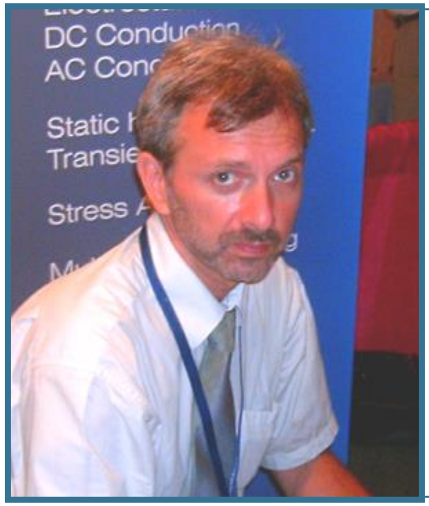
AC conduction simulation with QuickField



Vladimir Podnos

Director of Marketing and Support
Tera Analysis Ltd.

Alexander Lyubimtsev

Support Engineer
Tera Analysis Ltd.

https://quickfield.com/seminar/seminar_ac_cond.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

https://quickfield.com/pack.htm

QuickField Analysis Options

Magnetic analysis suite	Magnetostatics
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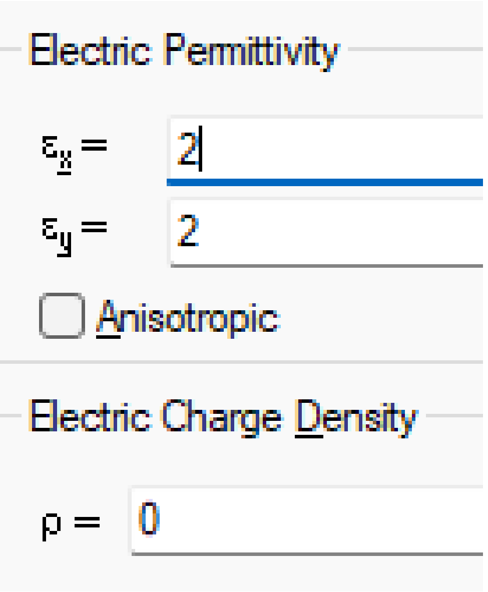
	Transient Heat transfer
	Stress analysis

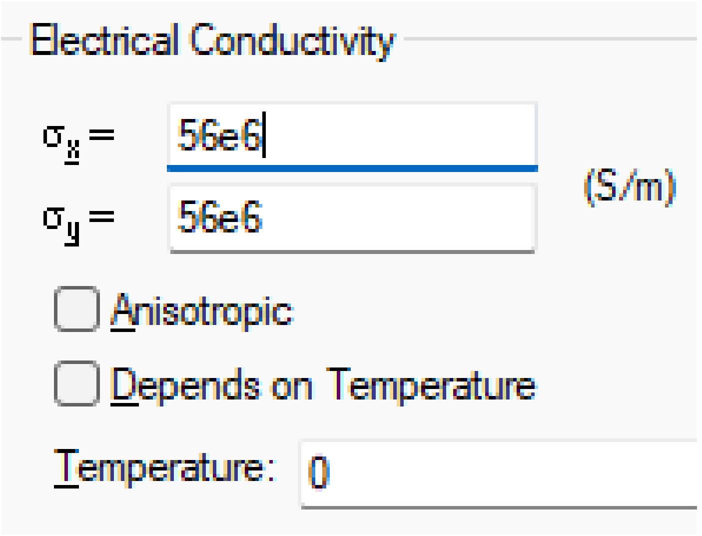
https://quickfield.com/pack.htm

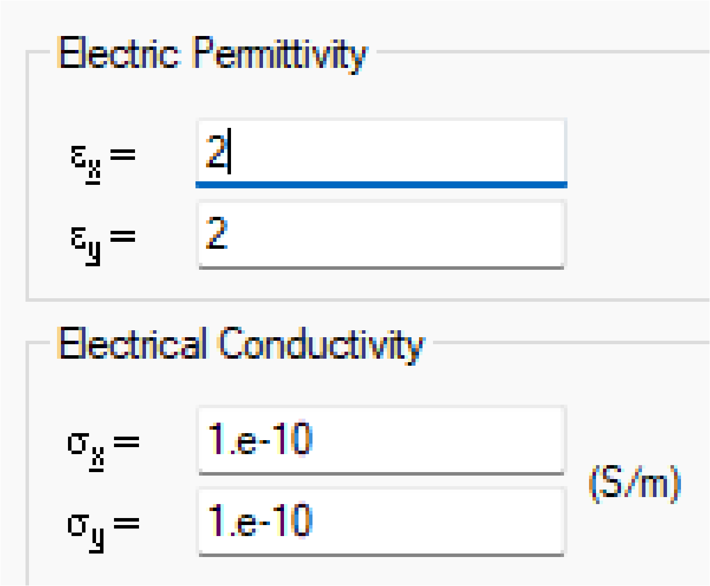
Electrostatics vs. DC Conduction vs. AC Conduction

In electric problems there is only electric field.
Magnetic field is ignored, there is no eddy current

Electrostatics	DC Conduction	AC Conduction
Electric permittivity No currents. No heat loss.	Electrical conductivity Only conductivity current	Electric permittivity and electrical conductivity. Conductivity current, displacement current.







QuickField AC vs. Transient

AC

Electric Permittivity

$\varepsilon_x =$ 2

$\varepsilon_y =$ 2

Electrical Conductivity

$\sigma_x =$ 1.e-10

$\sigma_y =$ 1.e-10 (S/m)

Specify phasor magnitude and phase

☑ Voltage: $U = U_o$

$U_o =$ 5 (V)

$\varphi =$ 0 (deg)

Transient

Electric Permittivity

Edit Curve $\varepsilon = \varepsilon(E)$ ...

☑ Nonlinear Permittivity

☐ Anisotropic Permittivity

Electrical Conductivity

Edit Curve $\sigma = \sigma(E)$ ...

☑ Nonlinear Conductivity

☐ Anisotropic Conductivity

Coordinates

◉ Cartesian

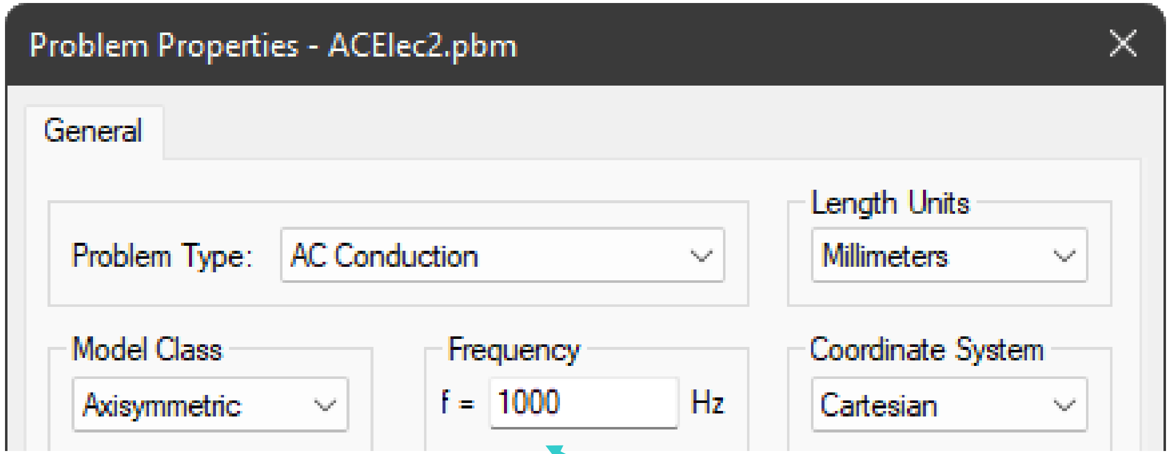
○ Polar

Specify formula of time

☑ Voltage: $U = U_o$

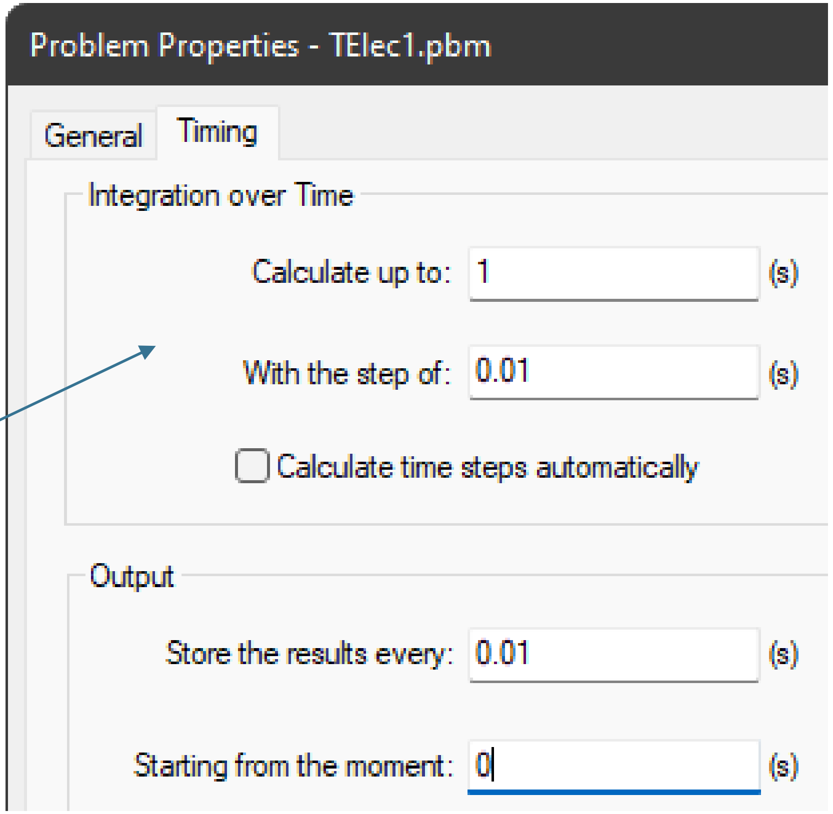
$U_o =$ 25 * impulse(t,0,0.01) (V)

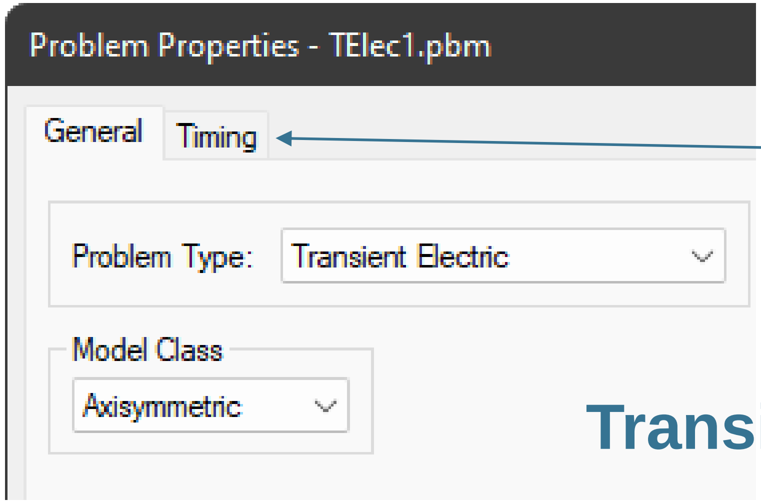
QuickField AC vs. Transient



AC

Specify frequency value

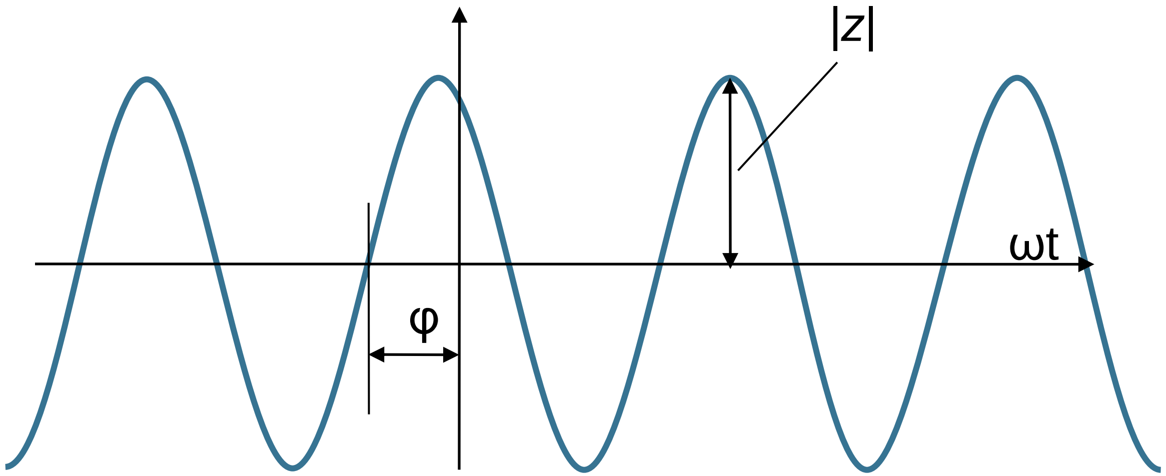




Specify integration time step and final time

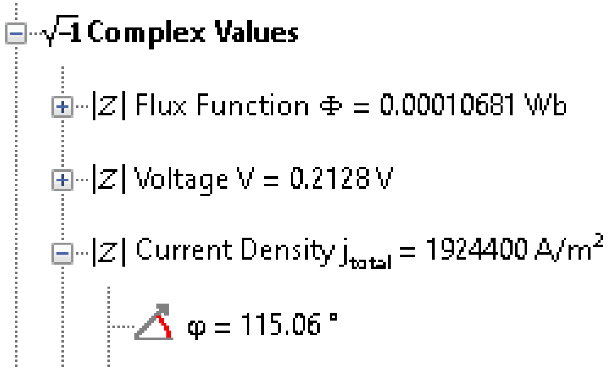
Transient

QuickField AC vs. Transient



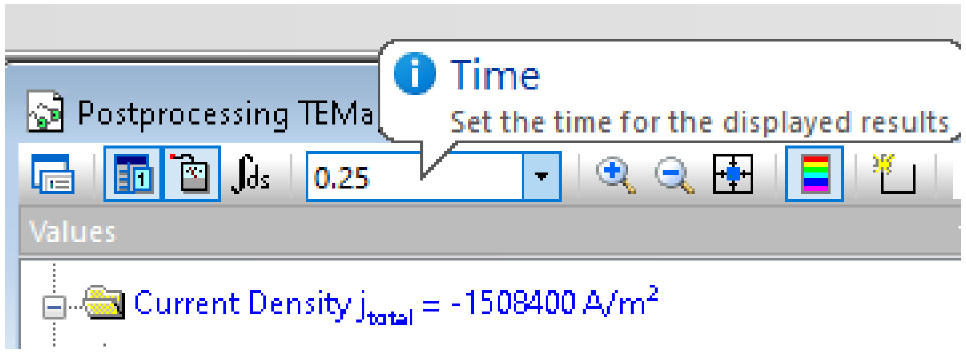
AC

Field components are considered to be time-harmonic, vary with time as $z = z_0 \cdot \cos(\omega t + \varphi_z)$, and presented as complex values with real and imaginary parts.

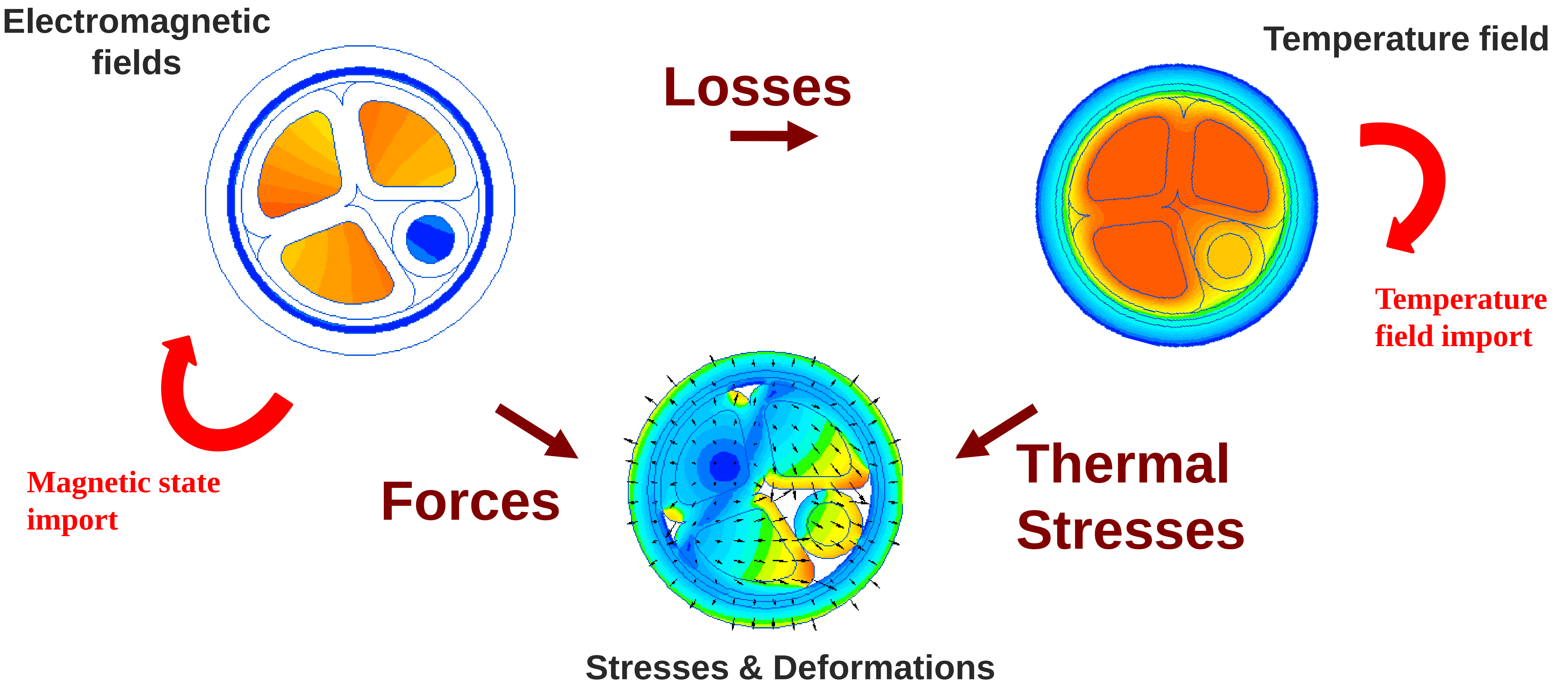


Transient

Field sources and boundary conditions can be defined by time-dependent formulae (including time-harmonic), and the transient solution is obtained by time integration using time steps.



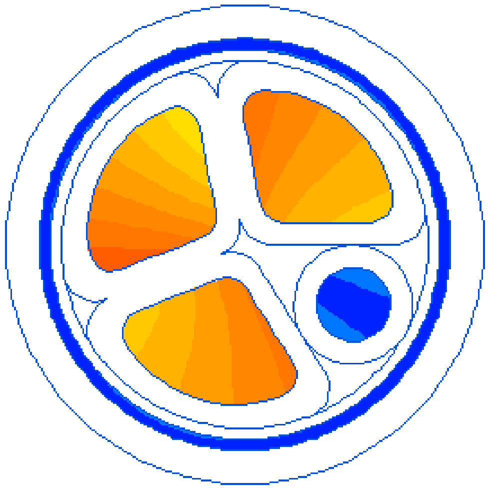
MultiPhysics (2D)



https://quickfield.com/coupling.htm

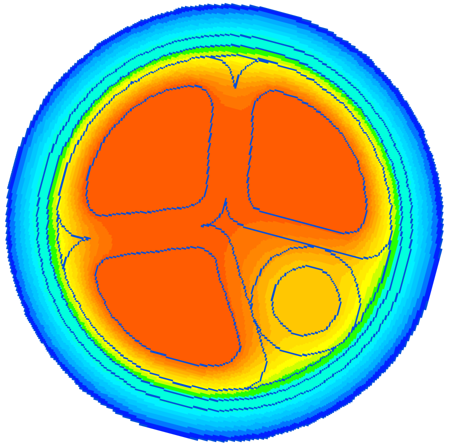
MultiPhysics (2D)

Electromagnetic fields



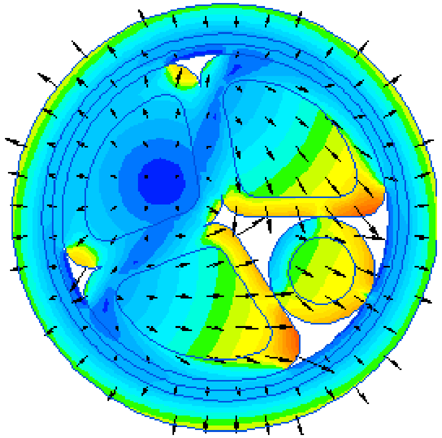
Joule Losses →

Temperature field



Temperature field import

Thermal Stresses

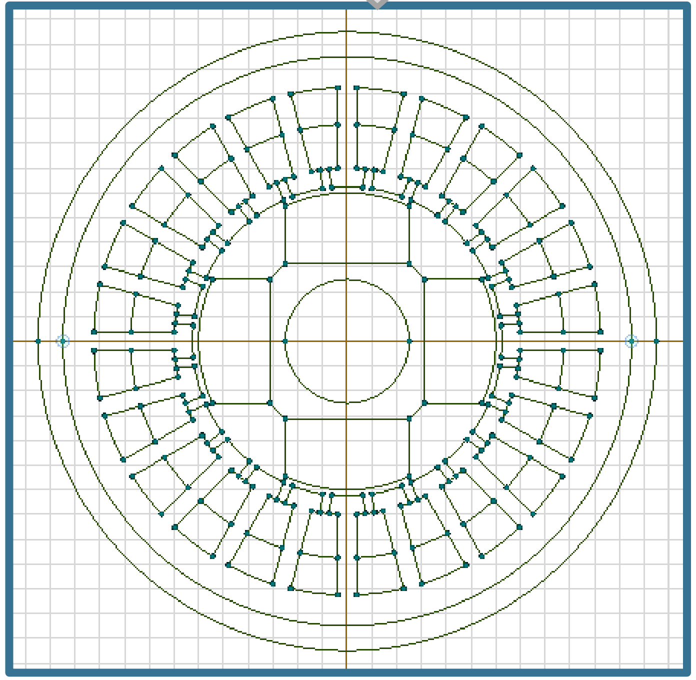


Stresses & Deformations

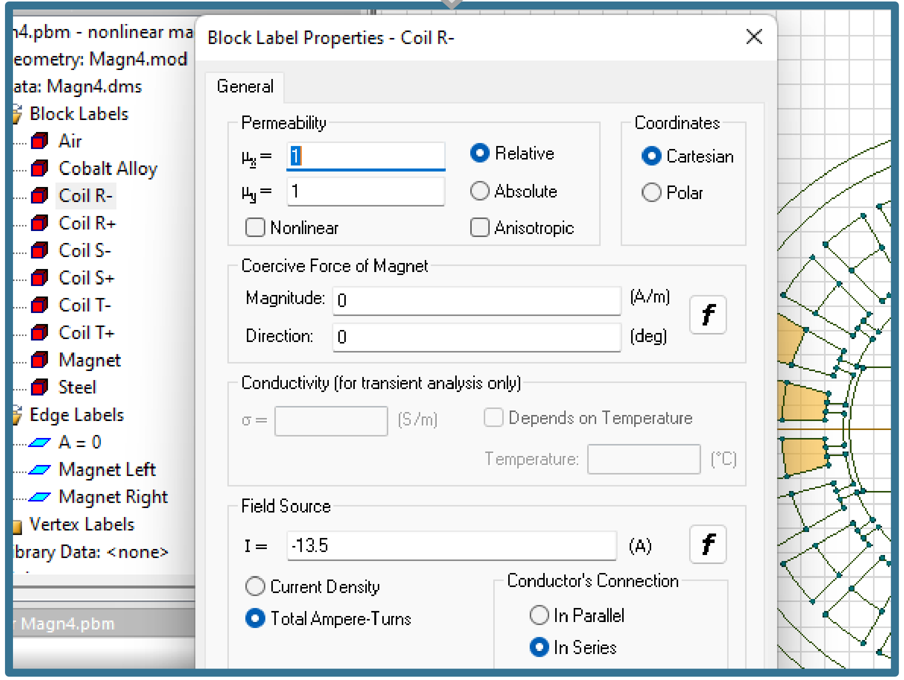
https://quickfield.com/coupling.htm

QuickField Workflow

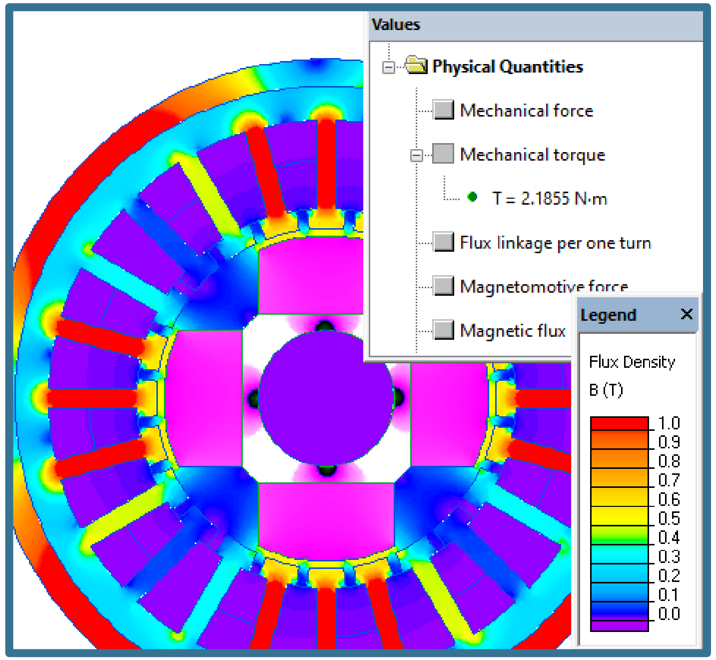
Problem setup



Model editor



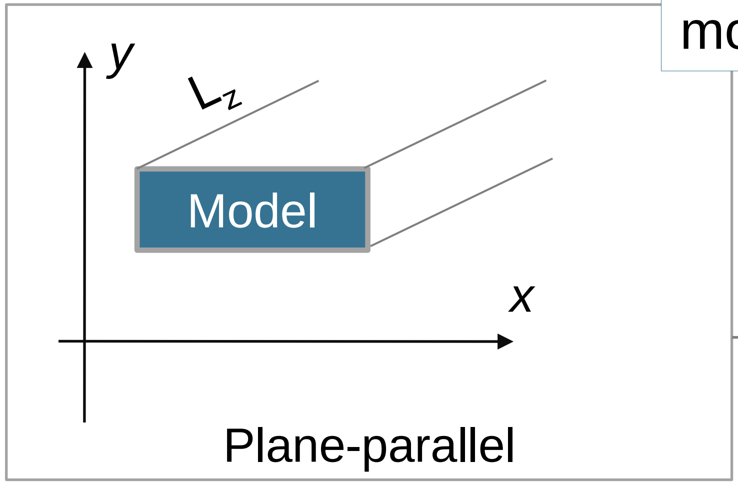
Material physical properties, field sources and boundary conditions

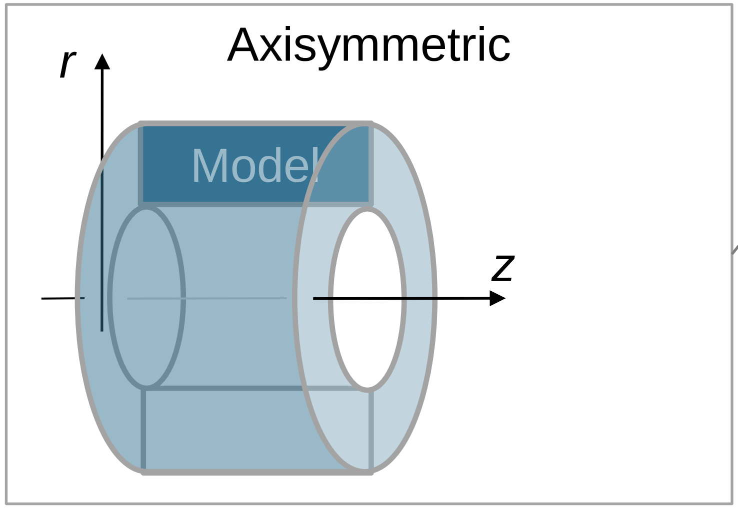


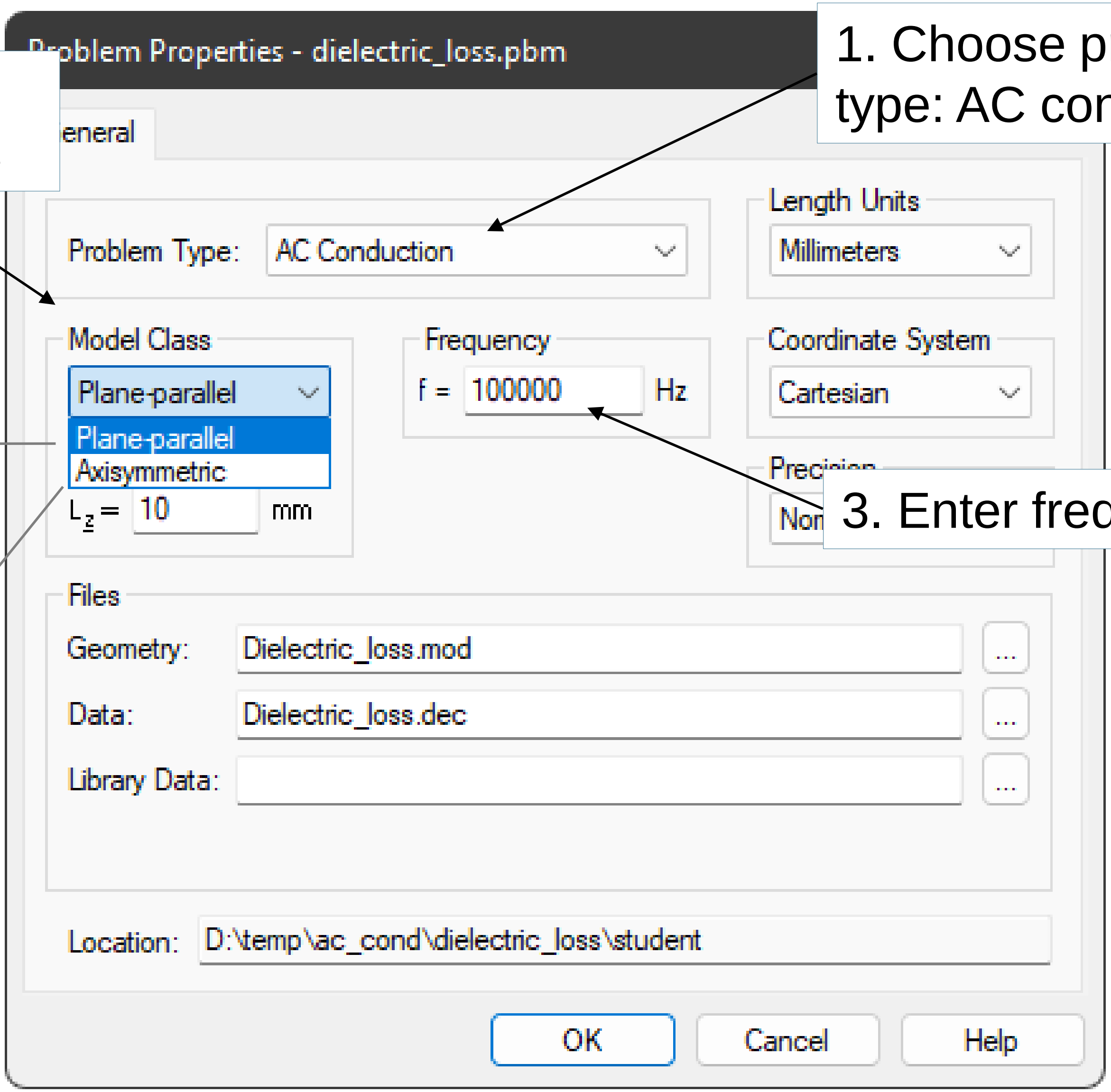
Results analysis

QuickField AC Conduction. Problem setup

2. Choose model class







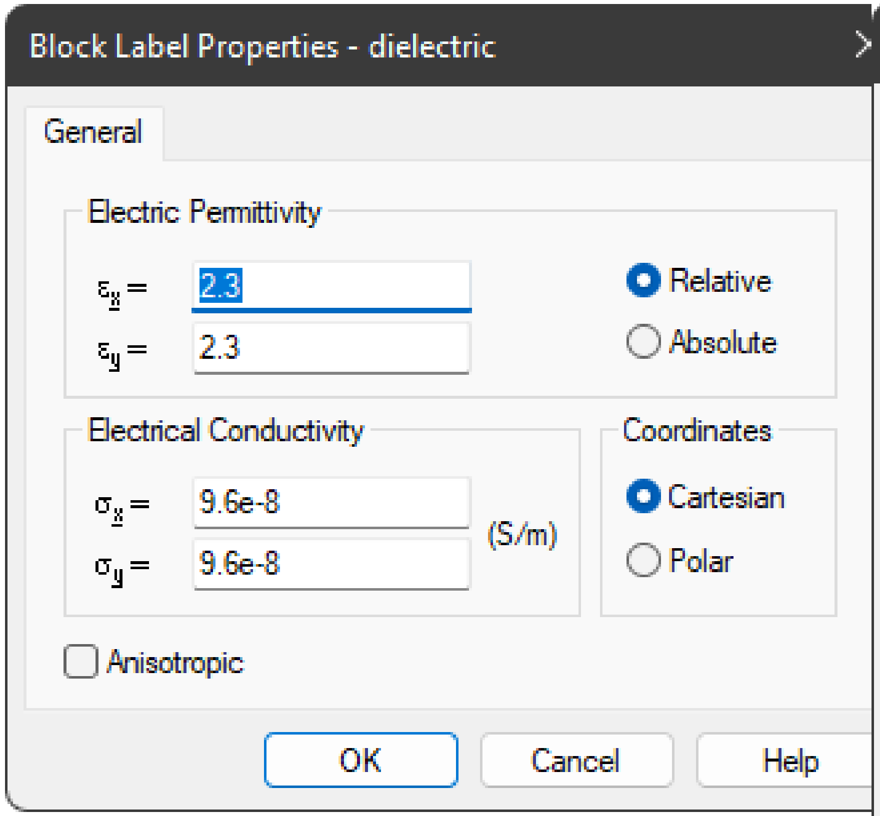
1. Choose problem type: AC conduction

3. Enter frequency value

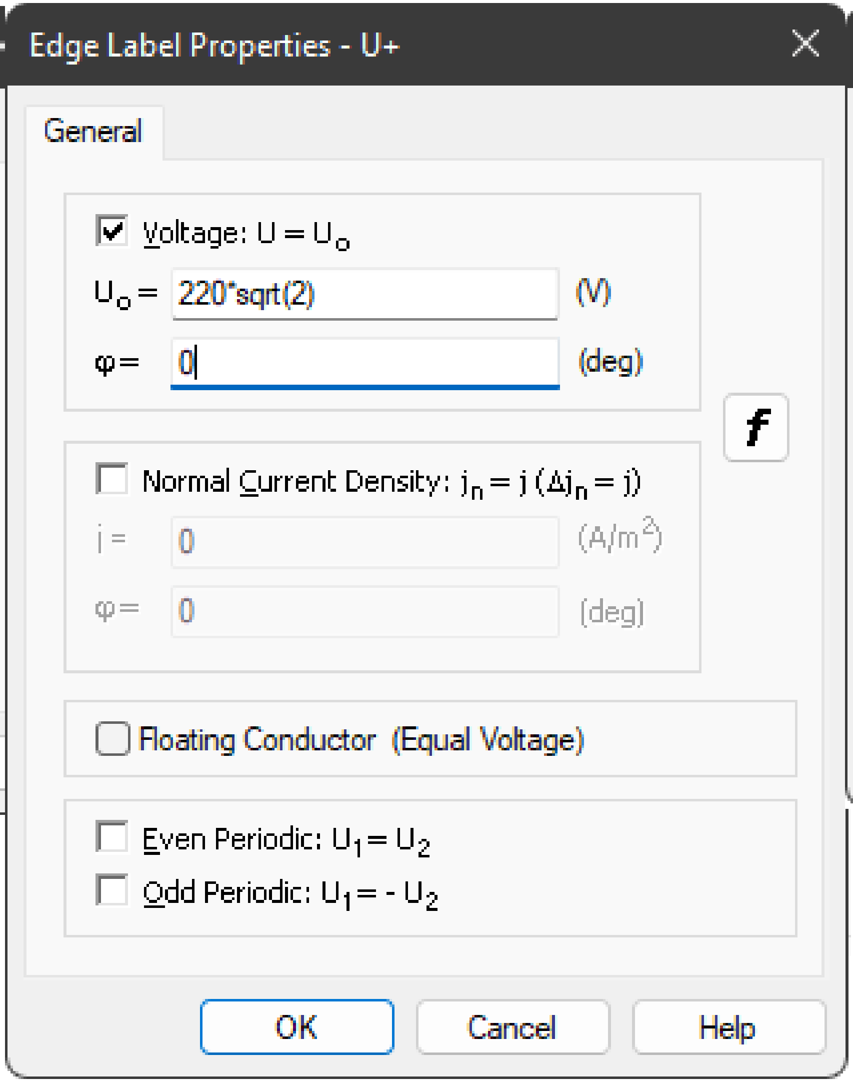
https://quickfield.com/ac_cond.htm

QuickField AC Conduction. Label properties

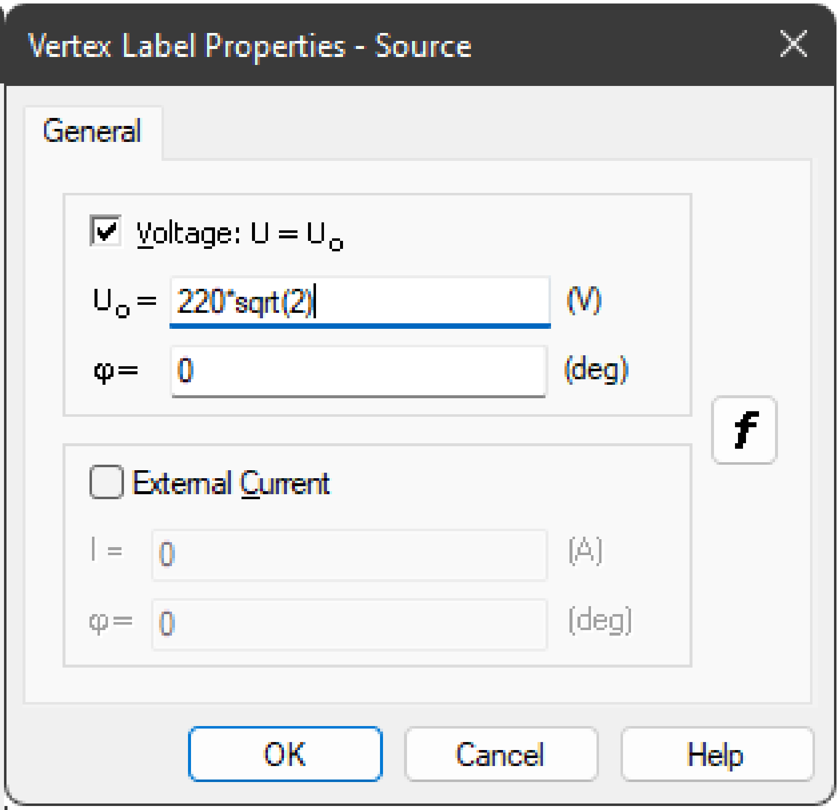
Block



Edge



Vertex



https://quickfield.com/ac_cond.htm

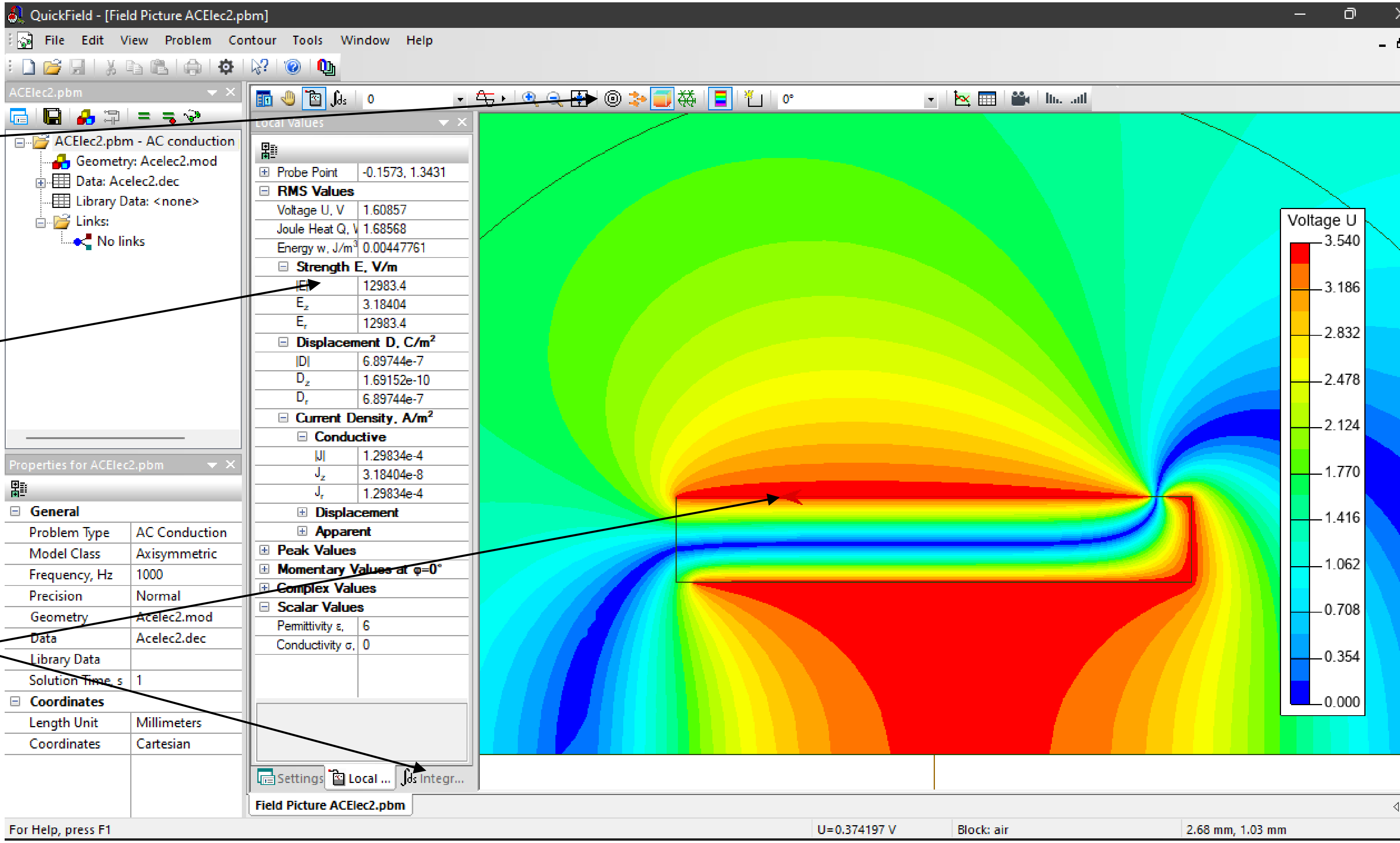
QuickField AC Conduction. Results

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

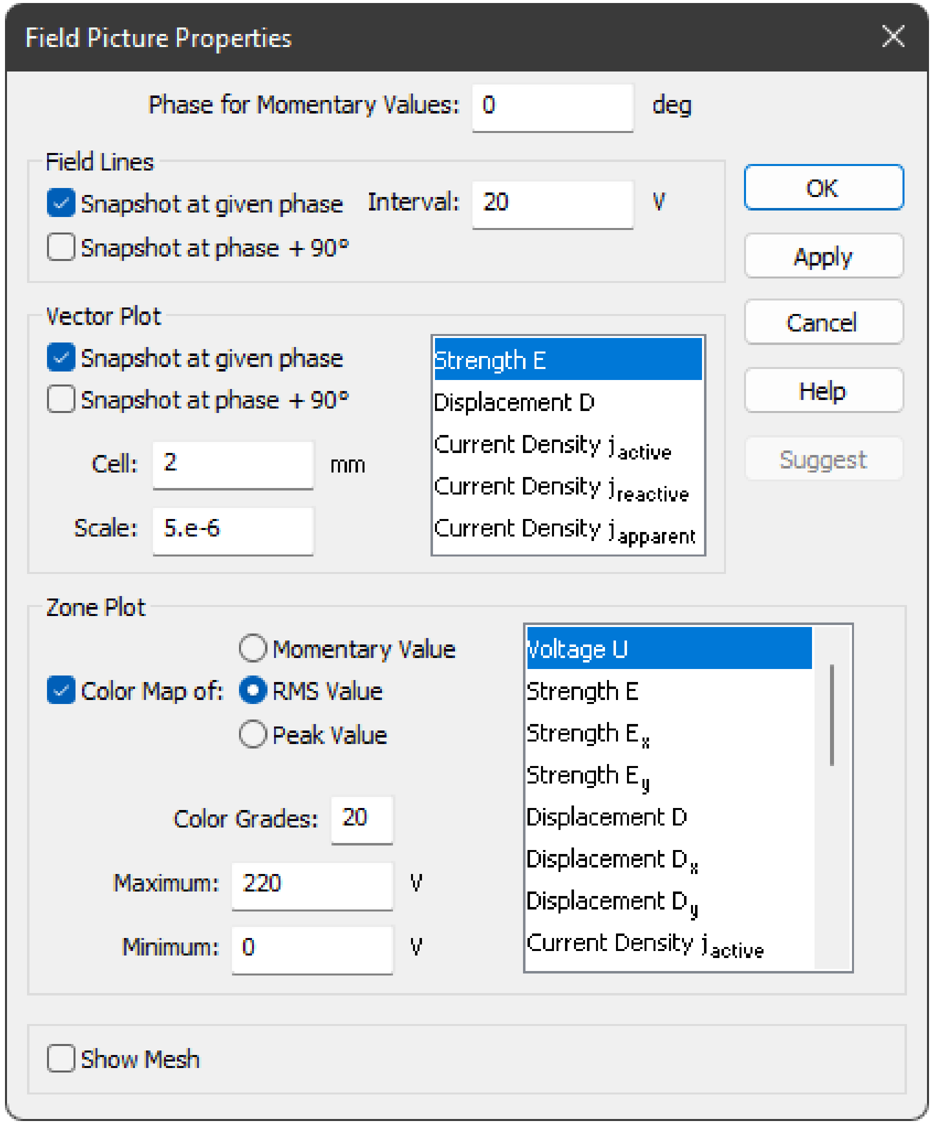
Contour analysis, including field parameters distribution and integral calculations



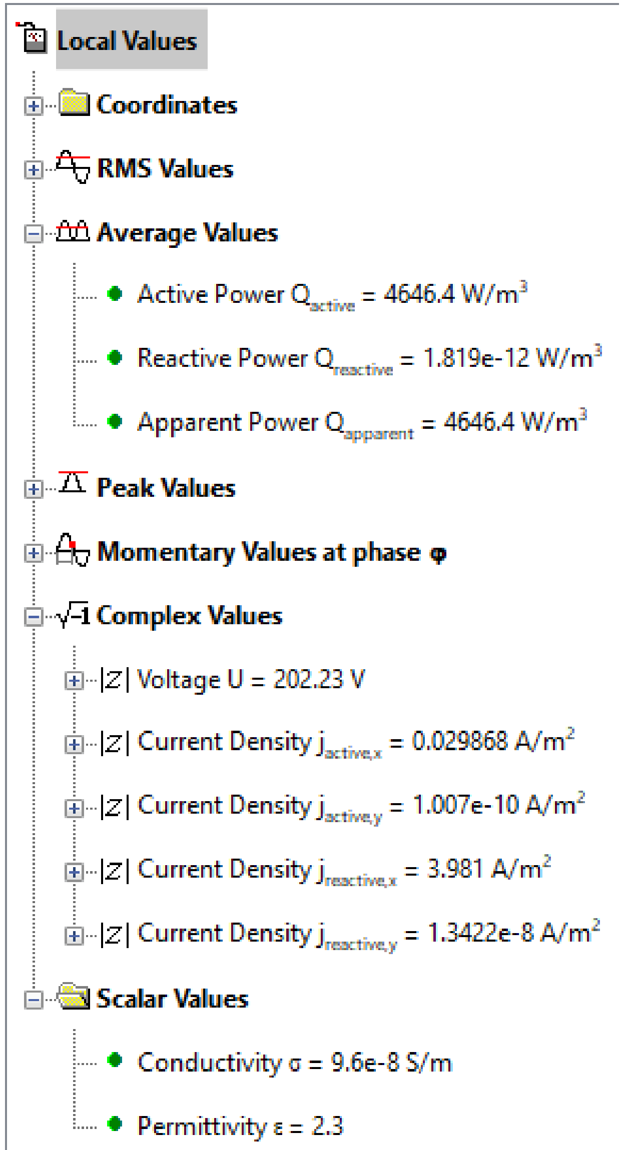
https://quickfield.com/post.htm

QuickField AC Conduction. Results

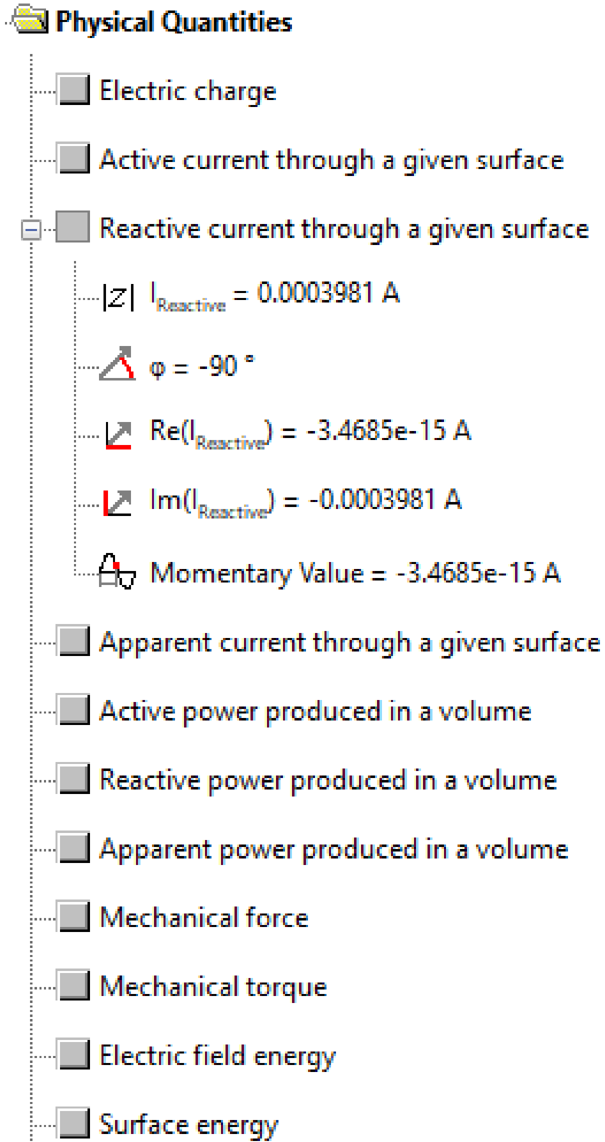
Field maps



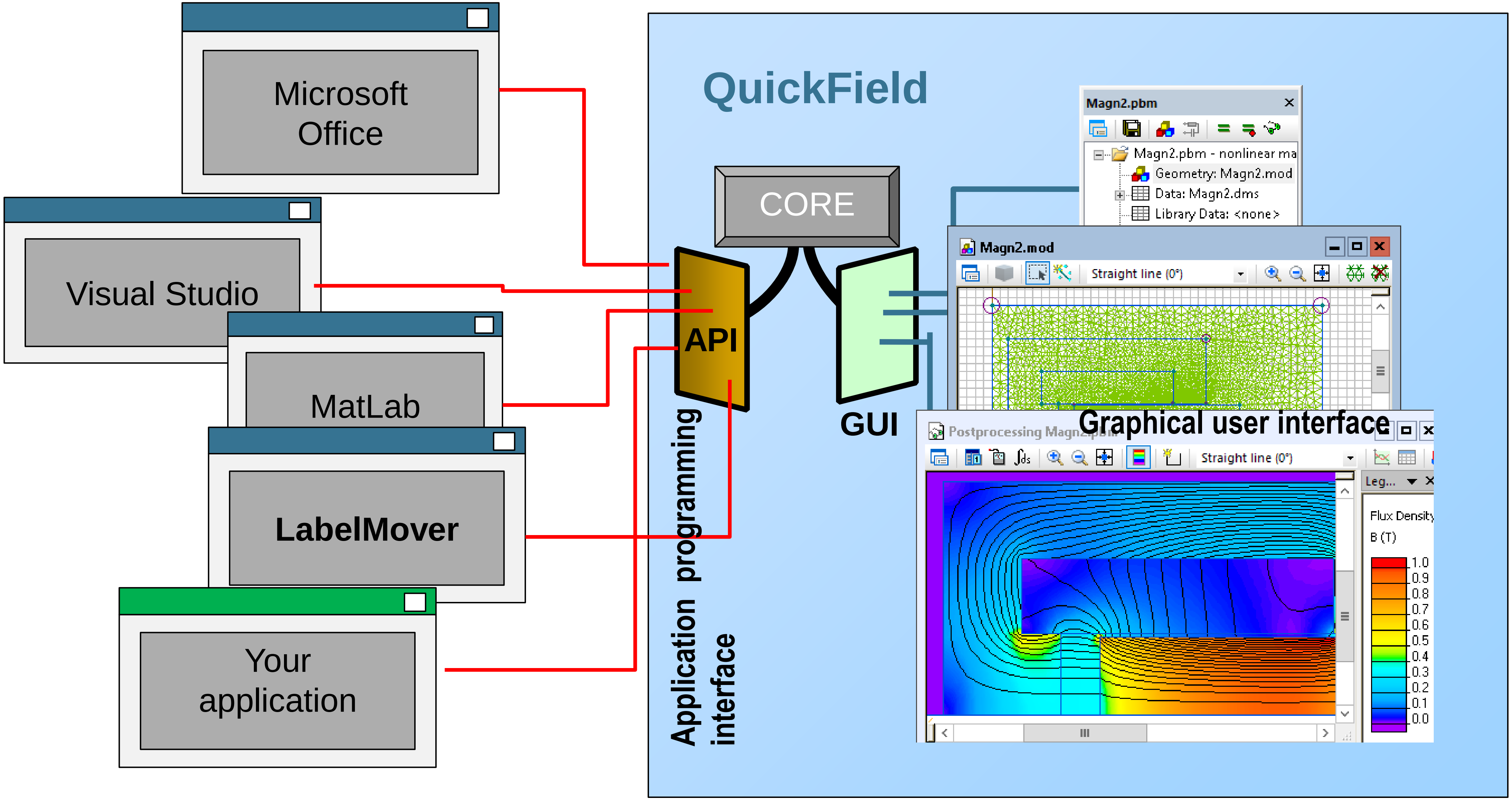
Local field data



Integrals



QuickField API



https://quickfield.com/programming.htm

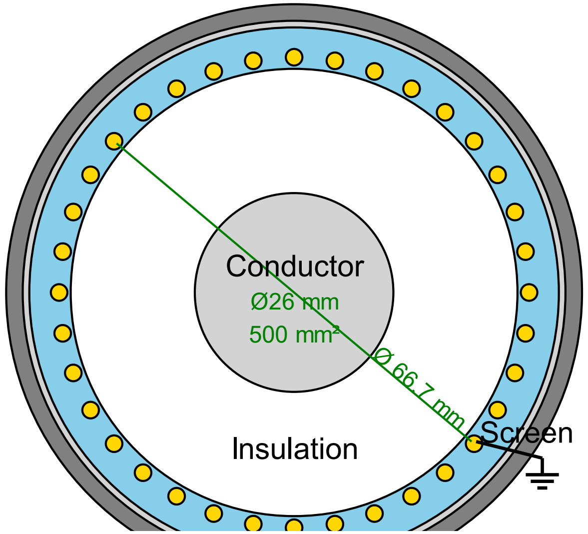
QuickField Difference

Field simulation software

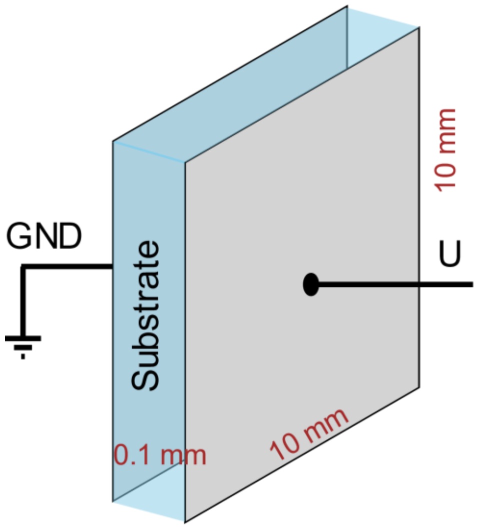
www.QuickField.com

No training required

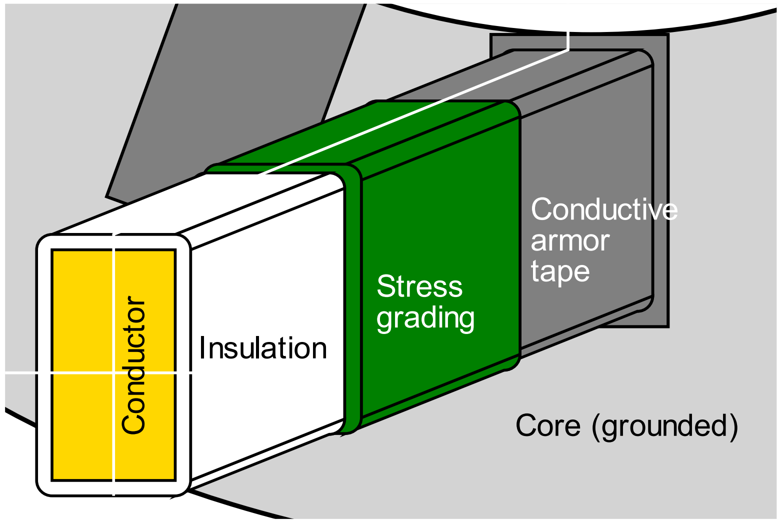
AC conduction simulation with QuickField



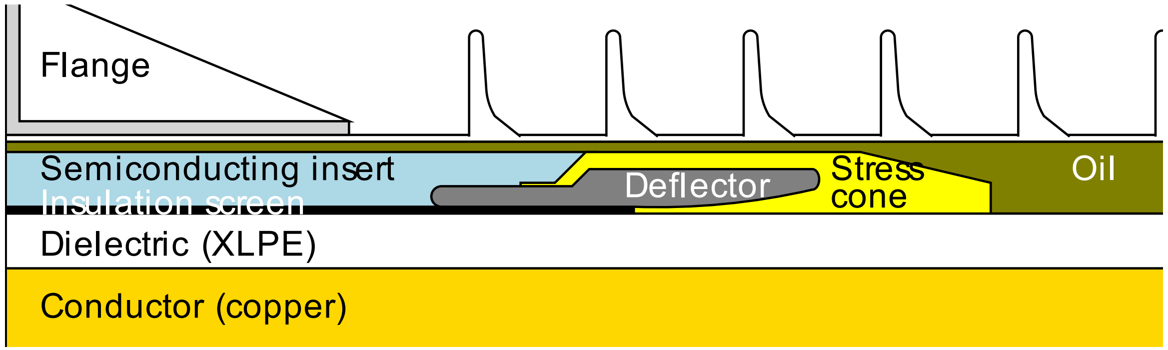
Dielectric loss in cable



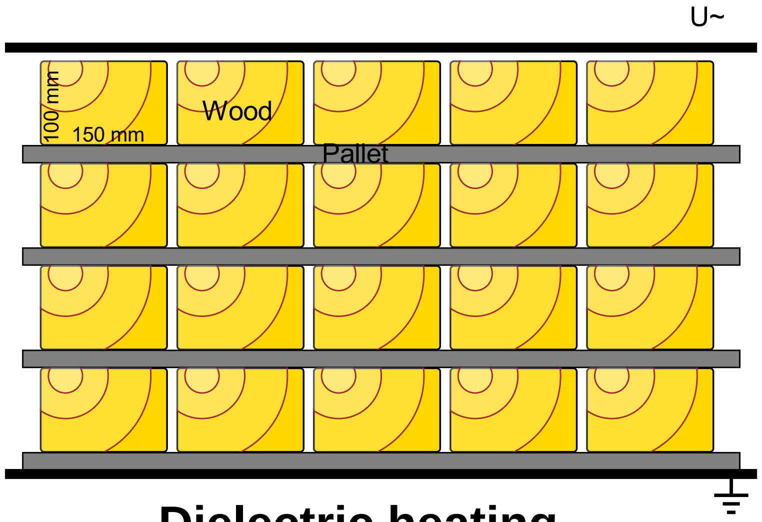
Plane capacitor dielectric loss



Core-end insulation electric stress



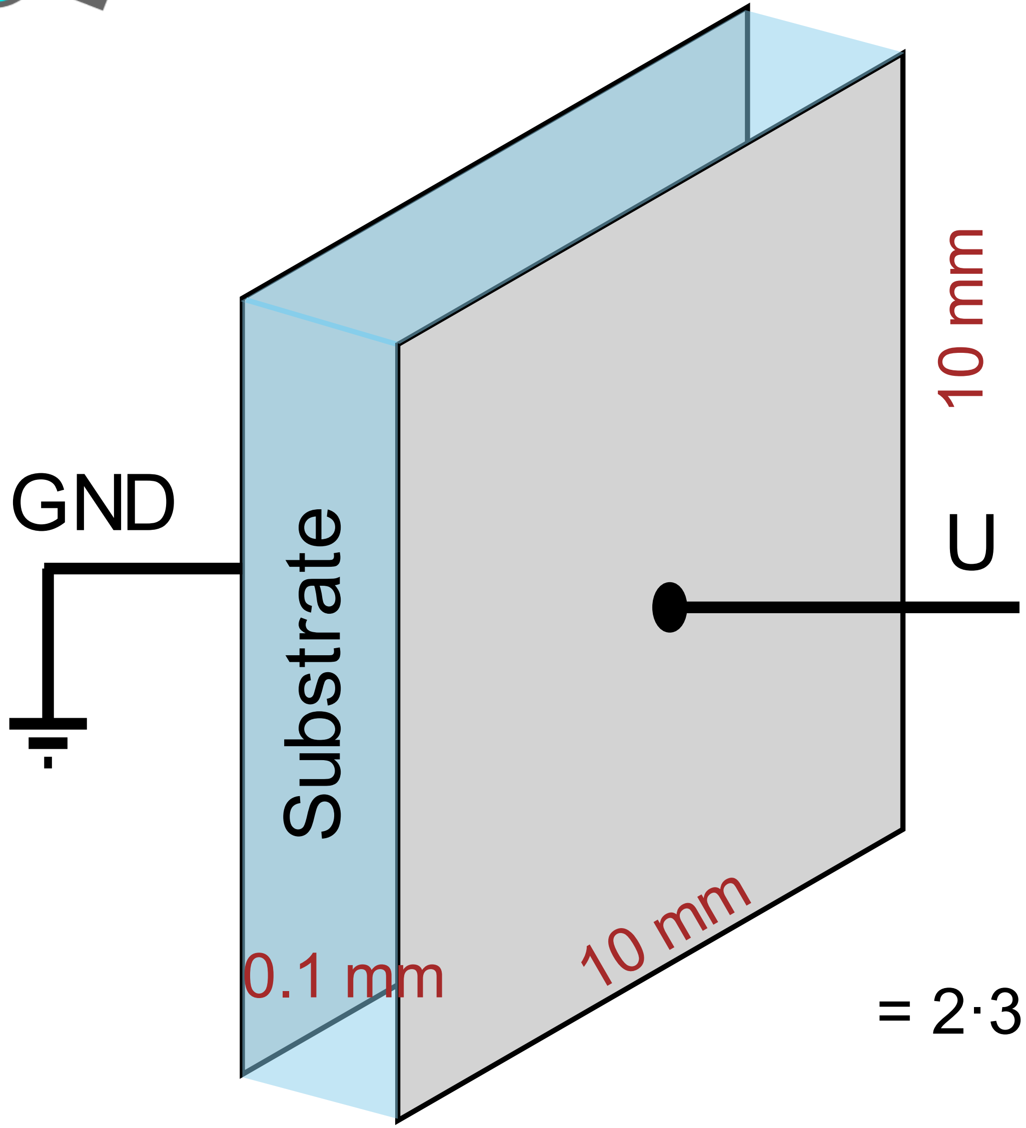
Cable termination to oil filled bushing



Dielectric heating

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

Plane capacitor dielectric loss



Problem specification:

Relative permittivity of substrate ε = 10

Voltage U = 5 V, frequency f = 1 MHz

Loss tangent tan(δ) = 0.01

Task:

Calculate dielectric loss in the substrate.

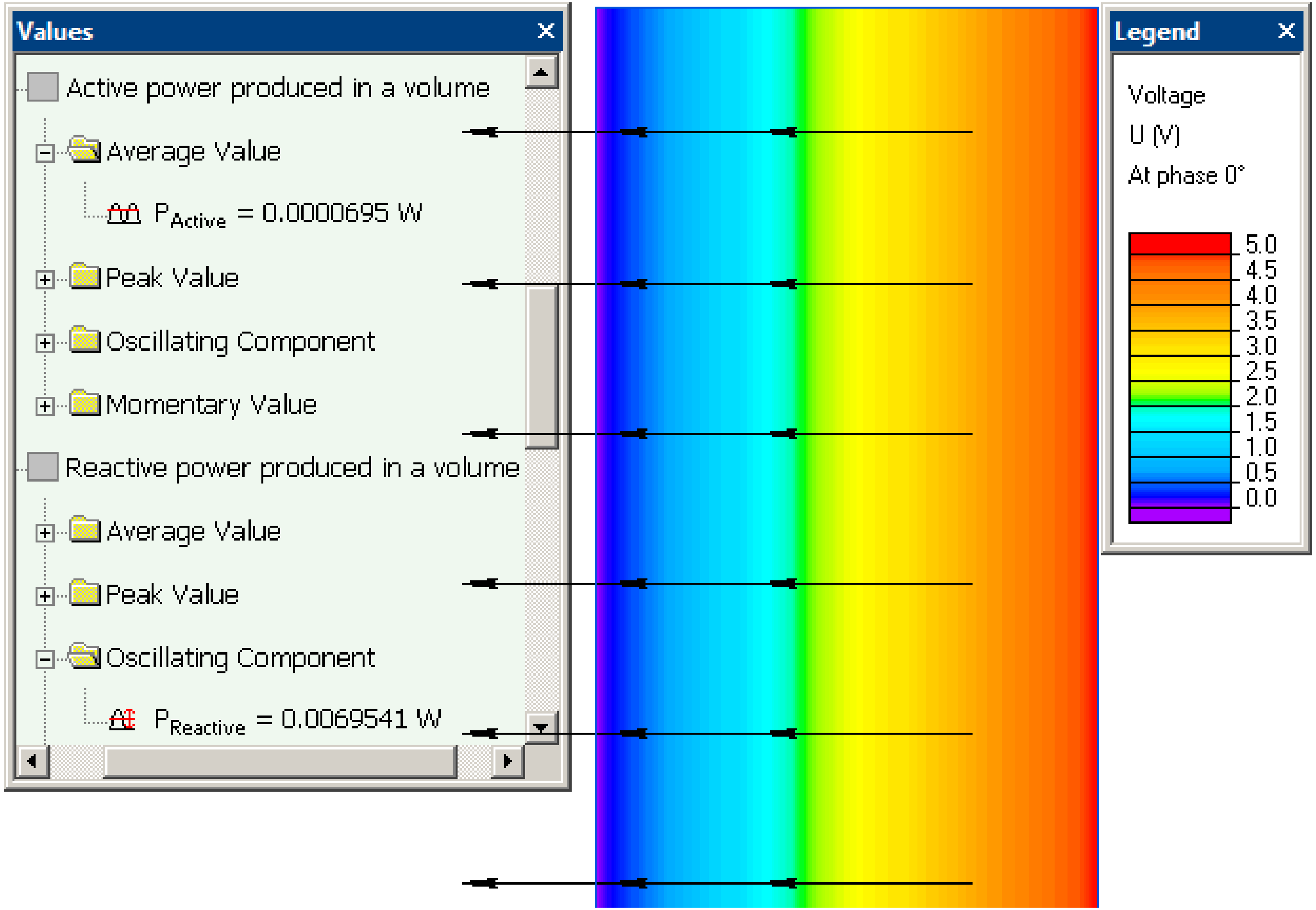
Apparent conductivity

$g = 2\pi f \cdot \varepsilon \cdot \varepsilon_0 \cdot \tan(\delta) =$

$= 2 \cdot 3.142 \cdot 10^6 \cdot 10 \cdot (8.854 \cdot 10^{-12}) \cdot 0.01 = 5.56 \cdot 10^{-6}$ S/m.

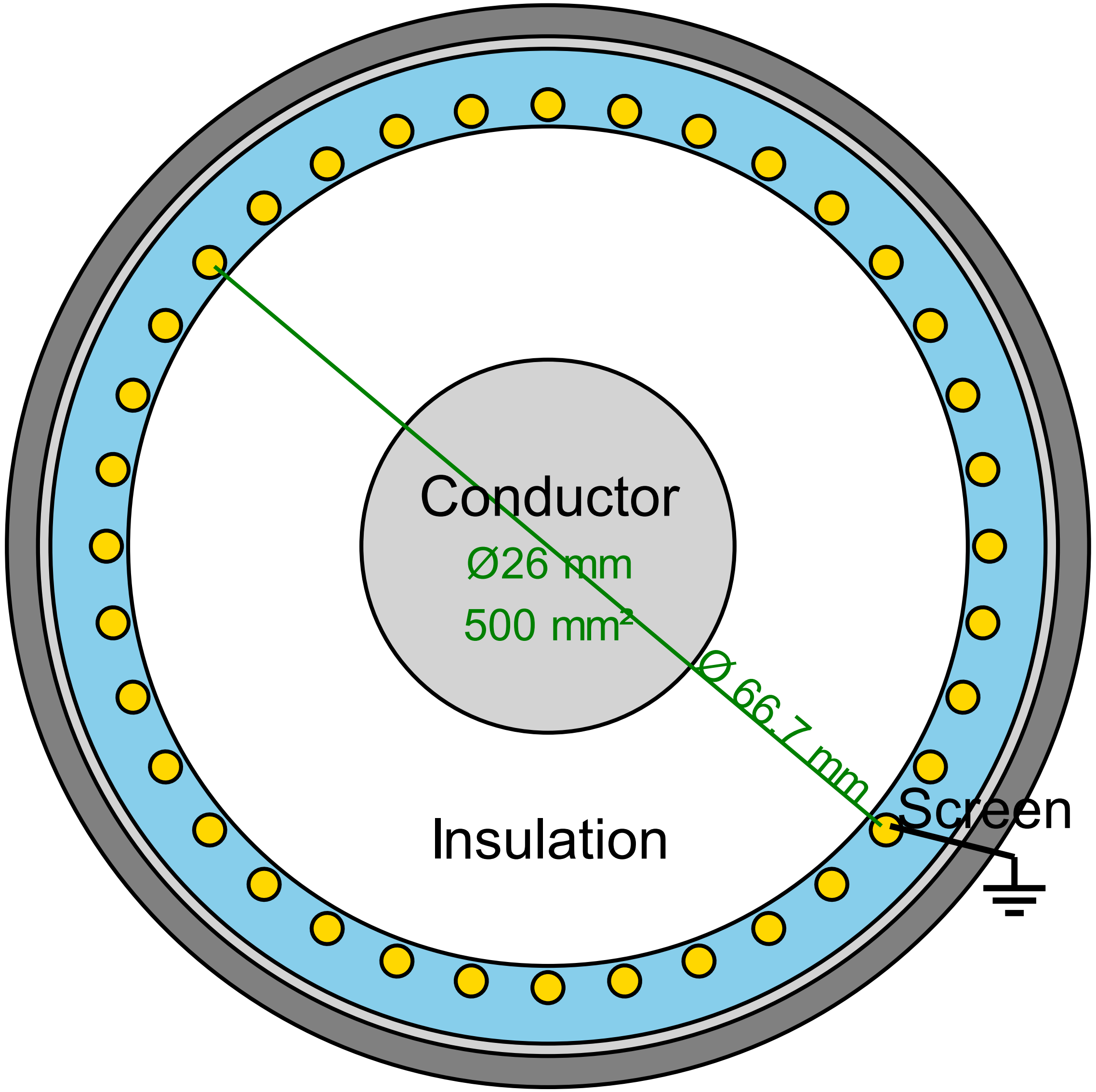
https://quickfield.com/advanced/acelec1.htm

Plane capacitor dielectric loss



https://quickfield.com/advanced/acelec1.htm

Dielectric loss in cable



Problem specification:

Voltage *U* = 132 kV (r.m.s.), frequency *f* = 50 Hz.

XLPE permittivity 2.5, loss tangent tan(δ) = 0.001

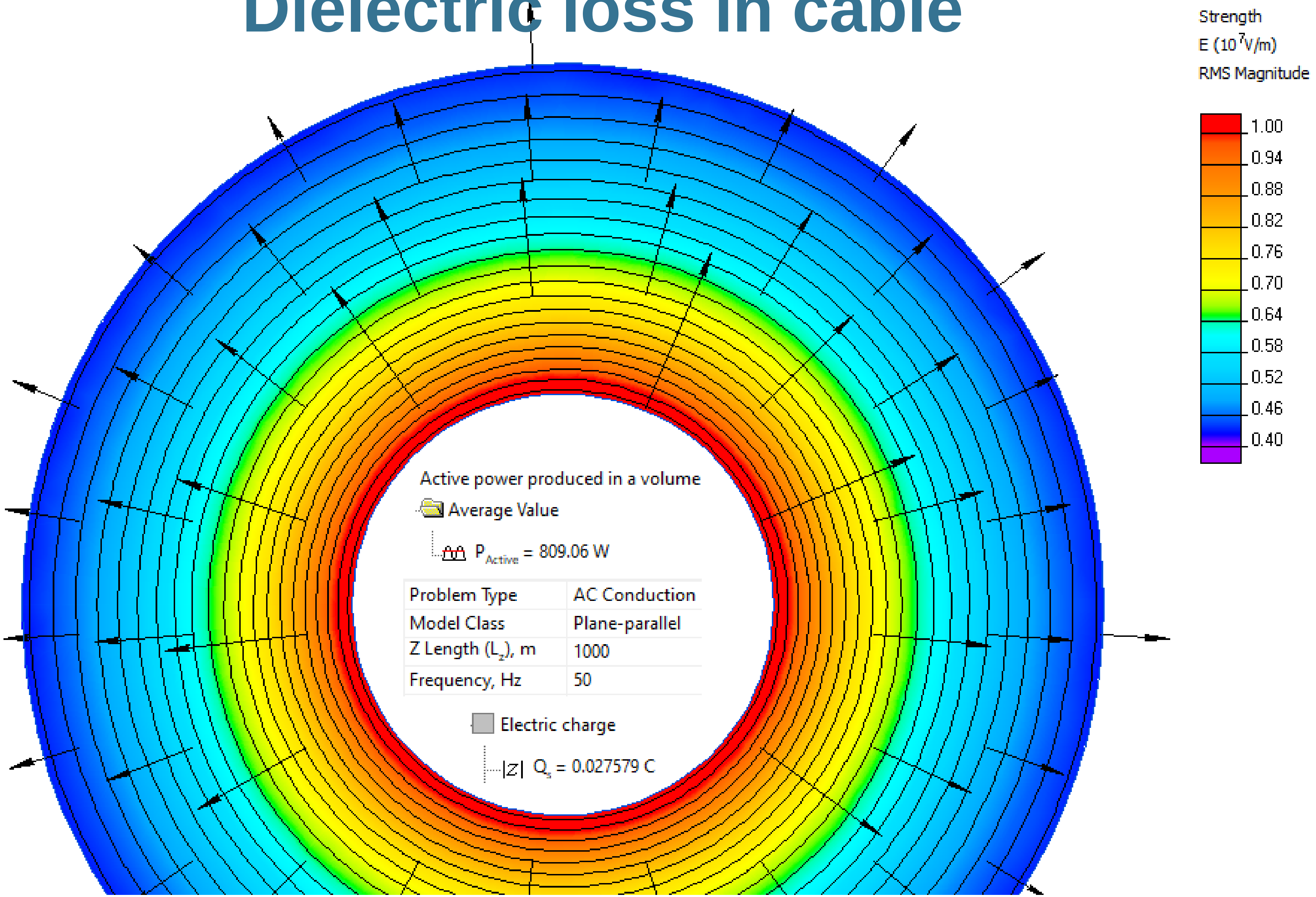
Task:

Calculate the capacitance and dielectric losses

Apparent conductivity $\sigma = 2\pi f \cdot \varepsilon \cdot \varepsilon_0 \cdot \tan(\delta) =$
$= 2 \cdot 3.142 \cdot 50 \cdot 2.5 \cdot 8.854e\text{-}12 \cdot 0.001 =$
$= 6.95$ pS/m.

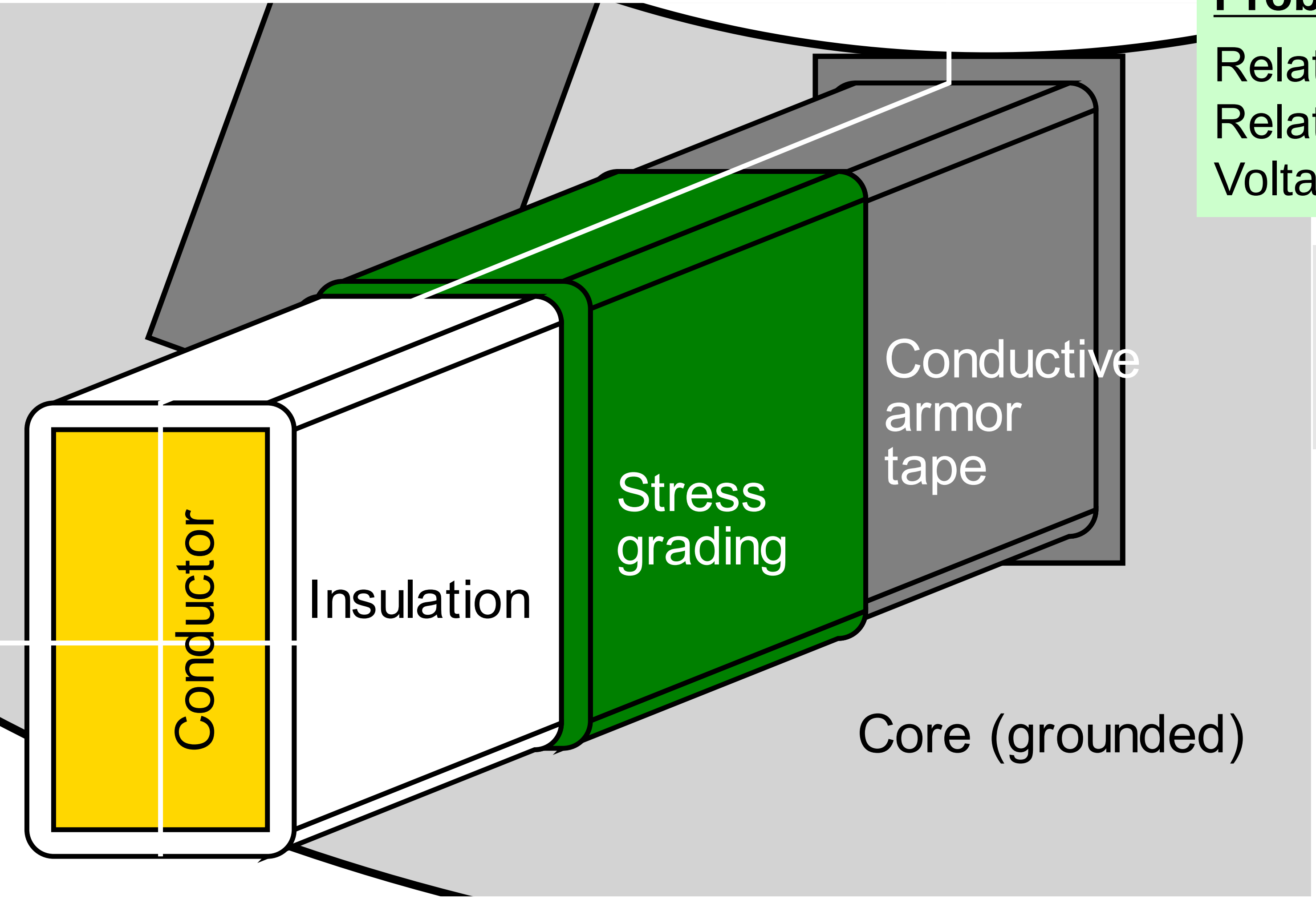
https://quickfield.com/advanced/cable_dielectric_losses.htm

Dielectric loss in cable



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

Core-end insulation electric stress



Problem specification:

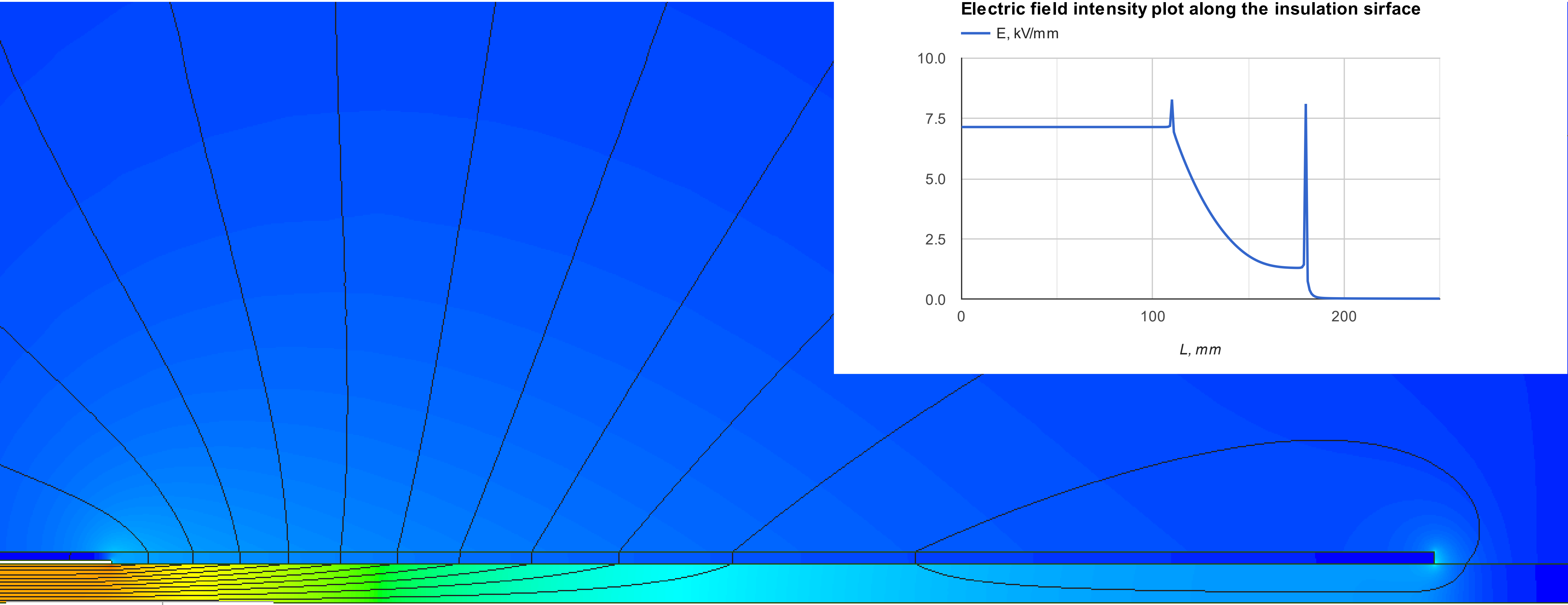
Relative permittivity of stress grading paint ε = 4,
Relative permittivity of insulation ε = 3
Voltage U_f = 15 kV (r.m.s.), frequency f = 50 Hz.

Task:

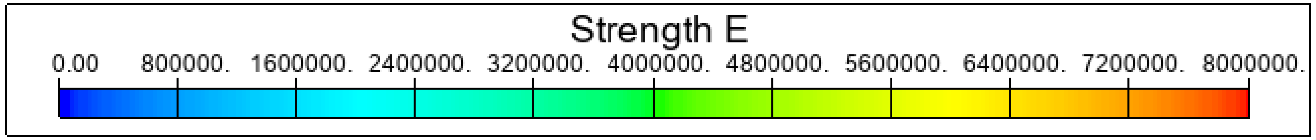
Calculate the electric field stress distribution

https://quickfield.com/advanced/acelec3.htm

Core-end insulation electric stress

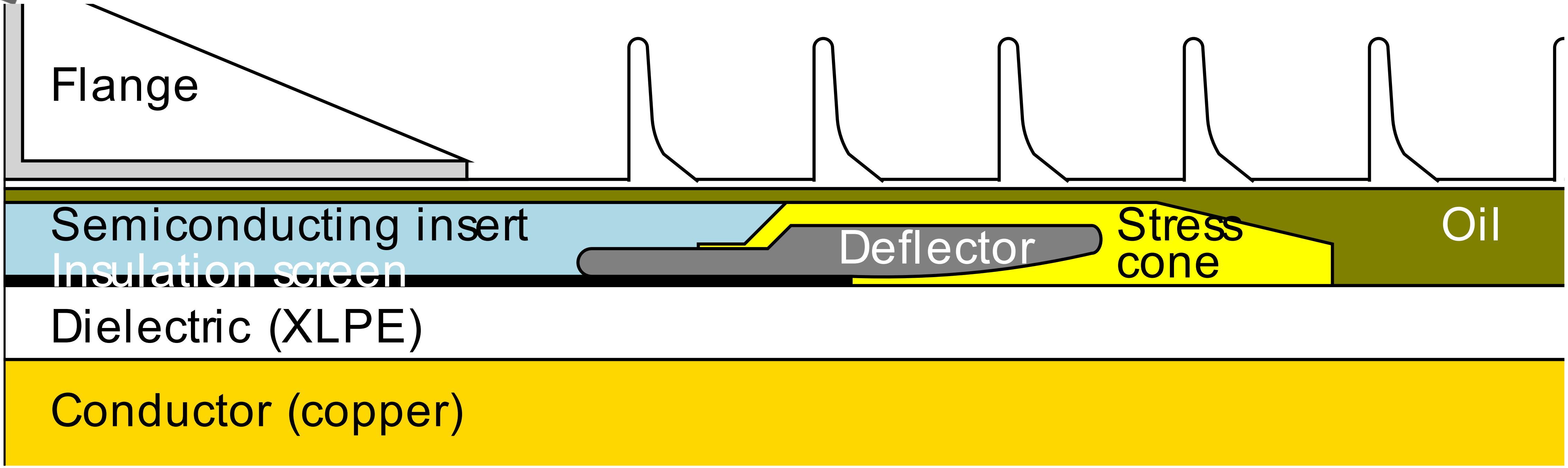


Problem Type	AC Conduction
Model Class	Plane-parallel
Z Length (L_z), mm	1000
Frequency, Hz	50



https://quickfield.com/advanced/acelec3.htm

Cable termination to oil filled bushing



Problem specification:

Voltage U = 64 kV (r.m.s.), frequency f = 50 Hz.

Relative permittivity of media: oil 12, insulator 2.3, stress cone 22, deflector 2.5.

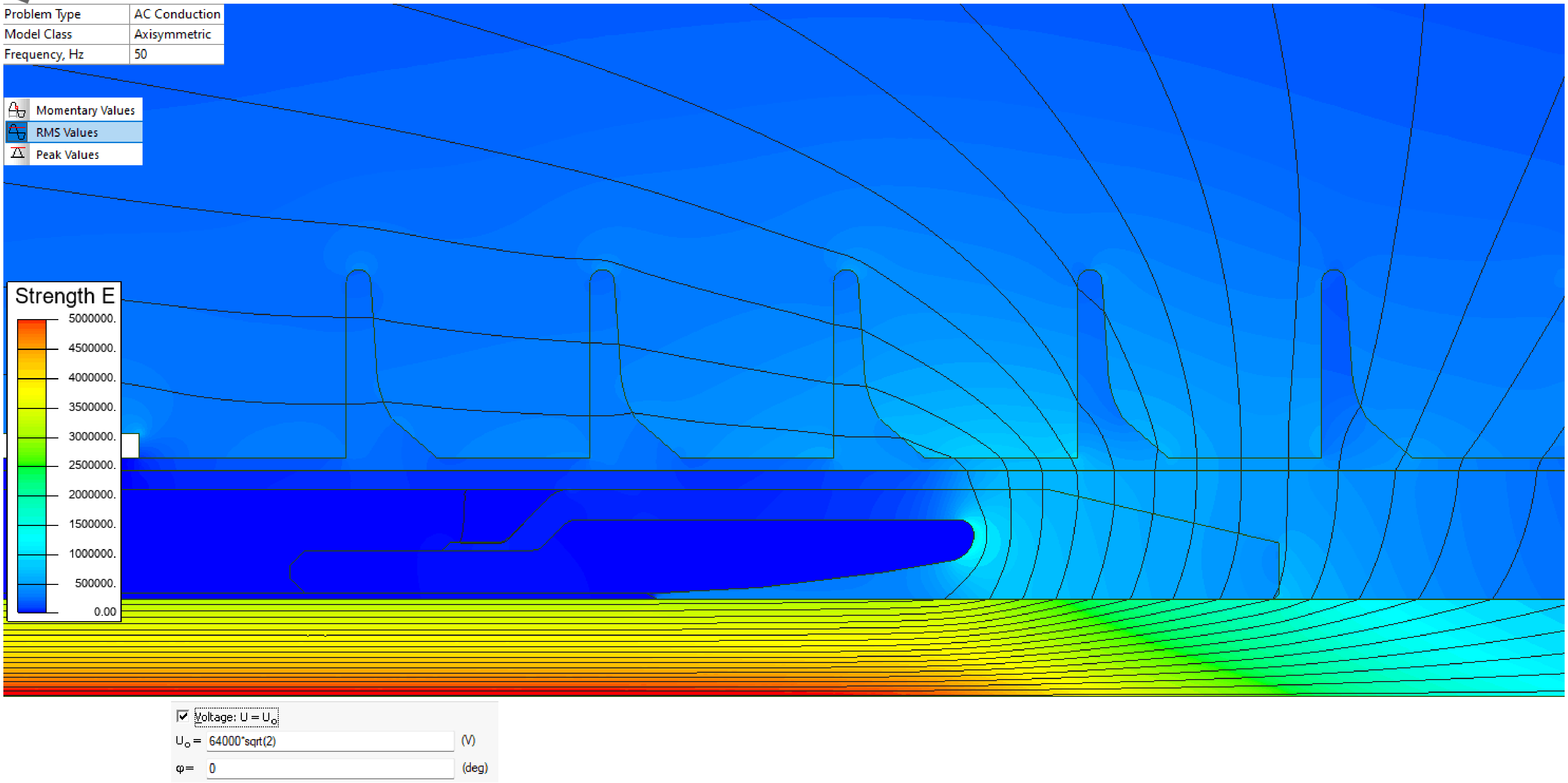
Deflector electrical conductivity 0.0002 S/m.

Task:

Calculate the electric field stress distribution

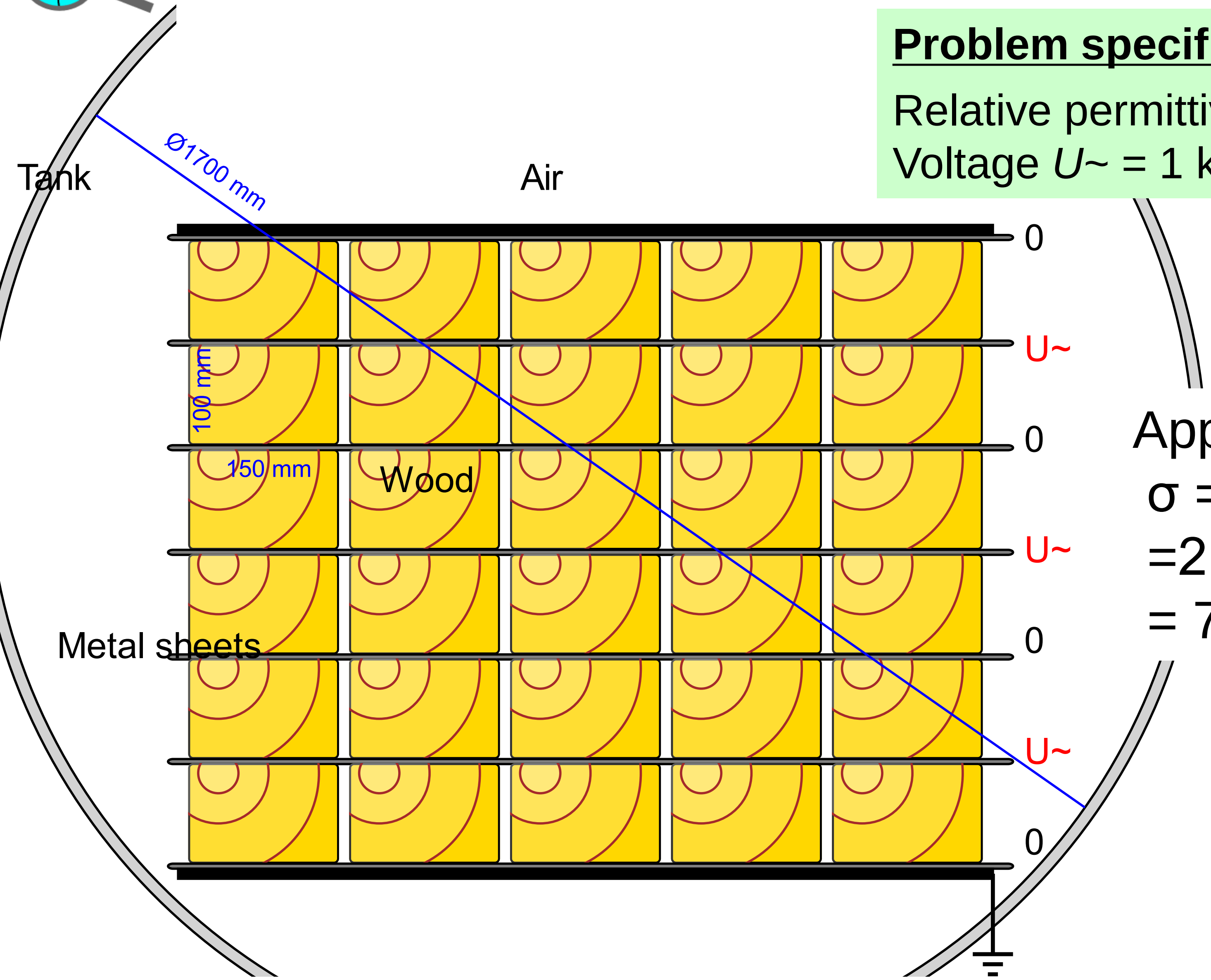
https://quickfield.com/advanced/cable_stress_cone.htm

Cable termination to oil filled bushing



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

Dielectric heating



Problem specification:

Relative permittivity of wood ε = 2, loss tangent *tan(δ)* = 0.1
Voltage *U~* = 1 kV, frequency *f* = 6.87 MHz

Task:

Calculate temperature rise in the wood.

Apparent conductivity

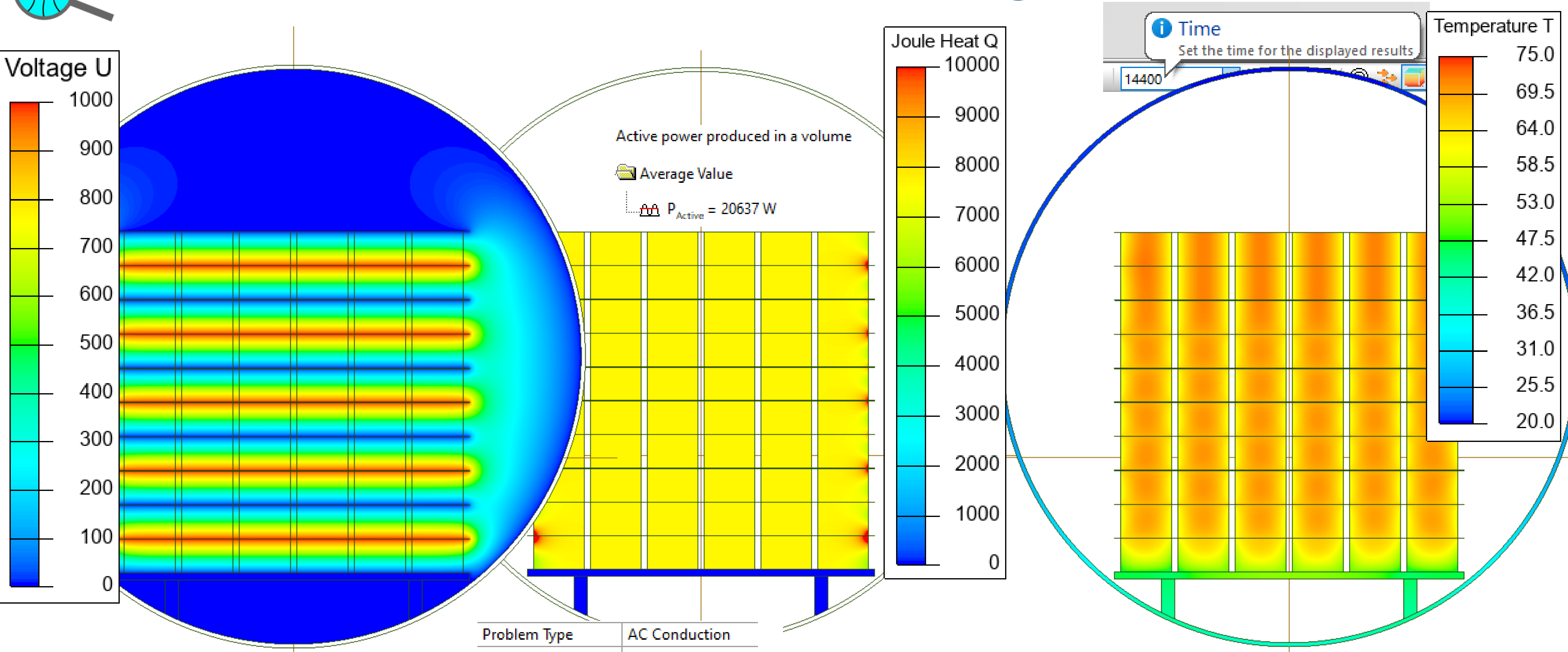
$\sigma = 2\pi f \cdot \varepsilon \cdot \varepsilon_0 \cdot \tan(\delta) =$

$= 2 \cdot 3.142 \cdot (6.87 \cdot 10^6) \cdot 2 \cdot (8.854 \cdot 10^{-12}) \cdot 0.1 =$

= 76.4 uS/m

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

Dielectric heating



Problem Type	AC Conduction
Model Class	Plane-parallel
Z Length (L_z), m	3
Frequency, Hz	6780000

Problem Type	Transient Heat Transfer
Model Class	Plane-parallel
Z Length (L_z), mm	3000

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

This recording is over

More recordings and simulation examples at

www.quickfield.com

Your feedback is welcome: support@quickfield.com