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MagNet 7.5 Release

June 2014

Features that extend the applications of MagNet

- Force fields
  - Link to MpCCI
- Perfect electric boundary condition
- Non-linear BH properties along 3-axes
- Improvements to the non-linear surface impedance approximation model

Force fields and link to MpCCI

Force density

- In MagNet 7.5, there is a built-in function to compute the force density on any component in a device. The component may be ferromagnetic, permanent magnet or a current carrying conductor.
- With the formulation employed in computing the force density field, it is possible to obtain the force on a component even when it is touching other component(s).

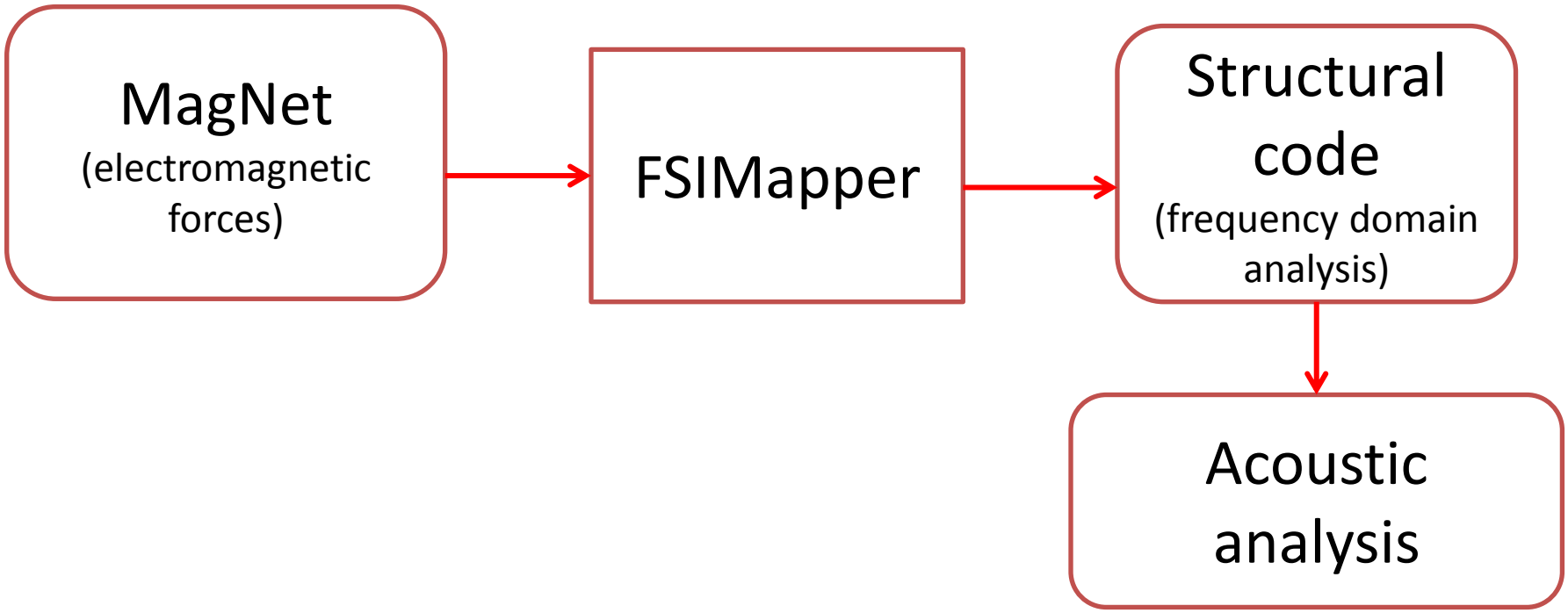
Nodal forces and link to MpCCI

- An Extension is being implemented which computes the nodal forces based on the force density field. The main purpose for this new Extension is to create a link between MagNet and MpCCI, enabling magnetics-structural coupled simulations.
- This Extension will be released, separately, over the next few weeks.

Vibration and noise

- The first application of this new Extension is to provide a solution for the study of vibration and noise.
- In collaboration with Infolytica, Fraunhofer SCAI is implementing an adaptor in FSIMapper, one of the tools within the MpCCI coupling environment, in order to create a link between MagNet and a number of structural analysis codes available in the market.

Flow diagram for performing a vibration and noise study



Thin perfect electric insulators

Thin perfect electric insulators

- Thin perfect electric insulators, applied as a boundary condition to a surface, stop the current flow from one conducting component to a touching conducting component.
- There is no longer a need to create a volume to represent the very thin insulating sheet; hence, there is no need to mesh a very thin region.
- There are a number of applications: one application is the modeling of segmented magnets.

Example: a permanent magnet motor

- In high speed applications, the eddy current losses in the permanent magnets deteriorate their magnetic properties and may even pose a risk of thermal demagnetization.
- In this application, an effective method to reduce the eddy current losses is to segment the permanent magnets.

Example: a permanent magnet motor (Contd.)

- In the next few slides, a surface mount permanent magnet machine is used to investigate the effect of segmentation.
- Generally, very thin insulation layers are employed to separate the PM segments, which are difficult to model and mesh.
- The perfect electric insulator (PEI) boundary condition provides a very simple method to model the insulation layer.

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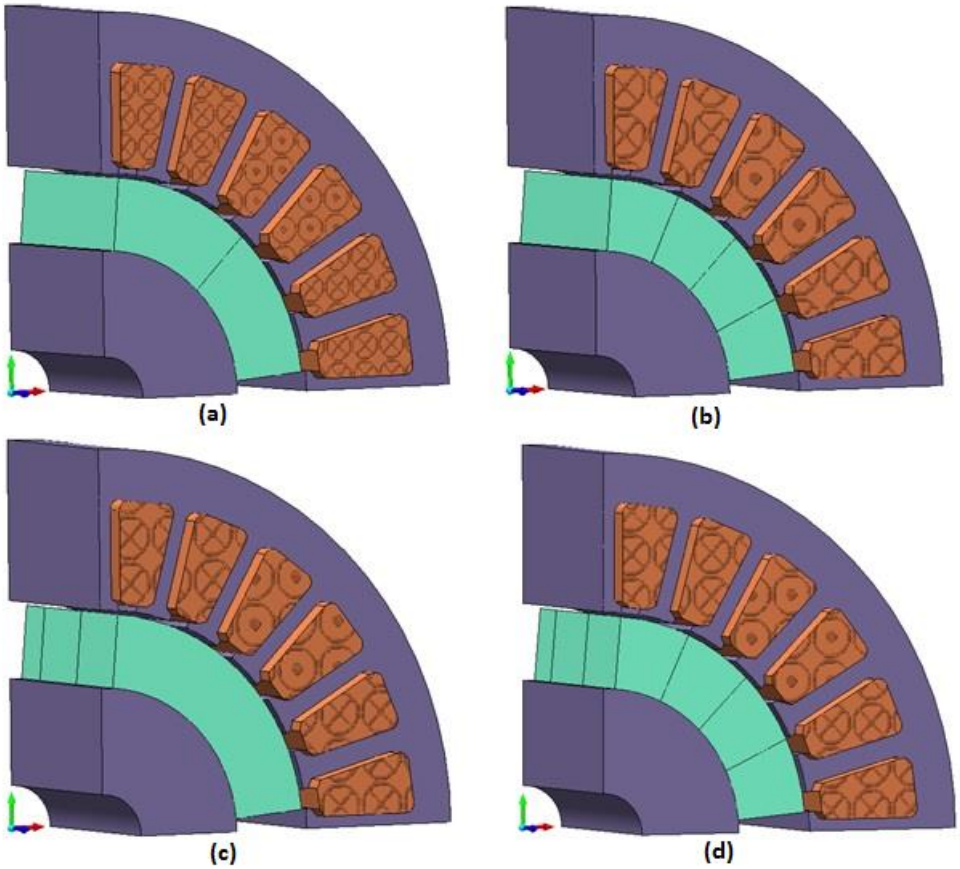
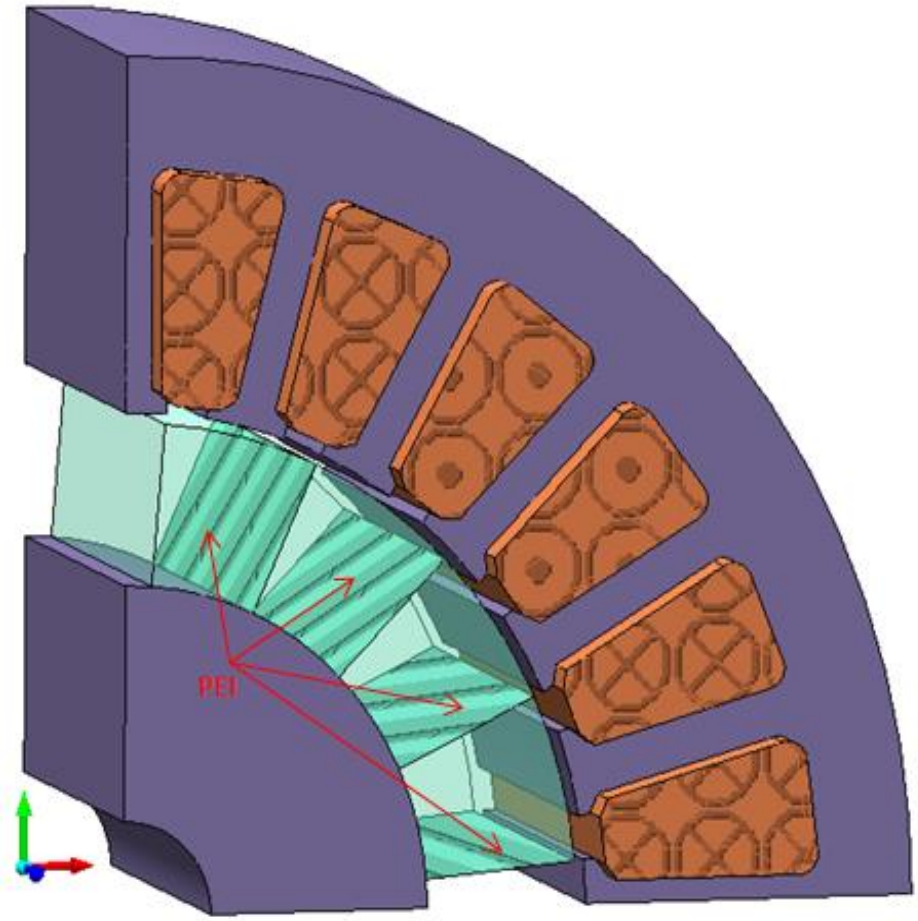
Example: reducing eddy current losses in a permanent magnet motor



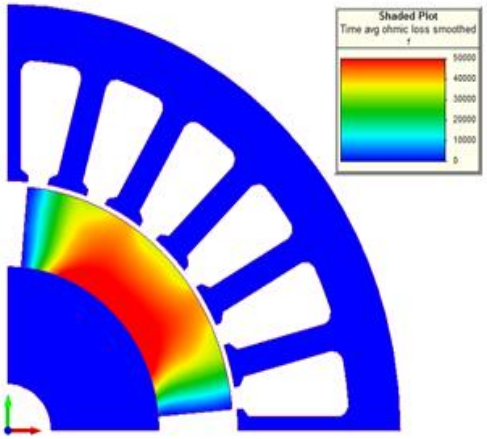
Assigning perfect electric insulators

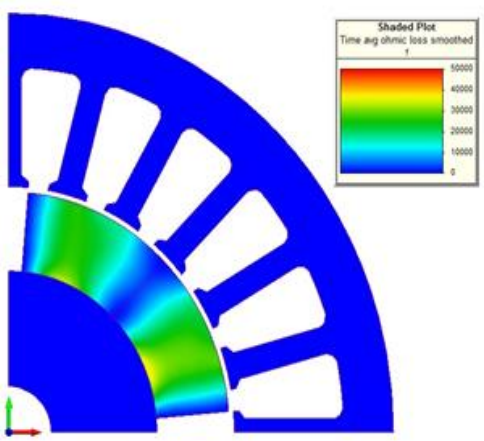
Surfaces defined as perfect electric insulator

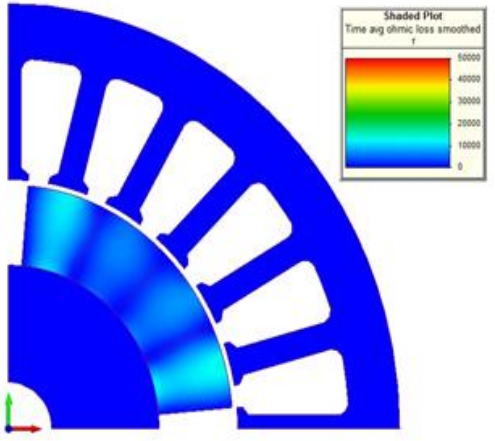


Effect of segmentation on eddy current losses

- No segmentation,
- 2 segments and
- 4 segments







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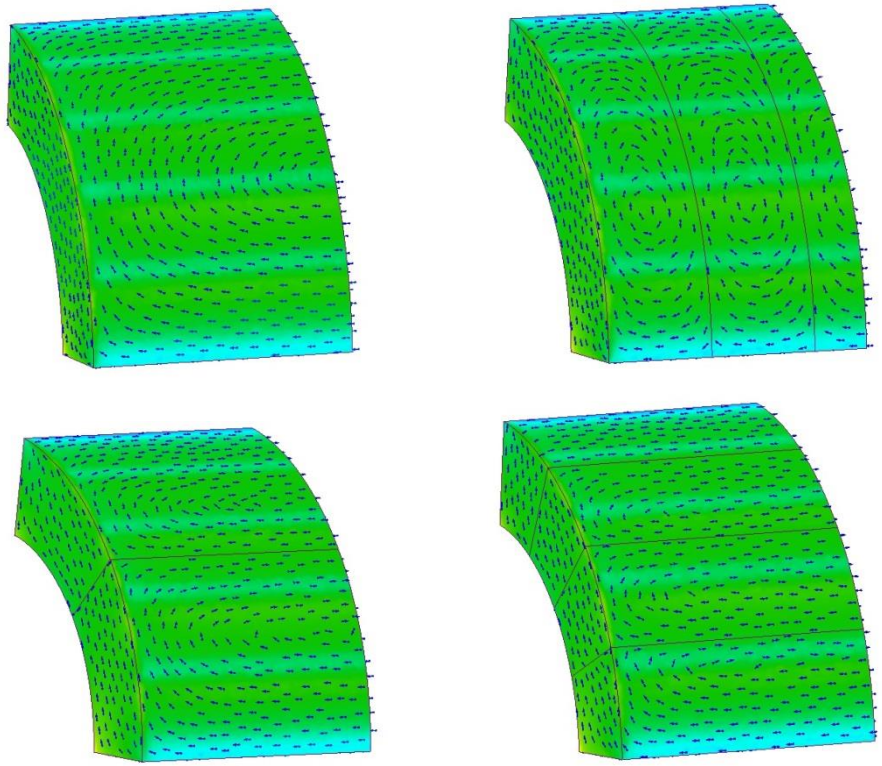
Circumferential and axial segmentations

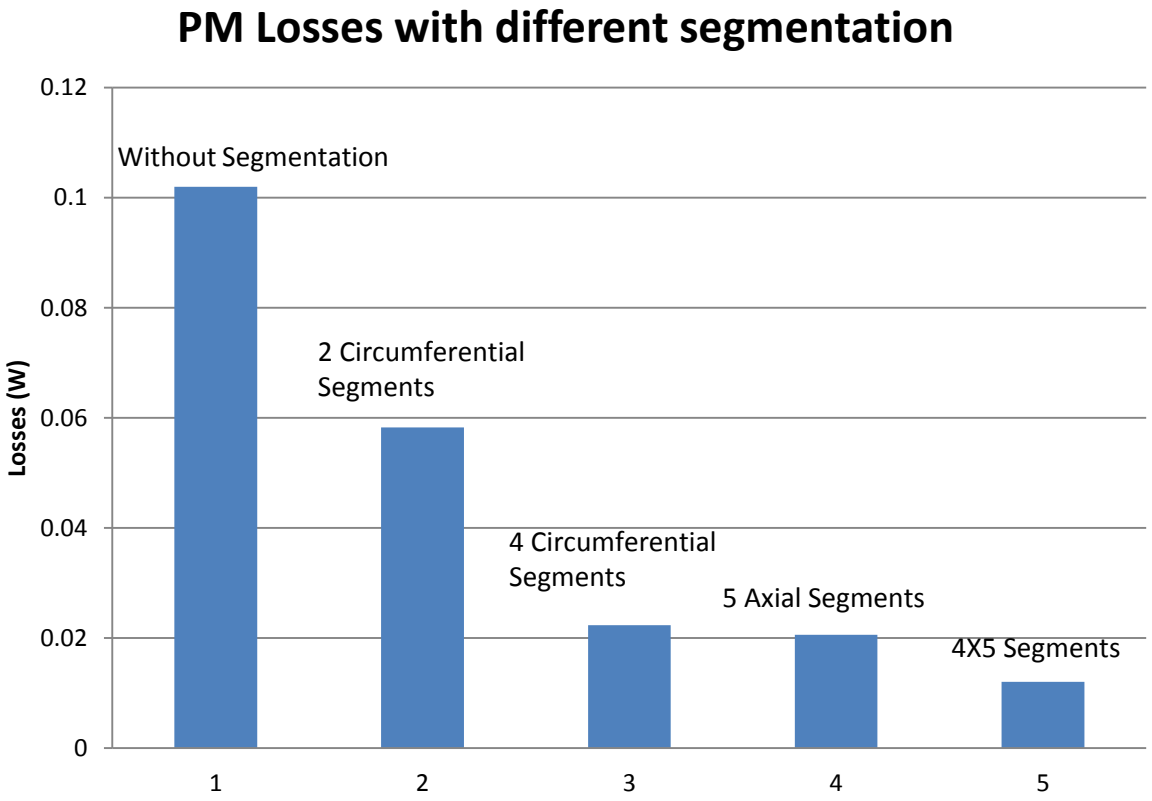
Current density arrow plot

- No segmentation
- Circumferential segments
- Axial segments



Permanent magnet losses

- No segmentation
- Circumferential segments
- Axial segments
- Mixture of circumferential and axial segments



Thin perfect electric insulator applications

- Segmented magnet modeling is not the only application of thin perfect electric insulators
- Any time, two adjacent conducting components are separated by a thin insulator, the new boundary condition can be used to make the modeling easier

Anisotropic non-linear BH properties

Nonlinear BH properties along 3-axes

- In MagNet 7.5, it is possible to define three nonlinear BH properties corresponding to the three axes.
- This feature was requested by several of our users in the power transformer industry.

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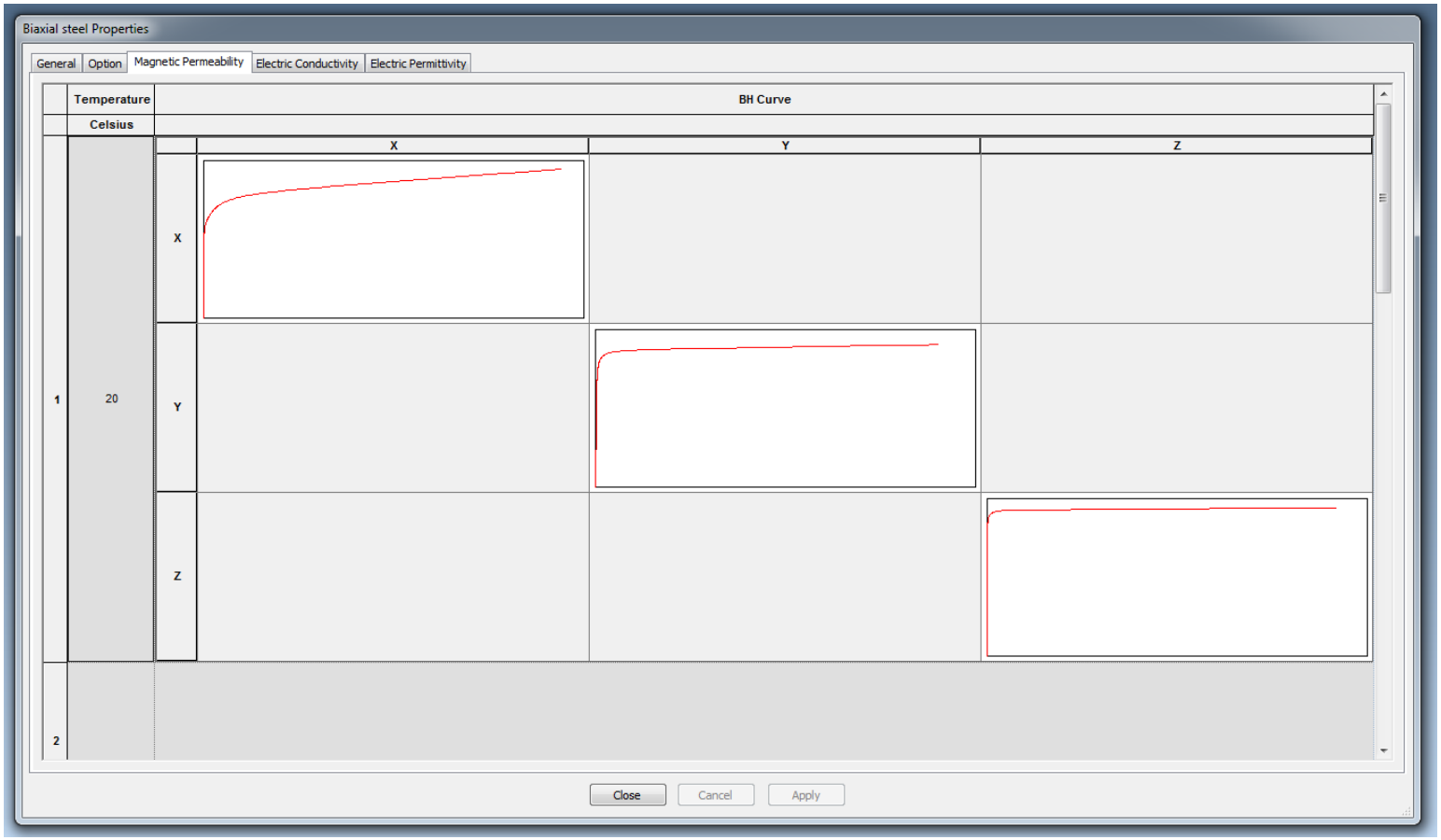
Example: Nonlinear BH properties along 3-axes



Improvements in the non-linear surface impedance model

Surface impedance approximation

- The tank and the clamping plate in a transformer are large structures which could use the surface impedance approximation to reduce the problem size.
- To increase its usefulness, the surface impedance boundary condition supports nonlinear BH properties; making the nonlinear time harmonic simulation quite advantageous as a more efficient alternative to time domain simulation.

Improvements to nonlinear surface impedance model

- After experience with the work of several power transformer designers, Infolytica came up, in MagNet 7.5, with its own unmatched in-house formulation of the nonlinear Surface Impedance approximation.
- In the new formulation, both the low and the high saturation regions of the non-linear BH properties are modeled accurately.

Improvements to nonlinear surface impedance model (Contd.)

- Additionally, in a non-linear context, if the B field is sinusoidal, then H is non-sinusoidal and vice versa. Any realistic model is always B- or H-sinusoidal to some extent. The new formulation, implemented in MagNet, covers both the B- and H-sinusoidal cases.
- The new formulation has been tested on a wide range of materials. The accuracy of the results, using the new formulation, has been confirmed by comparing to measurements for a few cases, made available by our users in the power transformer industry. With the release of version 7.5, there will be a new application page on the website that demonstrates its accuracy.