

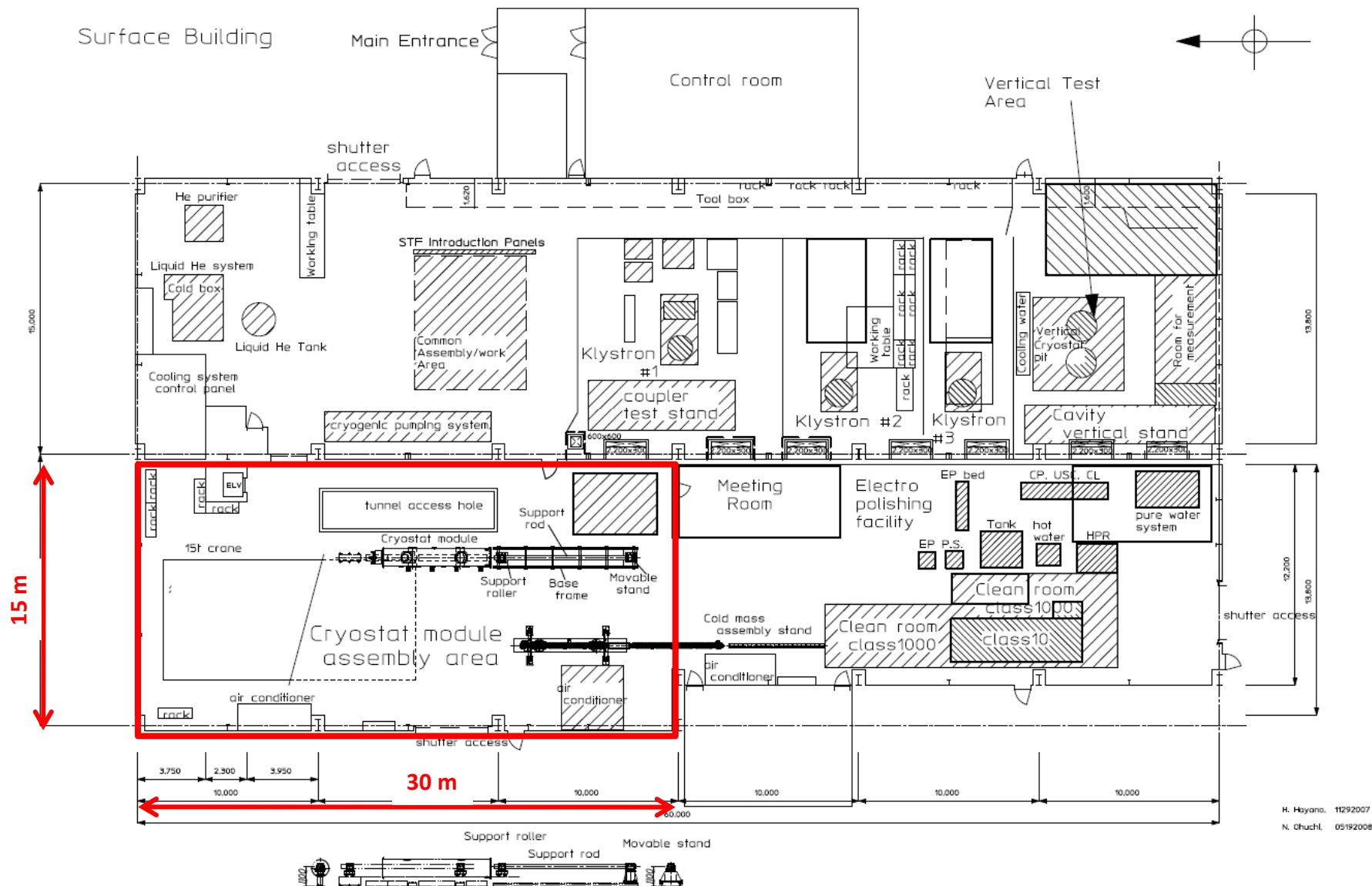
# STF-Cryomodule Assembly Report

Norihito Ohuchi  
(KEK)

# Outline

1. STF (**S**uperconducting RF **T**est **F**acility) and cryomodules
2. STF cryomodule assembly procedure
3. Assembly man-hours for 4 cavity-module
4. Summary and future plan

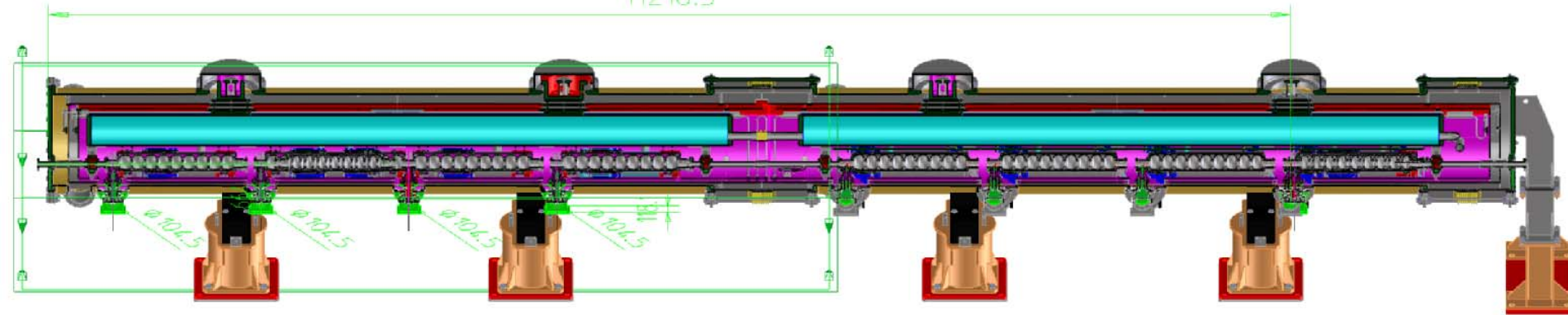
# STF (Superconducting RF Test Facility)



H. Hayano, 11292007  
N. Ohuchi, 05192008

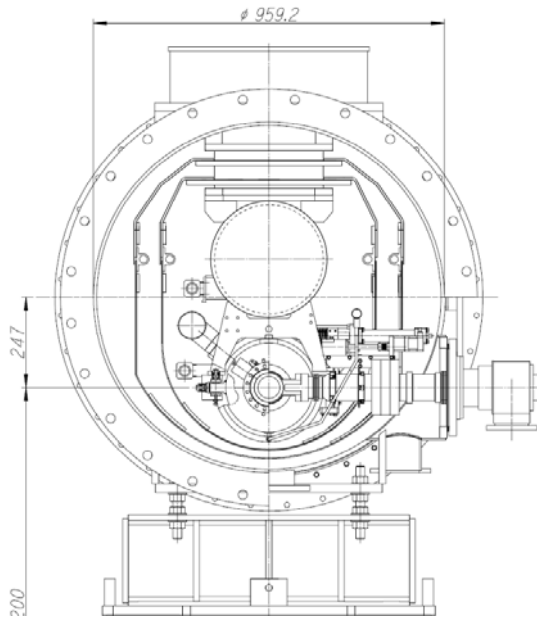
# STF Cryomodules

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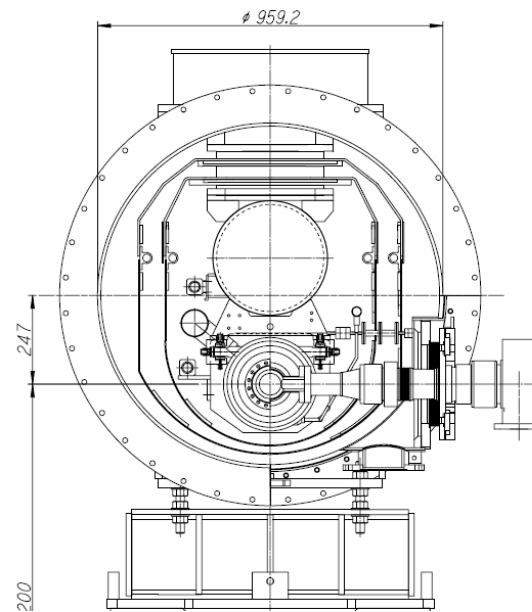


STF cryomodule B (for four LL cavities)

STF cryomodule A (for four Tesla like cavities)



Cross section for LL cavity



Cross section for Tesla-like cavity

## Cryomodule A

- Length = 5515 mm

## Cryomodule B

- Length = 5950 mm

The mechanical and thermal designs are based on the TESLA-III cryomodule.

Two cryomodules were assembled in the ground floor, and they were connected in the tunnel.

# Cryomodule assembly experience in STF

- 2006 Oct. 30 - 2007 Feb. 09
  - Cryomodules A and B, which had one cavity, had been constructed and assembled in the tunnel.
- 2007 Aug. 27 - Sep. 14
  - Due to helium leak problem, the cryomodule B was disconnected and the cryomodule A was modified for cool-down.
    - Cold test of the cryomodule A was performed from Oct. 3 to Dec. 6 including cool-down and warm-up.
- 2007 Dec. 17 - 2008 March 14
  - The cryomodule B was reassembled and installed into the tunnel.
    - Cold test of the cryomodule B was performed from Feb. 13 to April 4.
  - Four Tesla-like cavities were assembled in a string, and assembly of the cryomodule A was completed.
- 2008 April 16 - May 16
  - The cryomodule A was installed into the STF tunnel and the cool-down started from May 20.

# Cryomodule Assembly

Clean Room



Cryomodule  
Assembly Area



Tunnel

1. In C-1000
  - Preparation of input coupler.
  - Alignment cavity-vessel.
2. In C-10
  - Assembly of input couplers to cavity beam pipe.
  - Connection of cavities to make a string.
  - Assembling gate valves
3. In C-1000
  - Leak test of cavity string
  - Enclosing Ar gas in the cavity string.

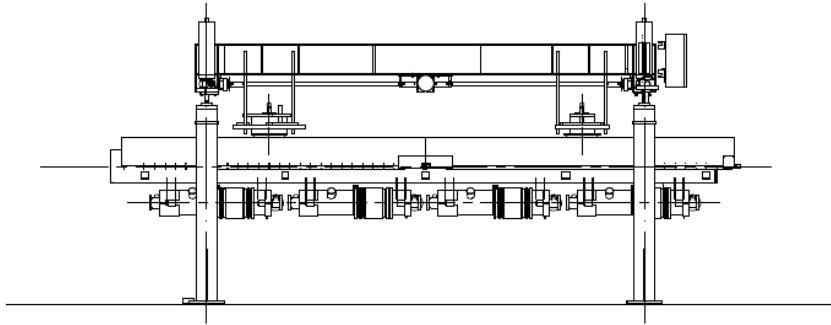
- AA1. Assembling tuner system to cavity vessels
- AA2. Fiducialization of the cavity vessel to the standard point on the cold mass.
- AA3. Holding the cavity-string under the GRP
  - Measurement of the positions of cavities.
- AA4. Setting and welding the cooling pipes
  - Pressure and leak tests of these pipes
  - Setting the sensors and signal wires
  - Checking sensors
- AA5. Wrapping SI on the helium supply pipe and cooling pipes
- AA6. Assembling 5K thermal anchors to cold couplers
  - Setting the sensors and signal wires
  - Checking sensors
- AA7. Assembling 5K shields and wrapping SI on the shields
- AA8. Assembling 80K thermal anchors to cold couplers
  - Setting the sensors and signal wires
  - Checking sensors
- AA9. Assembling 80K shields and wrapping SI on the shields
- AA10. Inserting the cold mass into the vacuum vessel
  - Inserting process and alignment of cold mass
  - Setting caps on the vessel
- AA11. Pressure and leak tests of the cooling pipes under the final pressure conditions

- T1. Setting the cryomodule in the tunnel
- T2. (Alignment of the cryomodule w.r.t. the beam line)
  - Assembling the beam pipes
  - Leak test of beam pipe
- T3. Welding cooling pipes and tests
  - Pressure and leak tests of cooling pipes
  - Checking sensors
- T4. Setting thermal shields and SI in the connection area
- T5. Assembling warm couplers and the wave guide system
  - Leak test of input couplers
- T6. Closing vacuum vessel with end flange and vacuum bellows
- T7. Leak test of the cryomodule in the final pressure condition

# Cold mass assembly (3)

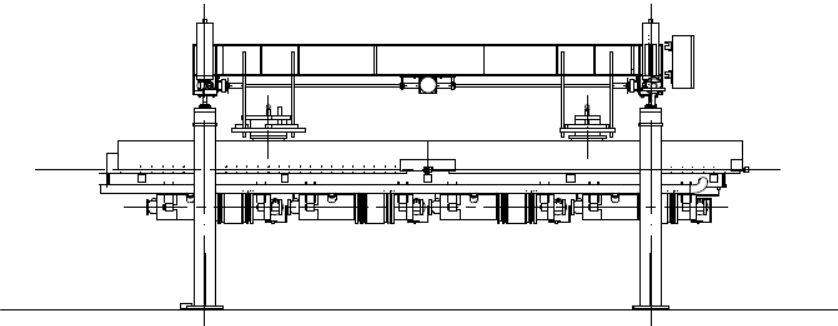
## Assembling scheme of the cold mass

1



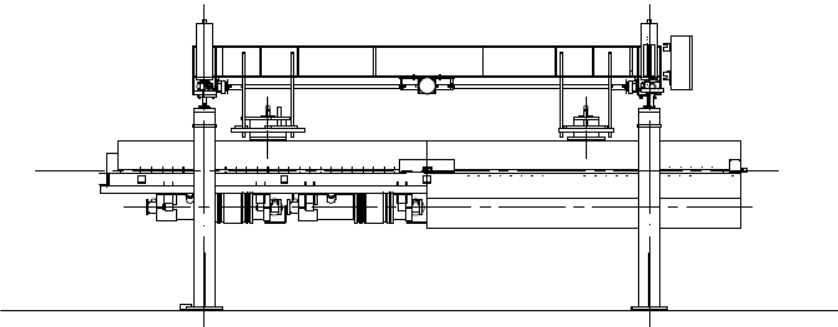
1. Holding the cavity-string under the GRC
  - Measurement of the positions of cavities with a laser tracker with respect to the target on the support posts.

2

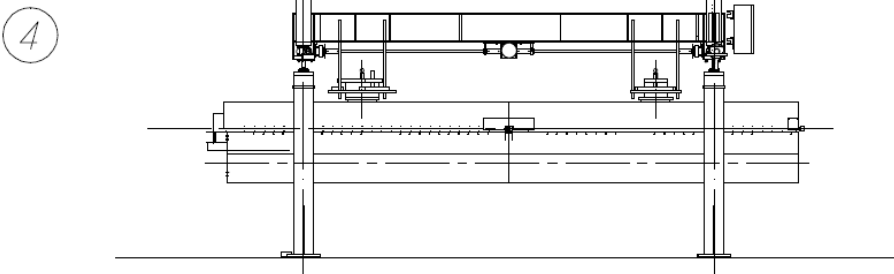


1. Setting and welding the cooling pipes
  - Pressure and leak tests of these pipes
  - Setting the sensors and signal wires
  - Checking sensors
2. Wrapping SI on the helium supply pipe and cooling pipes
3. Assembling 5K thermal anchors to cold couplers
  - Setting the sensors and signal wires
  - Checking sensors

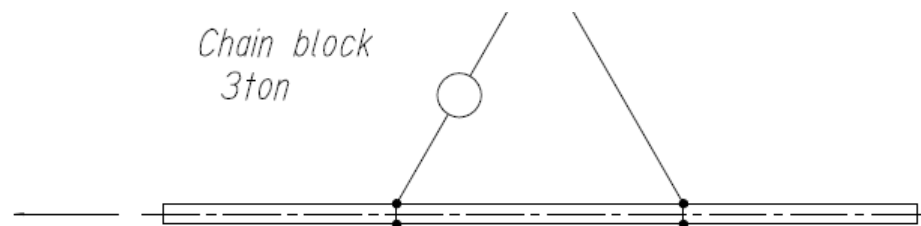
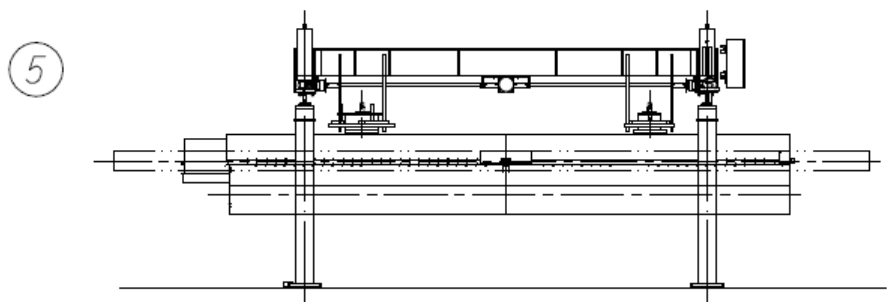
3



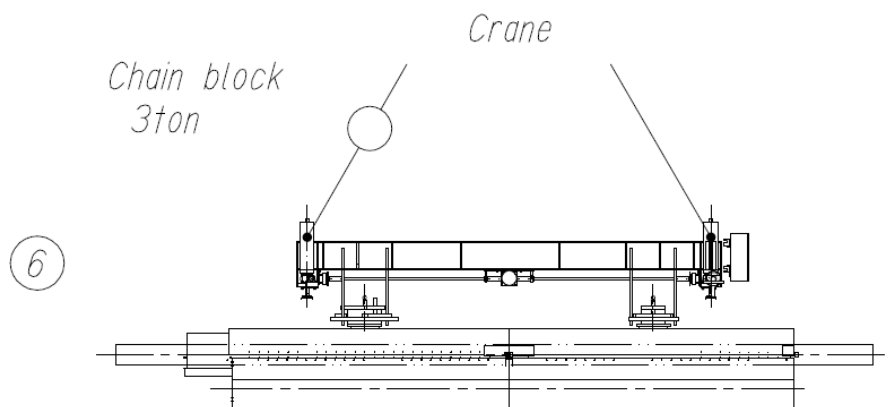
1. Assembling 5K shields and wrapping SI on the shields
2. Assembling 80K thermal anchors to cold couplers
  - Setting the sensors and signal wires
  - Checking sensors



1. Assembling 80K shields and wrapping SI on the shields

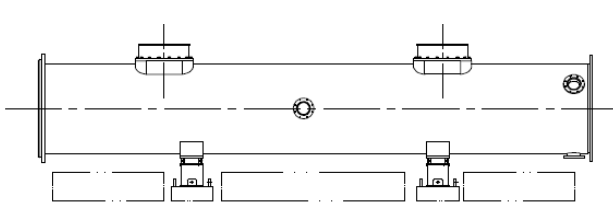
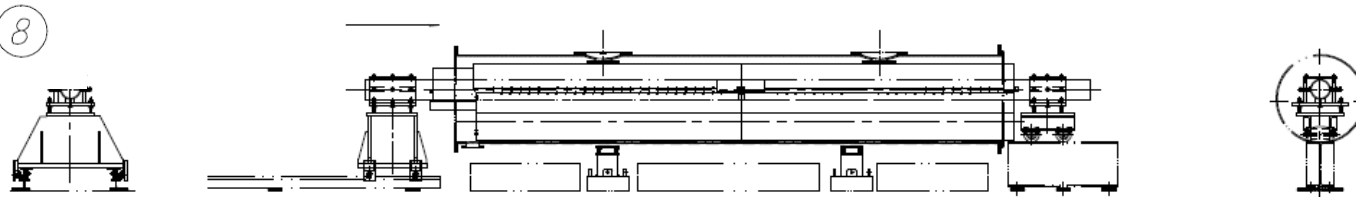
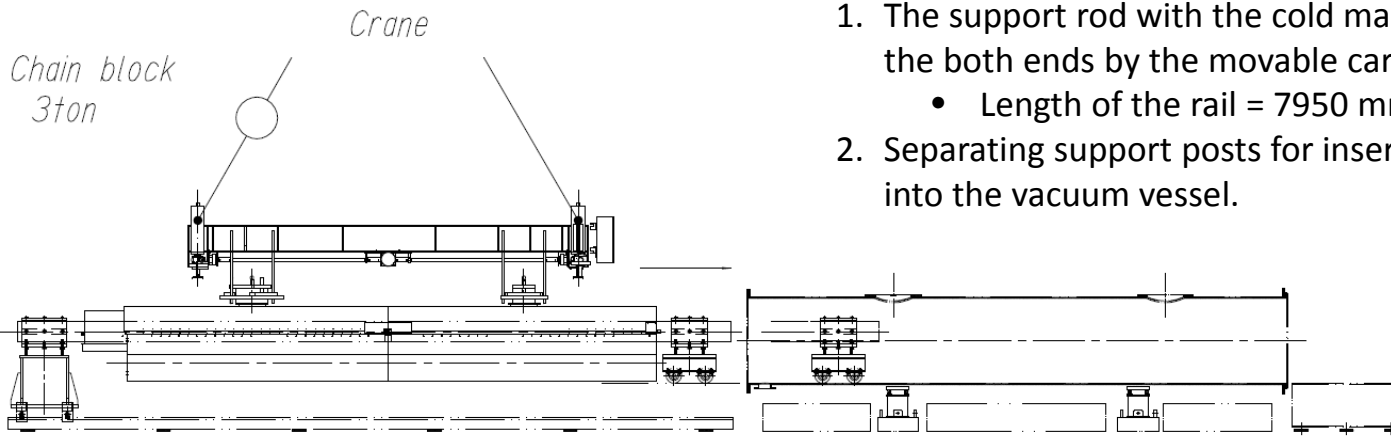


1. Inserting the support rod into the gas return pipe
  - Outer diameter of the rod = 216.3 mm
  - Length = 7910 mm



1. Hanging the cold mass with the upper-side of the assembly trestle
2. Moving the cold mass from the cold mass assembly area to the insertion area of cold mass into the vacuum vessel.





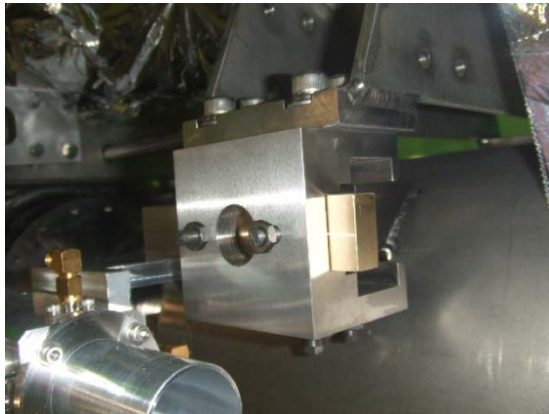
# Cold mass assembly (4)



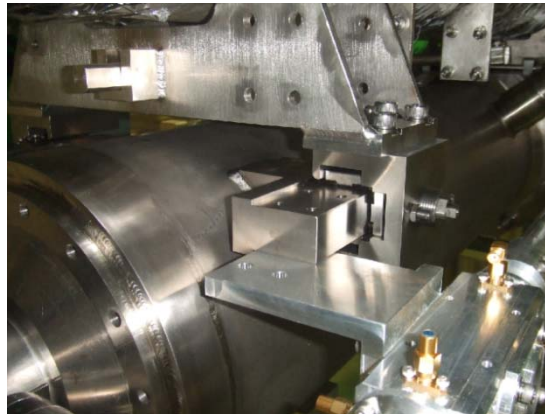
Moving the cavity-string under the GRP



Supporting the cavity-string from the GRP



Setting the C-clamp and roll bearings



Setting the spring loads with the length of the screw



# Cold mass assembly (5)

## Welding cooling pipes

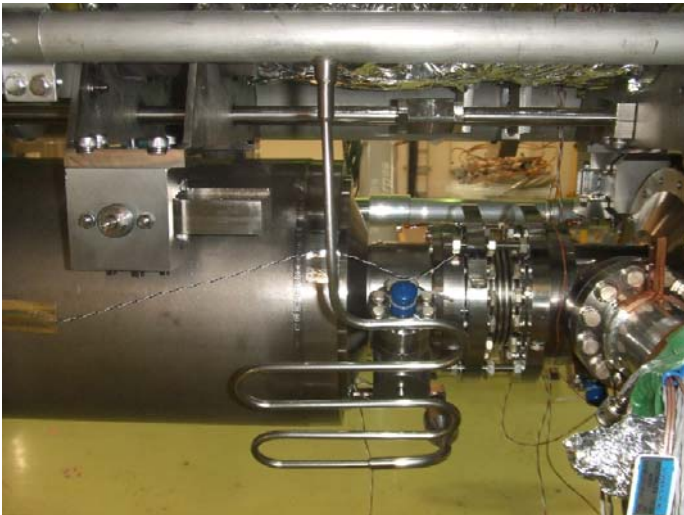


Welding the helium supply pipe by the company welder.



Ti-SUS junction.

Cavity jacket : Ti  
helium supply pipe : SUS



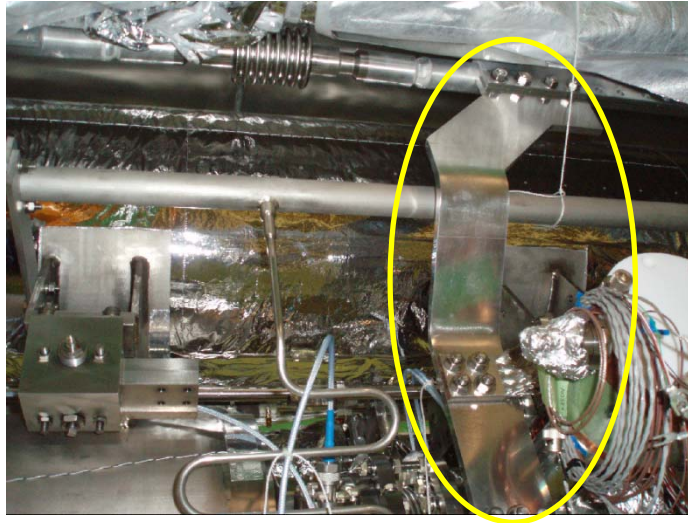
Cool-down and warm-up helium pipe.



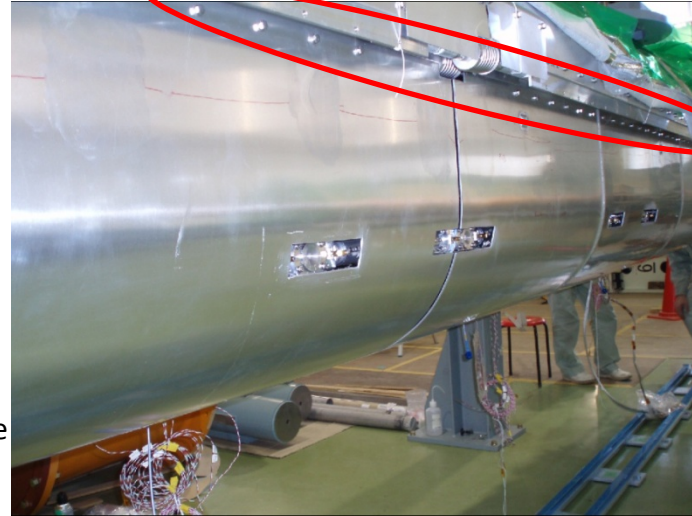
Leak test of cooling pipes. Masking the test parts.

# Cold mass assembly (5)

## Thermal interceptors and thermal shields



5K thermal interceptor of cold coupler is directly connected to the cooling pipe.



Thermal shields are assembled with bolts. (No welding)



Setting the temperature sensors and signal wires. Checking the sensors. Wrapping SI over the thermal shields.

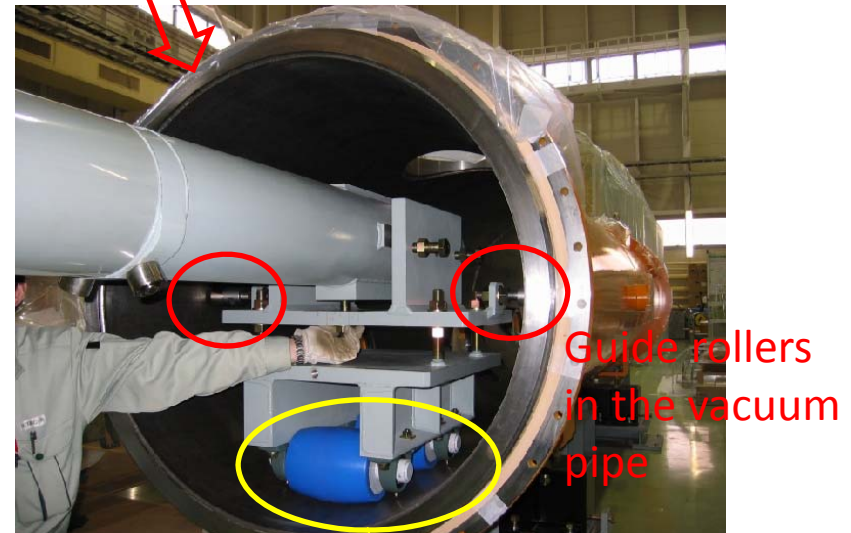
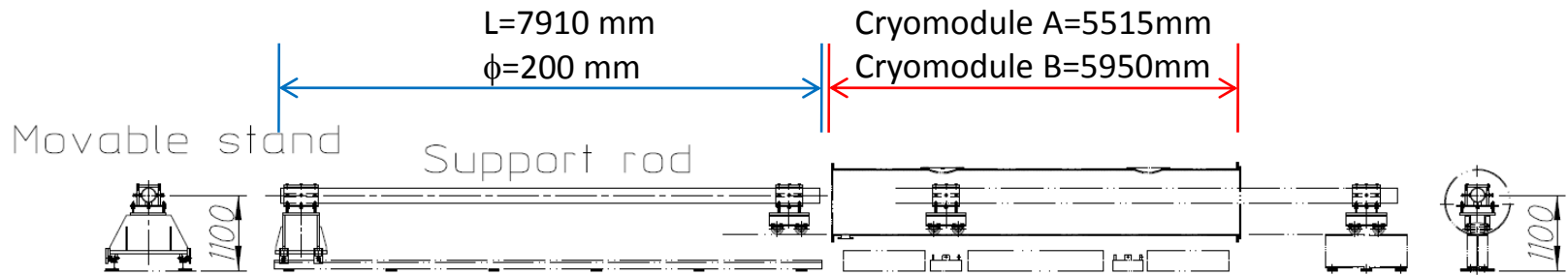


Completing SI over the thermal shields.



# Cold mass assembly (6)

## Insertion tool of cold mass into vacuum vessel



Plastic roller

# Cold mass assembly (7)



Support rod



Inserting the support rod into the GRP.



Hanging the cold mass with the upper-side of the assembly trestle.



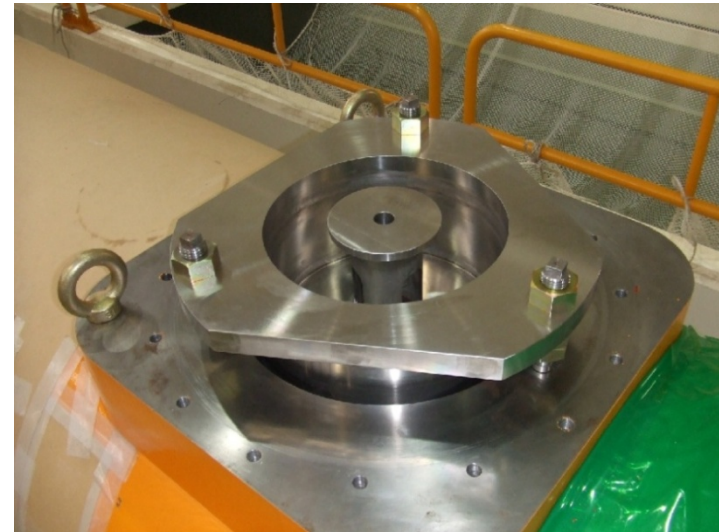
Moving the cold mass to the insertion area.



## Cold mass assembly (8)



Completing the insertion process of cold mass into the vacuum vessel.



Setting the support component on the support post.  
Hanging the cold mass from the vacuum vessel.



For the leak test, the vacuum vessel was closed with special end caps.



Final leak test in the assembly area. The vessel was in a vacuum condition, and the cooling pipes were pressurized with helium gas.

# Assembly work in the tunnel (1)



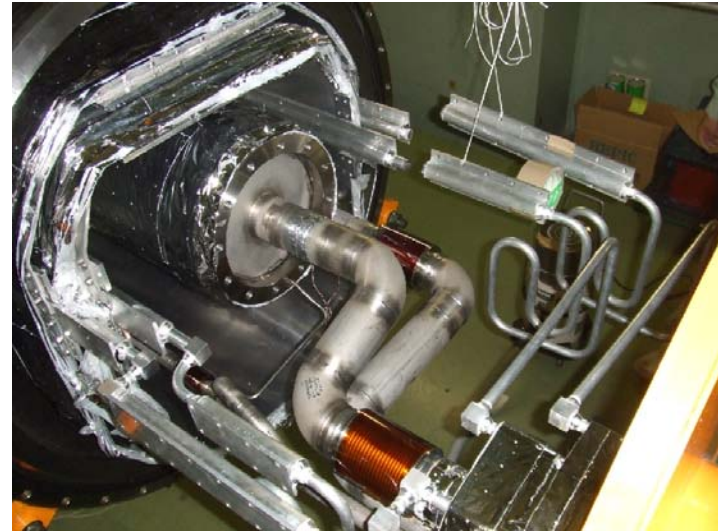
Transporting the cryomodule into the tunnel.



Placing the cryomodule on the stand in the tunnel.



Assembling the beam pipe in the local clean room.  
Leak test was done after the assembly.



Welding cooling pipes in the tunnel.  
After welding work, pressure and leak tests were done.



## Assembly work in the tunnel (2)



Leak test of cooling pipes between the cryomodule and the cryogenic system.



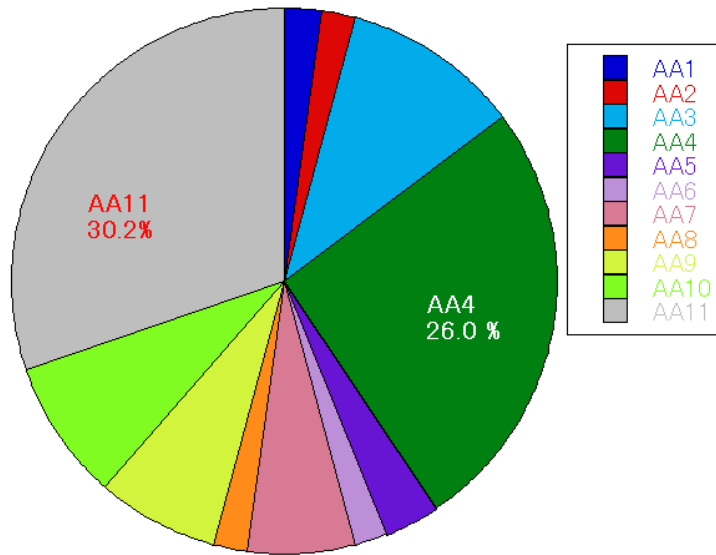
Thermal shields in the end of the cryomodule.



SI on the thermal shields in the end of the cryomodule.

# Man-hours for assembly steps of four cavity module

Ratio of man-hours during works at assembly area



Total man-hours for **assembling four cavities** in the module : 768 hours

AA4. Setting and welding the cooling pipes

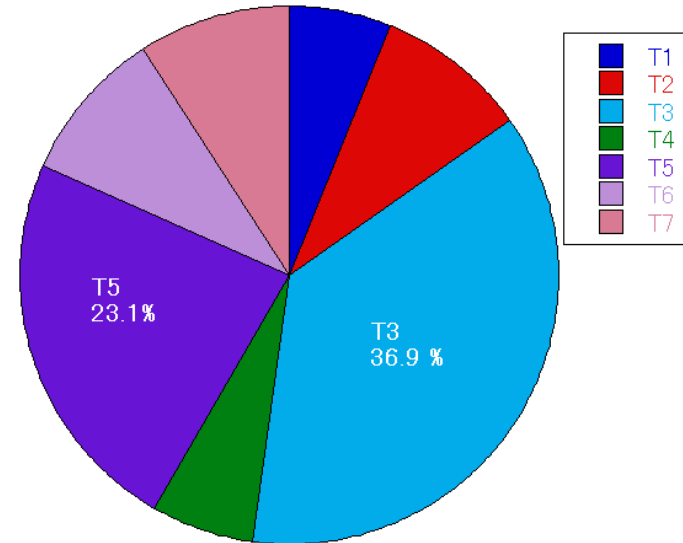
- Pressure and leak tests of these pipes
- Setting the sensors and signal wires
- Checking sensors

AA11. Pressure and leak tests of the cooling pipes under the final pressure conditions

**Total man-hour of module assembly strongly depends on the welding process, the pressure and leak tests.**

**Requirements for cost down: auto-welding machine, pipe-cutter and large vacuum pump for leak test**

Ratio man-hours cryomodule assembly in STF tunnel



Total man-hours for installation Cryomodule in STF tunnel : 520 hours

T3. Welding cooling pipes and tests

- Pressure and leak tests of cooling pipes
- Checking sensors

T5. Assembling warm couplers and the wave guide system (works in the local clean room)

- Leak test of input couplers

# Summary and Future Plan

1. KEK constructed two 6 m STF-cryomodules as the main subject of STF-1.
  - Feb. 2007, these two modules, which contained one cavity, were assembled and connected in the tunnel.
  - Due to He leak troubles , two 6 m modules were disassembled and re-assembled separately. Cold tests of two cryomodules were done individually.
2. Four Tesla-like cavities had been assembled in the Cryomodule A. The cold-test is being continued from 20 May to the end of 2008.
3. From these assembly experiences, welding processes and leak tests appeared to be major parts of the assembly time.
  - Requirement of auto-welding machine, pipe-cutter and well-designed vacuum pump system.
4. Under the international collaboration, S1-Global is planed at the KEK-STF to make a cryomodule combination of which average gradient should be over 31.5 MV/m. (will be presented at WG3)
  - Assembly process and tools for the different type cavities will be compared and studied.
5. The assembly procedure and tools of STF-2 module will contain the experiences at STF1 and S1-Global.