

Release 2022 R1 Highlights
Ansys Motor-CAD



/ New Features in Motor-CAD at 2021R1 (version 15)

- Motor-CAD software is under continuous development, with the latest major software release of v14 in January 2021.
- Planned changes in Motor-CAD v15 in January 2022 will include:
 - New features
 - New templates
 - New calculation methods
 - Improved integration with Ansys toolset.

Outline

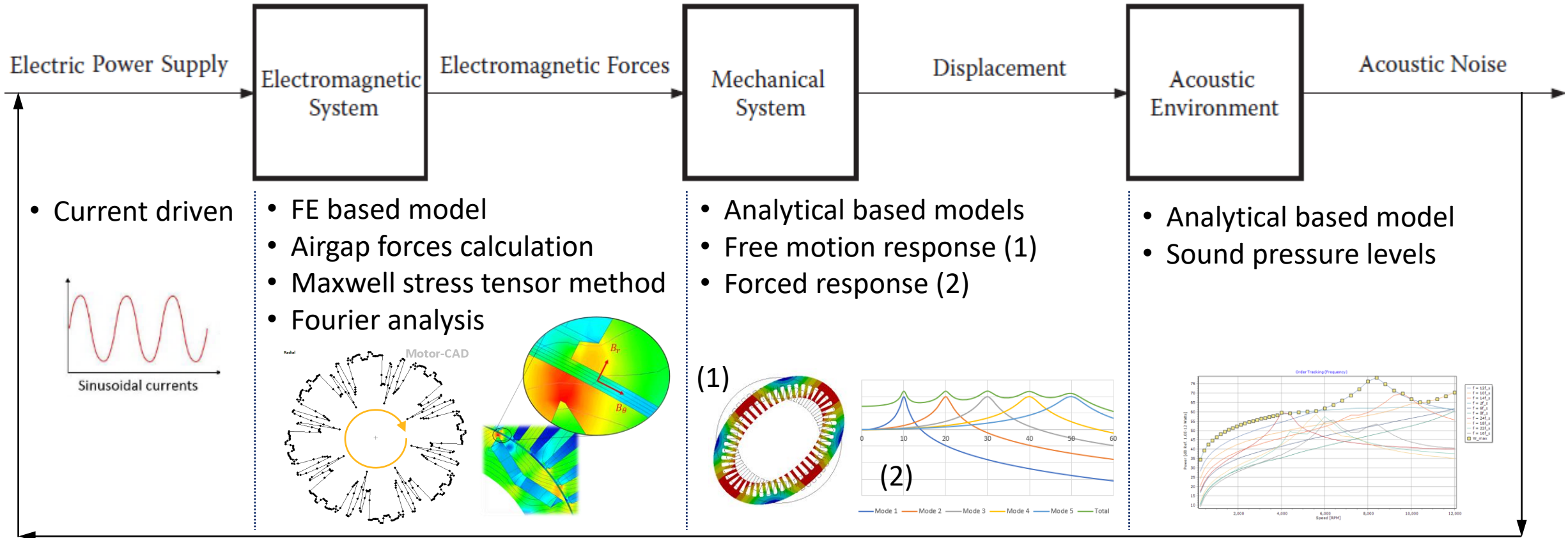
- New NVH Solution
- Integration with Ansys
- Usability (UX)



**New NVH Solution
Motor-CAD Standalone**

Ansys

NVH: Analysis Workflow



Operating point (torque, speed, temperatures)

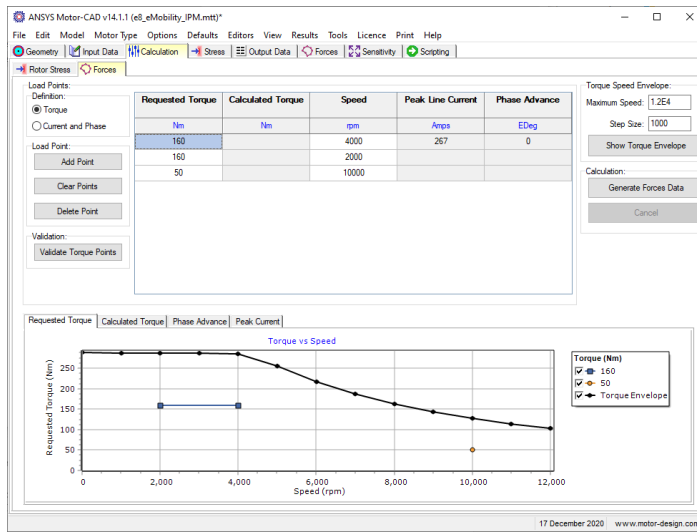
NVH simulation loop: single and multiple operating points



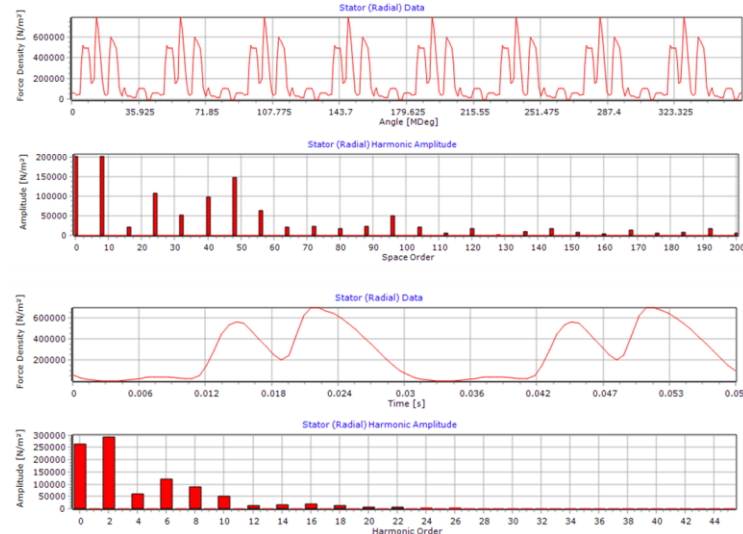
NVH: Excitation Forces

- 1D and 2D Time and Frequency analysis of radial forces using Motor-CAD Electromagnetic FEA Solver.
- Force calculations for single/multiple operating points
- Campbell diagram shows dominant harmonics across speed range
- Force export for high fidelity NVH analysis in dedicated tools
- Available for BPM, SYNCREL and SRM machine types

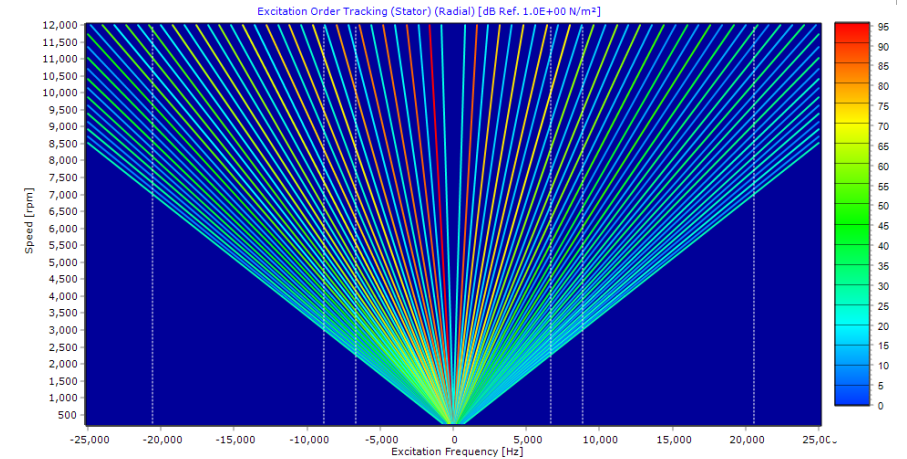
Multiple operating point calculations



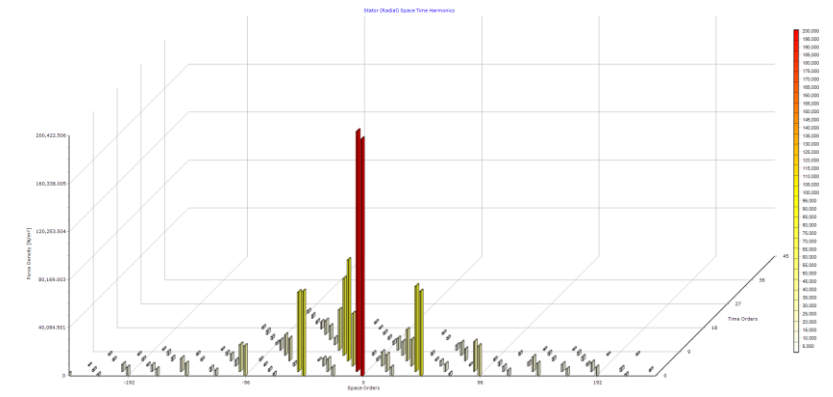
1D Time & Space Force Analysis



Campbell Diagram



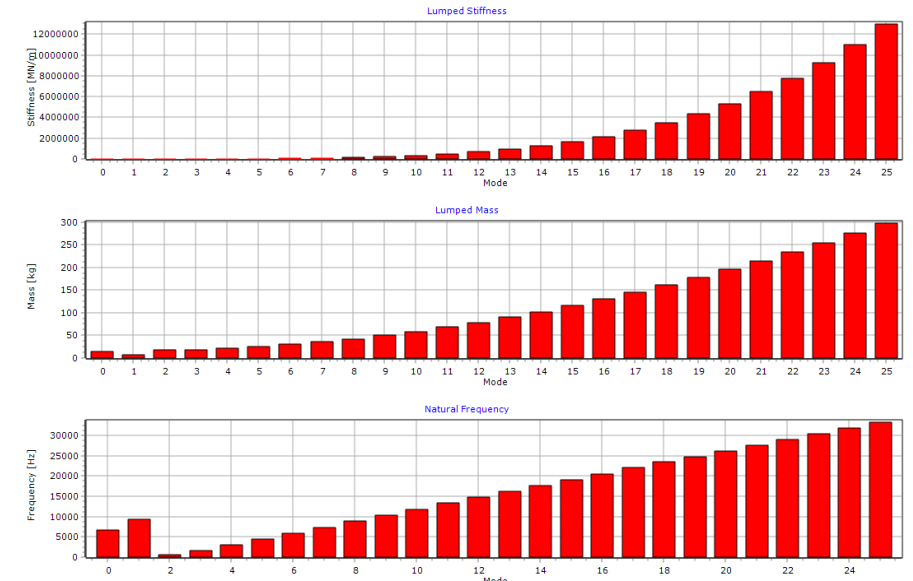
2D Frequency Domain Force Analysis



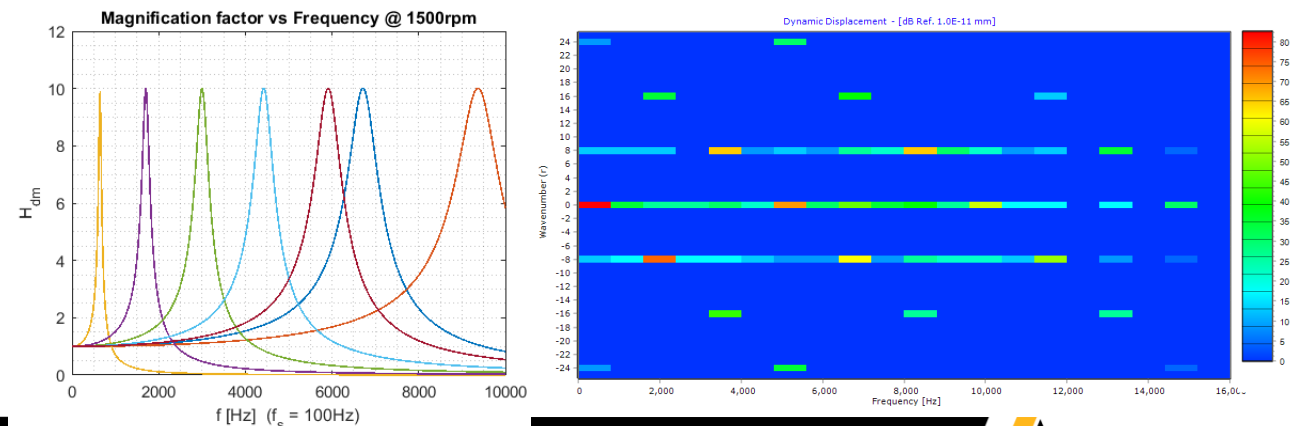
NVH: Structural Analysis

- Based on fast analytical structural models
- Free motion response:
 - Modal Analysis based on equivalent thin ring model
 - Calculate natural frequencies of stator structure
- Forced response:
 - Static displacement calculation
 - Effect of resonance visualised as magnification factor
 - Dynamic displacement calculation
 - Dynamic velocity provides input into acoustic models
 - Dynamic acceleration direct measure for vibration

Modal analysis results

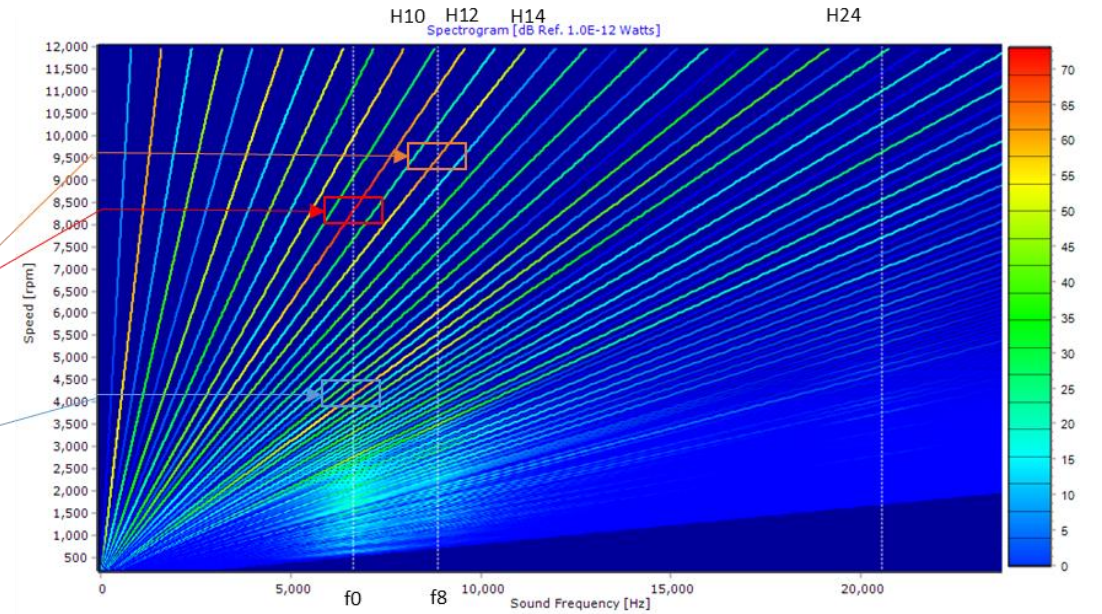
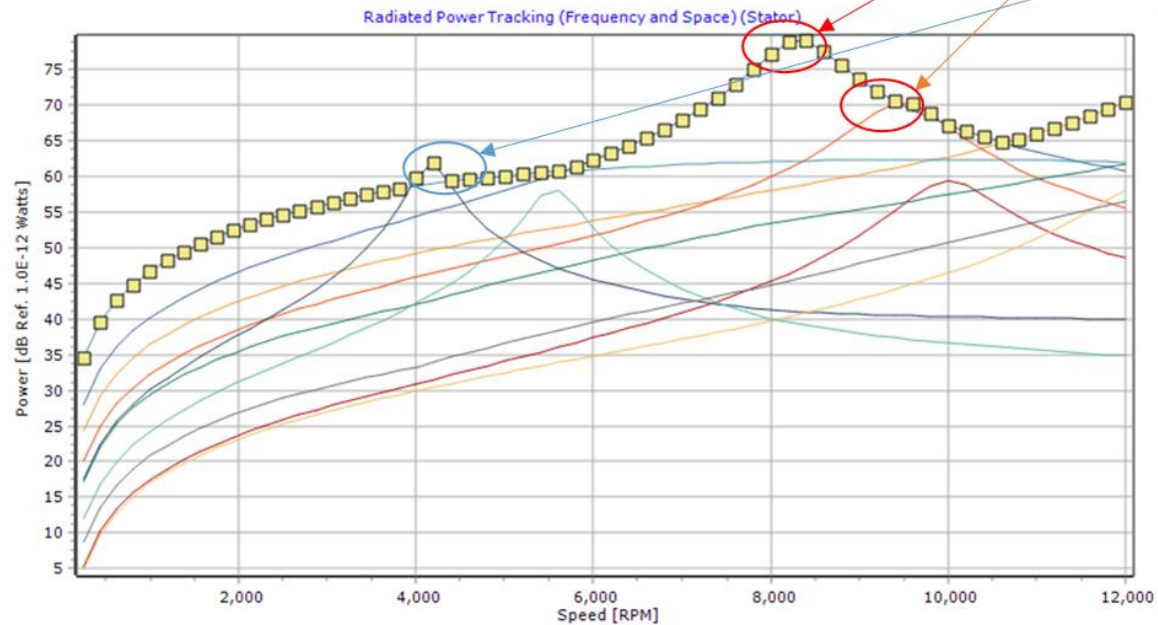


Dynamic displacement and magnification factors



NVH: Acoustic analysis

- Based on fast analytical acoustic models
- Spectrograms and spatiograms quantify acoustic response across speed range
- Order tracking provides further insight for root cause analysis and identifying measures to reduce noise



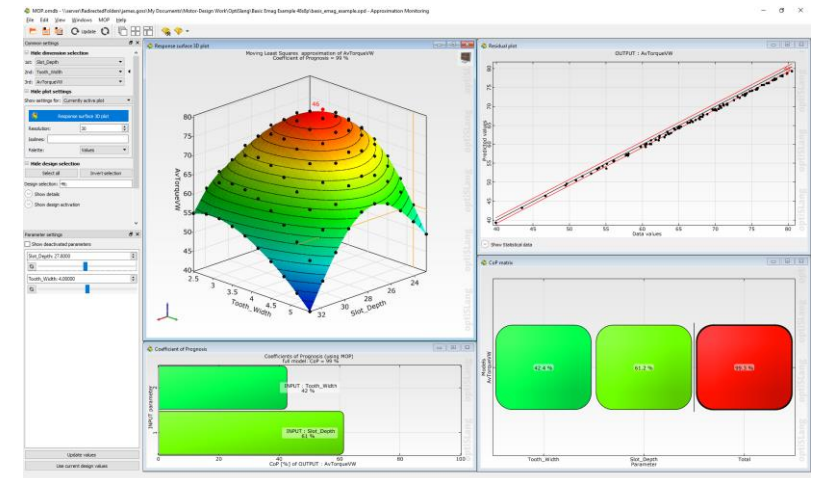
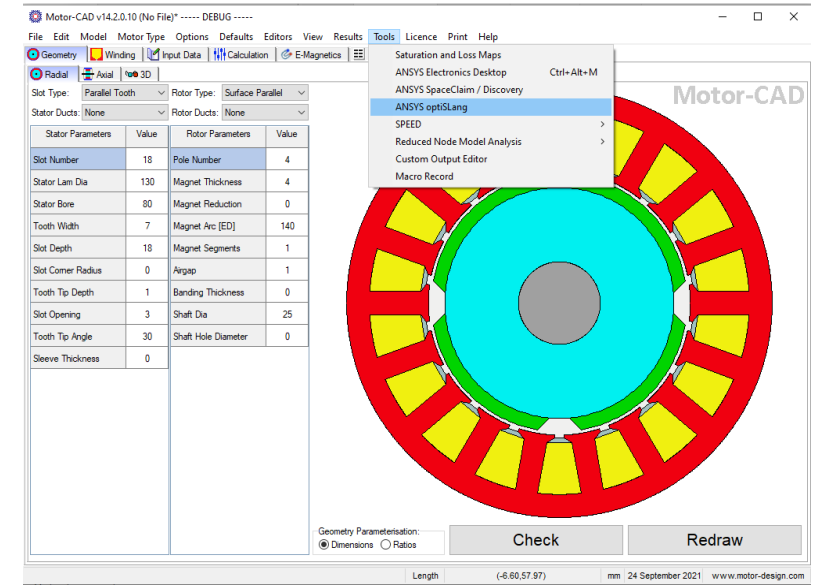
- New Motor-CAD NVH Solution:
 - Quickly compare noise for different motor concepts
 - Easily identify the cause of any motor noise early on
 - Provide the tools to enable a motor designer to make changes to reduce noise
- Avoid noise issues before they become a problem.

Integration with Ansys

Ansys

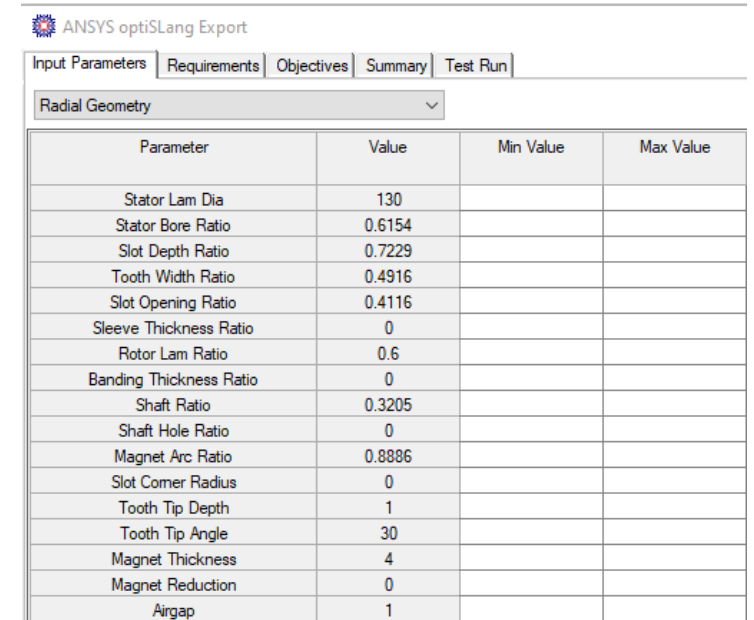
Ansyes optiSLang Export (1/3)

- Allows users to create a fully set-up optiSLang project ready to run based upon a base machine design in Motor-CAD. Template based optimisation.
- No scripting required, removes a significant amount of the workflow. Can go from a Motor-CAD file to an optiSLang MOP just via GUI interaction.
- Also useful for more experienced users. The exported script can be used as a template to customise and create more complex procedures. Fully compatible with the current Python node methodology.
- Available for BPM, SYNCREL and IM machine types.



ANSYS optiSLang Export (2/3)

- User can pick from a range of input parameters and specify upper and lower bounds.
- Geometry, magnetic model and winding parameters.
- Outputs (requirements/constraints and objectives) can then be specified. Peak & continuous performance, mechanical analysis, torque ripple, duty cycle analysis, volume and mass.

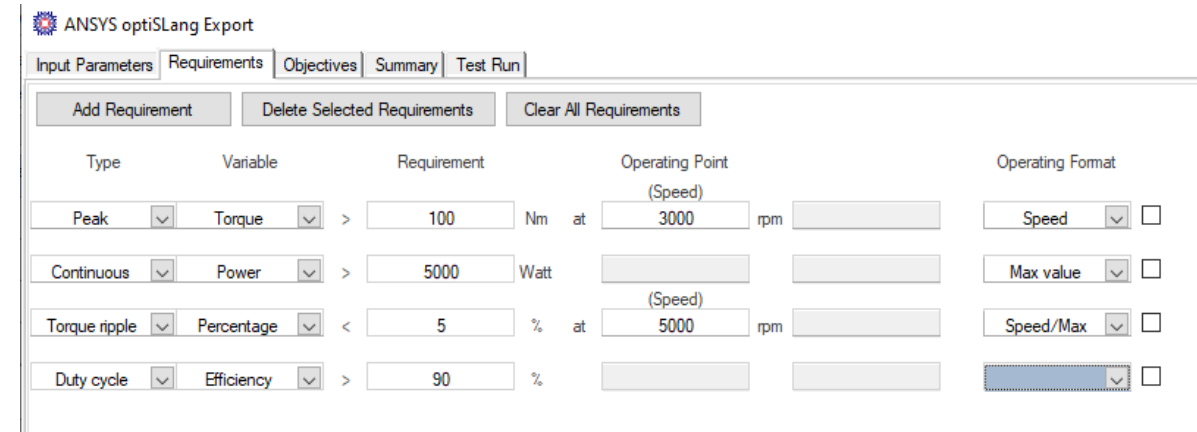


ANSYS optiSLang Export

Input Parameters | Requirements | Objectives | Summary | Test Run

Radial Geometry

Parameter	Value	Min Value	Max Value
Stator Lam Dia	130		
Stator Bore Ratio	0.6154		
Slot Depth Ratio	0.7229		
Tooth Width Ratio	0.4916		
Slot Opening Ratio	0.4116		
Sleeve Thickness Ratio	0		
Rotor Lam Ratio	0.6		
Banding Thickness Ratio	0		
Shaft Ratio	0.3205		
Shaft Hole Ratio	0		
Magnet Arc Ratio	0.8886		
Slot Corner Radius	0		
Tooth Tip Depth	1		
Tooth Tip Angle	30		
Magnet Thickness	4		
Magnet Reduction	0		
Airgap	1		



ANSYS optiSLang Export

Input Parameters | Requirements | Objectives | Summary | Test Run

Add Requirement | Delete Selected Requirements | Clear All Requirements

Type	Variable	Requirement	Operating Point	Operating Format
Peak	Torque	> 100 Nm	(Speed) 3000 rpm	Speed <input type="checkbox"/>
Continuous	Power	> 5000 Watt		Max value <input type="checkbox"/>
Torque ripple	Percentage	< 5 %	(Speed) 5000 rpm	Speed/Max <input type="checkbox"/>
Duty cycle	Efficiency	> 90 %		<input type="checkbox"/>

ANSYS optiSLang Export (3/3)

- A summary of the optimisation is shown before exporting. Users just have to specify the optiSLang exe to be used and the export directory. Everything else should be handled by the install.
- Test run feature also available. This shows the Python script that will be used and allows users to see the output values for the current design and roughly how long a single run takes.

ANSYS optiSLang Export

Input Parameters | Requirements | Objectives | Summary | Test Run

Input Parameters:

Variable	Min Value	Max Value
Stator Lam Dia	100	200
Stator Bore Ratio	0.5	0.8
Tooth Width Ratio	0.4	0.6
Shaft Ratio	0.2	0.4
Magnet Thickness	3	5

Requirements:

- Peak Shaft Torque > 100 Nm at 3000 rpm
- Continuous Shaft Power > 5000 Watts at maximum point on speed curve
- Torque Ripple (M/Vv) [%] < 5 % at 5000 rpm, maximum current
- Average Efficiency (Point by Point) > 90 %

Objectives:

- Minimise Weight Magnet
- Minimise Active Volume

optiSLang Exe Location:
C:\Program Files\Dynardo\ANSYS optiSLang\2021 R2\optislang.exe

Optimisation Export Folder:
C:\Workspace\Motor-CAD64\Dev\RobertKelly\Output\optiSLangExport

ANSYS optiSLang Export

Input Parameters | Requirements | Objectives | Summary | Test Run

Control:

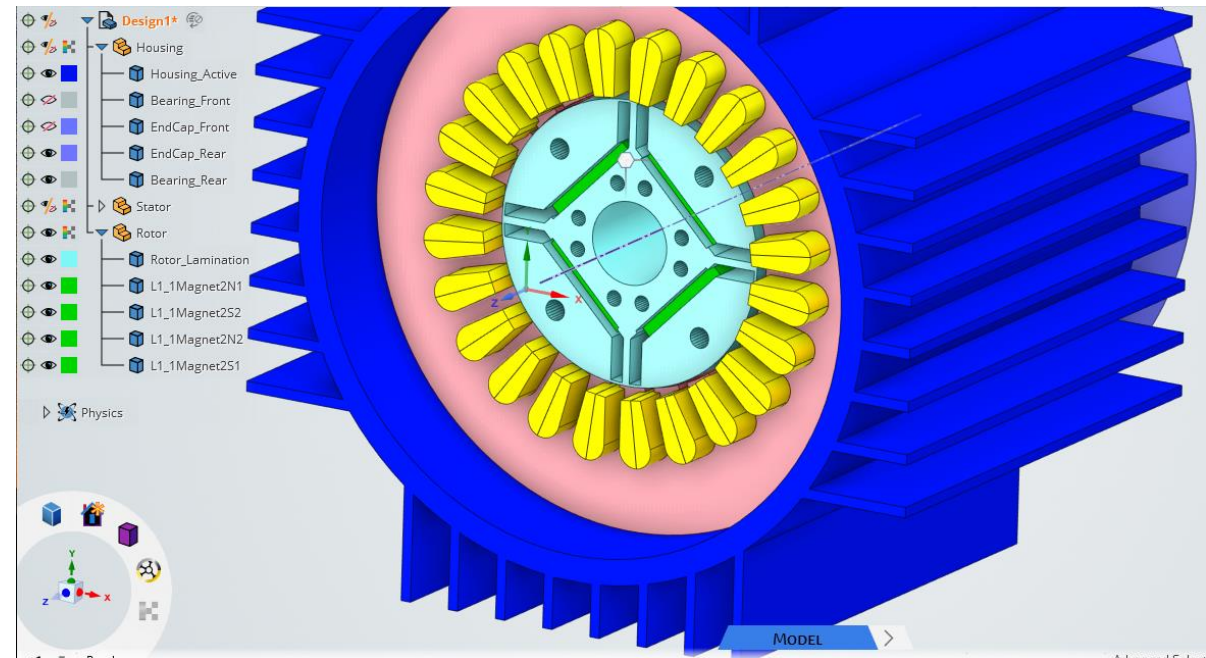
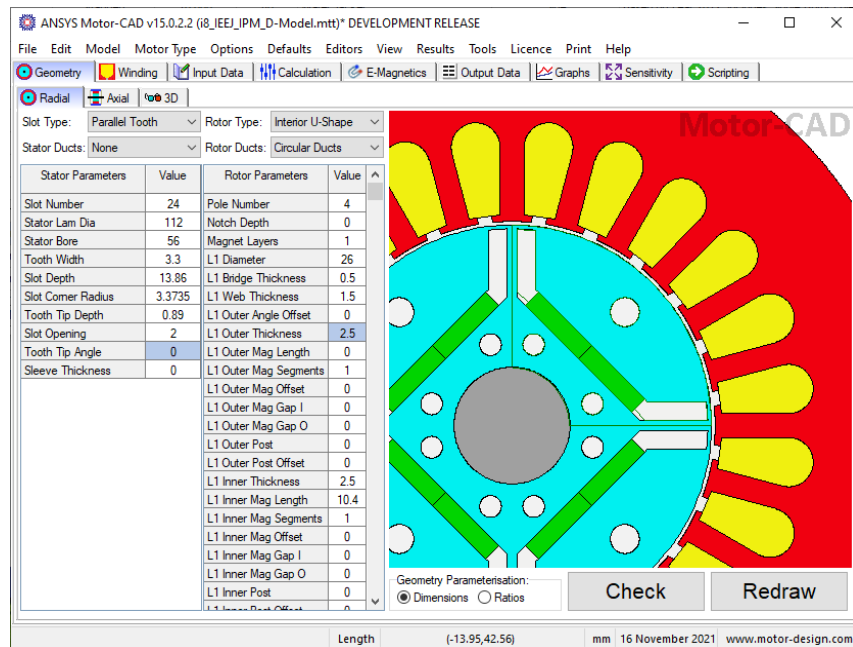
Script:

```
1  ### -----###
2  ### -----Motor-CAD to optiSLang coupled export script-----###
3  ### -----###
4
5  import win32com.client
6  import os
7  import time as timeModule
8  from os import getcwd
9  from os.path import join, dirname, exists, basename
10 from collections import OrderedDict
11 from time import localtime, strftime, sleep, time
12 from scipy.io import loadmat
13
14 ### -----###
15 ### To be filled in by user if not being used with export--- ###
16 ### -----###
17
18 refDir = 'To be filled in by user or optislang'
19 motFileName = 'To be filled in by user or optislang (no .mot extension)'
20
21 ### -----###
```

1 Test run outputs will appear here upon completion.

Export of geometries to Ansys Discovery (1/4)

- Export of 3D geometries from Motor-CAD into Discovery for use in Ansys Toolset.
- Is achieved using Python scripting
- Ability to have export of geometry that is not available in Motor-CAD template.
 - Export custom geometry in Motor-CAD defined from dxf



Export of geometries to Ansys Discovery (2/4)

ANSYS Motor-CAD v15.1.1 (e8_eMobility_IPM.mtt)*

File Edit Model Motor Type Options Defaults Editors View Results Tools Licence Print Help

Geometry Winding Input Data Calculation E-Magnetics

FEA FEA Editor FEA Paths

Use Custom Regions: E-Magnetic Mechanical Thermal Slot Thermal Pole

Check Mode: Automatic Manual

View Options: Show Airgap and Boundaries Display DXF Errors

Positions E-Magnetics

Region Name	Region Material	X	Y
Units			
AmatureSlotL1	Copper (Pure)	77.19	3.577
AmatureSlotR1	Copper (Pure)	77	6.529
L1_1Magnet2	N30UH	39.98	27.41
L1_1Magnet1	N30UH	47.65	8.886
L2_1Magnet2	N30UH	53.5	29.68
L2_1Magnet1	N30UH	58.82	16.84
Rotor	M350-50A	59.59	24.68
Rotor Pocket		41.4	38.6
Rotor Pocket		51.55	36.79
RotorDuctFluidRegion		29.54	12.23
RotorDuctFluidRegion		44.73	42.93
RotorDuctFluidRegion		61.99	1.275
Shaft		2.053	0.8505
Stator	M350-50A	98.59	6.462
StatorAir		66.45	4.355
StatorWedge		67.28	4.41

Region Check 100% complete. 3 December 2021 www.motor-design.com

SpaceClaim / Discovery Export

Model Type: 3D 2D

Machine Component Selection: Housing Stator Rotor

File: C:\workspace\Discovery_Export.py

Select file

Cancel Export

Design1 - SpaceClaim

File Sketch Design Display Assembly Measure Facets Repair Prepare Workbench Detail Sheet Metal Tools KeyShot

ANSYS 2021 R1

```
1 # SpaceClaim python script created by Motor-CAD v14.1
2 # Motor-CAD file: C:\workspace\Motor-CAD64\Dev\Lyndon
3
4 # Geometry utility functions
5
6 # Look up list for components
7 compColourList = list()
8
9 # Set Component Colour
10 def SetComponentColour(aComponent, aR, aG, aB):
11     compSelection = ComponentSelection.Create(aComponent)
12     options = SetColorOptions()
13     options.UseAlpha = True
14     options.Exact = True
15     options.RandomColor = False
16     options.RandomSeed = 0
17     options.EdgeColorTarget = EdgeColorTarget.Body
18     options.FaceColorTarget = FaceColorTarget.Body
19     ColorHelper.SetColor(compSelection, options, Color.FromRGB(aR, aG, aB))
20 # EndBlock
21
22 def GetPoint(aX, aY):
23     return Point2D.Create(aX, aY)
24
25 # Sketch Lines
```

e8_Full.py

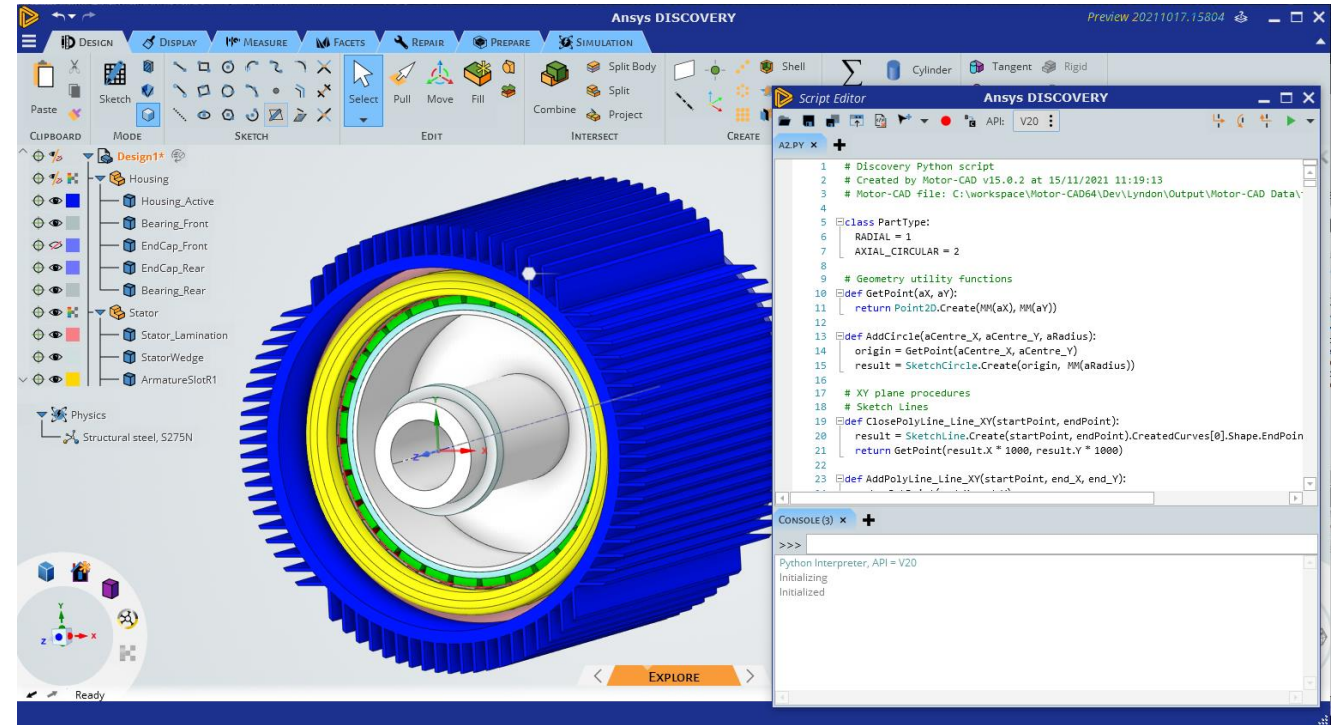
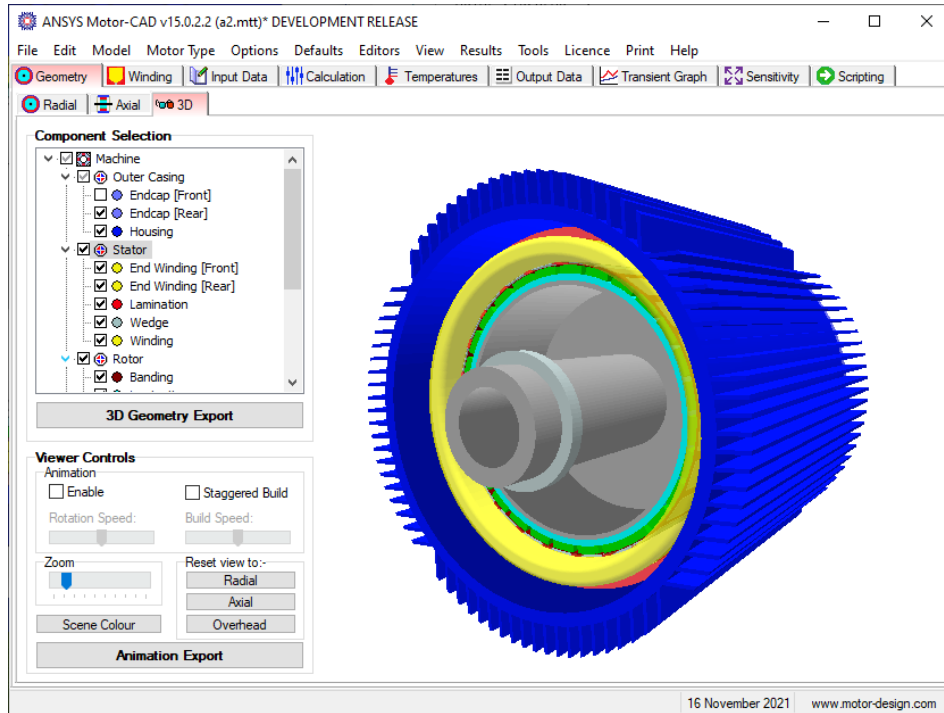
Interpreter

```
>>>
```

result = ComponentHelper.SetRootActive(None)
ViewHelper.ZoomToEntity(Selection.Create(GetRootPart()))

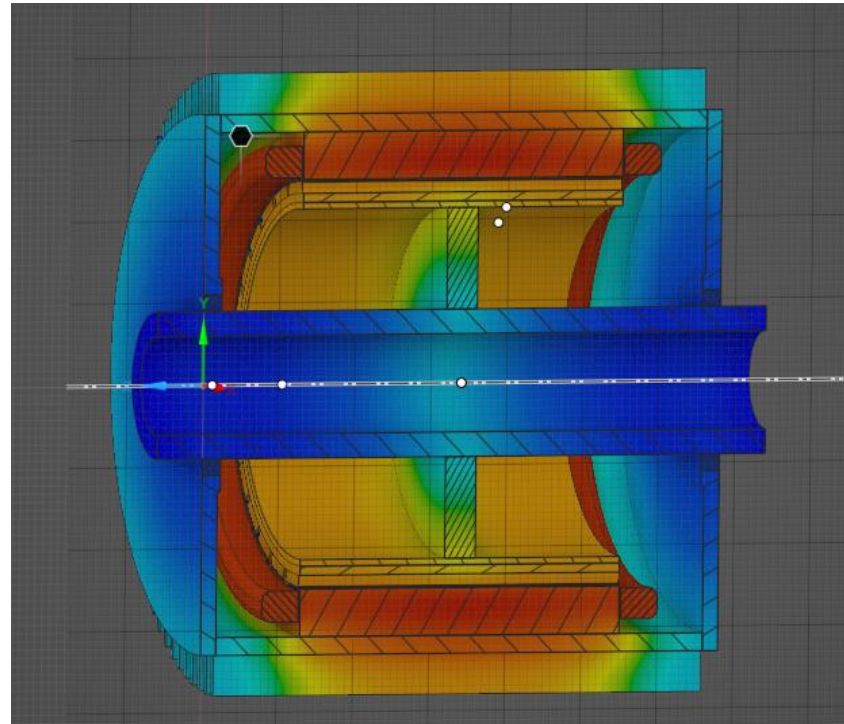
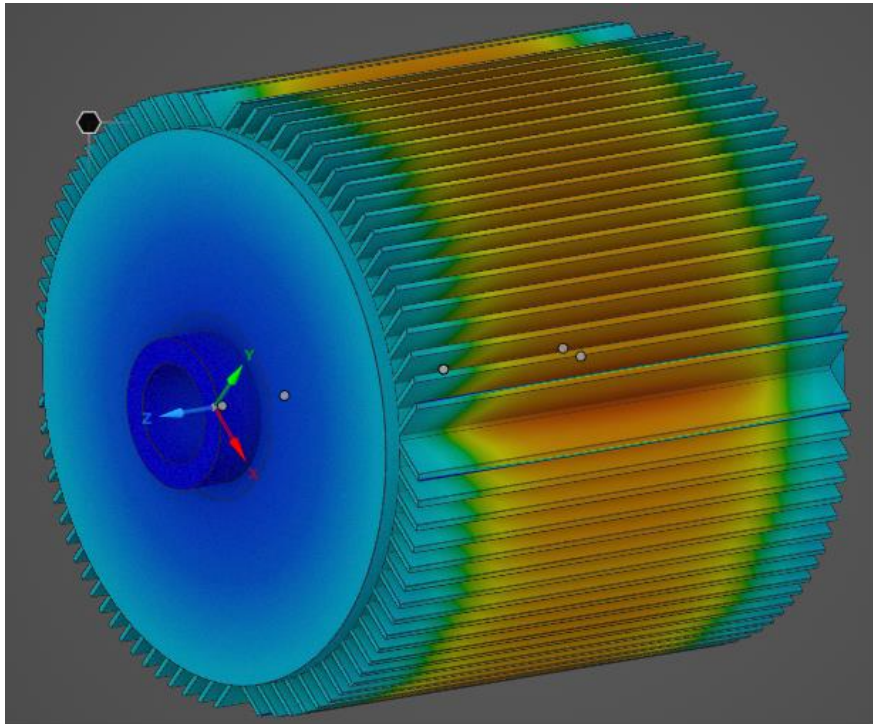
Console (1)

Export of geometries to Ansys Discovery (3/4)



Thermal Analysis in Ansys Discovery (4/4)

- Geometry exported from Motor-CAD can then be used for more detailed analysis in Ansys Discovery
- This example shows thermal analysis of the machine in Ansys Discovery



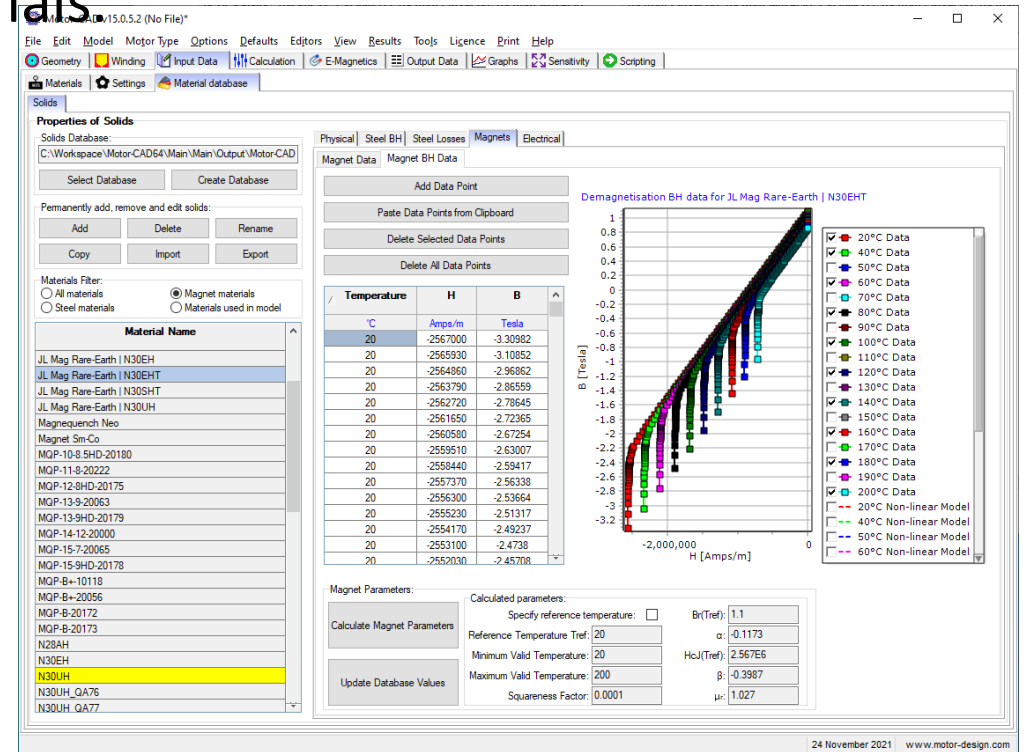
Granta Material Database (1/2)

Large database of Magnet and Electrical Steel materials from Granta are now included with Motor-CAD (>800 materials).

- Import materials from Granta databases.
- Granta licence required to access these materials.

- AlNiCo_magnet.gdb
- Bonded_molded_magnet.gdb
- Ferrite_ceramic_magnet.gdb
- Neodymium_magnet.gdb
- Neodymium_magnet_JL_Mag.gdb
- Samarium_cobalt_magnet.gdb
- Alloy_powder_core.gdb
- Cobalt_steel.gdb
- Electrical_steel_grain_oriented.gdb
- Electrical_steel_non_grain_oriented.gdb
- Ferrite_core.gdb
- Iron_powder_core_plus_SMC.gdb
- Metglas_and_nanocrystalline.gdb
- Nickel_steel.gdb

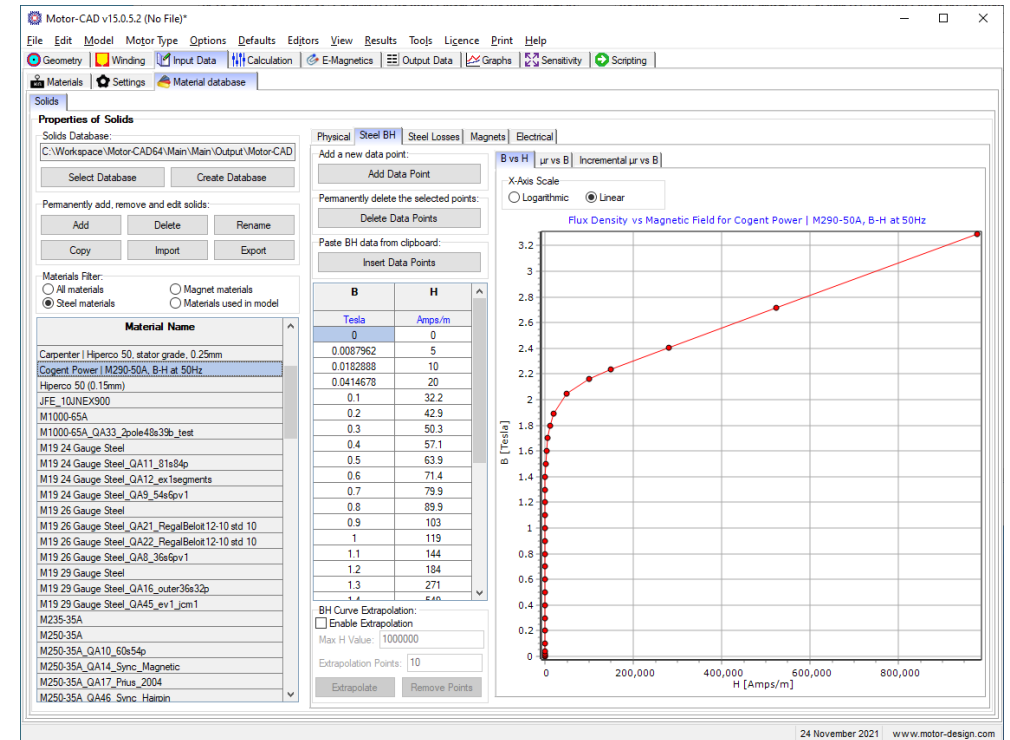
Material	Type	Thermal Conductivity	Specific Heat	Density	Resistivity	Temp. Coef. of Resistivity	Magnet BH Values	Notes
Units		W/m ² /°C	kJ/kg/°C	kg/m ³	Ohm.m			
<input type="checkbox"/> Arnold N48H	Magnet	8.7	470	7500	1.8E-6	0	135	Neodymium magnet - Arnold - N48H. Data provided by MagWeb and
<input type="checkbox"/> Arnold N48M	Magnet	8.7	470	7500	1.8E-6	0	137	Neodymium magnet - Arnold - N48M. Data provided by MagWeb and
<input type="checkbox"/> Arnold N48SH	Magnet	8.7	470	7500	1.8E-6	0	112	Neodymium magnet - Arnold - N48SH. Data provided by MagWeb and
<input type="checkbox"/> Arnold N50	Magnet	8.7	470	7500	1.8E-6	0	138	Neodymium magnet - Arnold - N50. Data provided by MagWeb and
<input type="checkbox"/> Arnold N50H	Magnet	8.7	470	7500	1.8E-6	0	135	Neodymium magnet - Arnold - N50H. Data provided by MagWeb and
<input type="checkbox"/> Arnold N50M	Magnet	8.7	470	7500	1.8E-6	0	116	Neodymium magnet - Arnold - N50M. Data provided by MagWeb and
<input type="checkbox"/> Arnold N52	Magnet	8.7	470	7500	1.8E-6	0	140	Neodymium magnet - Arnold - N52. Data provided by MagWeb and
<input type="checkbox"/> Arnold N52M	Magnet	8.7	470	7500	1.8E-6	0	166	Neodymium magnet - Arnold - N52M. Data provided by MagWeb and
<input type="checkbox"/> Arnold N55	Magnet	8.7	470	7500	1.8E-6	0	115	Neodymium magnet - Arnold - N55. Data provided by MagWeb and
<input type="checkbox"/> AT&M ATMAX33H	Magnet	8.7	470	7300	1.5E-6	0	46	Neodymium magnet - AT&M - ATMAX33H. Data provided by MagWeb
<input type="checkbox"/> AT&M ATMAX45H	Magnet	8.7	470	7300	1.5E-6	0	133	Neodymium magnet - AT&M - ATMAX45H. Data provided by MagWeb
<input type="checkbox"/> AT&M ATMAX50M	Magnet	8.7	470	7300	1.5E-6	0	113	Neodymium magnet - AT&M - ATMAX50M. Data provided by MagWeb
<input type="checkbox"/> BJMT N48UHa	Magnet	8.7	470	7500	1.5E-6	0	107	Neodymium magnet - BJMT - N48UHa. Data provided by MagWeb and
<input type="checkbox"/> BJMT N50UH	Magnet	8.7	470	7500	1.5E-6	0	106	Neodymium magnet - BJMT - N50UH. Data provided by MagWeb and
<input type="checkbox"/> BJMT N52UH	Magnet	8.7	470	7500	1.5E-6	0	106	Neodymium magnet - BJMT - N52UH. Data provided by MagWeb and
<input type="checkbox"/> Bunting N335H	Magnet	8.7	470	7500	1.5E-6	0	71	Neodymium magnet - Bunting - N335H. Data provided by MagWeb and
<input type="checkbox"/> Bunting N33UH	Magnet	8.7	470	7500	1.5E-6	0	52	Neodymium magnet - Bunting - N33UH. Data provided by MagWeb and
<input type="checkbox"/> Bunting N35H	Magnet	8.7	470	7500	1.5E-6	0	75	Neodymium magnet - Bunting - N35H. Data provided by MagWeb and
<input type="checkbox"/> Bunting N50	Magnet	8.7	470	7500	1.5E-6	0	141	Neodymium magnet - Bunting - N50. Data provided by MagWeb and
<input type="checkbox"/> Daido Electronics ND-31HR	Magnet	8.7	470	7600	1.35E-6	0	52	Neodymium magnet - Daido Electronics - ND-31HR. Data provided by
<input type="checkbox"/> Daido Electronics ND-31SHR	Magnet	8.7	470	7700	1.35E-6	0	47	Neodymium magnet - Daido Electronics - ND-31SHR. Data provided by
<input type="checkbox"/> Daido Electronics ND-35HR	Magnet	8.7	470	7600	1.35E-6	0	52	Neodymium magnet - Daido Electronics - ND-35HR. Data provided by
<input type="checkbox"/> Daido Electronics ND-39R	Magnet	8.7	470	7600	1.35E-6	0	77	Neodymium magnet - Daido Electronics - ND-39R. Data provided by



Granta Material Database (2/2)

Material	Type	Thermal Conductivity	Specific Heat	Density	Resistivity	Temp. Coef. of Resistivity	Lamination Thickness	K _H (Steinmetz)	K _H (Bertotti Classical)	K _H (Bertotti Maxwell)	Keddy	K _{exc} (Bertotti Classical)	K _{exc} (Bertotti Maxwell)	Alpha (Steinmetz)	Alpha (Bertotti Classical)	Alpha (Bertotti Maxwell)
Units		W/m°C	kJ/kg°C	kg/m³	Ohm.m											
<input type="checkbox"/> AK Steel M-19, 14ml, B-H	Steel	73	460	7650	6E-7	0	0.3556	0.0098487	1E-8	0.012140506	3.516	0.0034902617	0.0010193048	3.8936191	0.21083338	
<input type="checkbox"/> AK Steel M-19, 14ml, B-H	Steel	73	460	7650	6E-7	0	0.3556	0.0103687	1E-8	0.012099216	3.493	0.0034902668	0.0010203131	3.7933899	3.771283	
<input type="checkbox"/> AK Steel M-19, 14ml, B-H	Steel	73	460	7650	6E-7	0	0.3556	0.0100833	1E-8	0.012127253	3.500	0.0034902668	0.0010199599	3.8895978	3.8417903	
<input type="checkbox"/> AK Steel M-19, 19ml, B-H	Steel	73	460	7650	6E-7	0	0.4699	0.0320809	0.020013565	0.02443524	2.367	0.0017157506	0	1.5760826	3.177904	
<input type="checkbox"/> AK Steel M-19, 19ml, B-H	Steel	73	460	7650	6E-7	0	0.4699	0.0337749	0.019885978	0.024435392	2.275	0.0017195092	0	1.6688383	3.1888003	
<input type="checkbox"/> AK Steel M-19, 19ml, B-H	Steel	73	460	7650	6E-7	0	0.4699	0.0323765	0.020064888	0.024435347	2.324	0.0017140229	0	1.6107308	3.1794652	
<input type="checkbox"/> AK Steel M-22, 19ml	Steel	73	460	7650	4.93E-7	0	0.4699	0.0128121	0.0024926571	0.01161455	1E-5	0.00288052	0.0010523205	1.3541464	4.1303122	
<input type="checkbox"/> AK Steel M-36, 14ml	Steel	73	460	7650	4.3E-7	0	0.3556	0.0212281	0.013766035	0.031382519	3.615	0.0023091603	0	1.4307888	4.5146129	
<input type="checkbox"/> AK Steel M-36, 14ml, B-H	Steel	73	460	7650	4.3E-7	0	0.3556	0.0198638	0.014281608	0.031382549	3.686	0.0022694842	0	1.4372749	4.4805521	
<input type="checkbox"/> AK Steel M-36, 19ml	Steel	73	460	7650	5.99E-7	0	0.4699	0.0240954	0.0065738012	0.025189041	5.268	0.003195388	0.00061988943	2.3152706	4.0001708	
<input type="checkbox"/> AK Steel M-36, 19ml, B-H	Steel	73	460	7650	5.99E-7	0	0.4699	0.0243770	0.0065907569	0.025206367	5.270	0.0031925785	0.00061944705	2.2909577	4.0002275	
<input type="checkbox"/> Arcelor Mittal M195-35A,	Steel	73	460	7650	5.5E-7	0	0.35	0.0139076	0.0030323361	0.019936561	3.375	0.0022894765	0.00039421041	1.9046715	5	
<input type="checkbox"/> Arcelor Mittal M195-35A,	Steel	73	460	7650	5.5E-7	0	0.35	0.0135977	0.0030883219	0.019911512	3.416	0.0022778382	0.00039480982	1.5923014	4.990521	
<input type="checkbox"/> Arnold Aron 5	Steel	73	460	7500	4.8E-7	0	0.127	0.0288929	0.024310678	0.020431521	1.962	0.00225697621	9.2125511E-5	1.6390069	1.7632324	
<input type="checkbox"/> Arnold Aron 7	Steel	73	460	7500	4.8E-7	0	0.1778	0.0291107	0.0051178058	0.025811163	1.002	0.001608662	0.00048457757	1.4689412	5	
<input type="checkbox"/> Baosteel B50AH300	Steel	73	460	7700	4.5E-7	0	0.5	0.0205917	0.0069671065	0.024458437	6.683	0.0026750442	0.00022346182	1.8363704	2.2964503	
<input type="checkbox"/> Baosteel B50AH470	Steel	73	460	7750	4.5E-7	0	0.5	0.0243873	0.013323194	0.021072283	6.781	0.0024594978	0.00040172866	1.8017857	2.2454821	
<input type="checkbox"/> Baosteel B50AH600	Steel	73	460	7750	4.5E-7	0	0.5	0.0253009	0.010197435	0.017022005	1E-5	0.0036670065	0.0016648267	1.7474298	2.2408575	
<input type="checkbox"/> Baosteel B65A470	Steel	73	460	7650	4.4E-7	0	0.65	0.0294360	0.0088383634	0.018733631	1E-5	0.0038205625	0.00064272483	1.5349089	2.3662141	
<input type="checkbox"/> Baosteel B65A700	Steel	73	460	7750	3E-7	0	0.65	0.0418341	0.017626866	0.02735238	1E-5	0.0039310194	0	1.6514396	2.4056578	
<input type="checkbox"/> Baosteel B65A800	Steel	73	460	7800	2.9E-7	0	0.65	0.0542220	0.026917648	0.037277903	1E-5	0.0042497737	0	1.5729142	2.0944873	
<input type="checkbox"/> China Steel 35CS440, B-H	Steel	73	460	7700	3.9E-7	0	0.35	0.0262014	0.015847431	0.021155806	3.656	0.001736701	0.00040631808	1.6652162	2.2229116	
<input type="checkbox"/> China Steel 35CS550	Steel	73	460	7750	3E-7	0	0.35	0.0383944	0.025927433	0.028543076	3.956	0.0019303322	0.00044584096	1.6112524	1.8989656	

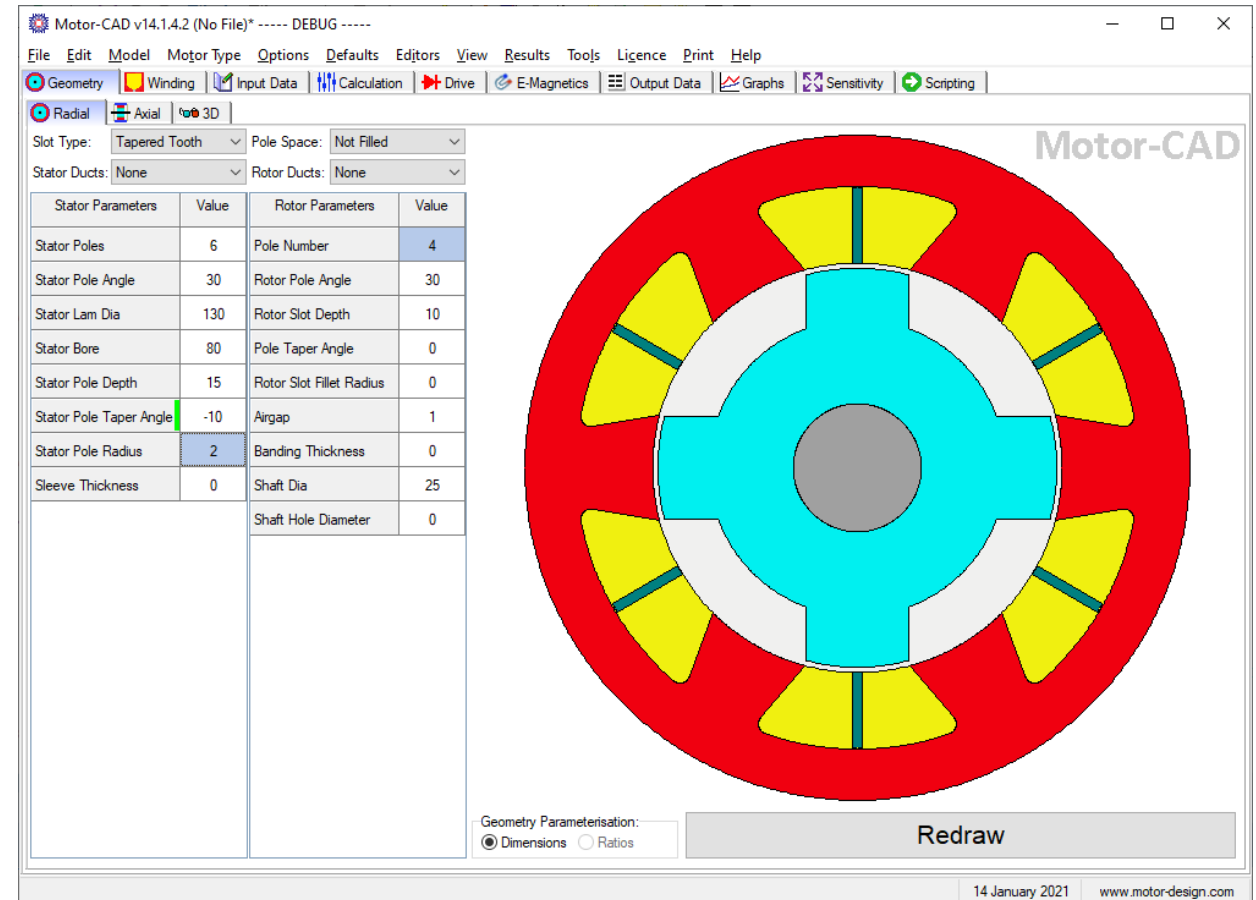
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- Ferrite_ceramic_magnet.gdb
- Neodymium_magnet.gdb
- Neodymium_magnet_JL_Mag.gdb
- Samarium_cobalt_magnet.gdb
- Alloy_powder_core.gdb
- Cobalt_steel.gdb
- Electrical_steel_grain_oriented.gdb
- Electrical_steel_non_grain_oriented.gdb
- Ferrite_core.gdb
- Iron_powder_core_plus_SMC.gdb
- Metglas_and_nanocrystalline.gdb
- Nickel_steel.gdb



Usability (UX)

New tapered tooth SRM geometry

- New taper angle of stator pole option



Rounding of duct corners

Important for Emag and mechanical calculations

- Rectangular ducts
- Arc ducts
- Separate rounding parameter for each duct layer
- Stator, housing and rotor ducts

The image displays two screenshots of the Motor-CAD v14.1.1.2 software interface, illustrating the design and parameterization of rounded duct corners in a motor.

Top Screenshot (Stator Design):

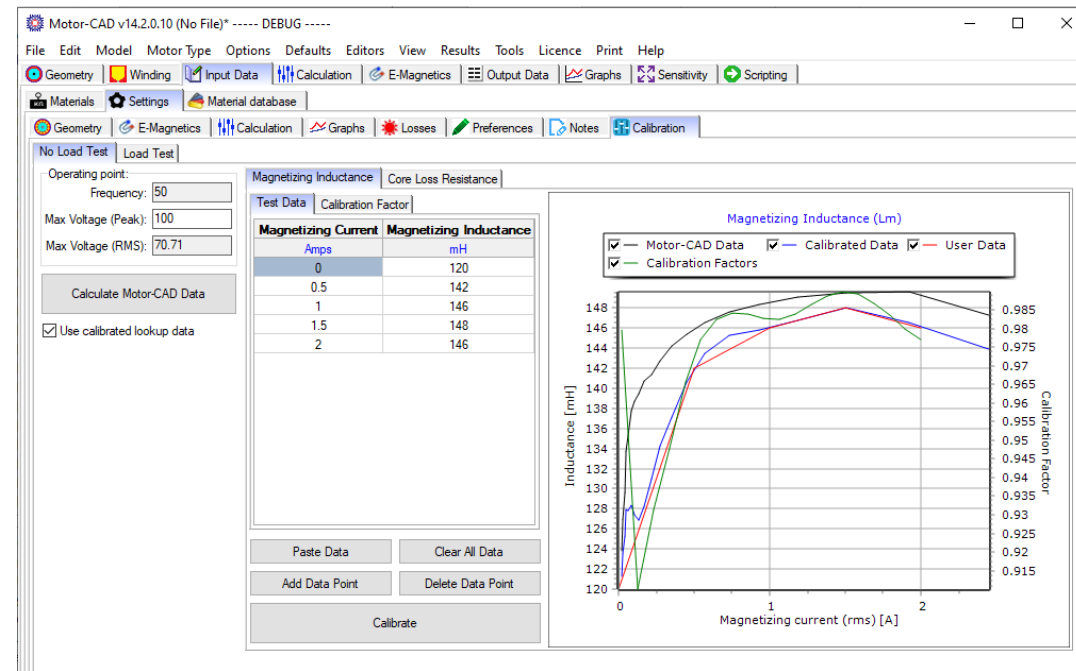
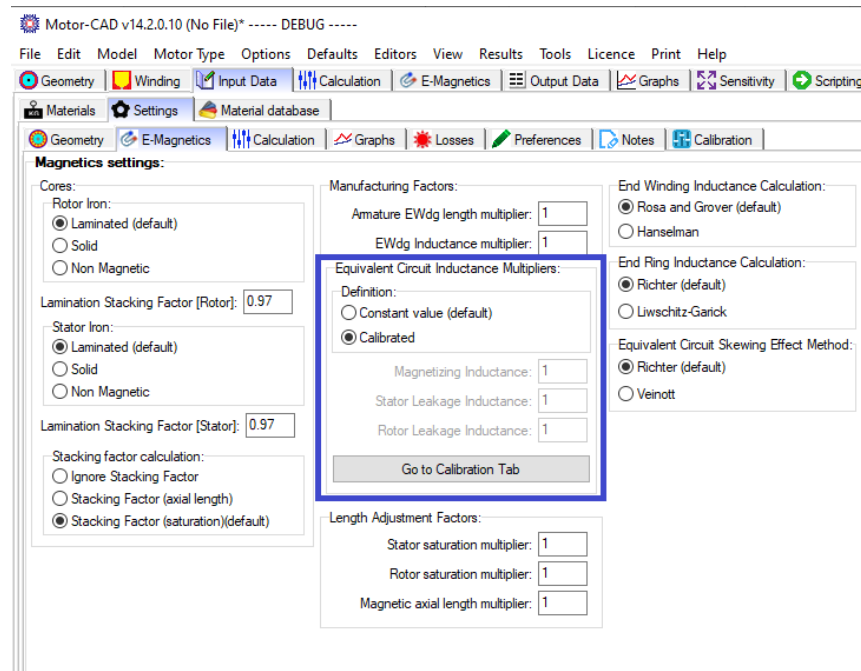
- Parameters:**
 - Stator Parameters: Slot Number (18), Housing Dia (140), Stator Lam Dia (130), Stator Bore (80), Tooth Width (7), Slot Depth (18), Slot Corner Radius (0), Tooth Tip Depth (1), Slot Opening (3), Tooth Tip Angle (30), Sleeve Thickness (0), Fin Extension (10), Fin Thickness (2), Fin Pitch/Thick (5), Fin Pitch [Calc] (10), Corner Cutout [%] (40), Corner Cutout Add (0).
 - Rotor Parameters: Pole Number (4), Magnet Thickness (4), Magnet Reduction (0), Magnet Arc [ED] (140), Magnet Segments (1), Airgap (1), Banding Thickness (0), Shaft Dia (25), Shaft Hole Diameter (0), Rotor Duct Layers (2), L1 RDuct Rad Dia (32), L1 RDuct Channel (4), L1 RDuct Height (3), L1 RDuct Width (10), L1 RDuct Corner Rad (1.5), L1 RDuct Angle (45), L2 RDuct Rad Dia (55), L2 RDuct Channel (12), L2 RDuct Angle (45).
- Geometry:** Radial, Axial, 3D views. Slot Type: Parallel Tooth, Rotor Type: Surface Parallel, Rotor Ducts: Rectangular Ducts.
- Model:** A 3D cross-sectional view of the stator core with 18 slots, showing rounded corners in cyan and green.
- Buttons:** Check, Redraw, Draw plate, Draw base, Draw Cooling.
- Status:** Length (18.63,30.33) mm, 13 January 2021, www.motor-design.com.

Bottom Screenshot (Rotor Design):

- Parameters:**
 - Stator Parameters: Slot Number (18), Housing Dia (140), Stator Lam Dia (130), Stator Bore (80), Tooth Width (7), Slot Depth (18), Slot Corner Radius (0), Tooth Tip Depth (1), Slot Opening (3), Tooth Tip Angle (30), Sleeve Thickness (0), Fin Extension (10), Fin Thickness (2), Fin Pitch/Thick (5), Fin Pitch [Calc] (10), Corner Cutout [%] (40), Corner Cutout Add (0), Plate Height (350), Plate Width (350).
 - Rotor Parameters: Pole Number (4), Magnet Thickness (4), Magnet Reduction (0), Magnet Arc [ED] (140), Magnet Segments (1), Airgap (1), Banding Thickness (0), Shaft Dia (25), Shaft Hole Diameter (0), Rotor Duct Layers (2), L1 RDuct Inner Dia (30), L1 RDuct Depth (4), L1 RDuct Corner Rad (2), L1 RDuct Web Width (1), L1 RDuct Channel (4), L1 RDuct Angle (0), L2 RDuct Inner Dia (50), L2 RDuct Depth (5), L2 RDuct Corner Rad (1.5), L2 RDuct Web Width (1), L2 RDuct Channel (12), L2 RDuct Angle (45).
- Geometry:** Radial, Axial, 3D views. Slot Type: Parallel Tooth, Rotor Type: Surface Parallel, Rotor Ducts: Arc Ducts.
- Model:** A 3D cross-sectional view of the rotor core with 18 slots, showing rounded corners in cyan and green.
- Buttons:** Check, Redraw, Draw plate, Draw base, Draw Cooling.
- Status:** Length (6.20,34.83) mm, 17 February 2021, www.motor-design.com.

Calibrated of Induction Machine equivalent circuit parameters

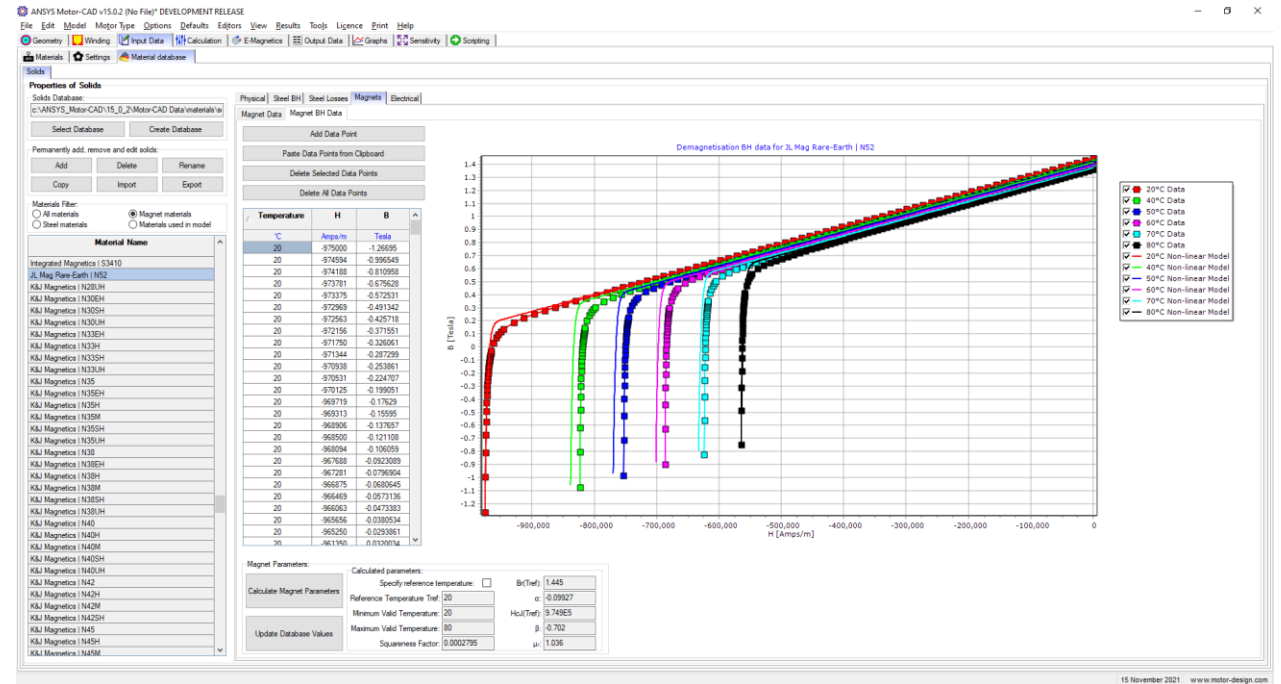
- Calibration of equivalent circuit multipliers from test data.
 - No-load test -> L_m and R_{fe} as functions of magnetizing current and Back EMF. Used for calibrating lookup data.
 - Load test -> L_1 , L_2 and R_2 as functions of speed.



Magnet Data Fitting

New functionality to use demagnetisation curves:

- Similar functionality to iron losses, each point needs a temperature, B value and H value
- Calculate magnet parameters from the data to use in Motor-CAD model:
 - $B_r(T_{ref})$
 - $H_{cJ}(T_{ref})$
 - α
 - β
 - μ_r
 - Squareness factor
- Can specify reference temperature to increase accuracy for most 'useful' magnet temperature



Magnet Parameters:

Calculate Magnet Parameters

Update Database Values

Calculated parameters:

Specify reference temperature:

Reference Temperature Tref: 20

Minimum Valid Temperature: 20

Maximum Valid Temperature: 80

Squareness Factor: 0.0002795

Br(Tref): 1.445

α : -0.09927

HcJ(Tref): 9.749E5

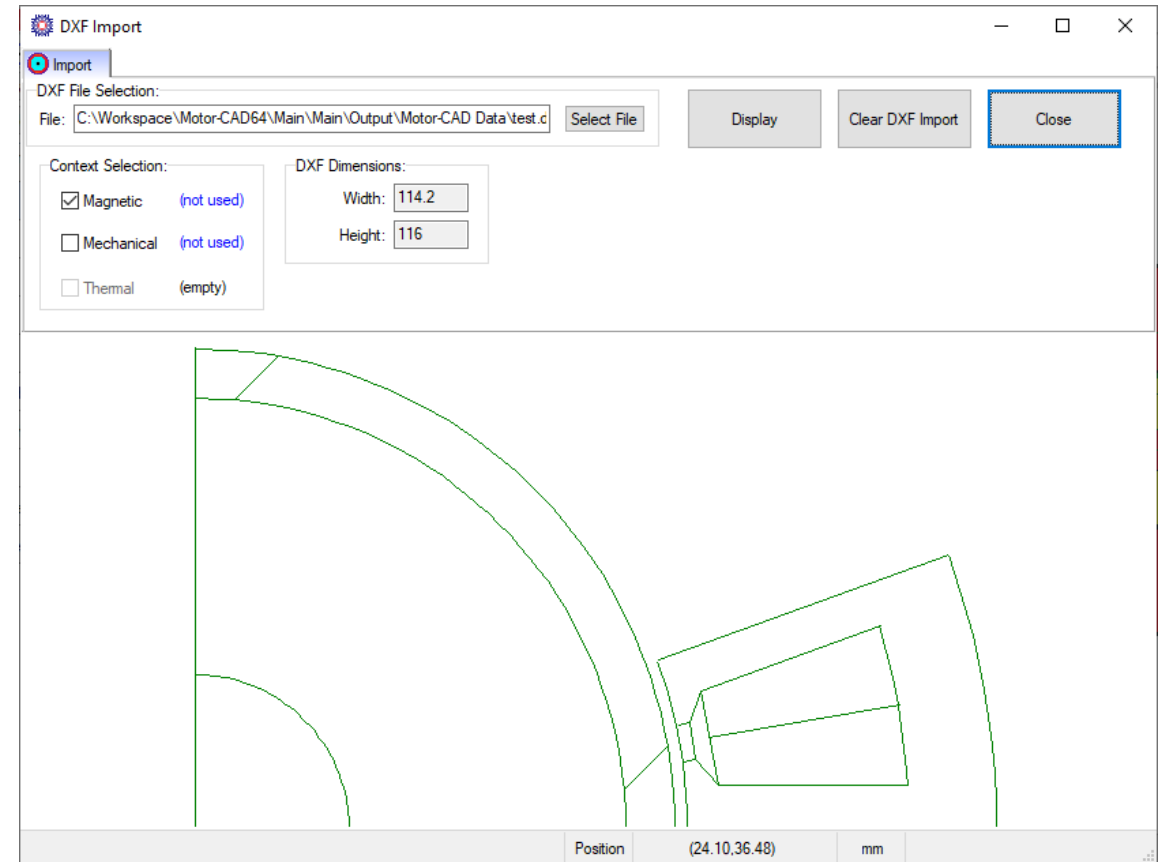
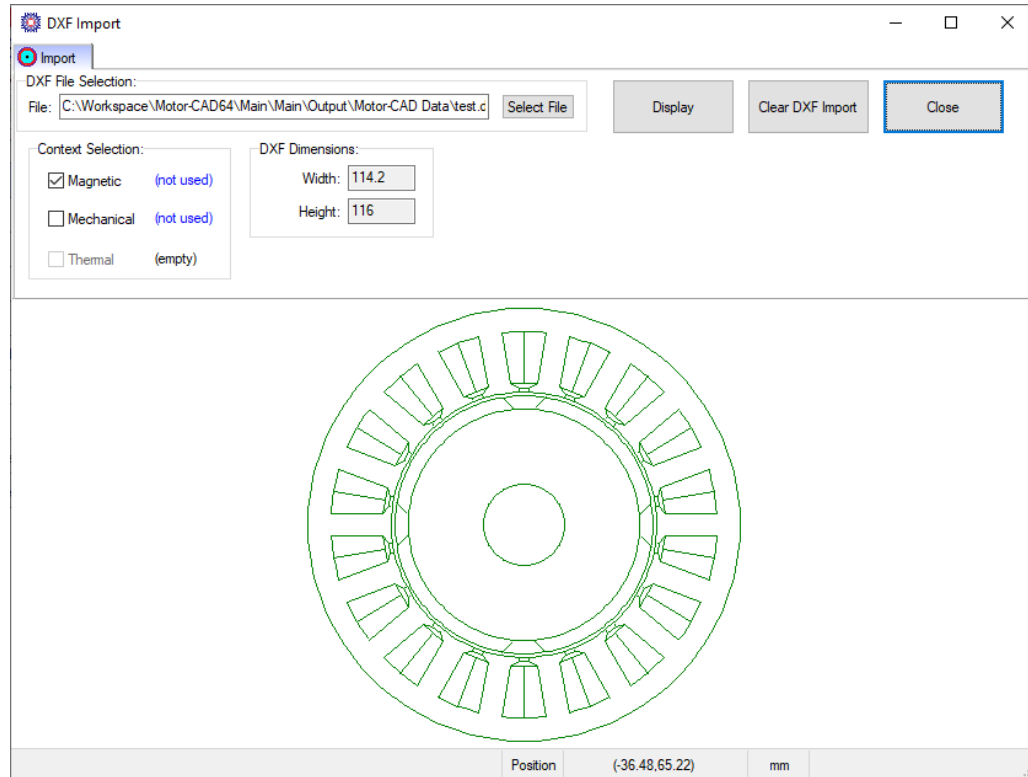
β : -0.702

μ_r : 1.036



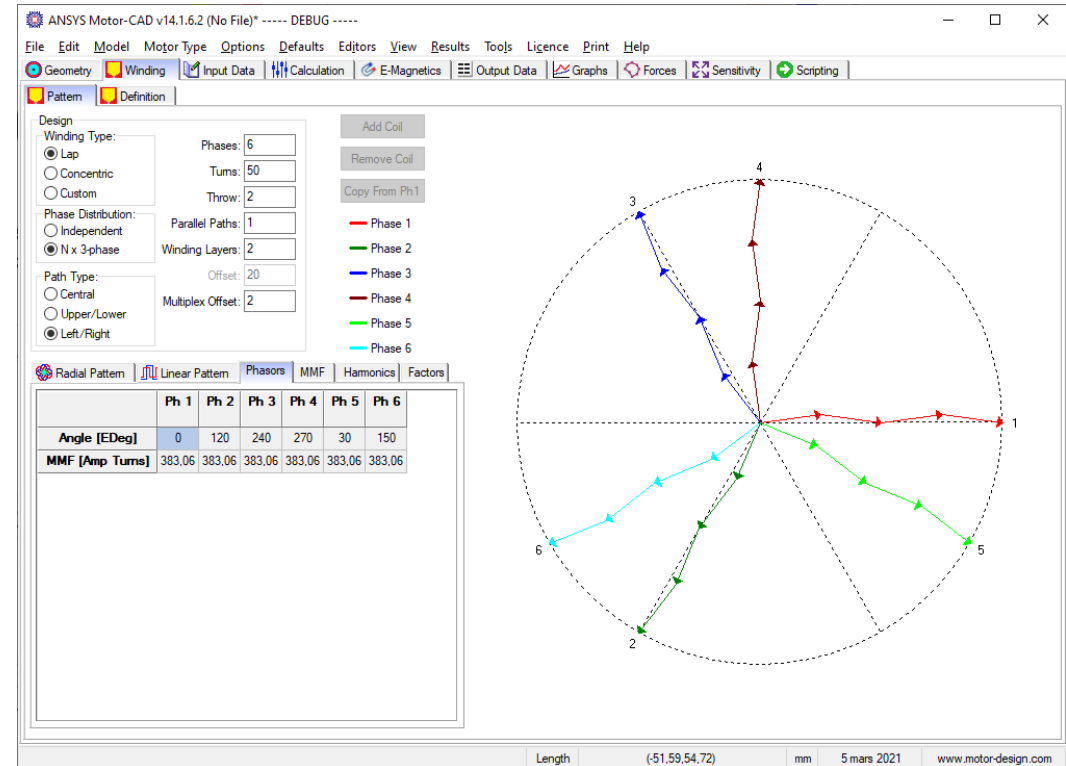
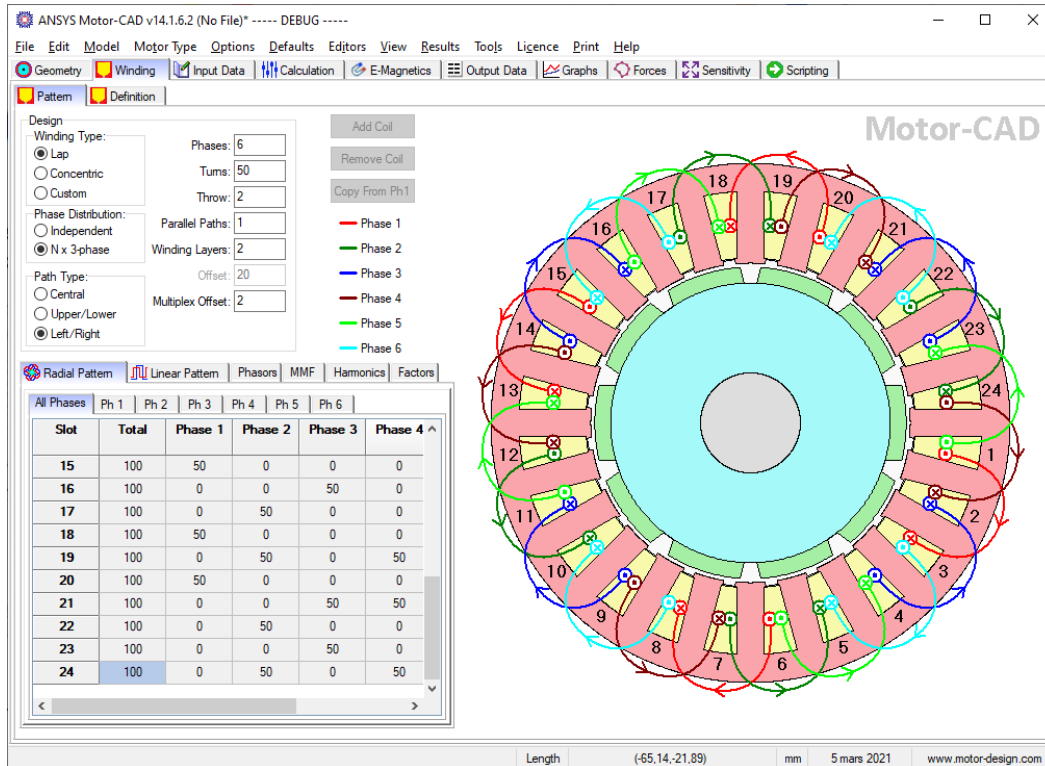
DXF Import Interface

- Interface showing imported dxf
- Easier to check imported dxf geometry



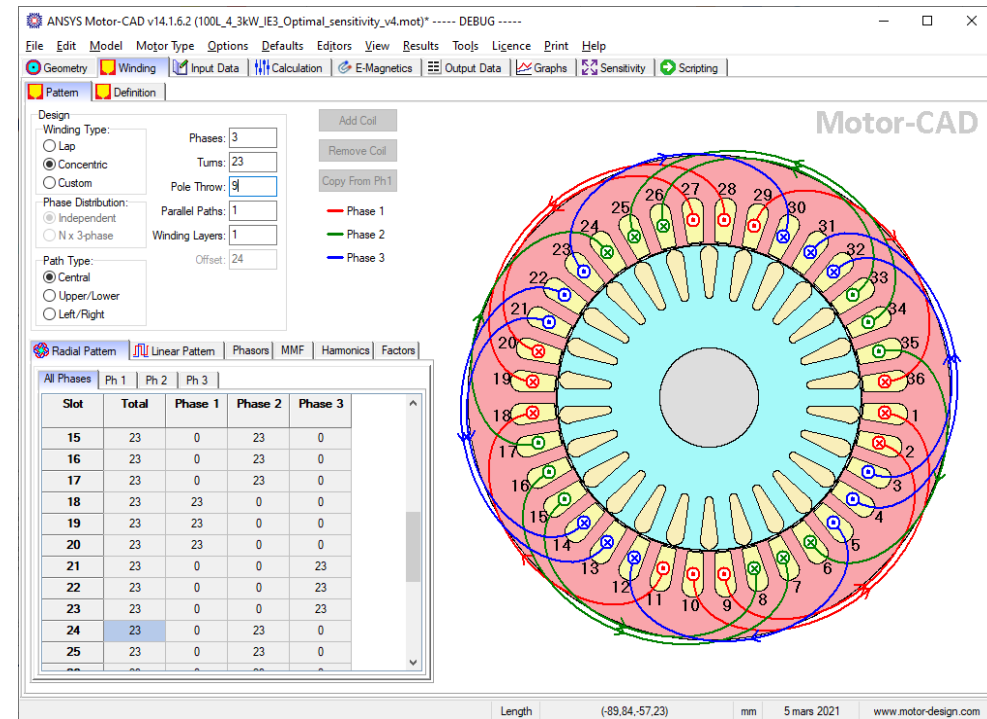
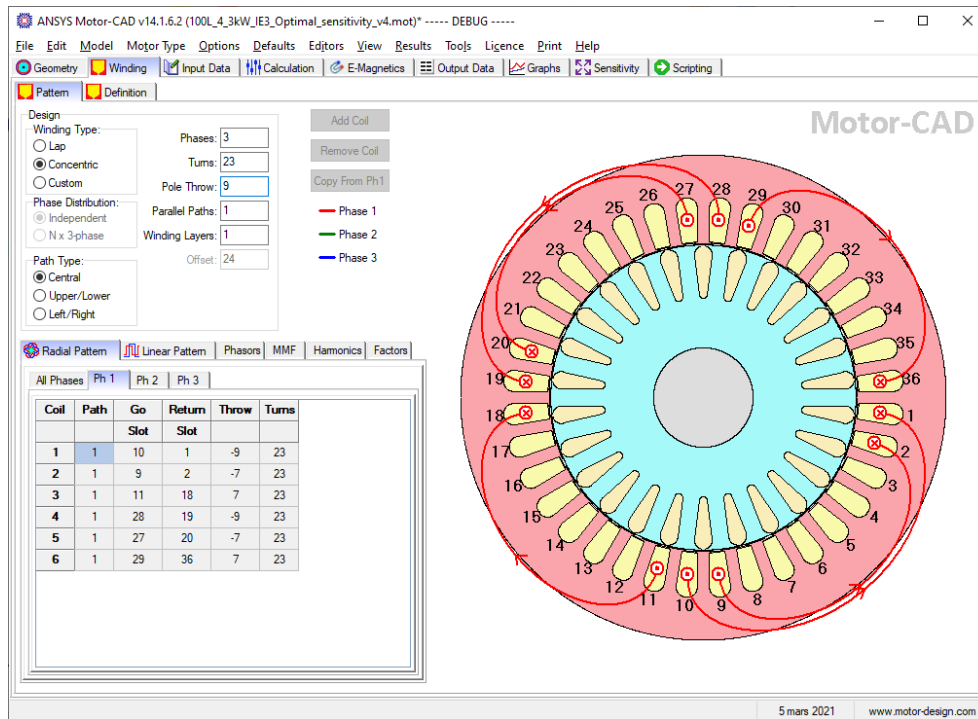
Multiphase Winding improvement

- New option to specify the multiphase offset between phasegroups



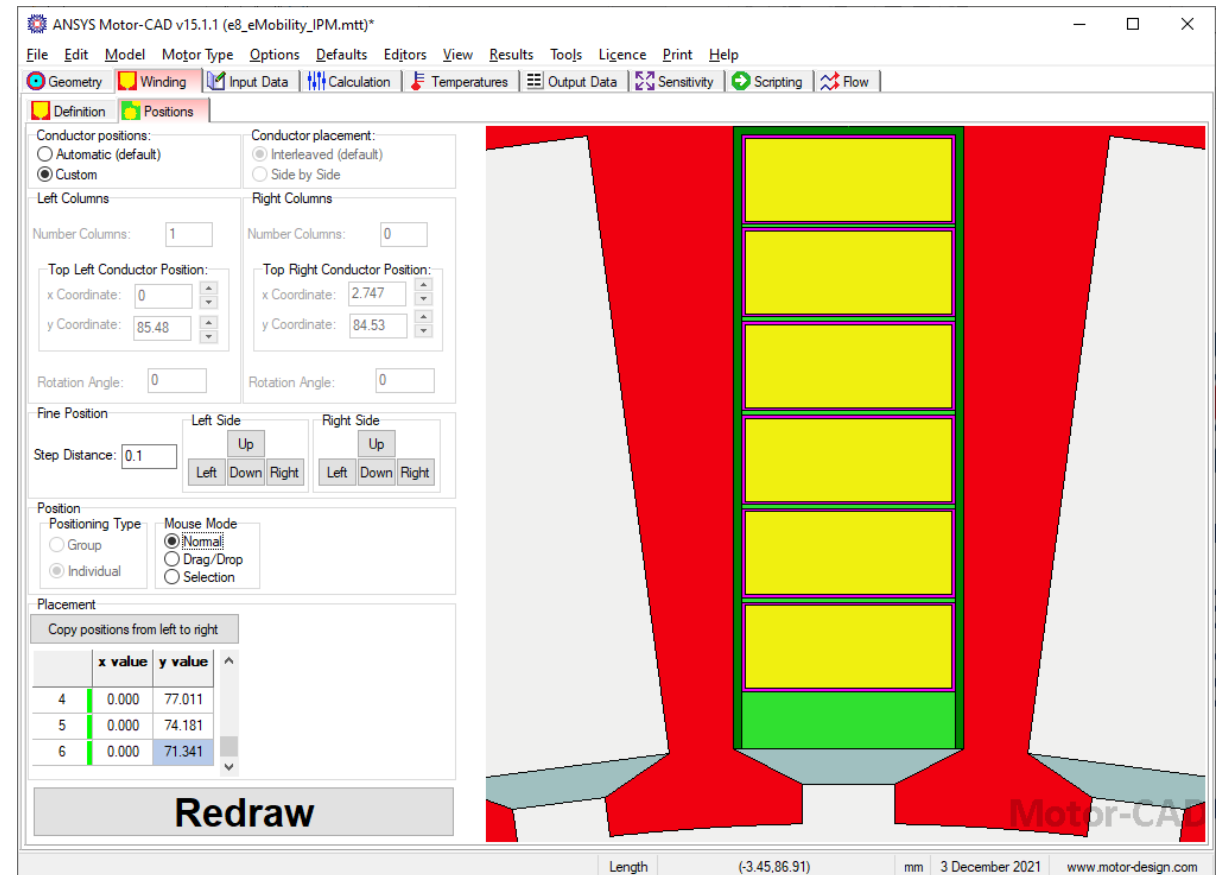
Concentric winding improvement

- Improved Concentric winding options
- Added winding when have non integer number of coils per pole
- e.g. For 36 slots 4 poles have average of 1.5 coils per pole



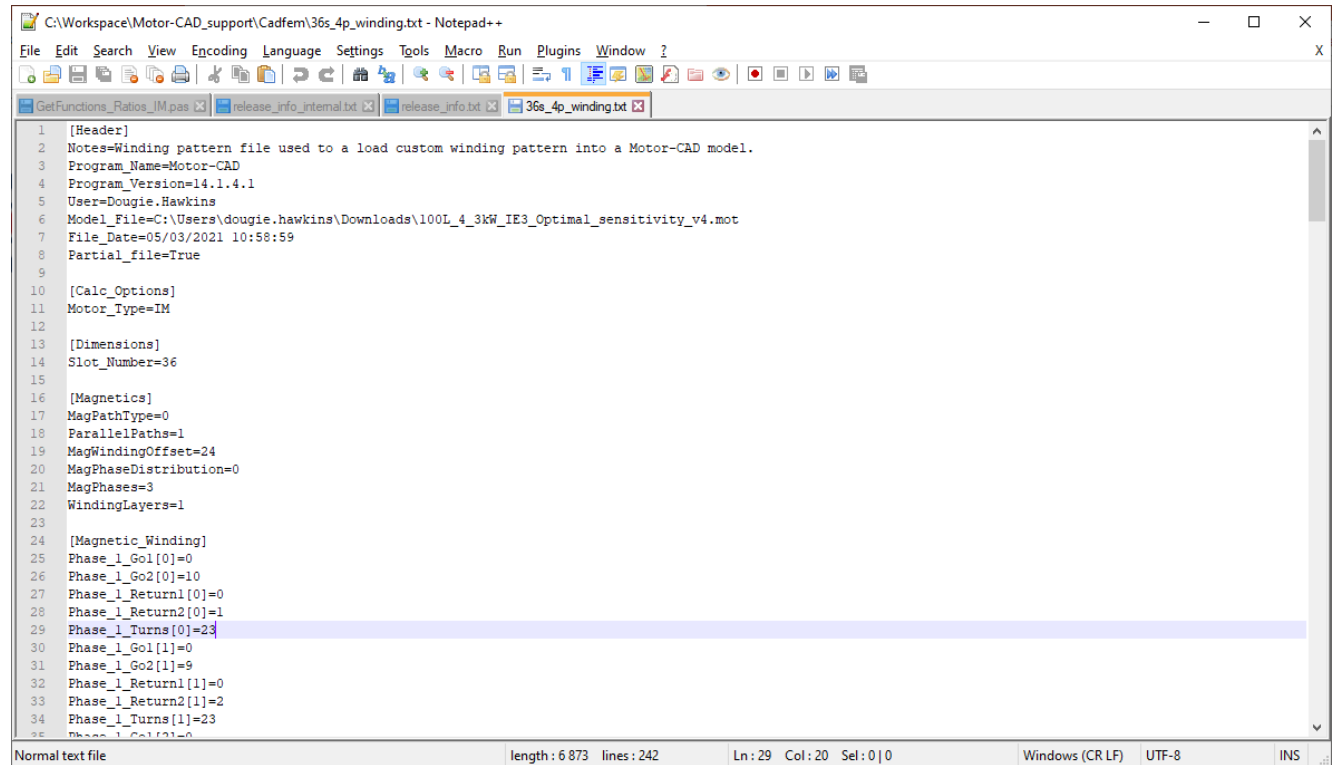
Improved custom conductor placement

- Improved interface for specifying each conductor locations in slot.
- Important for designs where AC winding losses are significant.



Load / save winding pattern

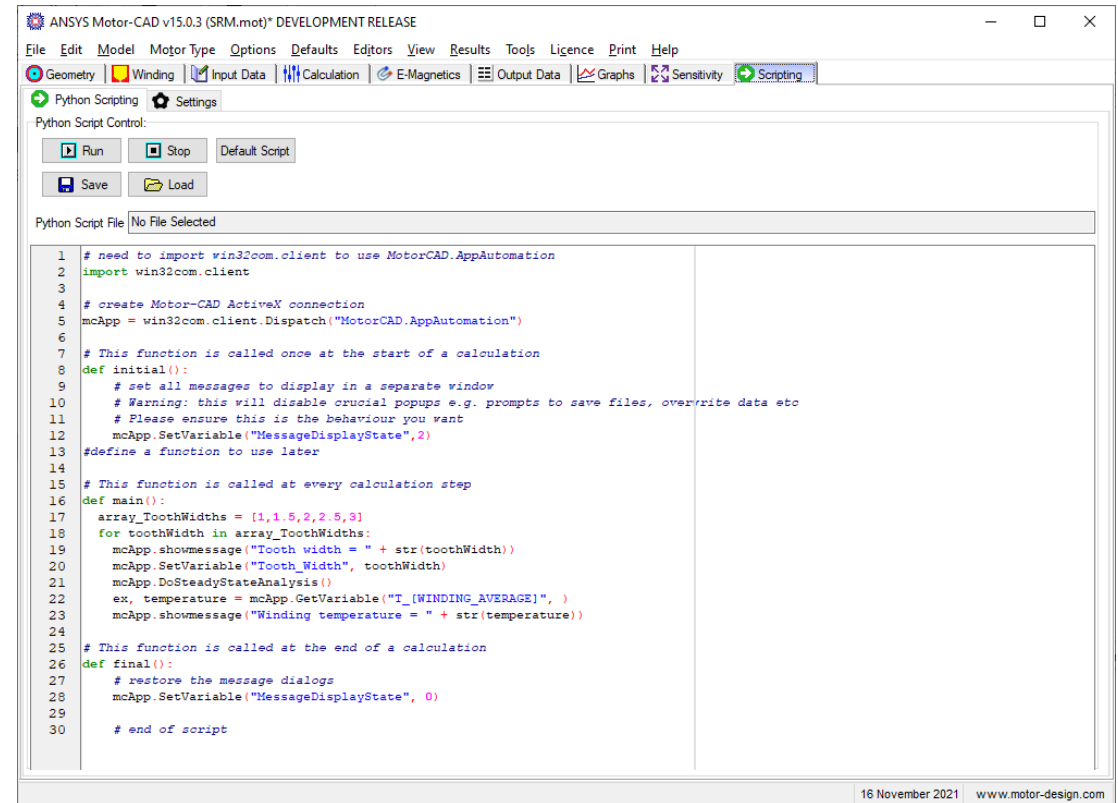
- New option to load or save a winding pattern from a file
- Also enabled for ActiveX



```
C:\Workspace\Motor-CAD_support\Cadfer\36s_4p_winding.txt - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
GetFunctions_Ratios_IM.pas release_info_internal.txt release_info.txt 36s_4p_winding.txt
1 [Header]
2 Notes=Winding pattern file used to load custom winding pattern into a Motor-CAD model.
3 Program_Name=Motor-CAD
4 Program_Version=14.1.4.1
5 User=Dougie.Hawkins
6 Model_File=C:\Users\dougie.hawkins\Downloads\100L_4_3kW_IE3_Optimal_sensitivity_v4.mot
7 File_Date=05/03/2021 10:58:59
8 Partial_file=True
9
10 [Calc_Options]
11 Motor_Type=IM
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13 [Dimensions]
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21 MagPhases=3
22 WindingLayers=1
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32 Phase_1_Return1[1]=0
33 Phase_1_Return2[1]=2
34 Phase_1_Turns[1]=23
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37 Phase_1_Return1[2]=0
38 Phase_1_Return2[2]=1
39 Phase_1_Turns[2]=23
40 Phase_1_Go1[3]=0
41 Phase_1_Go2[3]=10
42 Phase_1_Return1[3]=0
43 Phase_1_Return2[3]=1
44 Phase_1_Turns[3]=23
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46 Phase_1_Go2[4]=10
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50 Phase_1_Go1[5]=0
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53 Phase_1_Return2[5]=1
54 Phase_1_Turns[5]=23
55 Phase_1_Go1[6]=0
56 Phase_1_Go2[6]=10
57 Phase_1_Return1[6]=0
58 Phase_1_Return2[6]=1
59 Phase_1_Turns[6]=23
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62 Phase_1_Return1[7]=0
63 Phase_1_Return2[7]=1
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66 Phase_1_Go2[8]=10
67 Phase_1_Return1[8]=0
68 Phase_1_Return2[8]=1
69 Phase_1_Turns[8]=23
70 Phase_1_Go1[9]=0
71 Phase_1_Go2[9]=10
72 Phase_1_Return1[9]=0
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74 Phase_1_Turns[9]=23
75 Phase_1_Go1[10]=0
76 Phase_1_Go2[10]=10
77 Phase_1_Return1[10]=0
78 Phase_1_Return2[10]=1
79 Phase_1_Turns[10]=23
80 Phase_1_Go1[11]=0
81 Phase_1_Go2[11]=10
82 Phase_1_Return1[11]=0
83 Phase_1_Return2[11]=1
84 Phase_1_Turns[11]=23
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87 Phase_1_Return1[12]=0
88 Phase_1_Return2[12]=1
89 Phase_1_Turns[12]=23
90 Phase_1_Go1[13]=0
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92 Phase_1_Return1[13]=0
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338 Phase_1_Return2[62]=1
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368 Phase_1_Return2[68]=1
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372 Phase_1_Return1[69]=0
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378 Phase_1_Return2[70]=1
379 Phase_1_Turns[70]=23
380 Phase_1_Go1[71]=0
381 Phase_1_Go2[71]=10
382 Phase_1_Return1[71]=0
383 Phase_1_Return2[71]=1
384 Phase_1_Turns[71]=23
385 Phase_1_Go1[72]=0
386 Phase_1_Go2[72]=10
387 Phase_1_Return1[72]=0
388 Phase_1_Return2[72]=1
389 Phase_1_Turns[72]=23
390 Phase_1_Go1[73]=0
391 Phase_1_Go2[73]=10
392 Phase_1_Return1[73]=0
393 Phase_1_Return2[73]=1
394 Phase_1_Turns[73]=23
395 Phase_1_Go1[74]=0
396 Phase_1_Go2[74]=10
397 Phase_1_Return1[74]=0
398 Phase_1_Return2[74]=1
399 Phase_1_Turns[74]=23
400 Phase_1_Go1[75]=0
401 Phase_1_Go2[75]=10
402 Phase_1_Return1[75]=0
403 Phase_1_Return2[75]=1
404 Phase_1_Turns[75]=23
405 Phase_1_Go1[76]=0
406 Phase_1_Go2[76]=10
407 Phase_1_Return1[76]=0
408 Phase_1_Return2[76]=1
409 Phase_1_Turns[76]=23
410 Phase_1_Go1[77]=0
411 Phase_1_Go2[77]=10
412 Phase_1_Return1[77]=0
413 Phase_1_Return2[77]=1
414 Phase_1_Turns[77]=23
415 Phase_1_Go1[78]=0
416 Phase_1_Go2[78]=10
417 Phase_1_Return1[78]=0
418 Phase_1_Return2[78]=1
419 Phase_1_Turns[78]=23
420 Phase_1_Go1[79]=0
421 Phase_1_Go2[79]=10
422 Phase_1_Return1[79]=0
423 Phase_1_Return2[79]=1
424 Phase_1_Turns[79]=23
425 Phase_1_Go1[80]=0
426 Phase_1_Go2[80]=10
427 Phase_1_Return1[80]=0
428 Phase_1_Return2[80]=1
429 Phase_1_Turns[80]=23
430 Phase_1_Go1[81]=0
431 Phase_1_Go2[81]=10
432 Phase_1_Return1[81]=0
433 Phase_1_Return2[81]=1
434 Phase_1_Turns[81]=23
435 Phase_1_Go1[82]=0
436 Phase_1_Go2[82]=10
437 Phase_1_Return1[82]=0
438 Phase_1_Return2[82]=1
439 Phase_1_Turns[82]=23
440 Phase_1_Go1[83]=0
441 Phase_1_Go2[83]=10
442 Phase_1_Return1[83]=0
443 Phase_1_Return2[83]=1
444 Phase_1_Turns[83]=23
445 Phase_1_Go1[84]=0
446 Phase_1_Go2[84]=10
447 Phase_1_Return1[84]=0
448 Phase_1_Return2[84]=1
449 Phase_1_Turns[84]=23
450 Phase_1_Go1[85]=0
451 Phase_1_Go2[85]=10
452 Phase_1_Return1[85]=0
453 Phase_1_Return2[85]=1
454 Phase_1_Turns[85]=23
455 Phase_1_Go1[86]=0
456 Phase_1_Go2[86]=10
457 Phase_1_Return1[86]=0
458 Phase_1_Return2[86]=1
459 Phase_1_Turns[86]=23
460 Phase_1_Go1[87]=0
461 Phase_1_Go2[87]=10
462 Phase_1_Return1[87]=0
463 Phase_1_Return2[87]=1
464 Phase_1_Turns[87]=23
465 Phase_1_Go1[88]=0
466 Phase_1_Go2[88]=10
467 Phase_1_Return1[88]=0
468 Phase_1_Return2[88]=1
469 Phase_1_Turns[88]=23
470 Phase_1_Go1[89]=0
471 Phase_1_Go2[89]=10
472 Phase_1_Return1[89]=0
473 Phase_1_Return2[89]=1
474 Phase_1_Turns[89]=23
475 Phase_1_Go1[90]=0
476 Phase_1_Go2[90]=10
477 Phase_1_Return1[90]=0
478 Phase_1_Return2[90]=1
479 Phase_1_Turns[90]=23
480 Phase_1_Go1[91]=0
481 Phase_1_Go2[91]=10
482 Phase_1_Return1[91]=0
483 Phase_1_Return2[91]=1
484 Phase_1_Turns[91]=23
485 Phase_1_Go1[92]=0
486 Phase_1_Go2[92]=10
487 Phase_1_Return1[92]=0
488 Phase_1_Return2[92]=1
489 Phase_1_Turns[92]=23
490 Phase_1_Go1[93]=0
491 Phase_1_Go2[93]=10
492 Phase_1_Return1[93]=0
493 Phase_1_Return2[93]=1
494 Phase_1_Turns[93]=23
495 Phase_1_Go1[94]=0
496 Phase_1_Go2[94]=10
497 Phase_1_Return1[94]=0
498 Phase_1_Return2[94]=1
499 Phase_1_Turns[94]=23
500 Phase_1_Go1[95]=0
501 Phase_1_Go2[95]=10
502 Phase_1_Return1[95]=0
503 Phase_1_Return2[95]=1
504 Phase_1_Turns[95]=23
505 Phase_1_Go1[96]=0
506 Phase_1_Go2[96]=10
507 Phase_1_Return1[96]=0
508 Phase_1_Return2[96]=1
509 Phase_1_Turns[96]=23
510 Phase_1_Go1[97]=0
511 Phase_1_Go2[97]=10
512 Phase_1_Return1[97]=0
513 Phase_1_Return2[97]=1
514 Phase_1_Turns[97]=23
515 Phase_1_Go1[98]=0
516 Phase_1_Go2[98]=10
517 Phase_1_Return1[98]=0
518 Phase_1_Return2[98]=1
519 Phase_1_Turns[98]=23
520 Phase_1_Go1[99]=0
521 Phase_1_Go2[99]=10
522 Phase_1_Return1[99]=0
523 Phase_1_Return2[99]=1
524 Phase_1_Turns[99]=23
525 Phase_1_Go1[100]=0
526 Phase_1_Go2[100]=10
527 Phase_1_Return1[100]=0
528 Phase_1_Return2[100]=1
529 Phase_1_Turns[100]=23
530 Phase_1_Go1[101]=0
531 Phase_1_Go2[101]=10
532 Phase_1_Return1[101]=0
533 Phase_1_Return2[101]=1
534 Phase_1_Turns[101]=23
535 Phase_1_Go1[102]=0
536 Phase_1_Go2[102]=10
537 Phase_1_Return1[102]=0
538 Phase_1_Return2[102]=1
539 Phase_1_Turns[102]=23
540 Phase_1_Go1[103]=0
541 Phase_1_Go2[103]=10
542 Phase_1_Return1[103]=0
543 Phase_1_Return2[103]=1
544 Phase_1_Turns[103]=23
545 Phase_1_Go1[104]=0
546 Phase_1_Go2[104]=10
547 Phase_1_Return1[104]=0
548 Phase_1_Return2[104]=1
549 Phase_1_Turns[104]=23
550 Phase_1_Go1[105]=0
551 Phase_1_Go2[105]=10
552 Phase_1_Return1[105]=0
553 Phase_1_Return2[105]=1
554 Phase_1_Turns[105]=23
555 Phase_1_Go1[106]=0
556 Phase_1_Go2[106]=10
557 Phase_1_Return1[106]=0
558 Phase_1_Return2[106]=1
559 Phase_1_Turns[106]=23
560 Phase_1_Go1[107]=0
561 Phase_1_Go2[107]=10
562 Phase_1_Return1[107]=0
563 Phase_1_Return2[107]=1
564 Phase_1_Turns[107]=23
565 Phase_1_Go1[108]=0
566 Phase_1_Go2[108]=10
567 Phase_1_Return1[108]=0
568 Phase_1_Return2[108]=1
569 Phase_1_Turns[108]=23
570 Phase_1_Go1[109]=0
571 Phase_1_Go2[109]=10
572 Phase_1_Return1[109]=0
573 Phase_1_Return2[109]=1
574 Phase_1_Turns[109]=23
575 Phase_1_Go1[110]=0
576 Phase_1_Go2[110]=10
577 Phase_1_Return1[110]=0
578 Phase_1_Return2[110]=1
579 Phase_1_Turns[110]=23
580 Phase_1_Go1[111]=0
581 Phase_1_Go2[111]=10
582 Phase_1_Return1[111]=0
583 Phase_1_Return2[111]=1
584 Phase_1_Turns[111]=23
585 Phase_1_Go1[112]=0
586 Phase_1_Go2[112]=10
587 Phase_1_Return1[112]=0
588 Phase_1_Return2[112]=1
589 Phase_1_Turns[112]=23
590 Phase_1_Go1[113]=0
591 Phase_1_Go2[113]=10
592 Phase_1_Return1[113]=0
593 Phase_1_Return2[113]=1
594 Phase_1_Turns[113]=23
595 Phase_1_Go1[114]=0
596 Phase_1_Go2[114]=10
597 Phase_1_Return1[114]=0
598 Phase_1_Return2[114]=1
599 Phase_1_Turns[114]=23
600 Phase_1_Go1[115]=0
601 Phase_1_Go2[115]=10
602 Phase_1_Return1[115]=0
603 Phase_1_Return2[115]=1
604 Phase_1_Turns[115]=23
605 Phase_1_Go1[116]=0
606 Phase_1_Go2[116]=10
607 Phase_1_Return1[116]=0
608 Phase_1_Return2[116]=1
609 Phase_1_Turns[116]=23
610 Phase_1_Go1[117]=0
611 Phase_1_Go2[117]=10
612 Phase_1_Return1[117]=0
613 Phase_1_Return2[117]=1
614 Phase_1_Turns[117]=23
615 Phase_1_Go1[118]=0
616 Phase_1_Go2[118]=10
617 Phase_1_Return1[118]=0
618 Phase_1_Return2[118]=1
619 Phase_1_Turns[118]=23
620 Phase_1_Go1[119]=0
621 Phase_1_Go2[119]=10
622 Phase_1_Return1[119]=0
623 Phase_1_Return2[119]=1
624 Phase_1_Turns[119]=23
625 Phase_1_Go1[120]=0
626 Phase_1_Go2[120]=10
627 Phase_1_Return1[120]=0
628 Phase_1_Return2[120]=1
629 Phase_1_Turns[120]=23
630 Phase_1_Go1[121]=0
631 Phase_1_Go2[121]=10
632 Phase_1_Return1[121]=0
633 Phase_1_Return2[121]=1
634 Phase_1_Turns[121]=23
635 Phase_1_Go1[122]=0
636 Phase_1_Go2[122]=10
637 Phase_1_Return1[122]=0
638 Phase_1_Return2[122]=1
639 Phase_1_Turns[122]=23
640 Phase_1_Go1[123]=0
641 Phase_1_Go2[123]=10
642 Phase_1_Return1[123]=0
643 Phase_1_Return2[123]=1
644 Phase_1_Turns[123]=23
645 Phase_1_Go1[124]=0
646 Phase_1_Go2[124]=10
647 Phase_1_Return1[124]=0
648 Phase_1_Return2[124]=1
649 Phase_1_Turns[124]=23
650 Phase_1_Go1[125]=0
651 Phase_1_Go2[125]=10
652 Phase_1_Return1[125]=0
653 Phase_1_Return2[125]=1
654 Phase_1_Turns[125]=23
655 Phase_1_Go1[126]=0
656 Phase_1_Go2[126]=10
657 Phase_1_Return1[126]=0
658 Phase_1_Return2[126]=1
659 Phase_1_Turns[126]=23
660 Phase_1_Go1[127]=0
661 Phase_1_Go2[127]=10
662 Phase_1_Return1[127]=0
663 Phase_1_Return2[127]=1
664 Phase_1_Turns[127]=23
665 Phase_1_Go1[128]=0
666 Phase_1_Go2[128]=10
667 Phase_1_Return1[128]=0
668 Phase_1_Return2[128]=1
669 Phase_1_Turns[128]=23
670 Phase_1_Go1[129]=0
671 Phase_1_Go2[129]=10
672 Phase_1_Return1[129]=0
673 Phase_1_Return2[129]=1
674 Phase_1_Turns[129]=23
675 Phase_1_Go1[130]=0
676 Phase_1_Go2[130]=10
677 Phase_1_Return1[130]=0
678 Phase_1_Return2[130]=1
679 Phase_1_Turns[130]=23
680 Phase_1_Go1[131]=0
681 Phase_1_Go2[131]=10
682 Phase_1_Return1[131]=0
683 Phase_1_Return2[131]=1
684 Phase_1_Turns[131]=23
685 Phase_1_Go1[132]=0
686 Phase_1_Go2[132]=10
687 Phase_1_Return1[132]=0
688 Phase_1_Return2[132]=1
689 Phase_1_Turns[132]=23
690 Phase_1_Go1[133]=0
691 Phase_1_Go2[133]=10
692 Phase_1_Return1[133]=0
693 Phase_1_Return2[133]=1
694 Phase_1_Turns[133]=23
695 Phase_1_Go1[134]=0
696 Phase_1_Go2[134]=10
697 Phase_1_Return1[134]=0
698 Phase_1_Return2[134]=1
699 Phase_1_Turns[134]=23
700 Phase_1_Go1[135]=0
701 Phase_1_Go2[135]=10
702 Phase_1_Return1[135]=0
703 Phase_1_Return2[135]=1
704 Phase_1_Turns[135]=23
705 Phase_1_Go1[136]=0
706 Phase_1_Go2[136]=10
707 Phase_1_Return1[136]=0
708 Phase_1_Return2[136]=1
709 Phase_1_Turns[136]=23
710 Phase_1_Go1[137]=0
711 Phase_1_Go2[137]=10
712 Phase_1_Return1[137]=0
713 Phase_1_Return2[137]=1
714 Phase_1_Turns[137]=23
715 Phase_1_Go1[138]=0
716 Phase_1_Go2[138]=10
717 Phase_1_Return1[138]=0
718 Phase_1_Return2[138]=1
719 Phase_1_Turns[138]=23
720 Phase_1_Go1[139]=0
721 Phase_1_Go2[139]=10
722 Phase_1_Return1[139]=0
723 Phase_1_Return2[139]=1
724 Phase_1_Turns[139]=23
725 Phase_1_Go1[140]=0
726 Phase_1_Go2[140]=10
727 Phase_1_Return1[140]=0
728 Phase_1_Return2[140]=1
729 Phase_1_Turns[140]=23
730 Phase_1_Go1[141]=0
731 Phase_1_Go2[141]=10
732 Phase_1_Return1[141]=0
733 Phase_1_Return2[141]=1
734 Phase_1_Turns[141]=23
735 Phase_1_Go1[142]=0
736 Phase_1_Go2[142]=10
737 Phase_1_Return1[142]=0
738 Phase_1_Return2[142]=1
739 Phase_1_Turns[142]=23
740 Phase_1_Go1[143]=0
741 Phase_1_Go2[143]=10
742 Phase_1_Return1[143]=0
743 Phase_1_Return2[143]=1
744 Phase_1_Turns[143]=23
745 Phase_1_Go1[144]=0
746 Phase_1_Go2[144]=10
747 Phase_1_Return1[144]=0
748 Phase_1_Return2[144]=1
749 Phase_1_Turns[144]=23
750 Phase_1_Go1[145]=0
751 Phase_1_Go2[145]=10
752 Phase_1_Return1[145]=0
753 Phase_1_Return2[145]=1
754 Phase_1_Turns[145]=23
755 Phase_1_Go1[146]=0
756 Phase_1_Go2[146]=10
757 Phase_1_Return1[146]=0
758 Phase_1_Return2[146]=1
759 Phase_1_Turns[146]=23
760 Phase_1_Go1[147]=0
761 Phase_1_Go2[147]=10
762 Phase_1_Return1[147]=0
763 Phase_1_Return2[147]=1
764 Phase_1_Turns[147]=23
765 Phase_1_Go1[148]=0
766 Phase_1_Go2[148]=10
767 Phase_1_Return1[148]=0
768 Phase_1_Return2[148]=1
769 Phase_1_Turns[148]=23
770 Phase_1_Go1[149]=0
771 Phase_1_Go2[149]=10
772 Phase_1_Return1[149]=0
773 Phase_1_Return2[149]=1
774 Phase_1_Turns[149]=23
775 Phase_1_Go1[150]=0
776 Phase_1_Go2[150]=10
777 Phase_1_Return1[150]=0
778 Phase_1_Return2[150]=1
779 Phase_1_Turns[150]=23
780 Phase_1_Go1[151]=0
781 Phase_1_Go2[151]=10
782 Phase_1_Return1[151]=0
783 Phase_1_Return2[151]=1
784 Phase_1_Turns[151]=23
785 Phase_1_Go1[152]=0
786 Phase_1_Go2[152]=10
787 Phase_1_Return1[152]=0
788 Phase_1_Return2[152]=1
789 Phase_1_Turns[152]=23
790 Phase_1_Go1[153]=0
791 Phase_1_Go2[153]=10
792 Phase_1_Return1[153]=0
793 Phase_1_Return2[153]=1
794 Phase_1_Turns[153]=23
795 Phase_1_Go1[154]=0
796 Phase_1_Go2[154]=1
```

Python scripting interface

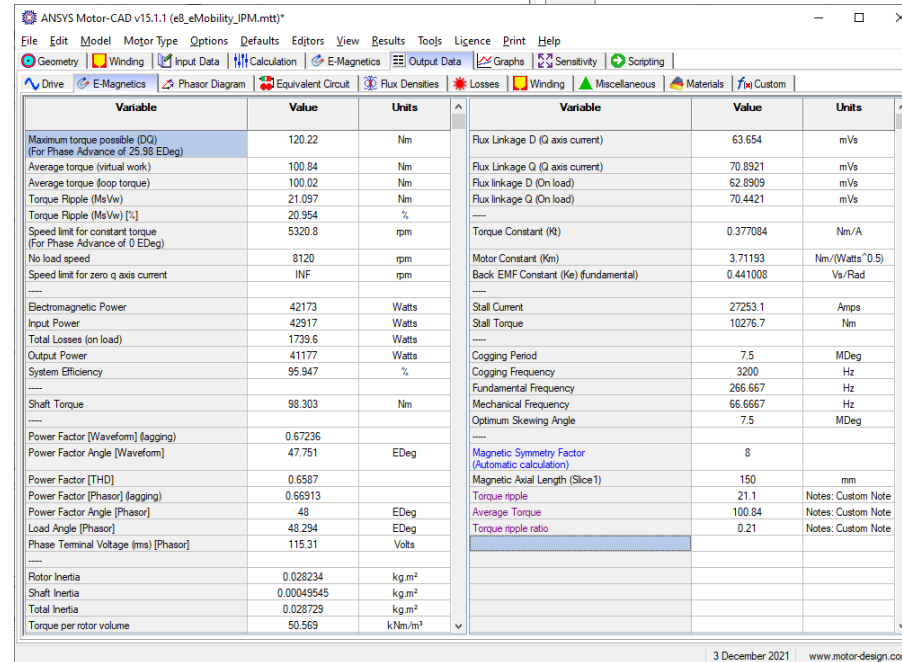
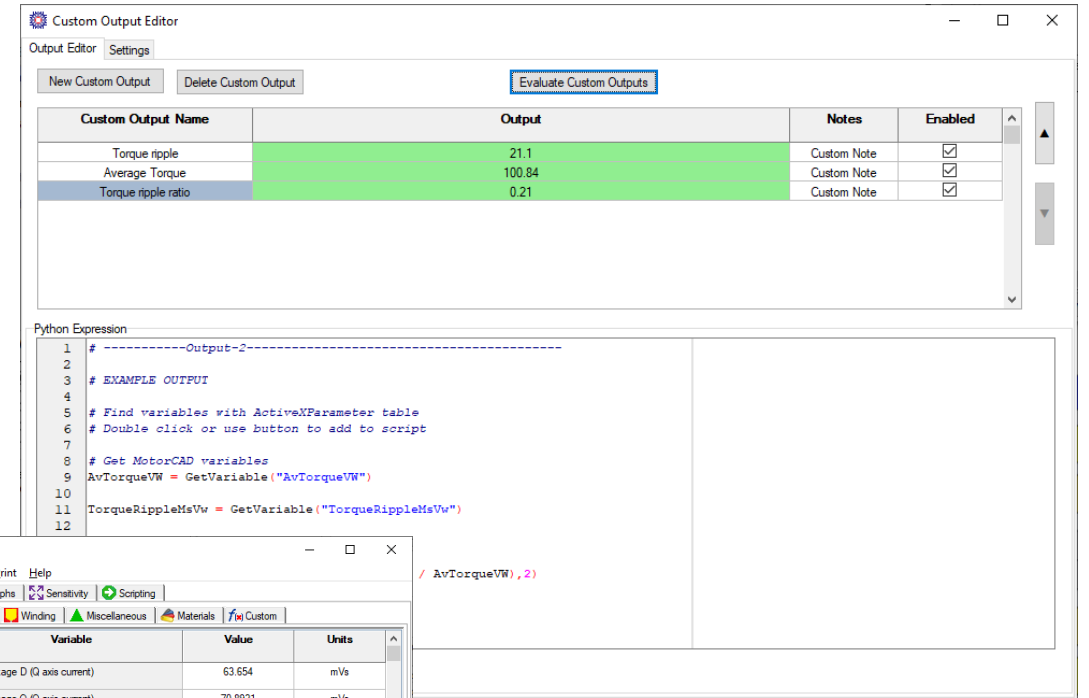
- User interface to allow users to run python scripts.
- Gives full functionality of Python to user scripts.
- Examples:
 - Generate non template geometries
 - Calculate currents during EMag calculations
 - Calculate heat transfer coefficients during thermal calcs
 - Calculate losses in thermal calcs
 - Automate workflows with Ansys tools (Maxwell, Discovery, Fluent)



```
1 # need to import win32com.client to use MotorCAD.AppAutomation
2 import win32com.client
3
4 # create Motor-CAD ActiveX connection
5 mcApp = win32com.client.Dispatch("MotorCAD.AppAutomation")
6
7 # This function is called once at the start of a calculation
8 def initial():
9 # set all messages to display in a separate window
10 # Warning: this will disable crucial popups e.g. prompts to save files, overwrite data etc
11 # Please ensure this is the behaviour you want
12 mcApp.SetVariable("MessageDisplayState",2)
13 #define a function to use later
14
15 # This function is called at every calculation step
16 def main():
17 array_ToothWidths = [1,1.5,2,2.5,3]
18 for toothWidth in array_ToothWidths:
19 mcApp.showmessage("Tooth width = " + str(toothWidth))
20 mcApp.SetVariable("Tooth_Width", toothWidth)
21 mcApp.DoSteadyStateAnalysis()
22 ex, temperature = mcApp.GetVariable("I_[WINDING_AVERAGE]", )
23 mcApp.showmessage("Winding temperature = " + str(temperature))
24
25 # This function is called at the end of a calculation
26 def final():
27 # restore the message dialogs
28 mcApp.SetVariable("MessageDisplayState", 0)
29
30 # end of script
```

Improved custom output

- User interface to allow users to run python scripts for custom outputs.
- Very flexible able to get:
 - Calculated values
 - Graph values
 - Thermal circuit values
 - FEA result values



SYNC machine Rotor Damper Bars

- New modelling of rotor damper bars

ANSYS Motor-CAD v15.1.1 (SYNC_Generator_DamperBars_ACLoad.mot)*

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Geometry Amature Winding Field Winding Input Data Calculation E-Magnetics Output Data Graphs Sensitivity Scripting

Drive E-Magnetics Phasor Diagram Equivalent Circuit Flux Densities Losses Winding Miscellaneous Materials

Variable	Value	Units	Variable	Value	Units
Phase Resistance	1.568	Ohms	Field Winding Resistance	0.3095	Ohms
-----			-----		
D Axis Inductance	108.4	mH	Field Winding Inductance	268.1	mH
Q Axis Inductance	140.7	mH	Field Winding Reactance	84.24	Ohms
Stator Slot Leakage Inductance	10.12	mH	Referred Field Winding Reactance	105.5	Ohms
Stator Differential Leakage Inductance	2.629	mH	-----		
Armature End Winding Inductance (Rosa and Grover)	1.704	mH	Field Winding Leakage Inductance	193.1	mH
Stator Leakage Inductance (Total)	14.45	mH	Referred Field Winding Leakage Inductance	241.8	mH
Magnetizing Inductance (D Axis)	93.93	mH	Field Winding Leakage Reactance	60.67	Ohms
Magnetizing Inductance (Q Axis)	126.3	mH	Referred Field Winding Leakage Reactance	75.97	Ohms
-----			-----		
D Axis Reactance	34.05	Ohms	Damper Bar Slot Leakage Inductance	0.001459	mH
Q Axis Reactance	44.2	Ohms	Damper Bar Differential Leakage Inductance	0.0004342	mH
Stator Slot Leakage Reactance	3.179	Ohms	Damper End Ring Inductance (front)	0.0002482	mH
Stator Differential Leakage Reactance	0.8259	Ohms	Damper End Ring Inductance (rear)	0.0002695	mH
Armature End Winding Reactance	0.5353	Ohms	Damper End Ring Inductance	0.0002589	mH
Stator Leakage Reactance (Total)	4.54	Ohms	Inter-Bar Damper End Ring Inductance (front)	2.458E-005	mH
Magnetizing Reactance (D Axis)	29.51	Ohms	Inter-Bar Damper End Ring Inductance (rear)	2.669E-005	mH
Magnetizing Reactance (Q Axis)	39.66	Ohms	Inter-Bar Damper End Ring Inductance	2.563E-005	mH
-----			-----		
Damper Bar Resistance	0.0004092	Ohms	Damper Cage Leakage Inductance (total)	0.002152	mH
Damper End Ring Resistance (front)	1.853E-006	Ohms	Damper Cage Leakage Reactance (total)	0.000676	Ohms
Damper End Ring Resistance (rear)	3.705E-006	Ohms	Referred Damper Cage Leakage Inductance	36.67	mH
Damper End Ring Resistance	2.779E-006	Ohms	Referred Damper Cage Leakage Reactance (total)	11.52	Ohms
Damper Cage Resistance (total)	0.0004372	Ohms	-----		
-----			First Order Transient Reactance (D Axis)	25.79	Ohms
Rotor to Stator Transform for Impedance	1.704E004		First Order Transient Reactance (Q Axis)	44.2	Ohms
Referred Damper Bar Resistance	6.972	Ohms	Second Order Transient Reactance (D Axis)	12.22	Ohms
Referred Damper End Ring Resistance	0.04735	Ohms	Second Order Transient Reactance (Q Axis)	13.47	Ohms
Referred Damper Cage Resistance (total)	7.45	Ohms	-----		

RotorAir B=0.012T μR=1 J= 0A/mm2 C= 0AT Area= 3976mm2

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Geometry Amature Winding Field Winding Input Data Calculation Drive E-Magnetics Output Data Graphs Sensitivity Scripting

Radial Axial 3D

Slot Type: Form Wound Rotor Type: Salient Pole

Stator Ducts: None Rotor Ducts: None

Slip Rings: None

Stator Parameters	Value	Rotor Parameters	Value
Slot Number	72	Rotor Slots	6
Stator Lam Da	740	Pole Width	80
Stator Bore	520	Pole Depth	100
Slot Width	11	Pole Tip Width	54
Slot Depth	47.5	Pole Tip Depth	40
Wedge Depth	1	Pole Tip Radius	0
Wedge Inset	1	Pole Base Radius	0
Wedge Thickness	4	Pole Surface Radius	246
Steeve Thickness	0	Pole Surface Offset	10
		Areas (Calculated)	4
		Liner Pole Side	1
		Liner Pole Tip	1
		Liner Coil Base	1
		Rotor Coil Width	32.5
		Rotor Coil Depth	87
		Winding Separators	1
		Wdg Separator Length	10
		Wdg Separator Low [%]	10
		Wdg Separator Up [%]	90
		Damper Bars	7
		Damper Bar Opening	1
		Damper Bar Depth	1
		Damper Bar Pitch	200
		Damper Bar Diameter	10
		Banding Thickness	0
		Shaft Dia	150
		Shaft Hole Diameter	0

Geometry Parameterisation: Dimensions Flans

Redraw

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File Edit Model Motor Type Options Defaults Editors View Results Tools Licence Print Help

Geometry Amature Winding Field Winding Input Data Calculation E-Magnetics Output Data Graphs Sensitivity Scripting

FEA FEA Editor FEA Paths

Solve E-Magnetic Model

Shading: Region Flux Density Vector Potential Current Density Eddy Current Density

Shading function: B/T

Shading region: B

Options: Legend Outlines Mesh

Equipotential Lines: 20 A

Vector Lengths: 0 B

Shading Range: Automatic Min Max

Min: 0 Max: 2.2

Debug: Save Load

Geometry Options: View: Point Labels Results Virtual Lines Geometry Boundaries Mesh

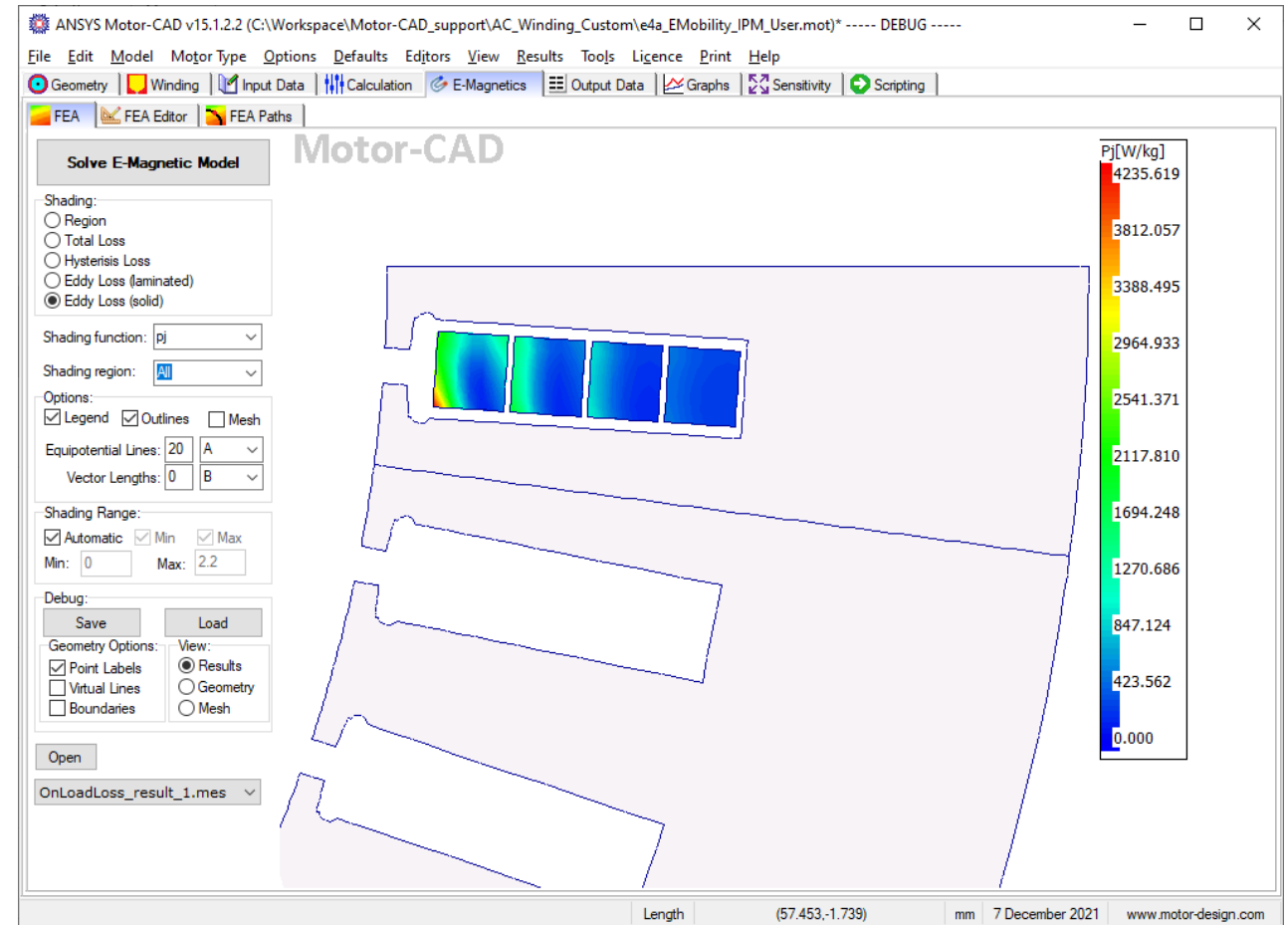
Open

StaticLoad_result_1.mes

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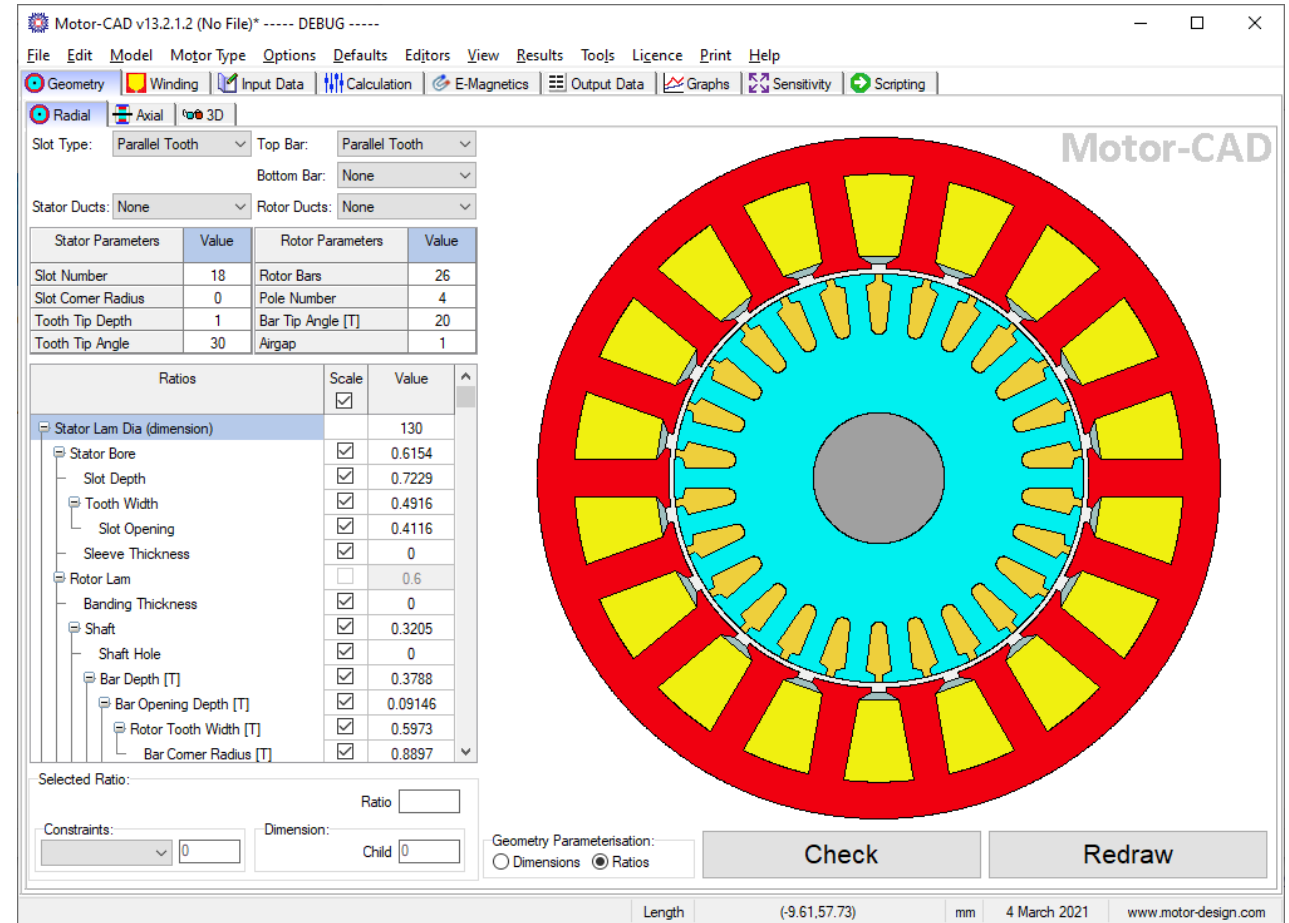
Improved AC winding loss calculation

- Now able to make a full FEA AC winding loss calculation using a custom dxf geometry
- Custom stator lamination shape can be used.
- Conductors can be positioned in slot.



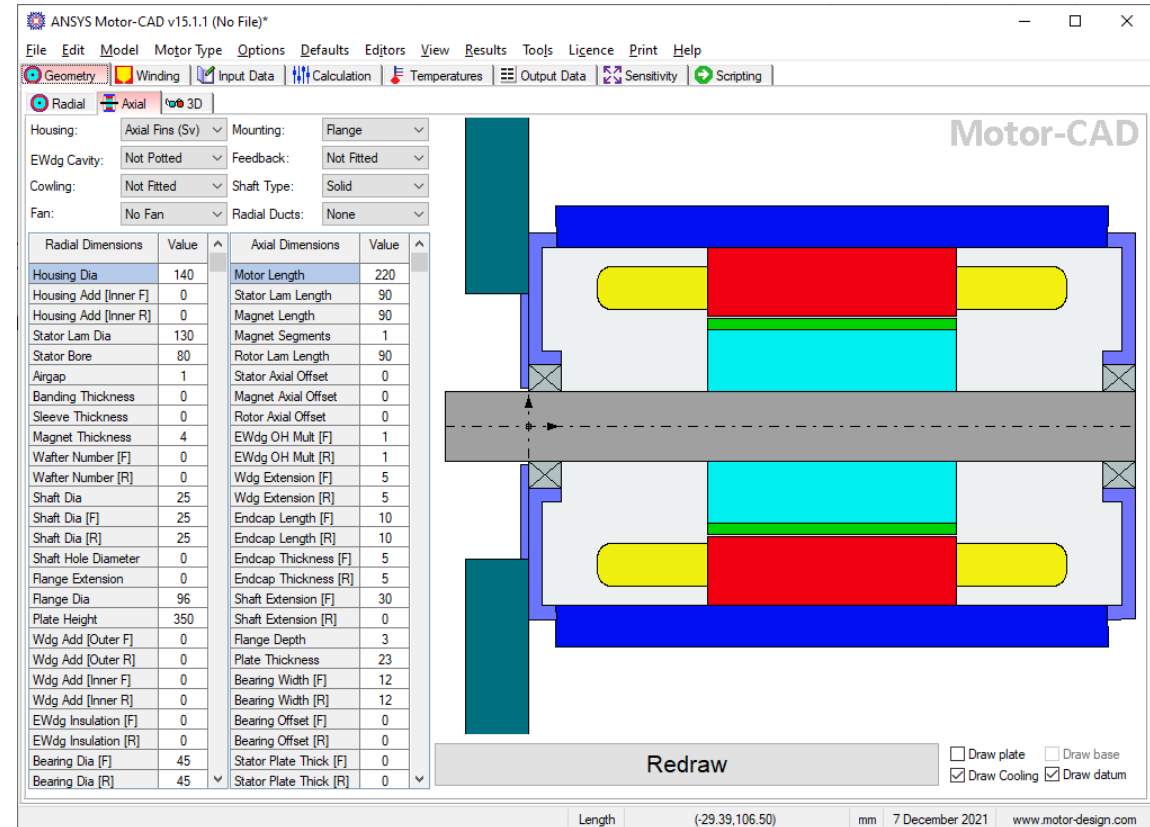
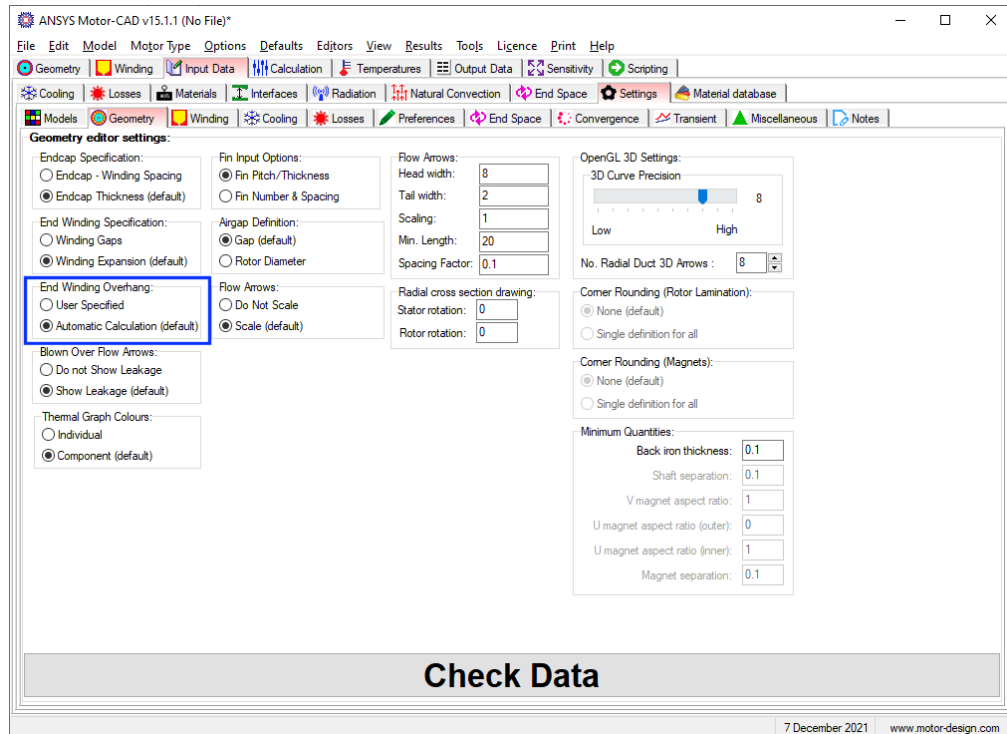
New geometry ratios for IM machines

- Expanding on the BPM/SYNCREL ratios from V14.
- Useful for optimisation and required for Ansys optiSLang export.



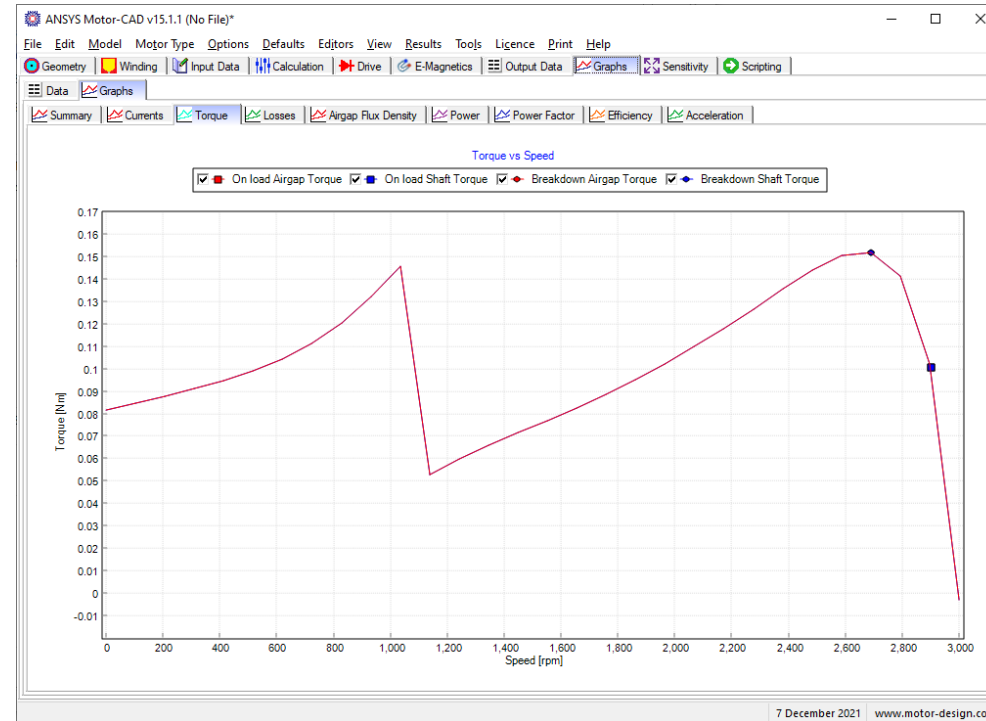
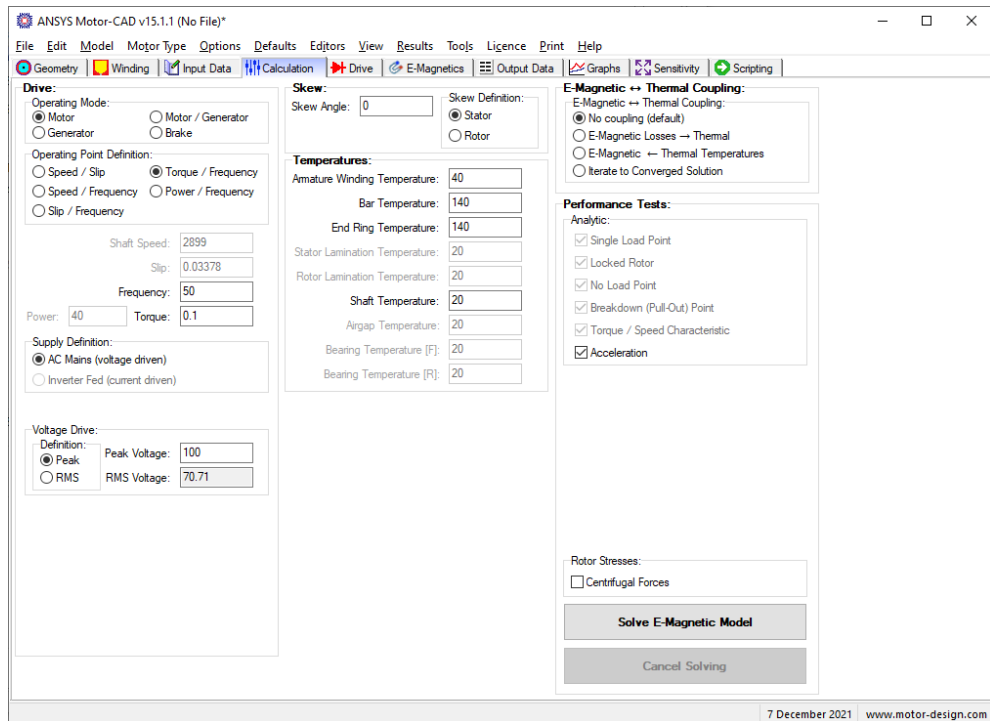
Endwinding overhang calculation

- New option for automatic calculation of endwinding overhang.
- Overhang used for thermal calculations based on winding pattern.



IM1PH machine added operating points

- Added operating point specifications for:
 - Torque / Frequencyand
 - Power / Frequency



 **Ansys**

