6. Cavity Mechanical Tuning

6.1 Detuning Angle
6.2 Bead Pull method
6.3 Pre-tuning method
6.4 Field flatness conservation @ EP

6.1 Detuning Angle ψ of Cavity

$$\Delta f/f_C = - \tan(\psi)/(2Q_L)$$

V_C ψ

V_g

$\Delta\Omega$

ω_g ω_c

p_g p_t

ω_g

D.C ψ

$\omega_g t$

RF Amp

$\omega_g t + \psi(\omega_c) + \phi$

ϕ

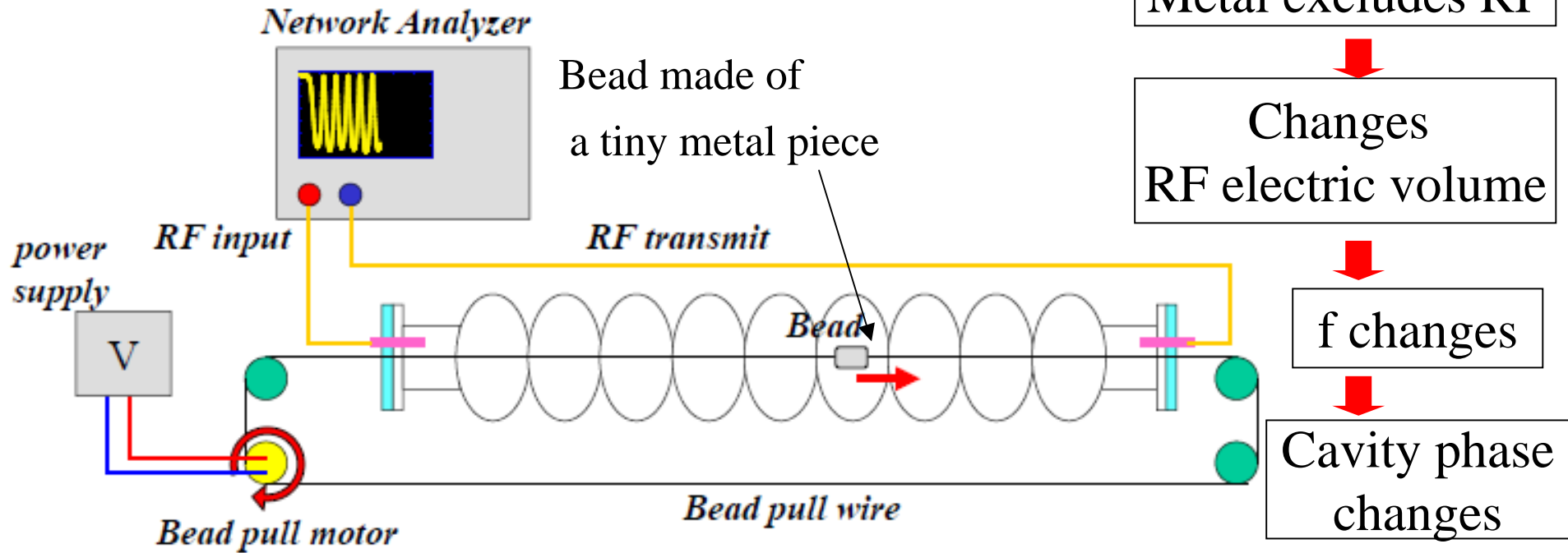Mixer

SG
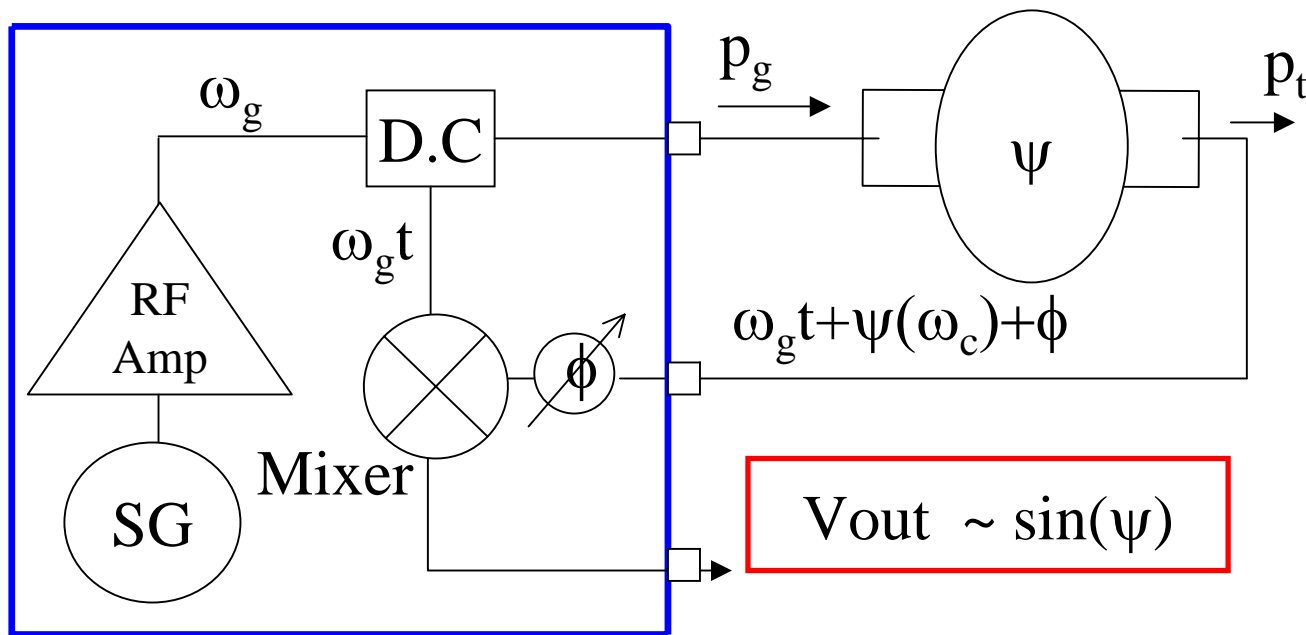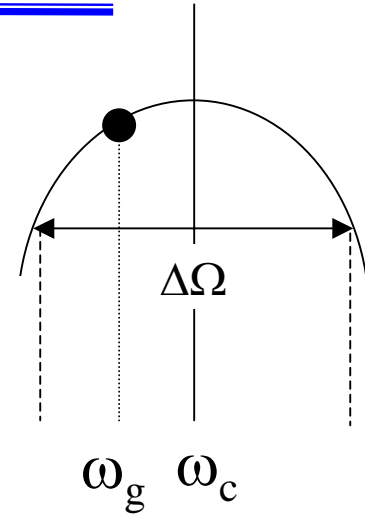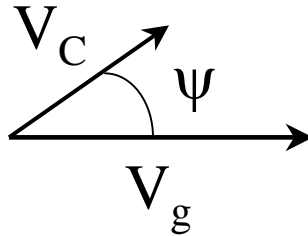
$$V_{out} \sim \sin(\psi)$$

Network Analyzer

(Phase measurement)

Δf can be measured by knowing ψ, used Network Analyzer.

6.2 Bead Pull Method

Network Analyzer

Bead made of
a tiny metal piece

Metal excludes RF

⬇

Changes
RF electric volume

⬇

f changes

⬇

Cavity phase
changes

power supply

RF input

RF transmit

V

Bead
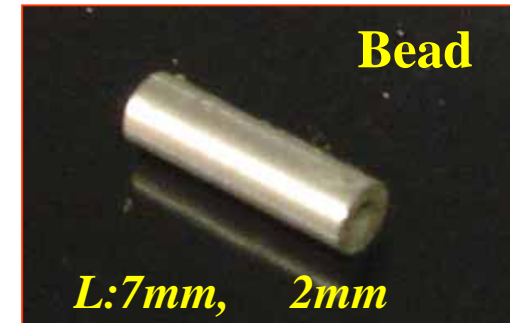
Bead pull motor

Bead pull wire

$$\text{Field Flatness } [\%] = \left(1 - \frac{E_{cmax.} - E_{cmin.}}{\frac{1}{N}\sum E_{ci}}\right) \times 100\%$$

$$\cong \sqrt{\frac{Phase_{min.}}{Phase_{max.}}} \times 100\%$$

$Phase_{max.}$ $Phase_{min.}$
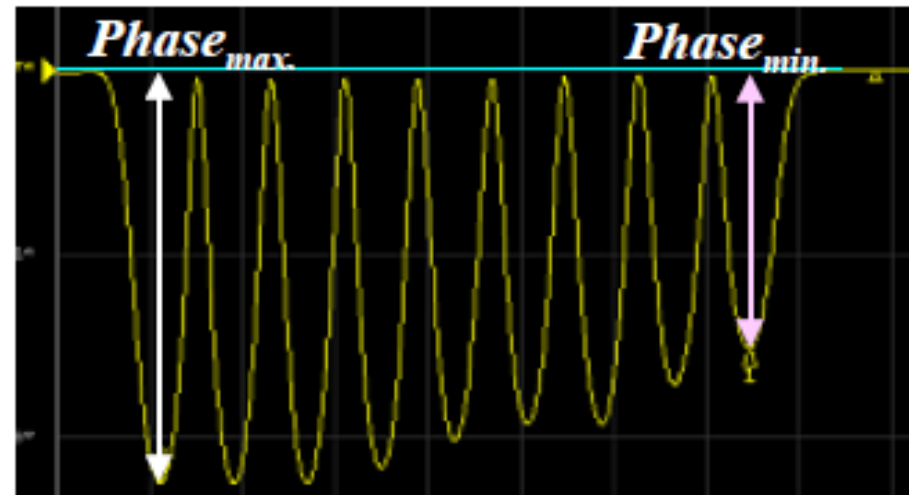
Pre-tuning & field flatness meas. system

A cavity set on the KEK tuning machine

Bead
L:7mm, 2mm

KEK Tuning Machine
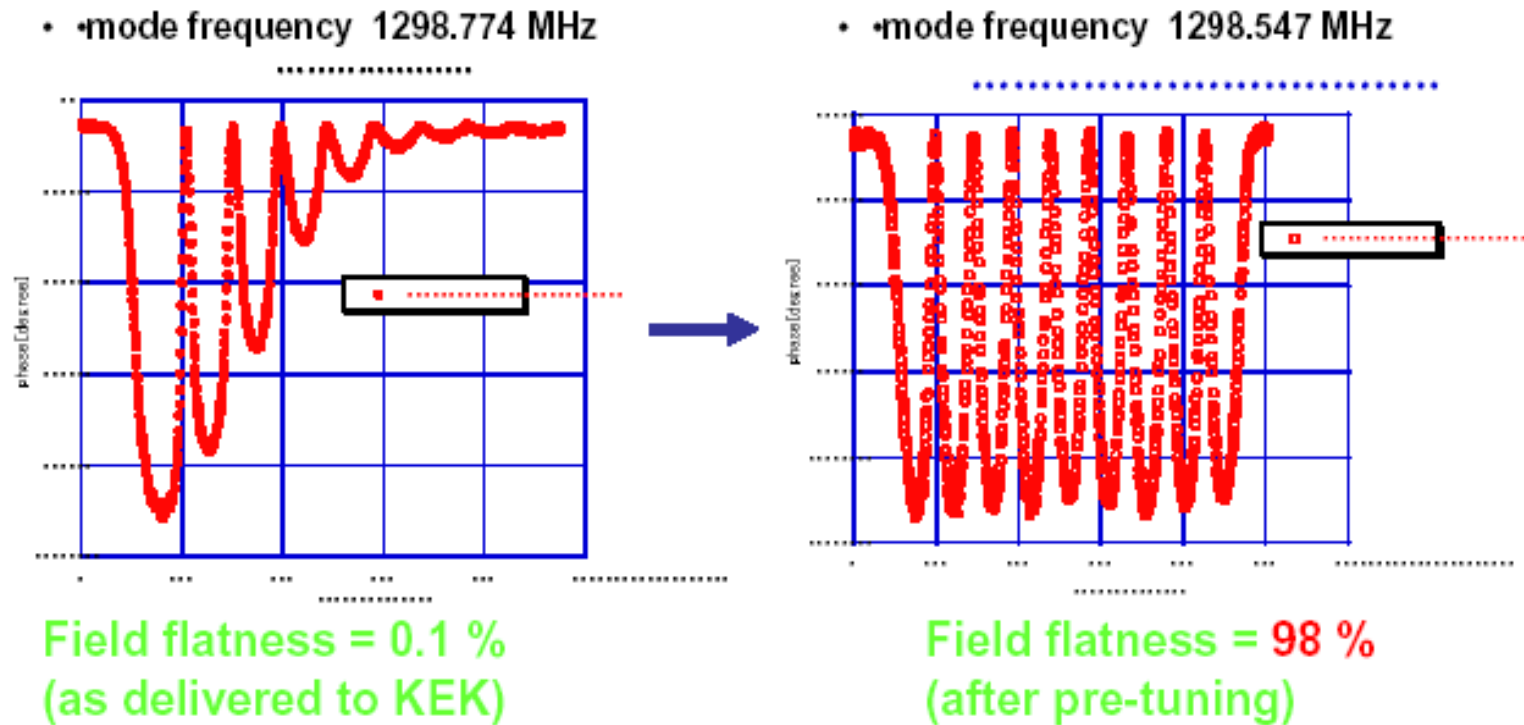
Field Flatness Measurements

After jig dressing
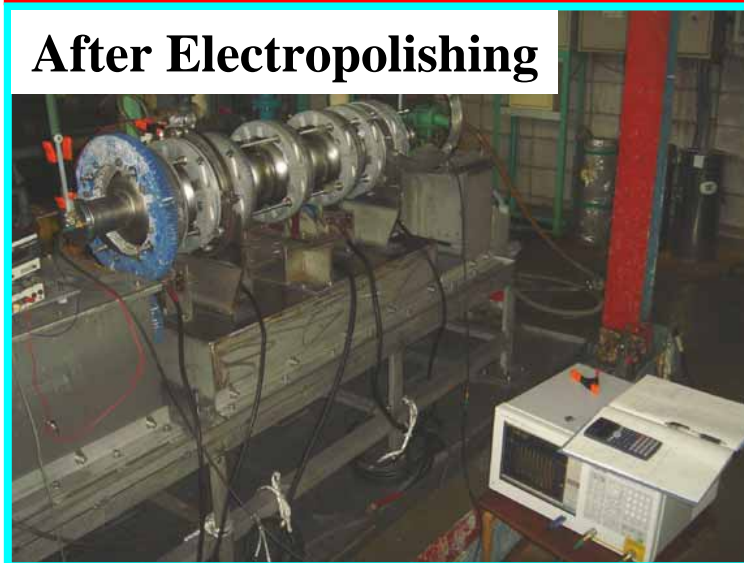
After Electropolishing

196

6.4 Cavity mechanical Tuning

- • mode frequency 1298.774 MHz

- • mode frequency 1298.547 MHz

Field flatness = 0.1 %
(as delivered to KEK)

Field flatness = 98 %
(after pre-tuning)

Cavity	Field flatness (min/max) as delivered / after pre-tuning		Freq. target 1298.141 (MHz) @R.T. as delivered / after pre-tuning	
1st	0.1%	/ 98%	1298.774	/ 1298.547
2nd	57.6%	/ Not yet	1301.447	/ Not yet
3rd	31.5%	/ Not yet	1301.577	/ Not yet
4th	51.5%	/ Not yet	1301.696	/ Not yet

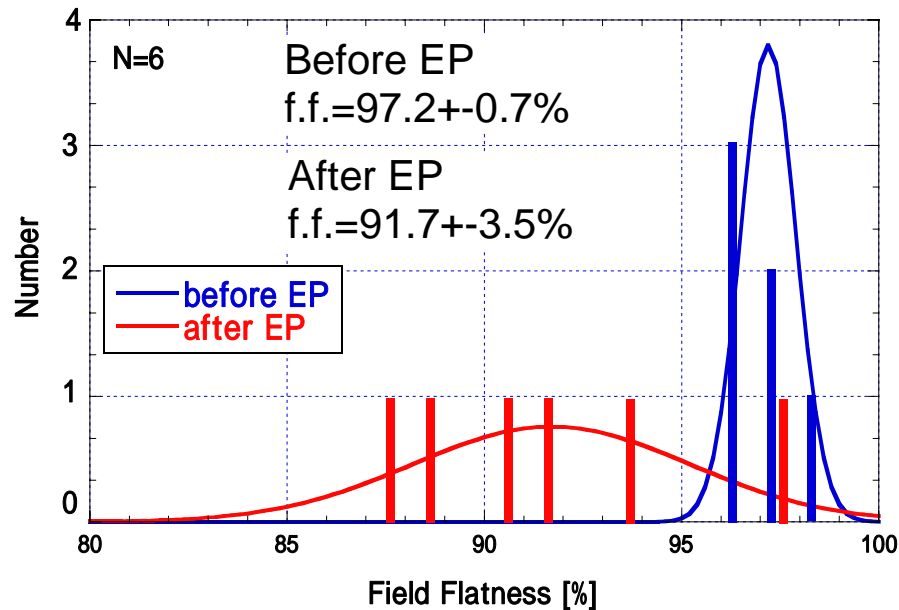Cell-to-cell coupling is as small as 1.6%, but no problem in pre-tuning.

Field Flatness Control

We have noticed that sometimes field flatness is very much destroyed after vertical test.

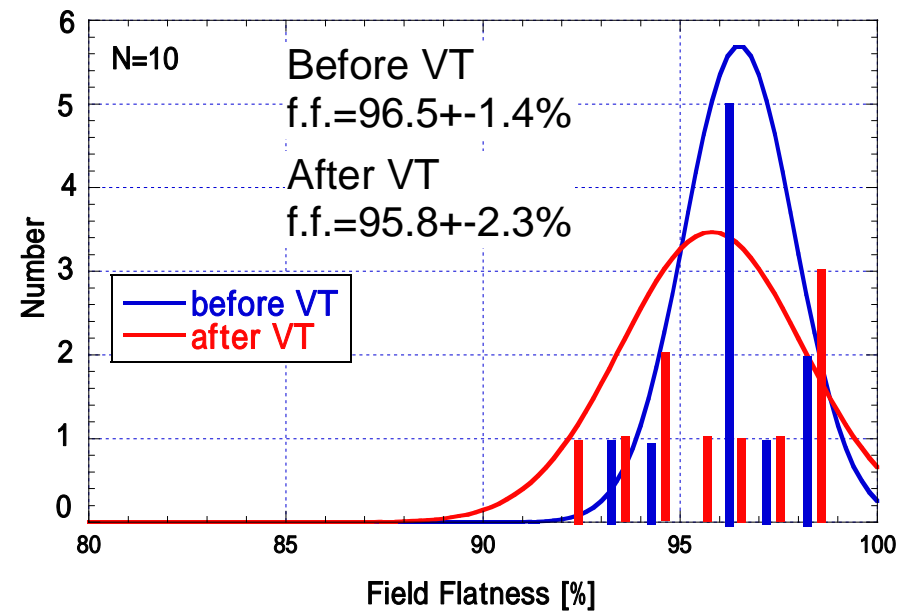The biggest destroy (~ -6%) happens during EP. We have tried to fix it but not yet.

So far, we routinely measure the flatness after EP and tune up to > 96% if destroyed <93%, then take HPR.

Before/After EP process

N=6
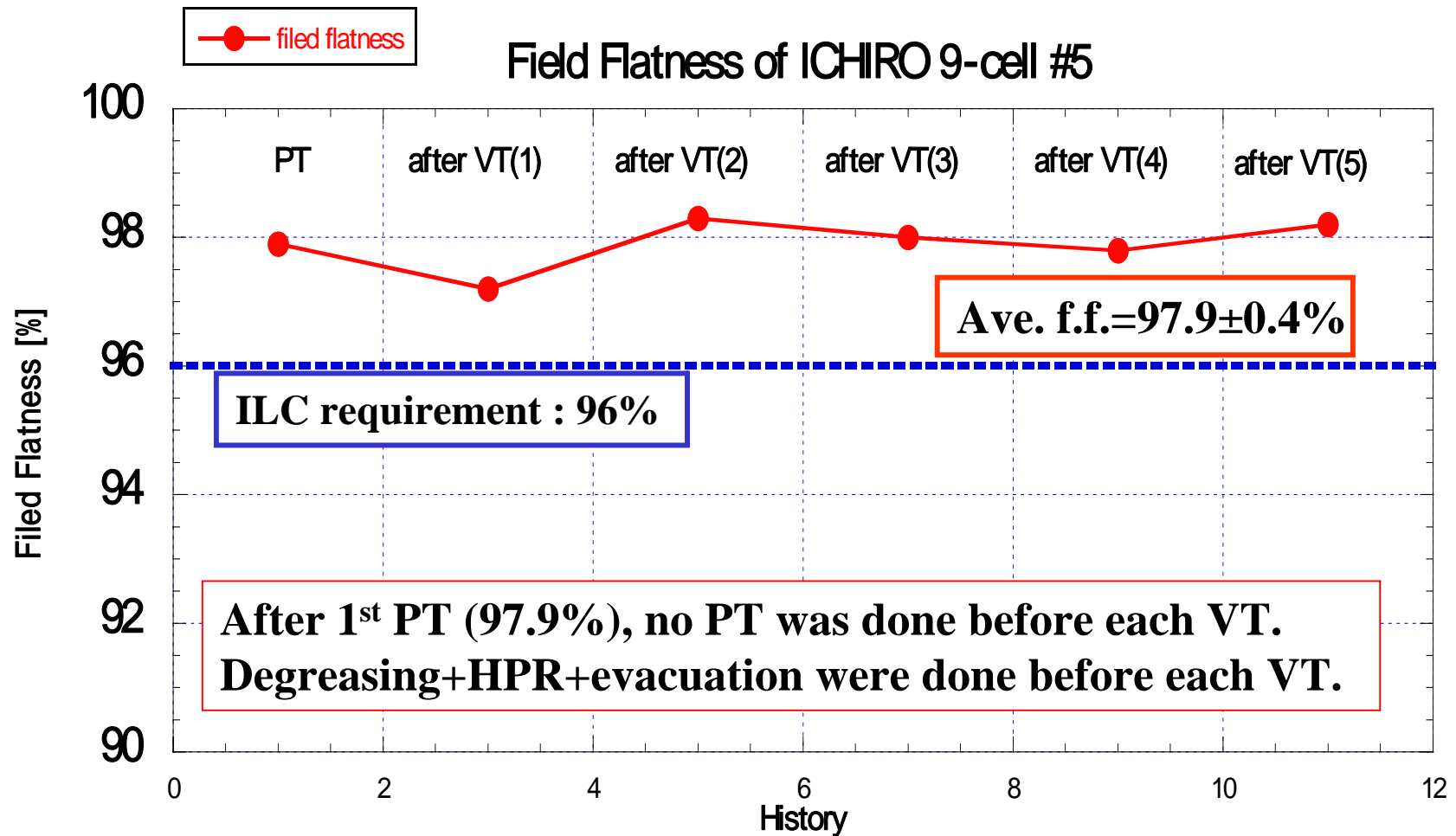Before EP
f.f.=97.2+-0.7%

After EP
f.f.=91.7+-3.5%

before EP
after EP

=5.5± 3.0%

Before/After VT

N=10
Before VT
f.f.=96.5+-1.4%

After VT
f.f.=95.8+-2.3%

before VT
after VT

=0.6± 2.3%

Field Flatness Change

Field Flatness of ICHIRO 9-cell #5

- filed flatness

PT   after VT(1)   after VT(2)   after VT(3)   after VT(4)   after VT(5)

Ave. f.f.=97.9±0.4%

ILC requirement : 96%

**After 1st PT (97.9%), no PT was done before each VT.
Degreasing+HPR+evacuation were done before each VT.**

Filed Flatness [%]

History

Field Flatness of > 96% is in hand.