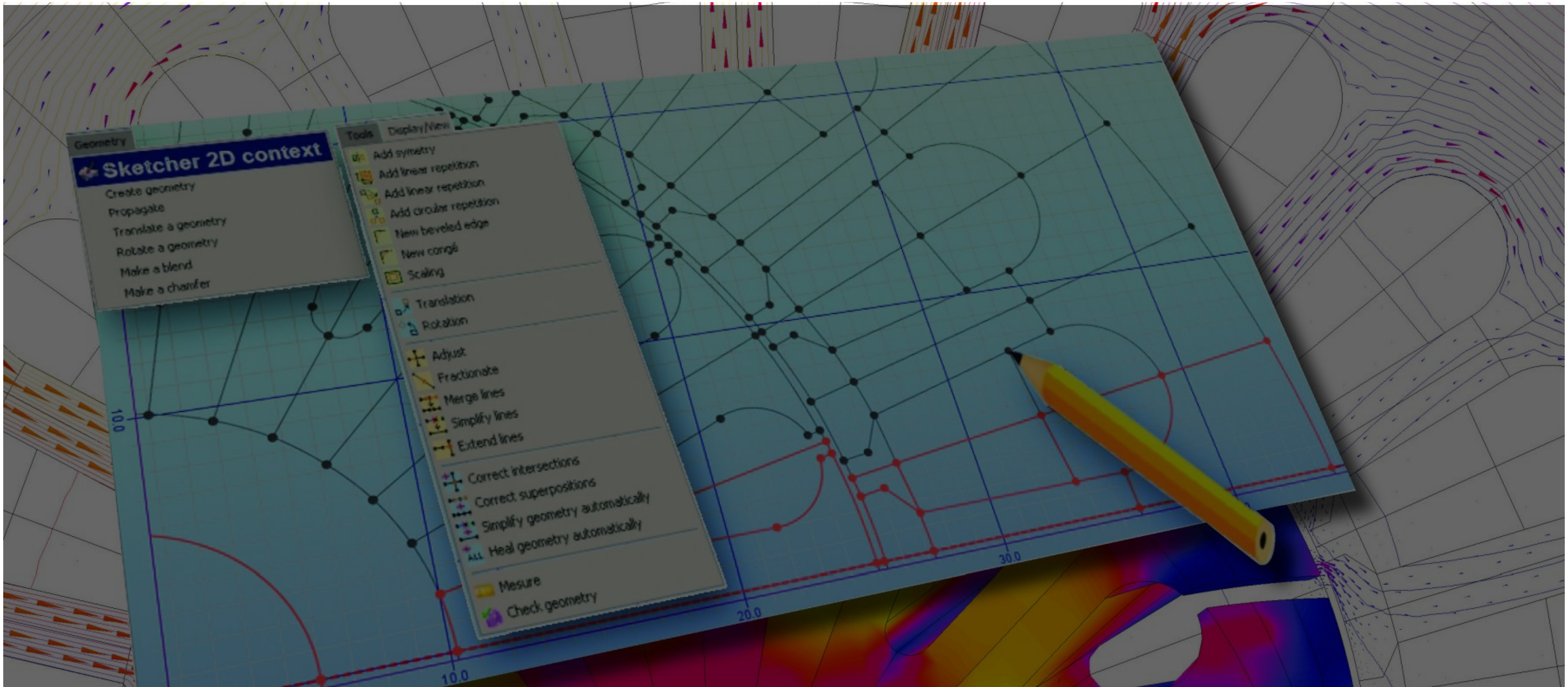
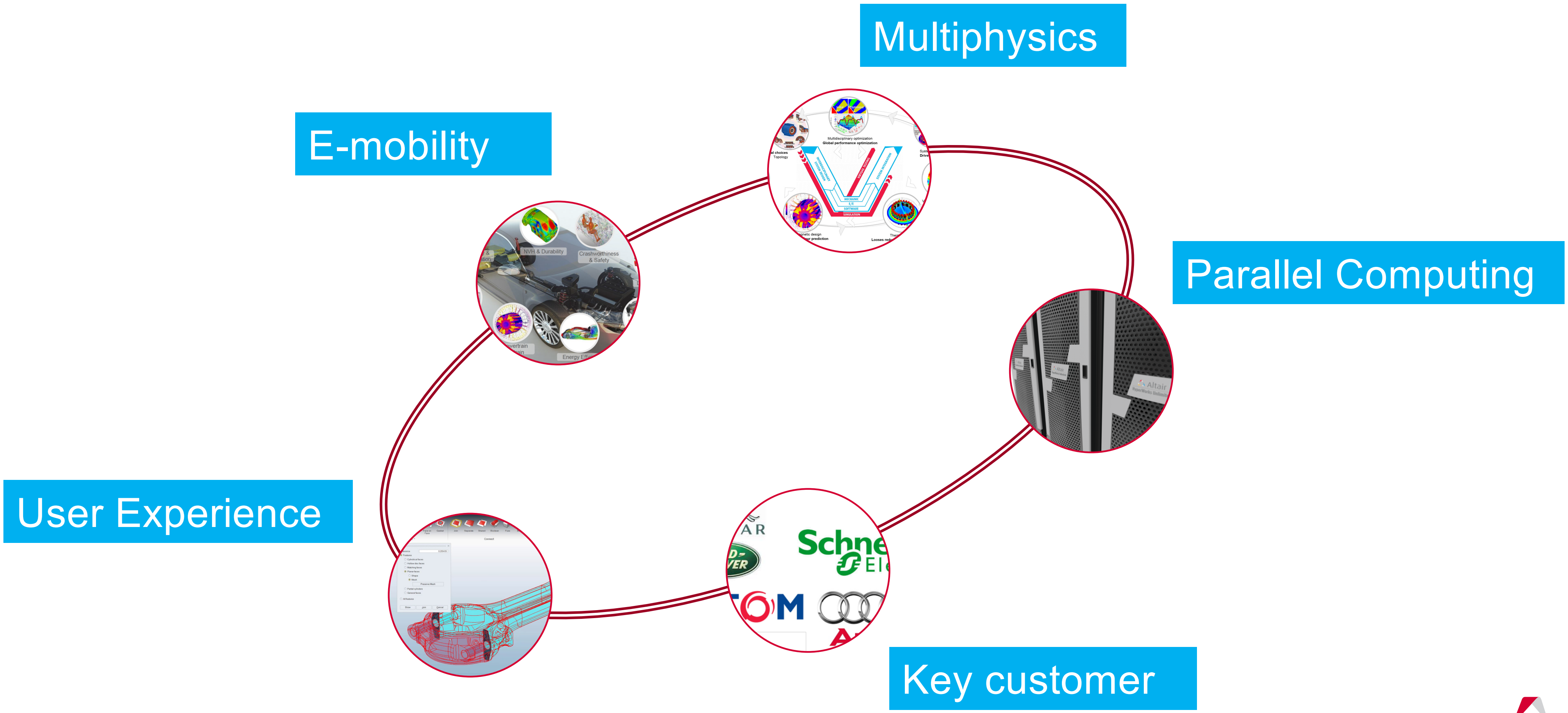


Altair **Flux**™– New Features and Roadmap

V. Leconte – Sr Dir. Of Business Development – LF EM Solutions

Altair


Multiphysics
E-mobility
Parallel Computing
User Experience
Key customer

LATEST RELEASES

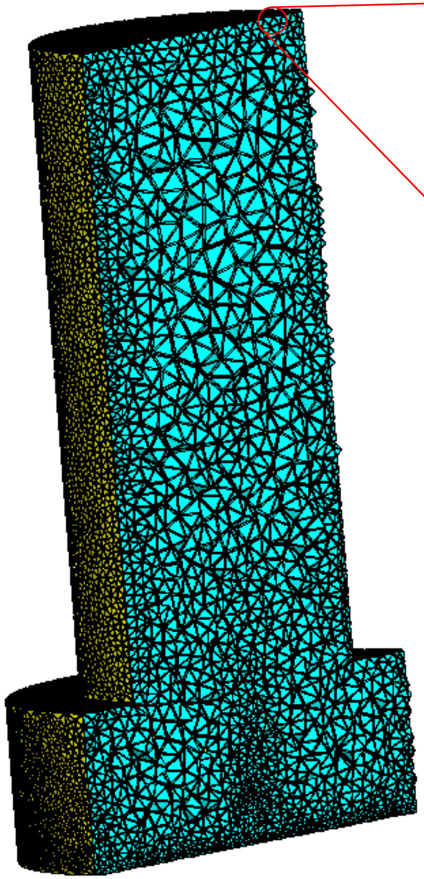
Altair Flux 2019 Main Features

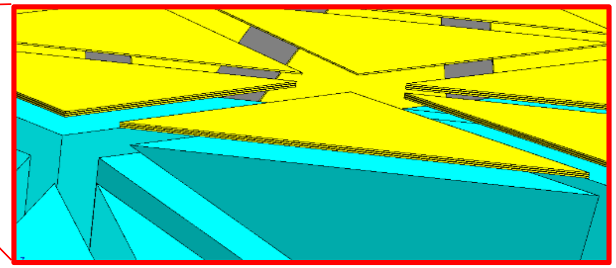
LAYERS MESH GENERATOR FOR SKIN EFFECT

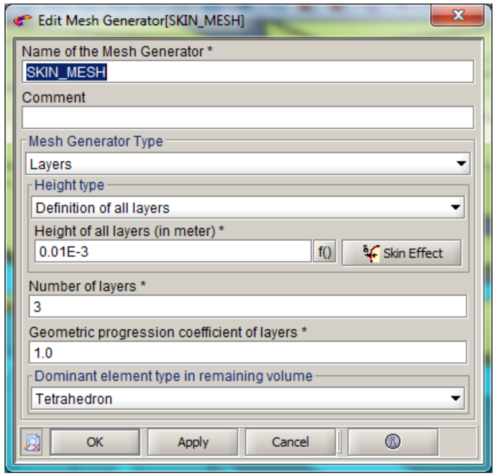
- **Skin effect** representation
  - **Faster** resolution
  - **High accuracy** results

- New mesh generator type
  - For **3D eddy current simulations**
  - **Mesh layers** to model **skin depth**
  - Based on **MeshGems-Hybrid**

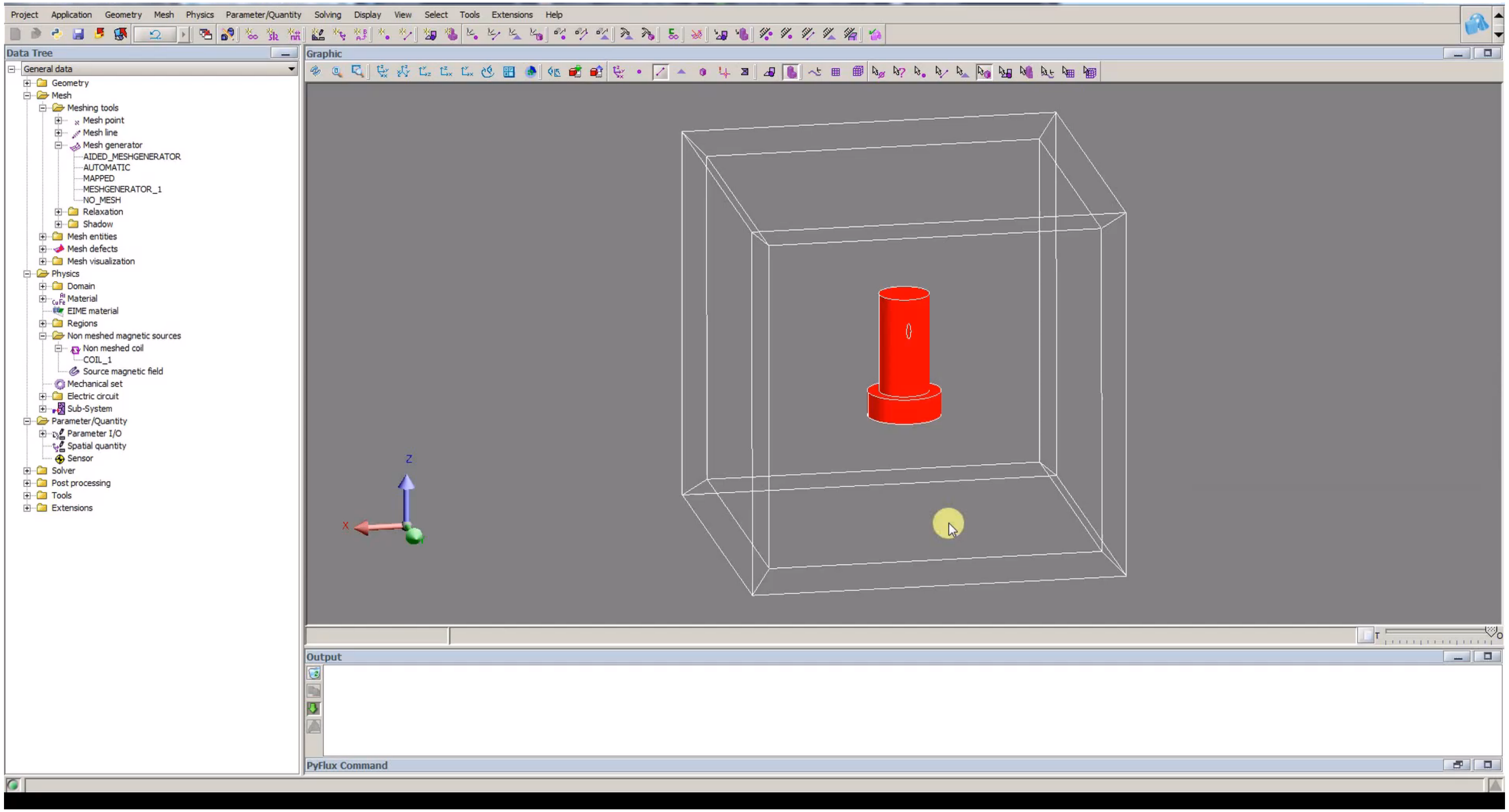
- Mesh layers are defined by:
  - **Thickness of the layers**
  - **Number of layers**
  - **Thickness progression** in each layer
  - Dominant **element type**



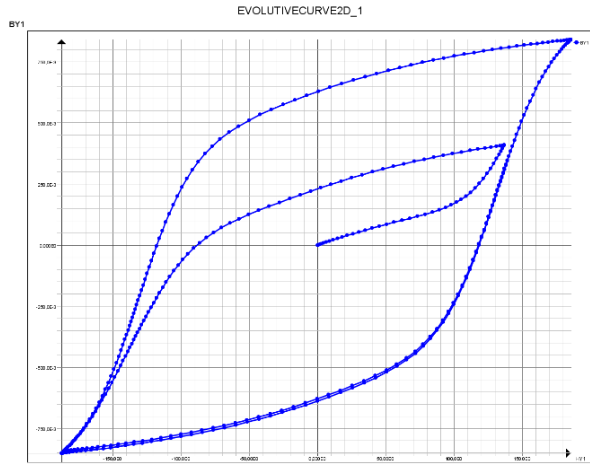




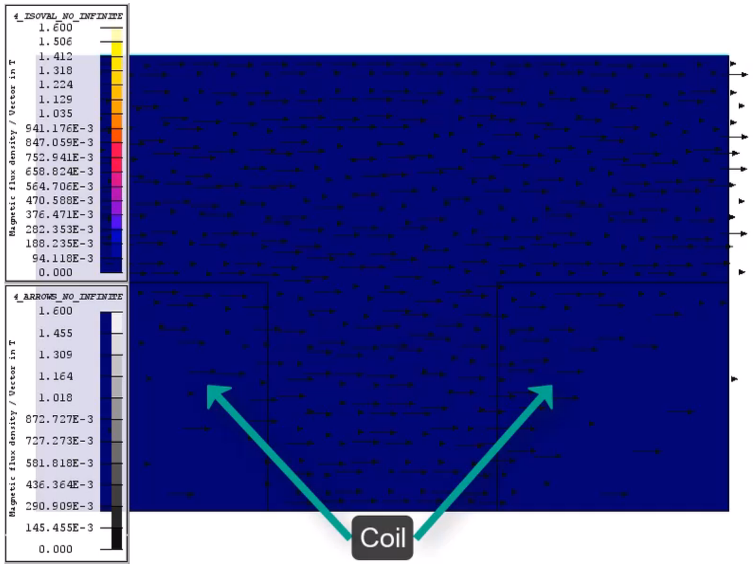
LAYERS MESH GENERATOR FOR SKIN EFFECT



PREISACH'S MODEL



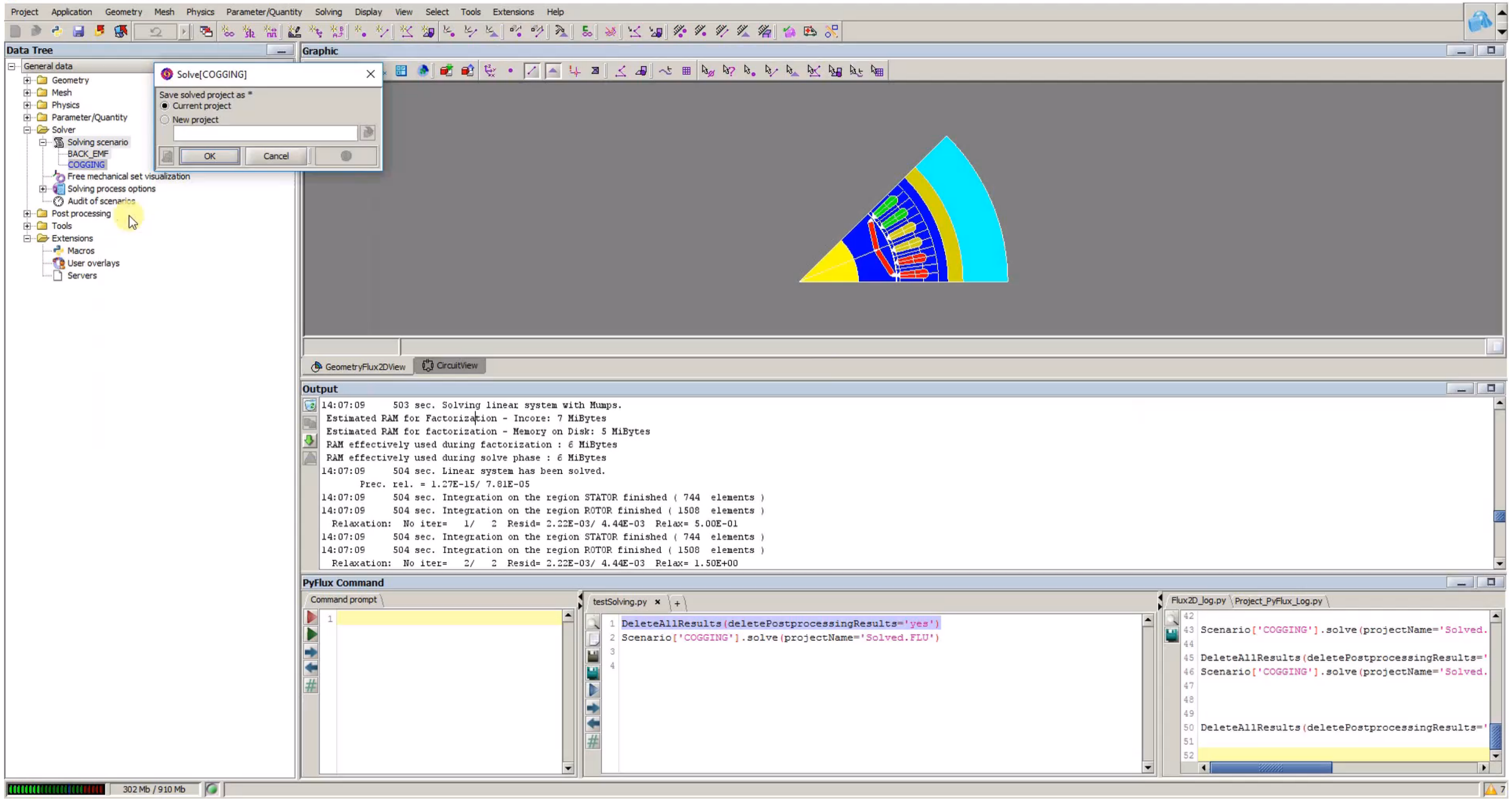
- **Better evaluation of iron losses and remanence effects**
- **Hysteresis during solving**
  - Preisach static vector model
  - 2D and 3D
- **Accurate, straightforward**
  - **Simpler** than Jiles-Atherton model
  - Powerful to generate **minor loops**
  - **Coefficients fitting** with experimental data



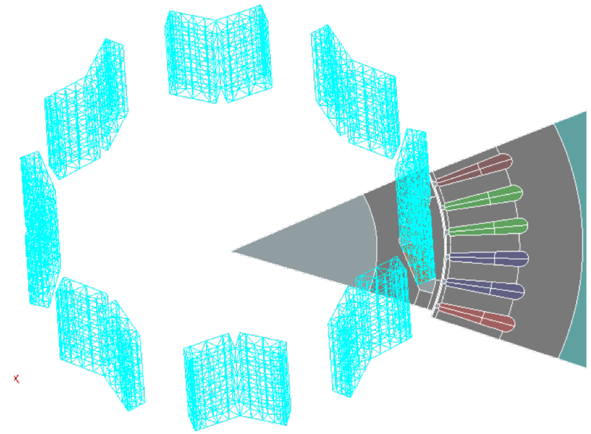
- Available in **Beta Mode**

PREISACH’S MODEL (BETA)

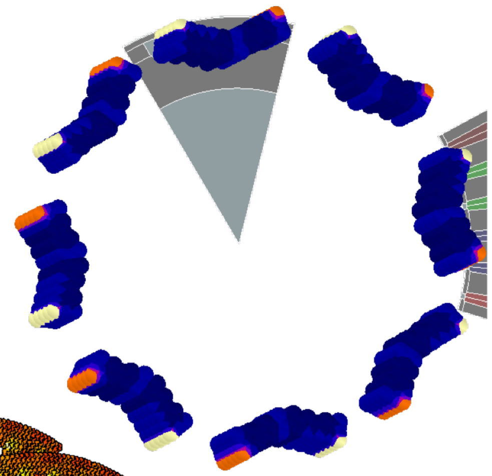
RESULTS PREVIEW DURING SOLVING



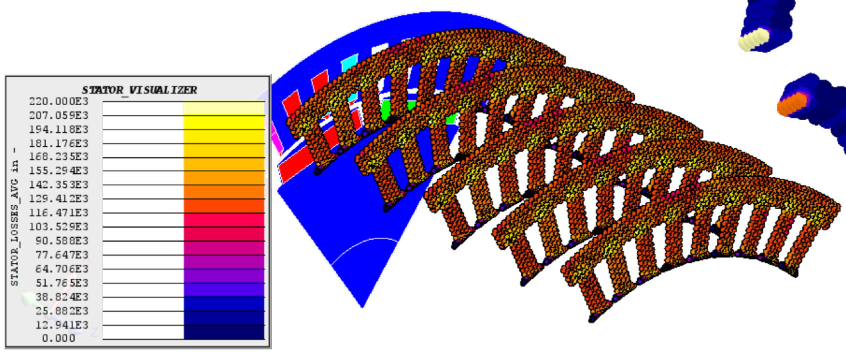
IMPROVED IMPORT/EXPORT CONTEXT



- **For Multiphysics coupling** purposes
- **Specific contexts** for **thermal** and **mechanical** coupling
- Any Flux **spatial quantity** can be **post-treated** and **exported**
- Data collected over **defined supports**
- Export for **3D full device** can be generated from a **2D simulation !**

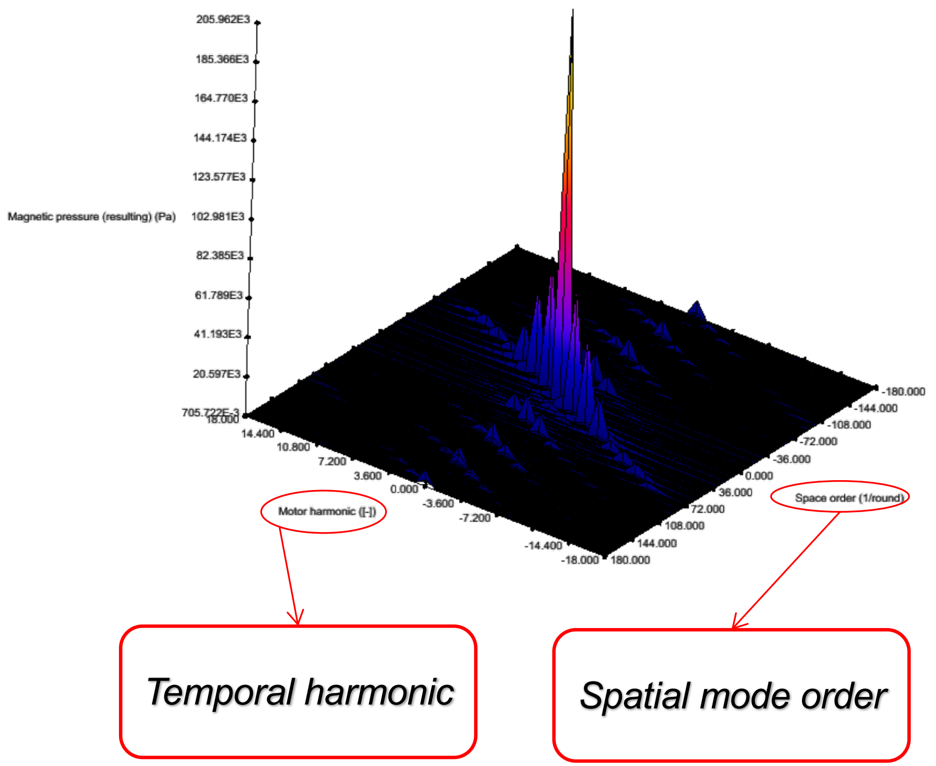


- After collect data:
  - **Data visualizer** can be used
  - **Export available** in several formats



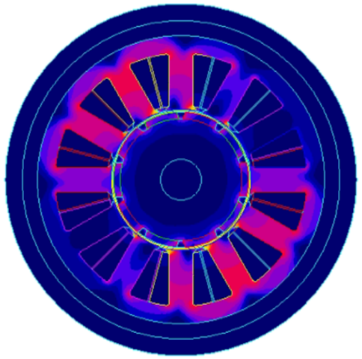
3D CURVES DEDICATED TO ROTATING MACHINES

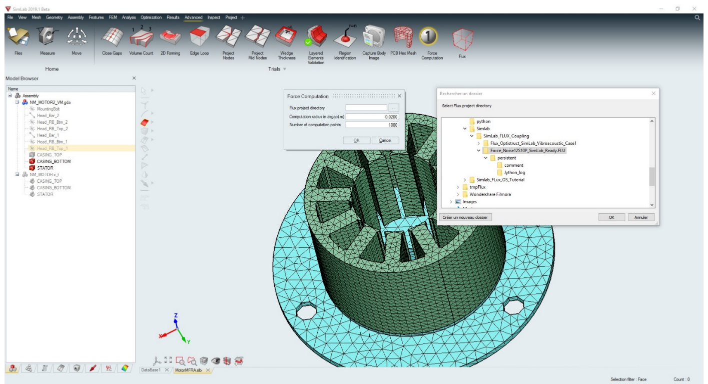
- Postprocessing option in **transient magnetic**
  - New option in **curve menu**
- Useful for **NVH analysis** of **electrical machines**
- 3D curve of **magnetic pressure over the stator**
- Two different representations
  - **Real domain: time** and **angular position**
  - **Frequency domain: frequency** and **spatial order**
    - Typical input for **vibration analysis**



FLUX RUN AUTOMATICALLY BY SIMLAB TO PERFORM NVH ANALYSIS BY OPTISTRUCT

SimLab UI → Import CAD → Mesh → **Force Computation** → Complete the model setup → Solve /Export as Optistruct "Modal Frequency Analysis"





SL

- Collect the parameters required for "Flux to do force computation" and export the surface mesh information
- Write a python script
- Call Flux in back ground.

Flux

- With the help of SimLab created Python script

1. Load the project
2. Open Mechanical analysis
3. Do force computation and export the information as bulk data.

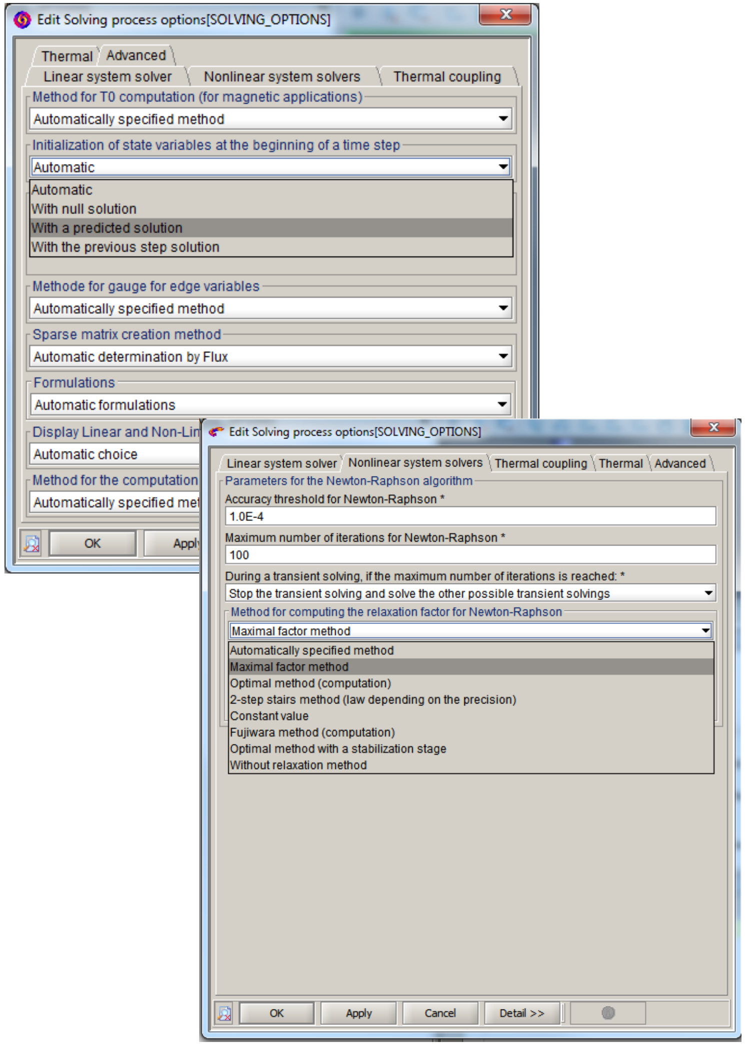
SL

- Read flux exported bulk file (Based on the information present in the Bulk file, Load cases will be created automatically).

Background

FASTER AND BETTER CONVERGENCE

- New **initialization method in transient solving**
- **Solution** of present time step **predicted from previous time-steps**
- More **reliable** and **robust non-linear solving**
  - New relaxation method for non-linear solving: **Maximal factor method**
  - Switch **automatically** from the Newton-Raphson to the fixed-point method

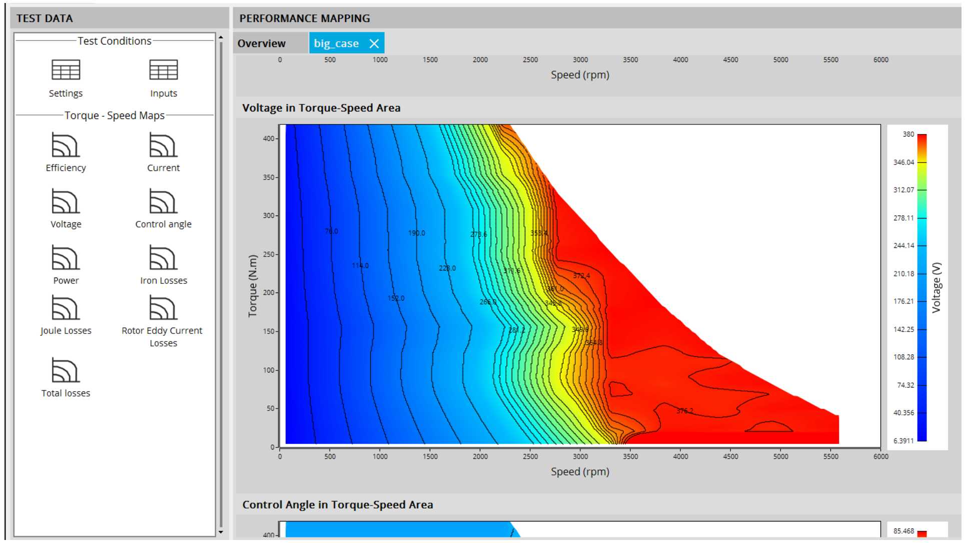


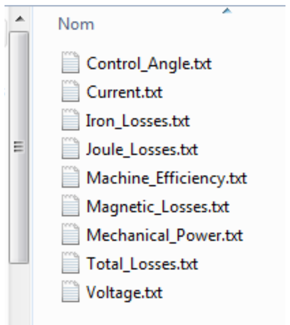
LATEST RELEASES

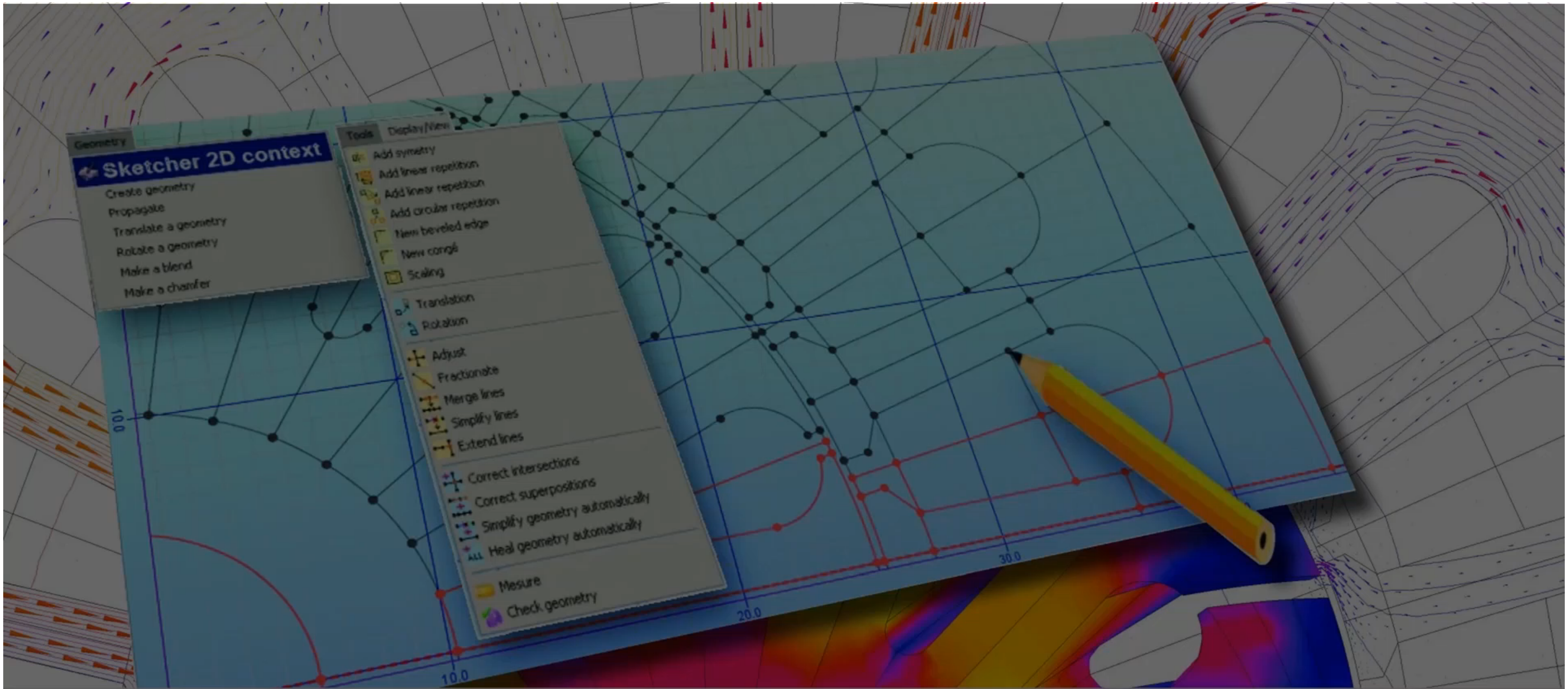
Altair Flux 2019.1 Main Features

FLUX E-MACHINE TOOLBOX : FEMT

- **Brand-new Altair Flux tool**
- Accurate calculus of **efficiency map**
- Launch from **Supervisor** or your **2D/3D/ Skew project**
- **Several maps available** including **efficiency**, **losses**, currents and voltages
- **Automatic report generation**
  - PDF
  - HTML
- **Outputs available** in dedicated files





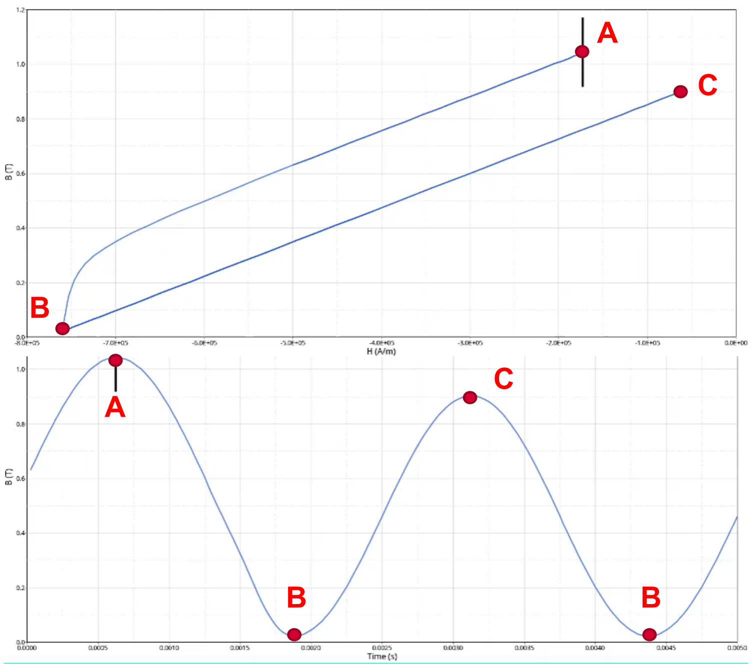


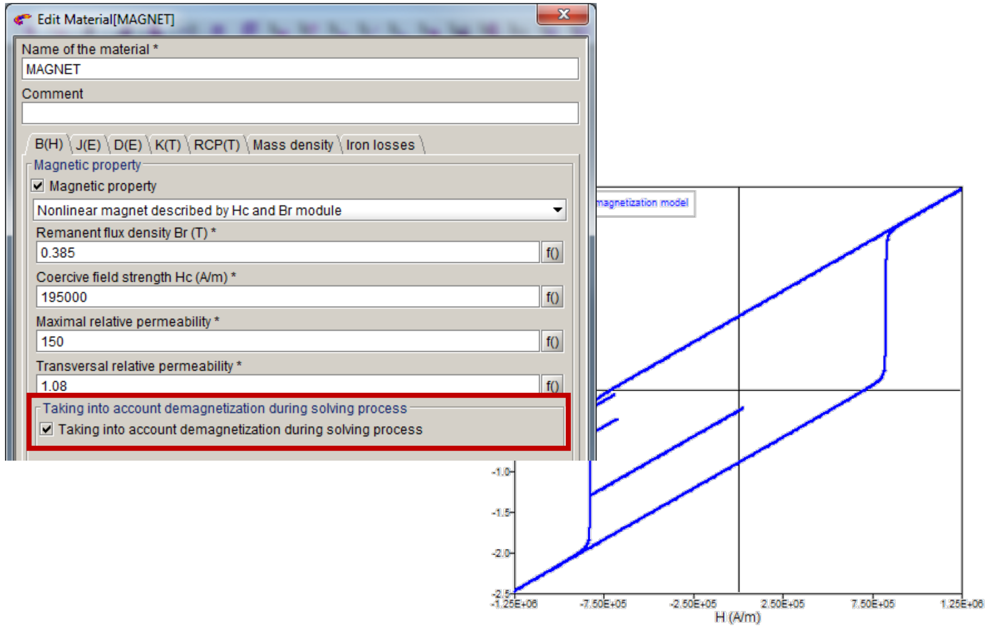
Flux e-Machine Toolbox : FeMT

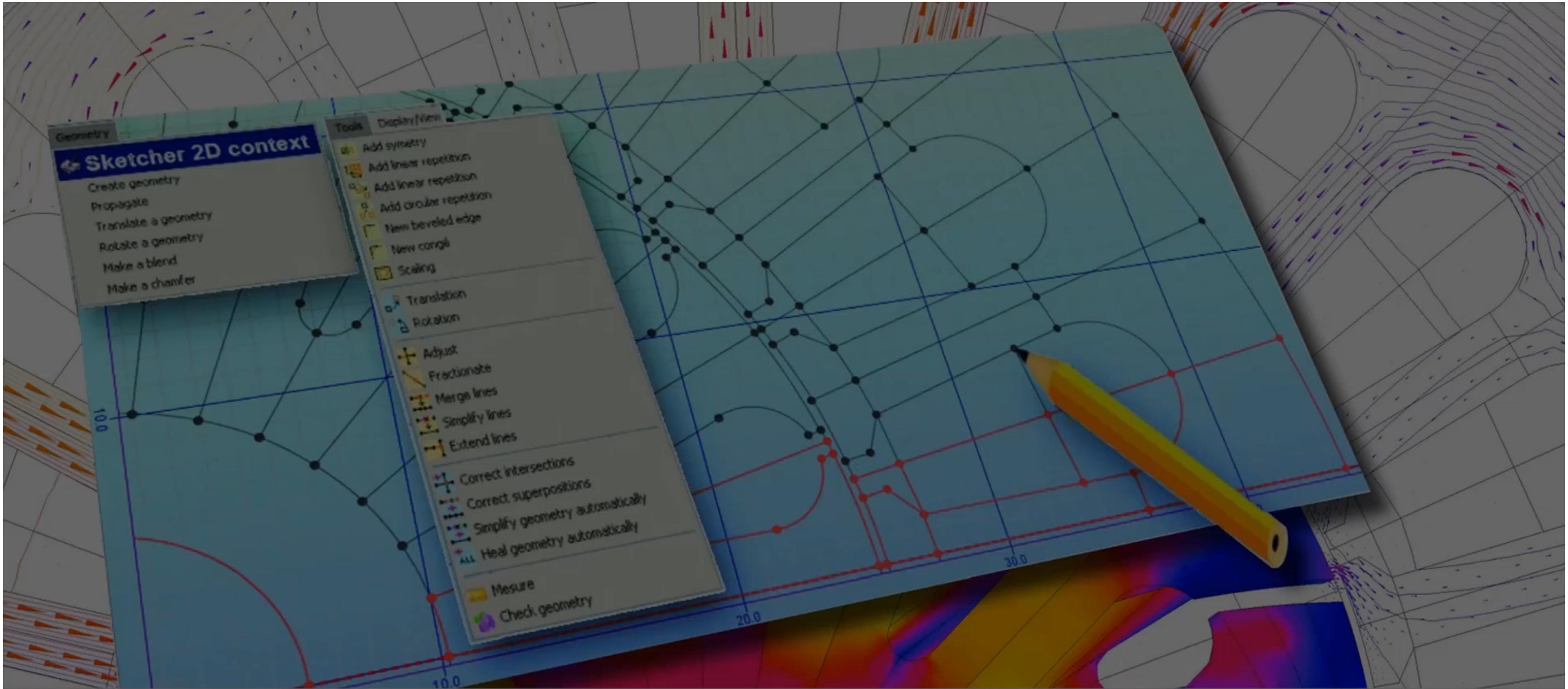
Altair

DEMAGNETIZATION DURING SOLVING PROCESS

- **BH curve** takes into account **demagnetization process**
- Real behavior and efficiency of devices depends on the real magnetization state of their magnets
- Easy to use – Just **check the option from material properties**
- **Deep insight** in real magnet behavior in its real environment





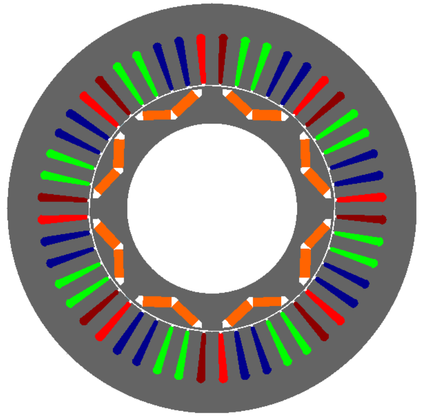


Altair Flux 2019.1 : Demagnetization During Solving

Altair

IRON LOSSES – MODIFIED BERTOTTI MODEL

- **Computation time reduction**
  - Case of study: Prius Motor
  - 1375 steps simulated (transient parametric study)
  - Critical improvement for multiphysics and optimization processes



	Solving time	Postprocessing time	Total time
2018.1 with distribution (10 Cores)	9min 05s	1d 22h 27min 9s	1d 22h 36min 14s
2019	1h 03min 04s	11h 40min 39s	12h 43min 43s
2019.1	48min 56s	6s	49min 02s
2019.1 with distribution (10 Cores)	9min 05s	5min 43s	14min 48s

Speed Up

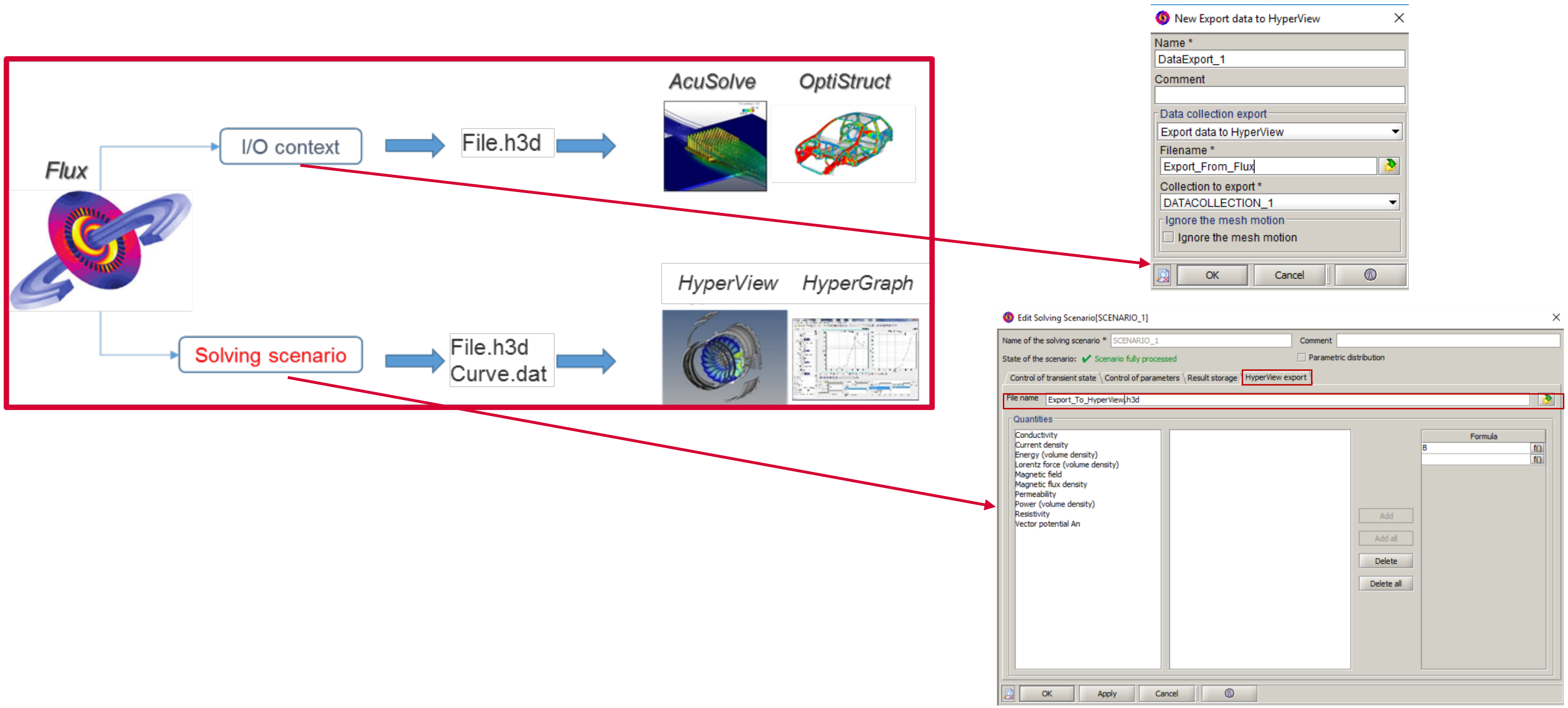
3.5

57

189

DATA EXPORT TO HYPERVIEW

- **H3D export : augmented post-processing in Hyperview and HyperGraph**
- Available in the **scenario menu** and in the **Import/Export context**



DATA EXPORT TO HYPERVIEW

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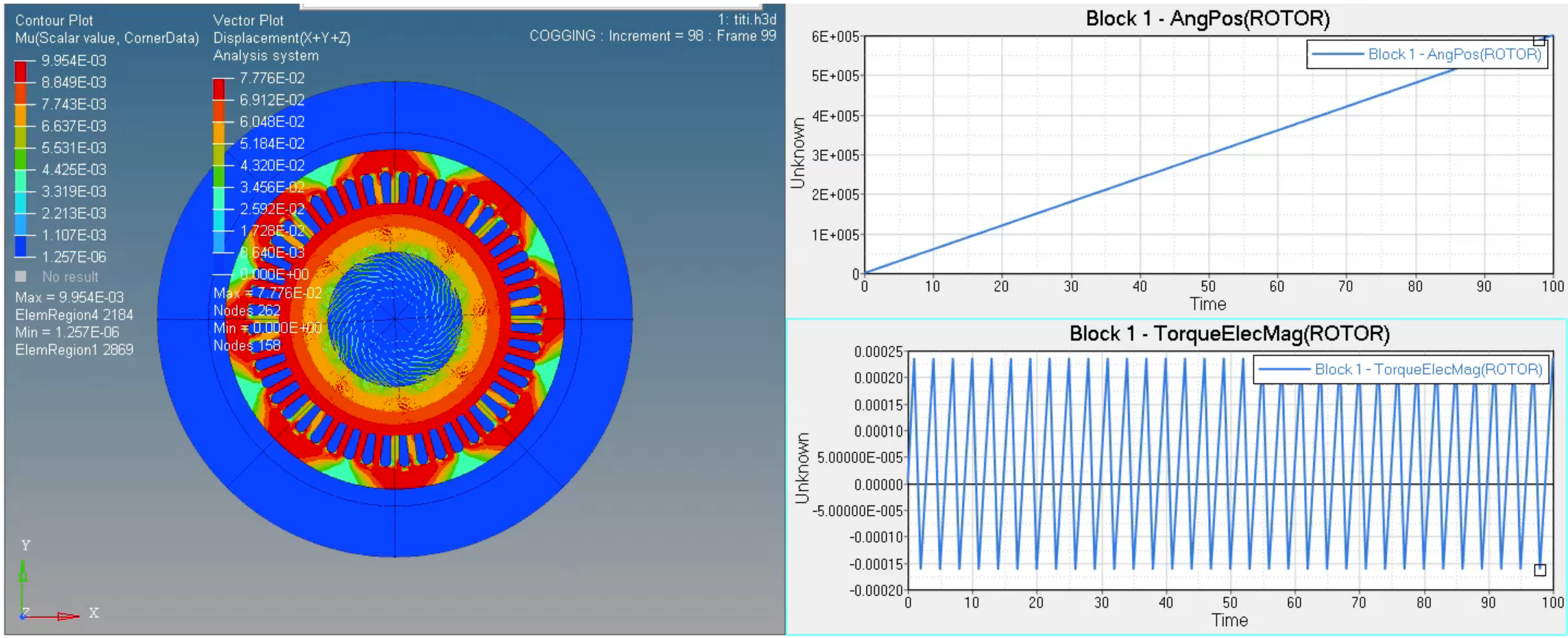
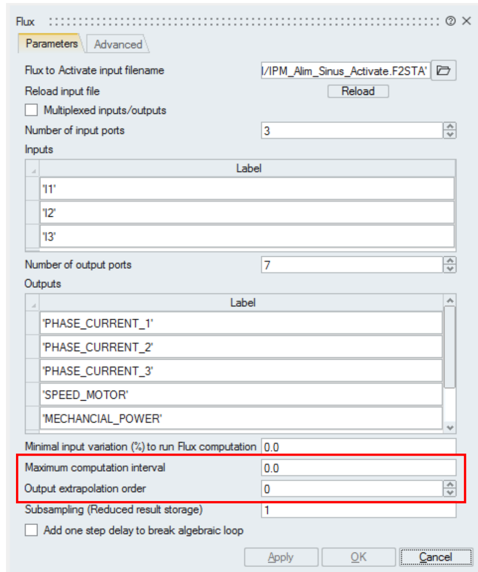
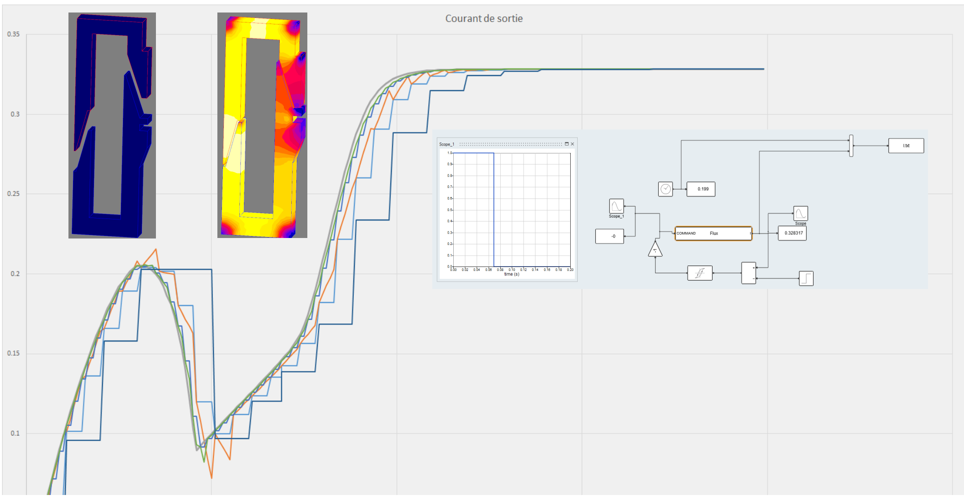


FLUX-ACTIVATE COSIMULATION

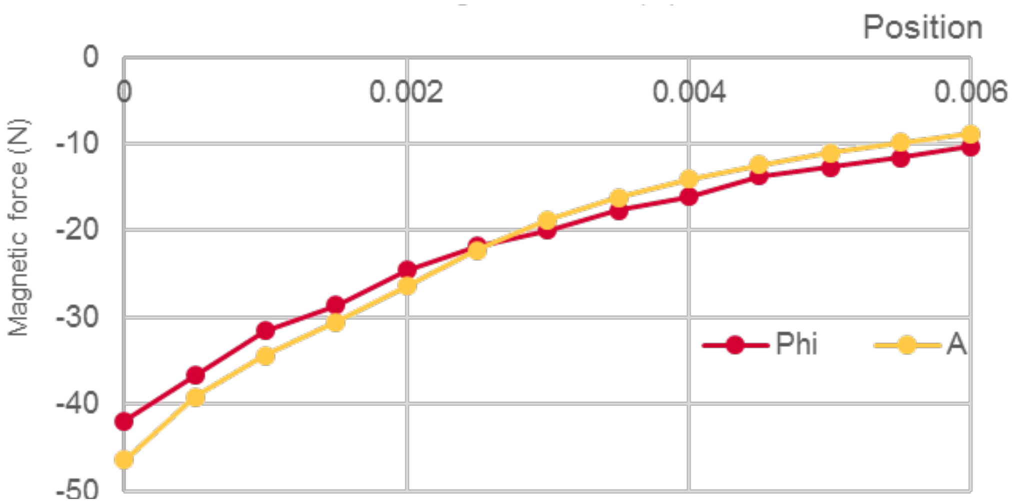
- **Enhanced coupling** between Flux 2019.1 – Solid Thinking Activate 2019.2 .
- **Two new parameters** among coupling options
  - **Maximum computation interval**: Allows Flux launching even if there are not changes from Activate side
  - **Output extrapolation order**: Allows **linear extrapolation** between Flux results
- **Advantages**
  - The user can choose the ratio between accuracy and speed

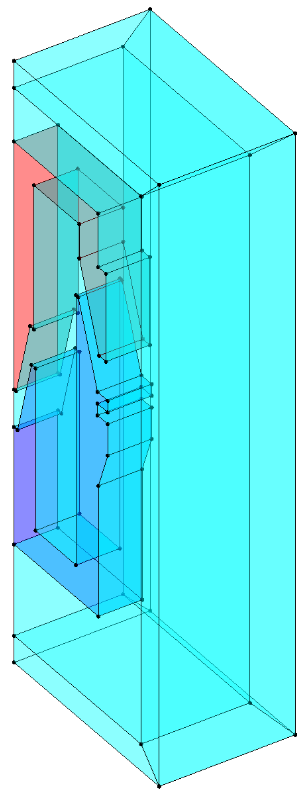




SPEEDING-UP 3D SIMULATIONS

- Magnetic vector potential **A** formulation **available for translating motion**
- **Advantages** :
  - **No artificial magnetic cuts**
  - **Better non-linear convergence**
  - **Faster and better results with solid conductor**
- **Test case**: **Translating motion tutorial** of Altair Flux





Speed Up

2,5

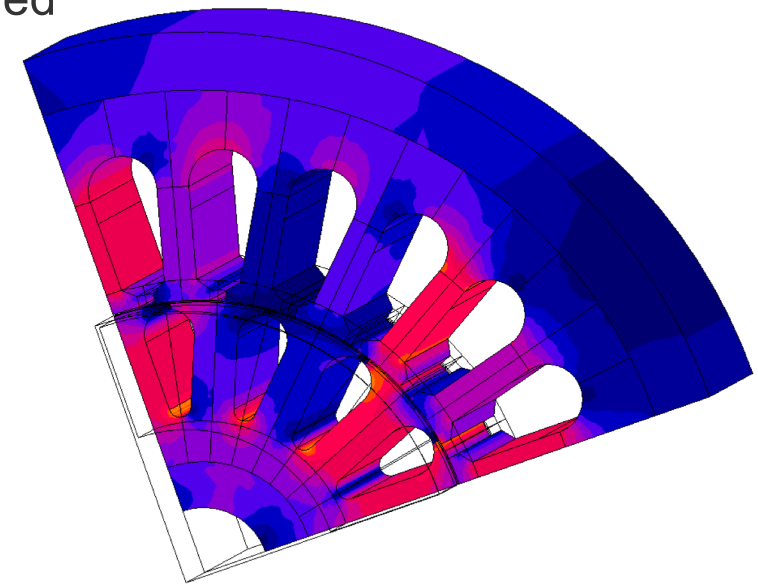
SPEEDING-UP 3D SIMULATIONS

- Magnetic vector potential **A** formulation **available to model induction machine's slip**
- **Advantages** :
  - **No artificial magnetic cuts in the squirrel cage**
  - **Better non-linear convergence**
- **Limitations:** Mechanical sets using sliding mesh not allowed
- **Test case**: Classical rotating induction motor

Speed Up

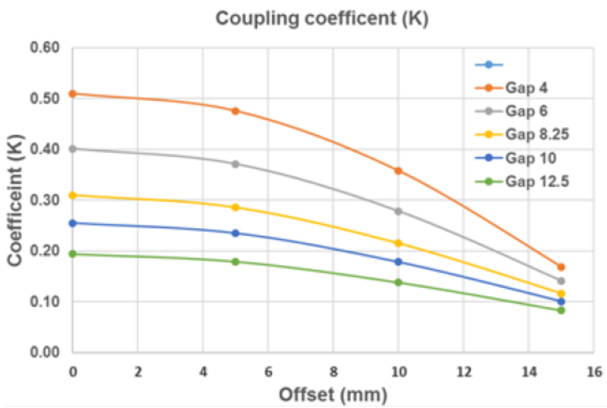
3,2

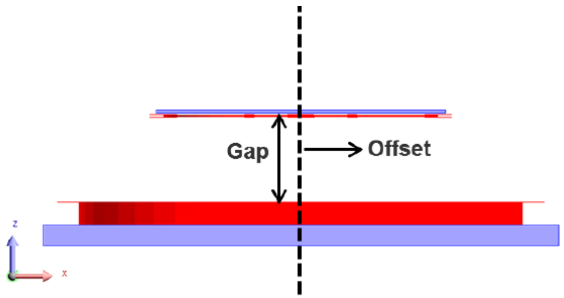
	A-V	T-ϕ
Torque s=0.05 (N.m)	0.331	0.316
Solving time (10 step)	1H37	4H37



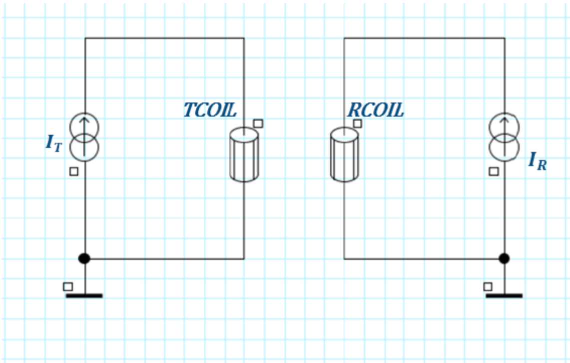
AND ALSO… THREE NEW SUPERVISOR EXAMPLES

- **Wireless power transfer (3D)**
- Model based on **wireless power transfer demo kit by Linear Technology**
- **Coupling coefficient** and **self/mutual inductances** are calculated
- **Parametric studies** depending on **gap** and alignment **offset**

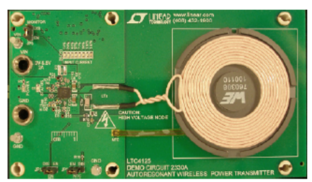




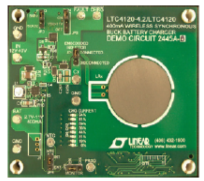
Coils arrangement (Nominal case Gap = 8.25 mm, Offset = 0)



Electric circuit setup



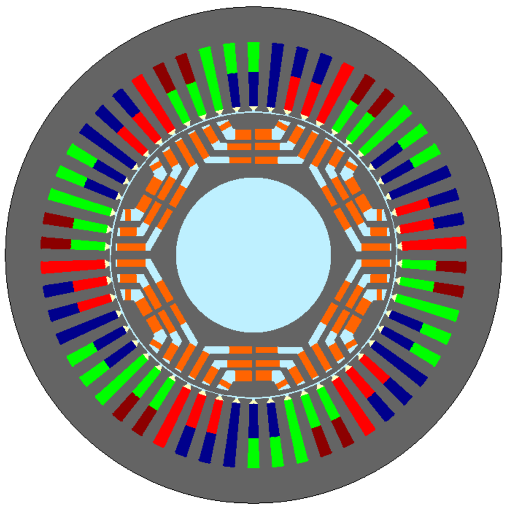
- Transmitter circuit and coil

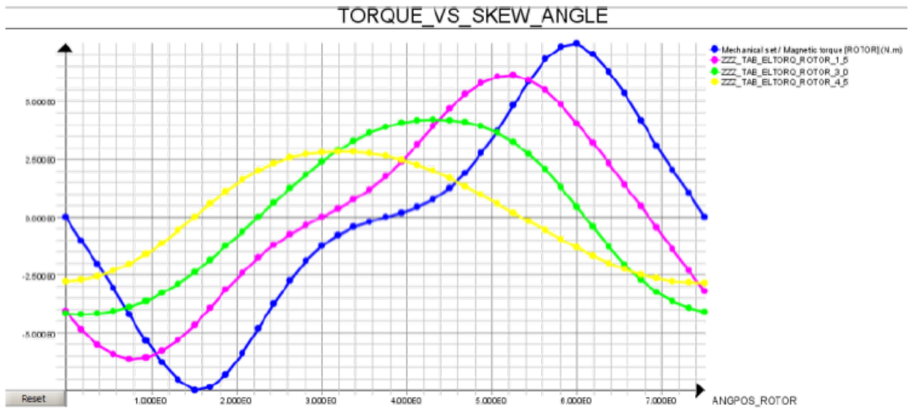


- Receiver circuit and coil

AND ALSO… SEVEN NEW MACROS

- **Compute skew effect from curve (2D):**
- **Goal** : From a **2D magnetic computation**, the **impact of skew** on some quantity (e.g., **EMF** and **torque**) is calculated
- **Method** : Several 2D simulations are run to represent skew effect
- **Constrain**: No eddy currents in rotor

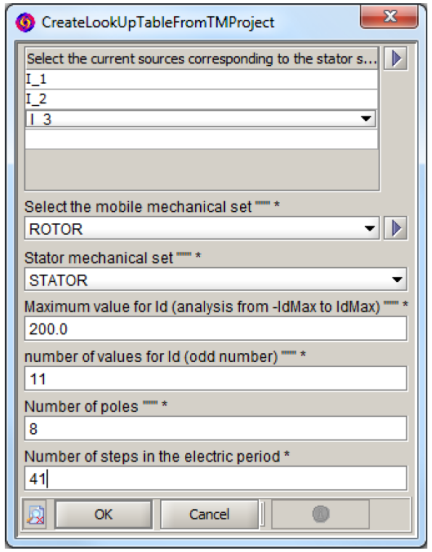




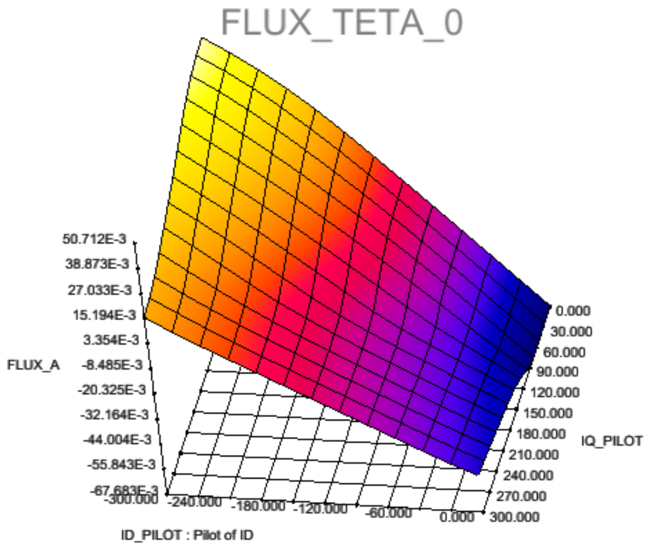
Cogging torque – Initial curve in blue

AND ALSO… SEVEN NEW MACROS

- **Create look up table for electric machine from transient magnetic project:**
- **Goal** :Generate tables: **Flux in abc axis** and **torque** versus I_d, I_q and **rotor position**
- **Method** : Each point of the table is simulated independently
- **Warning**: solving time may be quite long. **Distribution calculus is advised**



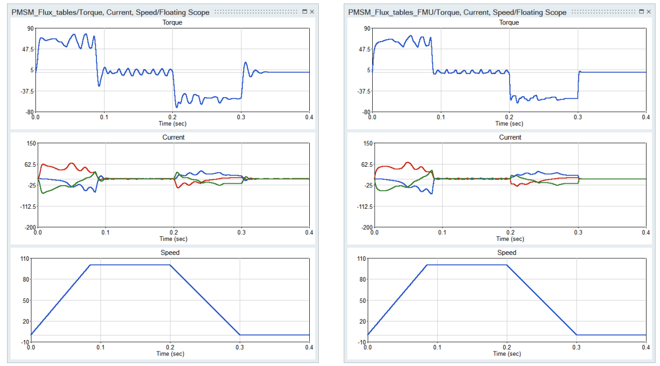
*11*11*41 = 4961 computations required in this example*



Altair Flux 2020

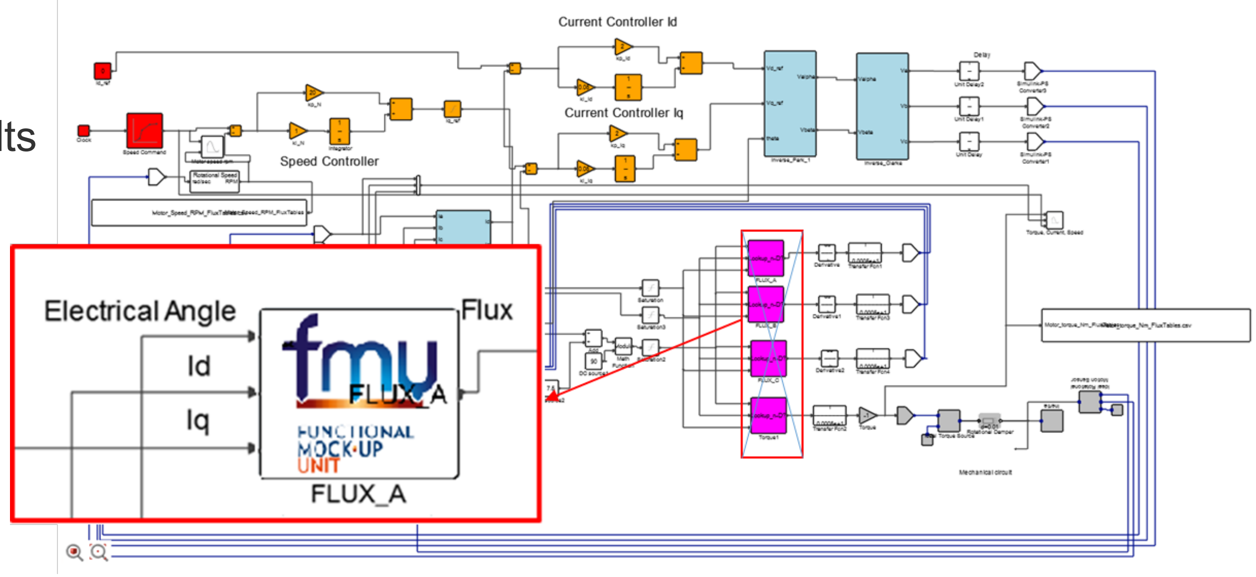
EASIER COUPLING WITH SIMULATION TOOLS

Table model FMU model



- Direct menu in Flux to export FMUs and lookup tables
- Advantages :
  - Easy to use
  - Speed up of Activate simulation with FMU
  - Compatible with other system simulators
- Example
  - PMSM used for HEV power train
  - Time divided by 3 with same results

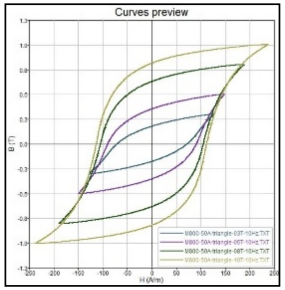
Vector Control of a Permanent Magnet Synchronous Machine modelled by Magnetostatic Tables from Flux2D



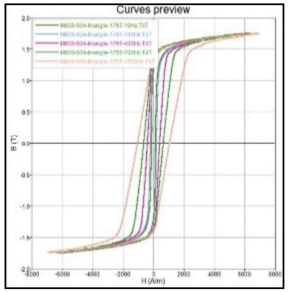
BETTER ACCESS TO ACCURATE SIMULATION OF IRON LOSSES

Measurements

Static part

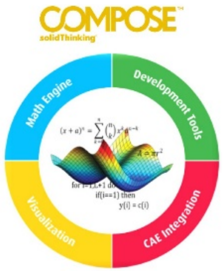


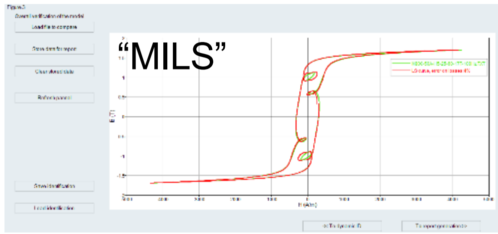
Dynamic part



Measurements text file →

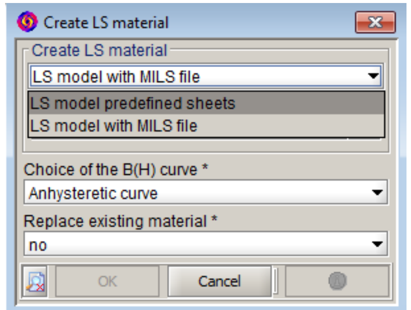
Identification module for LS model





Text file ".mils" →

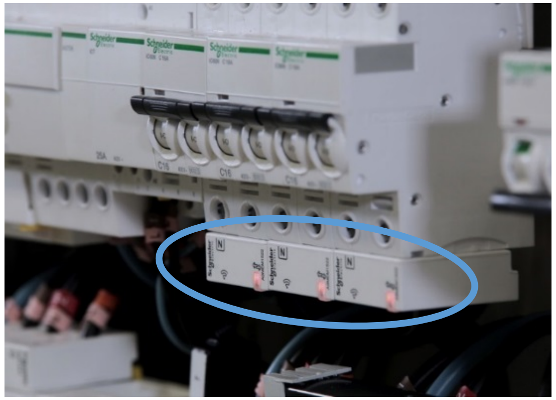
Flux

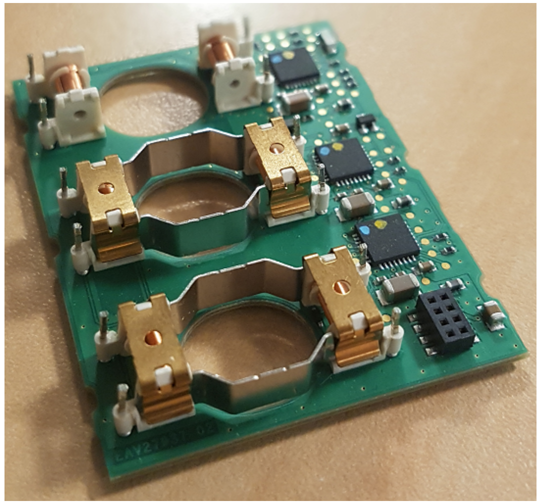


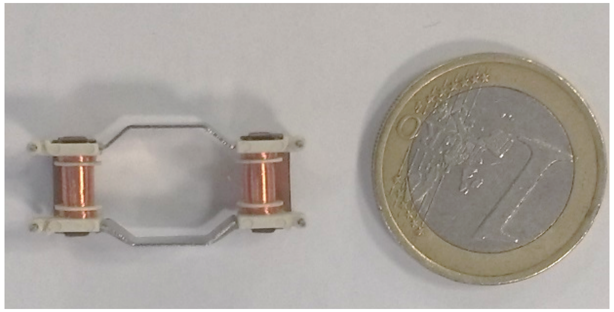
NEW METHOD FOR 3D MAGNETOSTATIC

Life Is On | Schneider Electric

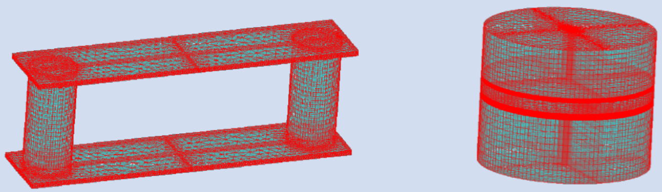
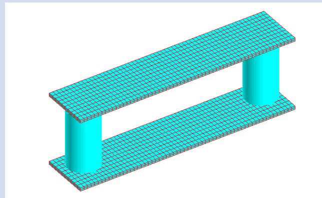
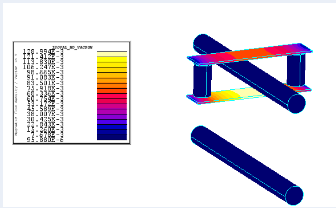
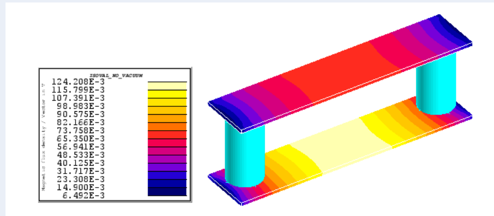
- For situations with a lot of flux leakage in air
- Using Integral Methods
- Advantages :
  - No air mesh
  - Fast computation
  - Accuracy of the Flux
- Example : Crosstalk in “PowerTag” sensor







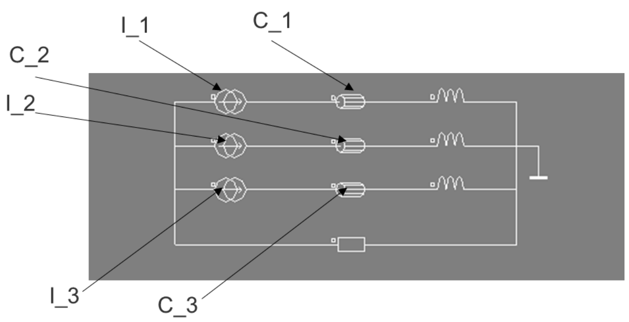
NEW METHOD FOR 3D MAGNETOSTATIC

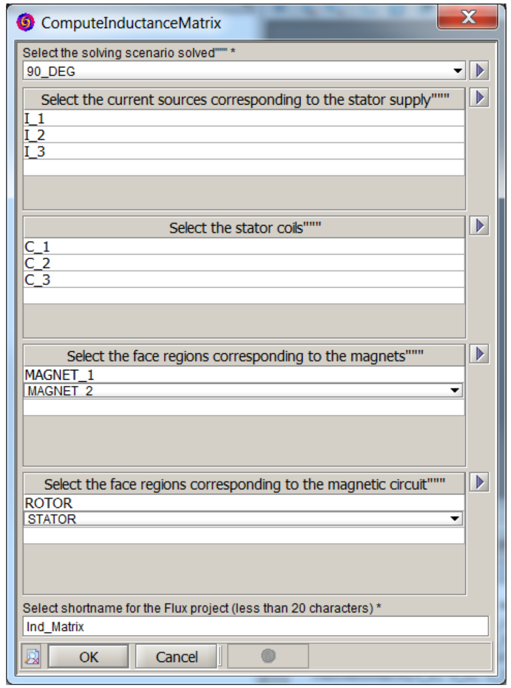
	Finite Elements	Integral Method
Mesh		
Results	F_COIL1 = -4,36E-10 Wb F_COIL2 = -4,36E-10 Wb 	F_COIL1 = -4,49E-10 Wb F_COIL2 = -4,49E-10 Wb 
Computation time	45 min	5 min

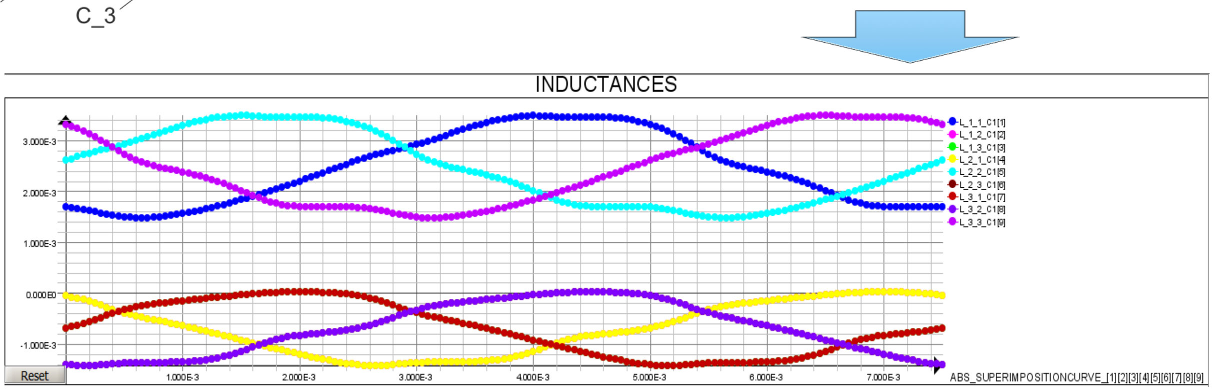
INDUCTANCE COMPUTATION IN TRANSIENT

- To compute the differential and apparent inductances of a rotating machine in 2D for system solving

- Advantages :
  - Faster than Macros
  - Direct access from Flux

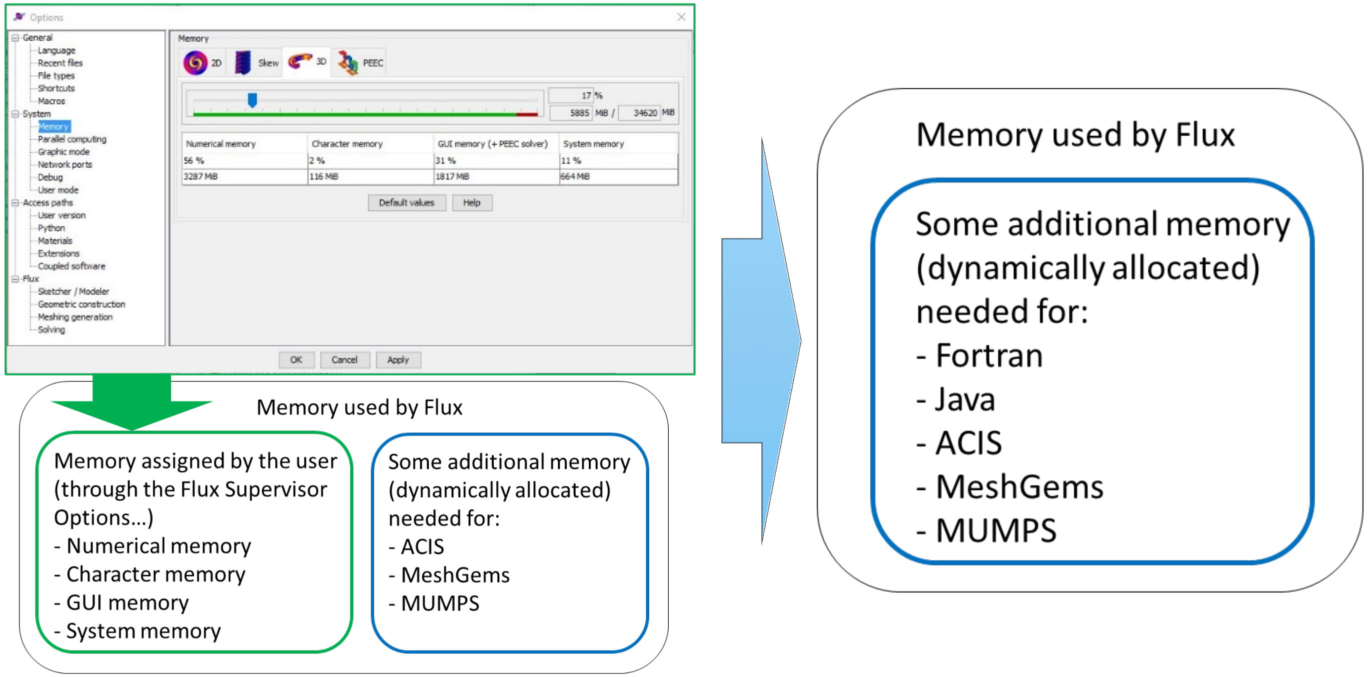






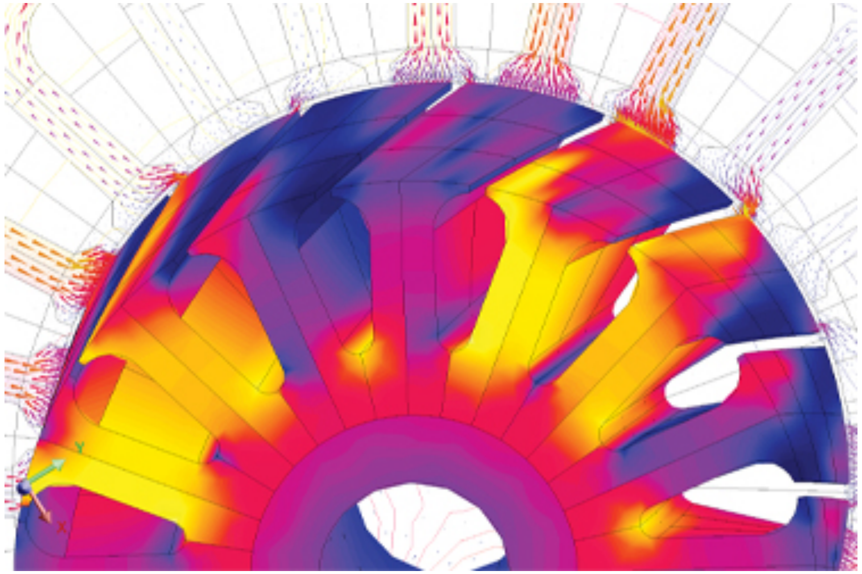
DYNAMIC MEMORY ALLOCATION

- To help users to allocate the memory in Flux
- Advantages :
  - No more questions about memory
  - Useful for HPC computation



IMPROVEMENTS OF SKEW MODULE

- Faster Solving of Steady-state AC models
- Optimized I/O Context
- Iron Losses in Laminated regions



IN PREPARATION FOR FUTURE VERSIONS

MAIN PRIORITIES

USER EXPERIENCE

MODELING CAPABILITIES

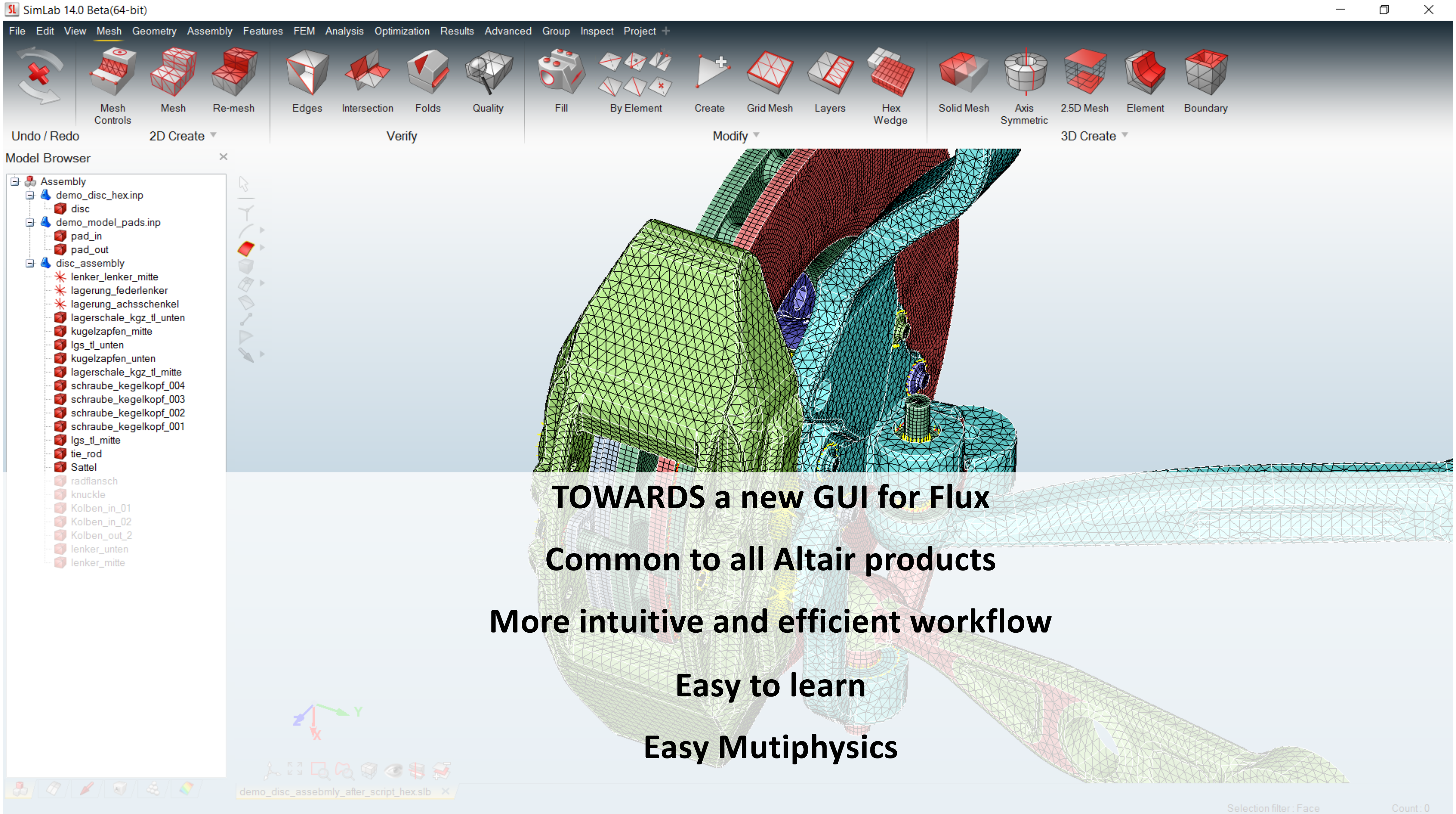
SOLVER PERFORMANCE

USER EXPERIENCE

- Improvements on the environment
  - New documentation : already some improvement in Flux 2020

- Defining coils in 3D in a more flexible and easier way
  - Non-meshed coils easier creation
  - Less constraints on the definition of meshed coils

- Towards full automatic choice of solver options



TOWARDS a new GUI for Flux

Common to all Altair products

More intuitive and efficient workflow

Easy to learn

Easy Mutiphysics

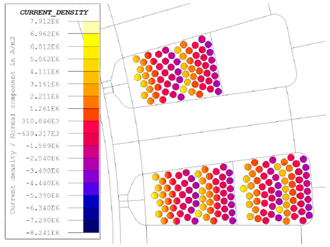
SOLVER PERFORMANCE

- Continue our efforts to shorten solving times
  - Using parallel computation and domain decomposition

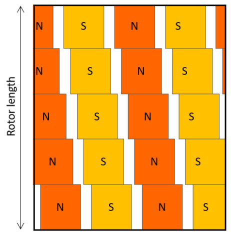
- Special effort to speed-up transient computations (especially for 3D eddy currents)
  - Going faster to reach steady state
  - Solving several time-steps in parallel
  - Using A-V formulations with movement consideration : sliding mesh

- Introducing topology optimization

MODELING CAPABLITIES



- Better evaluation of losses
  - Losses in coils and iron sheets in transient using homogenization methods
- Material database manager
  - Bringing more material references from manufacturers
  - Adding data losses to materials
- More capabilities for Flux Skew
  - Zig-zag skew and step skew



- Taking advantage of PollEx technologies for Power Electronics simulation
- Going further in multiphysics workflows
  - Flux-AcuSolve 2-way coupling through SimLab
  - Magneto-structural interactions
  - Going further in NVH analysis taking into account multiple speeds

Thank you!