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GIVING BEEKEEPING GUIDANCE BY COMPUTATIONAL-ASSISTED DECISION MAKING

EU Horizon 2020 Research and Innovation Action

A SPATIALLY RESOLVED TEMPERATURE MEASUREMENT SYSTEM FOR A HONEYBEE COLONY BROOD BOX

Adam McVeigh, Michael I Newton, Costas Tsakonas and Martin Bencsik

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817622.

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Nottingham Trent University

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- Honeybee colonies need suitable temperatures.
- Require 32-35°C for brood rearing.
- A single sensor provides a snapshot of colony.
- More sensors provides a clearer picture.
- Colony temperature management.
- High resolution sensor array.
- 480 negative coefficient temperature sensors.

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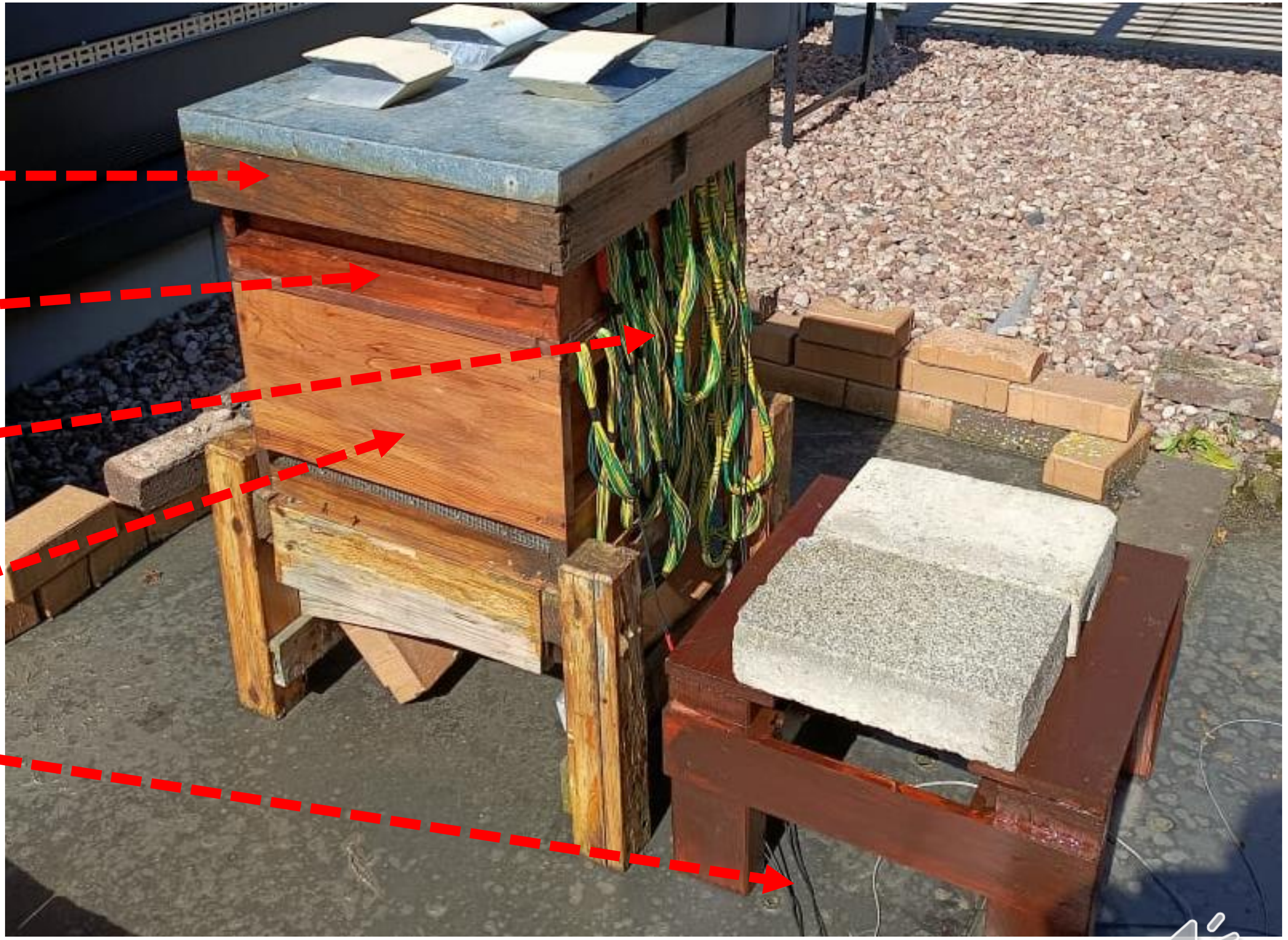
- British National Hive
- Roof
- Adapted Super with electronics
- Cables joining frames to electronics
- Brood Box with frames inside with thermistors
- Cable linking system to Raspberry Pi



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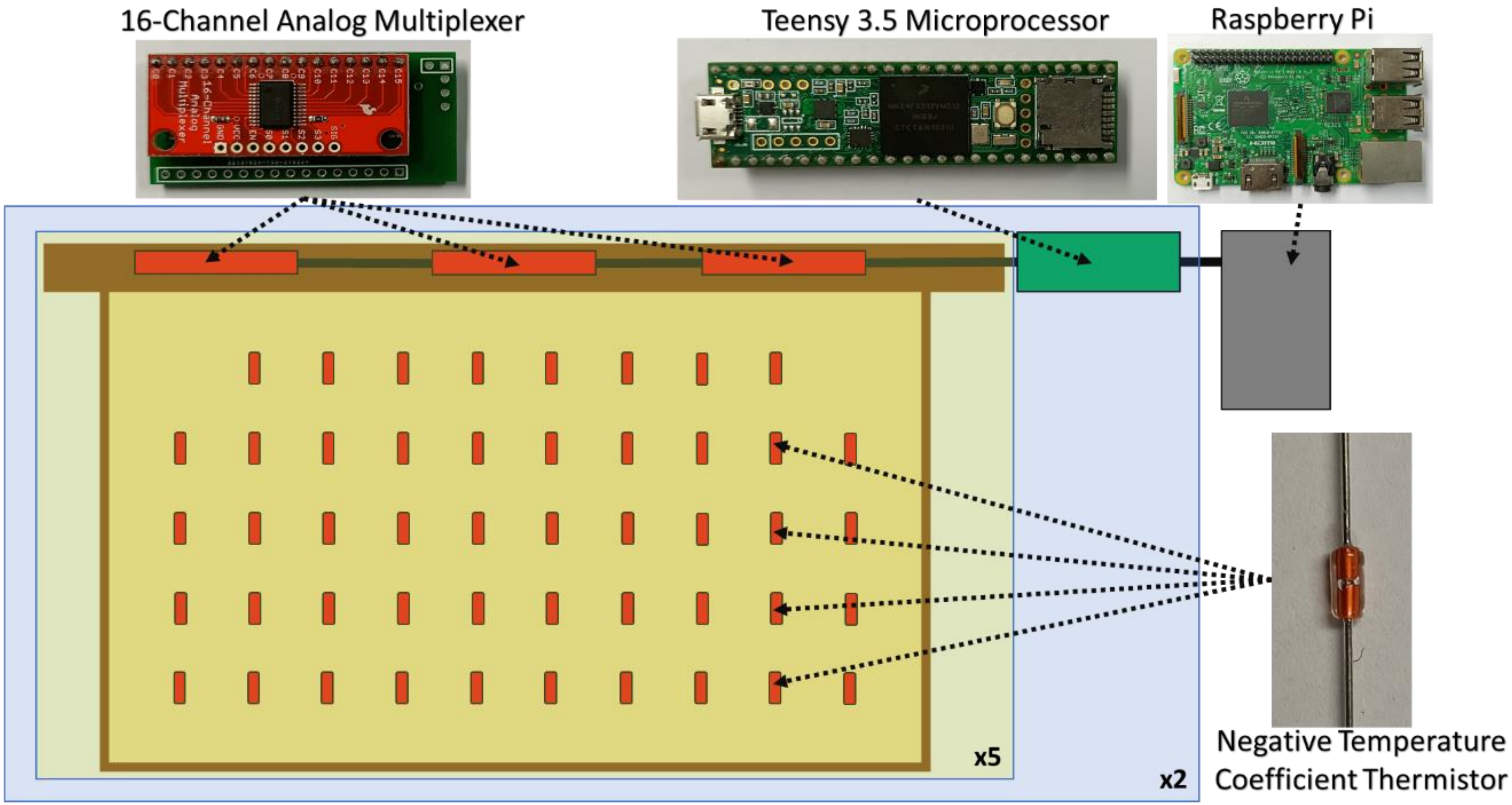

- Schematic of electronics.
- 10 frames each with 48 negative temperature coefficient thermistors.
- Each frame connects to three 16-Channel Analog Multiplexers.
- Multiplexers connect to Teensy 3.5 microprocessors.
- Two Teensy 3.5s
- Linked to a Raspberry Pi

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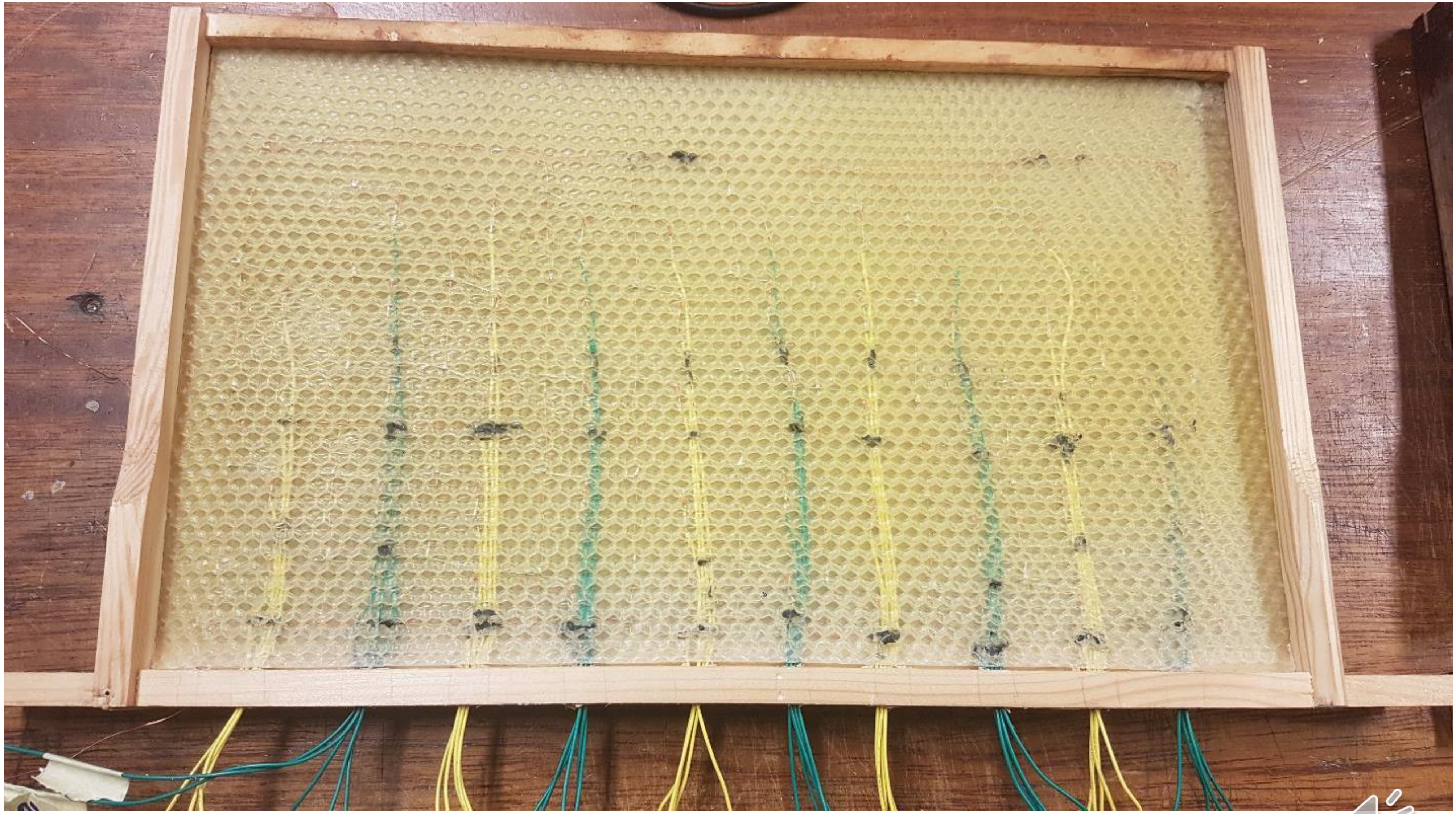
- A prototype system.
- Sensors embedded between four sheets of foundation wax.
- Protect electronics.
- More appealing to bees.



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- First system of frames introduced to a colony.
- Bees chewed away foundation wax.
- Exposing electronics, which still collected data.
- Not normal frame use.
- Wax too thick.
- Cells not aligned suitably.
- Electronics?

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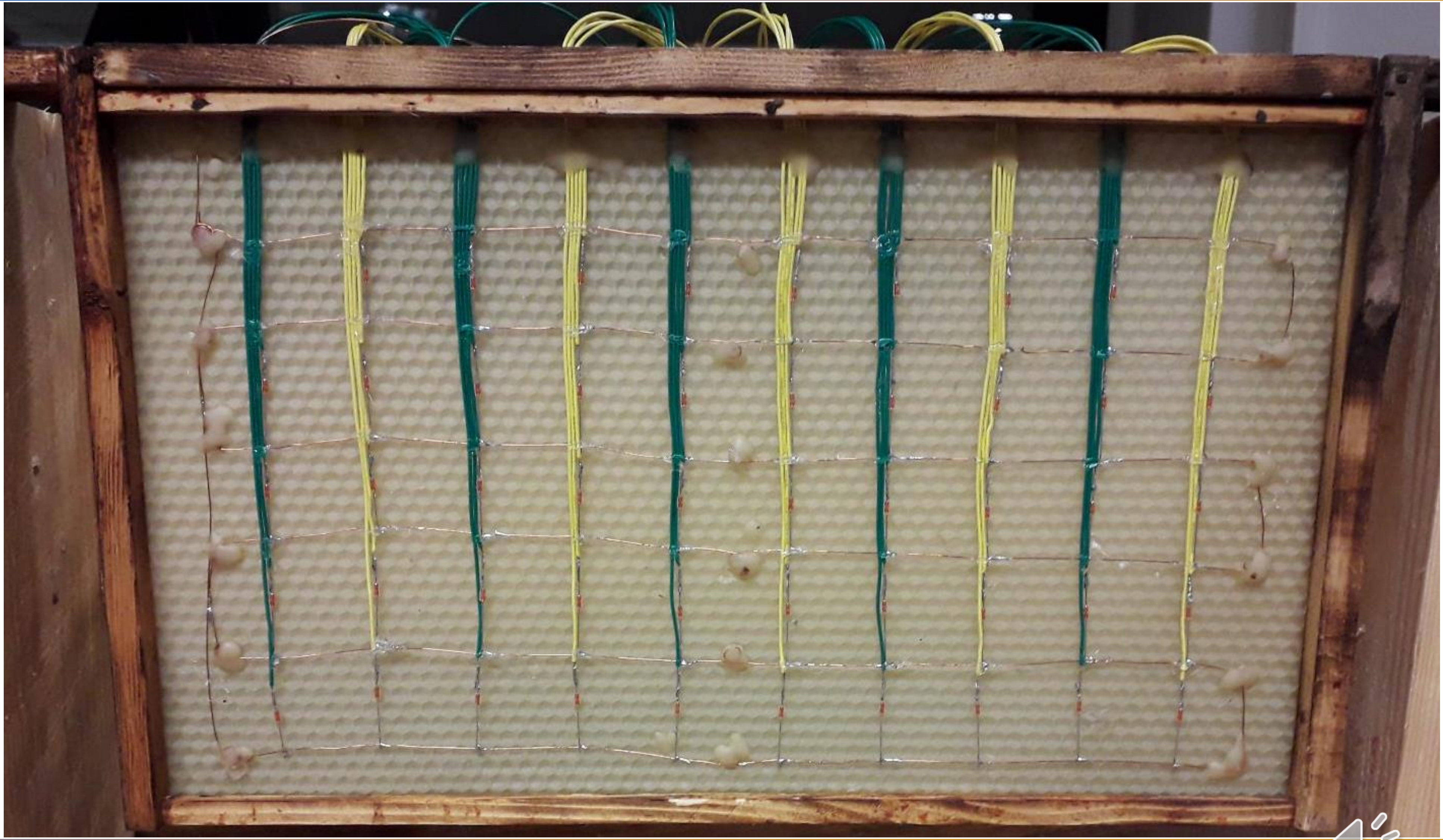
- Second version.
- Sensors laid on foundation wax.
- 1 sheet of foundation wax.
- Expected that less sheets of foundation wax would improve appeal to a colony.



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- The second system with a swarm.
- Built normal honeycomb.
- Including the side with electronics.
- Cells were built over the sensors.
- Used for brood rearing.
- Eggs were observed.
- The system is accepted by the colony and is suitable for normal use.
- Electronics did not cause refusal.

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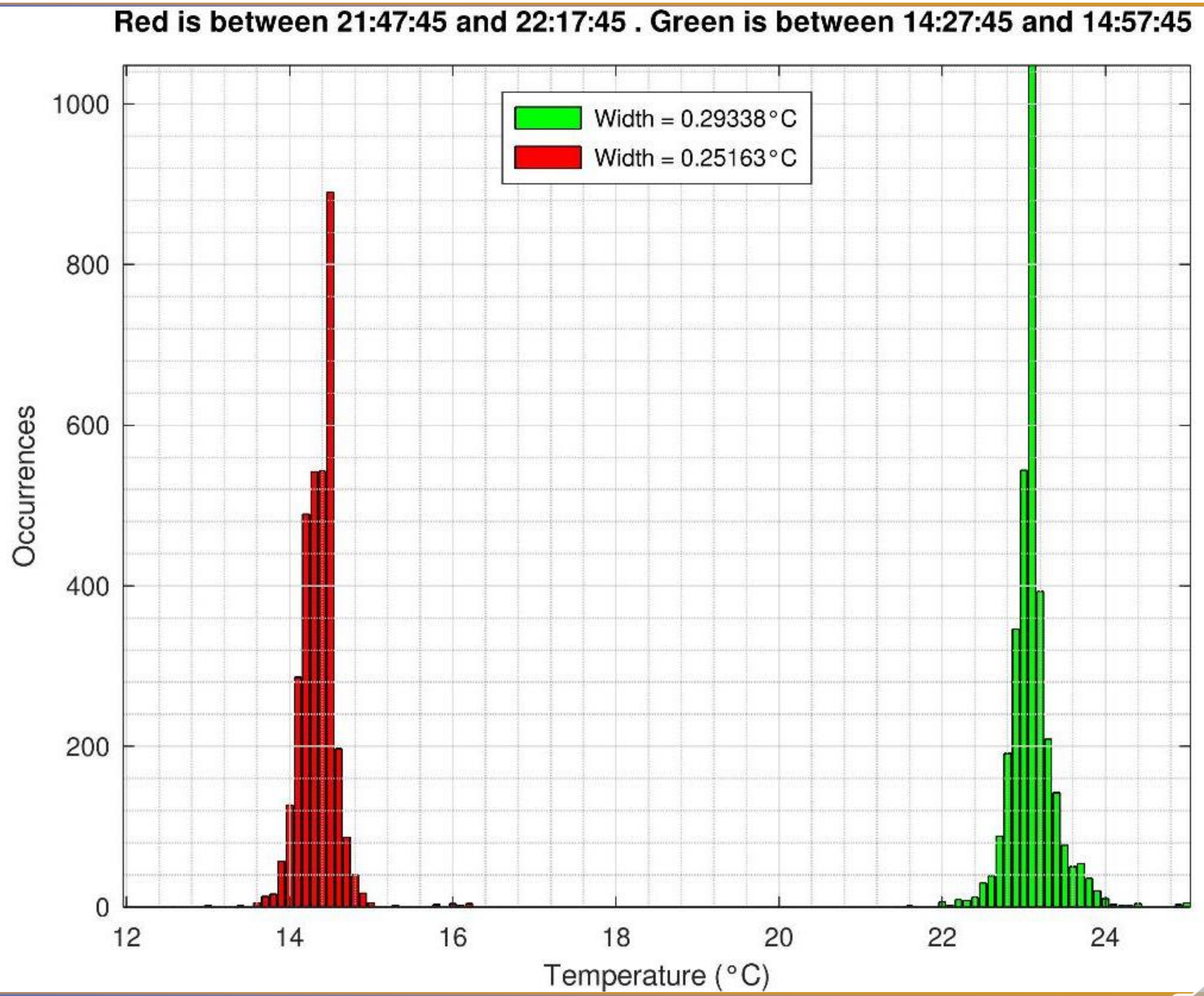
- Sensors tested before the colony introduced.
- Consistent measurements.
- Small error in line with quoted tolerances.
- Figure displays measurements from all sensors in the afternoon (green) and evening (red).
- Consistent with ambient air temperatures.
- Data has been linear scaled to compensate for systematic and random errors. We assume the scaling factors remain constant.



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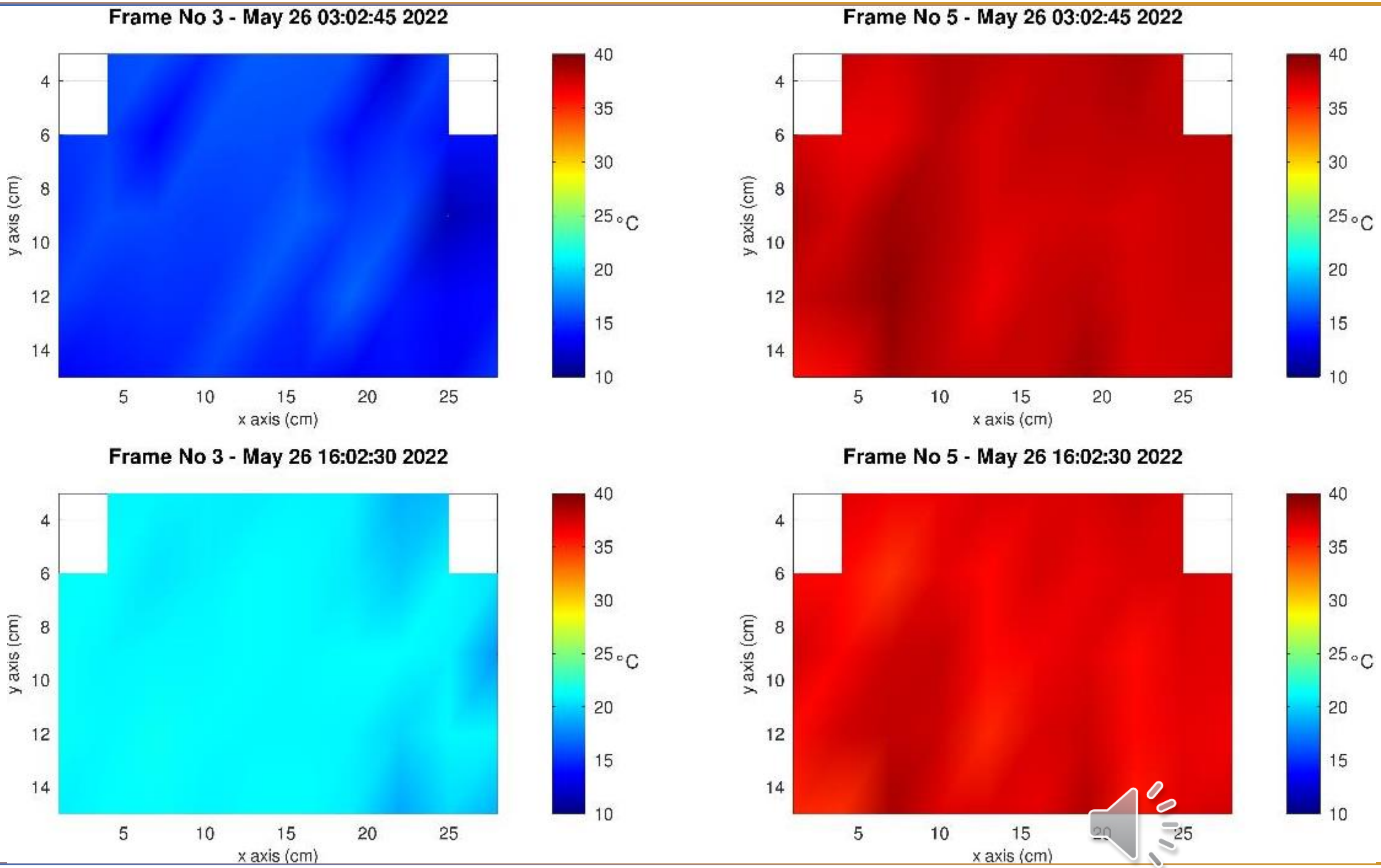
- Spatially resolved temperature measurements collected.
- Figure shows temperatures on two frames.
- Two time points on the same day.
- Frame 5 is being used for brood rearing.
- Frame 3 is not being used by the colony.
- Spatial variation in temperature on both frames.



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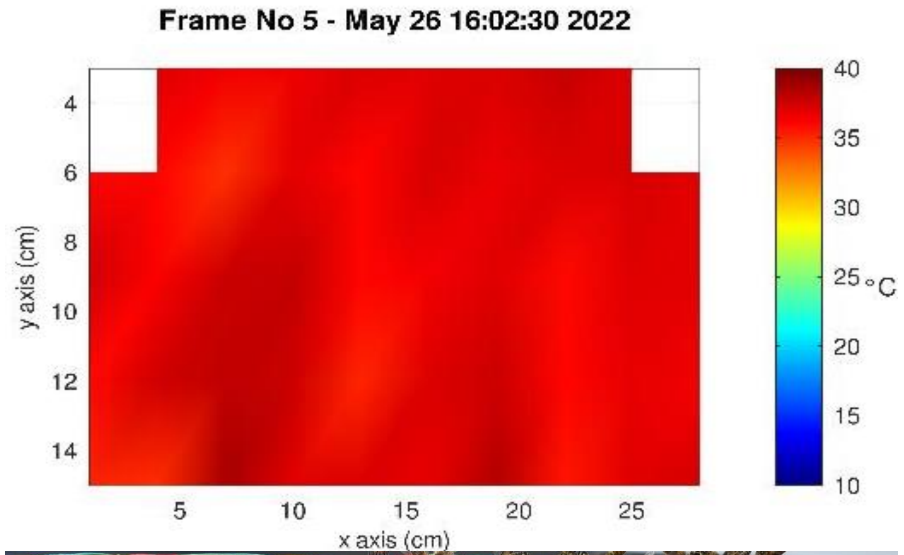

- Spatially resolved temperature measurements of a colony.
- Temperature measurements using an array of thermistors on a sheet of foundation wax.
- Using a single sheet of wax is important in determining acceptance.
- Second system was accepted and used normally.
- Minimal disruption of the foundation wax is optimum.
- Recording distinctive features such as brood temperatures.
- Quantify spatial temperature variation across the colony.
- Data to aid understanding of colony thermal dynamics.

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