Process List

• General Cleaning	JPL FS505146
• Gold Plate	MIL-G-45204, Type 3, Class 3
• Bonding	D-8208, Section 3.18
• Bonding	BS515871
• Torque	ES504255
• Solder Joint	D-8208, Section 3.14.
• Passivation	JPL FS505146
• Connector Installation	D-8208, Section 3.12.

Materials and Processes Review

- **M&P review to ensure functional, reliability, and safety requirements.**
- **Materials evaluated for:**
  - **Stress Corrosion Cracking Resistance**
  - **Outgassing**
- **Data obtained from:**
  - **MSFC-HDBK-527/JSC-09604**
  - **MSFC-SPEC-522**

Materials and Processes Review

(Continued)

- Materials Identification and Usage List (MIUL) completed.
  - All materials and processes used identified
  - Each material and process assigned a rating of 1 through 4
    - 1 or 2 rating acceptable for flight
    - 3 or 4 require Material Usage Agreement (MUA)
- All materials and processes have been rated 1 or 2 and are acceptable for flight

Materials Identification and Usage List (MIUL)

Materials Identification and Usage List - Metallic Materials

tem o.	Material Description/ Condition	Application	Material Specifications	Stress Corrosion Cracking Rating	JPL Rating[1]	Comments
1	Invar 36	Structural Elements	ASTM B753-T36 or AMS-I-23011 Class 7			
2	Al 7075 T73	Structural Elements	SAE-AMS-QQ-A-225/9			
3	Al 6061 T651	Structural Elements	SAE-AMS-QQ-A-250/11			
4	A286	Fasteners				
5	303 CRES	Fasteners	AMS 5738			
6	Copper, 99.999% pure	Thermal Strap				
7	CDA 172	Clamps	B194			

Materials Identification and Usage List (MIUL)

Materials Identification and Usage List - Non-Metallic Materials

tem 'o.	Material Description/ Brand Name Supplier	Application	Material Specifications	Thermal Vacuum Stability (%)	JPL Rating[1]	Comments
1	Vespel, Dupont SP1	Structural Support		TML = VCM= WVR=		
2	Kevlar 29 3000 Denier Yarn, Dupont	Tension Member		TML = VCM= WVR=		
3	Miller Stevens 903	Adhesive		TML = VCM= WVR=		

Materials Usage and Identification List (MIUL)

Materials Identification and Usage List - Processes

ITEM NO.	PROCESS	SPECIFICATION	MATERIALS PROCESSED	APPLICATION	JPL EVALUATION	
					APPROVE/ DISAPPROVE[1]	COMMENTS
	Gold Plating	MIL-G-45204, Class 3, Type 3	Invar 36	Corrosion Protection, Thermal Conduction		
	Gold Plating	MIL-G-45204, Class 3, Type 3	Copper	Thermal Conduction		
	Passivation	FS 505146	303 CRES	Passivation		
	Bonding	D-8208, Section 3.18, FP513414	Solithane 113/C113-300 Filled Polyurethane	Spot Bonding of Component Parts		
	Bonding	BS515871	Scotch Weld 2216 B/A with Filler	Spot Bonding of Component Parts		
	Workmanship	FS504040		Workmanship Standards for Mechanical Parts and Material		
	Torque	ES504255		Torque Requirements, Threaded Fasteners, Spacecraft Structural and Electronic Equipment		
	Solder Joint	D-8208, Section 3.14, Fp513414		Solder Joint		
	Installation	D-8208, Section 3.12, FP513414		Connector Installation – Rectangular Miniature		

Drawing Status

This slide to be provided at CDR

Conclusions on BDA Detailed Design

- The design will survive the current ERD loads.
- We have made all the practical design changes to the BDA to increase our load capacity.
- Ready to fabricate mechanical hardware if the present kevlar design does not change
- In order to bring our survivable launch loads higher than 0.12 g^2/Hz, we need to do more investigation on Kevlar.

5.2 Feedhorn Design & Test

Working Group

Jason Glenn, CU	Design & Testing
Brooks Rownd, CU	Testing
Martin Caldwell, RAL	Optical Simulations
Anthony Murphy, Maynooth	Horn Field Calculations
Hien Nguyen, JPL	Testing
Goutam Chattopadhyay, JPL	Cavity Simulations
Bruce Swinyard, RAL	Instrument Scientist

Overview

- Requirements
- Design Strategy & Tradeoffs
- Simulations
- Testing Strategy
- Risk Analysis

Status

- Designs complete
- Modeling nearly complete
- P/SW & S/LW prototypes manufactured
- Preliminary P/SW tests

Presented by Jason Glenn

Feedhorn Requirements and Interfaces

•$\eta_{optical,,design}$ (Phot, Spec) = 0.85, $\eta_{optical, minimum}$(Phot) = 0.45

•Ω_{Phot} = single-mode

•Ω_{Spec} = multi-mode

•Bandpass $\rightarrow$ waveguide aperture

•*Redundancy in case of bad pixels constrains apertures*

•Photometer bandwidths driven by science, $\lambda/\Delta\lambda = 3$

- •P/SW $\lambda_C = 250\ \mu m$,
- •P/MW $\lambda_C = 350\ \mu m$
- •P/LW $\lambda_C = 500\ \mu m$

•Spectrometer bandwidths driven by science, photon backgrounds

- •S/SW $200\ \mu m < \lambda < \lambda_{crossover}$ TBD
- •S/LW $\lambda_{crossover}$ TBD $< \lambda < 609\ \mu m$

•*Feedhorn lengths constrained by mechanical envelopes*

•Optimization for point source sensitivity $\rightarrow$ single mode

General design strategy: design horns and cavities at chosen wavelength, calculate performance at other wavelengths within the band, modify design.

Feedhorn Array Formats

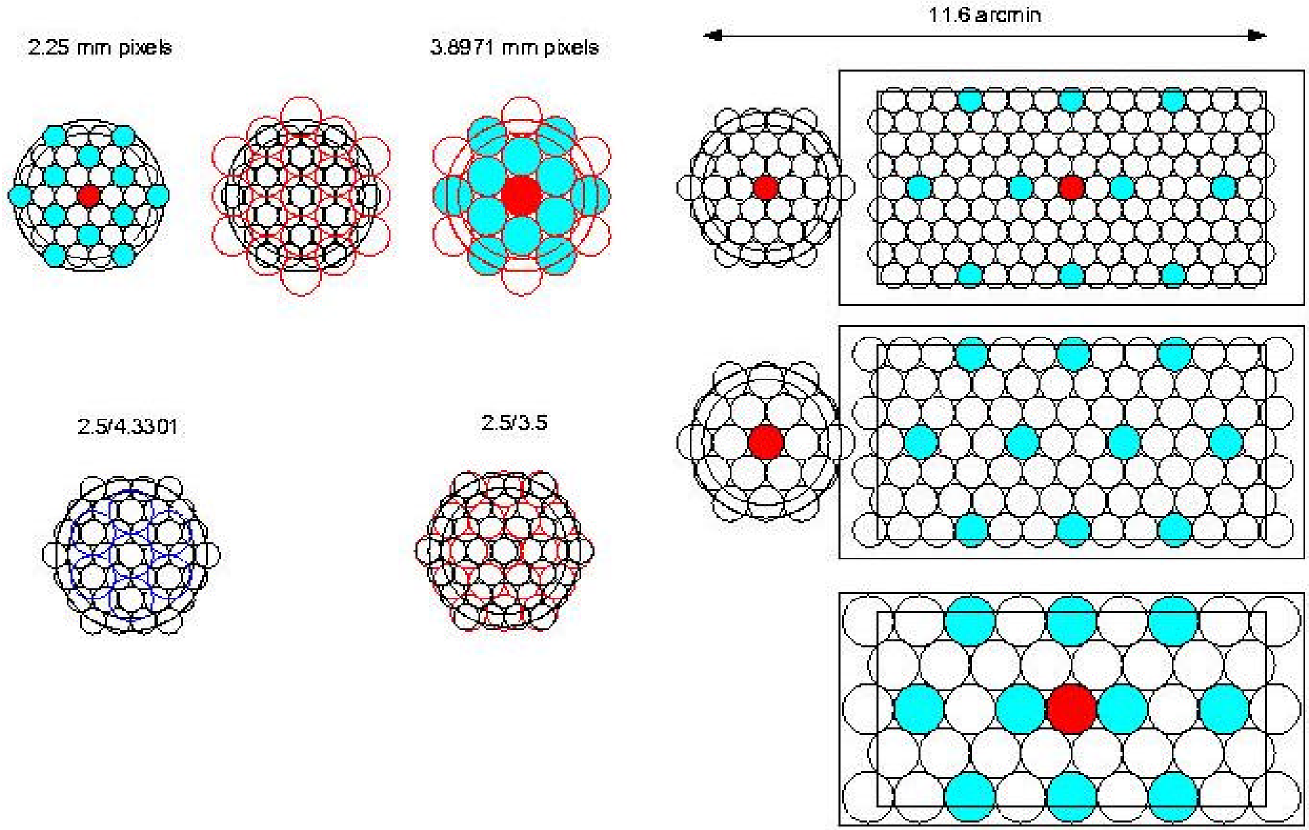
Viewed from "above" the horns looking at their apertures

S/SW
37 horns

S/LW
19 horns

New configuration:
max overlap,
smaller apertures

Old configuration:
less overlap



P/SW
139
horns

P/MW
88
horns

P/LW
43
horns

Feedhorn Design Tradeoffs

•Lengths: $\eta_{aperture}$ & manufacturing difficulty increase with L, constrained by BDA envelopes P/MW

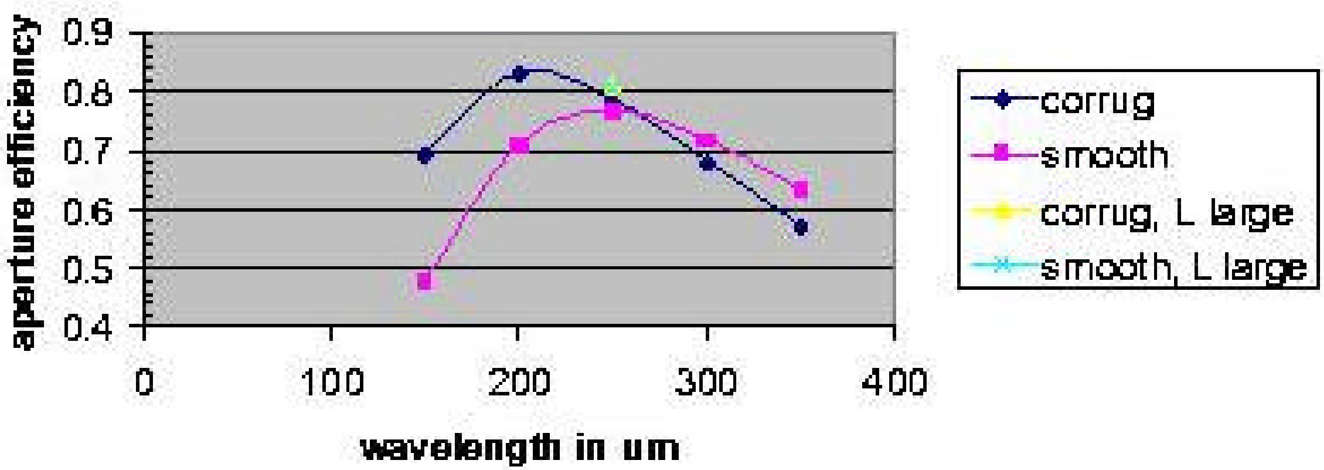
L = 7.5 mm	T_E(dB) = -6	$\eta_{aperture}$ = 40% (46% refocus)
L = 31.75 mm	*T_E(dB) = -9*	*$h_{aperture}$ = 76%*
L = ∞	T_E(dB) = -9	$\eta_{aperture}$ = 80%

•Apertures: 2fλ apertures for max $\eta_{aperture}$

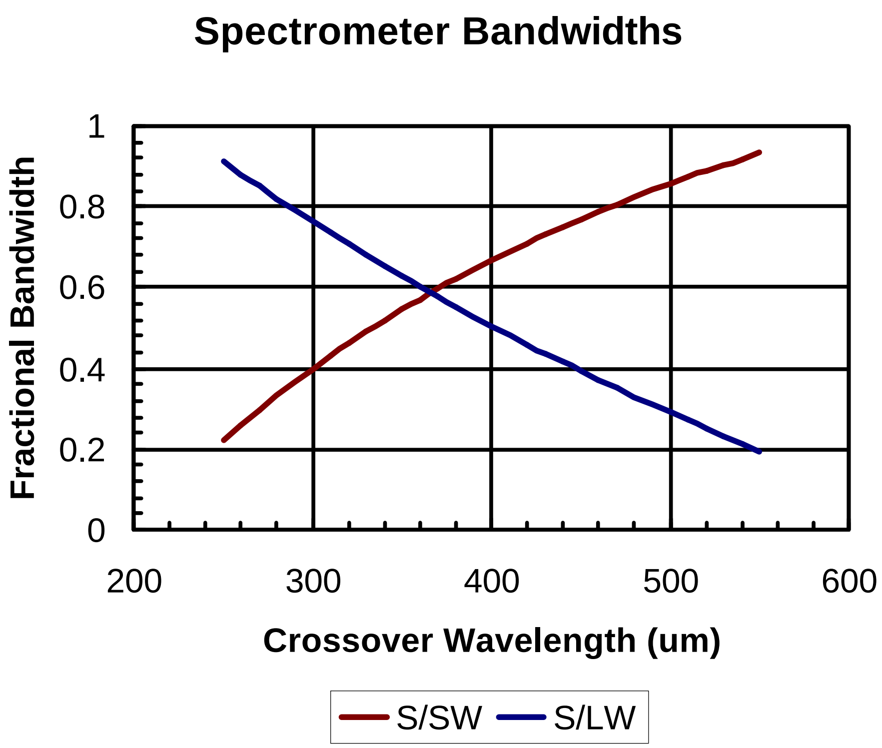
•Profiles: Long, aperture-limited horns do not require profiling

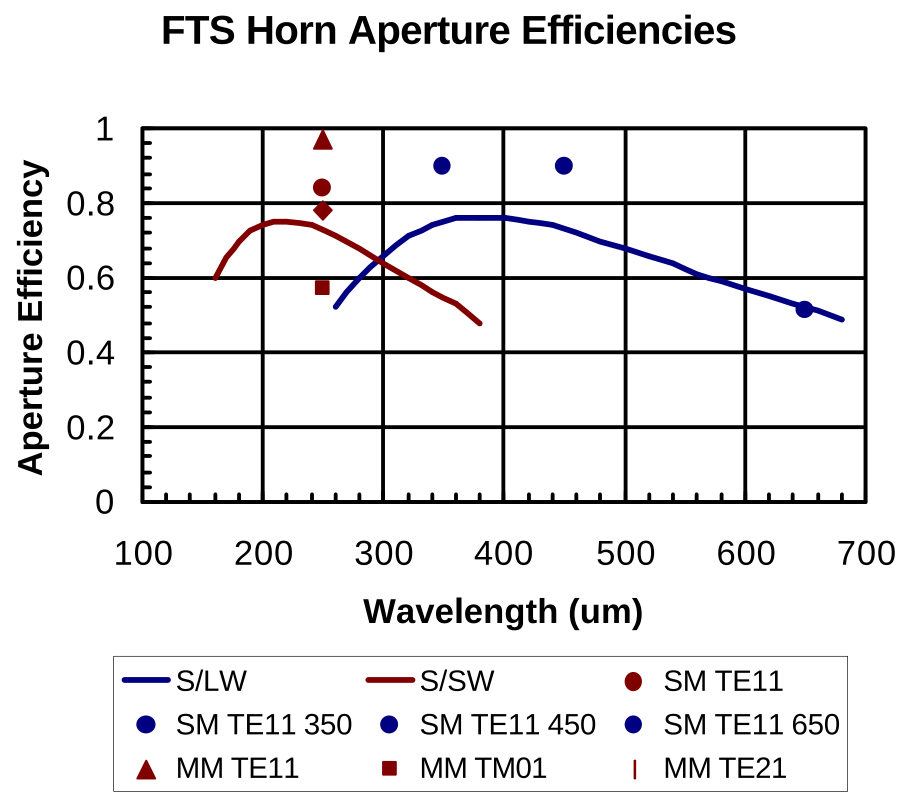
→Straight-walled, conical

•Corrugations: cost ↑x2, steeply tapered edges not required with cold stops



Spectrometer Crossover Wavelength





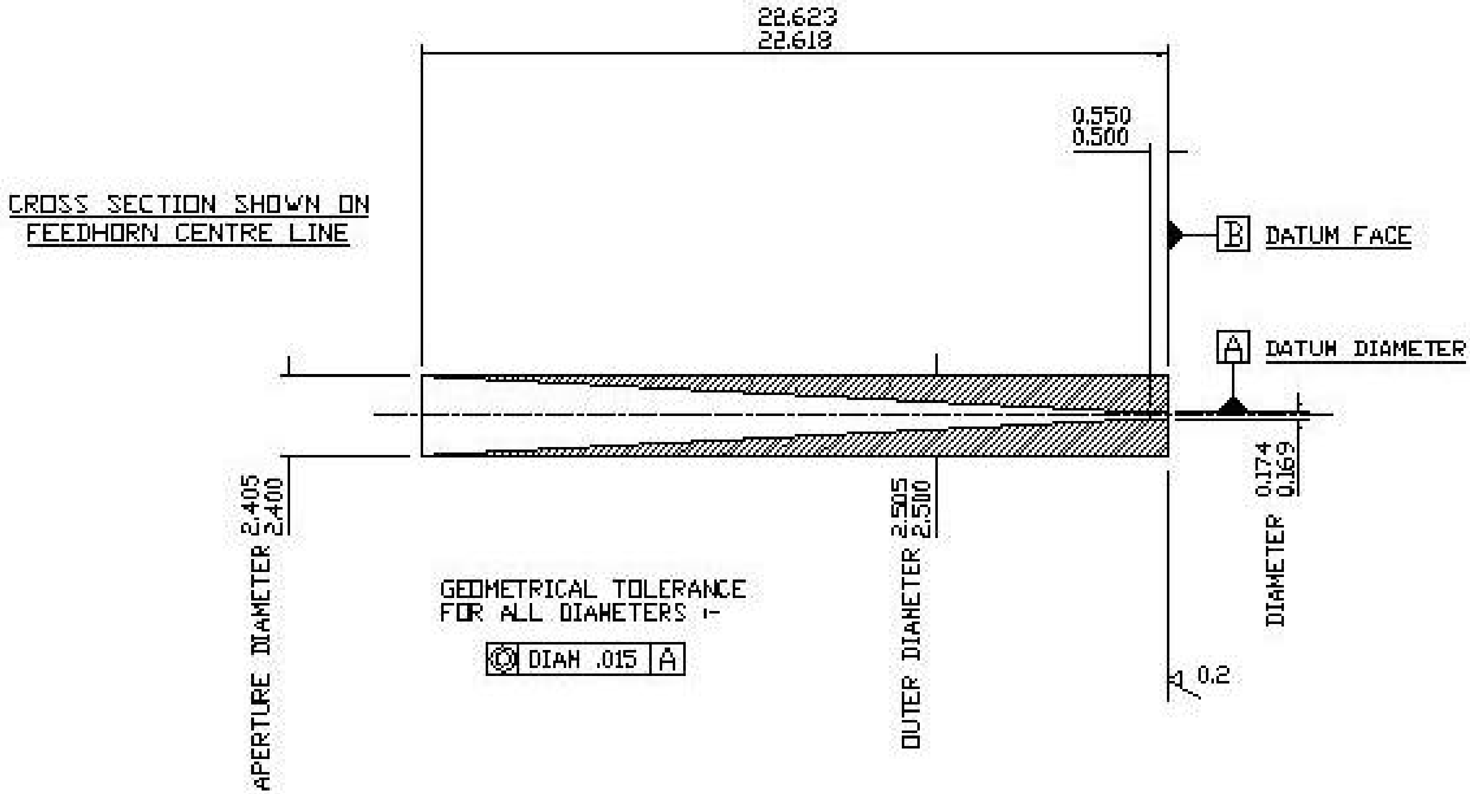
Background photon power equal for $\lambda_{crossover} = 300\ \mu m$

$\Rightarrow \lambda_{crossover} = 300$ to $310\ \mu m$

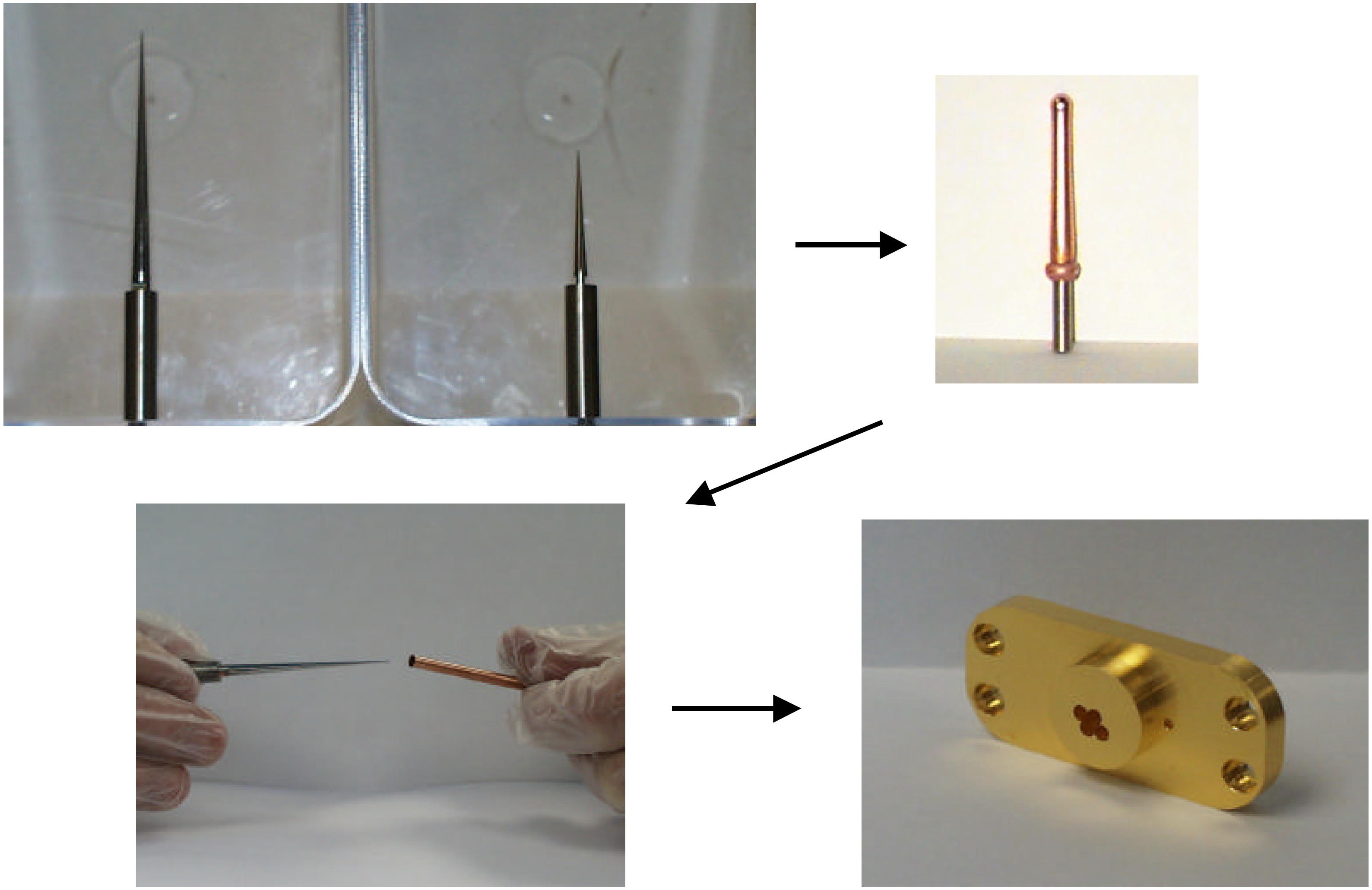
Feedhorn Parameters

Array	λc (μm)	Band (μm)	Length (mm)	Aperture (mm)	Wave. Dia. (μm)	Wave. Len. (μm)	Defocus (mm)
P/SW	250	209-291	23.68	2.40	171	500	1.6
P/MW	350	292-408	32.75	3.40	239	700	2.5
P/LW	500	418-583	46.36	4.90	342	1000	4.0
S/SW	265	200-310	23.68	2.15	208	550	0.0
S/LW	450	300-*670*	46.36	3,80	393	900	0.0

P/SW Schematic (drawing courtesy RAL)



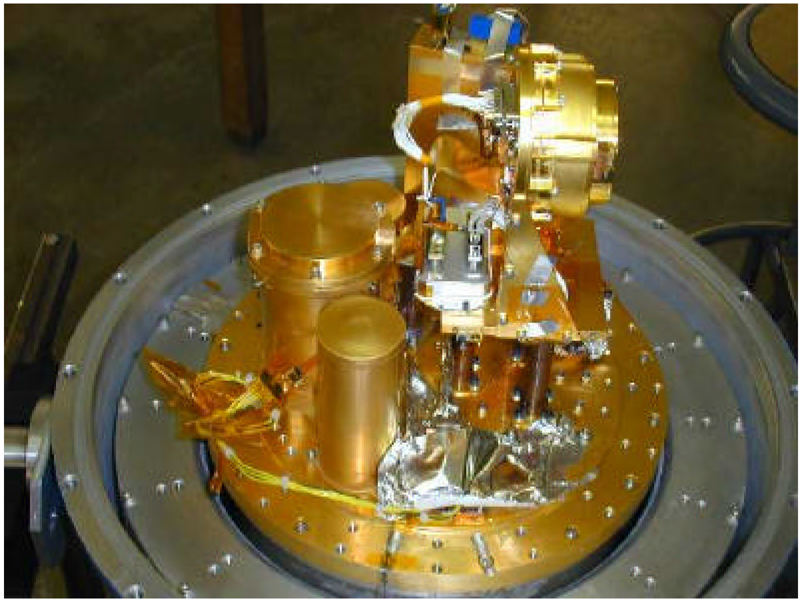
Prototype Feedhorn Manufacturing @ RAL

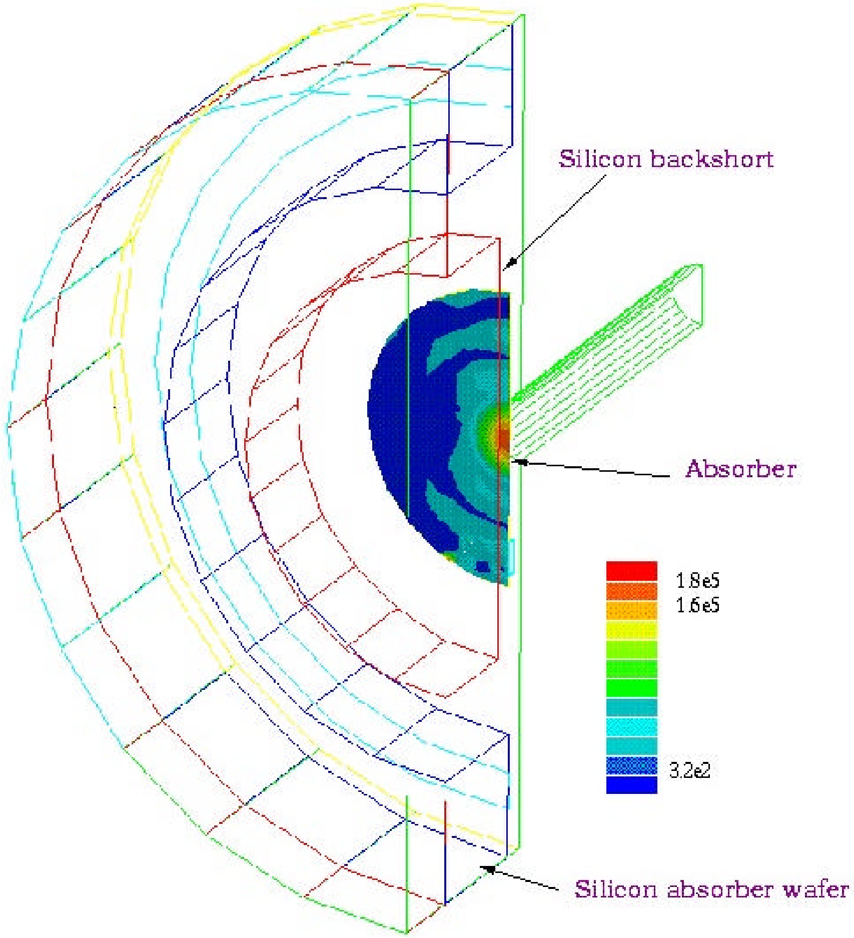


Photos courtesy RAL

Feedhorn Simulations & Preliminary Results

- •E-fields calculated for each horn configuration
- •Fields summed and propagated through optics to form beams on the sky and calculation efficiencies
- •Mode coupling to absorbers simulated with HFSS





Preliminary results: P/SW, 3 channels, $\eta_{optical} = 0.6$

Feedhorn Risk Analysis

•<u>Primary risk</u>: feedhorn tolerances cannot be met. S/SW and P/SW at greatest risk.

→*Reduced AW and/or D l*

→*Beams are not likely to be affected because we have cold stops.*

•<u>Secondary risk</u>: supplier cannot meet schedule or cost.

→ Mitigated by a 3-stage manufacturing approach:

-Prototypes (P/SW-tightest tolerances)

-CQM (2 substages: P/LW, S/LW)

-Flight units and spares

•Bad feedhorns within an array cannot be replaced (optical pretesting prior to assembly under review)

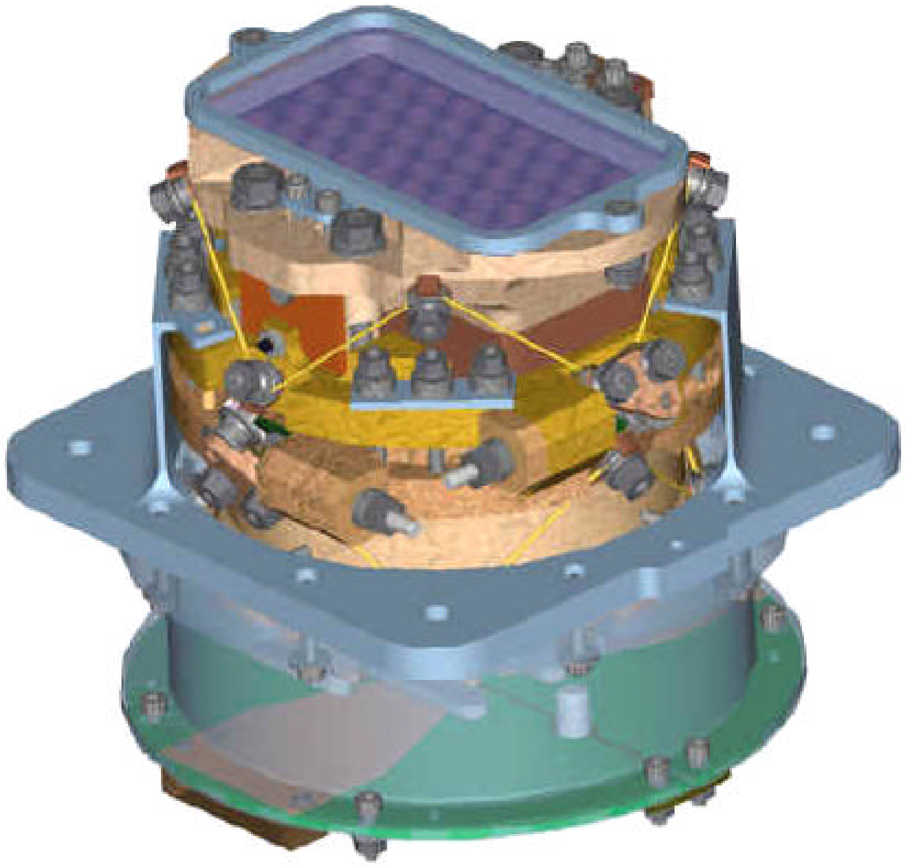
Future Work & Schedule

- Modeling
  - -Complete set of efficiencies and beam profiles on the sky as f(λ)
  - -P/SW efficiency at λ = 265 μm
  - -Tolerances on frontshorts
  - -Coupling of S/LW higher order modes
- CQM P/LW horns delivered to JPL 10/2001
- CQM S/LW horns delivered to JPL 12/2001
- Ongoing beam & optical efficiency testing of witness horns @ CU
- Flight & flight-spare horns delivered to JPL 11/2002

5.3
BDA Thermal Model and Test Results

Terry Cafferty

BDA thermal design goals



Heat load into 3He fridge
- 8 uW for all 5 BDAs
- min performance 15 uW

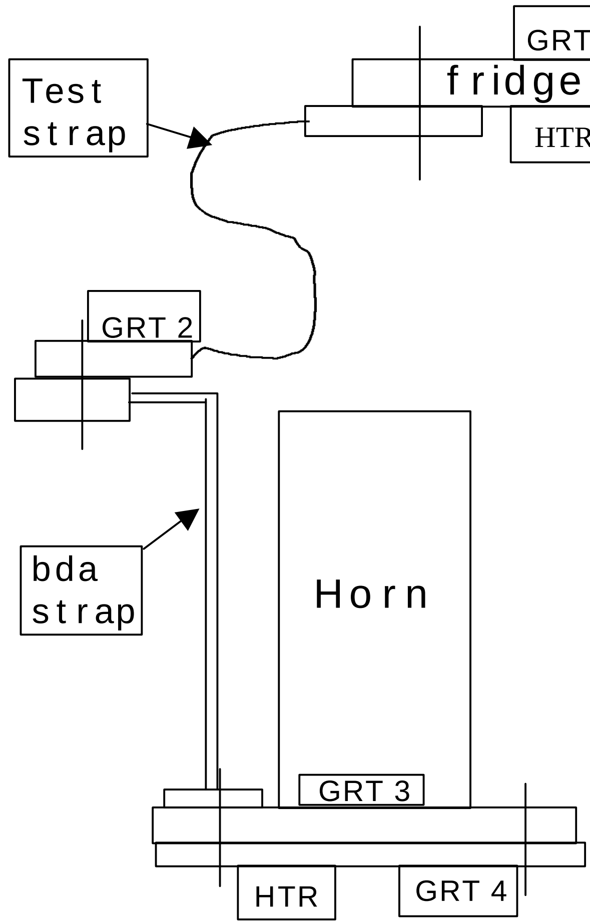
bolometer-3He fridge gradient
- 10 mK based on 290 mK fridge and 300 mK bolometers

Bolometer assembly thermal time constant
- 100 s min based on assumed fridge stability of 0.1 mK/hr and detector stability of 10 uK/$Hz^{0.5}$ from 0.1 - 10 Hz (should eliminate need for active thermal control of detector we have 2 uW budgeted if needed)

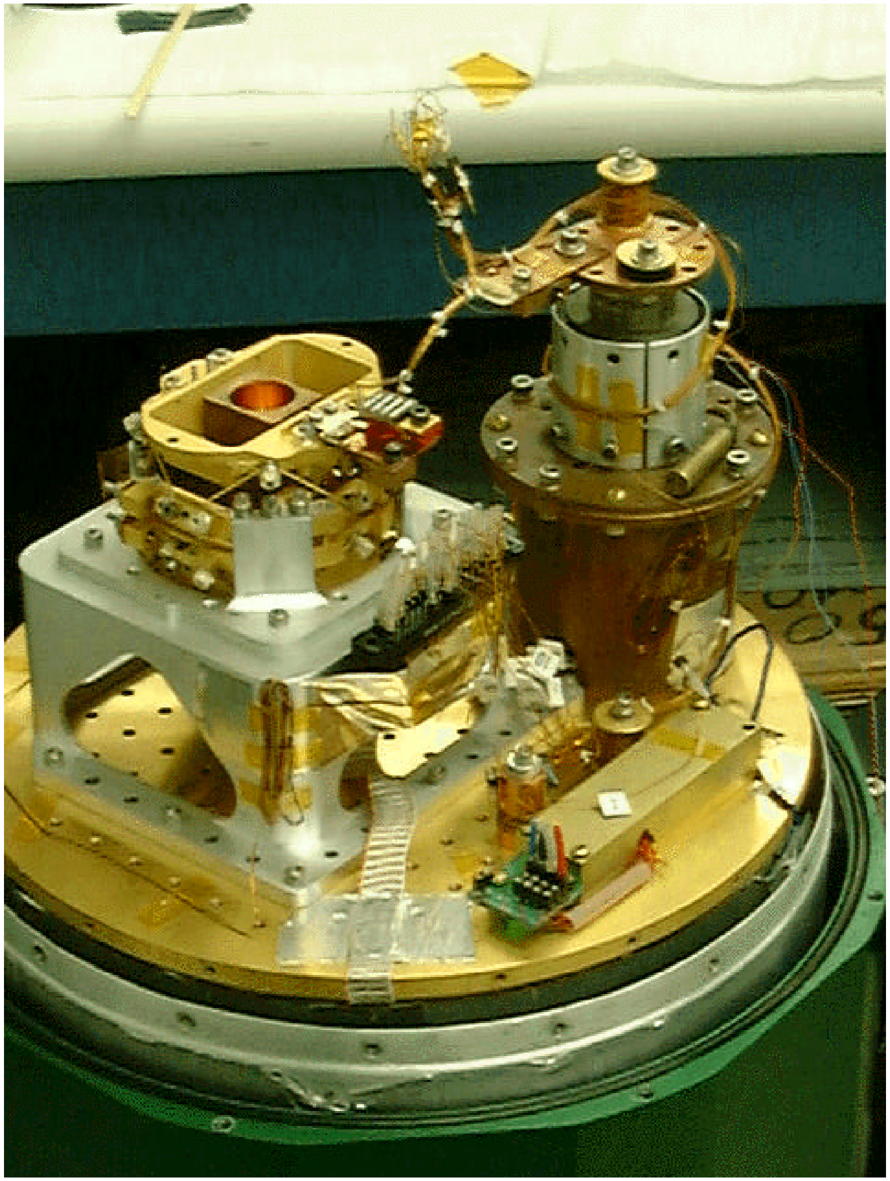
BDA predicted thermal performance

- total heat load (1.7 K He bath)
  - 8.3 uW (1.66 uW / BDA average)
    - 3.4 uW kevlar
    - 2.2 uW kapton portion of cables
    - 2.7 uW constantan portion of cables
- predicted temperature drop
  - ~16 mK bol plate to strap attach point (average)
  - dominated by interface thermal resistance
- predicted time constant
  - ~160 s average

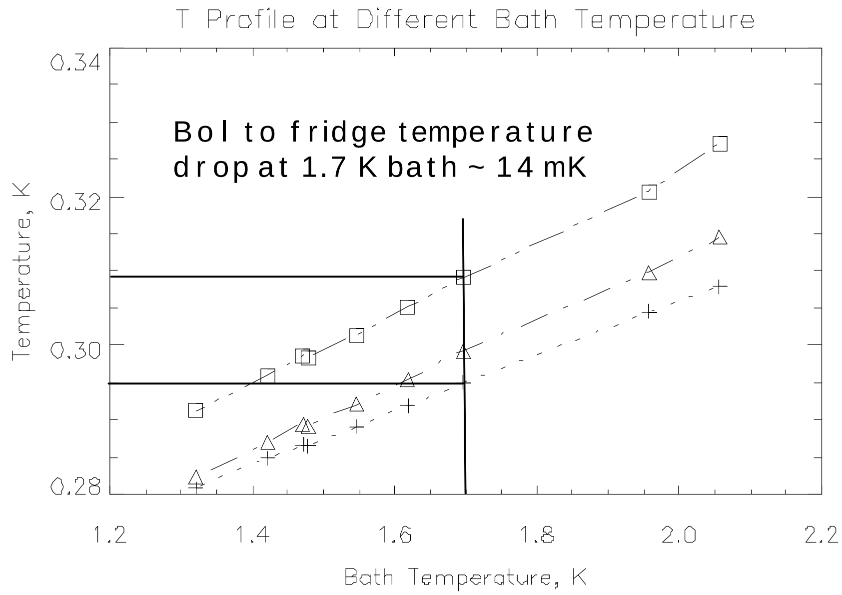
BDA thermal characterization test

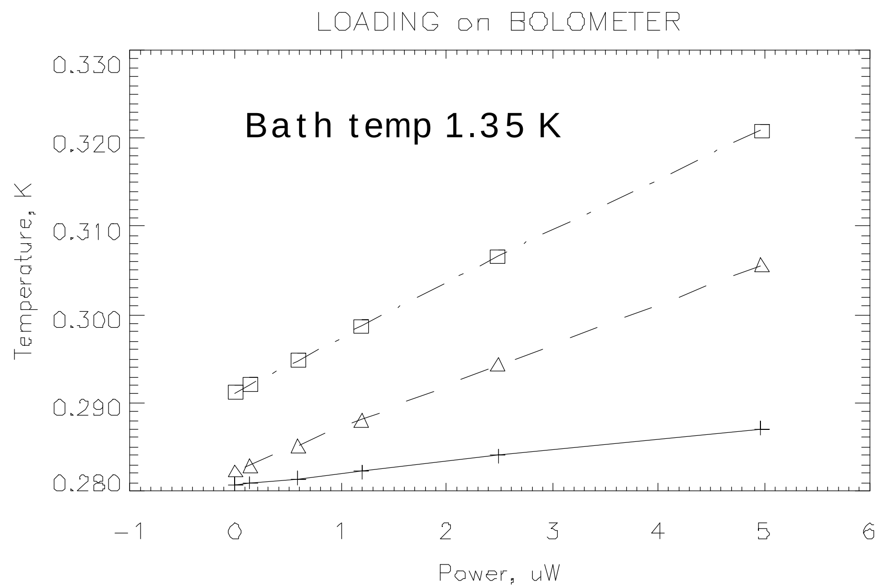


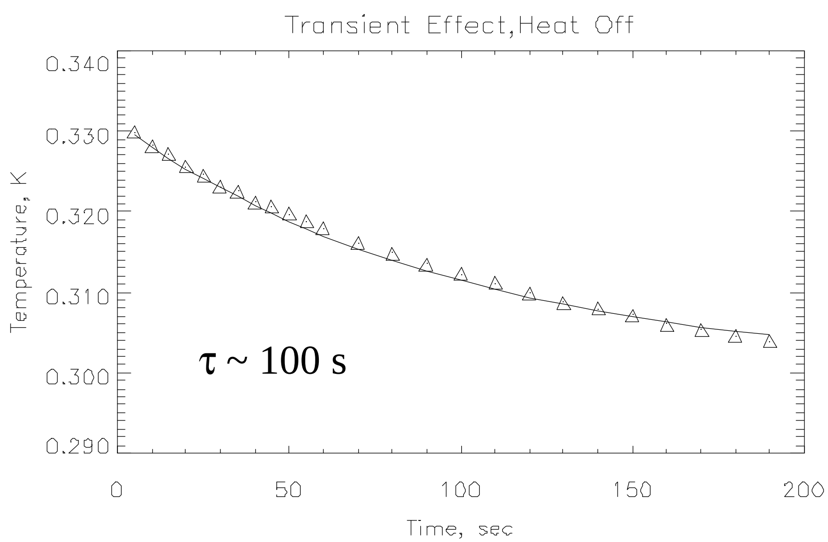
GRT1	Fridge
GRT2	Strap Junction
GRT3	Horn
GRT4	Bolplate
GRT5	Helium Bath



BDA thermal characterization test results





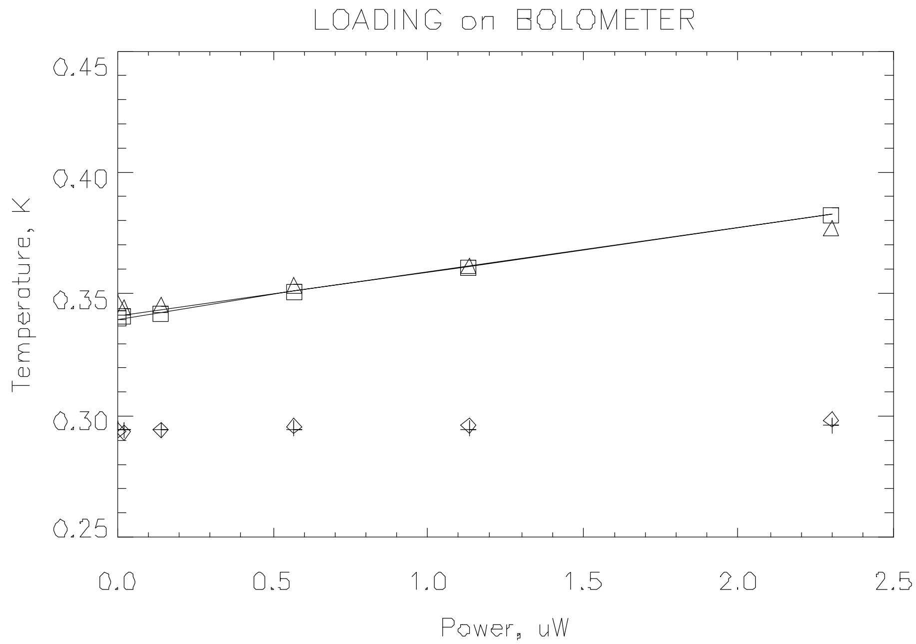


Summary of test results
Time constant ~ 100 s (meets goal)
Bol-fridge ΔT ~ 14 mK (goal <10)
Derived heat load ~1.4 uW @ 1.7K bath
(goal average 1.6 uW)

BDA thermal conclusions

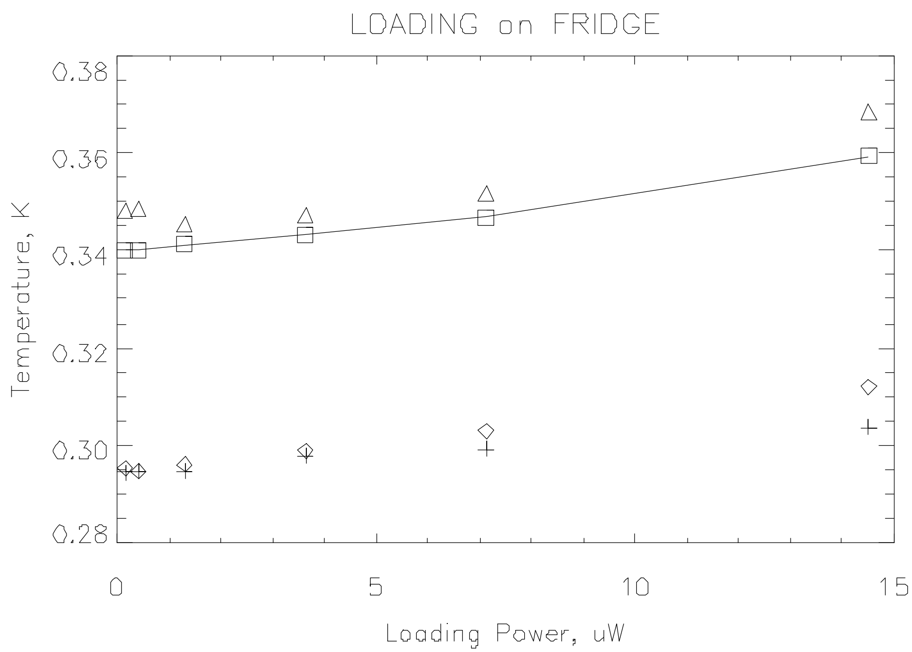
- measured 0.3 K heat load meets goal when observed systematic parasitic heat load is subtracted
- measured bulk 0.3K assembly thermal time constant of ~ 100 s meets design goal
- measured temperature drop from fridge to bolometers 14 mK, goal 10 mK
- maximum additional heat load due to ‘soft’ caging system for failed Kevlar is ~10 uW / BDA
- BDA is good to go from thermal point of view

BDA Temperature Profile: Heat Load on Bolometer



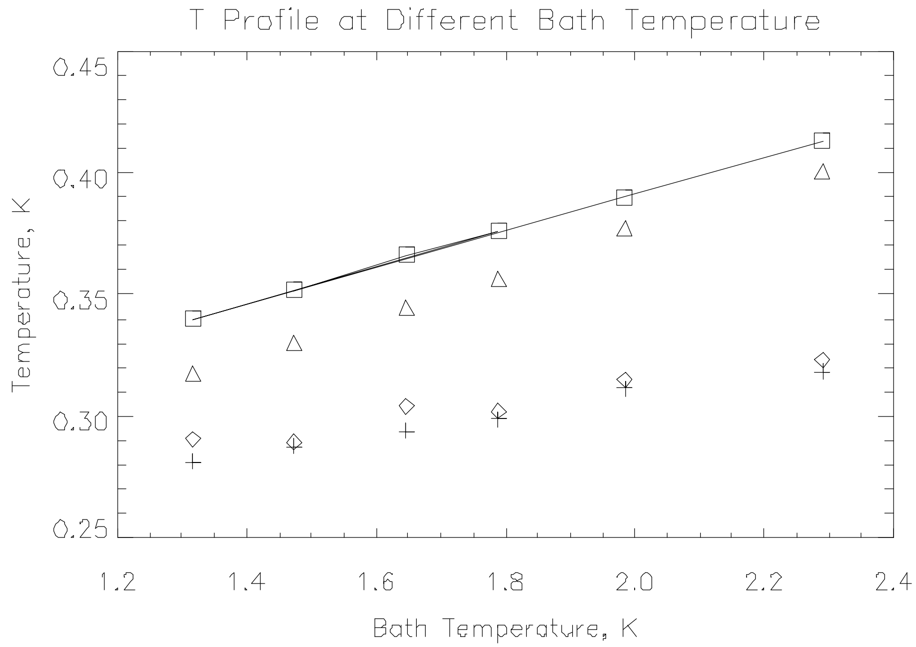
Bath Temperature 1.35 K

TEMPERATURE PROFILE ON BDA DUE TO HEAT ON FRIDGE

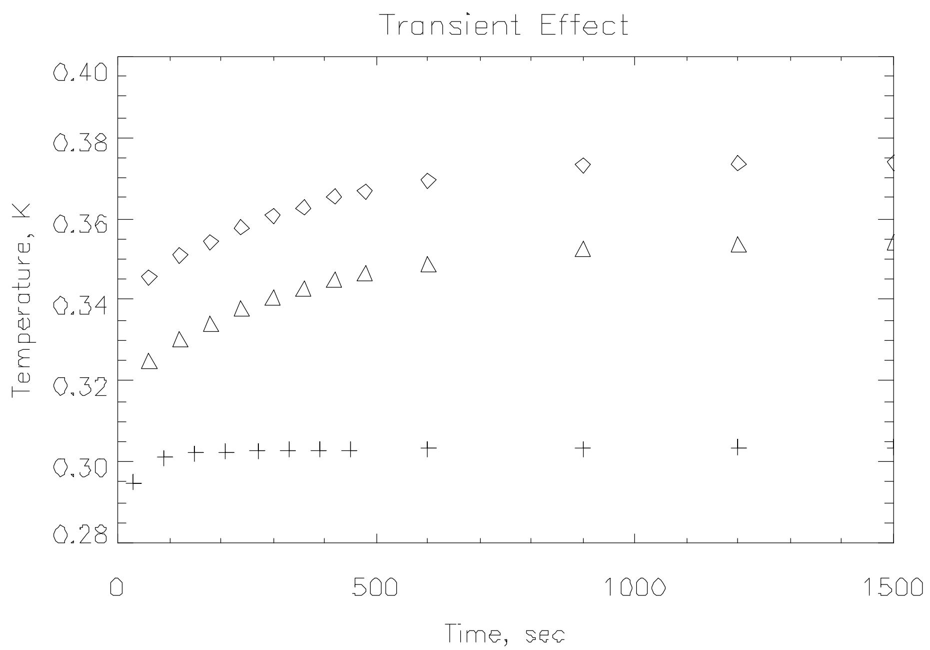


Temperature Reading Uncertainty ~ 4 mK

Temperature Gradient in BDA

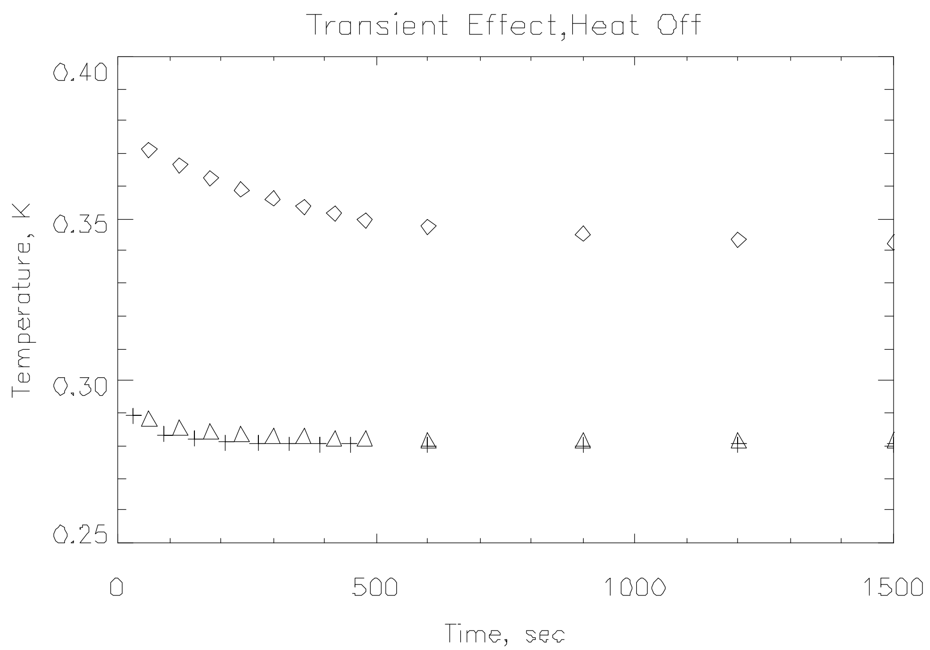


Transient Measurement: Heat On Fridge



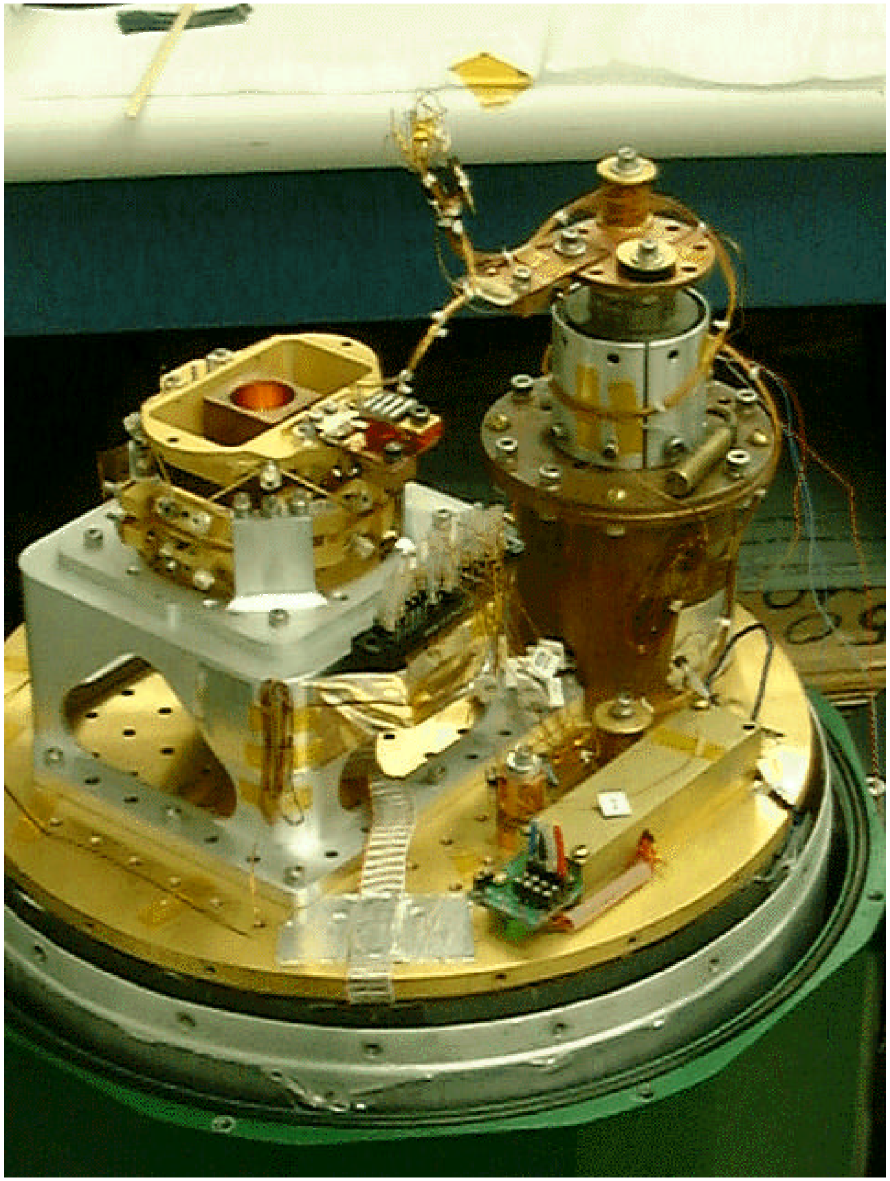
Input 150 mV or ~30 uW into Fridge

Transient Measurement: Heat Off Fridge

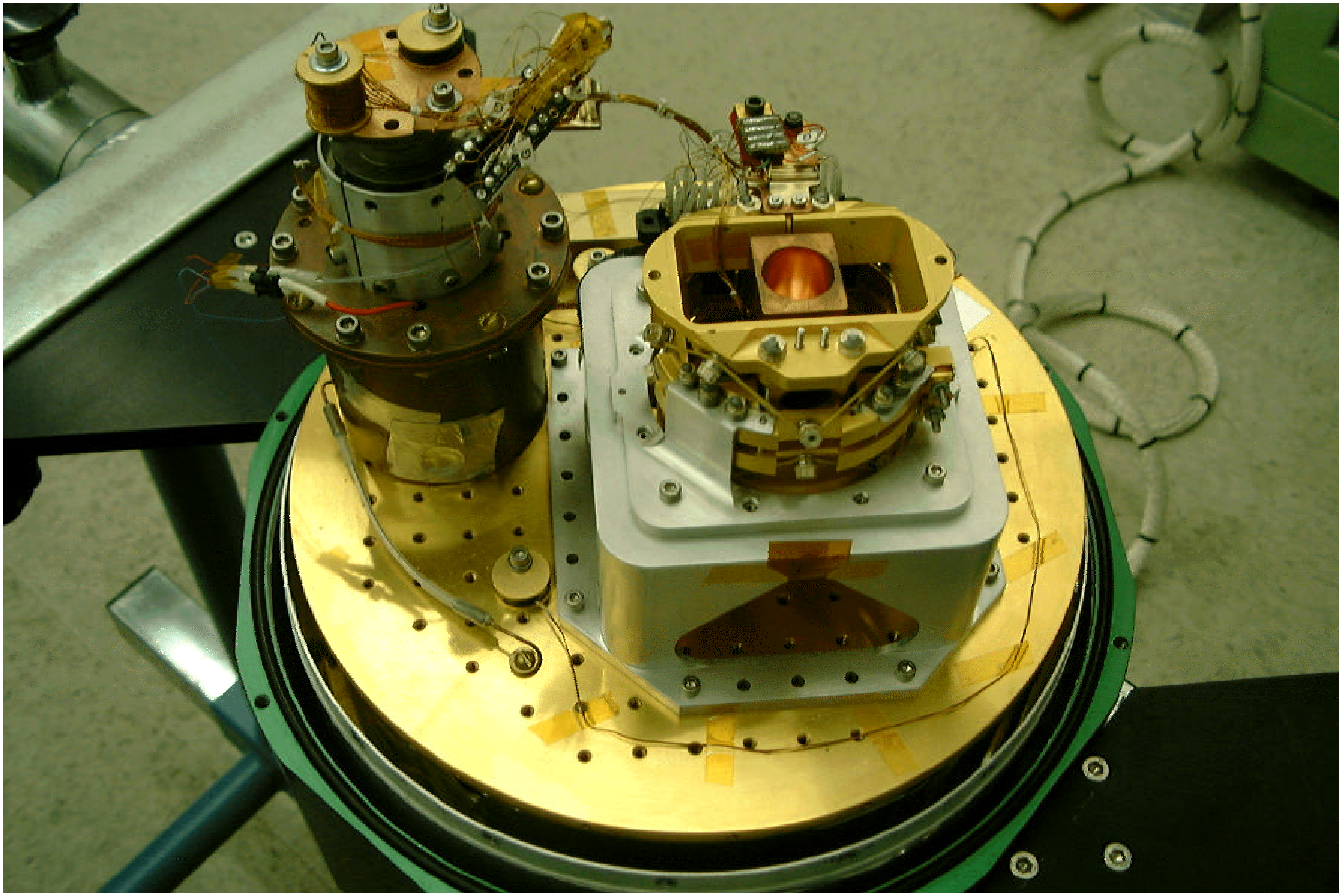


Some Changes

1. Tape up the hole in the shields (~4-40 tapped thru holes)
2. Add charcoal getter
3. Tightening up the four screws on the thermal strap
4. Tightening up the screws between the bottom cover plate and the structure



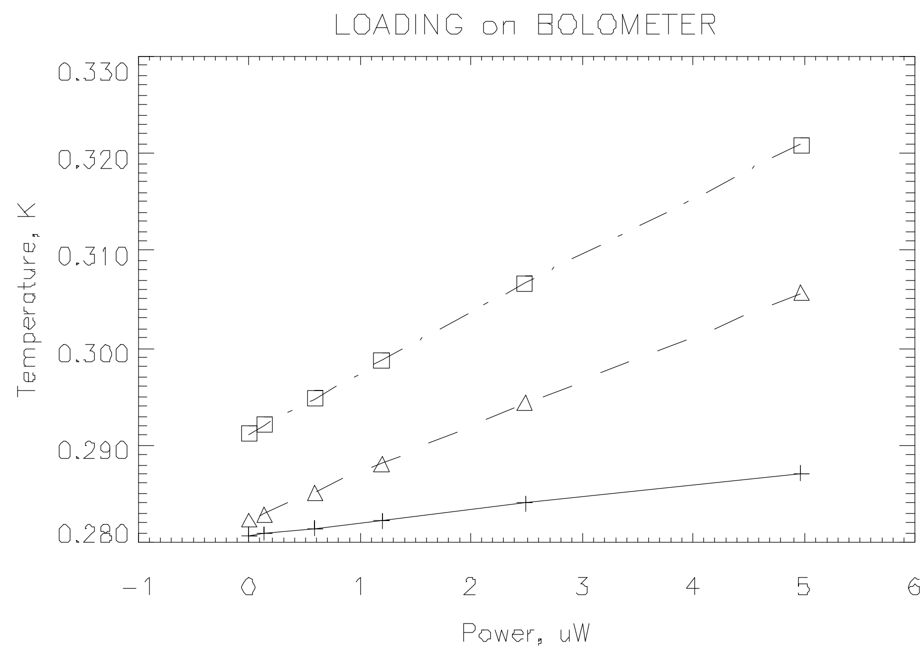
BDA for Thermal Characterization



New Measurements after Tightening Screws

What was being done?

I applied some electrical power to rhe heater at the bolometer site, and recorded all the temperatures.

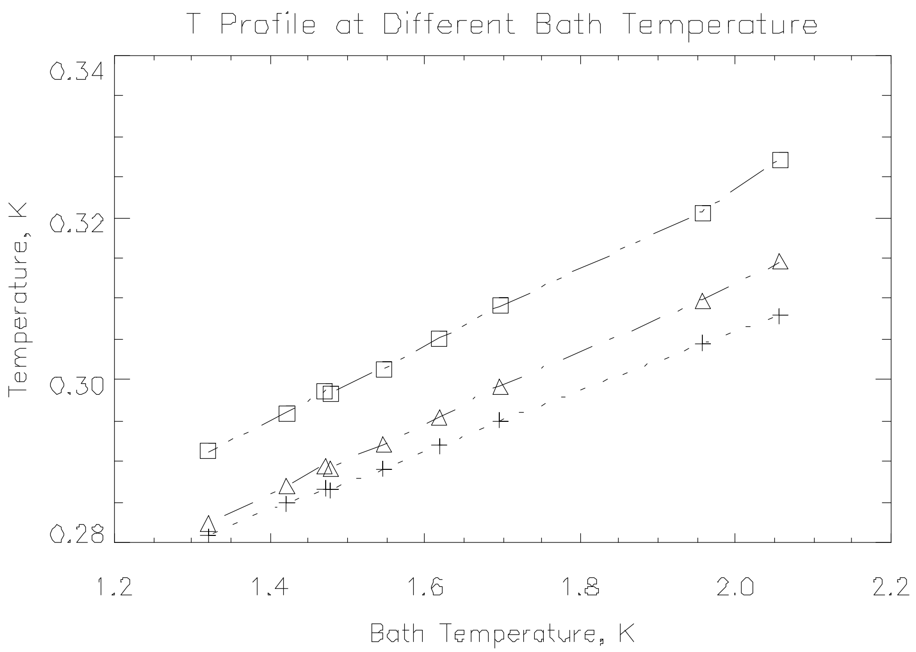


Varying Bath Temperature

What was being done:

Varying the bath temperature (by changing the speed of the pump) and recording all the temperatures (the temperature of the bottom of the thermal strap is missing because the wires were touching)

At 1.7 K the difference between T_bol and T_fridge is ~ 14 mK.

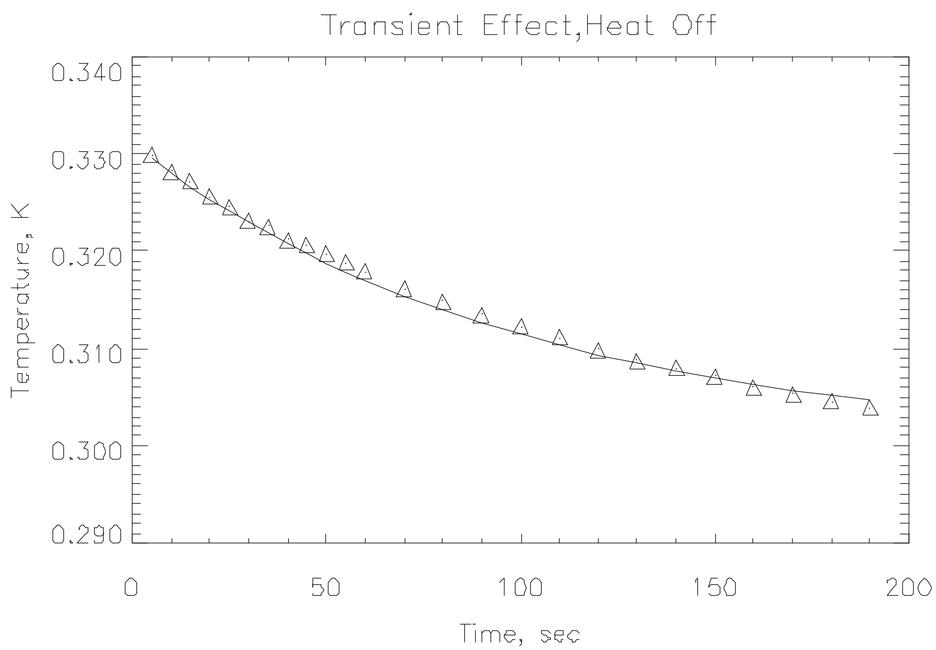


Transient Measurement

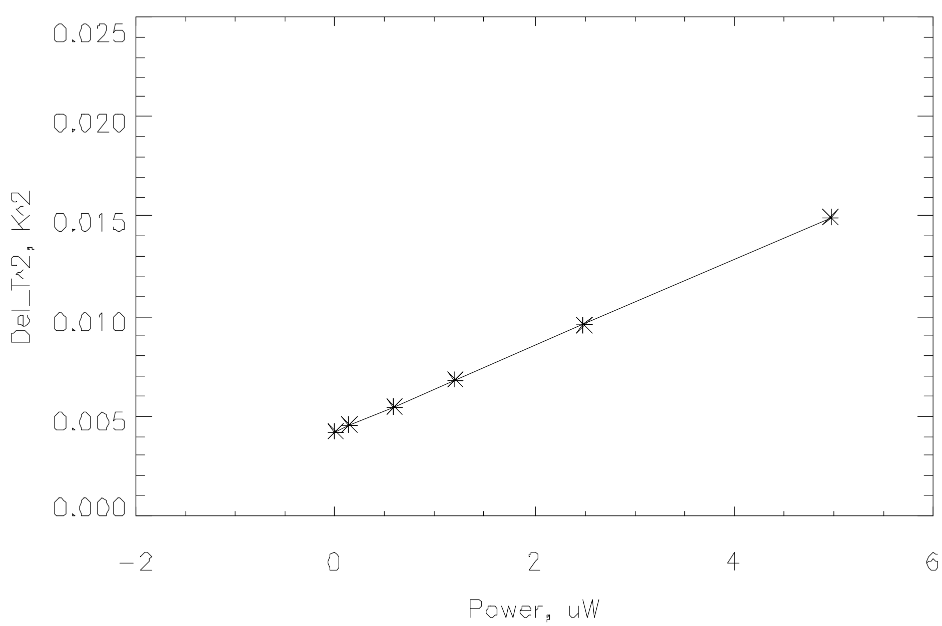
What did I do?

Turned on the power of the heater on the fridge let it come to the equilibrium, then turned it off. The data in the left figure were recorded during the cooling off phase (temperature is on bolometer site)

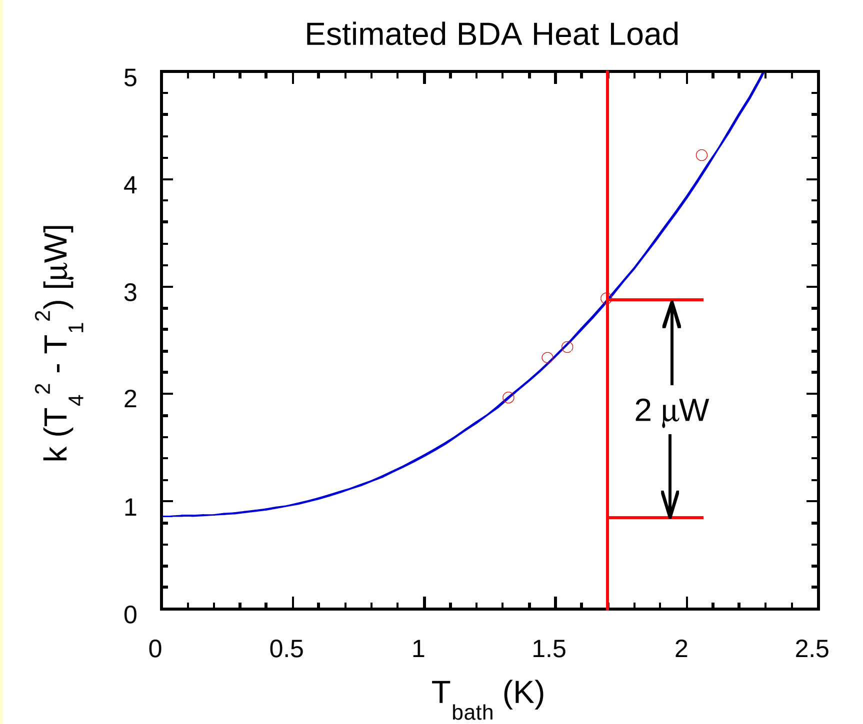
Triangle is data
Line is eye-balled fit of with 100 sec time constant



Estimate of BDA Heat Load



- Estimate loading from T_{bol} and T_{fridge} (T_{strap} not functioning)
- Extrapolate to $(T_{bol}^2 – T_{fridge}^2) = 0$



- Fit estimate power to
  $$P0 + k(T_{bath}^{2.4} – 0.3^{2.4})$$
- BDA measured load at 1.7 K is 2.0 µW
- Reasonable agreement with the theoretical load of 1.4 µW
- Recommend measurements on kapton cable

Summary

- Testing program confirmed thermal model accuracy
- Some uncertainty in total heat load
  - Should measure conductance of kapton cables at a future date
- Assembly procedures and tightening of fixtures was demonstrated to be important

5.4
SPIRE Array Fabrication

Judith Podosek, Minhee Yun, and Anthony Turner

Jet Propulsion Laboratory, Pasadena, CA 91109

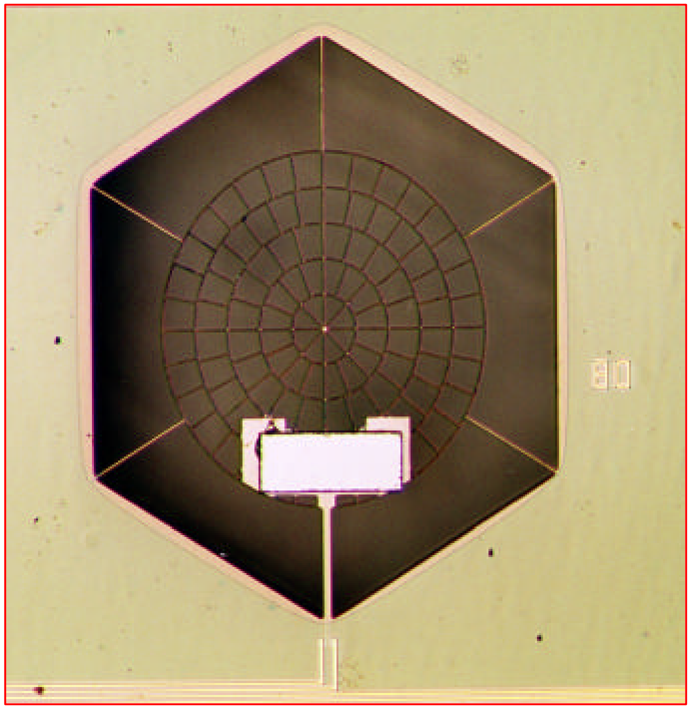
Introduction

- **Advantages & Requirements**
- **Fabrication Processes**
- **Risks**
- **Present Status**
- **Future Work**

Advantages

Spider-web architecture provides

- low absorber heat capacity
- minimal suspended mass
- low-cosmic ray cross-section
- low thermal conductivity = high sensitivity



Design Values

	Wavelength (μm)	NEP x 10^{-17} (W $Hz^{-1/2}$)	Tau (ms)	Dark pixels	# of detectors	Dimension (arcmin)	Thermi-stors	Requirement Reference	5 MΩ Resistors
Photometer	250	8.9	9	2	139	4x8	2	IRD-PHOT-R02	1
	350	6.7	11	2	88	4x8	2	IRD-PHOT-R02	1
	500	4.9	14	2	43	4x8	2	IRD-PHOT-R02	1
Spectrometer	250 TBC	12.0	3.4	2	37	2.1	2	IRD-SPEC-R04	1
	400 TBC	11.9	4.9	2	19	2.1	2	IRD-SPEC-R04	1

Design Values, cont.

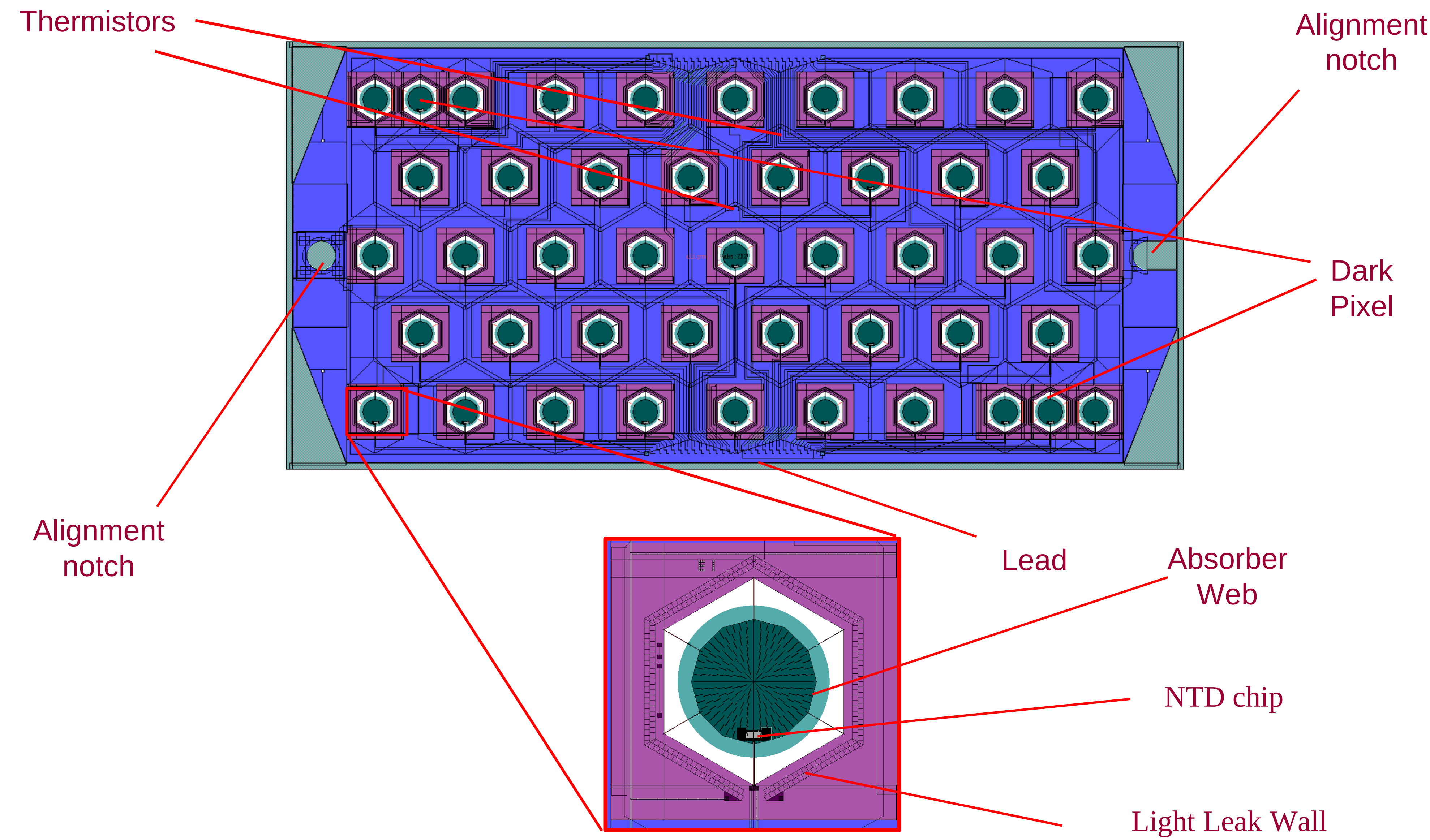
Table 3-1-1(SSSD) Summary of Detector Design Values

Quantity	Units	P/LW	P/MW	P/SW	S/LW	S/SW
Q	pW	3	4	5	12.5	9.8
$\mathbf{NEP_{tot}}$	e-17 W/√Hz	6.0	7.9	10.0	14.0	13.4
$\mathbf{G_0}$	pW/K	50	64	80	140	210
$\mathbf{V_{bol}}$	mV_{rms}	3.7	4.2	4.7	7.6	6.3
$\mathbf{S_{dc}}$	e8 V/W	4.3	3.7	3.3	2.1	2.1

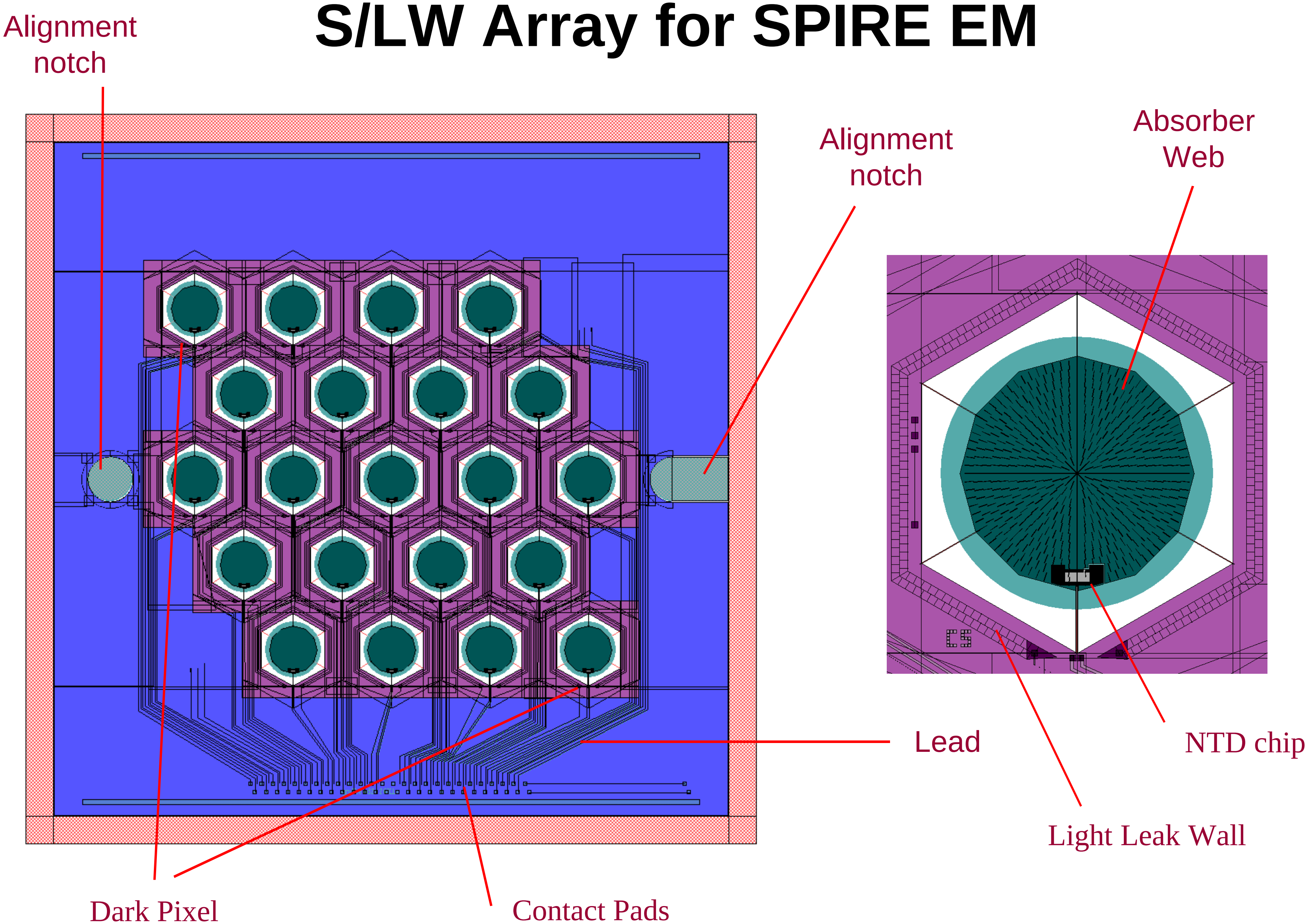
Table 3-1-2(SSSD) Summary of Common Detector Design Values

Quantity	Value	Unit
R_0	180	W
D	41.8	K
T_{bol}	0.39	K
R_{bol}	5.8	MW
Z/R	0.4	

P/LW Array for SPIRE CQM



S/LW Array for SPIRE EM



MDL (MicroDevices Laboratory) Fabrication Process Description

- MDL is a DNP organization that has adopted facility and process improvements to accommodate a flight program
  - Facilities Monitoring
    - ✓ Particle Detector PMS

      Wafer Particle Detector
    - ✓ Electrostatic Discharge (ESD) Control

      Ionizing blowers

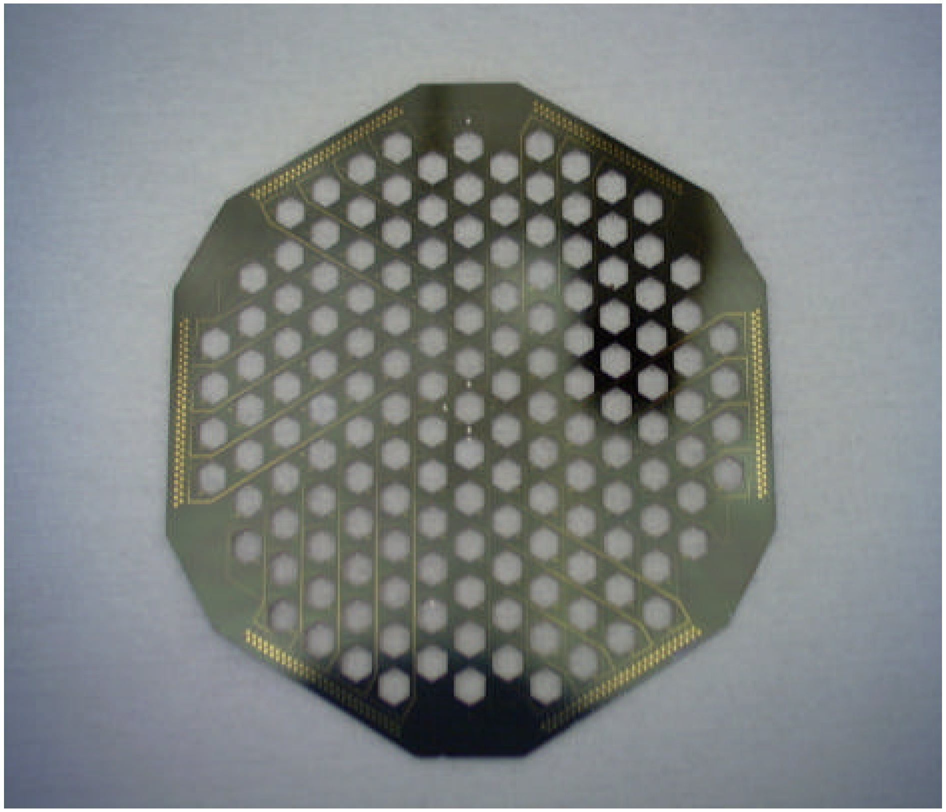
      Simco, Aerostat, Ionizer, Semtronic

      NRD Ionizer cartridges for N2 guns and Nuclespot Static Eliminators
    - ✓ Thermocouple Temperature Readouts

MDL Fabrication Process Description, continued

- Designated locked flight cabinets
- All materials used in this program will have certifications and are used exclusively for the flight project
- Travelers, AIDS, Procedures, Traceability to manufacture to the lots, etc have been implemented
- All personnel working on project have taken the flight hardware classes
- Facilities certified, ESD
- Cleanliness certifications in place

Example of Technology Heritage, Bolocam



- **Bolocam ; 151 Detectors**
  - **Web Failure : 18**
  - **Chip Failure : 10**
  - **Lithographic Error : 2**
  - **Yield = 80.2 % (121/151)**

We have successfully delivered the 151 detector array Bolocam with a better than 80% yield. The lessons we learned during the fabrication of this array enables us to expect even better yield on the HSO detector arrays.

Risks

Devices	Risks	Mitigation
Detector Arrays	Lithographic error	Most critical lithography steps now use non-contact aligners (stepper, e-beam)
	In bump	Establish the highest temperature to which the detector can be subject to and remain viable
	Tight schedule	Have added processing engineers and inserted slack
Backshort	Uniformity across surface	Ultra clean process & Deep RIE development

Array Status

	Device	Deliver to	Current Status
EM	P/SW (7 elements, 250µm)	Univ. of Colorado, Feedhorn test	Completed/Delivered
	S/LW (7 elements, 400µm)	Univ. of Colorado, Feedhorn test	Final test before delivery
	S/LW (21 elements, 400µm)	JPL, Cryo./Noise test	Ready for release
CQM	P/LW (43 elements, 500µm)	JPL, Cryo./Noise test	Oct., 2001
	S/SW (37 elements, 250µm)		Feb., 2002
	S/LW (21 elements, 400µm)		
FM	S/LW (21 elements, 400µm)	JPL, Cryo./Noise test	2002 2003
	P/LW (43 elements, 500µm)		
	P/MW (88 elements, 350µm)		
	P/SW (140 elements,250µm)		
Spare	SSW (37 elements, 250µm)	JPL, Cryo./Noise test	2002 2003
	PMW (88 elements, 350µm)		
	PSW (140 elements, 250µm)		

Document Status

Document Title	Document #	Statue
AIDS for Wafer level fabrication of CQM P/LW Array	**221731**	**Signed off**
Procedure for Wafer level fabrication of CQM P/LW Array	**JPL D# EP518503 Version A**	**Signed off**
Traveler for Wafer level fabrication of CQM P/LW Array	**N/A**	**Signed off**
Map of Wafer level CQM P/LW Array	**N/A**	**Signed off**
Array Data sheet for Wafer level fabrication of CQM P/LW	**N/A**	**Signed off**
AIDS for Device level fabrication of CQM P/LW Array	**221732**	**Signed off**
Procedure for Device level fabrication of CQM P/LW Array	**JPL D# EP518504 Version A**	**Signed off**
Traveler for Device level fabrication of CQM P/LW Array	**N/A**	**Signed off**
Map of CQM P/LW Array Device	**N/A**	**Signed off**
Data sheet for Device level fabrication of CQM P/LW Array	**N/A**	**Signed off**

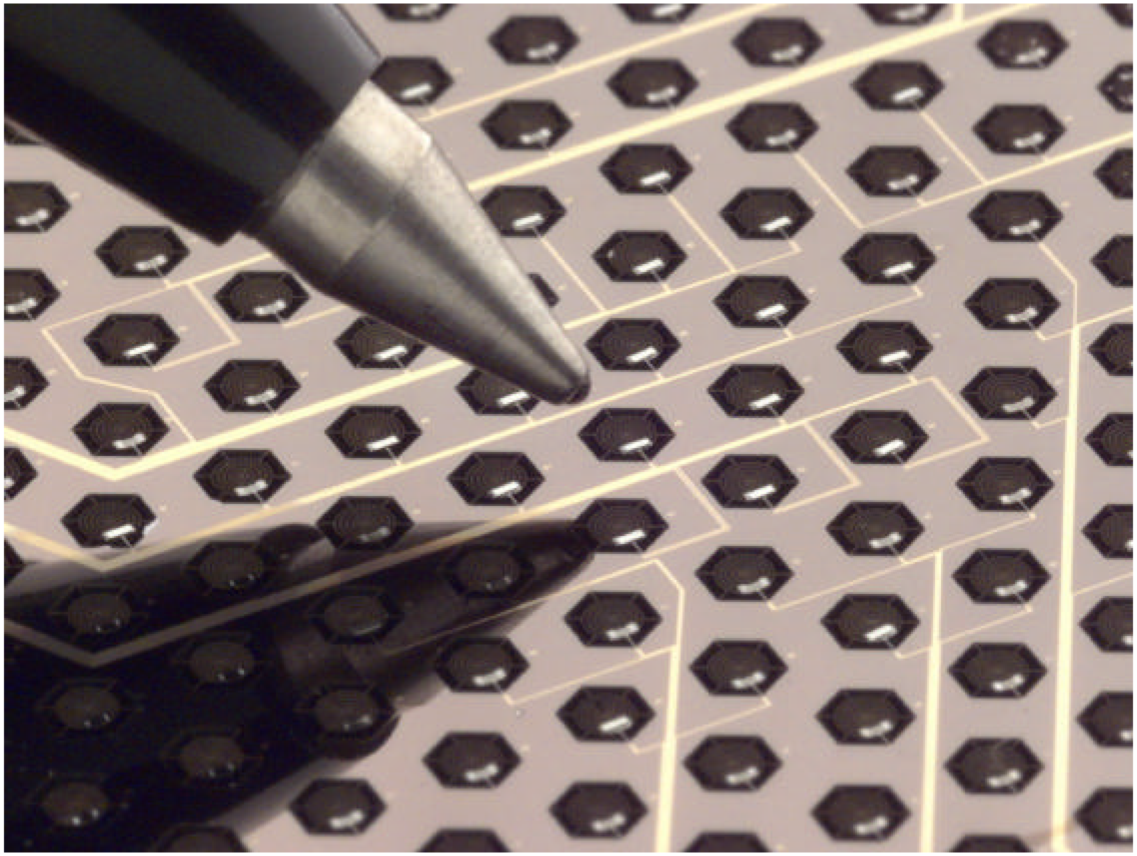
Summary and Future Work

- Process techniques have been developed, resulting in an increase the viability of the applicable device fabrication. (ex. ; NTD chip bonding, stepper lithography)
- Final devices will have 90% or better yield with array performance to specification.
- We are on schedule with the EM delivery.
- We have completed Bolocam fabrication and delivered to Caltech.
- Future work as stated in Array Status.

5.5
SPIRE DETECTOR DEVELOPMENT

Hien Nguyen

SPIDER WEB BOLOMETER ARRAY

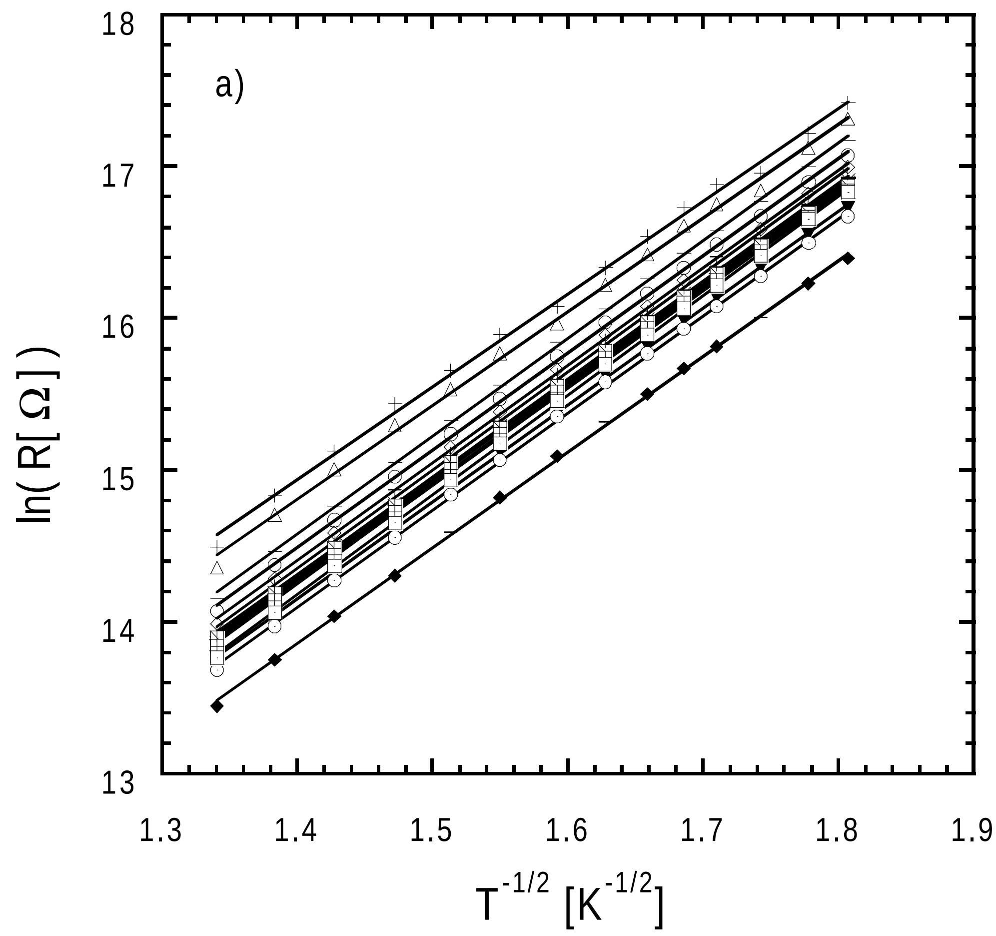


ıe array of micromesh bolometers designed for photometry at λ = 350 μm. Each device has a 725 μm diameter absorber with grid spacing of 72.5 μm and a filling factor of 0.077. The absorber is suspended by five 5 μm wide, 240 μm long support legs. ıe thermistors are placed to one side of the absorber and read out with two leads deposited on a single, 18 μm wide support ember. The pixel spacing is 1.75 mm in order to allow the array to be tested with 1fλ or 2fλ f/5 feeds, although only the 2fλ eds were eventually tested in a 19-element format.

Bolometer Description

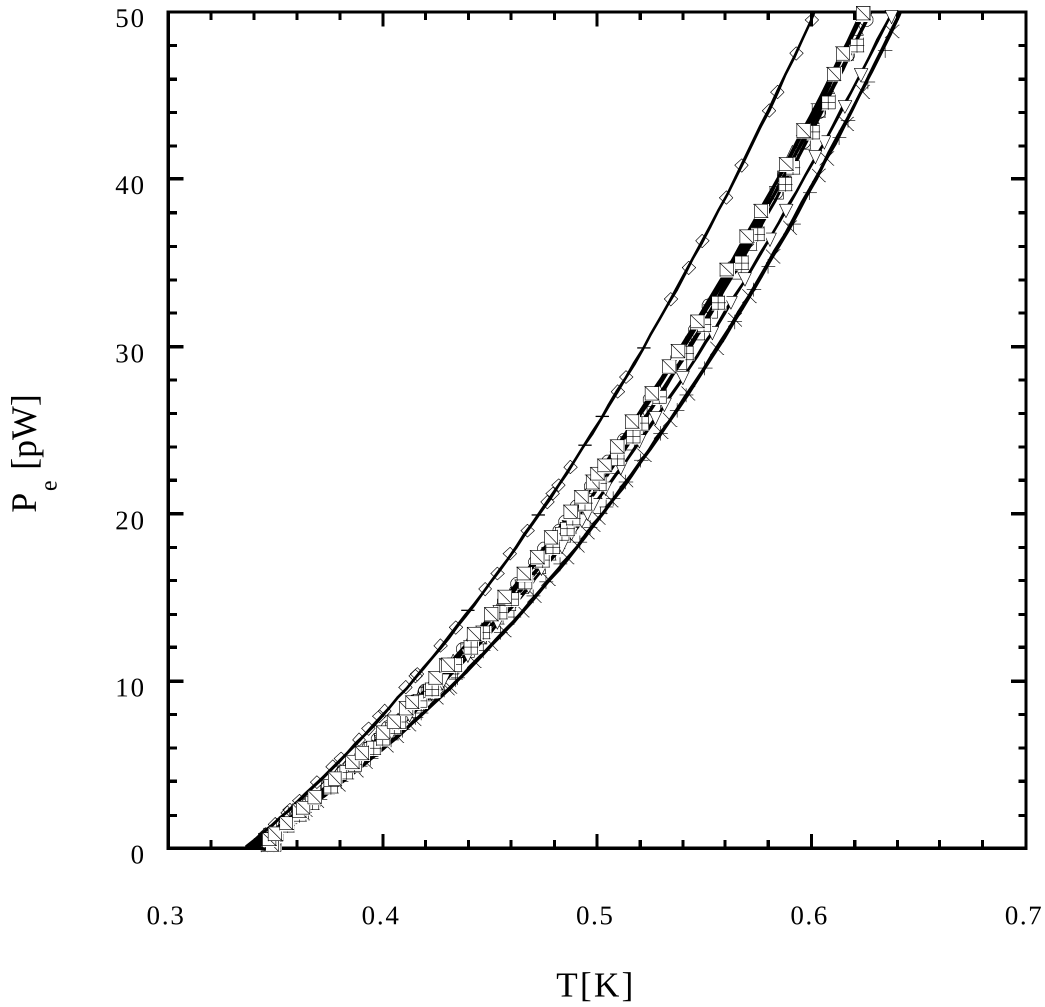
- Demonstration array to meet requirements of 350 micron wavelength photometer
  - Used in technology downselection
- Detector demonstrates performance near specification
  - Array was placed through flight-like performance test program

Resistance vs. Temperature



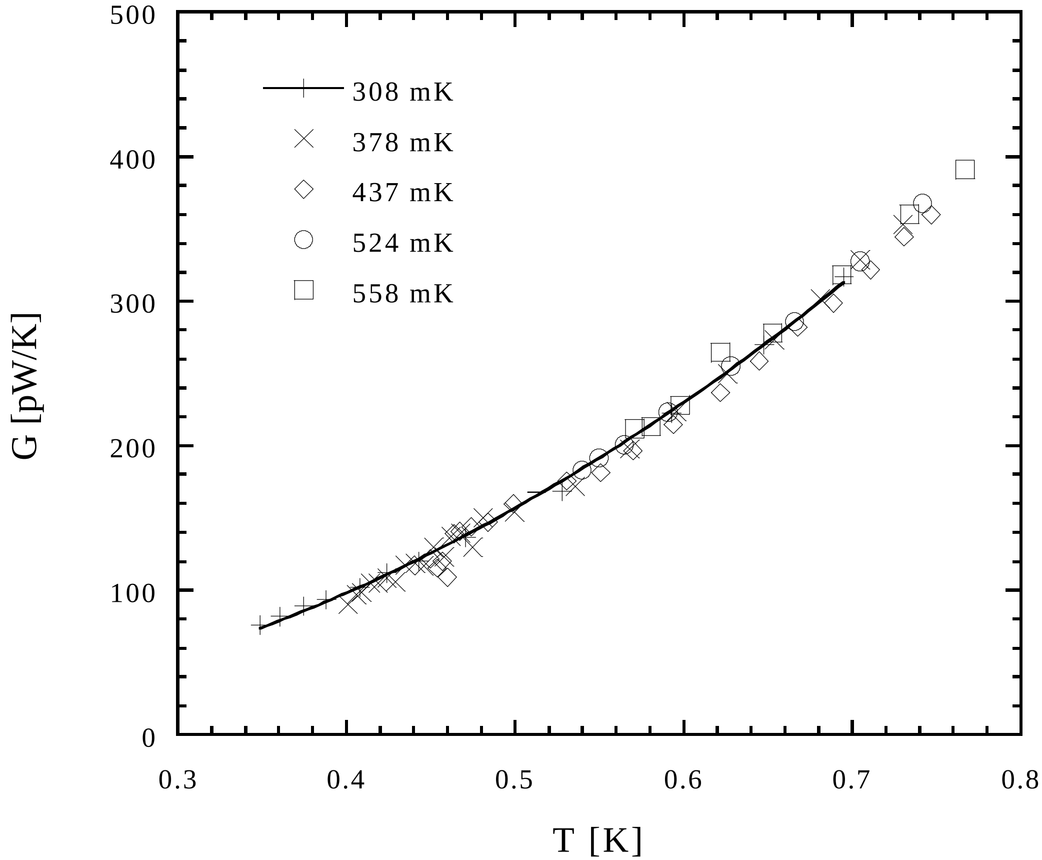
Hopping conduction in NTD Ge: $R = R_0\, e^{\sqrt{\Delta/T}}$

Thermal Conductance



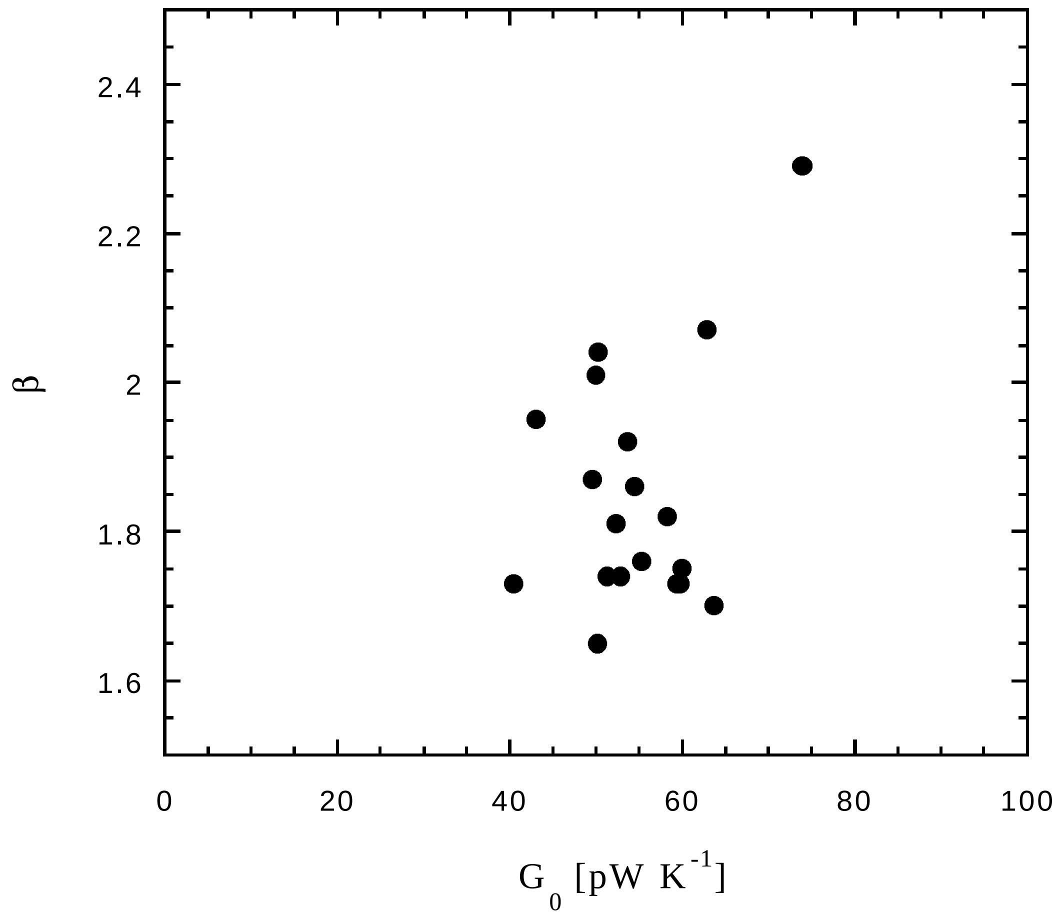
Measurement of thermal conductance from dark load curves

G vs. T



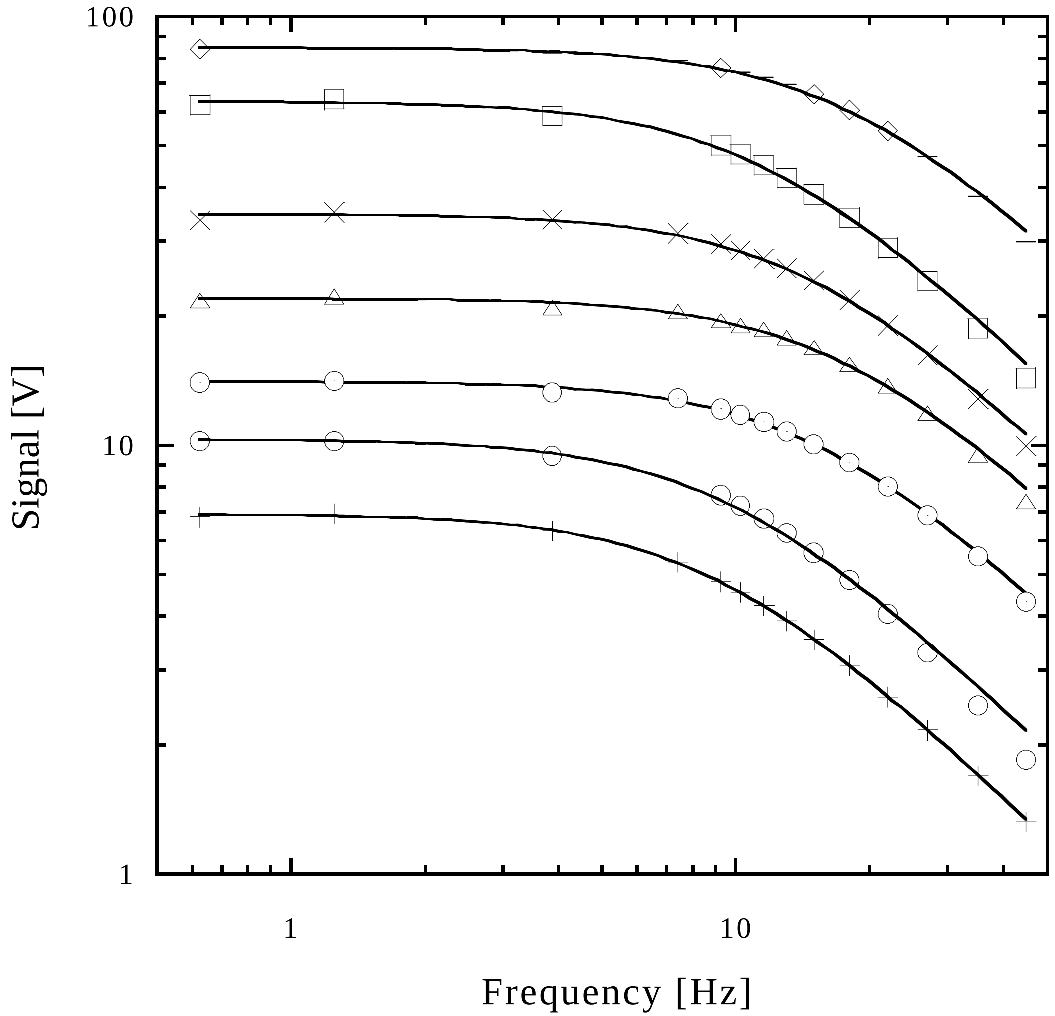
- Comparison of thermal conductivity derived from dark load curves over a range of temperatures
- Good agreement indicates electrical non-linearities small

Scatter in Thermal Conductance



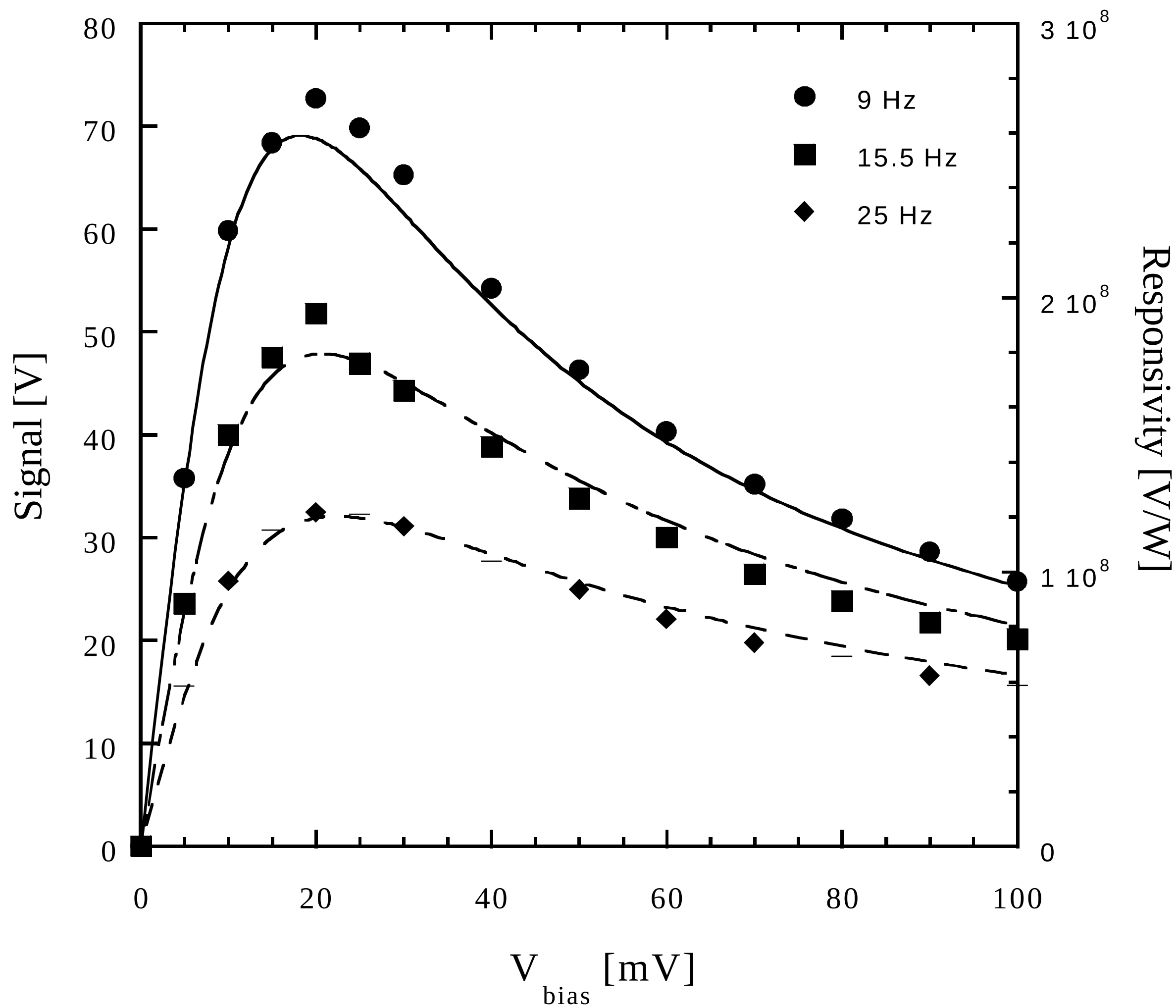
~15 % scatter in the thermal conductivity over the array

Time Constant



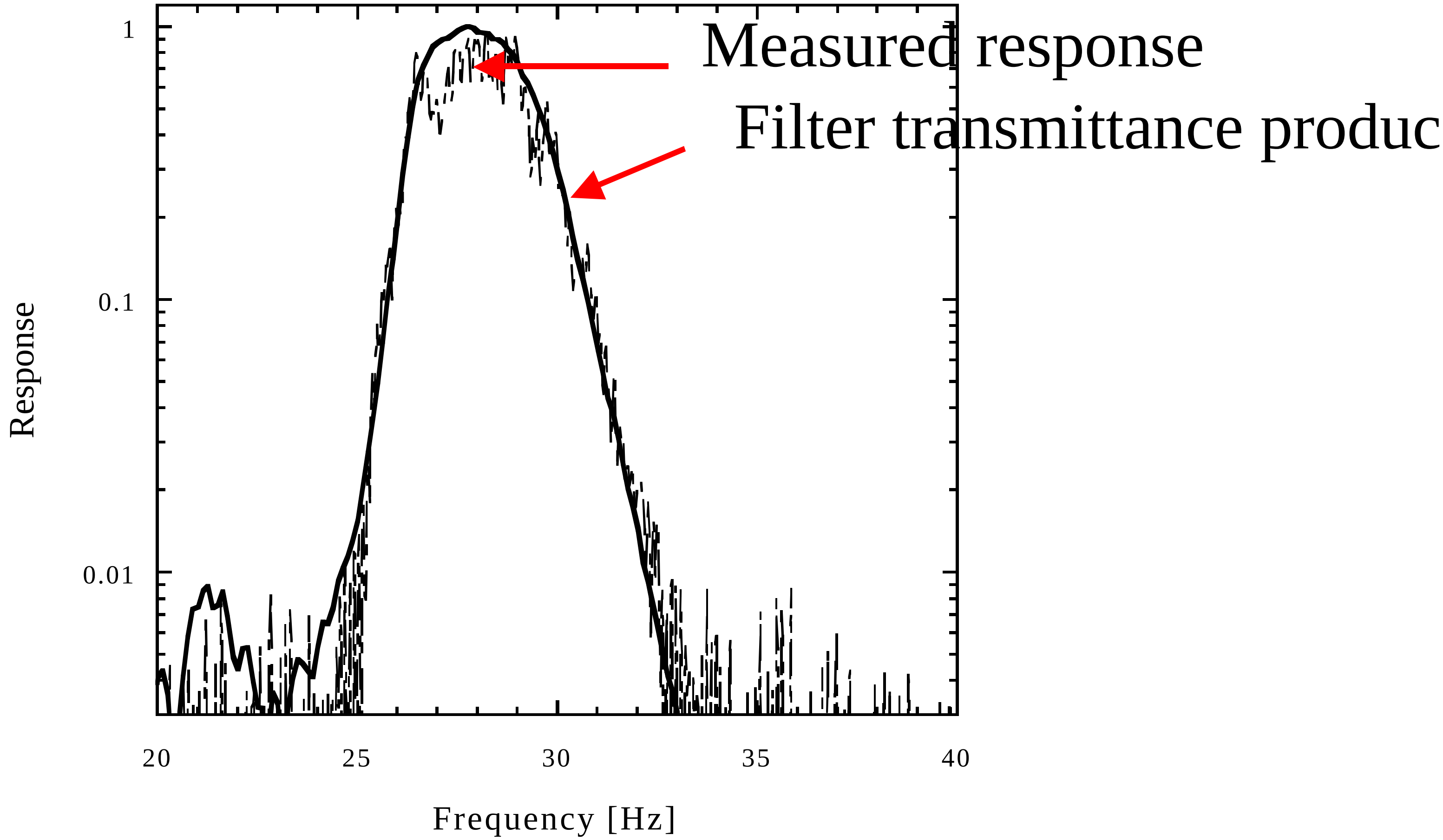
Response described by a single-pole filter

Responsivity



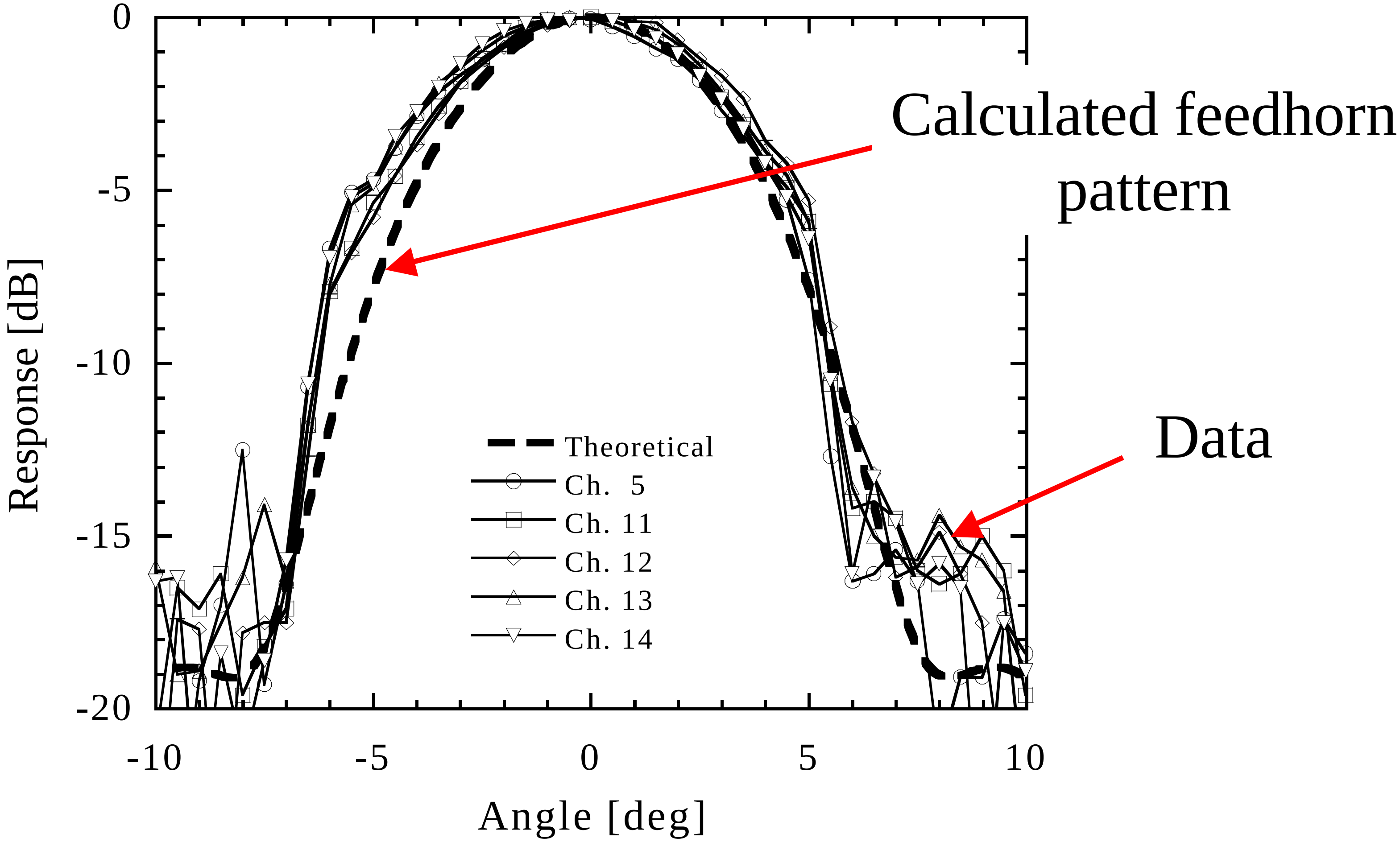
Good agreement between electrical model and optical data

Spectroscopy



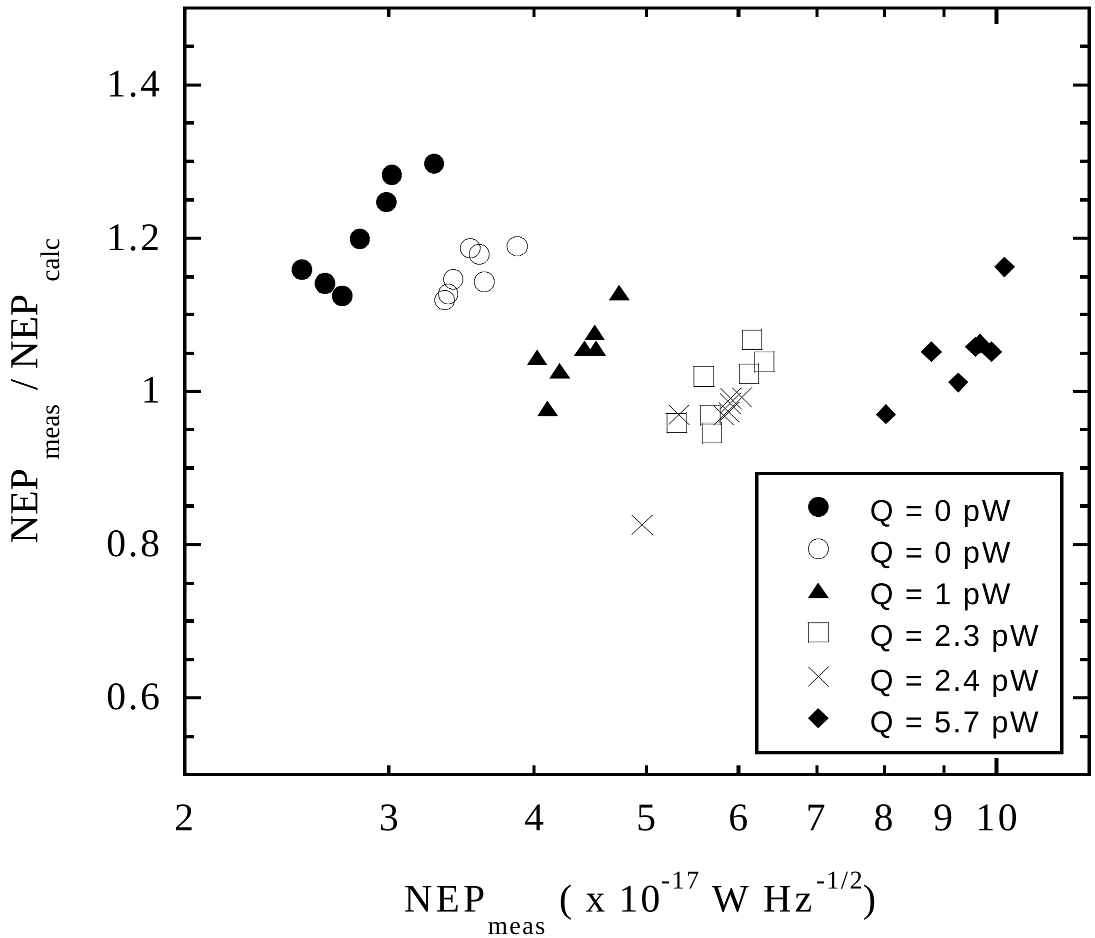
Reasonable agreement with expected profile
Some dips in passband – may be from feedhorn

Beam Map



Some deviations from model – may be from Lyot stop

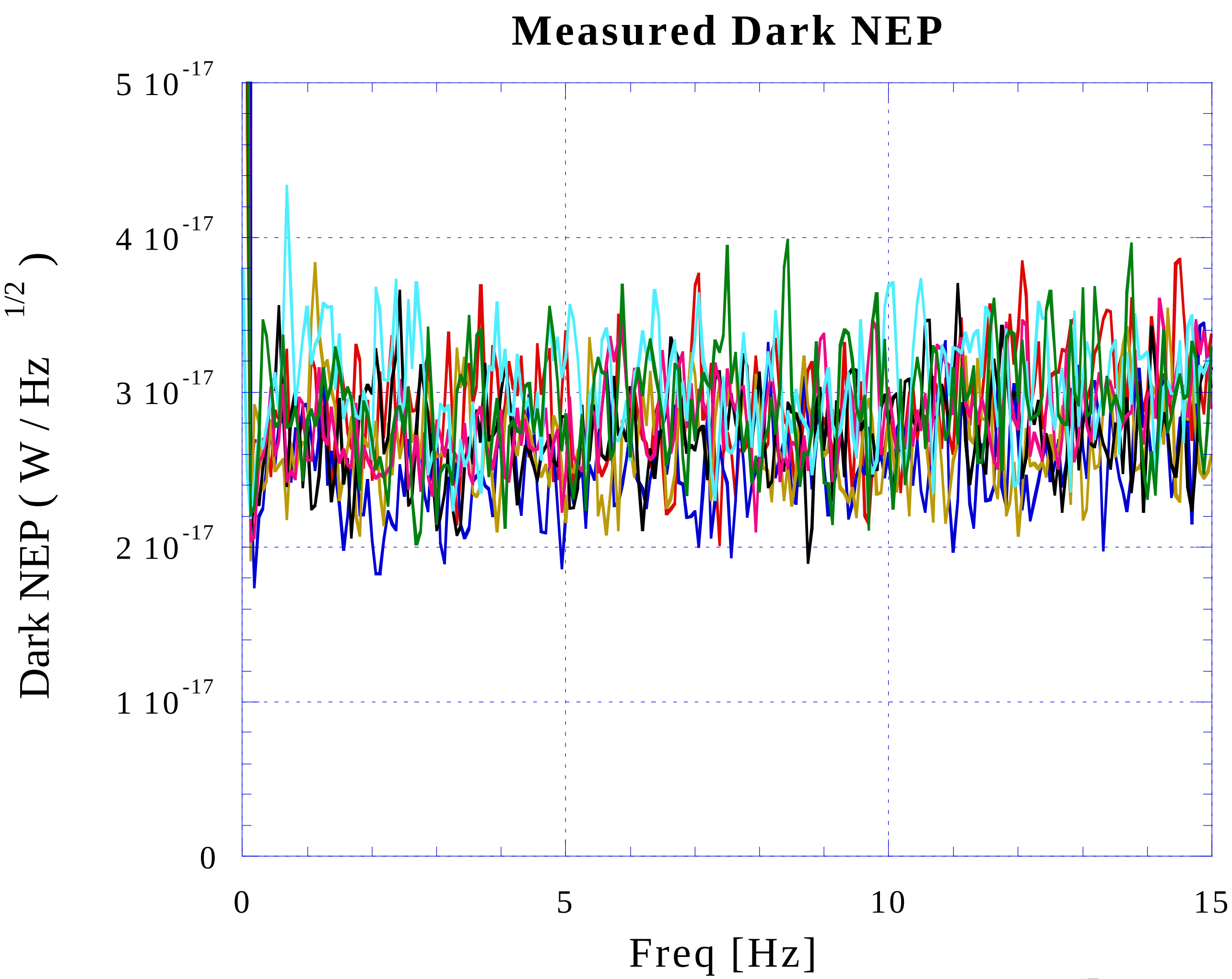
Background-limited performance ratio



Near-background limited performance

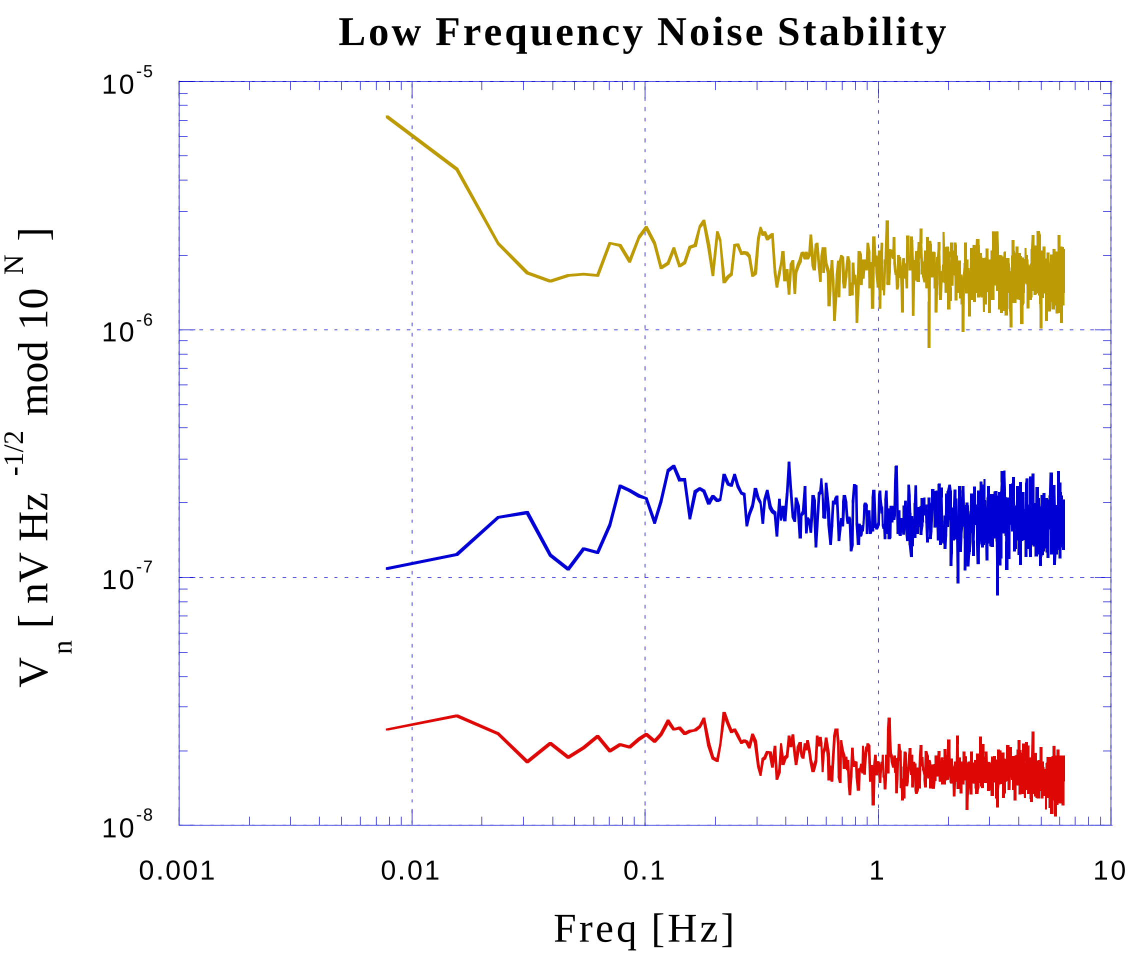
Photon loading calculated from optical load curve

Dark Noise Measurements



Close agreement with Mather noise model

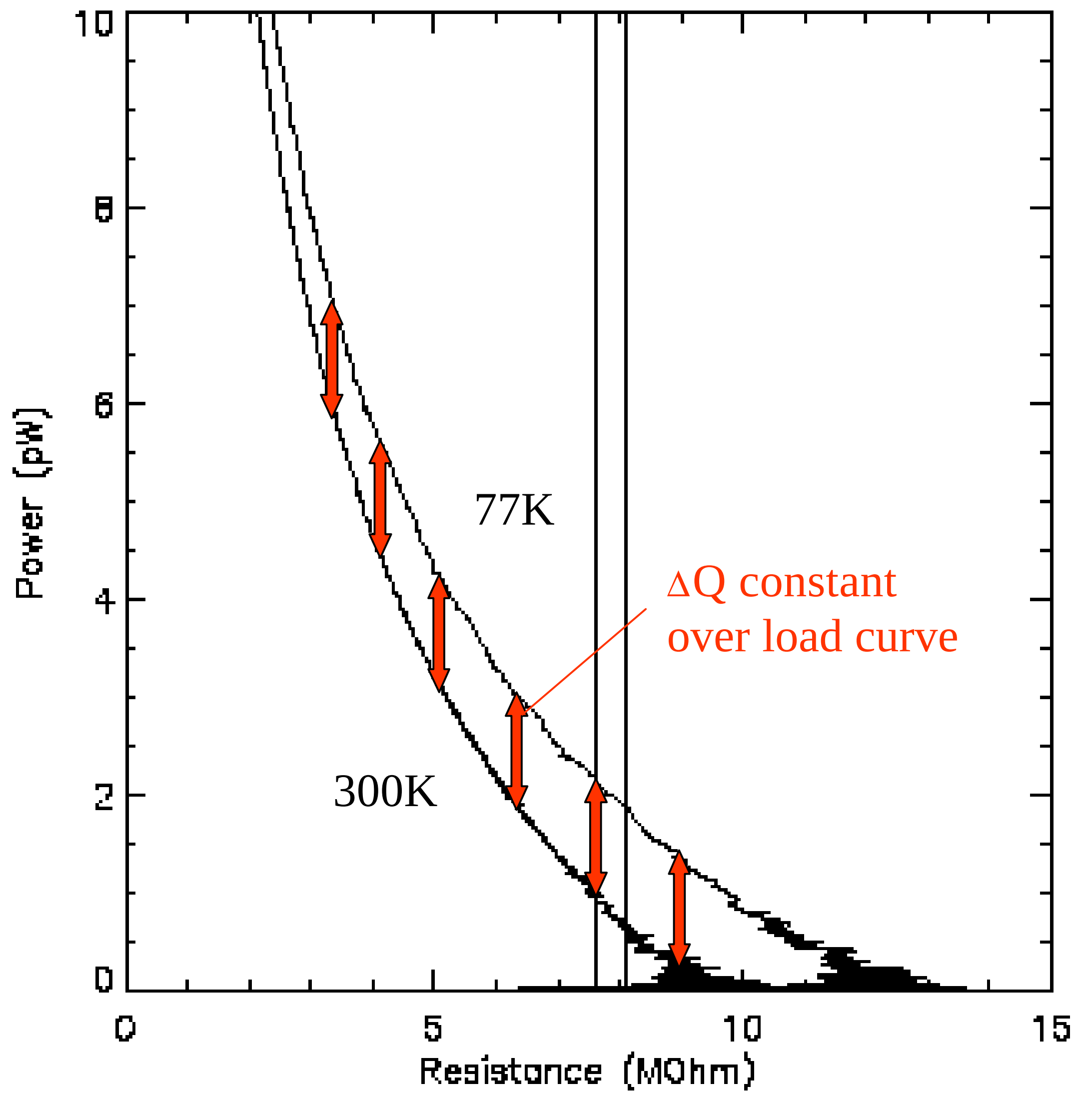
Low Frequency Noise Stability



Measurement of Optical Efficiency

TECHNIQUE

- Take IV Curves for each optical loading
- Compute Resistance as a function of electrical power (bias Voltage)
- Optical power inferred from difference in electrical power $\Delta Q = \Delta P_{electrical}$



Measurement of System Cross-talk

1. Optical Cross-talk

- Focus light into one pixel and measure the response
- 10 Hz chop, DC bias at QMW

  ave = 5.5 % for adjacent pixels

  < 0.4 % Other pixels

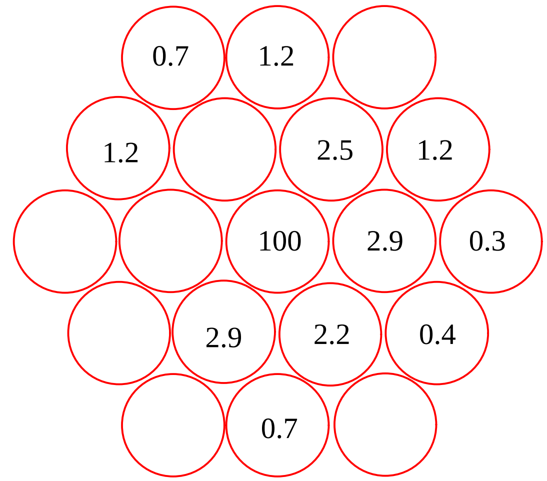
•Adjacent pixel coupling was 2.7 % at JPL with different external optics

•Cross-talk may arise from bacus optics, feedhorns, or electrical coupling, *but appears due to defocus of external optics*

•N-N cross-talk < 1 % based on symmetry of focal plane maps

2. Electrical Cross-talk

- Measure the response with AC-bias at 200 Hz and demodulate
- <u>no increase</u> above optical cross talk.
- Crosstalk in 5 MW load resistor < 0.05%



A Optical Cross-talk Map

Summary

Measured Array Specifications

Quantity	Measured Value	Spec (Target)	Units
Dark <NEP_{bol}>	2.7×10^{-17}	(2.5×10^{-17})	[W/√Hz]
Dark <S_e>	5.88×10^{8} (± 6 %)		[V/W]
Yield	0.9	0.9	
<G_0>	54.8 ± 7.6	120 (60)	[pW/K]
<C_0>	0.96 ± 0.24	(1.0)	[pJ/K]
τ	11.7 ± 0.8	8 / 30	[ms]
η_{bol}	0.46 – 0.64	0.8	
1/f knee	~30	100	[mHz]
NEP_{bol}/NEP_{blip}	1.10 (+0.05, –0.15)	1.15	
DQE	0.38 - 0.53	0.60	

- **Good optical efficiency**
  but below expected value
  with η_{bol} = 0.8, DQE = 0.66
- **G_0 and C_0 equal to target quantities**
- **High uniformity in NEP and responsivity**
  high yield
  background limited for Q > 1.5 pW
- **Detectors show theoretical noise and responsivity**
  close agreement with Mather bolometer model
  no excess noise or non-linearity
- **Stable noise performance for drift-scanned observations**

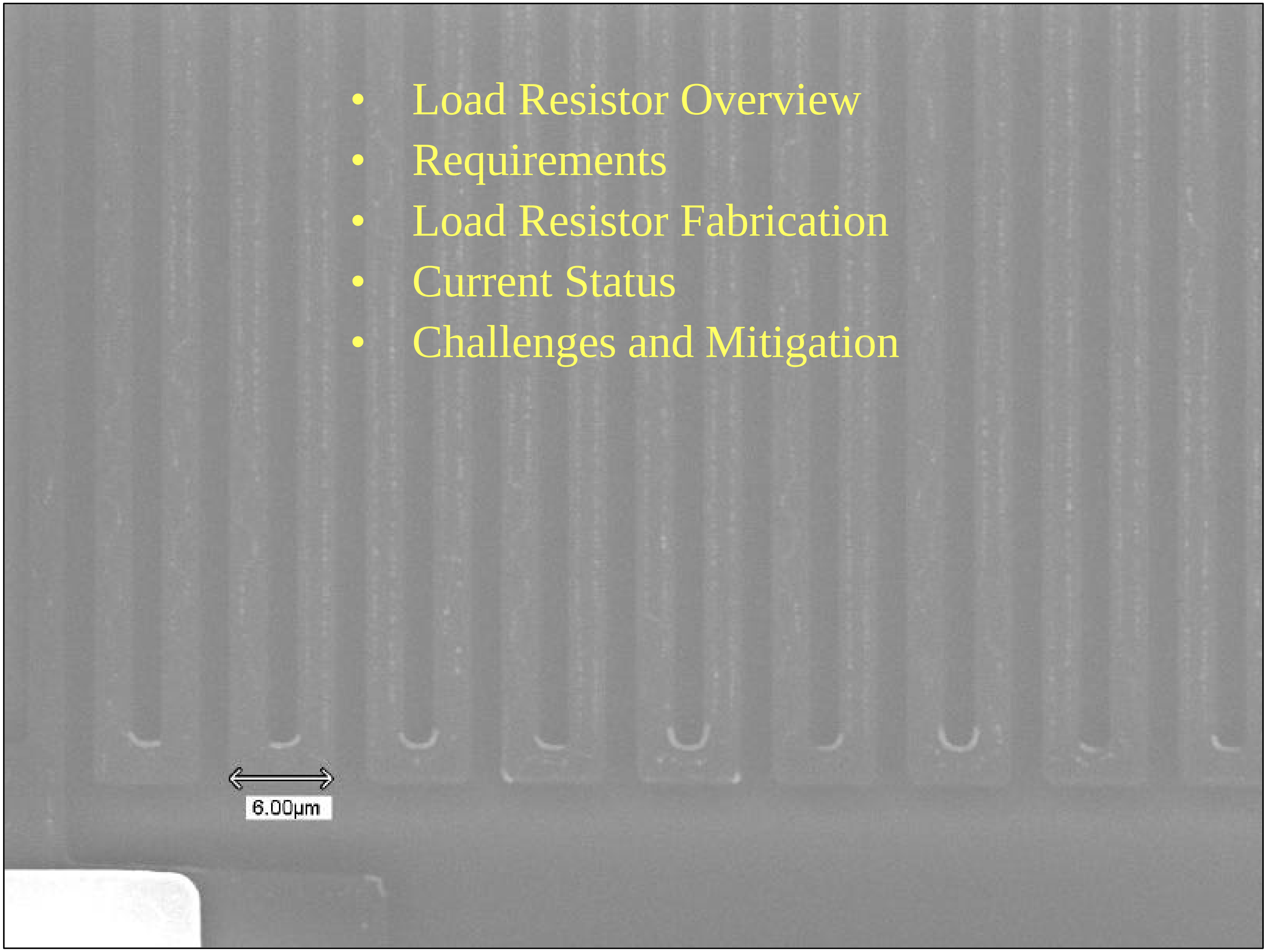
Design Changes from Downselect Array

- Low optical efficiency is primary issue to be resolved
  - High efficiency demonstrated in millimeter-wave instruments
  - High beta (1.85) indicates significant contribution from silicon nitride
  - No significant change after modifying feedhorns waveguides
  - Cavity dimensions confrimed by measurement
  - Bolocam array wafer with same process also showed low efficiency compared with earlier array
- Loss may be due to thermal inefficiency
  - Decrease nitride thickness from 1.8 μm to 0.8 μm
  - Increase support beams from 250 μm to 500 μm
  - Increase absorber metal thickness from 10 to 12.5 nm

5.6
Load Resistor Fabrication

Anthony Turner, Eric Jones

Overview



- Load Resistor Overview
- Requirements
- Load Resistor Fabrication
- Current Status
- Challenges and Mitigation

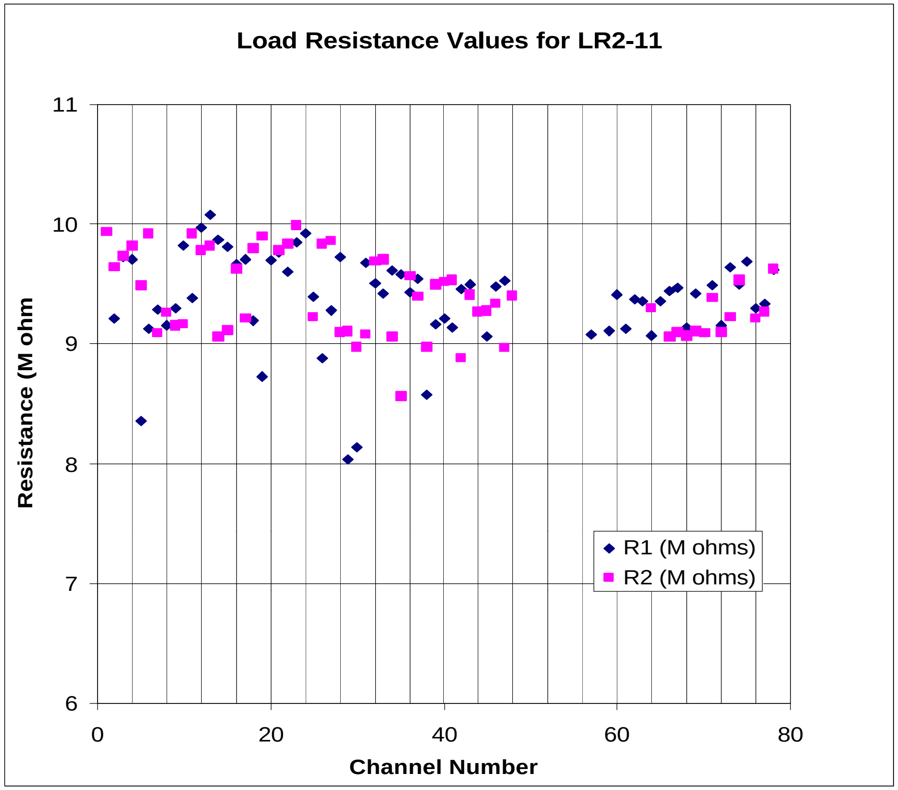
Load Resistor Requirements

Device Type	Channels	#Load R needed	Channel Yield Left 26 channels	Channel Yield Center 26 channels	Channel Yield Right 26 channels
PLW	48	2 per array 4 total		>95%	
PMW	93	2 per array 4 total	>85%	>85%	>85%
PSW	144	2 per array 4 total	>95%	>95%	>95%
SLW	24	1 per array 2 total		>80%	
SSW	42	2 per array 4 total		>90%	
Total		18 devices plus spares			

•Note: 14 load resistor fabricated per wafer. Channel yield and channel location will determine which array they can be coupled to.

Load Resistor Current Status

- EM Load Resistor have been completed and are awaiting cyrogenic tests
- Yield to this date has not been determined.
- Preliminary measurements indicate:
  - resistor yield of 85-95%
  - channel yield of 70-90%
  - Majority of failures due to a defect in the Si wafer (scratches in wafer)
- Preliminary tests conducted:
  - Conductivity measurements
  - N_2 Dip thermal shock test
    - No failures in passivation layer
  - Conductivity measurements after thermal shock
    - No failures in resistors
    - No failures in leads



Load Resistor Open Issues

- Open Issues
  - Process sheets are 90% complete
  - Noise data has yet to be conducted
  - Small line widths make photolithography process very challenging but within achievable constraints
- Mitigations
  - Multiple wafer runs should provide all devices needed for flight detectors

5.7
Kapton Cables for SPIRE Bolometer Arrays

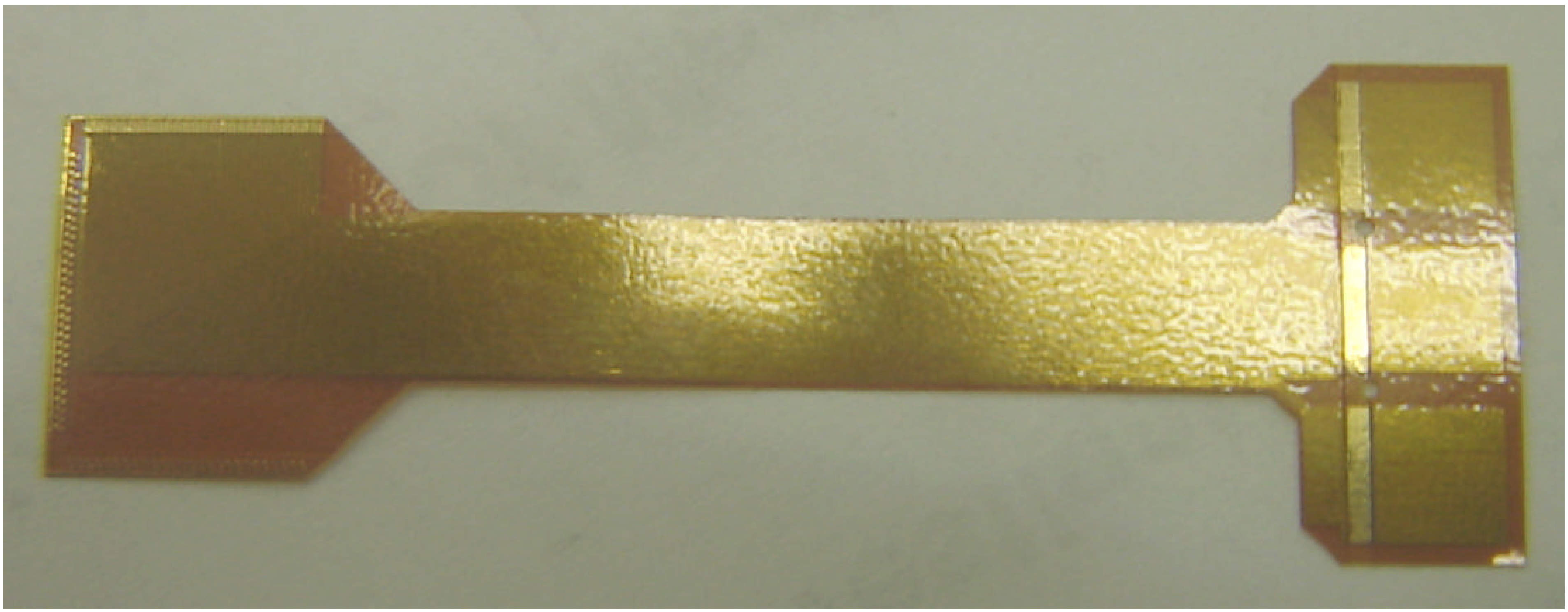
By

Anthony Turner

July 20, 2001

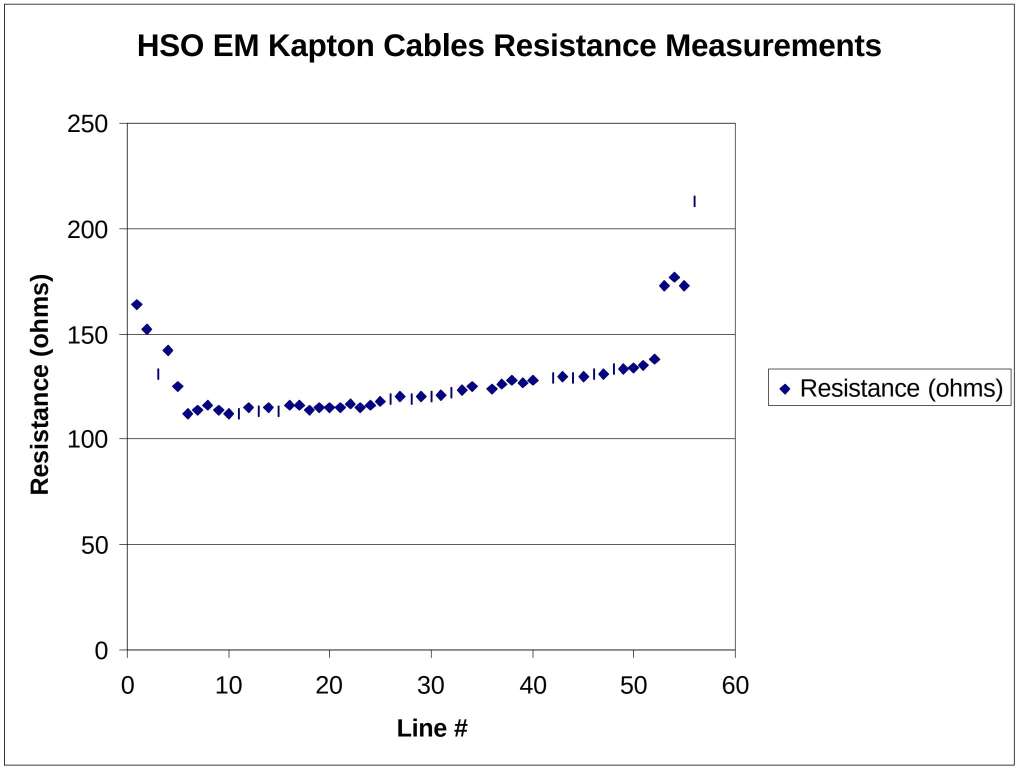
Overview

- Kapton Cable Overview and Status
  - Cable Fabrication
- Challenges and Mitigations



Kapton Cable Status

- Initial EM1 Cable yield:
  - Line yield 90% (50um lines)
  - Line resistance is 100-200 ohms for lead lines
  - Handling issues
- Wirebond tests
  - Wirebonds successful but difficult on EM1 cables
  - G10 backing board added into design for structural support during wirebonding
- Thermal Test
  - Initial thermal tests



Environmental Tests

- Test at LN2 temperature did not have any failures
- Further tests and pictures will be presented

Open Issues

- Open Issues
  - Constantan foil etch is difficult to control. Should be fine with new cable design 100um lines.
  - Thermal conductance of cable should be measured directly.
  - Probe testing on cable directly is difficult.
  - Have to make one more EM cable run before CQM cables.

- Mitigations
  - New design with plated through holes will be easier to test.
  - New design can also be provided by other manufactures

5.8
BDA Manufacture and Assembly

Leonard Husted

BDA Manufacture and Assembly

- Contents
  - Manufacturing Approach
  - Manufacturing Facilities
  - Personnel Skills/Certification
  - Exploded Views
  - Assembly Documentation Required
  - Manufacturing Processes
  - Tooling
  - Manufacturing Process Flow
  - Summary

Manufacturing Approach

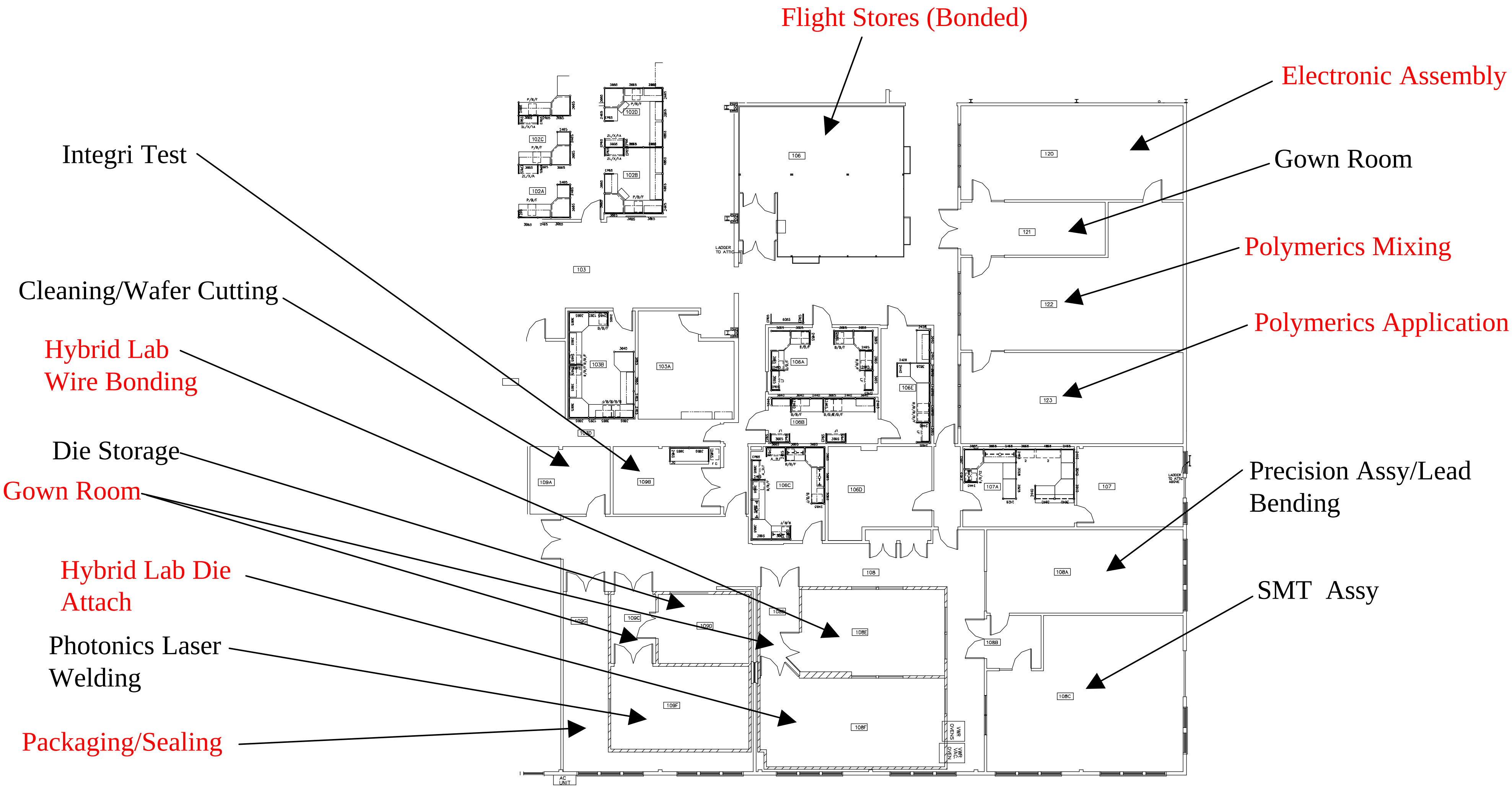
- Fabrication
  - Competitive procurement of mechanical hardware from 2 sources: ASI or Swales
  - Electronic hardware produced in JPL's MDL
- Assembly
  - Detector assembly will be produced in Electronic Packaging (Bldg. 103)
  - Suspension assembly will be produced in Mechanisms Assembly Laboratory (Bldg. 170)

Facilities

- **Building 103 Flight Assembly**
  - **Controlled Access**
  - **Temperature Controlled 72+/- 3 deg**
  - **Humidity Controlled 30-70%**
  - **Conductive Floor Tiles**
  - **ESD Certified**
  - **Hybrid Lab 10,000 Class**
  - **O2 Sensors**

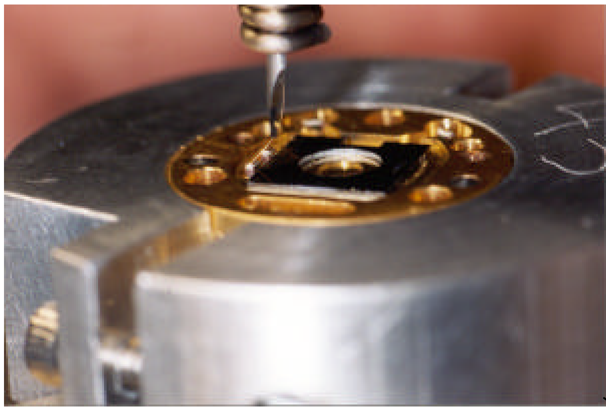
Facilities

- **Building 103 Flight Assembly**

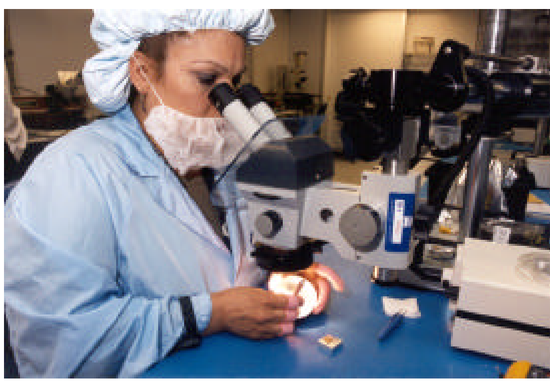


Facilities

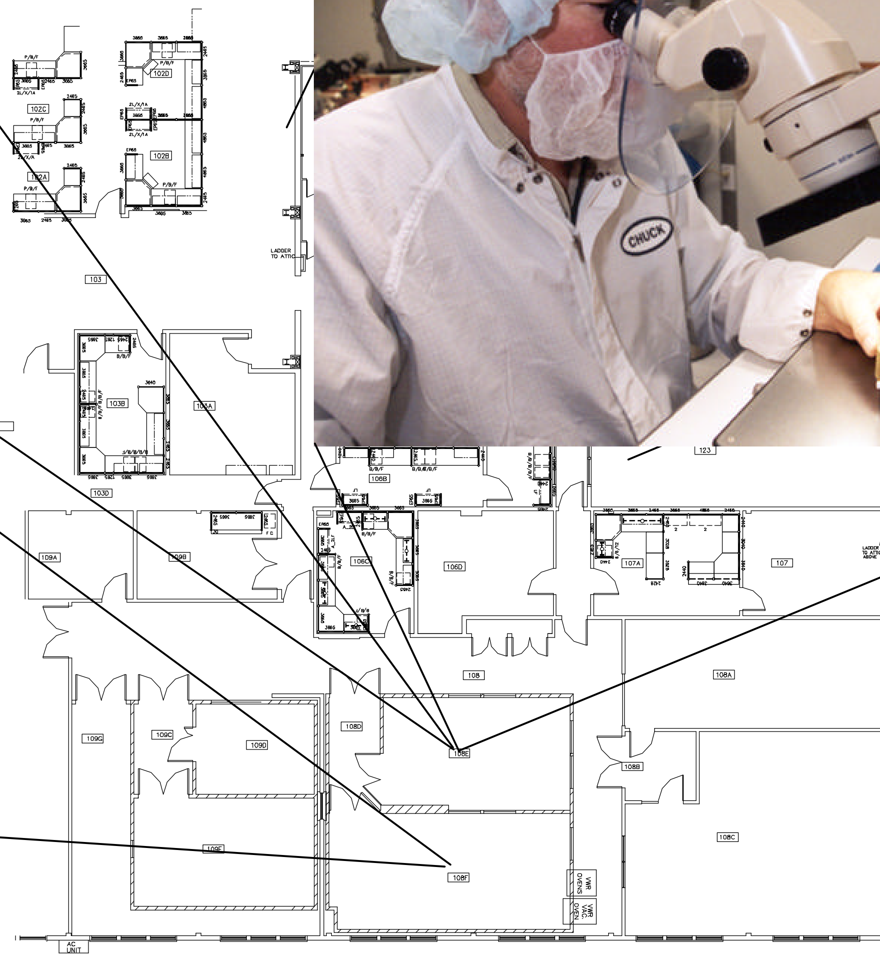
- **Building 103 Flight Assembly**



Wire Bonding- Bolometer/Load Resistor/Flex Harness

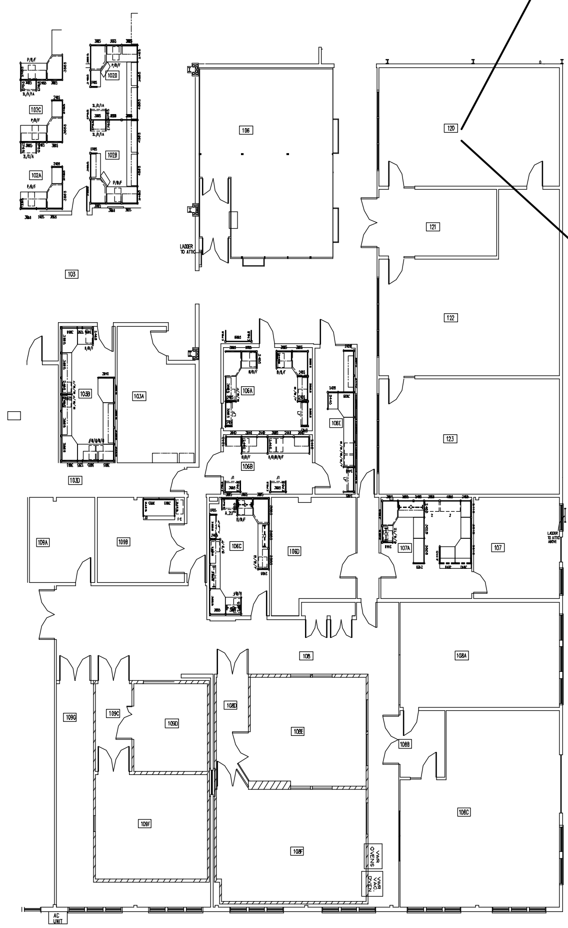


Component Attach- Bolometer/Load Resistor/ Flex Harness



Facilities

- **Building 103 Flight Assembly**



Electronic Assembly- Flex
Harness Assembly

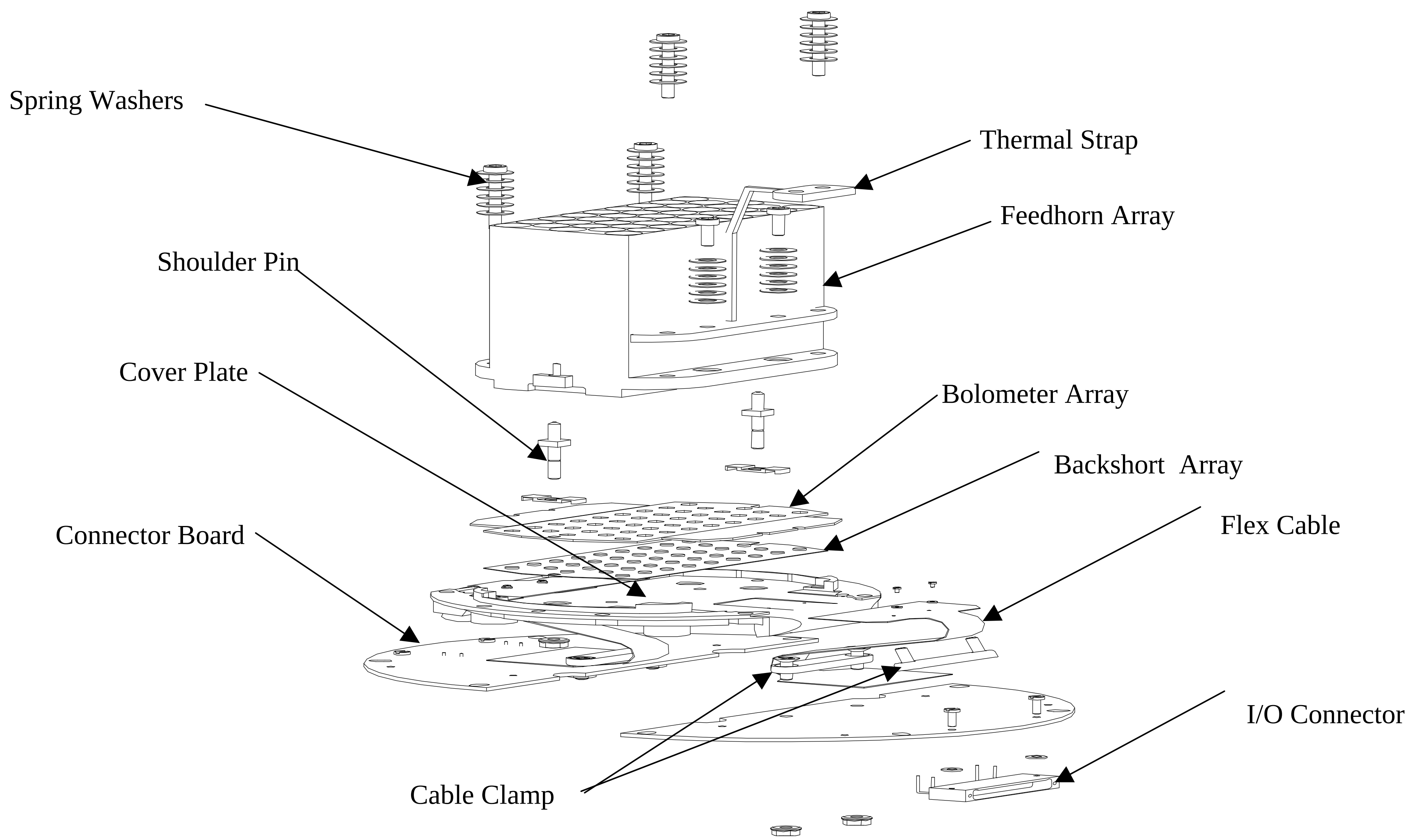
Personnel Skills/Certification

- Skills

Certified Personnel	COURSE NAME	COURSE CODE	NASA STD	SPIRE Skills Needed
26	Hand Soldering to NASA STD 8739.3	AA0003	8739.3	X
22	Crimp, Cable & Harness	BB0003	87394	
5	Wire Wrap	DD0003 / HH0006		
4	Fundimentals of SMT Fab	KK1003	8739.2	
17	Flight Polymerics / Conformal Coating Oper / Insp	NN2003 / NN2006	8739.1	X
27	Connector CSFT/ Mate & Demate & Torquing	NN3003		X
25	Flight System Connector Cleaning	NN4003		X
13	Flight Systems Mechanical Hardware	NN6003		X
25	Inspect, Measure and Testing Equip	IMTE	8739.3	X
3	Semi-Rigid Coax Cable	OO2003	8739.3	
20	Integrated Cicuit & Lead Forming & Trimming	OO9003	8739.3	
2	Fiber Optic Termination	PP0003	8739.5	
28	Critical H/W Handling	RR2006		X
23	ESD Avoidance	ER3003	8739.7	X
4	Wire Bonding	Trained by Equip Mfgr		X

Detector Assembly

- Detector Exploded View



BDA Assembly Manufacturing

- Documentation Required

Document Title	Number	Status		
		In work	Complete	Released
BDA Assembly Drawing	10209800	X	80%	8/17/01
Detector Assembly Drawing	10209810	X	80%	8/17/01
Detector Wire Bonding Diagram	TBD			8/24/01
Load Res/Flex Cable Wire Bond Diagram	TBD			8/24/01
AIDS-Detector Assemby	TBD	X	75%	8/24/01
AIDS-BDA	TBD			8/24/01

BDA Manufacturing

- Manufacturing Processes

Process	Std	Procedure	Requirement
Cleaning	YES	FP 513414 Sect 2.3.1	Drawing
Adhesive Bonding	YES	FP 513414 Sect 9.0	Drawing
Wire Bonding	YES	FP 513414 Sect 10.18	Mil-Std-883 M2011.7
Die Attach	YES	FP 513414 Sect 10.14	Mil-Std-883 M2019.5
Soldering	YES	FP 513414 Sect 6.1.2	D 8208
Solder Tinning	YES	FP 513414 Sect 6.2.2	D 8208
Torque	YES	ES 517040	Drawing
Vacuum Bake	YES	FP 513414 Sect 6.1.2	
Mechanical Assembly	YES	AIDS	Drawing
Inspection	YES	AIDS	Drawing
Resistance Test	YES	AIDS	Drawing
Conformal Coat	YES	FP 513414 Sect 9.5	Drawing
Identification	YES	FP 513414 Sect 9.0	Drawing

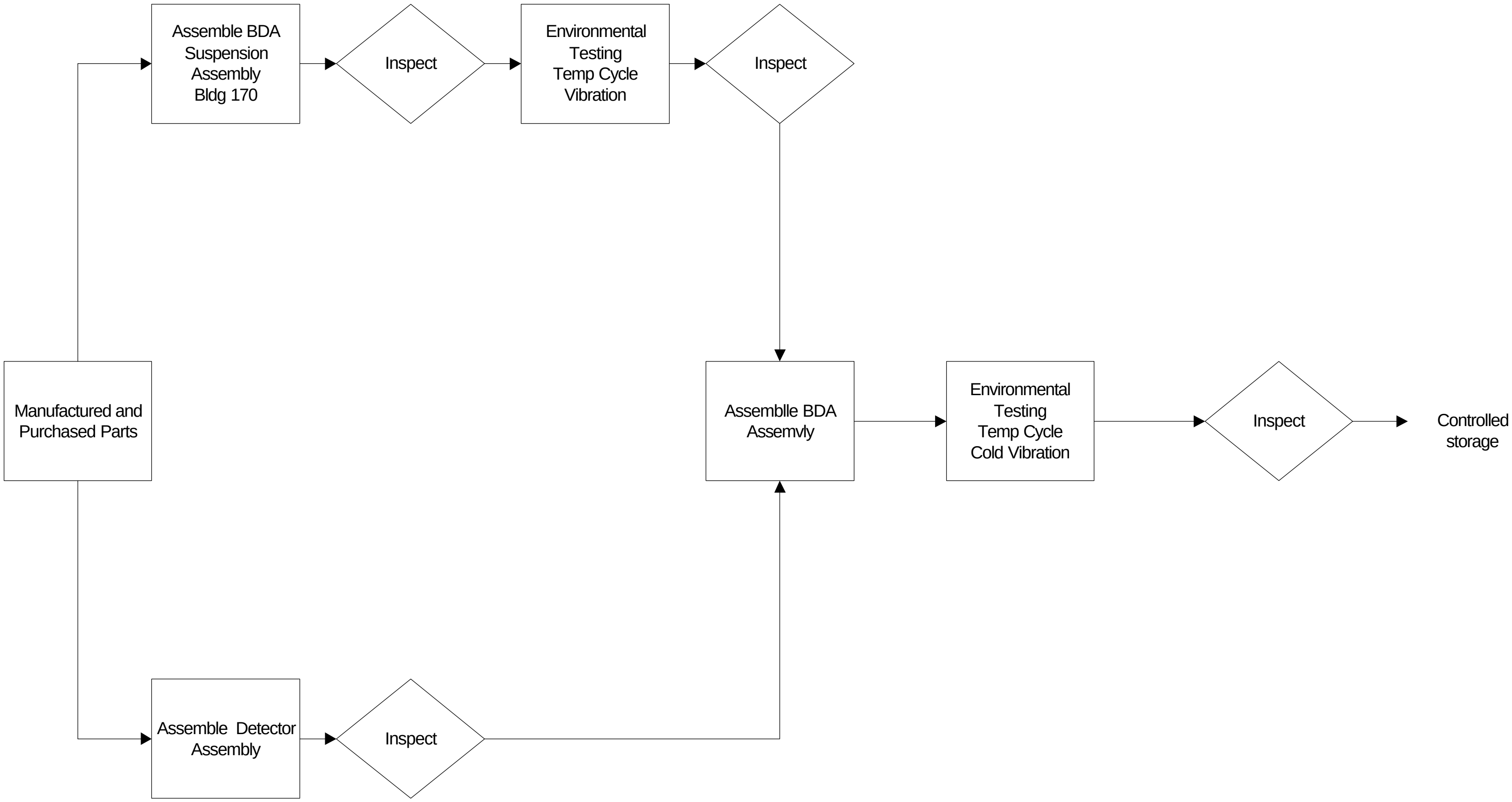
Detector Assembly Manufacturing

- Tooling Required

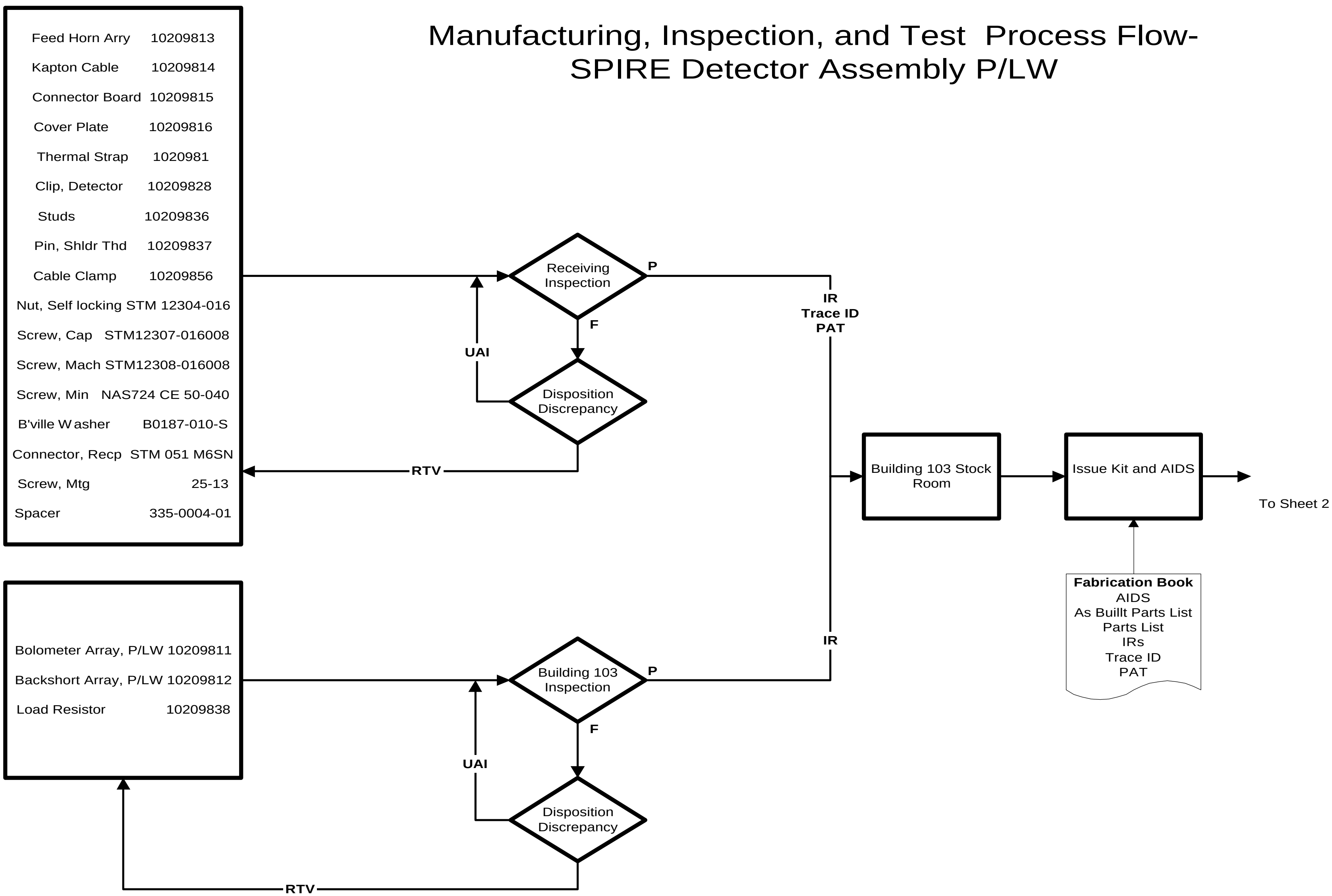
  – Detector Assembly
    - Load Resistor Adhesive Bonding Fixture
    - Wire Bonding Fixture
    - Flex Print Harness Assembly Fixture
    - Holding Fixture

BDA Assembly

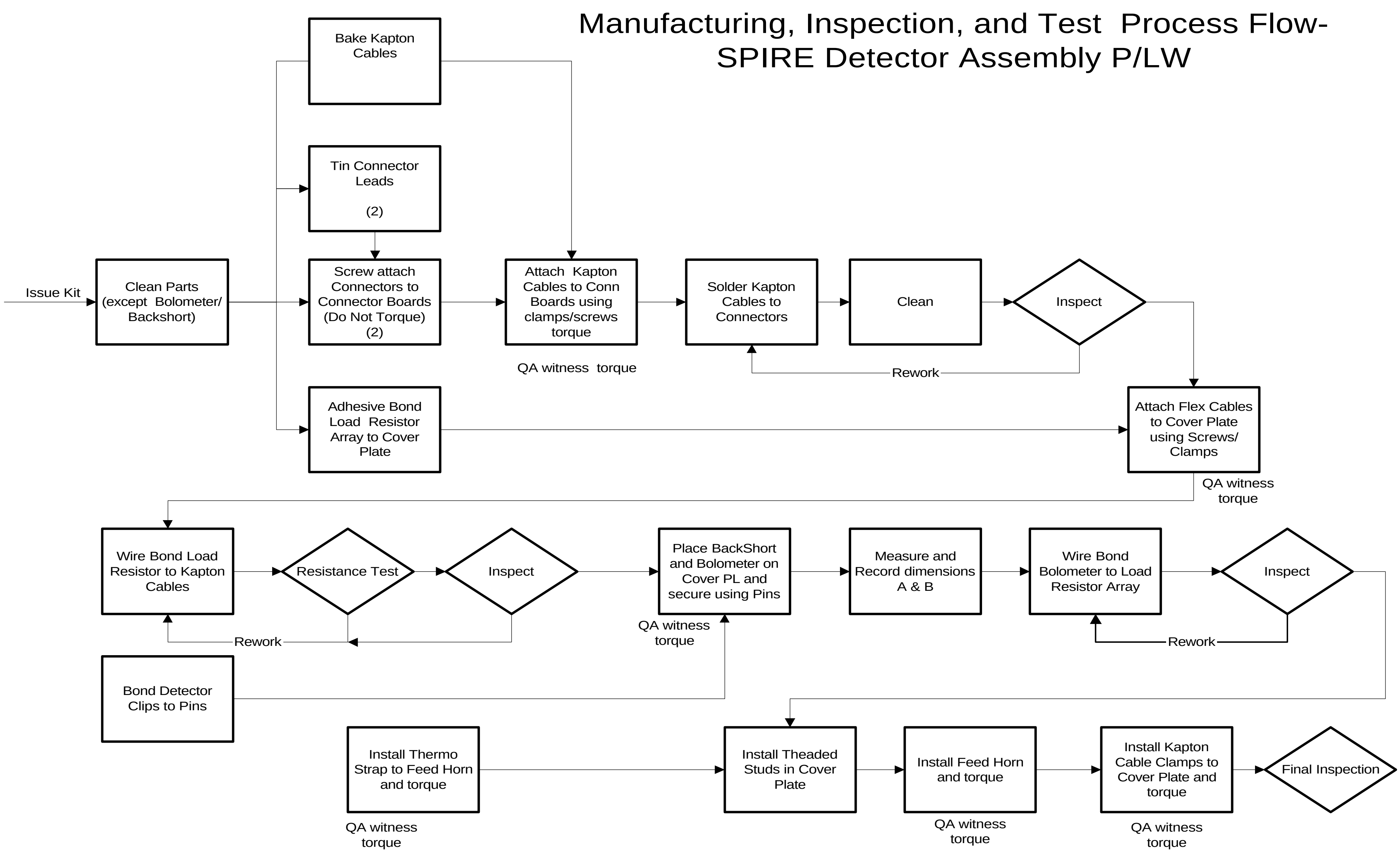
- BDA Assembly Flow



Detector Assembly



BDA Manufacturing



BDA Manufacturing

- Summary
  - Methods/Process Development Needed
    - Cold Wire Bonding Bolometer
    - Wire Bonding to Flex Harness
    - Adhesive type and how applied
    - Tooling
  - Open Issues
    - Epoxy selection
    - Drawings incomplete
    - AIDS incomplete
    - Connector Savers

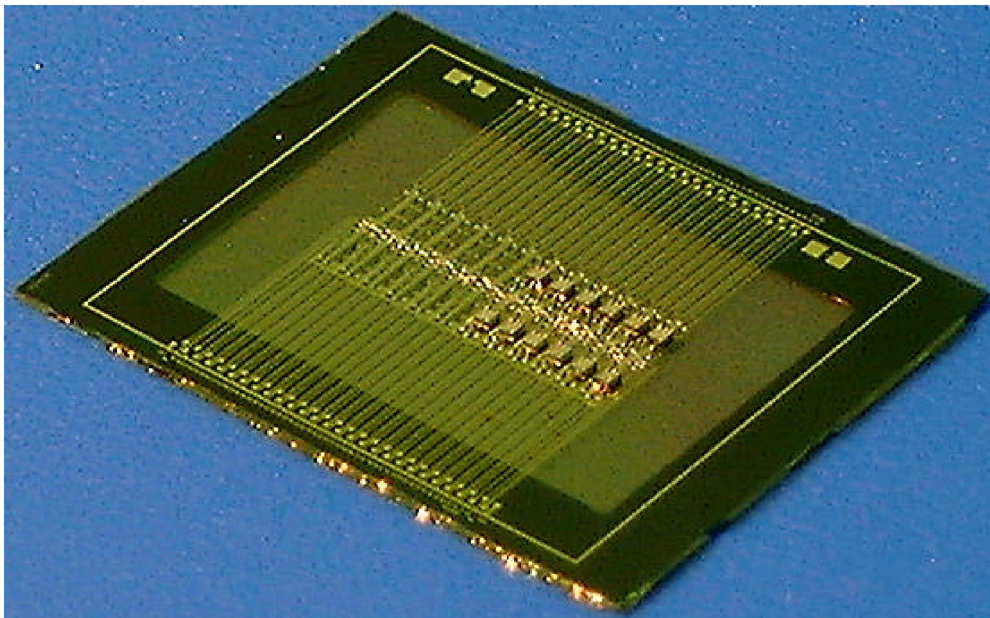
6.0
JFET Modules

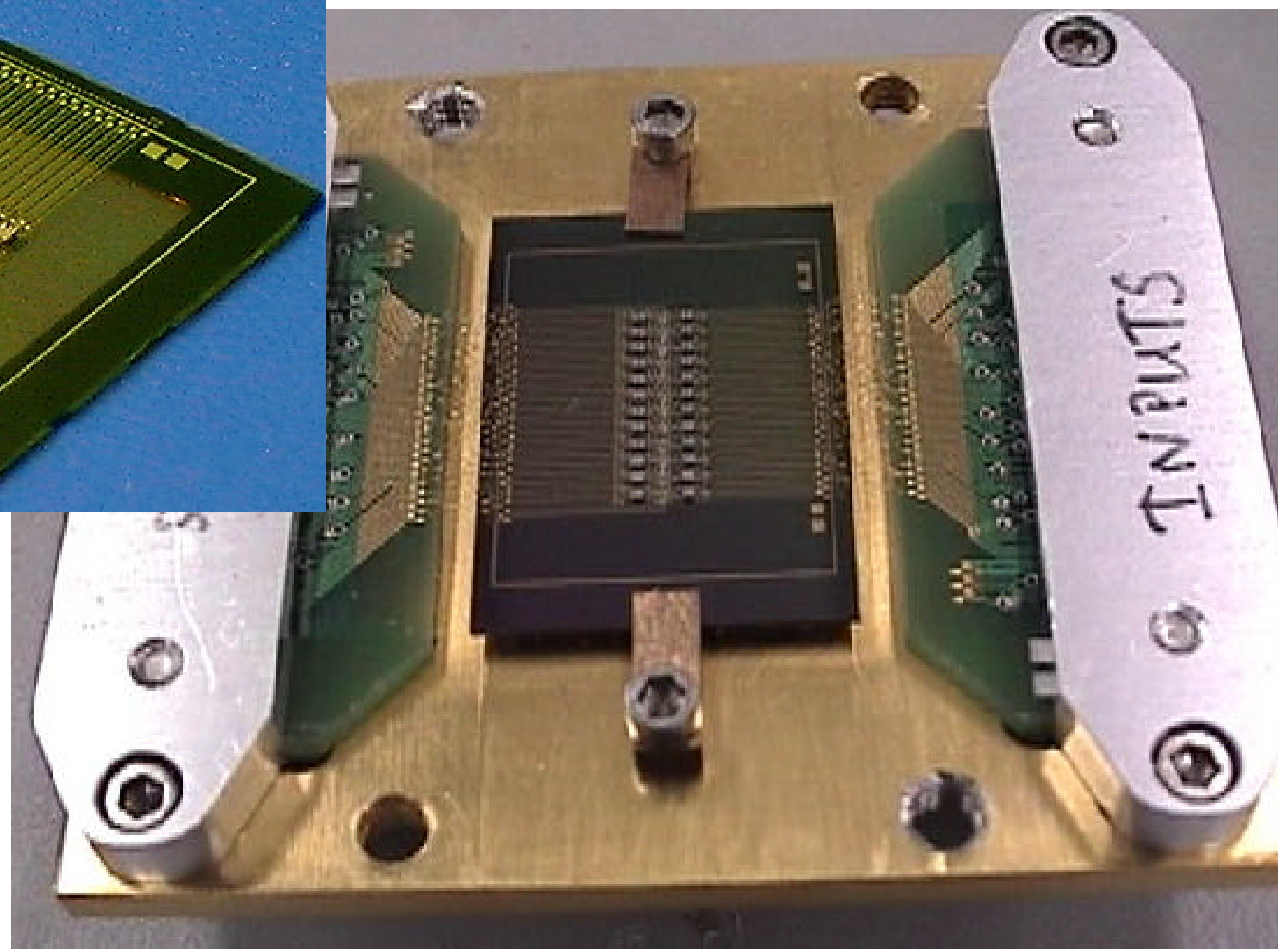
6.1
JFET Testing Status

Jamie Bock

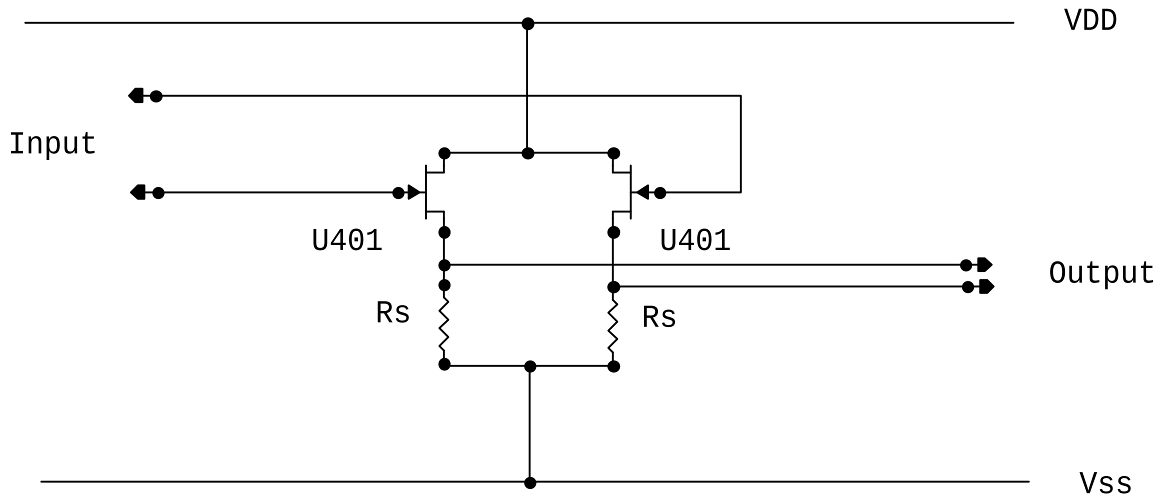
JFET Testing Status

James J. Bock
Jet Propulsion Laboratory





Main Design Features



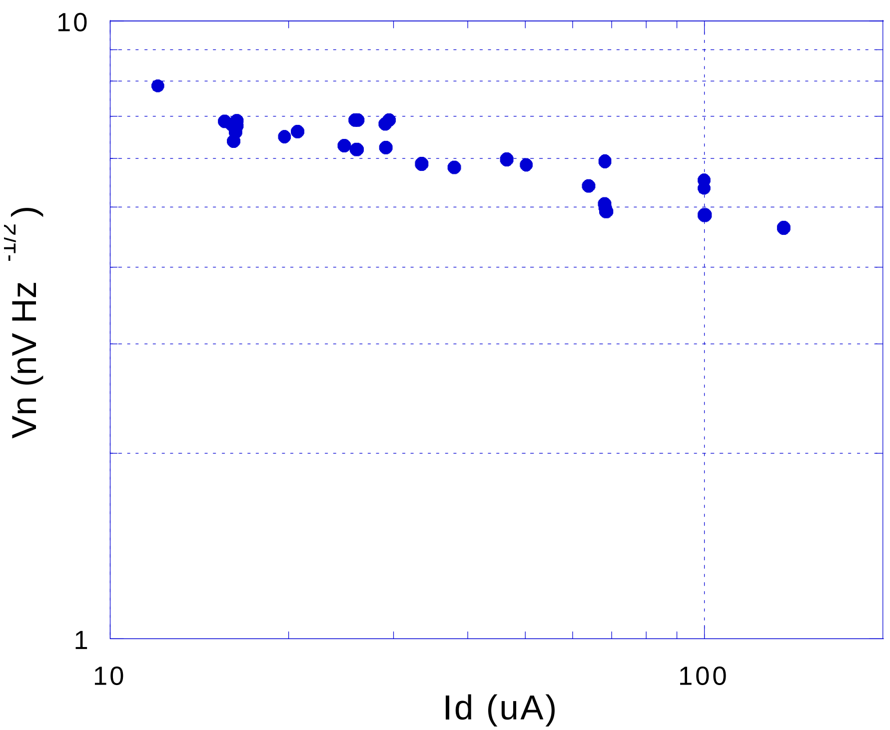
- Silicon JFETs flown on COBE, IRAS, IRTS
- U401 is a reliable dual package
- Differential readout
- Low noise and power

Table 1. JFET Power Dissipation (JFET-TEC-04)

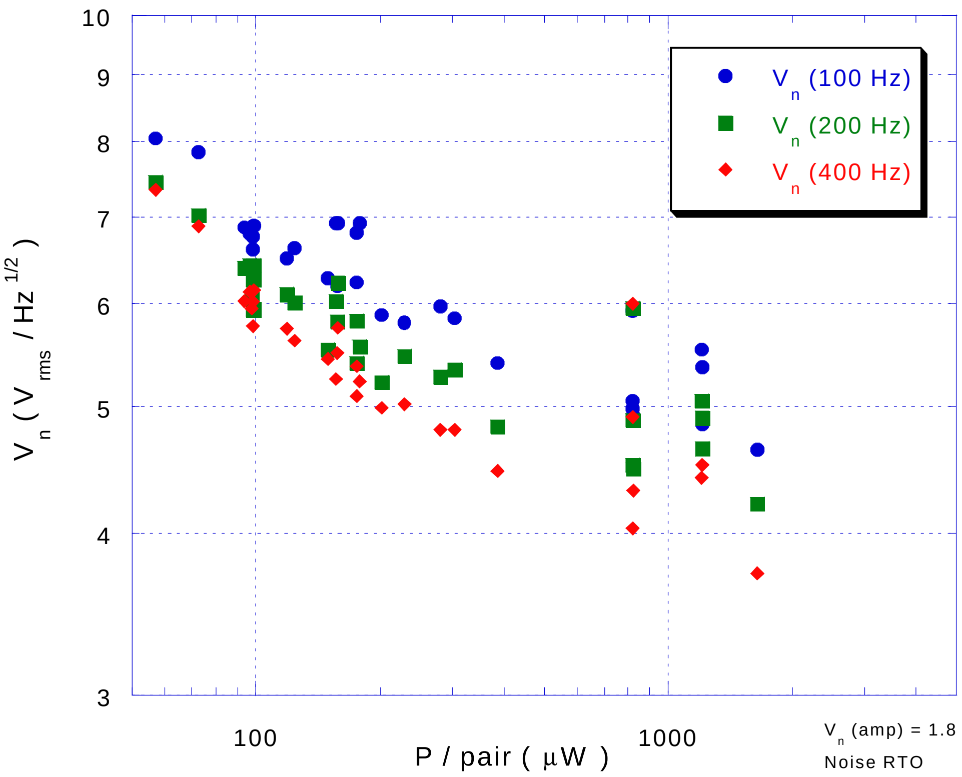
Power (mW)	/pair	/membrane	/module	/phot	/spect
Design value	0.115	2.75	5.5	33	8.25
1.5 * DV	0.170	4.13	8.25	49.5	12.38
Min. P. value	0.230	5.5	11	66	16.5

U401 Noise Performance (1)

Noise performance @ 100 Hz vs. drain current



Siliconix U401 Performance



V_n (amp) = 1.8 nV / Hz$^{1/2}$
Noise RTO
P = 2*[P(Rs) + P(JFET)]
c/o Brett Kornfeld

U401 Noise Performance (2)