

Interface of Plug-Compatible Cryomodule Components

KEK

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From the presentation by Hitoshi Hayano
at KEK-kick-off meeting on 2007/9/12-14

Possible plug-compatible units

C1-level : Cryomodule

C2-level : Cryostat with GRP, He-pipes, and thermal shields.

Vacuum vessel and cold mass

C3-level:Cryostat vessel, GRP supports, Pipes, Thermal Shields, Invar fixture,
Cavity support, Quad support, Cryostat Pumping system,
Instruments(vacuum, temperature, etc)
Installation fixture and method,
Transportation fixture and method,

C2-level : Cavity package with He jacket, tuner and coupler,

Cavity package

C3-level:Cavity, Jacket, Magnetic shield, Tuner, Coupler,
Instruments (RF cable, temperature sensor, piezo drive, etc)

C2-level : Quad-steer-BPM package,

Quadrupole package

C3-level:Quad magnet, Steer dipole coils, Current feedthrough, BPM

C2-level : HOM absorber

HOM absorber unit

C2-level : Beam line pumping

Beam line pumping unit

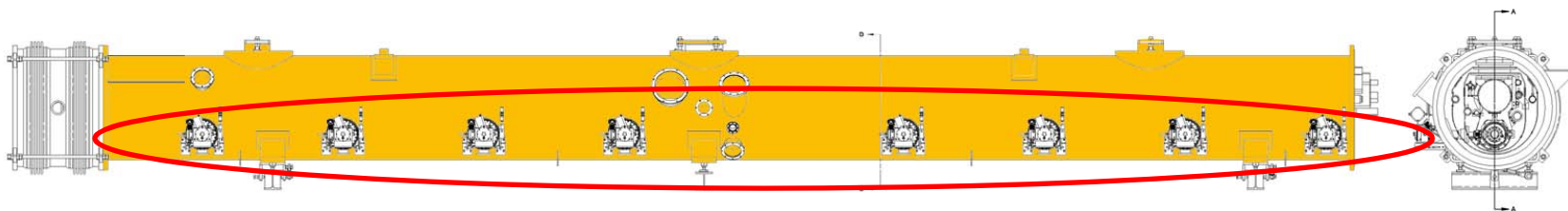
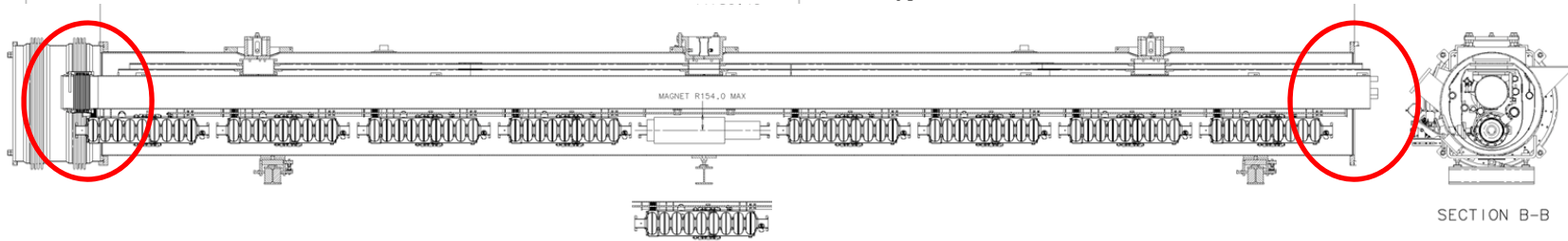
Previous Works for Cryomodule Component Engineering Design

- **Defined cavity parameters by Lutz at FNAL-GDE Meeting on 2007/10/23**
 - **Cavity length = 1247 mm**
 - **Maximum outer diameter**
 - **Cells = 210 mm, HOM coupler = 232 mm \Rightarrow Max. Radius = 116 mm**
- **Definition of the responsible group to the interface components at FNAL-GDE Meeting on 2007/10/23**
- **Helium vessel parameters at SCRF technology meeting on 2008/1/18 after TTC meeting at DESY**
 - **Max. allowable pressure at room temp. and vacuum inside = 2 bar**

C1 level (cryomodule) interface for engineering design

C1-level : Cryomodule (1)

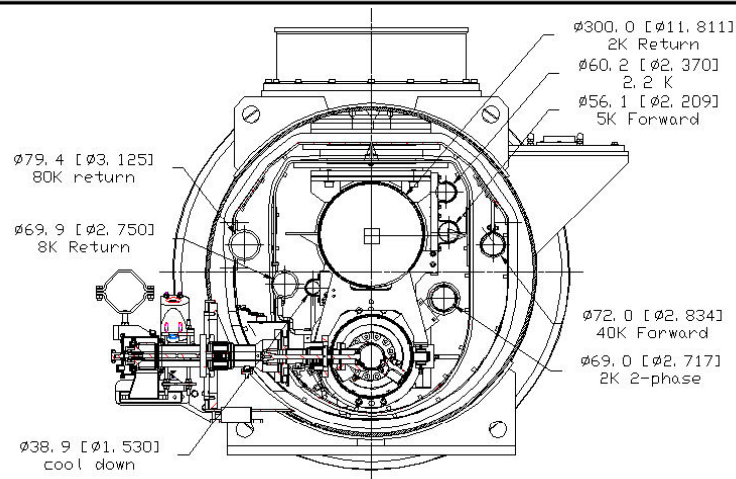
Cryostat (vacuum vessel)	Length of cryostat, m
	Outer diameter, m
	Connection flange type between cryomodules
Beam pipe	Outer diameter, mm
	Position of beam pipe axis (x,y) w.r.t. the cryostat center at room temp., m
	Height of beam pipe axis w.r.t. the base level of the vessel support at room temp., m
	Connection flange between beam pipe and gate valve
Input coupler connection flange to the wave guide flange	Position of input coupler axes w.r.t. the cryostat center
	Connection flange type to wave guide
	Positions of the connection flanges to wave guides w.r.t the cryostat center
Thermal shields	Shield shape
	Shield position w.r.t. the cryostat center
	Connection type between shields in the cryomodules
Vacuum connection flange of input coupler	Connection flange type to vacuum system
	Positions of the connection flanges to vacuum system w.r.t the cryostat center
Quadrupole	Terminal type of current leads
Correctors	Terminal type of current leads
RF cables	Terminal type of cables



C1 level (cryomodule) interface for engineering design

C1-level : Cryomodule (2)

Gas return pipe	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
2K 2-phase supply pipe	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
2.2 K cooling pipe	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
5K cooling pipe (forward)	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
5K cooling pipe (return)	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
40K cooling pipe (forward)	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
40K cooling pipe (return)	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m
Precooling pipe	Pipe size, mm (defined by the cryogenic group)
	Position of the pipe axis (x,y) w.r.t. the cryostat center at room temp., m



C2 level interface for engineering design (1)

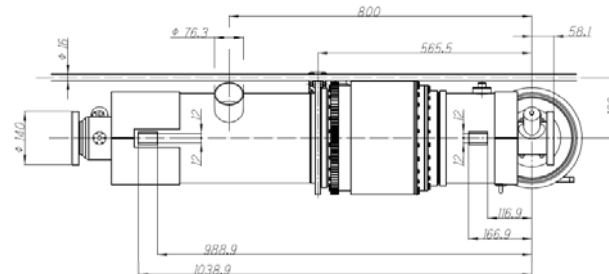
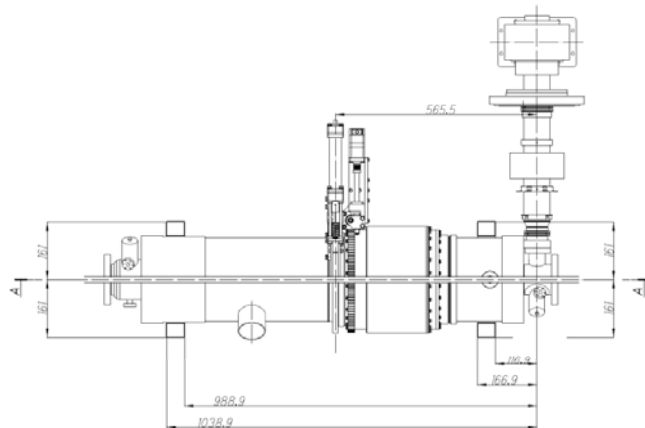
C2-level : Cold Mass (Vacuum vessel, support post, cooling pipes, shields)

Cryostat (vacuum vessel)	Length of cryostat, m
	Outer diameter, m
Input coupler connection flange on the vacuum vessel	Connection flange type between cryomodules
	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
	Distance between the connection surface and cavity axis
Tunner shaft connection flange on the vacuum vessel	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
	Distance between the connection surface and cavity axis
Cavity package support	Positions of the connection surfaces of the support legs w.r.t. the cryostat center
	Connection design with sliding mechanism
Quadrupole package support	Position of the connection surface under GRP w.r.t. the cryostat center
	Connection design
2K 2-phase supply pipe connection to cavity vessel	Connection design
Precooling pipe connection to cavity vessel (flange or welding)	Connection design

C2 level interface for engineering design (2)

C2-level : Cavity Package (cavity jacket, tuner, input coupler)-1

	Slot length, mm
	Distance between beam pipe flanges of one cavity, mm
	Distance between beam pipe bellows flanges, mm
	Maximum allowable outer radius, mm
Helium jacket	Material
	Outer diameter, mm
Beam pipe flange	Material
	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
Input coupler connection flange to the vacuum vessel	Distances between the connection surface and input coupler axis
	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
Support Tab (front)	Distance between the connection surface and cavity axis
	Material
	Horizontal positions from input coupler axis and wide, mm
	Horizontal positions from beam axis and wide, mm
	Vertical positions from cavity center and thickness, mm

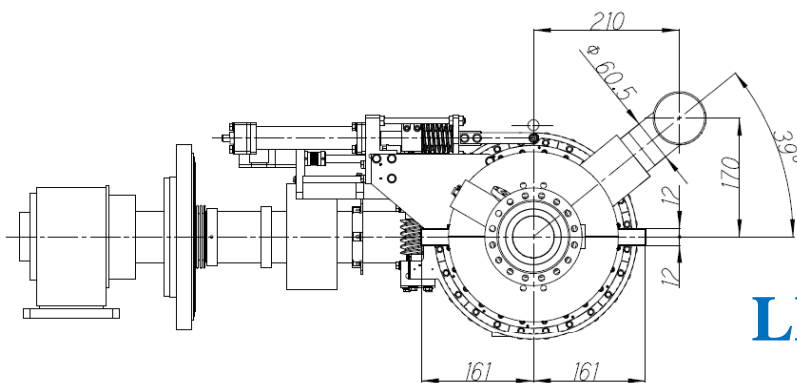


LL-cavity-package

C2 level interface for engineering design (2)

C2-level : Cavity Package (cavity jacket, tuner, input coupler)-2

Support Tab (backward)	Material
	Horizontal positions from input coupler axis and wide, mm
	Horizontal positions from beam axis and wide, mm
	Vertical positions from cavity center and thickness, mm
Tuner shaft connection flange for the outside motor	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
	Distances between the connection surface and input coupler axis
Transition pipe to 2K-2phase LHe supply pipe	Material
	Outer diameter, mm
	Angle to the horizontal phase, degree
	Pipe length, mm
	Location from input coupler axis, mm
Precooling pipe connection (flange or welding)	Connection design
RF cables	Terminal type of cables

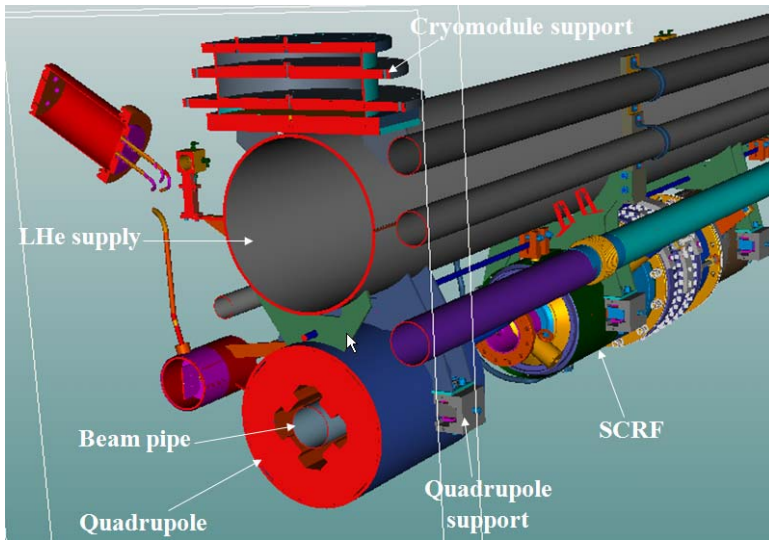


LL-cavity-package

C2 level interface for engineering design (3)

C2-level : Quadrupole Package

	Distance between beam pipe flanges, mm
	Maximum allowable outer radius, mm
Beam pipe flange	Outer diameter, mm
	Inner diameter, mm
	Thickness, mm
	PCD, bolts
	Sealing
	Position of the connection surface w.r.t. the cryostat center
Connection to GRP (under the center support post)	Support mechanism
2K-2phase pipe connection	Connection design
Precooling pipe connection	Connection design
Feedthrough for current leads	Connection design



Quadrupole design by FNAL

C2 level interface for engineering design (4)

C2-level : HOM Absorber, Vacuum Pump System

HOM Absorber		Distance between beam pipe flanges, mm
		Maximum allowable space w.r.t. beam line
	Beam pipe flange	Outer diameter, mm
		Inner diameter, mm
		Thickness, mm
		PCD, bolts
		Sealing
		Position of the connection surface w.r.t. the cryostat center
Vacuum Pump System	Connection flanges to input couplers	Connection design

C3 level interface for engineering design

C3-level :Cold Mass, Cavity Package, Quadrupole Package

Cold Mass	Cryostat (vacuum vessel)	
	Support post	
	Thermal shields	
	Gas return pipe	
	Cooling pipes	
	Invar fixture	
	Cavity sliding support	
	Quadrupole support	
Cavity Package	Cavity and beam pipe	
	Helium jacket and magnetic shield	
	Connection flange to input coupler	Material
		Outer diameter, mm
		Inner diameter, mm
		Thickness, mm
		PCD, bolts
		Sealing
		Position of the connection surface w.r.t. the cavity axis (beam line), mm
	Connection flange to HOM coupler	Material
		Outer diameter, mm
		Inner diameter, mm
		Thickness, mm
		PCD, bolts
	Sealing	
	Input coupler	
	Tuner	
	HOM coupler	
Quadrupole Package	Quadrupole	Each component has interfaces between the other components.
	Correctors	
	BPM	
	Helium jacket and magnetic shield	
	Current leads and feedthrough	

Discussion

1. Which level of the compatibility will be required for ILC cryomodule design work?

- **C1? C2? C3?**
 - **Mass-production strategy in three regions**
 - **Production of one-third of total cryomodules in each region**
 - **Cryomodule tests in each region**
 - **Strategy of component exchange during the accelerator operation**
 - **Accident of component inside the cryomodule**

Proposal

1. **Compatibility at C1 level: “MUST”**
2. **Compatibility at C2 level**
 - **Cold mass**
 - Vacuum vessel, support post, gas return pipe and cavity support, cooling pipes
 - **Cavity-string**
 - Cavities, input couplers, HOM couplers, tuner, connection bellows and flanges
 - **In the string, NO COMPATIBILITY in the base design**
 - **Quadrupole package**
 - **HOM absorber**
 - **Pumping system**
3. **No compatibility at C3 level**
4. **Assign the responsible people for designing the interface components**
 - **FNAL: Don Mitchell, DESY: Lutz Lilje, KEK: Norihito Ohuchi**