

# S1-G cryomodule (20090930)

Norihito Ohuchi

# S1-Global

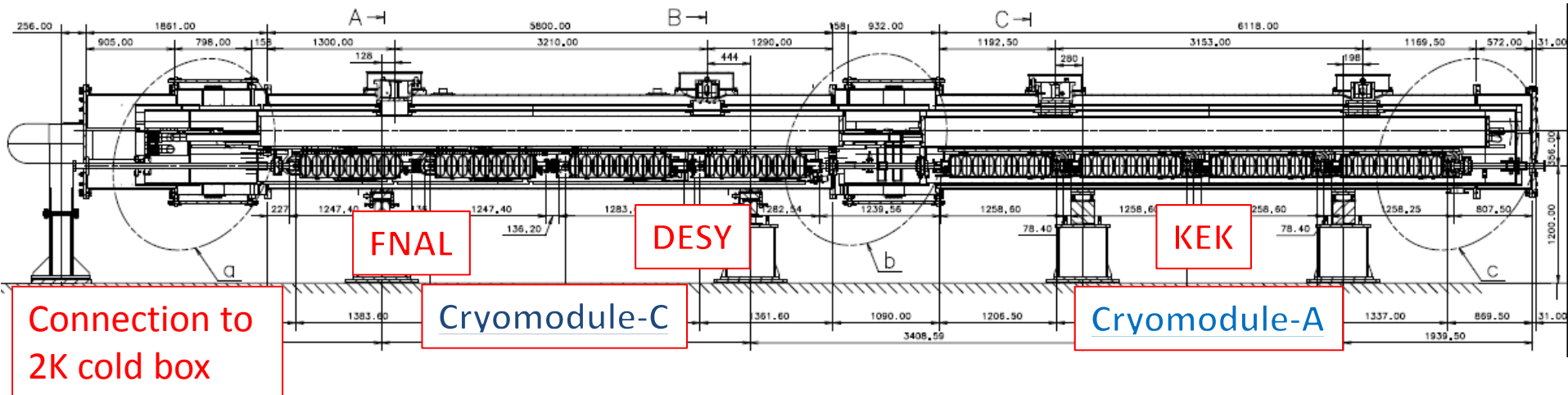
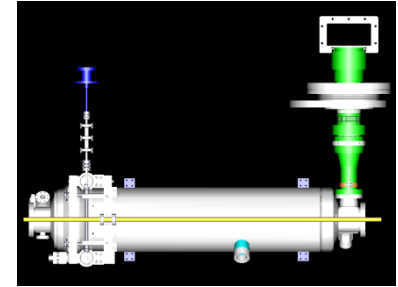
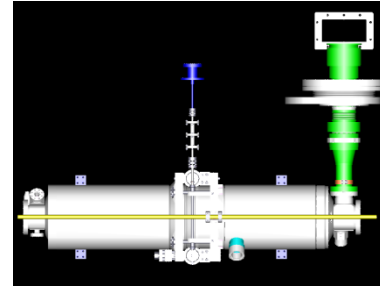
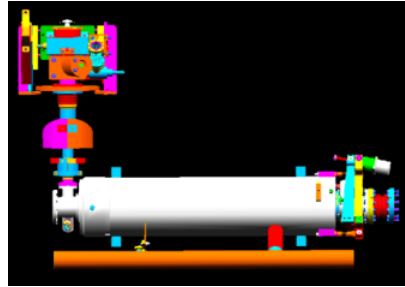
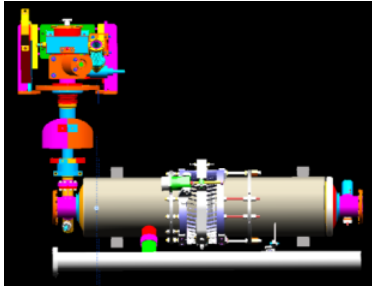
## The main target of the S1-Global :

Operating a cryomodule with an average accelerating gradient of 31.5 MV/m with 8 cavities under the international research collaboration.

## Included research subjects:

1. Experience the design, assembly and the alignment procedures for cavity packages from participating parties.
2. Measure the heat loads for the cavity packages and the cryomodule for the static and the 31.5 MV/m dynamic conditions.
3. Conduct the comparative studies of performance of cavities from the participating institutes.
4. Attempt to attain an average accelerating gradient of 31.5 MV/m in a pulsed RF operation at 5Hz with 1ms flat-top length, 0.07% rms amplitude variation and 0.35 degree rms phase variation.
5. Advance implementation of the 'plug-compatibility concept'

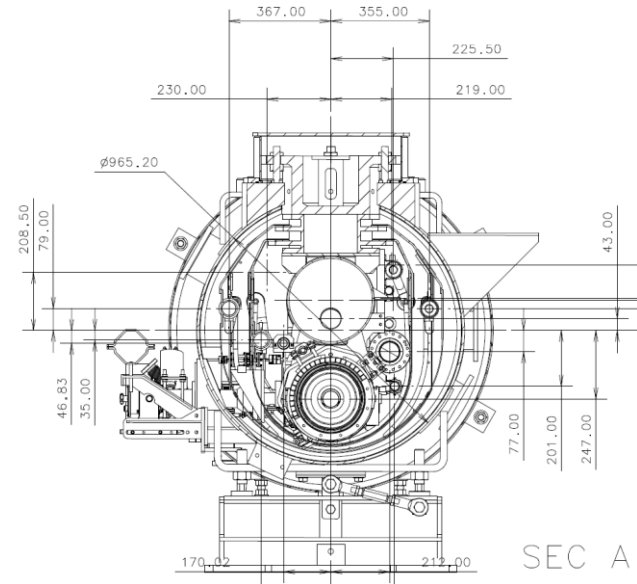
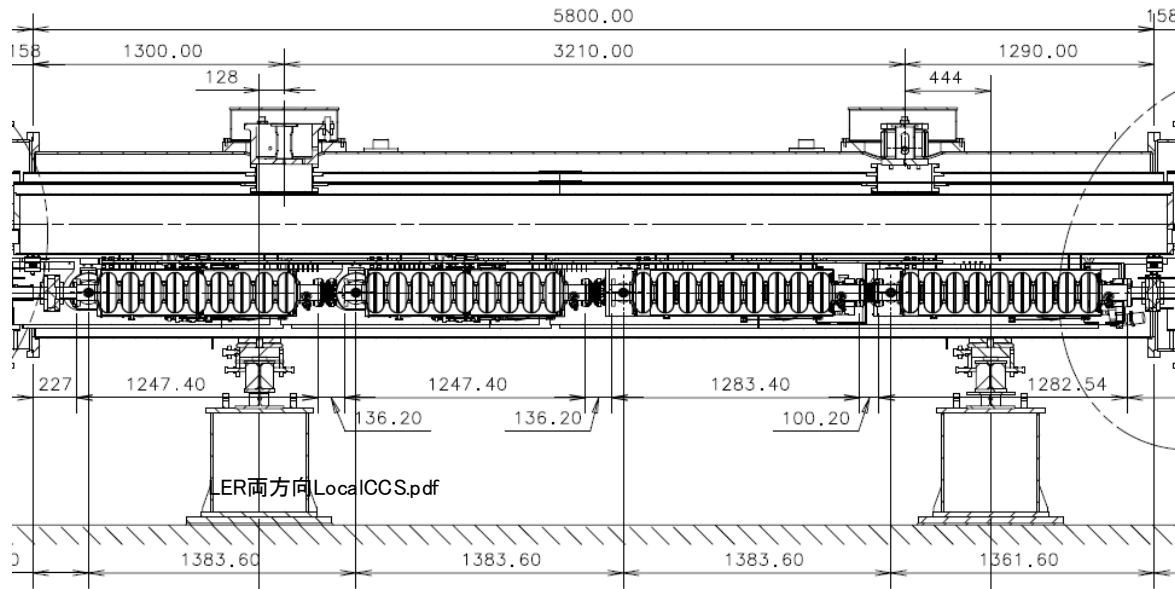
# S1-Global cryomodule overview



- S1-Global collaborative profile
  - INFN: Design and construction of the 6m Module-C for DESY and FNAL cavities
  - DESY: Two TESLA type cavities with Saclay tuner
  - FNAL: Two TESLA type cavities with blade tuner
  - SLAC: Power distribution system for Module-C and input coupler conditioning
  - KEK: 6m Module-A for KEK cavities, four TESLA-like cavities and infrastructure for completing the module tests

# Design of Module-C

## Module-C

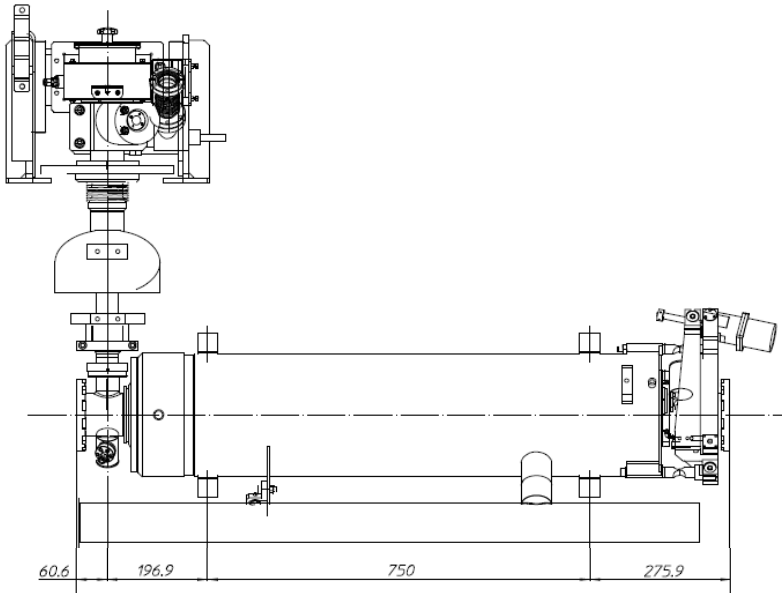


Cross section of Module-C

### Design features of Module-C:

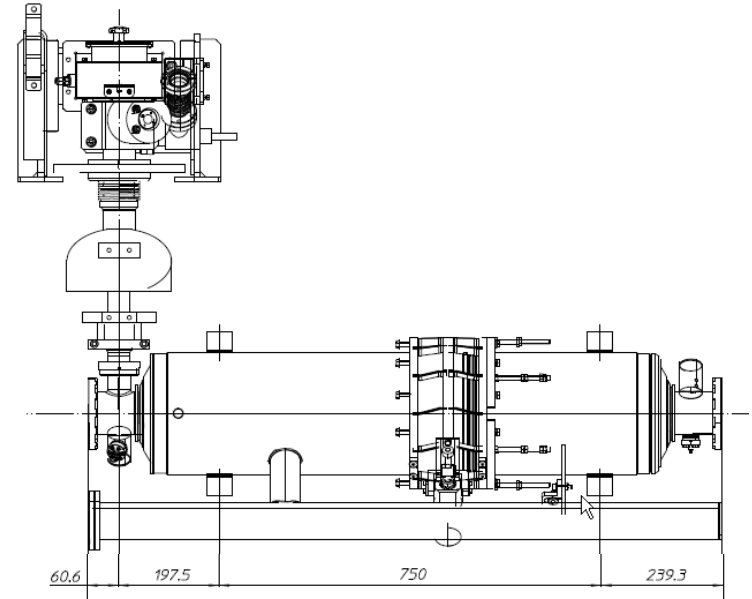
- Design is based on the TTF Type-III cryomodule, and the vacuum vessel length is 5800 mm.
- The cold mass is designed to be supported with two support posts from the vacuum vessel.
- The distance between input couplers on the vessel is 1383.6 mm, and the distance between cavities on the string at warm is 1384.14 mm. They are same as TTF III.
- Design difference of cavity packages are included;
  - DESY cavity: Saclay tuner, outer magnetic shield and package length=1283.4mm
  - FNAL cavity: Blade tuner, outer magnetic shield and package length=1247.6mm

# FNAL/DESY cavities



- Two DESY cavities will be transported to KEK in December.
- The horizontal tests of two cavities will have been completed in DESY.
- The cold couplers will be assembled before transportation.

The preparation of DESY cavities will be presented by Denis Kostin.

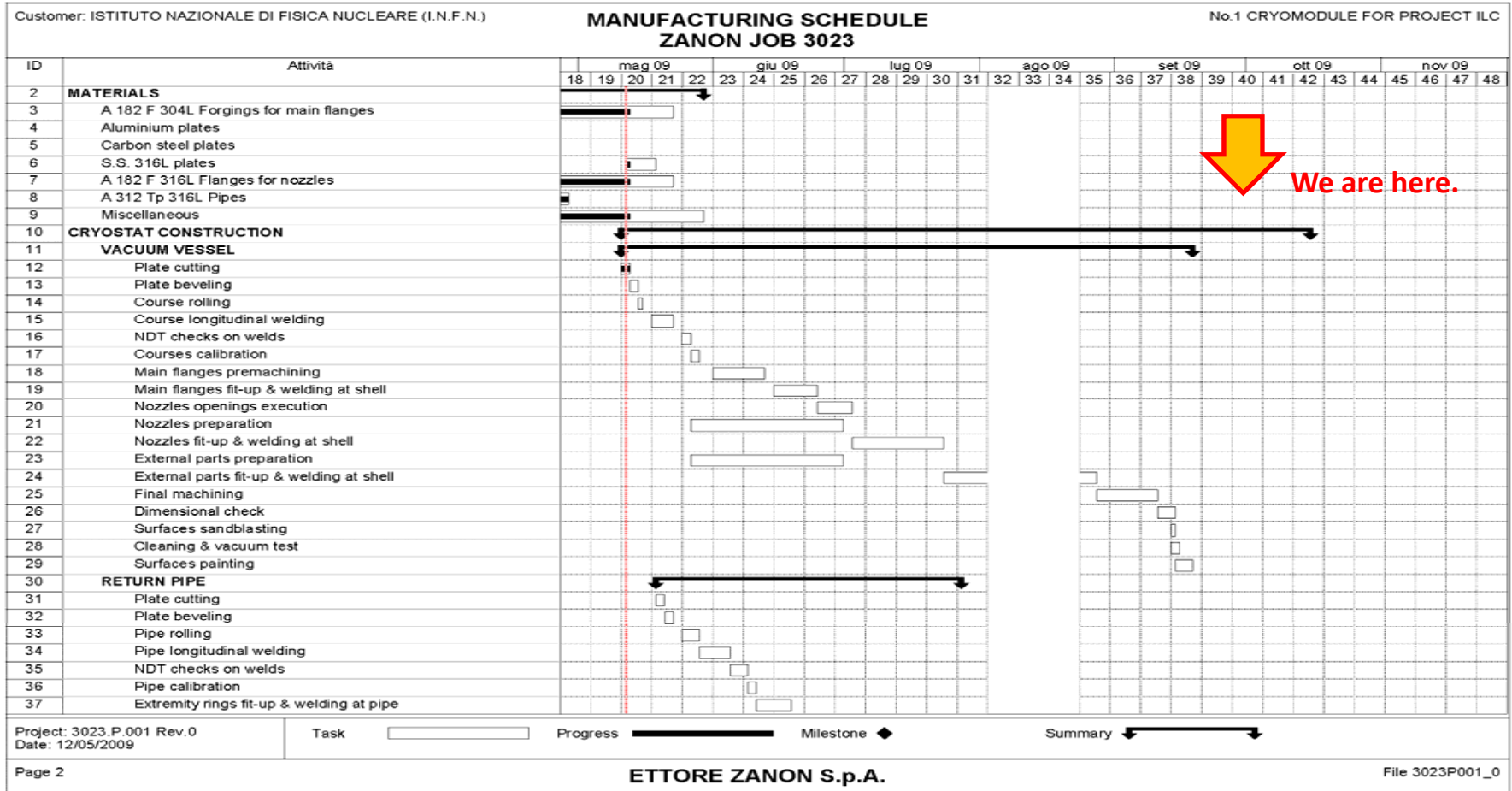


- Two FNAL cavities will be transported to KEK in the end of December.
- Two cavities will be tested in the vertical cryostat, and the LHe supply pipe will be welded to the jacket before transportation to KEK.
- The cold couplers will be assembled before transportation.

The preparation of FNAL cavities will be presented by Jim Kerby.

# Cryomodule components of Module-C

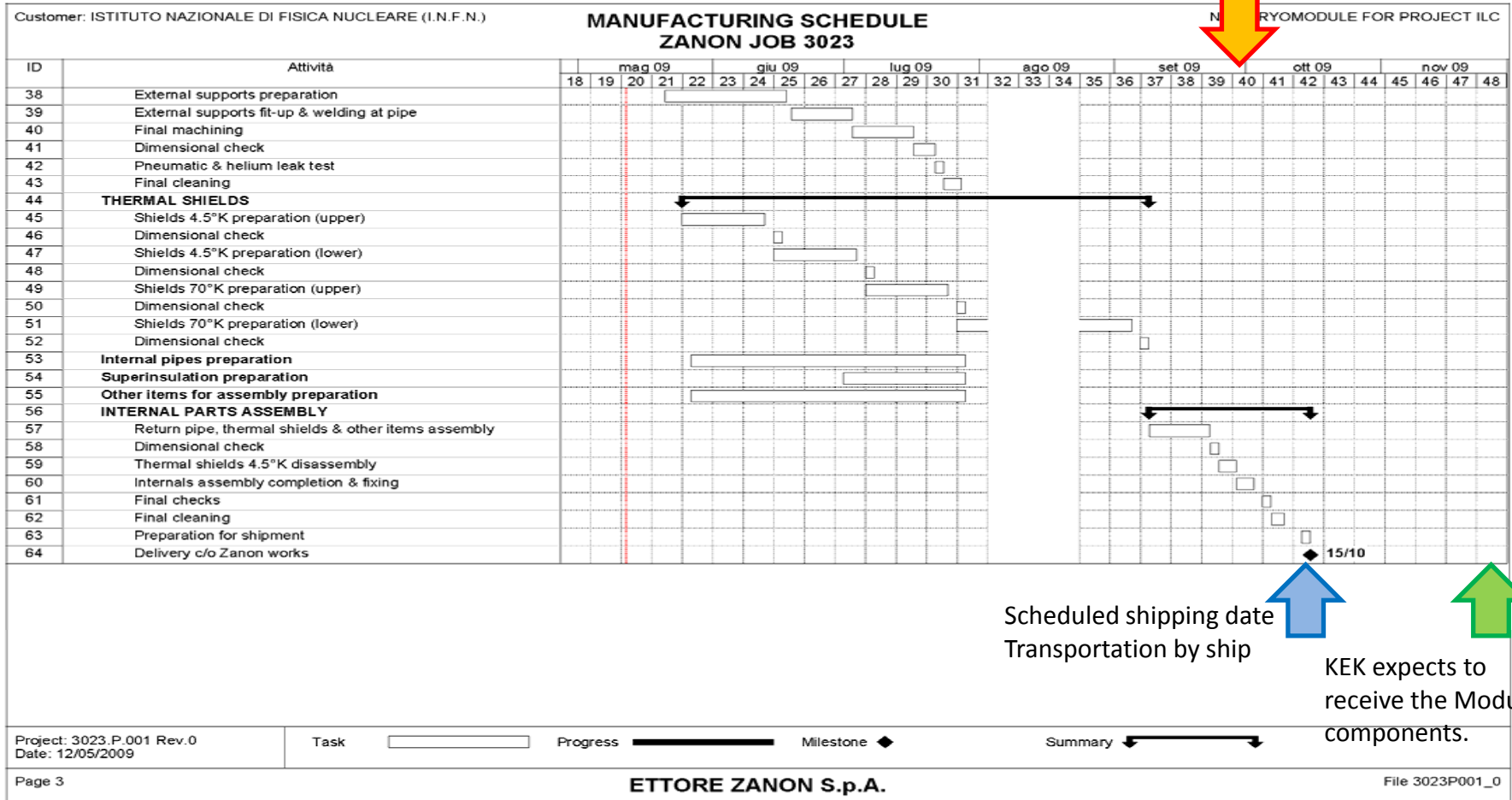
Construction schedule of Module-C components by INFN/Zanon



# Cryomodule components of Module-C

Construction schedule of Module-C components by INFN/Zanon

We are here.





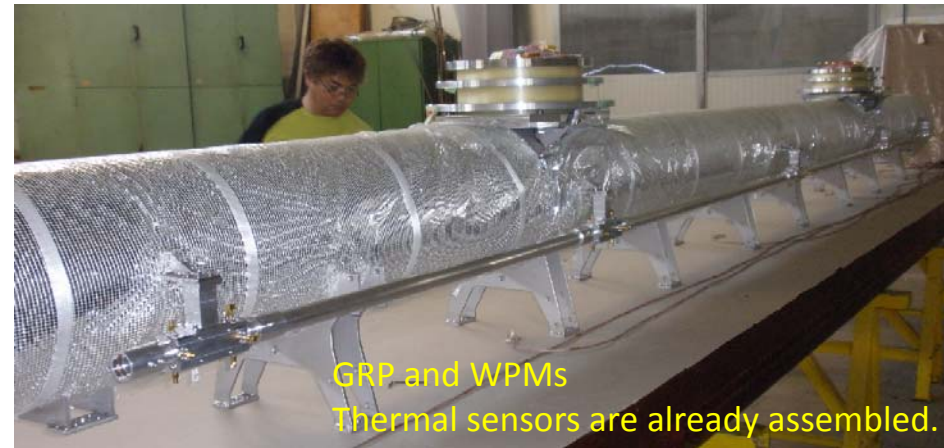
# Construction situation in Zanon at 16 Sept. 2009



Machining the vacuum vessel was almost completed.

Rust will be removed from the vessel surface, and after painting and treating the vacuum flange surface, the vessel will be packed.

The cold mass was assembled in the final shape, and after disassembling the thermal shields in the lower part, the set of components will be packed.

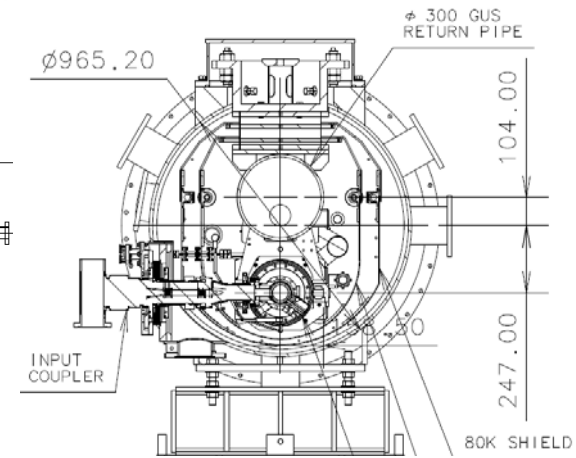
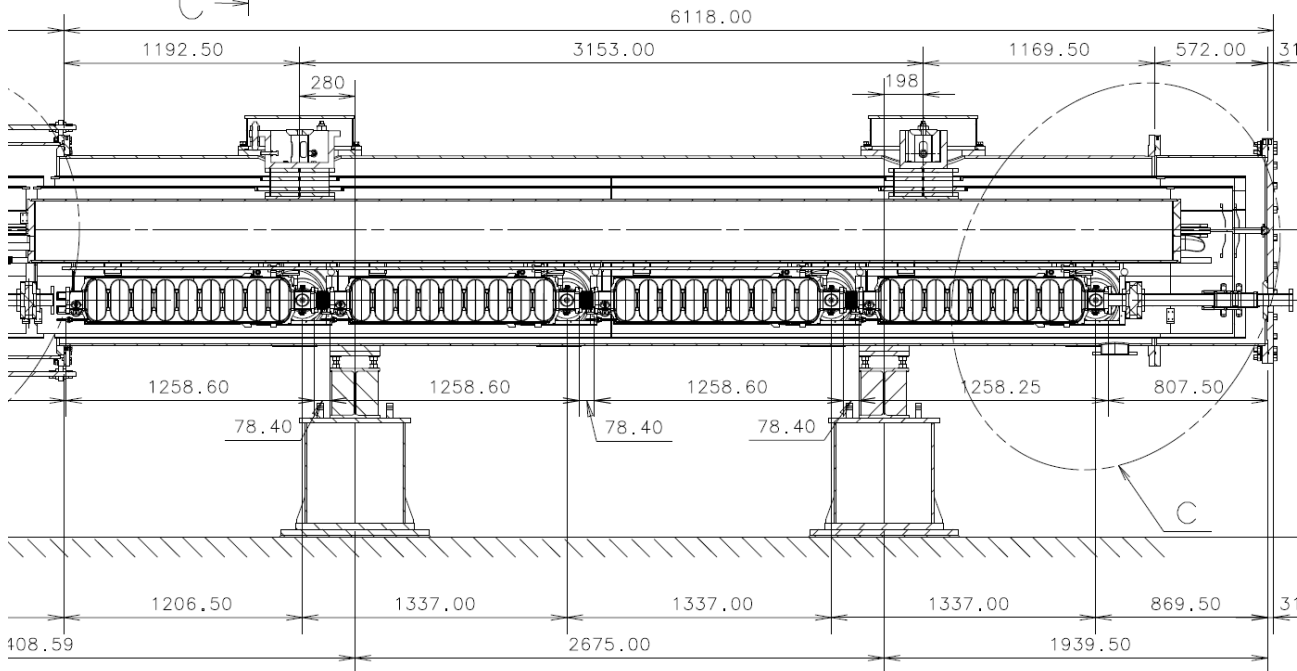




- The components will be packed at Oct. 9.
  - Vacuum vessel and two closed caps for support posts
  - Assembled GRP and upper thermal radiation shields with SI
  - Lower thermal radiation shields
  - Cavity support components [C-shape clamp and sliding mechanism]
  - 4 T-shape ports, 8 blind flanges and seals
- In the week of Oct. 12, the components in containers will be handed over to the transport company.
- The components of Module-C will be transported to KEK in the middle of November.

# Design of Module-A

## Module-A

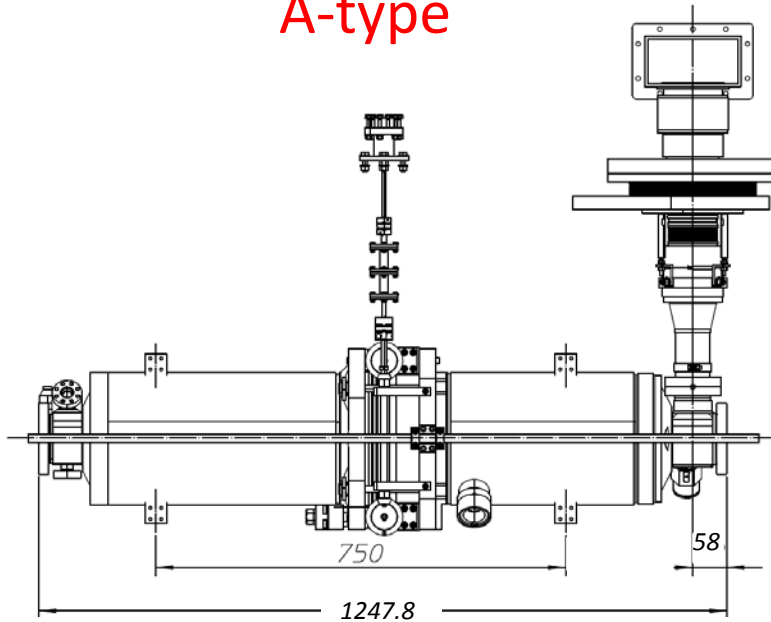


Cross section of Module-A

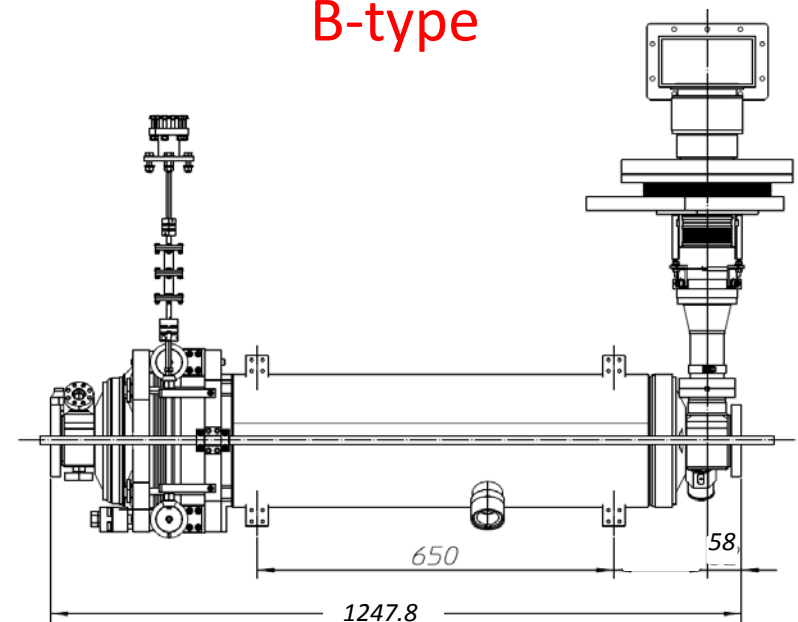
1. Module-A cryostat and cold mass components are those for STF Tesla-like cavities; re-used.
2. Design features of Module-A:
  - Thermal and mechanical designs are based on the TTF Type-III cryomodule, and the length of the vacuum vessel is 5515 mm.
  - Module-A is connected to Module-C with a big vacuum bellows and reduced cooling pipes.
  - Cooling pipe sizes are different from those of Module-C.
  - KEK cavities have two types of tuner location with respect to the cavity jacket.
  - Ti-SUS junctions are used in the cross-connect pipe between LHe supply pipe and cavity jackets, and in the cool down/warm up pipe.

# KEK cavities of S1-G cryomodule

A-type



B-type



- The tuner is located in the middle of He jacket.
- The support lug distance is 750 mm.
- The support lugs locate in the horizontal plane of beam axis.
- The plug compatible standard design.

- The tuner is located out side of support lugs and on the opposite side of input coupler.
- The support lug distance is 650 mm.
- The support lugs locate in the horizontal plane of beam axis.

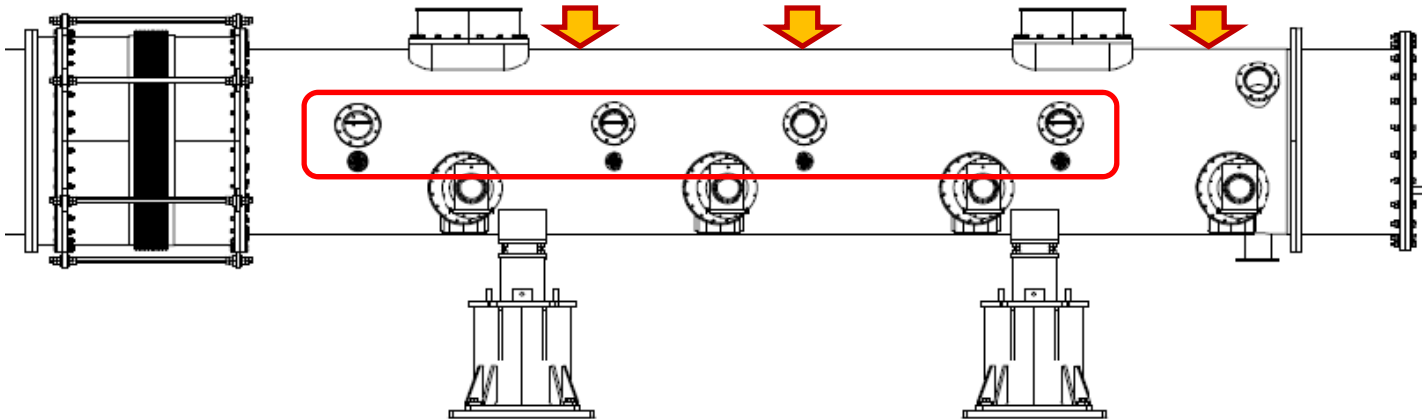
## KEK is constructing five Tesla-like cavities for S1-G.

- A-type: 2 cavities, B-type: 2 cavities, and choosing the better four cavities in the five cavities.
- The distance between cavity flanges is designed to be 1247.8 mm while 1258.6 mm for the old design.
- Inner magnetic shielding with respect to the jacket.

The preparation of KEK cavities will be presented by Eiji Kako.

# Modification of the vacuum vessel

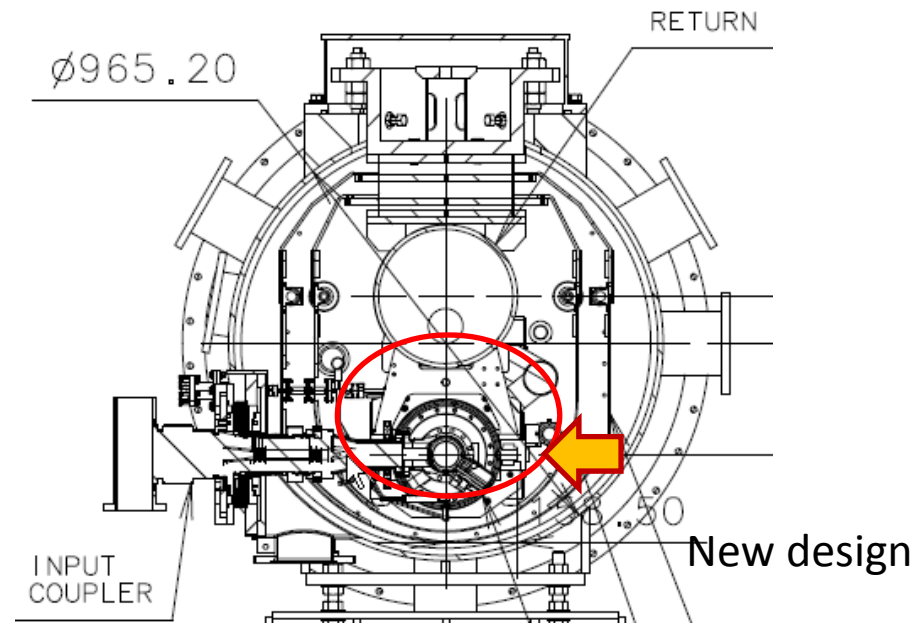
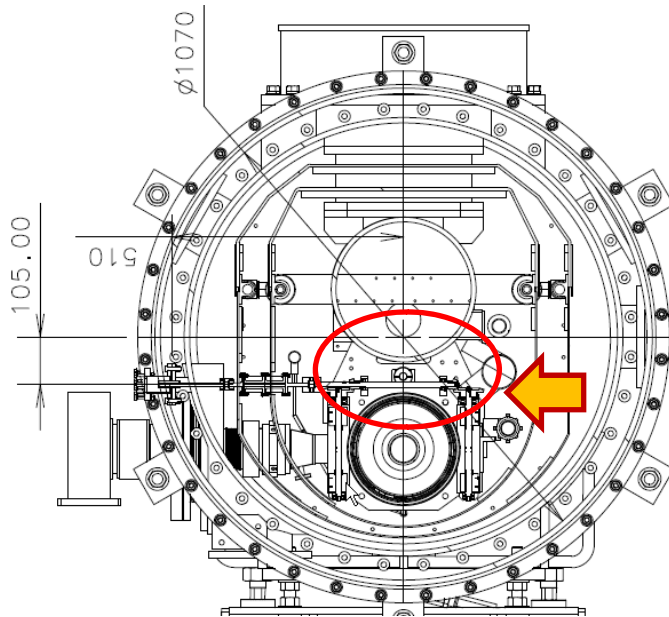
1. 4 ports for the new tuner driver shaft and 4 access windows for assembling the tuners.
2. 3 view windows of laser position monitors to measure the GRP deformation during thermal cycle.





## Modification of the He gas return pipe and shield plates

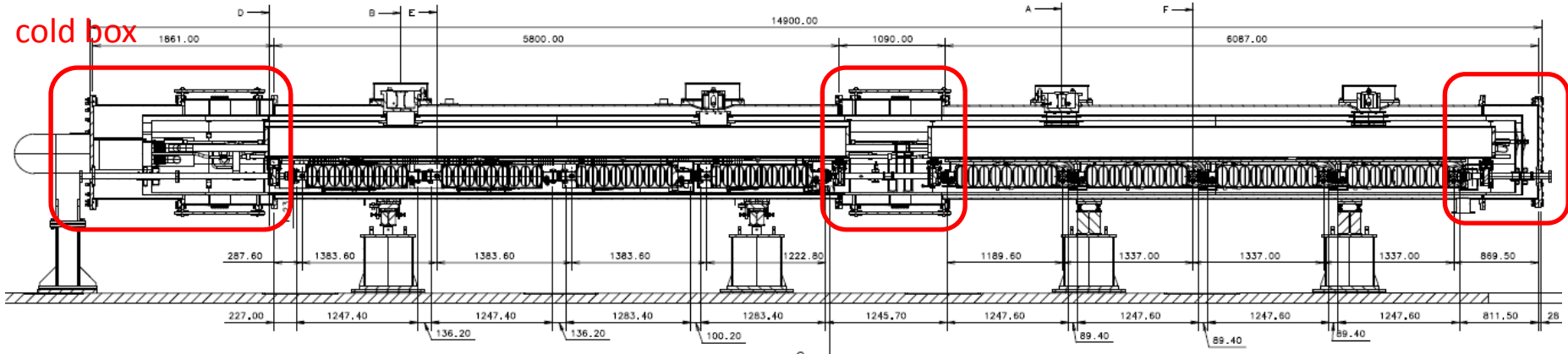
1. Removing the present cavity support shapes and making the redesigned shapes at the new locations.
2. Making windows on the thermal shields for the tuner shafts and laser position monitors.
3. Assembling 5 WPMs on the He gas return pipe.





# Construction of additional components

To 2K  
cold box



The following components are newly constructed:

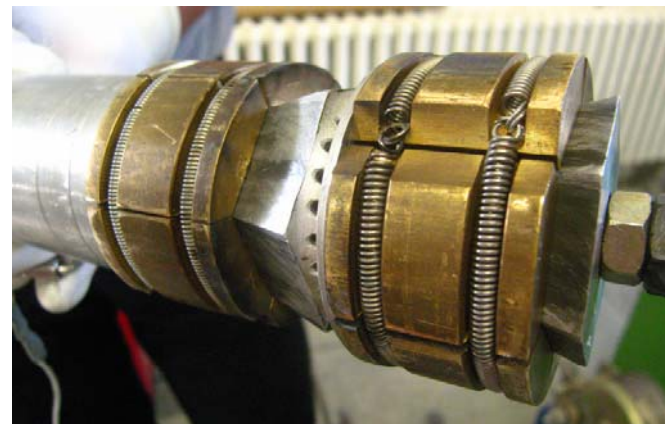
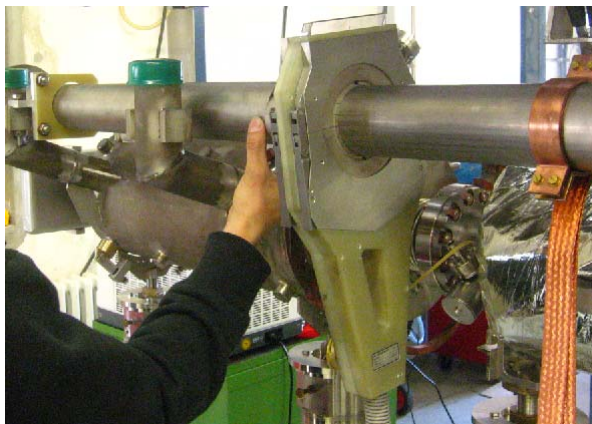
- Cooling pipes, vacuum short pipes, thermal shields and beam pipe between Module-C and the end flange to the 2K cold box
- Cooling pipes, vacuum short pipes and thermal shields between Module-C and Module A.
- The vacuum short pipe, the end flange and beam pipe for the end of Module-A.

Modification of Module-A components and construction of additional components will be done from September to December 2009 by Hitachi.



# Assembly work of FNAL/DESY cavities and Module-C in the KEK-STF

- Discussions of assembly of cavities and modules have started from September.
  - Eiji Kako and Shuichi Noguchi visited FNAL at 10 and 11 September, and Eiji Kako and Norihito Ohuchi visited DESY at 18 September to discuss assembly of FNAL/DESY cavities and Module-C.
- Eiji Kako will propose the discussion items for assembly of DESY and FNAL cavities in the discussion session.
- For the Module-C assembly:
  - Welding of Ti pipe of LHe supply pipe is the different process for KEK including tools.
  - Possibility of using the auto-welding and the pipe fixing machines of DESY or FNAL and welding work at STF by the DESY and FNAL personnel.

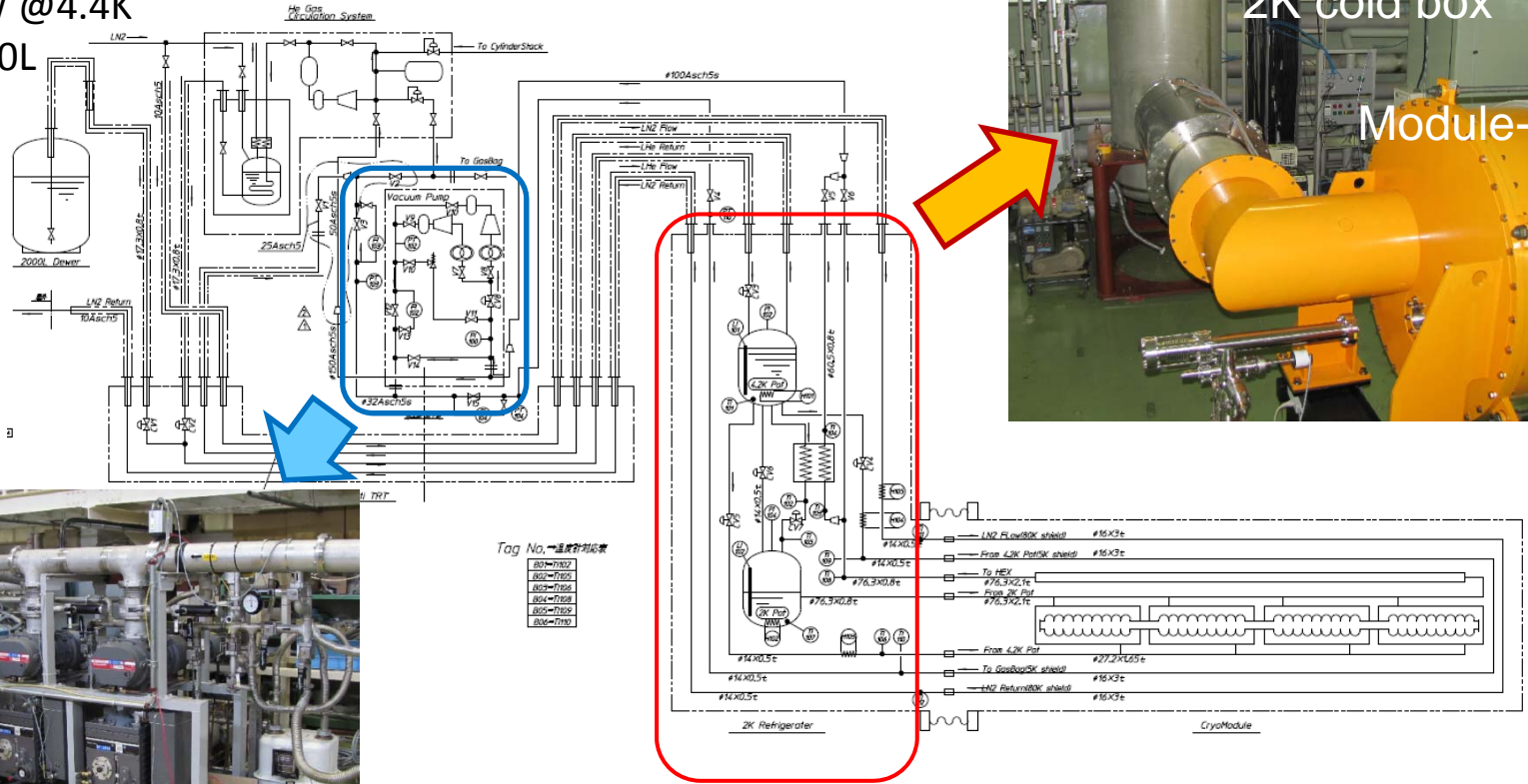


# Preparation of cryogenics for S1-G

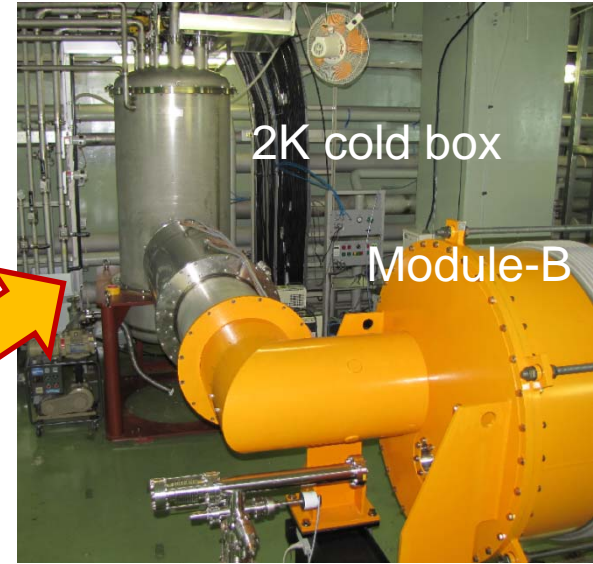
## Increasing pumping power

- 4 units ( rotary pump + mechanical booster pump) → 5 units
- Pumping capacity = 1700m<sup>3</sup>/h@3kPa
- Cooling capacity at 2K of the 2K CB system : 32 W

Cold box: 600 W @4.4K  
LHe dewer: 2000L



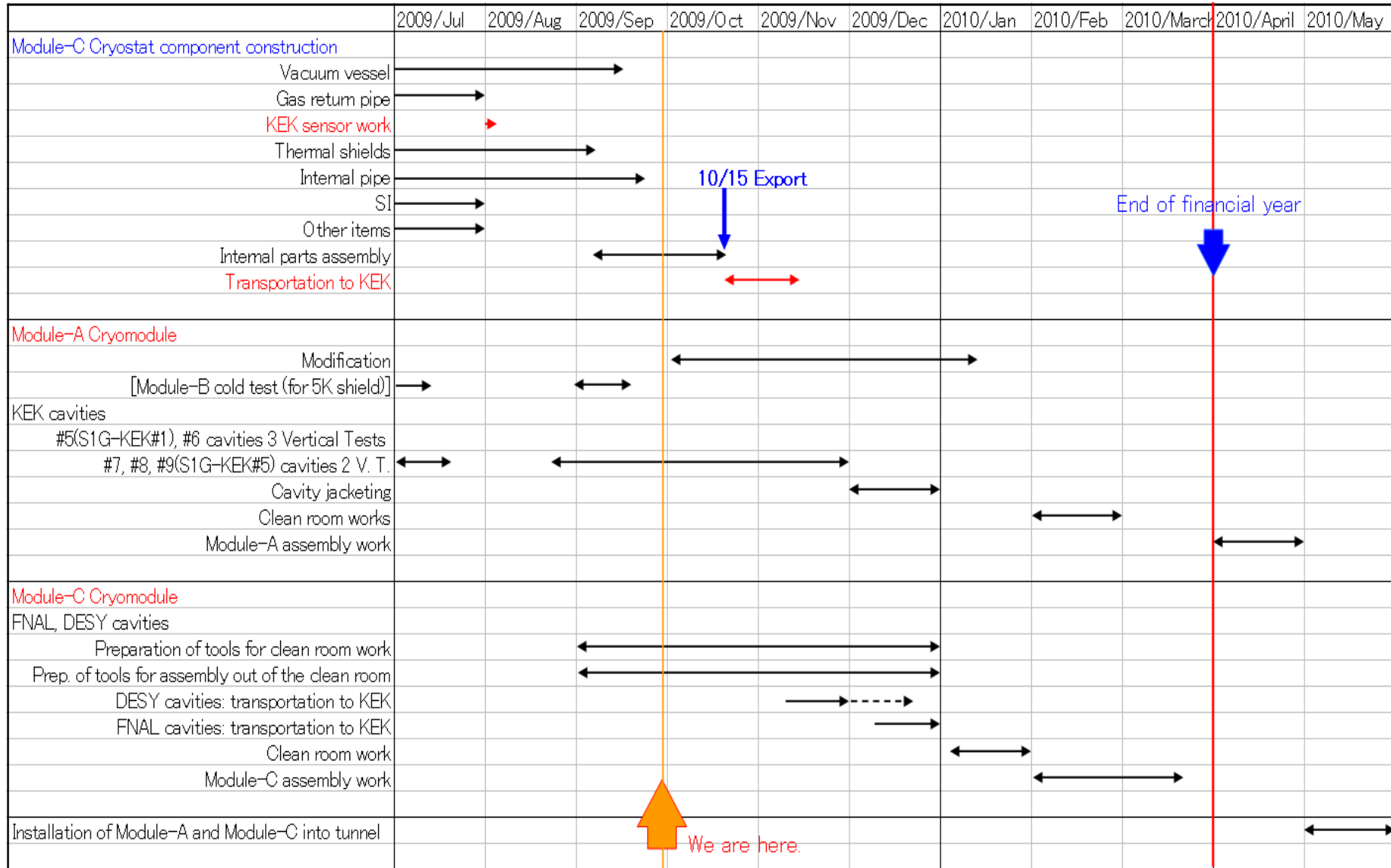
Pumping units



2K cold box

Module-B

# Cryomodule construction schedule



# Module assembly schedule-1

	2010	Jan				Feb				March				
	4	11	18	25	1	8	15	22	1	8	15	22	29	
Module-C cavites (FNAL, DESY)														
Preparation		→												
Class-10			→											
Class-1000				→										
Outside of clean room (meas. of alignment)					→									
Module-A cavites (KEK)														
Preparation					→									
Class-10						→								
Class-1000							→							
Outside of clean room (meas. of alignment)								→						
Module-C assembly														
Preparation for welding liquid helium supply pipe/Setting GRP under assembly stand						↔								
Welding liquid helium supply pipe, PT and LT/Welding flanges to GRP ends/Welding pipes of thermal shields/PT, LT							↔							
Mounting the cavity-string to GRP/Assembling tuners								↔						
SI on LHe supply pipe/Assembly of 5K shields/Sensors and wirings/SI on 5K shield									↔					
Assembly of 80K shields/Sensors and wirings/SI on 80K shields/Inserting the cold mass into vacuum vessel										↔				
Assembling warm input couplers to Module-C											↔			
Installing the Module-C in the tunnel and assembling the beam pipe/PT, LT												↔		

# Module assembly schedule-2

	2010	March					April					May				June				July		
		29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12					
Module-A assembly																						
Mounting the KEK cavity-string to GRP																						
Welding LHe supply pipe and cool-down pipes/PT and LT																						
Mounting sensors and wiring/SI on LHe supply pipe/Assembling 5K shield																						
SI on 5K shield/ Assembling 80K shield																						
SI on 80K shield/Checking sensors/Inserting the cold mass into V.V./Installing Module-A in the tunnel																						
Intermediate area between Modules and 2K cold box																						
Welding pipes between Module-C and 2K cold box																						
Welding pipes in the Module-A end																						
Welding pipes between Module-C and Module-A/PT, LT of cooling pipes/Assembling beam pipe																						
Assembling thermal shields/SI/Wiring																						
Assembling warm input couplers																						
Closing Modules/Vacuum pumping Modules/Final LT																						
Preparing cool-down																						
Cool-down and cold test																						

# Summary

- Construction of Module-C components has been almost completed.
  - Components of Module-C is scheduled to leave Italy 15 October.
- Modification of Module-A and construction of additional components will be done from September to December 2009.
- Discussions of assembly of FNAL/DESY cavities and Module-C have started from September.
- Assembly of cavities can start from January 2010.