

# Fabrication of TESLA(Euro-XFEL)-shape Cavity at KEK

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**LCWS14 at Belgrade / Serbia**  
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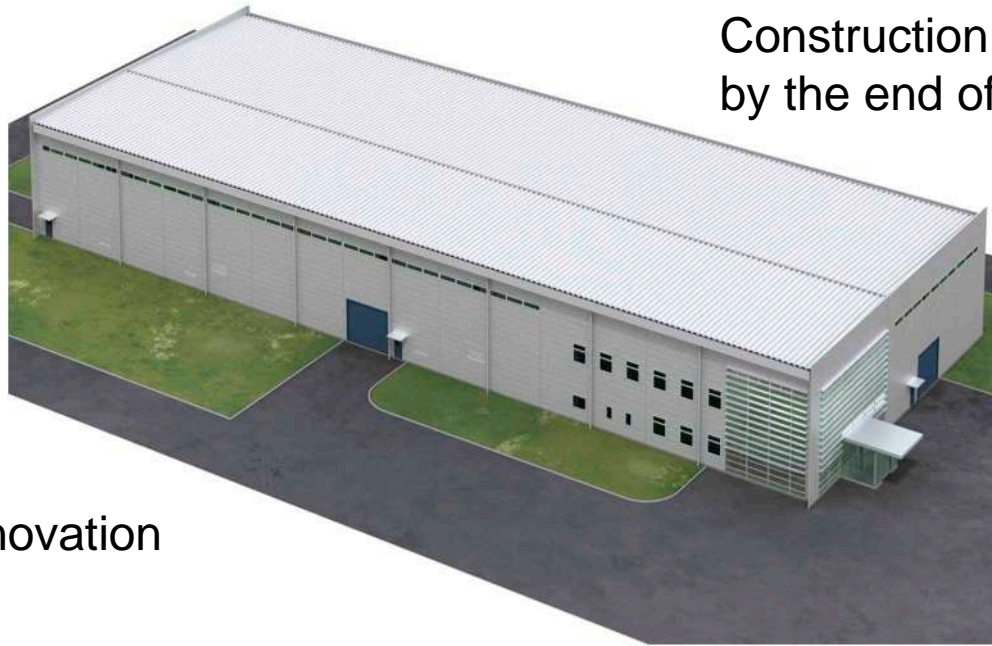
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- Fabrication of four TESLA(Euro-XFEL)-shape cavities by vendors.
- Japanese High Pressure Gas (HPG) Safety Act.
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- Summary

# Construction status of new COI building



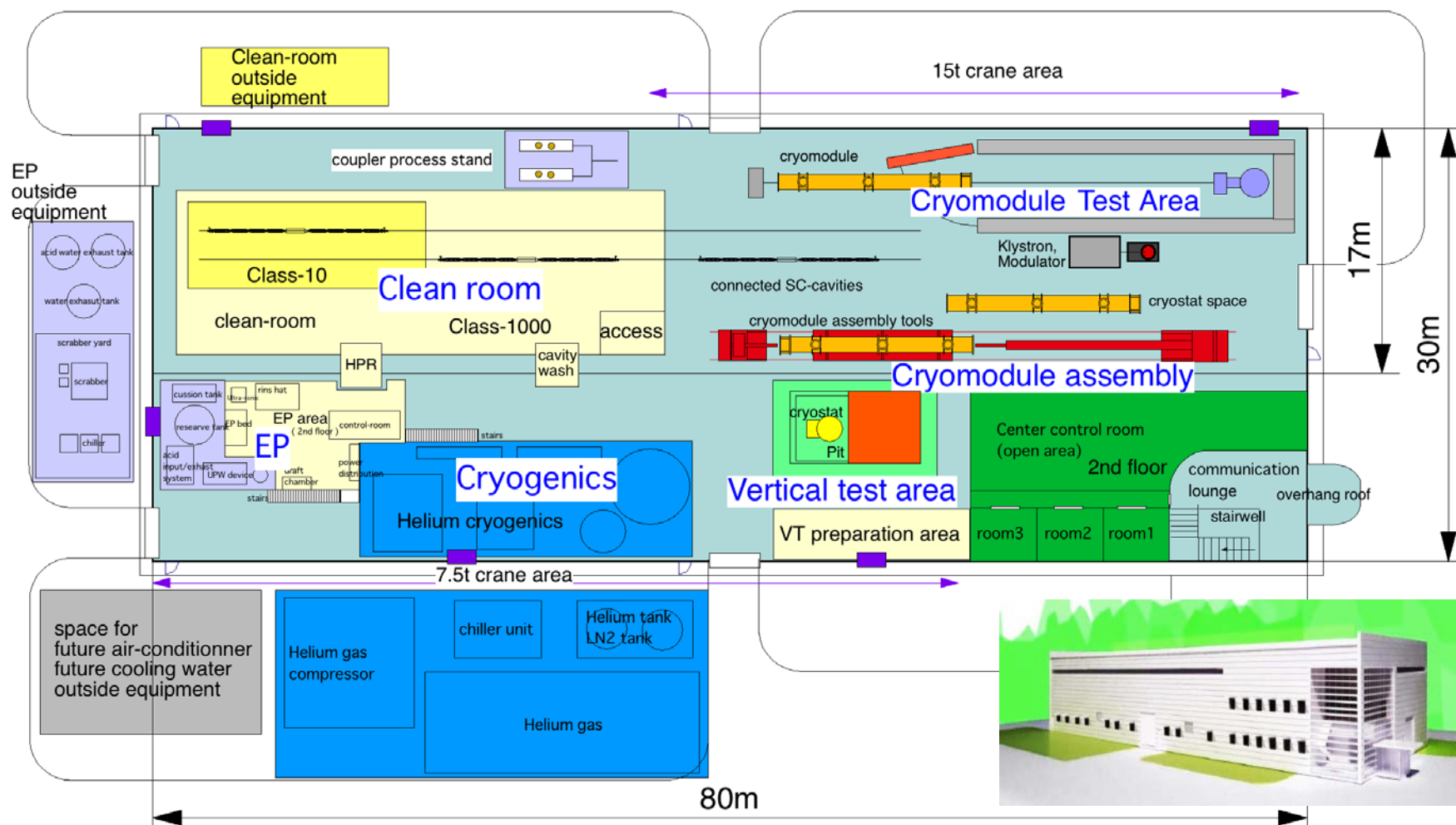
Construction will be completed  
by the end of Jan. 2015



COI =  
Center of Innovation

# New SRF facility : promotion of superconducting accelerator utilization

New building (80m x 30m) is under construction at North of STF  
Superconducting Accelerator Development Hall



SC cavity inspection & process, vertical test, cryomodule assembly, cryomodule test

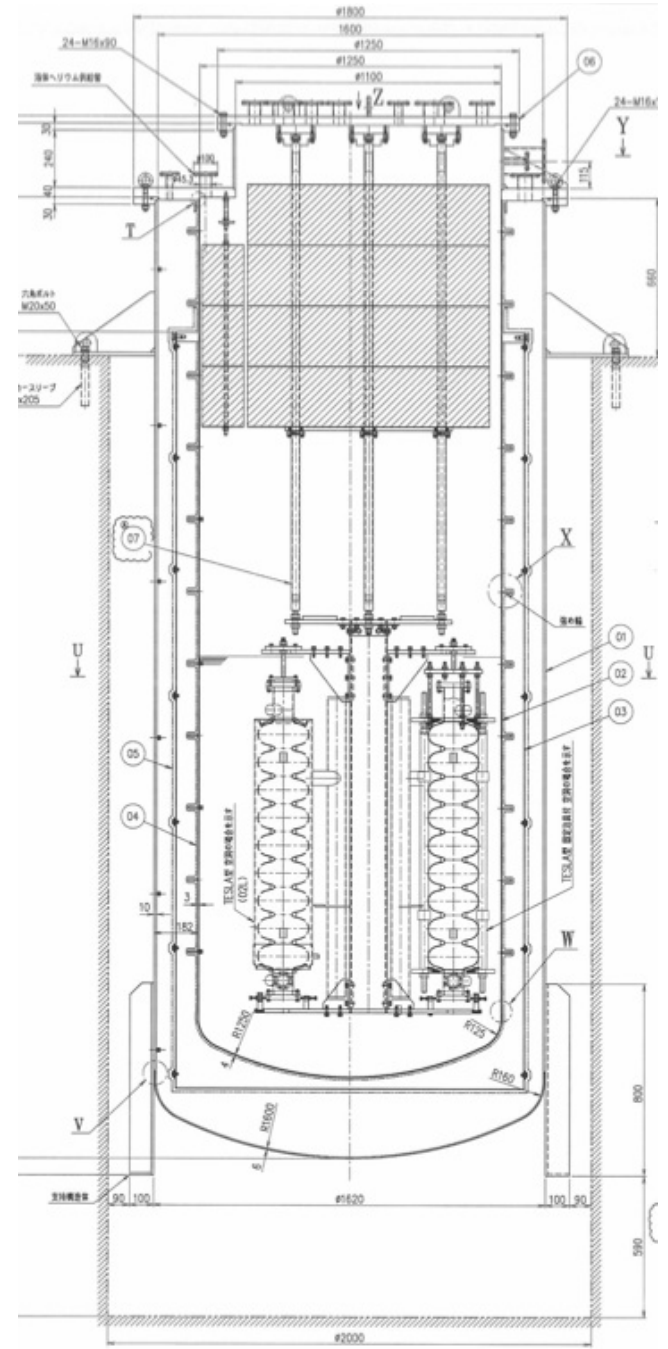
## Vertical Test

## Under Building 4-cavity Vertical Test Stand, following DESY AMTF

# DESY AMTF



## KEK new vertical test cryostat



# Motivation for fabrication of TESLA(Euro-XFEL)-shape cavity

- We had no experience of fabrication of TESLA(Euro-XFEL)-shape cavity.
- We need TESLA(Euro-XFEL)-shape cavities for the commissioning of new facilities of COI building.
- We should have an experience of High-Pressure-Gas code process for TESLA (Euro-XFEL)-shape cavity.

# Fabrication of TESLA(Euro-XFEL)- shape cavities

- We ordered four TESLA(Euro-XFEL)-shape cavities to industrial vendors by the Center-of-Innovation (COI) budget.
- Two TESLA(Euro-XFEL)-shape cavities were fabricated by Mitsubishi Heavy Industries.
- Two TESLA(Euro-XFEL)-shape cavities were fabricated by Toshiba.
- Both vendors successfully delivered the cavities.

# Fabrication of two TESLA(Euro-XFEL)-shape cavities by MHI



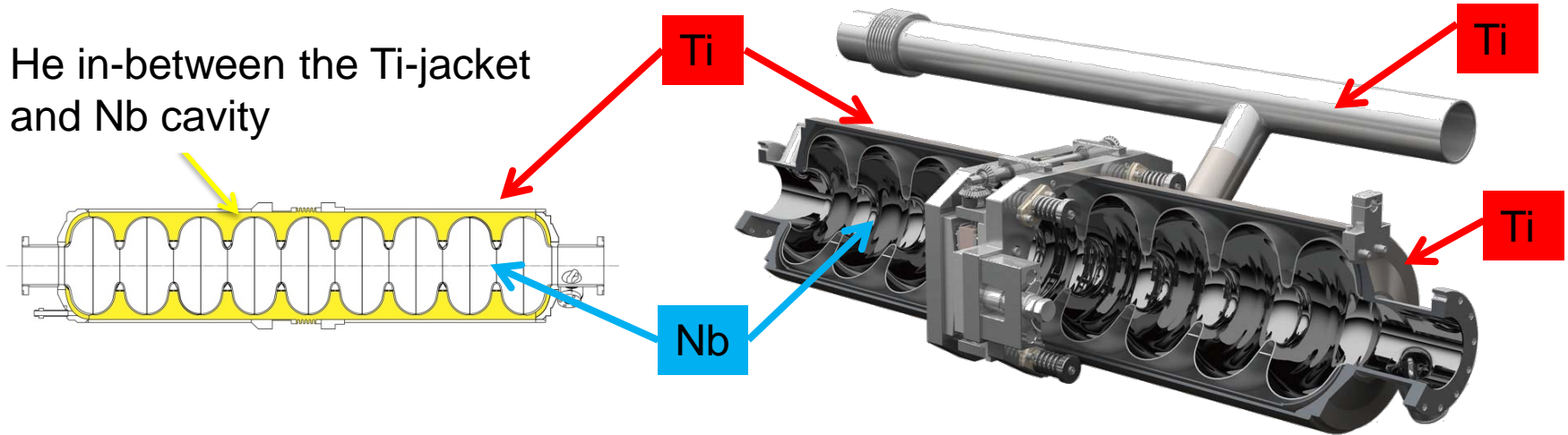
# Fabrication of two TESLA(Euro-XFEL)-shape cavities by Toshiba



# Experiment plans by using TESLA(Euro-XFEL)-shape cavities

- It will take more than one year to complete the assembly of facilities in COI building.
- The four TESLA(Euro-XFEL)-shape cavities can be used for some R&D experiments until the completion of COI facilities.
- One cavity will be sent to Cornell for the collaboration of Vertical EP (VEP) experiments.

# Japanese High-Pressure Gas safety act

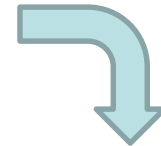


One must fabricate cavities complying with **Japanese High-Pressure Gas (J-HPG) safety act** if we use the cavities in accelerators.

For cavities by vendors,  
Manufacturer: KEK  
Applicant: vendors



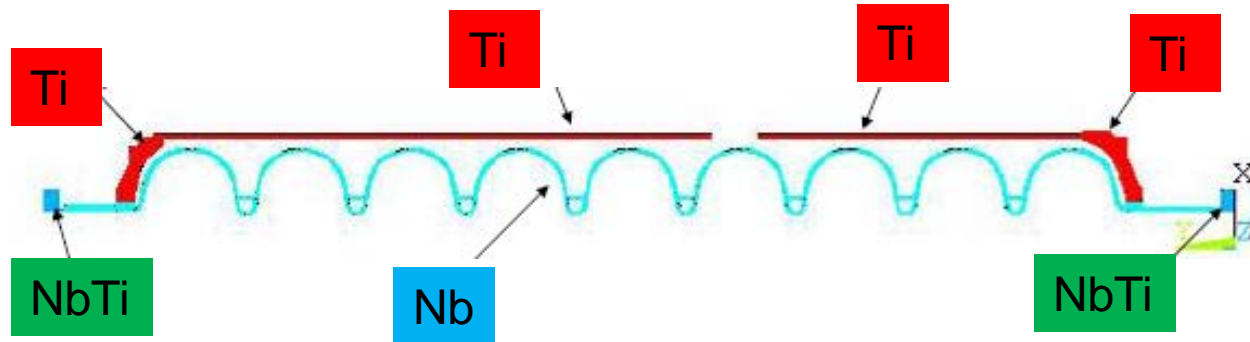
For cavity by KEK/CFF,  
Manufacturer: KEK  
Applicant: **KEK/CFF**



In case of ILC in Japan, a significant fraction of cavities might be imported from foreign vendors. KEK/CFF can guide them for the procedures of J-HPG safety act.

# Japanese High-Pressure Gas safety act

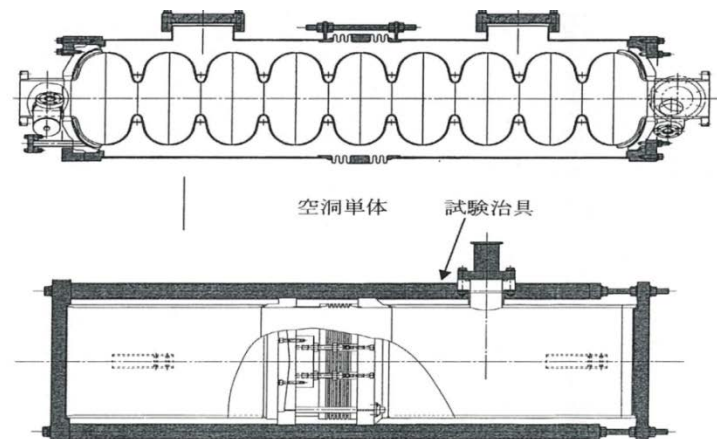
We must fabricate cavities complying with Japanese High-Pressure Gas (PHG) code if we use the cavities in cryomodule.



We must confirm the strength of liquid-He pressure-vessel by analysis with simulation and declare the welding details of Nb cavity and Ti jacket to the authority. In addition, we must perform series of pressure tests and report the results to the authority.

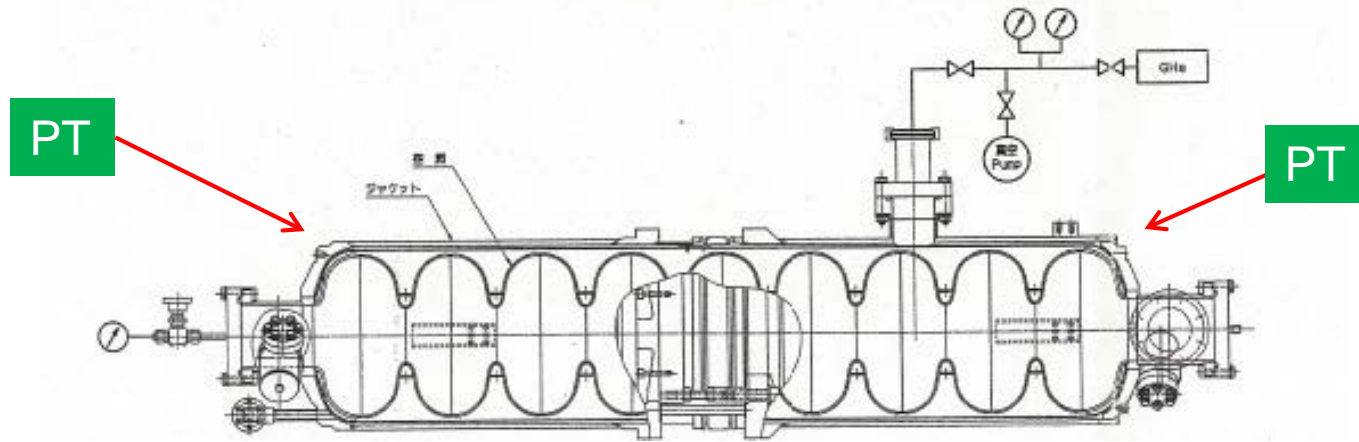
(Step-1) Bare 9-cell cavity (pressure-test with water)

(Step-2) Only He jacket (pressure-test with water)



# Japanese High-Pressure Gas safety act

(Step-3) 9-cell cavity with welded He jacket (Pressure-test with gas and liquid penetrant test (PT) along welding seams between cavity and He jacket)

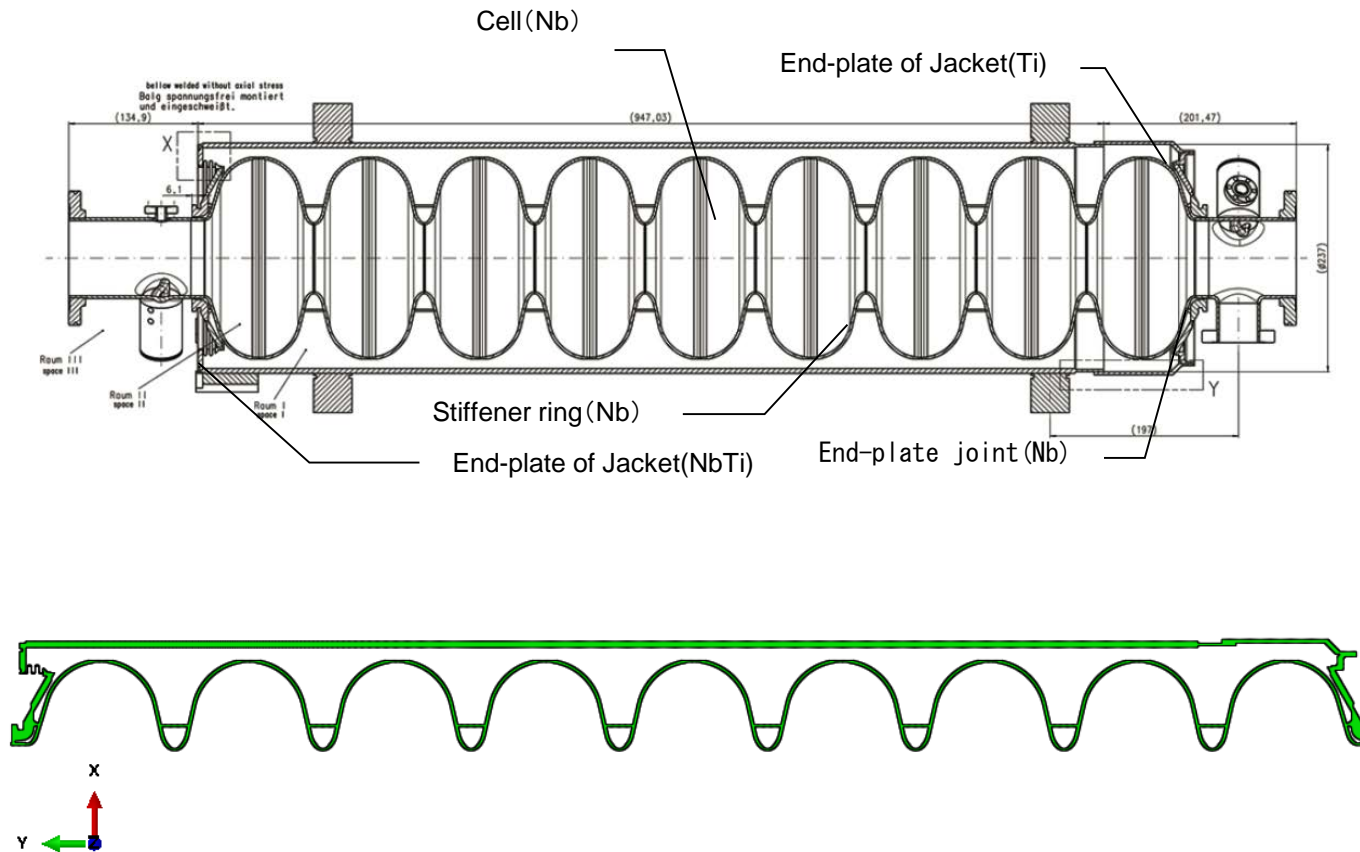


All the HPG-code process of past STF cavities had been done by the cavity vendor. But we (KEK/CFF) are trying to do the HPG process of KEK/CFF cavities by ourselves.



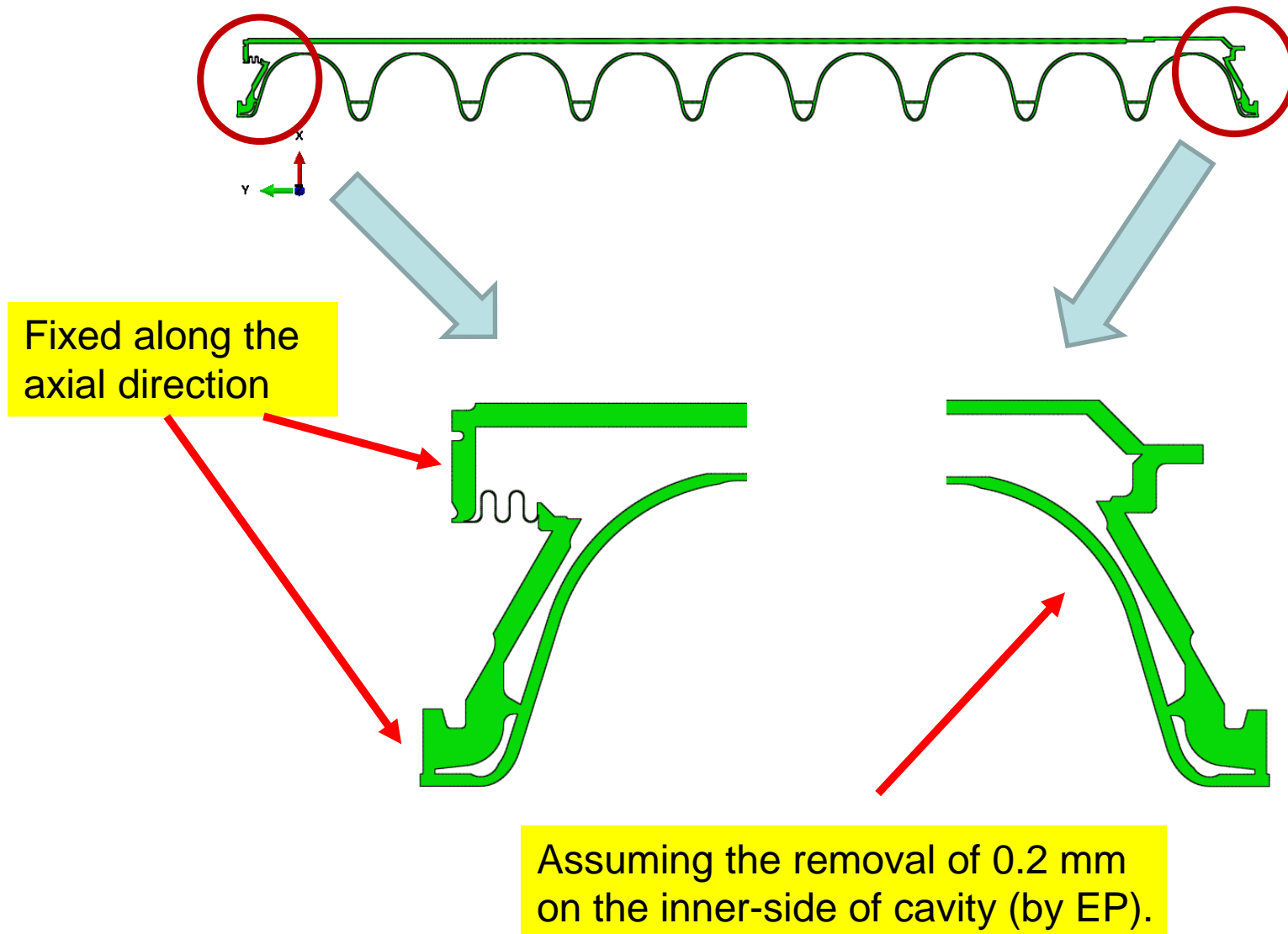
For realization of ILC, we need more cavity-vendors in Japan. In addition, in case of ILC in Japan, 2/3 of cavities might be imported from foreign vendors. If we (KEK/CFF) have the experience of HPG-code process, KEK/CFF can guide new and/or foreign vendors for the Japanese HPG-code process. Also if KEK/CFF controls the HPG-code process, the cavity cost might be reduced.

# Simulation analysis by Toshiba



Simulation analysis with TESLA(Euro-XFEL)-shape cavity

# Simulation analysis by Toshiba

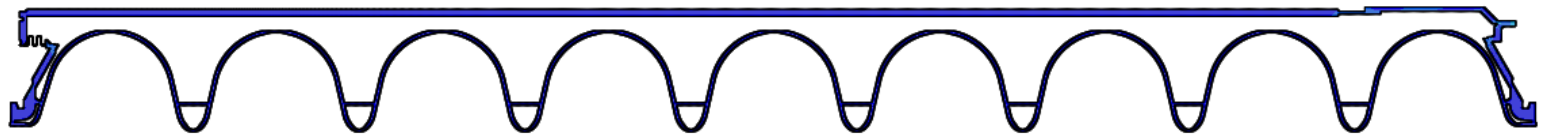
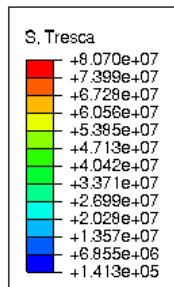


# Simulation analysis by Toshiba

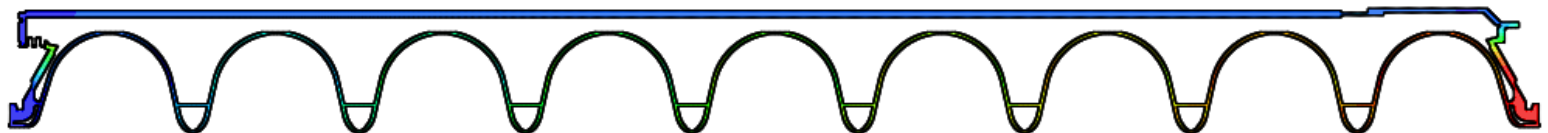
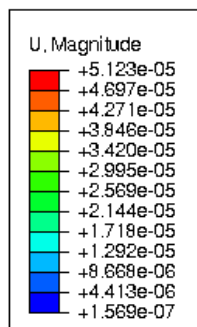
Case-A: T=20 °C, Pressure=0.2 MPa

Preliminary

Unit in MPa



Stress distribution



Displacement x 5

Unit in m

# Simulation analysis by Toshiba

Case-A: T=20 °C, Pressure=0.2 MPa

Preliminary

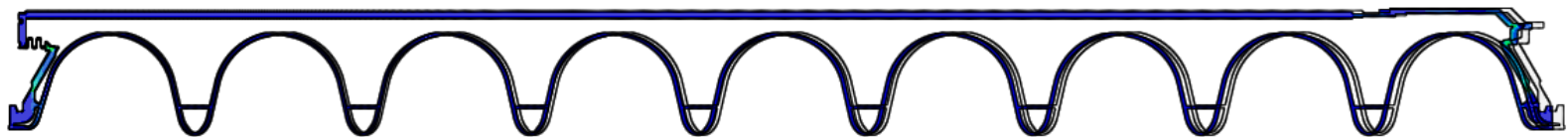
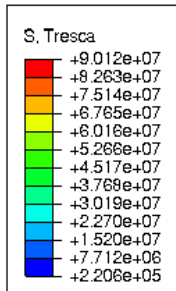
		Peak stress in MPa	Acceptable limit in MPa
Cavity	Cells (including end-cells)	16	39
	Equator	5	39
	Iris	6	39
	Joint to stiffener ring	10	78
Jacket	End-plate of jacket (joint to cavity)	17	39
	Conical disk	13	90
	Joint to bellows	17	127.5
	Joint to bellows (fixed side)	30	127.5
	Jacket cylinder	28	127.5
	Bellows	80	255

# Simulation analysis by Toshiba

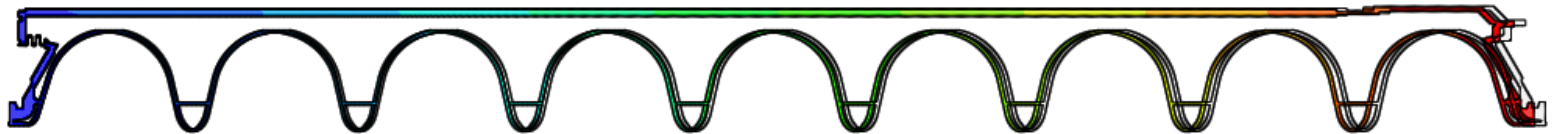
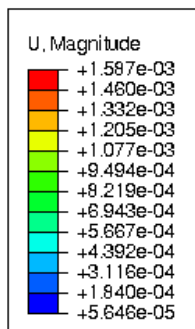
Case-B:  $T = -271^{\circ}\text{C}$ , Pressure = 0.2 MPa

Preliminary

Unit in MPa



Stress distribution



Unit in m

Displacement x 5

# Simulation analysis by Toshiba

Case-B: T=-271 °C, Pressure=0.2 MPa

Preliminary

		Peak stress in MPa	Acceptable limit in MPa
<b>Cavity</b>	Cells (including end-cells)	10	39
	Equator	3	39
	Iris	7	39
	Joint to stiffener ring	9	78
<b>Jacket</b>	End-plate of jacket (joint to cavity)	11	39
	Conical disk	72	90
	Joint to bellows	39	127.5
	Joint to bellows (fixed side)	29	127.5
	Jacket cylinder	75	127.5
	Bellows	41	255

# Summary

- New Center-of-Innovation (COI) building will be completed by the end of Jan 2015.
- TESLA(Euro-XFEL)-shape cavities are needed for the commissioning of New Facilities in COI building.
- Fabrication of four TESLA(Euro-XFEL)-shape cavities were ordered to industrial vendors (MHI and Toshiba) and the four cavities were successfully delivered.
- We will go through the process of Japanese High Pressure Gas (HPG) safety act with TESLA(Euro-XFEL)-shape cavity to guide vendors, in particular, foreign vendors.
- Simulation analysis of stress distribution in TESLA(Euro-XFEL)-shape cavity was done by Toshiba. The preliminary results show the TESLA-shape cavity might comply with the Japanese HPG safety act.