Surface Inspection of DESY AC71

(It has been reached to 40MV/m, however the last measurement was 26MV/m.)

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History of TESLA AC71

AC71 (made by Accel, Ingot :Wah Chang, Heraeus: 1999 July) , 2001/11/28 ~ 2006/2/21

・Vertical Test at 2 K : 17 times, No T-map data.

1st test (2001/11/28) : Max Eacc= 21.8 MV/m, Qo= 1.1×10^10, No T-map data （800℃ HT）

Too early quench below 22MV/m

EP: total 185 um removed.

9th test (2004/11/12) : Max Eacc= 40.7 MV/m, Qo= 1.1×10^10, No T-map data

→all mode measurement : 41.5 MV/m ~ 48.2 MV/m quench limited.

But, RF problem seen (not stable coupling and P_{ref} at higher power).

Field flatness should be checked.

EP: total 297.9 um removed.

17th test (2006/2/21) : Max Eacc= 25.95 MV/m, Qo= 1.6×10^10, No T-map data

EP: total 461.3 um removed.

AC71 history from TTF database(1)

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Qo @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Qo=1E10	Lowest meas. Qo	Qo @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
AC71	3	Accel	16	185	ep	800	28.Nov.01	1	v1	21.75	1.2E+10	2	bd	8.3	16.24	13.44					
										21.81	1.1E+10	2	bd	14.55	21.77	21.81	1.1E+10				
										21.85	1.1E+10	1.99	bd	15.31	19.14	21.85	1.1E+10				
				Aim: test of cavity | first test | After EP at KEK						**Result:** not ok: Too early quench below 22 MV/m							**Remark:**				
				185	ep	800	11.Dec.01	2	v1	21.41	1.2E+10	2	bd	15.38	18.96	21.41	1.2E+10				
										20.38	1.2E+10	2	bd	11.26	19.11	20.38	1.2E+10				
										21.74	1.2E+10	1.99	bd	11.44	19.48	21.74	1.2E+10				
				Aim: test of cavity | new test | T-mapping added or fail						**Result:** ok							**Remark:**				
				202.5	bcp	800	08.Jul.02	3	v1	31.16	3.7E+09	2.01	pwr	22.52	28.62	24.82		1.5E+10		28.55	
										32.27	2.6E+09	1.98	pwr	23.61	29.03	27.88		1.6E+10		28.65	
										31.49	2.3E+09	2.01	pwr	22.29	27.71	26.49		1.4E+10		27.33	
										31.94	2.9E+09	2	pwr	23.56	28.79	27.32		1.4E+10		28.24	
				Aim: test of cavity | new preparation | low voltage quench (< 25 MV/m)						**Result:** ok							**Remark:** Big improvement: 32.2 MV/m limited by power,Q = 2.6E +9.Low FE started at 23 MV/m (maximum level 0.0442 mGy/min).During 1st pi mode measurement MP quenches and x rays started at 15 MV/m, fast processable.At 25 MV/m LLP seen.All modes limited by power:				
				202.5	bcp	800	25.Jul.02	4	v2	31.65	4.6E+09	2	pwr	24.01		28.37		1.3E+10		29.1	
										31.5	4.6E+09	2	pwr	26.21		28.29		1.4E+10		28.99	
										31.45	4.6E+09	2	pwr	26.67		28.23		1.4E+10		28.95	
				Aim: test of cavity | new preparation | After baking at 128 C						**Result:** ok							**Remark:** The same result like in previuos test : Eaccmax = 31.5 MV/m, Q = 4.6E+9, limited by power.Low FE started at 25 MV/m. MP region (20-25 MV/m) fast processable.Above 25 MV/m Q drop seen.. MP seen in all modes exept 3/9, 2/9 and 1/9 pi modes. Very good cavity.				

AC71 history from TTF database(2)

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Qo @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Qo=1E+10	Lowest meas. Qo	Qo @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
AC71	3	Accel	16	249.1	ep	800	16.Apr.04	5	v2	29.96	5.5E+09	1.99	pwr	11.92	20.38	26.68		1.2E+10		27.96	
										29.55	6.4E+09	2	pwr	20.12	24.16	26.23		1.2E+10		28.17	
										28.8	9.7E+09	1.99	bd	18.48	22.45	28.02		1.6E+10			
										28.26	7.6E+09	2	bd	15.13	19.03	25.92		1.3E+10		27.76	
				Aim: test of cavity | new preparation | 2 hours EP at DESY						**Result:** ok										**Remark:** Eacc= 28.2 MV/m , Q=6.4E +9,limited by quench, with strong FE starting at 15 MV/m. During first measurement LPP at 18 MV/m seen, long MP time about 1 hour. No Q disease was found after warm-up to 100 -150 K . Fields in cells 33.9 to 40 .0 MV/m found.				
				249.1	ep	800	07.May.04	6	v2	5.62	4.4E+08	2	pwr	5.22	5.61	4.35				5.61	
										5.46	4.7E+08	2	pwr	5		4.59					
										5.55	3.2E+08	2	pwr	5		4.58					
										5.56	2.7E+08	2	pwr	4.94	5.52	4.51				5.49	
				Aim: test of cavity | new preparation | high field emission						**Result:** not ok										**Remark:** Field emission is enhanced at the last test although 9xHPR was applied. Field emitter located in cell 5. Other cells have gradients from 23 to 34 MV/m.			
				297.9	ep	800	19.Oct.04	7	v1	30.31	7.4E+09	2	pwr	18.68	24.03	29.52		1.3E+10		29.74	
										30.46	7.5E+09	1.99	pwr	26.19		29.53		1.6E+10		29.81	
										31.25	5.2E+09	2.01	pwr	24.37		29.53		1.6E+10		29.78	
										29.88	4.7E+09	2	pwr	23.4		27.92		1.4E+10		28.48	
				Aim: test of cavity | new preparation | low voltage quench (< 25 MV/m)						**Result:** ok										**Remark:** Cavity again reached above 30 MV.m.For pi mode after MM Emax=31.2 MV/m,Q= 5.2E+9, limited by power.FE started at 23 MV/m.During 1st run LPP seen at 26 MV/m.All modes are limited by power.Fields in cells are between 33.4 and 36.9 MV/m. Q slope is seen.				
				297.9	ep	800	04.Nov.04	8	v2	39.23	8.9E+09	2	rf	24.3	33.06	37.52		1.5E+10		33.81	
				Aim: test of cavity | new test | after baking at 120 C						**Result:** ok										**Remark:** Cavity showed very good Q and field:39.2 MV/m, Q = 8.9E+9, RF limited, with x rays start at 24 MV/m.During test changes of reflected and transmitted power were observed and FE level.. Cavity should be checked for field flatness and for burned parts.			

AC71 history from TTF database(3)

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Qo @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Qo=1E+10	Lowest meas. Qo	Qo @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
AC71	3	Accel	16	297.9	ep	800	12.Nov.04	9	v1	40.66	1.1E+10	2	bd	27.57	35.77	39.89		1.5E+10		34.25	
										39.98	1.0E+10	2	bd	27.62	38.58	39.74		1.5E+10		34.18	
										40.42	1.4E+10	2	bd	25.72	35.52	40.42	1.4E+10	1.5E+10		34.1	
										39.22	1.1E+10	2	bd	34.14	37.31	39.22	1.1E+10	1.6E+10		34.74	
				Aim: test of cavity | new test | Change of insert to find the reason of RF problems						**Result:** ok								**Remark:** The same result:40 MV/m,Q=1.4E+10,limited by quench.FE start at 26 MV/m.Modes measur.:all modes quench limited,fields:41.5 to 48.2 MV/m.Field flatness should be checked.Still RF problems seen (not stable coupling and Pref at higher power).				
				297.9	ep	800	12.Jan.05	10	v1	20.78	3.6E+09	2	fe	8.73	14.33	15.59				18.94	
										19.44	6.3E+09	1.99	fe	13.62	16.54	17.96					
				Aim: test of cavity | new preparation | New antenna mounted for founding source of RF problems						**Result:** ok								**Remark:** Strong FE started already at 8.3 MV/m .Field only 19.4 MV/m, Q = 6.3 E +9,,FE level about 0.2 mGy/mi.New EP is proposed to remove field emitter. RF problems with changes of Pref, Ptrans and coupling were found, like in previous tests.				
				346.7	ep	800	18.Mar.05	11	v1	20.73	7.1E+09	2	rf	15.59	16.67	18.16					
										22.47	7.3E+09	2	rf	21.82	22.09	20.58					
										28.66	3.1E+09	2	pwr	14.8	18.73	20.52		7.1E+09		24.09	
										28.67	3.2E+09	1.99	pwr	16.25	20.2	23.56		1.0E+10		26.12	
										29.58	3.9E+09	2	pwr	17.54	21.3	25.43		1.2E+10		27.21	
										14.14	1.4E+10	2	rf			14.14	1.4E+10				
										30.09	3.9E+09	2	pwr	17.22	21.38	26.14		1.2E+10		27.65	
										25.63	5.8E+09	2	rf	16.05	24.25	21.45		8.4E+09		25.03	
				Aim: test of cavity | new preparation | After 40 um EP at DESY, 7 x HPR, kept at 100-150 K						**Result:** not ok								**Remark:** Cavity showed no Q disease.Max. gradient 30.9 MV/m, Q = 1.8 E10. limited by power, with strong FE from 15 MV/m for best pi mode meas. In 1st pi mode run FE already at 9 MV/m. Modes limited by power or RF problems. Fields found between 34.5 to 37.3 MV/m.				

AC71 history from TTF database(4)

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Qo @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Qo=1E+10	Lowest meas. Qo	Qo @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
AC71	3	Accel	16	351.7	ep+	800	18.Apr.05	12	v1	25.16	2.9E+09	2	pwr	12.91	17.41	17.45		4.1E+09		22.19	
										25.26	2.9E+09	2	pwr	13.52	15.24	20.35		5.1E+09		23.12	
										26.41	3.2E+09	2	bd	14.06	17.23	20.58		6.9E+09		24.04	
				Aim: test of cavity | new preparation | high field emission						**Result:** not ok										**Remark:** No improvement : now cavity is limited by quench and huge FE (2 mGy/min) at 26.4 MV/m, Q=3.2E+9. Practically no MP and processing. FE seen in each mode. Mode measurement: fields in particular cells between 30.8 and 35.5 MV/m.			
				412.9	ep	800	27.Oct.05	13	v1	25.89	3.2E+09	2	pwr					3.5E+09		19.38	
				Aim: test of cavity | new preparation | high field emission						**Result:** ok										**Remark:** Q disease found for this cavity: starting Q=8E+9, final 3.2E+8, limited by power at 25.9 MV/m. No x rays, no MP observed. Cavity will be now warm-up to RT and fast cooldown again. In last test 12 no Q diesease was detected. Why is now seen?			
				412.9	ep	800	28.Oct.05	14	v1	31.32	5.2E+09	2.01	pwr	24.37	30.86	29.65		1.6E+10		29.86	
										27.64	9.7E+09	2	bd	18.23	22.4	27.47		1.4E+10			
				Aim: test of cavity | new test | Warmup to RT and cooldown-was Q disease earlier						**Result:** ok										**Remark:** No Q disease now. In 1st pi mode run cavity was limited by power at 31.2 MV/m, Q=5.2 E+9, with low x rays.MM:fields between 27.6 and 35.2 MV/m.Field emission was activated during MM and finally cavity reached 27.6 MV/m, Q=9.7E+9, with stronger x rays			
				461.3	ep	800	12.Jan.06	15	v2	30.24	5.0E+09	1.99	pwr	15.04	17.49	28.62		1.4E+10		28.92	
										30.29	4.9E+09	2	pwr	21.01	25.13	28.72		1.9E+10		28.98	
										30.35	4.8E+09	1.99	pwr	20.98	23.61	28.72		1.8E+10		28.97	
				Aim: test of cavity | new preparation | Q disease found earlier for this cavity						**Result:** ok										**Remark:** No Q disease found now for the cavity. Cavity is limited by power at 30.3 MV/m,Q=4.8E+9, with FE from 20 MV/m.In 1st run FE onset was at 15 MV/m, at 20 MV/m LPP observed. No MP was seen. All modes limited by power, only last 2 lowest modes by quench.			

AC71 history from TTF database(5)

Cavity Information				CW-Test Results						Power Rise Results											
														FE Onset							
Cavity	Production No.	Firm	Ingot No.	Removed Material [µm]	Cavity Status	Last HT [°C] before Test	Test Date	Test No.	Test Location	Max. Eacc [MV/m]	Qo @ Max. Eacc	Temperature [K]	Limitation	@ 4E-4 [mGy/min]	@ 1E-2 [mGy/min]	Eacc @ Qo=1E+10	Lowest meas. Qo	Qo @ Eacc=23.5 [MV/m]	Lowest meas. Eacc	Eacc @ (100W/9)*cell#	Lowest Loss> (100W/9)*cell#
AC71	3	Accel	16	461.3	ep	800	21.Feb.06	17	v2	25.95	1.6E+10	2	bd	21	24.07	25.95	1.6E+10	1.9E+10			

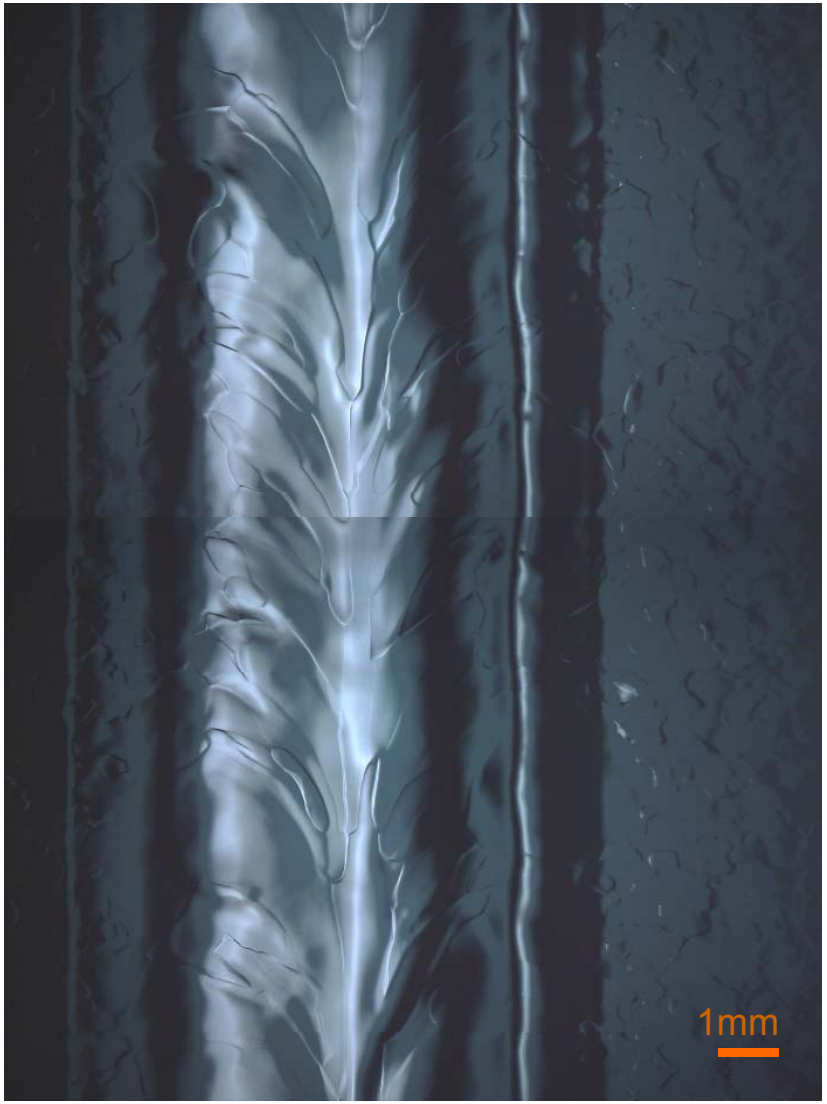
Aim: test of cavity | new test | Measurement with a spectrum analyser

Result: ok

Remark: The same result like in previous test:Eacc=26.0 MV/m, Q=1.6E+10, BD, with moderate x rays from 23 MV/m.No 7/9 pi mode found with spectrum analyser, also other modes not seen.MM:only 7/9 pi mode measured,Result the same like before.

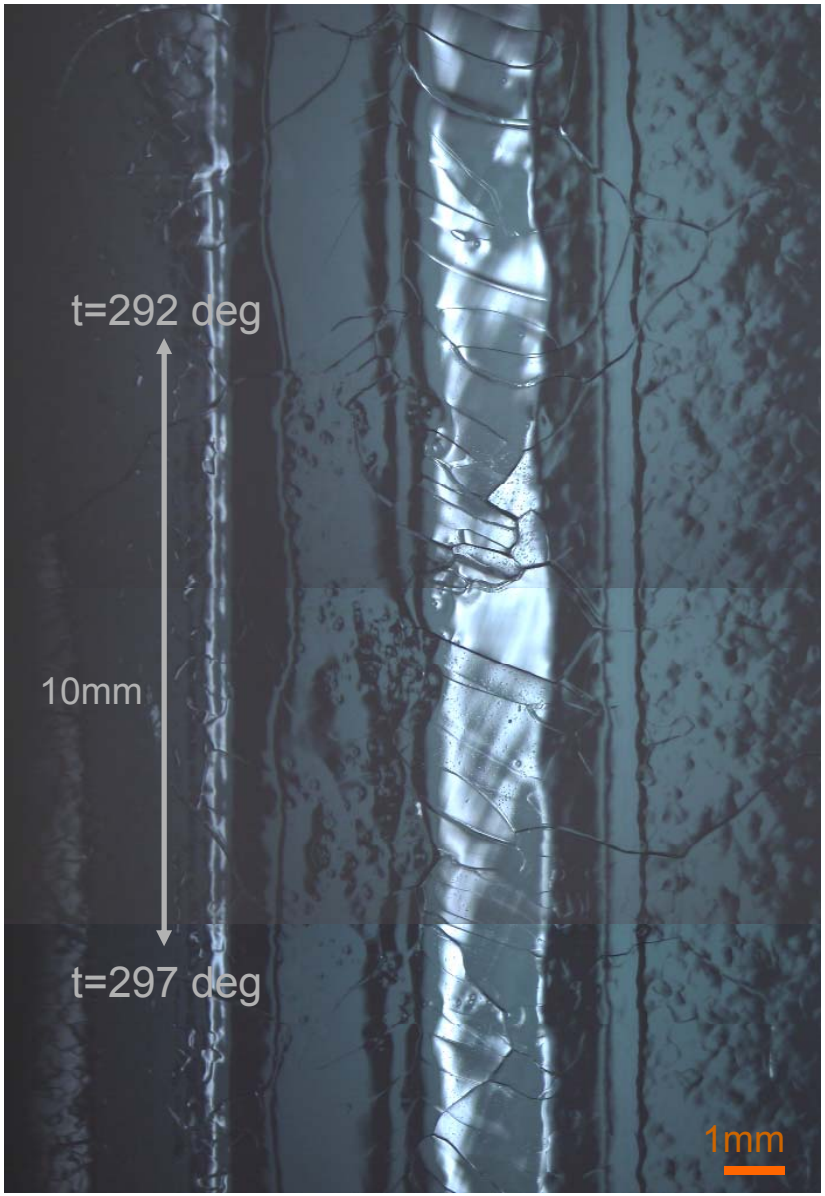
Equator Comparison(1): AC71 vs. Z110

AC71 #8 equator, t=151 ~ 159 deg, normal

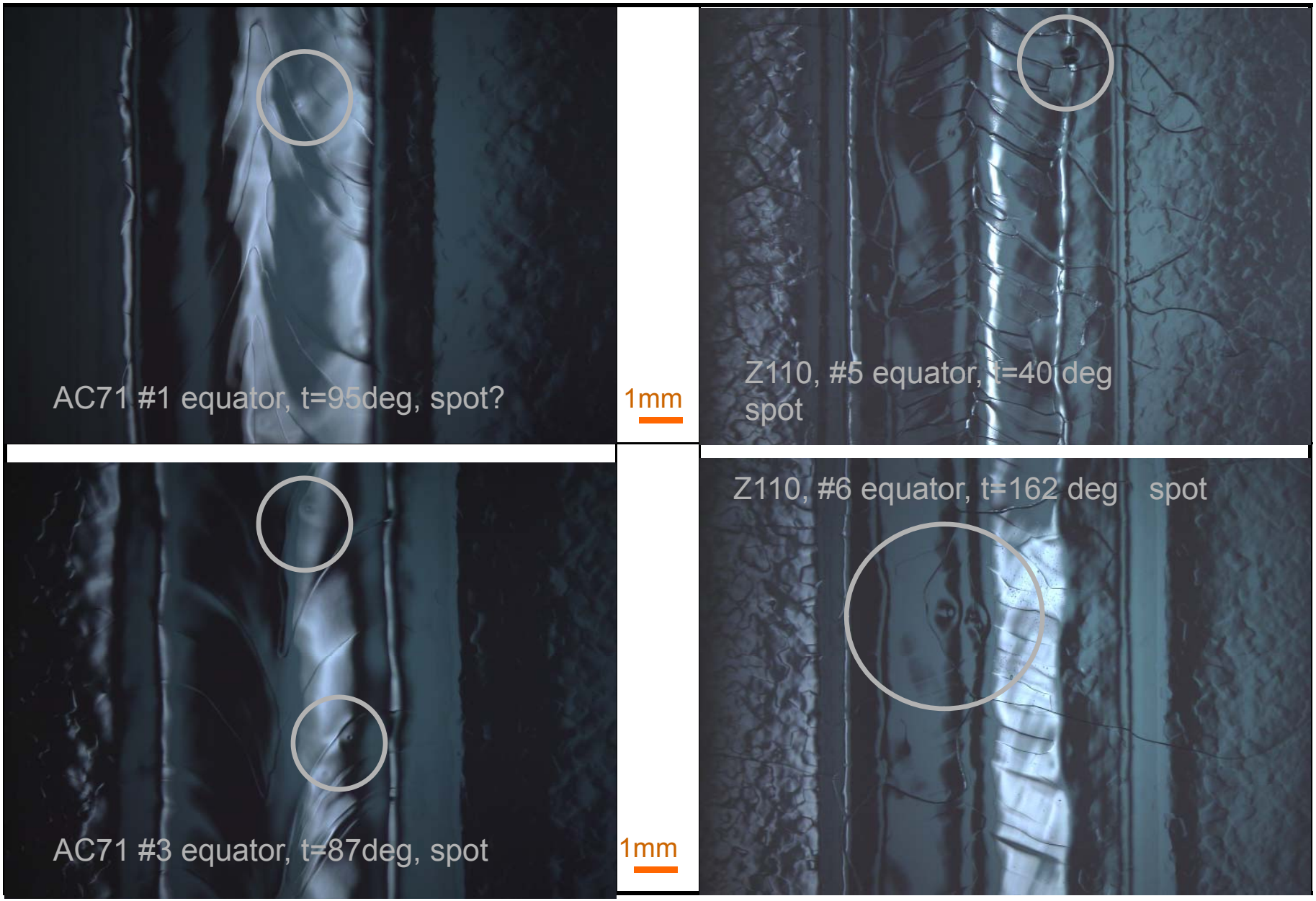


smooth and clean EBW seam in AC７１

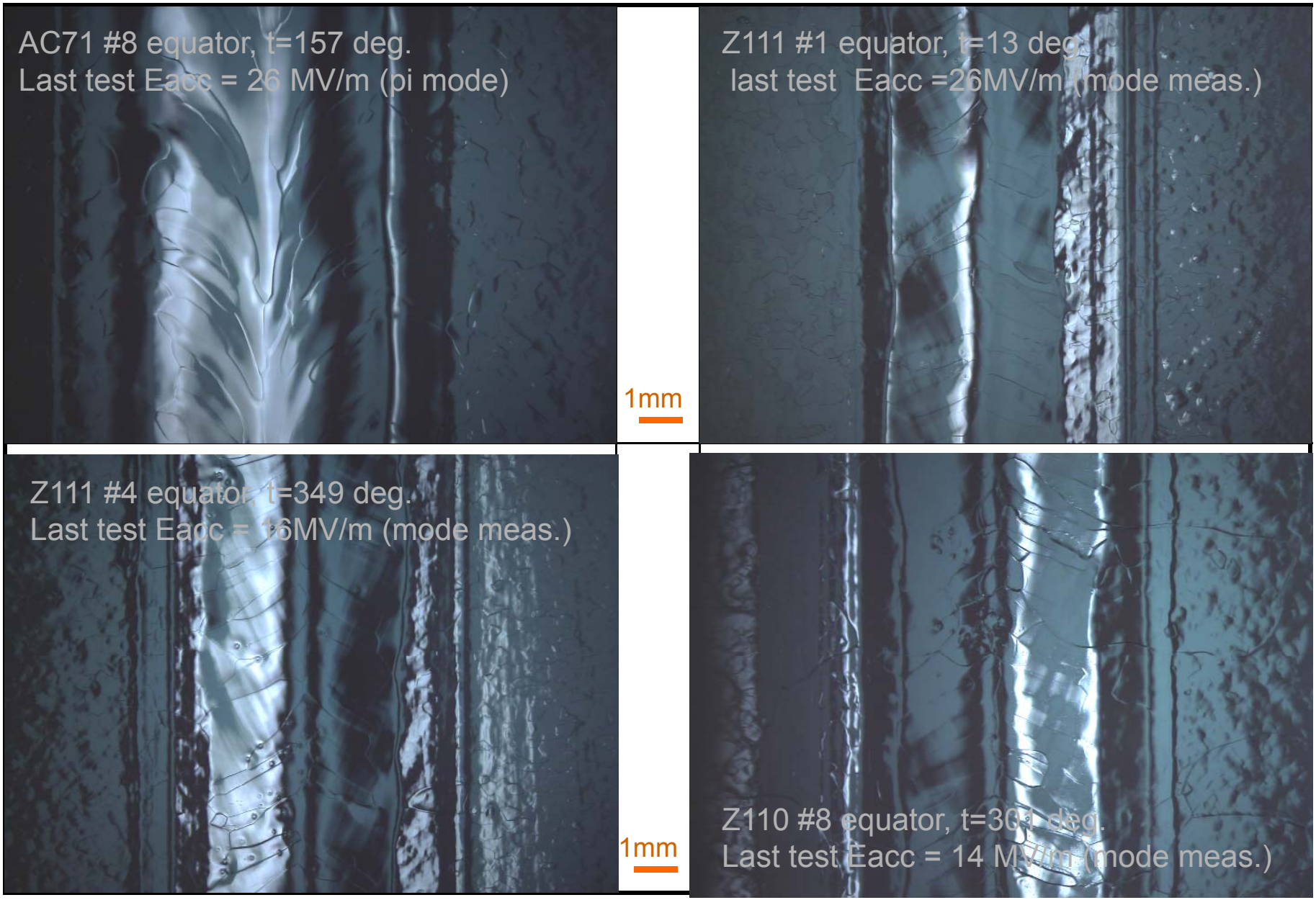
Z110 #8 equator, t=288 ~ 299 deg, heating spot



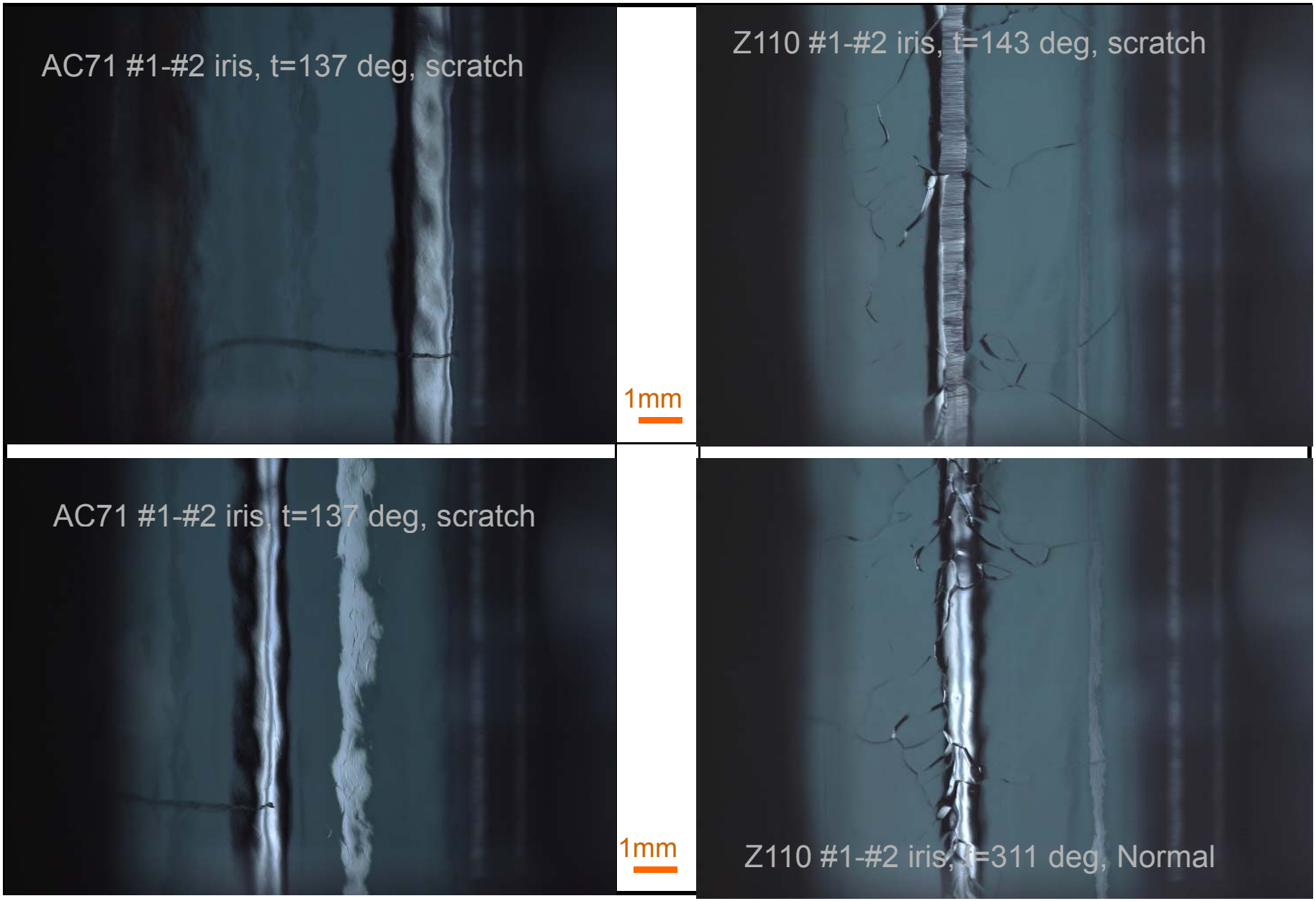
Equator Comparison(2): AC71 vs. Z110



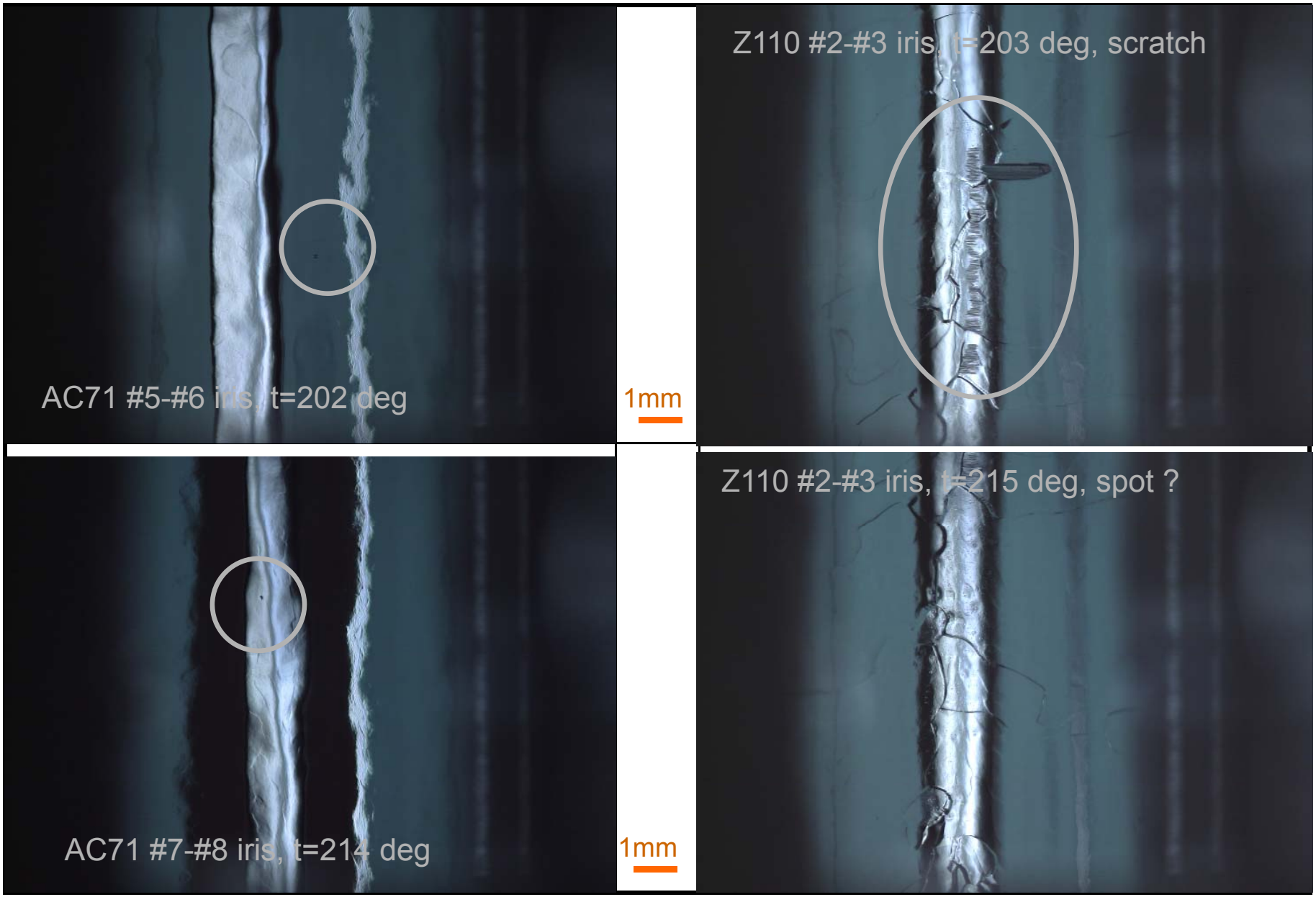
Equator Comparison(3): AC71 vs. Z110
EBWs in each cell gradient.



Iris Comparison(1): AC71 vs. Z110



Iris Comparison(2): AC71 vs. Z110



Summary

- All equator and Iris of AC71 were inspected by the Kyoto-camera in KEK.

The maximum gradient attained was 40MV/m, however, it reduced to 26MV/m in the last test. Appearance of strong field emitter was suspected after 40MV/m result.

- EBW of AC71 are fine and smooth than Z110.
- There were several spots with small size and less bumpy.
- The scratch like trace was found on Iris between #1 cell and #2 cell.

FYI：Maximum gradient of each cell for AC 71, 74, 80 (they are currently in KEK)

Best and Last CW-Test at all

			Best CW-Test							Last CW-Test						
Cavity	Prod No	Cells	BCP/EP Cavity	CW-Test Date	Max. Eacc	Qo at Max. Eacc	Limit	FE Onset	Eacc at Q=1e+10	BCP/EP Cavity	CW-Test Date	Max. Eacc	Qo at Max. Eacc	Limit	FE Onset	Eacc at Q=1e+10
AC71	3	ALL	EP	12-Nov-04	40.66	1.1E+10	bd	27.57	39.89	EP	21-Feb-06	25.95	1.6E+10	bd	21.00	25.95
		1&9			46.14		bd					26.04		bd		
		2&8			41.46		bd					25.95		bd		
		3&7			45.44		bd					25.95		bd		
		4&6			45.44		bd					25.95		bd		
		5			48.24		bd					27.71		bd		
AC74	3	ALL	BCP	24-Apr-03	27.94	9.7E+09	bd	23.51	27.83	EP	09-Mar-05	18.32	7.6E+09	bd	6.44	15.24
		1&9			33.07		bd					24.86		bd		
		2&8			30.23		bd					28.39		bd		
		3&7			38.30		bd					28.04		bd		
		4&6			34.38		bd					34.35		bd		
		5			40.76		bd					36.56		bd		
AC80	3	ALL	EP	11-Mar-04	28.58	1.0E+10	bd	23.89	28.42	EP	06-Sep-05	21.54	1.2E+10	bd	17.57	21.54
		1&9			29.35		bd					21.89		bd		
		2&8			28.58		bd					24.15		bd		
		3&7			28.58		bd					26.52		pwr		
		4&6			28.58		bd					32.53		pwr		
		5			28.58		bd					34.62		pwr		