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

KEK, Masashi YAMANAKA
Introduction of Cavity Fabrication Facility (CFF)

Cavity Fabrication Facility

- Map of KEK
- STF building
- MEC
- Chemical polishing
- Press machine
- Vertical lathe
- EBW
- Surface inspection
- Clean room 19m x 14m x 5m (Height)
- Cleanliness ISO 5

Completed in July 2011
Main equipments in CFF

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

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

Chemical polishing

Microscope
(Surface inspection)

CNC vertical 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  Fabrication of second cavity named KEK-1 was started and is in process.
Mechanical parts for cavity

- Beam-pipe (Nb)
- End-Plates (Ti) + Nb ring
- Flanges (Nb-Ti alloy)
- Dumb-bell (Nb)
- End-cells (Nb)
- End-Plates (Ti) + Nb ring
- Center cells (Nb)
- Input-port pipe (Nb)

Assembled by EB welding
Q-E curve of vertical test at STF

KEK-0 (First product)
Accelerated 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

- Stack of dumbbells is easy
- Available for multiple welding
  Suits to mass production

KEK-1: Dumbbells are placed horizontally
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

- Fixrure
- Testpiece (Nb plate)
- Alignment target
- Direction of beam
- Gun in horizontal
Example of EBW test result using plate

- Getting penetrated bead from surface
- Search for good parameters of welding (voltage, current, speed, focus, etc)
Example of data analysis

Region for good welding
Development of new manufacturing method

**Outer conductor** ($\phi 48 \times 64$)
Manufacturing in plastic forming to reduce the amount of material
Ordinary: Multiple press forming
**New method:**
Deep drawing in single forming

**Antenna**
Ordinary: machining with end mill
**New method:**
Water jet cutting + press forming

Material after deep drawing (height > 70 mm)

HOM coupler

Left: Before press, Right: After press

Press process

Collaboration with Shinohara Press Service
Study of seamless cavities

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

Reduction of EBW
- Low cost
- High reliability

Collaboration with FNAL and LANL

Necking

Hydro forming

Copper tube
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 process to improve productivity is EBW.
• KEK is carrying out study of seamless cavity.