Meeting for S1-Global module design Cryomodule and Cryogenics 20081029

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INFN and KEK have been discussing the general design of S1-Global cryomodule up to now.
We should start the working phase of the detail cryomodule design, and we would like to confirm the design among the concerned persons.
Therefore, I will propose the Webex meeting every two weeks.

The subjects on the meeting;

S1-Global cryomodule

(1) Design work of the S1-Global cryomodule
(2) Understanding of interface parts between the components of INFN, DESY, FNAL and KEK

Cryomodule and cryogenics R&D work

In 2009 and 2010, KEK will perform the 5K shield study with 6m cryostat and S1-Global.
From these two tests, the following points are included for the cryomodule and cryogenic system group.

(1) The 5K shield problem
- Heat load in the module
- Design of the module without 5K shield
- Effect without 5K shield on the cryogenic system design

(2) The S1-global module test
- Interface design between the different cavity package for the plug-compatibility
- Assembly study for the different types of cavities, and optimization of assembly and tool
- Heat load measurement for the different types of cavities, and the study leads to the requirements of cooling power of the cryogenic system (heat load estimation of cryomodule)

(3) The other items to be discussed

The above items are ILC-WPs for cryomodule and cryogenic system group.

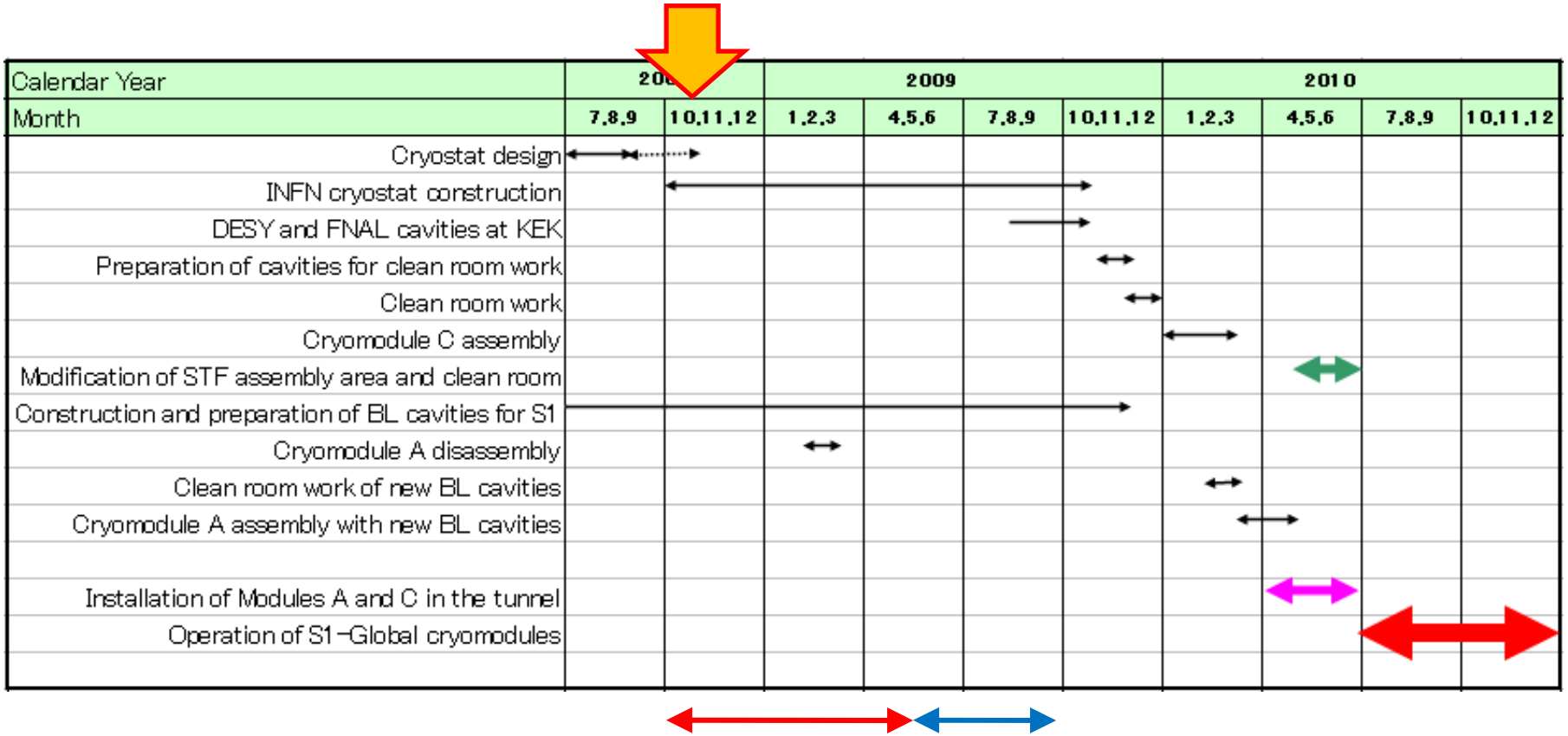
Discussion items

1. Meeting schedule
2. S1-global module
   - Schedule of S1-global
   - Status of design work for the module
   - Module-C characteristics between INFN and KEK
   - Design modification of KEK cavity vessel
3. Cryogenics and cryomodule study
   - Test plan of 5K shield study

Meeting schedule

- The 1st meeting on 29 Oct. 2008.
- The following meeting will be scheduled at every two weeks.
  - One meeting might be scheduled after the ML-SCRF meeting by Akira Yamamoto.
  - Another meeting will be scheduled at 22:00 (JPT).
    - FNAL 7:00 , Jlab 8:00, INFN and DESY 14:00
- The meeting time : 1.5 hours.
  - The first half : S1-Global design
  - The second half : Cryomodule and cryogenic study

S1-Global module :schedule of S1-global

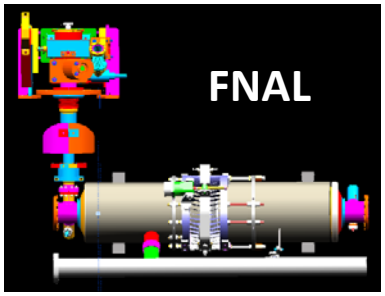


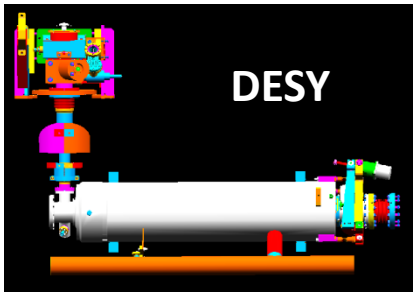
Components and assembly design of Module-C and Module-A

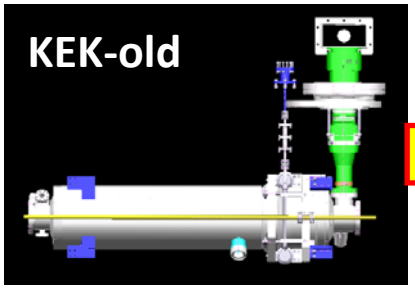
Assembly design of modules in the STF tunnel

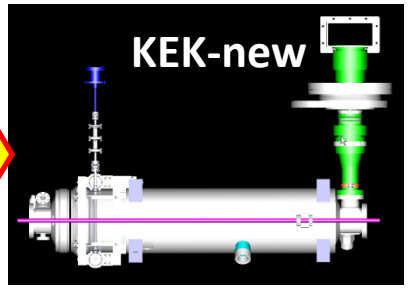
S1-Global module : Status of design work for the modules

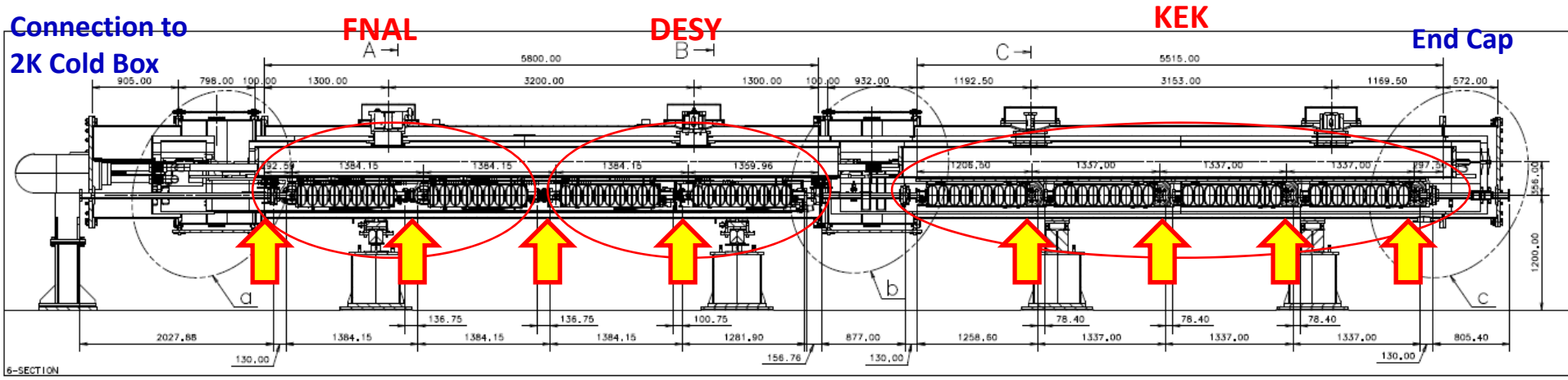
General Design of Cryomodules







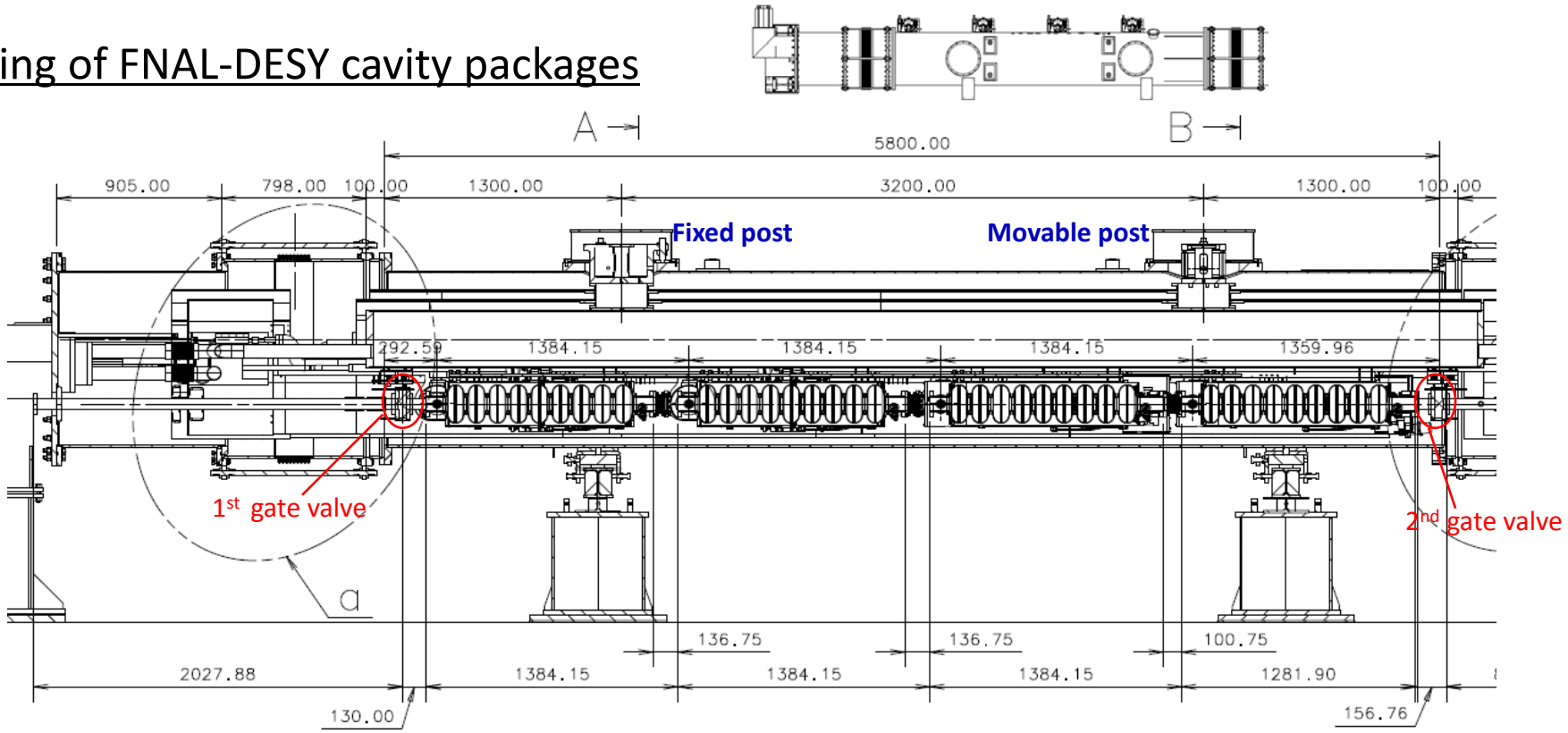




- Module C: 2 FNAL cavities and 2 DESY cavities, Module A: 4 KEK Tesla-like cavities
- The total length=14778mm
  - Module-C = 5800 mm, Module-A = 5515 mm
  - Vacuum bellows to 2K cold box = 795 + 100 mm, Vacuum bellows between modules = 932 + 100 mm
  - Connection to 2K cold box = 905 + 28 mm, End cap = 572 + 28 mm

S1-Global module : Status of design work for the modules

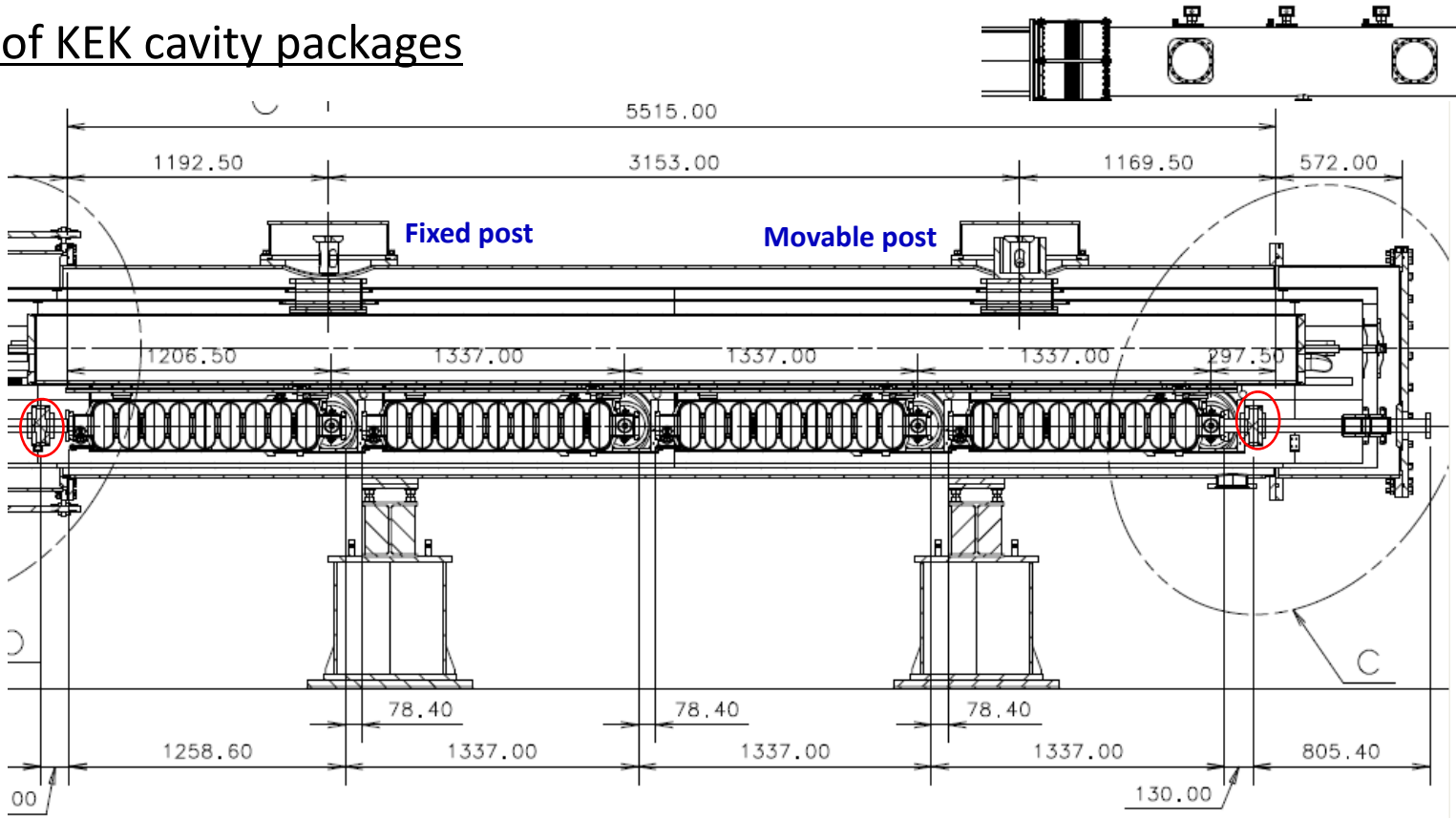
String of FNAL-DESY cavity packages



- Distance between input couplers = 1384.15 (same as XFEL module)
- Cavity length (flange to flange)
  - FNAL = 1247.4 mm, DESY = 1283.4 mm
  - 1st cavity to 2nd cavity = 136.75mm, 2nd to 3rd = 136.75mm, 3rd to 4th =100.75 mm
  - 1st gate valve center to 1st cavity = 130 mm, 2nd gate valve to 4th cavity = 130 mm

S1-Global module : Status of design work for the modules

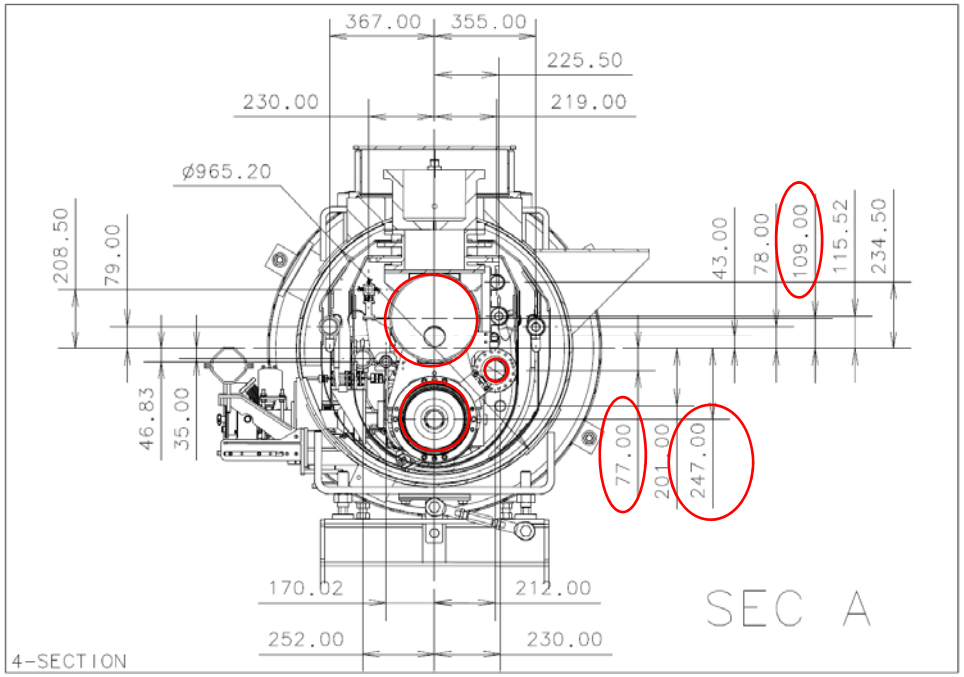
String of KEK cavity packages



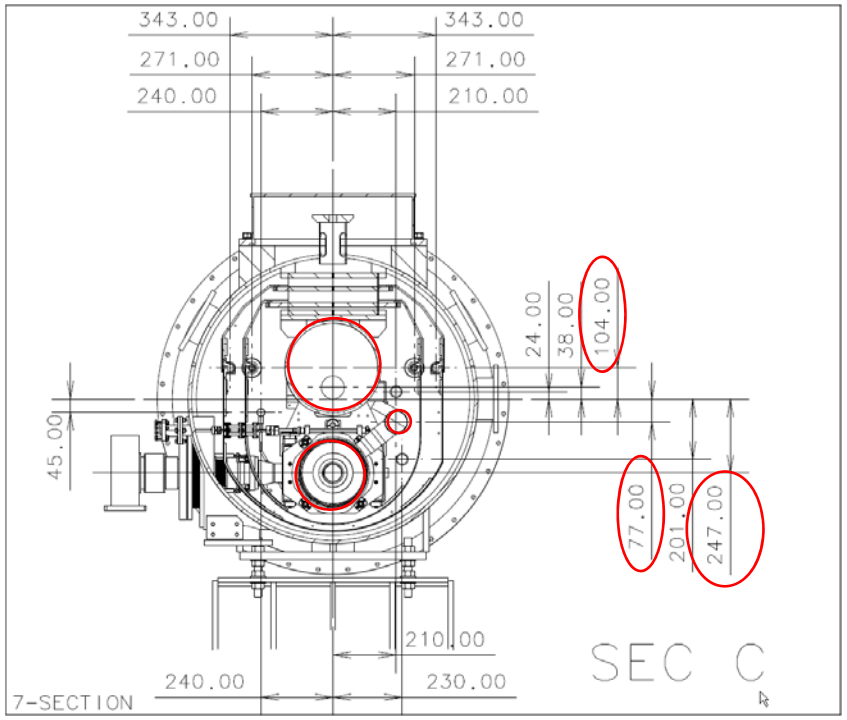
- Distance between input couplers = 1337.0
- Cavity length (flange to flange)
  - KEK-Tesla-like = 1258.6 mm ⇒ 1247.6 mm
  - Cavity to cavity = 78.4 mm ⇒ 89.4 mm
  - The gate valve to the cavity flange = 130 mm

S1-Global module : Status of design work for the modules

Cross-section of modules



Cross section of Module-C

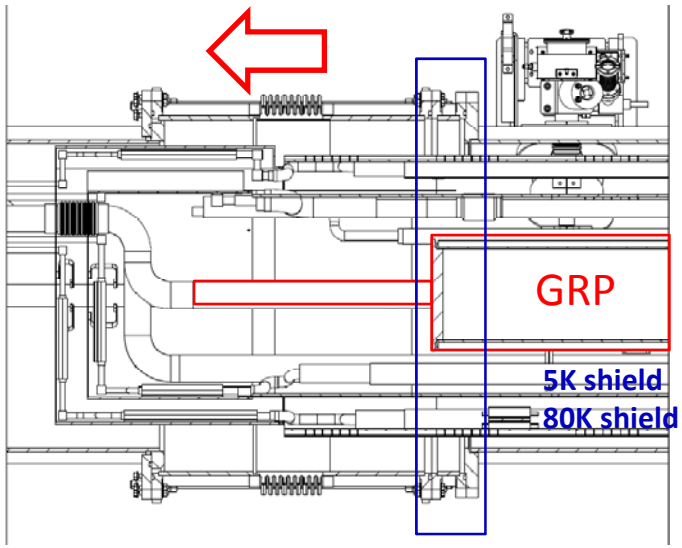


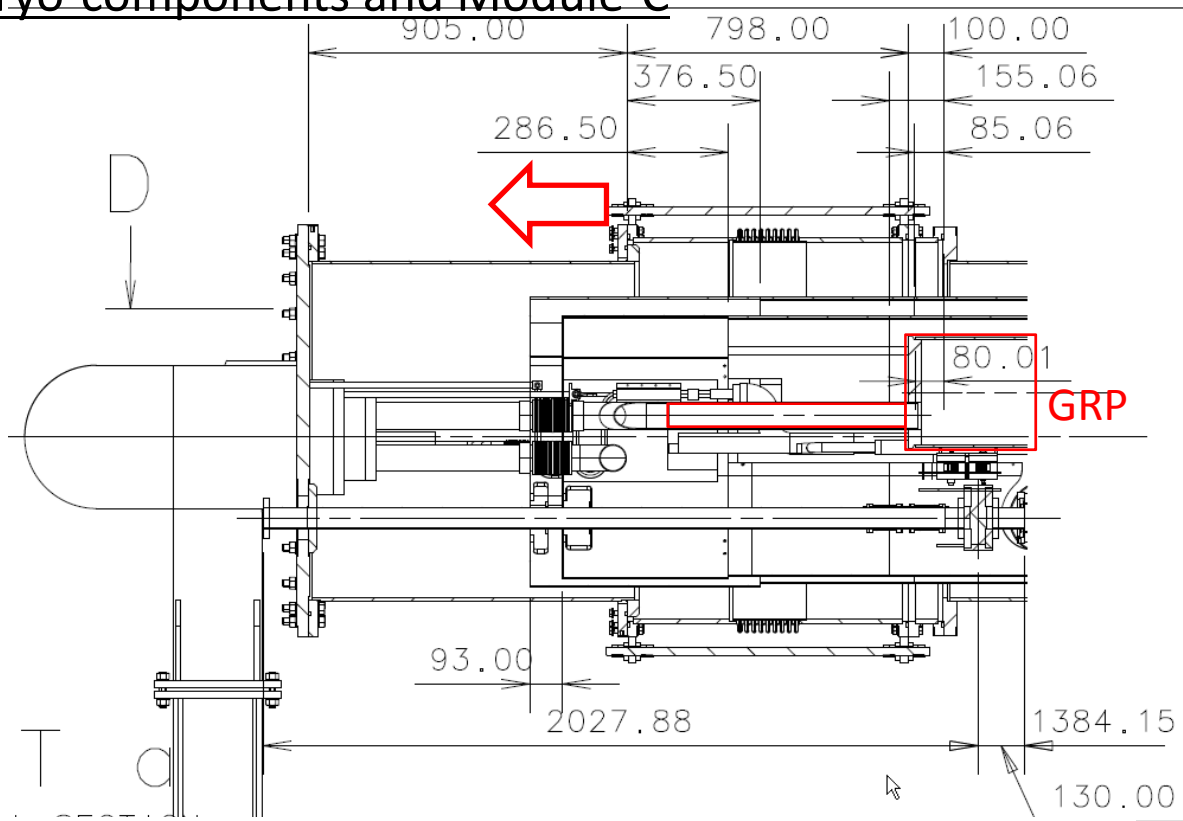
Cross section of Module-A

- Distance between the cavity vessel center and the vacuum vessel center
  - FNAL and DESY = 247 mm, KEK= 247 mm
- Distance between the helium supply pipe center and the vacuum vessel center
  - FANL and DESY = 77 mm, KEK= 77mm
- Distance between the gas return pipe center and the vacuum vessel center
  - FNAL and DESY = 109 mm, KEK = 104 mm
  - Dia. of gas return pipe in Module-C= 312 mm, dia. of gas return pipe in Module-A=318.5 mm

S1-Global module : Status of design work for the modules

Connection area between KEK cryo-components and Module-C

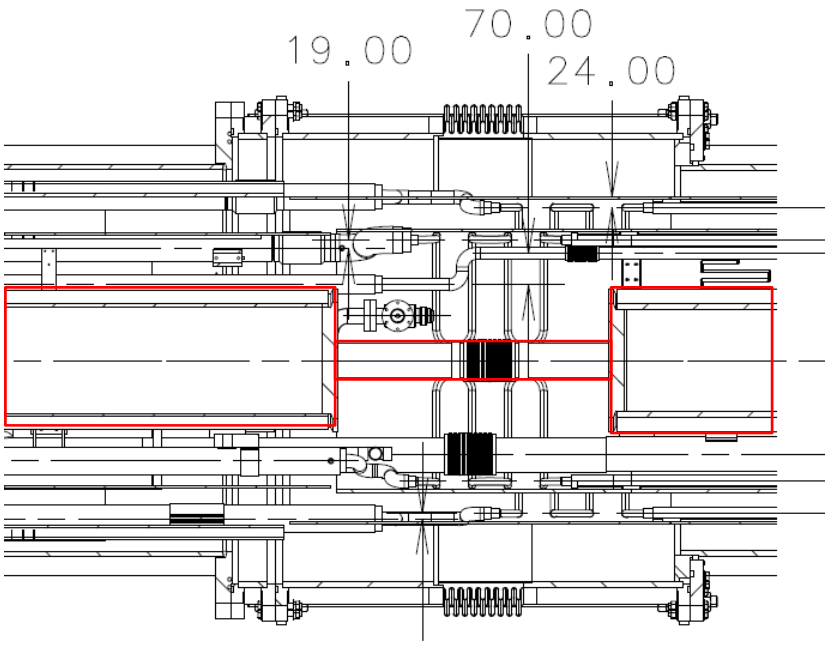




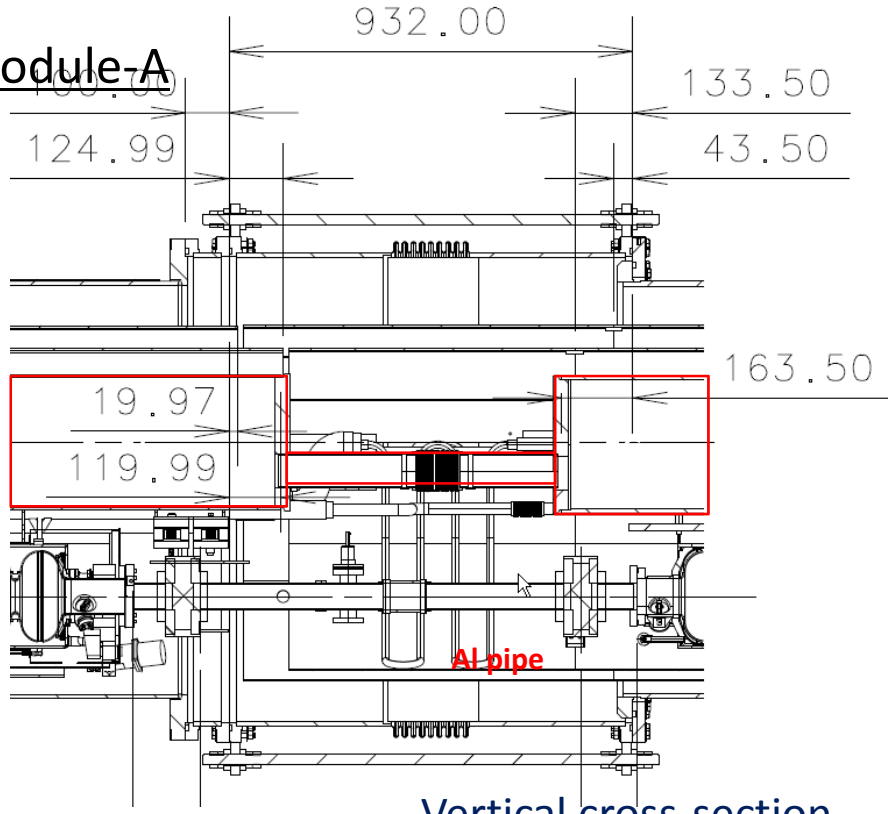
- The GRP of Module-C is connected with the pipe of O.D. 76.3 mm at the both ends of cryostat.
- The vacuum big bellows is moved to the side of the end flange.
  - The vacuum big bellows are used for the STF modules.
- For connecting Module-C flange and the vacuum bellows, the additional connection part will be manufactured by KEK.
- The flanges of Module-C and the connection part are connected with claw cramps.
  - Connection by claw cramp is necessary for alignment of two cryomodules.

S1-Global module : Status of design work for the modules

Connection area between Module-C and Module-A



Horizontal cross-section

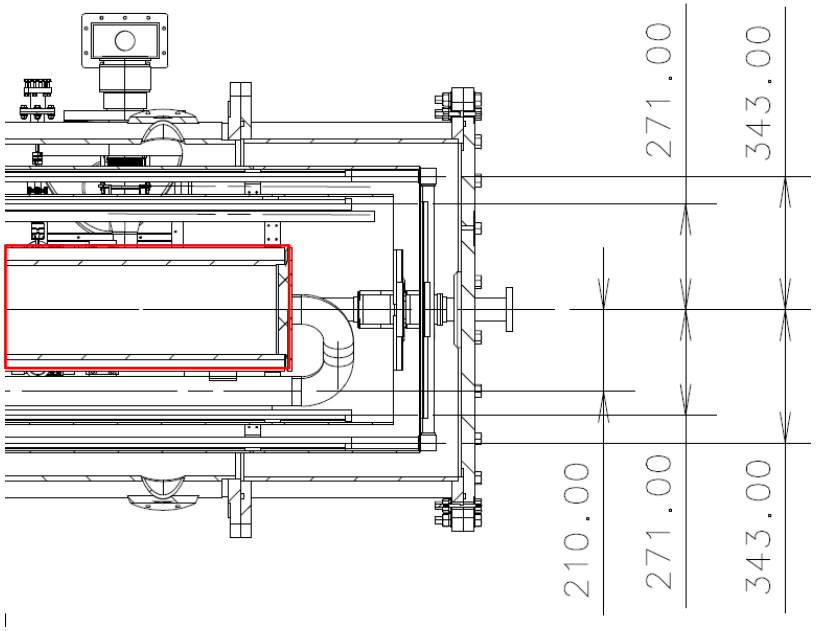


Vertical cross-section

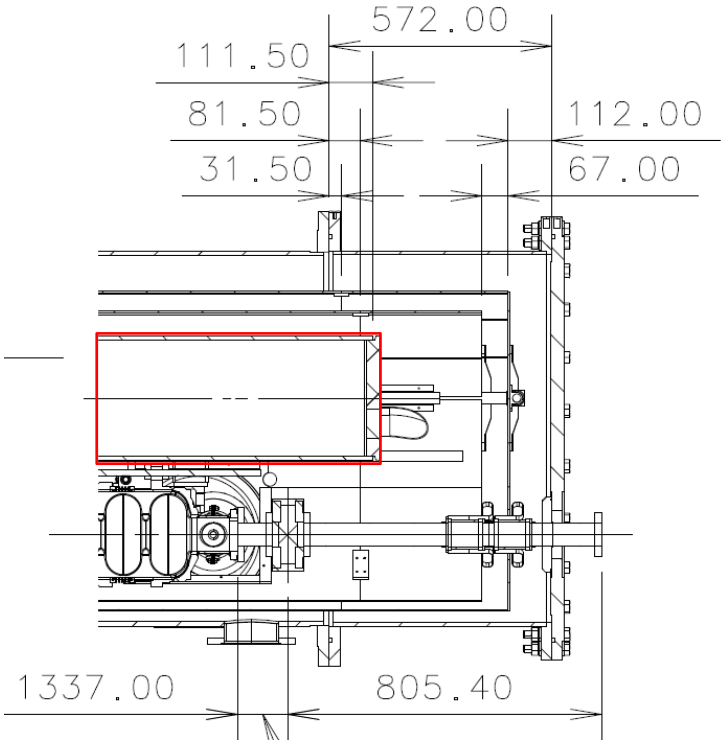
- The GRPs of Module-C and Module-A are connected with the pipe of O.D. 76.3 mm and bellows.
- Al pipes of thermal shields of the both modules are connected by welding.
  - The connection Al pipes are shaped like a snake in order to accommodate the position change of pipes and shields due to the thermal shrink.
- The vacuum flanges of Module-C and the vacuum bellows are connected with claw cramps.
- The vacuum flanges of Module-A and the vacuum bellows are connected with bolts and nuts.

S1-Global module : Status of design work for the modules

End area of Module-A



Horizontal cross-section



Vertical cross-section

- The GRP of Module-A is connected to the 2K supply pipe of O.D. 76.3 mm with the U-shaped short pipe .
- End components are covered with 4K and 80K shields.
- The beam pipe is installed with the gate valve.
  - The beam pipe is thermal-anchored with 4K and 80K shields.

S1-Global module : Status of design work for the modules

Pipe size of Modules

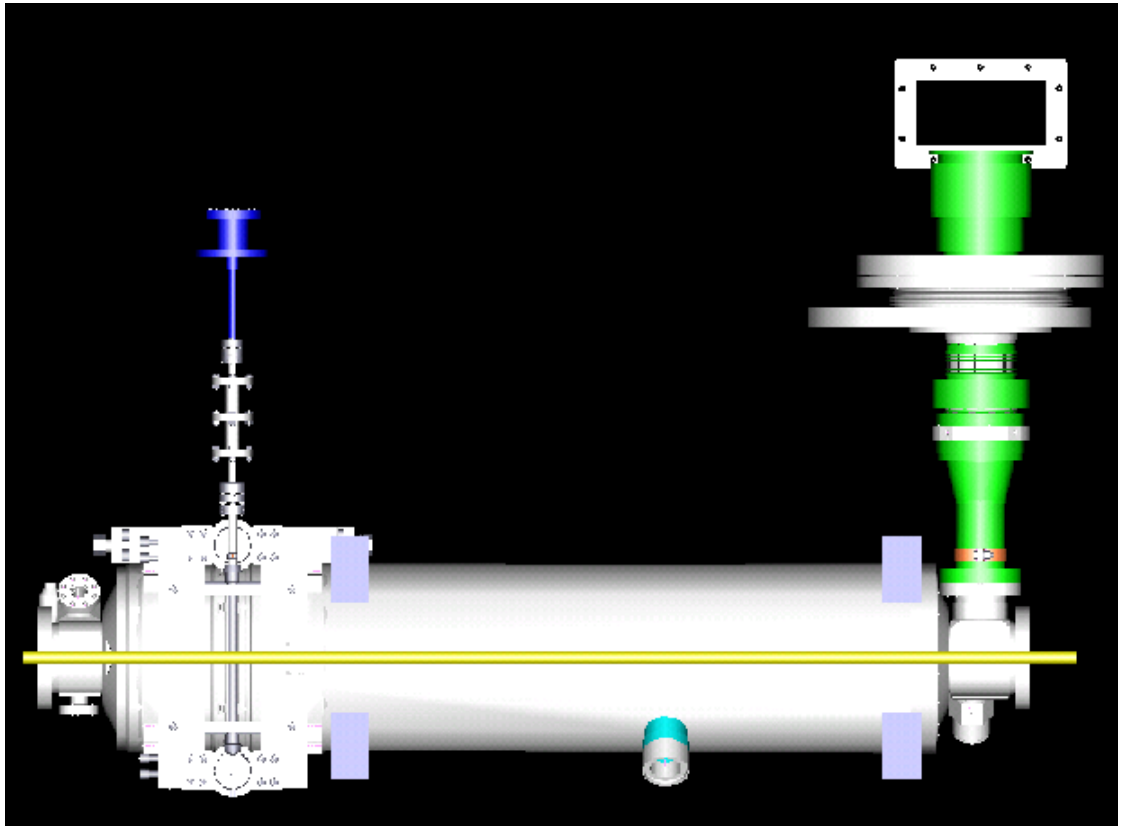
	Module-C (Type-III)	Module-A
GRP	OD=312, ID=300	OD=318.5, ID=297.9
2K LHe Supply Pipe	OD=75, ID=72.1	OD=76.3, ID=72.2
5K Shield (forward)	ID=60.3	OD=30, ID=22
5K Shield (return)	ID=60.3	OD=30, ID=22
80K Shield (forward)	ID=60.3	OD=30, ID=22
80K Shield (return)	ID=60.3	OD=30, ID=22
Precooling	ID=42.2	OD=27.2
2.2 K line	ID=48.3	None

S1-Global module : Module-C characteristics between INFN and KEK (By Serena)

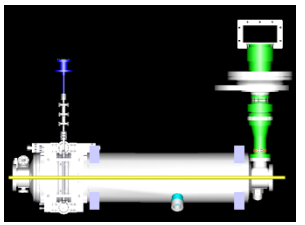
- 4 cavities instead of 8:
  - Total length of the module: 5800 mm from end flange to end flange.
  - Different length of all pipes (included GRP): overlength of 500 mm from end flange.
  - Different position of the shapes.
  - Shorter invar rod.
  - Different position of the lifting lugs.
  - Different position of the vessel supports.
- Cavity distance (i.e. coupler distance): 1384.15 mm
- No reinforcing rings.
- Two posts only, one fixed (on the left in the drawings), one sliding.
- No bimetallic joint at the end of the Aluminum pipes.
- No end bellow for the vacuum vessel.
- No end bellow for the Gas Return Pipe.
- Same cross section as cryomodule type 3+.
- Aluminum finned pipes can be modified: both the shape and the diameter (minimum diameter 22 mm) can be different, but compatible with shields design.
- No sliding flange on the vessel (and no rail): on both side the end flange will be fixed and clamped.
- Three openings: one for pumping the inside of the cryomodule, the other two for the terminal flanges of signal cables. The inner diameters of the openings are 139.8 mm and the connection flanges are ISO 160F flanges.
- No WPM system, but WPM supports on GRP are required.
- Warm-up cool-down pipe design slightly modified with respect to cryomodule 3+; the same as CM2 for Fermilab.

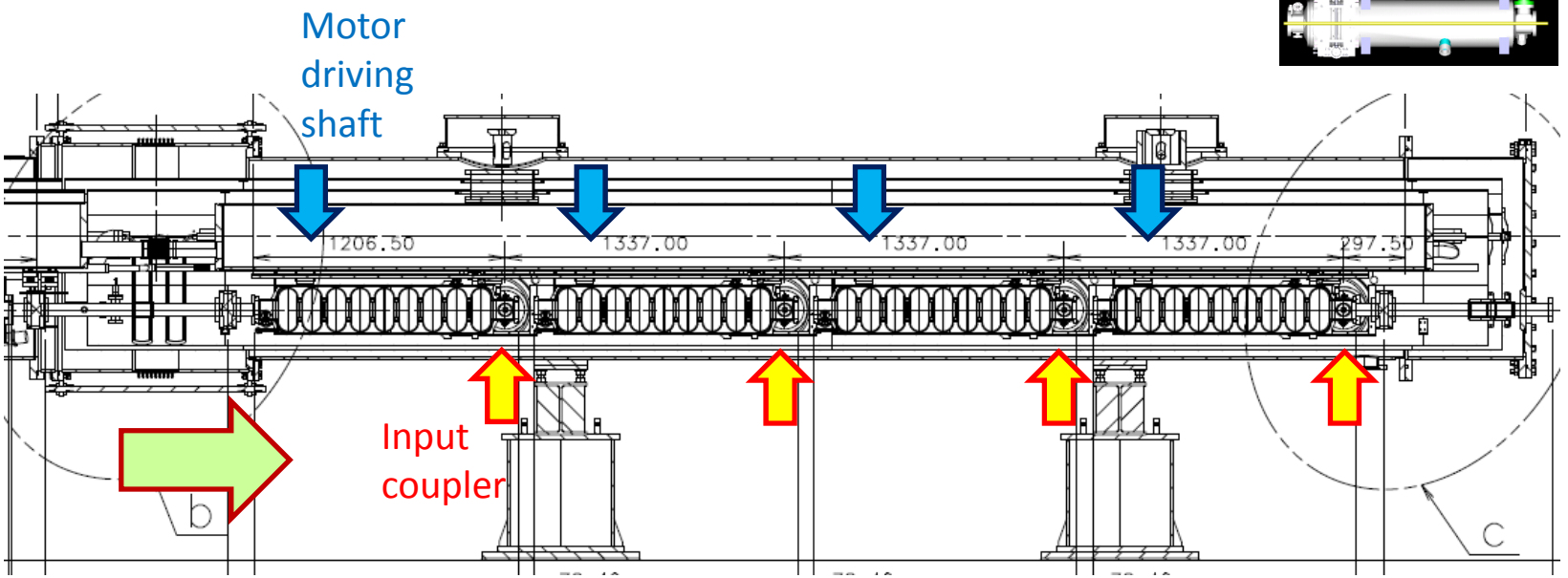
S1-Global module : Design modification of KEK cavity vessel

- Position of the slide jack tuner
- Cavity length (1258.6mm → 1247.6mm)



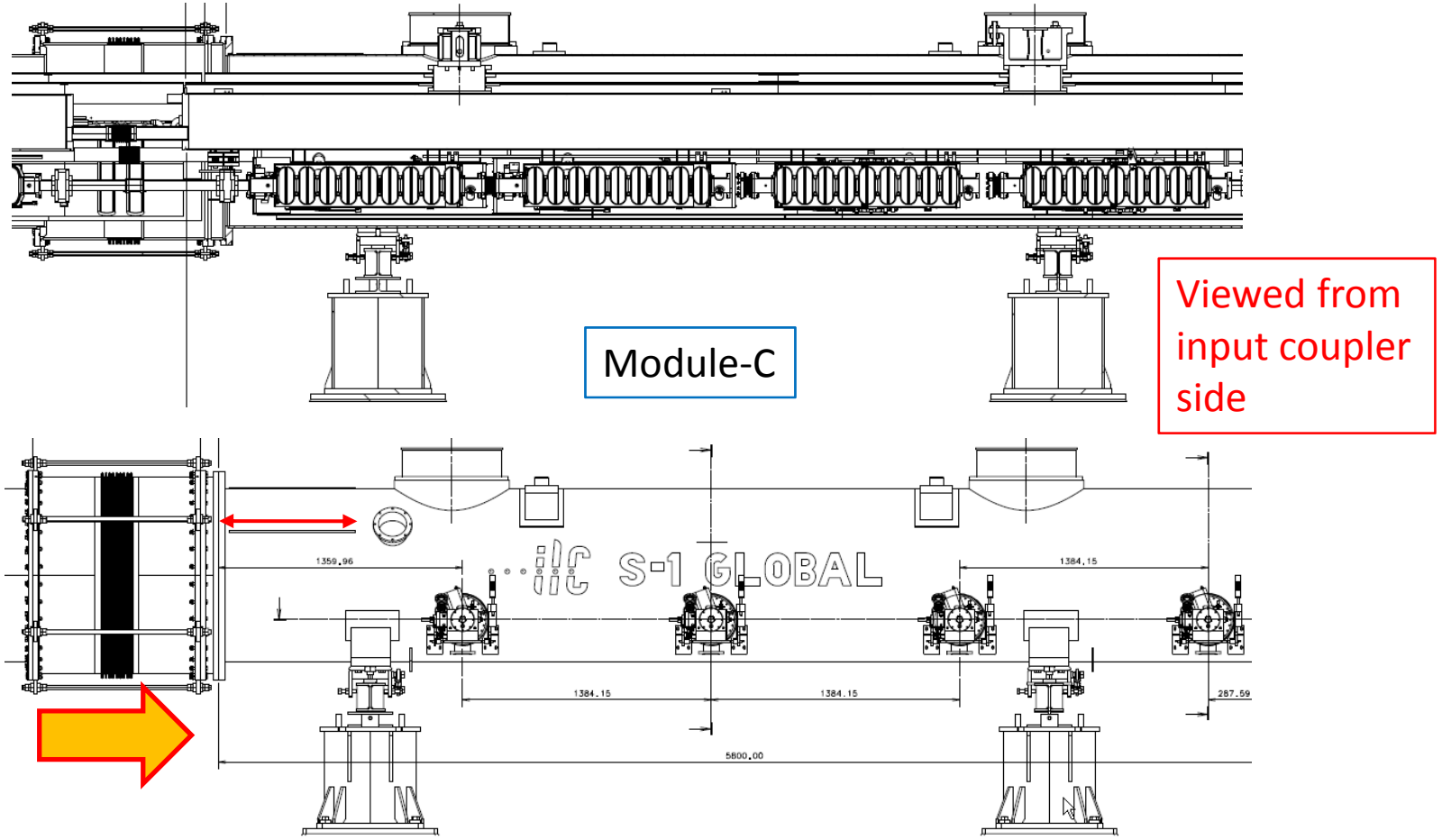
S1-Global module : Design modification of KEK cavity vessel





- The vacuum bellow was designed to move on the side of Module-A.
  - Interference between the vacuum bellows and the motor driving shaft.

S1-Global module：Design modification of KEK cavity vessel



- The vacuum bellow can be designed to move on the side of Module-C.
  - Lengthen the vacuum vessel in the center side. (Need the modification of the present CAD data)
  - Need the sliding flange and the rail.

S1-Global module : Next step

- Component design
  - Module-C (INFN)
    - Vacuum vessel
    - GRP
    - Cooling pipes
    - Thermal shields
    - etc.
  - Module A and interface (KEK)
    - Modification of the present design
      - Vacuum vessel
      - Support of cavity vessel
    - Interface components
- Cavity assembly design in the module
  - DESY and FNAL cavities (INFN)
  - Finalizing KEK cavity package design (KEK)

Cryomodule and cryogenics R&D work: Test plan of 5K shield study

Measurement of heat loads with and without 5K shields by STF Module-B (2009 April – December)

For the study of ILC-cryomodule design

ILC Cryomodule Thermal Model

5K line :

input couplers, support posts and current leads

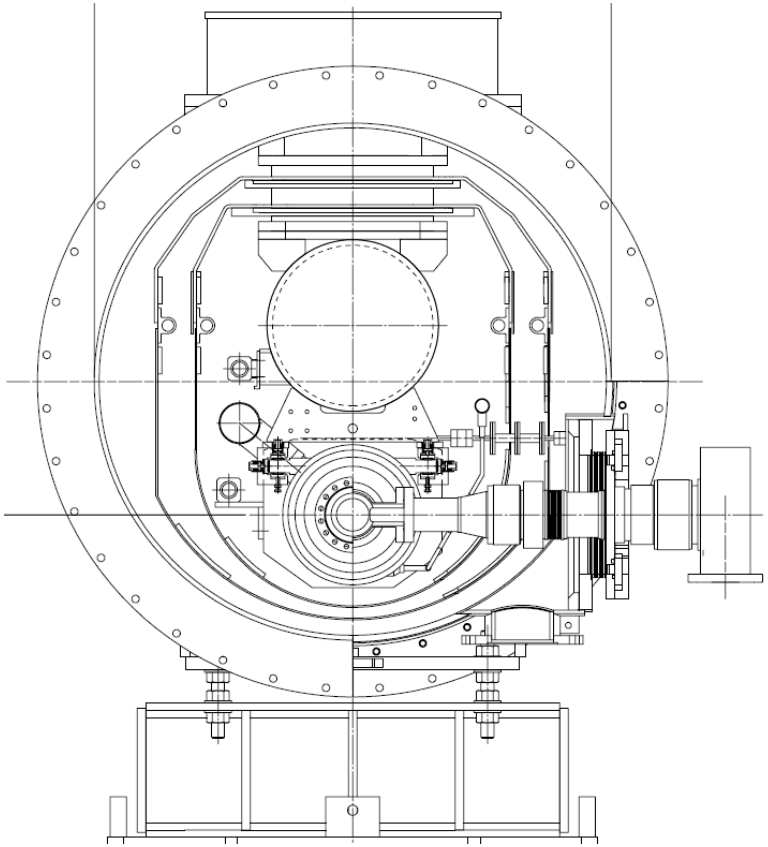
40K line :

thermal shield, support posts and current leads (44K)

HOM couplers, HOM absorber and input couplers (66K)

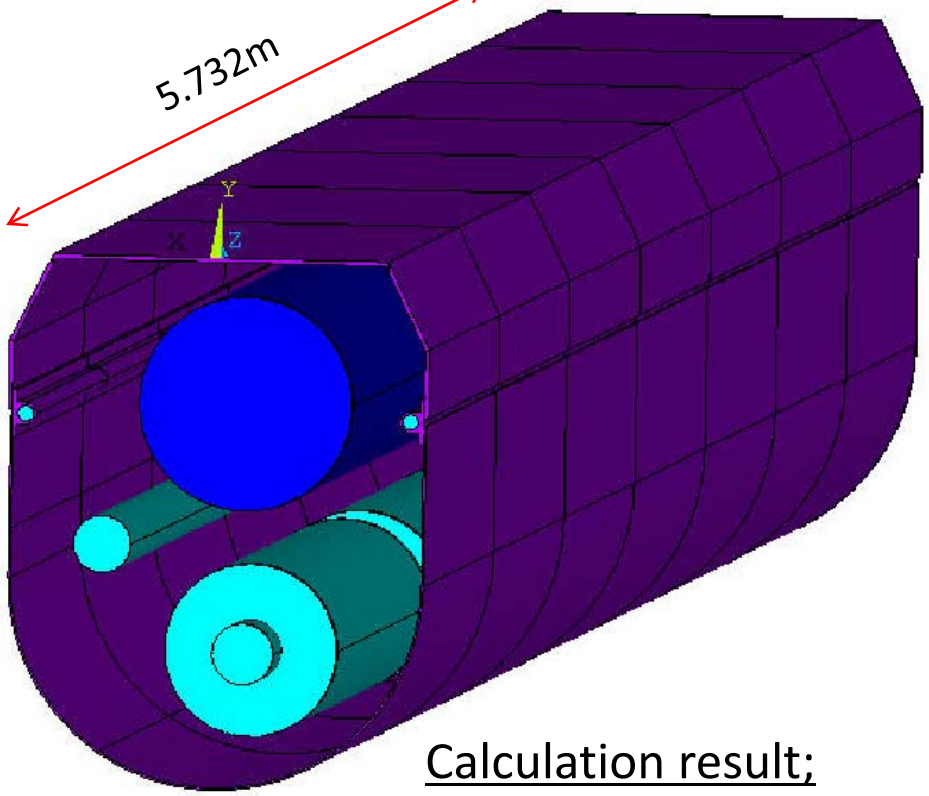
Calculation: The difference between the required powers at 300K of two cases : 0.11 kW/Module

The heat load at 2K will be measured with and without the bridge of the 5K shields.



Cryomodule and cryogenics R&D work: Thermal tests at STF

80 K shield surface=14m^2
Emissivity=0.2



2K surface=9.75m^2
Emissivity=0.03

<u>Calculation result;</u>
Shield length=5.732 m
q = 0.83 W at 2 K

- Heat load measurement of cryomodule at STF
  - Volumetric flow measurement of the evaporation helium gas.
  - Calibration by heater
    - Heater power=2.96W
    - Measured heat load= 2.88W
  - The temperature of outer shield (80K shield) can be changed.

Cryomodule and cryogenics R&D work: Next Step

- Define the test items for the 5K shield study.
  - Preparation of the cold test.
- Study of the cryogenic system with or without 5K shield.
  - Cryogenic system design (Cold Box)
  - Heat loads of the components in the cryomodule
    - Heat load in RDR
    - XFEL
    - STF