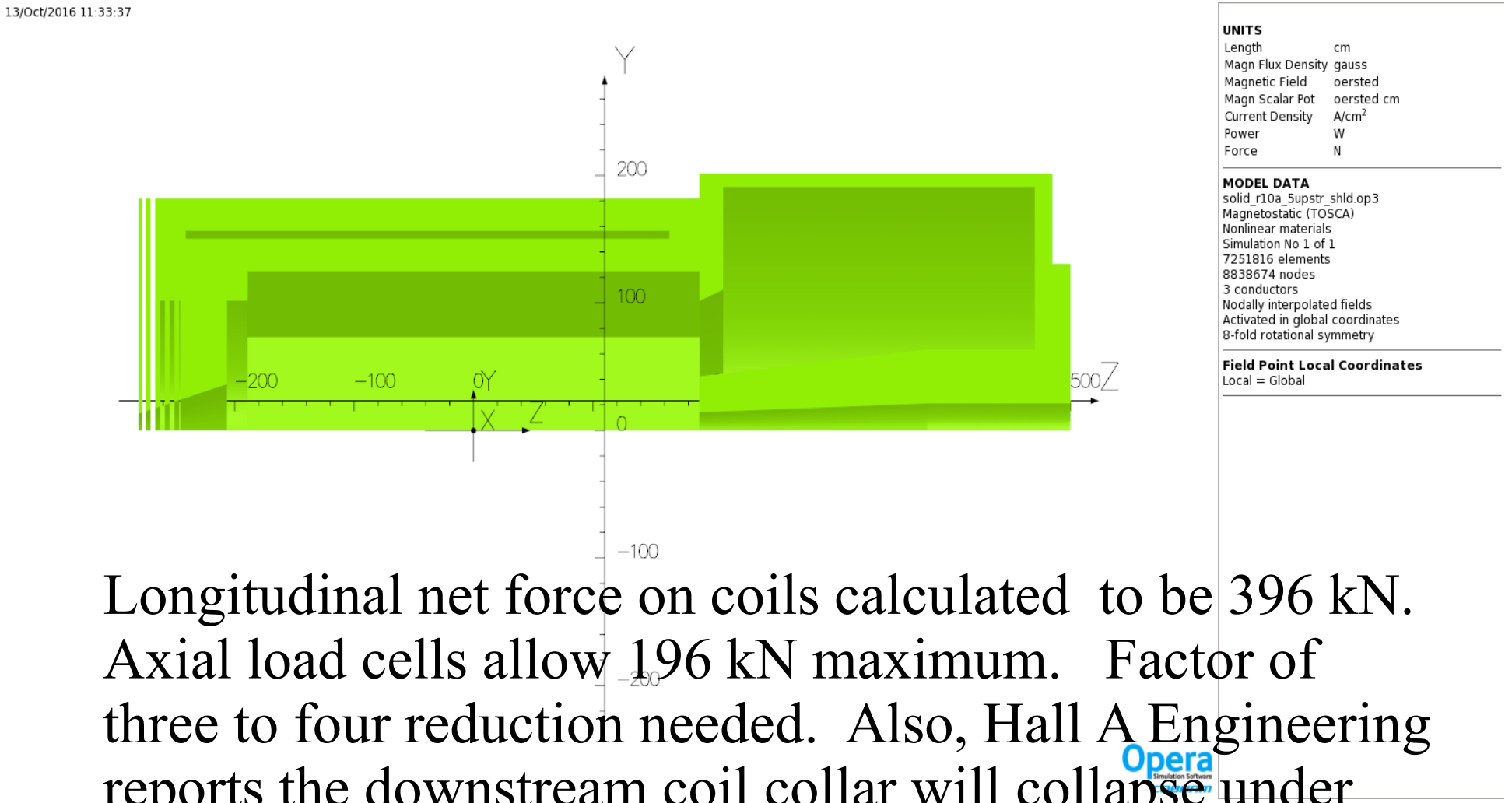
Force calculations on Opera models of SolID magnet system

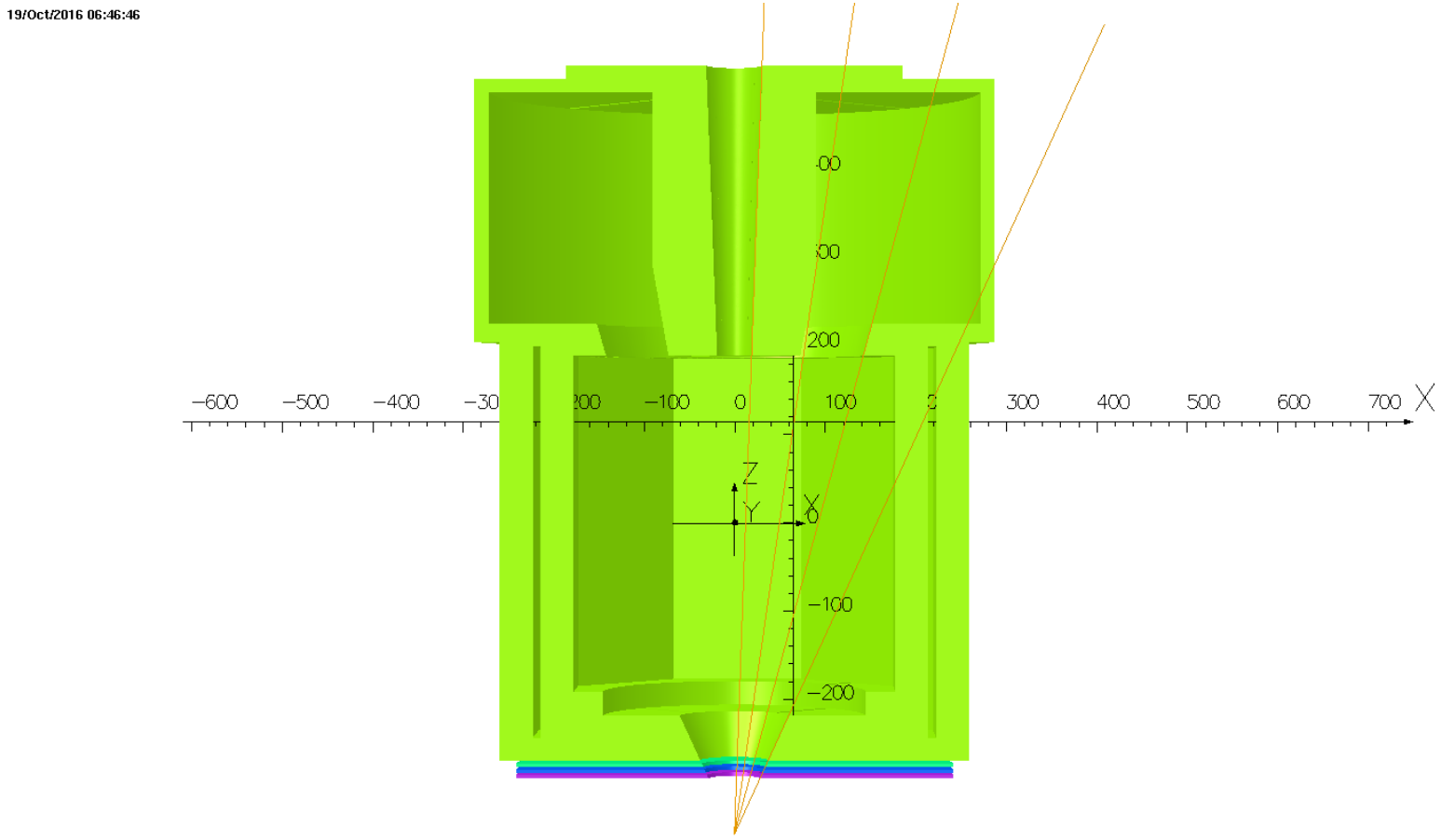
Jay Benesch
31 October 2016

PCDR model, rerendered

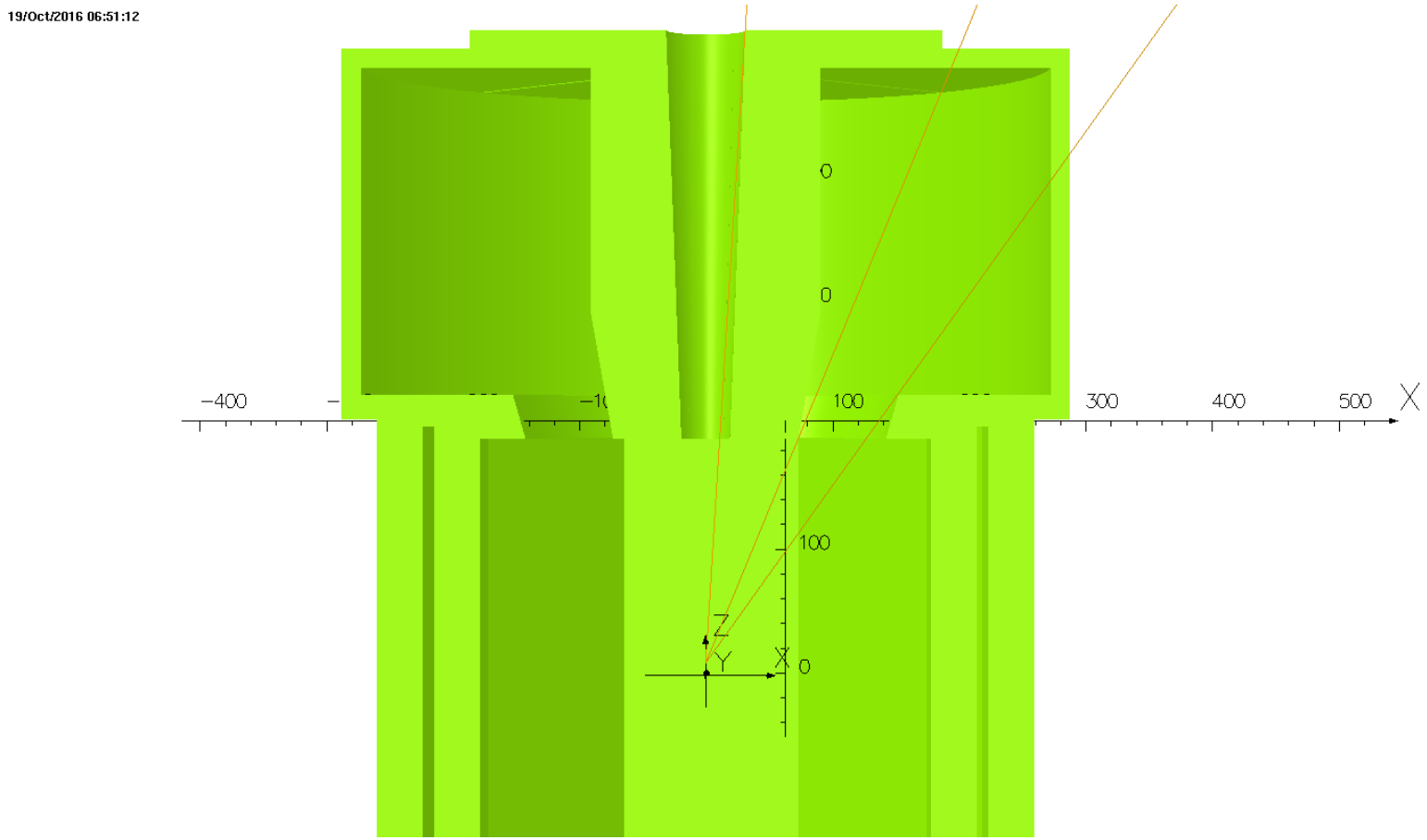


Longitudinal net force on coils calculated to be 396 kN. Axial load cells allow 196 kN maximum. Factor of three to four reduction needed. Also, Hall A Engineering reports the downstream coil collar will collapse under weight of octagons - it needs to be thicker in Z.

SIDIS angles: 2, 8, 14.7 and 24 degrees from (0,0,-350)



PVDIS angles: 3.5, 22 and 35 degrees from (0,0,10).



UNITS

Length	cm
Magn Flux Density	gauss
Magnetic Field	oersted
Magn Scalar Pot	oersted cm
Current Density	A/cm^2
Power	W
Force	N

MODEL DATA

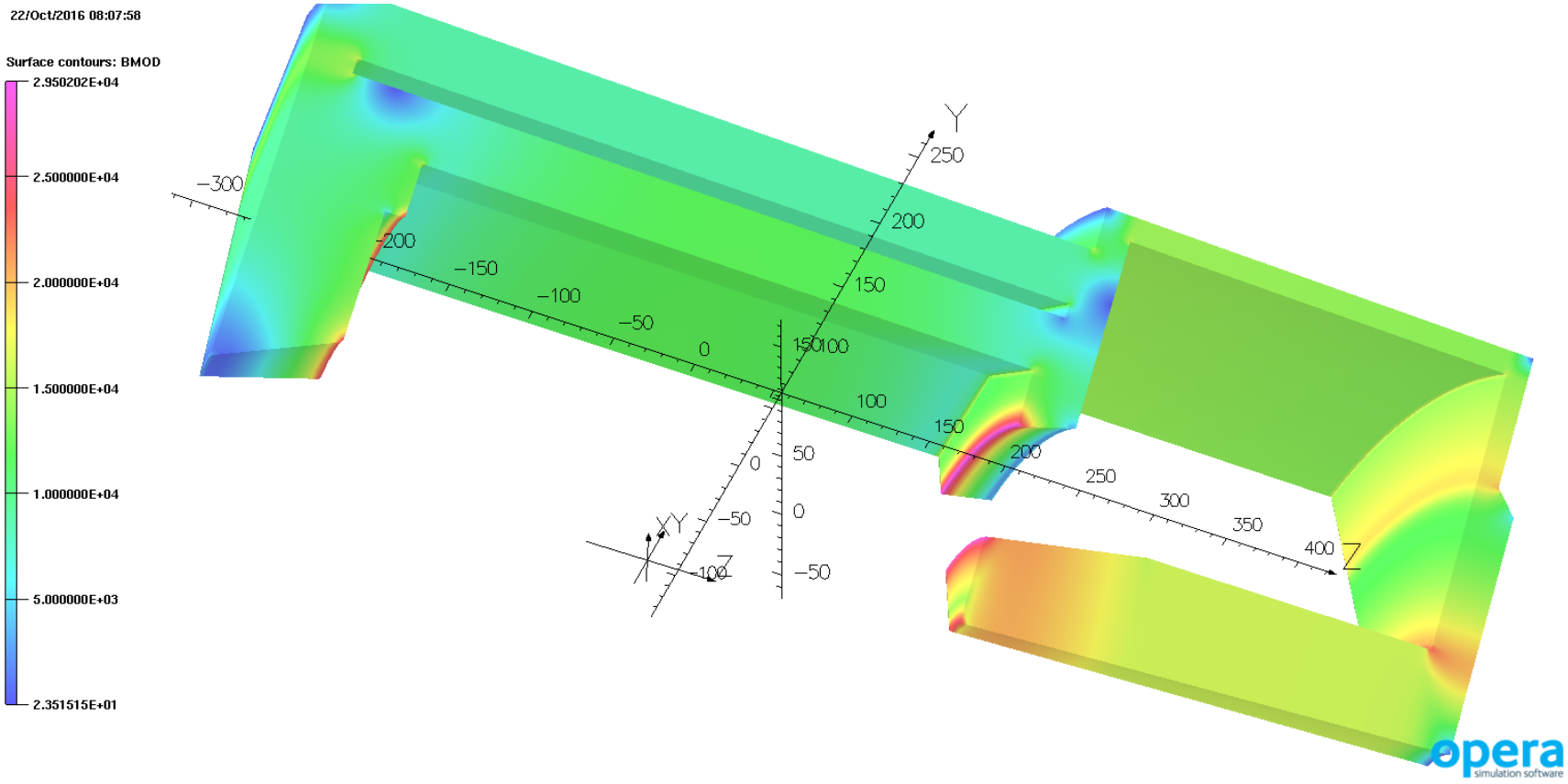
solid_r20a.op3
Magnetostatic (TOSCA)
Nonlinear materials
Simulation No 1 of 1
23979099 elements
25707022 nodes
3 conductors
Nodally interpolated fields
Activated in global coordinates
8-fold rotational symmetry

Field Point Local Coordinates

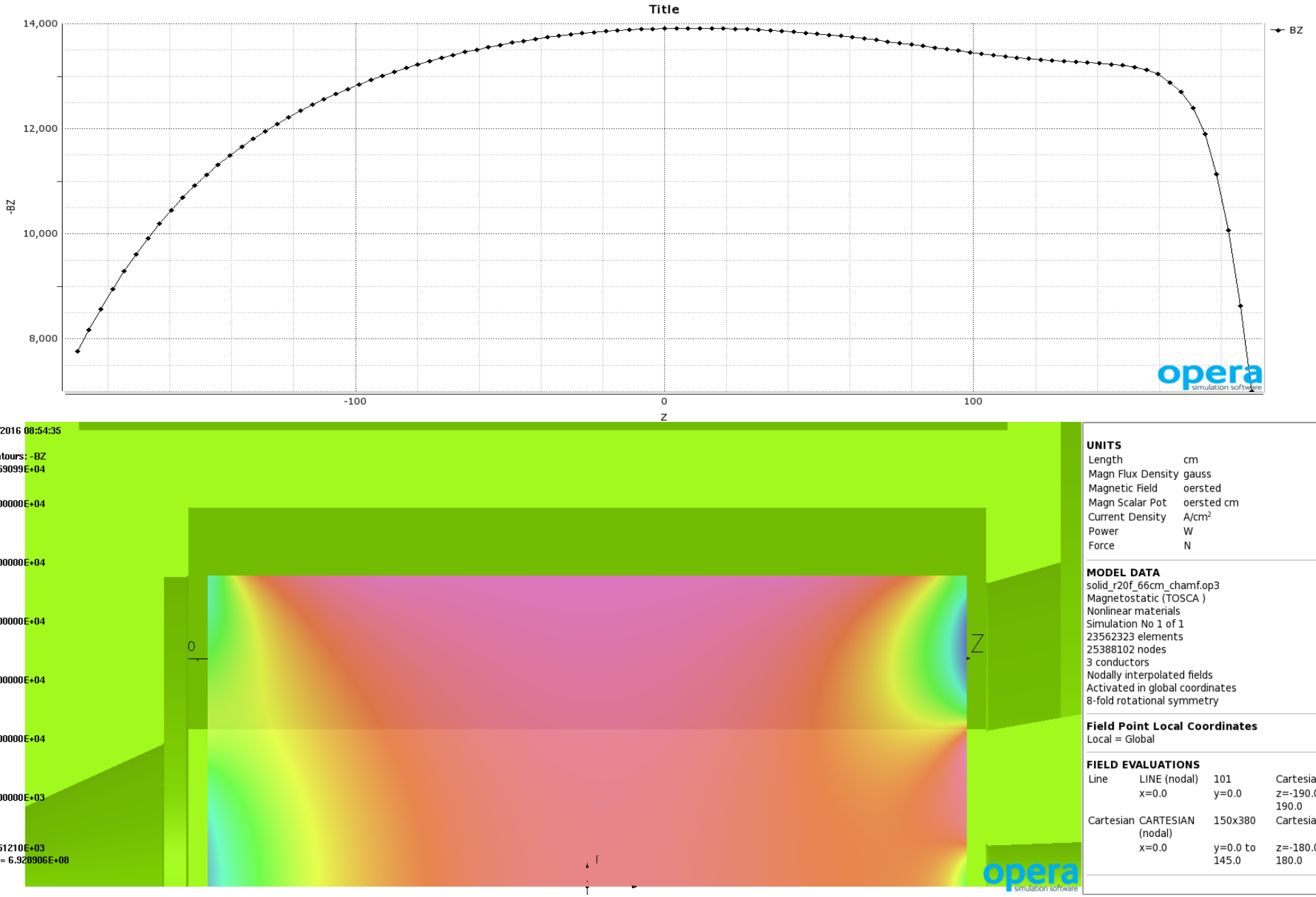
Local = Global

opera simulation software

Current baseline

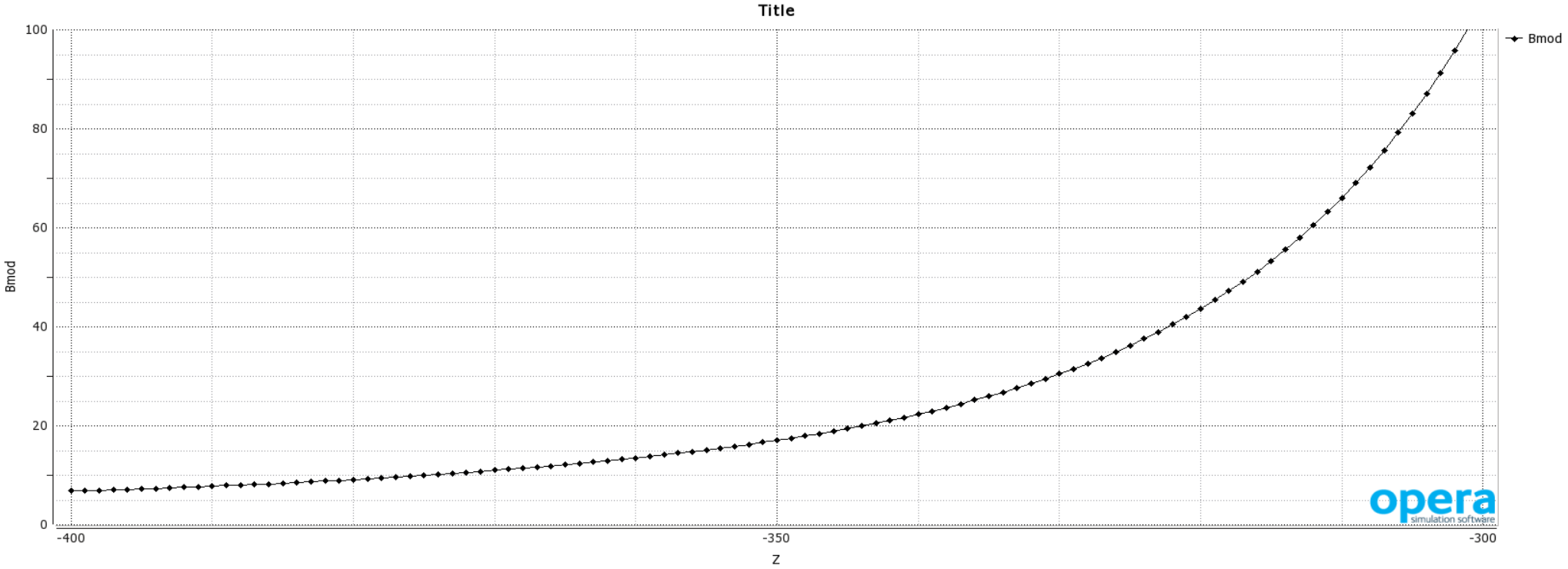


Upstream plug is 26” with 24 degree conical hole. Downstream coil collar is 14” thick. Net force on coil 23 kN vs 196 kN allowable.



Bz fields in octagonal barrel, along axis (top) and YZ plane, bottom.

Bmod in vicinity of SIDIS target



0-100 G vertical scale, -400 to -300 cm horizontal scale.

Forces and torques on steel parts, model with octagonal symmetry

segment	Z force (N)	Z torque (N-cm) about (0,0,0)
cone	-2.29E6	6.89E4
endcap endplate	-1.46E6	1.53E4
endcap cylinder	-2.11E5	-80
downstream coil collar	-9.49E5	-1.97E5
cotagons and endcap interface	2.13E6	-3.45E4
upstream coil collar	6.7E5	1.88E5
upstream plug	2.18E6	7.0E3

Z force coil 1	2.71E6 N
Z force coil 2	6.25E4 N
Z force coil 3	-2.8E6 N
Total force on coils	-2.34E4 N

Differences between model with symmetric steel and model with cut-out for service turret

symmetric - turret	X	Y	Z
coil 1 force (N)	-1231	2253	272
coil 1 torque (N-cm)	369044	152246	0
coil 2 force (N)	-559	89	-81
coil 2 torque (N-cm)	71317	18862	0
coil 3 force (N)	-1556	1214	23
coil 3 torque (N-cm)	-141055	-205647	0
all coil force (N)	-3346	3555	214
all coil torque (N-cm)	299306	-34539	0

Further work

A long document detailing the path my analysis has taken will be sent to SolID email list later this week. This will include results similar to slide 9 from models with twice the number of elements. These completed calculation Sunday. These have 29M elements and occupied 29 GB each. Since I have 64 GB RAM, I can double number of elements only once more. A box with 128 GB of 50% faster RAM costs $5300.