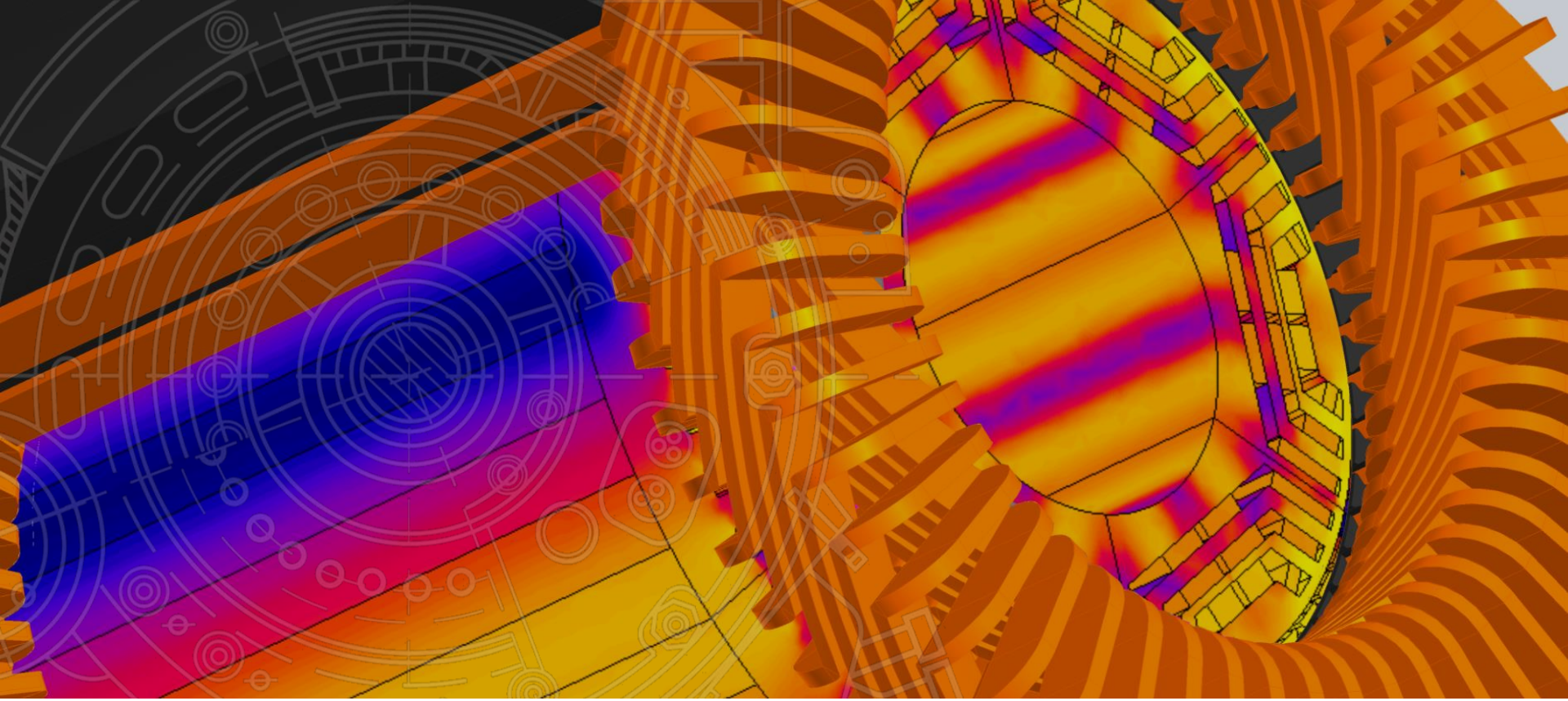


DC MOTOR ANALYSIS

FLUX 2D APPLICATION NOTES

March 2021, Altair Valorization and Support Team

GENERAL PRESENTATION OUTLINE

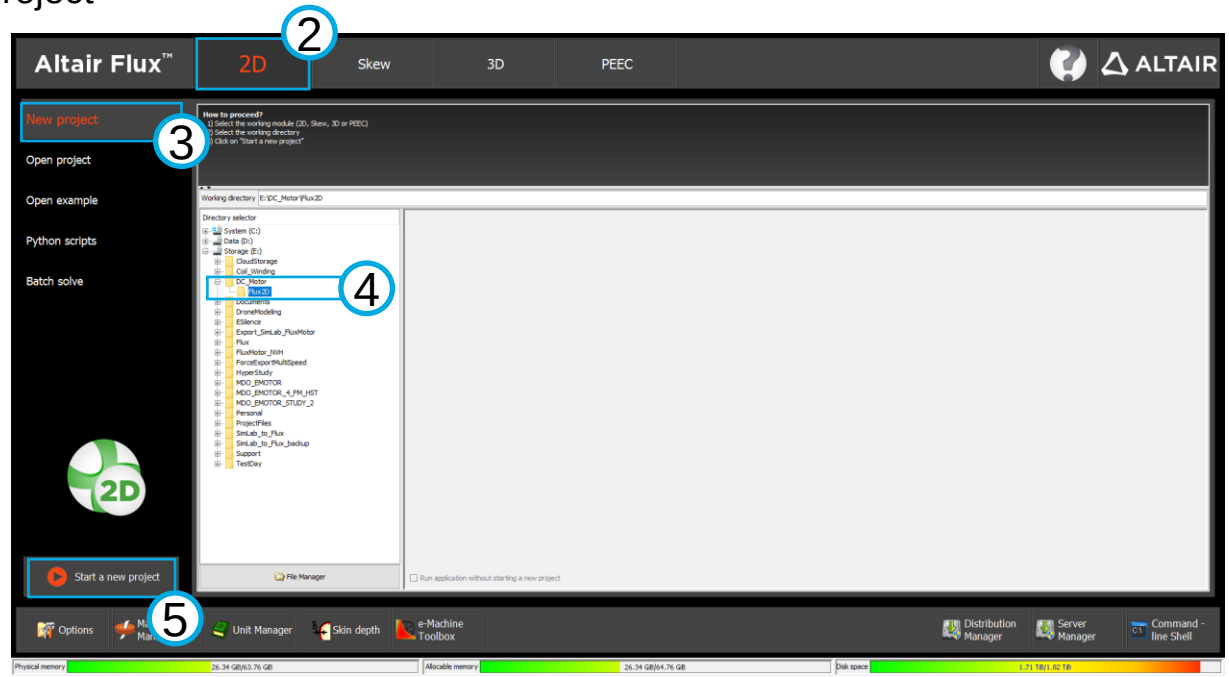
- Part 1: Geometry and mesh
- Part 2: Brush angle analysis
- Part 3: Back EMF analysis
- Part 4: Constant speed analysis
- Part 5: Conclusion

I. GEOMETRY AND MESH

GEOMETRY AND MESH

- Flux 2D project: initiation
  - Create a new Flux 2D project

Step	Action
1	Open Flux supervisor
2	Select the [2D] simulation context
3	Click on [New project]
4	Select the working path : “~/DC_Motor”
5	Click on [Start a new project]



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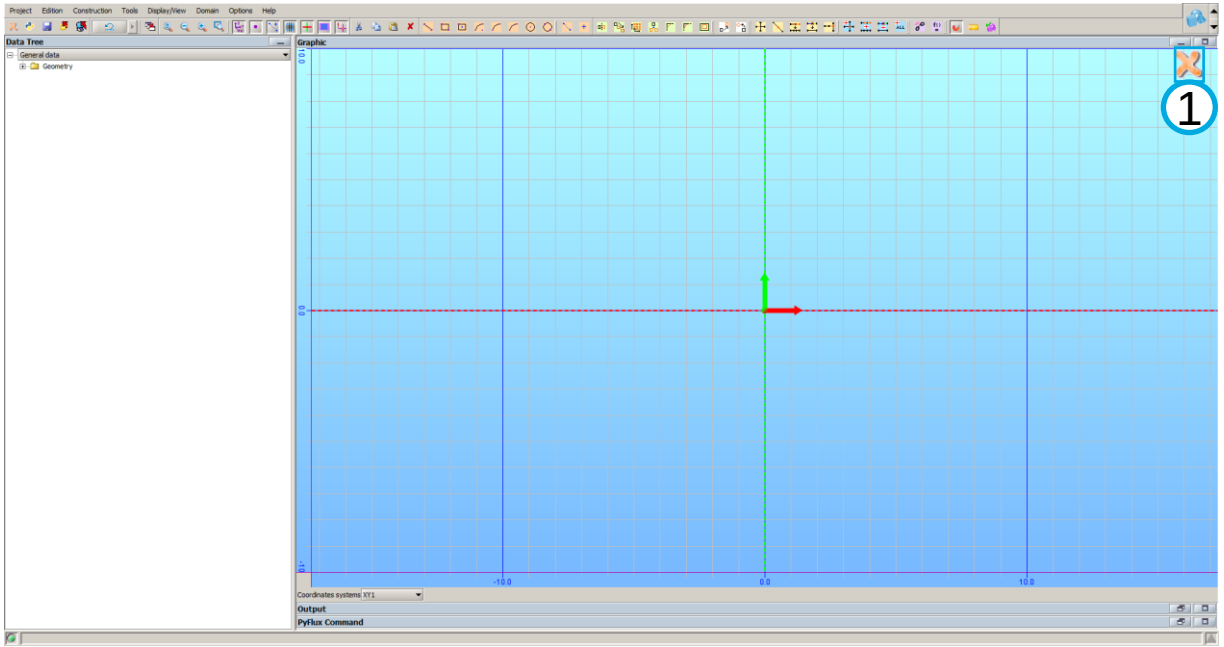
GEOMETRY AND MESH

- Flux 2D project: initiation
  - Close the Sketcher 2D Context

Step	Action
1	Click on the icon to close the Skecher 2D Context



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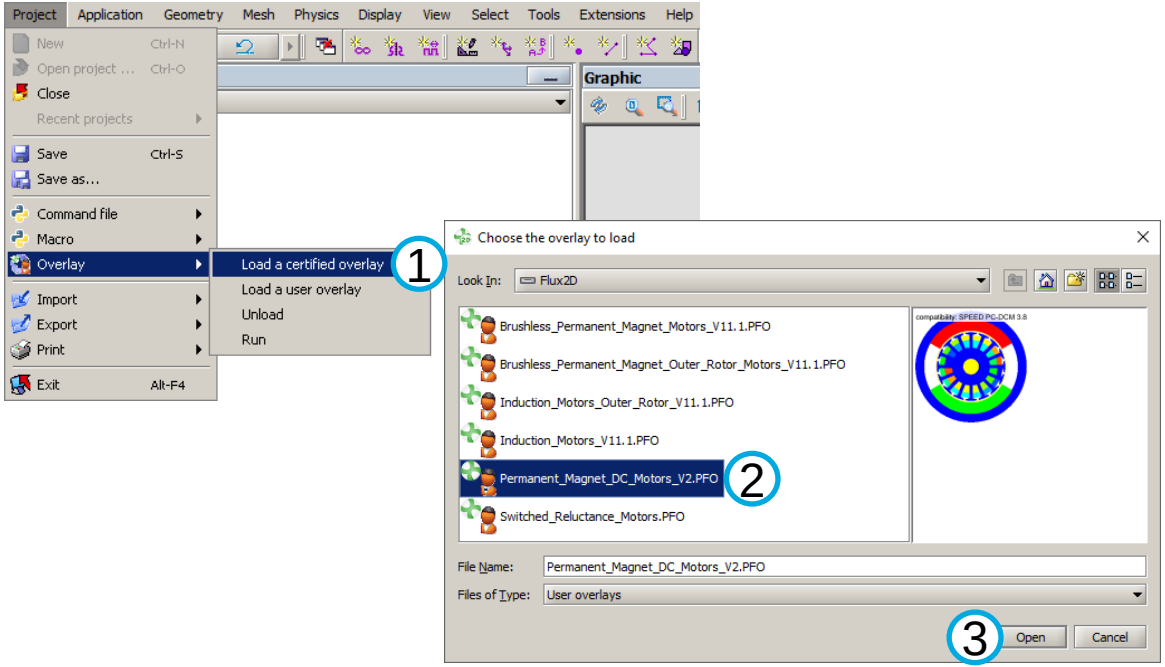
GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Load Overlay

Step	Action
1	Click on [Project] – [Overlays] – [Load a certified overlay]
2	Select the Overlay “Permanent_MagnetDC_MotorV2.PFO” in the folder “Flux2D”
3	Click on [Open]



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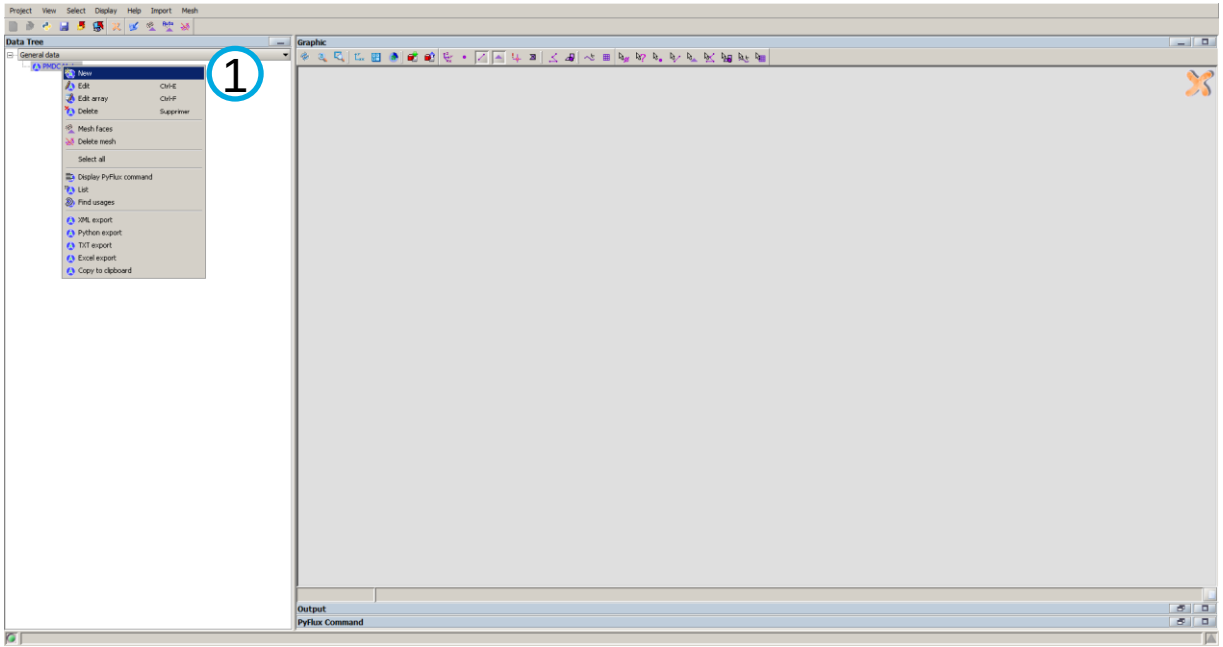
GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Run Overlay

Step	Action
1	Right click on the loaded overlay and click on [New]



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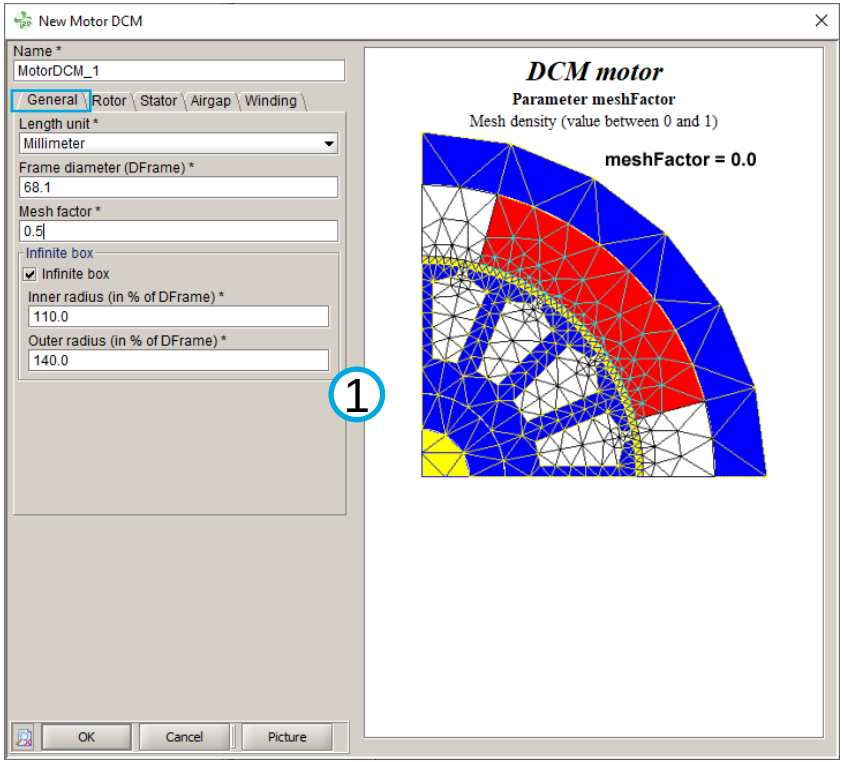
GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Run Overlay

Step	Action
1	Set values for the motor parameters

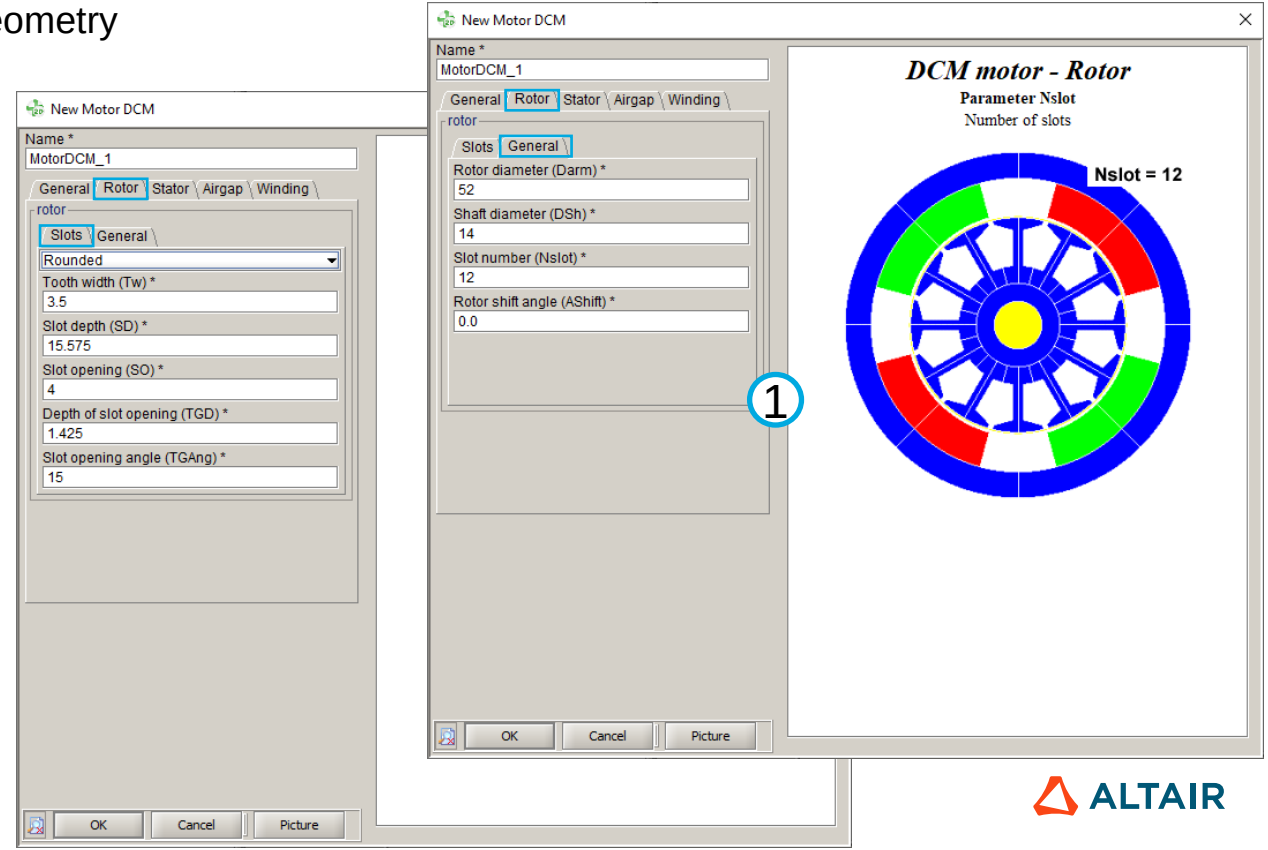


ALTAIR

GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Run Overlay

Step	Action
1	Set values for the motor parameters

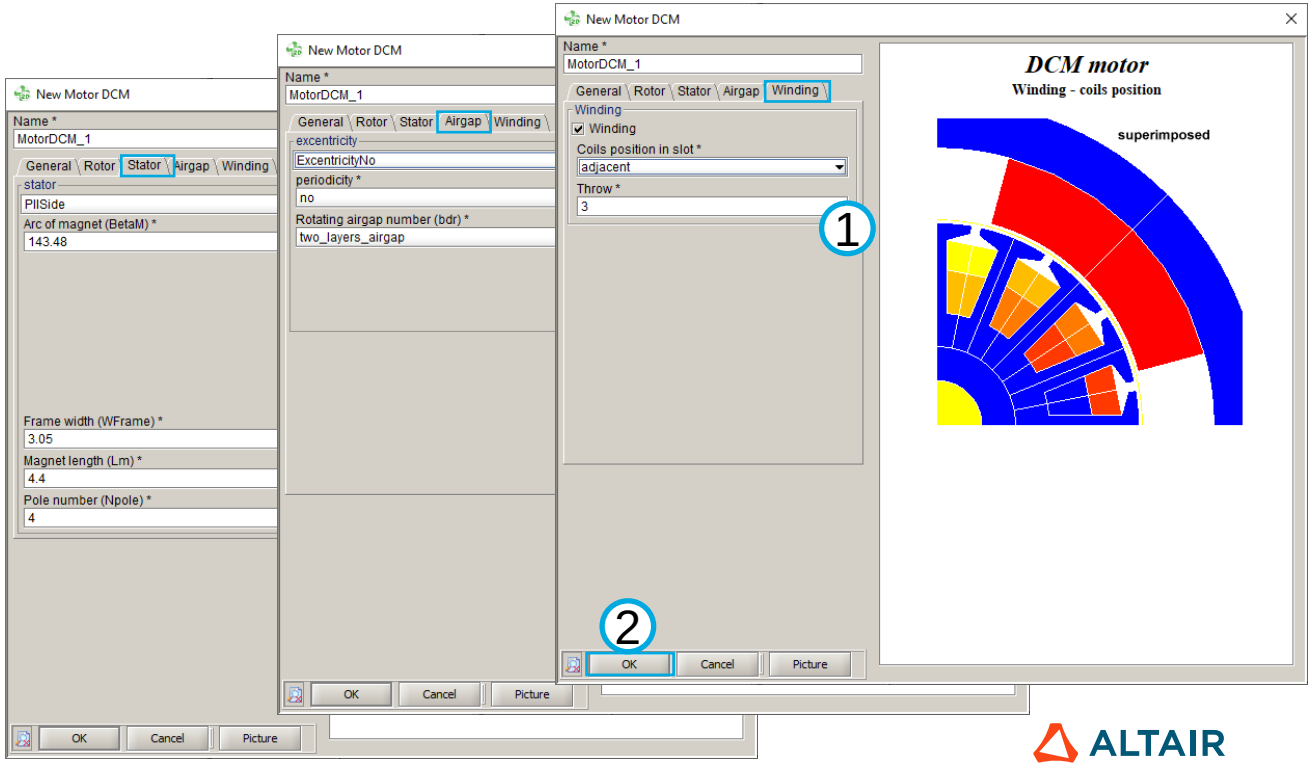


ALTAIR

GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Run Overlay

Step	Action
1	Set values for the motor parameters
2	Click on [OK]



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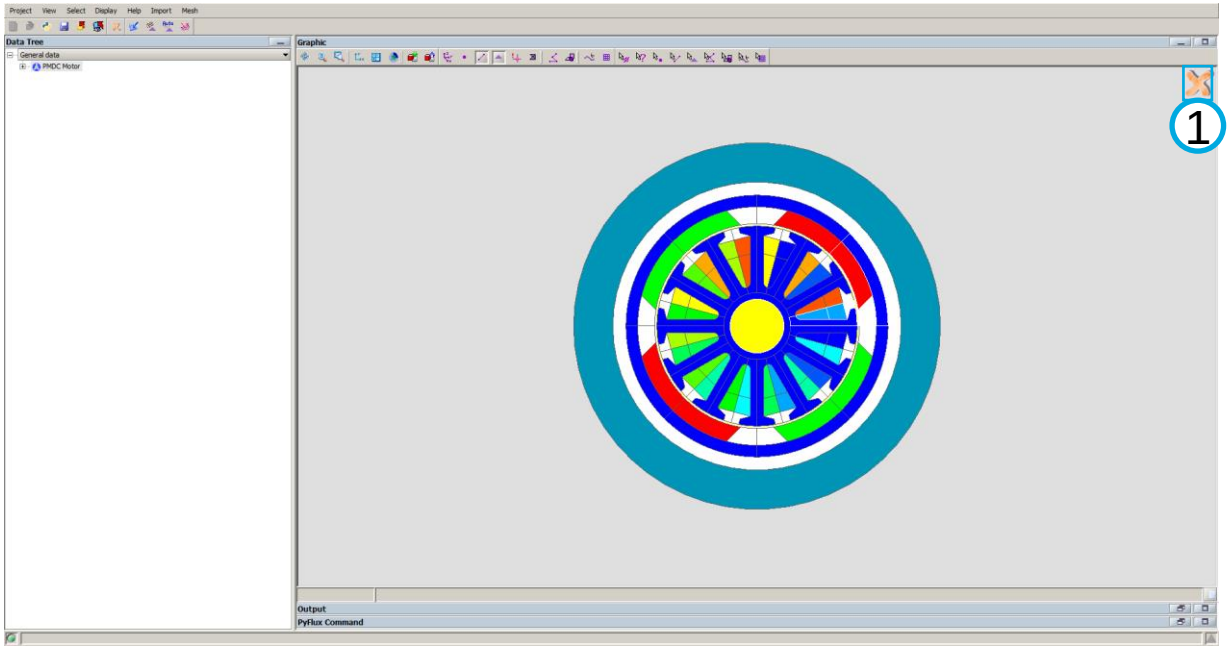
GEOMETRY AND MESH

- Flux 2D project: create geometry
  - Run Overlay

Step	Action
1	Click on the icon to close the Overlay Context



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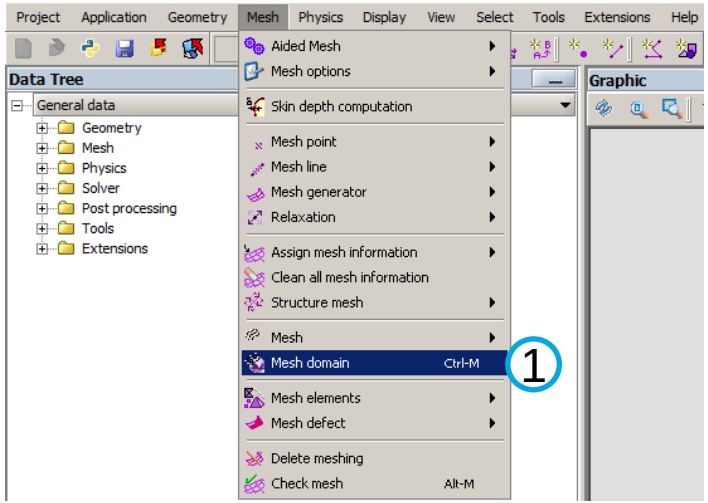
GEOMETRY AND MESH

- Flux 2D project: create mesh
  - Mesh domain

Step	Action
1	Click on [Mesh] – [Mesh domain]




```
Surface elements :
   Number of elements not evaluated     : 0  %
   Number of excellent quality elements : 97  %
   Number of good quality elements      : 3  %
   Number of average quality elements   : 0  %
   Number of poor quality elements      : 0  %
   meshDomain executed
```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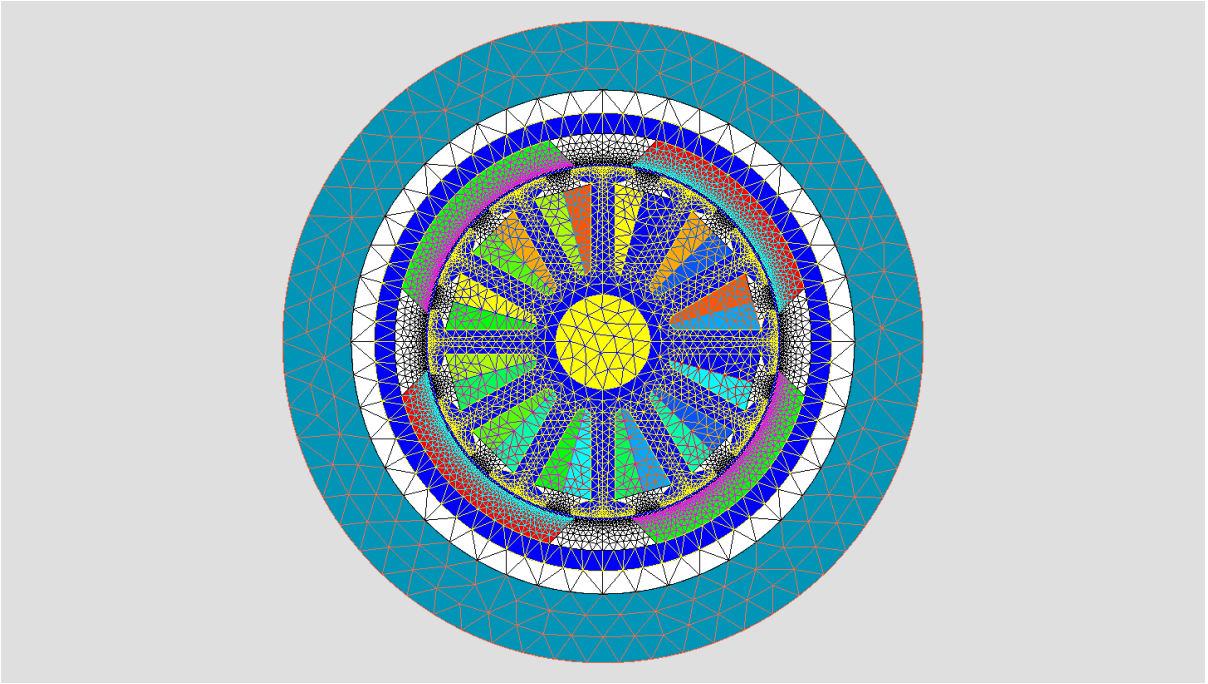
GEOMETRY AND MESH

- Flux 2D project: create mesh
  - Mesh domain



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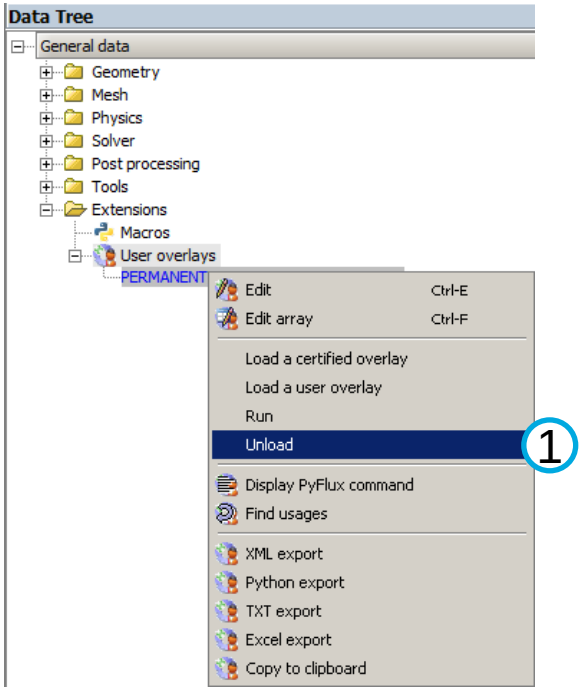
GEOMETRY AND MESH

- Flux 2D project: complete geometry and mesh
  - Unload Overlay

Step	Action
1	Right click on the Data Tree [Extensions] – [User overlays] – [PERMANENT_MAGNET_DC_MOTORS_V2], and click on [Unload]

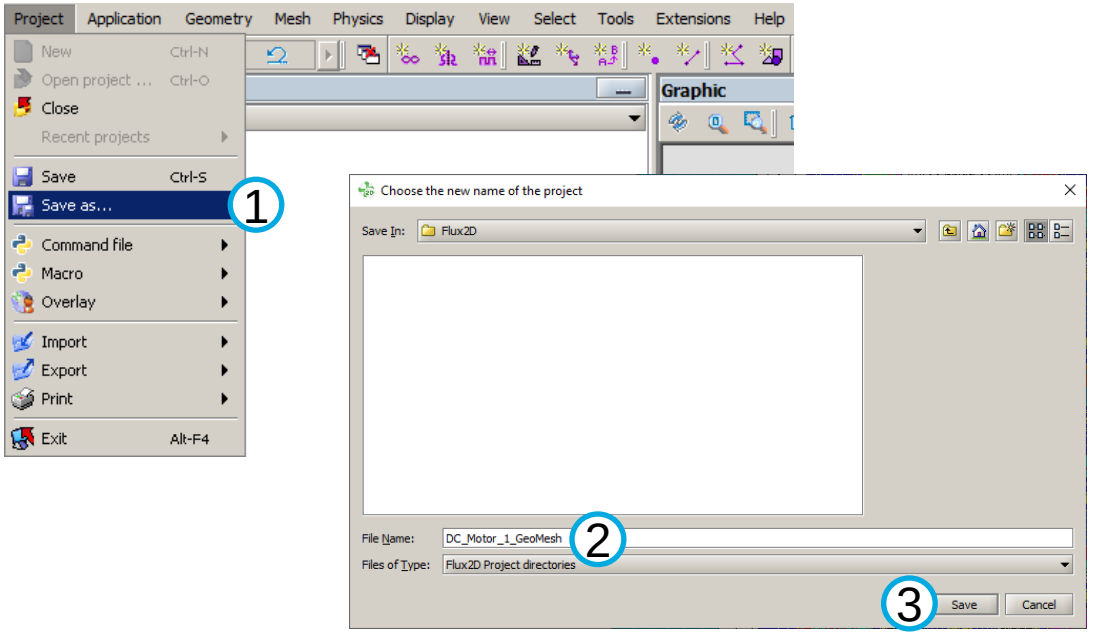


ALTAIR

GEOMETRY AND MESH

- Flux 2D project: complete geometry and mesh
  - Save project

Step	Action
1	Click on [Project] – [Save as]
2	Define the project name “DC_Motor_1_GeoMesh”
3	Click on [Save]



ALTAIR

II. BRUSH ANGLE ANALYSIS

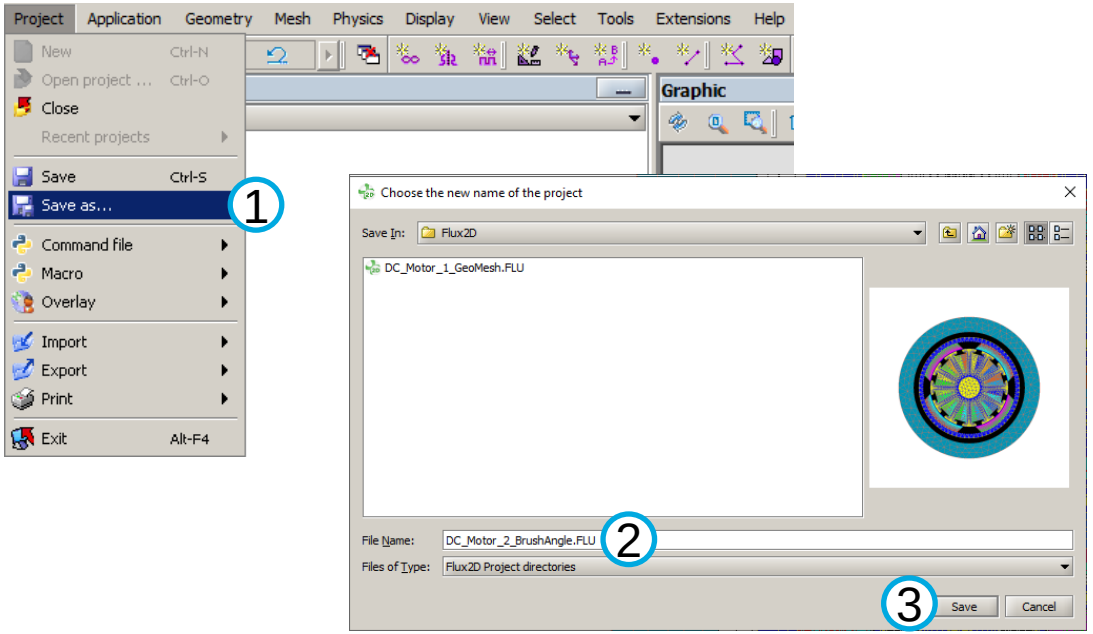
BRUSH ANGLE ANALYSIS

- Why brush angle determination?
- One difficulty with collector is the way to set the brush angles
  - We propose to run a specific computation at constant speed (close to the working speed)
  - With no stator, and no magnet (they are defined as air or vacuum region)
  - With a specific variable for initial brush angle
  - The goal is to display the animation of flux density line and to check where they are compared to the stator flux density
  - According to theory, the rotor flux density should be in quadrature with stator flux density in order to get the maximum torque available

BRUSH ANGLE ANALYSIS

- Flux 2D project: initiation
  - Save project

Step	Action
1	Click on [Project] – [Save as]
2	Define the project name “DC_Motor_2_BrushAngle”
3	Click on [Save]



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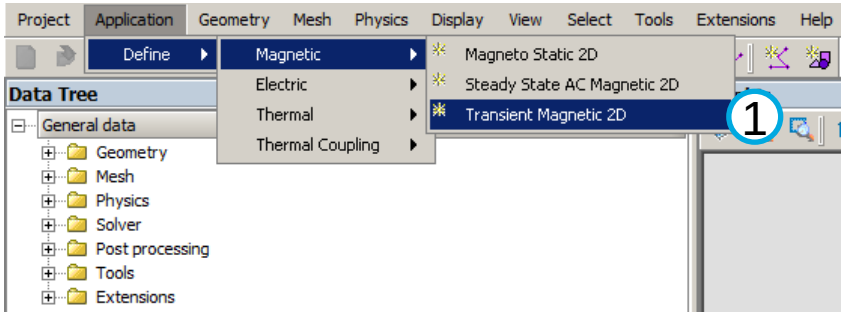
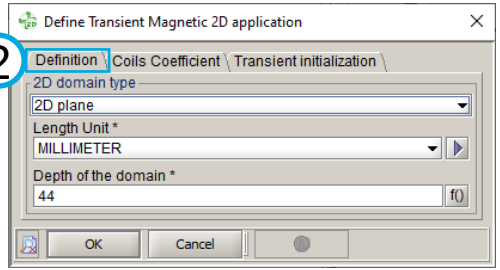
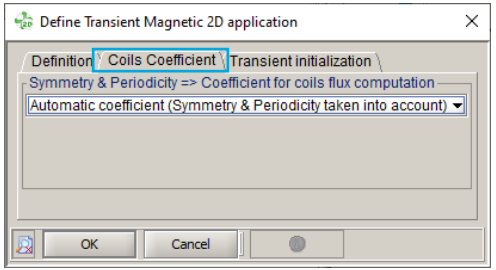
BRUSH ANGLE ANALYSIS

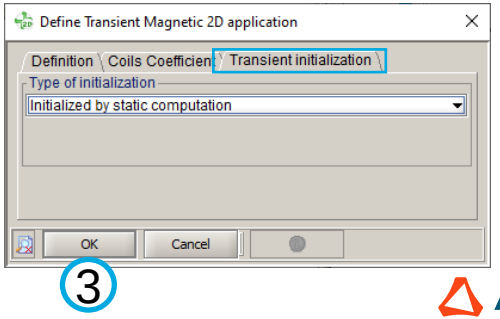
- Flux 2D project: define physics
  - Define physics application

Step	Action
1	Click on [Application] – [Define] – [Magnetic] – [Transient Magnetic 2D]
2	Define the physics parameter setting
3	Click on [OK]









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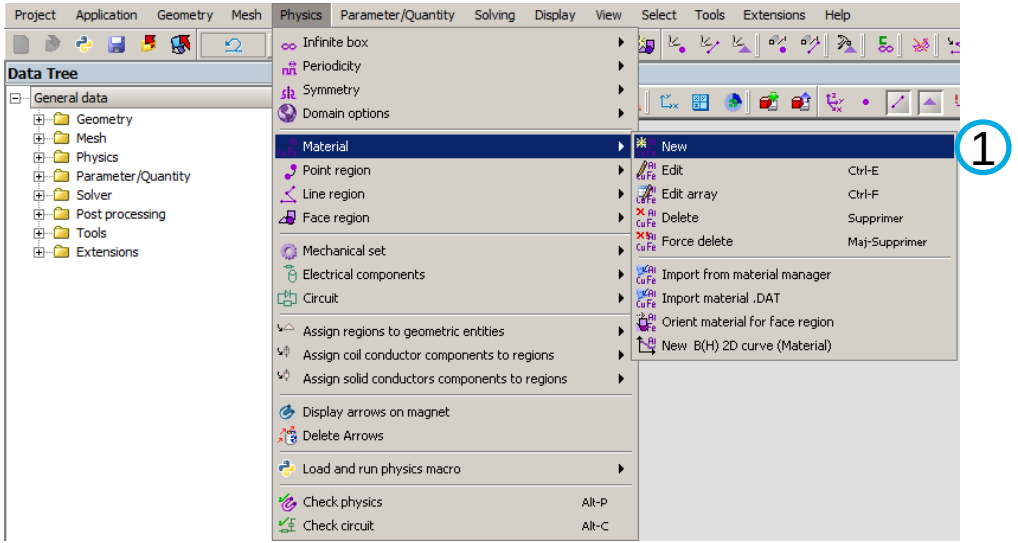
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Create materials

Step	Action
1	Click on [Physics] – [Material] – [New]

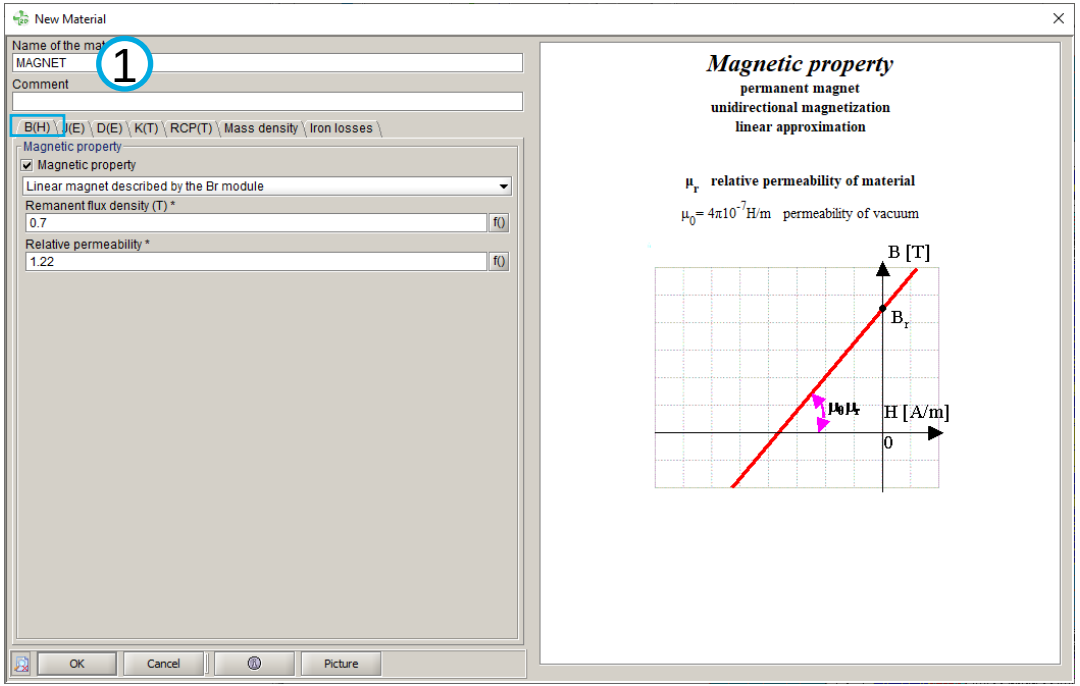


ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Create material: MAGNET

Step	Action
1	Create the material “MAGNET”

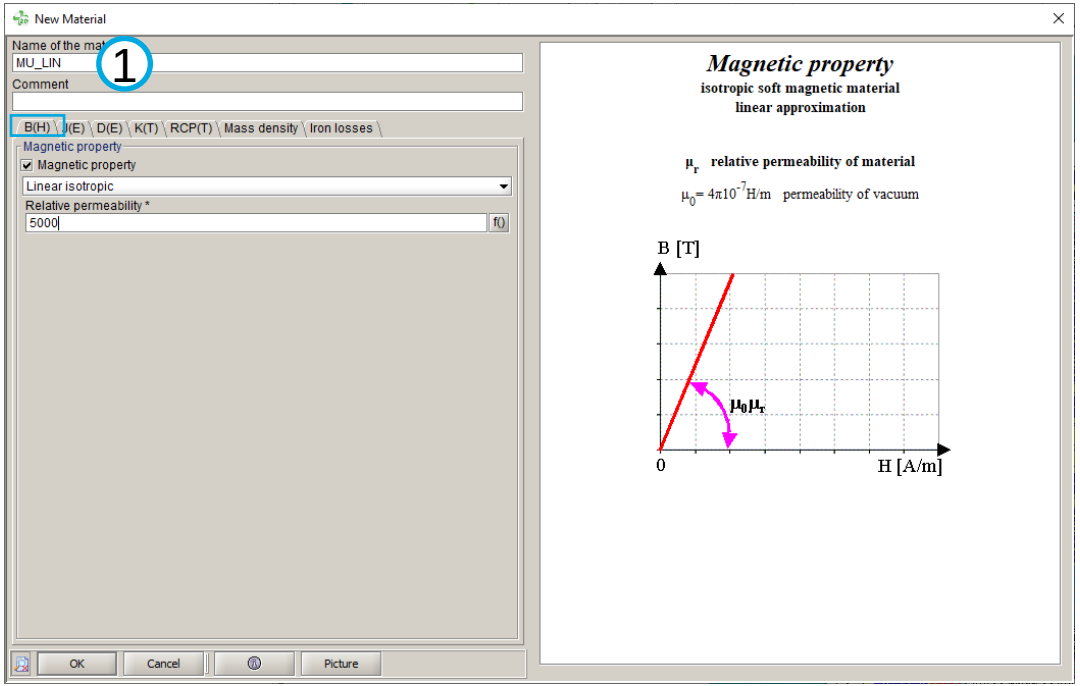


ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Create material: MU_LIN

Step	Action
1	Create the material “MU_LIN”



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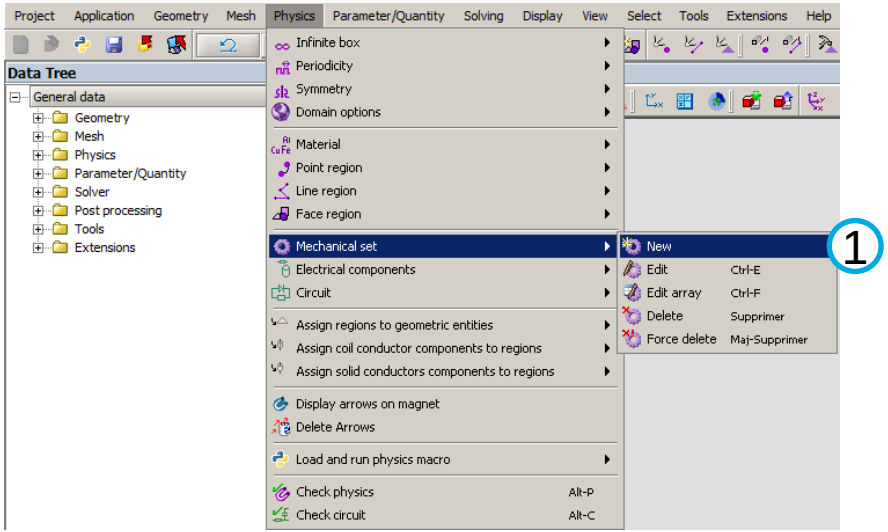
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Create mechanical sets

Step	Action
1	Click on [Physics] – [Material] – [New]



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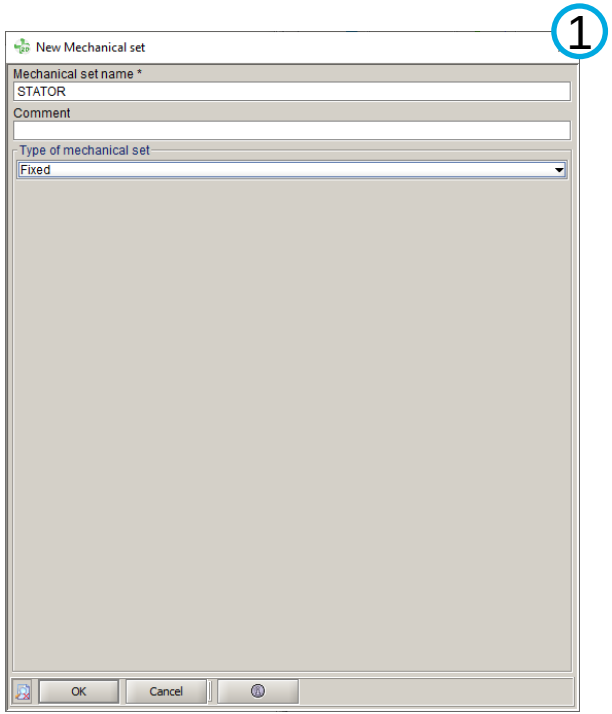
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Mechanical set: STATOR

Step	Action
1	Create the mechanical set STATOR



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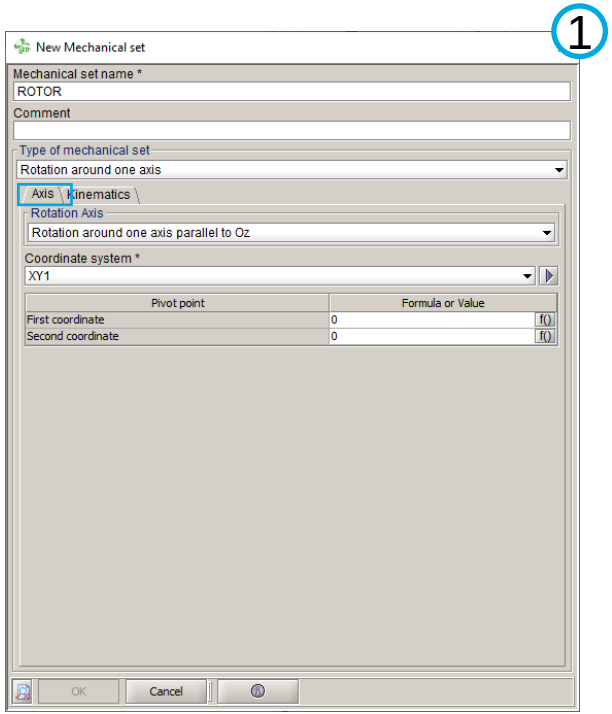
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Mechanical set: ROTOR

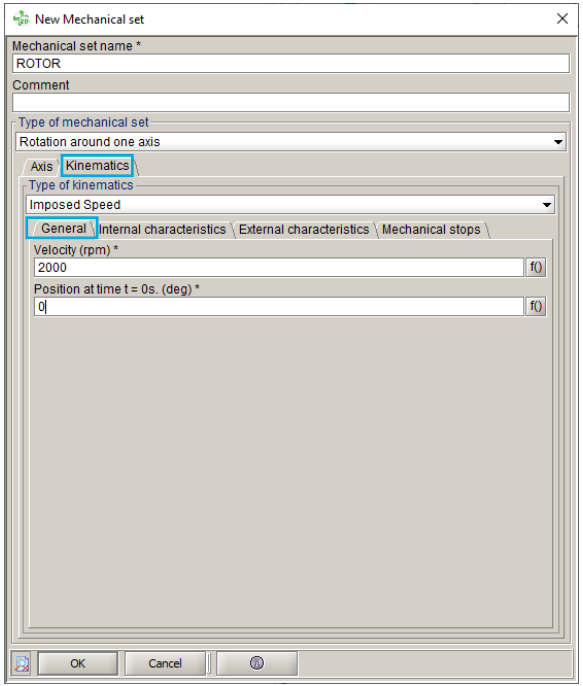
Step	Action
1	Create the mechanical set ROTOR

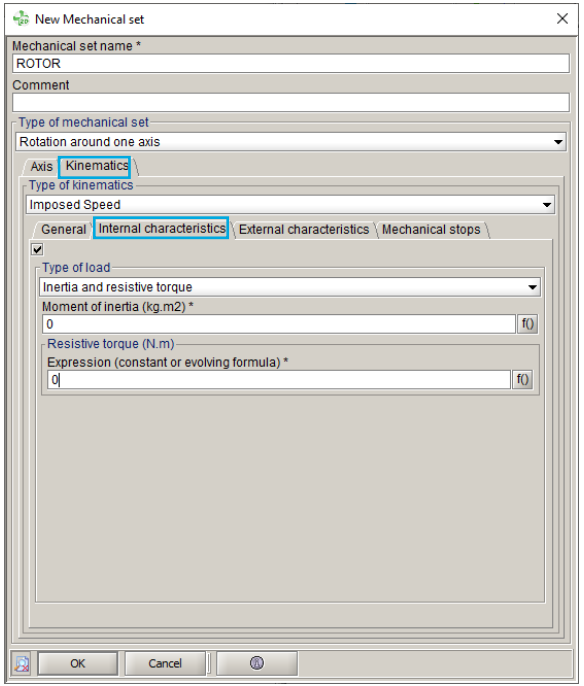


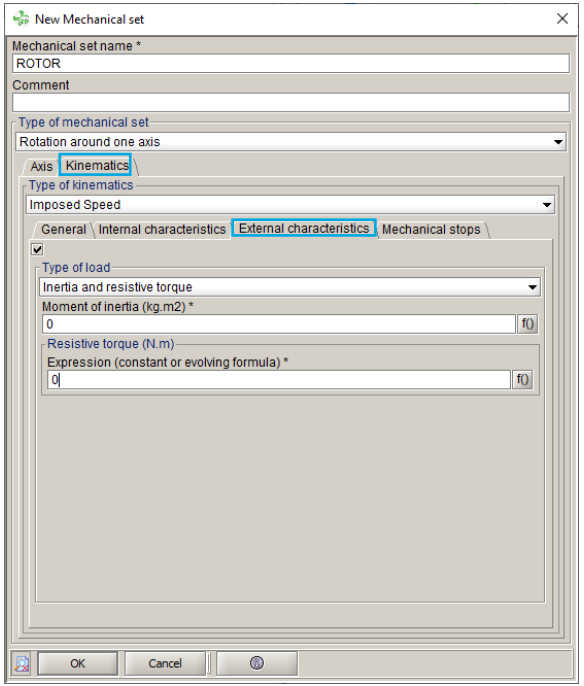
ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Mechanical set: ROTOR







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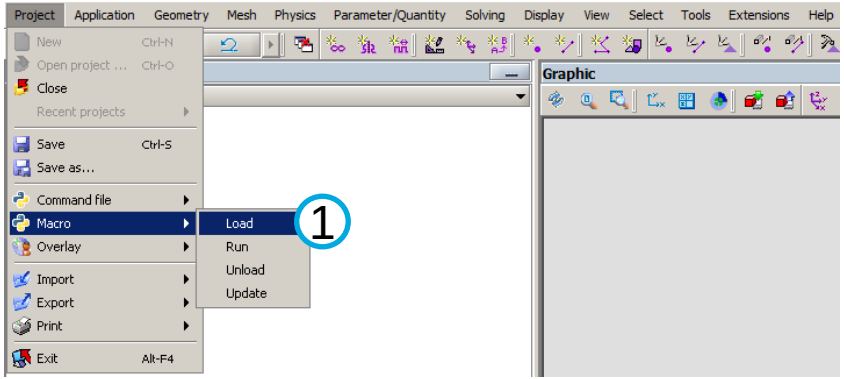
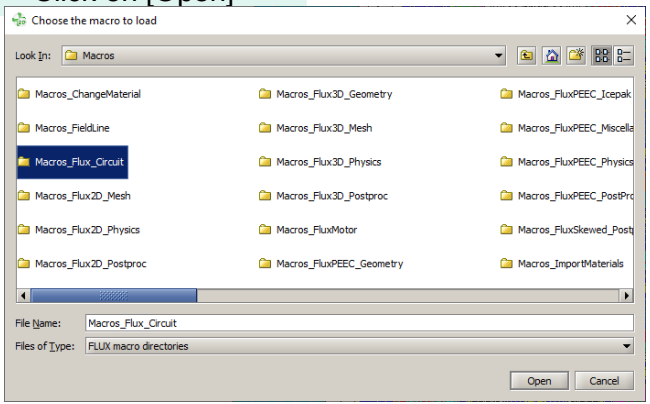
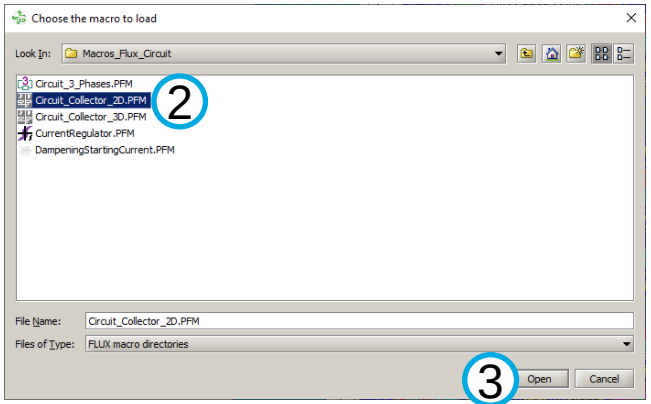
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Load Macro

Step	Action
1	Click on [Project] – [Macro] – [Load]
2	Select the macro “Circuit_Collector_2D.PFM” in the folder “Macros_Flux_Circuit”
3	Click on [Open]







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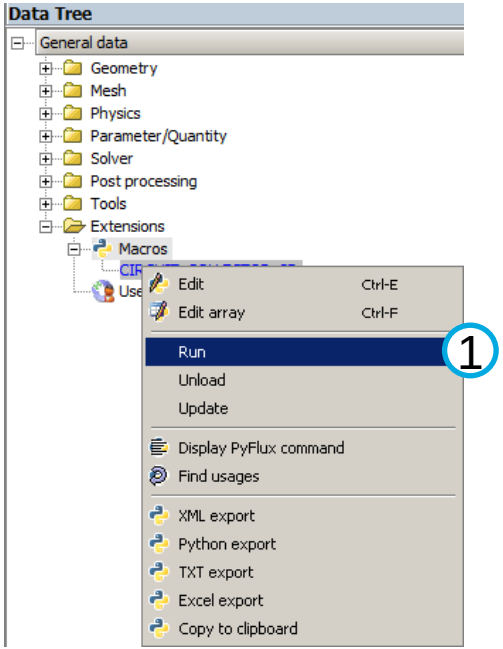
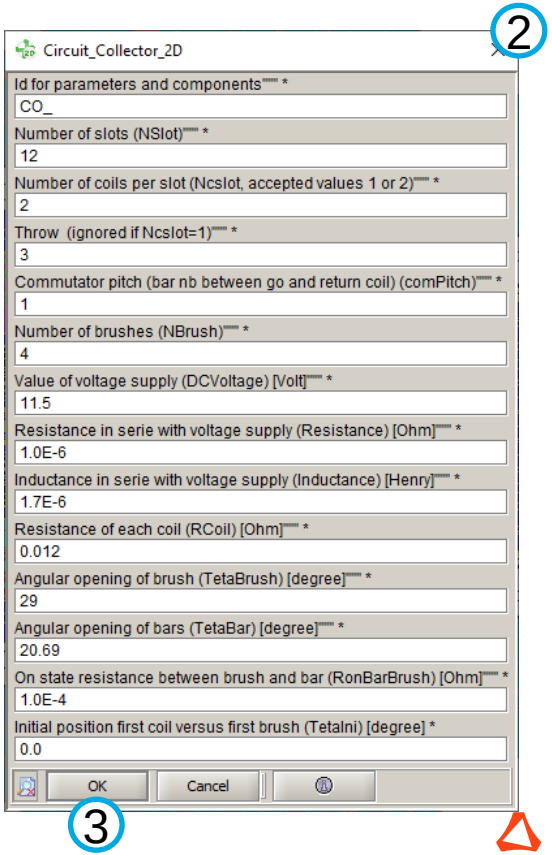
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Run Macro

Step	Action
1	Right click on the Data Tree [Extensions] – [Macros] – [CIRCUIT_COLLECTOR_2D], click on [Run]
2	Set the macro parameters
3	Click on [OK]





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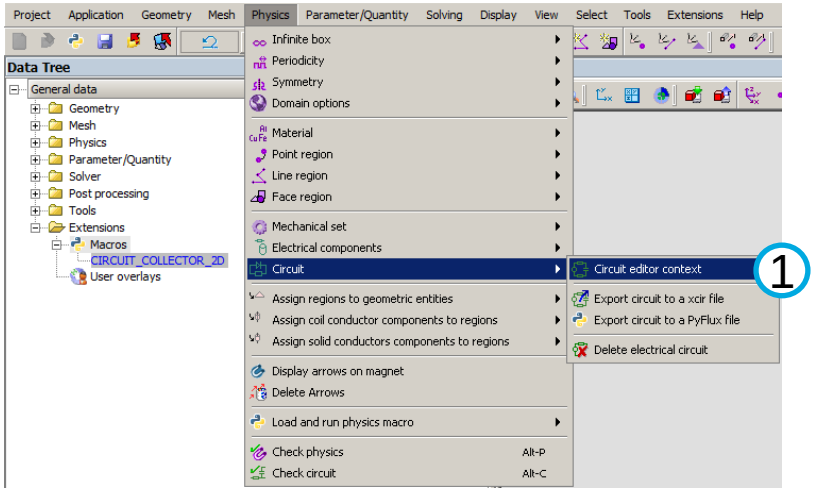
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Verify circuit

Step	Action
1	Click on [Physics] – [Circuit] – [Circuit editor context]

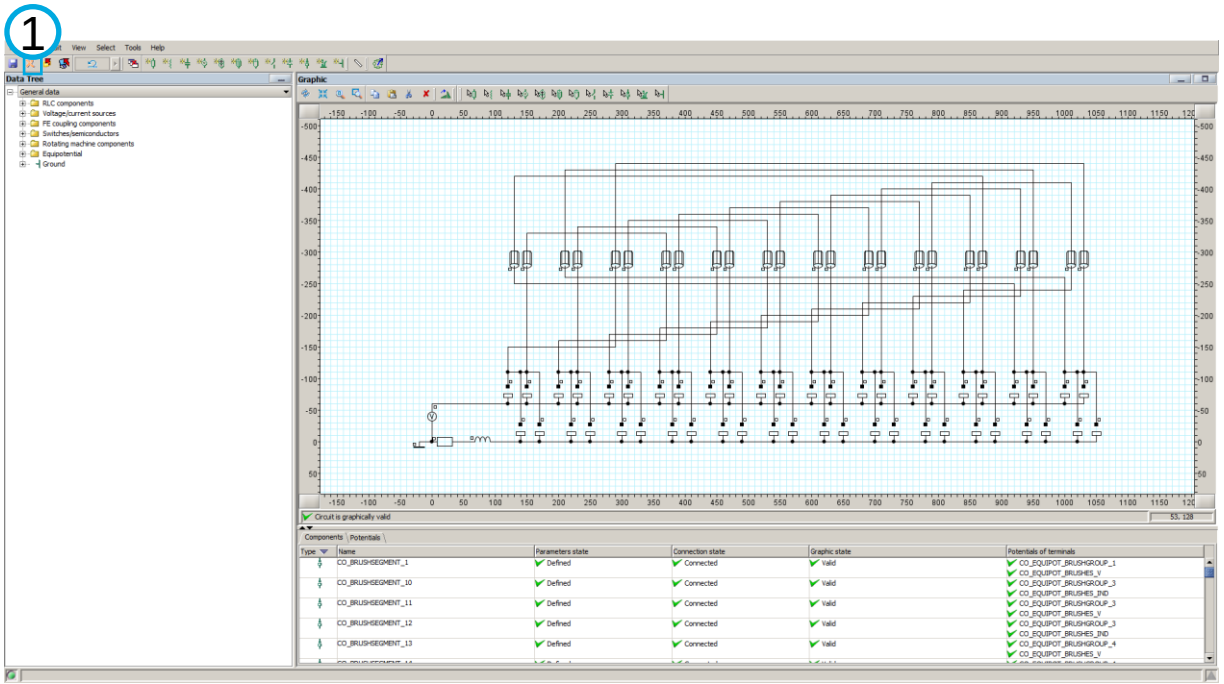


ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Verify circuit

Step	Action
1	Click on the icon to close the circuit editor context



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BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition

Step	Action
1	Modify the following face regions - Magnets - Rotor / Stator

Edit Face region[MAGNET_1,MAGNET_2,MAGNET_3,MAGNET_4]

Entities	Modify all	MAGNET_1	MAGNET_2	MAGNET_3	MAGNET_4
Face region					
Name *		MAGNET_1	MAGNET_2	MAGNET_3	MAGNET_4
Comment	Initial values	MAGNET POLE1	MAGNET POLE2	MAGNET POLE3	MAGNET POLE4
Transientmagnet *					
Sub types	Initial values	Air or vacuum r...	Air or vacuum r...	Air or vacuum r...	Air or vacuum r...
Air or vacuum region		Air or vacuum r...	Air or vacuum r...	Air or vacuum r...	Air or vacuum r...
Color	Initial values	Red	Green	Red	Green
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	STATOR	STATOR	STATOR	STATOR	STATOR

OK Apply Cancel

Edit Face region[ROTOR,SHAFT,STATOR]

Entities	Modify all	ROTOR	SHAFT	STATOR
Face region				
Name *		ROTOR	SHAFT	STATOR
Comment	Initial values	ROTOR	SHAFT	STATOR
Transientmagnet *				
Sub types	Initial values	Magnetic non conducti...	Magnetic non conducti...	Air or vacuum region
Air or vacuum region				Air or vacuum region
Magnetic non conducting region		Magnetic non conducti...	Magnetic non conducti...	
Material *	Initial values	MU_LIN	MU_LIN	
Color	Initial values	Blue	Yellow	Blue
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE
Mechanical set	Initial values	ROTOR	ROTOR	STATOR

OK Apply Cancel

ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition: Air

Step	Action
1	Modify the following face regions

Edit Face region[INFINITE,ROTATING_AIRGAP,ROTOR_AIR,STATOR_AIR,WEDGE]

Entities	Modify all	INFINITE	ROTATING_AIRGAP	ROTOR_AIR	STATOR_AIR	WEDGE
Face region						
Name *		INFINITE	ROTATING_AIRGAP	ROTOR_AIR	STATOR_AIR	WEDGE
Comment	Initial values	Infinite region	ROTATING AIRGAP	ROTOR_AIR	STATOR_AIR	WEDGE
Transientmagnet *						
Sub types		Air or vacuum region	Air or vacuum region	Inactive region	Air or vacuum region	Air or vacuum region
Air or vacuum region		Air or vacuum region	Air or vacuum region		Air or vacuum region	Air or vacuum region
Inactive region				Inactive region		
Color	Initial values	Turquoise	Yellow	White	White	White
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set		STATOR	ROTOR		STATOR	ROTOR

OK Apply Cancel

ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition: Phase

Step	Action
1	Modify the following face regions

Edit Face region[PHASE_NEG_1,PHASE_NEG_2,PHASE_NEG_3,PHASE_NEG_4,PHASE_NEG_5,PHASE_NEG_6]

Entities	Modify all	PHASE_NEG_1	PHASE_NEG_2	PHASE_NEG_3	PHASE_NEG_4	PHASE_NEG_5	PHASE_NEG_6
Face region							
Name *		PHASE_NEG_1	PHASE_NEG_2	PHASE_NEG_3	PHASE_NEG_4	PHASE_NEG_5	PHASE_NEG_6
Comment	Initial values	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG
Transientmagnet *							
Sub types	Initial values	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...
Coil conductor region		Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor re...
conductor *							
Component *	Initial values	CO_COIL_1N	CO_COIL_2N	CO_COIL_3N	CO_COIL_4N	CO_COIL_5N	CO_COIL_6N
Turn number *	Initial values	7	7	7	7	7	7
Series or parallel *							
Sub types	Initial values	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...
All the symmetrical		All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetric...
Compute coil losses	Initial values						
Conductor material *	Initial values	MAGNET	MAGNET	MAGNET	MAGNET	MAGNET	MAGNET
Sub types	Initial values						
Sub types	Initial values	Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...
Positive orientation for		Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...	Positive orientati...
Color	Initial values	COIL_NEG_1	COIL_NEG_2	COIL_NEG_3	COIL_NEG_4	COIL_NEG_5	COIL_NEG_6
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	Initial values	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR

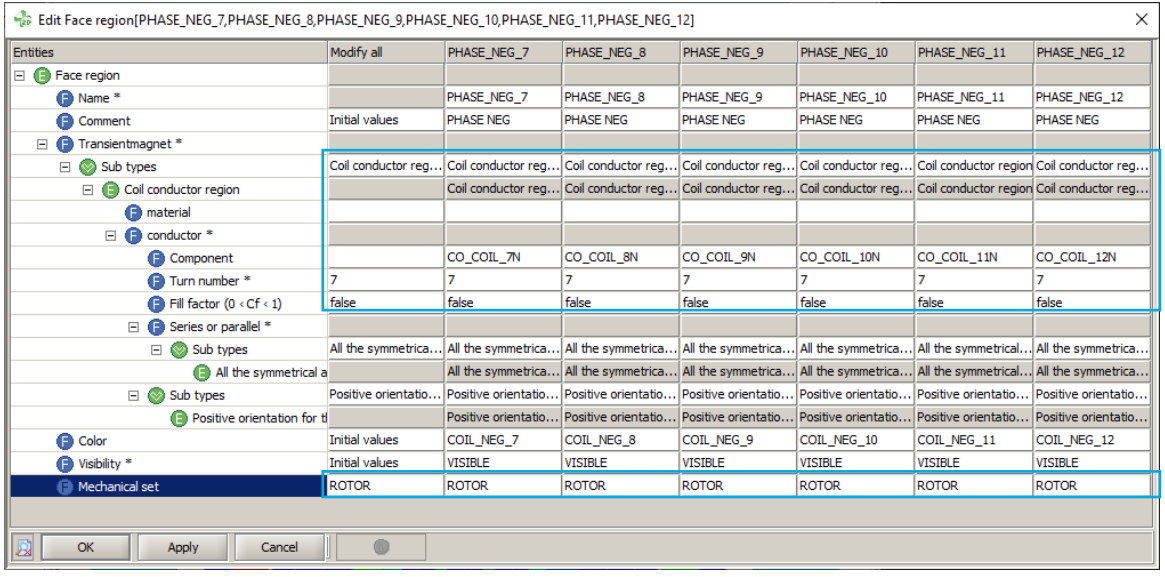
OK Apply Cancel

ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition: Phase

Step	Action
1	Modify the following face regions



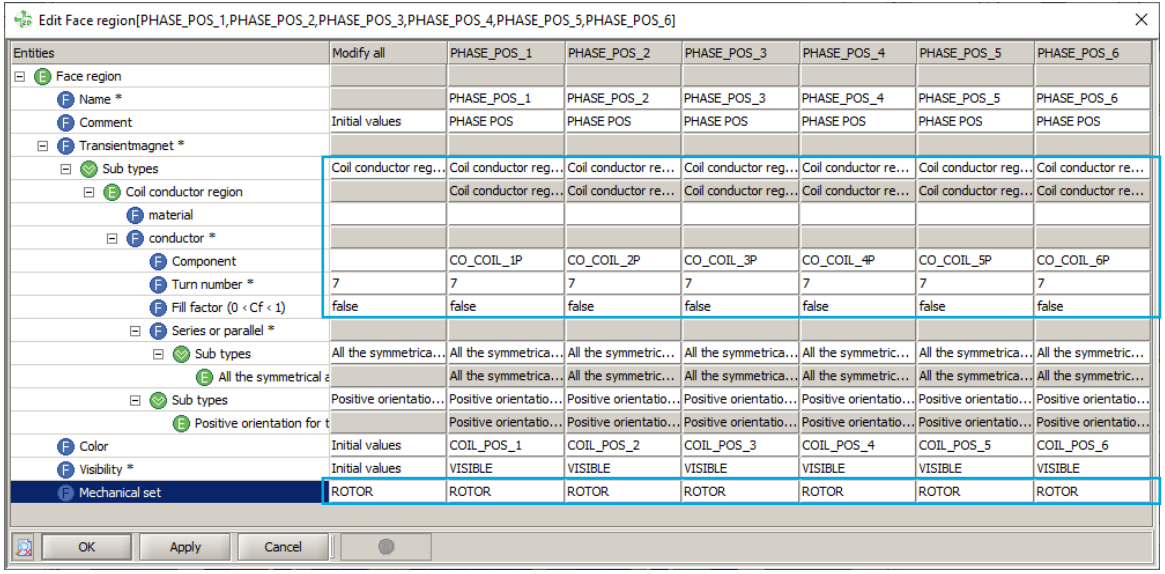
Entities	Modify all	PHASE_NEG_7	PHASE_NEG_8	PHASE_NEG_9	PHASE_NEG_10	PHASE_NEG_11	PHASE_NEG_12
Face region							
Name *		PHASE_NEG_7	PHASE_NEG_8	PHASE_NEG_9	PHASE_NEG_10	PHASE_NEG_11	PHASE_NEG_12
Comment	Initial values	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG	PHASE NEG
Transientmagnet *							
Sub types	Coil conductor reg...	Coil conductor reg...	Coil conductor reg...	Coil conductor reg...	Coil conductor reg...	Coil conductor region	Coil conductor reg...
Coil conductor region		Coil conductor reg...	Coil conductor reg...	Coil conductor reg...	Coil conductor reg...	Coil conductor region	Coil conductor reg...
material							
conductor *							
Component		CO_COIL_7N	CO_COIL_8N	CO_COIL_9N	CO_COIL_10N	CO_COIL_11N	CO_COIL_12N
Turn number *	7	7	7	7	7	7	7
Fill factor (0 < Cf < 1)	false	false	false	false	false	false	false
Series or parallel *							
Sub types	All the symmetrica...	All the symmetrica...	All the symmetrica...	All the symmetrica...	All the symmetrica...	All the symmetrical...	All the symmetrica...
All the symmetrical a		All the symmetrica...	All the symmetrica...	All the symmetrica...	All the symmetrica...	All the symmetrical...	All the symmetrica...
Sub types	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Positive orientation for t		Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Color	Initial values	COIL_NEG_7	COIL_NEG_8	COIL_NEG_9	COIL_NEG_10	COIL_NEG_11	COIL_NEG_12
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR

ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition: Phase

Step	Action
1	Modify the following face regions



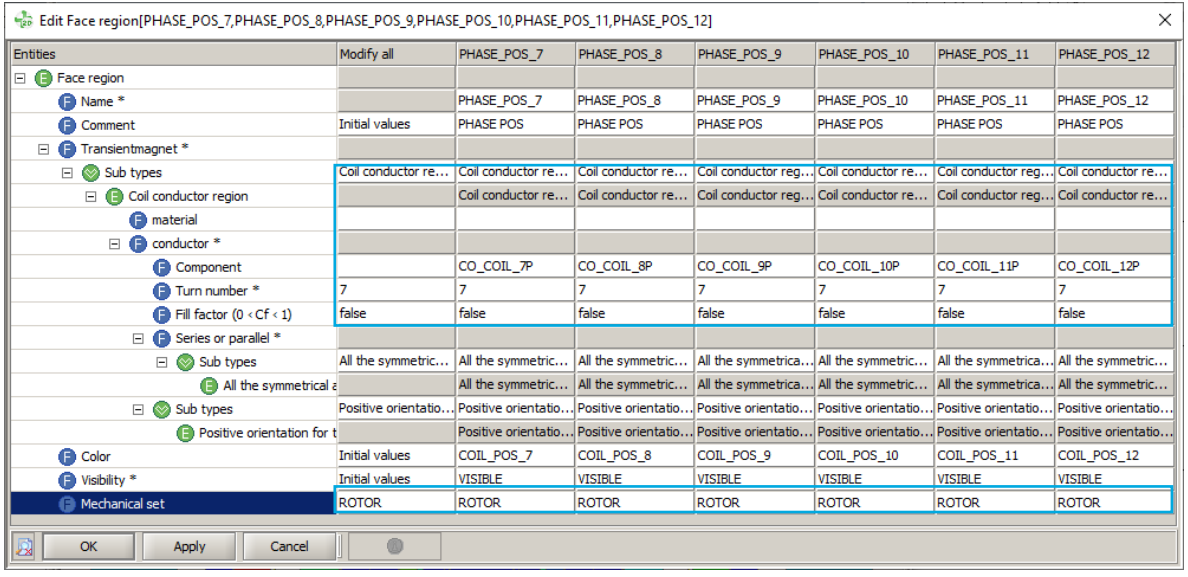
Entities	Modify all	PHASE_POS_1	PHASE_POS_2	PHASE_POS_3	PHASE_POS_4	PHASE_POS_5	PHASE_POS_6
Face region							
Name *		PHASE_POS_1	PHASE_POS_2	PHASE_POS_3	PHASE_POS_4	PHASE_POS_5	PHASE_POS_6
Comment	Initial values	PHASE POS	PHASE POS	PHASE POS	PHASE POS	PHASE POS	PHASE POS
Transientmagnet *							
Sub types	Coil conductor reg...	Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...
Coil conductor region		Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...
material							
conductor *							
Component		CO_COIL_1P	CO_COIL_2P	CO_COIL_3P	CO_COIL_4P	CO_COIL_5P	CO_COIL_6P
Turn number *	7	7	7	7	7	7	7
Fill factor (0 < Cf < 1)	false	false	false	false	false	false	false
Series or parallel *							
Sub types	All the symmetrica...	All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...
All the symmetrical a		All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...
Sub types	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Positive orientation for t		Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Color	Initial values	COIL_POS_1	COIL_POS_2	COIL_POS_3	COIL_POS_4	COIL_POS_5	COIL_POS_6
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR

ALTAIR

BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Face region definition: Phase

Step	Action
1	Modify the following face regions



Entities	Modify all	PHASE_POS_7	PHASE_POS_8	PHASE_POS_9	PHASE_POS_10	PHASE_POS_11	PHASE_POS_12
Face region							
Name *		PHASE_POS_7	PHASE_POS_8	PHASE_POS_9	PHASE_POS_10	PHASE_POS_11	PHASE_POS_12
Comment	Initial values	PHASE POS	PHASE POS	PHASE POS	PHASE POS	PHASE POS	PHASE POS
Transientmagnet *							
Sub types	Coil conductor re...	Coil conductor re...	Coil conductor re...	Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...
Coil conductor region		Coil conductor re...	Coil conductor re...	Coil conductor reg...	Coil conductor re...	Coil conductor reg...	Coil conductor re...
material							
conductor *							
Component		CO_COIL_7P	CO_COIL_8P	CO_COIL_9P	CO_COIL_10P	CO_COIL_11P	CO_COIL_12P
Turn number *	7	7	7	7	7	7	7
Fill factor (0 < Cf < 1)	false	false	false	false	false	false	false
Series or parallel *							
Sub types	All the symmetric...	All the symmetric...	All the symmetric...	All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...
All the symmetrical a		All the symmetric...	All the symmetric...	All the symmetrica...	All the symmetric...	All the symmetrica...	All the symmetric...
Sub types	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Positive orientation for t		Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...	Positive orientatio...
Color	Initial values	COIL_POS_7	COIL_POS_8	COIL_POS_9	COIL_POS_10	COIL_POS_11	COIL_POS_12
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR	ROTOR

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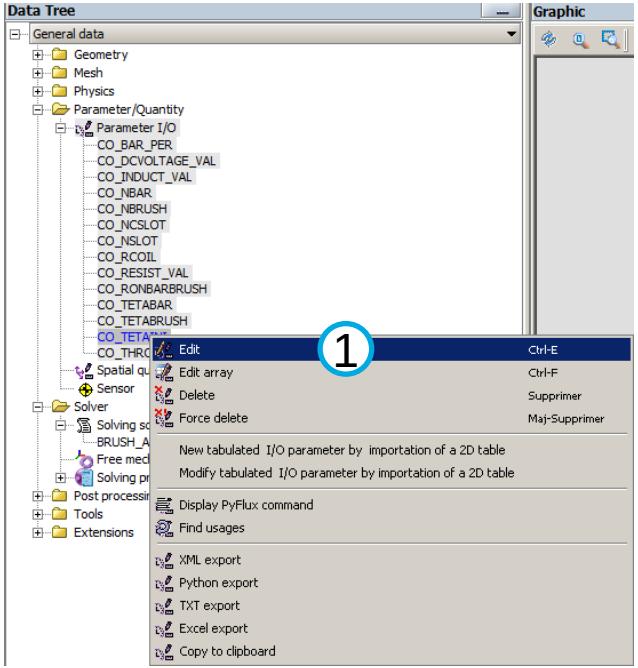
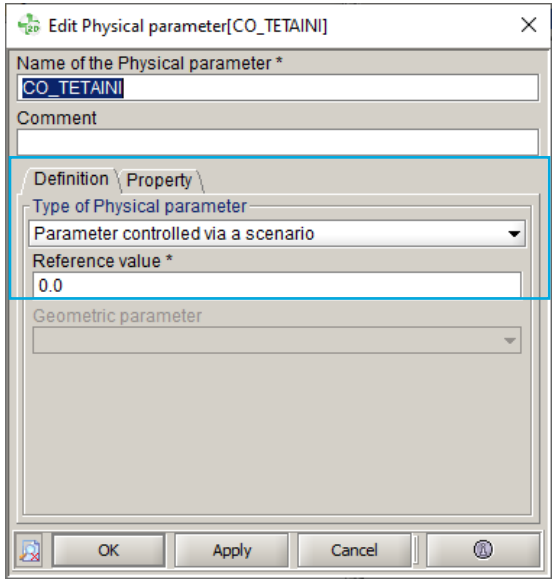
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Modify I/O parameter

Step	Action
1	Right click on the Parameter I/O “CO_TEAINI”, and edit the parameter





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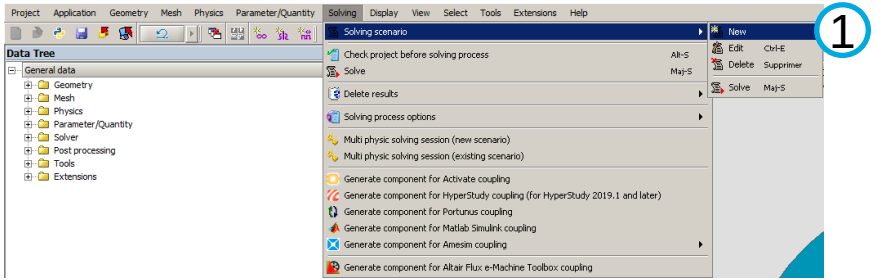
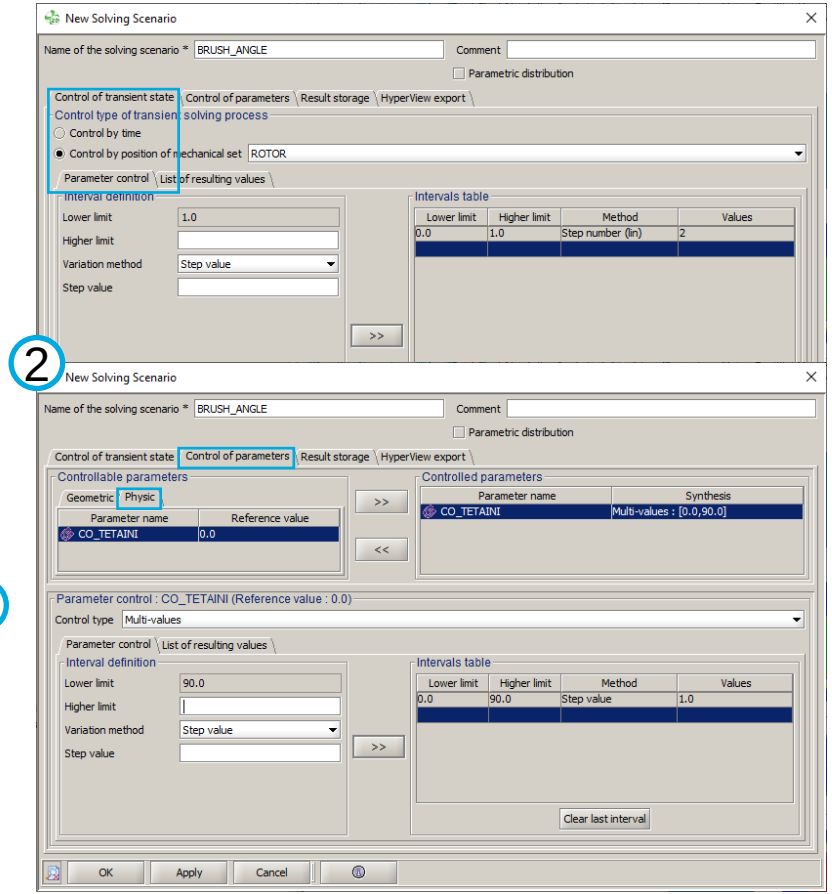
BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Create solving scenario

Step	Action
1	Click on [Solving] – [Solving scenario] – [New]
2	Create the following scenario “BRUSH_ANGLE”

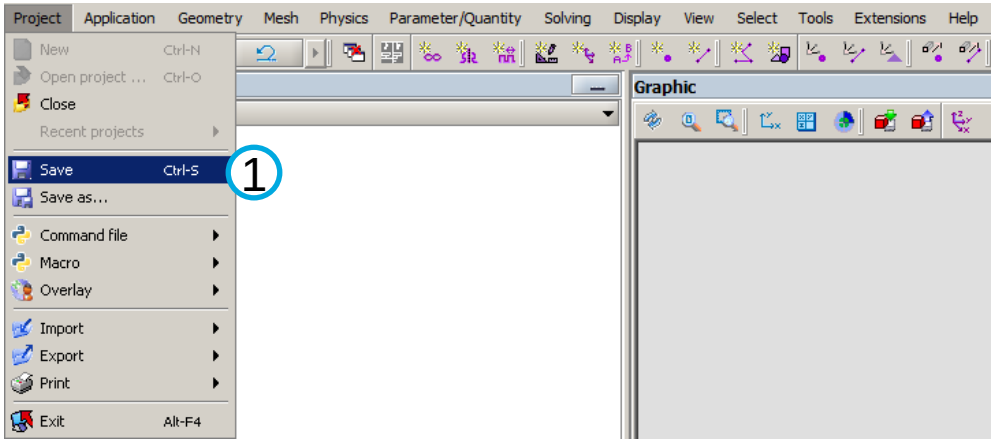




BRUSH ANGLE ANALYSIS

- Flux 2D project: define physics
  - Save project

Step	Action
1	Click on [Project] – [Save]



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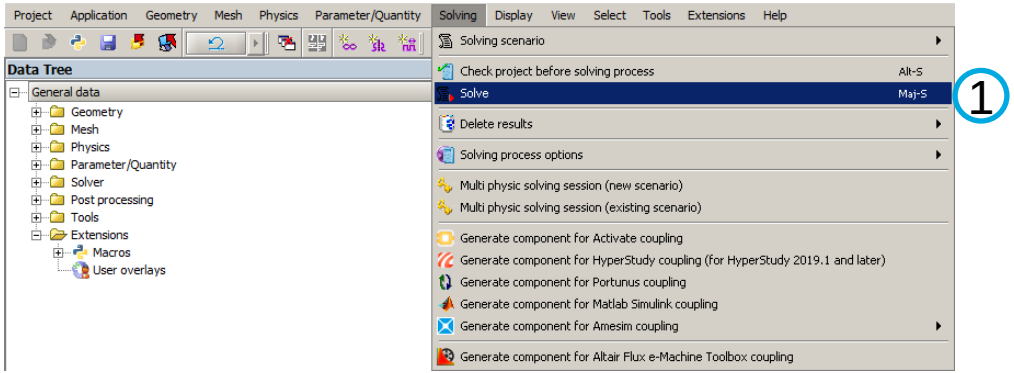
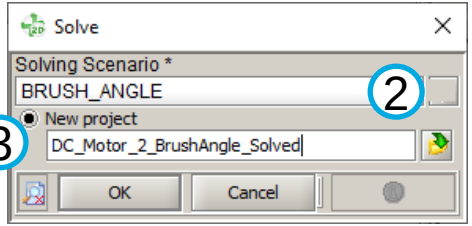
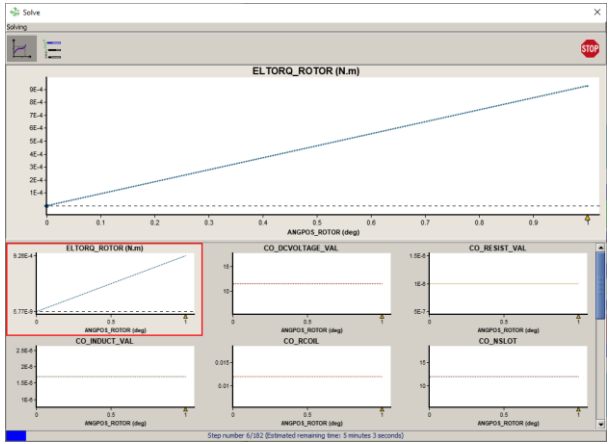
BRUSH ANGLE ANALYSIS

- Flux 2D project: solving
  - Solve scenario

Step	Action
1	Click on [Solving] – [Solve]
2	Select the scenario “BRUSH_ANGLE”
3	Save the solved project as a new project “DC_Motor_2_BrushAngle_Solved”







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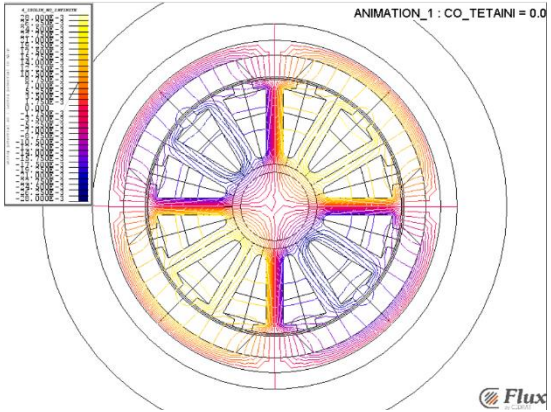
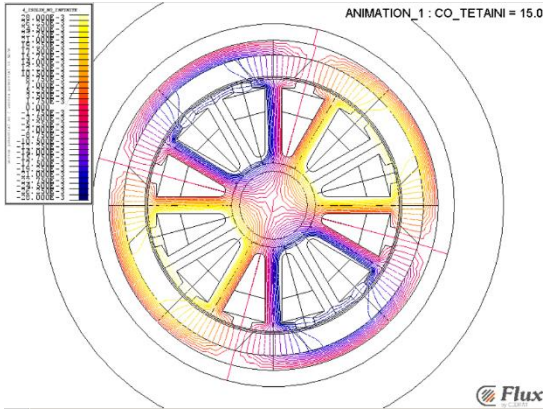
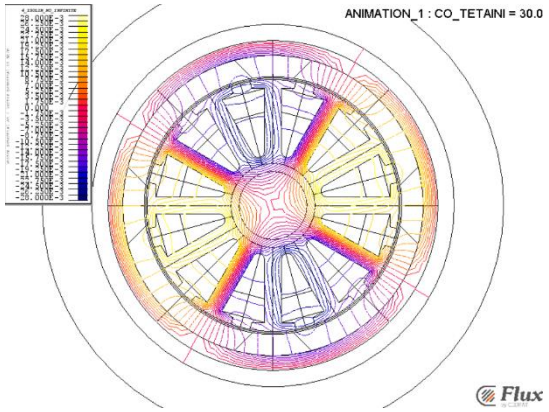
BRUSH ANGLE ANALYSIS

- Display flux lines



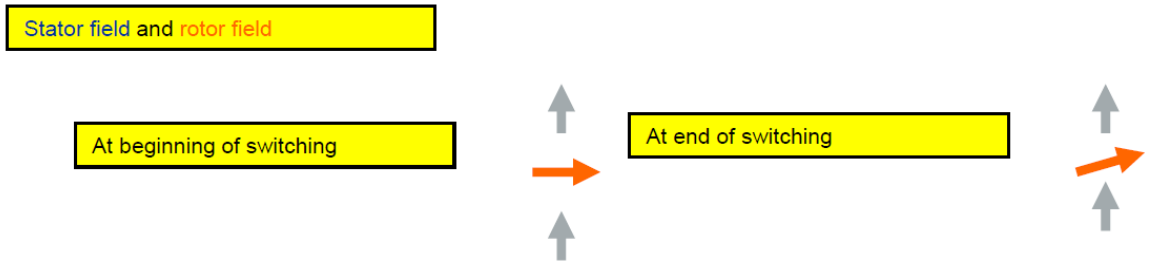




- By modifying the parameter Co_TETAINI, one can rotate the initial flux line distribution
- If Co_TETAINI is set to 0°, then the flux line will be perpendicular to magnets flux lines

BRUSH ANGLE ANALYSIS

- On theoretical point of view , the coils should be fed to create a rotor magnetic field in quadrature with stator field



- The computation with no magnet allows to check that point
- It will lead to a positive torque in that case (for positive speed)

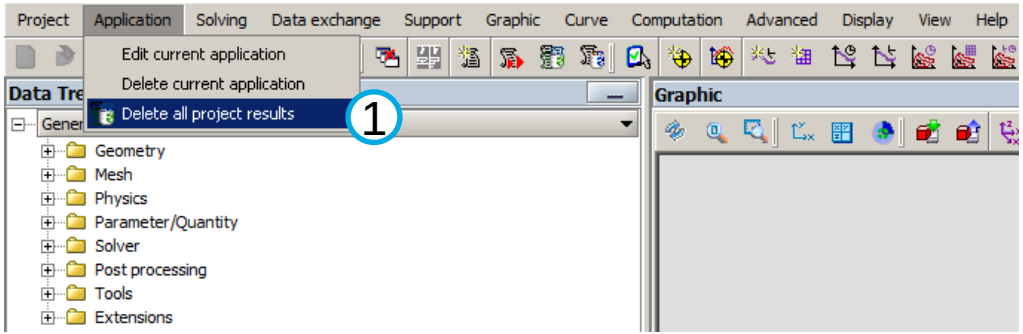
- Modifying the SHIFT_ANGLE parameter will allow to adjust this angle

III. BACK EMF ANALYSIS

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Delete project results

Step	Action
1	Click on [Application] – [Delete all project results]

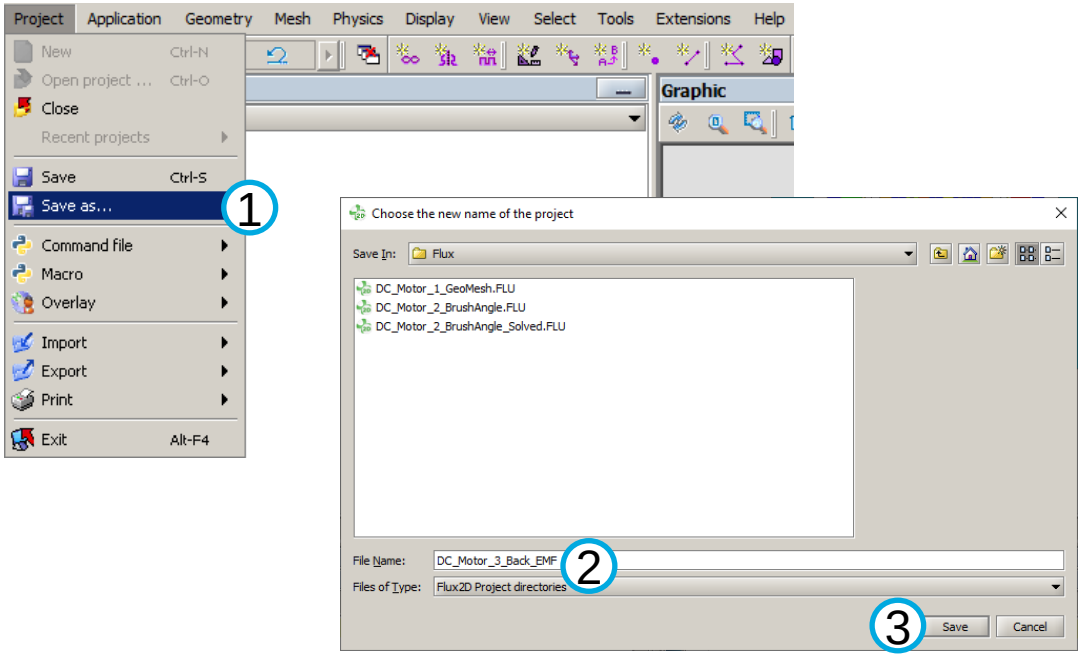


ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Save project

Step	Action
1	Click on [Project] – [Save as]
2	Define the project name “DC_Motor_3_Back_EMF”
3	Click on [Save]



ALTAIR

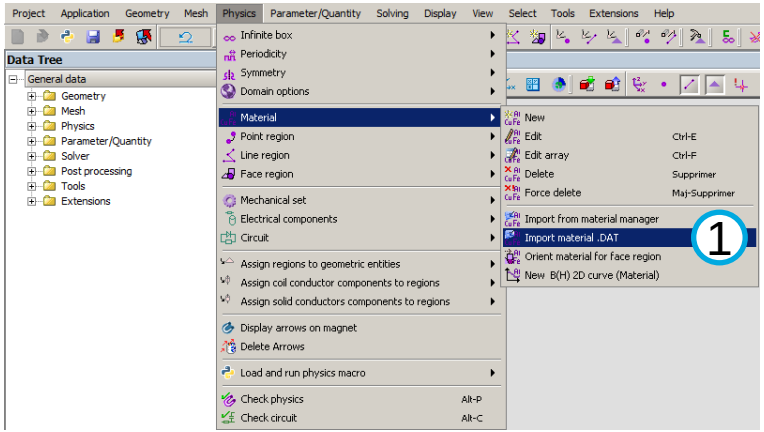
BACK EMF ANALYSIS

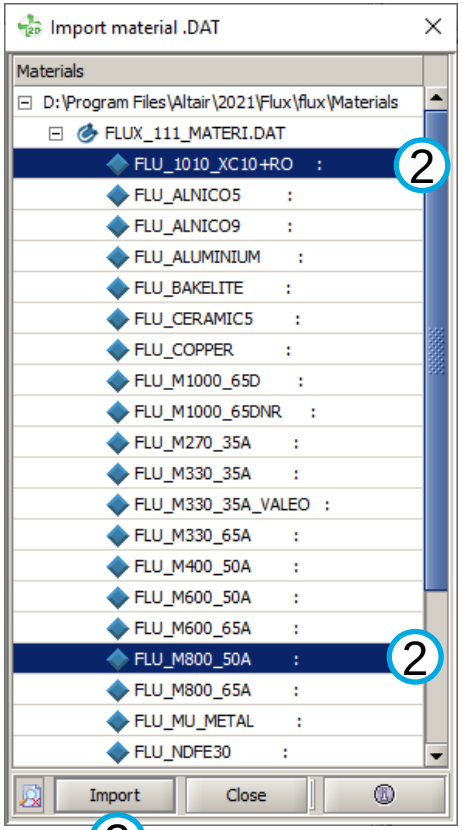
- What do we need to do ?
  - Replace air or vacuum region by magnet and stator
  - Replace linear region of rotor by M800-50A
  - Set the resistance of supply to CO_RESIST_VAL = 10000 Ω (back EMF will be taken on the resistance)
  - Set the speed to 10000 rpm

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Import materials

Step	Action
1	Click on [Physics] – [Material] – [Import material .DAT]
2	Select the two materials: FLU_1010_XC106RO FLU_M800_50A
3	Click on [Import]





ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify face regions

Step	Action
1	Modify the following face regions

Edit Face region[ROTOR,SHAFT,STATOR]

Entities	Modify all	ROTOR	SHAFT	STATOR
Face region				
Name *		ROTOR	SHAFT	STATOR
Comment	Initial values	ROTOR	SHAFT	STATOR
Transientmagnet *				
Sub types	Initial values	Magnetic non conducti...	Magnetic non conductin...	Magnetic non conducti...
Magnetic non conducting region		Magnetic non conducti...	Magnetic non conductin...	Magnetic non conducti...
Material *		FLU_M800_50A	FLU_1010_XC10+RO	FLU_1010_XC10+RO
Color	Initial values	Blue	Yellow	Blue
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE
Mechanical set	Initial values	ROTOR	ROTOR	STATOR

OK Apply Cancel

ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify face regions

Step	Action
1	Modify the following face regions

Edit Face region[MAGNET_1,MAGNET_2,MAGNET_3,MAGNET_4]

Entities	Modify all	MAGNET_1	MAGNET_2	MAGNET_3	MAGNET_4
Face region					
Name *		MAGNET_1	MAGNET_2	MAGNET_3	MAGNET_4
Comment	Initial values	MAGNET POLE1	MAGNET POLE2	MAGNET POLE3	MAGNET POLE4
Transientmagnet *					
Sub types	Magnetic non conducting ...	Magnetic non conducting ...	Magnetic non conducting ...	Magnetic non conducting ...	Magnetic non conducting ...
Magnetic non conducting region		Magnetic non conducting ...	Magnetic non conducting ...	Magnetic non conducting ...	Magnetic non conducting ...
Material *	MAGNET	MAGNET	MAGNET	MAGNET	MAGNET
Color	Initial values	Red	Green	Red	Green
Visibility *	Initial values	VISIBLE	VISIBLE	VISIBLE	VISIBLE
Mechanical set	Initial values	STATOR	STATOR	STATOR	STATOR

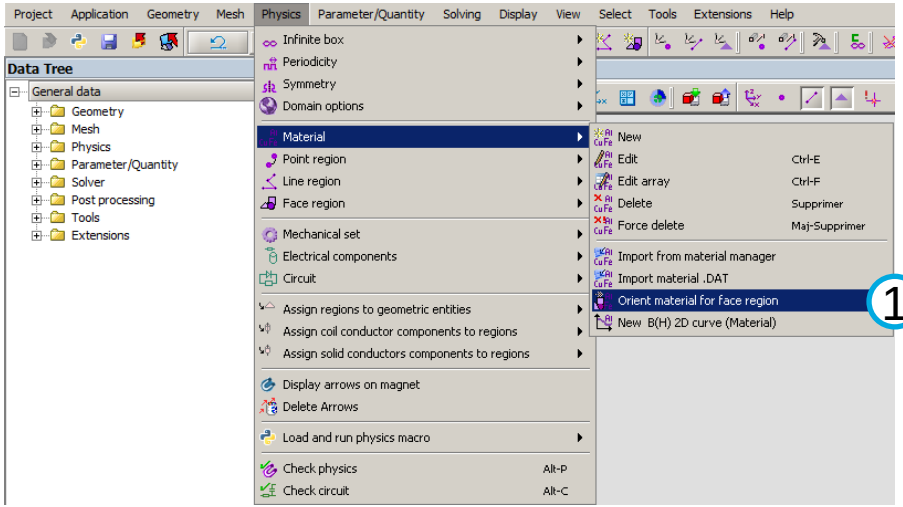
OK Apply Cancel

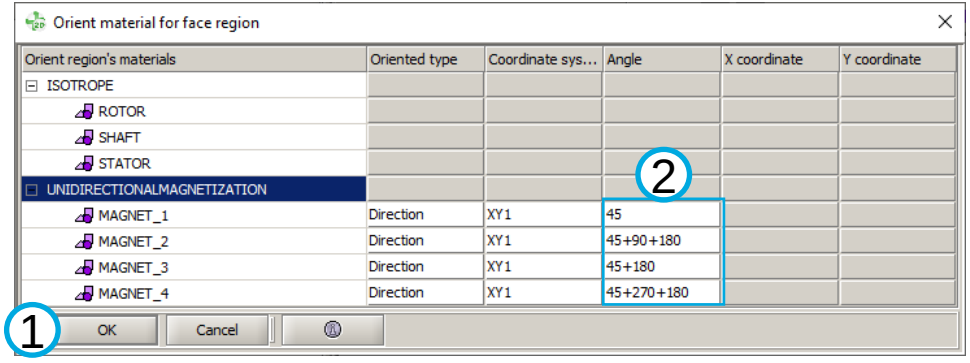
ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Orient materials

Step	Action
1	Click on [Physics] – [Material] – [Orient material for face region]
2	Define the orientation angle for the four magnets
3	Click on [OK]





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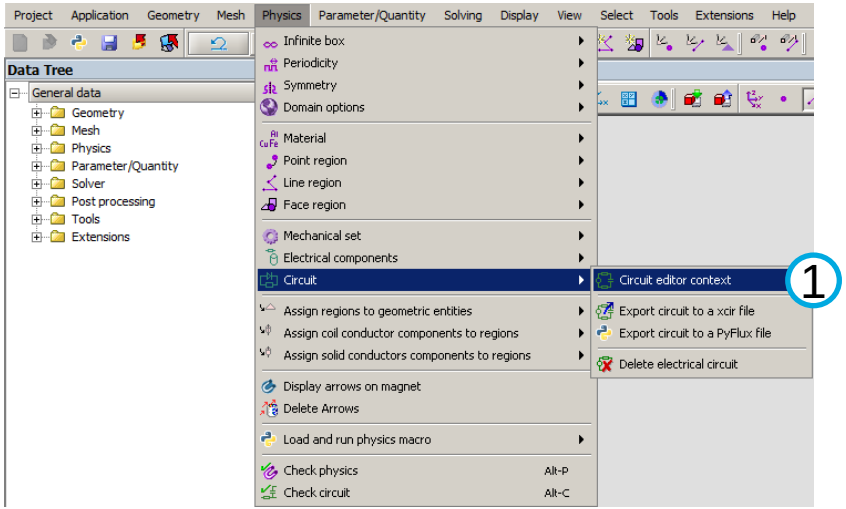
BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Click on [Physics] – [Circuit] – [Circuit editor context]

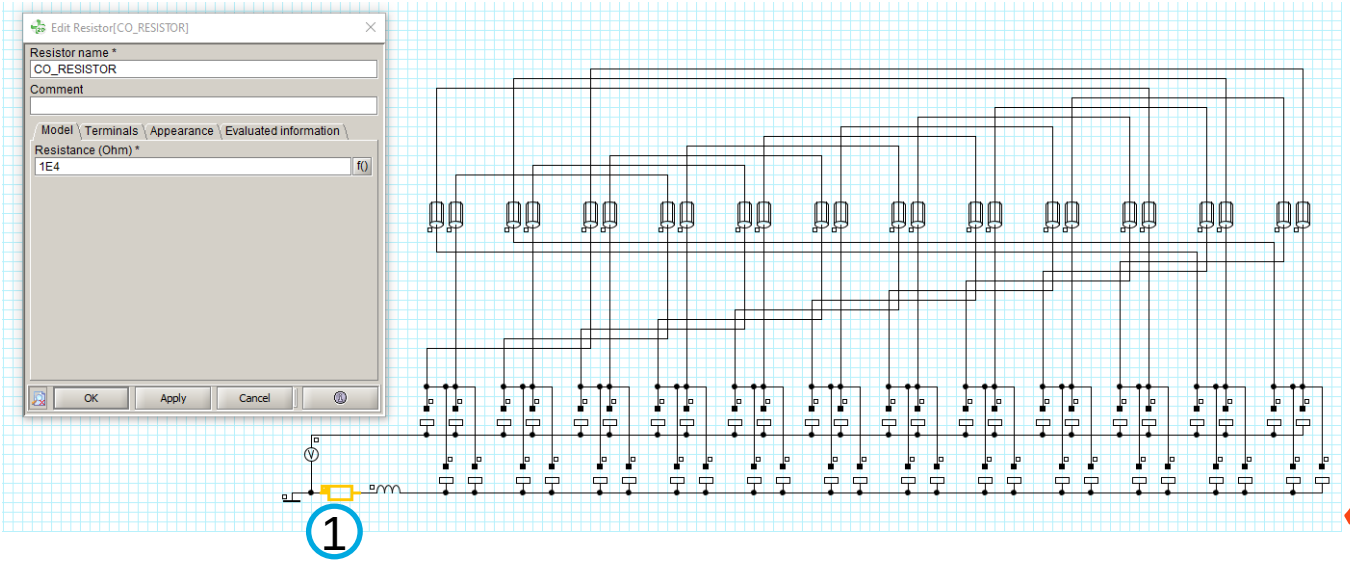


ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Modify the resistance value

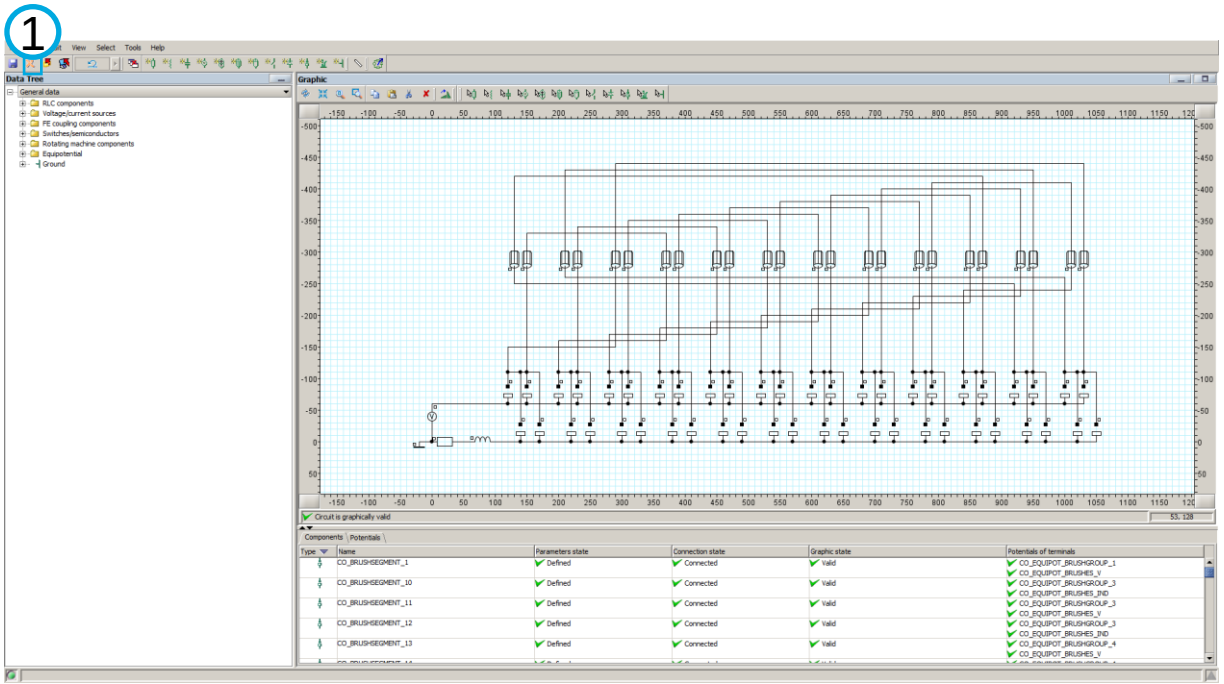


ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Click on the icon to close the circuit editor context

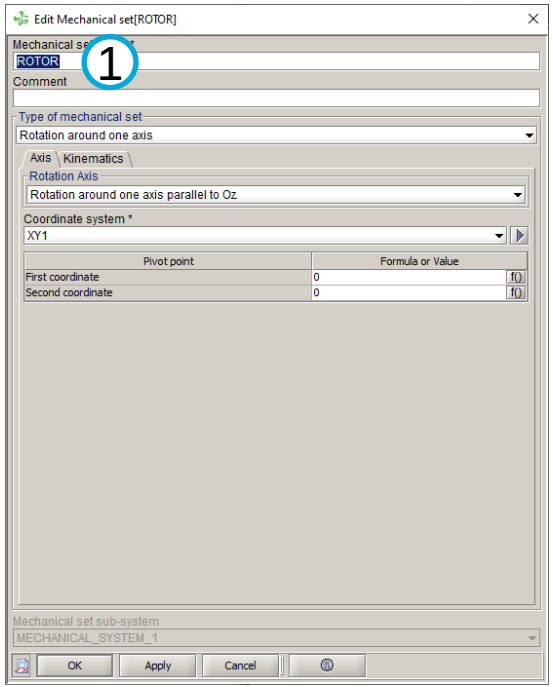


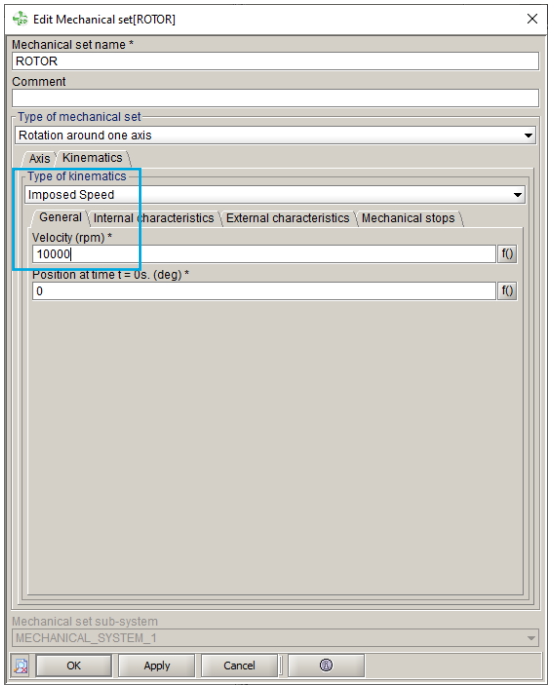
ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: define physics
  - Modify mechanical set

Step	Action
1	Modify the velocity value for the mechanical set “ROTOR”



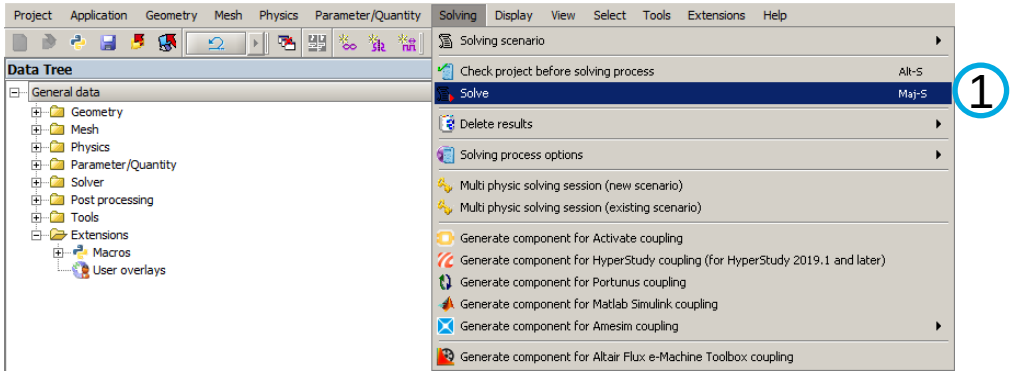


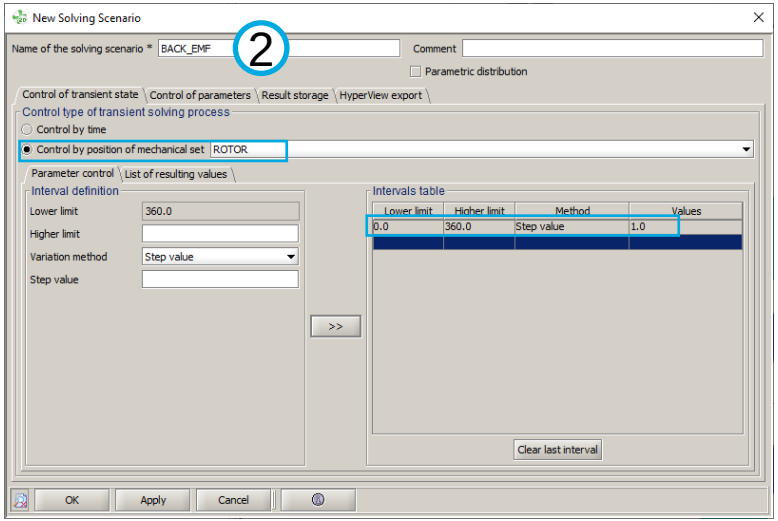
ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: solving
  - Create scenario

Step	Action
1	Click on [Solving] – [Solving scenario] – [New]
2	Create the following scenario “BACK_EMF”



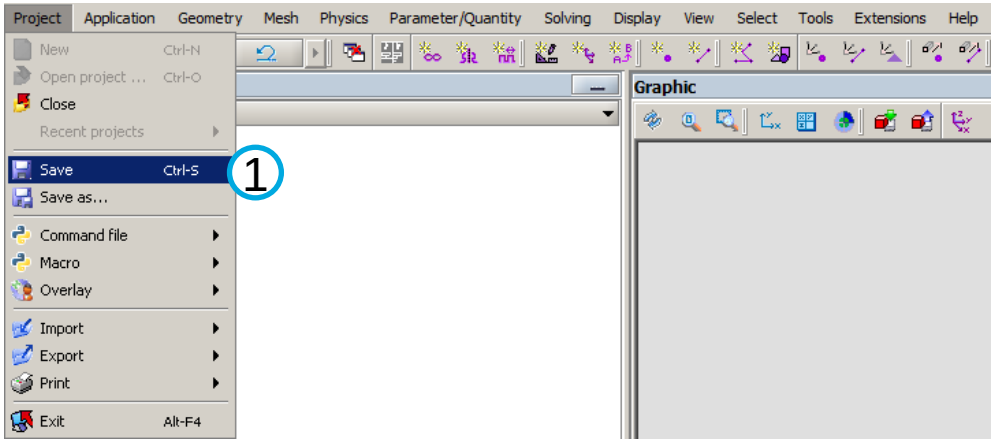


ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: solving
  - Save project

Step	Action
1	Click on [Project] – [Save]

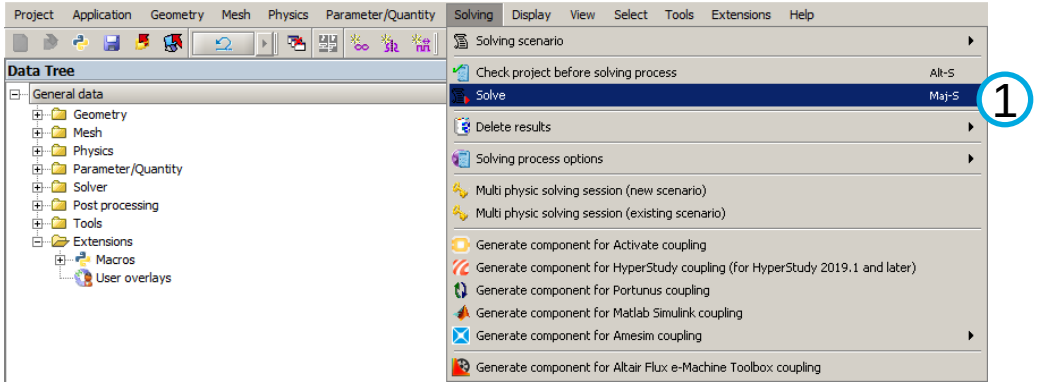


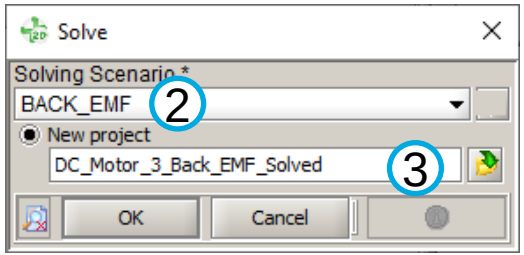
ALTAIR

BACK EMF ANALYSIS

- Flux 2D project: solving
  - Solve project

Step	Action
1	Click on [Solving] – [Solve]
2	Select the solving scenario “BACK_EMF”
3	Save the solved project as a new project “DC_Motor_3_Back_EMF _Solved”





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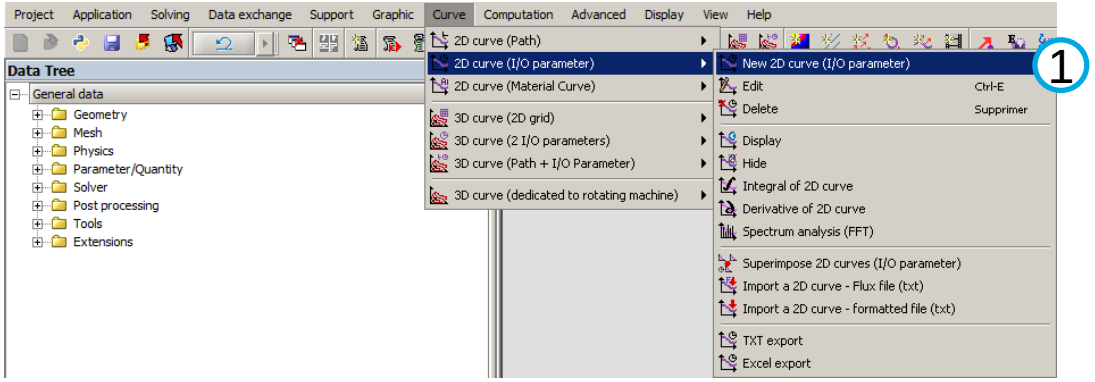
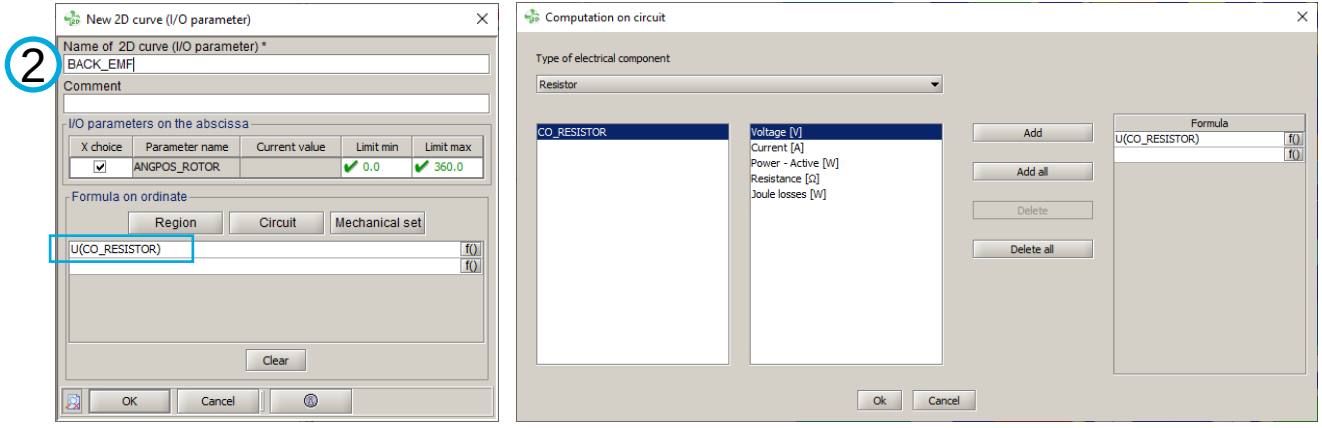
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Display of Back EMF

Step	Action
1	Click on [Curve] – [2D curve (I/O parameter)] – [New 2D curve (I/O parameter)]
2	Create the curve “BACK_EMF”





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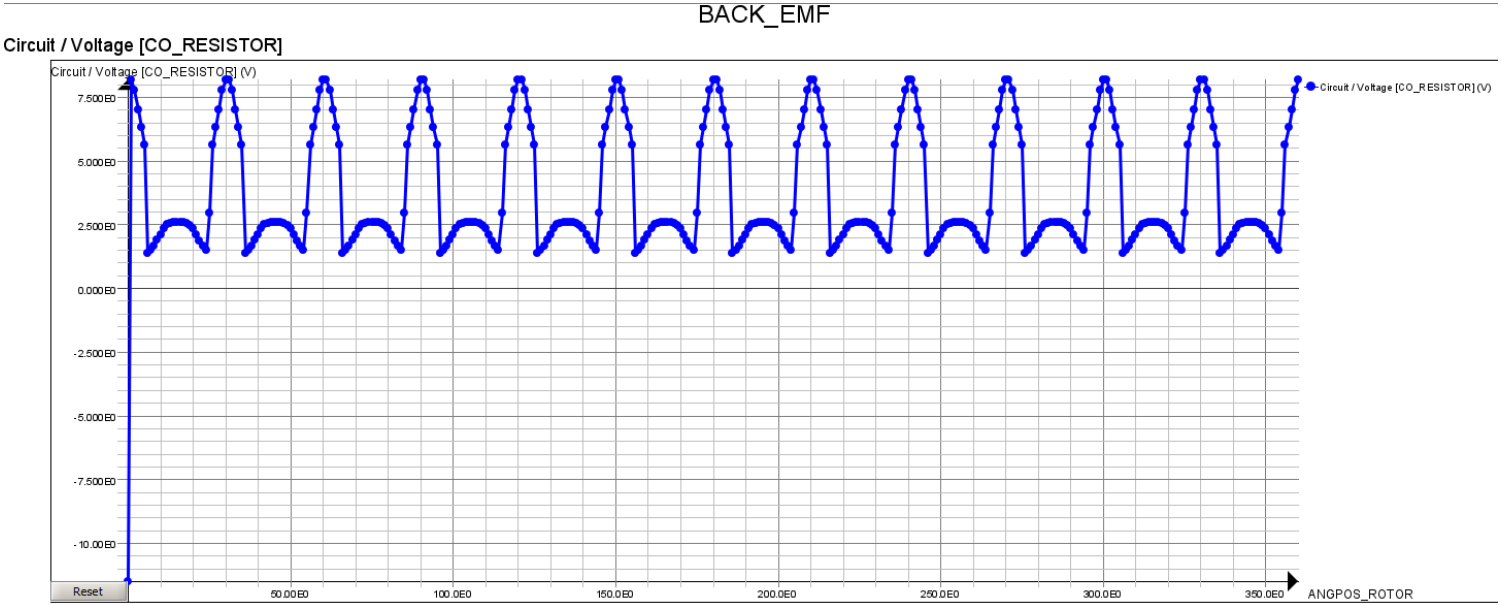
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Display of voltage on R1 and of position



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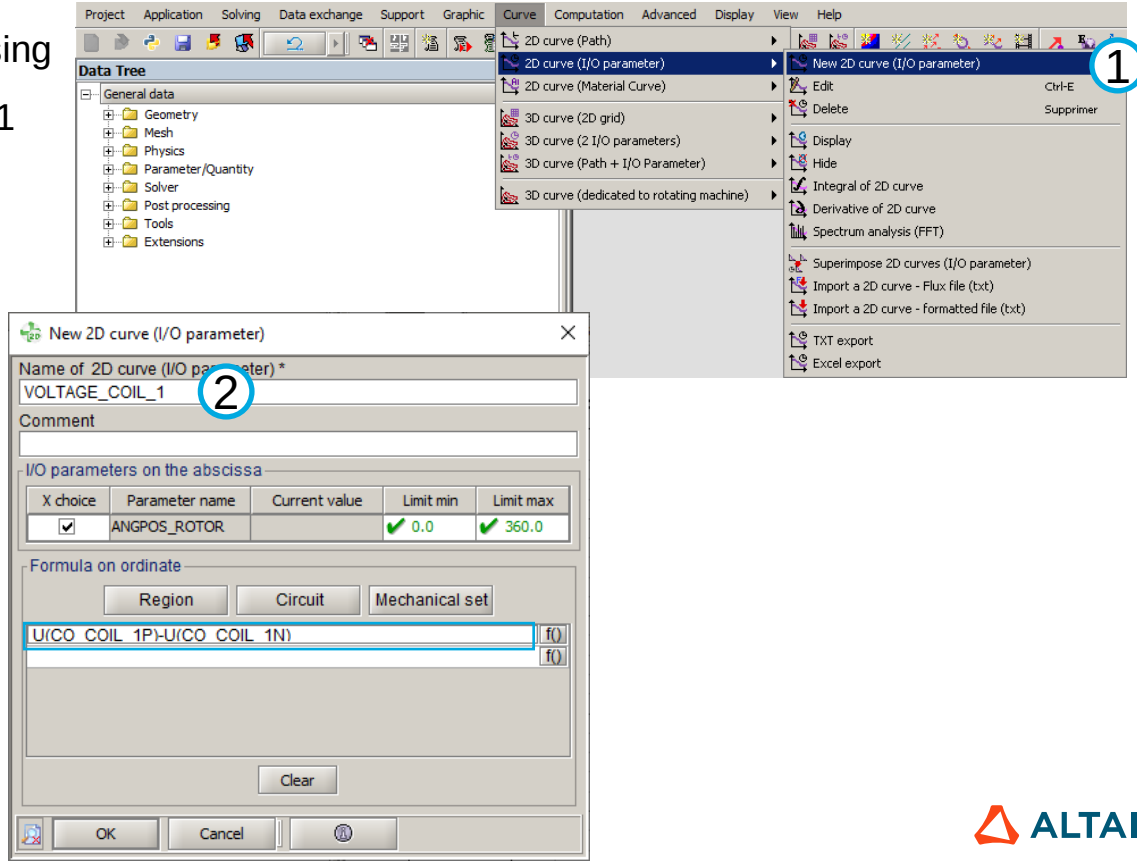
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Display of voltage on Coil_1

Step	Action
1	Click on [Curve] – [2D curve (I/O parameter)] – [New 2D curve (I/O parameter)]
2	Create the curve for the voltage on Coil_1



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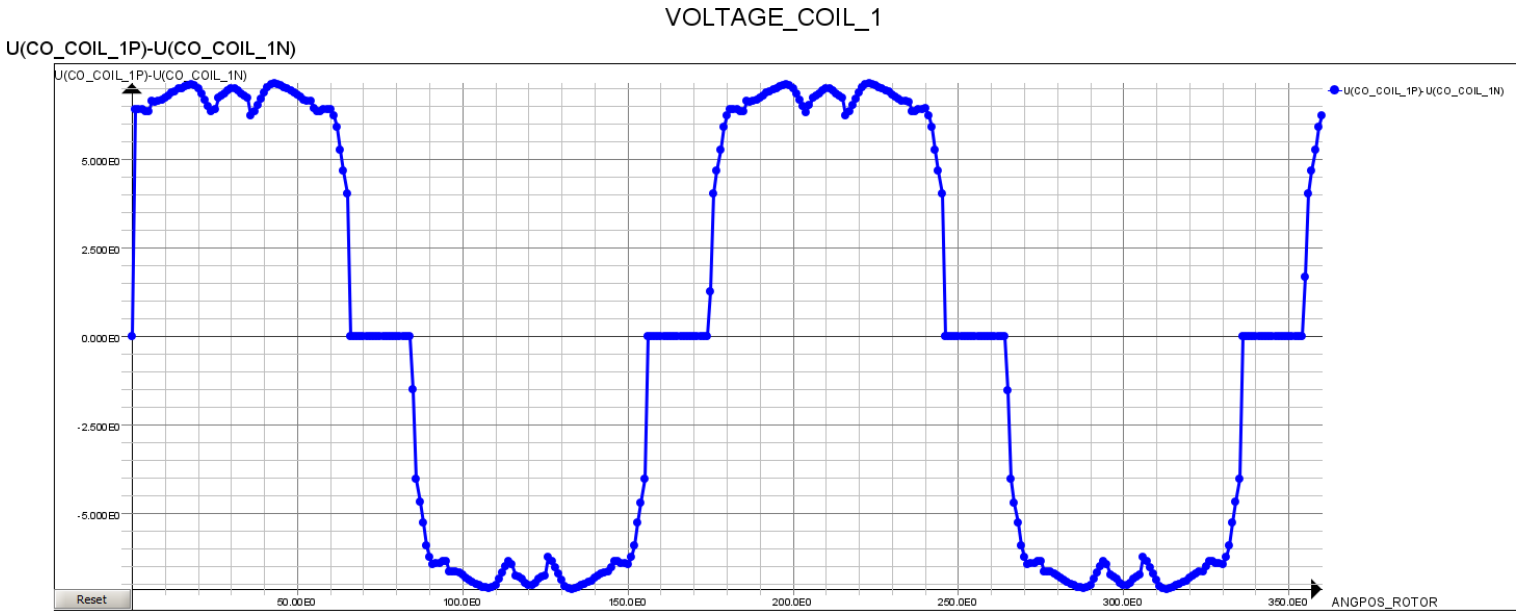
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Display of voltage on Coil_1



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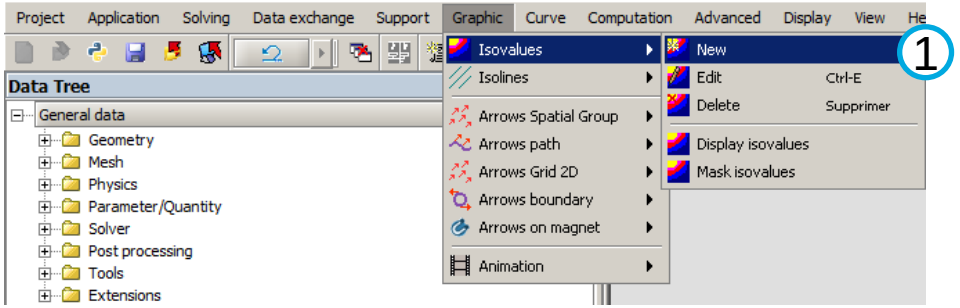
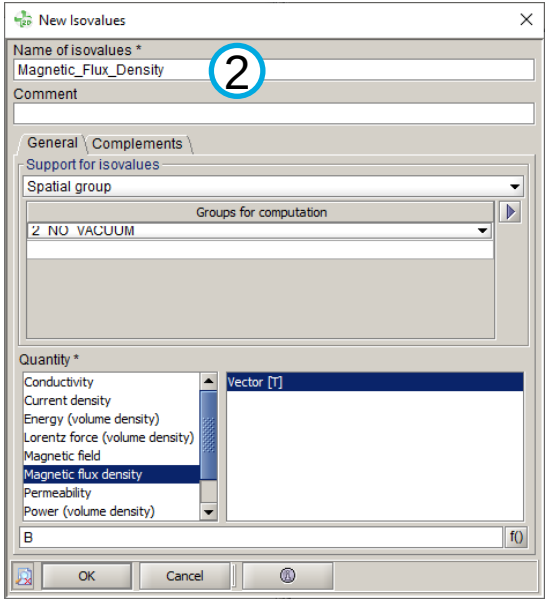
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Isovalue magnetic flux density

Step	Action
1	Click on [Graphic] – [Isovalues] – [New]
2	Create the isovalue for the magnetic flux density





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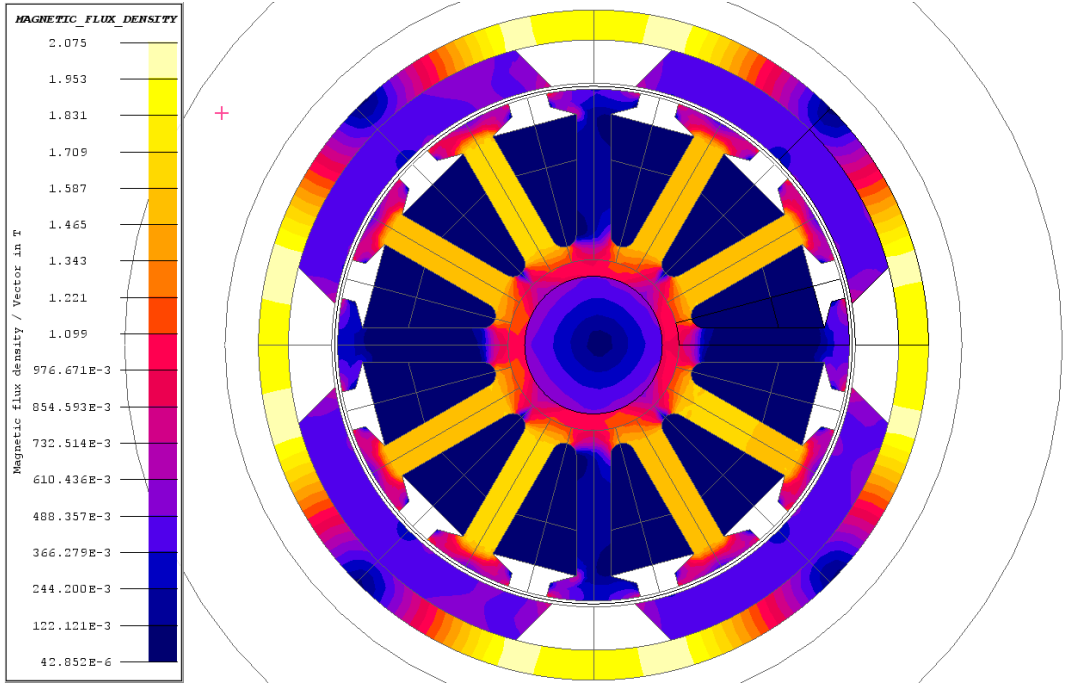
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Isovalue magnetic flux density



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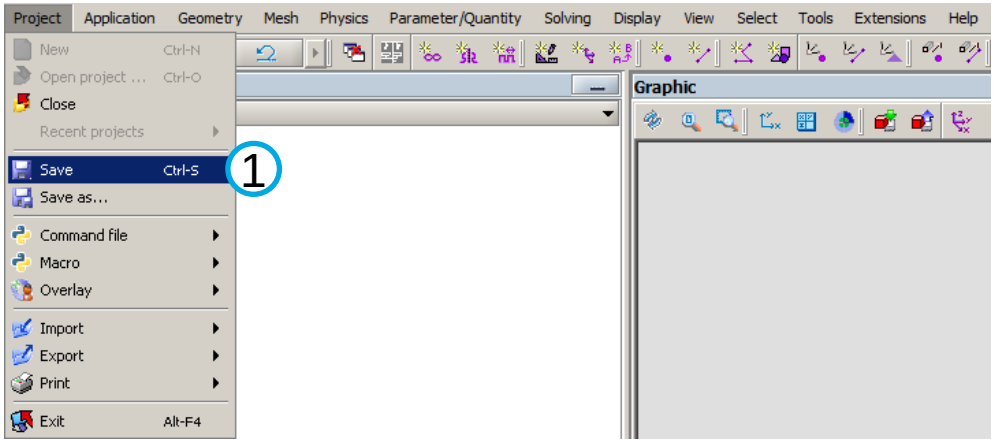
BACK EMF ANALYSIS

- Flux 2D project: post-processing
  - Save project

Step	Action
1	Click on [Project] – [Save]



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IV. CONSTANT SPEED ANALYSIS

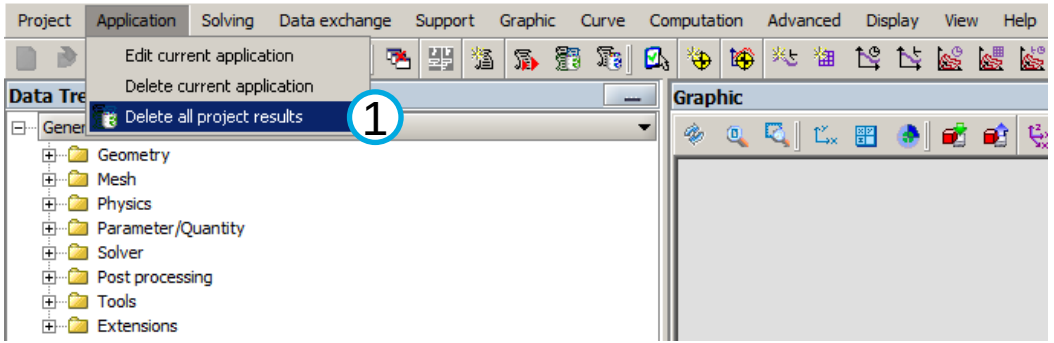
CONSTANT SPEED ANALYSIS

- Next computation is to set the speed at 10000 rpm
- Goal : look at current ripple and torque ripple
- Delete all the results of the previous project BACKEMF.FLU.
- Save as CONSTANT_SPEED.FLU

CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Delete project results

Step	Action
1	Click on [Application] – [Delete all project results]



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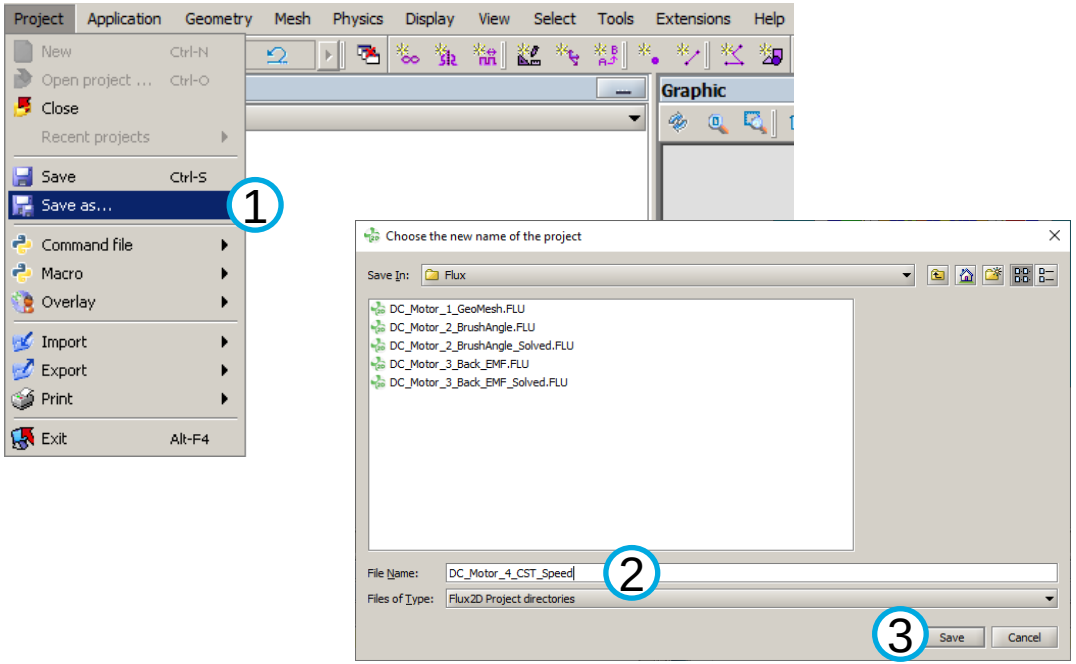
CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Save project

Step	Action
1	Click on [Project] – [Save as]
2	Define the project name “DC_Motor_4_CST_Speed”
3	Click on [Save]



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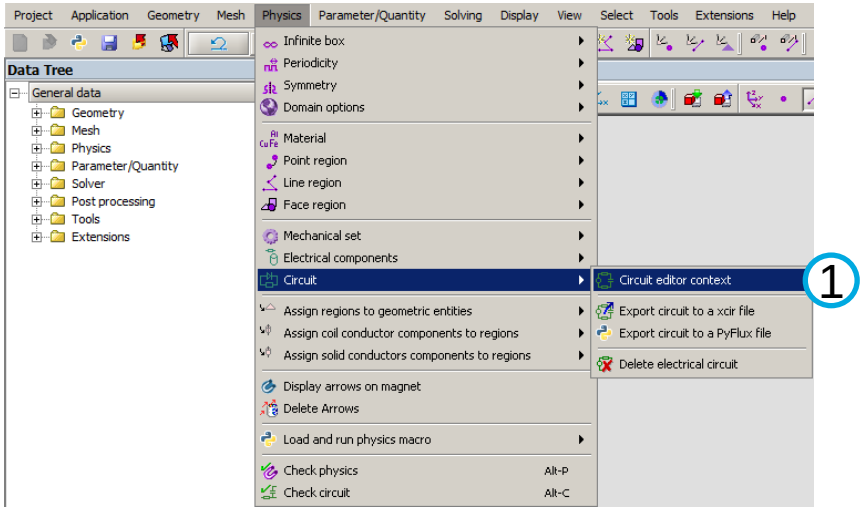
CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Click on [Physics] – [Circuit] – [Circuit editor context]



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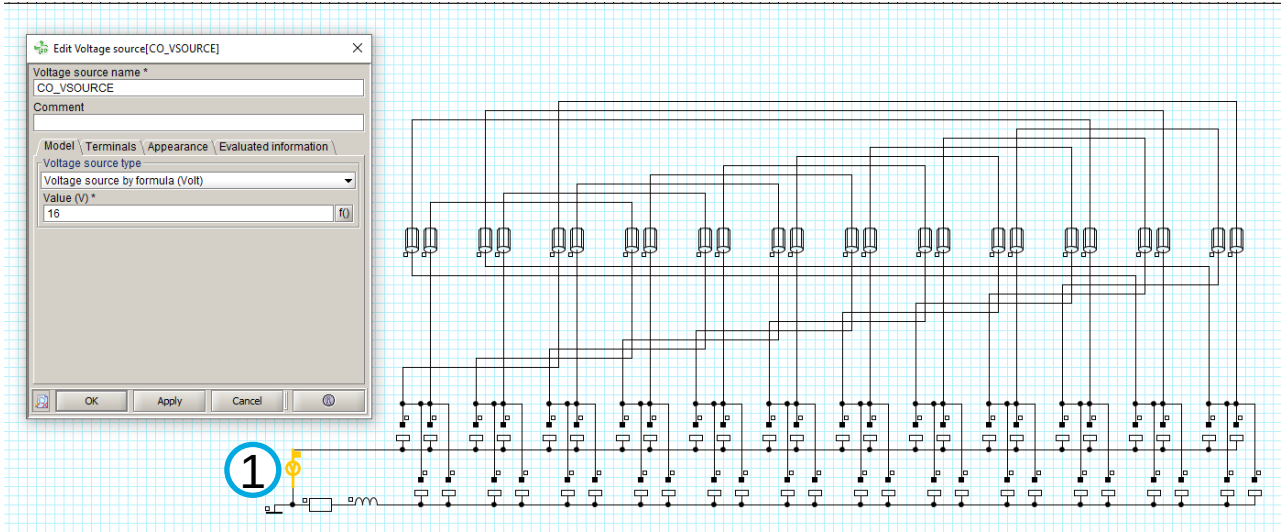
CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Modify the voltage source value



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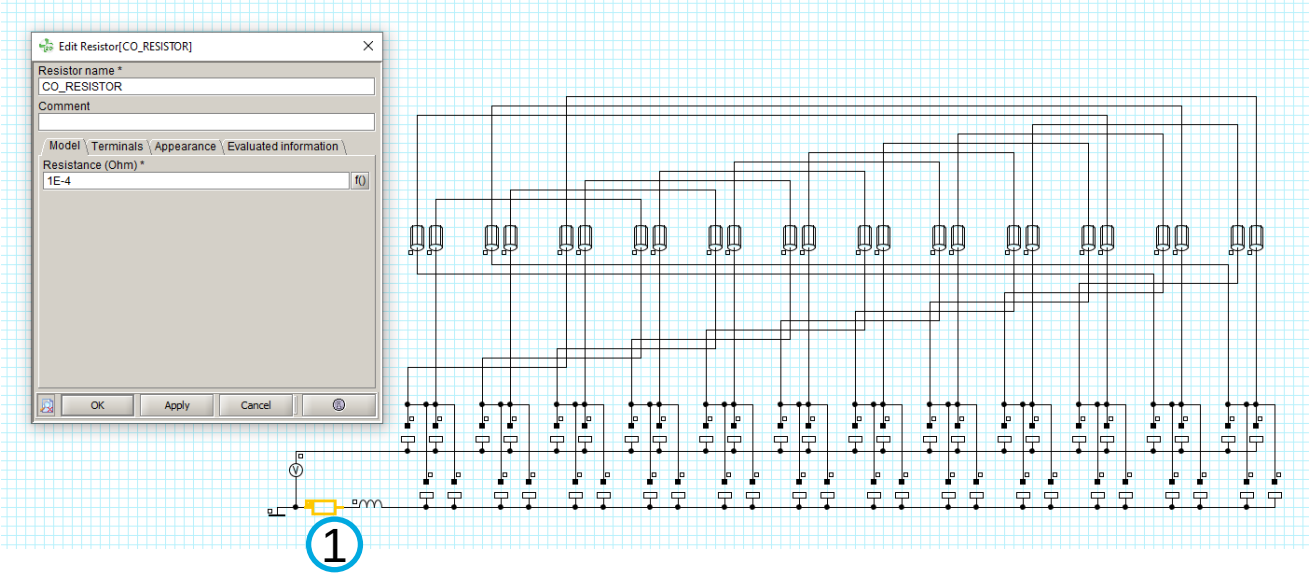
CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Modify the resistance value



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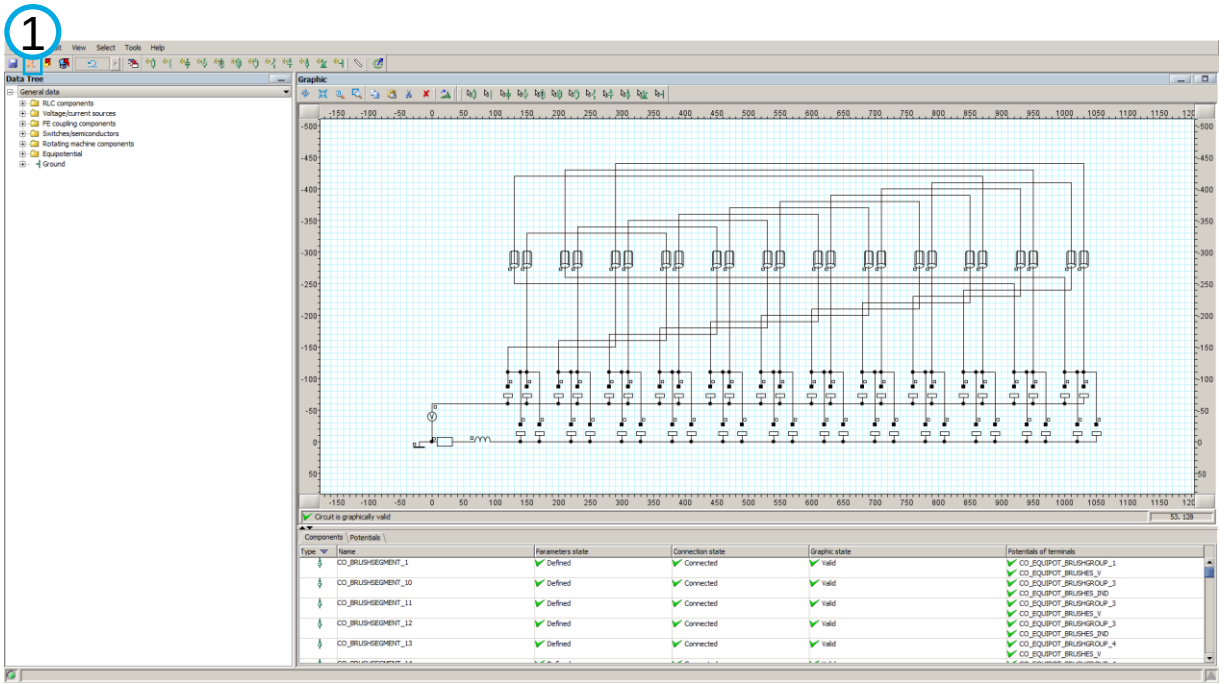
CONSTANT SPEED ANALYSIS

- Flux 2D project: define physics
  - Modify electric circuit

Step	Action
1	Click on the icon to close the circuit editor context



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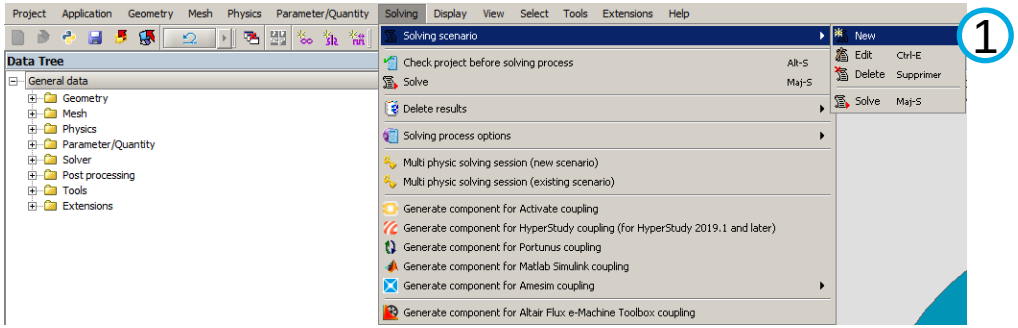
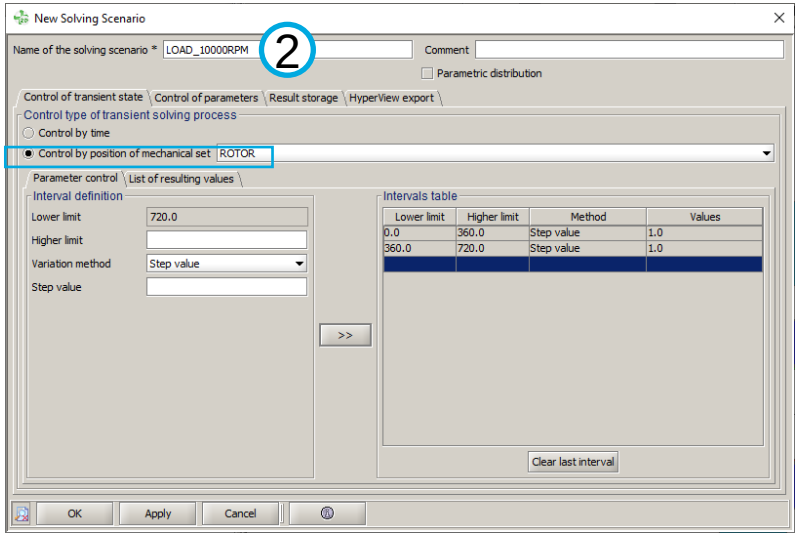
CONSTANT SPEED ANALYSIS

- Flux 2D project: solving
  - Create solving scenario

Step	Action
1	Click on [Solving] – [Solving scenario] – [New]
2	Create the following scenario “LOAD_10000RPM”





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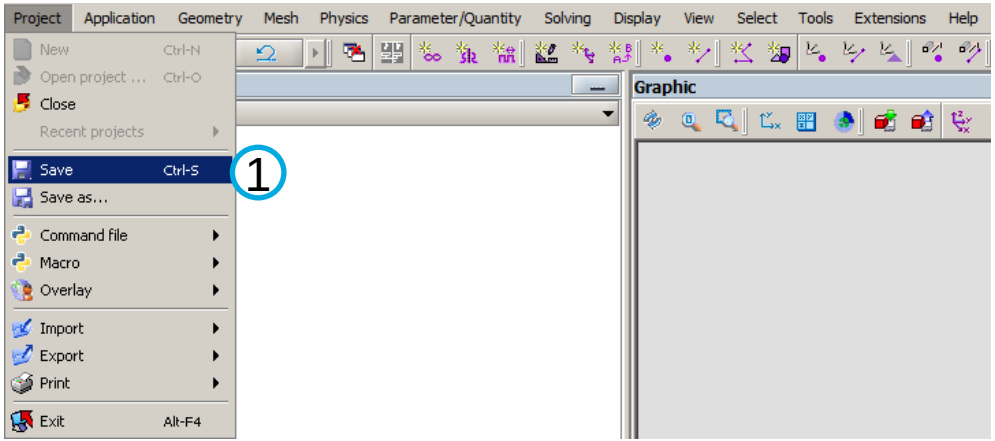
CONSTANT SPEED ANALYSIS

- Flux 2D project: solving
  - Save project

Step	Action
1	Click on [Project] – [Save]



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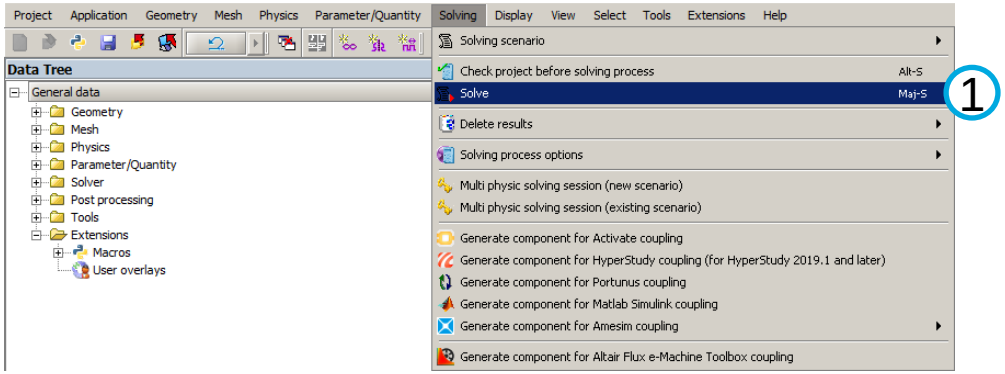
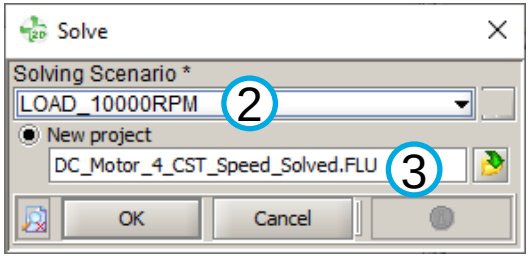
CONSTANT SPEED ANALYSIS

- Flux 2D project: solving
  - Solve scenario

Step	Action
1	Click on [Solving] – [Solve]
2	Select the solving scenario “LOAD_10000RPM”
3	Save the solved project as a new project “DC_Motor_4_CST_Speed_Solved”





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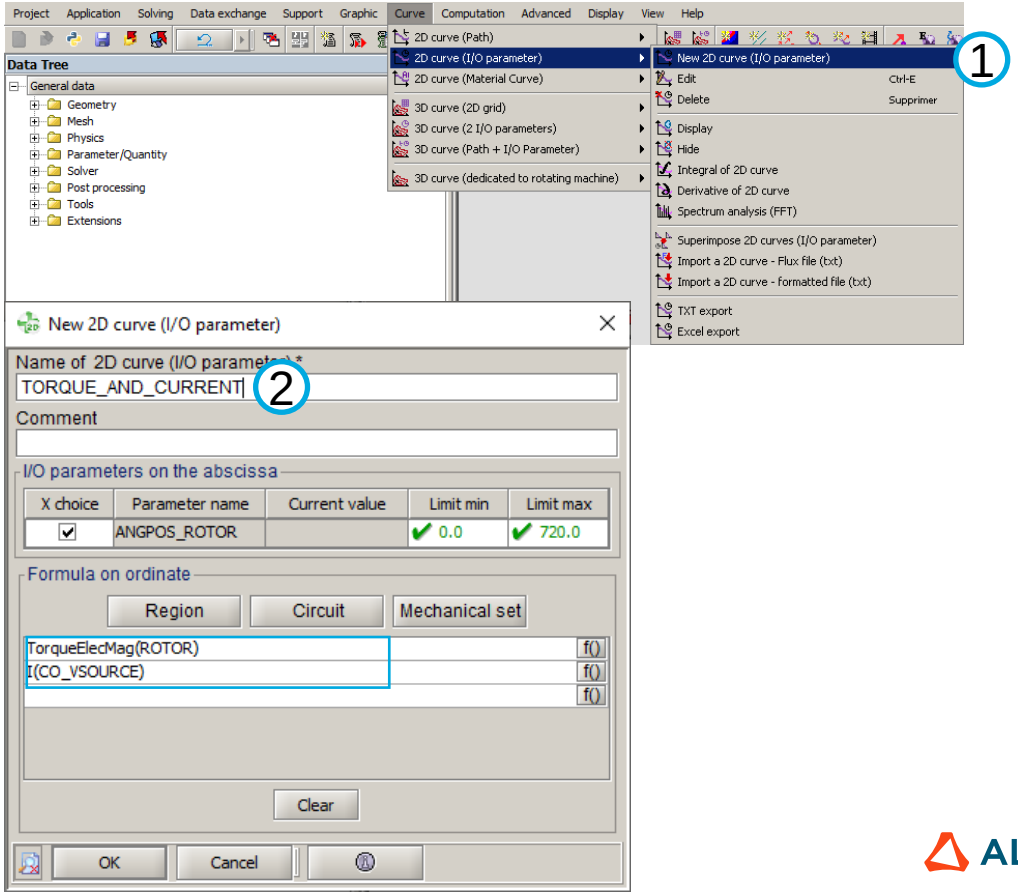
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Torque and current

Step	Action
1	Click on [Curve] – [2D curve (I/O parameter)] – [New 2D curve (I/O parameter)]
2	Create the curve “TORQUE_AND_CURRENT”



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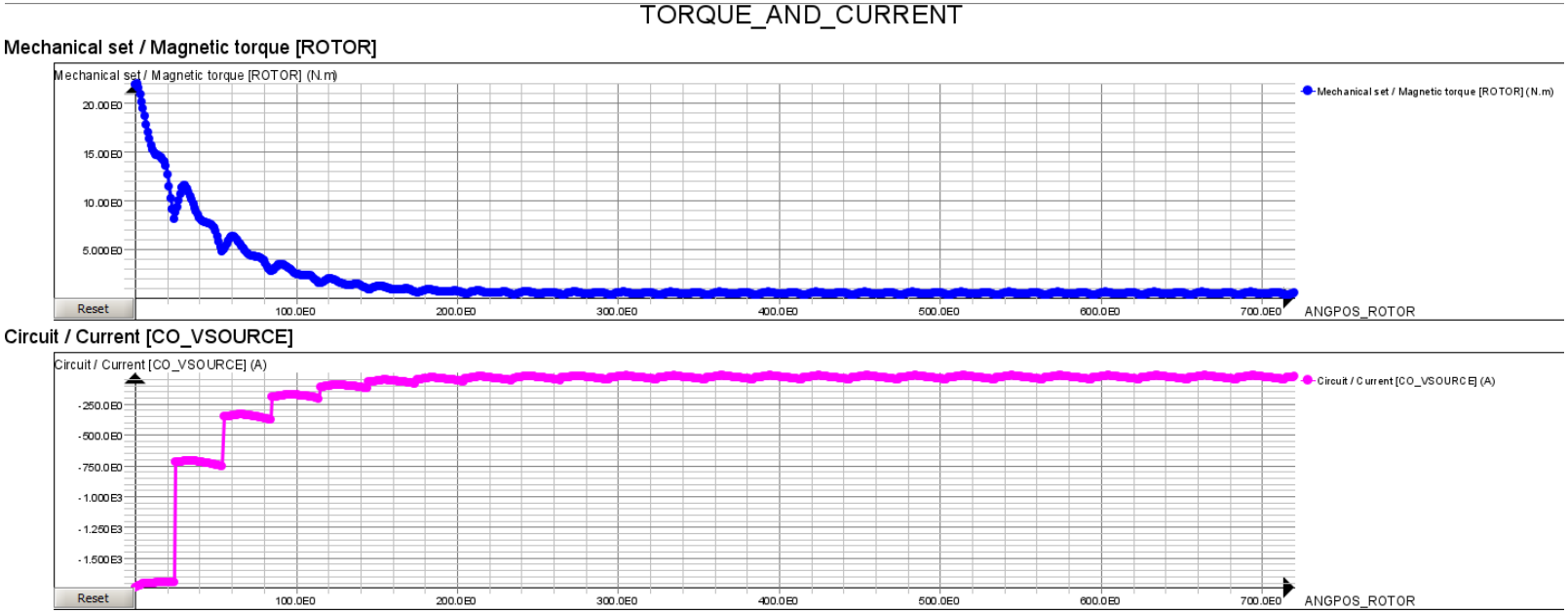
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Torque and current



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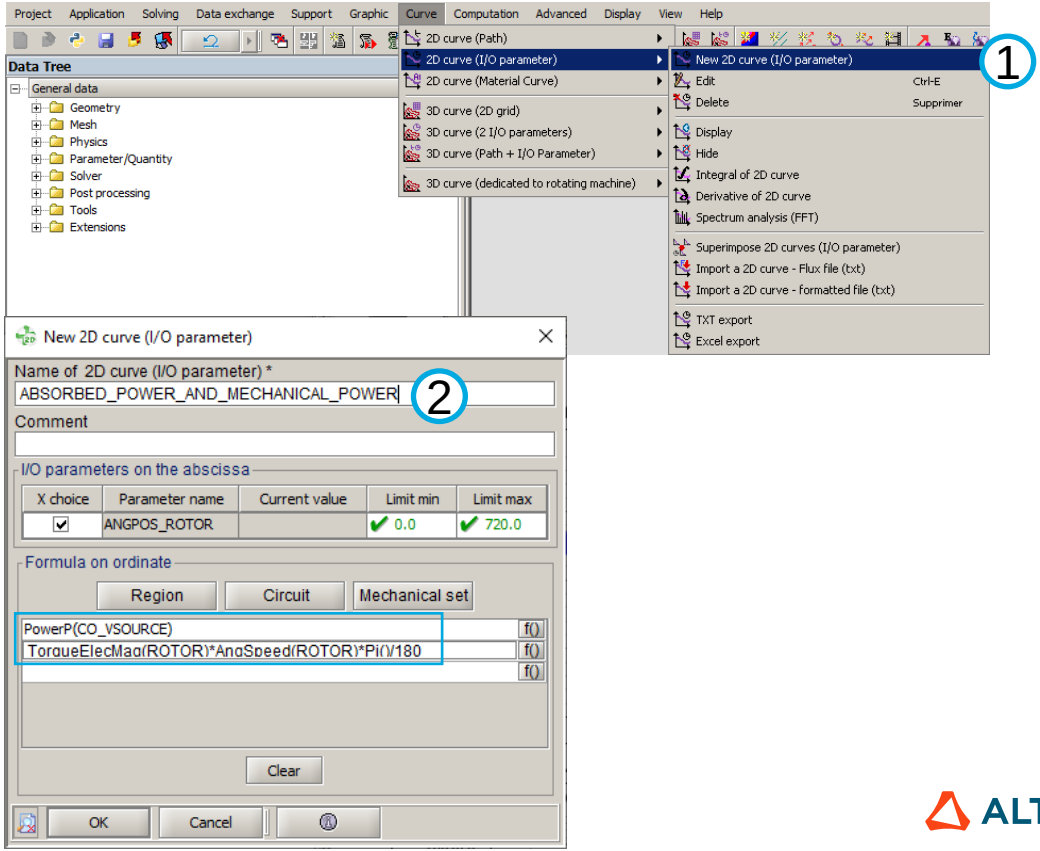
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Power

Step	Action
1	Click on [Curve] – [2D curve (I/O parameter)] – [New 2D curve (I/O parameter)]
2	Create the curve for absorbed power and mechanical power



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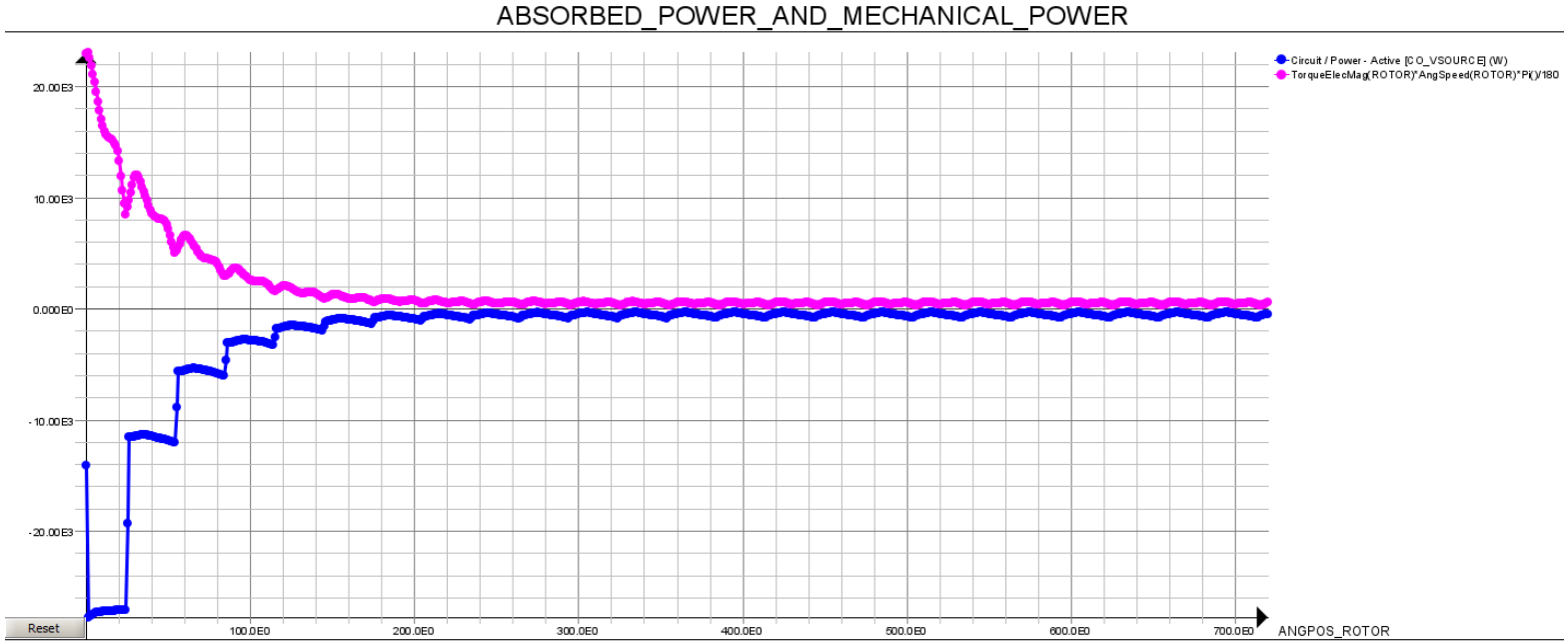
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Power



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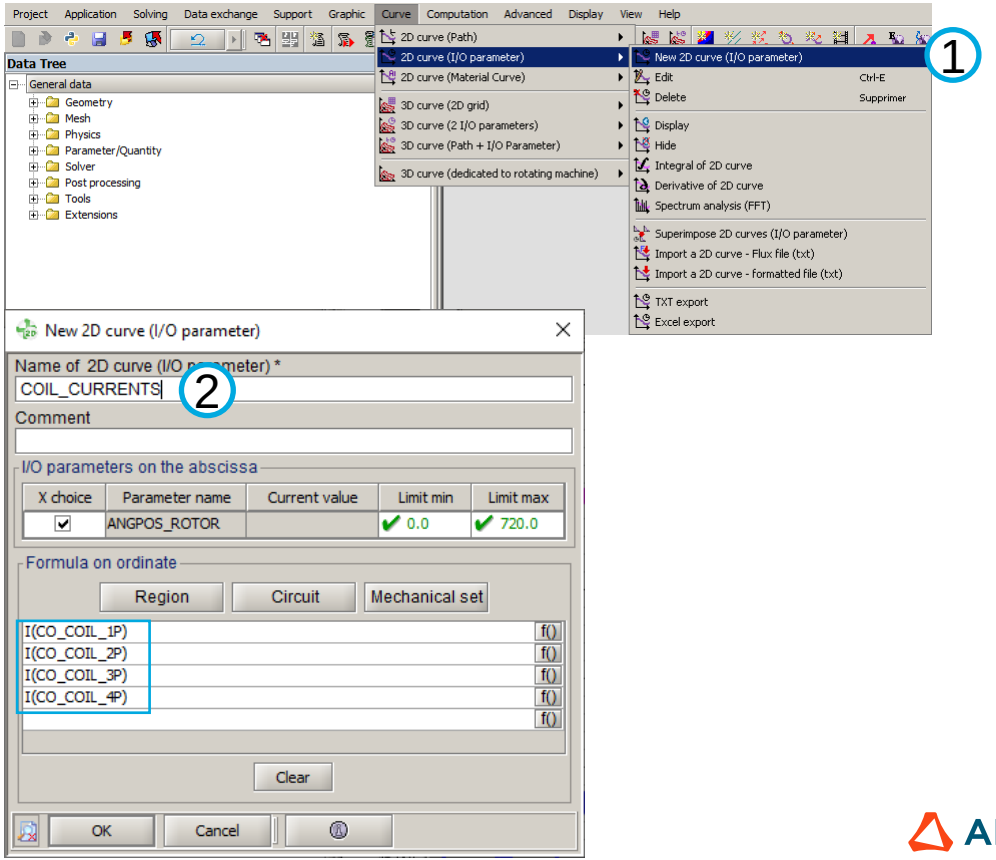
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Coil currents

Step	Action
1	Click on [Curve] – [2D curve (I/O parameter)] – [New 2D curve (I/O parameter)]
2	Create the curve for the coil currents



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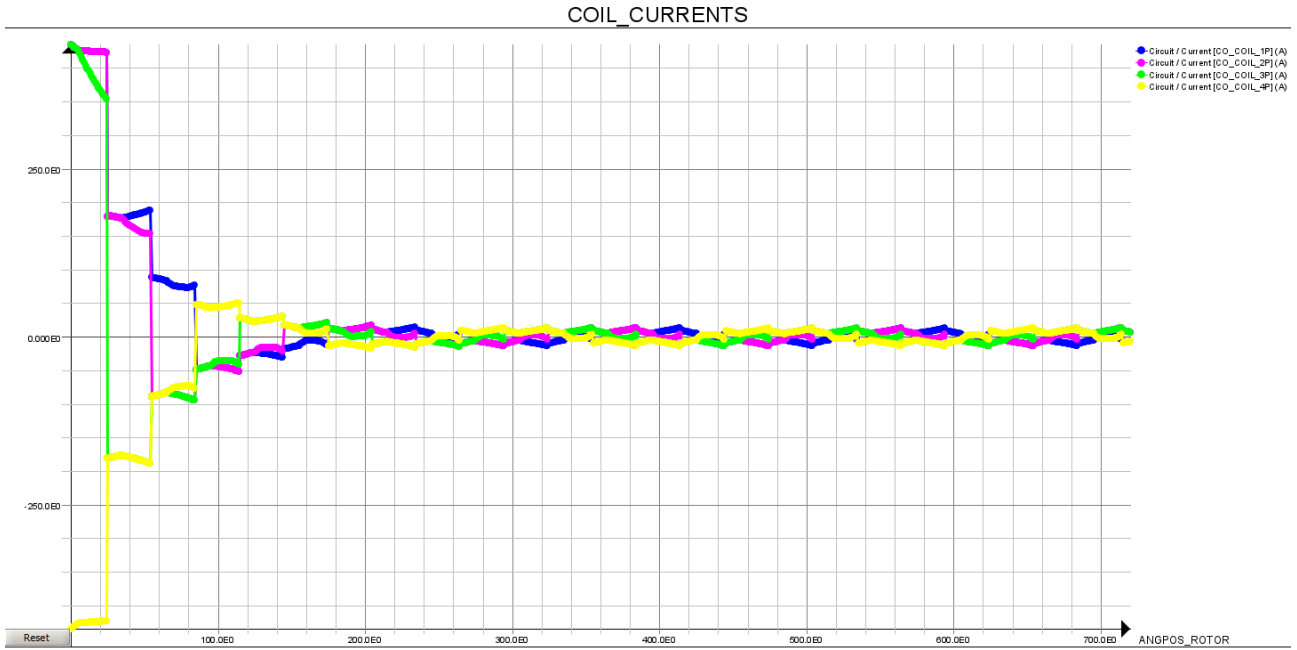
CONSTANT SPEED ANALYSIS

- Flux 2D project: postprocessing
  - Coil current



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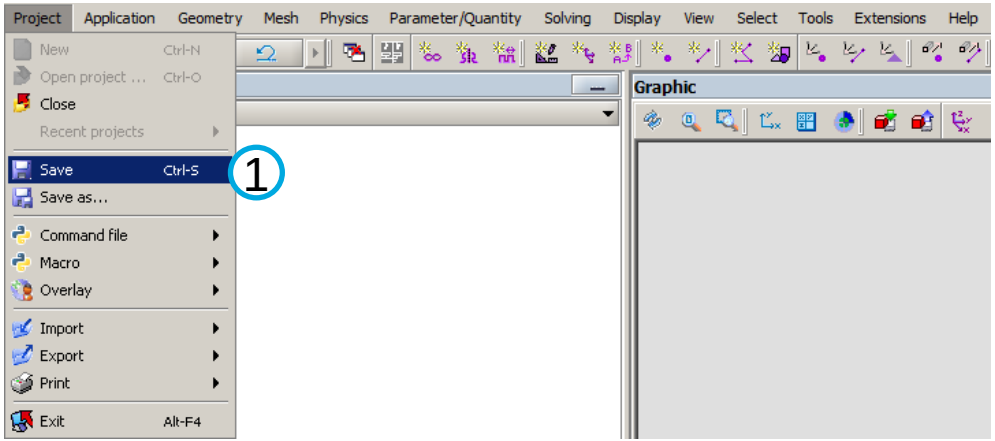
CONSTANT SPEED ANALYSIS

- Flux 2D project: solving
  - Save project

Step	Action
1	Click on [Project] – [Save]



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V. CONCLUSION

CONCLUSION

- In this tutorial, the DC motor model is created by Flux Overlay.
- Three different analysis have been created to analyze the motor performance.

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