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Some Critical Issues in the CLIC-SLAC-KEK Collaboration Structures

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IWLC2010
October, 2010

Outline

1. Work Status
   - T24 Structures
   - Schedule toward the year 2010 end
   - Some Problems
     - TD24 couplers and others
2. Diffusion Bonding Quality
   - C10
   - TD18 and others
3. Surface Preparation – Etching Tests Revisit and Discussion

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1. Work Status

Collaboration Status at SLAC

1. T24_VG1.8 with SLAC flanges is under high power test at the NLCTA.
2. T24_VG1.8 with KEK flanges capped off with vacuum is supposed to be in Japan by now.
3. Fabrication of two TD24_VG1.8 structures with SLAC and KEK flanges is in the progress for assembly.
   - The one with SLAC flanges will be high power tested in the beginning of 2011.
   - The one with KEK flanges will be deliver it to KEK by the end of 2010.
4. The second CERN made T18 structure will be tested sometime in November or December of this year.

Tuning Status for T24_VG1.8

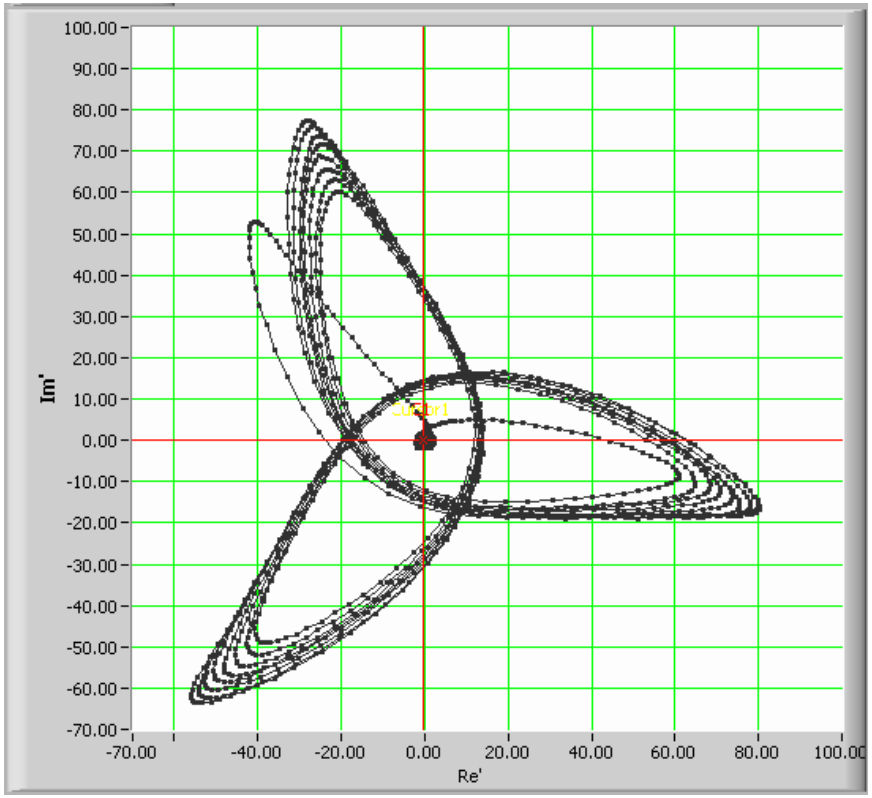
With SLAC Flanges

Target frequency: 11424 MHz at 45°C and vacuum after tuning the frequency by 5.6 MHz higher.

Filling time: 57.5 ns

S11: ~ 0.01

S12: 0.73 (Alexej 0.755 5/29/2008)



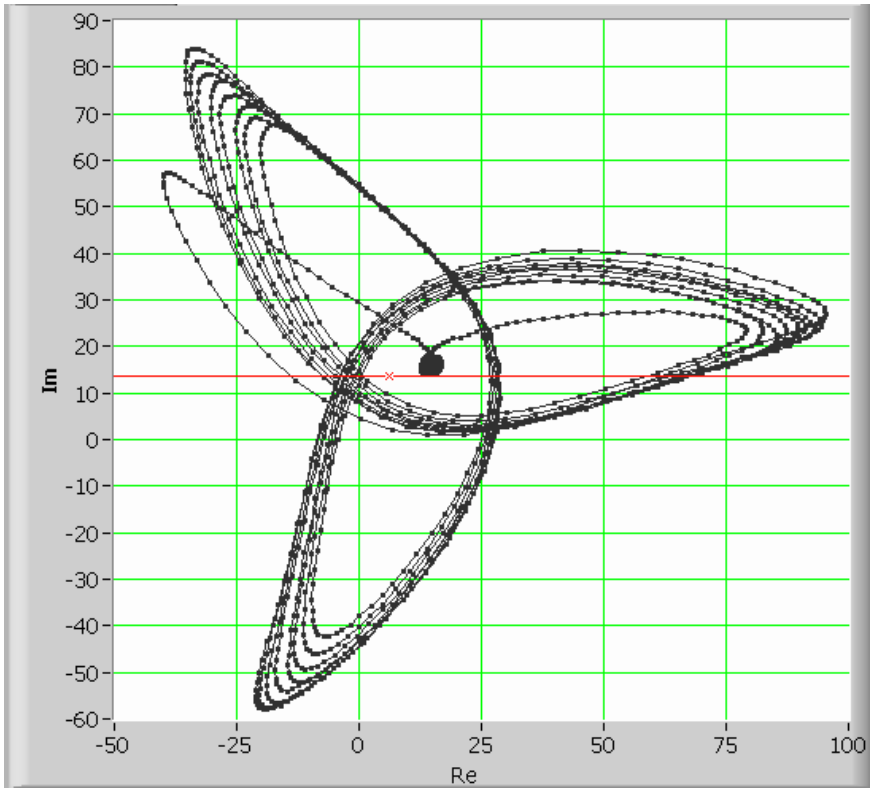
With KEK Flanges

Target frequency: 11424 MHz at 30°C and vacuum after tuning the frequency by 2.5 MHz higher.

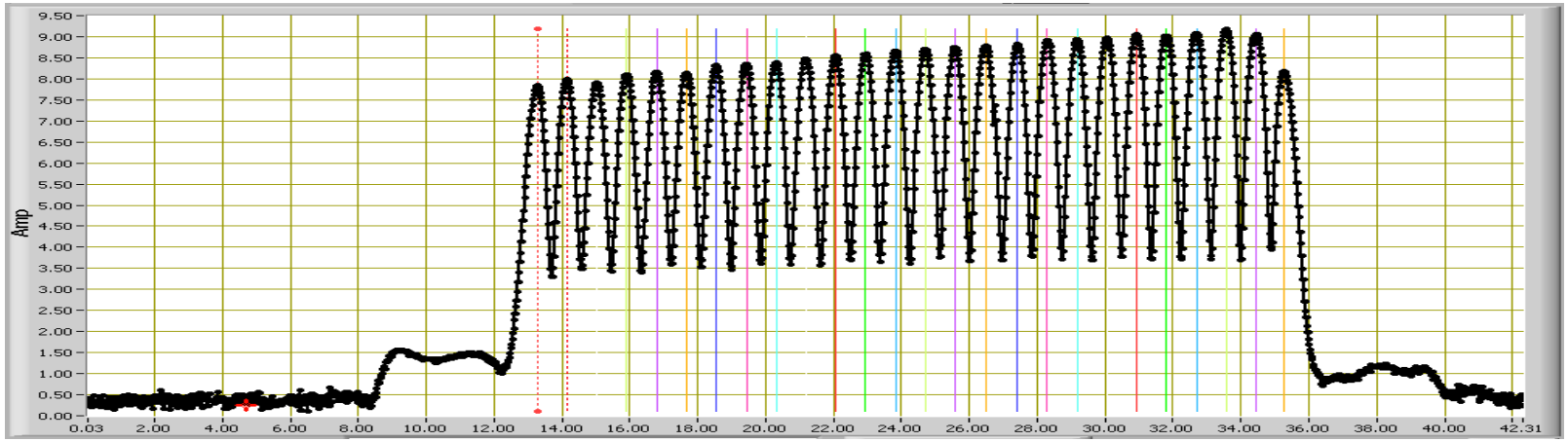
Filling time: 57.5 ns

S11: ~ 0.025

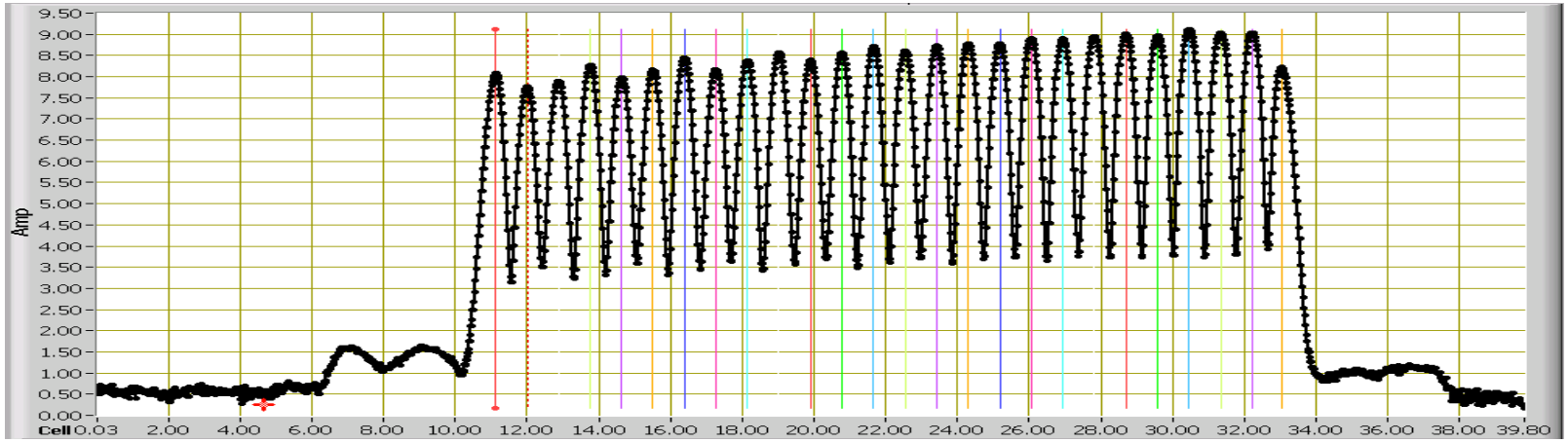
S12: 0.72



Field Amplitude for T24_VG1.8

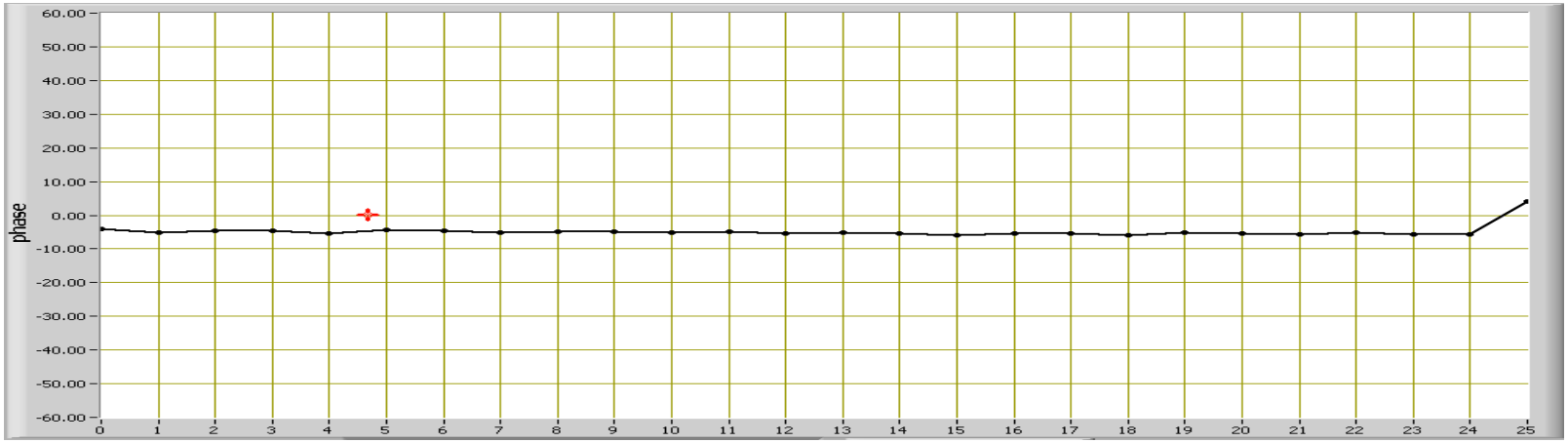


With SLAC Flanges

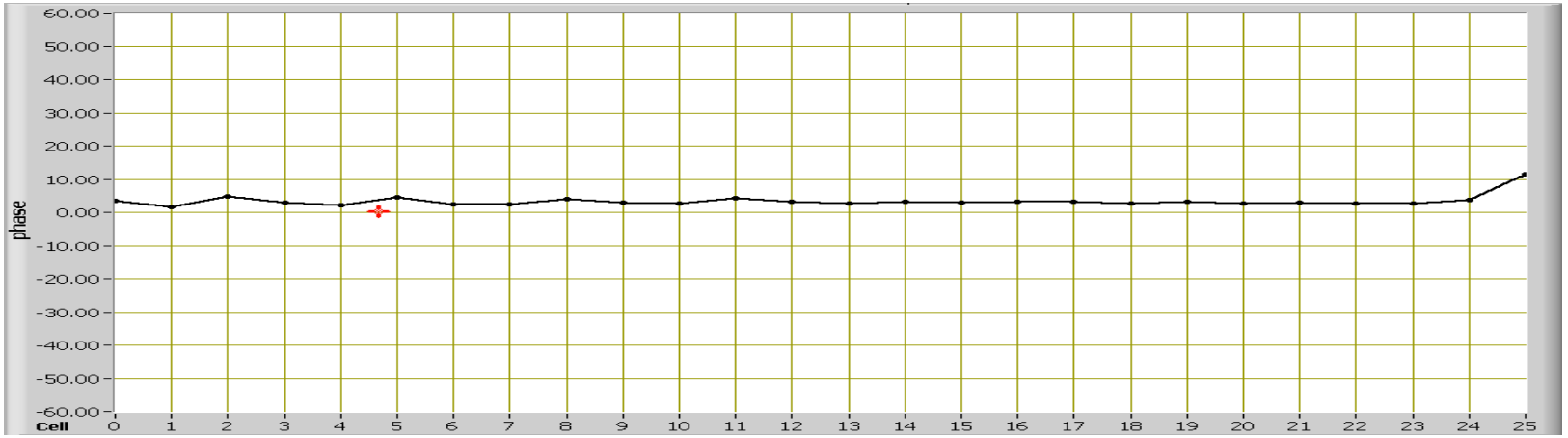


With KEK Flanges

Cell to Cell Phase for T24_VG1.8

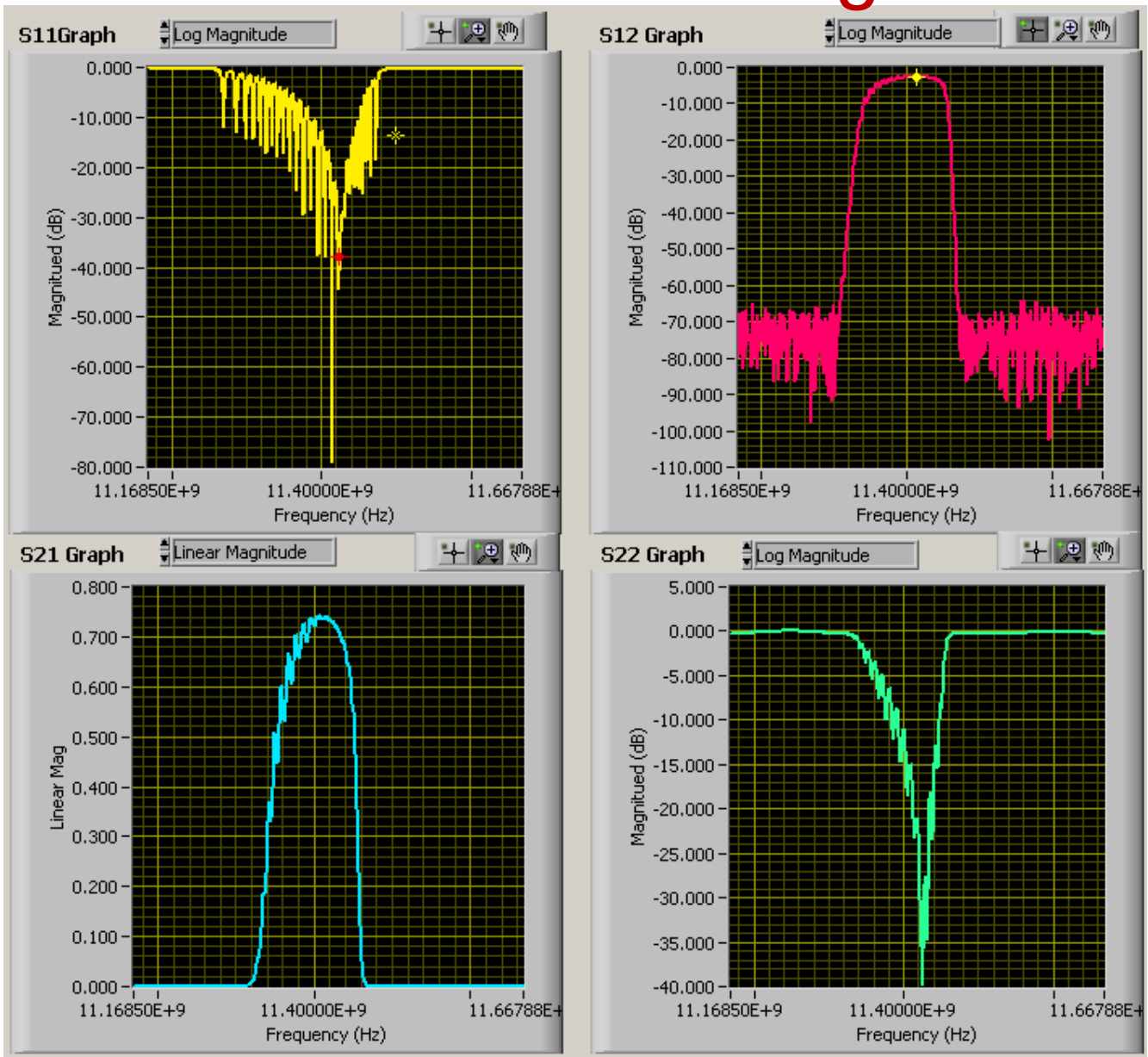


With SLAC Flanges

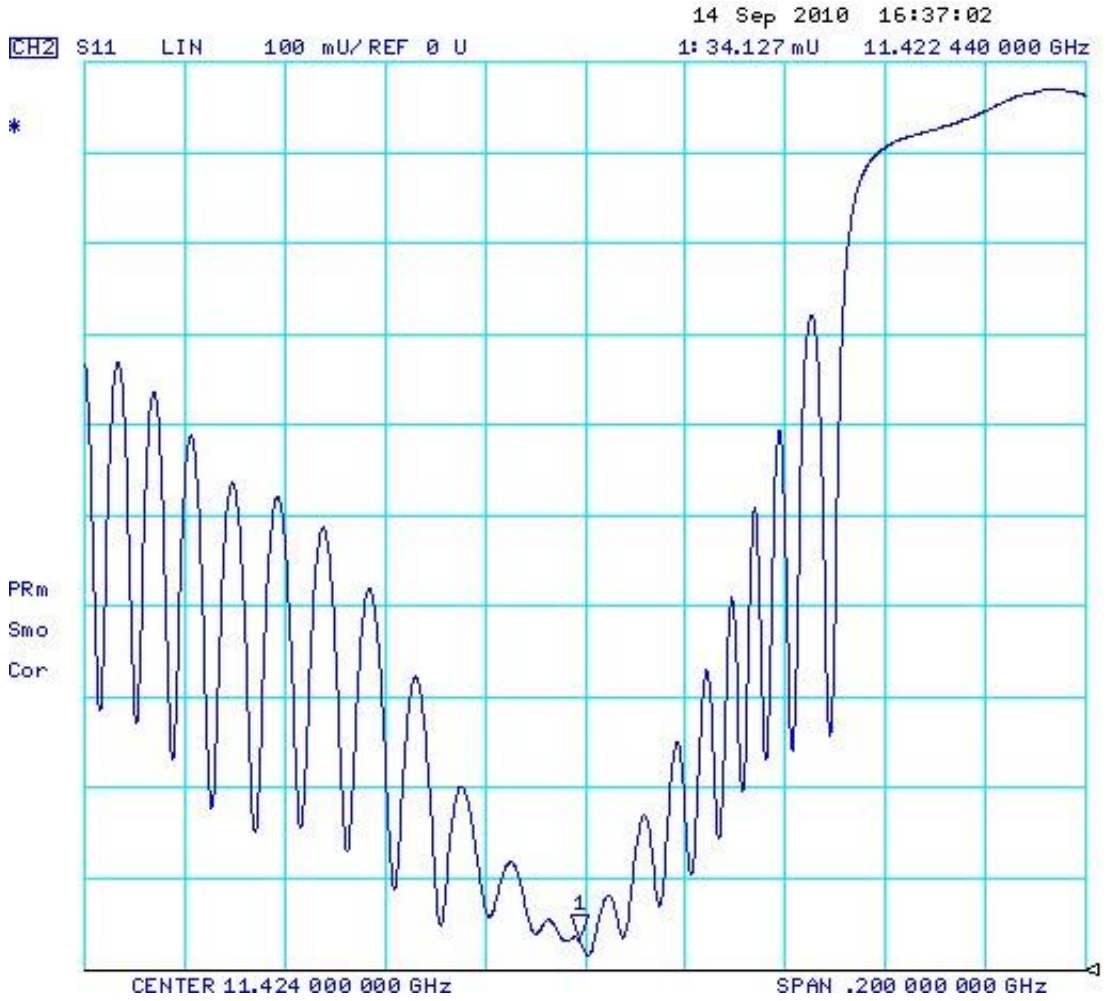


With KEK Flanges

S Parameters for T24_VG1.8 with SLAC Flanges

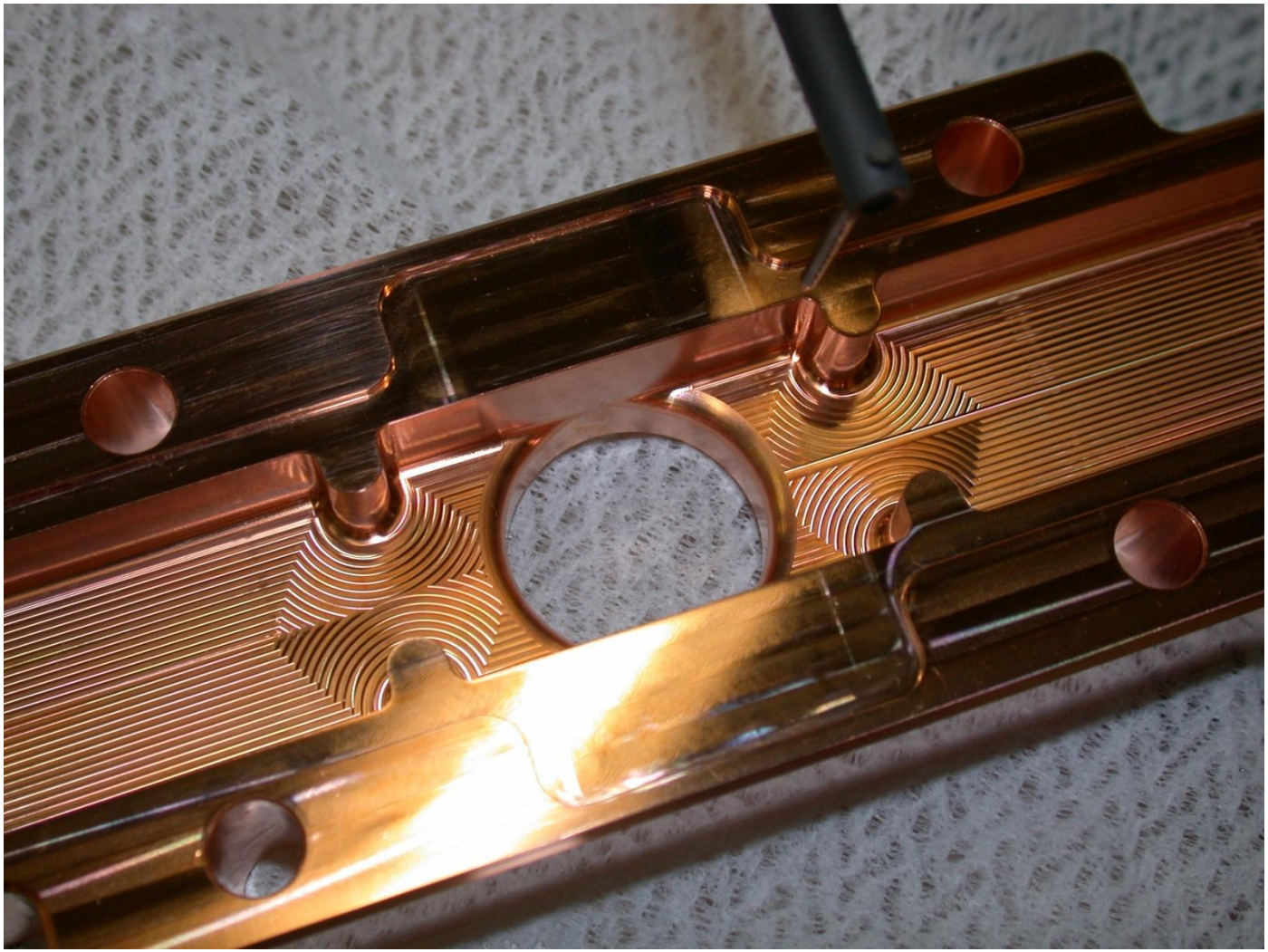


S11 Measurement at NLCTA after Installation of the T24_VG1.8 with SLAC Flanges



$$E_{Ave} = 100MV/m * \sqrt{P_{in}(MW)/41.1}$$

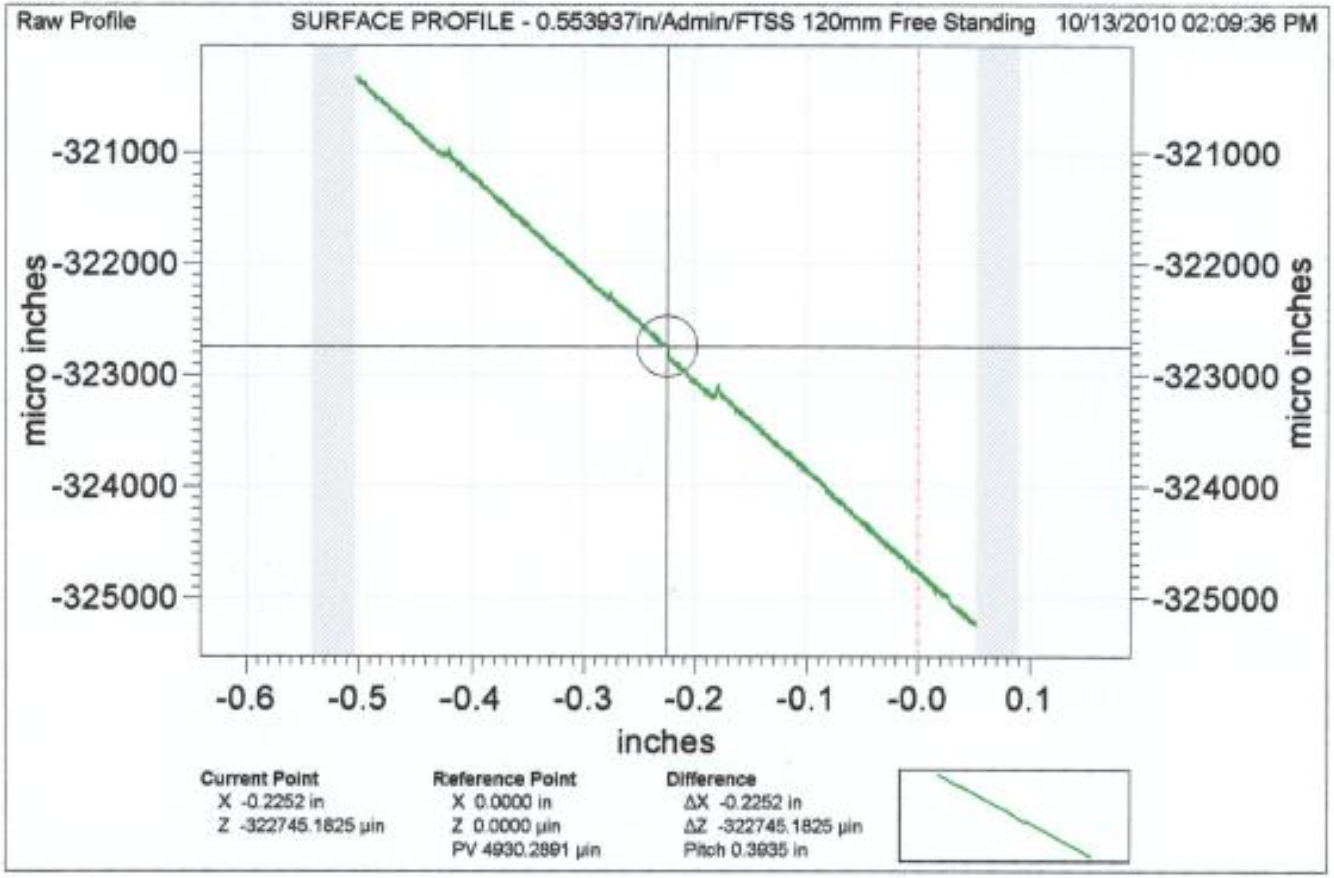
Machining Marks in TD24_VG1.8 Coupler Bodies (4 each)



Measurement for Machining Marks in a TD24_VG1.8 Coupler Body

LEFT SIDE

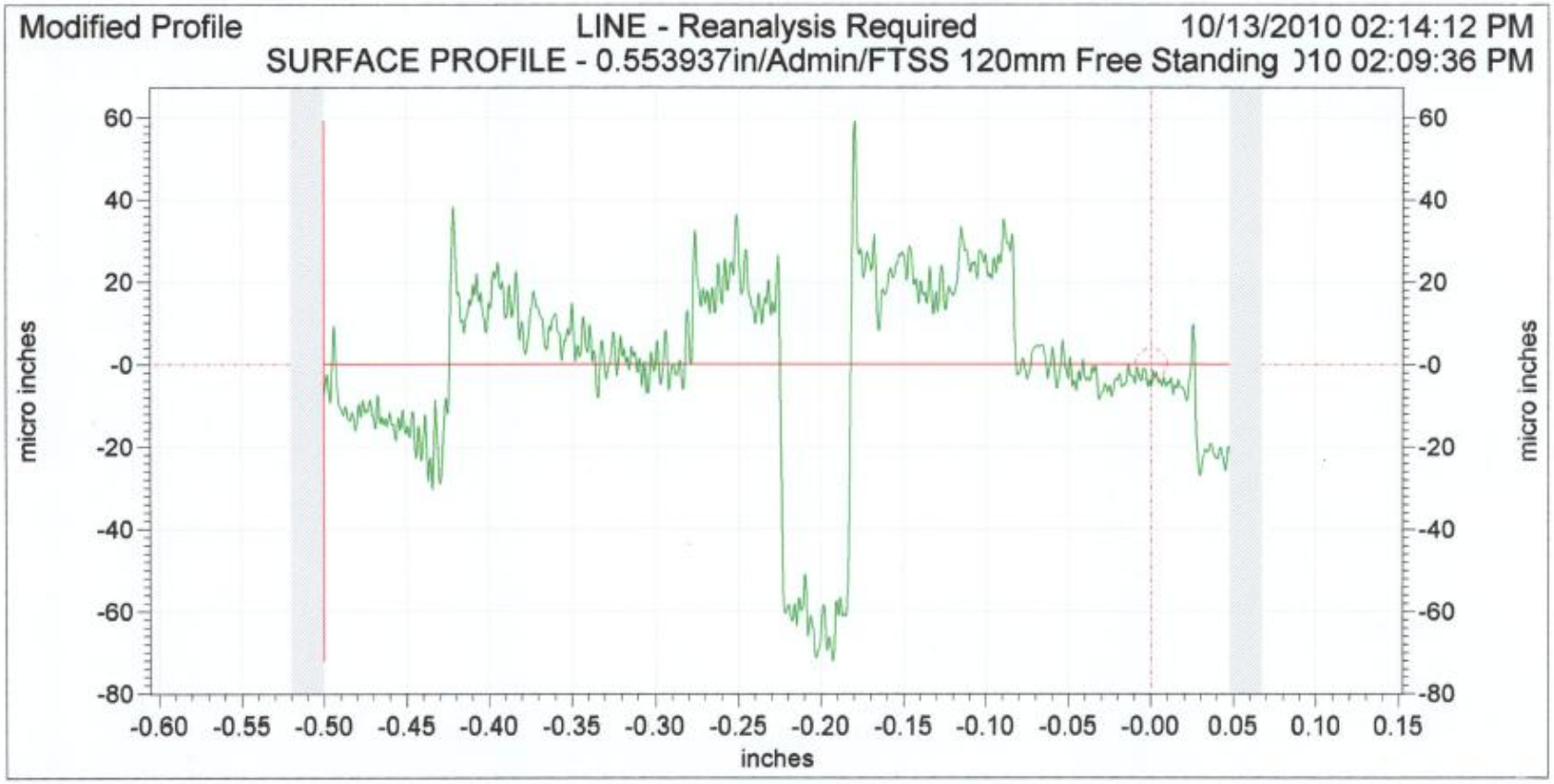
Taylor Hobson



Enlarged View of Fine Machining Marks

14 CB-A
LEFT SIDE

Taylor Hobson



- A 90 µin (2.3 µm Deep, 1 mm Wide) Groove;
- Milling machining marks are very small
- Pursue coupler brazing due to the low field in the waveguide

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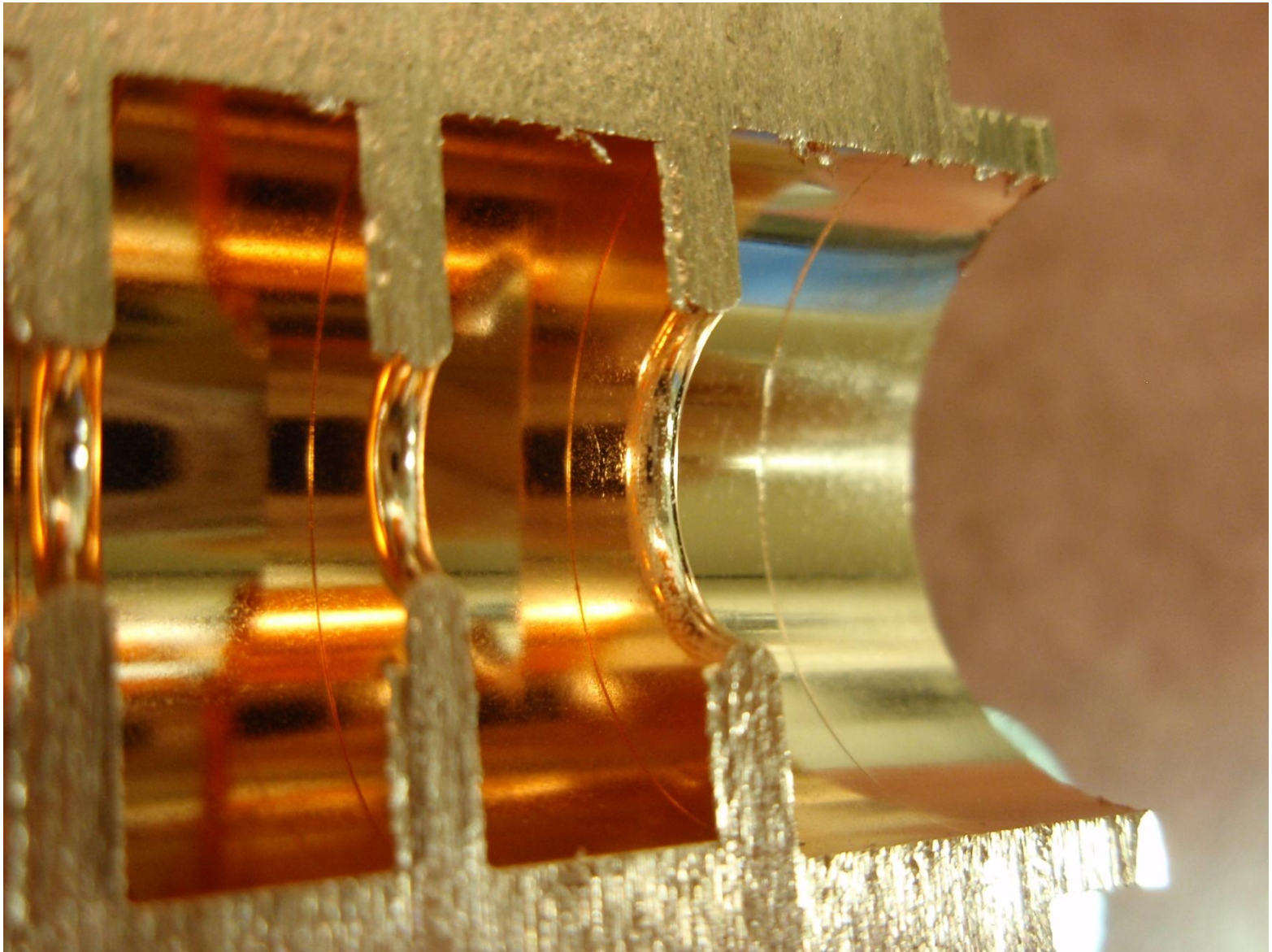
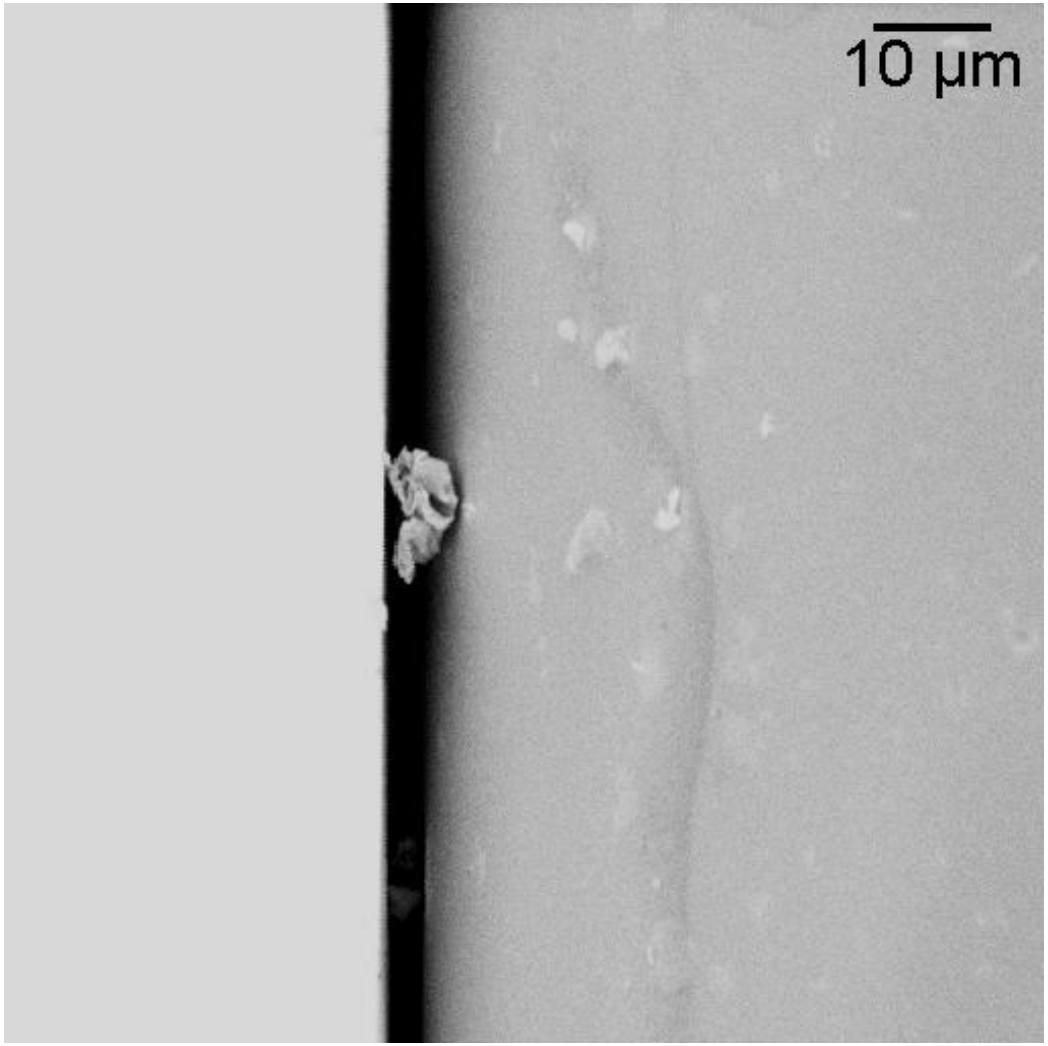
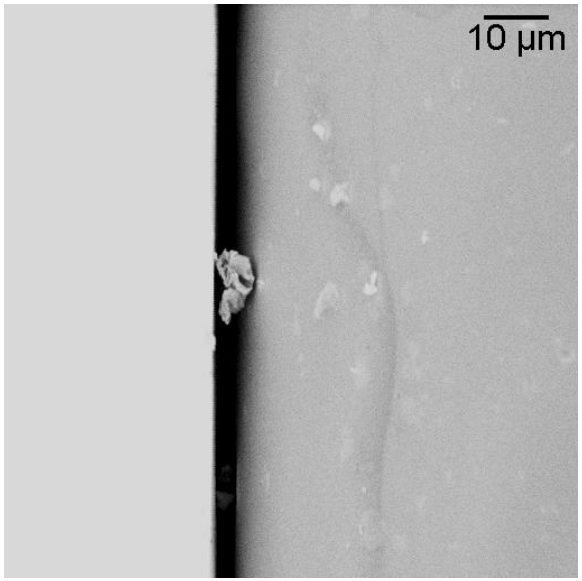
2. Diffusion bonding quality

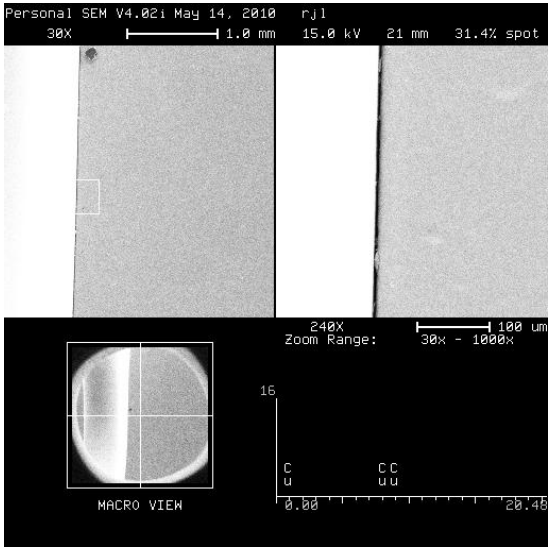
Cutoff Picture Reveals a Possible Bonding Problem



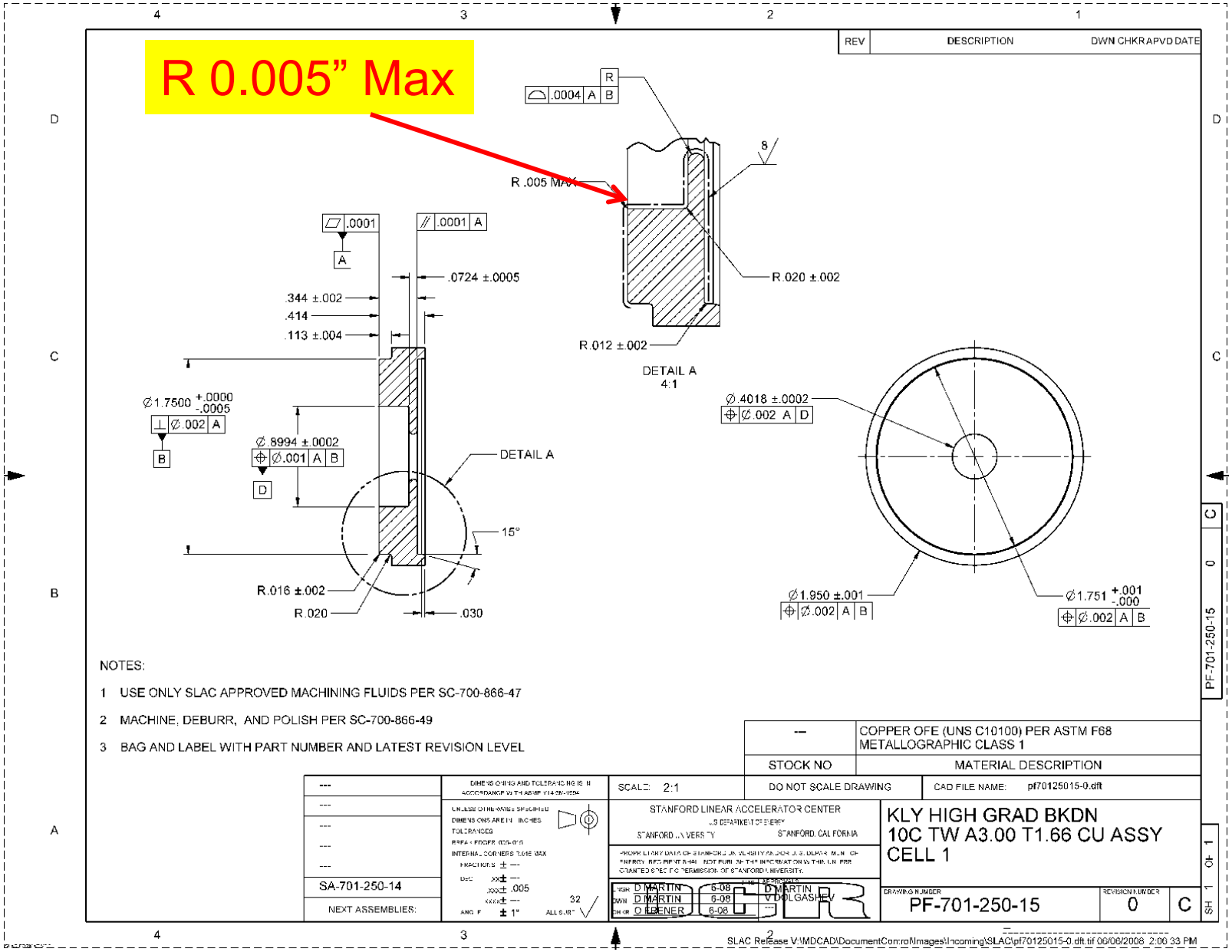
SEM Picture for Bonding Area in a C10 Structure



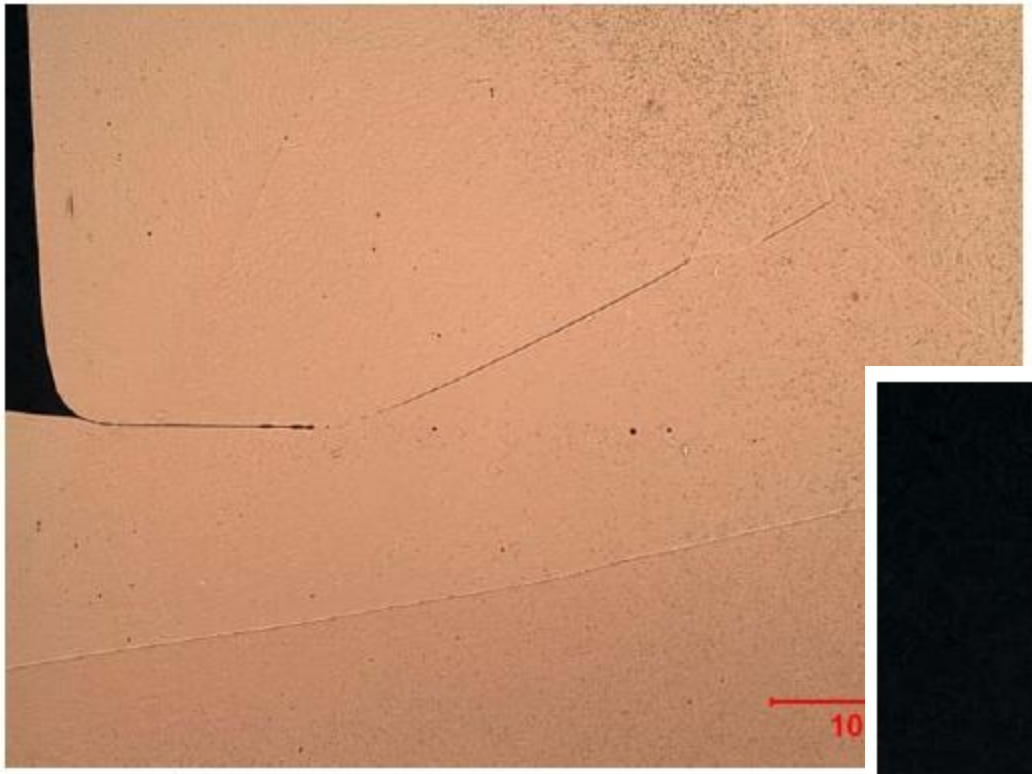




Drawing for a C10 Standard Cup



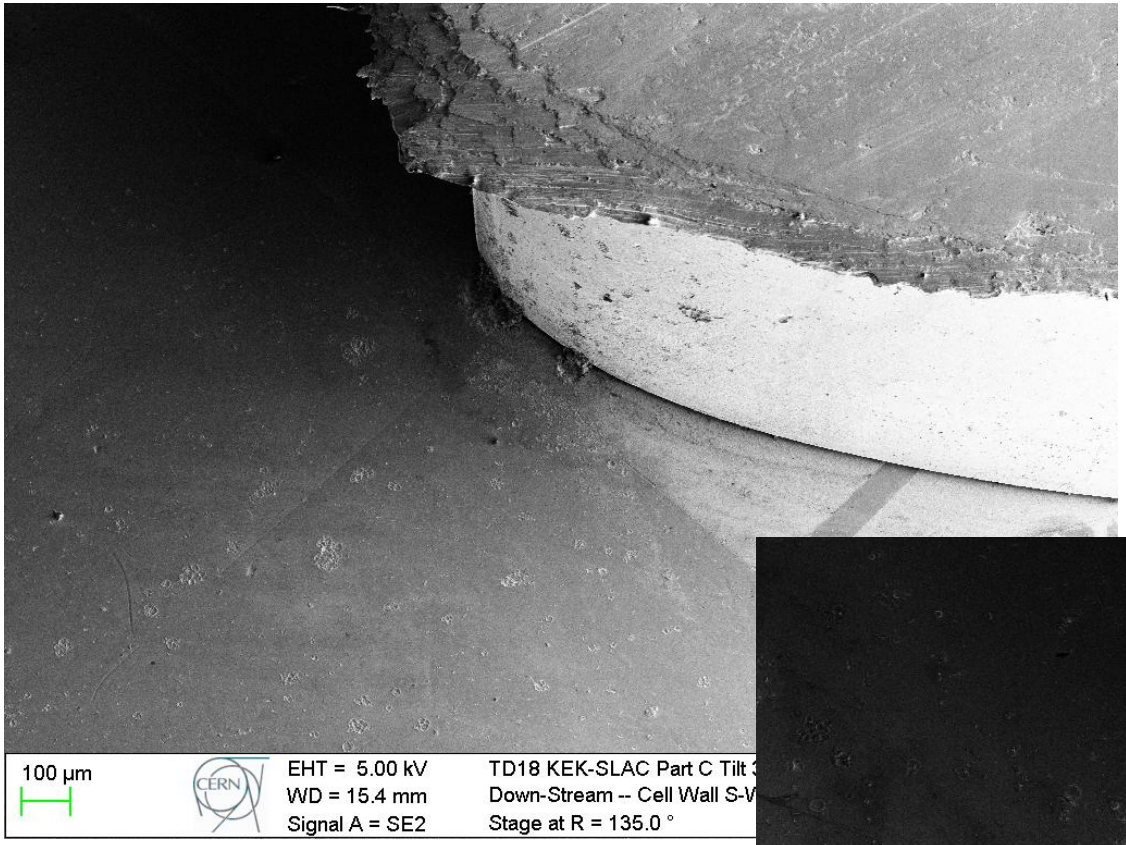
Metallographic Pictures for Bonding Area in a C10 Structure

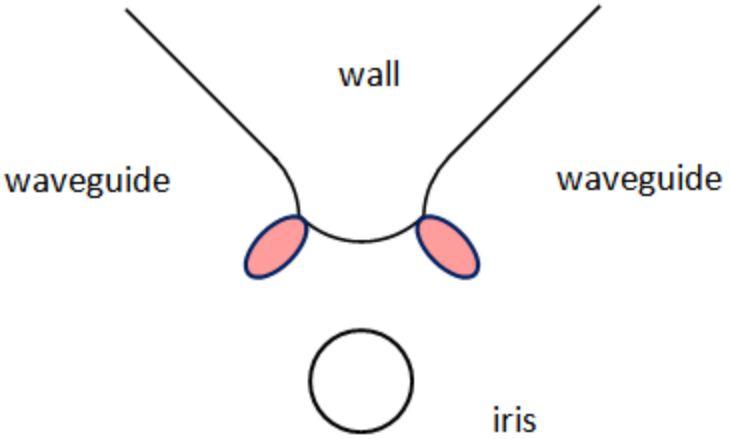


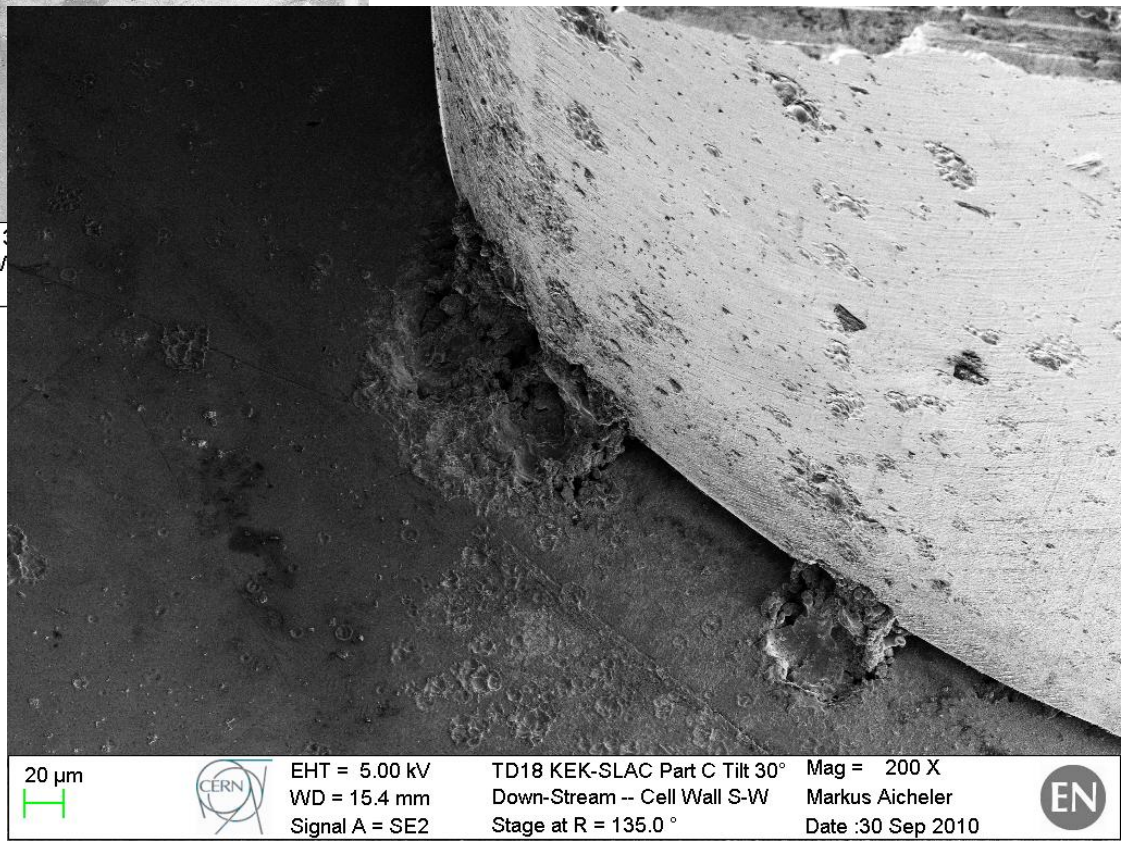
- Very good bonding
- Corner radius is much smaller than drawing specified 0.005" (127 microns). The red bar is 254 microns.

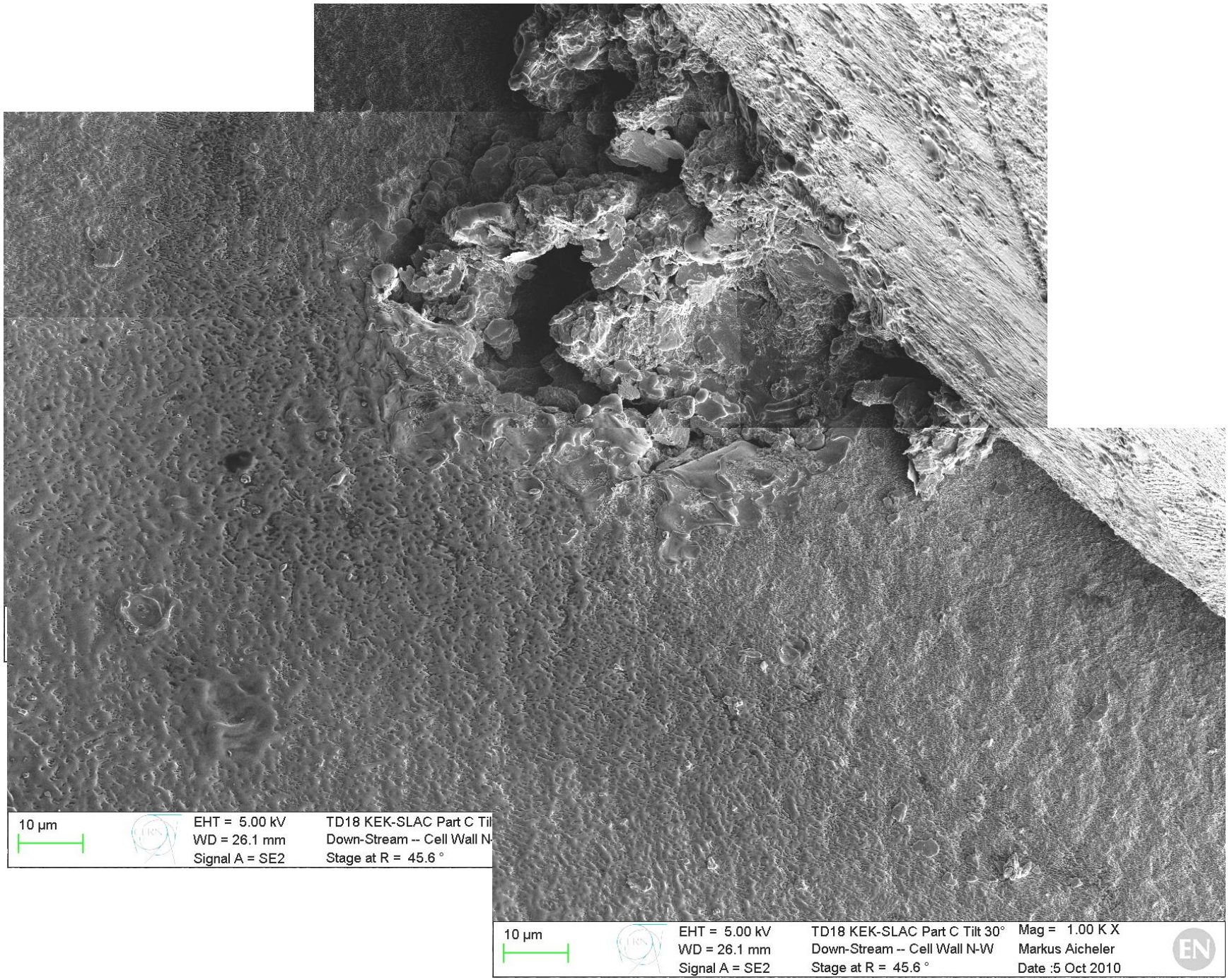
CERN Pictures for TD18 Structure after High Power Test

Part C
Down-stream side – Cell Wall S-W!
Tilt 30°



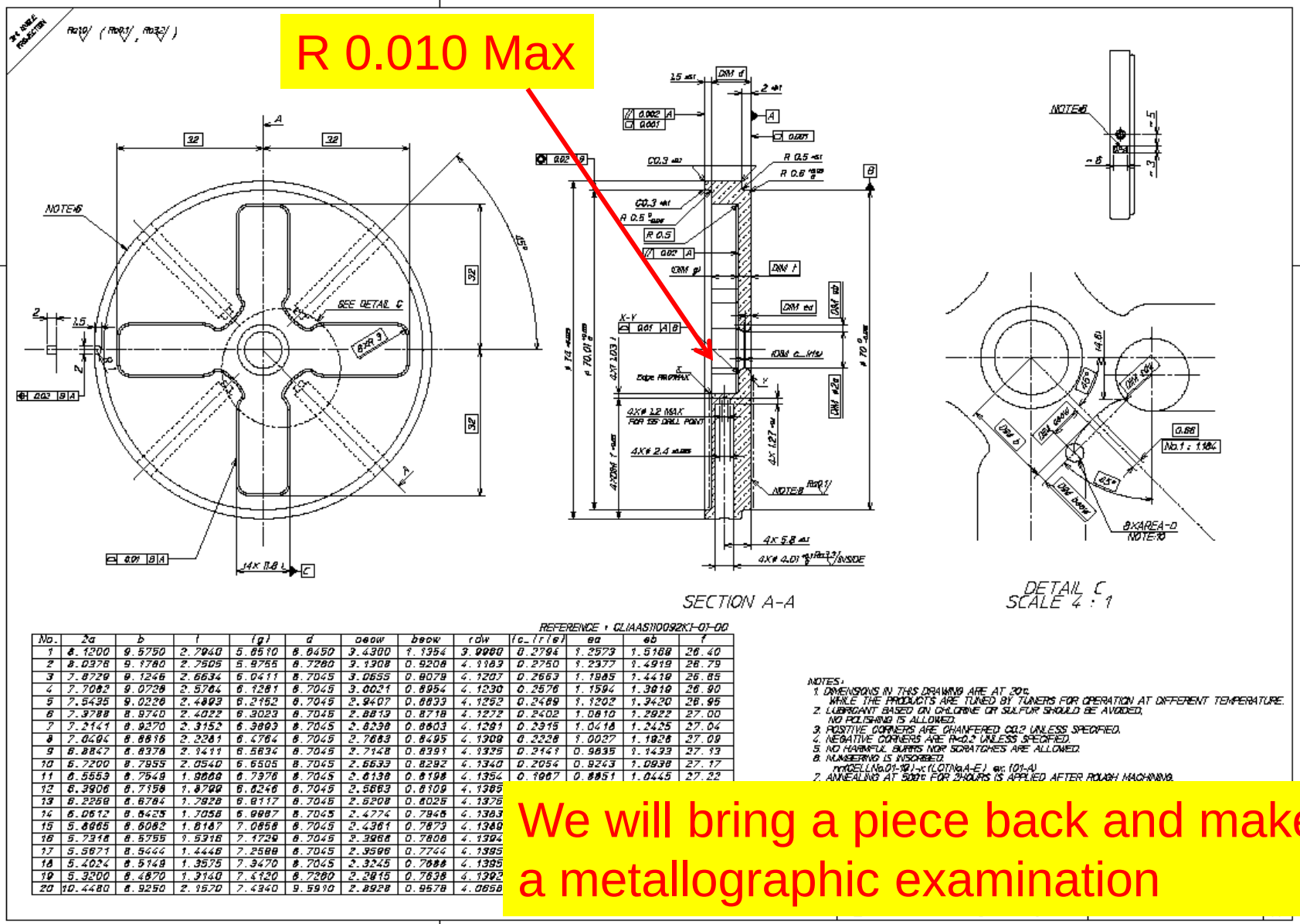





10 µm
EHT = 5.00 kV
WD = 26.1 mm
Signal A = SE2
TD18 KEK-SLAC Part C Til
Down-Stream -- Cell Wall N-
Stage at R = 45.6 °
10 µm
EHT = 5.00 kV
WD = 26.1 mm
Signal A = SE2
TD18 KEK-SLAC Part C Tilt 30°
Down-Stream -- Cell Wall N-W
Stage at R = 45.6 °
Mag = 1.00 K X
Markus Aicheler
Date :5 Oct 2010
EN

Drawing for TD18 Standard Cup

R 0.010 Max



REFERENCE : CLIAAS1100092KI-01-00

No.	2a	b	f	fg1	d	beow	beow	row	fc_1r16	ea	eb	f
1	8.1200	9.5750	2.7940	5.8510	8.6450	3.4300	1.1354	3.9980	0.2794	1.2573	1.5168	26.40
2	8.0378	9.1780	2.7505	5.9755	8.7280	3.1308	0.9208	4.1183	0.2750	1.2377	1.4919	26.79
3	7.8729	9.1246	2.6634	6.0411	8.7045	3.0655	0.8079	4.1207	0.2663	1.1985	1.4419	26.85
4	7.7082	9.0726	2.5764	6.1281	8.7045	3.0021	0.8954	4.1230	0.2576	1.1594	1.3919	26.90
5	7.5435	9.0226	2.4893	6.2152	8.7045	2.9407	0.8833	4.1253	0.2489	1.1202	1.3420	26.95
6	7.3788	8.9740	2.4022	6.3023	8.7045	2.8813	0.8718	4.1272	0.2402	1.0810	1.2922	27.00
7	7.2141	8.9270	2.3152	6.3893	8.7045	2.8238	0.8603	4.1291	0.2315	1.0418	1.2425	27.04
8	7.0494	8.8816	2.2281	6.4764	8.7045	2.7683	0.8495	4.1308	0.2228	1.0027	1.1926	27.09
9	6.8847	8.8378	2.1411	6.5634	8.7045	2.7148	0.8393	4.1325	0.2141	0.9635	1.1433	27.13
10	6.7200	8.7955	2.0540	6.6505	8.7045	2.6633	0.8292	4.1340	0.2054	0.9243	1.0938	27.17
11	6.5553	8.7549	1.9668	6.7376	8.7045	2.6138	0.8198	4.1354	0.1967	0.8851	1.0445	27.22
12	6.3906	8.7159	1.8798	6.8246	8.7045	2.5663	0.8109	4.1365				
13	6.2259	8.6784	1.7928	6.9117	8.7045	2.5208	0.8025	4.1376				
14	6.0612	8.6425	1.7058	6.9987	8.7045	2.4774	0.7946	4.1383				
15	5.8965	8.6082	1.6187	7.0858	8.7045	2.4361	0.7873	4.1389				
16	5.7318	8.5755	1.5316	7.1729	8.7045	2.3968	0.7808	4.1394				
17	5.5671	8.5444	1.4446	7.2599	8.7045	2.3596	0.7744	4.1395				
18	5.4024	8.5149	1.3575	7.3470	8.7045	2.3245	0.7688	4.1395				
19	5.3200	8.4870	1.3140	7.4120	8.7280	2.2915	0.7638	4.1393				
20	10.4480	8.9250	2.1570	7.4340	9.5990	2.8928	0.9578	4.0658				

We will bring a piece back and make a metallographic examination

How much to Define the Bonding Corner Radius

The bonding corner radius seems to be a critical important dimension. It should be practically achievable and reasonable small. The followings are bonding corner radii in drawings for various structures:

C10 (SLAC) 0.005” or 127 microns (actually machined < 20 microns)
T18 (KEK/SLAC) 100 microns
TD18 (KEK/SLAC) 10 microns
T24 (KEK/SLAC) 100 microns
TD24 (KEK/SLAC) 10 microns
T24 (CERN) 50 microns

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3. Surface Preparation – Etching Tests (2002) Revisit and Discussion

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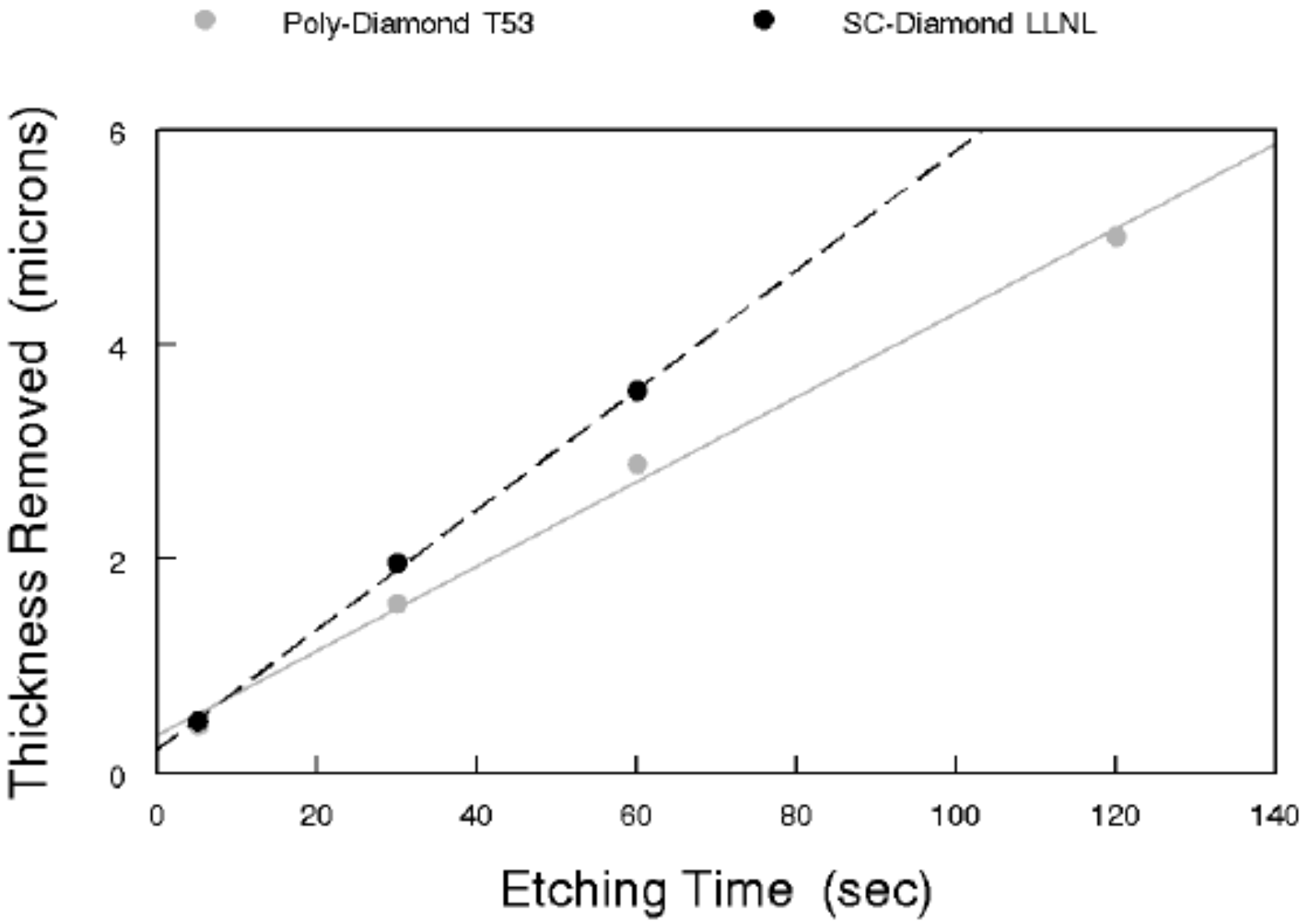
Test Plan

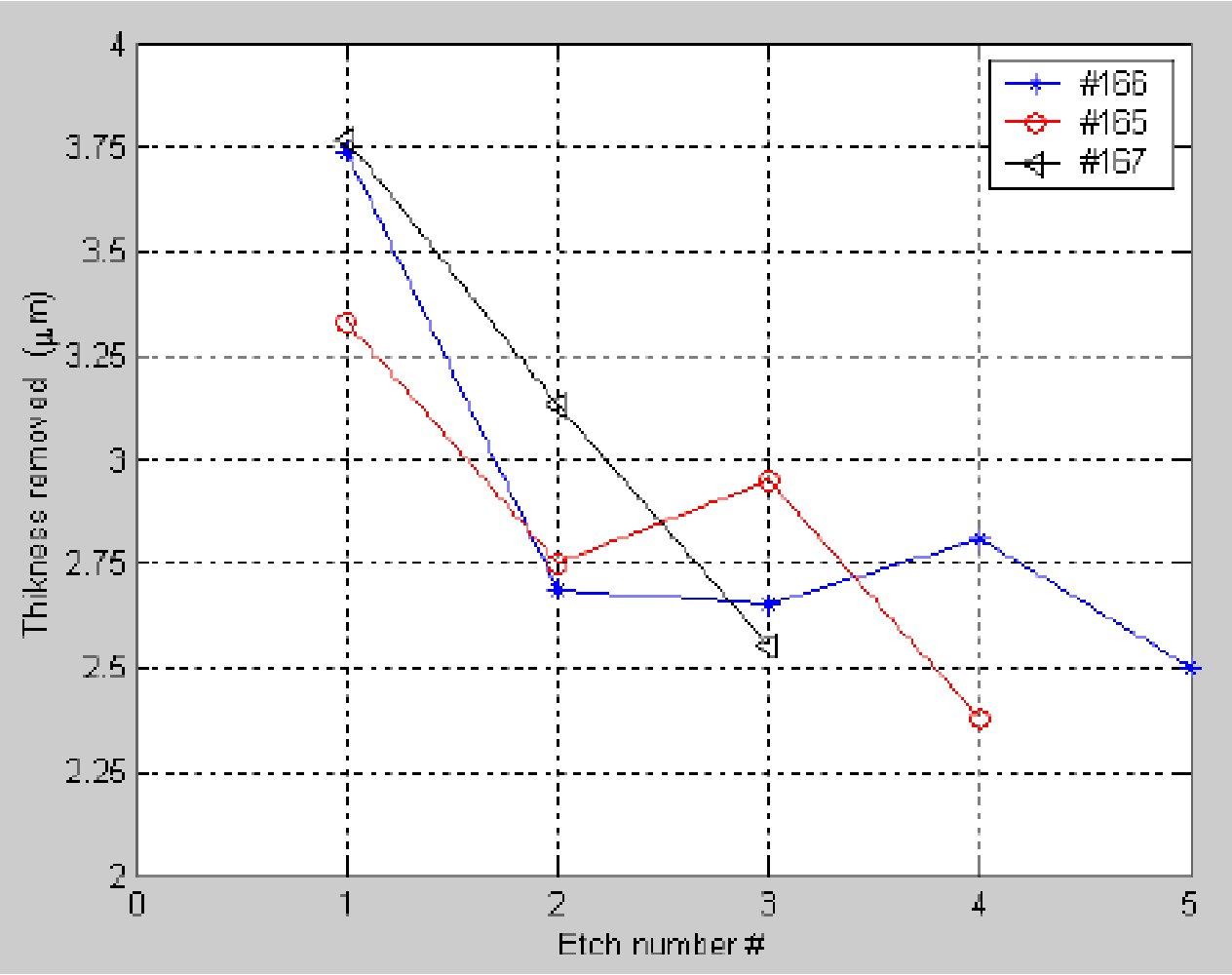
- Use 1" diameter coupons with raised ~ 1 cm^2 "mesa", using material stress-relieved in H_2.
- Finish-machine mesas with polycrystalline (T53) or single-crystal (LLNL) diamond tooling.
- Degrease with perchloro-ethylene, then etch individual coupons for 5, 30, 60 or 120 seconds. H_2-heat treat at 1020°C, 2 hours, followed by 950°C, 4 hours, to simulate degassing and brazing cycles.
- Analyze the mesas at each processing point with microbalance weighing, BSE, atomic force microscopy and, sometimes, XPS, SEM and optical microscopy.

Done by R. Kirby, C. Pearson and F. Pimpec in 2002.

Microbalance Results

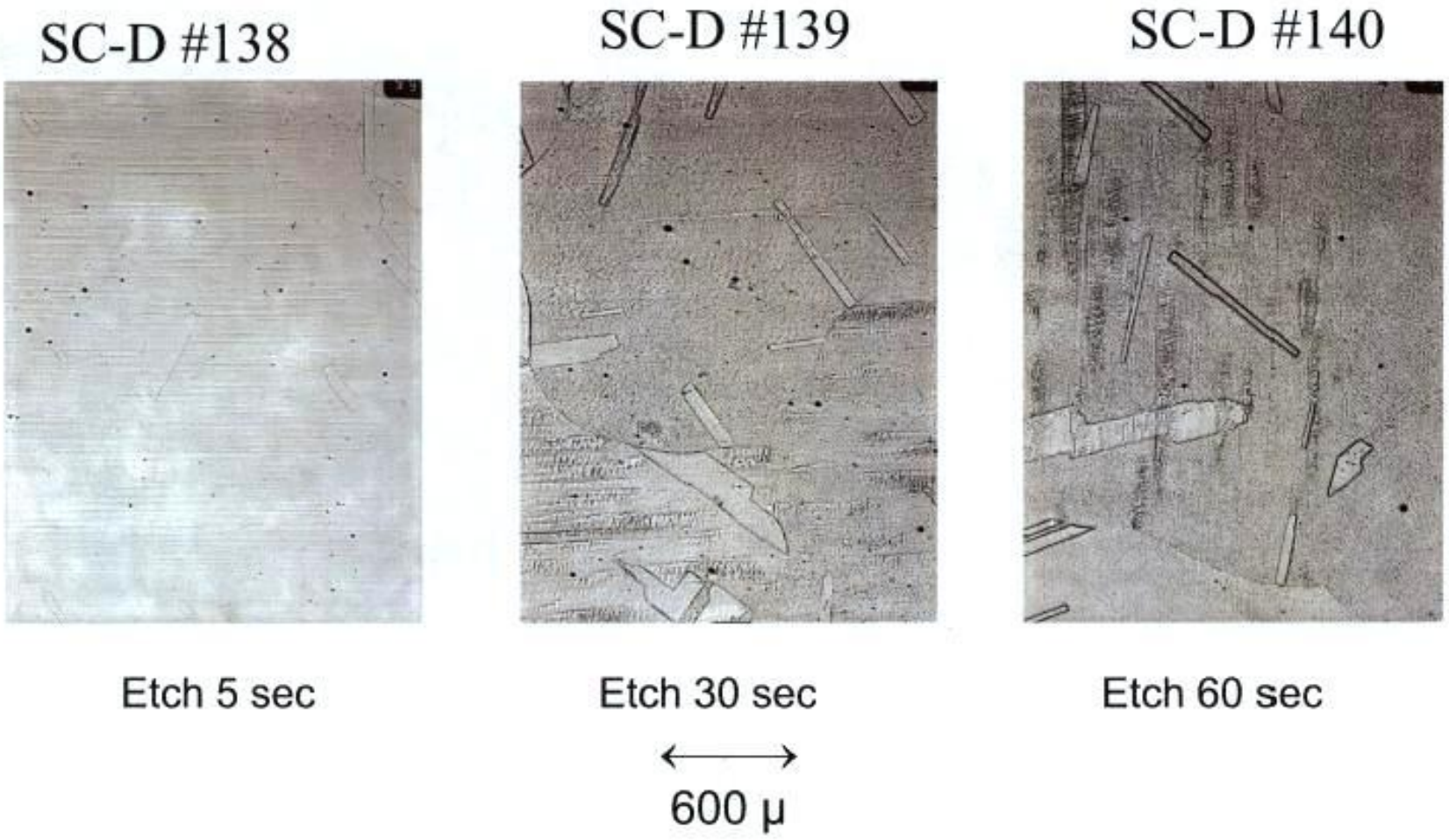


Etch Rate vs. Etch History



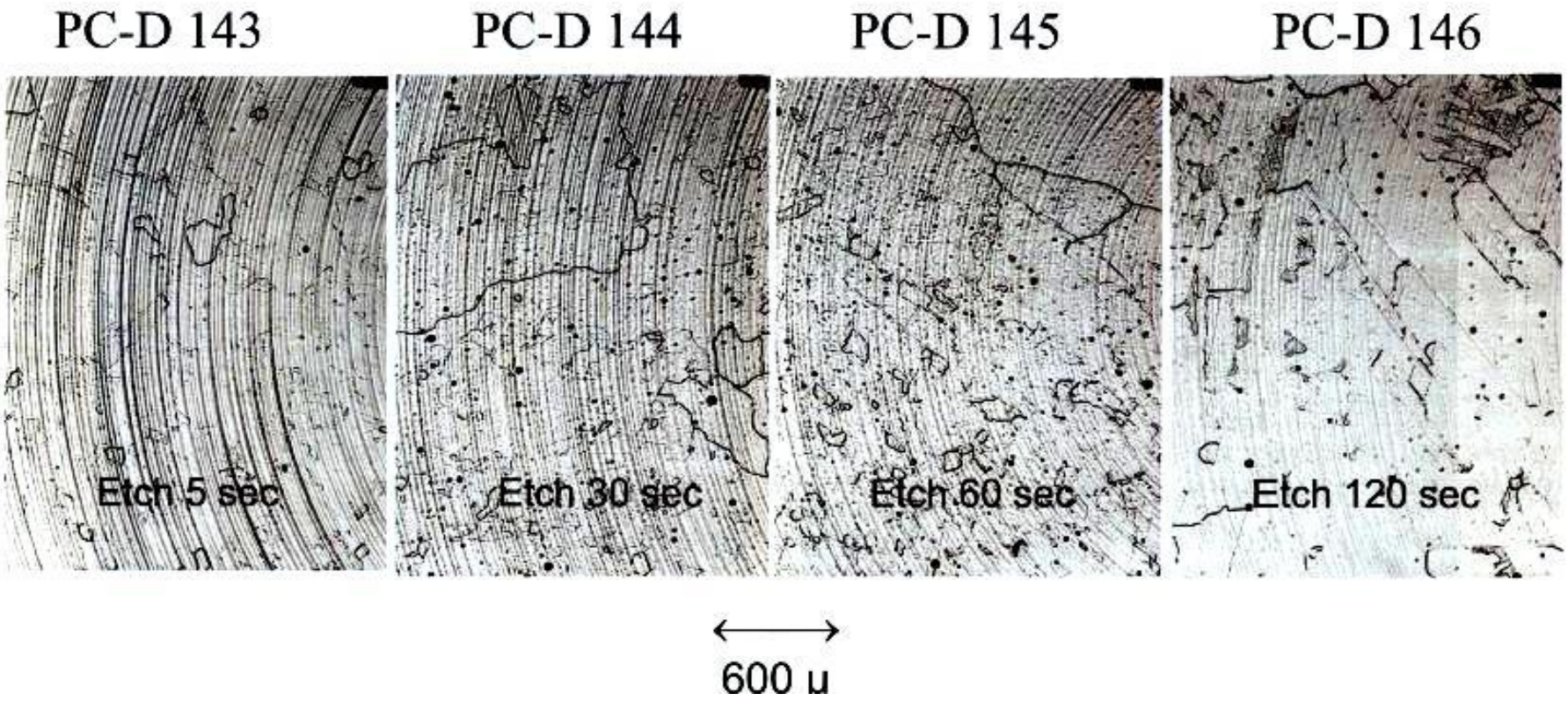
Poly-diamond-machined coupons were not stress-relieved before etching. Error bar on weight measurement is ~± 3.5 nm.

Single-Crystal Diamond Machining



5 seconds BSE image reveals grains;
10 seconds optical shows grain edges developing;
5 – 10 seconds etching is proper.

Polycrystalline Diamond Machining



60 seconds BSE image reveals grains;
60 -120 seconds optical shows grain edges developing;
45 seconds or little more etching is proper.

Microbalance Results

AFM Average Roughness Values

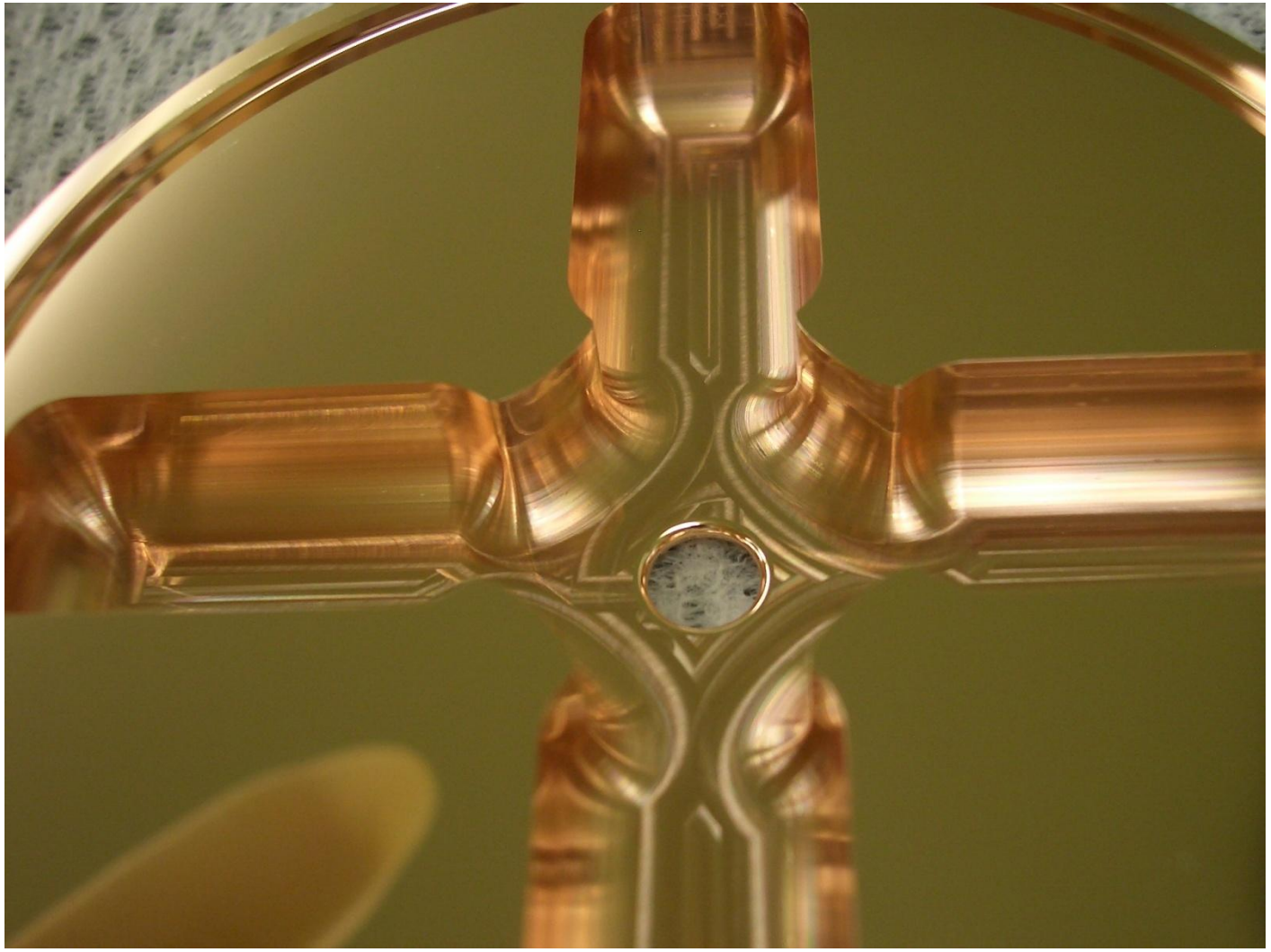
Poly-diamond Machined

Coupon #	143	144	145	146
Bare machining (nm)	128.73	100.63	123.95	130
After ETCH (nm)	105.12 (5")	40.42 (30")	44.41 (60")	90.48 (120")
Heat treatment (nm)	67.15	35.63	31.32	53.06

SC-diamond Machined

Coupon #	137	138	139	140
Bare machining (nm)	4.73	6.27	8.67	3.35
After ETCH (nm)	4.74 (0")	6.32 (5")	12.46 (30")	21.33 (60")
Heat treatment (nm)	/	8.00	19.83	20.60

TD24 Structure Assembly



I'd like to confirm the time of heavier etching for TD24 Cups. 30 seconds?