

COMPARING CREO SIMULATE WITH CREO SIMULATION LIVE



ptc



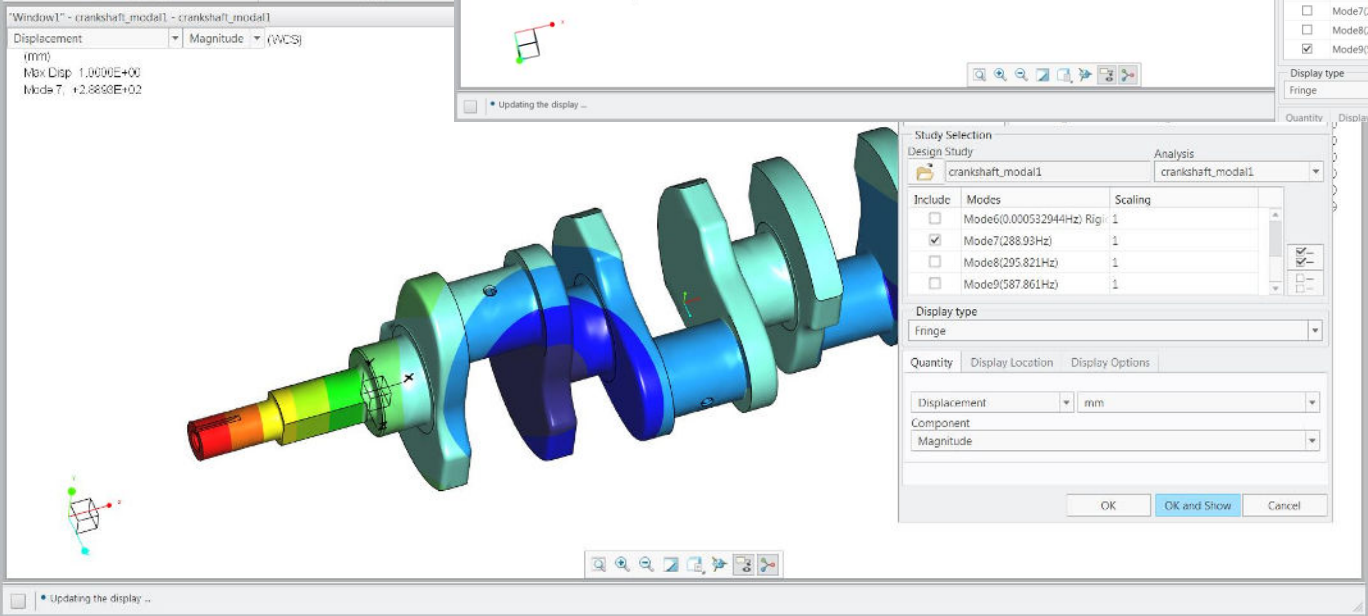
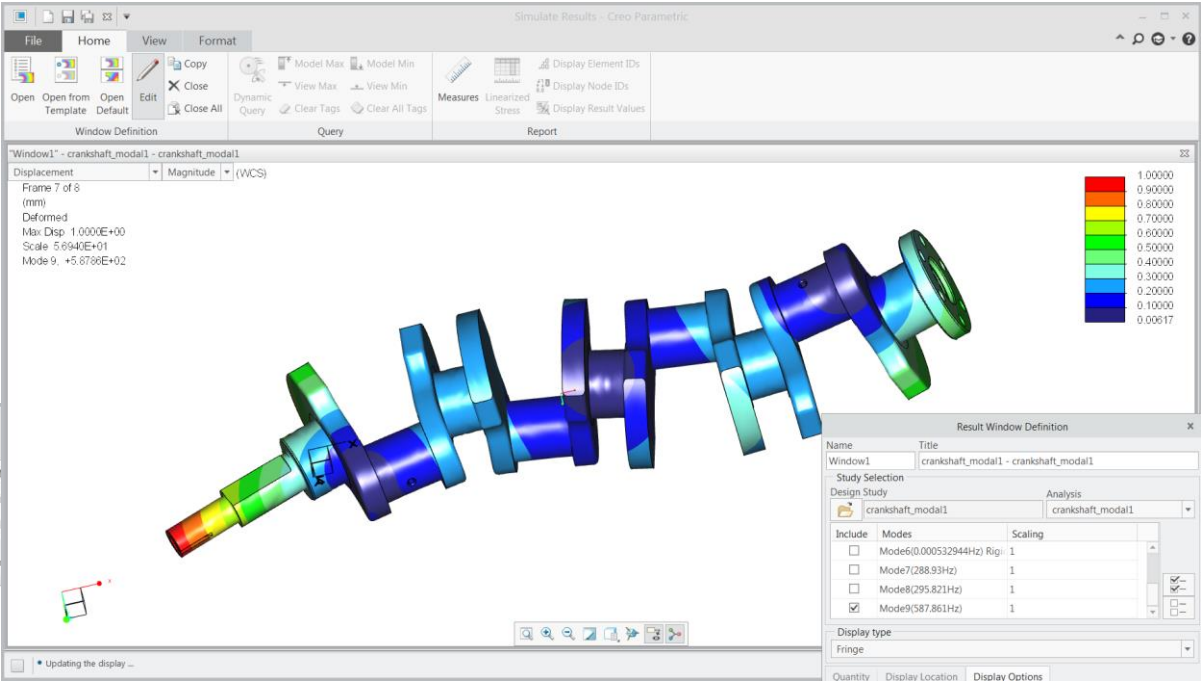
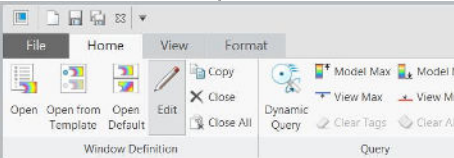
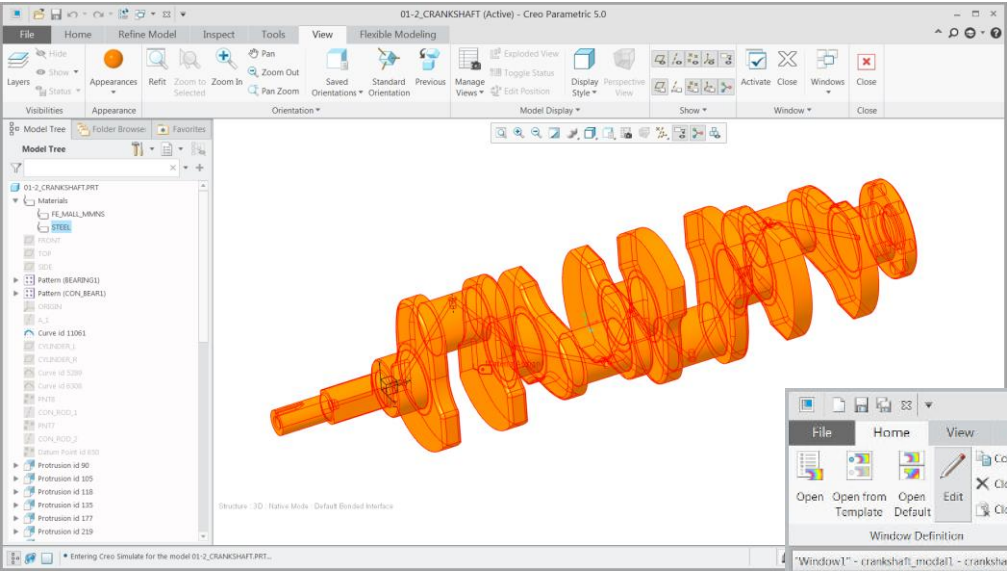
AGENDA

Datasets Used in Comparison

- Engine Crankshaft - Modal Analysis
- V8 Engine – Structural Analysis
- Manifold – Thermal Analysis
- Tuning Fork – Modal Analysis

ENGINE CRANKSHAFT - MODAL ANALYSIS

CREO SIMULATE RESULTS



Single Pass Adaptive
3 minutes total time (includes meshing)

Memory and Disk Usage:

Machine Type: Windows 7 64 Service Pack 1
RAM Allocation for Solver (megabytes): 512.0

Total Elapsed Time (seconds): 149.04
Total CPU Time (seconds): 186.33
Maximum Memory Usage (kilobytes): 1525494
Working Directory Disk Usage (kilobytes): 1207296

Number of Rigid Modes: 6

Number of Modes: 9

Mode	Frequency (Hz)
1	0.000000e+00
2	0.000000e+00
3	0.000000e+00
4	0.000000e+00
5	0.000000e+00
6	5.329435e-04
7	2.889300e+02
8	2.958206e+02
9	5.878609e+02

RMS Stress Error Estimates:

Mode	Stress Error (% of Max Modal Stress)
1	2.7%
2	2.1%
3	2.5%
4	3.6%
5	2.6%
6	2.1%
7	2.6%
8	3.4%
9	2.7%

CREO SIMULATION LIVE RESULTS 293.3 / 595.6

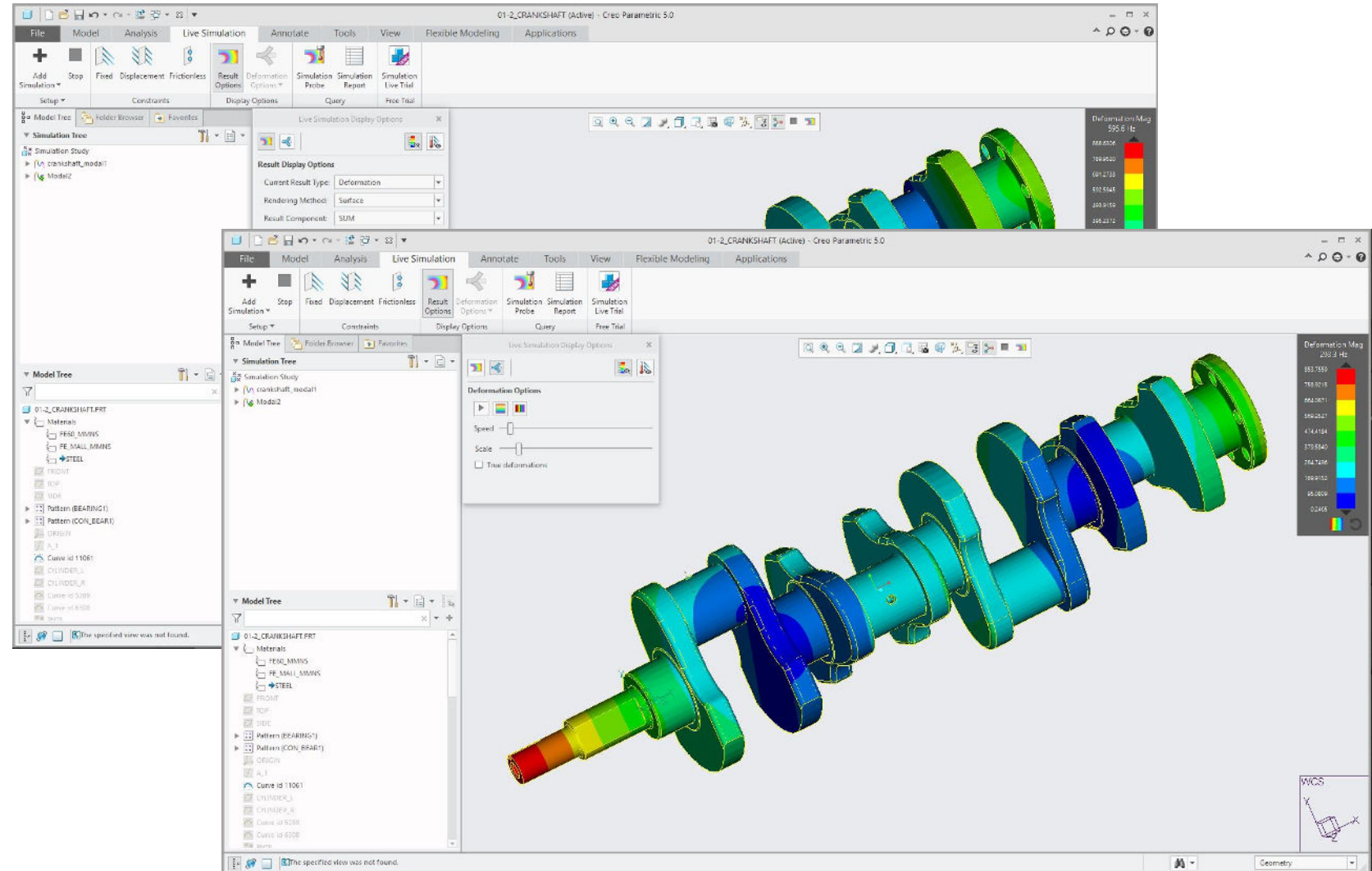
Results

Mode 1: 293.3Hz

Mode 3: 595.6Hz

Time taken

< 2 seconds

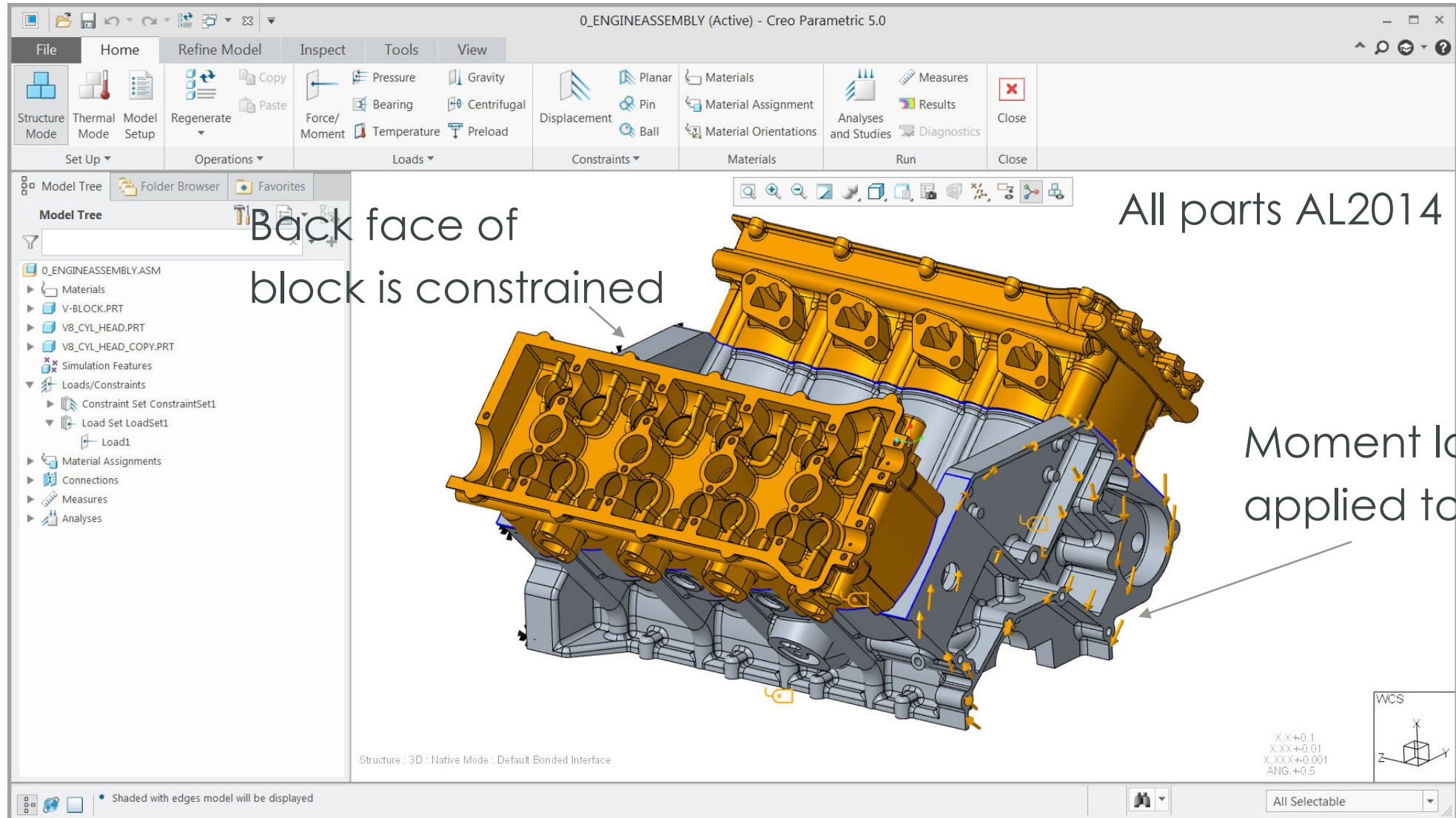


RESULTS COMPARISON

	Creo Simulation Live	Creo Simulate	% difference
Mode 1	293.3 Hz	288.9 Hz	1.5%
Mode 3	595.6 Hz	587.9 Hz	1.3%
Solution Time	3 sec	3 minutes	60x

V8 ENGINE - TORQUE LOAD

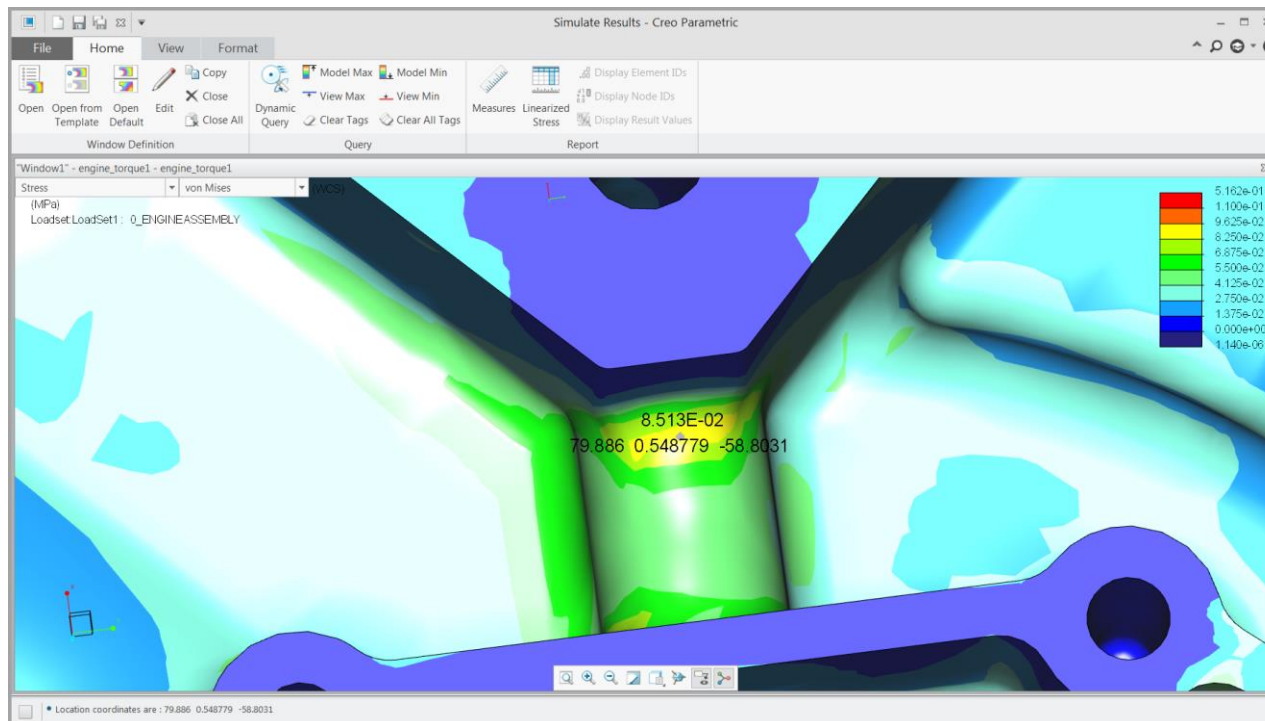
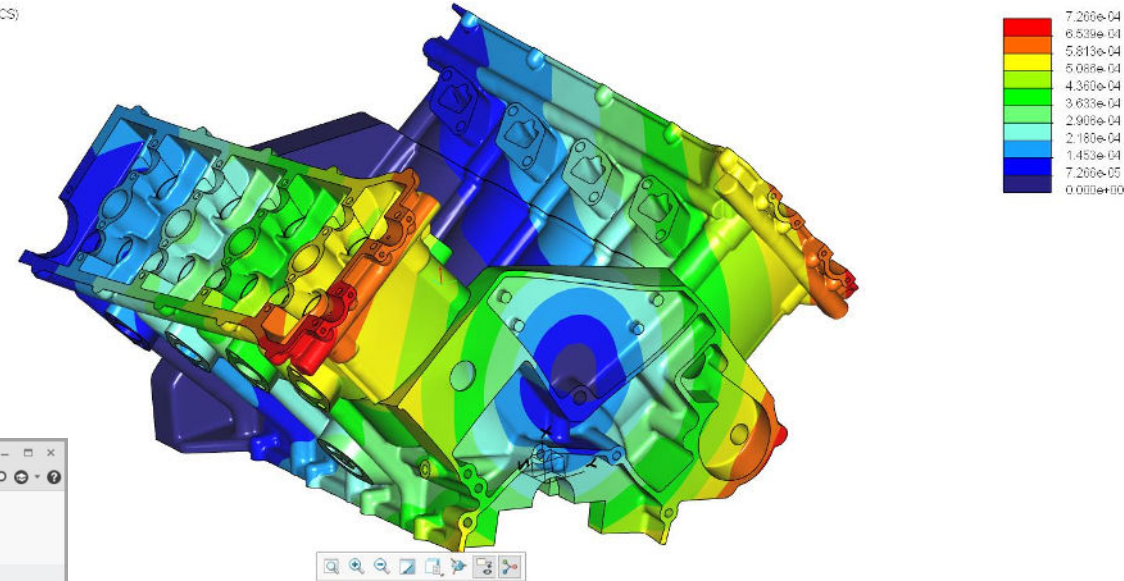
V8 ENGINE MODEL – STATIC ANALYSIS



CREO SIMULATE RESULTS

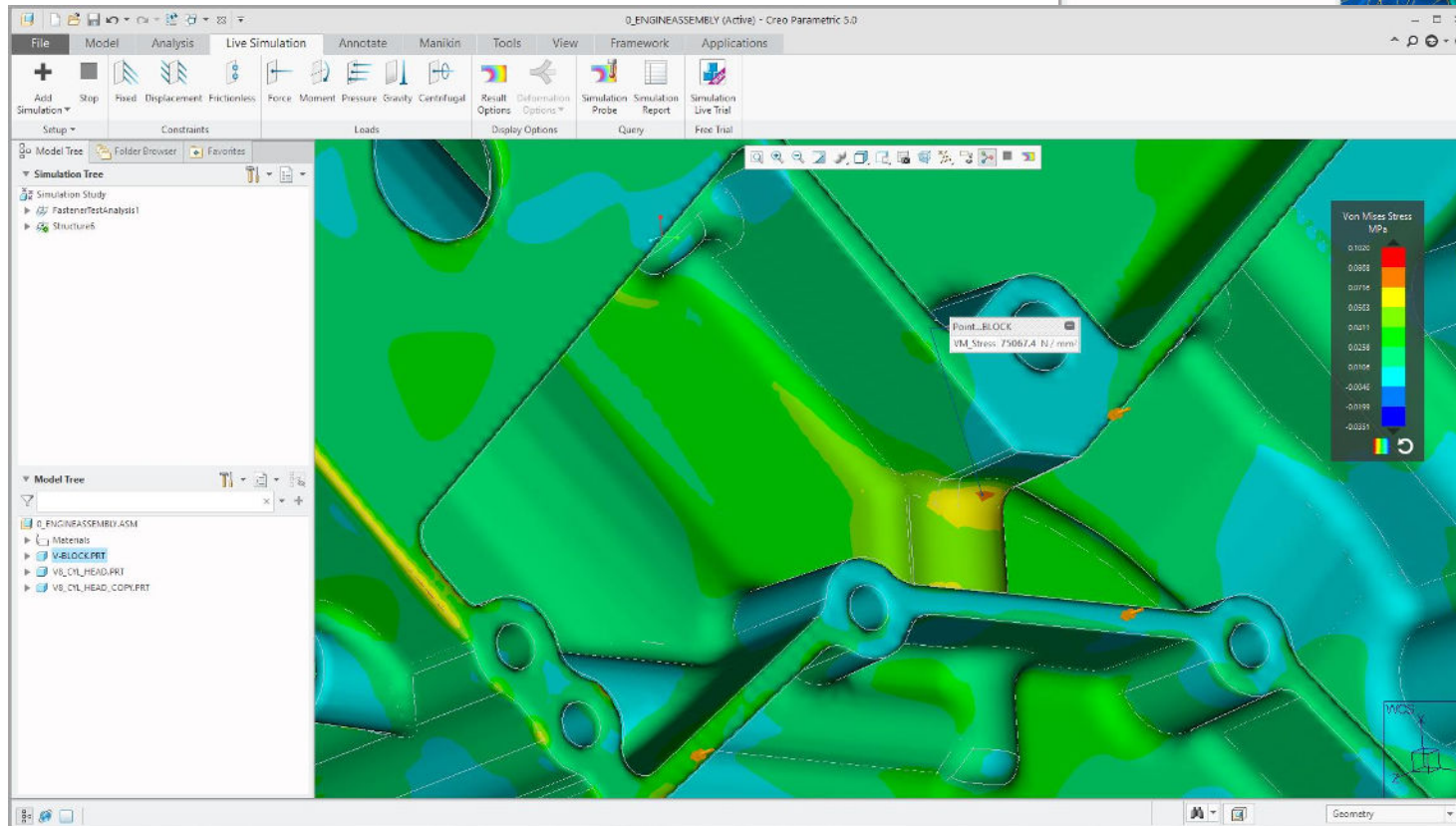
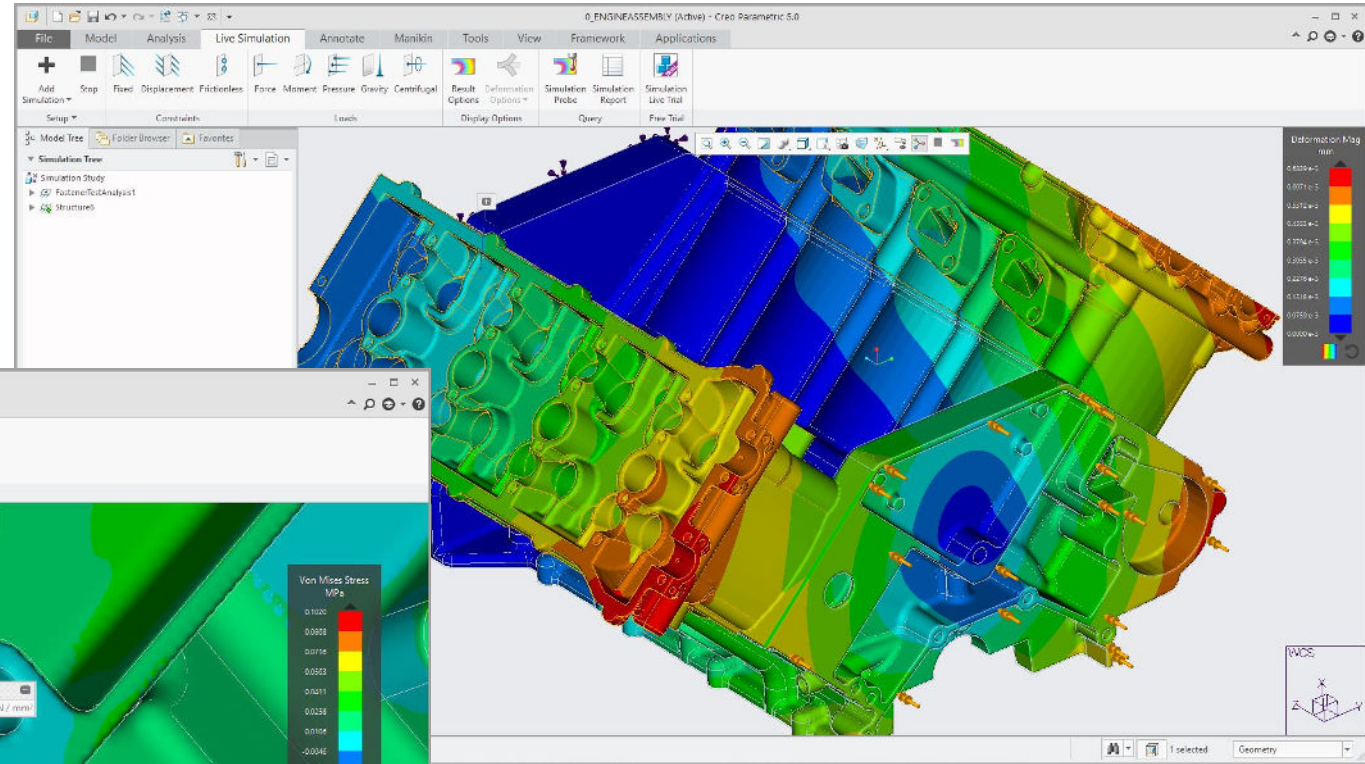
- Max displacement $0.7266\text{e-}3$
- VMS at Ref point $8.513\text{e-}2$

Displacement
Frame 5 of 8
(mm)
Deformed
Max Disp: $7.266\text{E-}04$
Scale: $6.199\text{E+}01$
Loadset/LoadSet1: 0_ENGINEASSEMBLY



CREO SIMULATION LIVE RESULTS

- Max displacement $0.6829\text{e-}3$
- VMS at ref point $7.5067\text{e-}02$

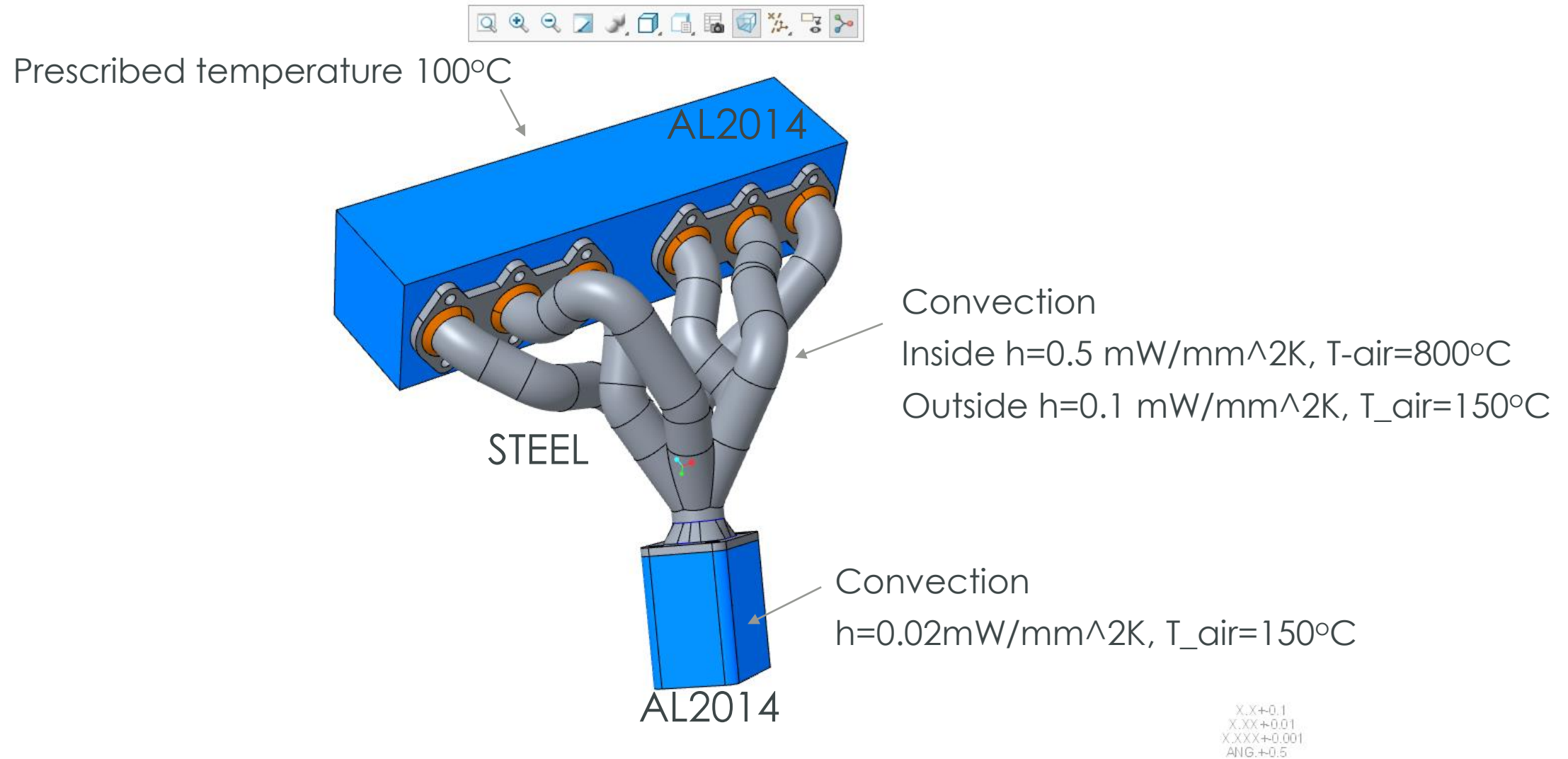


RESULTS COMPARISON

	Creo Simulation Live	Creo Simulate	% difference
max displacement	0.6829e-3 mm	0.7266e-9 mm	6%
Stress at Ref point	7.5067e-02	8.513e-2	12%
Time for single solution	<10 sec	3 hours	!!!!!! 😊

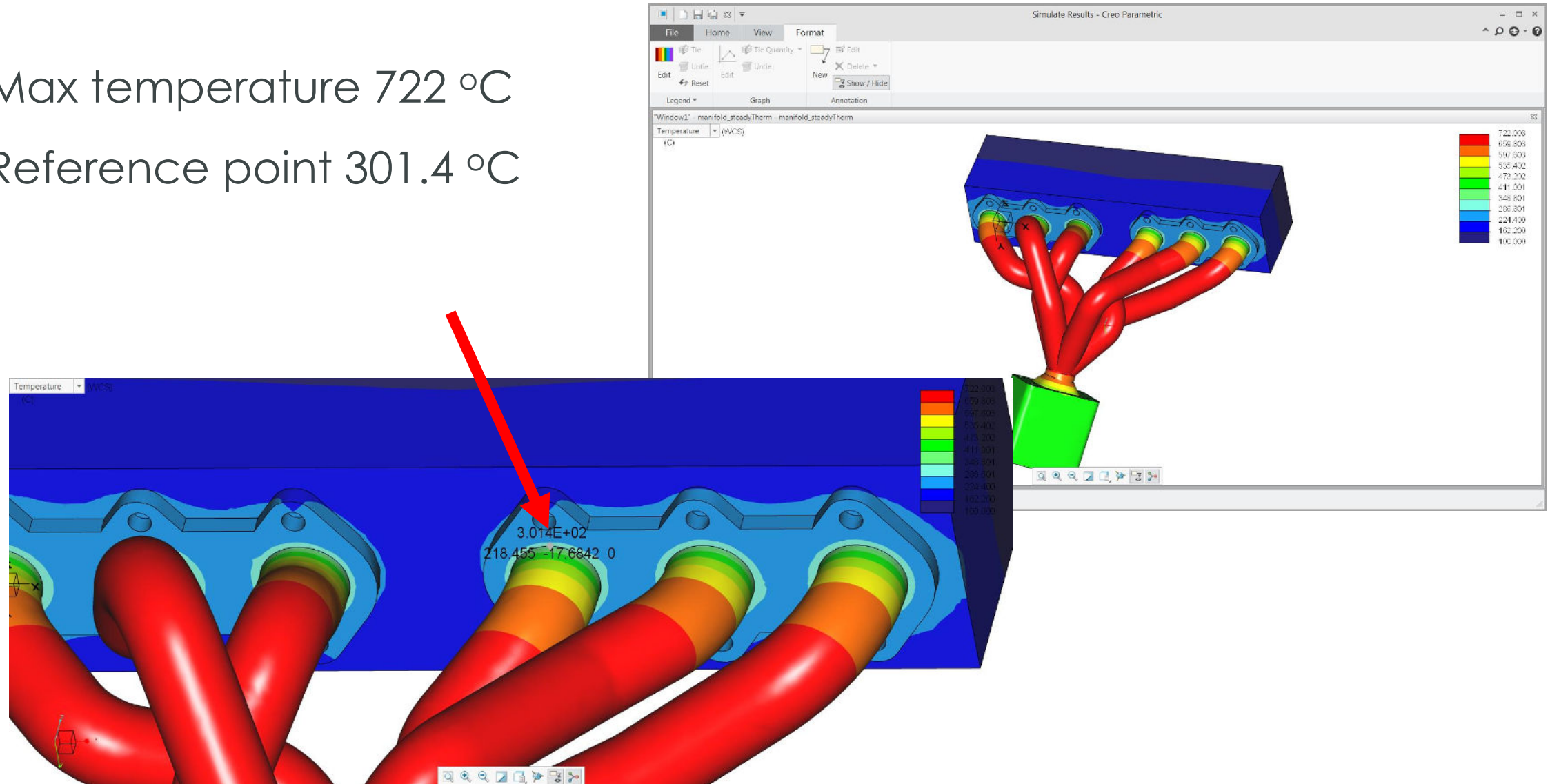
MANIFOLD – THERMAL ANALYSIS

STEADY STATE THERMAL MODEL



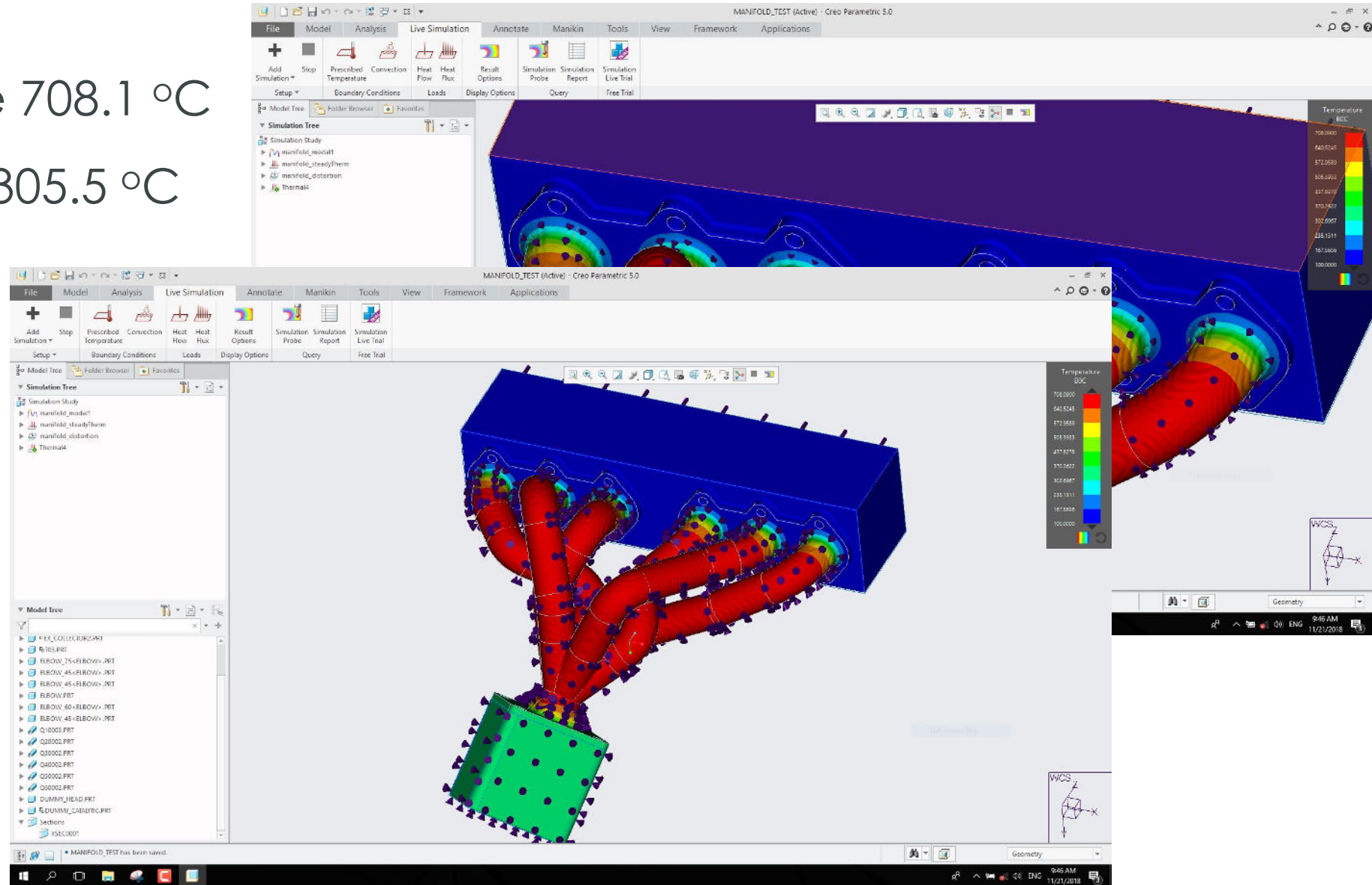
SIMULATE RESULTS

- Max temperature 722 °C
- Reference point 301.4 °C



CREO SIMULATION LIVE RESULTS

- Max temperature 708.1 °C
- Reference point 305.5 °C



RESULTS COMPARISON

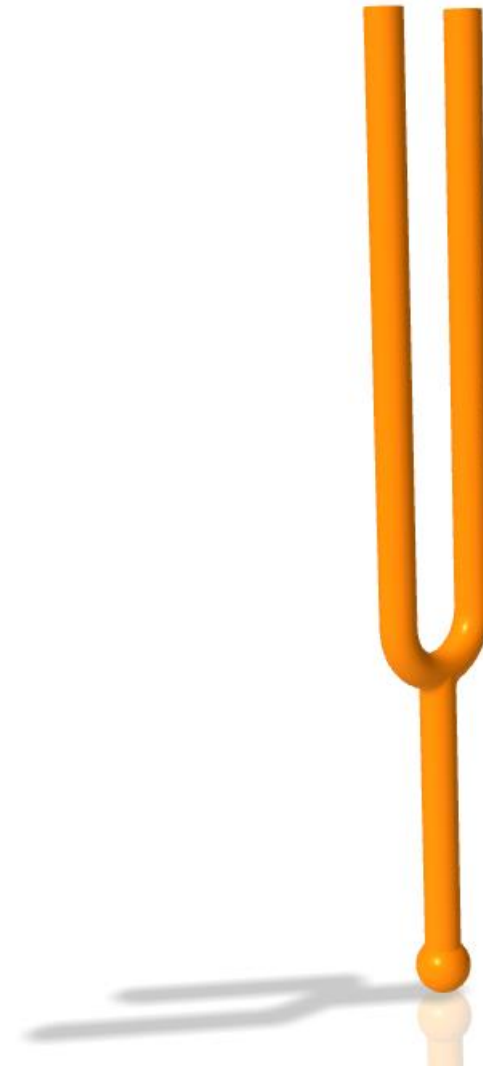
	Creo Simulation Live	Creo Simulate	% difference
Max temperature	708.1 °C	722.0 °C	1.9%
Ref point temp.	305.5 °C	301.4 °C	1.3%
Solution Time	<1 sec	1 minute	60x

* Steady State thermal analysis is AMAZING fast

TUNING FORK – MODAL ANALYSIS

TUNING FORK ANALYSIS

- Used for tuning musical instruments
- A standard reference frequency is 440Hz (A above middle C)
- This frequency is produced when the two “legs” are oscillating
- The first model of vibration is the dominant one, and thus the frequency of the first mode should be 440Hz

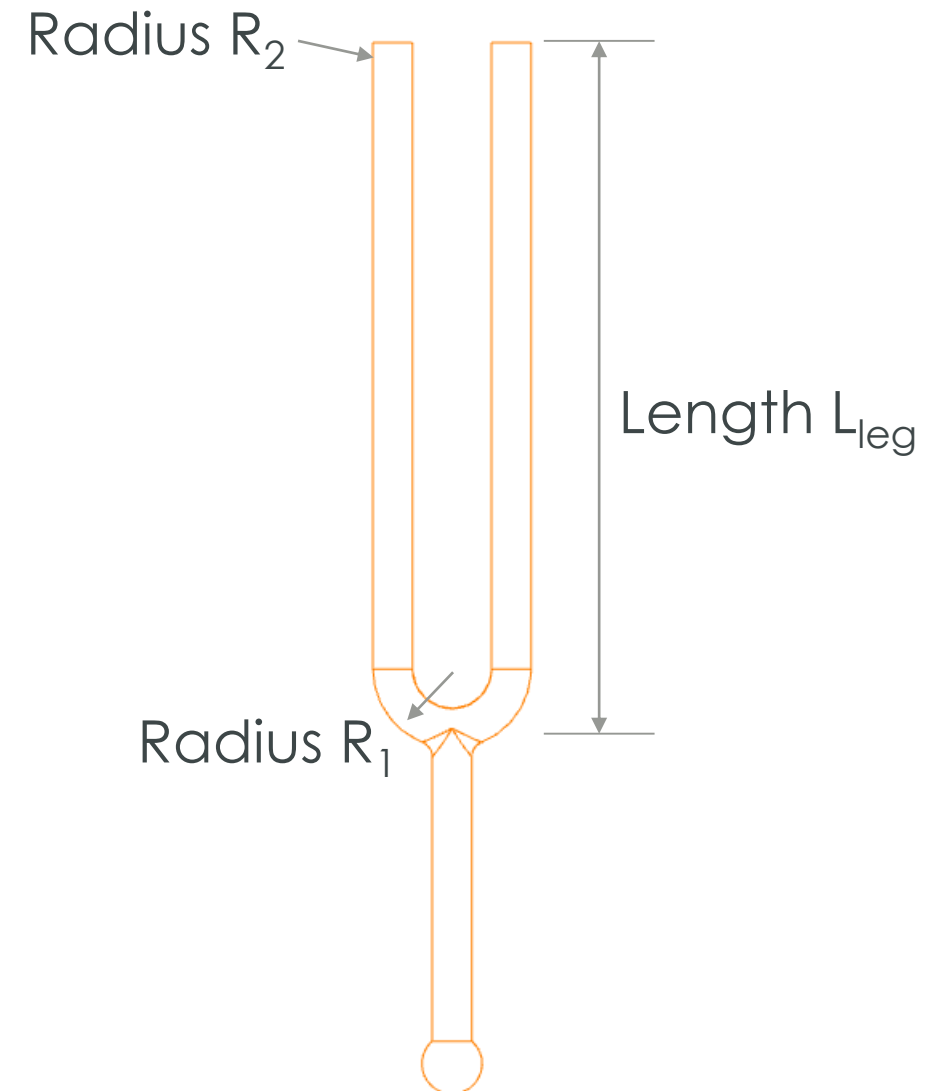


THEORY

- In a rigidly constrained cantilever beam the theoretical* natural frequency is

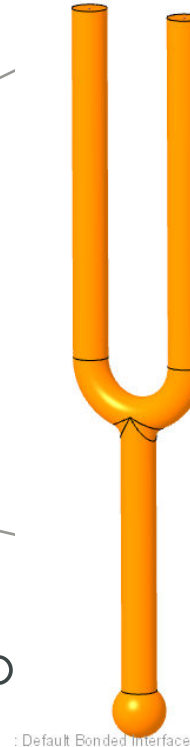
$$f = \frac{1.875^2 \cdot R_2}{4\pi L_{leg}^2} \cdot \sqrt{\frac{E}{\rho}} \quad (1)$$

- Where $L_{leg} = L + \frac{1}{2}\pi R_1$
- Material: AISI4130 where
 $E = 205\text{GPa}$, and $\rho = 7850\text{ kg/m}^3$
- $R_1=7.5\text{mm}$, $R_2=2.5\text{mm}$
- For $f=440\text{Hz}$, $\rightarrow L=78\text{mm}$
- This will be slightly underestimated due to slight differences due to cantilever beam approximation of real geometry



CREO SIMULATE MODEL

- Geometry as shown
 - Set parameter L = 50mm
- Material assigned
- Create Modal analysis
 - Unconstrained
- Results
 - Look for first non-rigid mode (should be the two fork legs moving symmetrically)
 - So for L=50 → f=972Hz



Material Definition

Name
STEEL_AISI_4130

Description

Parameters

File Edit Parameters Tools Show

Look In
Part TUNINGFORK

Filter By Default Customize...

Name	Type	Value	Designate	Access	Source	Description
DESCRIPTION	String	TuningFork	<input checked="" type="checkbox"/>	Full	User-Define	
MODELED_BY	String	Greg	<input checked="" type="checkbox"/>	Full	User-Define	
PART_NUMBER	String	440	<input checked="" type="checkbox"/>	Full	User-Define	
MANUFACTURER	String		<input checked="" type="checkbox"/>	Full	User-Define	
L	Real Number	50.000000	<input type="checkbox"/>	Full	User-Define	
R1	Real Number	7.500000	<input type="checkbox"/>	Full	User-Define	
R2	Real Number	2.500000	<input type="checkbox"/>	Full	User-Define	
PTC_MATERIAL_NAME	String	STEEL_AISI_4130	<input type="checkbox"/>	Full	User-Define	

Reset OK Cancel

Mode	Frequency (Hz)
1	0.000000e+00
2	0.000000e+00
3	0.000000e+00
4	0.000000e+00
5	2.314839e-03
6	4.082460e-03
7	9.718596e+02
8	1.474661e+03
9	1.881424e+03
10	1.926127e+03

with rigid mode search

Modes Temperature distribution Output Convergence Excluded elements

Modes
☒ Number of modes
☐ All modes in frequency range

Number of modes 10

Minimum frequency 0

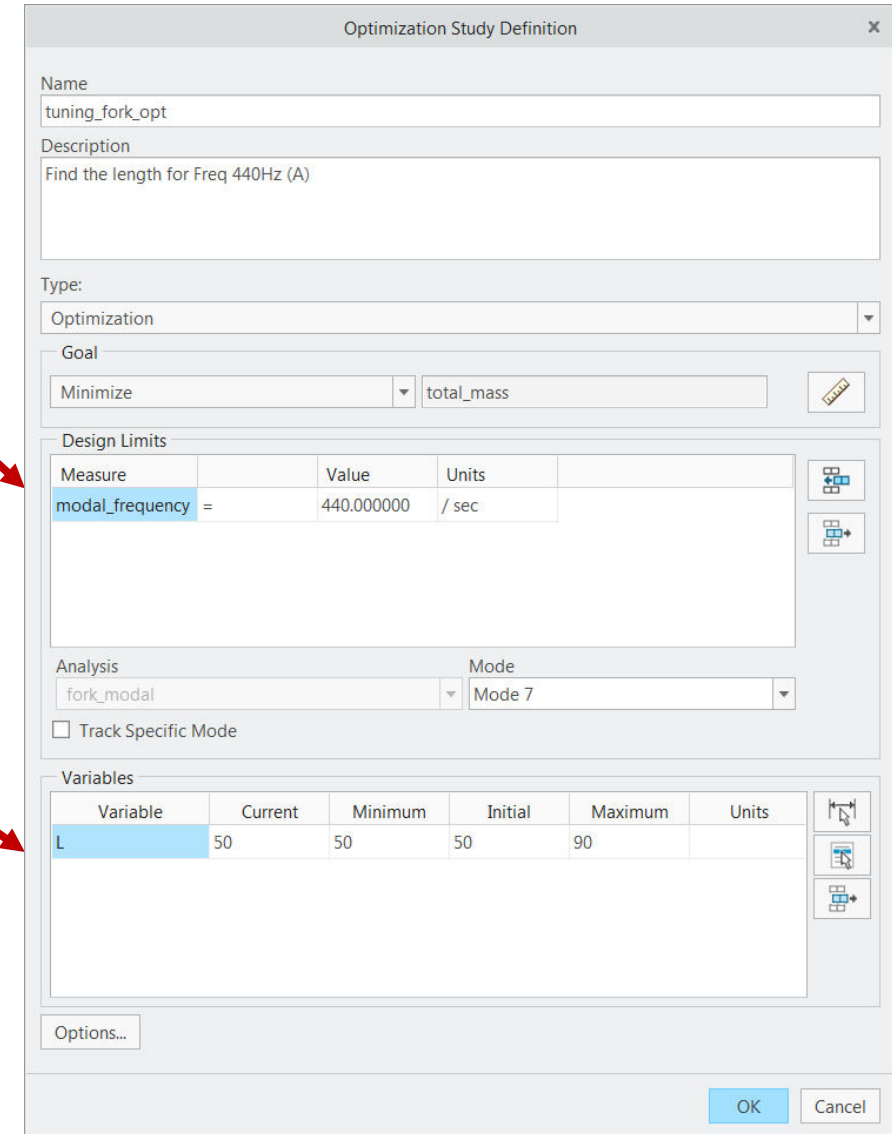
Maximum frequency 0

OK Cancel

OPTIMIZING THE MODEL

- We want to determine length L to give **f=440Hz**
- Use **Optimization Study** in Creo Simulate
- Set the Design Limit to be 440Hz on Mode 7
- Assign parameter L some upper/lower limits
- Run the study
 - Result... **L=79.4mm (giving f=440.4Hz)**

```
Parameters:
  L              79.3952
Status of Optimization Limit: 1
modal_frequency  4.4035e+02 = 4.4000e+02 (satisfied
within tolerance)
```



Optimization Study Definition

Name: tuning_fork_opt

Description: Find the length for Freq 440Hz (A)

Type: Optimization

Goal: Minimize total_mass

Design Limits

Measure		Value	Units
modal_frequency	=	440.000000	/ sec

Analysis: fork_modal Mode: Mode 7

☐ Track Specific Mode

Variables

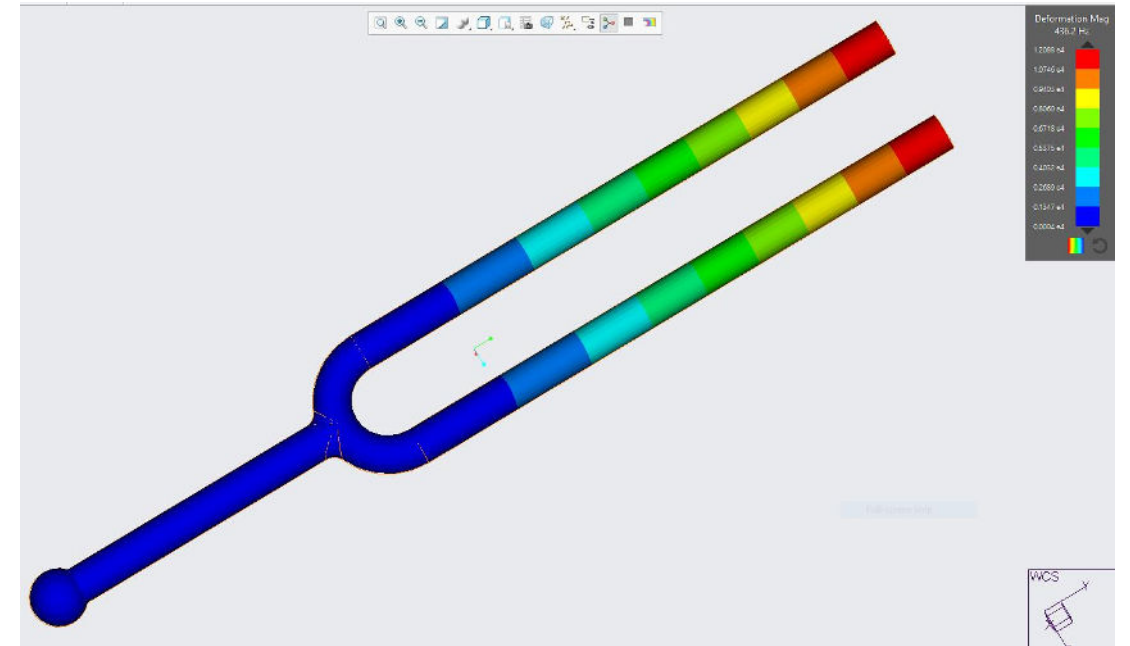
Variable	Current	Minimum	Initial	Maximum	Units
L	50	50	50	90	

Options...

OK Cancel

COMPARING TO CREO SIMULATION LIVE

- The geometry/material from previous analysis used directly
- Unconstrained modal analysis defined
- Results: $f=436.2$ Hz
- This is **about a 1% difference** from Creo Simulate 😊



- The technology used in Creo Simulation Live is shown in these examples (and by ANSYS benchmarks) can clearly be seen to be accurate.
- As long as the physics of the problem can be modeled with linear static, modal and steady state thermal assumptions, then the results in Creo Simulation Live will not differ by any significant amount from traditional FEA codes such as Creo Simulate, and many others.
- Note: In very large models such as the V8 Engine example, there is more chance that small geometric features may be approximated/ignored, thus leading to larger differences in stress results. For the purposes of providing design guidance or evaluating typical design level what-if questions, these differences will have little influence. (compare to other uncertainties in material properties, load values, etc.)
- The value of having near real-time results feedback, completely inside the design environment is enormous, and will revolutionize the way simulation is used to drive designs!

