Radiofrequency Ablation and its Effect on Heat Generation on Ground Pads
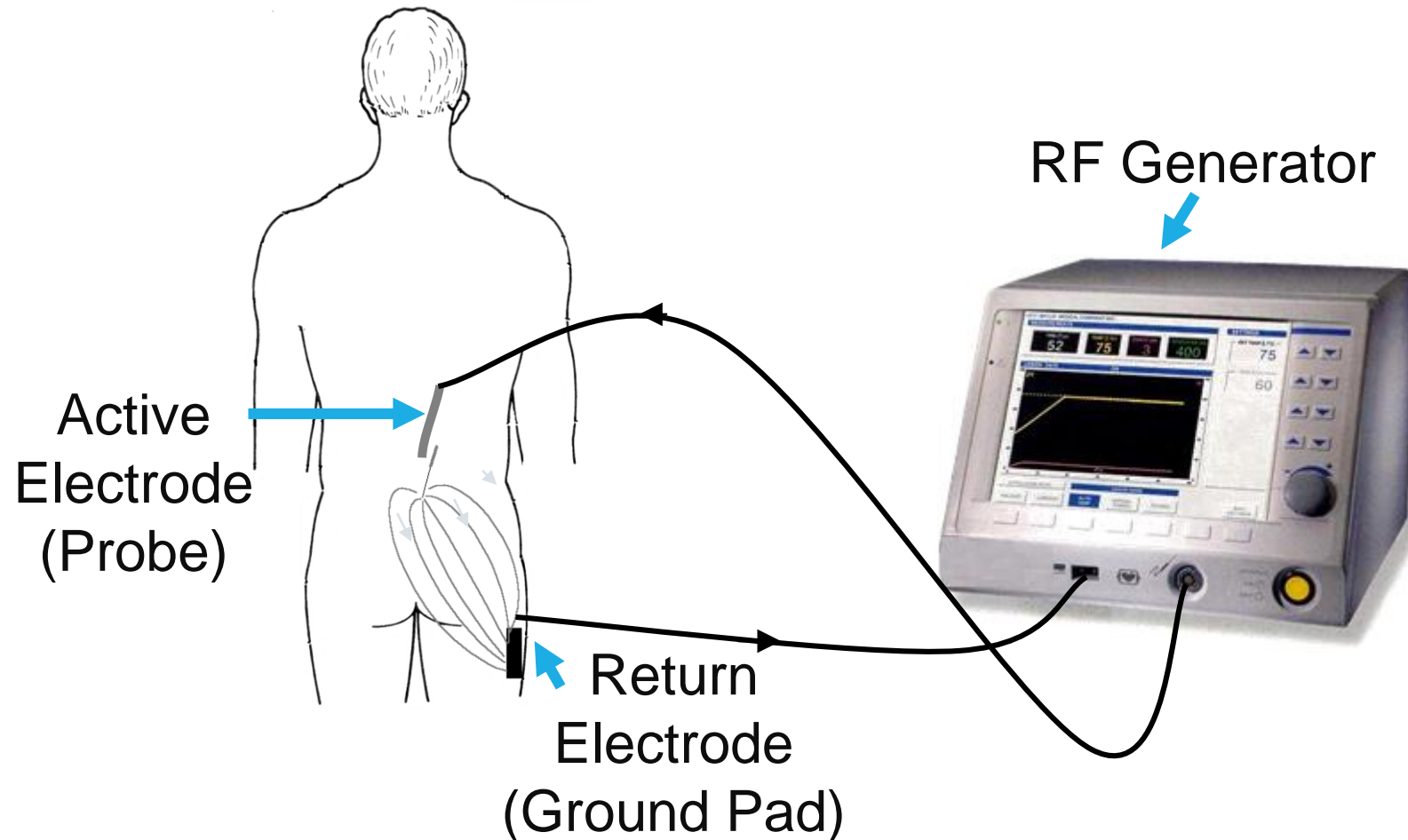
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HALYARD

Radiofrequency Ablation and Pain Management

Active Electrode (Probe)

RF Generator

Return Electrode (Ground Pad)

- ➢ Generator Feedback Loop
  - o Temperature
  - o Power
- ➢ Monopolar Setup
  - o Active Electrode
  - o Ground Pad
  - o Radiofrequency (RF) Generator
  - o Patient

Why Thermal Rise Matters

➢ Must be below 6 degree temperature rise, per IEC 60601-2-2

➢ Time consuming process for real time testing

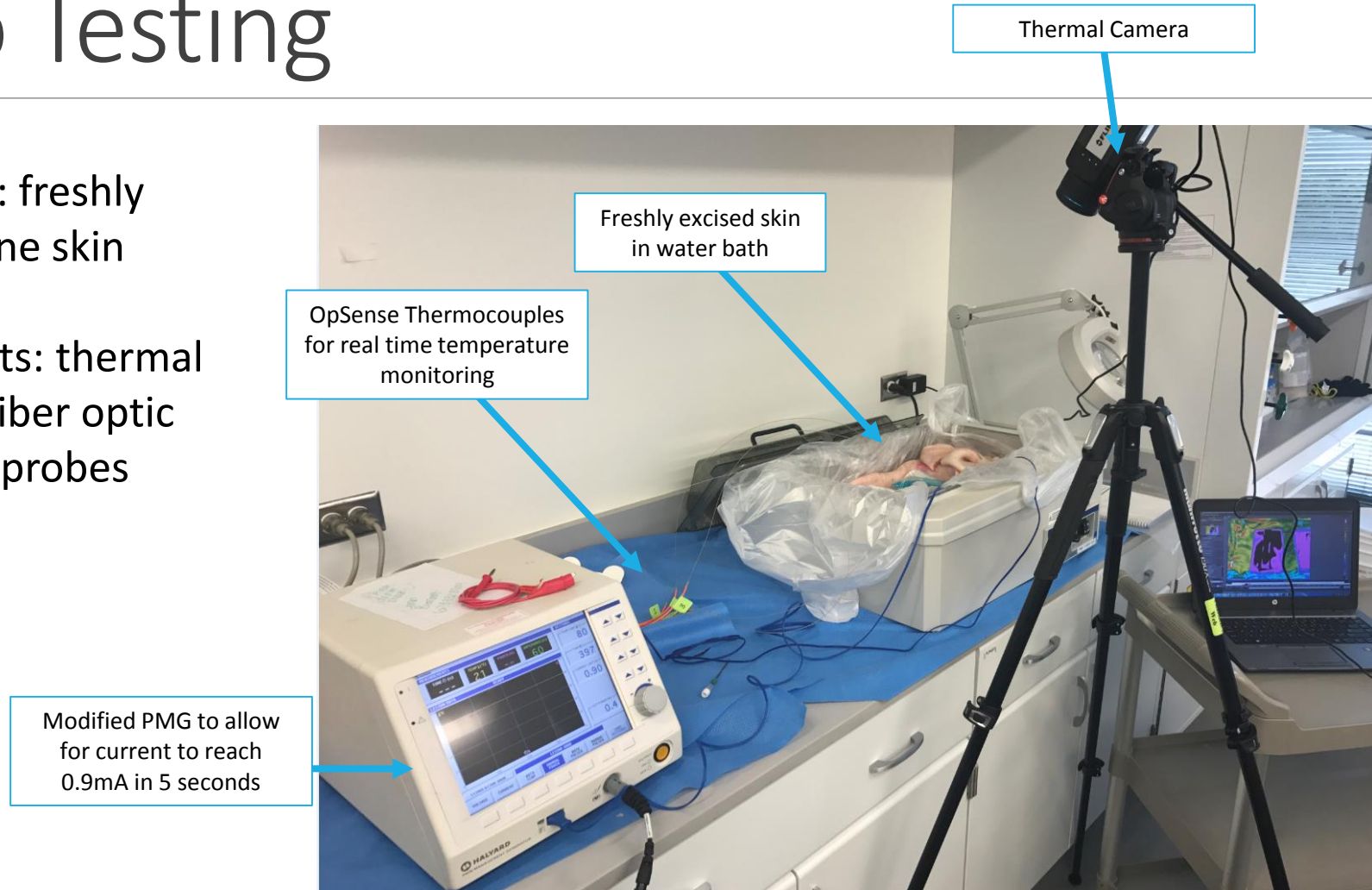➢ Difficult to measure temperature in real time

IEC 60601-2-2

Edition 6.0   2017-03

Medical electrical equipment –
Part 2-2: Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories

Ex-Vivo Testing

- Test Medium: freshly excised porcine skin
- Temperature measurements: thermal camera and fiber optic temperature probes

Thermal Camera

Freshly excised skin in water bath

OpSense Thermocouples for real time temperature monitoring

Modified PMG to allow for current to reach 0.9mA in 5 seconds

Ex-Vivo Testing – Thermal Profile

Right before
removing GP

Right after
removing GP

Time for a Model
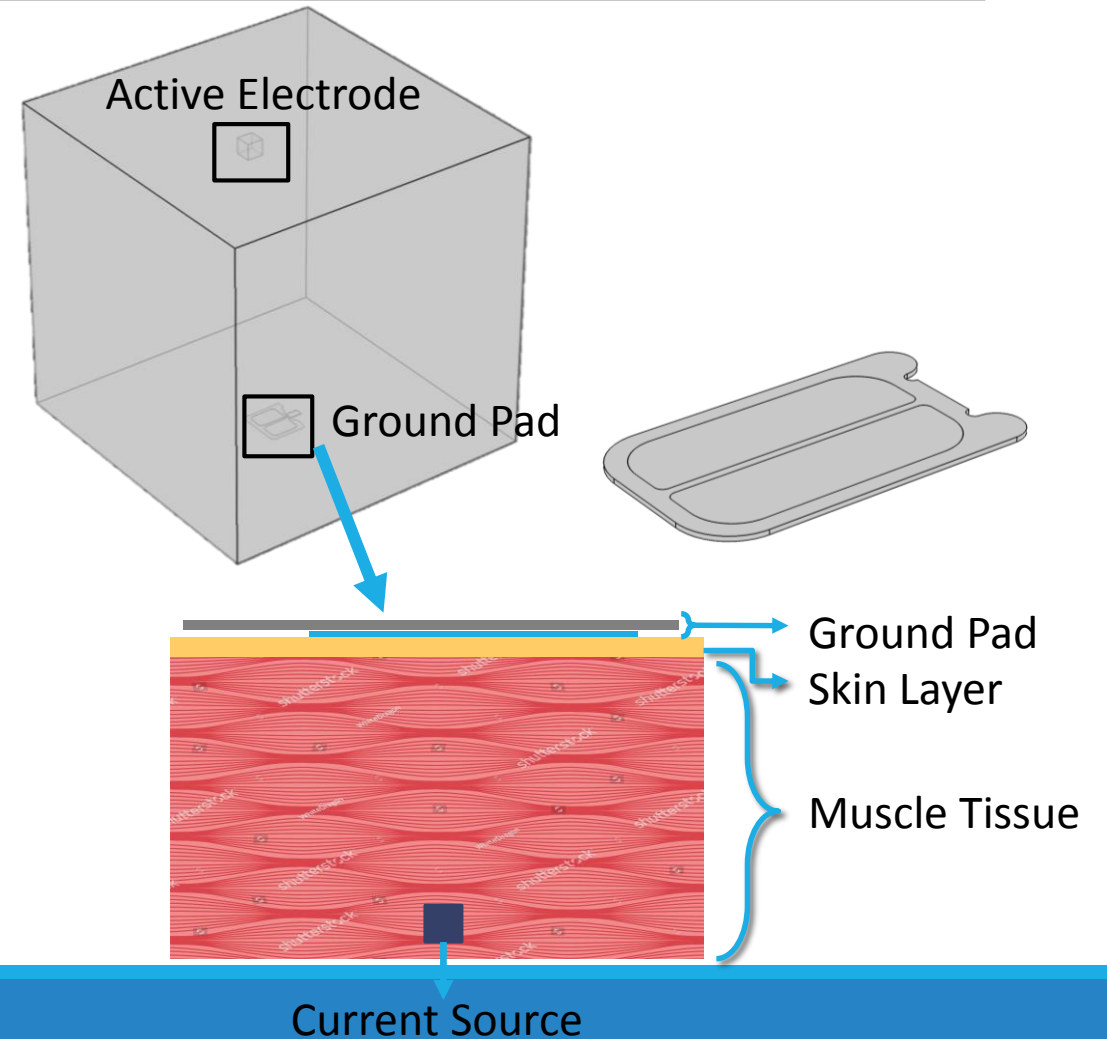
The Model – Geometry and Tissue Properties

- Block of muscle tissue surrounded by a layer of skin
- Surface of grounding pad rests on skin
- Steel cube embedded in muscle tissue acts as the source of RF current
- Material properties derived from literature

Active Electrode

Ground Pad

Ground Pad

Skin Layer

Muscle Tissue

Current Source
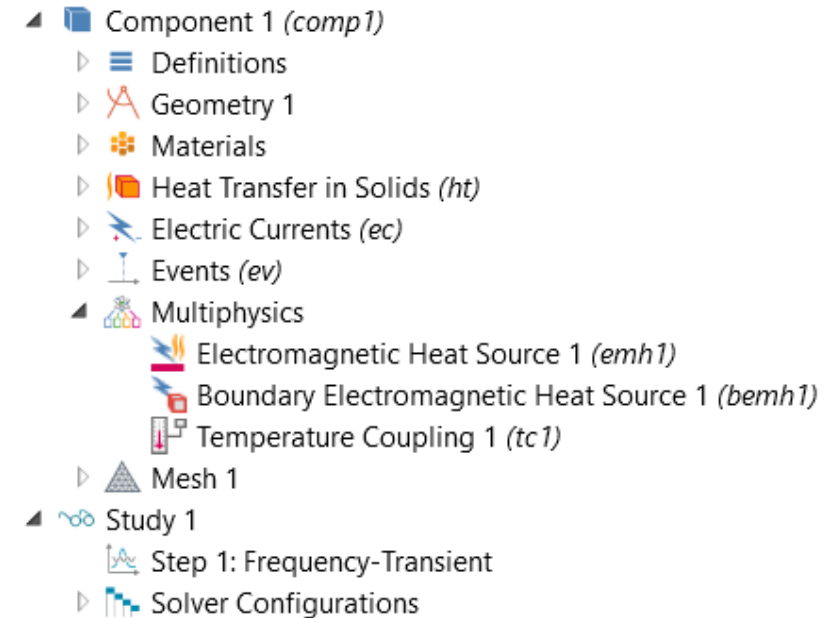
The Model – Physics and Study

➢ Physics
  o Heat Transfer in Solids
  o Electric Currents
  o Events
➢ Multiphysics
  o Electromagnetic Heat Source
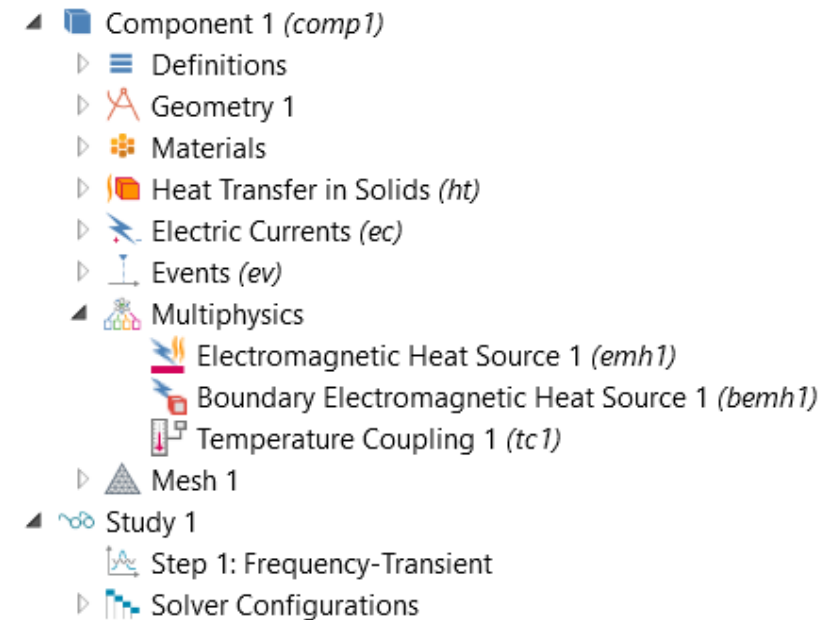 o Boundary Electromagnetic Heat Source
  o Temperature Coupling
➢ Study
  o Frequency-Transient Study to show the effects of the RF over time

The Model -- Events Module

➤ "Events" can be used to modify boundary conditions while a simulation is running
- o Can be triggered at a specific time or after a specified change in a variable

➤ Events are used to prevent electrical outputs beyond the capabilities of the generator
- o Temperature/Power PID feedback loop integration

◢ 🔲 Component 1 *(comp1)*
  ▷ ≡ Definitions
  ▷ 🅰 Geometry 1
  ▷ ⁂ Materials
  ▷ 🔳 Heat Transfer in Solids *(ht)*
  ▷ ⚡ Electric Currents *(ec)*
  ▷ ⌐ Events *(ev)*
  ◢ 🔥 Multiphysics
    ⚡ Electromagnetic Heat Source 1 *(emh1)*
    ⚡ Boundary Electromagnetic Heat Source 1 *(bemh1)*
    🌡 Temperature Coupling 1 *(tc1)*
  ▷ 🔺 Mesh 1
◢ ∞ Study 1
  📈 Step 1: Frequency-Transient
  ▷ 📊 Solver Configurations

The Model -- Mesh

➢ The geometric model is divided into sub-domains to allow for a more customizable mesh
- o Close to the ground pad, the mesh is finer to ensure accurate results
- o Farther away from the ground pad, the mesh is coarser to decrease simulation time

➢ Sub-domains are merged after meshing for application of physics.
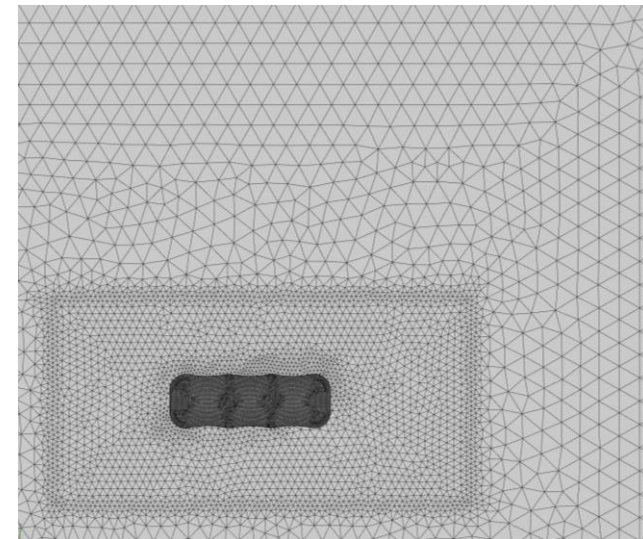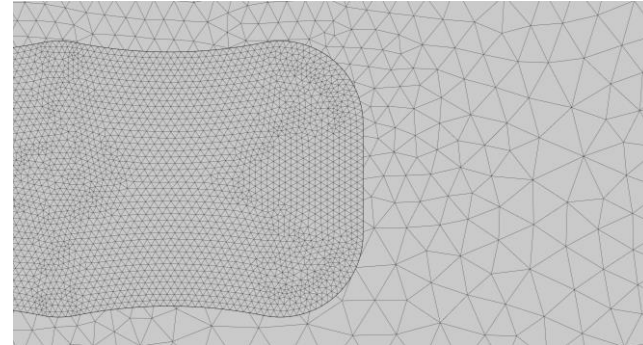
The Model - Results

➢ Areas with highest current densities → largest temperature rise
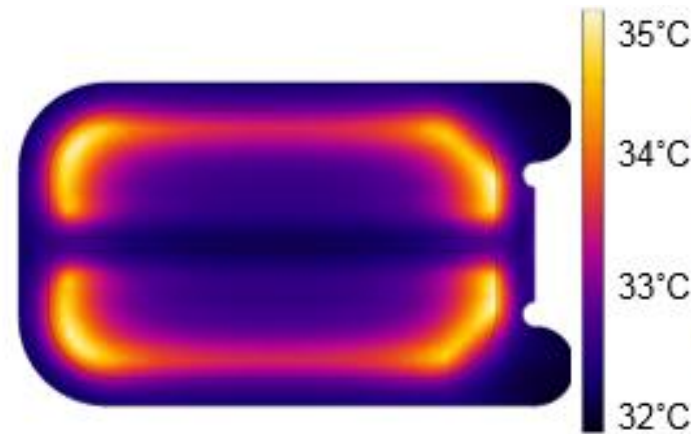➢ Current density focused around edges

Figure 3. Temperature Distribution at 10 minutes, 0.9 A
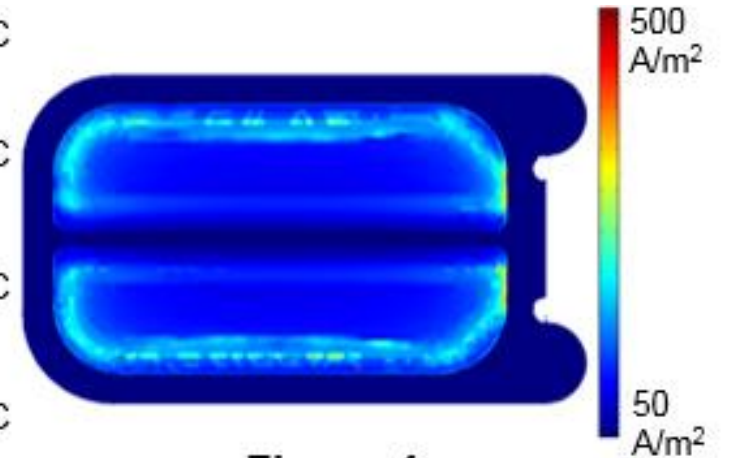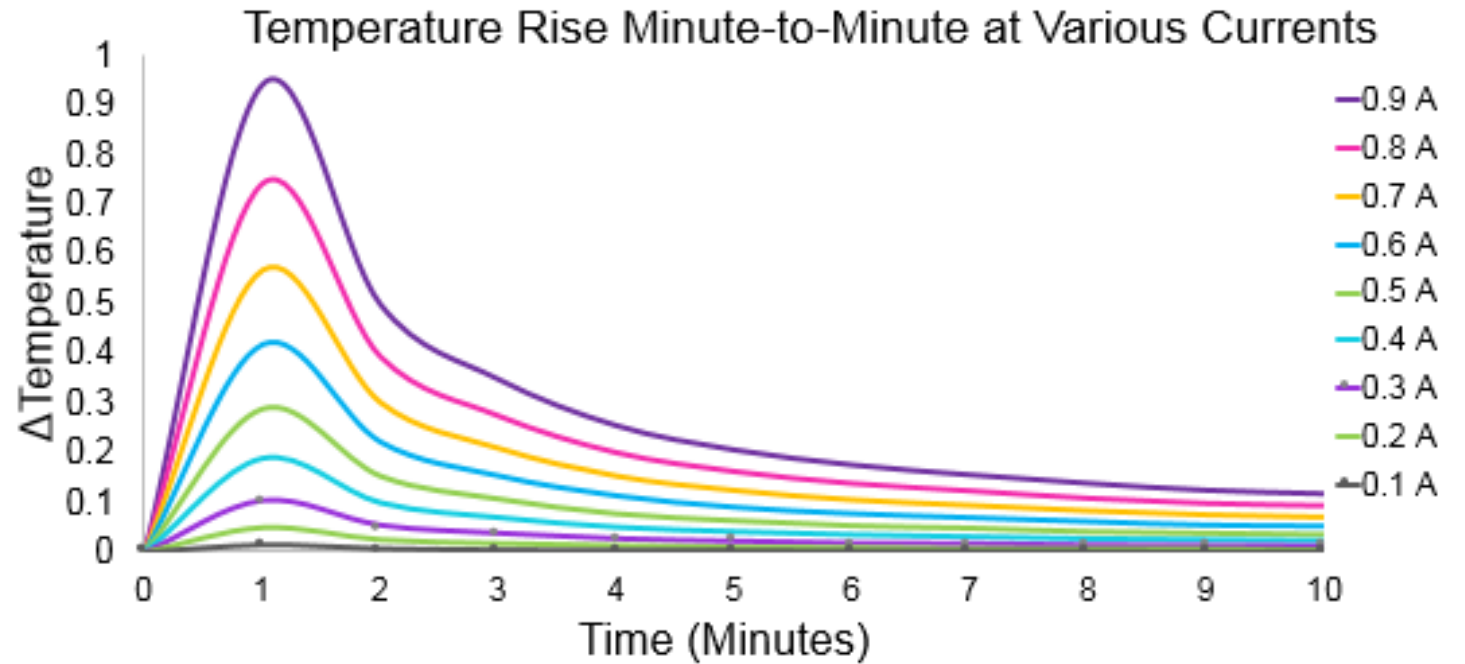

Figure 4. Current Density at 10 minutes, 0.9 A

The Model – Results (cont.)_

➤ Largest temperature rise at one minute, temperatures continued to rise beyond five minutes

Temperature Rise Minute-to-Minute at Various Currents

Conclusion

➢ Thermal rise was concentrated in areas of high current density
  o Along edges of ground pad

➢ The largest ΔT occurred after one minute of running at all current levels

➢ Relatively increasing the current in 0.1A intervals showed that a higher increase occurred at higher current levels
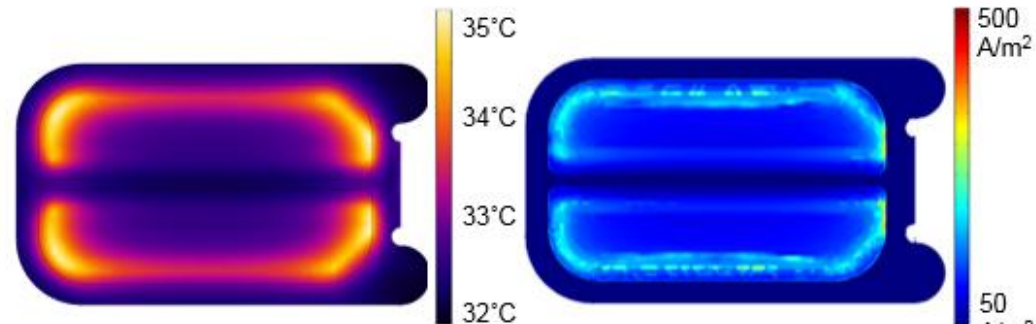
Figure 3.
Temperature Distribution at
10 minutes, 0.9 A

Figure 4.
Current Density at 10
minutes, 0.9 A

Questions?

Thank You