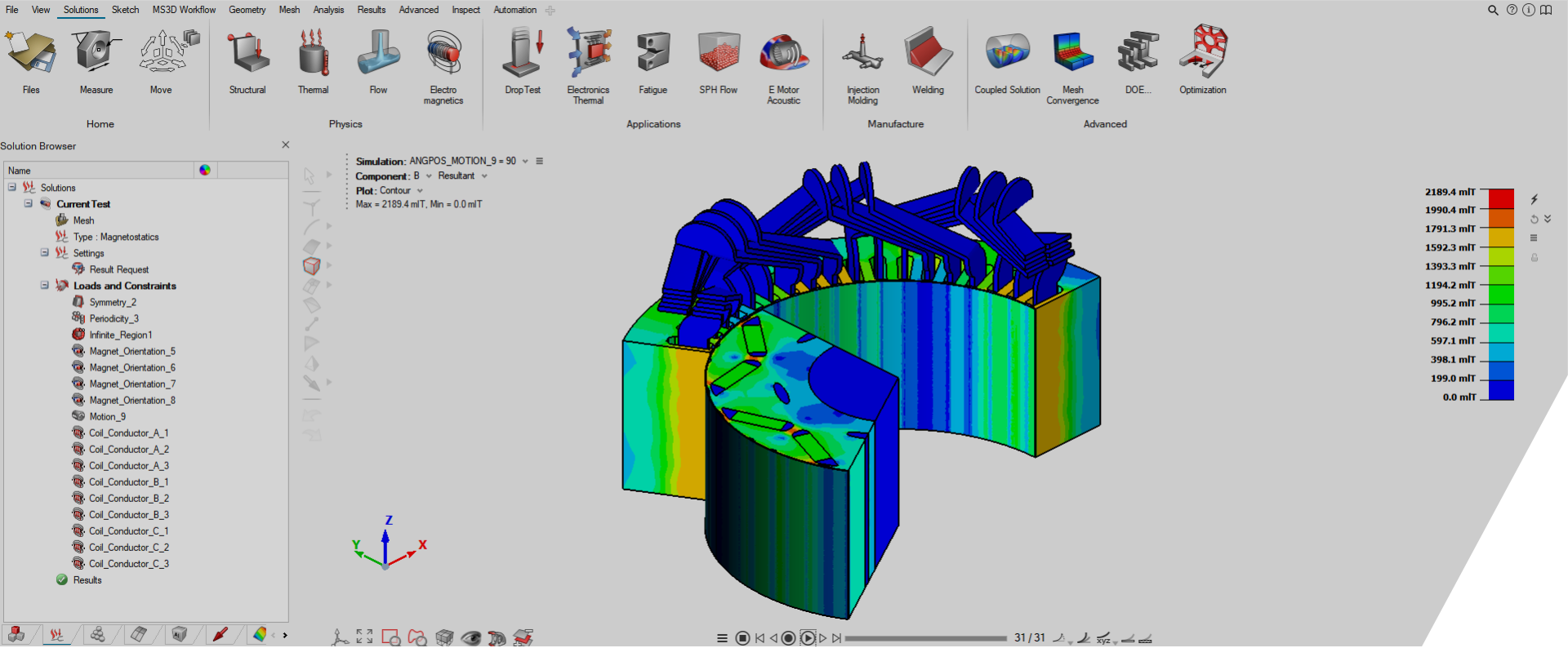

TESLA MODEL 3'S ELECTRIC MOTOR: BASIC ELECTROMAGNETIC ANALYSIS

MODELING AND ANALYSIS OF E-MOTORS IN SIMLAB

November 2025, Altair Flux / FluxMotor Valorization and Support Team

OUTLINE

Modeling and Analysis of the Tesla Model 3's Electric Motor

- Introduction
- 3D e-Motor Design (Periodic Modeling)
- Basic Motor Analysis (with Flux)
- Conclusion

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BASIC MOTOR ANALYSIS (WITH FLUX)

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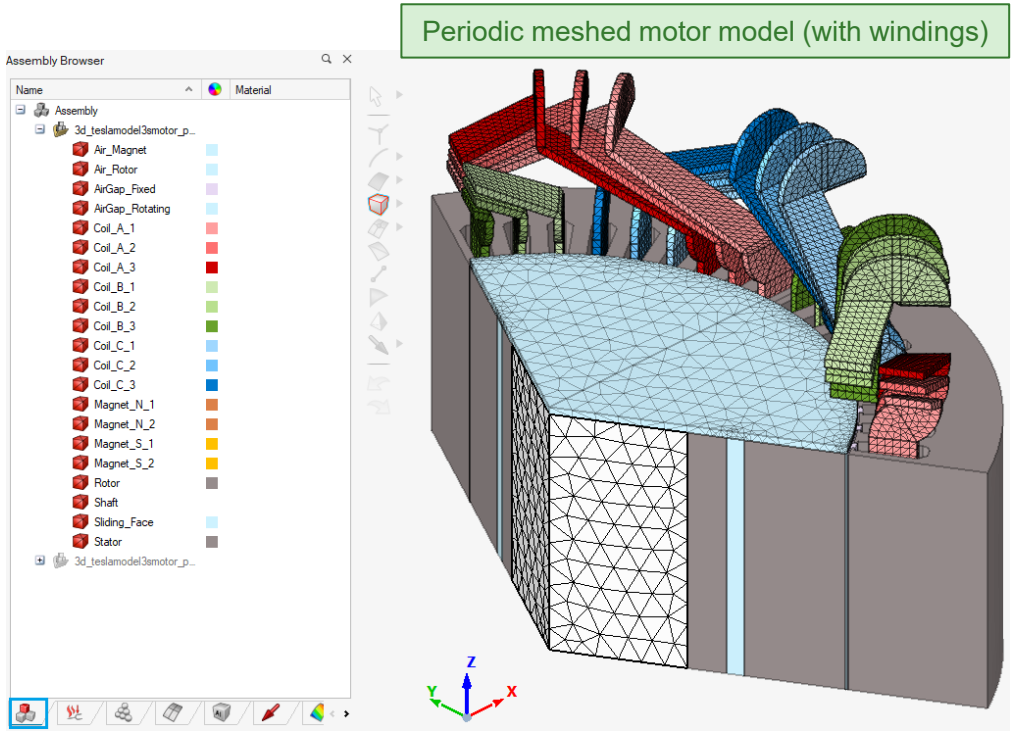
BASIC MOTOR ANALYSIS (WITH FLUX)

- Periodic motor model design
  - Open the project “3D_TeslaModel3sMotor_PeriodicModel.slb”



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BASIC PHYSICAL DESCRIPTION

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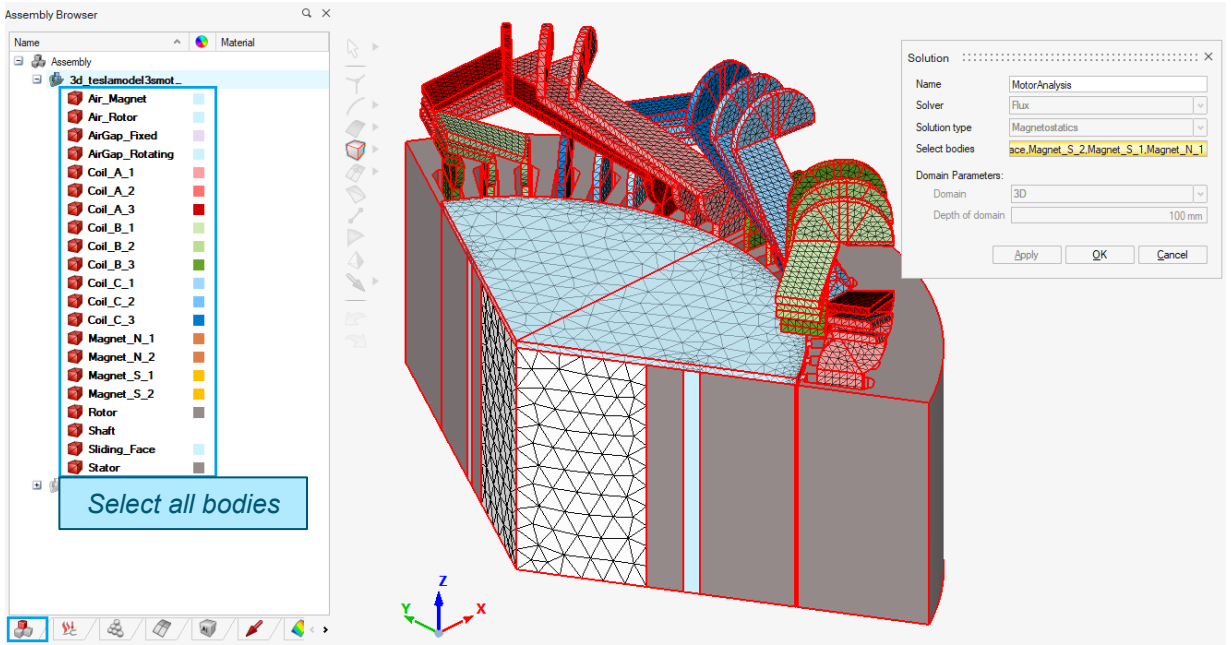
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Complete the **Solution** definition
  - [Analysis] – [Edit Solution]
    - Select all bodies



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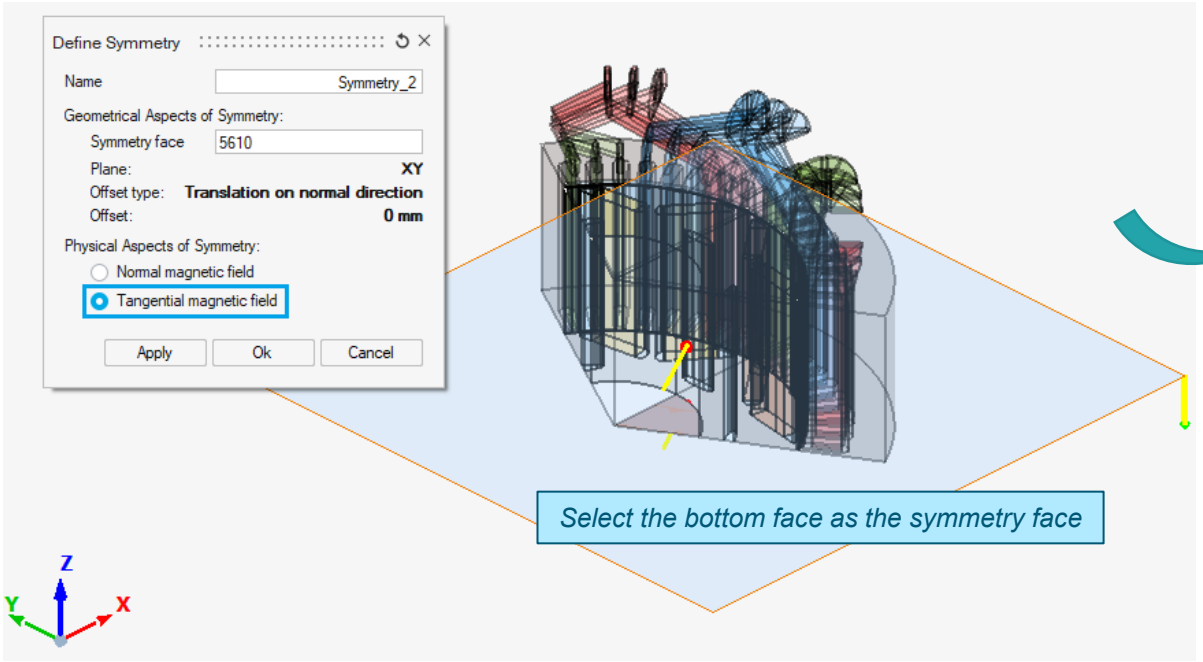
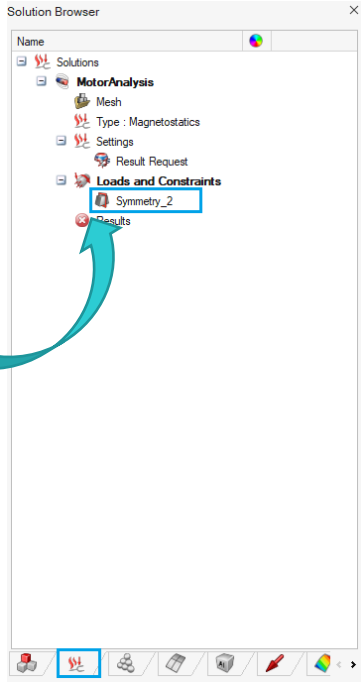
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Symmetry**
  - [Analysis] – [Symmetry]





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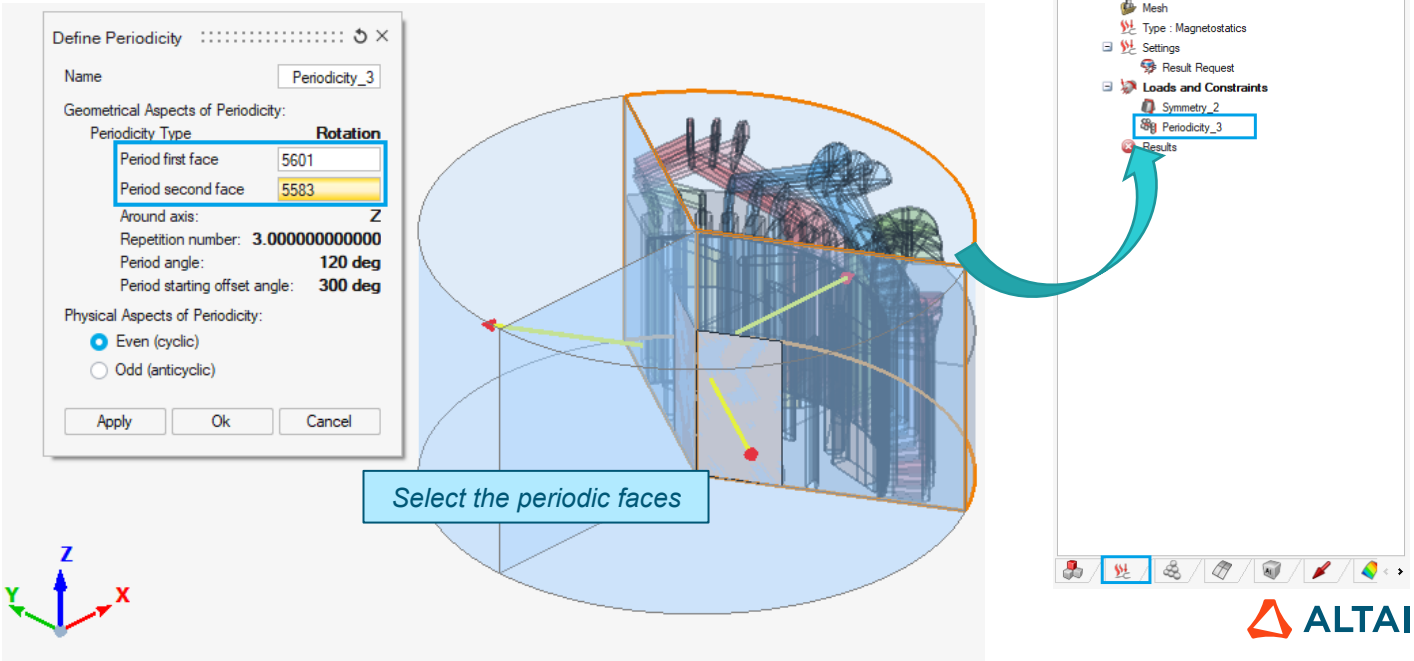
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Periodicity**
  - [Analysis] – [Periodicity]



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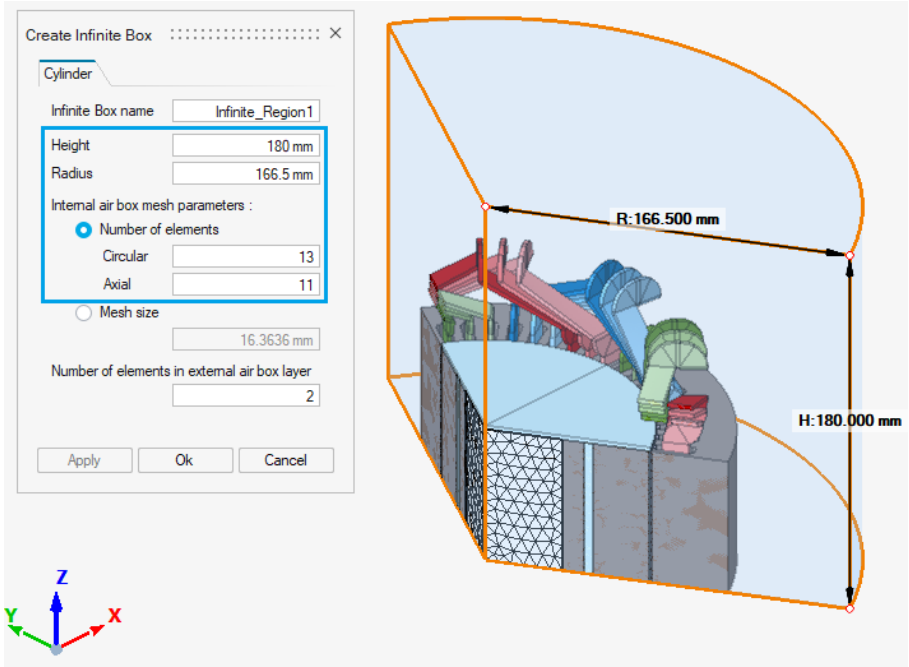
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Infinite Box**
  - [Analysis] – [Infinity Box]

N.B.: this step might take several minutes.



Infinite box parameters	
Height	180 mm
Radius	166.5 mm
Number of elements	
Circular	13
Axial	11

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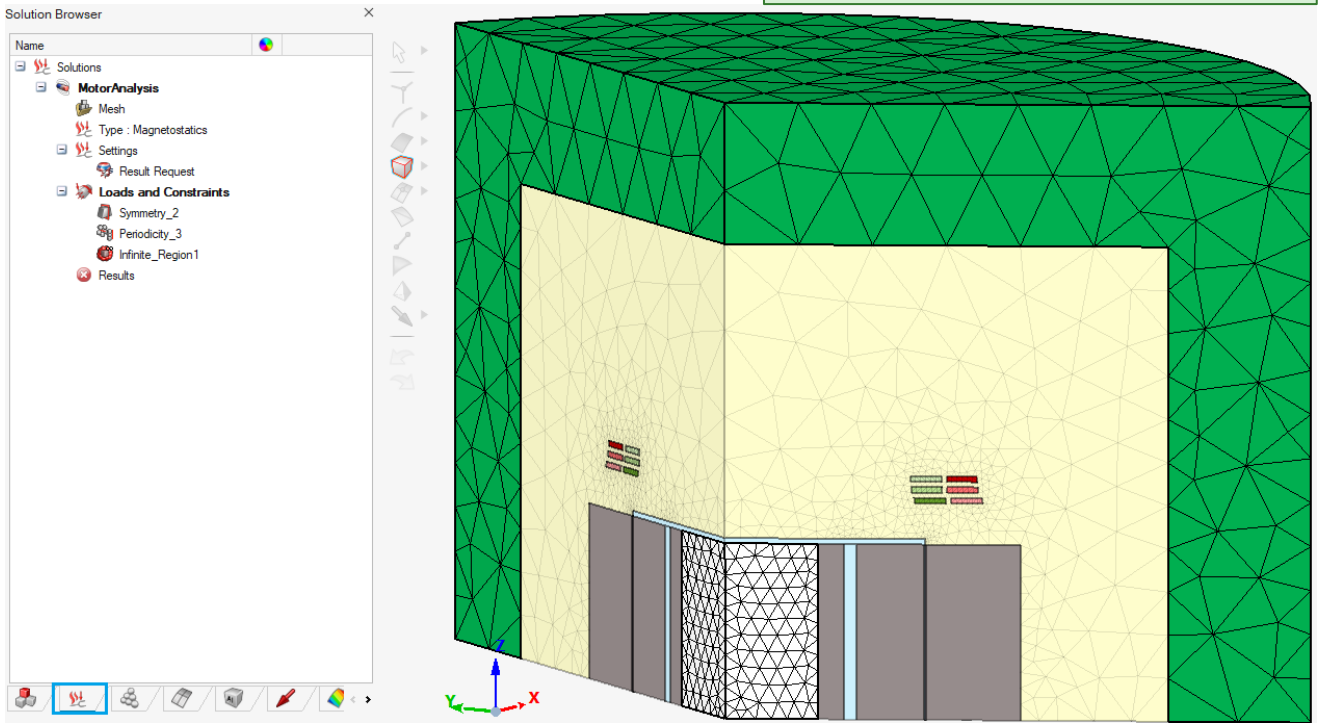
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Infinite Box**



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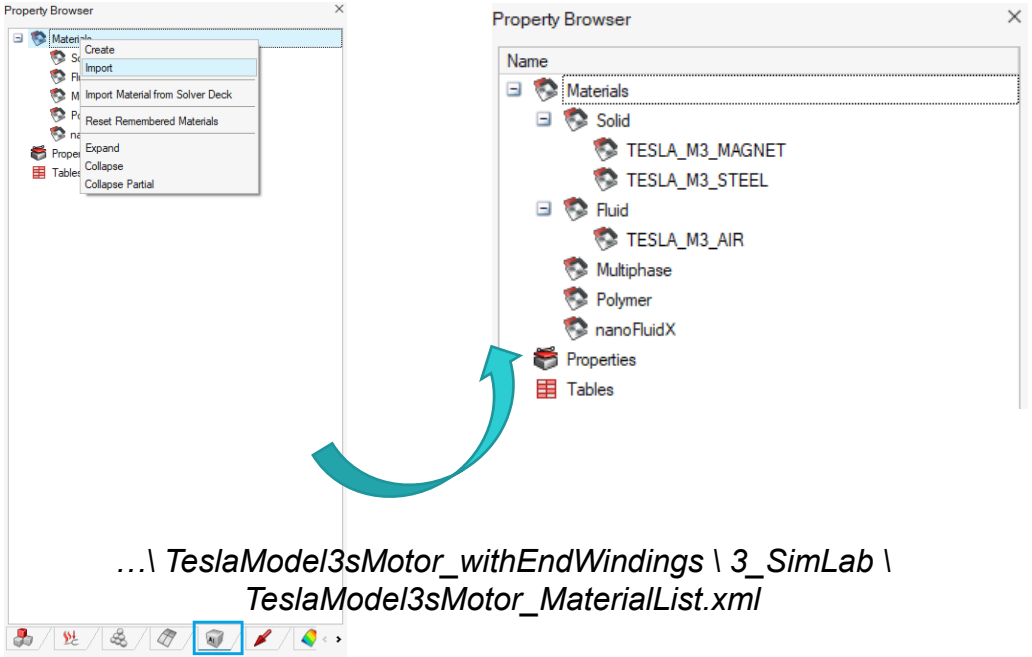
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Materials**
  - Import materials



…\ TeslaModel3sMotor_withEndWindings \ 3_SimLab \ TeslaModel3sMotor_MaterialList.xml

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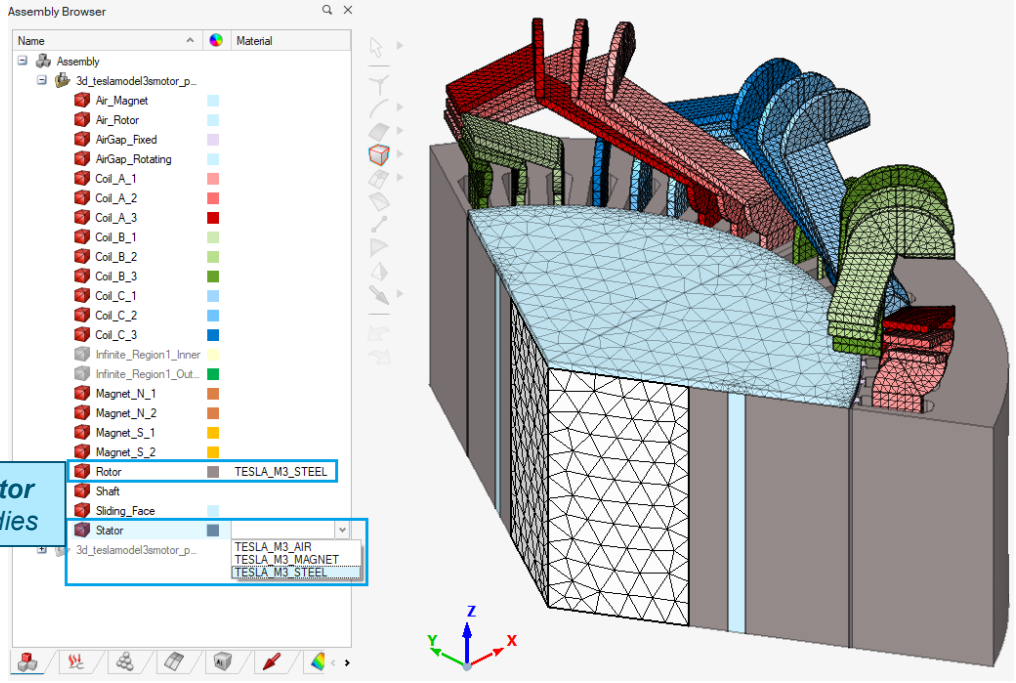
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Materials**
  - **Stator** and **Rotor** bodies



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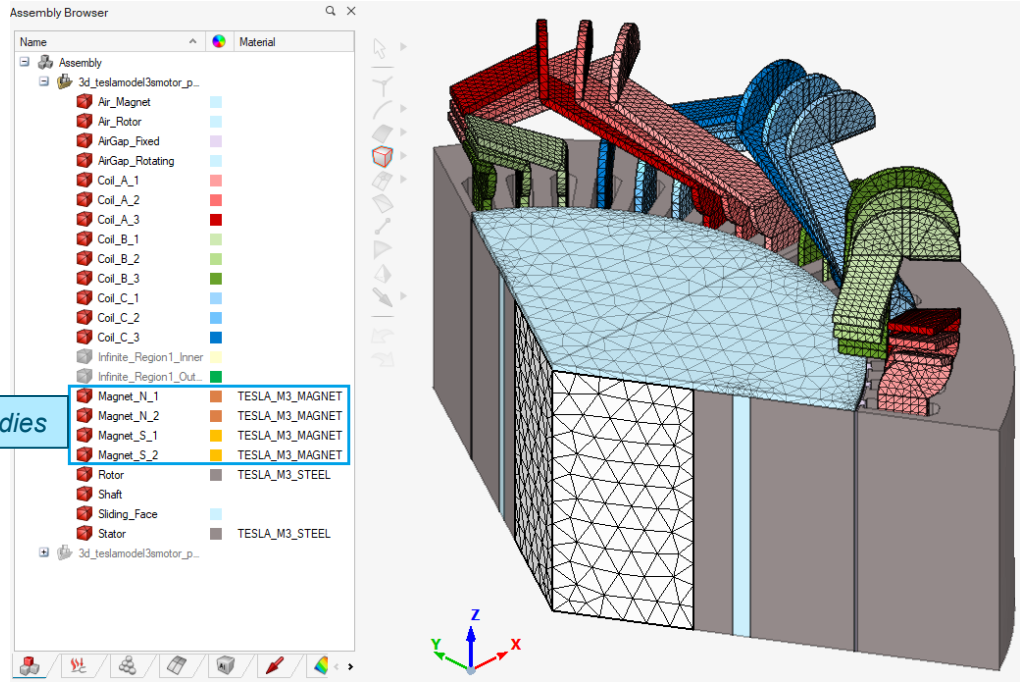
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Materials**
  - **Magnet** bodies

*Select all **magnet** bodies*



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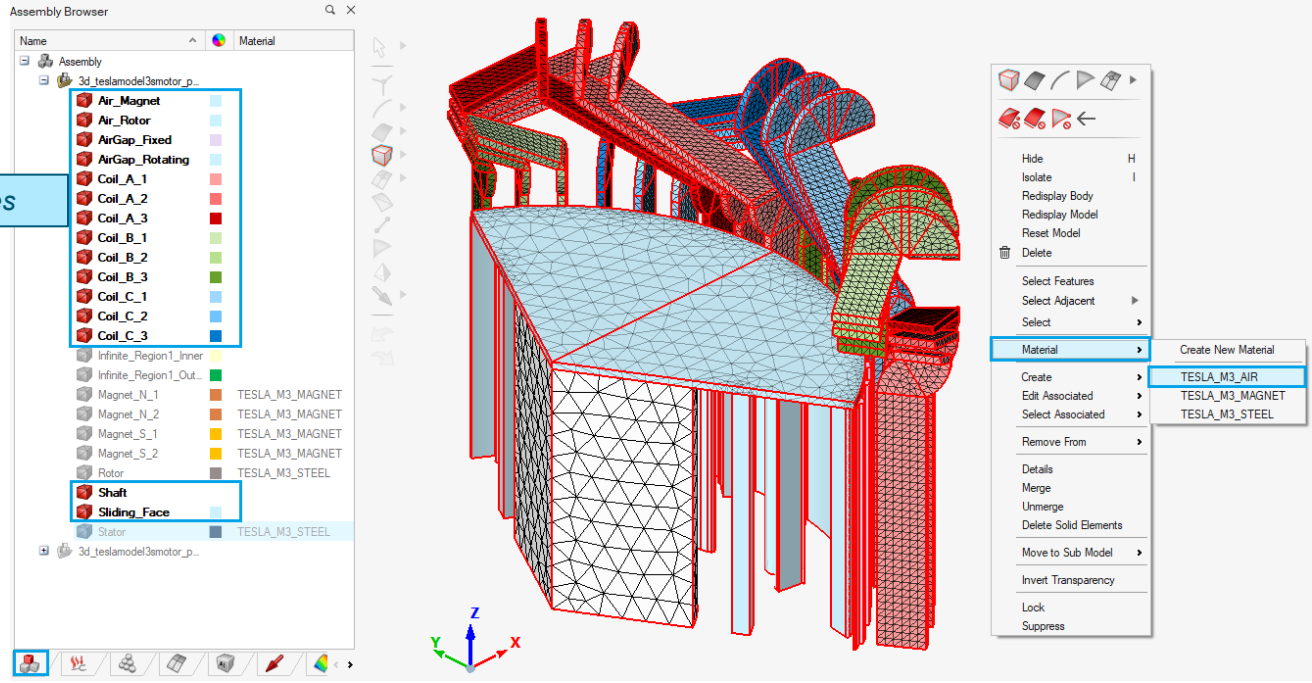
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Materials**
  - **Air** bodies

*Select all **air** bodies*



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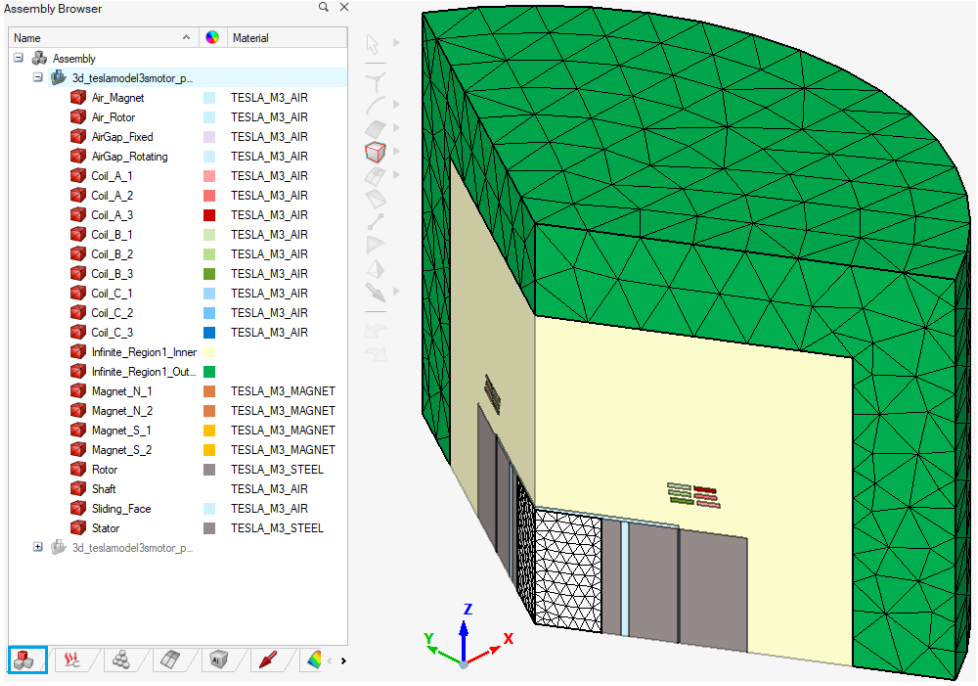
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Materials**
  - Final material definition list



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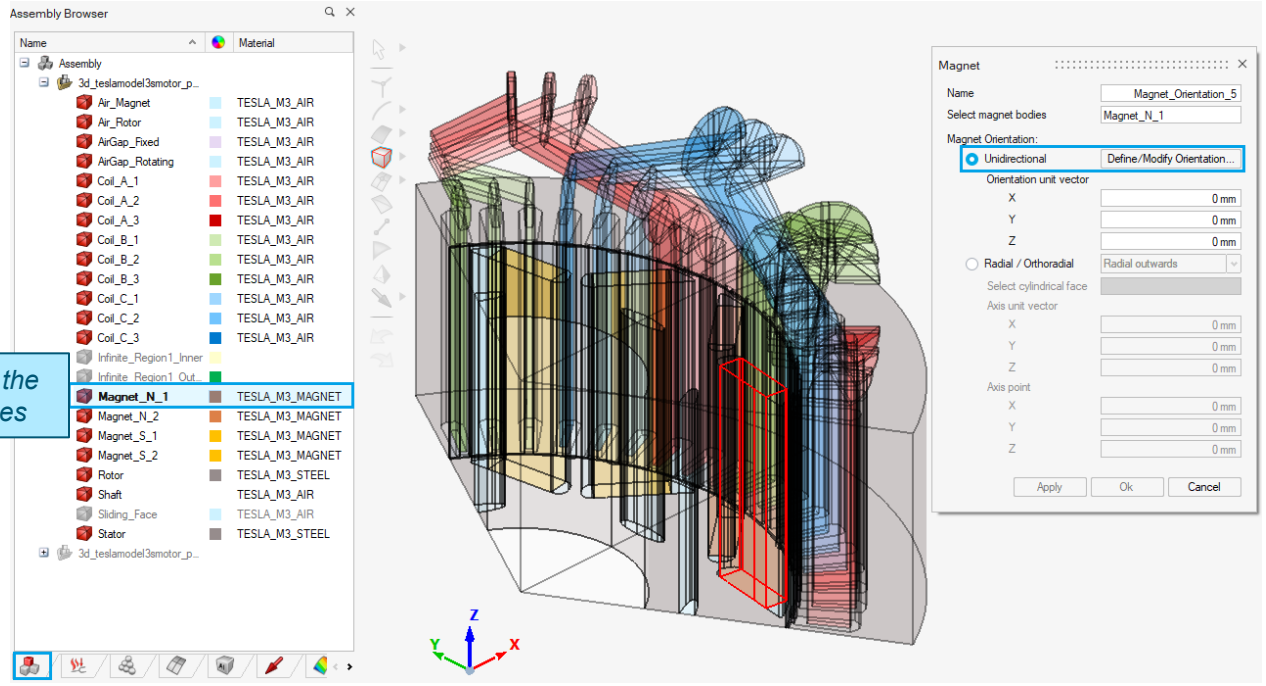
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Magnet**
  - [Analysis] – [Magnet]

Select one of the magnet bodies



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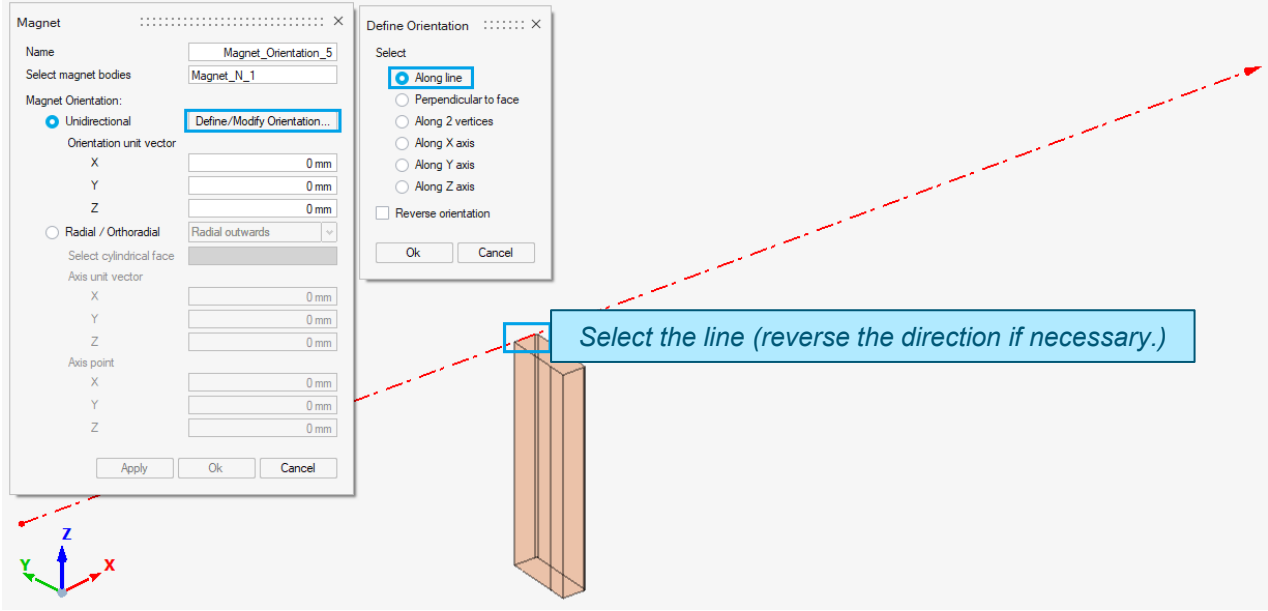
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Magnet**
  - [Analysis] – [Magnet]
    - Define the orientation (Unidirectional – Along line)



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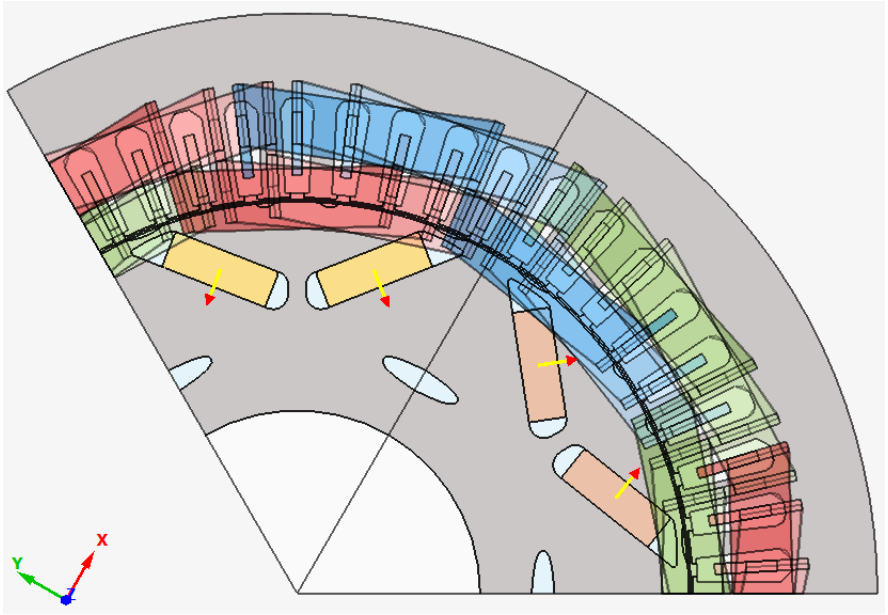
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Magnet**
  - [Analysis] – [Magnet]
    - Final magnet orientation



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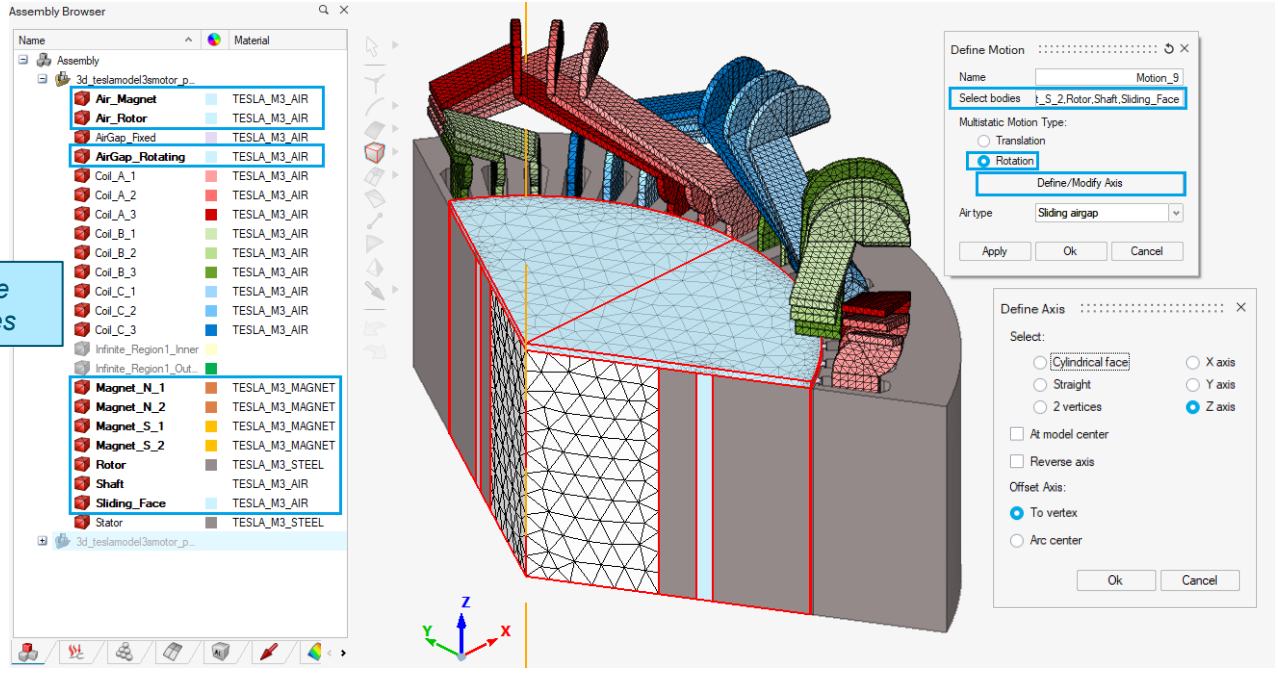
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Define **Motion**
  - [Analysis] – [Motion]

Select all the motion bodies



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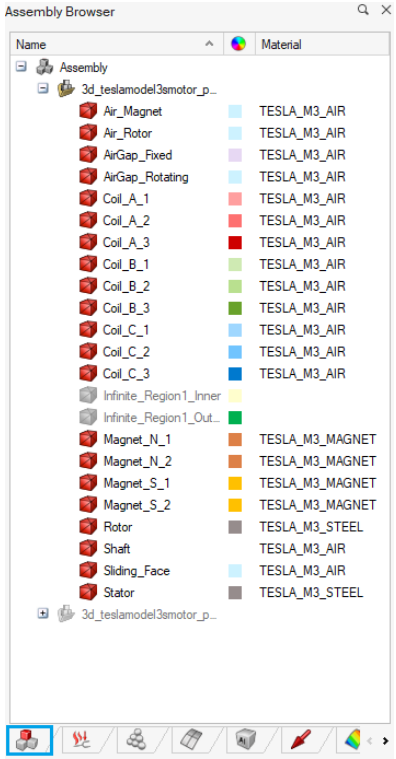
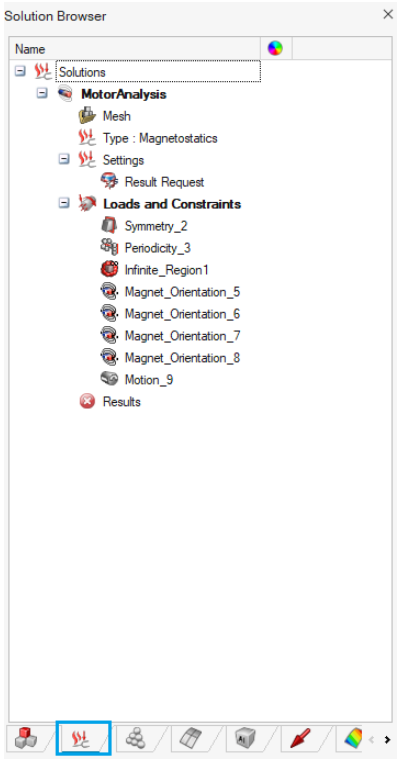
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Finish basic physical description
  - Check Model Browser
    - Assembly Browser
    - Solution Browser





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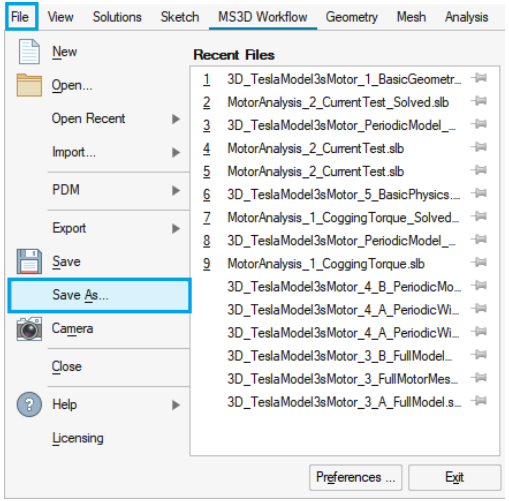
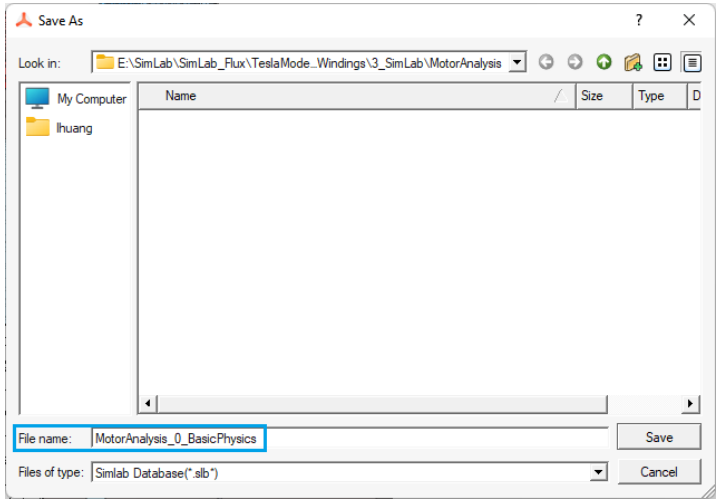
BASIC MOTOR ANALYSIS (WITH FLUX)

Basic Physical Description

- Save the project [File] – [Save]
  - Save the project as “MotorAnalysis_0_BasicPhysics.slb”





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ANALYSIS 1: COGGING TORQUE

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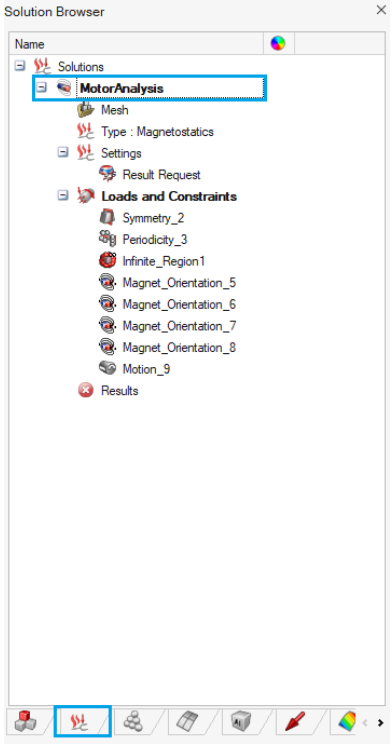
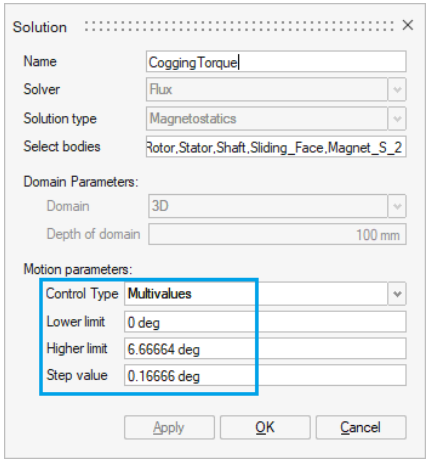
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Define solving parameters
  - Motion parameters
    - Change the solution name to “CoggingTorque”
    - Double click on the solution and modify parameter setting

Motion parameters	Value
Control Type	Multivalues
Lower limit	0 deg
Higher limit	6.66664 deg
Step value	0.16666 deg





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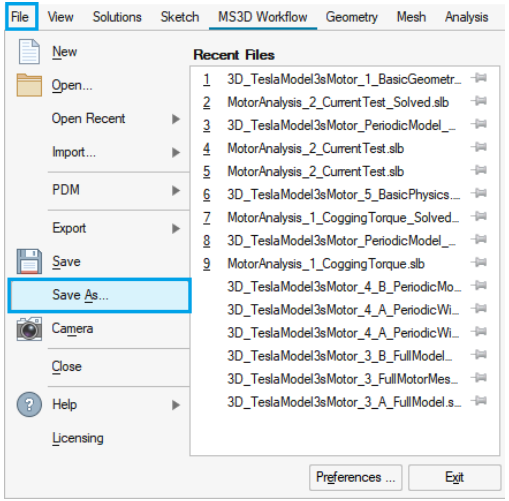
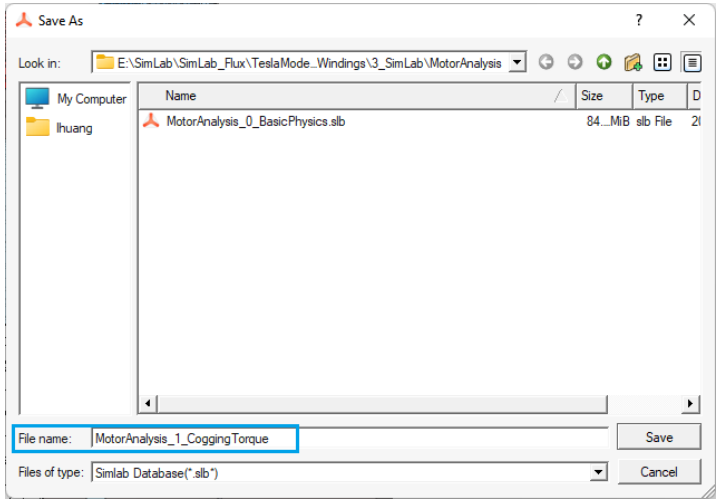
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Save the project before solving ([File] – [Save])
  - Save the project as “MotorAnalysis_1_CoggingTorque.slb”





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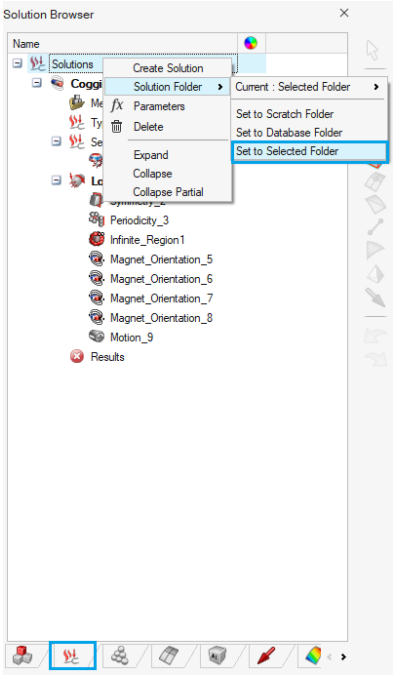
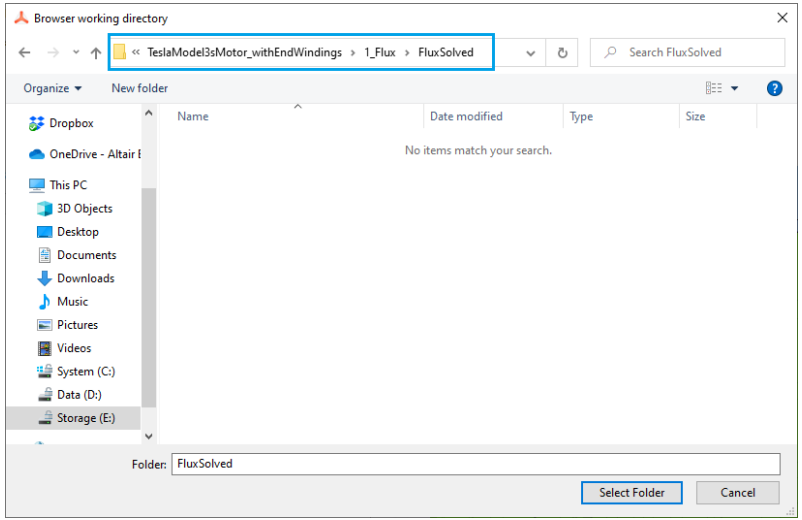
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Solve the project
  - Right click on the “Solutions” and select the solving folder for Flux





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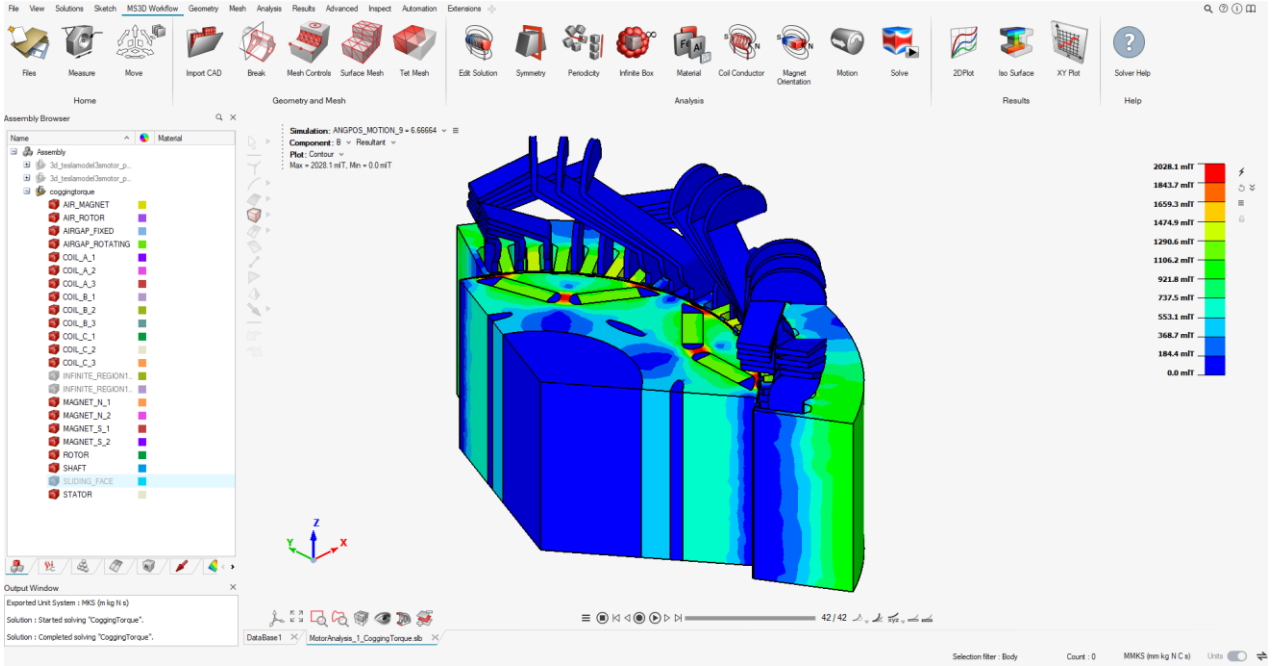
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Solve the project
  - [Analysis] – [Solve]

Solution time: about 3.5 hours



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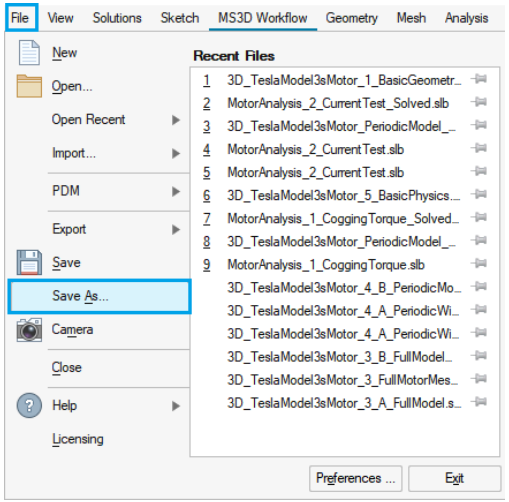
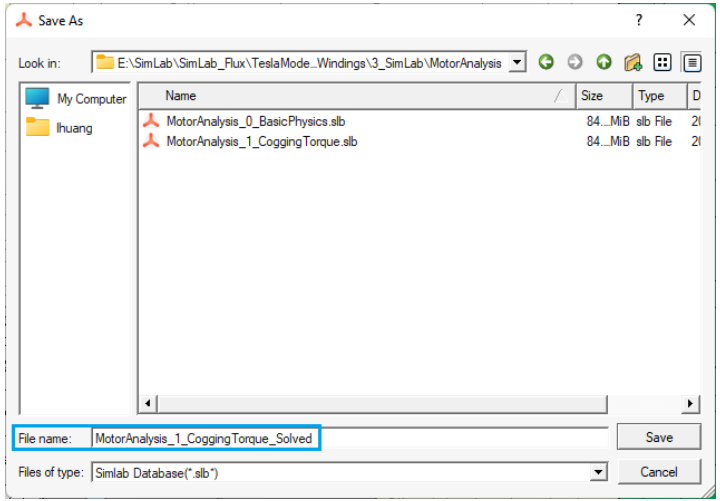
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Save the solved project ([File] – [Save])
  - Save the project as “MotorAnalysis_1_CoggingTorque_Solved.slb”





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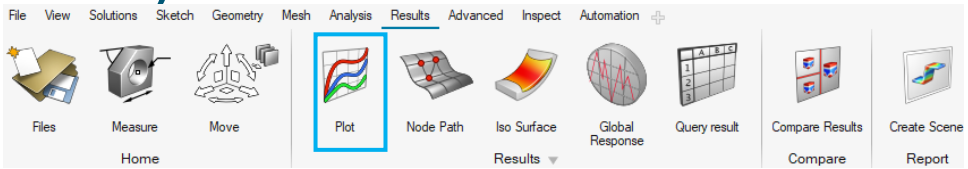
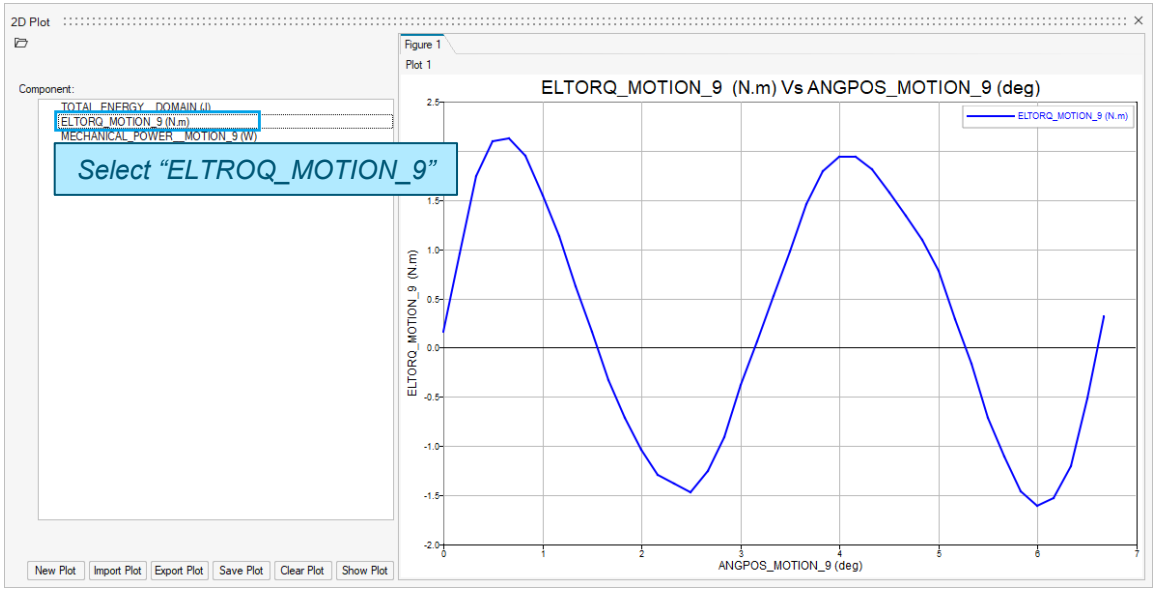
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque



- Motor electromagnetic simulation: post-processing
  - Curve plot: cogging torque
    - [Results] – [Plot]



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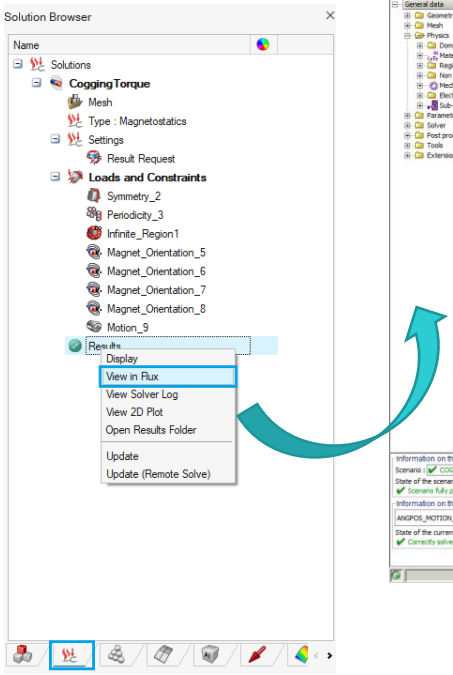
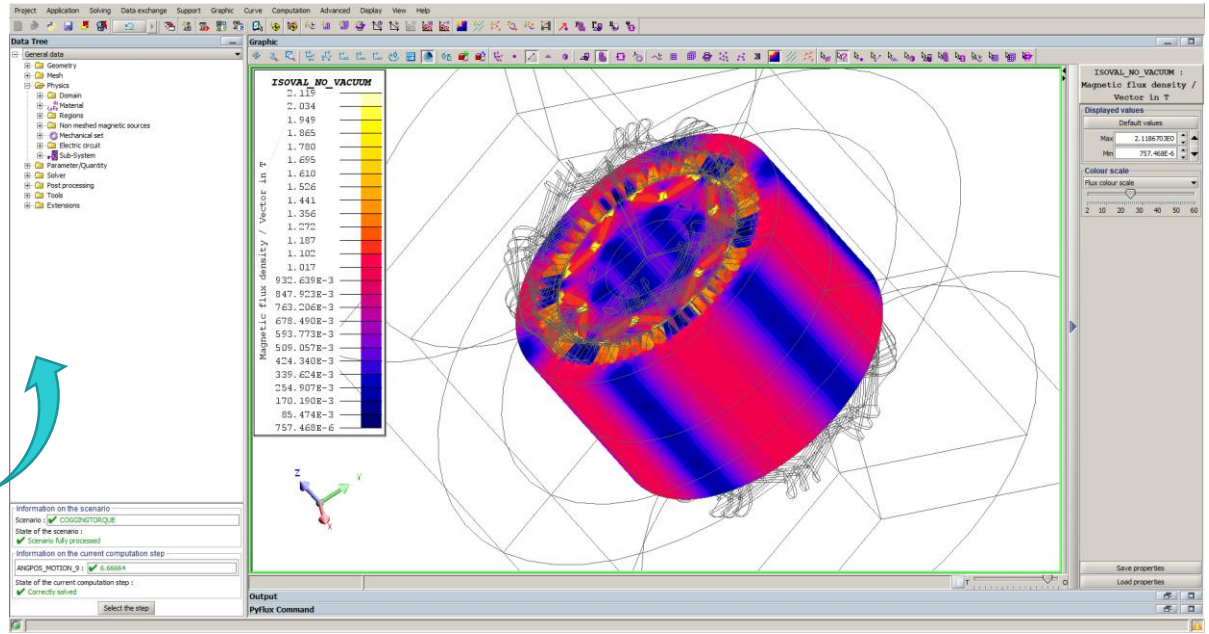
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 1: Cogging Torque

- Motor electromagnetic simulation: post-processing
  - Open the solved Flux project





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ANALYSIS 2: CURRENT TEST

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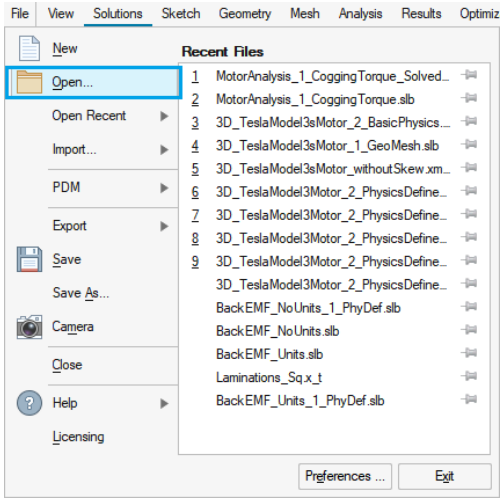
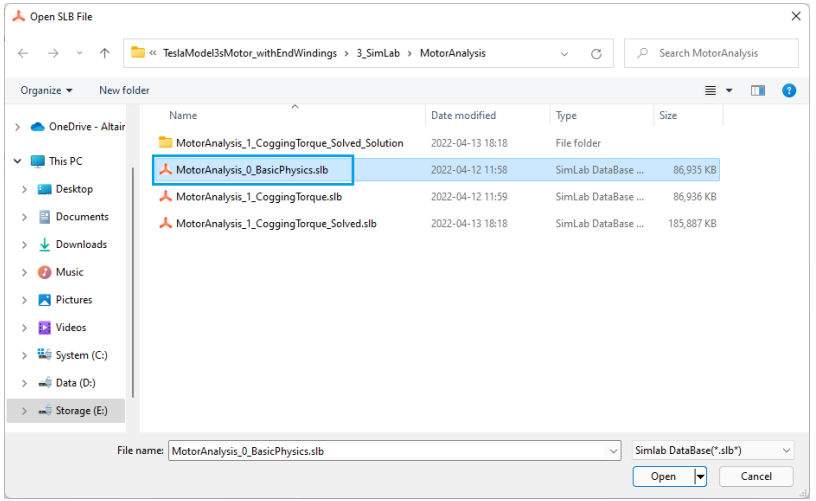
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Open SimLab project with basic physical description
  - Open the project [File] – [Open]
    - Open the project “MotorAnalysis_0_BasicPhysics.slb”





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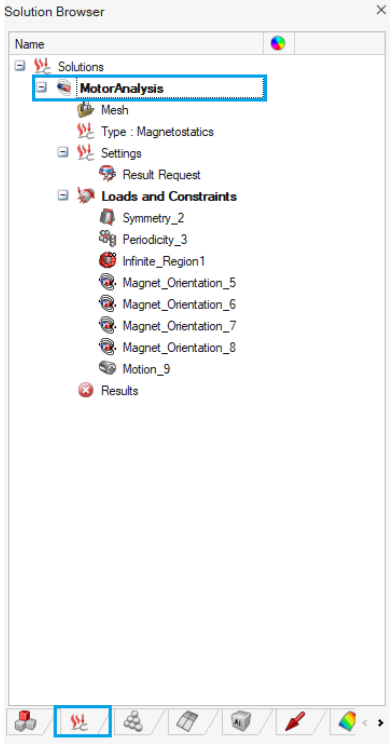
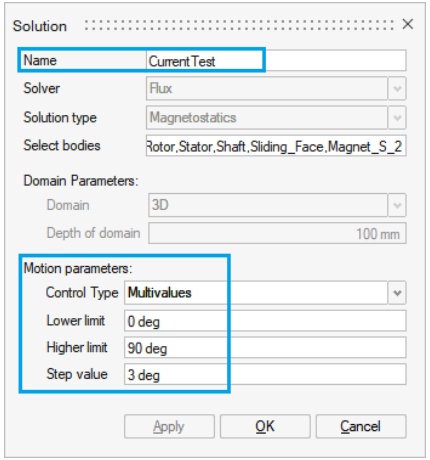
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Define solving parameters
  - Motion parameters
    - Change the solution name to “CurrentTest”
    - Double click on the solution and modify parameter setting

Motion parameters	Value
Control Type	Multivalues
Lower limit	0 deg
Higher limit	90 deg
Step value	3 deg





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BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Define **Coil Conductor**
  - [Analysis] – [Coil Conductor]
    - Current expression

Terms	Expression
I1	-I_PEAK*Sin(THETA*_IM_PN/2*Pi()/180+CTRL_ANGLE*Pi()/180)
I2	-I_PEAK*Sin(THETA*_IM_PN/2*Pi()/180+CTRL_ANGLE*Pi()/180-2*Pi()/3)
I3	-I_PEAK*Sin(THETA*_IM_PN/2*Pi()/180+CTRL_ANGLE*Pi()/180-4*Pi()/3)
I_PEAK	I_RMS*Sqrt(2)
I_RMS	156.443
THETA	0.0
CTRL_ANGLE	0.0

Terms	Value
Turns	5
PhaseA	0
PhaseB	191600 mA
PhaseC	-191600 mA

Simplified current values (for test)

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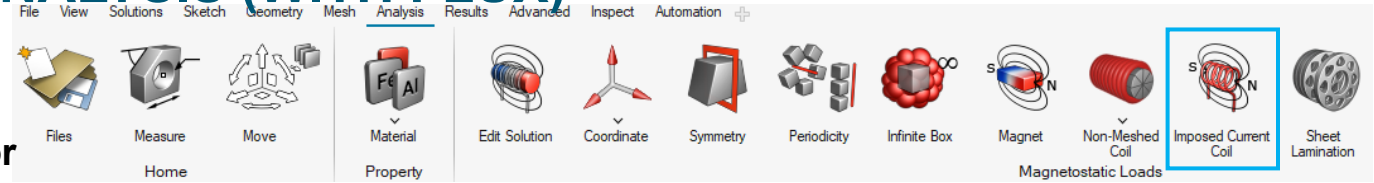
BASIC MOTOR ANALYSIS (WITH FLUX)

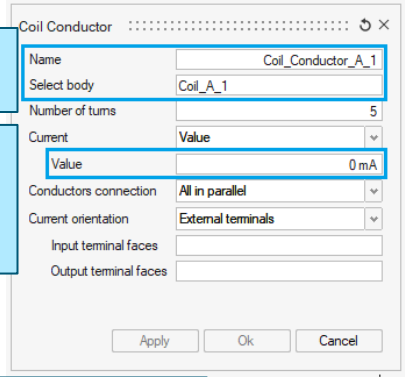
Analysis 2: Current Test

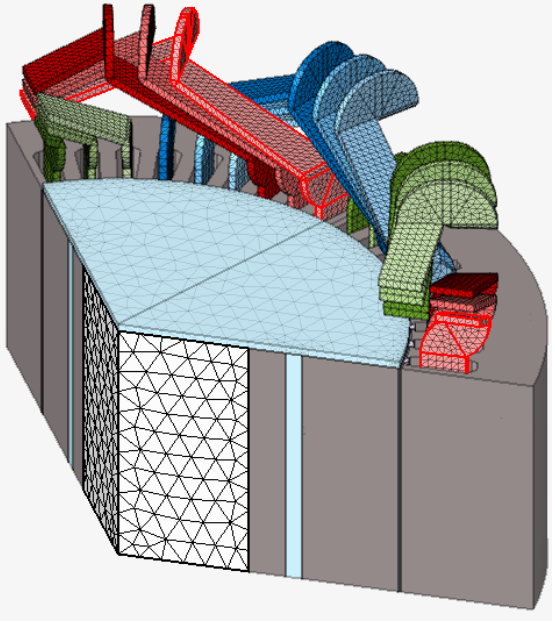


- Define **Coil Conductor**
  - [Analysis] – [Imposed Current coil]
    - Example: Coil_Conductor_A_1

*Select the body **Coil_A_1***

*Define the number of turns as **5**, current value as **0** mA, connection type as "**All in parallel**"*





***P.S.:** current value for Phase B bodies is **191600** mA, for Phase c bodies is **-191600** mA*

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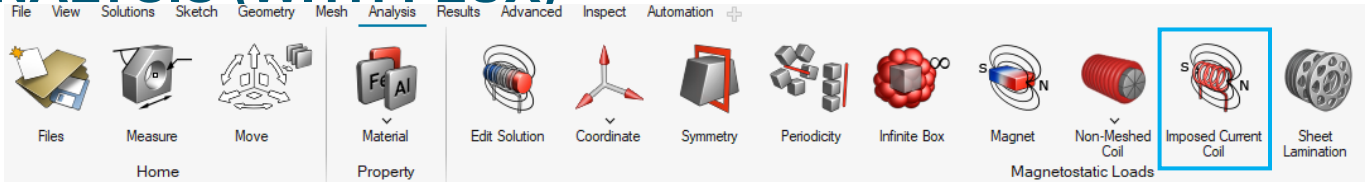
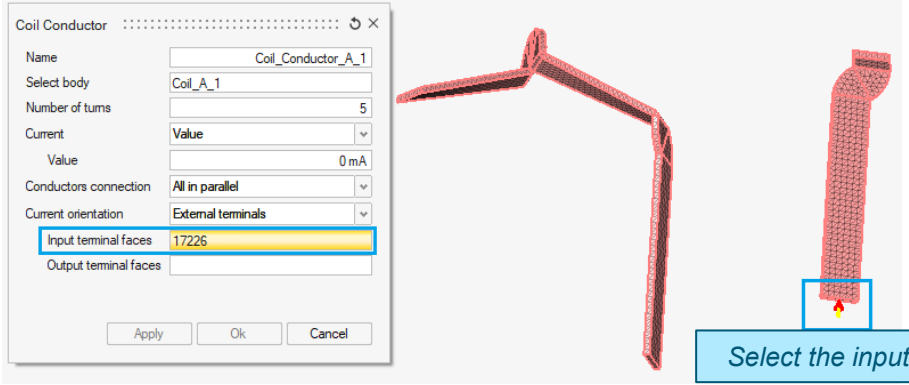
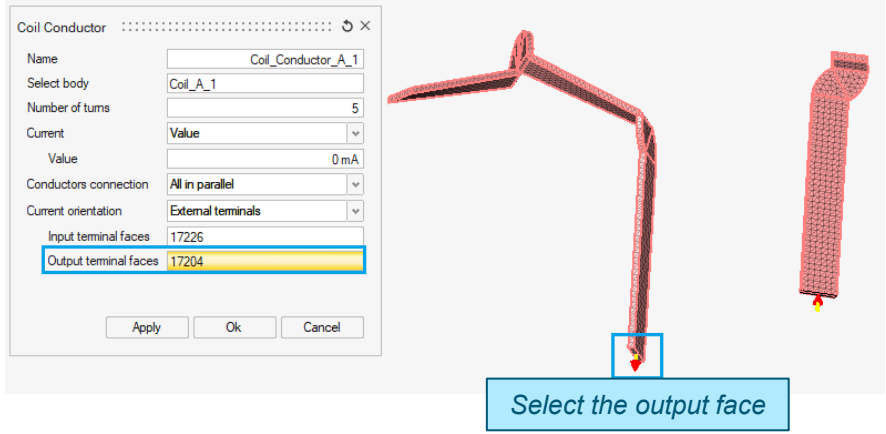
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test



- Define **Coil Conductor**
  - [Analysis] – [Imposed Current Coil]
    - Example: Coil_Conductor_A_1
      - Define input and output terminals





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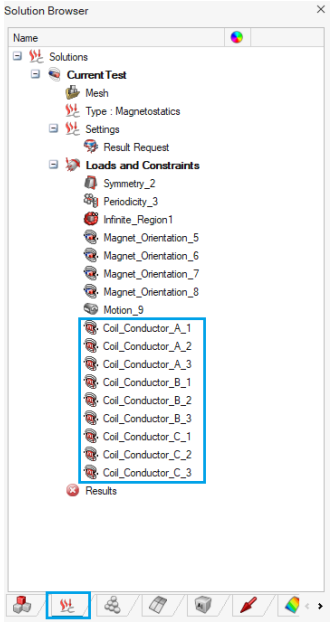
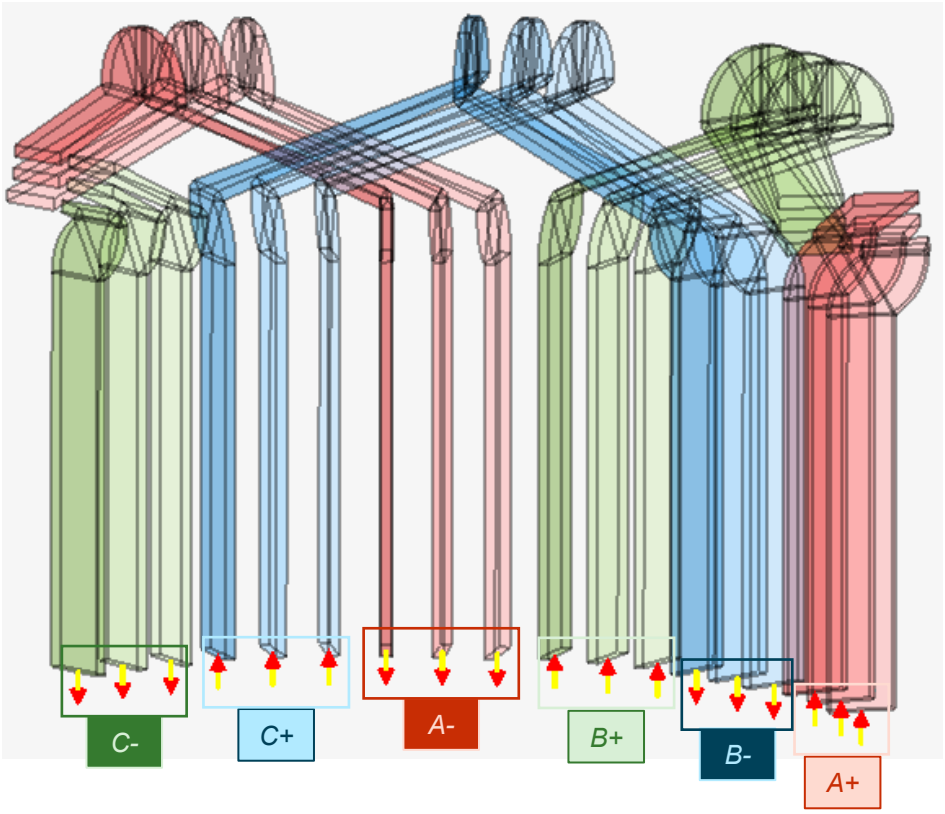
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Define **Coil Conductor**
  - [Analysis] – [Imposed Current Coil]
    - Final **Coil Conductor** list





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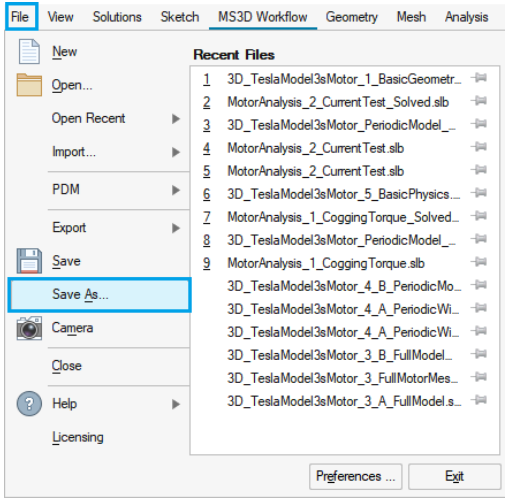
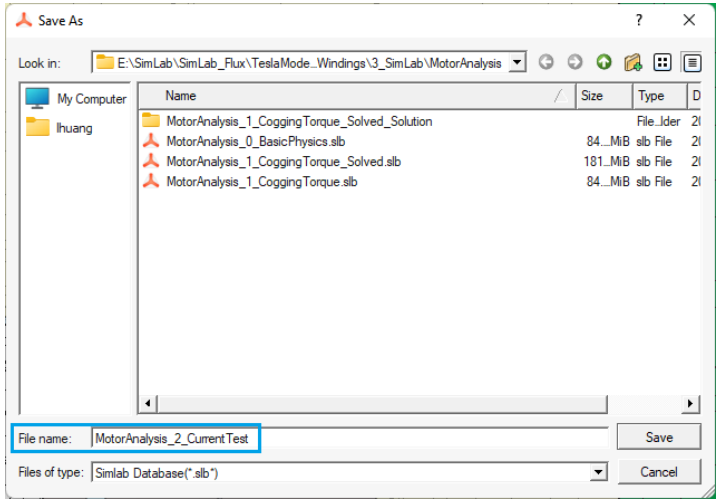
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Save the project before solving ([File] – [Save])
  - Save the project as “MotorAnalysis_2_CurrentTest.slb”





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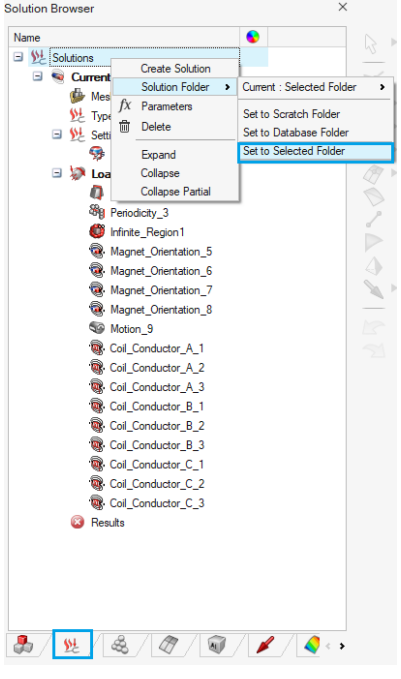
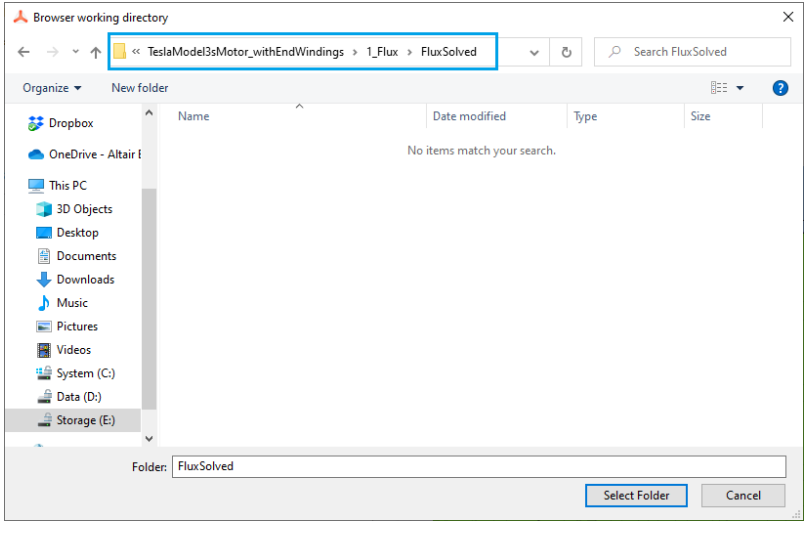
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Solve the project
  - Right click on the “Solutions” and select the solving folder for Flux





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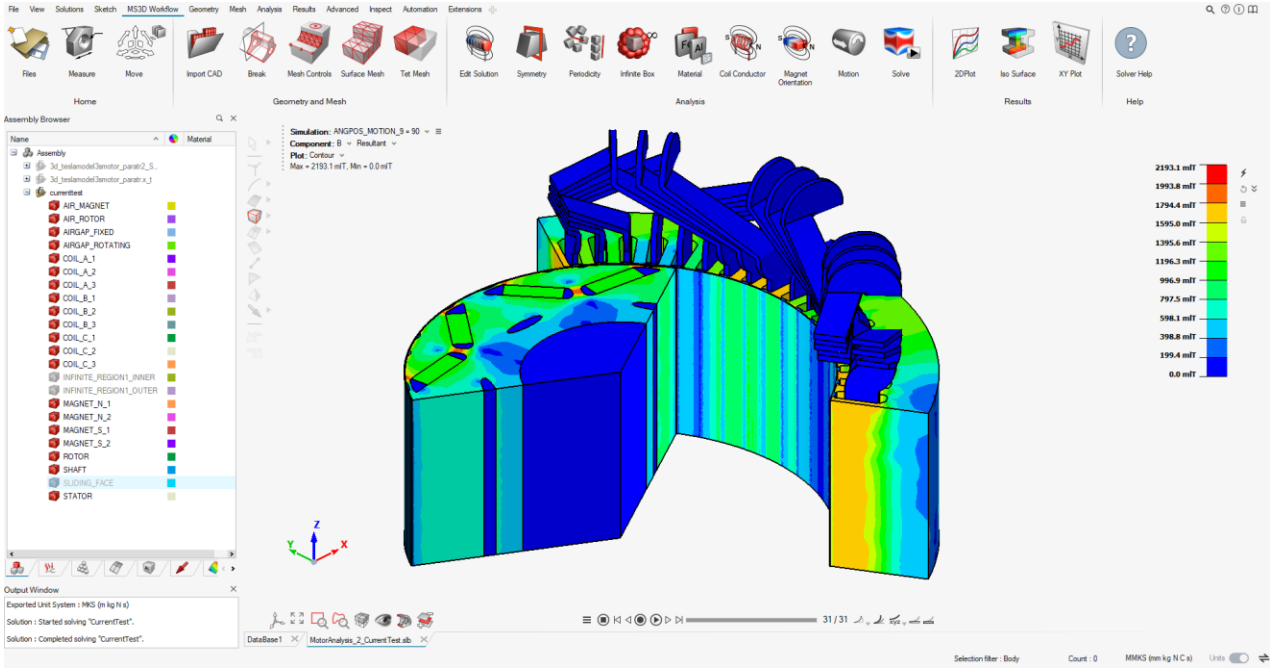
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Solve the project
  - [Analysis] – [Solve]

Solution time: about 5.5 hours



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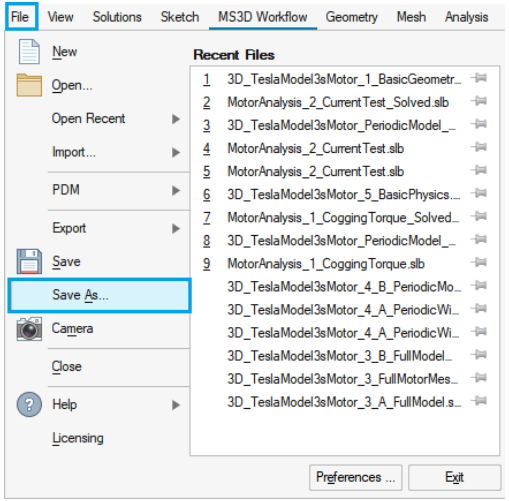
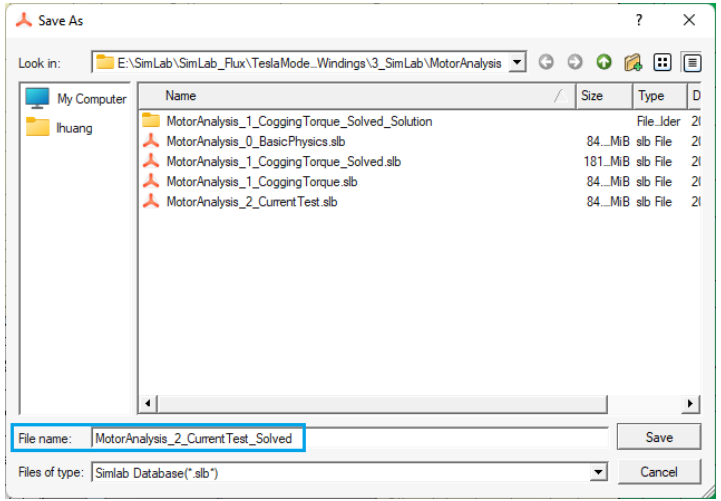
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Save the solved project ([File] – [Save])
  - Save the project as “MotorAnalysis_2_CurrentTest_Solved.slb”





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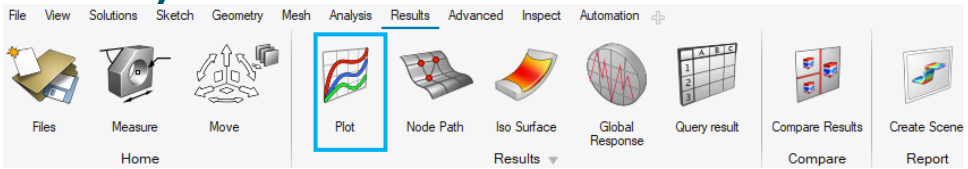
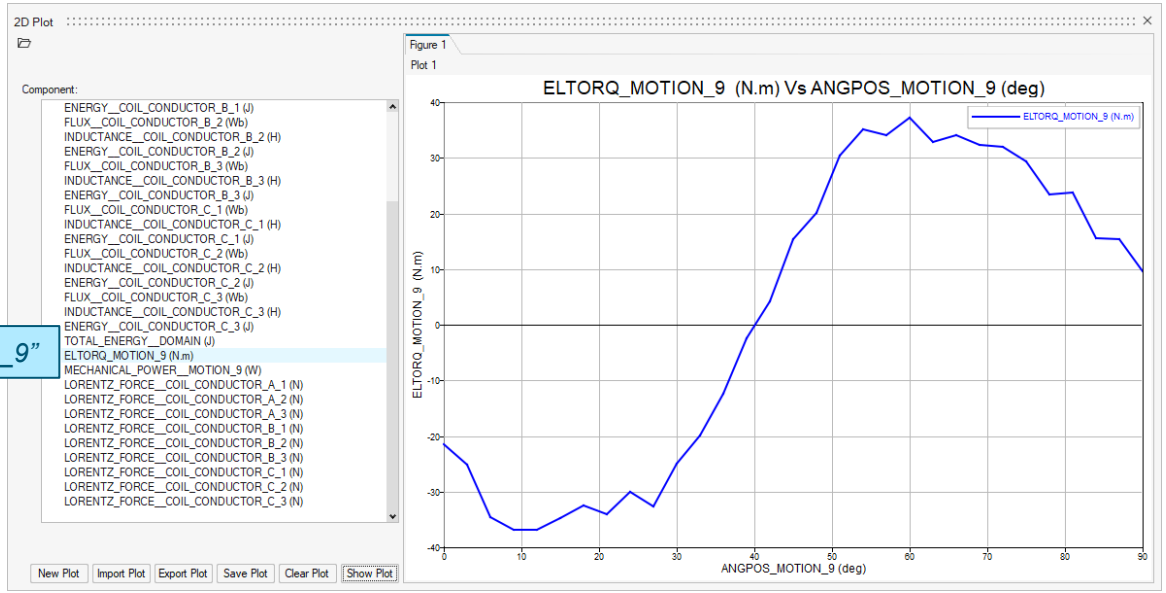
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test



- Motor electromagnetic simulation: post-processing
  - Curve plot: electromagnetic torque
    - [Result] – [Plot]

Select "ELTROQ_MOTION_9"



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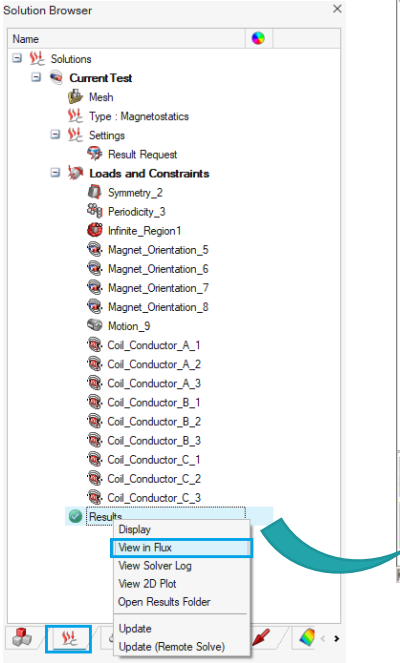
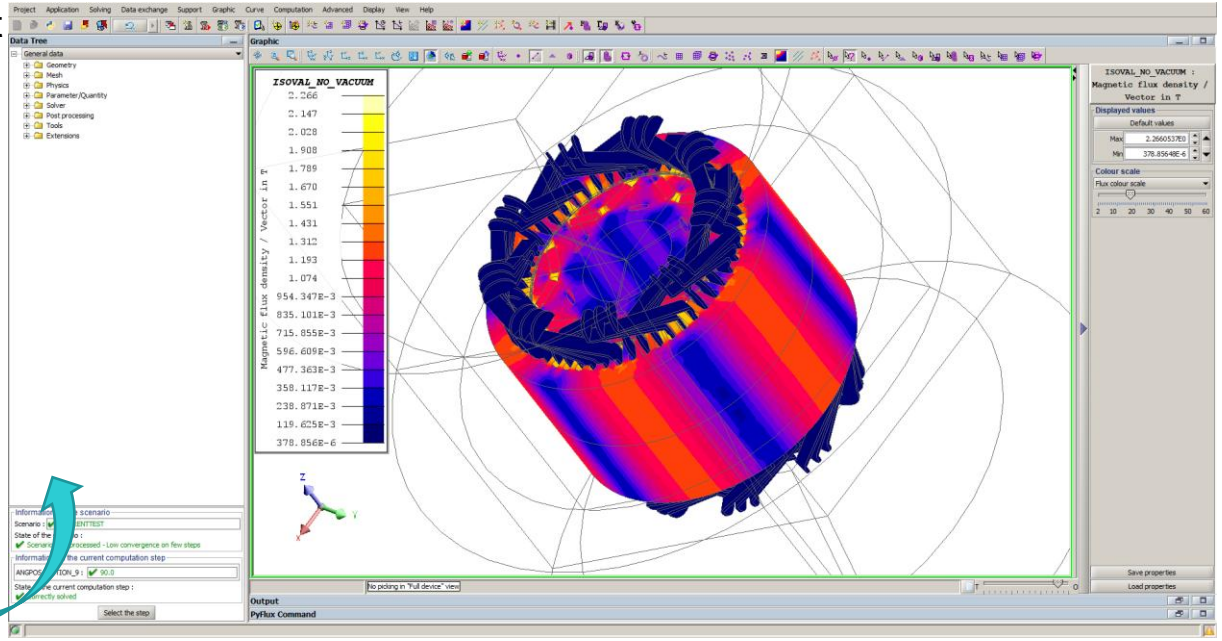
BASIC MOTOR ANALYSIS (WITH FLUX)

Analysis 2: Current Test

- Motor electromagnetic simulation: post-processing
  - Open the solved Flux project





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CONCLUSION

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CONCLUSION

- An application example (Tesla Model 3's motor) has been successfully modeled in SimLab.
- A periodic motor model with meshed motor windings are created for further analysis.

- Two basic motor analyses (**Cogging Torque** and **Current Test**) have been created and solved in SimLab with the new magnetostatics 3D application.
- The solved Flux projects are saved in the working directory, and they can be used for the post-processing.

THANK YOU

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#ONLYFORWARD

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