



# The Effects of Thermal Stimulation on the Behavior of *Caenorhabditis elegans*

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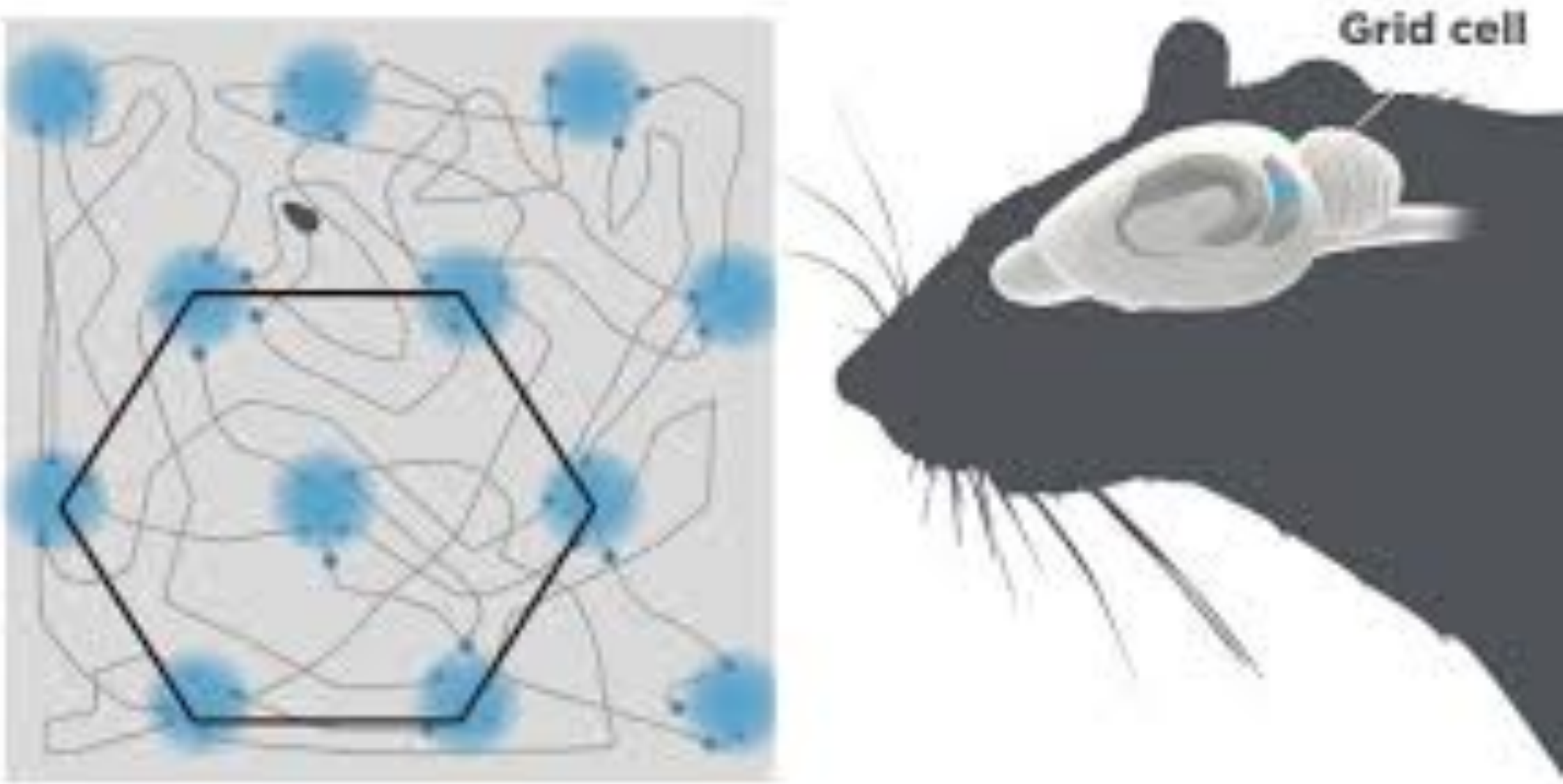


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## INTRODUCTION

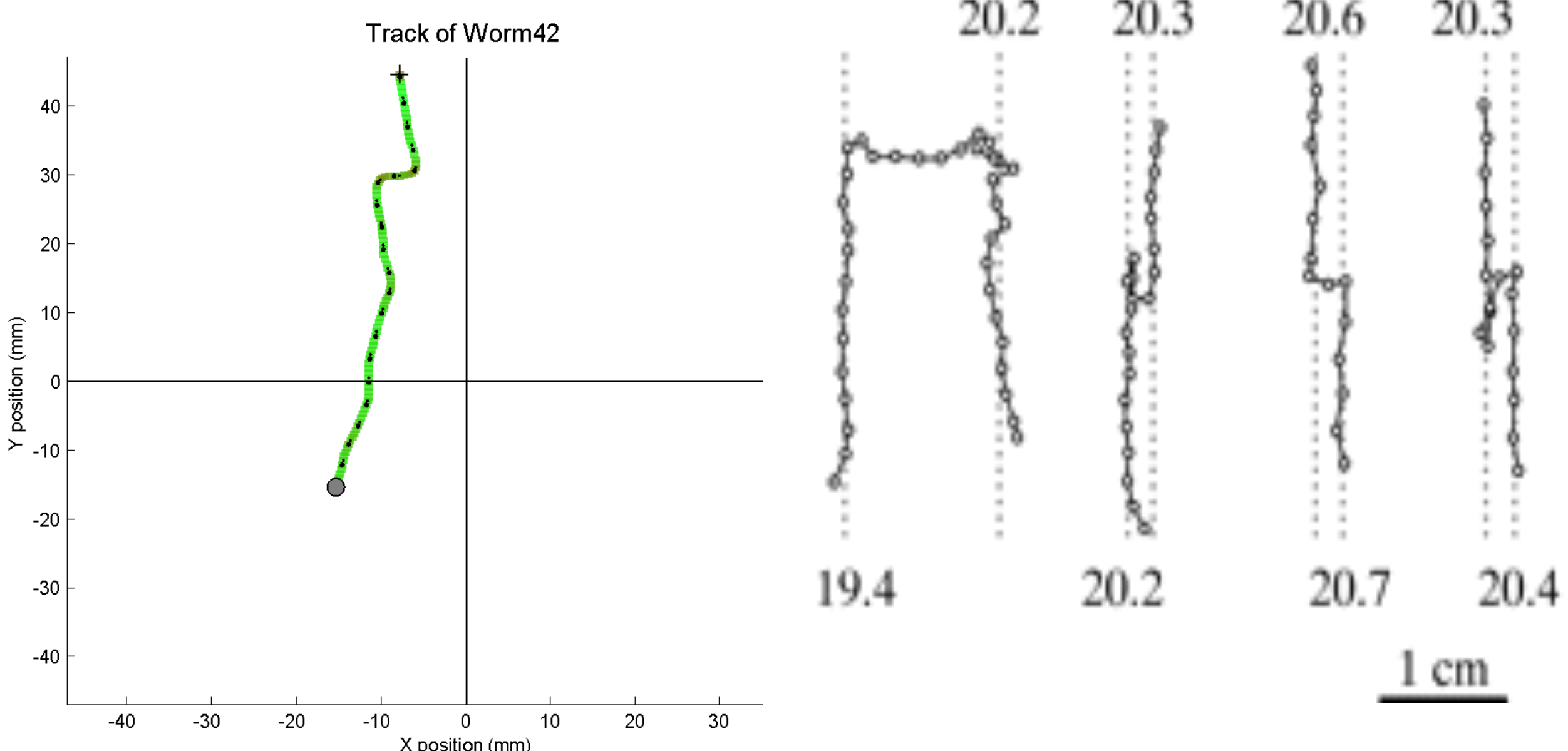
The nematode *Caenorhabditis elegans* is often used in neuroscience research to gain a deeper insight into the neural pathways of more complex organisms because of its simple neuronal network of 302 neurons. However, the behaviors of these creatures have not been extensively observed. Luo et. al. noted that *Caenorhabditis elegans* can stay on a path at the same temperature (isothermal behavior) on a surface with a temperature gradient. They also make these rare deterministic movements from one temperature to another, taking a path perpendicular to the gradient; we call these 90 degree turns. Because these movements are grid-like, we hypothesize that *Caenorhabditis elegans* could possibly have an integrated navigation system that is similar to that of grid cells in the entorhinal cortex of a mouse. We believe that this grid-like pattern that the nematodes navigate in implies that they could potentially have a higher level perception of two-dimensional space.



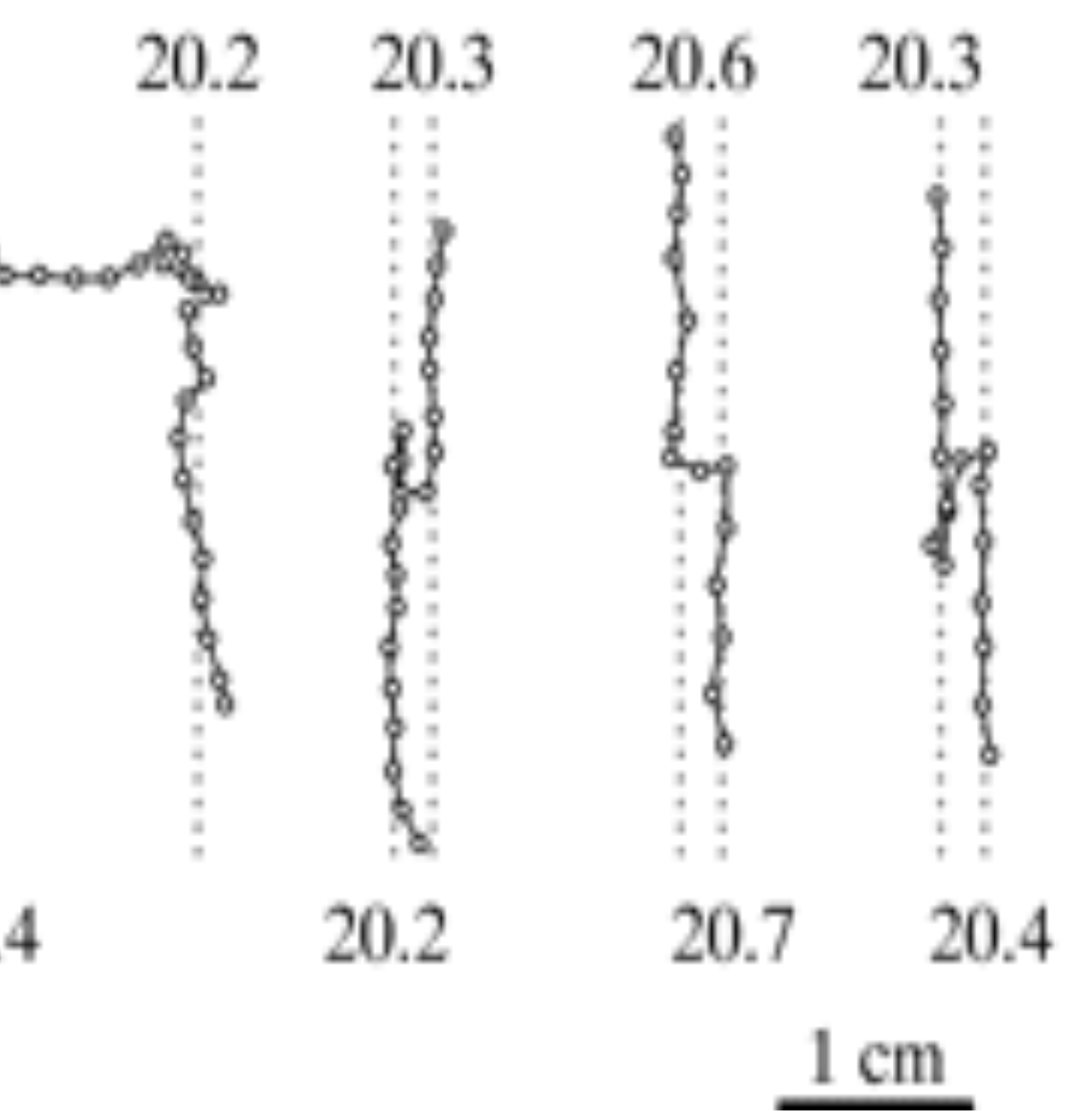
**Figure 1.** Grid Cell pattern found in mouse brain, used for navigation (Moser et al 2008).

## OBJECTIVES

- It has been observed by previous researchers that when dropped on a thermal gradient, the nematode will travel to the temperature in which they were last fed because they associate it with food (isothermal behavior). We wanted observe this behavior at 20 °C.
- Our experiment aimed to use thermal stimuli to recreate the 90 degree turn, in which the *C. elegans* find and track their cultivation temperature after turning perpendicular from one temperature to another.



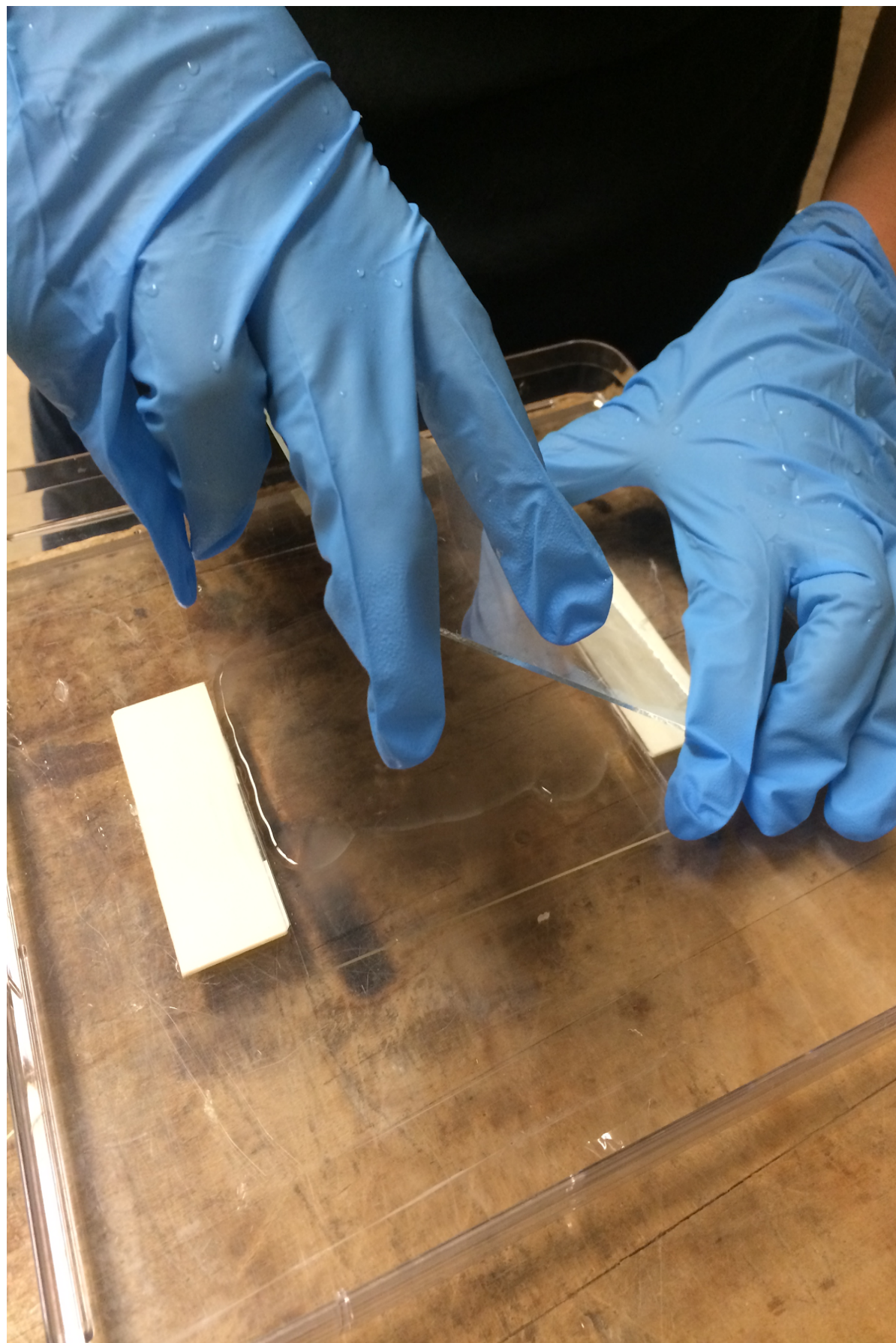
**Figure 2.** Track of one worm with .5 degrees/cm temperature gradient (Karen Jiang 2014).



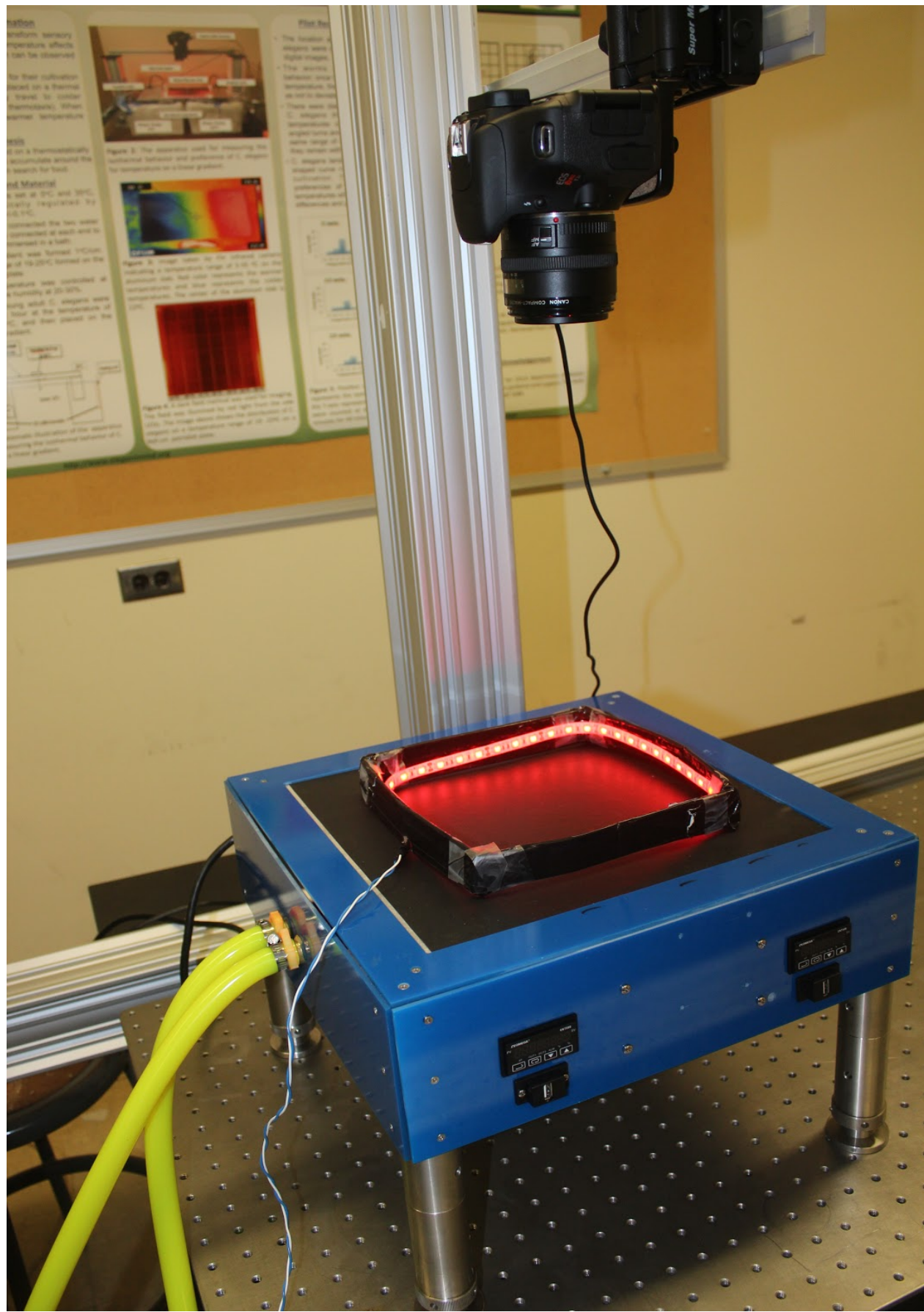
**Figure 3.** Track of several worms with .7 degrees/cm temperature gradient (Luo et al. 2006).

## MATERIALS & METHODS

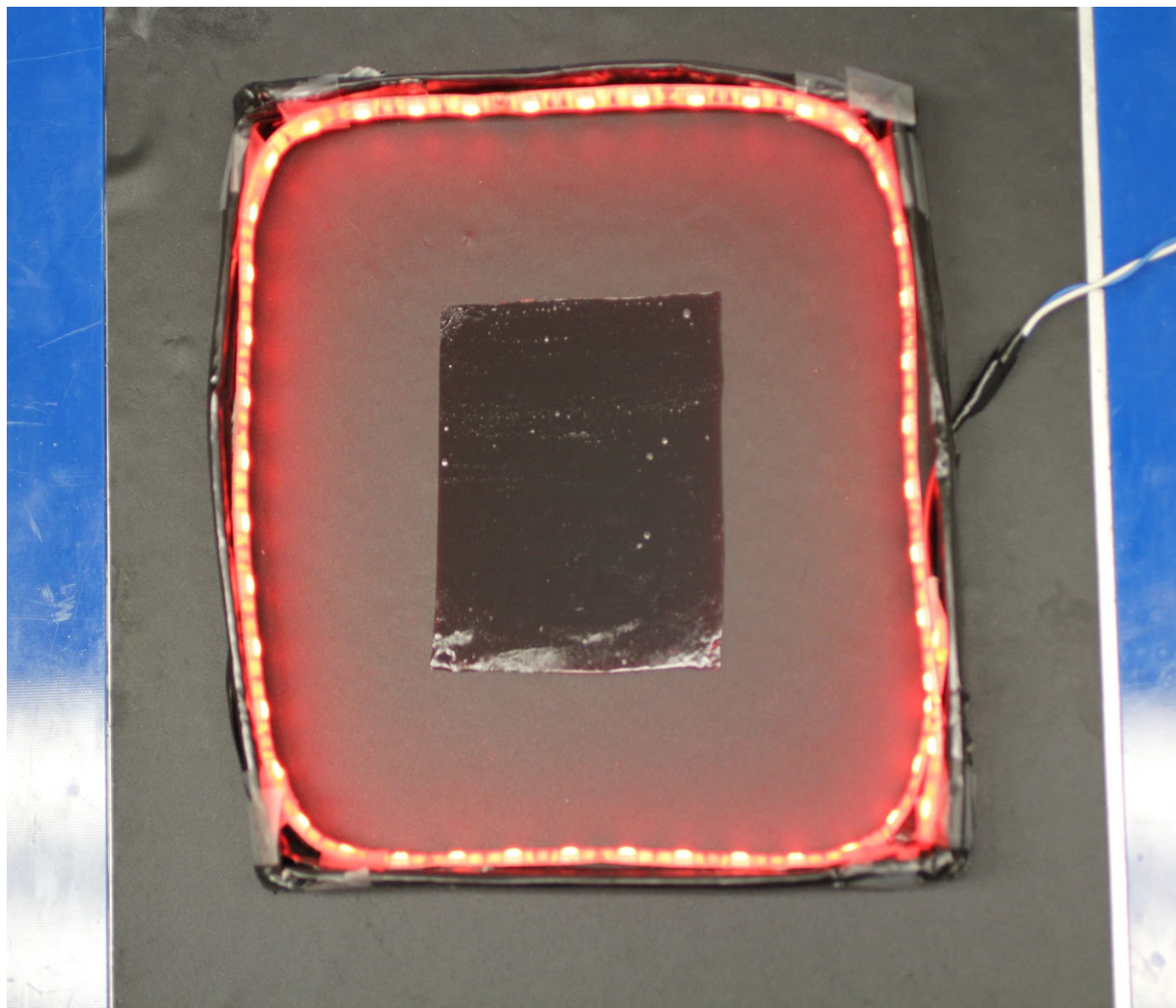
- 15 ml of 2% agar is poured in between two glass plates to make a thin layer of agar (10 cm x 10 cm)
- Agar pad is placed on a linear temperature plate (hot on one side and cold on the other) \*will include a picture of setup with labels\*
- A sample of 10-15 healthy adult *C. elegans* is placed on the agar pad at 20°C (temperature at which they were cultivated)
- As soon as the sample is dropped, a Canon 60D camera is turned on to capture a time lapse of 700 photos for a total of 35 minutes
- Images are processed and edited through an imaging program called ImageJ
- The tracks of the worms are then analyzed from the processed photos through an undergraduate-designed program on MatLab



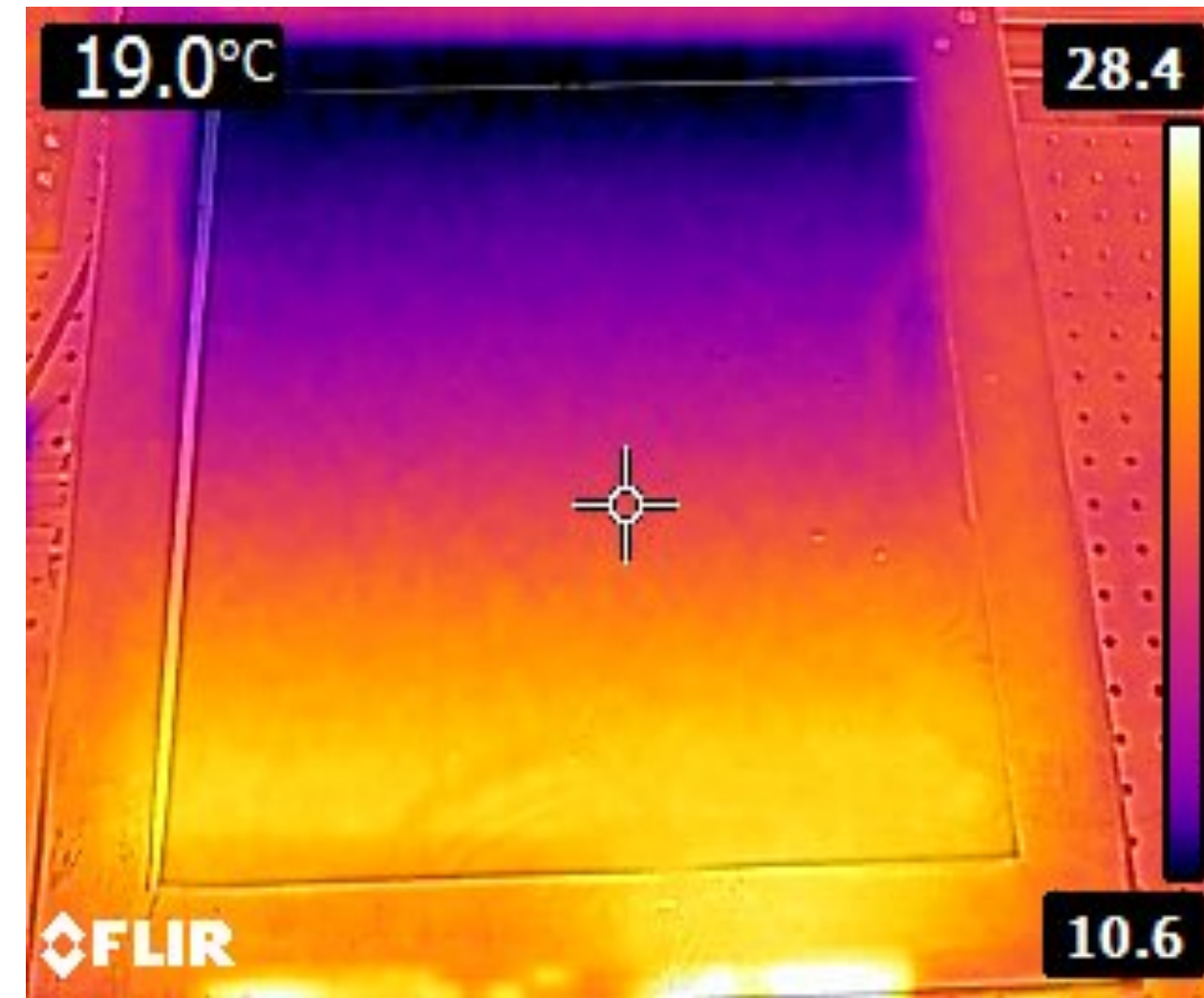
**Figure 4.** Preparation of agar pad.



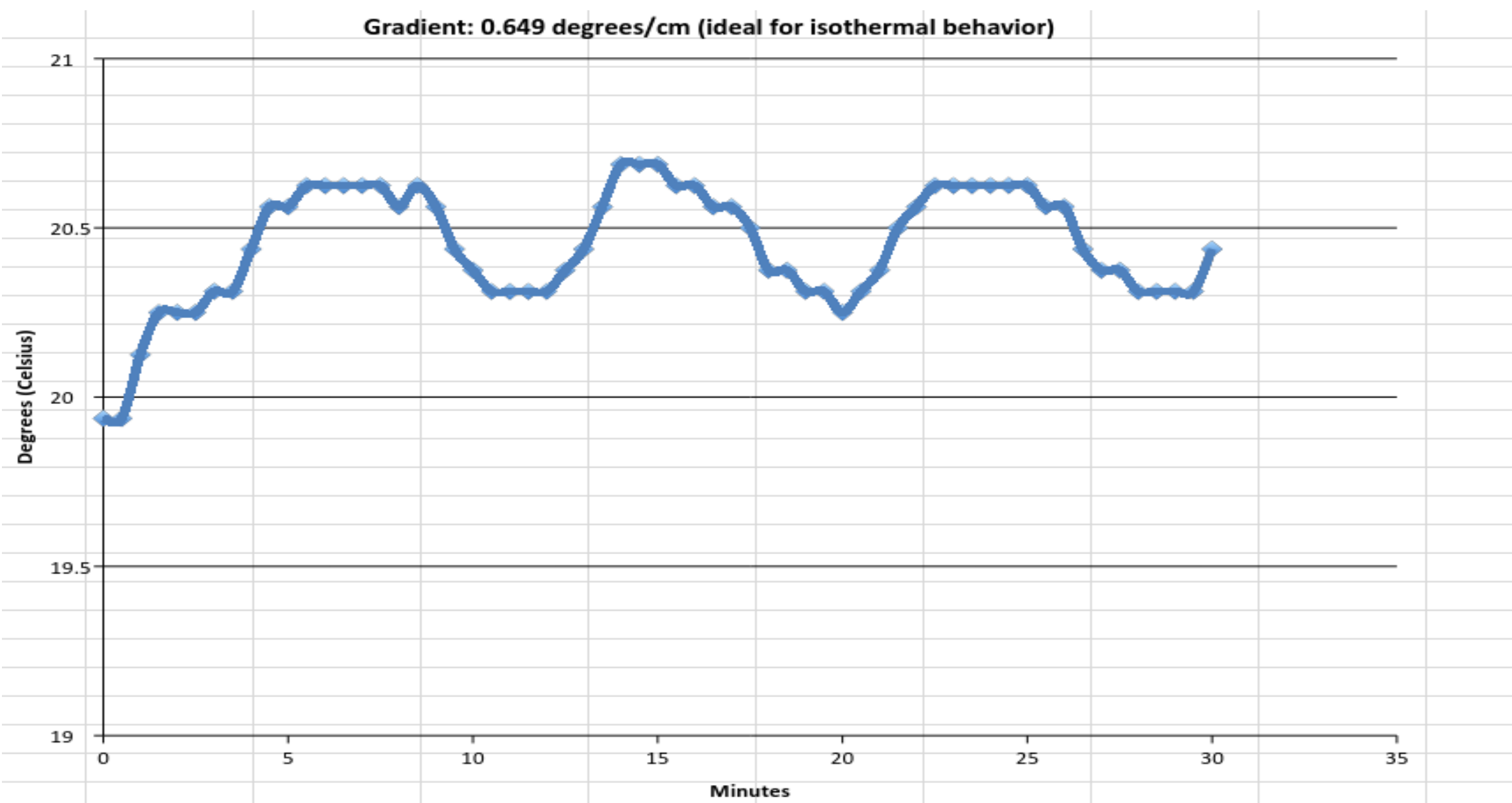
**Figure 5.** Set up of temperature plate hardware.



**Figure 6.** Agar pad placed on thermal plate with a 0.5-0.7 degrees/cm temperature gradient.



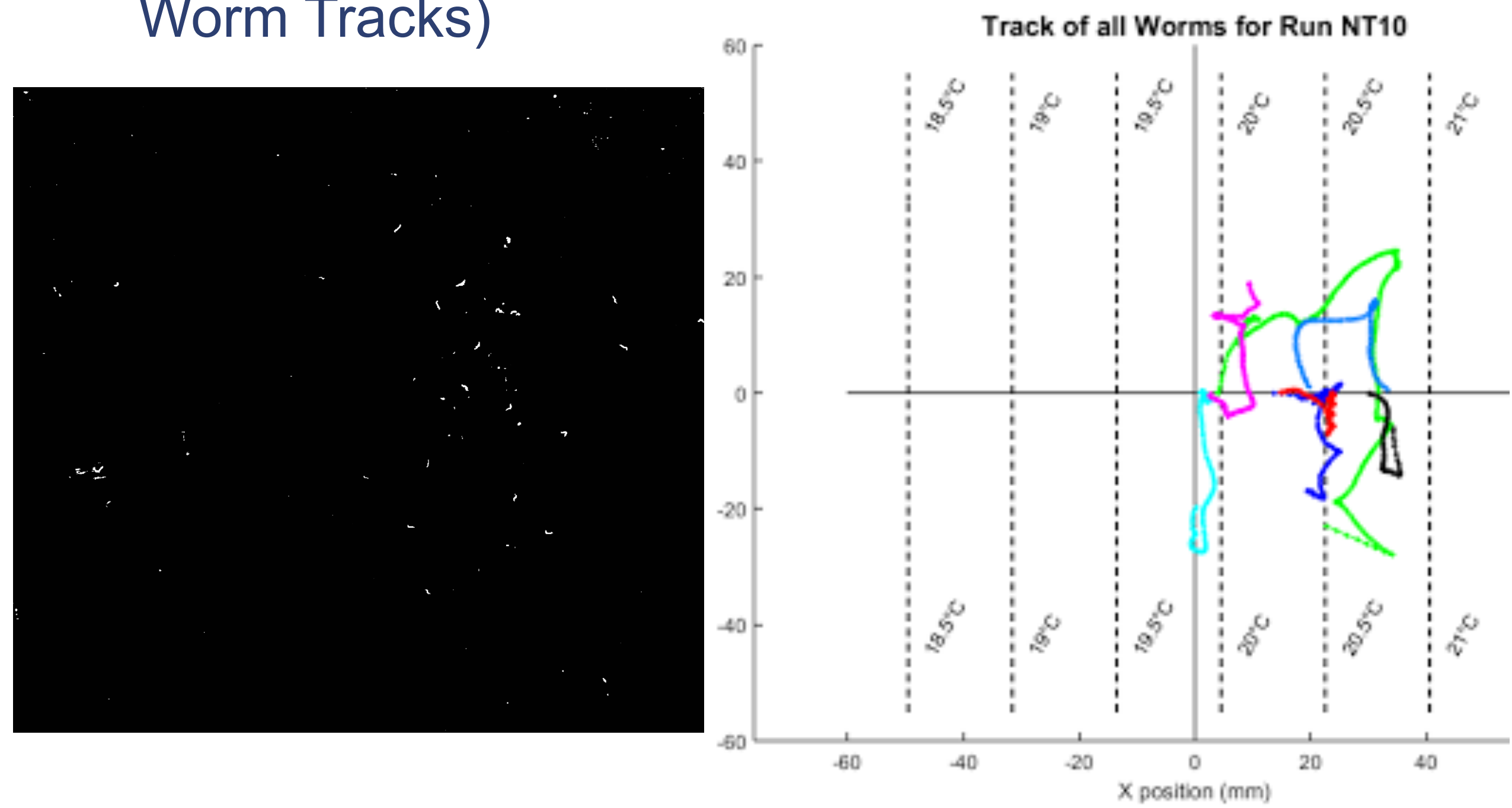
**Figure 7.** Thermal gradient taken with infrared camera.



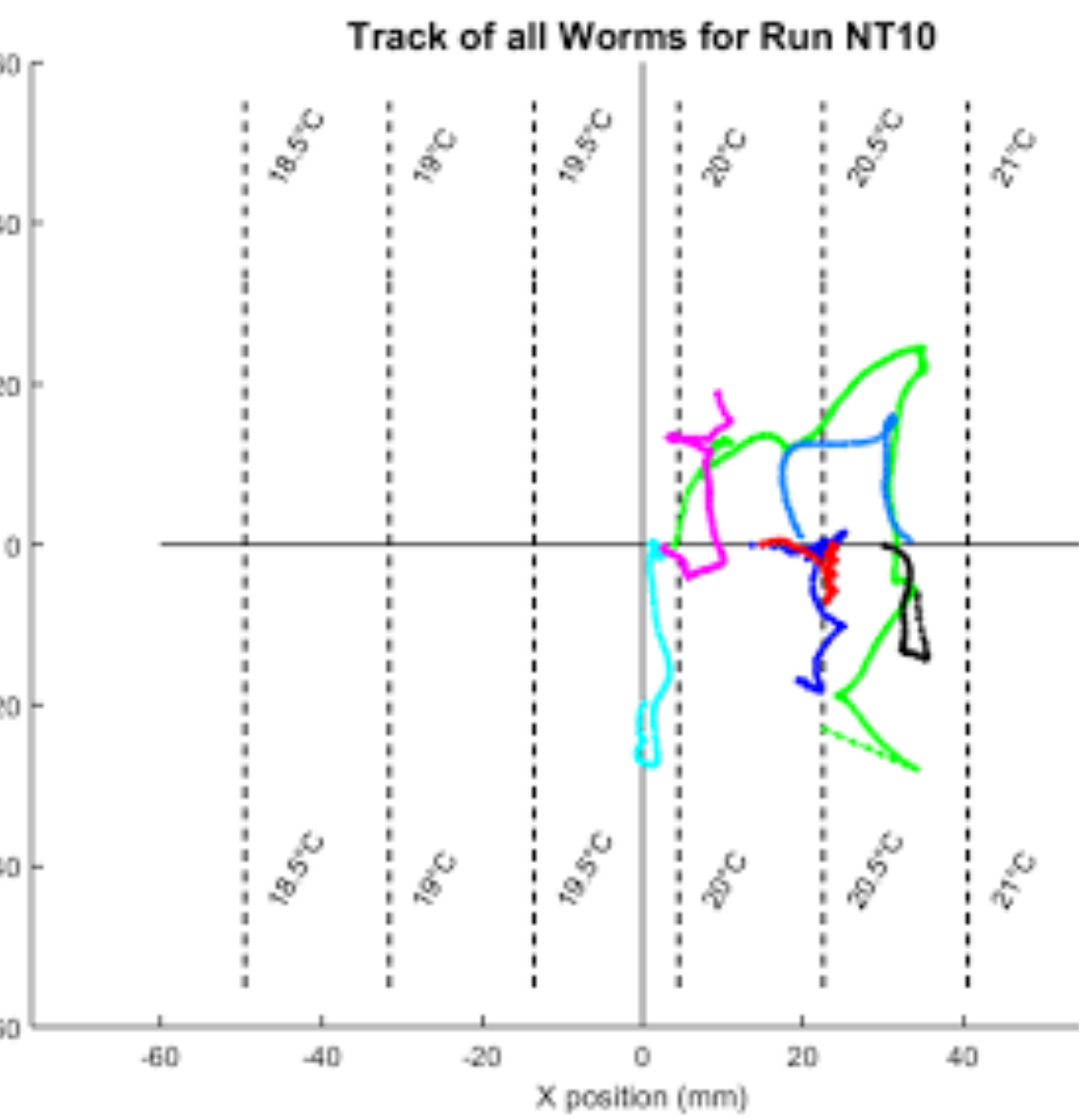
**Figure 8.** Temperature fluctuation measured at one point on temperature plate

## RESULTS

- As expected, we were able to observe 90 degree behavior in the sample below (See Dark Blue Worm Track)
- We also saw some isothermal behavior at the 20 degree point (See Light Blue and Pink Worm Tracks)
- Some isothermal behavior was observed at somewhat higher temperatures (See Red and Black Worm Tracks)



**Figure 9.** Raw video still taken with Canon 60D camera.



**Figure 10.** Results from experiment with .28 Degrees/cm gradient .

## CONCLUSIONS

- We were able to observe both the 90 degree and isothermal behavior
- We believe this demonstrates *C. elegans* have a navigation integration system similar to the grid cells found in a mouse's entorhinal cortex (Figure 8)
- However, the temperature gradient failed to be within the *C. elegans* sensitivity range of .1 degree. As shown below by the temperature graphs (Figure 9), our systems varied roughly +/- 0.5 degrees
- In order to improve future research, we aim to create a system that will have a +/- 0.1 stable temperature gradient.

## REFERENCES

- Luo, L., Clark D. A., Biron, D., Mahadevan, L., & Samuel, A. D.T. 2006. Sensorimotor control during isothermal tracking in *Caenorhabditis elegans*. *Journal of Experimental Biology*, 209: 4652-4662. doi: 10.1242/jeb.02590
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## ACKNOWLEDGEMENTS

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