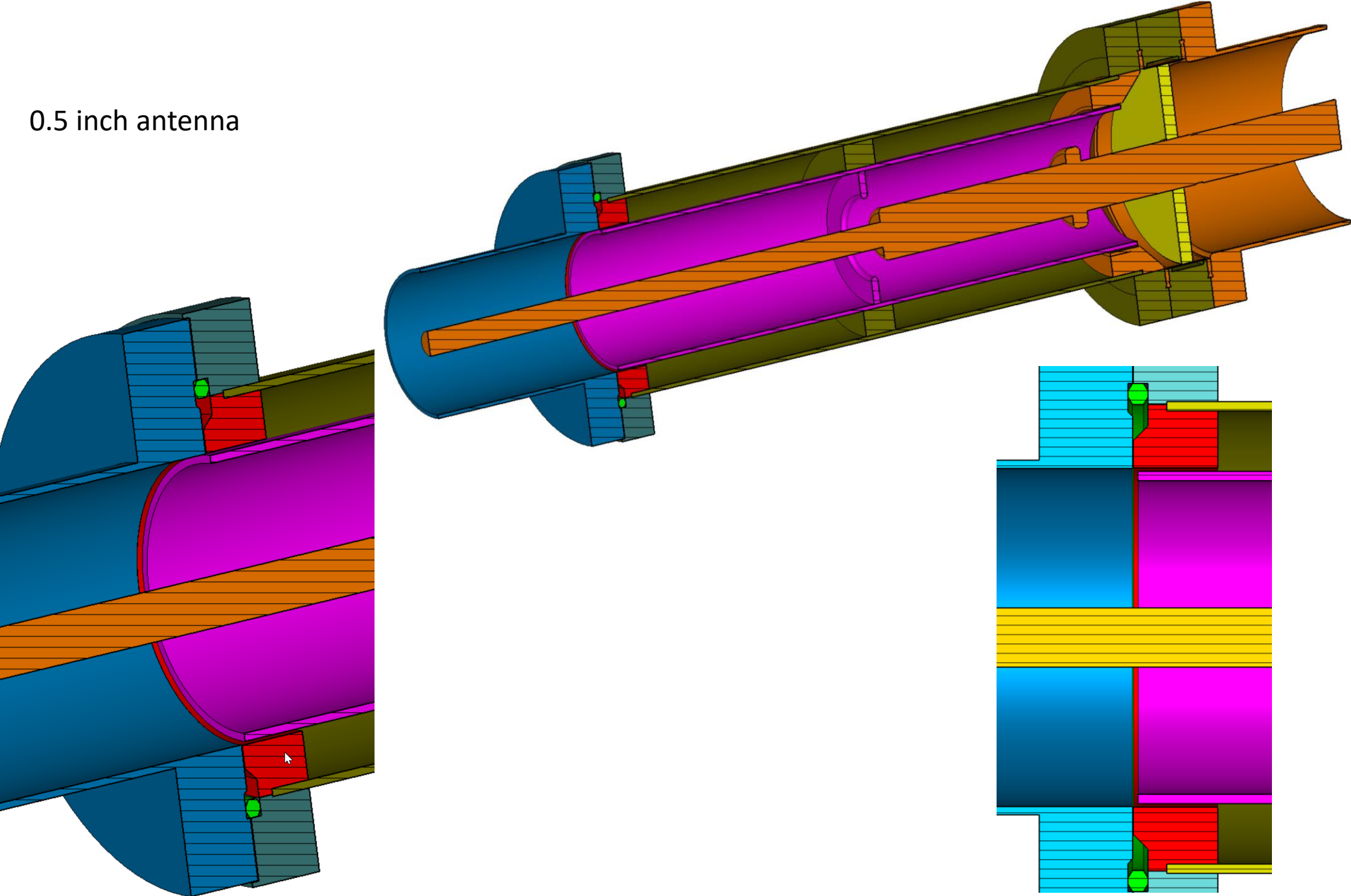


650 MHz, 200 kW coupler with low cryogenic loadings.

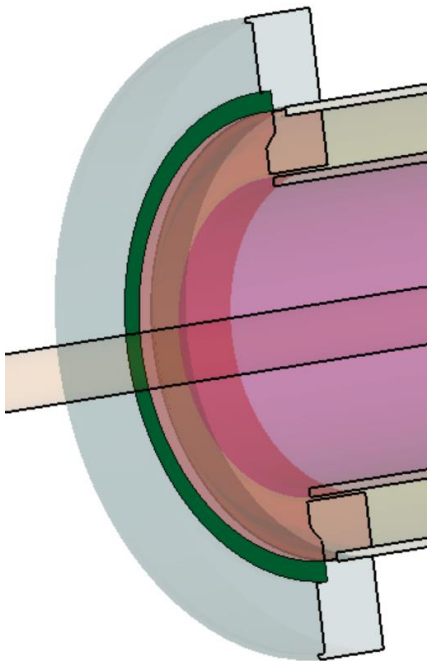
S. Kazakov

06/23/2020

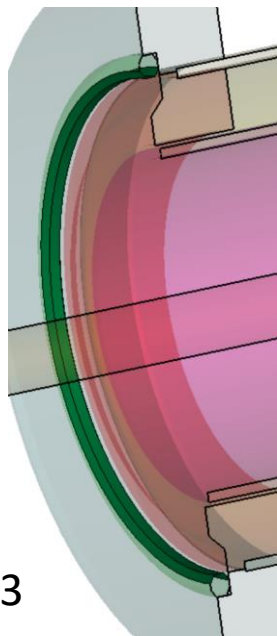
0.5 inch antenna



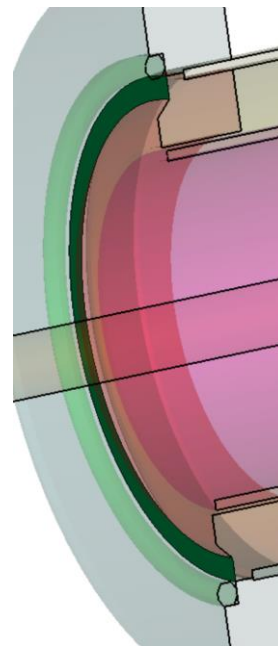
SS surface



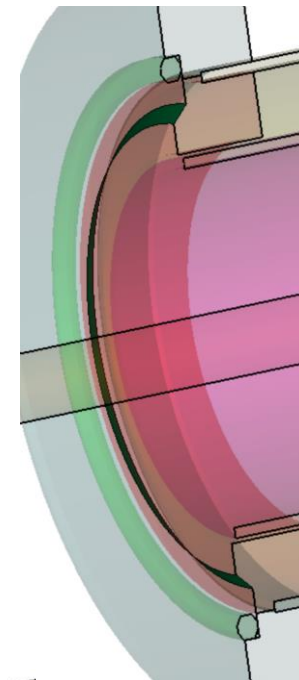
Al gasket surface



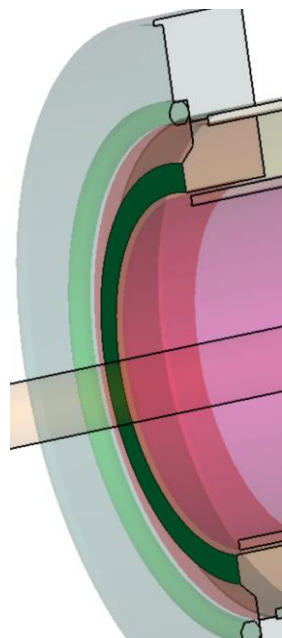
Cu surface #1



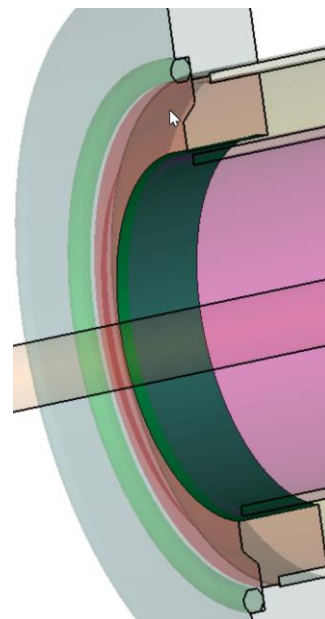
Cu surface #2



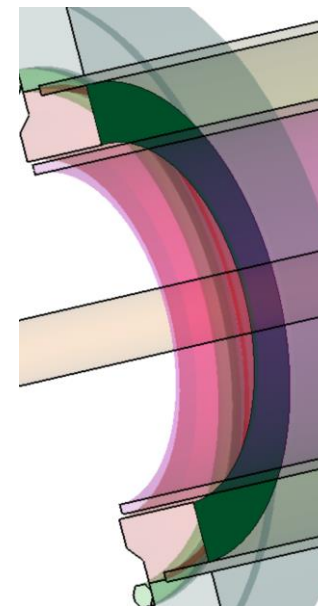
Cu surface #3



Cu surface #4



Cu surface #5



Losses in surfaces:

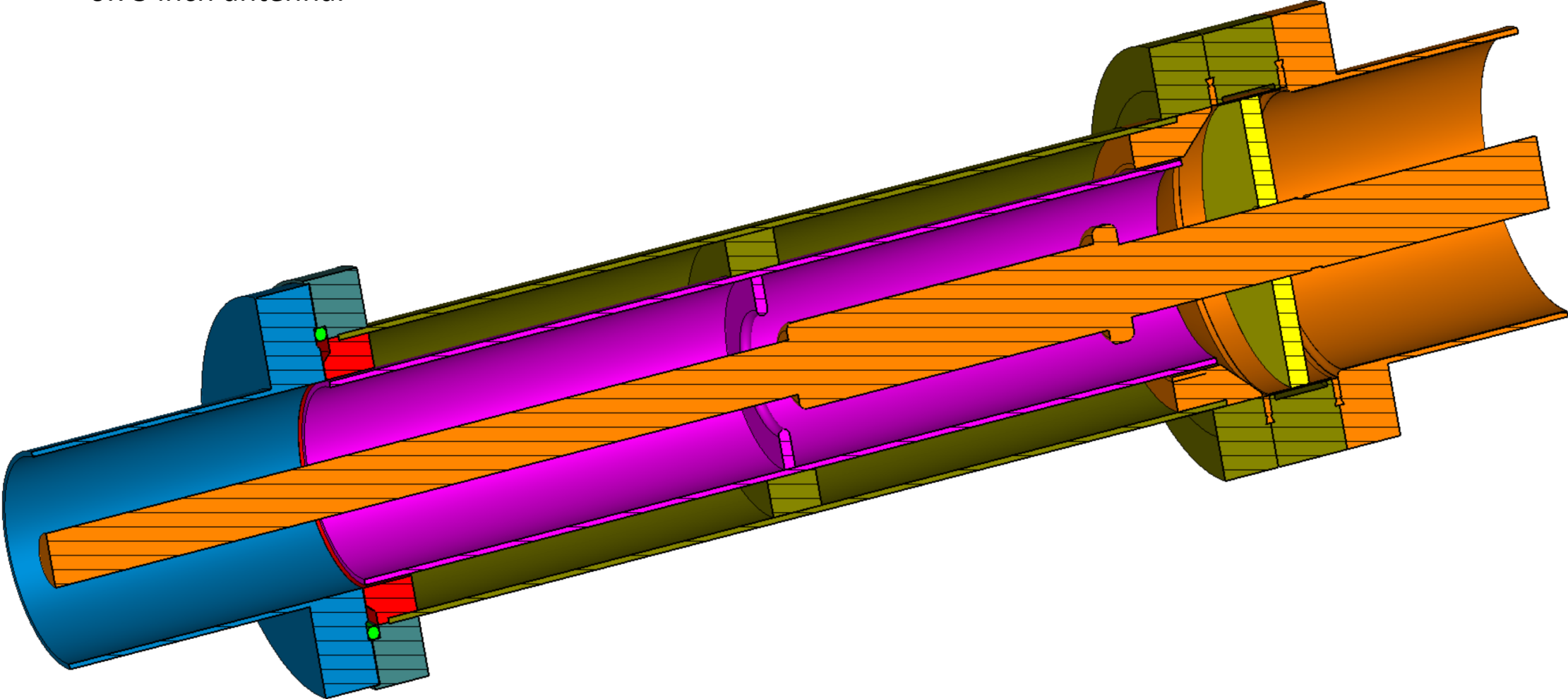
	Result name	Type	Template name	Value (W), P = 0.5W	200 kW
1	Al_gasket_Int_loss (f=650) (1)	0D	Evaluate Field on Face	6.748405464e-07	0.267
2	Cu_5K_1_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.778048926e-07	0.071
3	Cu_5K_2_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.788087135e-07	0.072
4	Cu_5K_3_Int_loss (f=650) (1)	0D	Evaluate Field on Face	2.300030212e-07	0.092
5	Cu_5K_4_Int_loss (f=650) (1)	0D	Evaluate Field on Face	2.666604675e-07	0.107
6	Cu_5K_5_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.520198638e-09	0.00061
7	SS5K_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.270932892e-06	0.508
					Total = 1.12W

Highest losses in SS and Al surfaces.

Direct electrical contact between coupler Cu insert and acc. cavity flange will reduce losses significantly.

Losses with direct contact: Cu #4 + Cu #5 = **0.108W**

0.75 inch antenna.



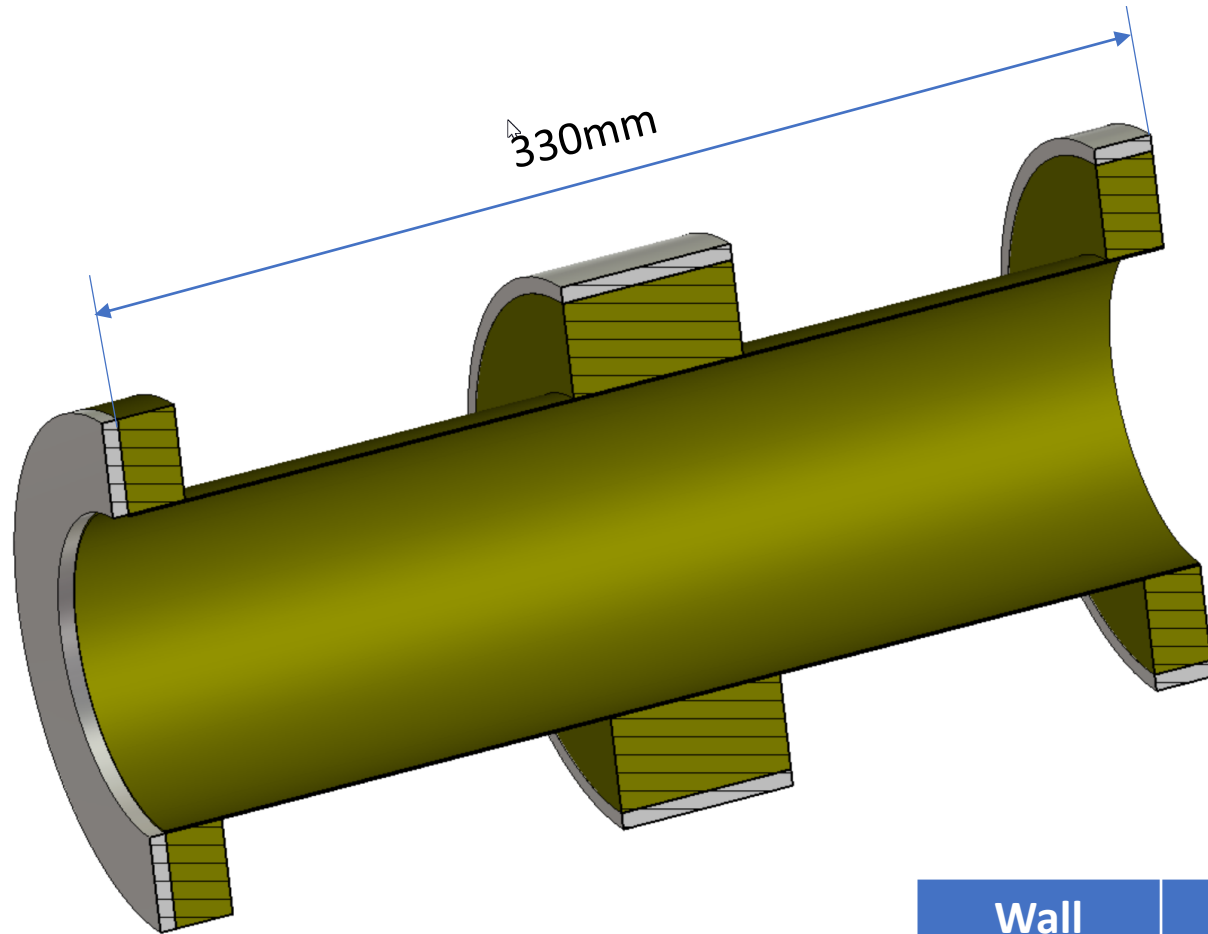
Losses in surfaces:

	Result name	Type	Template name	Value(W), P=0.5W	200kW
1	Al_gasket_Int_loss (f=650) (1)	0D	Evaluate Field on Face	8.808699878e-07	0.352
2	Cu_5K_1_Int_loss (f=650) (1)	0D	Evaluate Field on Face	2.320832922e-07	0.093
3	Cu_5K_2_Int_loss (f=650) (1)	0D	Evaluate Field on Face	2.334512065e-07	0.093
4	Cu_5K_3_Int_loss (f=650) (1)	0D	Evaluate Field on Face	3.004213382e-07	0.120
5	Cu_5K_4_Int_loss (f=650) (1)	0D	Evaluate Field on Face	3.48599039e-07	0.139
6	Cu_5K_5_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.9970644e-09	0.0008
7	SS5K_Int_loss (f=650) (1)	0D	Evaluate Field on Face	1.496200021e-06	0.598

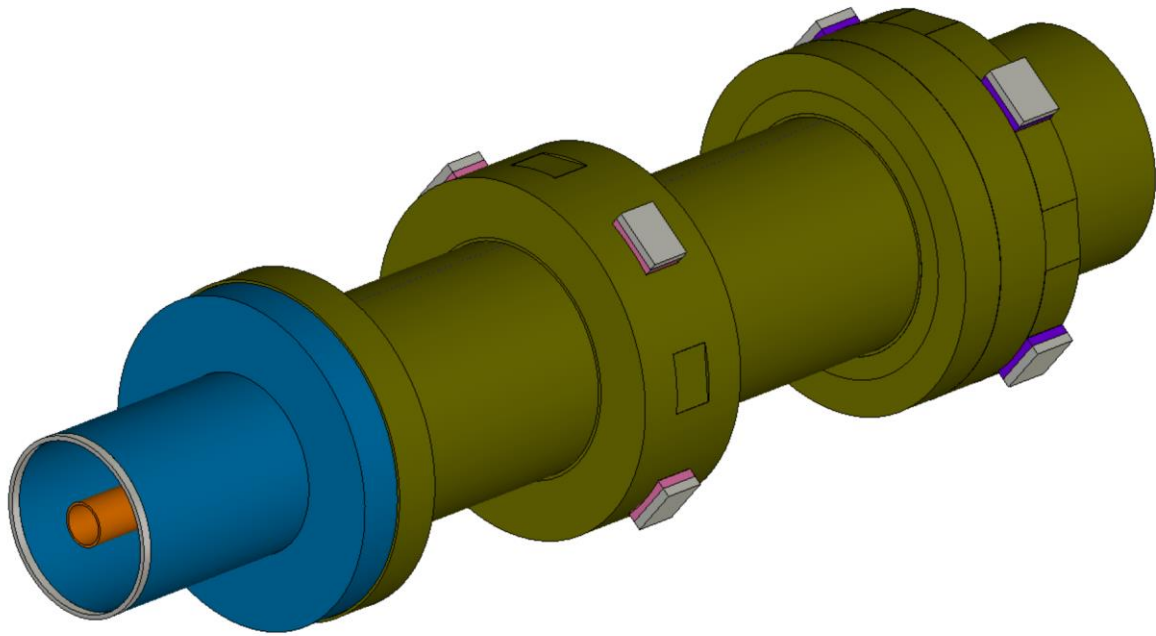
Total = 1.396W

Losses with direct contact: Cu #4 + Cu #5 = **0.140W**

Rough estimates of static losses



Wall	4K, W	70K, W	293K, W
0.6mm	0.38	3.8	-4.2
0.8mm	0.51	5.1	-5.6



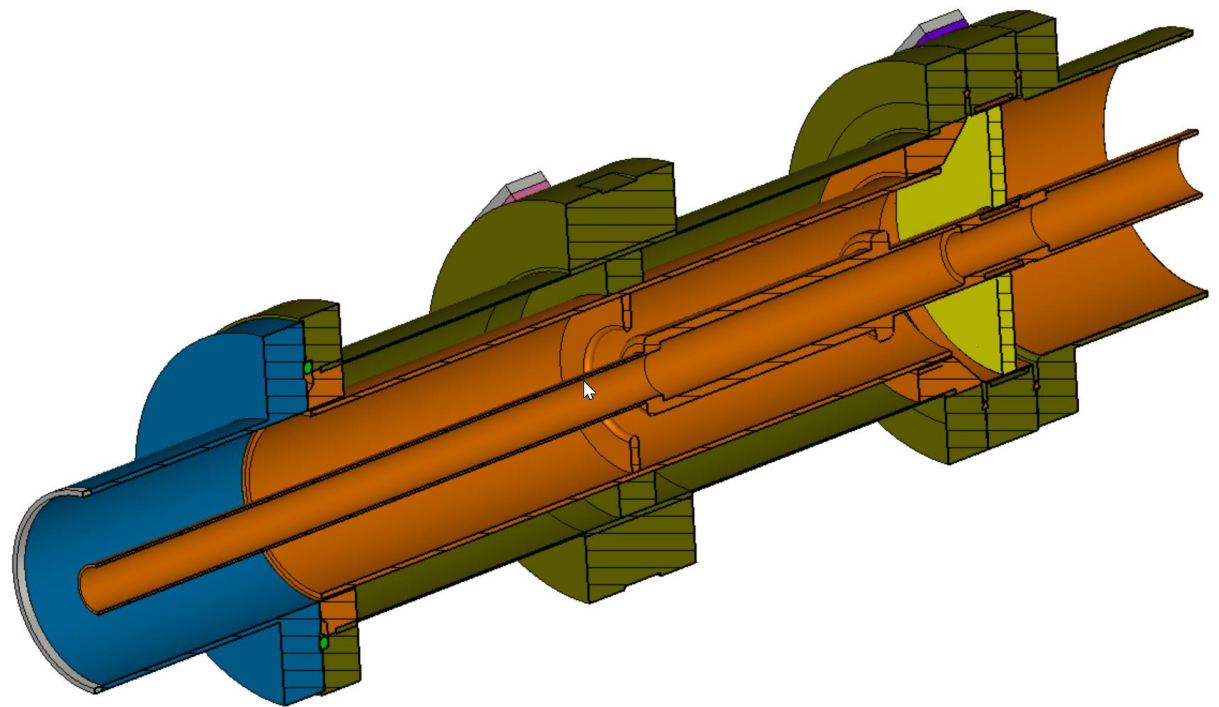
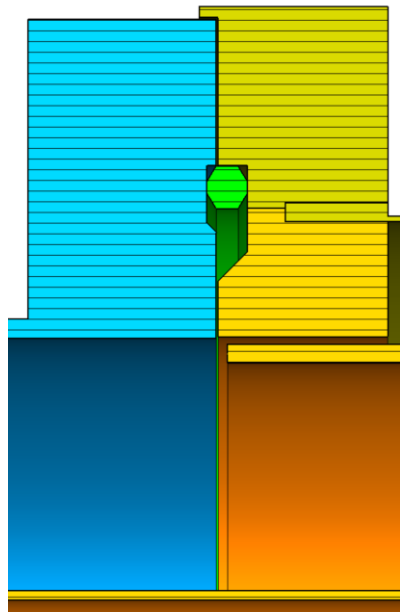
Thermal simulation 200 kW, TW,
Air 6g/s.

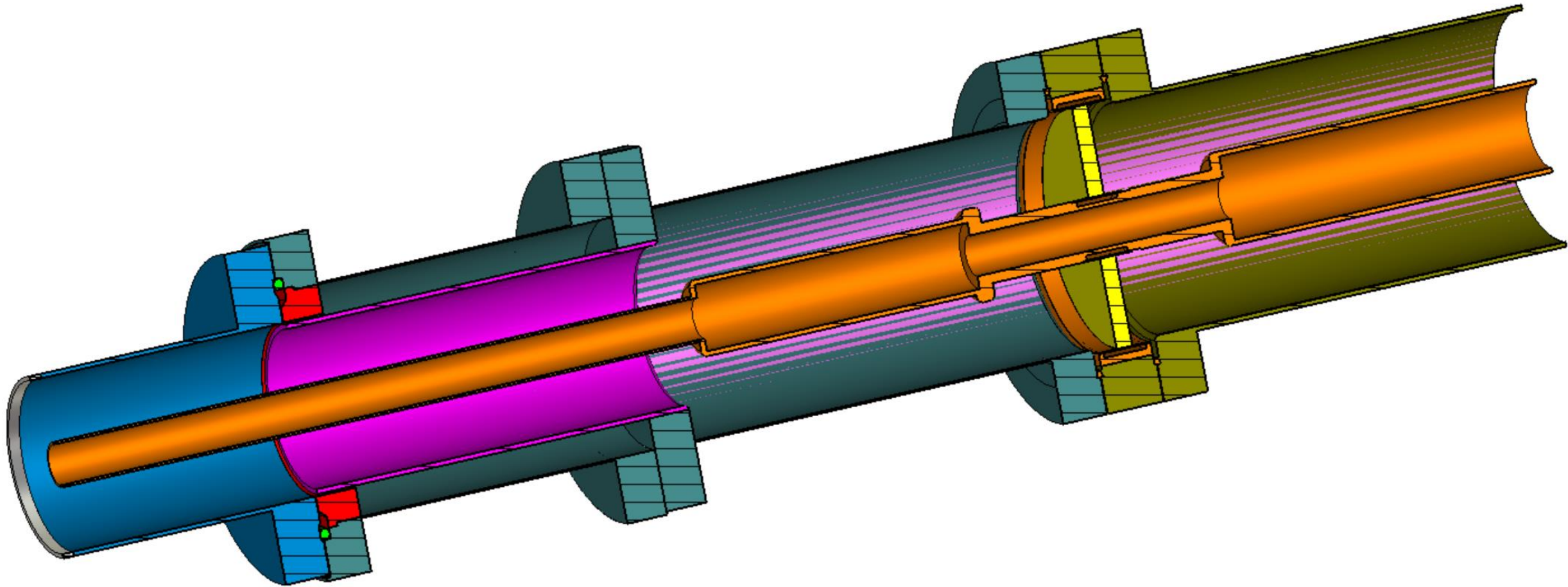
200 kW, TW

Case	"4K"	"50K"	"293K"
50K	2.09W	30.4W	5.8W
70K	2.33W	30.0W	5.9W

Static

Case	"4K"	"50K"	"293K"
50K	0.26 W	4.0 W	-0.86 W
70K	0.47 W	3.6 W	-0.79 W

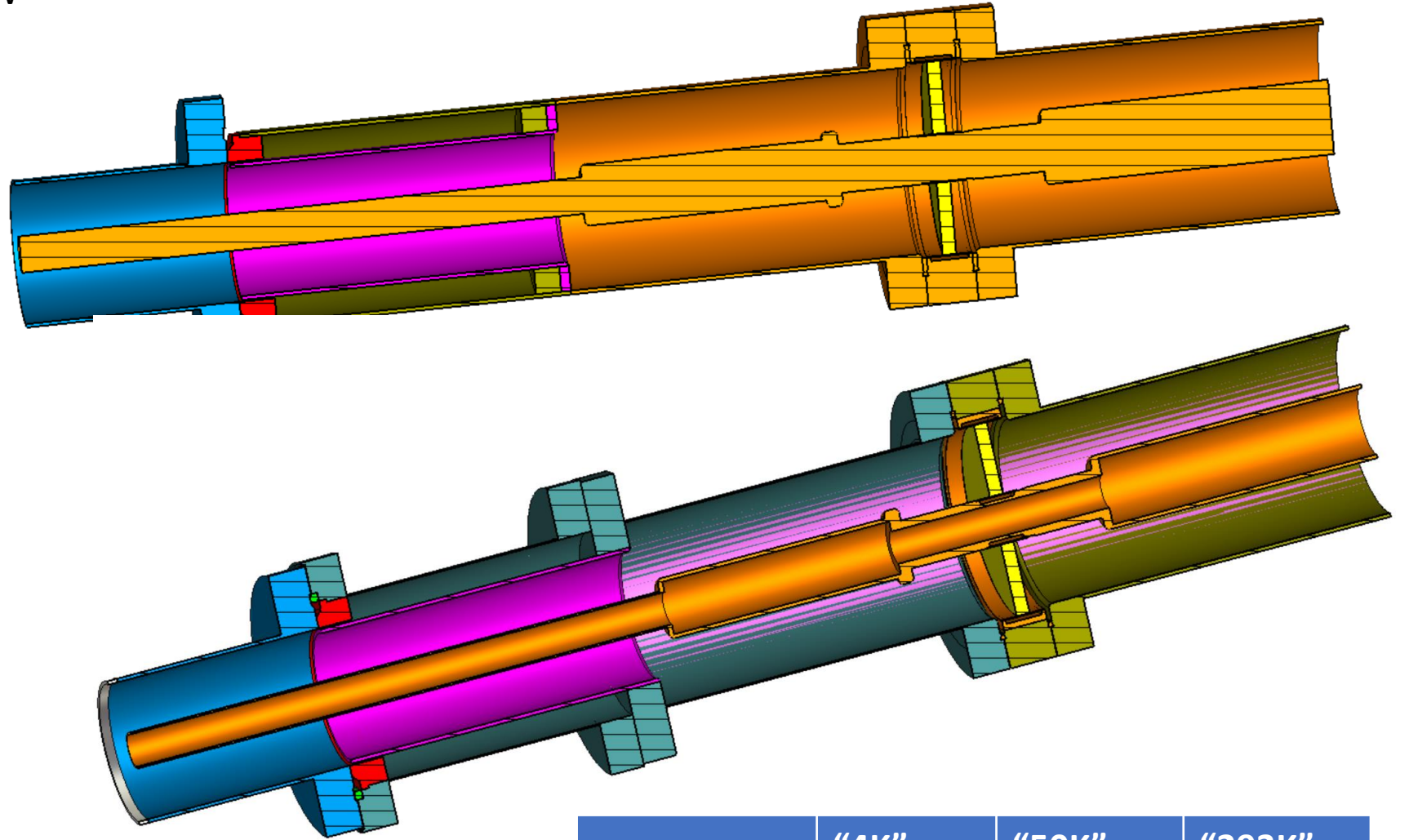
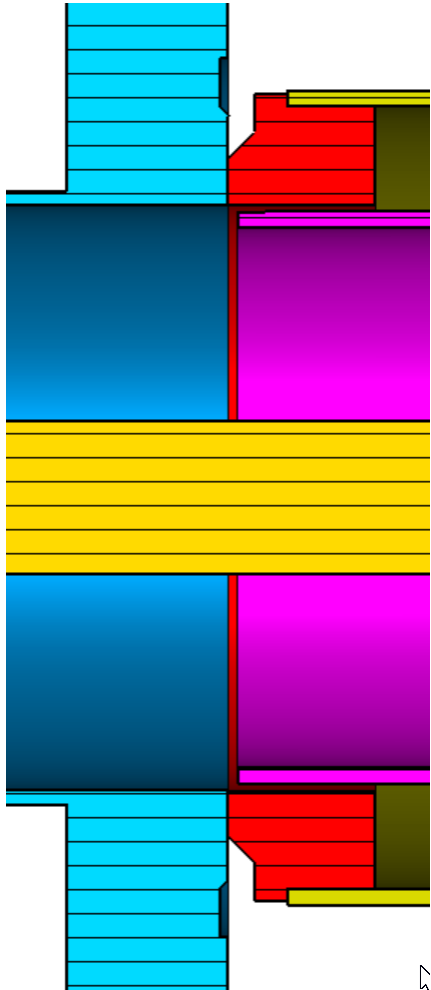




	"4K"	"50K"	"293K"
Static	0.27 W	4.9 W	0.36
200 kW, TW	2.97 W	19.8 W	11.4W

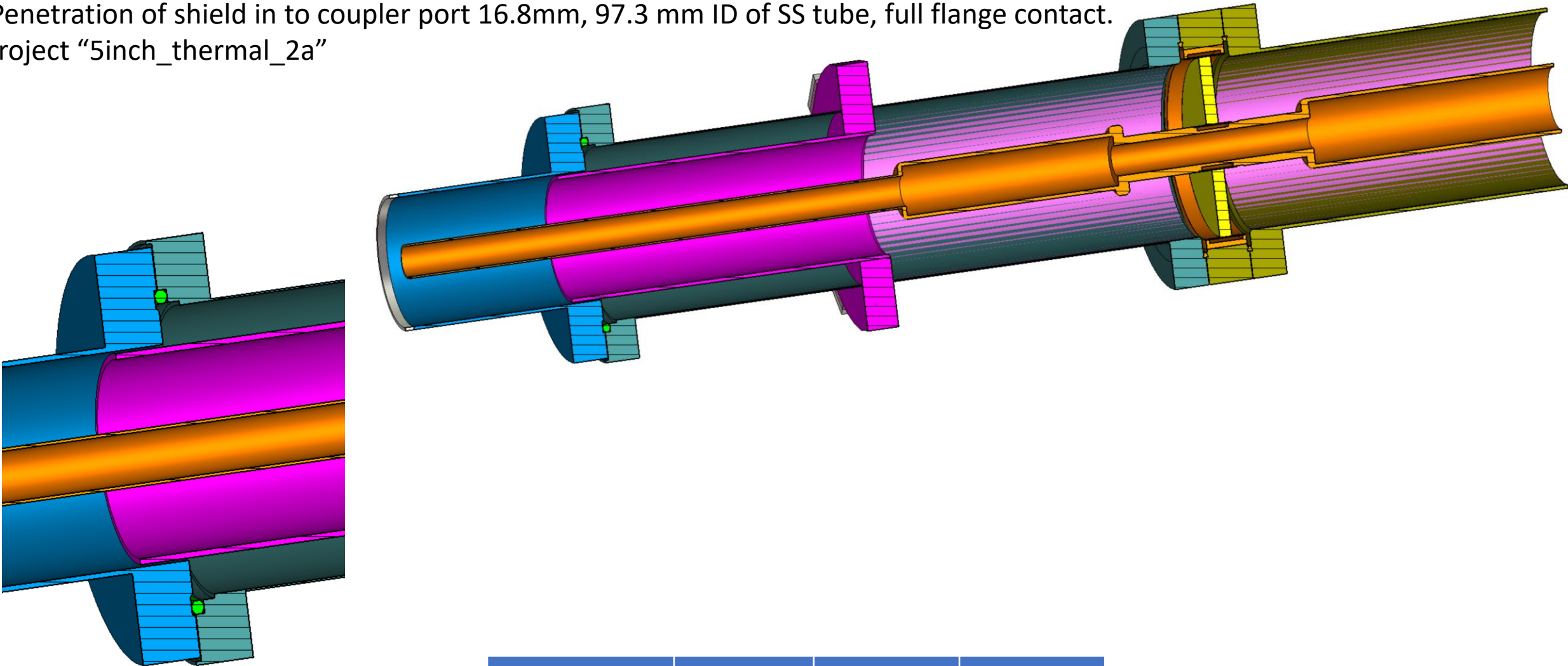
No gap between cavity flange and coupler flange.

Project 4_inch_thermal_4_200kW



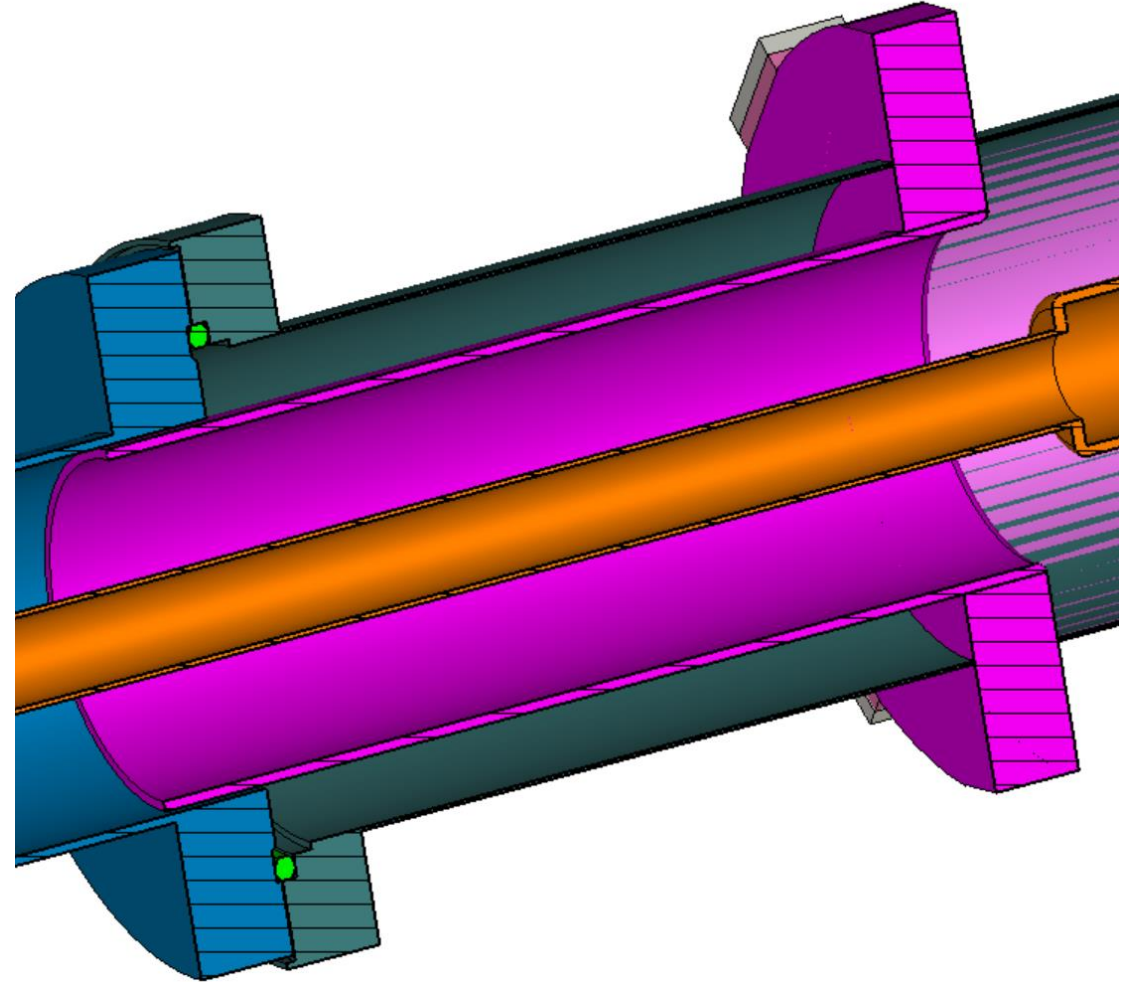
	"4K"	"50K"	"293K"
Static	0.27 W	4.7 W	0.40 W
200 kW, TW	1.16 W	19.8 W	11.4W

Penetration of shield in to coupler port 16.8mm, 97.3 mm ID of SS tube, full flange contact.
Project "5inch_thermal_2a"



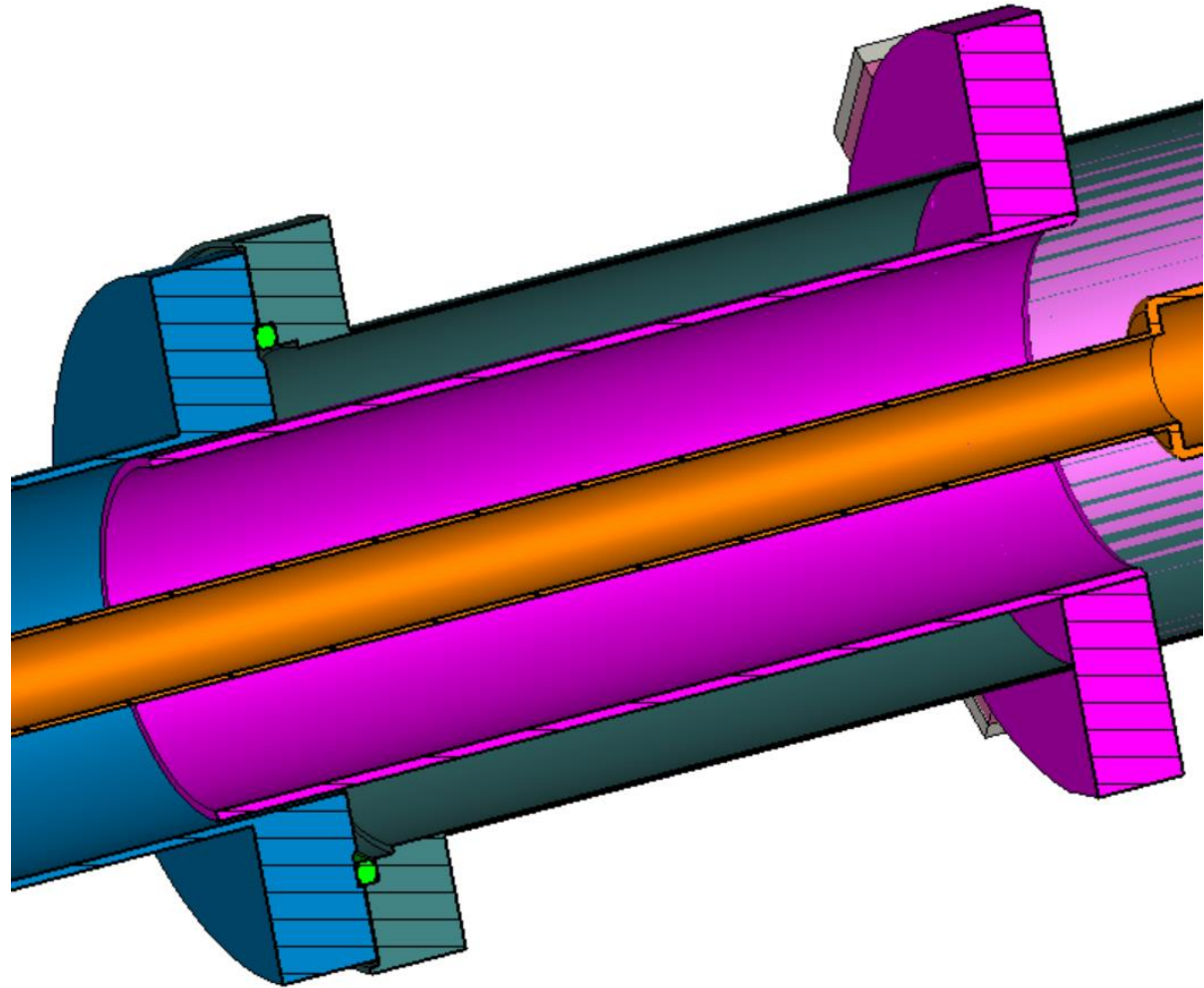
	"4K"	"50K"	"293K"
Static	0.21 W	4.9 W	0.37 W
200 kW, TW	0.79 W	20.6 W	11.4W

5mm longer penetration of shield in to coupler port (21.8mm), 97.3 mm ID of SS tube, full flange contact.
Project "6inch_6_thermal"



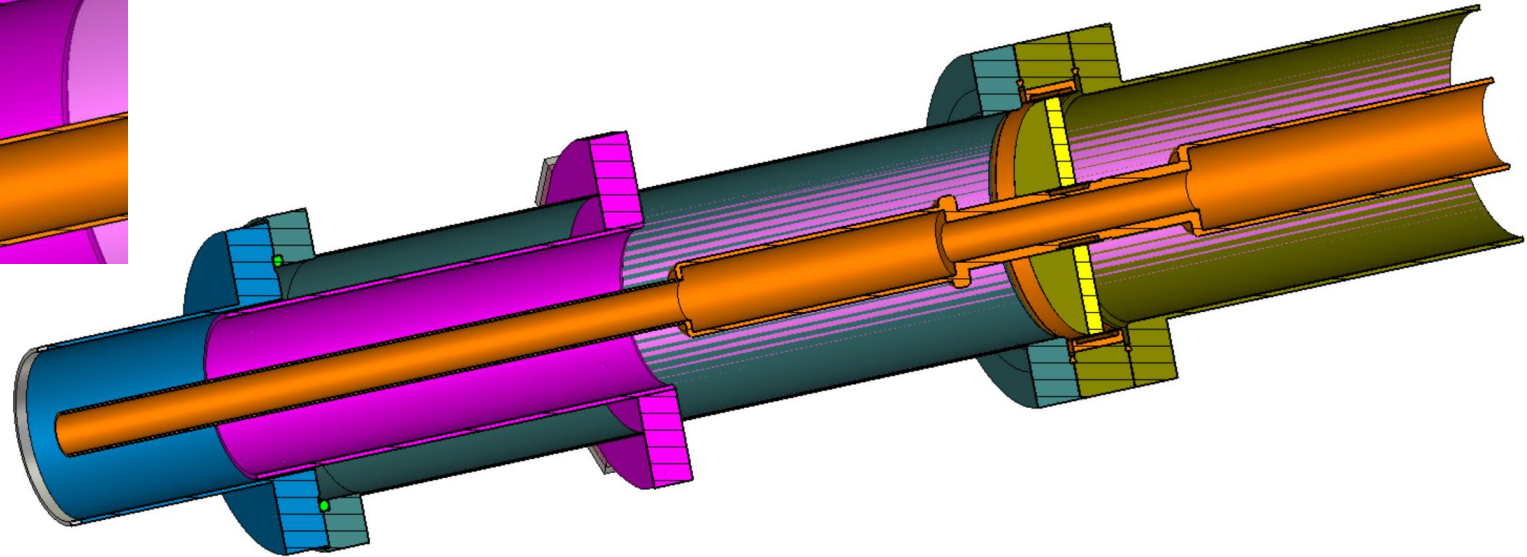
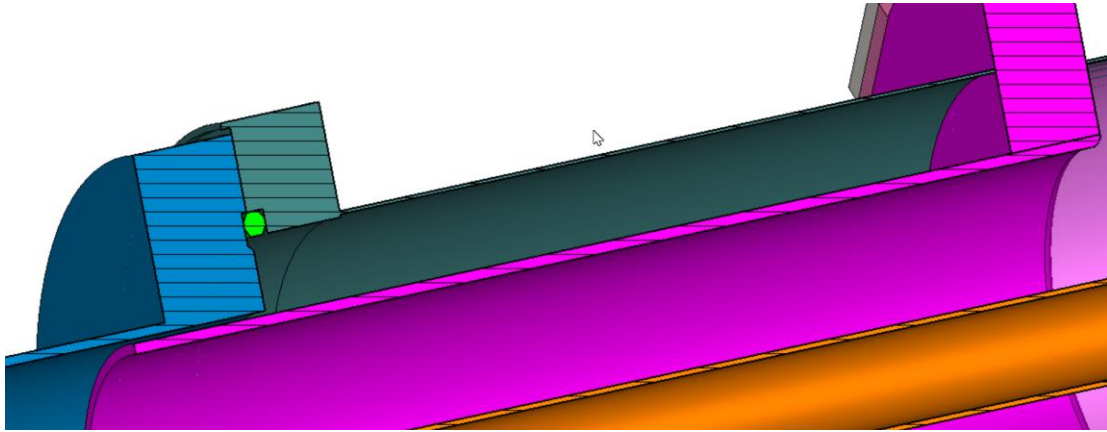
	"4K"	"50K"	"293K"
Static			
200 kW, TW	0.63 W	20.4 W	11.4W

10mm longer penetration of shield in to coupler port (26.8mm), 97.3 mm ID of SS tube, full flange contact.
Project "4inch_7_thermal"

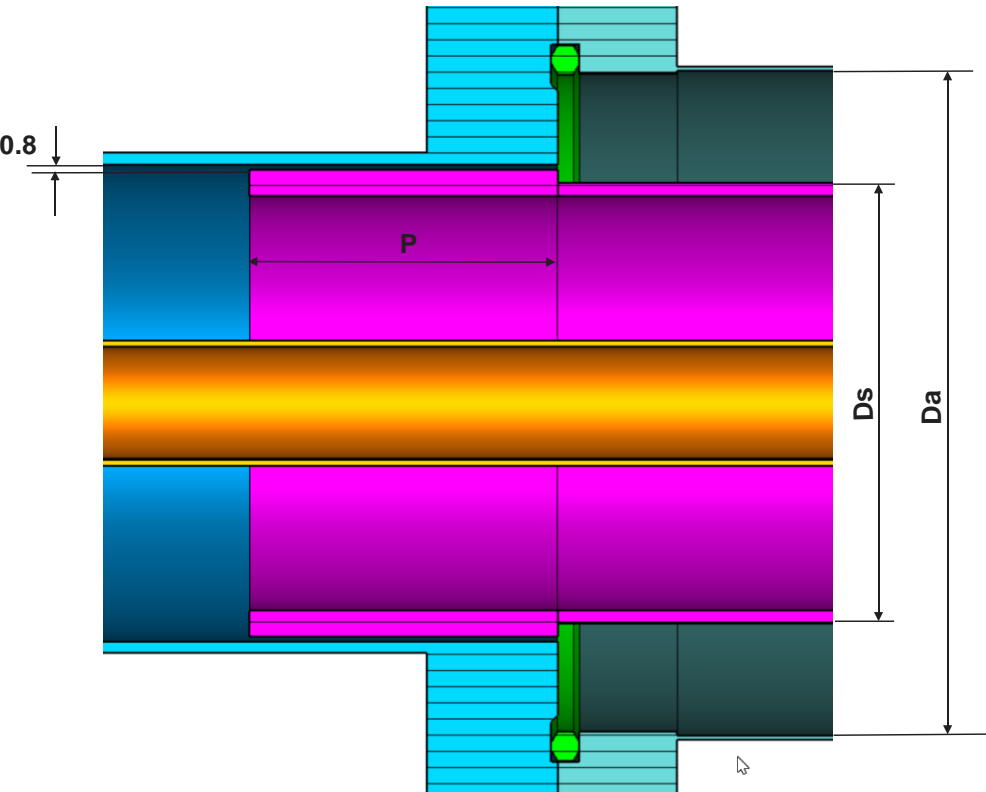
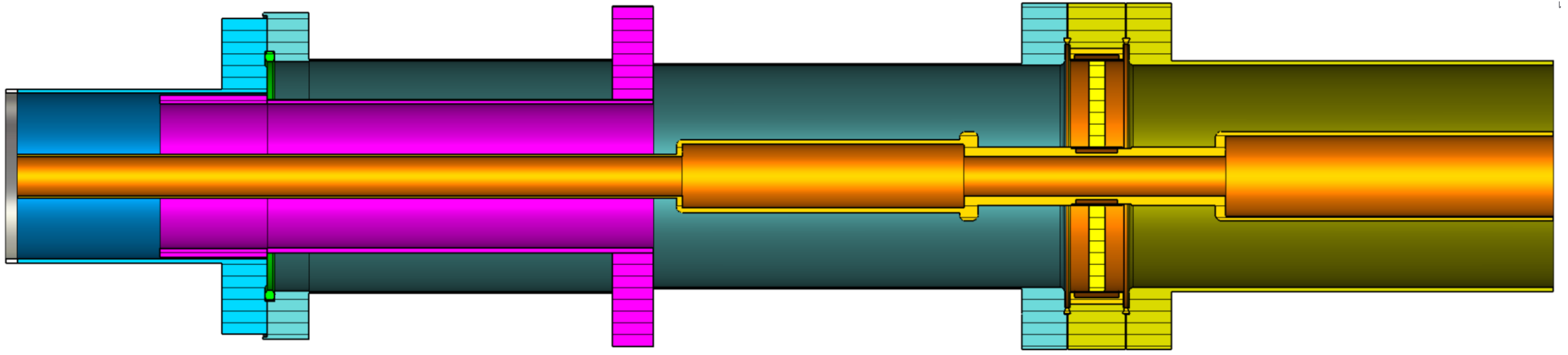


	"4K"	"50K"	"293K"
Static			
200 kW, TW	0.53 W	20.4 W	11.4W

10mm longer penetration of shield in to coupler port (26.8mm), 101.3mm ID of SS tube, full flange contact.
Project "4inch_8_thermal_a"



	"4K"	"50K"	"293K"
Static	0.22 W	4.8 W	0.39 W
200 kW, TW	0.46 W	20.2 W	11.4W

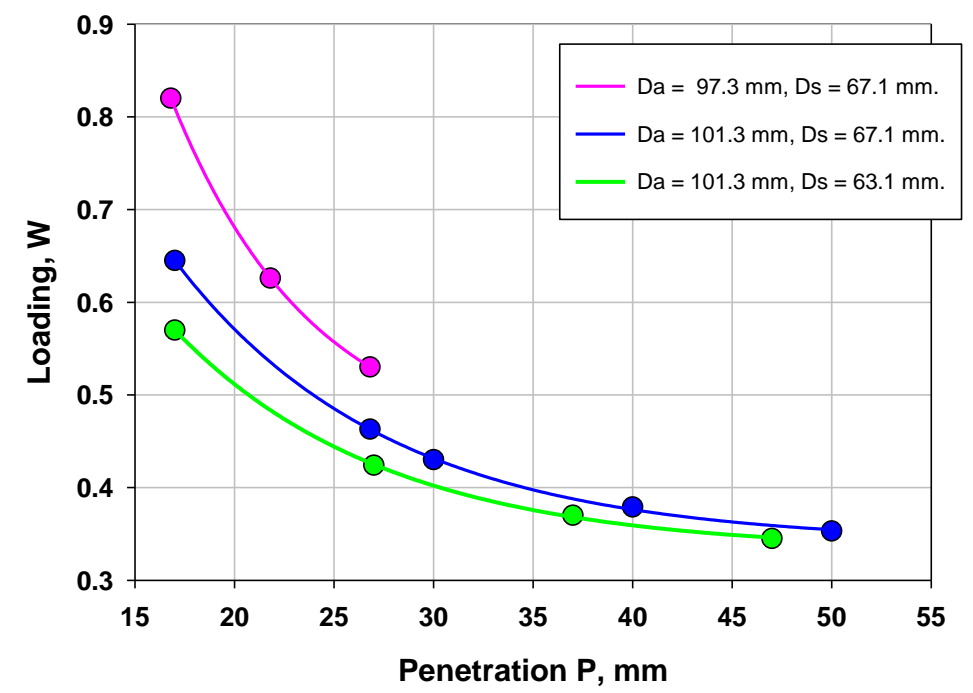


P – penetration of shield into coupler port

Ds – outer diameter of shield

Da – inner diameter of outer conductor







Total cryogenic loading to 4K for 200kW, TW vs shield penetration.

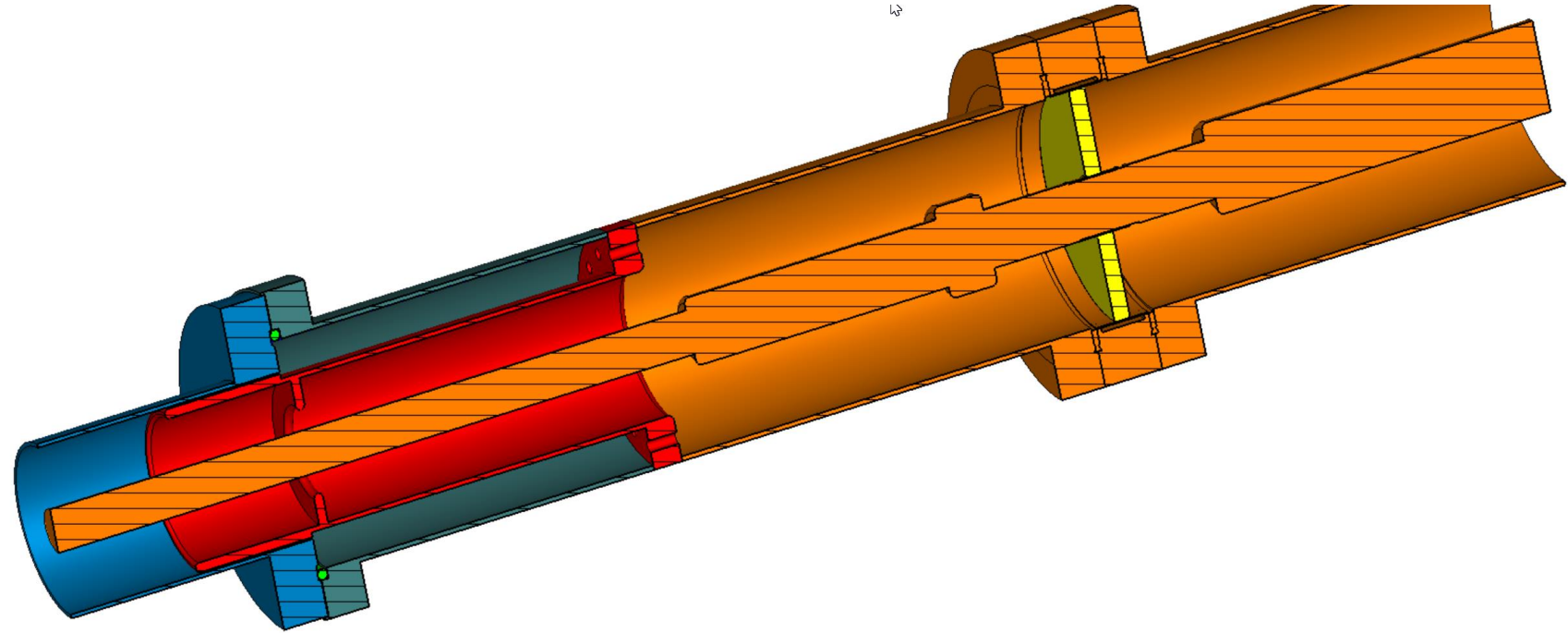
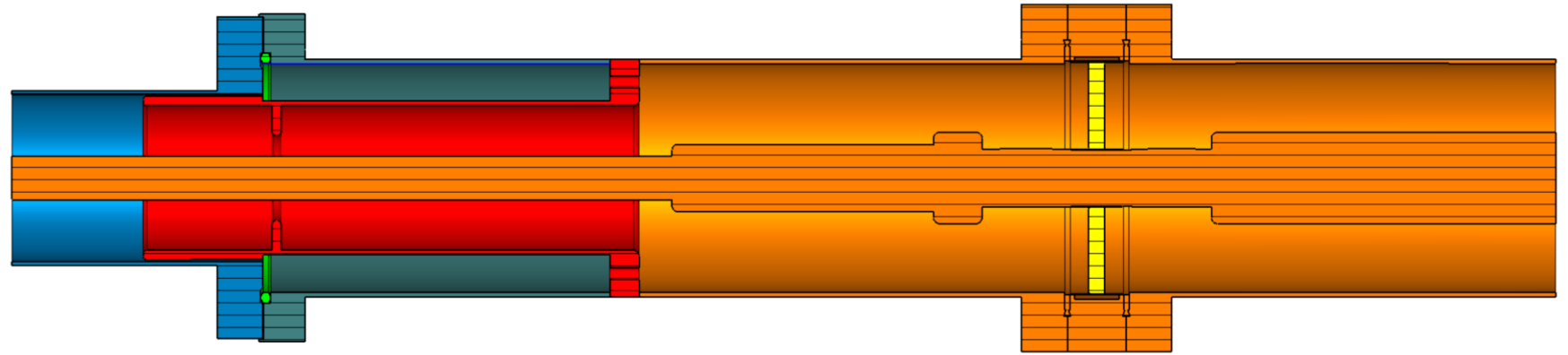


New slides of 07/23/2020

RF configuration of 200 kW coupler

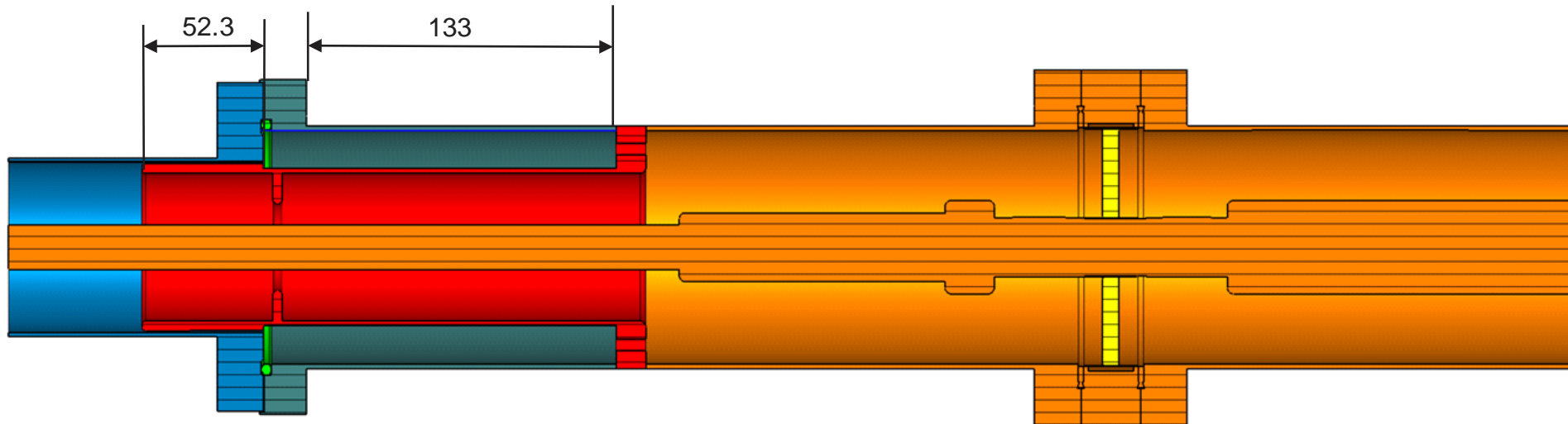
Parameters of materials:

-  "copper", $5.8E+7$ S/m
-  "cold copper", $2.5E+8$ S/m
-  "Stainless steel", $1.6E+6$ S/m
-  "Al", $7.2E+7$ S/m
-  "Super Cond.", $5.8E+20$ S/m
-  "Ceramics", Loss tng = $1E-4$



File: "C:\CST_projects\IARC_coupler\DIR_iris\Total_vac_part_materials_holes_cold_copper_acc.cst"

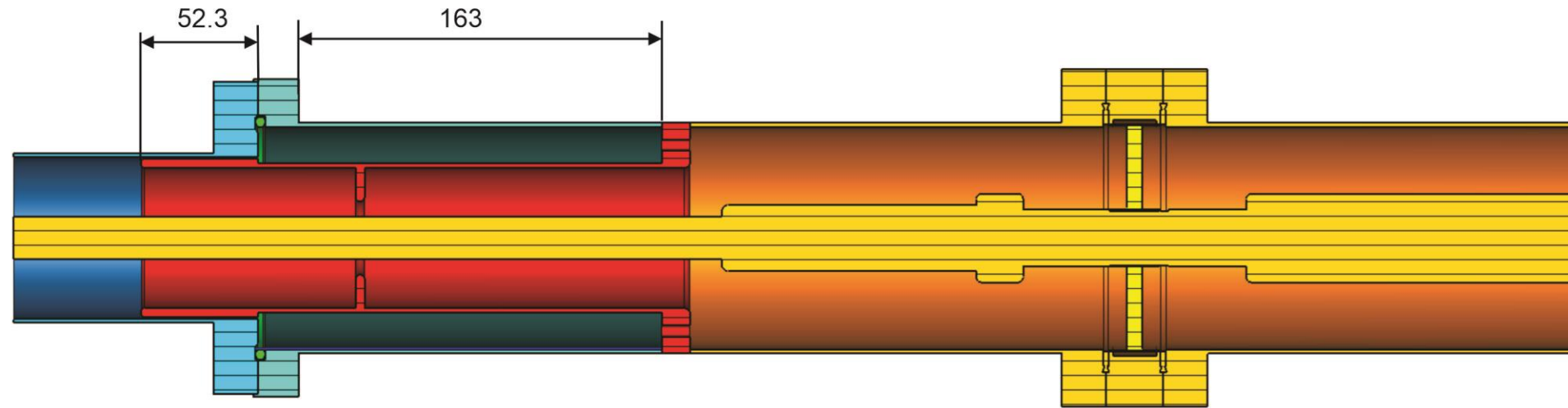
File: "C:\CST_projects\IARC_coupler\DIR_iris\Total_vac_part_materials_holes_cold_copper_acc.cst"



Losses for 200 kW, TW

Part	Losses, W
"Cold copper"	13.35
"Stainless steel"	0.16
"Al"	3.5E-4
"Antenna"	171.8
"Ceramic"	17.17
"Outer cnd, vacuum"	11.80

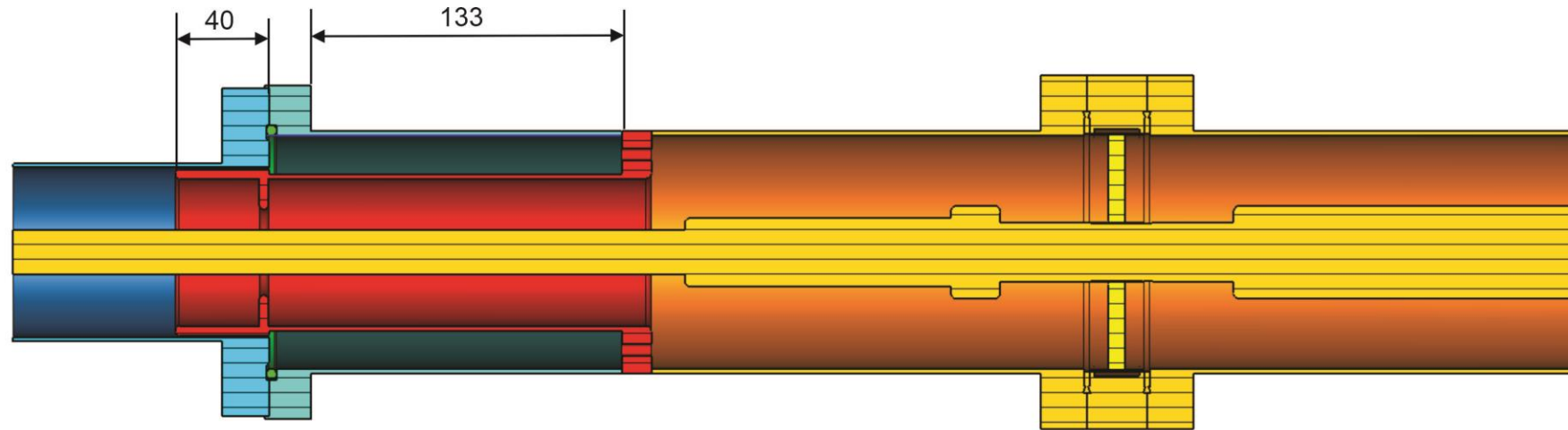
File: "C:\CST_projects\IARC_coupler\DIR_iris\Total_vac_part_materials_holes_cold_copper_acc_longer_30mm"



Losses for 200 kW, TW

Part	Losses, W
"Cold copper"	15.25
"Stainless steel"	0.34
"Al"	2.3E-3
"Antenna"	180.1
"Ceramic"	17.29
"Outer cnd, vacuum"	11.76

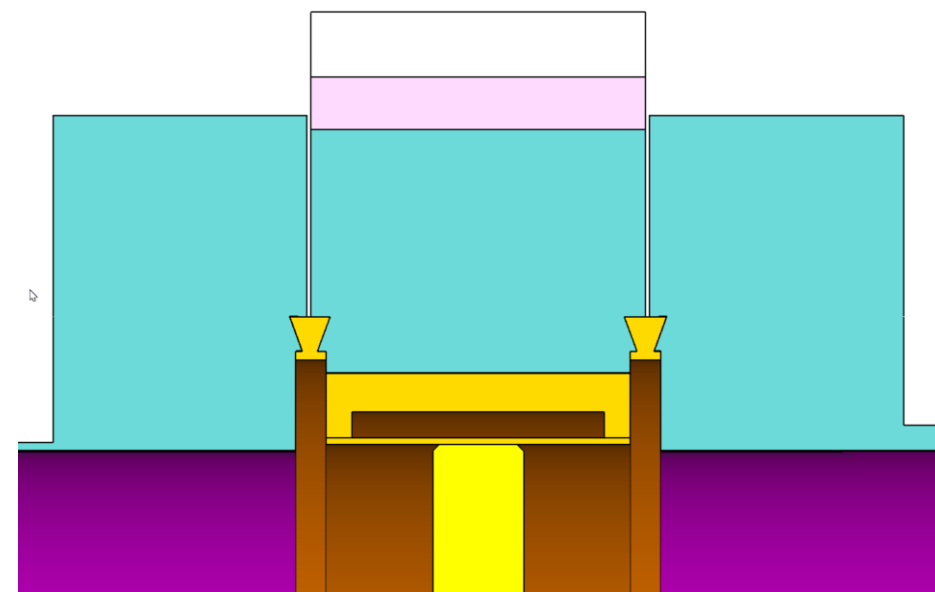
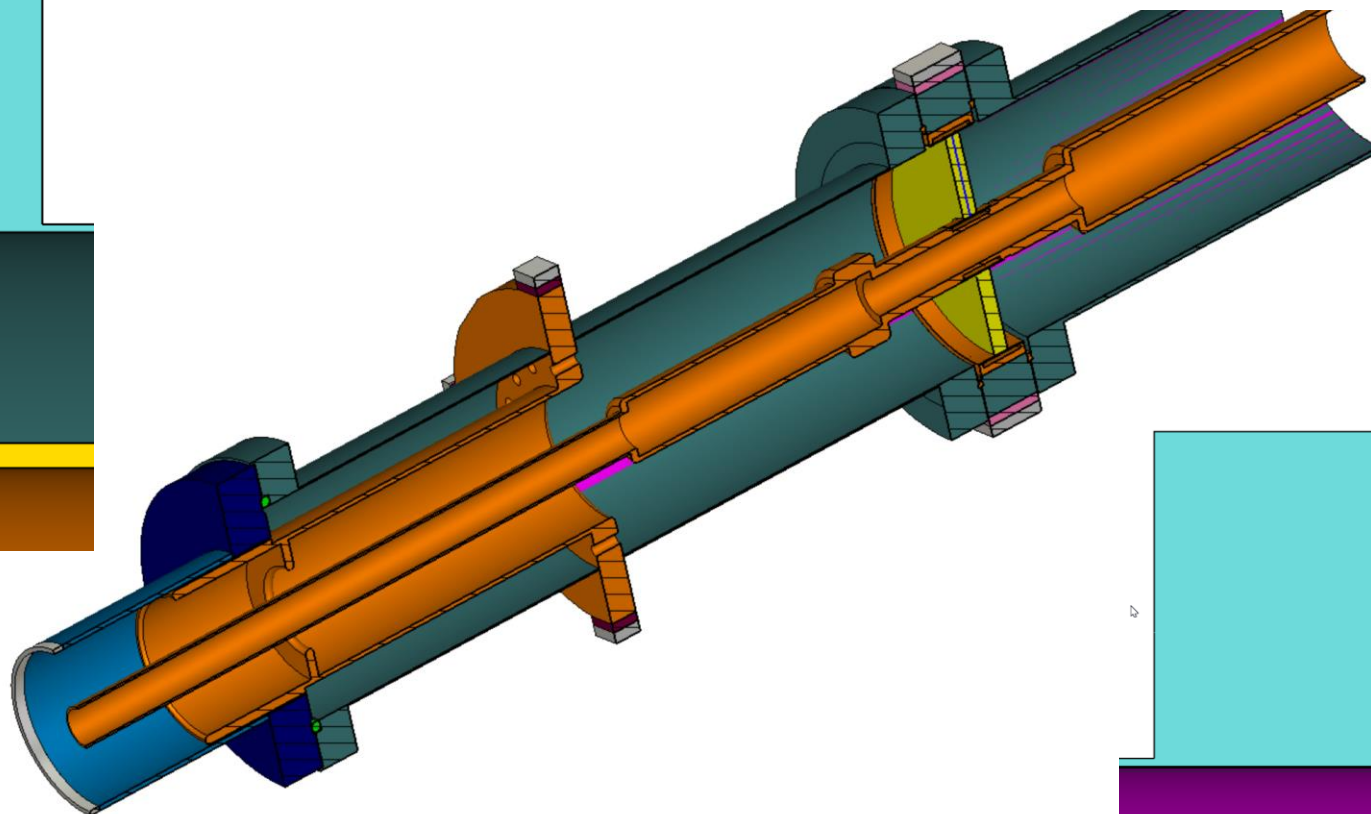
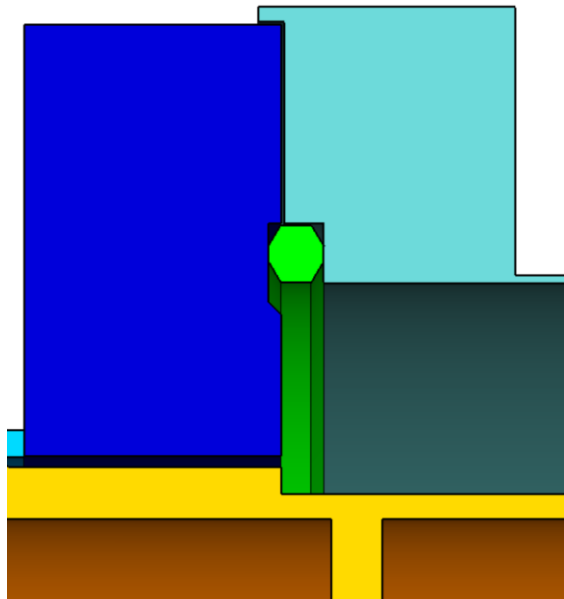
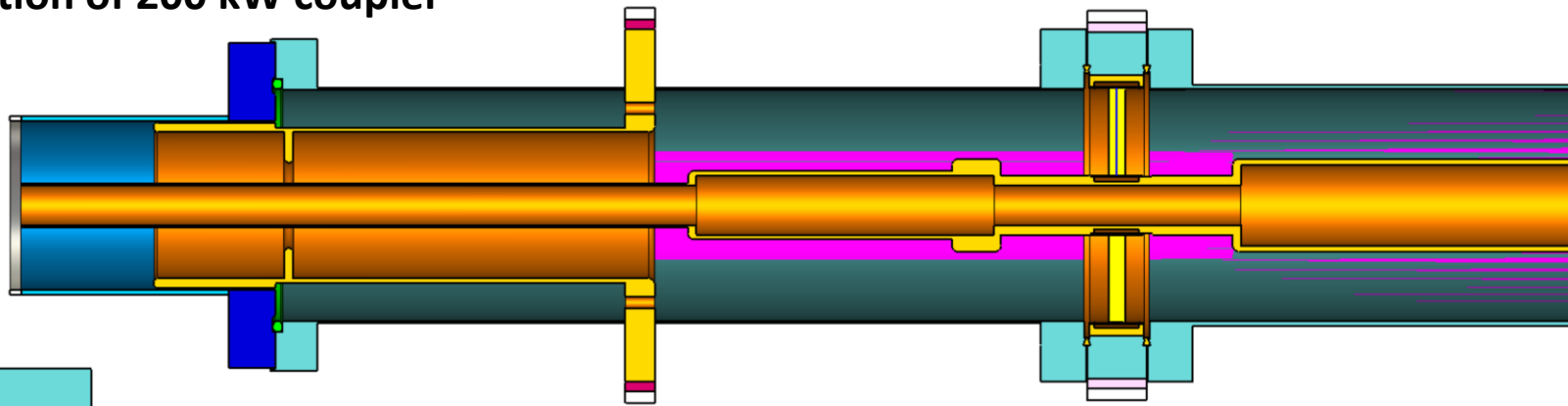
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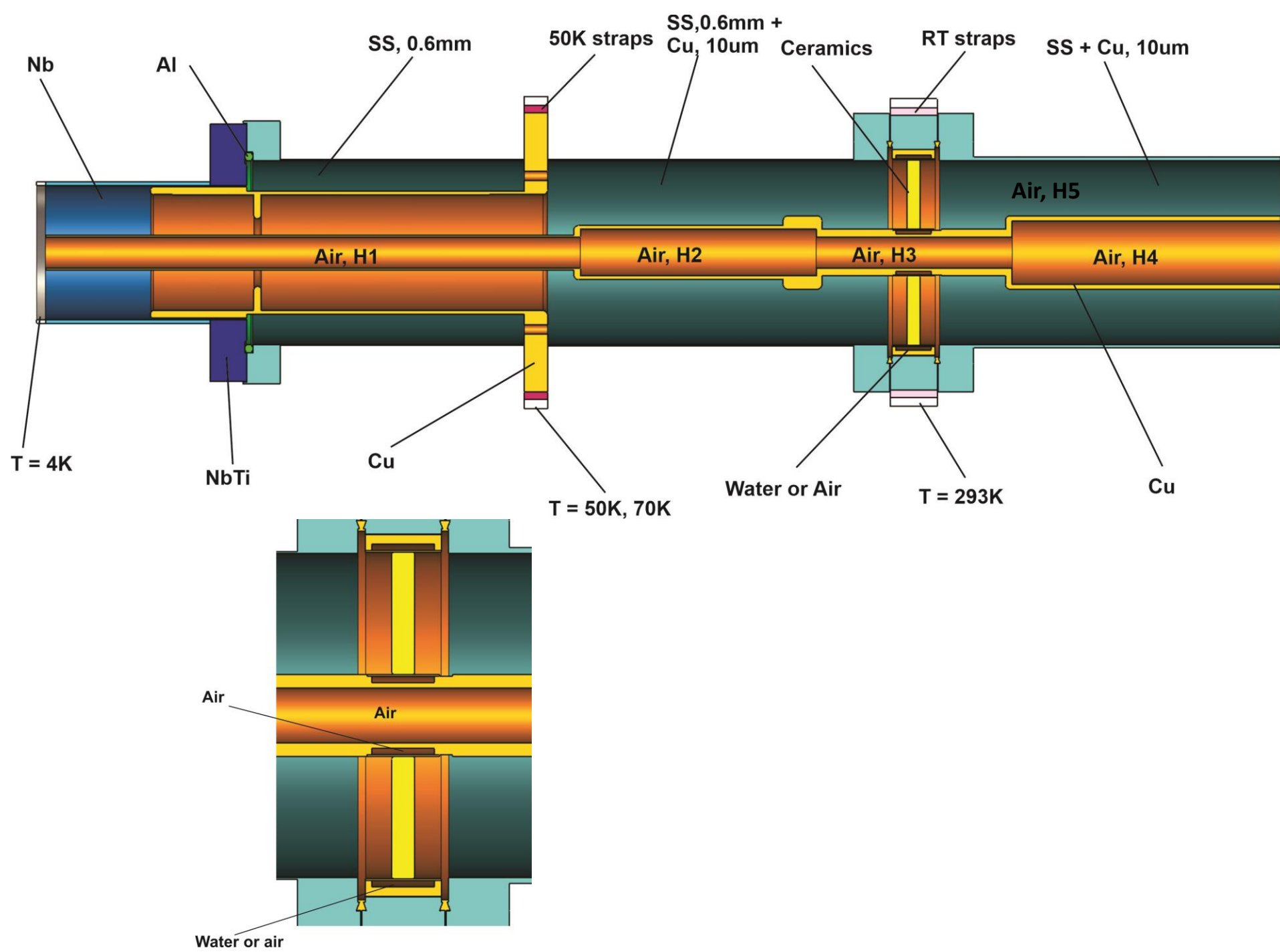


Losses for 200 kW, TW

Part	Losses, W
"Cold copper"	12.58
"Stainless steel"	0.24
"Al"	5.3E-4
"Antenna"	171.7
"Ceramic"	17.3
"Outer cnd, vacuum"	11.80

Thermal configuration of 200 kW coupler





Nb

Temperature [K]	Thermal conductivity [W/m/K]
0	0.001
1	3.6
2	71.8
3	107
4	142
5	175
6	206
7	234
8	258
9	278
10	294
11	305
12	311
13	314
14	312
15	308
16	301
18	281
20	249
25	182
30	139
35	112
40	95.3
45	83.8
50	75.8
60	66.1
70	61.2
80	58.4
90	56.6
100	55.2
123.2	53.7
150	53
173.2	52.7
220	52.6
223.2	52.7
250	53
300	53

NbTi

Temperature [K]	Thermal conductivity [W/m/K]
2	2.5
3	6.5
4	16.25
6	62.5
8	86.25
10	103
12	113
14	123
16	130
18	136.25
20	140

Al

Temperature [K]	Thermal conductivity [W/m/K]
1	1.2
5	6.8
10	14.2
20	28.4
40	52
100	95.7
150	116
200	128.7
250	136.8
300	141.6

Ceramic, 26 W/m/K

50K strap, 4.2 W/m/K

RT strap, 0.76 W/m/K

SS

Temperature [K]	Thermal conductivity [W/m/K]
2	0.136
4	0.2724
10	0.9039
20	2.1686
30	3.4686
40	4.6703
50	5.7302
60	6.6466
70	7.4348
80	8.1143
90	8.7048
100	9.2236
120	10.1013
140	10.8344
150	11.1652
160	11.4791
171	11.8095
180	12.0711
200	12.6327
220	13.1778
240	13.7145
260	14.2474
273	14.5929
280	14.7787
293.4	14.88

H1 = 165 W/m²/K (200kW)

H2 = 68 W/m²/K (200kW)

H3 = 140 W/m²/K (200kW)

H4 = 33 W/m²/K (200kW)

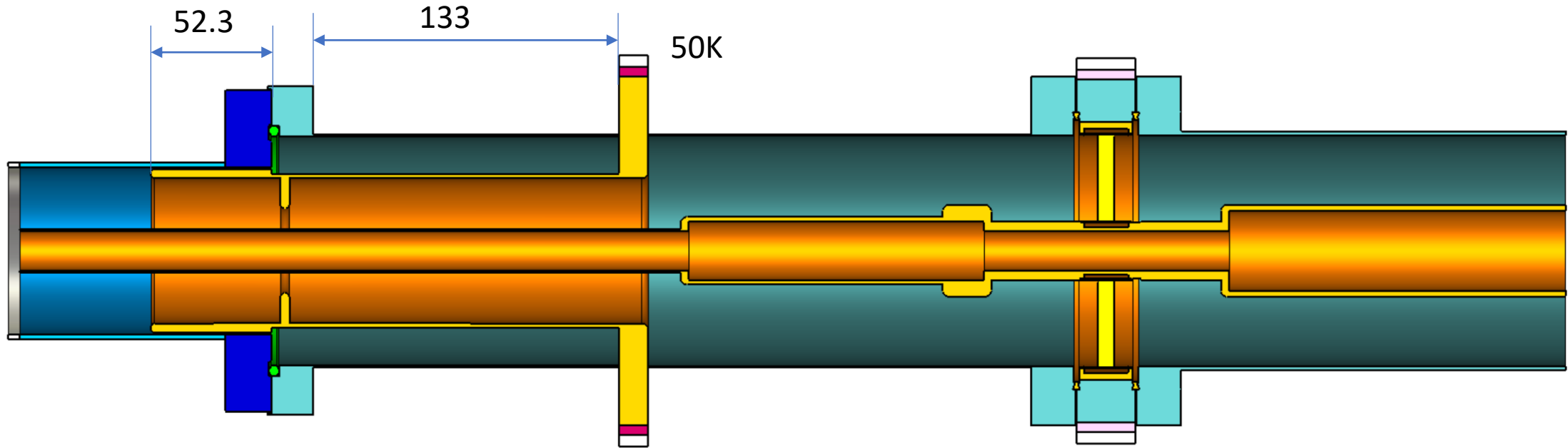
H5 = 5 or 10 W/m²/K (200kW)

Cu

Temperature [K]	Thermal conductivity [W/m/K]
2	44
10	220
20	417
30	553
40	609
50	588
60	524
70	467
80	437
90	422
100	412
120	400
150	393
200	390
300	390

Water, 2000 W/m²/K

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1.cst"



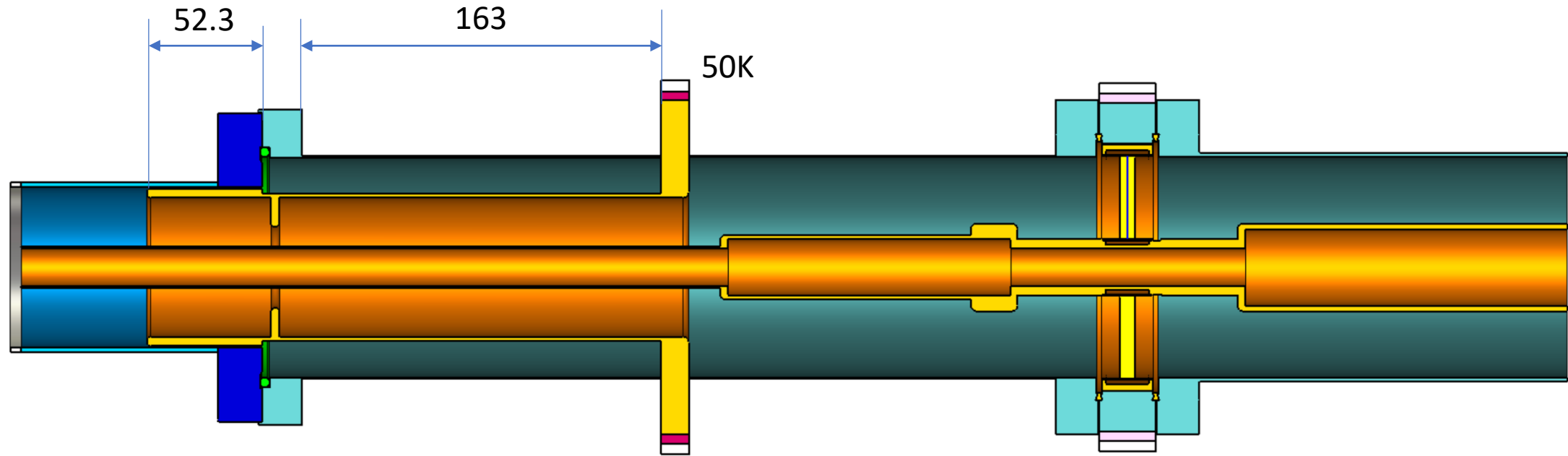
50K strap, 2.1 W/m/K

P = 0 kW

```
Heat Flow [temperaturesource1]: -2.503640e-01 W
Heat Flow [temperaturesource2]: -4.539967e+00 W
Heat Flow [temperaturesource3]: 2.372050e+00 W
Heat Flow [surfaceprops1]: 3.031336e-01 W
Heat Flow [surfaceprops2]: 3.701827e-01 W
Heat Flow [surfaceprops3]: 3.447789e-01 W
Heat Flow [surfaceprops4]: 4.453234e-01 W
Heat Flow [surfaceprops5]: 1.747358e-01 W
Heat Flow [surfaceprops6]: 7.801264e-01 W
```

Total Heat Flow: 8.913393e-08 W (avg) = 1.782679e-07 W (peak)

File: "C:\CST_projects\IARC_coupler\DIR_iris\ Teplo_Total_vac_part_materials_1_0kW_TW_cold_copper_8_50K_straps_30mm_longer"



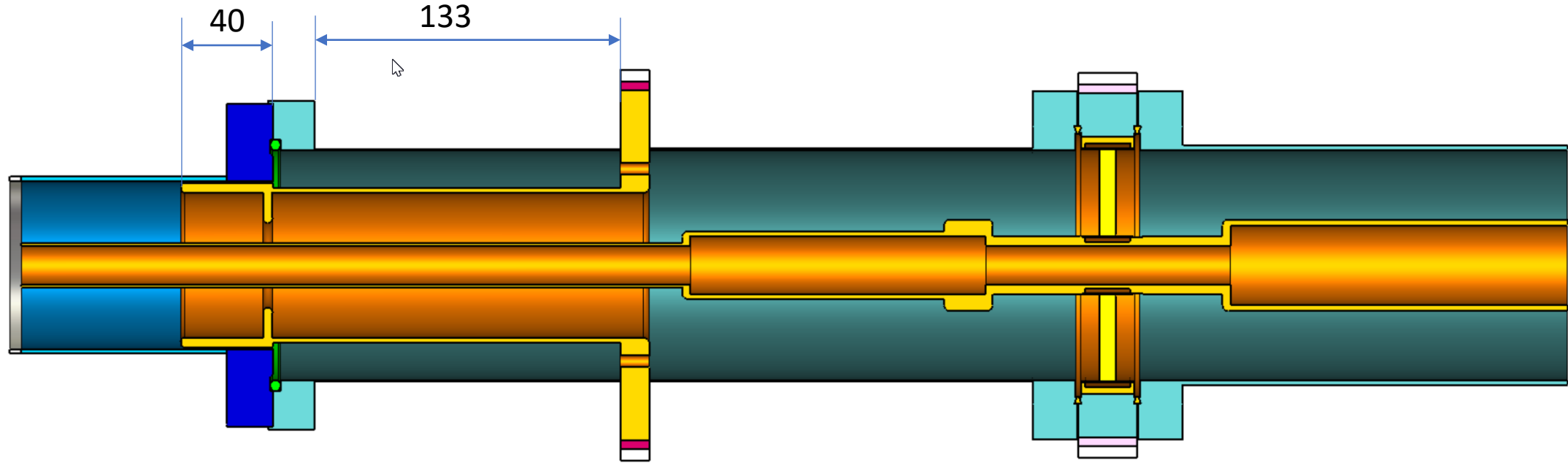
50K strap, 4.2 W/m/K

P = 0 kW

```
Heat Flow [temperaturesource1]: -1.831278e-01 W
Heat Flow [temperaturesource2]: -4.647997e+00 W
Heat Flow [temperaturesource3]: 2.396058e+00 W
Heat Flow [surfaceprops1]: 3.105106e-01 W
Heat Flow [surfaceprops2]: 3.748312e-01 W
Heat Flow [surfaceprops3]: 3.499023e-01 W
Heat Flow [surfaceprops4]: 4.339324e-01 W
Heat Flow [surfaceprops5]: 1.766480e-01 W
Heat Flow [surfaceprops6]: 7.892428e-01 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 0.000000e+00 W
Heat Flow [thermalloss0: Surface Loss Distribution]: 0.000000e+00 W

Total Heat Flow: 7.797643e-09 W (avg) = 1.559529e-08 W (peak)
```

File: "C:\CST_projects\IARC_coupler\DIR_iris\ Teplo_Total_vac_part_materials_1_0kW_TW_cold_copper_8_70K-straps_water_40mm_insert_static"

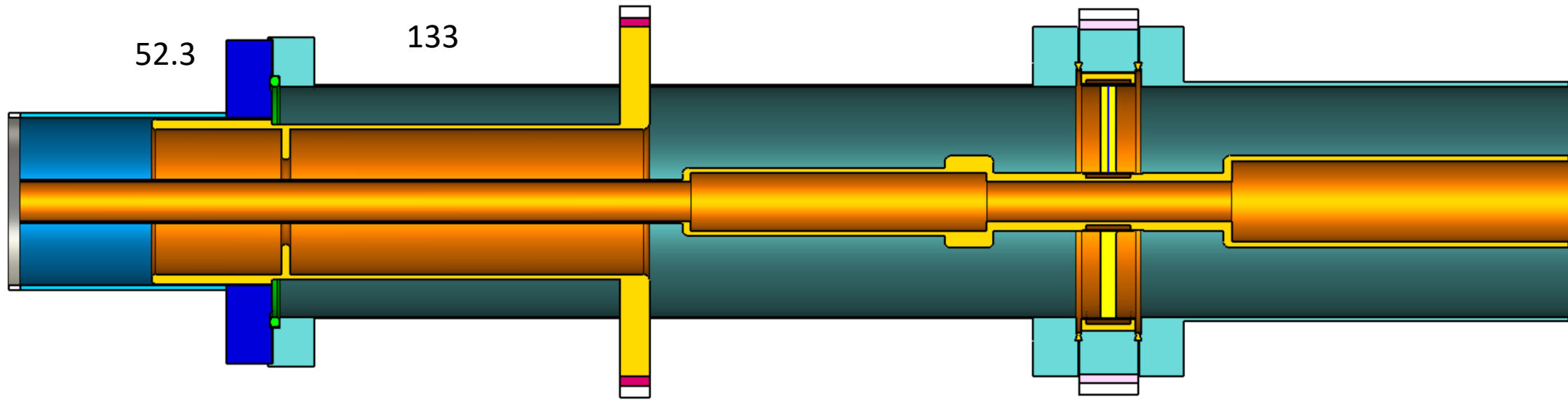


70K strap, 4.2 W/m/K

P = 0 kW

Heat Flow [temperaturesource1]:	-4.139383e-01 W
Heat Flow [temperaturesource2]:	-4.213307e+00 W
Heat Flow [temperaturesource3]:	9.240417e-02 W
Heat Flow [surfaceprops1]:	2.807146e-01 W
Heat Flow [surfaceprops2]:	7.325703e-01 W
Heat Flow [surfaceprops3]:	1.508561e+00 W
Heat Flow [surfaceprops4]:	7.611607e-01 W
Heat Flow [surfaceprops5]:	-4.567673e-02 W
Heat Flow [surfaceprops6]:	1.565294e-02 W
Heat Flow [surfaceprops7]:	1.294431e+00 W
Heat Flow [surfaceprops8]:	-1.257239e-02 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]:	0.000000e+00 W
Heat Flow [thermalloss0: Surface Loss Distribution]:	0.000000e+00 W
Total Heat Flow: 6.598925e-08 W (avg) = 1.319785e-07 W (peak)	

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1_200kW_TW_cold_copper.cst"



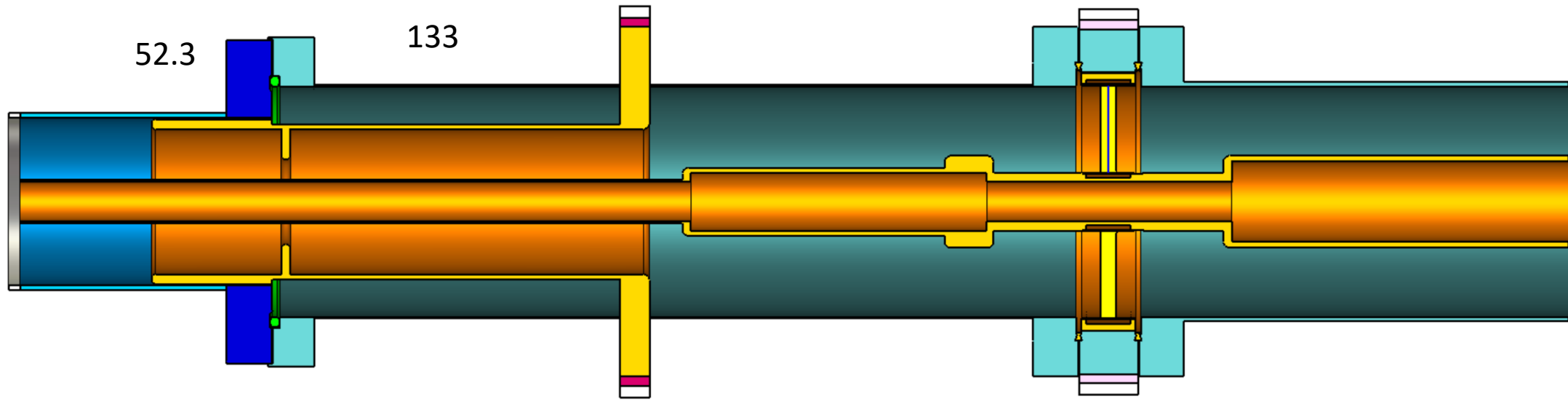
50K strap, 2.1 W/m/K

P = 200 kW, TW

```
Heat Flow [temperaturesource1]: -5.743188e-01 W
Heat Flow [temperaturesource2]: -2.358437e+01 W
Heat Flow [temperaturesource3]: -1.802839e+01 W
Heat Flow [surfaceprops1]: -9.319472e+01 W
Heat Flow [surfaceprops2]: -2.724700e+01 W
Heat Flow [surfaceprops3]: -3.428811e+01 W
Heat Flow [surfaceprops4]: -2.752240e+01 W
Heat Flow [surfaceprops5]: -2.053826e+00 W
Heat Flow [surfaceprops6]: -1.326965e+01 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 1.715727e+01 W (avg) (imported: 1.715727e+01 W (avg))
Heat Flow [thermalloss0: Surface Loss Distribution]: 2.226055e+02 W (avg) (imported: 2.226055e+02 W (avg))
```

```
Total Heat Flow: -1.506331e-07 W (avg) = -3.012663e-07 W (peak)
```

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1_200kW_TW_cold_copper_8_50K-straps"



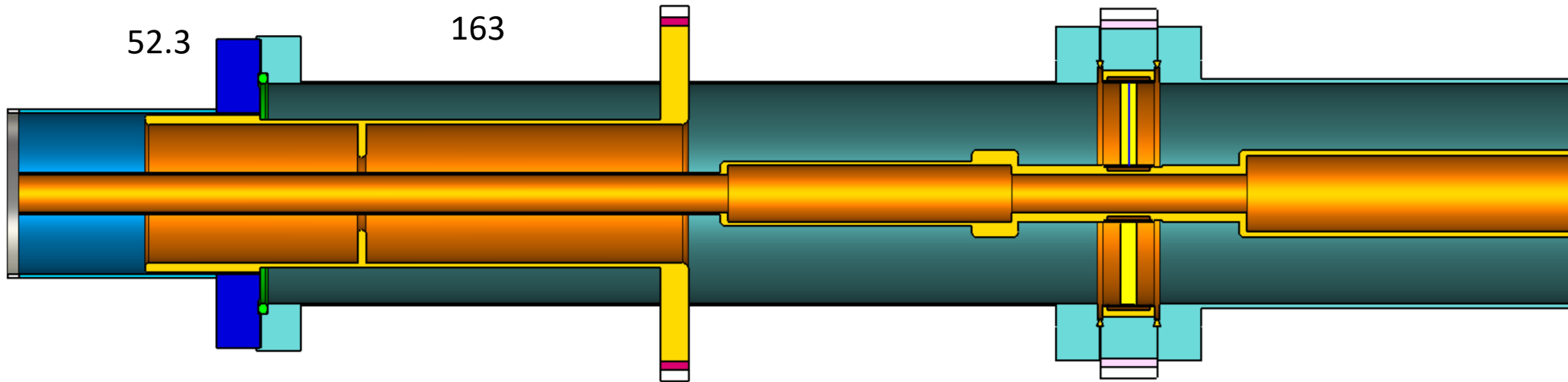
50K strap, 4.2 W/m/K

P = 200 kW, TW

```
Heat Flow [temperaturesource1]: -3.988061e-01 W
Heat Flow [temperaturesource2]: -2.406102e+01 W
Heat Flow [temperaturesource3]: -1.783891e+01 W
Heat Flow [surfaceprops1]: -9.319030e+01 W
Heat Flow [surfaceprops2]: -2.723819e+01 W
Heat Flow [surfaceprops3]: -3.423167e+01 W
Heat Flow [surfaceprops4]: -2.751282e+01 W
Heat Flow [surfaceprops5]: -2.040899e+00 W
Heat Flow [surfaceprops6]: -1.321110e+01 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 1.715727e+01 W (avg) (imported: 1.715727e+01 W (avg))
Heat Flow [thermalloss0: Surface Loss Distribution]: 2.225664e+02 W (avg) (imported: 2.225664e+02 W (avg))
```

Total Heat Flow: -1.641604e-07 W (avg) = -3.283208e-07 W (peak)

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1_200kW_TW_cold_copper_8_50K_straps_30mm_longer.cst"



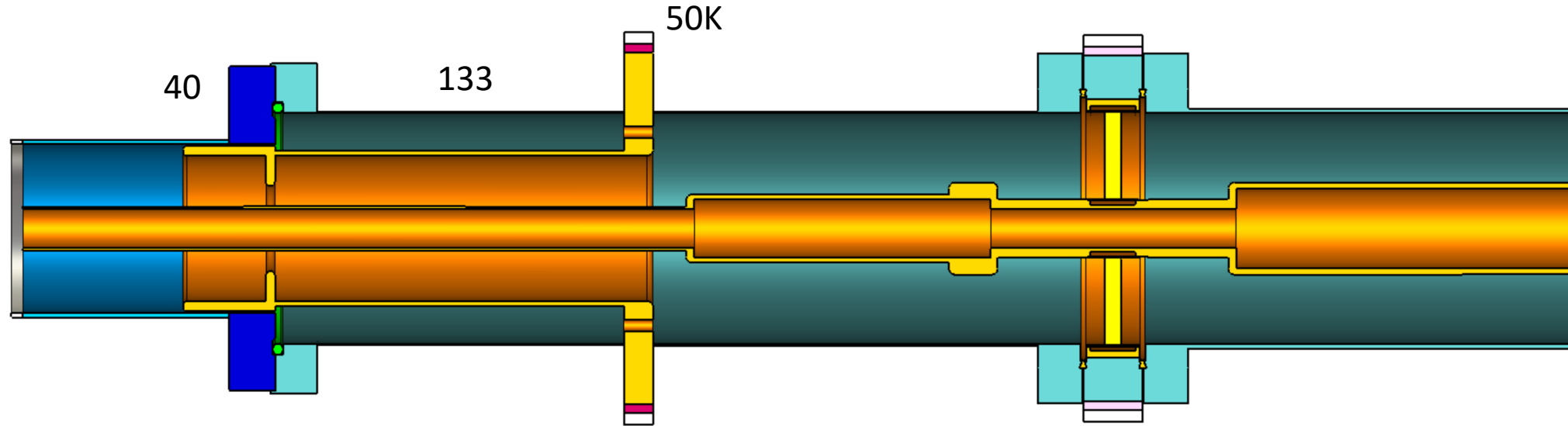
50K strap, 4.2 W/m/K

P = 200 kW, TW

```
Heat Flow [temperaturesource1]: -4.271762e-01 W
Heat Flow [temperaturesource2]: -2.620562e+01 W
Heat Flow [temperaturesource3]: -1.729544e+01 W
Heat Flow [surfaceprops1]: -1.028293e+02 W
Heat Flow [surfaceprops2]: -2.748863e+01 W
Heat Flow [surfaceprops3]: -3.491127e+01 W
Heat Flow [surfaceprops4]: -2.763865e+01 W
Heat Flow [surfaceprops5]: -1.959801e+00 W
Heat Flow [surfaceprops6]: -1.301126e+01 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 1.724140e+01 W (avg) (imported: 1.724140e+01 W (avg))
Heat Flow [thermalloss0: Surface Loss Distribution]: 2.345258e+02 W (avg) (imported: 2.345258e+02 W (avg))

Total Heat Flow: -8.239476e-08 W (avg) = -1.647895e-07 W (peak)
```

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1_200kW_TW_cold_copper_8_50K-straps_water_40mm_insert.cst"



50K strap, 4.2 W/m/K

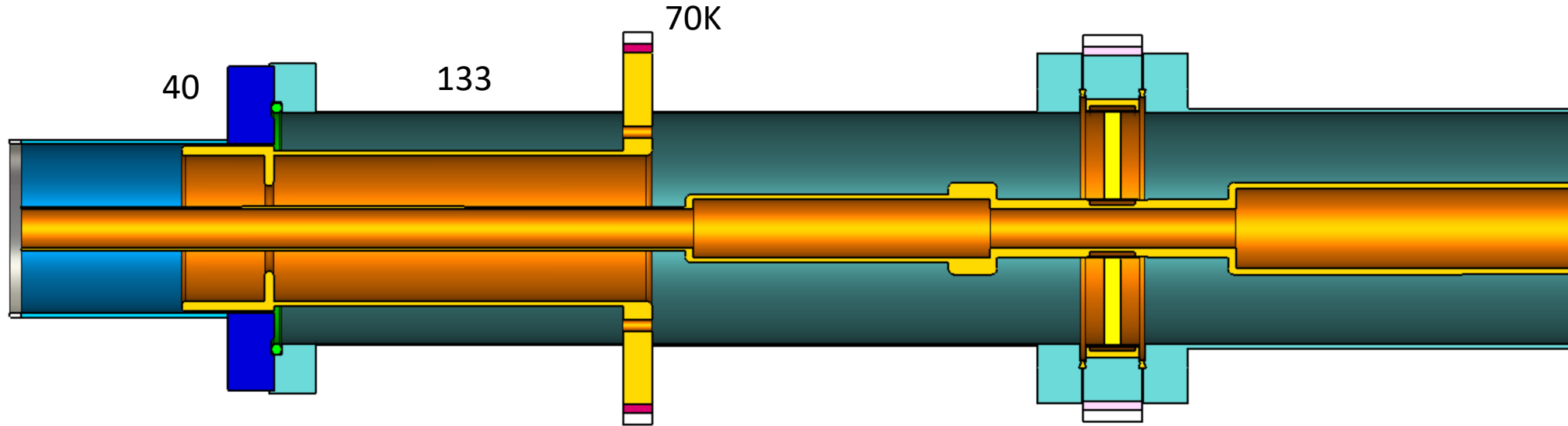
P = 200 kW, TW

T_straps = 50K

```
Heat Flow [temperaturesource1]: -4.100480e-01 W
Heat Flow [temperaturesource2]: -2.256897e+01 W
Heat Flow [temperaturesource3]: -5.281224e-01 W
Heat Flow [surfaceprops1]: -9.293046e+01 W
Heat Flow [surfaceprops2]: -2.614556e+01 W
Heat Flow [surfaceprops3]: -2.682340e+01 W
Heat Flow [surfaceprops4]: -2.640935e+01 W
Heat Flow [surfaceprops5]: -3.512875e-01 W
Heat Flow [surfaceprops6]: -7.564450e+00 W
Heat Flow [surfaceprops7]: -3.533773e+01 W
Heat Flow [surfaceprops8]: -8.364429e-02 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 1.726298e+01 W (avg) (imported: 1.726298e+01 W (avg))
Heat Flow [thermalloss0: Surface Loss Distribution]: 2.218900e+02 W (avg) (imported: 2.218900e+02 W (avg))

Total Heat Flow: -1.090008e-07 W (avg) = -2.180016e-07 W (peak)
```

File: "C:\CST_projects\IARC_coupler\DIR_iris\Teplo_Total_vac_part_materials_1_200kW_TW_cold_copper_8_70K-straps_water_40mm_insert.cst"



50K strap, 4.2 W/m/K

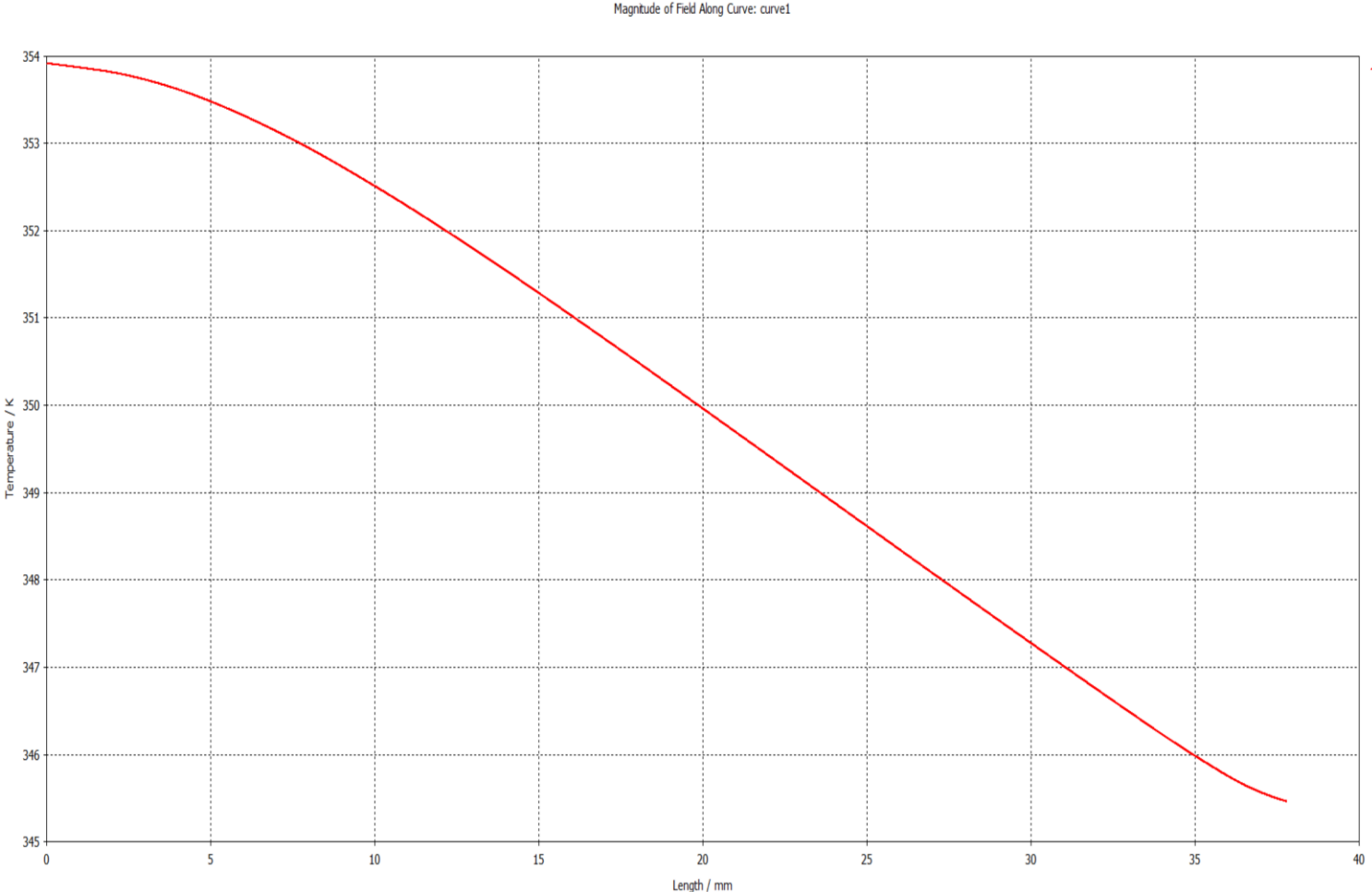
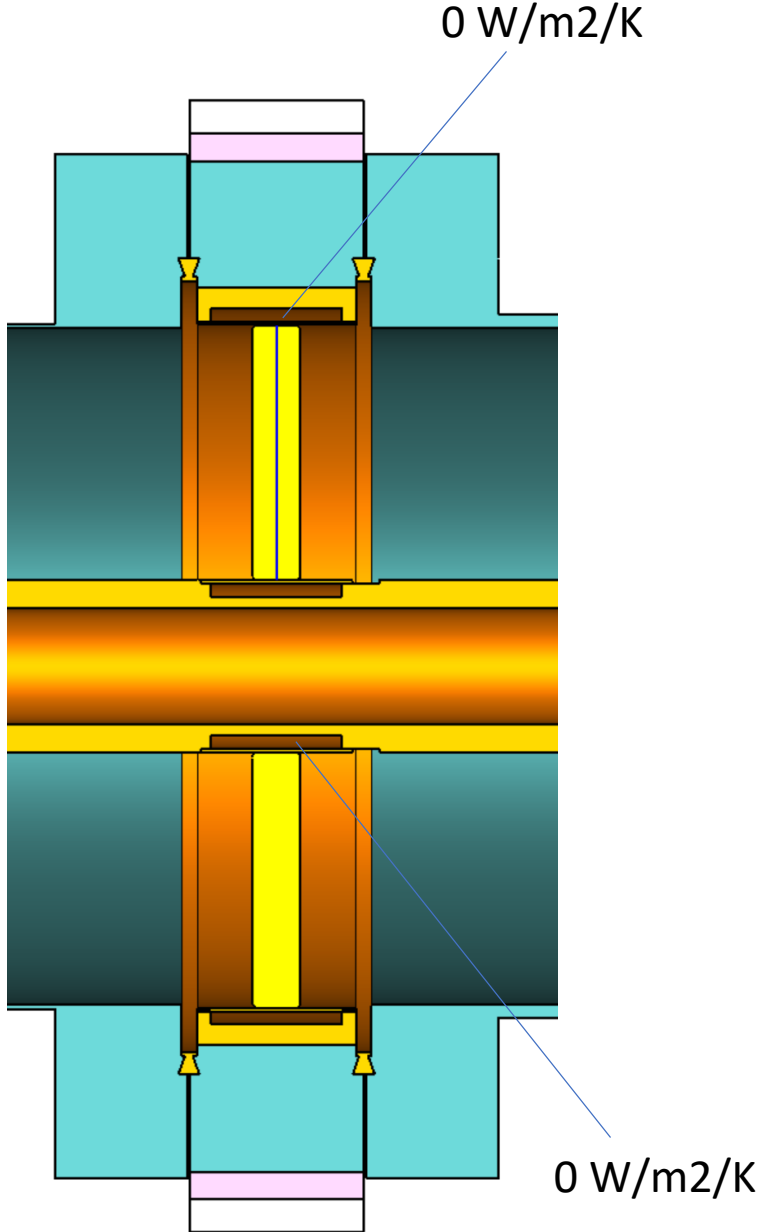
P = 200 kW, TW

T_straps = 70K

```
Heat Flow [temperaturesource1]: -6.266667e-01 W
Heat Flow [temperaturesource2]: -2.201696e+01 W
Heat Flow [temperaturesource3]: -5.359161e-01 W
Heat Flow [surfaceprops1]: -9.293044e+01 W
Heat Flow [surfaceprops2]: -2.614419e+01 W
Heat Flow [surfaceprops3]: -2.682842e+01 W
Heat Flow [surfaceprops4]: -2.640804e+01 W
Heat Flow [surfaceprops5]: -3.515215e-01 W
Heat Flow [surfaceprops6]: -7.562107e+00 W
Heat Flow [surfaceprops7]: -3.562343e+01 W
Heat Flow [surfaceprops8]: -8.366476e-02 W
Heat Flow [thermalloss0: El. Volume Loss Distribution]: 1.726298e+01 W (avg) (imported: 1.726298e+01 W (avg))
Heat Flow [thermalloss0: Surface Loss Distribution]: 2.218484e+02 W (avg) (imported: 2.218484e+02 W (avg))

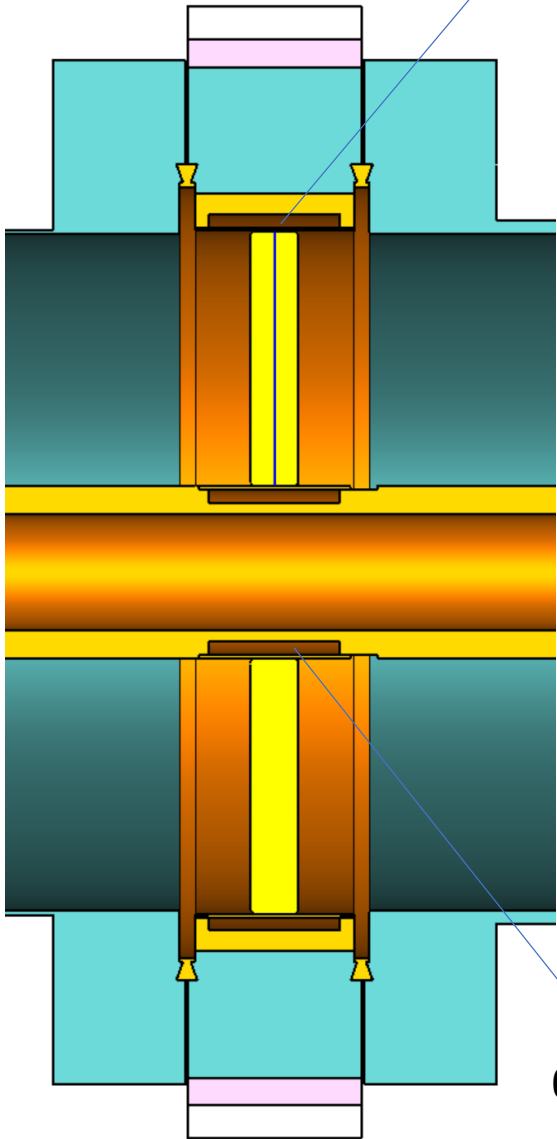
Total Heat Flow: -1.304621e-07 W (avg) = -2.609241e-07 W (peak)
```

Window temperature, 200 kW, TW.

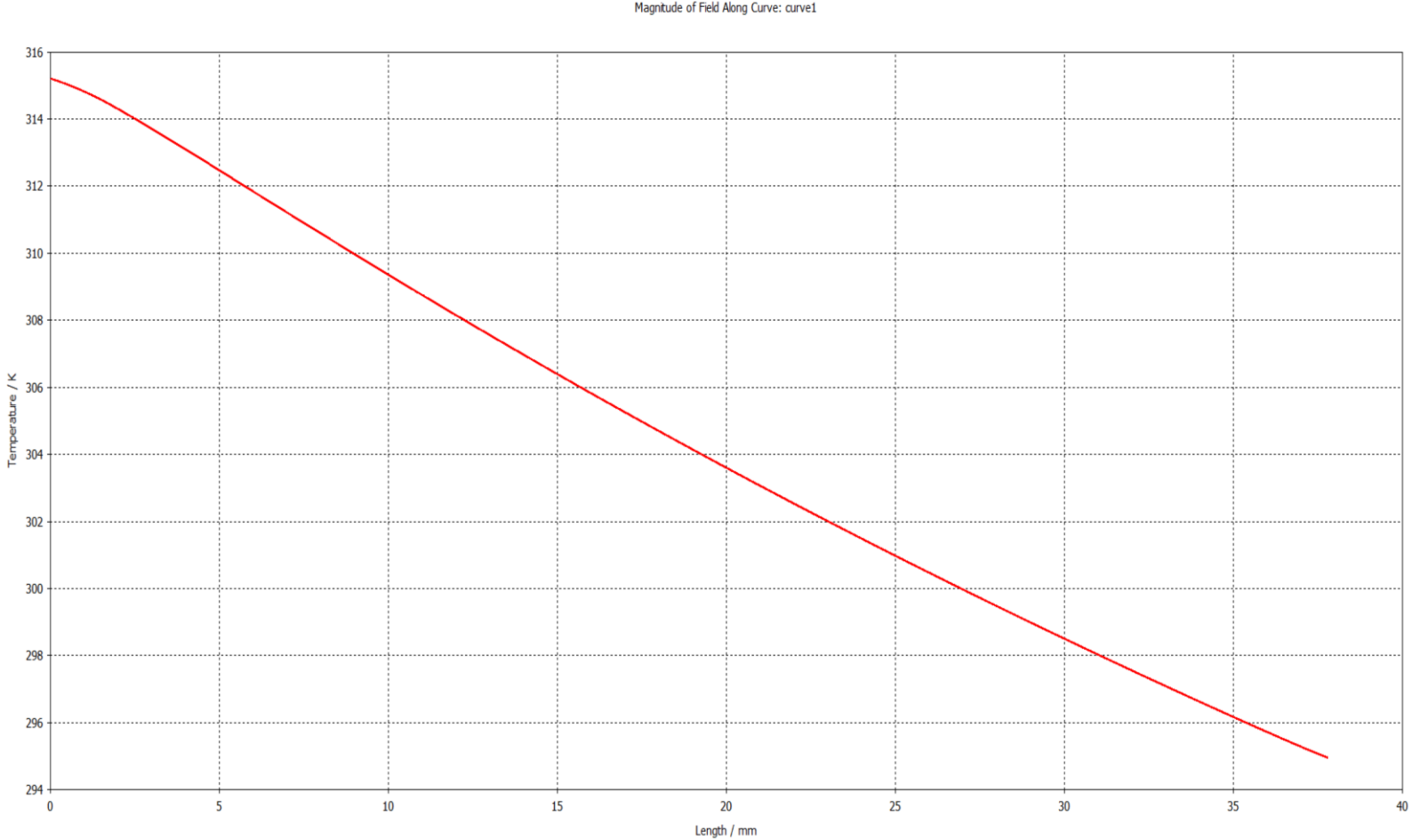


Window temperature, 200 kW, TW.

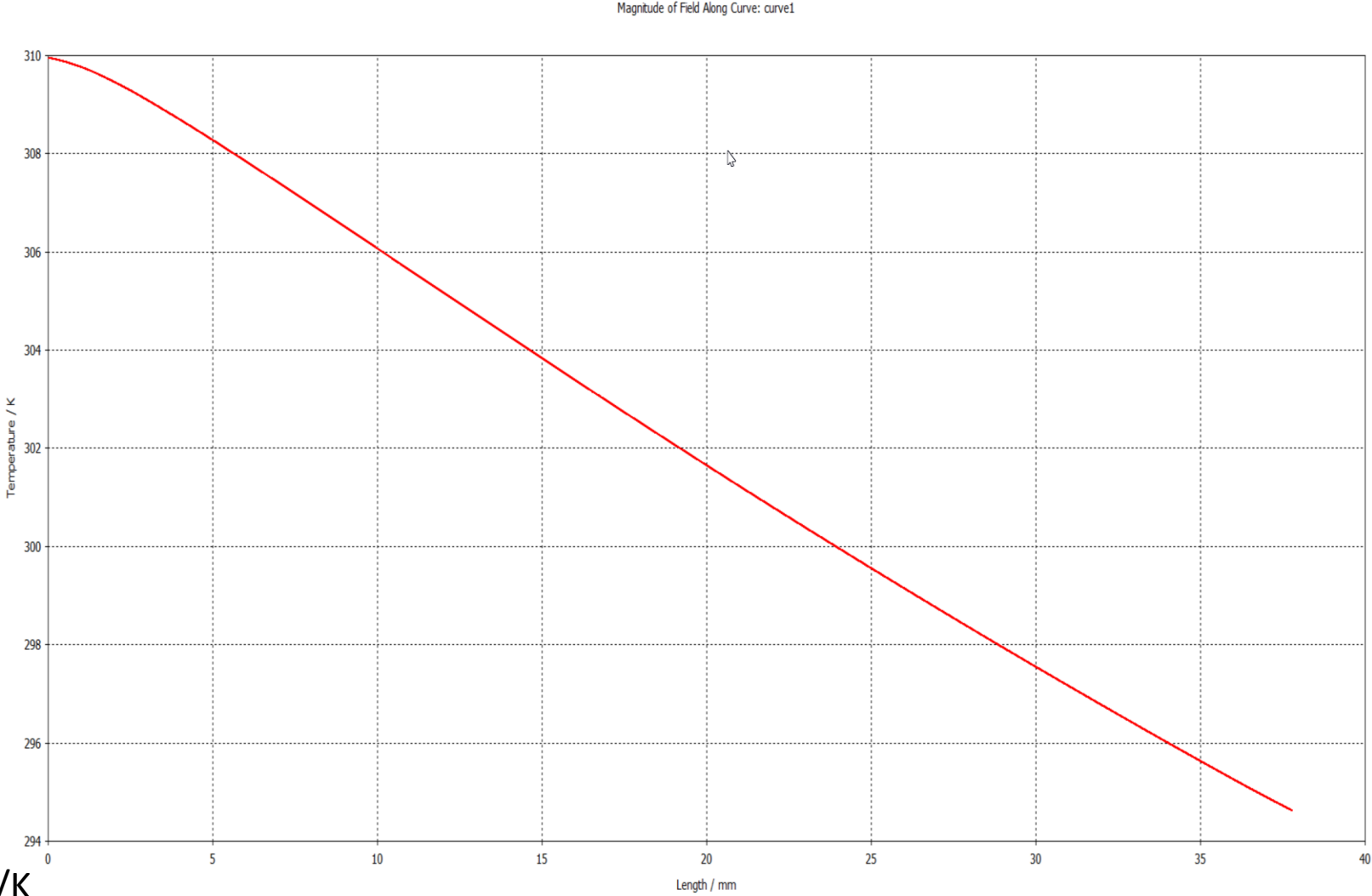
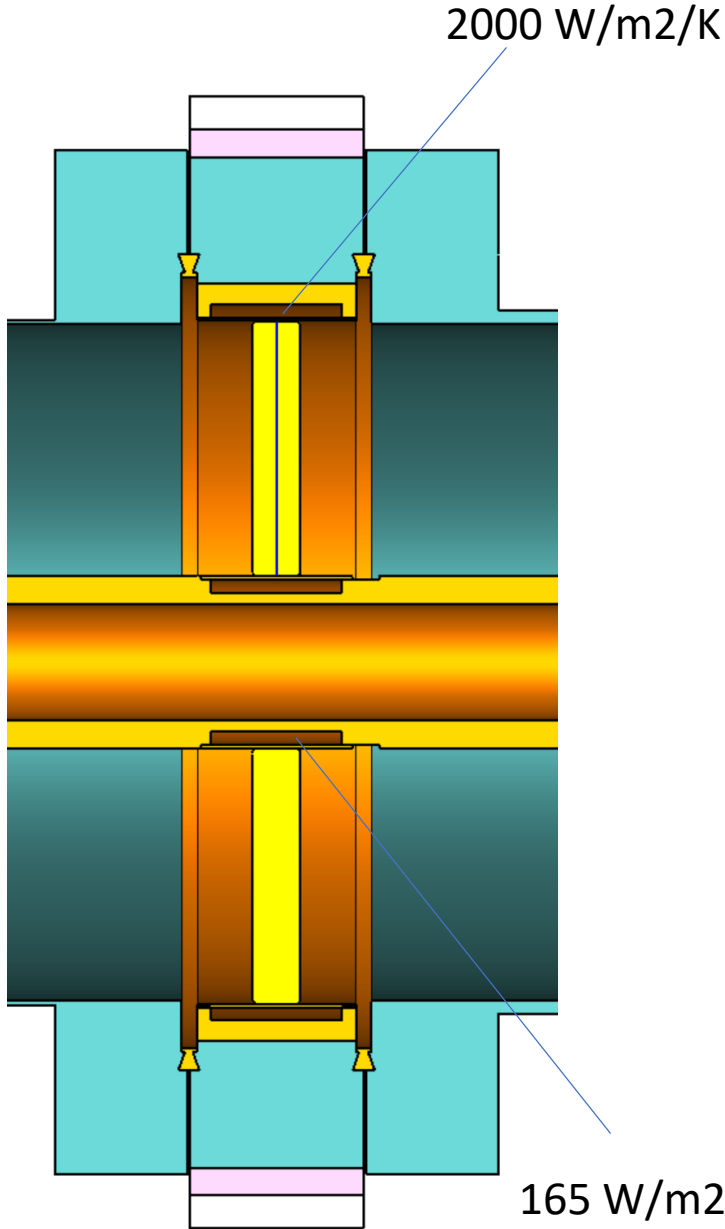
2000 W/m²/K

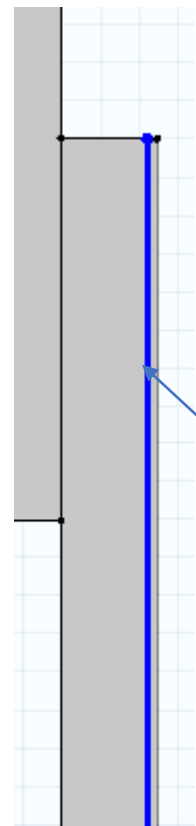


0 W/m²/K



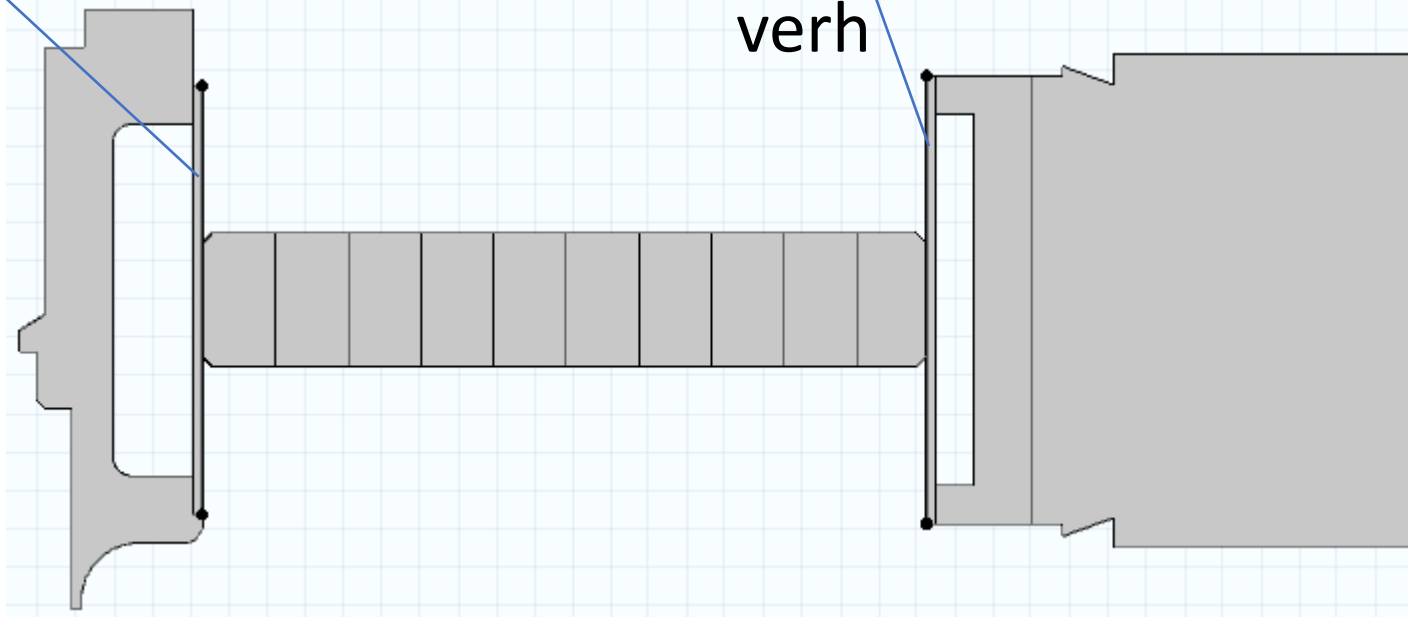
Window temperature, 200 kW, TW.



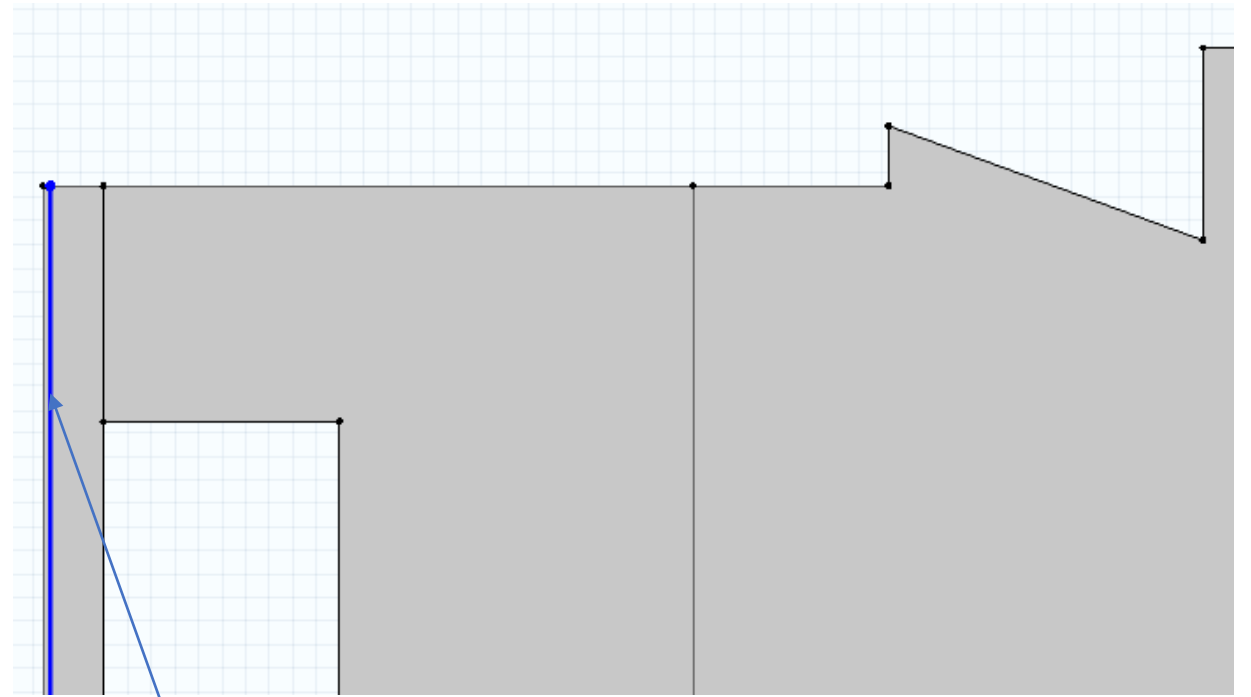


50 μm offsets

niz



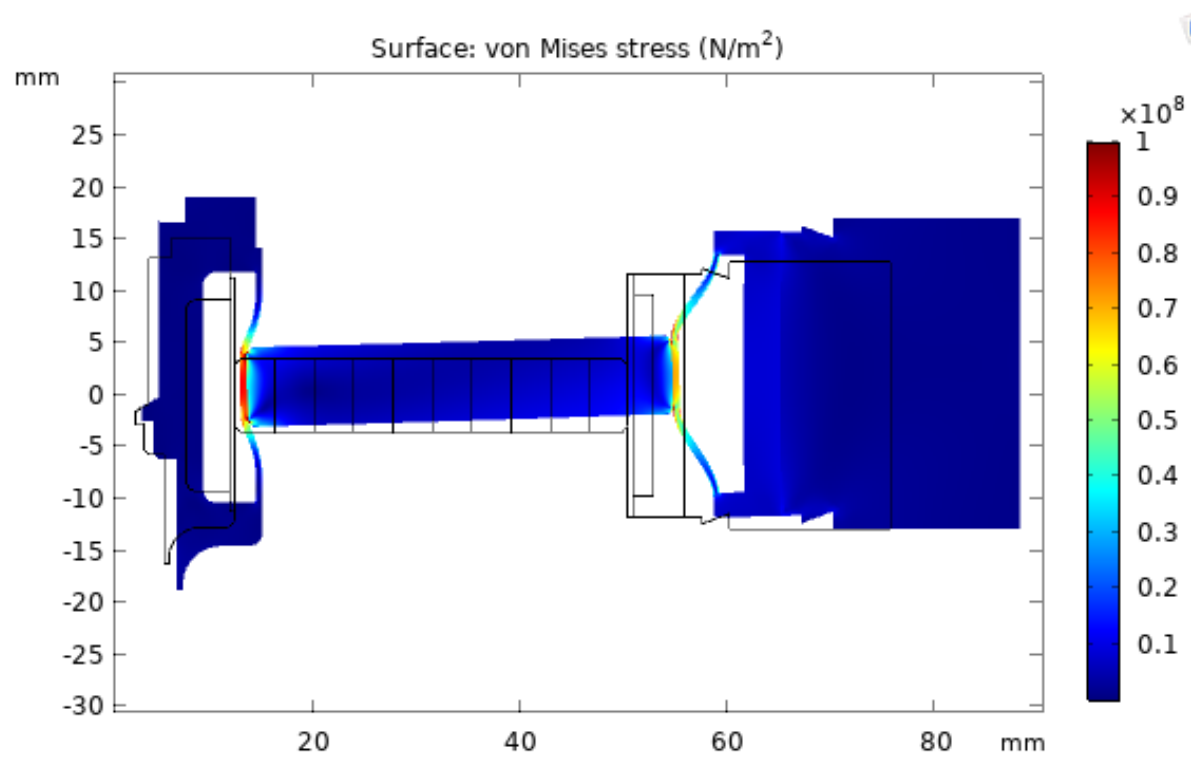
verh



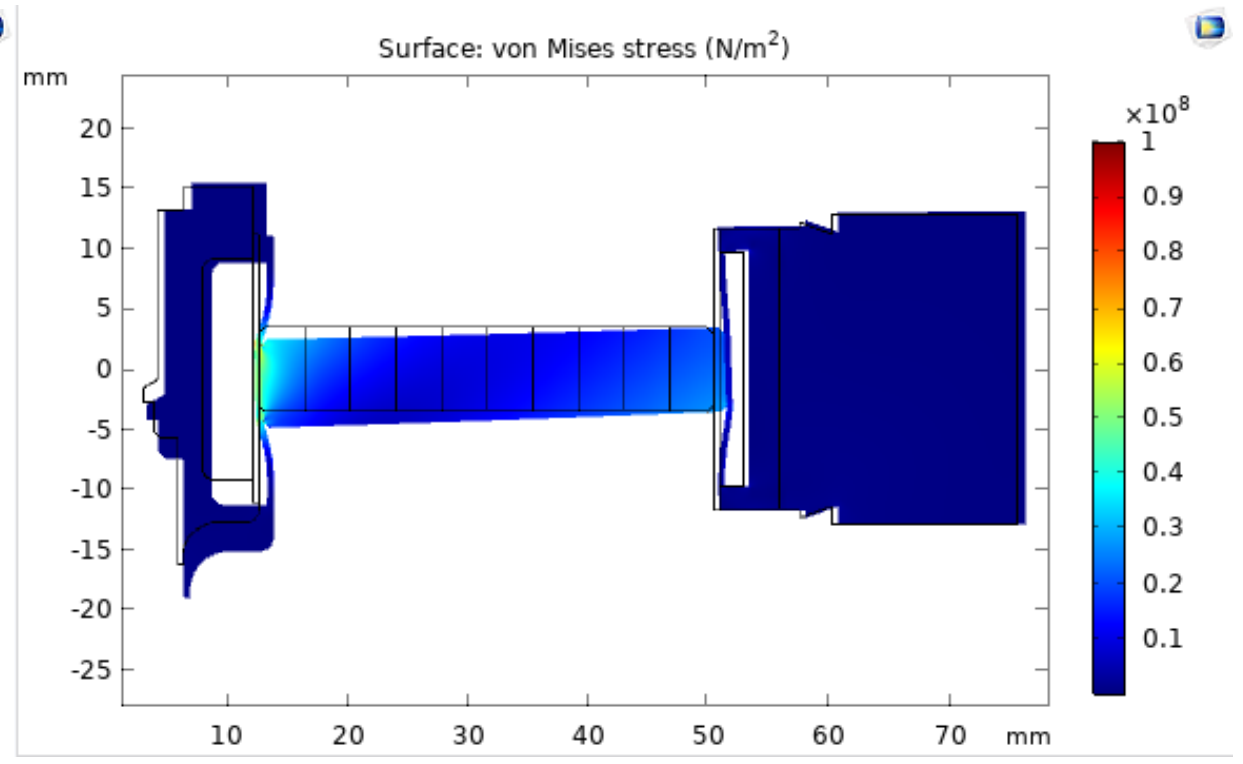
Thermal-stress deformation

Plots normalized at Max. Stress 100 MPa

Air

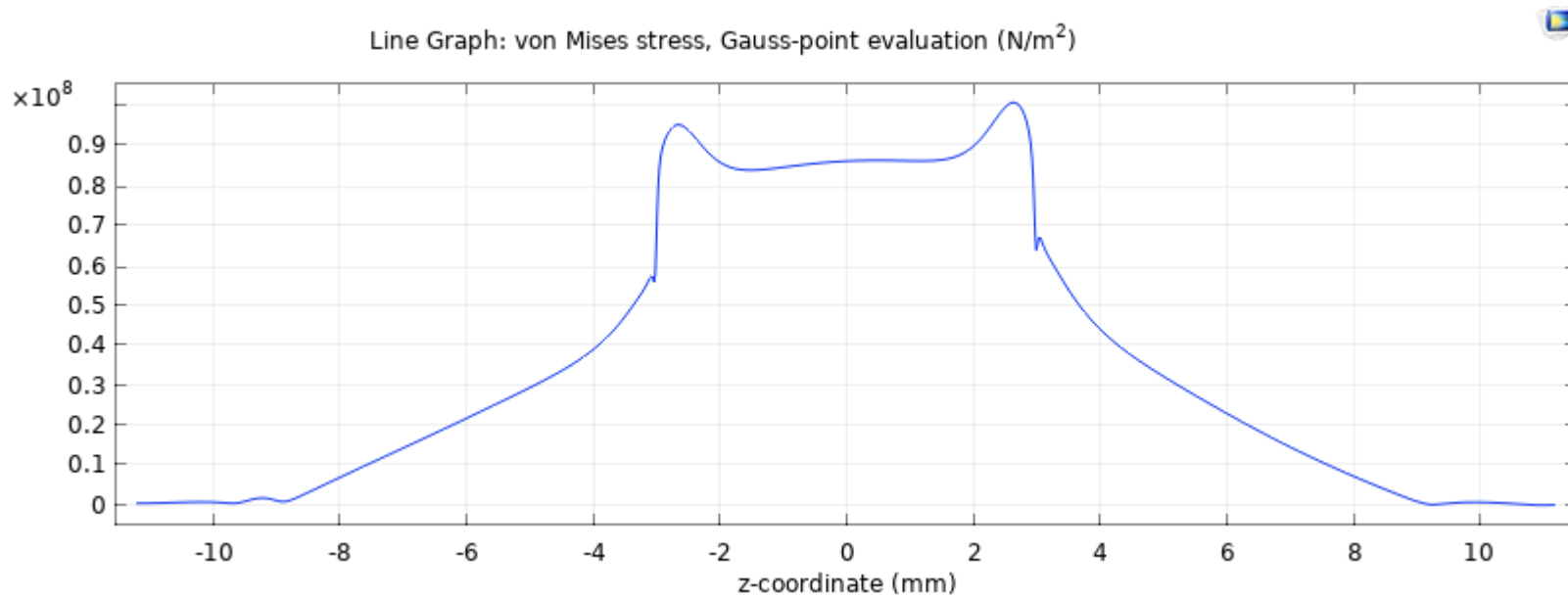


Water

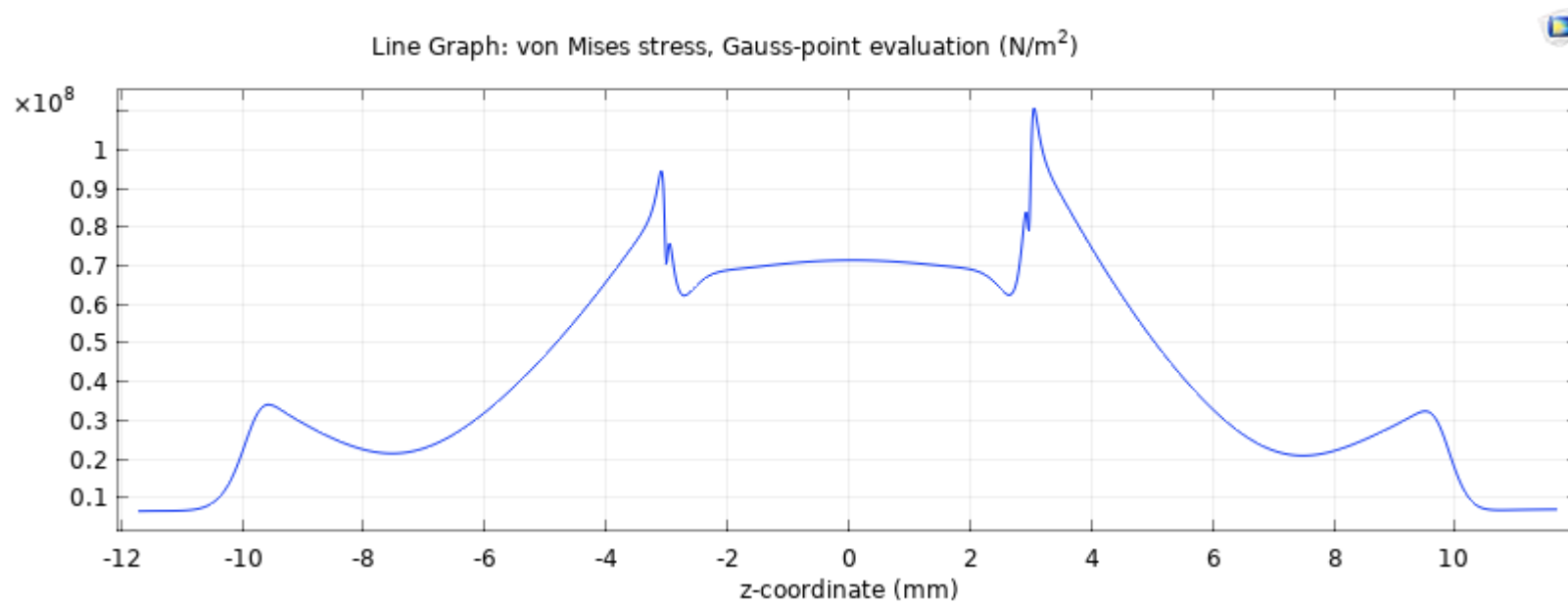


Air

niz

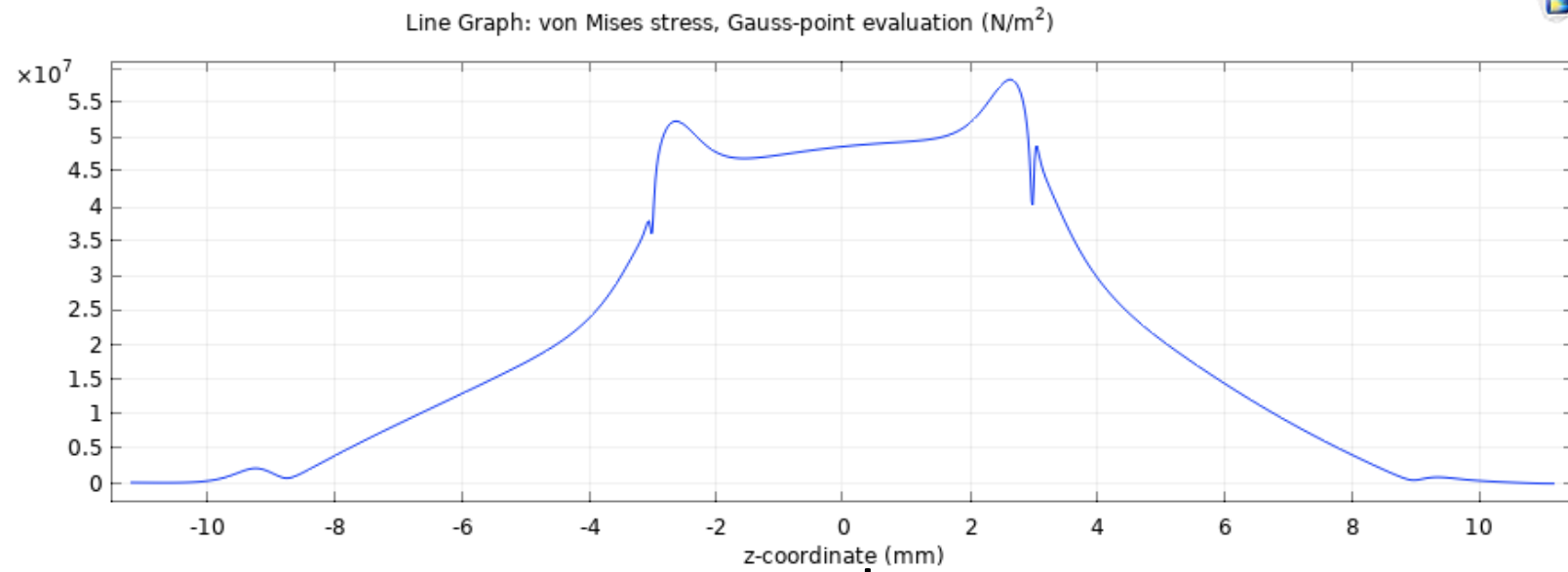


verh

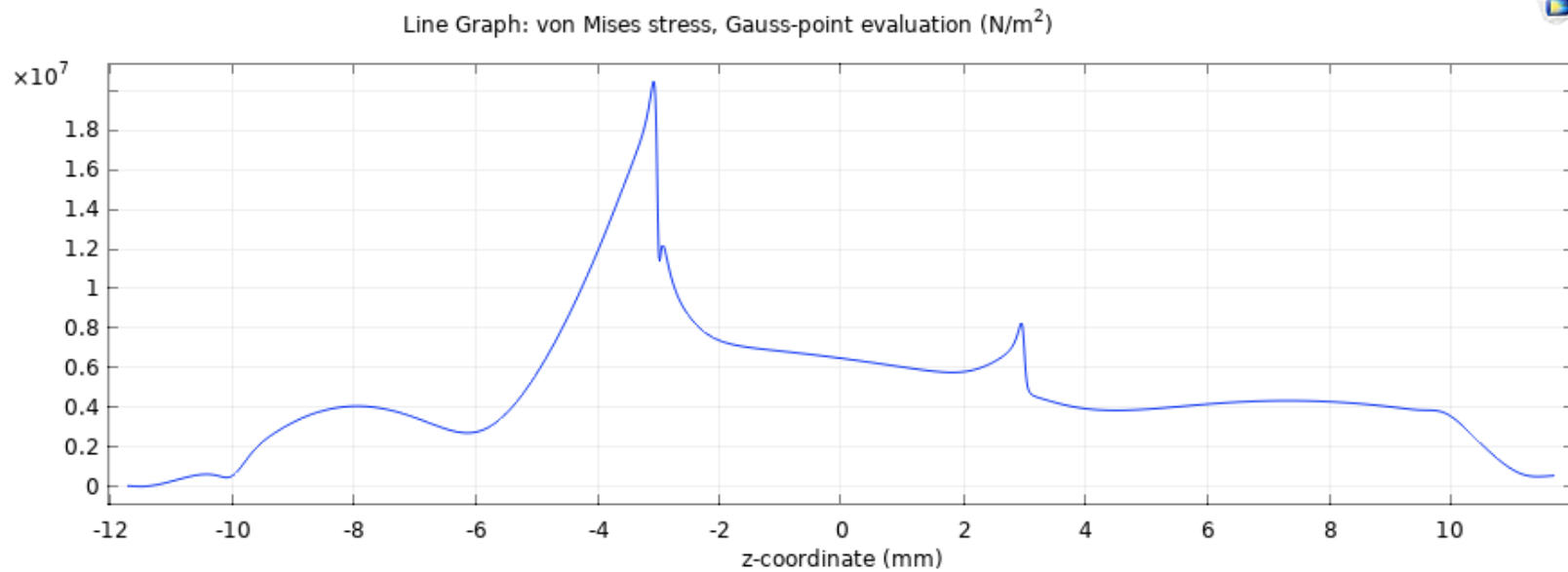


Water

niz



verh



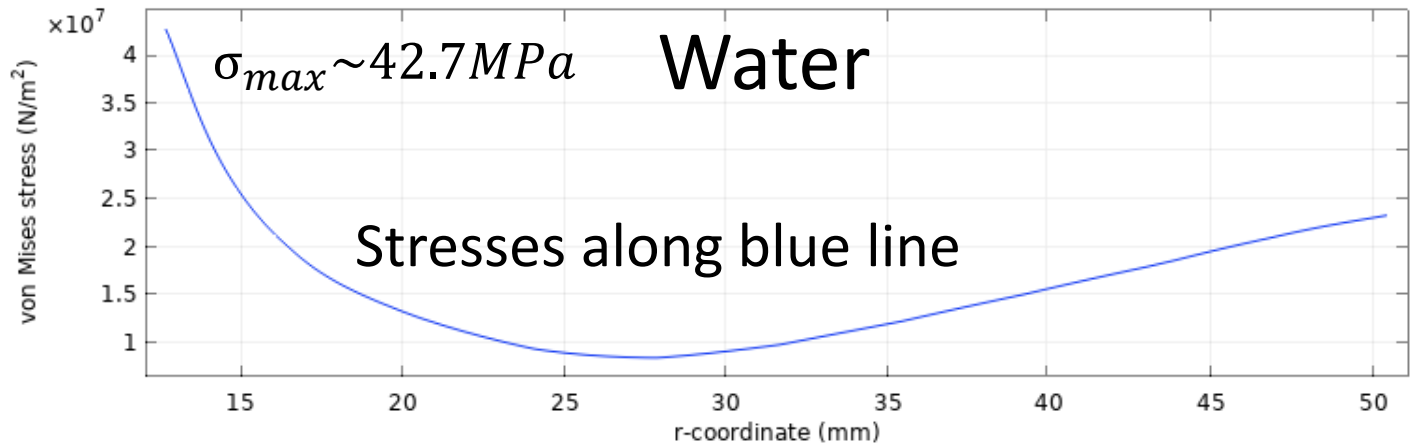
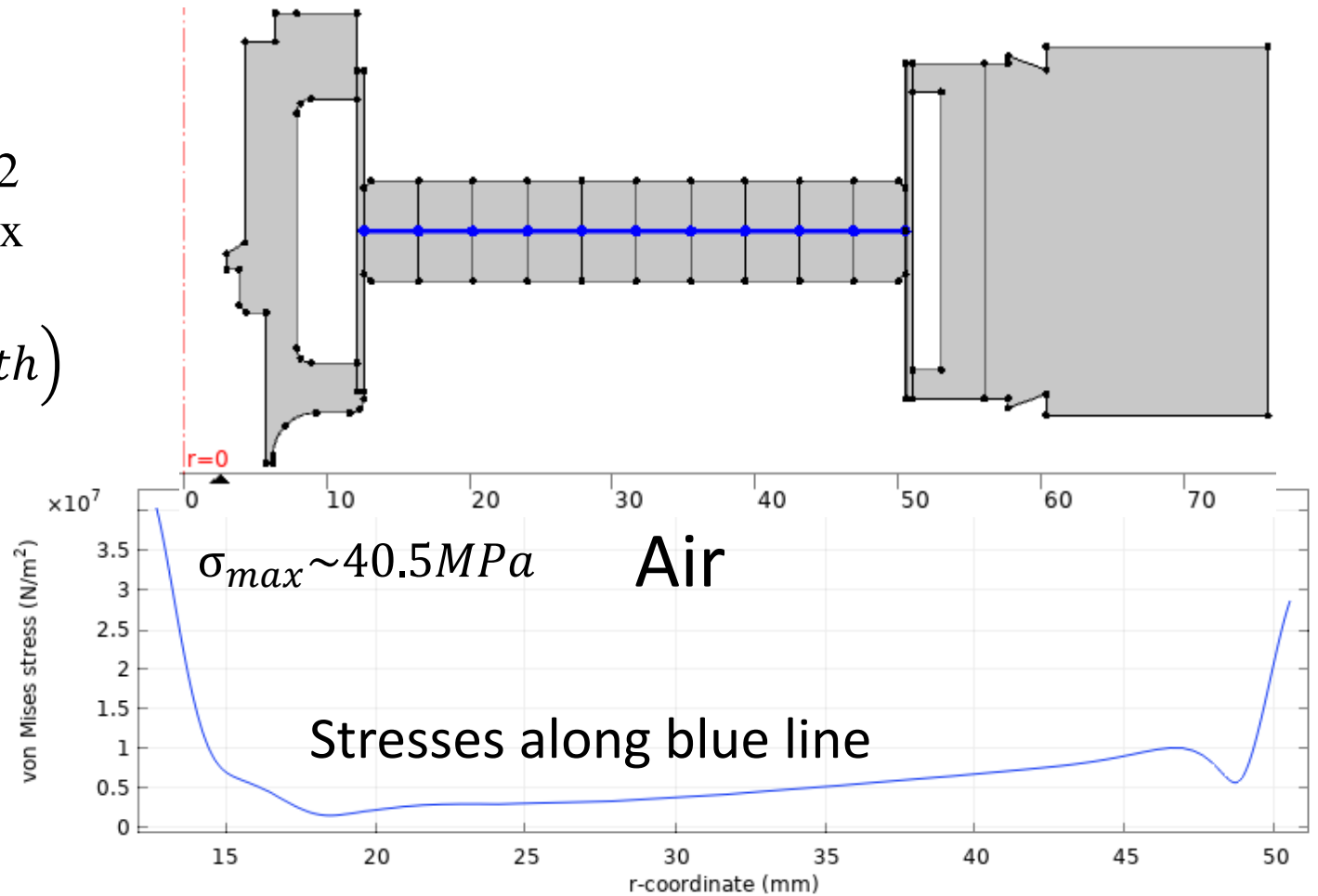
ASME BPV Code Section VIII Division 1,2
Code Section II Part D Mandatory Appendix

$$S = \min \left(\frac{\text{Ultimate strength}}{3.5}, \frac{2}{3} \cdot \text{Yield strength} \right)$$

For ceramic allowable stress is defined
by ultimate (tensile) strength value

For 98% Al_2O_3 $\sigma_{ultimate} \sim 200 \text{ MPa}$

$\sigma_{allowable} \sim 57 \text{ MPa}$



Stresses in window for 200 kW, 10% reflection.

Air, Air

Max. stresses in copper sleeve: ~ 110 MPa

Max. stresses in ceramic: ~ 40.5 MPa (stretching)




Water, Air

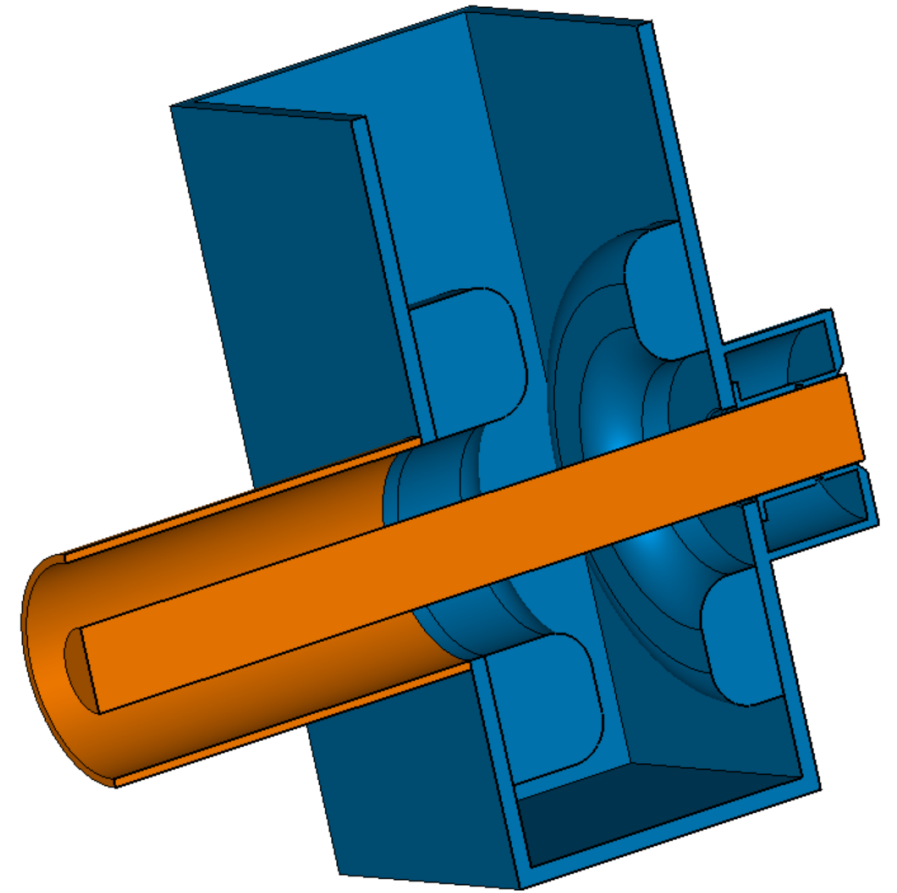
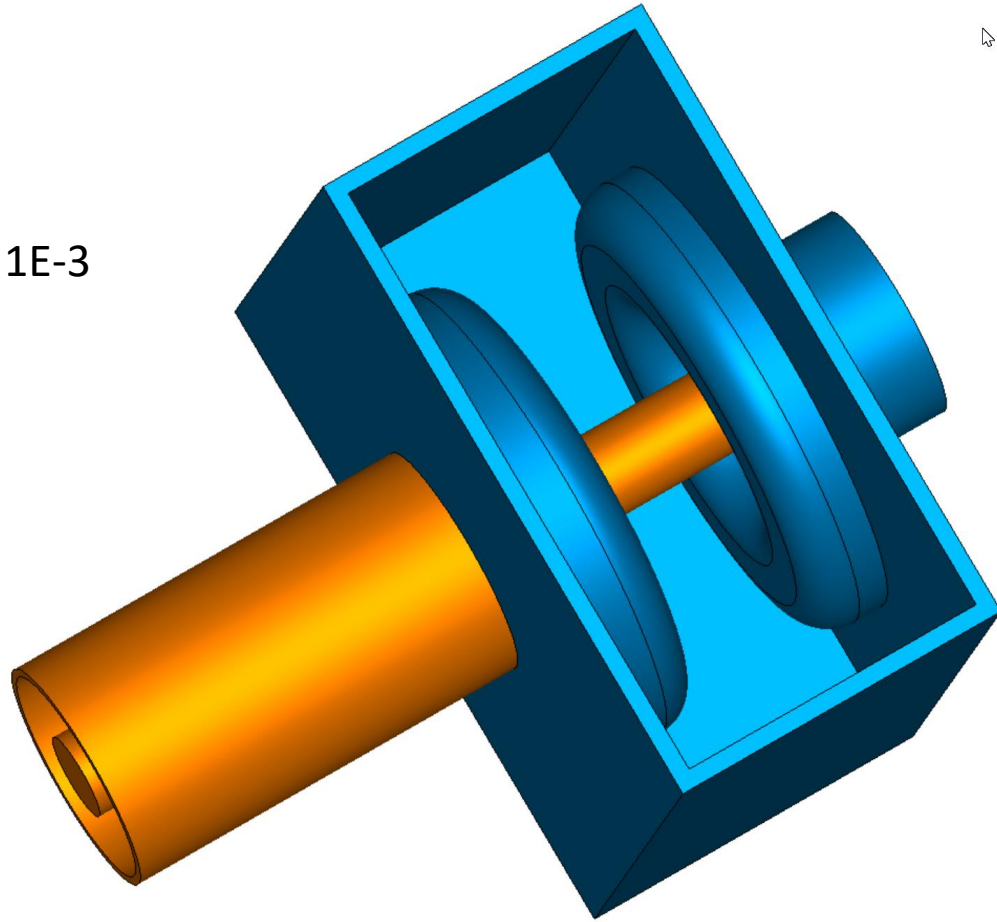
Max. stresses in copper sleeve: ~ 60 MPa

Max. stresses in ceramic: ~ 42.7 MPa (compressing)

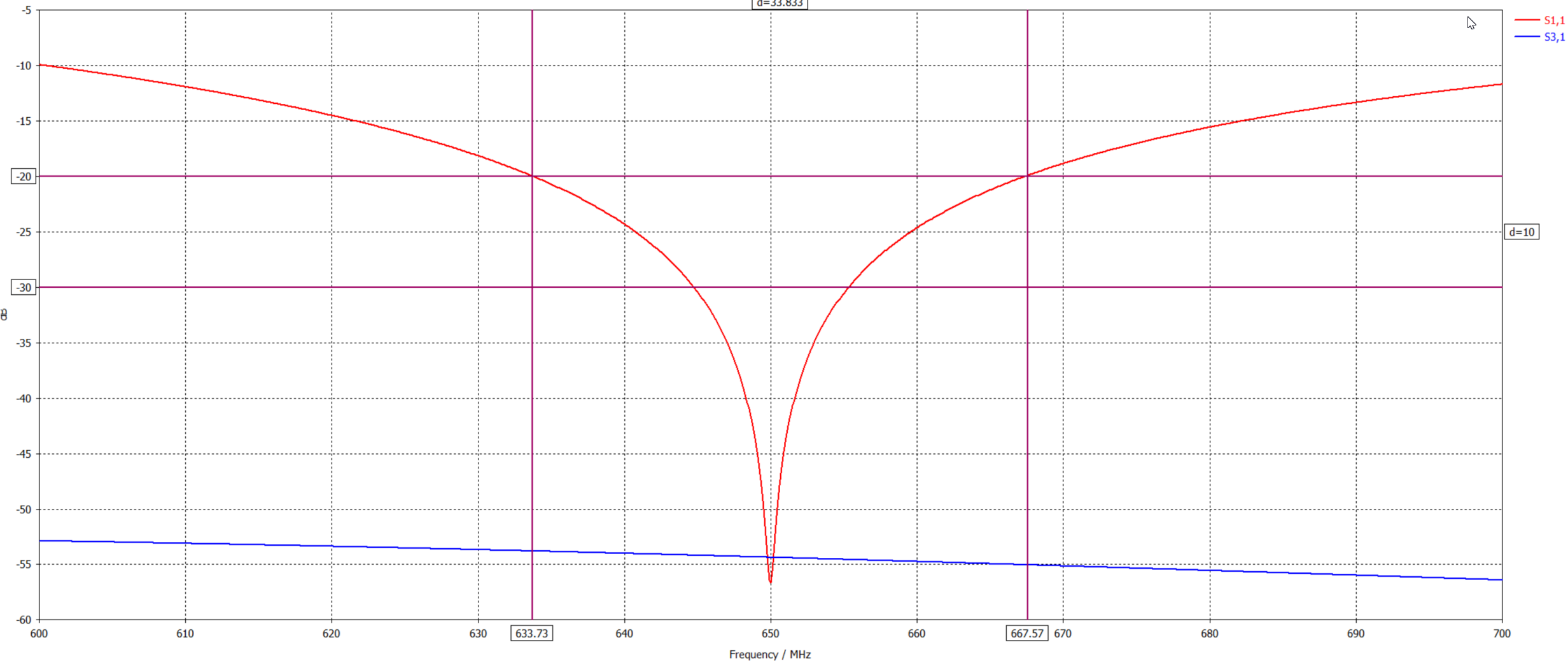
Air part of coupler.

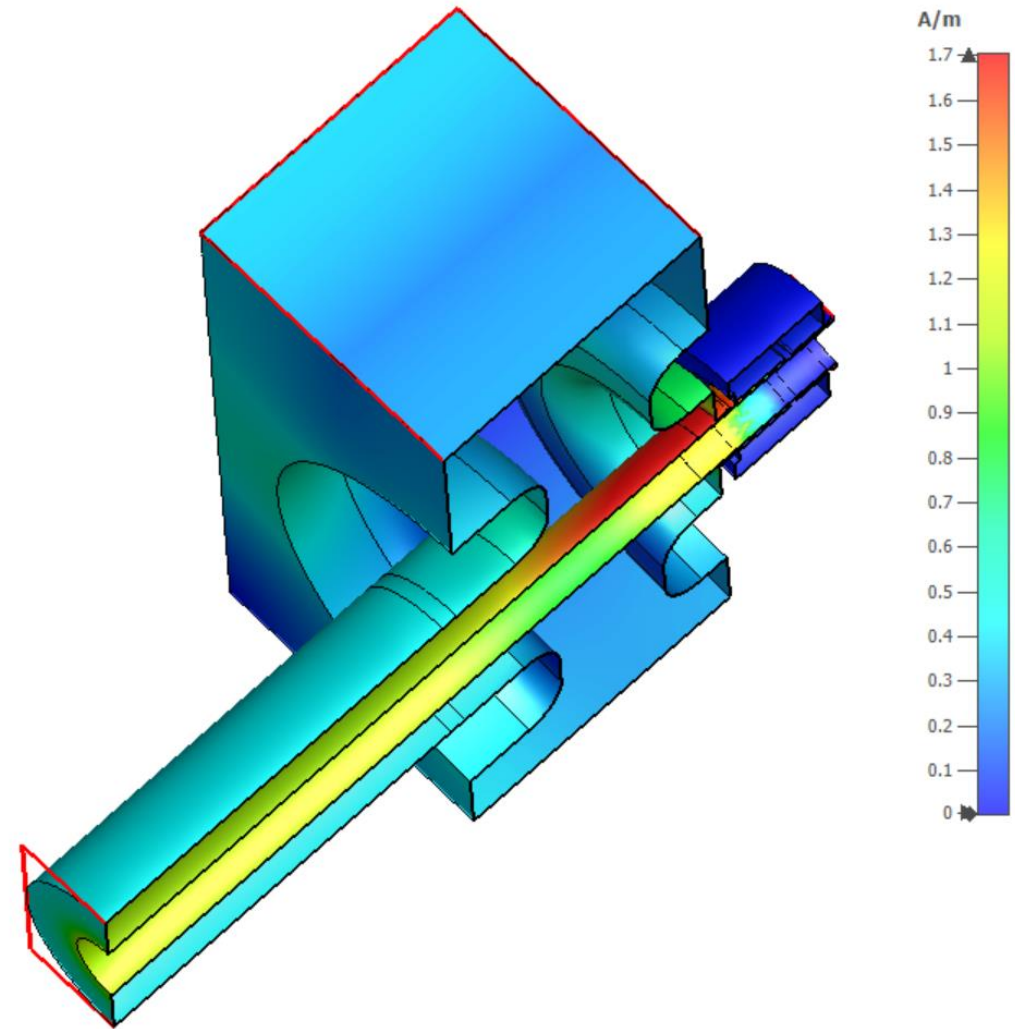
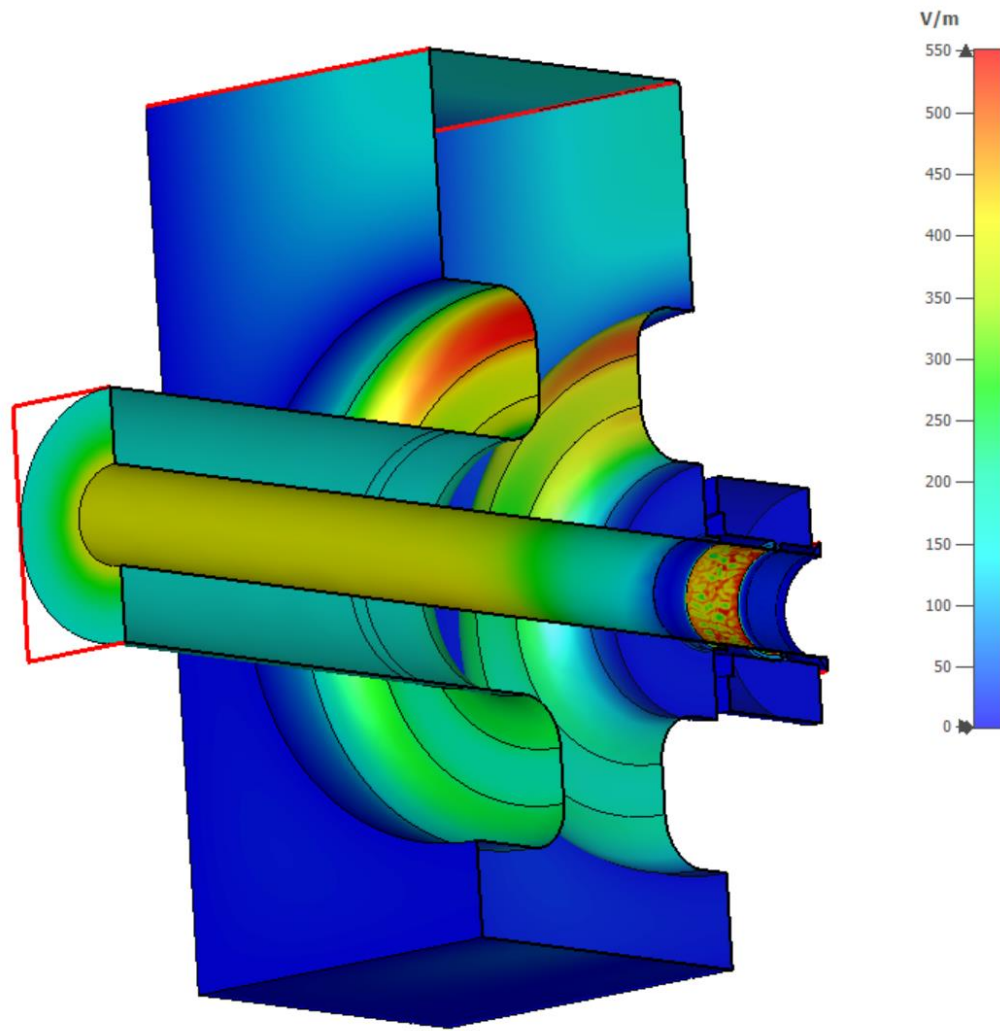
File: "C:\CST_projects\IARC_coupler\Dir_waveguide\W3_materials.cst"

-  Copper, $5.8E+7$
-  Al, $3.56E+7$
-  Kapton, loss tng $1E-3$



S-Parameters [Magnitude in dB]





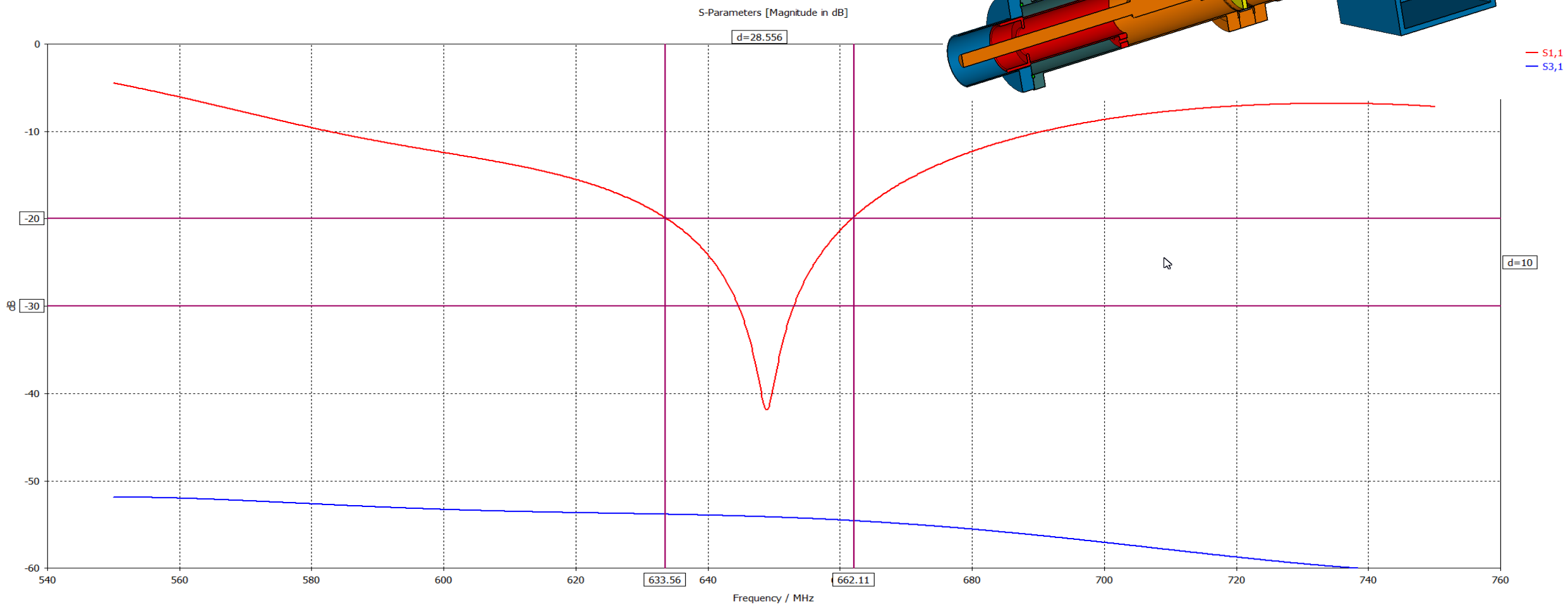
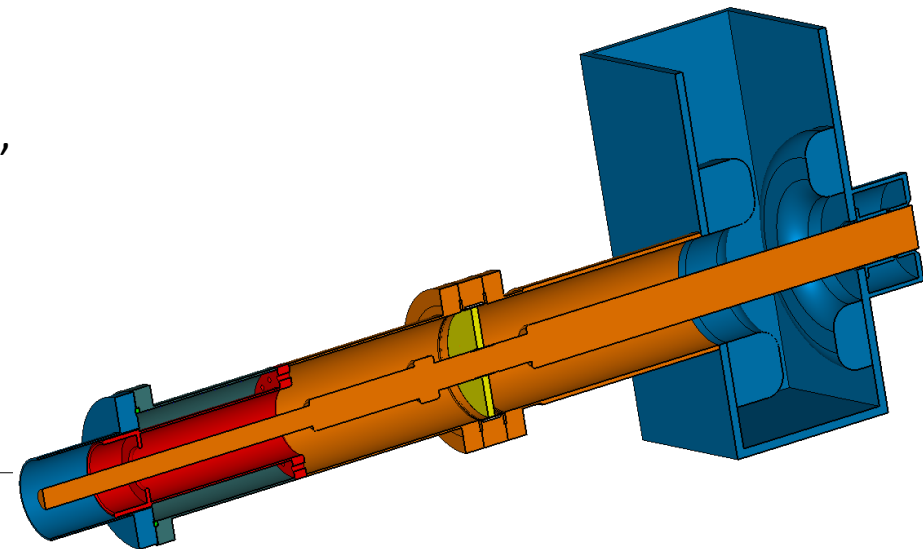
$P = 0.5\text{W}$, TW, max $E = 550\text{ V/m}$, max $H = 1.7\text{ A/m}$

$P = 200\text{ kW}$, full reflection, max $E = 7.0\text{ kV/cm}$, max $H = 0.022\text{ kA/cm}$

Losses, 200 kW, TW and full reflection:


Case	Total lss, W	Inner cnd, W	Waveguide, W	Kapton, W
TW,	201.6	82.6	102.0	2.34
Full rfl, 0dgr	325.6	149.2	137.6	4.40
45 dgr	222.0	102.4	86.4	1.18
90 dgr	224.8	92.8	104.0	0.008
135 dgr	332.4	125.6	180.8	1.57
180 dgr	480.0	182.0	271.2	4.96
225 dgr	584.0	228.4	322.4	8.18
270 dgr	582.4	238.0	304.8	9.36
315 dgr	476.0	205.2	228.0	7.80

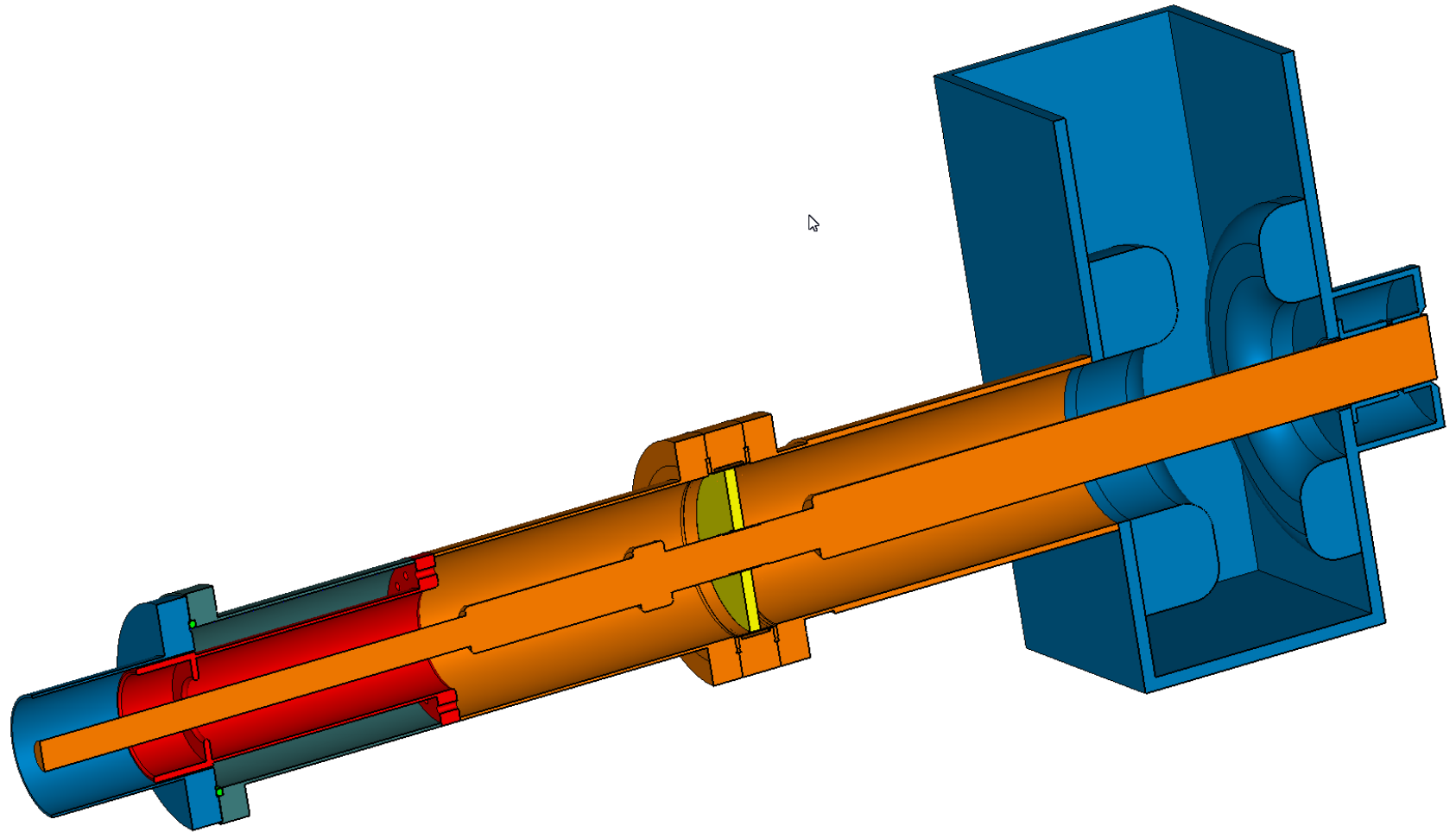
File: "C:\CST_projects\IARC_coupler\Dir_waveguide\Total_RF_1.cst"



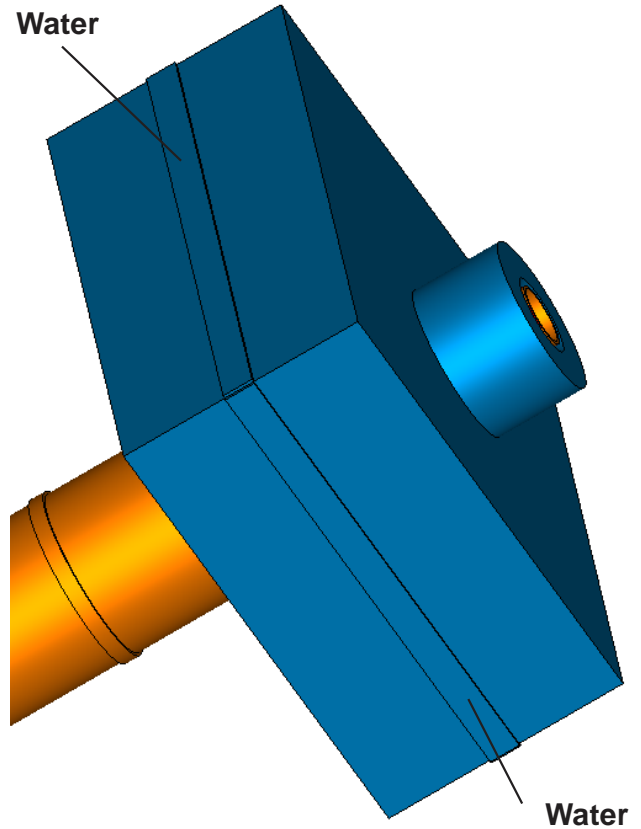
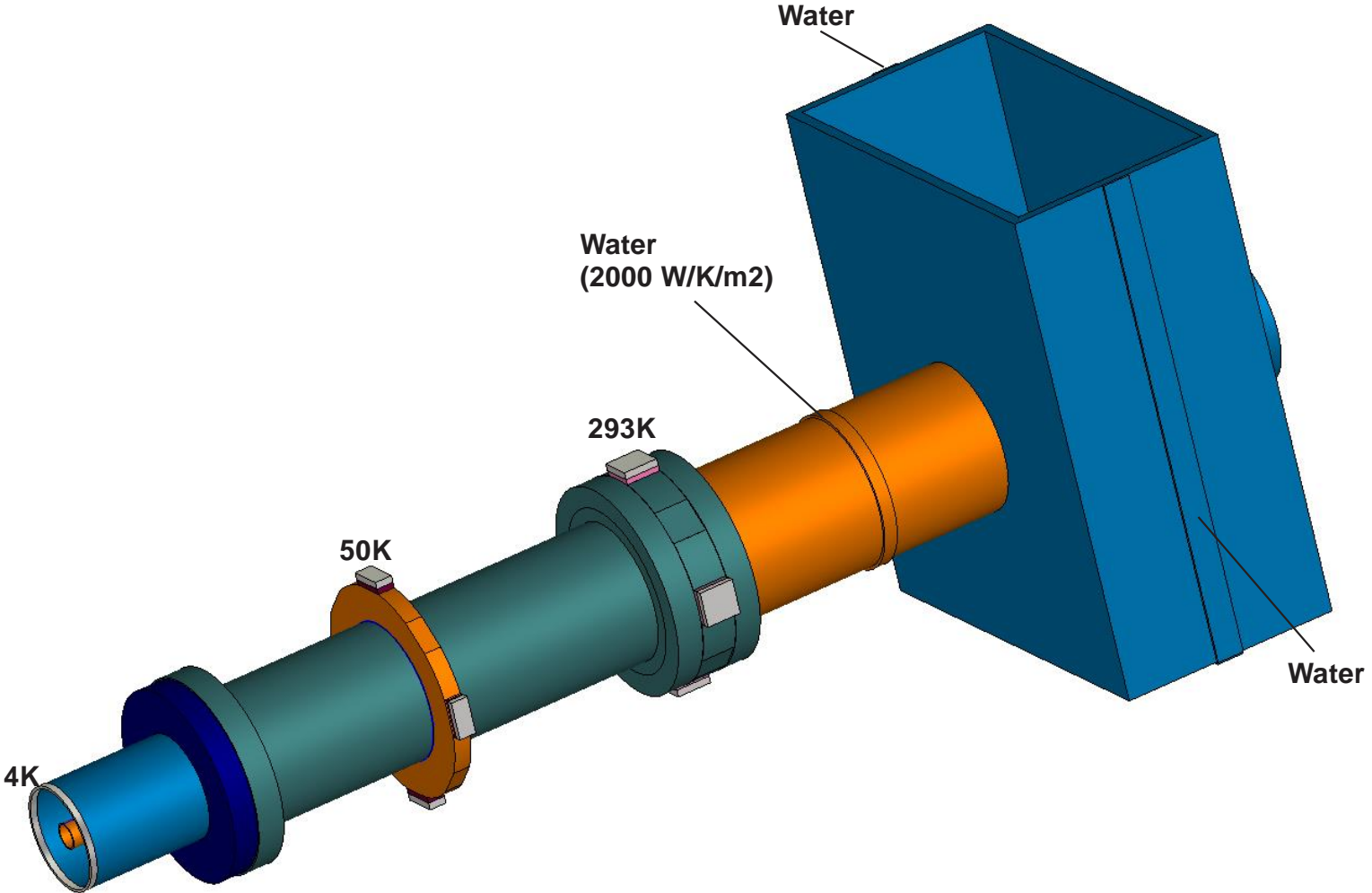
File: "C:\CST_projects\IARC_coupler\Dir_waveguide\Total_RF_1_acc.cst"

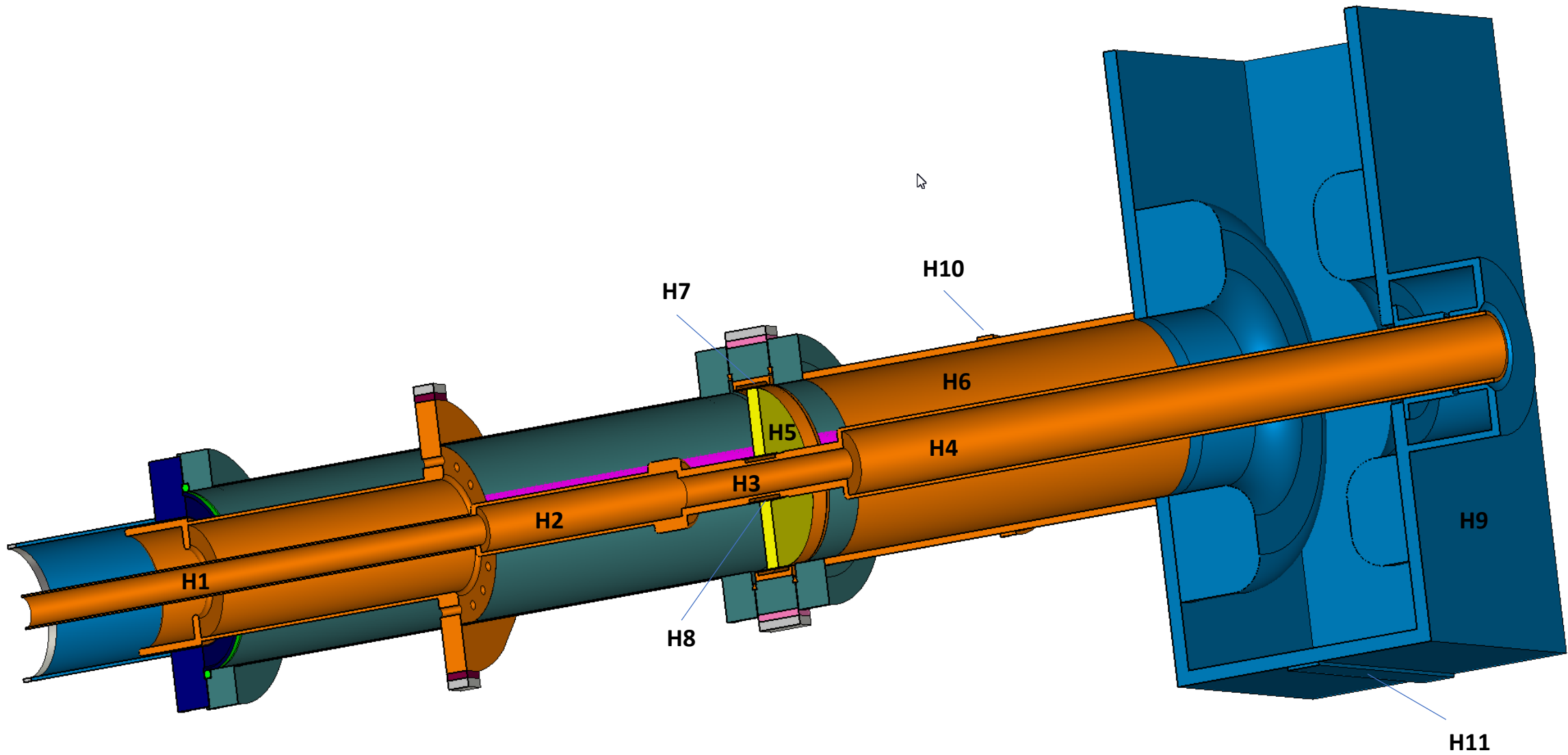
Parameters of materials:

-  "copper", $5.8E+7$ S/m
-  "cold copper", $2.5E+8$ S/m
-  "Stainless steel", $1.6E+6$ S/m
-  "cold Al", $7.2E+7$ S/m
-  "Super Cond.", $5.8E+20$ S/m
-  "Ceramics", Loss tng = $1E-4$
-  "Al", $3.56E+7$ S/m
-  "Kapton", Loss tng, $1E-3$



Total geometry, thermal configuration.





Nb

Temperature [K]	Thermal conductivity [W/m/K]
0	0.001
1	3.6
2	71.8
3	107
4	142
5	175
6	206
7	234
8	258
9	278
10	294
11	305
12	311
13	314
14	312
15	308
16	301
18	281
20	249
25	182
30	139
35	112
40	95.3
45	83.8
50	75.8
60	66.1
70	61.2
80	58.4
90	56.6
100	55.2
123.2	53.7
150	53
173.2	52.7
220	52.6
223.2	52.7
250	53
300	53

NbTi

Temperature [K]	Thermal conductivity [W/m/K]
2	2.5
3	6.5
4	16.25
6	62.5
8	86.25
10	103
12	113
14	123
16	130
18	136.25
20	140

Al_10K

Temperature [K]	Thermal conductivity [W/m/K]
1	1.2
5	6.8
10	14.2
20	28.4
40	52
100	95.7
150	116
200	128.7
250	136.8
300	141.6

Ceramic, 26 W/m/K
 50K strap, 4.2 W/m/K
 RT strap, 0.76 W/m/K
 Al, 237 W/K/m
 Kapton, 5 W/m/K

SS

Temperature [K]	Thermal conductivity [W/m/K]
2	0.136
4	0.2724
10	0.9039
20	2.1686
30	3.4686
40	4.6703
50	5.7302
60	6.6466
70	7.4348
80	8.1143
90	8.7048
100	9.2236
120	10.1013
140	10.8344
150	11.1652
160	11.4791
171	11.8095
180	12.0711
200	12.6327
220	13.1778
240	13.7145
260	14.2474
273	14.5929
280	14.7787
293.4	14.88

H1 = 165 W/m²/K (200kW)
 H2 = 68 W/m²/K (200kW)
 H3 = 140 W/m²/K (200kW)
 H4 = 32 W/m²/K (200kW)
 H5 = 10 W/m²/K (200kW)

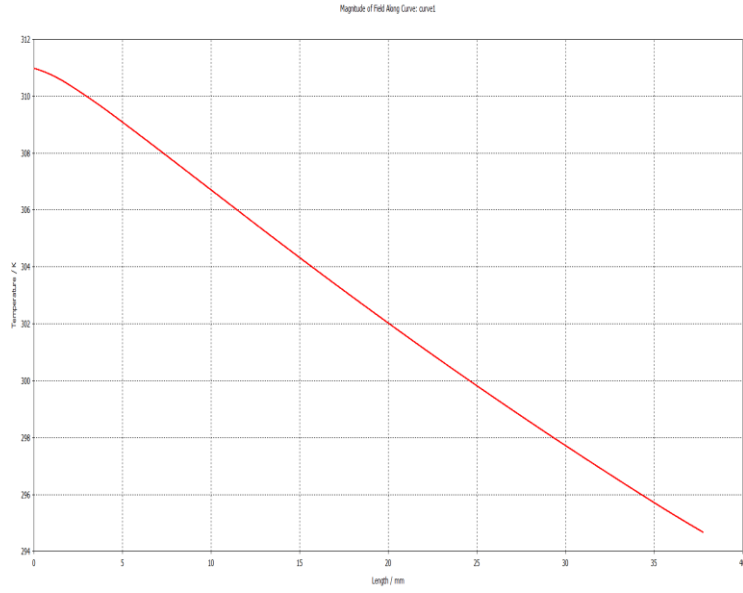
Cu

Temperature [K]	Thermal conductivity [W/m/K]
2	44
10	220
20	417
30	553
40	609
50	588
60	524
70	467
80	437
90	422
100	412
120	400
150	393
200	390
300	390

H6 = 10 W/m²/K (200kW)
 H7 = 2000 W/m²/K (200kW)
 H8 = 165 W/m²/K (200kW)
 H9 = 5 W/m²/K (200kW)
 H10 = 2000 W/m²/K (200kW)
 H11 = 2000 W/m²/K (200kW)
 Water, 2000 W/m²/K

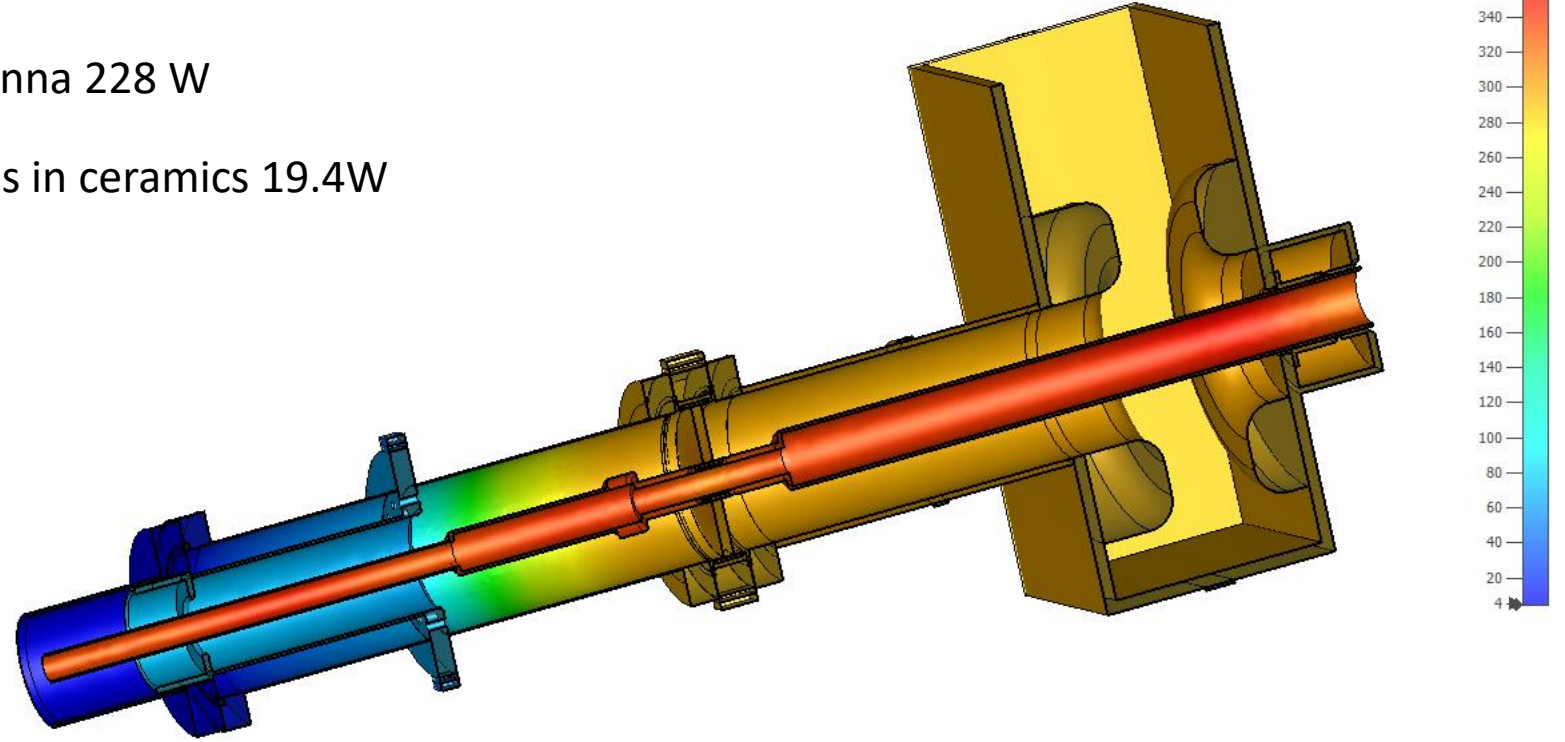
200 kW, TW

T along ceramics

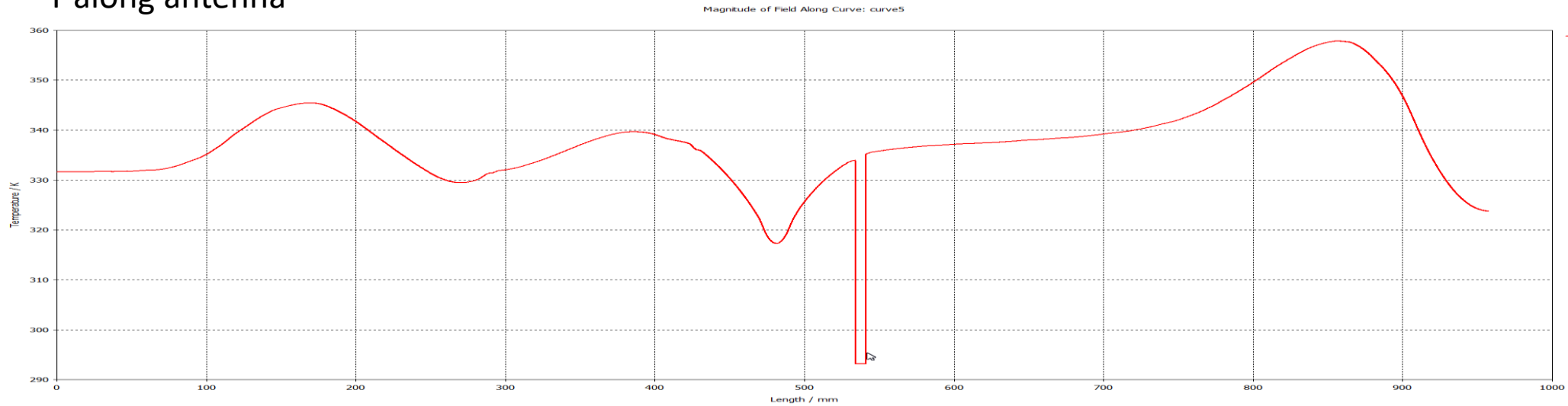


Losses in antenna 228 W

Losses in ceramics 19.4W



T along antenna

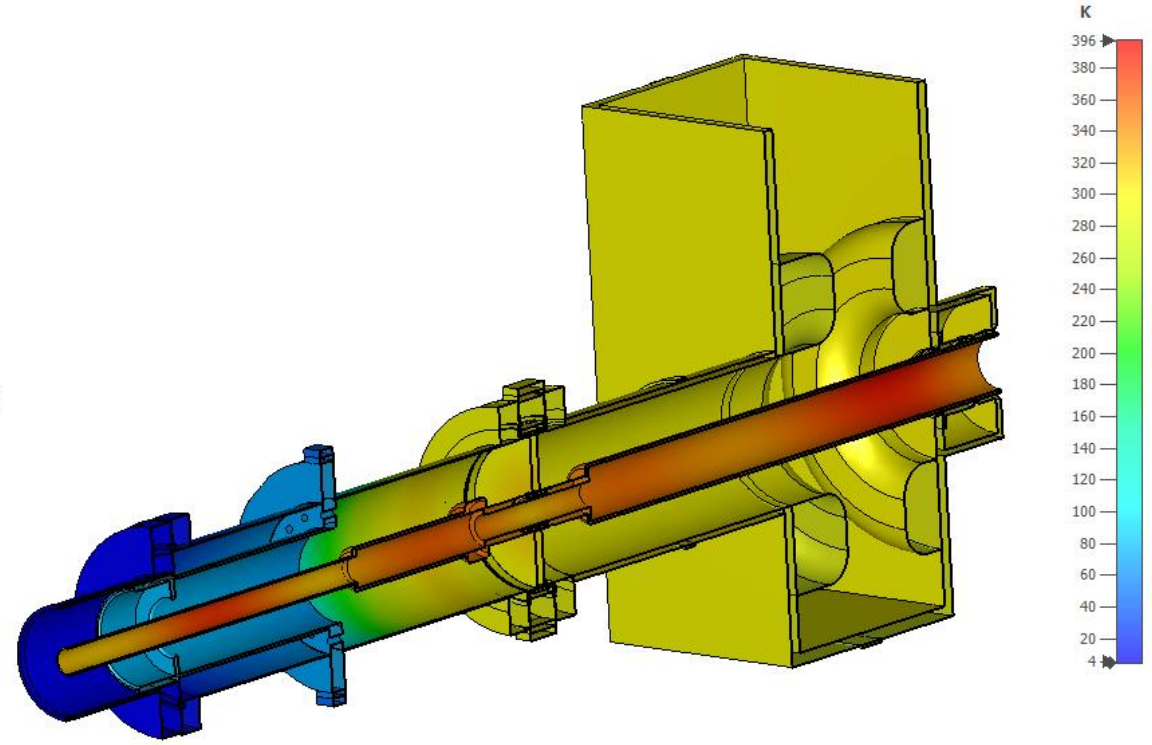
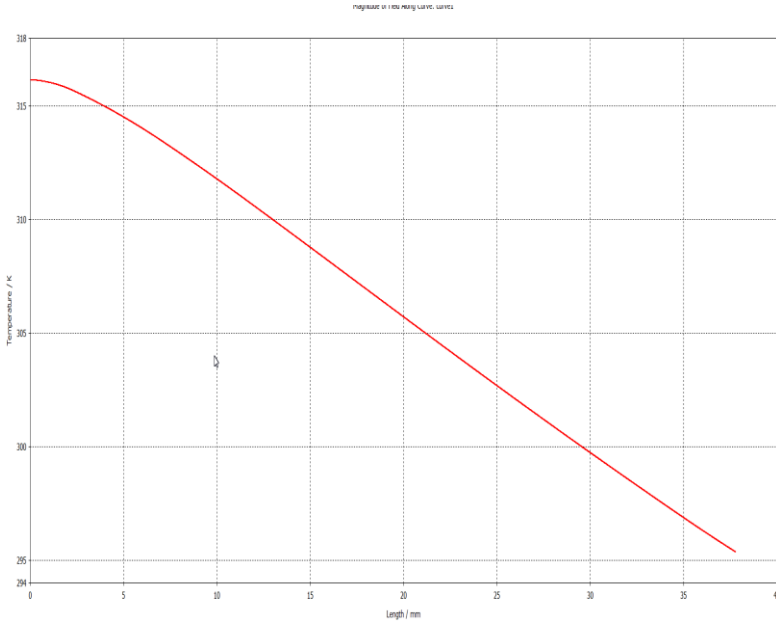


200 kW, 10% reflection, 0 dgr

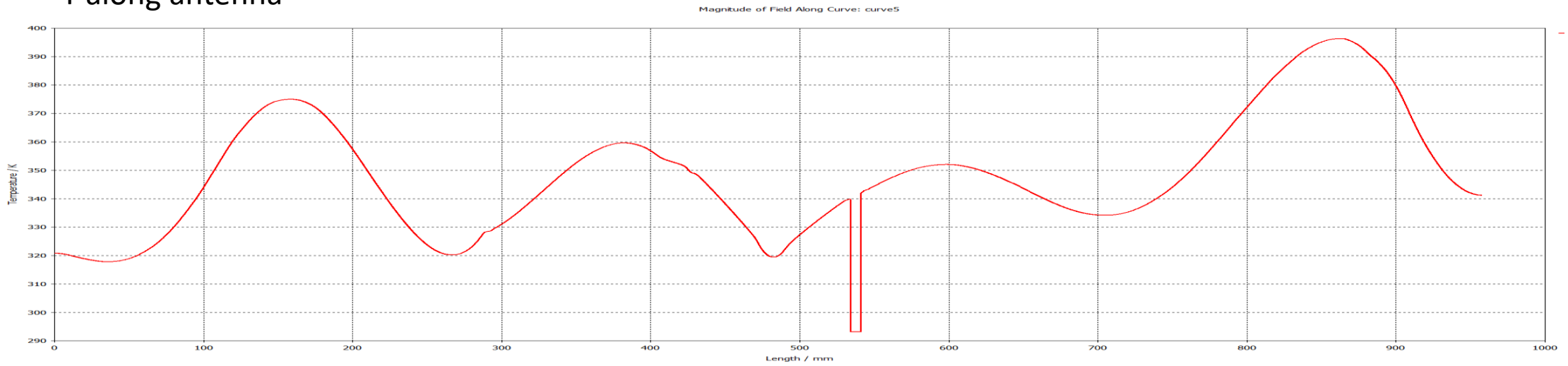
T along ceramics

Losses in antenna 281 W

Losses in ceramics 33.7W



T along antenna

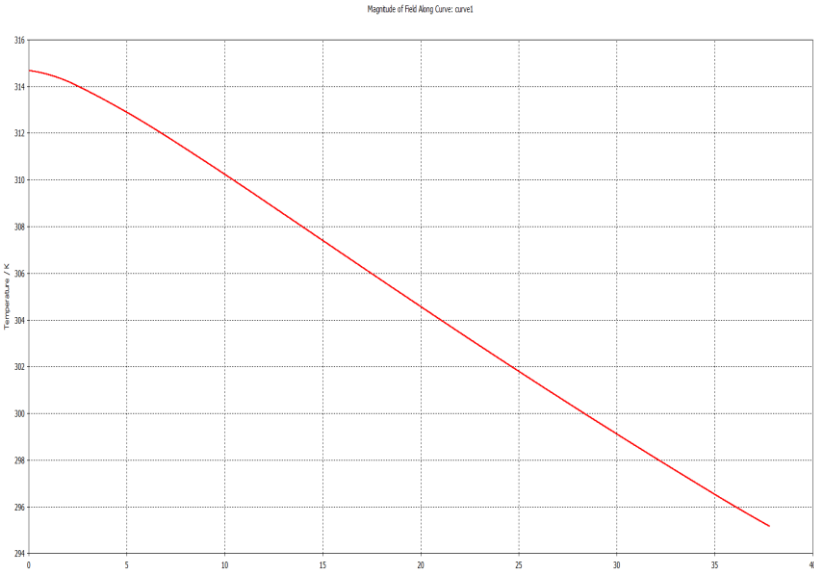
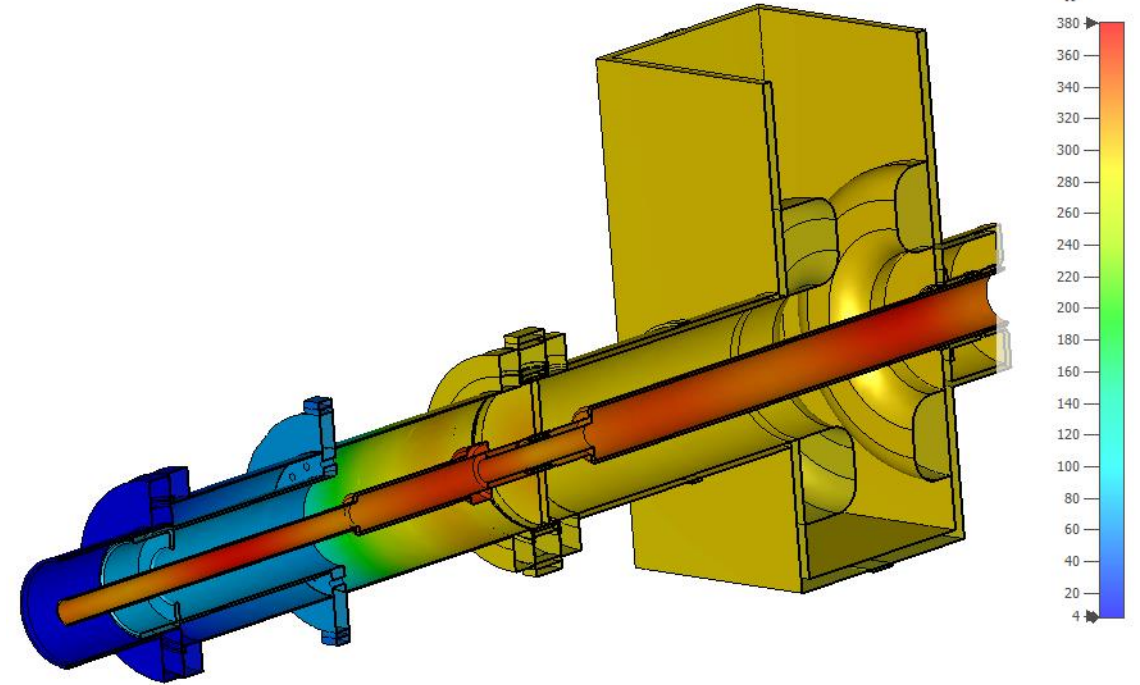


200 kW, 10% reflection, 45 dgr

T along ceramics

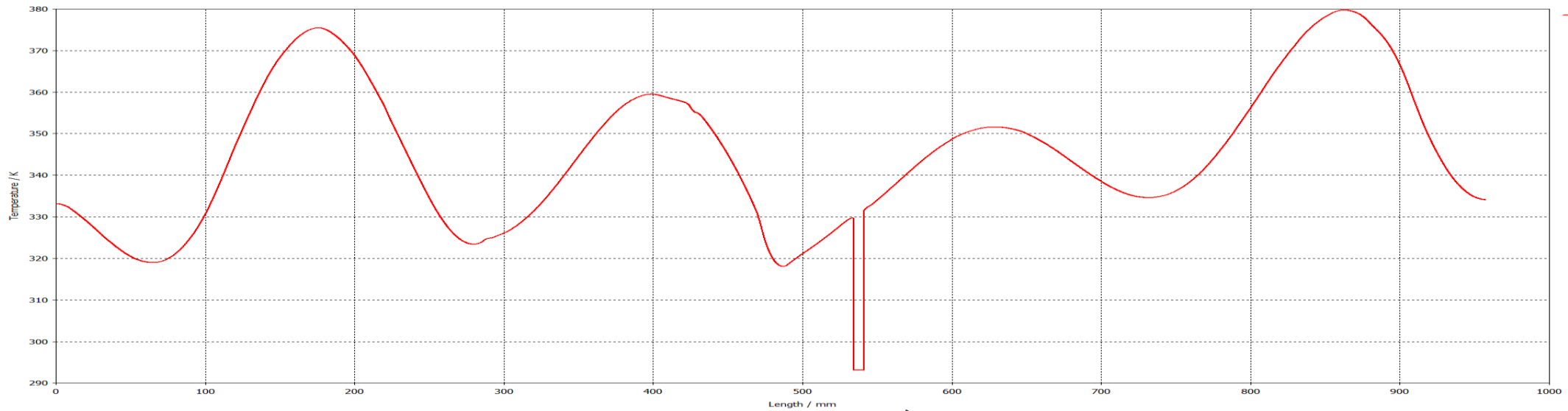
Losses in antenna 269 W

Losses in ceramics 28.7W



T along antenna

Magnitude of Field Along Curve: curve5

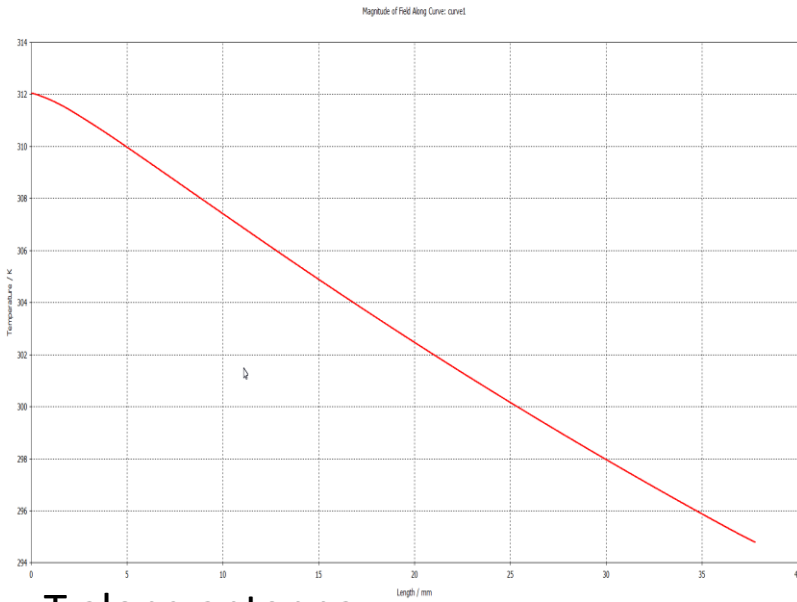
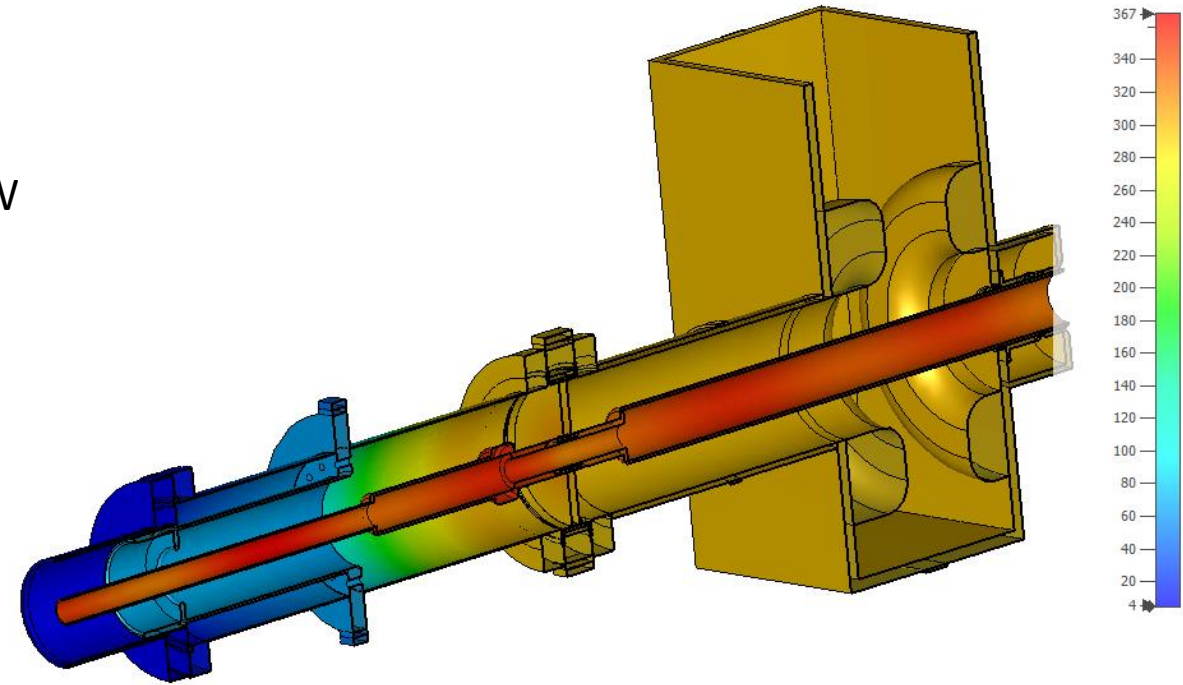


200 kW, 10% reflection, 90 dgr

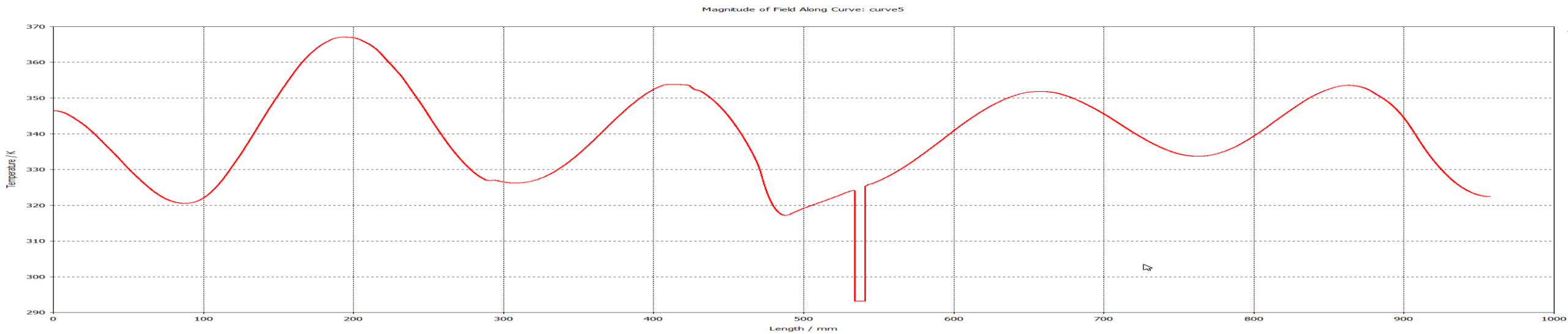
T along ceramics

Losses in antenna 247 W

Losses in ceramics 19.8 W



T along antenna

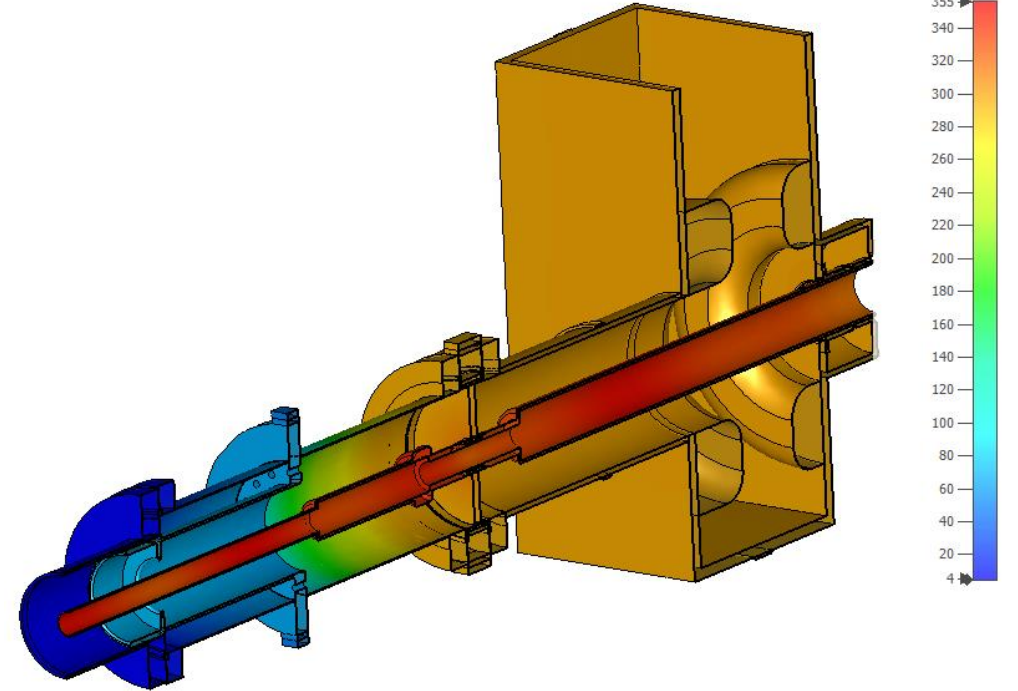
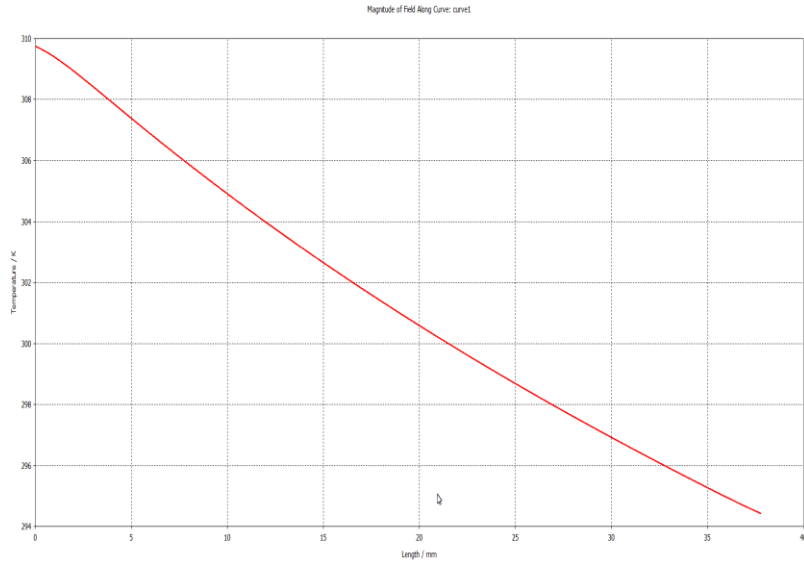


200 kW, 10% reflection, 135 dgr

T along ceramics

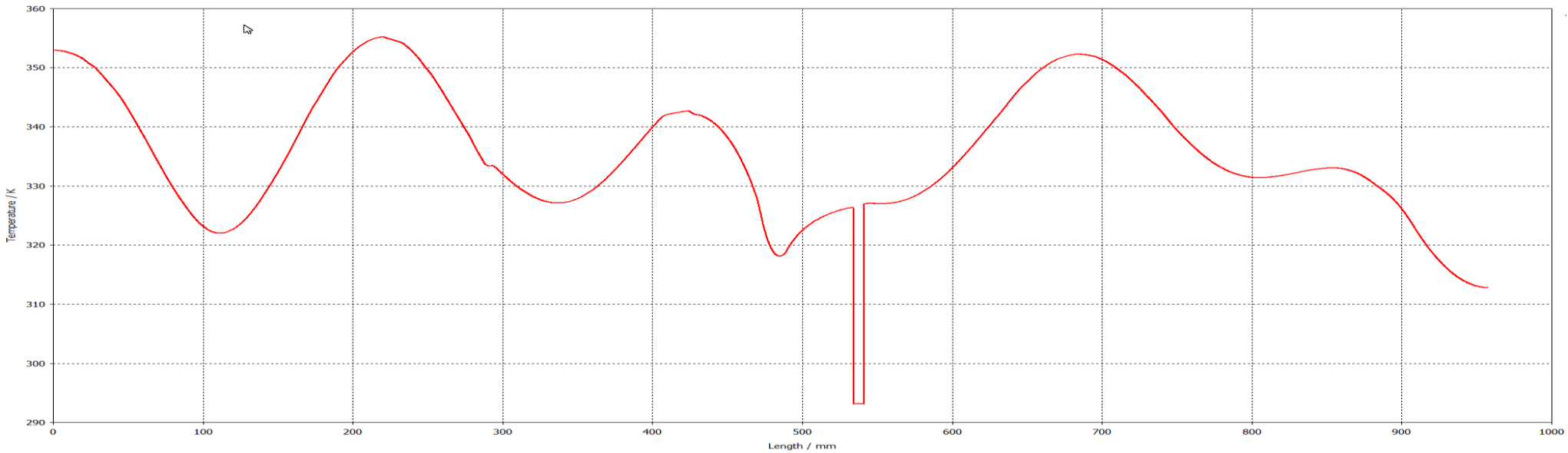
Losses in antenna 226 W

Losses in ceramics 11.4 W



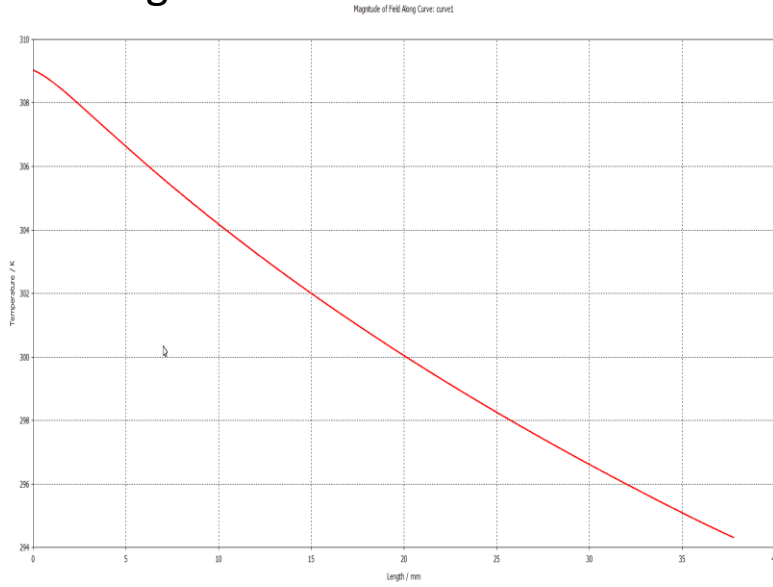
T along antenna

Magnitude of Field Along Curve: curve5



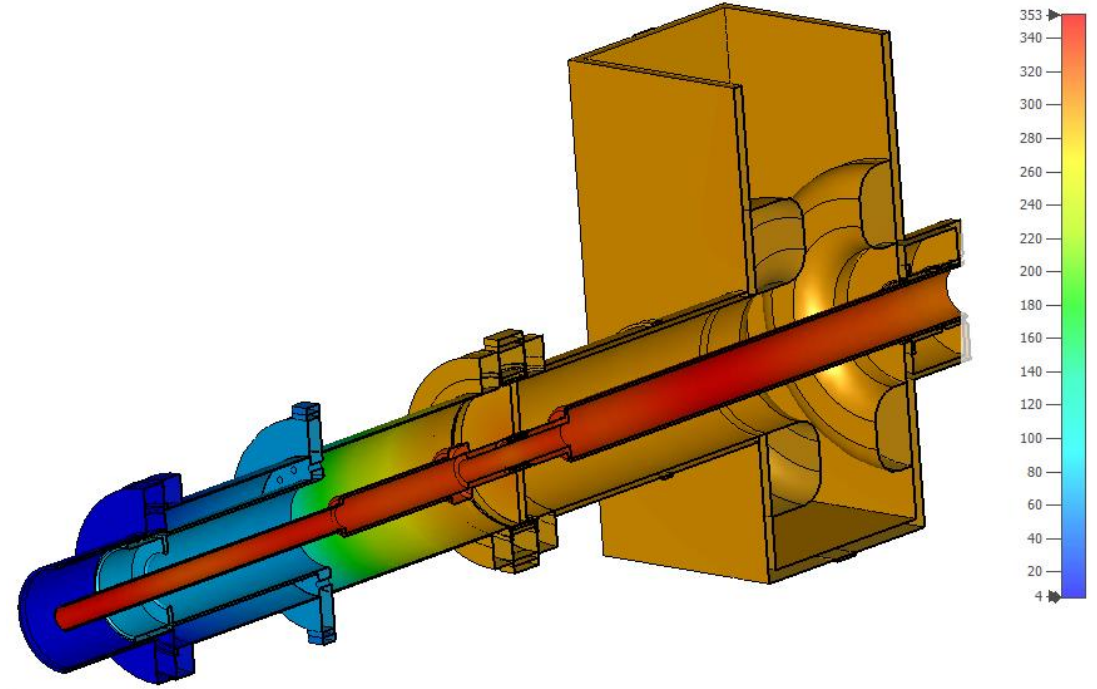
200 kW, 10% reflection, 180 dgr

T along ceramics

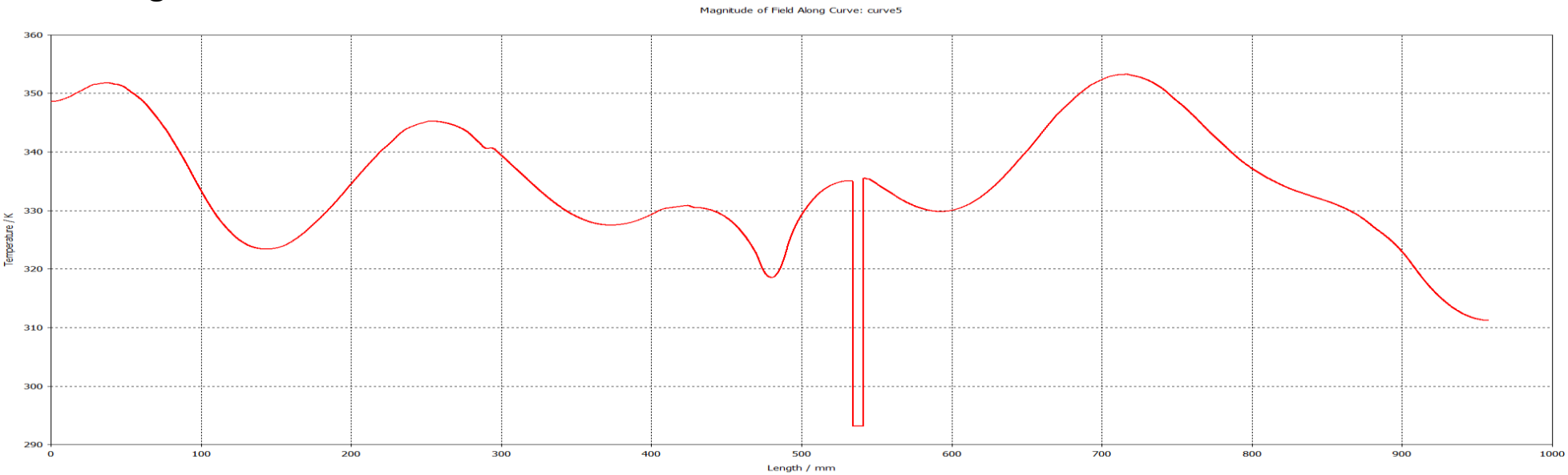


Losses in antenna 220 W

Losses in ceramics 9.2 W



T along antenna

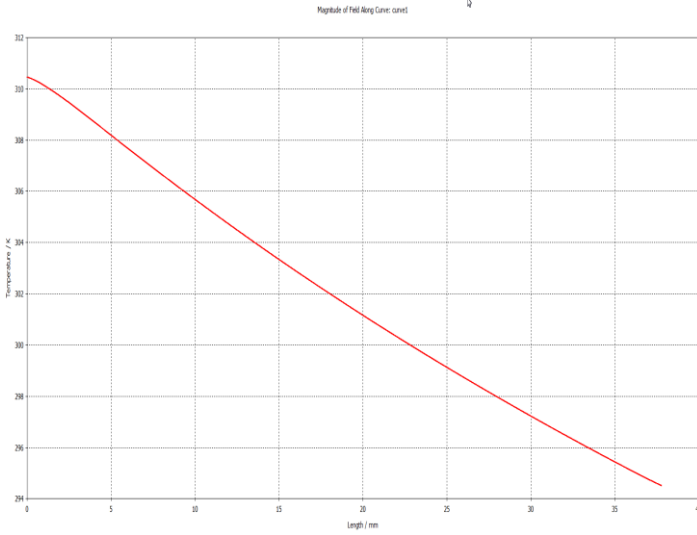
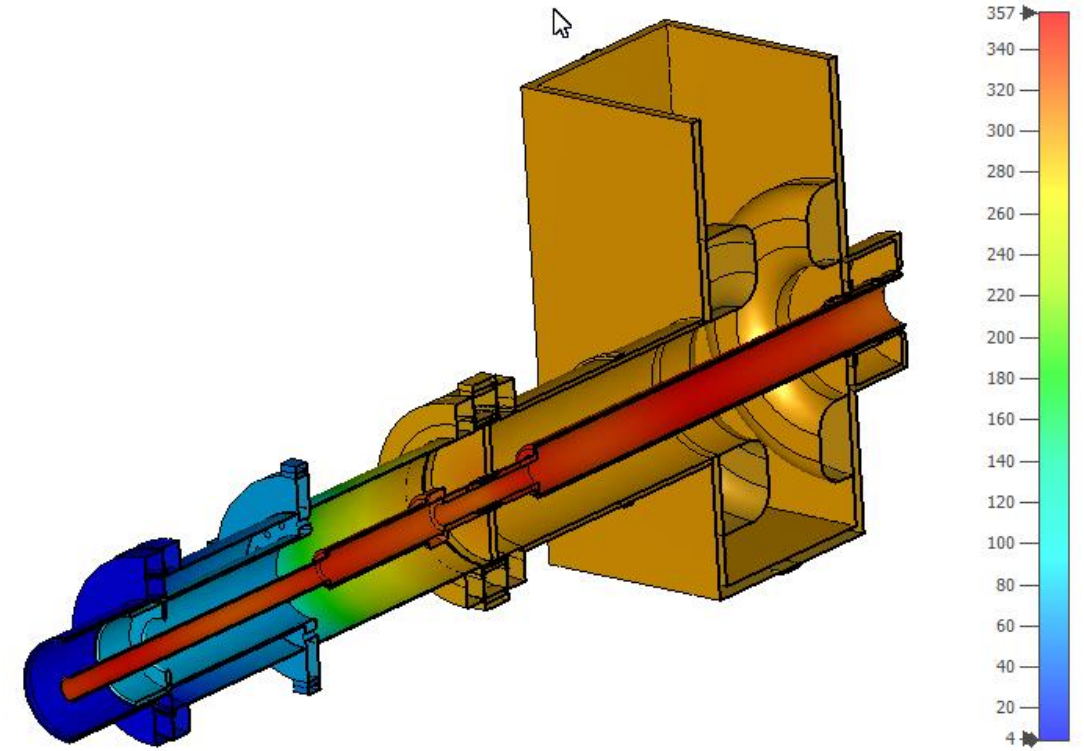


200 kW, 10% reflection, 225 dgr

T along ceramics

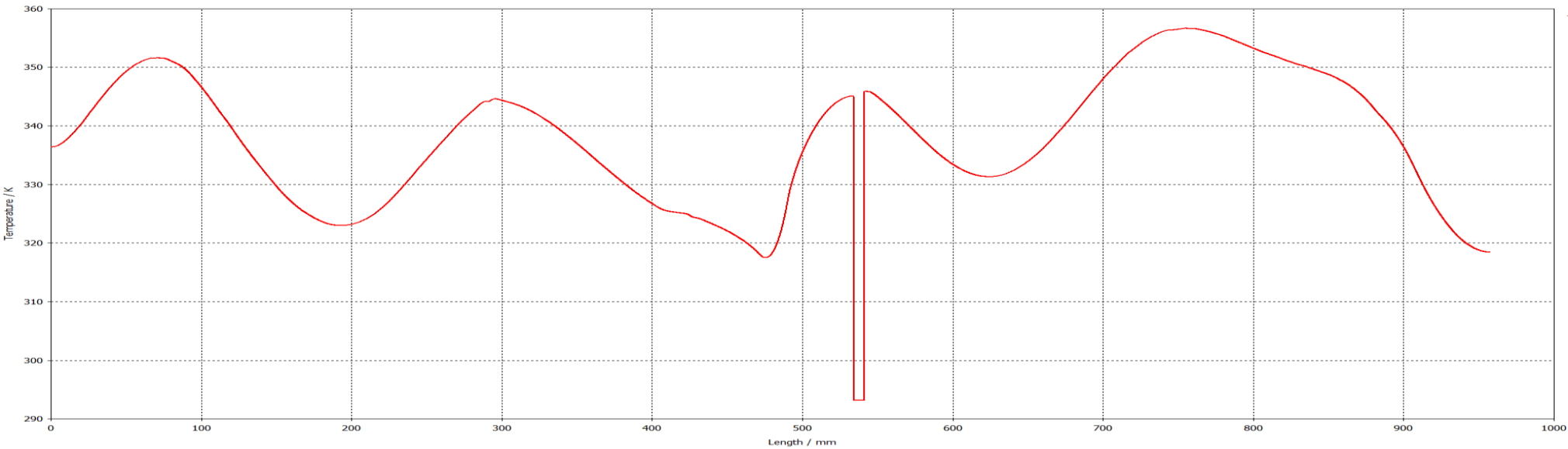
Losses in antenna 232 W

Losses in ceramics 14.1 W



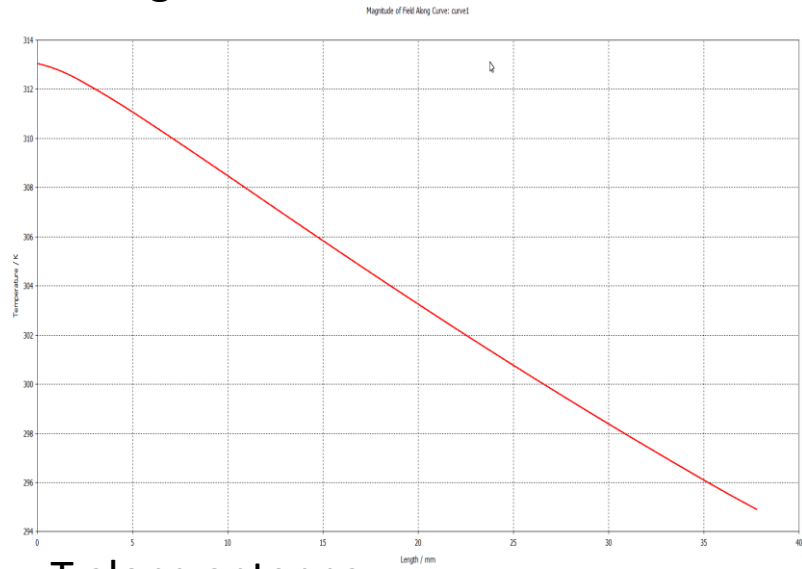
T along antenna

Magnitude of Field Along Curve: curve5



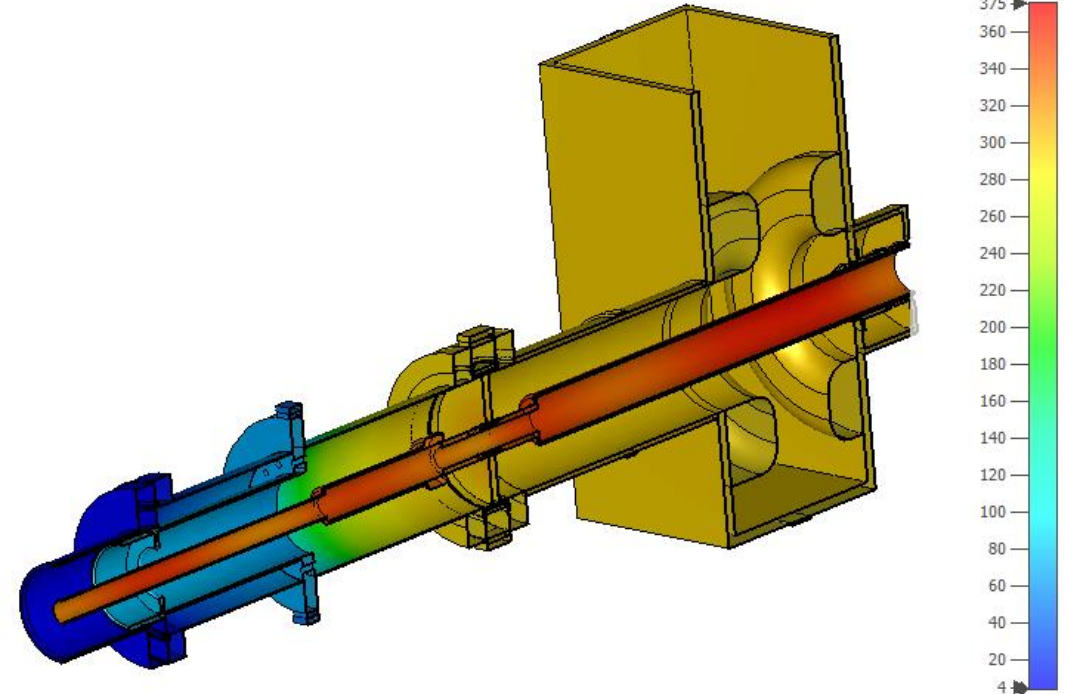
200 kW, 10% reflection, 270 dgr

T along ceramics

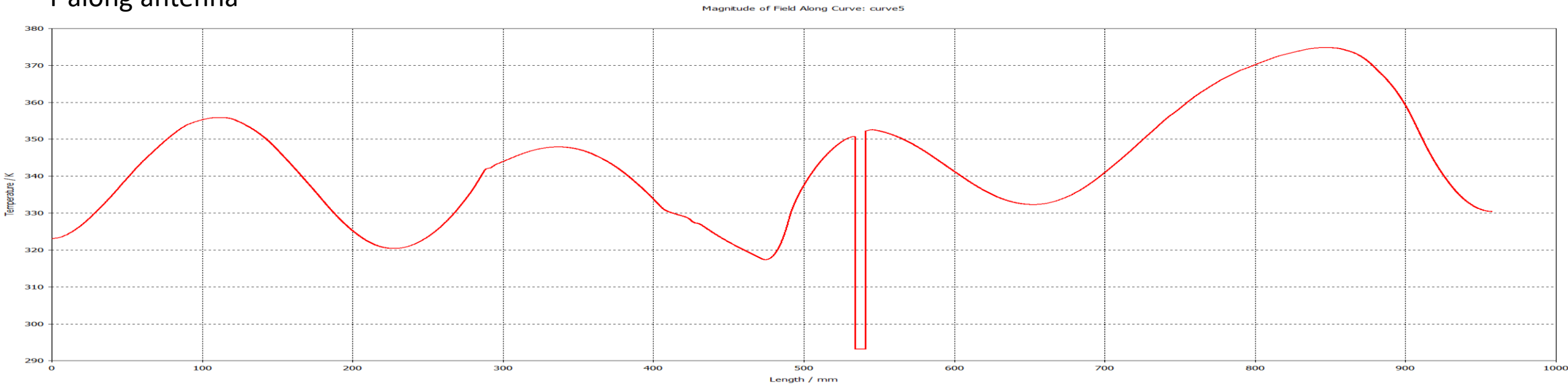


Losses in antenna 255 W

Losses in ceramics 23.4 W



T along antenna

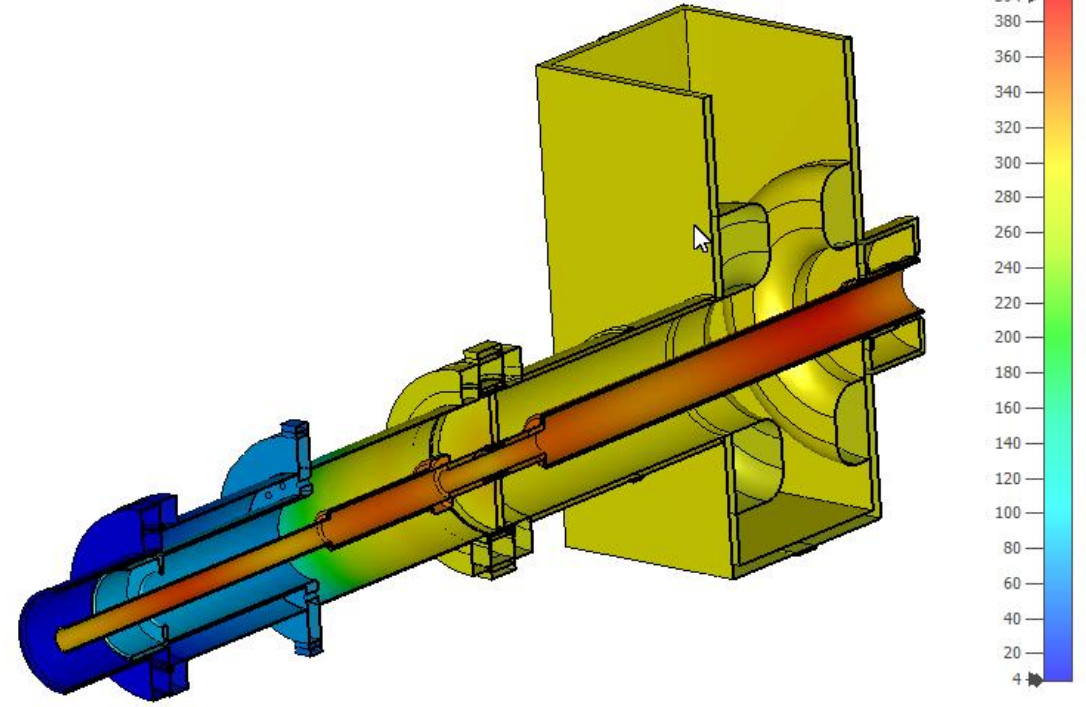
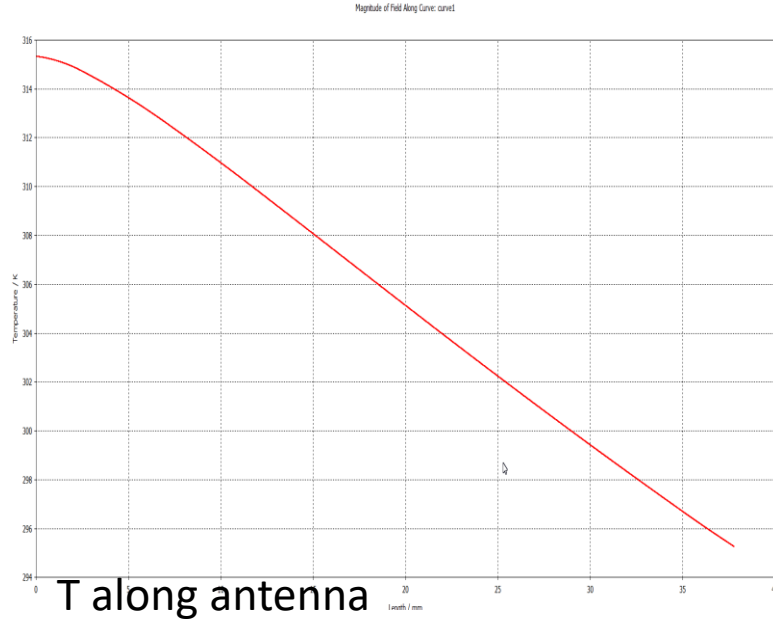


200 kW, 10% reflection, 315 dgr

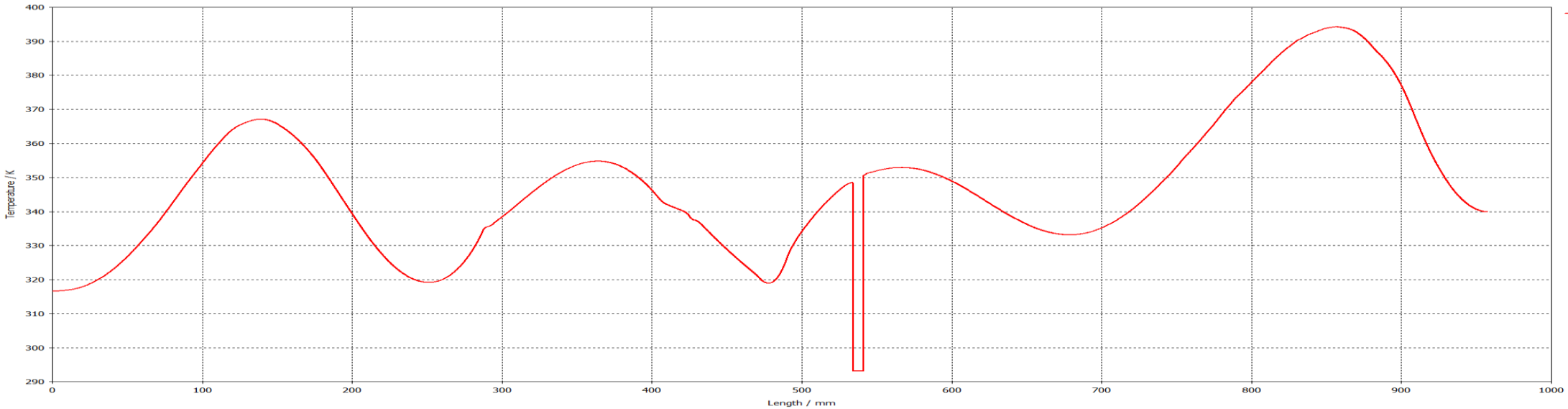
T along ceramics

Losses in antenna 275 W

Losses in ceramics 31.5 W



Magnitude of Field Along Curve: curve5



200 kW, 10% reflection:

Max. window temperature:	~ 317 K (44 C).
Max. power loss in ceramic (loss tng. 1E-4):	~ 32 W.
Max. antenna temperature:	~ 395 K (122 C).
Max. power loss in antenna:	~ 280 W.
Max. temperature of antenna tip:	~ 353 K (80 C)