Cryomodule

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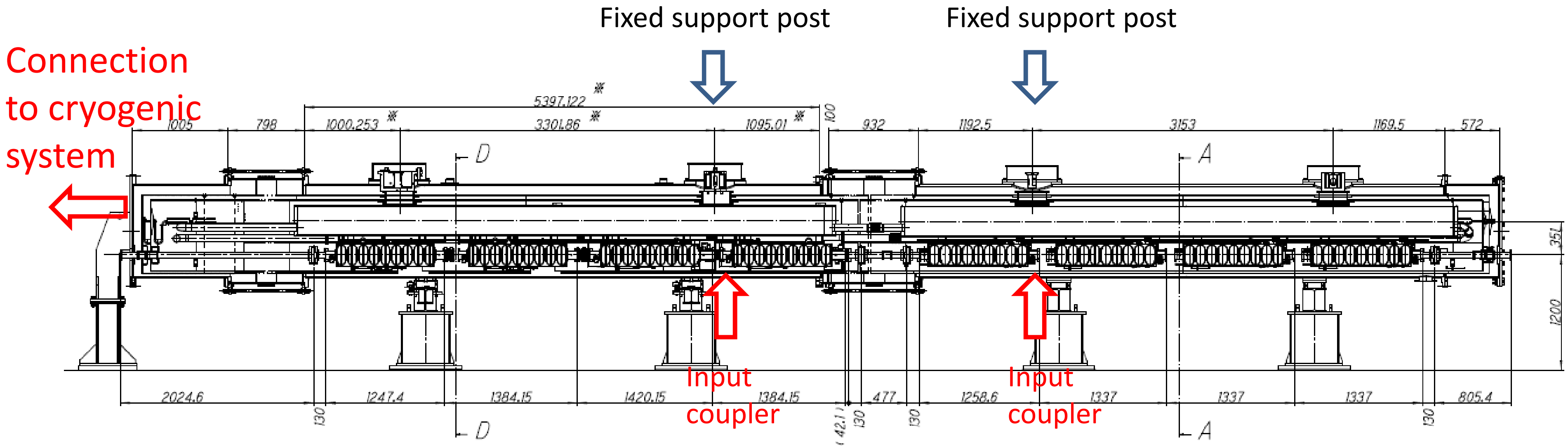
1) S1-Global cryomodule design
2) Plug-compatible design

S1-Global cryomodule design (1)

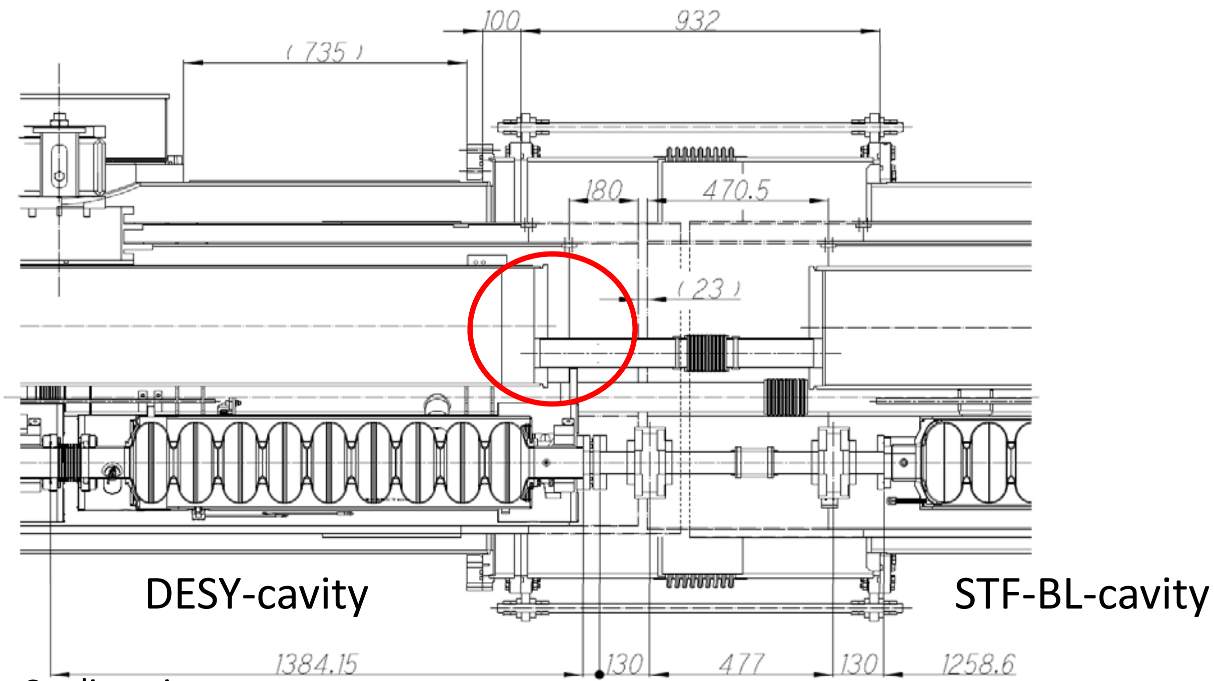


FNAL-DESY-cavities: Module C

KEK-BL-cavities: Module A

1. The configuration and the interface design of the S1-Global cryomodules were discussed between INFN and KEK.
   - Because of the position of input couplers, Module-C locates at the upper stream position.
2. The flange design of vacuum vessel of Module-C is the same as the type-III cryomodule design (same as XFEL).
   - KEK will use the present vacuum bellows, and the additional connection flanges and pipes are prepared by KEK.

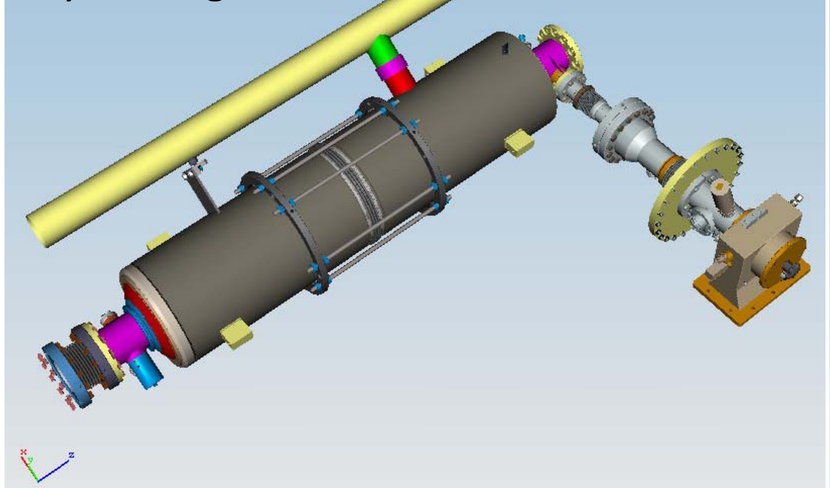
S1-Global cryomodule design (2)

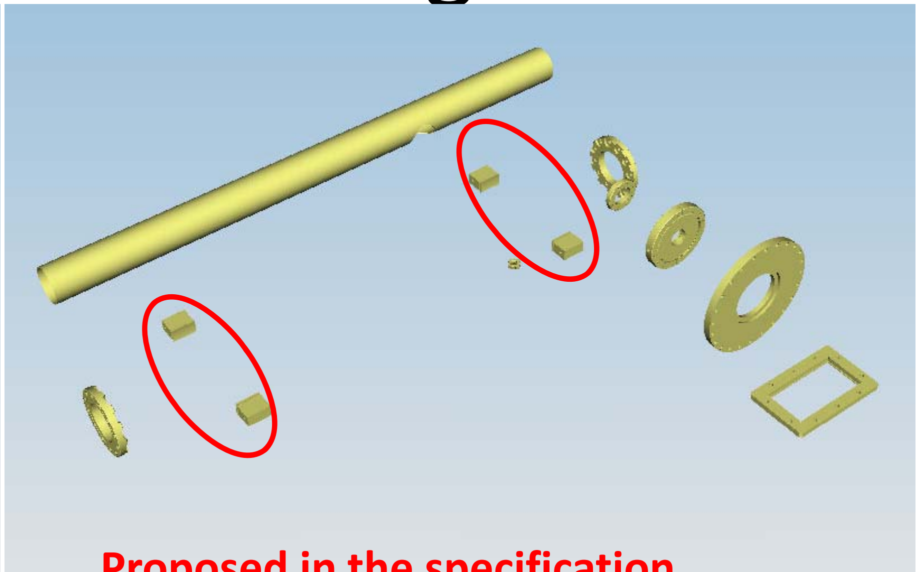


1. Cooling pipes
   - The end of gas return pipe has the plate and the reduced pipe at the transportation to KEK because of the pressure and leak tests in INFN.
   - Al shield pipes of Module C are connected to the STF pipes with the additional Al pipes by welding.
2. The input coupler positions of FNAL and DESY cavities are different because the FNAL cavity has a short beam pipe on one side.
   - It will be confirmed on the drawing.
3. KEK got the XFEL cryomodule drawing from Carlo, and the XFEL module design will be reflected in the S1-global cryomodule design.
4. KEK tries to complete the specific cryomodule design in August. The design should be reviewed by the concerned people.

Plug Compatible Design

Cavity Package

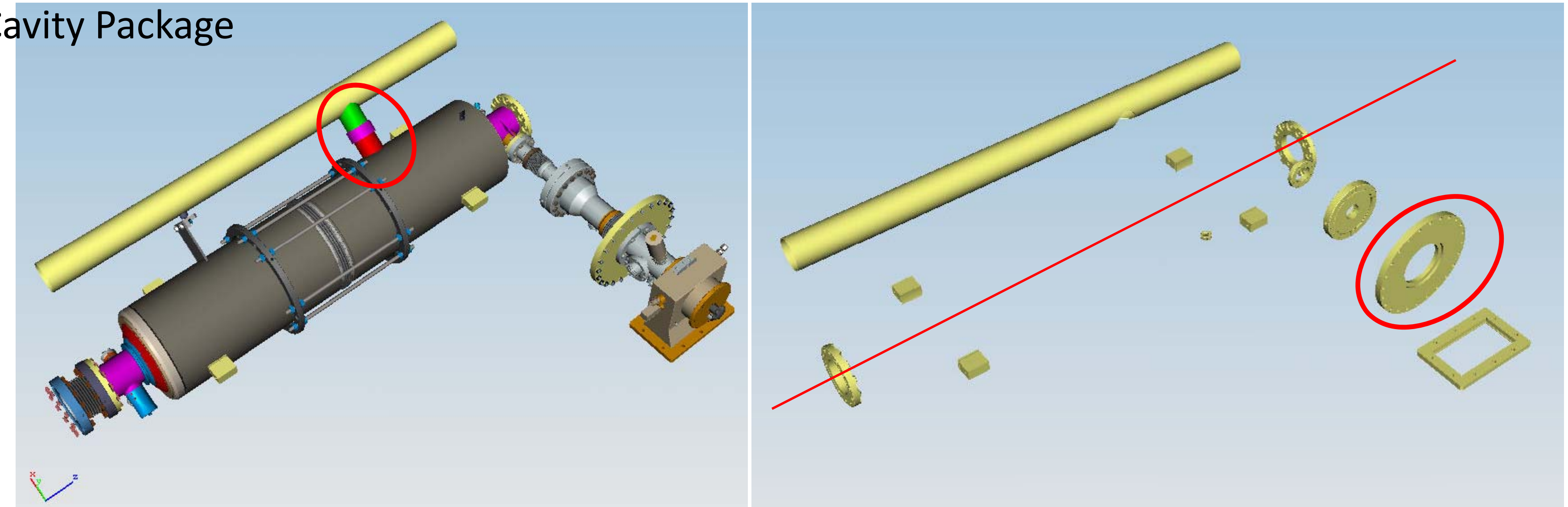




Proposed in the specification

		KEK-STF-BL	KEK-STF-LL	FNAL-T4CM	DESY-XFEL
Support Lug (front)	Material	SUS316	SUS316	Ti	Ti
	Horizontal positions from input				
	coupler axis and wide, mm	Z=-77.5, W=67	Z=-141.9, W=50	Z=-947.51, W=50	Z=-946.87, W=40
	Horizontal positions from beam				
	axis and wide, mm	X=155, W=38	X=161, W=38	X=161, W=41	X=161, W=35.82
	Vertical positions from cavity				
	center and thickness, mm	Y=160, T=24	Y=0, T=24	Y=0, T= 24	Y=0, T=24
Support Lug (backward)	Material	TP340	SUS316	Ti	Ti
	Horizontal positions from input				
	coupler axis and wide, mm	Z=-997.5, W=105	Z1=-1013.9, W=50	Z=-197.51, W=50	Z=-196.87, W=40
	Horizontal positions from beam				
	axis and wide, mm	X=155, W=38	X=161, W=38	X=161, W=41	X=161, W=35.82
	Vertical positions from cavity				
	center and thickness, mm	Y=160, T=24	Y=0, T=24	Y=0, T=24	Y=0, T=24

Cavity Package



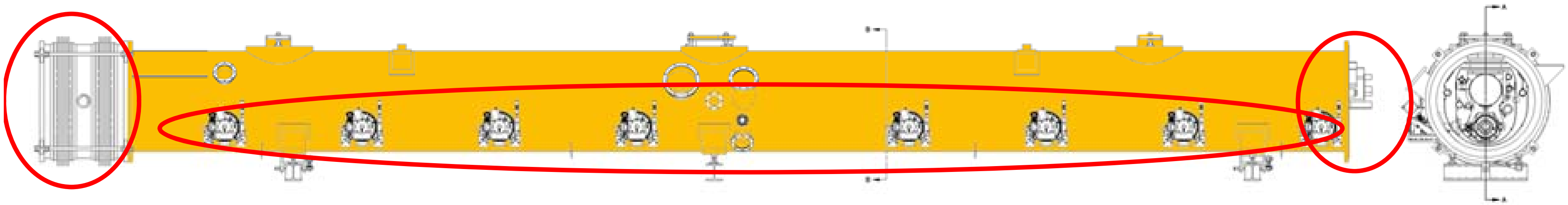
Input Coupler		KEK-STF-BL	KEK-STF-LL	FNAL-T4CM	DESY-XFEL
Connection flange	Material	SUS316L	SUS316	316L S.S.	316L S.S.
to vacuum vessel	Outer diameter, mm	185	265	260	260
	Inner diameter, mm	104	212.5		
	Thickness, mm	16	21	16	16
	PCD, bolts	ϕ144, 16-M8×10/8	ϕ245, 12-ϕ8.5	24, M8 SHCS S.S.	24, M8 SHCS S.S.
	Sealing	O-Ring (G-165)	O_Ring	O_Ring	O_Ring
	Distance between the connection				
	surface and cavity axis	485	488	473.5	473.5

1. We will study the new flange design of the STF input coupler in order to connect it to the FNAL and DESY flanges.
2. Locations of the cross connect pipe to the LHe supply pipe and the cool-down pipe will be decided after studying the tuner location on the helium jacket.
3. Interference between the cavity packages and the components in the cryostat should be studied with 3D-CAD drawings.

Vacuum vessel	Cryomodule slot length	12680	12680
	Material (demagnetized)	Carbon Steel	Carbon Steel
	Length (+ vacuum bellow length)	11830 (+850)	11830 (+850)
	tolerance of length	± 3	± 3
	Outer diameter	965.2	965.2
	Inner diameter	946.2	946.2
	Height of vessel center axis from the support base level	832	832
	Input coupler port	8	9
	Main Coupler #1 z position	-4744.1	-4744.1
	Main Coupler #2 z position	-3417.4	-3417.4
	Main Coupler #3 z position	-2090.7	-2090.7
	Main Coupler #4 z position	-764	-764
	Main Coupler #5 z position	(Quadrupole PKG)	562.7
	Main Coupler #6 z position	1889.4	1889.4
	Main Coupler #7 z position	3216.1	3216.1
	Main Coupler #8 z position	4542.8	4542.8
	Main Coupler #9 z position	**5869.5**	5869.5
	(Tuner driver-shaft port)	8	9
	Port for current leads	1	0
	current lead terminals (quadrupole, 2 dipoles)	6	0
	Port for signal wires	2	2
	Port for vacuum	2	2
	Residual magnetic field on the beam line	< 0.1 Gauss	< 0.1 Gauss

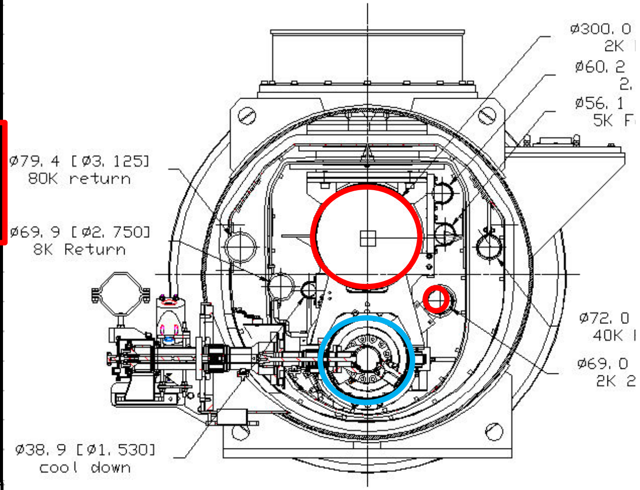
Interface

1. Connection flanges of vacuum vessel and vacuum bellow:
   T3 (XFEL) and T4-CM design
2. Main coupler flanges on the vessel:
   Locations defined in Spec. Table
   Design need to be studied



Cooling Pipes

Cooling pipes		
2.2 K subcooled supply pipe	Material	SUS
	Inner diameter , mm	60
	Maximum design pressure , bar	20
	Position w.r.t. the cavity center (x,y)	(219, 481.5)
Major return header (GRP)	Material	SUS
	Inner diameter , mm	300
	Maximum design pressure , bar	2 at warm (4 at cold)
	Position w.r.t. the cavity center (x,y)	(0., 356)
5K shield and intercept (supply)	Material	Al 1050 or equivalent material
	Inner diameter , mm	56.1
	Maximum design pressure , bar	20
	Position w.r.t. the cavity center (x,y)	(225.5, 362.5)
8K shield and intercept (return)	Material	Al 1050 or equivalent material
	Inner diameter , mm	70
	Maximum design pressure , bar	20
	Position w.r.t. the cavity center (x,y)	(-252, 210)
40K-80K shield and intercept (supply)	Material	Al 1050 or equivalent material
	Inner diameter , mm	72
	Maximum design pressure , bar	20
	Position w.r.t. the cavity center (x,y)	(355, 325)
40K-80K shield and intercept (return)	Material	Al 1050 or equivalent material
	Inner diameter , mm	80
	Maximum design pressure , bar	20
	Position w.r.t. the cavity center (x,y)	(-367, 326)
2-phase pipe	Material	SUS or Ti
	Inner diameter , mm	72.1
	Maximum design pressure , bar	2 at warm (4 at cold)
	Position w.r.t. the cavity center (x,y)	(210.6, 170.6)
Cooldown and Warmup	Material	SUS
	Inner diameter , mm	38.9
	Maximum design pressure , bar	2 at warm (4 at cold)
	Position w.r.t. the cavity center (x,y)	(-170, 200)
Helium vessel to 2-phase pipe cross-connect	Material	SUS or Ti
	Inner diameter , mm	54.9
	Maximum design pressure , bar	2 at warm (4 at cold)



1. The beam line (cavity axis) locates in the position of (0, -247) with respect to the center of vacuum vessel).
2. The thermal radiation shield design with or without 5K shield should be done in the condition of plug compatible design.