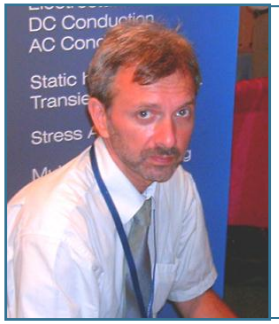
Simulation of power transmission lines in QuickField



Vladimir Podnos

Director of Marketing and Support

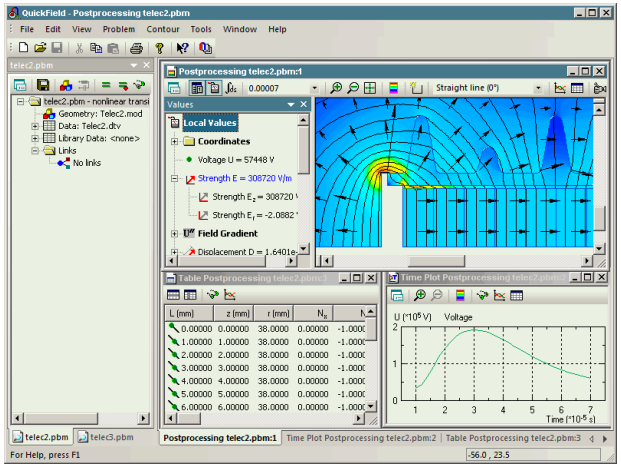
Overview of QuickField capabilities

Alexander Liubimtsev

Support engineer

QuickField live presentation:
power transmission line simulations

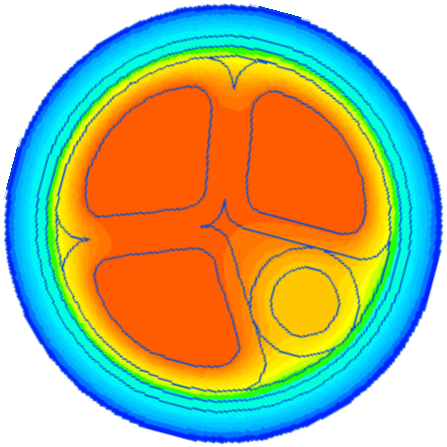
QuickField Analysis Options



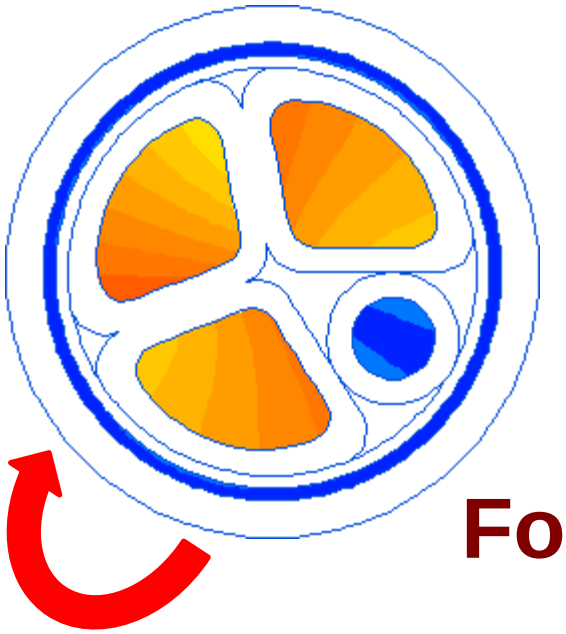
- Magnetic Suite
  - AC Magnetics
  - Transient + DC Magnetics
  - DC Magnetics
- Electric Suite
  - AC conduction + Electrostatics & DC conduction
  - Transient Electric + Electrostatics & DC conduction
  - Electrostatics & DC conduction
- Thermostructural
  - Stress Analysis
  - Transient Heat transfer
  - Steady State Heat transfer

MultiPhysics

Temperature Field

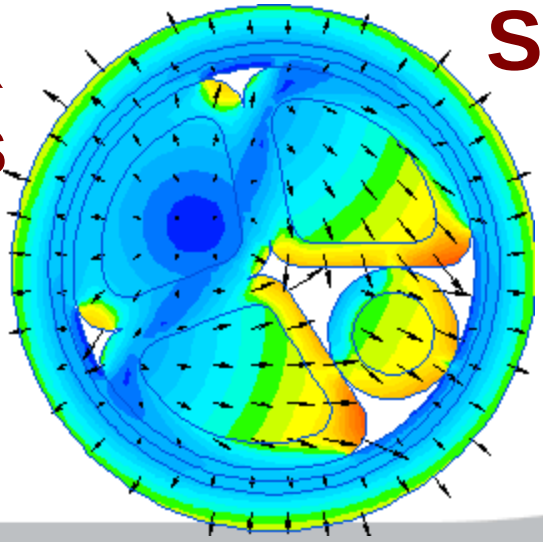


Electromagnetic fields



Thermal Stresses

Forces

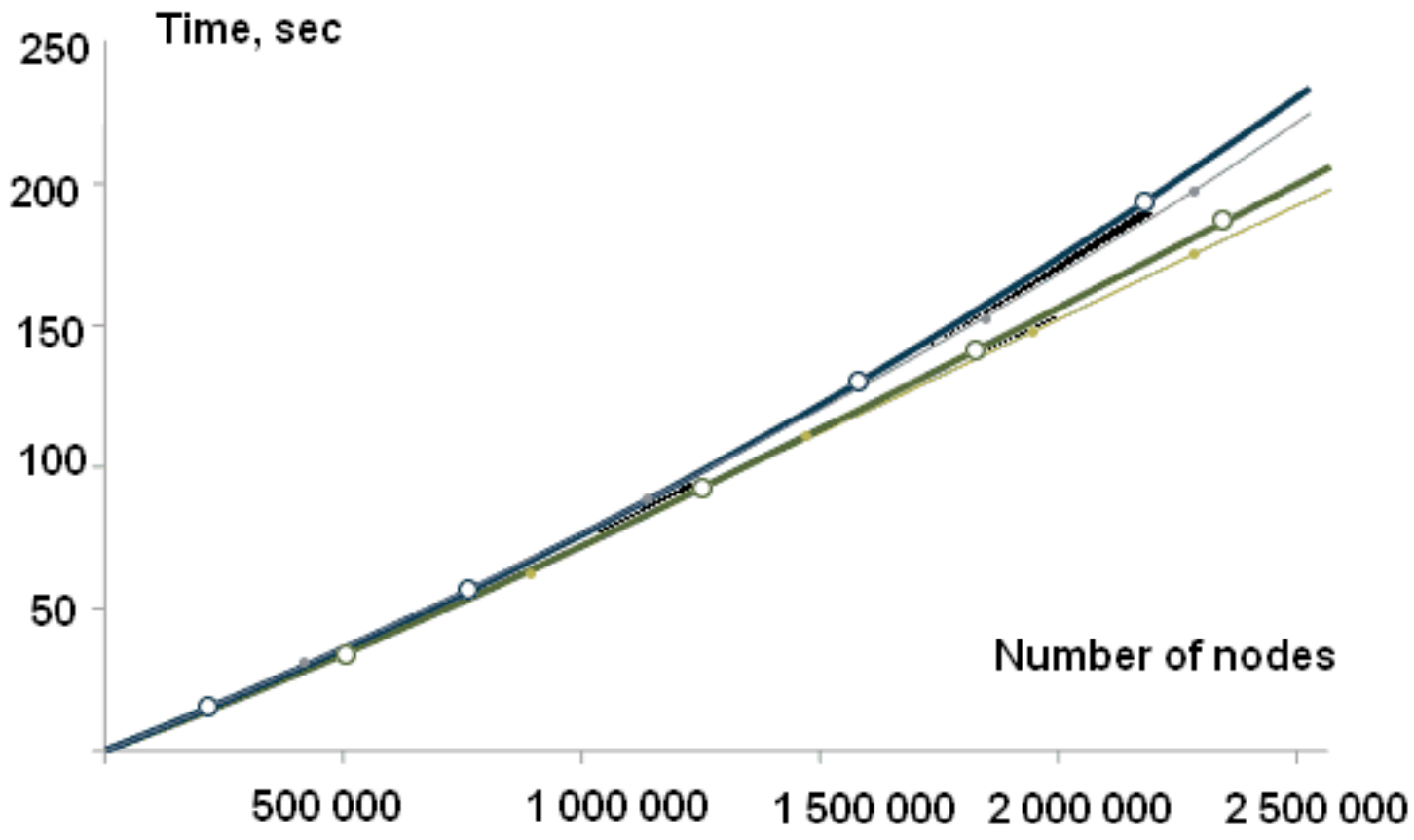


Magnetic state import

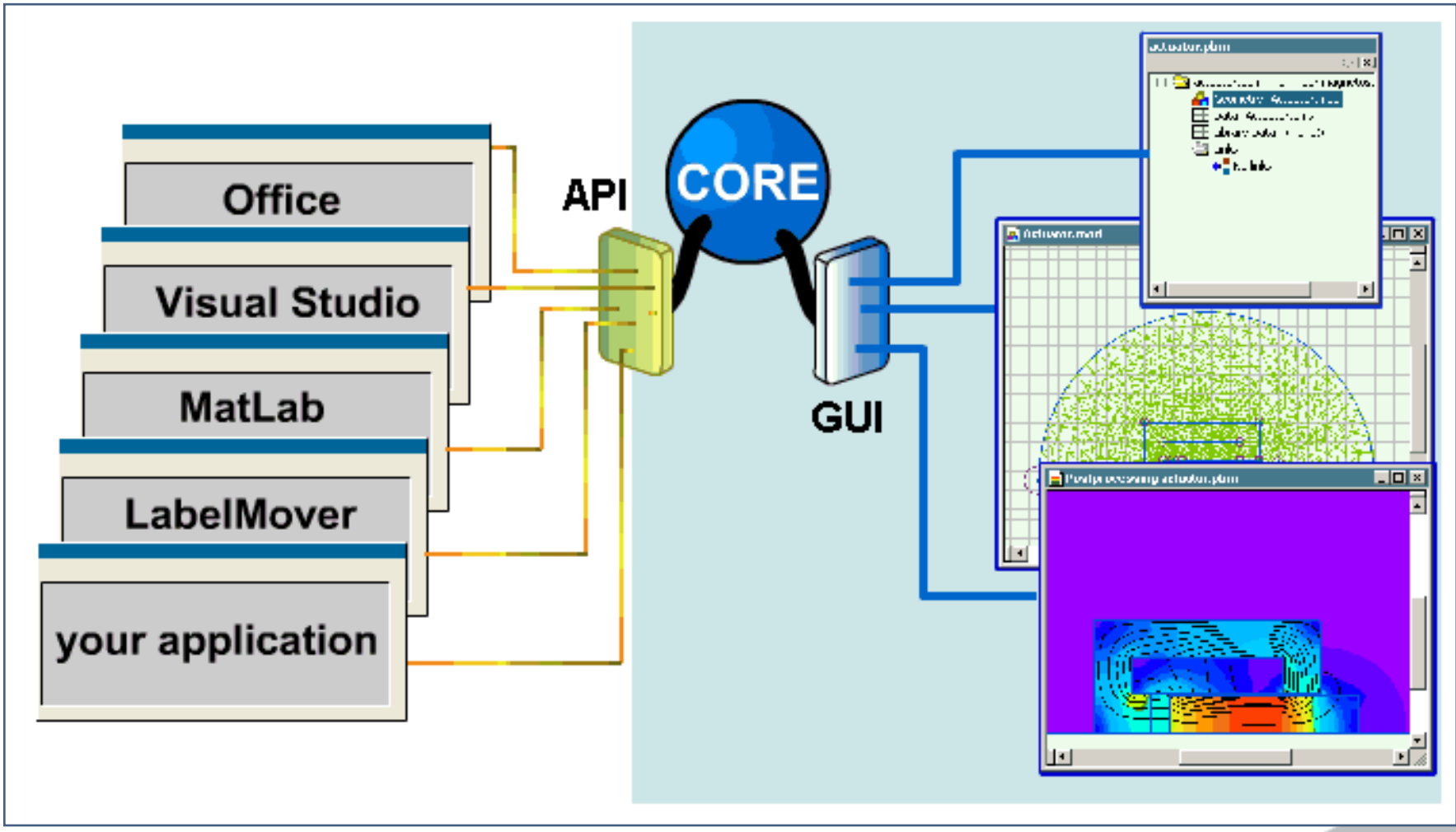
Stresses & Deformations

QuickField solvers

Solution time for various sizes of finite element mesh



Open object interface



ActiveField API object model

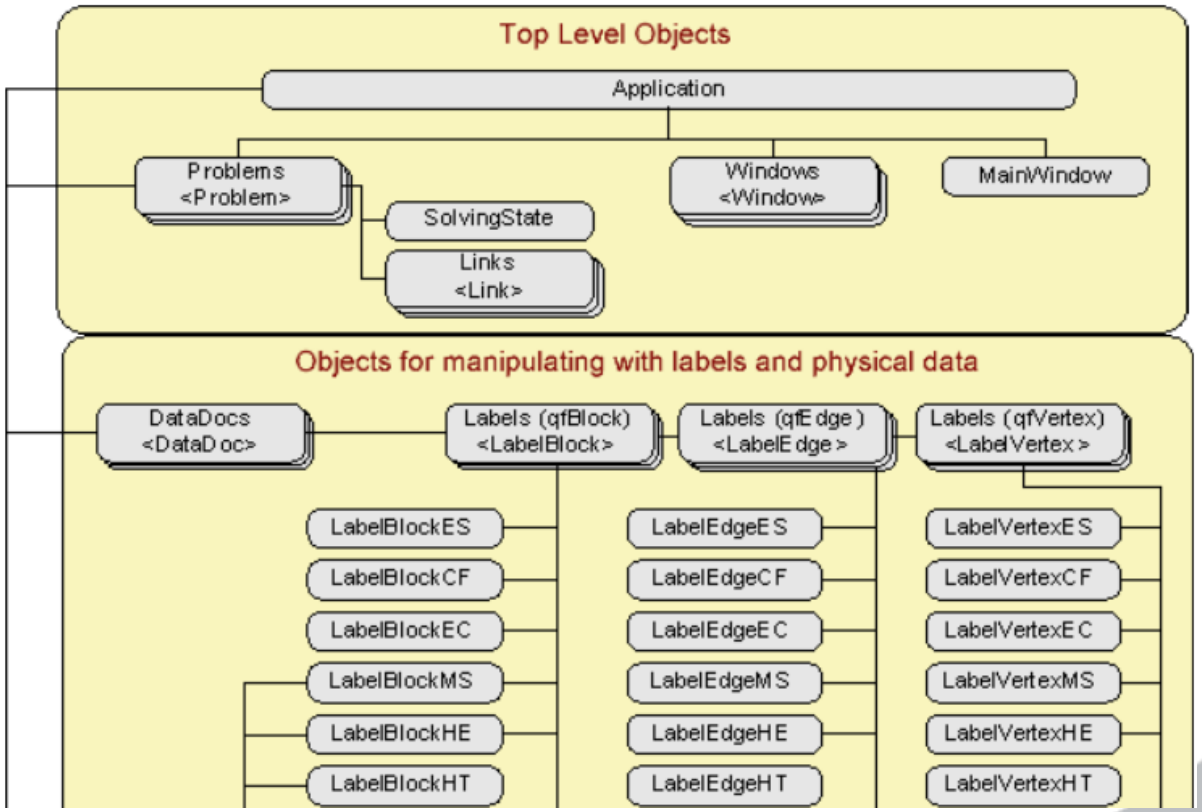
ActiveField™ help | Main QuickField Site | Free Downloads | Contacts

Objects

Properties

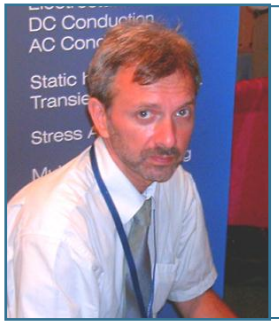
Methods

QuickField Object Model



QuickField Difference

Simulation of power transmission lines in QuickField



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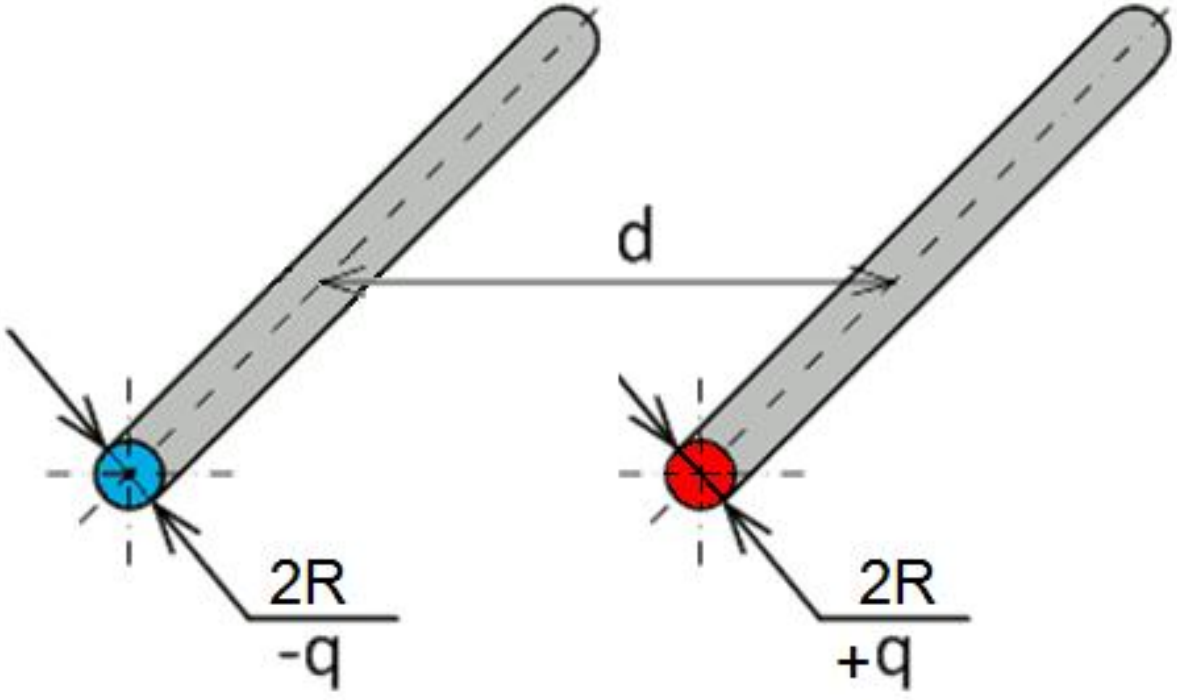
Simulation of power transmission lines in QuickField

1. Parallel wires capacitance.
2. Transmission line capacitance.
3. Fiber-optic cable and electric transmission line.
4. Parallel wires inductance.
5. Transmission line transposition.
6. Phase-to-phase fault.
7. Disc insulator. Heating.
8. Disc insulator. Mechanical stress.

Parallel wires capacitance



Given:

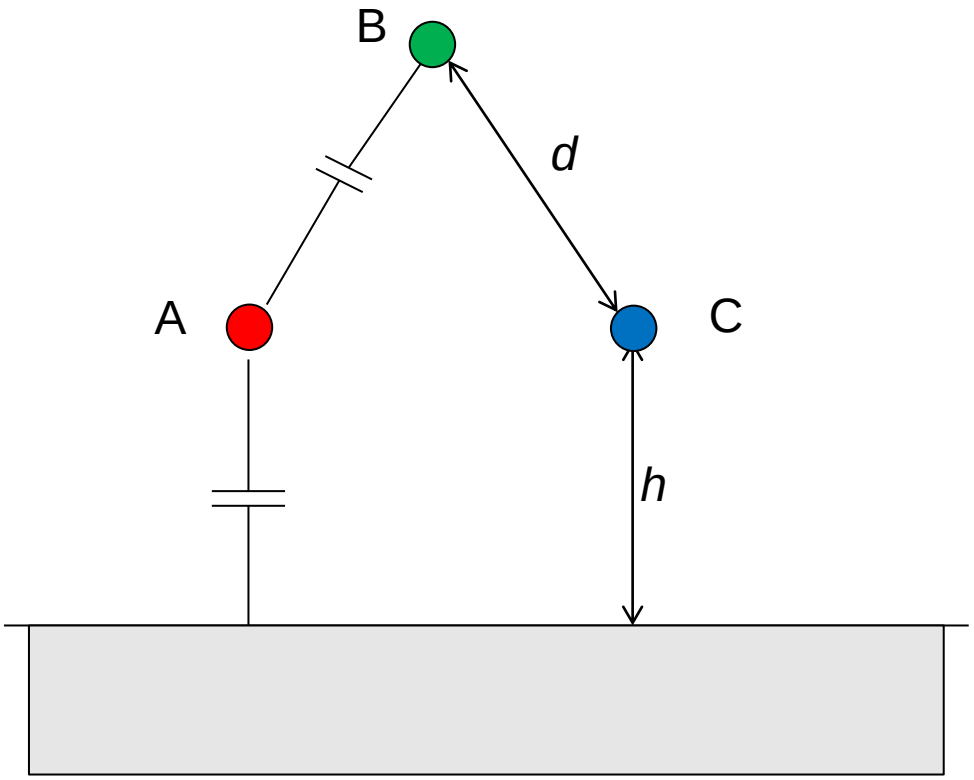
D = 0.5 m
R = 0.005 m.

Calculate:
Capacitance between two wires
C = q / (U2-U1)

$$C = \frac{\pi\varepsilon}{\ln\left(\frac{D}{2\cdot R}+\sqrt{\frac{D^2}{4\cdot R^2}-1}\right)} = 6{,}0375\ [\text{uF/km}]$$

http://quickfield.com/advanced/parallel_wires_capacitance.htm

Transmission line capacitance



Given:

Line voltage (RMS) *U*= 10 kV
d = 1 m
h = 6 m

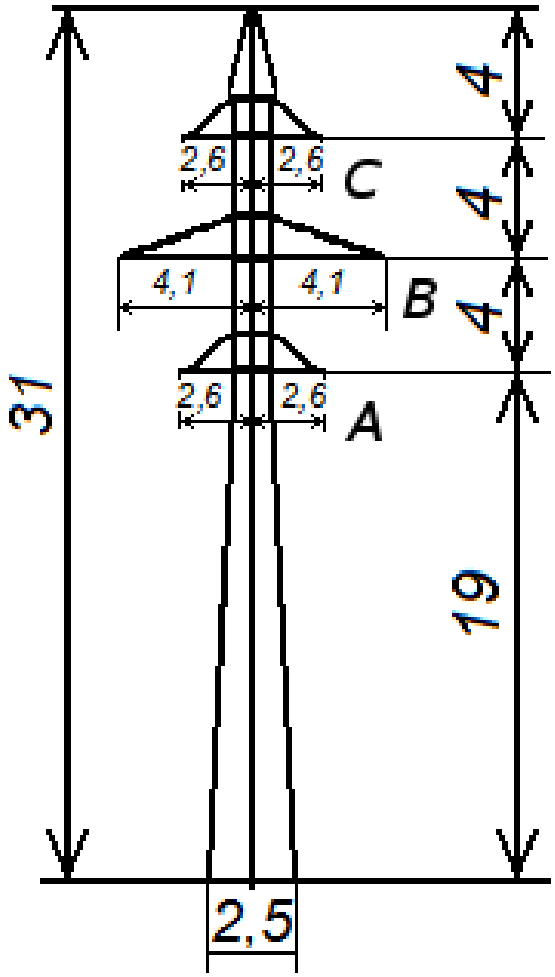
Calculate:
Self and mutual capacitances.

$$U_a = C`_{aa} * q_a + C`_{ab} * q_b + C`_{ac} * q_c$$

C` - potential coefficient [1/F]

http://quickfield.com/advanced/transmission_line_capacitance.htm

Fiber-optic cable and electric transmission line



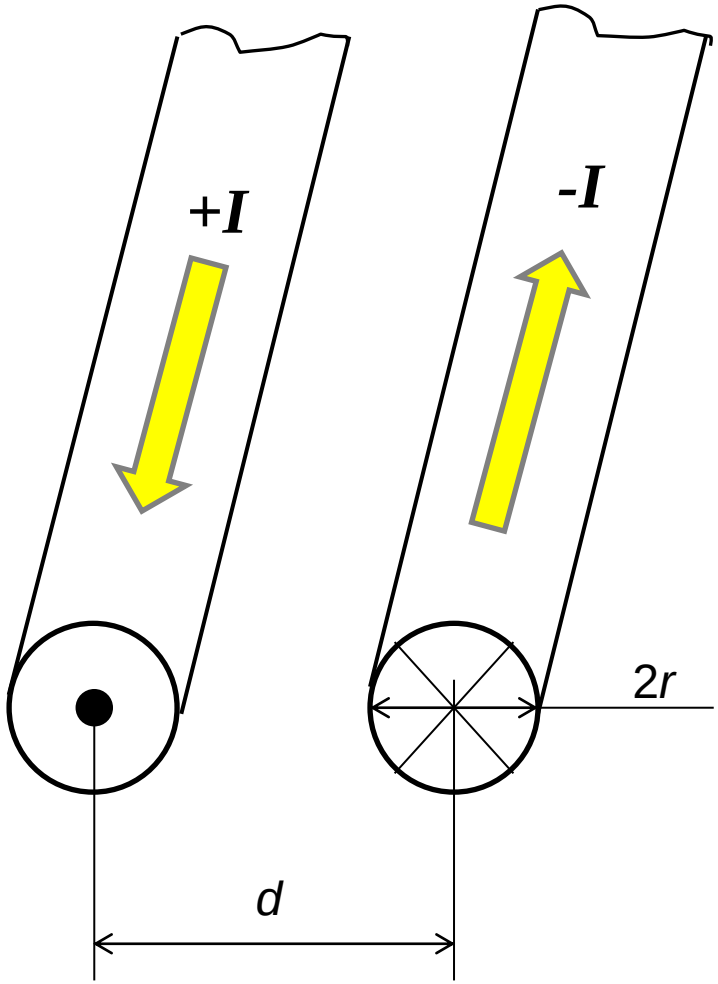
Given:

Line voltage (RMS) U = 110 kV

Calculate :
Electric field strength

http://quickfield.com/advanced/optical_cable.htm

Parallel wires inductance



Given :

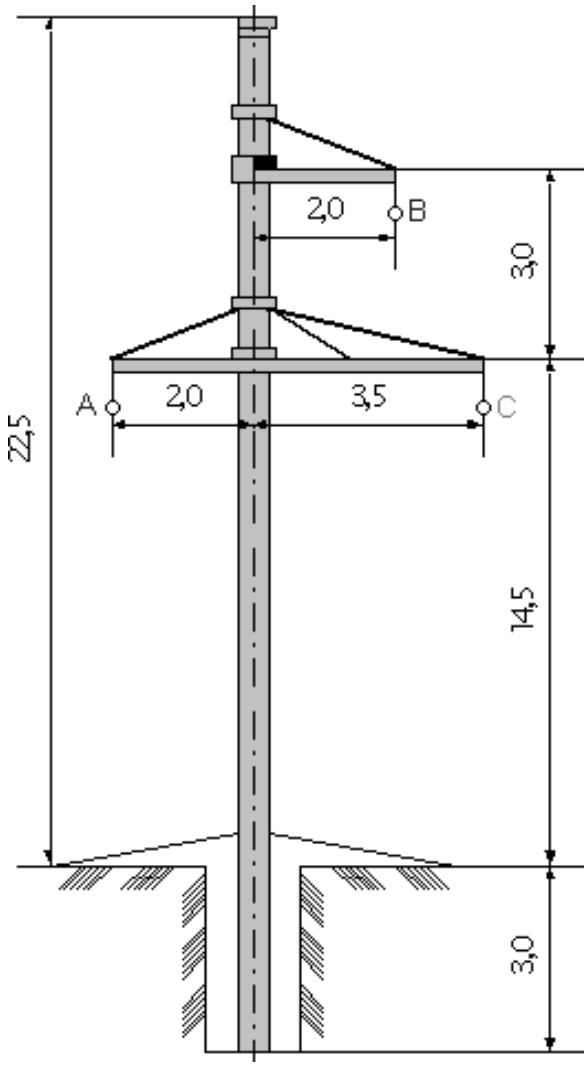
d = 0.5 m
r = 0.005 m

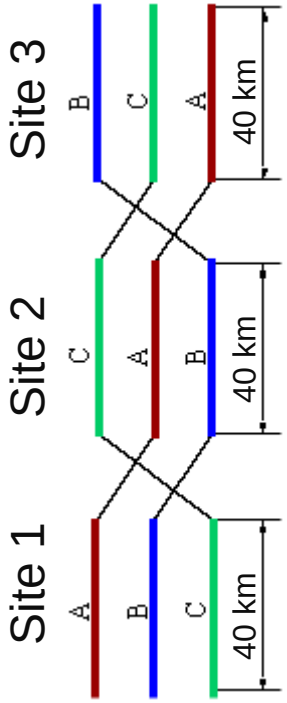
Calculate :
Inductance between the wires $L = \Phi / I$ [H/m]

$$L = \mu_0/\pi \ [\ln(d/r) + 0.25] =$$
$$= 1.94 \text{ mH/km}$$

http://quickfield.com/advanced/parallel_wires_inductance.htm

Transmission line transposition





Given :

Line voltage (RMS) U = 110 kV

Length of the line = 120 km

Load:

R_l = 100 Ω,

L_l = 72.3 Ω (0.23 H).

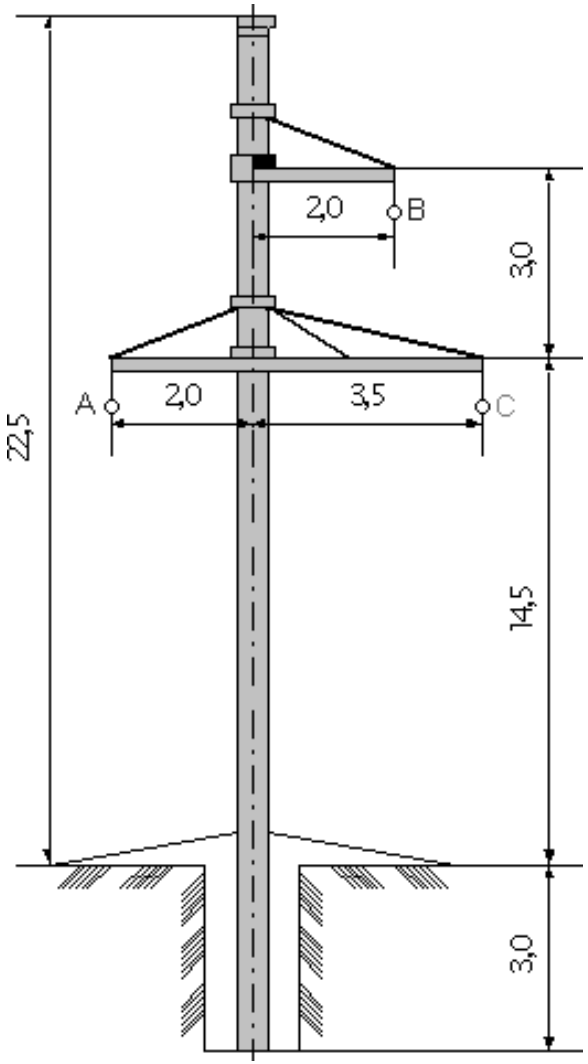
Calculate :

Inductances.

$$\Phi_a = L_{aa} * I_a + M_{ab} * I_b + M_{ac} * I_c$$

http://quickfield.com/advanced/transposition.htm

Phase-to-phase fault



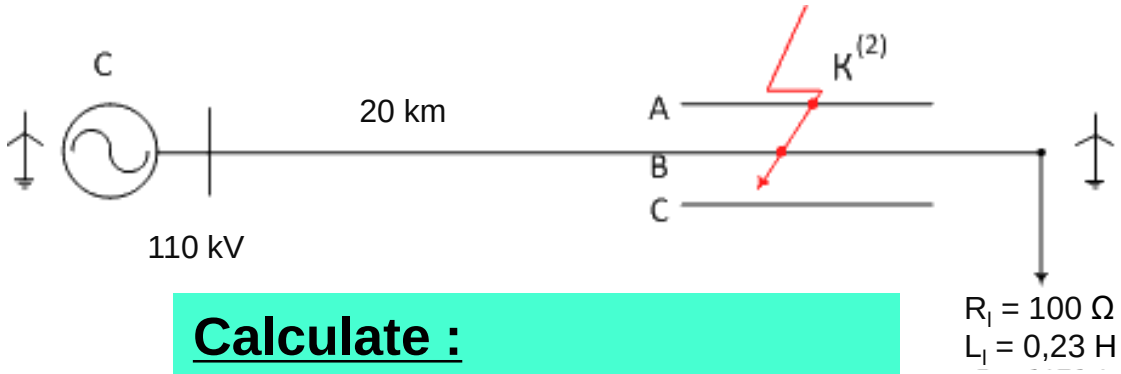
Given :

Line voltage (RMS) U_{pp} = 110 kV

Length of the line = 20 km

Internal impedance of the source:

R = 1 Ω, L = 0.02 H.



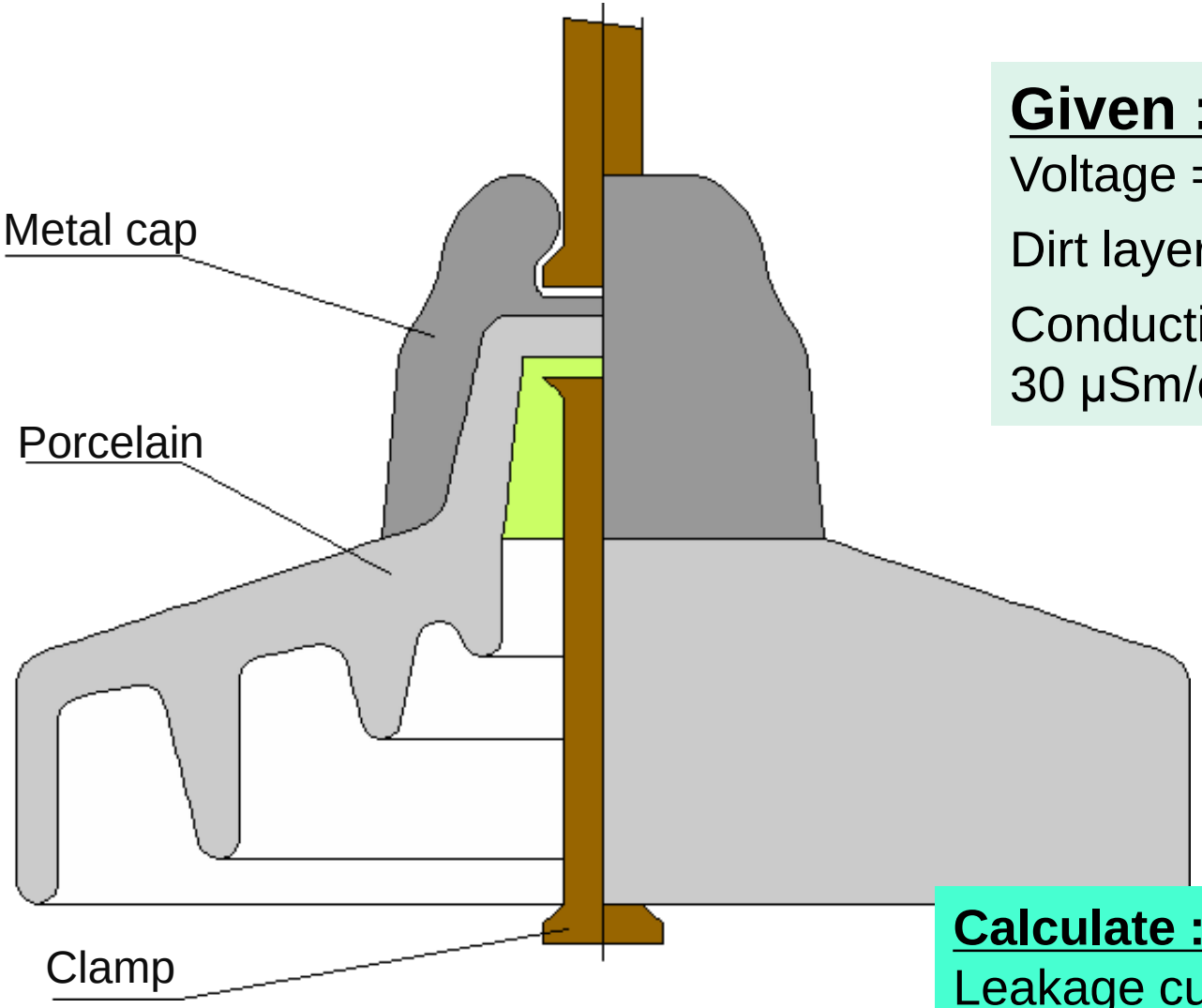
Calculate :

Short circuit currents.

Ampere forces.

http://quickfield.com/advanced/line_to_line_short.htm

Disc insulator. Heating



Given :

Voltage = 10 kV

Dirt layer thickness =1 mm.

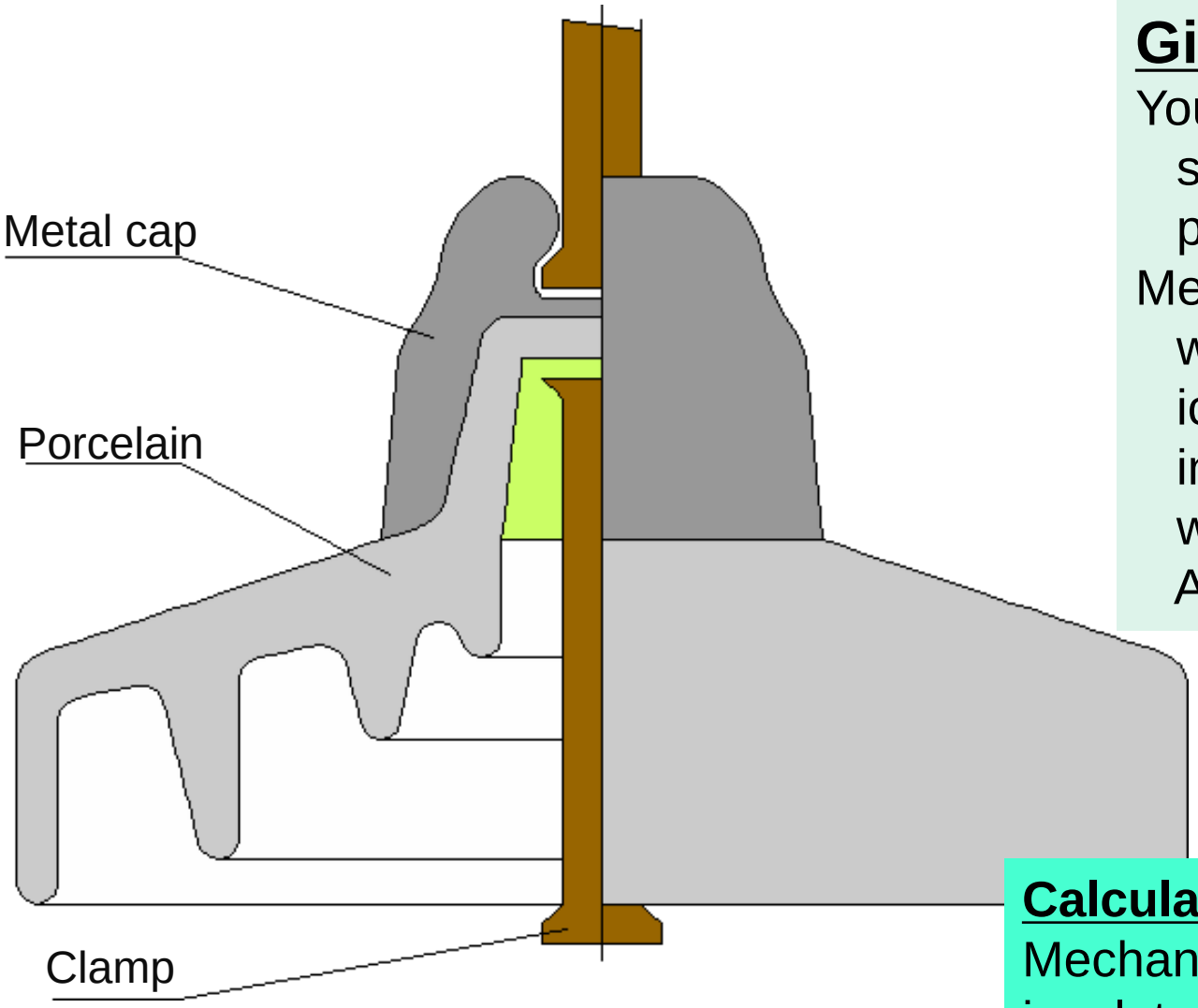
Conductivity of the layer 30 μSm/cm.

Calculate :

Leakage currents, Power of losses, insulator temperature

http://quickfield.com/advanced/insulator.htm

Disc insulator. Stress



Given:

Young modulus:
- steel 210 GPa,
- porcelain 59 GPa.

Mechanical load:
- wire weight 900 N
- ice weight 600 N
- insulators 300 N
- wind force 800 N
- Ampere force 200 N

Calculate :

Mechanical stresses in insulator

http://quickfield.com/advanced/insulator.htm