STAGE TOP PLATFORM FOR STABLE AND LONG TERM INTRAVITAL IMAGING OF MOUSE MAMMARY TUMOR MODELS

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Problem Definition

Motivation

- Intravital imaging is a useful tool in cancer research.
- Difficulty of keeping polydimethylsiloxane (PDMS) lens stable for imaging.

Background

- Imaging windows can be placed in many locations in a mouse [1].
- Many research focuses related to cancer [2].
- Metal and glass lens can be kept stable for imaging, but has a tendency to fall out.
- PDMS lens allows for longer-term imaging of a single tumor, but can not be kept stable using the same system as the metal lens.

Figure 1: Metal and glass imaging window [1]

Figure 2: PDMS imaging window [1].

Design Criteria

- Dimensions: 2.75 x 4.0 x 1.0 inches the size of a K-frame.
- The microscope has a limited Z range of 9.3 millimeters so the platform needs to be lowered to allow for a better range of Z motion.
- The clamping mechanism must hold the PDMS lens (as shown in Figure 3) and the tumor still by applying constant pressure onto the mammary gland while still allowing adequate blood flow to the tumor.
- Materials must withstand being in a heating chamber of 31 ℃ for an extended period of time.
- The design must fit under the heating chamber that will be placed over the microscope as shown in Figure 4.
- The platform needs to be strong enough to hold a mouse and the clamping mechanism.
- Budget is $1,500.

Figure 3: The PDMS lens inserted into a mouse.

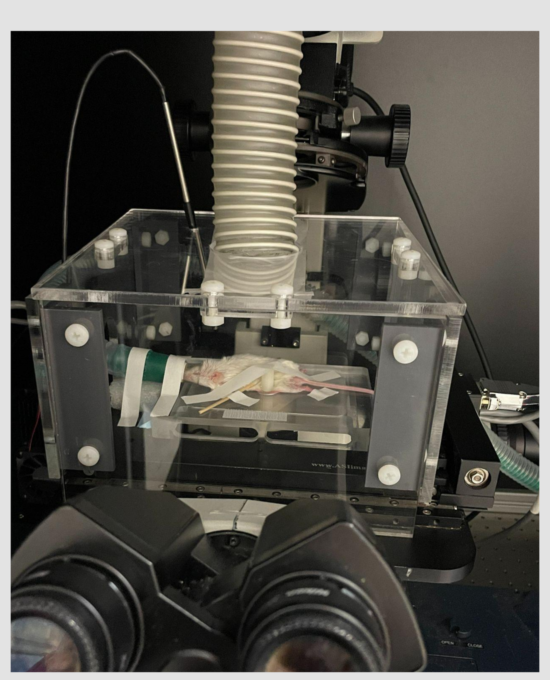


Figure 4: The heating chamber covering the stage top platform.

Quantitative Specifications

- The stage top platform along with the clamping mechanism must keep the PDMS lens and tumor still throughout the imaging process.
- A maximum drift of 10 microns so no more than 2% of the viewing frame is lost during imaging.

Figure 5: A reference to the size of a micron [3].

Final Design

Platform

- Acrylic due to its low thermal conductivity.
- Mill to shave underside of the platform.
- Mill to drill small hole of 15.2 mm through remaining plastic.
- Mill to drill larger hole 17.8 mm down 1.7 mm.
- Belt sander to round edges.

Stabilizing Apparatus

- 12.7 mm hole drilled through plastic.
- Bolt is placed through the hole.
- Velcro is attached to the platform and plastic.
- Bolt is adjustable and can add different amounts of force necessary.
  - Rubber shrink wrap tubing around the end of the bolt for thermal insulation.

Figure 6: An image of the final prototype with the attached stabilizing apparatus.

Testing and Results

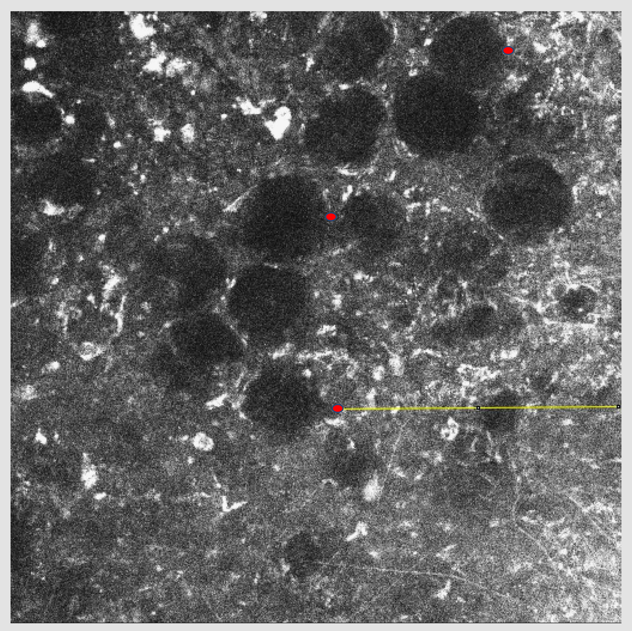
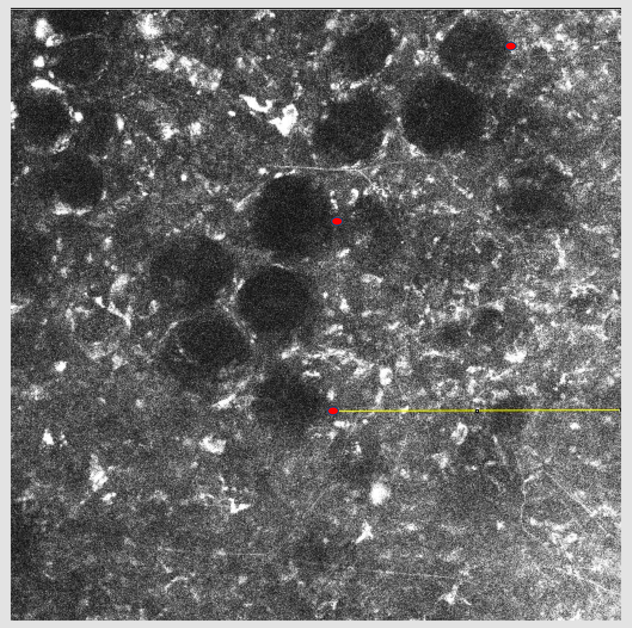


Figure 7: The starting frame from the test run using the team's prototype. Points of reference for calculating drift are labeled with red dots.

Figure 8: The final frame from the test run using the team's prototype. The amount of drift from the starting frame to final frame averaged to 6.81 microns. The average was calculated from the three different reference points.



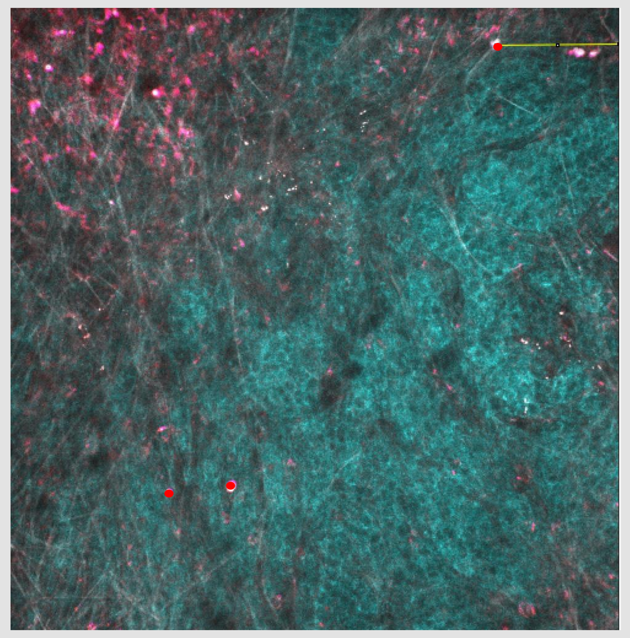
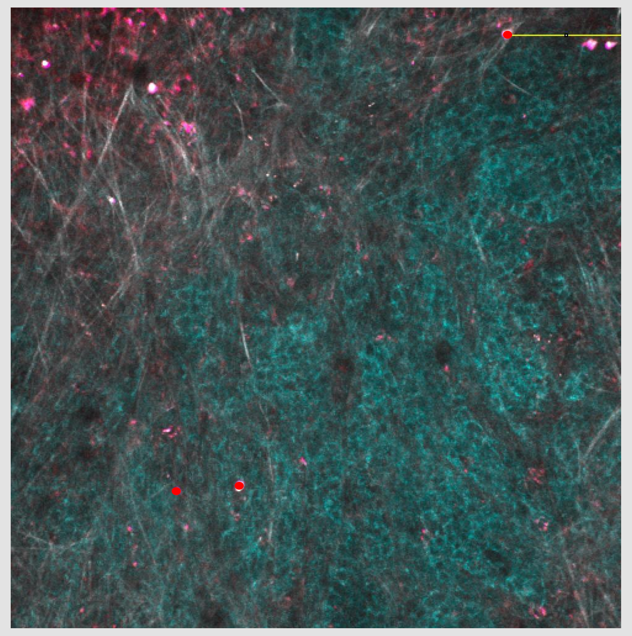


Figure 9: The starting frame from a standard collection using a rigid metal lens. Points of reference for calculating drift of the viewing window are labeled with red dots.

Figure 10: The final frame from a standard collection using a rigid metal lens. The amount of drift from the starting frame to final frame averaged to 4.32 microns. The average was calculated from the three separate reference points.



Future Work

- Adjust final design to work with interchangeable plates.
  - Allows both metal and PDMS lenses to be used during intravital imaging.
- Add lighting fixtures on the bottom-side of the design for fine tune adjustments during imaging sessions.
- Add heating element to maintain physiological conditions of the mouse.
- Pressure testing will be performed to mitigate the chances of deforming the lens and hemorrhaging within the mouse.
- Streamline anesthesia delivery and vital sign monitoring.
- End goal is to image multiple mice during imaging sessions.

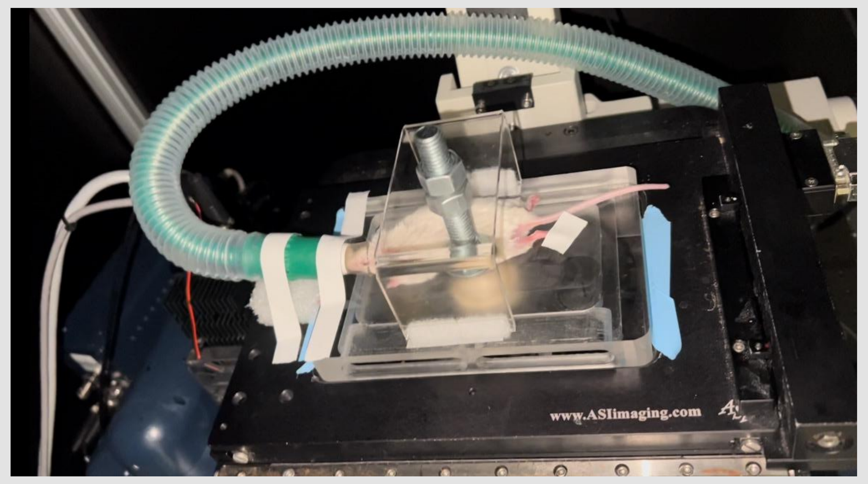


Figure 11: Actual set up of platform and clamping mechanism on the microscope stand.

References

[1] G. Jacquemin, "Longitudinal high-resolution imaging through a flexible intravital imaging window," *Science Advances*, Jun-2021. [Online]. Available: https://www-science-org.ezproxy.library.wisc.edu/doi/10.1126/sciadv.abg7663. [Accessed: 11-Oct-2022]

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[3] "What is Micron Rating & Why micron size matters for water filters?," *Celtic Water Solutions*, 05-Jul-2021. [Online]. Available: https://celticwatersolutions.ie/blog/what-is-micron-rating-for-water-filters/. [Accessed: 07-Dec-2022].

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