SRF2013, PARIS
September 23-27, 2013
Cité Internationale Universitaire

Cavity fabrication study in CFF at KEK

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Purpose of fabrication of cavities on the KEK site

Development of a mass production technology in order to fabricate more than 16000 cavities within 3 to 5 years for ILC project

- Improvement of yield ratio = Stable quality
- Reduce the cost drastically
- Development of mass production technologies

Development on the KEK site

Speed up the R&D

Realization of ILC

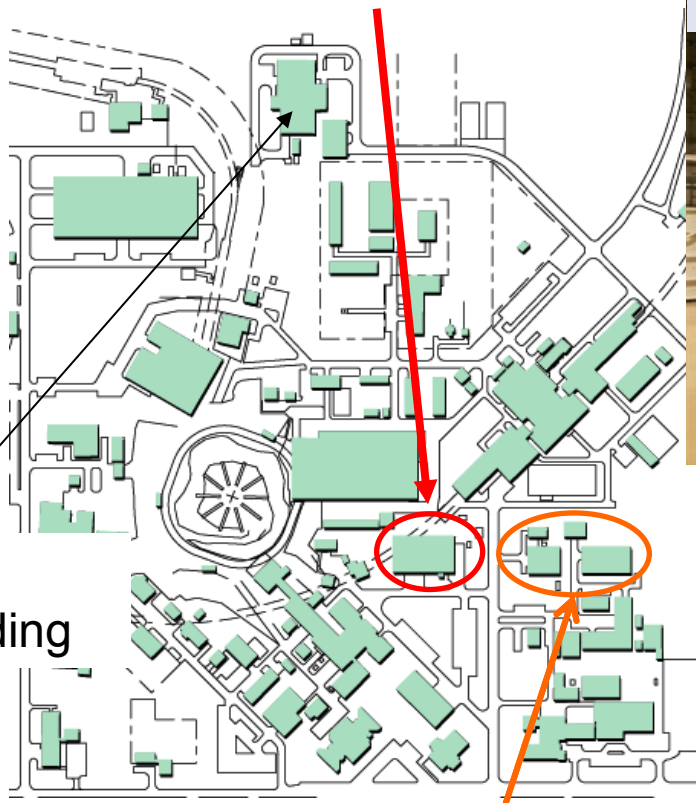
Cooperation with STF

Establish the Cavity Fabrication Facility

Collaboration with many companies

Introduction of Cavity Fabrication Facility (CFF)

Cavity Fabrication Facility



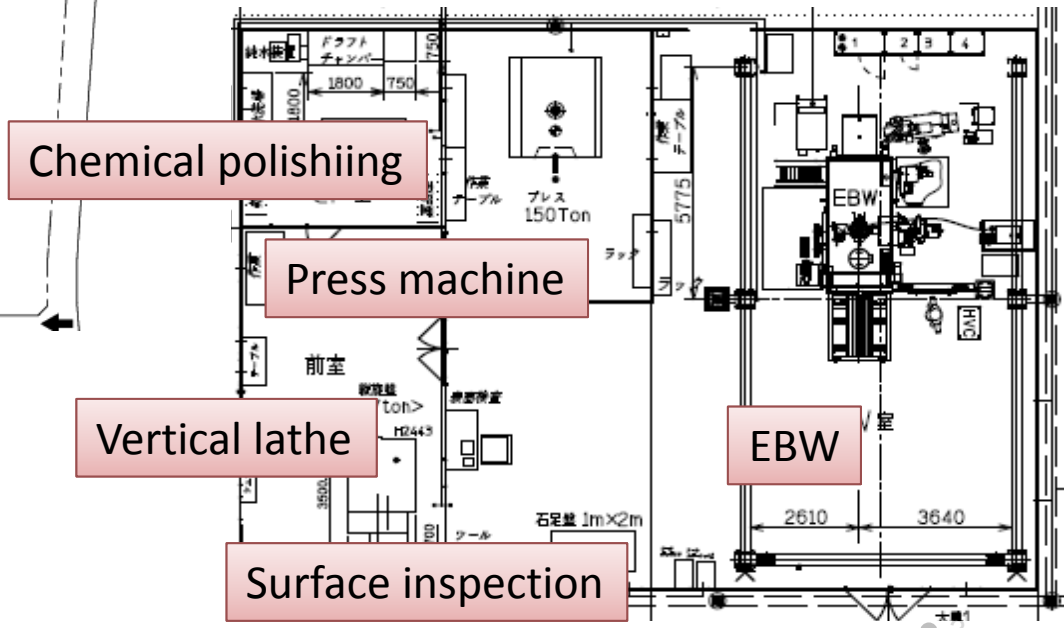
STF building

MEC

Map of KEK

Clean room 19m x 14m x 5m (Height)
Cleanness ISO 5

Completed in July 2011



Main equipments in CFF

EB welding machine
（SST, Germany）
Max. beam voltage: 150 kV

Microscope
(Surface inspection)

Servo press machine
(AMADA, Japan)
Max. applying force:
1500 kN

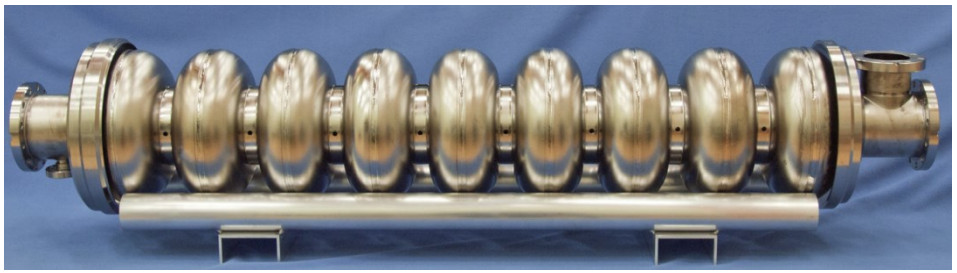
Chemical polishiing

CNC vertival lathe
(Moriseiki, Japan)

Present status of production

July 2011	Construction of Cavity Fabrication Facility (CFF) was finished.
Feb. 2012	The first cavity named KEK-0 was fabricated in CFF, and its acceleration gradient attained 29 MV/m.
April 2012	Fablication of second cavity named KEK-1 was started and is in process.

Opening of CFF



KEK-0 cavity

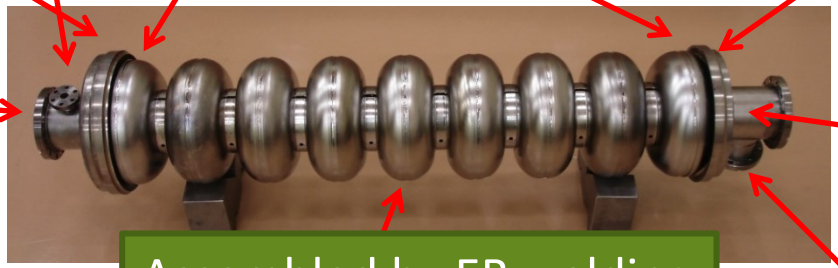
Mechanical parts for cavity

Beam-pipe (Nb)

End-Plates (Ti) + Nb ring

End-cells (Nb)

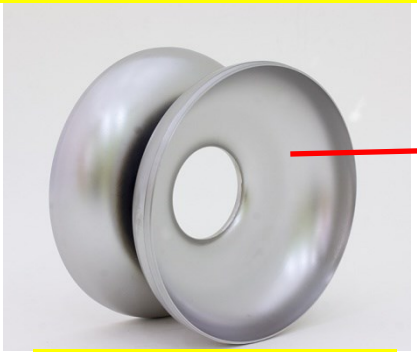
End-Plates (Ti) + Nb ring

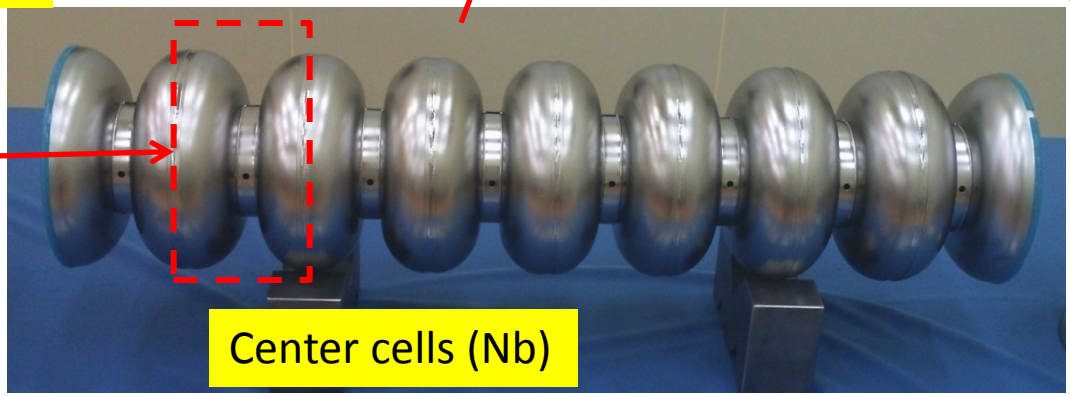


Assembled by EB welding

Flanges (Nb-Ti alloy)

Beam-pipe (Nb)



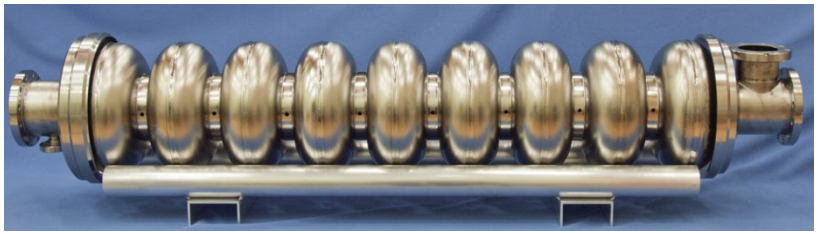


Dumb-bell (Nb)

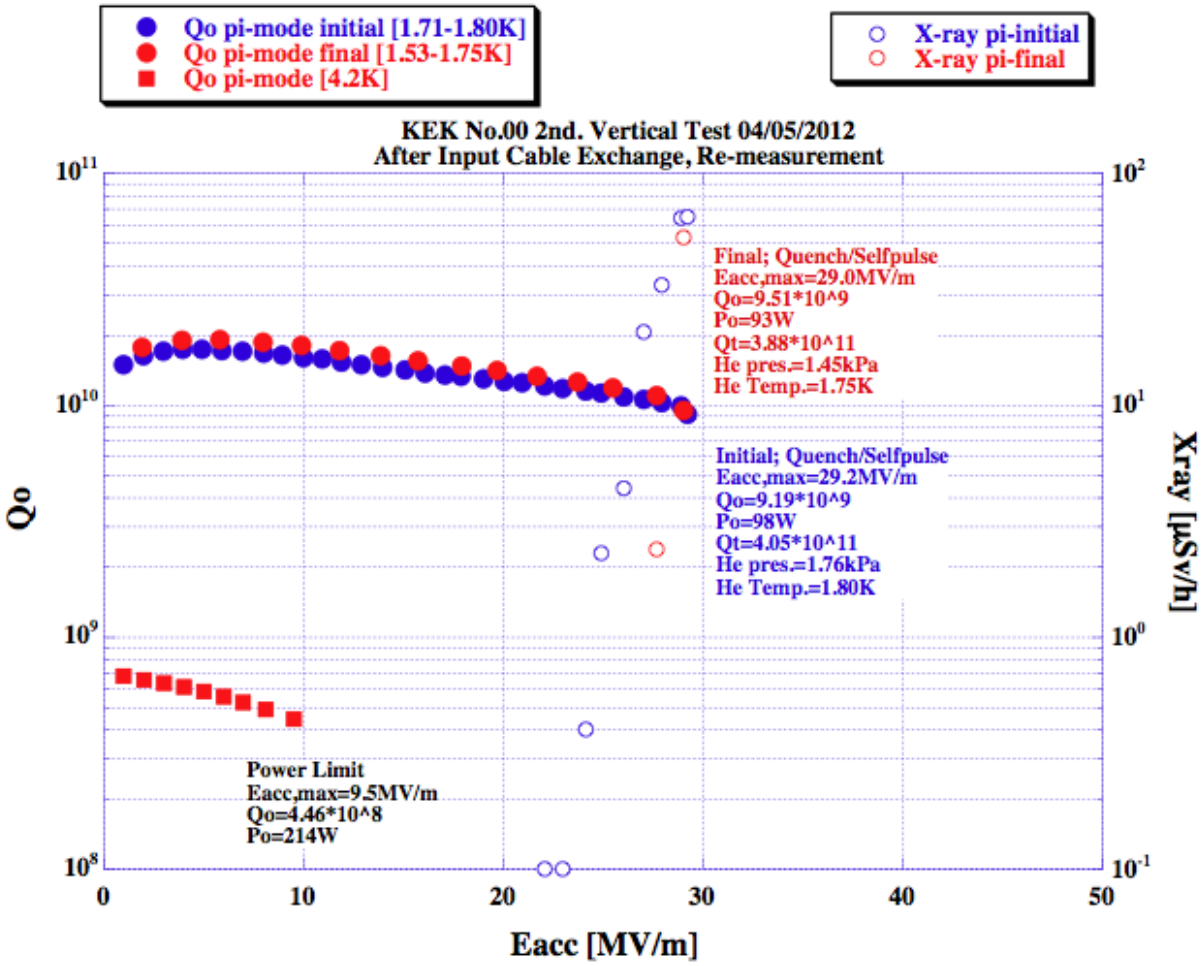
Center cells (Nb)

Input-port pipe (Nb)

Q-E curve of vertical test at STF



KEK-0 (First product)
Acceleration gradient attained 29 MV/m,
did not meet the ILC specification (31.5).



Production of KEK-1

Second production (Now,in process)

- Change of Direction of EB gun
- With HOM coupler
- Improvement of design in detail
- Development of some jigs and fixtures

Most important process

↓

EB Welding

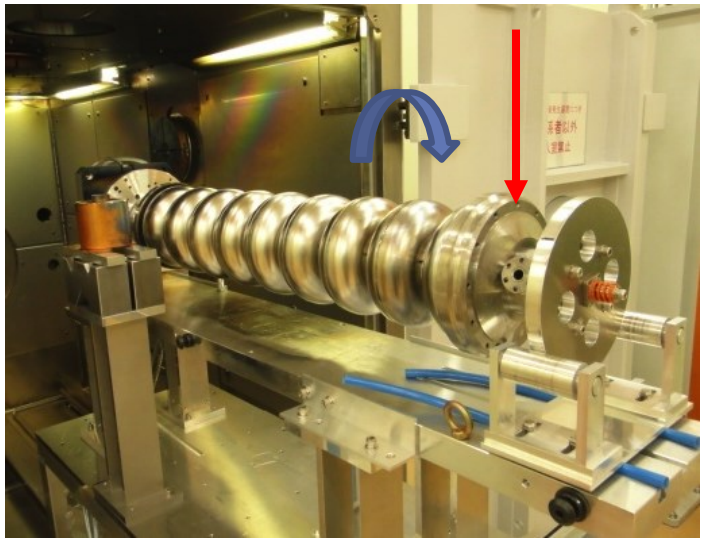
↓

Progress the skill of EBW

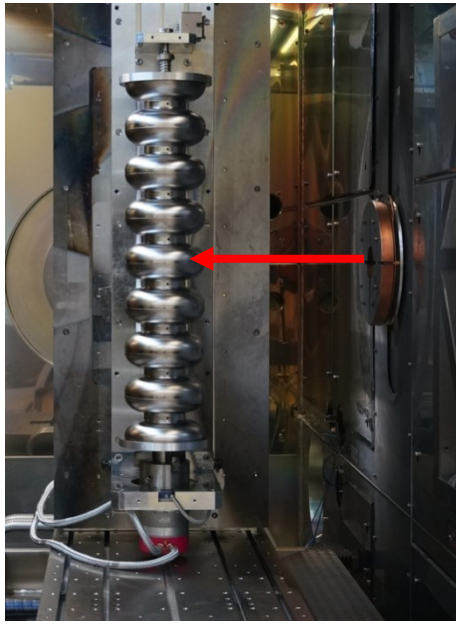
HOM coupler

New jigs for correcting shape of cells

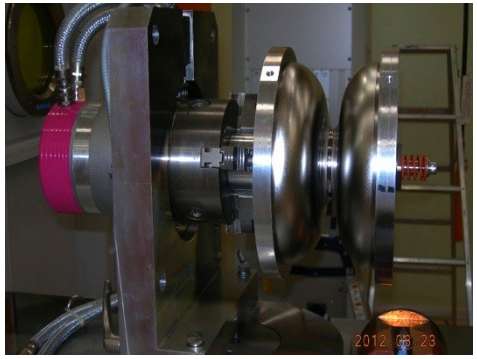
Change of direction of EB gun

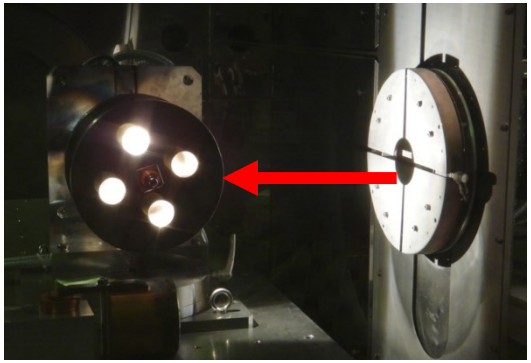


KEK-**0**
Gun: Vertical
Cavity: Horizontal



KEK-**1**
Gun: Horizontal
Cavity: Vertical

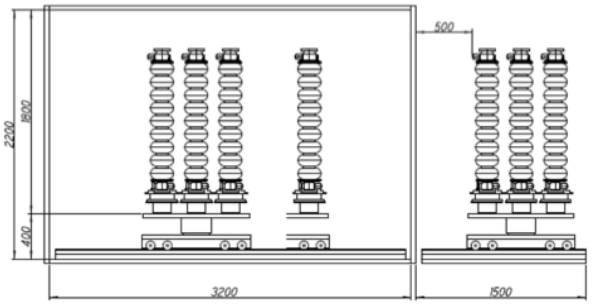




KEK-1: Dumbbells are placed horizontally

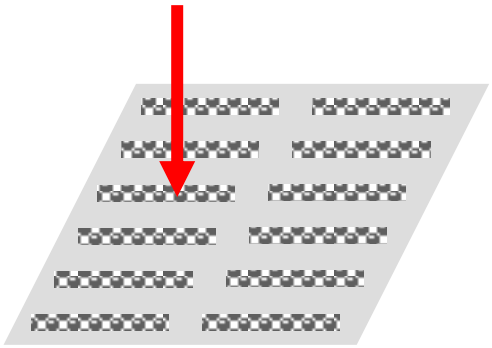
- Stack of dumbbells is easy
- Available for multiple welding

Suits to mass producition

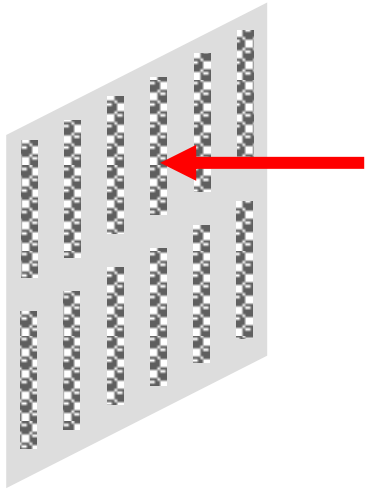


Procedure of EB welding test for cell iris

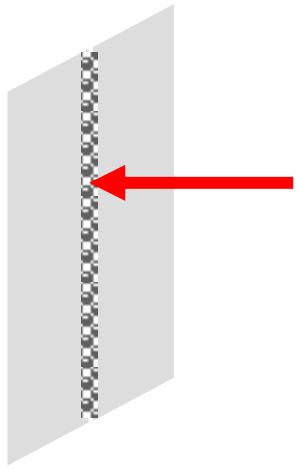
1. Gun: Vertical
   Workpiece: Horizontal
   (Nb plate 300x300 t2.6)



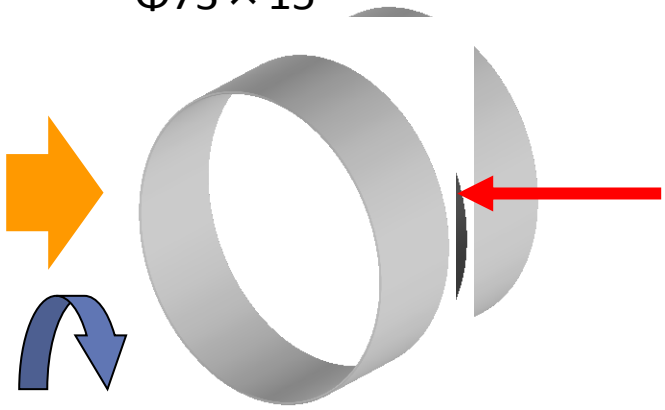
2. Gun: Horizontal
   Workpiece: Vertical



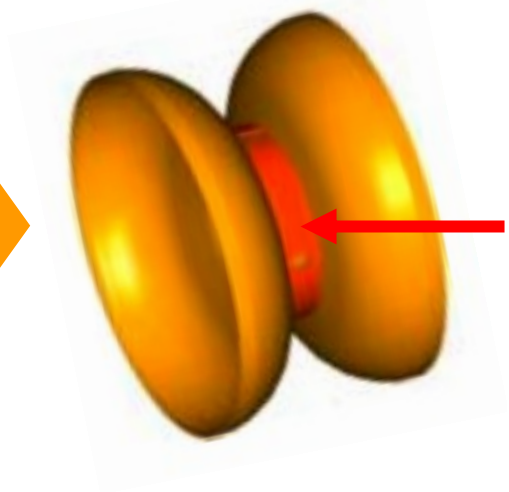
3. Butt joint of plate
   (24x150)



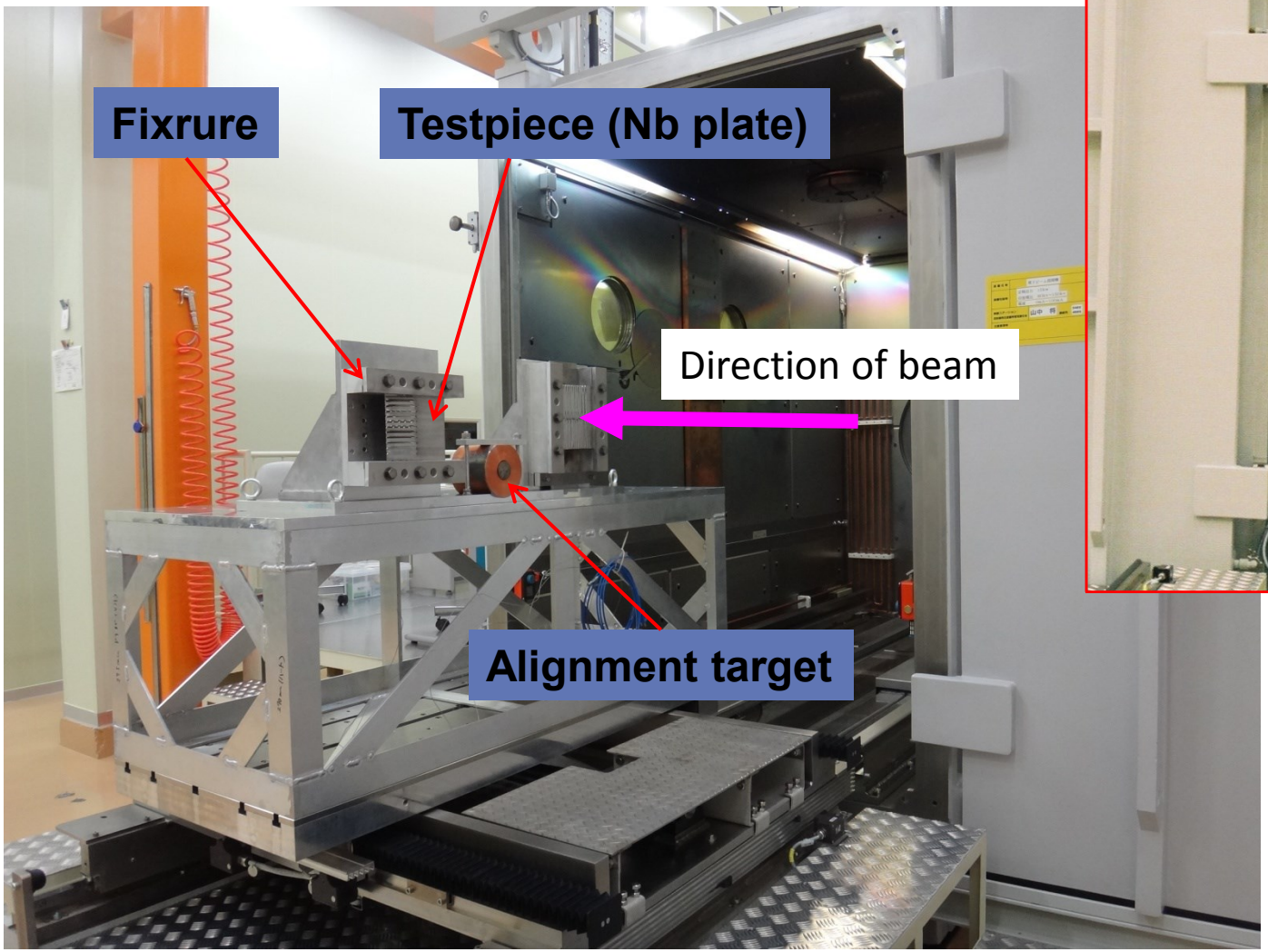
4. Butt joint of ring
   Φ73 × 15

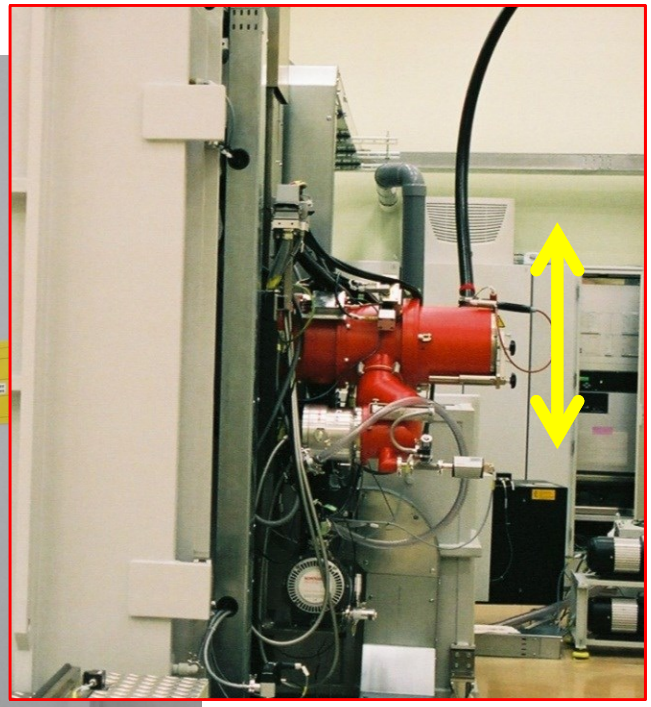


5. Dumbbell (iris)



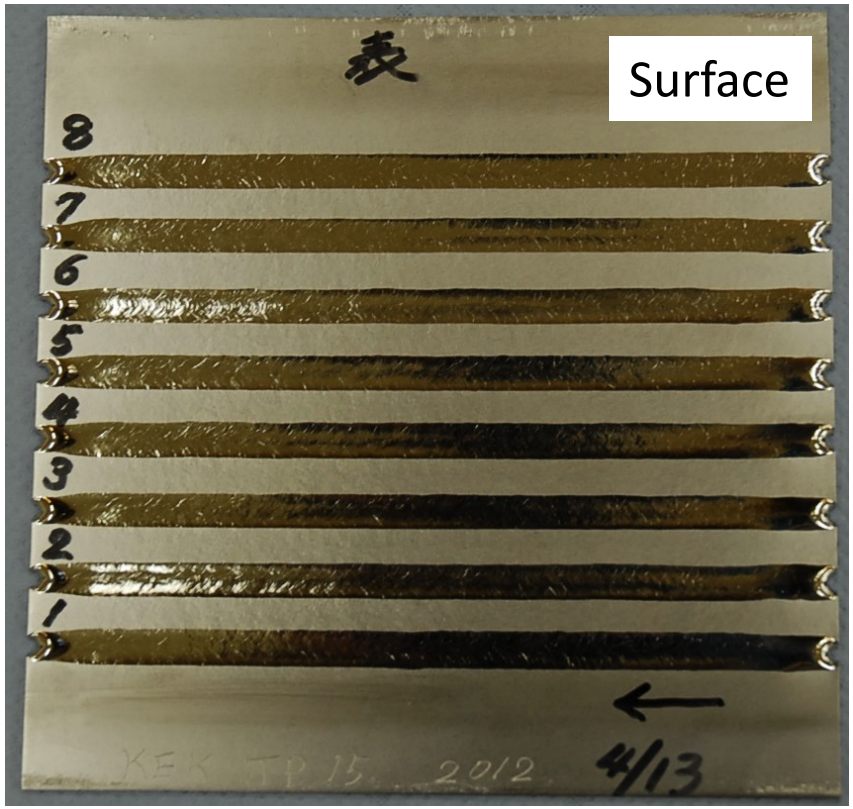
Setup of EBW test

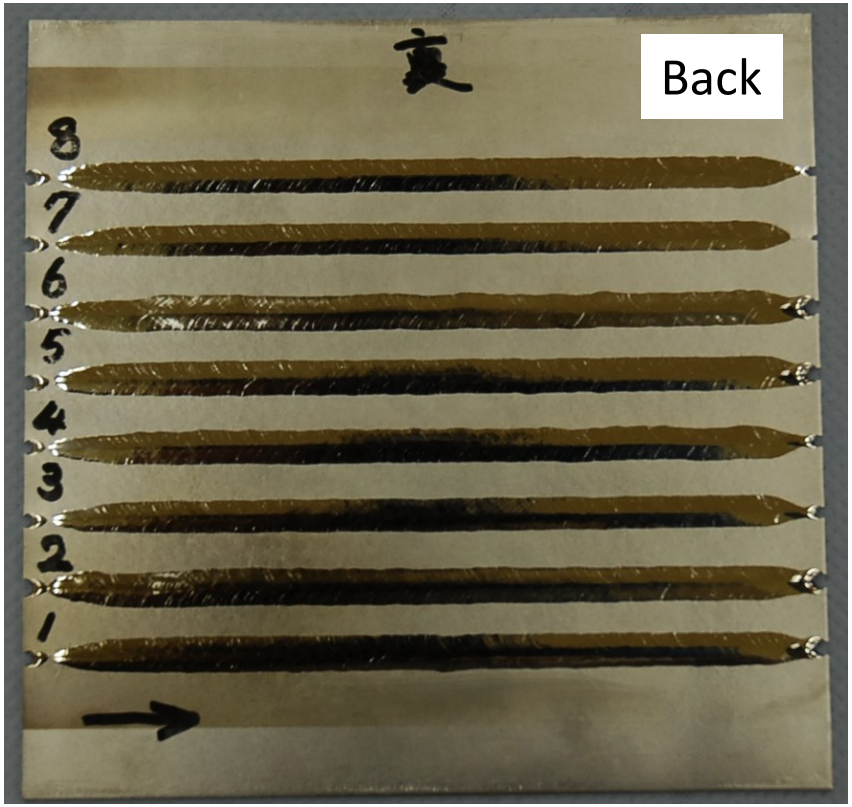




Gun in horizontal

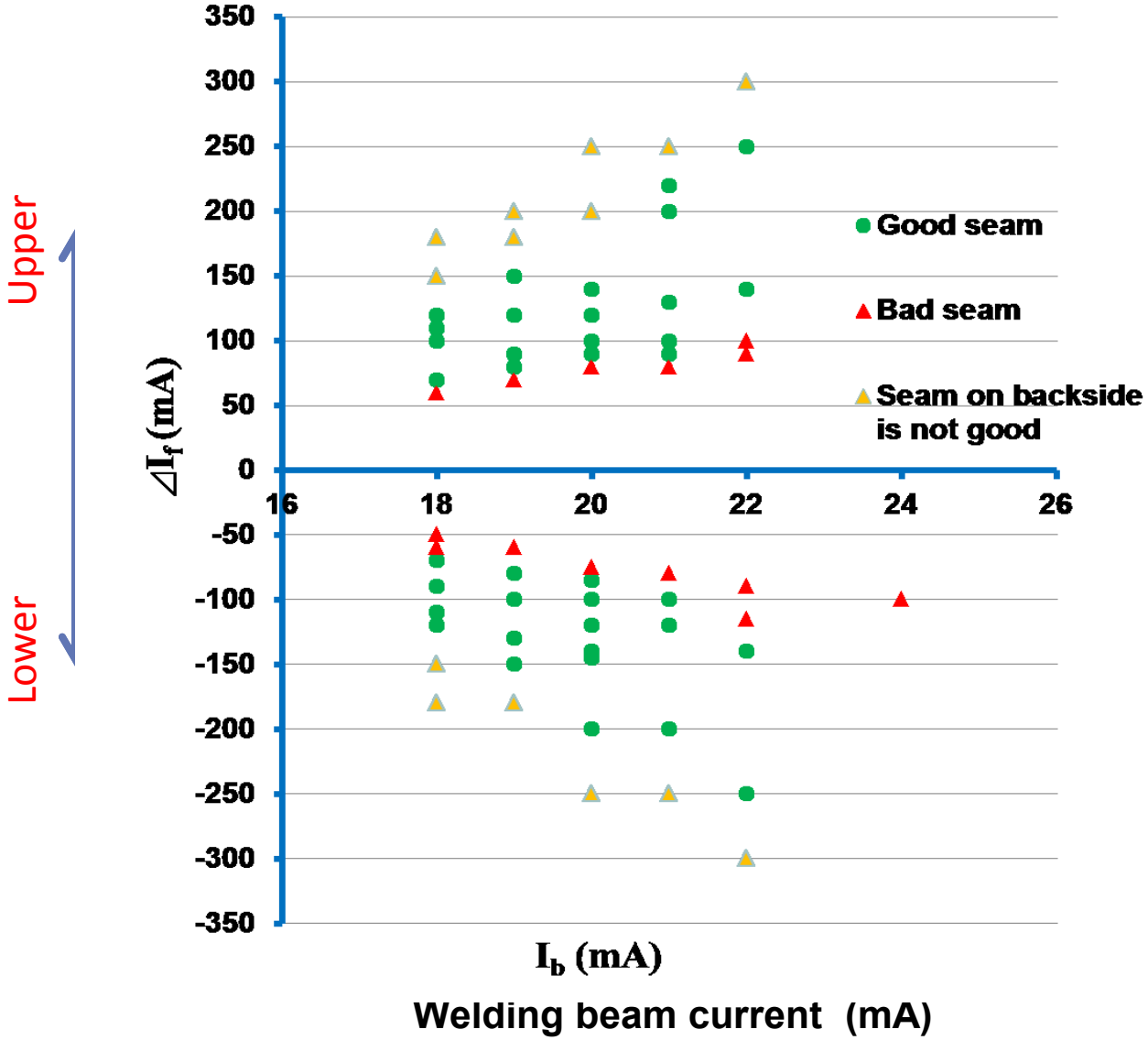
Example of EBW test result using plate





・Getting penetrated bead from surface
・Serach for good parameters of welding
(volatege, current, speed, focus, etc)

Example of data analsys



Region for good welding

T. Kubo et al., "Study on optimum EBW condition for Nb cavities," TUIOC06

Development of new manufactuing method

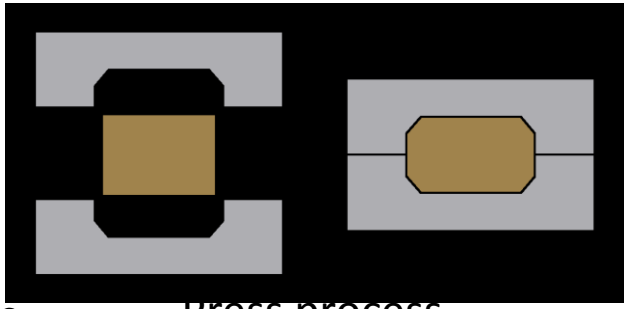
Outer conductor（ϕ48 × 64）
Manufacturing in plastic forming to reduce the amount of material
Ordinary： Multiple press forming
New method:
Deep drawing in single forming

Antenna
Ordinaly: machineing with end mill
New method:
Water jet cutting + press forming

HOM coupler

Material after deep drawing (height > 70 mm)

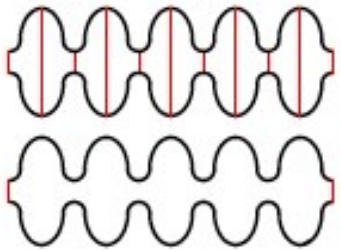
Left: Before press, Right: After press



Press process

Collaboration with Shinohara Press Service

Study of seamless cavities



Single Cells Cavity

EBW

Seamless Cavity

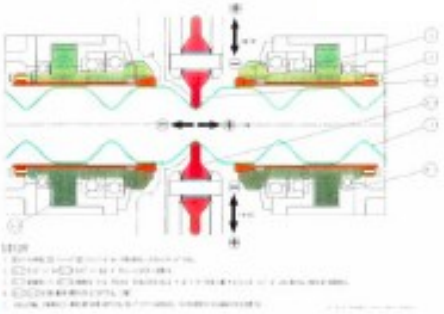
Reducition of EBW

Low cost
High reliability

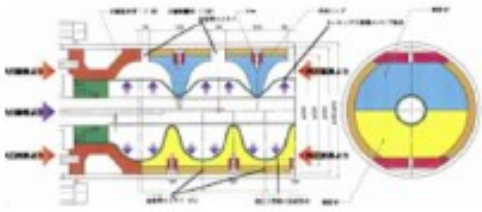
Approch:

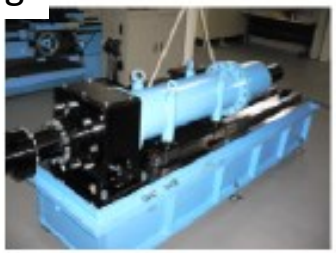
- Development of Nb tube
- Improvement of forming and heat treatment

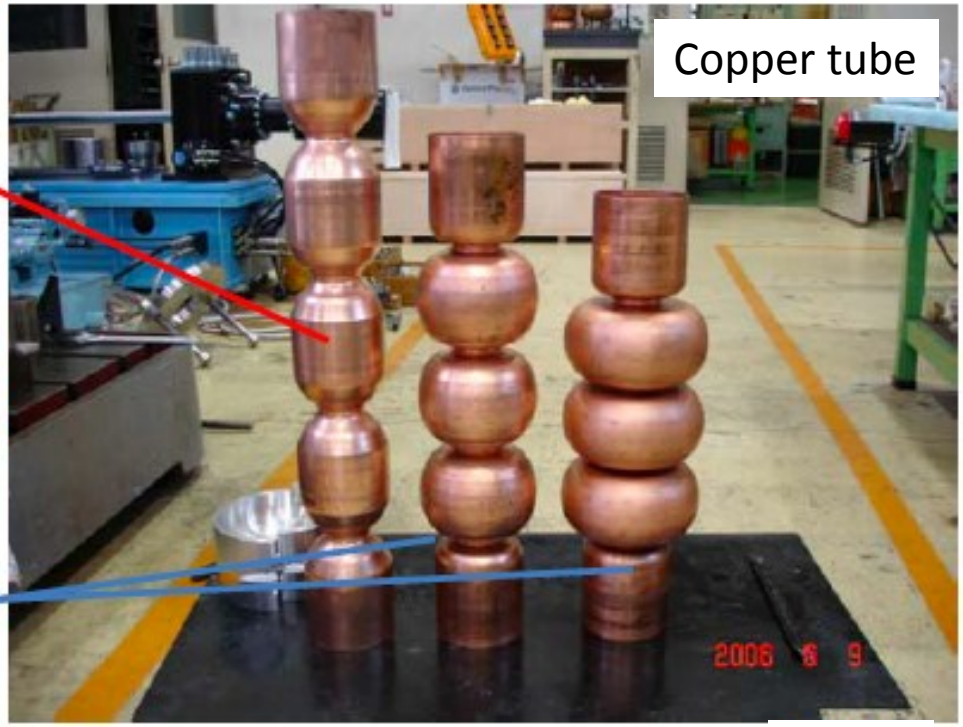
Necking



Hydro forming





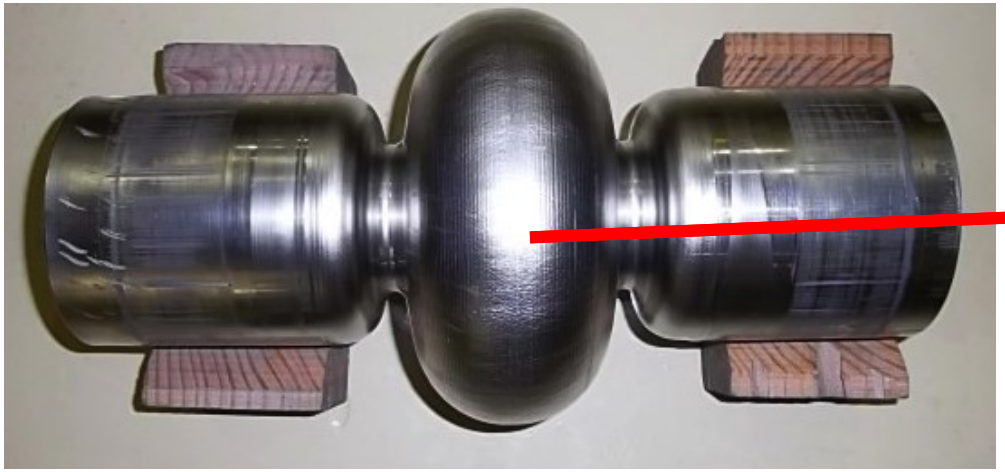


Collaboration with FNAL and LANL

Success of forming with Nb tube

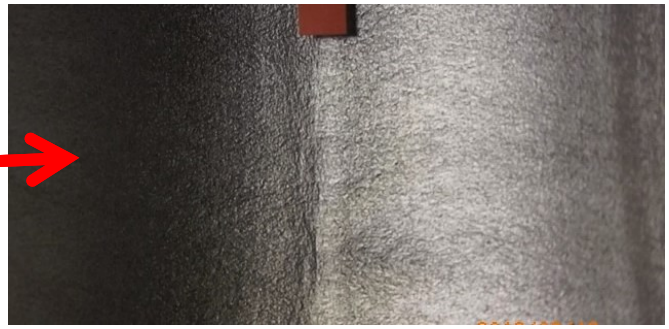
After necking

After hydroforming (1/2 stage)



Finished hydroforming (1-cell)

Equator



Cross view at equator area (inside)

Nb tube was manufactured by ATI Wah Chang and provided by FNAL

Summary

- Construction of Cavity Fabrication Facility (CFF) was finished in 2011.
- The first cavity named KEK-0 was fabricated in CFF, and its acceleration gradient attained 29 MV/m.
- Fabrication of KEK-1 with HOM is ongoing in CFF.
- Most important porcess to improve productivity is EBW.
- KEK is carrying out study of seamless cavity.