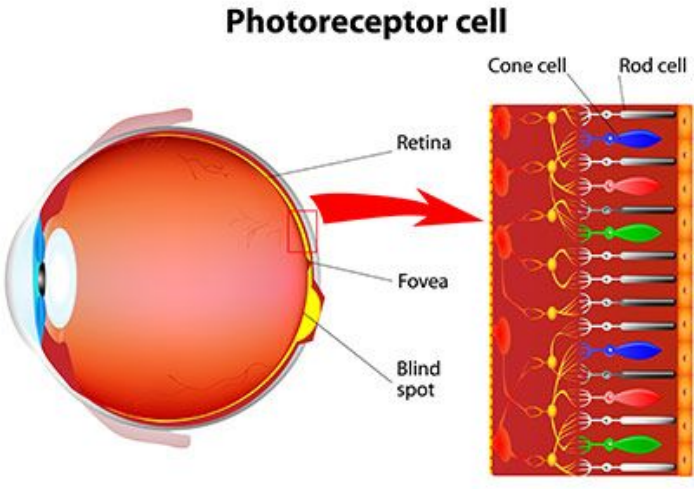
Rodent Rotation and Translation Stage (RRaTS)

Kurt Vanderheyden	Team Leader
Kyle Schmidt	Communicator
Kevin Tan	BWIG
Nolan Thole	BPAG
Riley Pieper	BSAC

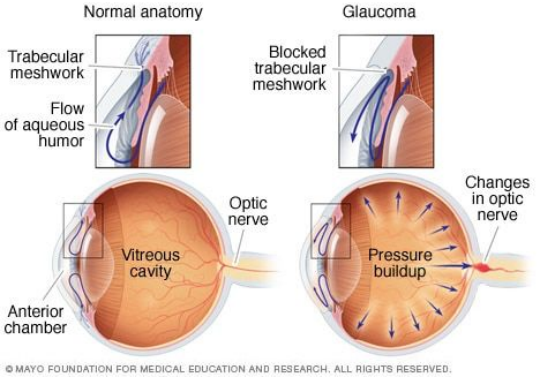
Problem Statement

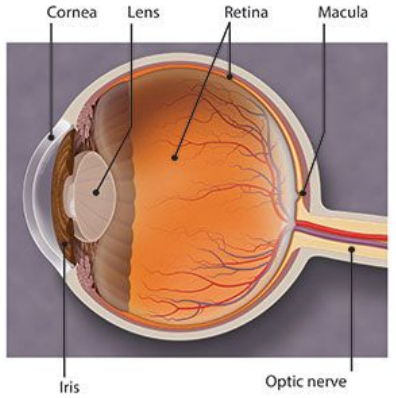
- Imaging of photoreceptors in rats requires precise alignment
- Must develop a stage with translational and rotational capabilities
  - Translational for alignment
  - Rotational for imaging all parts of the eye
- Must keep eye at the intersection of the axes
- Open top to allow easy access to the rodent



Ocular Imaging

- Reasons for Imaging rats:
  - Glaucoma
    - Damage to the optic nerve
    - High pressure in eye
  - Macular degeneration
    - Macula is damaged and central vision loss
    - Wet= growth of abnormal blood vessels
    - Dry= part of macula gets thinner and protein clumps develop
  - Cell replacement therapy
  - Gene therapy



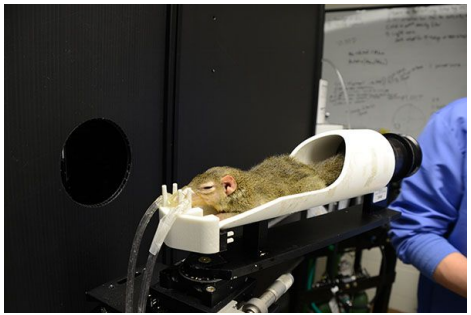


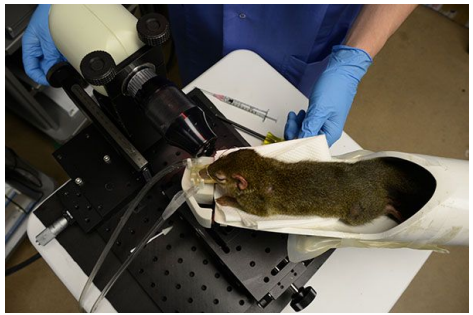
Imaging Subjects

- Average rat weighs 250-500
- Average length 17-21 cm
- Rats used in lab because:
  - Frequent reproduction
  - Genetic purity
  - Similarity to human biology

Current Lab Setup

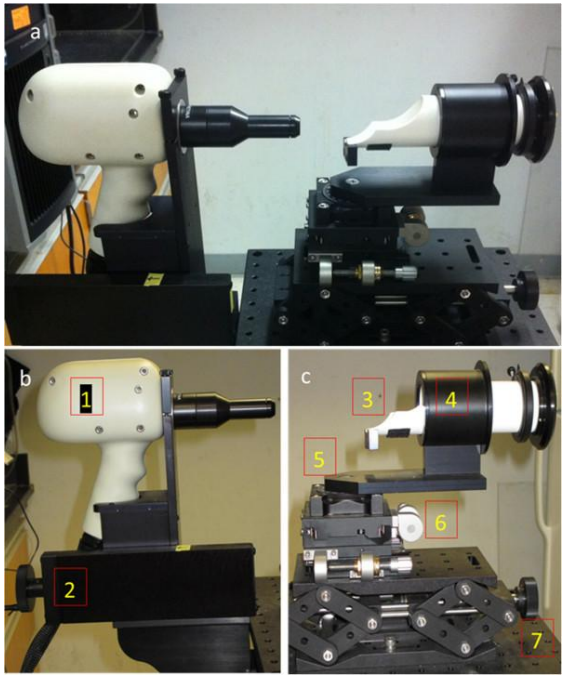
- Current alignment stage gets in the way
- Lacks adjustability for working distance
    - Currently 10mm, optimally work up to >100mm
- Live feedback from computer for alignment





Competing Solutions

- Bioptigen’s rodent aligning system
- Two degrees of rotation: roll and yaw
- 1 degree of translation inside the rotational axes
- 3 degrees of translation outside the rotational axes
- Why design a new solution?
  - Lacking pitch rotation
  - Translation within the rotational axes is required for positioning the eye in the center of rotational axes
  - No longer sold

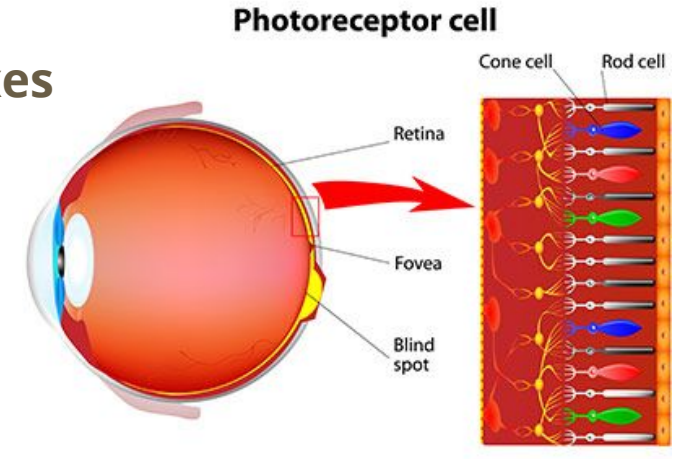


Previous Design Team's Solution

- Provided 5 degrees of freedom
- Struggles
  - Failed to keep eye in center of axes
  - Difficult to sanitize
  - Poor choice of materials

Problem Statement - Refined

- Imaging of photoreceptors in rats requires precise alignment
- Must develop a stage with translational and rotational capabilities
  - Translational for alignment
  - Rotational for imaging all parts of the eye
- **Must keep eye at the intersection of the axes**
- Open top to allow easy access to the rodent

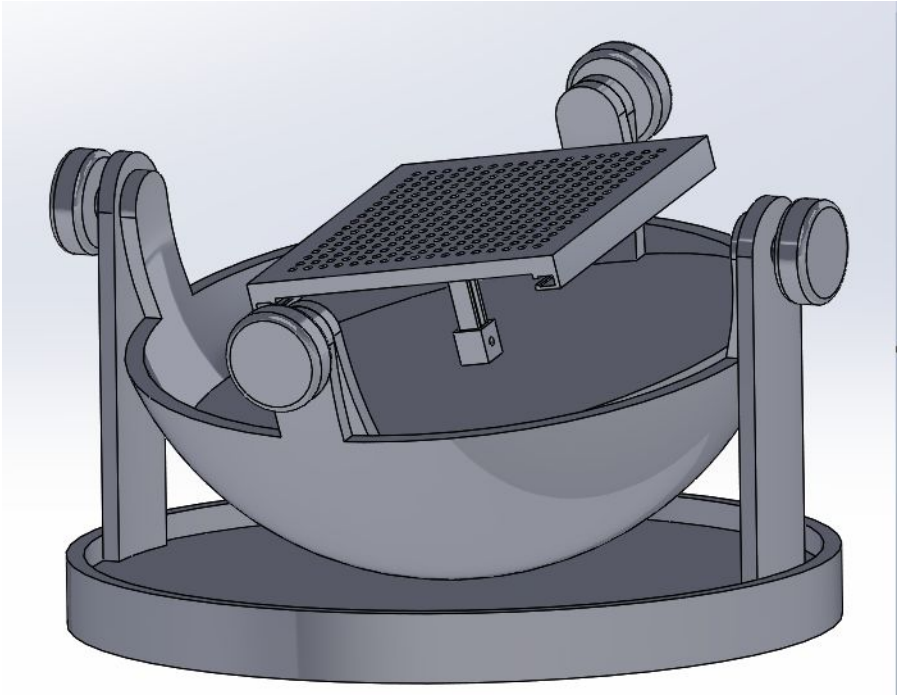


Product Design Specifications

- 5 Degrees of Freedom (minimum)
  - 2 Rotational: pitch yaw
  - 3 Translational: x y z
- Adjustment Precision:
  - Eye Alignment: 100 microns
  - Rotation: 2°
  - Optimal Resolution: 500 microns FOV
- Interchangeable Sample Holder: Flexibility
- Smooth Surfaces: Sterilizability
- Budget: $350

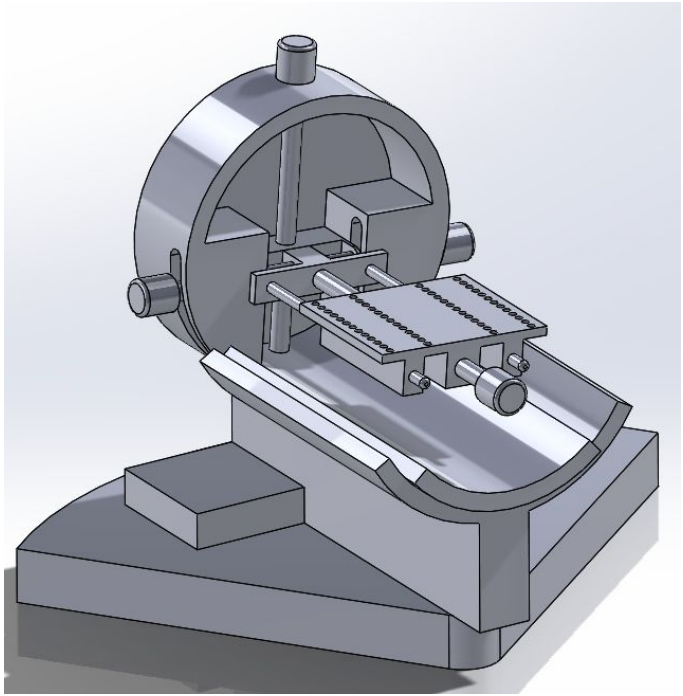
Design Alternatives Considered - Bowls

- 6 Degrees of Freedom
- Friction-Based Adjustment
  - Rotational Knobs
  - Spinning Plate
  - Translating Rails - Internal Translation
- Mount Sample Holder on Stage



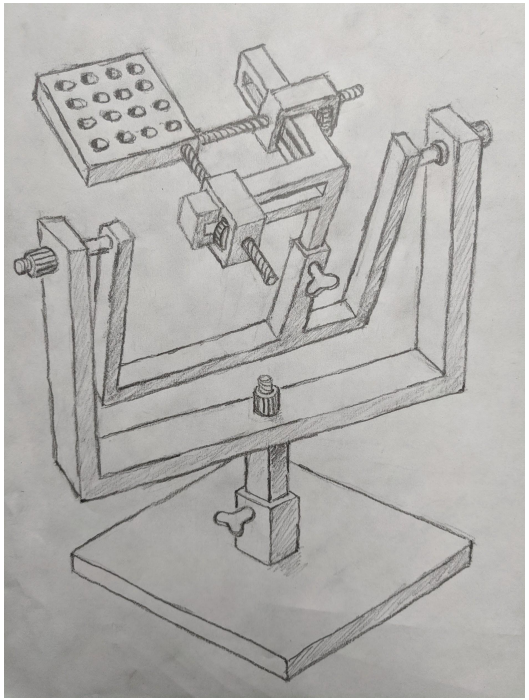
Design Alternatives Considered - Pizza

- 5 degrees of freedom
- Rotational Adjustment - Friction
  - Cylinder - Pitch
  - Pivot - Yaw
- Internal Translation
  - Precise Dial Alignment
  - Travel Along Threaded Rods

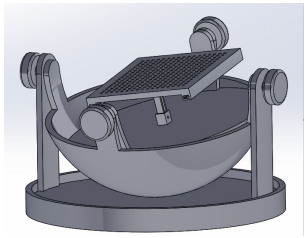


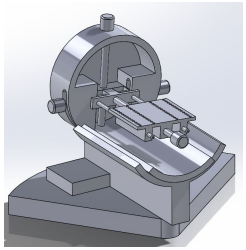
Design Alternatives Considered - Field Goal

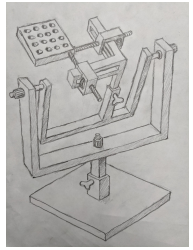
- 6 degrees of freedom
- External translation
  - Telescoping raising/lowering
- Rotational adjustment - Thumb screw
  - Pitch and Yaw
- Internal translation
  - fine knob adjustment
  - Telescoping raising/lowering



Design Matrix







Criteria	Design 1: Bowls	Design 2: Pizza	Design 3: Field Goal
Ease of Adjustment (20)	3	5	3
Rotational Freedom (18)	5	4	3
Translational Freedom (15)	3	4	2
Ease of Fabrication (12)	3	2	5
Sterilizability (12)	4	3	3
Strength (8)	2	4	2
Safety (5)	4	5	4
Simplicity (5)	3	2	5
Cost (5)	3	1	5
Total (100)	69	72.8	65.2

Future Work

- Optimize the Pizza Design (ongoing)
  - Component to Guide Pupil Alignment?
  - Integration of Design with Imaging System (Cart?)
- Develop Fabrication Plan for Pizza Design
- Determine Necessary Materials for Prototype
- Conduct Testing on Prototype
  - Rotational Precision
  - Translational Precision (Accuracy of Pupil Alignment)

Acknowledgements

- Prof. Jeremy Rogers
- Dr. Ben Sajdak
- Prof. Aaron Suminski

References

- E. Ades, “Species Specific Information: Rat,” Johns Hopkins University, 11-Mar-2009. [Online]. Available: http://web.jhu.edu/animalcare/procedures/rat.html#normative. [Accessed: 01-Oct-2019].
- wiseGEEK. (2019). Why are Rats Used in Animal Testing? (with pictures). [online] Available at: https://www.wisegeek.com/why-are-rats-used-in-animal-testing.htm [Accessed 25 Sep. 2019].
- Medicalxpress.com. (2019). Researchers uncover evidence of restored vision in rats following cell transplant. [online] Available at: https://medicalxpress.com/news/2018-11-cell-transplant-vision-rats.html [Accessed 25 Sep. 2019].
- G. Musser. (2018, Oct. 10). Rat [Online]. Available: https://www.britannica.com/animal/rat
- Mayo Clinic. (2019). *Glaucoma - Symptoms and causes*. [online] Available at: https://www.mayoclinic.org/diseases-conditions/glaucoma/symptoms-causes/syc-20372839 [Accessed 2 Oct. 2019].
- American Academy of Ophthalmology. (2019). *What Is Macular Degeneration?*. [online] Available at: https://www.aao.org/eye-health/diseases/amd-macular-degeneration [Accessed 2 Oct. 2019].