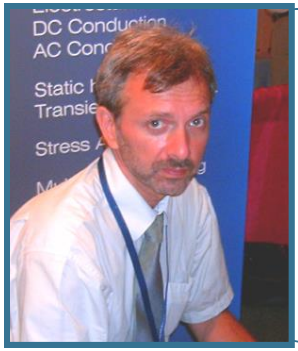
# Microelectromechanical systems simulation with QuickField



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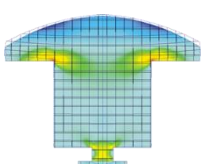
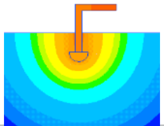
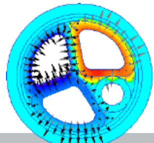
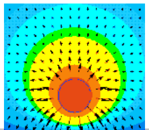
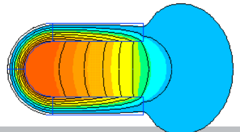
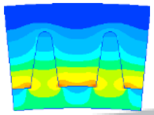
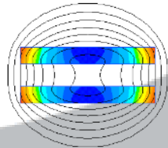
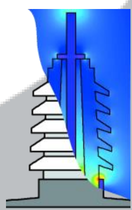
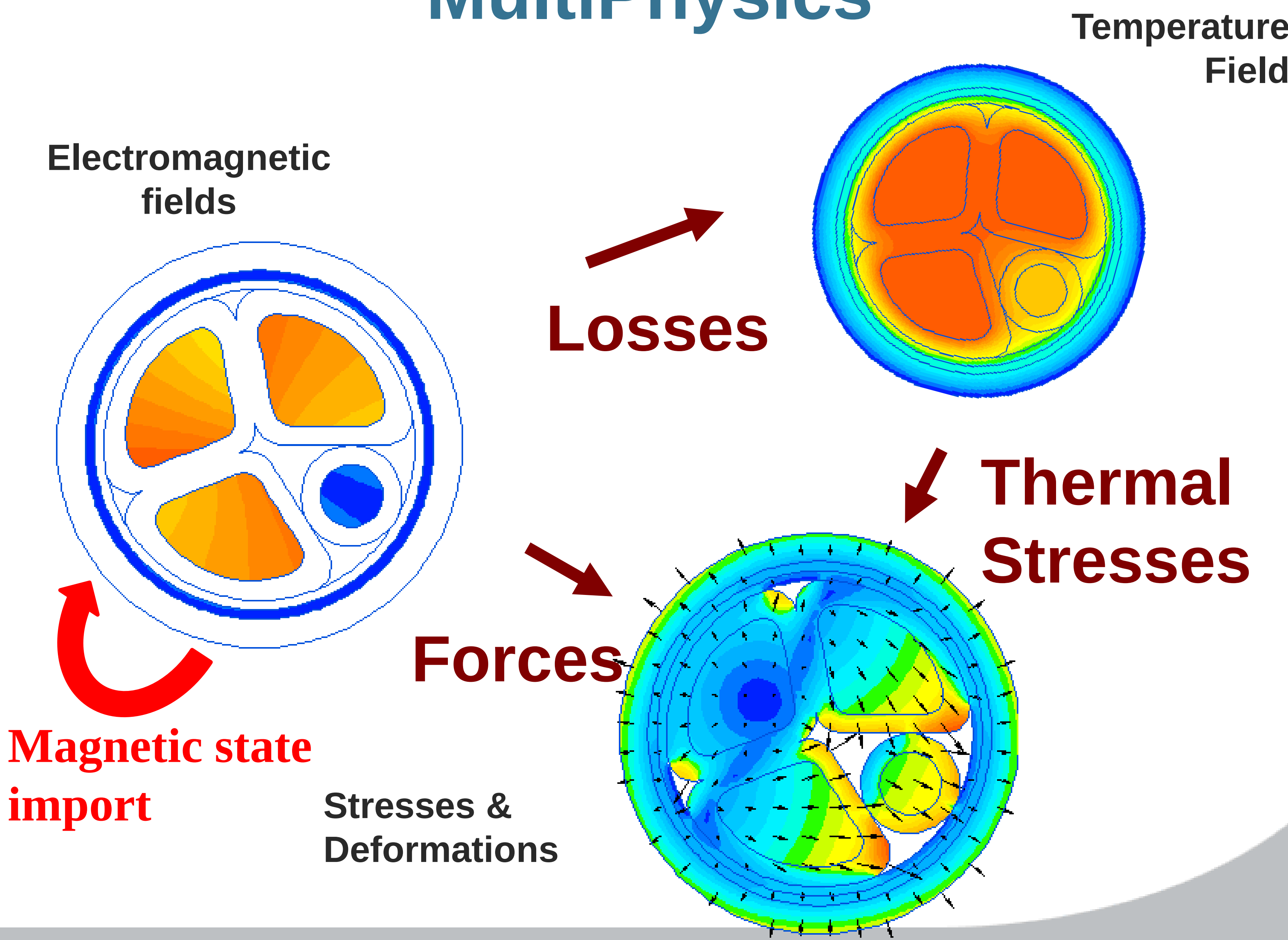
**Support Engineer**
**Tera Analysis Ltd.**

# QuickField Analysis Options

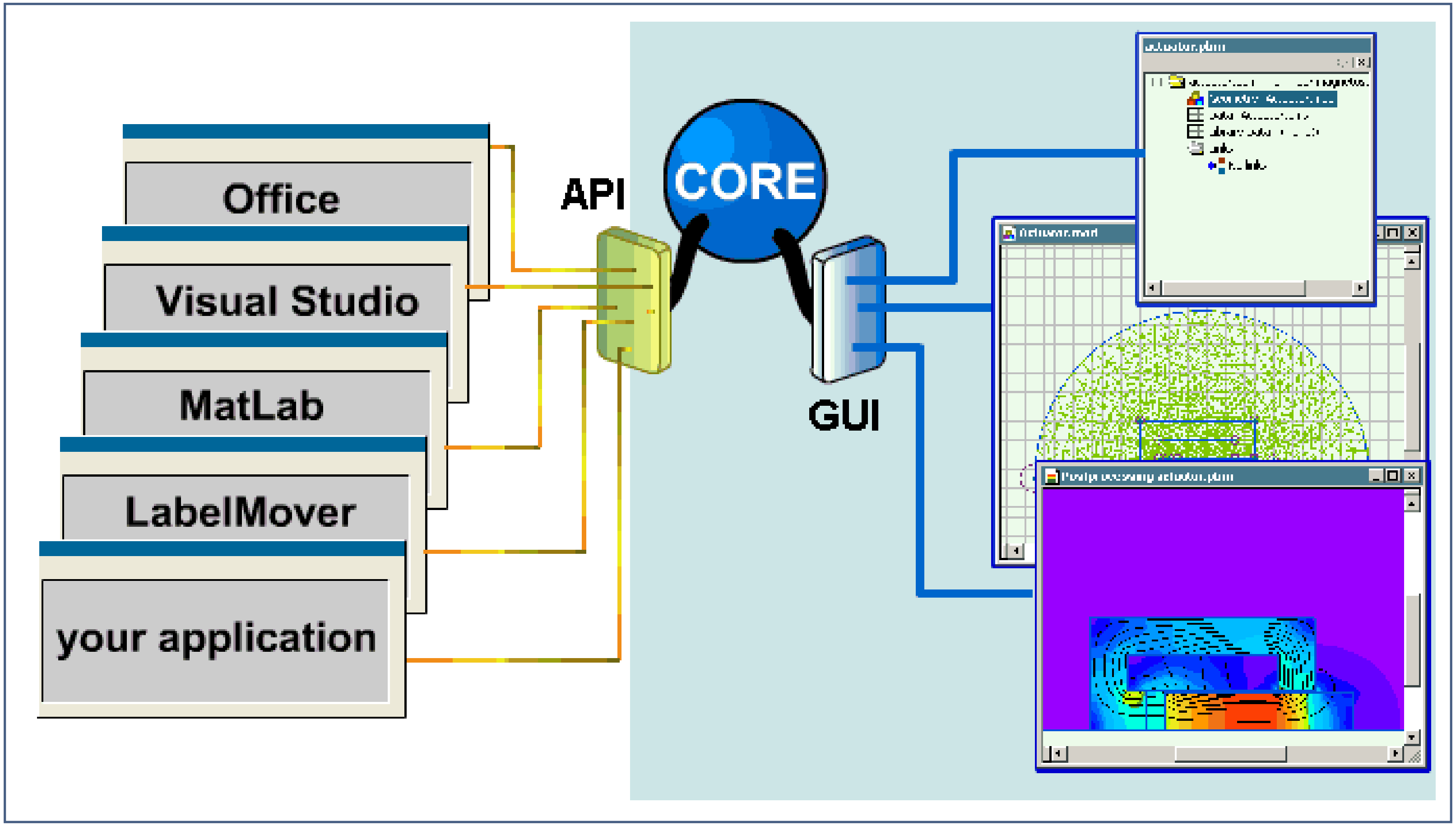
| | |
|---|---|
| **Magnetic analysis suite** | |
| Magnetic Problems | Magnetostatics |
| | AC Magnetics |
| | Transient Magnetic |
| **Electric analysis suite** | |
| Electric Problems | Electrostatics (2D,3D) and DC Conduction (2D,3D) |
| | AC Conduction |
| | Transient Electric field |
| **Thermostructural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

# MultiPhysics



# Open object interface

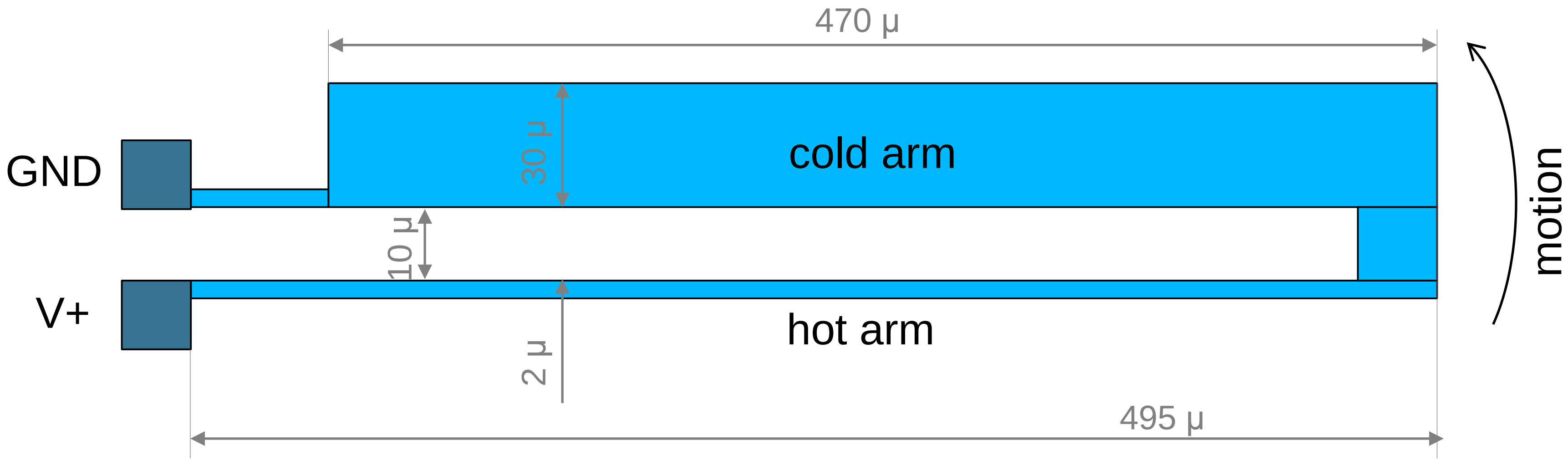


# QuickField Difference

# Microelectromechanical systems simulation with QuickField

1. Thermal actuator
2. Electric comb-drive resonator
3. Mechanical stress sensor

# Thermal actuator




**Problem specification:**

Voltage applied V+ = 5 V
Resistivity: $2.3 \cdot 10^{-5}$ Ohm*m
Thermal conductivity: 150 W/(m*K)
Thermal expansion coefficient: $2.9 \cdot 10^{-6}$ 1/K
Young's modulus 169 GPa, Poisson's ratio 0.22

**Tasks:**

Calculate power, temperature, displacement.

Reference:
https://www.researchgate.net/publication/229047849_DESIGN_AND_INVESTIGATION_OF_A_THERMAL_ACTUATOR

# Thermal actuator

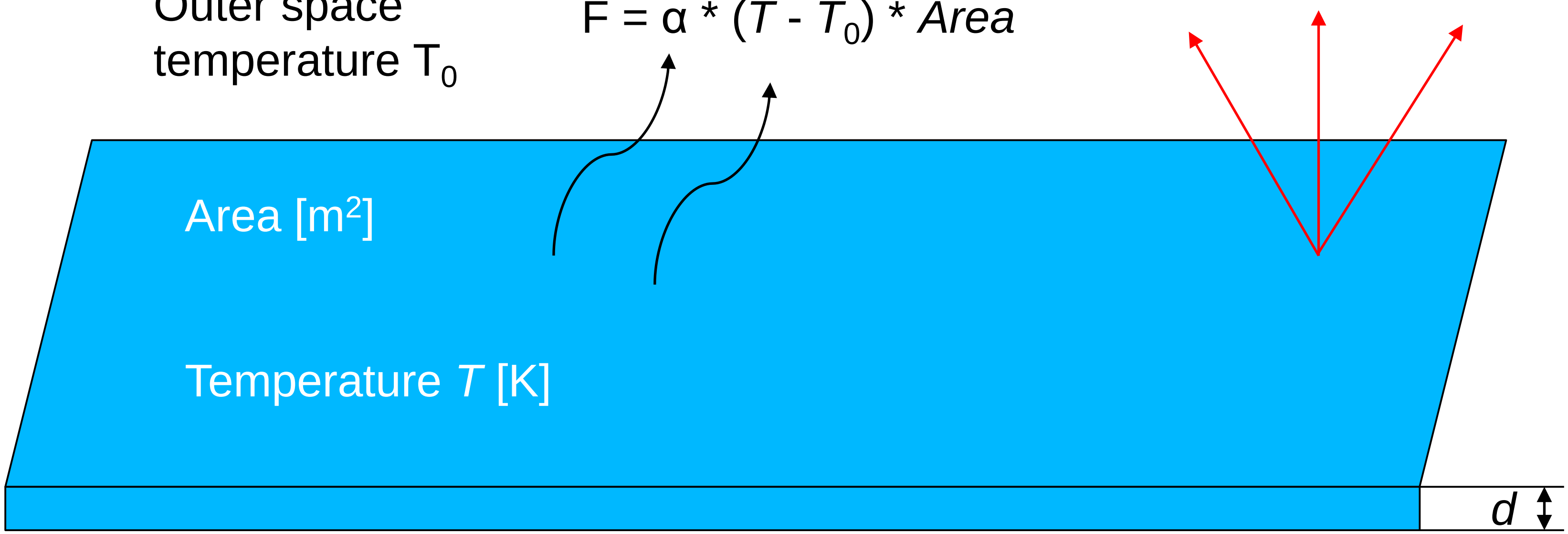
Radiation heat flux

$F = \beta * k_{SB} * (T^4 - T_0^4) * Area$

Convection heat flux

$F = \alpha * (T - T_0) * Area$

Outer space temperature $T_0$



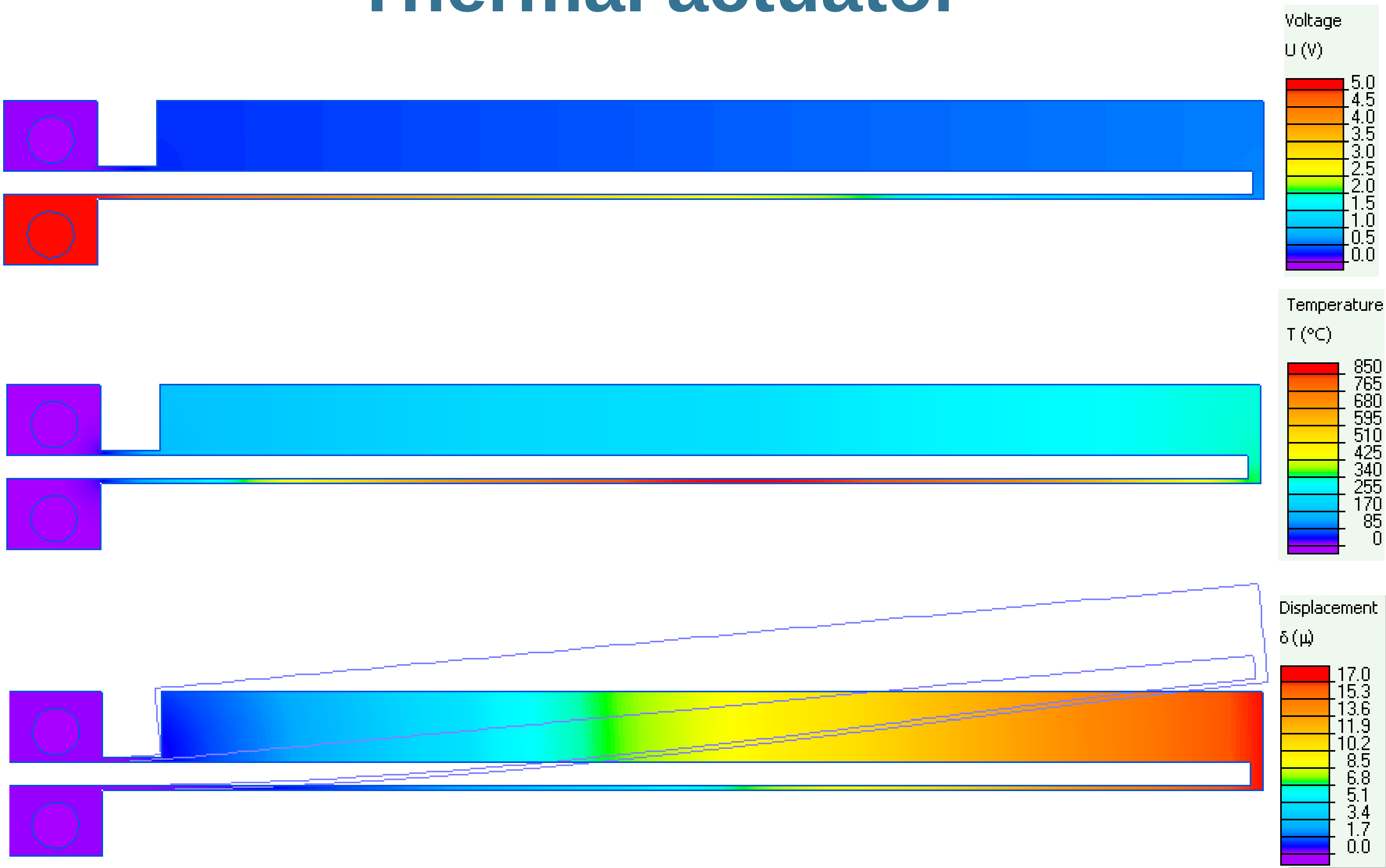

QuickField model - zero temperature drop along the plate thickness

*Volume heat source = Heat flux / Volume*

$= Heat\ flux / (Area * d)$

$= \alpha * (T - T_0) / d + \beta * k_{SB} * (T^4 - T_0^4) / d$

# Thermal actuator

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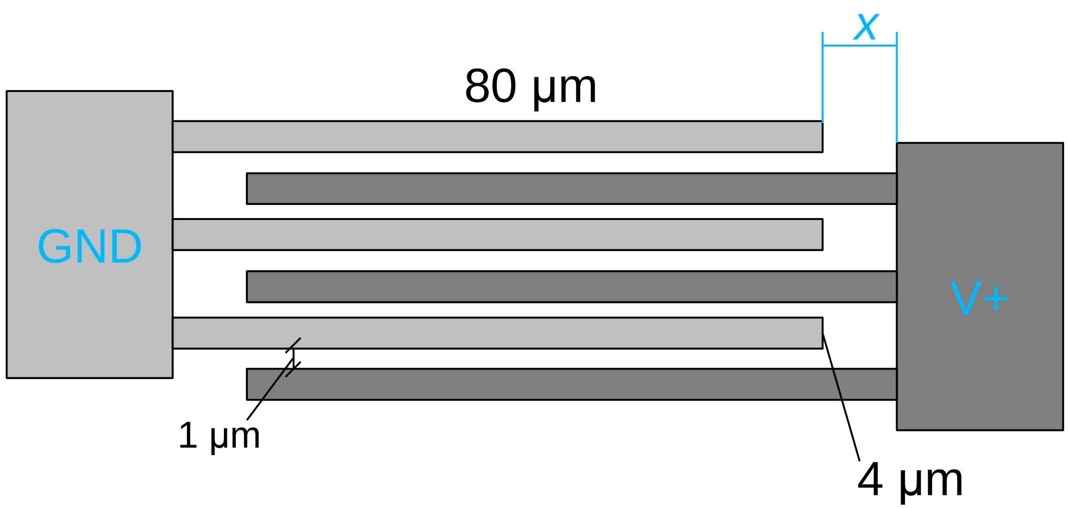
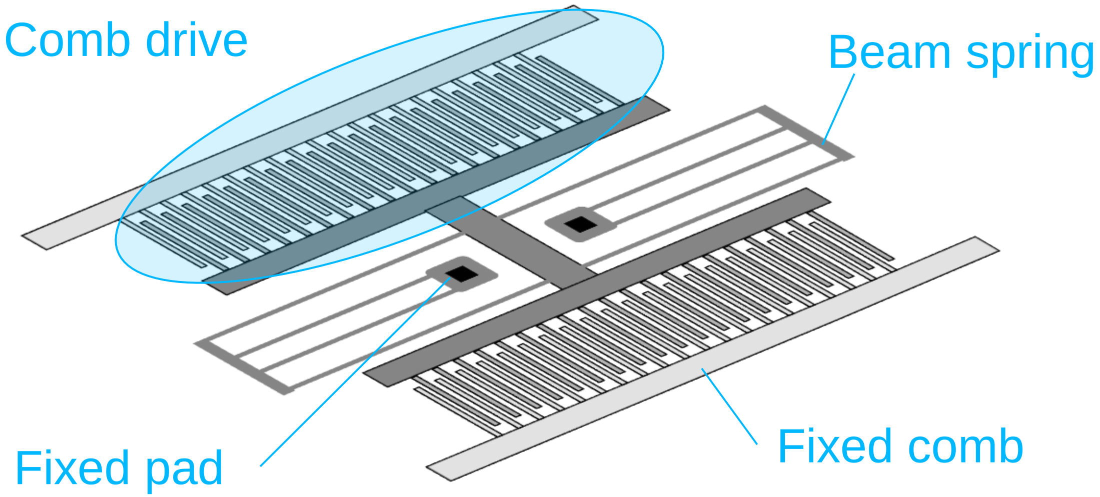
# Electric comb drive resonator




**Problem specification:**

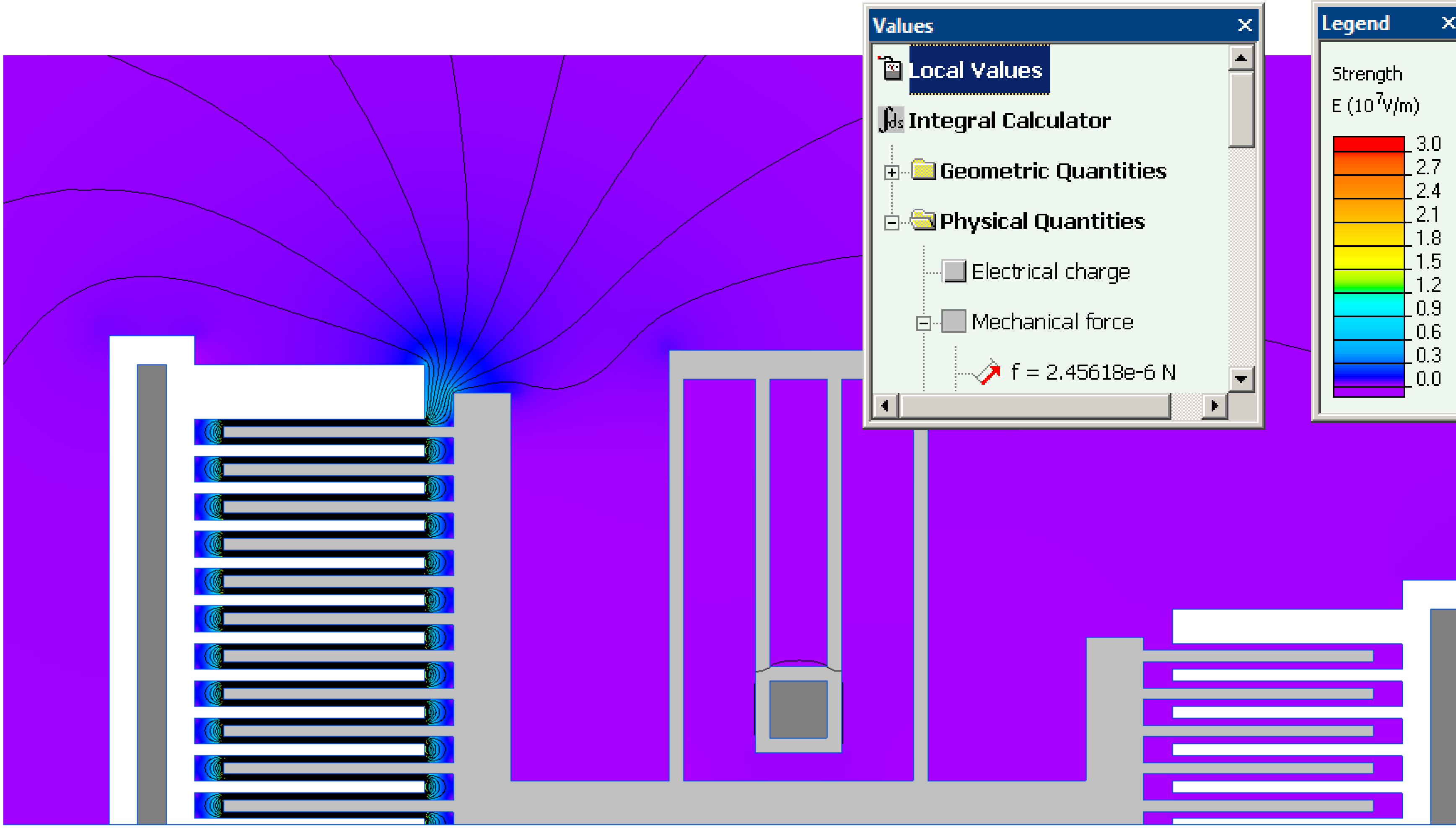
Voltage applied 50 V




**Tasks:**

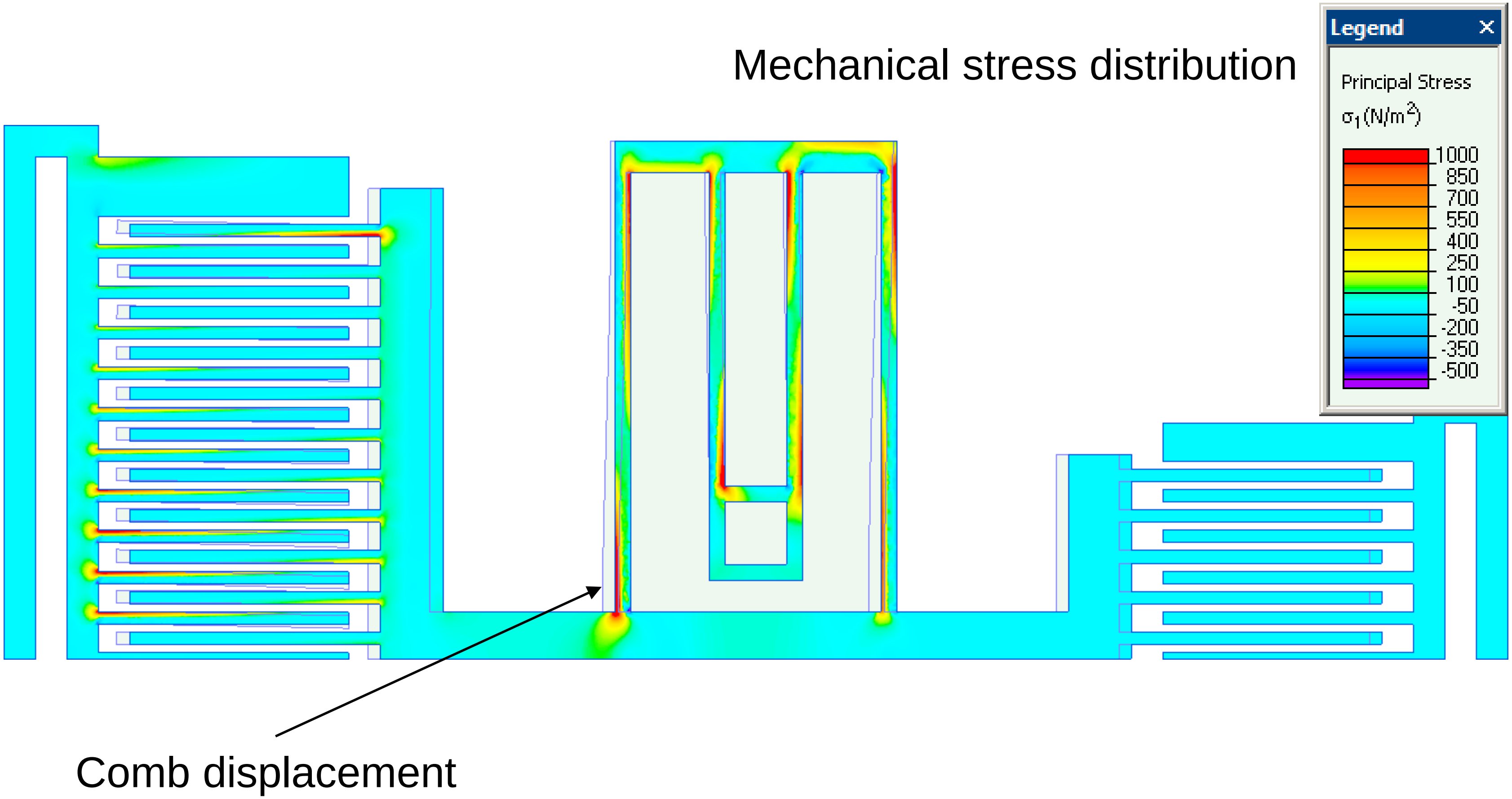
Calculate force, displacement

# Comb drive resonator

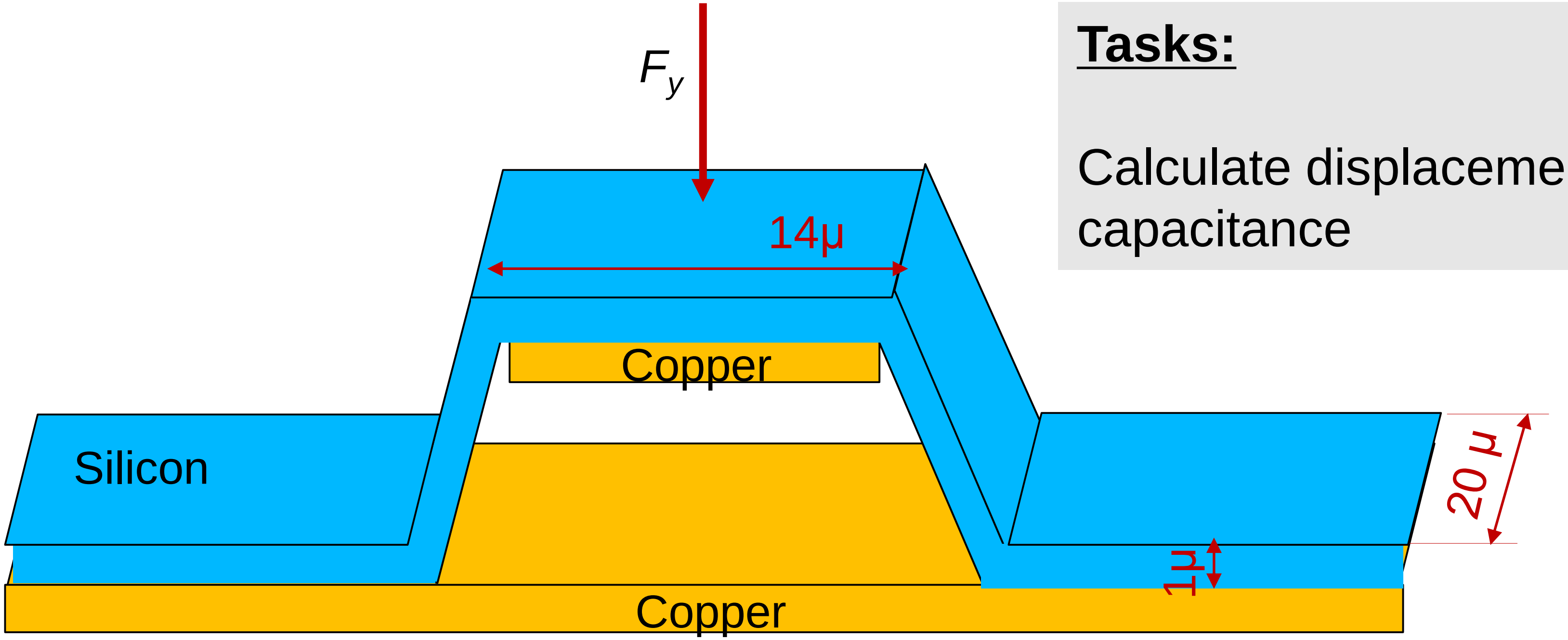



Electric strength distribution

# Comb drive resonator



# Mechanical stress sensor



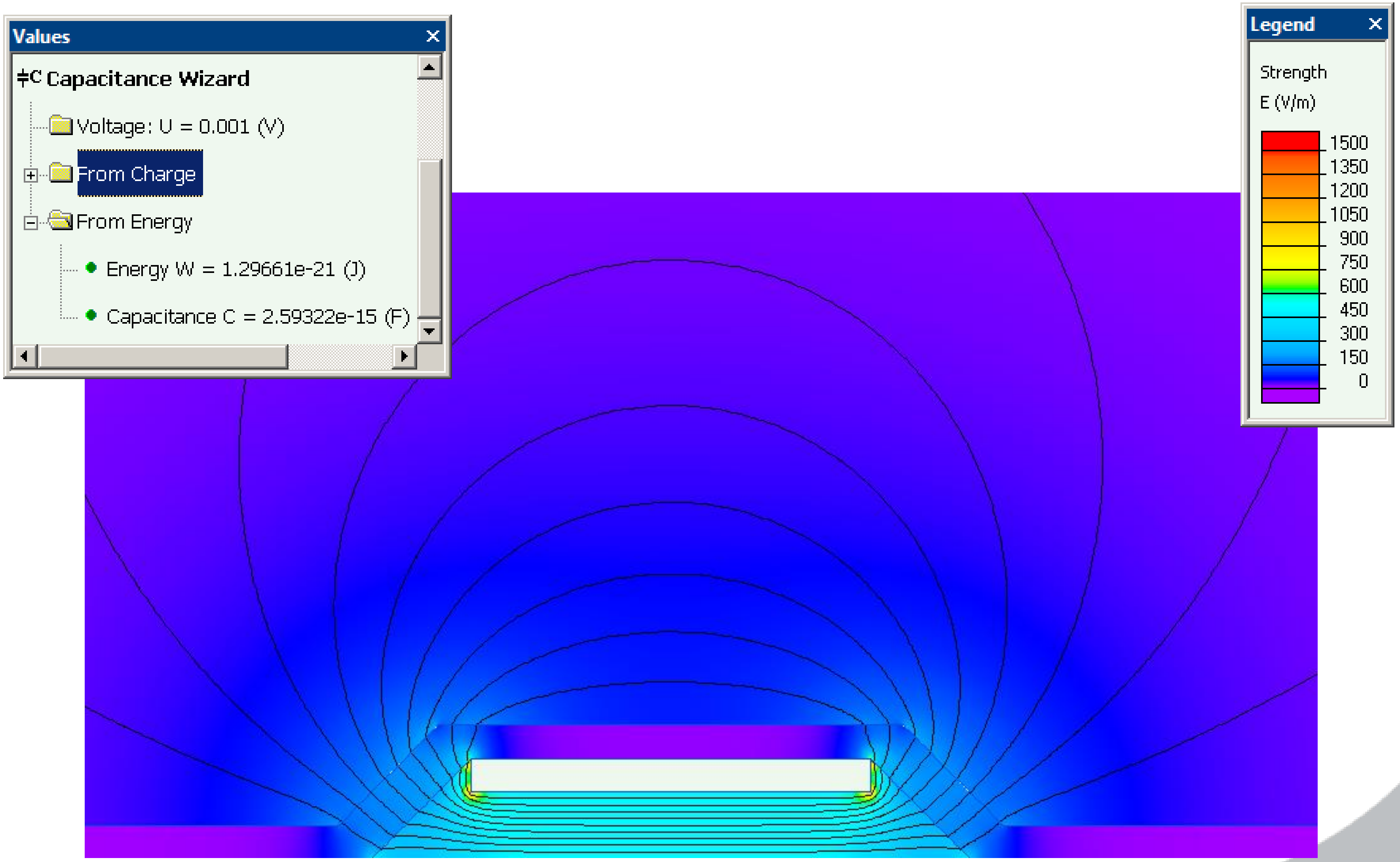

**Tasks:**

Calculate displacement, capacitance

**Problem specification:**

$F_y$ = -100 MPa (-0.028 N)
Silicon Young's modulus 130 GPa, Poisson's ratio 0.1
Copper Young's modulus 140 GPa, Poisson's ratio 0.34

# Mechanical stress sensor



# Mechanical stress sensor