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# Influence of air-gap length and cross-section on magnetic circuit parameters

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# Influence of air-gap length and cross-section on magnetic circuit parameters

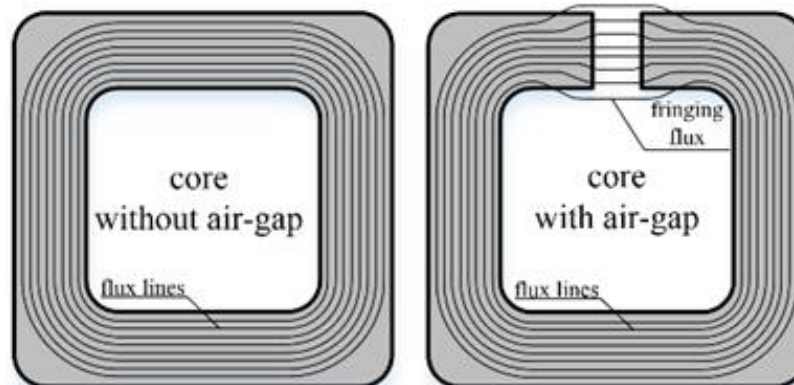
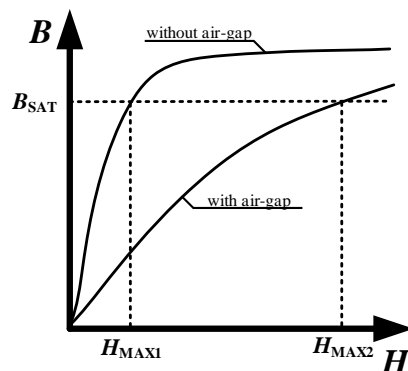
## Agenda

1. Introduction
2. Computational methods
3. Use of Comsol Multiphysics
4. Results
5. Conclusions

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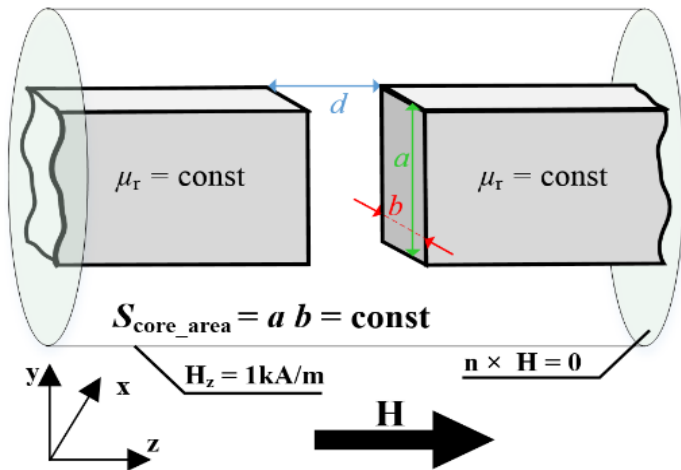
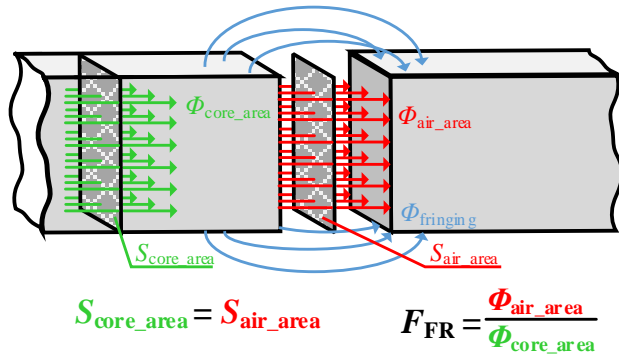
## Introduction

- Magnetic inductors and transformers are the fundamental components for PE devices (high frequency filters, EMC chokes, energy storages, galvanic insulations)
- Air-gap significantly modifies the parameters of magnetic circuit
- The optimal selection of shape and dimensions of air-gap is very important from designing point of view



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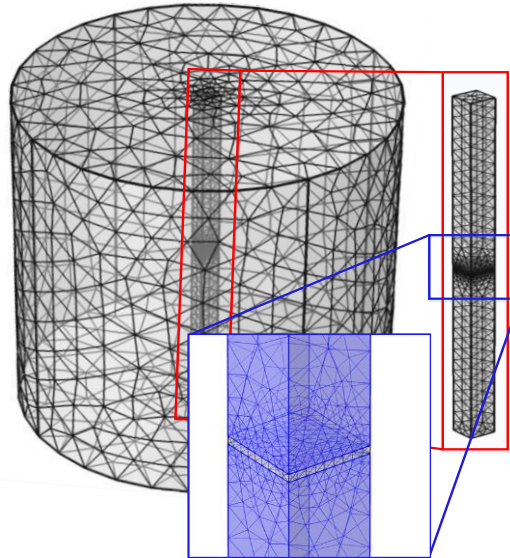
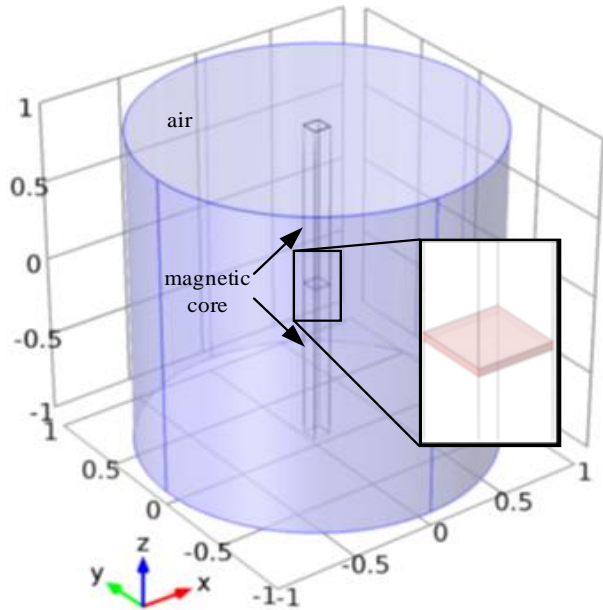
## Computational methods



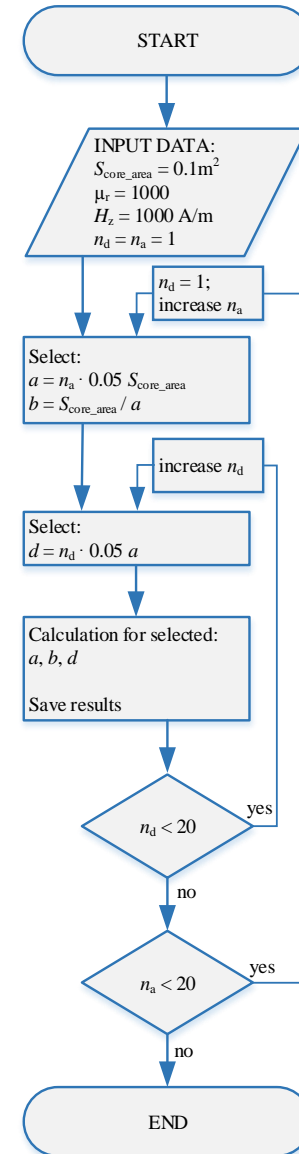
- AC/DC module was applied for the calculations
- By varying cross-section and air-gap optimal solutions for this kind of magnetic circuit are proposed
- The magnetic flux in the core is produced by external vector of magnetic field - additional boundary condition to surfaces of model ( $H_x=0$ ;  $H_y = 0$ ;  $H_z = 1000 \text{ A/m}$ )
- Determination of total magnetic flux amount in the magnetic core cross-section compare to the magnetic flux in the air-gap area with the same cross-section as magnetic core -  $F_{FR}$  (factor of magnetic fluxes ratio)

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## Use of Comsol Multiphysics

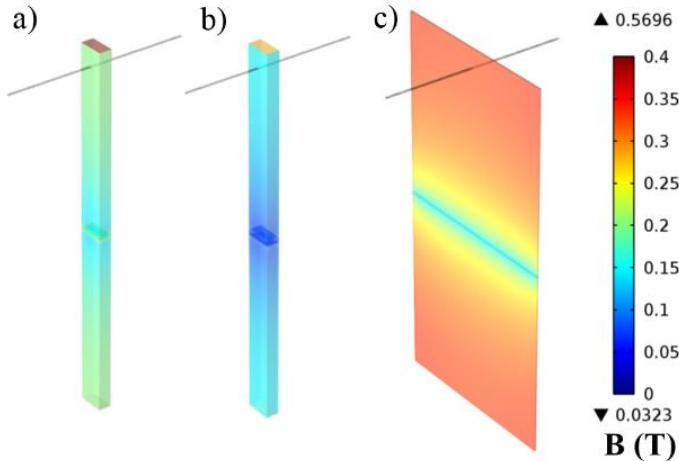


	Minimum	Maximum
Time	8 s	312 s
Physical memory	12.52 GB	14.62 GB
Virtual memory	13.60 GB	14.86 GB
Degrees of freedom	157 162	4 058 514



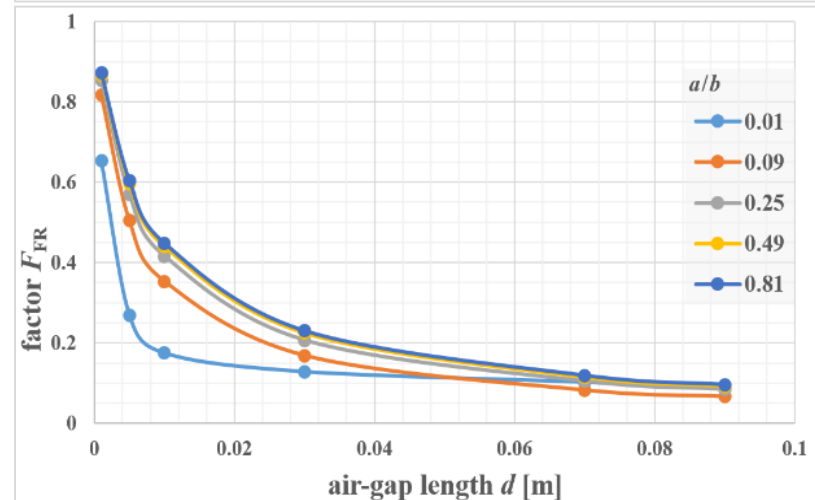
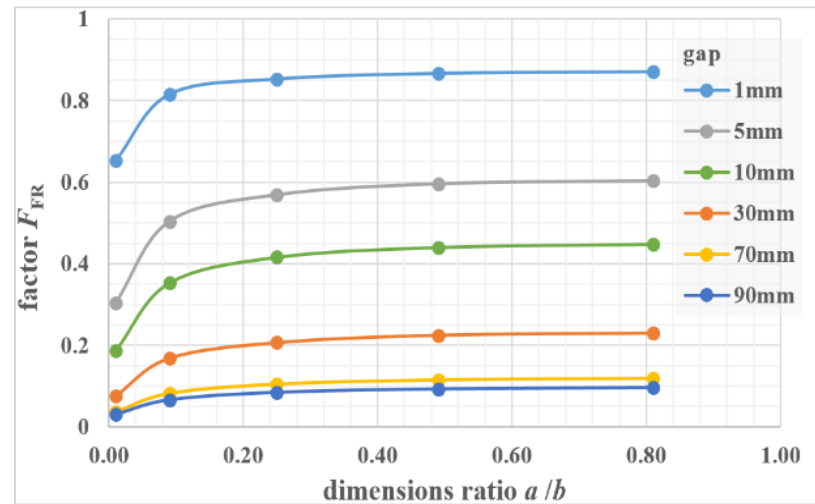
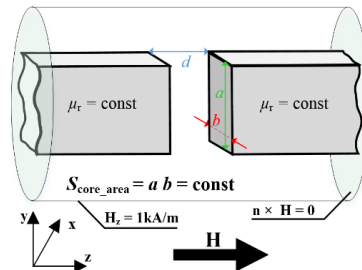
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## Results



Magnetic flux distribution for exemplary cases of FEM analyses:

- a) base case with given ratio of cross-section and given length of air-gap,
- b) case with the same (as case "a") ratio of cross-section and bigger length of air-gap, c) case with different ratio of cross-section and the same length of air-gap (as case "a").



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## Conclusions

- COMSOL Multiphysics® software is a useful software for electromagnetic calculations of complex and sophisticated geometries
- FEM analyses allows to determine optimal dimensions of magnetic core cross-section, magnetic core dimensions ratio and level of fringing flux
- FEM calculation allows to optimise the magnetic circuit for specific requirements of applications (no fringing flux, strictly defined fringing flux, etc.)
- Determining of optimal length of air gap and dimension ratio of magnetic core cross-section is a one of the most crucial aspects in a designed process of optimised inductors
- Obtained results are useful for design engineers in the optimisation process of inductors and transformer designs

Thank you very much for your attention!

I also would like to invite you to see the poster: 23

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