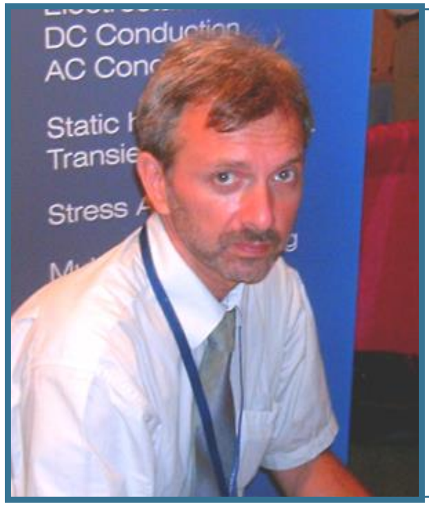
Film heaters modelling with QuickField



Vladimir Podnos

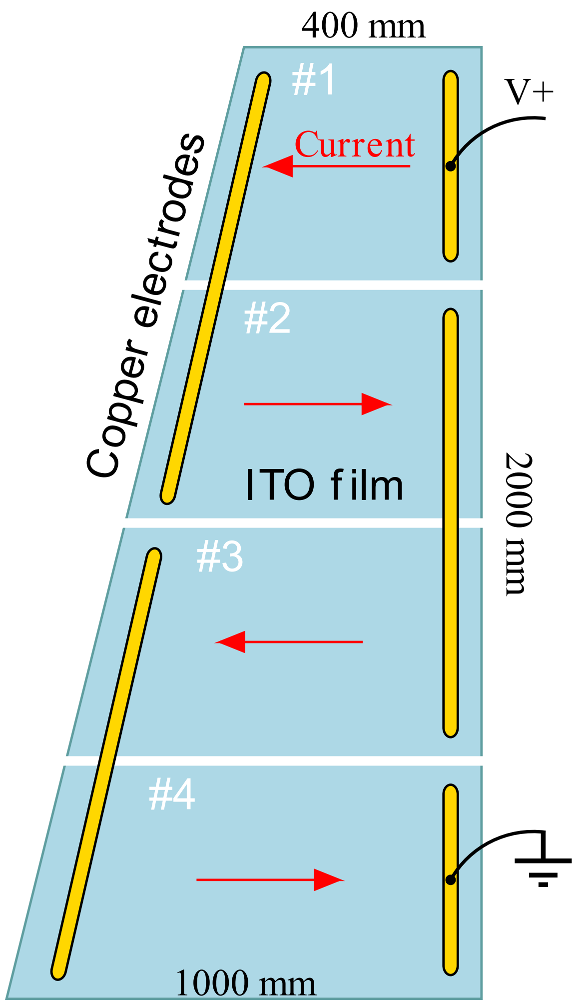
Director of Marketing and Support
Tera Analysis Ltd.

Alexander Lyubimtsev

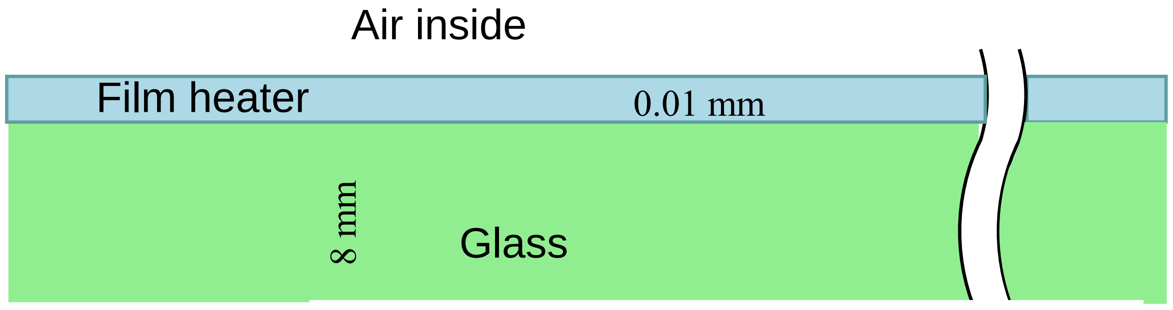
Support Engineer
Tera Analysis Ltd.

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

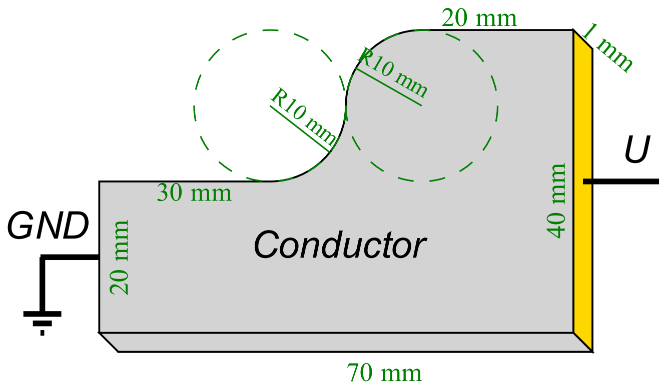
Film heaters modelling with QuickField



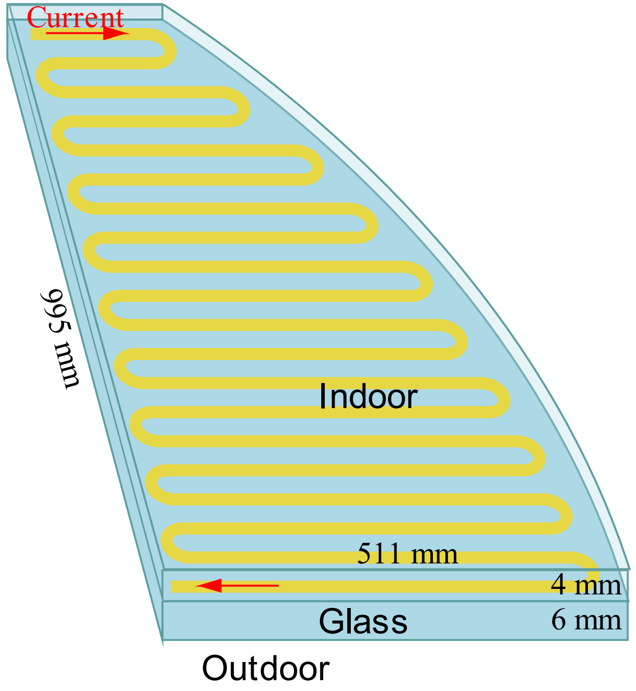
Electric heating film for glass



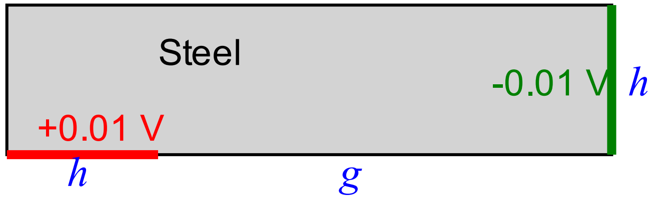
Glass film heater



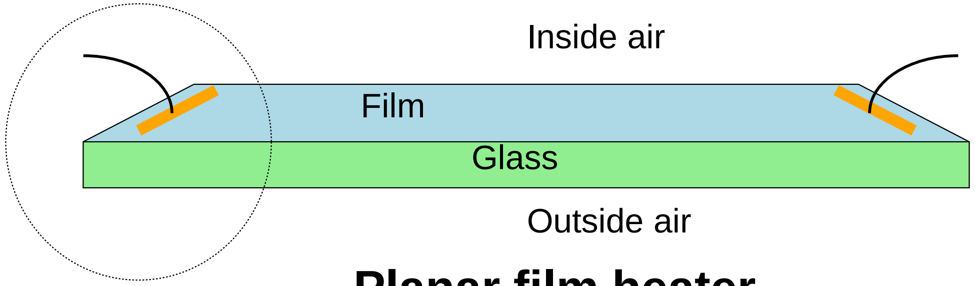
Temperature distribution in the conducting film



Planar heater 3D



Thin film resistance



Planar film heater

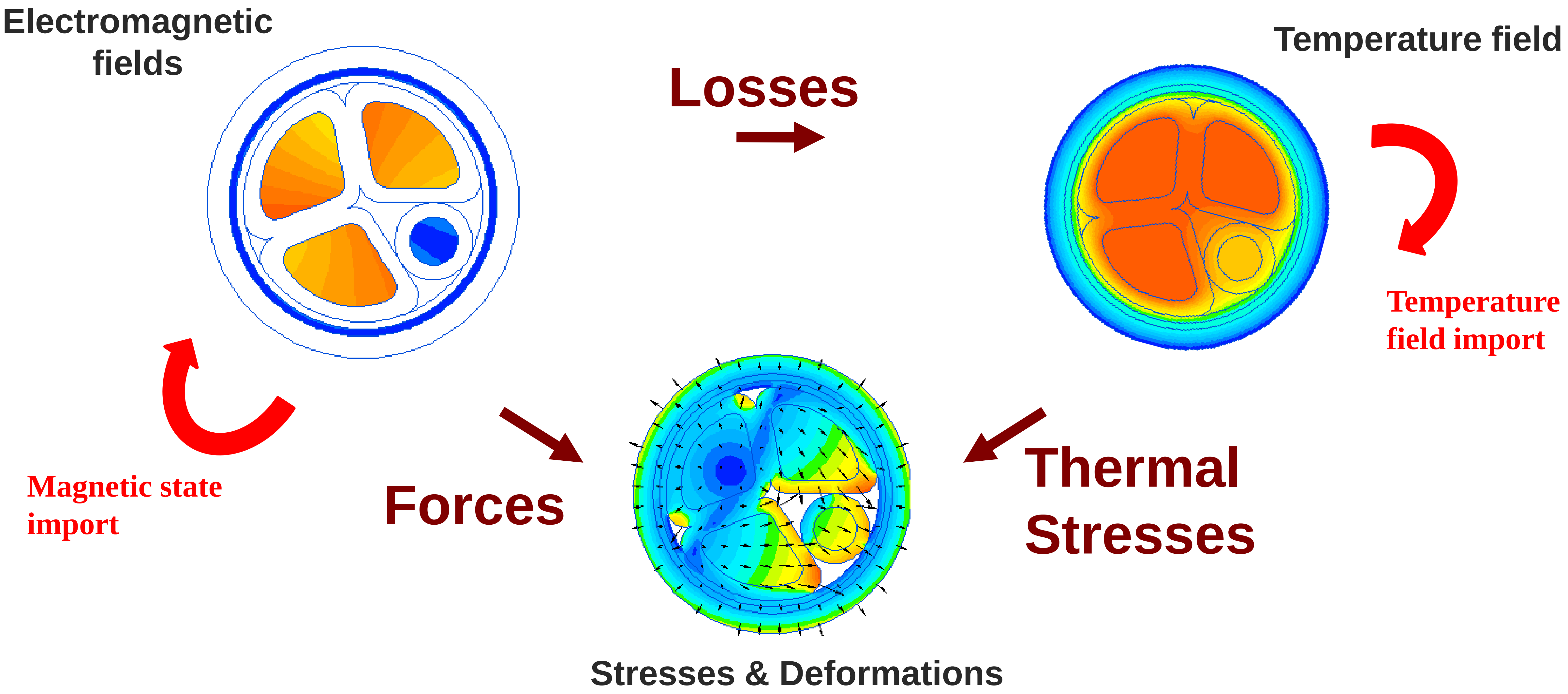
https://quickfield.com/seminar/seminar_film_heaters.htm

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

MultiPhysics (2D)



https://quickfield.com/coupling.htm

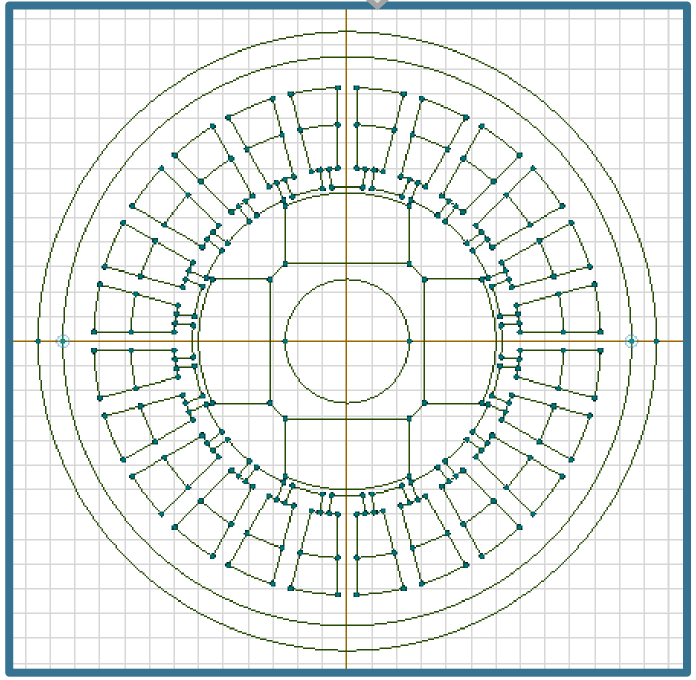
MultiPhysics (2D)

	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

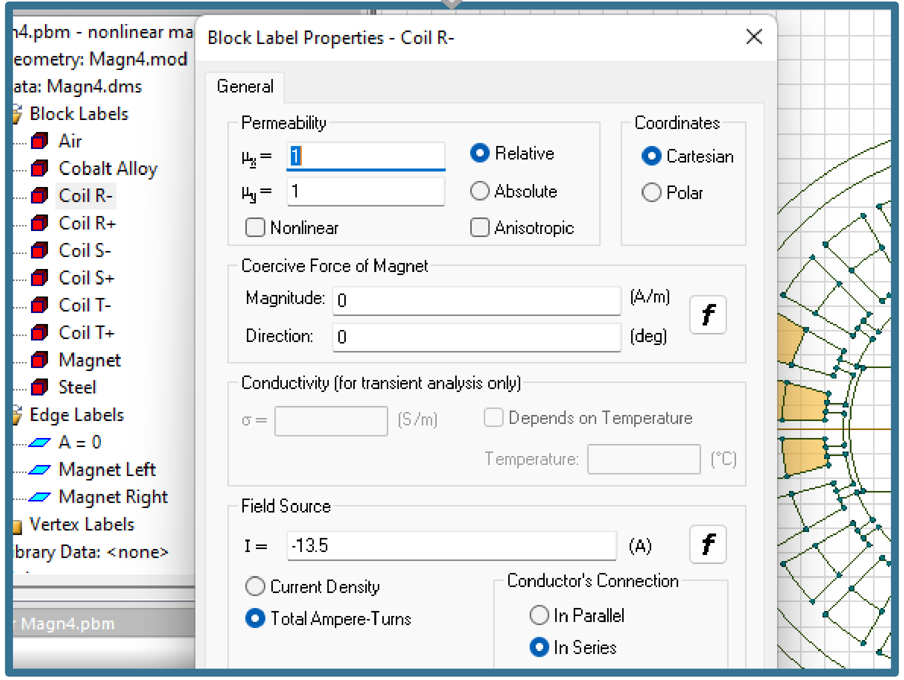
https://quickfield.com/coupling.htm

QuickField Workflow

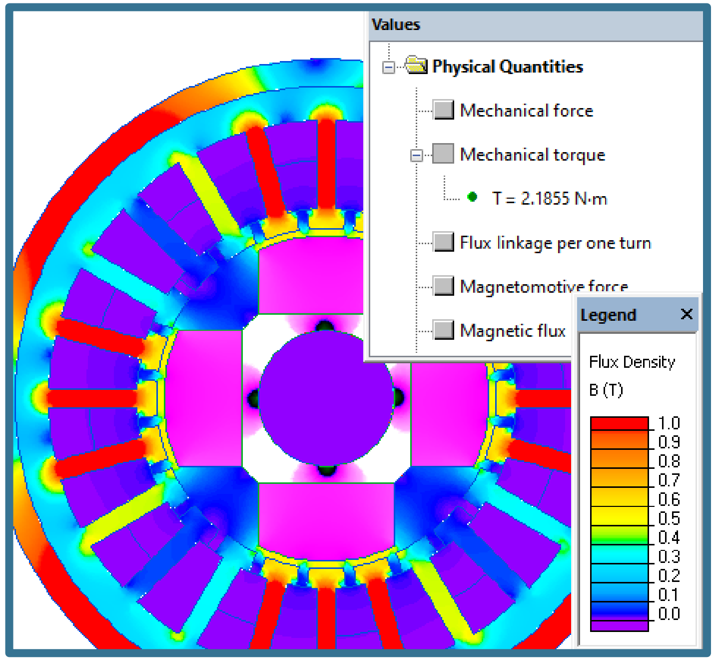
Problem setup



Model editor

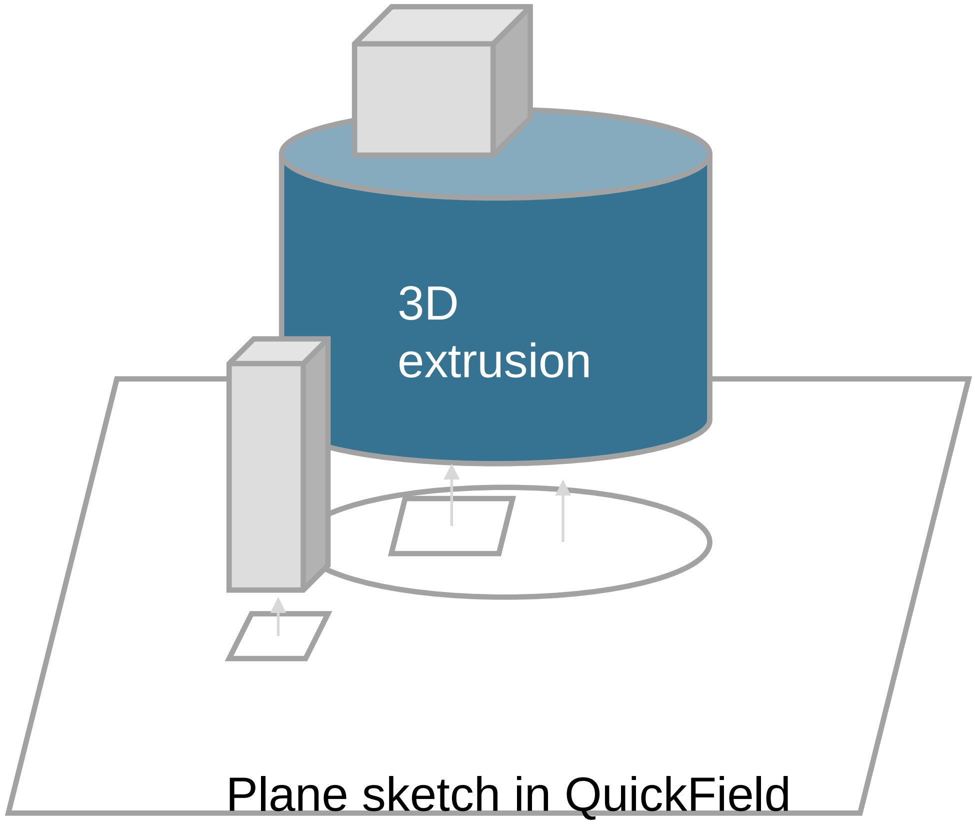


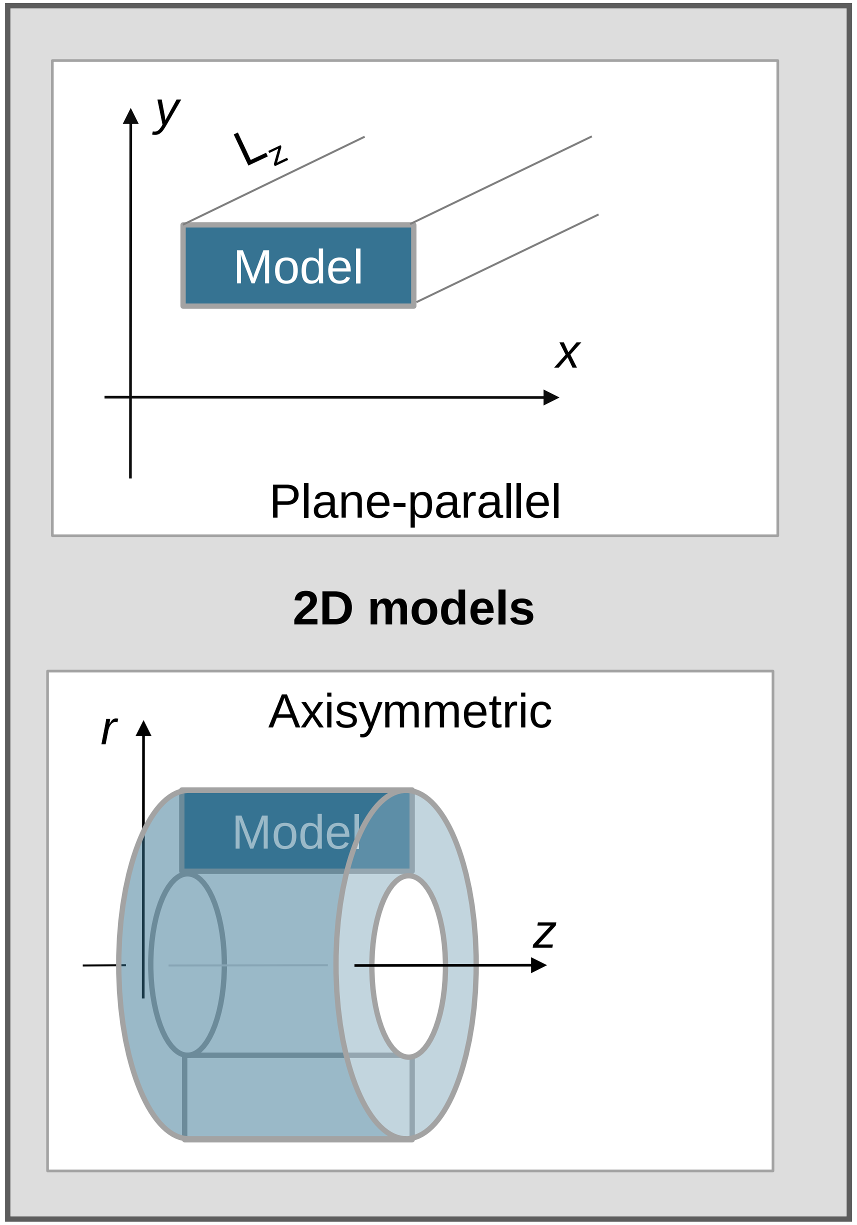
Material physical properties, field sources and boundary conditions

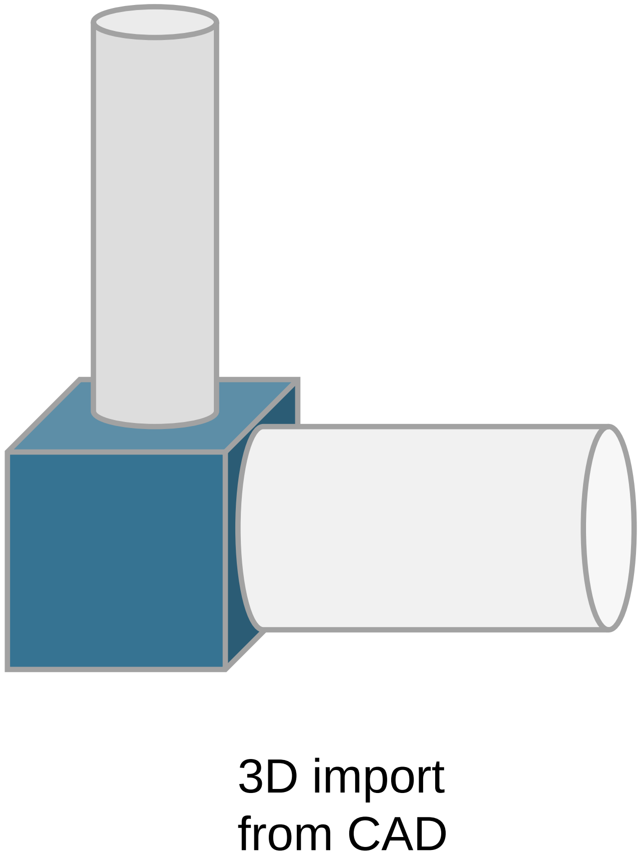


Results analysis

QuickField model class

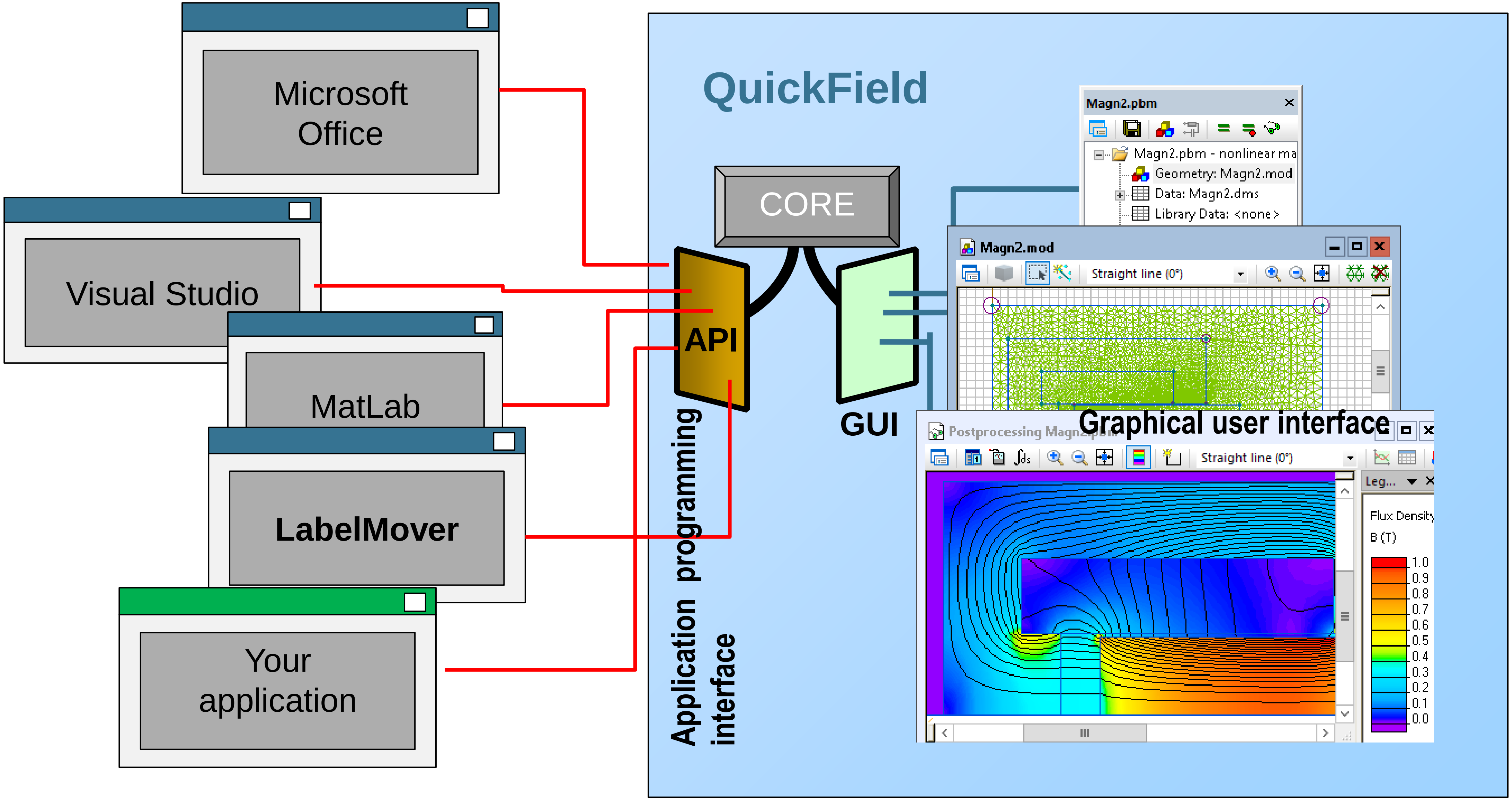






https://quickfield.com/prep.htm

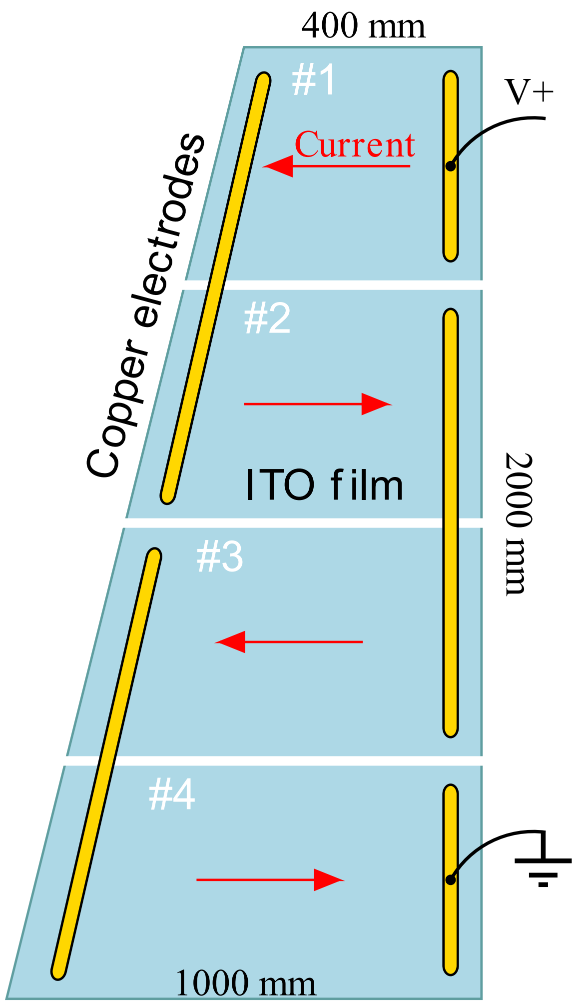
QuickField API



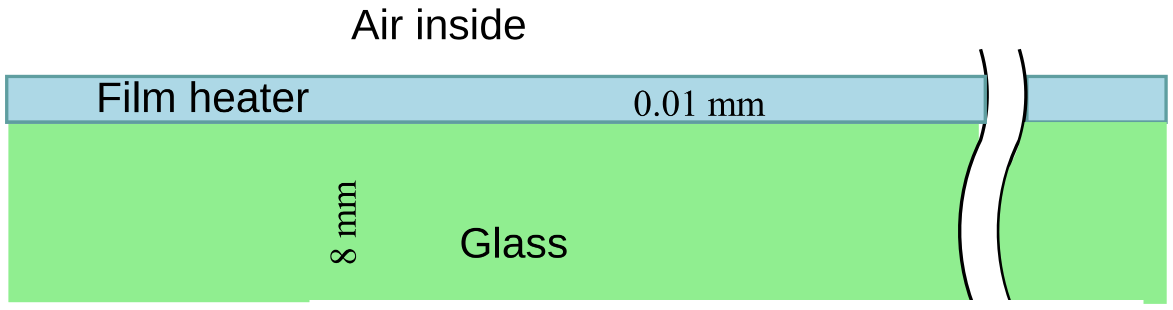
https://quickfield.com/programming.htm

QuickField Difference

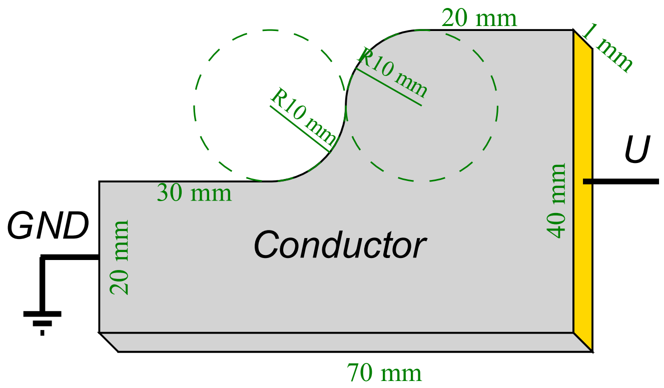
Film heaters modelling with QuickField



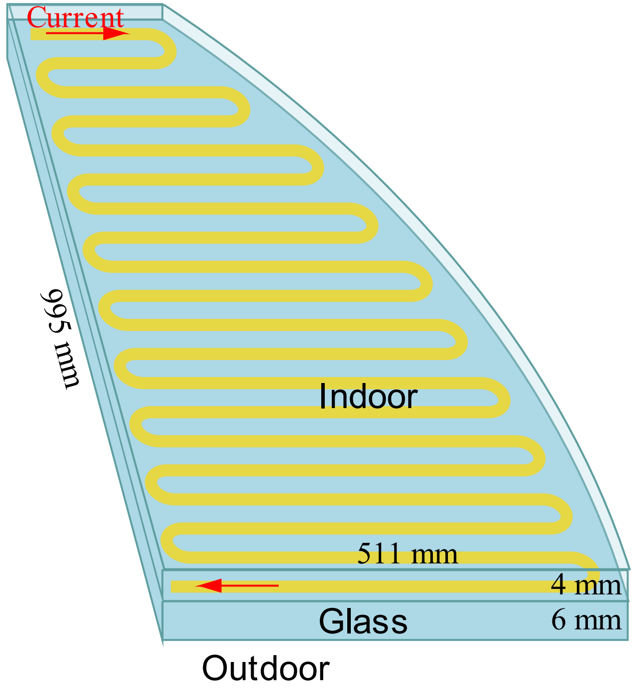
Electric heating film for glass



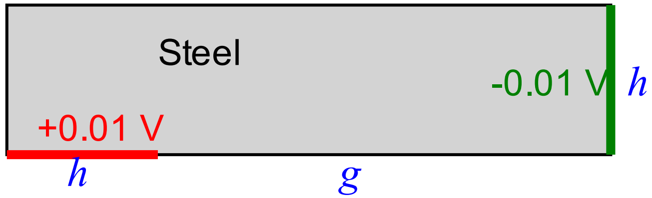
Glass film heater



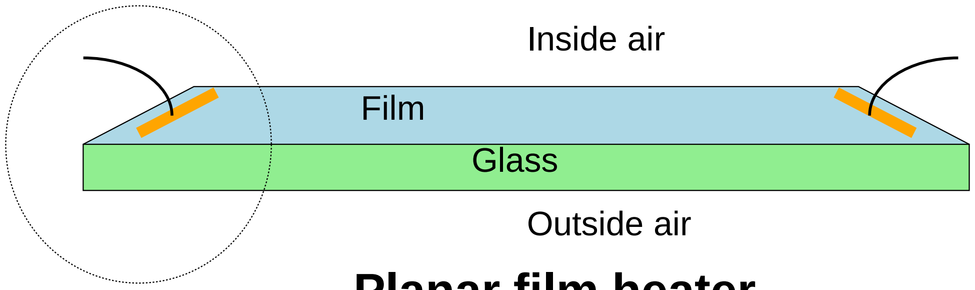
Temperature distribution in the conducting film



Planar heater 3D



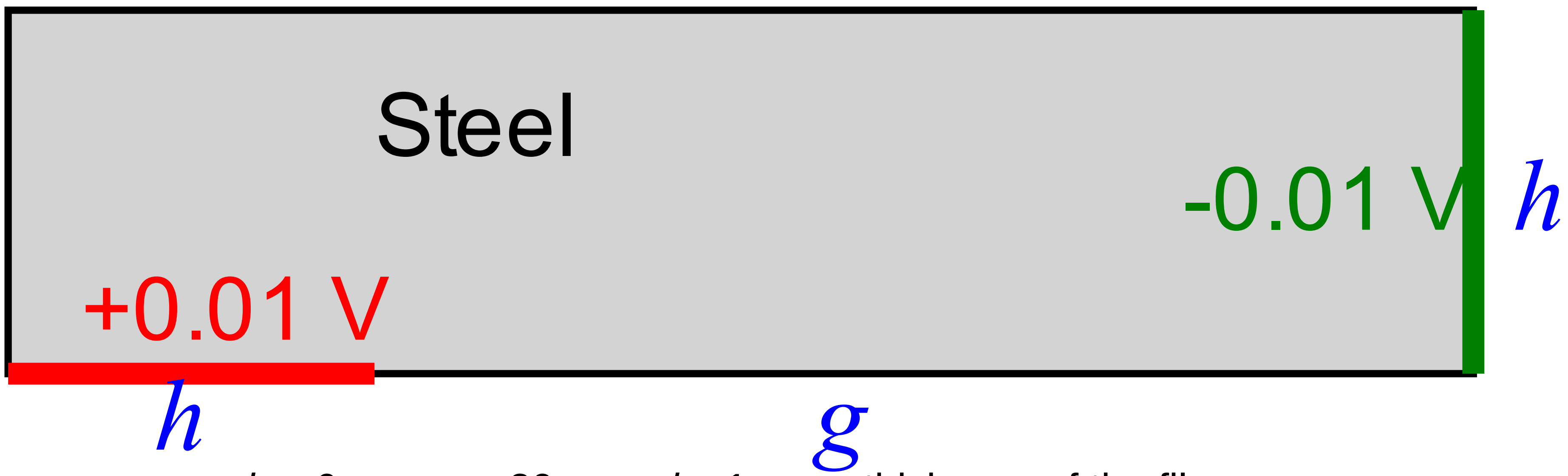
Thin film resistance



Planar film heater

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

Thin film resistance



h = 6 mm, *g* = 20 mm, *d* = 1 mm - thickness of the film

Resistance = (*g*/*h* + 0.469) / (γ·*d*)

Roland Schinzinger, Patricio A. A. Laura Conformal Mapping: Methods and Applications, 1991, Elsevier Science Publishers, B.V., p. 224.

Problem specification:

Voltage applied *U* = 0.02 V;

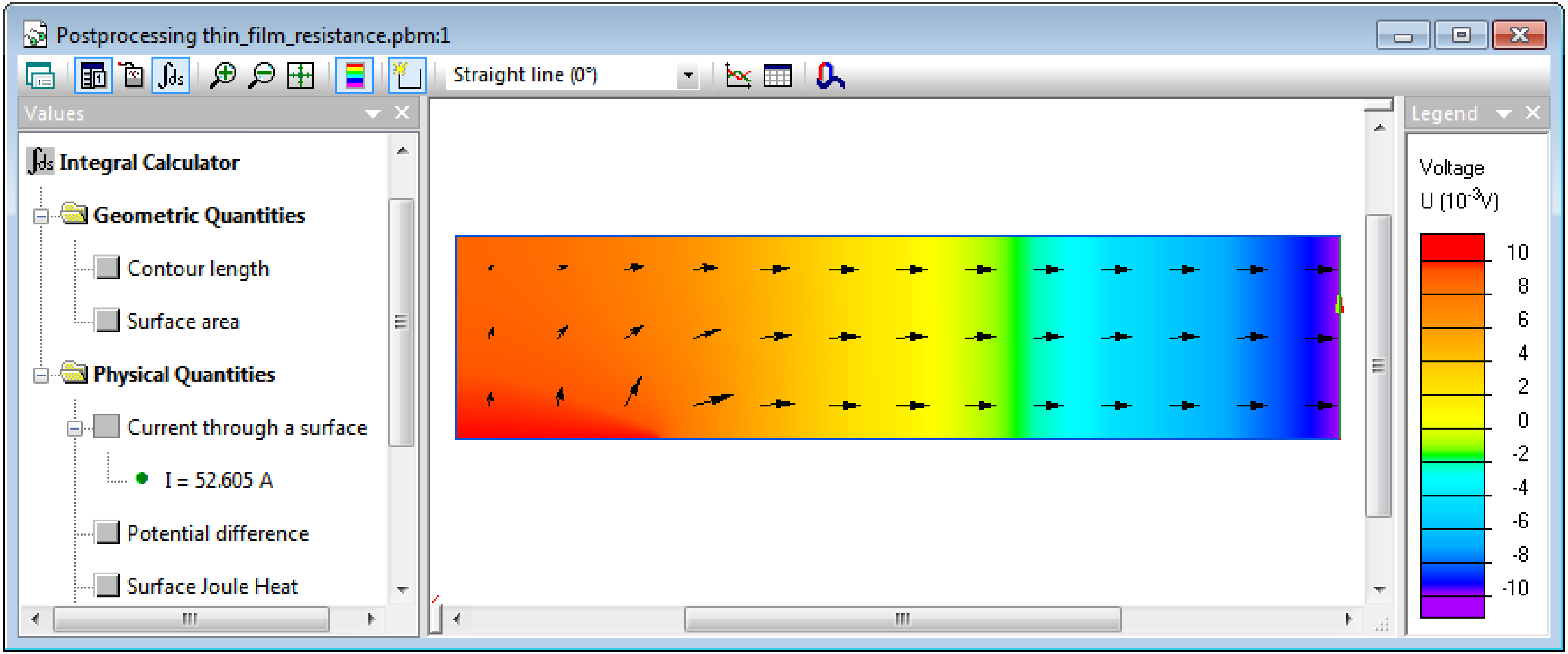
Electrical conductivity γ =10 MS/m;

Task:

Calculate the electrical resistance of the film and compare with the analytical result.

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

Thin film resistance

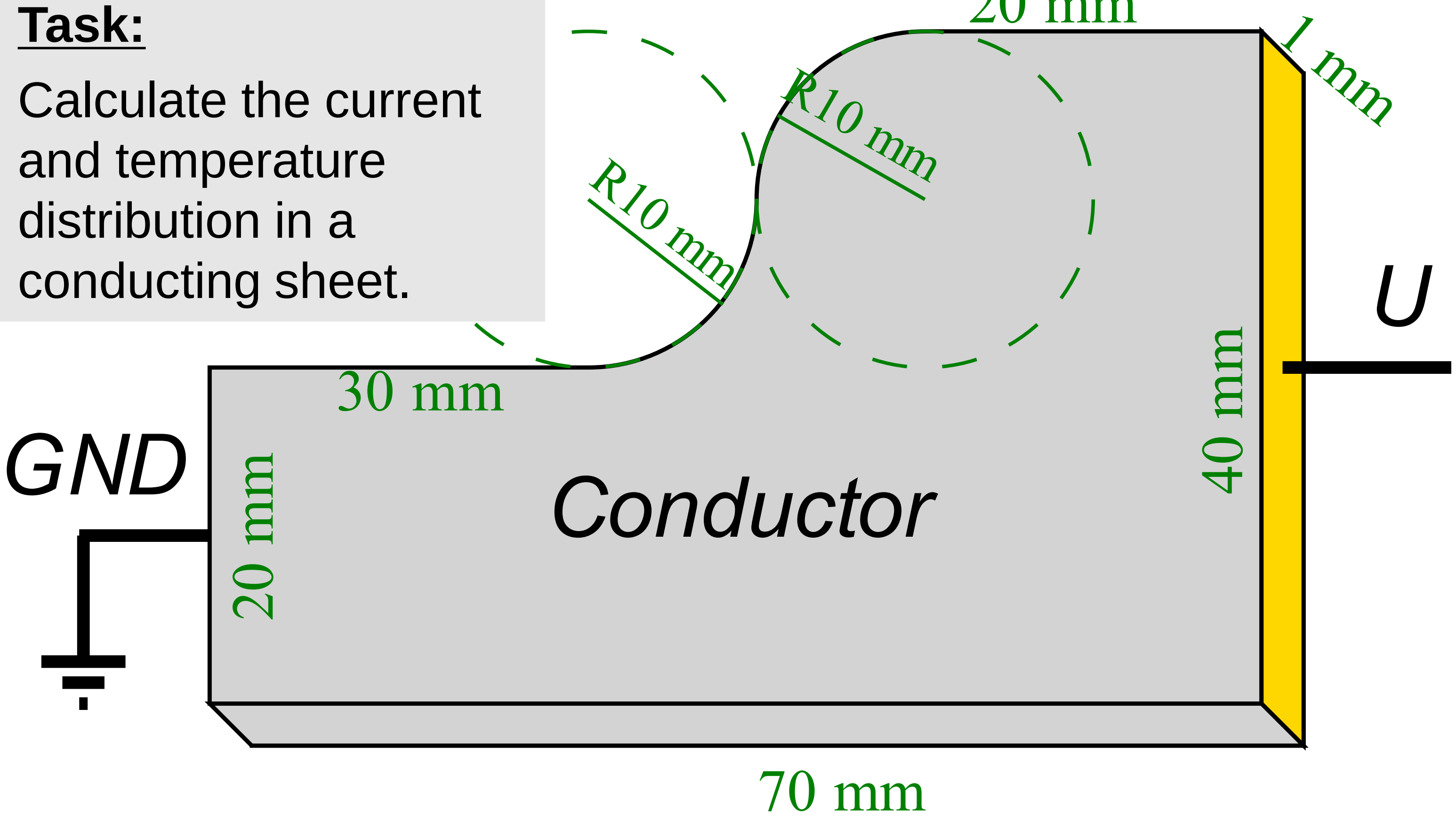


https://quickfield.com/advanced/thin_film_resistance.htm

Temperature distribution in the conducting sheet

Task:

Calculate the current and temperature distribution in a conducting sheet.



Problem specification:

Voltage applied *U* = 0.02 V;

Electrical conductivity 1 MS/m;
Thermal conductivity 50 W/K-m.

Convection coefficient 10 W/K-m²;
Ambient air temperature 0°C.

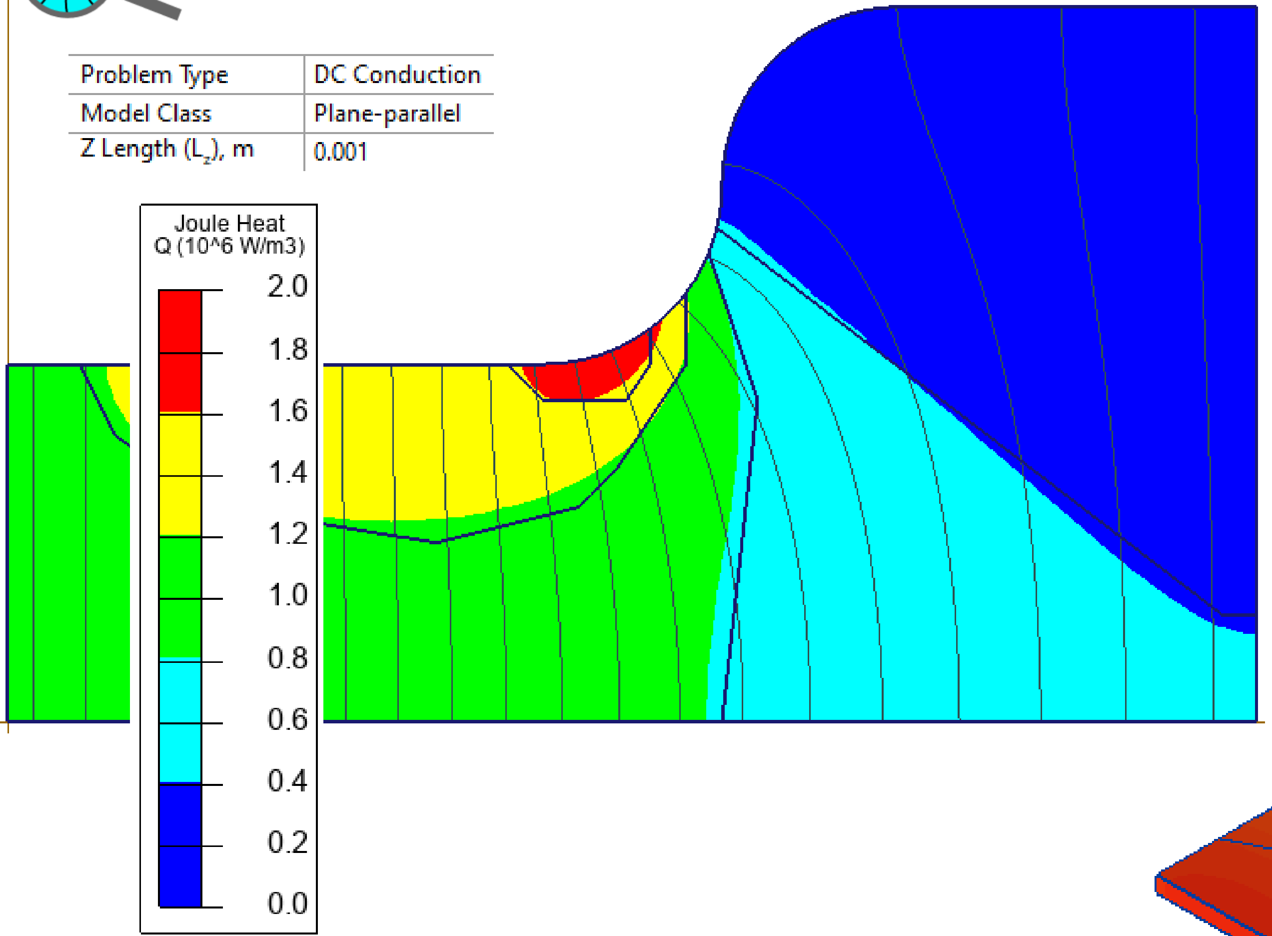
Joule heat power distribution

DC Conduction > 3D Steady-state Heat transfer

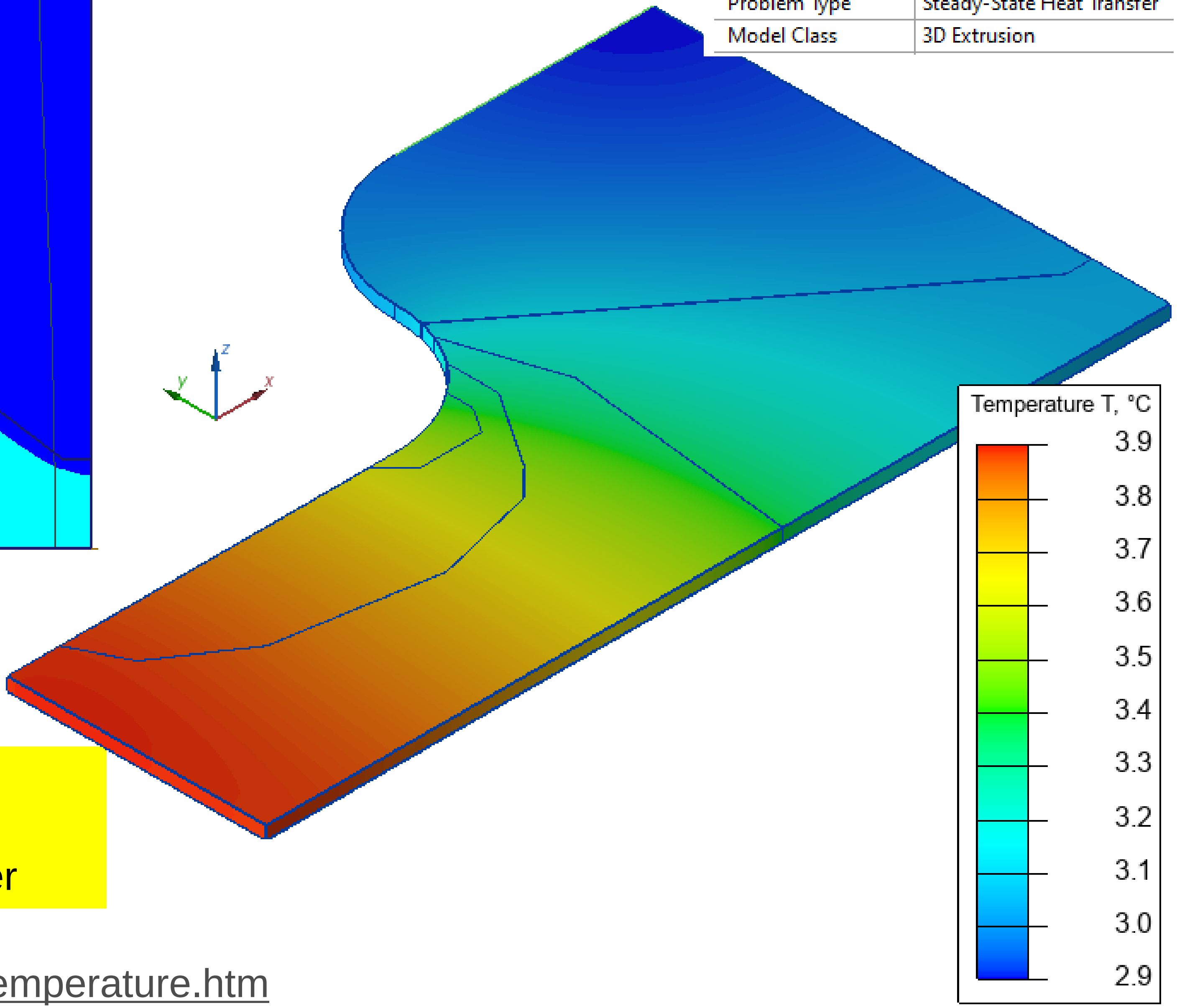
https://quickfield.com/advanced/conducting_sheet_temperature.htm

Temperature distribution in the conducting sheet

Problem Type	DC Conduction
Model Class	Plane-parallel
Z Length (L_z), m	0.001



Problem Type	Steady-State Heat Transfer
Model Class	3D Extrusion

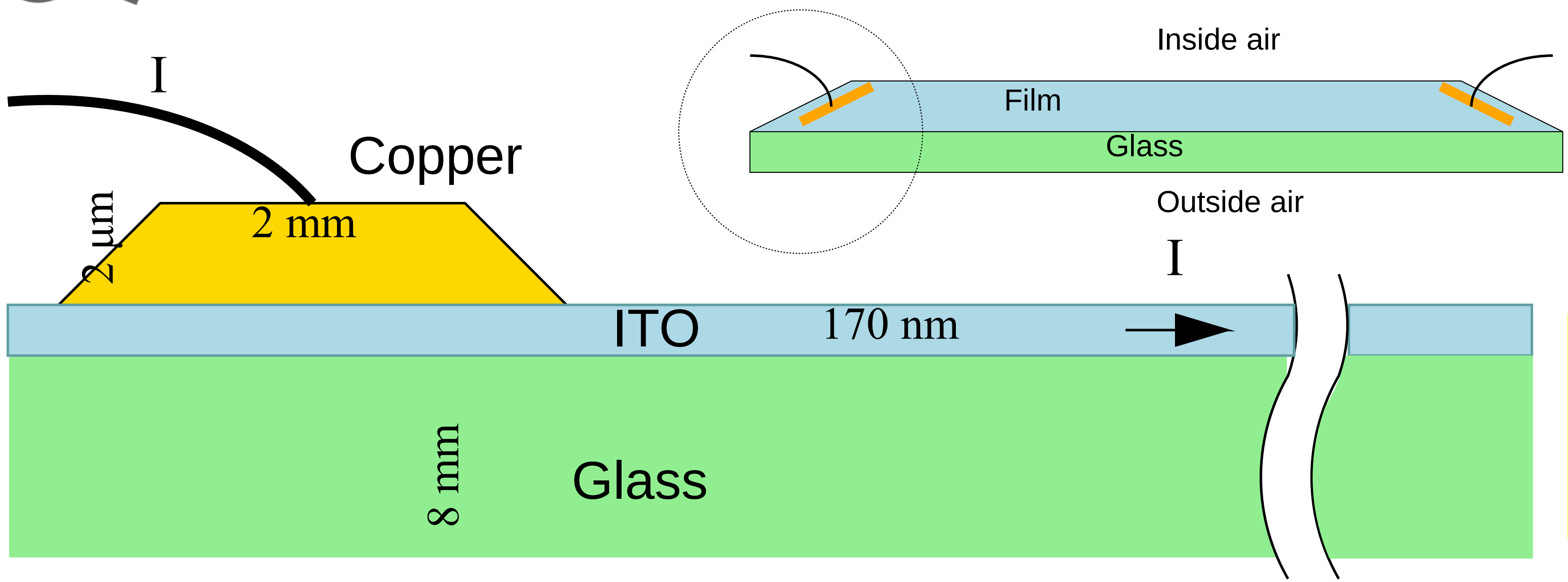


Joule heat power distribution

DC Conduction > 3D Steady-state heat transfer

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

Planar film heater



Task:

Calculate the heater power and the glass temperature.

Joule heat power distribution

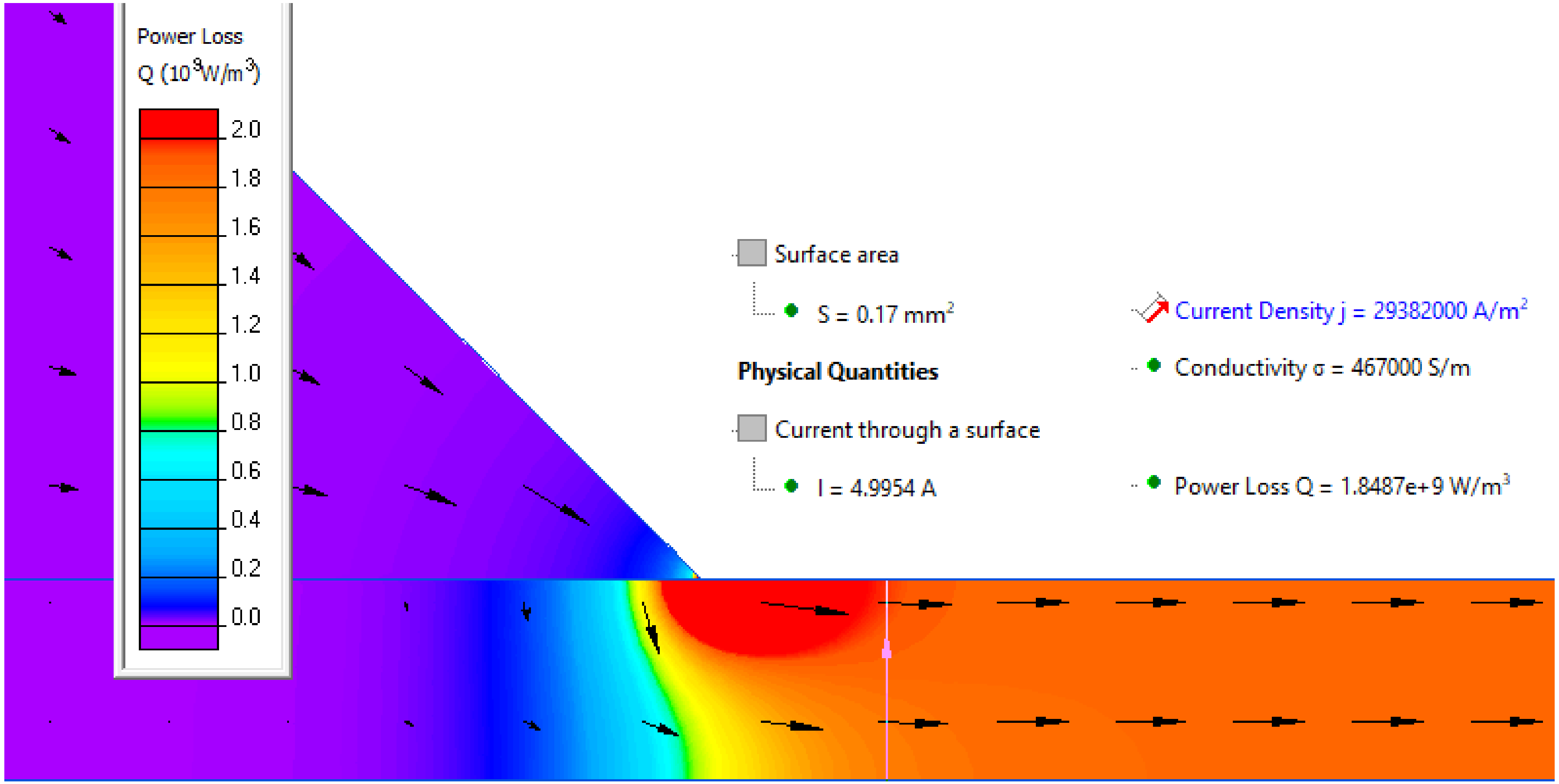
DC Conduction >
Steady-state heat transfer

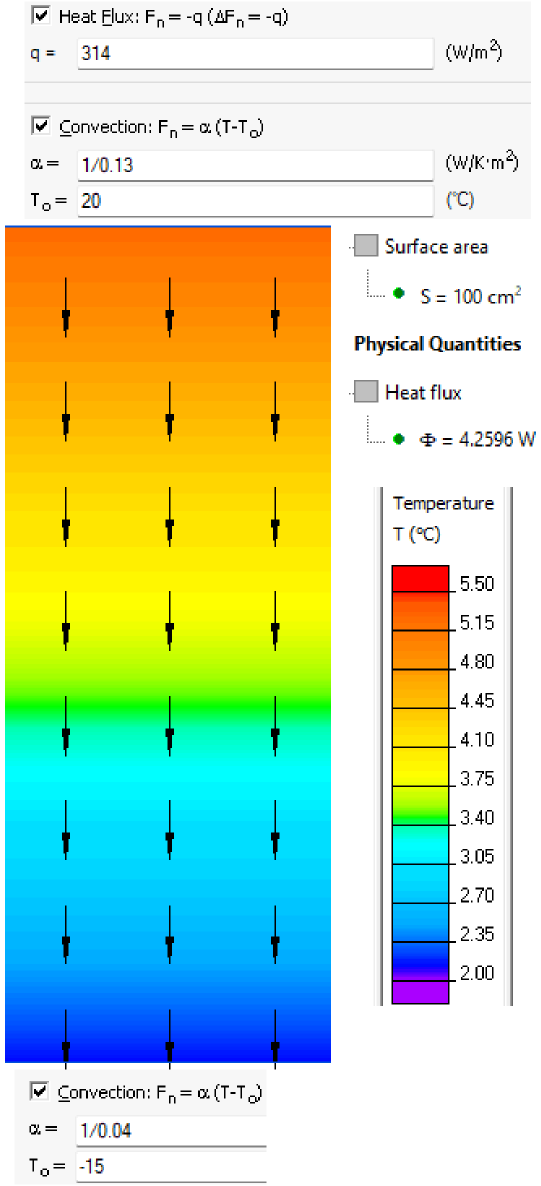
Problem specification:

Indium tin oxide film sheer resistance R_s = 12.6 Ohm/sq.
Electrical conductivity of copper 56 MS/m.
Electric current I = 5 A.
Thermal conductivity of glass 1 W/m · K.
Inside air temperature +20°C, convection coefficient 1/0.13 W/(K·m²)
Outside air temperature -15°C, convection coefficient 1/0.04 W/(K·m²)

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

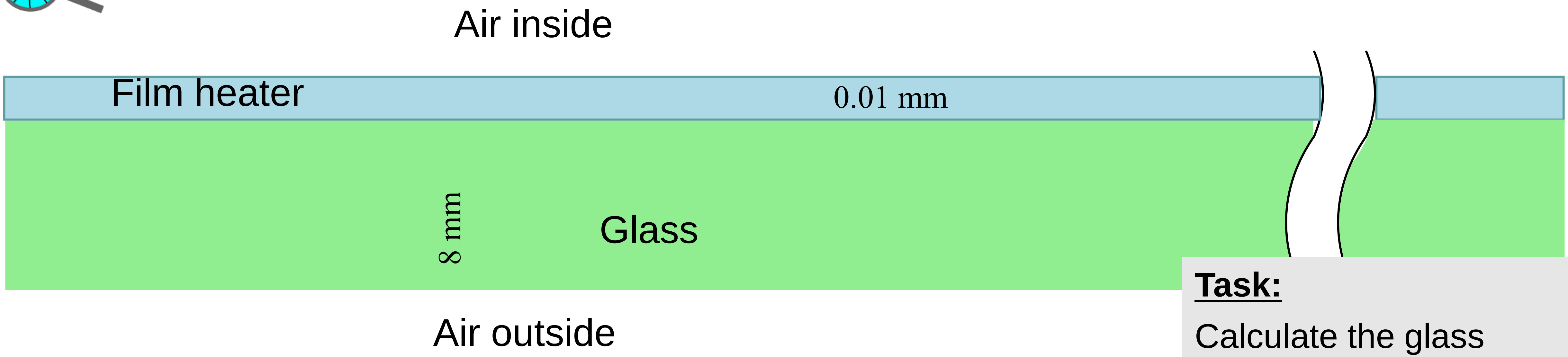
Planar film heater





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

Glass film heater



Task:

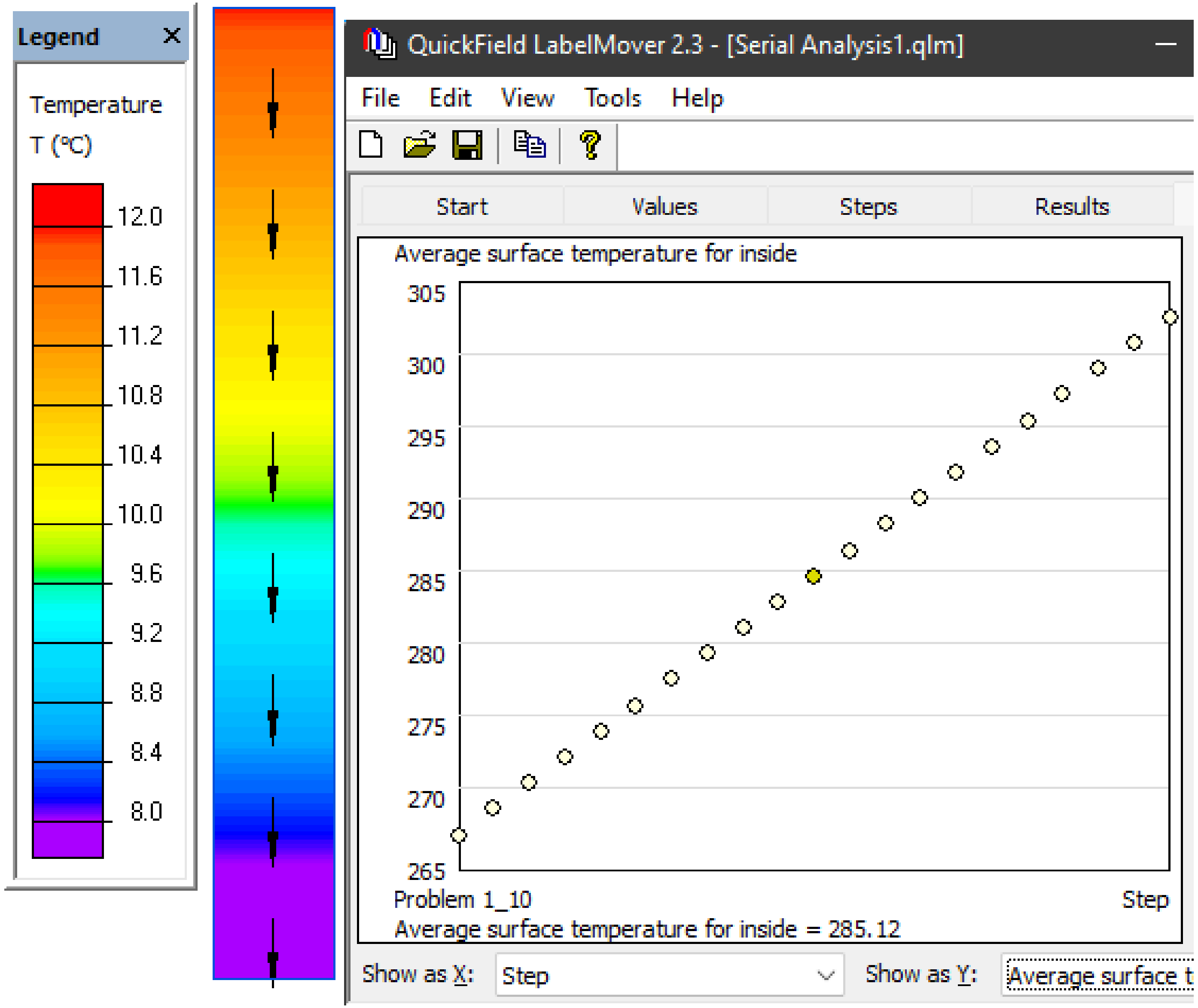
Calculate the glass temperature as a function of the heater power *q*.

Problem specification:

Film heat power q = 0..1000 W/m².
Thermal conductivity: glass 1 W/m*K, film 4 W/m*K.
Inside air temperature +20°C, surface resistance 0.13 K·m²/W.
Outside air temperature -15°C, surface resistance 0.04 K·m²/W.

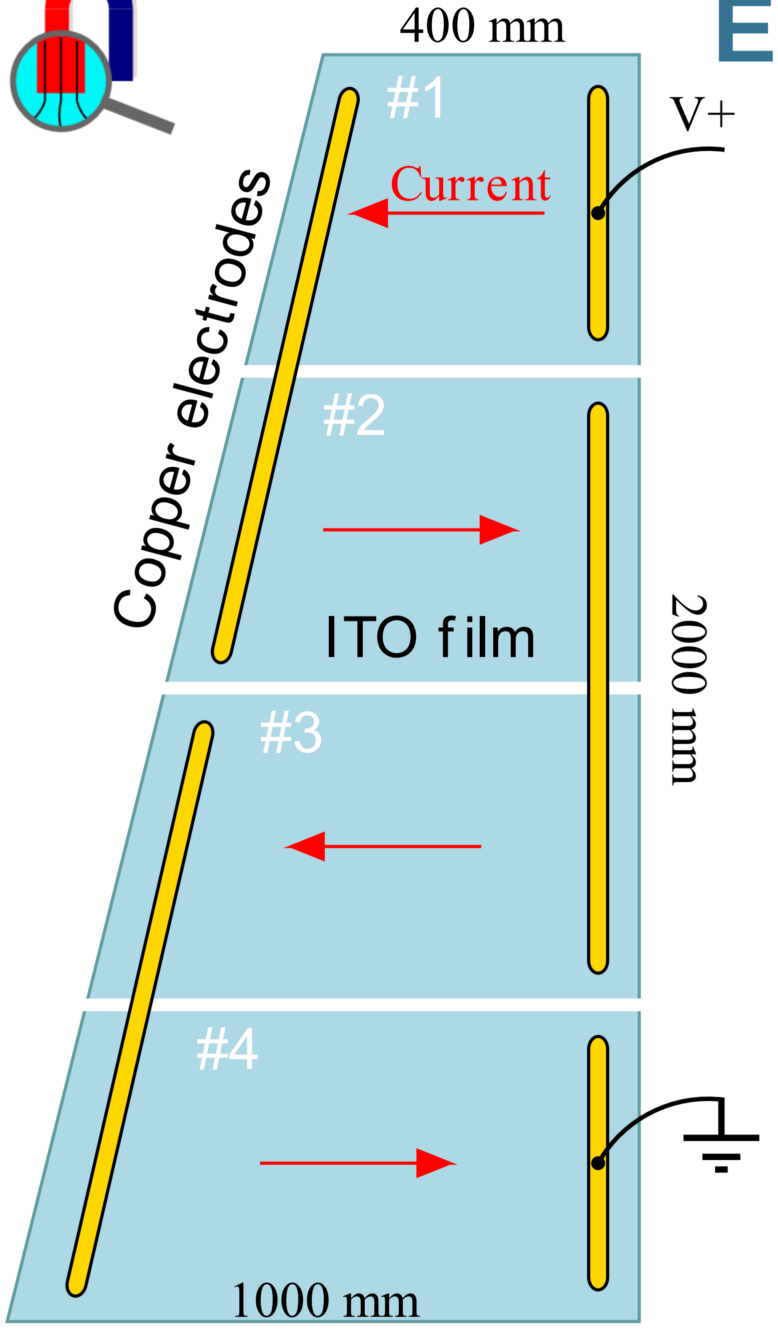
https://quickfield.com/advanced/glass_film_heater.htm

Glass film heater



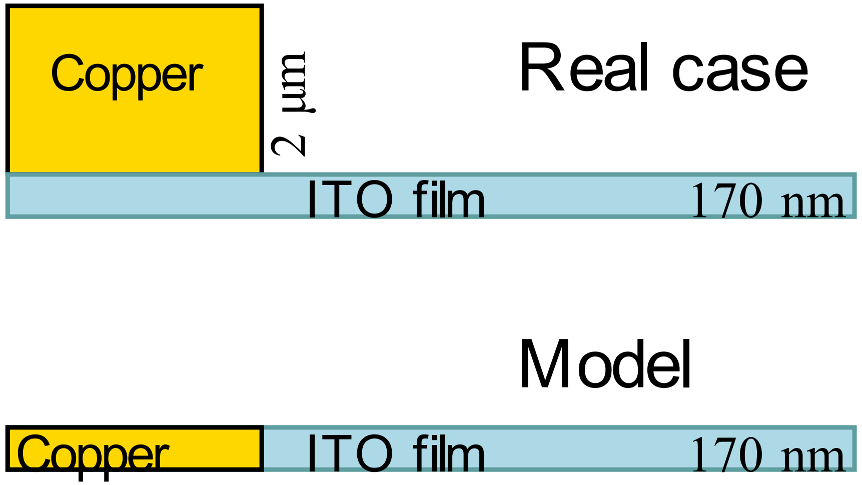
https://quickfield.com/advanced/glass_film_heater.htm

Electric heating film for glass



Problem specification:

Indium tin oxide film sheet resistance R_s = 12.6 Ω/sq.
Copper electrode electric conductivity σ = 56 MS/m.
Voltage $V+$ = 220 V.

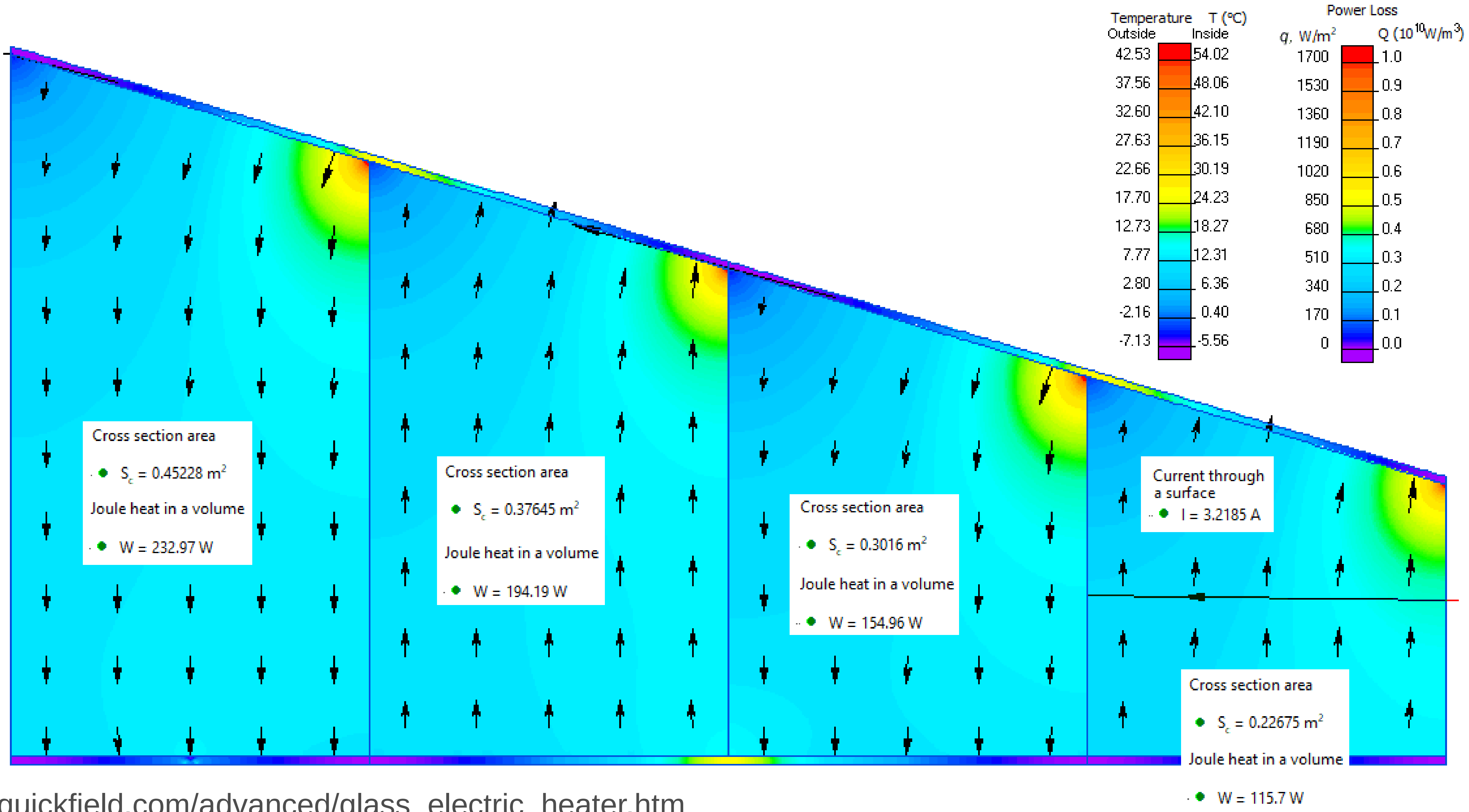


Task:

Calculate the current and the Joule heat power.

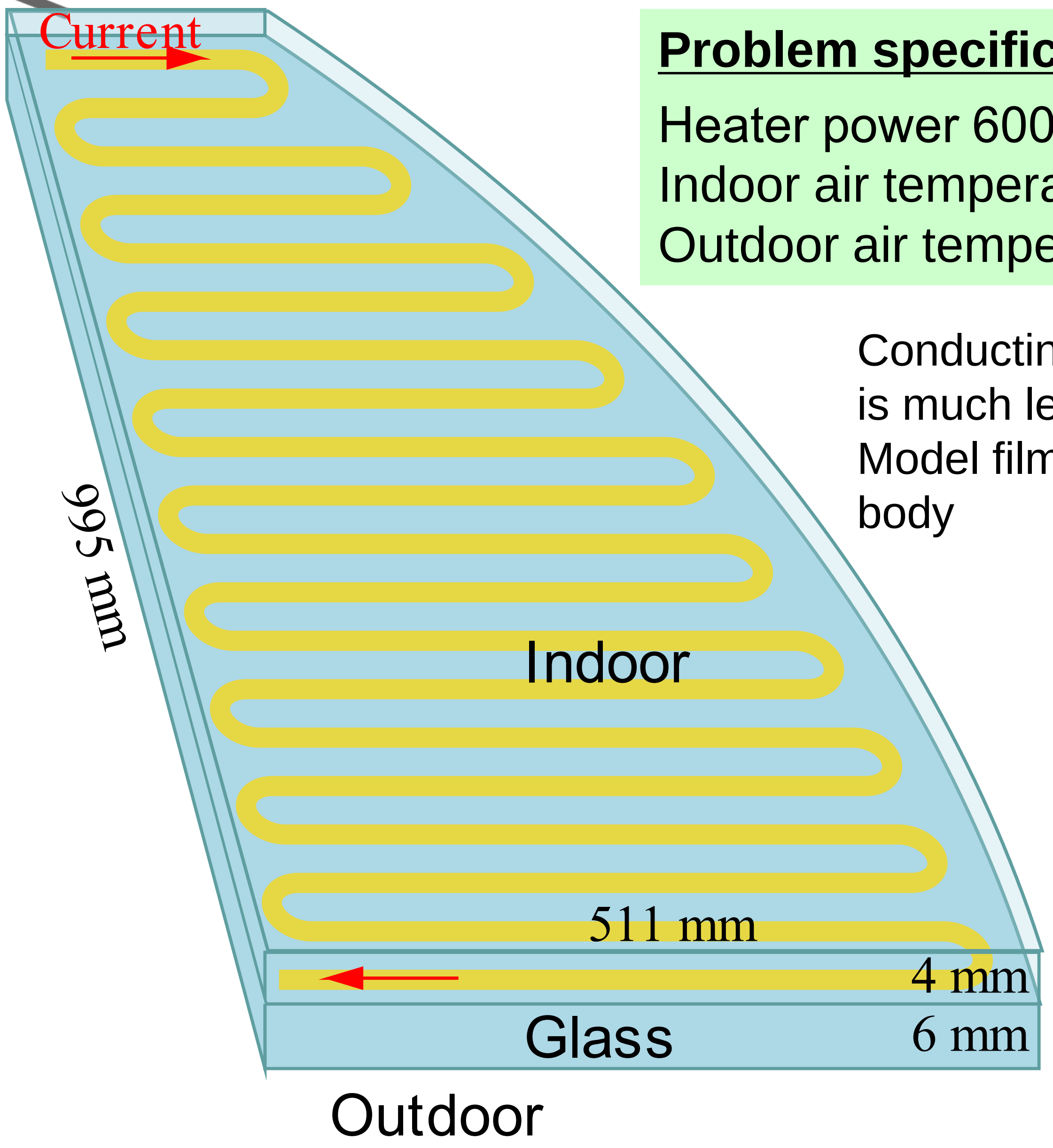
https://quickfield.com/advanced/glass_electric_heater.htm

Electric heating film for glass



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

Planar heater 3D



Problem specification:

Heater power 600 W/m². (per conductor surface)
Indoor air temperature is +20°C, convection coefficient is 8 W/m²*K.
Outdoor air temperature is -15°C, convection coefficient is 23 W/m²*K.

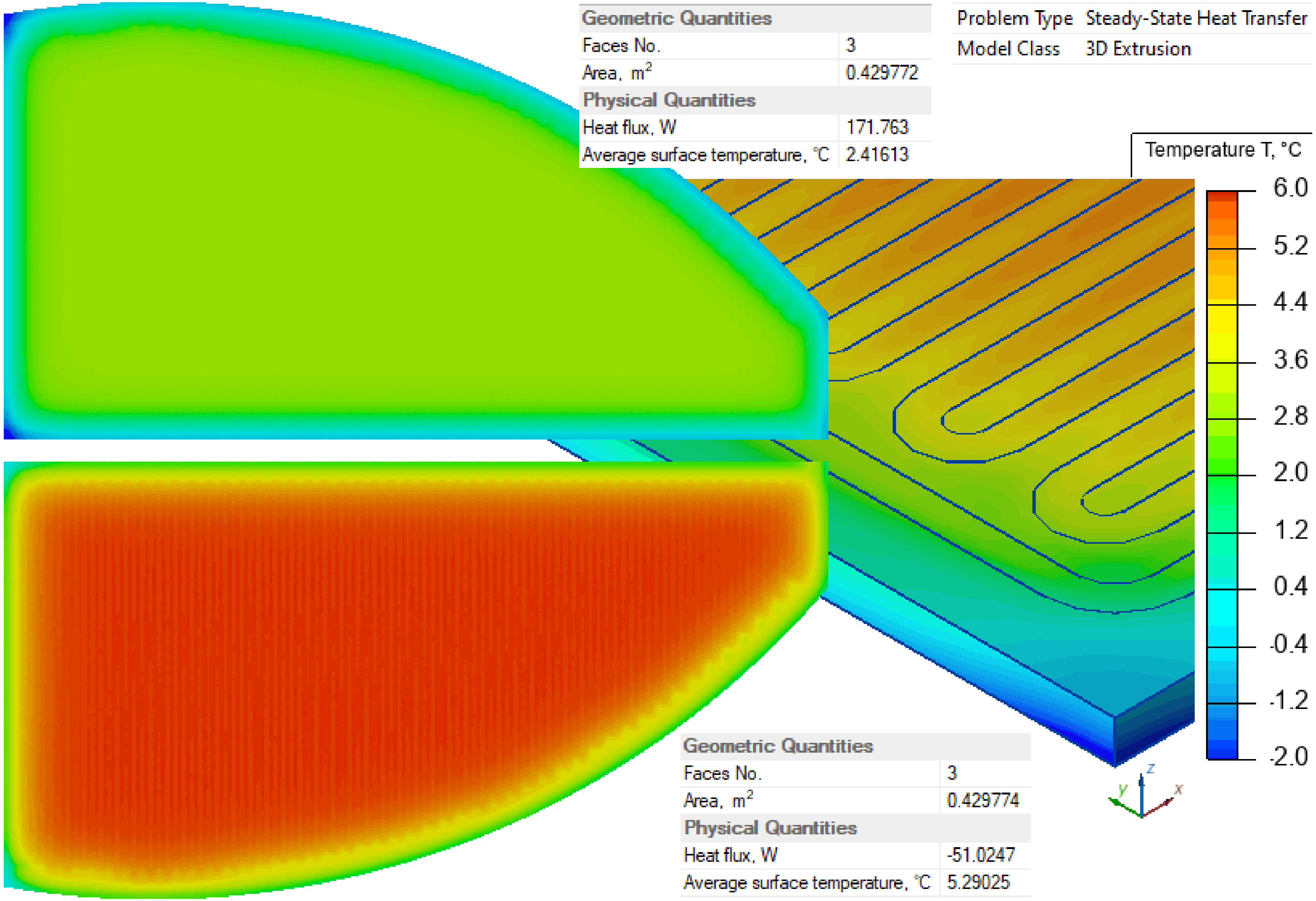
Conducting film thickness (~0.01 mm) is much less than that of the glass. Model film as a surface, not as a body

Task:

Calculate temperature distribution in the glass.

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

Planar heater 3D



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

This recording is over

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