Structure Fabrication Status, SLAC

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CLIC08
October 2008

What we are contributing

- Experiences in accelerator electrical design.
- Experiences in accelerator mechanical design and fabrication technologies.
- Fabrication of test structures designed by CLIC, SLAC and KEK.
- Microwave tuning and characterizations of test structures.
- High power tests for test structures at 11424 MHz test stations.

I will report:

- Work Done Since the Collaboration
- Work Ongoing
- Work for Other Future Structures

Work Done Since the Collaboration

1. 2 x T18_VG2.4_DISC Structures #1, #2
   - One with SLAC flanges, which has been high power tested at NLCTA
     - Best performance so far
     - Backward feeding for more detailed studies for higher field breakdown
   - One with KEK flanges, which will be high power tested at KEK

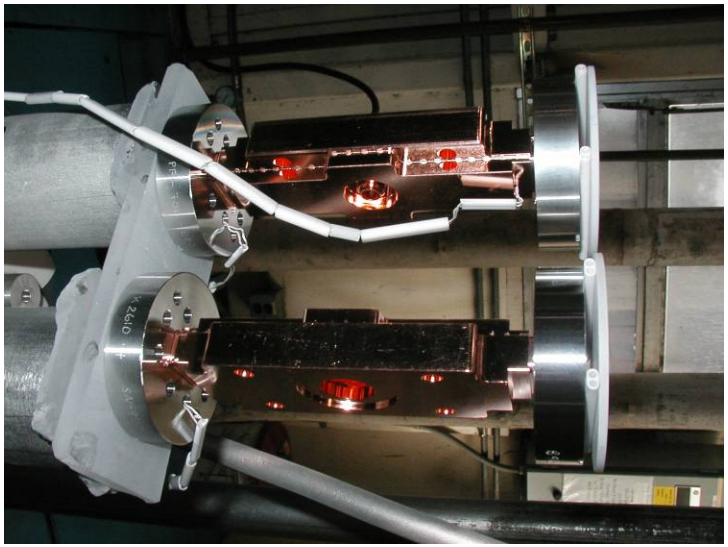
2. HDX11 Cu Structure
   - SLAC Provided RF feed related components
   - Electrical polishing and reassembly
   - Microwave evaluation
   - High power tested in the NLCTA

3. T28_vg2.9 (T26) Structure
   - Use T53VG3MC components and completion by the end of May, 2008
     - High power tested in the NLCTA since June 2008
     - Removal in the middle of October for inspection

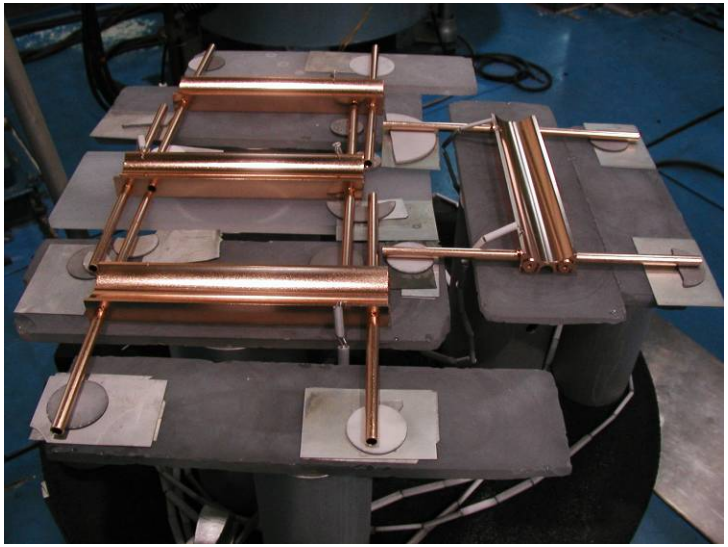
Schedule for 2 x T18_VG2.4_DISC Structures

- Completion of all parts by May13.
- Cell diffusion bonding and structure brazing assembly by May 23.
- Structure tuning and characterization by May 29.
- High temperature vacuum baking and final assembly on strongback by the middle of June.
- Best performance in high gradient test.

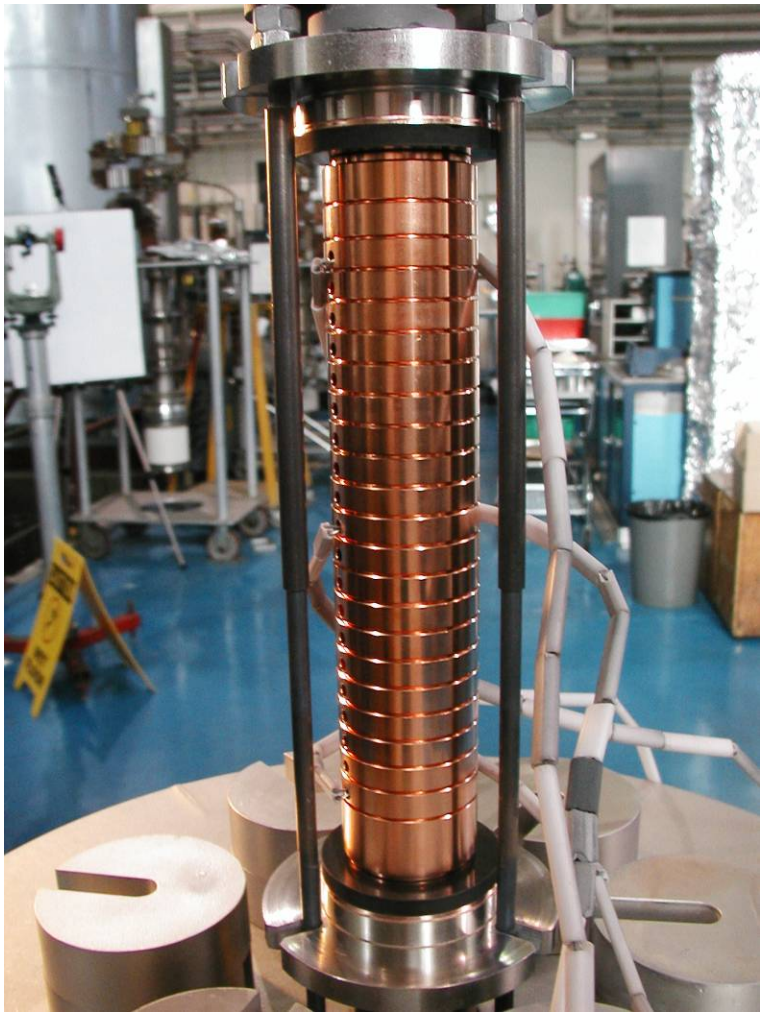
Fabrication of T18_vg2.4_Disc Structures



Input/Output Couplers ready for brazing

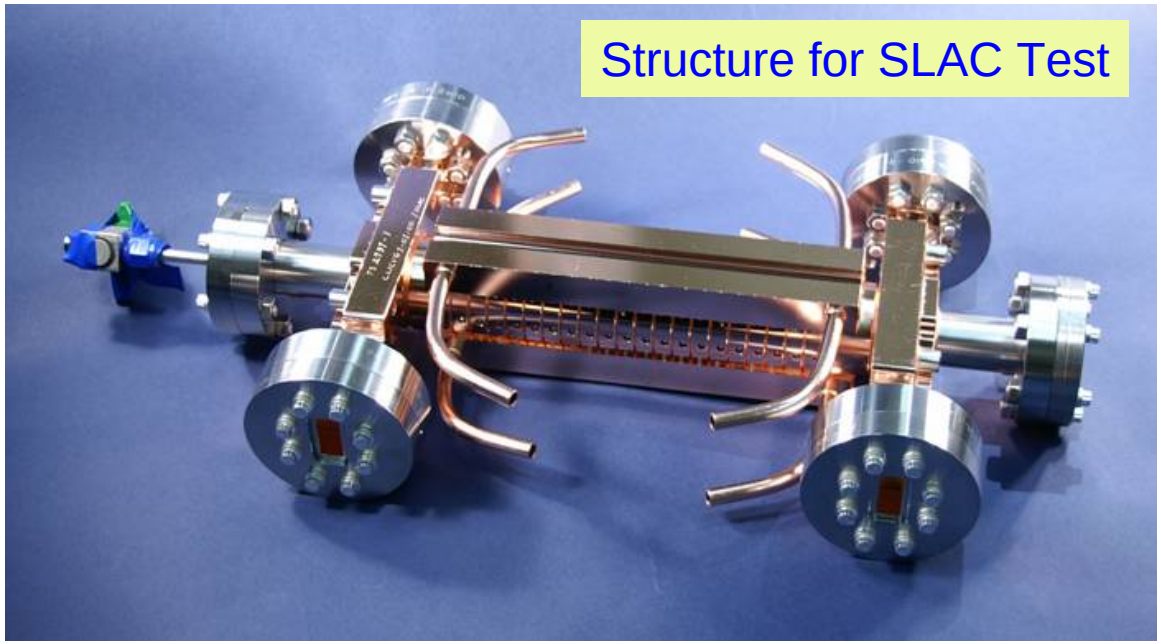


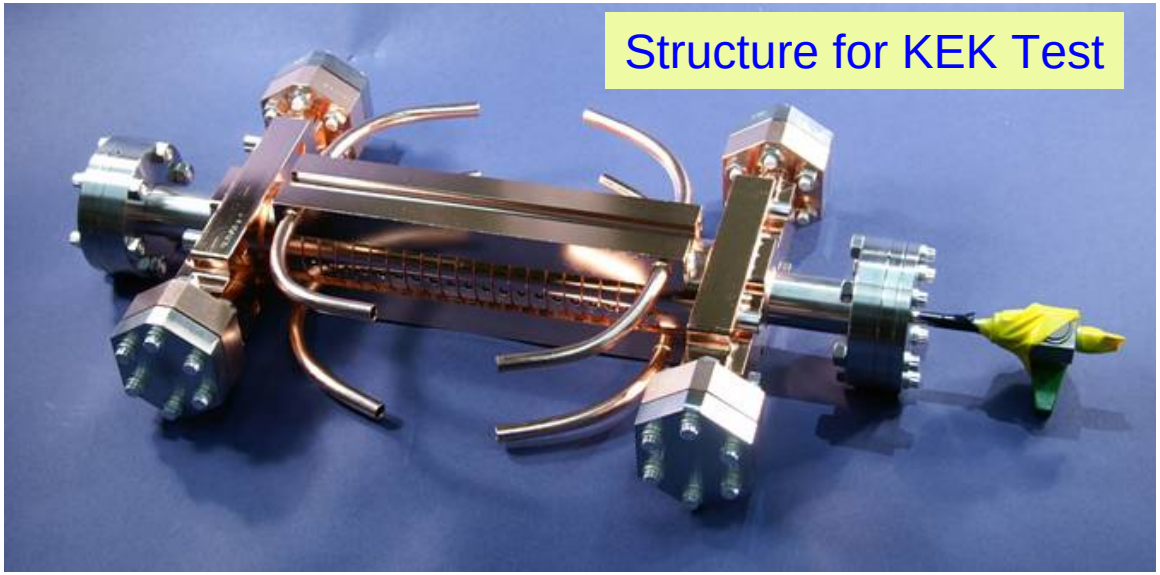
Cooling Blocks under brazing



Accelerator Body under Diffusion Bonding

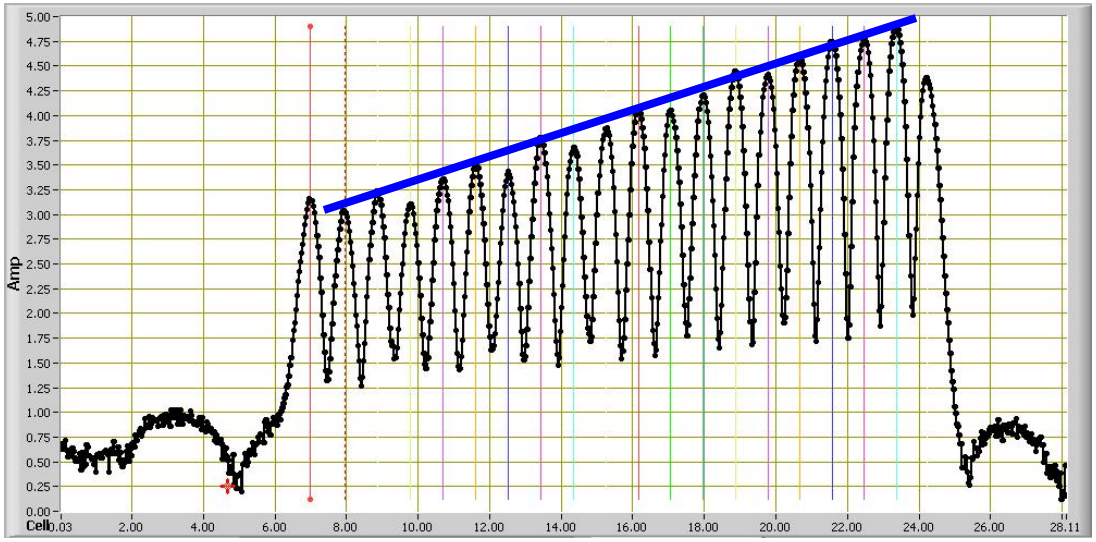
Two T18_VG2.4_DISC Structures





T18_VG2.4_DISC with SLAC Flanges after Tuning

Field Amplitude



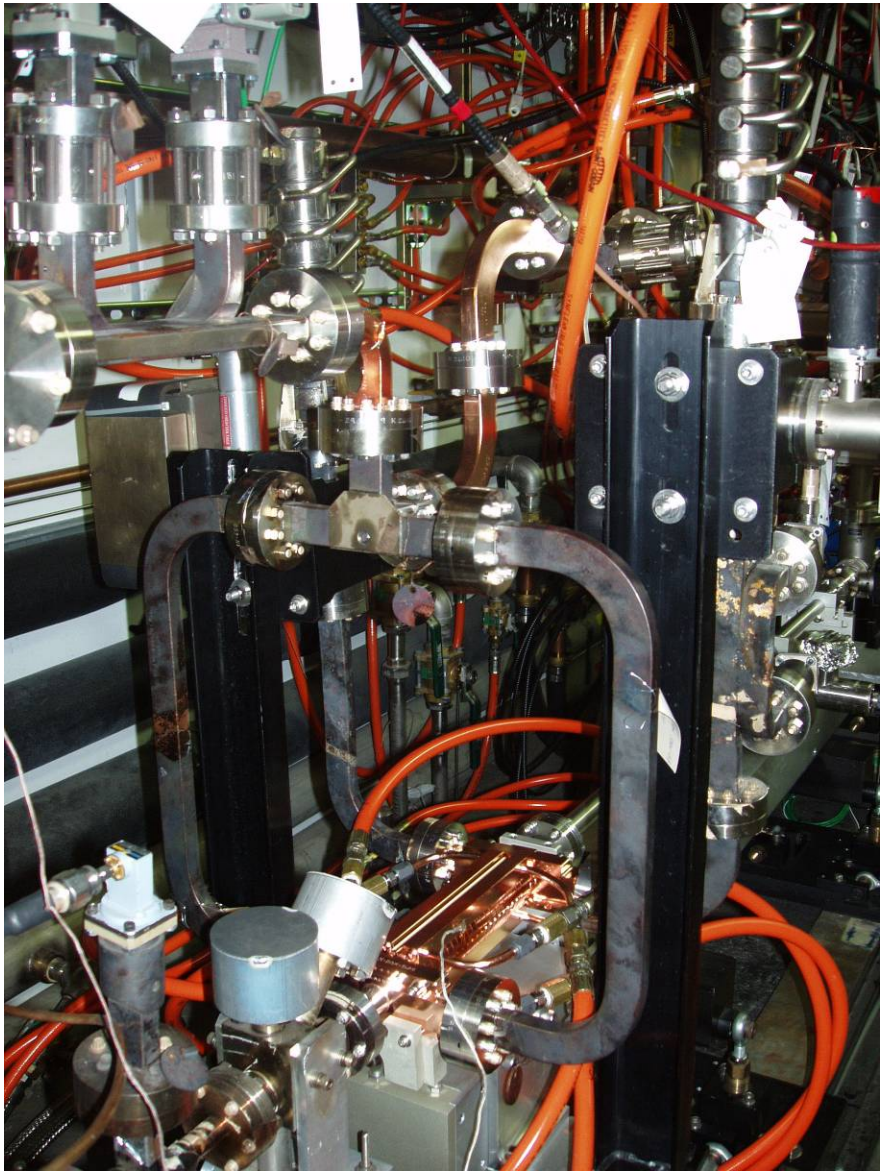
Cumulated Phase Change

120°

Tuning and Microwave Measurements for T18_VG2.4_DISC Structure with SLAC Flanges

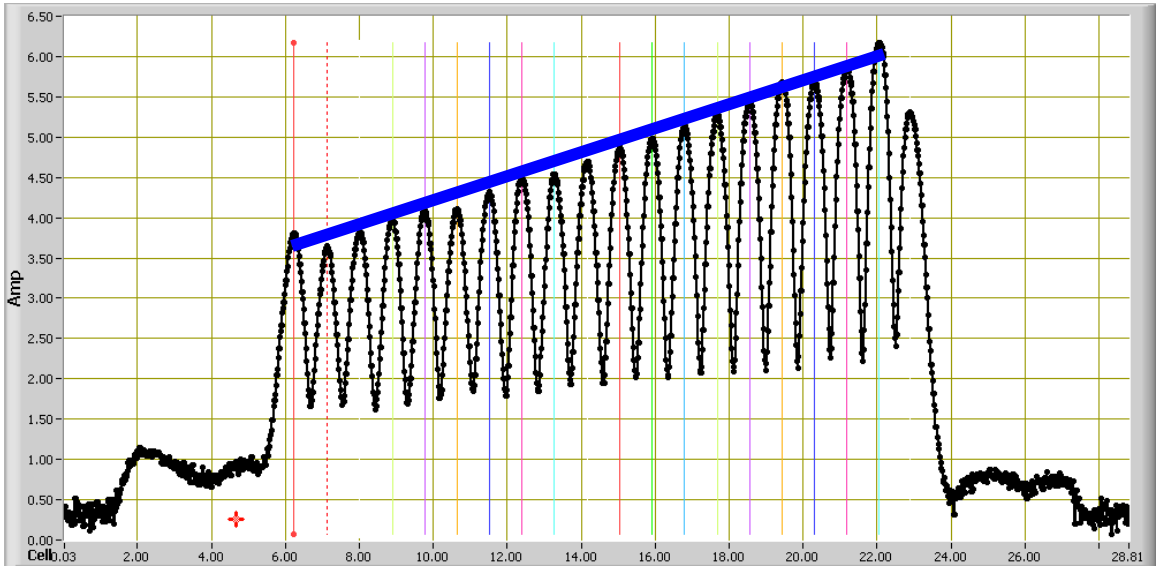
- Target frequency and tuning: machining temperature for all parts was 20 degree C and design operation temperature was 30 degree C. Because the NLCTA cooling system is set 45 degree C, We set the bead tuning conditions and correct perturbations in order accordingly.
- Field distribution is ~ linearly ramping with Eout / Ein ~1.58 for regular accelerating cells, which is consistent with design calculation. But, the input coupler has field overshot.
- Structure matching: S11=0.035 with negligible reflection.
- Power loss in the structure: S12=0.8, Pout/Pin=0.64.
- Filling time: 36 ns.

T18_VG2.4_DISC Structure with SLAC Flanges Installed at NLCTA for High Power Test

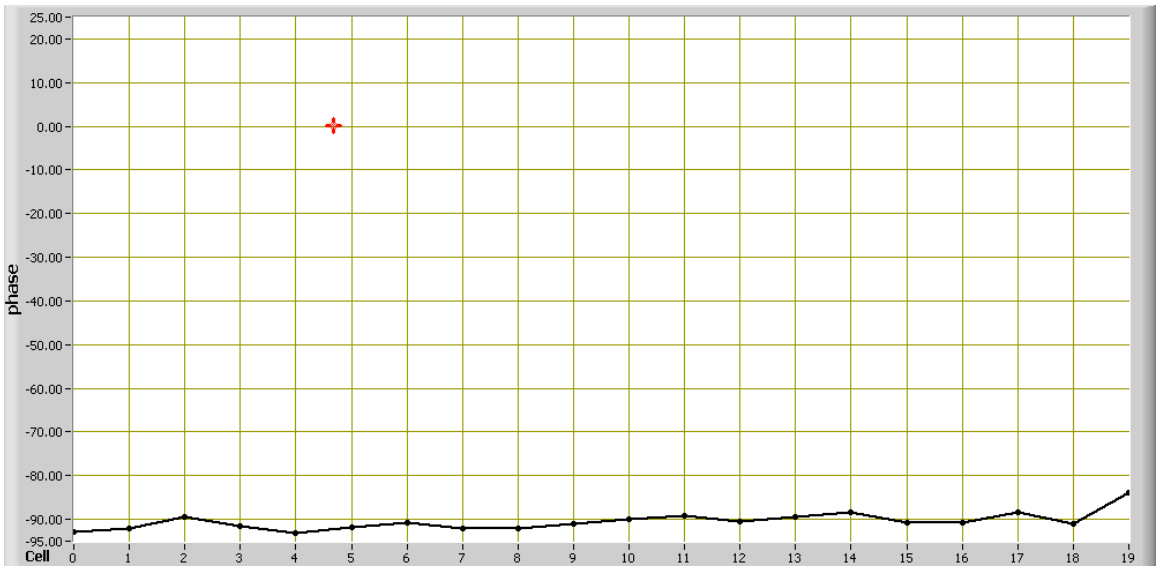


T18_VG2.4_DISC with KEK Flanges after Tuning

Field Amplitude

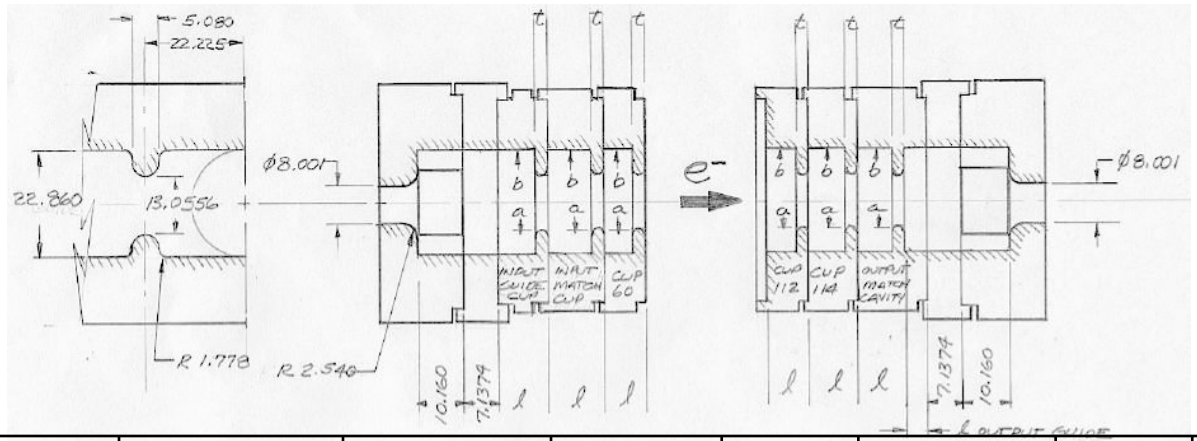


Accumulated Phase Change



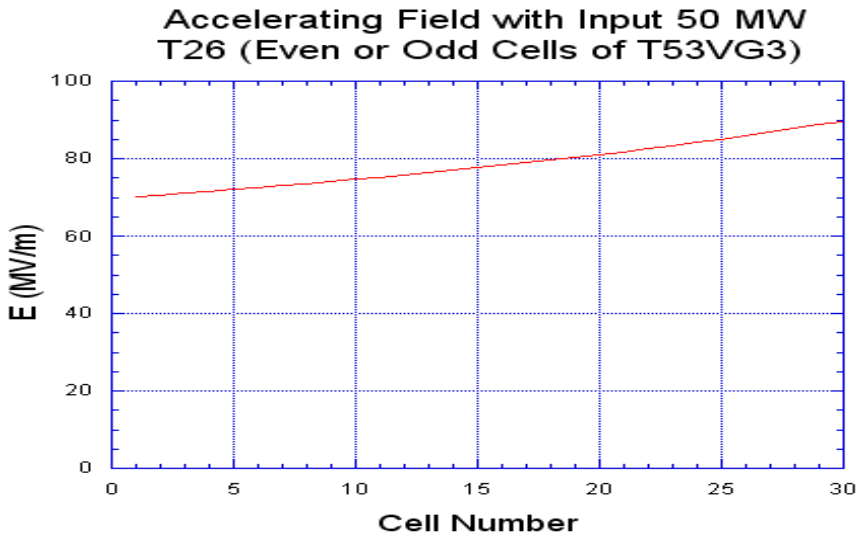
120°

Design for T28_VG2.9 (T26) Structure



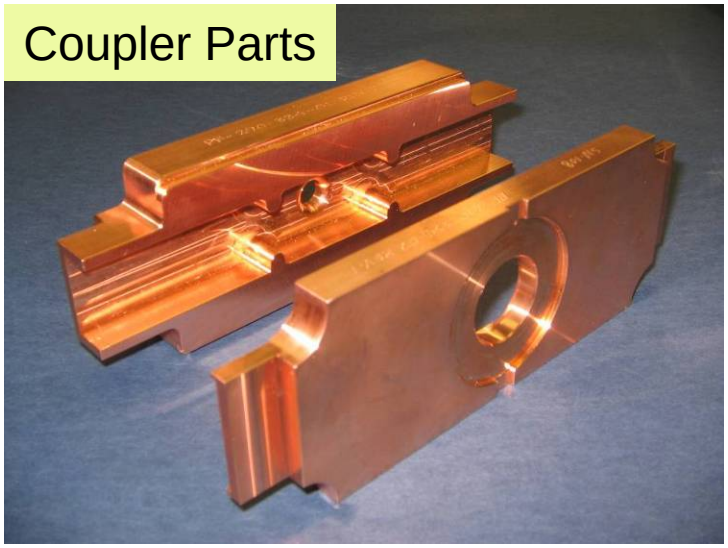
Structure Type	L (cm)	Total Acc. Cells	v_g % c	2a mm	T mm	r MΩ/m	τ	Q_{ave}	T_f ns
Even Cell Of T53VG3	26	30	3.30-1.62	7.8-6.3	1.66	92-107	0.19	6843	35.8

- Input and output to use existing universal coupler assembly.
- Check and small modification of input/output matching.
- Regular cups: 28 even number cups from T53VG3.
- Total 30 accelerating cells in the structure.

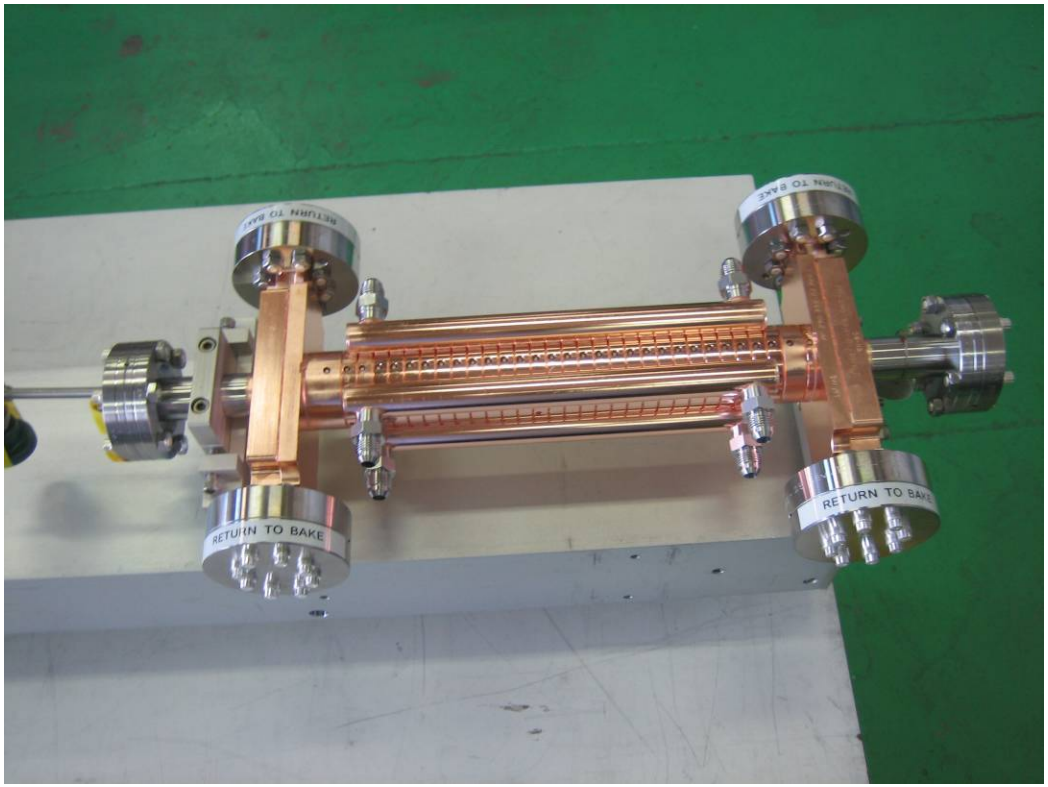


T28_vg2.9 (T26) Structures

Coupler Parts



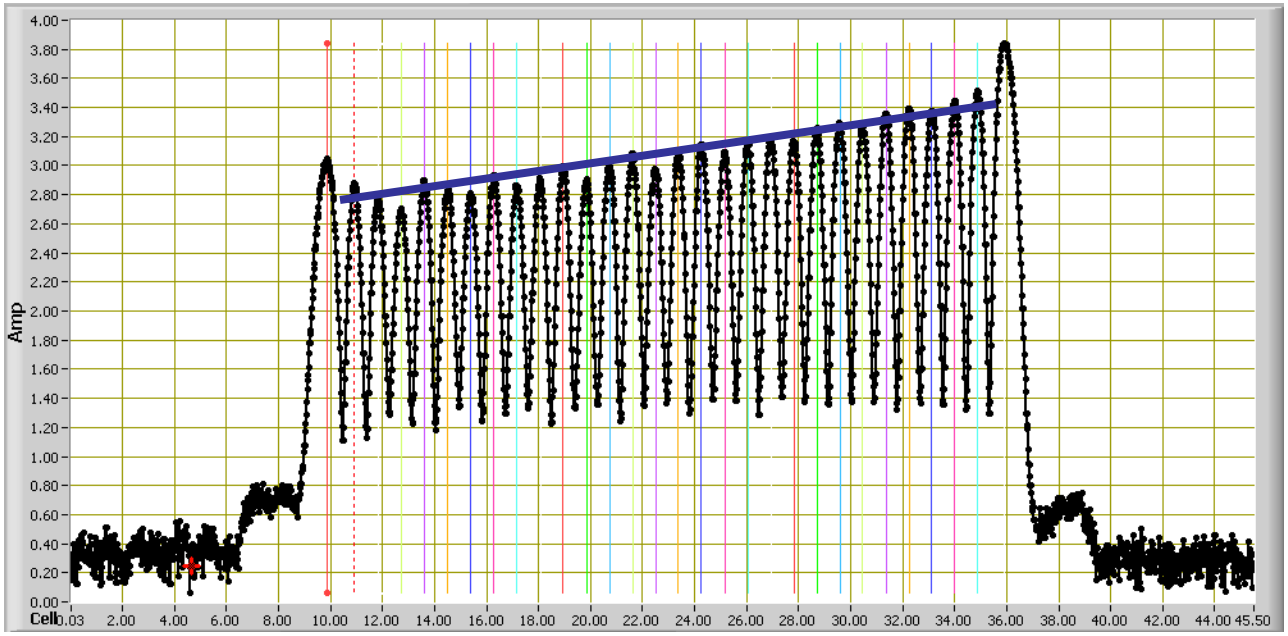
Accelerator Cups



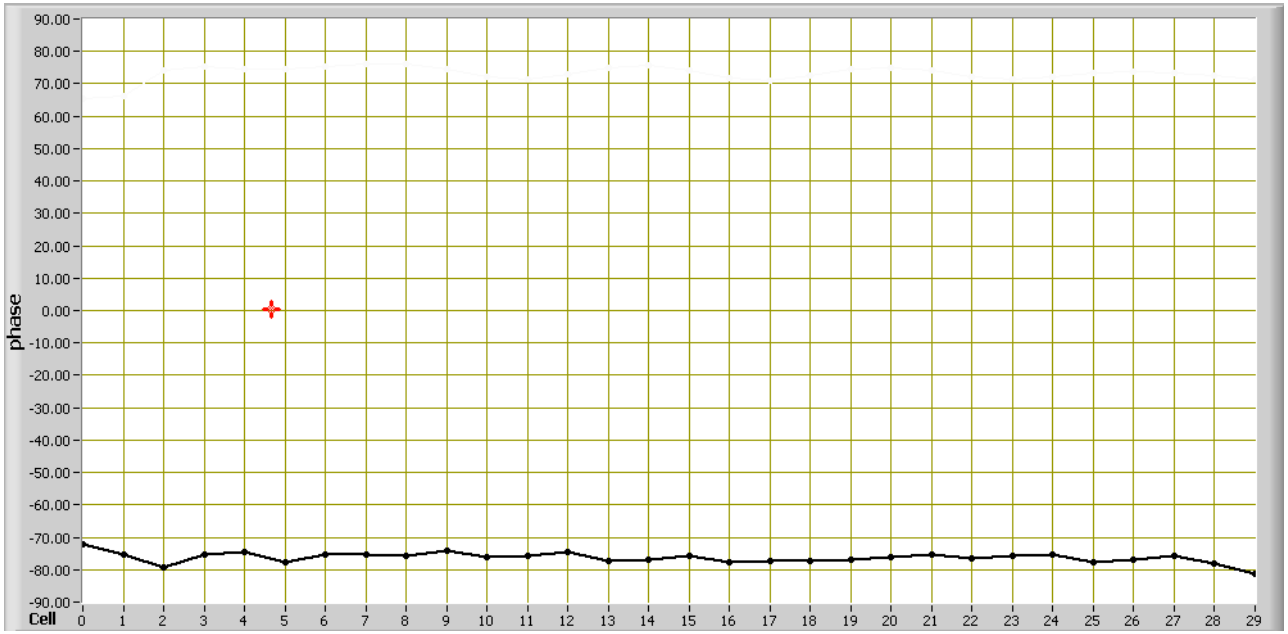
Setting Up for Brazing of T28_vg2.9 (T26) Structure

T28_vg2.9 (T26) Structure after Tuning

Field Amplitude



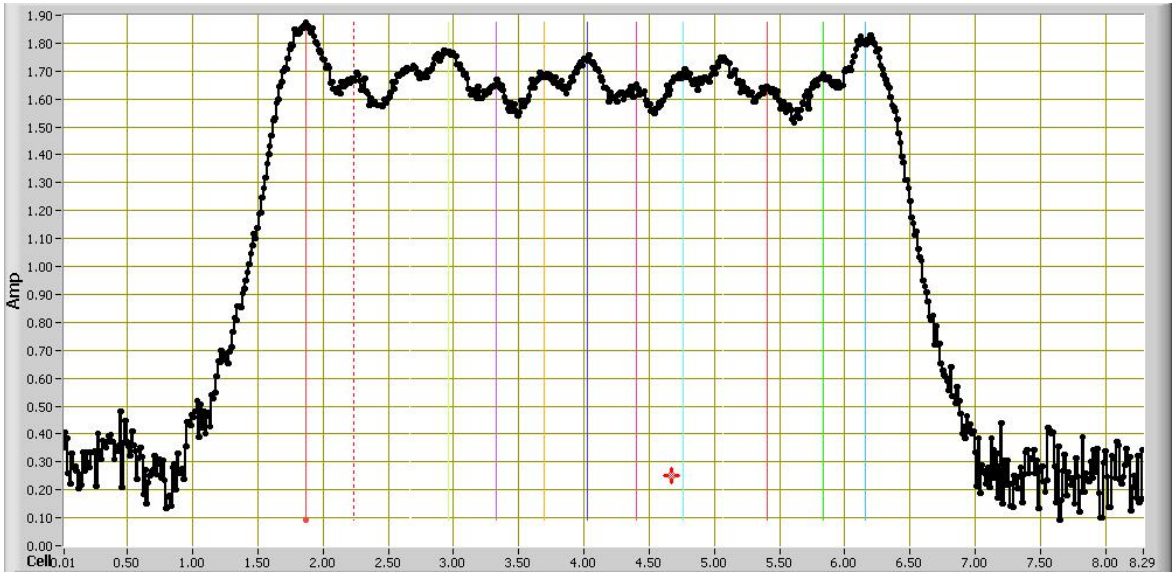
Accumulated Phase Change



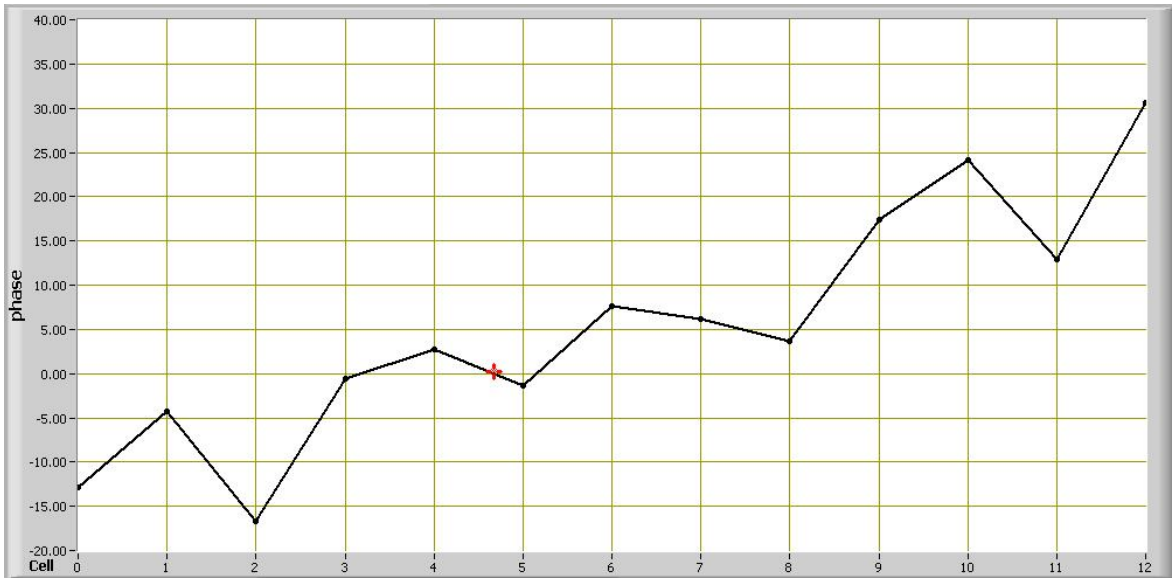
120°

HDX11 Cu Structure after Reassembly

Field Amplitude



Cumulated Phase Change



60°

Microwave Measurements and Evaluation for HDX11-Cu Structure

After electrical polishing and reassembly, the microwave measurements were done in the room temperature, nitrogen condition:

- The field distributions based on the bead pulling studies were done for the frequency from 11405 MHz to 11430 MHz, the corresponding cumulated RF phase shift was ranging from 65 degrees to 28 degrees. the amplitude modulation gets worse when the phase shift reduces. When we do the high power tests, we have to consider the uniformity of the fields: the couple cells have higher field and every four cells have higher fields. As we know the trip rate could on order higher, when the gradient increase 10%.
- At this stage, it is hard to determine the exact impact to the frequency from the electrical polishing, because of lack of comparison with data before polishing.
- All S parameters of S11, S12, S22 were recorded. The filling time was measured to be ~ 4 ns.

Work Ongoing

1. 2 x T18_VG2.4_DISC Structures #3 and #4
   - Surface finish check completed
   - All parts cleaning completed
   - #3, #4 body bonded
   - Coupler surface conditions under discussion
2. TD18_VG2.4_QUAD #3
   - SLAC provides RF feed related components
   - Four quadrant brazed with cooling tube flanges and vacuum baked
   - Final assembly and start of high power tested by end of November
3. T26 Structure Test in Station - 2
   - High power testing at the Station-II of the NLCTA;
   - Higher breakdown rate at 150 ns, 95 MV/m.
4. T18 Backward Test in Station -1
5. Four Short (10-cell) Test Structures with Various Iris and Disc Thickness for High Gradient Studies.
   - 2 x C10_VG 0.7 #1, #2
   - 2 x C10_VG 1.35 #1, #2

TD18_VG2.4_DISK #3 and #4

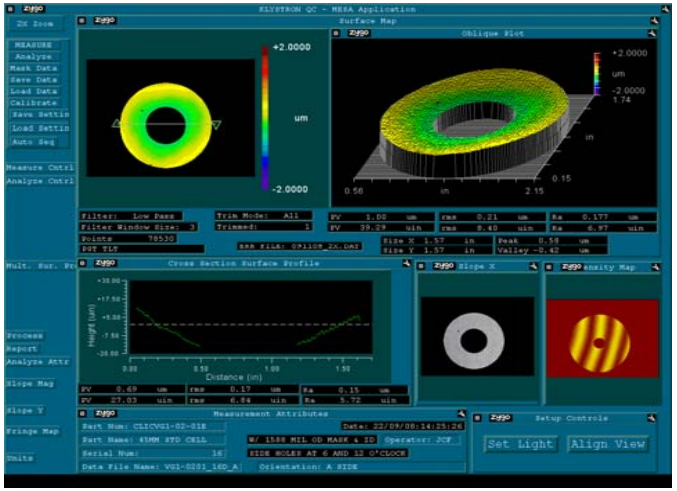
- Surface finish check completed.
- Both #3, #4 accelerator bodies bonded.
- Couplers brazing on hold due to the finding of some machining problems for coupler parts.
- Discussion with KEK for two option:

  Re-machining of coupler parts in Japan;

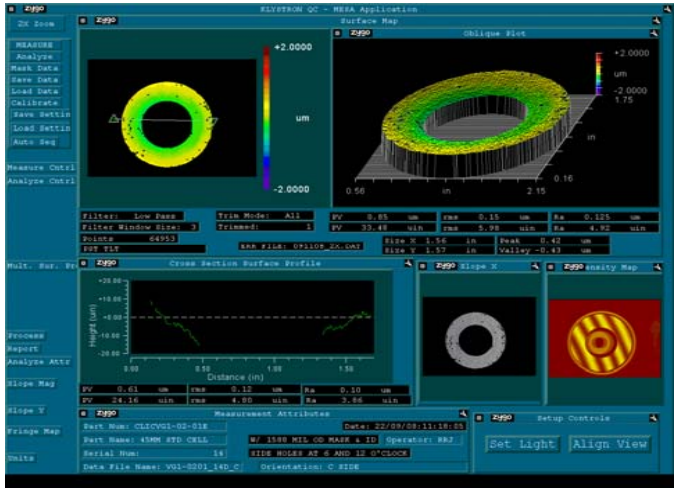
  Fixing the parts at SLAC.

ZYGO Surface Flatness Measurement for a Typical Cup of T18_VG2.4_DISC #3 and #4

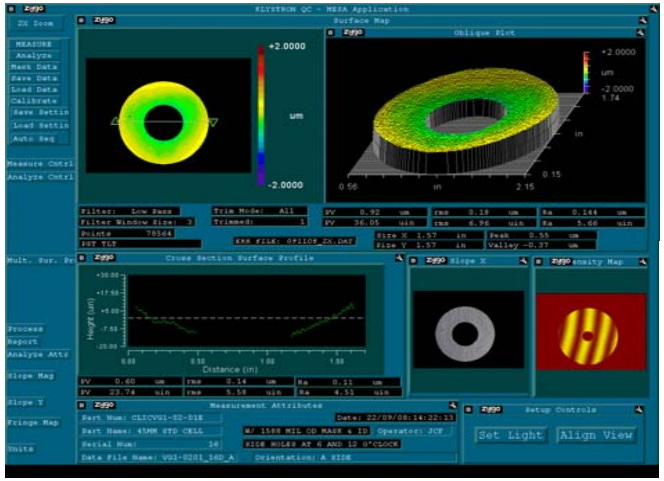
Both sides show less than 1 micron concaved



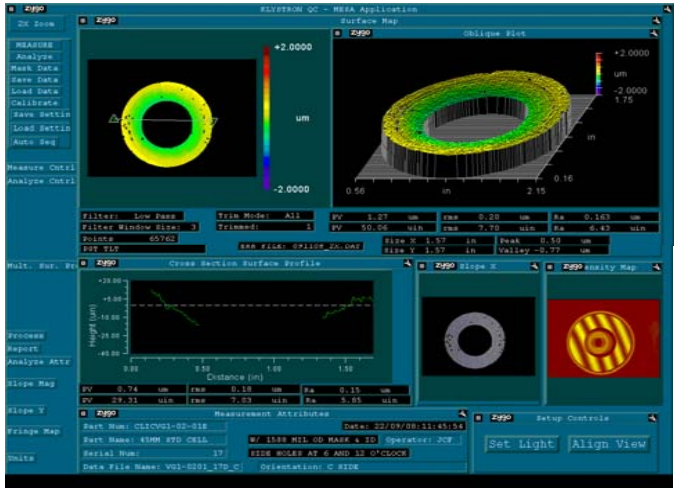
16D-A



14D-C



17D-A



17D-C

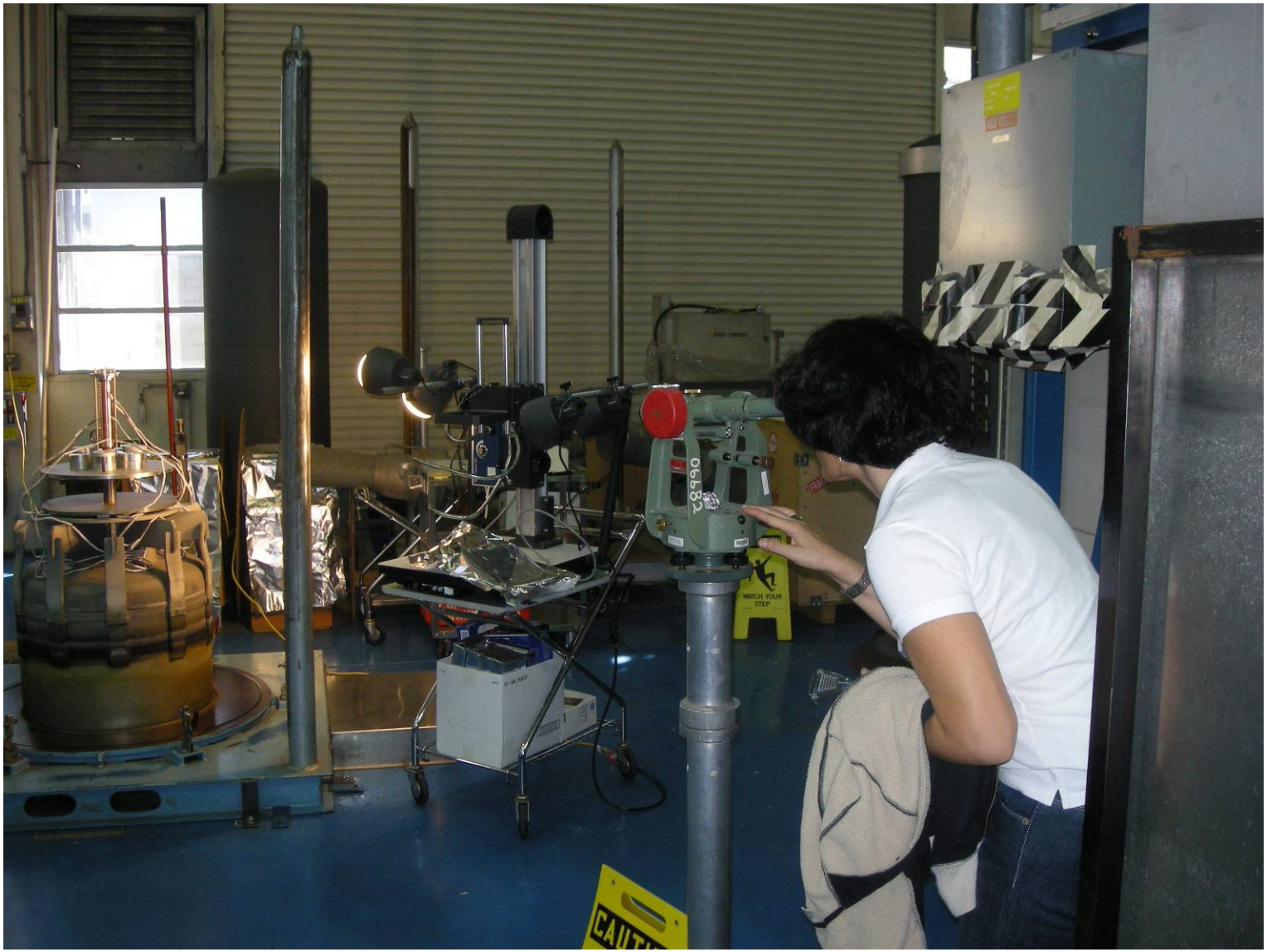
ZYGO Data for T18_VG2.4_DISK #3

Cell #	Surface Variation A side	Concave or Convex?	Surface Variation C side (cavity side)	Concave or Convex?
Input	0.39	Concave	0.51	Concave
0	1.72	Concave	0.68	Concave
1	2.01	Concave	0.6	Concave
2	1.34	Concave	0.53	Concave
3	1.35	Concave	0.34	Concave
4	1.2	Concave	0.53	Concave
5	1.34	Concave	0.35	Concave
6	1.38	Concave	0.64	Concave
7	1.21	Concave	0.64	Concave
8	1.41	Concave	0.74	Concave
9	1.57	Concave	1.03	Concave
10	1.24	Concave	1.02	Concave
11	1.5	Concave	1.01	Concave
12	1.27	Concave	1.21	Concave
13	1.36	Concave	1.03	Concave
14	1.39	Concave	0.8	Concave
15	1.4	Concave	0.98	Concave
16	1.18	Concave	1.29	Concave
17	1.09	Concave	0.95	Concave
18	1.31	Concave	0.95	Concave
19	1.42	Concave	0.34	Concave
20	1.11	Concave	1.27	Concave
Output	0.36	Concave	0.33	Concave
Avg Variation - Microns	1.28	Concave	0.77	Concave
Max Variation -- Microns	2.01	Concave	1.29	Concave
Min Variation -- Microns	0.36	Concave	0.33	Concave

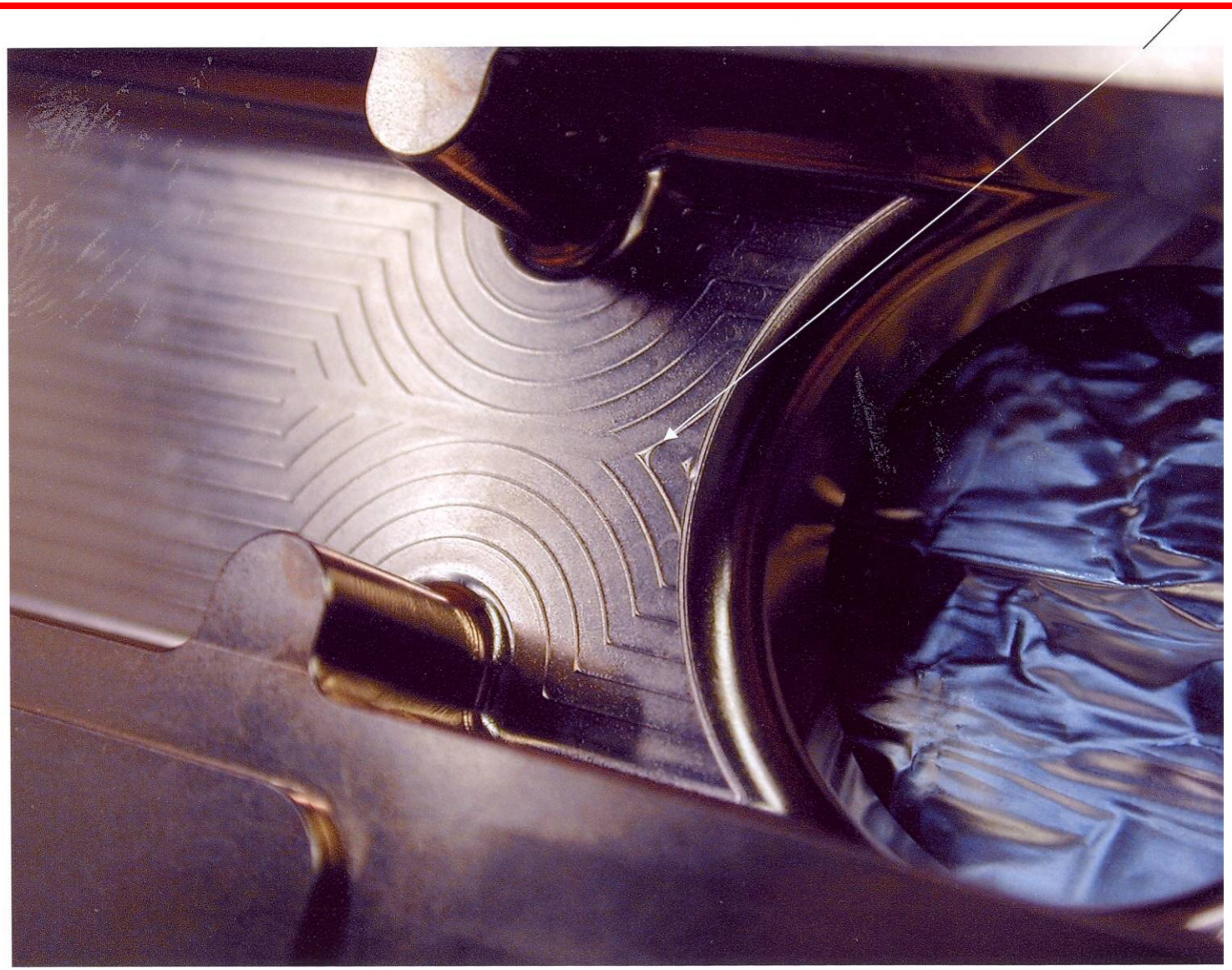
ZYGO Data for T18_VG2.4_DISK #4

Cell #	Surface Variation A side	Concave or Convex?	Surface Variation C side (cavity side)	Concave or Convex?
Input	0.57	Concave	0.49	Concave
0	0.86	Concave	0.34	Concave
1	1.12	Concave	0.51	Concave
2	1.06	Concave	0.62	Concave
3	1.27	Concave	0.49	Concave
4	1.13	Concave	0.47	Concave
5	1.24	Concave	0.46	Concave
6	1.37	Concave	0.62	Concave
7	1.27	Concave	0.66	Concave
8	1.50	Concave	0.56	Concave
9	1.07	Concave	1.35	Concave
10	1.11	Concave	1.11	Concave
11	1.06	Concave	1.29	Concave
12	1.02	Concave	1.06	Concave
13	1.16	Concave	1.13	Concave
14	1.00	Concave	0.85	Concave
15	1.02	Concave	1.06	Concave
16	0.92	Concave	1.25	Concave
17	1.00	Concave	1.27	Concave
18	0.93	Concave	0.88	Concave
19	0.86	Concave	0.72	Concave
20	0.94	Concave	0.76	Concave
Output	0.63	Concave	0.58	Concave
Avg Variation - Microns	1.05	Concave	0.81	Concave
Max Variation -- Microns	1.50	Concave	1.35	Concave
Min Variation -- Microns	0.57	Concave	0.34	Concave

Alignment Check for T18_vg2.4_DISK #4 Diffusion Bonding

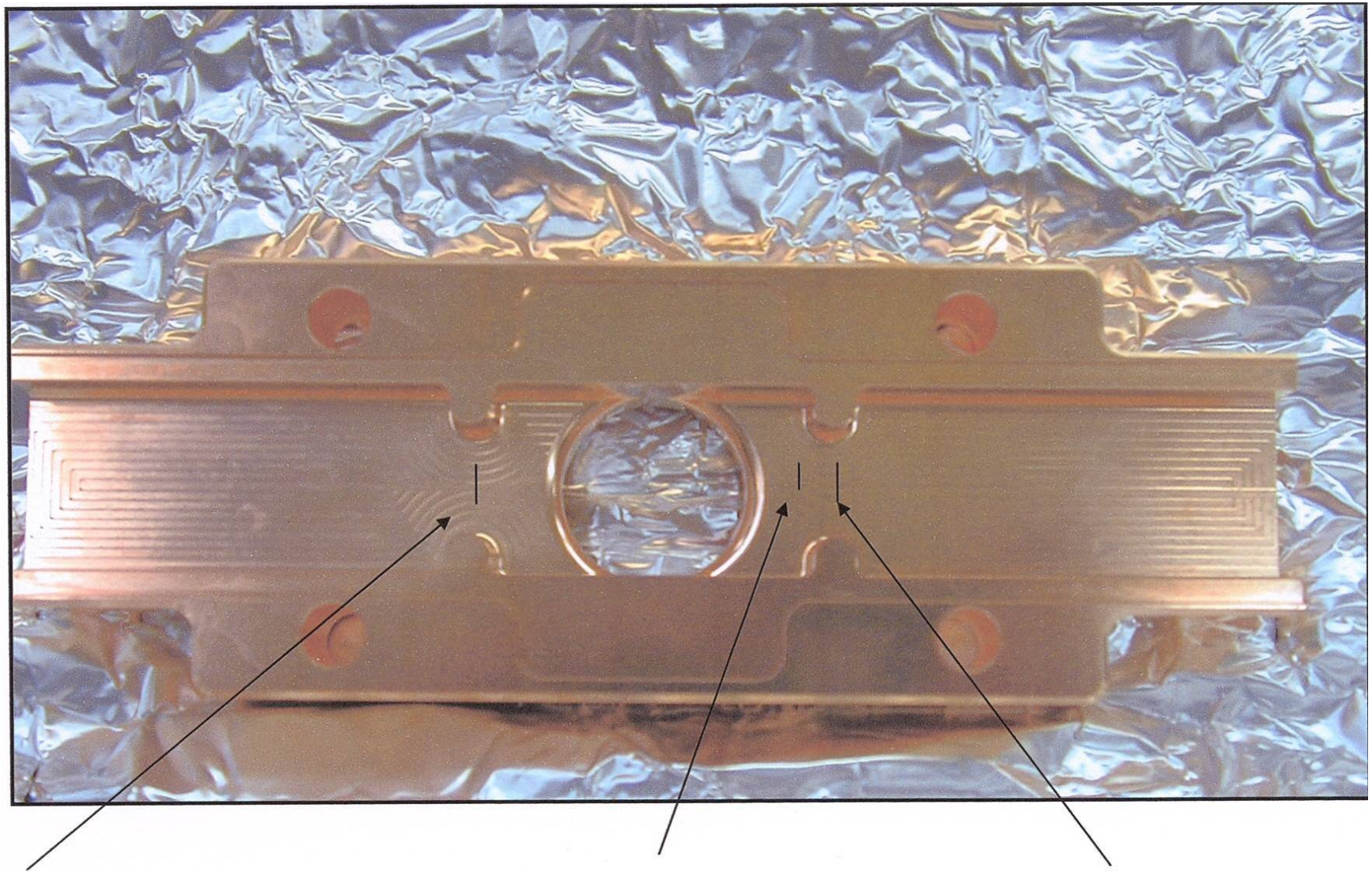


Tool Marks of Milling on the Flat Surface

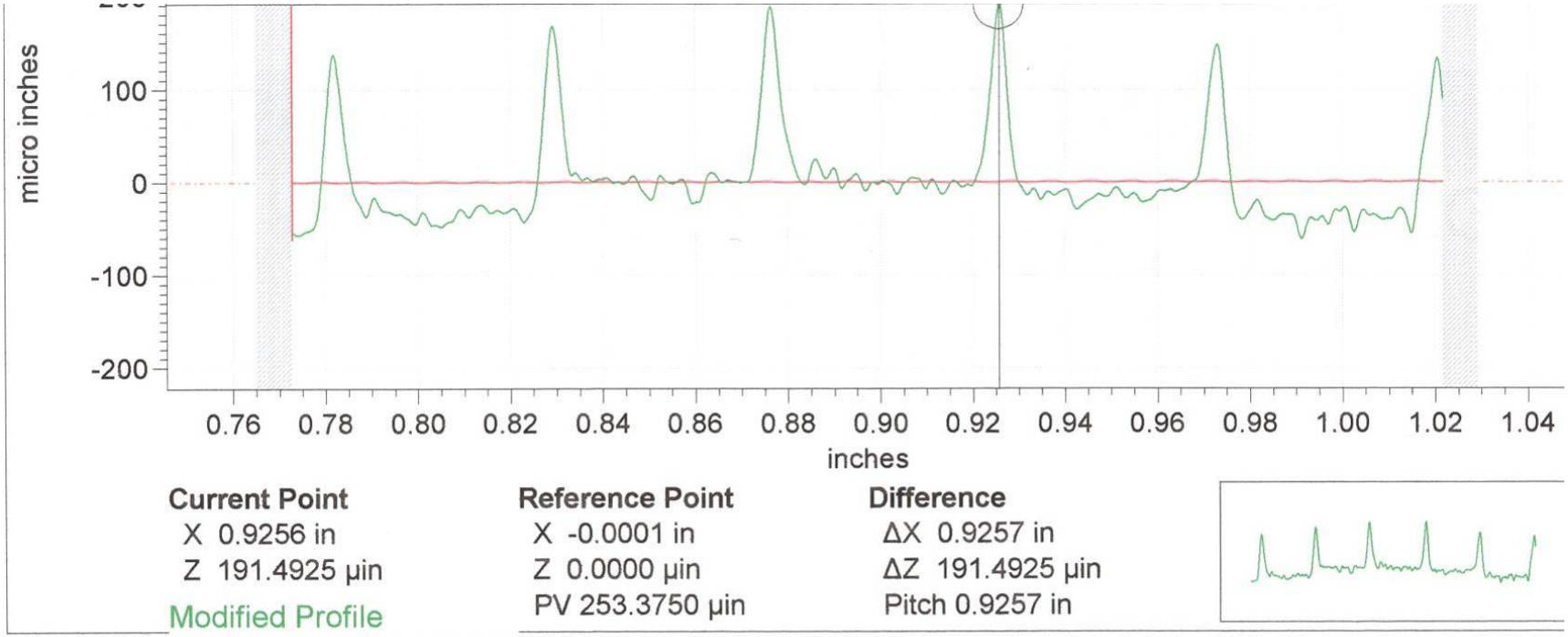


Subassembly for Test Cells

Measurement Traces
by Taylor Hobson Profile meter



Measurement of Tool Marks by Taylor Hobson Profile meter

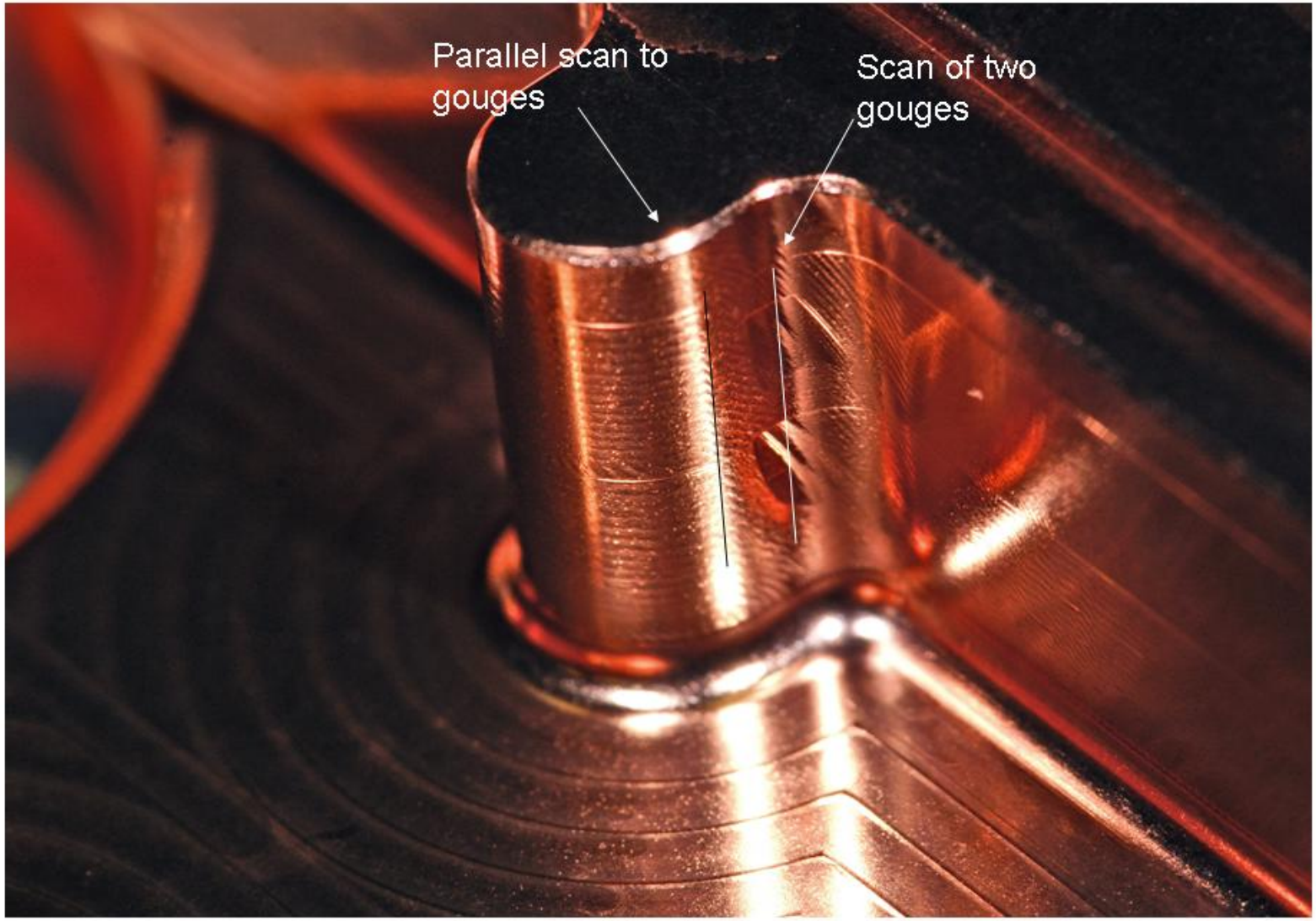


		Slope	-0.401	°	Pz(JIS)	210.945	µin
Pa	31.635	µin	Pq	48.413	µin		
Psk	1.9768		Pku	6.7372			
Pp	191.492	µin	Pv	61.882	µin		

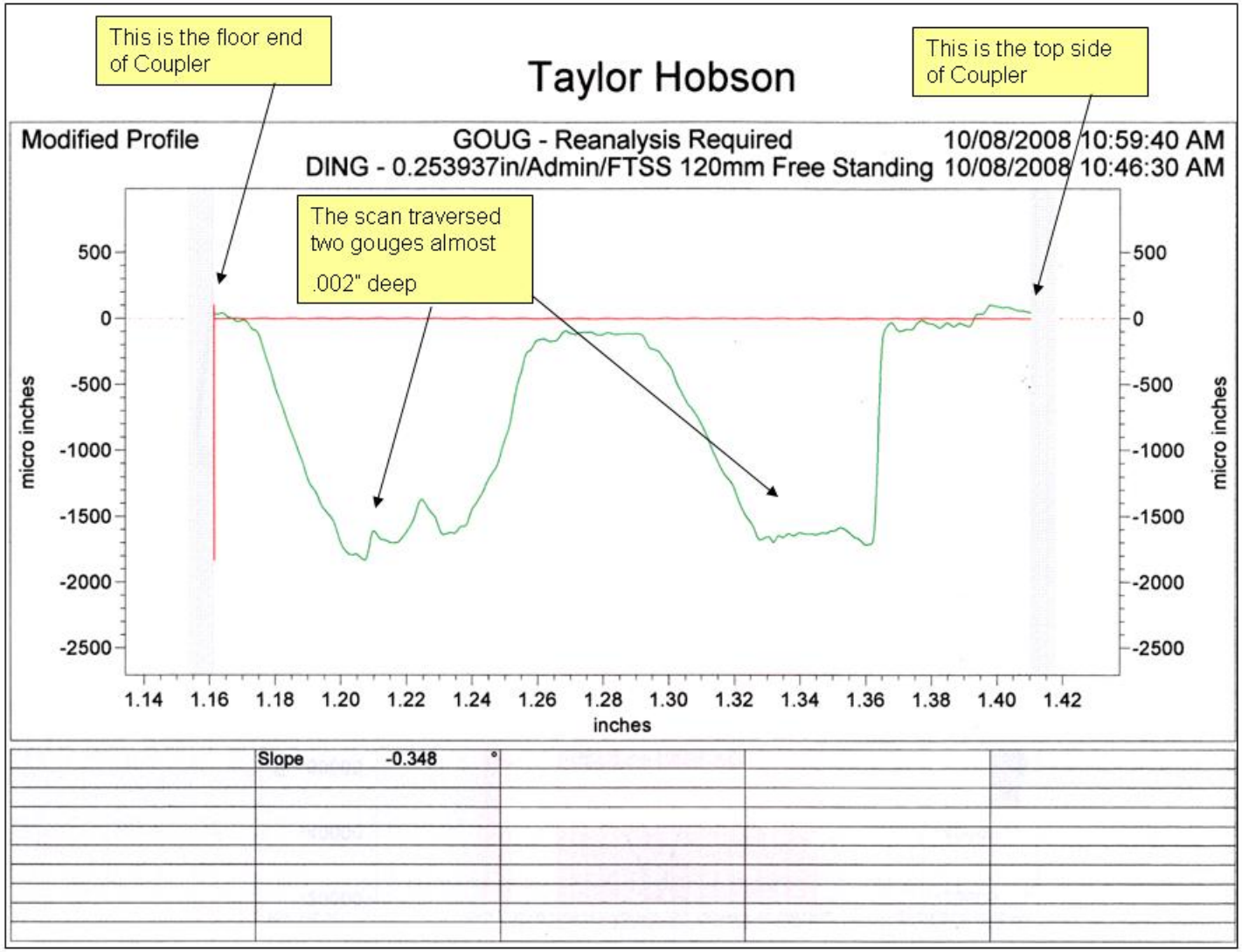
Measurement of Peaks of Tool Marks by Taylor Hobson Profile meter

		Slope	-0.403 °	Pz(JIS)	159.111 µin						
Pa	77.945 µin	Pq	191.685 µin								
Psk	3.1323	Pku	10.4351								
Pp	716.942 µin	Pv	15.863 µin								
PLo	0.148093 in	Pt	732.804 µin	Pmr(C)	62.82 %	Height (mean)	0.00 µin				
		Pdq	1.67 °	PHSC	0 peaks	Height (mean)	0.00 µin				
Pda	0.85 °	Pz	732.804 µin	Pdc	732.804 µin	mr1%	0.00 %	mr2%	100.00 %		
PS	0.000000 in	PSm	0.000000 in	Pmr	50.00 %	offset	0.00 µin	mr%	50.00 %		
Pln	0.148031 in	Pc	0.000 µin	PVo	0.0403 vol	offset	0.00 µin	mr%	50.00 %		
				PPc	67.6 pks/in	Height (mean)	0.00 µin				

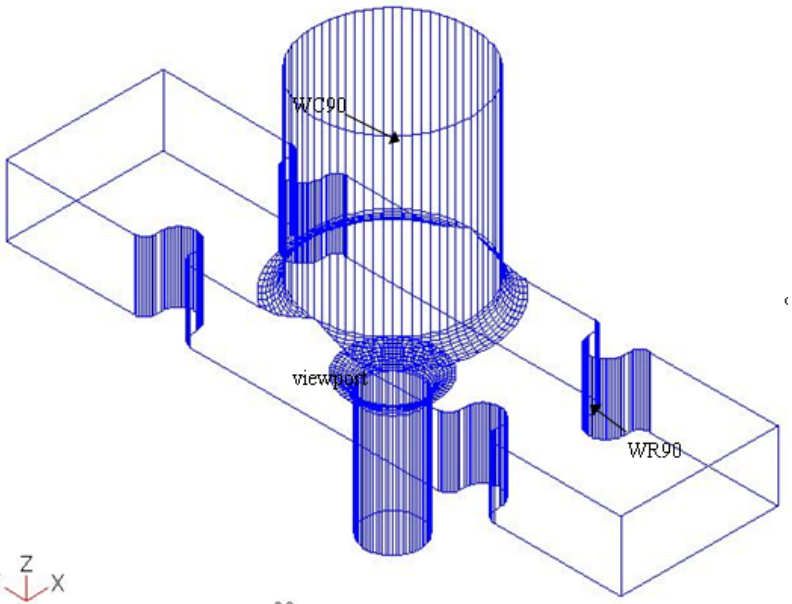
Tool Damages on Matching Bumps

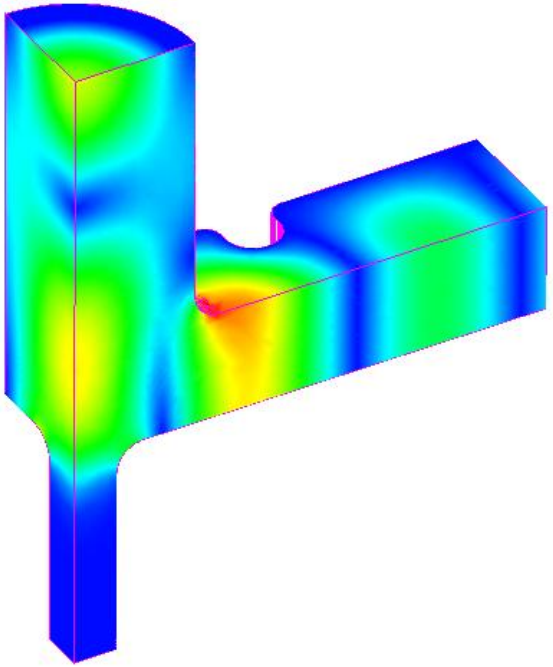


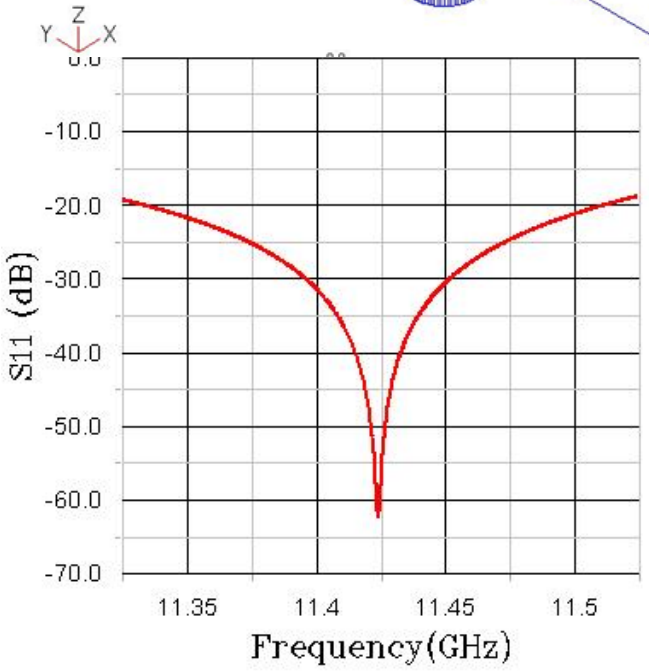
Measurement of Tool Damages on Matching Bumps by Taylor Hobson Profile meter



Mode Converter Coupler





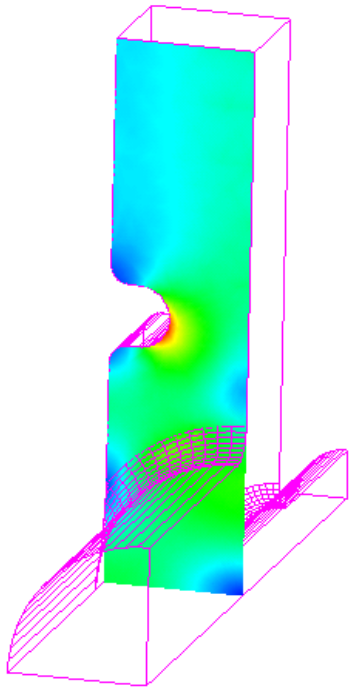


$|E^s|_{max}$= ~34 MV/m @ 48 MW

$|H^s|_{max}$= ~98.4 kA/m @ 48 MW (on inner edge of waveguide iris)

⇒pulsed heating ~3°

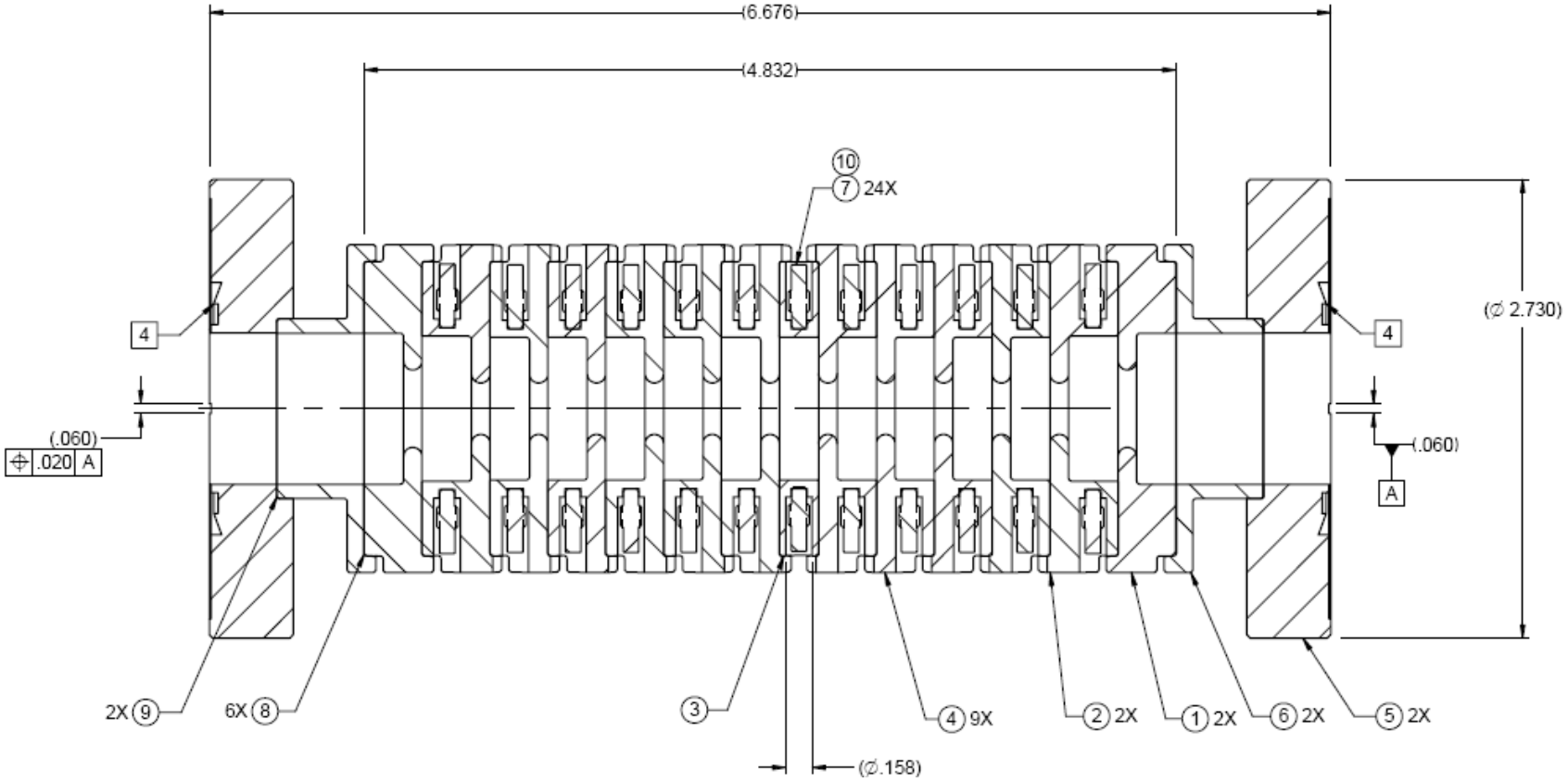
Input Power of only 55.5/2 MW is needed for 100 MV/m for T18 structure



Plan for 1st Four C10 Structures

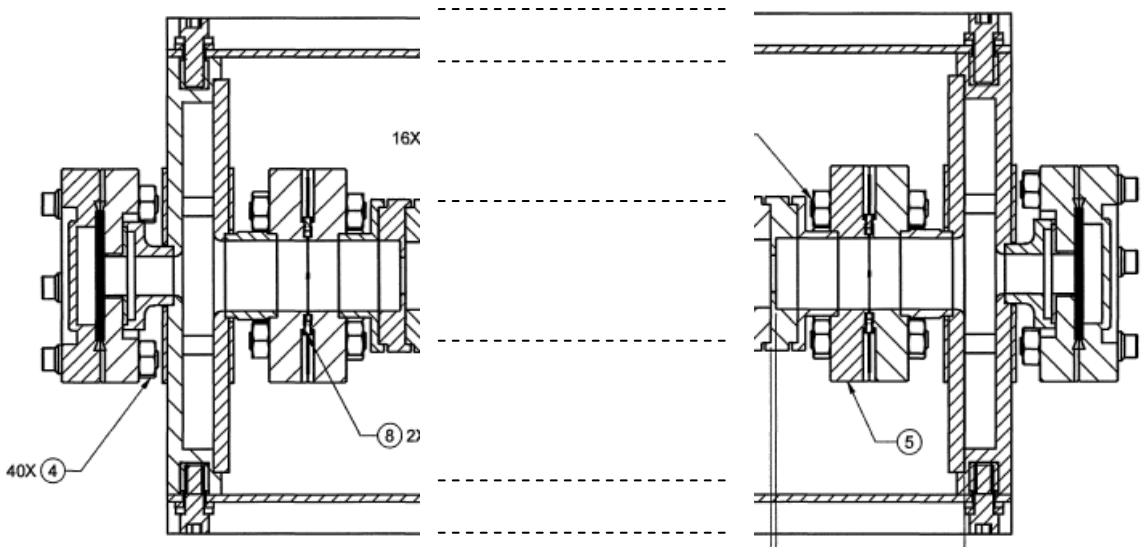
- Four structures: 2 x C10_VG_1.35 #1, #2 and 2 x C10_VG_0.7 #1, #2.
- CERN has completed the electrical design.
- SLAC makes the mechanical design, fabrication and high power tests.
- Draft of the addendum 3 is completed.
- Engineering design is completed.
- Test cells from an outside vendor (Robertson) have been examined by SLAC and fabrication of all cells will be completed in by October, 2008.
- The completion of the structures is scheduled to be in November, 2008.

Schematic View for C10 Structures - II

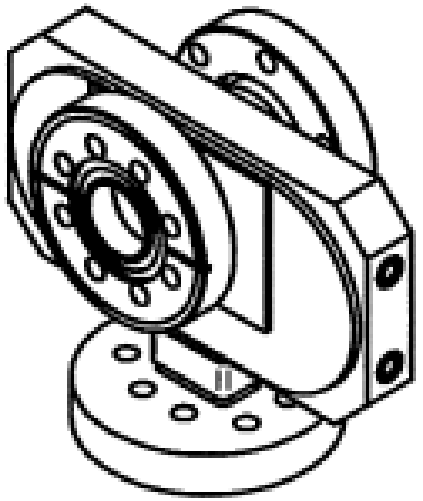


Subassembly for Test Cells

Schematic View for C10 Structures - I



Structure Assembly

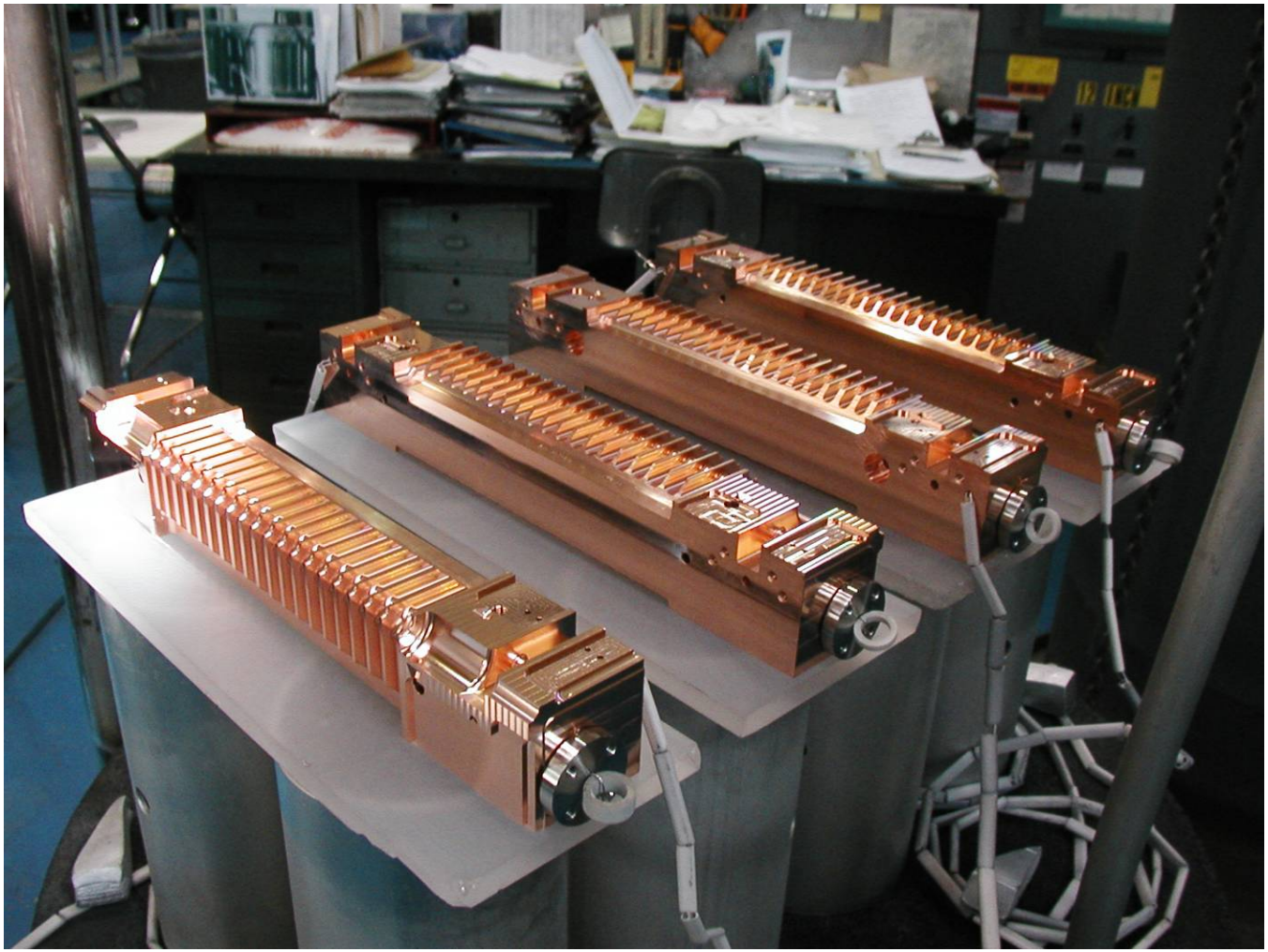


TM01 Mode Launcher

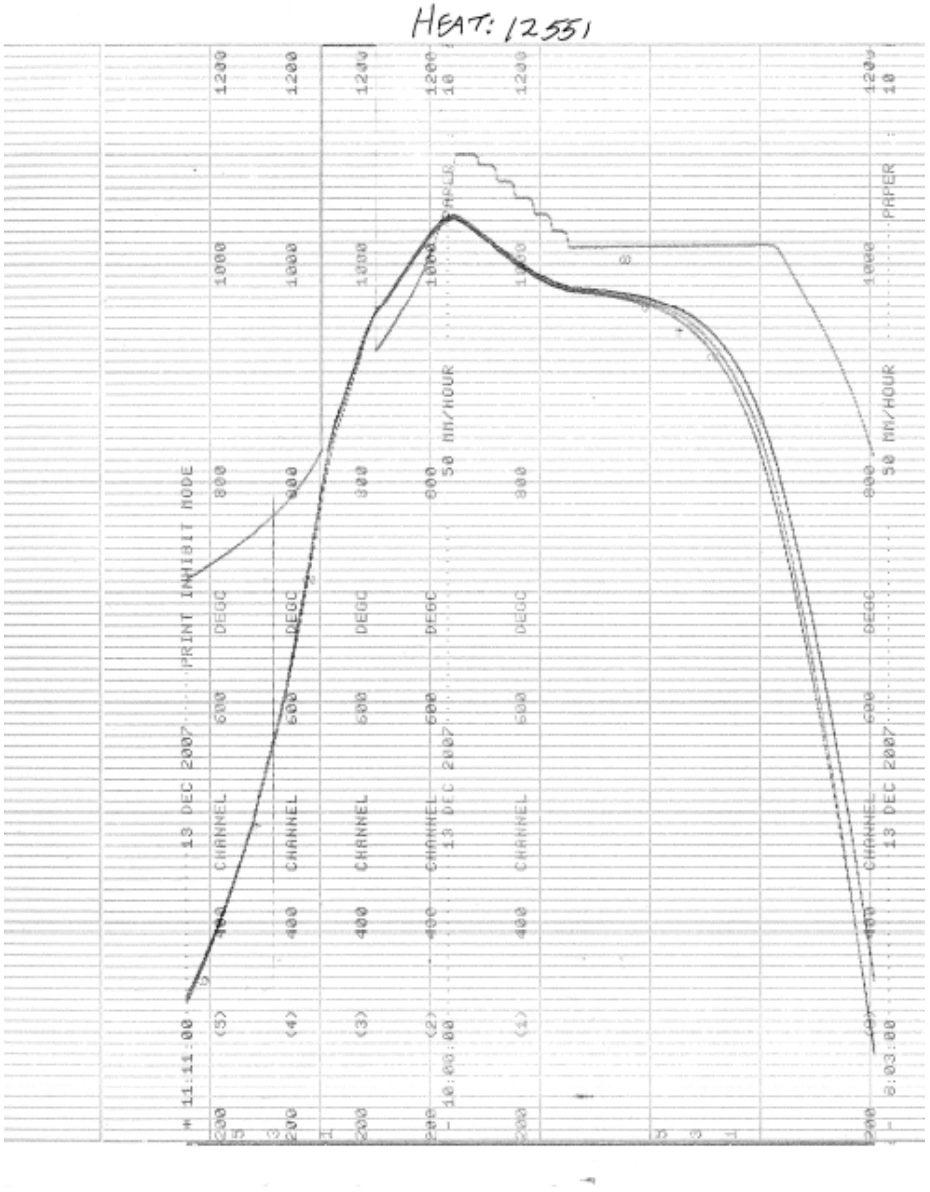
Work Plan for TD 18_VG2.4_QUAD #3

- Cooling tube fitting flanges brazed at a hydrogen furnace with 25/75 Au/Cu alloy
- Four quadrant assemblies vacuum baked at 650°C
- Test assemblies completed
- Final assembly, microwave measurements and leak check will be completed by October 25th.
- Installation at the NLCTA in the last week of October.

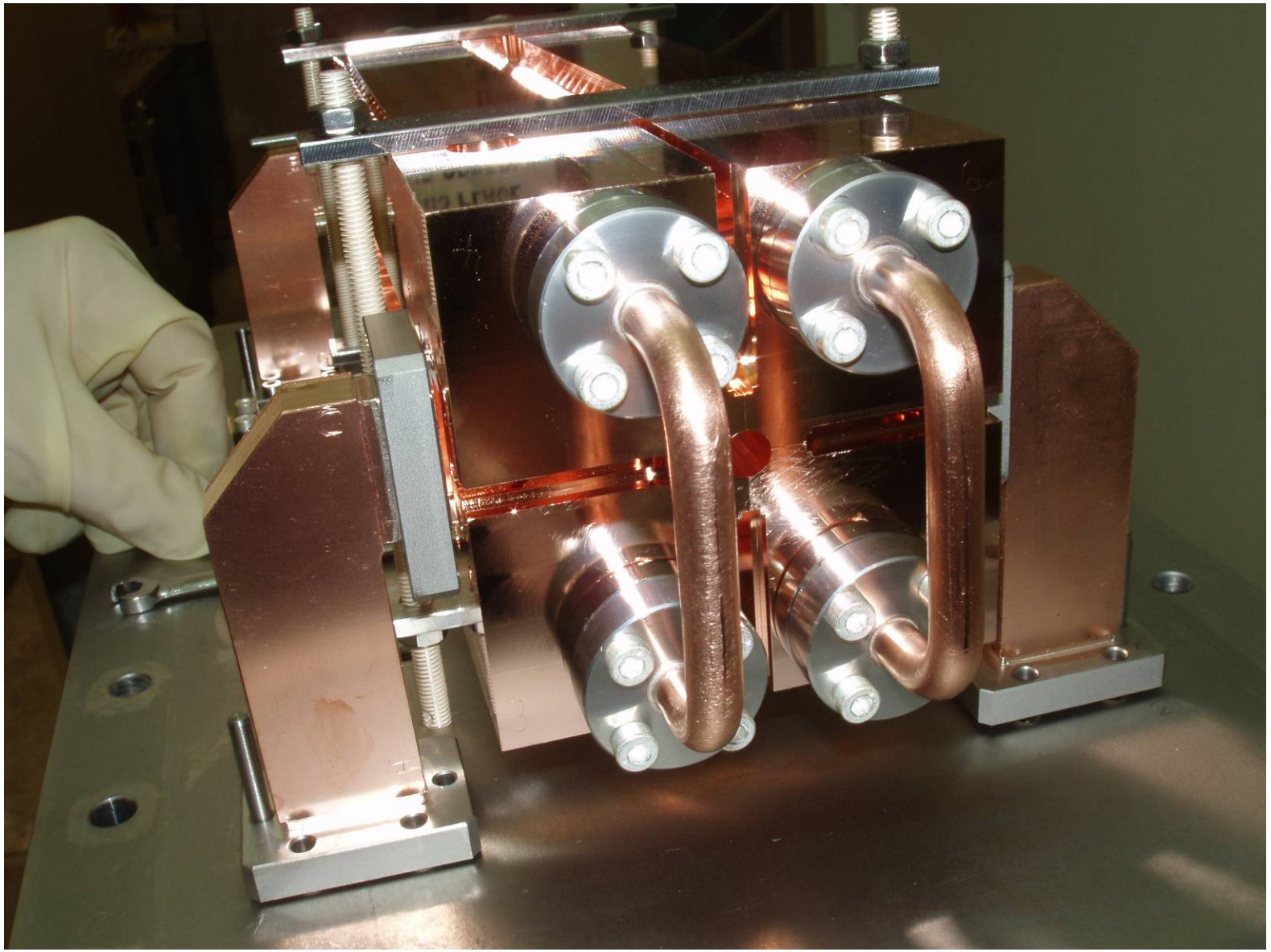
T8_vg2.4_QUAD Structure Brazing



Temperature Profile for T18_vg2.4_QUAD Structure Brazing



T18_vg2.4_QUAD Structure #3 Test Assembly



Work for Other Future Structures

2008

1. 2 x C10_VG_1.35 #1, #2 and 2 x C10_VG_0.7 #1, #2
   Assembly completion and High power testing
2. CERN T24_VG1.8_DISK #1
   High power testing
3. CERN T18_VG2.4_DISC #5
   High power testing
4. CERN TD18_VG2.4_DISK #1
   High Power Testing

2009

1. TD18_VG2.4_DISK #2, #3
   Assembly, Tuning and High power testing
2. C10 Structures 2xVG2.25 and 2xVG3.3
   Fabrication, Assembly, tuning and High power testing
3. KEK CD10 2xVG1.35#1, #2
   Assembly, tuning and High power testing
4. CERN CD10 2xVG1.35 #3
   Assembly and High power testing
5. TD24_VG1.8_DISK #1
   High power testing
6. T-500GeV
   High power testing