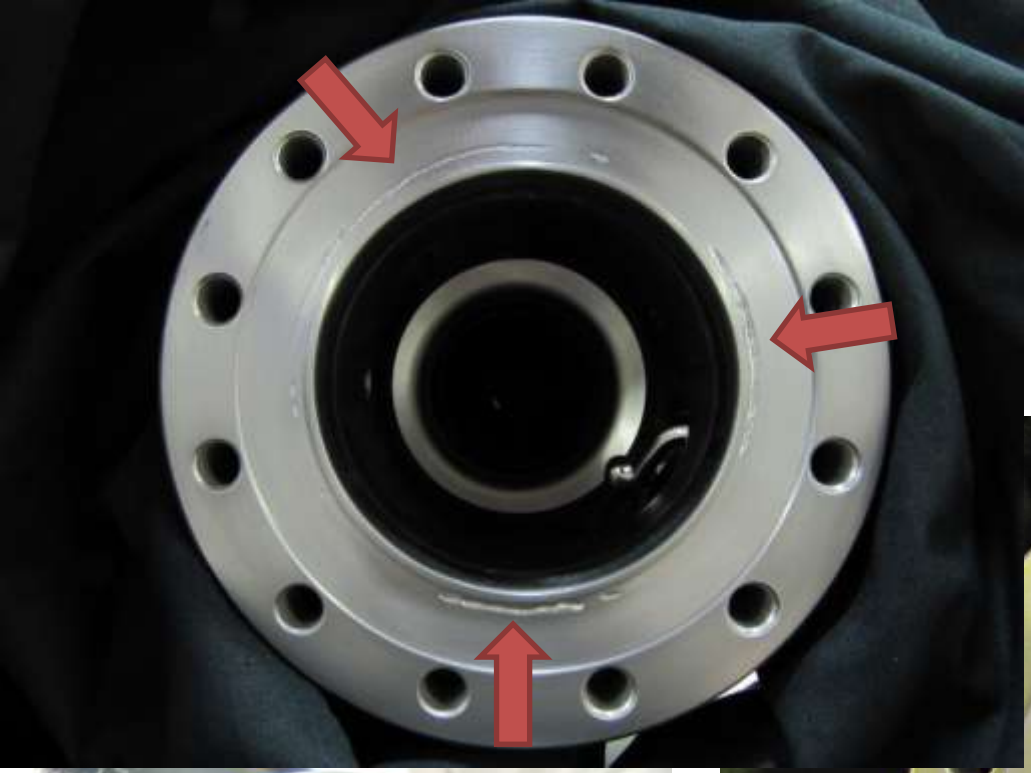
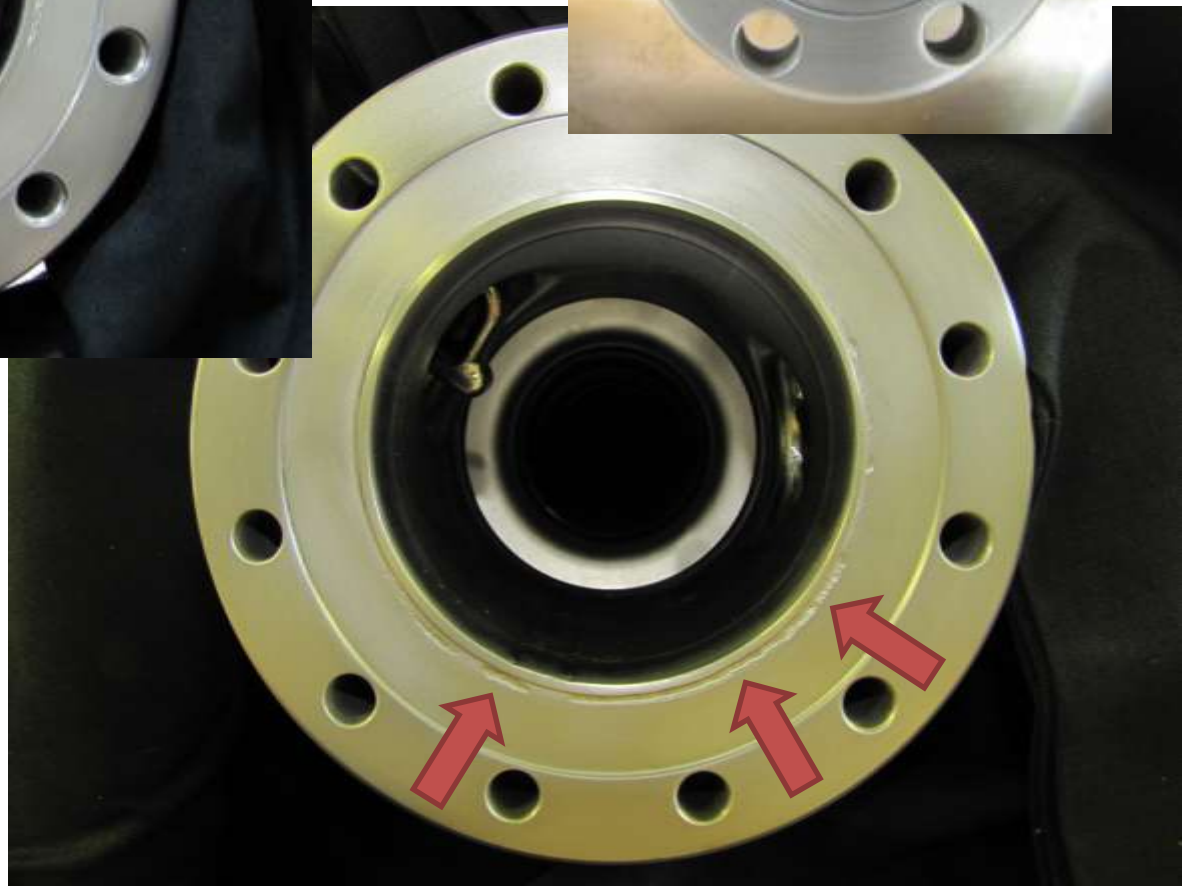
NR001 & NR002

- **Summary of QC findings**
- Visual inspection
- Optical inspection
- RF measurements
- CMM measurements

Visual inspection

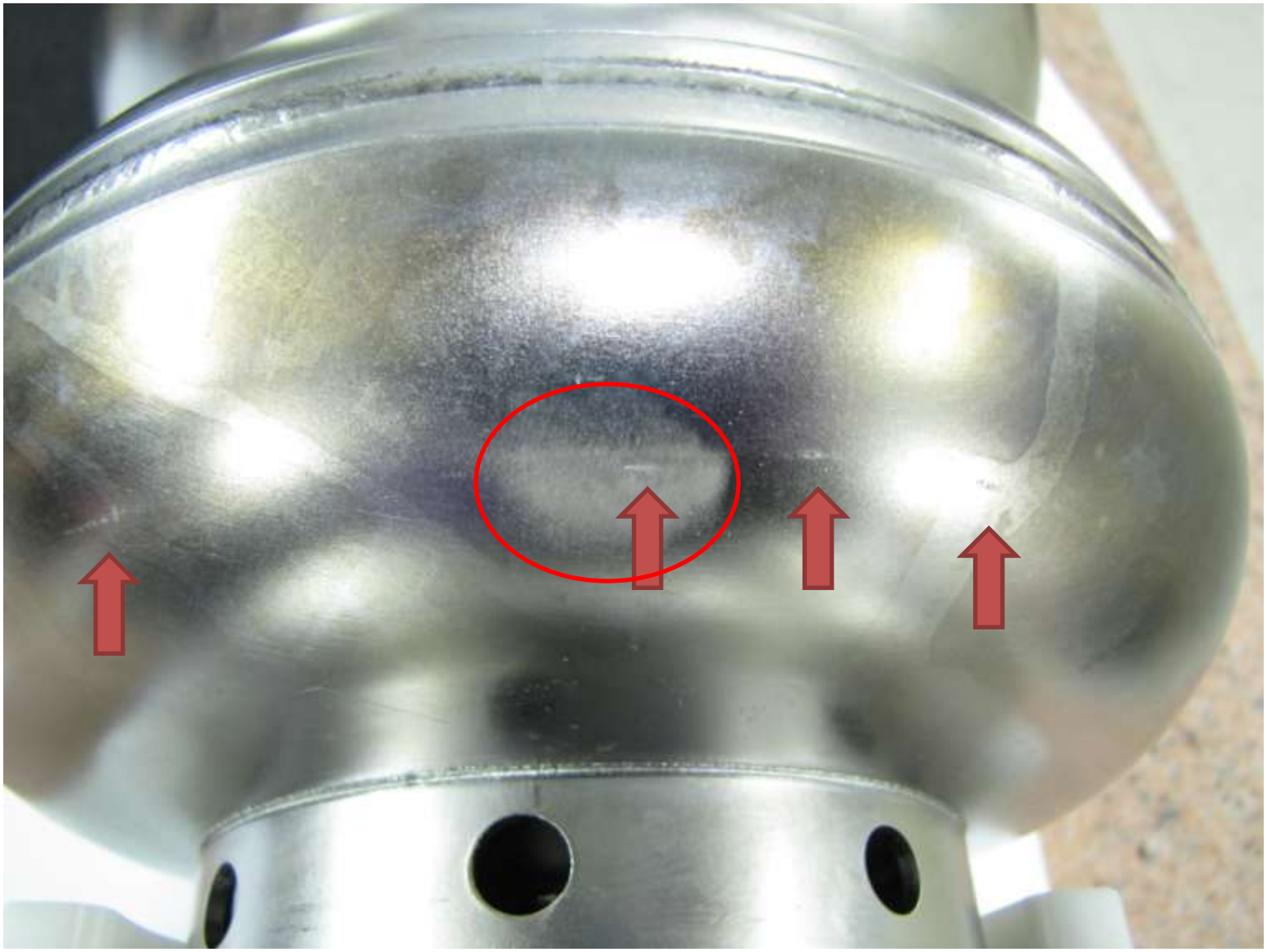




NR001 & NR002: all flanges have weld gaps and show a lot of polishing - BAD

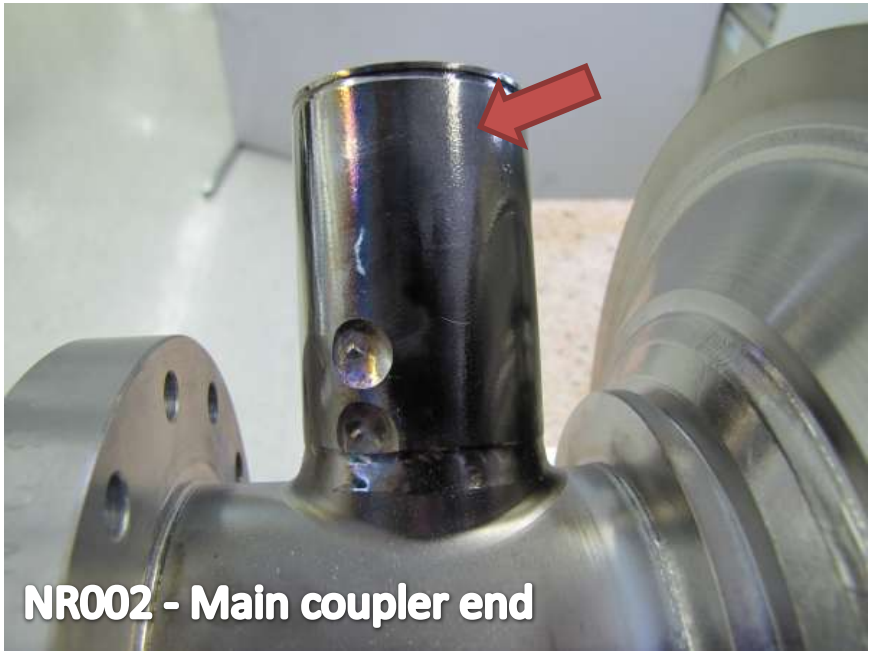
NR001: dent on end cell - BAD

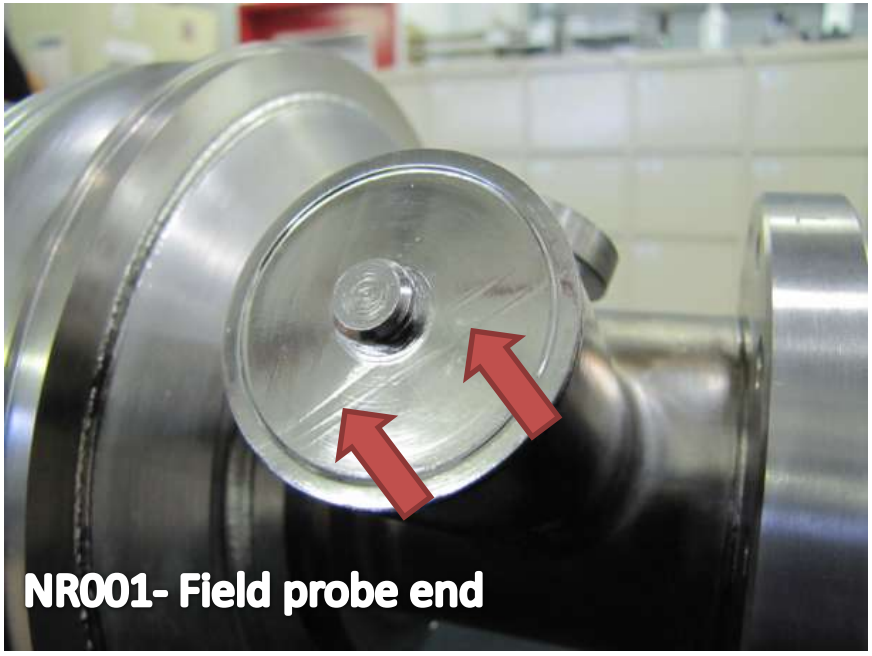
NR002: Discoloration, dirt (?) and fingerprint(?) inside beam tube at probe end - BAD.

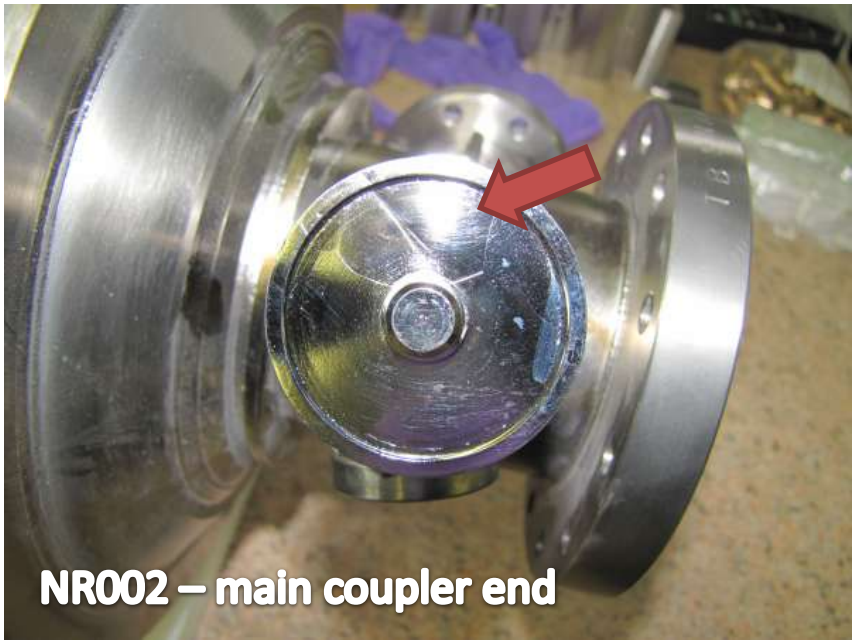


NR001: scratches and buffed area on half cell. Fixturing? – not necessarily bad per se but a sign that fixtures/handling is not appropriate.


NR001 - Main coupler end


NR002 - Main coupler end

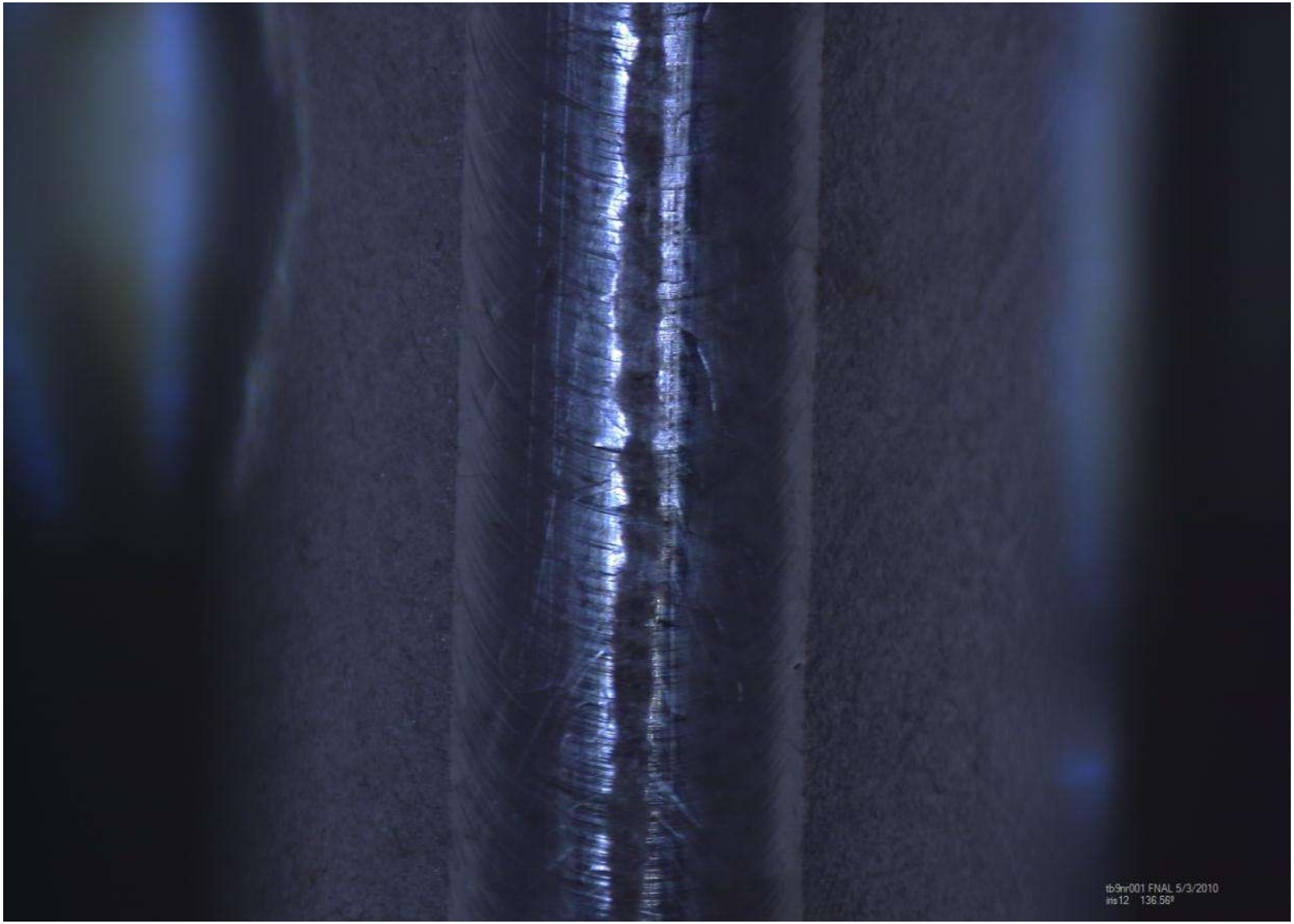

NR001- Field probe end


NR002 – main coupler end

Optical inspection

Iris welds

Picture size 10x7.5 mm



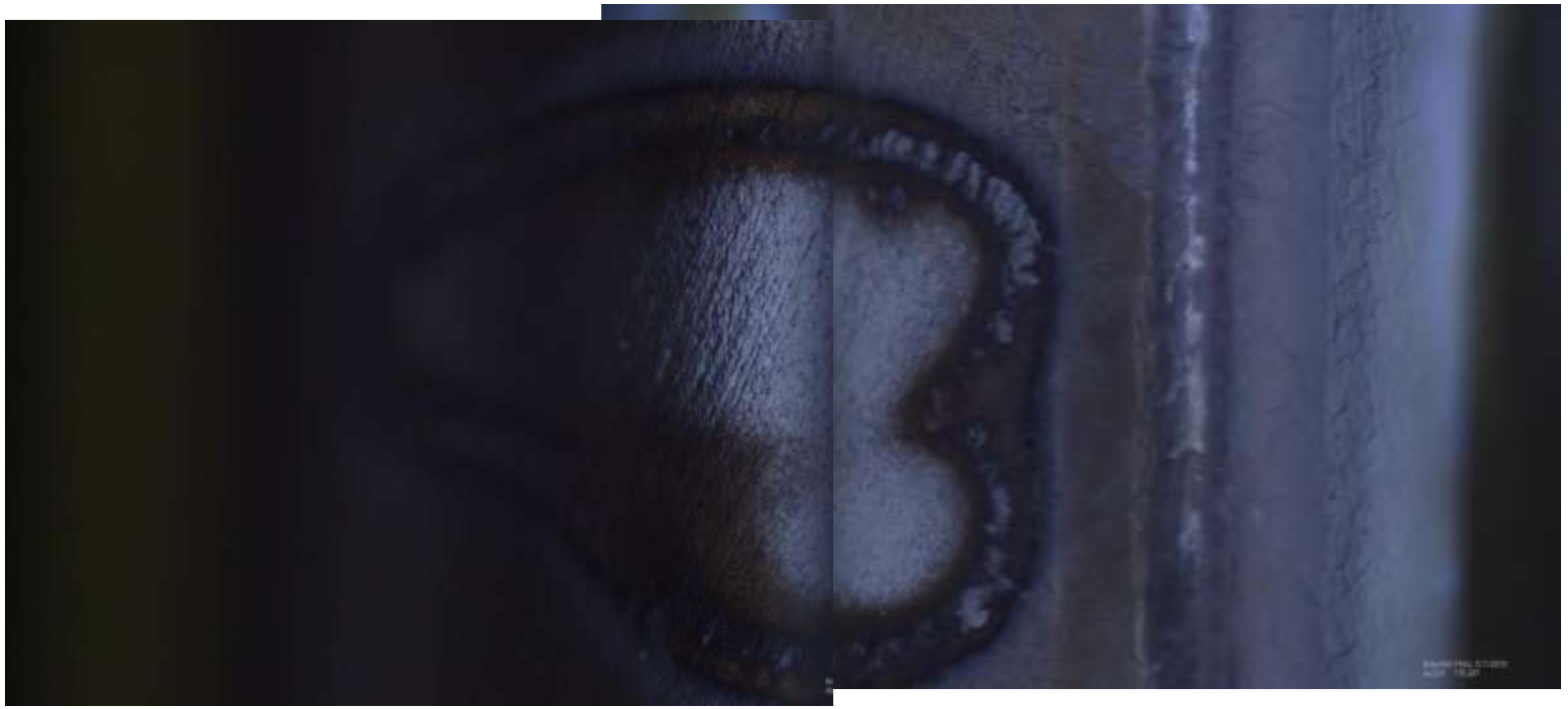
NR001 & NR002: this is a typical iris weld for these two cavities, just for reference.

Picture size 10x7.5 mm

NR002: unique defect on Iris between cells 2 and 3 – BAD, this should be caught at the dumb-bell stage and the part discarded.

Picture size 10x7.5 mm

Picture size 10x7.5 mm

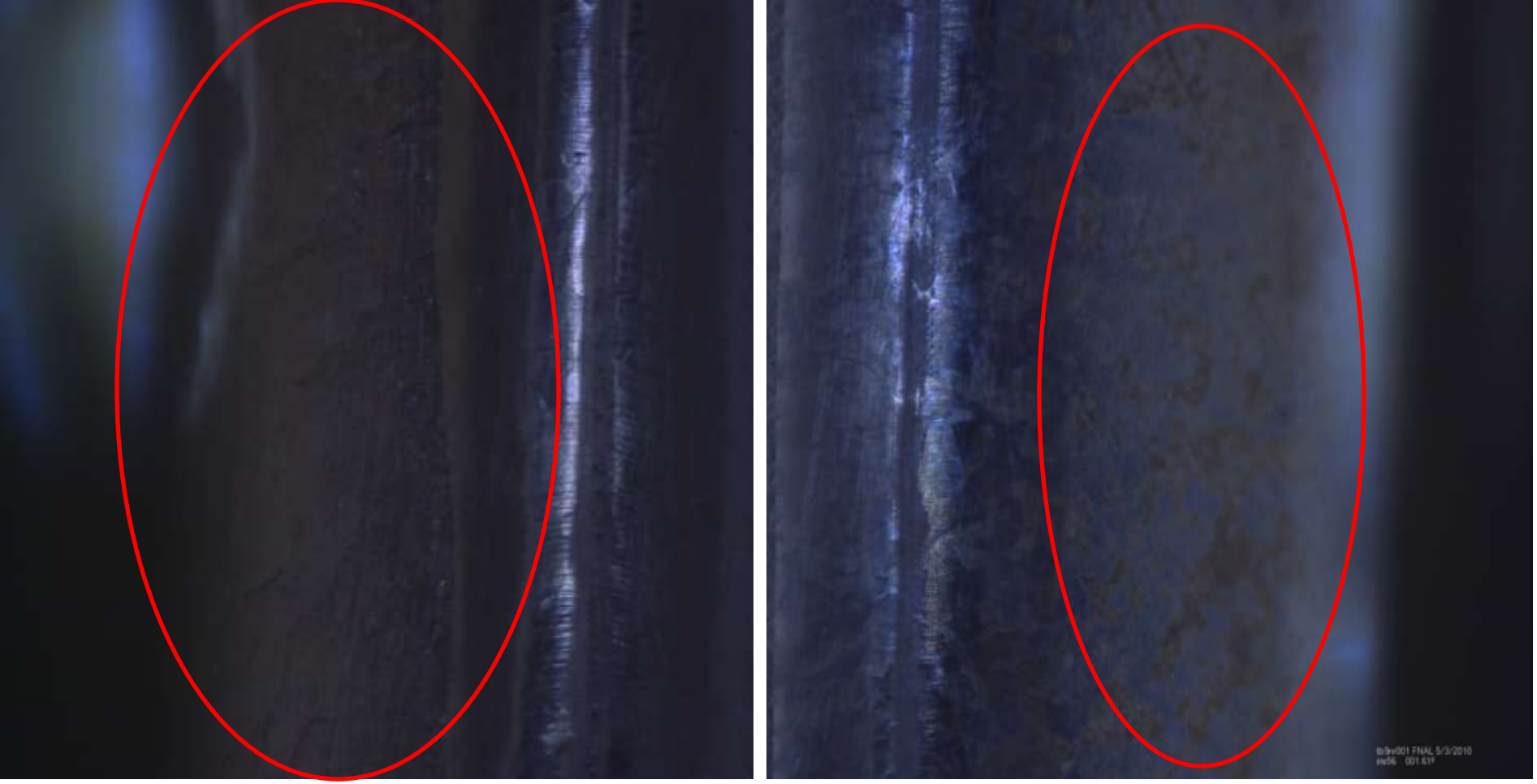


Large spot on iris weld between cells 2 and 3 of NR002.

BAD – these defects should not be present

Picture size 10x7.5 mm

NR002: Few of these spots are present near the welds, looks flat and may be an indicator of contaminations, perhaps bad vacuum during welding. BAD, these defects should not be present.



NR001 – iris5/6: reddish/brownish discoloration, perhaps benign but never seen before.

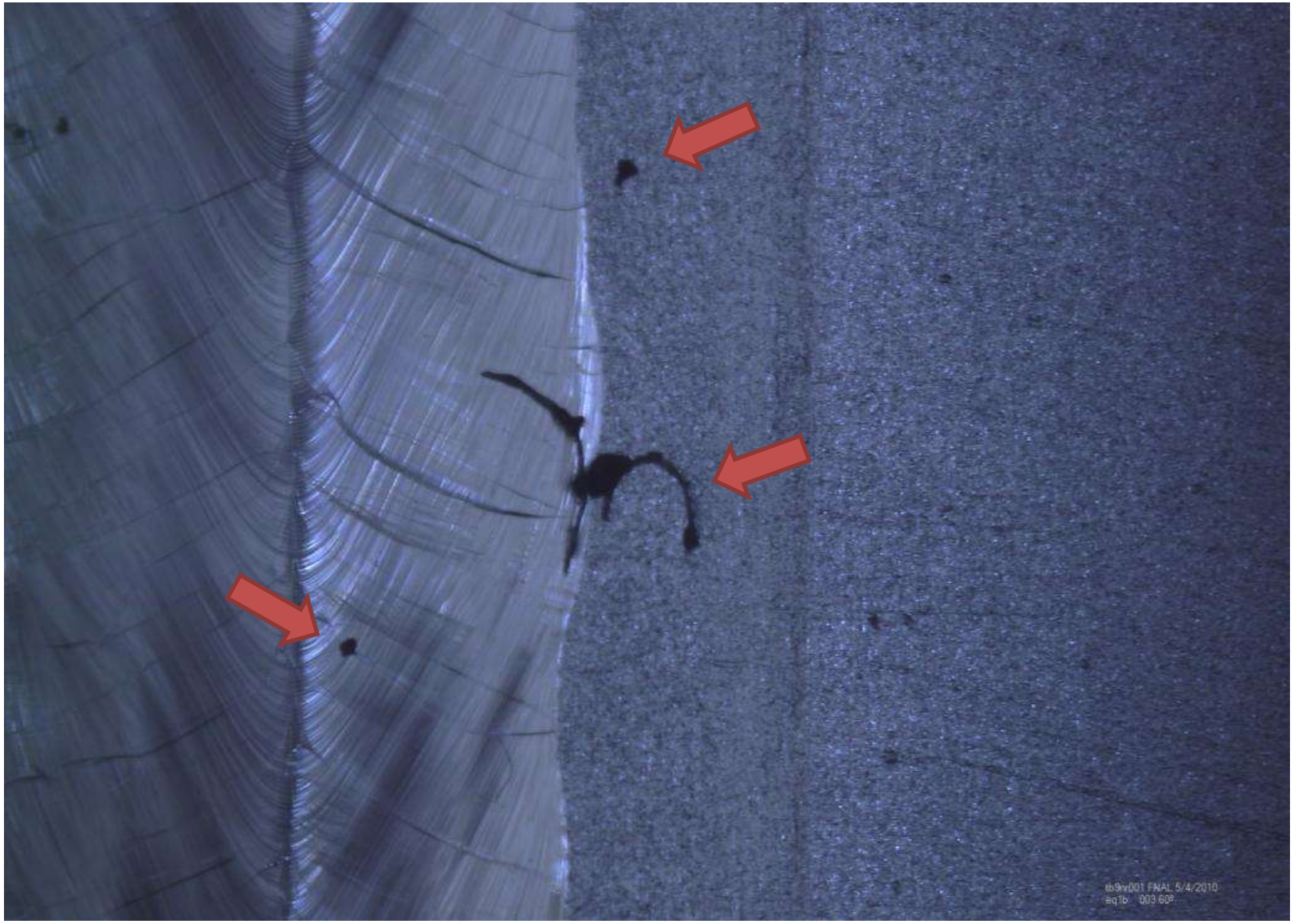
Optical inspection

Equator welds

Picture size 10x7.5 mm

NR001: typical equator weld with non-typical horizontal lines. Not necessarily bad, could be related to the forming process and should be given some thought.

Picture size 10x7.5 mm

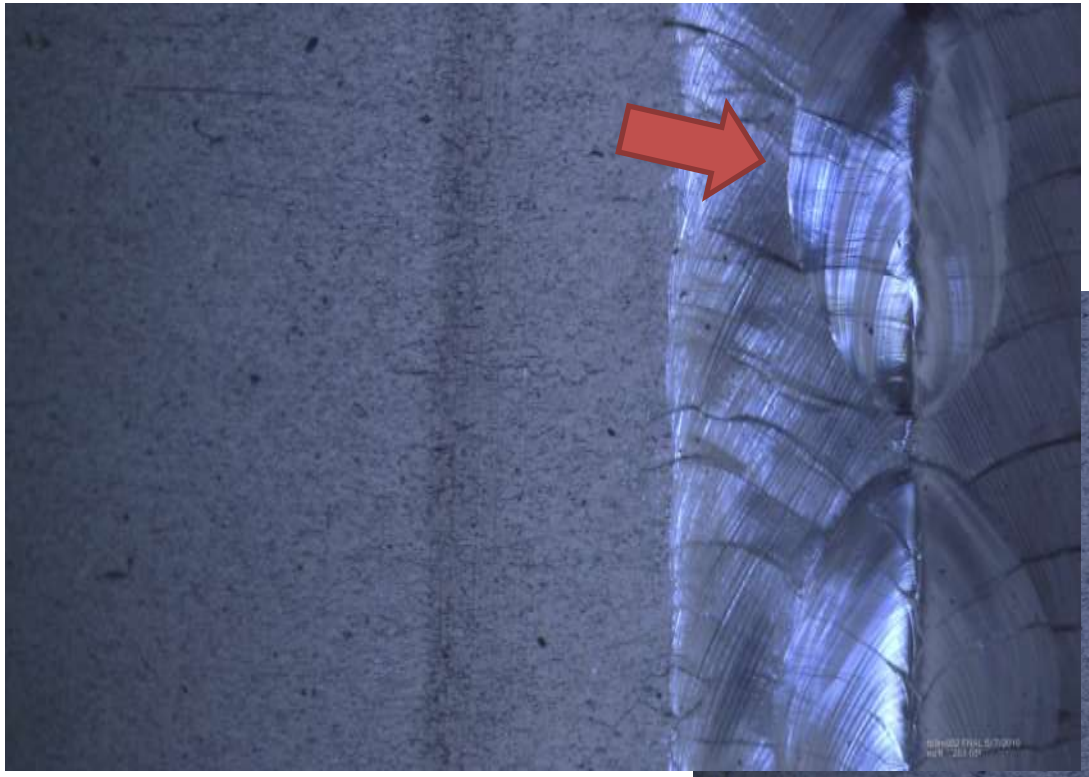


NR001 & NR002: typical dirt and fibers – BAD. Dirt should never be present before, during or after welding.

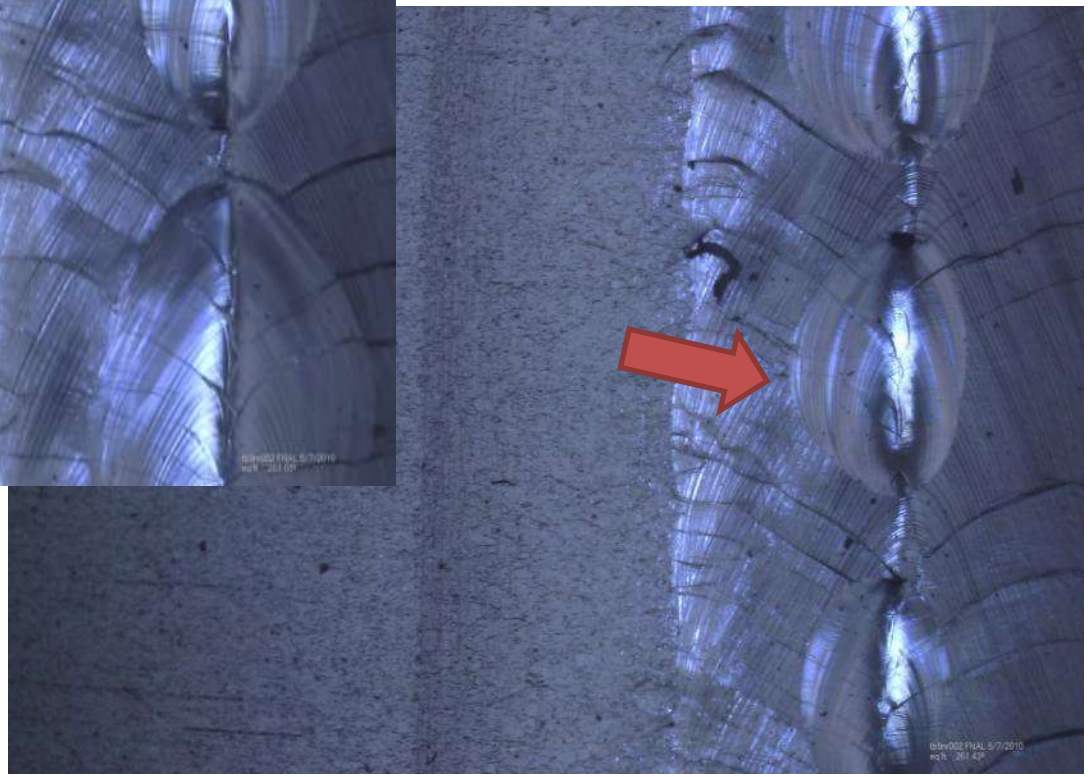
Picture size 10x7.5 mm

NR002: discolorations on equator weld, pictured is one of the worst extending ~20 deg and on both sides of weld. BAD – these discolorations should not be present

Picture size 10x7.5 mm



Picture size 10x7.5 mm



NR001 & NR002: Equator welds on cells 1 and 9 look different from the rest. Welds performed in a different orientation? Bumps are several hundreds of µm high. BAD – these features should not be present.

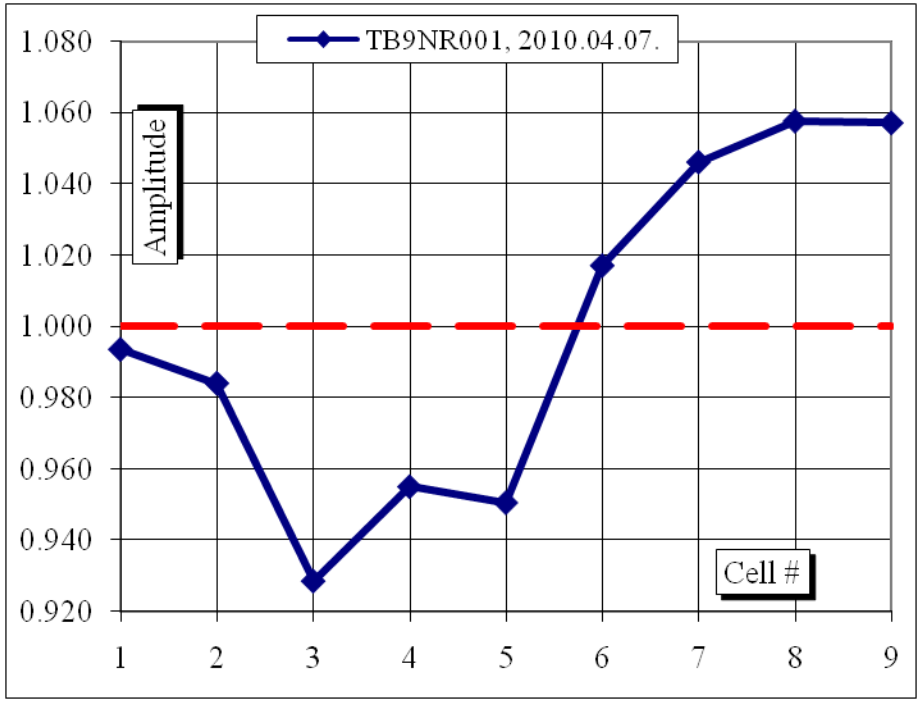
Picture size 10x7.5 mm

NR001 & 002: perhaps overlapping bead on equator weld, seen on all equator welds of both cavities. It's a bump and could cause quench. BAD - Overlapping is less pronounced on cavities from other vendors.

RF Measurements

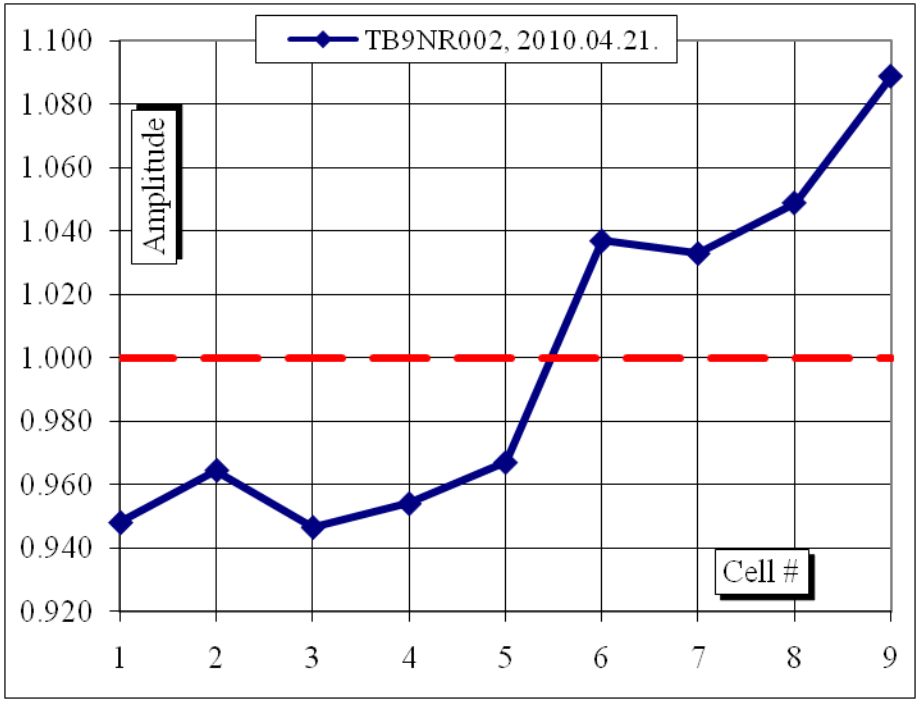
Field flatness

NR001



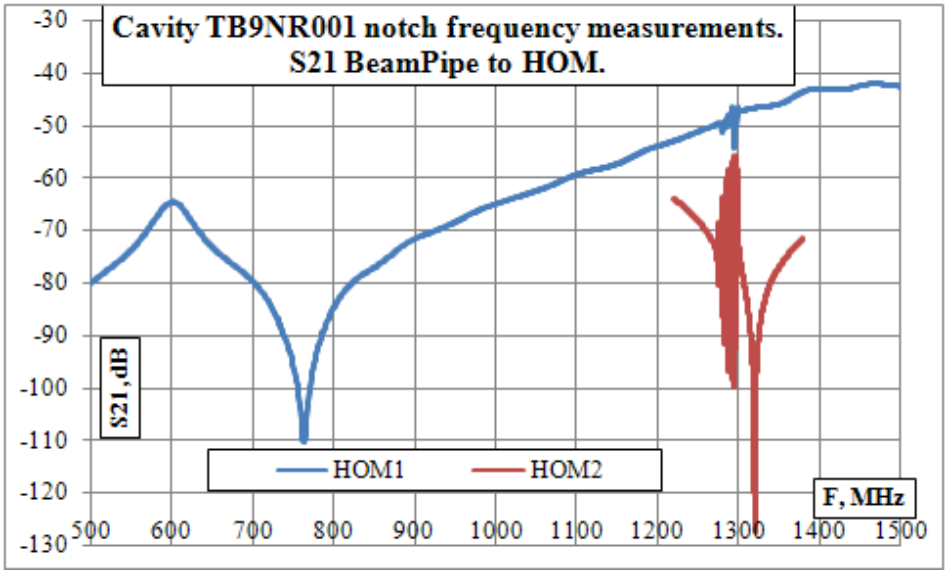
Field flatness Emin/Emax=88%
Better than typical untuned RI cavities
Worse than typical tuned AES cavities
NB: we will tune the cavities after 800C heat treatment

NR002

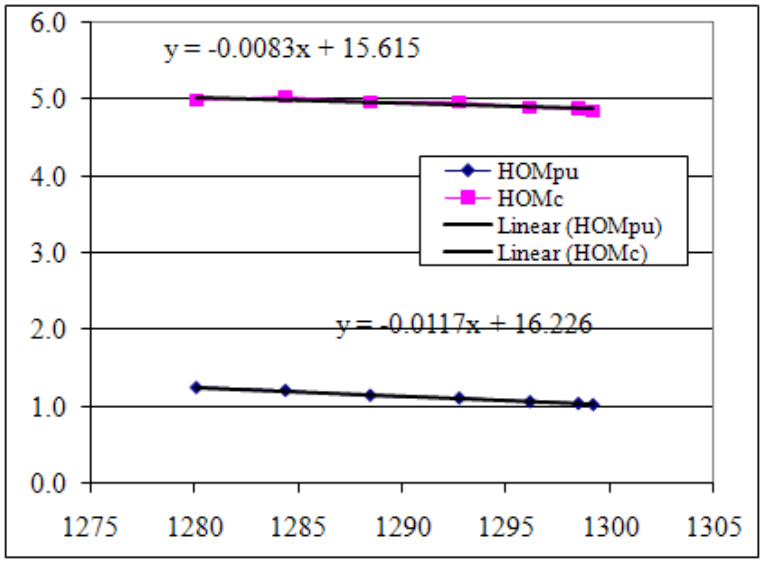


Field flatness Emin/Emax=87%
Better than typical untuned RI cavities
Worse than typical tuned AES cavities
NB: we will tune the cavities after 800C heat treatment

Cavity TB9NR001. HOM couplers notch frequency measurements.



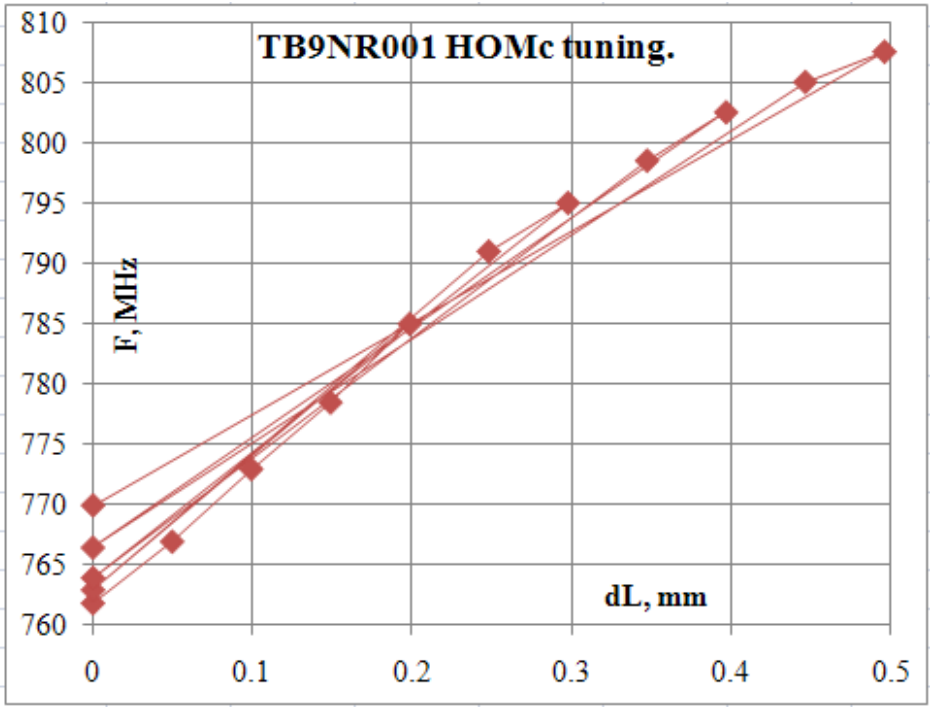
HOM1 notch frequency ~500 MHz lower than design.



Cavity TB9NR001. S21 through cavity.

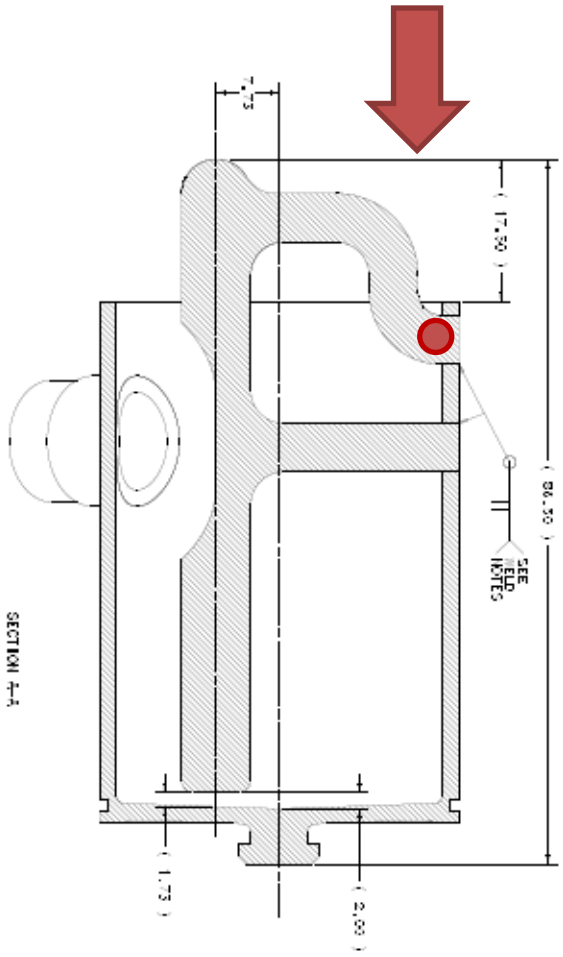
TB9NR001 HOMc tuning.

	L, mm	dL, mm	F, MHz
0	20	0	761.9
1	19.8	0.0496	767
2	19.9	0.0993	773
3		0.1489	778.5
4		0.1985	785
0		0	763
5		0.2481	791
6		0.2978	795
0		0	764
7		0.3474	798.5
8		0.397	802.5
0		0	766.5
9		0.4466	805
10	19.46	0.4963	807.5
0		0	770



Cavity TB9NR001 HOM1 (HOMc) tuning test. 0.5 mm deformation of tuning gap changed notch frequency only by 45 MHz.
It means that HOM1 of this cavity can not be tuned safely by usual tuning technique.

The optical images are not able to show the weld of the near leg of the formteil to the HOM can, this is an indication that the formteil “S” is in the way.



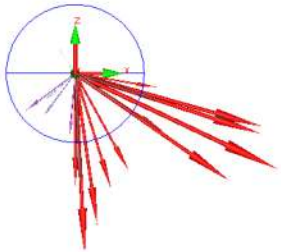
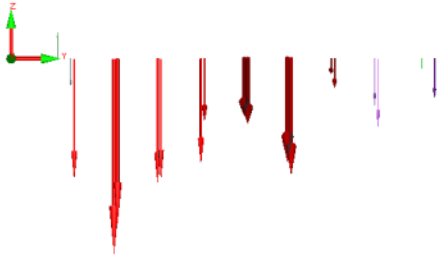
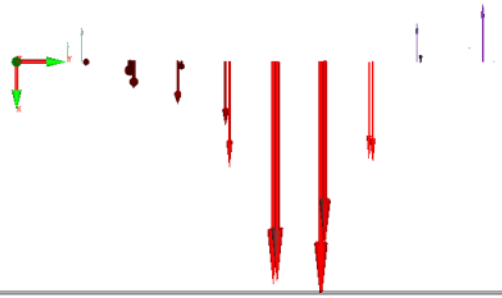
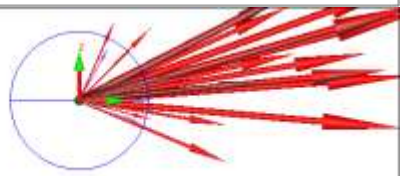
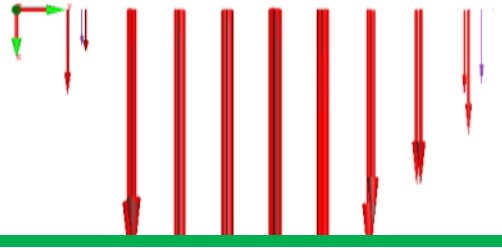
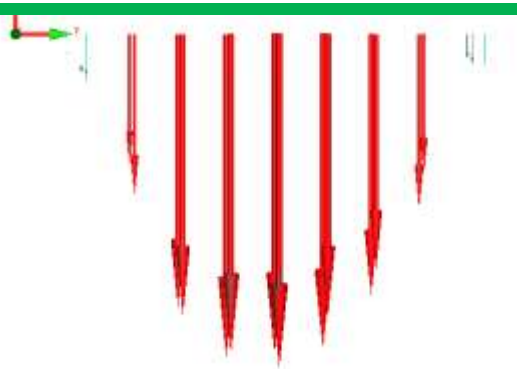
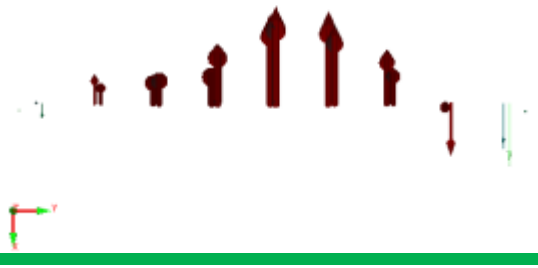
Typical - TB9RI024

CMM Measurements

CMM findings:

-NR001 is 3.373 mm longer than nominal
-NR002 is 2.710 mm longer than nominal
-Perpendicularity of end flanges from cavity axis is off by ~ 0.2 degrees
-Equator diameters of both cavities are 0.4-0.6 mm larger than normal
-Equators are 0.2-0.5 mm out of round more than normal
-Positions of equators relative to cavity axis are atypical (see next slide)

Position of equator welds relative to cavity axis

View from end flange	View from side	View from top
		
NR001		
		
NR002		
		
typical (RI026)		

Conclusions

- HOM notch frequencies shall be measured and adjusted prior to welding the end groups. The position of the formteil should be monitored and measured after welding.
- Welding of all flanges shall be performed in order to avoid gaps. Perform tests to qualify each weld.
- Iris welds shall be inspected thoroughly and dumbbells qualified prior to performing equator welds.
- The cleanliness of all parts and sub-assemblies shall be improved by large in all stages of fabrication.
- The vacuum level in the EBW chamber should be monitored (possibly improved?).
- The effects of the overlapping on equator welds must be studied and mitigated.
- The diameters of all equators appear larger than nominal, this should be studied.
- The weldment of the end groups to the dumbbell assembly must be studied and representative samples shall be made to qualify this joint.
- The fixturing of the end groups during the final welding should be improved to guarantee a better perpendicularity relative to the cavity axis.
- All handling and fixturing operations should be analyzed and improved to avoid any damage to the parts.
- The forming of the half-cells should be analyzed to identify the nature of the atypical horizontal streaks seen near the equator welds