College of Engineering
UNIVERSITY OF GEORGIA

Capstone Design Project Abstract

Project Title: Cooling a Brain Sectioning Device
Sponsor: Dr. Sheba MohanKumar
Team Members: Anastasia Marx, Conner Sweat, Nicholas Cox, and Grace Yankus
Faculty Mentor: Dr. Cheryl Gomillion

This project aimed to develop a device that maintains a brain sectioning matrix at a stable temperature range of -5℃ to 10℃ to prevent neurotransmitter degradation. The client, Dr. Sheba M.J. Mohankumar of the UGA Veterinary Department researches how stress, environmental exposures, and other factors affect neurotransmitters in the body. In order to conduct this research, it is necessary to study serial coronal sections of frozen mice brains to quantify and understand those interactions. Issues arose due to the unique width of the brain required to conduct this research: one millimeter. The two existing medical devices typically used for this kind of research, the cryostat and microtome, do not meet the necessary requirements for this research. The cryostat does not allow for sectioning at the required width, and the microtome does not maintain the correct and essential temperature range. It is crucial for the temperature range to be accurate because, if the brain is not maintained under those parameters, it causes rapid, irreversible degradation of neurotransmitters when too warm, and the fracturing of the brain when too cold, which is catastrophic for research purposes. However, Dr. Mohankumar found a brain sectioning matrix from Zivic Instruments with a slicing width of 1 millimeter. It was necessary for this project to develop a method of chilling this matrix and the brain tissue it holds for the average amount of time that it would be out in the open air, twenty to sixty minutes. There were three design contenders arose after thorough research and planning; a freezing plate platform where the matrix would sit on top of the plate, a freezing plate where adjustable sides secure the matrix to the plate, or a freezing plate where a matrix-sized indent was pre-molded into the ceramic or stainless steel platform. The final design was that of a freezing plate whose edges would come up to just under the sectioning blade's end. The plate's edges must stop just below the blades in order to not hinder our client's brain-slicing ability. The ideal temperature range is reached and maintained using thermoelectric cooling through Peltier plates. Peltier plates function by applying opposing charges across semiconductors. This charge difference creates a heat sink and pulls heat from the top plate into the bottom plate. Fans and vent channels are placed below the Peltier plates to channel the heated air from the heat sink down and away from the cooling mechanism. Along with this design, a casing will be 3-D printed to sit on top of the freezing plate with cut-out sections to fit the matrices. This design would allow the client to obtain the required width of brain sections while also maintaining the brain tissue at the necessary temperature range.

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