Portable Testing Chamber Updates

Portable Optical Table Team

Planned Tasks

- List of parameters & testing methods
- Establish a list of tools & materials for ordering (figure out what)
- Design prototype of testing chamber & schematic diagram (viable setup)
- Check available components in lab
- Bill of Materials
- Weekly meeting on Thursday

12/14/2022 Updates (some image characterization also)

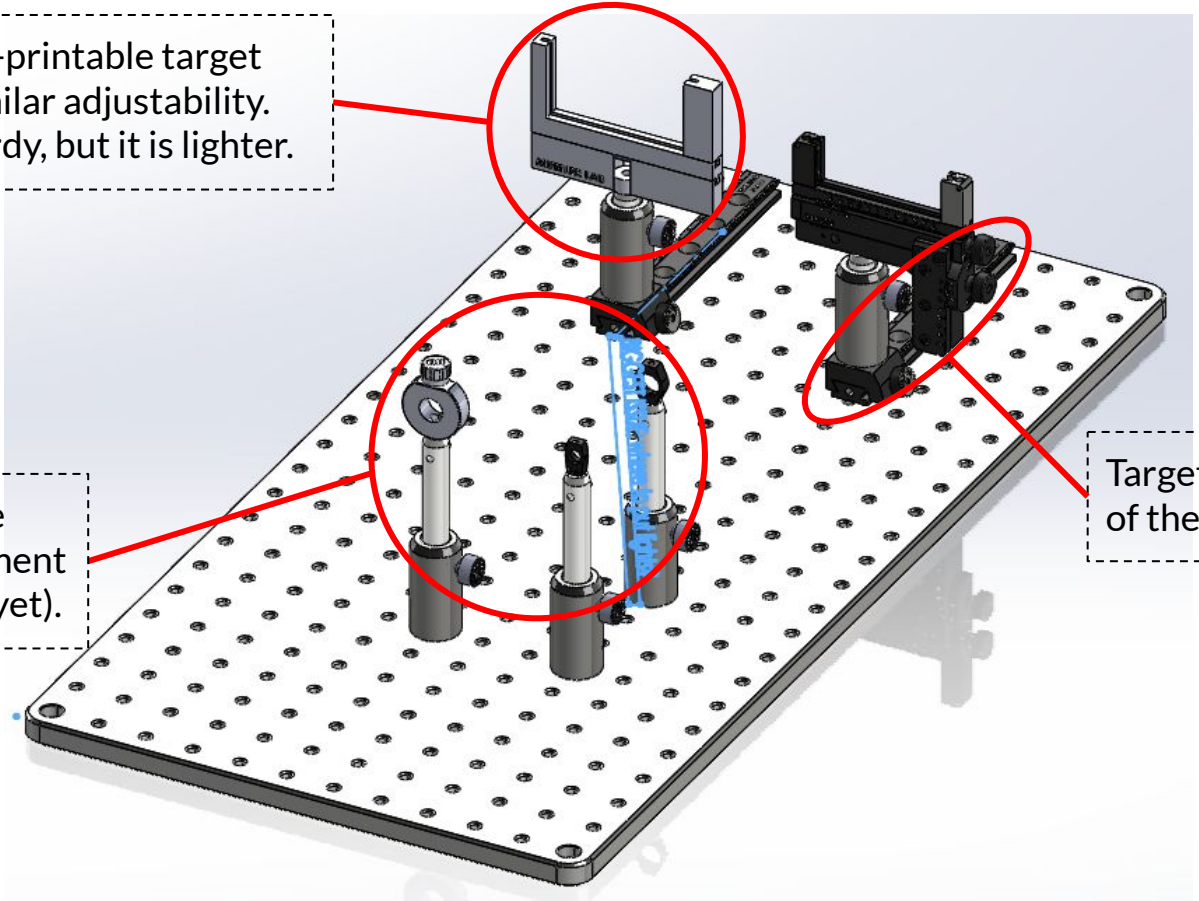
Objectives

- Develop a testing chamber for use in LMICs to characterize KeyScopes
  - Be able to test 0 and 30 degree scopes on one setup
  - Tests to be performed:
    i. Resolution
    ii. SMIA TV distortion
    iii. FOV
    iv. Brightness
    v. DOF
    vi. Color accuracy
  - Potentially conduct thermal testing as well
- Compare images taken on the portable setup versus current setup

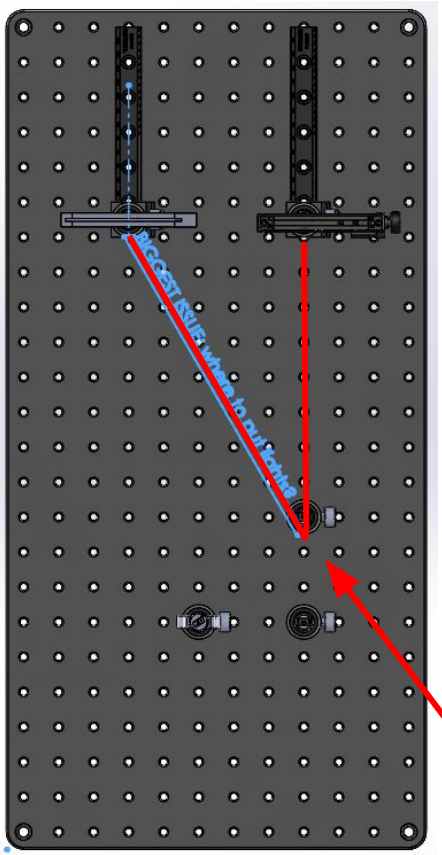
My old 3D-printable target holder. Similar adjustability. Not as sturdy, but it is lighter.

Potential scope mounts (placement not confirmed yet).

Target moves instead of the scope.



Isometric view of potential setup in Solidworks using off-the-shelf material.



1. Taped off an area to simulate the optical breadboard.

2. Two rails for convenient switching.

3. Probably fits on the previously ordered breadboard.

4. Decreased vertical height.

5. Aiming for reductions in both footprint and weight.

6. 30 degree angle adjustment.

Ideal setup vs temporary setup on the optical table. **Where to put the LEDs? Do we need them?**

Need an adapter within these mounts.

Potential Scope Mounts

MFM7 - Mini-Series Fixed Ø7 mm

Zoom

Complete Product Details

MFM05 - Mini-Series Fixed Ø1/2"

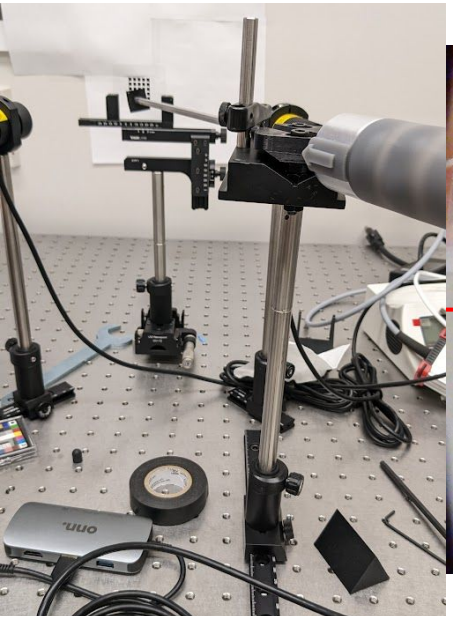
Zoom

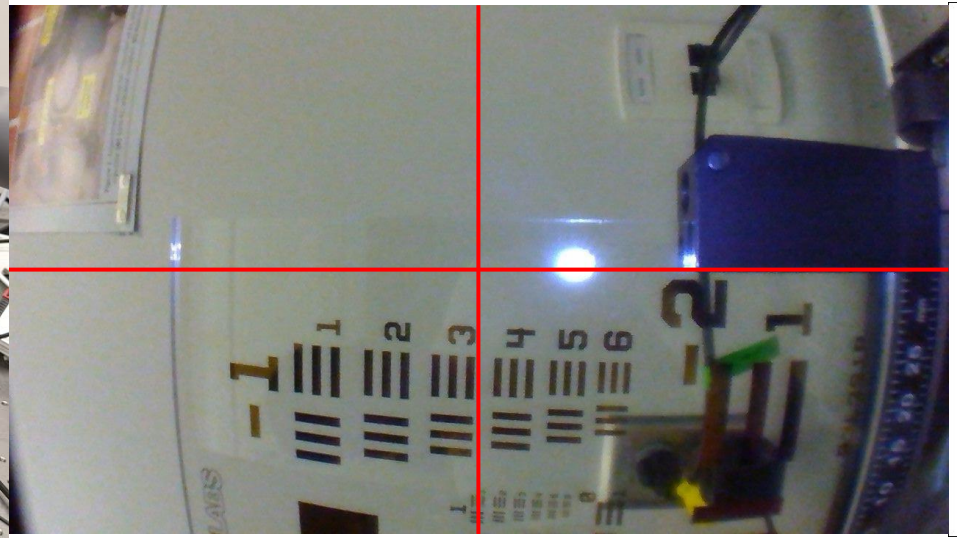
Complete Product Details

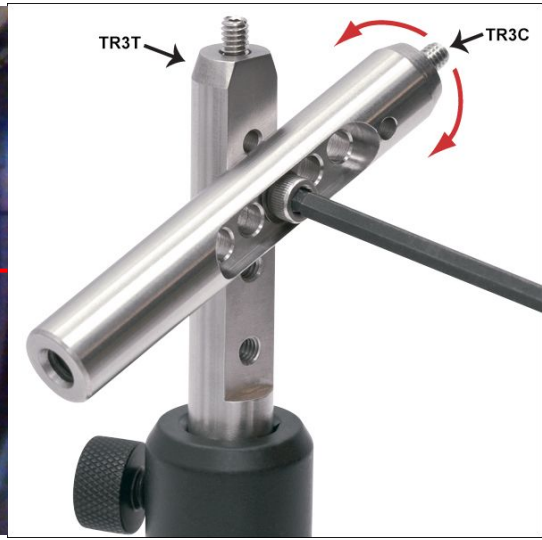
Ring Mount with 0.5"

Ring Mounts

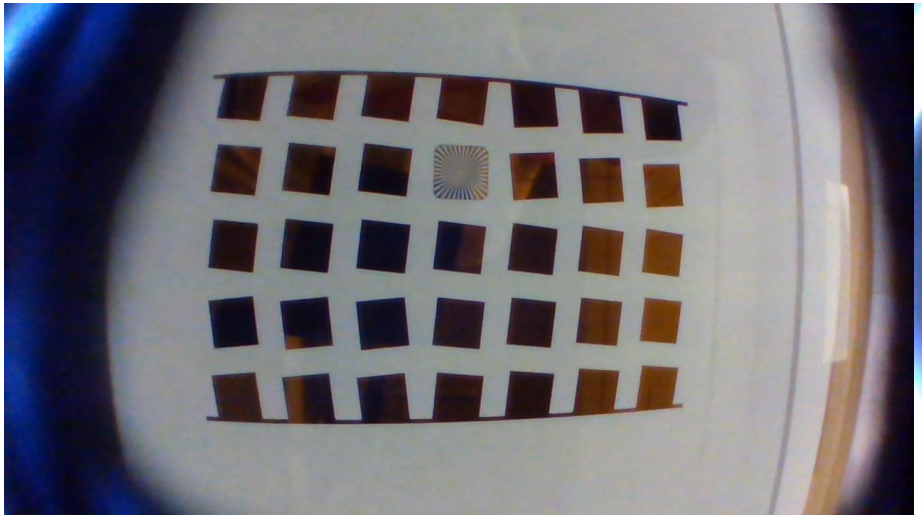
A Problem and Potential Solution



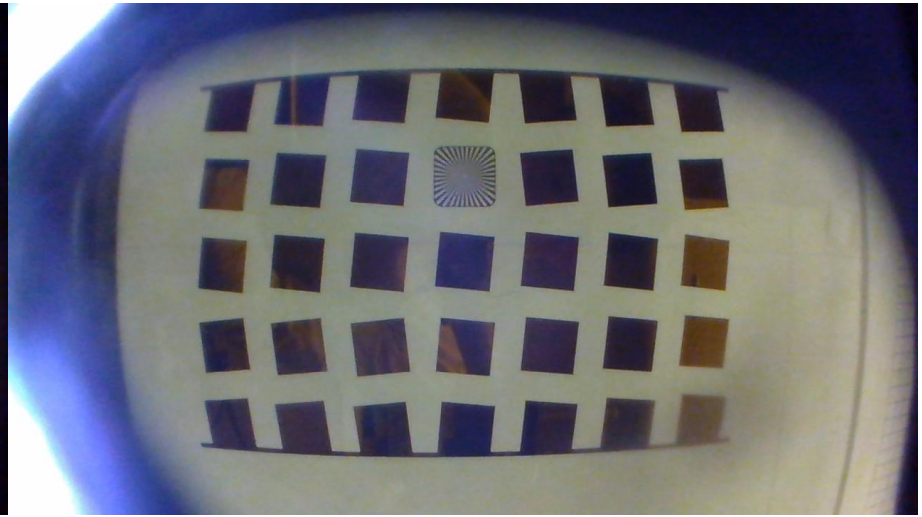




Preliminary Photos and Results

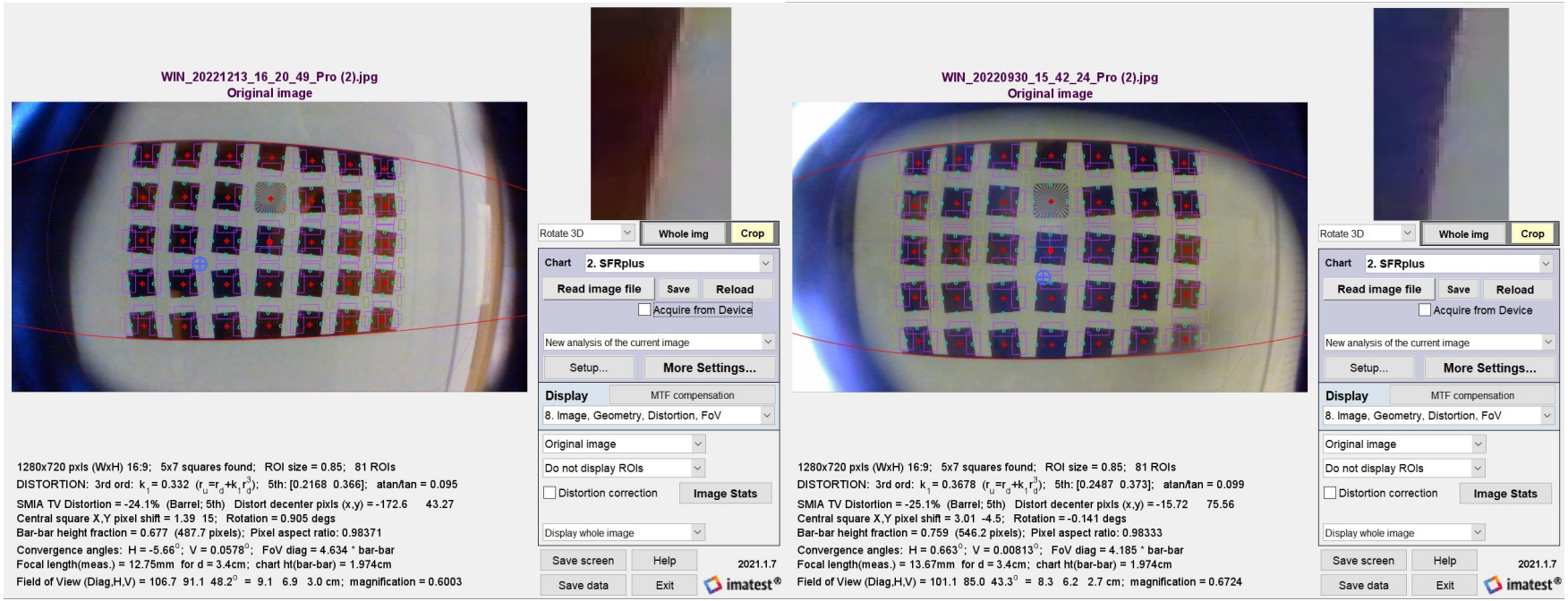


Recent image taken on portable table; not adjusted for tilt.



Old photo we took; adjusted for tilt.

Example


WIN_20221213_16_20_49_Pro (2).jpg
Original image
1280x720 pxls (WxH) 16:9; 5x7 squares found; ROI size = 0.85; 81 ROIs
DISTORTION: 3rd ord: k1 = 0.332 (ru=rd+k1rd3); 5th: [0.2168 0.366]; atan/tan = 0.095
SMIA TV Distortion = -24.1% (Barrel; 5th) Distort decenter pixls (x,y) = -172.6 43.27
Central square X,Y pixel shift = 1.39 15; Rotation = 0.905 degs
Bar-bar height fraction = 0.677 (487.7 pixels); Pixel aspect ratio: 0.98371
Convergence angles: H = -5.66°; V = 0.0578°; FoV diag = 4.634 * bar-bar
Focal length(meas.) = 12.75mm for d = 3.4cm; chart ht(bar-bar) = 1.974cm
Field of View (Diag,H,V) = 106.7 91.1 48.2° = 9.1 6.9 3.0 cm; magnification = 0.6003
Rotate 3D
Whole img
Crop
Chart
2. SFRplus
Read image file
Save
Reload
Acquire from Device
New analysis of the current image
Setup...
More Settings...
Display
MTF compensation
8. Image, Geometry, Distortion, FoV
Original image
Do not display ROIs
Distortion correction
Image Stats
Display whole image
Save screen
Help
2021.1.7
Save data
Exit
imatest®
WIN_20220930_15_42_24_Pro (2).jpg
Original image
1280x720 pxls (WxH) 16:9; 5x7 squares found; ROI size = 0.85; 81 ROIs
DISTORTION: 3rd ord: k1 = 0.3678 (ru=rd+k1rd3); 5th: [0.2487 0.373]; atan/tan = 0.099
SMIA TV Distortion = -25.1% (Barrel; 5th) Distort decenter pixls (x,y) = -15.72 75.56
Central square X,Y pixel shift = 3.01 -4.5; Rotation = -0.141 degs
Bar-bar height fraction = 0.759 (546.2 pixels); Pixel aspect ratio: 0.98333
Convergence angles: H = 0.663°; V = 0.00813°; FoV diag = 4.185 * bar-bar
Focal length(meas.) = 13.67mm for d = 3.4cm; chart ht(bar-bar) = 1.974cm
Field of View (Diag,H,V) = 101.1 85.0 43.3° = 8.3 6.2 2.7 cm; magnification = 0.6724
Rotate 3D
Whole img
Crop
Chart
2. SFRplus
Read image file
Save
Reload
Acquire from Device
New analysis of the current image
Setup...
More Settings...
Display
MTF compensation
8. Image, Geometry, Distortion, FoV
Original image
Do not display ROIs
Distortion correction
Image Stats
Display whole image
Save screen
Help
2021.1.7
Save data
Exit
imatest®

Part Name	Description	Part No.	Product Link	Quantity	Do we have it?	Item Price	Item Costs
Optical breadboard	NEWPORT, Aluminum, 12 x 24 in., 1 in. 1/4-20 Grid --> limited sizes	SA2-12	https://www.newport.com/p/SA2-12	1	FALSE	$323.00	$323.00
Rail	Thorlabs, 6" rail w/ metric marking (only at Thorlabs)	RLA0600	https://www.thorlabs.com/thorproduct.cfm?partnumber=RLA0600	2	FALSE	$49.20	$98.40
Rail carriers/sliders	Thorlabs, Slides on the rails, fixed using set screws	RC1	https://www.thorlabs.com/thorproduct.cfm?partnumber=RC1	2	FALSE	$28.99	$57.98
Post holders	Thorlabs, 2" post holder	PH2	https://www.thorlabs.com/thorproduct.cfm?partnumber=PH2	3	FALSE	$8.95	$26.85
Post for scope	Thorlabs, Steel 2" post --> aluminum: https://www.thorlabs.com/thorproduct.cfm?partnumber=TRA2	TR2	https://www.thorlabs.com/thorproduct.cfm?partnumber=TR2	1	FALSE	$5.90	$5.90
Post for target holder	Thorlabs, Steel 4" post --> aluminum: https://www.thorlabs.com/thorproduct.cfm?partnumber=TRA4	TR4	https://www.thorlabs.com/thorproduct.cfm?partnumber=TR4	1	FALSE	$6.67	$6.67
Target mount	Thorlabs, XY Mount for 1/2" - 3" Rectangular Optics, 8-32 Taps	XYF1	https://www.thorlabs.com/thorproduct.cfm?partnumber=XYF1#ad-image-0	1	FALSE	$393.92	$393.92
Scope mount option 1.1	Thorlabs, 1/2" diameter opening ~ 12.7 mm, tightened with setscrew	MFM05	https://www.thorlabs.com/thorproduct.cfm?partnumber=MFM7	1	FALSE	$28.54	$28.54
Scope mount option 1.2	Thorlabs, 7 mm diameter opening, tightened with set screw	MFM07	https://www.thorlabs.com/thorproduct.cfm?partnumber=MFM05	1	FALSE	$28.54	$28.54
Scope mount option 2	EDMUND OPTICS, 1/2/" diameter also, BUT has M3 set screw size, will need its own adapter or post (the toehrs are 8/32).	54-265	https://www.edmundoptics.com/p/ring-mount-with-05quot-inner-diameter-id/11119/	1	FALSE	$21.50	$21.50

List of Components to Order

Portable Optical Table - List of Components to Order

Part #	Part	Built in-house or Sourced?	Material	Vendor	Part #	Qty	Notes	Link
TC000-1	Camera	Sourced	Various	Misumi	MD-T17205LH-113-02	1	Custom order	https://drive.google.com/file/d/1zVg5WK4RJ1o7pJrEbrG7Ujo_YHK9Piu5/view?usp=sharing
TC2000-2	5.5mm OD tube	Built in-house	304 SS	Chamfr.com	ACT03688	1	Second order PN ACT03686	https://chamfr.com/product/tubing-304-ss-0-1860-id-0-0160-wall-50-length-quantity-6-bag/
TC2000-3	Small O-Ring	Sourced	Viton	McMaster	1170N19	2		https://www.mcmaster.com/1170N19/
TC2000-4	Top Cap	Sourced	6061 Aluminum	Xometry		1		
TC2000-5	Large O-Ring	Sourced	Viton	McMaster	1170N85	2		https://www.mcmaster.com/1170N85/

Portable Optical Table - Bill of Materials

Part #	Part	Built in-house or Sourced?	Material	Vendor	Part #	Qty	Notes	Link
TC2000-101	Emergency 5C collet to hold tube	Sourced with modification	Brass	McMaster	3209A14			https://www.mcmaster.com/3209A14/
TC2000-102	#8 drill	Sourced	carbide	McMaster	29045A728			https://www.mcmaster.com/29045a728/
TC2000-103	.1985" reamer	Sourced	carbide	McMaster	8803A383			https://www.mcmaster.com/8803A383/
TC2000-104	#9 drill	Sourced	carbide	McMaster	29045A729			https://www.mcmaster.com/29045A729/
TC2000-105	Loctite #4311 adhesive	Sourced	Cyanoacrylate	Ellsworth	1401789			https://www.ellsworth.com/products/adhesives/uv-curing/henkel-loctite-4311-uv-curing-adhesive-1-lb-bottle/

Future Tasks

- Update the prototype design of testing chamber & schematic diagram
- Order new components
- Build simulated chamber on lab optical table
- Update list of tools & materials
- Update Bill of Materials
- Troubleshoot depth of field characterization

Keyscope Characterization Updates

Laparoscope Team

Scope	Resolution	Brightness	Depth of Field	Distortion	Color Accuracy	Thermal (?)
KV2	☑	☑	☐	☑	☑	☑
KV4-1	☑	☑	☐	☑	☑	☐
KV4-2	☑	☑	☐	☑	☑	☐
KV5-1	☑	☑	☐	☐	☐	☐
KV5-2	☐	☐	☐	☐	☐	☐
KV5-3	☐	☐	☐	☐	☐	☐
KV6-1	☑	☑	☐	☑	☑	☑
KV6-2	☑	☑	☐	☑	☑	☑
KV6-3	☐	☑	☐	☐	☐	☐

Characterization Summary

2/10/23 Updates

Laparoscope Team Meeting Notes

11/3 Thursday - Meeting #1

Members: Tri, Michele, and Jason

- Check and update the progress table regularly.
- Want the most lightweight setup possible, so will opt for an aluminum optical breadboard.
- Willing to trade precision for portability and cost → see how much we can 3D print.
- There is optical equipment left over from an older lab.
- Too much work trying to inventory everything.
- The portable table setup will likely be different from the current setup. What differences?
- Simulate having a smaller board by taping off a chunk of the larger optical table and making sure everything we do is within the confines of that space.

11/30 Thursday - Meeting #2

Members: Everyone

- There is a video deposited in the drive about the assembly, we can use it to plan the next video
- Meet John at 2 pm on Wednesday next week
- Go through the assembly video updates

12/8 - Meeting #3

Members: Tri, Michele, and Jason, then with everyone else

- John will be building more scopes soon, the next Wednesday after the lab meeting
- When taking photos, try to take them all or as much as possible at the same time to minimize potential sources of error
- Preferably, need to take images for three versions of the keyscope to ensure consistency
- Look at papers or Imatest website for more info on color accuracy error values and what they mean
- Need a chamber for image characterization that also doubles as a chamber for thermal testing
- Make a different list of materials for the portable optical table
- Update materials list and BOM with ALL materials used
- Can replace some optical components with plastic
- Look for a paper-resolution target

Present shared slides → Tri and Jason, Michele and Jason

Laparoscope_summary of optical table .XLSX

File Edit View Insert Format Data Tools Help Last edit was made 59 minutes ago by Tri Tien Quang

Share

	B	C	D	E	F	G	H	I	
	Work	List of parameters and testing methods	List of tools, materials, dimensions, & other specifications	Check current setup & available parts	Design of optical table & schematic diagram	Order parts & build a simulated table	Testing and verification	Build a prototype	Tes
	Status	Done	In progress	Done	In progress	In progress			
	Notes	11/03/22 T, J, M **Key Parameters** - **Resolution** - **SMIA TV distortion** - **FOV** - Brightness - **DOF** - **Color accuracy** - Temperature **Future** - Low cost FOV - Low cost Distortion - Distortion profile function 11/09/22 T, J - DOF --> update - Brightness --> make - Fix the scope position, insert into testing housing through a hole, translatable target on long rail	Main materials - Scopes - Breadboard (1X) - Long rail w/ mm marking (1X) - Short rails **(#?X)** - **5/10 mm 0 deg scope mount (1X) --> Another holder?** - 30 deg scope mount (1X) - Diffuse lens **(1-2?X)** - Mounting poles **(#?X)** --> **lengths?** - Target holder (1X) - Target adapter, one for each target (1X) - Test Targets - Suitable box housing w/ lid for entire setup (1X) Resolution - USAF 1951 resolution target Distortion - 5 x 9 Imatest	- Alum optical breadboard - Microscope mount -	12/20/22 T, M - Created list of parts (full list and order list)	2/10/23 - T, M, J - Went over our compiled list of potential parts, debating the pros and cons of each, and deciding on which ones we will use in the meantime going forward. - The main variables we are considering are the weight, cost, and adaptability of the part. - We will mainly focus on off-the-shelf parts for now, expanding to in-house parts will be during the optimization phase of the project. - Tri suggested the 3-rail sliding system that allows us fine control of the exact X-Z play location we want to place our target. This is the focus of our group			

Metrics of Interest Weighted

1. Cost
2. Weight
3. Adaptability to future modifications
    a. Can work with targets of various shapes and sizes
    b. Can work with different scope diameters
4. Accessibility/replicability (for optimization step)

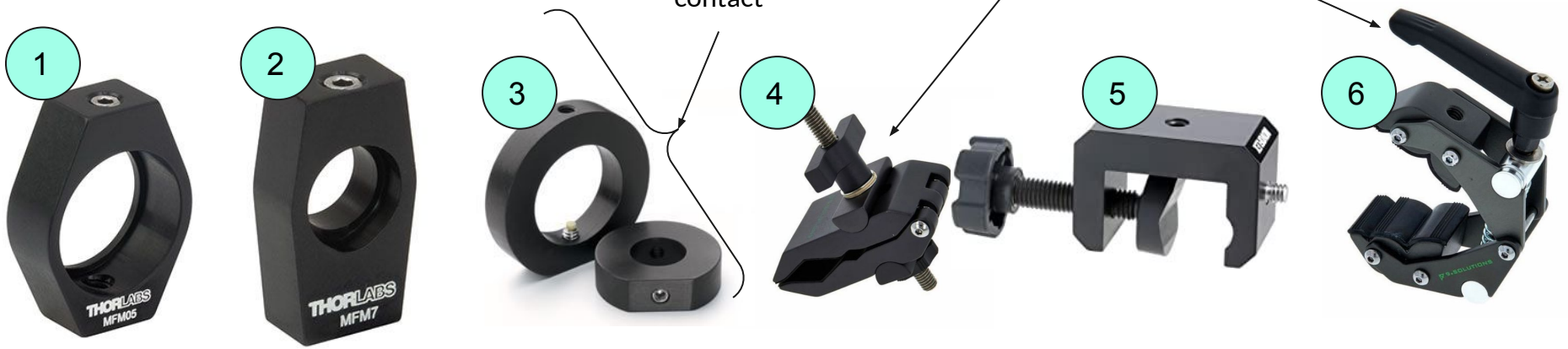
Full List of Current Parts

Items	Part	Description	Qty	Available	Ordering	Notes
1	Breadboard	12 x 18 in., 1/4 in., 1/4-20 Grid	1		1	UPDATED PART. Order later.
2	Rail	6" rail	3		3	Need to have metric marking, only at ThorLabs
3	Rail carriers/sliders	Slides on the rails	3	3		Fixed using set screws
4	Post holders	2" post holder	2	2		
5	Post for scope	Steel 2" post	1	1		Look to eventually replace with plastic part.
6	Post for target holder	Steel 4" post	1	1		Look to eventually replace with plastic part.
7	Target mount	Fixed Cylindrical Lens Mount	1		1	UPDATED PART.
8	Scope Mount	9.solutions Savior clamp mini	1		1	UPDATED PART.
9						
10						
Tools/Fixtures/Consumables						
1						
2						
3						

Full List of Considered Parts

Part	Description	In-house or Sourced?	Material	Vendor	Part #	Qty	Unit Cost	Total Cost	Notes
Breadboard	12 x 24 in., 1 in. 1/4-20 Grid	S	Aluminum	Newport	SA2-12	1	323	323	Very heavy
	NO TAP. 1/4" x 24" x 48"; 1/4" holes	S	Polypropylene	US Plastics	42563	1	75.7	75.7	3.6 kg. Need to be
	12 x 18 in., 1/4 in., 1/4-20 Grid	**S**	**Aluminum**	**Baselabtools**	**SAB1218-S**	**1**	**180**	**180**	**5.1lbs ~ 2.31kg**
	NOT TAP. 1/4" x 24 x24"; 1/4" holes	S	High Strength PVC	McMaster	92985T52	1	41.75	41.75	Need to be cut in ha
Rail	6" rail	S	Aluminum	ThorLabs	RLA0600	1	49.2	49.2	0.06 kg. Need to ha
	6" rail	**S**	**Aluminum**	**Baselabtools**	**RL19-060**	**1**	**39**	**39**	**Order w/ breadboa**
Post for scope	2" post	S	Aluminum	ThorLabs	TR2	1	5.9	5.9	0.047 kg. For testin
Post for target holder	4" post	S	Aluminum	ThorLabs	TR4	1	6.67	6.67	0.097 kg. For testin
Target mount	XY Mount for 1/2" - 3" Rectangular	S	N/A	ThorLabs	XYF1	1	393.92	393.92	0.13 kg. 8-32 Taps
	Filter Holder, 2" wide, uses a pair of	S	N/A	ThorLabs	FH2	1	22.48	22.48	0.02 kg. Clips on th
	Quick-Release Rectangular Filter	S	N/A	ThorLabs	SFH2	1	77.45	77.45	0.03 kg. Holds Plat
	Plate Holder, 3.0" Wide	S	N/A	ThorLabs	FP02	1	86.17	86.17	0.13 kg. Has M4 an
	Fixed Cylindrical Lens Mount	**S**	**N/A**	**ThorLabs**	**CH2B**	**1**	**76.01**	**76.01**	**0.05 kg**
	Filter Holder for 2" Square Filters	S	N/A	ThorLabs	SFH3	1	72.5	72.5	0.02 kg. M4 hole.
Scope Mount	1/2" diameter opening ~ 12.7 mm	S	N/A	ThorLabs	MFM05	1	28.54	28.54	0.0014 kg. 4-40 tap
	7 mm diameter opening	S	N/A	ThorLabs	MFM07	1	28.54	28.54	0.0018 kg. 4-40 tap
	NOVOFLEX 26mm Universal Clamp	S	N/A	Amazon	UNIKLEM-42	1	53.9	53.9	0.135 kg
	9.solutions Python clamp 3/8" male	S	N/A	Thomann	373517	1	26	26	0.430 kg
	9.solutions Savior clamp mini	**S**	**N/A**	**Thomann**	**373528**	**1**	**30**	**30**	**0.135 kg**
	1/2" diameter	S	Black Anodized Aluminum	EdmundOptics	54-265	1	21.5	21.5	Has 1/4"-20 screw
Screw adapter	Internal 8-32 Threads and External	S	Stainless steel	ThorLabs	AE8E25E	1	4.87	4.87	0.0017 kg. Each is
								0	
Tilt mechanism	2X Mini Ball Head with 1/4" Screw and	S	Aluminum and rubber	Neewer	B0BFWSZCX3	1	20.49	20.49	5.78 oz total, 2.89 o
	Mini Ball Head with 1/4" screw and tap	S	Aluminum Alloy	Ulanzi	B09NJJ2DKM	1	9.84	9.84	3.17 oz

Scope Mounts



Scope Mount	1	1/2" diameter opening ~ 12.7 mm	S	N/A	ThorLabs	MFM05	1	28.54	28.54	0.0014 kg. 4-40 ta
	2	7 mm diameter opening	S	N/A	ThorLabs	MFM07	1	28.54	28.54	0.0018 kg. 4-40 ta
	5	NOVOFLEX 26mm Universal Clamp	S	N/A	Amazon	UNIKLEM-42	1	53.9	53.9	0.135 kg
	4	9.solutions Python clamp 3/8" male	S	N/A	Thomann	373517	1	26	26	0.430 kg
	6	**9.solutions Savior clamp mini**	**S**	**N/A**	**Thomann**	**373528**	**1**	**30**	**30**	**0.135 kg**
	3	1/2" diameter	S	Black Anodized Aluminum	EdmundOptics	54-265	1	21.5	21.5	Has 1/4"-20 screw

Rationale

Current target holder:

- 0.09 kg, pretty sturdy.
- One point (at most three) of contact to hold laparoscope in place.
- Holds a variety of sizes of tubes ~5 to 50 mm.

Replacement:

- 0.135 kg, 50% heavier than current.
- Multiple rubberized surfaces of contact ensures stability of device.
- Holds tube sizes ranging from 0 to 30 mm.
- About 25% more affordable.

Target Holders

Z-axis limitations

Narrow clip opening

Deep inner groove.

Target mount		XY Mount for 1/2" - 3" Rectangular	S	N/A	ThorLabs	XYF1	1	393.92	393.92	0.13 kg. 8-32 Taps
	1	Filter Holder, 2" wide, uses a pair of	S	N/A	ThorLabs	FH2	1	22.48	22.48	0.02 kg. Clips on th
	2	Quick-Release Rectangular Filter	S	N/A	ThorLabs	SFH2	1	77.45	77.45	0.03 kg. Holds Plat
	3	Plate Holder, 3.0" Wide	S	N/A	ThorLabs	FP02	1	86.17	86.17	0.13 kg. Has M4 an
	4	**Fixed Cylindrical Lens Mount**	**S**	**N/A**	**ThorLabs**	**CH2B**	**1**	**76.01**	**76.01**	**0.05 kg**
	5	Filter Holder for 2" Square Filters	S	N/A	ThorLabs	SFH3	1	72.5	72.5	0.02 kg. M4 hole.

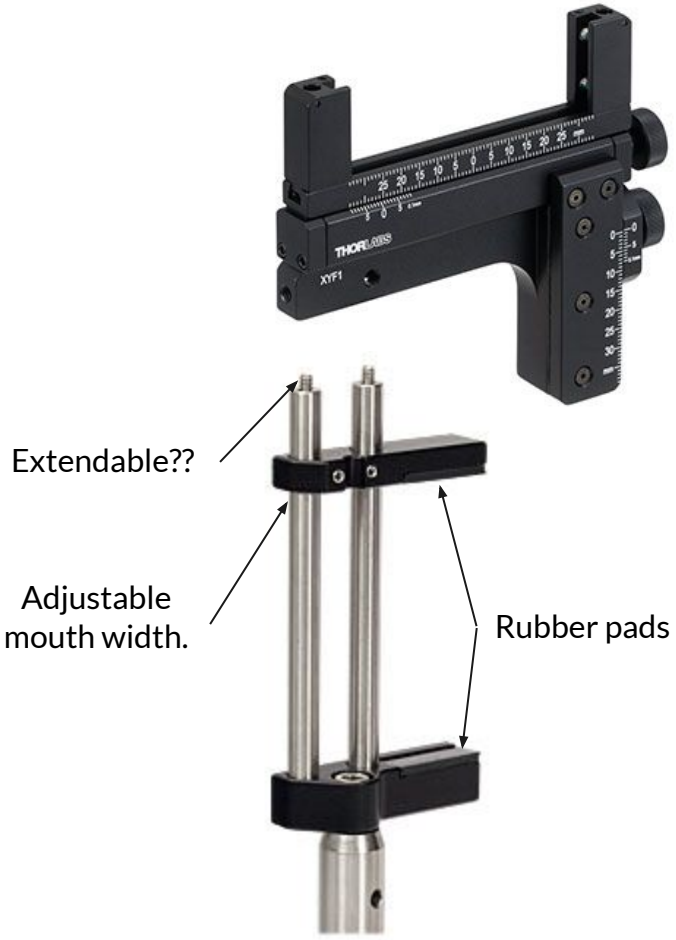
Rationale

Current target holder:

- More than four times the cost of the next most expensive.
- Tied for the heaviest target holder we considered (0.13 kg).
- Extra features that we do not need (fine adjustments).
- Is flexible and adaptable.

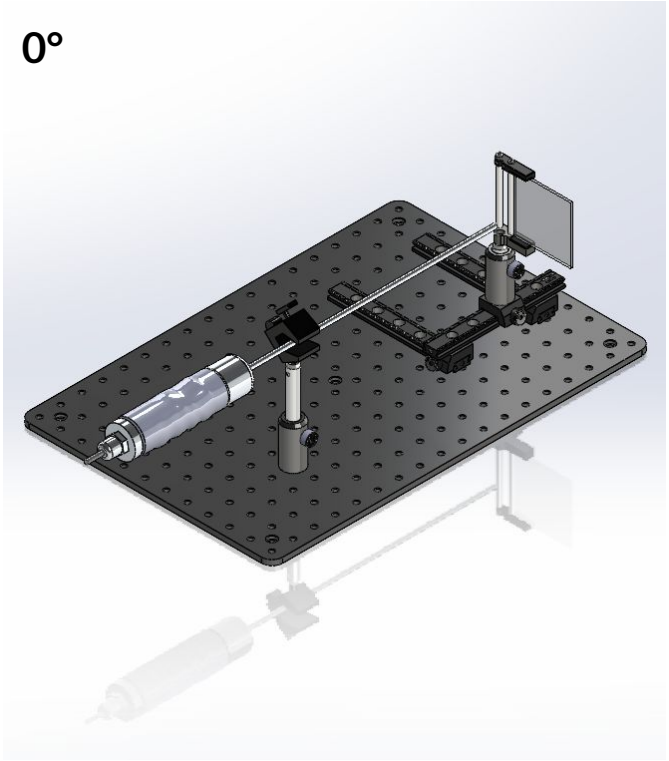
Replacement:

- Less than half the weight of current.
- Less than one-fifth the cost.
- Fits a wide range of targets (i.e. thiccer ones like depth of field), more flexible and adaptable.
- Smaller working range of ~2.7”, may not fit resolution target.

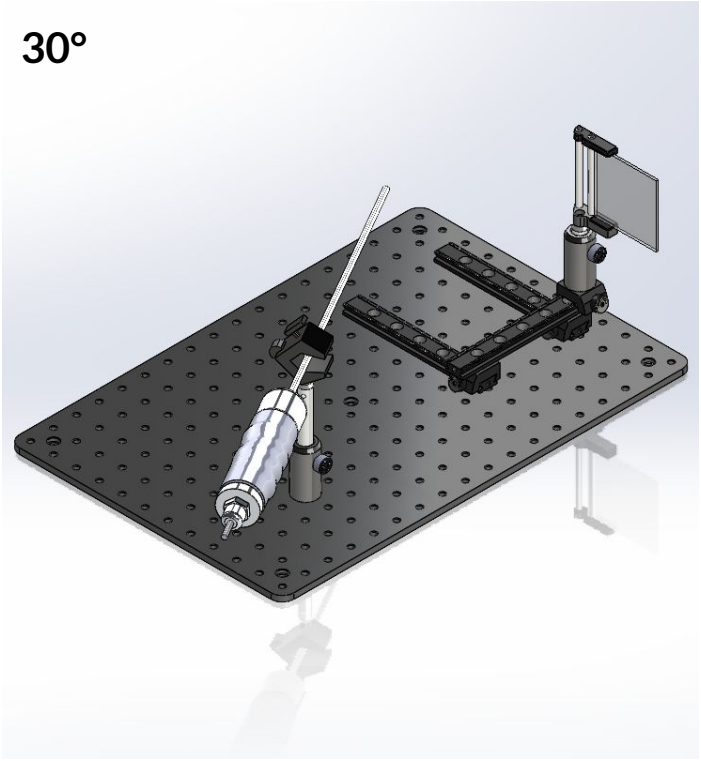


Portable Optical Table Arrangement

0°

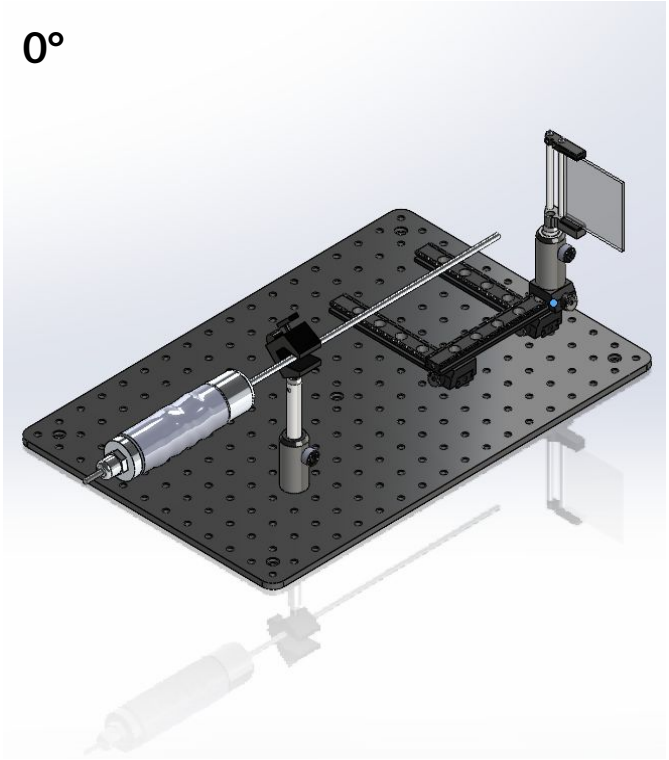


30°

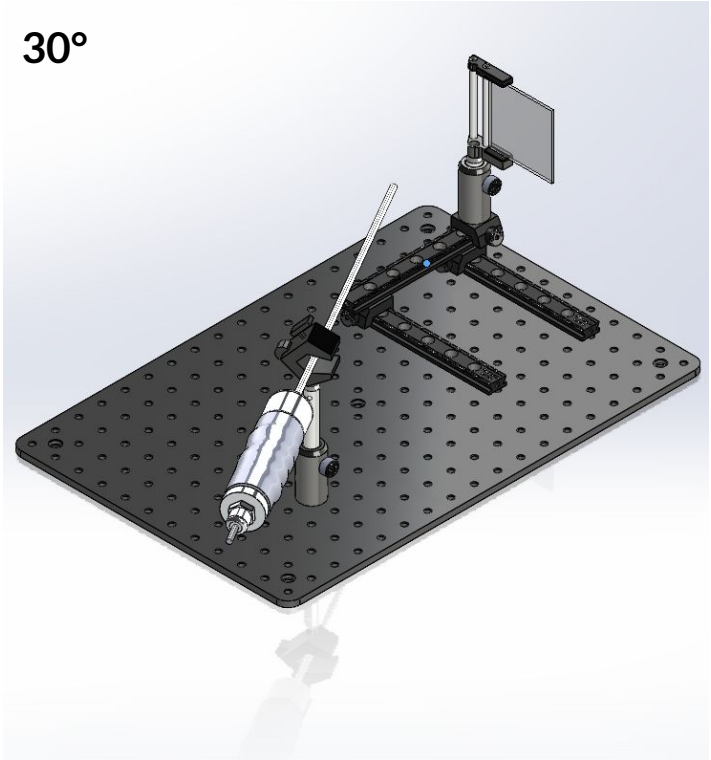


Portable Optical Table Arrangement

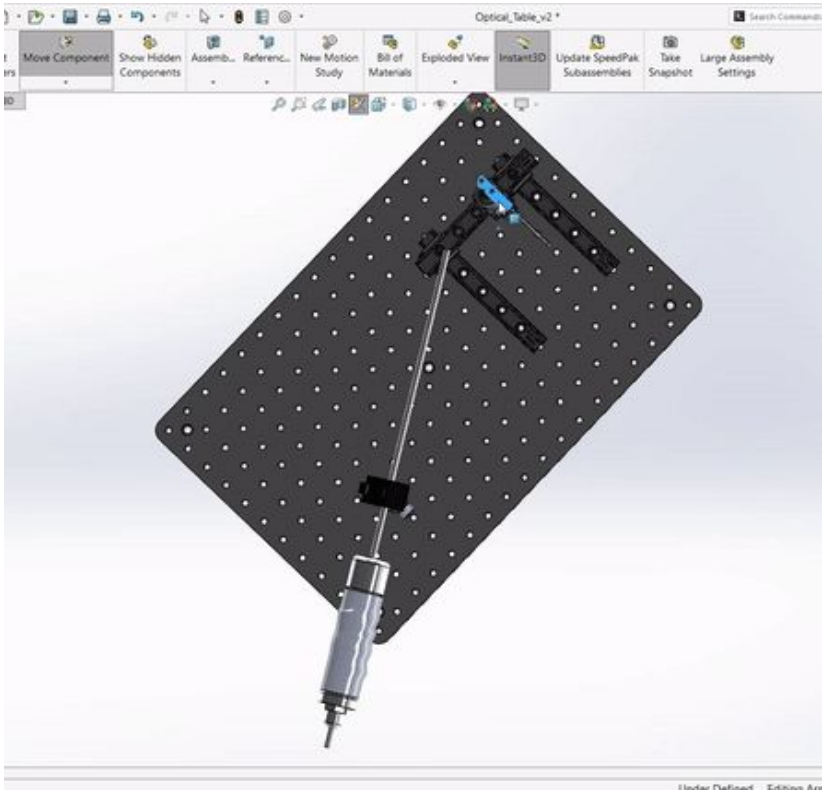
0°



30°



Portable Optical Table Arrangement



What's Next

- Test new parts as they arrive and compare characterization data to current optical table setup and past portable optical table setups.
- Optimize the setup via replacement with new parts of different material, vendor, or design.
  - Substitute with plastic parts
  - Find more affordable vendors
  - Optimize the protocol for setting up both the 0° and 30° laparoscope
- Future: work on enclosure and thermal testing

3/16/23 Updates

Progress

Work	List of parameters and testing methods	List of tools, materials, dimensions, & other specifications	Check current setup & available parts	Design of optical table & schematic diagram	Order parts & build a simulated table	Testing and verification	Build a prototype	Testing and verification
Status	Done	Done	Done	Done	In progress	In progress		
Notes	11/03/22 T, J, M **Key Parameters** - **Resolution** **- SMIA TV distortion** **- FOV** - Brightness **- DOF** **- Color accuracy** - Temperature **Future** - Low cost FOV - Low cost Distortion - Distortion profile function 11/09/22 T, J - DOF --> update - Brightness --> make - Fix the scope position, insert into testing housing through a hole, translatable target on long rail	Main materials - Scopes - Breadboard (1X) - Long rail w/ mm marking (1X) - Short rails **(#?X)** **- 5/10 mm 0 deg scope mount (1X) --> Another holder?** - 30 deg scope mount (1X) - Diffuse lens **(1-2?X)** - Mounting poles **(#?X)** --> **lengths?** - Target holder (1X) - Target adapter, one for each target (1X) - Test Targets - Suitable box housing w/ lid for entire setup (1X) Resolution - USAF 1951 resolution target Distortion - 5 x 9 Imatest	- Alum optical breadboard - Microscope mount -	12/20/22 T, M - Created list of parts (full list and order list)	2/10/23 - T, M, J - Went over our compiled list of potential parts, debating the pros and cons of each, and deciding on which ones we will use in the meantime going forward. - The main variables we are considering are the weight, cost, and adaptability of the part. - We will mainly focus on off-the-shelf parts for now, expanding to in-house parts will be during the optimization phase of the project. - Tri suggested the 3-rail sliding system that allows us fine control of the exact X-Z play location we want to place our target. This is the focus of our group	3/7/23 - T, M, J - Did imaging and characterization for initial comparison - Unable to do the resolution for the portable setup due to not having the extension poles delivered yet - Tried putting a hole in the cap of the scope, but it was not feasible due to the amount of light reflected back by the red cap. - fixed comparison testing at 40 mm for ease - Will print a white square on the back so that it can be used to calibrate the level-ness/orientation of the scope. 3/9/23 - T, M, J		

Metrics of Interest

- Cost
- Weight
- Adaptability to future modifications
  - Can work with targets of various shapes and sizes
  - Can work with different scope diameters
- Accessibility/replicability (for optimization step)

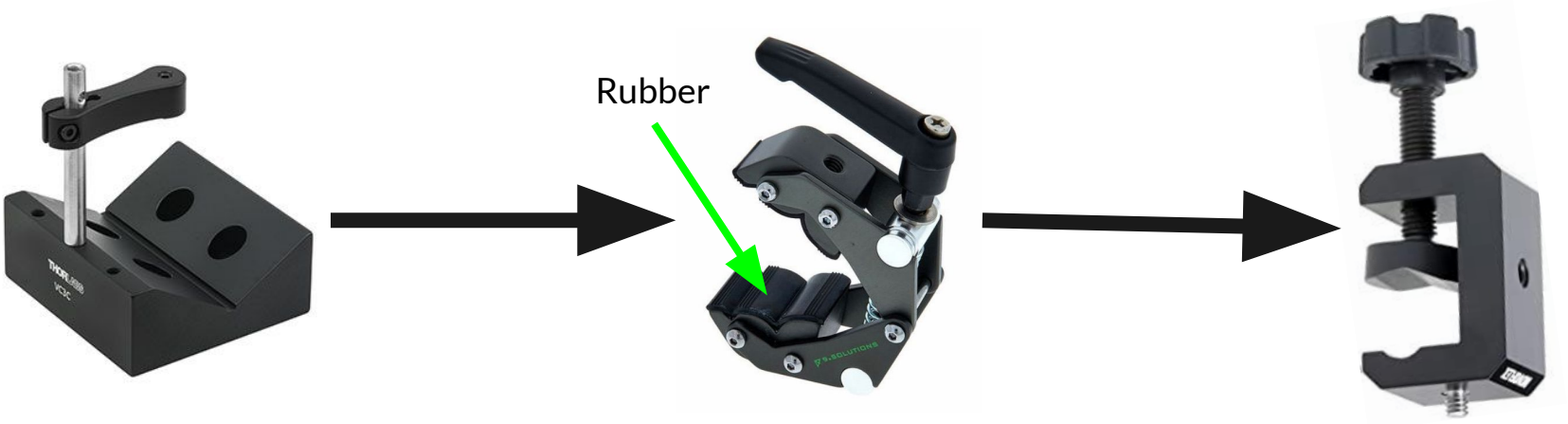
Optimizations

- Changed posts to aluminum from steel
  - Decreased weight
  - Black coating → less reflection
- Used shorter post holders → decreased weight
- Changed scope mount clamps
- Changed breadboards
- Shifted the placement of individual components (e.g. rails)

Updated Parts - Scope Mount

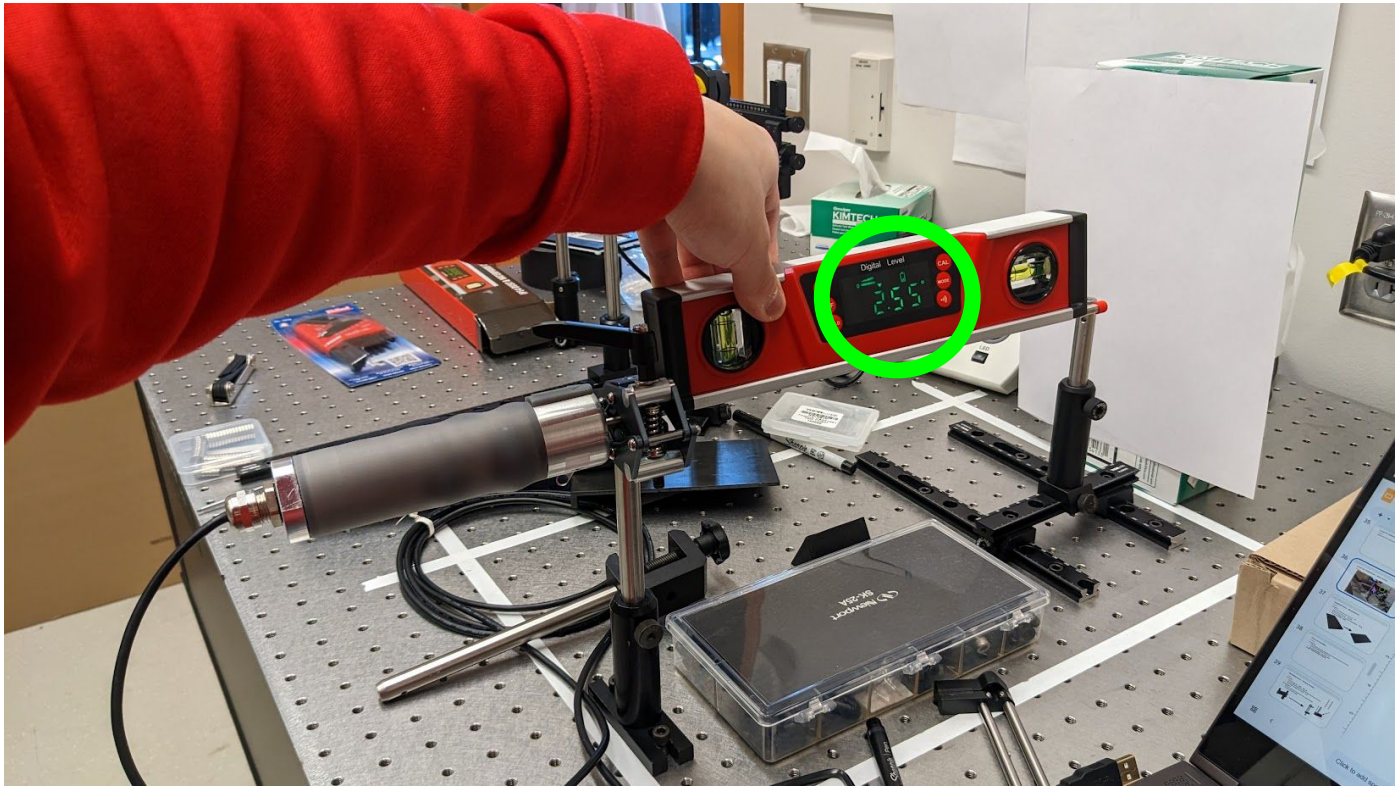
Justification:

- Rubber lining on jaw held the scope very securely but…one major flaw
- New screw-clamp holds the scope just as securely, if not more (e.g., less likely to fall when loosened)



Old mount **First choice: jaw clamp** **Current choice**

Level for Calibration - Old Clamp

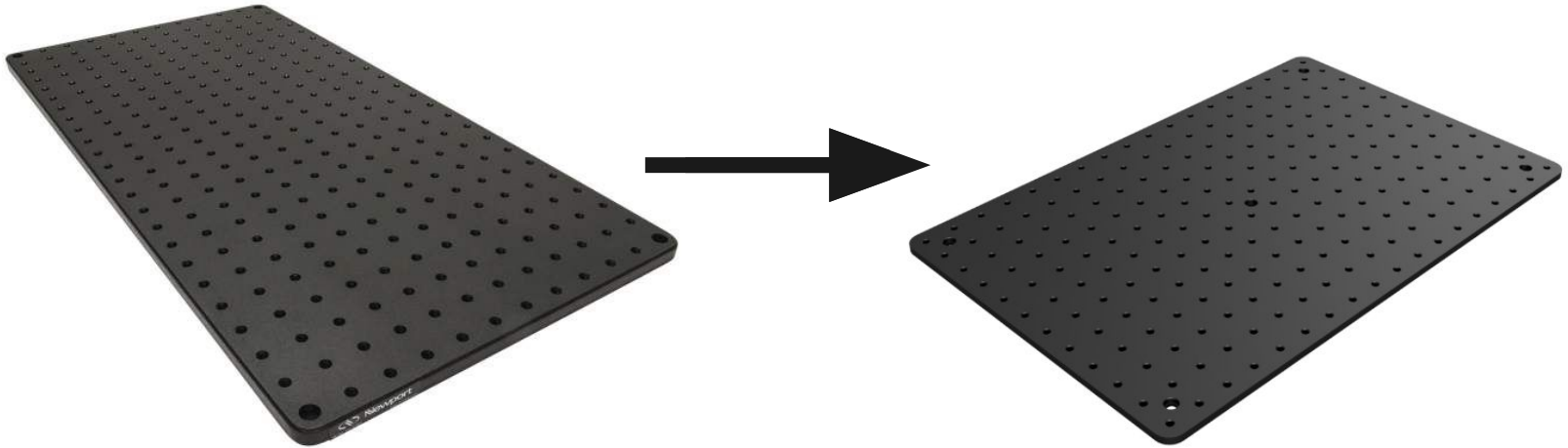


Level for Calibration - New Clamp

Updated Parts - Breadboard

Justification:

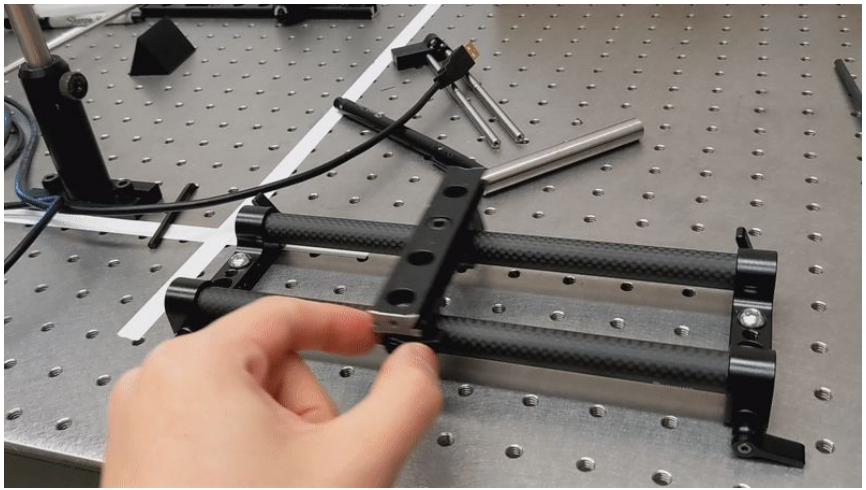
- Thinner breadboard currently in use (½” → **¼”**)
- Smaller footprint (12” x 24” → **12” x 18”**)
- Significantly lighter than the previous board (6.35 kg → **2.31 kg**)
- Less expensive ($355 → **$180**)



Parts to Consider

Justification:

- New sliding rail offers less resistance when moving compared to current choice
- Currently use a 18” dovetail rail cut in half
- More affordable ($133 → $18 + $15 + $15)



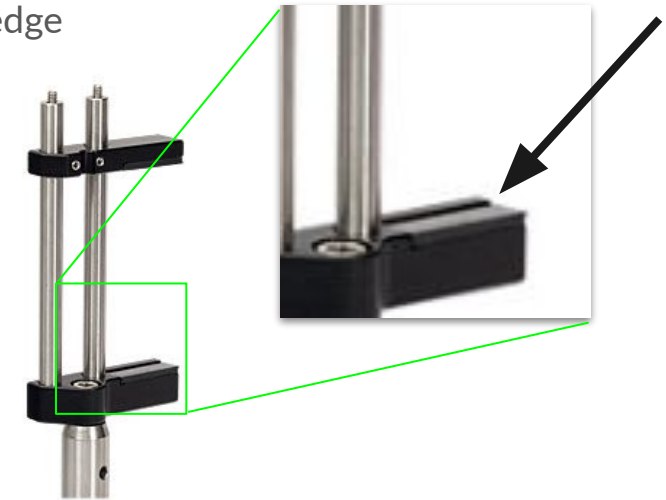
Updated parts - Target Holder

Justification:

- Much less expensive（$394 → **$76 + $9**)
- More secure than the other alternatives (holds target at top and bottom)
- Larger range of targets can be held (3” → **5.6”**)

Standardization:

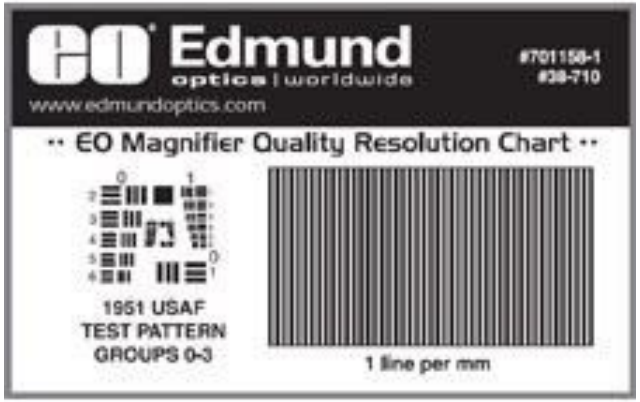
- Push target board to the back of the rubber against the edge
- More parallel-aligned targets



Updated parts - Resolution Target

Justification:

- Paper thin & light
- Much less expensive (~$8)
- Compatible with new target mount
- Plastic, not glass (no need to worry about breaking)

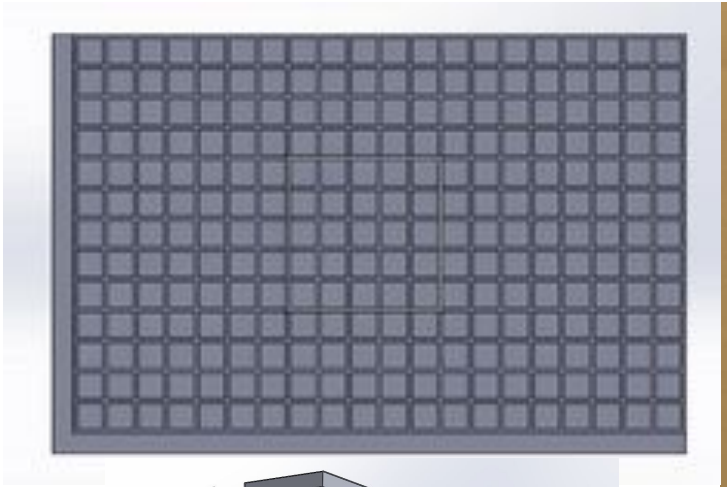


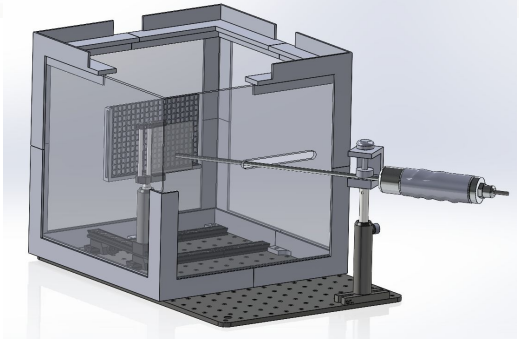
Target Board Specifications

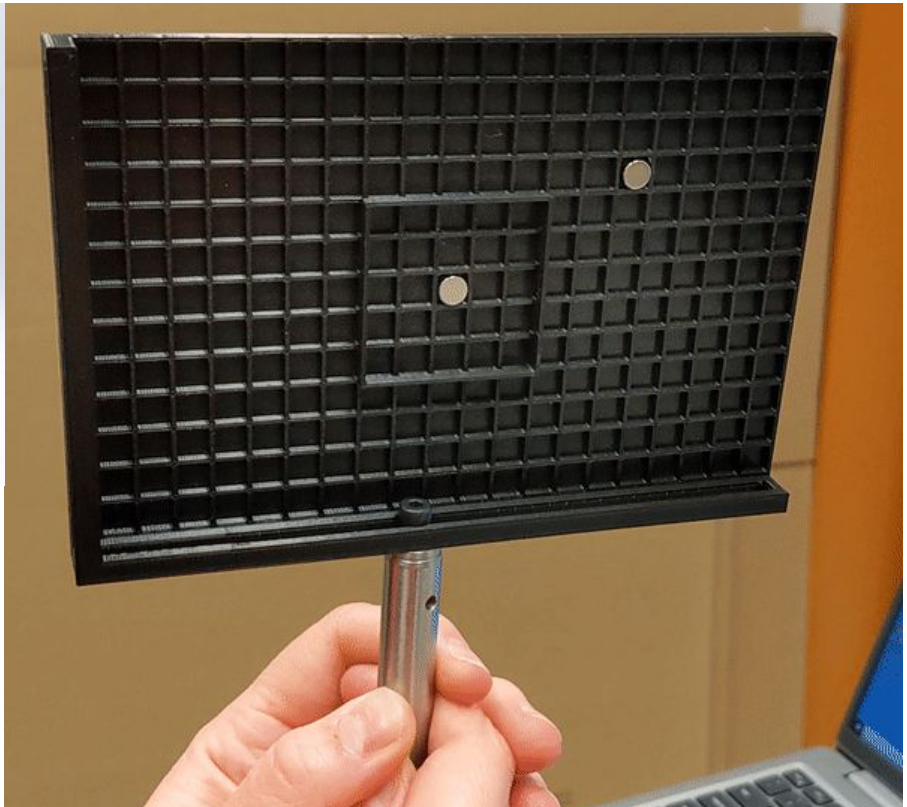
Justification:

- We want to use paper/printed targets due to their affordability, so we need a target board that can adapt to many different sizes of targets
- Length of board is about half the width of the enclosure to allow for translation of affixed target
- Length and width of board is greater than the field of view of the current camera at 100 mm (135 mm x 75mm), all potential targets will fit on the board
- Doubles as a moveable background
- Affixed using magnets
- Compatible with current posts

Target Board

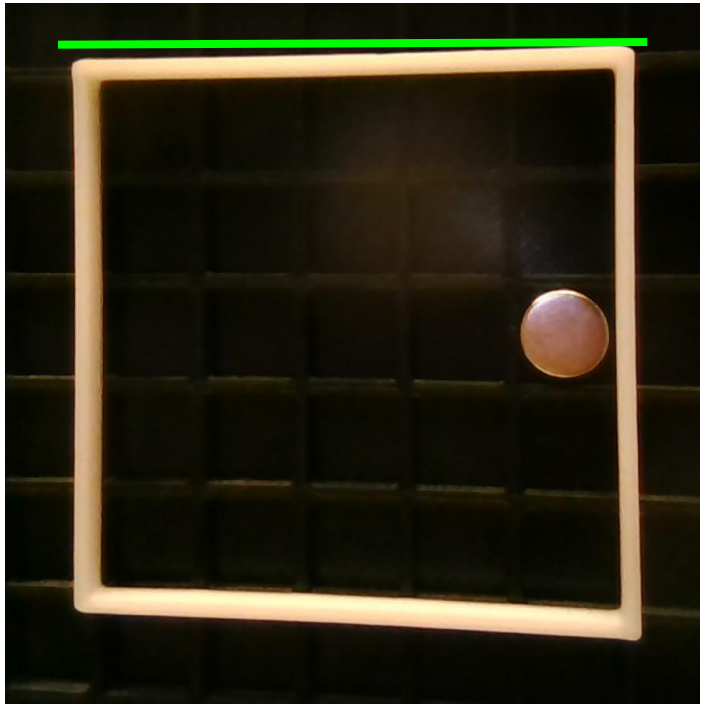


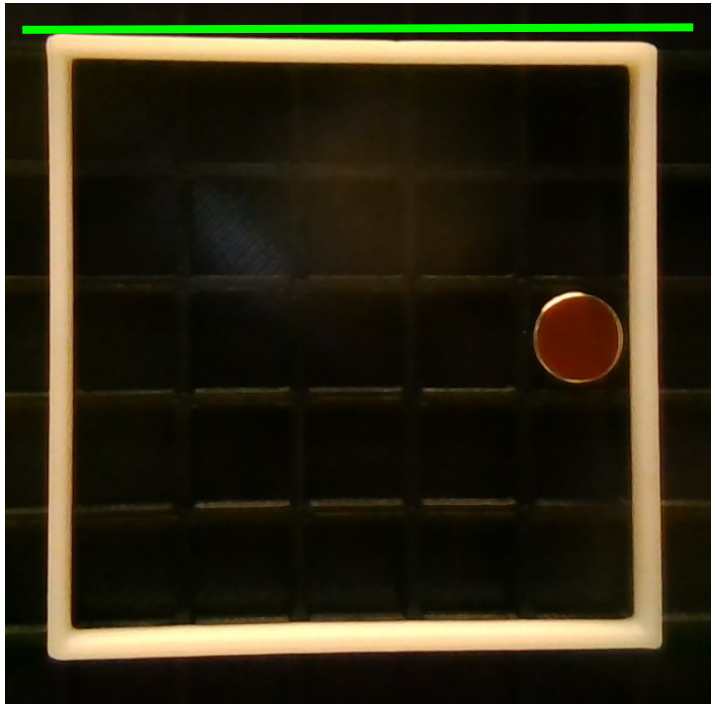




Target Board Calibration on Back

White square on the back can be used for manual and automatic calibration (future)

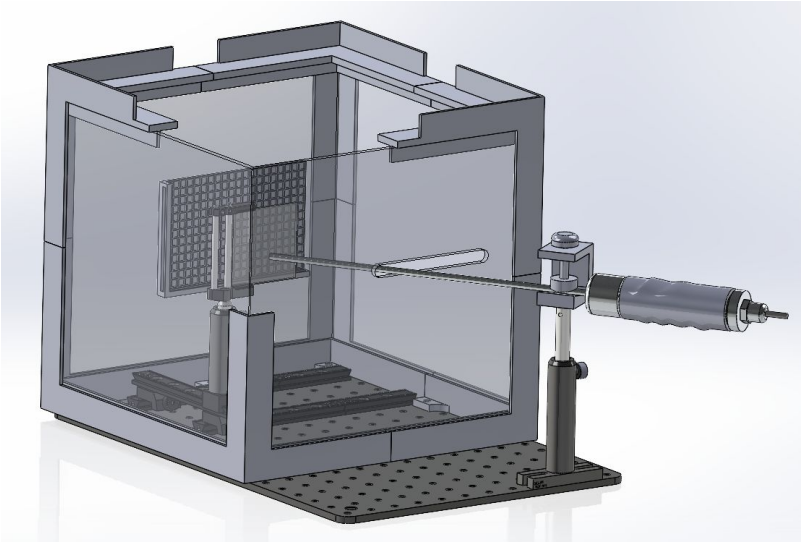




Testing Chamber Specifications

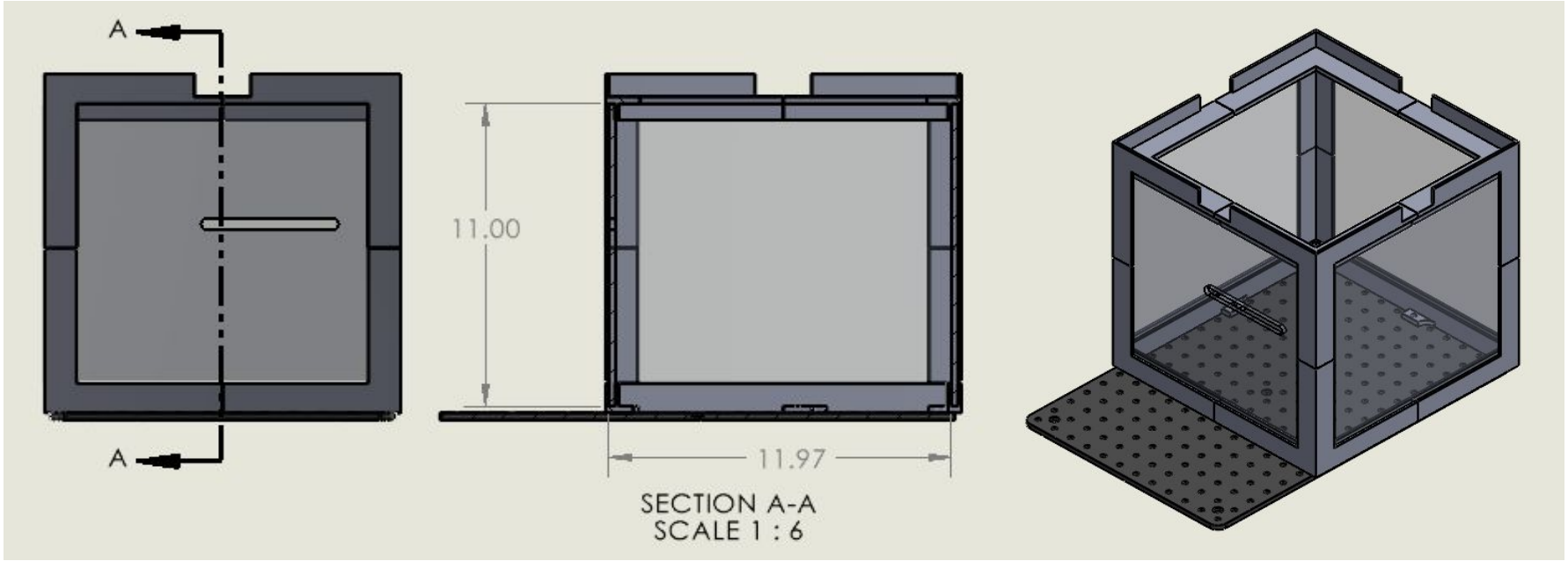
Justification:

- Need to future potential targets (most immediately, fit the target board)
- Help seal and prevent any light from entering the upper five faces
- Ideally double as a thermal testing enclosure
- Minimum number of 3D printed parts
- Pack flatly to save space
- Secures to the breadboard
- Have holes or slots for scope tip



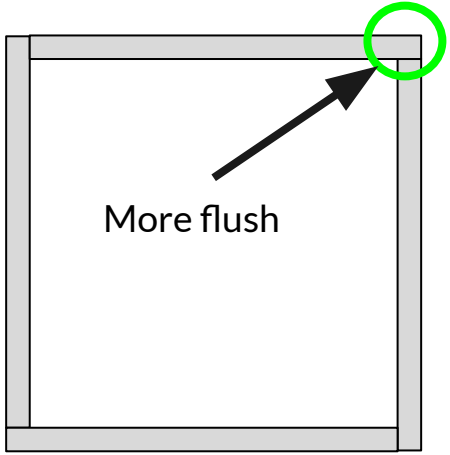
Testing Chamber Modeling

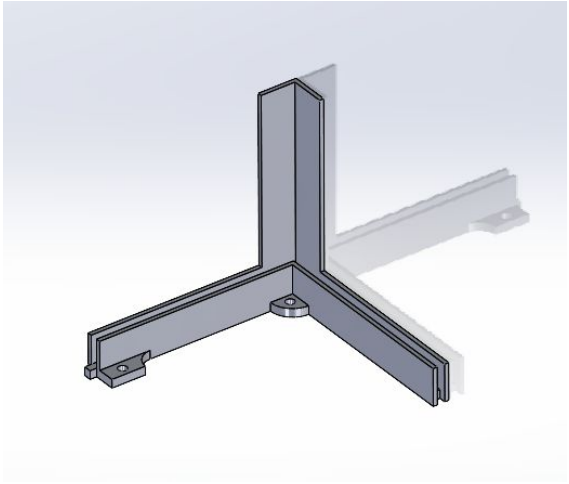
- 4 of 11” X 12” boards for sidewalls
- 1 of 11” X 11” boards for top

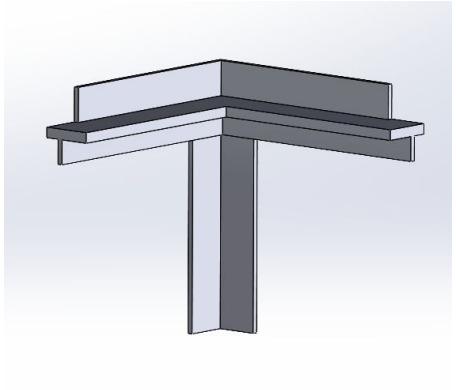


Testing Chamber Build

- Cut four standard 11” x 14” matte black boards into 11” x 12” boards (keeping edge as straight as possible)
- Cut one standard 11” x 14” matte black board into a 11” x 11’ board
- Print four copies of each top and bottom pieces
- Align boards as shown below:

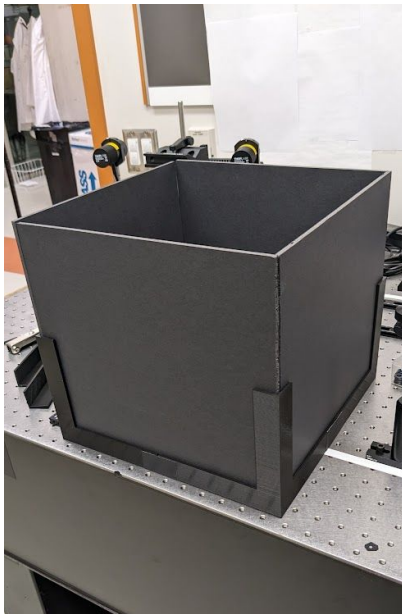


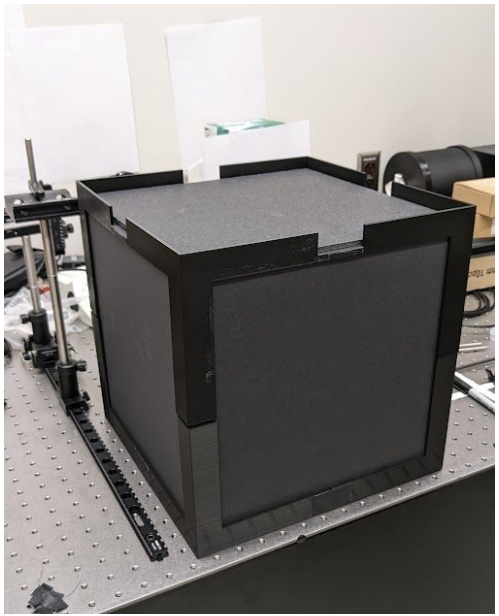


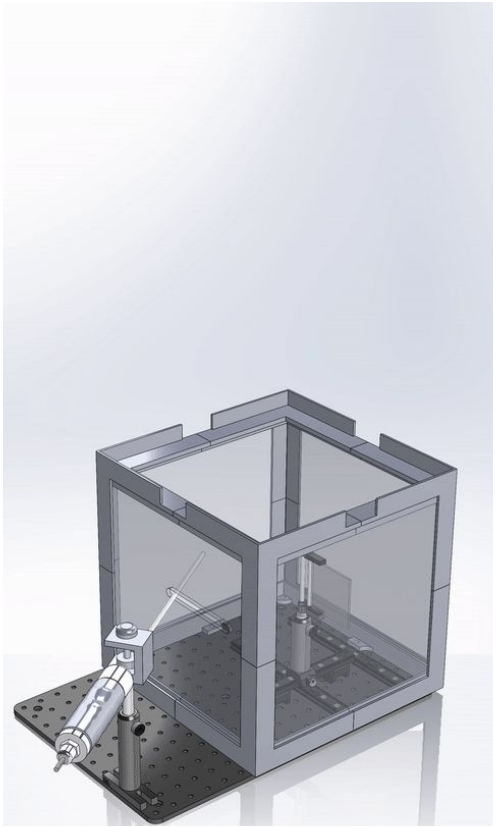


Testing Chamber v1

- Gaffers tape is used to seal remaining holes

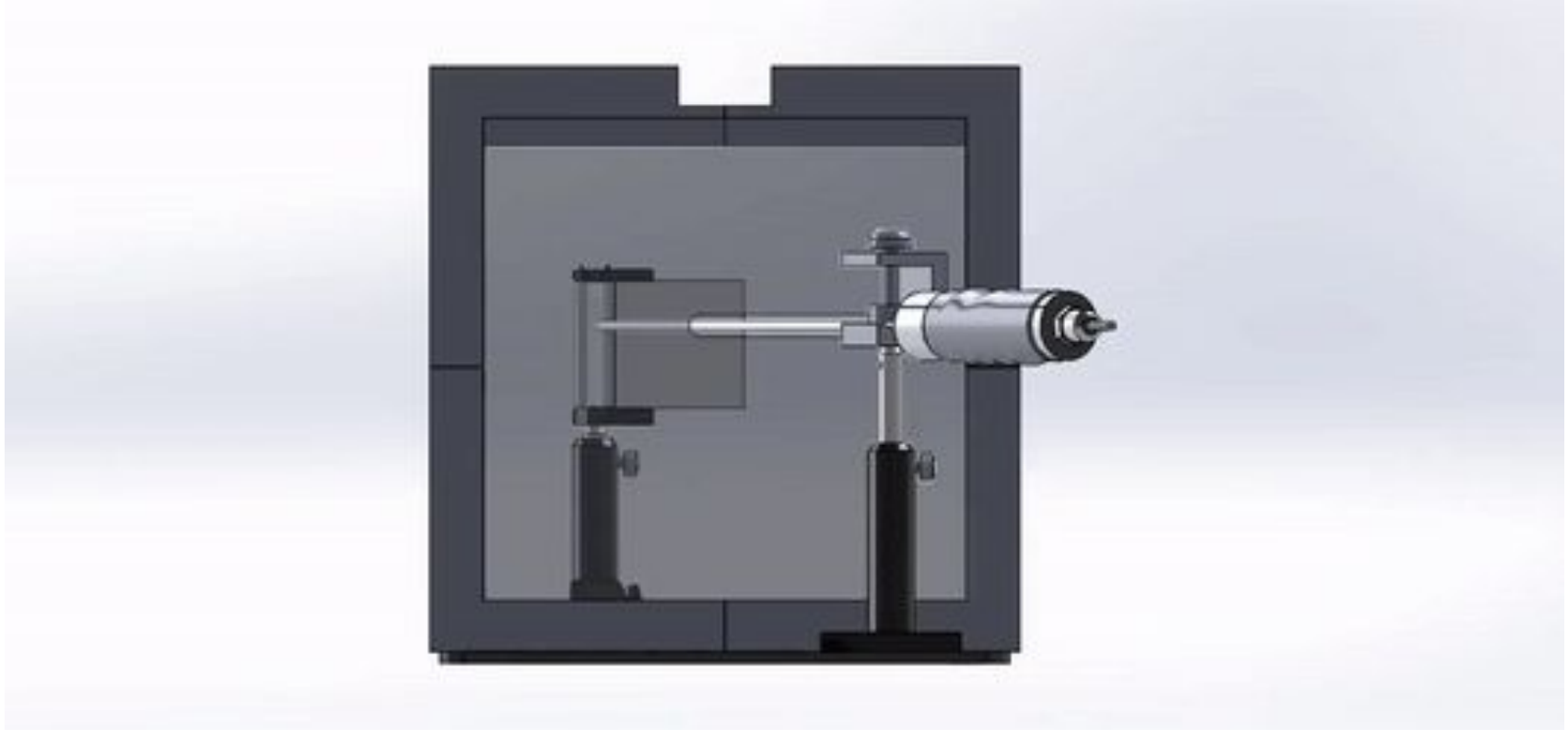




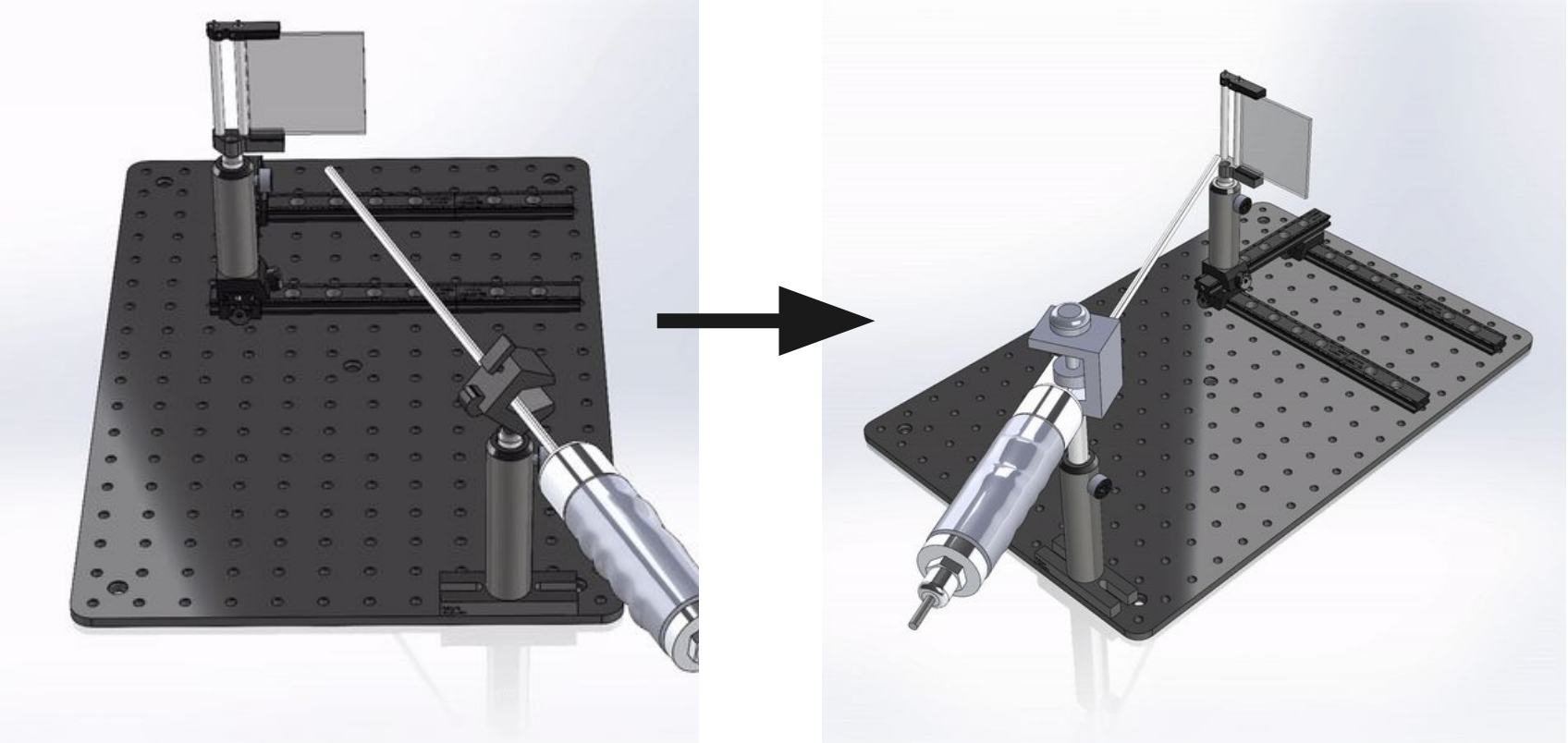


Testing Chamber Inside

Updated Portable Testing Setup



Updated Graphic to Show the Two Modes

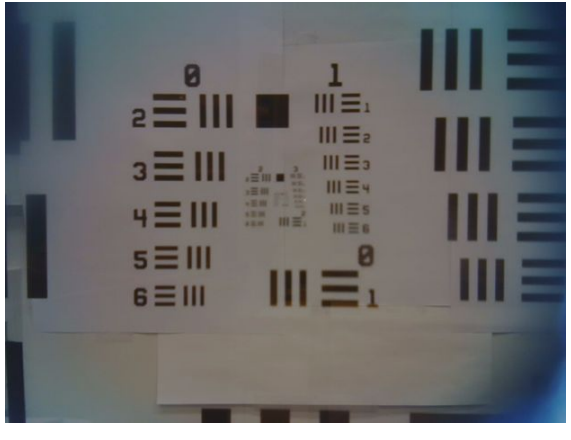


Initial Testing and Comparison - Resolution @ 40mm

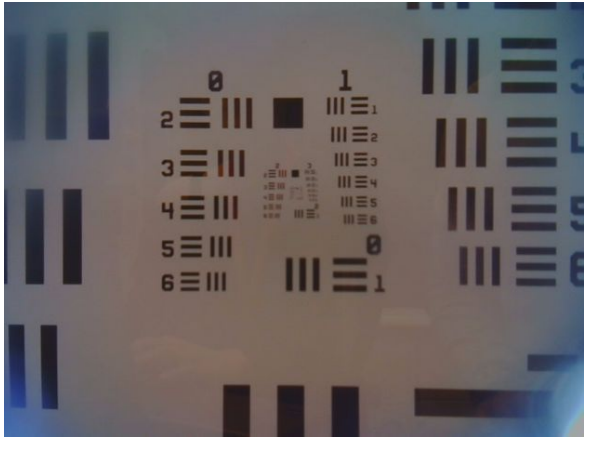
KV4-3

Testing Setup	Backlit	Ambient on, LED on	Ambient on, LED off	Ambient off, LED on (no tape)	Ambient on, LED on (new target)	Ambient on, LED on (no tape, new target)
Original	198.43	194.1	198.43	198.43	N/A	N/A
Portable Testing Chamber	N/A	191.21	N/A	N/A	170.35	140.31

Original



PTC

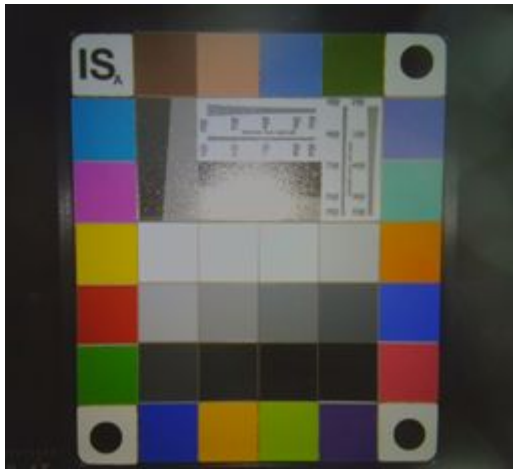


Initial Testing and Comparison - Color

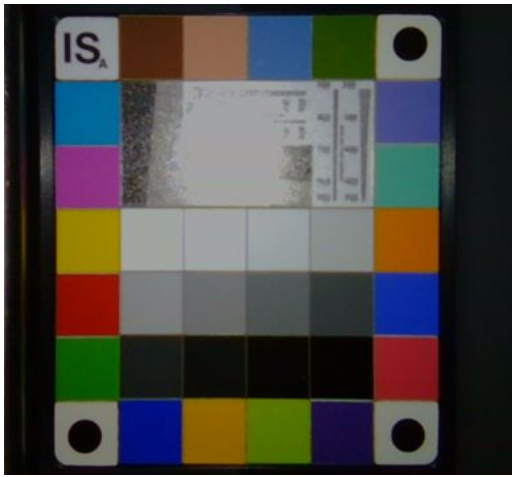
KV4-3

	Mean	E*ab Max	Mean	C*ab Max
Original	18.02	30.8	7.74	24.9
Portable Testing Chamber	22.64	36.1	9.28	32.3

Original



PTC

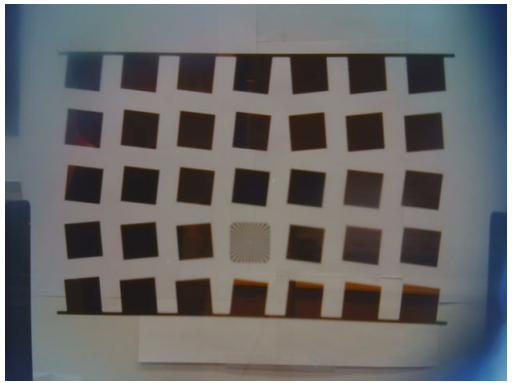


Initial Testing and Comparison - Distortion @ 40mm

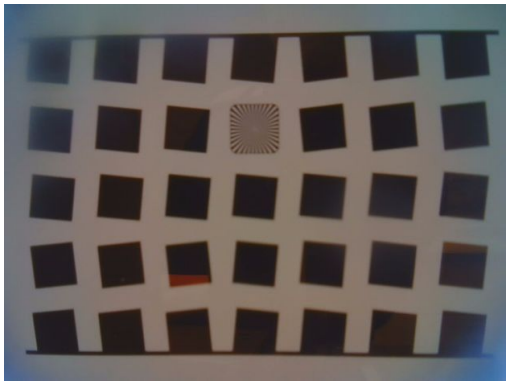
KV4-3

	Lighting Condition	SMIA TV Distortion (%)	Mean MTF 50 Center (Cy/Pxl)	Mean MTF 50 Corner (Cy/Pxl)	Focal Length (mm)	FoV - Diag (degrees)	FoV - H (degrees)	FoV - V (degrees)	FoV - Diag (cm)	FoV - H (cm)	FoV - V (cm)	Magnification
Original	**Ambient**	-2.14	0.20	0.00	18.41	61.87	49.93	38.40	4.80	3.70	2.80	0.85
Portable Testing Chamber	**Ambient**	-1.47	0.14	0.16	20.37	52.10	42.00	32.13	3.90	3.10	2.30	1.04

Original

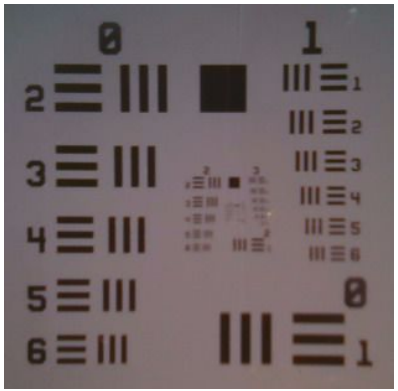


PTC

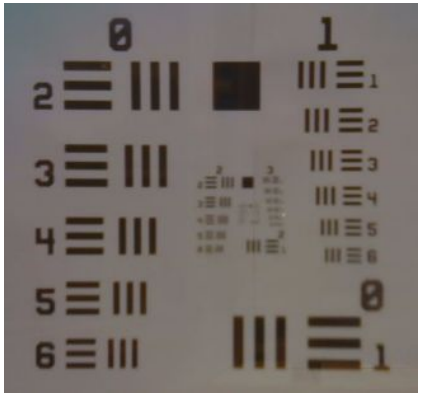


Light Sources

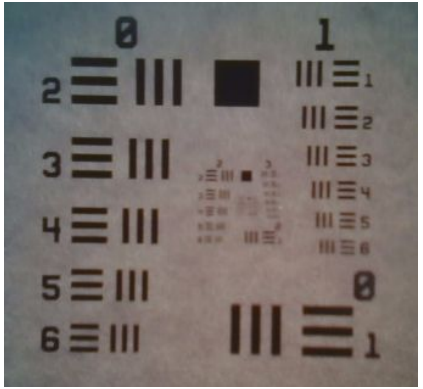
- LED/reflection mode (currently used)
- Ambient/scattering mode (previously used)
- Background/transmission mode (promising, but needs consistency)
- Which should we move forward with the testing chamber?



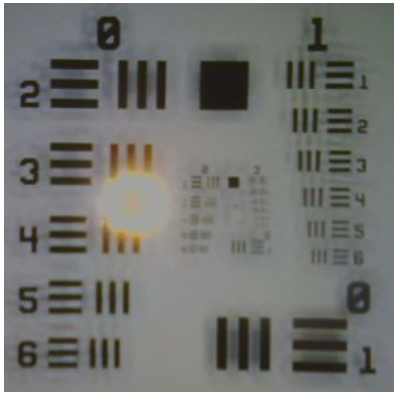
Scope LED off, tabletop LED only



Scope LED off, ambient lighting only

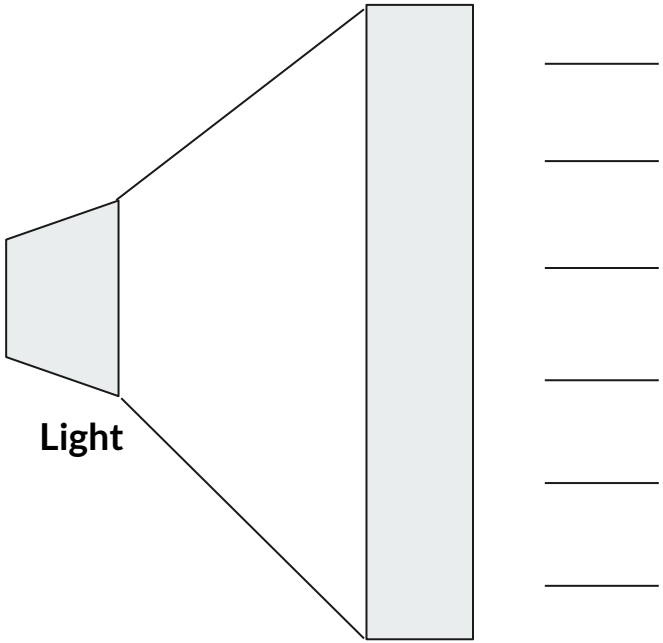


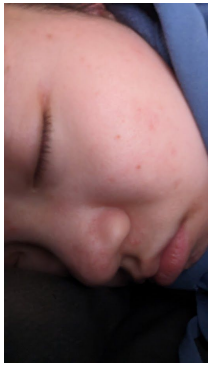
Scope LED off, transmission lighting



Scope LED on only

Light Sources - Transmission Mode



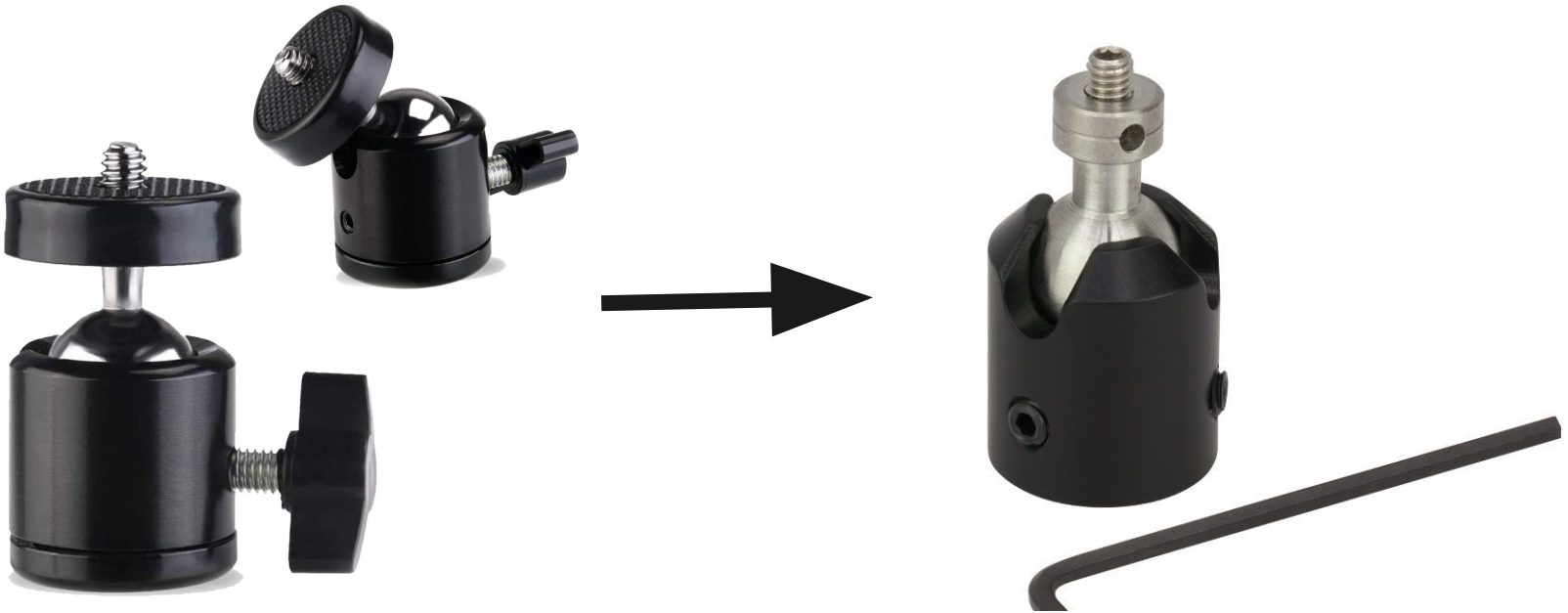


Object

Some camera module

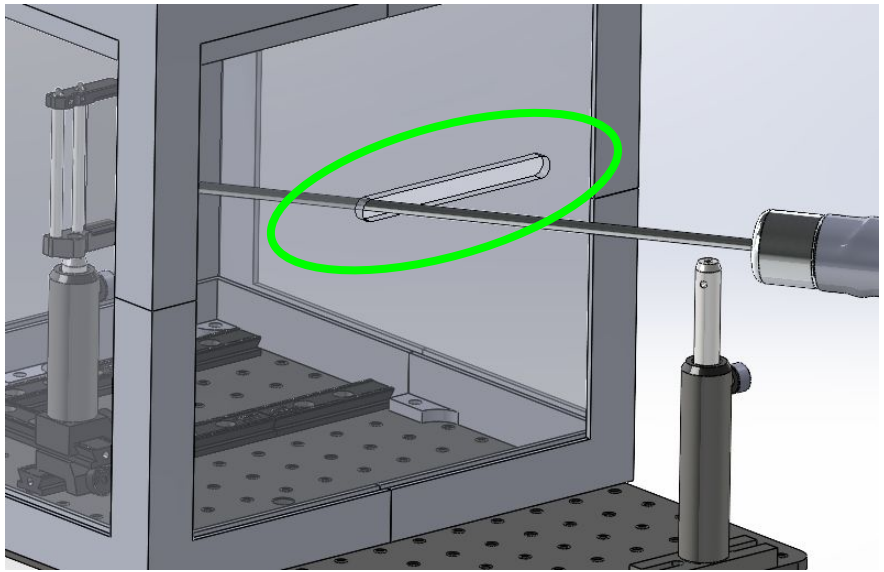
Angle Adjustment Enigma

- Ideally allows for finer adjustment of both the scope and the target board
- Especially for the slight rotation both towards or away from us



Scope Hole/Slot Placement

- Where to place?
- How big?
- Do we want to use a trocar for better seal?



Up Next

- Flesh out protocol for calibration steps (Tri big help)
- Continue optimizing portable testing chamber with newer components
- Find affordable targets to characterize other aspects of image quality
- Update bill of materials and supplies list to be up to date
- Finally build prototype so we can optimize it , adhering to our criteria of interest

About me (Jason)

NOT MY HAND NOR MY SPIDER

[Template]

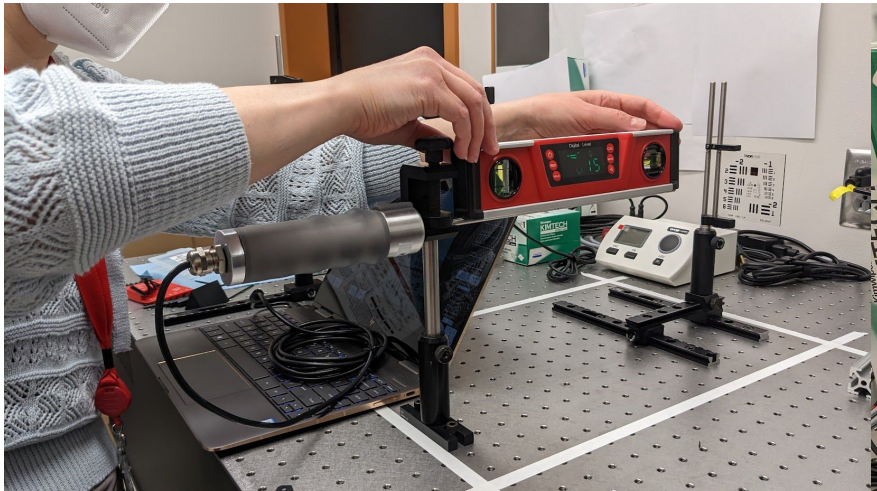
4/13/23 Updates

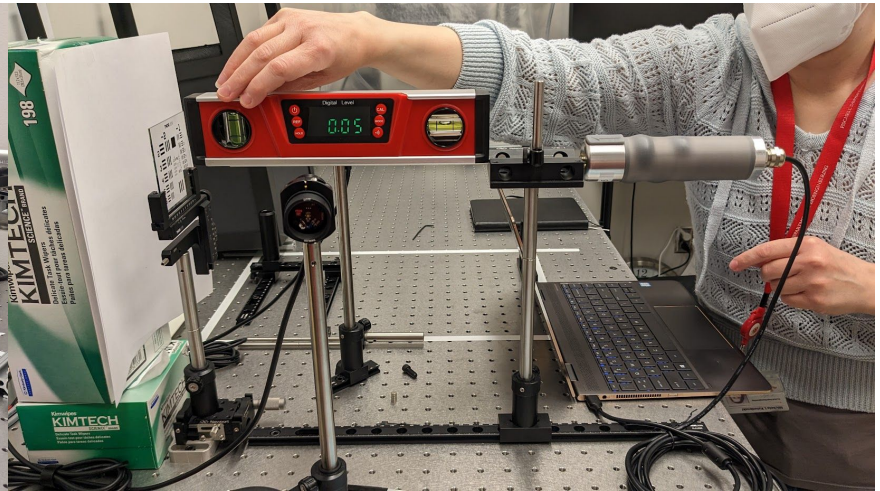
From Last Time

- Flesh out protocol for calibration steps (Tri big help)
- Continue optimizing portable testing chamber with newer components
- Find affordable targets to characterize other aspects of image quality
- Update bill of materials and supplies list to be up to date
- Finally build prototype so we can optimize it , adhering to our criteria of interest

Updated Terminology

- **Optical bench setup**: the older, standard setup on the large optical table with tabletop LEDs and a translating scope mount.
- **Simulated testing chamber (we are here):** the “in-between” model of our portable optical testing chamber built directly on the large optical table.
- **Portable testing chamber:** what we are aiming to ultimately construct.





Overall Plan

- [x] **Compare results of one scope on both the optical bench and the simulated setup, both using ambient room light, and ensure results are consistent.**
- [ ] Compare results of newly added LEDs for both setups and insure results are consistent; we want to maintain as much of the original imaging setup characteristics as possible.
- [ ] Build the prototype of the portable optical chamber and test this as well.
- [ ] Test to find the ideal scope entrance position and the LED placements to best replicate room ambient light.

Aggregated Data

	Optical Bench Setup	Simulated Chamber	Portable Chamber
Resolution	125.0	125.0	
SMIA Distortion	-2.39	-2.29	
Color Error Mean (C)	7.21	6.06	
Color Error Mean (E)	11.45	8.10	

Comparison Between Optical Bench Setup & Simulated Chamber

Resolution:

	Instrument: KV4-5							
	Trial	Distance	Group	Element	Resolution (µm)	Average Res	Std. Dev.	Error
LED off, ambient light on (on the **Simulated Testing Chamber** setup)	1	30	2	1	125	125	0	0
	2	30	2	1	125			
	3	30	2	1	125			
LED off, ambient light on (on the **Optical Bench** setup)	1	30	2	1	125	125	0	0
	2	30	2	1	125			
	3	30	2	1	125			

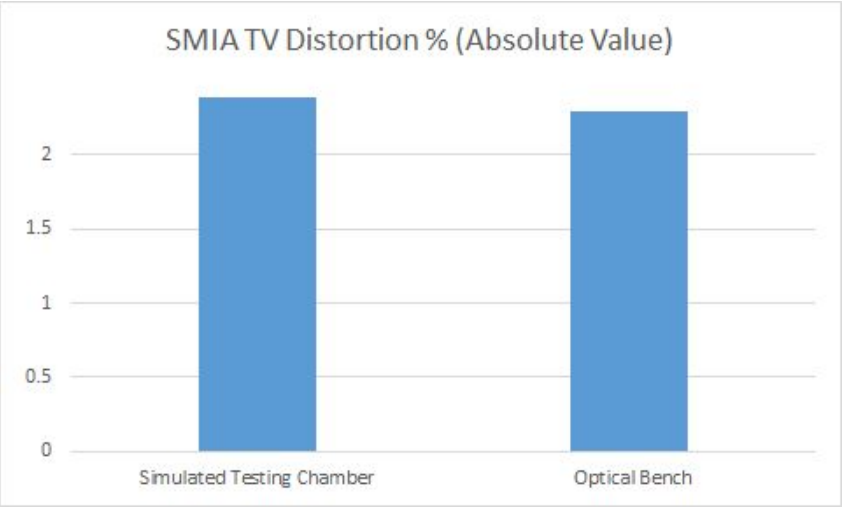
Comparison Between Optical Bench Setup & Simulated Chamber

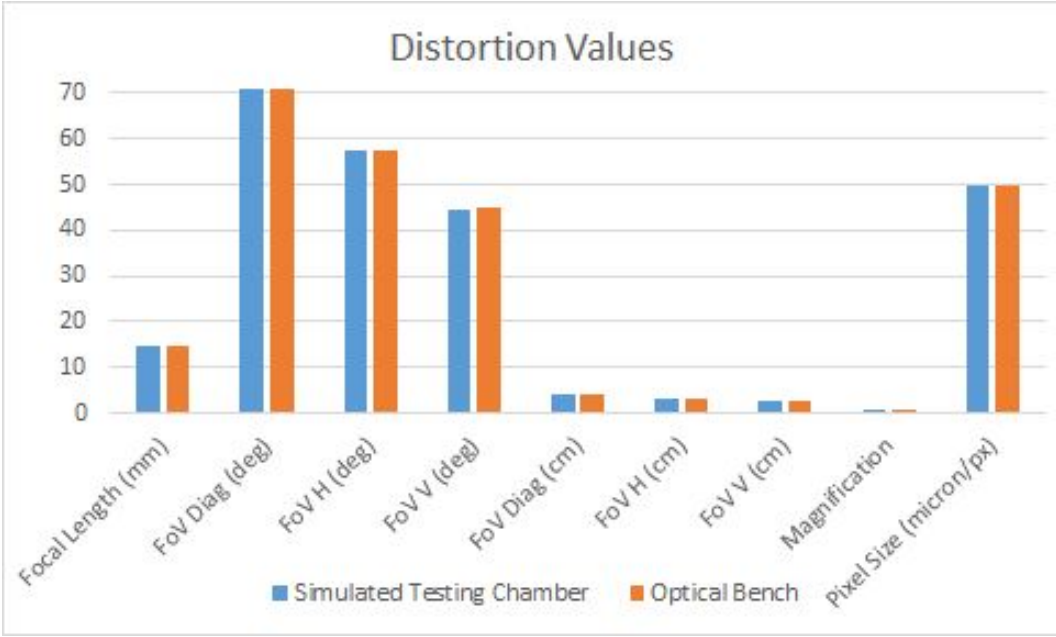
Distortion:

	KeyScope V4-5 - Simulated Testing Chamber												
Pic	Trial	Distance (mm)	SMIA TV	Mean MTF 50	Mean MTF 50	Focal Length	FoV - Diag	FoV - H	FoV - V	FoV - Diag	FoV - H	FoV - V	Magnification
10-59-28	1	30	-2.33	0.254	0.345	14.73	70.9	57.7	44.8	4.3	3.3	2.5	0.9642
10-59-29	2	30	-2.18	0.257	0.331	14.73	70.8	57.7	44.8	4.3	3.3	2.5	0.9641
10-59-36	3	30	-2.35	0.259	0.326	14.73	70.9	57.7	44.8	4.3	3.3	2.5	0.9644
Average			-2.29	0.26	0.33	14.73	70.87	57.70	44.80	4.30	3.30	2.50	0.96
STD DEV			0.09	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	KeyScope V4-5 - Optical Table												
Pic	Trial	Distance (mm)	SMIA TV	Mean MTF 50	Mean MTF 50	Focal Length	FoV - Diag	FoV - H	FoV - V	FoV - Diag	FoV - H	FoV - V	Magnification
11-31-09	1	30	-2.42	0.251	0.329	14.75	70.8	57.7	44.7	4.3	3.3	2.5	0.9671
11-31-10	2	30	-2.37	0.251	0.327	14.75	70.7	57.7	44.7	4.3	3.3	2.5	0.9671
11-31-11	3	30	-2.37	0.249	0.332	14.75	70.7	57.7	44.7	4.3	3.3	2.5	0.9671
Average			-2.39	0.25	0.33	14.75	70.73	57.70	44.70	4.30	3.30	2.50	0.97
STD DEV			0.03	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00

Comparison Between Optical Bench Setup & Simulated Chamber

Distortion:





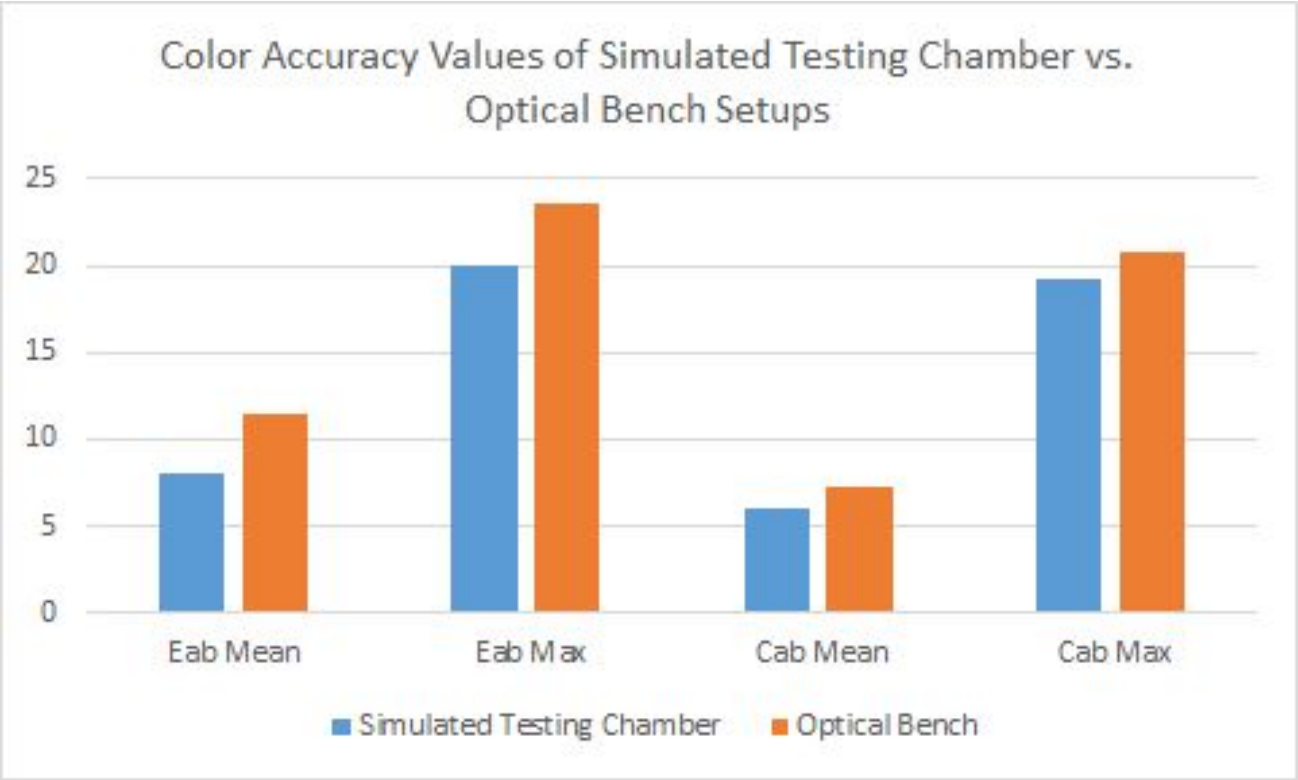
Comparison Between Optical Bench Setup & Simulated Chamber

Color:

Instrument: KV4-5 - Simulated testing chamber				
Image Name	E*ab Mean	E*ab Max	C*ab Mean	C*ab Max
10-52-48	8.13	19.9	6.11	19
10-52-49	8.1	20.1	6.05	19.3
10-52-53	8.06	20.1	6.03	19.2
Mean	8.096666667	20.03333333	6.063333333	19.16666667
Std dev	0.03511884584	0.1154700538	0.04163331999	0.1527525232
Instrument: KV4-5 - Original setup				
Image Name	E*ab Mean	E*ab Max	C*ab Mean	C*ab Max
11-22-32	11.41	23.6	7.21	20.9
11-22-34	11.53	23.5	7.22	20.7
11-22-35	11.41	23.5	7.21	20.8
Mean	11.45	23.53333333	7.213333333	20.8
Std dev	0.0692820323	0.05773502692	0.005773502692	0.1

Comparison Between Optical Bench Setup & Simulated Chamber

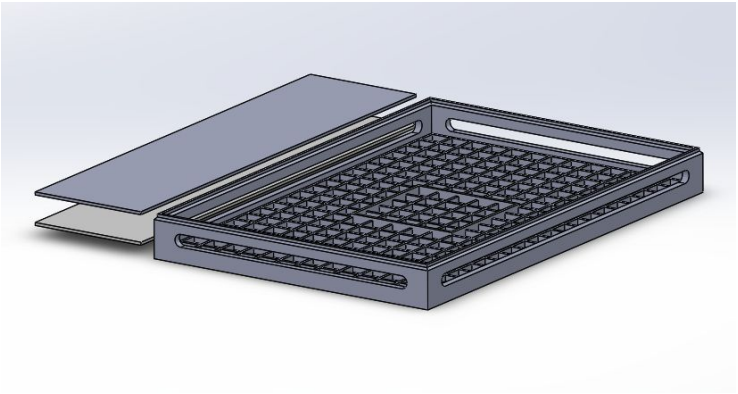
Color:



Resolution Target

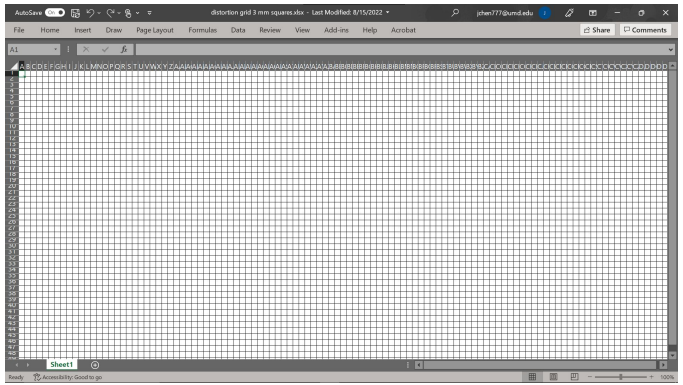
Justification:

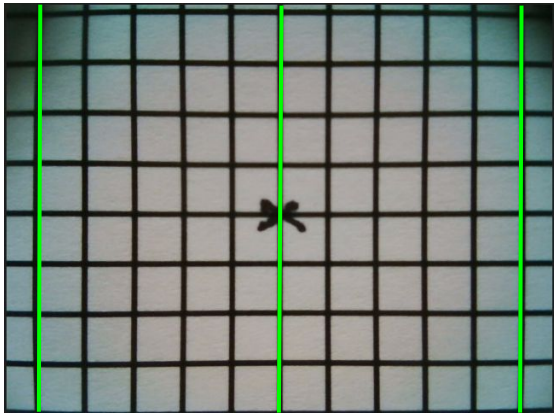
- Paper thin & light
- Much less expensive (~$8 vs $214.18)
- Compatible with new target mount
- Plastic, not glass (no need to worry about breaking)



Distortion Target

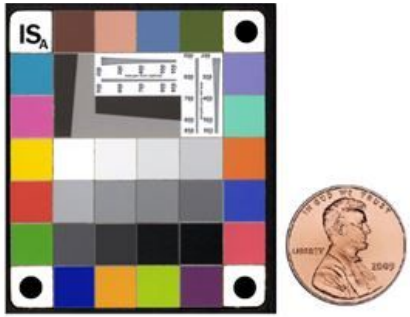
- Can print our own target and combine with MATLAB and write code for more accurate line recognition
- Keep looking for more standardized targets…





Color Target Options

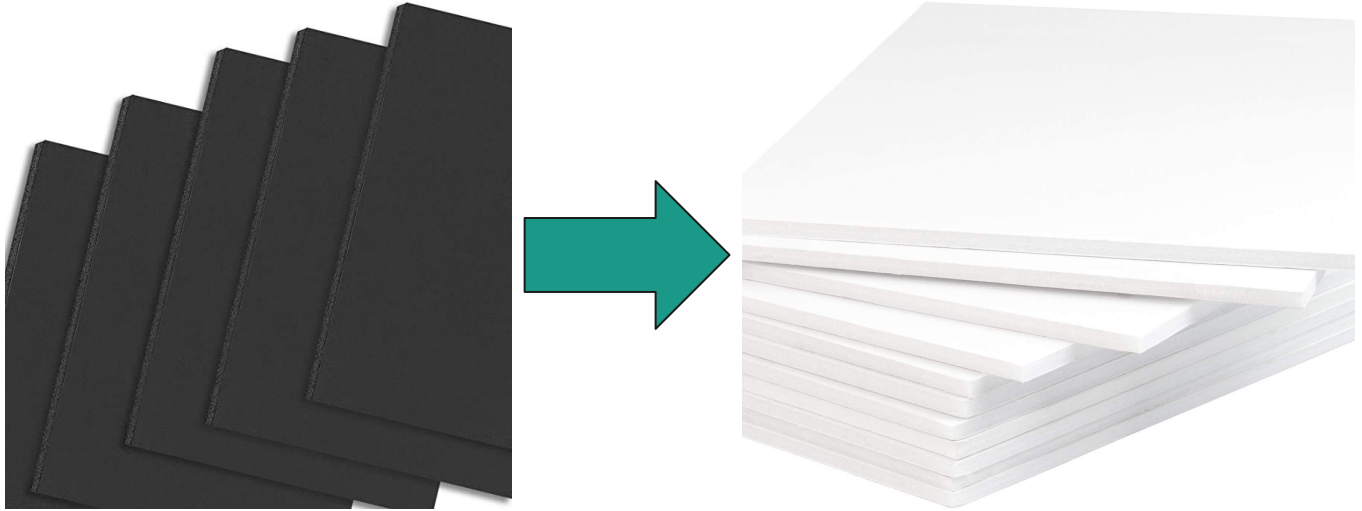
	ColorChecker Classic	QP Card 203	Rez Checker (Currently Used)
Cost	$69.00	$69.99	$324.00
Dimensions	2.25 x 3.25"	5.3" x 3.75"	1.875” x 1.625”
Software	Free download*	Free download*	Free download*
In stock?	Yes	2-4 week backorder	Yes



*= Need to download software to verify that they actually work

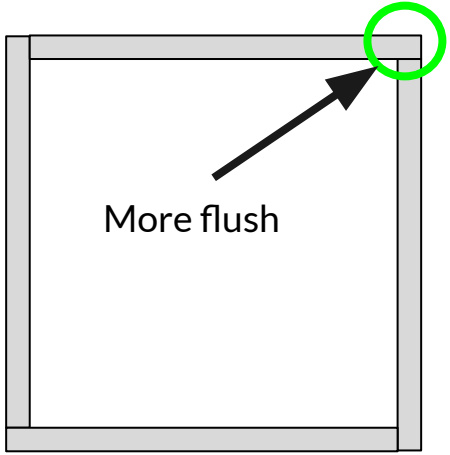
White Foam Enclosure

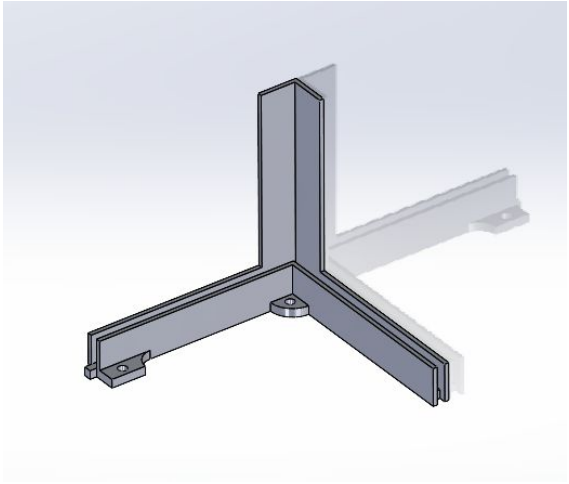
- Will try white foam enclosure since white scatters light better could aid in producing lighting conditions inside chamber
- Will also provide white background for glass targets
- Looking into printing the “frame” of our chamber in white also

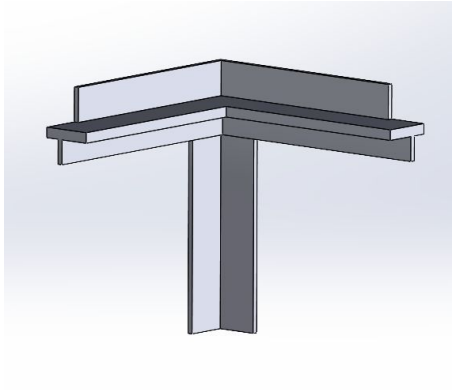


Updated Testing Chamber Build

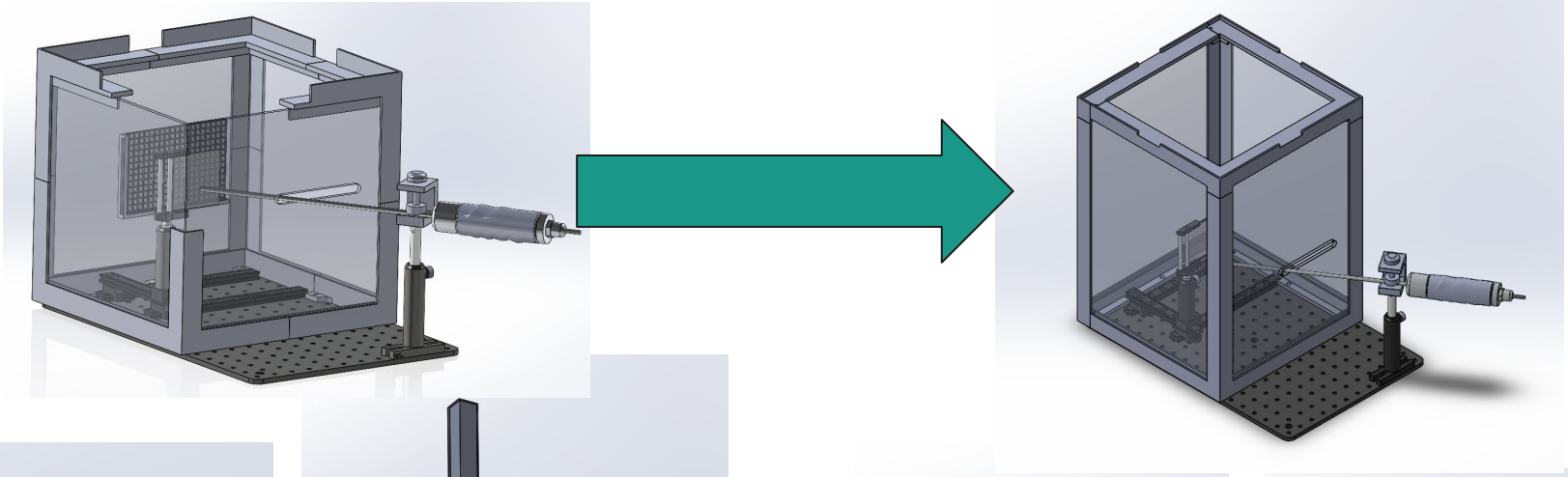
- Use four standard 12” x 16” matte white
- Cut one standard 12” x 16” matte black board into a 12” x 12” board
- Print four copies of each top and bottom pieces
- Align boards as shown below:





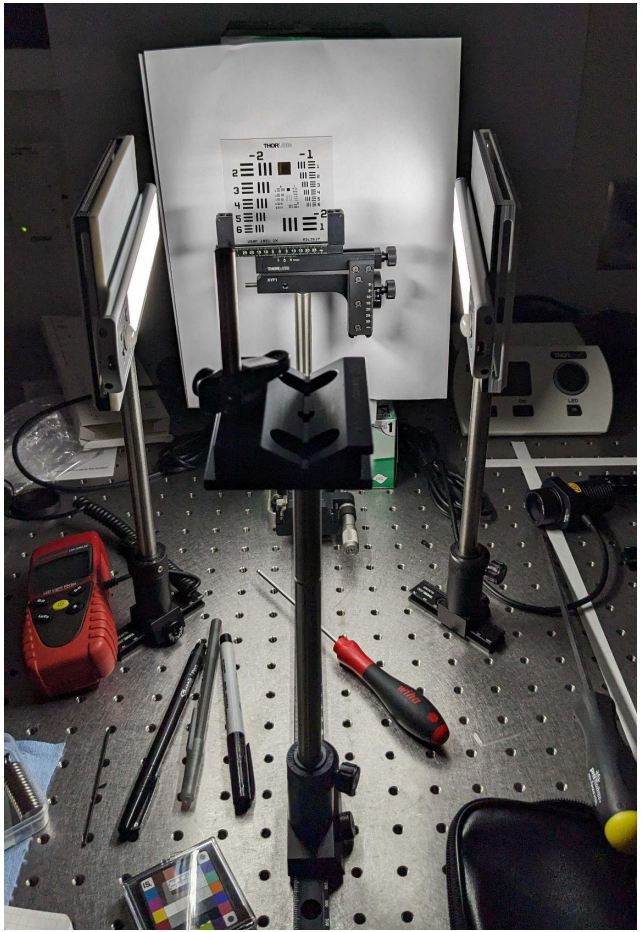


Updated Chamber Frame



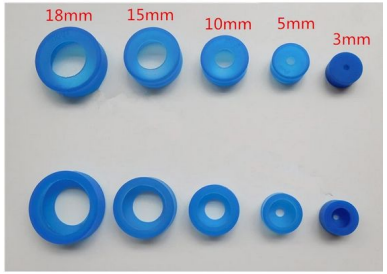
LEDs

- Compare different types (bar vs puck)
- Test on optical bench setup and simulated testing chamber
- Then test simulated testing chamber with enclosure on (will try different positions of LEDs to determine which orientation mimics ambient light results the best)



Chamber Scope Entry Seal

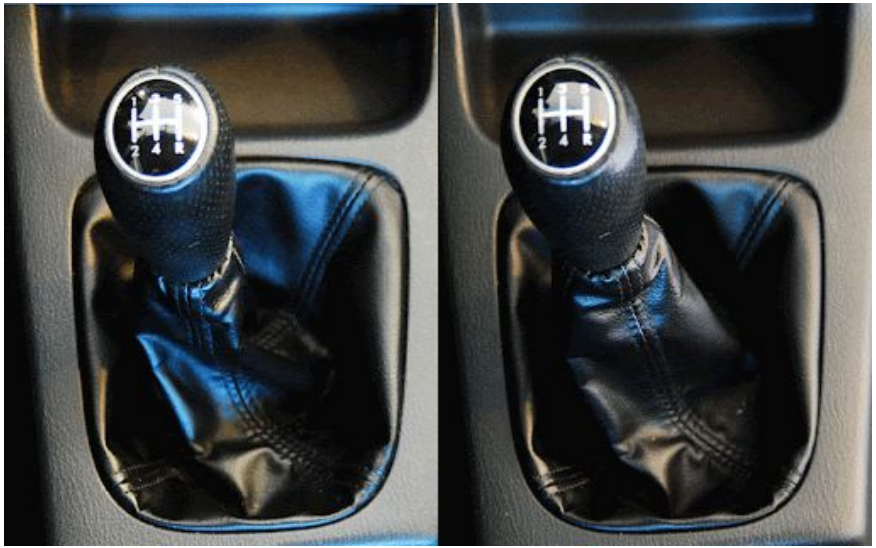
- Staggered brushes idea
- Cloth “bag”
- Soft rubber opening
- Sliding “door”



Sliding mechanism

Questions

- Any questions about the previous slide?
- How many prototypes to build?
- Any suggestions?



Next Steps

- Compare results of newly added LEDs for both setups and insure results are consistent; we want to maintain as much of the original imaging setup characteristics as possible.
- Construct the prototype of the portable optical chamber and test this as well.
- Test to find the ideal scope entrance position and the LED placements to best replicate room ambient light.
- Order and verify new test target options.

About me

- I can almost eat anything, but I despise olives (especially on pizza)
- I think plants are pretty cool
- I got a new tarantula: Pink Toe!
- I love horror movies, I recommend: The Wailing and Gonjiam Haunted Asylum

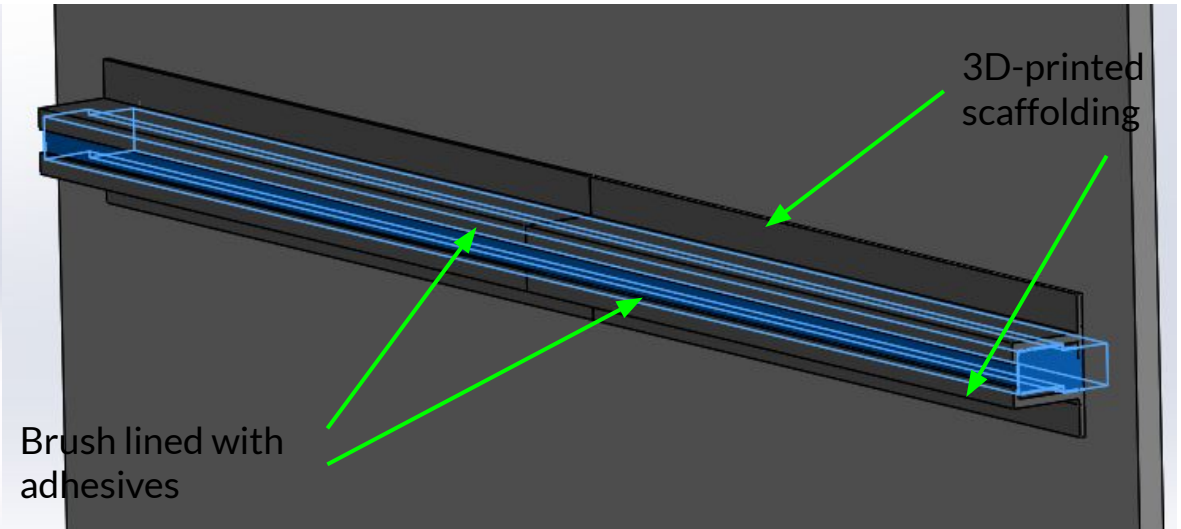
5/11/23 Updates

What we did

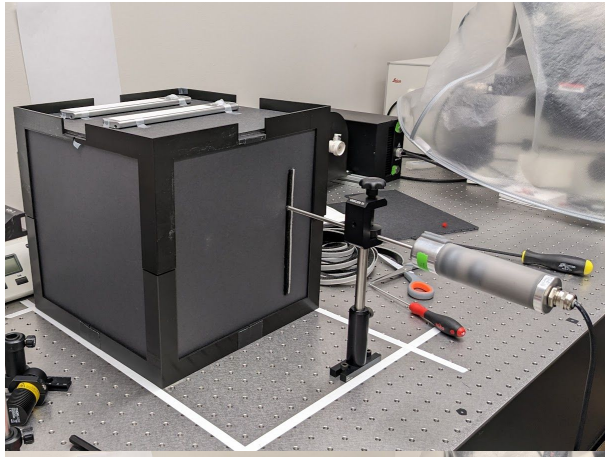
- LED and lighting optimization
- Troubleshooted characterization targets
- Building new testing chamber prototype
- Optimized the frame, shape, color, and joints of the testing chamber
- Built and tested optical testing chamber prototype
- Sought to document and duplicate portable testing chamber
- Updated BoM for portable testing chamber

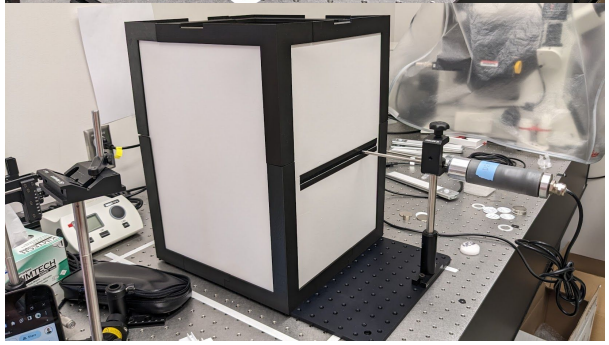
Light isolation idea 1: parting the brush

- Using the fine hairs of a adhesive brush strip to block out light
- Pros: elegant design, easy implementation, and blocks out light
- Cons: limited vertical range and requires some super glue



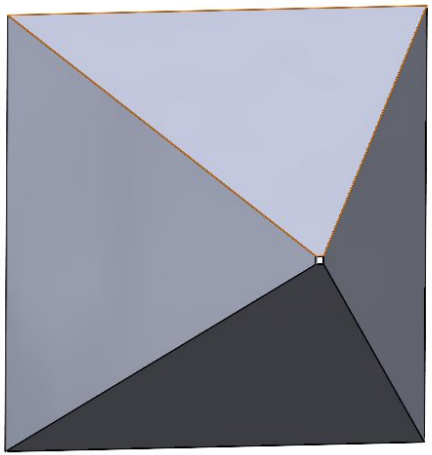
Light isolation idea 1: parting the brush

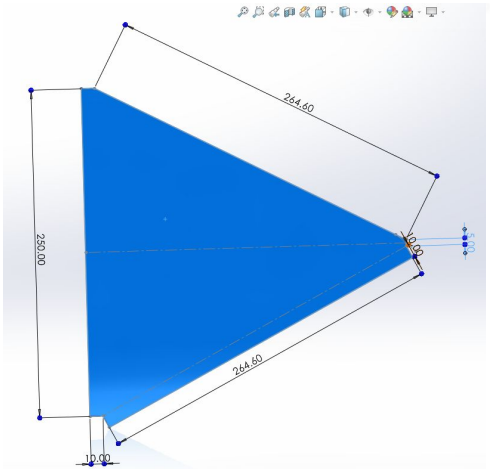


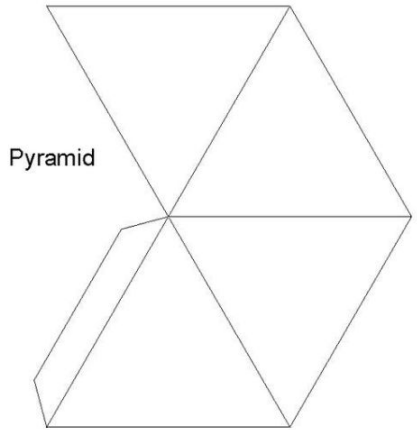


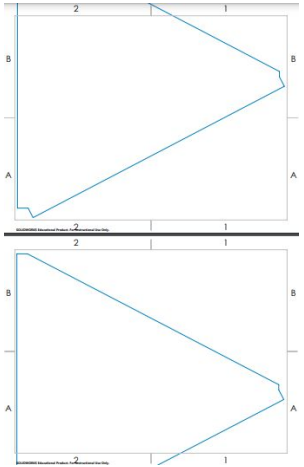
Light isolation idea 2: black out pyramid

- Using blackout curtain material in a flexible orientation
- Pros: allows the translation of device in all dimensions and blocks out light
- Cons: difficulty assembling pyramid out of fabric and also requires glue

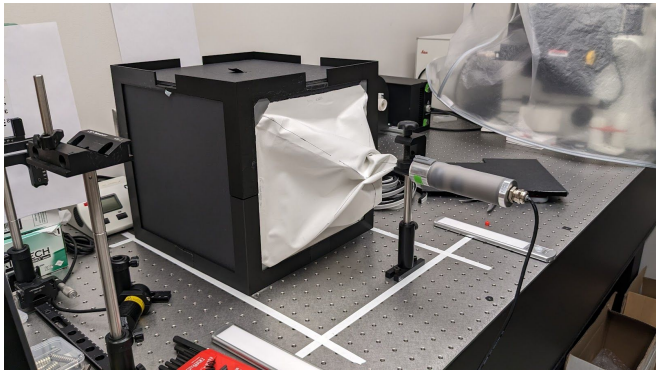


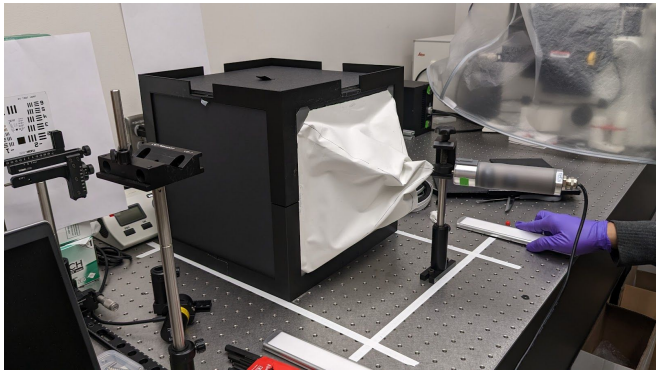






Light isolation idea 2: black out pyramid



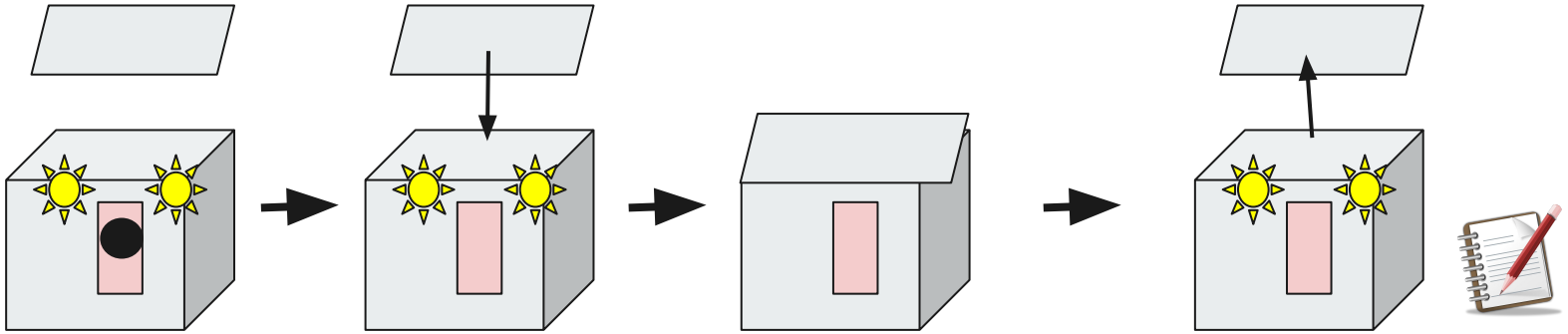


LED options

- **Light bar**
  - Pros: fewer components (simpler charging, placement, replacement, etc)
  - Cons: limited number of overall unique setups
- **Light pucks**
  - Pros: more freedom and customization in locations
  - Cons: too many components and WIRES!

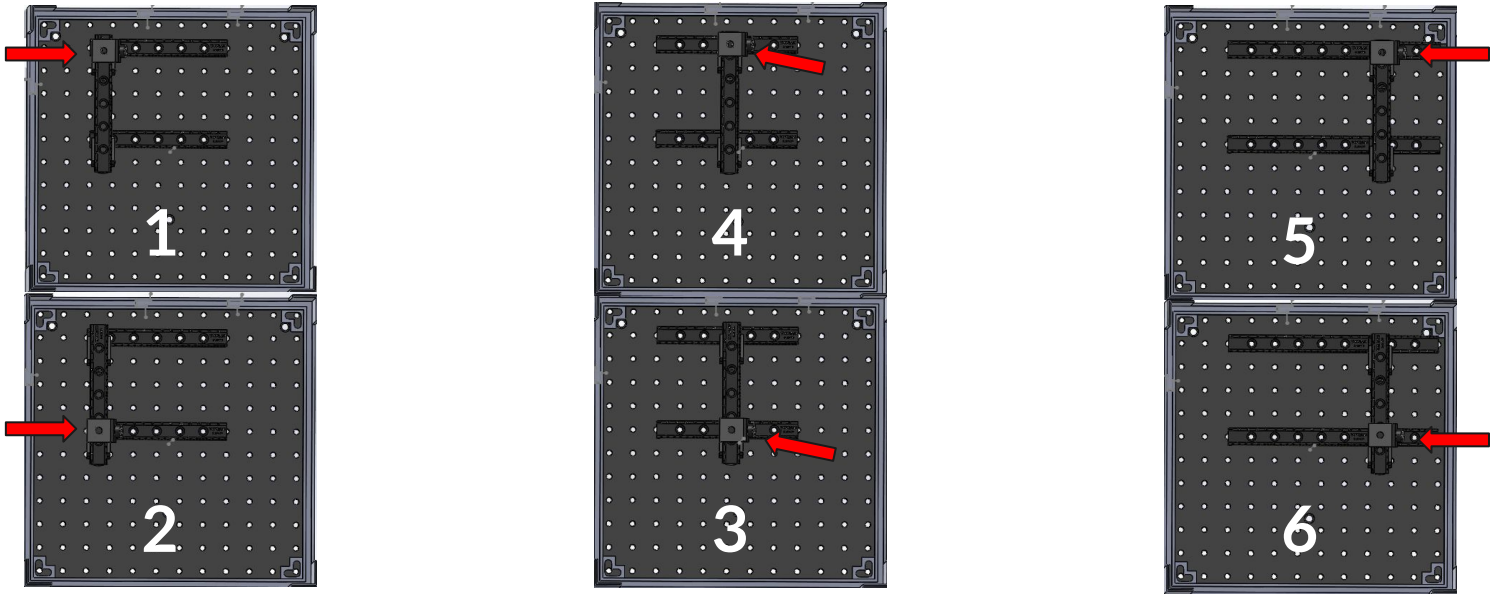
LED placement and testing protocol

1. Minimize light in the room
2. Have the luxmeter sensor covered and set to “keep max” mode
3. Remove sensor cover
4. Put on lid by approaching from furthest away from the sensor to avoid unintentionally close proximity
5. Wait three seconds, open lid, and take reading



LED placement and testing protocol

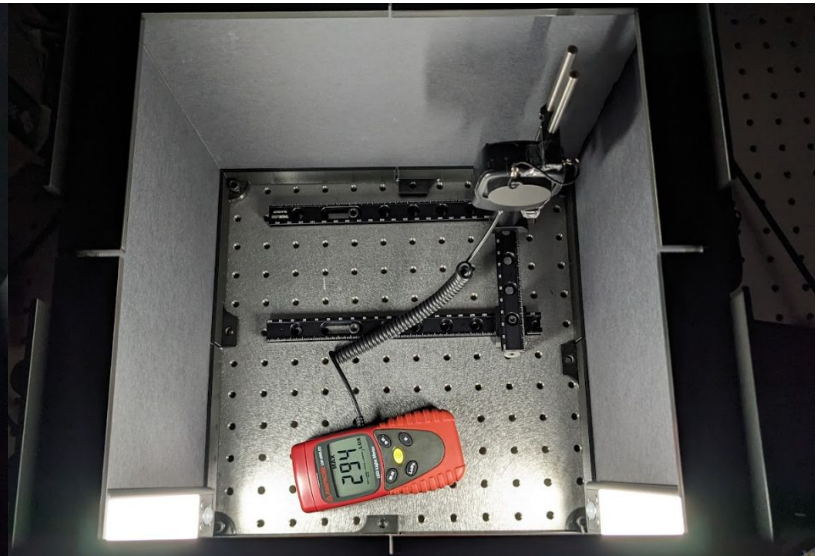
- Testing six locations to determine the averages and standard deviations
- Values and averages should be within 400 to 800 lux
- Aim for low standard variation across values taken at all six locations:



LED placement and testing: short simulated

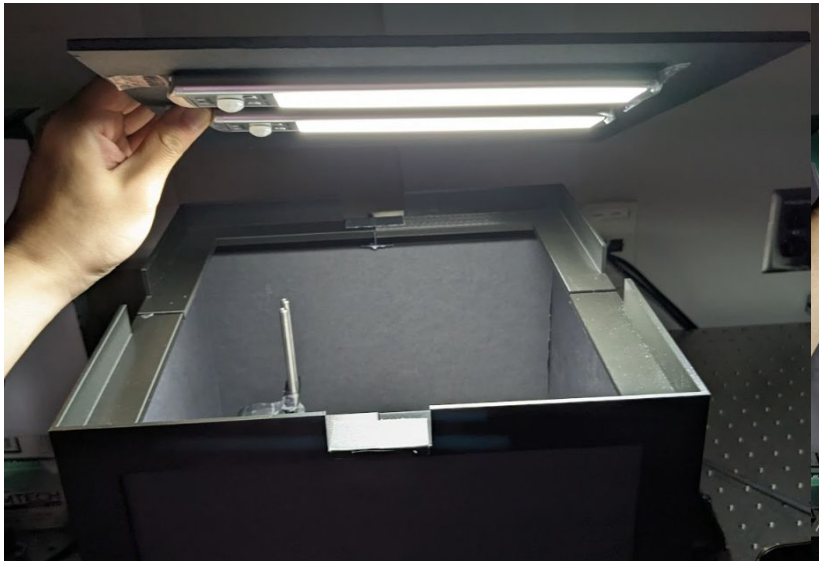
- Back vertical
- A lot of light not on the target
- Poor brightness

- Front vertical
- High brightness values
- Brighter closer to the front vs back

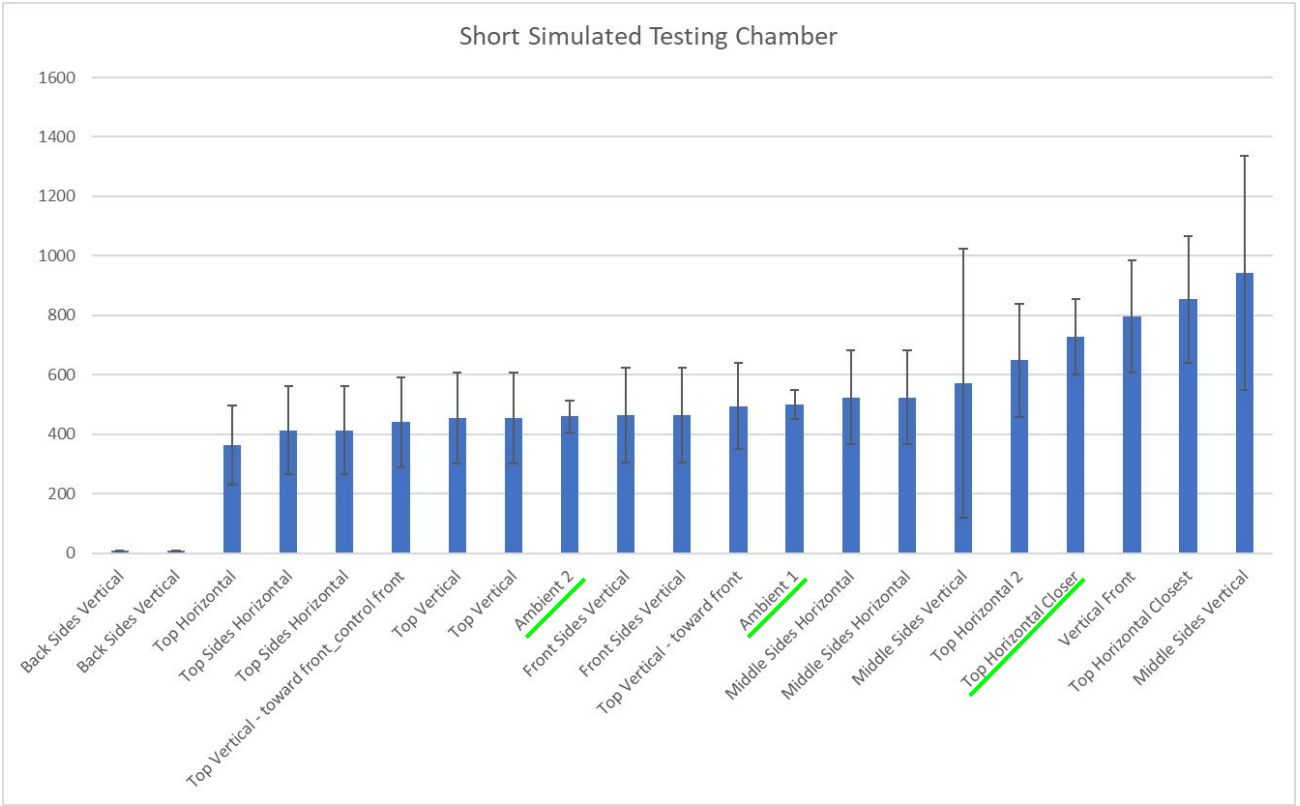


LED placement and testing: short simulated

- Both have desirable brightnesses
- Standard deviation of brightnesses for both are still quite high
- Middle vs side difference can be 200+ lux



LED placement and testing: short simulated

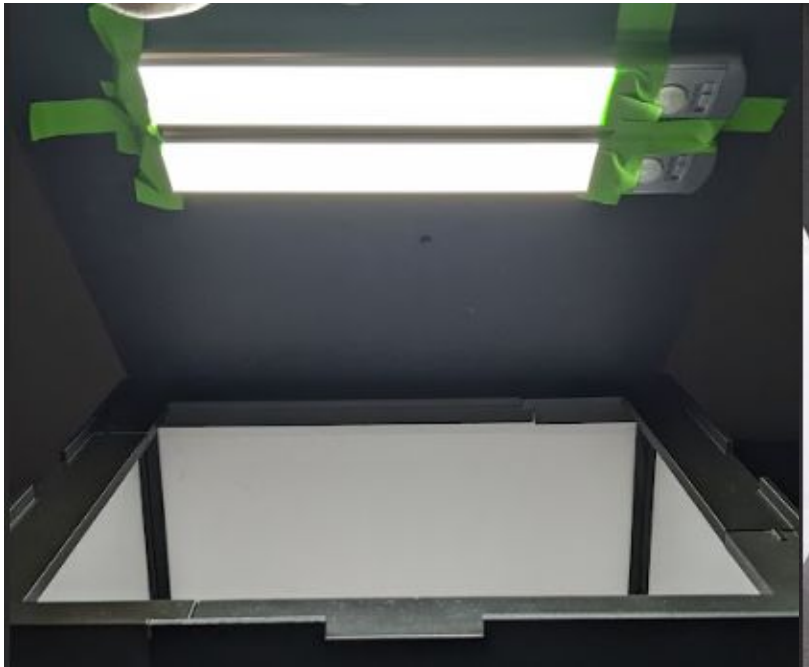
- 

LED placement and testing: tall simulated

- Top vertical
- Top horizontal

LED placement and testing: tall simulated

- Top horizontal closer to us
- Top horizontal farther from us



4 LED Set-up (Tall, horizontal)

Toward front of chamber

Toward back of chamber

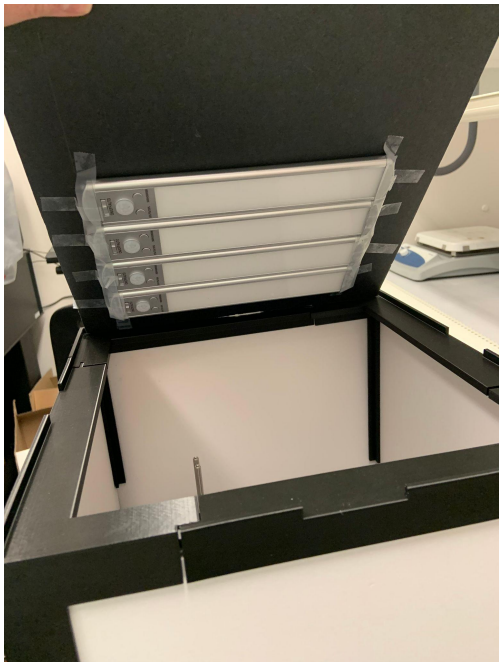


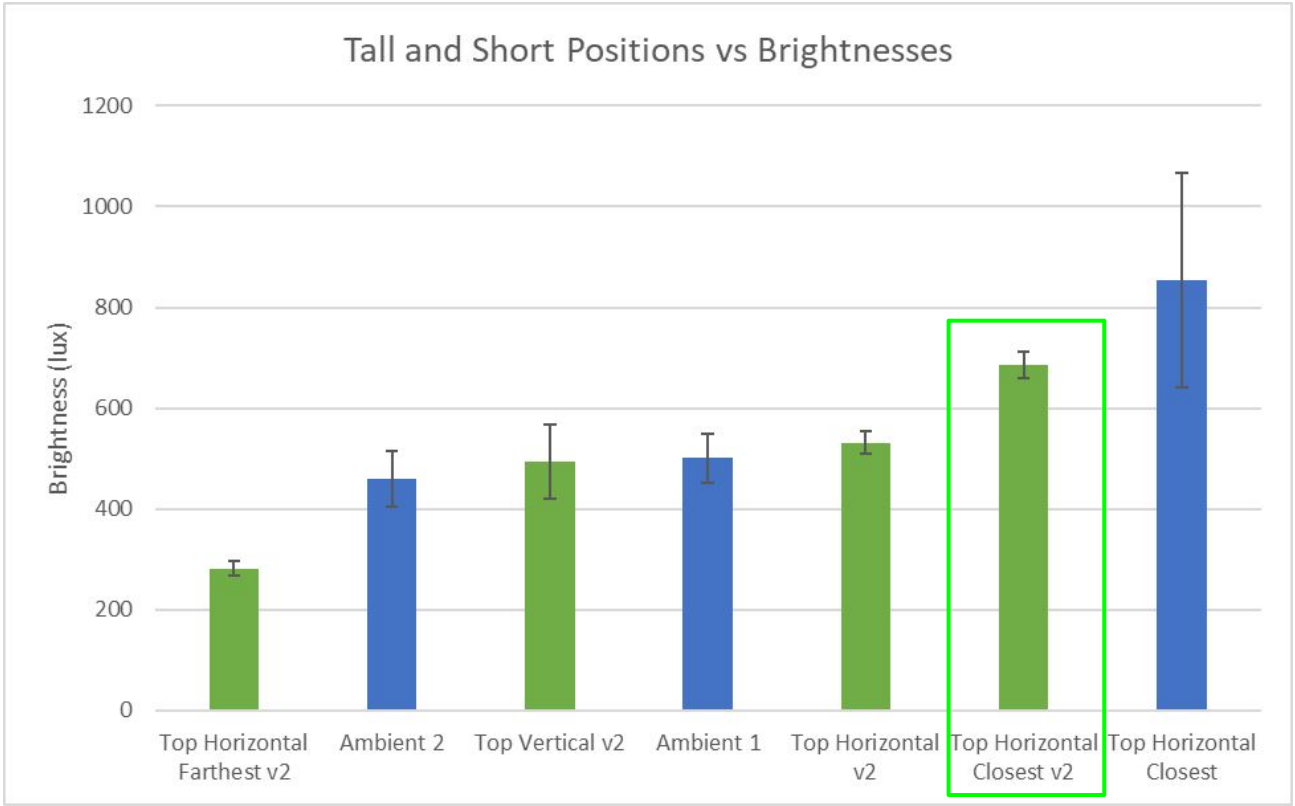
Table of Values (LED set-ups)

	Left				Center				Right			
Name	30	100	Difference	% error	30	100	Difference	% error	30	100	Difference	% error
Front Sides Vertical	573	290	283	65.58516802	669	403	266	49.62686567	563	294	269	62.77712952
Middle Sides Vertical	1459	767	692	62.17430368	574	752	178	26.84766214	1423	680	743	70.66096053
Top Sides Horizontal	311	567	256	58.3143508	218	499	281	78.38214784	322	564	242	54.6275395
Middle Sides Horizontal	452	692	240	41.95804196	291	554	263	62.24852071	454	703	249	43.04235091
Top Vertical	348	633	285	58.10397554	271	503	232	59.94832041	357	617	260	53.38809035
2 LEDs - Top Vertical v2	424	548	124	25.51440329	436	579	143	28.1773399	425	557	132	26.88391039
2 LEDs - Top Horizontal v2	517	546	29	5.45625588	533	561	28	5.118829982	499	531	32	6.213592233
2 LEDs - Top Horizontal Farthest v2	274	301	27	9.391304348	260	284	24	8.823529412	277	293	16	5.614035088
2 LEDs Top Horizontal Closest v2-1	**686**	**682**	**4**	**0.5847953216**	**719**	**714**	**5**	**0.6978367062**	**655**	**663**	**8**	**1.213960546**
2 LEDs Top Horizontal Closest v2-2	**684**	**666**	**18**	**2.666666667**	**716**	**718**	**2**	**0.2789400279**	**654**	**664**	**10**	**1.517450683**
4 LEDs, Top Horizontal, Close Together, Back of Box	849	1059	210	22.01257862	824	1098	274	28.5119667	825	1106	281	29.10409114
4 LEDs, Horizontal, Close Together, Front of Box	1322	1590	268	18.40659341	1348	1655	307	20.44622045	1279	1520	241	17.22043587

Findings:

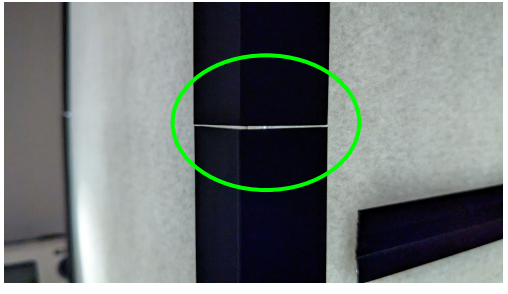
- 4 LEDs not necessarily better than 2
- Horizontal placement towards the front of chamber is optimal
- Higher “ceiling” led to better results
- Red highlighted row is current best option

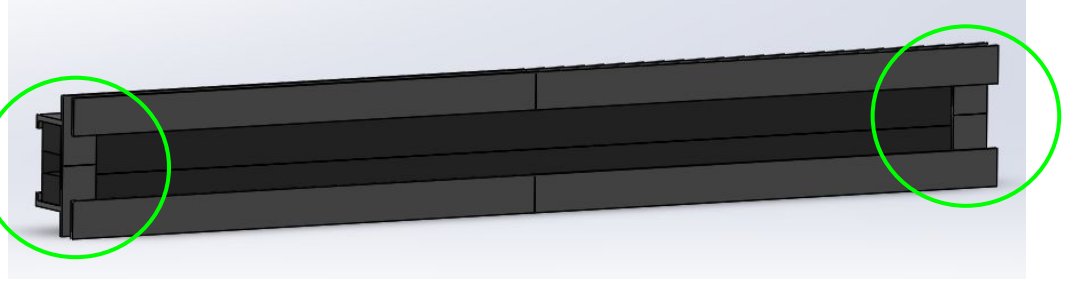
LED placement and testing: tall simulated

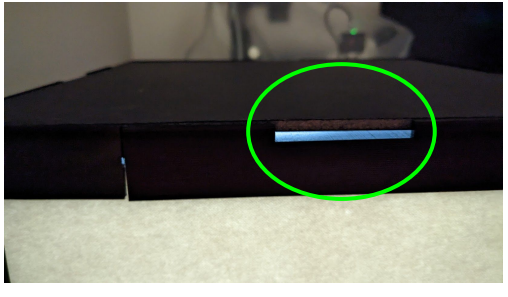


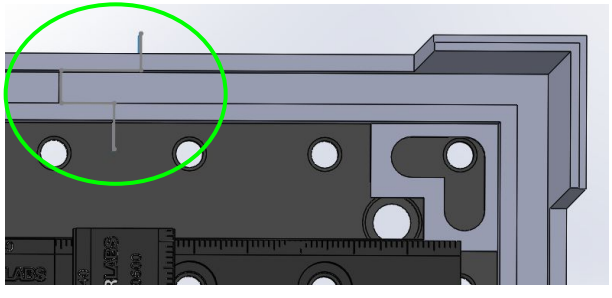
Issue: light still enters through some cracks

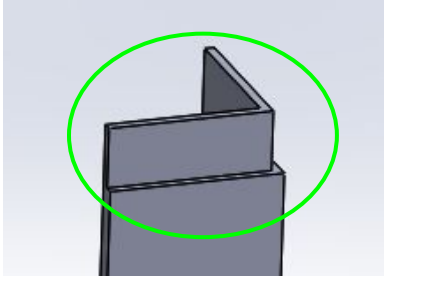
- Redesigning and printing frame to eliminate light penetration
- May design slot to span width of chamber wall; cracks would be covered by corners of frame











Portable optical table prototype build

Pros:

- Replicable and standardized (soon to be)
- Modular → replaceable components
- More uniform lighting
- Better fit → rail movement is not obstructed

Cons:

- White board lets light in from the outside
- Cracks let light in also
- Hard to take apart to interact with components inside

Issues with color target

- Figuring out how to use the color target
- Reached out to support
- Need to open and read ICC file somehow…

Download Argyll Color Management Microsoft Windows executables

From this page, you can access the V2.3.1 ZIP archive of the last stable code release, in the form of the main command line executables for:

- MSWindows 32 bit: X86 32 Bit
- MSWindows 64 bit: X86 64 Bit

Please refer to the installation documentation that is provided along with the source, or look at Installing on where to put the download, and what then to do with it.

Please help ensure that ArgyllCMS remains available in the future, by making a financial contribution:

Next steps

- Troubleshoot color accuracy software
- Print out new frame
- Make prototype chamber more user friendly
- Looking for substitute components to order and finalize BOM
- Continue to optimize LED set-up
- Create assembly instructions/video
- Calibration
- Create user manual
- Order a cart for chamber; optical table too tall for testing

All by Dr. Mueller's Trip!

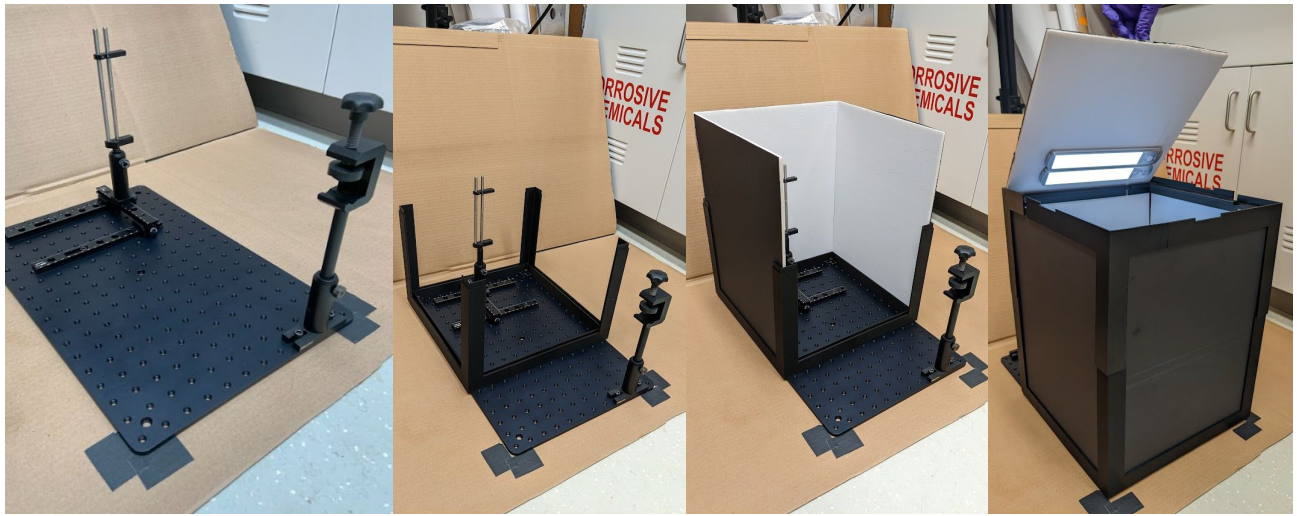
6/1/23 Updates

What we did

- Print out new frame
- Ordered duplicate materials and finalized BOM
- Create assembly instructions
- Started on user manual
- Proposed new ways to make the portable testing chamber (PTC) more user-friendly
- Prepared components for Dr. Mueller to bring to Uganda

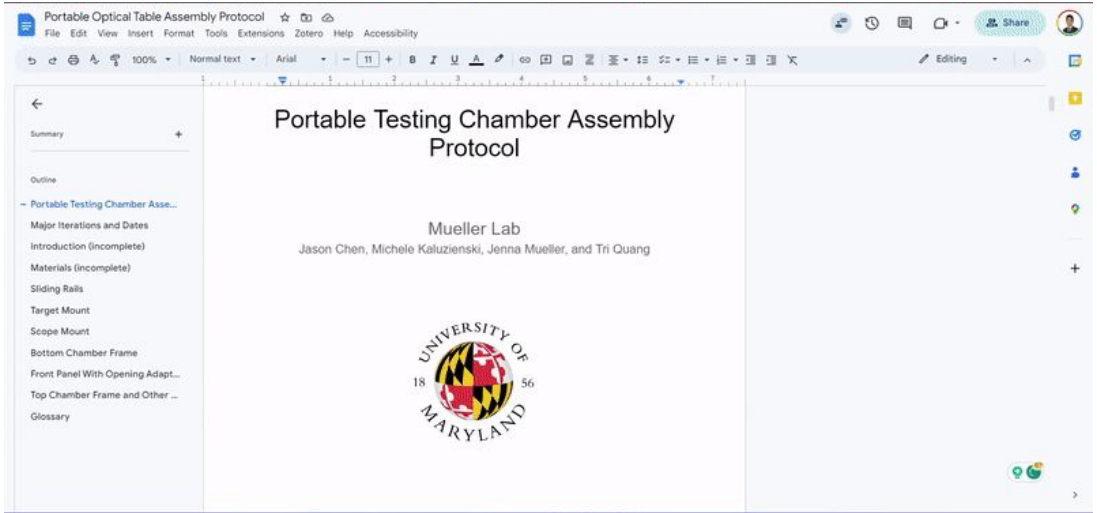
Portable Testing Chamber (PTC) Construction

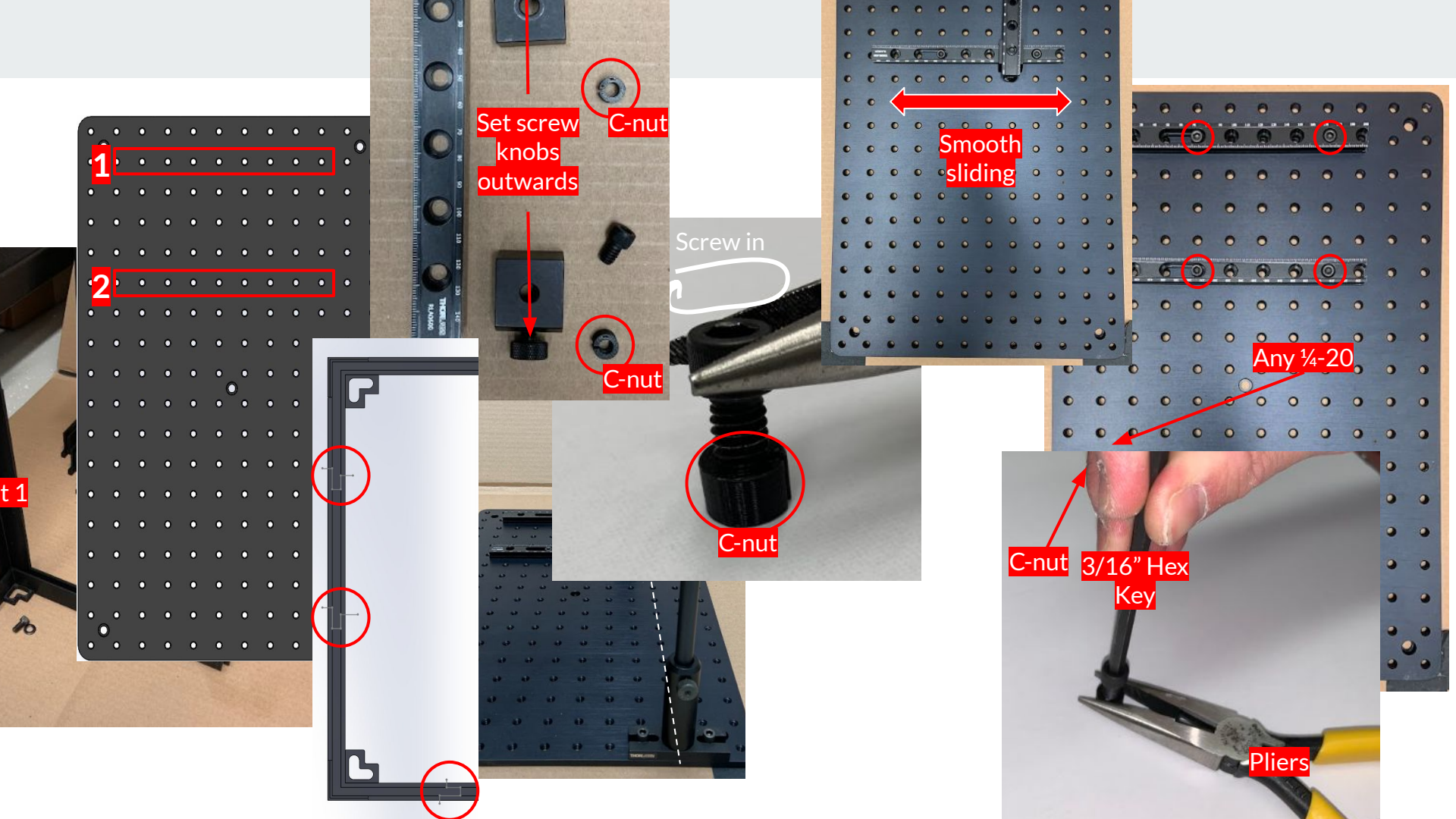
- Constructed most recent model of PTC with the updated components
- Did photoshoot with every step
- Walked through assembly with Dr. Mueller as well



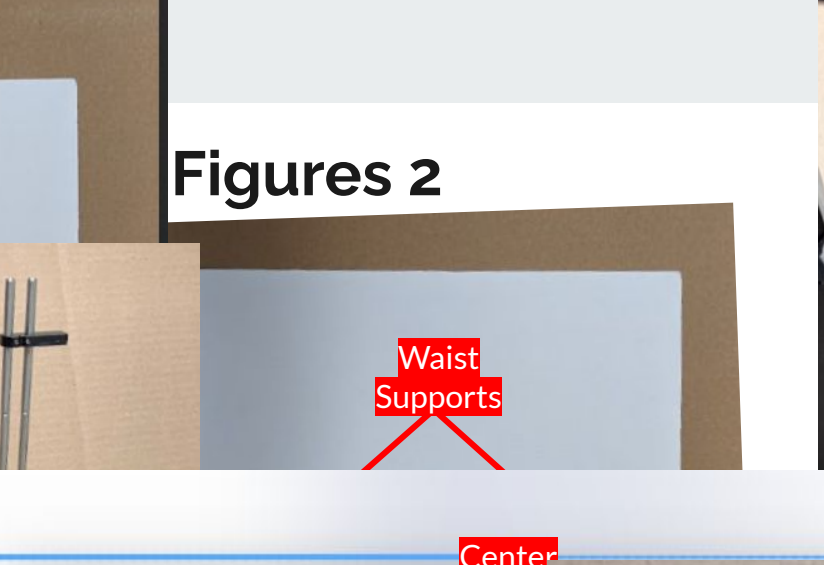
PTC Documentation

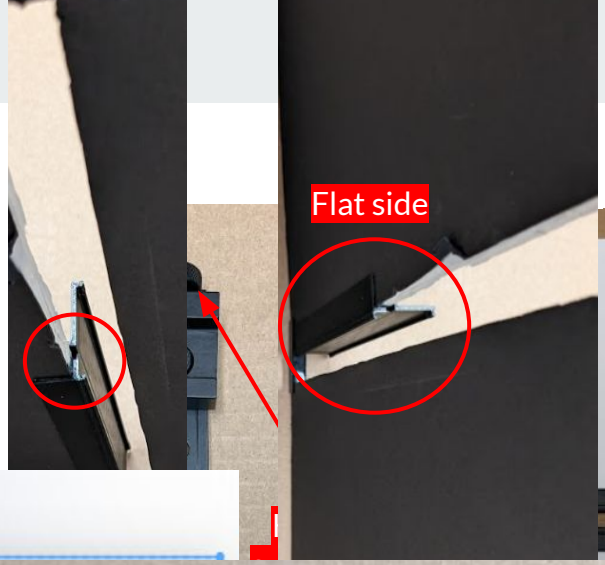
- Made updated list of all the materials needed to assemble
- Completed first draft of the assembly manual
- Noted improvements to be made when assembling with Dr. Mueller
- Began PowerPoint version of the assembly manual

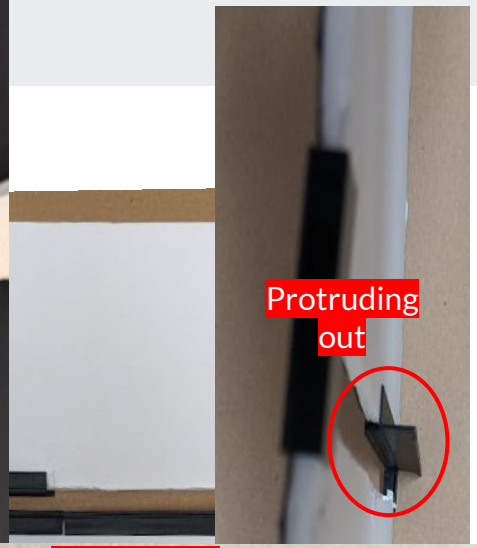


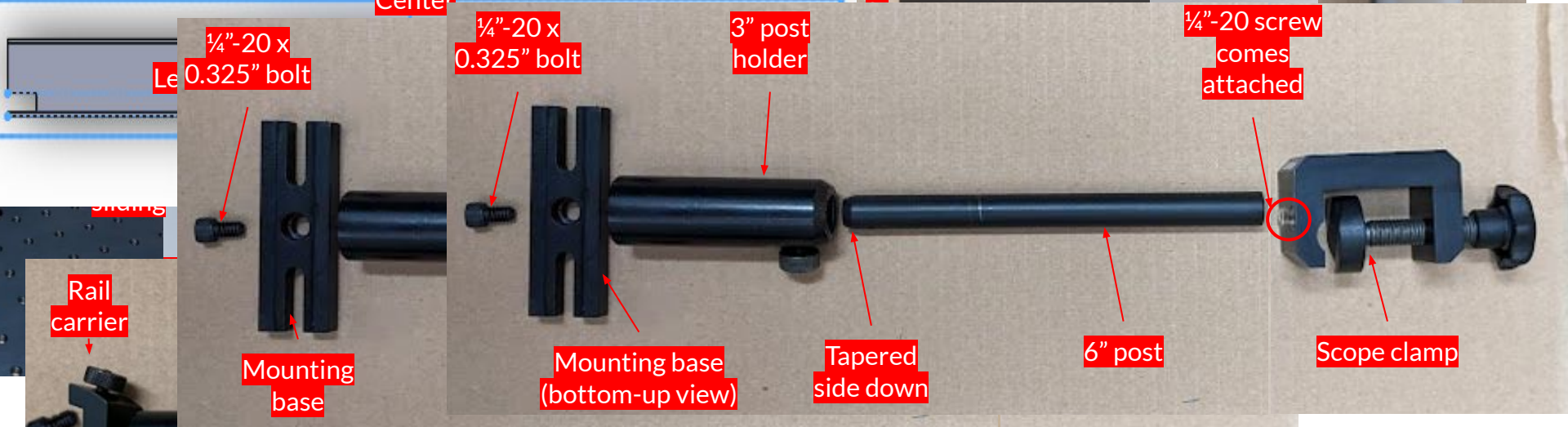

1
2
Set screw knobs outwards
C-nut
C-nut
Screw in
C-nut
Smooth sliding
Any ¼-20
C-nut
3/16” Hex Key
Pliers

Figures 2

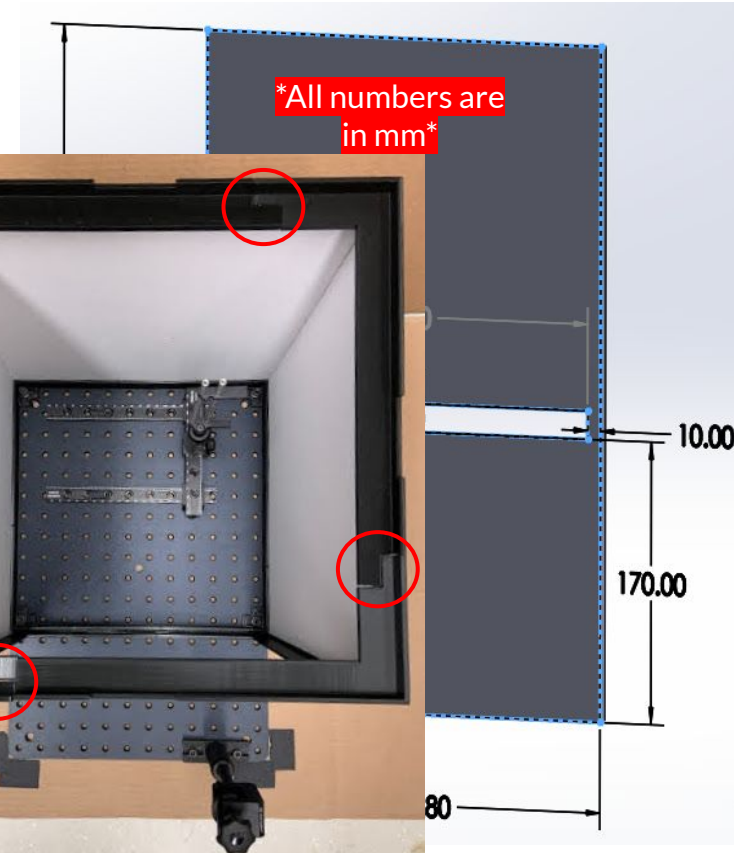

Waist
Supports
Center

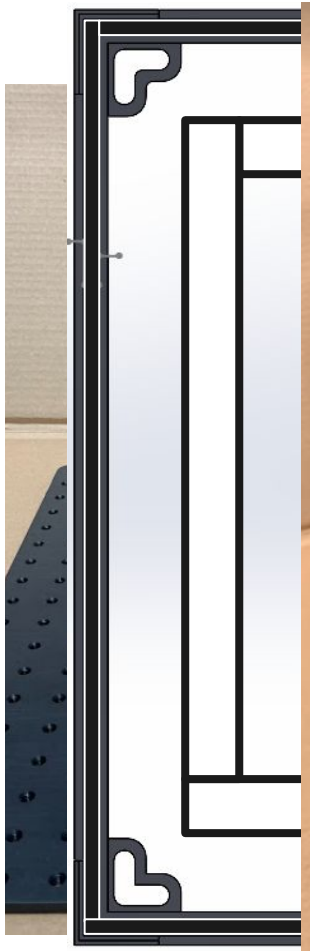

Flat side

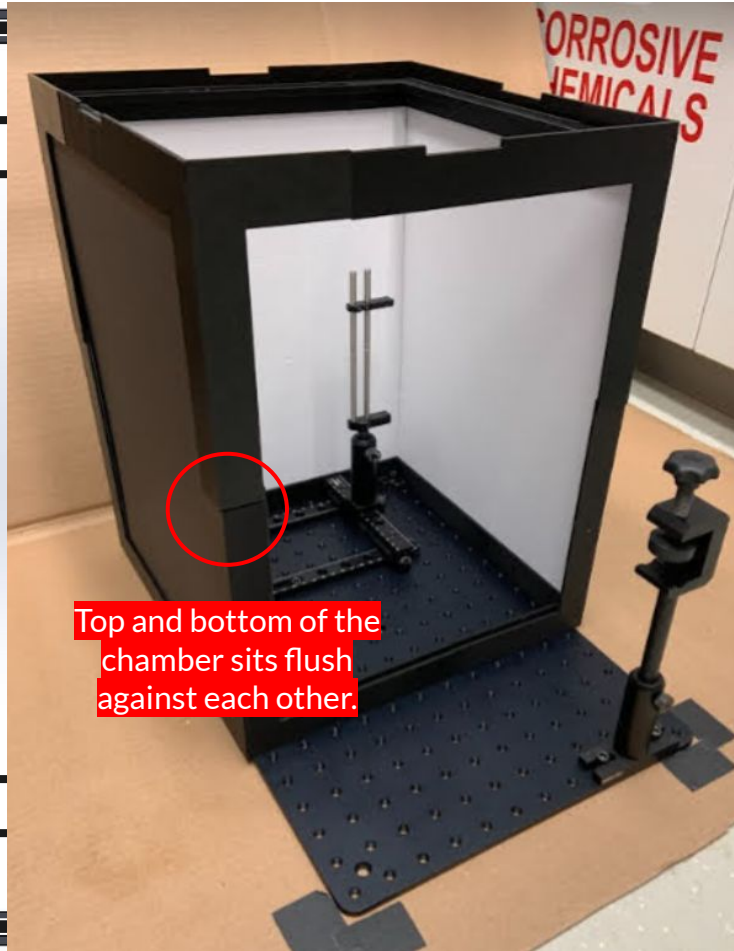

Protruding
out


¼”-20 x
0.325” bolt
¼”-20 x
0.325” bolt
3” post
holder
¼”-20 screw
comes
attached
Rail
carrier
Mounting
base
Mounting base
(bottom-up view)
Tapered
side down
6” post
Scope clamp

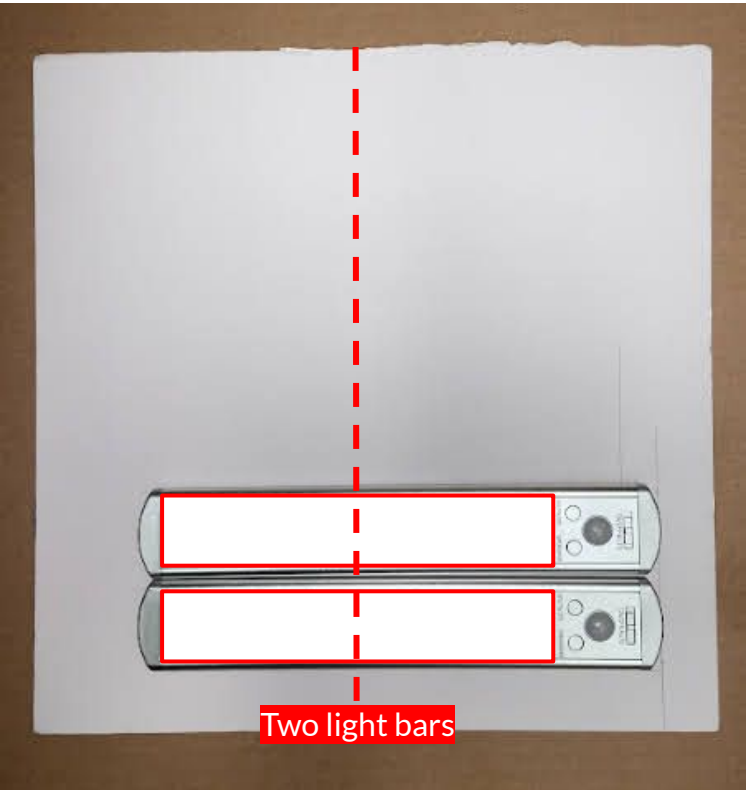
Figures 3

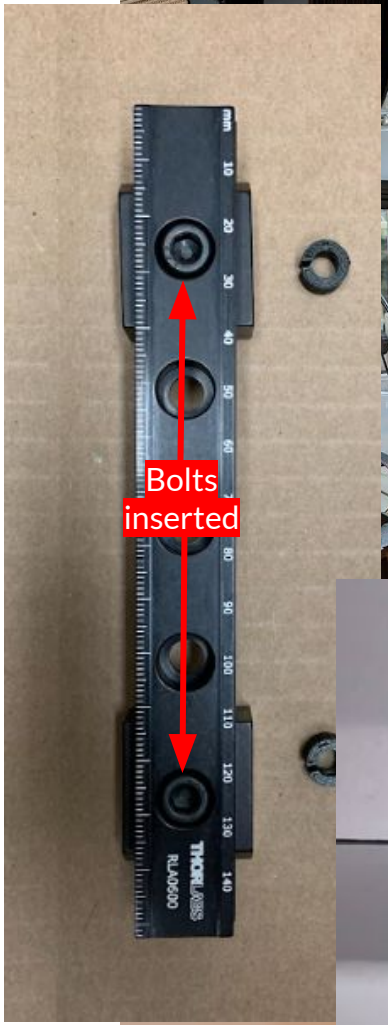

All numbers are in mm
10.00
170.00
80



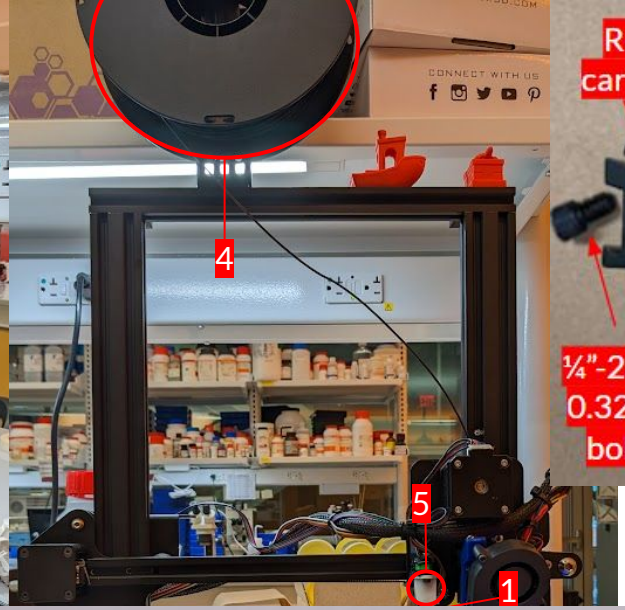

Top and bottom of the chamber sits flush against each other.

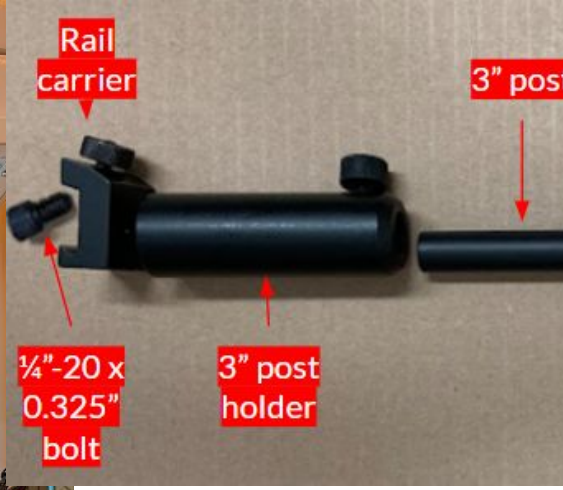
Figures 3

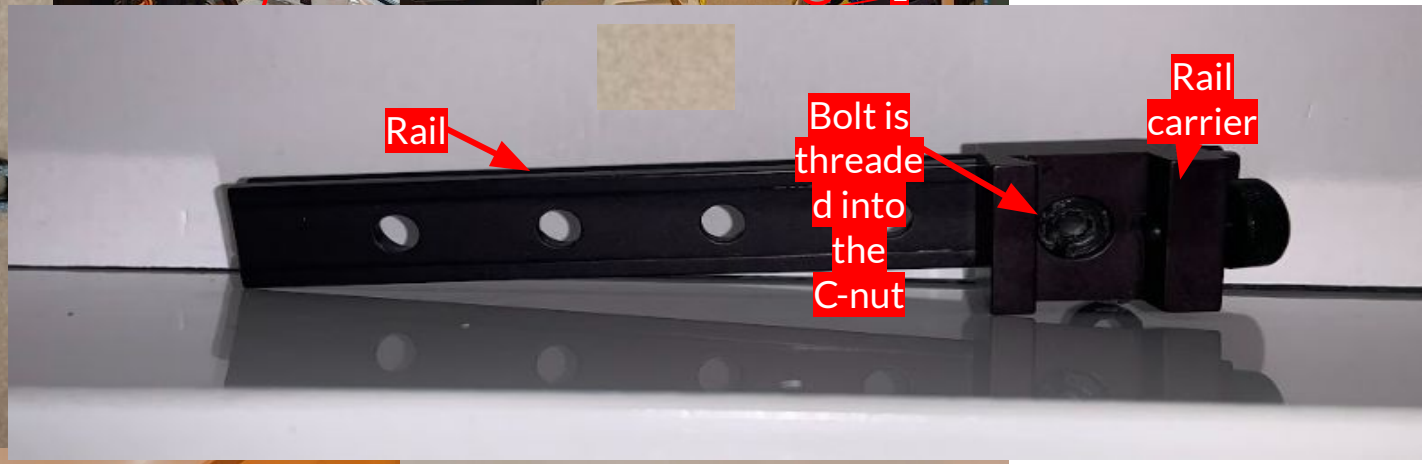



Bolts inserted


8
11


4
5
1


Rail carrier
3” pos
¼”-20 x 0.325” bolt
3” post holder


Rail
Bolt is threaded into the C-nut
Rail carrier

Next Steps

- Make prototype chamber more user friendly
  - Explore breaking down the front panel into two halves
  - Explore a side panel option
- **Start implementing calibration methods**
- Print out duplicate frames
- Revise assembly and user manuals
- Troubleshoot color accuracy software

6/22/23 Updates

Terminology Review

- **Portable testing chamber (PTC):** what we are aiming to ultimately construct.
- **Chamber seals**: refers to the four-parts required for establishing the opening to the chamber.

- **ColorChecker-24:** a card with standardized colors that we use to calibrate our devices OR characterize color accuracy

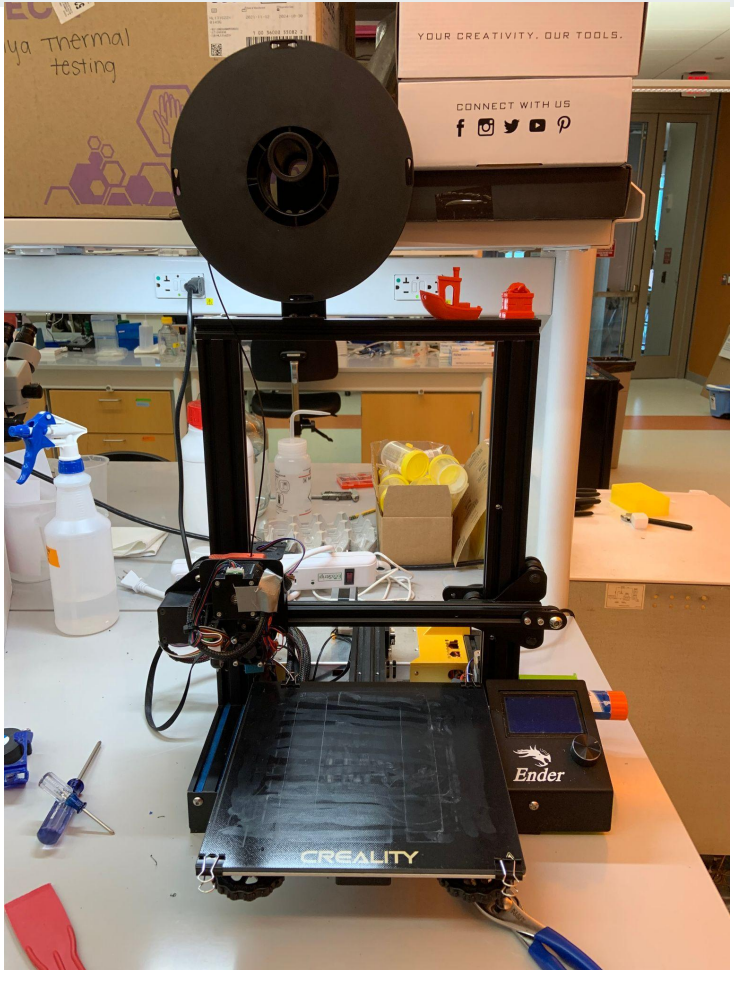
What we did

- Constructed second, updated model of the PTC (with Talya!)
  - Optimized chamber seals and frame for light isolation
  - Completed assembly manual for the construction process
  - Updated BOM with every build
  - Recorded and timed construction process as well
- Michele and Talya learned the ins and outs of 3D printing (very hands-on!)
  - Jason wrote user manual for the Ender 3 pro printer
  - Jason gave crash course on modifying existing CAD parts and slicing
- Read way too much about color analysis…ripped off Imatest Color Analysis

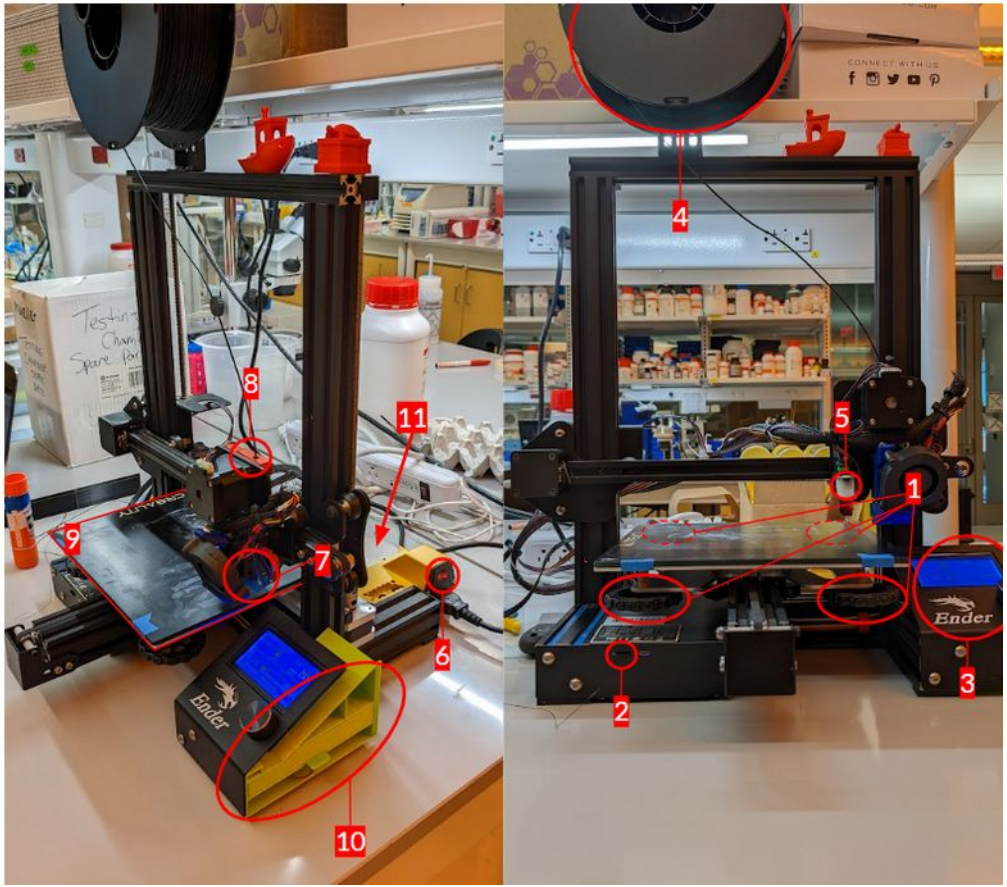
3D Printing

- Creality Ender 3 Pro Printer
- SolidWorks software
- Cura software

3D Printing - Creality 3 Ender Pro



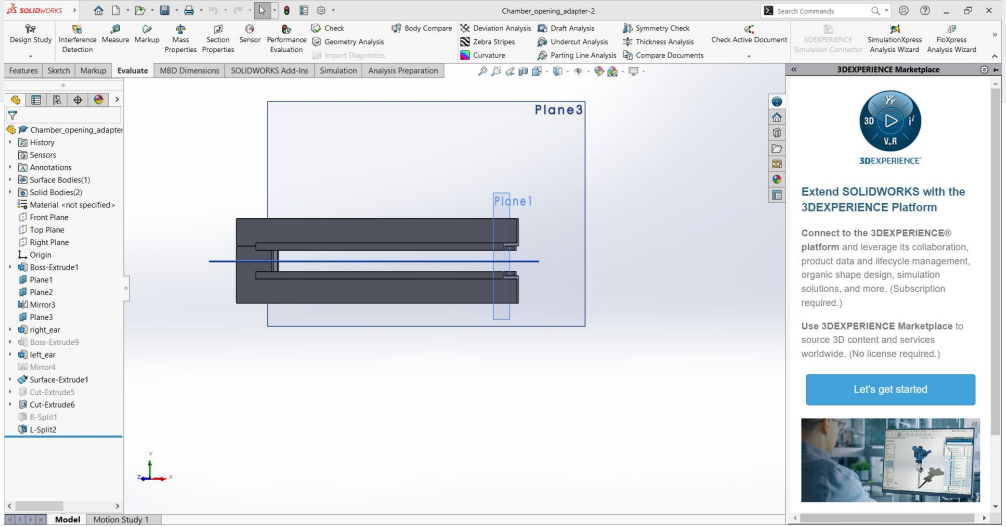
3D Printing - Creality 3 Ender Pro

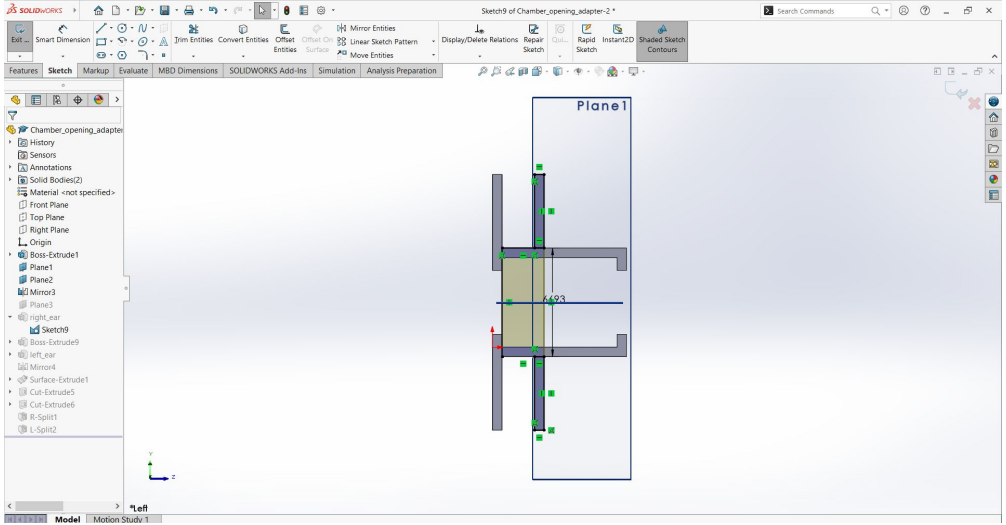


1. Gear-like tensioning knobs	2. TF/SD card port	3. LCD screen and control knob	4. Filament spool on its spindle
5. Auto-leveling calibrator	6. **RED POWER SWITCH**	7. Hotend, nozzle, and fans	8. Filament feeder
9. Build plate (or print bed)	10. Storage space	11. Power module	

3D Printing

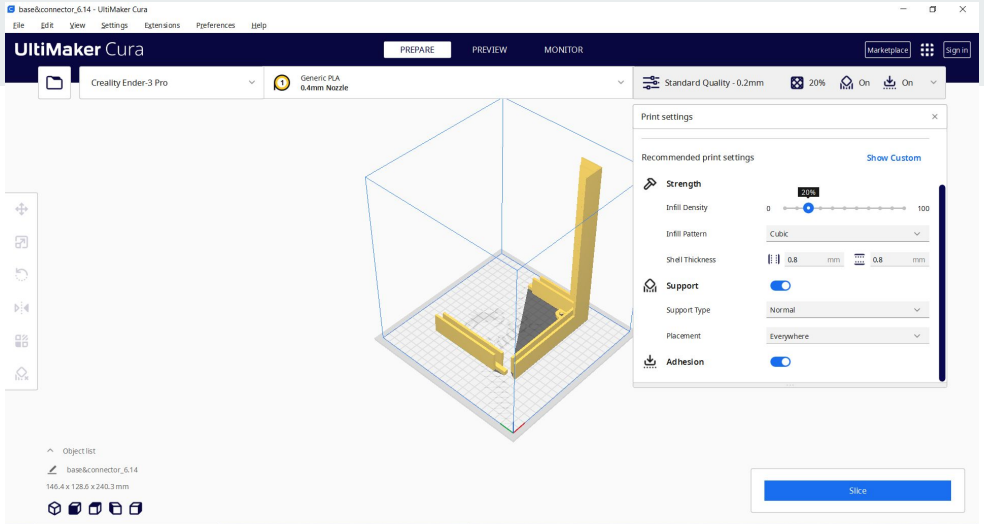
- **SolidWorks** - Creating actual object to print (shape, dimensions, etc.)

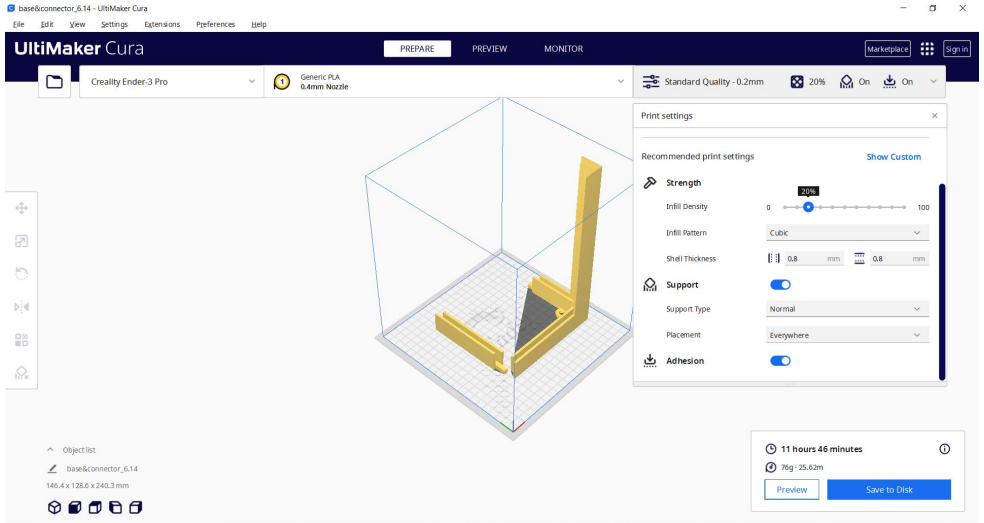




3D Printing

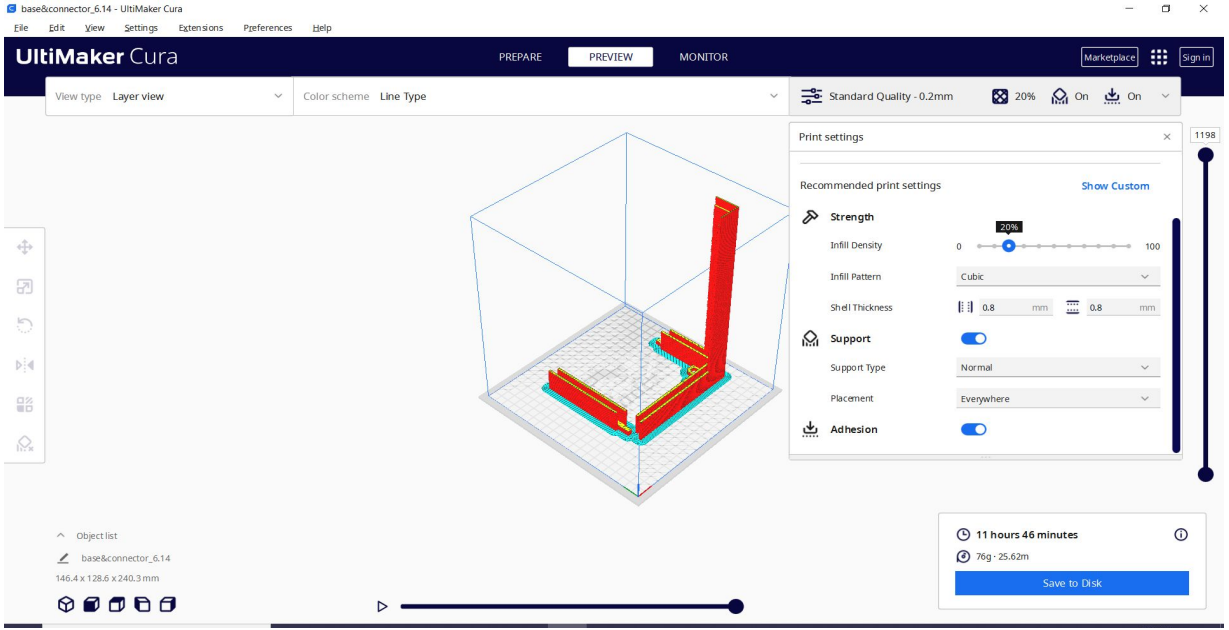
- **Cura** - Editing object to print - position, density, supports, adhesion





3D Printing

- **Cura** - Editing object to print - position, density, supports, adhesion



New prototype

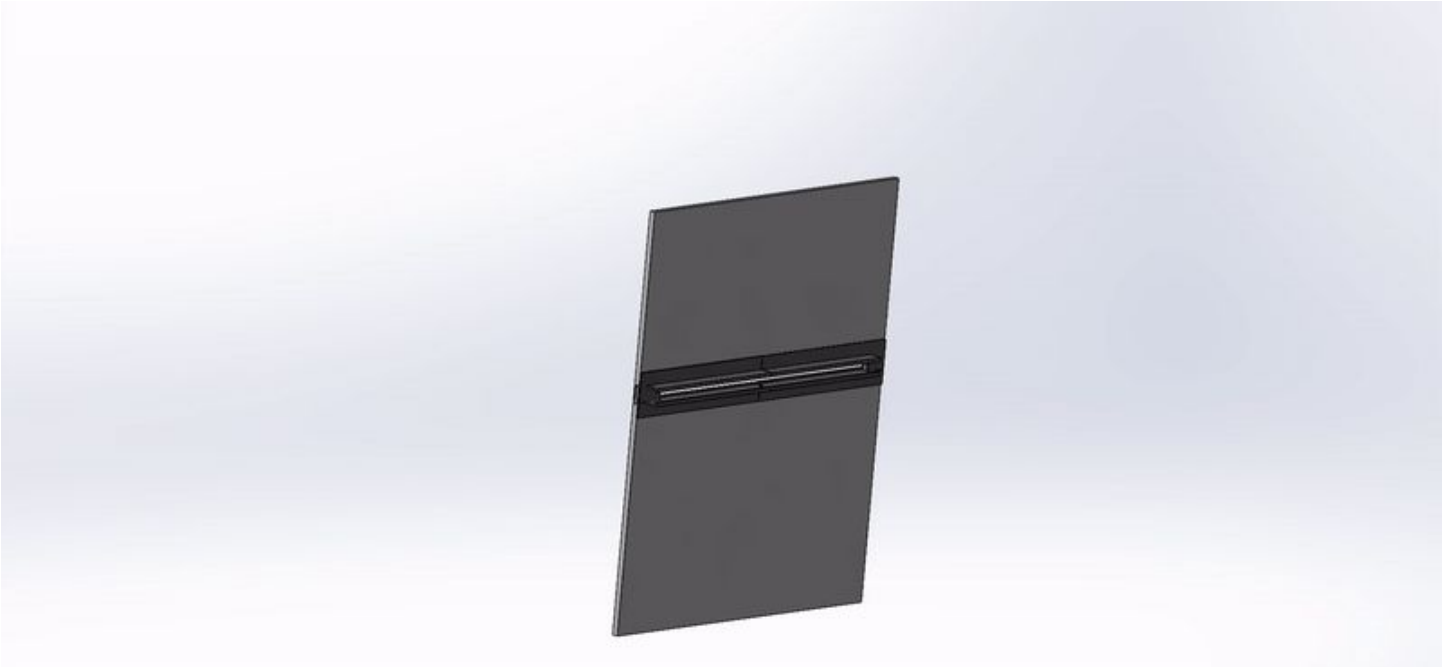
- Took a video for the entire process
  - In progress of editing
- All together process took ~15 min
  - Each section max 5 min
- 3D pieces all snap together easily
- Main change is the opening side panel

Assembly Video

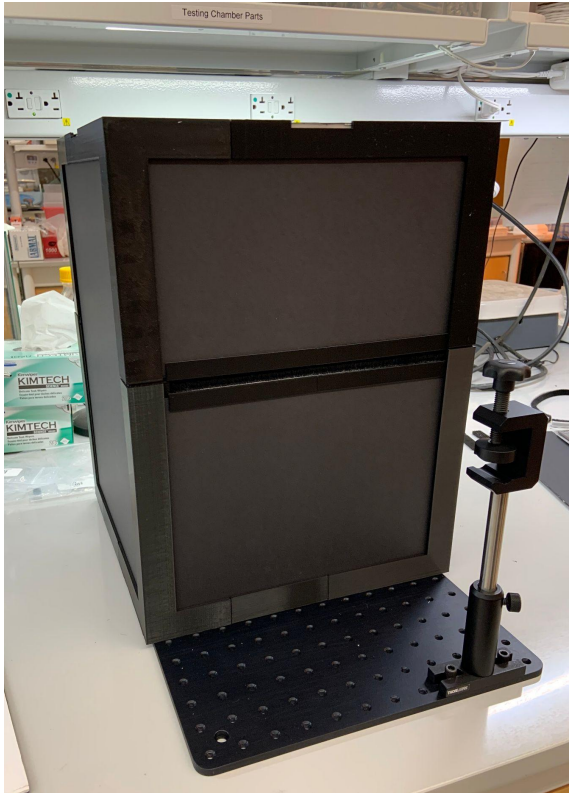
https://youtu.be/lRvfyFHYX7Y

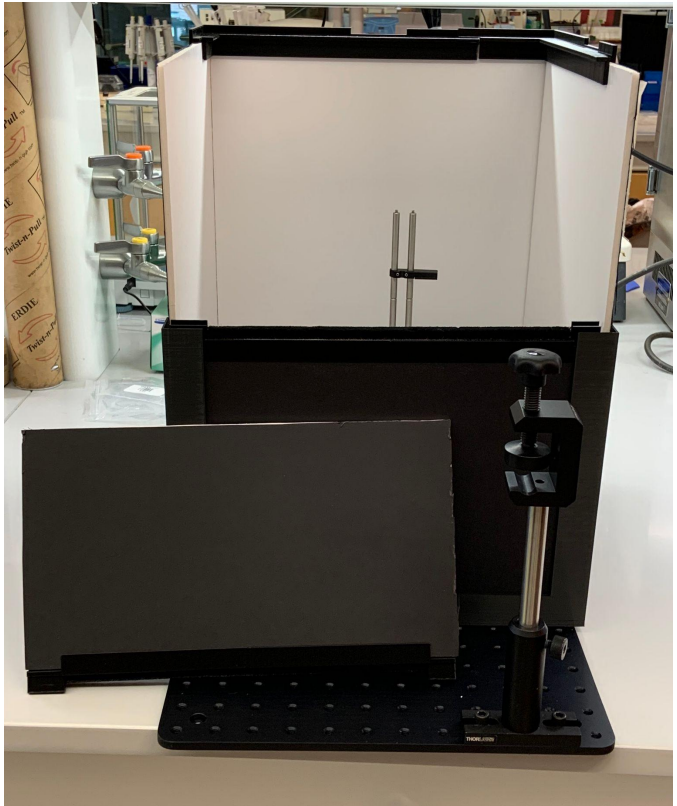
Updated chamber seal mechanism

- No longer need to remove the entire front panel!

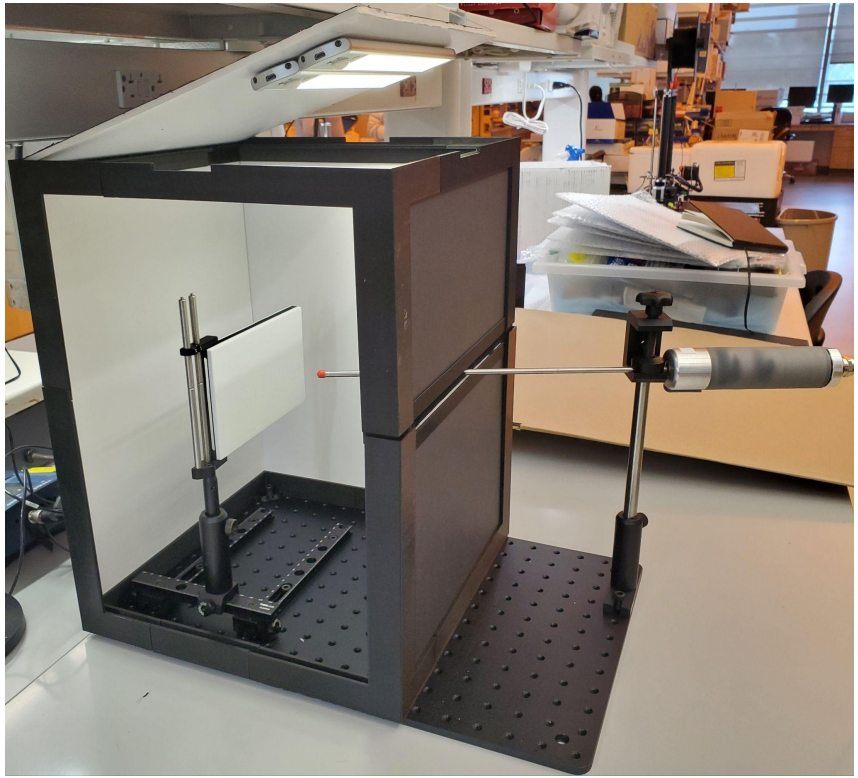


PTC Pics - New Opening



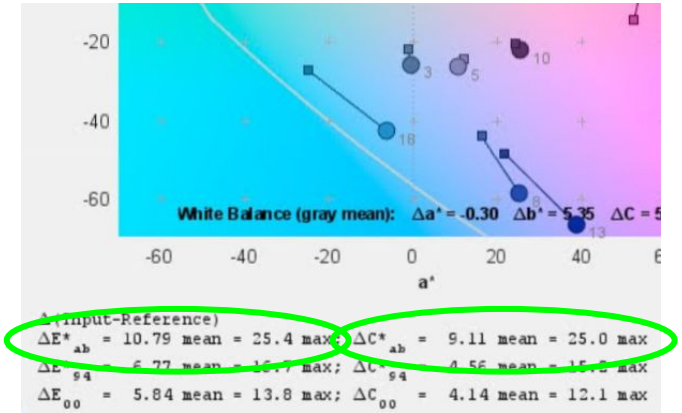


PTC Pics - Completed Chamber



Competitive Results

Imatest



VS

Bootleg MATLAB code

L* input	a* input	b* input
32.67	18.21	21.03
59.96	21.19	22.88
47.56	-0.5	-26.16
42.31	-22.18	35.54
57.52	10.69	-26.58
73.52	-28.49	-3.42
57	35.46	60.52
35.12	25.18	-58.97
50.96	52.8	30.3
27	25.45	-22.33
76.34	-31.35	69.31
71.1	10.1	72.18
24.58	38.83	-66.96
56.4	-49.1	45.62
47.21	57.85	42.72
78.75	-5.12	79.43
55.68	54.12	-6.96
56.94	-6.3	-42.94
81.02	0.65	6.59
80.87	-0.87	6.18
76.5	-1.34	6.52
61.51	-0.21	5.43
40.77	-0.58	3.34
19.88	[illegible]	2.24

31.0643	16.9473	19.3091
60.0249	21.3022	22.8126
47.7652	-0.4873	-26.2004
42.3100	-22.1337	35.4907
57.9859	10.6280	-26.6352
73.7671	-28.4246	-3.4265
56.8881	35.4378	60.3187
35.1736	25.0256	-58.8132
51.1440	52.8070	30.5407
27.0955	25.3716	-22.1664
76.6739	-31.3682	69.4808
71.0914	10.1640	72.1547
24.8451	38.9499	-67.2539
56.6587	-49.1568	45.7818
47.4857	58.0906	42.8322
78.9649	-5.1439	79.5714
55.7787	54.1365	-6.9304
57.1070	-6.4303	-42.8537
80.9864	0.6478	6.5655
80.9244	-0.7485	6.1114
76.6089	-1.3813	6.5246
61.7085	-0.1436	5.3744
40.7814	-0.6196	3.2060
20.5852	[illegible]	2.2997

deltaEab_Mean =

10.8111

deltaCab_Mean =

9.0332

deltaEab_Max =

25.6816

deltaCab_Max =

25.3183

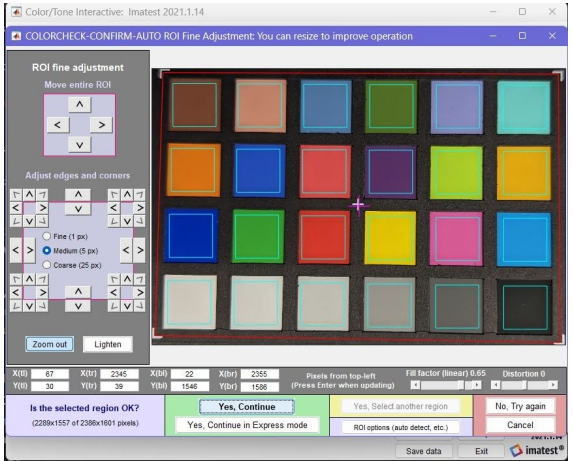
fx >>

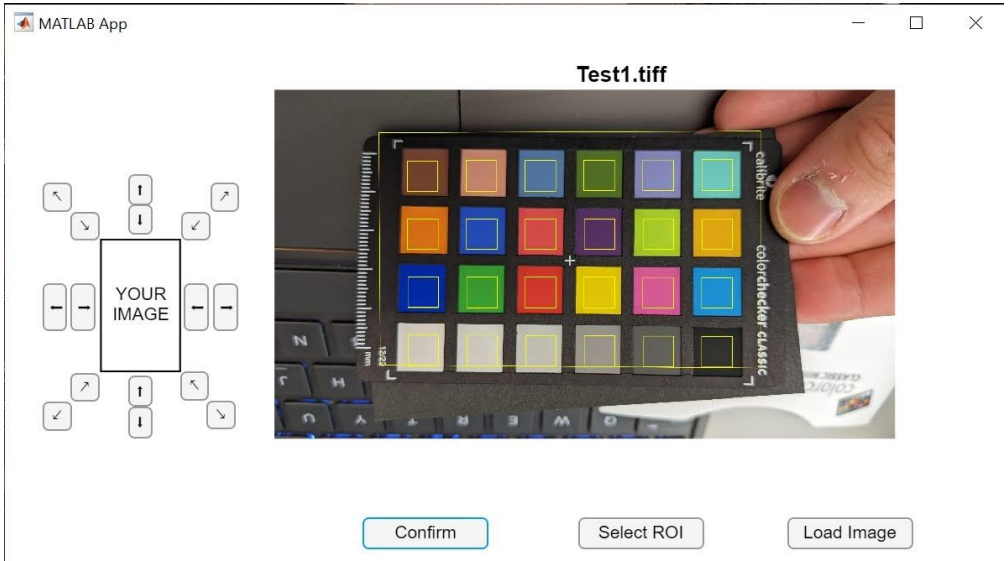
Next Steps

1. Work on manuscript for the PTC
2. **Start implementing calibration methods (before Tri leaves)**
3. Start characterization using testing chamber (meet Monday & Tuesday)
4. Train Ugandan team on image analysis (resolution)
5. Order new ColorChecker-24 Card to do more stringent testing of MATLAB app
6. Build laparoscope in the lab and document process (timings)
7. Keep look for alternative distortion testing targets
8. Continue to revise assembly and user manuals
9. Continue to learn/use 3D printing software and print new objects

Colorrrrrrrrrssssss

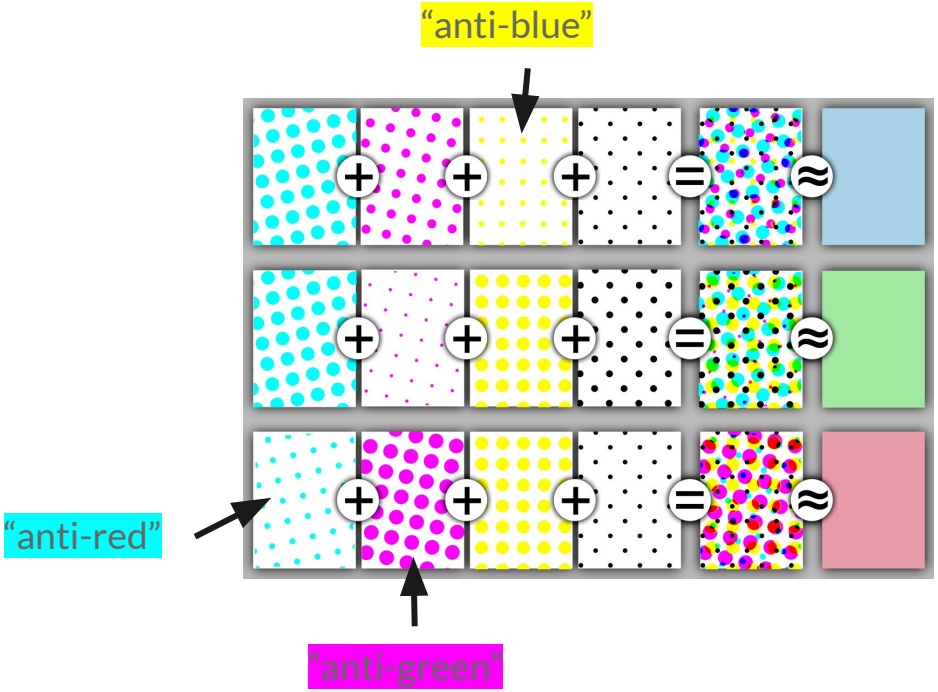
- ColorChecker-24 mini is a great target for calibration
- Made a ColorChecker MATLAB app:
  - Pro: very competitive results found
  - Con: sample size of 1…
- WIP and all commented





Fun Fact: Ink Printing - Color via “Subtraction”

- For printing, Cyan, Magenta, Yellow, and Black are used instead.

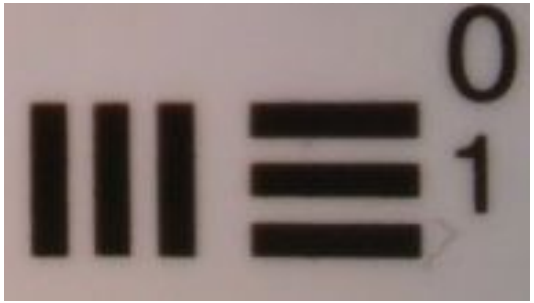


7/13/23 Updates

What we did

- Built laparoscope (KV4-6) from scratch and recorded video
- Compared resolution analysis with horizontal vs. vertical bars
- Showed Uganda team (Rebecca & Paula) how to perform resolution analysis and modified existing protocol
- Imaged and analyzed KV4-6 in PTC and Optical Bench Setup (OBS) with both old and new targets (resolution, color, distortion)
- Imaged and analyzed new paper targets
- Worked on manuscript
- Finished color analysis MATLAB code
- Working on Distortion MATLAB code

Resolution: Using Vertical vs. Horizontal Bars



Resolution Results - Horizontal Bars

Instrument: KV4-5 PTC Horizontal bars							
Trial	Distance	Group	Element	Resolution (µm)	Average Res	Std. Dev.	Error
1	30	2	1	125	125	0	0
2	30	2	1	125			
3	30	2	1	125			
4	30	2	1	125			
5	30	2	1	125			
6	30	2	1	125			
1	40	1	6	140.31	140.31	0	0
2	40	1	6	140.31			
3	40	1	6	140.31			
4	40	1	6	140.31			
5	40	1	6	140.31			
6	40	1	6	140.31			
1	50	1	5	157.49	158.1933	16.31898	6.662194
2	50	1	5	157.49			
3	50	1	4	176.78			
4	50	1	4	176.78			
5	50	1	6	140.31			
6	50	1	6	140.31			

Instrument: KV4-5 PTC Horizontal bars							
Trial	Distance	Group	Element	Resolution (µm)	Average Res	Std. Dev.	Error
1	60	1	3	198.43	202.9183	17.48062	7.136432
2	60	1	4	176.78			
3	60	1	3	198.43			
4	60	1	2	222.72			
5	60	1	2	222.72			
6	60	1	3	198.43			
1	70	1	1	250	240.9067	14.08733	5.751129
2	70	1	2	222.72			
3	70	1	1	250			
4	70	1	1	250			
5	70	1	2	222.72			
6	70	1	1	250			
1	100	0	5	314.98	303.5267	17.74343	7.243724
2	100	0	5	314.98			
3	100	0	6	280.62			
4	100	0	5	314.98			
5	100	0	5	314.98			
6	100	0	6	280.62			

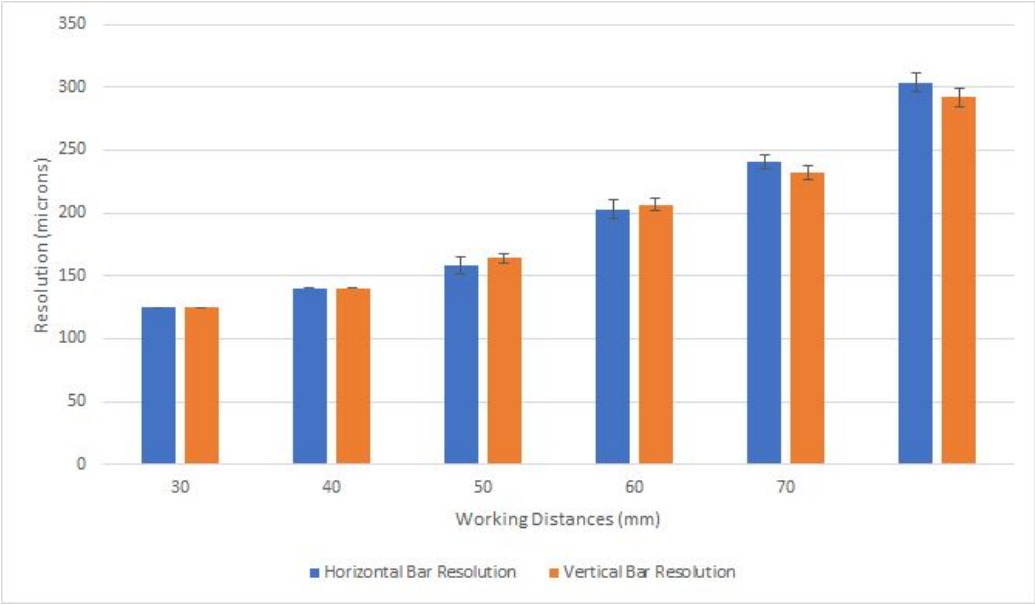
Resolution Results - Vertical Bars

Instrument: KV4-5 PTC Vertical bars							
Trial	Distance	Group	Element	Resolution (µm)	Average Res	Std. Dev.	Error
1	30	2	1	125	125	0	0
2	30	2	1	125			
3	30	2	1	125			
4	30	2	1	125			
5	30	2	1	125			
6	30	2	1	125			
1	40	1	6	140.31	140.31	0	0
2	40	1	6	140.31			
3	40	1	6	140.31			
4	40	1	6	140.31			
5	40	1	6	140.31			
6	40	1	6	140.31			
1	50	1	4	176.78	163.92	9.961313	4.066689
2	50	1	4	176.78			
3	50	1	5	157.49			
4	50	1	5	157.49			
5	50	1	5	157.49			
6	50	1	5	157.49			

Instrument: KV4-5 PTC Vertical bars							
Trial	Distance	Group	Element	Resolution (µm)	Average Res	Std. Dev.	Error
1	60	1	2	222.72	206.5267	12.5433	5.120782
2	60	1	2	222.72			
3	60	1	3	198.43			
4	60	1	3	198.43			
5	60	1	3	198.43			
6	60	1	3	198.43			
1	70	1	2	222.72	231.8133	14.08733	5.751129
2	70	1	2	222.72			
3	70	1	1	250			
4	70	1	1	250			
5	70	1	2	222.72			
6	70	1	2	222.72			
1	100	1	6	280.62	292.0733	17.74343	7.243724
2	100	1	5	314.98			
3	100	1	6	280.62			
4	100	1	6	280.62			
5	100	1	6	280.62			
6	100	1	5	314.98			

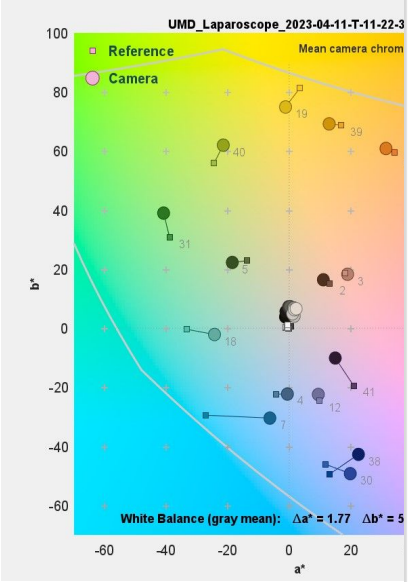
Results

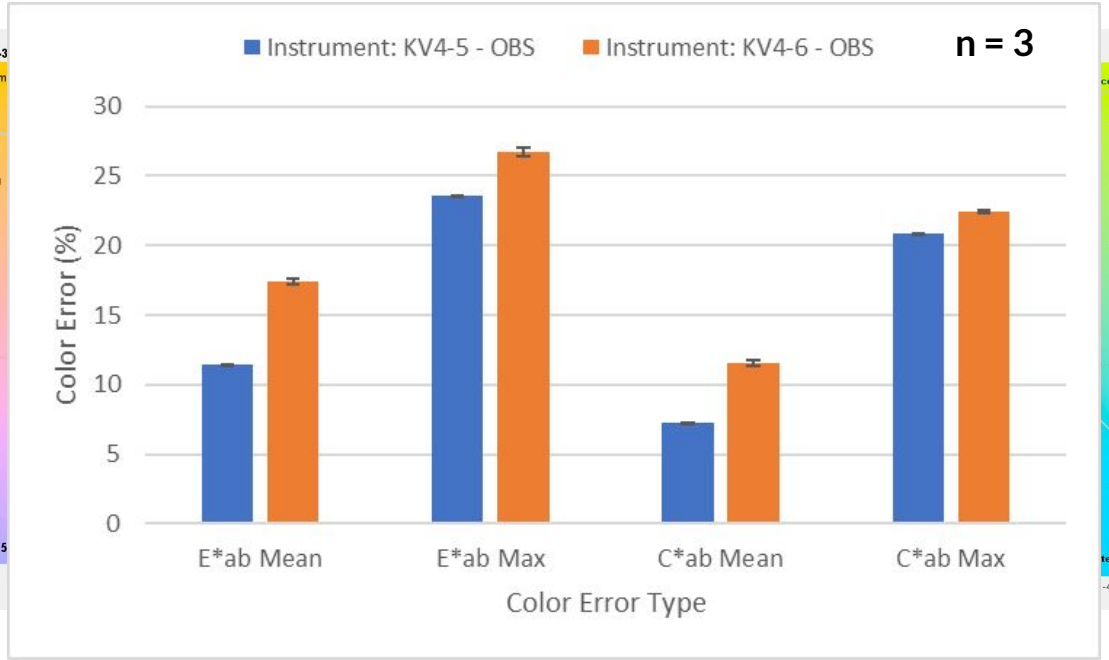
Distance	Horizontal Bar Resolution	Error	Vertical Bar Resolution	Error
30	125	0	125	0
40	140.31	0	140.31	0
50	158.1933333	6.662194	163.92	4.066689
60	202.9183333	7.136432	206.5266667	5.120782
70	240.9066667	5.751129	231.8133333	5.751129
100	303.5266667	7.243724	292.0733333	7.243724

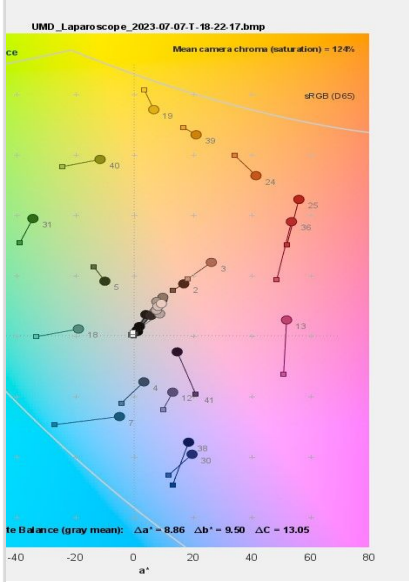


KV4-6 Image Quality Concern

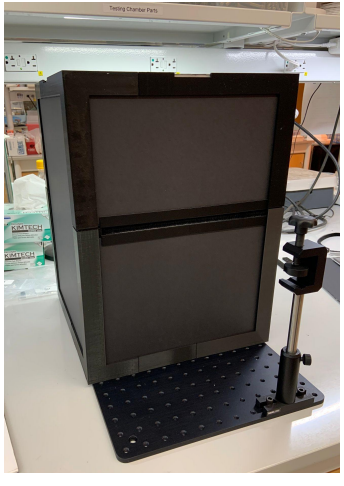
- KV4-6 is a redder than KV4-5 despite no changes in GUI settings

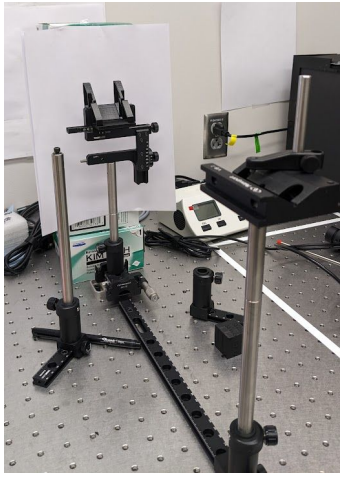




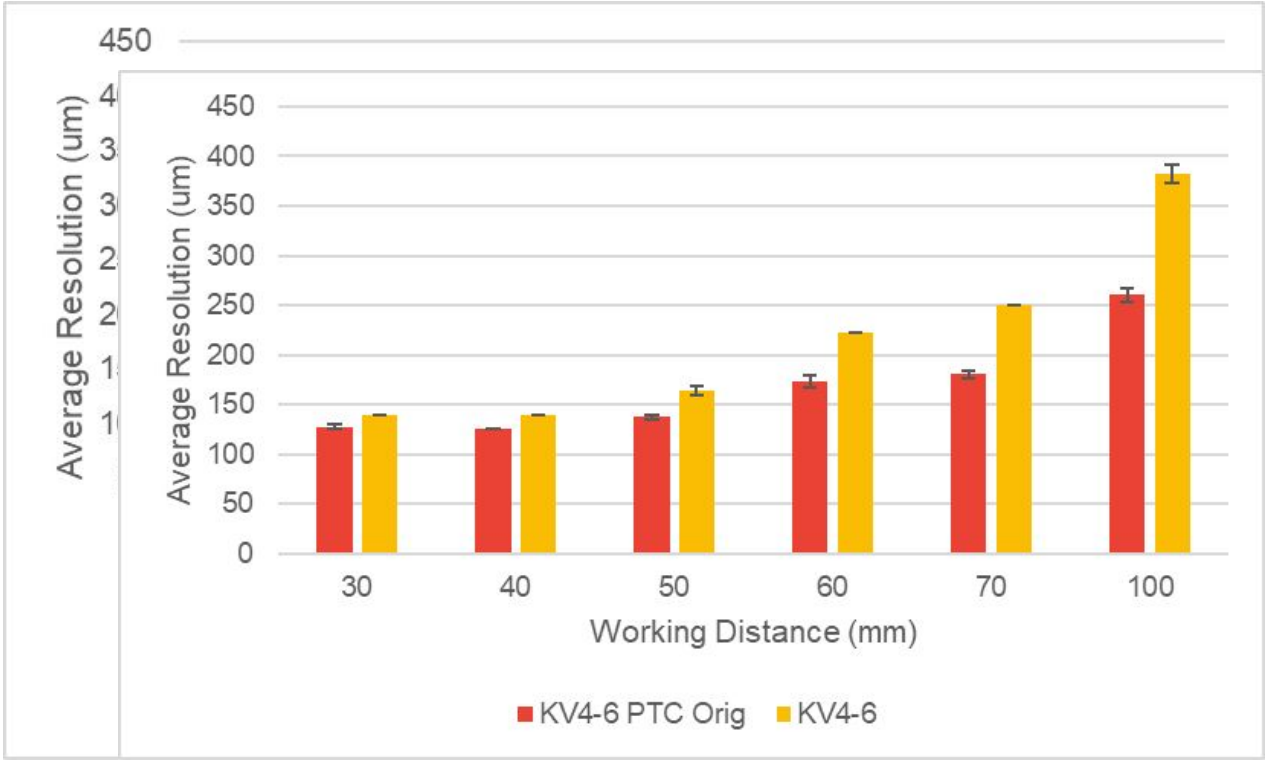


Comparing PTC and Optical Bench Setup (OBS)

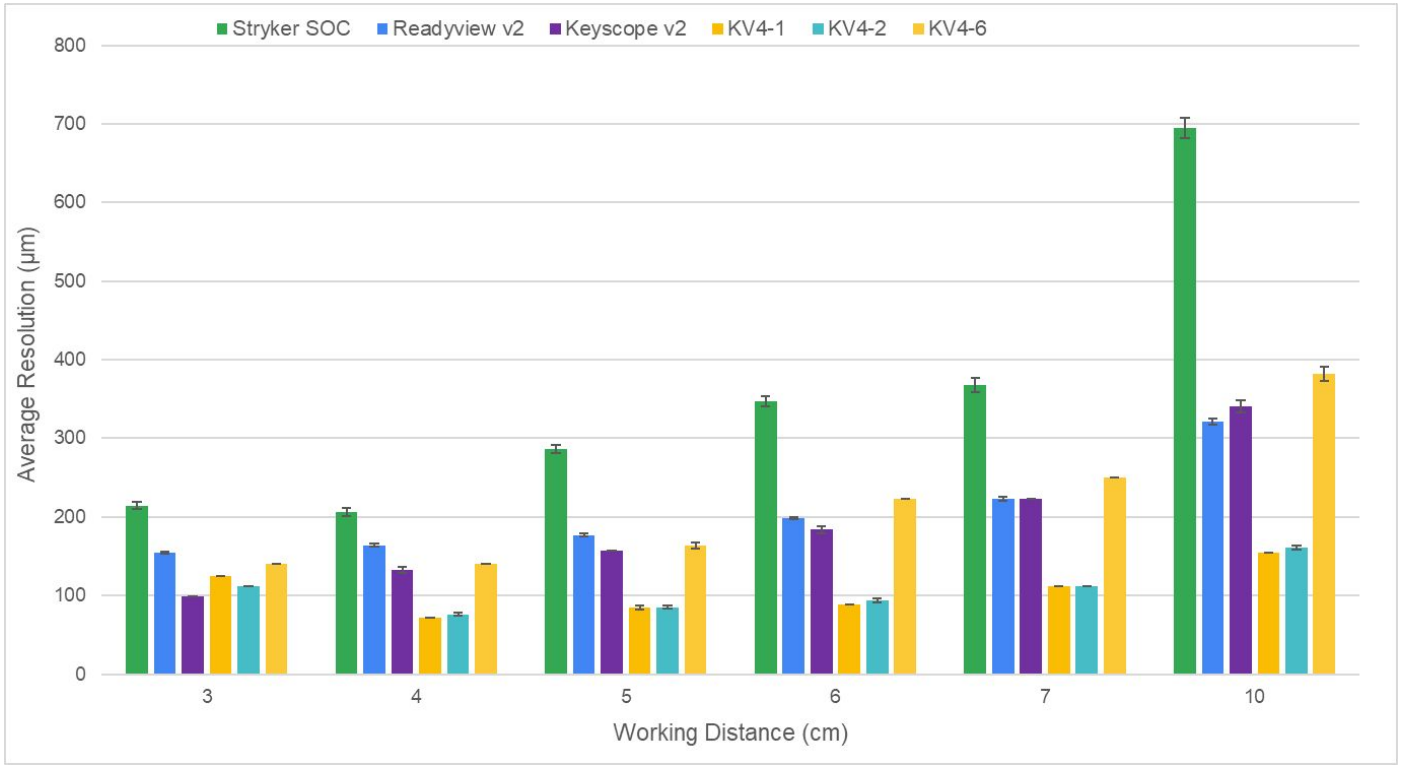




KV4-6 Resolution PTC vs OBS (Original Chart)



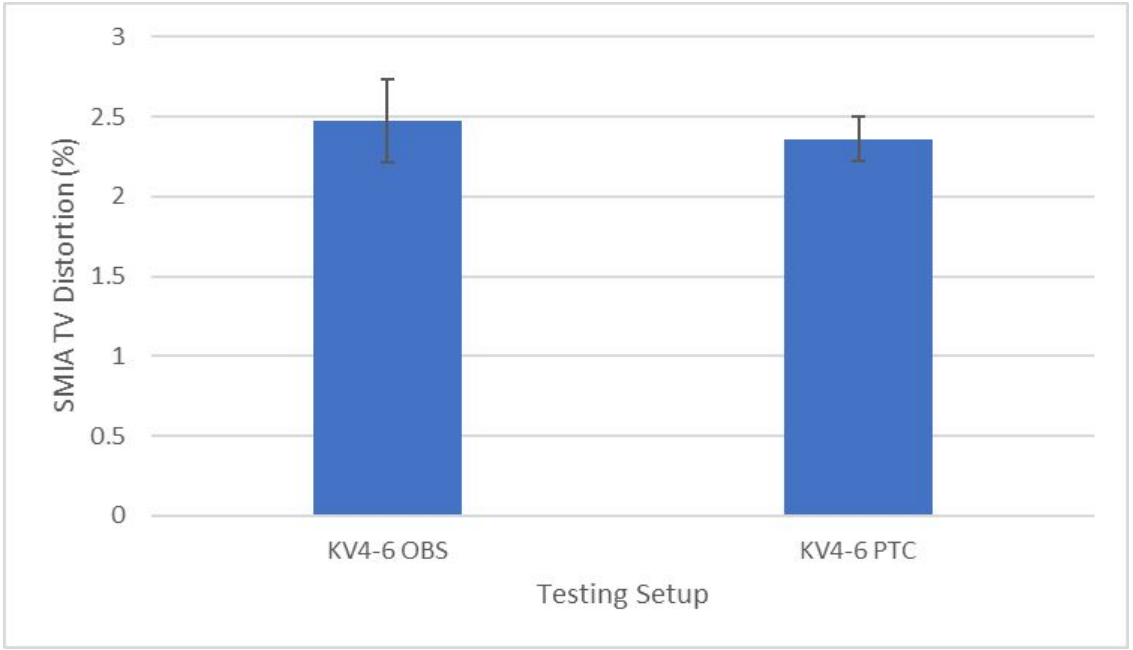
Compiled Results - Resolution



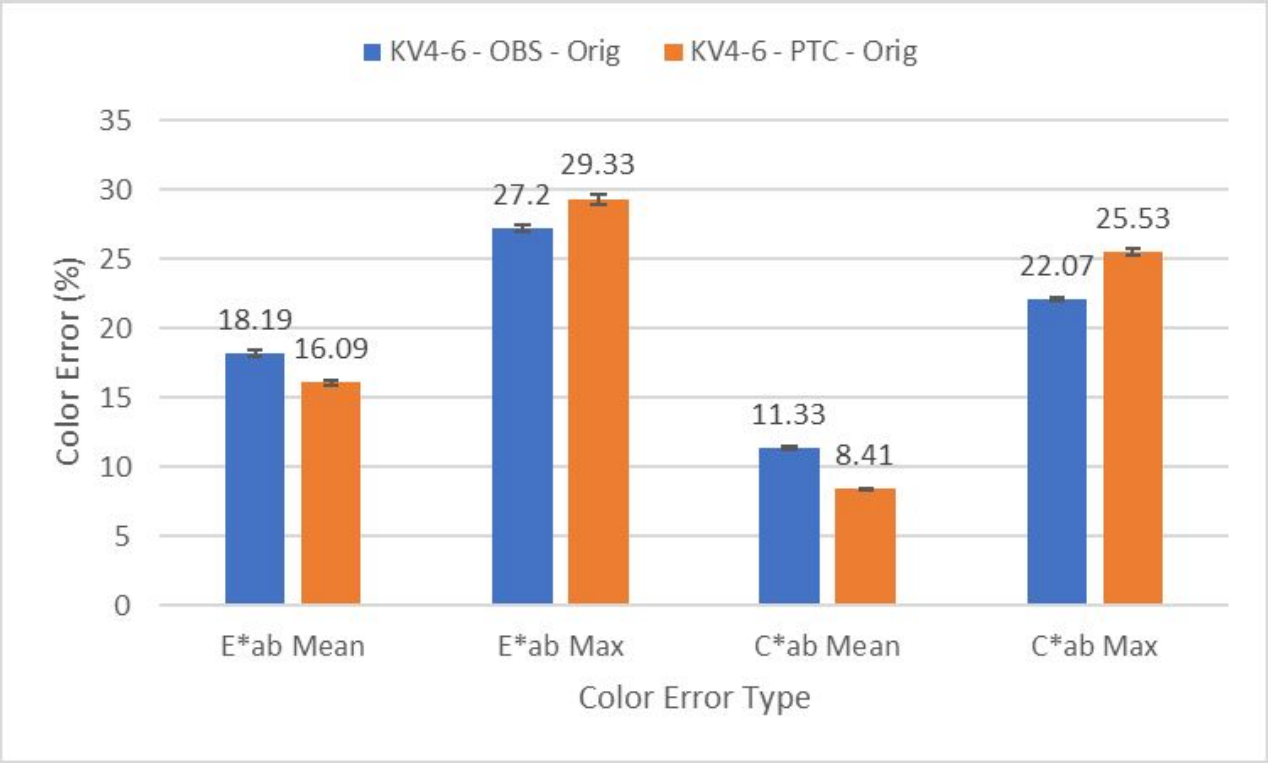
KV4-6 Distortion PTC vs OBS (Original Chart)

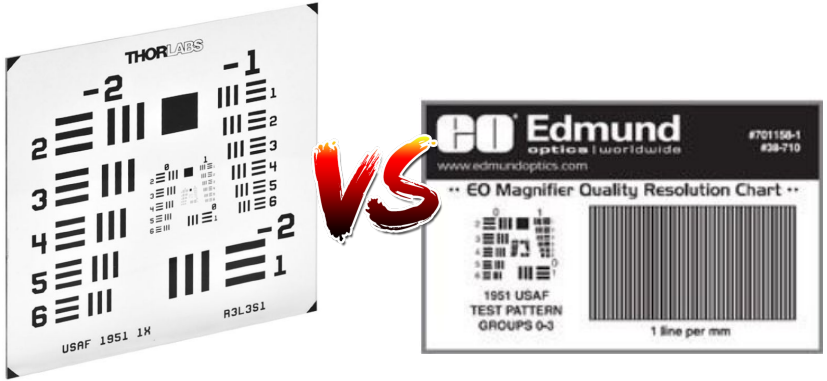
- Imatest results

KV4-6 OBS	KV4-6 PTC
SMIA TV Distortion (%)	SMIA TV Distortion (%)
-2.94	-2.94
-3.43	-2.53
-2.48	-2.02
-2.32	-2.32
-1.78	-1.99
-1.88	-2.33
-2.47	-2.36
0.63	0.35
0.26	0.14



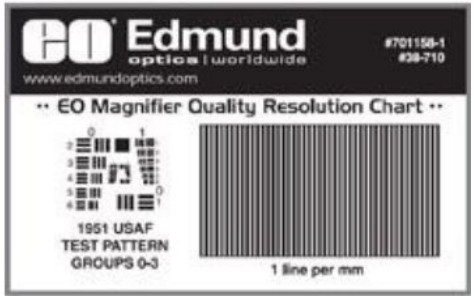
KV4-6 Color PTC vs OBS (Original Chart)

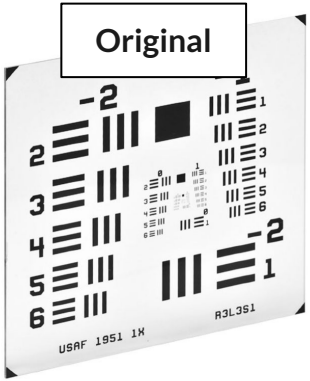


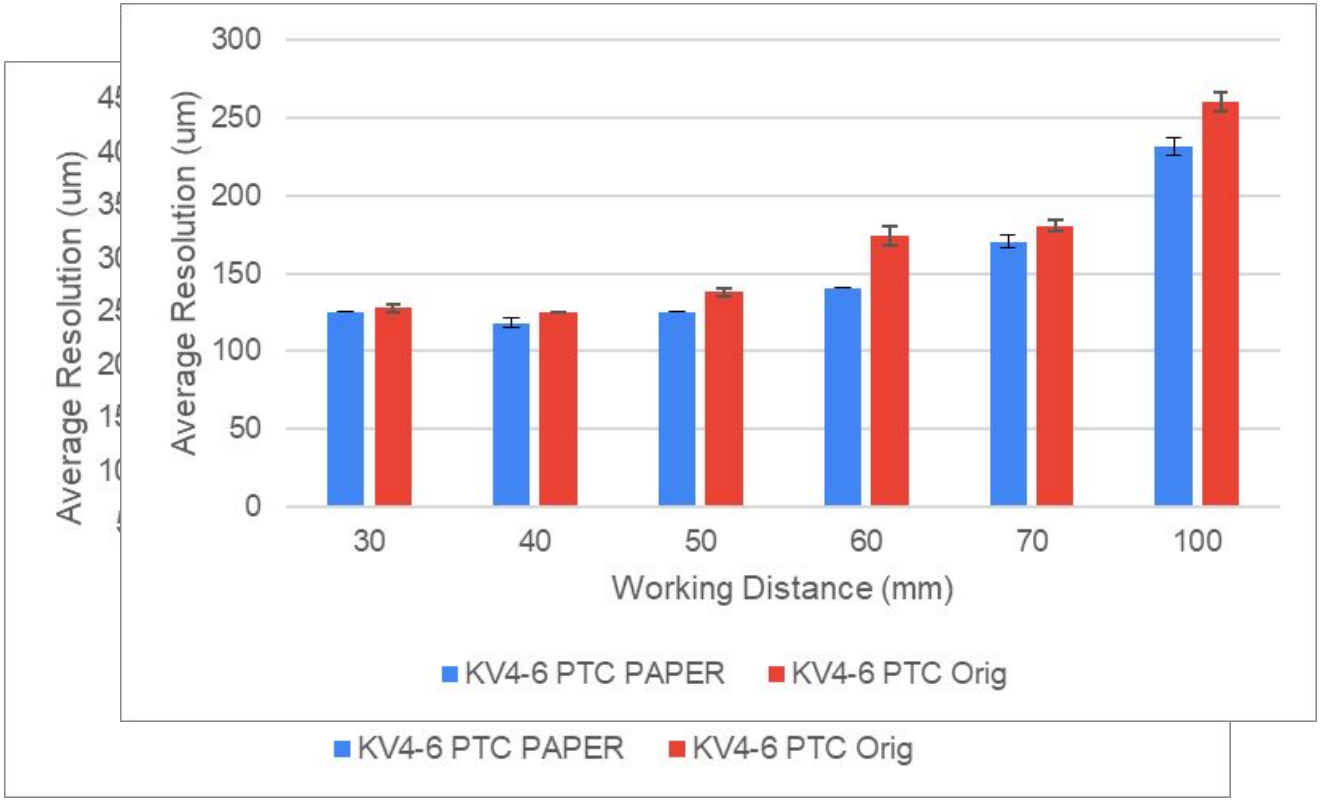


Comparing Original and New Paper Targets

KV4-6 Resolution Old (Glass) vs New (Paper) Targets

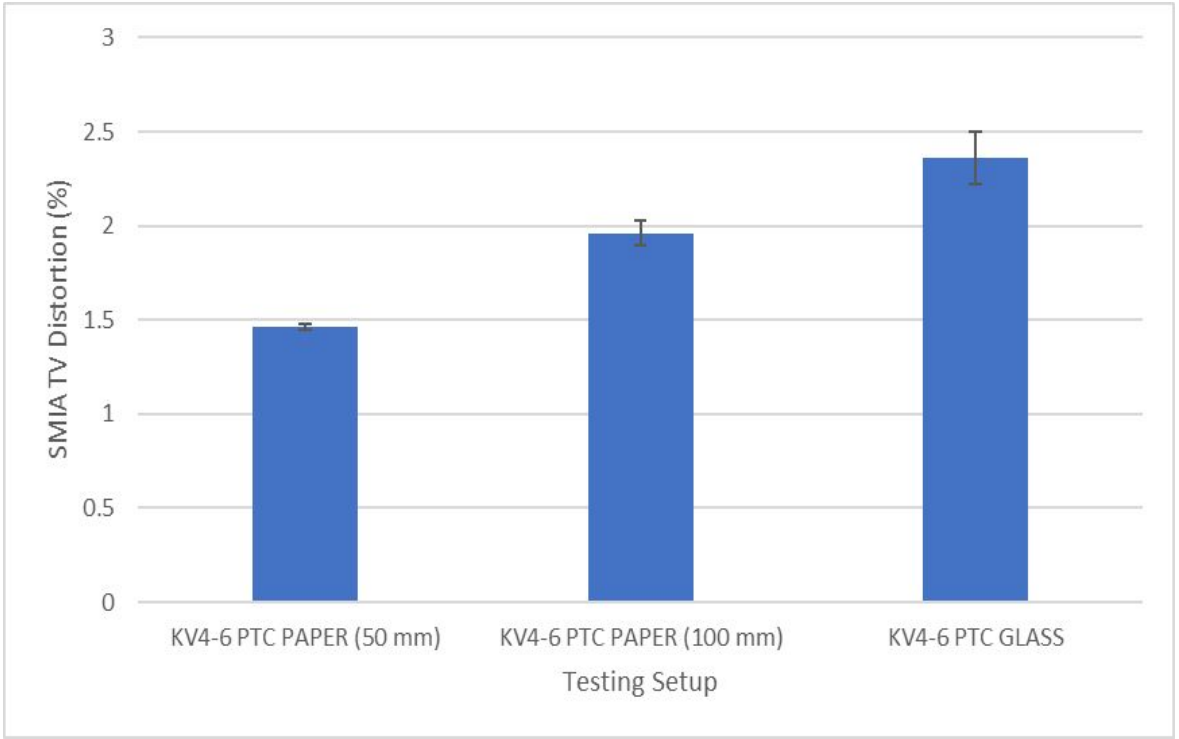






KV4-6 Distortion New Targets (Paper) vs Old (Glass)

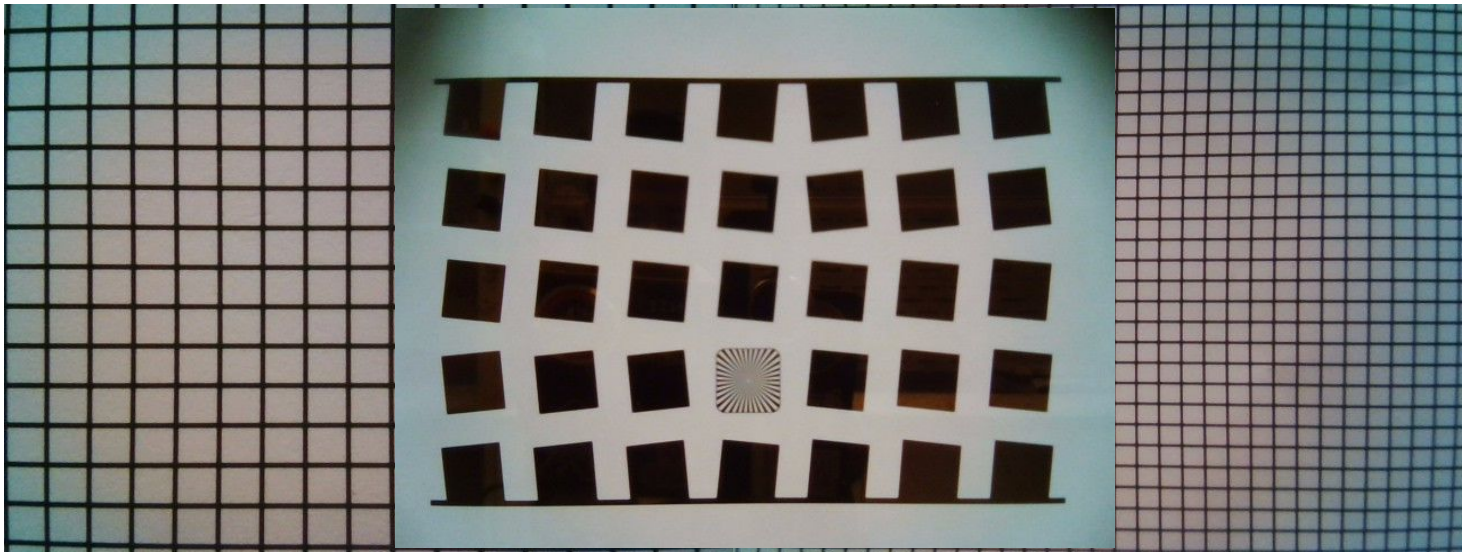
KV4-6 PTC PAPER (50 mm)	KV4-6 PTC PAPER (100 mm)	KV4-6 PTC GLASS
SMIA TV Distortion (%)	SMIA TV Distortion (%)	SMIA TV Distortion (%)
1.41	1.81	-2.94
1.48	1.81	-2.53
1.52	1.81	-2.02
1.48	2.12	-2.32
1.42	2.12	-1.99
1.46	2.1	-2.33
1.46	1.96	2.36
0.04	0.17	0.35
0.02	0.07	0.14



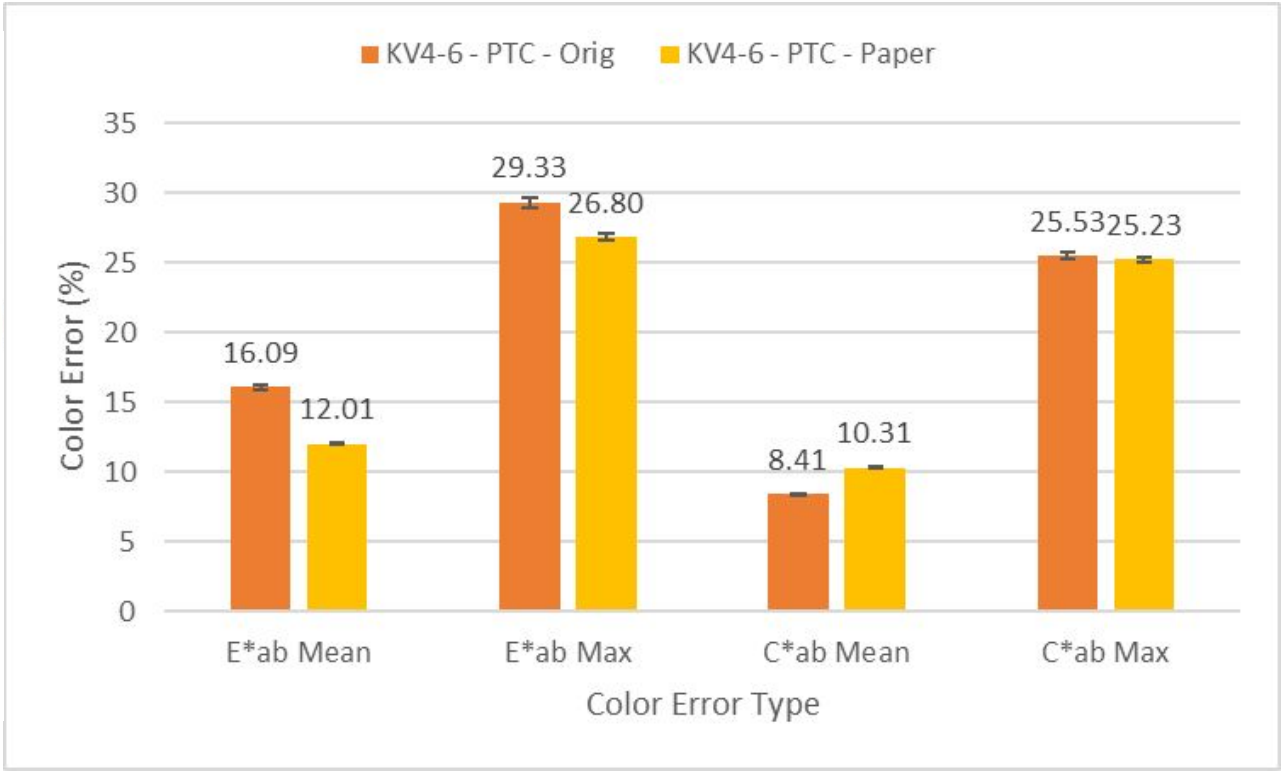
*All done by Imatest

KV4-6 Distortion New Targets (Paper) vs Old (Glass)

- 50mm vs 100mm working distances of printed 3 mm grid paper
- More visible distortion for 100 mm distance

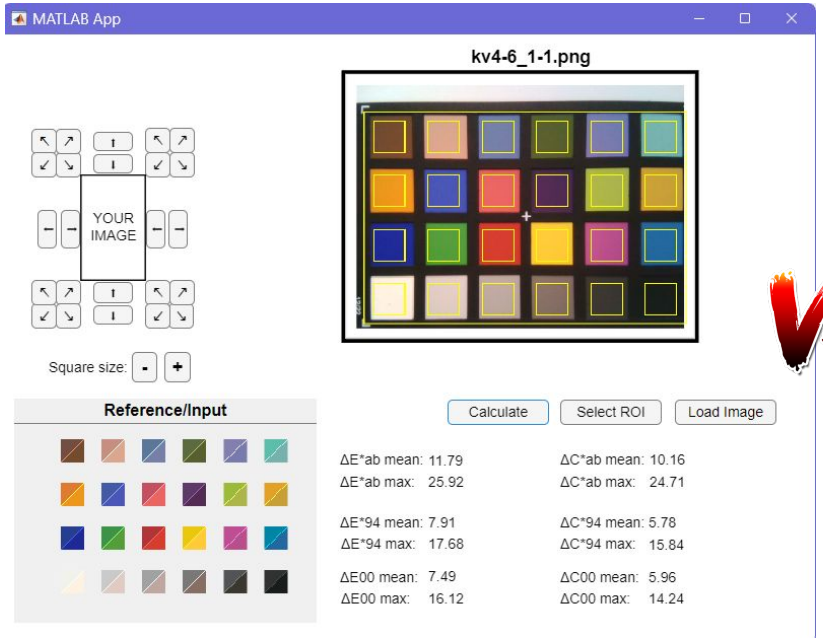


KV4-6 Color Old (Glass) vs New (Paper) Targets



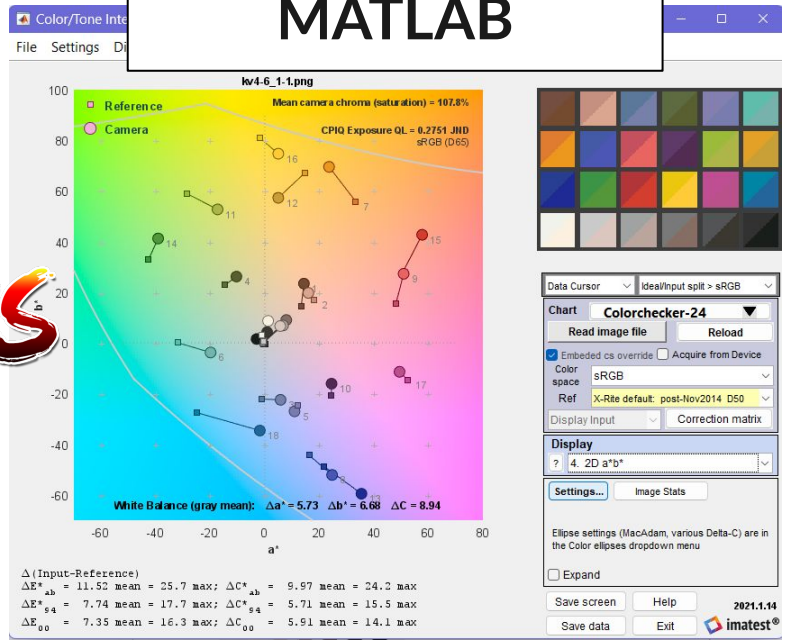
NEW KV4-6 Color Old (Glass) vs New (Paper) Targets

ColorChecker MATLAB App

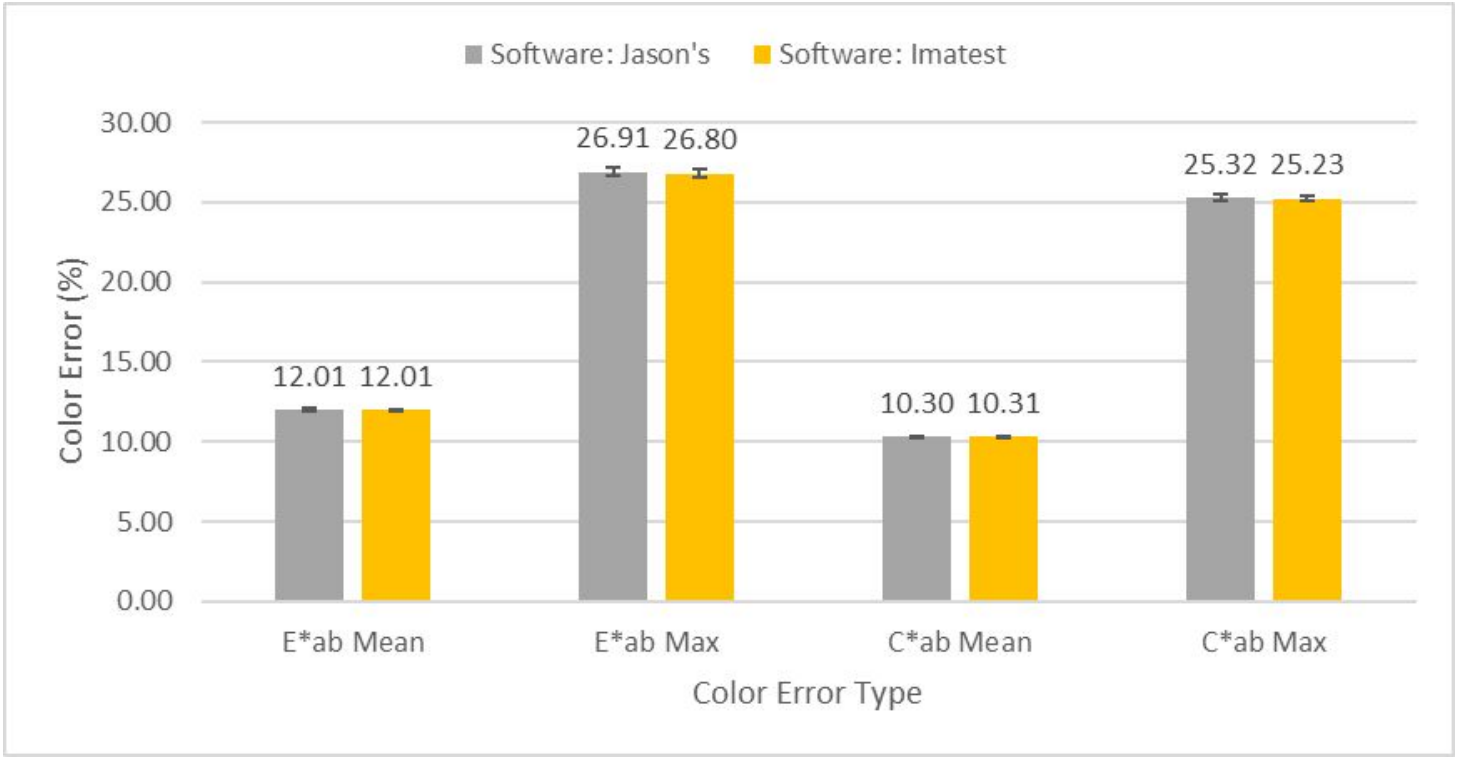


VS

MATLAB

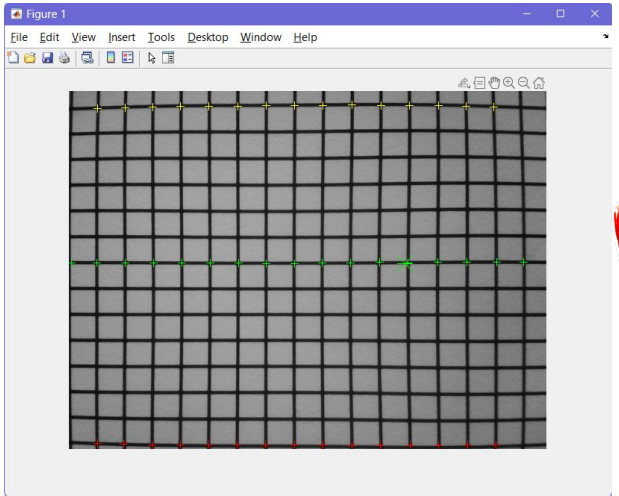


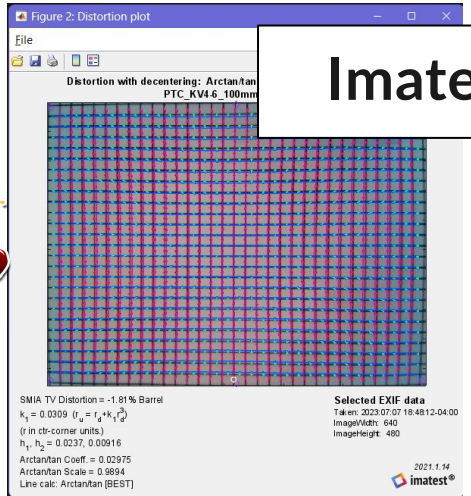
ColorChecker MATLAB App



Distortion MATLAB Code

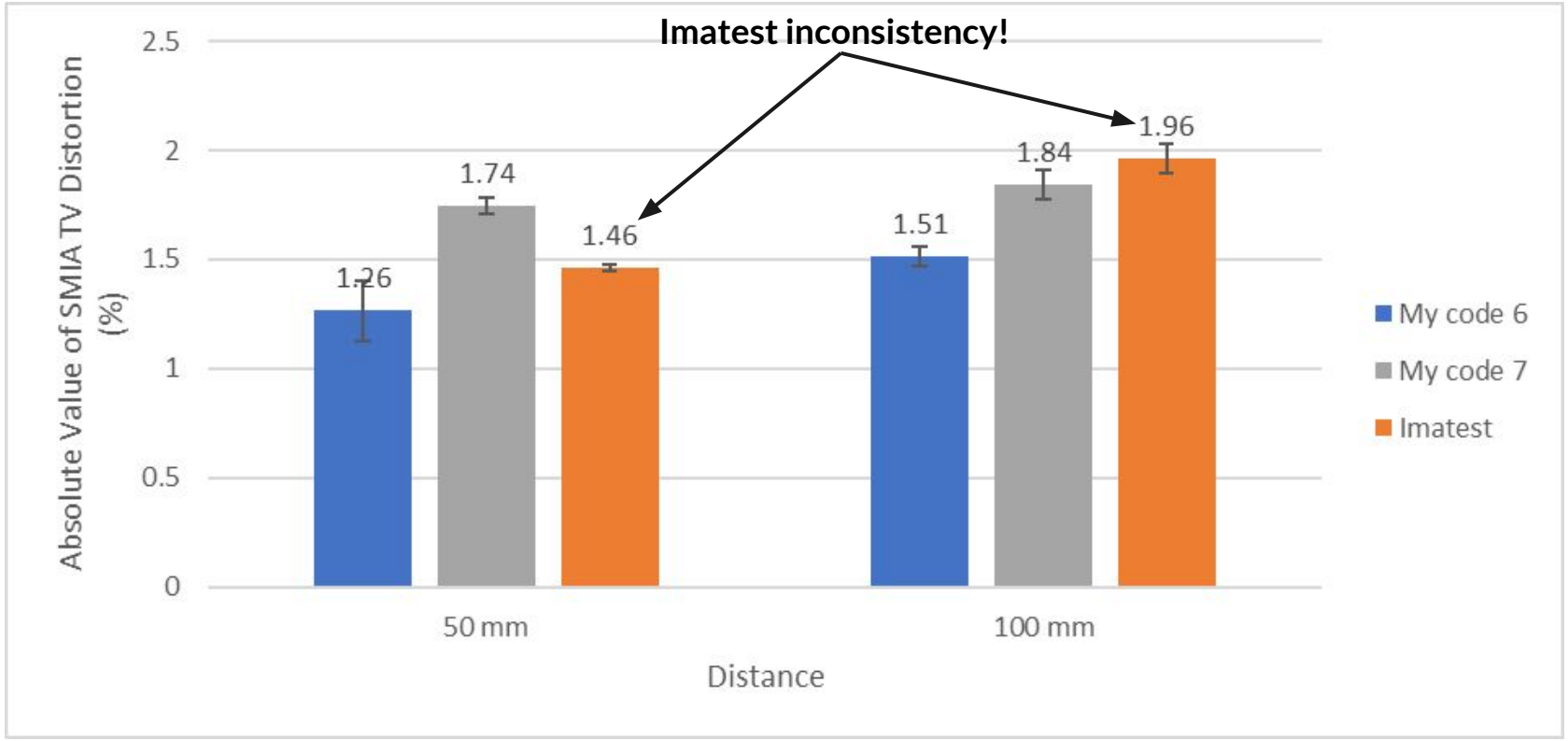
- First approach (seen below): using line recognition and simple formula to calculate SMIA TV distortion
- Second approach (not attempted): using the FDA paper method to find geometric distortion and using that to calculate theoretical SMIA TV distortion





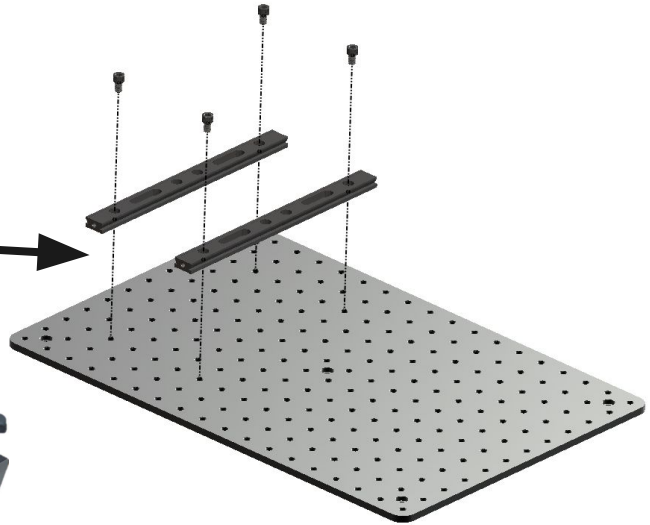
Imatest

Distortion MATLAB Code



Manuscript Draft and Figures

- Main priority right now
- Any examples I can follow?
- Formatting (e.g. bullets)? Citations?
- Is this the desired figure diagram?
- Or this?



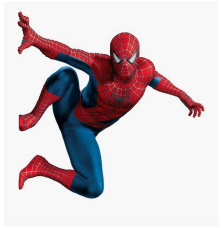
Next Steps

- Finish manuscript draft and initial figures
- Finish testing distortion software
- Further validate distortion software
- Generate protocols for both the updated color and distortion characterization methods and how to use code
- Tie everything together 😎
- Organize laparoscope bench
- Optimize chamber walls - when characterizing, there was noticeable tearing when removing boards and positioning frames onto them
- Laparoscope build - Jason & Michele
    - John will help us with connectors on Tuesday

Weird Facts About me

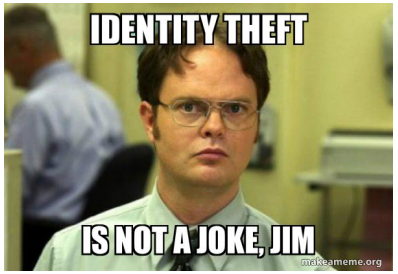
- I mainline podcasts on a daily basis
- I am a reformed driver (MAX 10 mph over when everyone speeding)
- I enjoy brushing my teeth (medium toothbrush good).

Guess the Person!

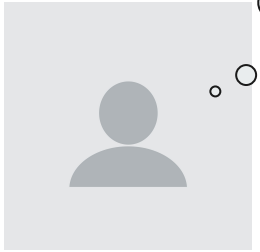


+

+



=



I like boba tea

+

=

[Template]

-

[Template]

-