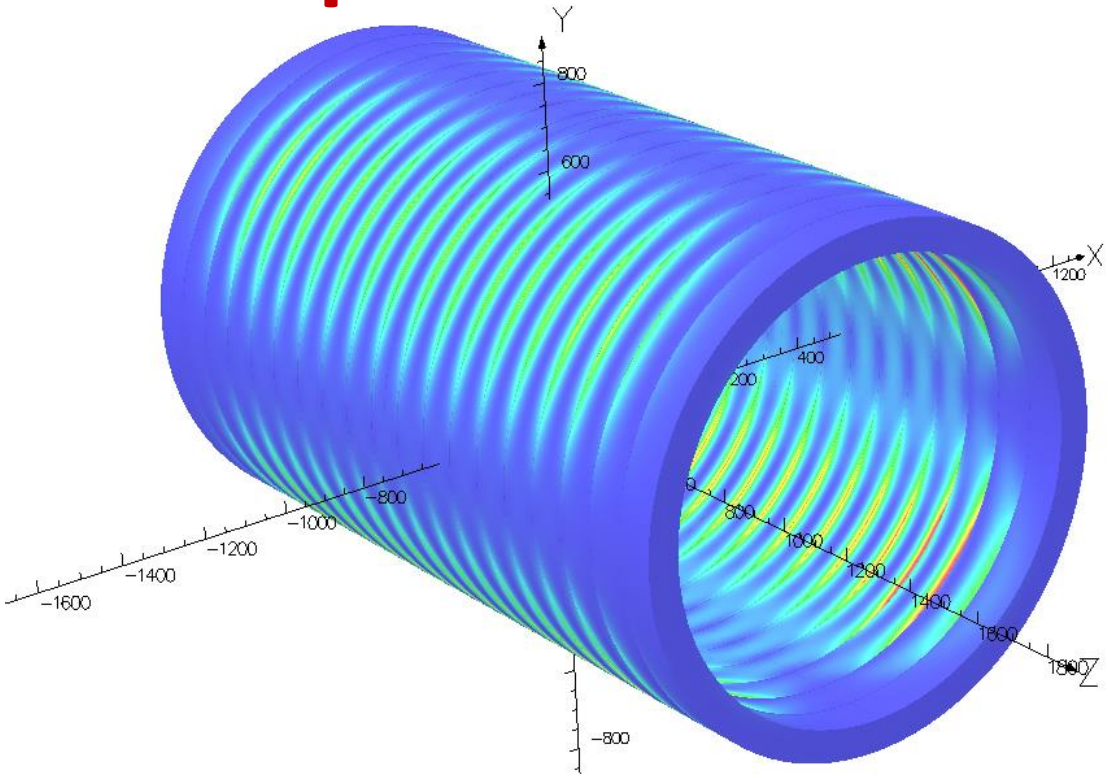
Model Opera ELEKTRA and Tempo



2014/12/23-SA

318711-QPOLE-Q2-Elektra-Tempo

Revision and Abstract

Description	Revision	Date
Creation		2014/12/23-SA

ABSTRACT

This report presents calculation made by Sigmaphi about eddy currents in force rings during the magnet loading.

OBJECTIVE

The objective of this calculation is to determine if the temperature rise during the magnet loading is acceptable or if it is necessary to increase the number of force rings.

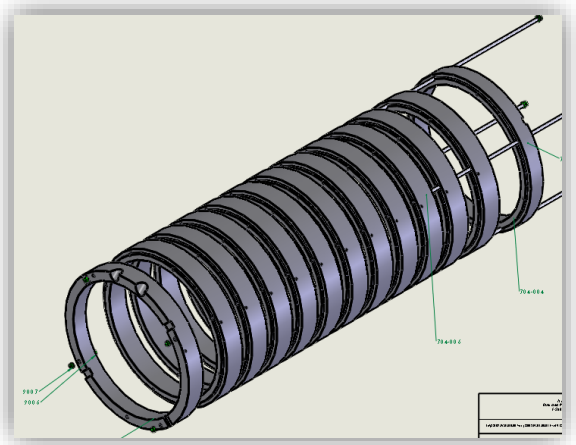
CONCLUSION

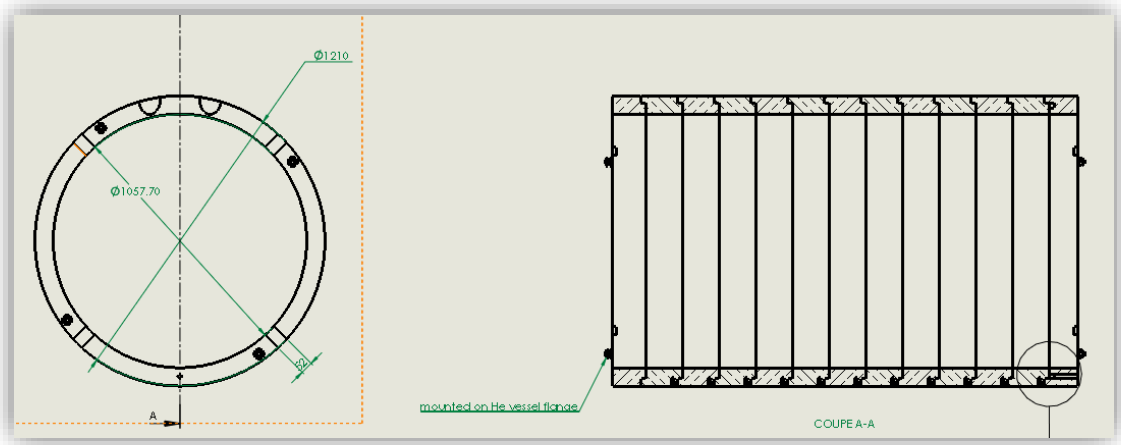
The temperature rise during the magnet loading is negligible. Consequently it is not necessary to increase the number of force rings.

318711-QPOLE-Q2-Elektra-Tempo

SOLID WORKS geometry of force rings

The geometry of collars is given on the drawing 317111-JLA-704-001-rev B
This assembly is composed of 13 collars instead of 19 in JLAB's reference design

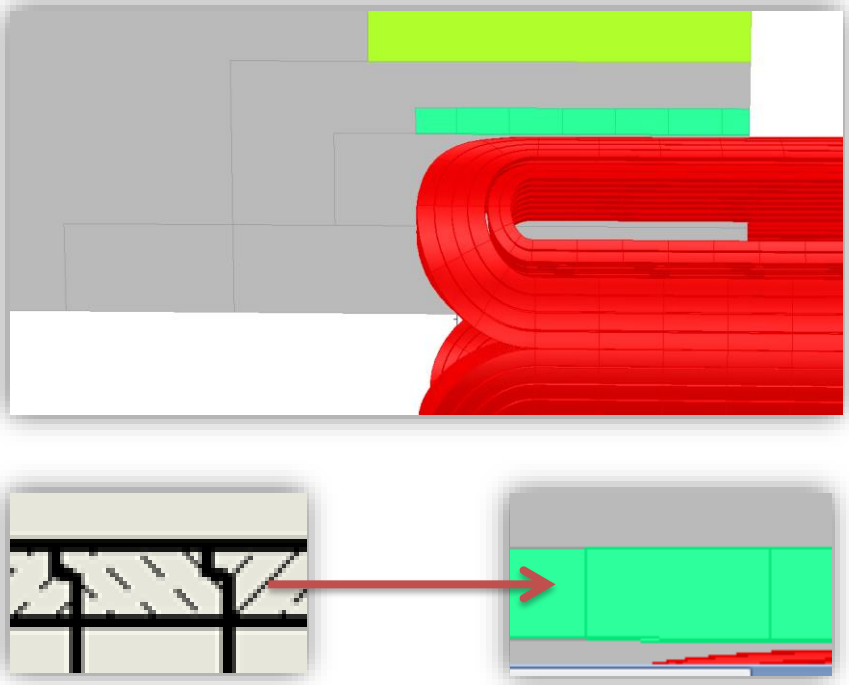


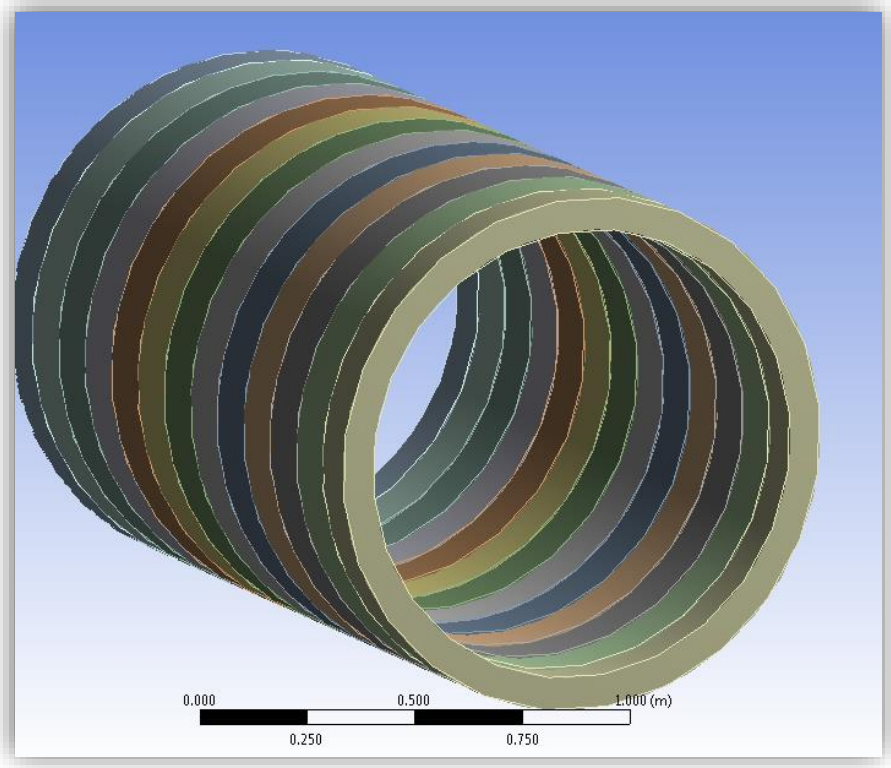


318711-QPOLE-Q2-Elektra-Tempo

OPERA & ANSYS geometry of force rings

The force rings geometry is simplified for OPERA calculations as shown on the following screenshots:



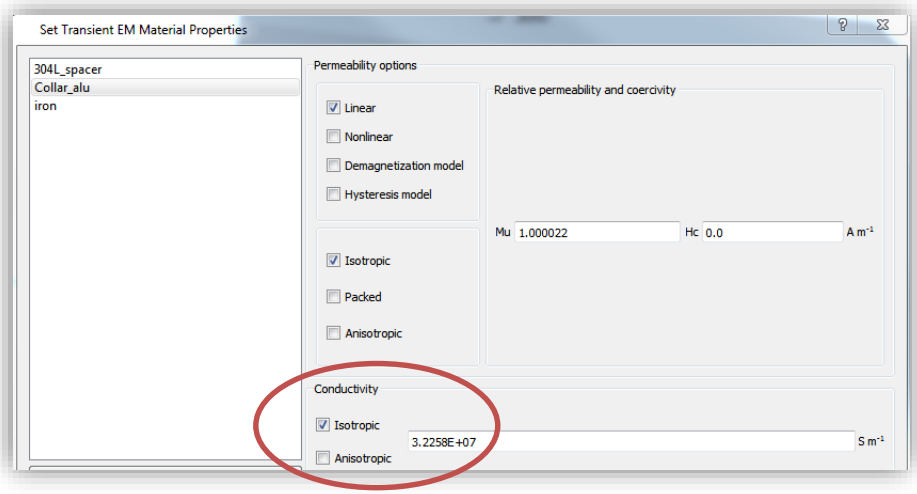


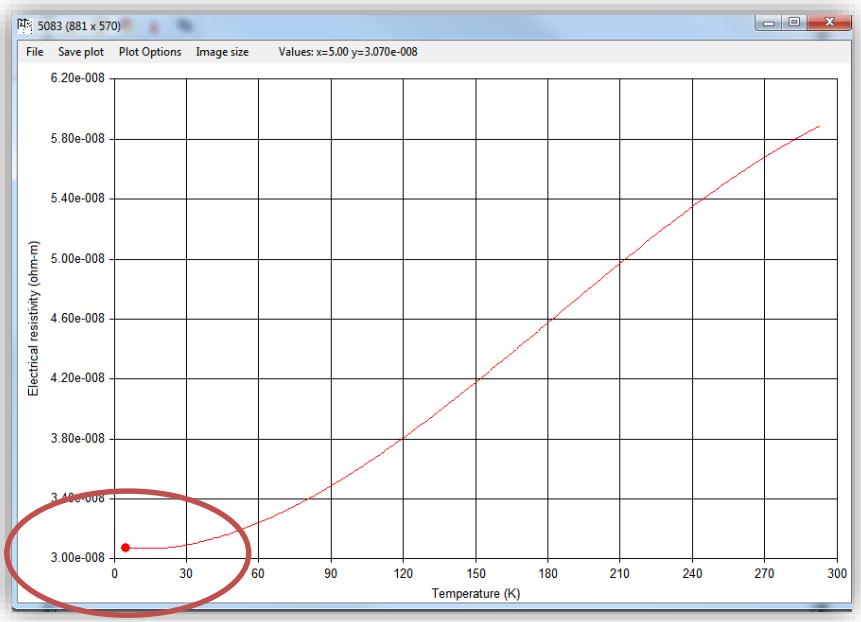
318711-QPOLE-Q2-Elektra-Tempo

Force rings material

The material of collars is Aluminum 5083 H116

We consider an electrical conductivity of $3.2258.10^7$ $S.m^{-1}$ according to *JAHM Material Properties Data Base*



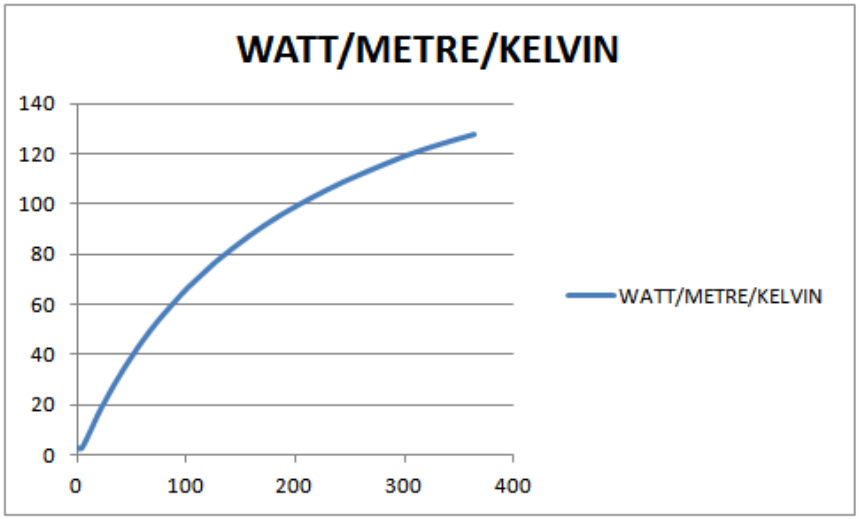


318711-QPOLE-Q2-Elektra-Tempo

Force rings material

The material of collars is Aluminum 5083 H116 according to *JAHM Material Properties Data Base*

	WATT/METRE/KELVIN
0	2.88
4	2.88
19	16.48
24	20.64
34	28.45
44	35.6
59	45.25
74	53.74
94	63.58
104	67.99
124	76.05
134	79.74
154	86.4
169	90.95
194	97.77
239	108.07
294	118.31
329	123.61
364	128.01



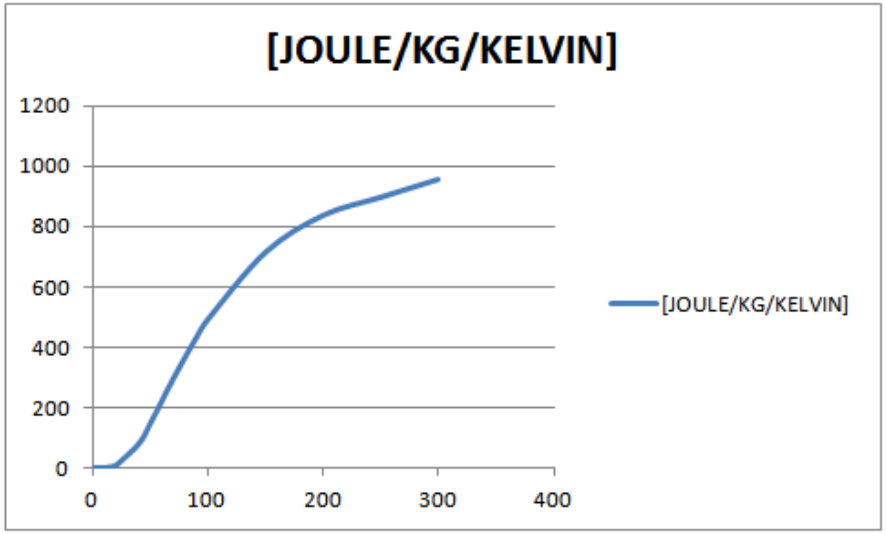
Thermal conductivity

318711-QPOLE-Q2-Elektra-Tempo

Force rings material

The material of collars is Aluminum 5083 H116 according to *JAHM Material Properties Data Base*

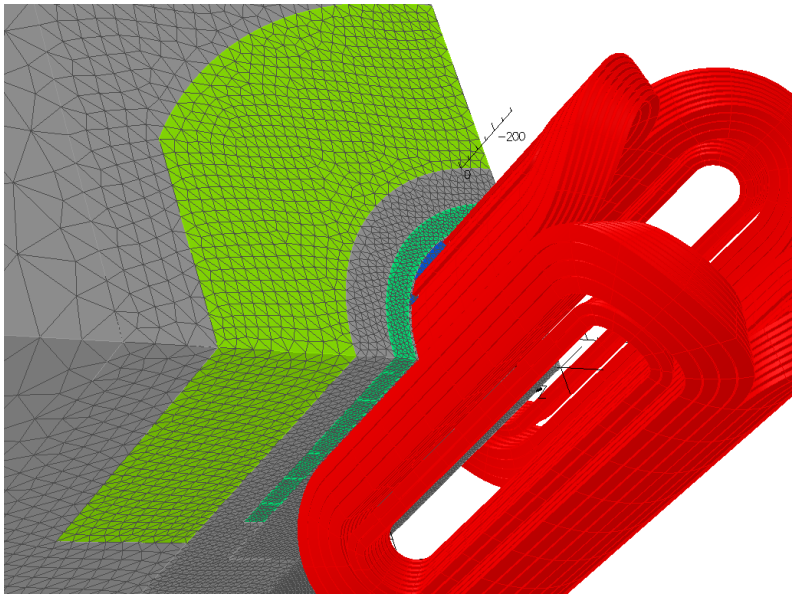
	[JOULE/KG/KELVIN]
0	0.28
4	0.28
8	1.0384
10	1.5762
12	2.2739
14	3.2291
16	4.5862
18	6.4108
19	7.539
20	8.8355
40	8.20E+01
50	1.49E+02
70	2.98E+02
90	4.34E+02
100	4.93E+02
150	7.14E+02
200	8.36E+02
250	8.96E+02
300	9.55E+02



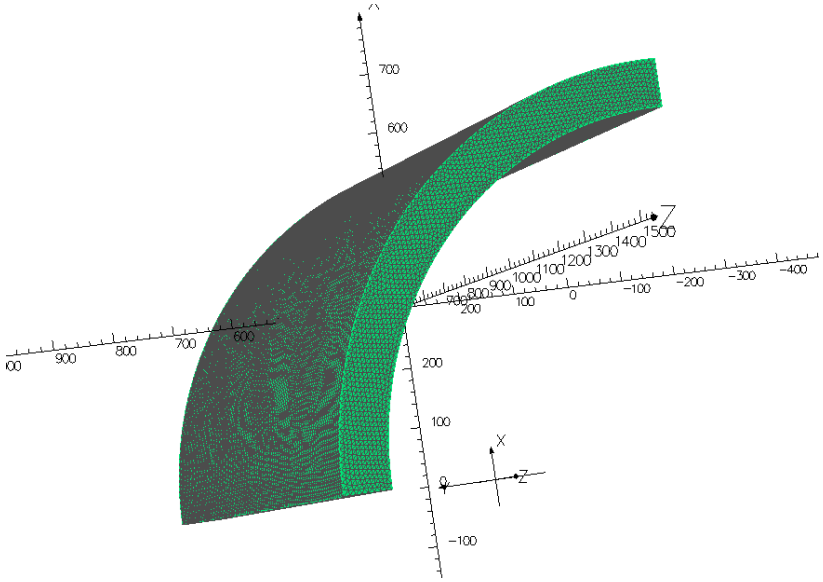
Specific heat

318711-QPOLE-Q2-Elektra-Tempo

View of the mesh (Elektra and tempo)



Elektra model



Tempo model

318711-QPOLE-Q2-Elektra-Tempo

Magnet loading (Elektra parameters)

Three charging cases are studied for each version (13 and 19 collars) :

- 20 seconds (protected quench)
- 35 seconds (unprotected quench)
- 1800 seconds (normal charging)

According to JLAB's technical specification the duration of the magnet loading is 60 minutes : *"The charging time of the magnet to maximum operating current shall not exceed one hour"*.
For design contingency we consider a charging time of 30 minutes.

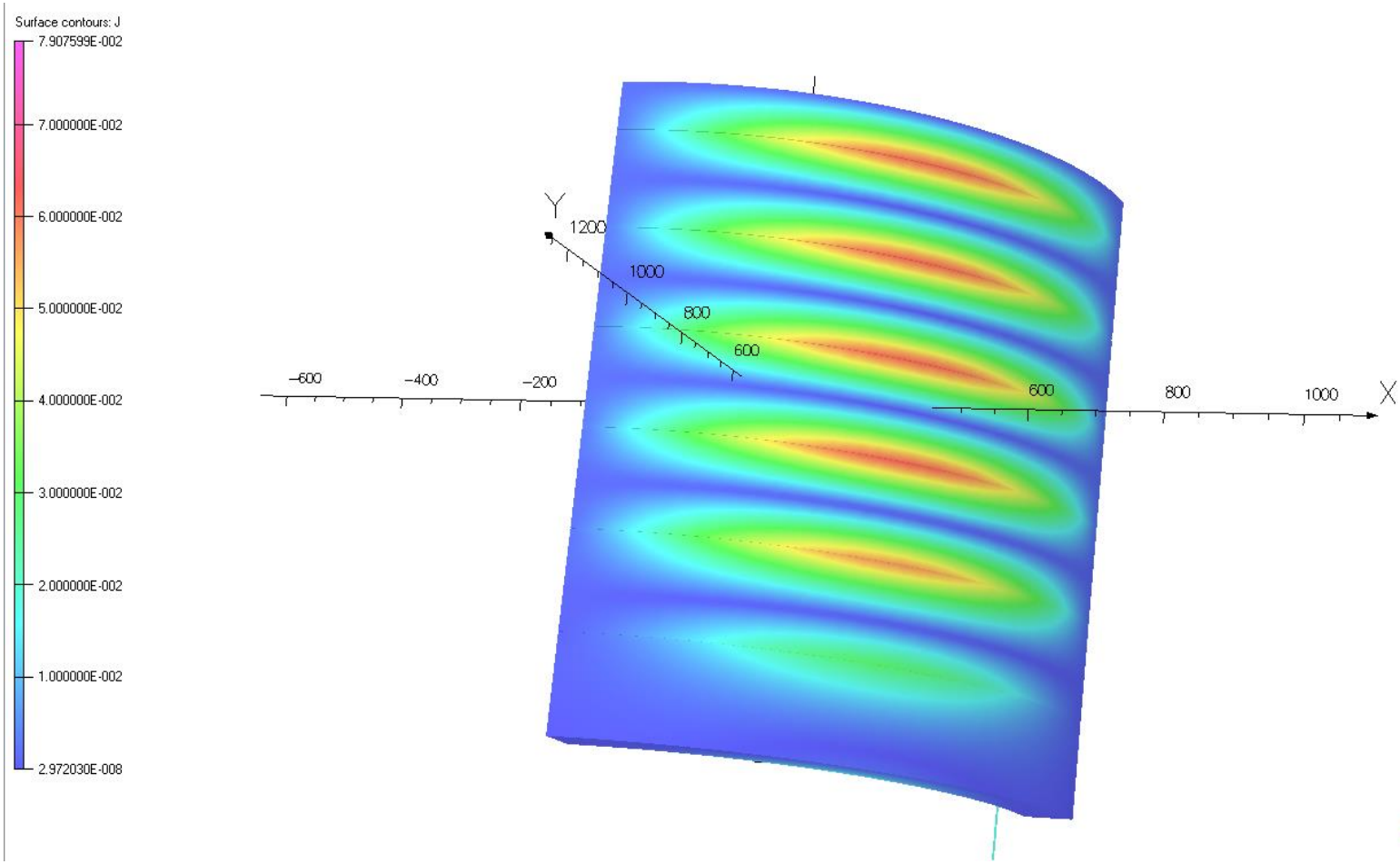
318711-QPOLE-Q2-Elektra-Tempo

summary

	J Min (A/mm²)	J Max (A/mm²)	Loss Min (W/mm 3)	Loss Max (W/mm 3)	T min (Kelvin)	T max (Kelvin)
13 Collars-20s	2.97 E-08	7.90 E-02	2.74 E-20	1.93 E-07	4.19	4.63
13 Collars-35s	1.89 E-05	2.78 E-01	1.11 E-14	2.40 E-06	6.18	8.79
13 Collars-1800s	1.45 E-07	5.46 E-03	6.39 E-19	5.26 E-10	4.195	4.198
19 Collars-20s	5.67 E-06	5.57 E-02	9.98 E-16	9.64 E-08	4.11	4.34
19 Collars-35s	1.032 E-05	1.98 E-01	3.30 E-15	1.22 E-06	5.79	7.42
19 Collars-1800s	6.64 E-08	3.89 E-03	1.34 E-19	4.70 E-10	4.099	4.101

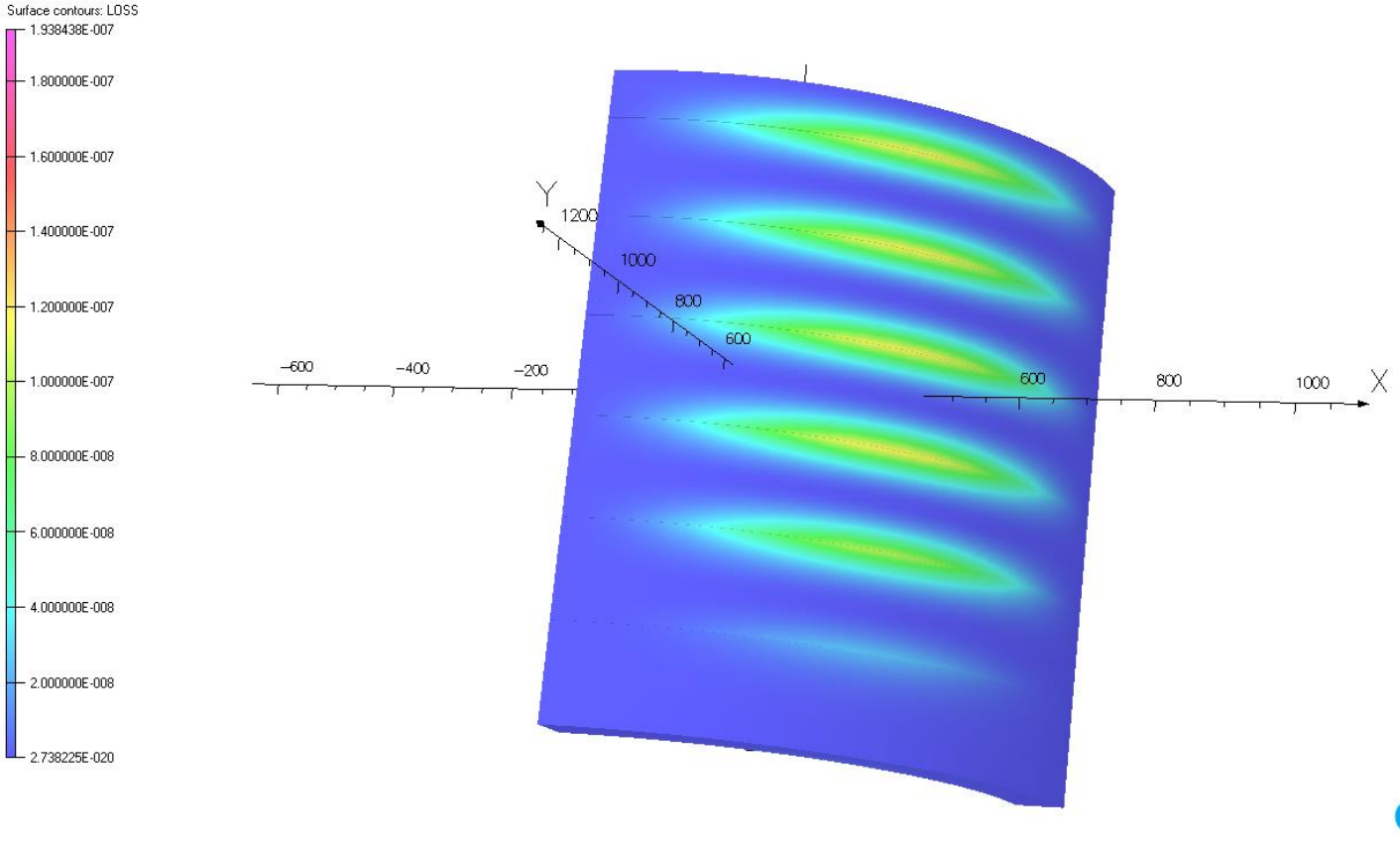
318711-QPOLE-Q2-Elektra-Tempo

Eddy current (A/mm2) –View 13 collars @20s-



318711-QPOLE-Q2-Elektra-Tempo

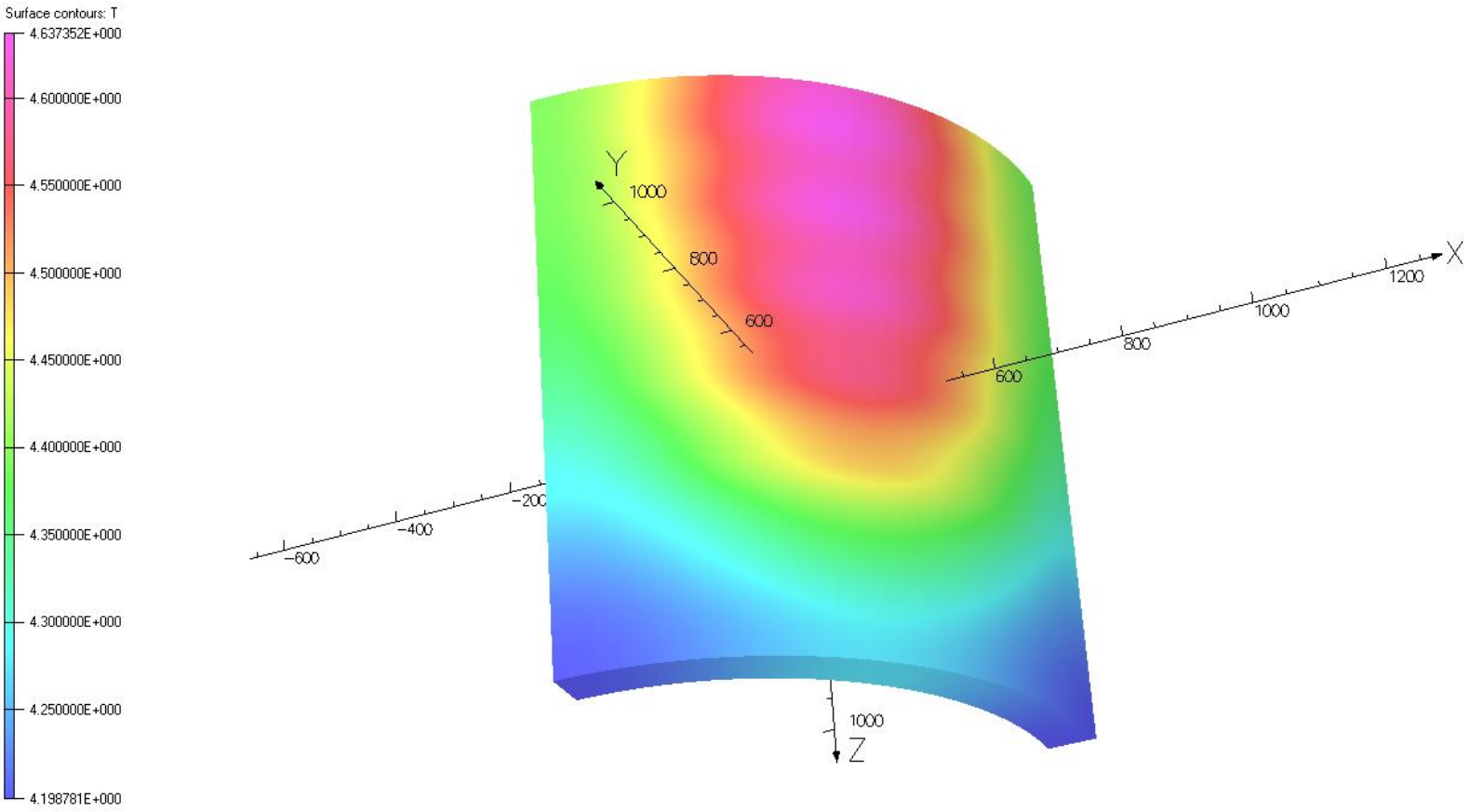
Loss – (W/mm3) View 13 collars @20s-



opera simulation software

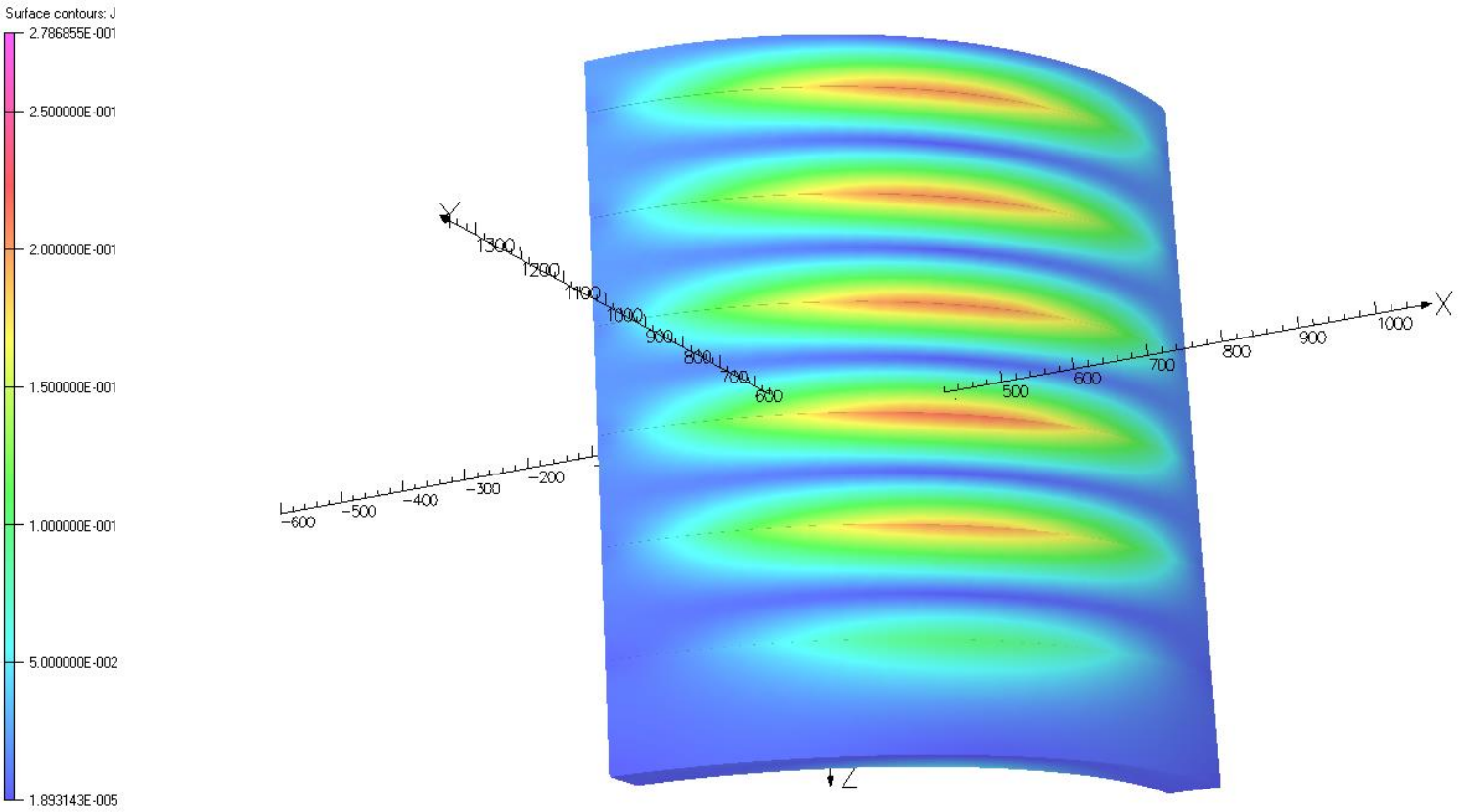
318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 13 collars @20s-



318711-QPOLE-Q2-Elektra-Tempo

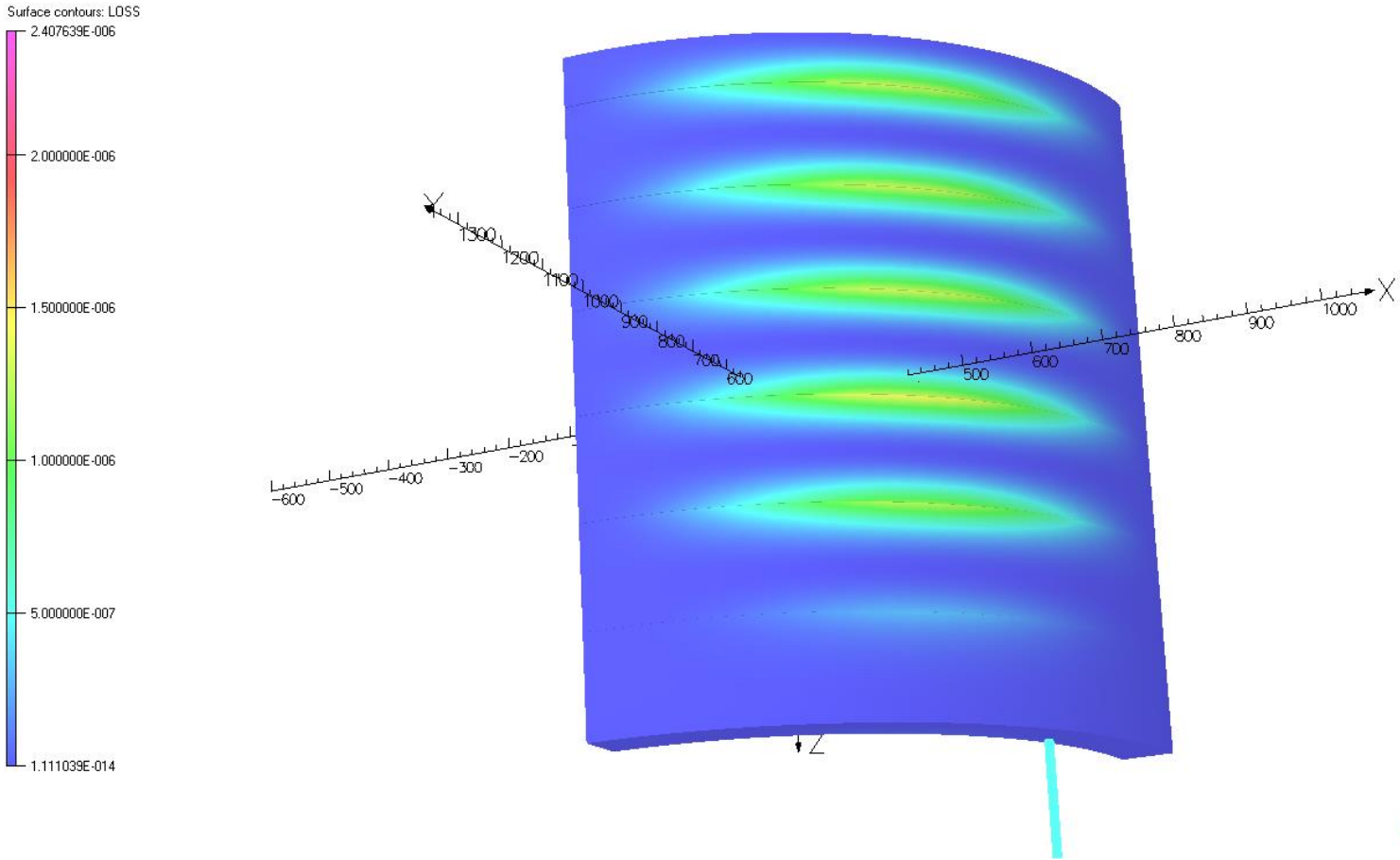
Eddy current (A/mm2) –View 13 collars @35s-



opera simulation software

318711-QPOLE-Q2-Elektra-Tempo

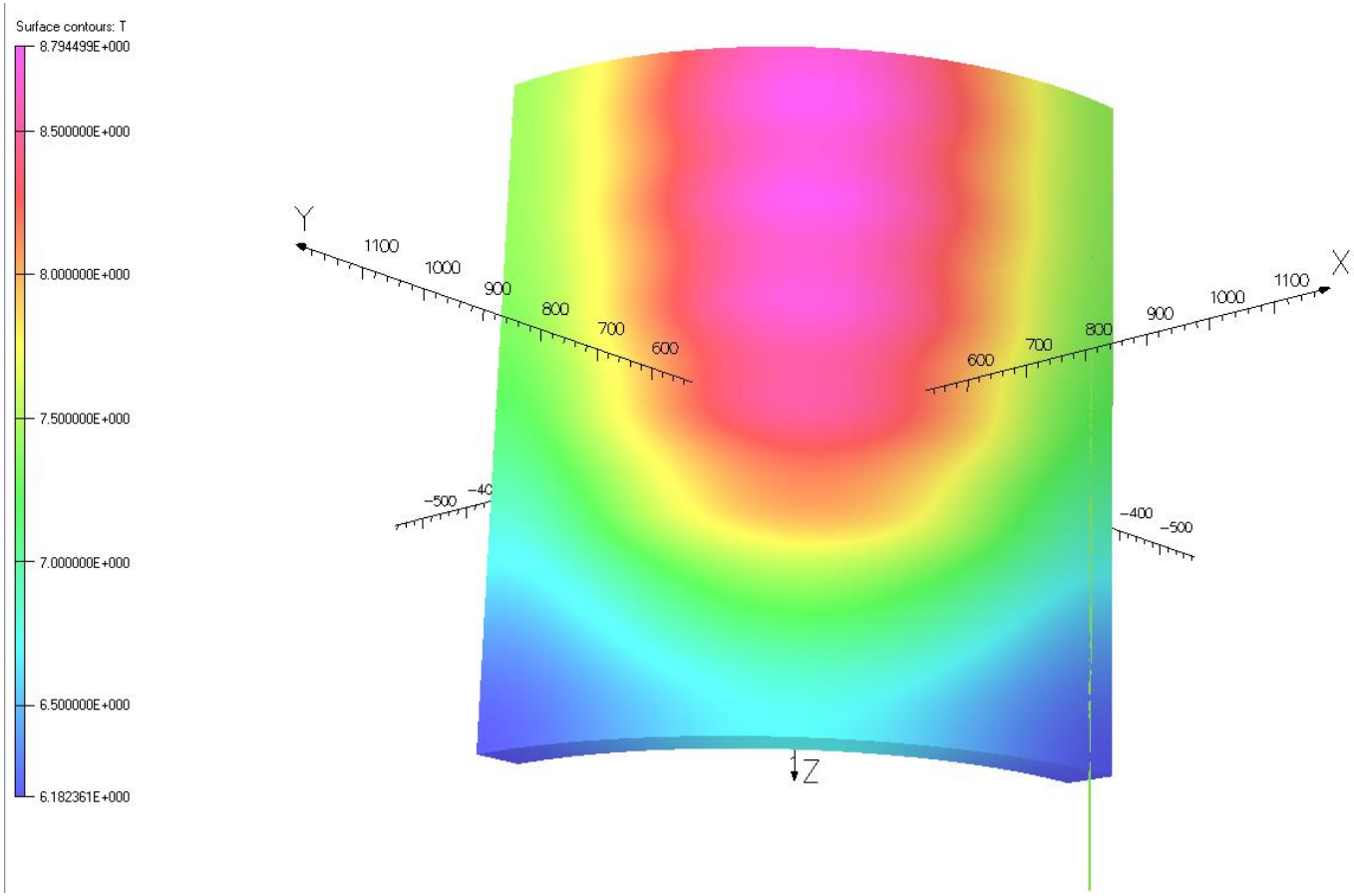
Loss – (W/mm3) View 13 collars @35s-



opera simulation software

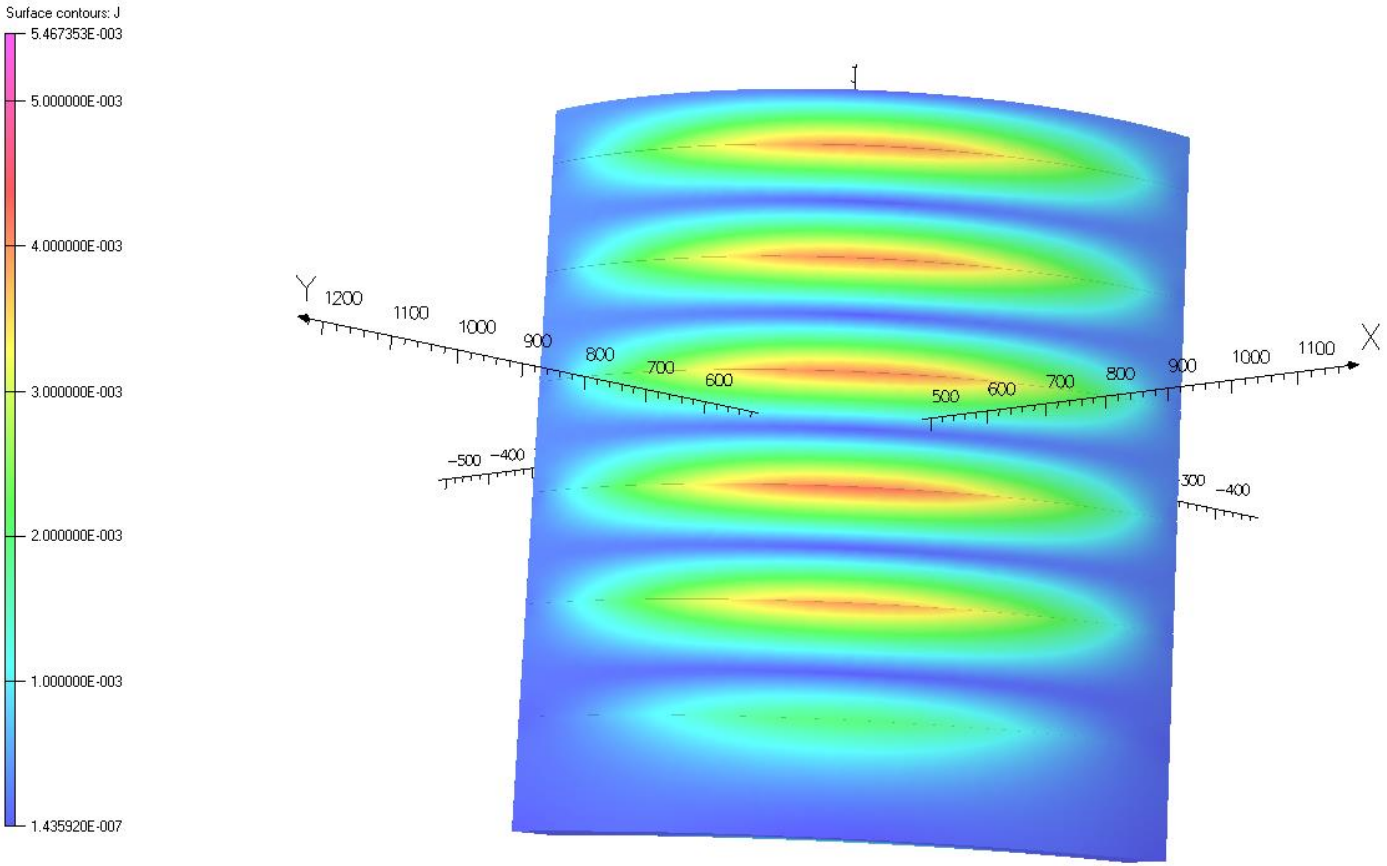
318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 13 collars@35s-



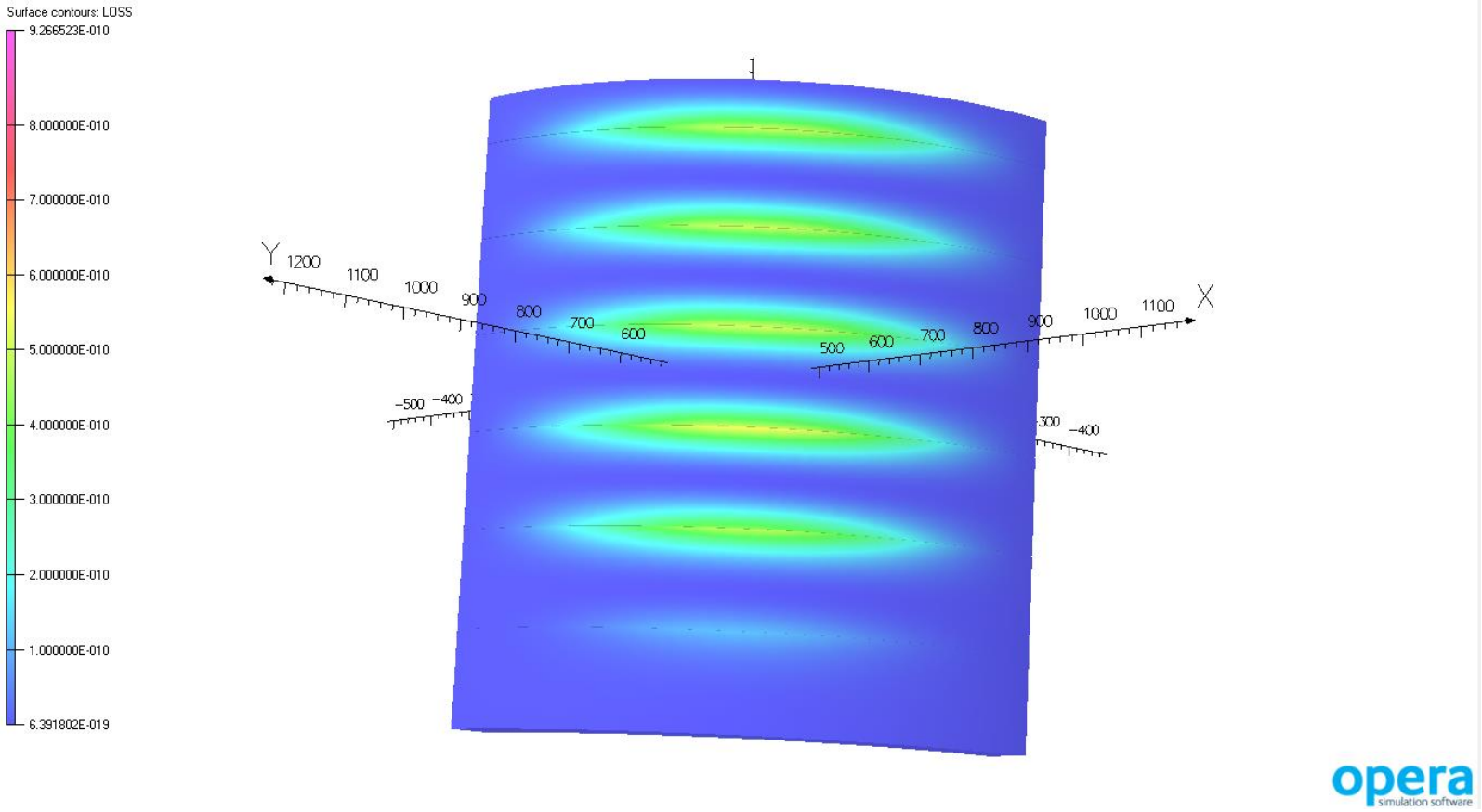
318711-QPOLE-Q2-Elektra-Tempo

Eddy current (A/mm2) –View 13 collars @1800s-



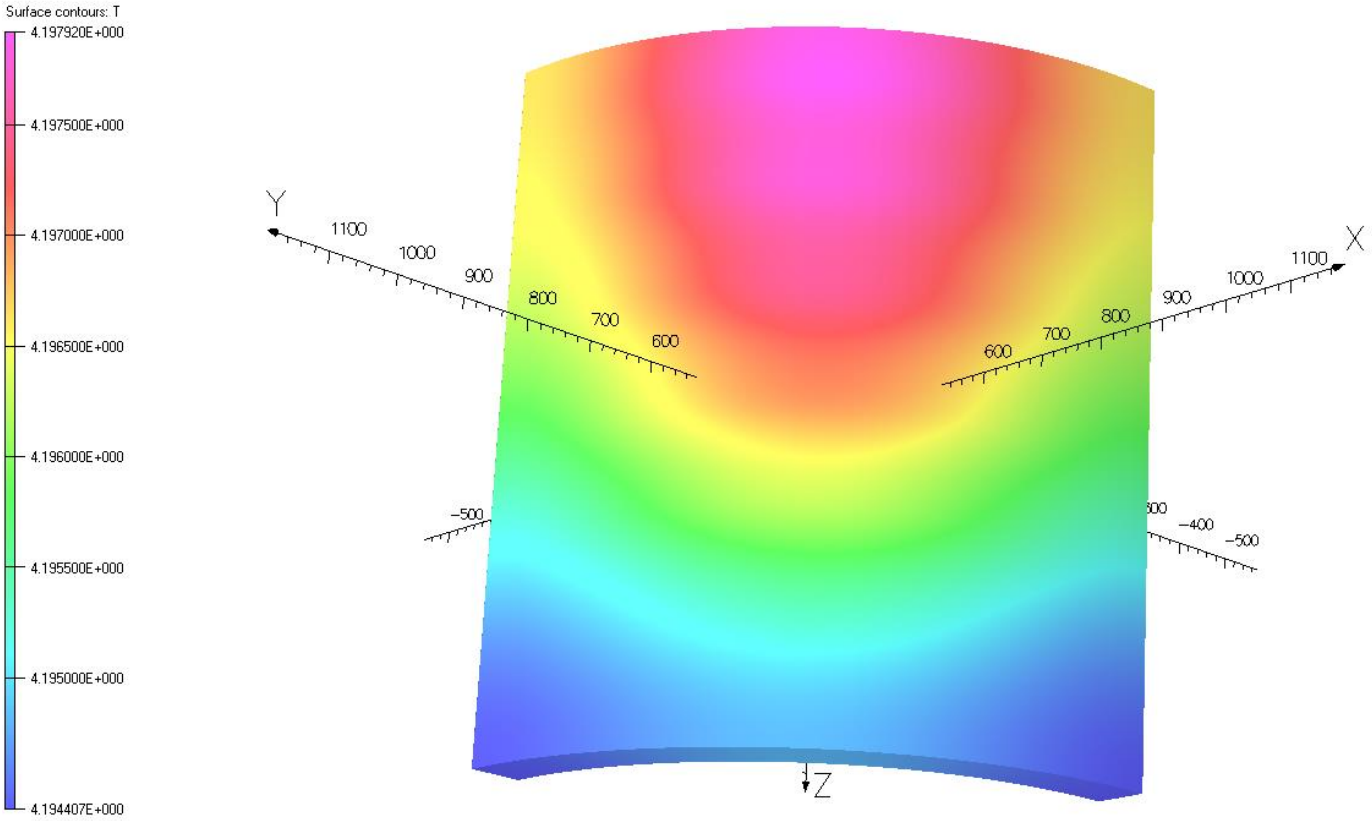
318711-QPOLE-Q2-Elektra-Tempo

Loss – (W/mm3) View 13 collars@1800s-



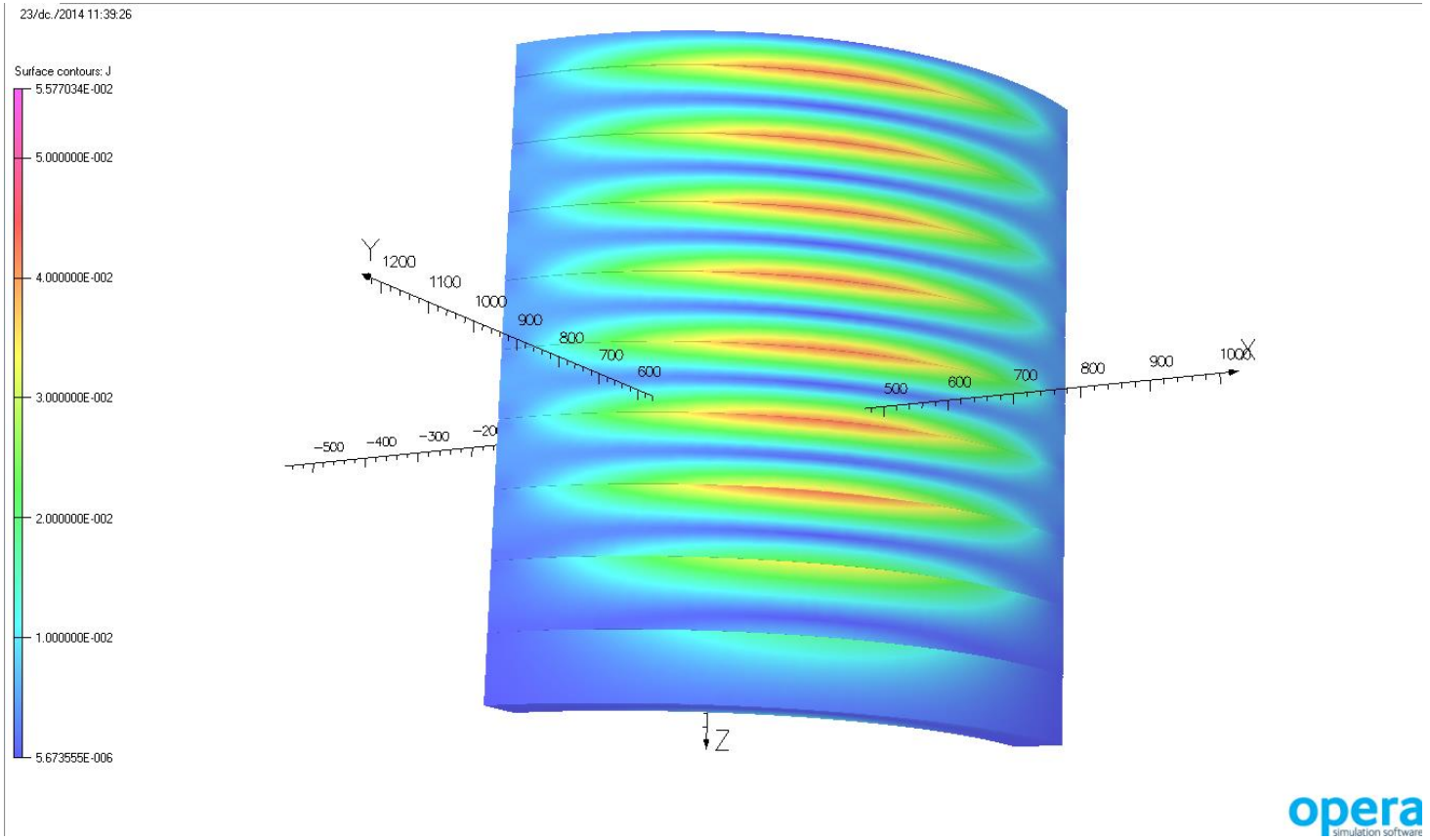
318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 13 collars @1800s-



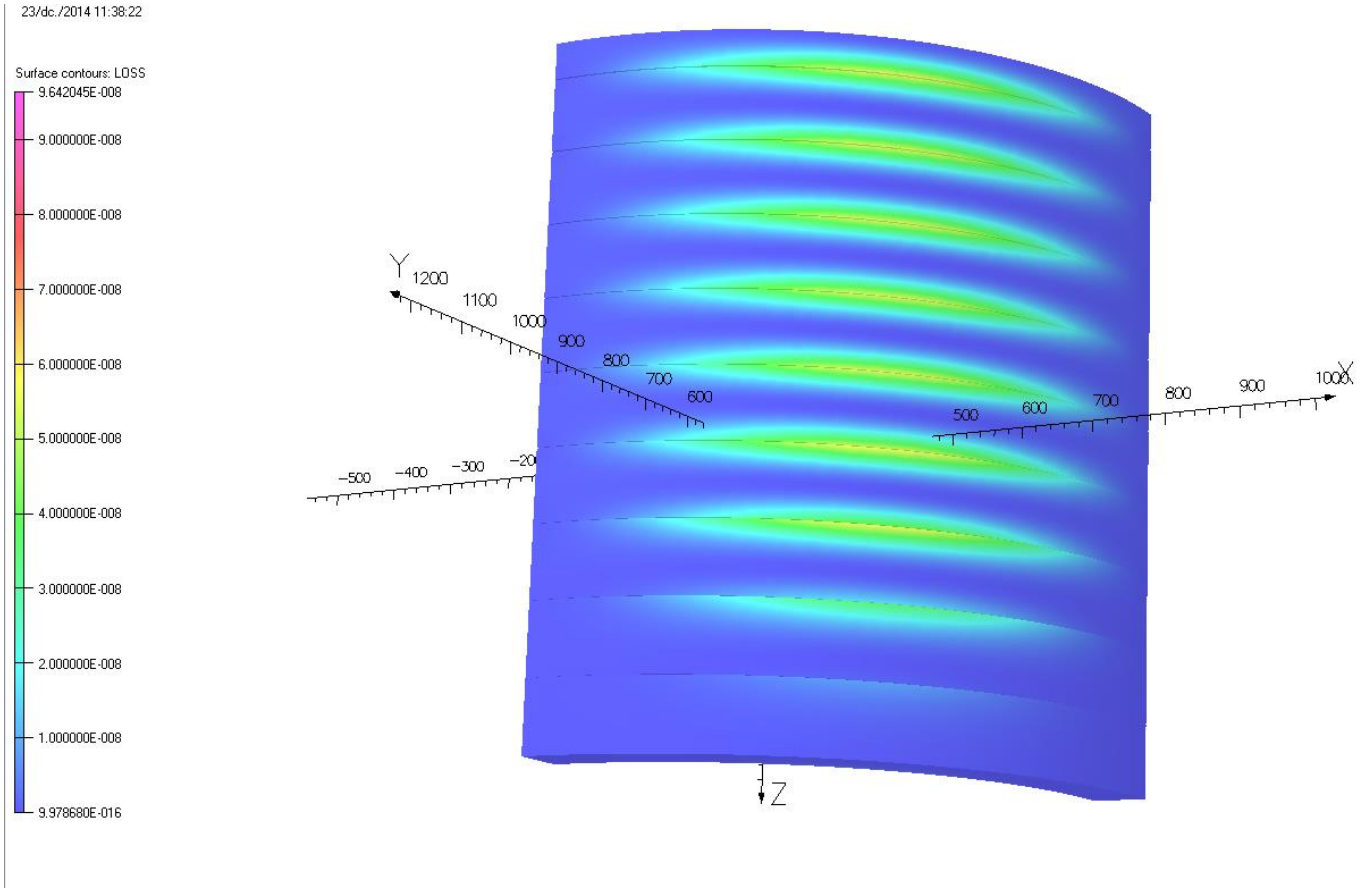
318711-QPOLE-Q2-Elektra-Tempo

Eddy current (A/mm2) –View 19 collars @20s-



318711-QPOLE-Q2-Elektra-Tempo

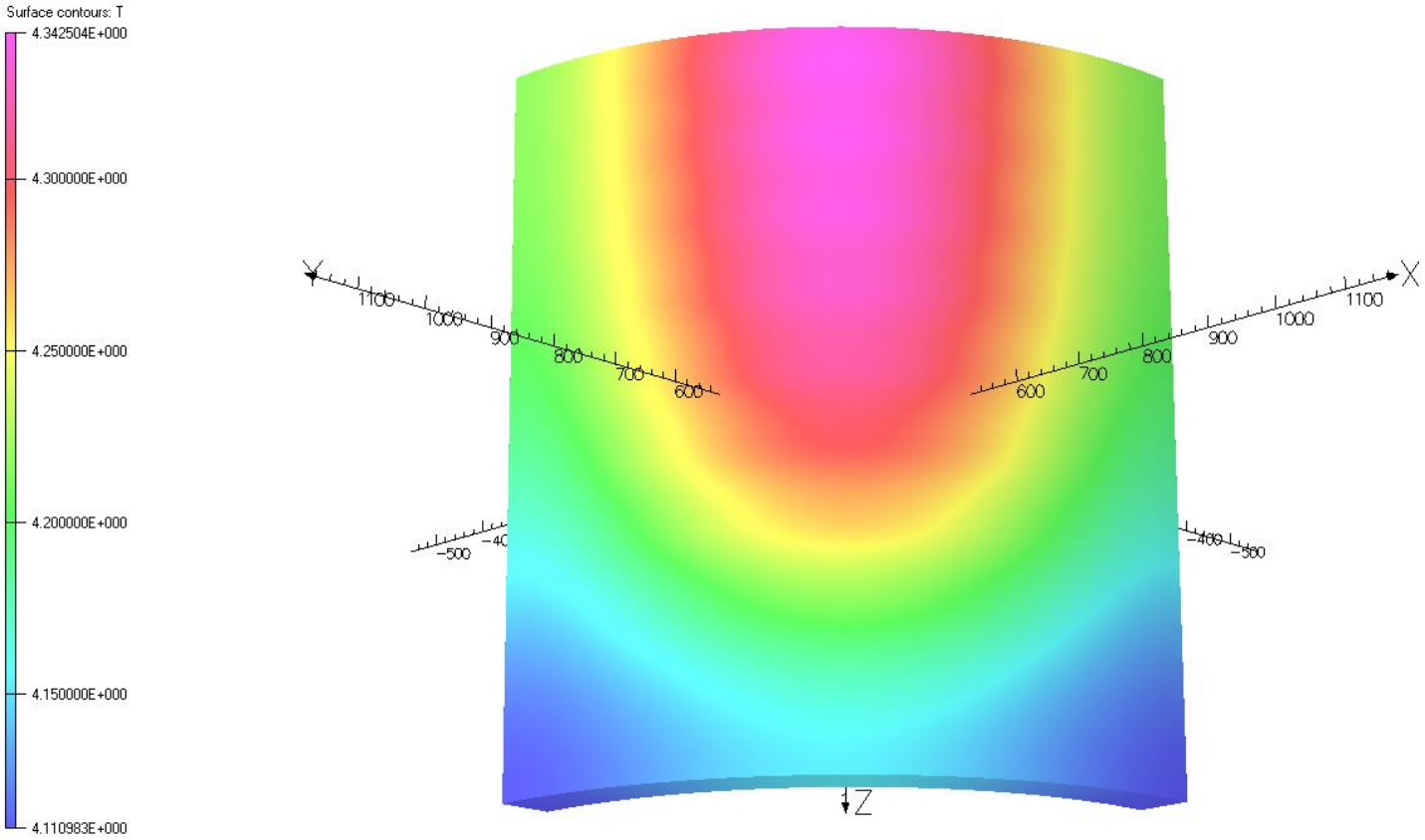
Loss – (W/mm3) View 19 collars @20s-



opera

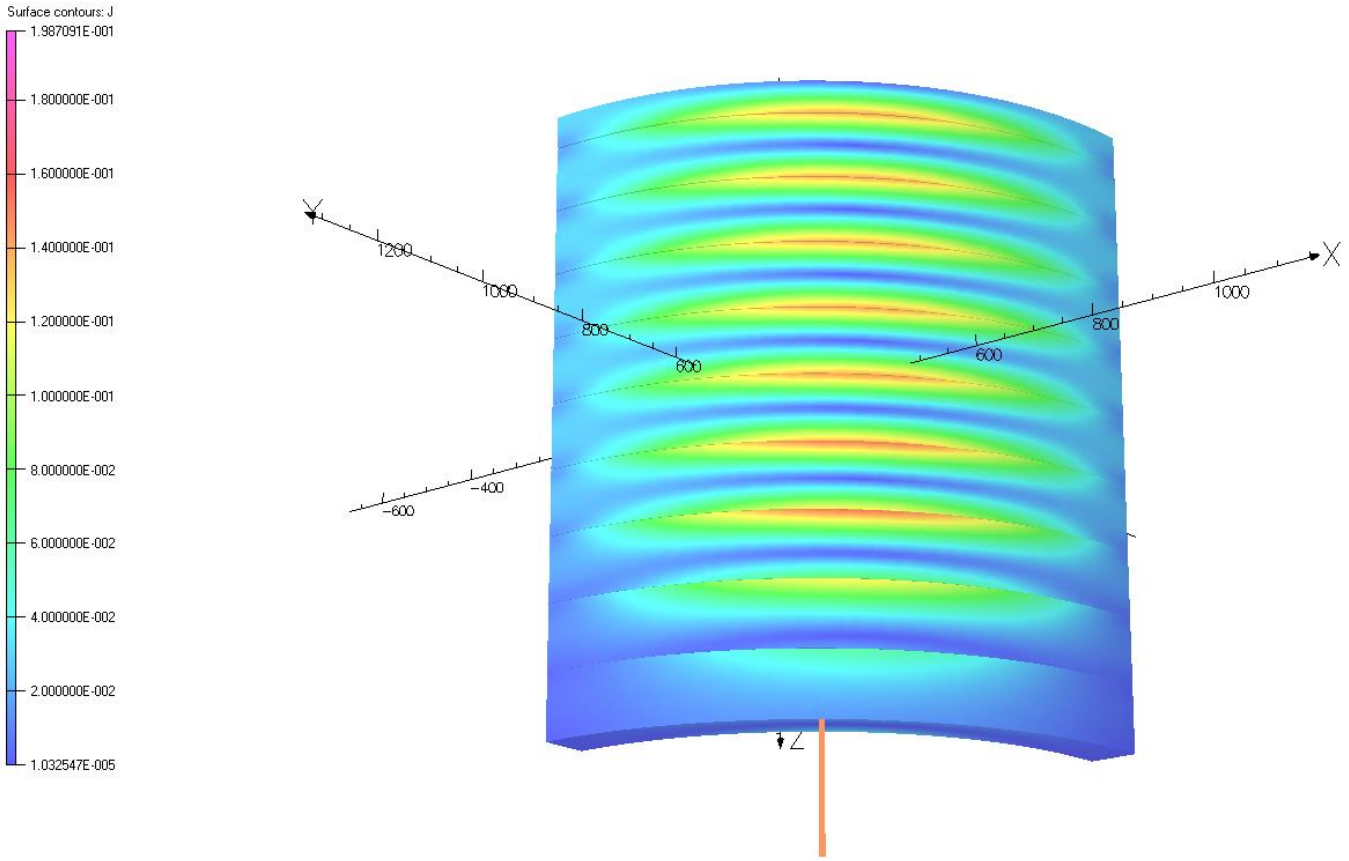
318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 19 collars @20s-



318711-QPOLE-Q2-Elektra-Tempo

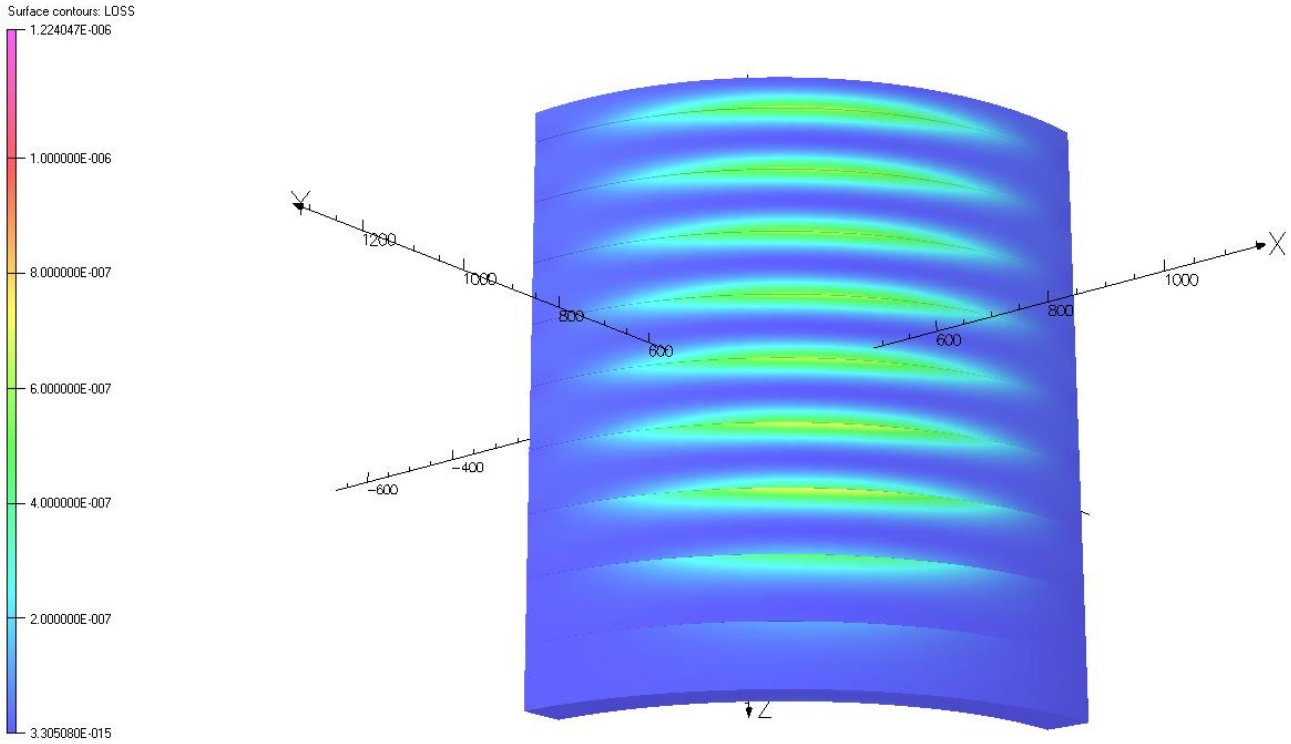
Eddy current (A/mm2) –View 19 collars @35s-



opera simulation software

318711-QPOLE-Q2-Elektra-Tempo

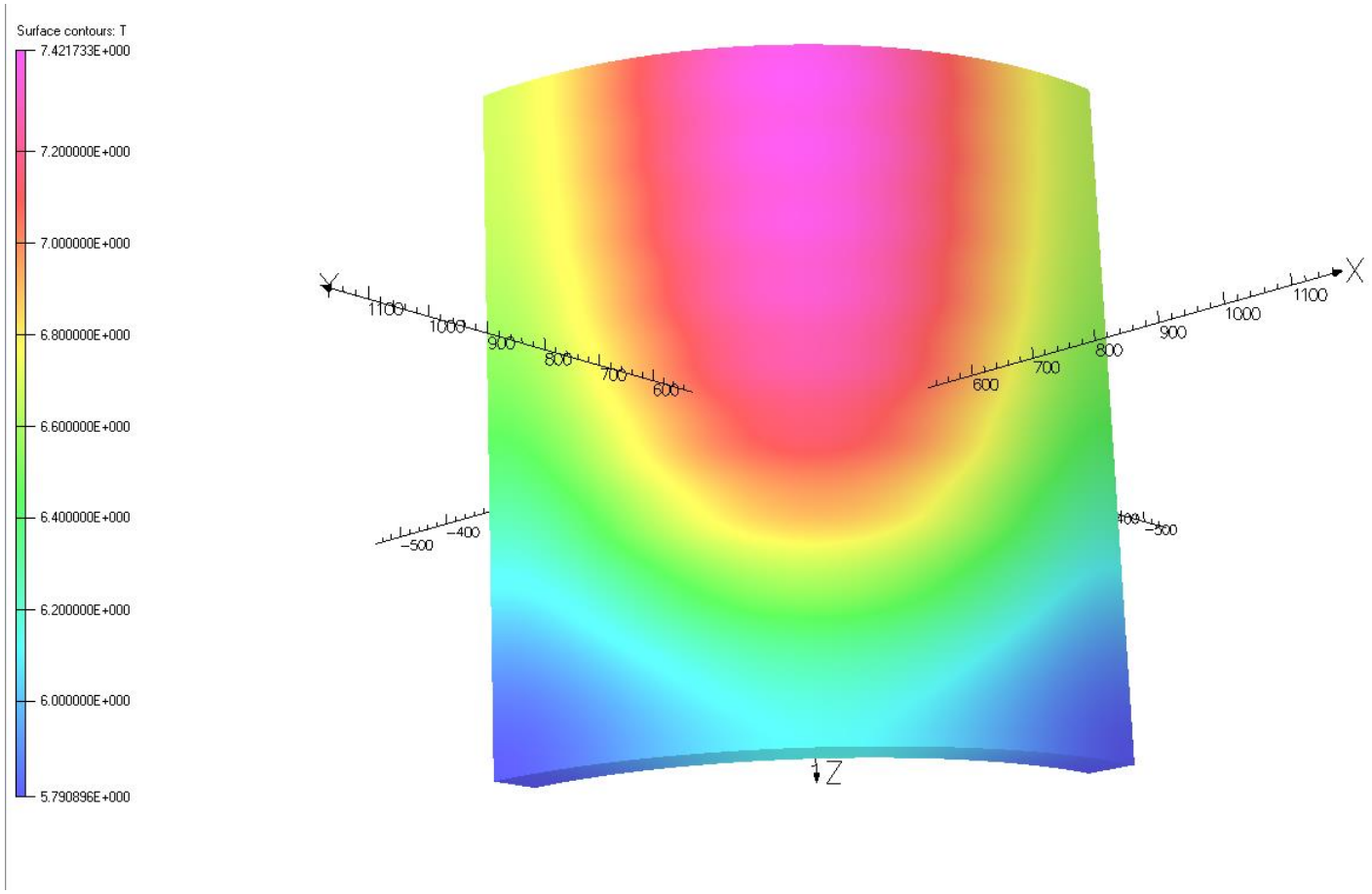
Loss – (W/mm3) View 19 collars @35s-



opera simulation software

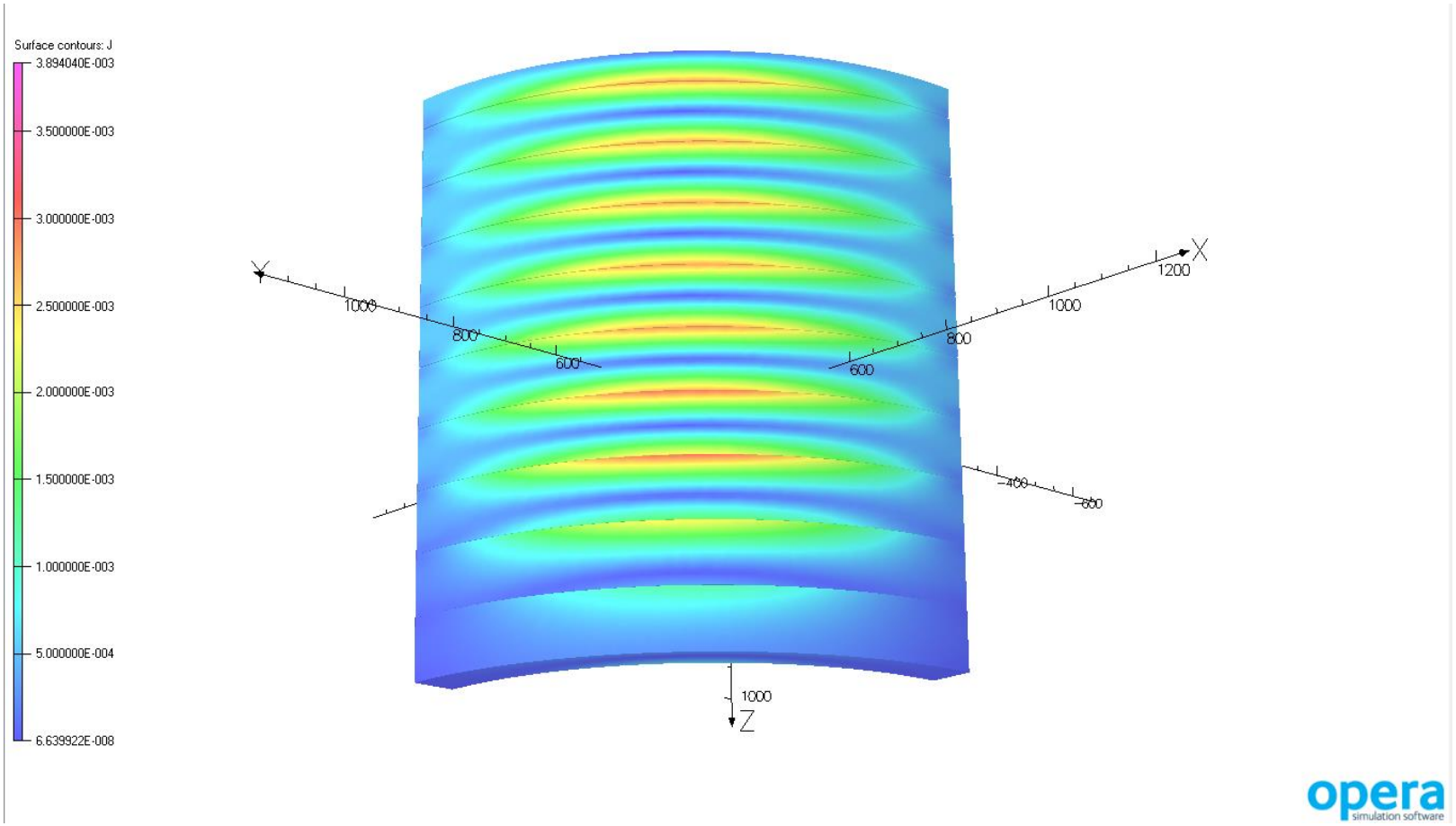
318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 19 collars @35s-



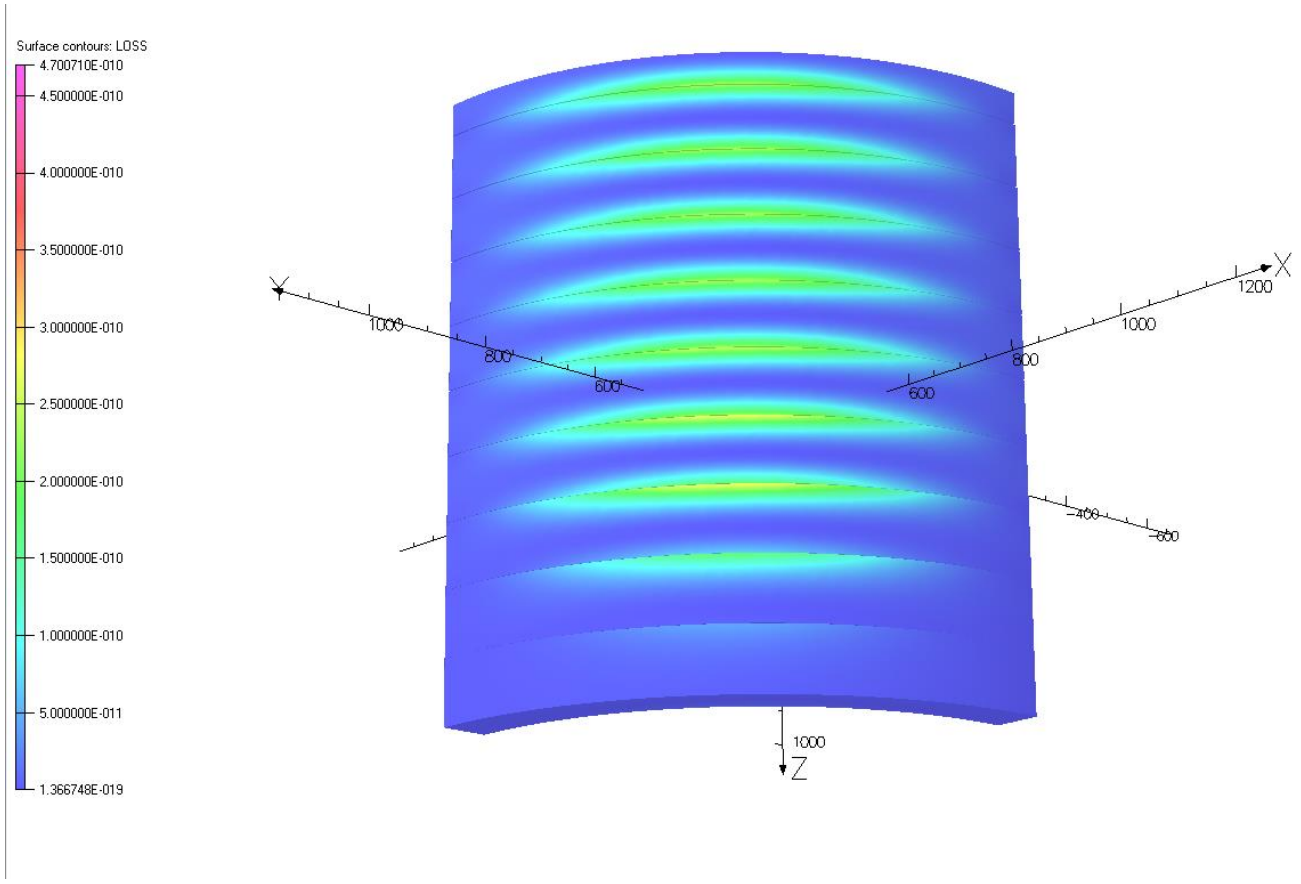
318711-QPOLE-Q2-Elektra-Tempo

Eddy current (A/mm2) –View 19 collars @1800s-



318711-QPOLE-Q2-Elektra-Tempo

Loss – (W/mm3) View 19 collars @1800s-



opera simulation software

318711-QPOLE-Q2-Elektra-Tempo

Temperature (K)–View 19 collars @1800s-