RESEARCH DESIGN PROJECT

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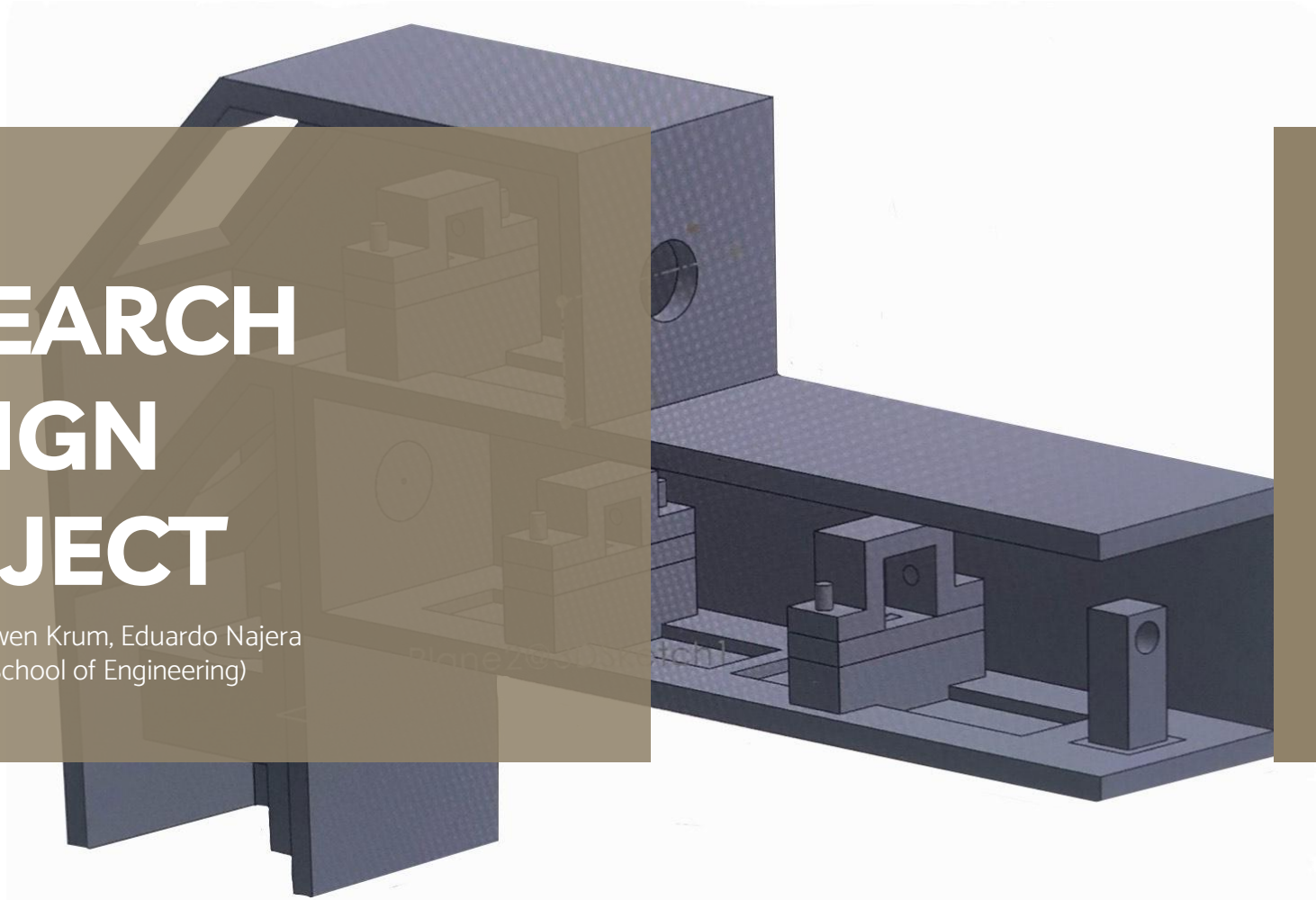


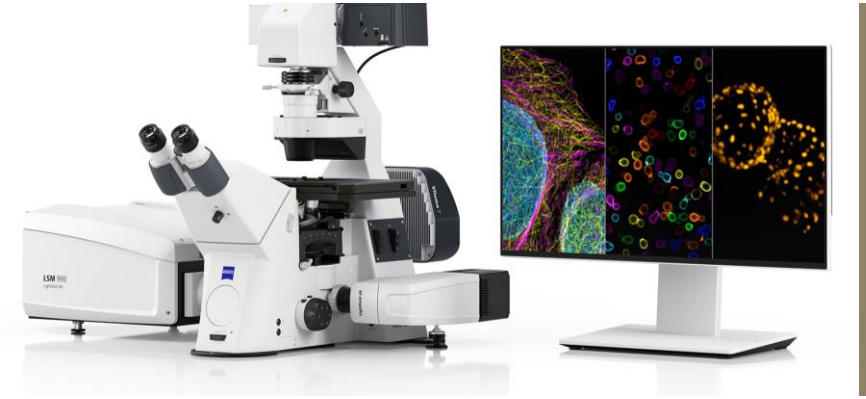
TRIBOMECHADYNAMICS LABORATORY

- Pioneering research at the **crossroads of structural dynamics, contact mechanics, and tribology**
- Goals include optimizing interfacial component design in terms of weight, wear, and properties
- Website: https://brake.rice.edu/

CONTEXT

BACKGROUND

A confocal microscope is needed to scan surface roughness for analyzing moving parts sliding against each other



PROBLEM

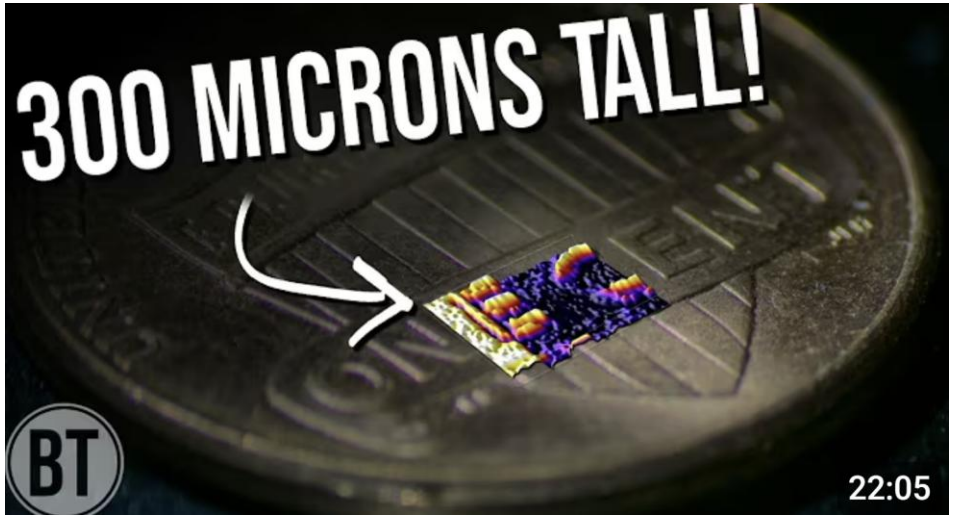
These types of microscopes are not only costly but also require multiple days to complete a scan and map results

PROJECT GOAL

Design and build **the optical unit** of a cost-effective confocal microscope that can complete scans within 24 hours while achieving micrometer-level resolution

STAGE 1: Background Research

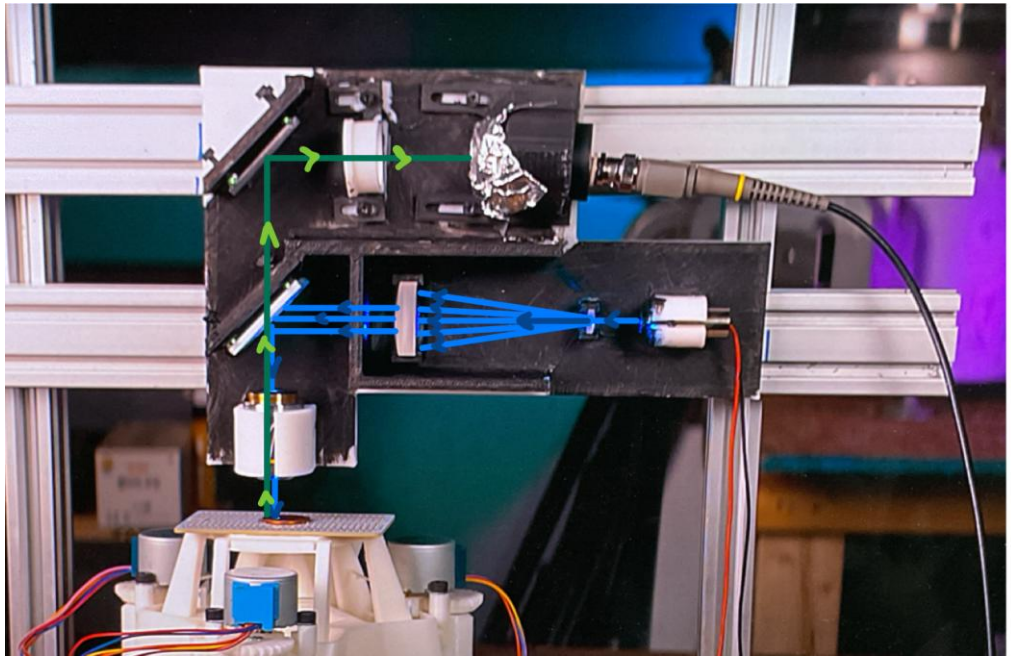
YouTube Video



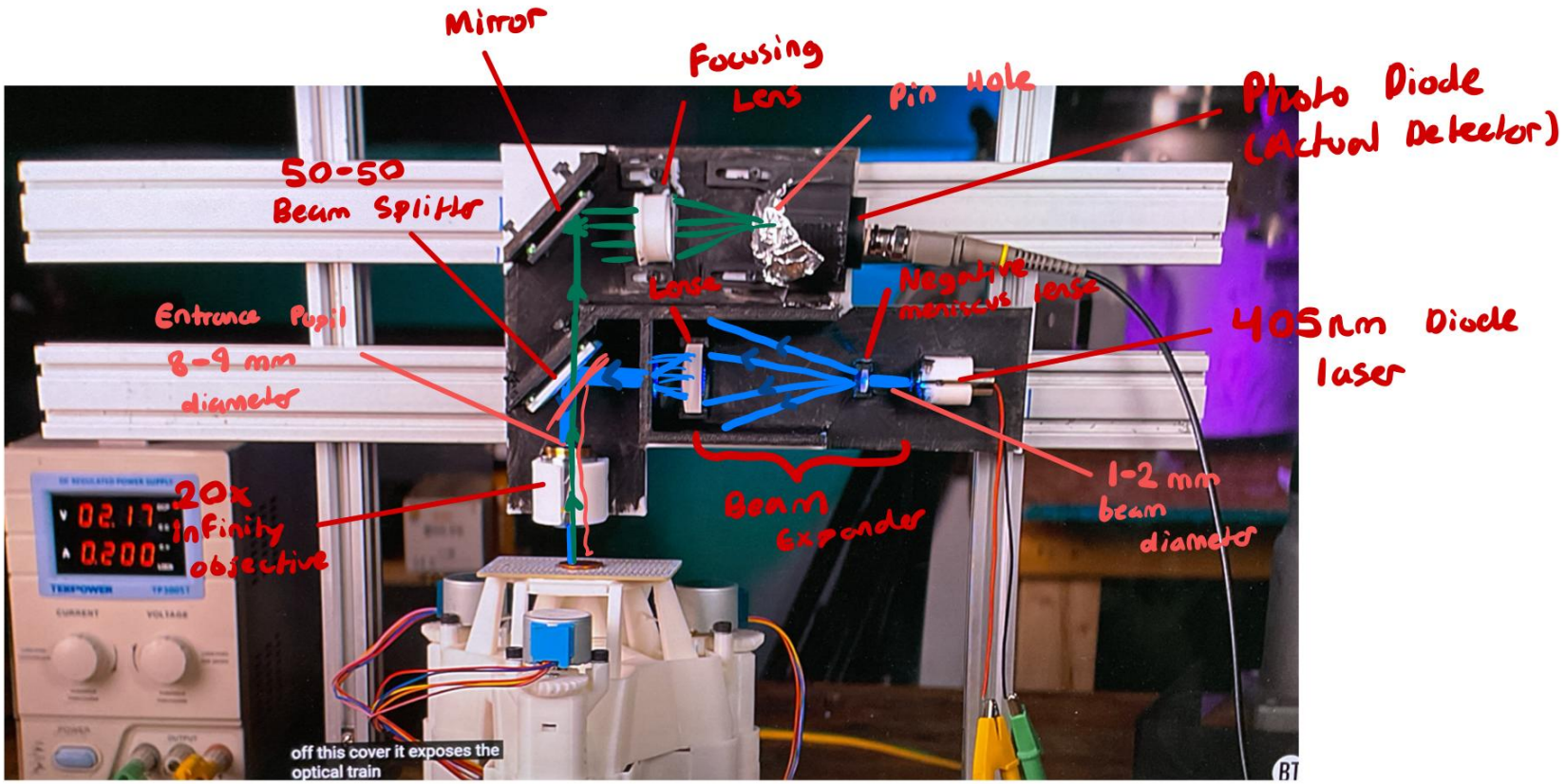
"DIY Scanning Laser Microscope"

https://www.youtube.com/watch?v=9TYlQ4urcg8&t=294s

The Basic Idea

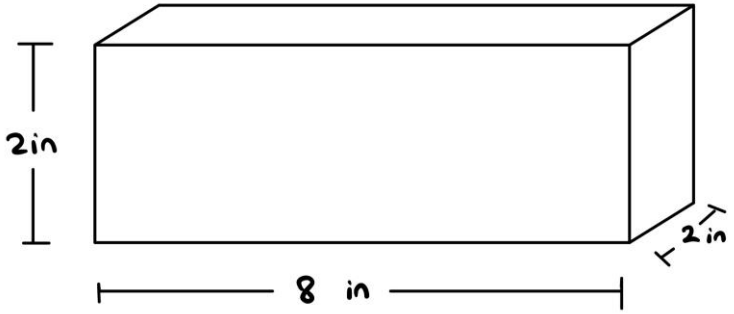


A laser is projected onto the penny using lenses and mirrors, and then bounces off the penny into a sensor to analyze results


Mirror
Focusing Lens
Pin Hole
Photo Diode (Actual Detector)
50-50 Beam Splitter
Lens
Negative meniscus lense
Entrance Pupil 8-9 mm diameter
405nm Diode laser
20x Infinity objective
Beam Expander
1-2 mm beam diameter
off this cover it exposes the optical train

STAGE 2:
Design

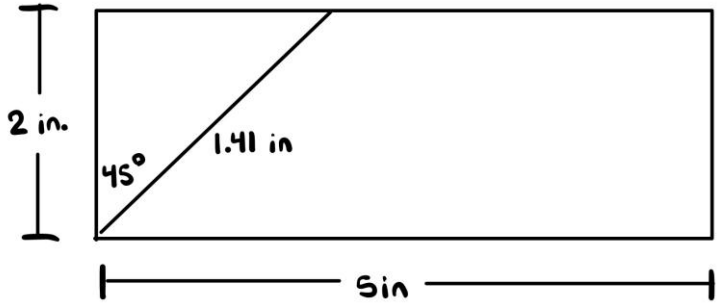
Beam Expander Unit



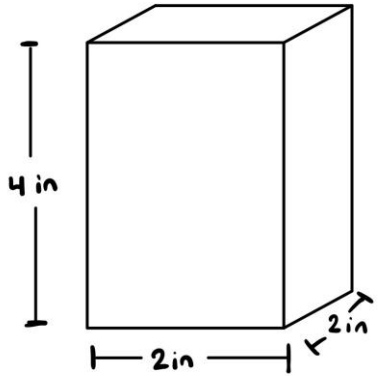
Wall Outward Thickness

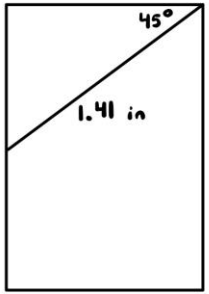
↳ 0.5cm

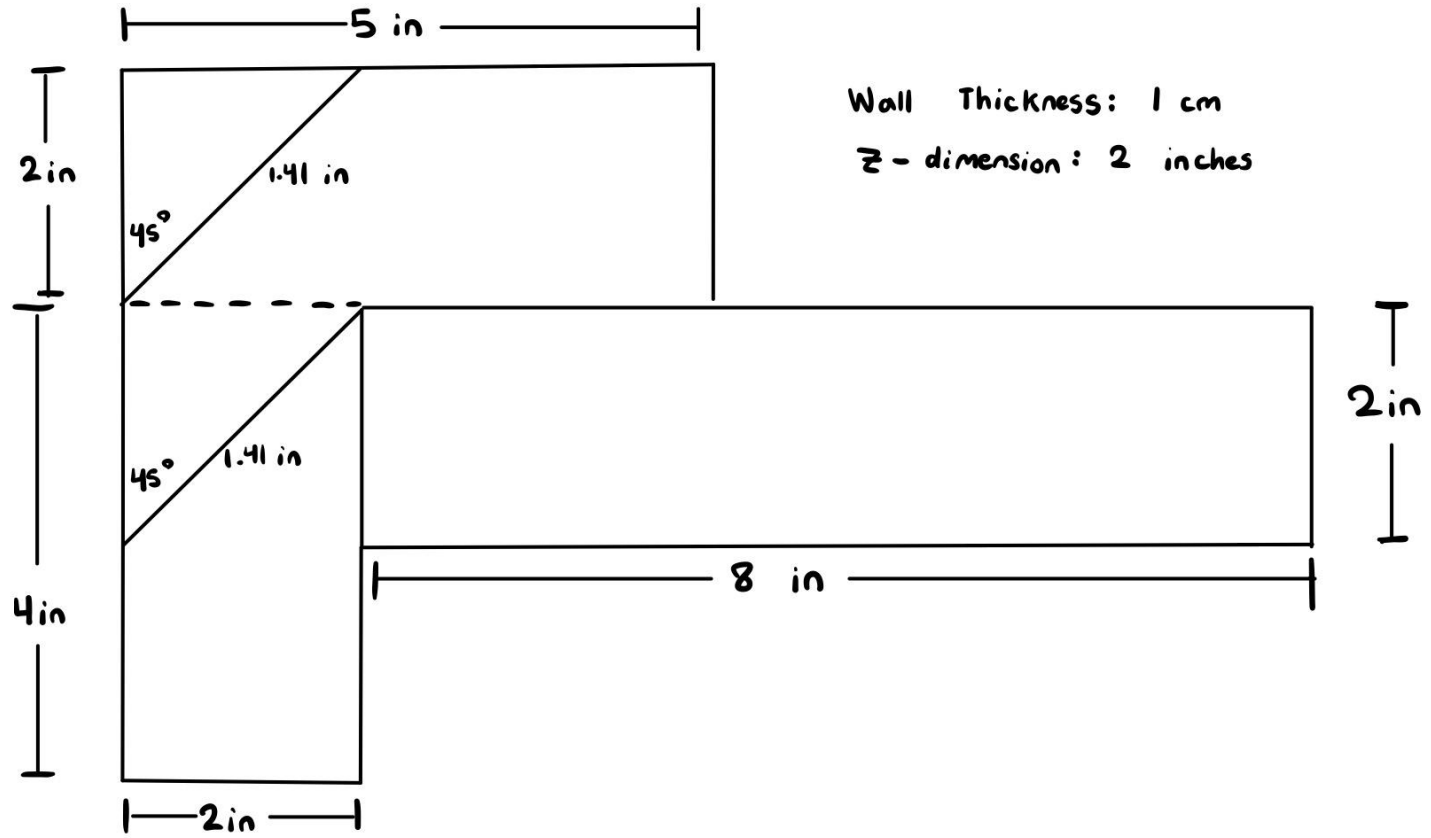
Photodiode unit



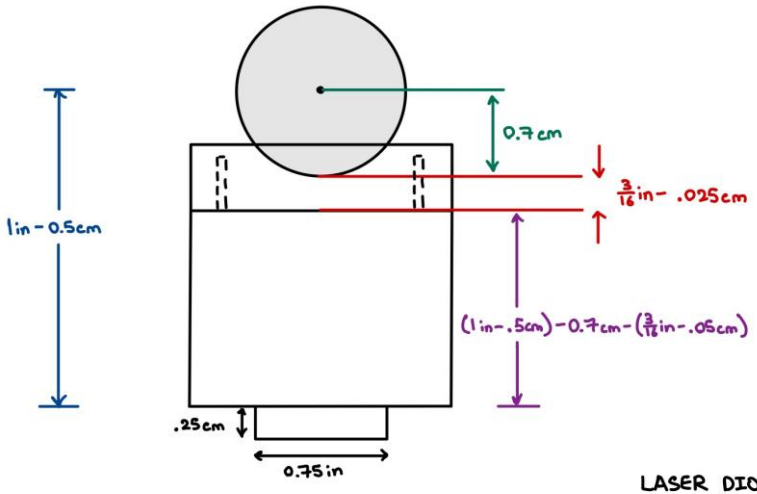
Infinity Objective Unit



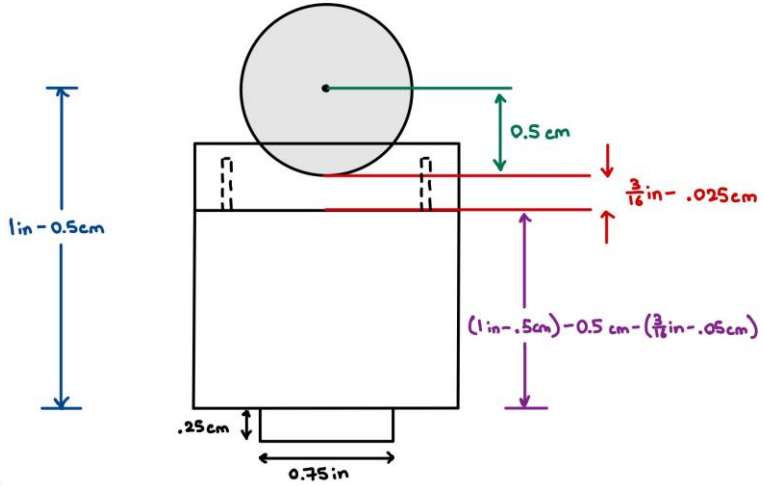



5 in
2 in
1.41 in
45°
45°
1.41 in
4 in
2 in
8 in
2 in
Wall Thickness: 1 cm
Z - dimension: 2 inches

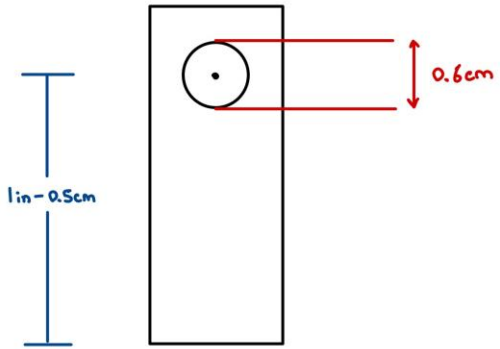
(+) LENS HOLDER



(-) LENS HOLDER



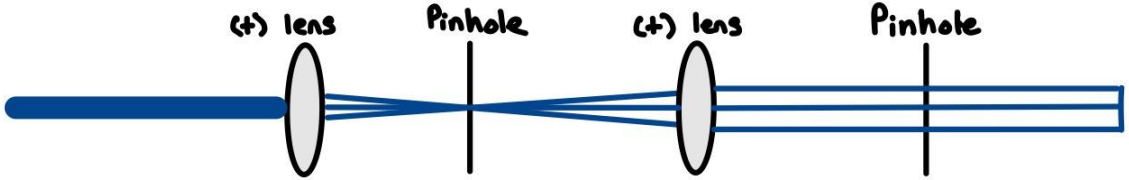
LASER DIODE HOLDER



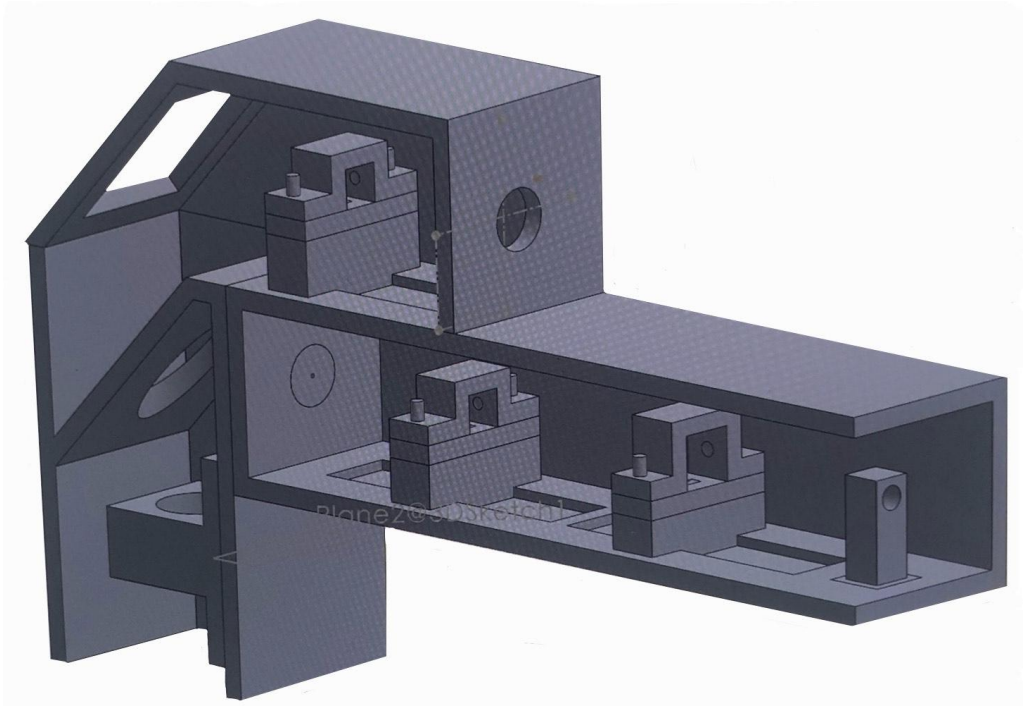
Two methods for beam expander

1.) A simple approach

2.) Complex, but "cleans up" laser beam



Final CAD Design (SOLIDWORKS)



STAGE 3: Building

BILL OF MATERIALS:

2 Positive meniscus lens ($20)
https://www.edmundoptics.com/p/10mm-dia-x-58mm-fl-positive-meniscus-lens-grade-2-/32768?gad_source=4&gclid=Cj0KCQjwsPCyBhD4ARIsAPaaRf1fohC62fO6my2kN9y-7Psza5jOjtKID0Bpc7V9zxN1Dy_ao5a1NeMaAklPEALw_wcB

Negative meniscus lens ($5)
https://www.edmundoptics.com/p/14mm-dia-x21mm-fl-negative-meniscus-lens-grade-2-/32828?gad_source=1&gclid=Cj0KCQjwsPCyBhD4ARIsAPaaRf3waCyNvdMe66LA2Gvc6TCrhBTQkUZ1SF4YGVIvD7NTSjx-idvDdWAaAl_uEALw_wcB

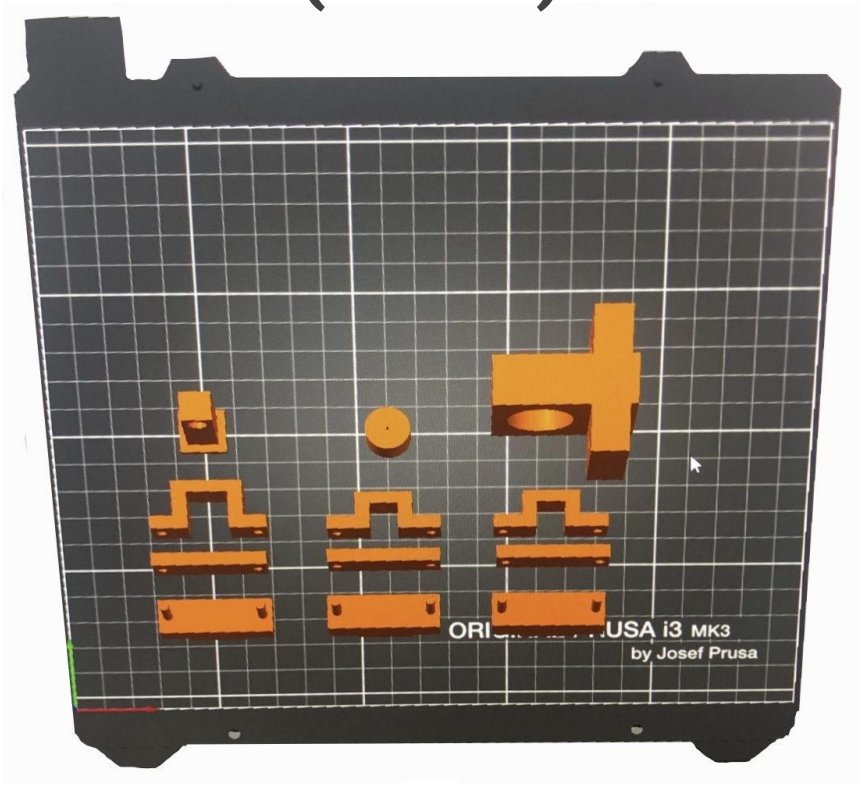
50-50 beam splitter ($25)
https://www.edmundoptics.com/p/20-x-2828-x-25mm-elliptical-beamsplitter-50r50t/1062?gad_source=4&gclid=Cj0KCQjwsPCyBhD4ARIsAPaaRf14JbS1FhC9th3y61p5EH4LLTGiz-Bev-8hscIaFOLSjuA8_dKTakwaAoaKEALw_wcB

20x infinity objective ($30)
https://amscope.com/products/a20x-v300?tw_source=google&tw_adid=&tw_campaign=20842288248&gad_source=1&gclid=Cj0KCQjwsPCyBhD4ARIsAPaaRf2-KvrWAQi3hjd-eNz5gCWL3_sD51AyKde4-X6UPyXW5gGSEEjaWp0aApt8EALw_wcB

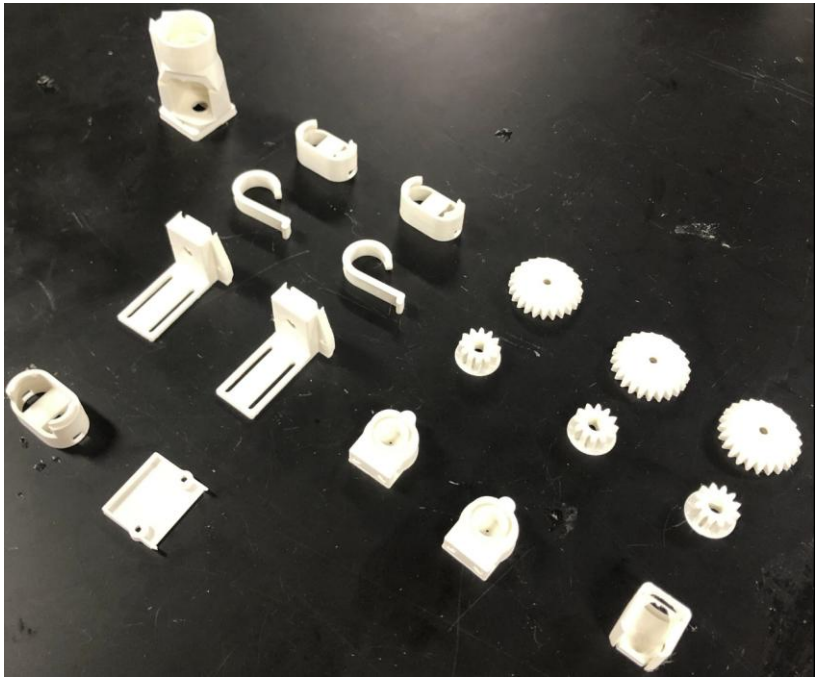
Photodiode ($25)
https://www.digikey.com/en/products/detail/marktech-optoelectronics/MT03-004/5866634?utm_adgroup=&utm_source=google&utm_medium=cpc&utm_campaign=Pmax_Texas%20Brand%20Awareness&utm_term=&utm_content=&utm_id=go_cmp-20669065899_adg-_ad-__dev-m_ext-_prd-5866634_sig-Cj0KCQjwsPCyBhD4ARIsAPaaRf09SVdTmuNaMBZGDXhUFCj09fSAYpeUg8woxw_vWoWKZKBvbYZN8pYaAvSiEALw_wcB&gad_source=1&gbraid=0AAAADrbLlgvbbyRGwn09gt6cXWJCj0cb&gclid=Cj0KCQjwsPCyBhD4ARIsAPaaRf09SVdTmuNaMBZGDXhUFCj09fSAYpeUg8woxw_vWoWKZKBvbYZN8pYaAvSiEALw_wcB

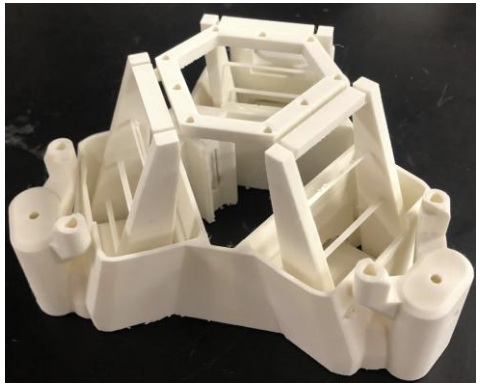
Mirror ($27)
https://www.edmundoptics.com/p/32-x-32mm-laser-diode-mirror/2038/

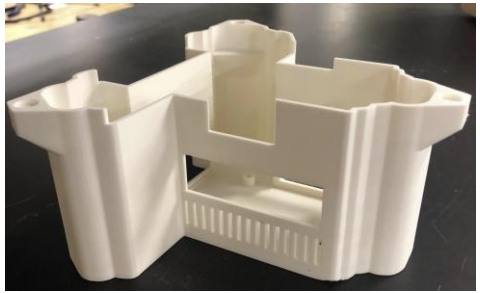
3D Printing (PRUSA)



3D Printed Microscope Stage Parts







From OpenFlexure.org

COMPLETE
OPTICAL UNIT

RESULTS

The optical unit was deemed successful by faculty professor Dr. Matthew Brake and will be continued to be worked on in the electrical aspect by his graduate researchers