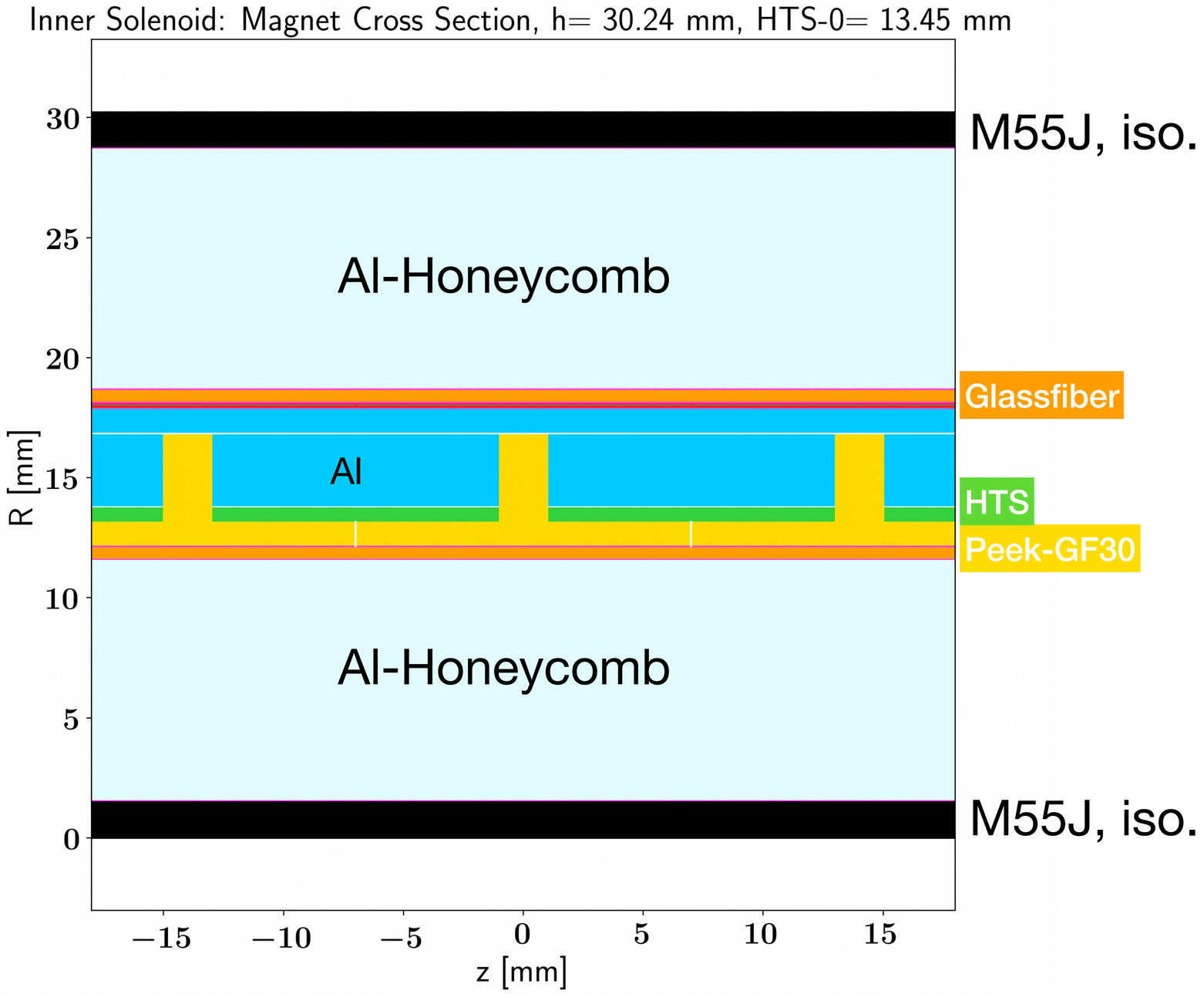
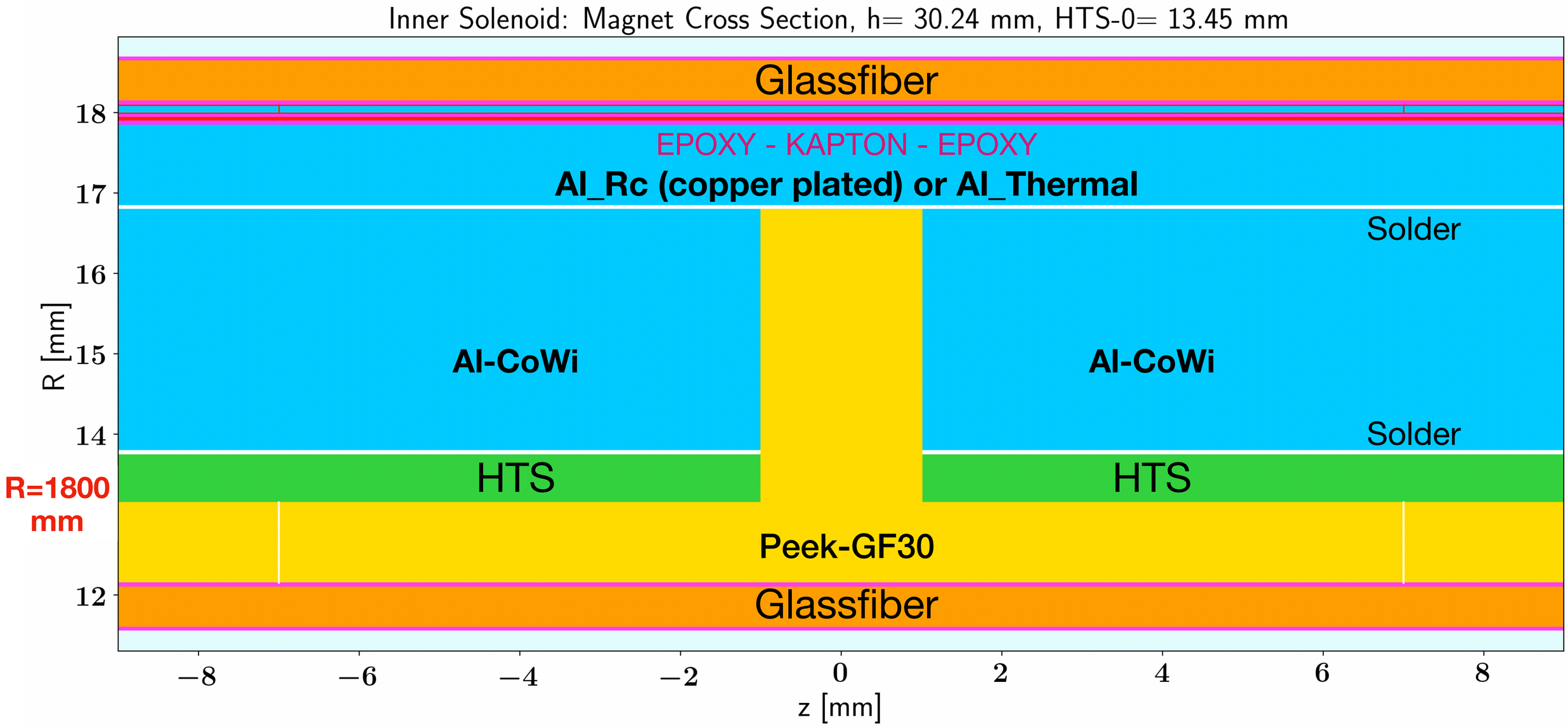
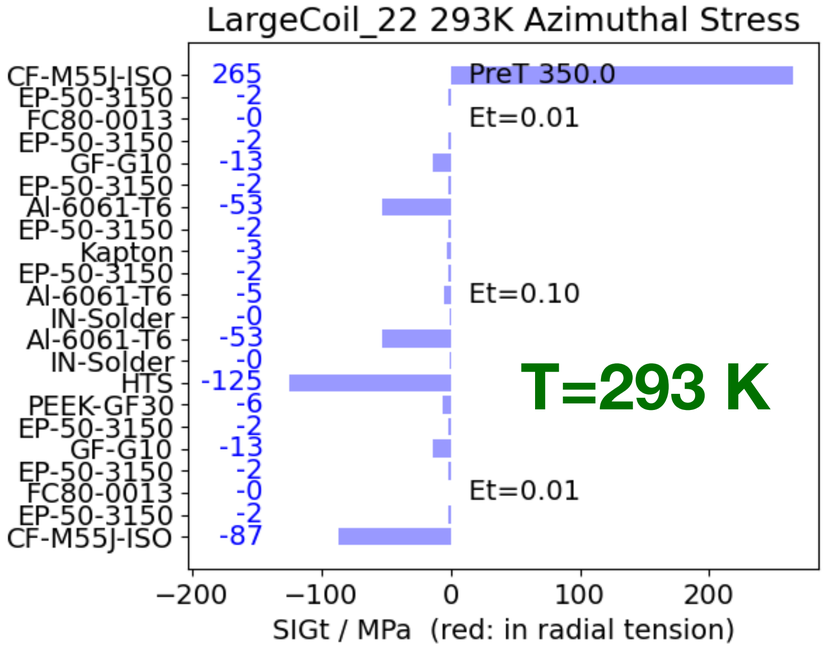
AMS-100 - (03. July 2020, Version 2.2)

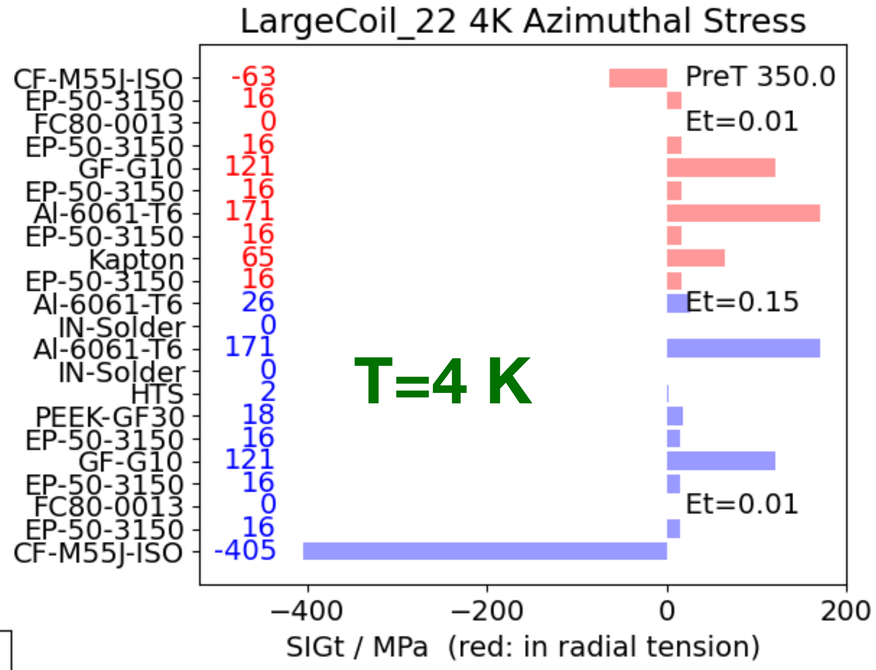


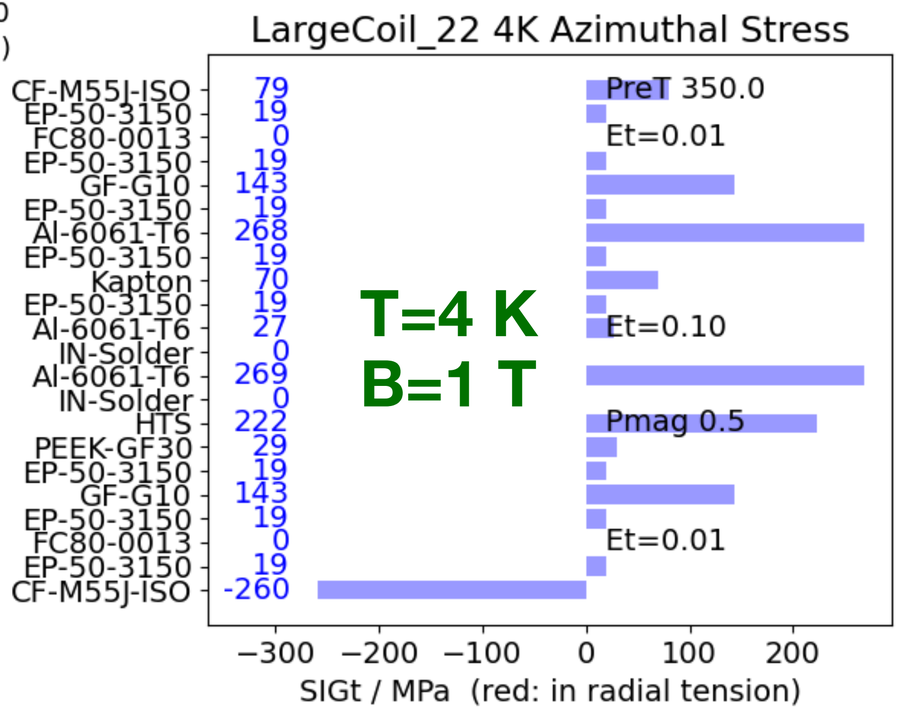
AMS-100 - (03. July 2020, Version 2.2)



AMS-100 - (03. July 2020, Version 2.2): Pre-Tension Outer CFRP by 350 MPA







AMS-100 - (03. July 2020, Version 2.2)

Inner Solenoid

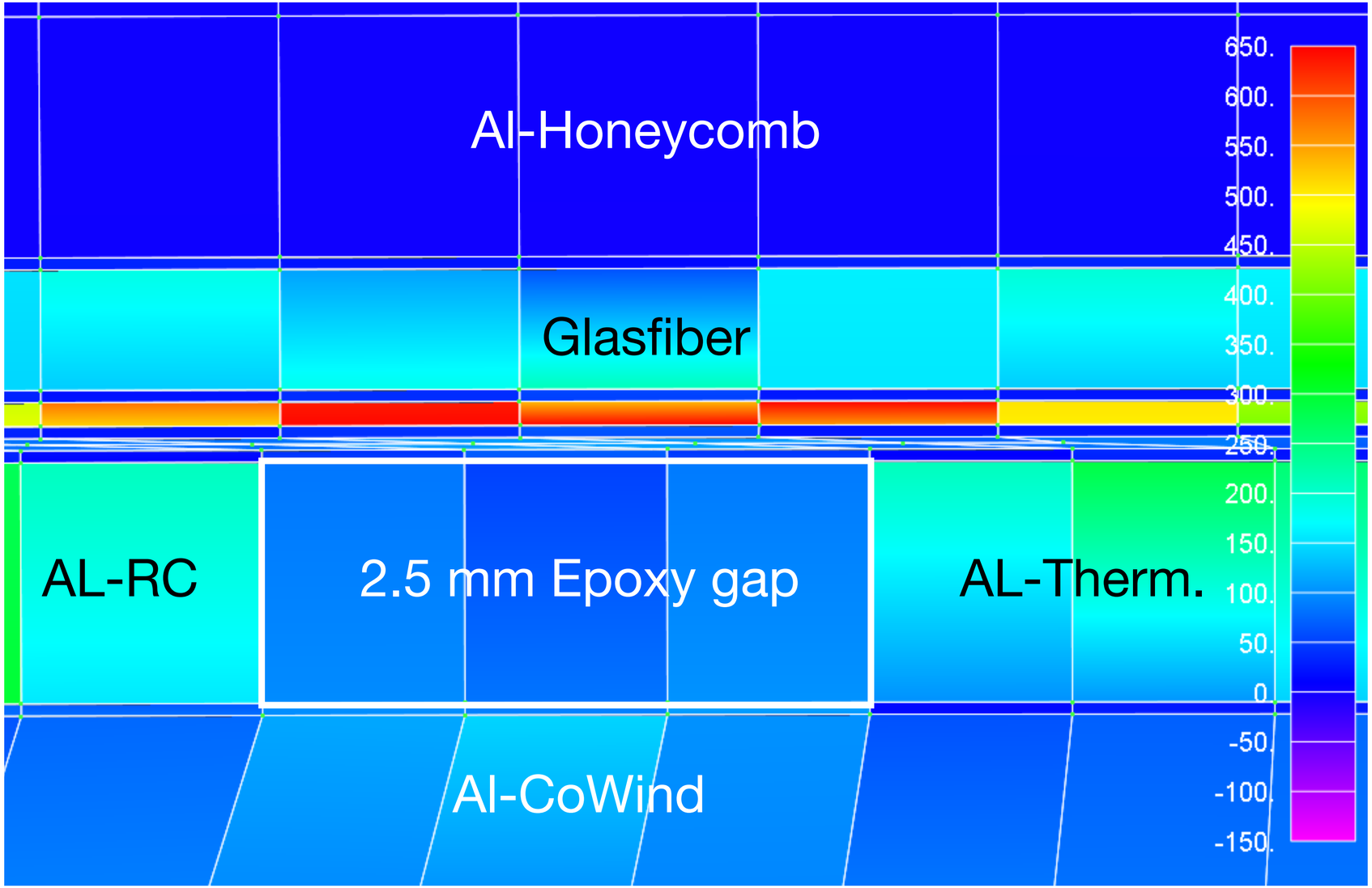
Orientation=1;
Z0= 0.00 m; CoilInnerRadius= 1.80 m; CoilThickness= 0.59 mm; nTapesPerStack= 22; Current=13200.0 A; LenZ= 5.40 m; nTurns= 386; nTurnsPerM= 71 1/m; TapeLength= 96.058 km;
MagneticMoment= 51.86 MAm^2; TorqueSun= 0.24 Nm; Energy= 28.13 MJ; EnergyDensity=511.84 kPa <=> 5.1184E+00 bar; Weight=1635.6 kg; X0= 0.131;
B(r=0,z=0)= 0.99 T; B(r=Rin-epsilon,z=0)= 1.04 T; B(r=Rout+epsilon,z=0)= -0.14 T; Stress_R=-139.69 kPa; Stress_Theta=1291.5 MPa; Stress_Z=-647.7 MPa
Volume= 0 m**3; Volume_Rin=178.00 cm; Volume_Rout=182.00 cm; nJoints= 321; PowerLoss= 2.31 Watt; Inductance= 0.32 Henry; PowerLossStackToStack= 0.62 Watt;
HoopForcePerTape= 1064.88 N; HoopStressPerTape= 3286.67 MPa; StrainPerTape= 1.57 % (Hastelloy Only)
QuenchDetectionCoil: Length= 4363 m, CrossSection= 1.40 mm2, Resistance= 62.33 Ohm
Co-WindCoil: Length= 4363 m, CrossSection= 36.00 mm2, Resistance= 2.42 Ohm
HTS-StackCoil : Length= 4366 m, CrossSection= 7.13 mm2, Resistance=753.44 Ohm

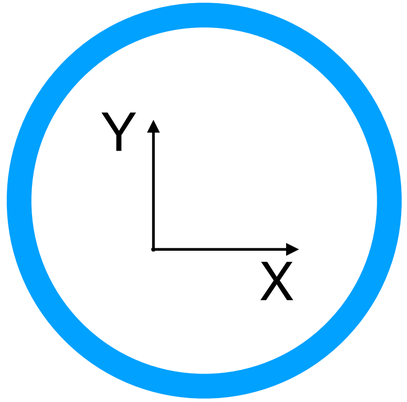
Name	R_i [mm]	d [mm]	Density [kg/m^3]	Mass [kg]	X0 [%]	NIL [%]	E0 [MPa]	CTE [1/K]	Strain [%]	Stress [MPa]
CFRP-M55J_Out	1815.59	1.500	1750.00	161.77	0.62	0.34	120000	1.000E-06	-0.20	-235.71
Epoxy-50-3150	1815.54	0.050	1160.00	3.57	0.01	0.01	2100	2.500E-05	0.50	10.45
Al-Honeycomb	1805.54	10.000	32.00	19.66	0.13	0.03	200	1.431E-05	0.19	0.38
Epoxy-50-3150	1805.49	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
FiberGlass	1804.99	0.500	2610.00	79.93	0.51	0.13	19000	1.667E-05	0.26	48.76
Epoxy-50-3150	1804.94	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Al_QDC	1804.84	0.100	2700.00	16.53	0.11	0.03	77749	1.431E-05	0.19	146.53
Epoxy-50-3150	1804.79	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Kapton	1804.74	0.050	1420.00	4.35	0.02	0.01	3758	4.804E-05	1.16	43.73
Epoxy-50-3150	1804.69	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Al_Rc	1803.69	1.000	2700.00	165.28	1.12	0.25	77749	1.431E-05	0.19	146.53
In-Solder	1803.64	0.050	7310.00	22.37	0.41	0.02	100	3.300E-05	0.73	0.73
Al_CoWi	1800.64	3.000	2700.00	495.28	3.37	0.76	77749	1.431E-05	0.19	146.53
In-Solder	1800.59	0.050	7310.00	22.33	0.41	0.02	100	3.300E-05	0.73	0.73
HTS-Coil	1800.00	0.594	9021.48	280.77	4.72	0.37	177510	9.244E-06	0.04	74.46
Peek-GF30_Gap	1799.00	1.000	1320.00	80.59	0.29	0.14	3760	1.400E-05	0.18	6.75
Epoxy-50-3150	1798.95	0.050	1160.00	3.54	0.01	0.01	2100	2.500E-05	0.50	10.45
FiberGlass	1798.45	0.500	2610.00	79.64	0.51	0.13	19000	1.667E-05	0.26	48.76
Epoxy-50-3150	1798.40	0.050	1160.00	3.54	0.01	0.01	2100	2.500E-05	0.50	10.45
Al-Honeycomb	1788.40	10.000	32.00	19.47	0.13	0.03	200	1.431E-05	0.19	0.38
Epoxy-50-3150	1788.35	0.050	1160.00	3.52	0.01	0.01	2100	2.500E-05	0.50	10.45
CFRP-M55J_In	1786.85	1.500	1750.00	159.21	0.62	0.34	120000	1.000E-06	-0.20	-235.71
sum		30.244	909.76	1635.57	13.09	2.67				

Total Al-Mass=676.18 kg; TfinalAfterQuench= 1.5421E+02 K
Weight = 1635.6 kg = Weight_Support= 1354.8 kg + Weight_Coil= 280.8 kg
X0 = 0.1309 = X0_Support = 0.0837 + X0_Coil = 0.0472 = X0_Cu = 0.0077 + X0_Hastelloy = 0.0344 + X0_Ag = 0.0052 + X0_Al = 0.0000
NIL = 0.0267 = NIL_Support= 0.0230 + NIL_Coil= 0.0037 = NIL_Cu= 0.0007 + NIL_Hastelloy= 0.0027 + NIL_Ag= 0.0003 + NIL_Al= 0.0000

AMS-100 - (03. July 2020, Version 2.2): Cool-Down from 293 K to 4 K

AL-QDC

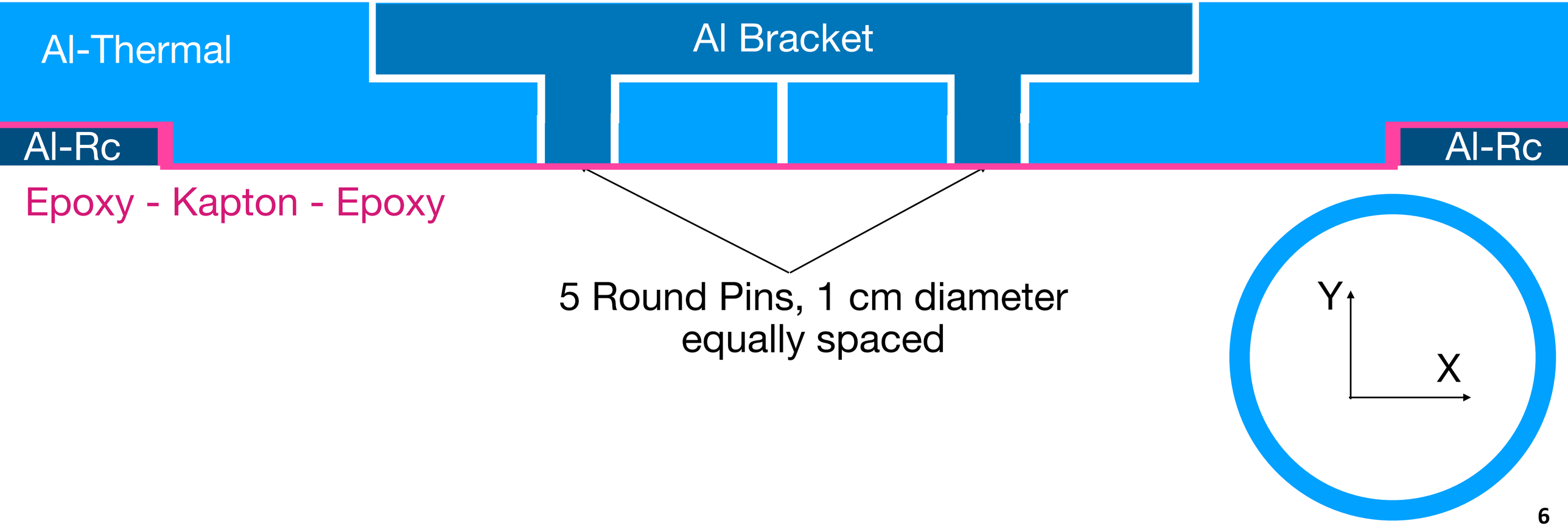




The local tension in the AL-QDC of 600 MPa is too high !

Create a „solid“ cylinder for the thermal Aluminum

Connection of the four AL 1/4-Shells
by using multiple ~20 cm long AL Brackets along the z-axis,
machined to fit locally with precision



AMS-100 - (08. July 2020, Version 2.3)

Al-Thermal

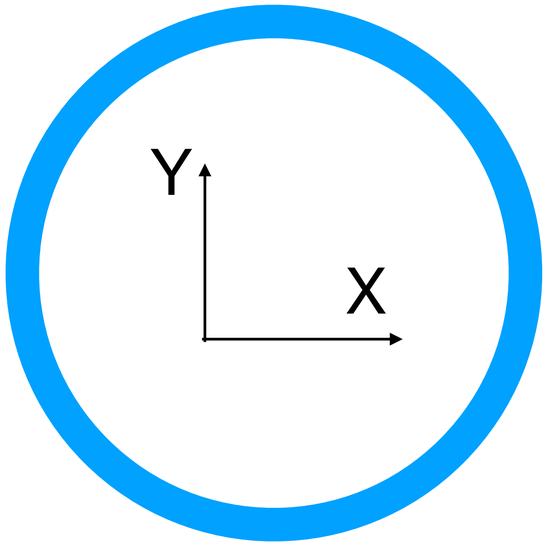
Al-Rc

Al-Rc

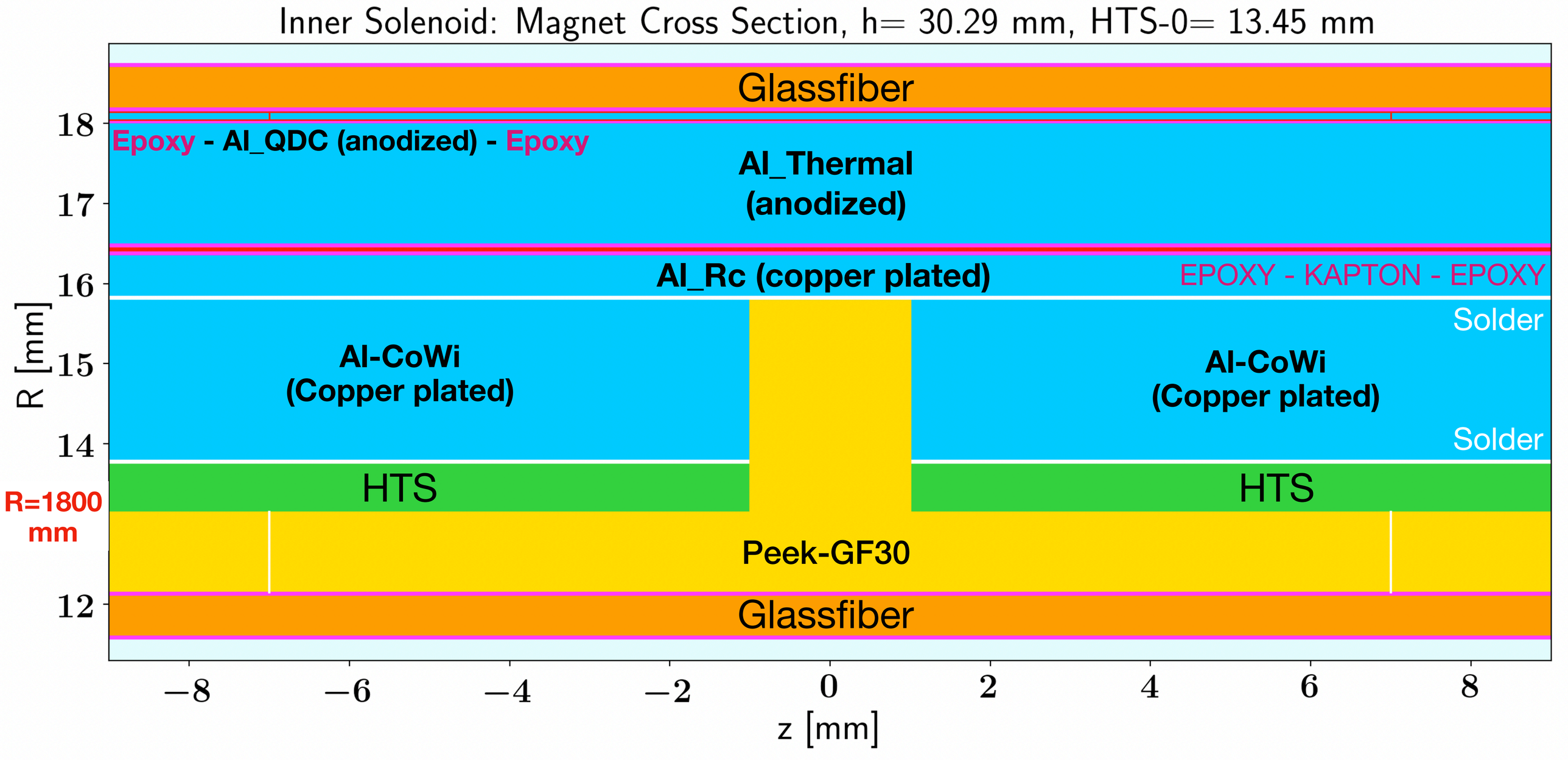
Al-CoWind

HTS

PEEK-GF30



AMS-100 - (08. July 2020, Version 2.3)



AMS-100 - (08. July 2020, Version 2.3)

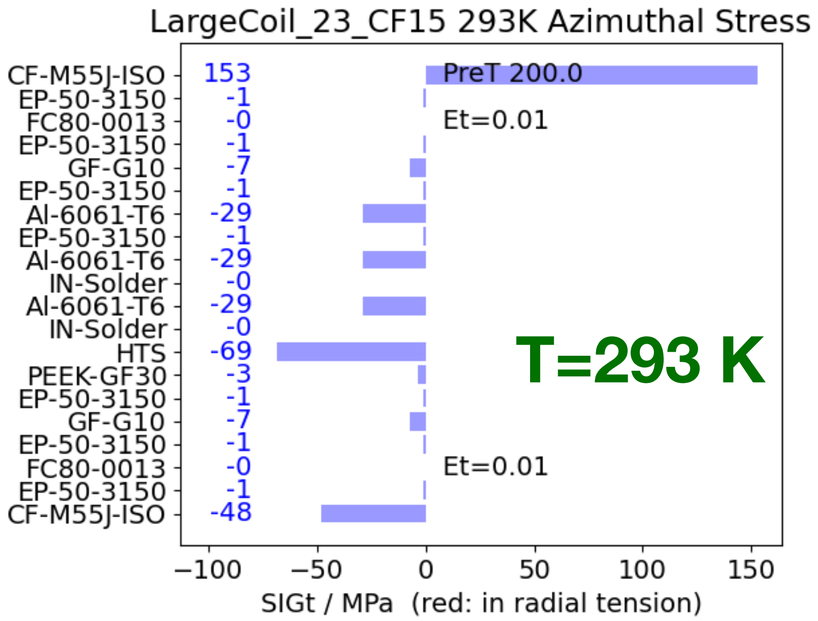
Inner Solenoid

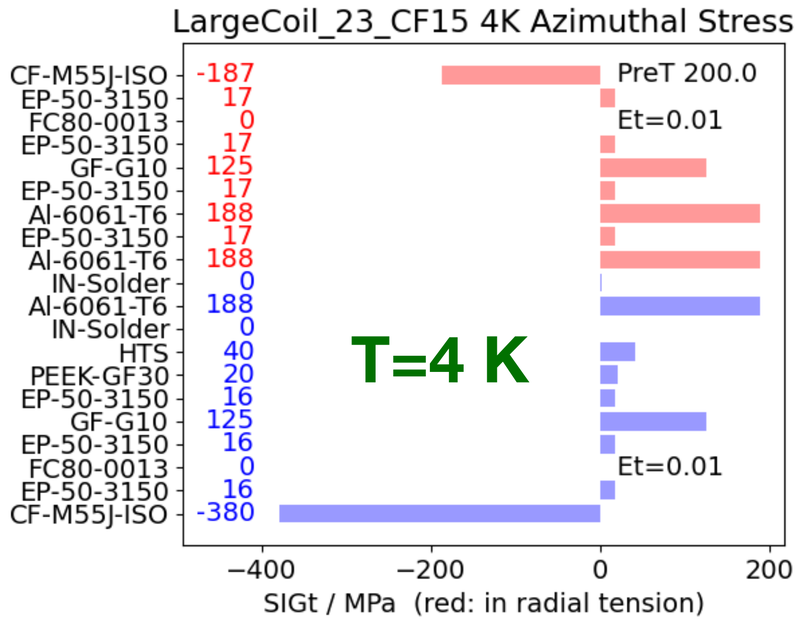
Orientation=1;
Z0= 0.00 m; CoilInnerRadius= 1.80 m; CoilThickness= 0.59 mm; nTapesPerStack= 22; Current=13200.0 A; LenZ= 5.40 m; nTurns= 386; nTurnsPerM= 71 1/m; TapeLength= 96.058 km;
MagneticMoment= 51.86 MAm^2; TorqueSun= 0.24 Nm; Energy= 28.13 MJ; EnergyDensity=511.84 kPa <=> 5.1184E+00 bar; Weight=1639.1 kg; X0= 0.131;
B(r=0,z=0)= 0.99 T; B(r=Rin-epsilon,z=0)= 1.04 T; B(r=Rout+epsilon,z=0)= -0.14 T; Stress_R=-139.69 kPa; Stress_Theta=1291.5 MPa; Stress_Z=-647.7 MPa
Volume= 0 m**3; Volume_Rin=178.00 cm; Volume_Rout=182.00 cm; nJoints= 321; PowerLoss= 2.31 Watt; Inductance= 0.32 Henry; PowerLossStackToStack= 1.23 Watt;
HoopForcePerTape= 1064.88 N; HoopStressPerTape= 3286.67 MPa; StrainPerTape= 1.57 % (Hastelloy Only)
QuenchDetectionCoil: Length= 4363 m, CrossSection= 1.40 mm2, Resistance= 62.33 Ohm
Co-WindCoil: Length= 4363 m, CrossSection= 24.00 mm2, Resistance= 3.64 Ohm
HTS-StackCoil : Length= 4366 m, CrossSection= 7.13 mm2, Resistance=753.44 Ohm

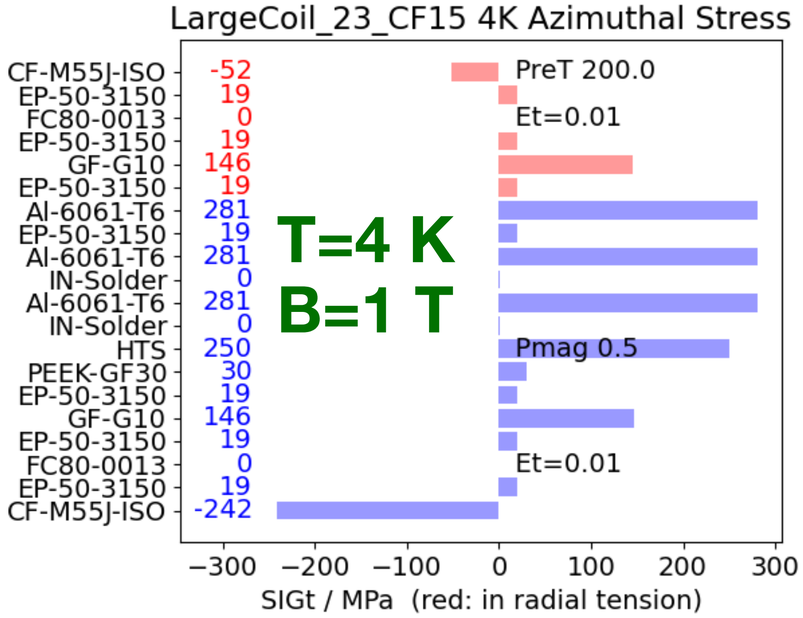
Name	R_i [mm]	d [mm]	Density [kg/m^3]	Mass [kg]	X0 [%]	NIL [%]	E0 [MPa]	CTE [1/K]	Strain [%]	Stress [MPa]
CFRP-M55J_Out	1815.64	1.500	1750.00	161.78	0.62	0.34	120000	1.000E-06	-0.20	-235.79
Epoxy-50-3150	1815.59	0.050	1160.00	3.57	0.01	0.01	2100	2.500E-05	0.50	10.45
Al-Honeycomb	1805.59	10.000	32.00	19.66	0.13	0.03	200	1.431E-05	0.19	0.38
Epoxy-50-3150	1805.54	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
FiberGlass	1805.04	0.500	2610.00	79.93	0.51	0.13	19000	1.667E-05	0.26	48.75
Epoxy-50-3150	1804.99	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Al_QDC	1804.89	0.100	2700.00	16.53	0.11	0.03	77749	1.431E-05	0.19	146.48
Epoxy-50-3150	1804.84	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Al_Therm	1803.34	1.500	2700.00	247.91	1.69	0.38	77749	1.431E-05	0.19	146.48
Epoxy-50-3150	1803.29	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Kapton	1803.24	0.050	1420.00	4.34	0.02	0.01	3758	4.804E-05	1.16	43.73
Epoxy-50-3150	1803.19	0.050	1160.00	3.55	0.01	0.01	2100	2.500E-05	0.50	10.45
Al_Rc	1802.69	0.500	2700.00	82.58	0.56	0.13	77749	1.431E-05	0.19	146.48
In-Solder	1802.64	0.050	7310.00	22.36	0.41	0.02	100	3.300E-05	0.73	0.73
Al_CoWi	1800.64	2.000	2700.00	330.09	2.25	0.50	77749	1.431E-05	0.19	146.48
In-Solder	1800.59	0.050	7310.00	22.33	0.41	0.02	100	3.300E-05	0.73	0.73
HTS-Coil	1800.00	0.594	9021.48	280.77	4.72	0.37	177510	9.244E-06	0.04	74.35
Peek-GF30_Gap	1799.00	1.000	1320.00	80.59	0.29	0.14	3760	1.400E-05	0.18	6.75
Epoxy-50-3150	1798.95	0.050	1160.00	3.54	0.01	0.01	2100	2.500E-05	0.50	10.45
FiberGlass	1798.45	0.500	2610.00	79.64	0.51	0.13	19000	1.667E-05	0.26	48.75
Epoxy-50-3150	1798.40	0.050	1160.00	3.54	0.01	0.01	2100	2.500E-05	0.50	10.45
Al-Honeycomb	1788.40	10.000	32.00	19.47	0.13	0.03	200	1.431E-05	0.19	0.38
Epoxy-50-3150	1788.35	0.050	1160.00	3.52	0.01	0.01	2100	2.500E-05	0.50	10.45
CFRP-M55J_In	1786.85	1.500	1750.00	159.21	0.62	0.34	120000	1.000E-06	-0.20	-235.79
sum		30.294	910.17	1639.13	13.11	2.68				

Total Al-Mass=676.18 kg; TfinalAfterQuench= 1.5421E+02 K
Weight = 1639.1 kg = Weight_Support= 1358.4 kg + Weight_Coil= 280.8 kg
X0 = 0.1311 = X0_Support = 0.0838 + X0_Coil = 0.0472 = X0_Cu = 0.0077 + X0_Hastelloy = 0.0344 + X0_Ag = 0.0052 + X0_Al = 0.0000
NIL = 0.0268 = NIL_Support= 0.0230 + NIL_Coil= 0.0037 = NIL_Cu= 0.0007 + NIL_Hastelloy= 0.0027 + NIL_Ag= 0.0003 + NIL_Al= 0.0000

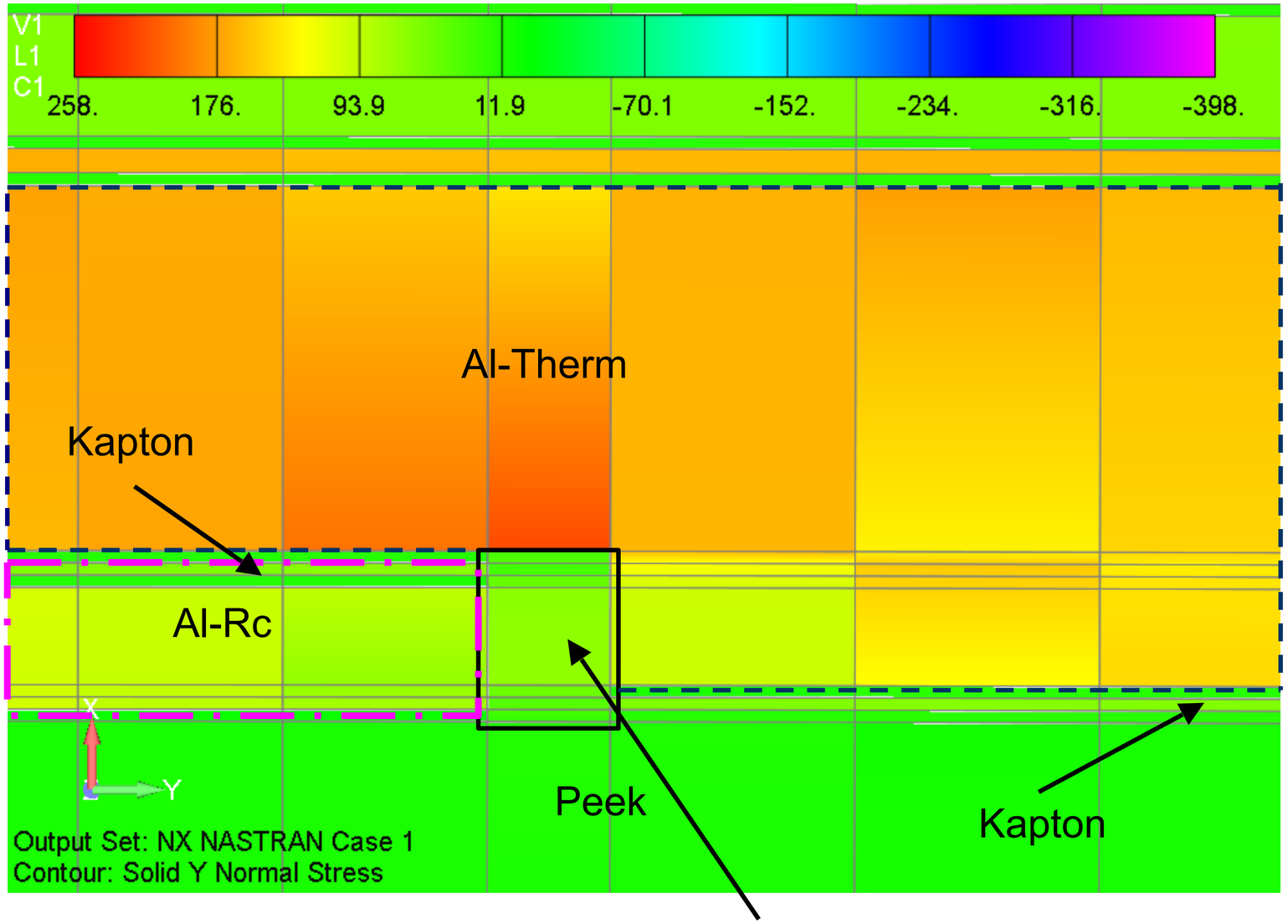
AMS-100 - (08. July 2020, Version 2.3): Pre-Tension Outer CFRP by 200 MPA

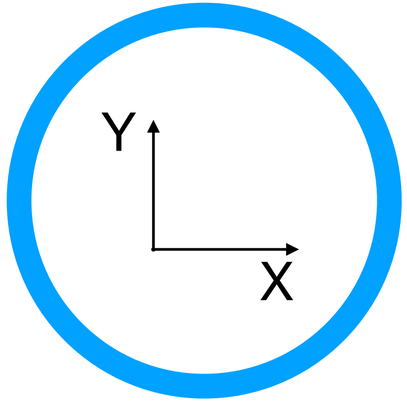






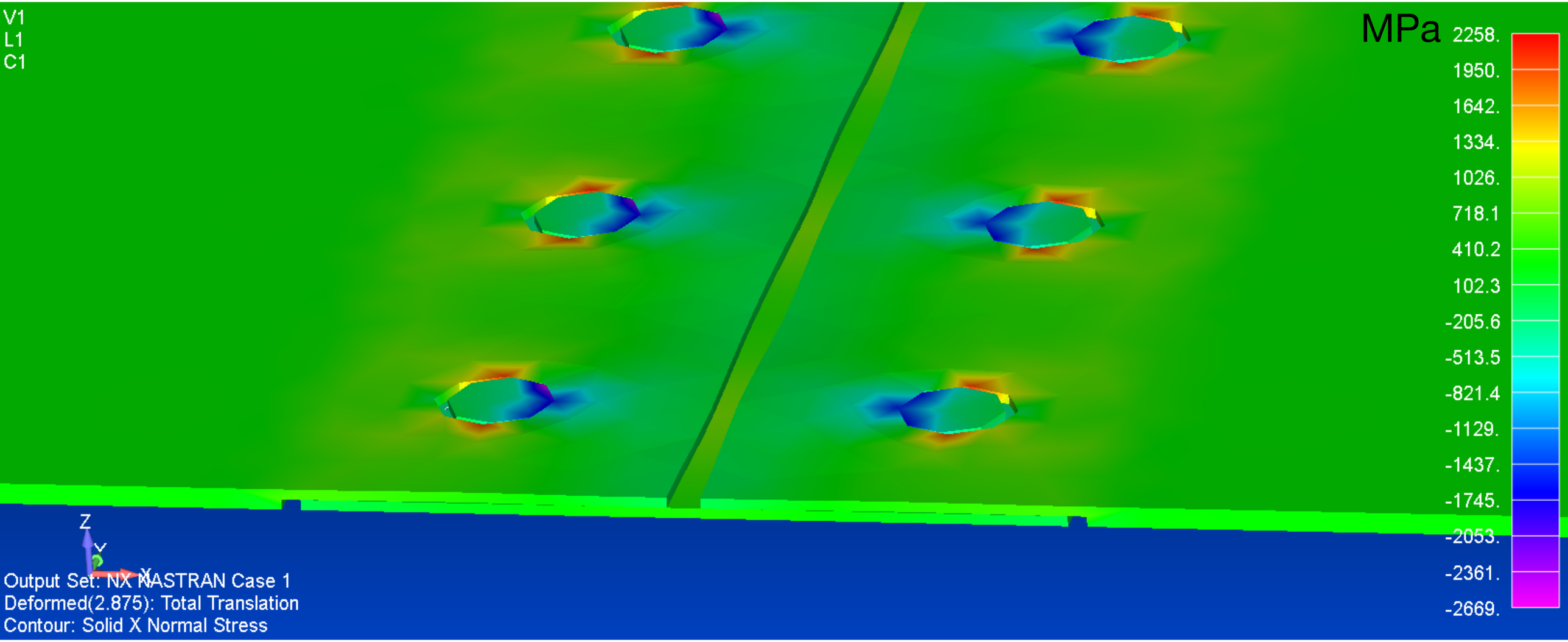
AMS-100 - (08. July 2020, Version 2.3): Cool-Down from 293 K to 4 K





Epoxy filled gap between Al-Rc and Al-therm

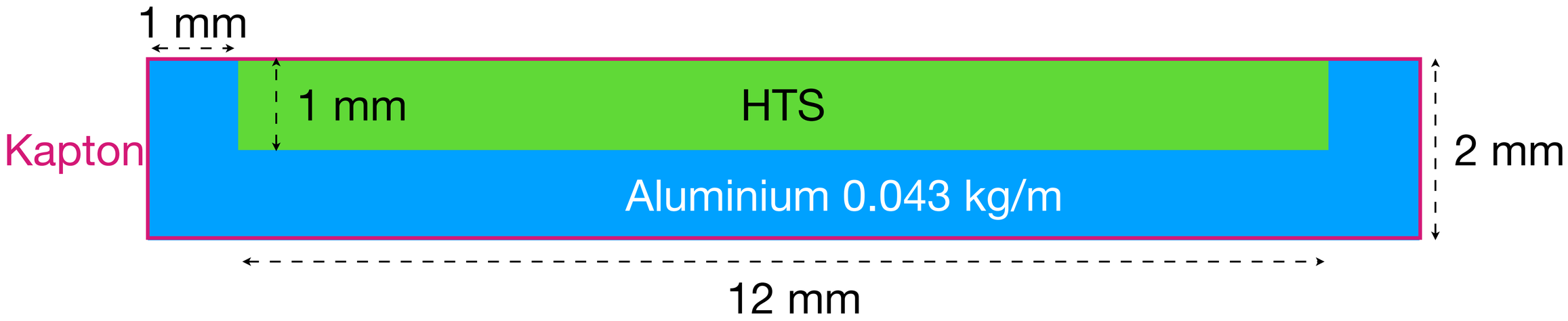
Hoop-Stress: 300 MPa

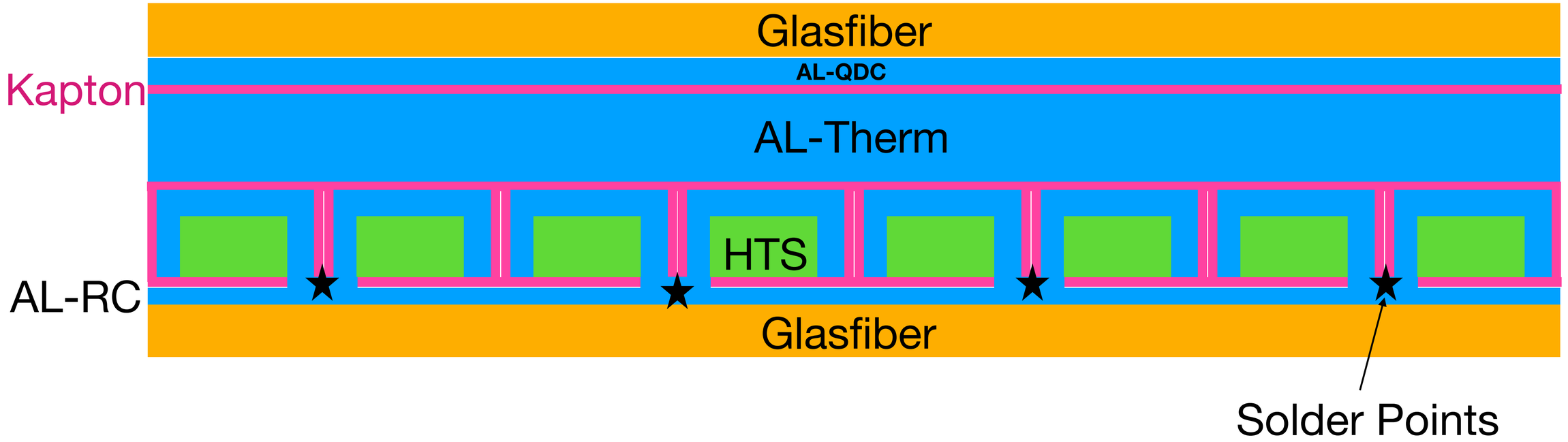


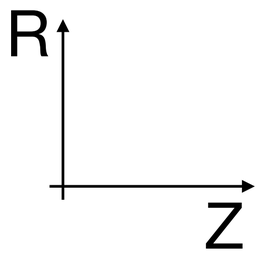
This will not work !

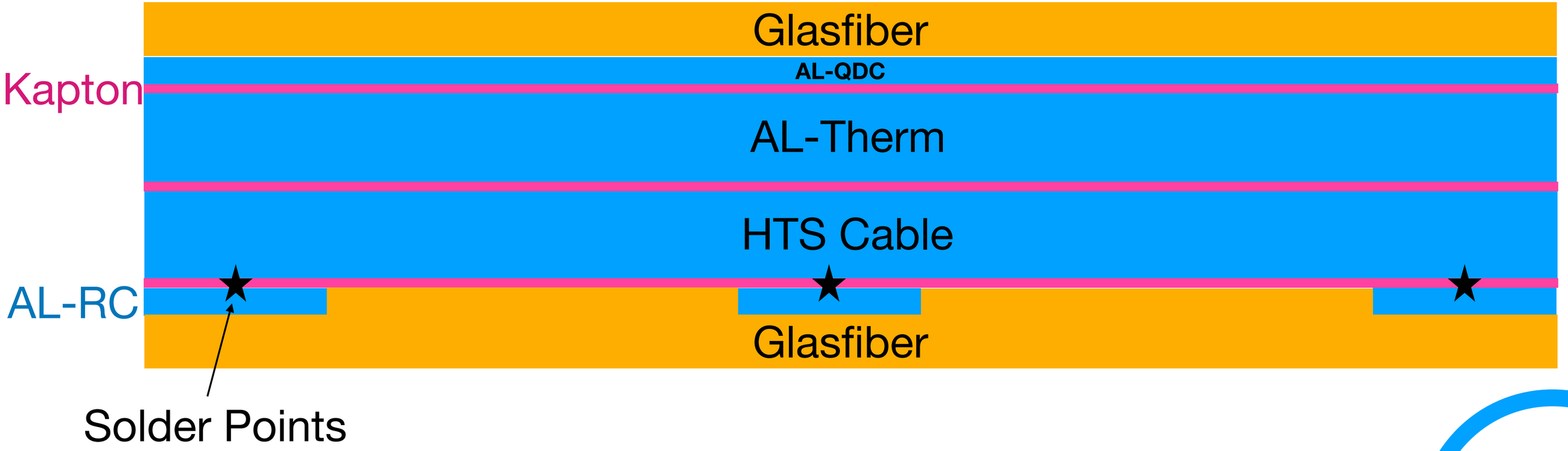
AMS-100 - 15. August 2020, Version 2.4

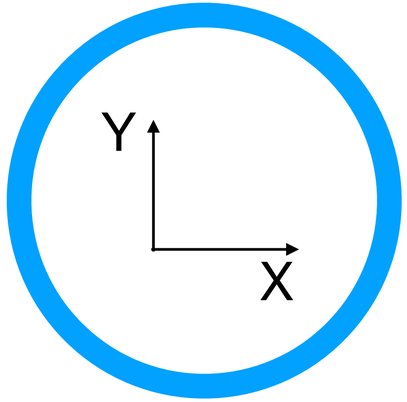
HTS Cable




Glasfiber
AL-QDC
Kapton
AL-Therm
HTS
AL-RC
Glasfiber
Solder Points


R
Z


Glasfiber
AL-QDC
Kapton
AL-Therm
HTS Cable
AL-RC
Glasfiber
Solder Points


Y
X