Status of RVC

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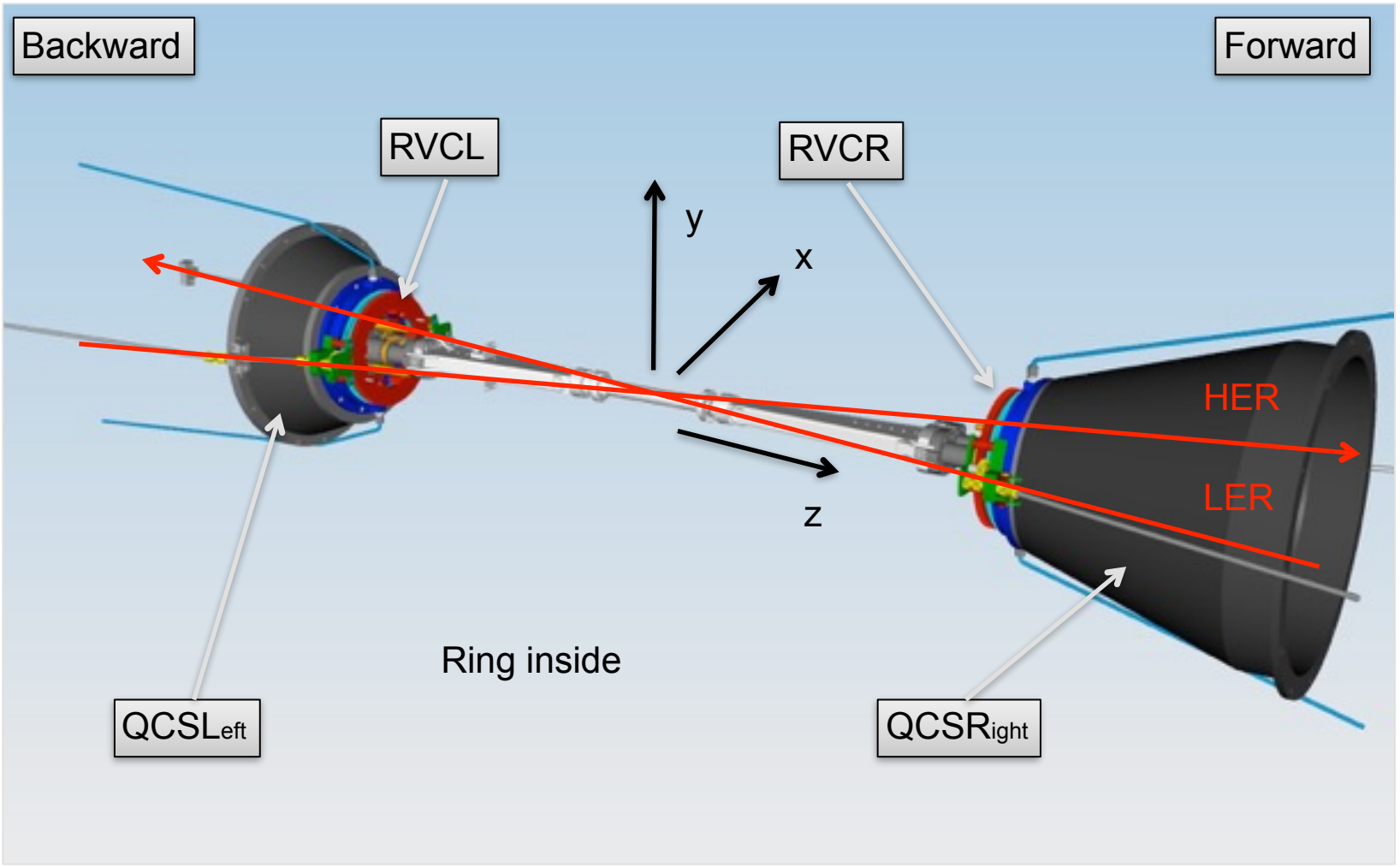
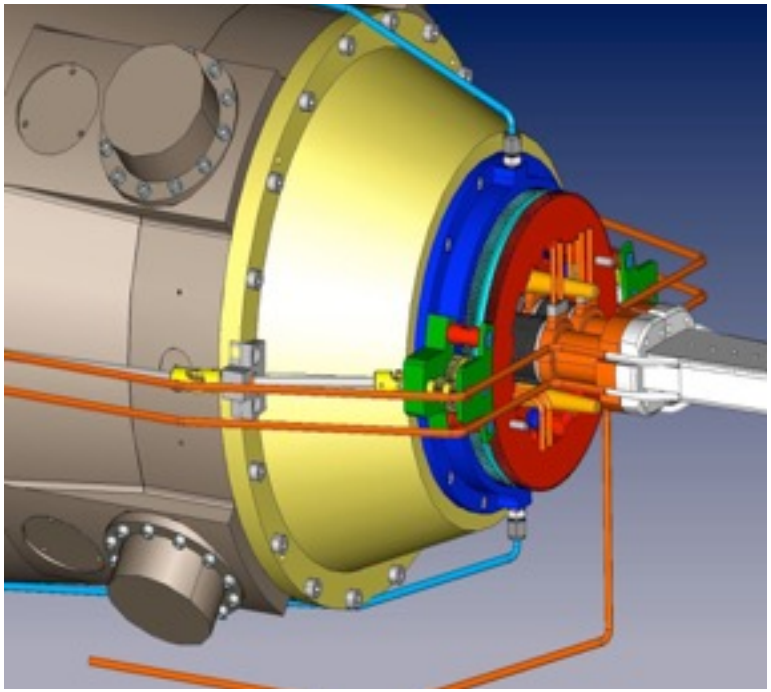
Overview


Backward
Forward
RVCL
RVCR
y
x
z
HER
LER
Ring inside
QCSLeft
QCSRight

RVC and QCS



- RVC prototype was extensively tested 2013/2014
- Bellow design between QCS and RVC only recently finished
  - probably most crowded and critical spot in entire machine
- Main issues of final RVC system test:
  - study forces on VXD versus QCS movements (earthquakes, magnet ramping)
  - verify vacuum tightness

Stress Test in February 2014: Transport to & at KEK

BPAC Comments / Recommendations Oct 2015

2.1.2 Concerns

The interface between the inner detector assembly and the QCS, including the bellows, is not yet well defined. An issue was raised regarding the **transverse stiffness of the beam pipe bellows**. That issue must be understood. The committee suggests that reference information on the bellows transverse stiffness is directly applicable to bellows in a fully compressed condition (when transverse deflection is dominated by shear), but that bending deflection of the bellows would reduce the effective transverse stiffness as the bellows are extended, thereby alleviating concerns.

Changes in the QCS design may modify the mechanical strength of the QCS. Furthermore, the machine background may also be affected due to the changes in the cryostat design. **Relative motion between the inner detector assembly and the QCS** will affect luminosity performance as well as the collision spot location.

2.1.3 Recommendations

1. The Emergency Decoupling Insertion device of the RVC should be thoroughly tested in all possible conditions.
2. The interface between the inner detector assembly and QCSs, including bellows, needs to be defined as soon as possible to complete integration work of the interaction region. **The committee recommends that the transverse stiffness of bellow assemblies be evaluated** over the range of lengths that may occur. If that evaluation leads to a concern, the **bellow's transverse stiffness should be determined by direct measurements** and compared with the stiffness that is acceptable.

…

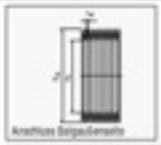
3.2.1 Concerns

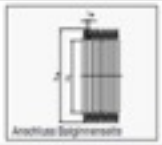
Though many successful tests have been completed, it is not clear whether no torque being applied to the VXD and beam pipe as the RVC is closed/opened. It is not clear whether a mechanism is needed to **maintain the relative azimuthal alignment of flange pairs** as they are mated.

Stainless Steel Membrane Bellows

6.7 | HYDRA-Membranbälge Schmalprofil
Vorzugsreihe

HYDRA





Bezugs-durch-messer	Nenn-druck	Balgprofil				Werkstoff	Länge je Membran-paar	max. Anzahl Membran-paare*	∅-Toleranzen			Nennauslenkung je Welle (für 10.000 Lastspiele)			Federrate je Welle (± 30%)			wirks. Quer-schnitt	Gewicht je Membran-paar
												axial	angular	lateral	axial	angular	lateral		
	P_N**	d_i	D_a	n_i	s		l_w		d_i	D_a		$2s_{t,0}$	$2\alpha_{t,0}$	$2l_{t,0}$	c_a	c_α	c_l	A	
mm	bar	mm	mm	-	mm	-	mm	-	mm	mm		mm	Grad	mm	N/mm	Nm/Grad	N/mm	cm²	g
12	8,0	12,0 x 20,0 x 1 x 0,10				1.4571	1,0	145	±0,3	±0,3		0,50 = + 0,10 / – 0,40	±0,72	±0,0021	200	0,11	76800	2,1	0,42
	12,0	12,0 x 20,0 x 1 x 0,15				1.4571	1,0	145	±0,3	±0,3		0,40 = + 0,08 / – 0,32	±0,57	±0,0017	500	0,28	192000	2,1	0,63
17	3,5	17,0 x 31,0 x 1 x 0,10				1.4571	1,5	95	±0,3	±0,3		0,90 = + 0,18 / – 0,72	±0,86	±0,0038	100	0,10	38400	4,65	0,84
	6,0	17,0 x 31,0 x 1 x 0,15				1.4571	1,5	95	±0,3	±0,3		0,80 = + 0,16 / – 0,64	±0,76	±0,0033	190	0,24	72900	4,65	1,27
25	8,0	25,5 x 36,5 x 1 x 0,10				1.4571	1,2	230	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,44	±0,0015	105	0,22	105000	7,6	0,85
	12,0	25,5 x 36,5 x 1 x 0,15				1.4571	1,2	230	±0,3	±0,3		0,50 = + 0,10 / – 0,40	±0,37	±0,0013	280	0,59	289000	7,6	1,27
29	6,0	29,5 x 42,5 x 1 x 0,10				1.4571	1,4	200	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,49	±0,0018	150	0,31	108000	10,3	1,16
	9,0	29,5 x 42,5 x 1 x 0,15				1.4571	1,4	200	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,38	±0,0016	265	0,75	263000	10,3	1,74
34	6,0	33,5 x 46,5 x 1 x 0,10				1.4571	1,4	200	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,40	±0,0016	105	0,27	129000	12,7	1,29
	9,0	33,5 x 46,5 x 1 x 0,15				1.4571	1,5	185	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,34	±0,0015	247	0,86	263000	12,7	1,94
	6,0	34,5 x 47,5 x 1 x 0,10				1.4571	1,3	215	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,39	±0,0015	100	0,27	148000	13,3	1,32
	9,0	34,5 x 47,5 x 1 x 0,15				1.4571	1,4	200	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,34	±0,0014	250	0,92	323000	13,3	1,98
36	4,0	36,0 x 53,0 x 1 x 0,10				1.4571	1,9	145	±0,3	±0,3		0,80 = + 0,16 / – 0,64	±0,41	±0,0023	70	0,30	97800	15,6	1,88
	6,0	36,0 x 53,0 x 1 x 0,15				1.4571	1,9	145	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,36	±0,0020	150	0,65	123000	15,6	2,82
37	6,0	37,0 x 50,0 x 1 x 0,10				1.4571	1,5	185	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,37	±0,0016	103	0,43	139000	15,0	1,40
	9,0	37,0 x 50,0 x 1 x 0,15				1.4571	1,5	185	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,32	±0,0014	210	1,29	391000	15,0	2,11
39	6,0	39,5 x 52,5 x 1 x 0,10				1.4571	1,5	185	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,35	±0,0015	97	0,45	137000	16,7	1,48
	9,0	39,5 x 52,5 x 1 x 0,15				1.4571	1,5	185	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,30	±0,0013	300	1,38	423000	16,7	2,23
42	6,0	42,5 x 55,5 x 1 x 0,10				1.4571	1,5	185	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,33	±0,0014	92	0,48	147000	19,0	1,58
	9,0	42,5 x 55,5 x 1 x 0,15				1.4571	1,5	185	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,28	±0,0012	210	1,62	497000	19,0	2,37
44	6,0	44,5 x 57,5 x 1 x 0,10				1.4571	1,5	185	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,31	±0,0014	100	0,57	173000	20,5	1,65
	9,0	44,5 x 57,5 x 1 x 0,15				1.4571	1,6	175	±0,3	±0,3		0,60 = + 0,12 / – 0,48	±0,27	±0,0013	290	1,42	391000	20,5	2,47

*für Anschlussteillänge > 20 mm, bei längeren Anschlussteilen verringert sich die maximale Membranpaarzahl
** Außendruck, bei Innendruckbelastung muss zusätzlich die Säulenstabilität (Knicksicherheit) gewährleistet sein

146 147

Bezugs-durch-messer	Nenn-druck	Balgprofil				Werkstoff	Länge je Membran-paar	max. Anzahl Membran-paare*	∅-Toleranzen			Nennauslenkung je Welle (für 10.000 Lastspiele)			Federrate je Welle (± 30%)			wirks. Quer-schnitt	Gewicht je Membran-paar
												axial	angular	lateral	axial	angular	lateral		
	P_N**	d_i	D_a	n_i	s		l_w		d_i	D_a		$2s_{t,0}$	$2\alpha_{t,0}$	$2l_{t,0}$	c_a	c_α	c_l	A	
mm	bar	mm	mm	-	mm	-	mm	-	mm	mm		mm	Grad	mm	N/mm	Nm/Grad	N/mm	cm²	g
34	6,0	33,5 x 46,5 x 1 x 0,10				1.4571	1,4	200	±0,3	±0,3		0,70 = + 0,14 / – 0,56	±0,40	±0,0016	105	0,37	129000	12,7	1,29

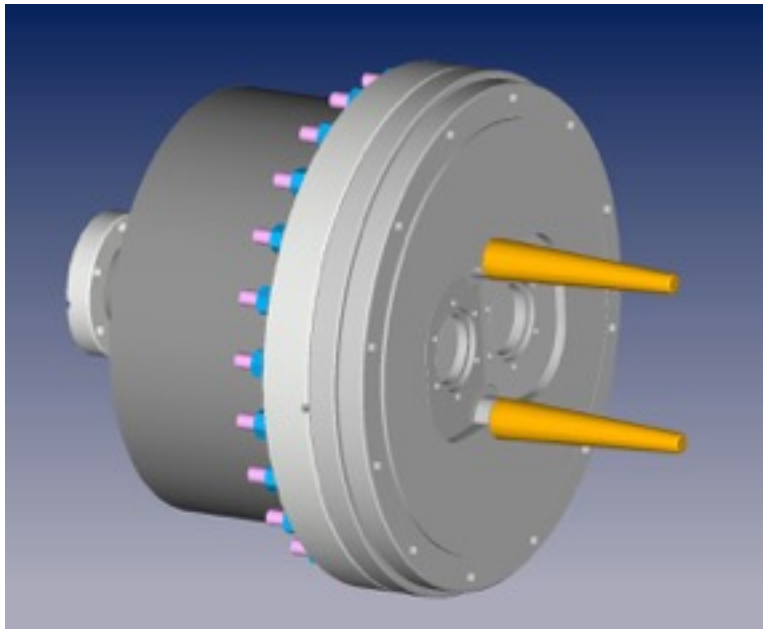
27 mm / 1,4 mm per profile ~ 20 profiles

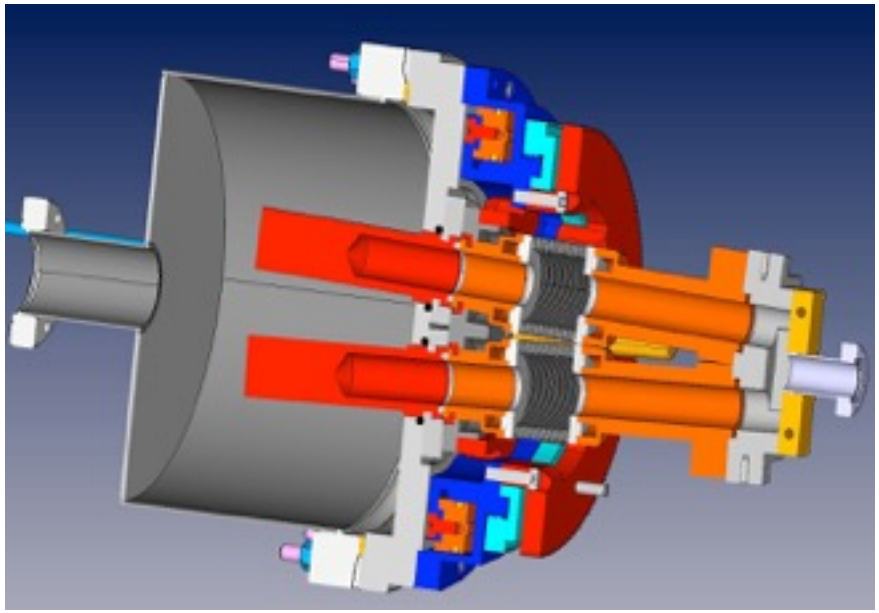
5 mm ?

1 mm ?

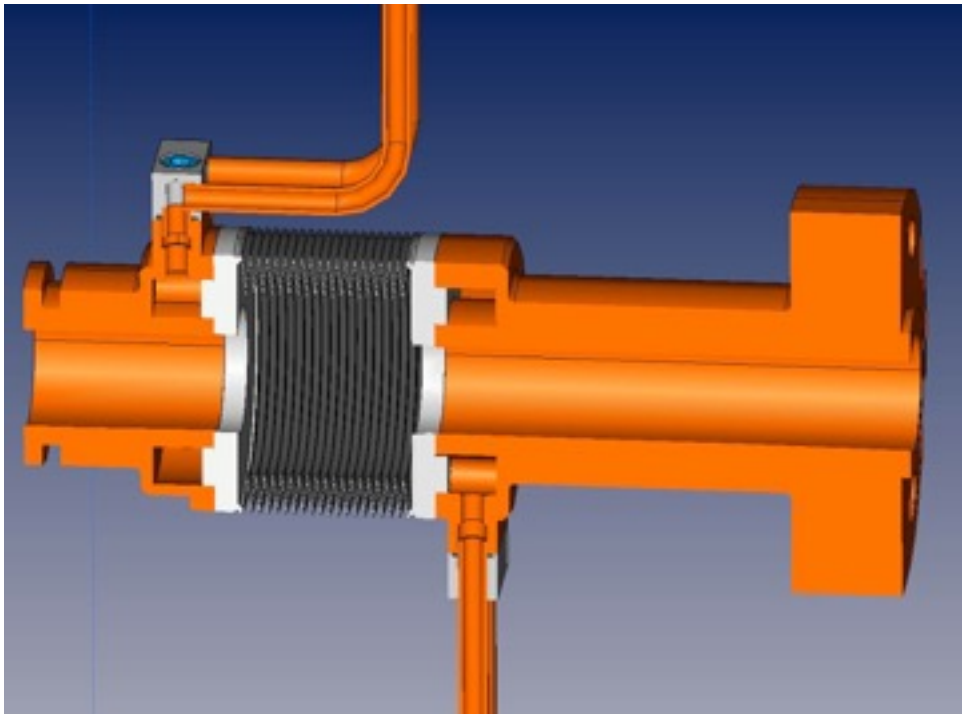
645 N/mm?

RVC Test Set-up at DESY

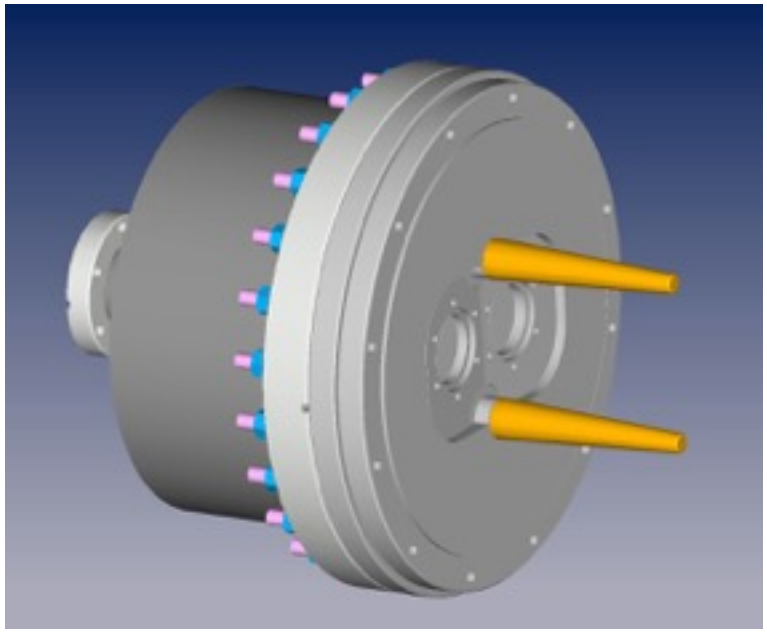


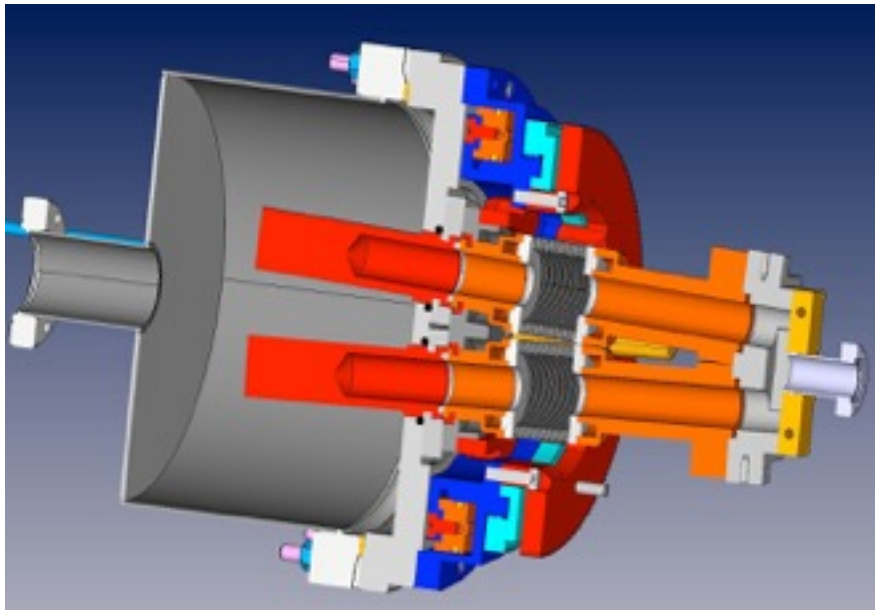


- QCS vacuum vessel flange (SS)
- QCS pipes (SS)
- QCS beam pipe flange (SS)
- Bellows pipe (CuCr1Zr)
  - updated design



RVC Test Set-up at DESY





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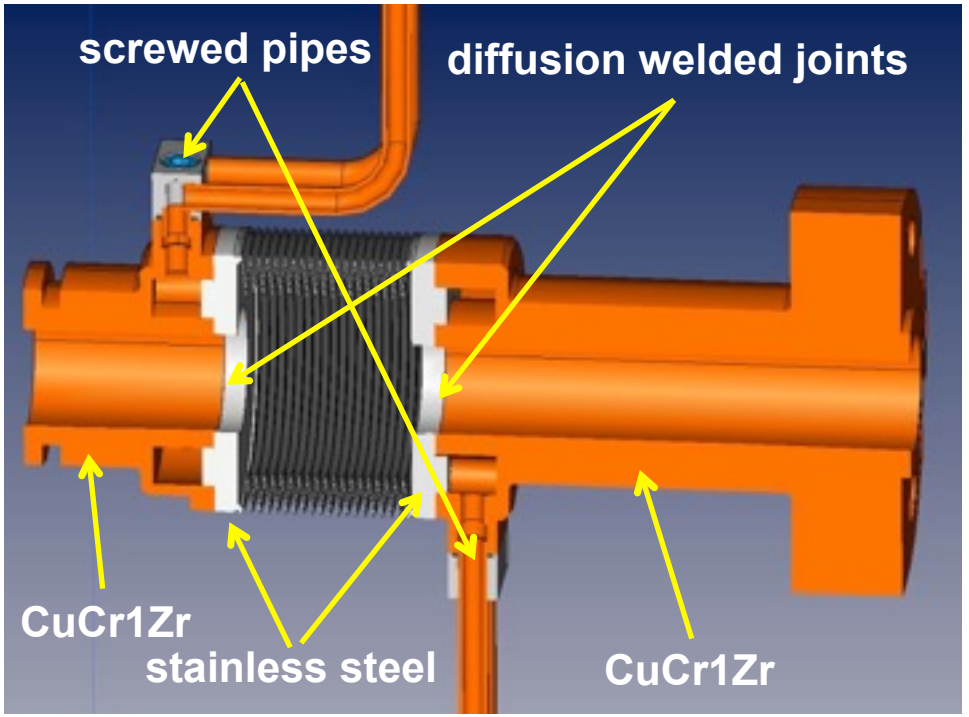
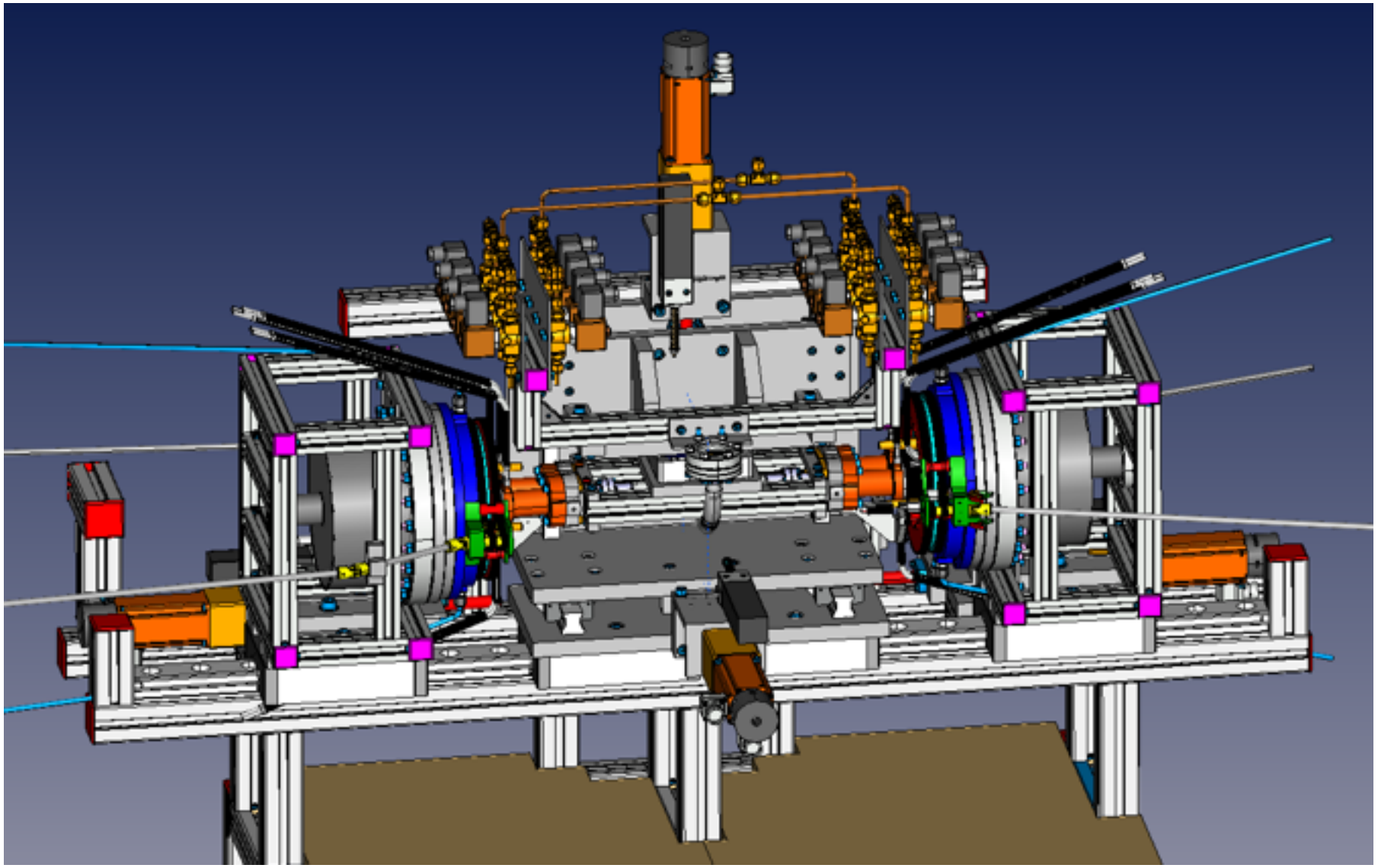
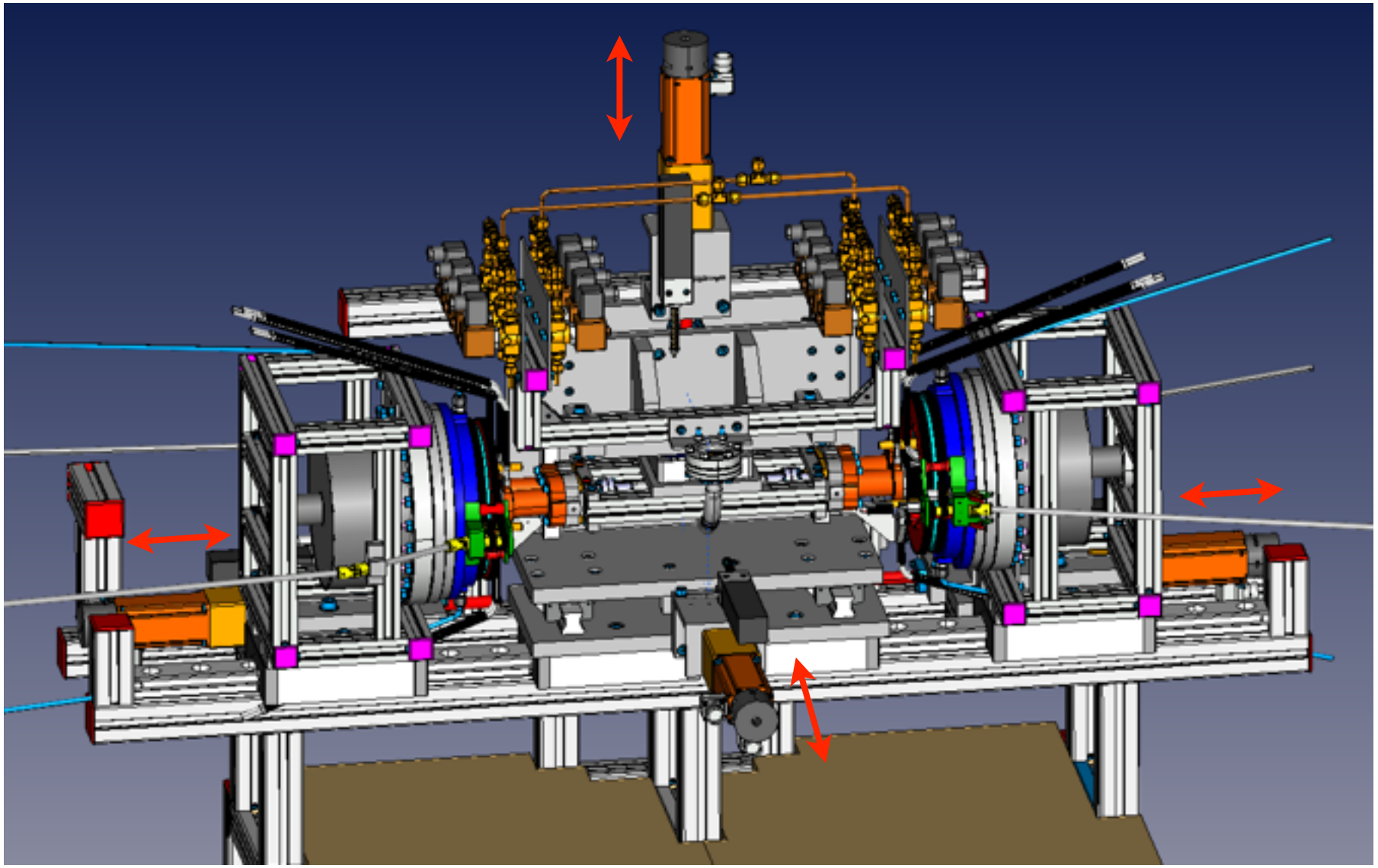


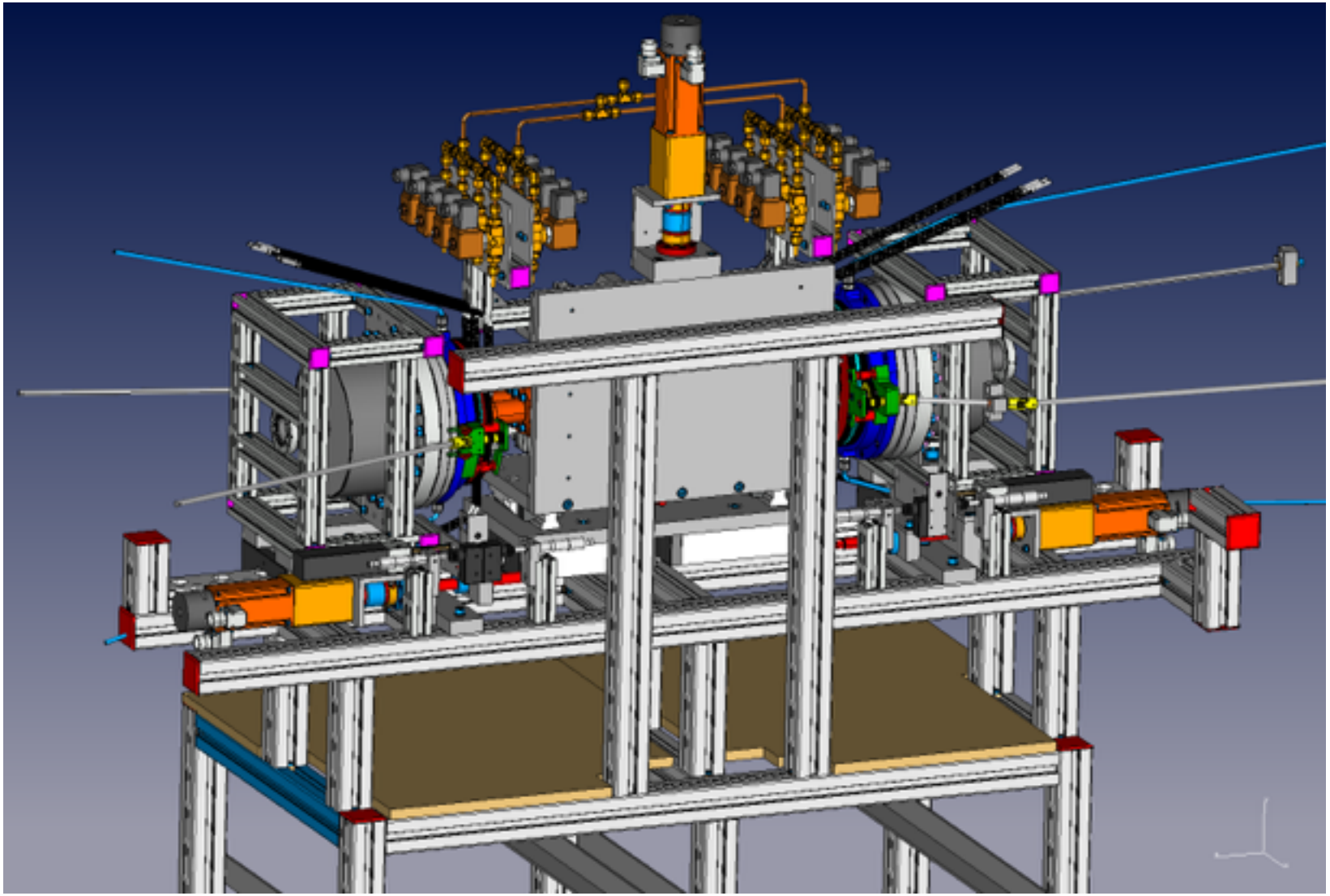
RVC Test Setup



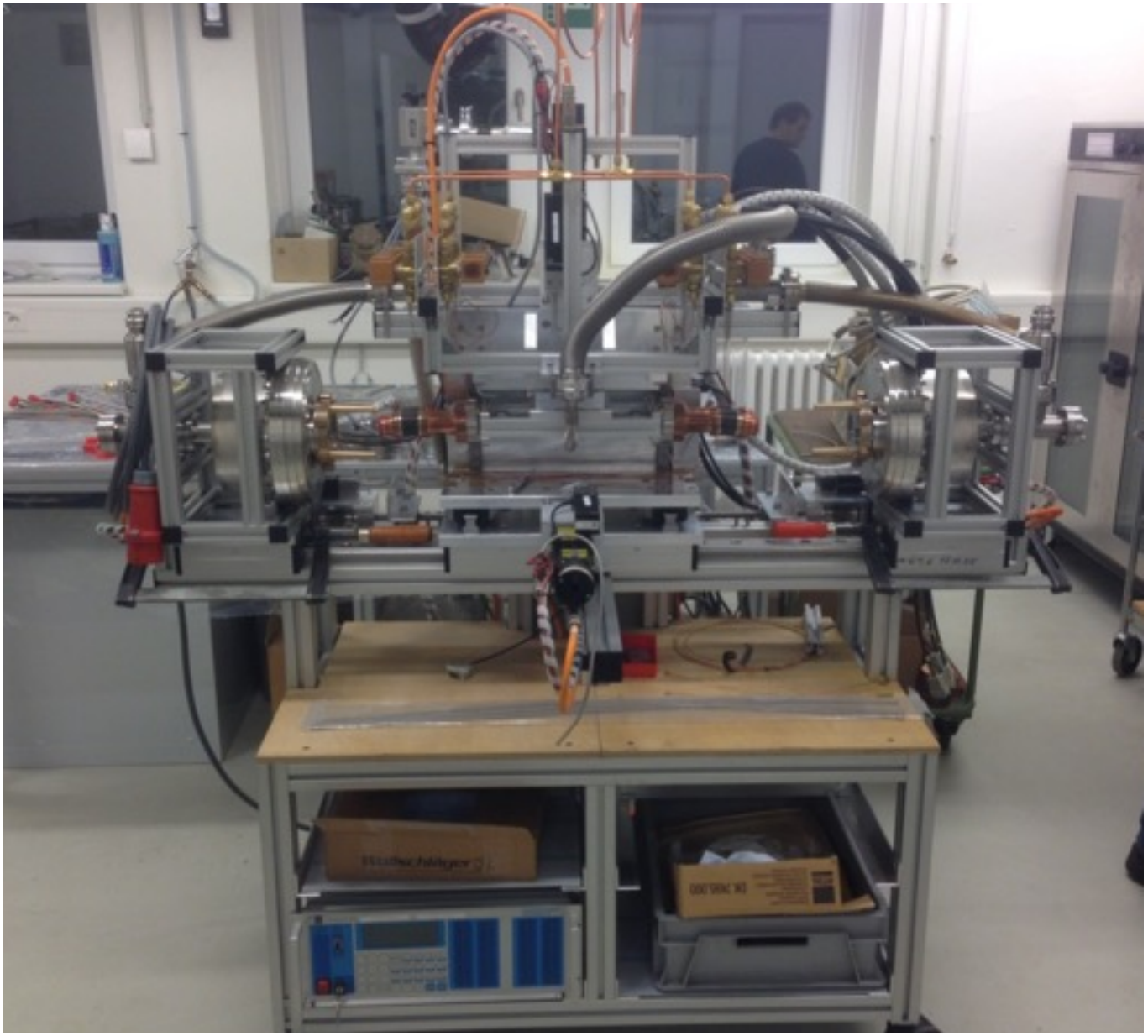
RVC Test Setup



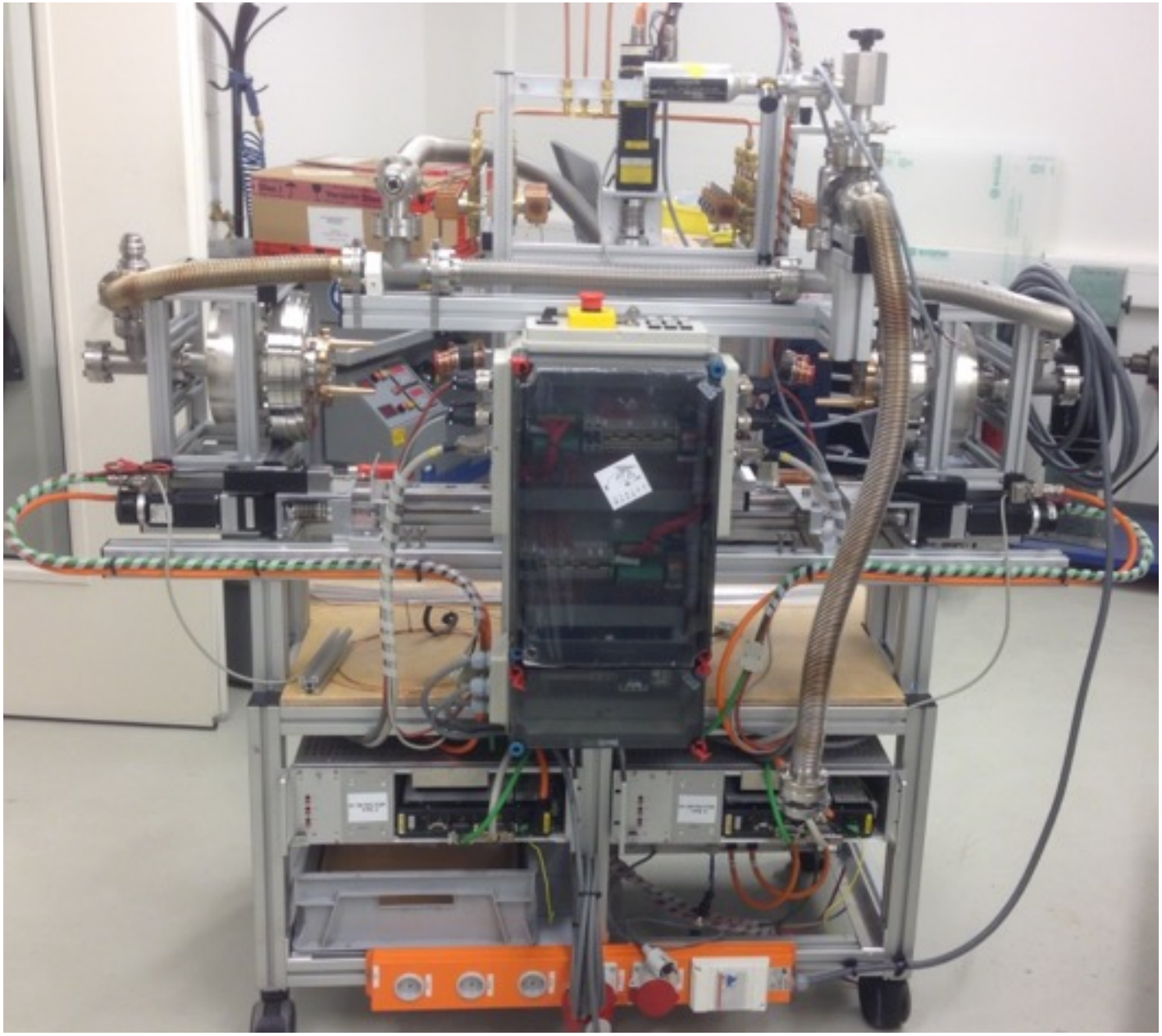
Backside of RVC Test Setup



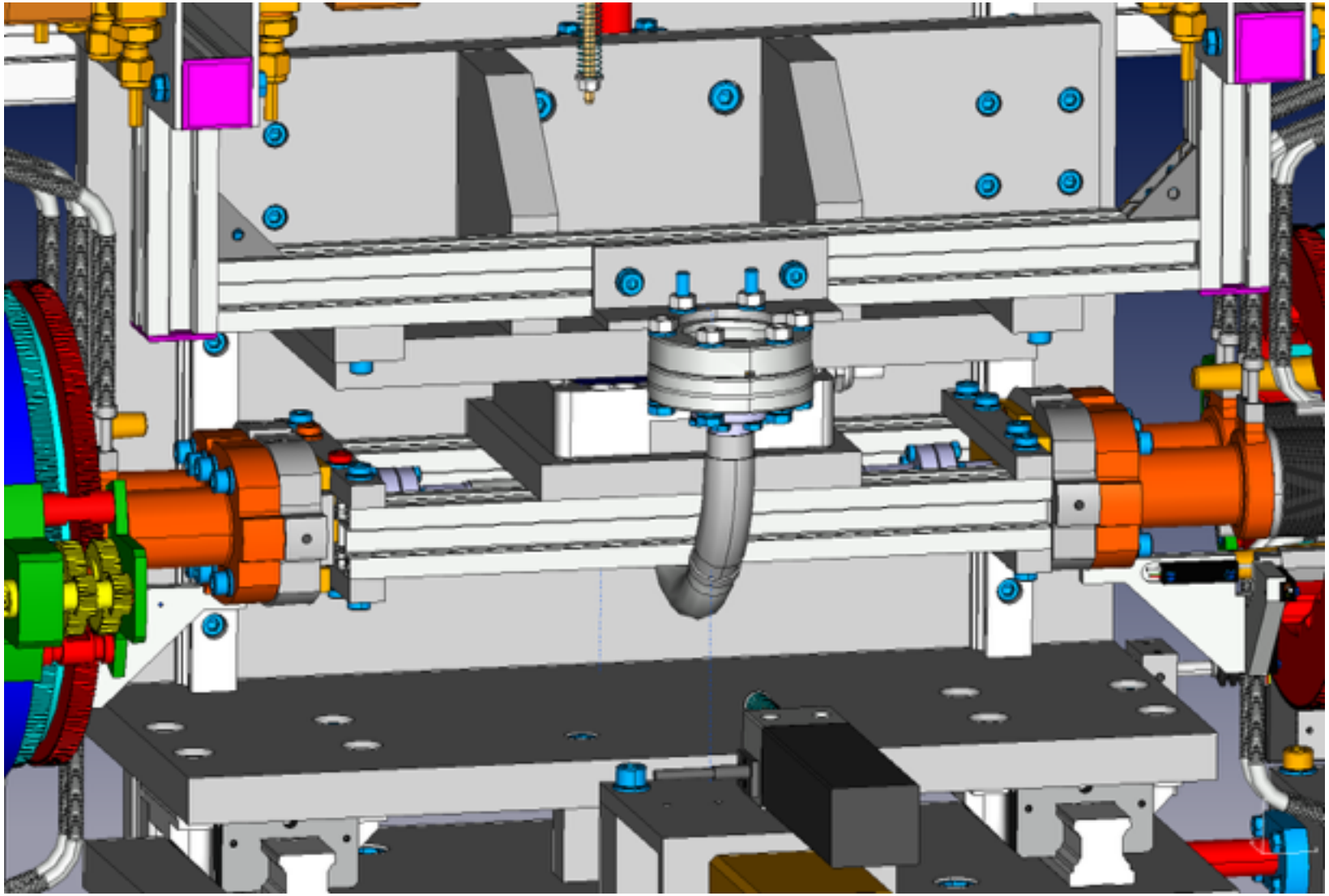
Status of RVC Test Set-up: Front View



Status of RVC Test Set-up: Back View

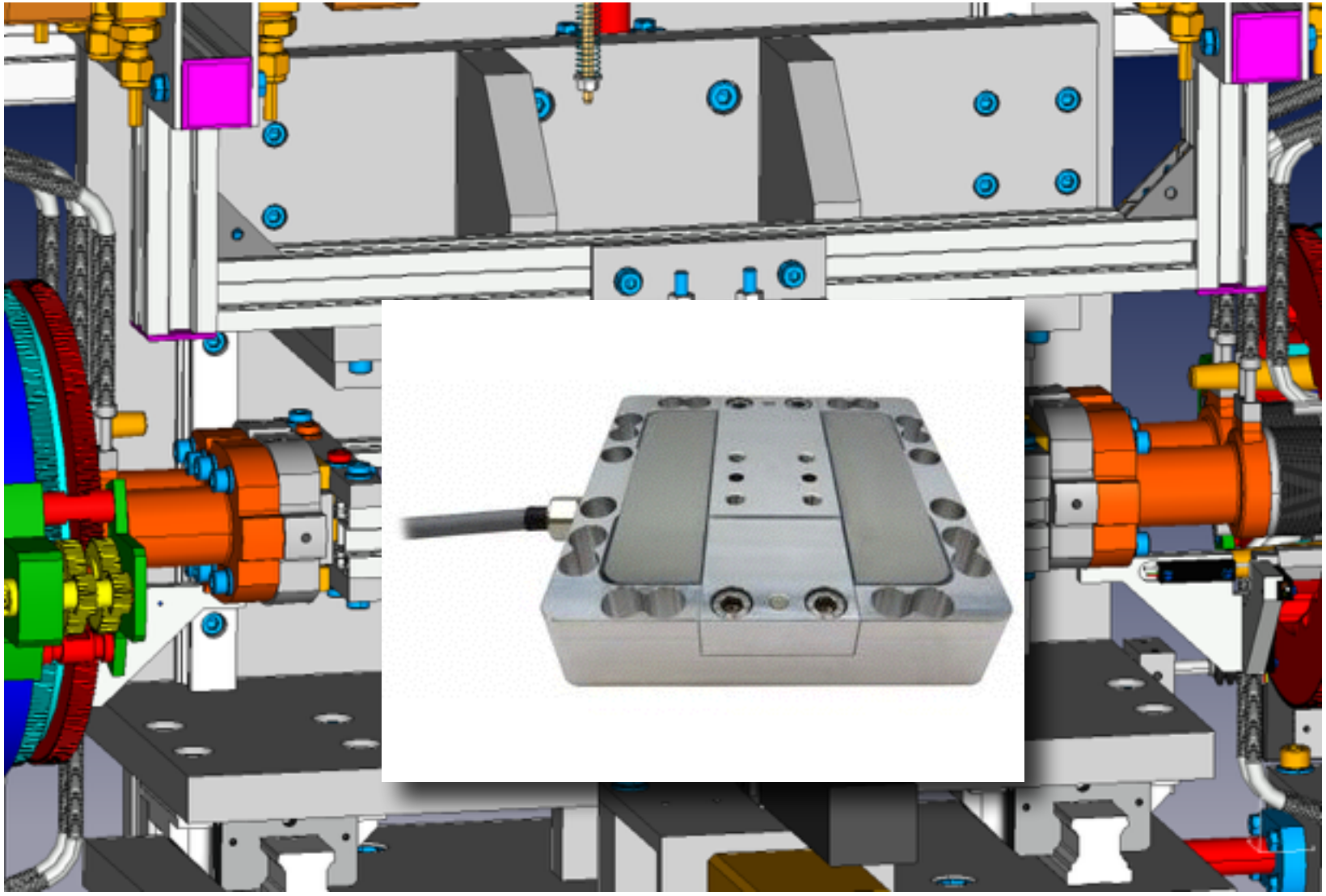


3D Force Sensor



3-axis force sensor to measure resulting force on central beam pipe as function of QCS movements

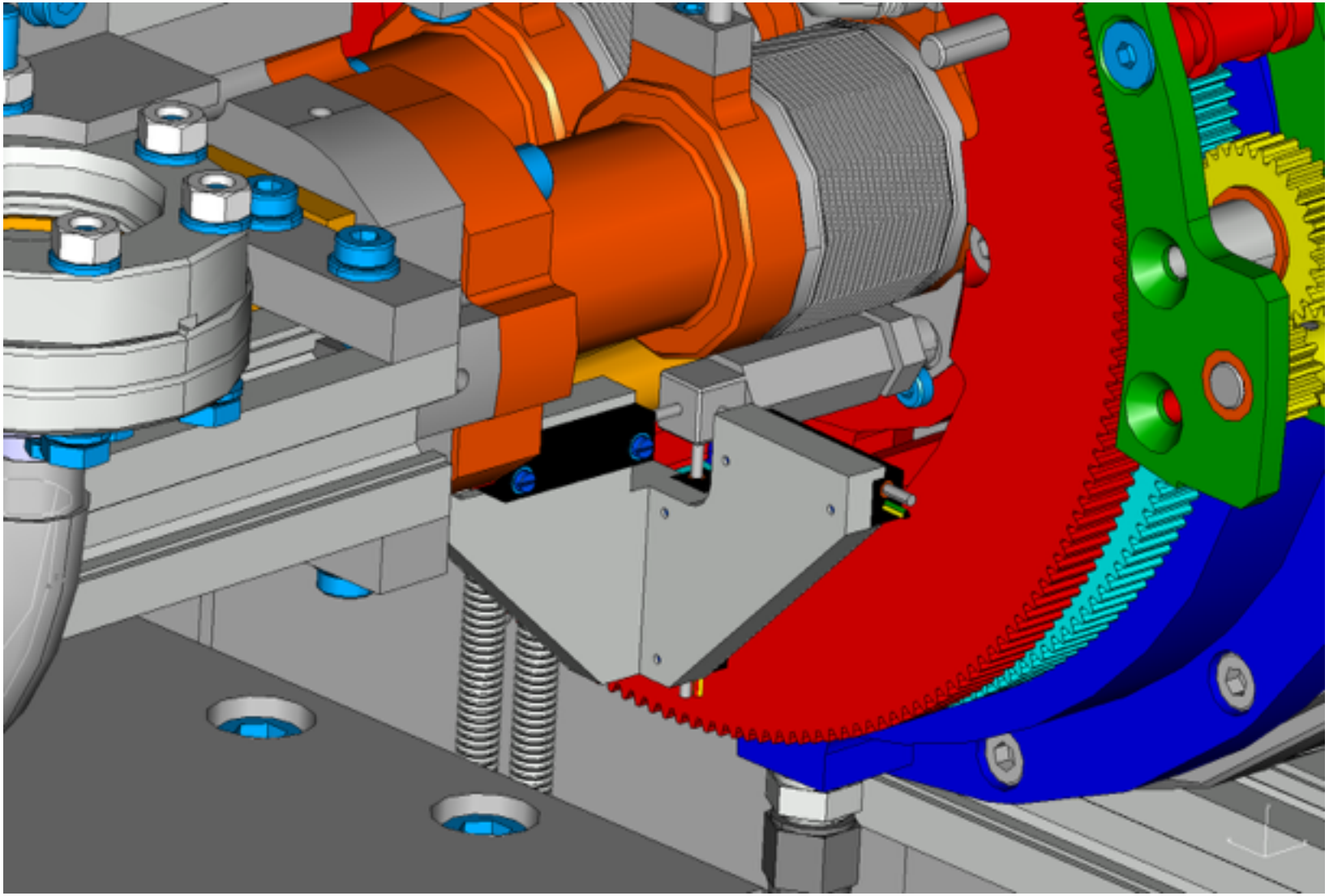
3D Force Sensor



3-axis force sensor to measure resulting force on central beam pipe as function of QCS movements

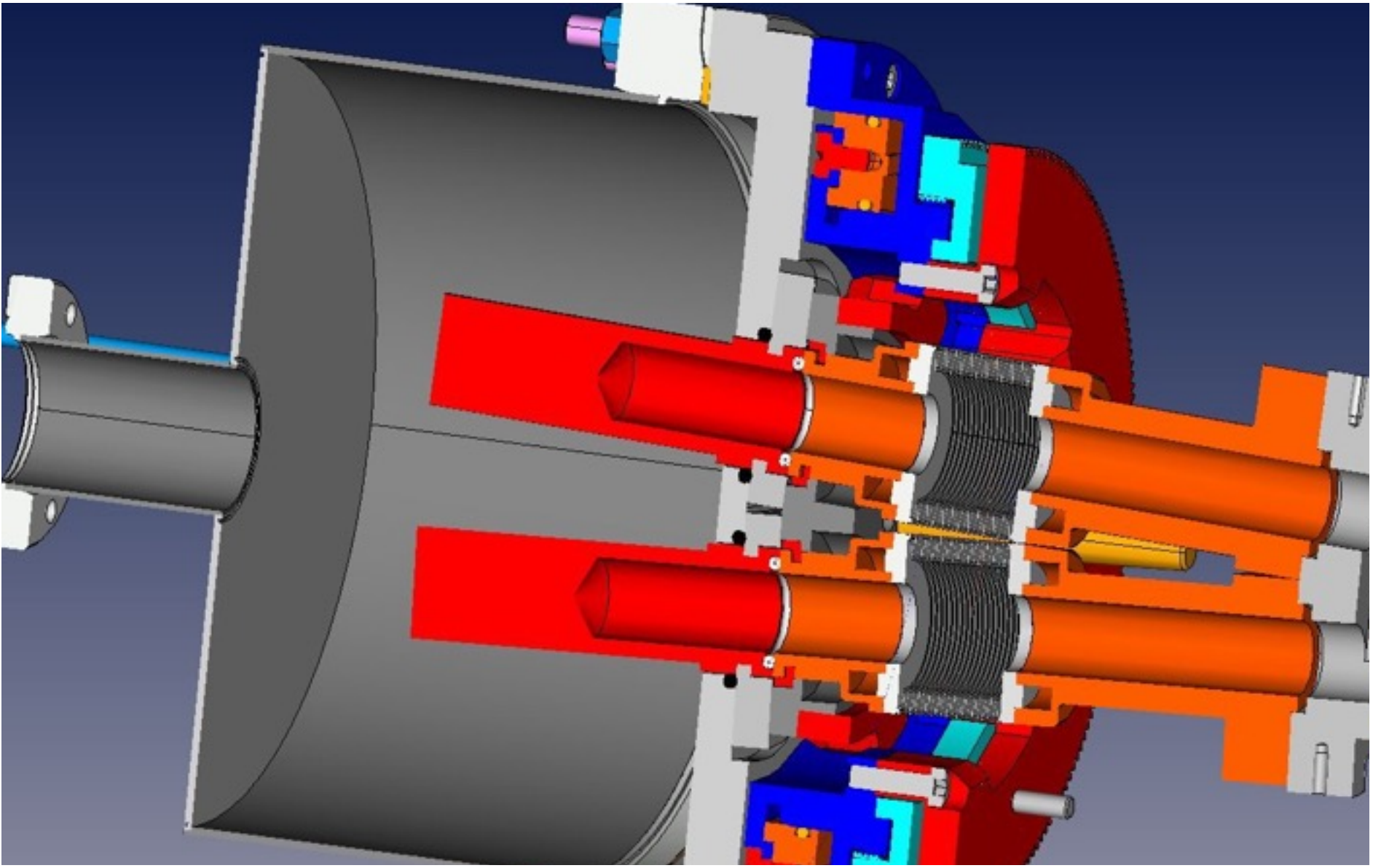
Mock-up of Central Beam Pipe

Monitoring Relative Movement between VXD and QCS



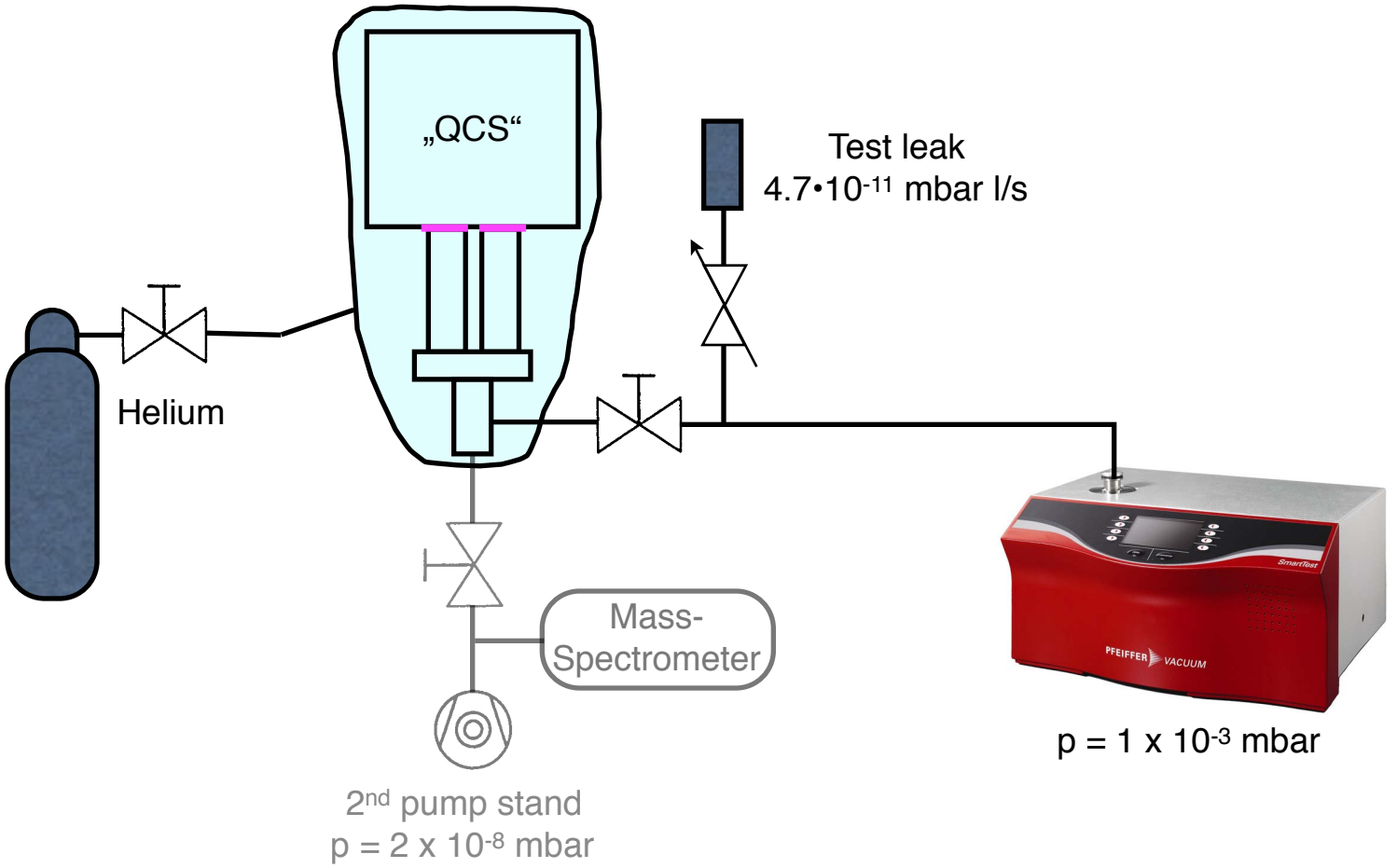
3-axis position encoders to monitor relative movement between VXD and QCS

Seals

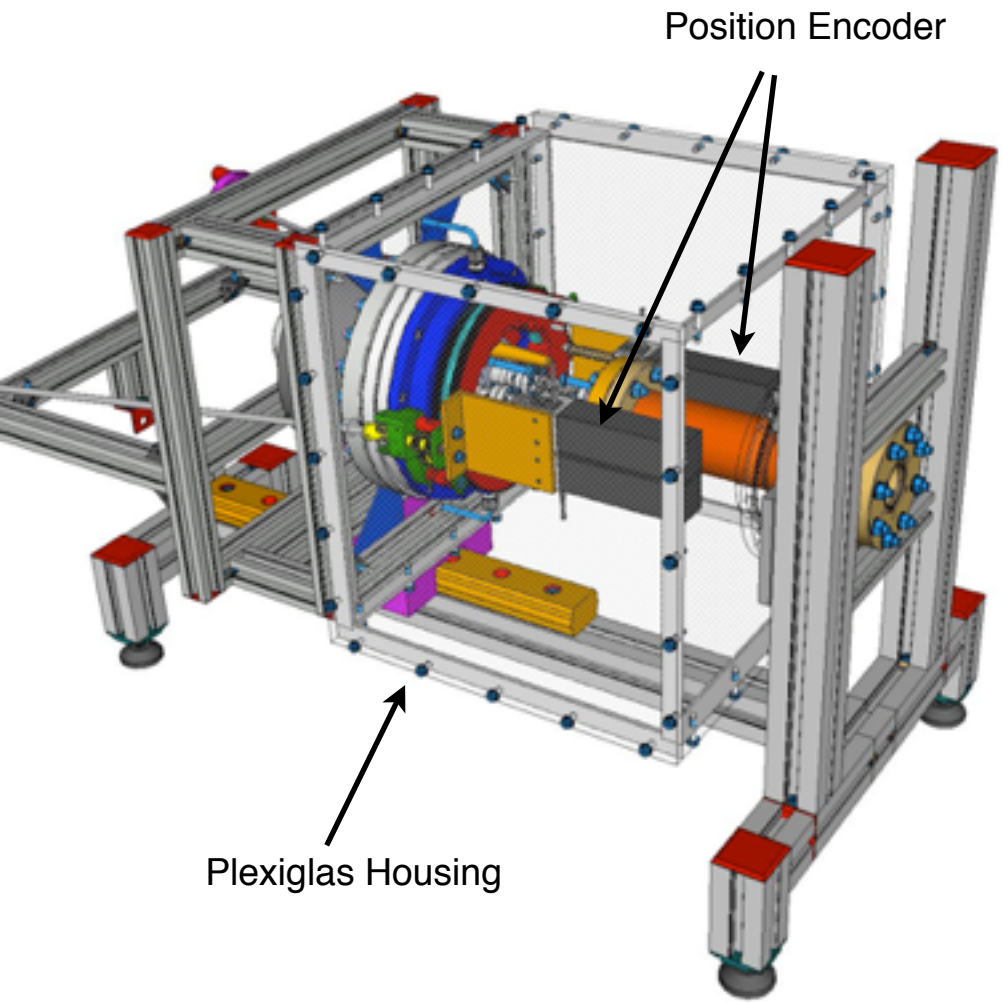


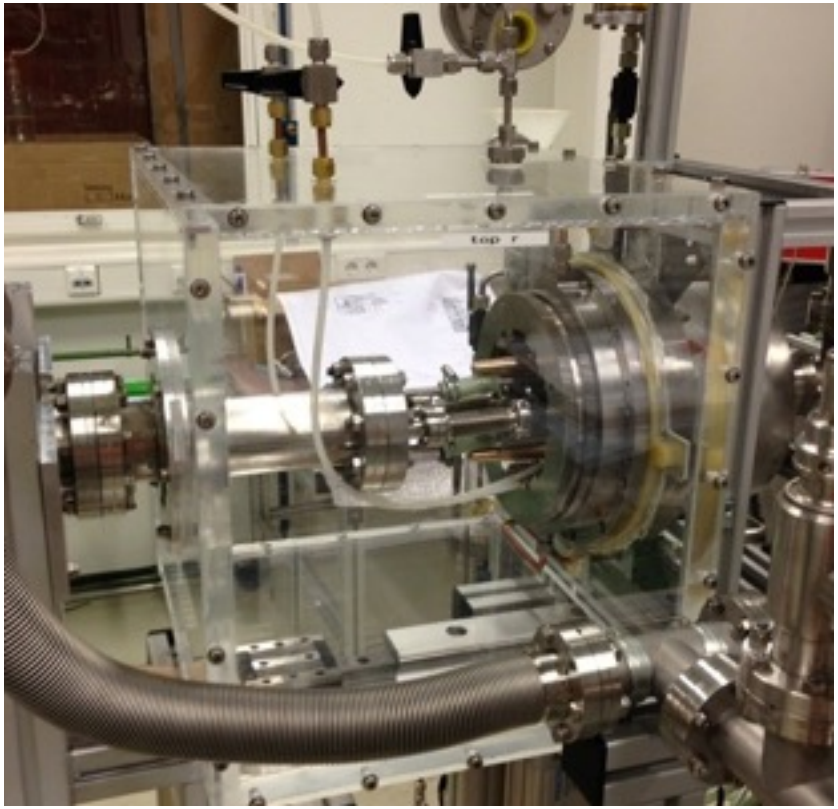
Integral Leak Test of RVC Prototype in 2013

- Test principle similar as for QCS flange
  - more complicated due to uneven outer envelope of test volume

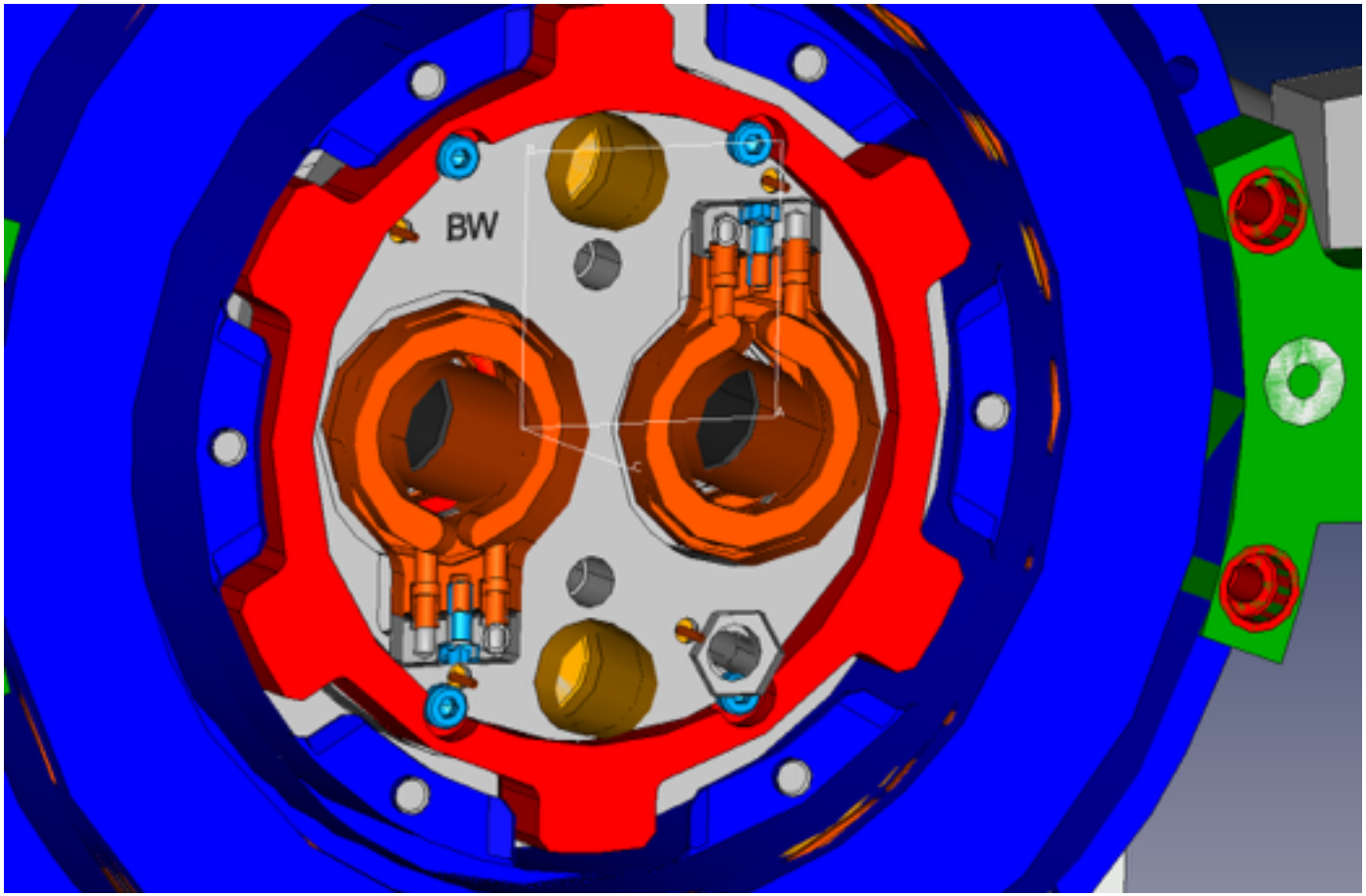


Integral Leak Test of RVC Prototype in 2013



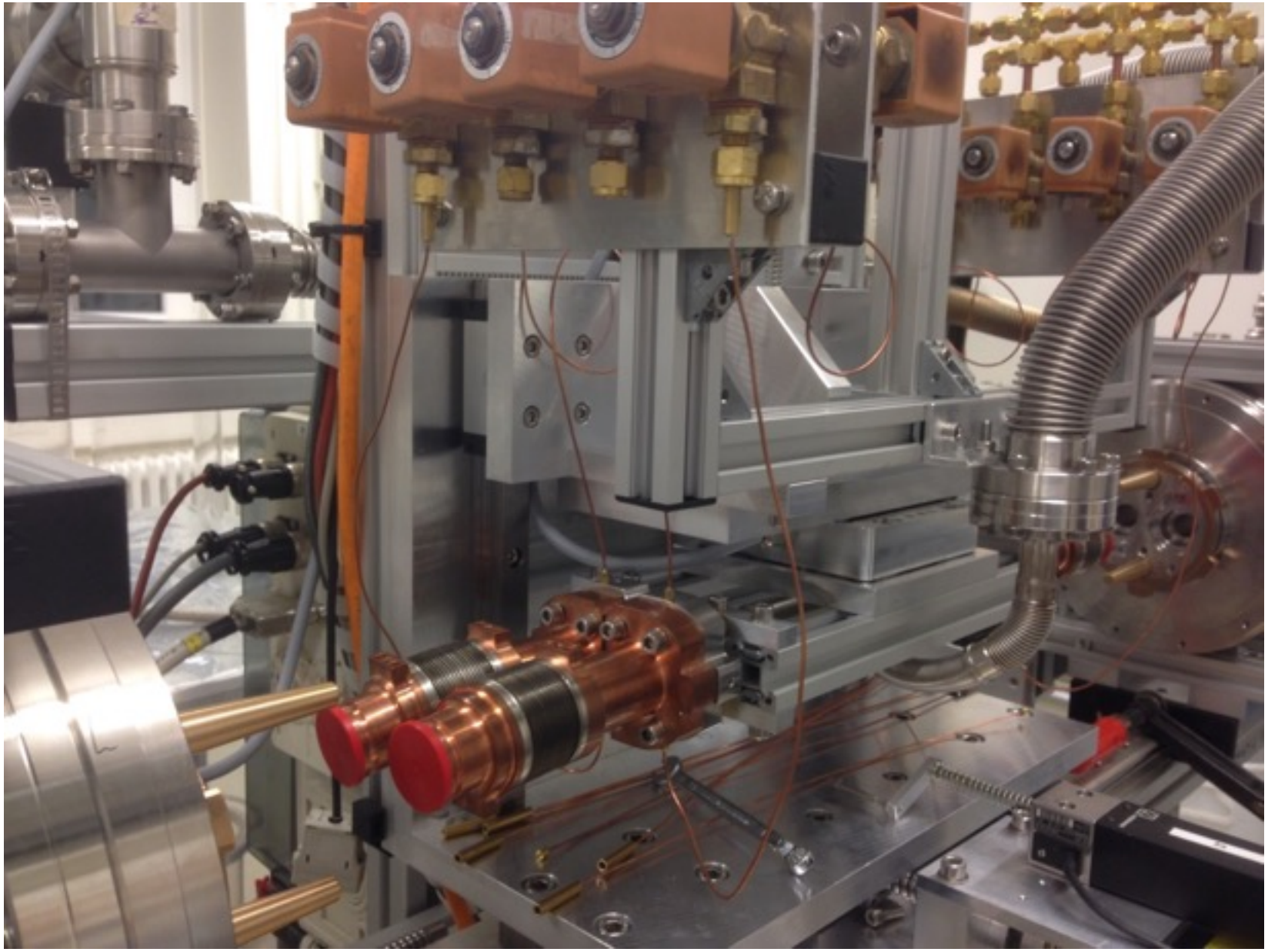


Provisions for Helium Leak Search

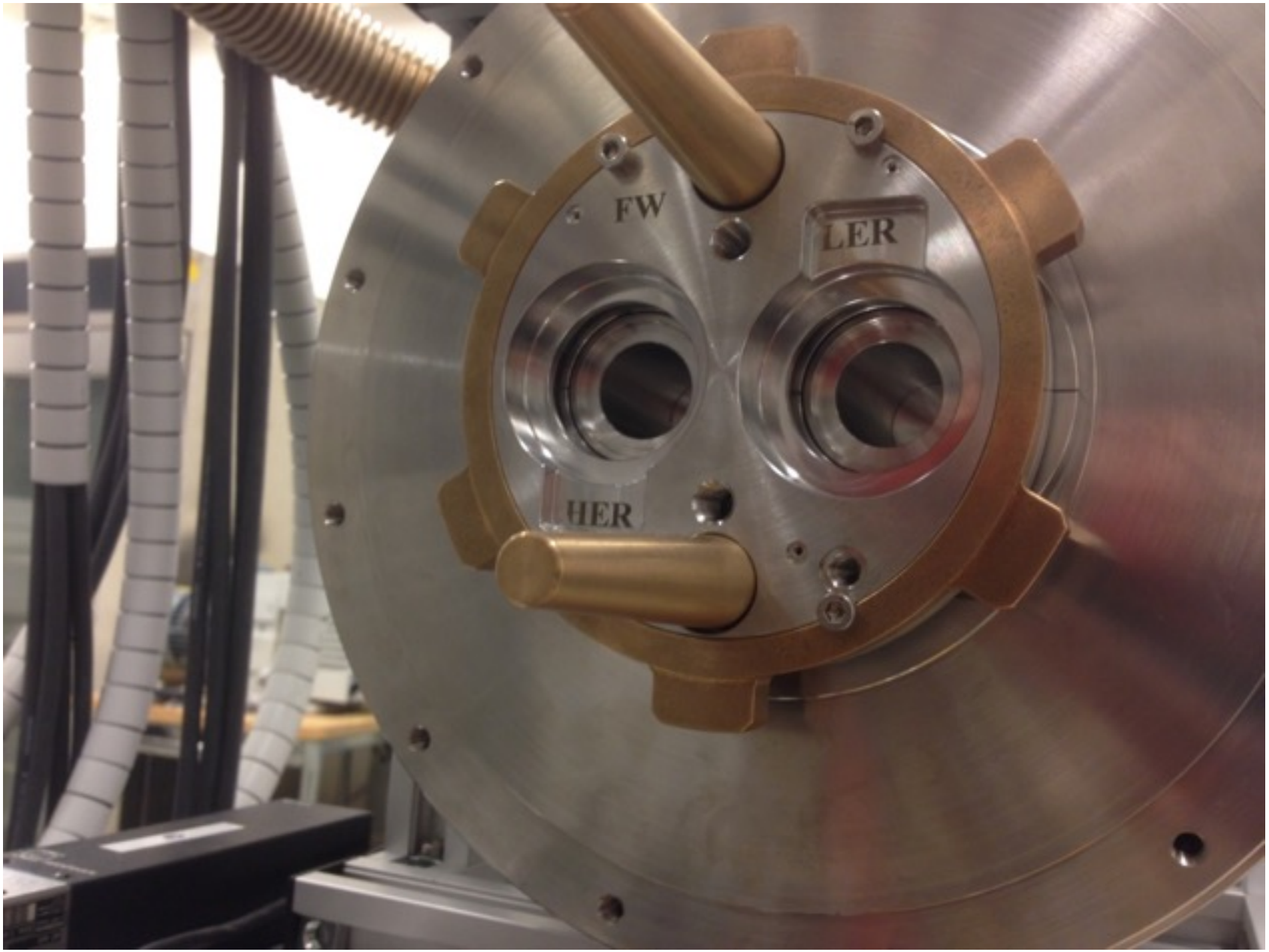


- After closing RVC must be able to perform Helium leak search independently for 2x4 Helicoflex seals
- Mandatory to avoid contamination of environment with Helium
  - KEK design uses rubber seal for QCS insulation vacuum

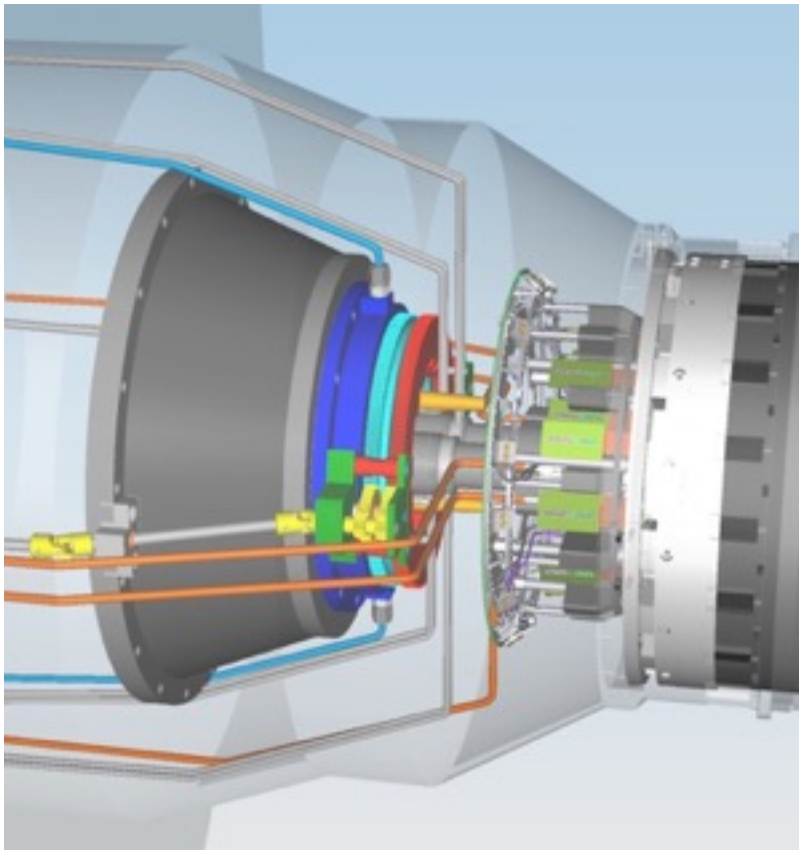
Pipes for Helium Leak Search

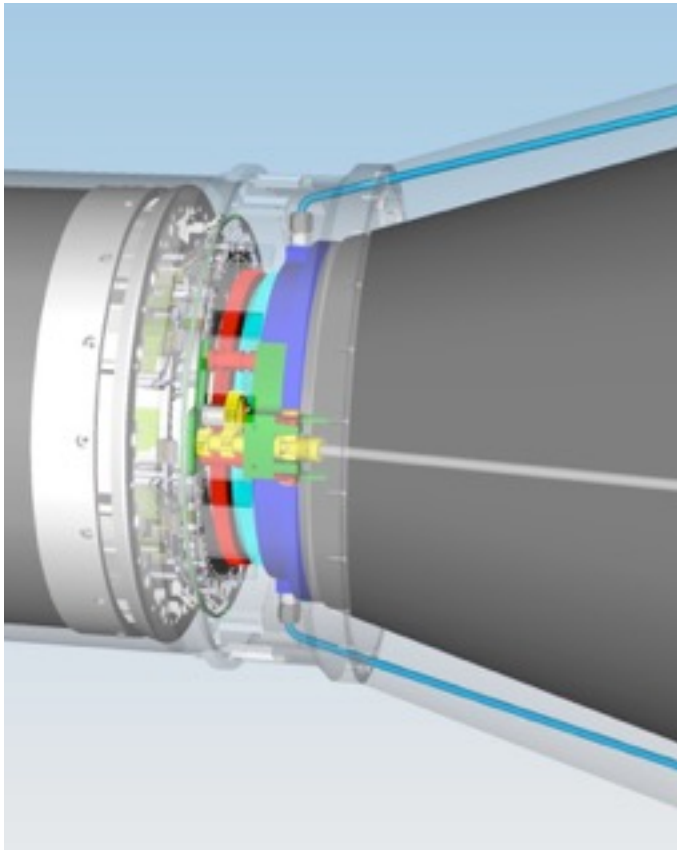


Flange with Helium Leak Search Channels



Open Issues





- Final dimensions of driving systems
- Integration of Emergency Deinstallation (EDI) hooks
- Exact pipe routing

Summary

- Mechanical assembly to be finished by February B2GM
- Mechanical and leak tightness tests will follow
- Detailed documentation will be provided by June B2GM