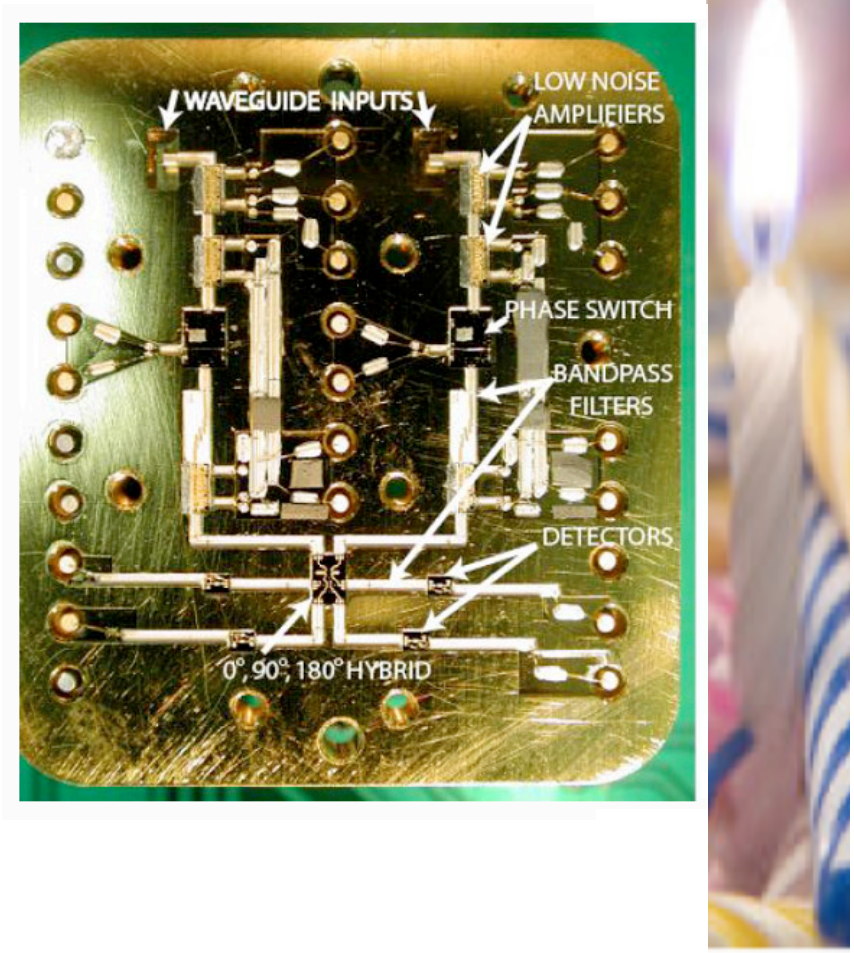
Our Proposed Involvement in QUIET Phase II

Assembly of ~1500 W-band Polarization Analyzer Modules

~ 2 year production run

Collaborative effort with Caltech and JPL



Technical Challenges

Precision Placement of 106 components

Components as small as 200 μm x 200 μm

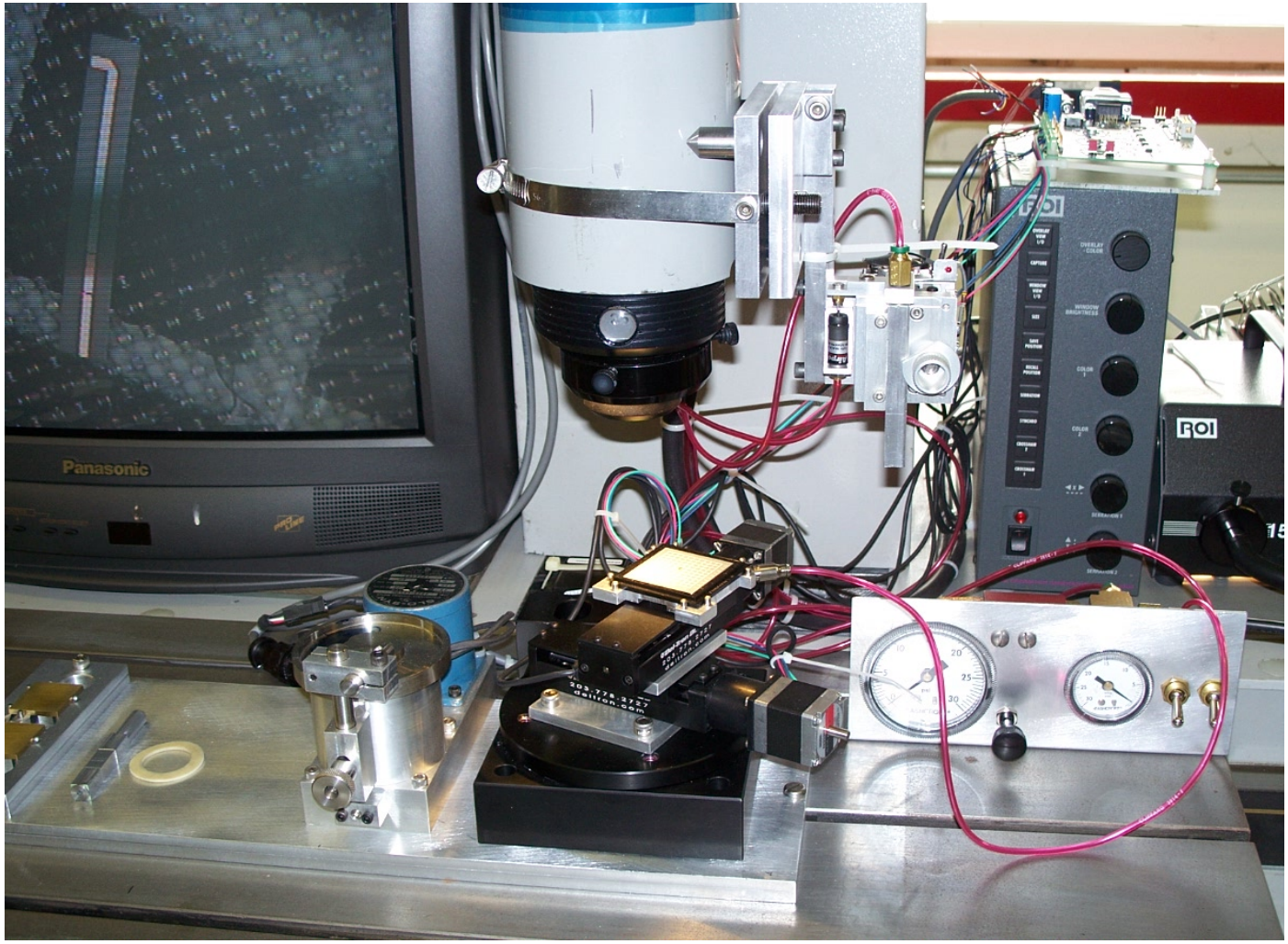
Very delicate HEMT components

Precision control of silver epoxy die bonding

Over 200 wirebonds per module

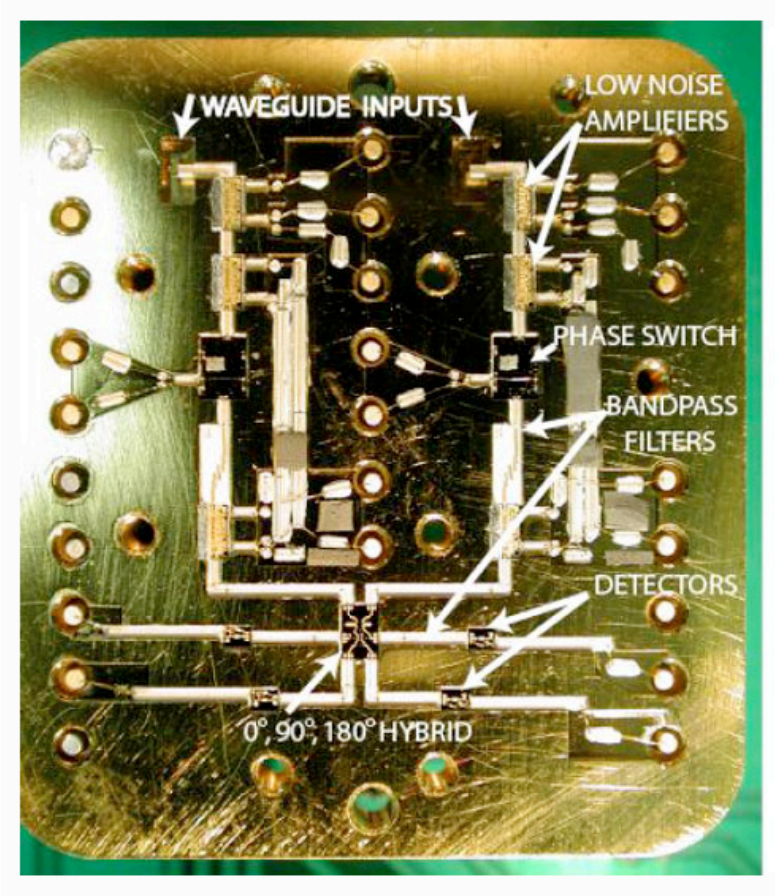
Harsh Cryogenic and Vacuum Environment

Hardware Completed for First Automated Pick-and-Place Station



Firmware and Labview programming in process

Strong Partnership with the QUIET Collaboration



Redesign of the layout to simplify assembly and improve performance.

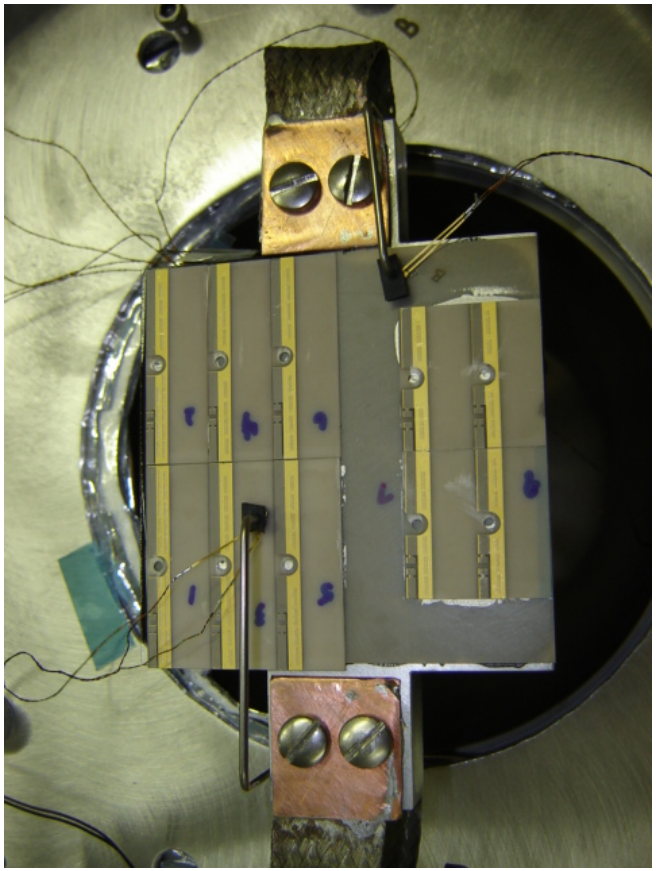
Lead role in working with Industry to fabricate chassis via “metal injection molding”. A potential big payoff.

Pursuing microwave simulation of module.
(also relevant for TES and NTD style bolometers)

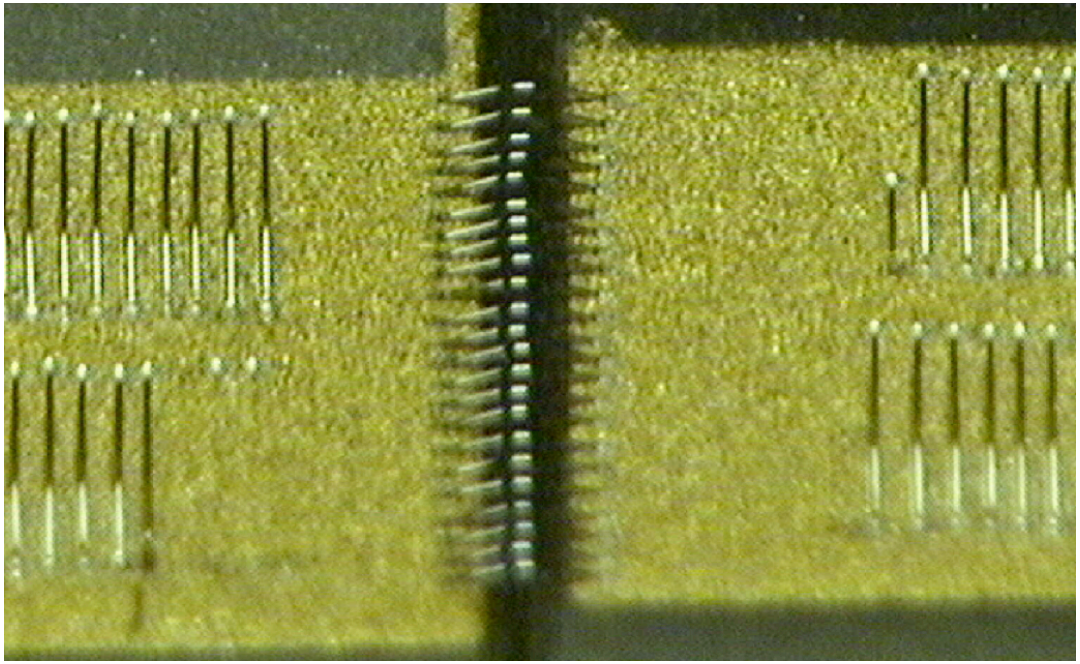
Lead role in improving module mechanical and electrical reliability.

Lead role in vacuum window mechanical engineering.

Mechanical Strength of Conductor Bonds

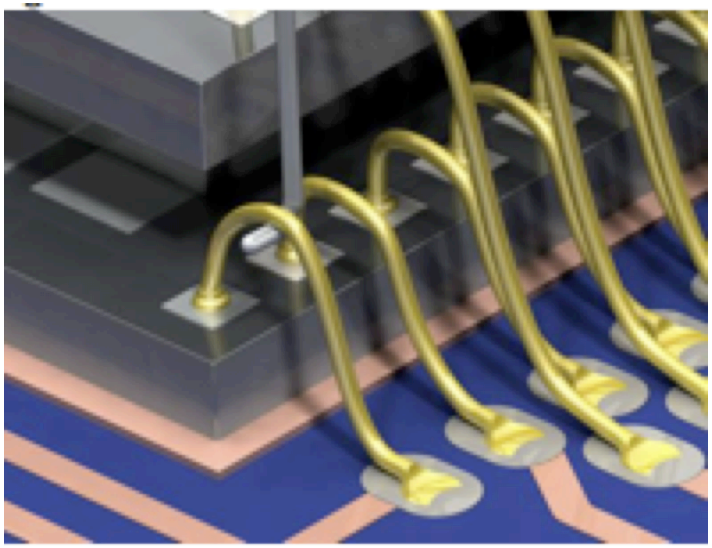


20 Kelvin Thermal Cycling of Wirebonds



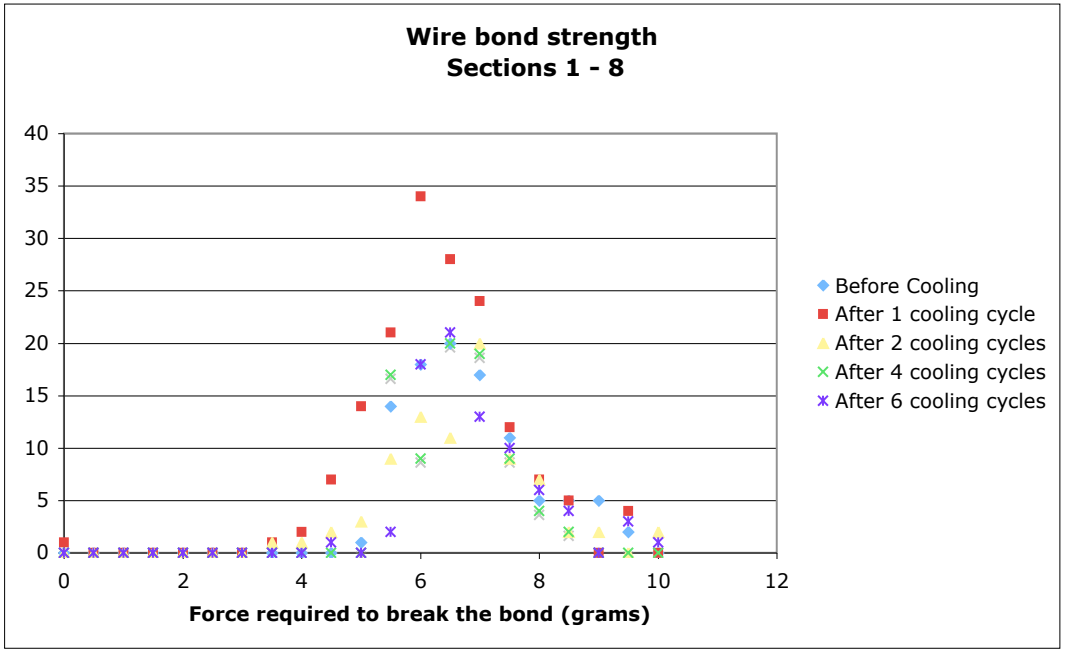
Mechanical Strength of Conductor Bonds

Wire Pull strength measurement



- 20K temperature does not weaken bonds

- Important verification for Phase 1 and 2.

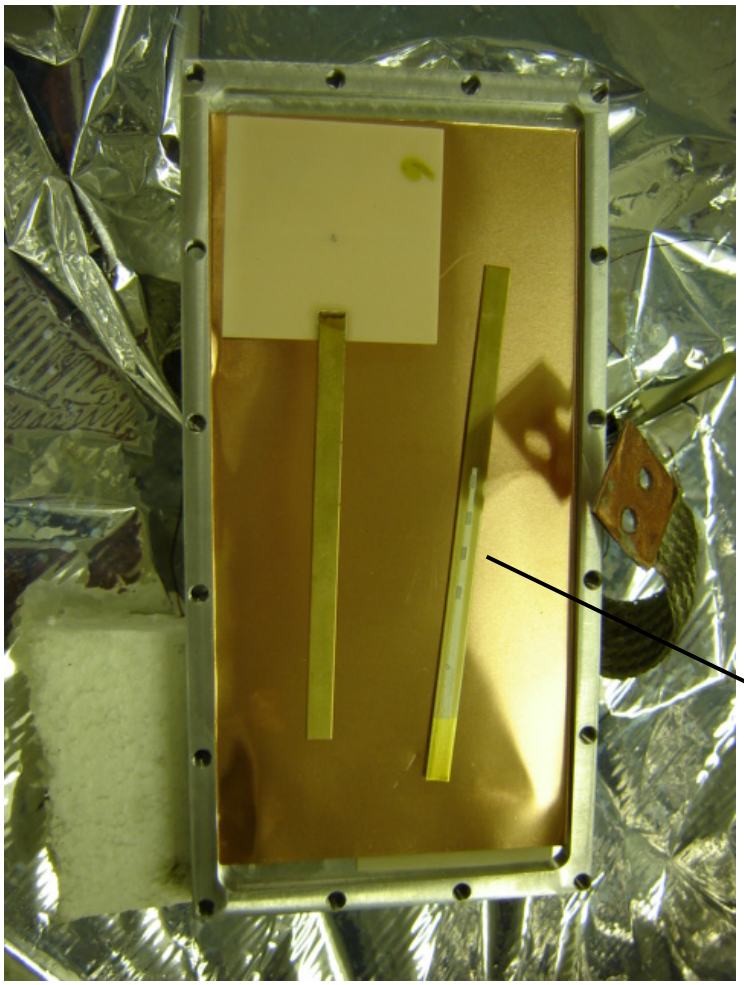


Mechanical Strength of Die Attachment Adhesives

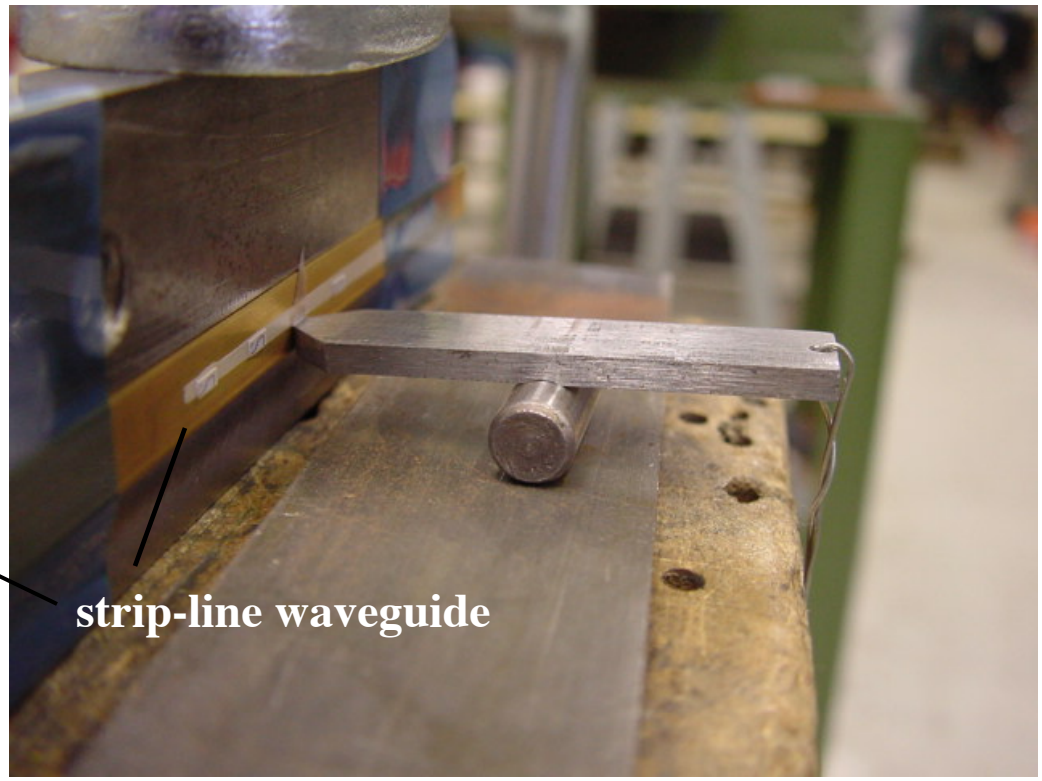
- Was not done for QUIET Phase 1

- Could reveal important steps to improve reliability

Thermal Stressing of Adhesives



Shear Measurement of Adhesive



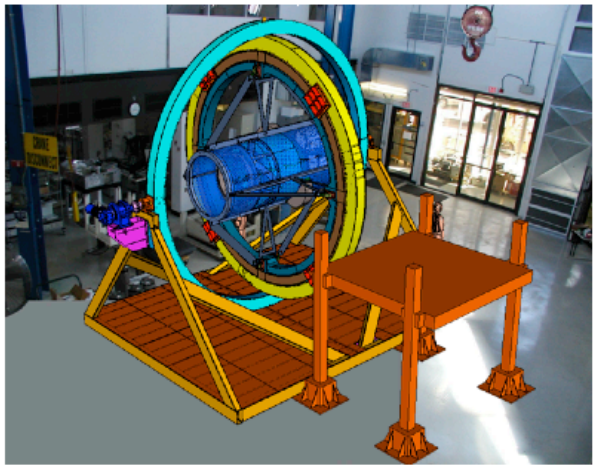
Our Proposed Involvement in QUIET Phase II

Integration of 1 W-band Receiver at "Lab A"

5x complexity of the Phase-I receiver

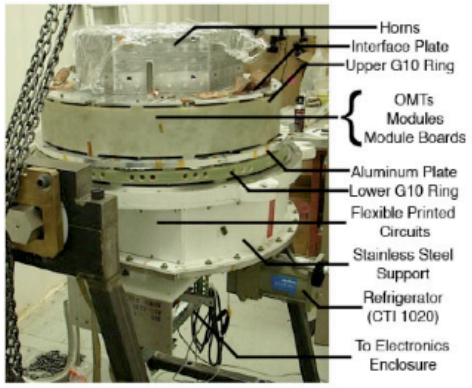
A collaboration wide effort with Chicago and Fermilab as lead !

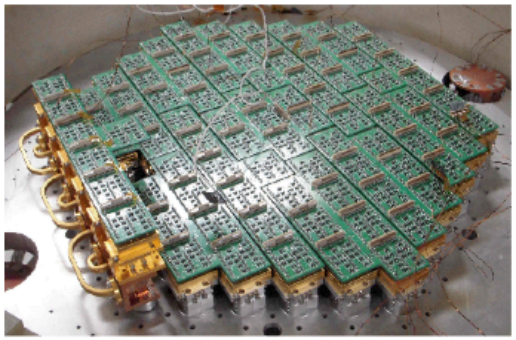
A very exciting prospect



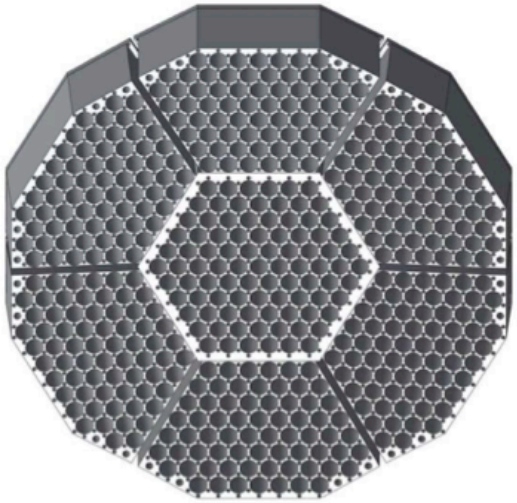
Great infrastructure for clean assembly and receiver operation

(currently used by DECAM)





91-element W-band Receiver Assembly In Chicago (Spring 09)



Status of QUIET

QUIET Phase 1 data taking continues in Chile, possibly through calendar 2010

Collecting W-band data using 91 element array

Status of Phase 2 Proposal

Presentation to PASAG in July 2009

FCPA review in Oct 2009

Presentation to PAC in Nov 2009

QUIET Phase 2 proposal presented to NSF in January 2010

Fermilab FWP sent to DOE in January 2010

Hope to hear from NSF in May 2010

Future Role and Building Strong Links to the World Wide Community

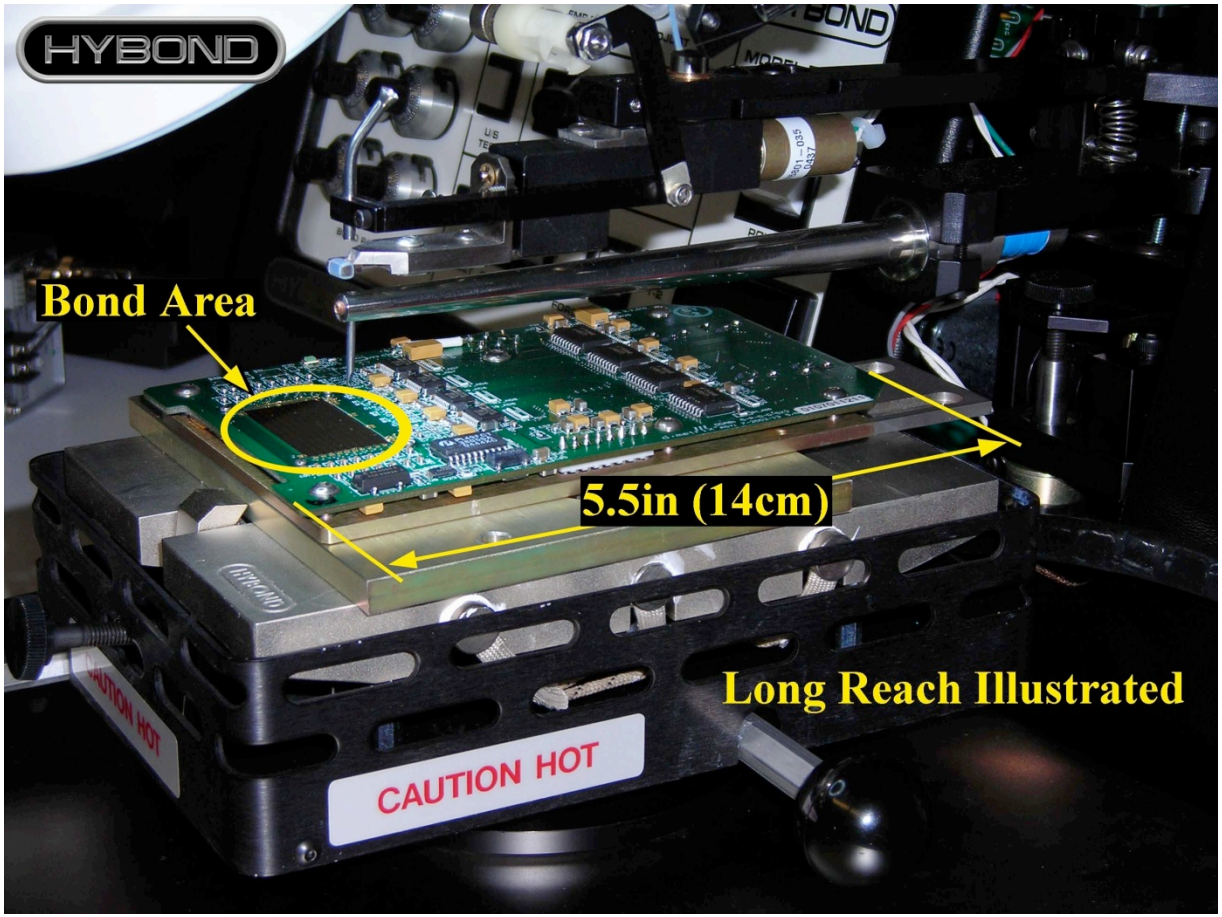
- Maintaining excellence in microdetector assembly (especially conductor bonding)

- Microwave simulations

Relevant for ANY applications requiring:

High density interconnections
Ultra Low Impedance
Low Thermal Mass

This includes TES-Bolometers



Recently ordered New gold ribbon bonder.

QUIET Phase 1 has the most sensitive array to date

Experiment	Reference	Detectors # @ freq.[GHz]	Sens. Per Feed $\mu K\sqrt{s}$	Array Sens. $\mu K\sqrt{s}$	
WMAP	Jarosik et al.,'03	2 @ 22-25 2 @ 28-36 4 @ 35-46 4 @ 53-69 8 @82-106	650 780 920 1130 1480	460 552 460 565 523	226
BICEP	Yoon et al.,'06 Chiang et al.,'09	25 @ 100 24 @ 150	480 420	96 86	64
QUAD	Hinderks et al.,'09 Brown et al.,'09	12 @ 100 19 @ 150	440 390	127 89	73
QUIET Phase I	Bischoff, Newburgh et al., in prep	16 @ 40 84 @ 90	275 556	64 61	

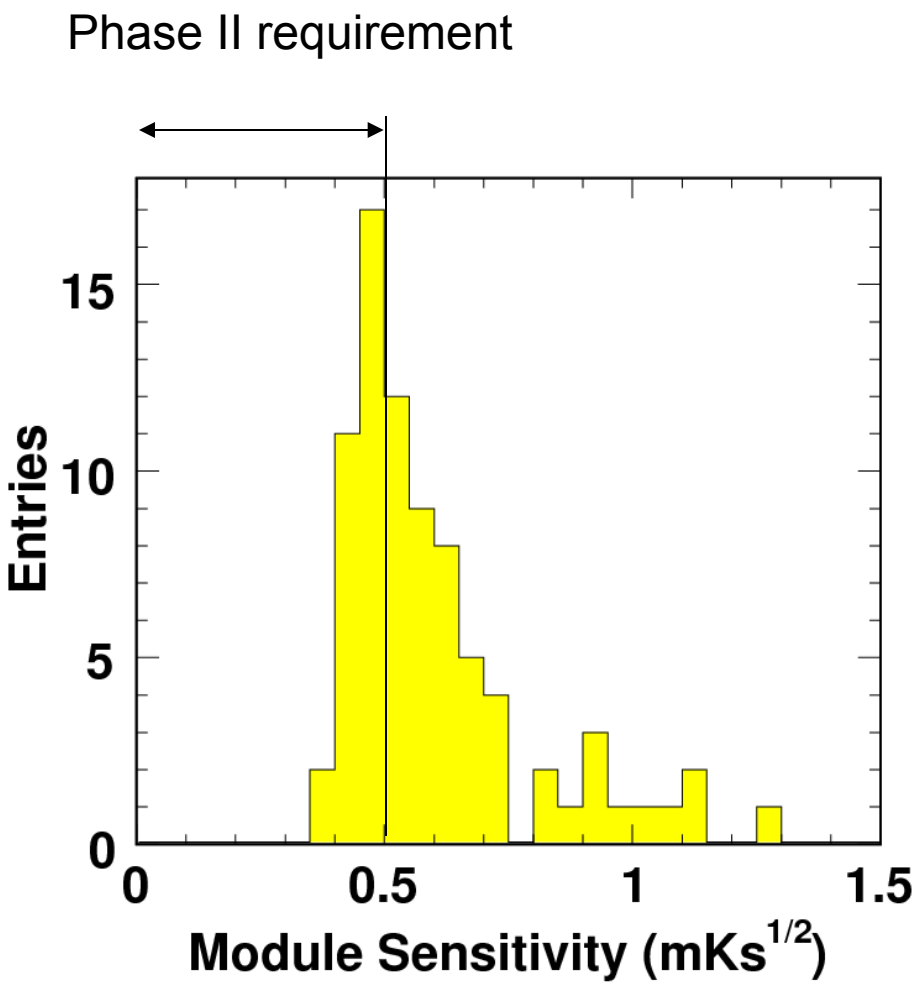
Developing special collaboration with KICP/ Chicago and JPL/CIT on HEMT-based microwave detector R&D.

Phase I W-band module sky performance

Achieve Better Sensitivity for Phase II by

Tighter selection of HEMT dies (no fundamental to change to design of die)

Improved voltage control of HEMTs



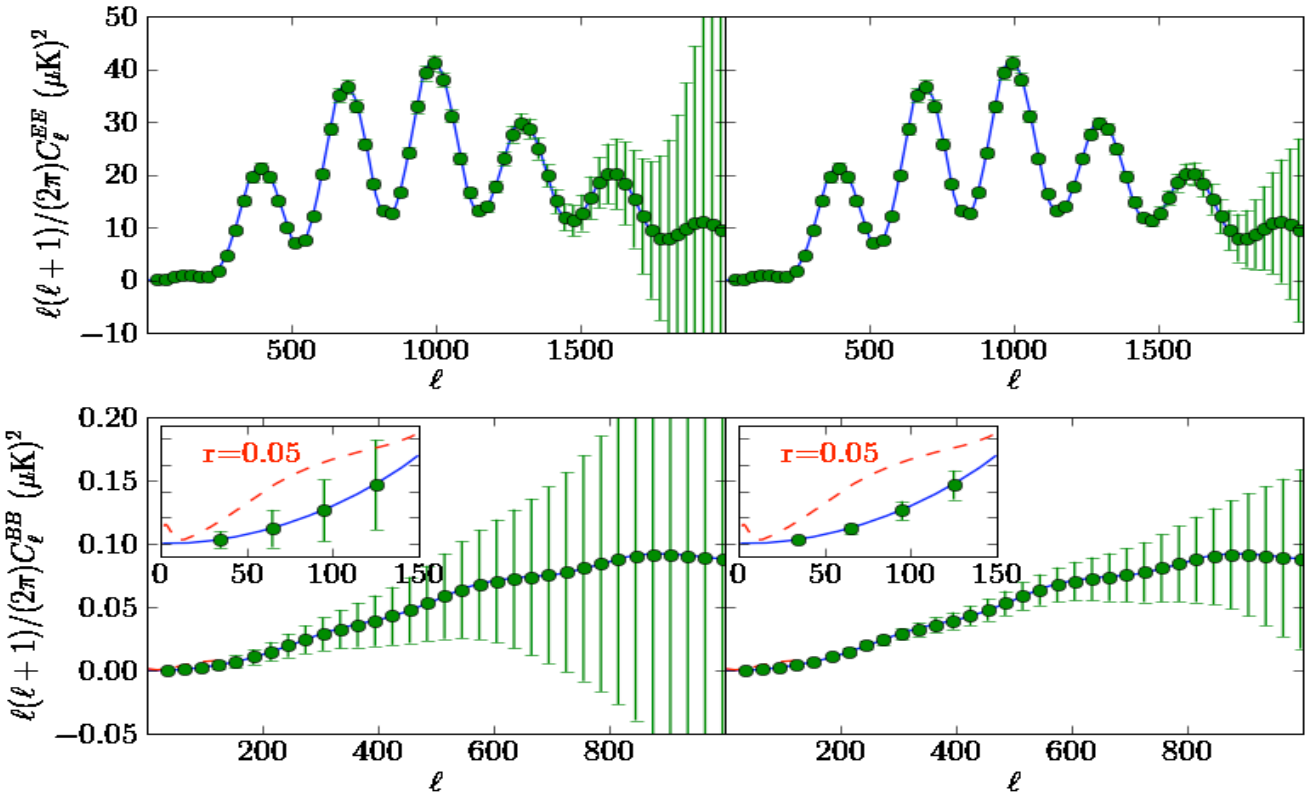
Areas of HEMT Improvements Being Pursued

- smaller features (35 nm)

- industrial partners to make HEMTs

- 3D microwave circuits are now being done

- **Post QUIET-II, an upgrade path to reduce 3x in noise temperature**



QUIET-II with
500 $\mu K\sqrt{s}$
W-band
detectors (phase 1 quality)

QUIET-II with
detectors expected
electronics
improvements to
W-band detectors

A sensitivity of r ~ .001
from the ground, should foregrounds permit

Where We Could Improve

We have made very important technical and engineering contributions to QUIET Phase 2.

A proper role for a national lab.

We haven't contributed to QUIET Phase 1 Data analysis:

- Lack of time due to commitments to other projects and job assignments.

- Situation very likely to improve in this coming year.