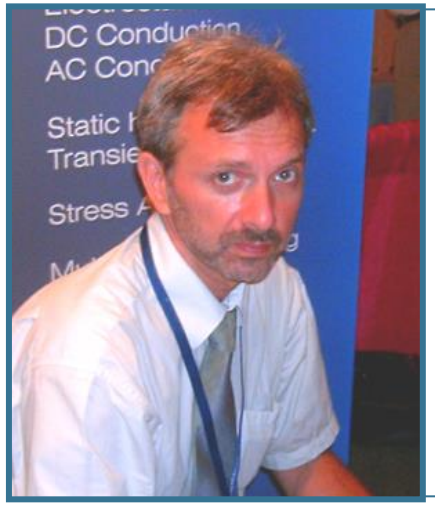
Induction heating modelling with QuickField



Vladimir Podnos

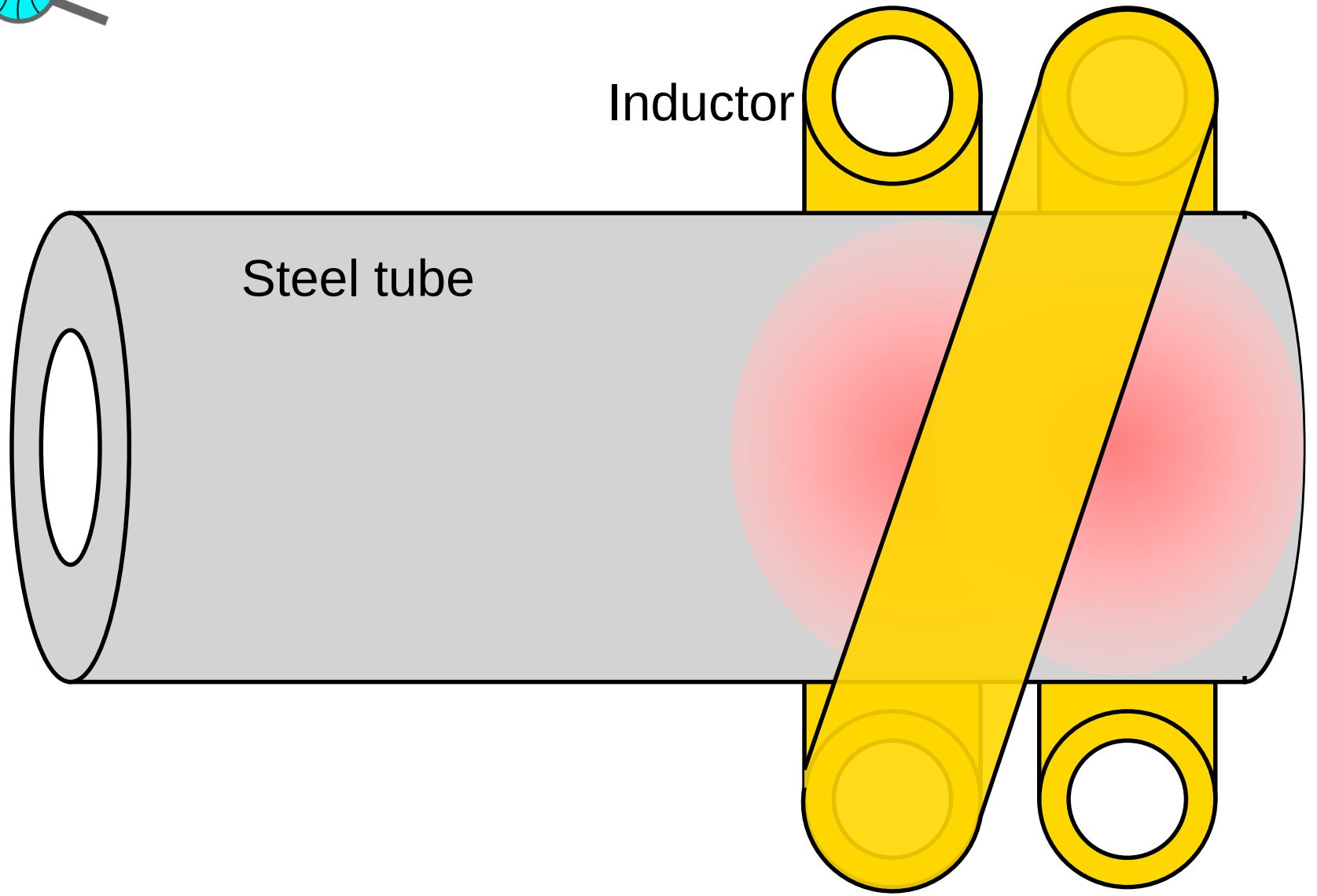
Director of Marketing and Support
Tera Analysis Ltd.

Alexander Lyubimtsev

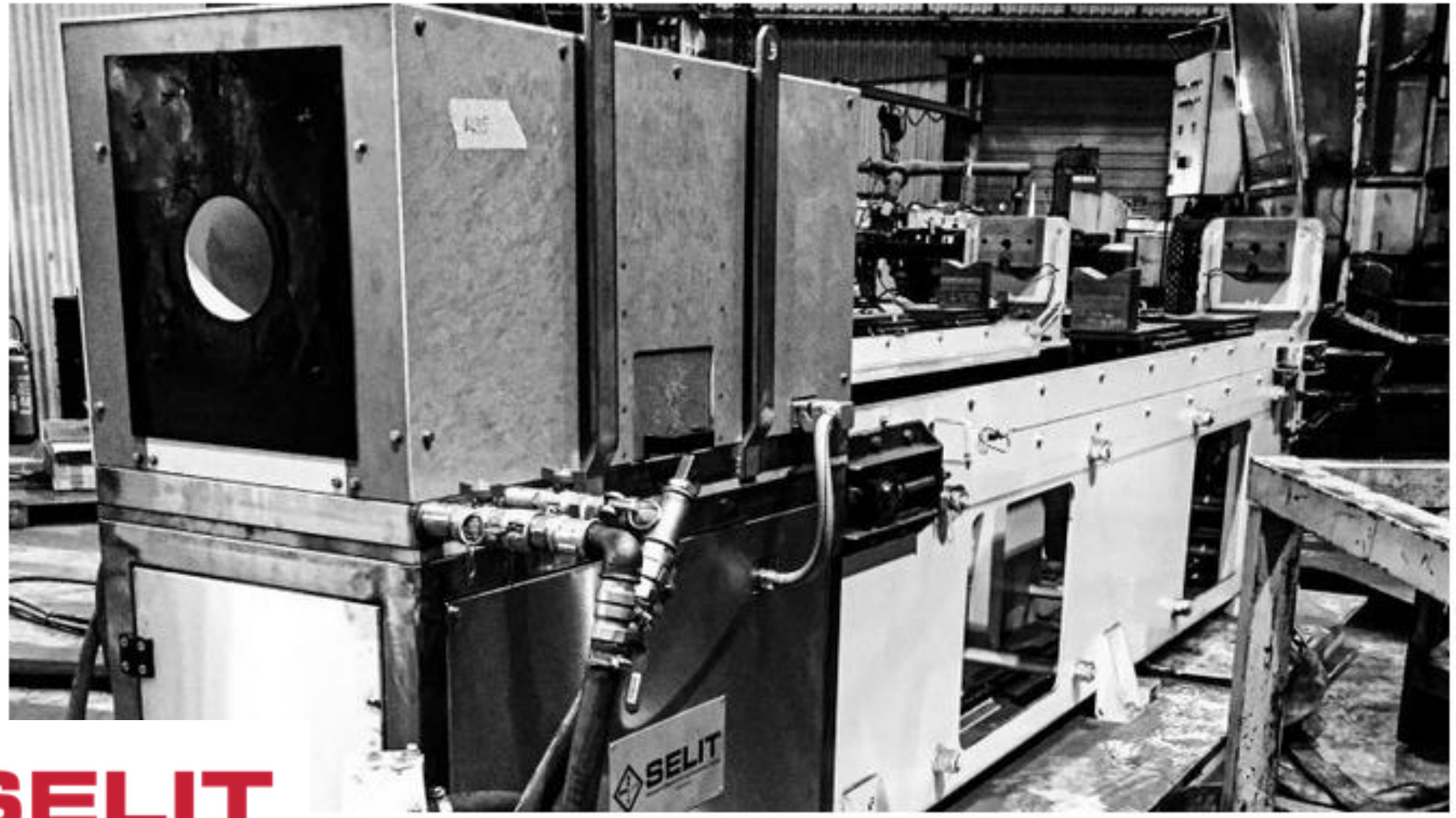
Support Engineer
Tera Analysis Ltd.

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

Induction heating modelling with QuickField



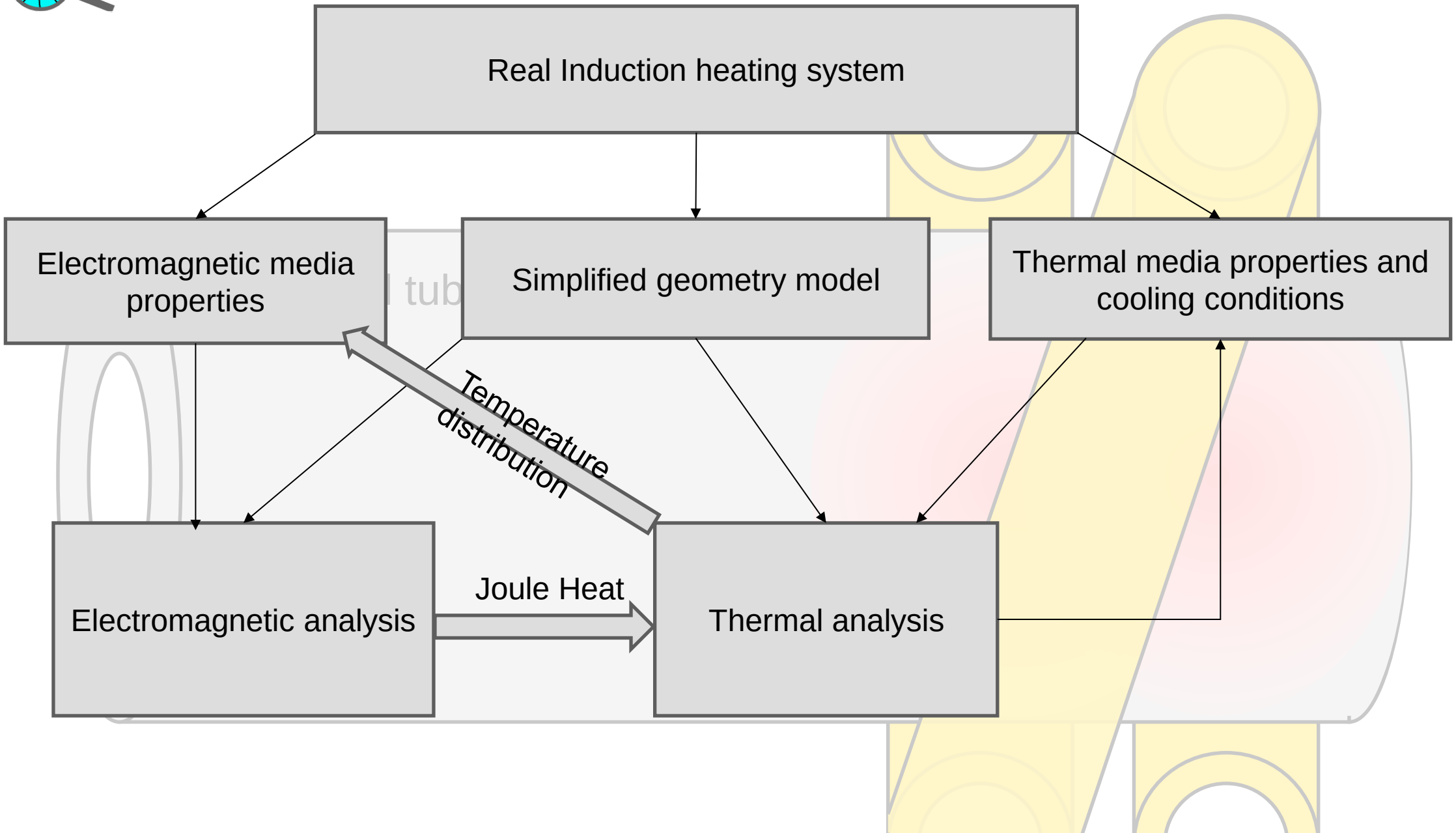
Induction heating modelling with QuickField



SELIT
INDUCTION HEATING SYSTEMS

https://www.selit-induction.com/

Induction heating simulation schema



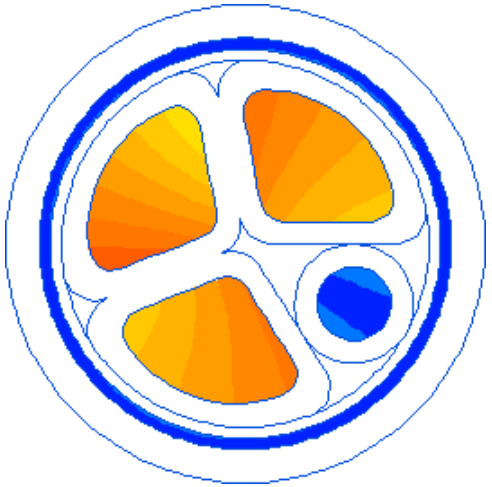
QuickField Analysis Options

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

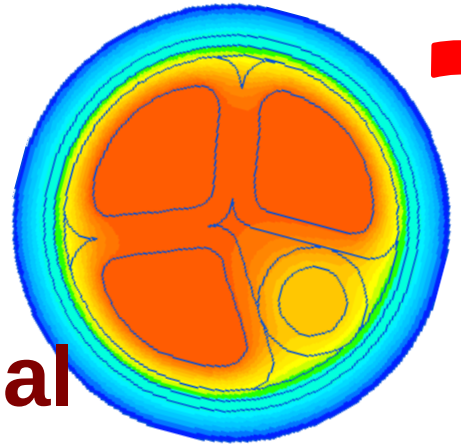
MultiPhysics (2D)

Electromagnetic fields



Losses

Temperature field

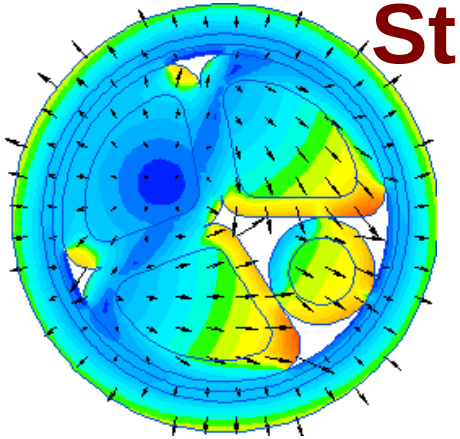


Temperature field import

Thermal Stresses

Magnetic state import

Forces



Stresses & Deformations

https://quickfield.com/coupling.htm

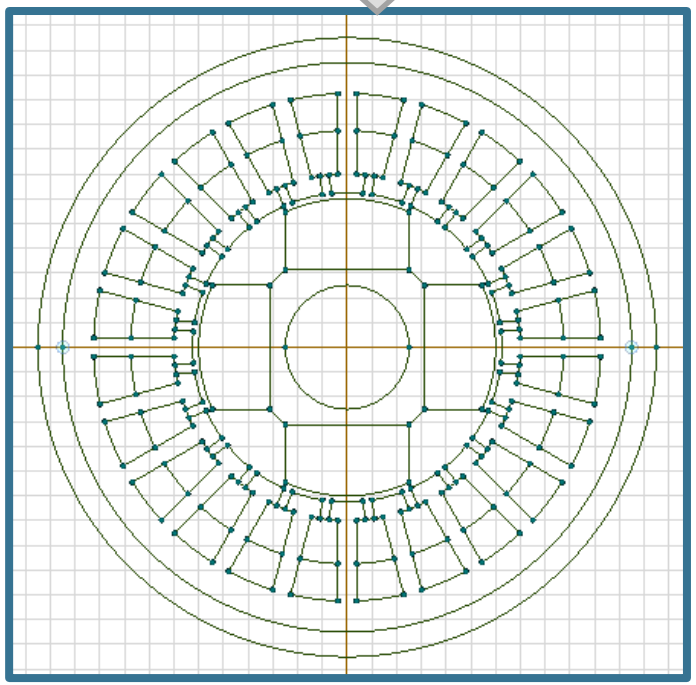
MultiPhysics (2D)

	Destination problem					
Source problem	DC magnetics	AC magnetics	Transient magnetics	Static heat transfer	Transient heat transfer	Stress Analysis
DC magnetics	Magnetic permeability	Magnetic permeability	Initial magnetic field			Force
AC magnetics				Joule heat	Joule heat	Force
Transient magnetics			Initial magnetic field	Joule heat	Joule heat	Force
Electrostatics						Force
DC conduction				Joule heat	Joule heat	
AC conduction				Joule heat	Joule heat	Force
Static heat transfer		Temperatures			Initial temperatures	Temperatures
Transient heat transfer		Temperatures			Initial temperatures	Temperatures

https://quickfield.com/coupling.htm

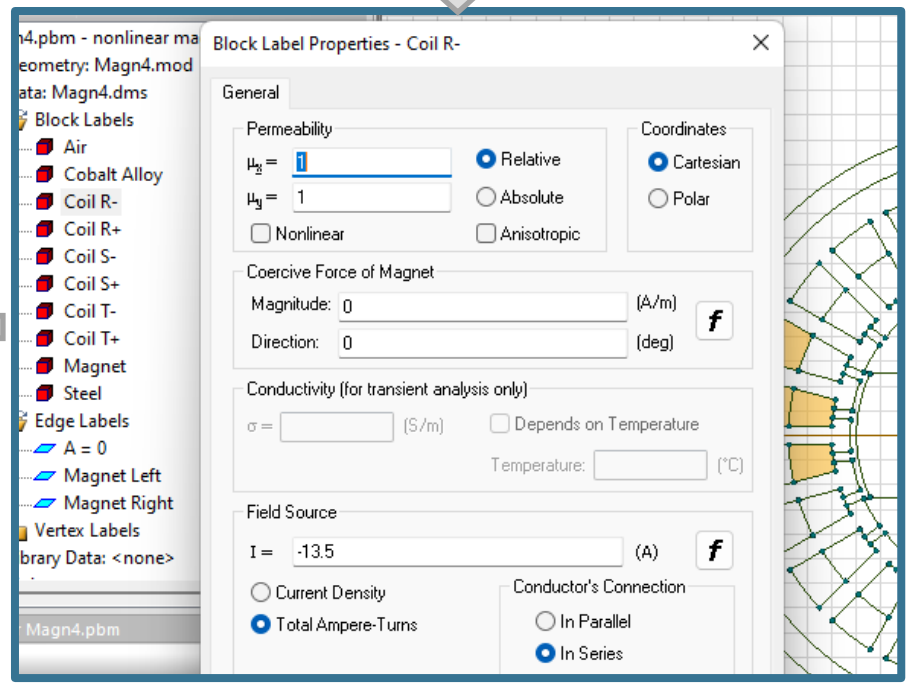
QuickField Workflow

Problem setup



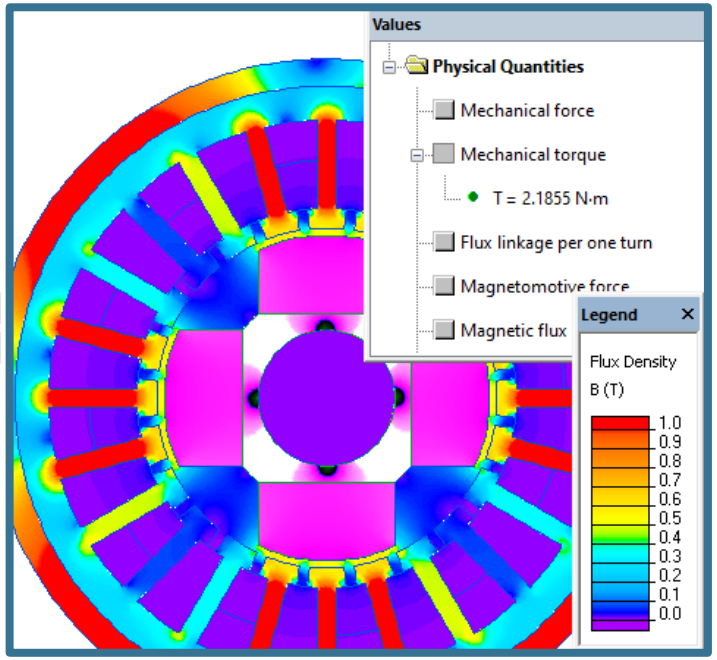
Model editor

+



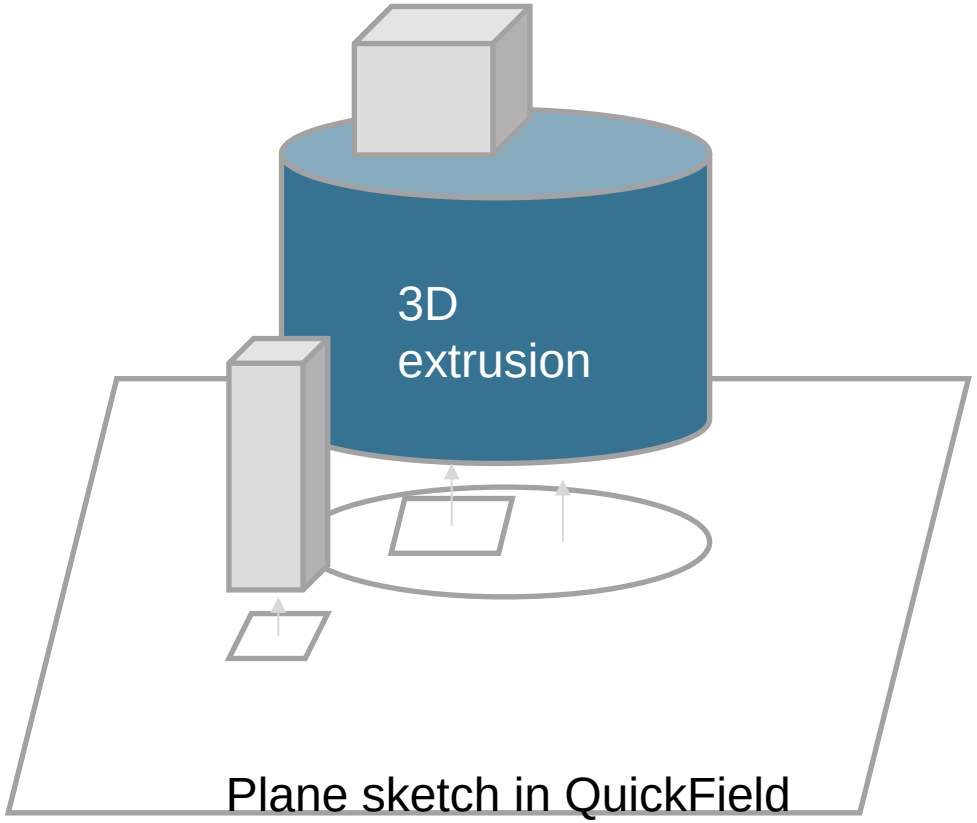
Material physical properties, field sources and boundary conditions

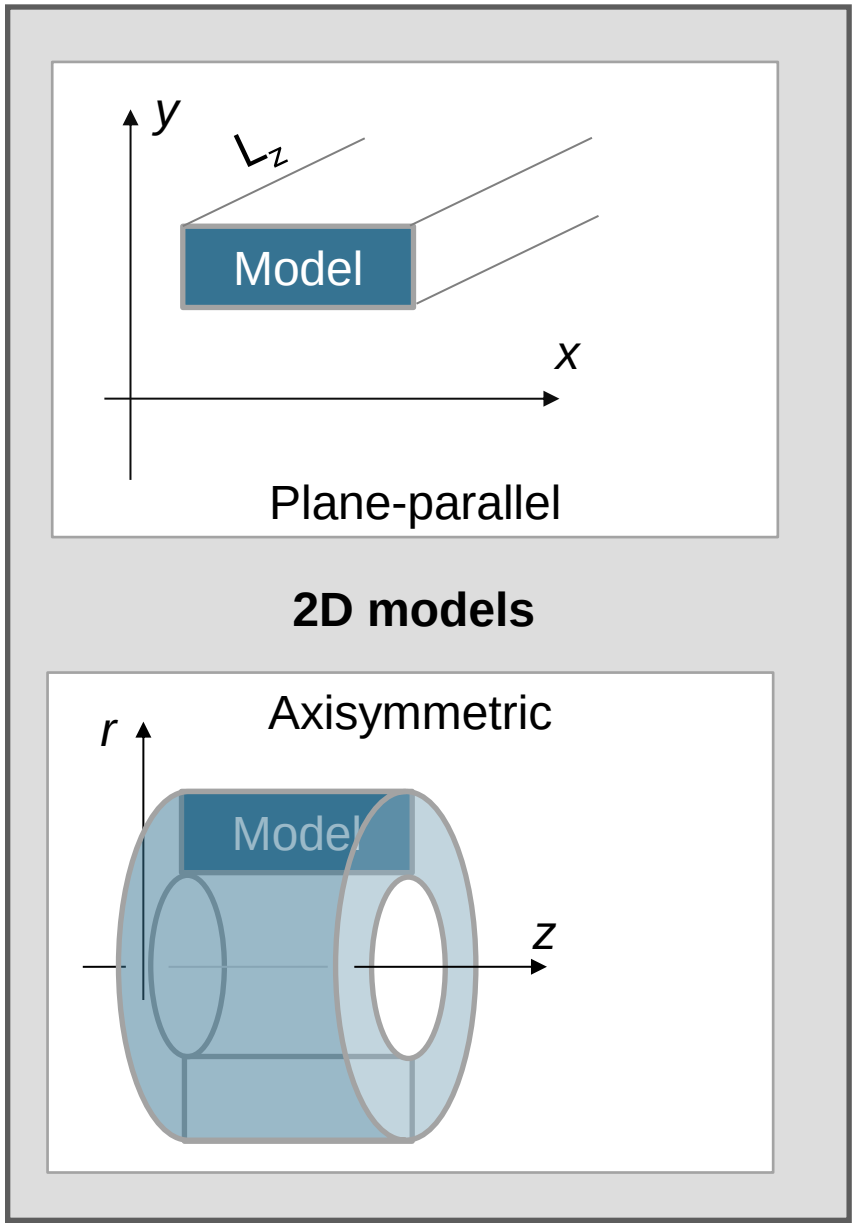
=

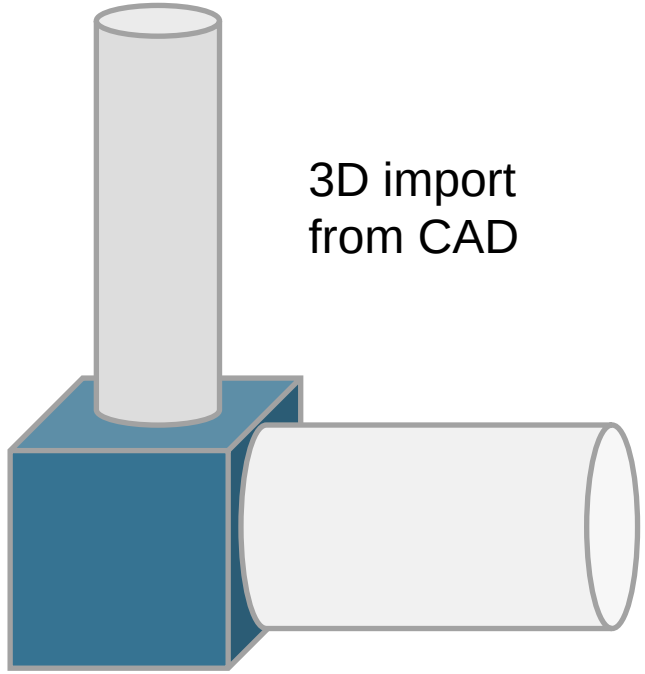


Results analysis

QuickField model class

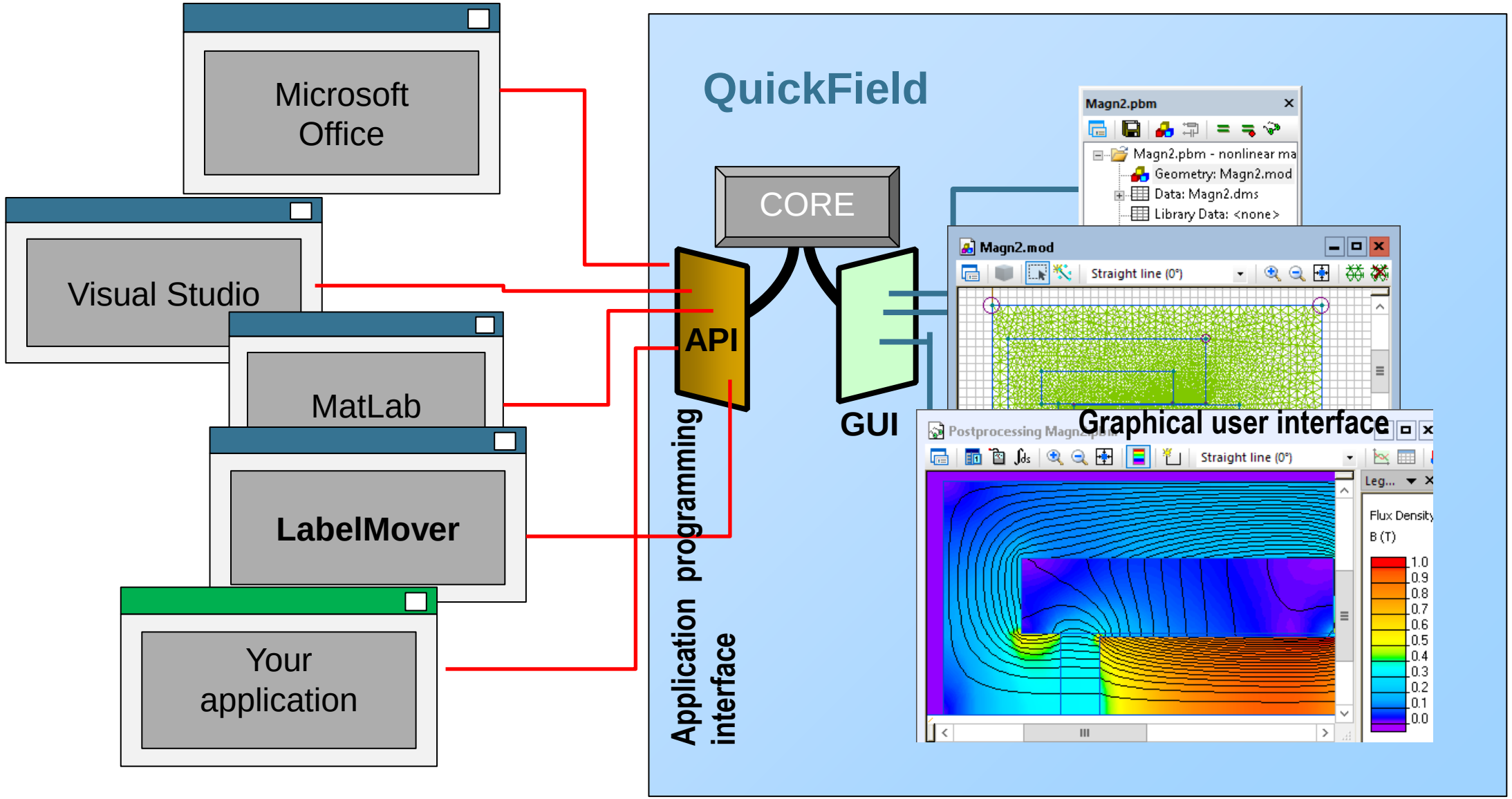






https://quickfield.com/prep.htm

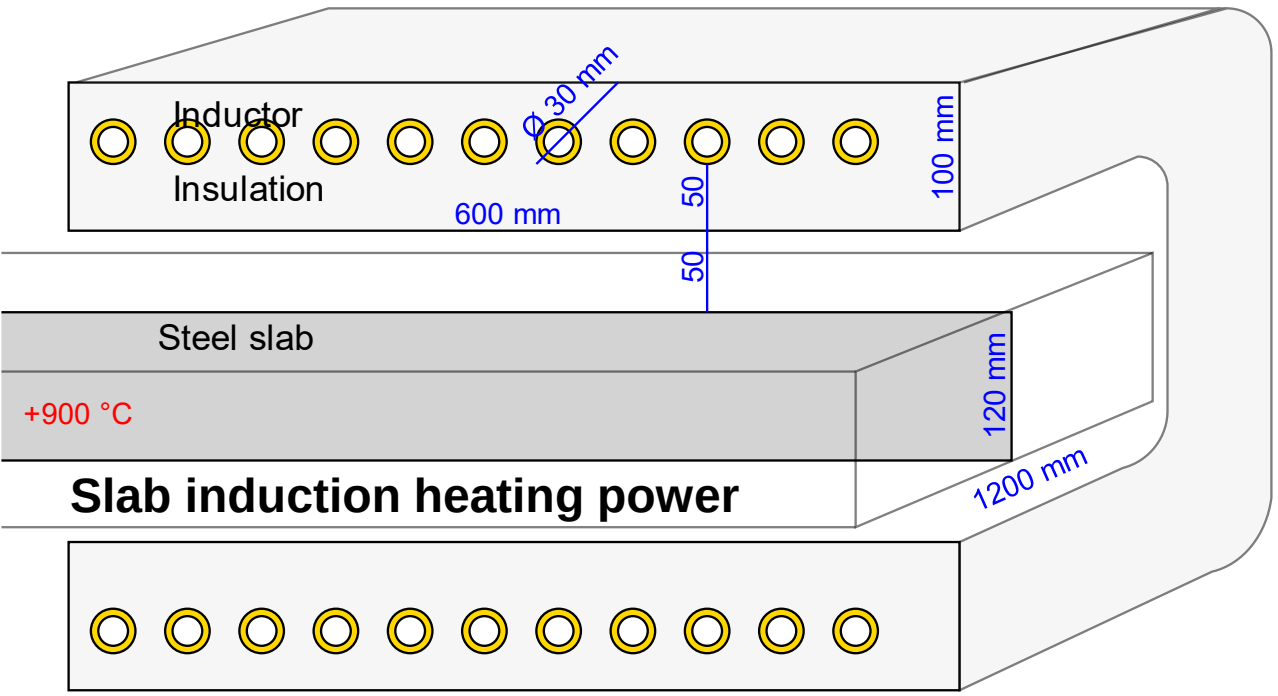
QuickField API



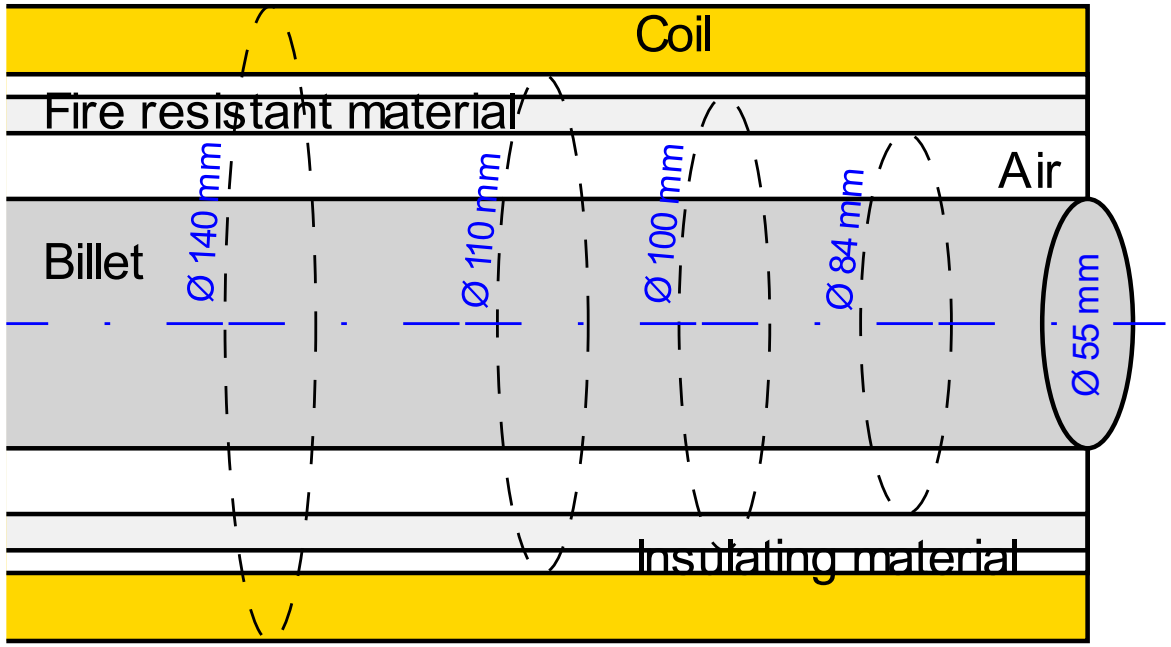
https://quickfield.com/programming.htm

QuickField Difference

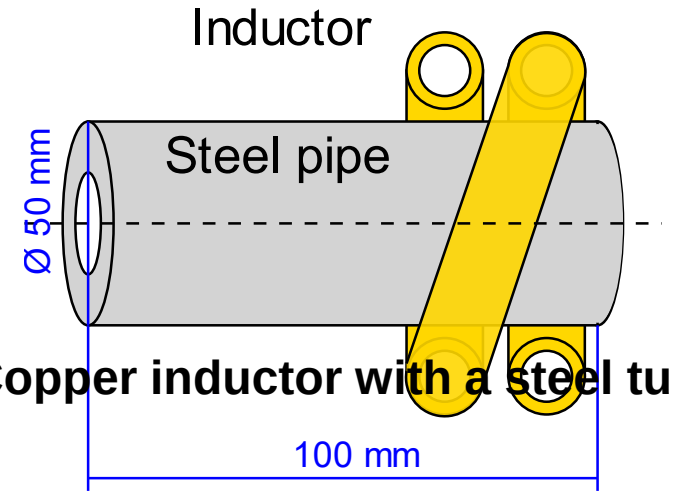
Induction heating modelling with QuickField



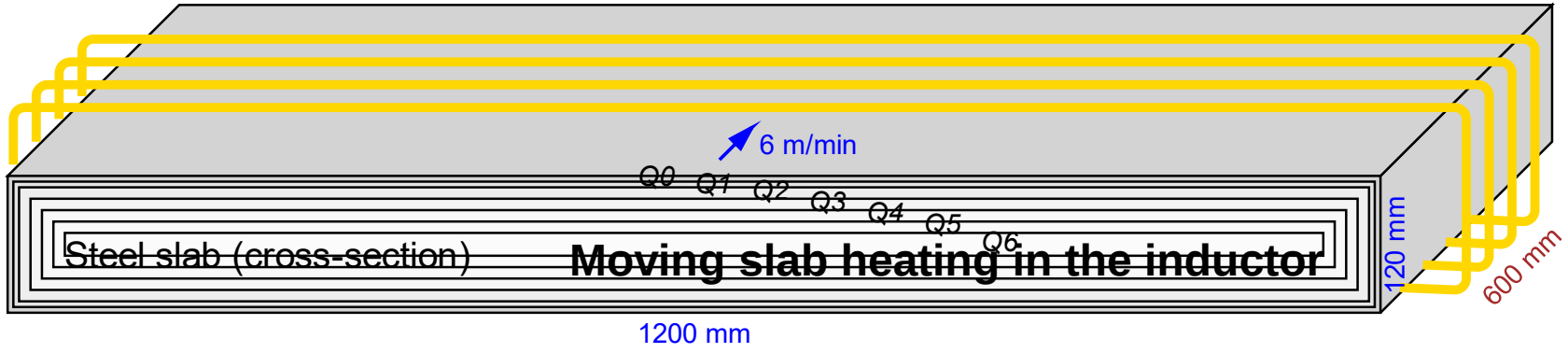
Slab induction heating power



Induction heating of the material with temperature dependent properties



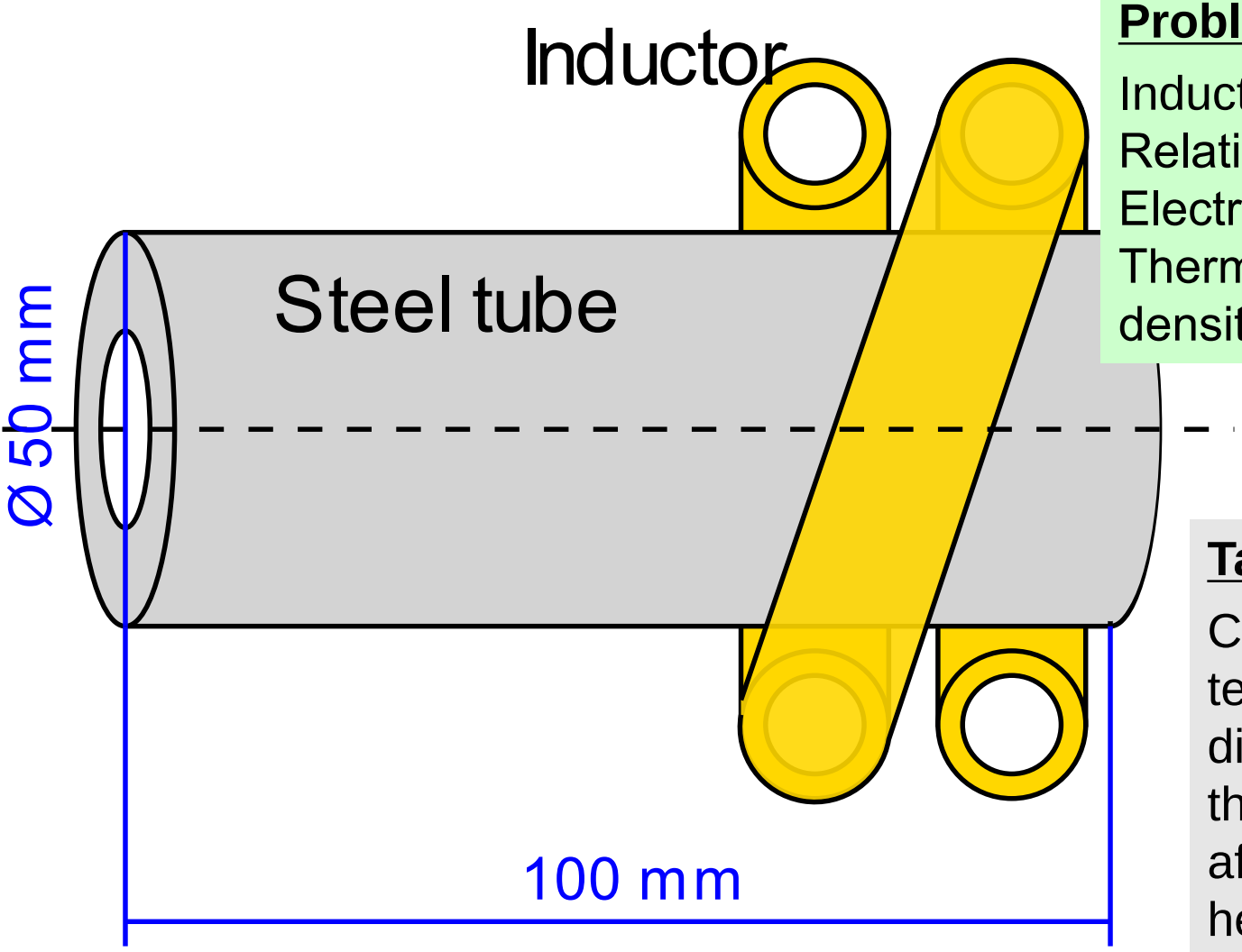
Copper inductor with a steel tube



Moving slab heating in the inductor

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

Copper inductor with a steel tube



Problem specification:

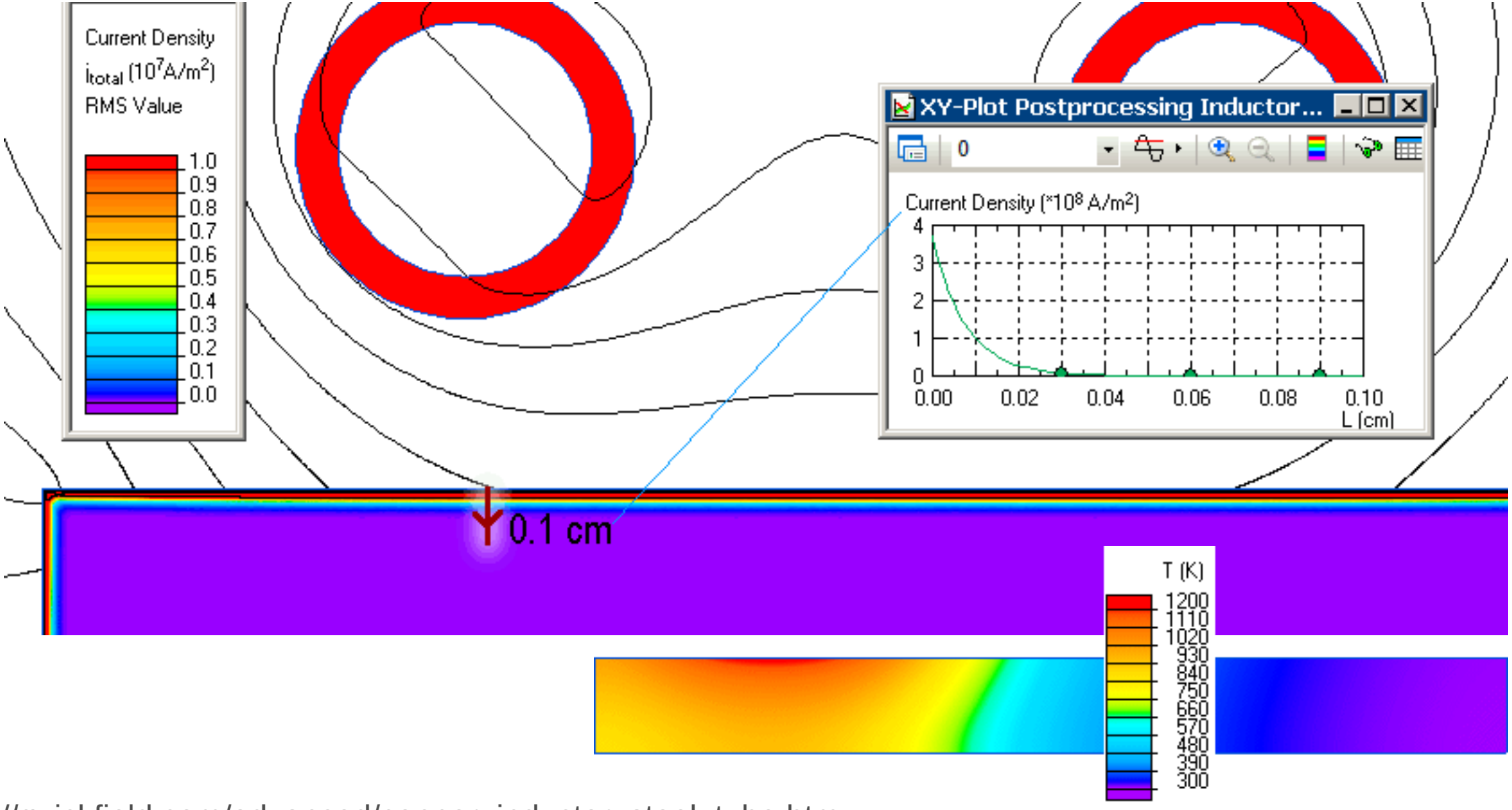
Inductor current I = 500 A (r.m.s), frequency f = 22 kHz.
Relative permeability of steel μ = 400;
Electric conductivity of steel σ = 5 MS/m;
Thermal conductivity of steel λ = 20 W/K*m,
density ρ = 7800 kg/m³, specific heat C = 420 J/K*kg.

Task:

Calculate the temperature distribution in the steel part after 10 s. of heating.

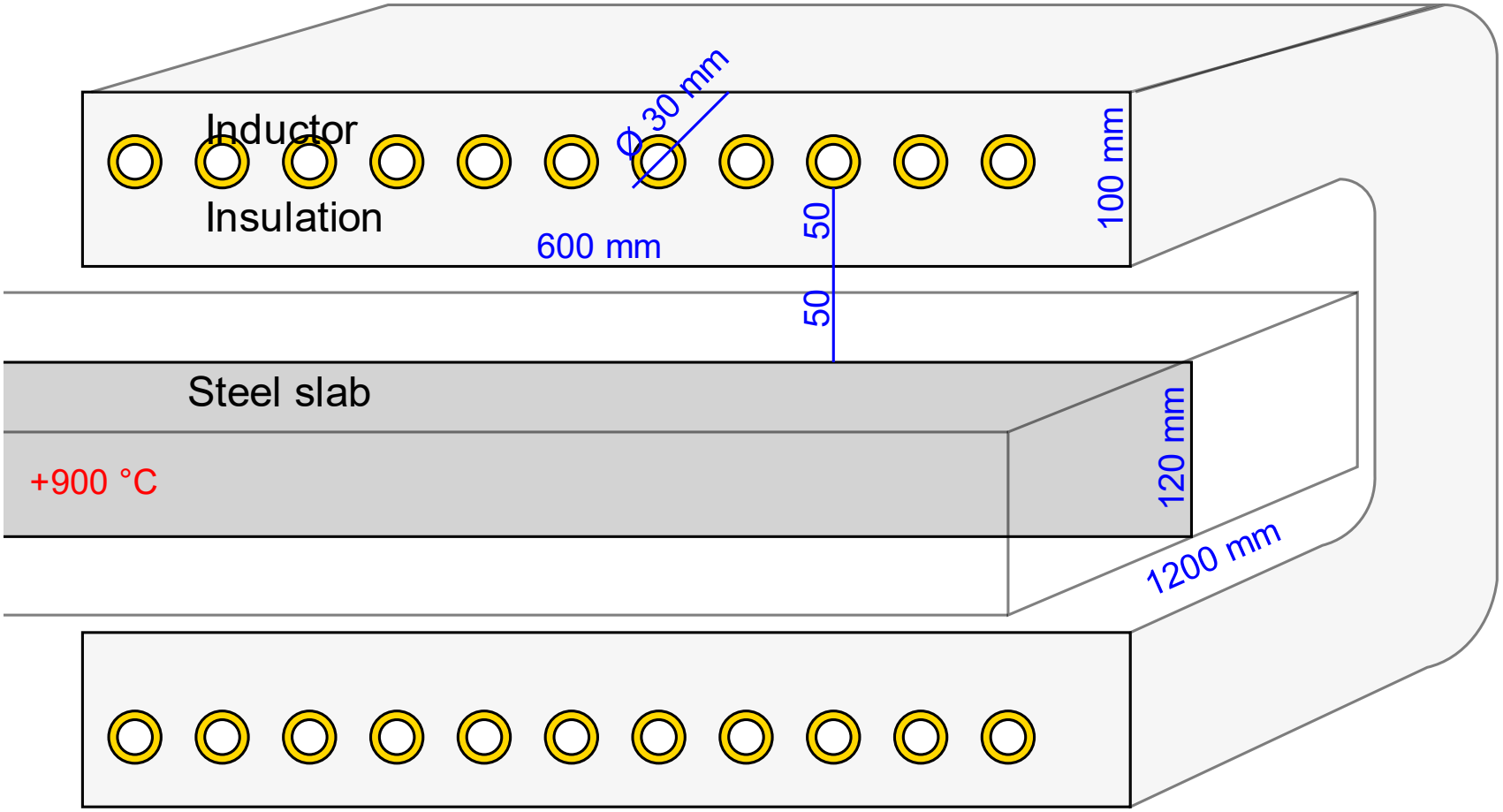
https://quickfield.com/advanced/copper_inductor_steel_tube.htm

Copper inductor with a steel tube



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

Slab induction heating power



Problem specification:

Coil current 12.5 kA (r.m.s), frequency 150 Hz,
Relative permeability of steel $\mu = 1$ at the temperature above 760°C.

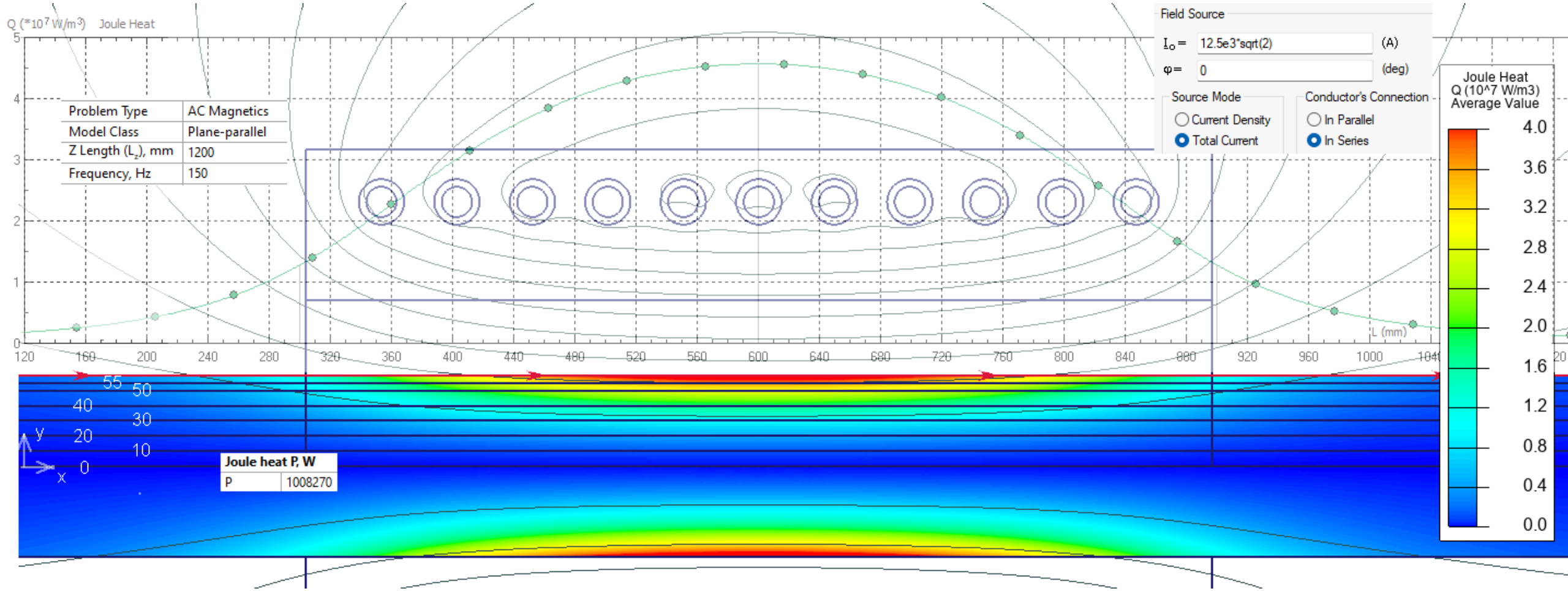
Electrical resistivity value depends on the temperature.

Task:

Calculate the Joule heating power distribution in the steel slab.

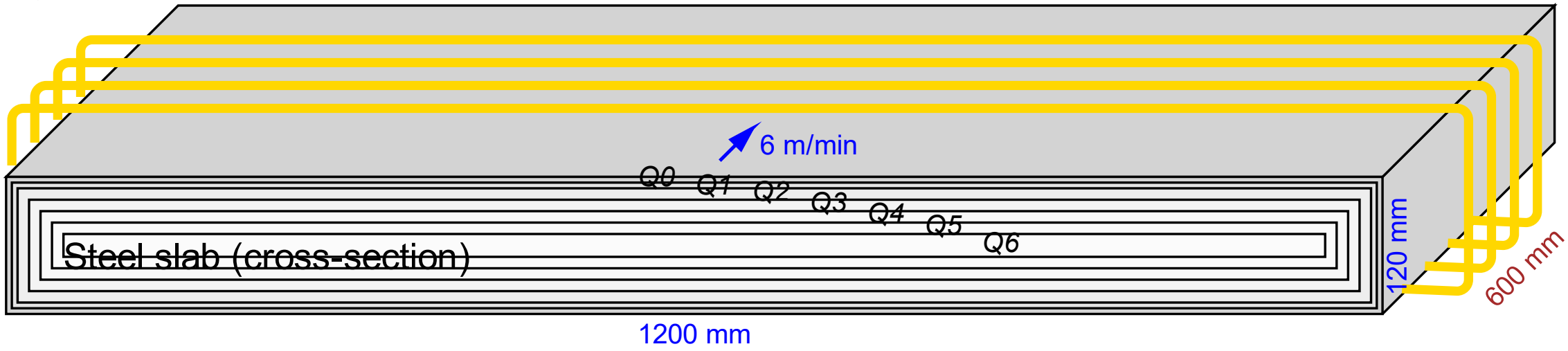
https://quickfield.com/advanced/slab_induction_heating.htm

Slab induction heating power



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

Moving slab heating in the inductor

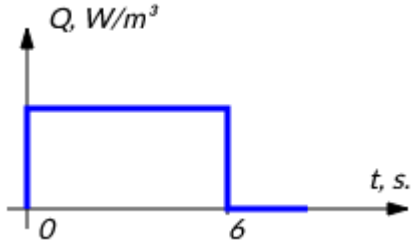


Problem specification:

Power density in the slab layers *Q* is calculated in the related AC magnetic example.
Slab initial temperature is +900°C.
Slab surface emissivity coefficient ε = 0.8, ambient temperature is +20°C.

Density of steel ρ = 7880 kg/m³.

Thermal conductivity and heat capacity depends on the temperature.

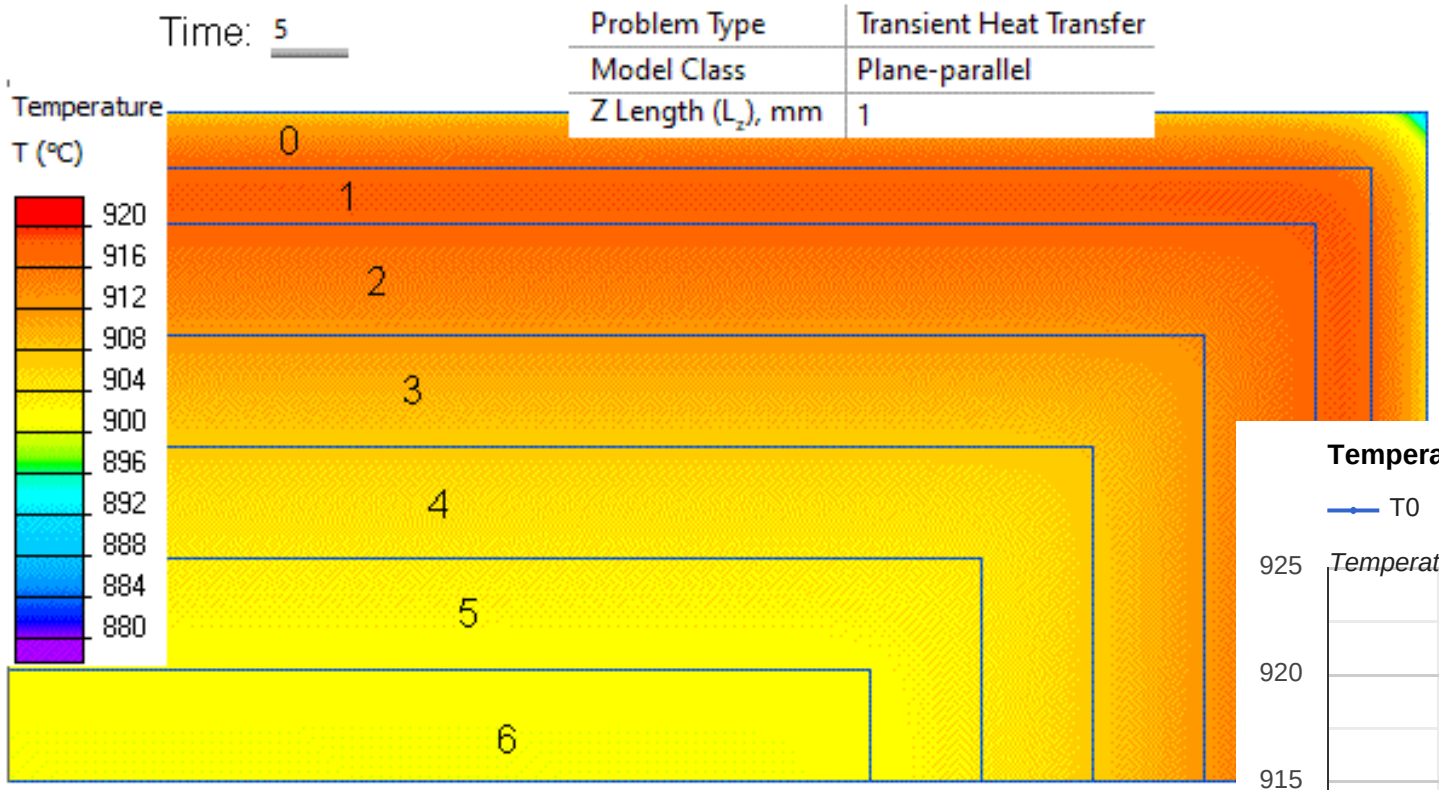


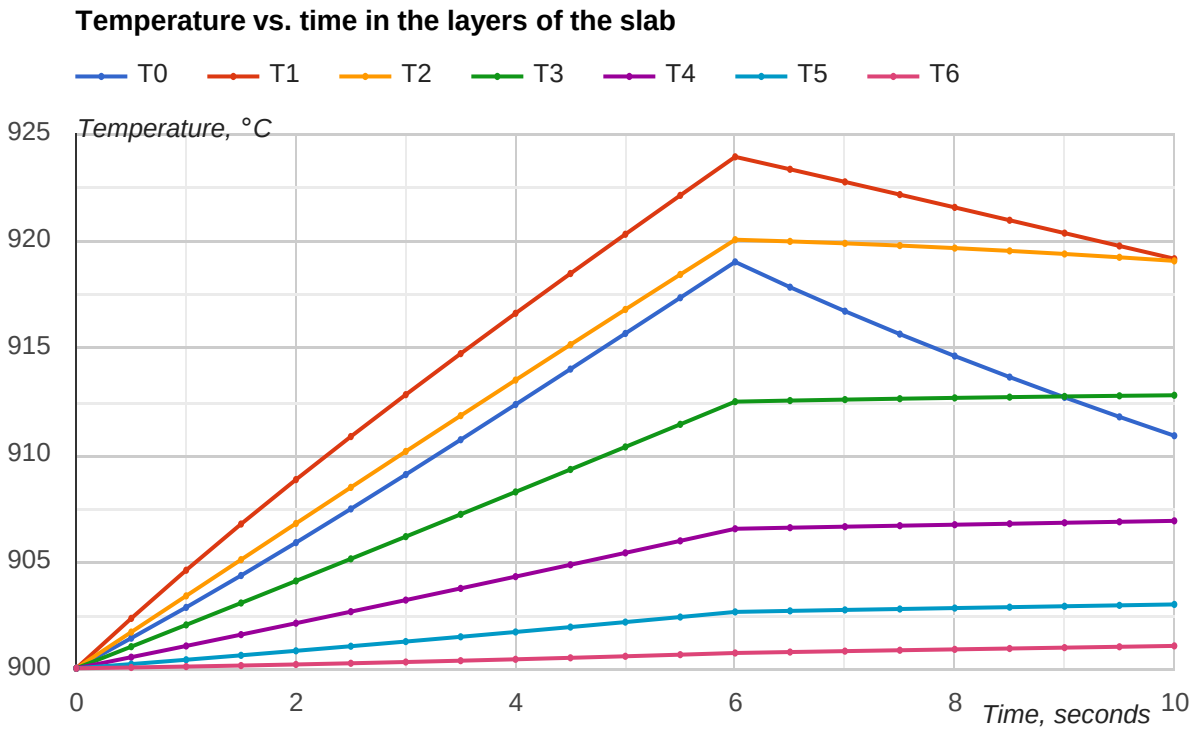
Task:

Calculate the temperature distribution in the steel slab.

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

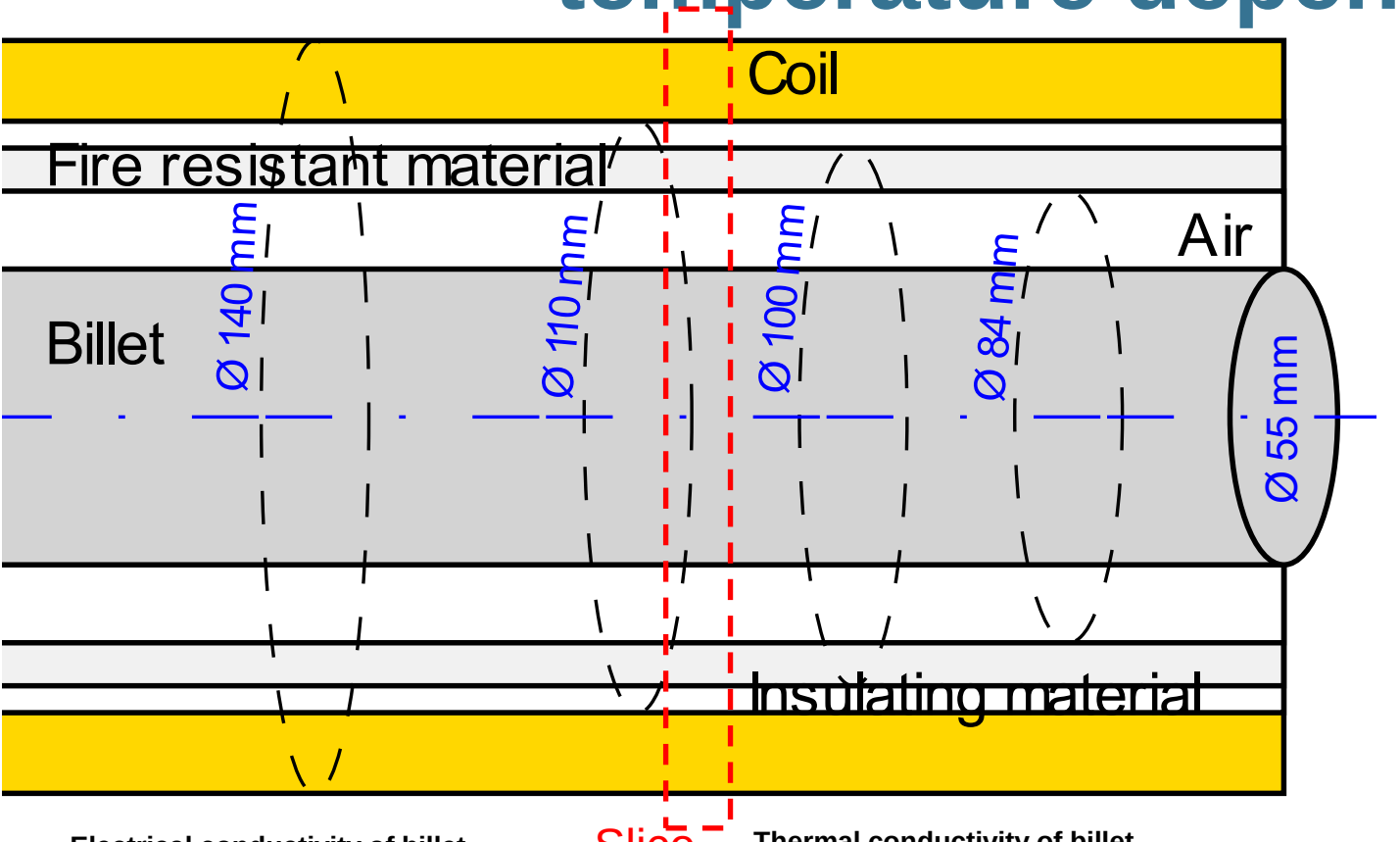
Moving slab heating in the inductor





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

Induction heating of the material with temperature dependent properties

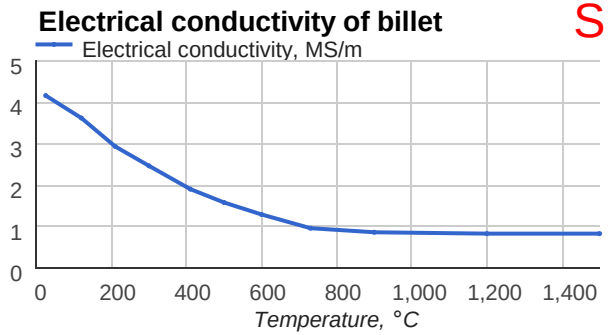


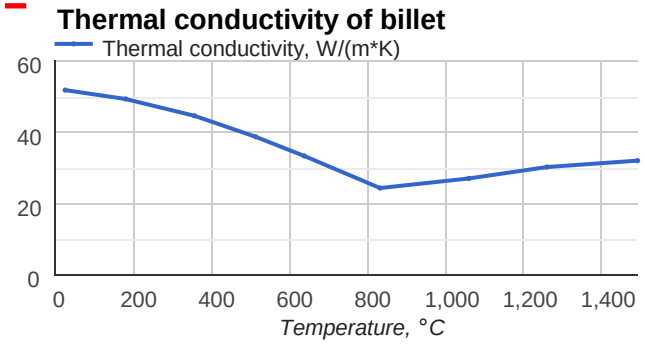
Problem specification:

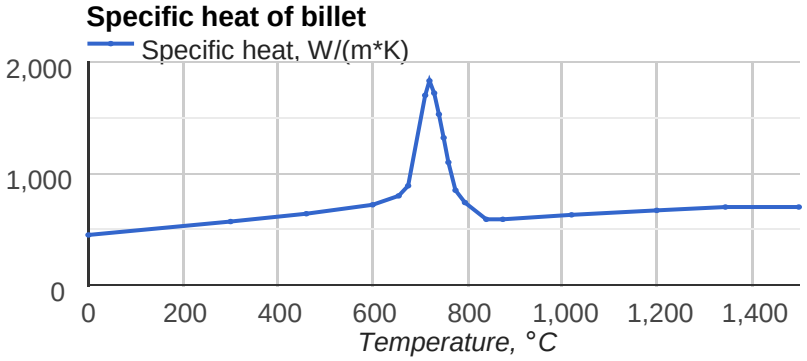
The initial temperature is 25°C.
Coil linear current density is 700 A (r.m.s) per 1 cm of the coil length.
Frequency is 8 kHz.
Billet density 7860 kg/m³.

Task:

Calculate the temperature distribution in the billet during the induction heating process.

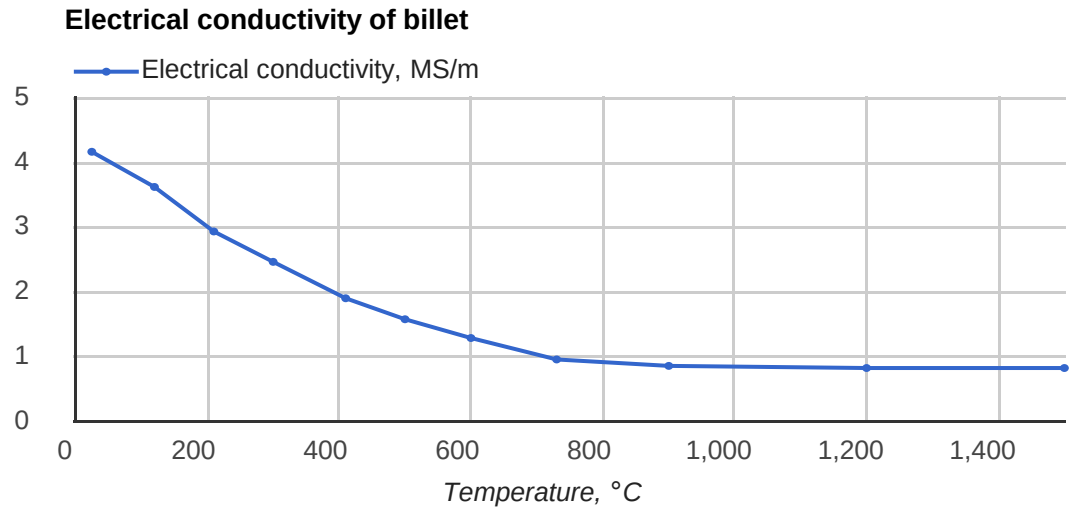


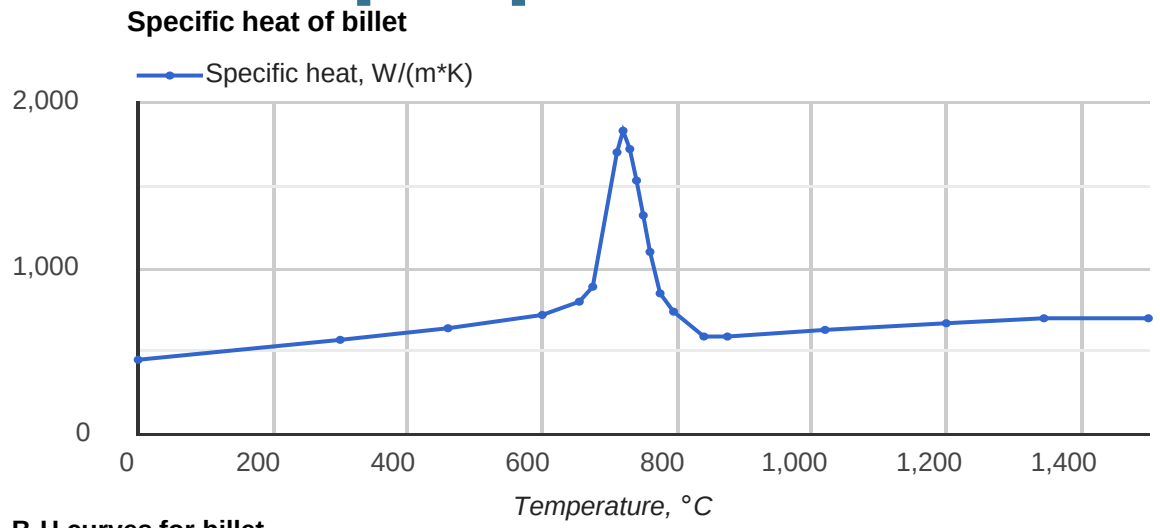


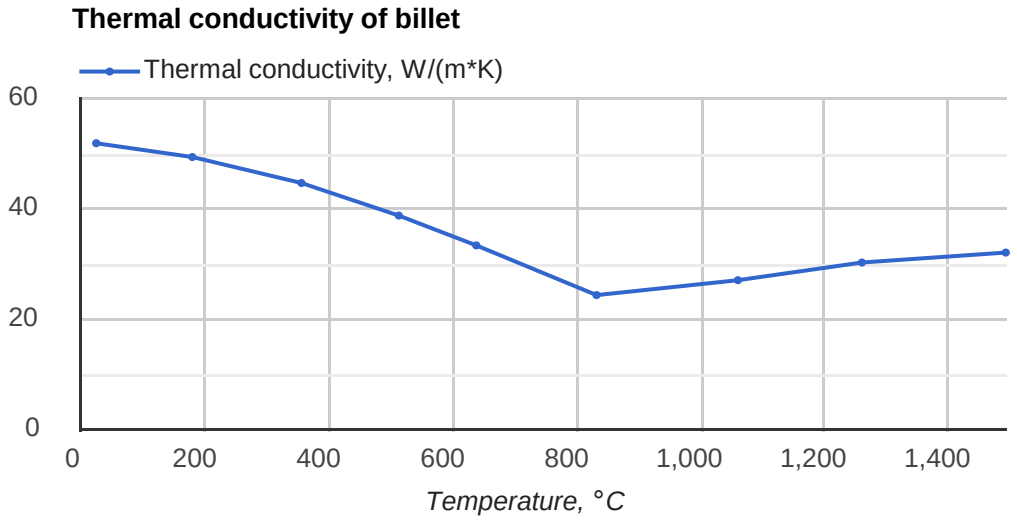


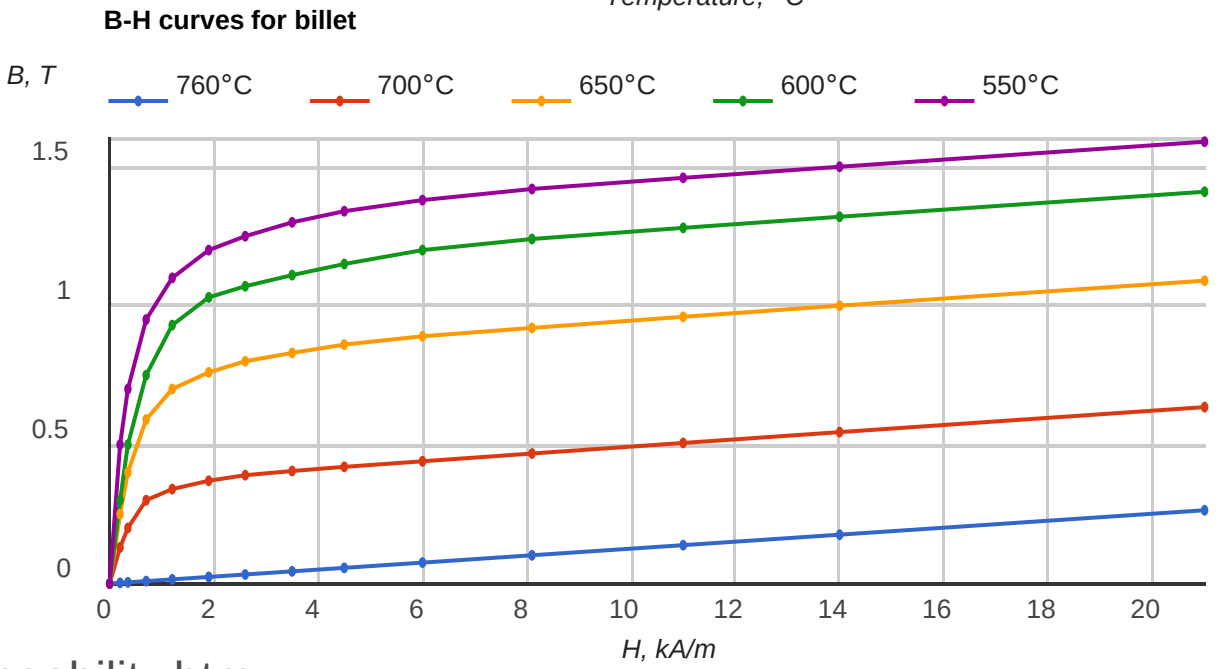
https://quickfield.com/advanced/induction_heating_permeability.htm

Induction heating of the material with temperature dependent properties



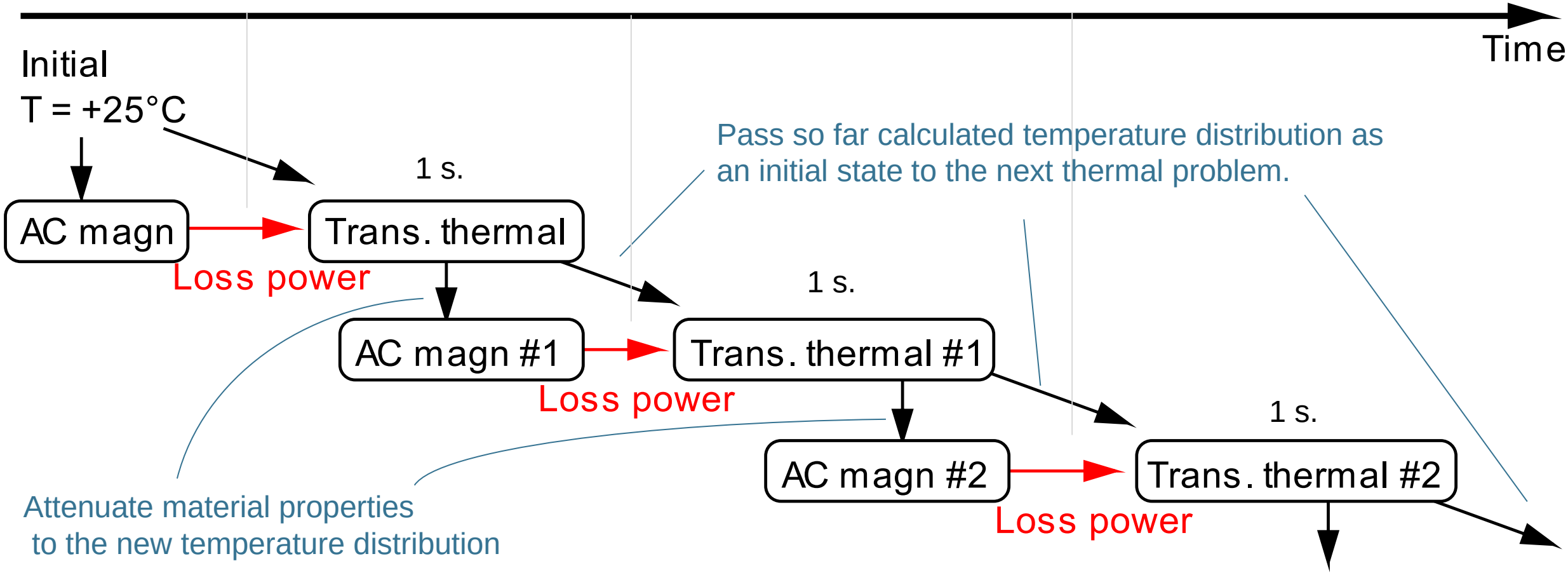






https://quickfield.com/advanced/induction_heating_permeability.htm

Induction heating of the material with temperature dependent properties



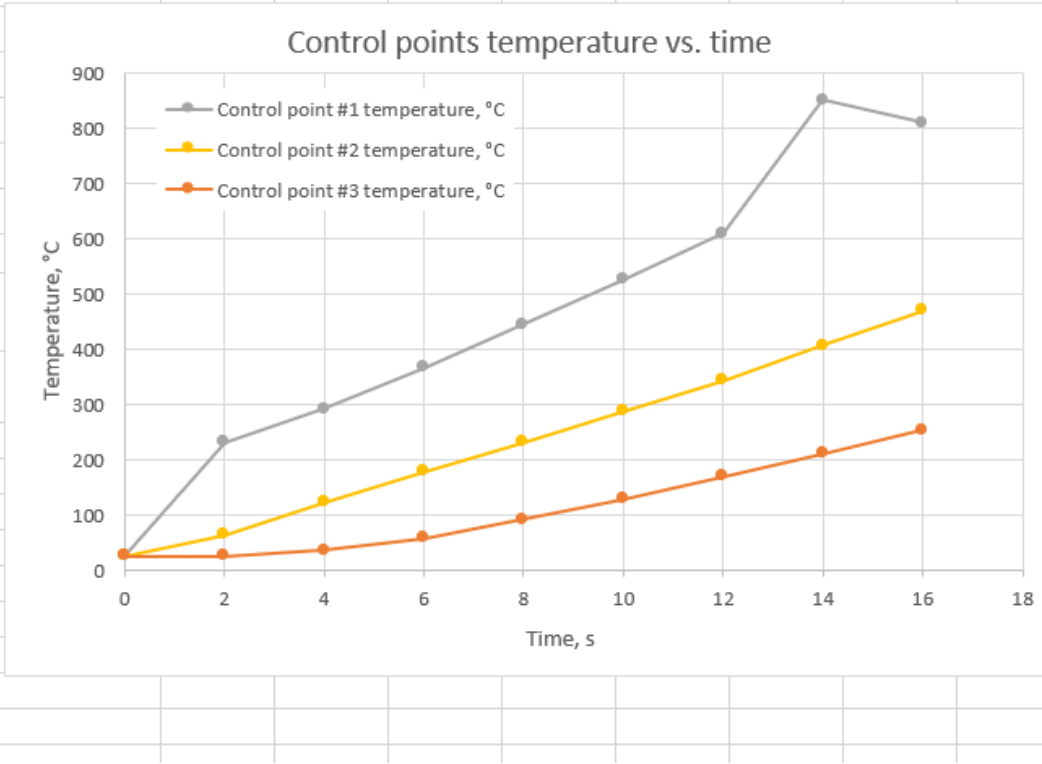
https://quickfield.com/advanced/induction_heating_permeability.htm

Induction heating of the material with temperature dependent properties

Start/Continue | Reset

Stage number:	7
Stage beginning time:	14
Stage ending time:	16
Work folder:	D:\temp\induction_heating_script\IHD_4
Status messages:	Stopped. Control point 1 temperature exceeds the defined limit.

Stage number	Time, s	Control point #1 temperature, °C	Control point #2 temperature, °C	Control point #3 temperature, °C	Click on the problem name to see a field view	
					Magnetic problem	Transient Heat Transfer problem
0	0	25	25	25		
0	2	232	64	26	Ac.pbm	HT.pbm
1	4	292	123	35	Ac1.pbm	HT1.pbm
2	6	367	178	58	Ac2.pbm	HT2.pbm
3	8	444	232	91	Ac3.pbm	HT3.pbm
4	10	525	287	129	Ac4.pbm	HT4.pbm
5	12	609	343	169	Ac5.pbm	HT5.pbm
6	14	851	406	211	Ac6.pbm	HT6.pbm
7	16	810	470	254	Ac7.pbm	HT7.pbm



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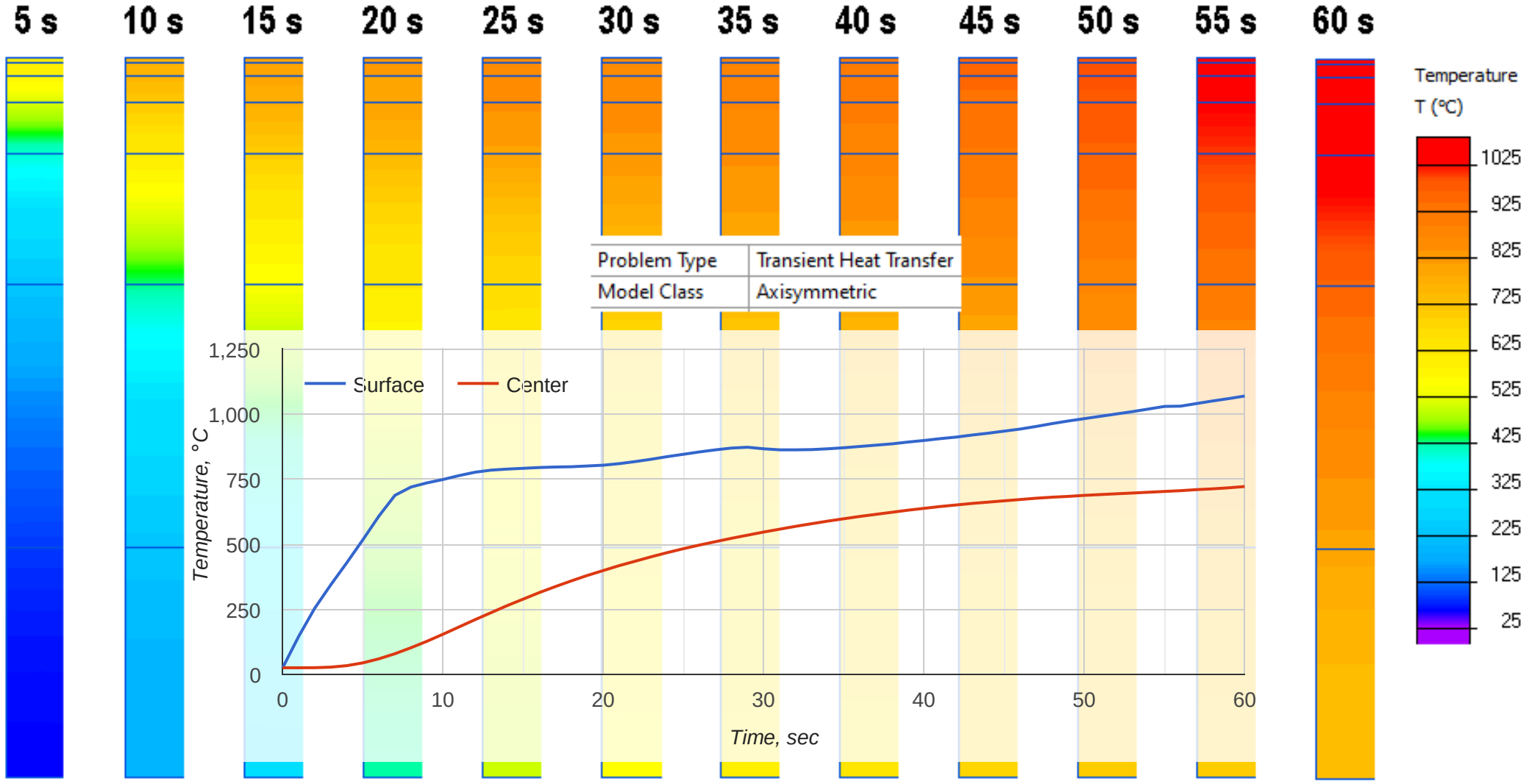
Induction heating of the material with temperature dependent properties



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

This recording is over

More recordings and simulation examples at www.quickfield.com

Your feedback is welcome: support@quickfield.com