Fabrication of four 9-cell ICHIRO high-gradient cavities for the R&D of ILC accelerator in KEK

(Poster ID: TuP20)

10-15 July 2005
SRF2005 at Cornell University

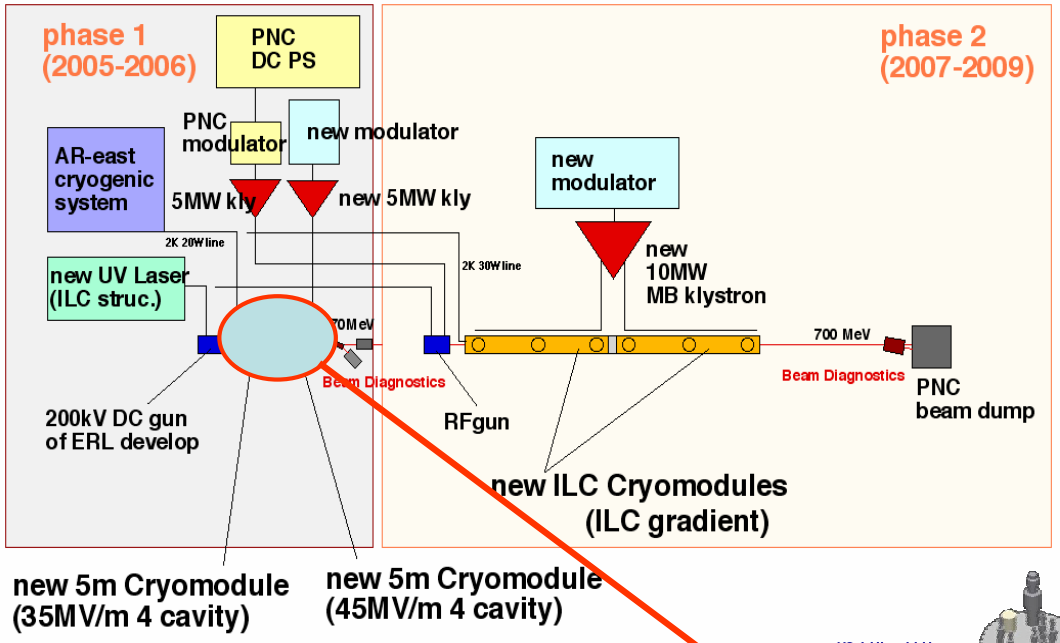
T. Saeki [(1)], F.Furuta [(1)], K.Saito [(1)], H.Inoue [(1)], Y.Morozumi [(1)], Y.Higashi [(1)], T.Higo [(1)], T.Yamaoka [(1)], K.Ueno [(1)], Y.Sohn [(2)], K.Ko [(3)], J.Sekutowicz [(4)]

Affiliation: (1)KEK, (2)PAL, (3)SLAC, (4)DESY

Abstract

After the first ILC Workshop in KEK in November 2004, the Working-Group 5 (WG5) Asia made a plan to fabricate four 9-cell high-gradient cavities in LL-shape for Super-conductivity Test Facility (STF) in KEK, where these cavities will be installed in a cryostat and operated at 45MV/m to accelerate real electron beams. These four cavities are designed as having the low Hp/Eacc ratio of 36 Oe/(MV/m), and thus the high gradient of Eacc ~ 51 MV/m is expected in the best case. We named the cavity as ICHIRO after the famous baseball player: ICHIRO's back number 51. This paper describes the fabrication of these four 9-cell ICHIRO cavities and also includes discussions about the dimensional deviations of fabricated cavities from the design values.

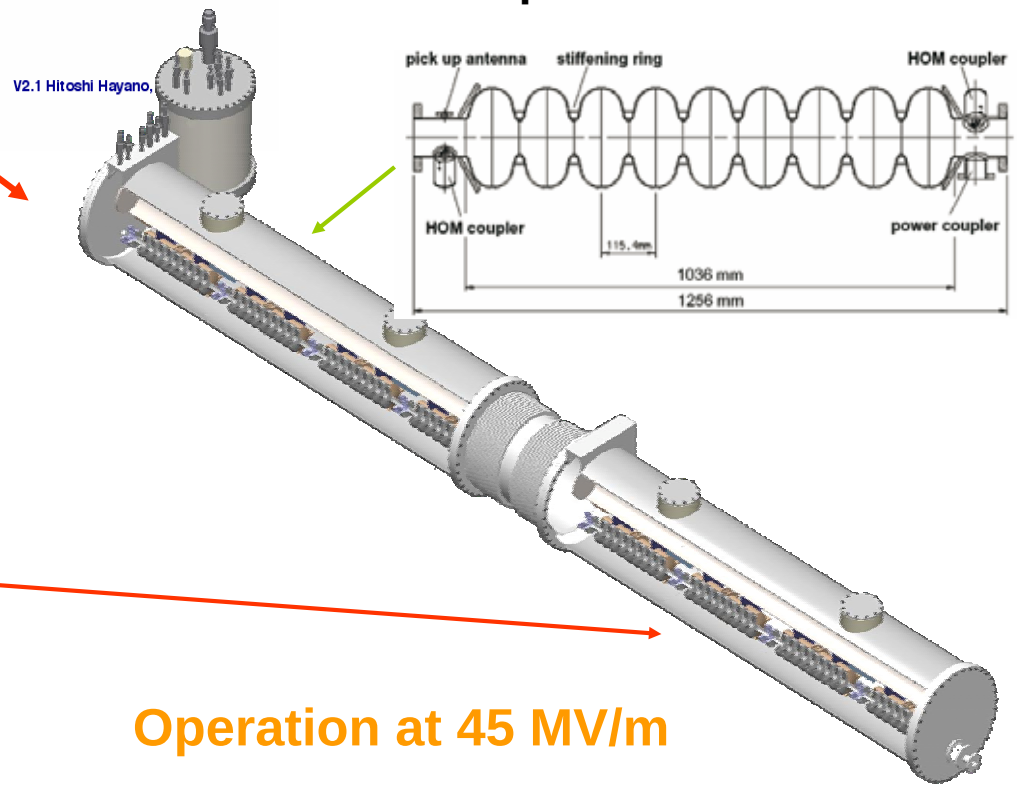
Plan of Superconducting RF Test Facility (STF)



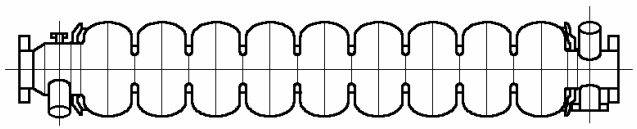
STF Phase 1

Details of STF phase 1, 2
=>Talk (ThA01) by Hayano

TESLA design cavities
Operation at 35 MV/m



Four 9-cell ICHIRO LL cavities



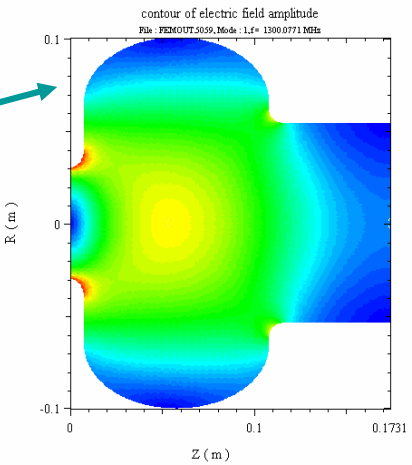
Already delivered to KEK !

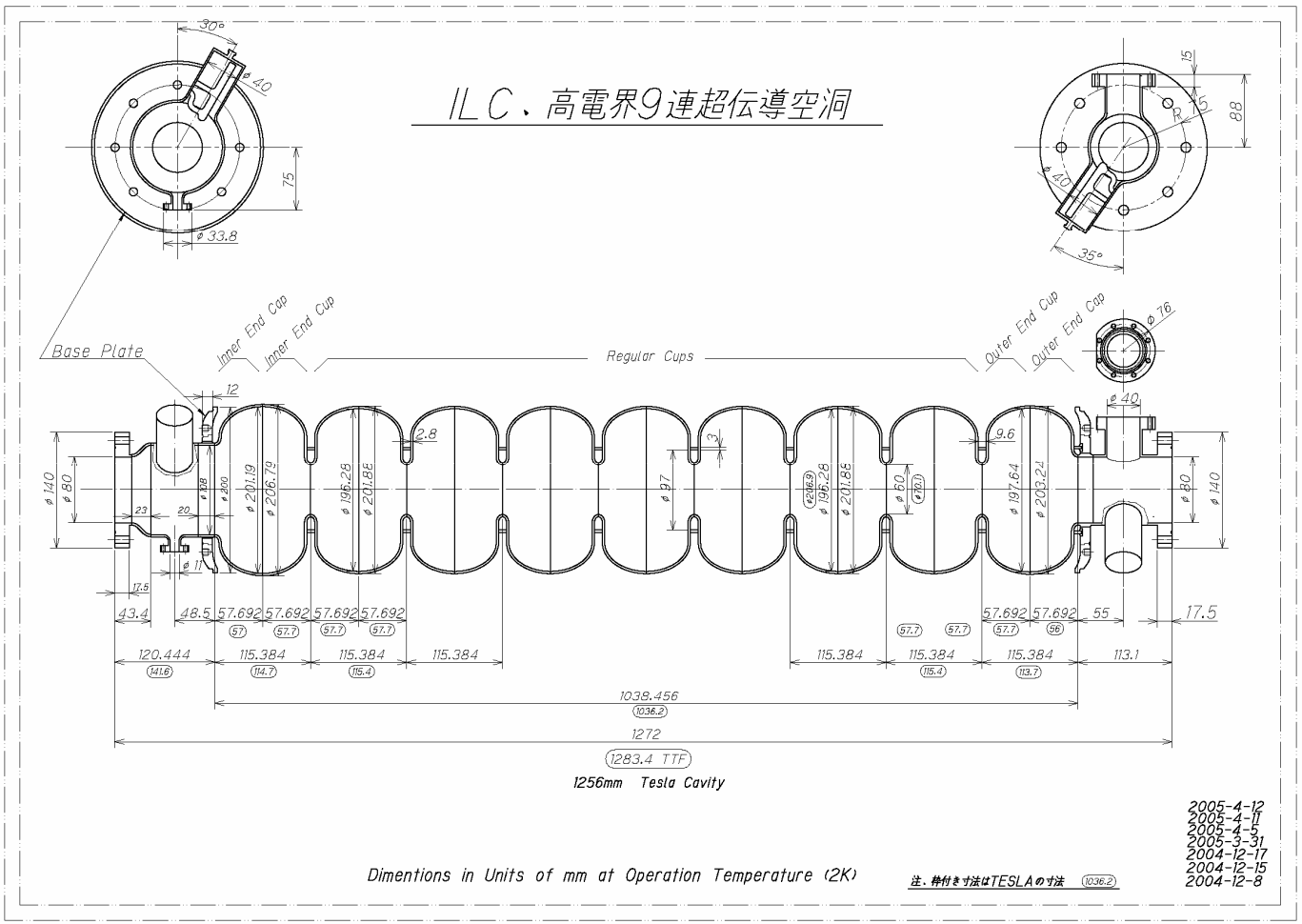
Operation at 45 MV/m

9-cell ICHIRO high-gradient Low-Loss (LL) cavity

Our goal is 51 MV/m !
(45 MV/m in operation)

Hp/Eacc = 36 Oe/(MV/m)
(Designed at KEK in collaboration with DESY.)
=> TuP19 for more details.



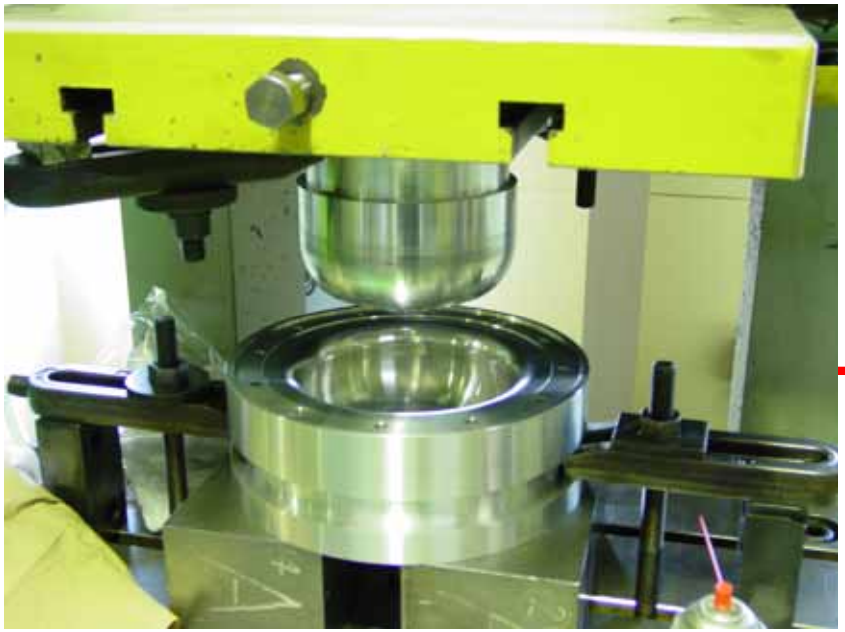


Most famous Japanese baseball-player.

Record breaker, 262 hits in single season in 2004.

Fabrication of ICHIRO Cavity in KEK(1)

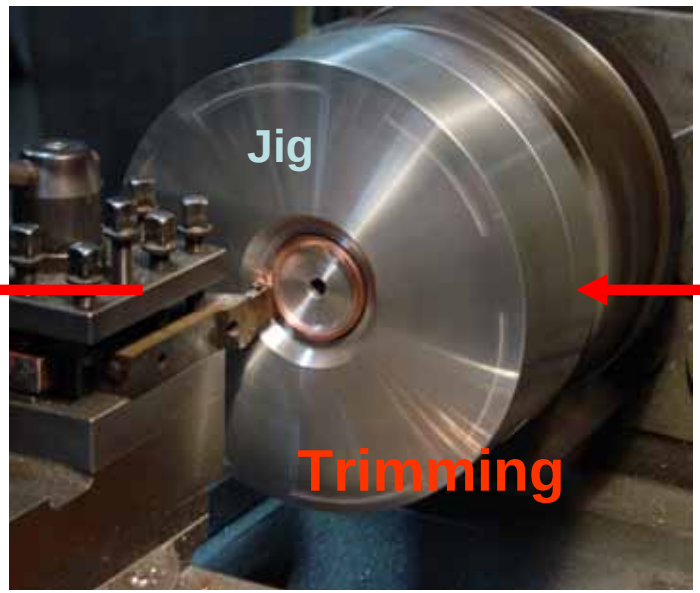
Pressing Nb plate



56 half-cells were pressed in a few hours

21 February 2005

After pressing



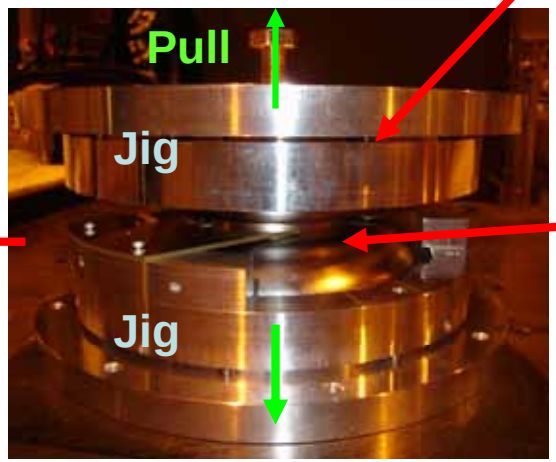
After trimming

Fabrication of ICHIRO Cavity in KEK(2)

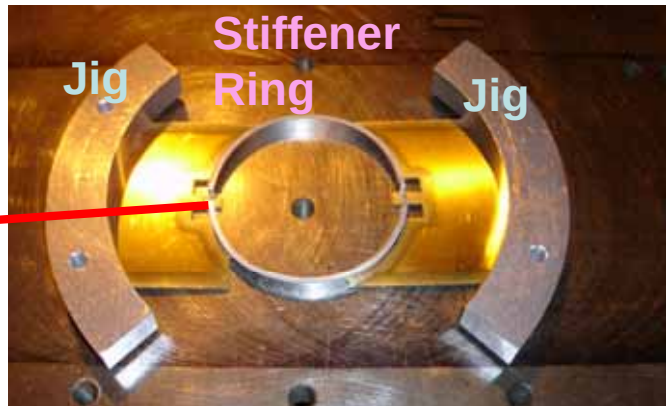
Electron Beam Welding (EBW)
In KUROKI corporation

Dumbbell

Dumbbell with stiffener-ring after EBW.



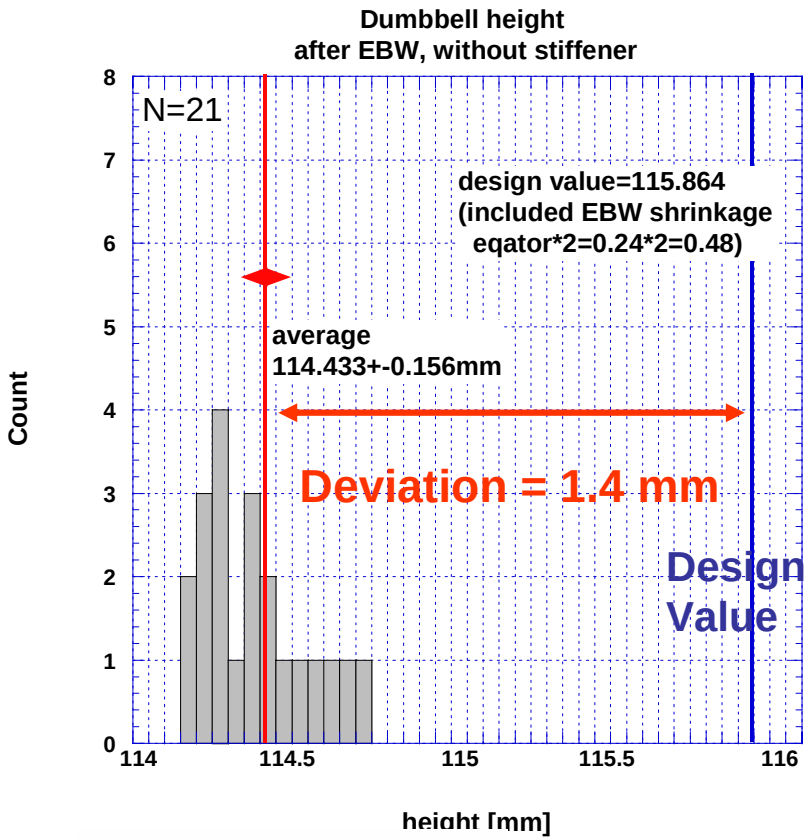
Pull and extend dumbbells to insert stiffener-ring.
=> EBW (dumbbell + ring)

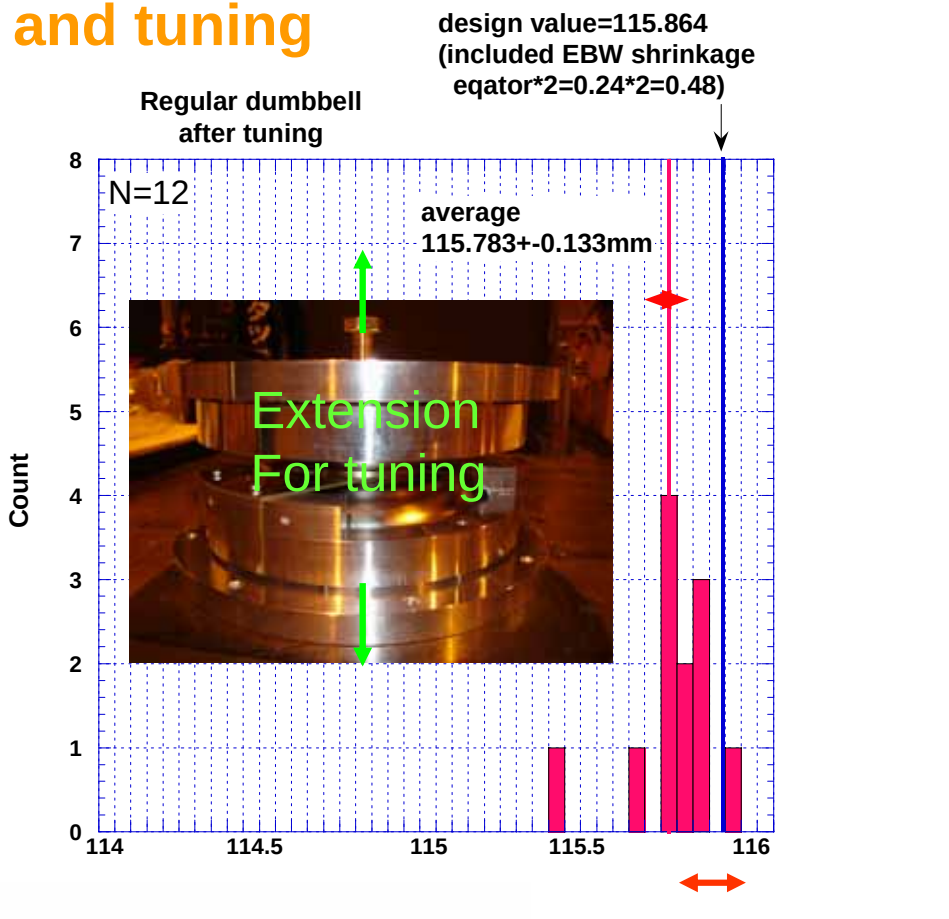


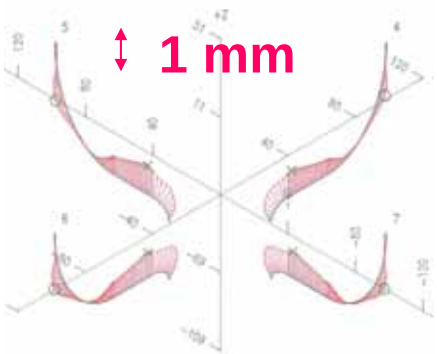
Insert stiffener-ring into the iris part of dumbbell.

Fabrication of ICHIRO Cavity in KEK(3)

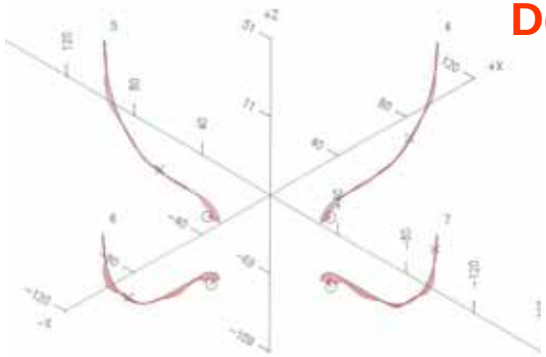
Dumbbell-height measurement and tuning







Dumbbell
Before
tuning



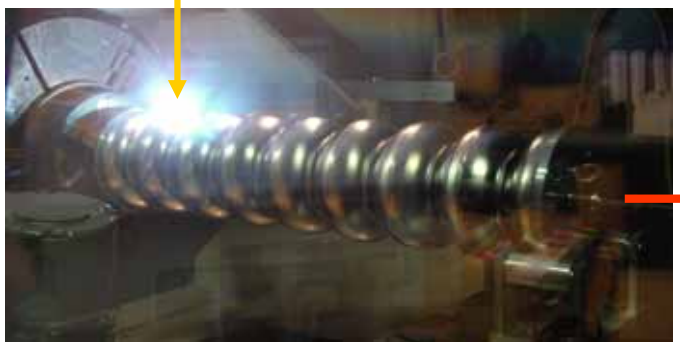
Dumbbell
After
tuning

All cups (dumbbells) were 3D-measured before/after EBW, tuning, etc…

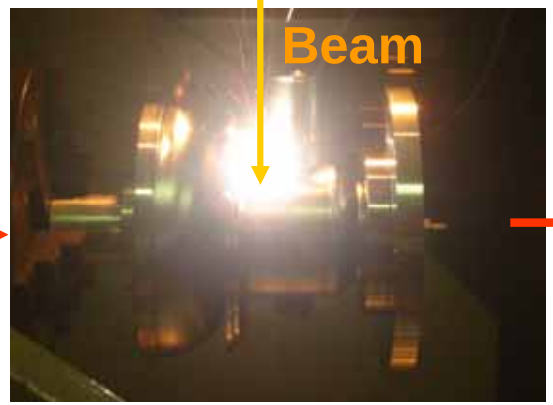
Fabrication of ICHIRO Cavity in KEK(4)

EBW of dumbbells

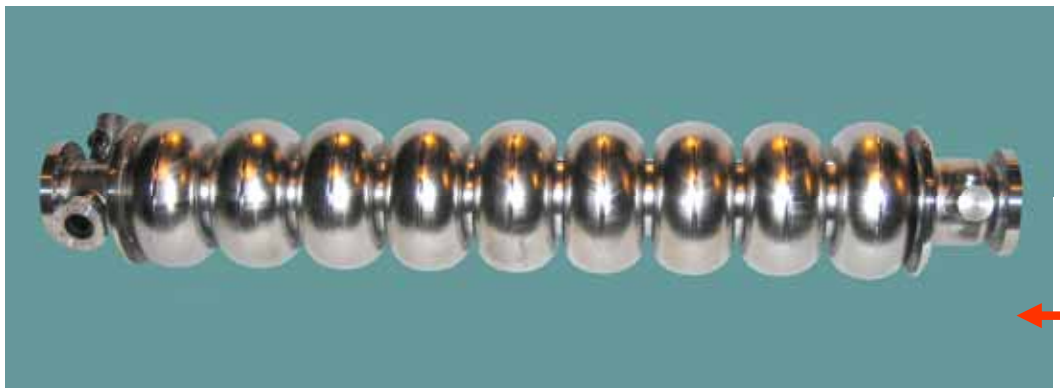
Beam



EBW of end-beam-pipe



End-beam-pipes with HOM and flanges



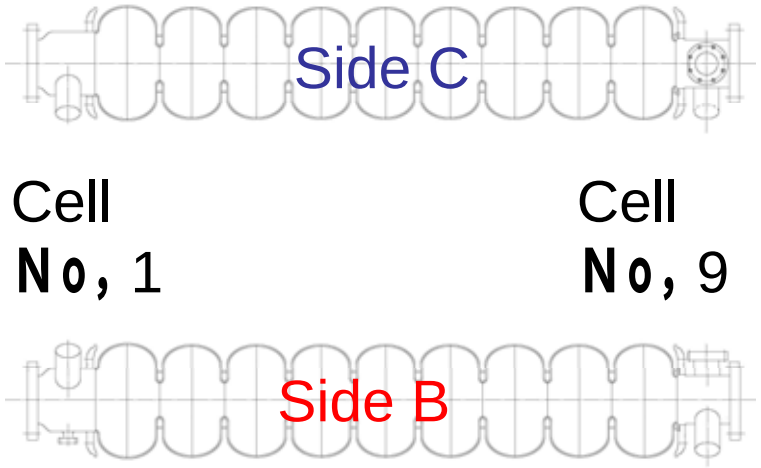
Beam

Four 9-cell ICHIRO high-gradient LL Cavities were successfully delivered to KEK ! (4 July 2005)

EBW of end-beam-pipes and cell-part

Dimensional measurements

Length and straightness of the cavities were measured by 3D-measurement machine.



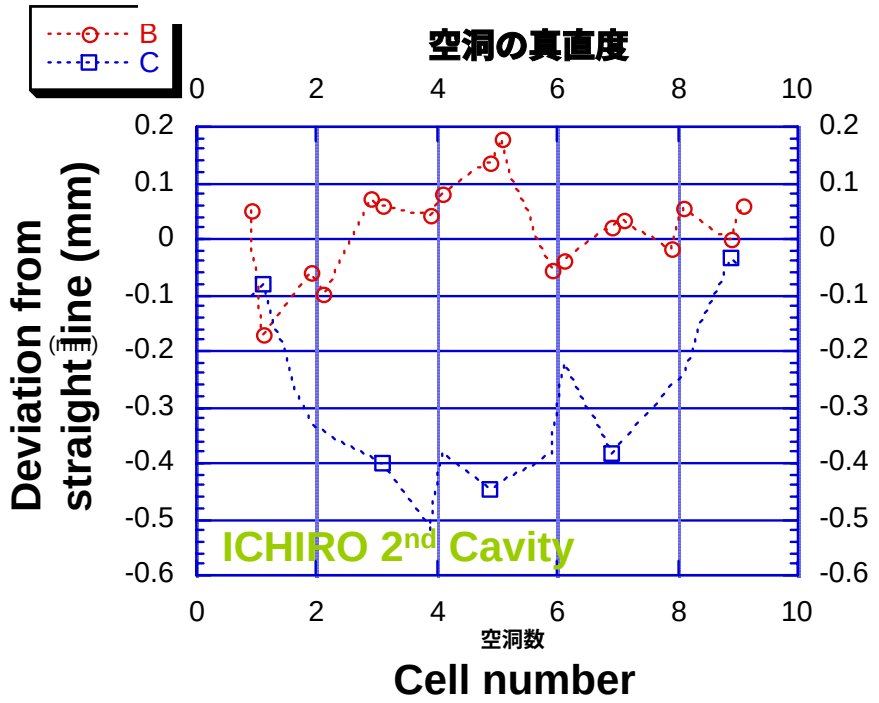
	EBW shrinkage
iris	0.148+-0.044 mm
equator	0.424+-0.125 mm

Dimensional deviation of length (only 9-cell part: 1038.5 mm)

-10 mm (1st 9-cell ICHIRO cavity)

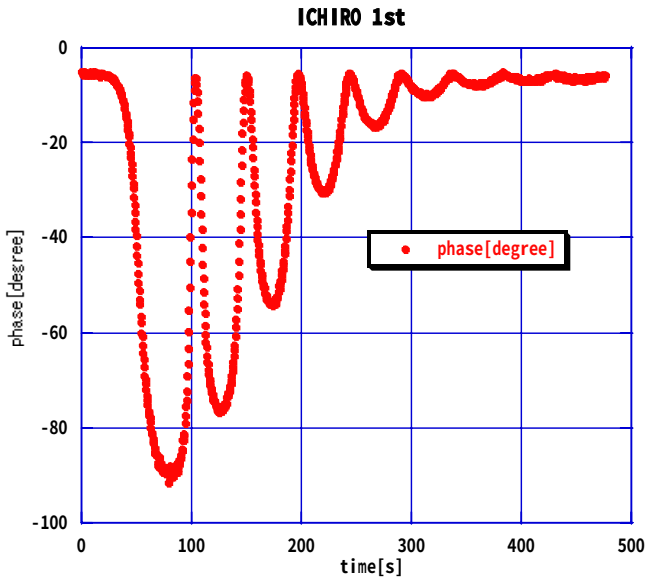
- 0.7 mm (2nd 9-cell ICHIRO cavity)

- 0.1 mm (3rd 9-cell ICHIRO cavity)



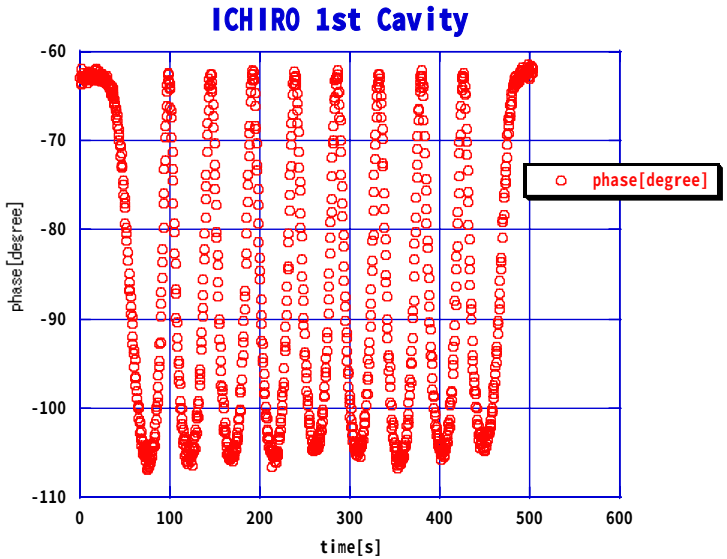
Field flatness after pre-tuning

π mode frequency 1298.774 MHz



Field flatness = 0.1 %
(as delivered to KEK)

π mode frequency 1298.547 MHz

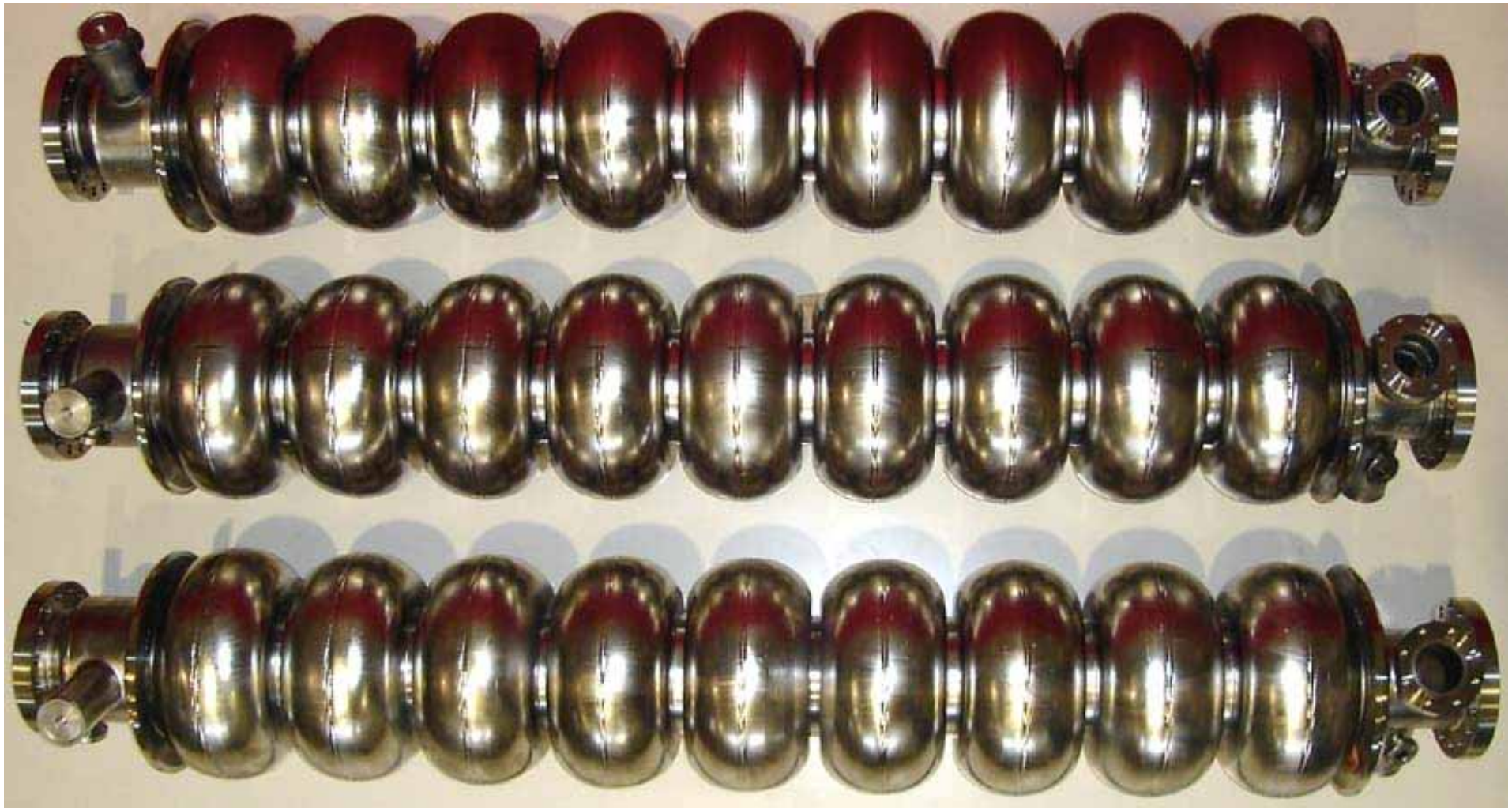


Field flatness = **98 %**
(after pre-tuning)

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.

2nd, 3rd, 4th 9-cell ICHIRO cavities



Summary

- In the STF phase 1 in KEK, we needs four high-gradient 9-cell cavities to accelerate test beams at the Eacc of 45 MV/m.
- Low-loss (LL) type cavity was designed in collaboration with DESY and KEK. It has Hp/Eacc of 36 Oe/(MV/m) to target the max. Eacc of 51 MV/m => 9-cell ICHIRO high-gradient LL cavity.
- The fabrication started in February 2005, press, trimming, EBW of dumbbells, stiffener-ring, end-beam-pipes, etc.
- 3D measurements were done before and after each step of fabrication for cups and dumbbells.
- Four 9-cell ICHIRO high-gradient LL Cavities were successfully delivered to KEK (4 July 2005) !
- Dimensional measurements were done for delivered cavities.

  => straightness : max. deviation ~ 0.5 mm

  length : deviation = 10 mm (1st cavity) => 0.1 mm (3rd cavity)

  EBW shrinkage = 0.15 mm at iris, 0.42 mm at equator.
- Field flatness = 98 % after pre-tuning (1st cavity)