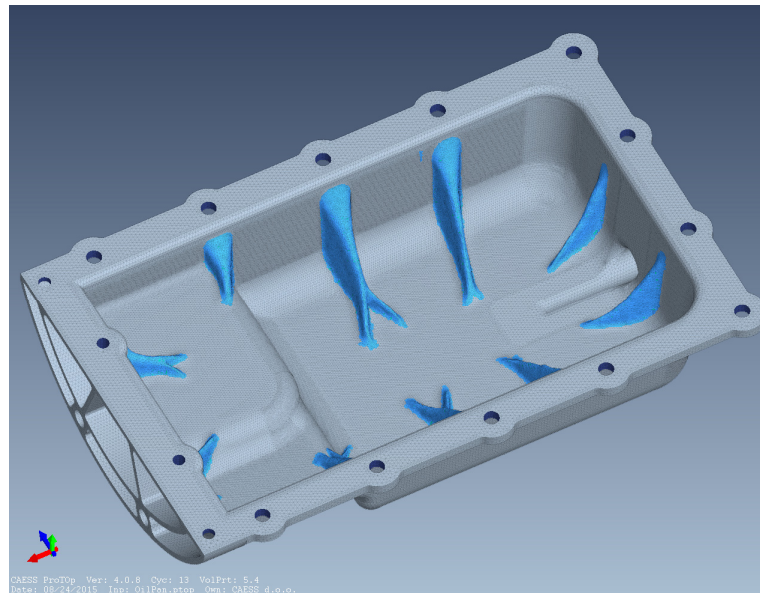


Case Study

Lowest eigenfrequency maximization of an oil pan by topology optimization



SOFTWARE

CAD and FEA model:

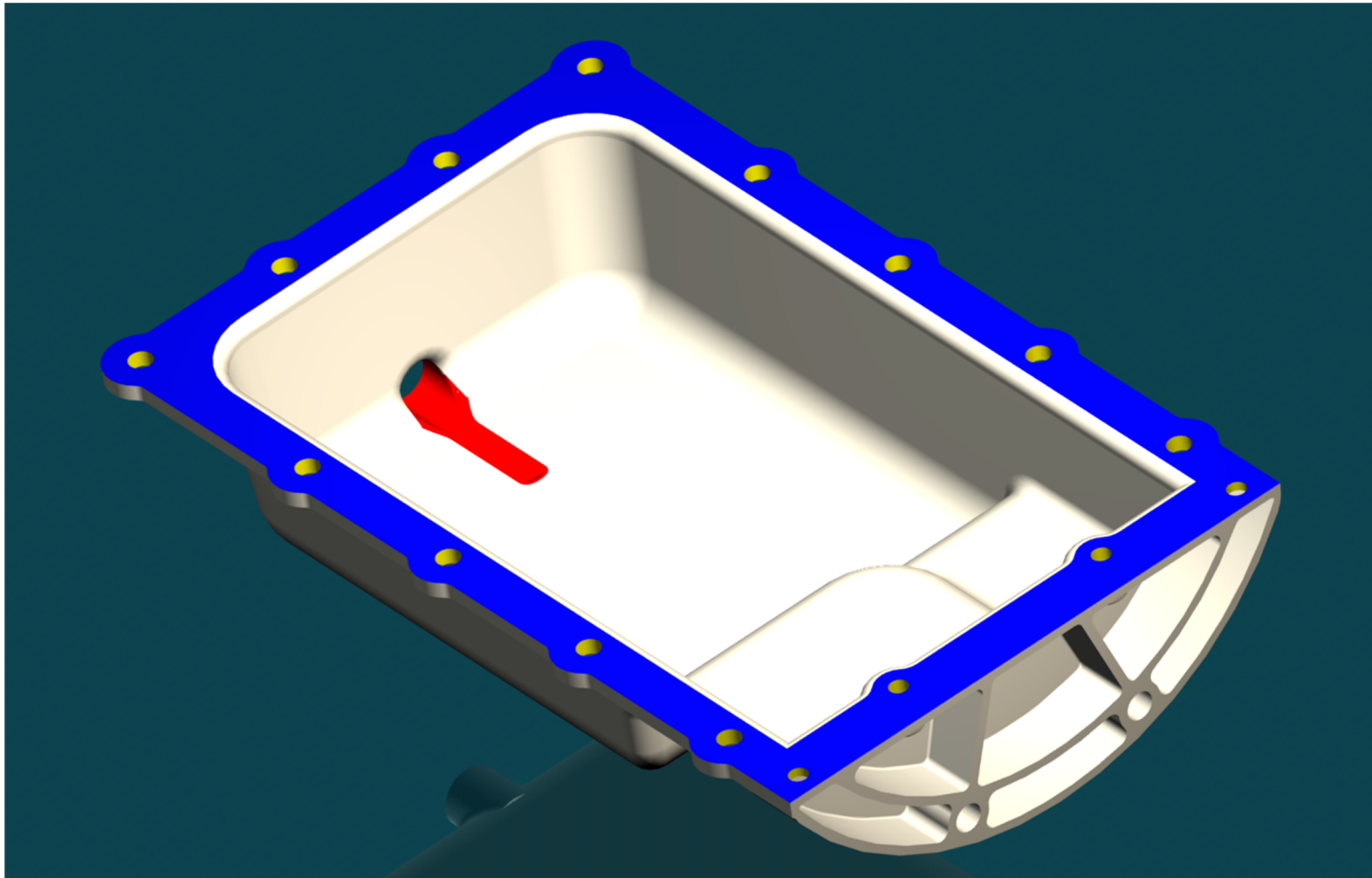
PTC Creo 3.0

Optimization:

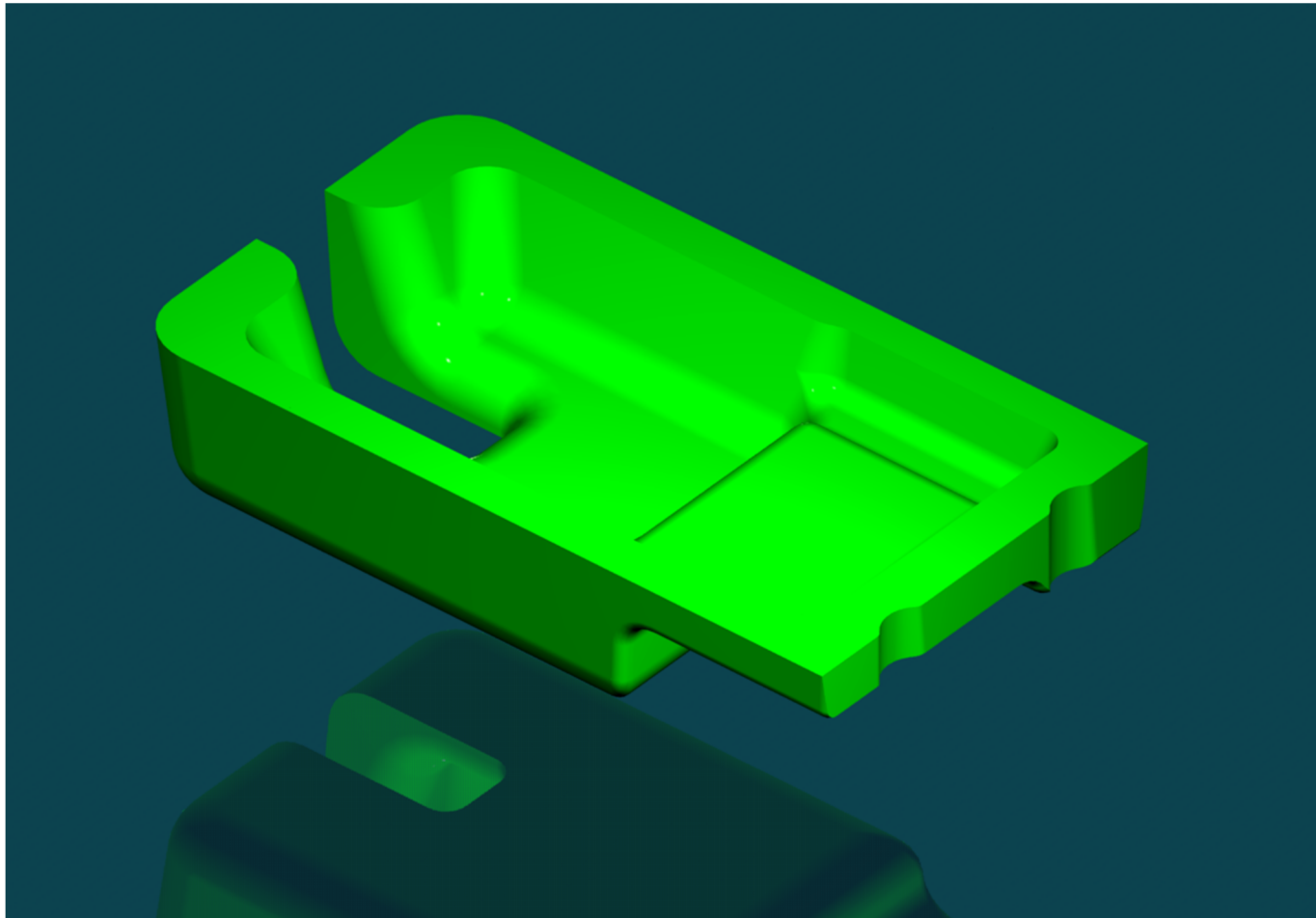
CAESS ProTOP 4.0.8

(extended with development modules for eigenfrequencies)

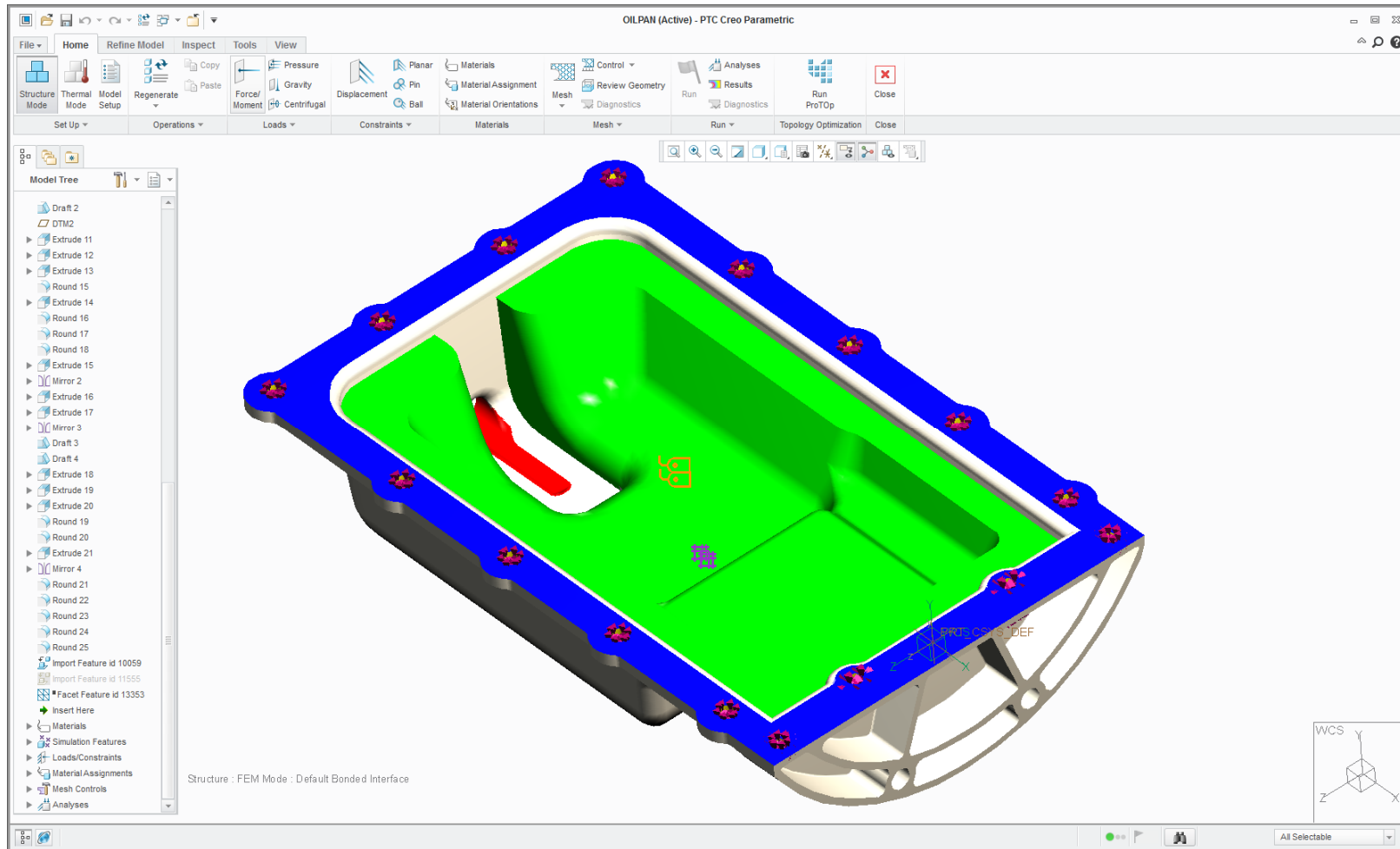
Model – Fixed domain



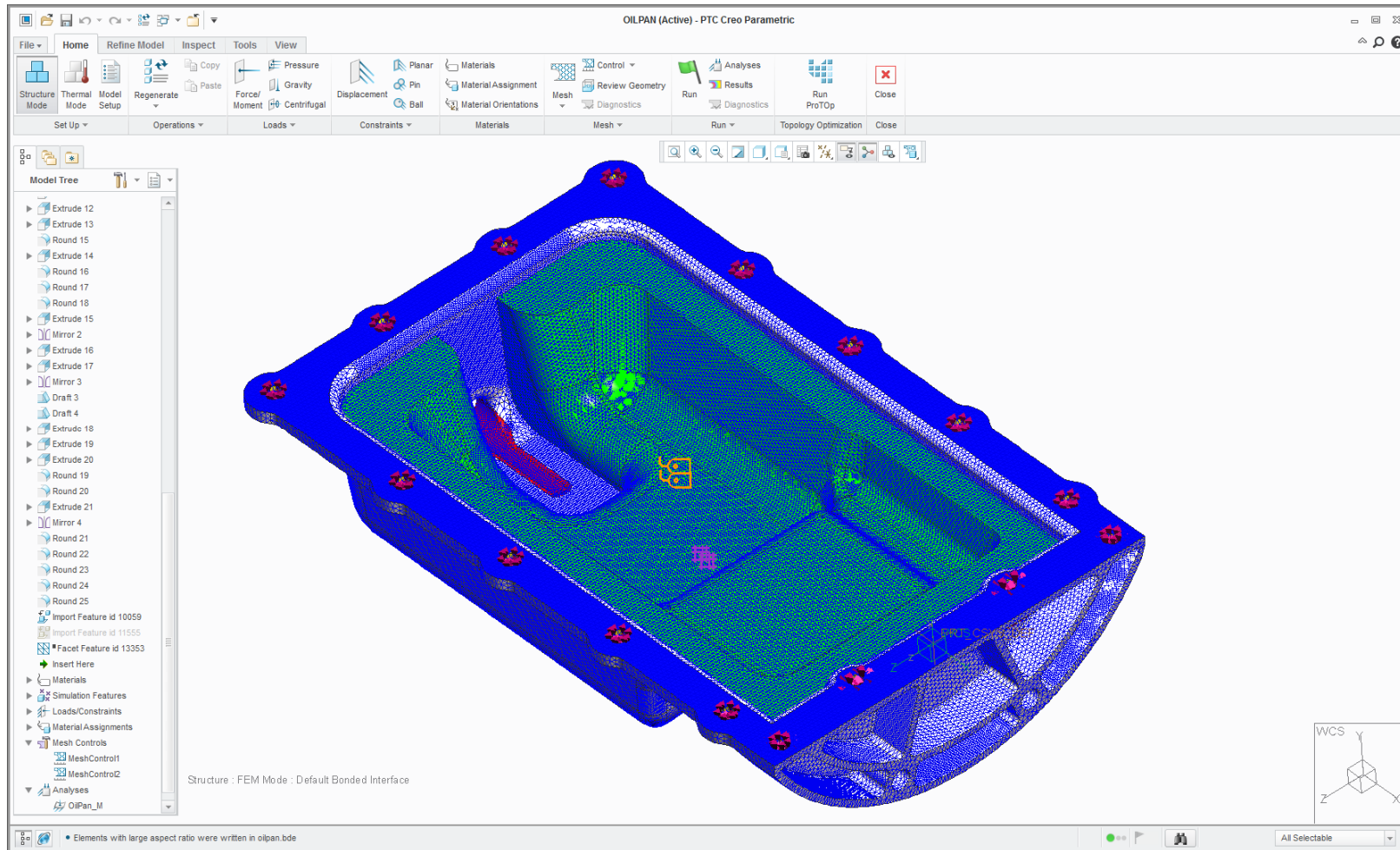
Model – Free (optimization) domain



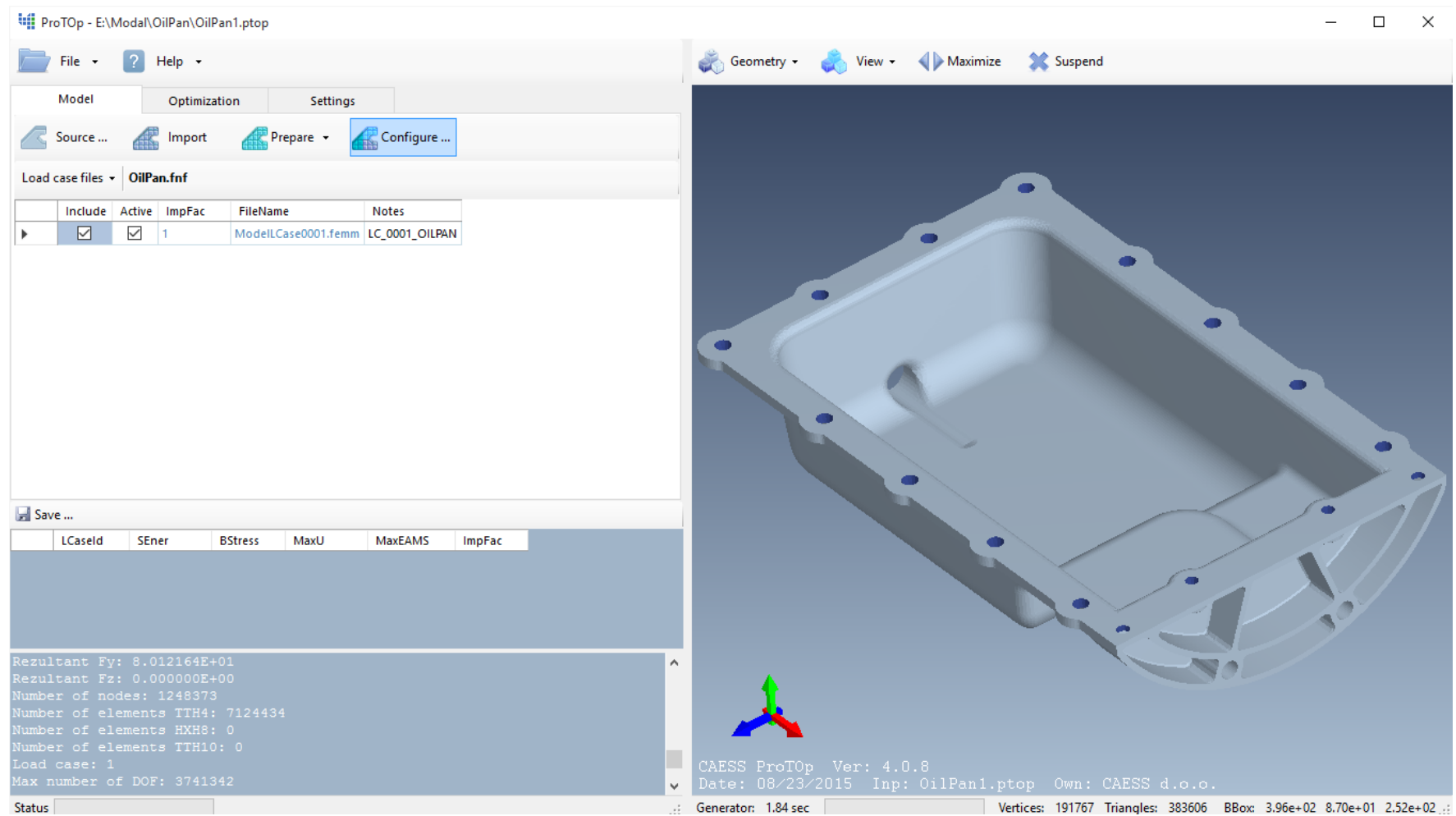
Model – Initial design with fixed (white) and free optimization (green) domains



FEA model



Optimization model – Fixed domain



ProTop - E:\Moda\OilPan\OilPan1.ptop

File Help

Model Optimization Settings

Source ... Import Prepare Configure ...

Load case files - OilPan.fnf

	Include	Active	ImpFac	FileName	Notes
▶	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	ModellCase0001.femm	LC_0001_OILPAN

Save ...

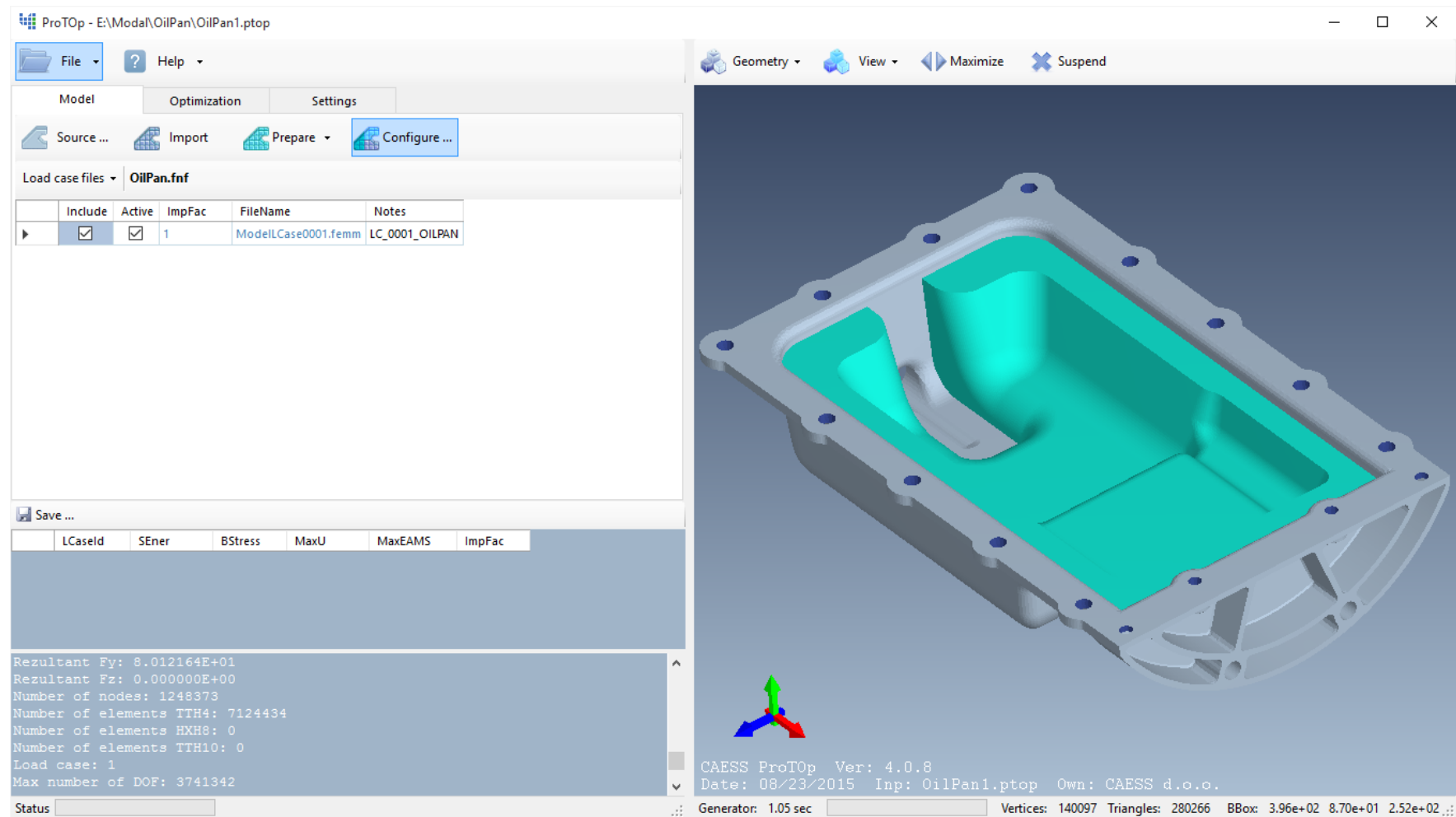
	LCaseld	SEner	BStress	MaxU	MaxEAMS	ImpFac

Resultant Fy: 8.012164E+01
 Resultant Fz: 0.000000E+00
 Number of nodes: 1248373
 Number of elements TTH4: 7124434
 Number of elements HXH8: 0
 Number of elements TTH10: 0
 Load case: 1
 Max number of DOF: 3741342

CAESS ProTop Ver: 4.0.8
 Date: 08/23/2015 Inp: OilPan1.ptop Own: CAESS d.o.o.

Status: Generator: 1.84 sec Vertices: 191767 Triangles: 383606 BBox: 3.96e+02 8.70e+01 2.52e+02

Optimization model – Fixed and free domains



ProTop - E:\Moda\OilPan\OilPan1.ptop

File Help

Model Optimization Settings

Source Import Prepare Configure

Load case files OilPan.fnf

	Include	Active	ImpFac	FileName	Notes
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	ModellCase0001.femm	LC_0001_OILPAN

Save ...

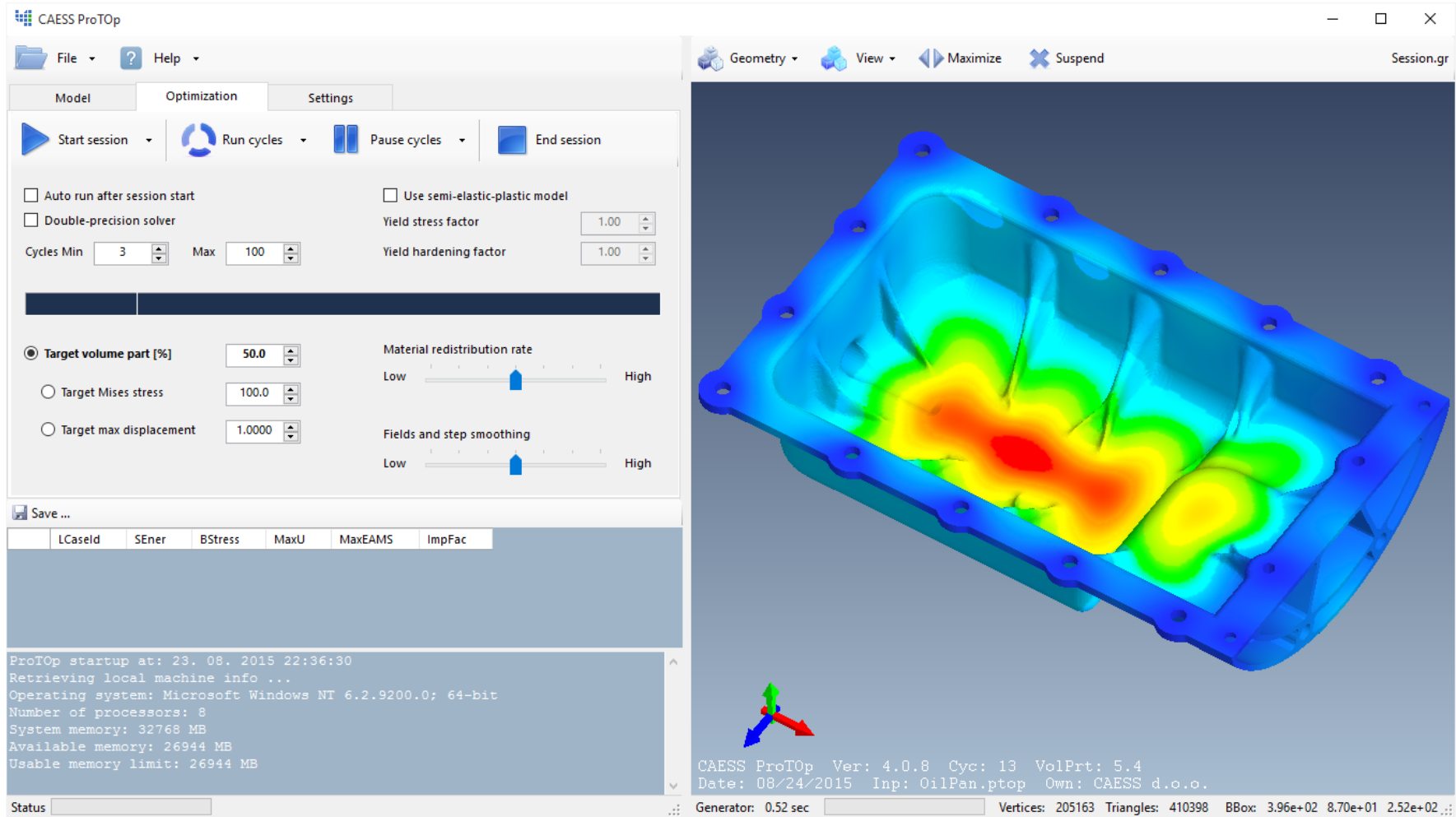
	LCaseld	SEner	BStress	MaxU	MaxEAMS	ImpFac

Resultant Fy: 8.012164E+01
 Resultant Fz: 0.000000E+00
 Number of nodes: 1248373
 Number of elements TTH4: 7124434
 Number of elements HXH8: 0
 Number of elements TTH10: 0
 Load case: 1
 Max number of DOF: 3741342

Status

CAESS ProTop Ver: 4.0.8
 Date: 08/23/2015 Inp: OilPan1.ptop Own: CAESS d.o.o.
 Generator: 1.05 sec Vertices: 140097 Triangles: 280266 BBox: 3.96e+02 8.70e+01 2.52e+02

Results – Final design and lowest eigenmode



The screenshot displays the CAESS ProTop software interface. The left sidebar contains the 'Settings' tab with various simulation parameters:

- Model:** Start session, Run cycles, Pause cycles, End session
- Auto run after session start
- Double-precision solver
- Cycles Min: 3, Max: 100
- Use semi-elastic-plastic model
- Yield stress factor: 1.00
- Yield hardening factor: 1.00
- Target volume part [%]: 50.0
- Target Mises stress: 100.0
- Target max displacement: 1.0000
- Material redistribution rate: Low to High (slider)
- Fields and step smoothing: Low to High (slider)

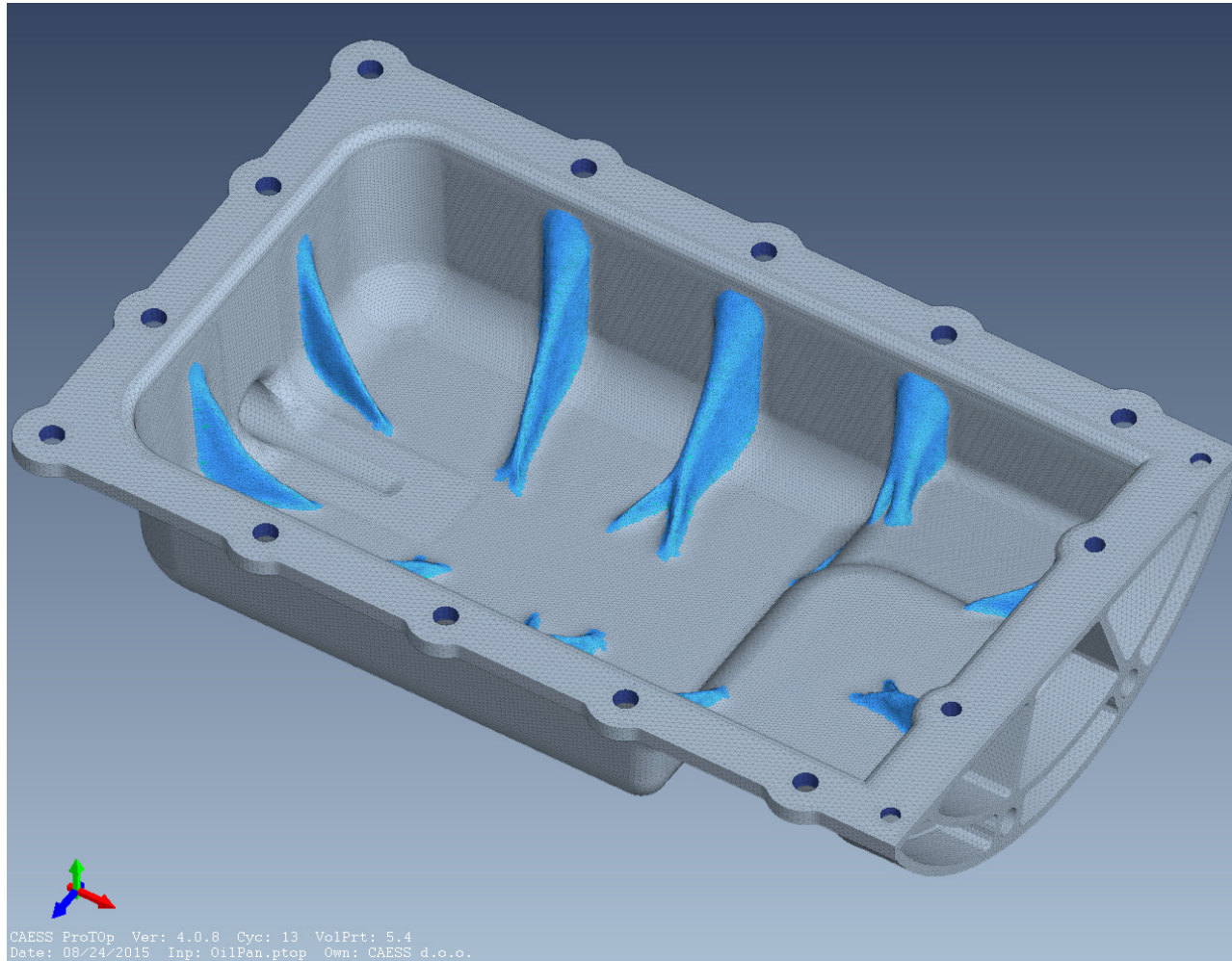
The main window shows a 3D visualization of a rectangular component with a stress distribution. The stress is color-coded, with red indicating high stress and blue indicating low stress. The component has a complex internal structure with several ribs and a central opening.

The bottom status bar provides the following information:

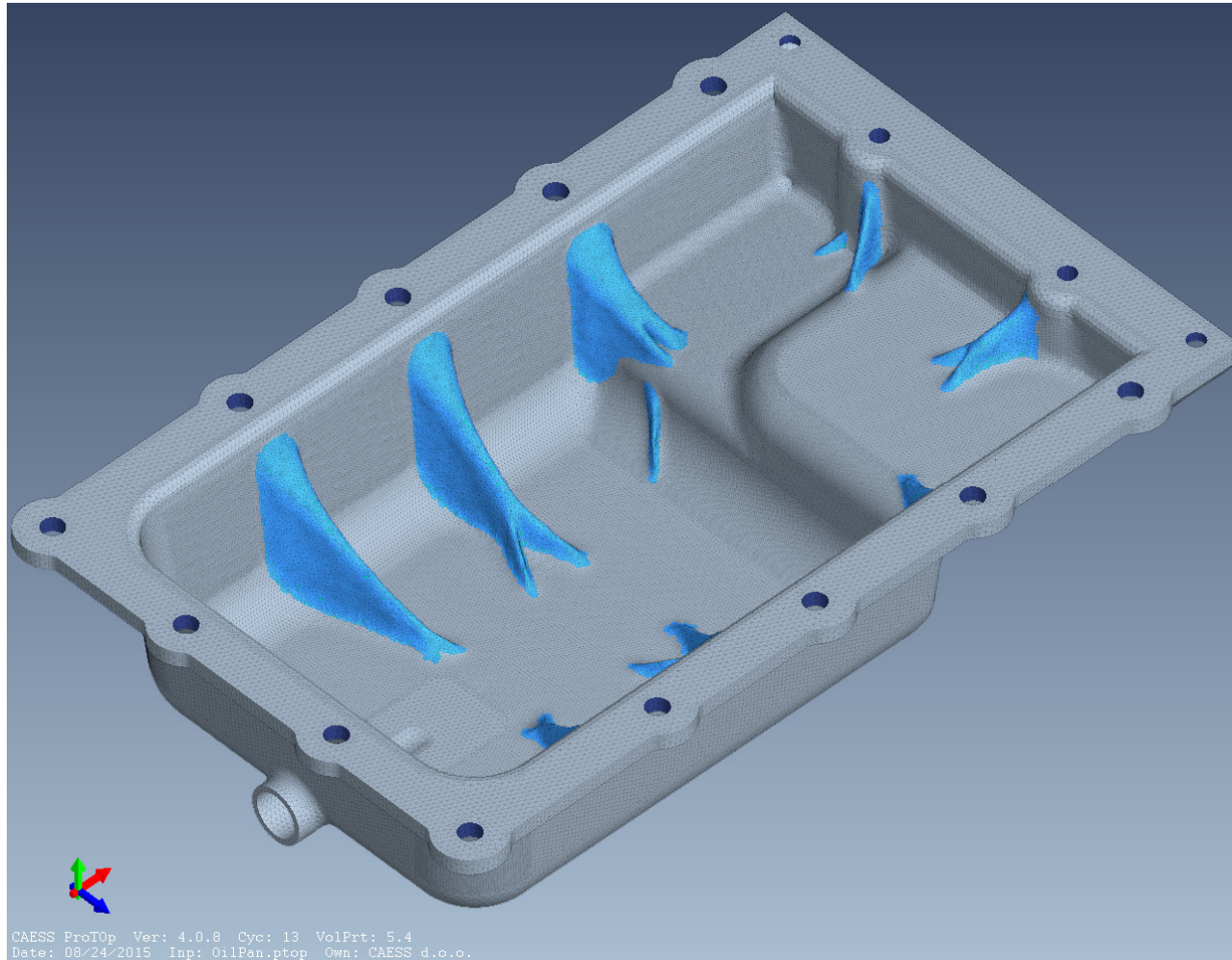
- Generator: 0.52 sec
- Vertices: 205163
- Triangles: 410398
- BBox: 3.96e+02 8.70e+01 2.52e+02

Additional information in the bottom right corner includes: CAESS ProTop Ver: 4.0.8 Cyc: 13 VolPrt: 5.4 Date: 08/24/2015 Inp: OilPan.ptop Own: CAESS d.o.o.

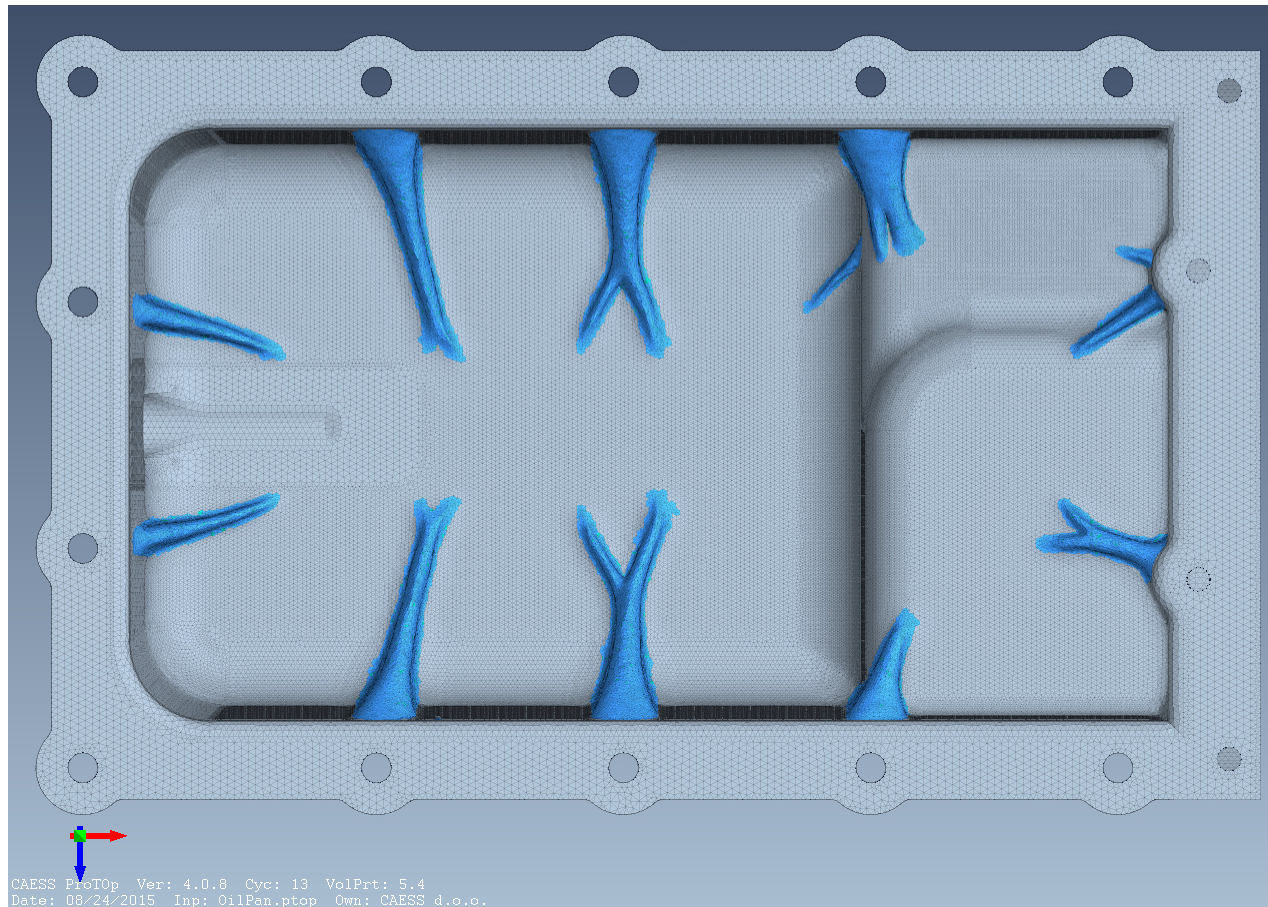
Results



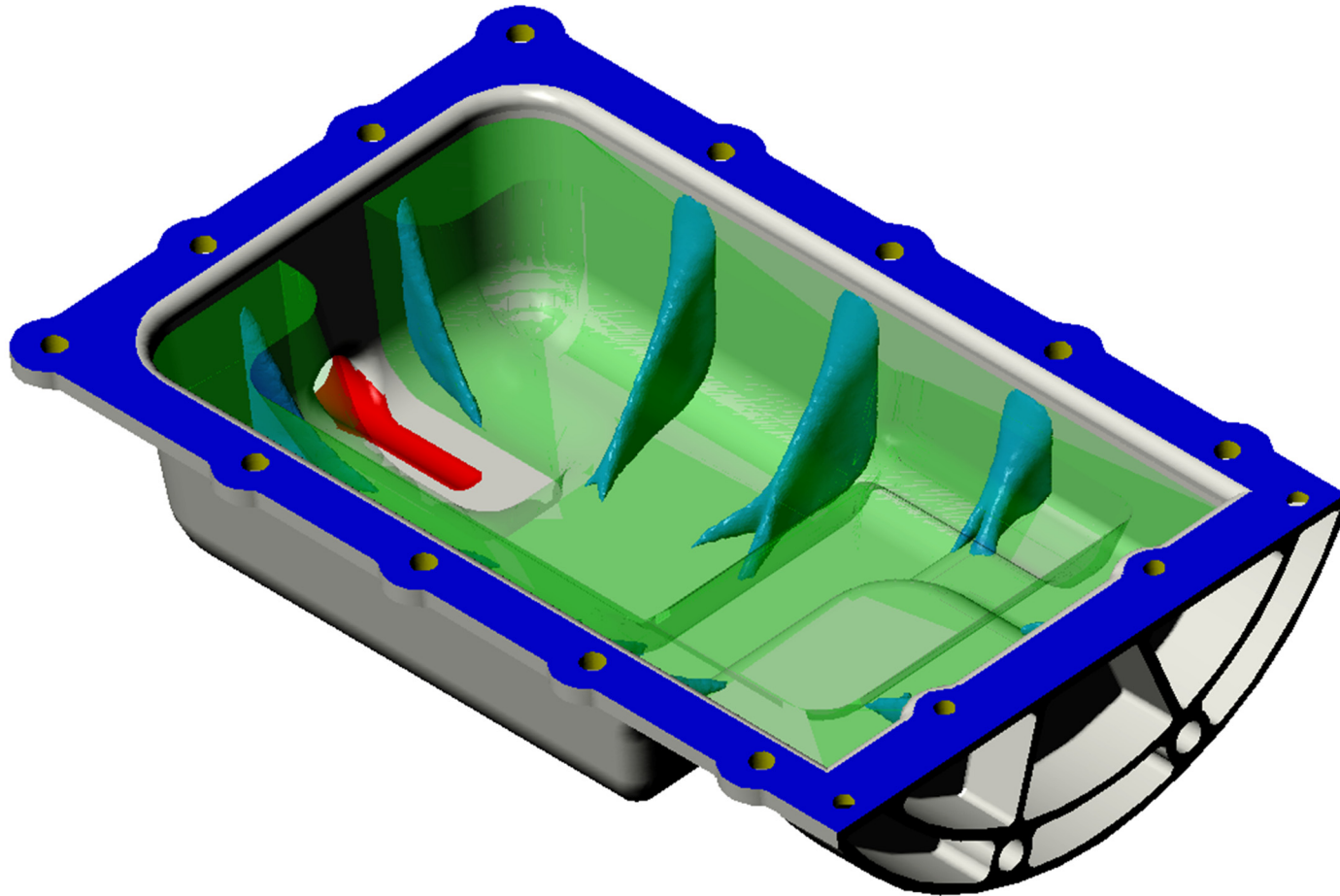
Results



Results



Results – fixed, initial free, and optimal free design domains



le State:Master Style(+)

Model data and results in numbers

FEA		
	Model 1	Model 2
Elements type and number	TTH4; 2.401.495	TTH4; 7.124.434
DOF	1.296.930	3.741.342

Structure		
	Initial – fixed domain	Optimal – fixed domain + ribs
Volume, mm ³	7,936e+05	9,079e+05
Lowest eigenfrequency, Hz	917	2354

Optimization CPU time: 4 hours (PC with i7 3770K CPU, 32 GB of RAM)