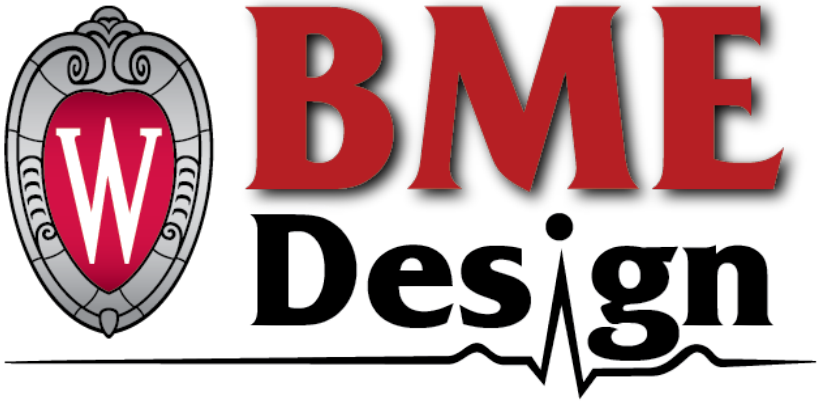

Stage Top Platform for Imaging of Mouse Mammary Tumor

Product Design Specifications
September 23rd, 2022
Lab Section 307

Joel Matthews (Team Leader), Hailey Kanter (Co-BWIG), Abbey Cohen (Co-BWIG), Abbylee Maeder (Communicator), Christy Li (BPAG), Amara Monson (BSAC)

Client:

Dr. Suzanne Ponik and Dr. Brian Burkel

Advisor:

Dr. Kris Saha

Function:

Dr. Suzanne Ponik and Dr. Brian Burkel have been using intravital imaging to analyze the microenvironment surrounding a tumor in the mammary gland of mice. Using a steel lens only allows for analysis of up to two weeks due to activity of the mice. Using a flexible PDMS lens [1] for intravital imaging has been shown to last in a mouse for up to 8 weeks, which allows for a better understanding of the long term effects in the microenvironment of a tumor in the mammary gland as well as multiple observation points. Creating a stage top platform that keeps a PDMS lens stable throughout imaging will allow researchers to use PDMS imaging lenses more and to gain more information about a tumor microenvironment. Additionally, pressure must be put on the mammary gland of the mouse to observe the tumor. To solve this, a clamp will be added to the platform for constant pressure on the specimen for clear imaging.

Client requirements:

- Create a stage top plate for a flexible PDMS lens for intravital imaging that allows the lens to remain stable for long periods of time.
- Add an additional apparatus to the plate that applies constant pressure on the mammary gland of the mouse to allow for clearer images.
- If there is time and money available, add an additional lens to the stage top platform so multiple mice can be imaged at once.
- The stage top platform must fit into the heating chamber of the microscope.

Design requirements:

1. Physical and Operational Characteristics

a. Performance requirements: The stage top platform must keep the flexible PDMS lens stable throughout the imaging process. This includes an apparatus attached to the platform applying constant pressure on the mammary gland for clear imaging to fully analyze the microenvironment of the tumor. The device must be reusable and work for imaging of multiple mice.

b. *Safety*: The mouse and the platform are in a heating chamber during imaging. Since the platform comes into contact with the mouse's skin and fur, the material cannot be thermally conductive and cannot cause burns to the skin. This also goes for the chemical makeup of the surface of the material and no damage should be done to the skin and fur of the mice.

c. *Accuracy and Reliability*: The device needs to allow for the accurate and precise range of motion of the objective lens. It also needs to maintain the same accuracy and precision

when using different objectives. The stage that the platform will rest on moves relative to the fixed lens. The range in the Z-direction is about 9.3mm. The X range is about 91mm and the Y range is about 67mm. These dimensions are limited by the riser dimensions and lens diameter of the microscope.

d. *Life in Service*: The platform needs to be able to lay in the microscope for up to 8 hours without moving at all. It will need to allow the operator the microscope to move the lens without disturbing the platform

e. *Shelf Life*: The stage top platform should be able to stay in use for many years. It will be in a lab at room temperature. The only external factor in the shelf life is the mice that will be laying on the platform. The device needs to be strong enough to hold up a mouse, but that is the only environmental condition.

f. *Operating Environment*: The device will be in a room temperature lab and may need to be placed in storage for long periods of time. It will come in contact with a sedated mouse. There are no changes in pressure or other environmental factors that need to be considered.

g. *Ergonomics*: This device will be designed for optimal use while laying flat on a surface, though it will remain functional while being moved to and from the microscope while being carried in a flat position. It will be mobile, with no restrictions based on height or reach. The device must be strong enough and stable enough to support the weight of a mouse.

h. *Size*: The device will be fit into a riser in order to be secured to the microscope. Our client suggested that we work with existing risers, which creates a size restriction of 2.75 inches by 4.0 inches. Additionally, the current design of the imaging tray and riser system is one inch tall, but has the microscope at the very top of its vertical limits, so it would be advantageous to reduce the height of the tray when in the riser by 2-3 millimeters.

i. *Weight*: As this device will be moved to and from the microscope often, it needs to be light enough to allow for easy removal from and insertion into the system. This is the only weight restriction.

j. *Materials*: Currently there are two stage top platforms in use for imaging. The first is made purely of metal, and the second is 3D printed and made purely of plastic. The materials being used are to be placed in a heating chamber while imaging is occurring. It is critical that the materials chosen for the final design do not overheat while in the heating chamber over an extended period of time. In addition to this, the type of material must be strong enough to support the full weight of a mouse.

k. *Aesthetics, Appearance, and Finish*: There are no requirements regarding aesthetics, appearance, or finish.

2. Production Characteristics

a. *Quantity*: The client is requesting one stage top platform for imaging that is compatible with the new PDMS lens. The client is requesting that the one stage top platform fulfills the need for constant pressure on the mammary gland to allow for clear imaging. If given the time and resources, the client is requesting a second stage top platform with an additional lens allowing two mice to be imaged synchronously.

b. *Target Product Cost*: When asked, our client provided a budget of $1,500. Dave Inman will be the contact for all budget related questions as he is in charge of the budget for this project. Our client suggested using the cheapest materials available when prototyping. Contact: drinman@wisc.edu

3. Miscellaneous

a. *Standards and Specifications*: Due to the intended use of our device being for research involving animals, there is no pre-approval required from the FDA. For the registration of a patent the design will be required to be registered with the FDA. This device classification would fall under the hematology sector of the FDAs classification panel, part 864. [2]

b. *Customer*: The design is to be built for any member of the client's team, along with other microbiologists, that will be working in direct contact with the high-power microscope. The client has not provided any materials, practices, or techniques that are unwanted in the design. The main and only preference the client has is to minimize cost.

c. *Patient-related concerns*: With the design's intended use, the product will not come into contact with any patients. The device will not contain nor store any patient data, all data obtained will be recorded by the researcher. The product should be able to hold the anesthetized mouse without movement for the duration of the examination period. As the device will not be exposed to bodily fluids, sanitization will not be a concern.

d. *Competition*: From the literature, there is one stage top holder that is designed specifically for the PDMS viewing window. It's patented under the number EP3656349A1 by Institut Curie. [1] This project is focused on developing a plate that can be used with the client's current system hence, while existing products are useful, it's not pertinent in this case and cannot be utilized by our client

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.

[2] Center for Veterinary Medicine, “How FDA regulates animal devices,” *U.S. Food and Drug Administration*,29-Jun-2021.[Online].Available: https://www.fda.gov/animal-veterinary/animal-health-literacy/how-fda-regulates-animal-devices. [Accessed: 22-Sep-2022].