

Sensors assembled in the S1-G Cryomodules

Norihito Ohuchi

Measurements of cryomodule thermal characteristics (static and dynamic conditions)

- Heat loads of the system
 - Heat load at 2K
 - Evaporation of 2K LHe
 - Mass flow rate, Pressures and Temperatures at cavity jacket and pump discharge
 - Heat load at 5K
 - Temperature rise after stopping flow of 5K helium to the 5K shield
 - Temperatures of 5K shield
 - Heat load at 80K
 - Temperature rise after stopping flow of liquid nitrogen to the 80K shield
 - Temperatures of 80K shield
- Heat loads of the components
 - Thermal calculation of the measured temperature profile in the components
 - Temperatures of the components
 - Input couplers, Support posts, Thermal anchors, Thermal shields, RF cables
- Cool-down effect on the cavity alignment
 - Measurement of the cavity-jackets and GRPs positions during cool-down by WPMs

List of temperature sensors (Module-A)

Cernox	(calibrated from 1.4K to 100K)	PtCo	(from 4K to 300K)	CC thermocouples	(from 70K to 300K)
#1 Cavity	Helium Vessel	#1 Cavity	Helium Vessel	#1 Cavity	80K thermal anchor of input coupler
	Connection area of input coupler with beam pipe	#2 Cavity	Helium Vessel		80K thermal anchor of input coupler close to cooling pipe
	5K thermal anchor of input coupler	#3 Cavity	Helium Vessel		Warm input coupler connection flange
	HOM coupler in the input coupler side-top	#4 Cavity	Helium Vessel	#2 Cavity	80K thermal anchor of input coupler
	HOM coupler in the input coupler side-bottom	5K Shield	0 degree in the side of mocule-C		80K thermal anchor of input coupler close to cooling pipe
	HOM coupler in the non-input coupler side-top		90 degree in the side of mocule-C		Warm input coupler connection flange
	HOM coupler in the non-input coupler side-bottom		180 degree in the side of mocule-C	#3 Cavity	80K thermal anchor of input coupler
#2 Cavity	Helium Vessel		270 degree in the side of mocule-C		80K thermal anchor of input coupler close to cooling pipe
	Connection area of input coupler with beam pipe		90 degree at fixed support post		Warm input coupler connection flange
	5K thermal anchor of input coupler		180 degree at fixed support post	#4 Cavity	80K thermal anchor of input coupler
	HOM coupler in the input coupler side-top		270 degree at fixed support post		80K thermal anchor of input coupler close to cooling pipe
	HOM coupler in the input coupler side-bottom		0 degree at shield center		Warm input coupler connection flange
	HOM coupler in the non-input coupler side-top		90 degree at shield center	Fixed support post	80K anchor at the 0 degree
	HOM coupler in the non-input coupler side-bottom		180 degree at shield center		80K anchor at the 180 degree
#3 Cavity	Piezo		270 degree at shield center		Room temp. area
	Helium Vessel		90 degree at movable support post	Movable support post	80K anchor at the 0 degree
	Connection area of input coupler with beam pipe		180 degree at movable support post		80K anchor at the 180 degree
	5K thermal anchor of input coupler		270 degree at movable support post		Room temp. area
	HOM coupler in the input coupler side-top		0 degree in the side of end flange	80K Shield	0 degree in the side of mocule-C
	HOM coupler in the input coupler side-bottom		90 degree in the side of end flange		90 degree in the side of mocule-C
	HOM coupler in the non-input coupler side-top		180 degree in the side of end flange		180 degree in the side of mocule-C
#4 Cavity	HOM coupler in the non-input coupler side-bottom		270 degree in the side of end flange		270 degree in the side of mocule-C
	Piezo	Fixed support post	5K anchor at the 0 degree		0 degree in the center
	Helium Vessel	Movable support post	5K anchor at the 180 degree		90 degree in the center
	Connection area of input coupler with beam pipe		5K anchor at the 0 degree		180 degree in the center
	5K thermal anchor of input coupler	GRP	5K anchor at the 180 degree		270 degree in the center
	HOM coupler in the input coupler side-top		Connection area to the fixed support post		0 degree in the side of end flange
	HOM coupler in the input coupler side-bottom		Connection area to the movable support post		90 degree in the side of end flange
GRP	HOM coupler in the non-input coupler side-top				180 degree in the side of end flange
	HOM coupler in the non-input coupler side-bottom				270 degree in the side of end flange
	Piezo			Beam pipe	Position inside of 80K thermal anchor
	Upstream-top (Module-C connection side)			GRP	Upstream-top (Module-C connection side)
	Upstream-bottom (Module-C connection side)				Upstream-bottom (Module-C connection side)
	Center-top				Center-top
	Center-bottom				Center-bottom
Beam Pipe	Downstream-top (end flange side)				Downstream-top (end flange side)
	Downstream-bottom (end flange side)				Downstream-bottom (end flange side)
	Position inside of 5K thermal anchor				

CERNOX: Total 39

Four cavities : 32
GRP : 6
Beam pipe : 1

PtCo: Total 28

Four cavities : 4
5K shield : 18
Support posts : 4
GRP : 2

CC: Total 37

Four cavities : 12
Support posts : 6
80K shield : 12
Beam pipe : 1
GRP : 6

WPM

WPM	ID Number	Location (mm)	
CM-A GRP	#1	-1123.5	z axis: the origin is the fixed post
	#2	226.5	
	#3	1576.5	
	#4	2926.5	
	#5	4276.5	
CM-A: Cav-#1	#1		
	#2		
CM-A: Cav-#2	#1		
	#2		
CM-A: Cav-#3	#1		
	#2		
CM-A: Cav-#4	#1		
	#2		

On the GRP in Module A, five WPMs will be assembled. Two WPMs on each KEK cavity jacket are planed to be assembled.

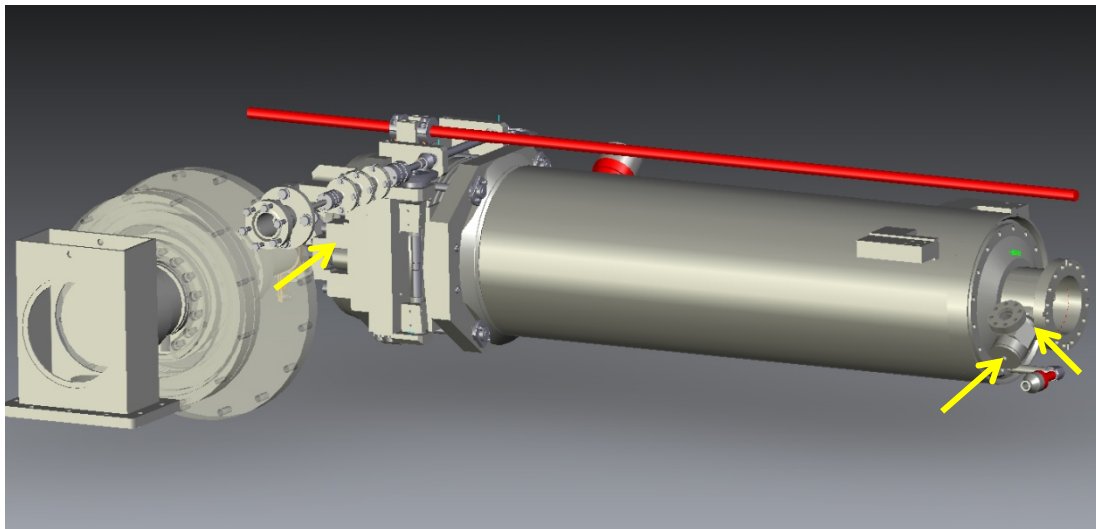
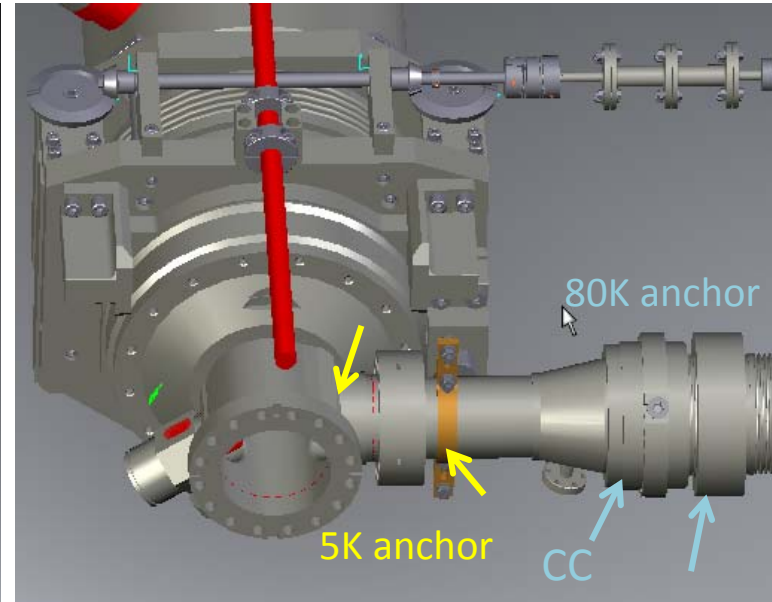
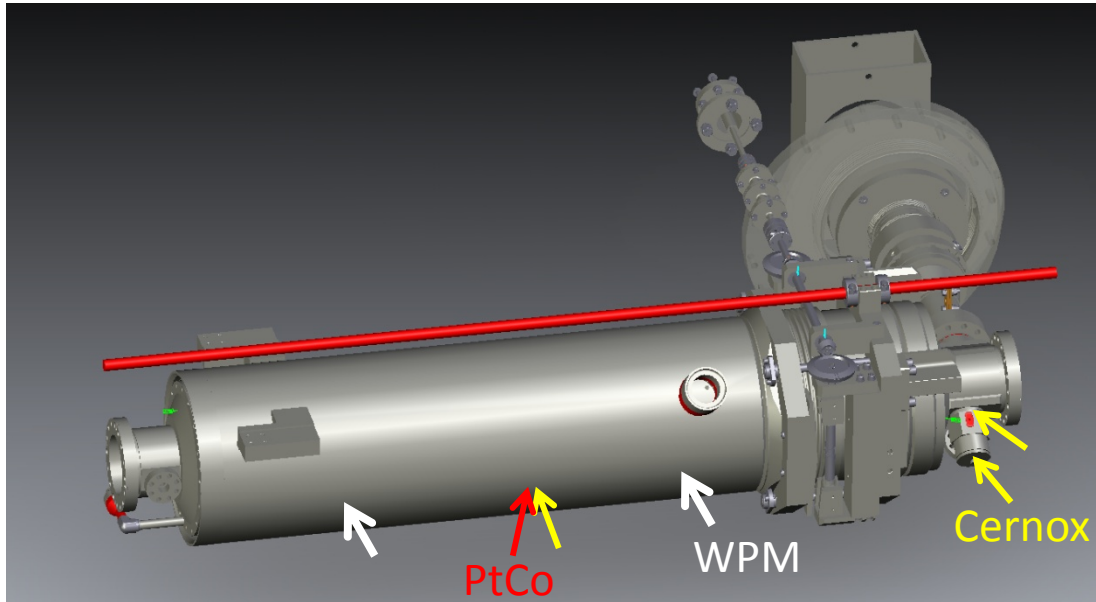
WPM	ID Number	Location (mm)	
CM-C GRP	#1	-1200	z axis: the origin is the fixed post physical center of GRP
	#2	0	
	#3	1600	
	#4	3200	
	#5	4600	
CM-C: Cav-#1	NA		
	NA		
CM-C: Cav-#2	NA		
	NA		
CM-C: Cav-#3	NA		
	NA		
CM-C: Cav-#4	NA		
	NA		

On the GRP in Module C, five WPMs will be assembled. WPMs on DESY and FNAL cavity jackets are not planed to be assembled.

Pressure sensors, etc

Pressure Sensors				
GRP	CM-A	Absolute pressure sensor (Hitachi)		0~27kPa
	Connection pipe between CM-A and CM-C	Absolute pressure sensor (Hitachi)		0~27kPa
	CM-A	Absolute pressure sensor (Baratron)		0~13.3kPa
	CM-A	Pressure sensor		-0.1 MPa~0.1 MPa
2K Cold Box	4K LHe vessel	Pressure sensor (Hitachi)		-0.1 MPa~0.5 MPa
	2K LHe vessel	Absolute pressure sensor (Baratron)		0~13.3kPa
	5K shield return gas line (cold)	Pressure sensor (Hitachi)		-0.1 MPa~0.5 MPa
5K shield piping	5K shield return gas line (room temperature)	Pressure sensor		-0.1 MPa~0.5 MPa
Pump system	Pump discharge pressure	Pressure sensor		-0.1 MPa~0.5 MPa
Vacuum vessel	CM-A	CCG		
	CM-A	Pirani gauge		
Mass flow meter				
Pump system	Pump discharge	Volume flow meter		0~65 Nm ³ /h
	Pump discharge	Volume flow meter		0~10 Nm ³ /h
5K shield piping	5K shield return gas line (room temperature)	Volume flow meter		0~65 Nm ³ /h
Temperature sensor				
2K Cold Box	4K LHe vessel	Cernox, PtCo		1.5K~40K, 4K~300K
	2K LHe vessel	Cernox		1.5K~40K
Pump system	Pump discharge (near mass flow meter)	CC		80K~320K
5K shield piping	5K shield return gas line (near mass flow meter)	CC		80K~320K
LHe level sensor				
2K Cold Box	4K LHe vessel	Superconducting level sensor (AMD)		
	2K LHe vessel	Superconducting level sensor (AMD)		

KEK- cavity jacket



Cernox

Helium Vessel
Connection area of input coupler with beam pipe
5K thermal anchor of input coupler
HOM coupler in the input coupler side-top
HOM coupler in the input coupler side-bottom
HOM coupler in the non-input coupler side-top
HOM coupler in the non-input coupler side-bottom
Piezo

PtCo

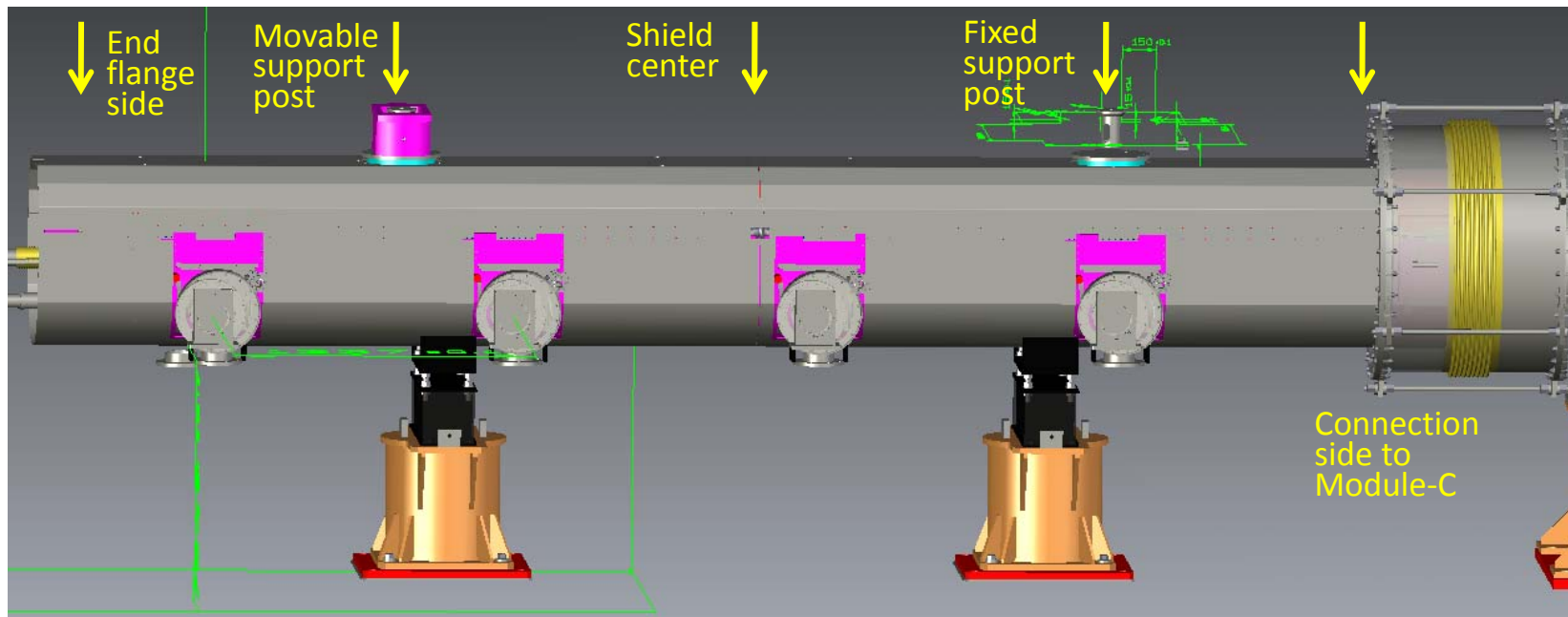
Helium Vessel

CC

80K thermal anchor of input coupler
Warm input coupler connection flange

WPM for KEK cavity jacket

Thermal shields for Module A

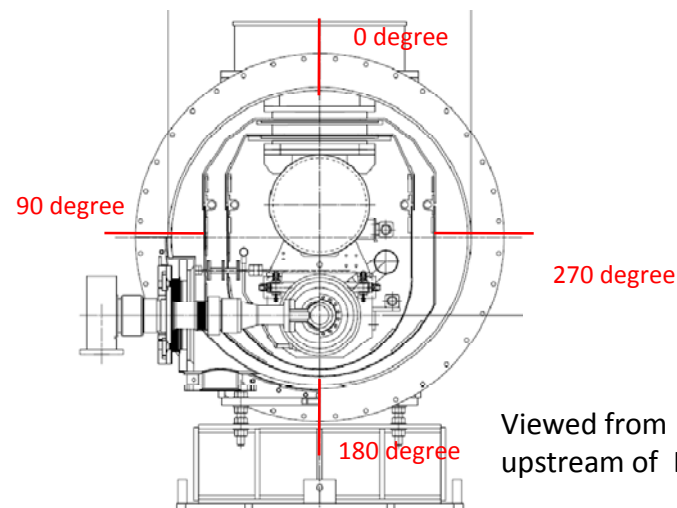


5K shield (PtCo)

0 degree in the side of module-C
90 degree in the side of module-C
180 degree in the side of module-C
270 degree in the side of module-C
90 degree at fixed support post
180 degree at fixed support post
270 degree at fixed support post
0 degree at shield center
90 degree at shield center
180 degree at shield center
270 degree at shield center
90 degree at movable support post
180 degree at movable support post
270 degree at movable support post
0 degree in the side of end flange
90 degree in the side of end flange
180 degree in the side of end flange
270 degree in the side of end flange

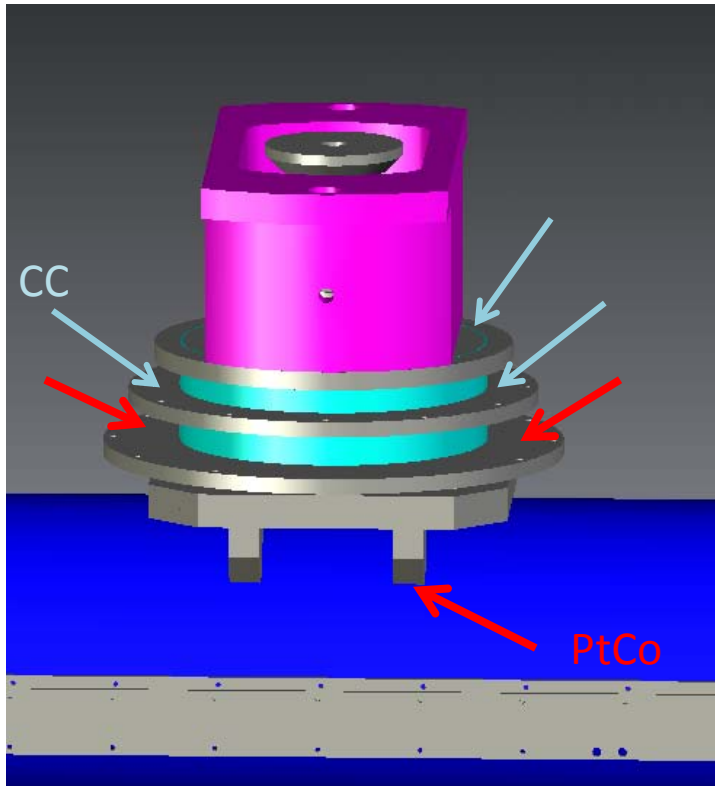
80K shield (CC)

0 degree in the side of module-C
90 degree in the side of module-C
180 degree in the side of module-C
270 degree in the side of module-C
0 degree in the center
90 degree in the center
180 degree in the center
270 degree in the center
0 degree in the side of end flange
90 degree in the side of end flange
180 degree in the side of end flange
270 degree in the side of end flange



Viewed from upstream of He flow.

Support Post



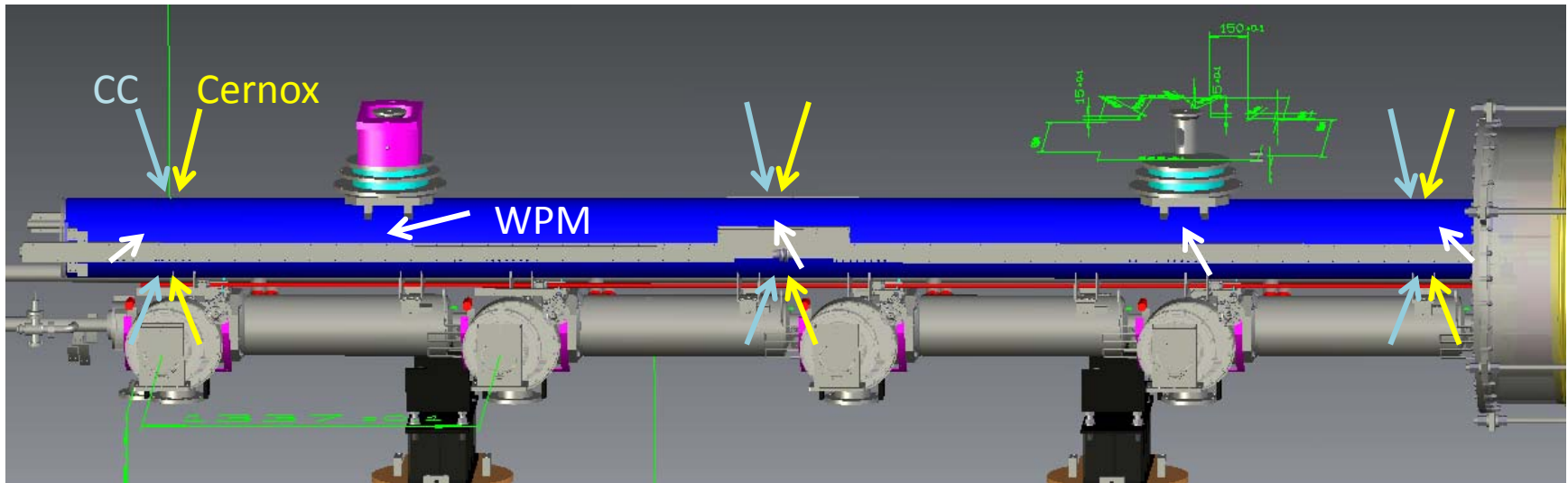
PtCo

Fixed support post	5K anchor at the 0 degree
	5K anchor at the 180 degree
Movable support post	5K anchor at the 0 degree
	5K anchor at the 180 degree
GRP	Connection area to the fixed support post
	Connection area to the movable support post

CC

Fixed support post	80K anchor at the 0 degree
	80K anchor at the 180 degree
	Room temp. area
Movable support post	80K anchor at the 0 degree
	80K anchor at the 180 degree
	Room temp. area

GRP



Cernox and CC

Upstream-top (valve box connection side)
Upstream-bottom (valve box connection side)
Center-top
Center-bottom
Downstream-top (module-C connection side)
Downstream-bottom (module-C connection side)

WPM

CM-A GRP	#1	-1123.5	z axis: the origin is the fixed post
	#2	226.5	
	#3	1576.5	
	#4	2926.5	
	#5	4276.5	

CM-C GRP	#1	-1200	z axis: the origin is the fixed post physical center of GRP
	#2	0	
	#3	1600	
	#4	3200	
	#5	4600	

