THE DEVELOPMENT OF NEW METODOLOGIES FOR THE ANALYSIS AND OPTIMAL DESIGN OF MULTILAYER SPIRAL INDUCTORS USED IN RADIOFREQUENCY APPLICATIONS

Project manager:
Associate Professor, Dr.Eng.Ec. Claudia PĂCURAR
Project members:
Associate Professor, Dr.Eng.Ec. Adina RĂCĂȘAN
Assistent, Dr.Eng. Claudia CONSTANTINESCU
PhD, Eng. Flaviu POP
Student, Sergiu ANDREICA

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Project Executive Summary

The Aim of Project

The development of new methodologies for analysis and optimal design of multilayer spiral inductors used in radiofrequency applications in general, respectively in biomedical applications in particular

Two research directions

The development, implementation and validation of a software package for analysis and optimal design of multilayer spiral inductors in high frequency, the APOBSIF Software Package

The building of a stand of design, optimization, construction, testing and validation of integrated circuits, the POCT Stand

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Objectives and Activities

Year	Specific Objectives	Associate Activities	Fulfilled
2015	The analysis, modeling and simulation of the multilayer spiral inductors for identifying, highlighting and analyzing the effects and phenomena that occur with the transition of their implementation from one layer to the realization on several layers in order to establish the advantages and disadvantages of using the multilayer spiral inductors compared with on one layer	The systematic study of scientific literature in the research field	100%
		The design of a set of multilayer spiral inductors with different shapes, dimensions and configurations	100%
		The analysis, numerical and analytical modeling and functional simulation of the set of designed inductors in the 1-20 GHz frequency domain	100%
		The identifying, highlighting and analysis of the effects and phenomena that occur with the transition from monolayer to multilayer spiral inductors	100%
		The establish of the advantages and disadvantages for the use of multilayer spiral inductors	100%
		The valorization and dissemination of the results through the publication of scientific papers	100%

Objectives and Activities

Year	Specific Objectives	Associate Activities
2016	The development of new techniques to reduce parasitic effects that occur with the transition from monolayer spiral inductors to the multilayer spiral inductors on which will based on the development and implementation of an optimal design algorithm aimed to find the optimal geometric configuration of the conductors displacement that forms the multilayer spiral inductor in order to minimize these parasitic effects	The development of techniques to reduce parasitic effects depending on the material properties used to construct multilayer spiral inductors
		The development of new techniques to reduce parasitic effects depending on the configuration of geometric displacement of the conductors that are forming multilayer spiral inductors
		The design, development, implementation, verification and validation of an optimal design algorithm for finding the optimal geometric configuration of the conductors displacement that are forming multilayer spiral inductor to minimize these parasitic effects

Objectives and Activities

Year	Specific Objectives	Associate Activities
2016	The development of new analytical formulas of high accuracy to calculate the inductance and the quality factor of the multilayer spiral inductors necessary to design, development, implementation, verification and validation of algorithms for analysis and multi-objective optimal design of high precision for complex structures	The development of new analytical formulas of high accuracy for multilayer spiral inductors inductance calculation
		The development of new analytical formulas of high accuracy for multilayer spiral inductors electrical parameters calculation
		The development of new high accuracy analytical formulas for multilayer spiral inductors quality factor calculation
		The design, development, implementation, testing and validation of algorithms for high-frequency analyzing of multilayer spiral inductors
		The design, development, implementation, testing and validation of an optimization algorithm for multilayer spiral inductors configuration in order to achieve maximum inductance
		The design, development, implementation, testing and validation of an optimization algorithm for multilayer spiral inductors configuration in order to achieve maximum quality factor
		The valorization and dissemination of the results through the publication of scientific papers in journals and through participation at prestigious international conferences in the research field

Objectives and Activities

Year	Specific Objectives	Associate Activities
2017	The design, development, implementation, testing and validation of an integrated software package dedicated to high frequency analysis and optimal design of spiral inductors using a powerful compiler, Microsoft Visual C #, bringing together the analysis and optimal design algorithms	The integration of the calculation and optimal design algorithms into an integrated software package
		The design of the graphical interface, materials library, pre and post-processing modules, installation kit and help
		The verification and validation of the software package by comparing to other similar applications
		Experimental test and validation of software package

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Objectives and Activities

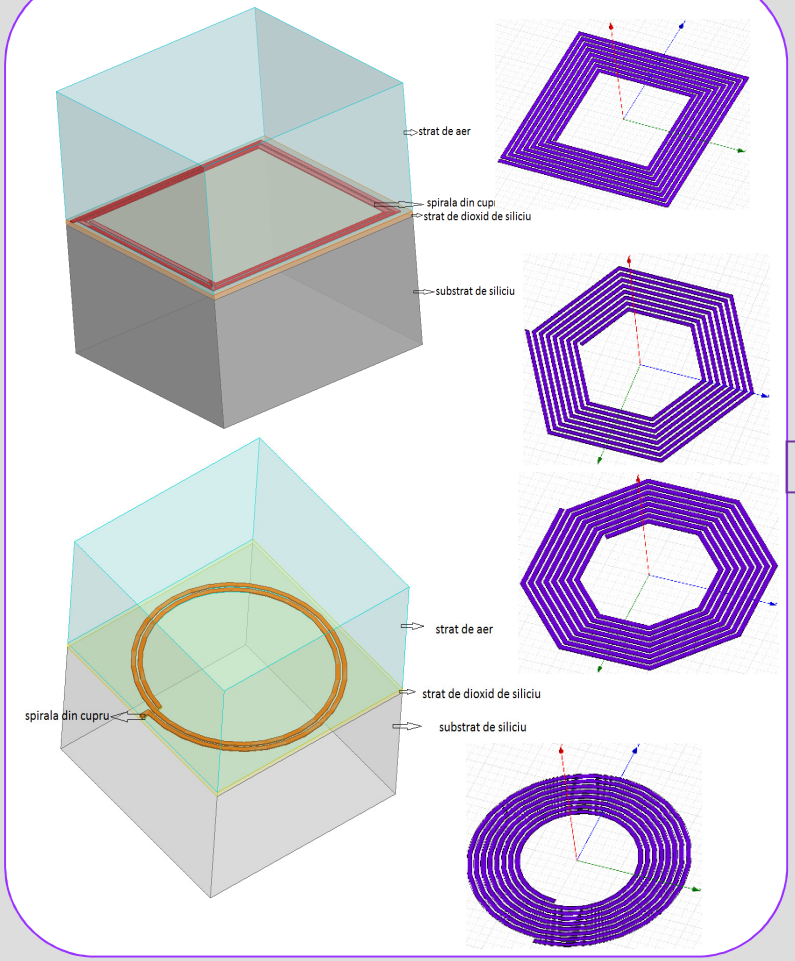
Year	Specific Objectives	Associate Activities
2017	The practical construction of monolayer and multilayer spiral inductors, the verification and testing for the use in RF applications in general, respectively in biomedical applications in particular	Optimal design of a variety range of monolayer and multilayer spiral inductors using our own software package
		The practical construction of the designed monolayer and multilayer spiral inductors
		The verification and testing of the spiral inductors constructed for use in radio frequency applications in general, and in particular biomedical applications
		The experimental testing of spiral inductors constructed by specific experimental measurements
		The valorization and dissemination of the results through the publication of scientific papers in journals and through participation at prestigious international conferences in the research field

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

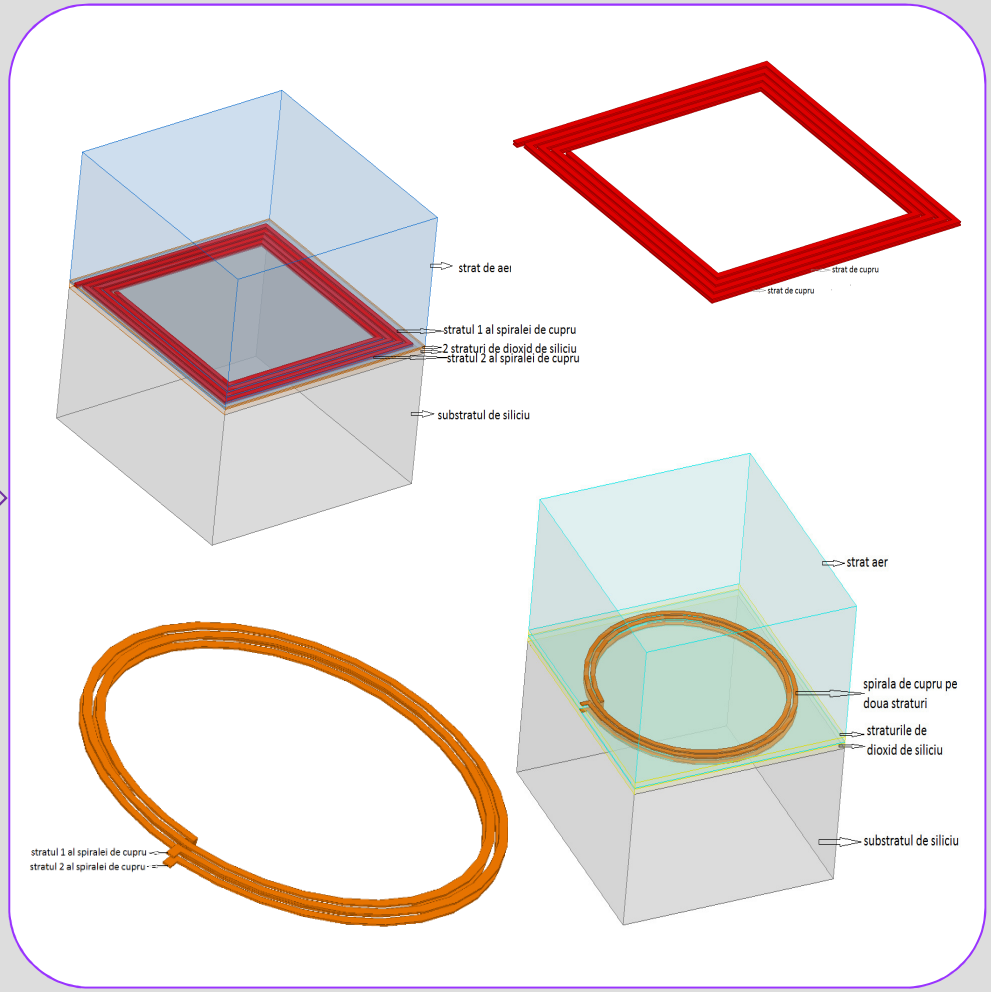
dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Milestones

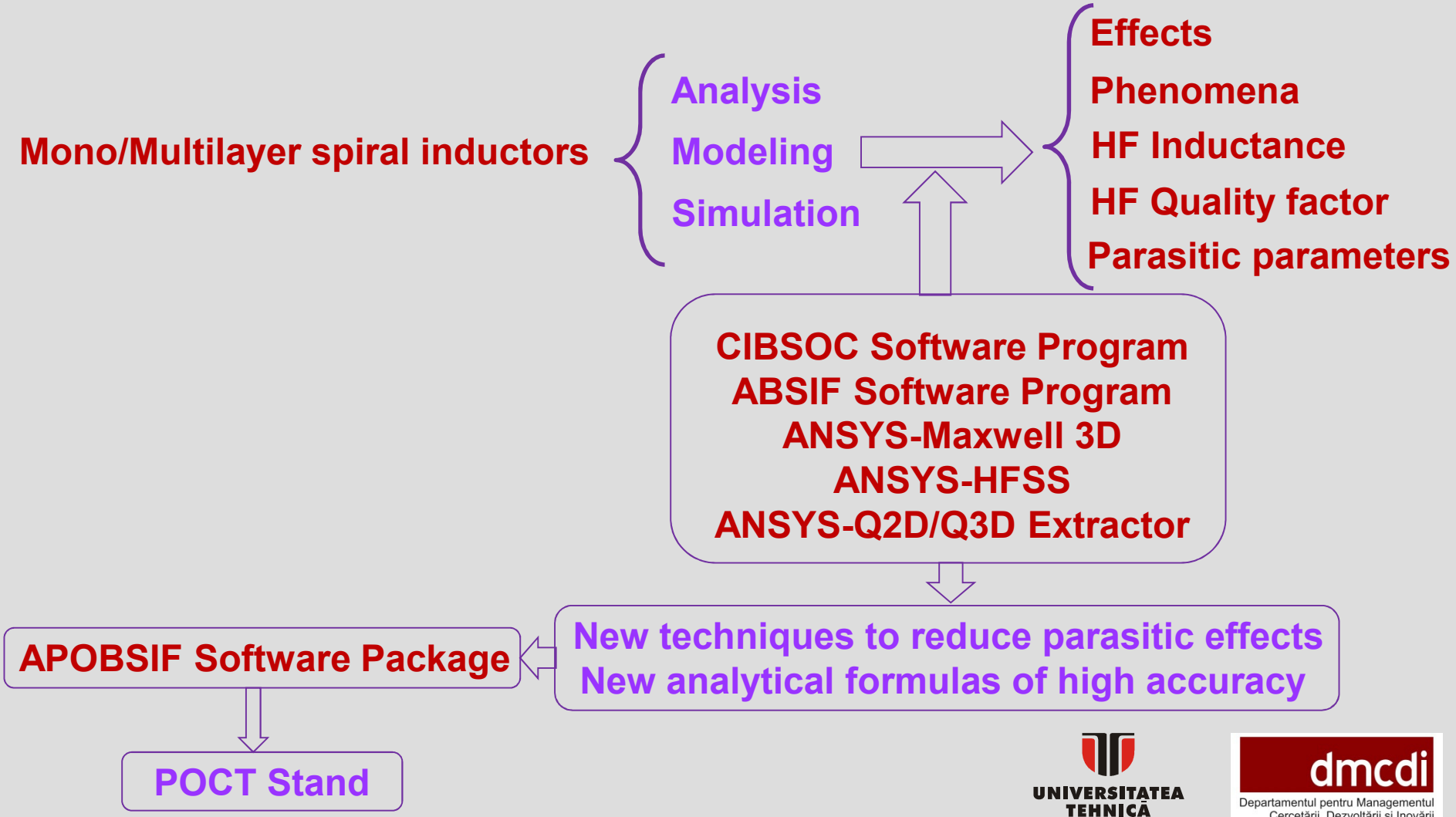
Monolayer spiral inductors



Multilayer spiral inductors



Challenges



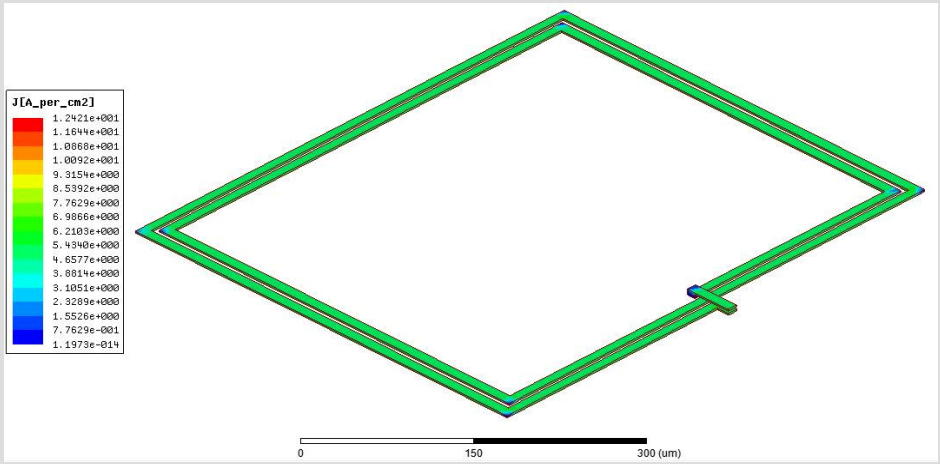
UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

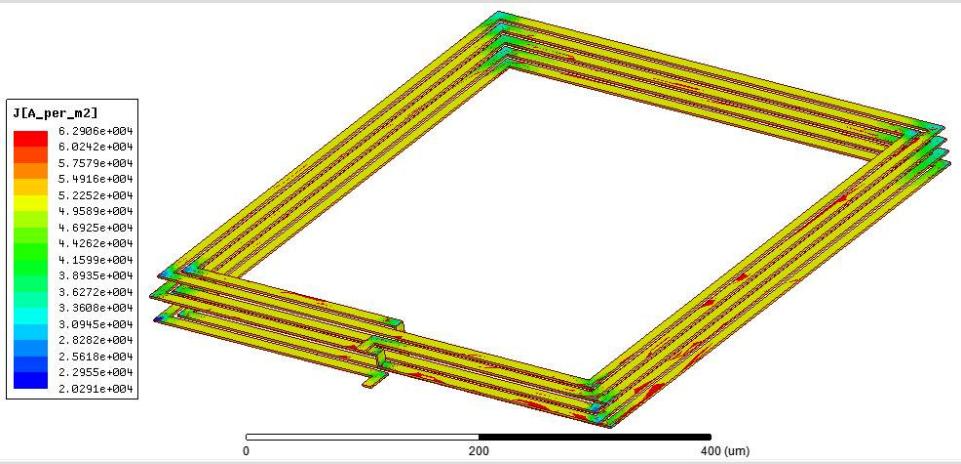
Results

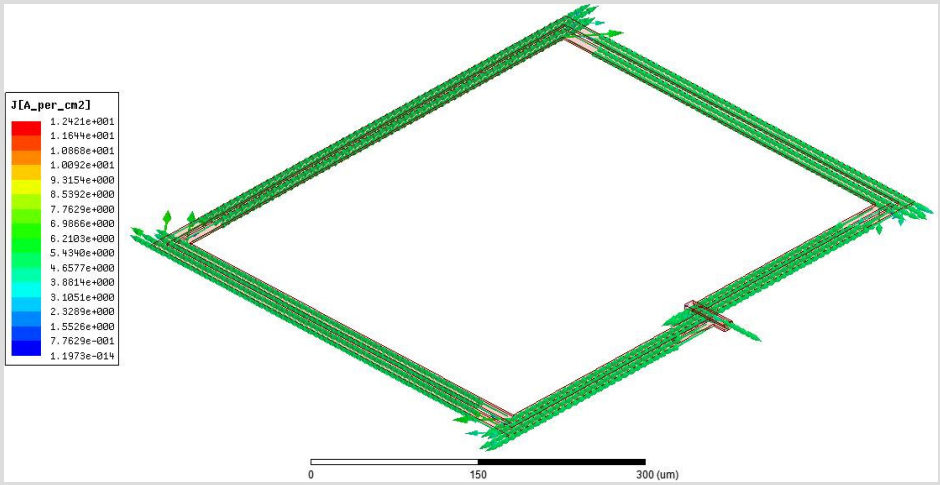
Effects and phenomena

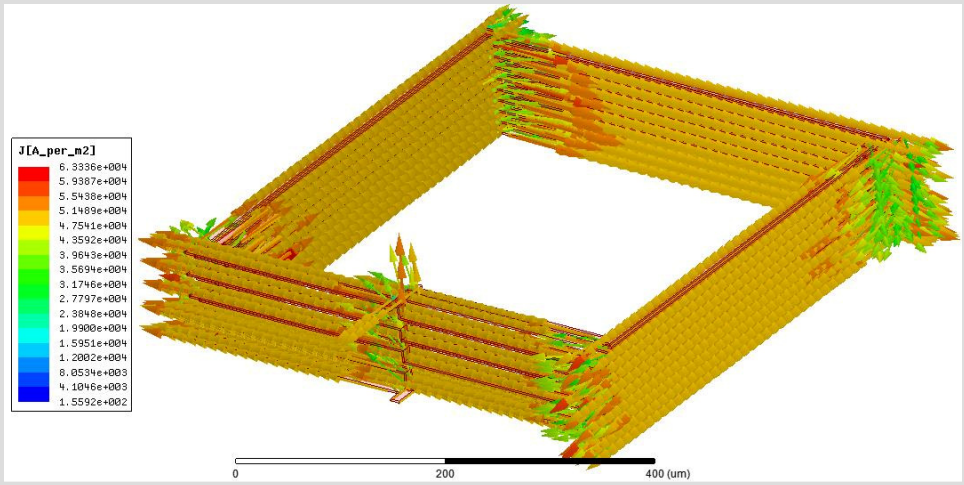
Monolayer spiral inductors



Multilayer spiral inductors



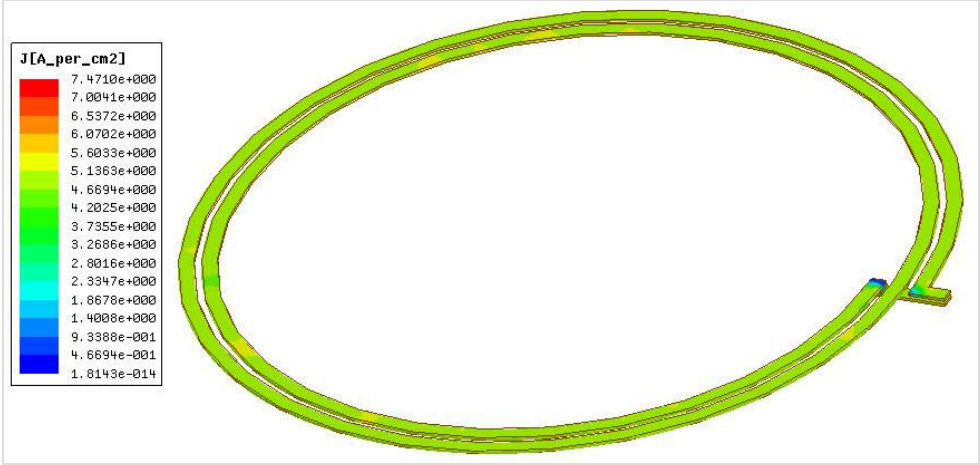




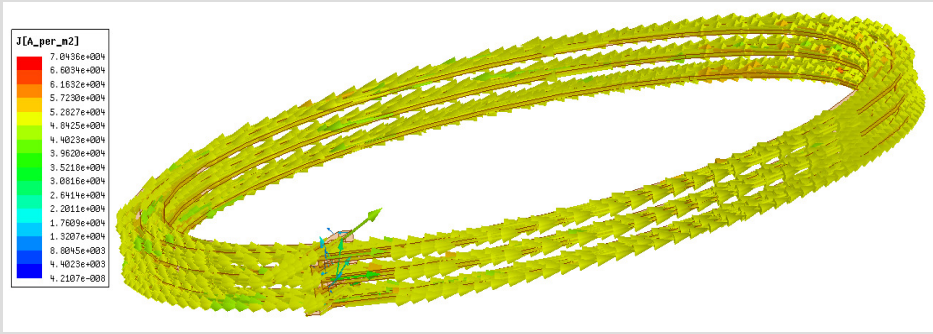
Results

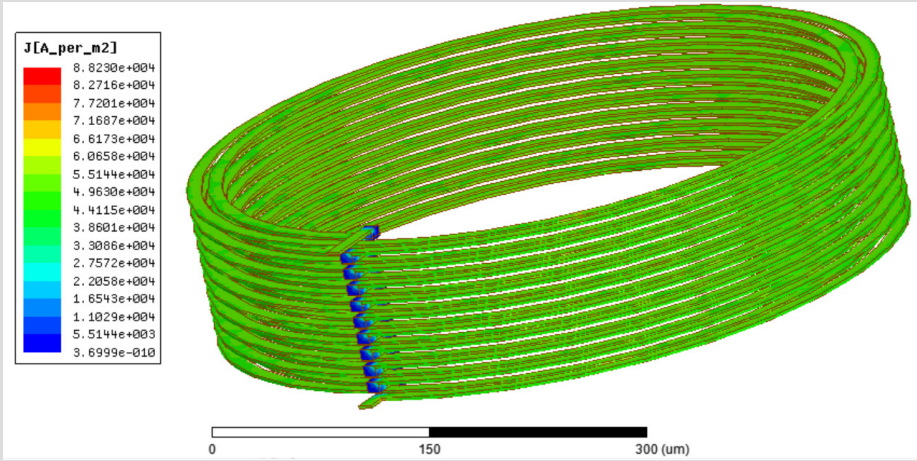
Effects and phenomena

Monolayer spiral inductors



Multilayer spiral inductors

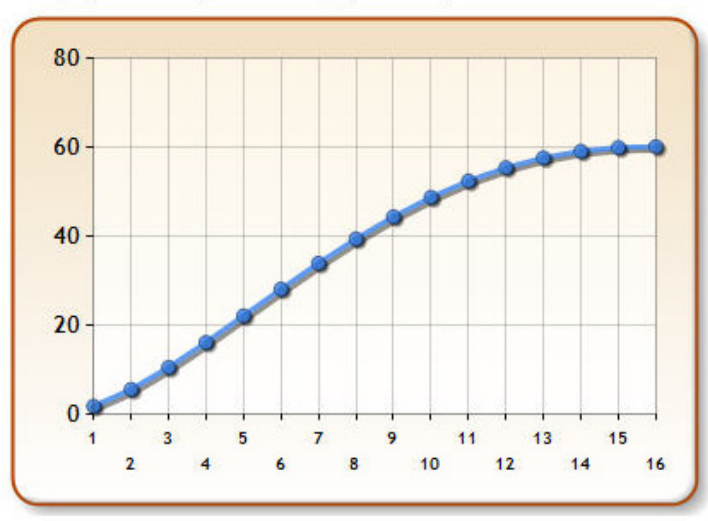


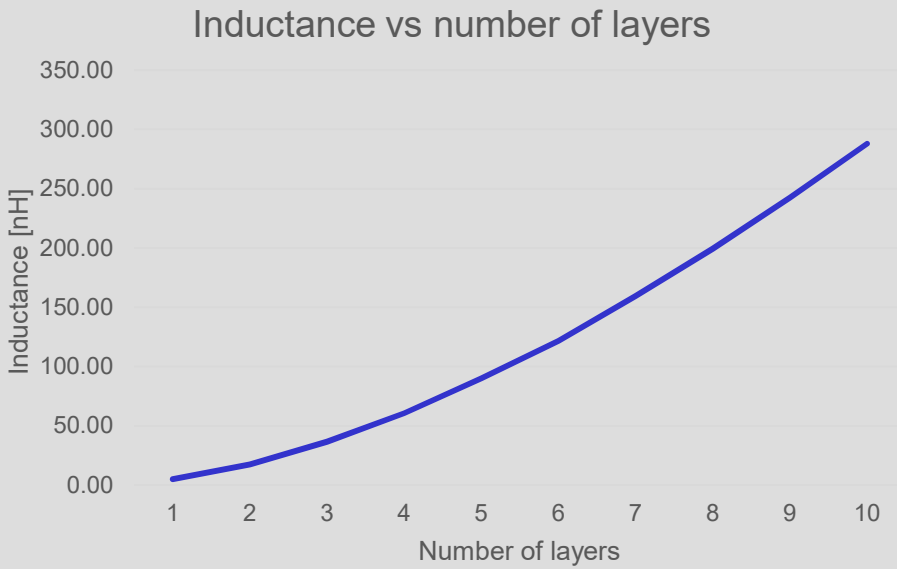


Results

Square spiral inductor

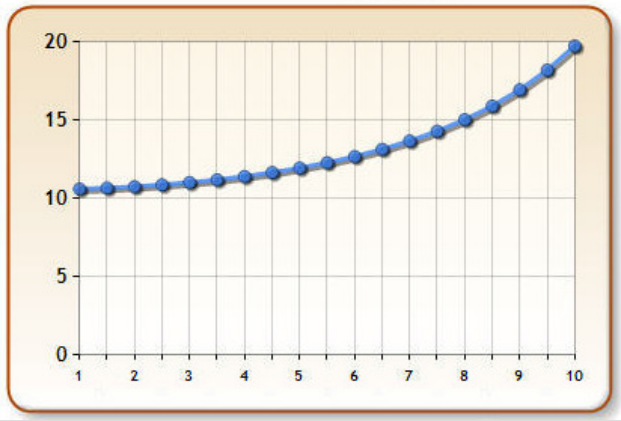
Inductance vs number of turns



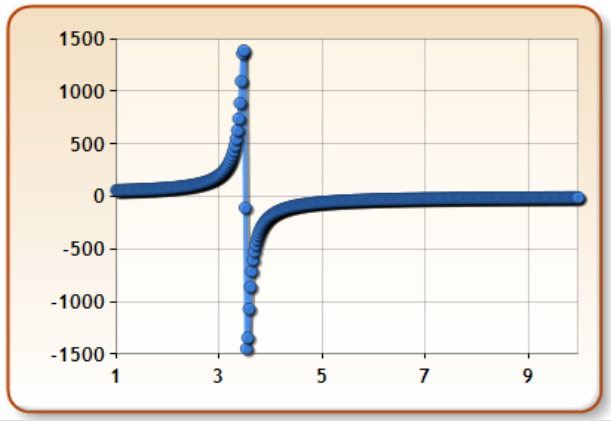


Inductance vs frequency

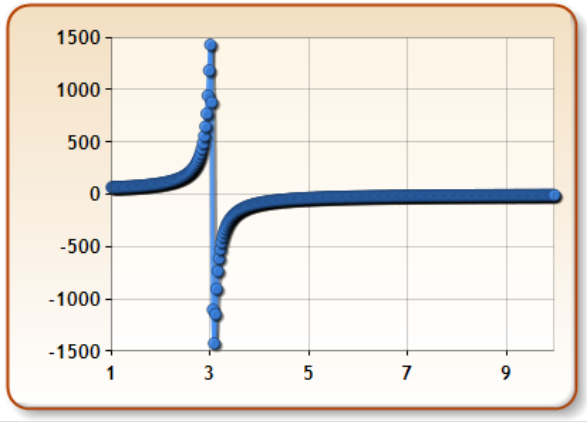
Ls=f(f) min=1, max=10, step =0,5GHz



Ls=f(f) min=1, max=10, step =0,025GHz



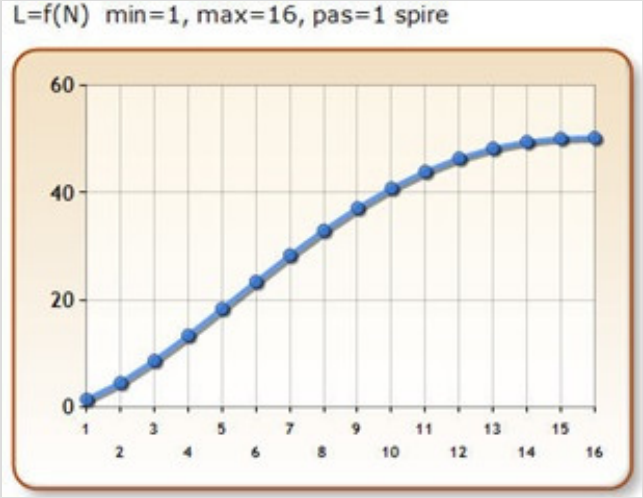
Ls=f(f) min=1, max=10, pas=0,025GHz



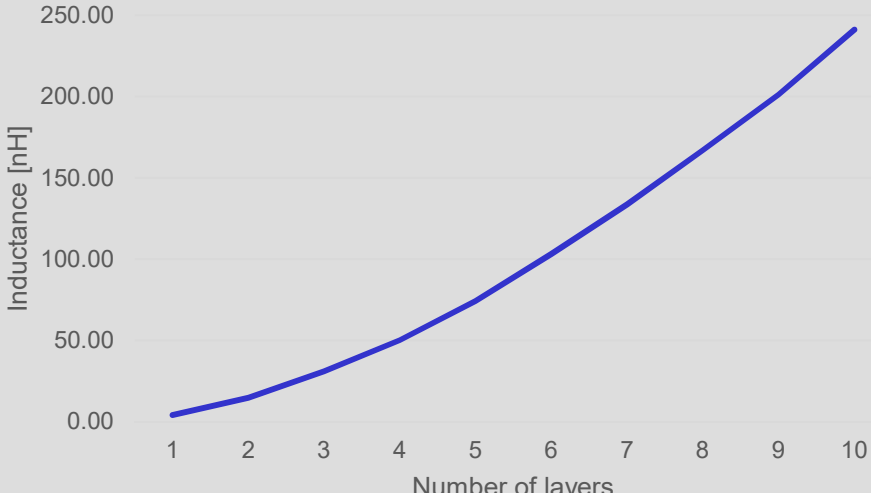
Results

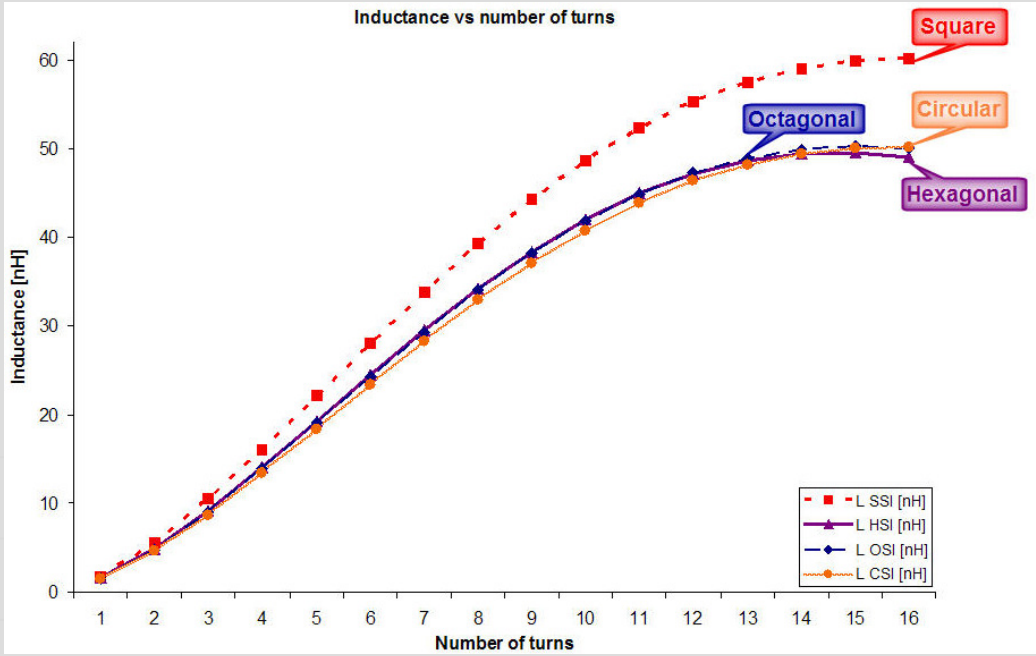
Circular spiral inductor

Inductance vs number of turns



Inductance vs number of layers





UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Results

The delivered results in 2015

Results provided in the project implementation plan	Delivered results in 2015
1 article published in BDI or ISI Journal	1 article published in BDI Journal
	2 articles accepted to be published in ISI Journal in 2016
1 paper to 1 international conference	2 papers to 1 international conference

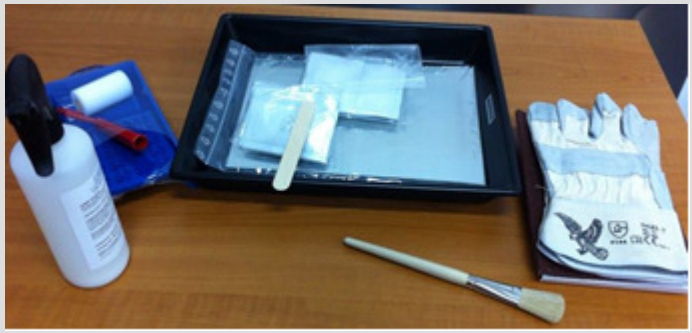
UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Equipments bought from the TE Project Budget

2015

LPKF ProMask consumable set



800 eur

LPKF ProLegend consumable set

880 eur

UV Exposer Unity

1 320 eur

Convection oven

1 100 eur

Next steps

The parasitic effects reduction

- Parasitic effects analysis
- Parasitic parameters extraction
- New techniques to reduce parasitic effects
- New techniques to reduce parasitic parameters
- New optimal design algorithm aimed to find the optimal geometrical configuration of the conductors displacement in order to minimize these parasitic effects.

New analytical formulas of high accuracy for HF inductance and quality factor computation

New algorithms for analysis and multi-objective optimal design of high precision for complex structures

New integrated software package dedicated to high frequency analysis and optimal design of mono/multilayer spiral inductors bringing together the analysis and optimal design algorithms

The POCT Stand for practical construction, verification and test of the monolayer and multilayer spiral inductors

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării

Equipments wanted to be bought from the TE Project Budget

2016 **2017**

LPKF Plotter ProtoMat S 103

32 620 eur

Compressor 50 l

2 820 eur

LPKF MultiPress S

21 000 eur

Automatic hydraulics

Dust extractor

1 700 eur

Status Light

880 eur

Microscope

620 eur

Accesories and consumable

2 560 eur

Thank you for your attention!!!

Contact:
Associate Professor, Dr.Eng.Ec. Claudia PĂCURAR
Technical University of Cluj-Napoca
Faculty of Electrical Engineering
Department of Electrotechnics and Measurements
26-28, G. Baritiu Street, 400027
Office: A11
Phone: +40-264-401468; +40-742-047447
e-mail: Claudia.Pacurar@ethm.utcluj.ro

UNIVERSITATEA TEHNICĂ CLUJ-NAPOCA

dmcdi
Departamentul pentru Managementul Cercetării, Dezvoltării și Inovării