

Industrialization study in the SRF cavity fabrication facility (Pilot Plant) at KEK

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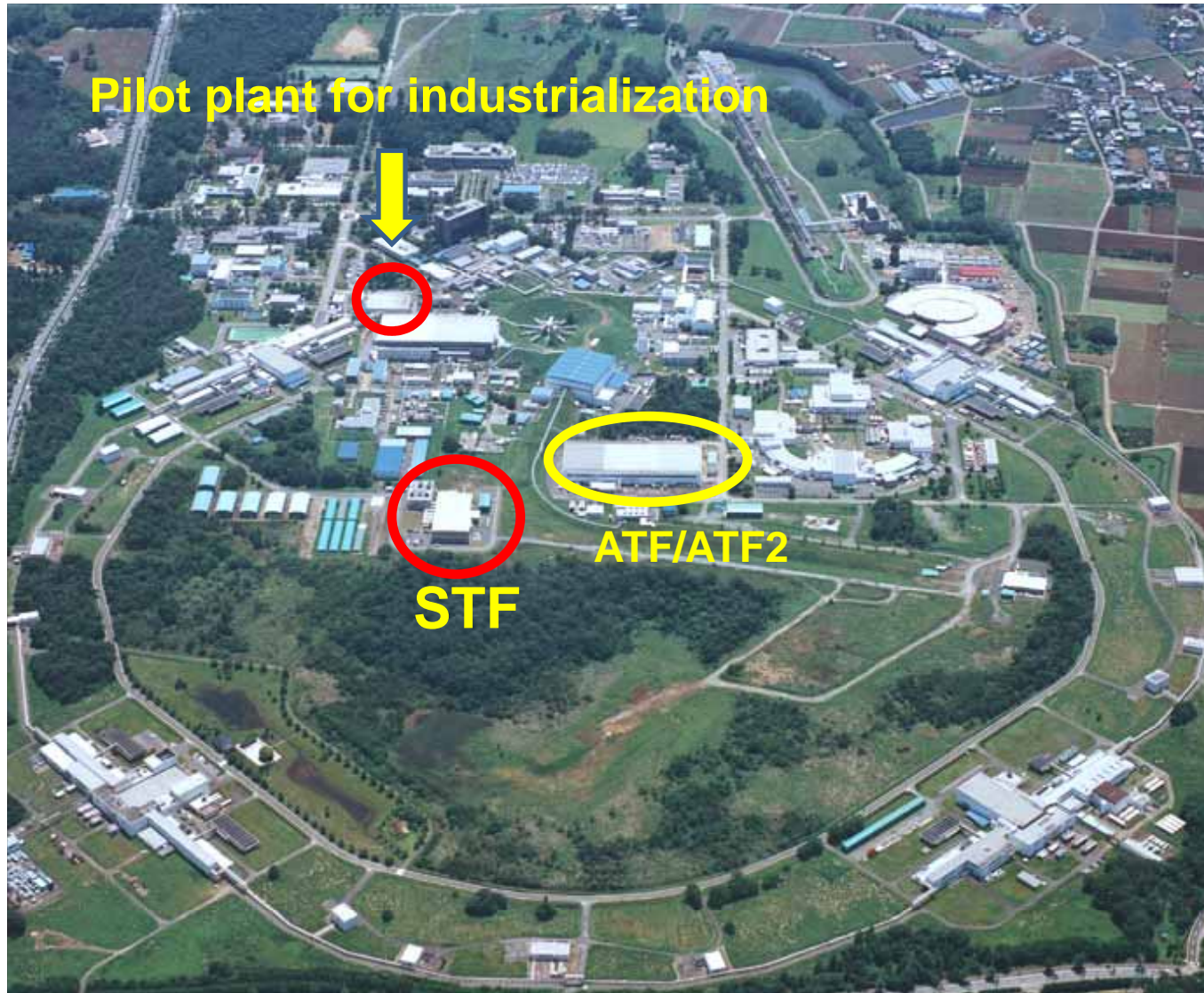
21 Mar. 2011

ALCPG2011 @ Eugene, Oregon

Introduction

- The cost of SRF cavity fabrication need to be much reduced in mass production.
- In order to lead the study on the mass production of ILC, we started the activities using the SRF cavity fabrication facility (pilot plant) at KEK.
- These activities are presented in following slides.

ILC Test Facilities at KEK



KEK つくばキャンパス(北側上空より)

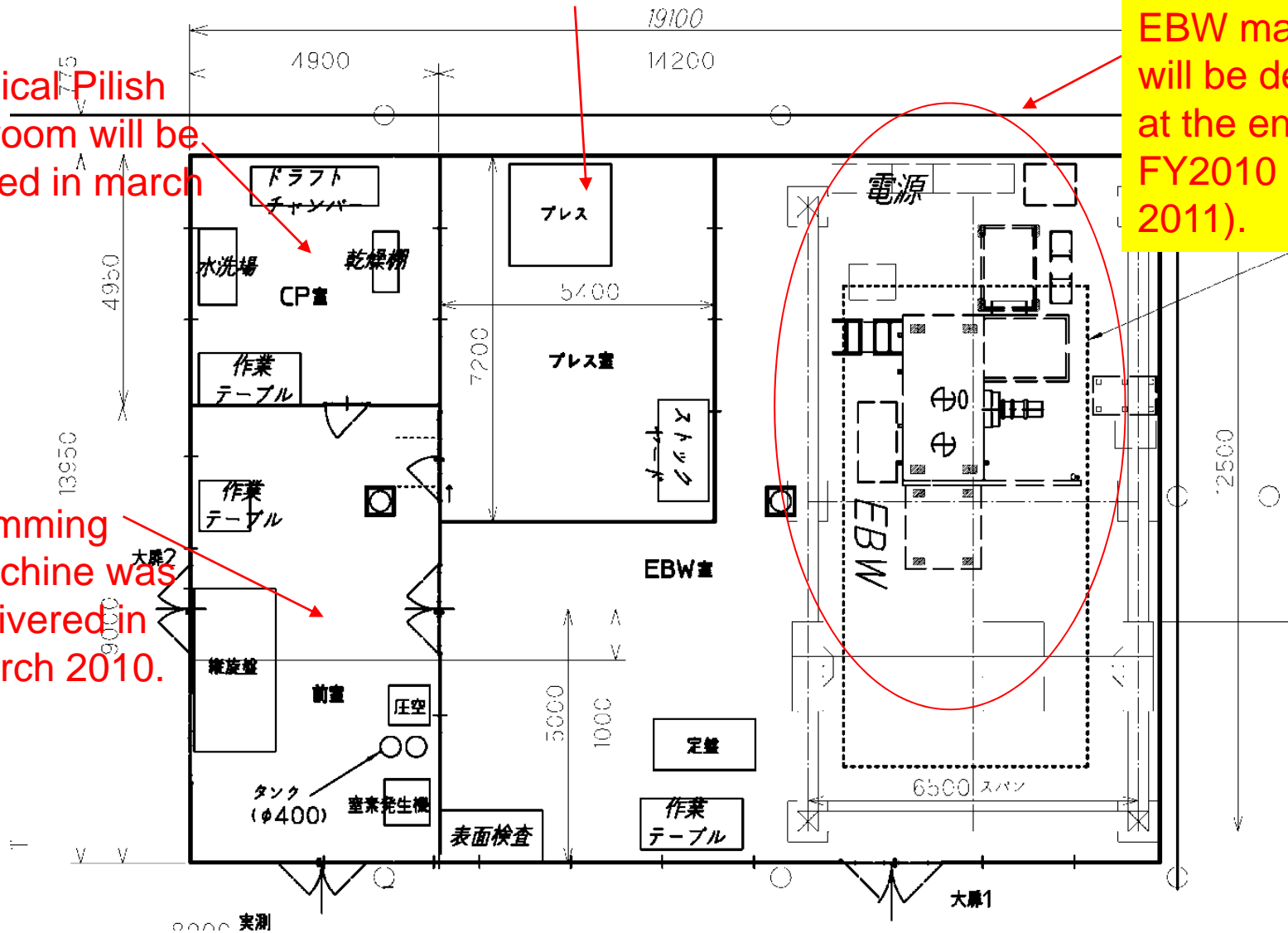
Drawing of the pilot plant for industrialization at KEK

Deep-drawing machine was delivered in march 2010.

Chemical Polish (CP) room will be installed in march 2011

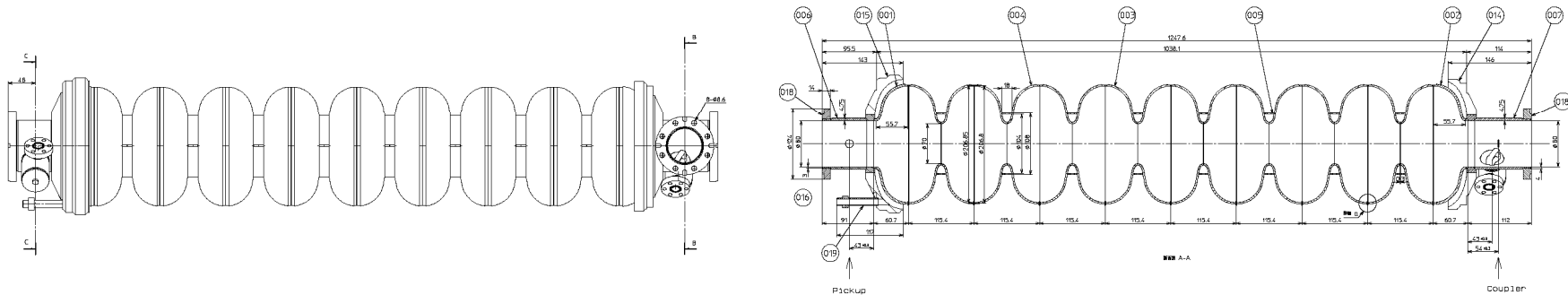
EBW machine will be delivered at the end of FY2010 (March 2011).

Trimming machine was delivered in march 2010.



Activities / schedule at Pilot Plant

Items	2010	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11
Fabrication of KEK-01 9-cell cavity w/o HOM	Deep-drawing Trimming Center-cell half-cup	Dumb-bells EBW		Equator EBW			End-group Fabrication	Complete			
EBW machine in Pilot Plant		Acceptance test at SST		Delivery to KEK	Installati on	Commisioning EBW for end-group	EBW for cavity fabrication				
Fabrication of KEK-02 9-cell cavity w/ HOM	Study on end-group fabrication method Collaboration with Shinohara Press Service Co. Ltd.							Center-cell Deep- drawing Trimming	End-group Fabrication with HOM		



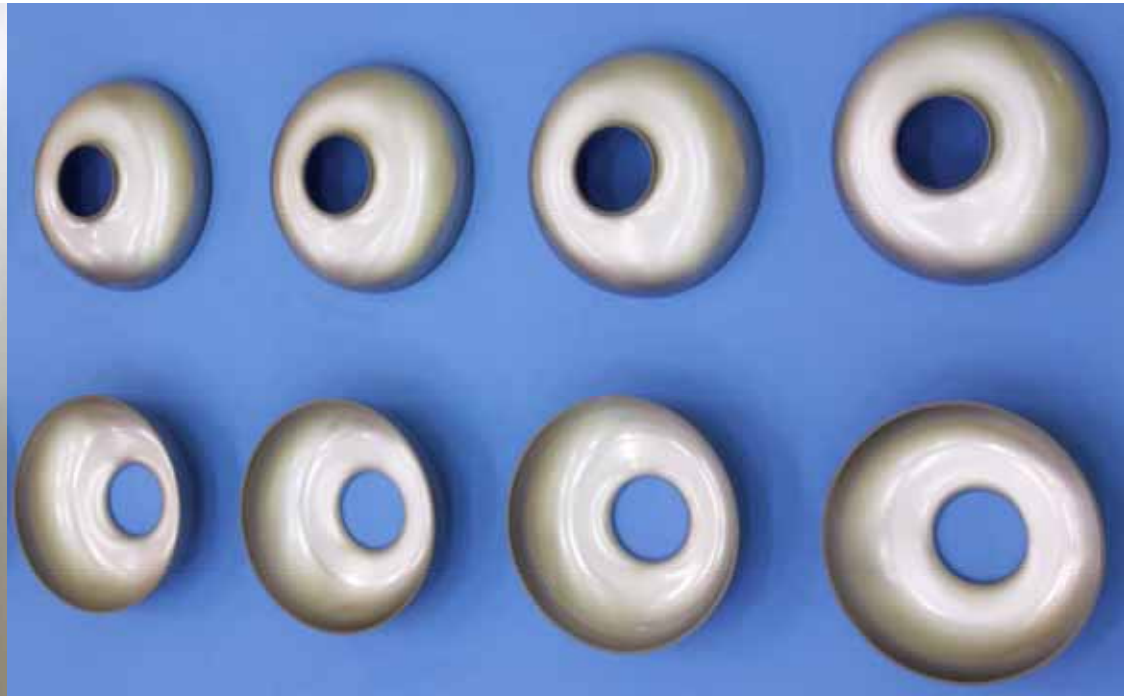
STF-Baseline 9-cell cavity with HOM

Fabrication of 9-cell cavity w/o HOM (KEK-01)

Items	2010	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11
Fabrication of KEK-01 9-cell cavity w/o HOM	Deep-drawing Trimming Center-cell half-cup	Dumb-bells EBW		Equator EBW		End-group Fabrication		Complete			
EBW machine in Pilot Plant		Acceptance test at SST	Delivery to KEK	Installati on	Commisioning EBW for end-group		EBW for cavity fabrication				
Fabrication of KEK-02 9-cell cavity w/ HOM	Study on end-group fabrication method Collaboration with Shinohara Press Service Co. Ltd.							Center-cell Deep- drawing Trimming	End-group Fabrication with HOM		

- 1) Started the fabrication of 9-cell cavity w/o HOM (KEK-01, in STF-Baseline design) from last summer (2010).
- 2) EBW in a job shop (Tosei Electrobeam Co. Ltd.).
- 3) The 1st 9-cell cavity (KEK-01) w/o HOM will be finished in summer 2011.

Deep-drawing of center-cell half-cups at Pilot Plant (September – November 2010)

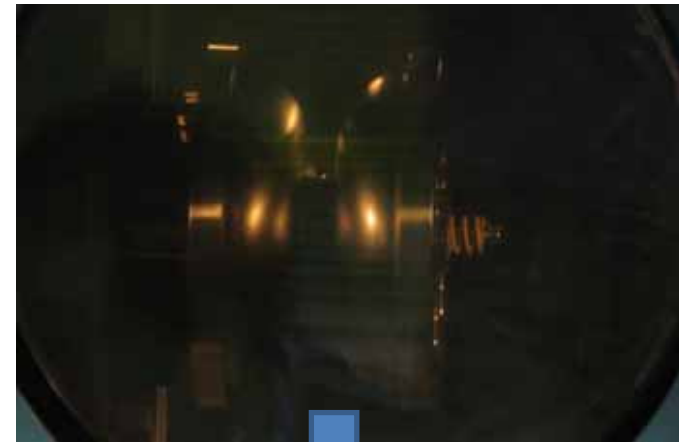


26 center-cell half-cups had been deep-drawn and been trimmed.

Trimming shape:
Iris: butt-joint shape, Equator: step-joint shape


EBW of Dumb-bell at Tosei Electronbeam Co. Ltd. (December 2010 – February 2011)

EBW at the iris of dumb-bell at a job shop (Tosei Electronbeam Co. Ltd.)



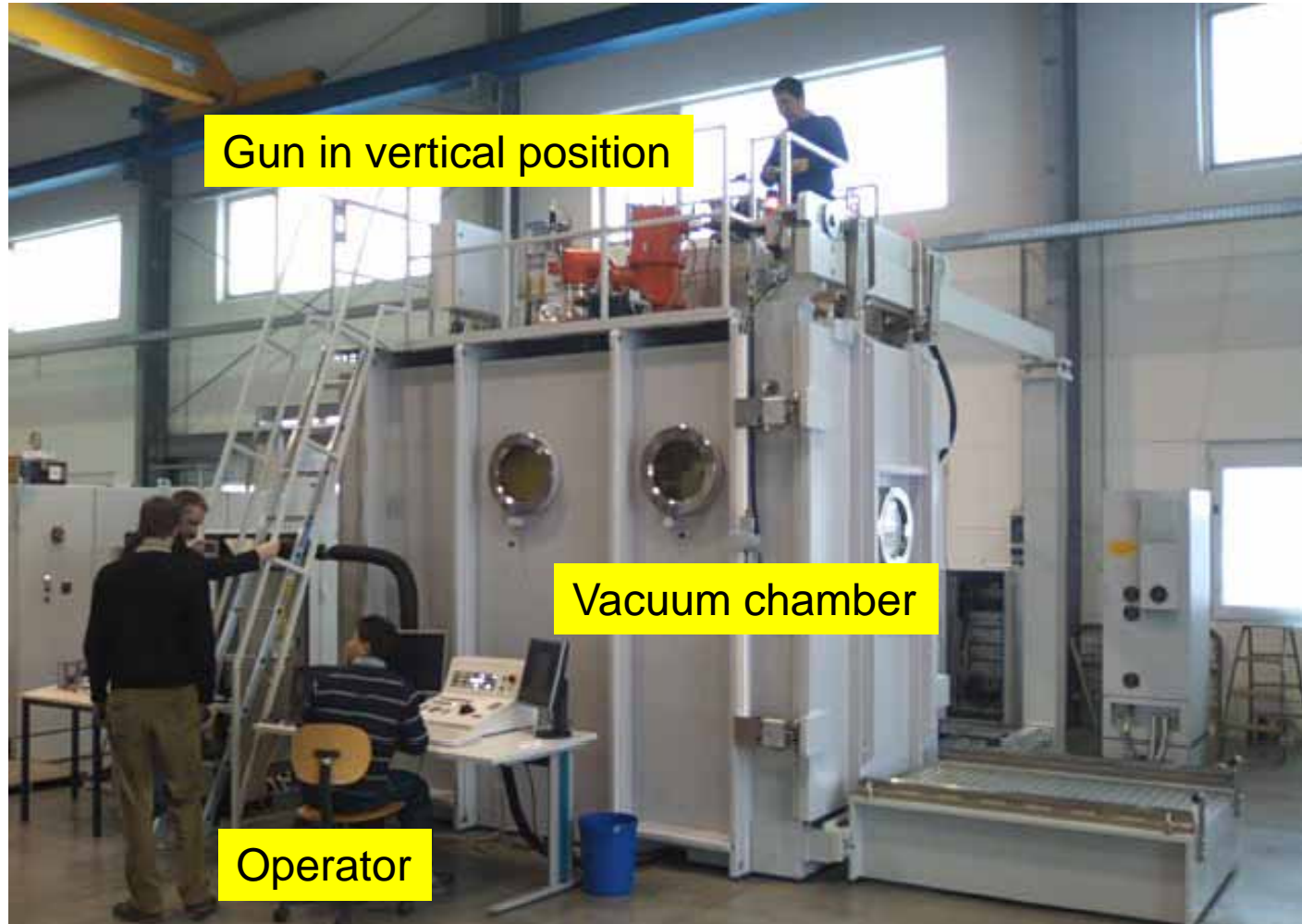
13 dumb-bells had been made.
5 of them will be used for the test EBW of equator.
8 of them will be used for the fabrication of 9-cell cavity w/o HOM (KEK-01).

Status of EBW machine for Pilot Plant

Items	2010	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11
Fabrication of KEK-01 9-cell cavity w/o HOM	Deep-drawing Trimming Center-cell half-cup	Dumb-bells EBW	Equator EBW			End-group Fabrication	Complete				
EBW machine in Pilot Plant		Acceptance test at SST	Delivery to KEK	Installati on	Commisioning EBW for end-group	EBW for cavity fabrication					
Fabrication of KEK-02 9-cell cavity w/ HOM	Study on end-group fabrication method Collaboration with Shinohara Press Service Co. Ltd.						Center-cell Deep- drawing Trimming	End-group Fabrication with HOM			

- 1) Acceptance test of EBW machine was done at SST factory (24 Jan – 4 Feb 2011).
- 2) EBW machine will be delivered at KEK on 31st March 2011.
- 3) Installation from beginning of April to end of April 2011.
- 4) Commissioning in May – June 2011. Start using EBW machine for the fabrication of EBW.

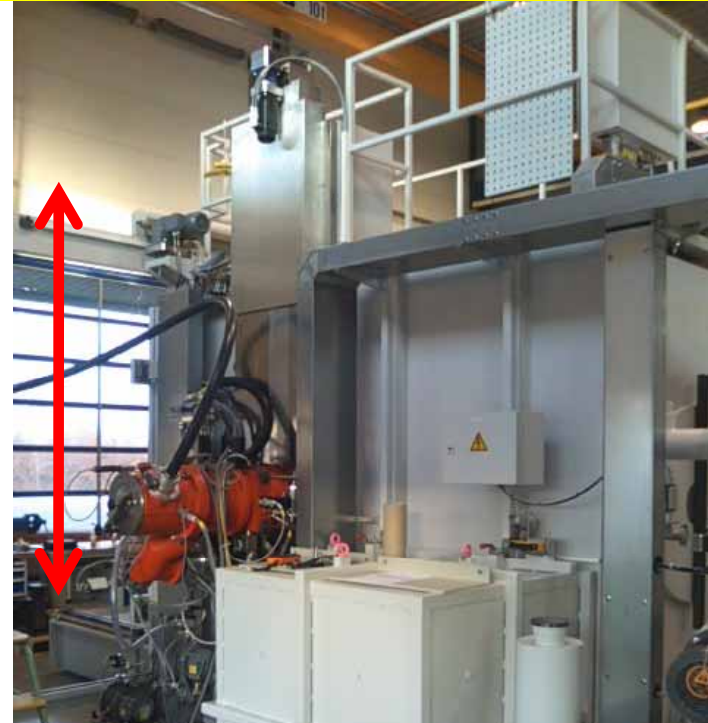
Steigerwald Strahltechnik GmbH (SST) Factory Munich, Germany, 24th Jan – 4th Feb 2011



Acceptance test of EBW machine was successfully done at SST factory

Steigerwald Strahltechnik GmbH (SST) Factory Munich, Germany, 4th Feb 2011



Acceptance test for the replacement of gun position (vertical to horizontal).



Gun is movable on Z axis
Movable range: 1.0m (Z)
Position repeatability: +/- 0.05 mm
Speed range: 1.0 – 30 mm/s

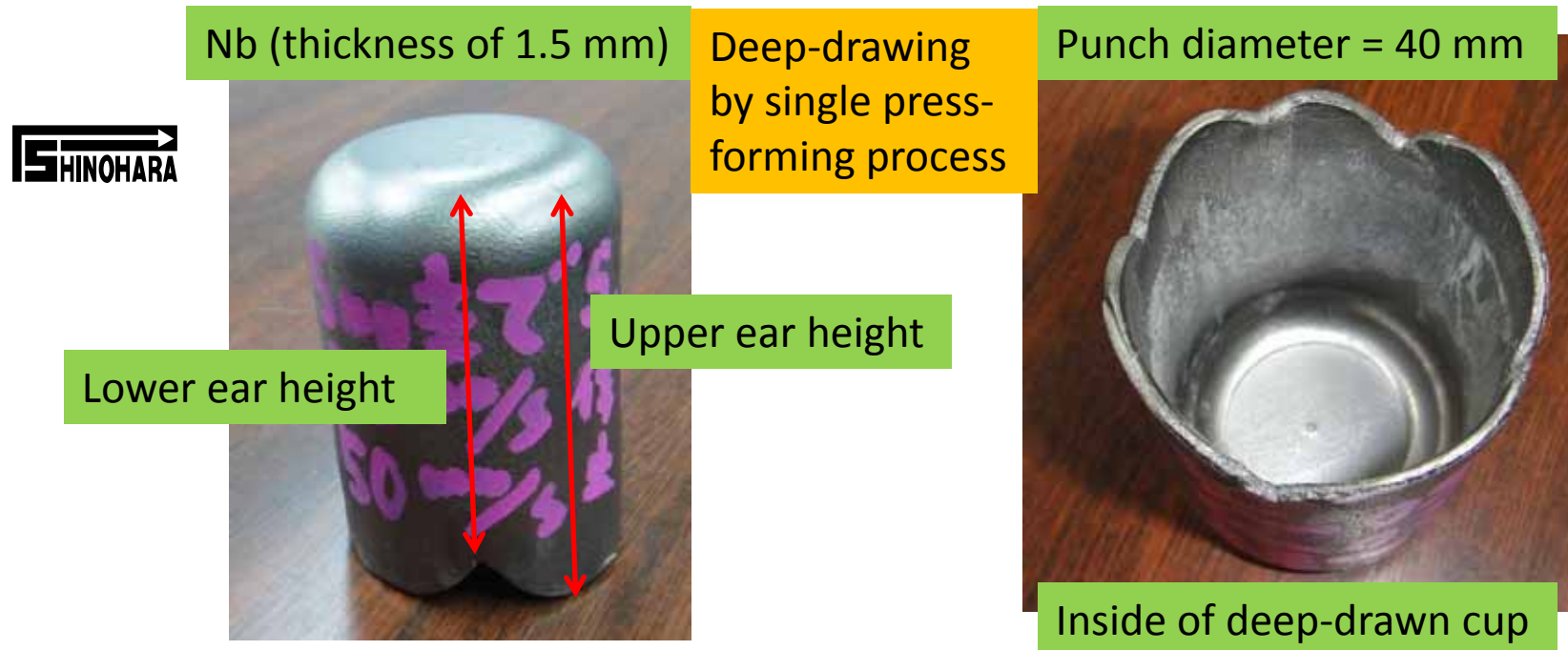
Beam operation and Z-movement of Gun were OK in horizontal position.

Fabrication of 9-cell cavity w/ HOM (KEK-02)

Items	2010	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	
Fabrication of KEK-01 9-cell cavity w/o HOM	Deep-drawing Trimming Center-cell half-cup	Dumb-bells EBW	Equator EBW			End-group Fabrication		Complete				
EBW machine Delivery and installation		Acceptance test	Delivery to KEK	Installati on	Commisioning EBW for end-group	EBW for cavity fabrication						
Fabrication of KEK-02 9-cell cavity w/ HOM	Study on end-group fabrication method Collaboration with Shinohara Press Service Co. Ltd.						Center-cell Deep- drawing Trimming	End-group Fabrication with HOM				

- 1) Started end-group fabrication study from summer 2010 in collaboration with Shinohara Press Service Co. Ltd.
- 2) Plan is to start the fabrication of 9-cell cavity with HOM (KEK-02, in STF-Baseline design) from summer 2011 with EBW machine in the Pilot Plant.

Innovative deep-drawing research work in collaboration with Shinohara Press Service Co. Ltd.



This collaboration started in September 2010. 1.5 mm thick Nb material sheet is used to investigate the advanced deep-drawing technology for the mass production of HOM-can. The required drawing ratio (blank diameter / punch diameter) and drawing height are tentatively attained with above Nb sheet.

Subject: Plane anisotropy is unexpectedly enormous which causes the large difference of lower and upper ear heights. This might be improved in the future, otherwise it might cause a problem in yield rate of valued Nb material in deep-drawing as well.

HOM-can: Protrusion Press forming

Using a deep-drawn Nb HOM-can (thickness of 1.5 mm), the test of protrusion press forming was done. The picture shows the HOM-cans before and after the protrusion press forming. A protrusion was formed on the flat-bottomed surface.



Future plan :

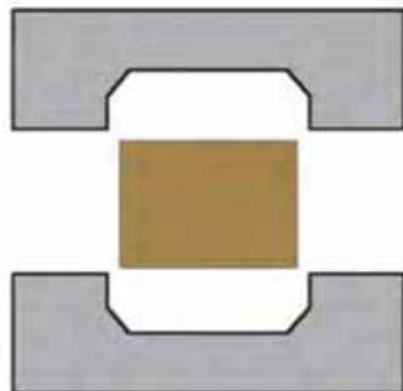
Study on the effect of work-hardening during the ultra deep-drawing of HOM-can on protrusion forming and also the achievement of more flatness accuracy and tolerance on both protrusion and flat-bottomed surface of HOM-can.

Study on production of HOM-antenna by press forming

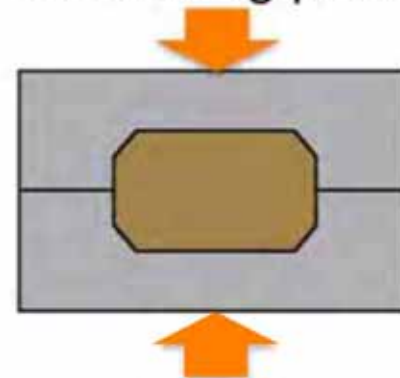
Use of Cu material at first, then go to Nb



Wire cut for preliminary work



Simulating press-cut of HOM Antenna



Edge shaping by press

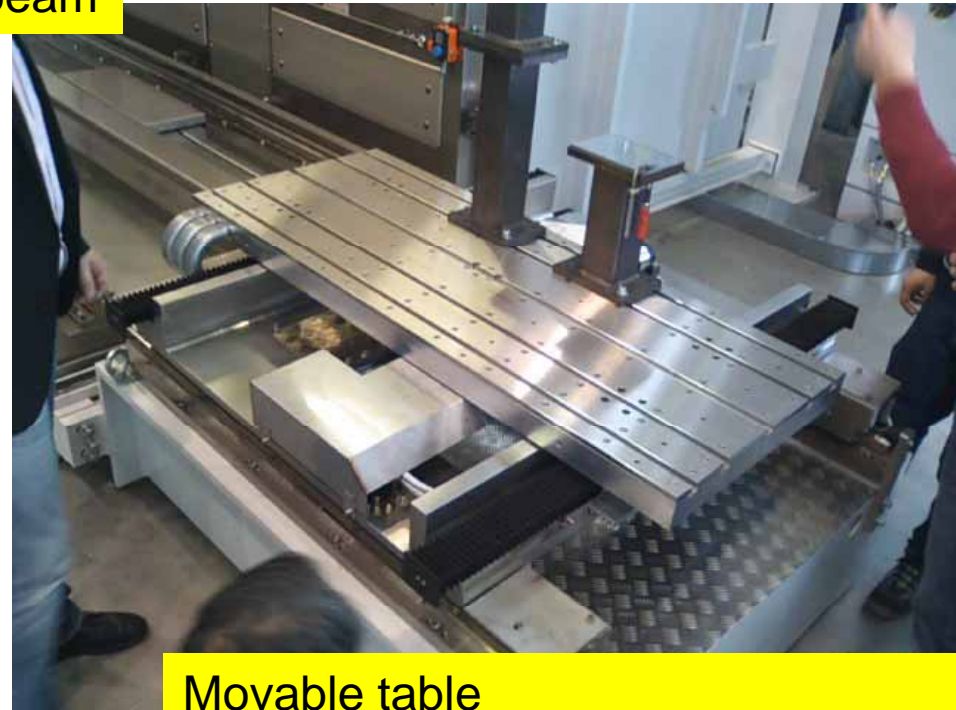
Summary

- Fabrication of 9-cell cavity without HOM (KEK-01, STF-Baseline design) is ongoing.
- 13 dumb-bells for KEK-01 was fabricated with a press machine in the pilot plant and an EBW machine in the job shop (Tosei Electrobeam).
- Acceptance test of EBW machine for the pilot plant had been done in SST factory in Jan – Feb 2011.
- EBW machine will be delivered in KEK on 31st March 2011. Plan is installation in April 2011 and commissioning in June – July 2011.
- Studies of end-group fabrication with HOM are ongoing in collaboration with Shinohara Press Service Co. Ltd.
- Fabrication of 9-cell cavity with HOM (KEK-02, STF-Baseline design) will start in summer 2011 with new EBW machine in the pilot plant.

Backup

Steigerwald Strahltechnik GmbH (SST) Factory Munich, Germany, 24th Jan – 4th Feb 2011

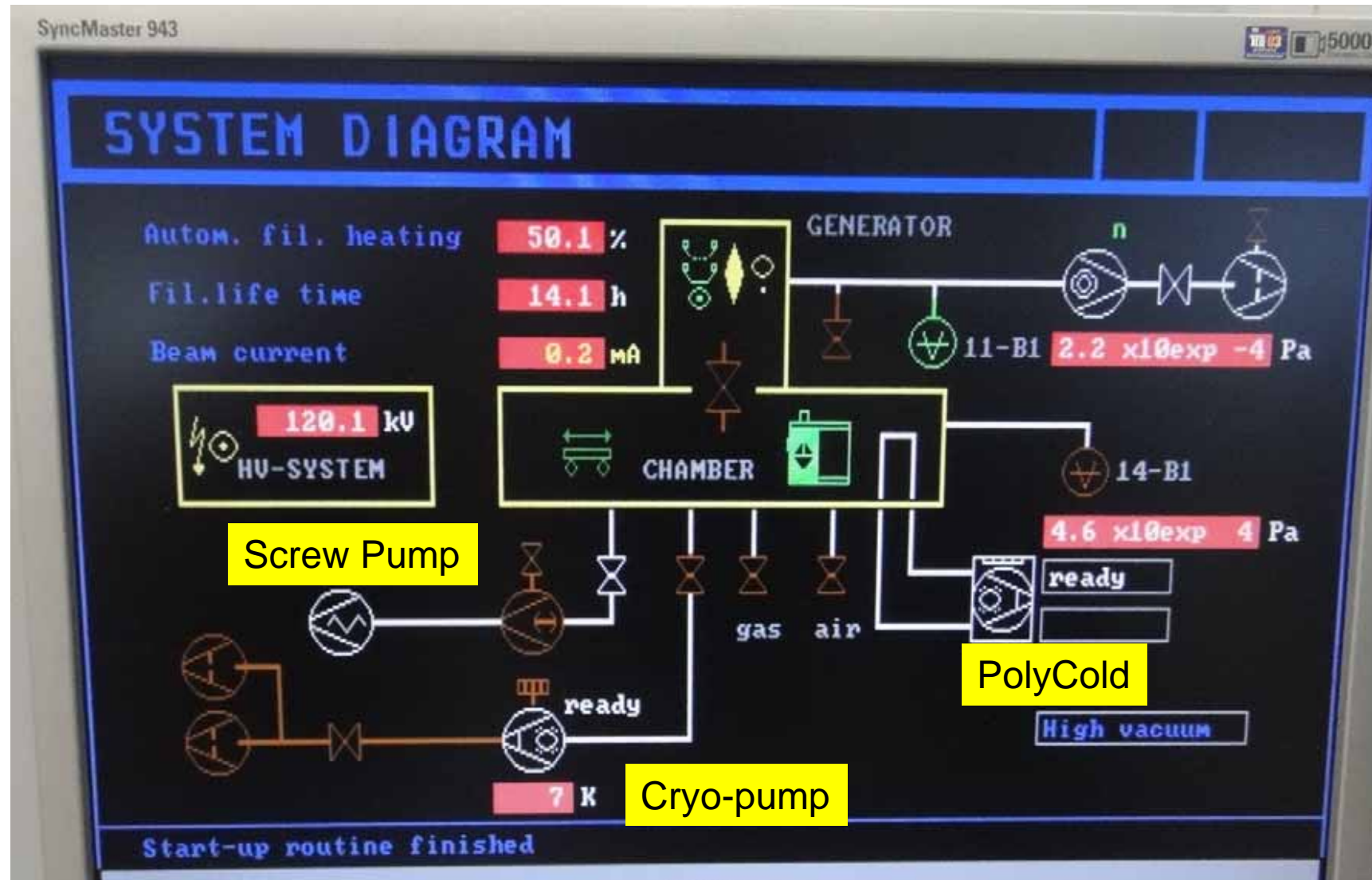
A hole for electron beam



Movable table
Movable range: 1.5m (X) x 0.8m (Y)
Position repeatability: ± 0.03 mm
Speed range: 0.3 – 100 mm/s

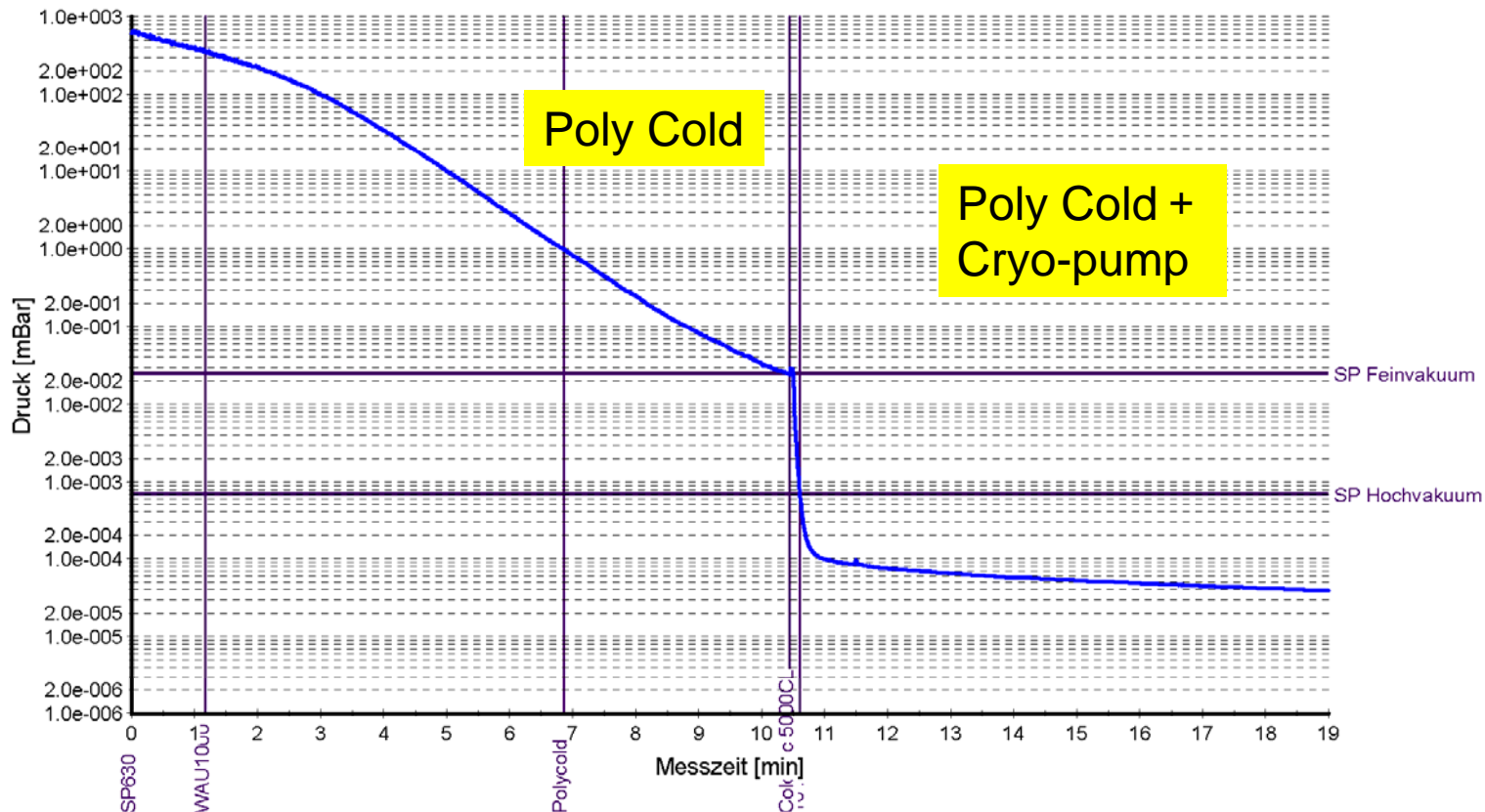
Vacuum chamber, detachable wall panels (stainless steel) on inside wall
3.2m (length) x 1.5m (width) x 2.2m (height)

Steigerwald Strahltechnik GmbH (SST) Factory Munich, Germany, 24th Jan – 4th Feb 2011



Steigerwald Strahltechnik GmbH (SST) Factory Munich, Germany, 2nd Feb 2011

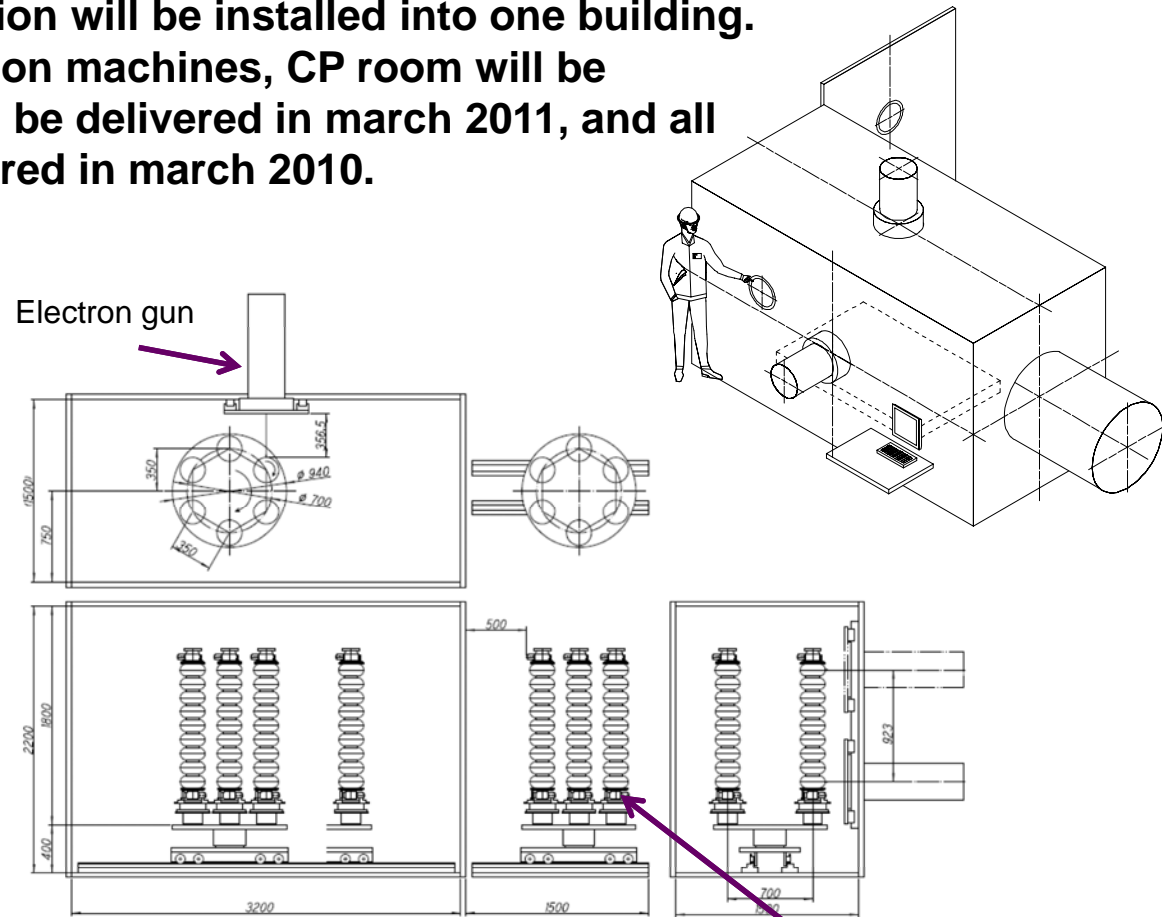
Pumpkurve KEK
100129



Acceptance test of vacuum chamber and pumping system

Plan of the pilot plant (KEK) for industrialization

Machines for cavity fabrication will be installed into one building. Clean environment, inspection machines, CP room will be provided. EBW machine will be delivered in march 2011, and all other machine will be delivered in march 2010.



An image of the cavity industrialization

6 cavities on the plat-form

Commissioning plan :

- 2009-2010 Commissioning of machines except EBW to fabricate one cavity
- 2011-2012 Commissioning of EBW machine to fabrication a few cavities
- 2013- R&D of cavity industrialization