Summary
（Cryomodule, Plug-compatible Interface)

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Presentations and Discussions

- Discussion of specific table definition
- Presentations of Plug-compatibility issues for cryomodules
  - Plug compatibility and EDMS — Don Mitchell
  - ILC and PrX cryomodules — Sergei Nagaitsev
  - Interfaces XFEL power couplers — Serge Prat
  - Radial wedge clamp flange seal — Ed daly

Specification Table for Cryomodule

- Items of specific parameters are discussed and almost decided.
  - Heat load
  - Alignment tolerance
  - Vacuum vessel dimensions and functions
  - Cavity helium jacket
  - Cooling pipes
  - Support posts, Thermal shields, Quadrupole package
  - Thermal constraint

		8 C + 1 Q	9 C + No Q.
Number		627	1188
Heat Load	at 2K	<11.7 W	<11.2 W
(Static + Dynamic)	at 5K	<14.2 W	<16.5 W
	at 40K	<149.4 W	<161.7 W
Alignment Tolerance [RMS]	Cavity offset w.r.t. cryomodule	0.3 mm	0.3 mm
	Quadrupole offset w.r.t cryomodule	0.3 mm	NA
	Quadrupole rotation w.r.t. design	0.3 mrad	NA
	Cavity pitch w.r.t. cryomodule	0.2 mrad	0.2 mrad
	Cavity yaw w.r.t. cryomodule	1 mrad	1 mrad
	Cryomodule offset w.r.t. design	0.2 mm	0.2 mm
	Cryomodule pitch w.r.t. design	0.02 mrad	0.02 mrad
	Cryomodule yaw w.r.t. design	0.1 mrad	0.1 mrad
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

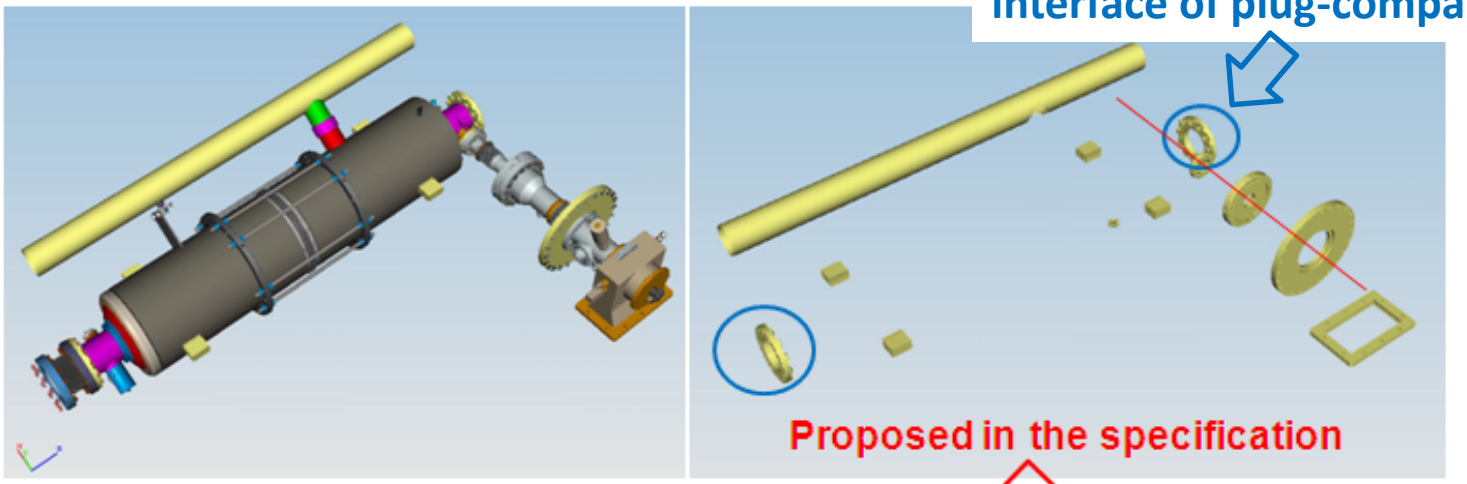
From comments and discussions for spec. table

- The listed values are mainly referred to the T4CM design.
  - The numbers must be revised from the concept design study of the cryomodule.
  - The listed number should be considered for industrialization.
  - ☐ Organize the group and the taskforce of Parameter Study of the ILC Cryomodule
- The machining tolerance and the alignment tolerance of the components in the module need to be decided with the process and cost for manufacture and assembly.
  - ☐ Taskforce of Tolerance Study of the ILC cryomodule
  - ☐ Company person should be included in this study.

Interface definition of the plug-compatible cryomodule

Cavity Package-1

The flange should be the interface of plug-compatibility.



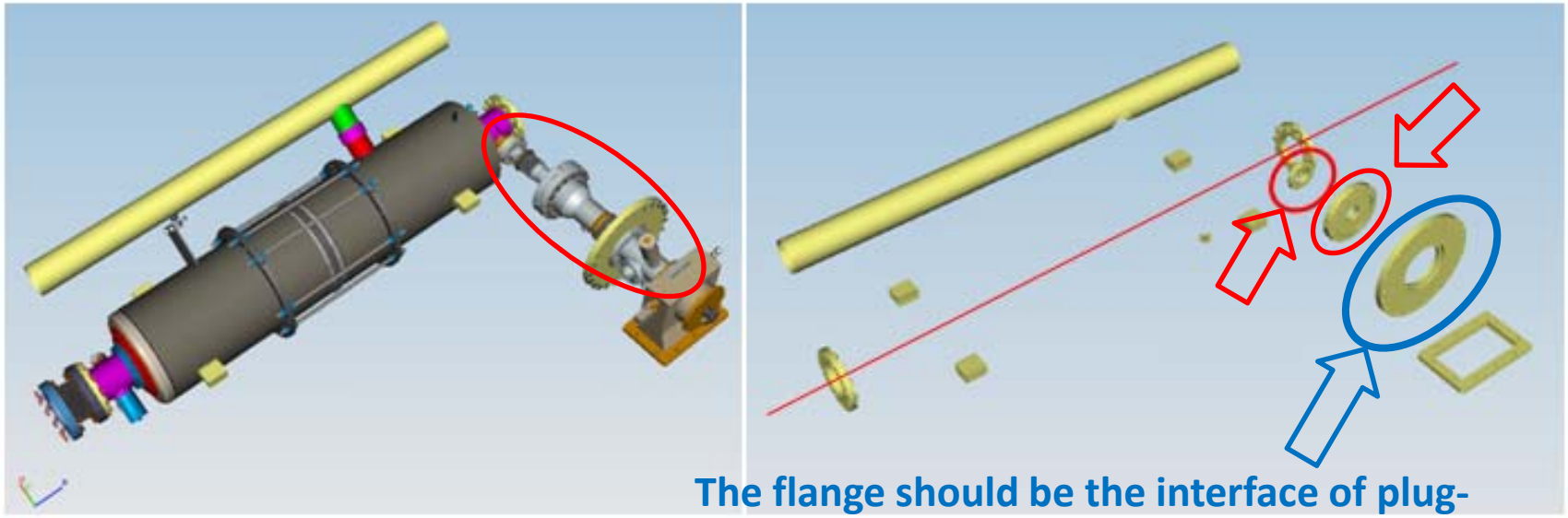
Helium Vessel Body		KEK-STF-BL	KEK-STF-LL	FNAL-T4CM	DESY-XFEL
Helium Jacket	Material	Ti	SUS	Ti	Ti
	Slot length, mm	1337	1337	1326.7	(1382:Type3)
	Distance between beam pipe flanges, m	1258.6	1254.5	1247.4	1283.4
	Distance between bellows flanges, mm	78.4	85.2	80.49 (cold)	
	Outer diameter, mm	242	236	240	240
Beam Pipe Flange	Material	NbTi	Ti	NbTi	NbTi
	Outer diameter, mm	130	140	140	140
	Inner diameter, mm	84	80	82.8	82.8
	Thickness, mm	14	17.5	17.5	17.5
	PCD, bolts	ϕ115, 16-ϕ9	ϕ120, 16-ϕ9	12, M8 SS studs	12, M8 SS studs
	Sealing	Helicoflex	M-O seal	Al Hex Seals	Hexagonal Al ring
	Distances between the connection				
	surface and input coupler axis	62, -1196.6	58.1, -1213.9	60.6, -1186.8	60.6, -1222.8

Many types of sealing and flange

+ RW clamp flange seal(J-Lab)

PM Akira Yamamoto will propose the taskforce of the connection flange system.

Cavity Package-2: Input Coupler



The flange should be the interface of plug-compatibility.

From Serge Prat presentation,

ILC couplers:

→ Define interface in terms of:

- material and geometry, heat load, surface finish, bolts and nuts, seals, which WP provides what

→ if these interfaces are respected, then couplers:

- are plug-compatible
- but may be different (≠ vendors, ≠ batches)

→ Big constraint on coupler structure (2 separate parts) due to module assembly principles:

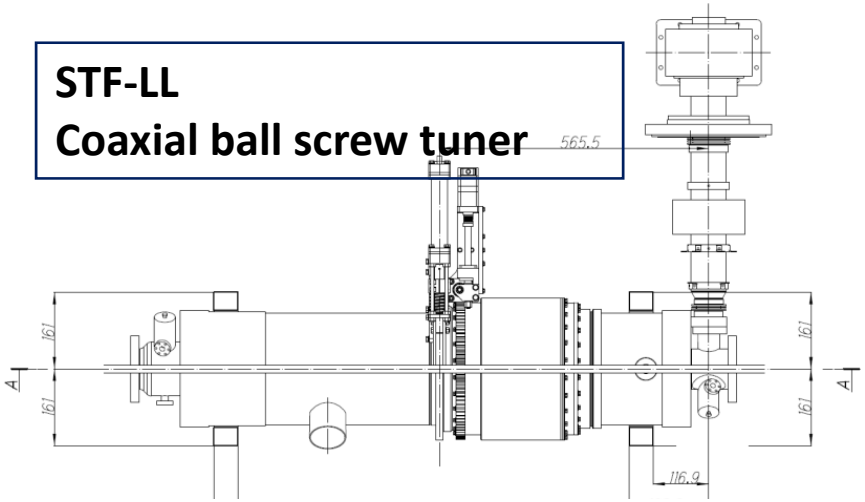
- cold part assembled on cavity string in clean room
- warm part assembled on cryomodule outside clean room

Tuner

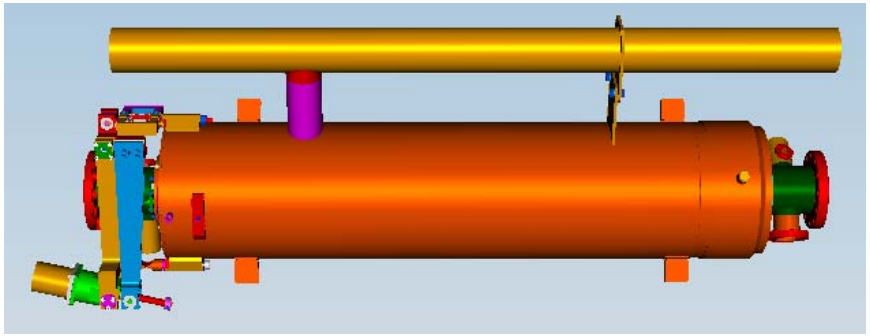
Interface items

Space envelope and location → Cavity integration group

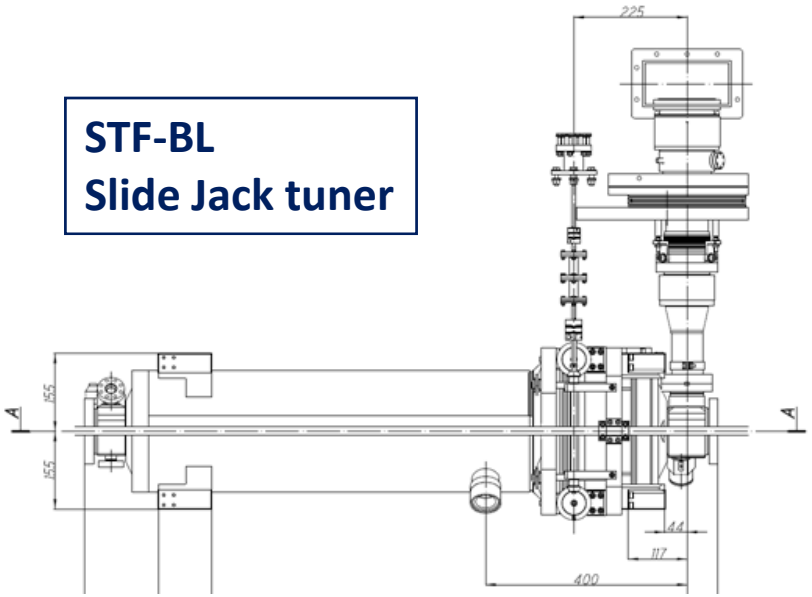
STF-LL
Coaxial ball screw tuner

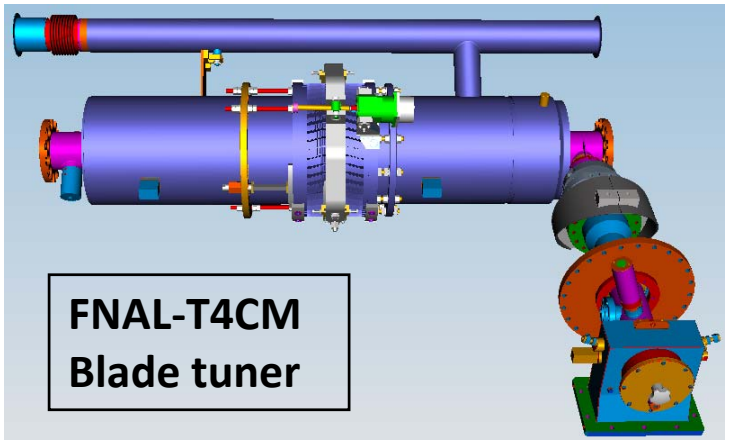


DESY-XFEL
Sacley tuner



STF-BL
Slide Jack tuner





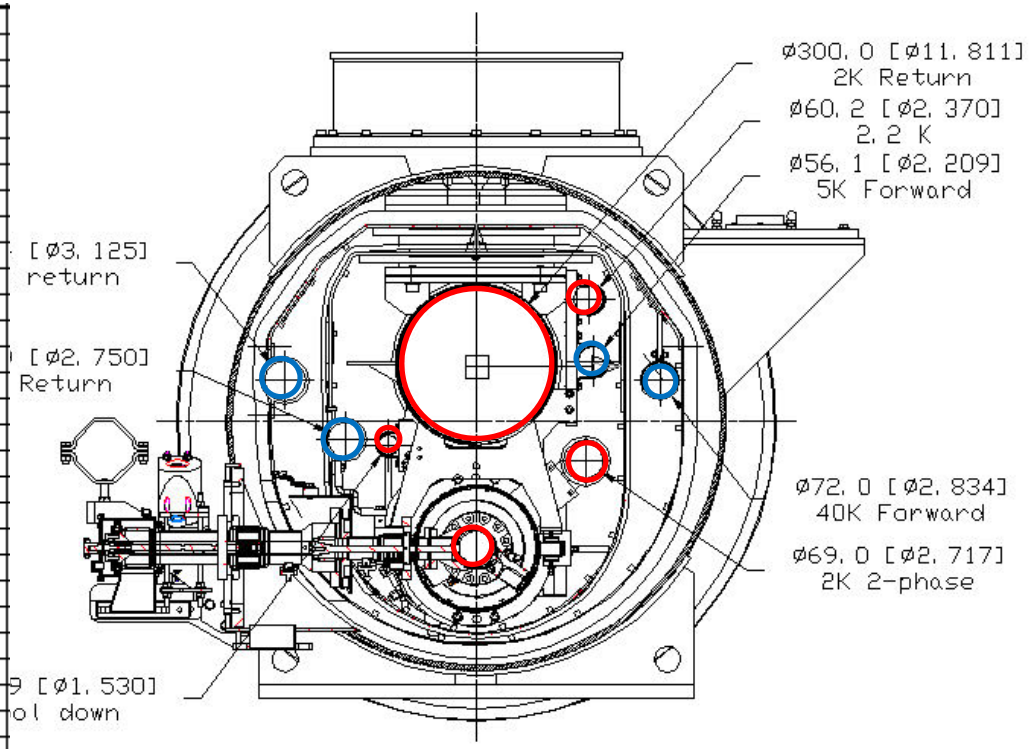
FNAL-T4CM
Blade tuner

Cooling Pipes

Interface items

Cooling pipe size, position and material are decided for plug-compatibility of cryomodule. These parameters are listed in the specification table.

Cooling pipes	
2.2 K subcooled supply pipe	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
Major return header (GRP)	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
	Tolerance of the straightness of GRP
5K shield and intercept (supply)	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
8K shield and intercept (return)	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
40K-80K shield and intercept (supply)	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
40K-80K shield and intercept (return)	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
2-phase pipe	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
Cooldown and Warmup	Material
	Inner diameter , mm
	Design pressure , bar
	Position w.r.t. the cavity center (x,y)
Helium vessel to 2-phase pipe cross-c	Material
	Inner diameter , mm
	Design pressure , bar



Pipe location constraints

1. GRP, Cool-down and warm-up pipe, LHe supply pipe and Cavity Jacket (LHe level).
2. Shield cooling pipe (intercept location)

Vacuum vessel

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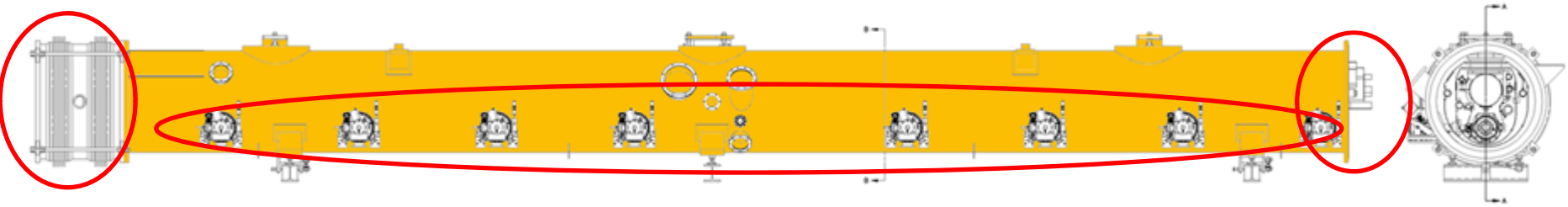
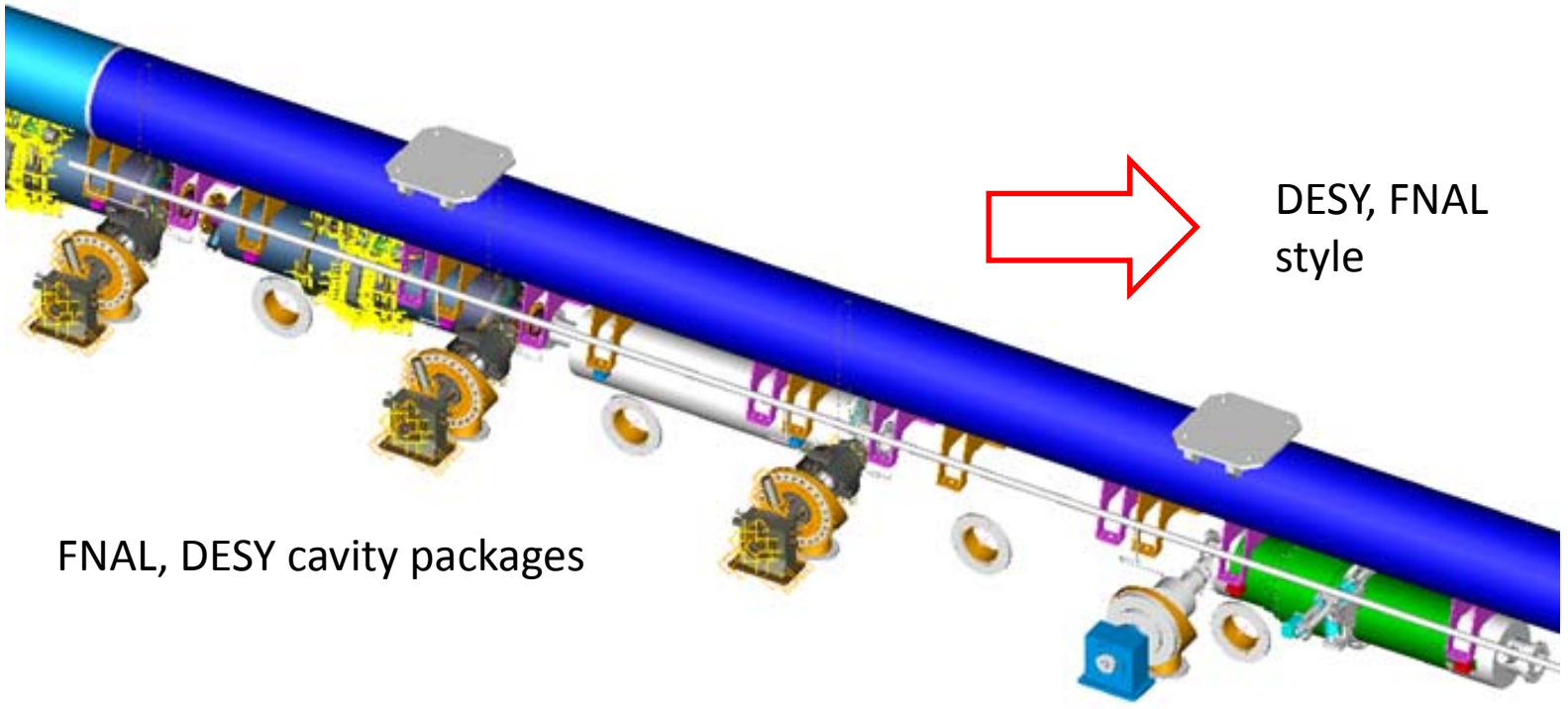
Interface

1. Connection flange of vessel and vacuum bellow:
   T4-CM or DESY XFEL design
2. Main coupler flanges on the vessel:
   Locations defined in Spec. Table
   Need design study of the flange



Input coupler and cavity jacket coordinate system incompatibility

- The direction of input coupler to cavity jacket
  - KEK-STF input couplers connect to beam pipes in the opposite direction with respect to the cavity package.



Conclusion

1. Specification
   - To finalize the items and values;
     - Group and Taskforce of Parameter Study of the ILC Cryomodule
     - Taskforce of Tolerance Study of the ILC cryomodule
2. Interface for plug-compatibility of cryomodule
   - Cavity package
     - Beam pipe connection flange and input coupler-vacuum vessel flanges
       - Taskforce of cold flange sealing system should be proposed.
     - Tuner space envelop and location (work with cavity package integration group)
   - Cooling pipe
     - Pipe size and location (should be decided in the specification table)
   - Vacuum vessel
     - Connection flange of vessel and vacuum bellow
     - Input coupler flanges
   - Coordinate system definition
     - Accelerator and cryomodule