Cavity Fabrication Industrialization

Progress and Further Study Plan in Asia

H. Hayano 10202010

KEK Pilot Plant: main R&D

KEK initiative on mass-production technology R&D in Pilot Plant

Center cell

EBW Quality Control Technology

multi-dumbbell, multi-cell, multi-cavity Jigs for EBW

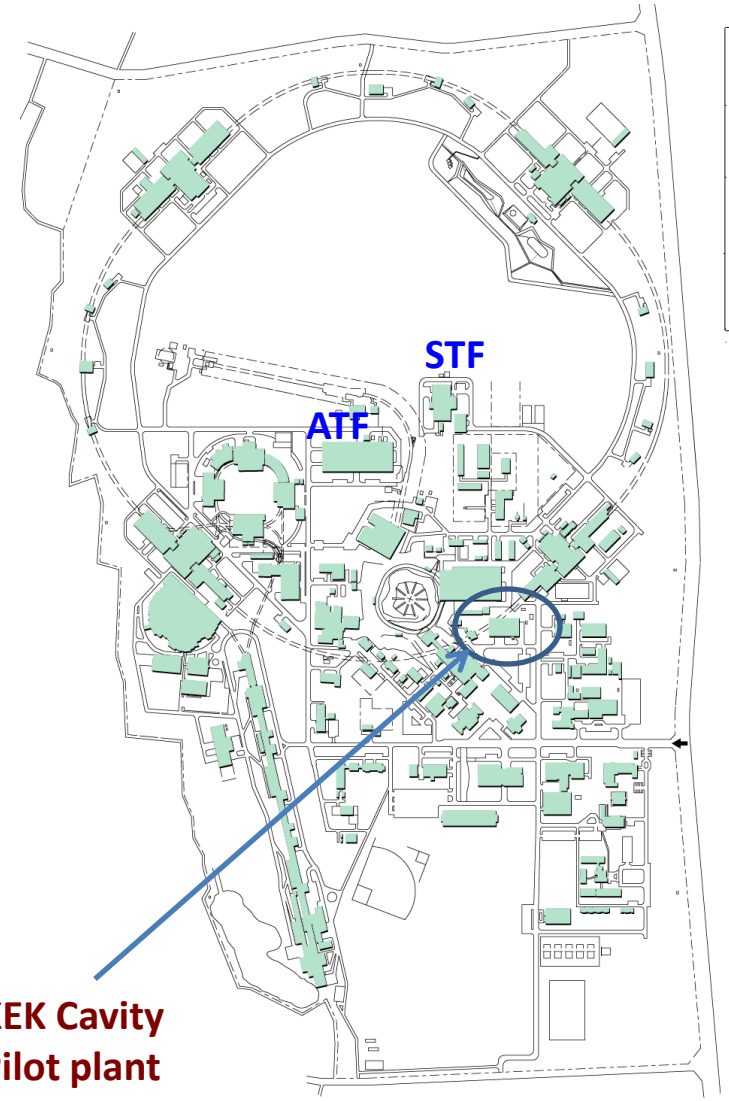
End-group

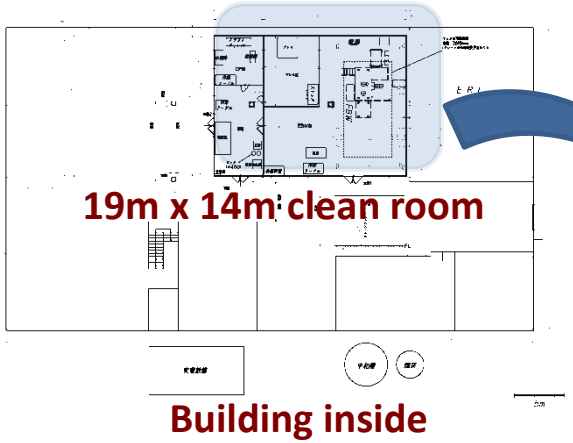
Deep Drawing Technology

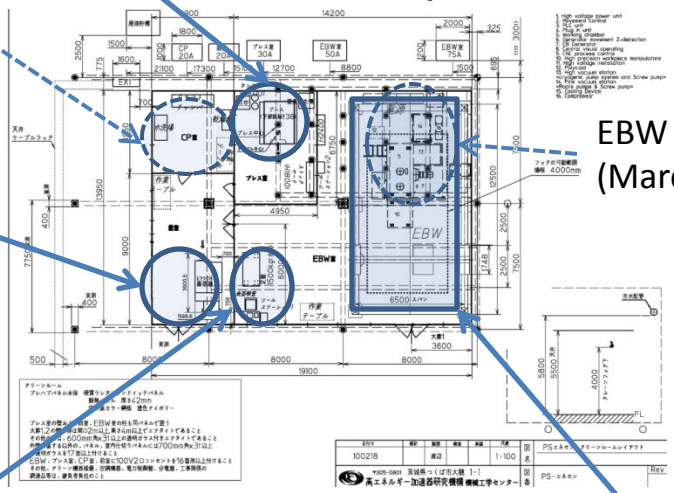
Fine-blanking (cutting-out) and Press-forming Technology

End-group Jigs for EBW

KEK Pilot plant

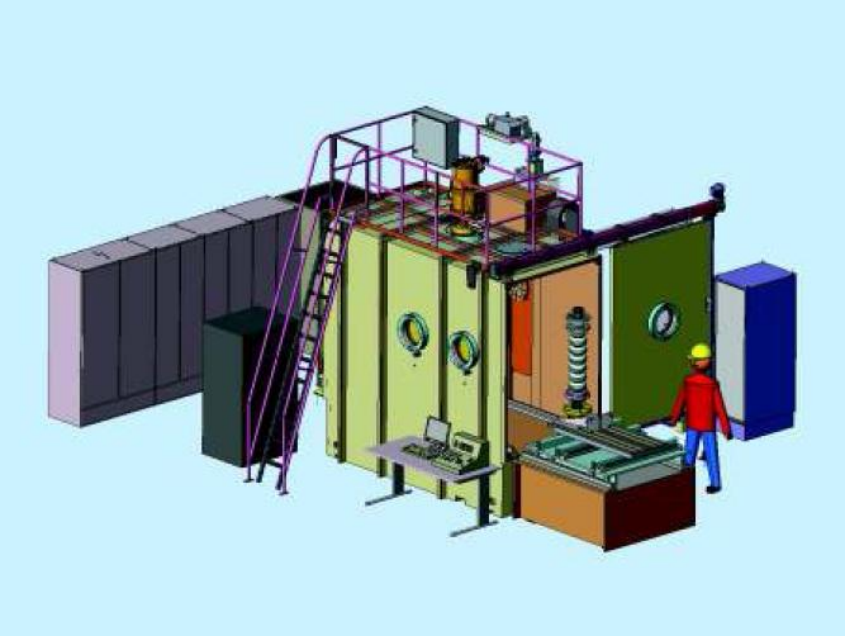






Main Machines in the facility

EBW

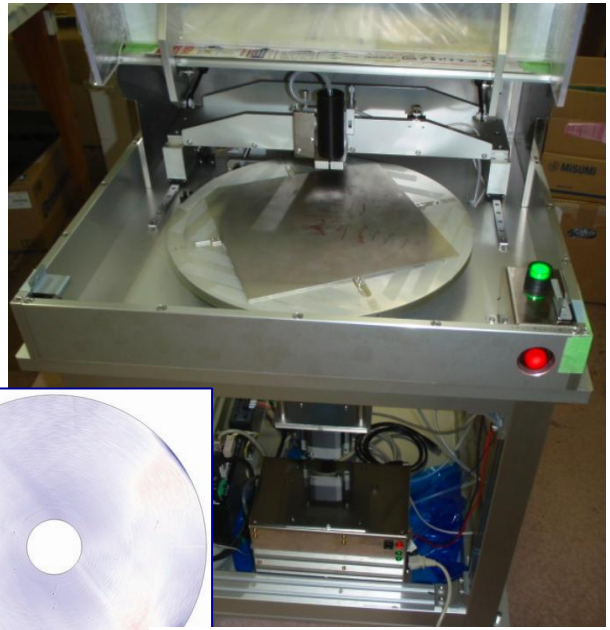


SST EBOCAM KS-110 – G150KM
Chamber (Stainless Steel)
X=3200 x Y=1500 x Z=2200(mm)
March 2011 installation

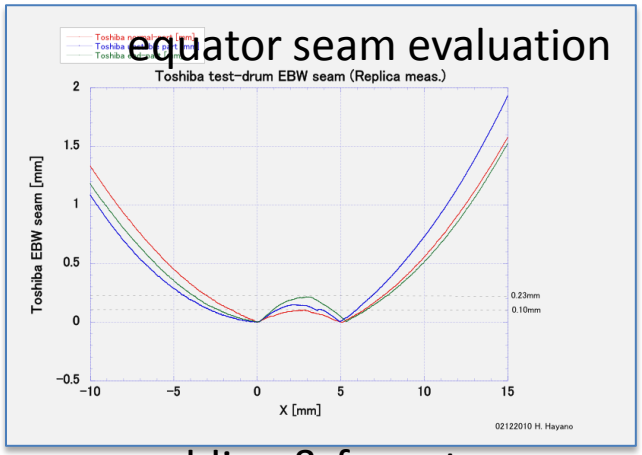
Press

Trim

inspection instruments for fabrication support

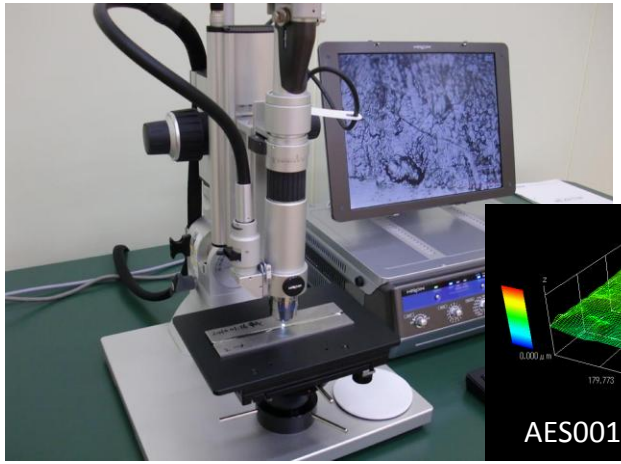


eddy current scanner

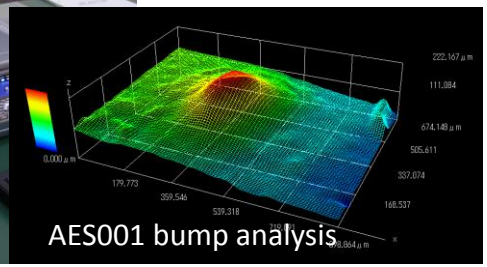


equator seam evaluation

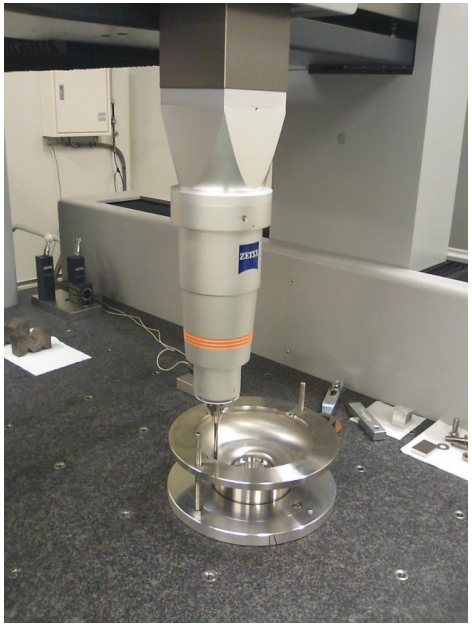
molding & form-tracer



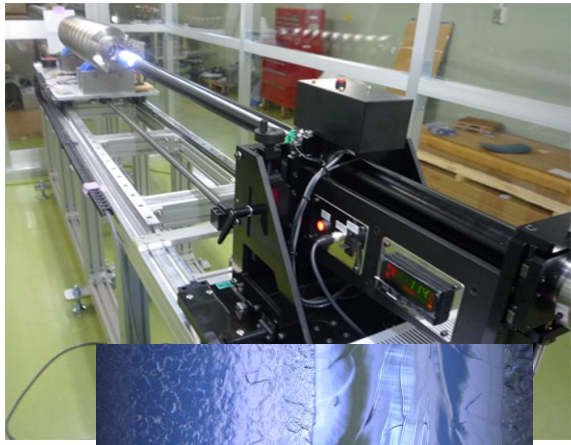
optical 3D profiler



AES001 bump analysis



3D coordinate machine



MHI008

inner surface inspection

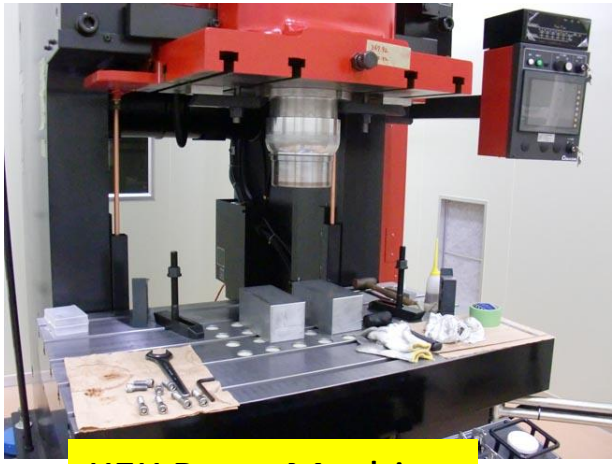
Center Cell Fabrication R&D

EBW, Press R&D were started

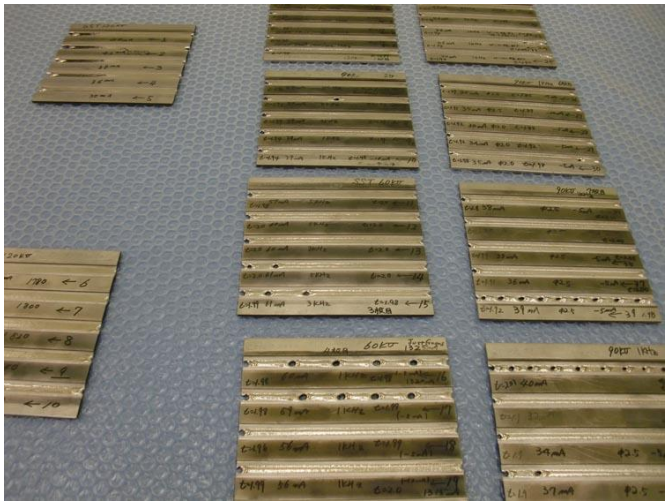
Tosei-electrobeam co.
SST EBW

Tosei-electrobeam co.
Mitsubishi-EBW

using EBW Job-shop



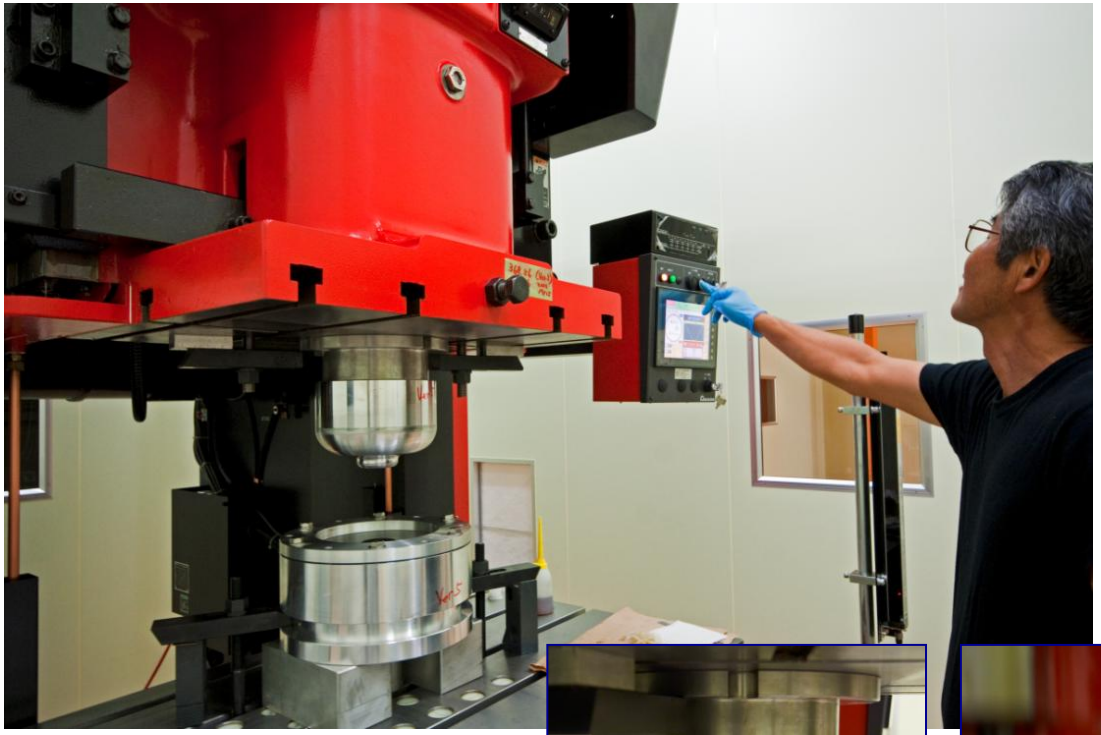
KEK Press Machine

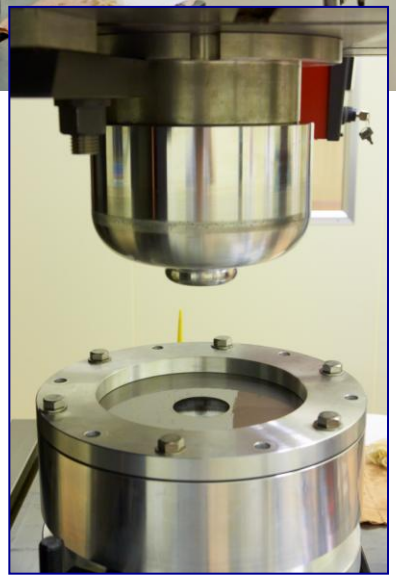


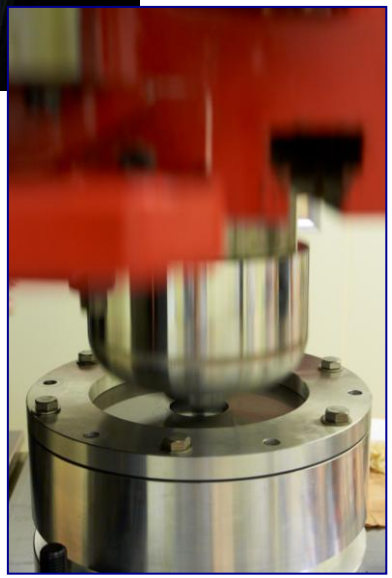
EBW test pieces

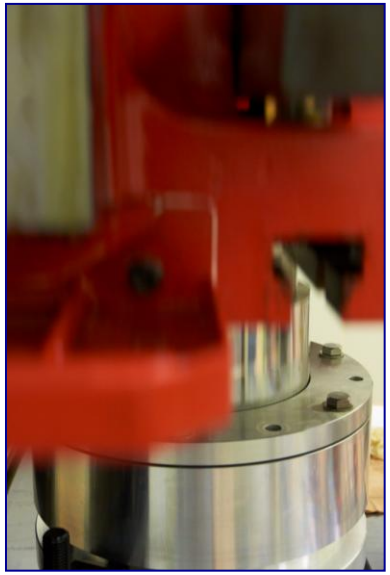
Press test cells

Press Test of Nb plates

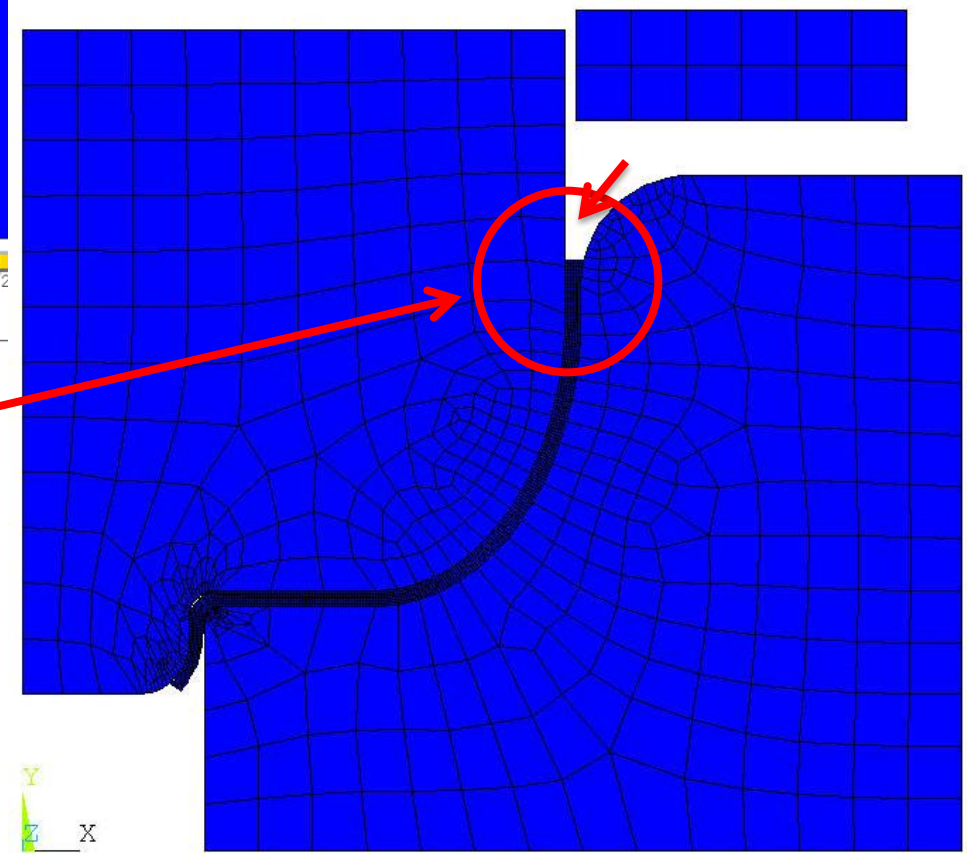








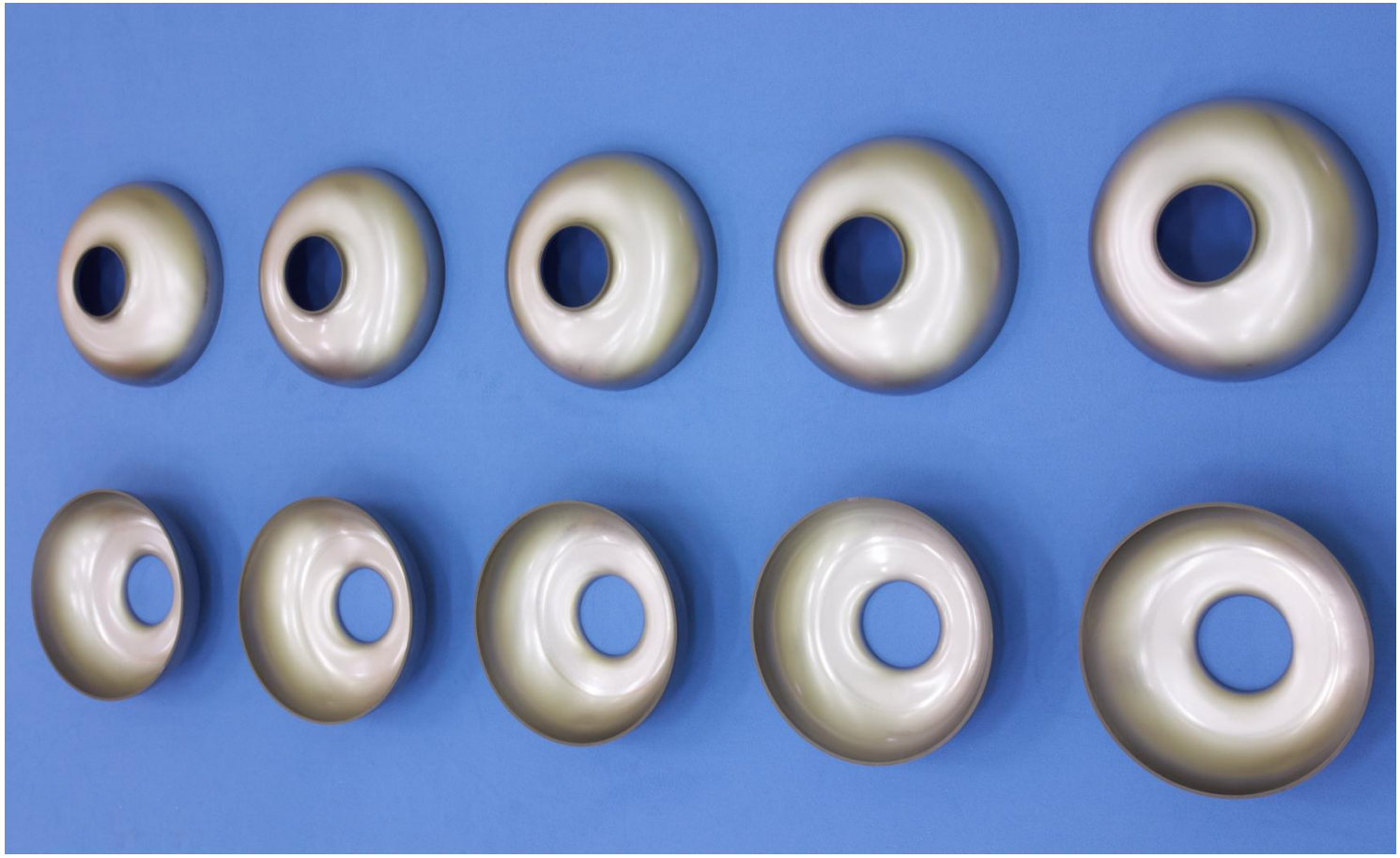
Simulation of LL-cavity cell press



To save Nb material, disk edge is not grabbed, but falling down into cup side.
So that, we found <u>any digital control motion press did not help</u> in this case.

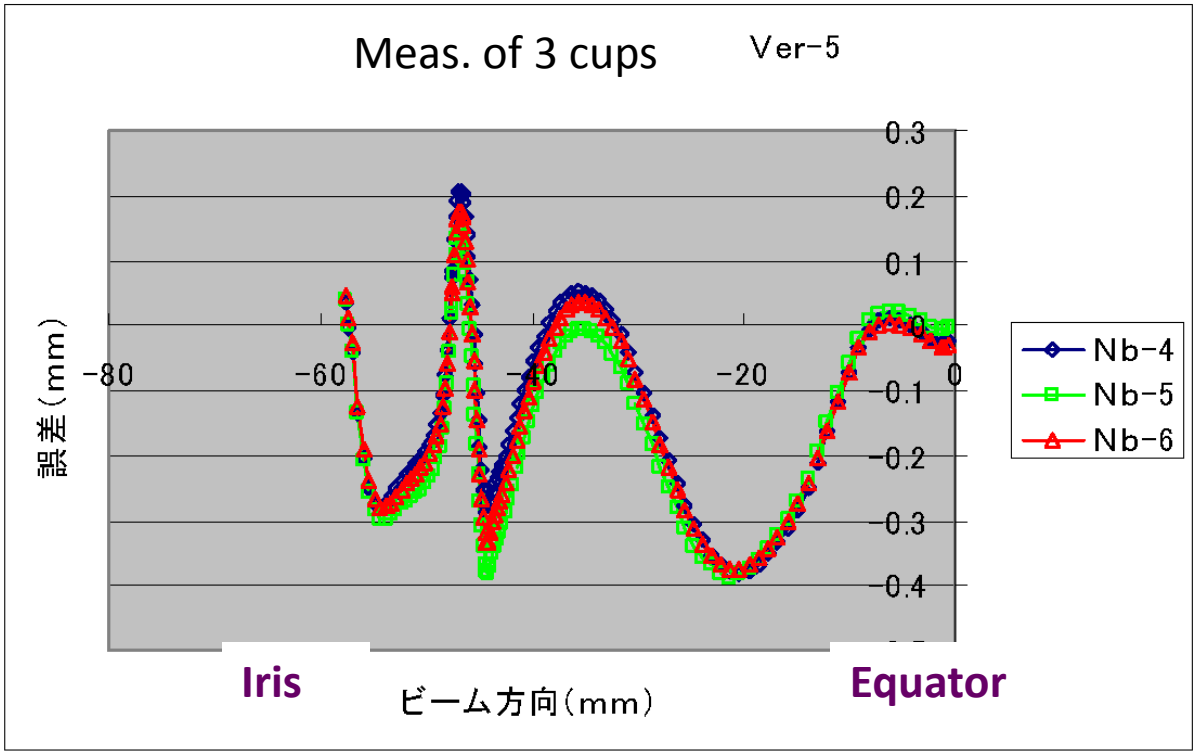
Nb half-cells by KEK Press Machine

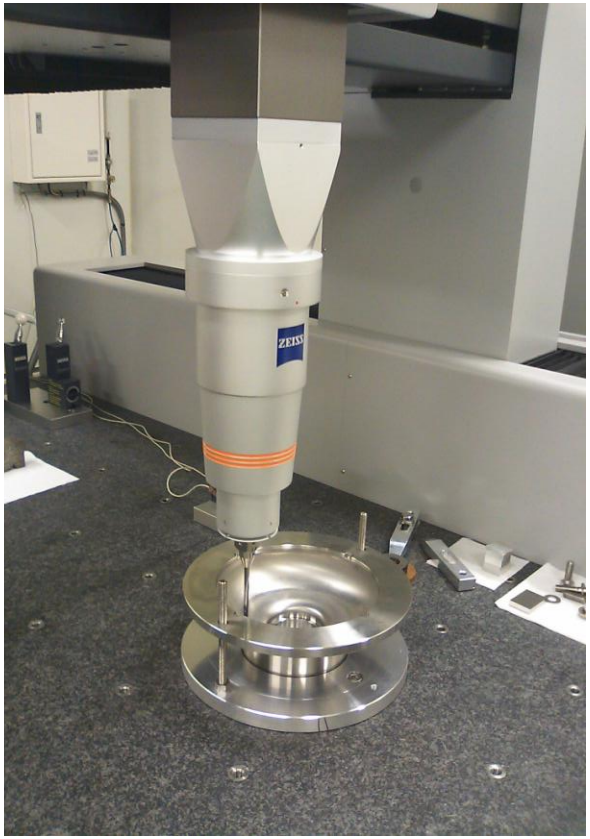
Used Press-Die Version-5 (Try and error of press die shape)



Deviation of cup-shape from the design shape

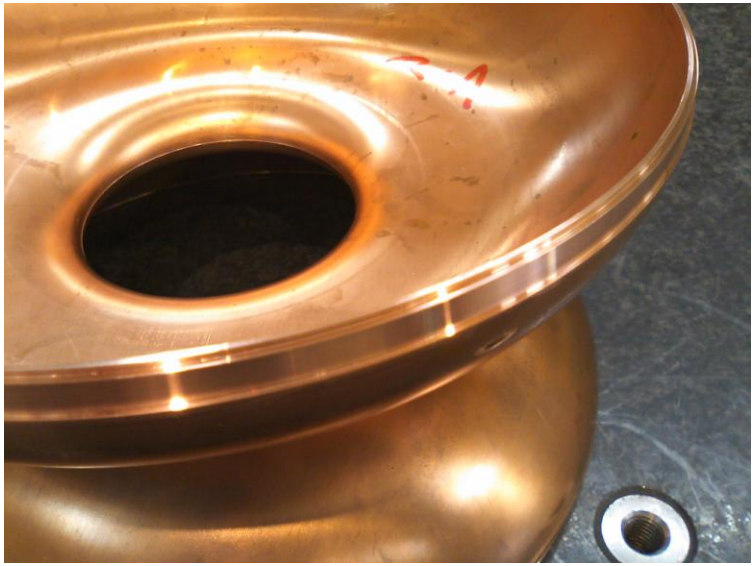
同金型（Ver-5）での３つのセルのばらつき



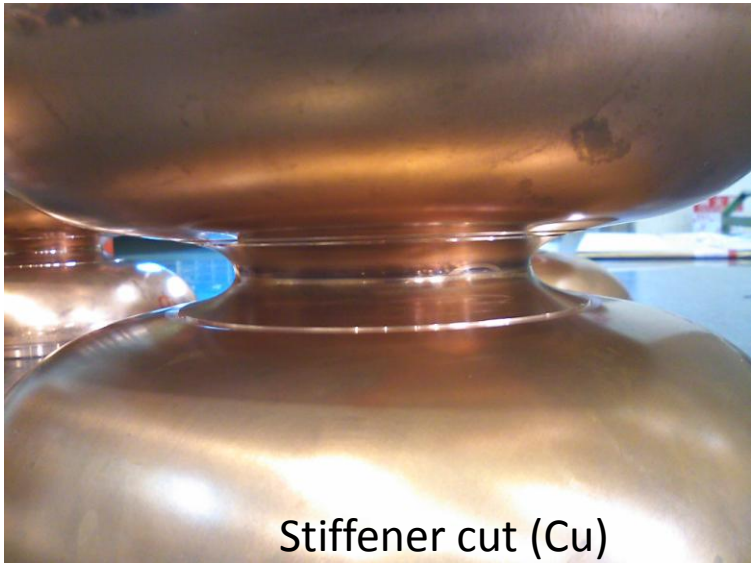


Deviation was +0.2mm ~ -0.4mm

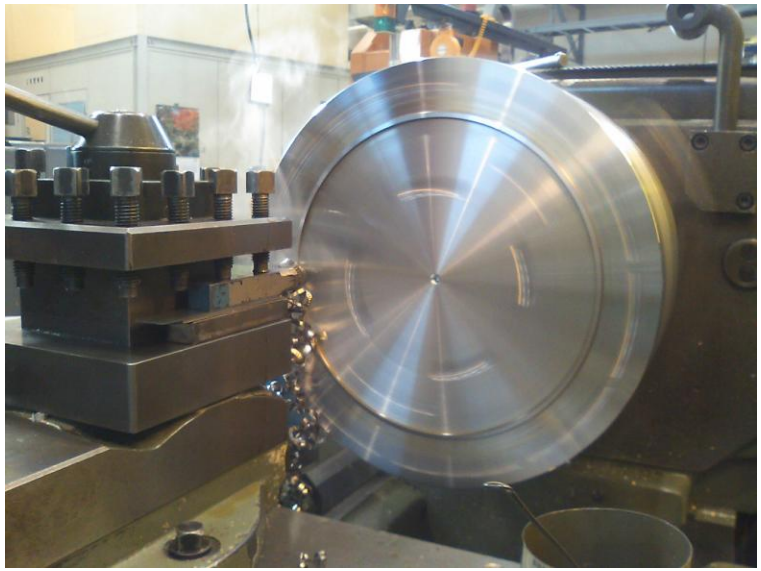
Trim Test of Cu cells, and Nb cells



Equator edge cut (Cu)



Stiffener cut (Cu)

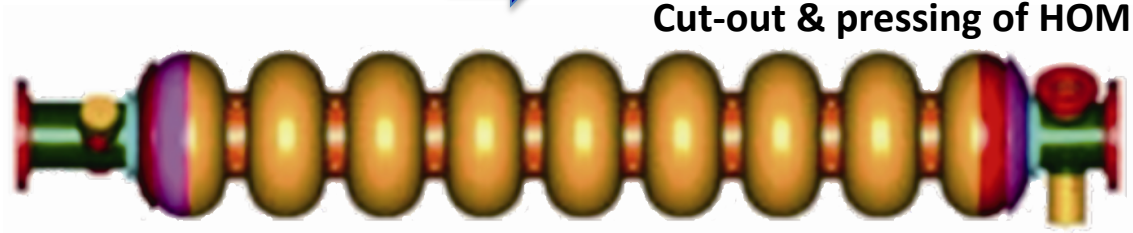


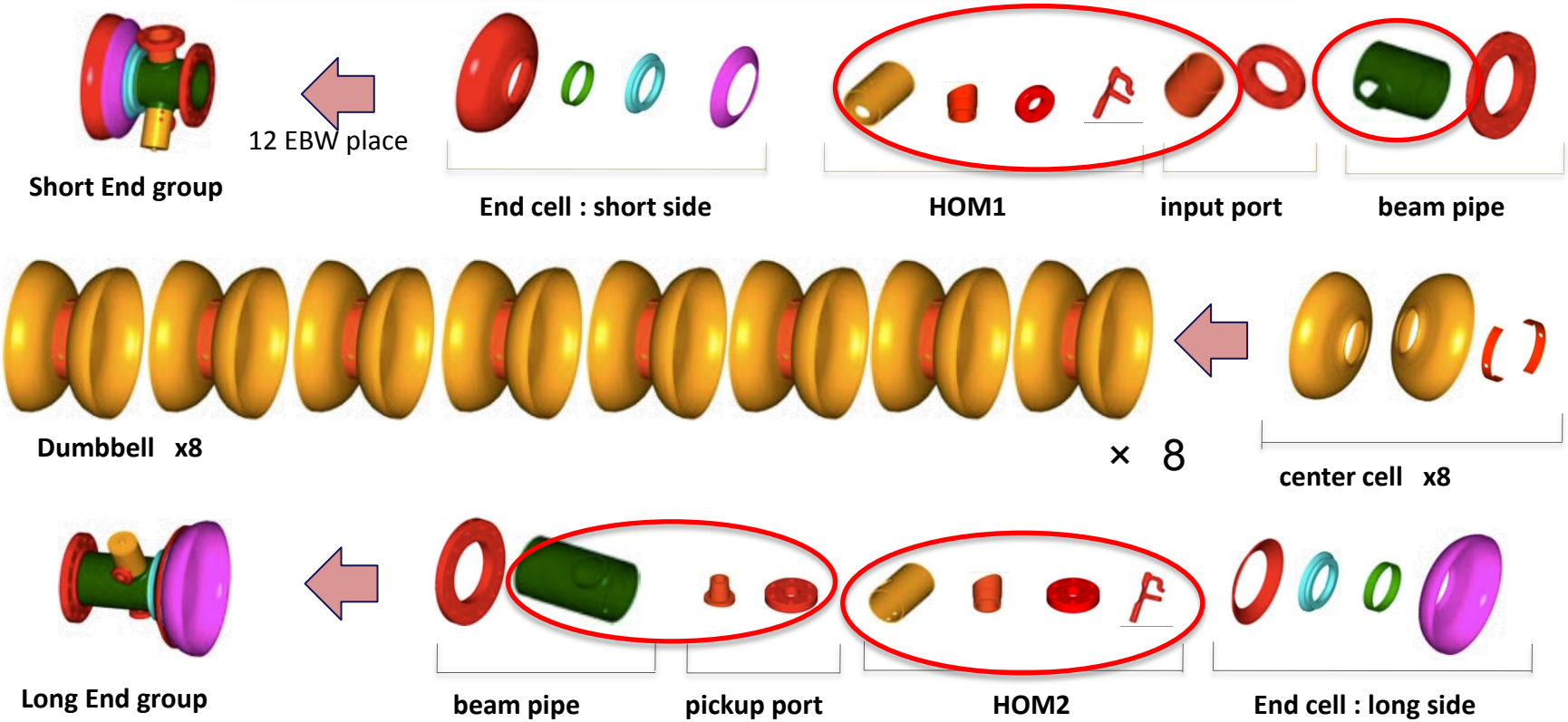
Equator edge cut (Nb)

End Group Fabrication R&D

Press machine application

Deep drawing of HOM-cup, beam-pipe
Burring of beam-pipe
Cut-out & pressing of HOM antenna, etc

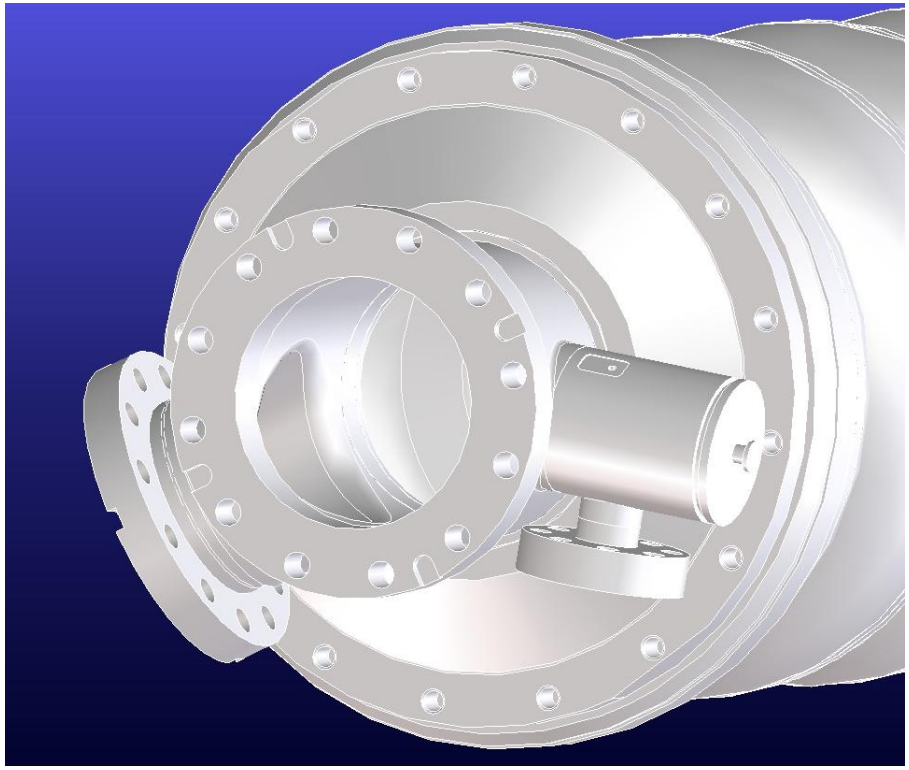




Cavity Fabrication (TESLA Cavity)

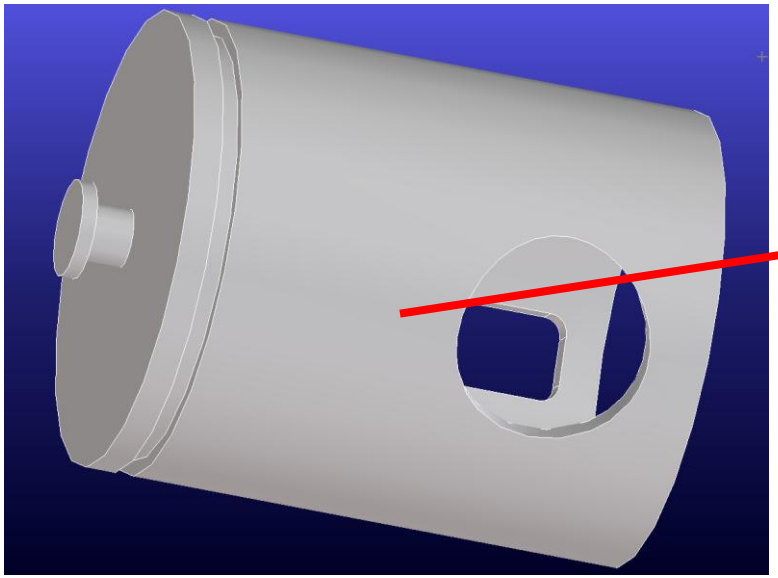
56 parts: Nb (RRR>300)= 46, Nb-Ti = 10, by press, burring, machining
75 Electron Beam Welding (EBW) place

KEK-End-Group, KEK-HOM-coupler



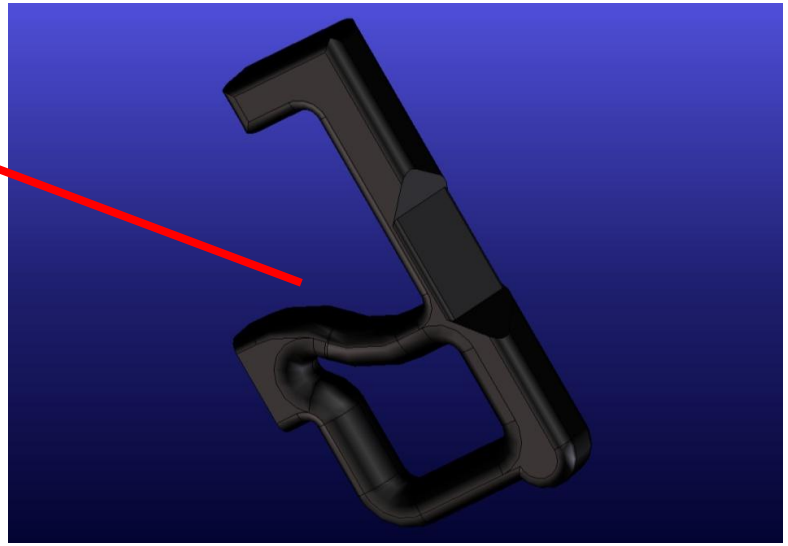
At First, we started HOM coupler fabrication study

KEK-HOM-coupler R&D



(1) Deep Drawing of HOM-cup,
(2) Cut-out of holes, or Burring of holes.
(3) Develop cost effective shape of tuning knob.

(4) Press cut-out from thick plate,
(5) Press cut-out of slope region,
(6) Press forming into design shape



Deep drawing of cup

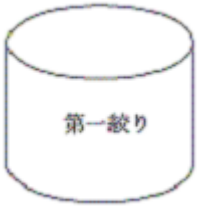
digital servomotor press advantage

conventional press

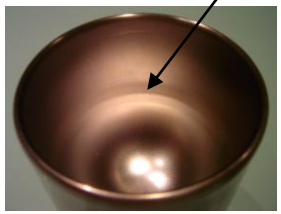
TPL150

①plate → ②1st deep drawing → ③2nd deep drawing → ④3rd deep drawing

Φ165 0.5 t



shock-line



SDE1522

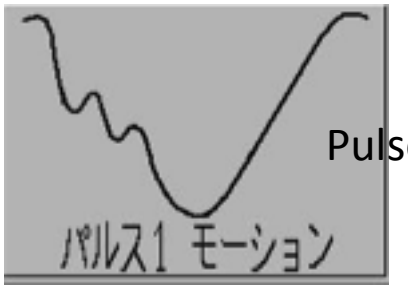
①plate → ② one deep drawing

Φ160 0.5 t

モーション設定	パルス1モーション
上昇移動量	0.1 mm
追い込み移動量	1 mm
繰り返し回数	30 回
加工ストローク数	10 min-1

no shock-line

digital servomotor press

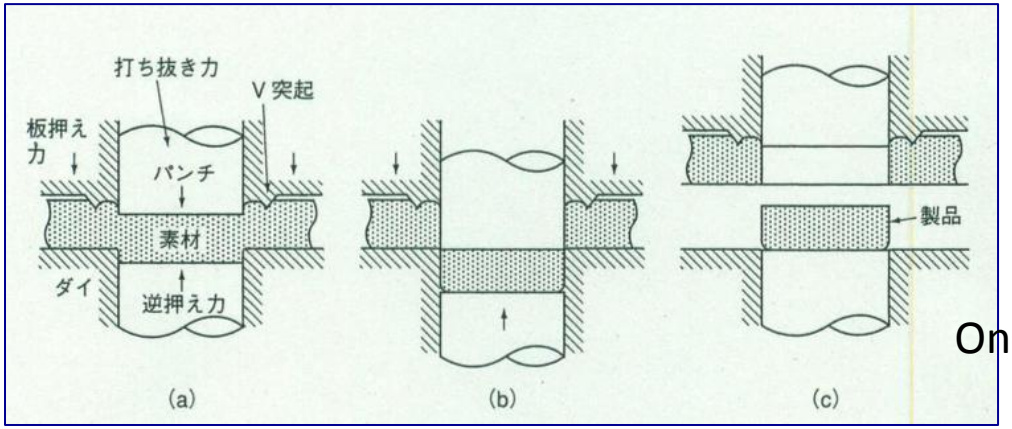


Pulse motion press

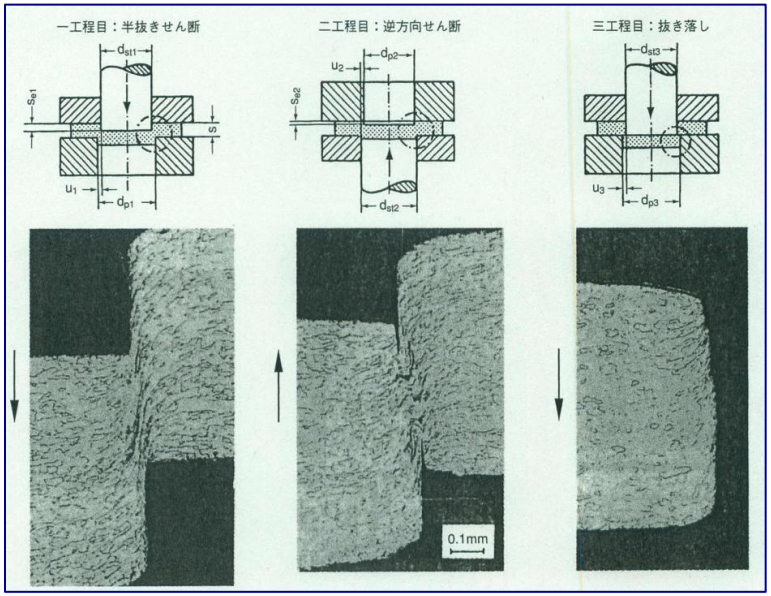
from Amada presentation

Fabrication by Fine-Blanking method (FB)

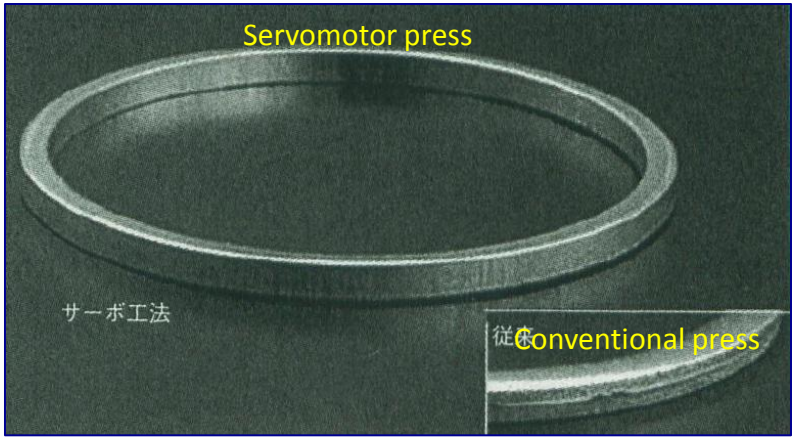
Thick plate Press-cut out without burr at cut-edge (Precise cut-out)



One action FB method



Three action FB method



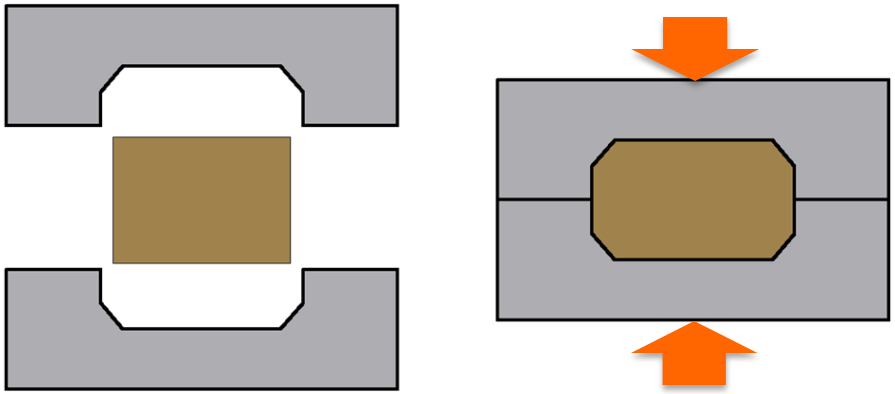
Combination of FB-method and Servo-Press

Study of Press-forming was started

Use of Cu material at first, then go to Nb

Wire cut

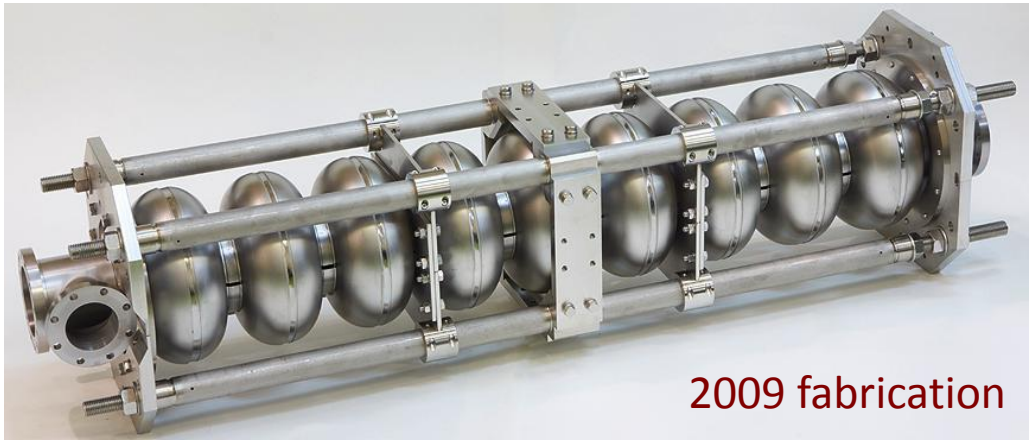
Simulating press-cut of HOM Antenna



Edge shaping by press

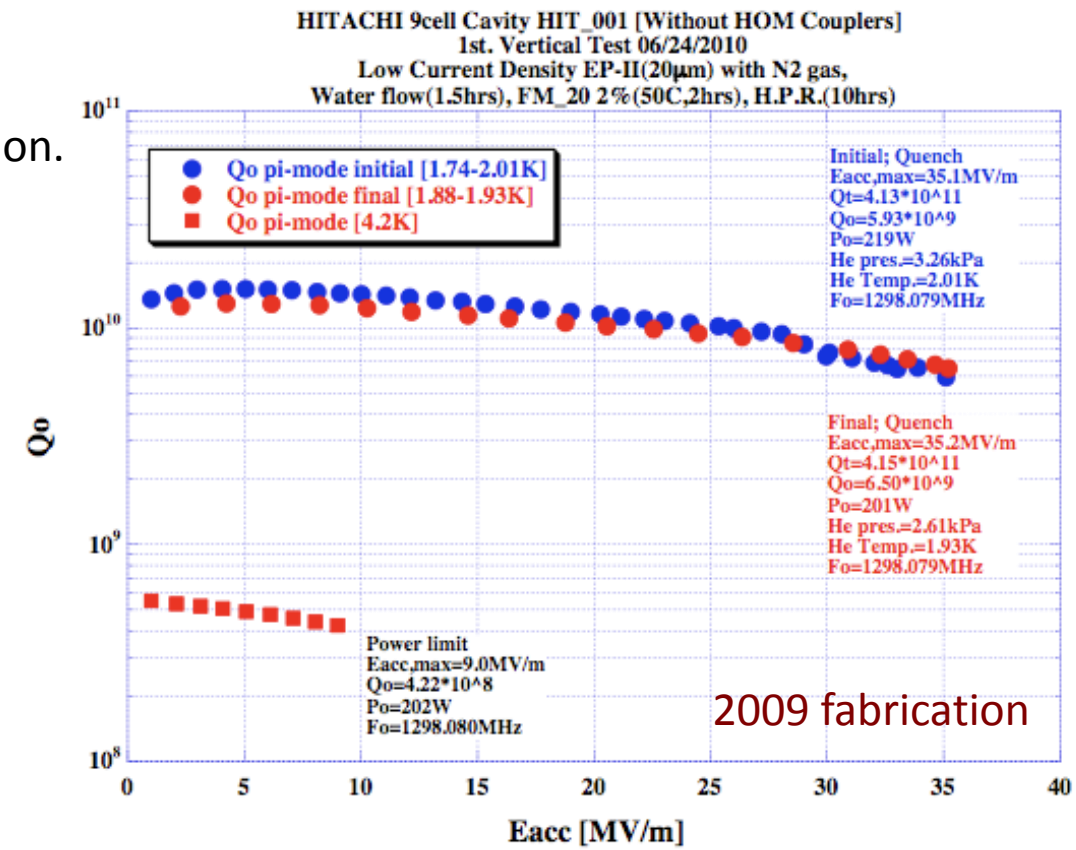
Vender development

KEK-Hitachi collaboration



2009: 9 cell cavity w/o HOM
fabrication.
Preparation of
High-pressure-code application.

2010: full-spec. 9 cell cavity
with HOM fabrication
in the next.

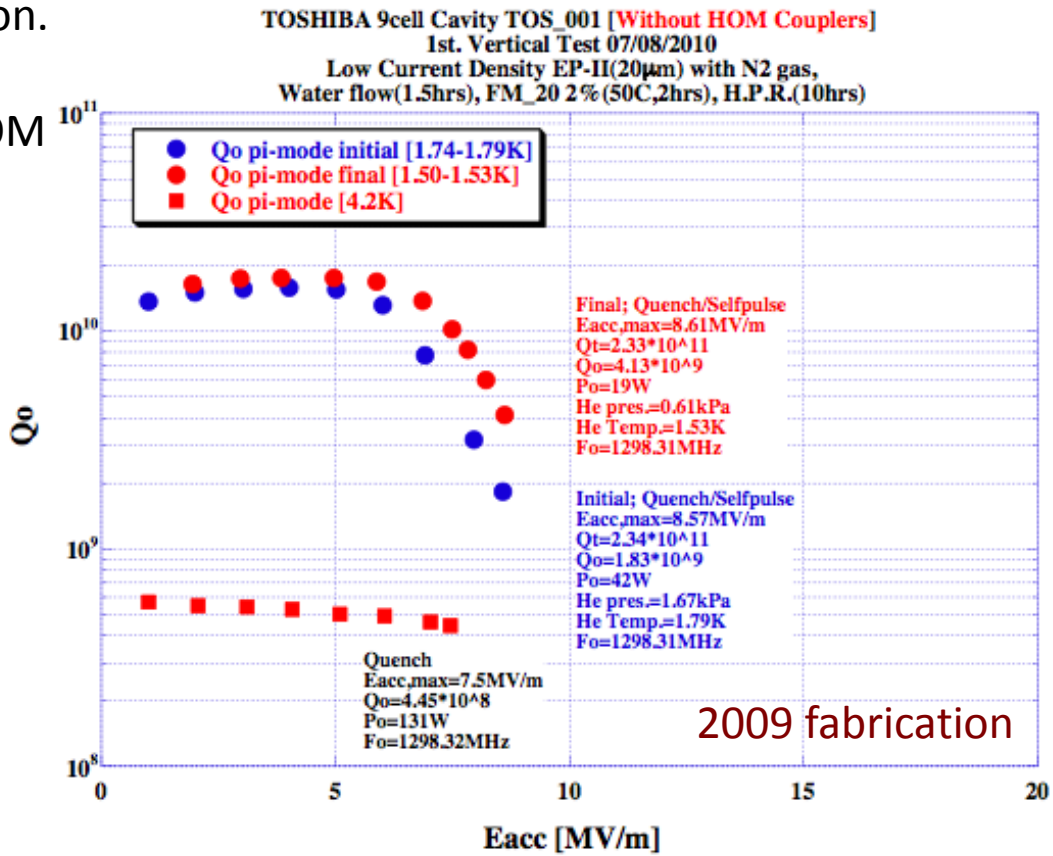


KEK-Toshiba collaboration

2009: 9 cell cavity w/o HOM
fabrication.
Preparation of
High-pressure-code application.

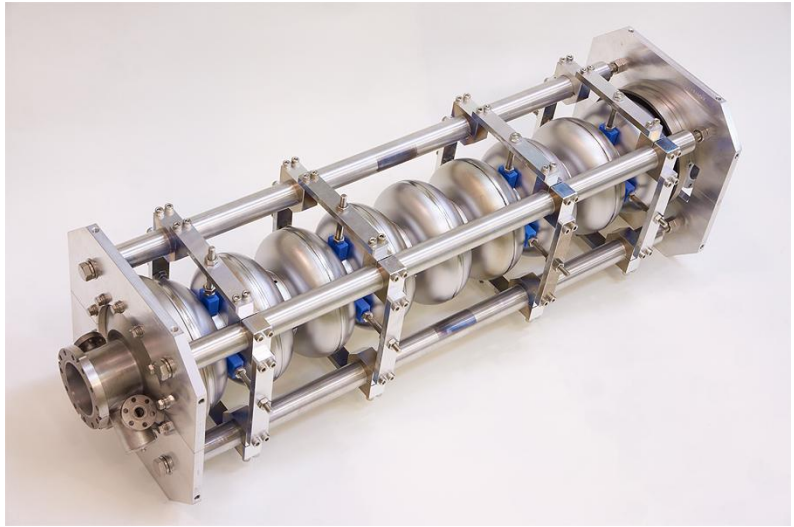
2010: one more 9 cell cavity w/o HOM
fabrication,
by changing EBW machine

and then,
full-spec. 9 cell cavity
with HOM fabrication.

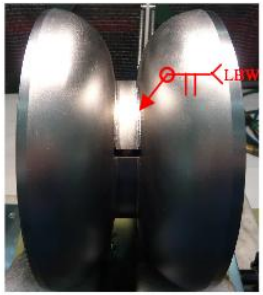


KEK-MHI development for cost-effective fabrication

MHI-A cavity



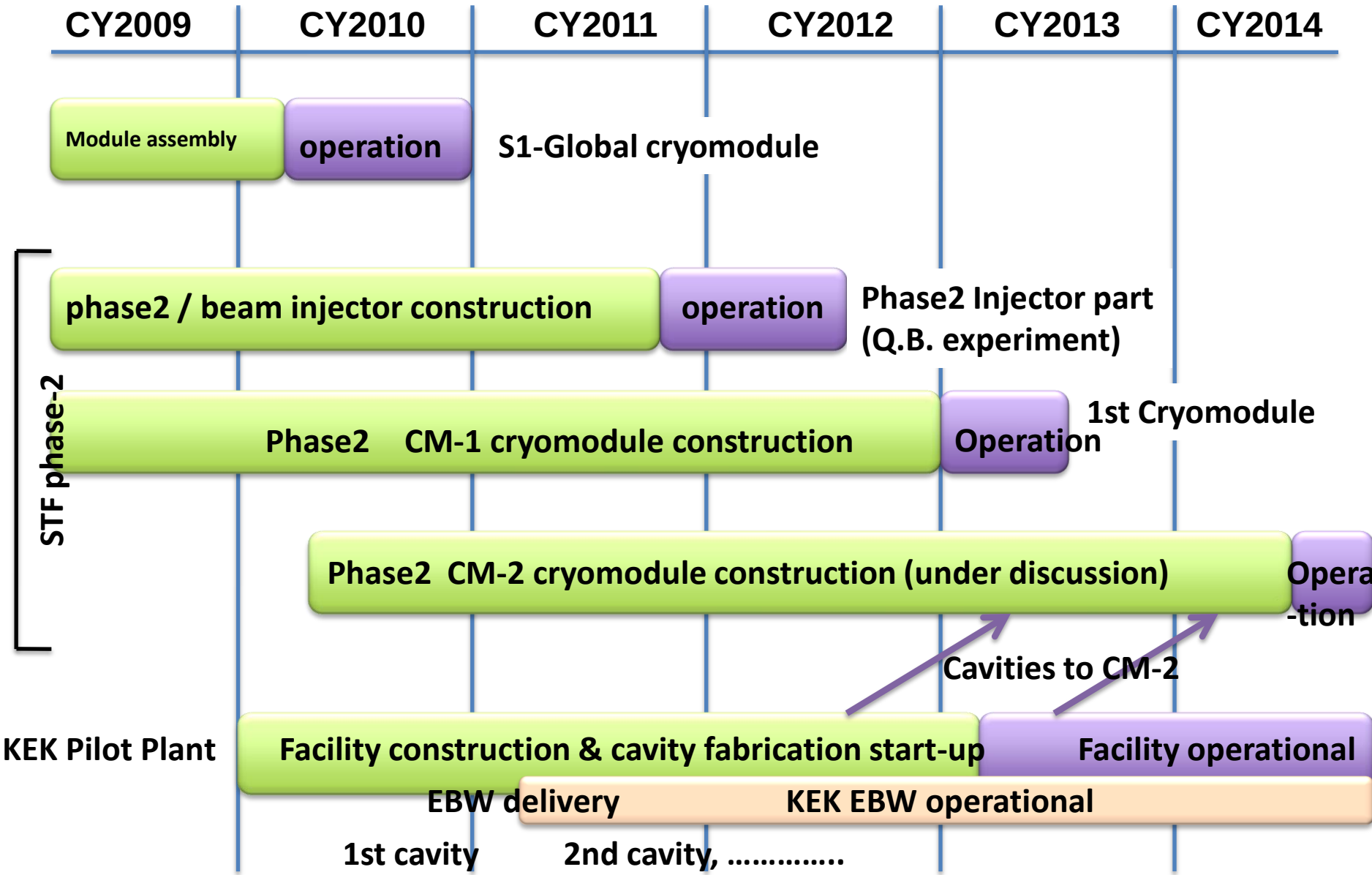
Deep drawing of HOM cup,
Laser beam welding,
more smooth EBW seam



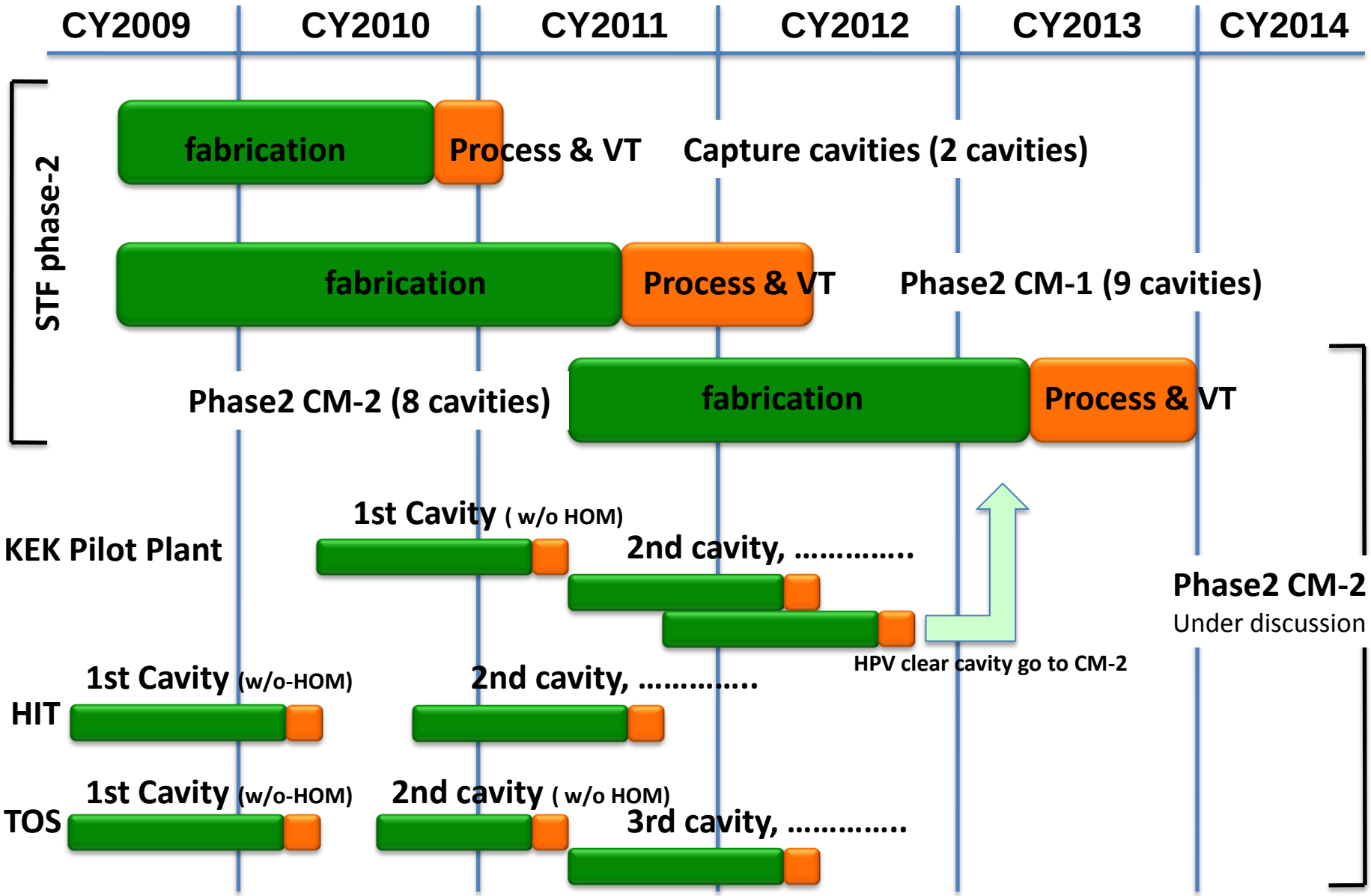
MHI trial of cylinder forming to dumbbell by spinning

Schedule Plan

STF Plans for 5 years (still under discussion)



STF Cavity Production plan



Summary

KEK pilot plant (R&D of EBW and press (deep drawing, FB, shaping))

Project was started in 2009,
Housing was completed, Press machine and trimming machine was delivered.
EBW machine delivery is scheduled on March 2011.
produce 1 cavity by using EBW Job-shop in 2010.
produce several cavities by KEK EBW with HPV clear, then put into STF phase2 cryomodule.
Collaboration with press-company for deep drawing, burring, and cut-out forming is started.
Industry participation will be after EBW machine delivery.

Collaboration with industries

Hitachi, Toshiba: 2009-2010 two years collaboration
MHI: total 11 cavities were fabricated. 11 more cavity fabrication by contract was started.
During this fabrication, cost effective fabrication is pursued.

Backup Slide

STF and KEK Pilot Plant

KEK　つくばキャンパス（北側上空より）

Industrialization of Cavity Fabrication

start preparation of ILC mass-production technology development

Accelerator Laboratory
Mechanical engineering center
Cryogenics engineering center

KEK Pilot Plant

mass-production R&D, technology in hand

Participation of collaborative company

AAA forum

mass-production technology transfer by KEK initiative

company A production line

company B production line

company C production line

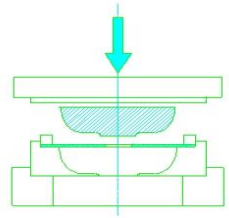
Pilot plant clean room

19m x 14m ISO class-5 clean room

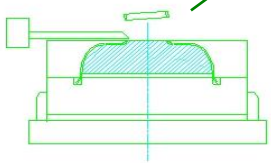
Chemical Polish room

Electron Beam Welder

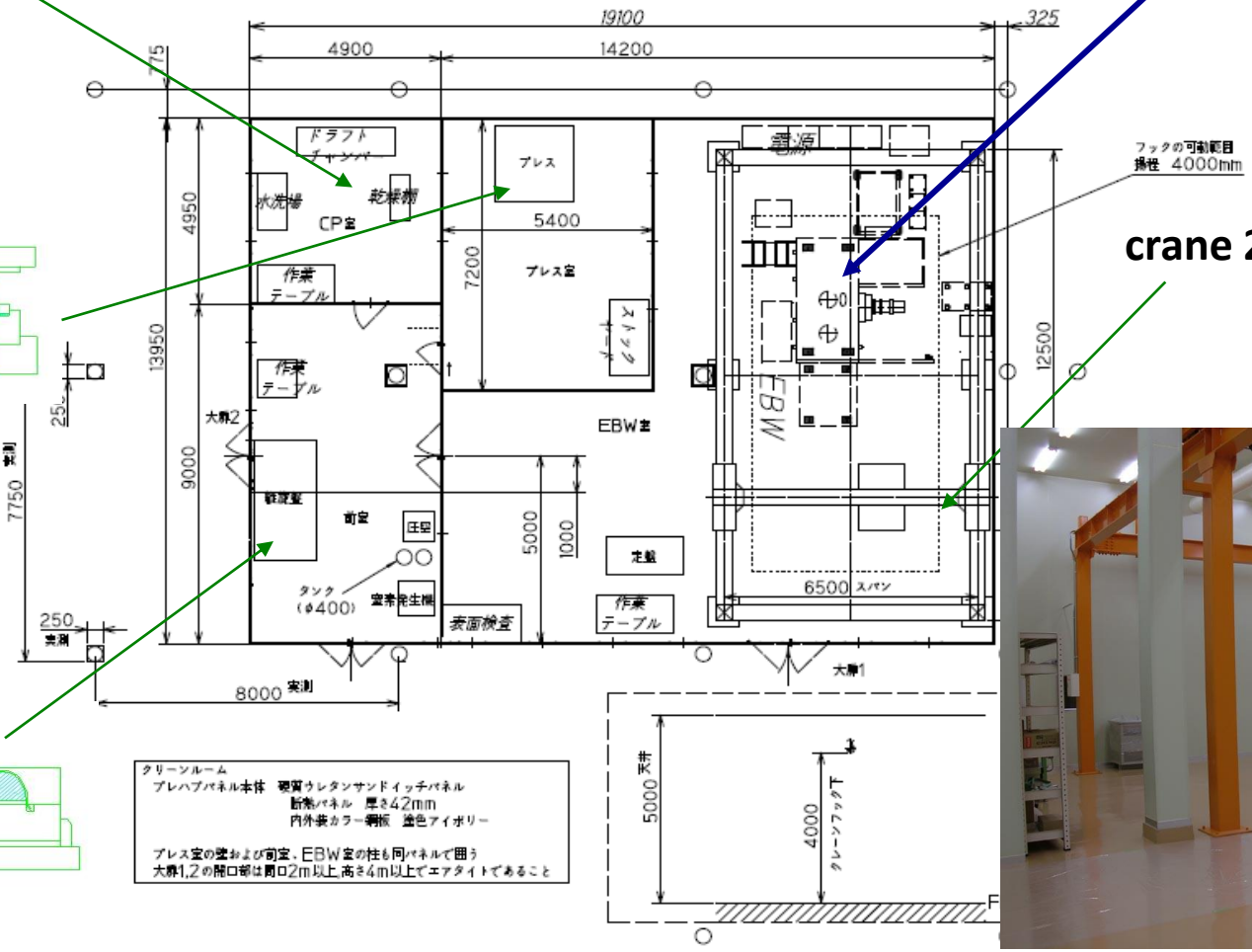
crane 2.8t



Press machine



Triming machine



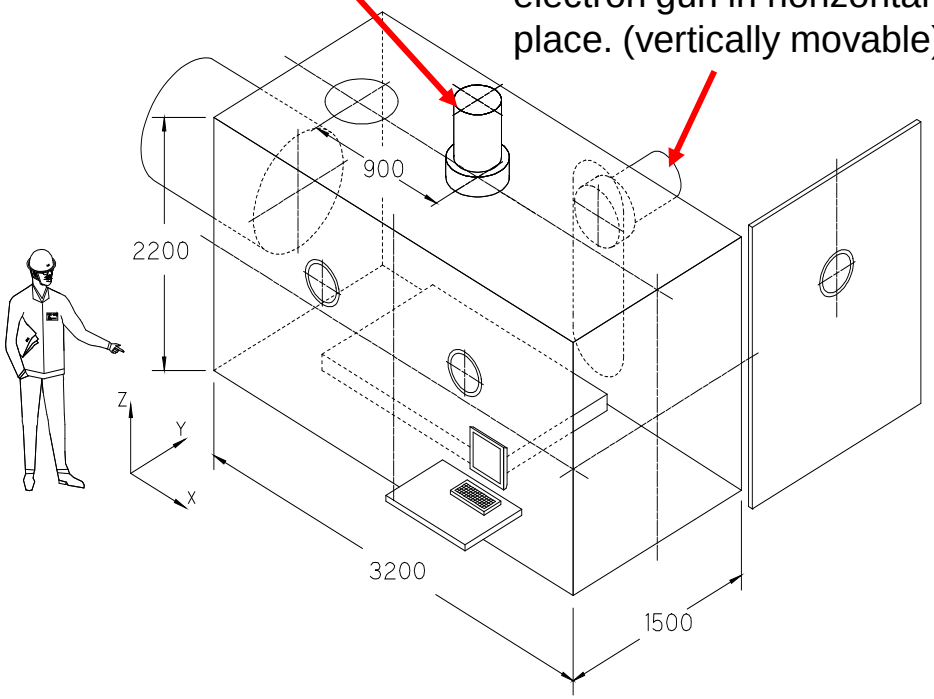
EBW place and crane girder

Main facility: Electron Beam Welder

we spent one year for survey of cavity EBW machine.
After bidding, one EBW machine was ordered.

electron gun

electron gun in horizontal place. (vertically movable)

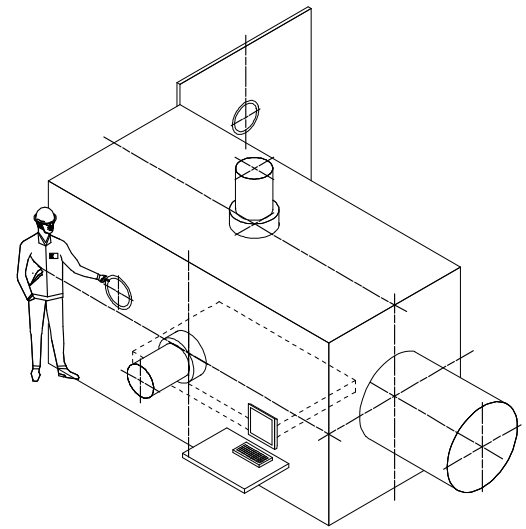


DESY EBW; the same company

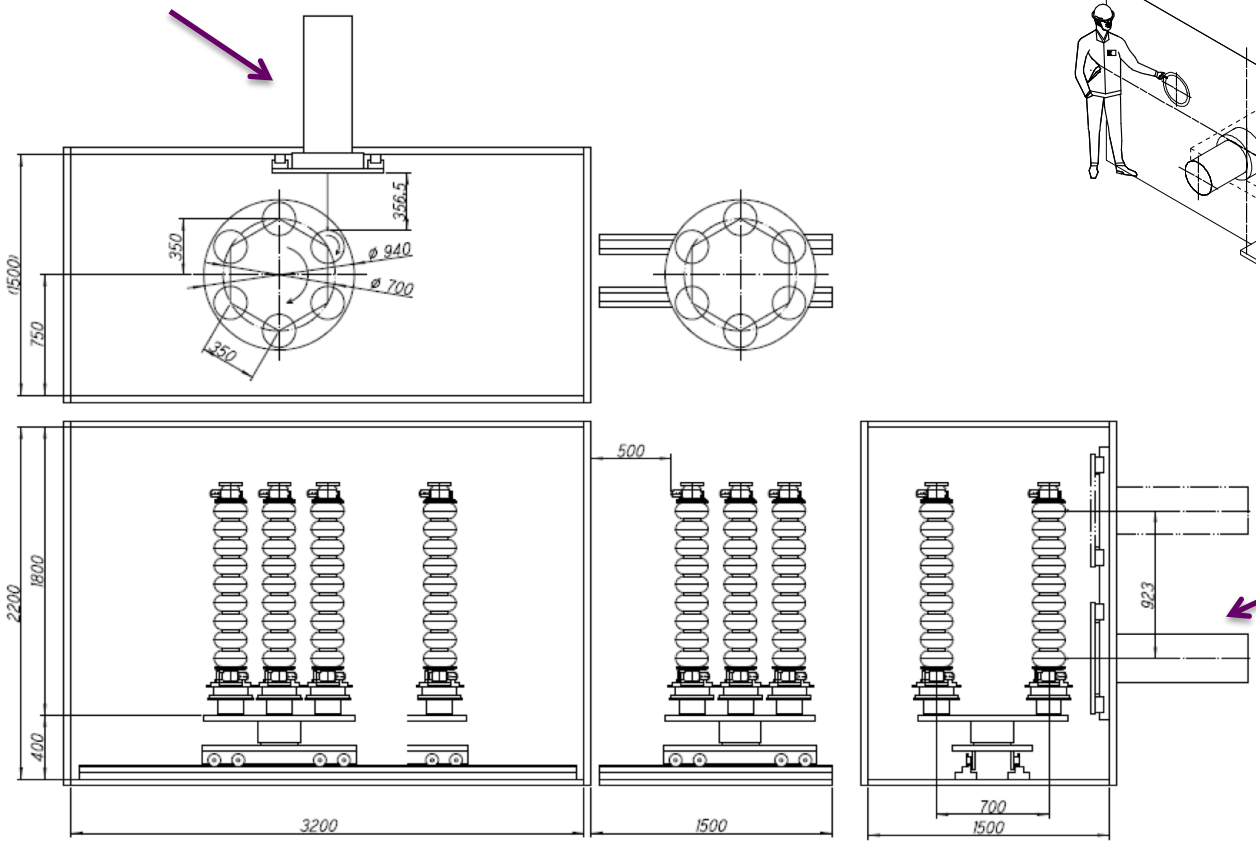
Steigerwald 150kV 15kW machine will be delivered in March 2011.

Plan of multi-cavity welding

6 cavities welding plan in the final process



electron gun from side wall

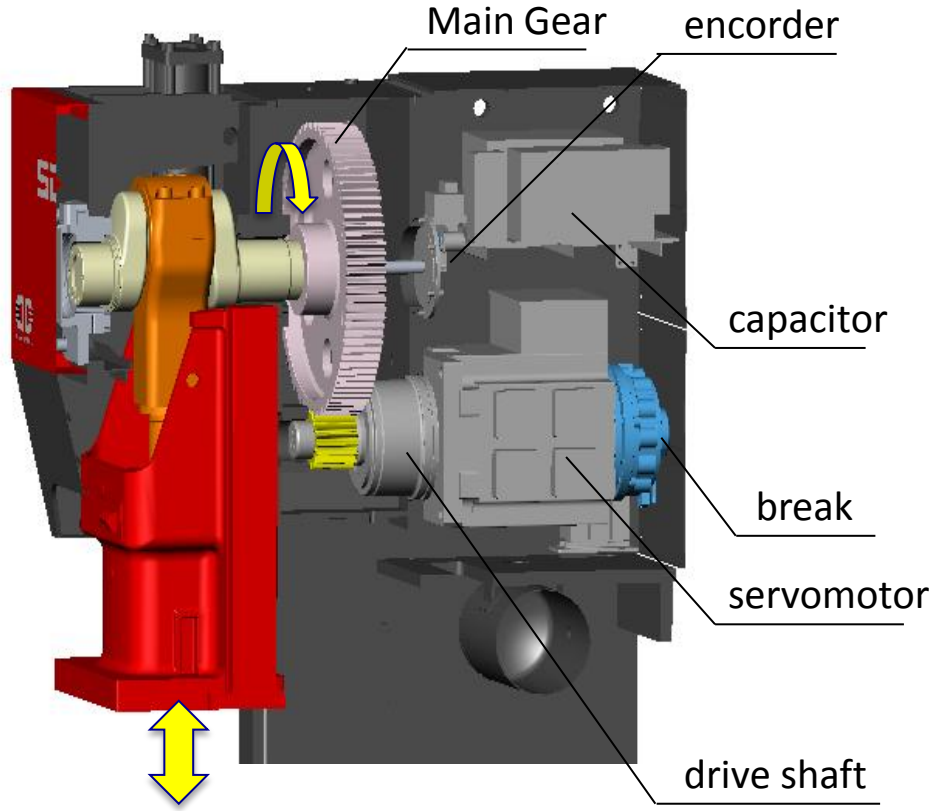


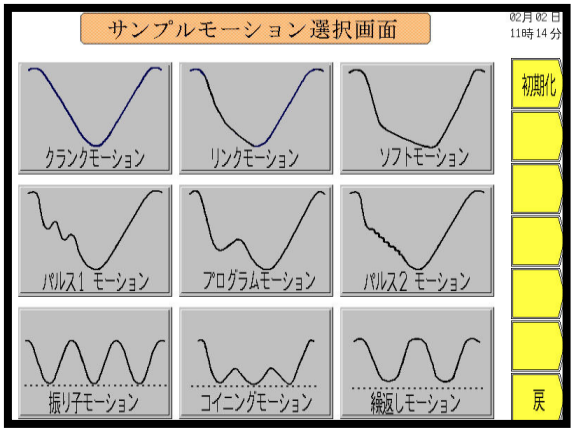
gun moves vertically

Digital servomotor Press machine

combination of servomotor and crank mechanism

from Amada presentation

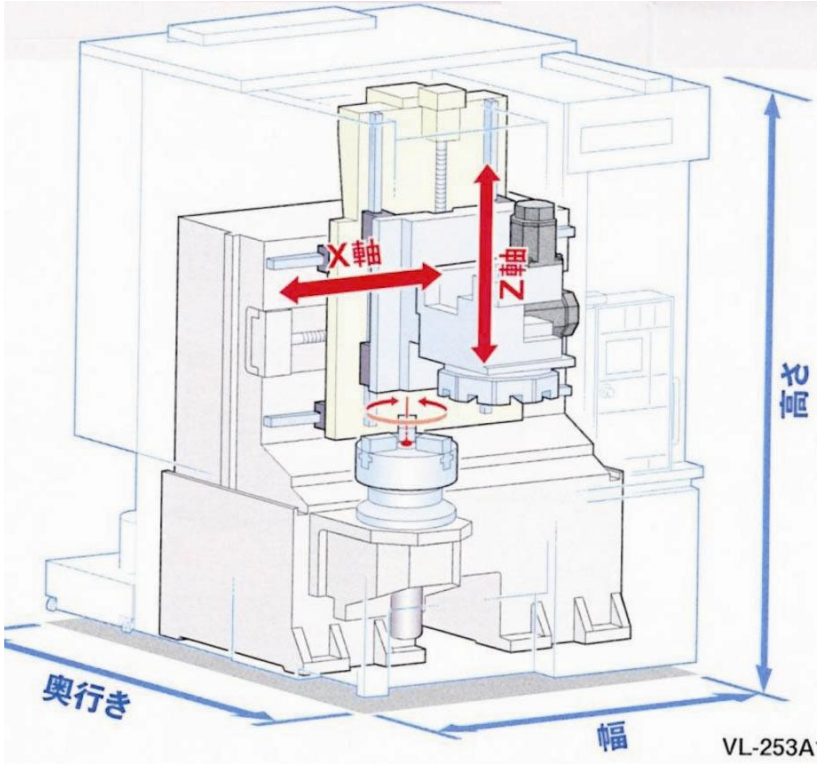




press motion controls

Cell trimming machine

cell cup is held in horizontal plane, and rotate.



2009 installation

Clean room construction
EBW performance was surveyed, bidded, and ordered
press machine
trim machine
optical instruments, eddy current scan for inspection
infra-structure (water, compressed-air, N_2-gas, etc)

2010-2011 installation

EBW
Jigs of EBW
Chemical Polish system
Jigs of deep-drawing and burring
3D coordinate machine
microwave measurement system
control & data-base system