Force calculations on Opera models of SolID magnet system

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Zhiwen's suggestions

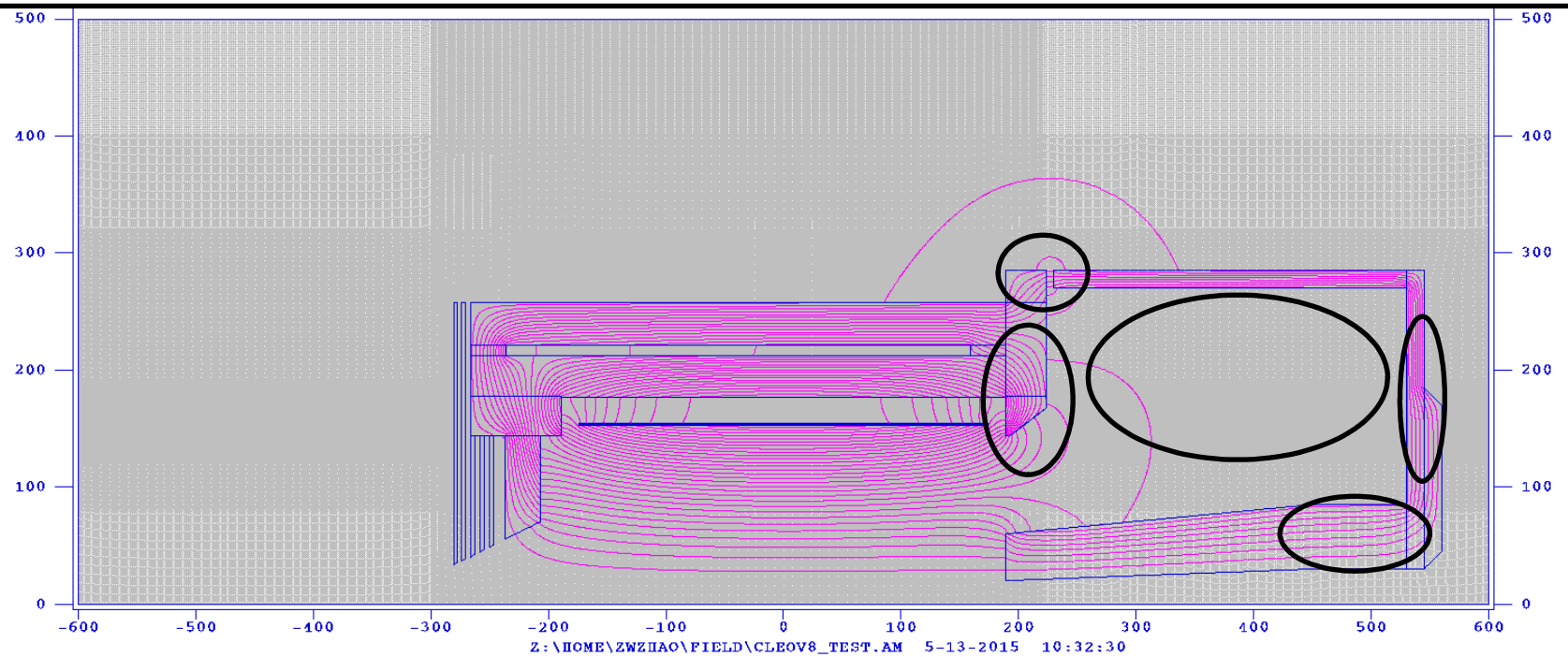
Just ideas, but changes are definitely needed

- Downstream collar enlarge by by 15cm in z (engineering need for support)
- Endcap move 15cm downstream and enlarge 30cm (SIDIS setup needs room)
- Endcap nose back reduce 5cm in r (EC hexagon module needs room)
- 6cm gap between downstream collar and endcap (let cable out, more cable out at back needed)
- Main impact, PVDIS EC large angle performance

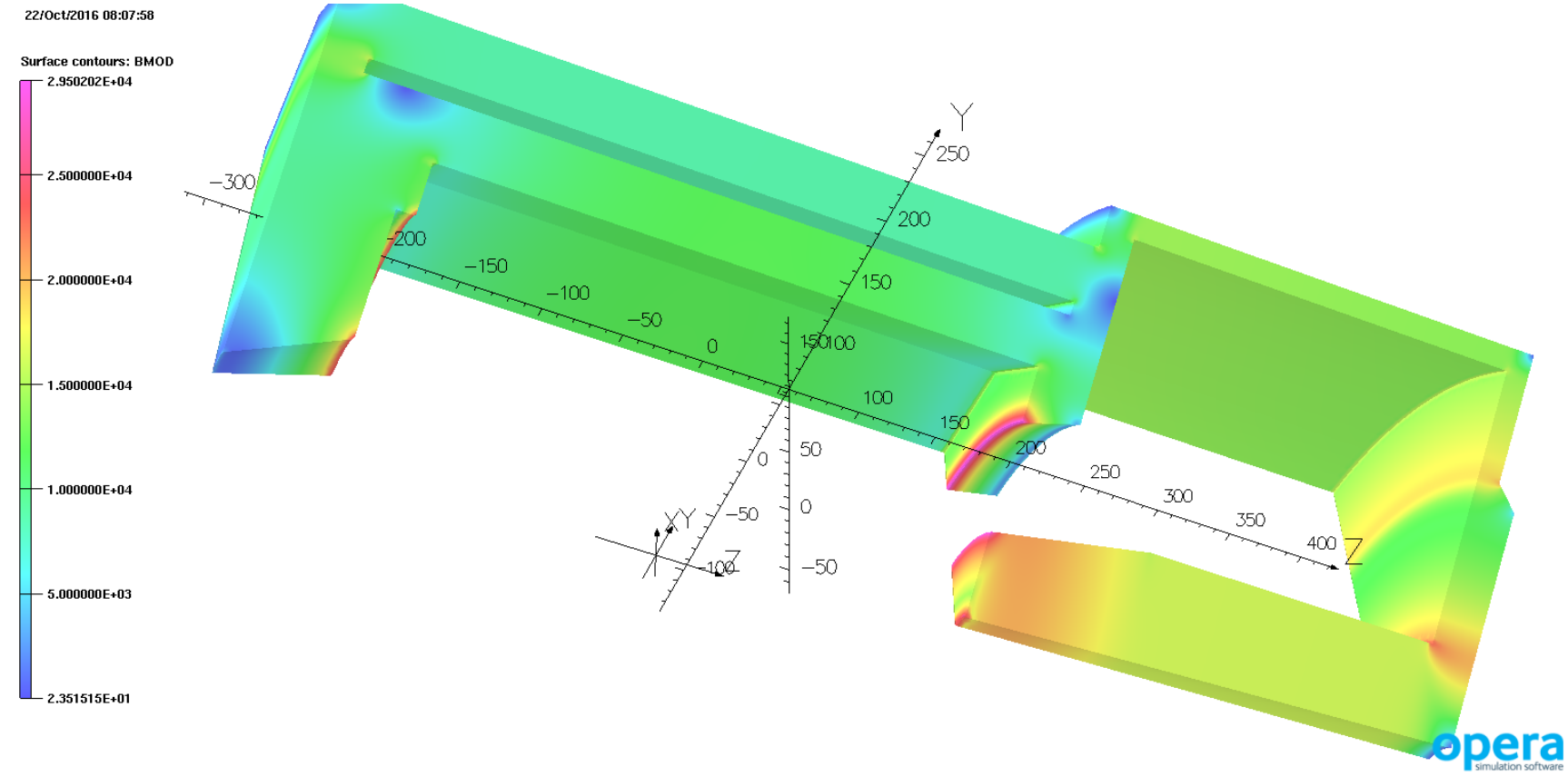
Need design with full 3D model and satisfy both physics and engineering requirement

needed by all subsystems to fix their design, must be a coherent effort

More realistic design now, More saving of man power, effort, cost, maybe even physics

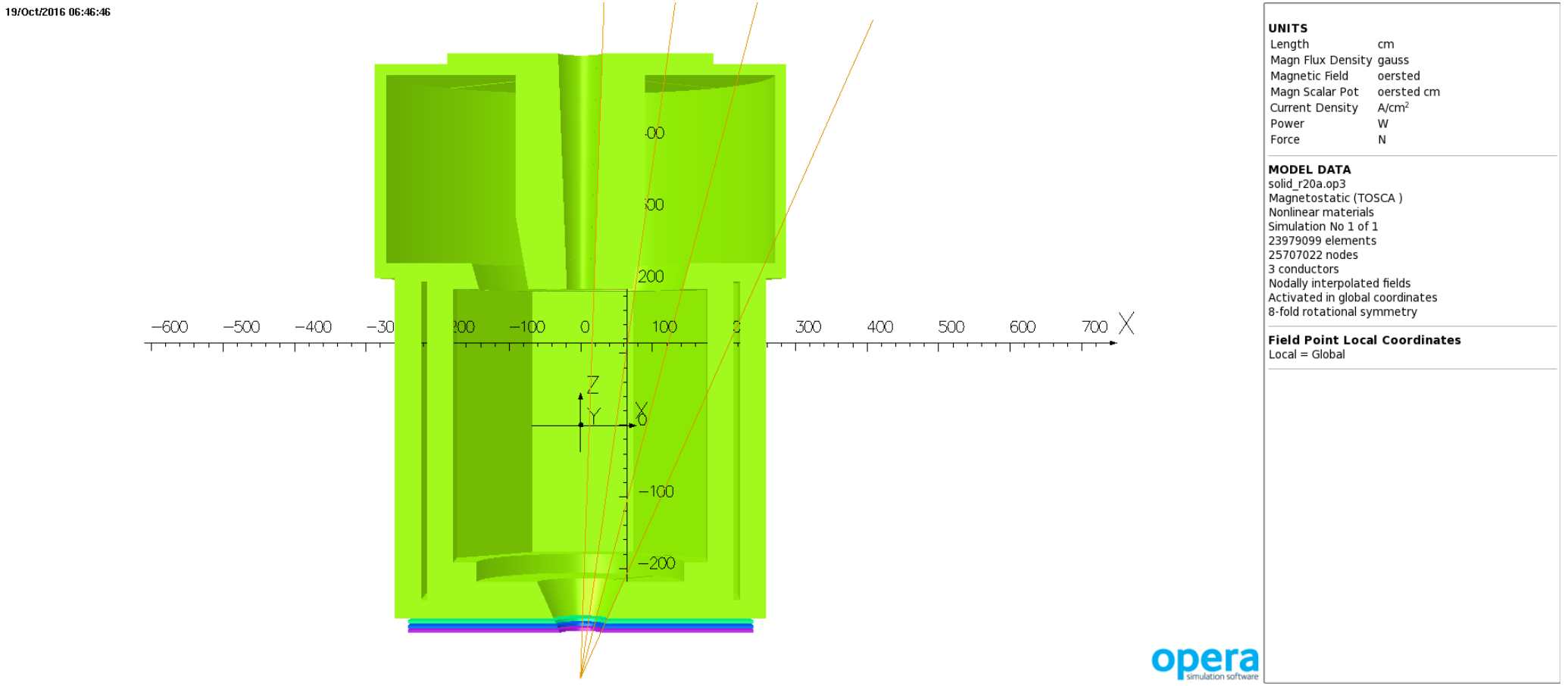


My current baseline

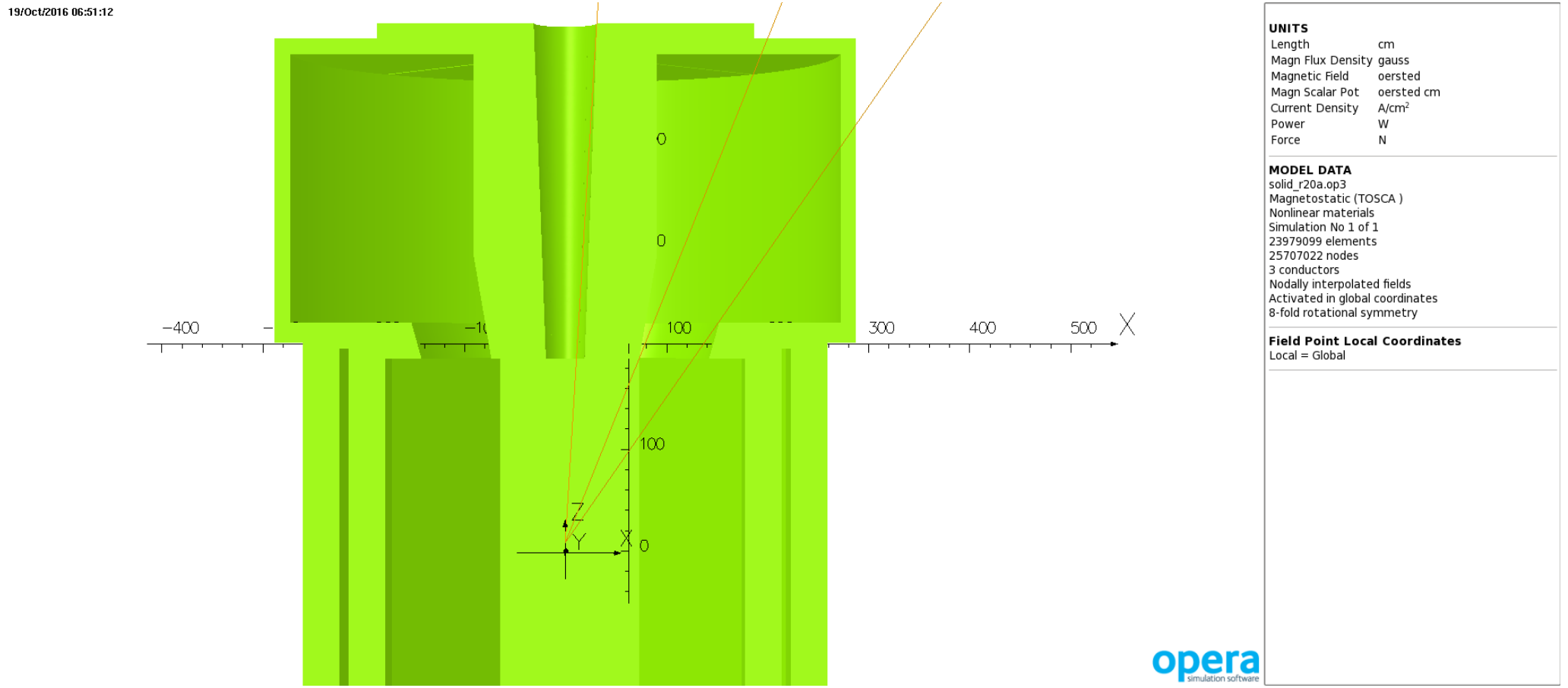


Upstream plug is 26” with 24 degree conical hole. Downstream coil collar is 14” thick. Net force on coil 23 kN vs 196 kN allowable.
~100 cm OD by ~6 cm Z upstream solenoid to null stray field for He3

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).



Model accomplishments

- Model defined with maximum steel cone consistent with PVDIS and SIDIS angular apertures.
- Provision made for mounting rails in cylinder within coil cryostat and on 90 cm OR cylinder joined to cone. No clearance on cone for mounts.
- Meshes developed which limit transverse forces in symmetric steel case under 1 kN and transverse torques under 100 kN-cm on superconducting coils. With 8-fold symmetry imposed, these are all zero.
- Forces and torques are within load cell limits.
- Model with service turret cut-out shows larger differences with symmetric model for first coil than second and third, as expected from geometry.

Stray field at entrance

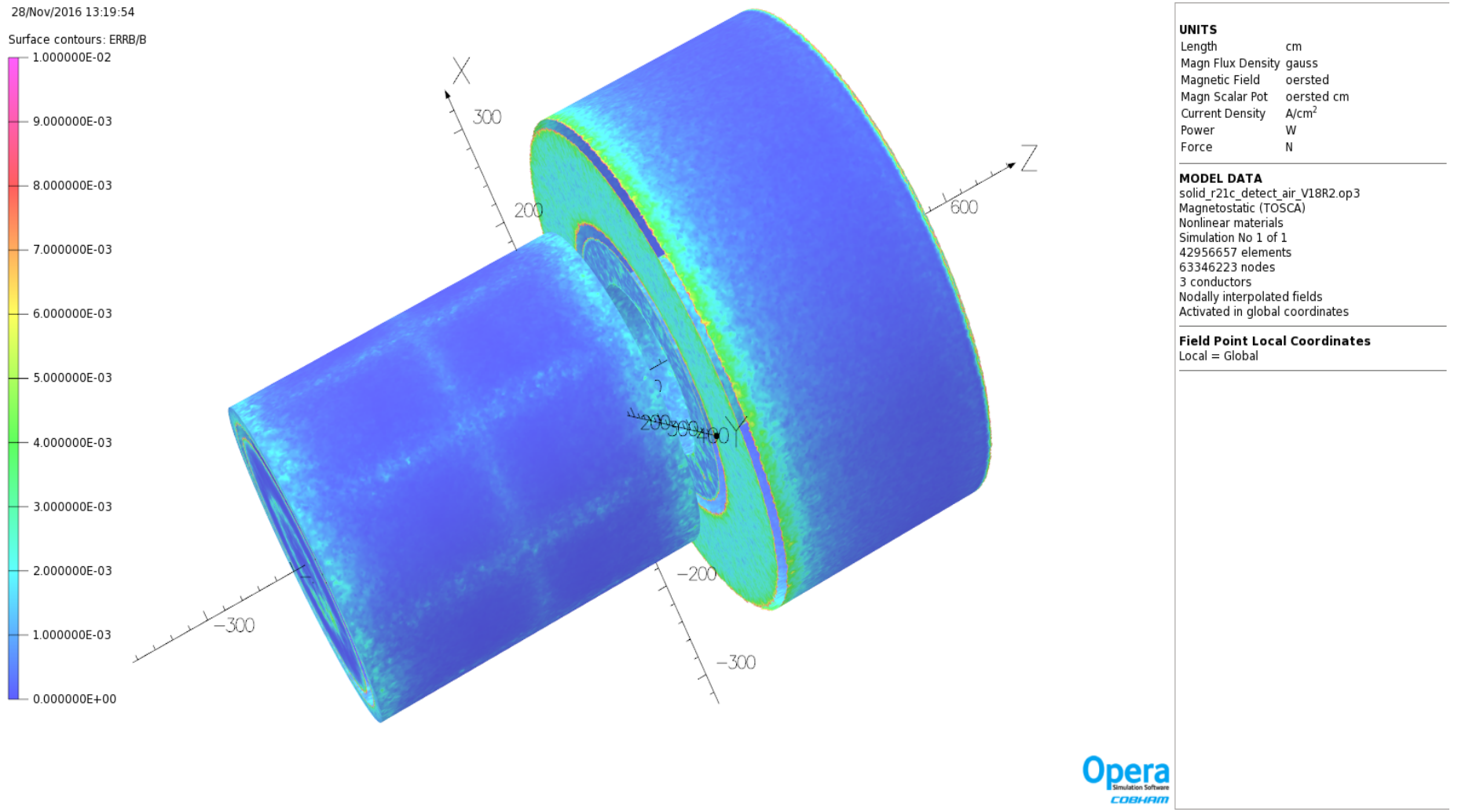
- Thia Keppel suggested putting a single solenoid against the upstream plug.
- ~12 kAT in such a coil reduced stray field over He3 target to under one Gauss.
- Problem solved.
- kAT must be revisited when final steel is defined.

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
octagons 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

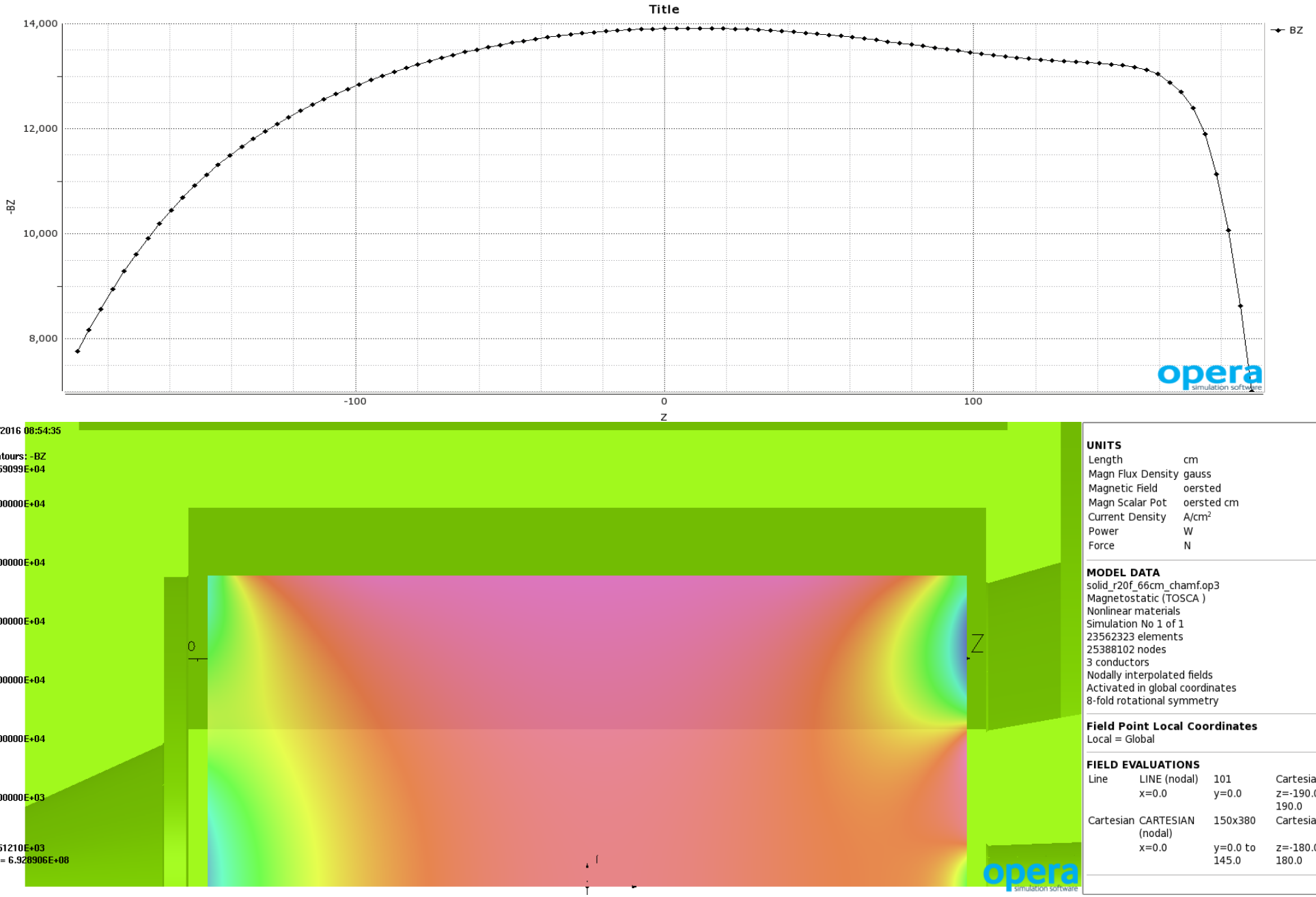
Errors in detector volumes



Errors over 1% of local B field not shown

Questions

- Do I have to remove steel from cone, and therefore from upstream plug, to allow for detector mounts? Is 90 cm OR OK?
- What does “Endcap nose back reduce 5cm in r (EC hexagon module needs room)” mean? Give me a number.
- What interior length is needed for endcap cylinder? 261 cm now.
- Is longer/heavier cone compatible with Whit's overall endcap support and floor rail system?
- Can endcap cylinder wall be increased to 6.5” from 6” to lower stray field inside it?
- Can plate at end of cylinder be increased to 6.5” to reduce peak field in steel?
- Are field errors on previous page OK?



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