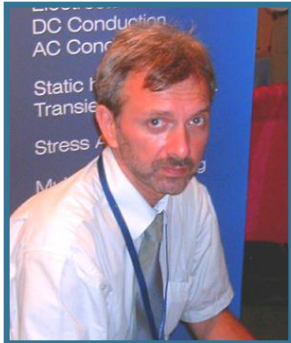




Pulsed power applications simulation in QuickField



Vladimir Podnos,
Director of Marketing and Support,
Tera Analysis Ltd.

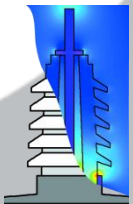
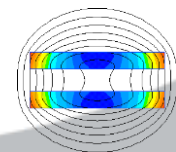
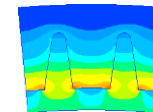
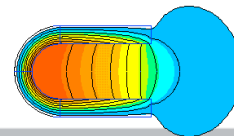
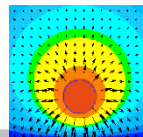
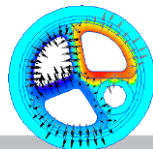
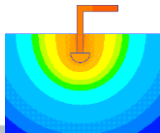
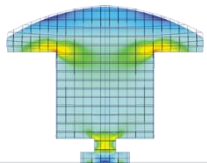


Alexander Lyubimtsev
Support Engineer,
Tera Analysis Ltd.



QuickField Analysis Options

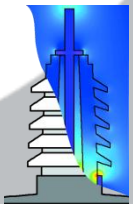
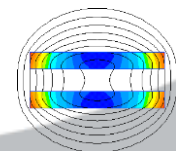
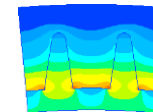
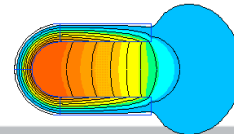
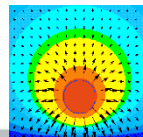
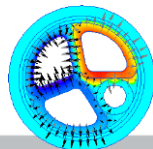
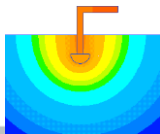
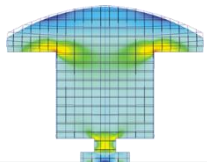
Magnetic analysis suite	
Magnetic Problems	Magnetostatics
	AC Magnetics
	Transient Magnetics
Electric analysis suite	
Electric Problems	Electrostatics and DC Conduction
	AC Conduction
	Transient Electric field
Thermostructural analysis suite	
Thermal and mechanical problems	Steady-State Heat transfer
	Transient Heat transfer
	Stress analysis





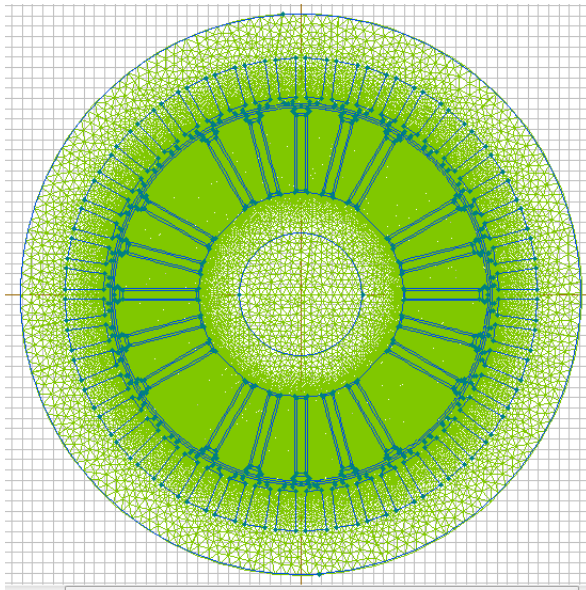
QuickField Analysis Options

Magnetic analysis suite	
Magnetic Problems	Magnetostatics
	AC Magnetics
	Transient Magnetics
Electric analysis suite	
Electric Problems	Electrostatics and DC Conduction
	AC Conduction
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Thermostructural analysis suite	
Thermal and mechanical problems	Steady-State Heat transfer
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	Stress analysis

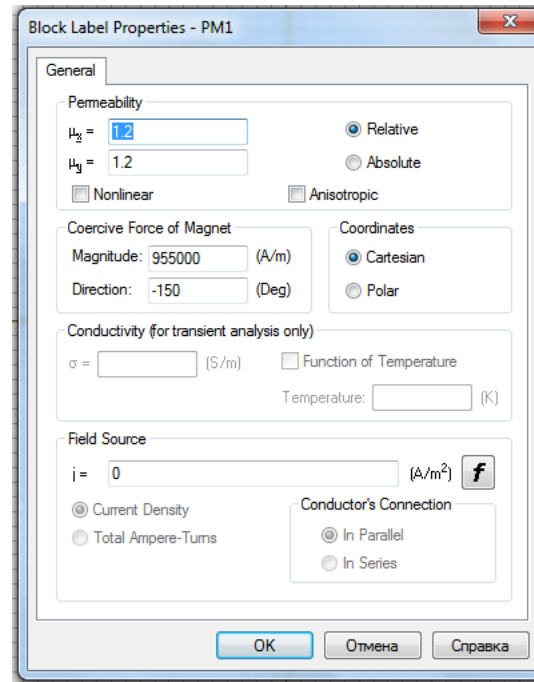




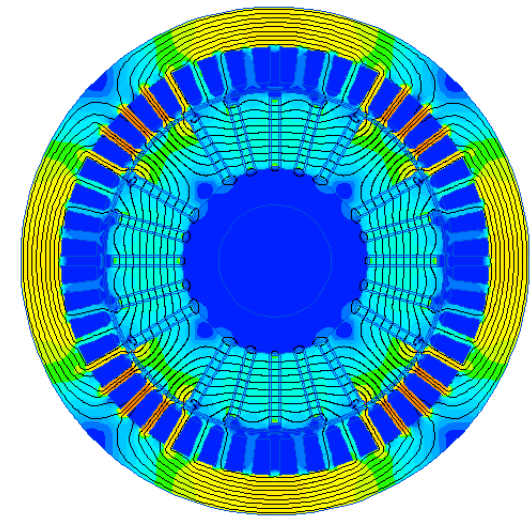
Stages of solution



Model



Physical parameters



Result



Transient field sources

Block Label Properties - PM1

General

Pemeability

$\mu_x =$ Relative
 $\mu_y =$ Absolute

Nonlinear Anisotropic

Coercive Force of Magnet

Magnitude: (A/m)
Direction: (Deg)

Coordinates

Cartesian Polar

Conductivity (for transient analysis only)

$\sigma =$ (S/m) Function of Temperature
Temperature: (K)

Field Source

$j =$ (A/m²) **f**

Current Density Total Ampere-Turns

Conductor's Connection

In Parallel In Series

Built in functions:

<i>abs</i>	<i>asin</i>
<i>sign</i>	<i>acos</i>
<i>max</i>	<i>atan</i>
<i>min</i>	<i>atan2</i>
<i>step</i>	<i>exp</i>
<i>impulse</i>	<i>log</i>
<i>sin</i>	<i>sqrt</i>
<i>cos</i>	<i>pow</i>
<i>tan</i>	<i>saw</i>



Transient results

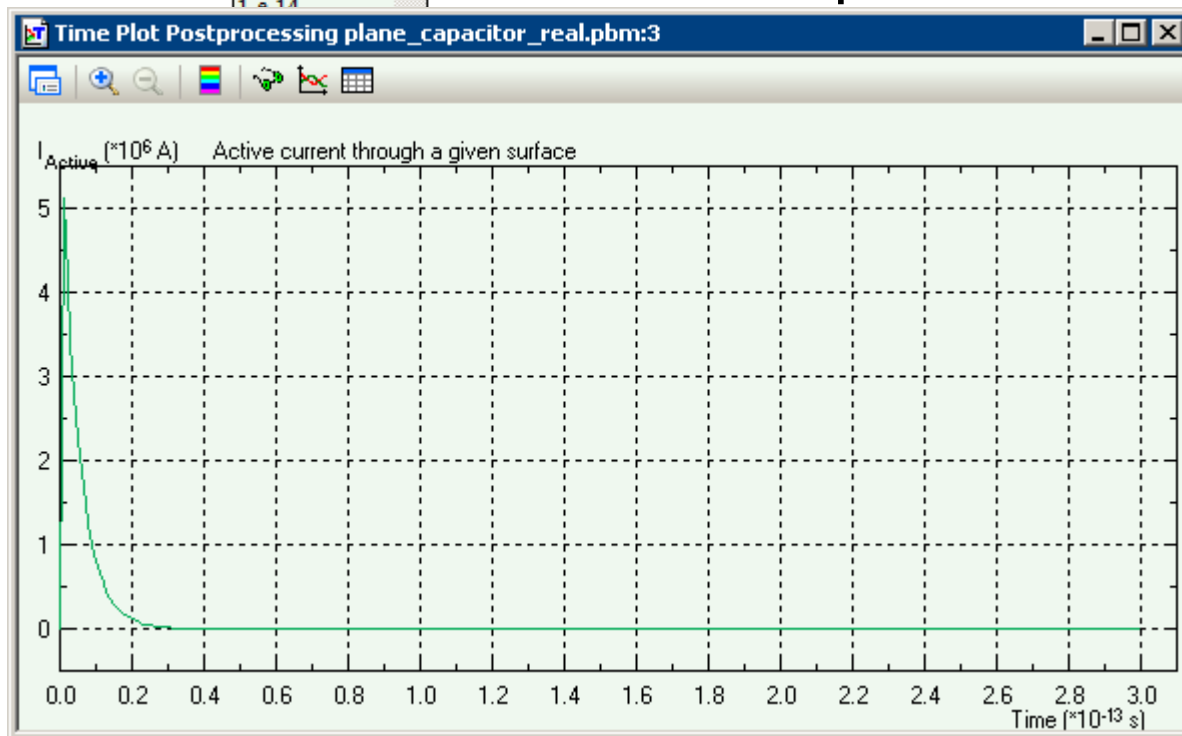
5.e-15

0
1.e-15
2.e-15
3.e-15
4.e-15
5.e-15
6.e-15
7.e-15
8.e-15
9.e-15
1.e-14

Time layers

Time plot

Time table



Time Table Postprocessing plan...

I_{ds} Active current through a given surface (A)

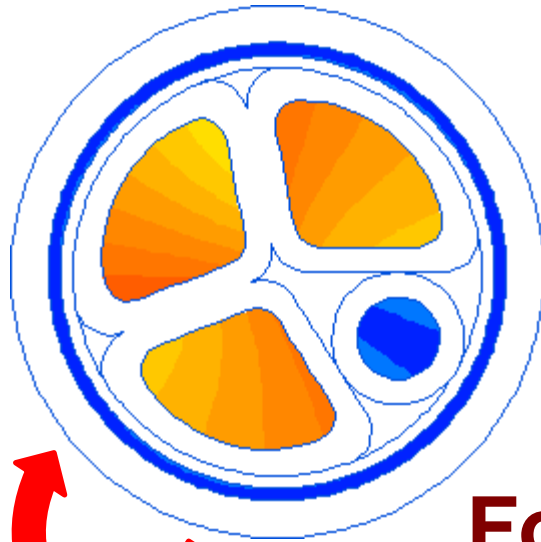
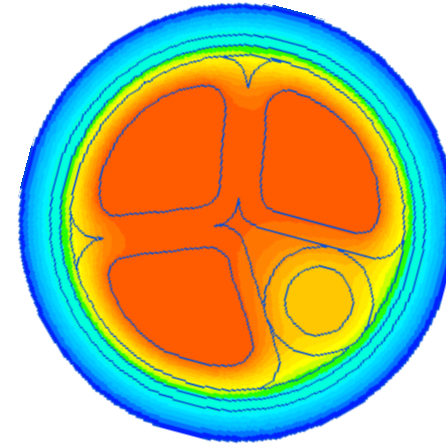
Time (s)	IActive
0	0
1.e-15	5128420
2.e-15	4172400
3.e-15	3404700
4.e-15	2778620
5.e-15	2267670
6.e-15	1850690
7.e-15	1510370
8.e-15	1232640
9.e-15	1005980
1.e-14	820996
1.1e-14	670028
1.2e-14	546821
1.3e-14	446270
1.4e-14	364208
1.5e-14	297236
1.6e-14	242579
1.7e-14	197973
1.8e-14	161569
1.9e-14	131859
2.e-14	107612
2.1e-14	87824.1



MultiPhysics.

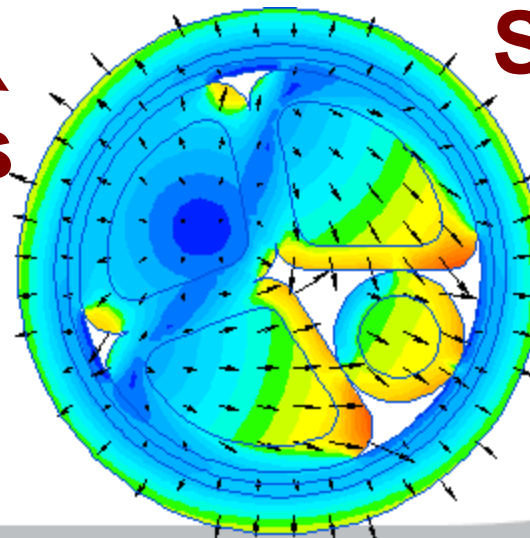
Temperature
Field

Electromagnetic
fields



Thermal
Stresses

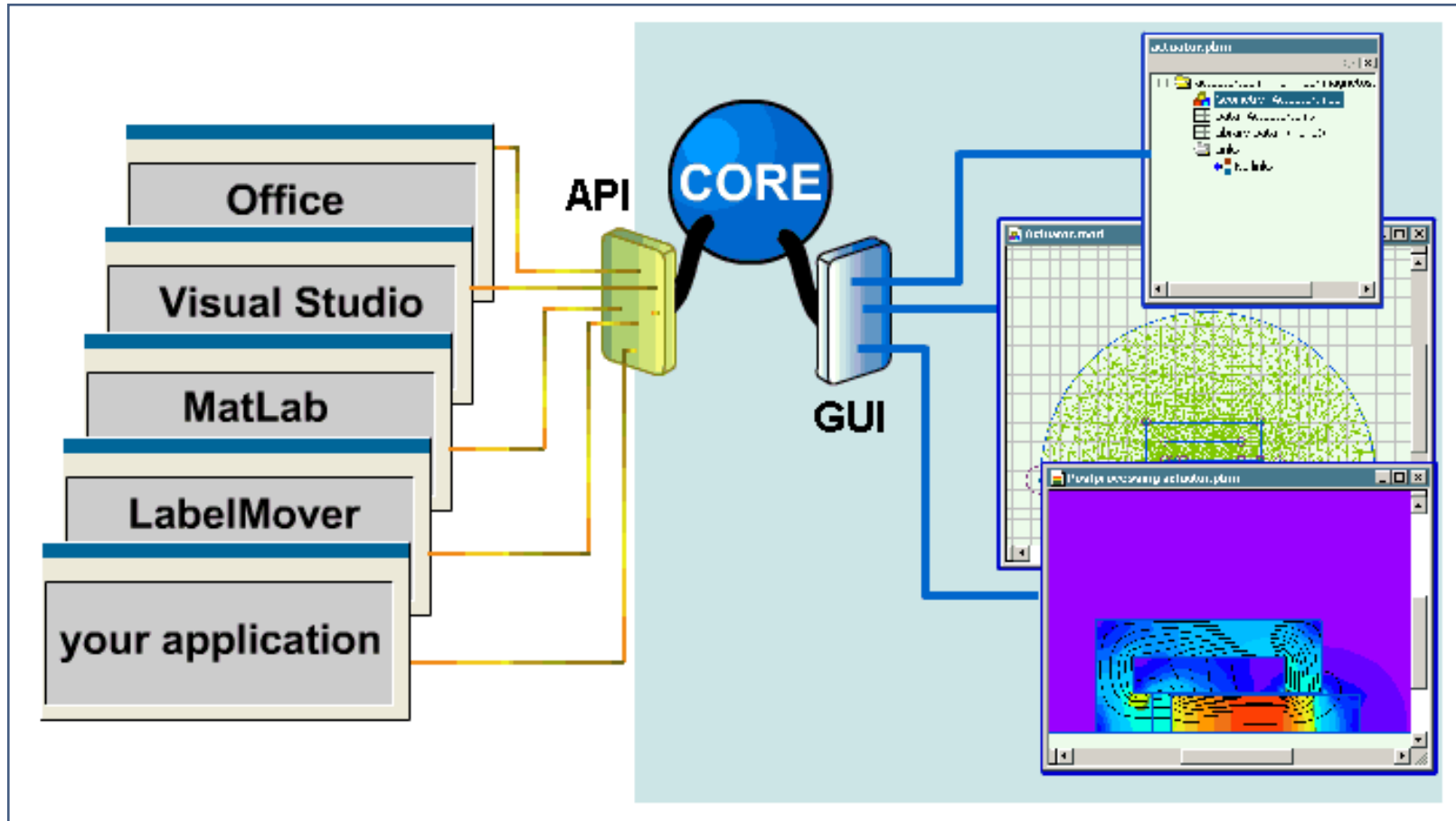
Forces



Magnetic state
import

Stresses &
Deformations

Open object interface



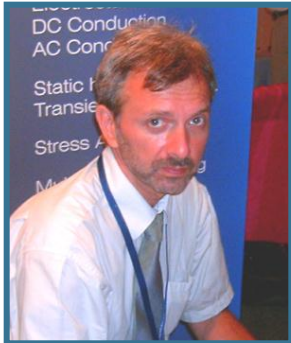


QuickField Difference





Pulsed power applications simulation in QuickField



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Alexander Lyubimtsev
Support Engineer,
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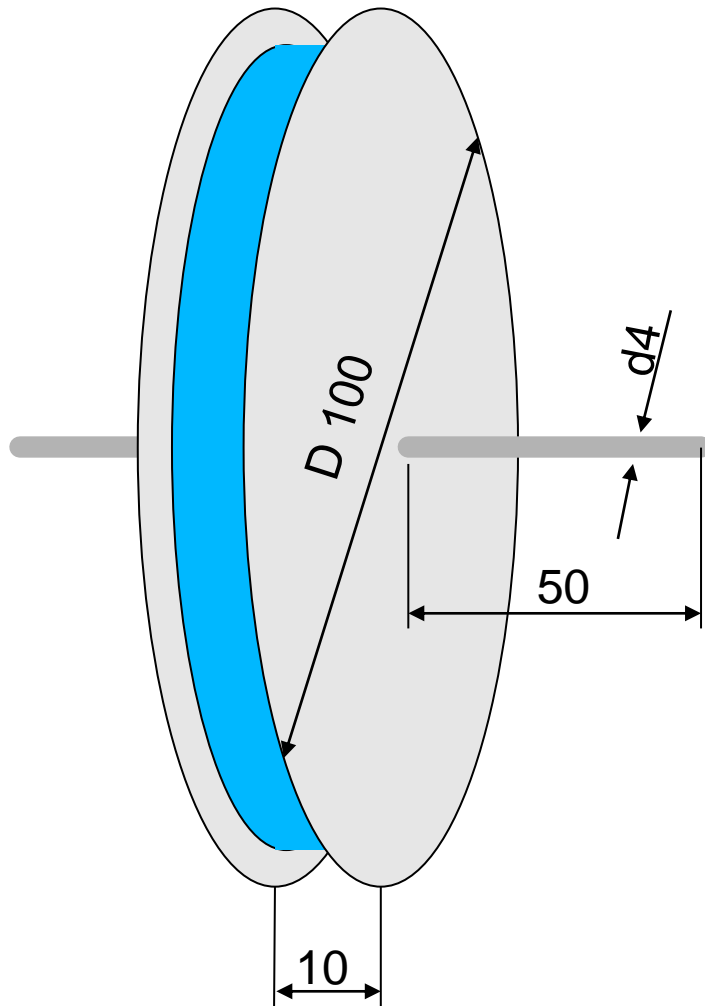


Simulating with QuickField

1. Disc capacitor. Voltage pulse.
2. Lightning arrester.
3. Multi-turn coil. Voltage pulse.
4. Pulse transformer.
5. Coil heating
6. Coil stress



Disc capacitor



All dimensions are in mm.

Problem specification:

Voltage step $U = 1$ kV

Dielectric relative

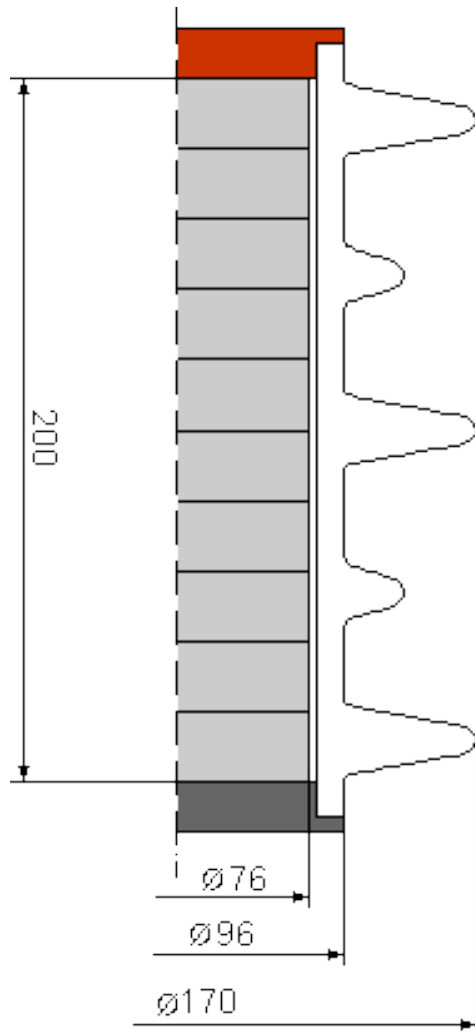
permittivity $\epsilon = 4$

Metal conductivity $\sigma = 56e6$ S/m

Calculate electric current $I(t)$



Lightning arrester



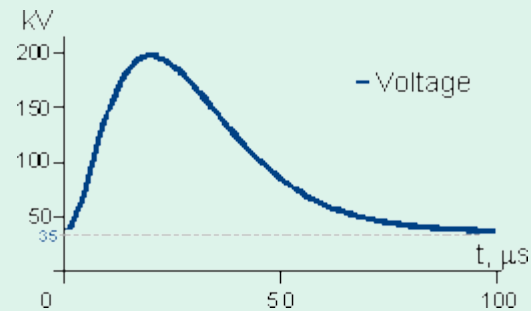
Problem specification:

Rate voltage $U = 35$ kV

ZnO permittivity $\varepsilon = 60$

ZnO conductivity $\sigma = \sigma(E)$

Lightning surge

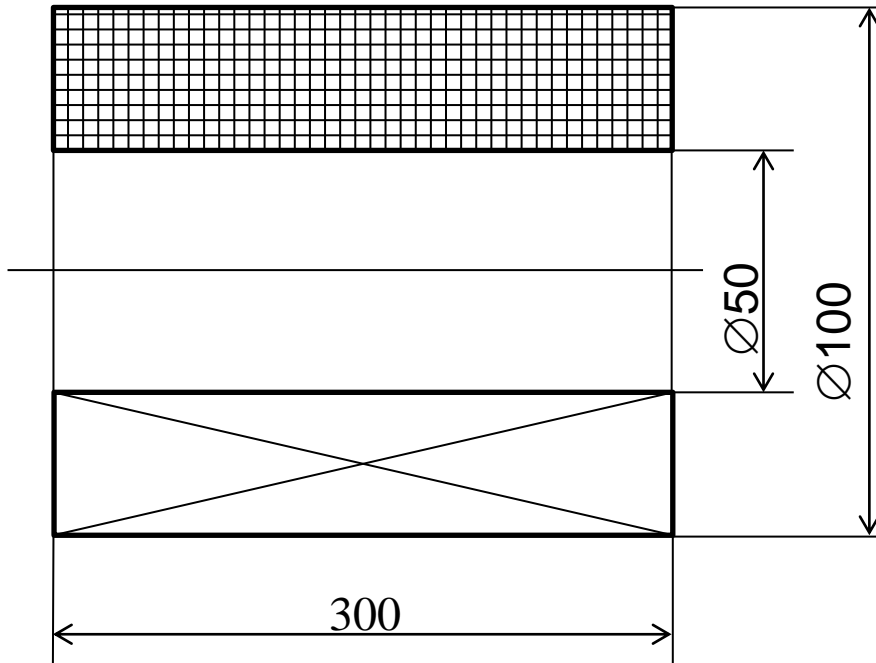


All dimensions are in mm.

Calculate electric current $I(t)$



Multi-turn coil



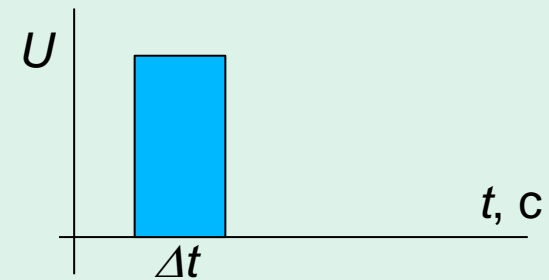
Problem specification:

Number of turns

$$N = 275$$

Voltage $U = 100 \text{ V}$

Pulse duration $\Delta t = 0.1 \text{ s}$

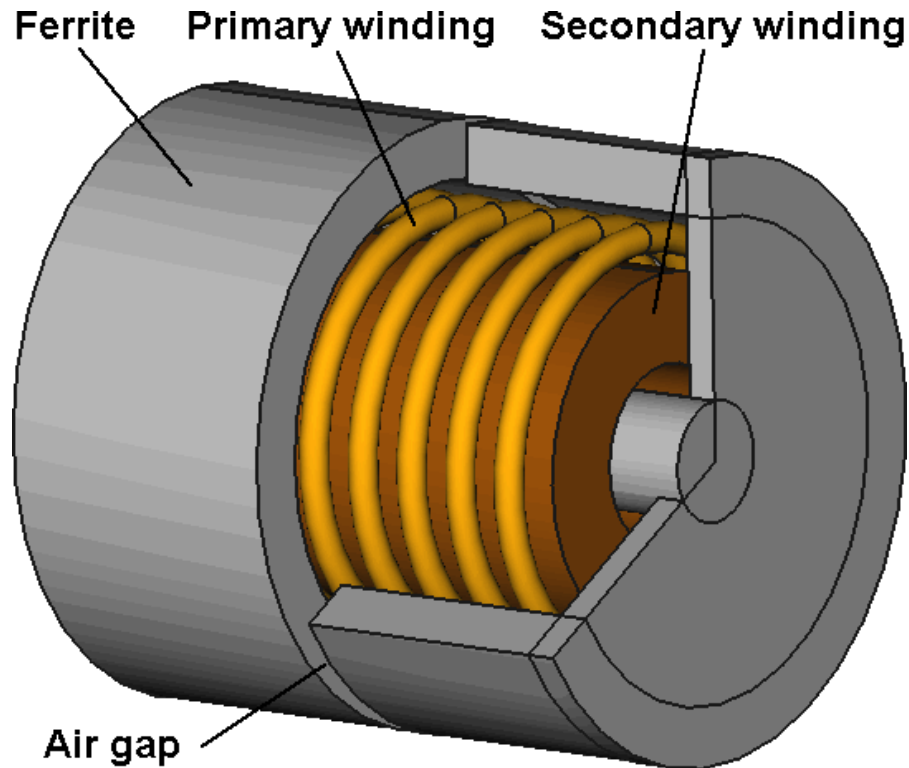


Calculate electric current $I(t)$

All dimensions are in mm.

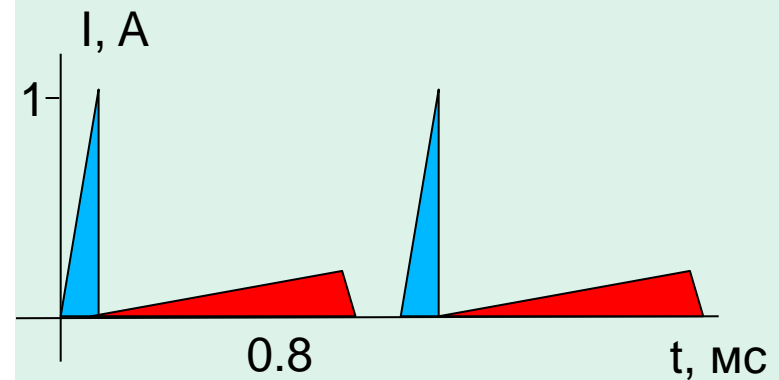


Pulse transformer



Problem specification:

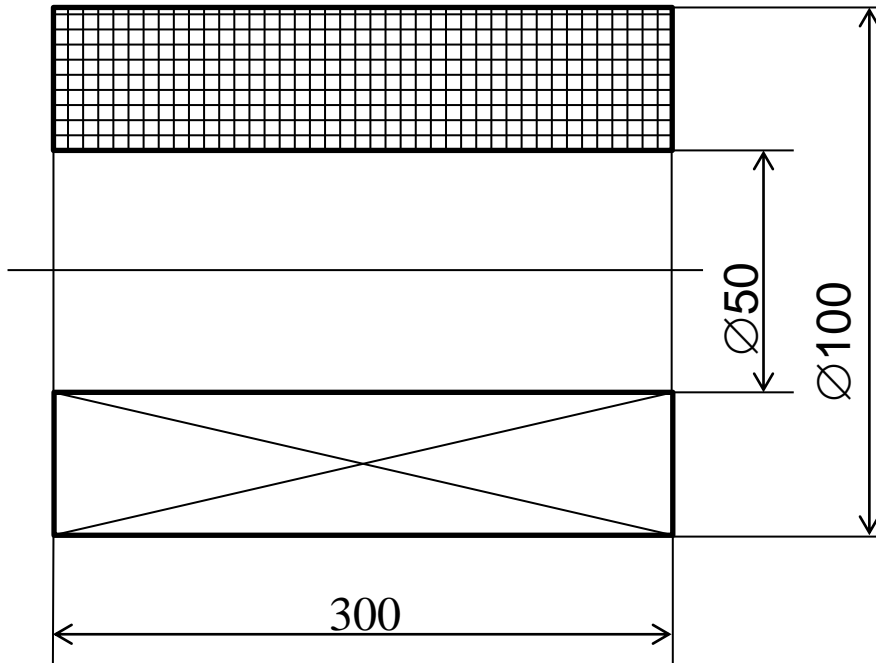
Number of turns $N1 = 13$,
Number of turns $N2 = 200$,
Currents in windings:



Find flux density outside
the air gap



Coil heating



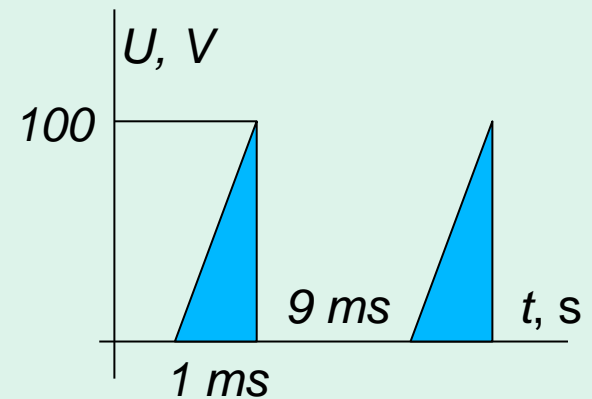
All dimensions are in mm.

Problem specification:

Convection coefficient

$$\alpha = 10 \text{ W/K}\cdot\text{m}^2$$

Voltage supply

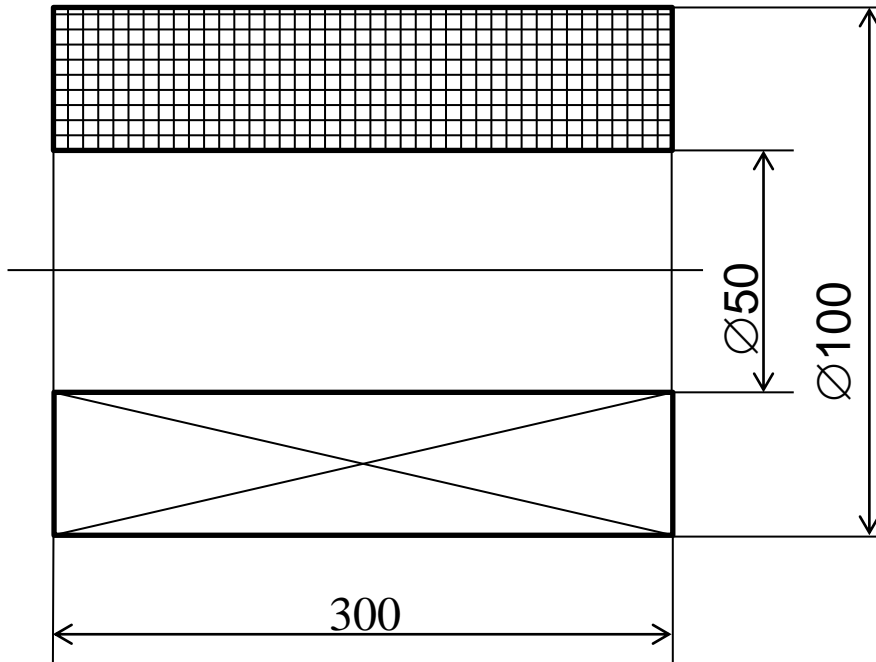


Volume power

$$W = \text{Power} / \text{Volume}$$



Coil stress



All dimensions are in mm.

Problem specification:

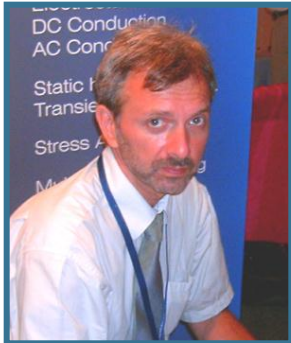
Young modulus of copper
 $E = 17 \text{ GPa}$, $\nu = 0.33$.

Young modulus of compound
 $E = 3 \text{ GPa}$, $\nu = 0.45$.

Calculate mechanical stress
and deformation of the coil



Pulsed power applications simulation in QuickField



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