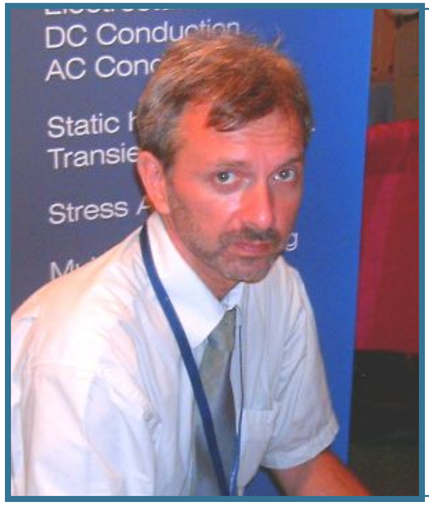
AC Magnetic simulation with QuickField



Vladimir Podnos

Director of Marketing and Support
Tera Analysis Ltd.

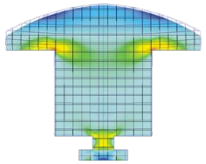
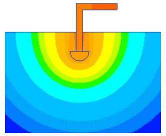
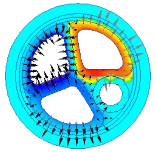
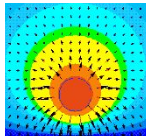
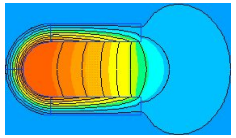
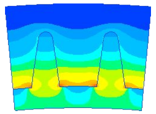
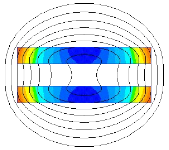
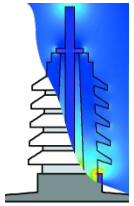
Alexander Lyubimtsev

Support Engineer
Tera Analysis Ltd.

https://quickfield.com/seminar/seminar_ac_magn.htm

QuickField Analysis Options

Magnetic analysis suite	Magnetostatics
	AC Magnetics
	Transient Magnetic
Electric analysis suite	Electrostatics (2D,3D) and DC Conduction (2D,3D)
	AC Conduction
	Transient Electric field
Thermostructural analysis suite	Steady-State Heat transfer (2D,3D)
	Transient Heat transfer
	Stress analysis

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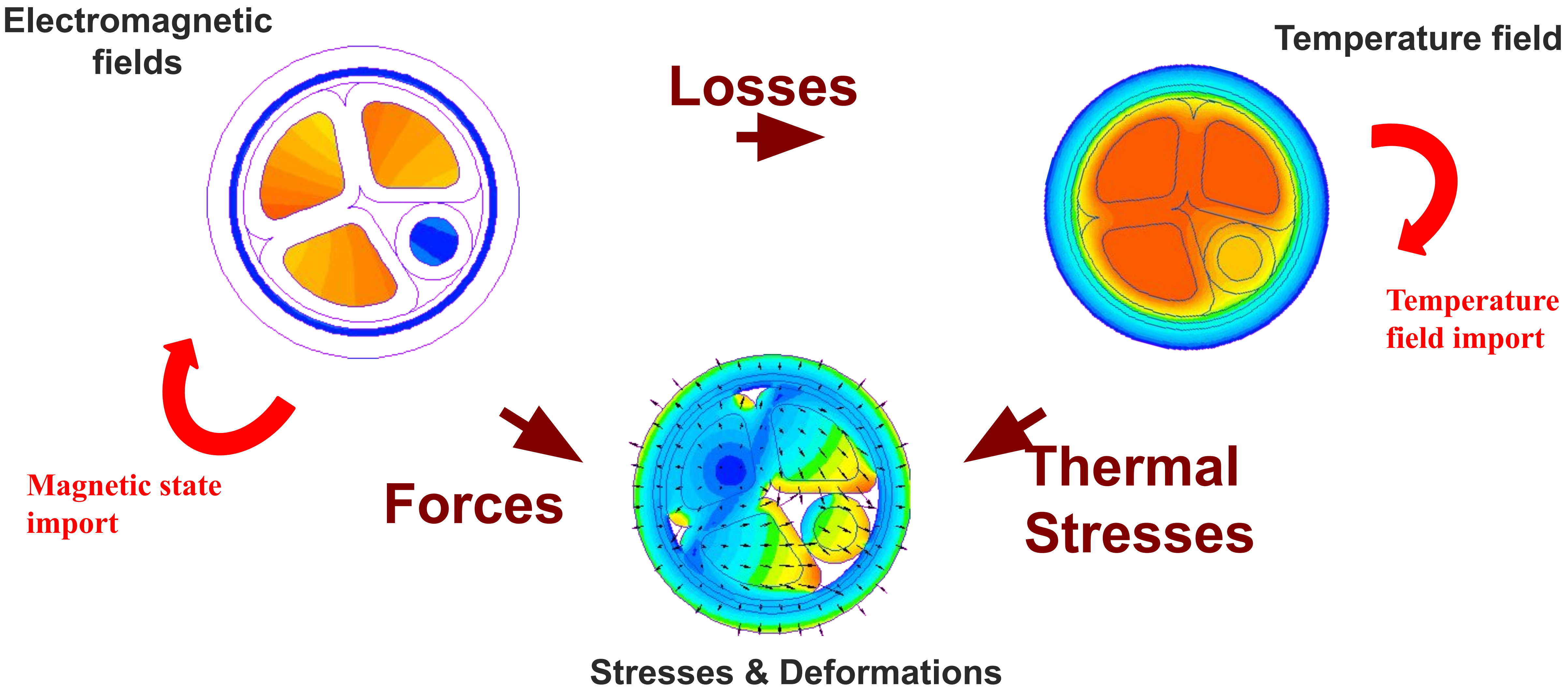
MultiPhysics (2D)



https://quickfield.com/coupling.htm

QuickField AC Magnetics

Magnetic analysis suite	Magnetostatics
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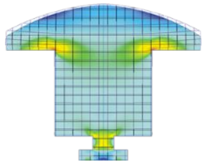
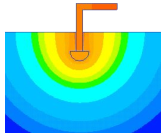
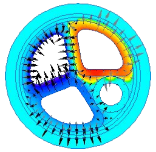
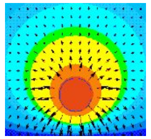
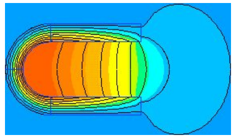
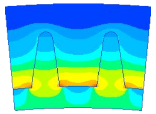
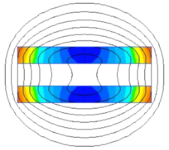
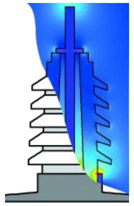
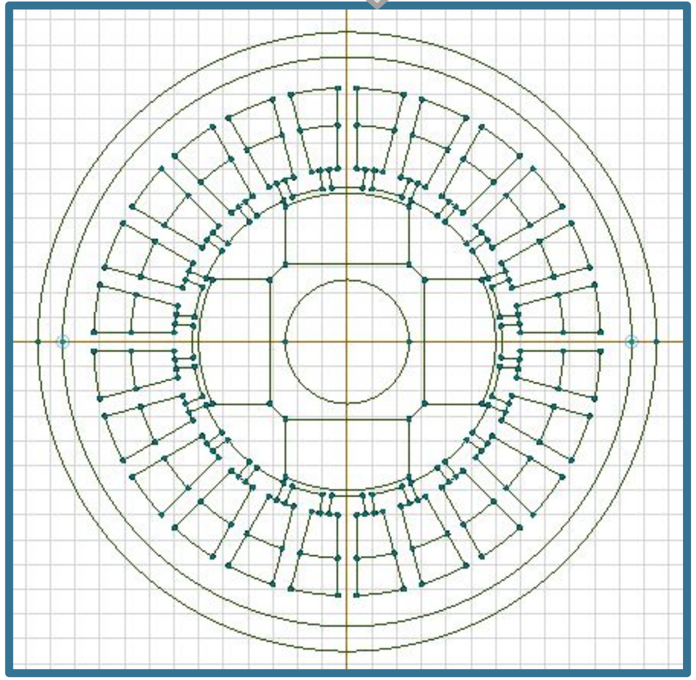









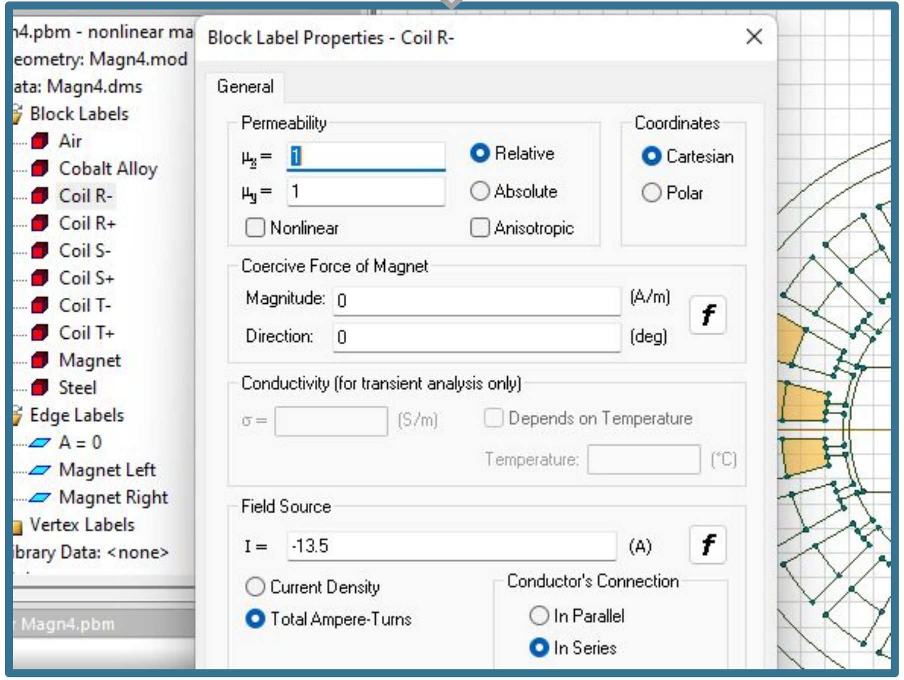
https://quickfield.com/pack.htm

QuickField Workflow

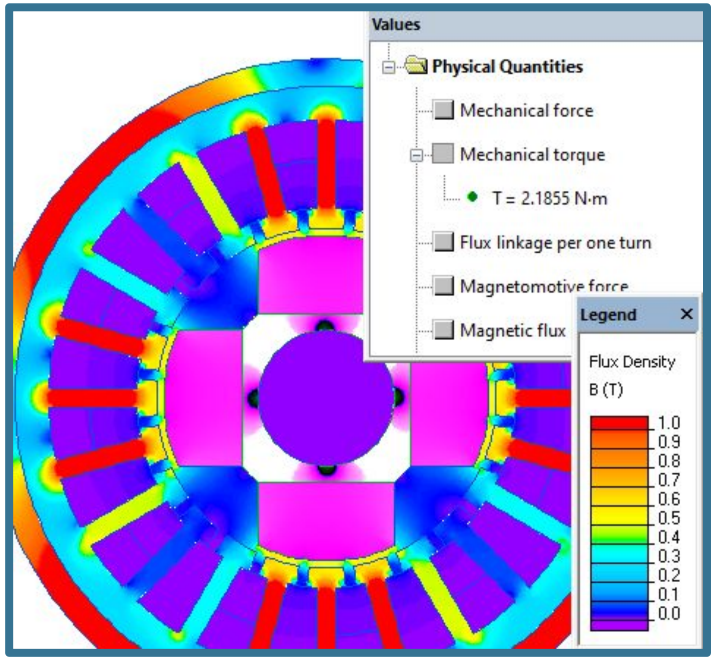
Problem setup



Model editor



Material physical properties, field sources and boundary conditions



Results analysis

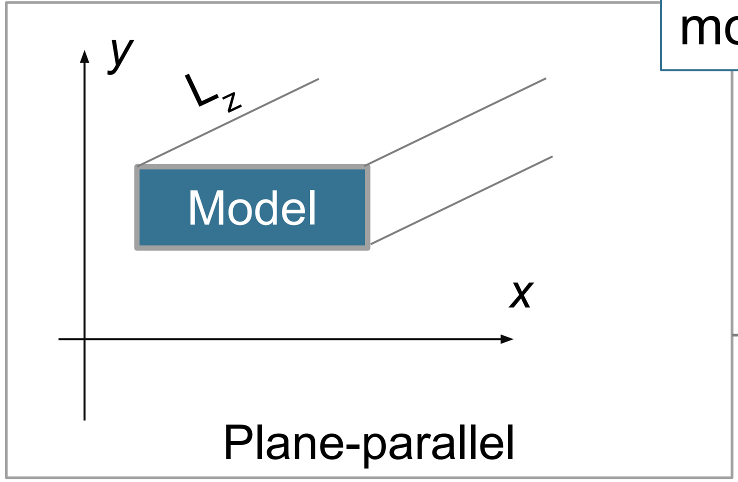
QuickField AC Magnetics. Problem setup

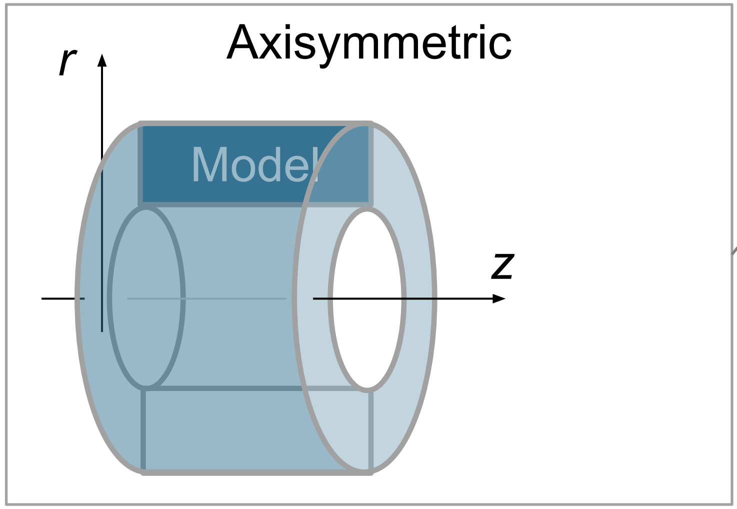
1. Choose problem type: AC magnetics

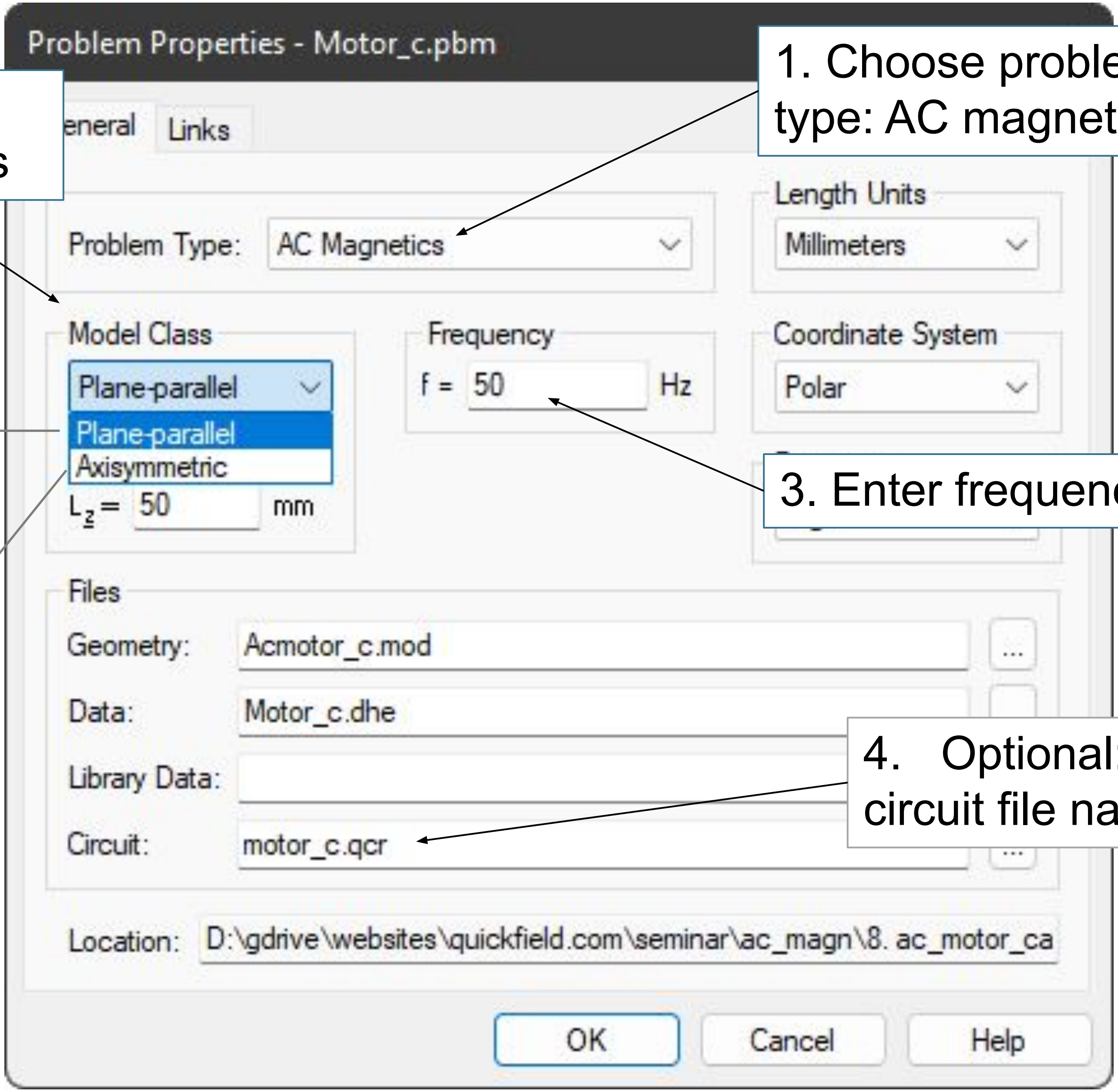
2. Choose model class

3. Enter frequency value

4. Optional: define circuit file name



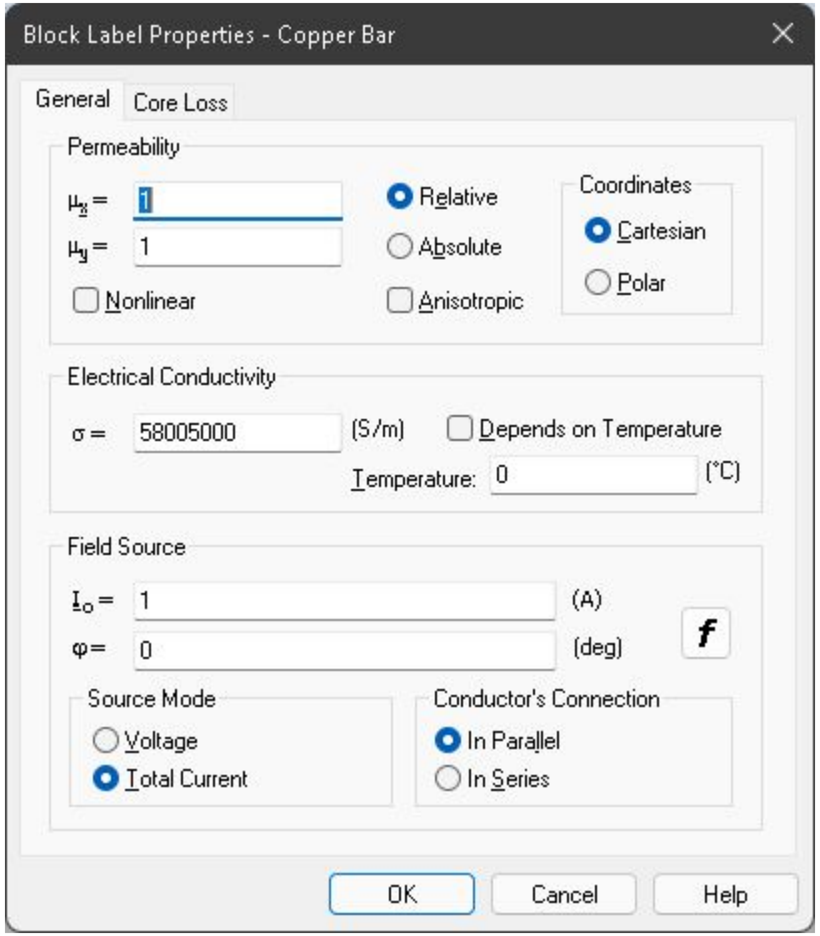




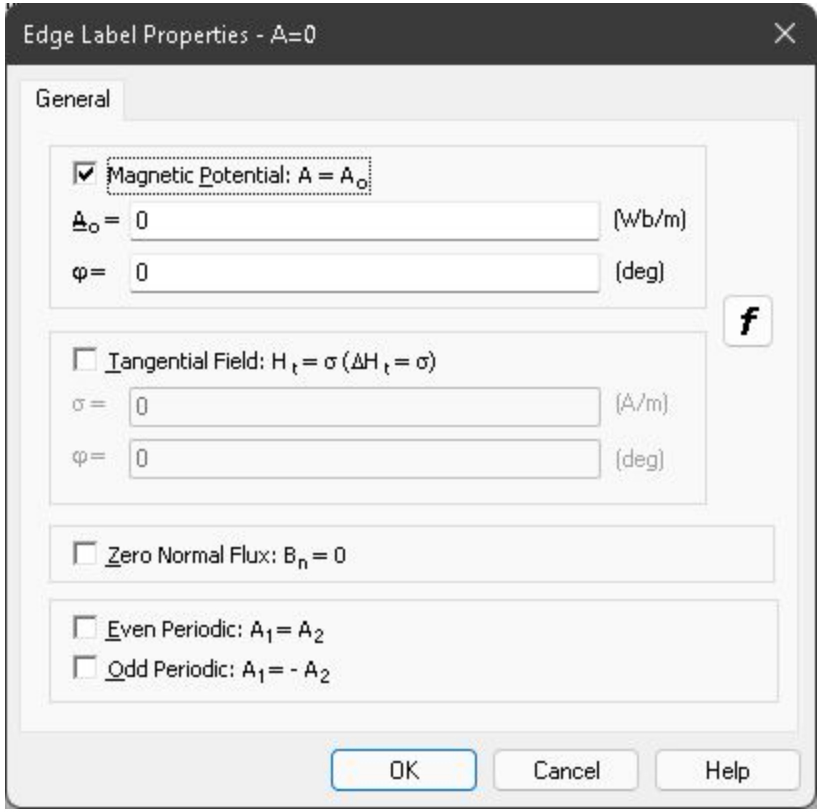
https://quickfield.com/acmag.htm

QuickField AC Magnetics. Label properties

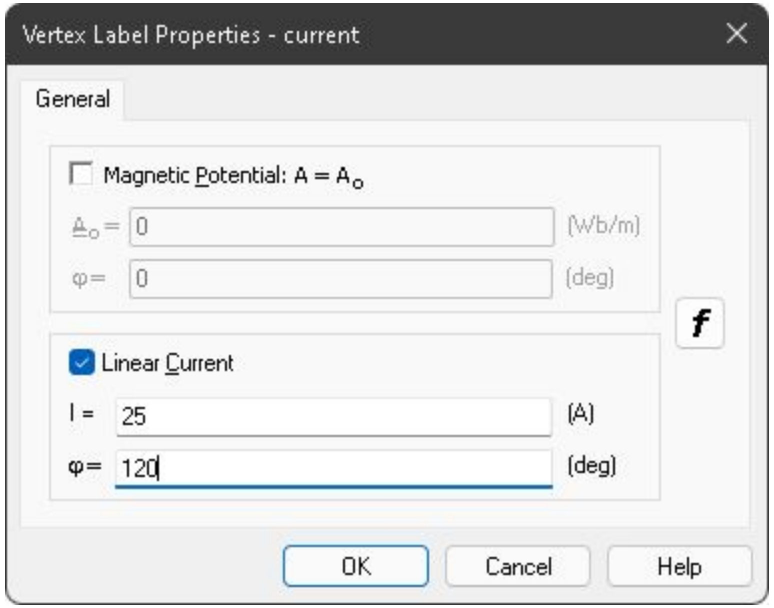
Block



Edge



Vertex



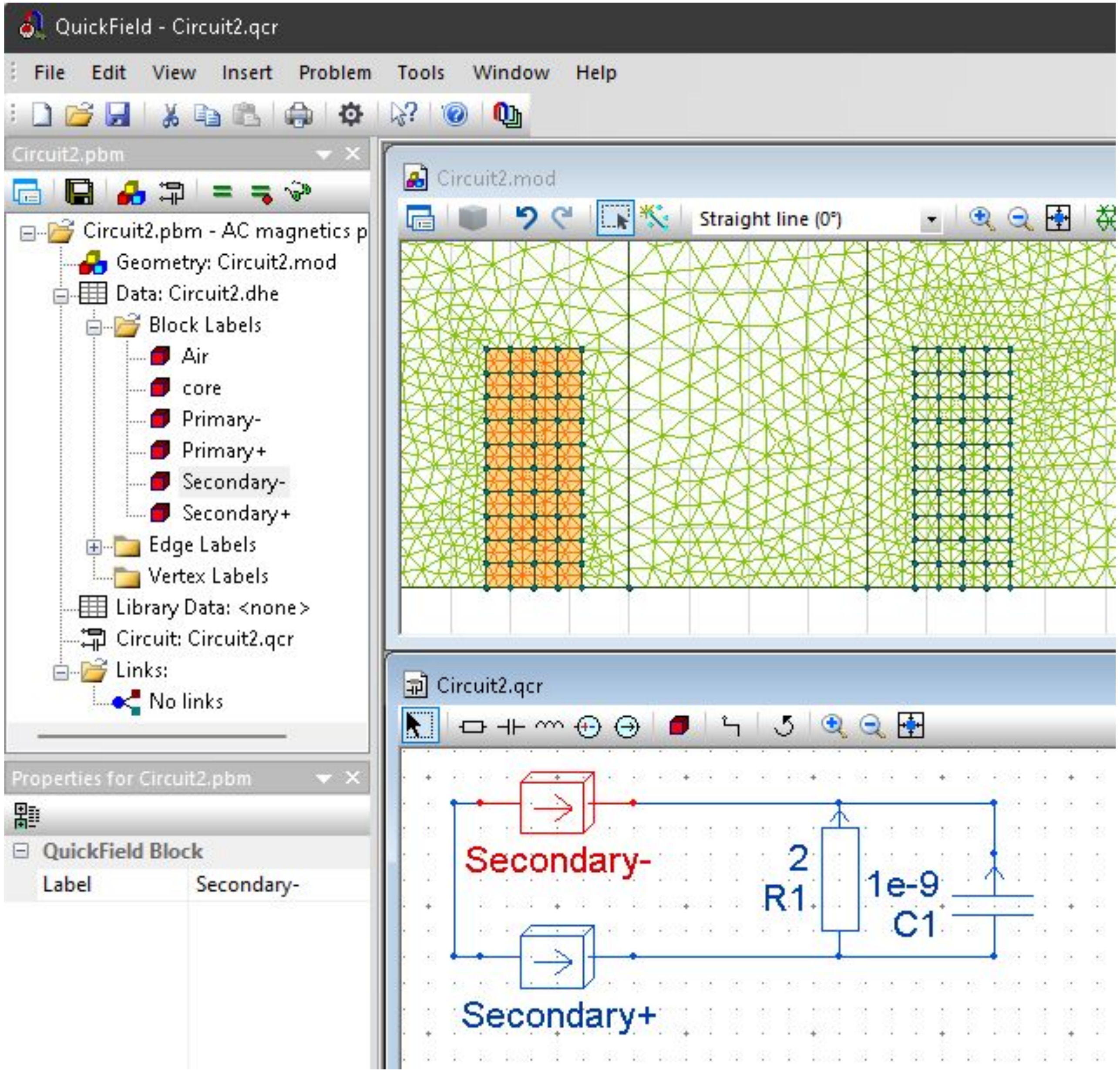
https://quickfield.com/acmag.htm

QuickField AC Magnetics. Circuit

AC magnetic problems in QuickField may be defined with the **electric circuits** connected to blocks of the field model. These formulations are suitable to model electromagnetic devices, like motors with complex winding scheme, or transformers with combined load.

Features

- Passive elements (R,L,C) and sources (U,I)
- Loads: constant, sinusoidal and complex pulse shape sources (you can use formulas to describe the electric source parameters)
- Results: voltage, current and impedance for each element. Current and voltage time plot.



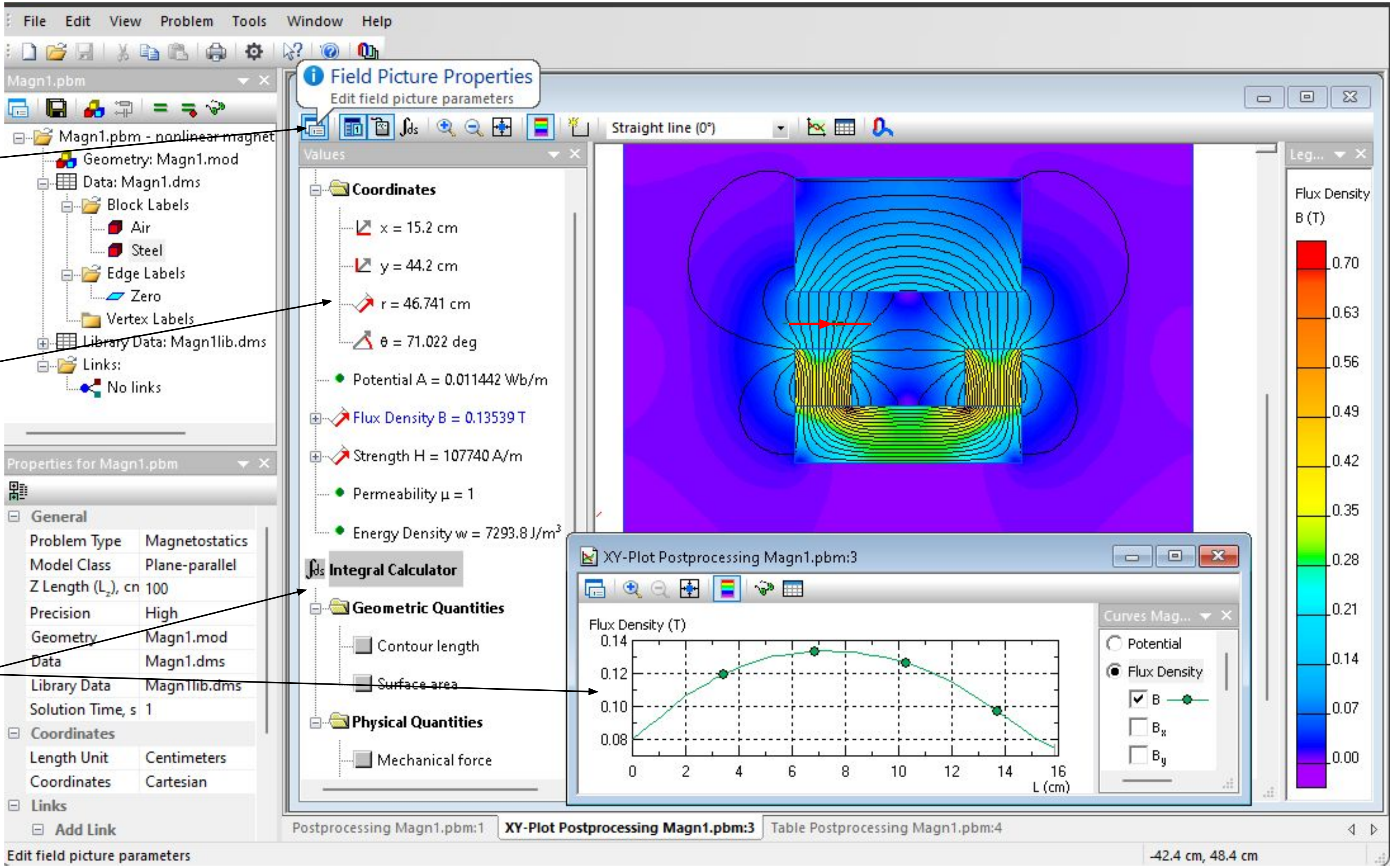
QuickField AC Magnetics. Results

Results analysis is the most complicated part, having more options. Generally the following types of result analysis are available:

Field maps showing the space distribution of different field parameters

Field parameters in arbitrary point

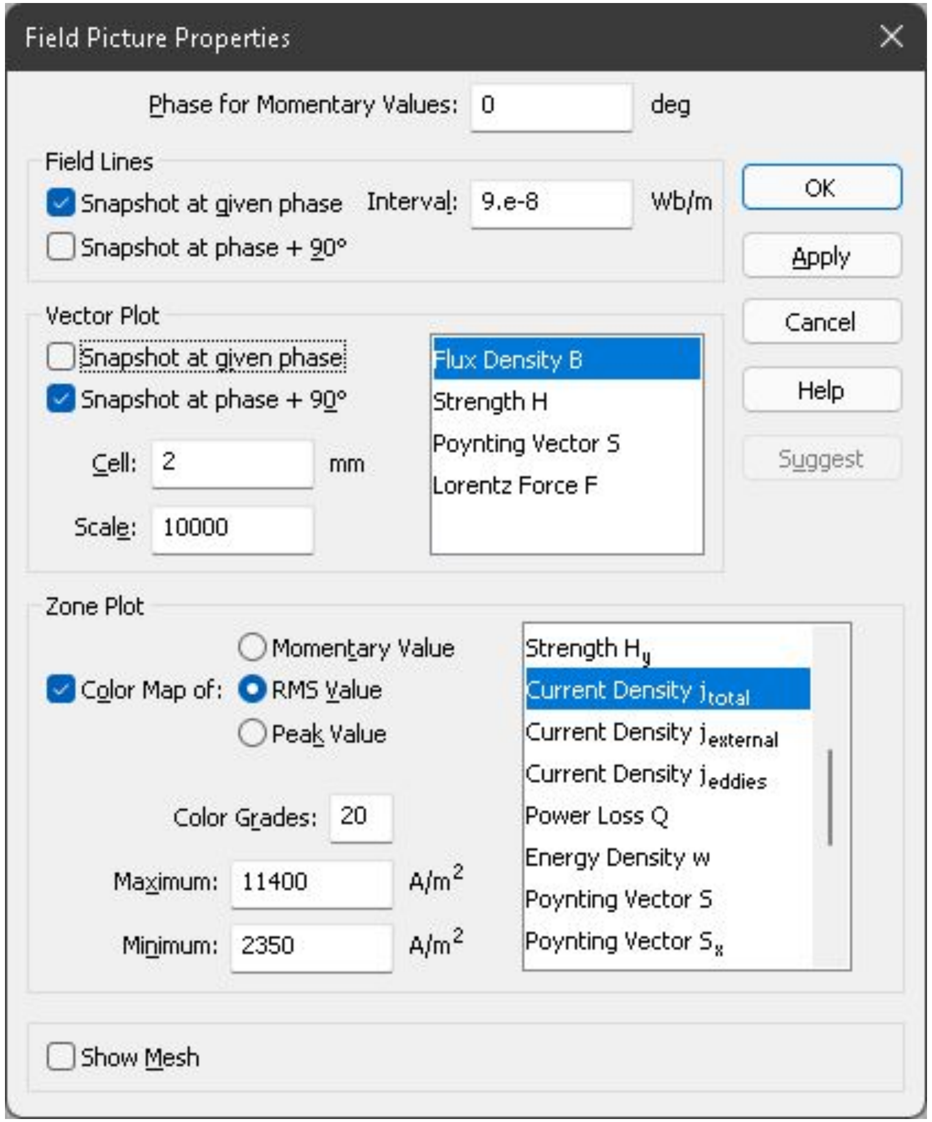
Contour analysis, including field parameters distribution and integral calculations



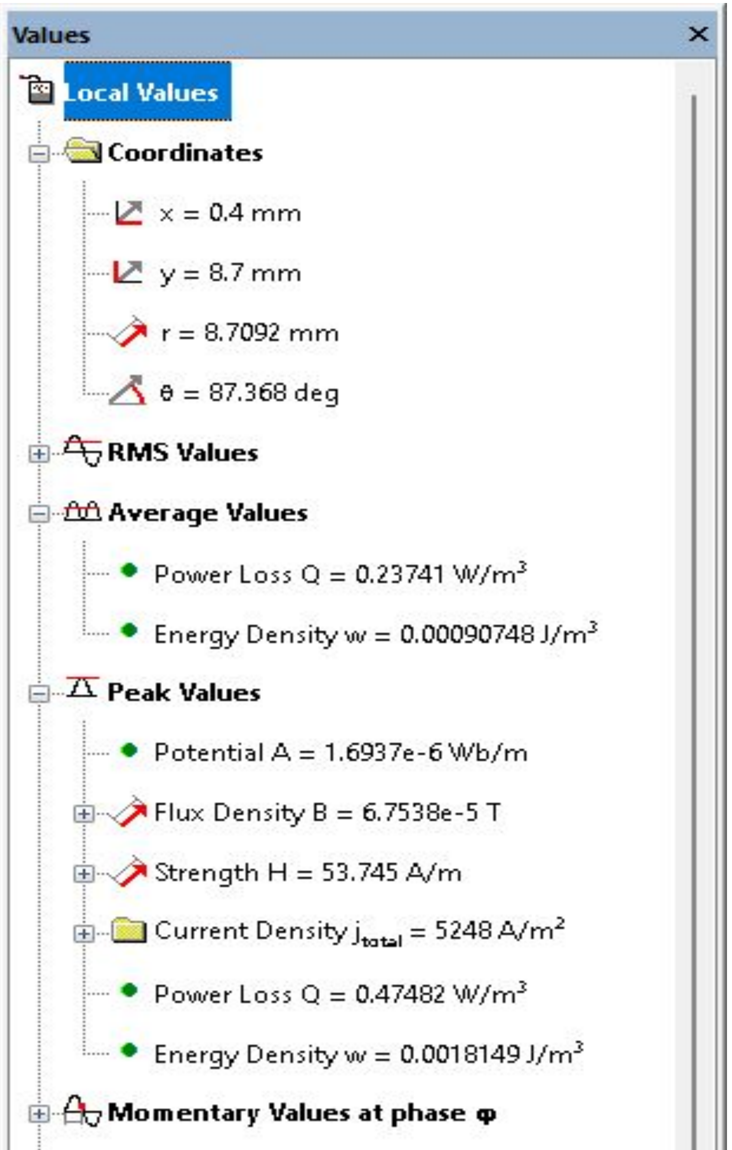
https://quickfield.com/post.htm

QuickField AC Magnetics. Results

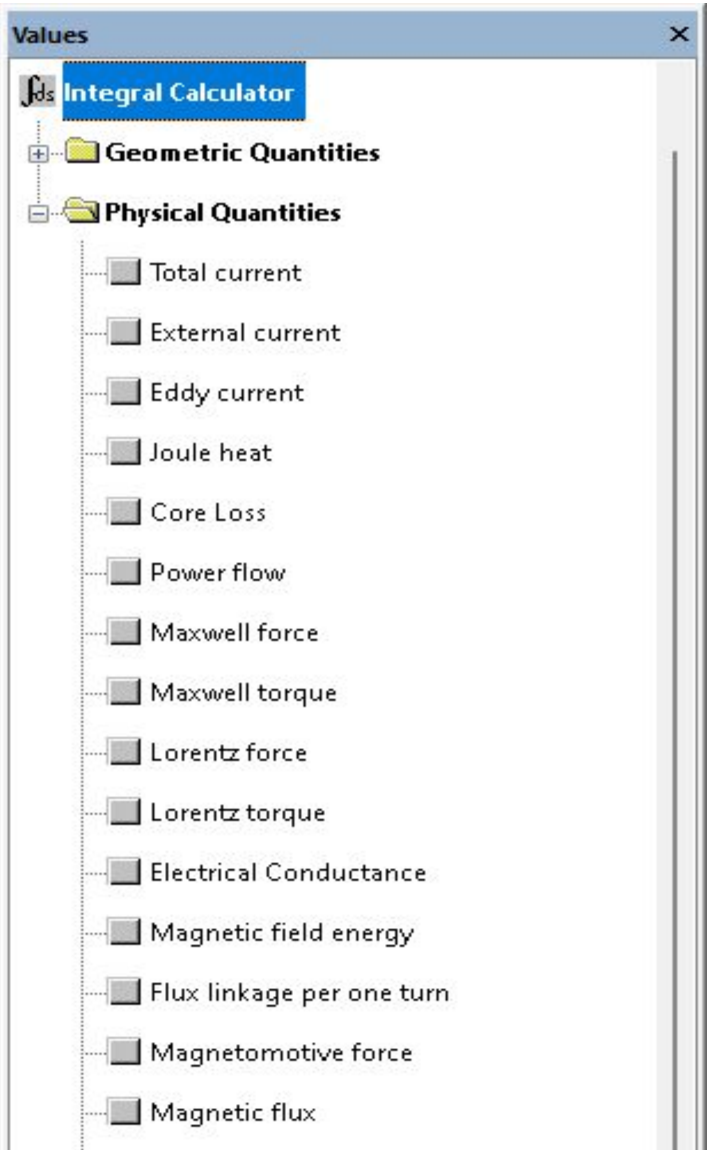
Field maps



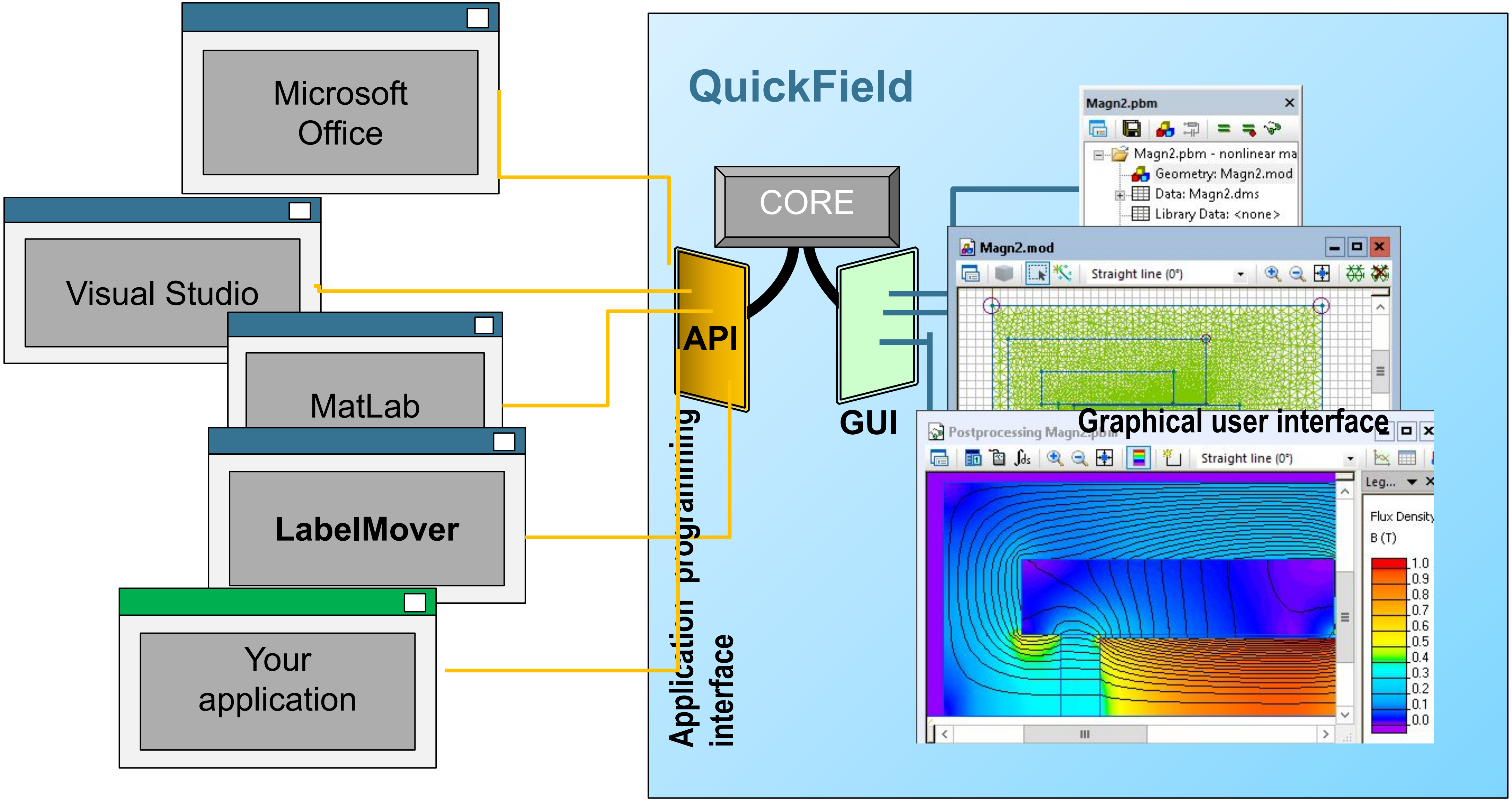
Local field data



Integrals



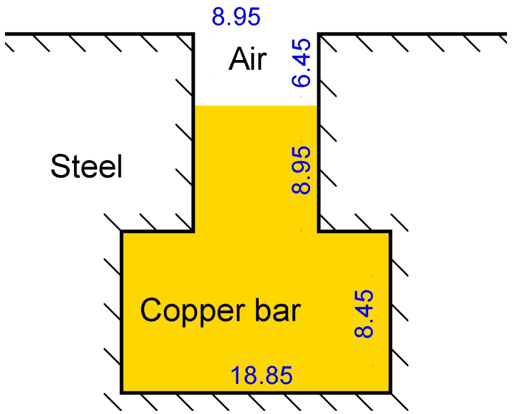
QuickField API



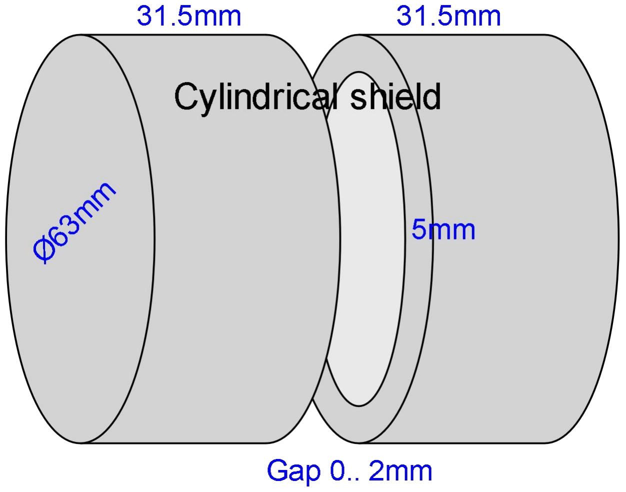
https://quickfield.com/programming.htm

QuickField Difference

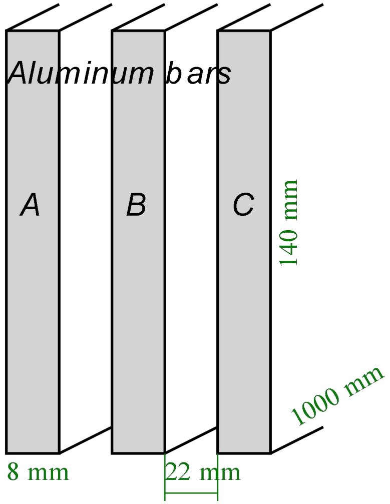
AC Magnetic simulation with QuickField



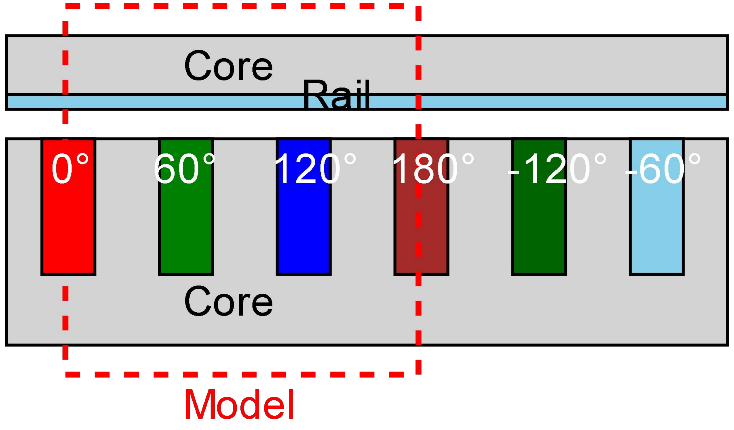
Slot embedded conductor skin effect



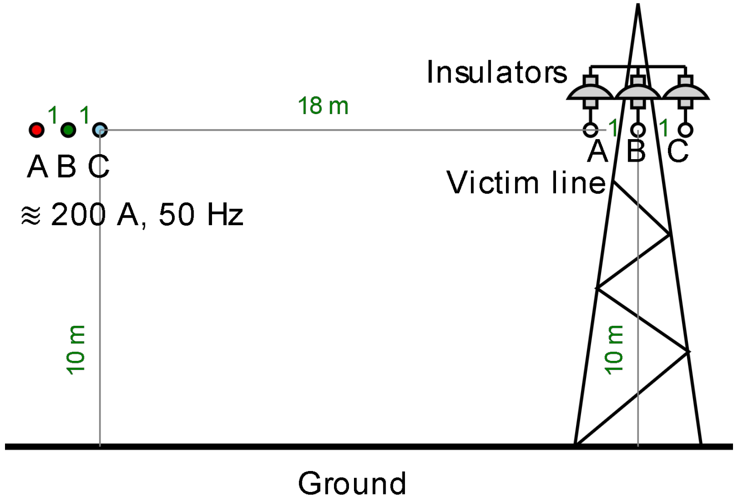
Electromagnetic shielding



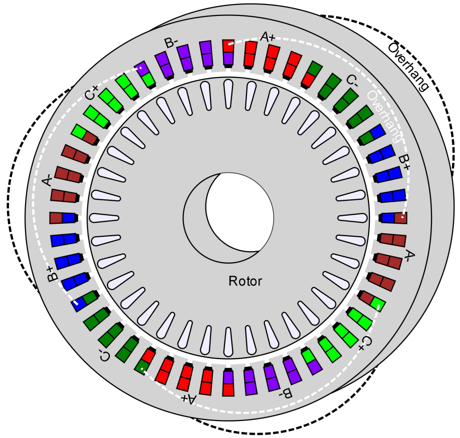
Three-phase busbar losses



Linear electric motor



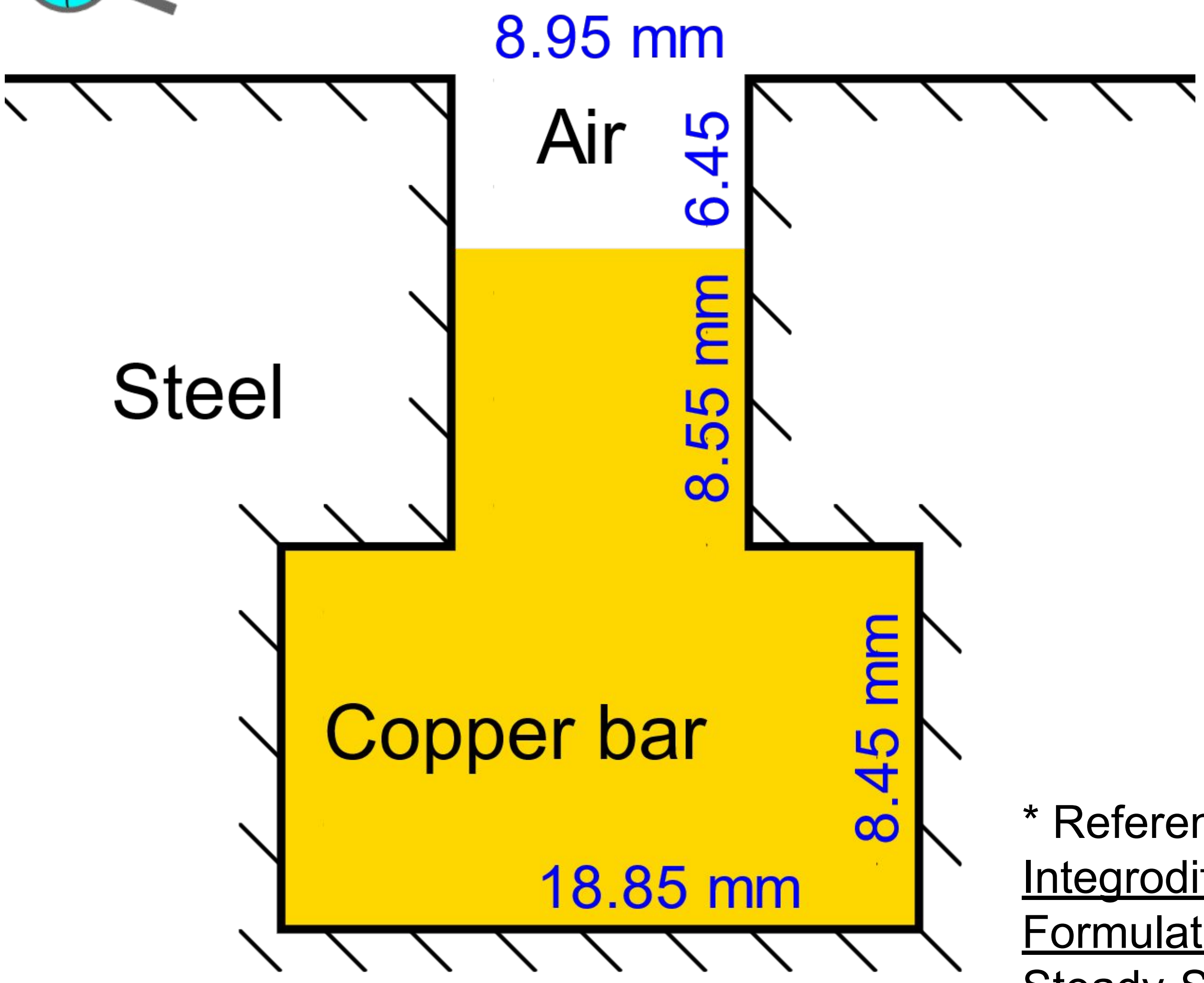
Transmission line magnetic coupling



Induction motor

https://quickfield.com/seminar/seminar_ac_magn.htm

Slot embedded conductor skin effect



All dimensions are in millimeters

Problem specification:

Conductivity of copper σ = 58 MS/m

Current in the conductor *I* = 1 A

Frequency *f* = 45 Hz

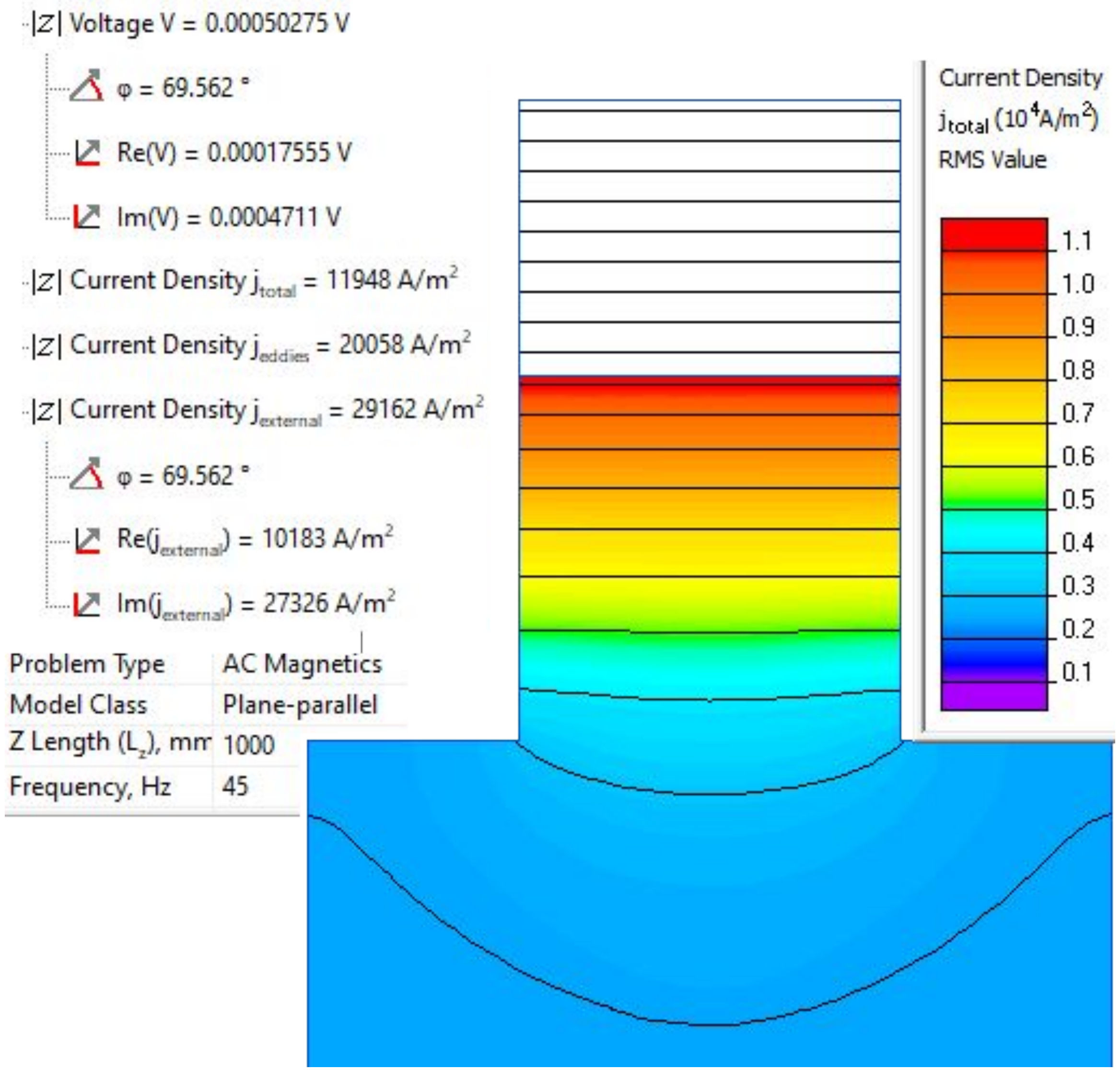
Task:

Determine current distribution within the conductor and complex impedance of the conductor.

* Reference: A. Konrad, Integrodifferential Finite Element Formulation of Two-Dimensional Steady-State Skin Effect Problems, IEEE Trans. Magnetics, Vol MAG-18, # 1, January 1982.

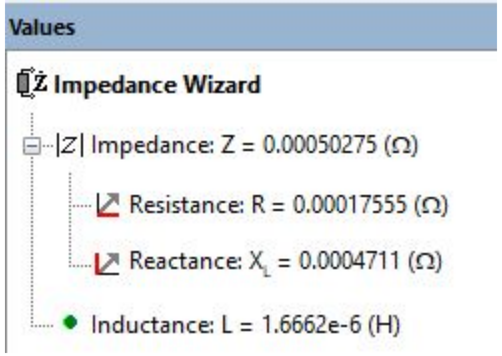
https://quickfield.com/advanced/hmagn1.htm

Slot embedded conductor skin effect



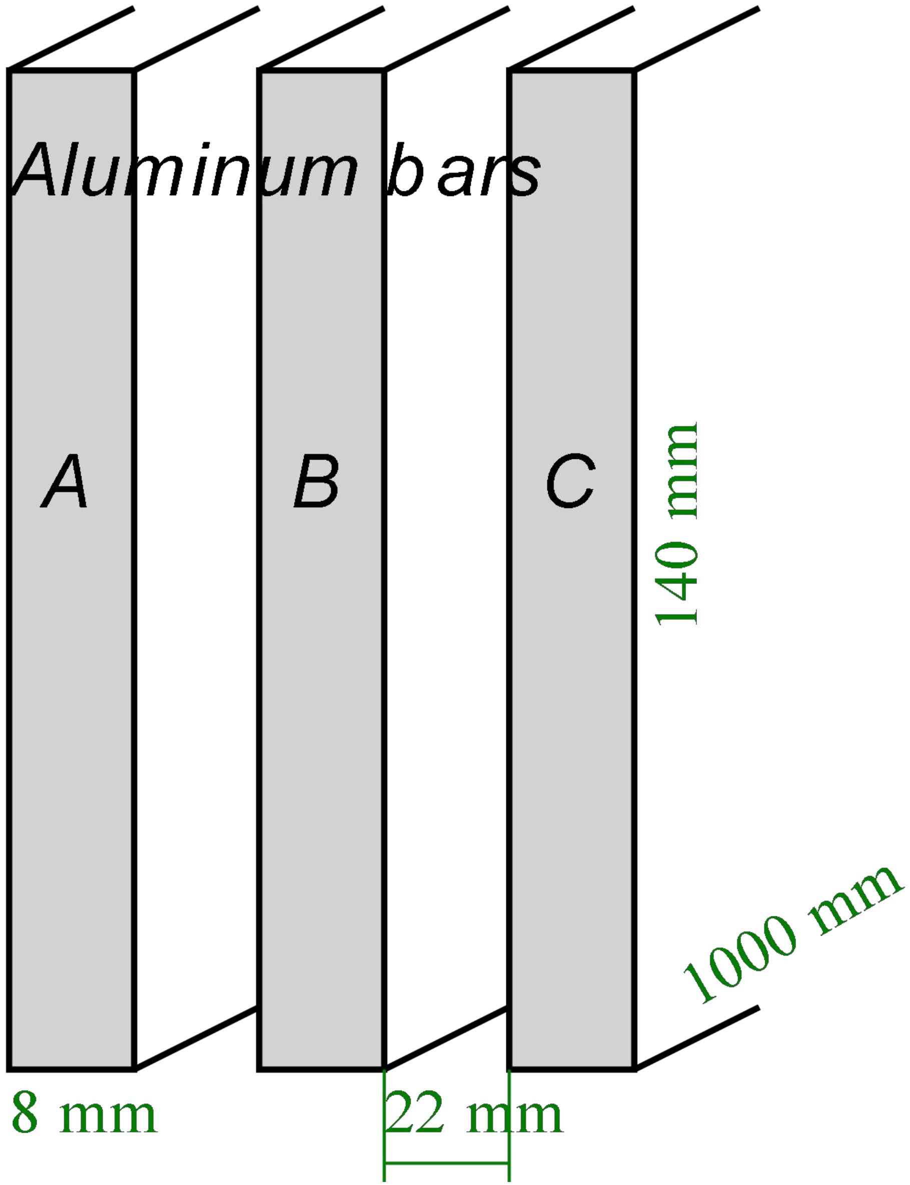
	External current density, A/m²
QuickField	10183 + j27326
Reference*	10182.7 + j27327.9

* Reference: A. Konrad, Integrodifferential Finite Element Formulation of Two-Dimensional Steady-State Skin Effect Problems, IEEE Trans. Magnetics, Vol MAG-18, # 1, January 1982.



https://quickfield.com/advanced/hmagn1.htm

Three-phase busbar losses



Problem specification:

Conductivity of aluminum σ = 37 MS/m

AC current *I* = 1000 A (R.M.S. value)

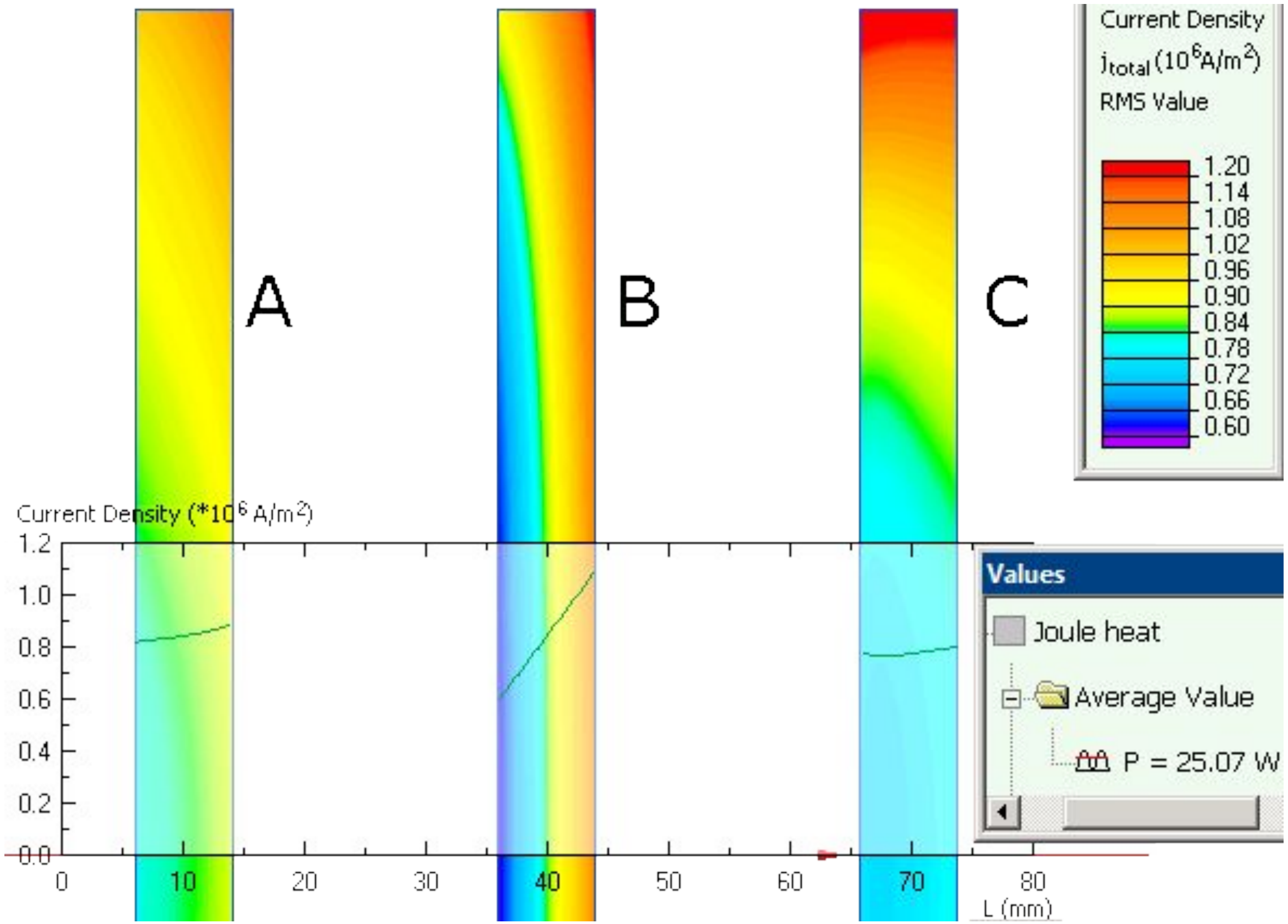
Frequency *f*: 50 Hz, 400 Hz, 1 kHz, 3 kHz

Task:

Calculate the dependence of the busbar losses on the alternating current frequency.

https://quickfield.com/advanced/busbars_ac_resistance.htm

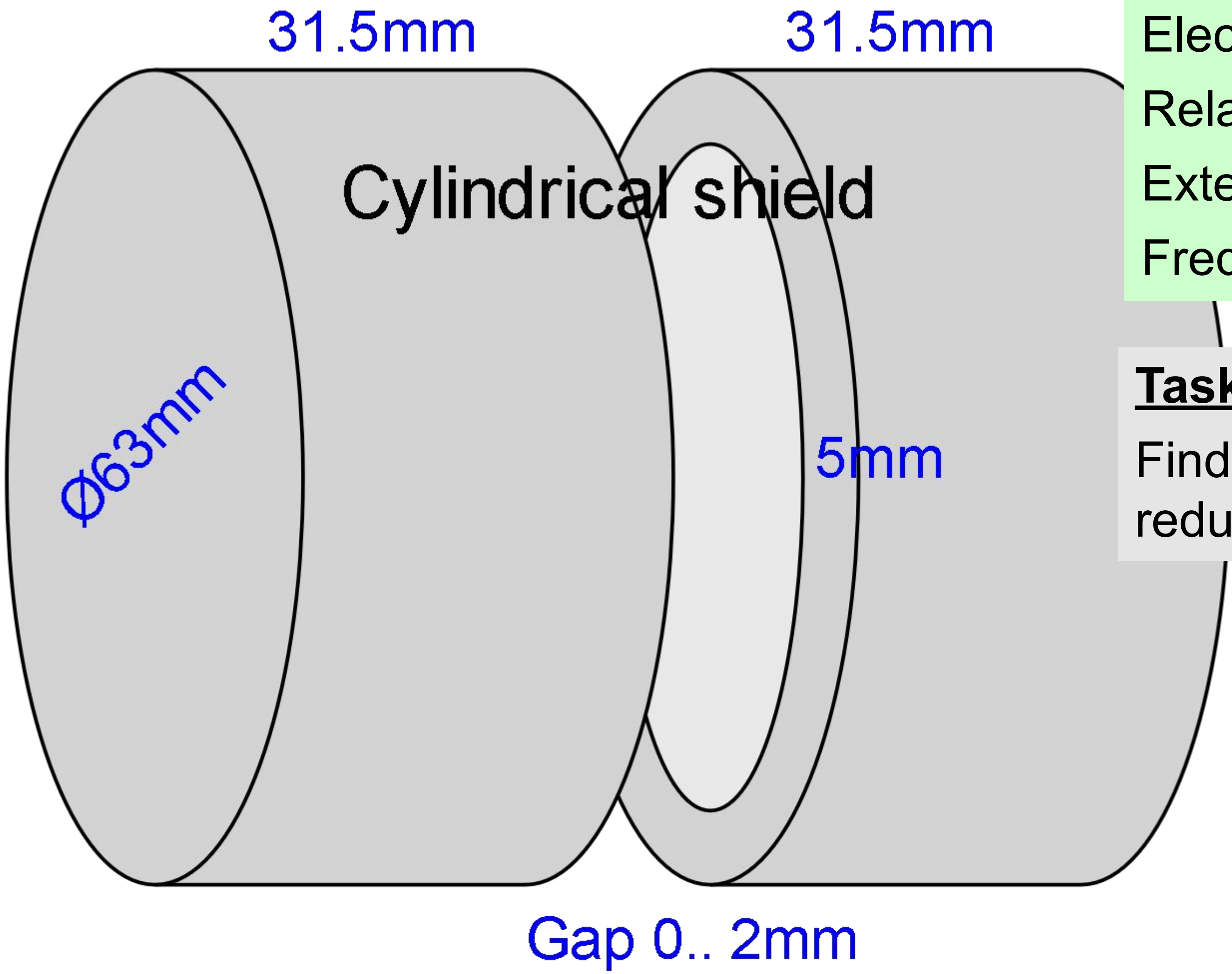
Three-phase busbar losses



	Joule heat losses, W per 1 m of busbar length		
Frequency, Hz	*A*	*B*	*C*
0	24	24	24
50	25.3	25.0	25.0
400	37.6	50.7	37.3
1000	56	90	56
3000	98	155	98

https://quickfield.com/advanced/busbars_ac_resistance.htm

Electromagnetic shielding



Problem specification:

Electrical conductivity of steel 10 MS/m

Relative magnetic permeability of steel μ=1000

External magnetic field flux density B = 0.139 T

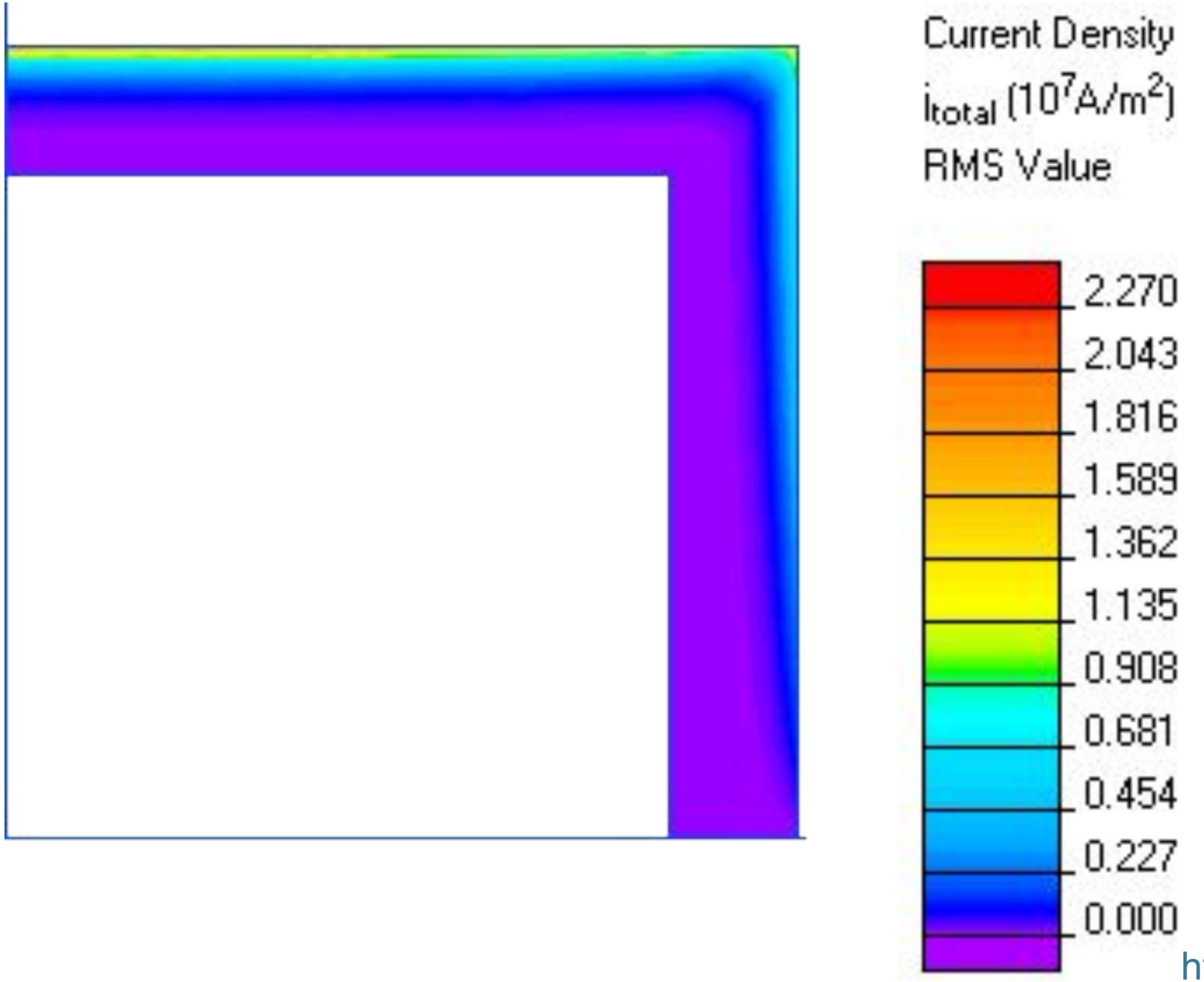
Frequency f = 50 Hz

Task:

Find the level of magnetic field reduction inside the shield

https://quickfield.com/advanced/toe_lab4.htm

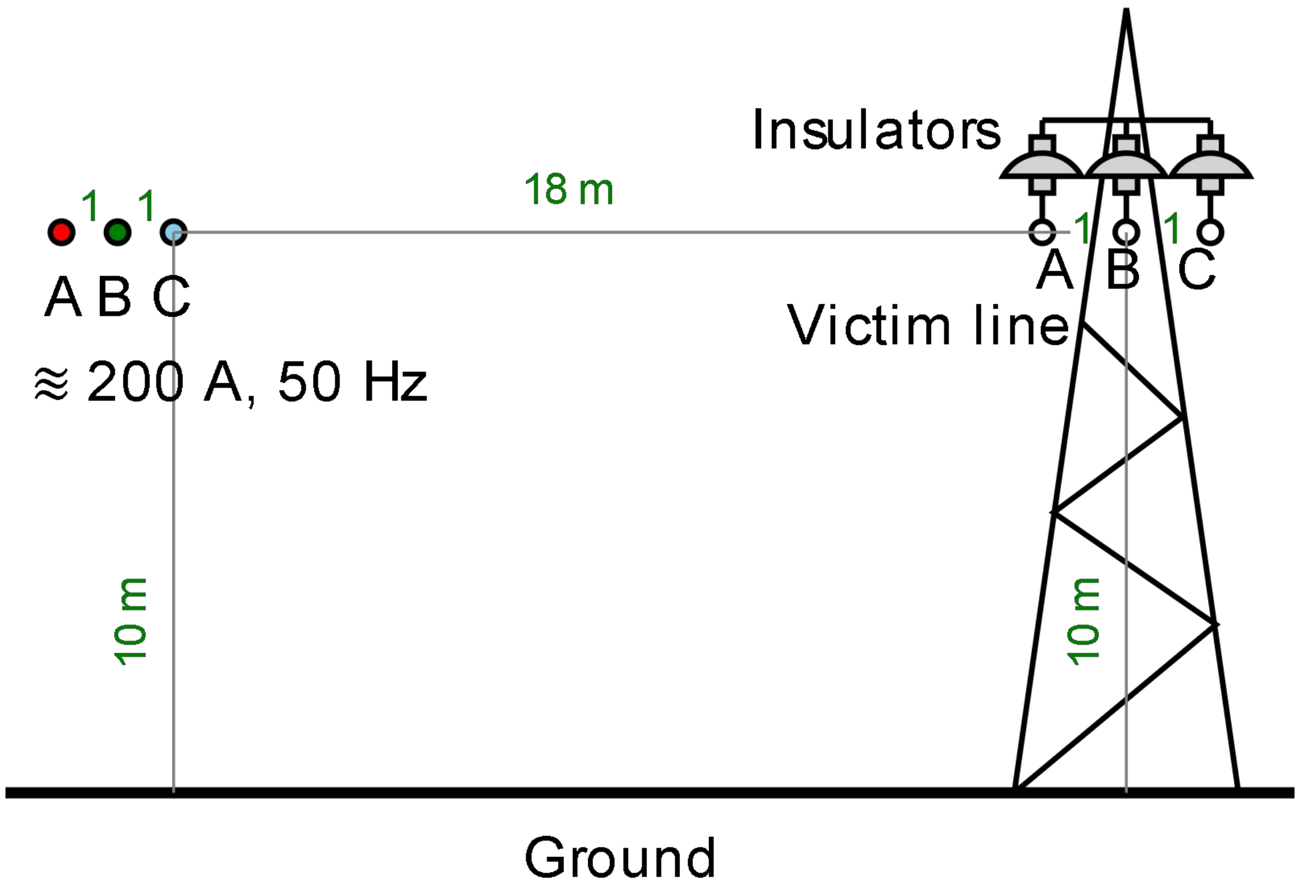
Electromagnetic shielding



Shield type	Peak value of flux density in the center, mT
Steel cylinder with slot 1 mm	30
Steel cylinder with slot 2 mm	40

https://quickfield.com/advanced/toe_lab4.htm

Transmission line magnetic coupling



Problem specification:

Left line current: 200 A (r.m.s)

Frequency f = 50 Hz

Ground electrical conductivity σ = 0.1 S/m

Transmission line length L_z = 10 km

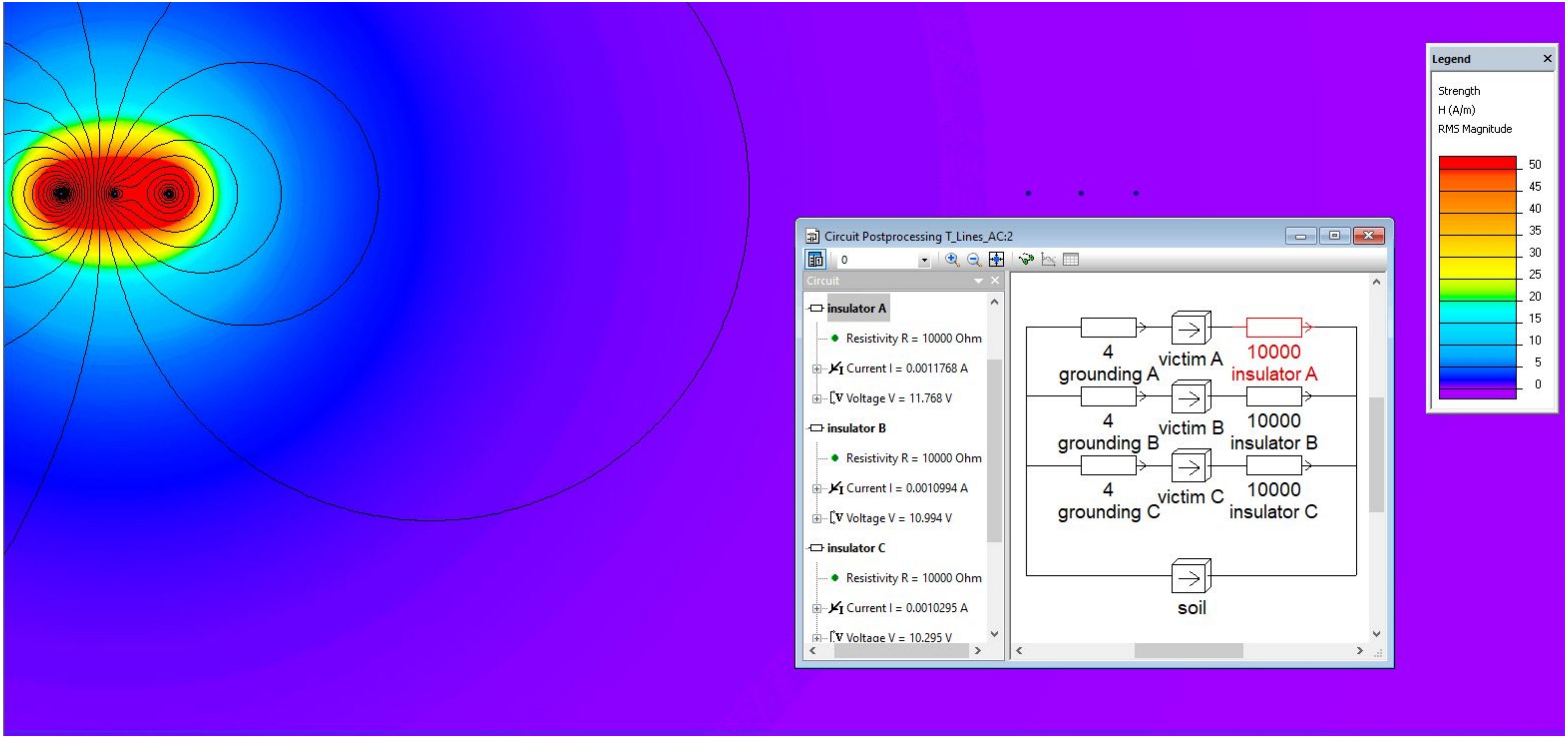
Victim line grounding resistance R = 4 Ohm

Task:

Find the electromagnetically induced voltages in the right (victim) transmission line at the ungrounded end of the 10 km segment.

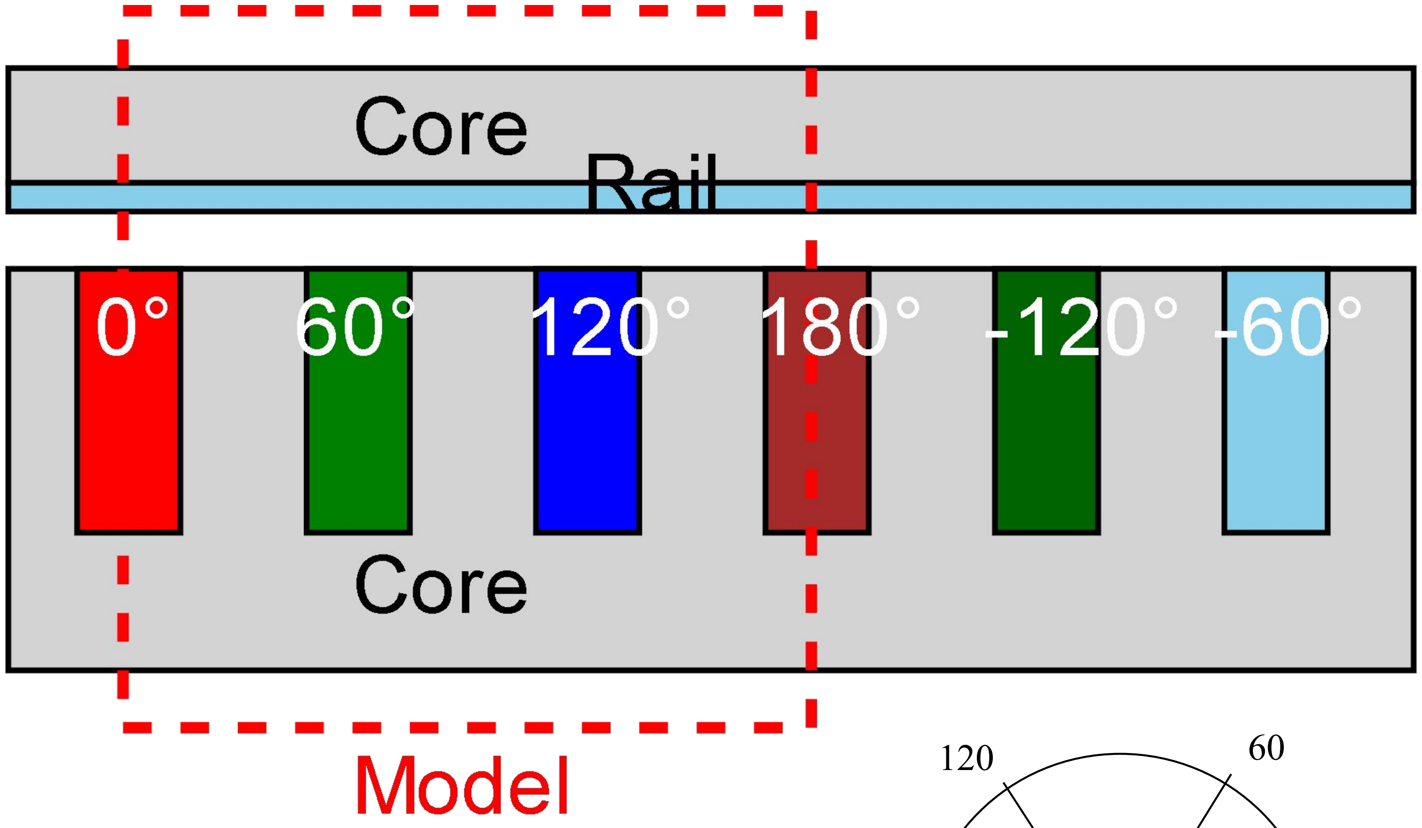
https://quickfield.com/advanced/transmission_line_magnetic_coupling.htm

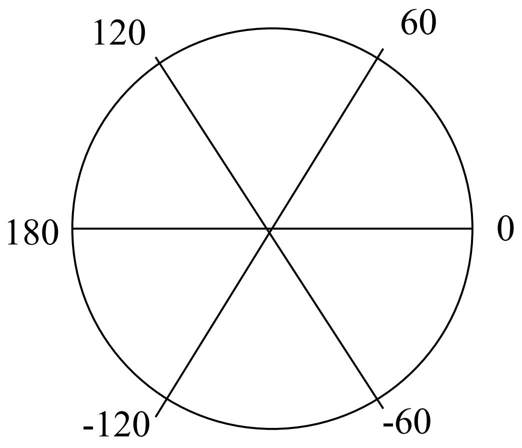
Transmission line magnetic coupling



https://quickfield.com/advanced/transmission_line_magnetic_coupling.htm

Linear electric motor





Problem specification:

Core permeability μ = 1000;

Rail conductivity σ = 37 MS/m;

Frequency *f* = 50 Hz.

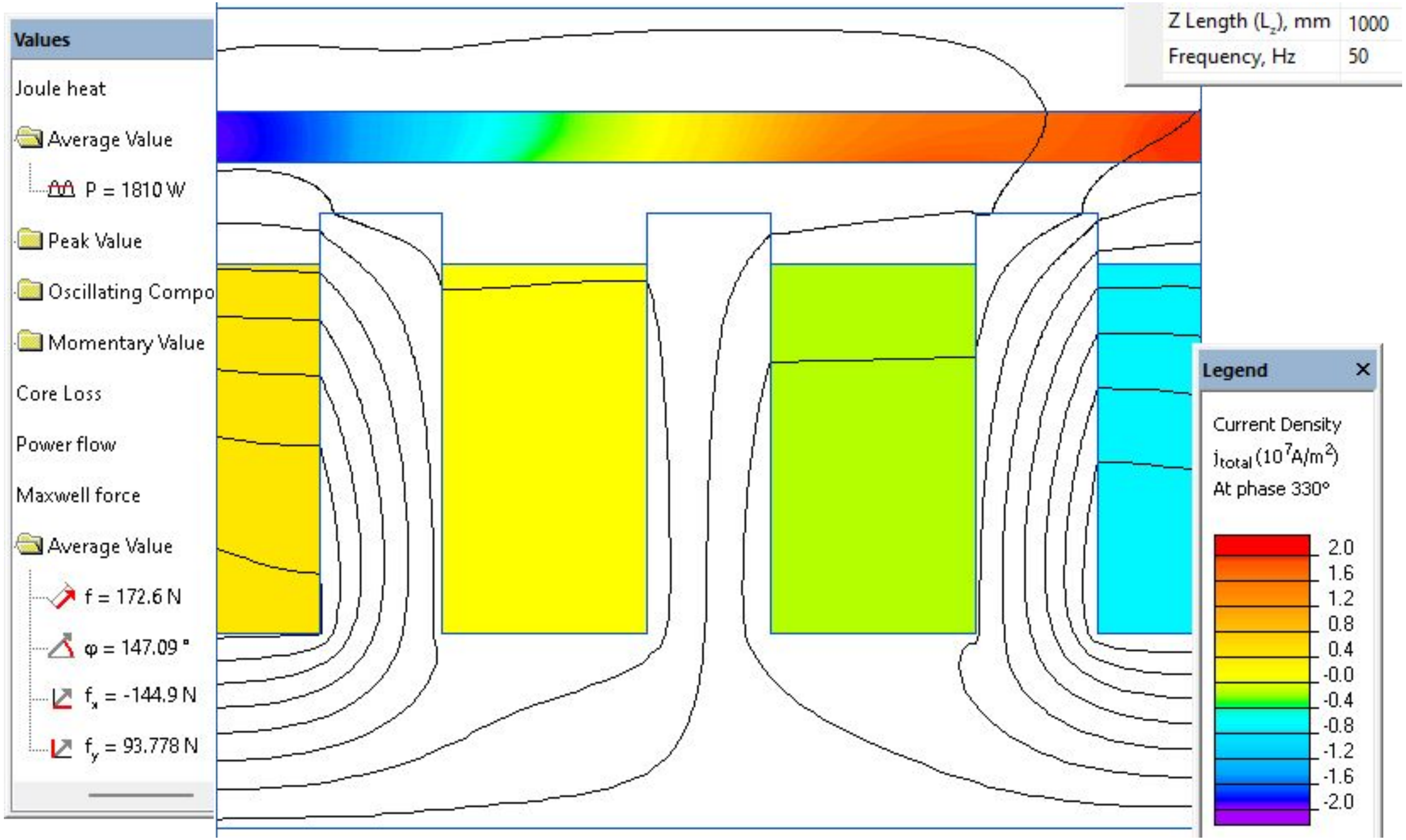
Slot total current I = 1844 A (r.m.s)

Task:

Calculate propulsion force acting on the rail and Joule heat loss.

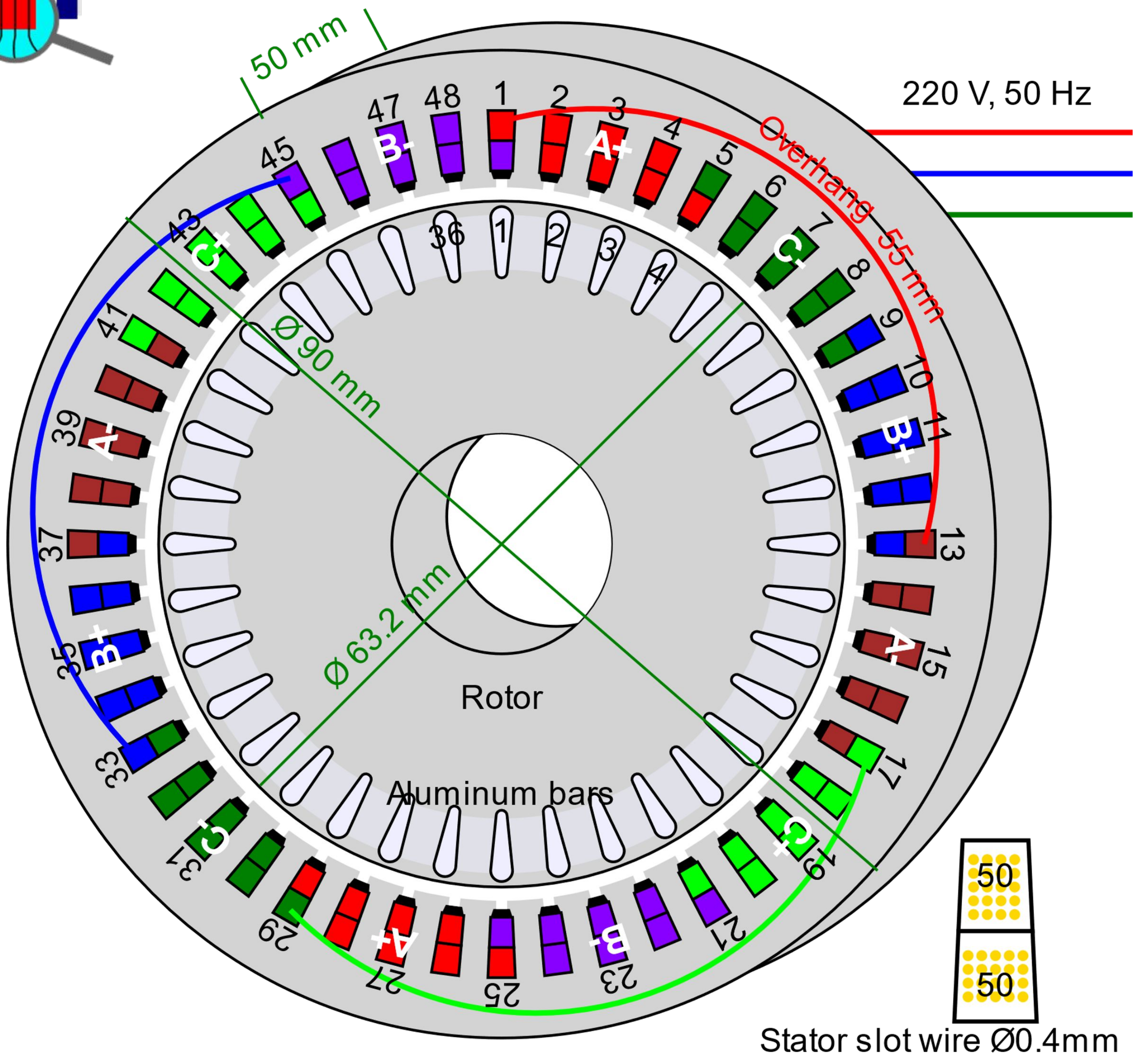
https://quickfield.com/advanced/perio2.htm

Linear electric motor



https://quickfield.com/advanced/perio2.htm

Induction motor



Problem specification:

Conductivity of copper σ_1 = 46.8 MS/m;

Conductivity of aluminum σ_2 = 31.1 MS/m;

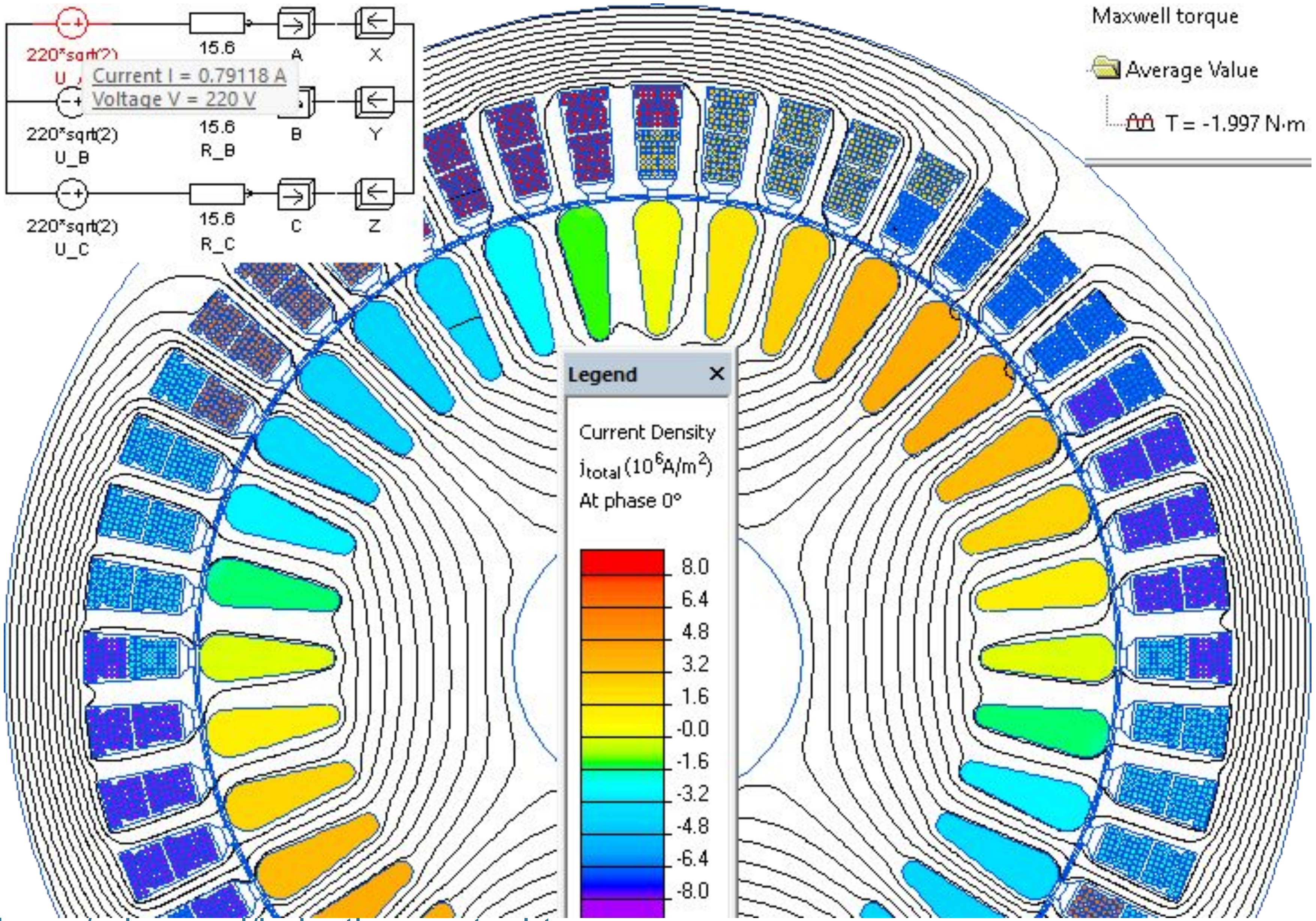
Task:

Calculate torque, current, Joule heat losses in the rotor at various rotation speeds

Rotation velocity	Rotor currents	Bar conductivity in the model
0 - stall		σ_2
Slip: $0<n<n_0$		$\sigma_2 * (1 - n / n_0)$
Synchronous	0	0

https://quickfield.com/advanced/induction_motor.htm

Induction motor



https://quickfield.com/advanced/induction_motor.htm

This recording is over

More recordings and simulation examples at

www.quickfield.com

Your feedback is welcome: support@quickfield.com