

ERL主加速部#4号機 縦測定結果の報告

2011/12/2

ERL検討会

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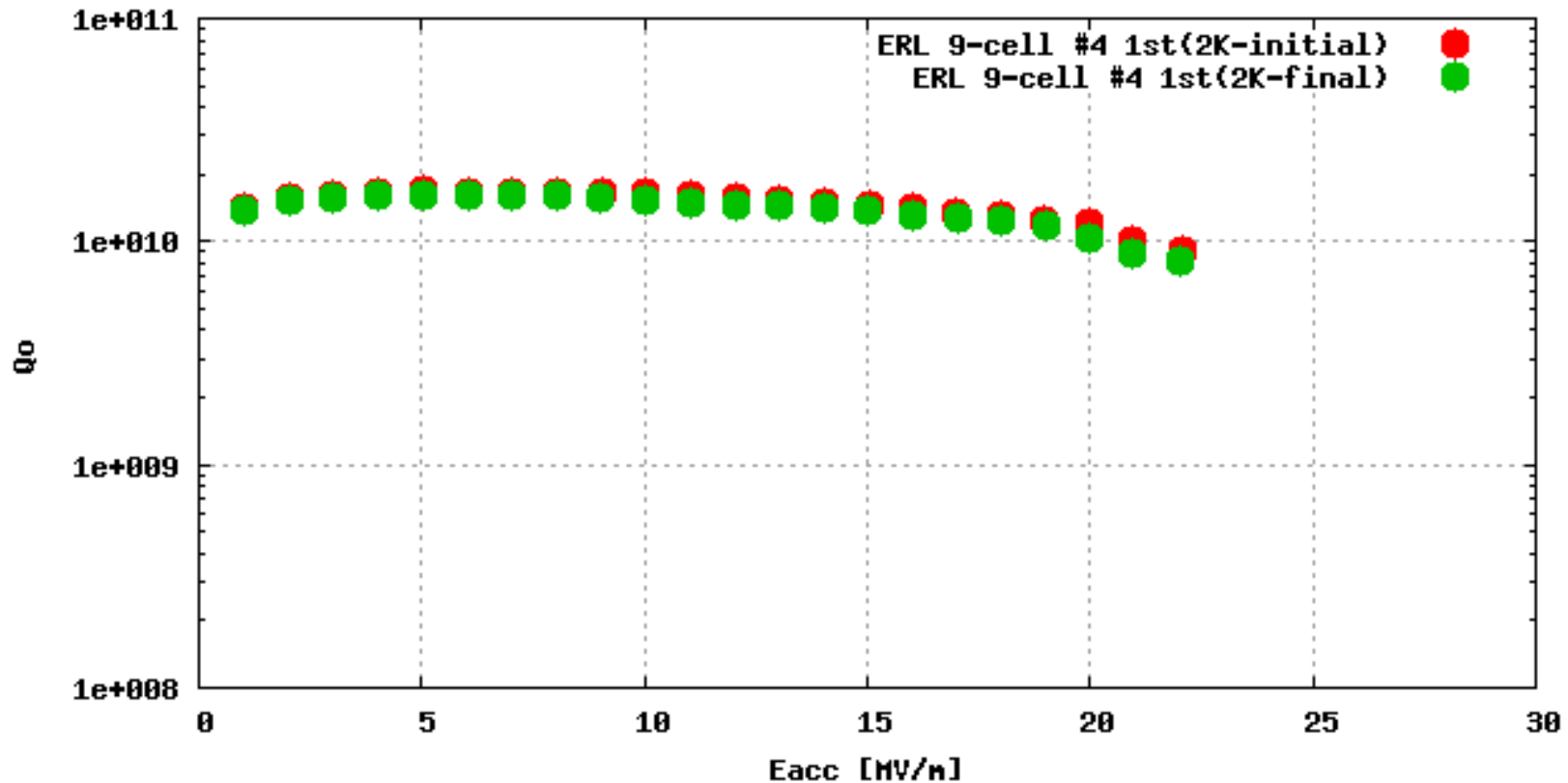
Specification for cERL main linac cavity

- Eacc
 - Required Eacc is 30 MV for two cavities
 - But, operated with vector sum mode at first stage
 - Assuming 2×10^7 coupling and maximum detuning of 50 Hz
 - Required maximum Eacc is $\sim 20 \text{ MV/m}$ for a cavity
- Q_0 value
 - Larger Q_0 value is desirable for He refrigerator
 - Target is 1×10^{10} at 15 MV/m
- Frequency
 - Frequency must be within mechanical tuner range (3mm = 900 kHz) at 2K, i.e. 1299.1~1300.0MHz
 - With good field flatness of $> 98\%$

History for ERL 9-cell #3/#4 cavities (for cERL)

	#3 cavity (1 st)	#3 cavity(2 nd)	#4 cavity (1 st)	#4 cavity(2 nd)
Pre-EP and EP-1	5 um + 120 um		5 um + 120 um	
Annealing	750 degree x 4hours		750 degree x 4hours	
Pre-tuning	> 98% flatness	> 99 % flatness	> 98% flatness	> 98 % flatness
EP-2	50 um	20 um	50 um	30 um
HPR	5hours + 5hours	7.5 hours + 5 hours	6hours + 5.5 hours	6 hours + 5 hours
Assembly				
Baking	> 110 degree, 48 hours	> 110 degree, 48 hours	> 110 degree, 48 hours	> 110 degree, 48 hours
Vertical test	(Done)	(Done)	(Done)	(Done)

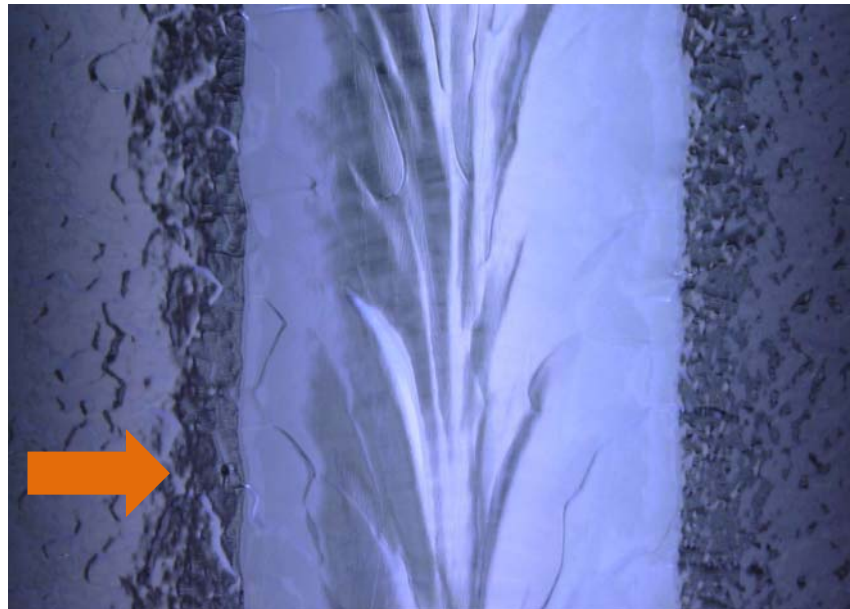
#4 cavity 1st vertical test (10/27)



- Initial (1.6-1.8K), Passband(8pi), Final (1.7-1.8K)
- Max. Field 22.7 MV/m, quench at 1 cell equator
- $Q=1.4 \times 10^{10}$ (@15MV/m), 1.0×10^{10} (@20MV/m)
- X-ray on set: (initial) 18MV/m \rightarrow (final) 15MV/m
- X-ray at 20 MV/m: (initial) 3.7uSv/h \rightarrow (final) 644 uSv/h

① 1 cell equator 264 deg(=224 for mapping)

After 1st vertical test



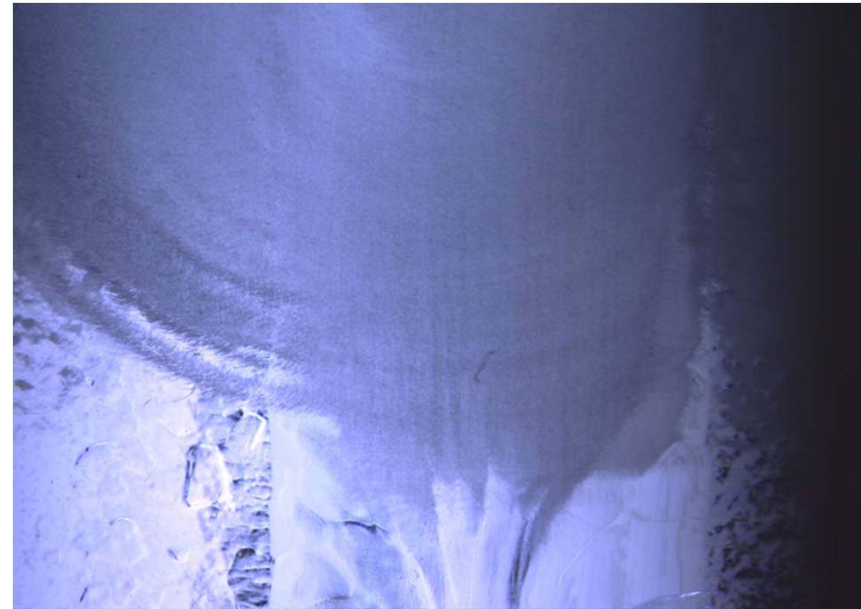
Defect was found after vertical test

Bump

Height ~10um

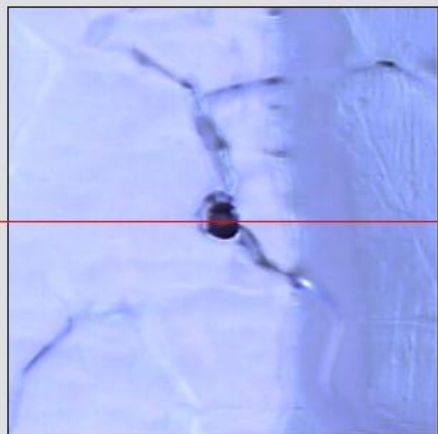
Width ~200um

Local grinding

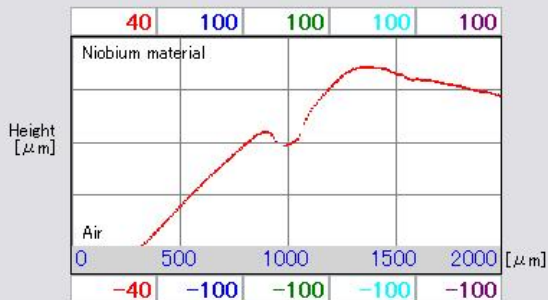


Defect disappeared after local grinding

Title Input



Height_Trans



Theta_Trans

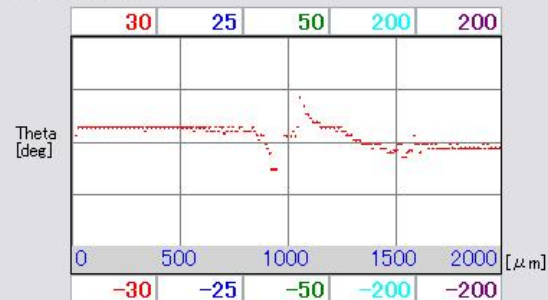


Chart Position

- 100
- 105
- 110
- 115
- 95

Comment Input Area

Comment Input Area

Bump
Height ~10um
Width ~200um

Height trans Save File Name: C:\Documents and Settings\Administrator\Desktop\trimming_repc

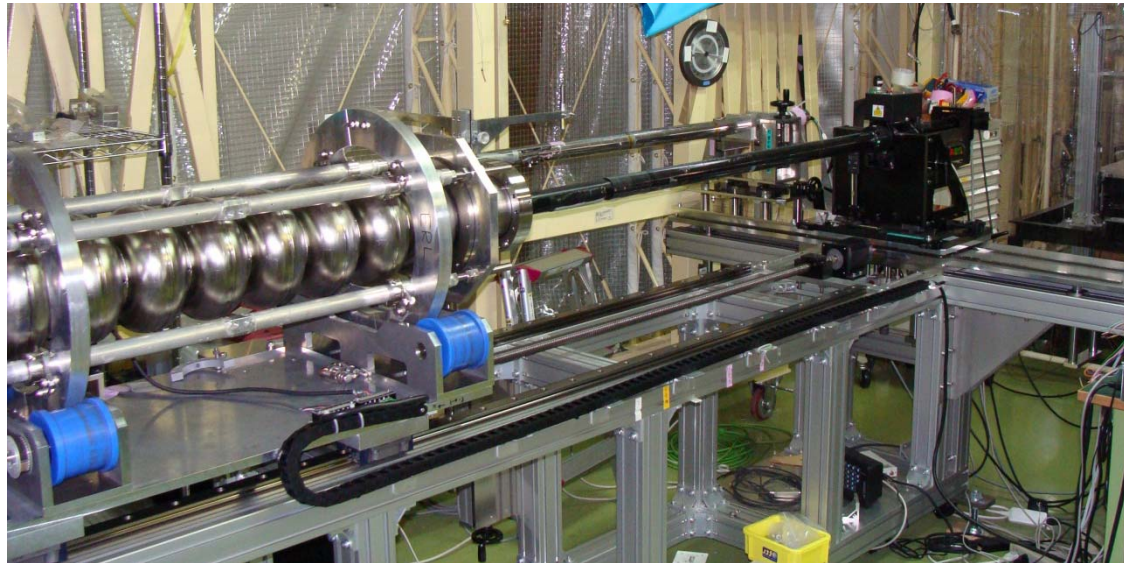
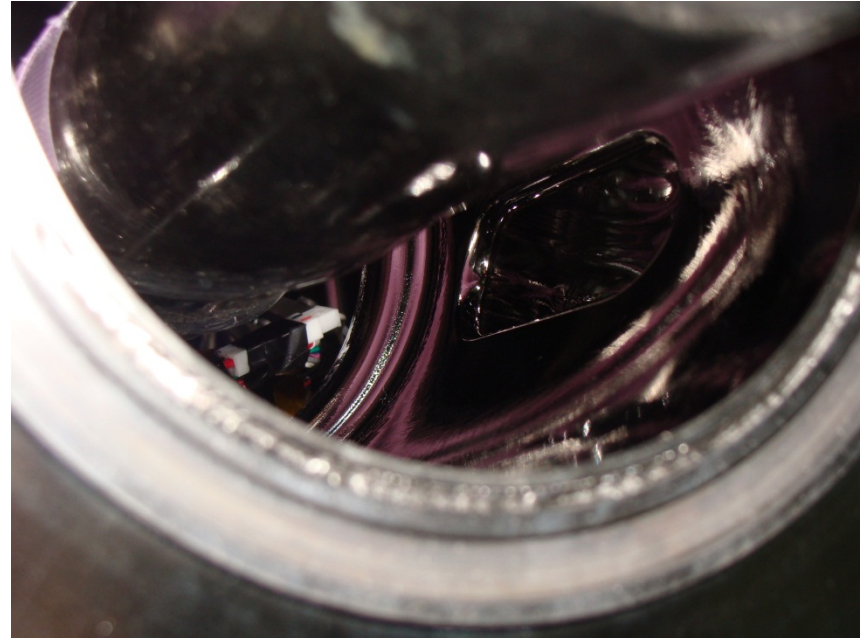
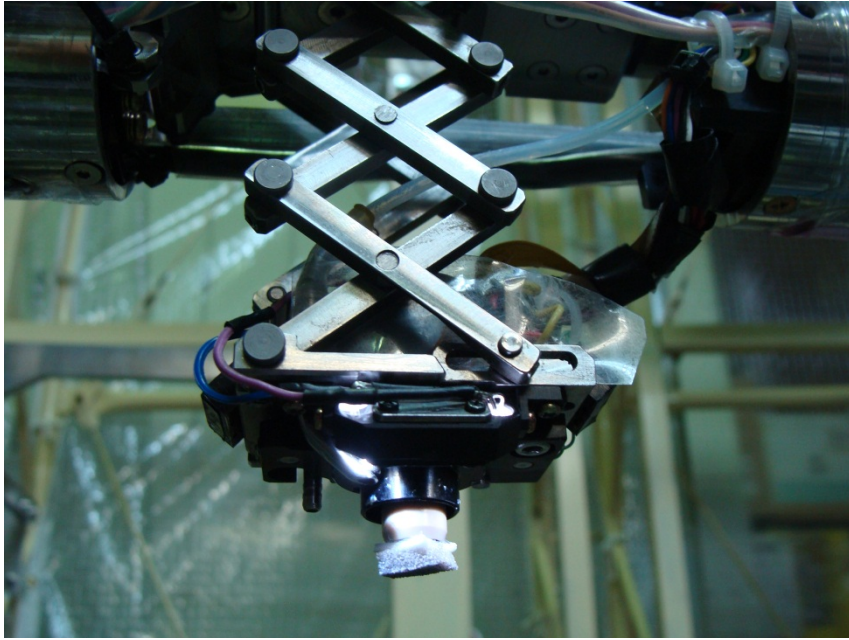
Save

Theta trans Save File Name: C:\Documents and Settings\Administrator\Desktop\trimming_repc

Save

Form Capture (report)

Local grinding



② 8 cell equator 194 deg

After 1st vertical test



Defect was found after vertical test

Pit

Height ~10um

Width ~150um

After local grinding



Defect disappeared after local grinding

③ 9 cell equator 102 deg

After vertical test



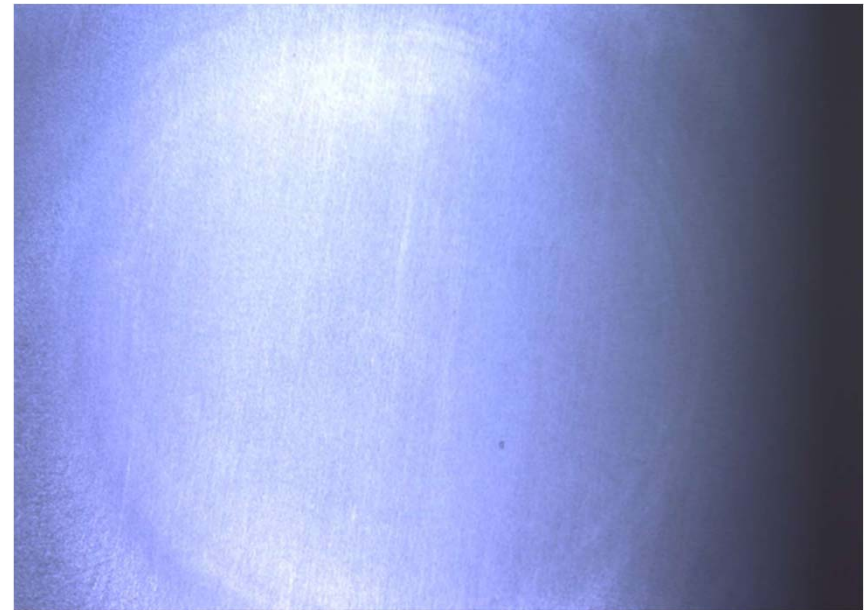
Defect was found after vertical test

Pit

Height 15~20um

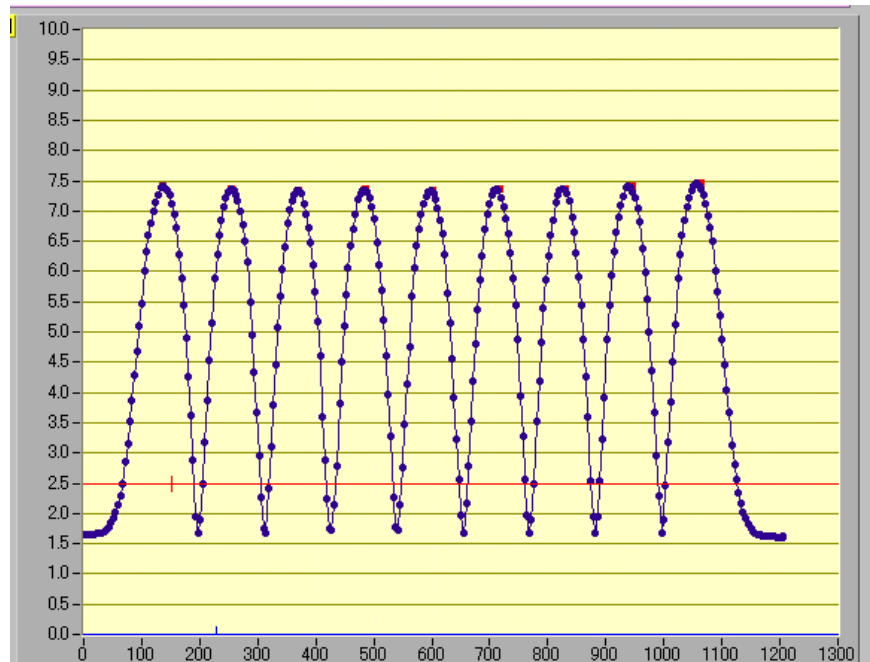
Width ~200um

After local grinding

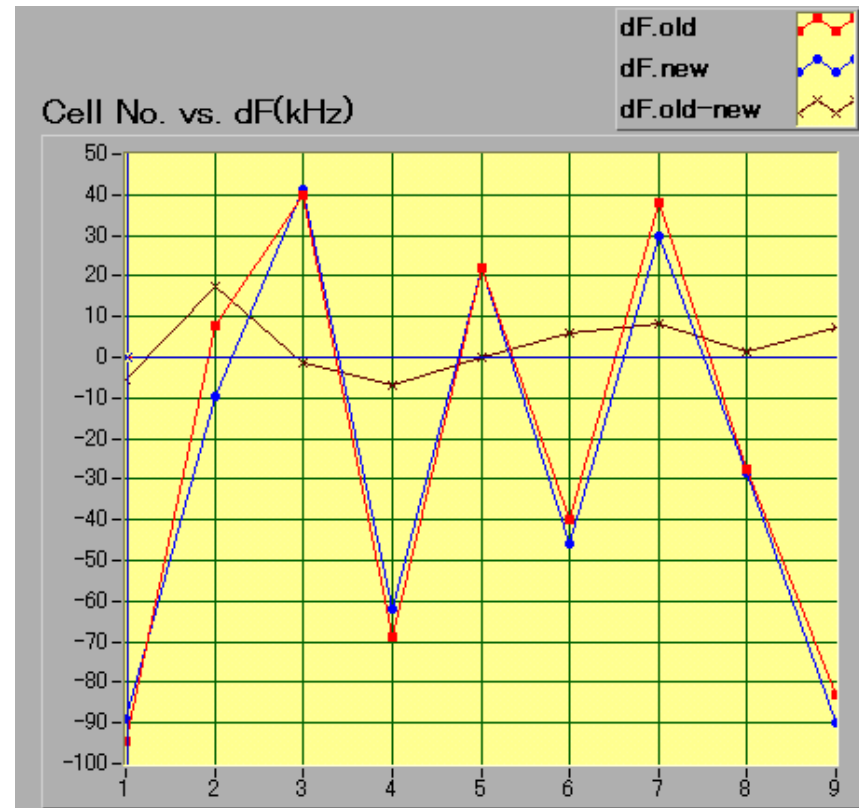


Defect disappeared after local grinding

Pre-tuning



Field flatness 98.5%



Frequencies of both end cells are $\sim 100\text{kHz}$ higher than those of center cells
→ should be better flatness after EP-2(30 μm)

2nd EP-2 for ERL-9cell #4 cavity

[before EP]

- Degreasing (FM20) : 240min at ultrasound bath
- 60min at ultrasound bath with ultra-pure water

[EP]

- Current density: 32 mA/cm²
- Amount of polishing: 30um
- Contained amount of Nb: 4.7 g/litter

[After EP]

- Degreasing (FM20) : 60min at ultrasound bath
- HPR: 6hour(flange open) + 5hour(flange close)

Cavity surface after EP-2

From LBP side

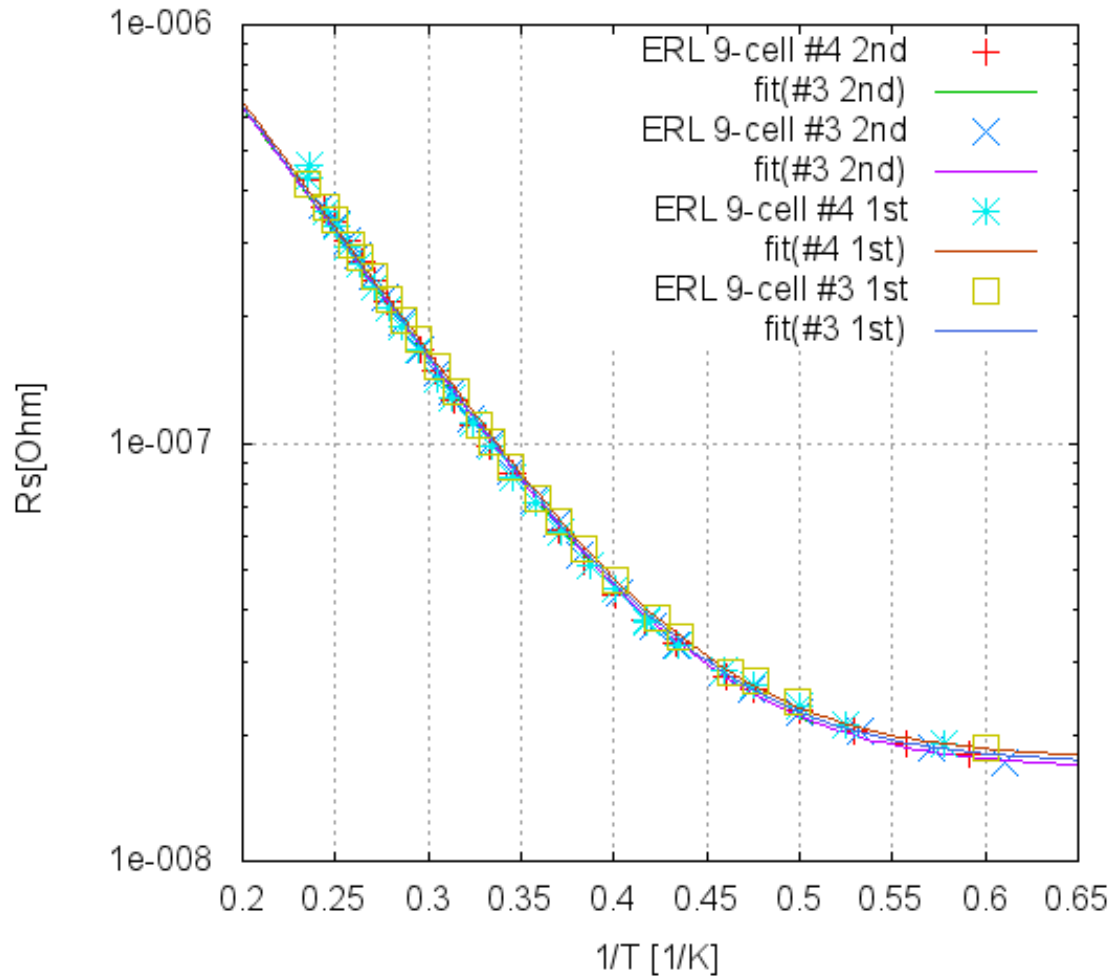


From SBP side



Cavity surface is generally fine.
Some defects, polished after EP-1 were seen. But edges seem to be smooth.

Q-T curve for ERL 9-cell #3 and #4 cavity



#3 cavity (1st VT)
1299.647 MHz(@2K)
17.5 nΩ

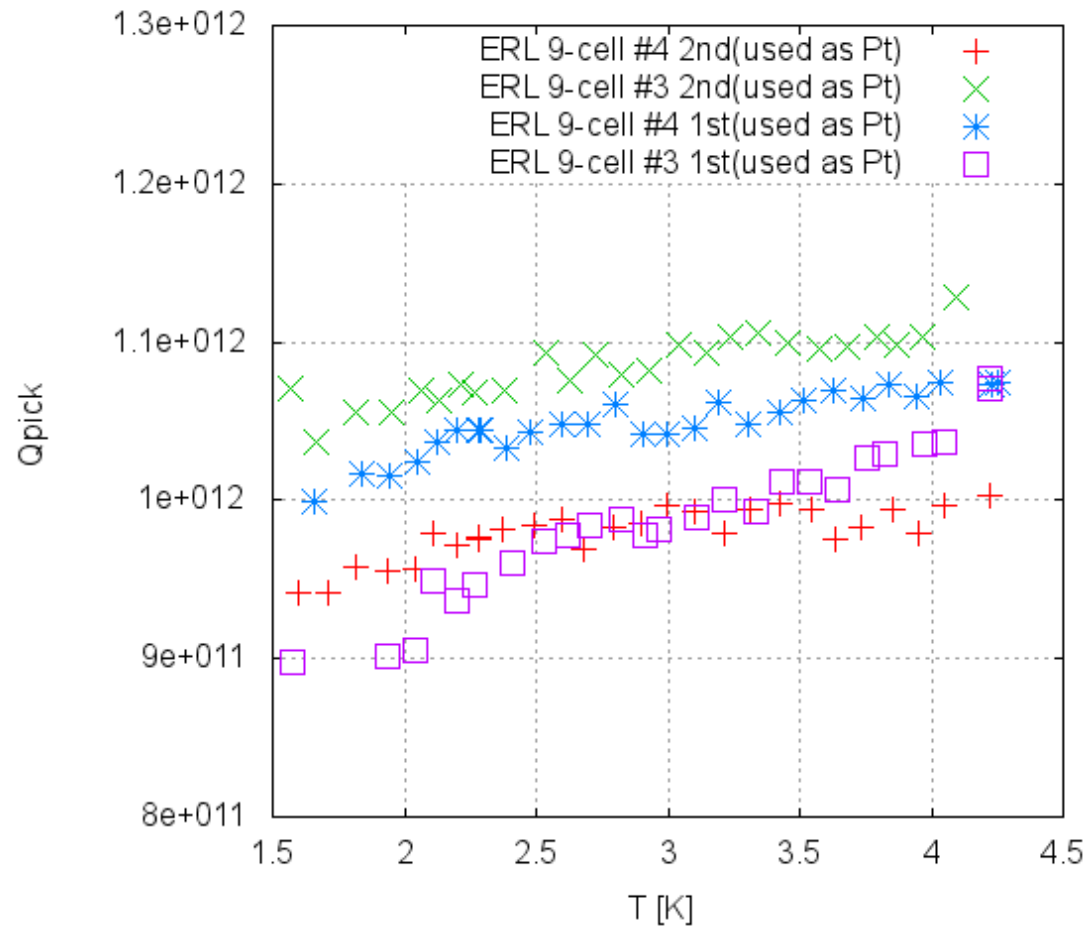
#3 cavity (2nd VT)
1299.603 MHz(@2K)
16.6 nΩ

#4 cavity (1st VT)
1299.717 MHz(@2K)
17.0 nΩ

#4 cavity (2nd VT)
1299.640 MHz(@2K)
16.6 nΩ

Residual resistance
Includes loss at SUS
flanges

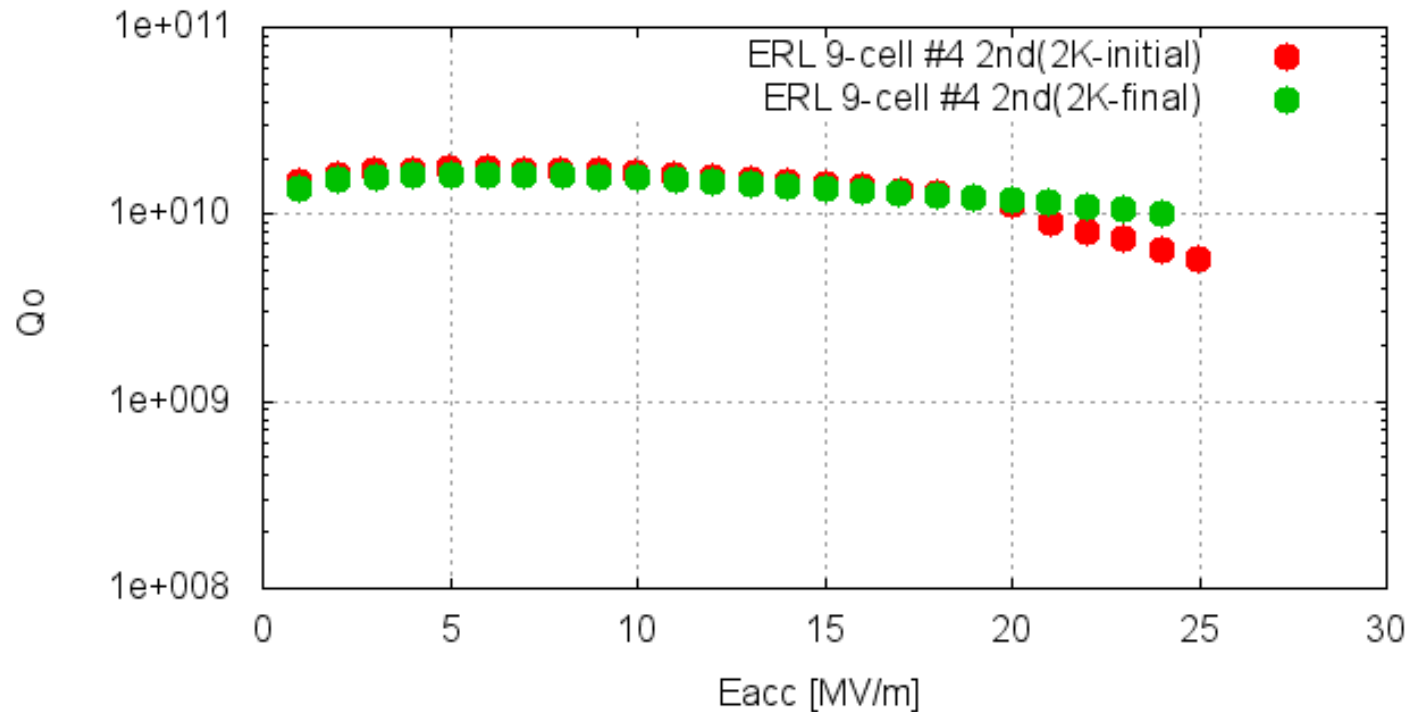
Qpickup for #3 and #4 cavities



Target of Q_{pickup} $1e12$

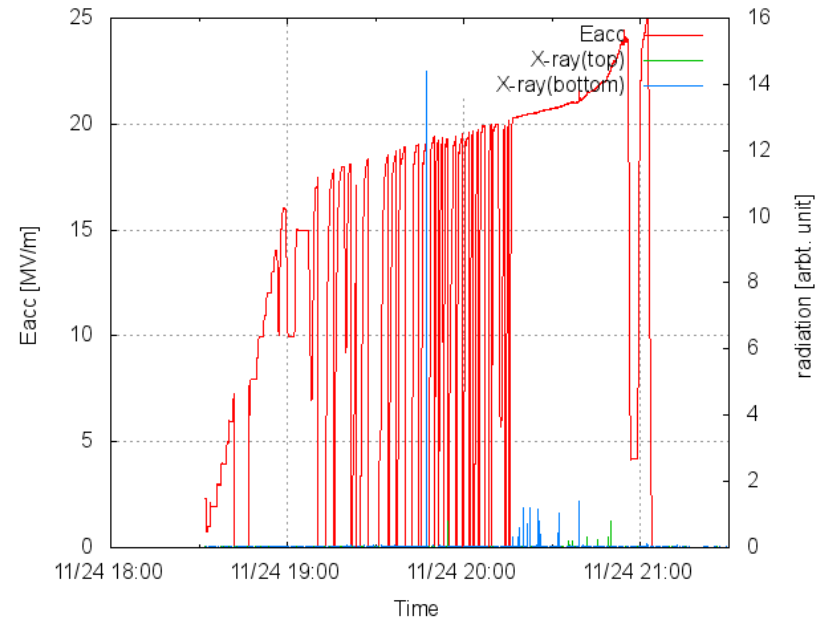
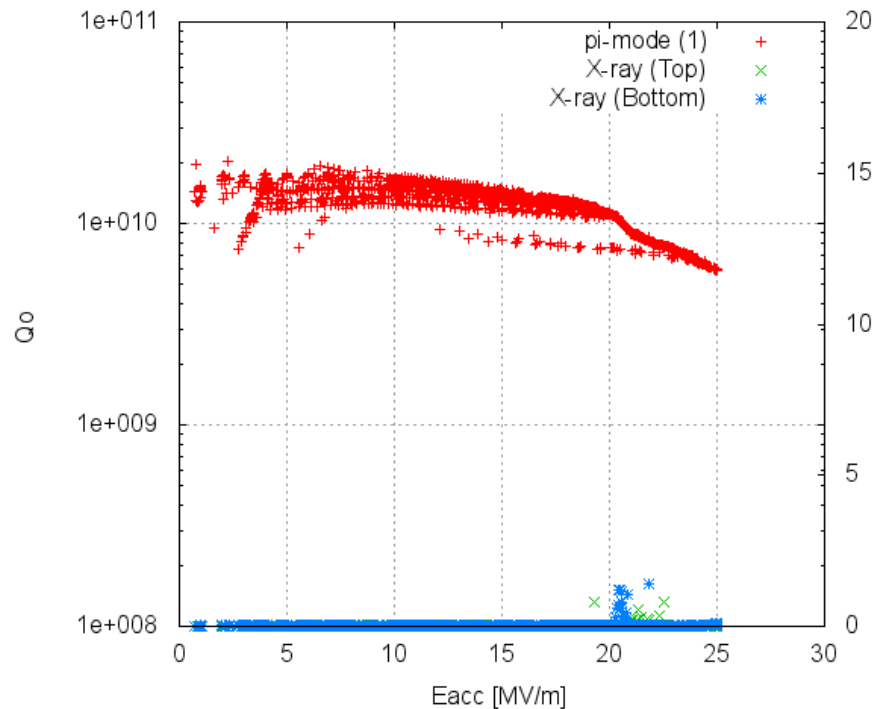
Q_{pickup} at 2K is OK, within 5~10%.

2K π -mode measurement



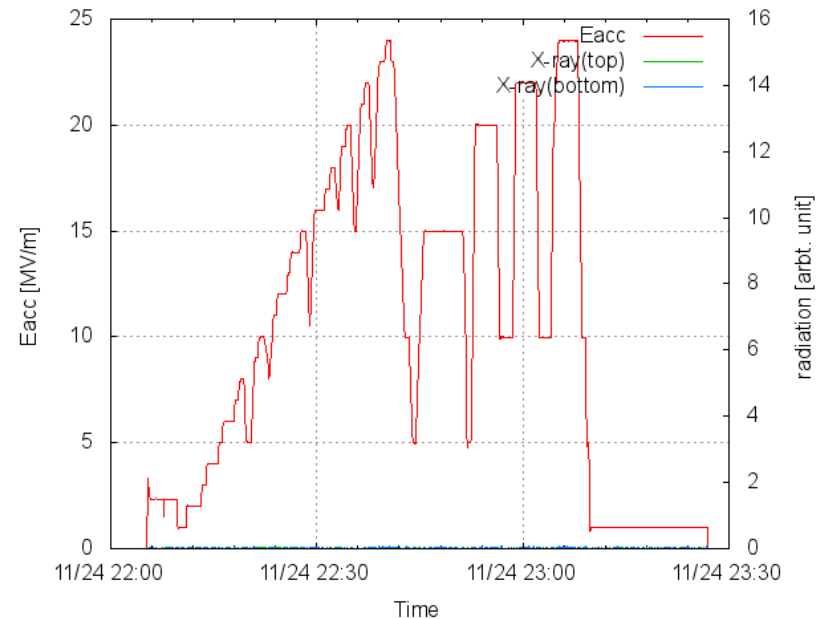
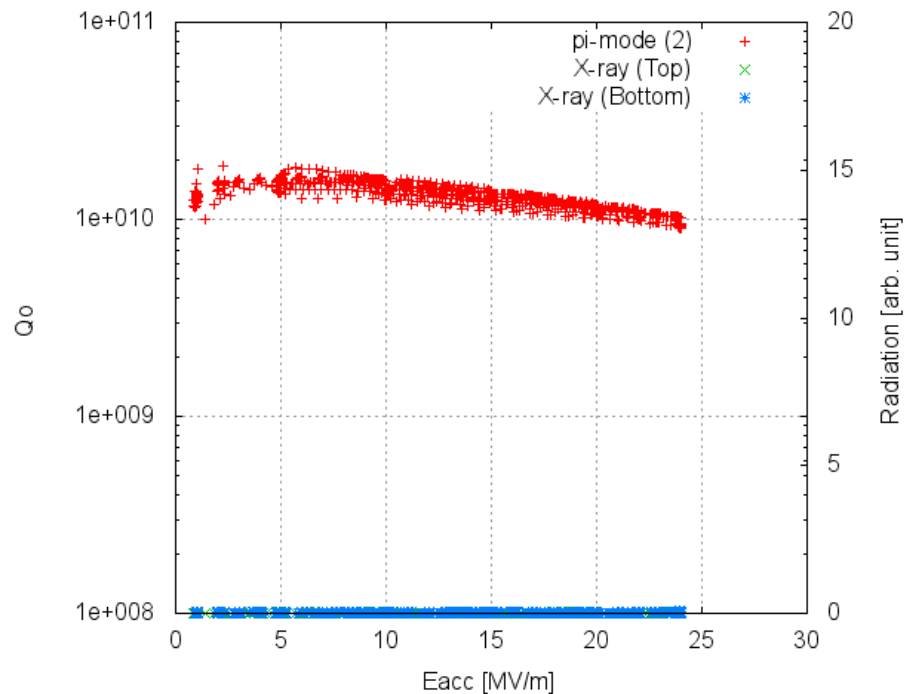
- Initial (1.6-2.1K), Final (1.7-1.8K)
 - At 3MV/m, $Q_0=1.5e10$ (1.8K) and $Q_0=1.1e10$ (2.1K)
- Reached to 25 MV/m. Satisfied ERL spec.
- 1.4×10^{10} (@15MV/m), 1.2×10^{10} (@20MV/m)
- No limitation up to 25MV/m

2K π -mode (initial)



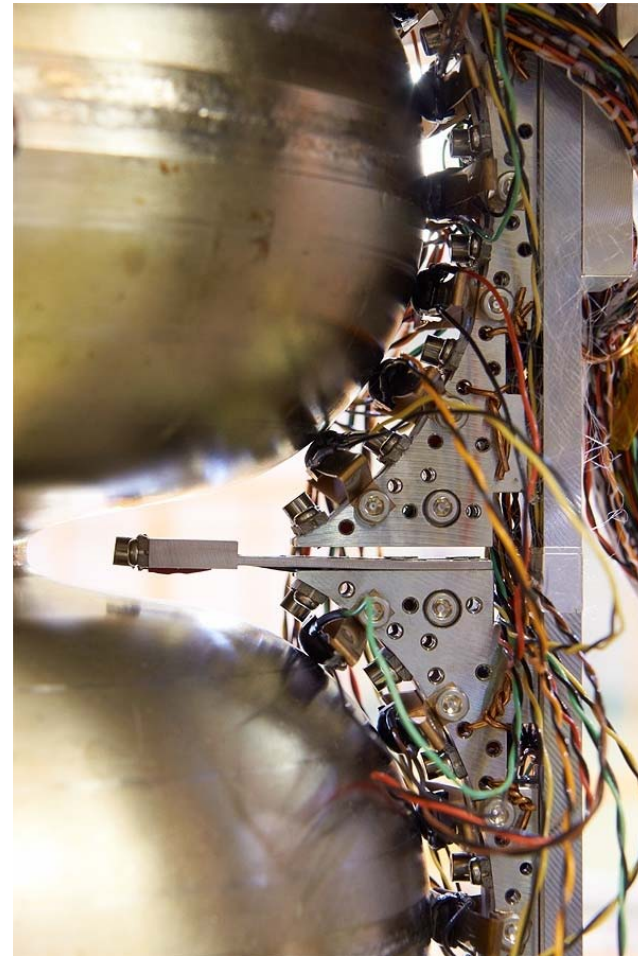
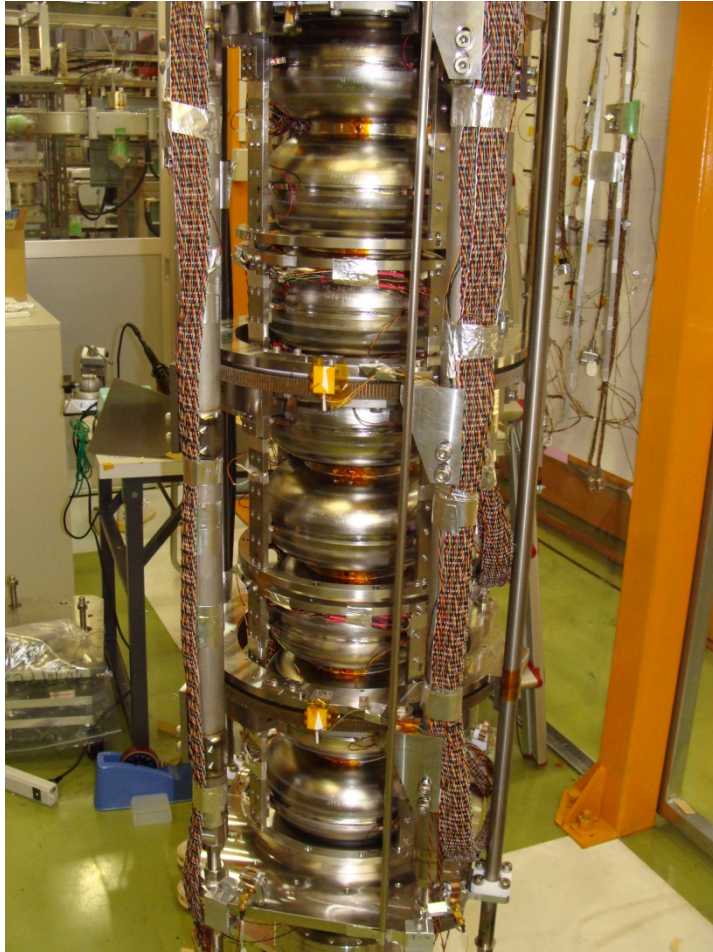
- Measured at temperature of 1.6~2.1K
- Reached to 25 MV/m
- Multipacting from 18 to 23 MV/m, accompanied by X-rays.
- But they were processed. Radiation is also processed up to 24 MV/m.
- Radiation was very small, 20 μ SV/h at 25MV/m.

2K π -mode (final)



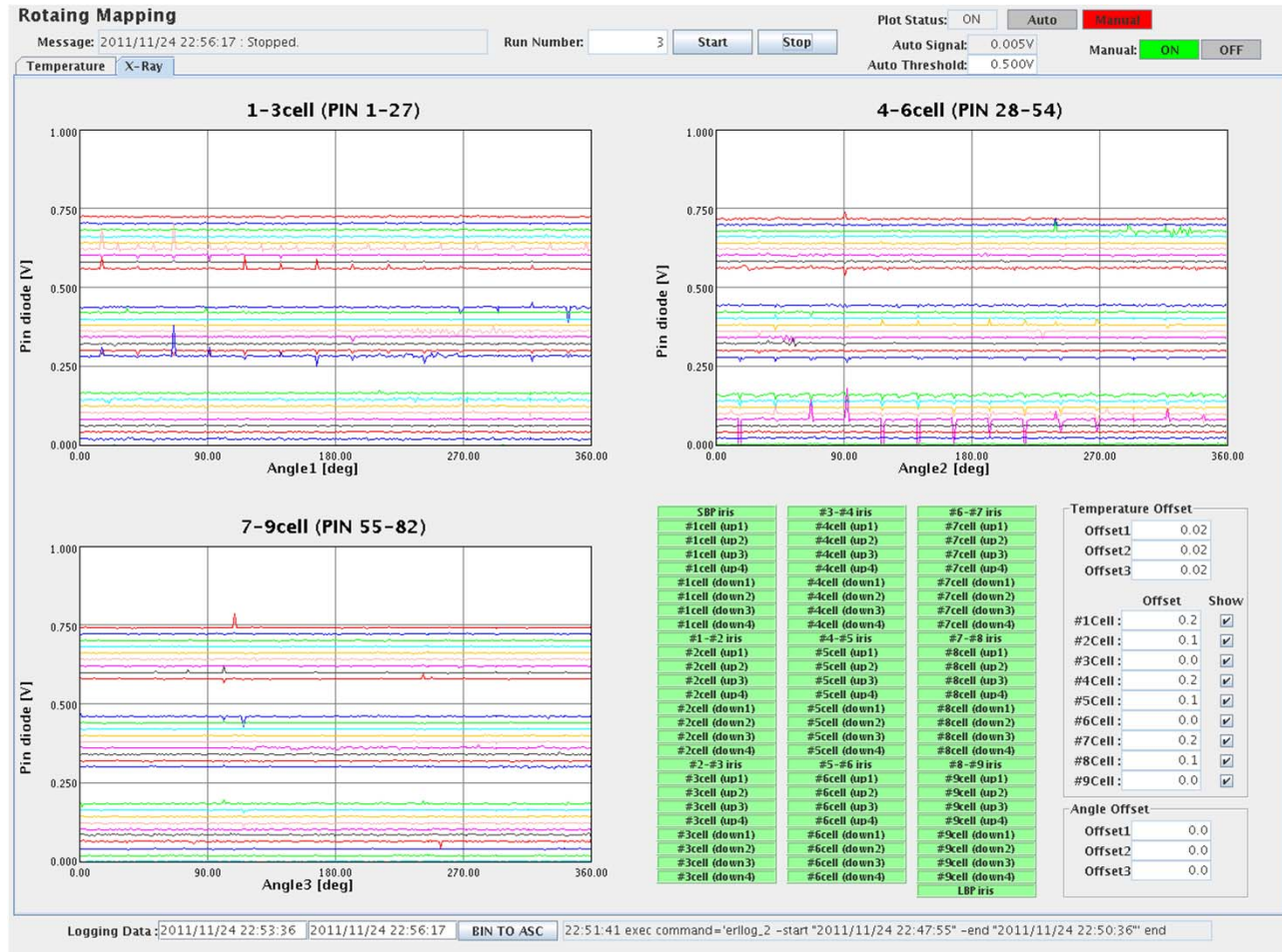
- Measured at temperature of $1.7 \sim 1.8$ K
- Reached to 24 MV/m, without quenches.
- X-ray on-set was 22 MV/m
- Radiation was very small, 4 μ SV/h at 24 MV/m.

X-ray mapping system



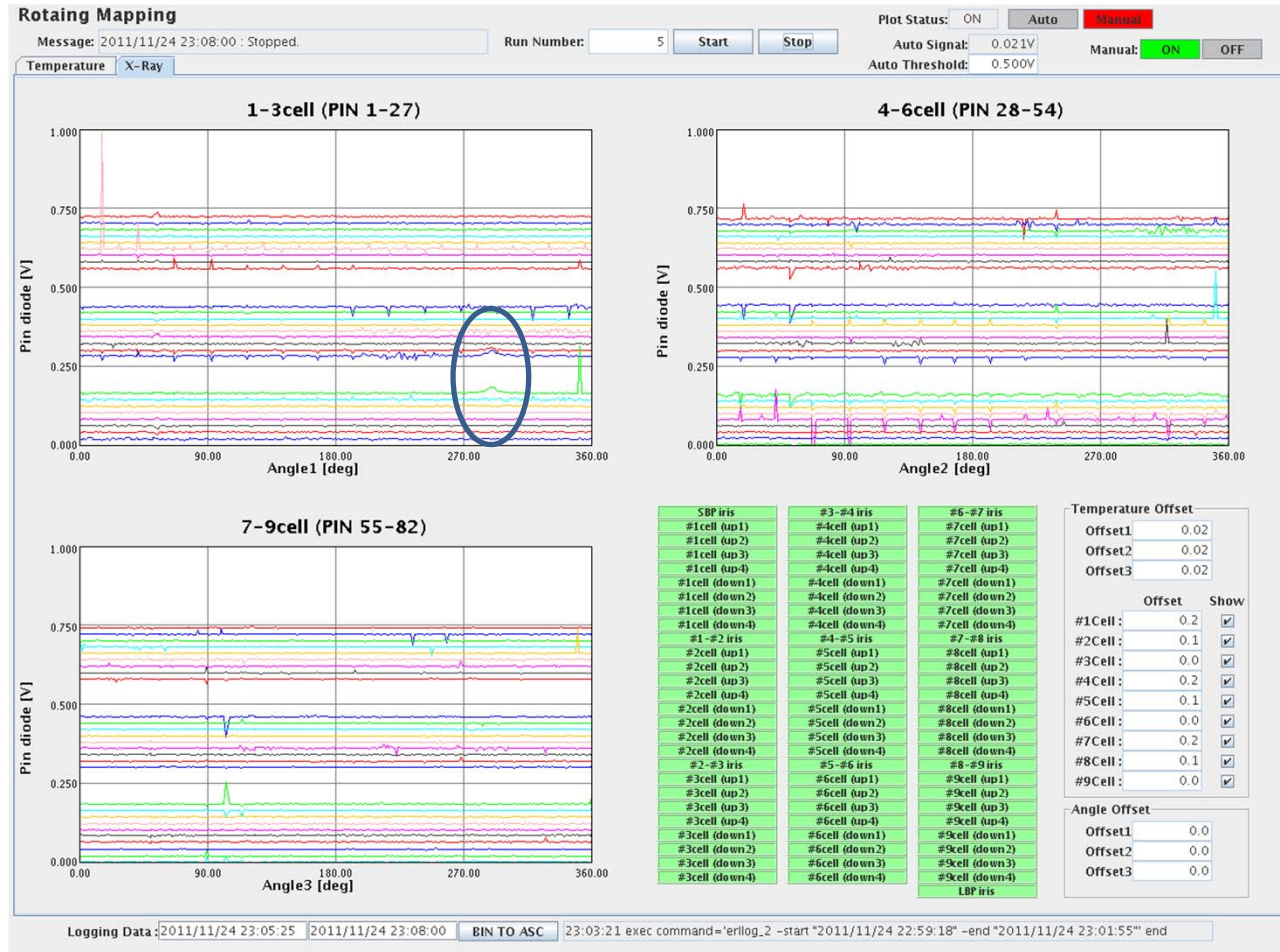
- Array of **Si diode** for X-ray detection and **carbon resistor** for temperature measurement
- They will rotate around cavity by using pulse motor

X-ray at 20 MV/m (final π -mode)



No X-rays were observed.

X-ray at 24 MV/m (final π -mode)



Small X-ray signal around 2-3 iris

Summary

- After 1st vertical test, several defects were found by surface inspection. The cavity was repaired by grinding such defects.
- Pre-tuning and 30um EP-2 were applied.
- 2nd vertical test was performed for ERL-9cell #4 cavity.
- 25 MV/m was successfully reached.
- $Q_0=1.4e10(@15MV/m)$ and $1.2e10(@20MV/m)$
- Radiation was very small. Its final on-set was 22 MV/m.
- ERL specification was satisfied.
- This cavity will go for He jacket welding.