The W-band Production Assembly

Technical Challenges of W-band assembly

The Robotic Assembly Concept

Retrofitting the Zeiss 500's for Robotic Assembly

The pickup tools

Dispensing Silver Epoxy

Other details

Material and Labor Estimate, and schedule

Technical Challenges for W-Band Assembly

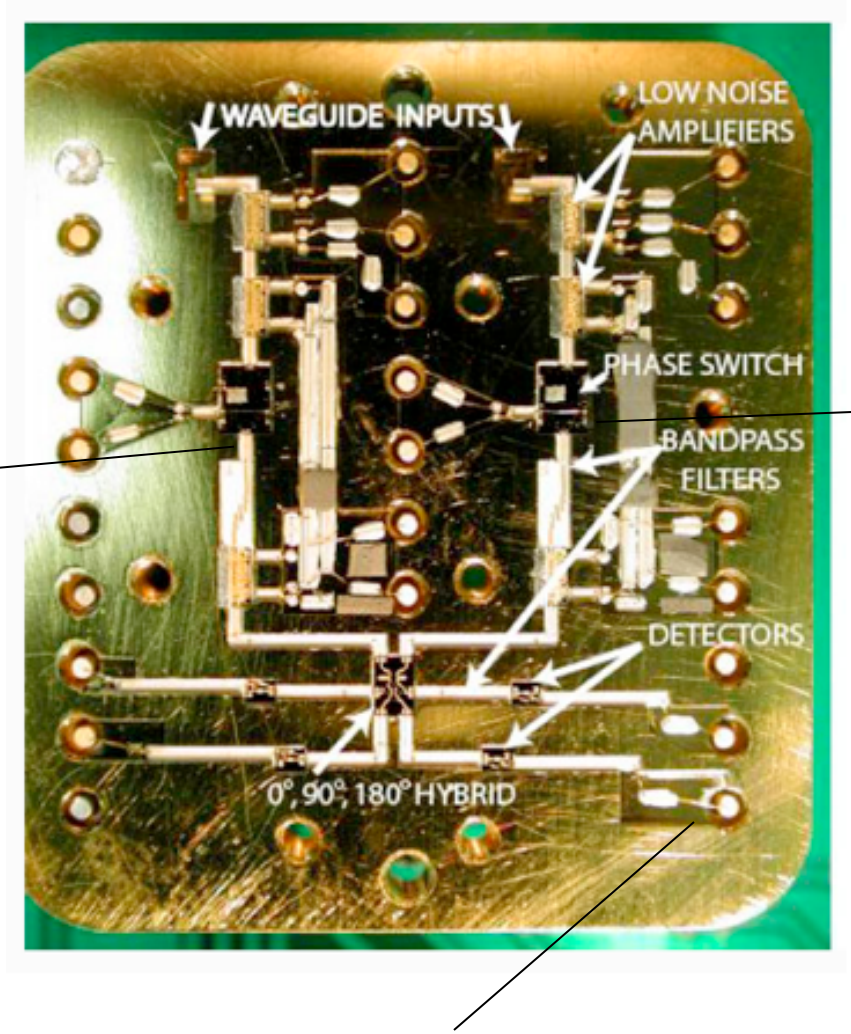
Precision Placement of 106 components (12.5 microns to 50 microns accuracy)

Components as small as 0.2 mm x 0.2 mm

ESD-sensitive active components

Control of silver epoxy deposition at the 100 micron level

Wirebonds and Epoxy adhesion survives repeated cycling between room T and 20K



Phase difference between the two paths less than 20 degrees

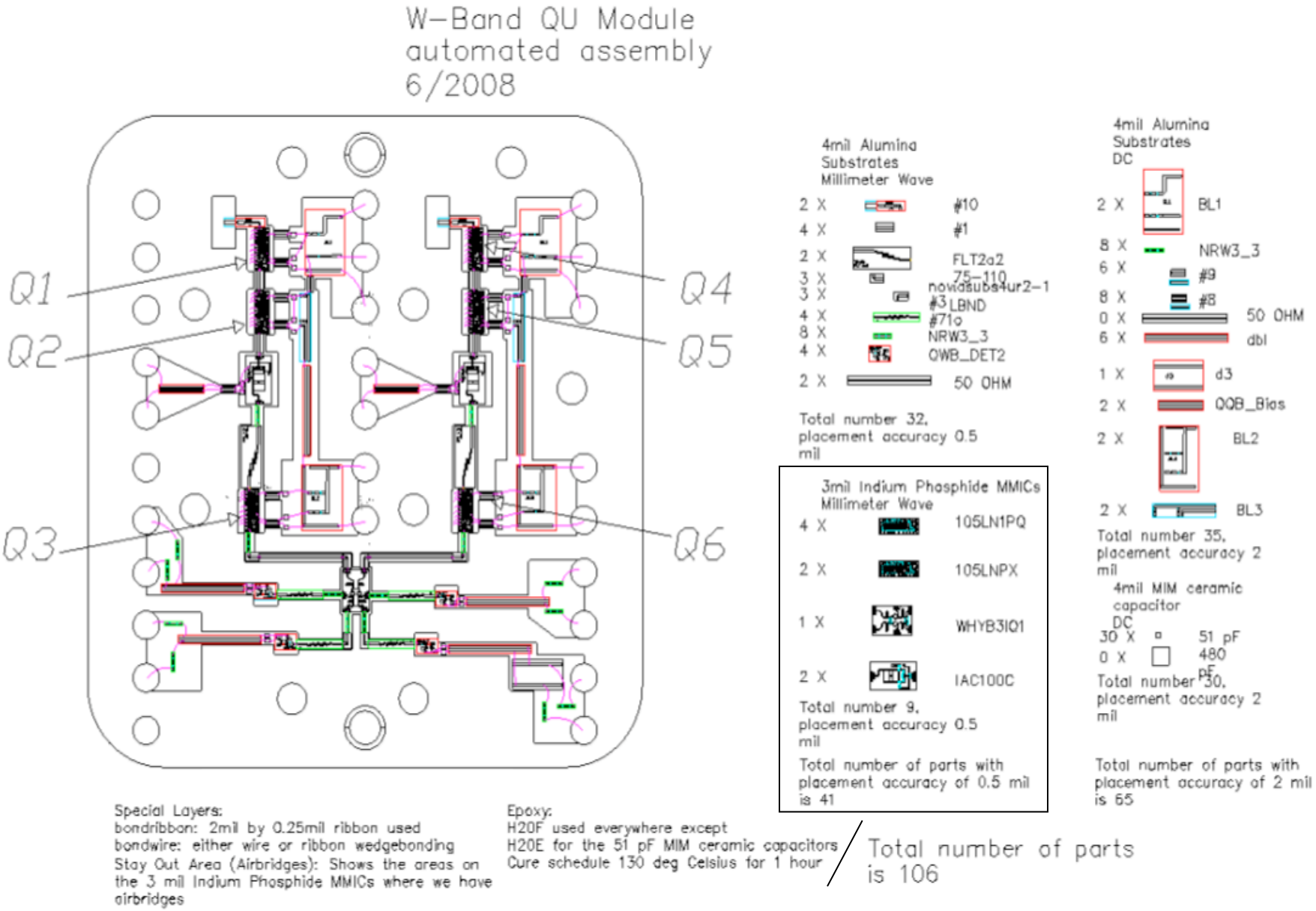
MMIC HEMT components have "air bridges" on top surface. Pickup tool cannot touch top surface.

Intermediate probing of components, needed for QA.

Systems Testing of Fully Assembled Modules and making Repairs

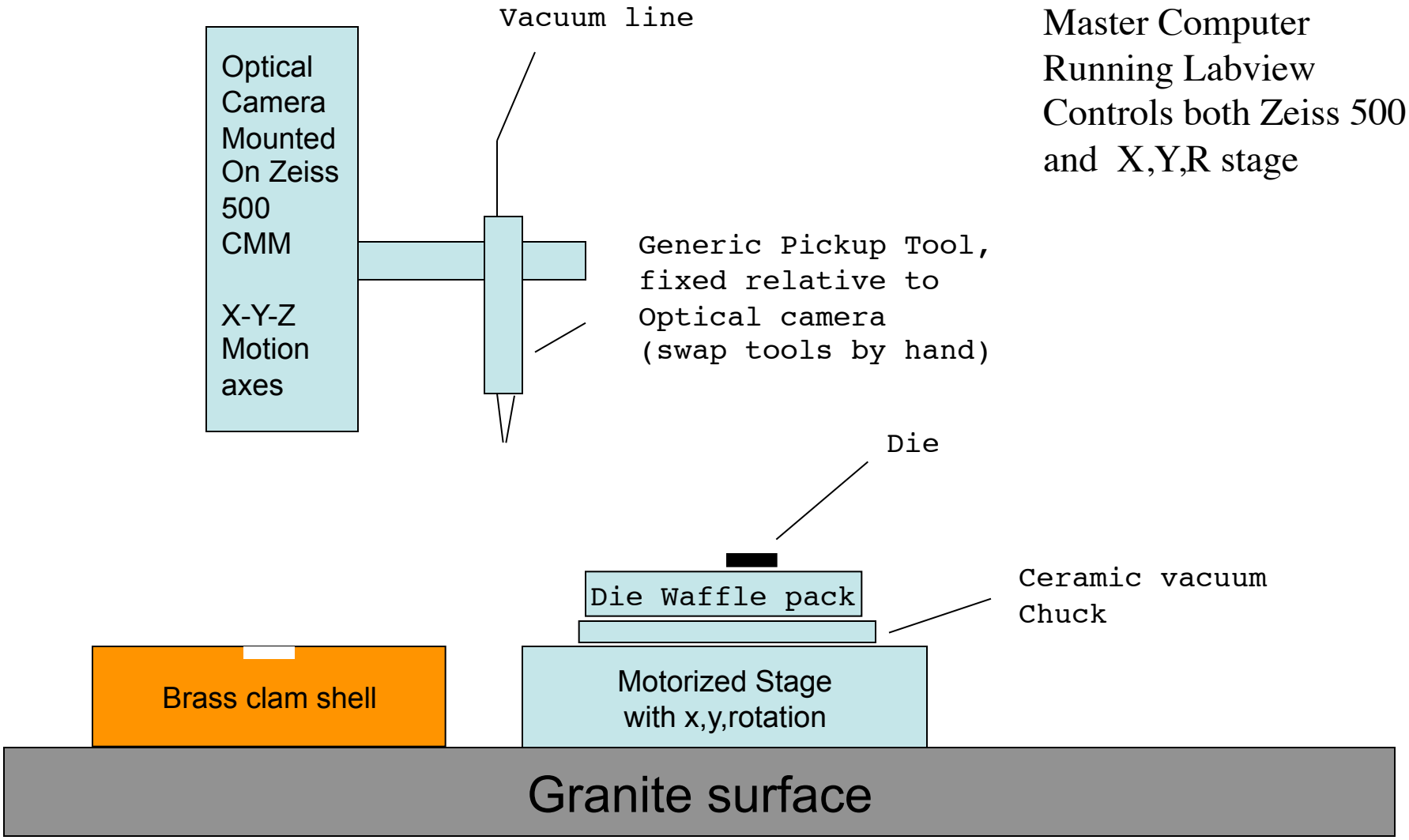
Automated Assembly to guarantee timely delivery of ~1500 working modules

Ribbon Bonding for making electrical connections (some require "deep-access" bonder)

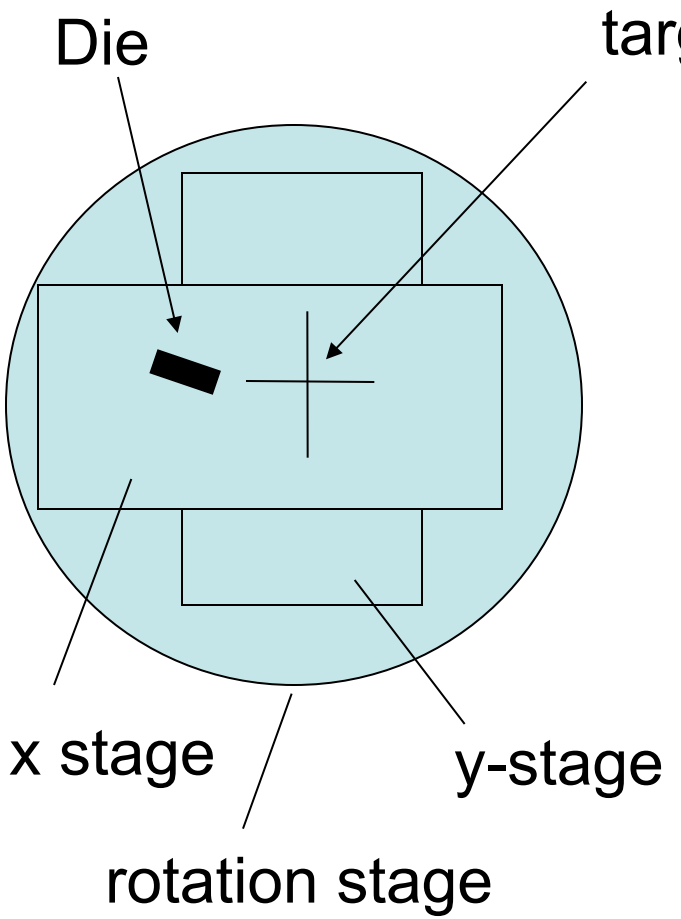


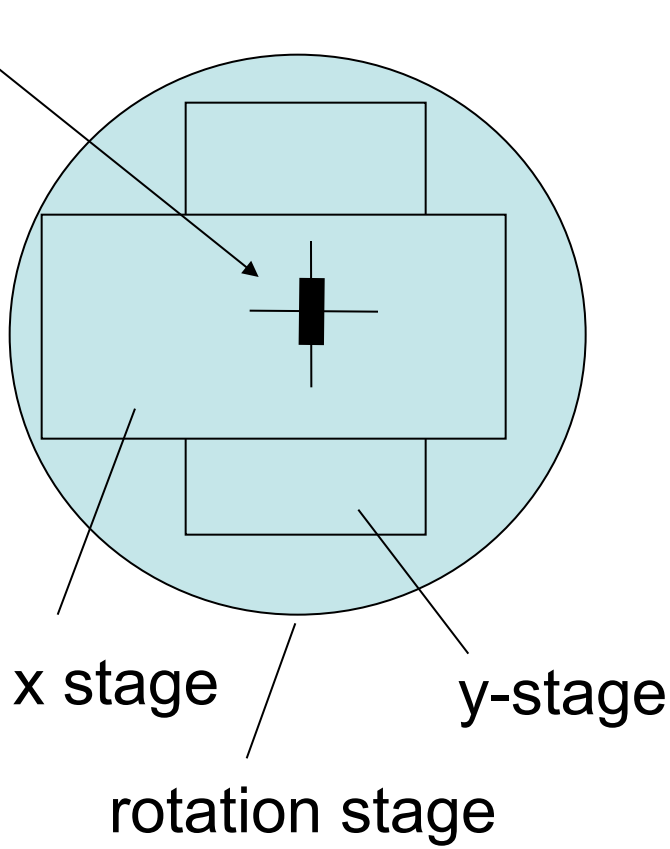
Components from JPL

Concept for Automated Module Assembly Station



Master Computer
Running Labview
Controls both Zeiss 500
and X,Y,R stage

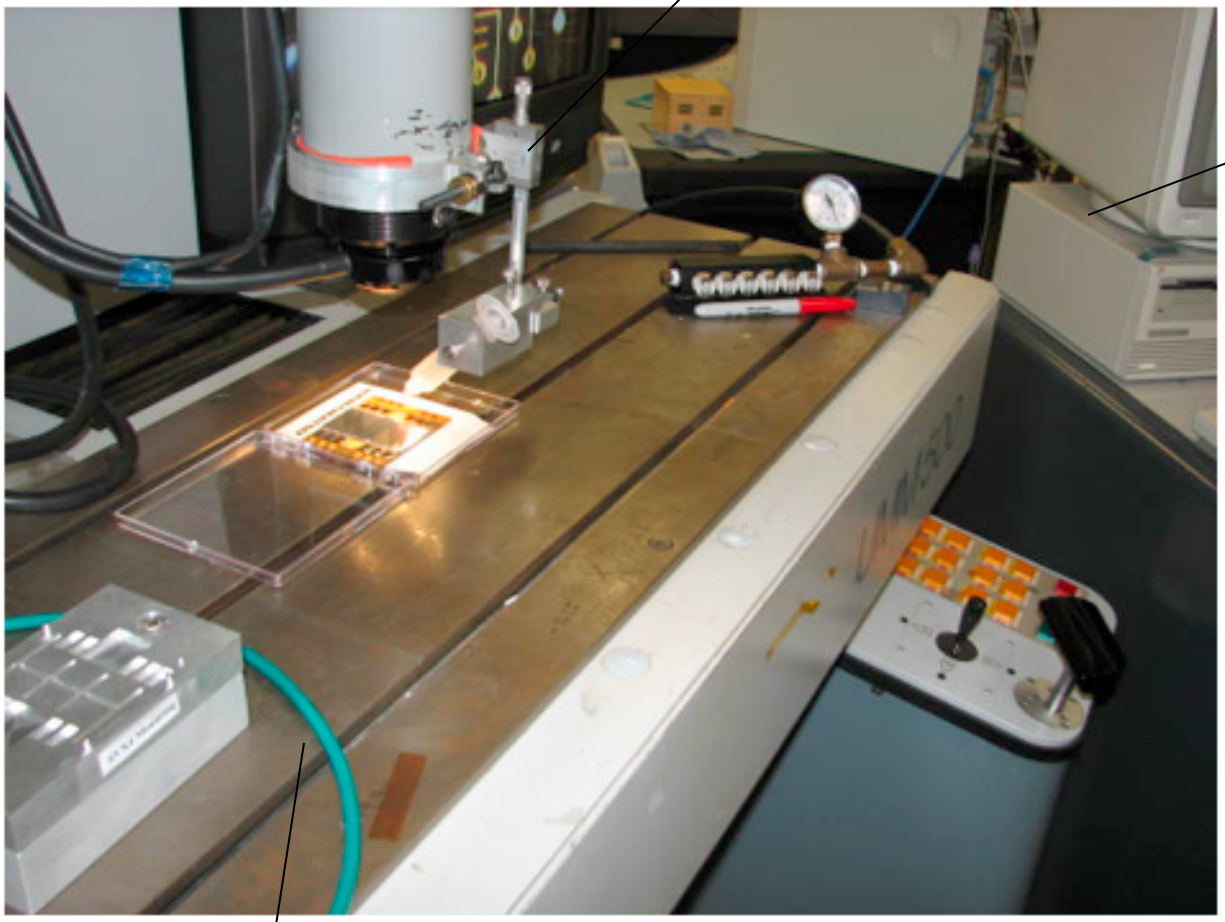




Stages are labview-interfaced stepper motors

Automatic Labview Vision system Operation moves die into target position

Silicone Encapsulant Dispensing Tool used in Run-IIb silicon R&D



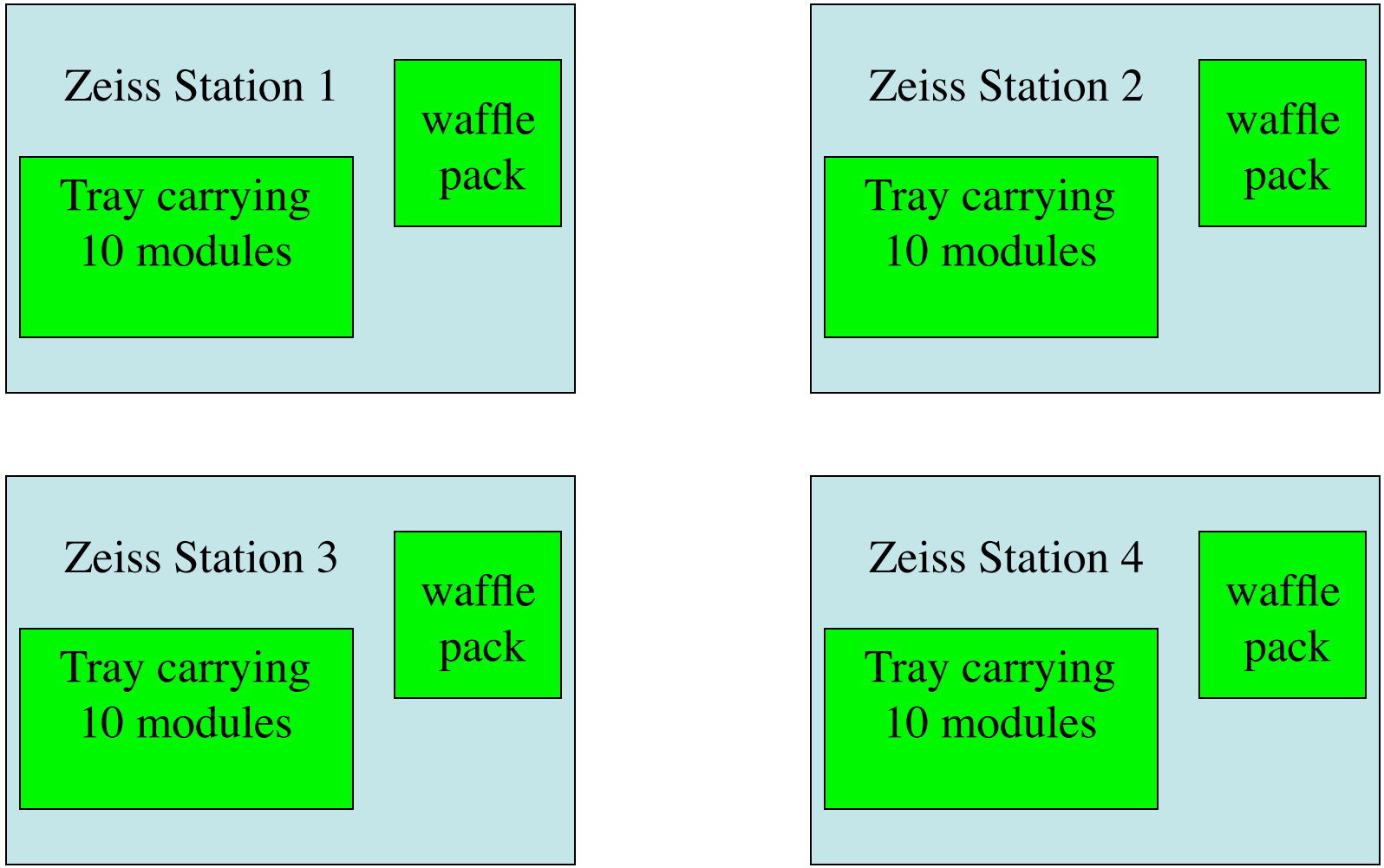
HP computer
(would need to be
modernized)

**Performs a
single Pick-and-Place
Operation in 15 seconds
(more than adequate)**

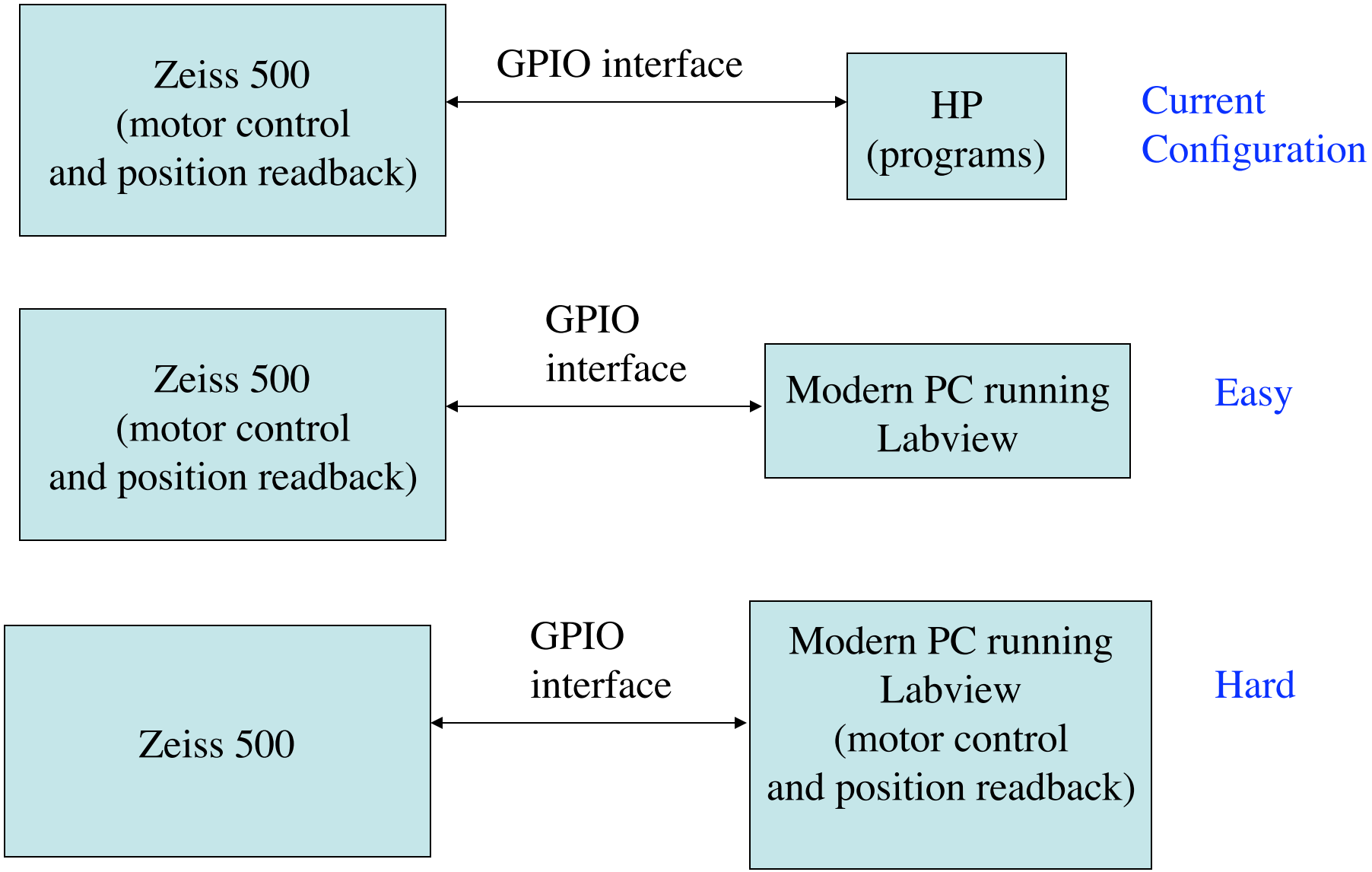
Large working surface
can accomadate
a tray of 10 modules

Making things parallel

- Parts can be placed down in any order
- Wirebonding probably done last



Our staff is researching the best/easiest way to modernize the Zeiss HP PC



Staff Experience in Electromechanical Machinery

Lab 8 group: Korienek, Lindenmeyer, Zimmerman, Schelpfeffer

Device	Duration (Actual time)
CMS Magnetic Field Mapper	2 years
ZIP Tracker Upgrade	2 years

Zeiss Retrofit is simpler than both of these jobs.

We estimate 30 weeks for Zeiss Retrofit, with 100% contingency

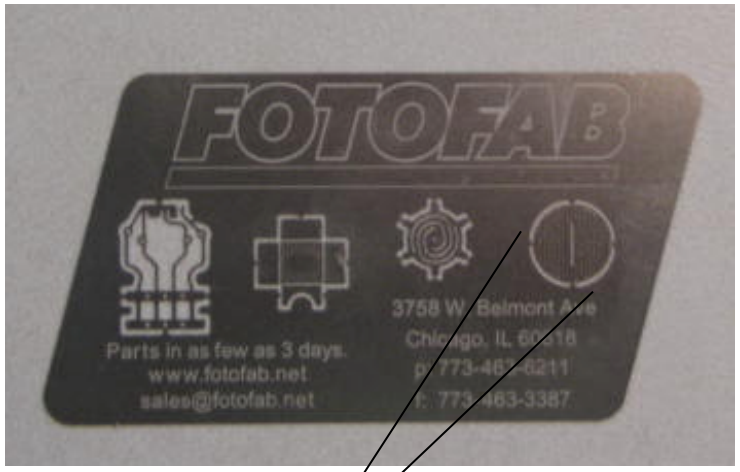
Note: Same group worked on Fermi/GLAST veto shield, GammeV 1, and Chameleon

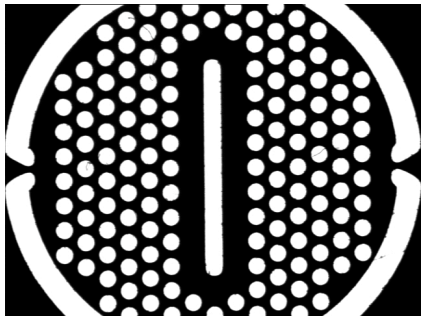
Cost to Retrofit the 4 Zeiss 500 machines into Robotic Assembly Machines						
Material Costs	**Cost Per**	**Number Of Items**	**Extended Cost**	**Contingency**	**Contigency ($)**	
Rotary Stage	1411	4	5644	**30%**	**1693.2**	
Linear Stage	1471	8	11768	**30%**	**3530.4**	
Motor Controller	800	12	9600	**30%**	**2880**	
Vacuum Pickup Tools	100	23	2300	**30%**	**690**	
Custom Carriage Trays	100	10	1000	**30%**	**300**	
Miscellaneous Tooling	10000	1	10000	**30%**	**3000**	
Module Testing Hardware	100000	1	100000	**30%**	**30000**	
Sum			140312		42093.6	
Labor Cost for Developing Tooling	**Number of Weeks**	**Personnel**	**Extended Cost**	**Hr Rate**	**Contingency**	**Contingency (dollars)**
Labview Programming	20	Computing Professional	62,624	**78.28**	**100%**	62624
Zeiss Programming	4	Senior Technician	9448	**59.05**	**100%**	9448
Labor to build tooling	10	Senior Technician	23,620	**59.05**	**100%**	23,620
Sum			95,692			95692
Labor Cost for W-band Assembly	**Labor Type**	**Number of Hours**	**Extended Cost**	**Hr Rate**	**Contingency**	**Contingency (dollars)**
Wirebonding	Sr. Tech	1200	70860	**59.05**	**30%**	21258
Assembly	Technician-II	500	23375	**46.75**	**50%**	11687.5
Inspection and Organization	Technical Supervisor	1600	130880	**81.8**	**50%**	65440
Sum			225115			98385.5

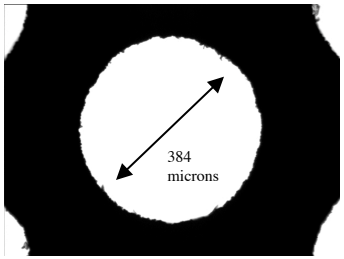
Handling of Very Small Parts

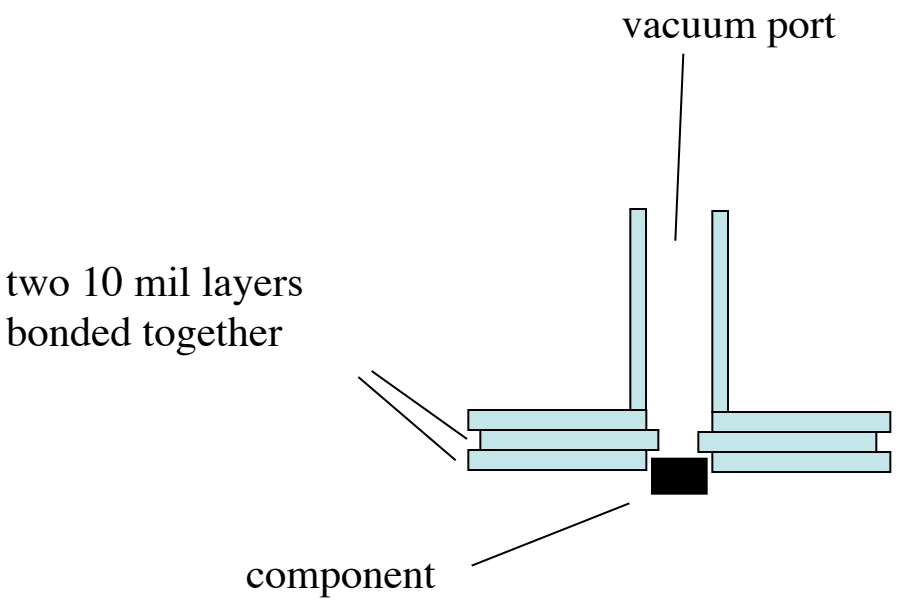
Smallest parts are the 200 micron x 200 micron capacitors

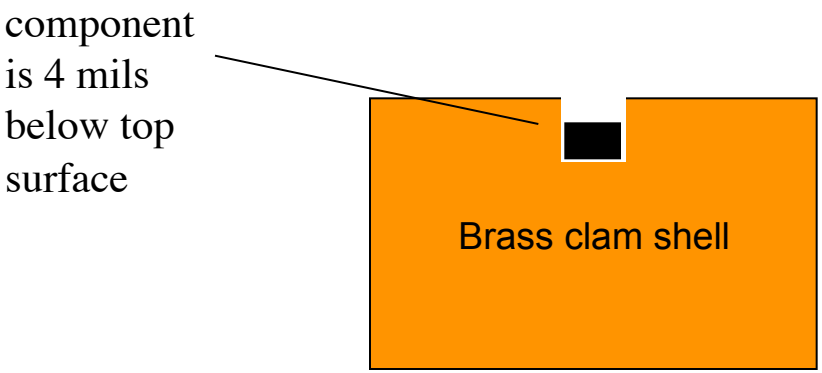
Can fabricate tool via photochemical milling ($200 per layer)





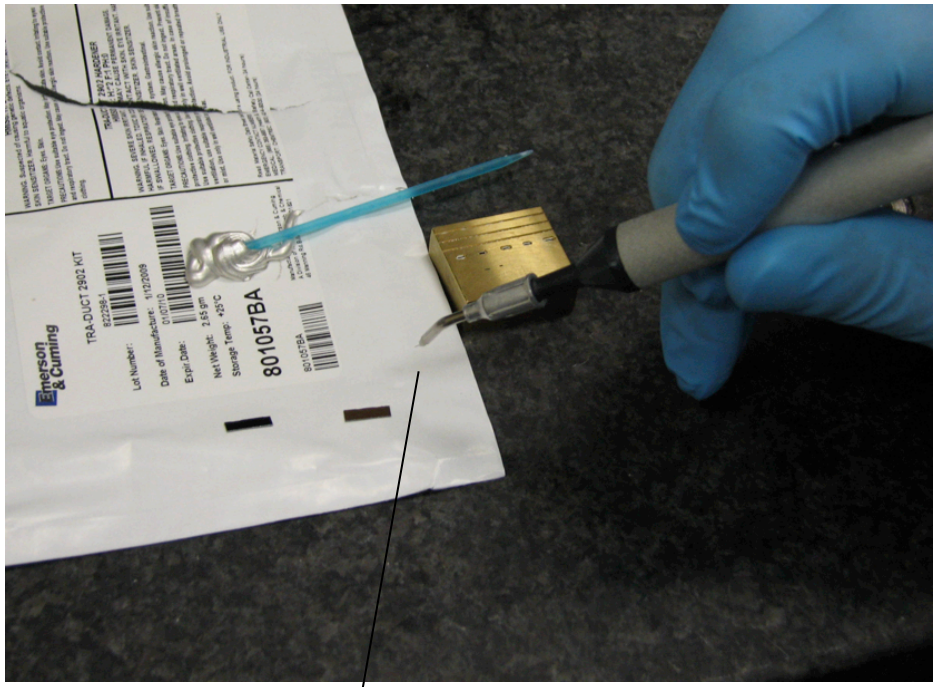






Handling of Very Small Parts

Commercial Pickup tool
with 150 micron diameter
vacuum pore ($40)



200 micron
wide
silicon strip
handled
by vacuum
pick-up tool

Commercial tool made for assembly robots

$1000/tool

GAISER TOOL COMPANY
High Precision Micro Tools Since 1957

EUTECTIC DIE COLLETS 3600 & 3700 SERIES

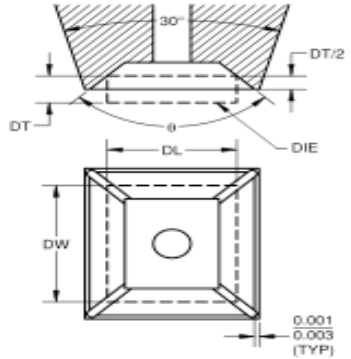
Eutectic die collets are used to attach the die to a substrate. Die collets are designed to pick up the die by the edges, not the face. The inside of the collets have slanted sides, usually 90° but can be user specified as needed. Four-sided collets are referred to as "inverted pyramid" style and two-sided collets are known as "channel" design.

The four-sided collet has the advantage of absolute control of positioning of the die because it is contained on all four sides.

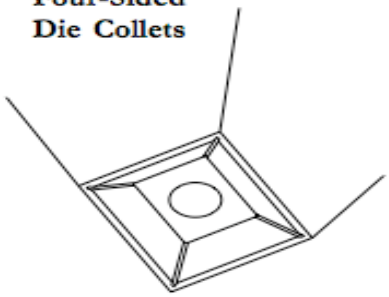
The two-sided channel design is advantageous because of the additional clearance on each end used to place the die adjacent to a wall or another device.

Both collets are manufactured so that 50% of the die thickness is engaged and 50% is exposed (of the die thickness specified in the part number). Under some conditions, either the eutectic or epoxy material may extrude up onto the collet face and contaminate it. To eliminate this problem, the collet should be ordered by calling out a thinner die size than is actually being used. The collet will be made with smaller and allow for more of the die to be exposed away from the face.

All die collets are available on shanks listed on the shank styles pages for die collets and vacuum pick-up tools. If a particular shank is not listed, Gaiser Tool Co. can manufacture it per customer specifications.

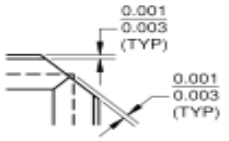


3600 Series Four-Sided Die Collets

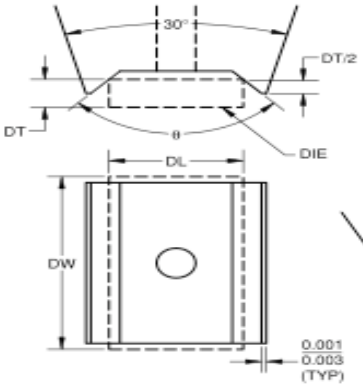


Corner Reliefs

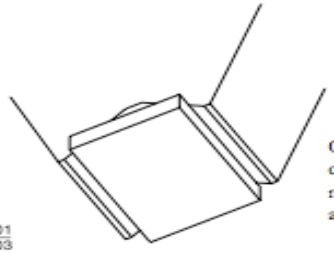
Internal Corner Reliefs
Standard for Small Collets



External Corner Reliefs
Standard for Large Collets
(0.060 x 0.060 or larger die size)



3700 Series Two-Sided Die Collets



On the 3700 two-sided die collet, the DW is contacted (touched) by the collet. The DL is not contacted by the collet. The vacuum leaks at the DL side.

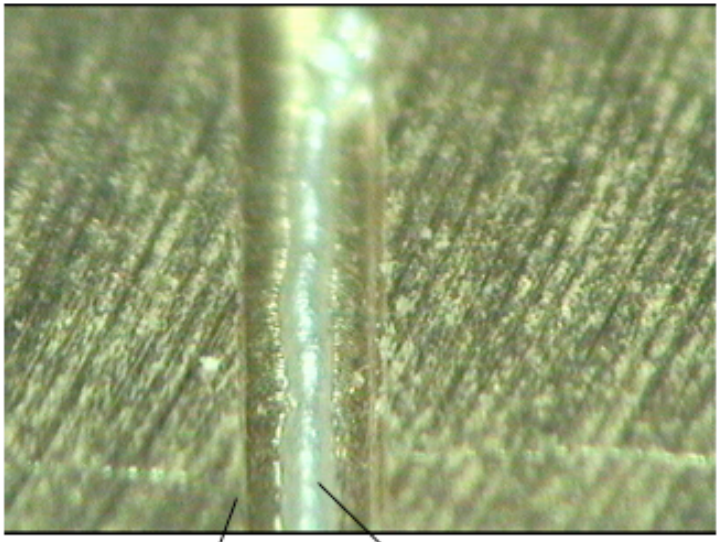
Specify: Series/Shank Style - Shank Length - Inside Wall Angle - Die Length - Die Width - Die Thickness - Options
Example:
3602-750-90-055-065-005
3702-500-90-055-095-010

Dimensions in inches unless otherwise specified

4544 McGrath Street . Ventura, CA 93003 . 805.644.5583 . Fax 805.644.2013 . www.gaisertool.com . info@gaisertool.com

Precision Glue Dispensing

We were able to dispense silver epoxy through a 100 micron diameter syringe.

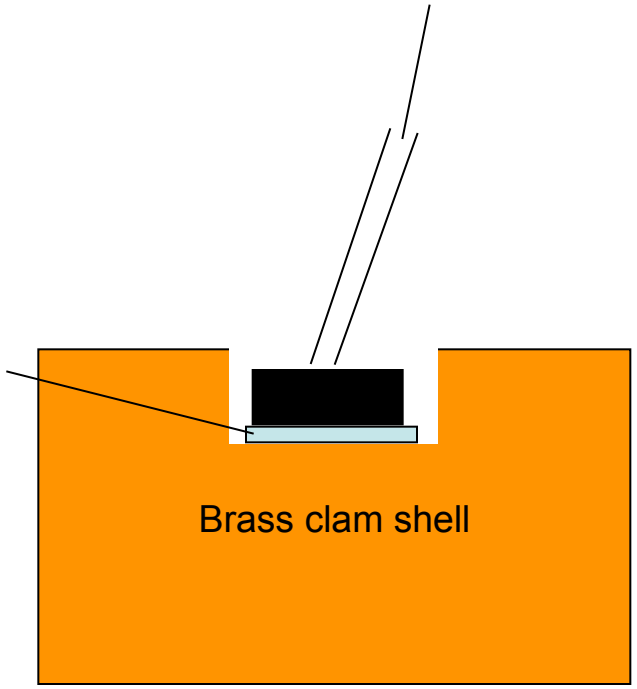


500 micron channel cut into brass

200 micron Ag Epoxy glue bead

Ultrasonic Scrubing to ensure good silver epoxy adhesion and no air gaps

Oven cure silver epoxy



Other Details

• Fermilab would handle the procurement of brass chassis, microstrips, capacitors, and band pass filters. Fermilab would interact directly with these vendors.

• The packaging style of components from vendor is *IMPORTANT*, and would be specified by us.

We control the schedule of all but 13 components (out of 106 components).
We can start assembly before delivery of components from CIT/JPL

• CIT/JPL delivers to Fermilab the following Diced Parts from InP wafer run:

Low Noise Amplifiers	(6/module)
Phase Switches	(2/module)
90 degree hybrids	(1/module)
Detector Diodes	(4/module)

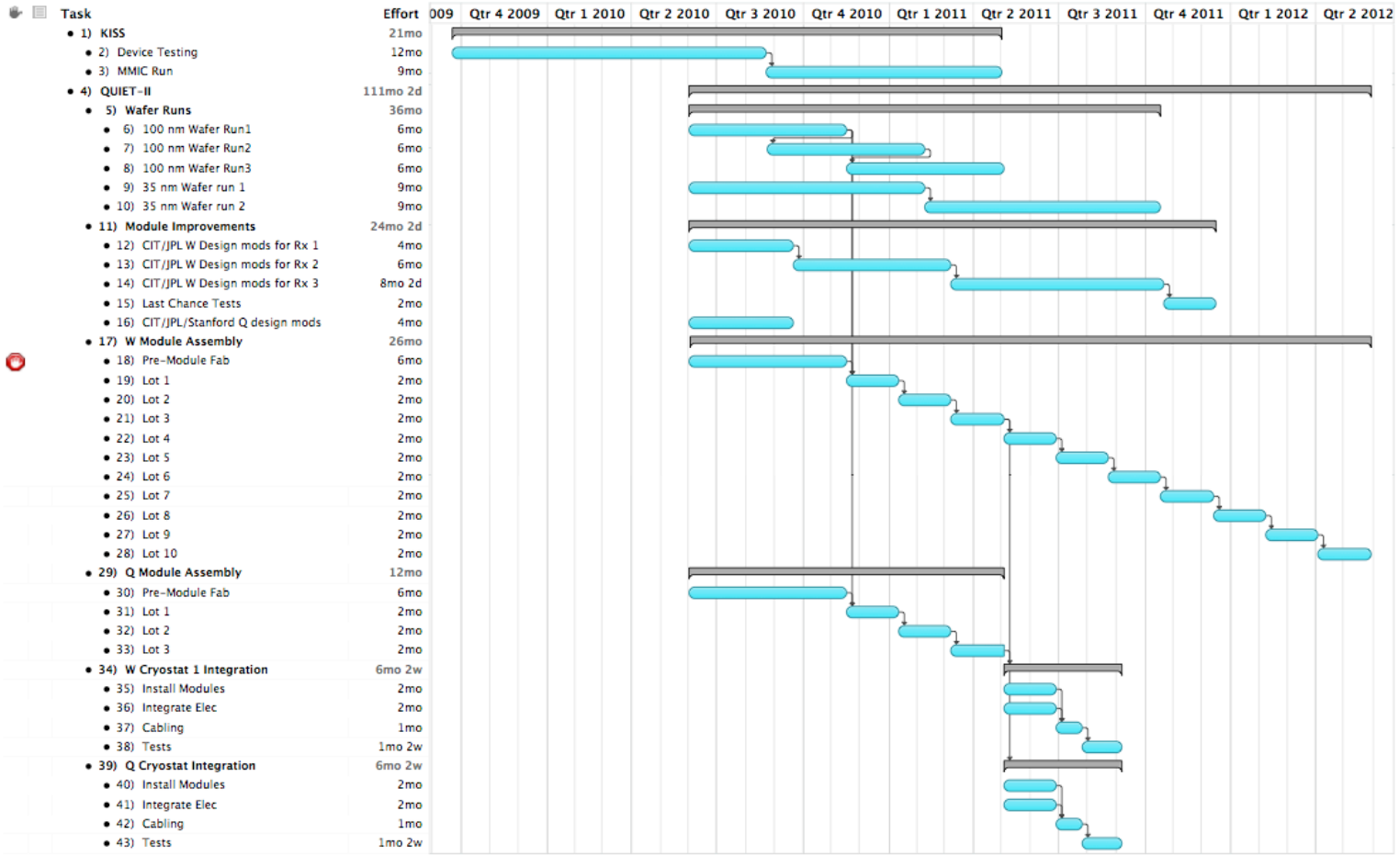
assembly takes 1.2 years
assuming good efficiency

we allow 2.25 years
in the schedule

Time Estimate assuming 100% Efficiency

Time Estimate for W-band Module Assembly of 1600 Modules						
Parts Placement utilizing 4 Tech-II Full time						
Time to Place One Part (minutes)	Number of Parts Per module	Modules Per Hour	Number of Zeiss machines	Total Number Per hour	Number of Modules	Total Number of hours
0.75	100	0.8	4	3.2	1600	500
Inspection time, setup, organization (Tech Supervisor)						
Time per module (hours)	Number of Modules	Total Time (hours)				
1	1600	1600				
Wirebonding Time (Sr. Tech)						
Time Per Module (hours)	Number of modules	Total Time (hours)				
0.75	1600	1200				
Actual Calendar Time Estimate	**Total assembly time (hours)**	**Total inspection/org time (hours)**	**Total Wirebonding Time (hours)**			
	500	1600	1200			
Number of days (5-hour work day)	100	320	240			
Number of Personnel	4	1	1			
Number of days	25	320	240			
Number of years	0.096153846	1.230769231	0.923076923			
(260 work days/year)						

JPL Wafer Production Schedule



Fermilab Assembly Schedule

W-band Module assembly

Milestone Task Name	Sub-task Name	Time Start	Time End	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Development of Tooling		Q1	Q3	x	x	x									
	Pickup Tooling Fabrication	Q1	Q2	x	x										
	Zeiss Software Programming	Q1	Q2	x	x										
	Labview Programming	Q1	Q3	x	x	x									
	Production Teststand Development	Q1	Q4	x	x	x	x								
	Other Production Preparation tasks	Q3	Q4			x	x								
W-band Module Assembly		Q4	Q12				x	x	x	x	x	x	x	x	x
	Delivery of first 500 modules	Q4	Q7				x	x	x	x					
	Delivery of second 500	Q8	Q10								x	x	x		
	Delivery of Remainder	Q11	Q12											x	x

Time is divided into quarters (3 month periods) Q1, Q2, ..., Q12
Q1 is the nominal start of approval to proceed within Fermilab, whenever that happens.
Q4 is the start of contruction. Parts from vendor should arrive from JPL and other vendor

These durations are longer (assume 2x) than specified on sheet 2 due to other lab commitments.
Assume that we will get better at building modules. So the last set of modules are built faster than the first set.