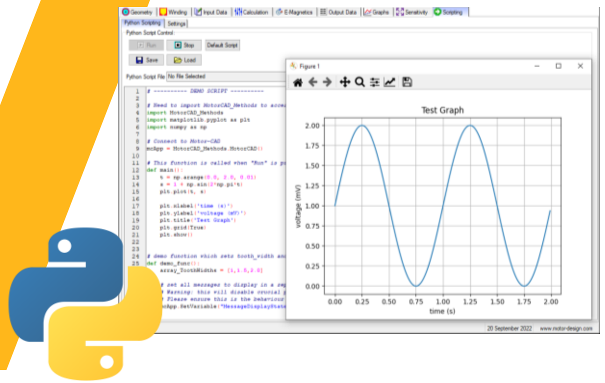
Ansys 2023 R1
Take A Leap Of Certainty

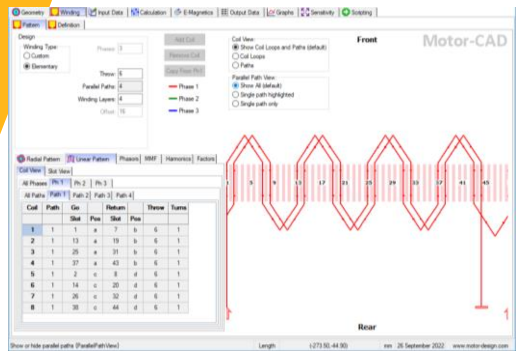
ANSYS Motor-CAD 2023 R1
新功能介绍

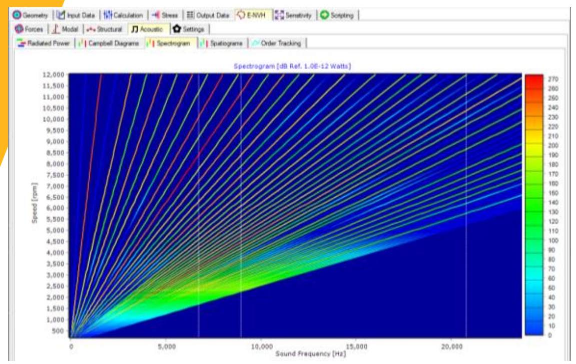
新科益系统与咨询（上海）有限公司

Ansys

Ansys Motor-CAD 2023 R1 Highlights







Automation and workflows

- ✓ New pymotorCAD automation interface
- ✓ New JSON-RPC communication interface
- ✓ Upgraded internal scripting
- ✓ More flexible custom outputs
- ✓ Enhanced automated export to Maxwell

New features for machines types, hairpin windings and oil cooling

- ✓ Improved models for induction machine electromagnetics
- ✓ Multi-physics optimization for wound field machines
- ✓ Enhanced winding definition and loss calculation
- ✓ New geometries and cooling methods

Mechanical and NVH enhancements

- ✓ Induction machine NVH
- ✓ Housing and winding stiffness included in the mechanical NVH model
- ✓ Faster NVH analysis and optimization of noise metrics
- ✓ Improved mechanical stress analysis for optimization workflows

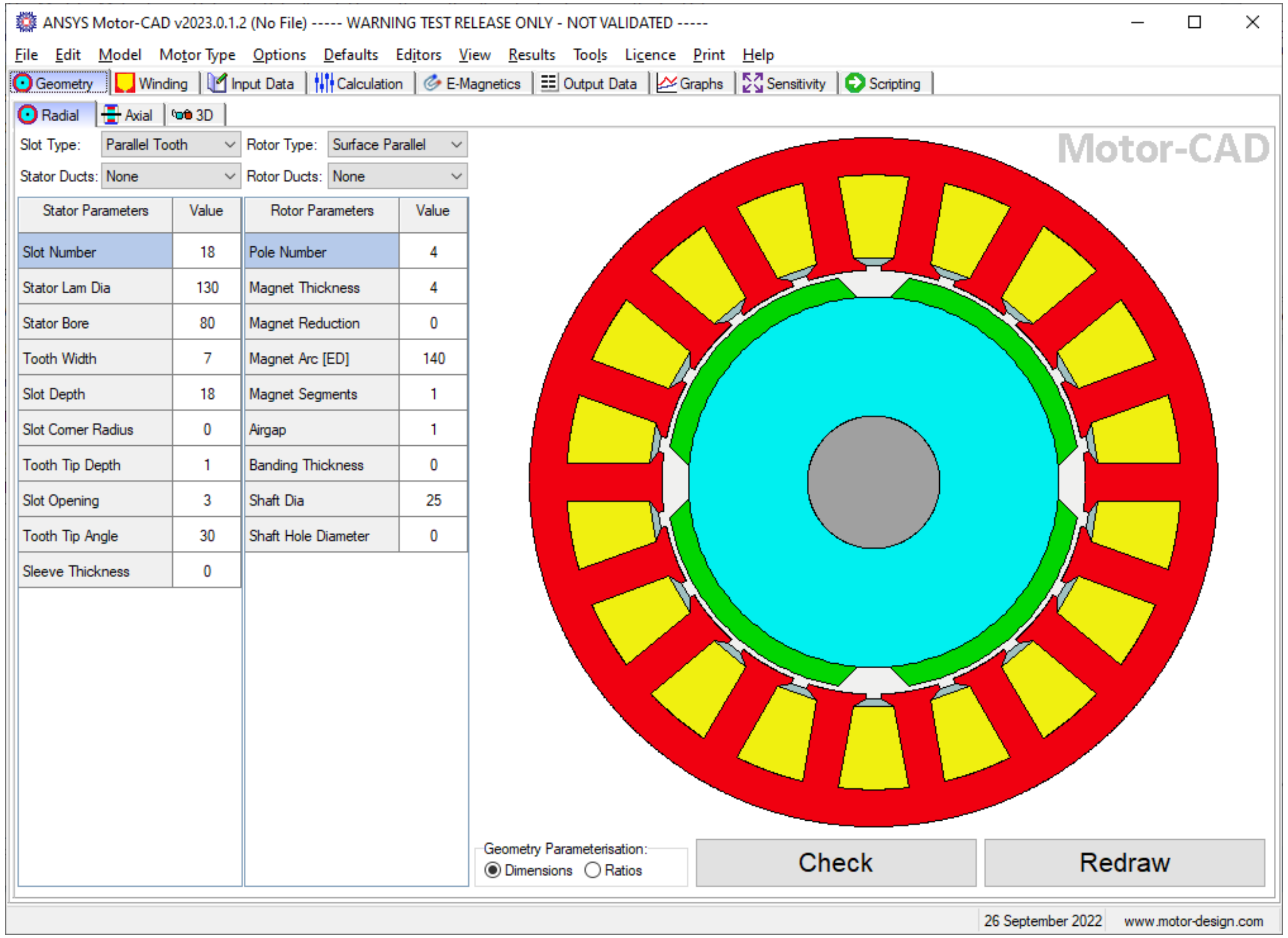
2023 R1: Product Release Detail

Motor-CAD 2023R1 新版本名

- Motor-CAD version names now align with Ansys release numbers.
- Previously:
  - 2022R1 was v15.1.1
  - 2022R2 was v15.1.7

Future:

- 2023R1 pre-releases will be v2023.0.x
- 2023R1 release will be v2023.1.1
- 2023R2 release will be v2023.2.1

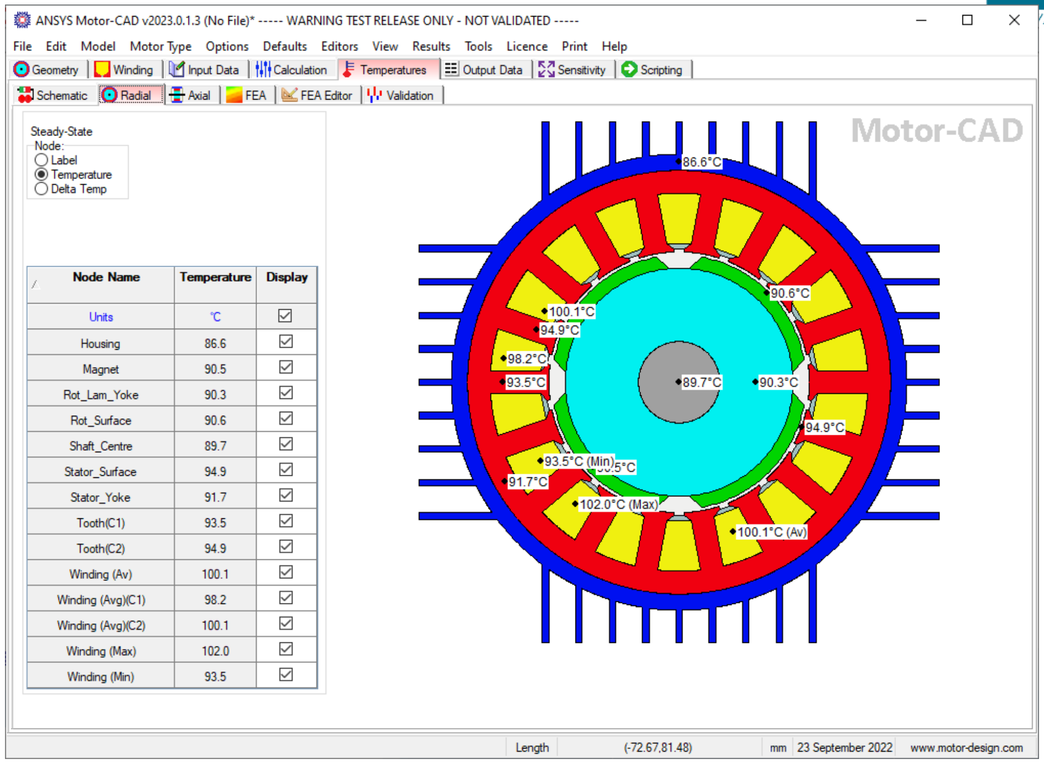


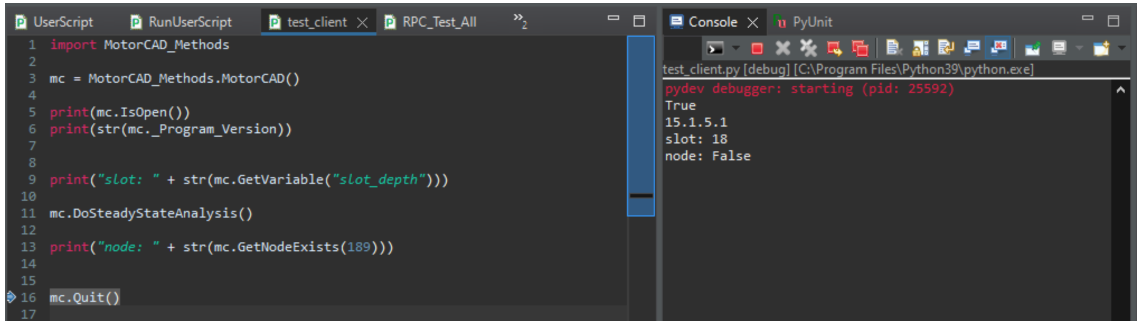
Automation and workflows

Ansys

新 pymotorcad API

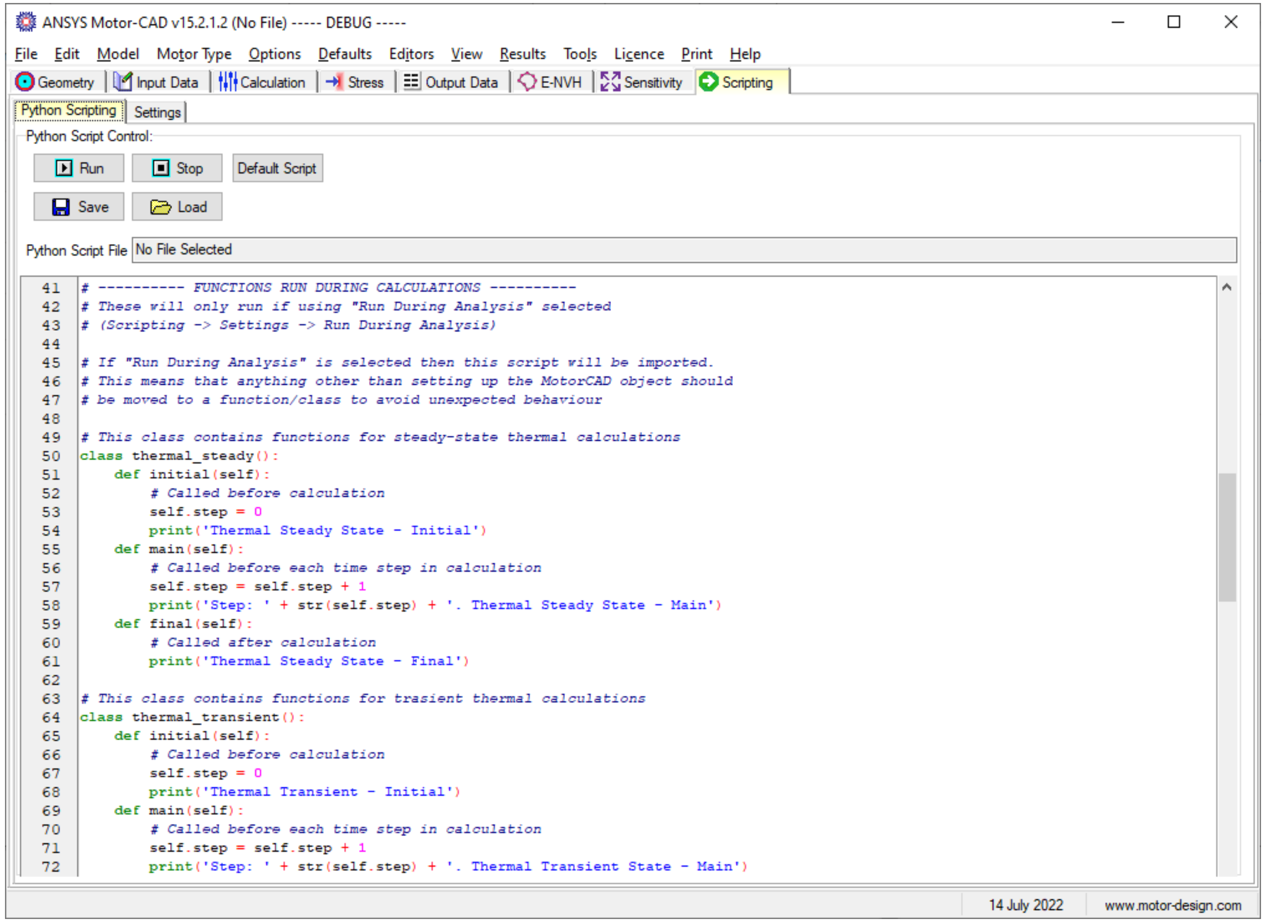
- pymotorcad package used as default option in internal scripting.
- pymotorcad will be available as a pip package for 2023R1 as part of PyAnsys.
- JSON-RPC API is now used for Automation calls instead of ActiveX.
- ActiveX still supported but pymotorcad very much recommended.
- Python can easily connect to local/remote Motor-CAD instances with pymotorcad package.
- Improved/new docstrings, error messages and debugging.
- New Launch Parameters:
  - Port can be specified for RPC server on launch.
  - Motor-CAD can run script upon launch from command line





内部脚本

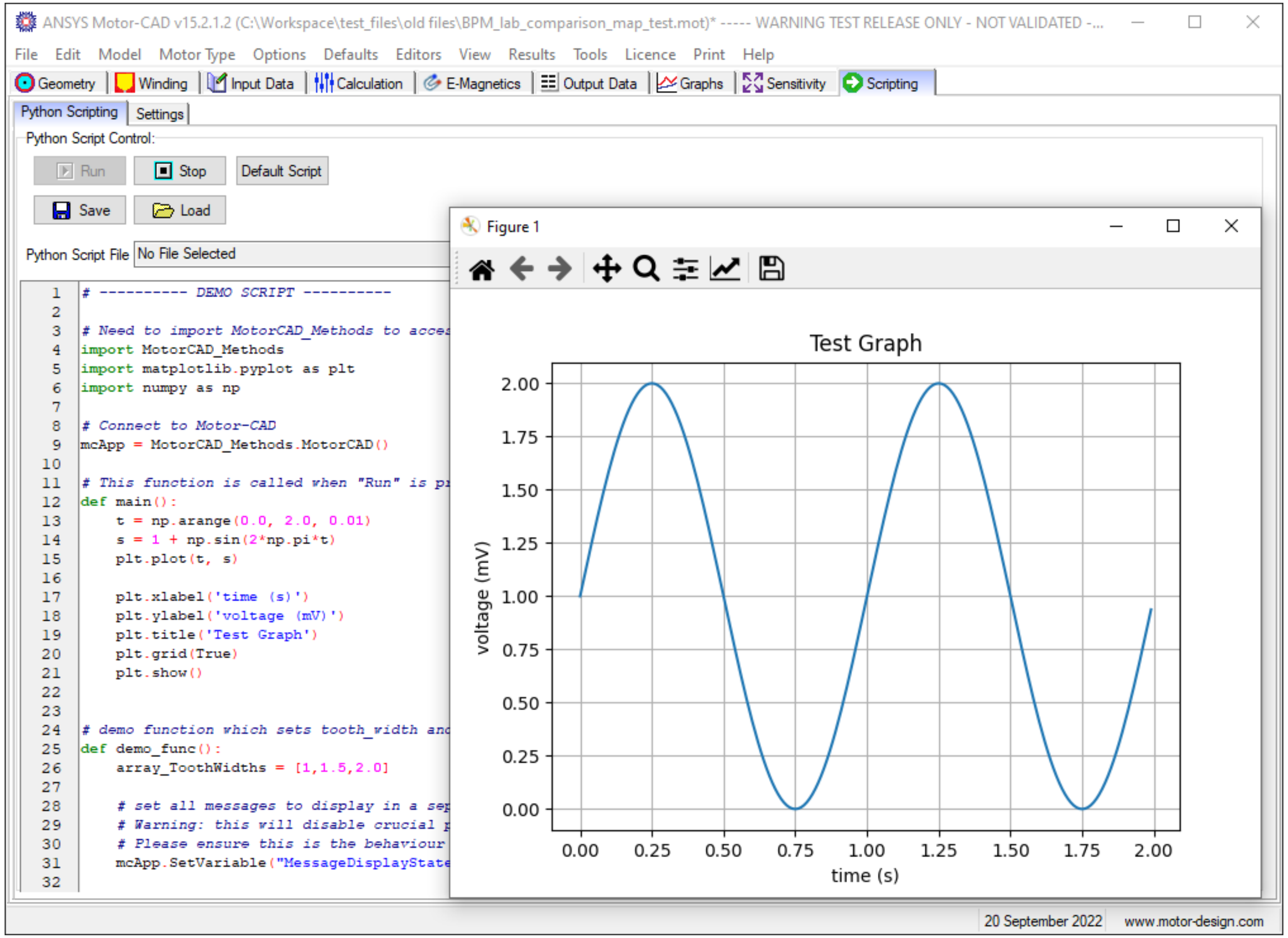
- Internal scripting uses new JSON-RPC interface.
    - fixes issue where script would run commands on wrong Motor-CAD instance.
- Internal scripts can be used for model setup, model adjustment during run and post processing of results
- Separate scripts can be run before, during and after calculations for:
    - E-Mag
    - Thermal Steady state
    - Thermal Transient
    - Mechanical Stress
    - Mechanical Forces



Python 版本更新

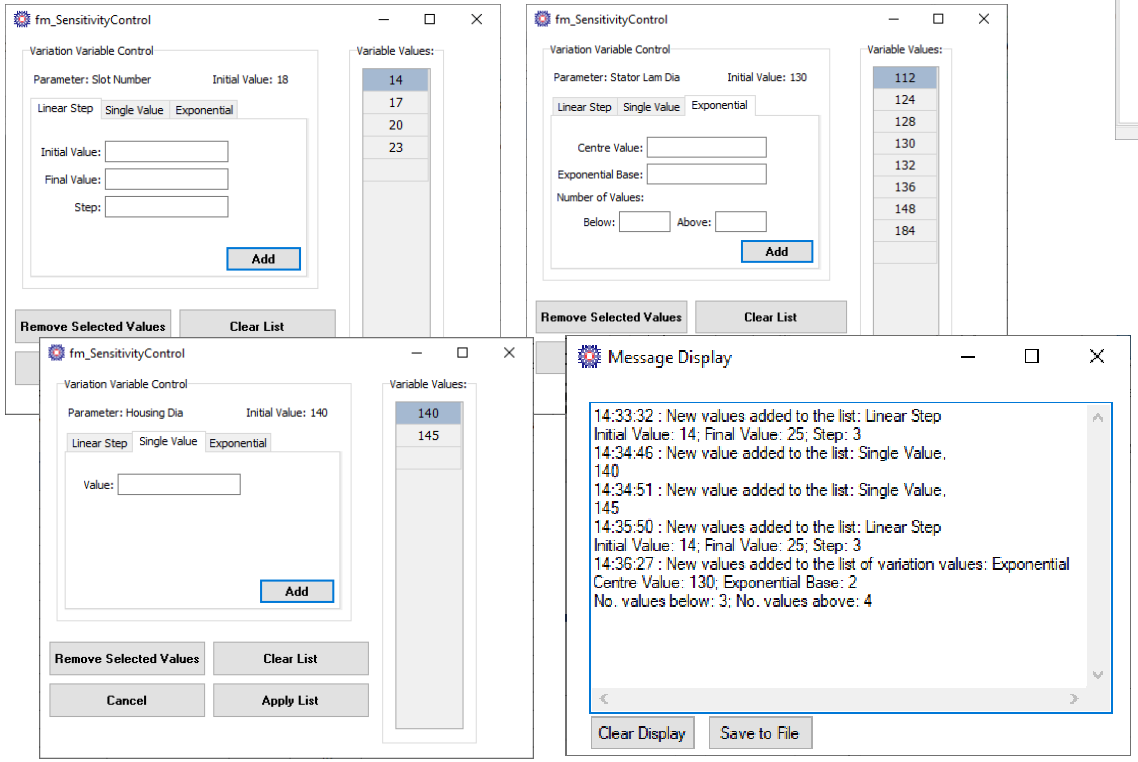
- Updated internal Python to 3.9.13.
- Lab Python updated to 3.9.13.

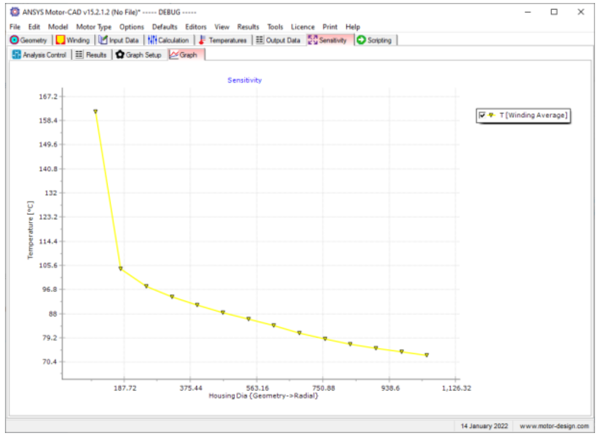
- Now able to generate GUIs in python from the internal scripts.
- E.g. Matplotlib graphs can now be generated by internal scripts.

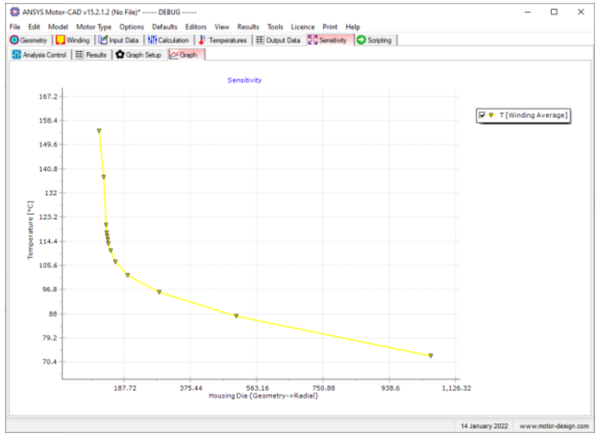


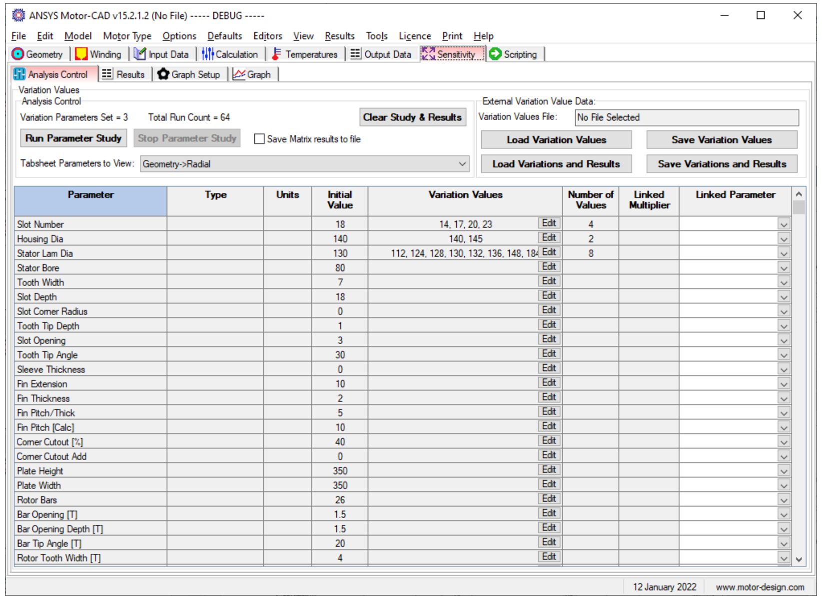
增强的灵敏度功能

- More options for setting sensitivity study values:
  - Single points , Linear range, logarithmic range



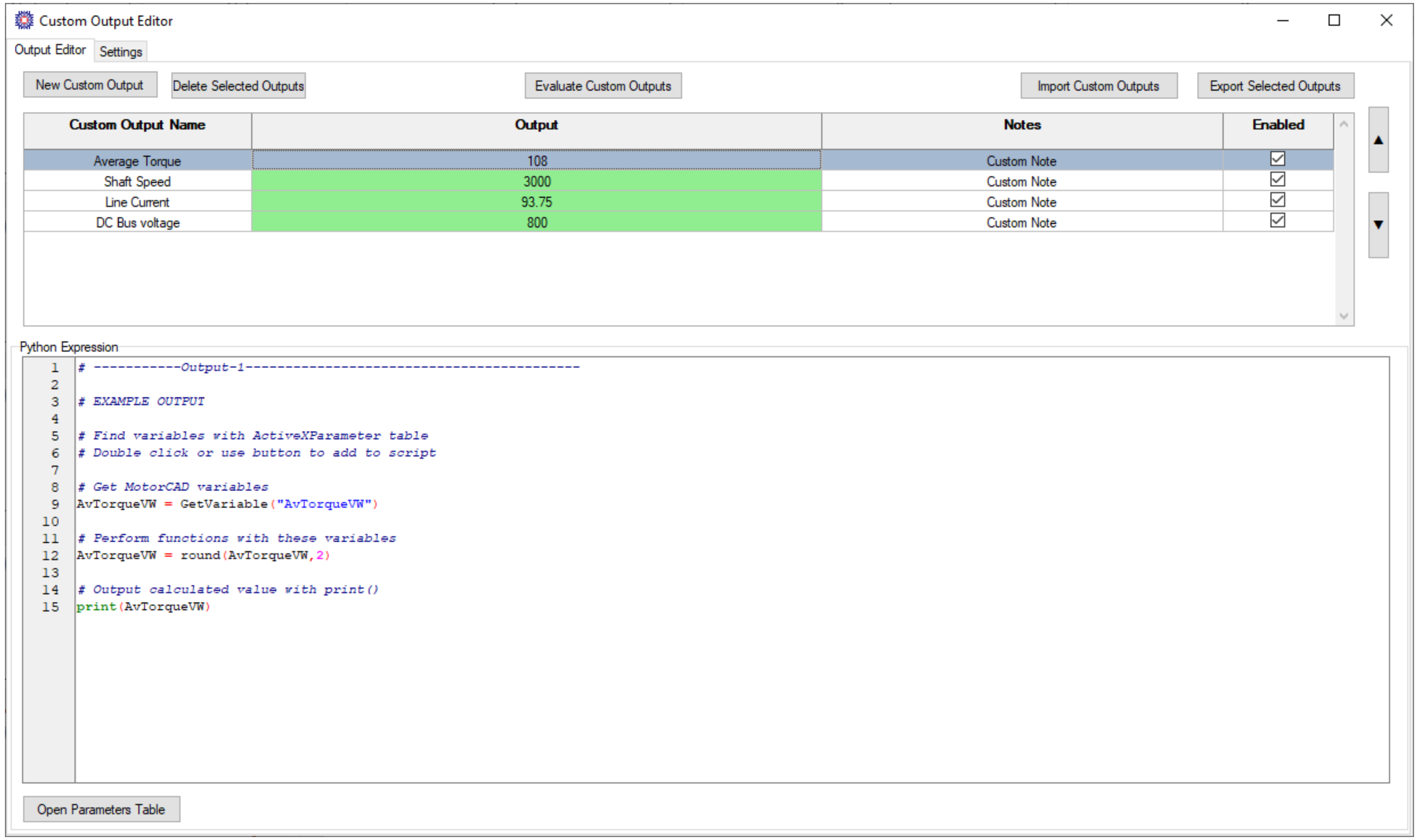






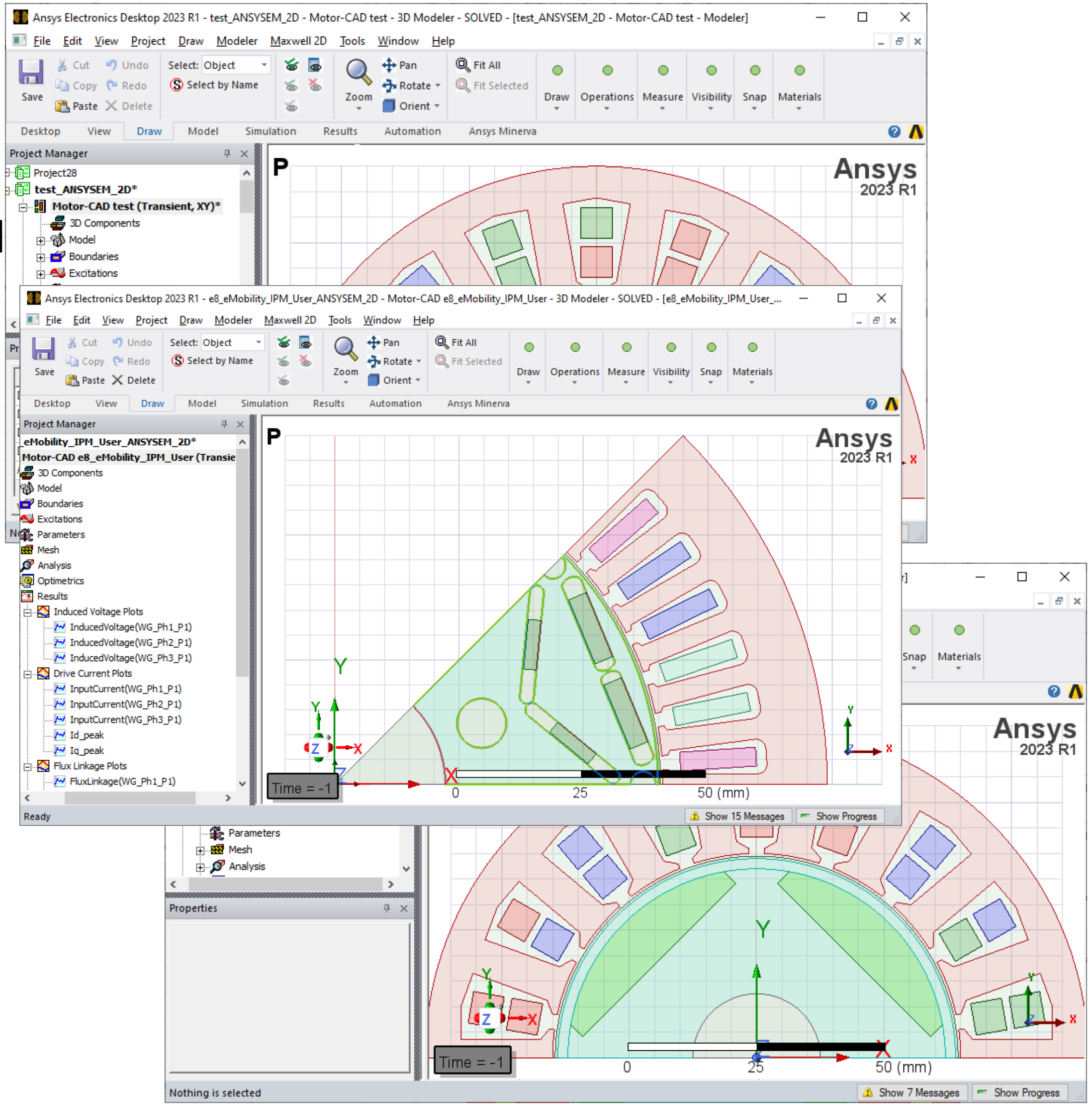
增加自定义输出的灵活性

- Python custom outputs have been added to sensitivity study.
- Added option to load default python custom output file at startup.
- Users can now have their own custom parameters setup whenever run they Motor-CAD.



Maxwell 导出增强

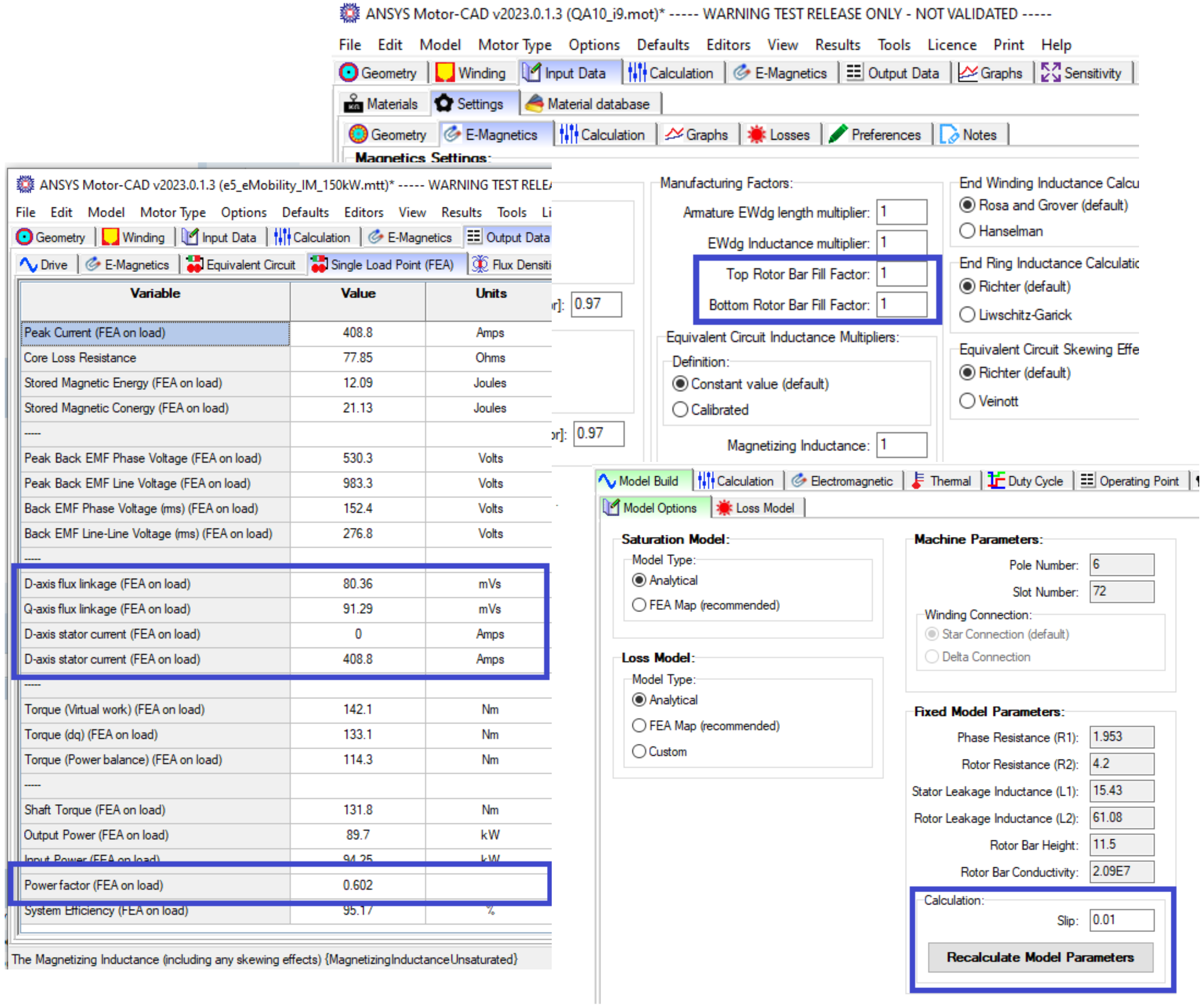
- Added use of magnet and rotor UDPs export for BPMOR and BPM machines with Surface/Inset/Embedded Radial/Parallel/Breadloaf rotor types
- Added use of stator UDP for export of Parallel Tooth/SqBase slots for BPM, BPMOR, IM, SYNC and SYNCREL machine types.
- Included Stator Pole Taper Angle in UDP export for SRM machines.
- Improved Outlines export; polyline coordinates drawn to tolerance in Motor-CAD,
- Removed inner and outer rotating bands from airgap in Maxwell export, replacing with single central rotating band.



电机拓扑增强

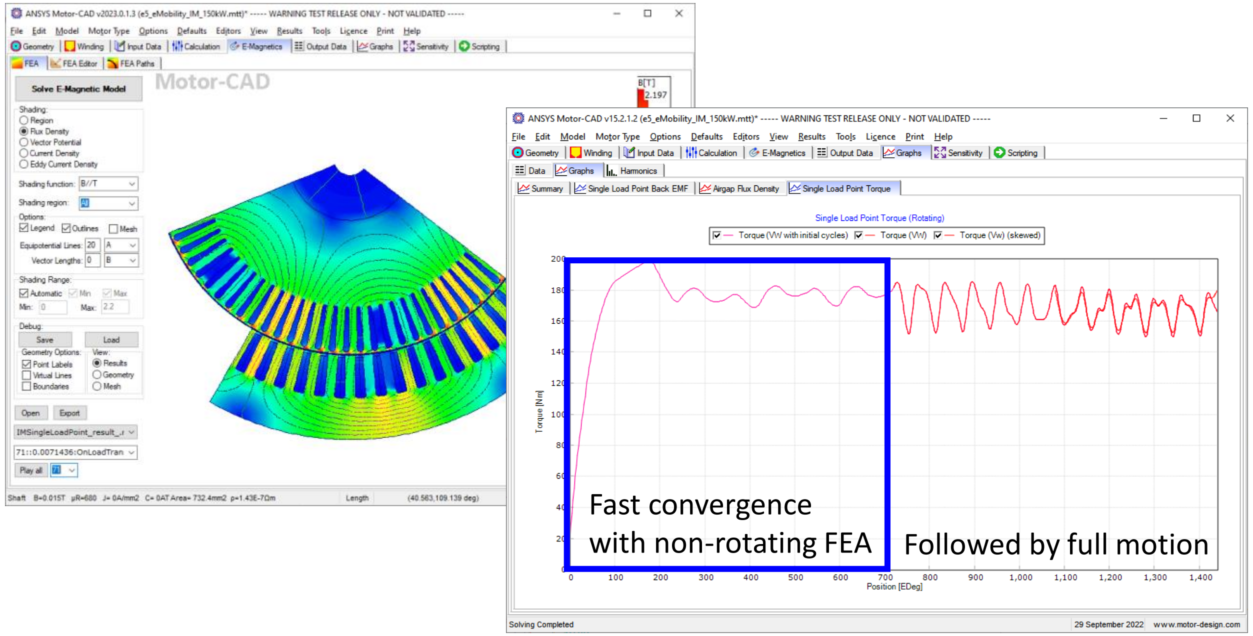
感应电机改进

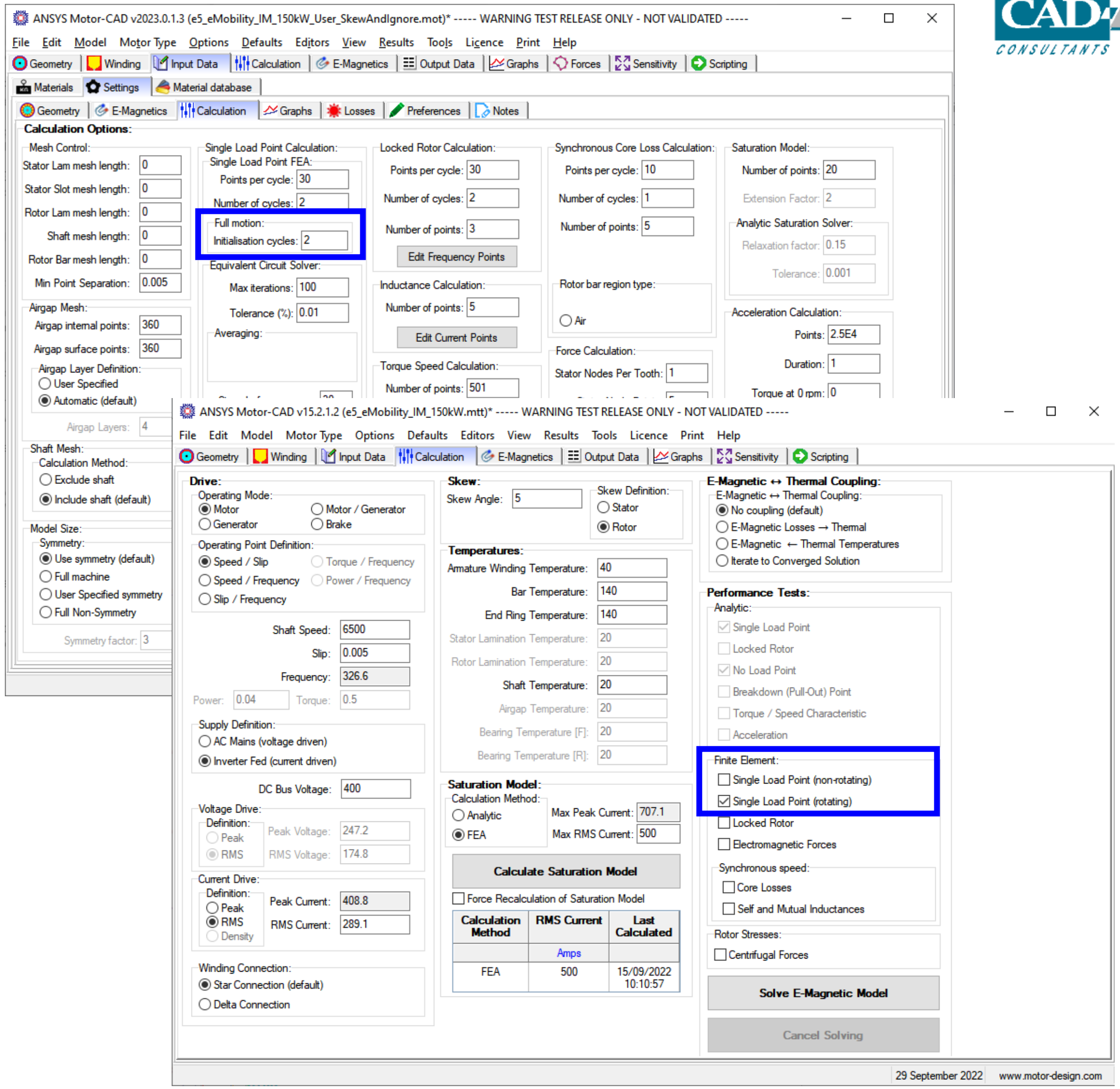
- Lab and Emag modules now use the same saturation model. Increased simplicity for the user, don't have to build it twice, and can now adjust the resolution in Lab.
- Calculation improvements (rotor leakage inductance correction).
- Rotor bar slot fill factors.
- Variable stator leakage inductance in Lab (calculated at model build time).
- Lab fixed parameter calculation improvements (now calculated using model build speed, current and user specified slip).
- Power factor, D&Q flux linkages and currents outputted from Single Load Point.



瞬态感应电机计算

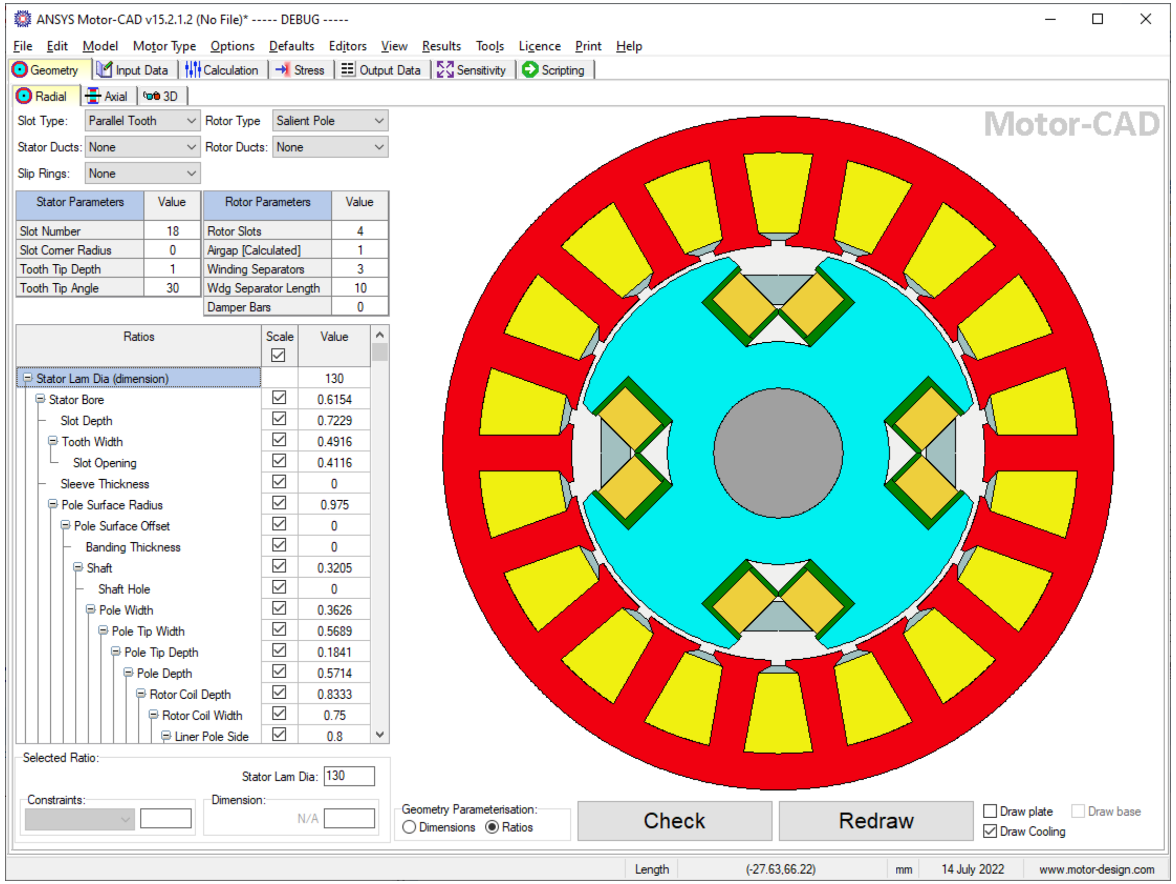
- New Single operating point transient electromagnetic calculation with rotation for induction machines.
- Adjustable initialisation cycles to speed up convergence.
  - Initial cycles run non-rotating analysis, for rapid rotor current convergence (resistivity adjusted to account for slip).
    - Generator mode solved at 2x synchronous speed
  - Remaining cycles run with rotation.





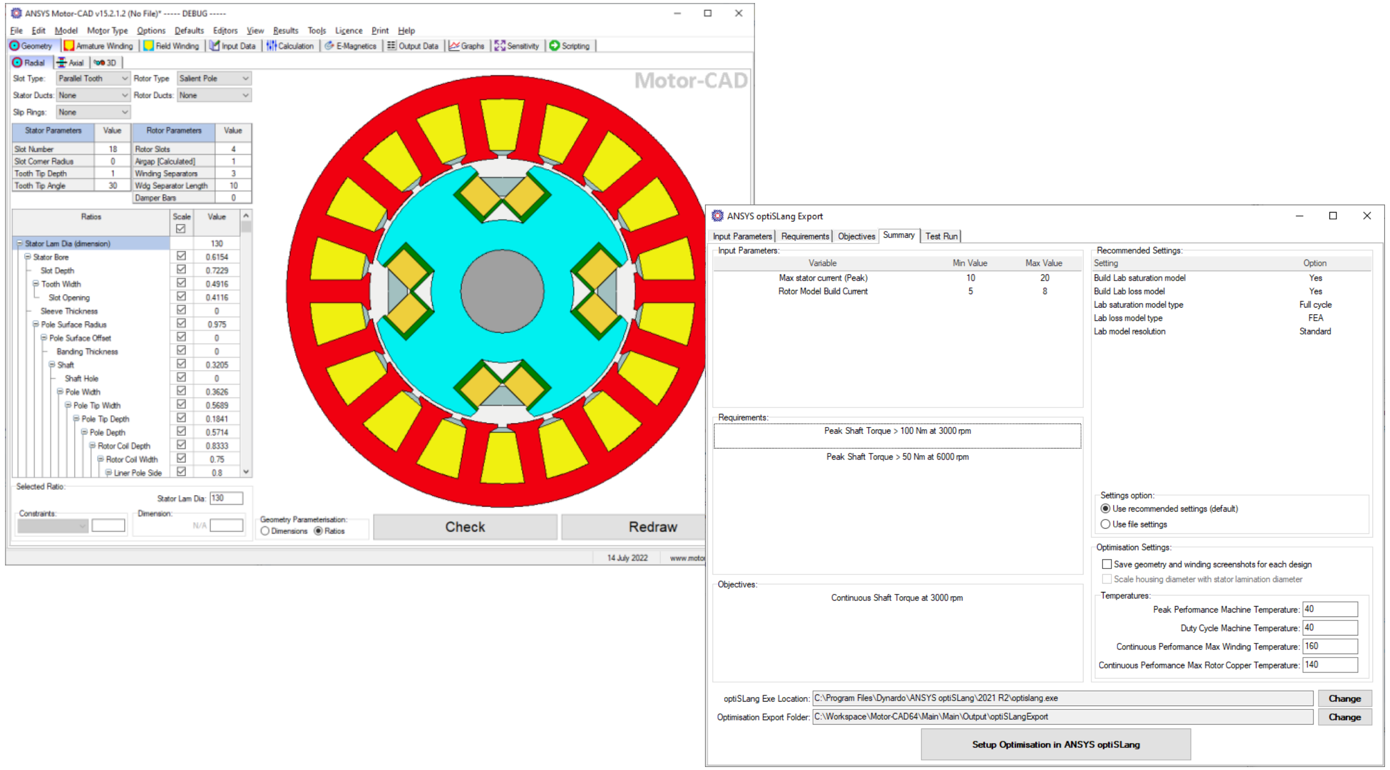
新 SYNC 电机几何比率

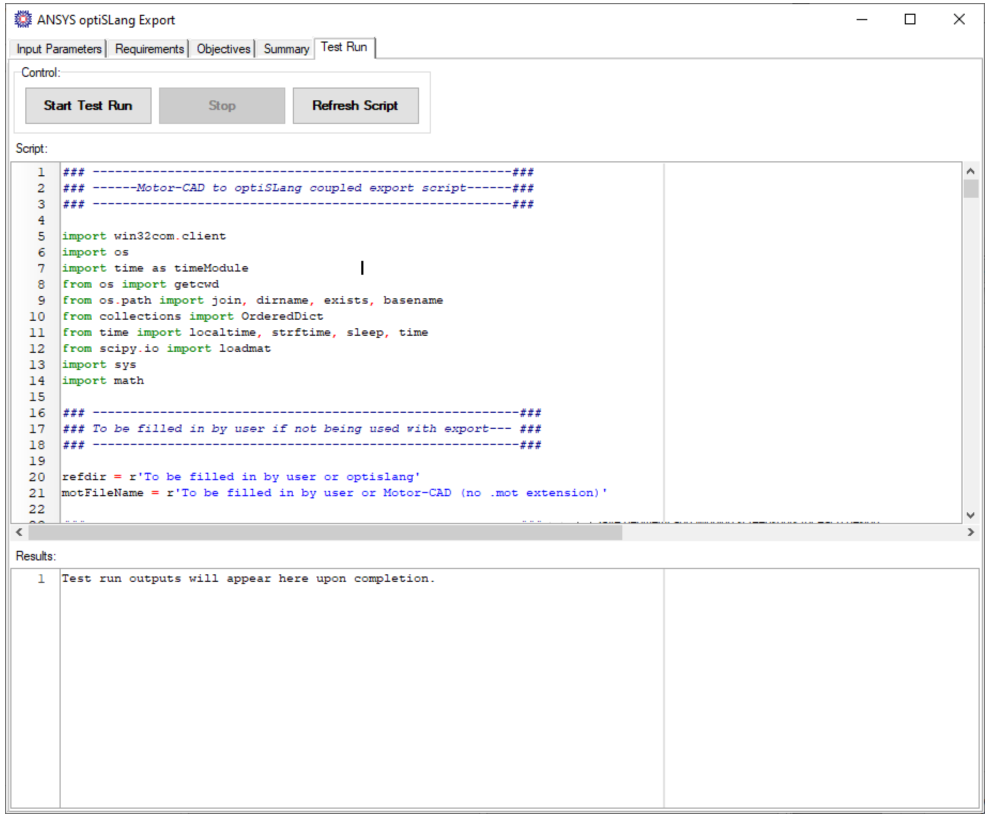
- Geometry Ratios added to SYNC machine templates to enable use with optiSLang.
- Salient Pole, Parallel Tooth and Parallel Slot rotor geometries.
- Avoids invalid geometry definitions.
- When using ratios the geometries are always valid.



SYNC 电机optiSLang 整合

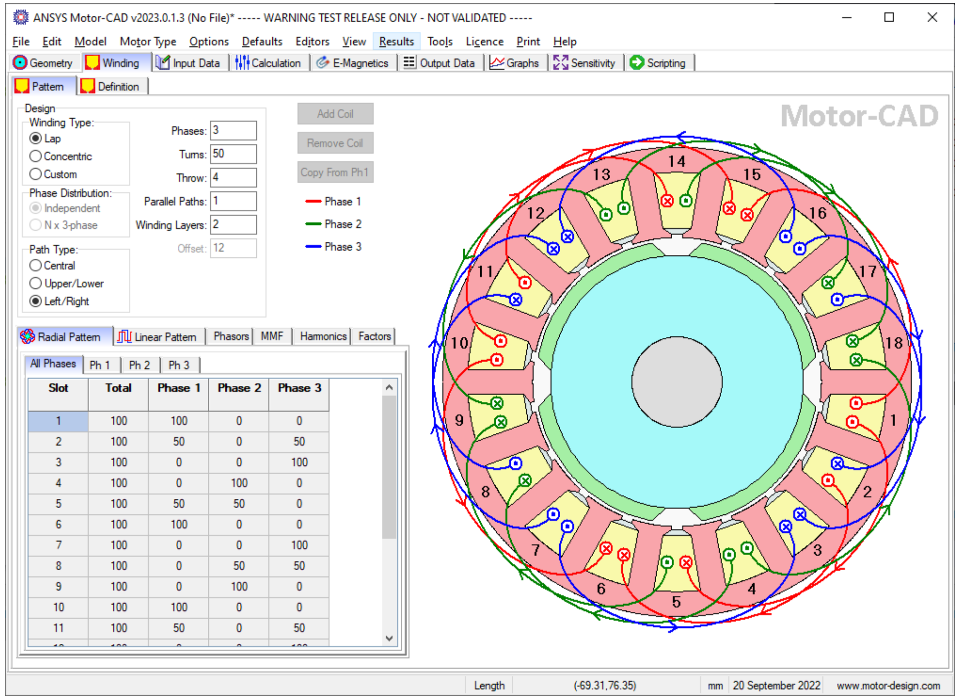
- Automatic generation of optiSLang study for the SYNC machine.
- No knowledge of scripting required.
- Ratio based geometries always valid.

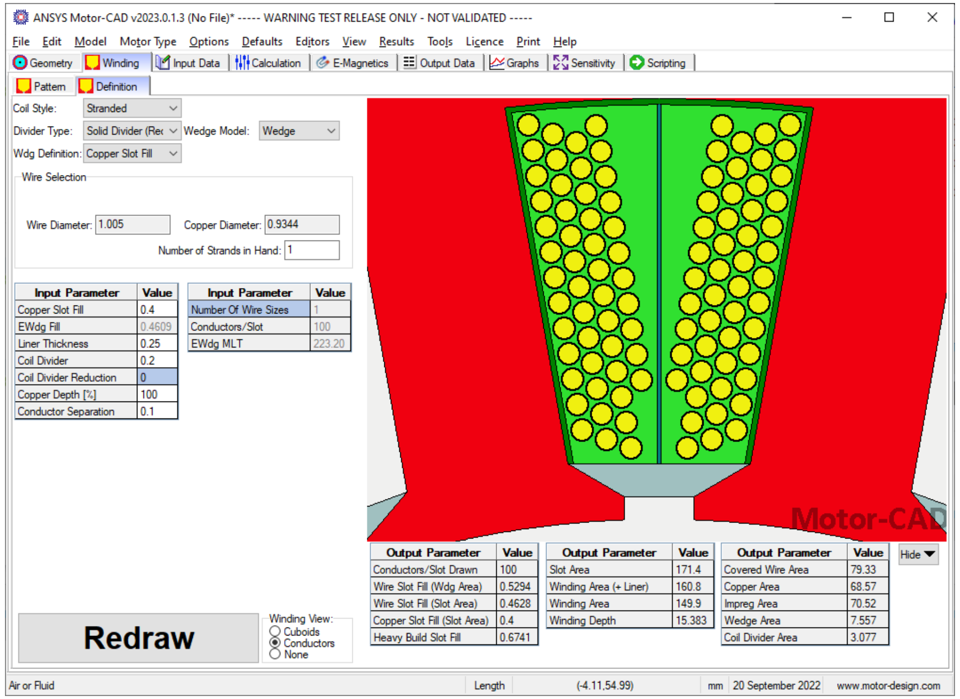




统一 Winding 定义

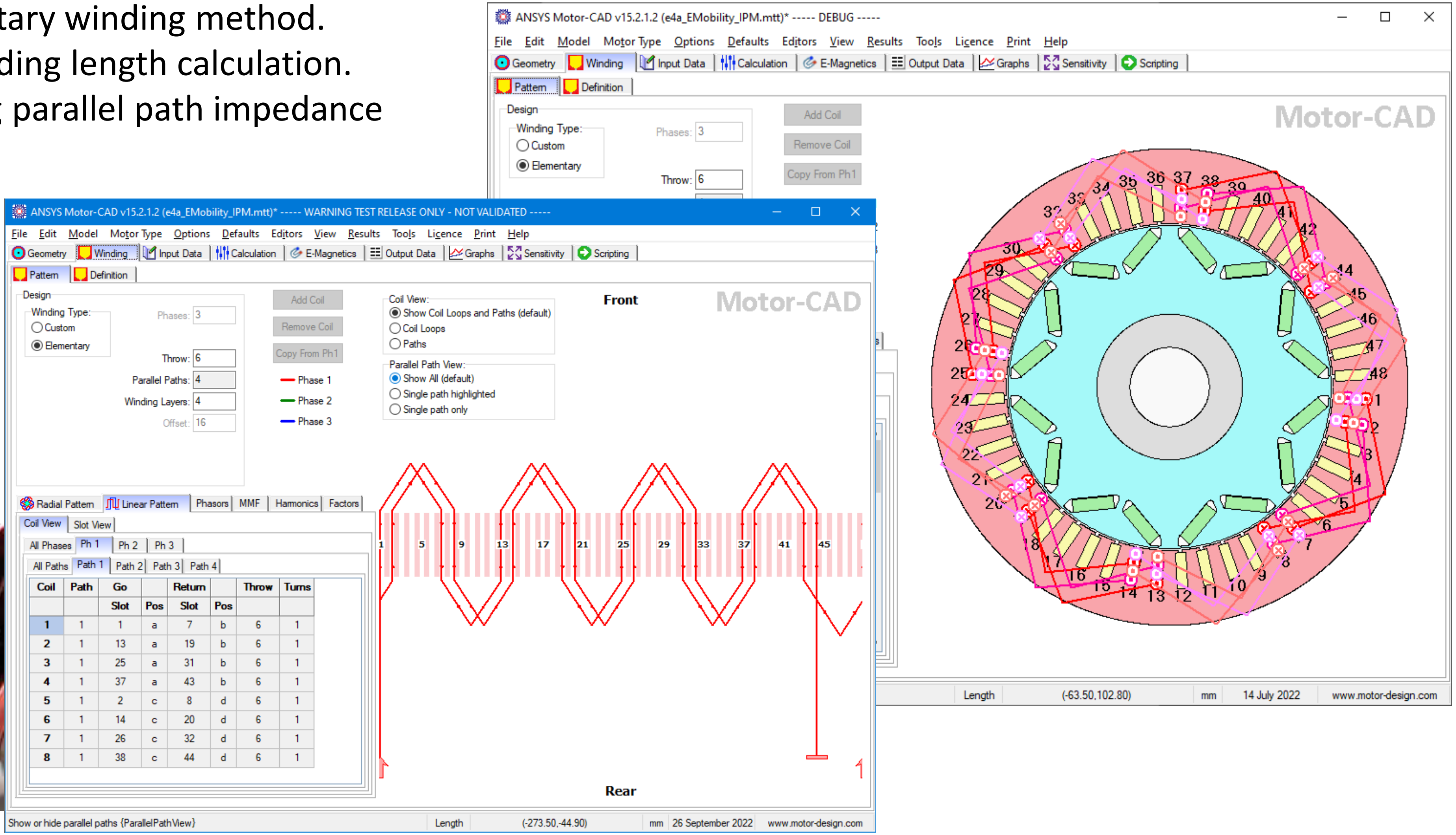
- Simplification of winding definition.
- Winding pattern now used as definitive source of winding data.
- No longer option to specify number of conductors in slot for thermal model.





新 hairpin winding图形生成

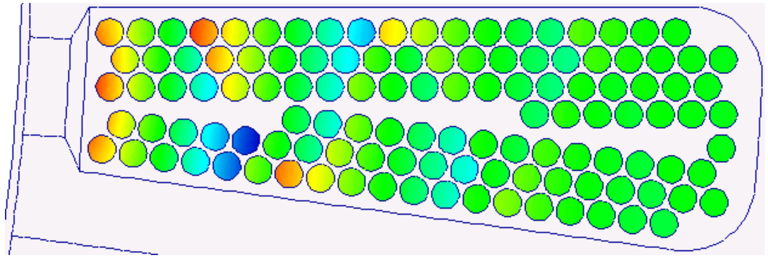
- New automatic elementary winding method.
- More accurate end-winding length calculation.
- Wave winding following parallel path impedance balancing rules.

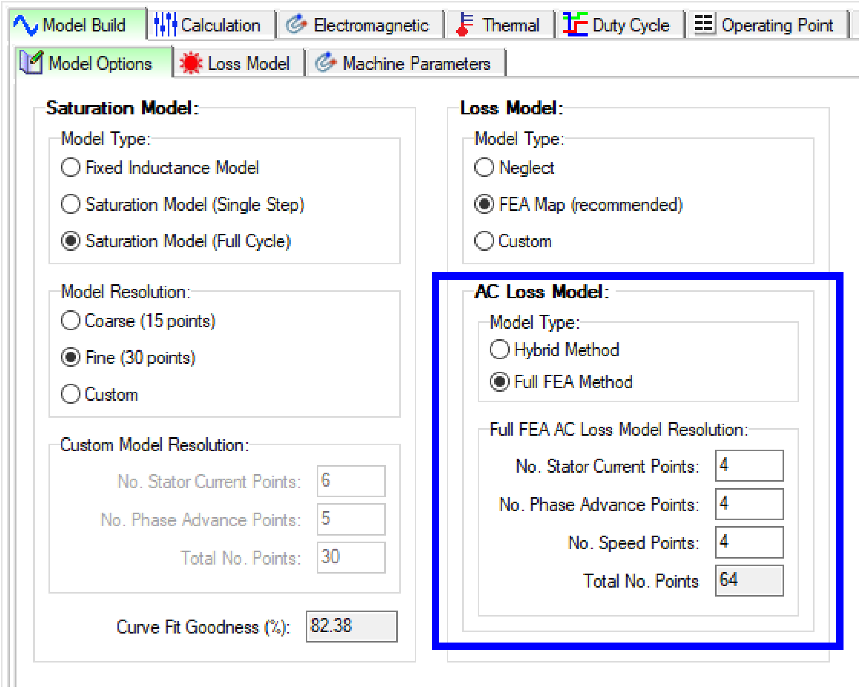


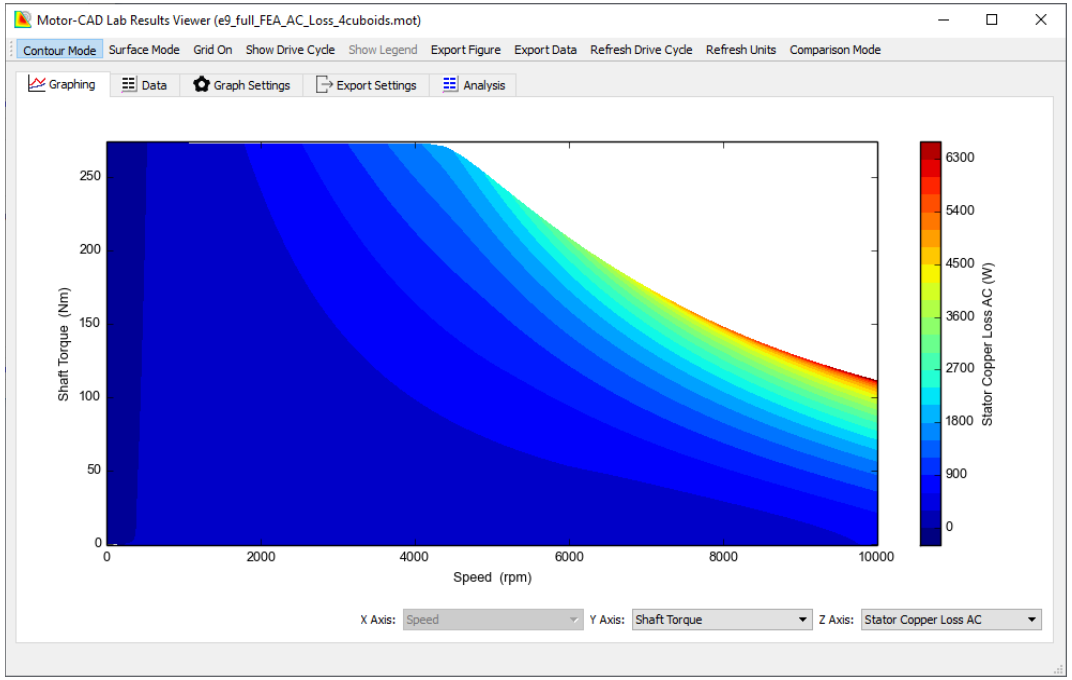
Coil	Path	Go Slot	Go Pos	Return Slot	Return Pos	Throw	Turns
1	1	1	a	7	b	6	1
2	1	13	a	19	b	6	1
3	1	25	a	31	b	6	1
4	1	37	a	43	b	6	1
5	1	2	c	8	d	6	1
6	1	14	c	20	d	6	1
7	1	26	c	32	d	6	1
8	1	38	c	44	d	6	1

高保真Lab AC winding 损耗map图

- Calculation of the Lab AC winding loss map using full FEA method.
- Improved AC winding loss calculation accuracy with variation of speed.

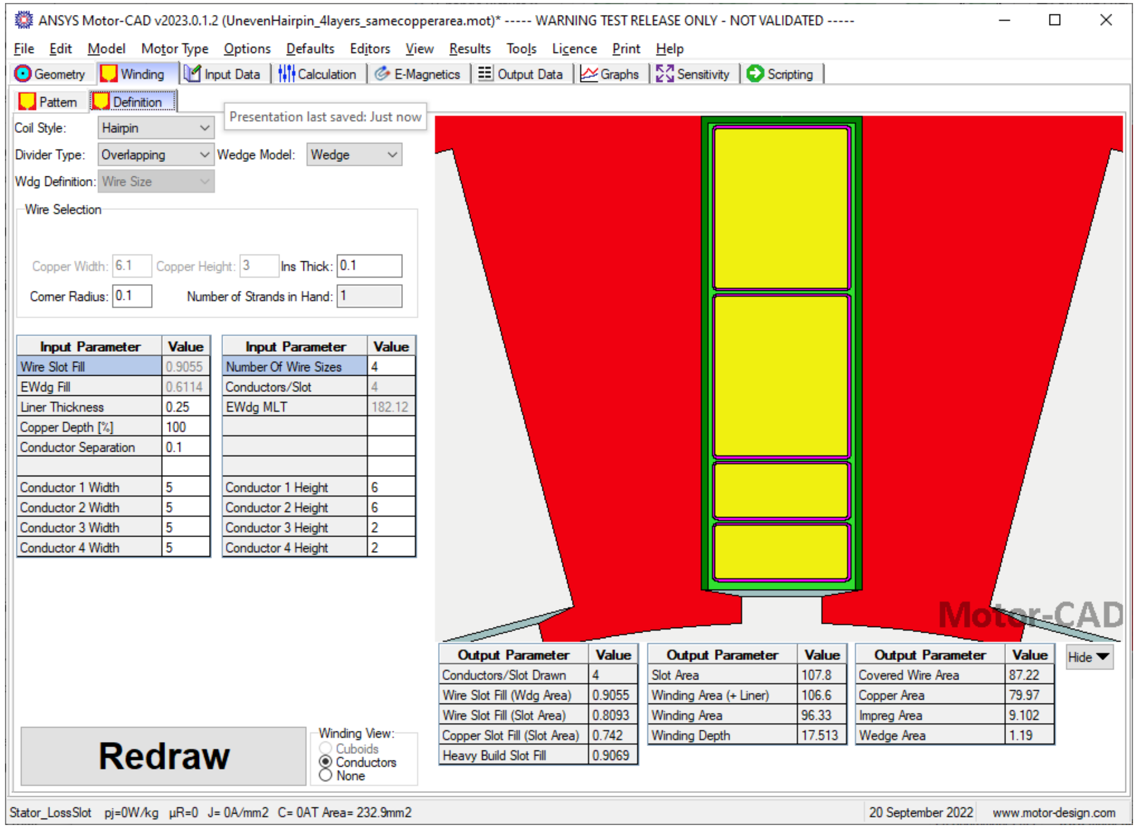


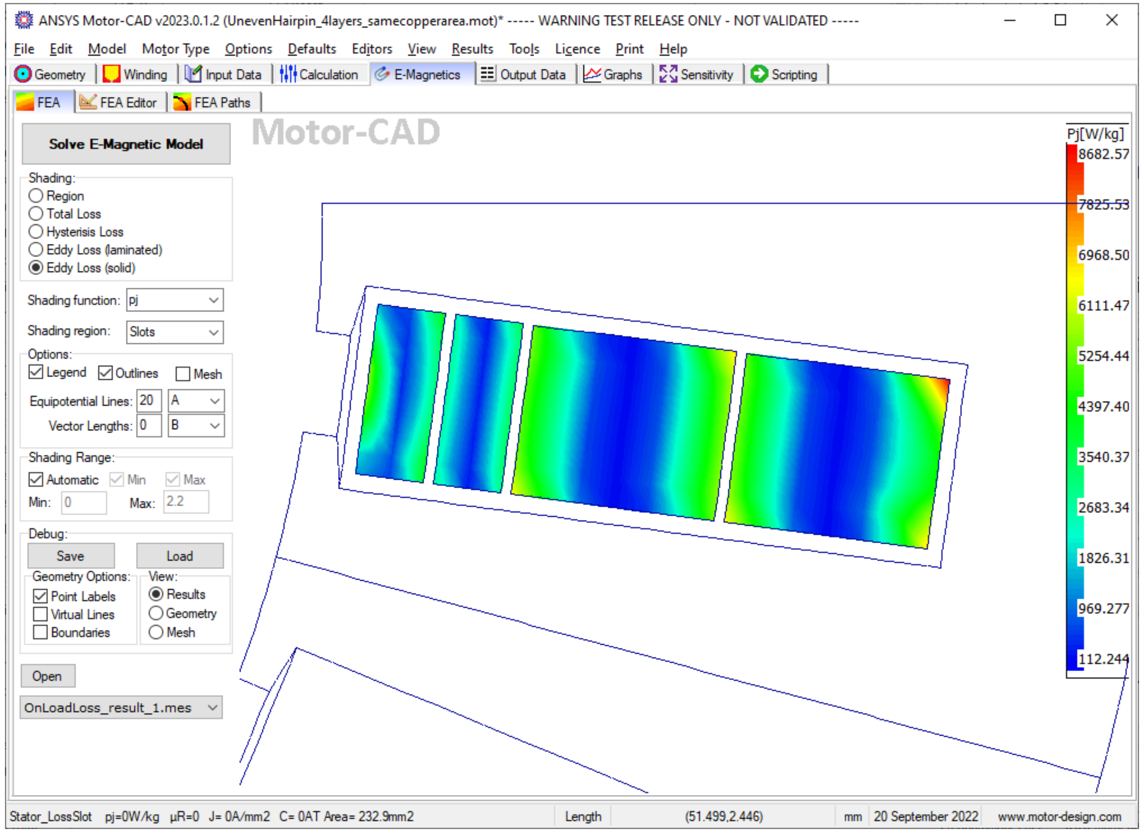




不同 hairpin 导体尺寸

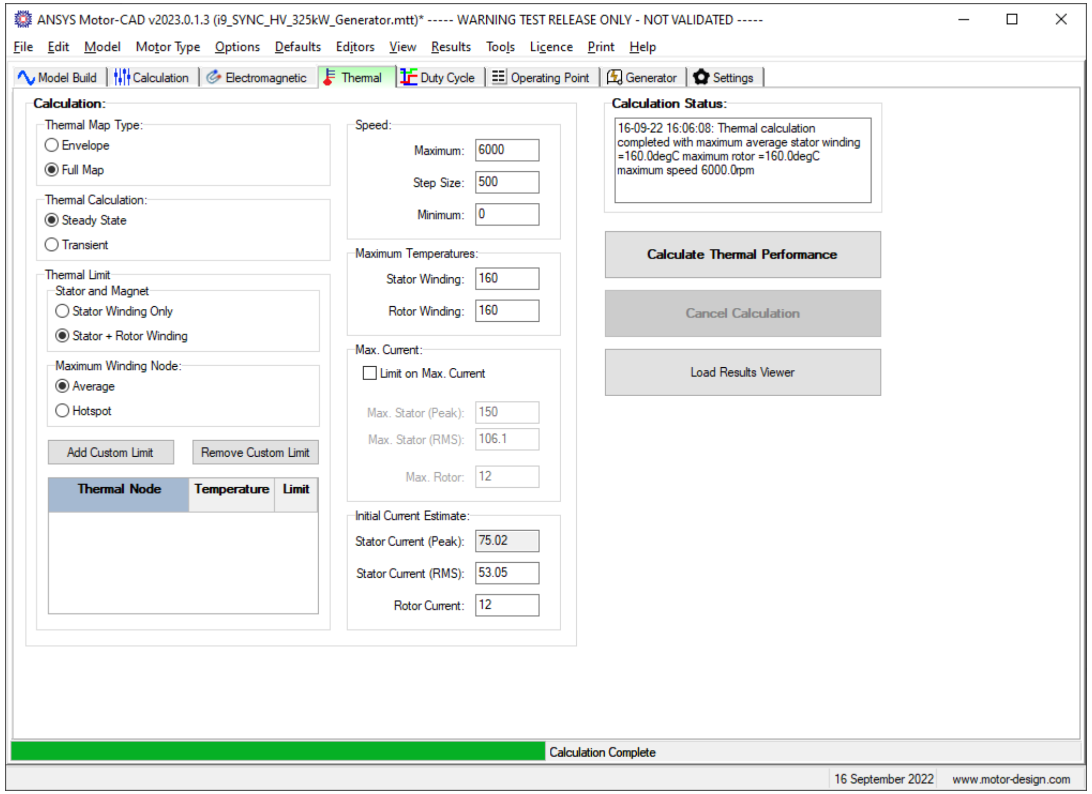
- Different sizes of hairpin conductors in slot.
- Used to reduce AC winding losses in conductors near slot opening.

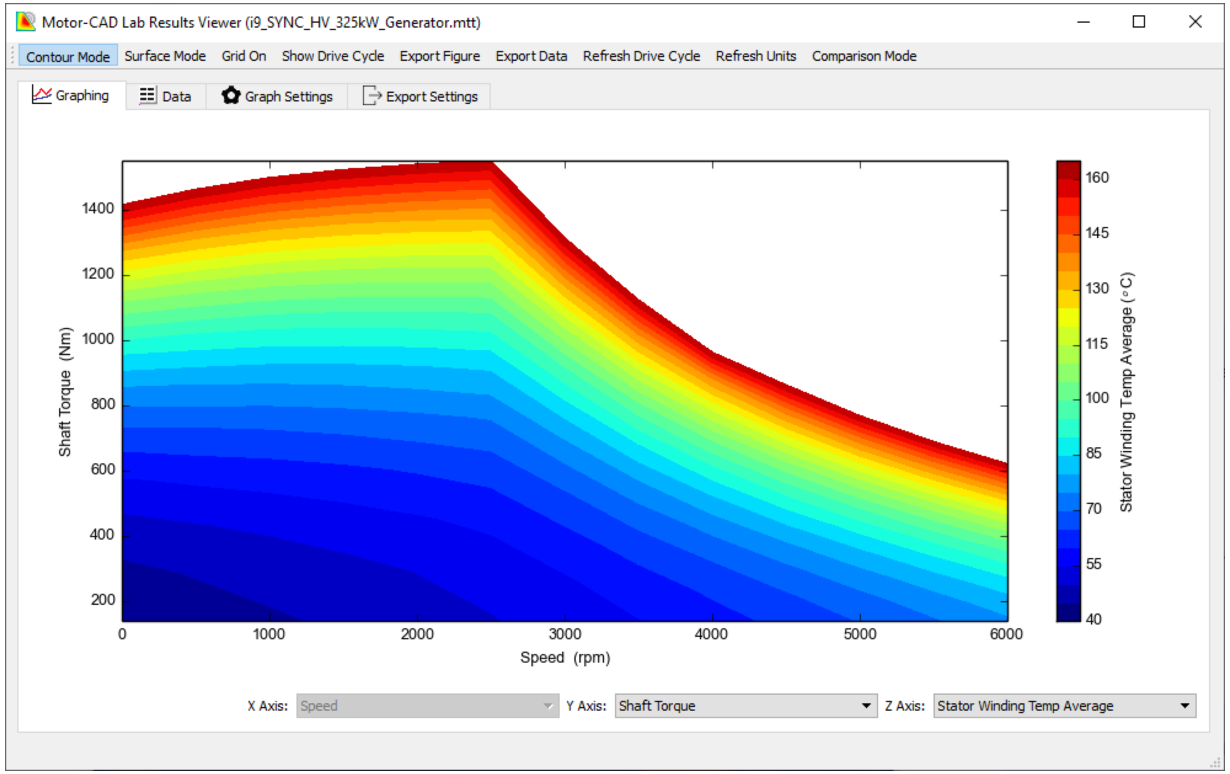




IM 与 SYNC 电机在Lab模块中热map图

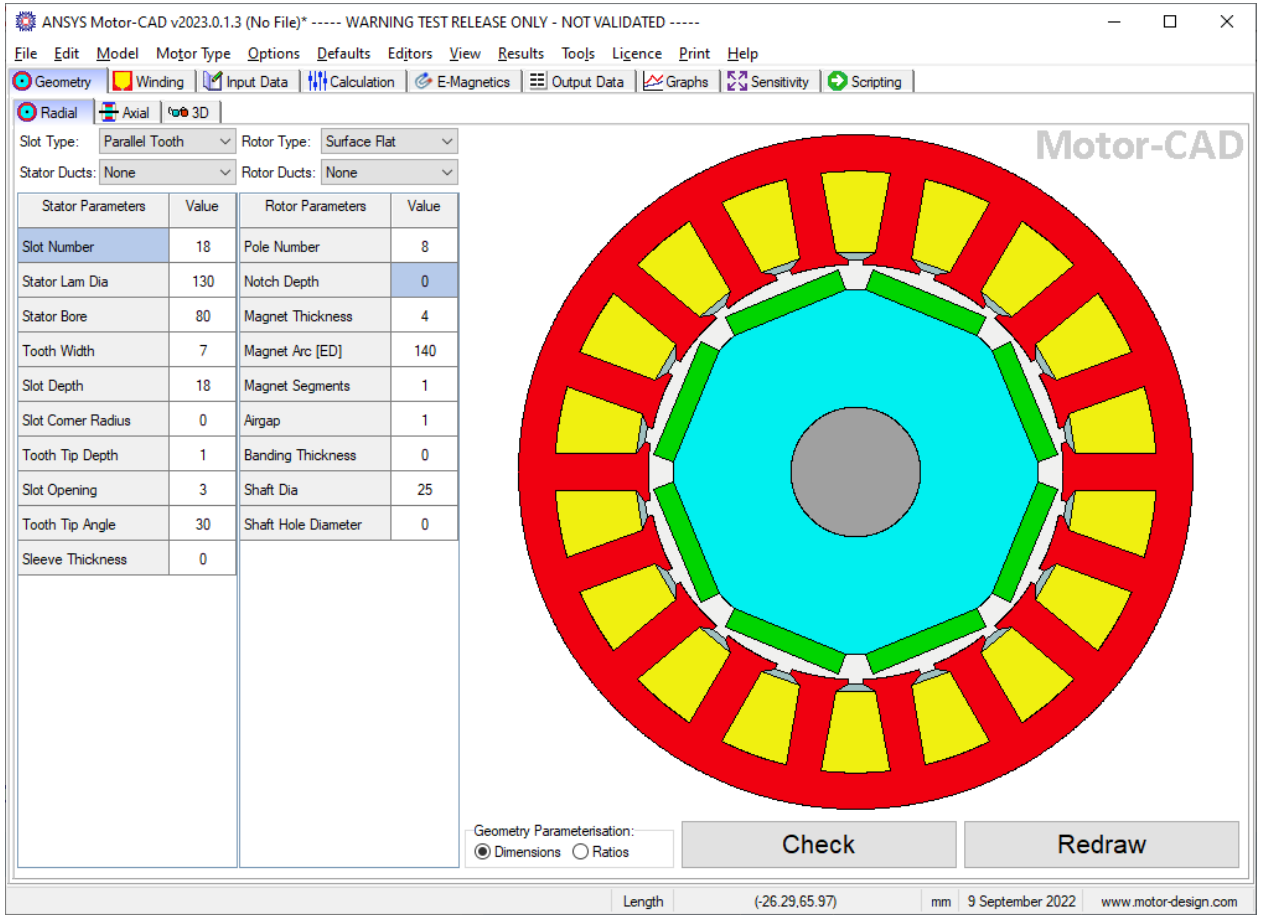
- Thermal performance of Induction and Synchronous machines across full torque/speed range.





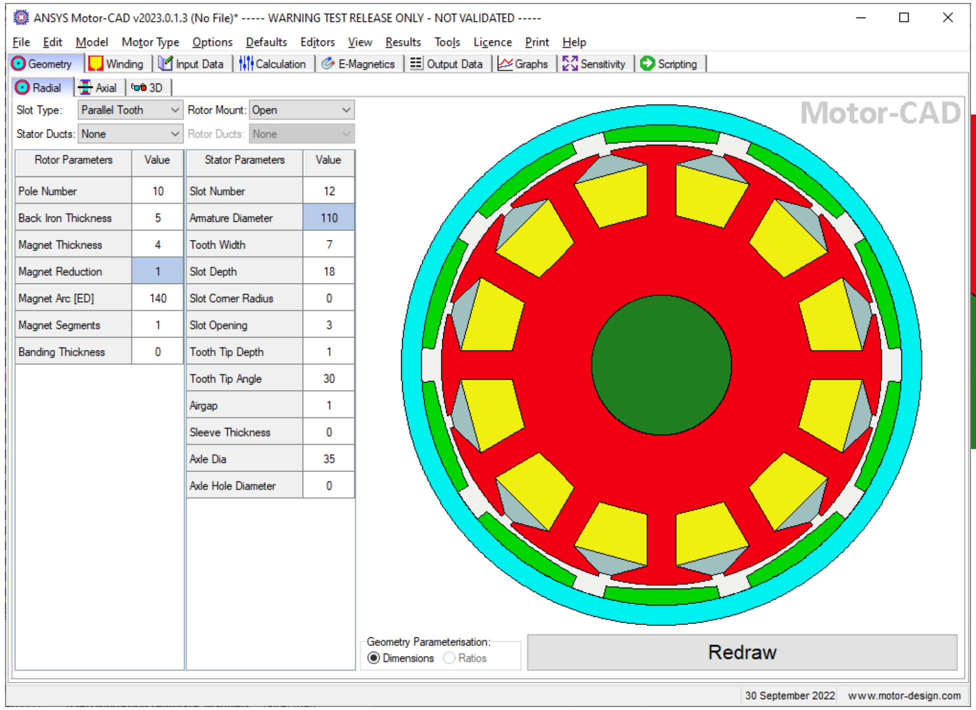
扁平表面磁体几何

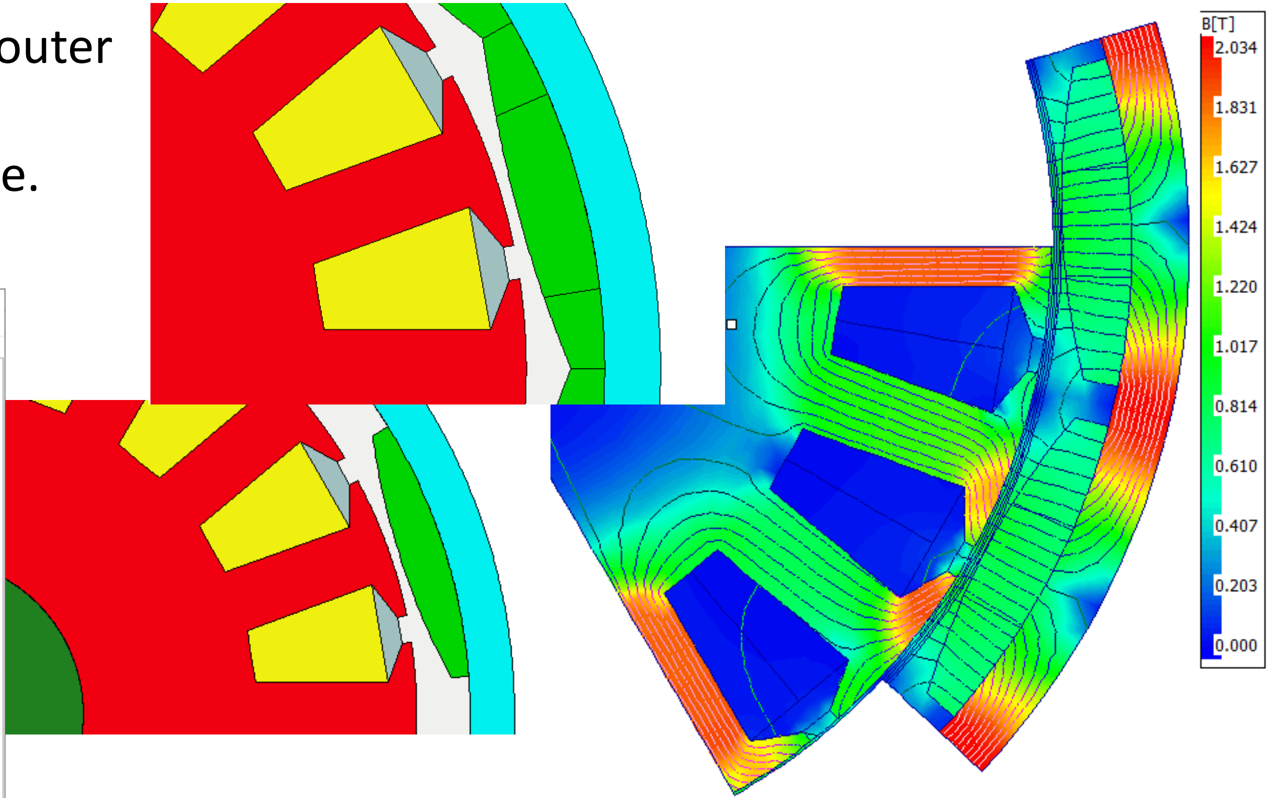
- Rectangular magnets mounted on rotor lamination surface.
- Can be defined as dimensions or ratios.
- Can make use of rotor notches if required.



Outer rotor magnet reduction geometry

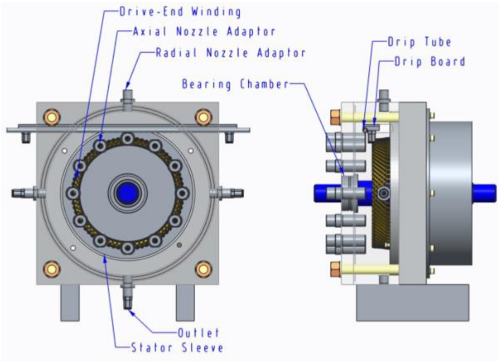
- New geometry parameter to shape the outer rotor magnets.
- Shaping of airgap to reduce torque ripple.

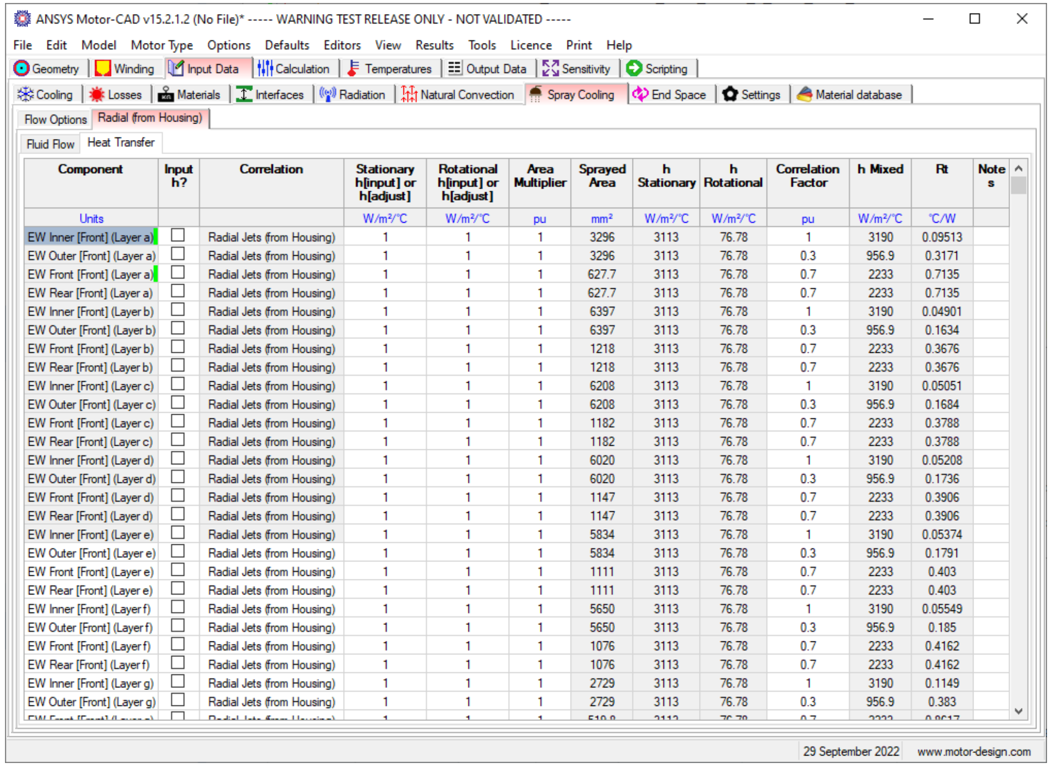




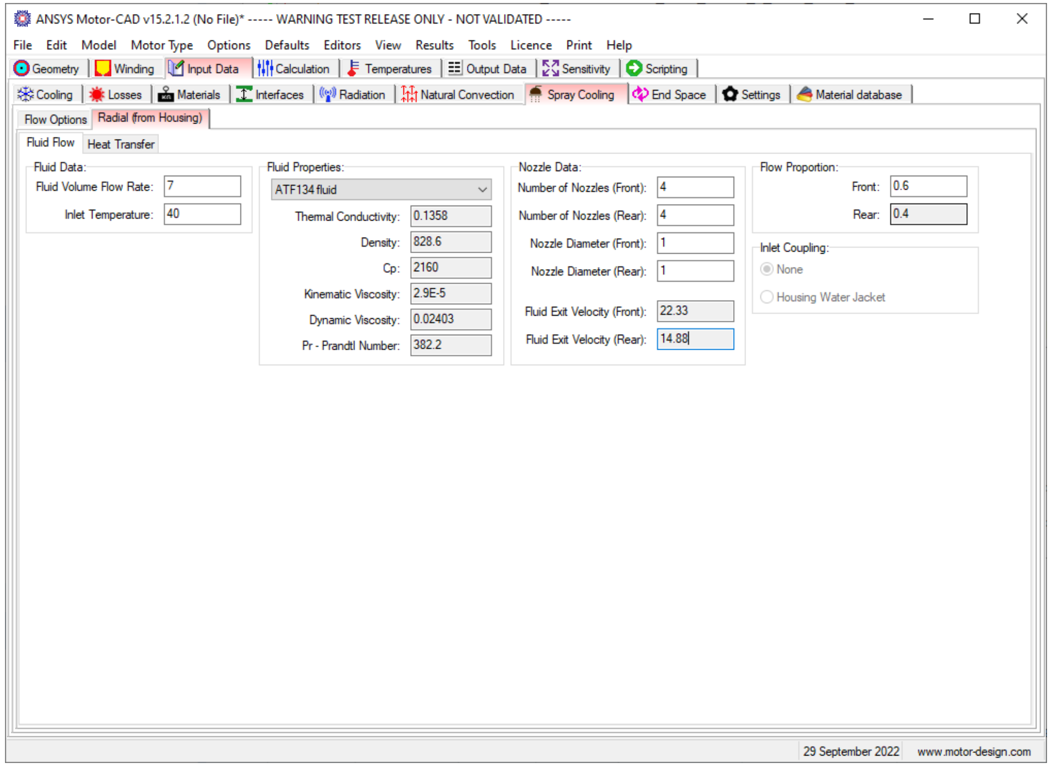
喷洒冷却方法改进

- Improved modelling following research project with University of Nottingham
- Independent cooling circuits for axial, radial drip and rotor/shaft nozzles
- New Heat Transfer Coefficient correlations – simplifies HTC calibration





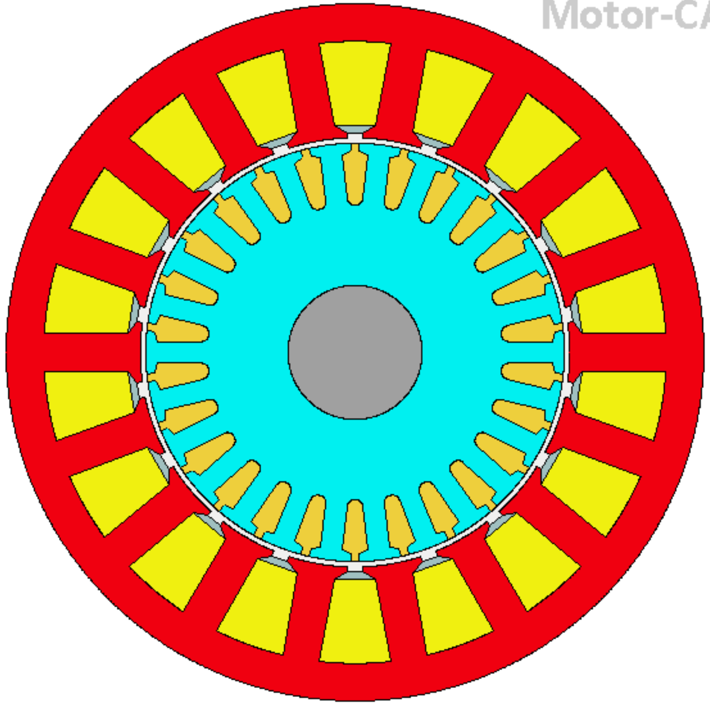
Component	Input h?	Correlation	Stationary h[input] or h[adjust]	Rotational h[input] or h[adjust]	Area Multiplier	Sprayed Area	h Stationary	h Rotational	Correlation Factor	h Mixed	Rt	Notes
Units			W/m²/°C	W/m²/°C	pu	mm²	W/m²/°C	W/m²/°C	pu	W/m²/°C	°C/W	
EW Inner [Front] (Layer a)	☐	Radial Jets (from Housing)	1	1	1	3296	3113	76.78	1	3190	0.09513	
EW Outer [Front] (Layer a)	☐	Radial Jets (from Housing)	1	1	1	3296	3113	76.78	0.3	956.9	0.3171	
EW Front [Front] (Layer a)	☐	Radial Jets (from Housing)	1	1	1	627.7	3113	76.78	0.7	2233	0.7135	
EW Rear [Front] (Layer a)	☐	Radial Jets (from Housing)	1	1	1	627.7	3113	76.78	0.7	2233	0.7135	
EW Inner [Front] (Layer b)	☐	Radial Jets (from Housing)	1	1	1	6397	3113	76.78	1	3190	0.04901	
EW Outer [Front] (Layer b)	☐	Radial Jets (from Housing)	1	1	1	6397	3113	76.78	0.3	956.9	0.1634	
EW Front [Front] (Layer b)	☐	Radial Jets (from Housing)	1	1	1	1218	3113	76.78	0.7	2233	0.3676	
EW Rear [Front] (Layer b)	☐	Radial Jets (from Housing)	1	1	1	1218	3113	76.78	0.7	2233	0.3676	
EW Inner [Front] (Layer c)	☐	Radial Jets (from Housing)	1	1	1	6208	3113	76.78	1	3190	0.05051	
EW Outer [Front] (Layer c)	☐	Radial Jets (from Housing)	1	1	1	6208	3113	76.78	0.3	956.9	0.1684	
EW Front [Front] (Layer c)	☐	Radial Jets (from Housing)	1	1	1	1182	3113	76.78	0.7	2233	0.3788	
EW Rear [Front] (Layer c)	☐	Radial Jets (from Housing)	1	1	1	1182	3113	76.78	0.7	2233	0.3788	
EW Inner [Front] (Layer d)	☐	Radial Jets (from Housing)	1	1	1	6020	3113	76.78	1	3190	0.05208	
EW Outer [Front] (Layer d)	☐	Radial Jets (from Housing)	1	1	1	6020	3113	76.78	0.3	956.9	0.1736	
EW Front [Front] (Layer d)	☐	Radial Jets (from Housing)	1	1	1	1147	3113	76.78	0.7	2233	0.3906	
EW Rear [Front] (Layer d)	☐	Radial Jets (from Housing)	1	1	1	1147	3113	76.78	0.7	2233	0.3906	
EW Inner [Front] (Layer e)	☐	Radial Jets (from Housing)	1	1	1	5834	3113	76.78	1	3190	0.05374	
EW Outer [Front] (Layer e)	☐	Radial Jets (from Housing)	1	1	1	5834	3113	76.78	0.3	956.9	0.1791	
EW Front [Front] (Layer e)	☐	Radial Jets (from Housing)	1	1	1	1111	3113	76.78	0.7	2233	0.403	
EW Rear [Front] (Layer e)	☐	Radial Jets (from Housing)	1	1	1	1111	3113	76.78	0.7	2233	0.403	
EW Inner [Front] (Layer f)	☐	Radial Jets (from Housing)	1	1	1	5650	3113	76.78	1	3190	0.05549	
EW Outer [Front] (Layer f)	☐	Radial Jets (from Housing)	1	1	1	5650	3113	76.78	0.3	956.9	0.185	
EW Front [Front] (Layer f)	☐	Radial Jets (from Housing)	1	1	1	1076	3113	76.78	0.7	2233	0.4162	
EW Rear [Front] (Layer f)	☐	Radial Jets (from Housing)	1	1	1	1076	3113	76.78	0.7	2233	0.4162	
EW Inner [Front] (Layer g)	☐	Radial Jets (from Housing)	1	1	1	2729	3113	76.78	1	3190	0.1149	
EW Outer [Front] (Layer g)	☐	Radial Jets (from Housing)	1	1	1	2729	3113	76.78	0.3	956.9	0.383	

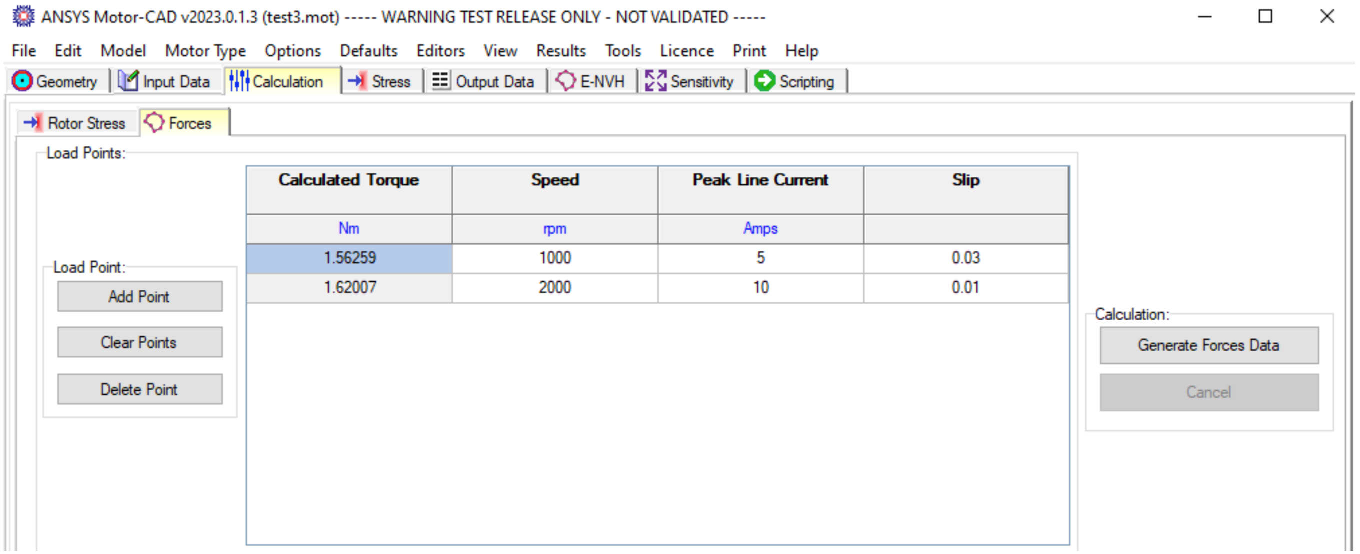


机械 与 NVH

NVH 改进

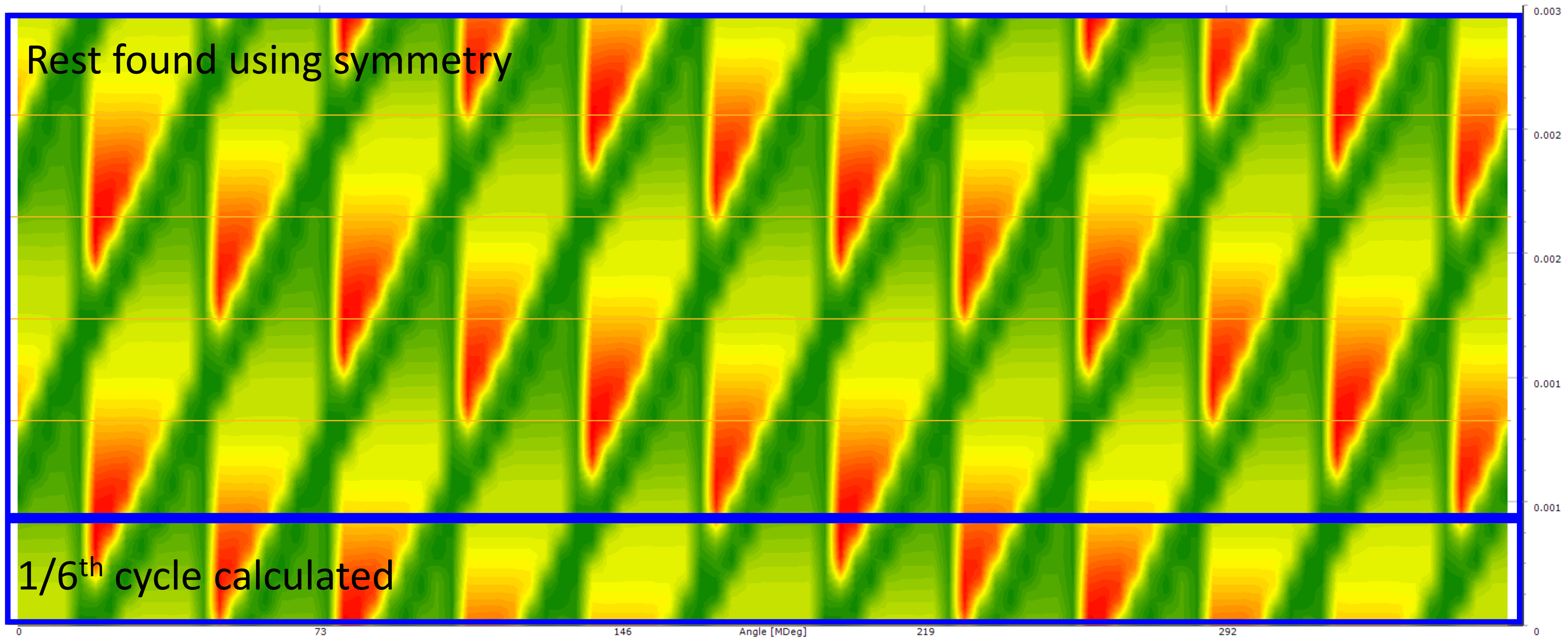
- New Induction machine NVH calculation
  - Define multi-speed operating points using RPM, line current and slip.
  - Enables full NVH calculation and force export for IM.
  - Transient IM calculation improvements significantly speed up calculation for reasonable results.





降循环 NVH

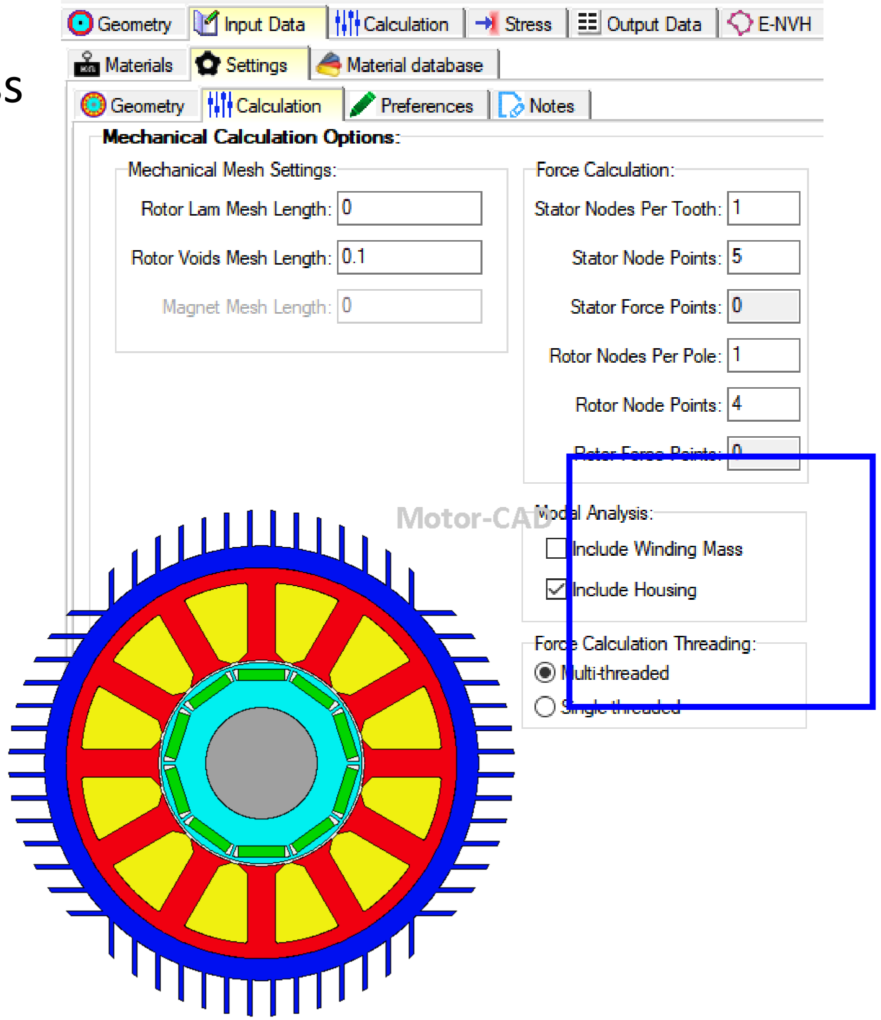
- Use 1/6 electrical cycle symmetry
  - Forces calculated for 1/6th of the cycle, rest populated using rotor and stator symmetry
- Use EMag multistatic FEA solver
- Speed up of NVH calculations
- Transient solver remains the default, reduced multistatic can be selected if preferred



Calculated forces for one electrical cycle around the stator

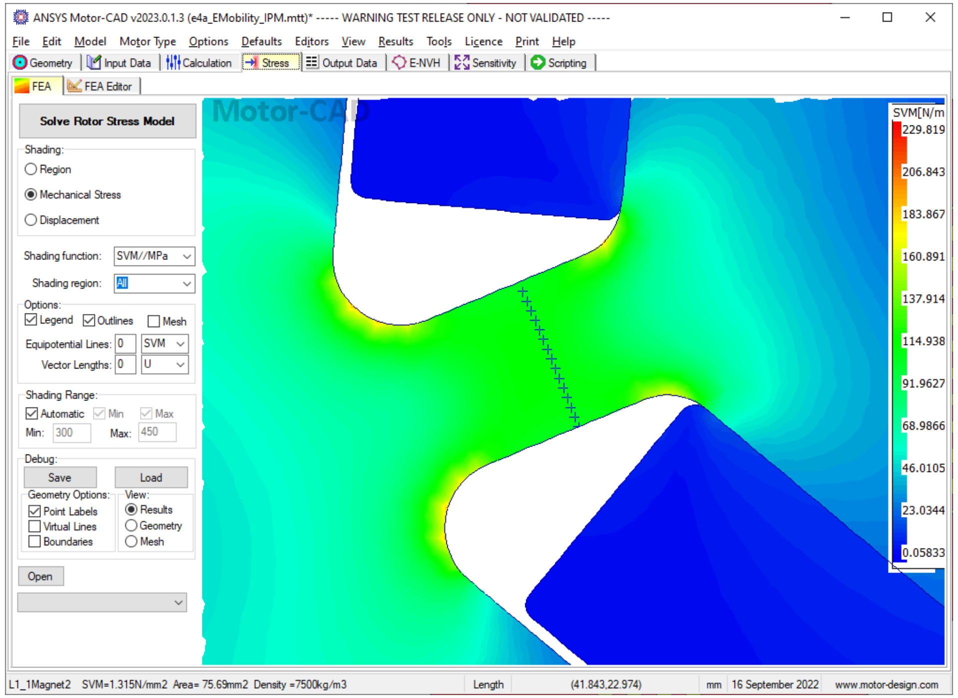
NVH 改进

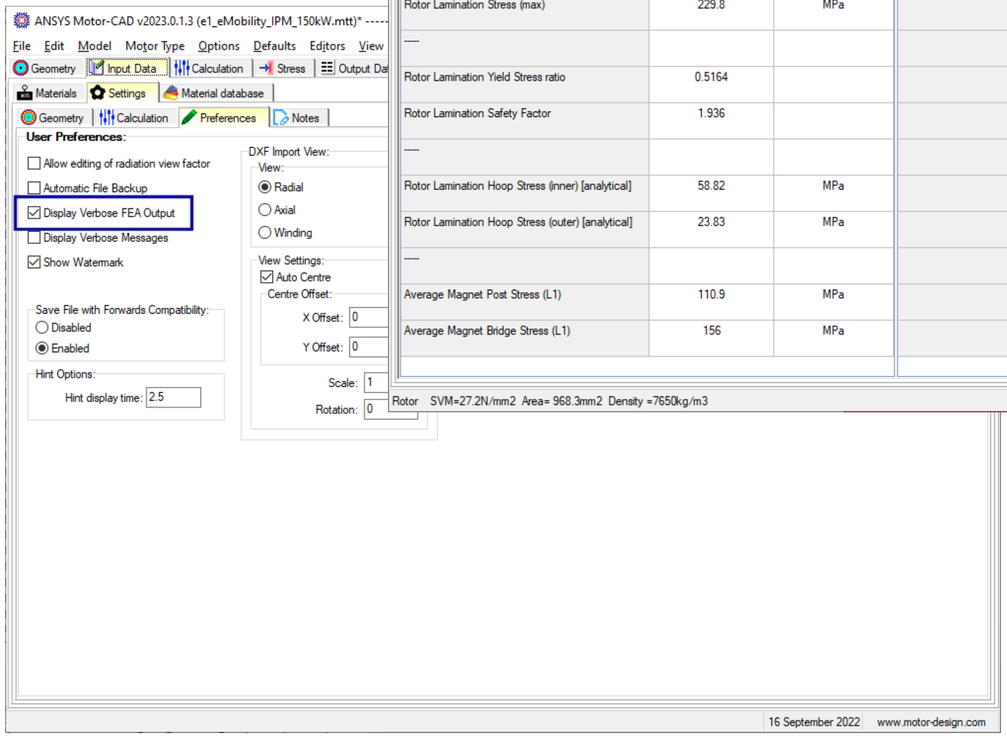
- Option to include housing as well as stator in analytical stiffness & modal calculation.
- Single threaded solver option for increased reliability.
- Outputs defined to allow NVH assessment to be included with OptiSLang optimisation.
- Results exported for improved integration with Ansys Mechanical/VRExperience/Sound NVH process.
- Improvements in useability.

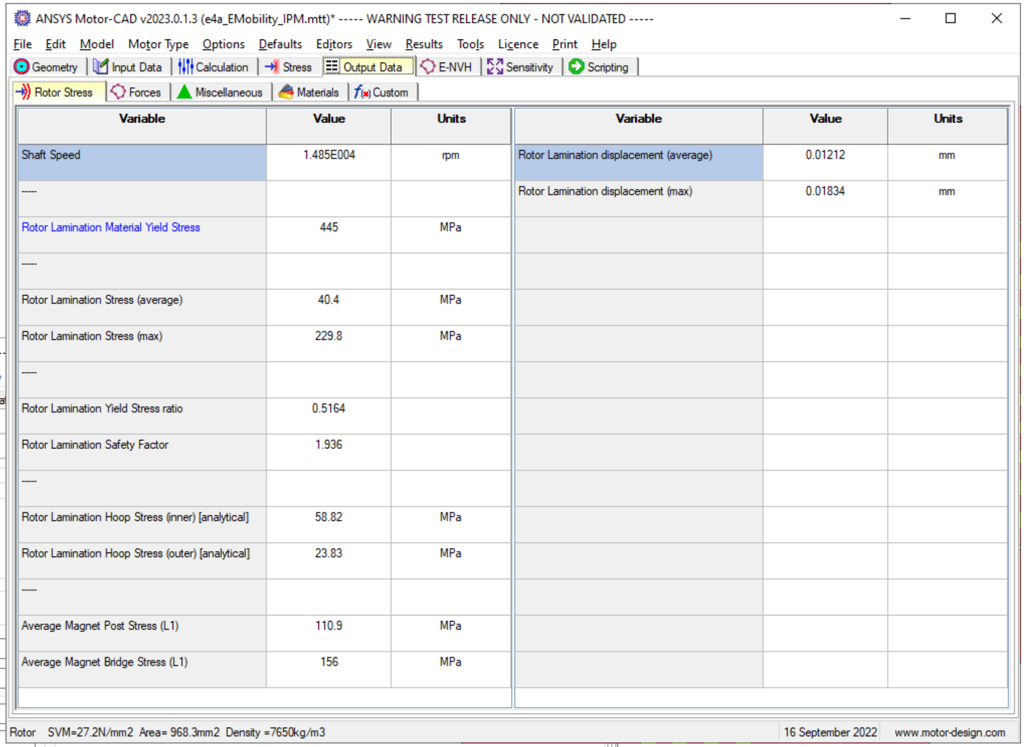


平均柱体和隔磁桥应力– V web 与 U magnets

- Gives a measure of the stresses in important parts of rotor lamination.
- Particularly useful for optimisation studies.
- Enable verbose FEA outputs to show measurement locations in FEA viewer.







Variable	Value	Units	Variable	Value	Units
Shaft Speed	1.485E004	rpm	Rotor Lamination displacement (average)	0.01212	mm
----			Rotor Lamination displacement (max)	0.01834	mm
Rotor Lamination Material Yield Stress	445	MPa			

Rotor Lamination Stress (average)	40.4	MPa			
Rotor Lamination Stress (max)	229.8	MPa			

Rotor Lamination Yield Stress ratio	0.5164				
Rotor Lamination Safety Factor	1.936				

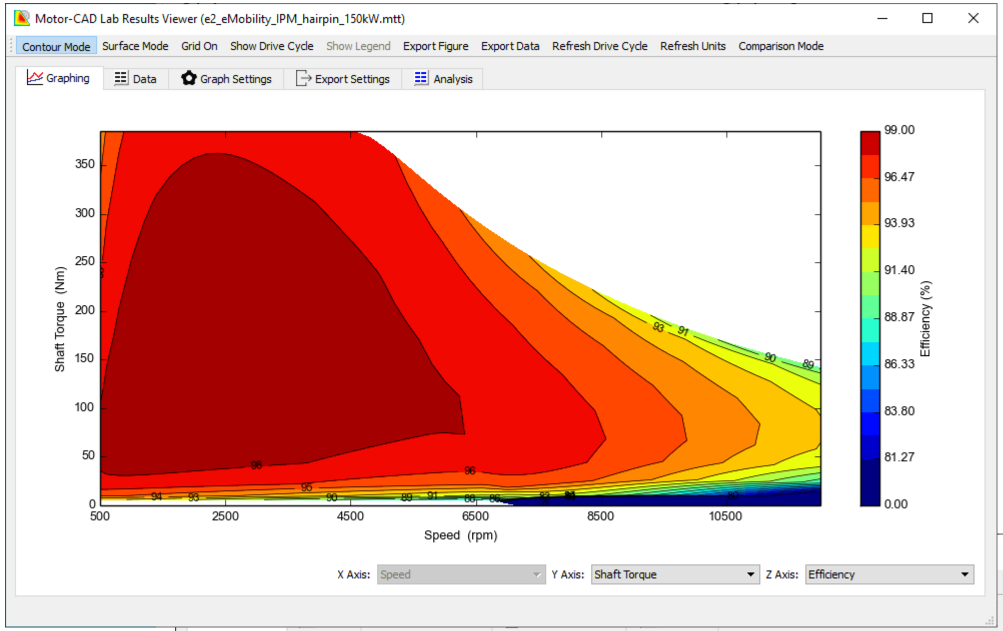
Rotor Lamination Hoop Stress (inner) [analytical]	58.82	MPa			
Rotor Lamination Hoop Stress (outer) [analytical]	23.83	MPa			

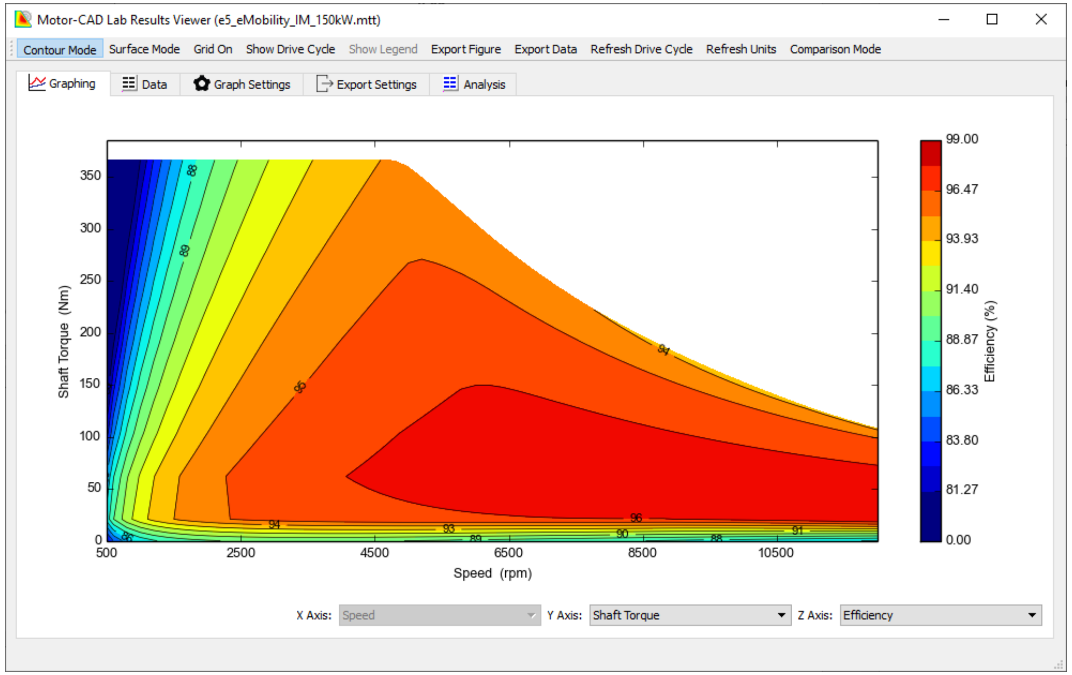
Average Magnet Post Stress (L1)	110.9	MPa			
Average Magnet Bridge Stress (L1)	156	MPa			

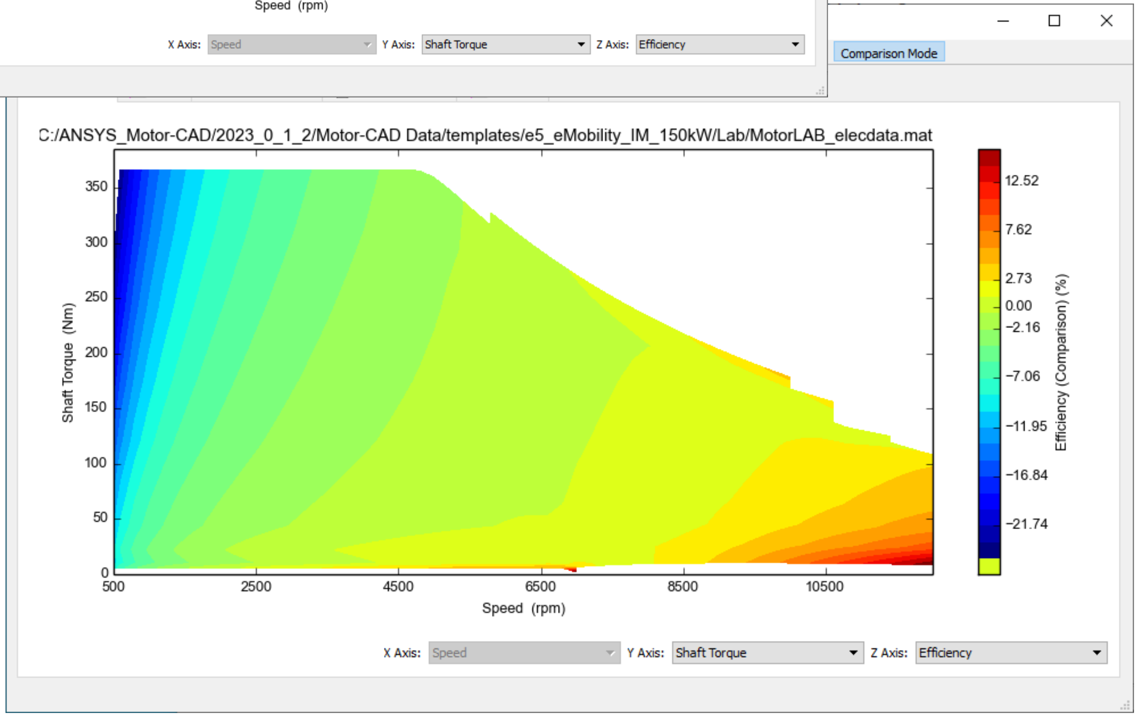
通用增强

Efficiency Map 比照

- Improved efficiency map comparison option.
- Allows comparison of data with different x/y ranges.
- Data points are interpolated.

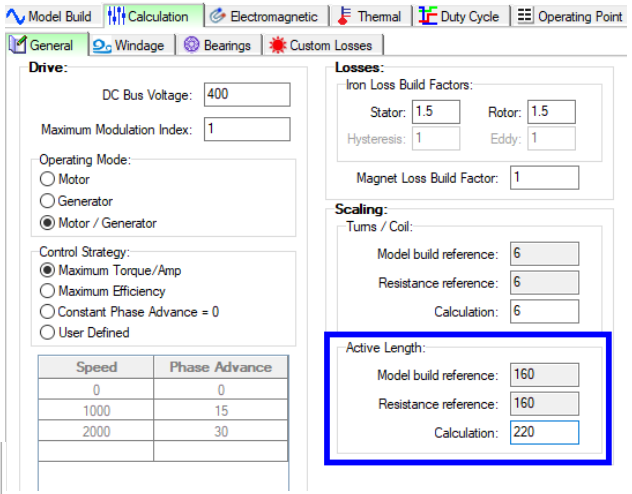


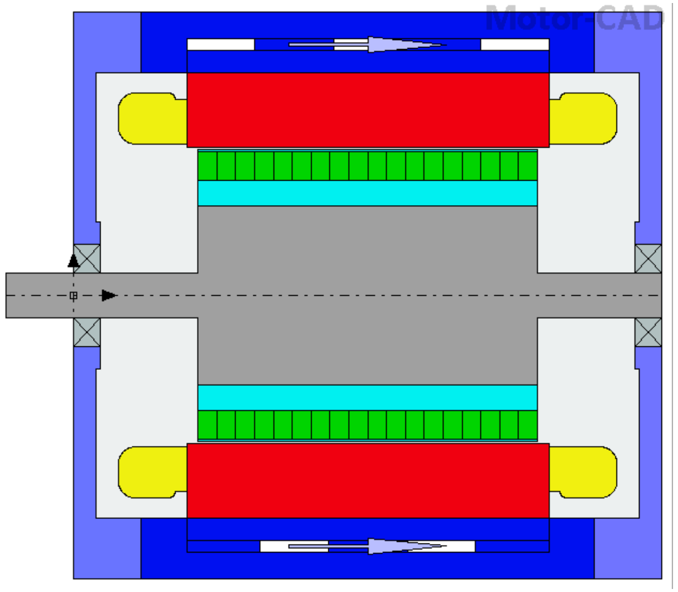


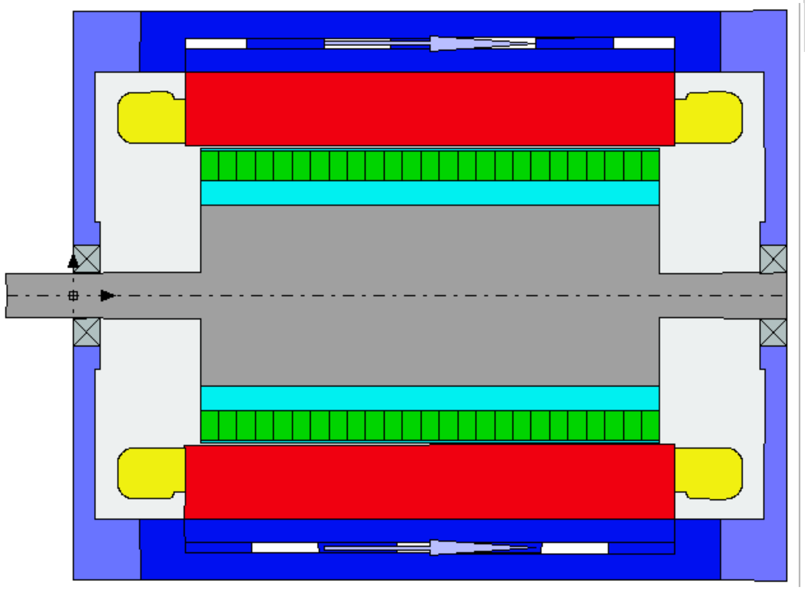


Lab轴向扩展

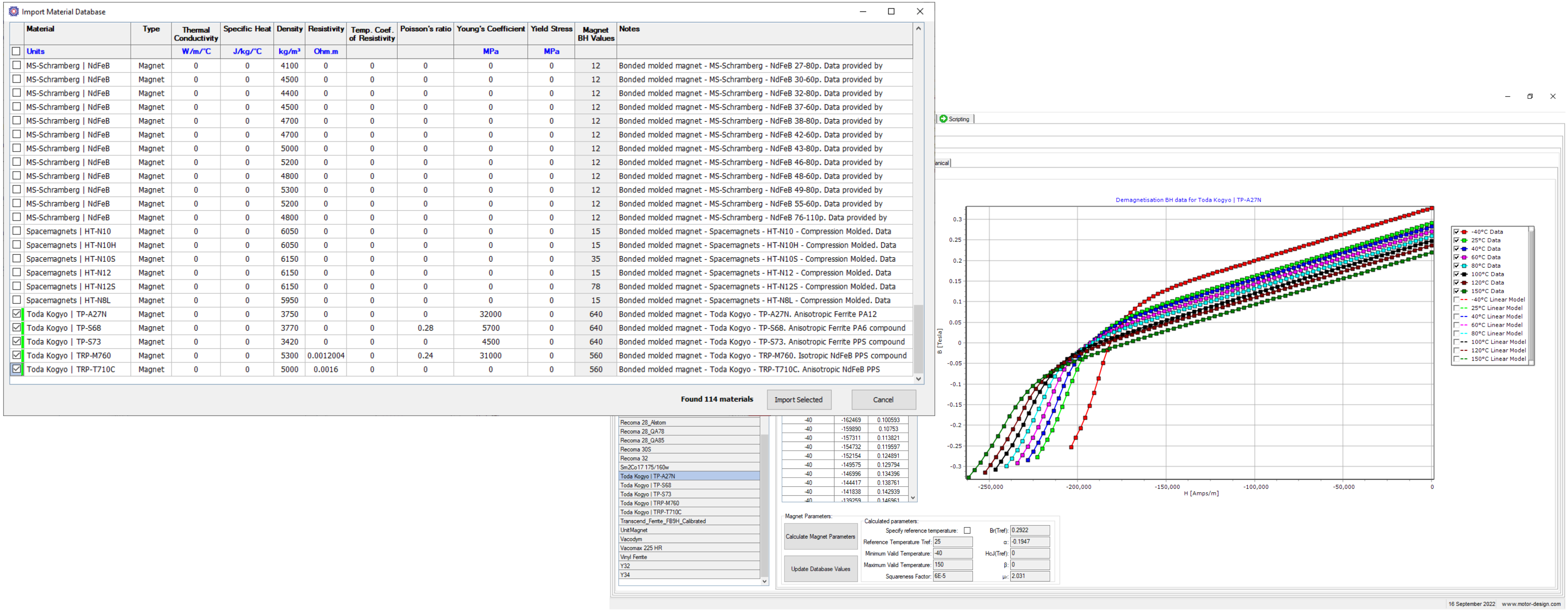
- Active length scaling for stator, rotor & magnet length.
- Accurate performance & loss calculations without rebuilding Lab model for different axial lengths.
- Thermal model axial length adjustments for coupled solution.
- Significant speed up of geometry optimisation e.g. optiSLang.







Toda Kogyo 粘合磁体的Granta 材料数据



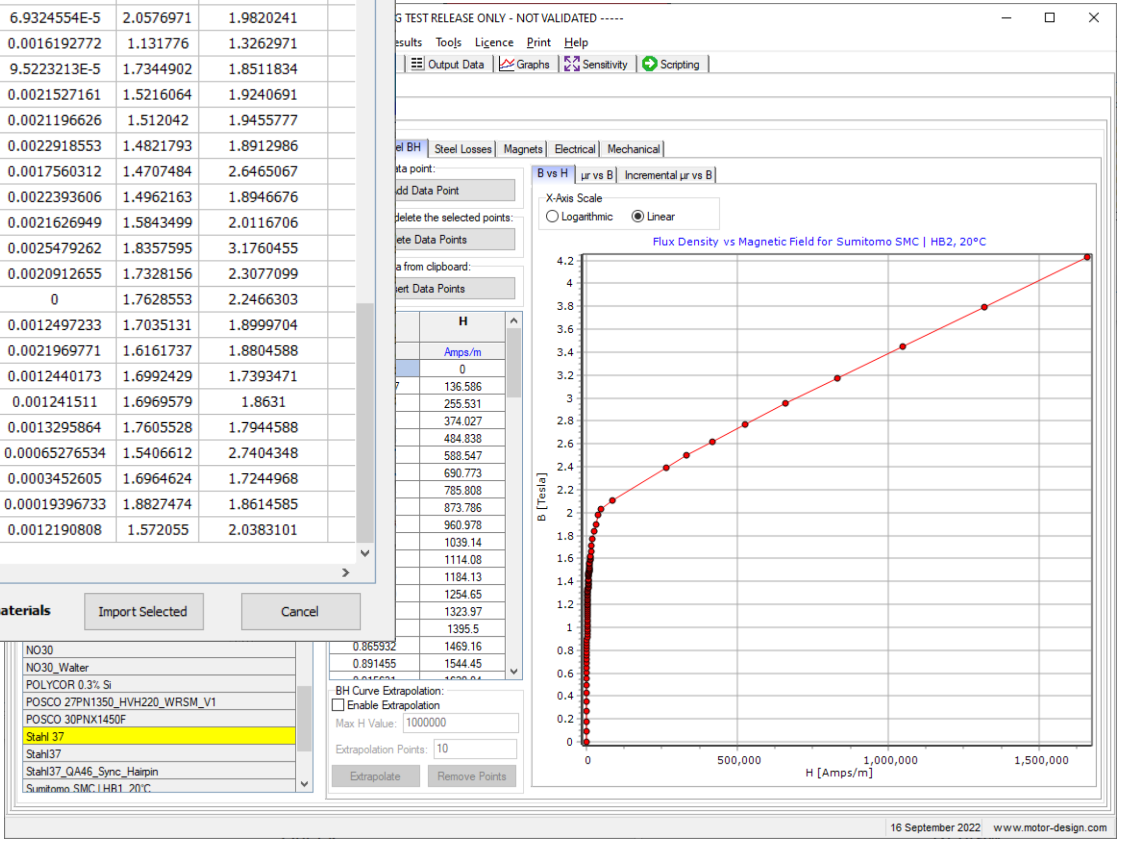
Material	Type	Thermal Conductivity	Specific Heat	Density	Resistivity	Temp. Coef. of Resistivity	Poisson's ratio	Young's Coefficient	Yield Stress	Magnet BH Values	Notes
Units		W/m/°C	J/kg/°C	kg/m³	Ohm.m			MPa	MPa		
MS-Schramberg | NdFeB	Magnet	0	0	4100	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 27-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4500	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 30-60p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4400	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 32-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4500	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 37-60p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4700	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 38-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4700	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 42-60p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	5000	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 43-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	5200	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 46-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4800	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 48-60p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	5300	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 49-80p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	5200	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 55-60p. Data provided by
MS-Schramberg | NdFeB	Magnet	0	0	4800	0	0	0	0	0	12	Bonded molded magnet - MS-Schramberg - NdFeB 76-110p. Data provided by
Spacemagnets | HT-N10	Magnet	0	0	6050	0	0	0	0	0	15	Bonded molded magnet - Spacemagnets - HT-N10 - Compression Molded. Data
Spacemagnets | HT-N10H	Magnet	0	0	6050	0	0	0	0	0	15	Bonded molded magnet - Spacemagnets - HT-N10H - Compression Molded. Data
Spacemagnets | HT-N10S	Magnet	0	0	6150	0	0	0	0	0	35	Bonded molded magnet - Spacemagnets - HT-N10S - Compression Molded. Data
Spacemagnets | HT-N12	Magnet	0	0	6150	0	0	0	0	0	15	Bonded molded magnet - Spacemagnets - HT-N12 - Compression Molded. Data
Spacemagnets | HT-N12S	Magnet	0	0	6150	0	0	0	0	0	78	Bonded molded magnet - Spacemagnets - HT-N12S - Compression Molded. Data
Spacemagnets | HT-N8L	Magnet	0	0	5950	0	0	0	0	0	15	Bonded molded magnet - Spacemagnets - HT-N8L - Compression Molded. Data
Toda Kogyo | TP-A27N	Magnet	0	0	3750	0	0	0	32000	0	640	Bonded molded magnet - Toda Kogyo - TP-A27N. Anisotropic Ferrite PA12
Toda Kogyo | TP-S68	Magnet	0	0	3770	0	0	0.28	5700	0	640	Bonded molded magnet - Toda Kogyo - TP-S68. Anisotropic Ferrite PA6 compound
Toda Kogyo | TP-S73	Magnet	0	0	3420	0	0	0	4500	0	640	Bonded molded magnet - Toda Kogyo - TP-S73. Anisotropic Ferrite PPS compound
Toda Kogyo | TRP-M760	Magnet	0	0	5300	0.0012004	0	0.24	31000	0	560	Bonded molded magnet - Toda Kogyo - TRP-M760. Isotropic NdFeB PPS compound
Toda Kogyo | TRP-T710C	Magnet	0	0	5000	0.0016	0	0	0	0	560	Bonded molded magnet - Toda Kogyo - TRP-T710C. Anisotropic NdFeB PPS

Sumitomo SMC 钢材的Granta 材料数据

Import Material Database

Material	Type	Thermal Conductivity	Specific Heat	Density	Resistivity	Temp. Coef. of Resistivity	Lamination Thickness	Kh (Steinmetz)	Kh (Bertotti Classical)	Kh (Bertotti Maxwell)	Keddy	Kexc (Bertotti Classical)	Kexc (Bertotti Maxwell)	Alpha (Steinmetz)	Alpha (Bertotti Classical)	(Be
☐ Units		W/m/°C	J/kg/°C	kg/m³	Ohm.m											
☐ Micrometals | 66 Material	Steel	0	0	6200	0.5	0	5	0.1	0.1	0.1	7.079	0.0010631899	0.0018624799	1.0924325	1.2521041	
☐ Micrometals | 70 Material	Steel	0	0	7400	0.5	0	5	0.0468557	0.049046037	0.048824026	1E-7	6.3783316E-5	6.9324554E-5	2.0576971	1.9820241	
☐ Micrometals | 8 Material	Steel	0	0	6500	0.5	0	5	0.1	0.1	0.1	5.087	0.00087548237	0.0016192772	1.131776	1.3262971	
☐ Micrometals | M125 Material	Steel	0	0	7700	0.5	0	5	0.0466896	0.045500353	0.045592817	1E-7	7.0245108E-5	9.5223213E-5	1.7344902	1.8511834	
☐ PMG | S280b	Steel	0	0	7000	10	0	5	0.1	0.1	0.083549279	2.022	0.0017891377	0.0021527161	1.5216064	1.9240691	
☐ PMG | S300b	Steel	0	0	7000	10	0	5	0.1	0.1	0.090373151	2.170	0.0019156407	0.0021196626	1.512042	1.9455777	
☐ PMG | S400b	Steel	0	0	7000	10	0	5	0.1	0.1	0.078460958	2.053	0.001823507	0.0022918553	1.4821793	1.8912986	
☐ PMG | S720	Steel	0	0	7000	10	0	5	0.1	0.049674941	0.1	1.894	0.0028016536	0.0017560312	1.4707484	2.6465067	
☐ PMG | STestb	Steel	0	0	7000	10	0	5	0.1	0.1	0.07784309	1.977	0.0017459808	0.0022393606	1.4962163	1.8946676	
☐ Sintex | B7	Steel	0	0	7450	0.001	0	5	0.1	0.066656984	0.067688441	2.048	0.002369494	0.0021626949	1.5843499	2.0116706	
☐ Sintex | B7X	Steel	0	0	7500	0.0007	0	5	0.0562431	0.017604187	0.03577057	3.093	0.0031787175	0.0025479262	1.8357595	3.1760455	
☐ Sintex | M7	Steel	0	0	7450	0.0004	0	5	0.0935959	0.05103864	0.06755147	2.672	0.0030042313	0.0020912655	1.7328156	2.3077099	
☐ Sintex | S10	Steel	0	0	7560	7E-5	0	5	0.1	0.06081615	0.078666565	3.160	0.0031683486	0	1.7628553	2.2466303	
☐ Sintex | S7	Steel	0	0	7570	0.0002	0	5	0.0992634	0.073808943	0.072650449	2.164	0.002130552	0.0012497233	1.7035131	1.8999704	
☐ Sintex | S7b	Steel	0	0	7520	0.0006	0	5	0.1	0.075508965	0.06414864	2.180	0.0021862285	0.0021969771	1.6161737	1.8804588	
☑ Sumitomo SMC | HB1, 20°C	Steel	33	453	7500	0.00099	0	0	0.1	0.093144087	0.080085907	1.075	0.00095366947	0.0012440173	1.6992429	1.7393471	
☑ Sumitomo SMC | HB2, 20°C	Steel	37	440	7450	0.00085	0	0	0.0700351	0.056735423	0.05178212	1.089	0.0010925885	0.001241511	1.6969579	1.8631	
☑ Sumitomo SMC | HB3, 20°C	Steel	33	453	7500	0.00029	0	0	0.1	0.093304122	0.082274099	1.227	0.0010701167	0.0013295864	1.7605528	1.7944588	
☑ Sumitomo SMC | HF1, 20°C	Steel	31	434	7200	0.00952	0	0	0.1	0.1	0.1	3.144	0.00087289501	0.00065276534	1.5406612	2.7404348	
☑ Sumitomo SMC | HF3, 20°C	Steel	10	455	7250	0.4209	0	0	0.0974358	0.093963313	0.08892647	1E-7	0.0001731877	0.0003452605	1.6964624	1.7244968	
☑ Sumitomo SMC | HX1, 20°C	Steel	8.9	460	6900	0.0219	0	0	0.1	0.097055337	0.099126921	1E-7	0.00013640398	0.00019396733	1.8827474	1.8614585	
☑ Sumitomo SMC | NM, 20°C	Steel	23	464	7450	0.003341	0	0	0.1	0.1	0.1	7.129	0.0012346151	0.0012190808	1.572055	2.0383101	

Found 56 materials Import Selected Cancel



Ansys