS devices)
- Thomas Cecil

Industry Partners

- Omnisys AB (spectrometer)
- Virginia Diodes (Local Oscillator)
- Universal Cryogenics (Cryostat)
- NGST (LNA MMIC Fab)



Spectral diagnostics of the interstellar life cycle define a new, pressing need for large-scale, high resolution spectroscopic surveys!

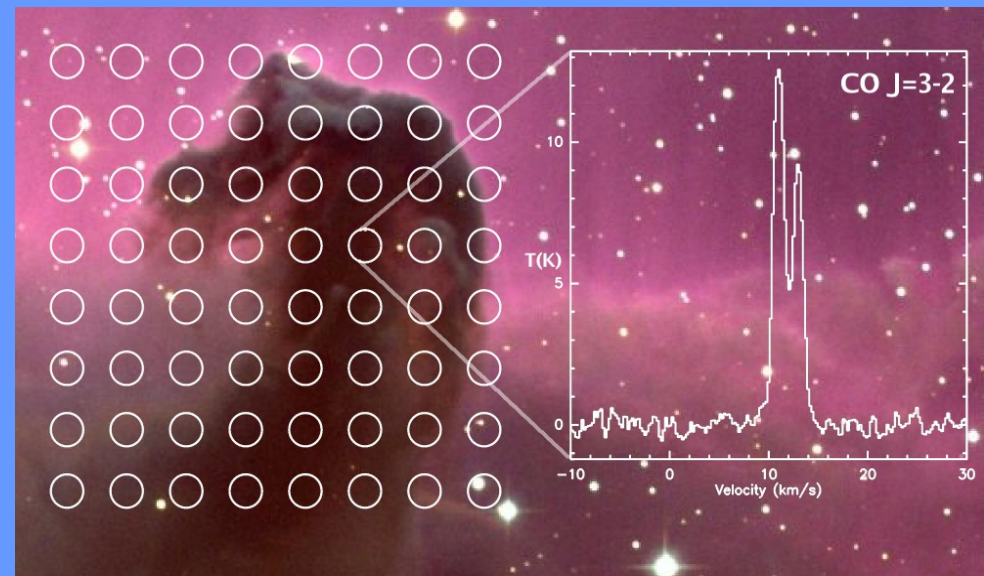
Continuum observations (dust emission) only tells part of the story.

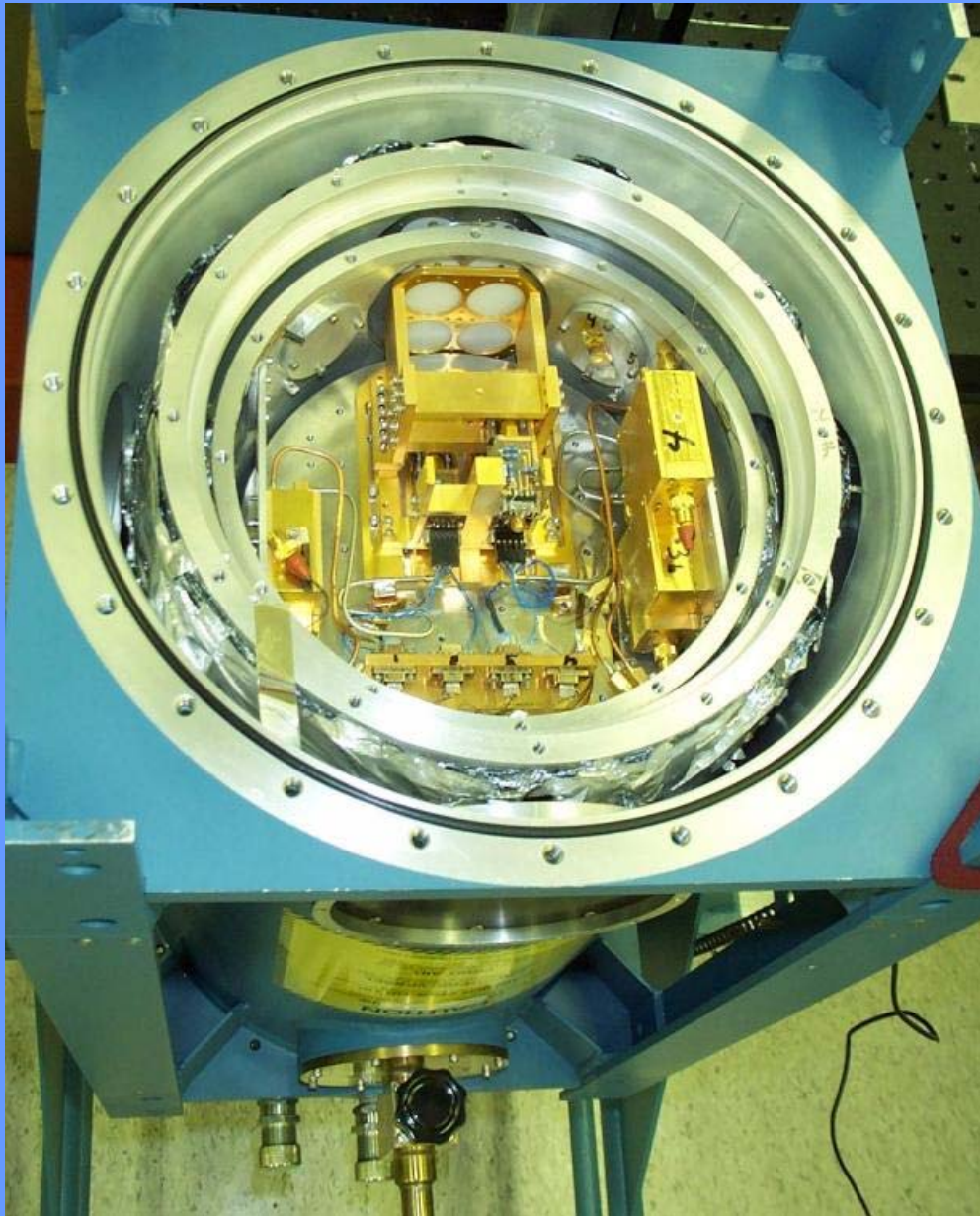
We want to know about the gas too!

We need wide field mapping (many square degrees), ~km/s spectral resolution and sub-arcminute spatial resolution.

Supercam 64 beam heterodyne array

- Supercam is a 8x8 pixel heterodyne array receiver (imaging spectrometer), designed to operate in the 870 μm atmospheric window at the 10m Heinrich Hertz Telescope.
- Supercam will be two orders of magnitude faster than current generation single pixel receivers.
- Funded by NSF MRI in 2004
- Key project: fully sampled $^{12}\text{CO}(3-2)$ and $^{13}\text{CO}(3-2)$ survey of over 500 square degrees of the Galactic plane.

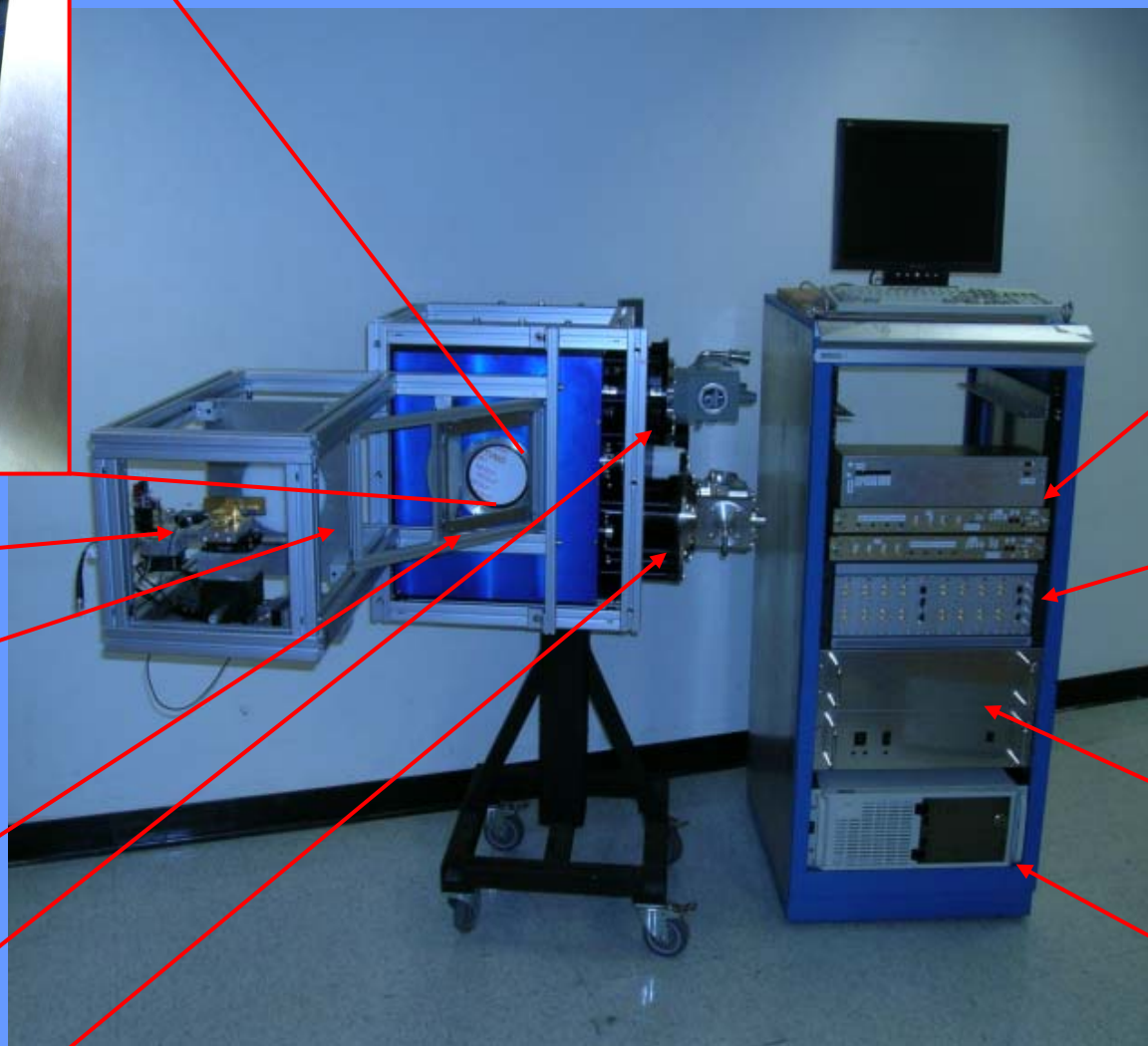
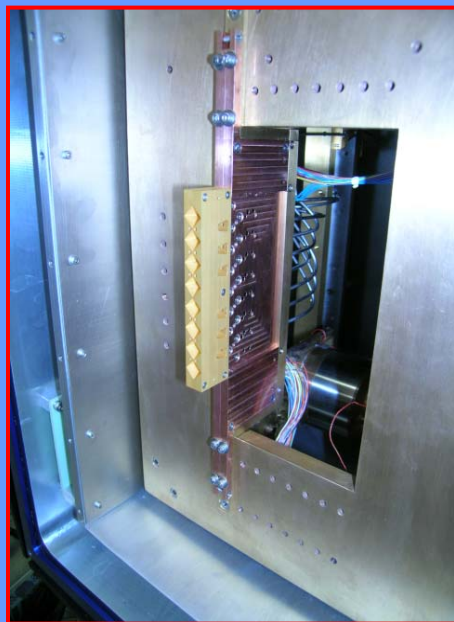




AST/RO PoleSTAR Receiver

- 4 pixels at 810 GHz
- IF bandwidth ~1 GHz
- JPL LO Chain
- $T_{\text{rec}} \sim 550\text{--}650\text{ K}$
- 4 channel Array AOS

Supercam System



LO System with 8
way power divider

LO Optics

LO Beamsplitter &
dewar window

CTI 350 cooler

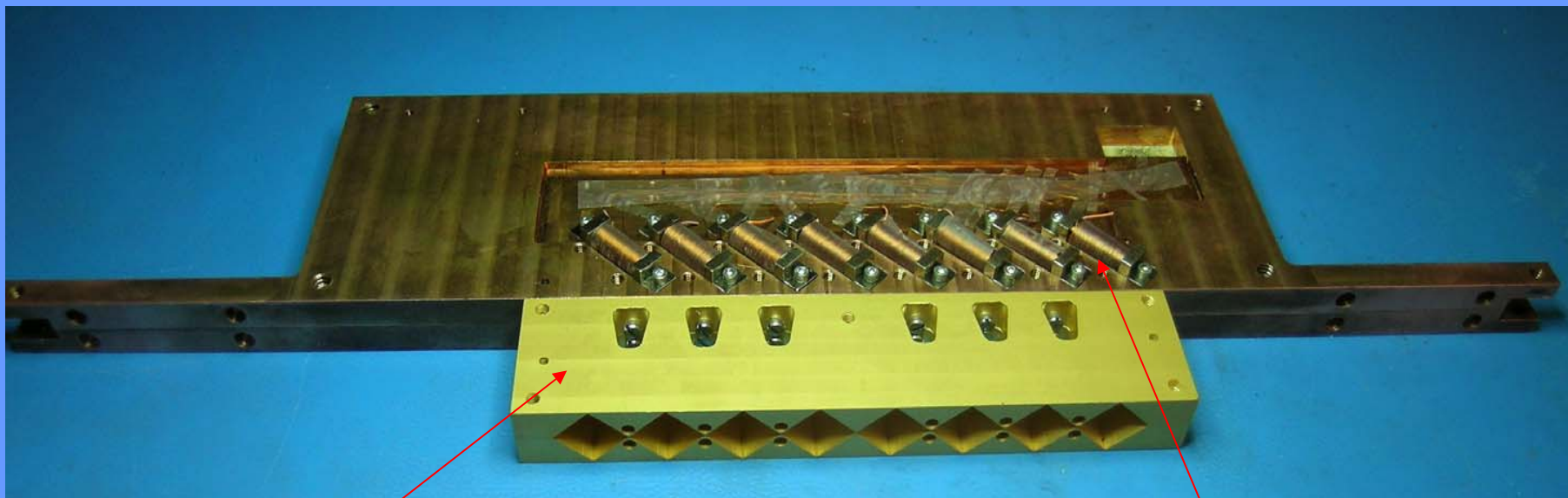
Sumitomo 4K
cooler

2 8 channel
downconverter modules

Omnisys Spectrometer
64x250 MHz complete
system

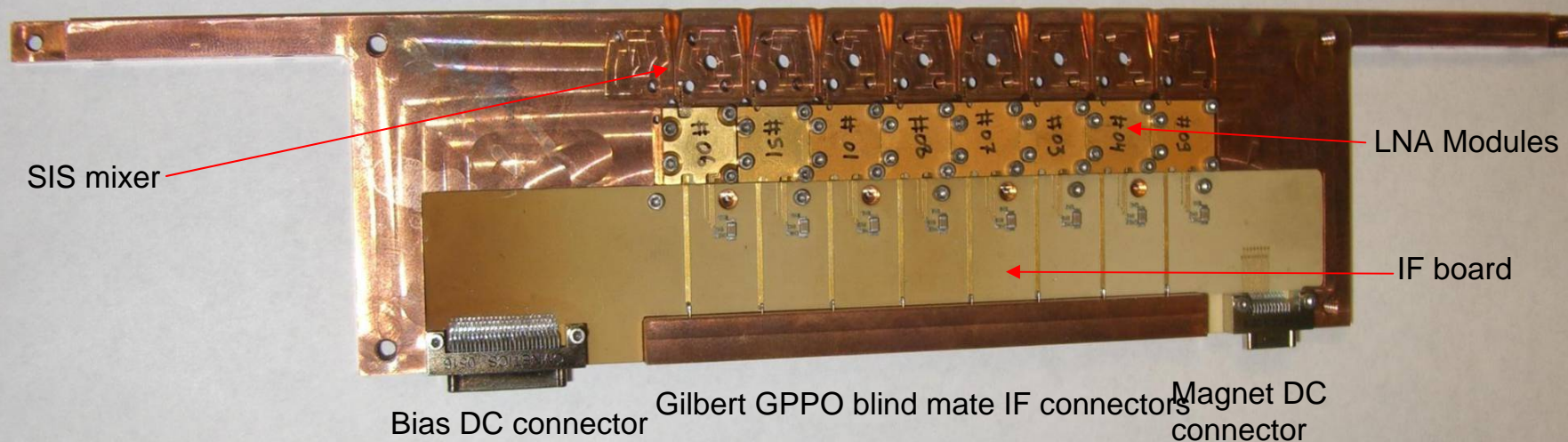
Prototype 8 channel
bias system (1 6U card
with power supplies)

Spectrometer and bias
control computer



Horn Extension Block

Electromagnets



SIS mixer

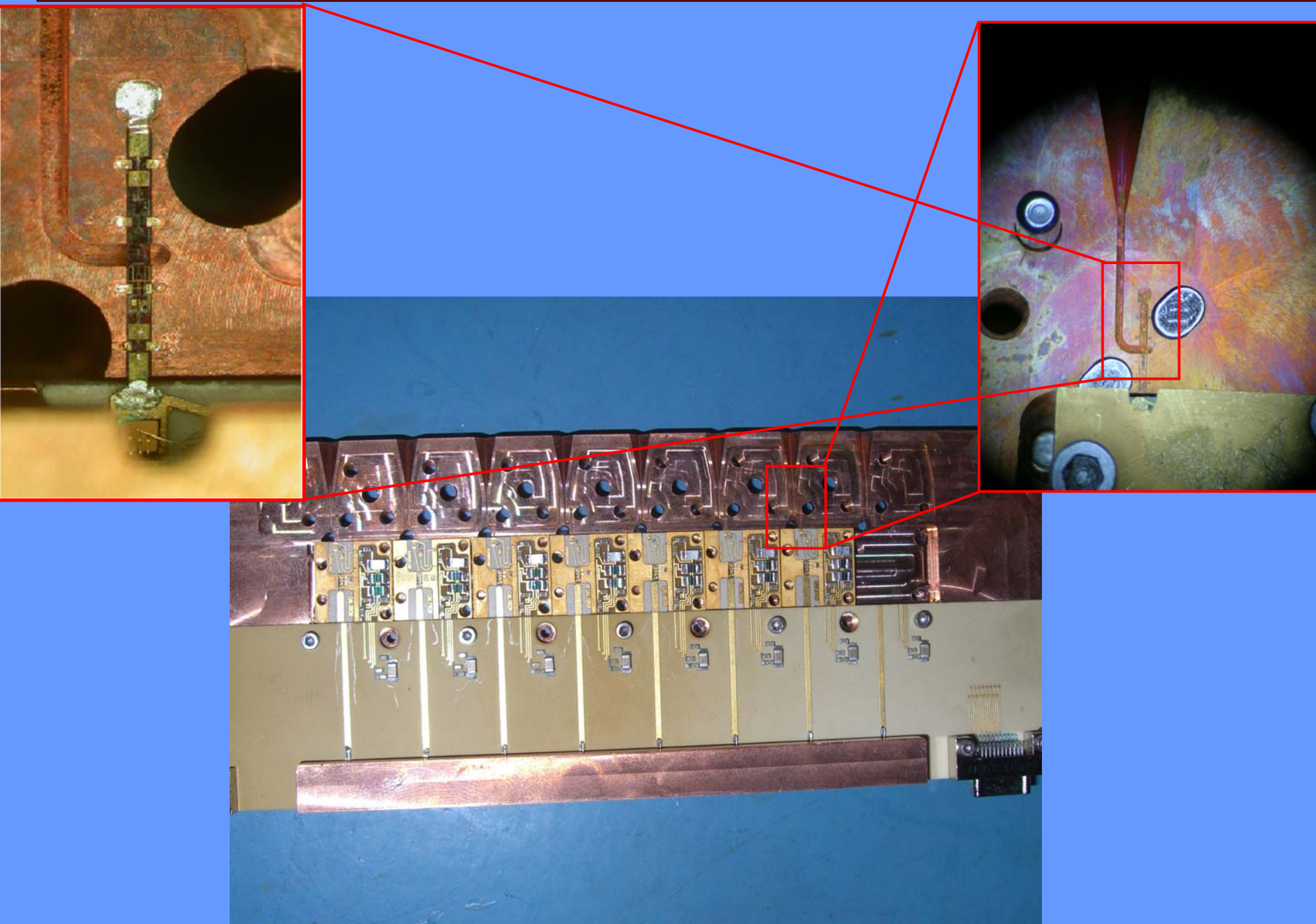
LNA Modules

IF board

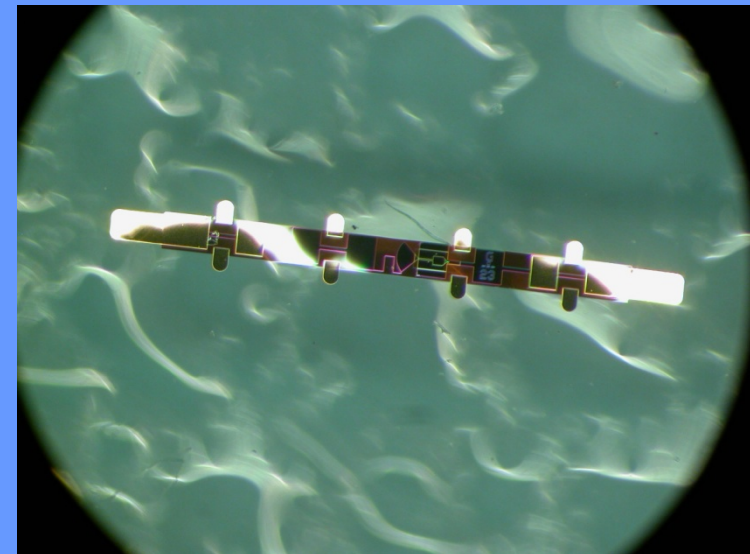
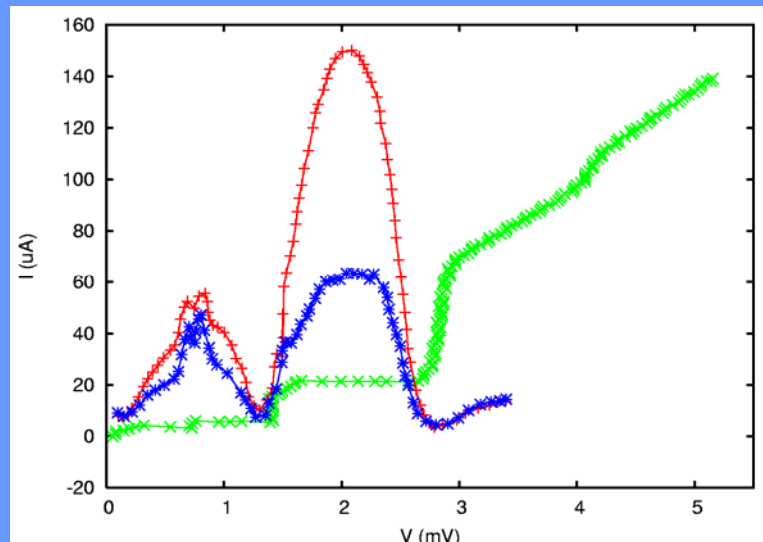
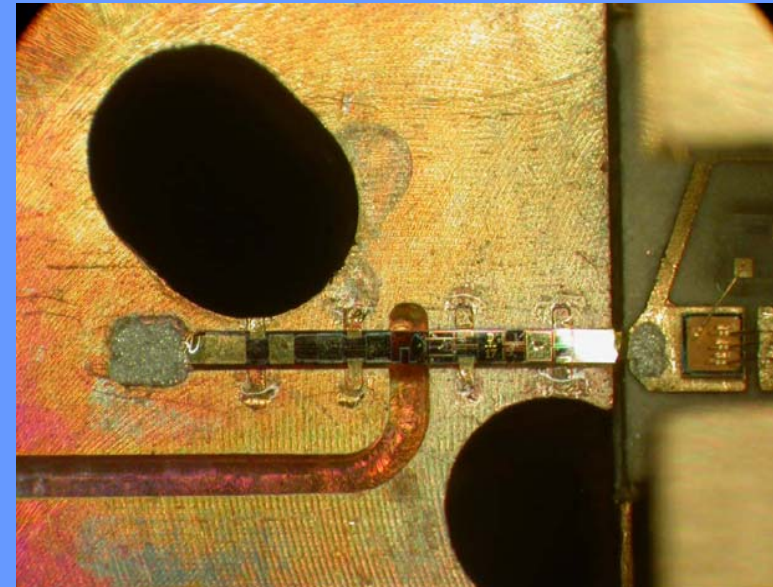
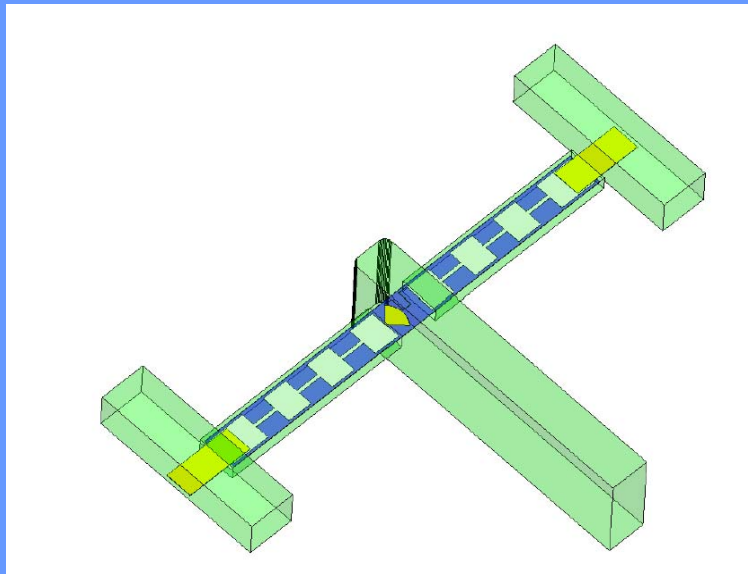
Bias DC connector

Gilbert GPP0 blind mate IF connectors

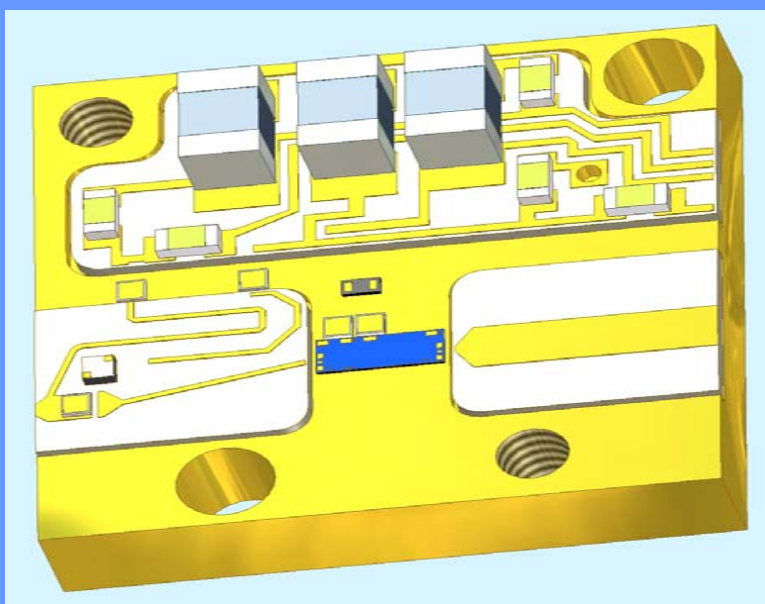
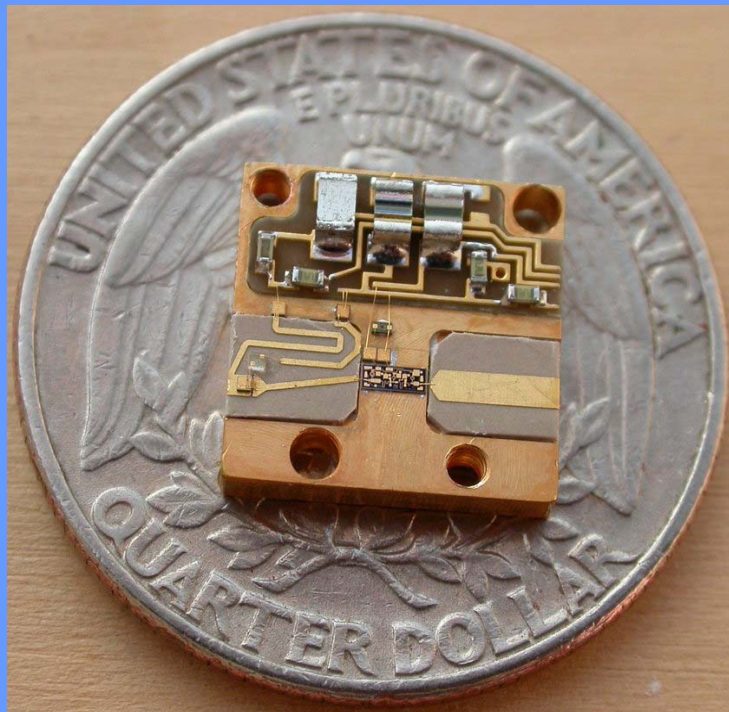
Magnet DC connector



SuperCam beam-lead on SOI SIS devices



Low Noise Cryo Amplifiers (Caltech)



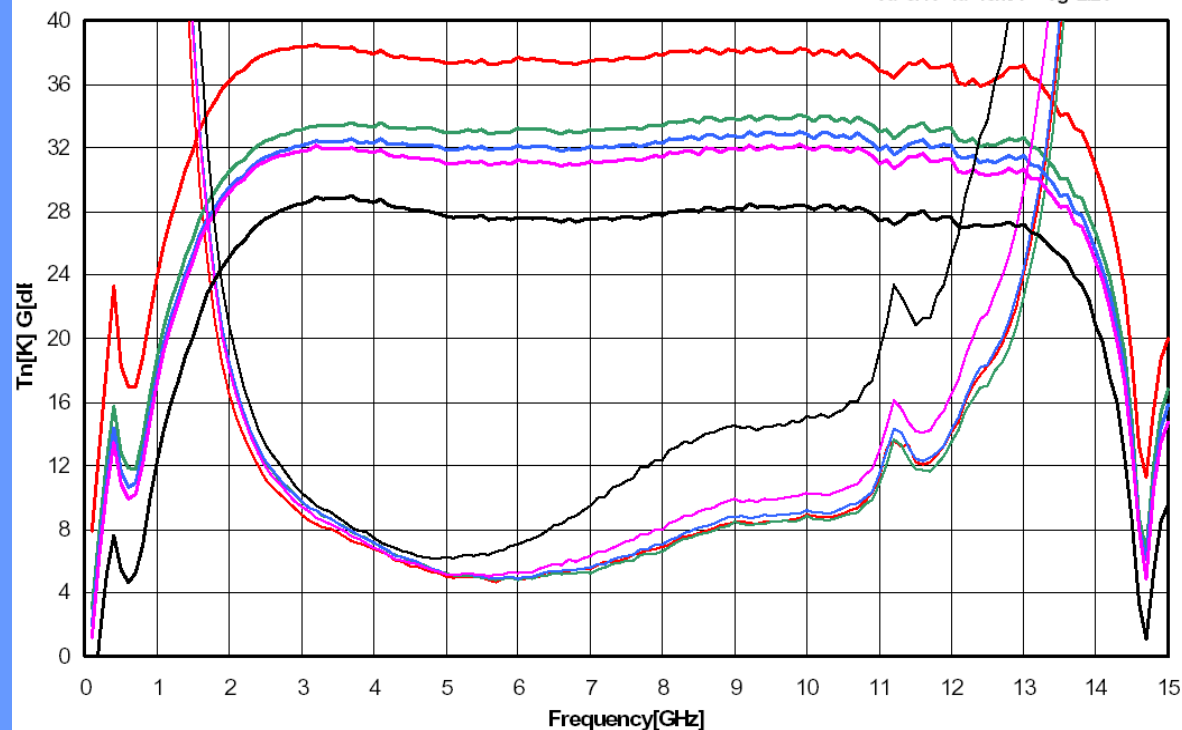
SuperCam LNA #SC09 at 13K

MMIC WBA13 R6C2M4 C1T1 4254-065

MARCH-13-2006

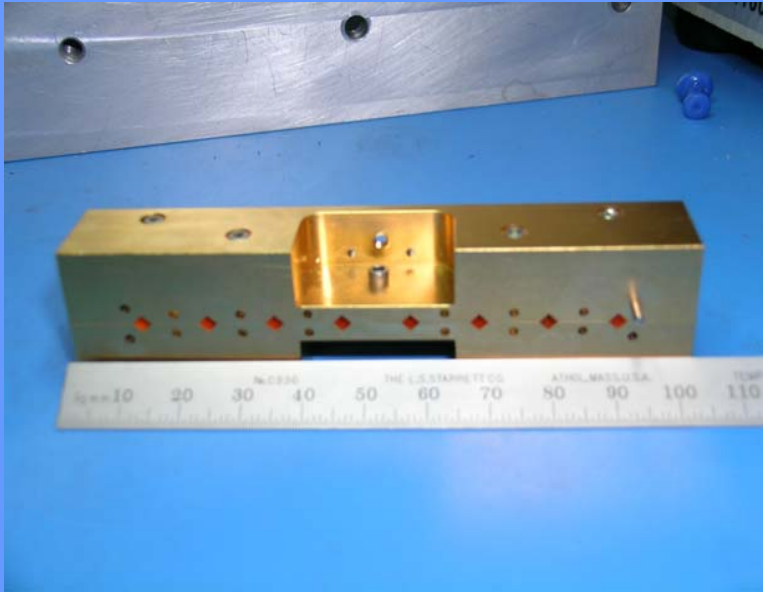
Bias Points:

Vd=1V	Id=20mA	Vg=2.2V
Vd=1V	Id=10mA	Vg=1.8V
Vd=0.8V	Id=10mA	Vg=1.9V
Vd=0.6V	Id=10mA	Vg=2.05V
Vd=0.4V	Id=10mA	Vg=2.2V



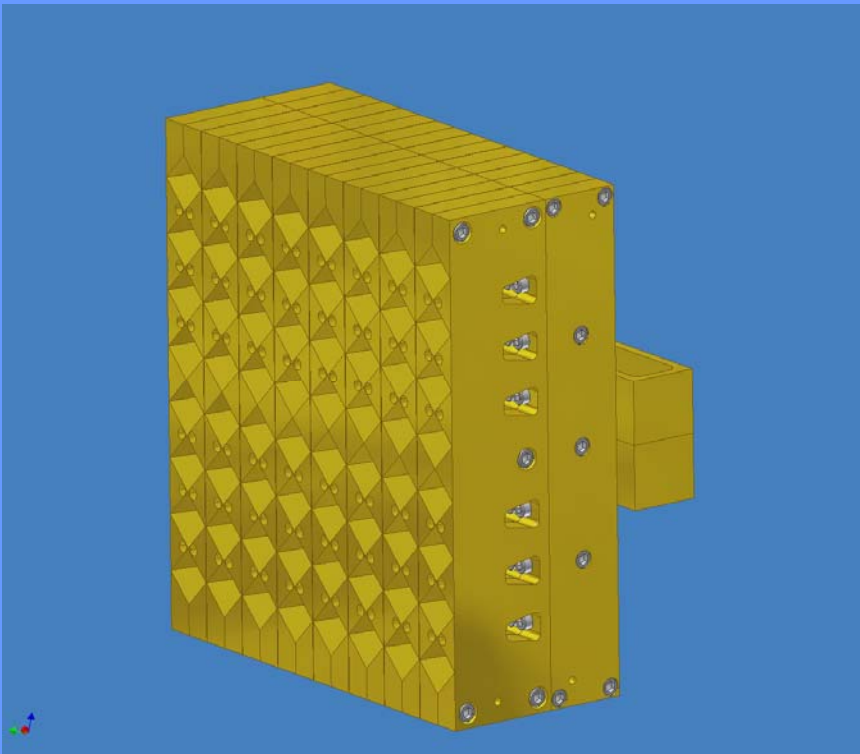
32 dB Gain, 5 K Noise at 8mW power
dissipation

N. Wadefalk, J. Kooi, H. Mani & S. Weinreb, Caltech

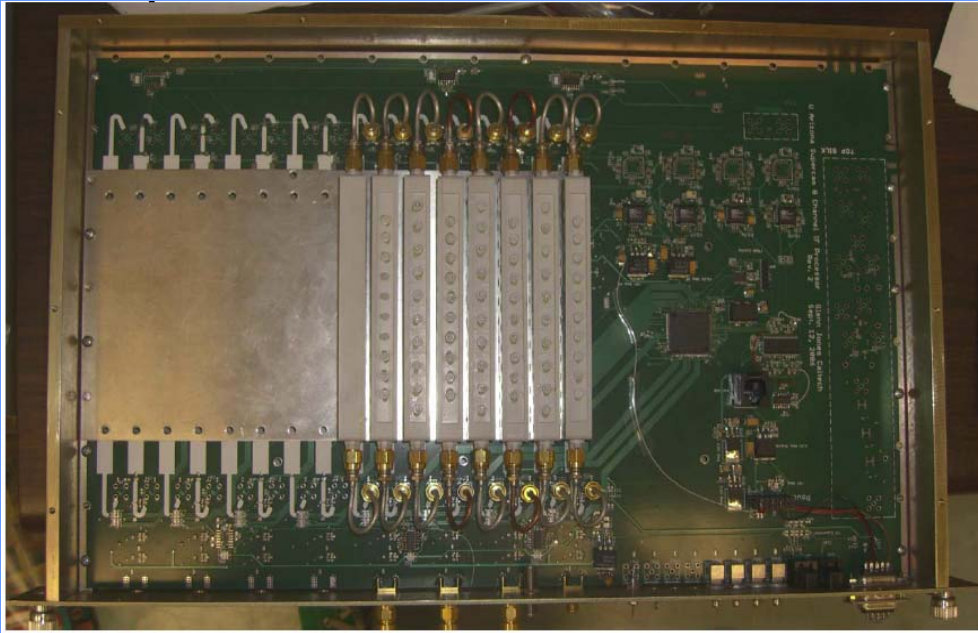


Local Oscillator

- Virginia Diodes synthesizer driven planar diode LO source
- 2mW power output, tunable from 320-370 GHz
- Waveguide LO power divider

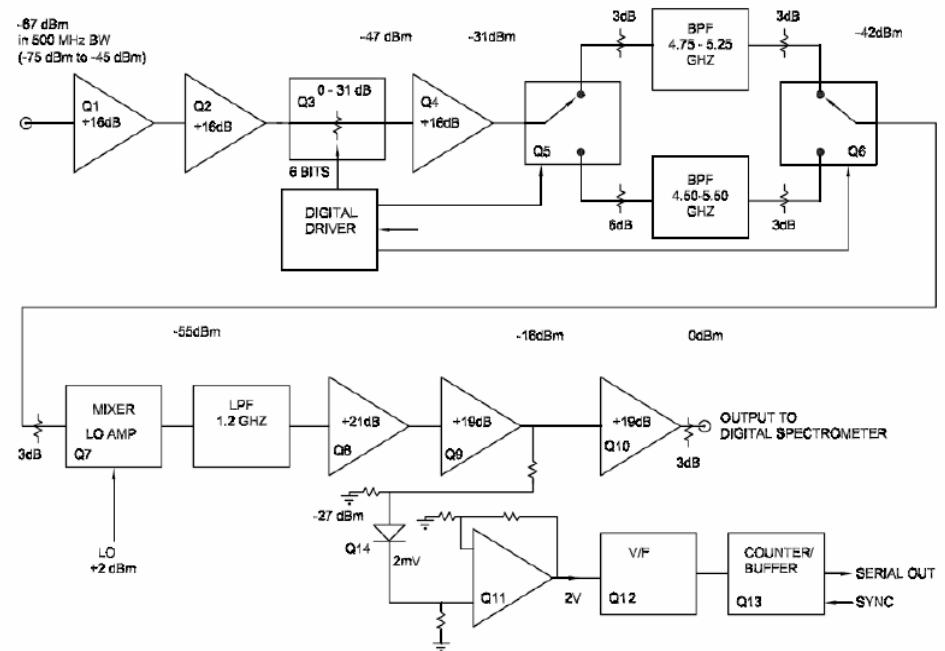


Supercam IF Processing (Caltech)



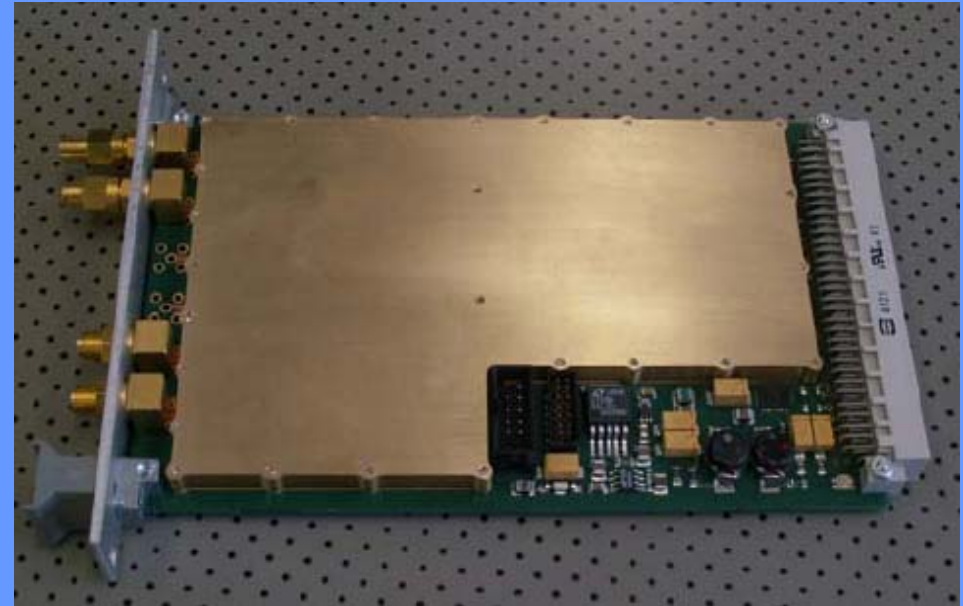
1x8 Downconverter module (Caltech: G. Jones and J. Bardin)

- Total power metering
- 250 MHz and 500 MHz bandwidth modes (1 GHz with filter change)
- Digital attenuators
- Low cost surface mount components

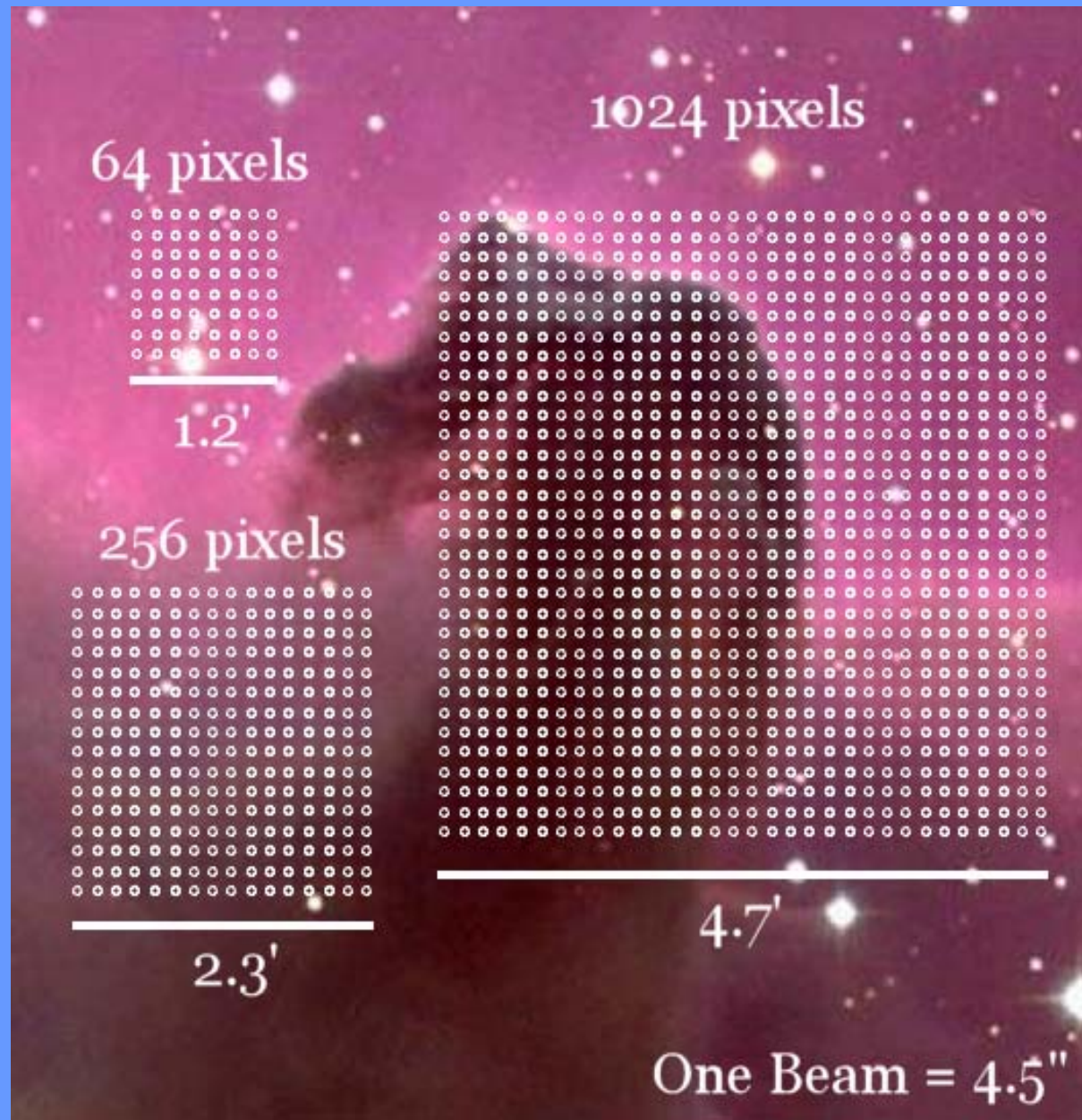


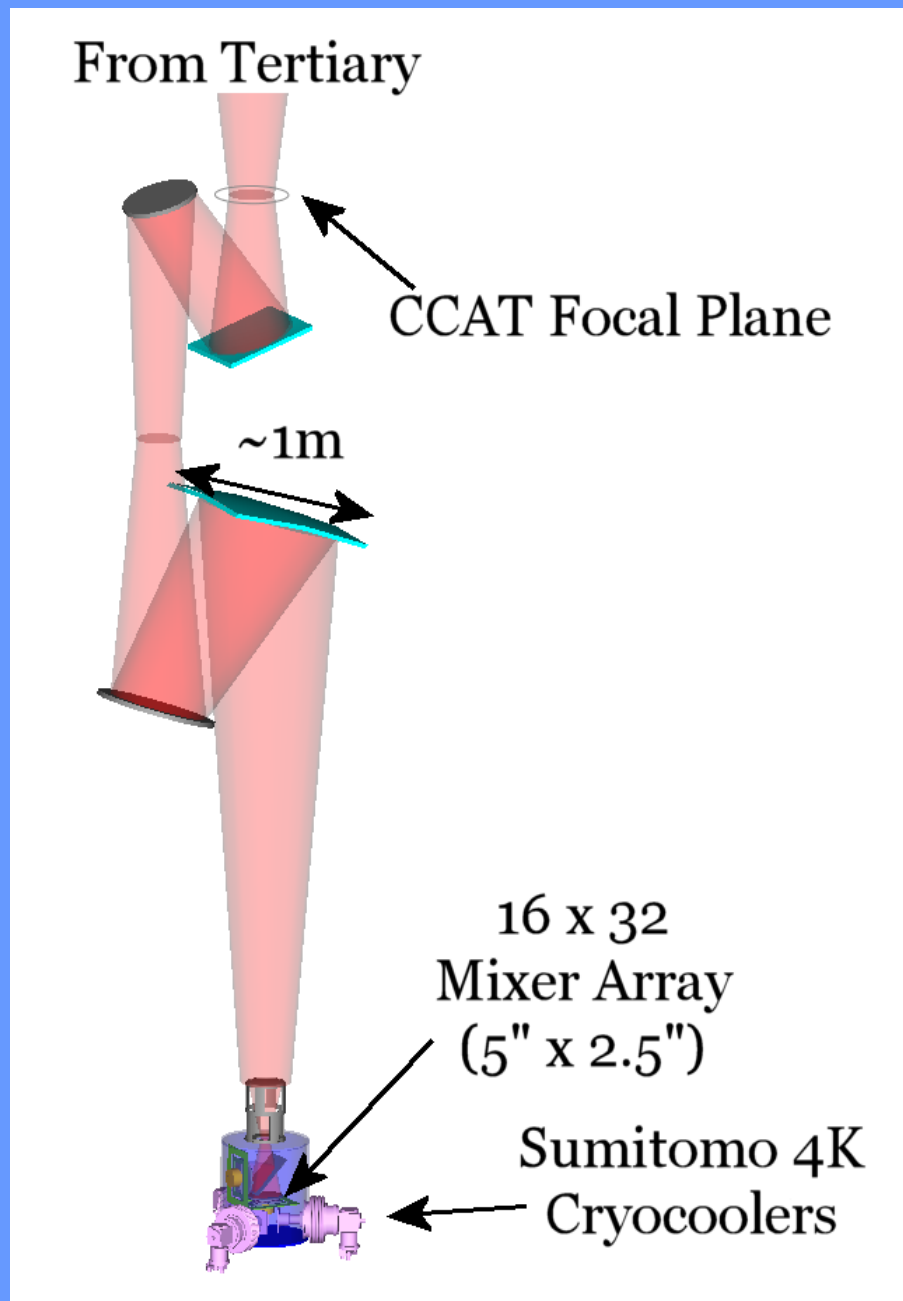
SuperCam Spectrometer System

- Built by Omnisys AB
- Real-Time FFT system
- Virtex 4 SX55 FPGA
- 4x 500 MHz or 2x 1 GHz per board
- 1024 channels
- power consumption 25W per board
- Ethernet interface
- SuperCam spectrometer initially uses 8 identical boards for 64 x 250 MHz or 16 x 1 GHz operation



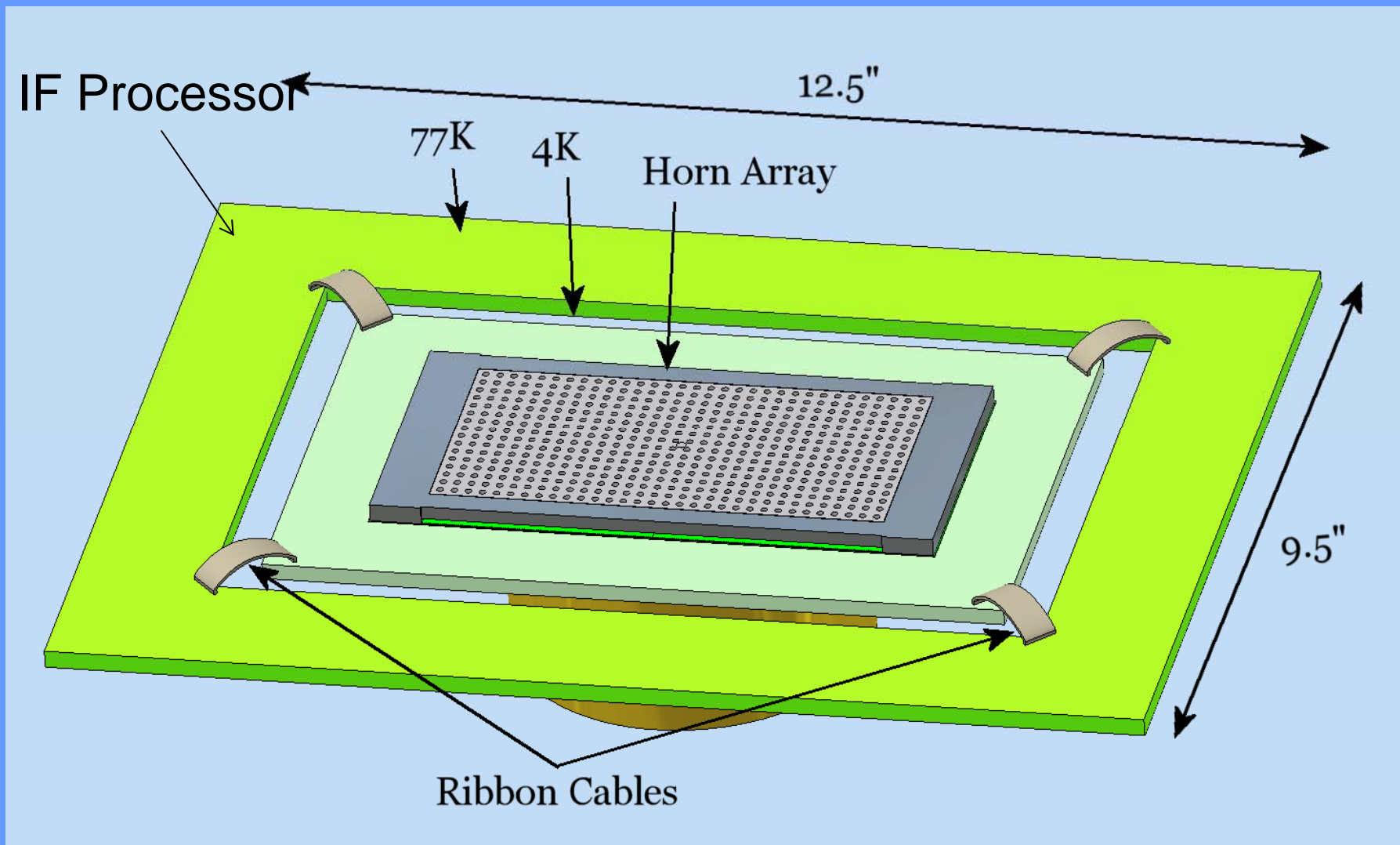
Prospects for Large Arrays on CCAT



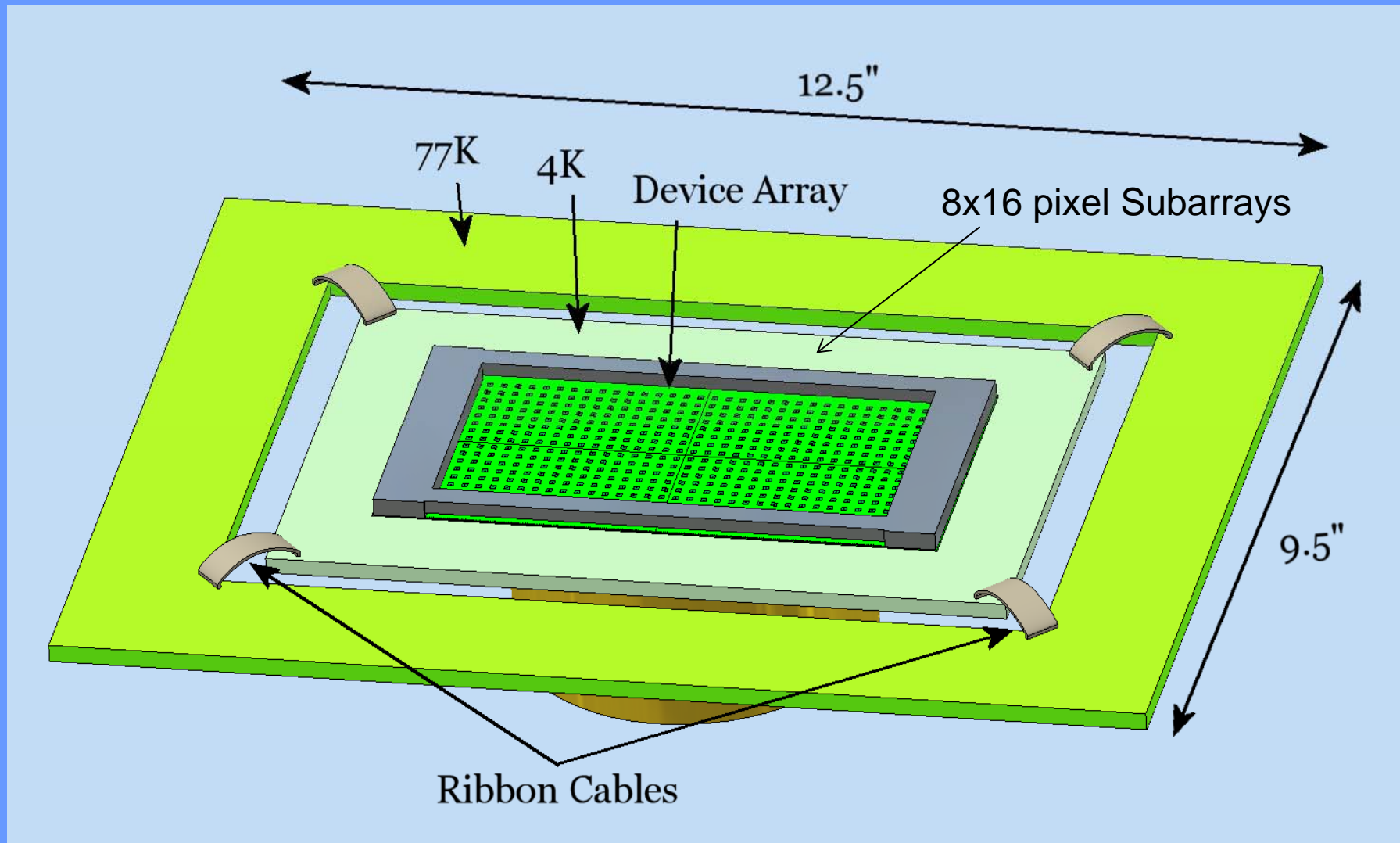


- Stacked, 16x8 arrays
- MMIC IF modules
- On-board IF processor
- Solid-State LOs (~5mW)
- >2 GHz/per pixel
- Cryo-Coolers

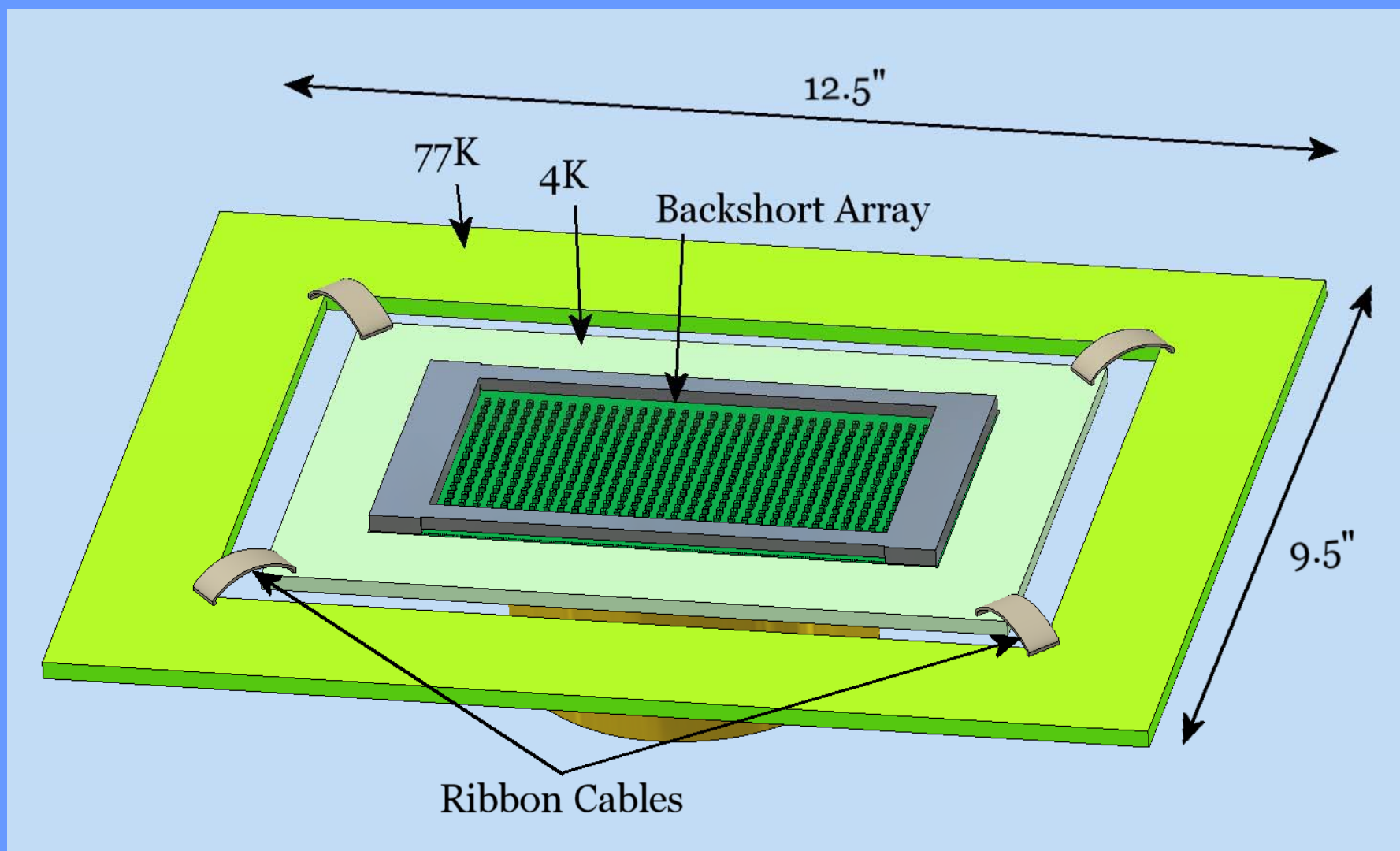
16x32 Array Concept



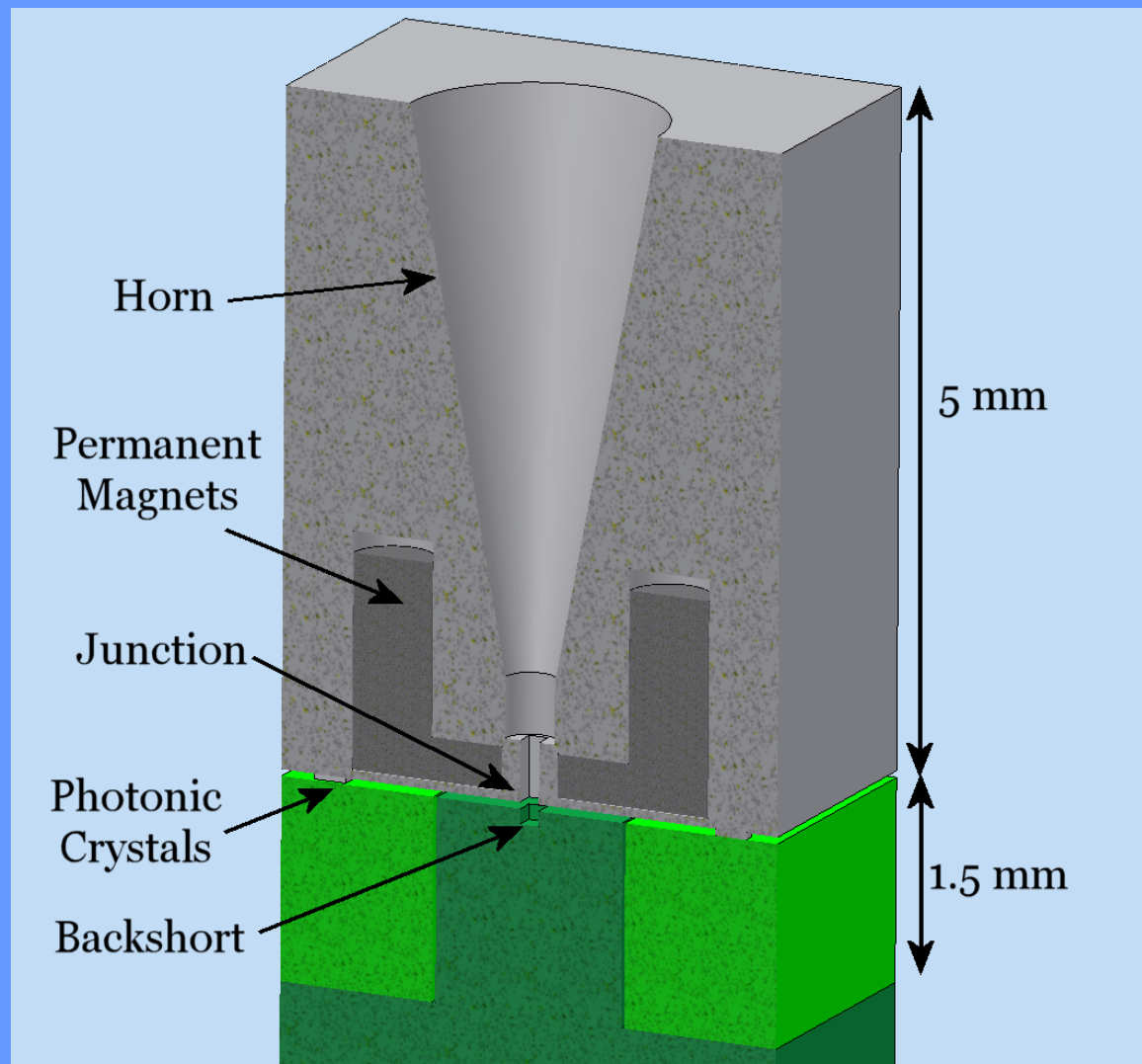
16x32 Array Concept



16x32 Array Concept



Stacked Pixel Concept



Cost/Pixel vs. Size

