PRODUCT DESIGN SPECIFICATIONS

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Project Title: Device for *in-vivo* 2-photon imaging of synapses in mobile mice

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Function:

2-photon microscopy is a highly useful tool for examining a variety of characteristics. In neuroscience, it has become particularly useful for imaging of synapses in the brain to determine brain function. Other groups have successfully used a cranial window in mice to perform synapse imaging by holding the mouse's skull rigidly to the stage of the microscope while leaving the body free to move. It is the goal of this project to create a similar device that will allow a mouse's head to be held in a fixed stereotaxic frame to be used for examination of synapses during sleep and waking periods.

Client Requirements:

The clients, Dr. Giulio Tononi and Dr. Ugo Faraguna, would like the construction of a fixed stereotaxic frame for 2-photon microscopy. The device is made up of two modules: a frame that holds the mouse's skull in a fixed position for microscopy of the cranial window, and a "treadmill" that allows freedom of movement for the mouse. The client would like the treadmill to be done as quickly as possible for design purposes and for training the animals. Important considerations include the fact that the device must have no electrical components; the treadmill should ideally provide no movement restrictions; and that the device must fit between the lens of the microscope and the table on which the microscope rests.

Design Requirements:

A. The "treadmill"

1. Physical and Operational Characteristics
    a. *Performance Requirements*
    The device should allow at minimum 1-dimensional mobility for the mouse. It should ideally allow complete freedom of movement for the mouse to run, stop, stand, and fall asleep with no discomfort whatsoever.
    b. *Design Restrictions*
    The device must be large enough to support mice of various sizes but also small enough to fit underneath the lens of the microscope and the table on which the microscope rests. No electrical components may be used.
    c. *Materials/Durability*
    Materials used should be inexpensive, but durable and able to

withstand long periods of extensive use. The device should require as little maintenance as possible.

2. Production Characteristics
    a. *Time*
    The device should be prototyped and tested as quickly as possible to allow for the mice to be trained properly.
    b. *Quantity*
    Only one prototype should be necessary provided it meets the functional requirements.

B. The stereotaxic frame

1. Physical and Operational Characteristics
    a. *Performance Requirements*
    The device should allow for complete immobilization of the head for effective, repeated use of 2-photon microscopy. The immobilization should be constant—that is, when a mouse is held in the stereotaxic frame and then released, when it is placed back in the frame it should be in the same position. The device must have two parts: one attached to the mouse's skull via dental cement and an appropriate attachment point on the frame itself. The frame should have a window that the cranial hole can be seen through. The frame should also have the potential for EEG monitoring.
    b. *Design Restrictions*
    The frame should be solid enough to prevent movement from the mouse. It should allow for repeated attachment and detachment of the mouse from the microscope stage. The attachment on the mouse's skull should be light and compact to limit restrictions on the mouse's normal mobility. There should be no electrical components aside from the interface to provide EEG monitoring, should that be necessary.
    c. *Materials/Durability*
    The frame should be extremely durable and able to withstand extensive use for extended periods of time. The attachment to the mouse's skull should ideally be made from plastic and either reusable or cheaply and easily purchased or constructed.
2. Production Characteristics
    a. *Time*
    The device should be prototyped after the arrival of the microscope to allow for proper measurements.
    b. *Quantity*
    Only one prototype should be necessary.