ePIC pfRICH Aerogel QA Progress Report

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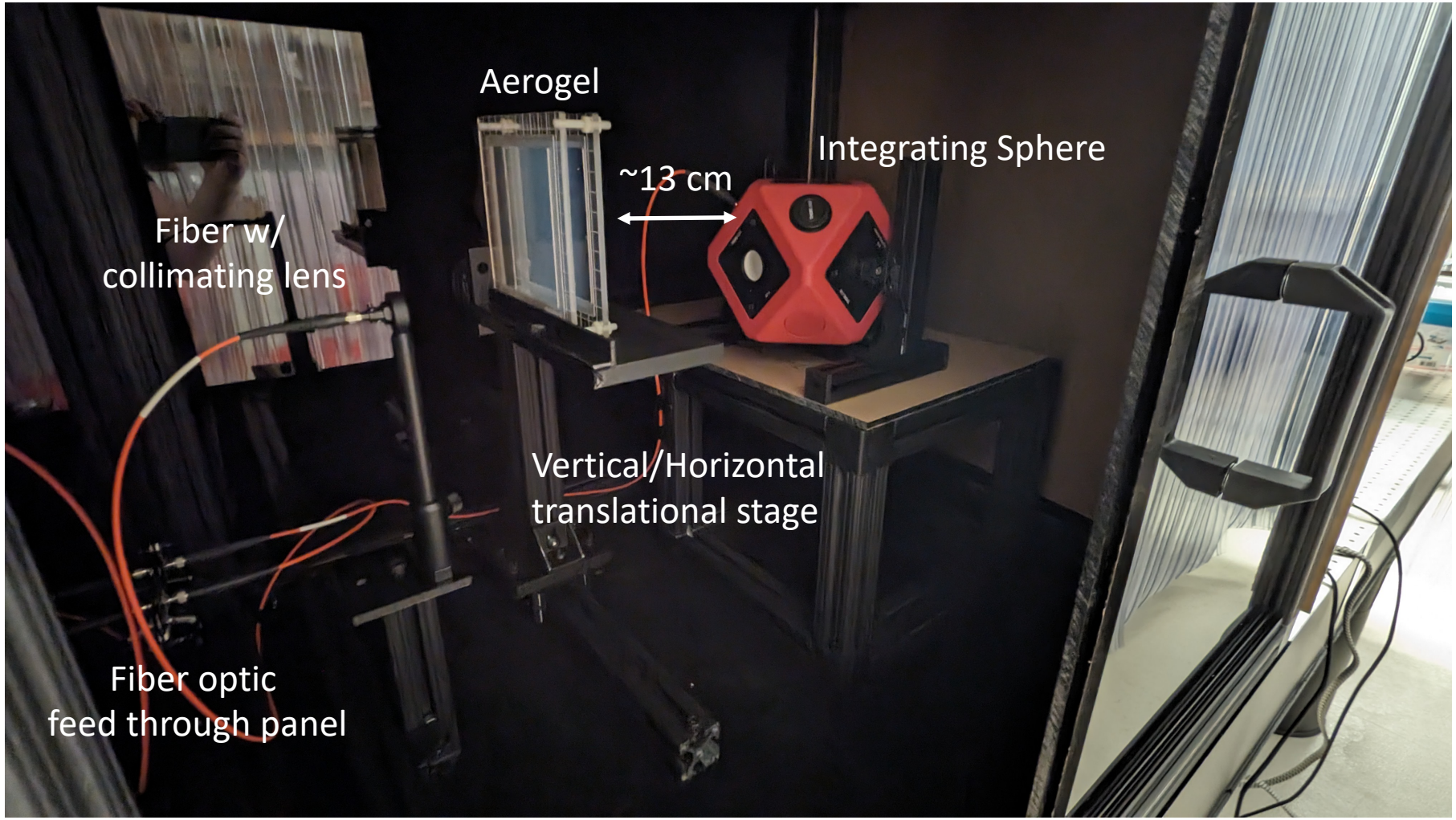
Aerogel Factory Tiles

- Current aerogel tiles from Aerogel Factory

Type	TSA1.04	TSA1.04	TSA1.04
Serial number	**TSA114-3**	**TSA120-1**	**TSA120-2**
Refractive index (at 405 nm)	**1.0377**	**1.0404**	**1.0401**
Transmission length (at 400 nm) [mm]	51.2	48.9	49.3
Transmittance (at 400 nm) [%]	61.2	60.6	60.5
Lateral tile size (nominal) [mm]	109.9	109.4	110.4
Thickness (nominal) [mm]	25.1	24.5	24.8
Weight [g]	42.79	42.21	43.12
Density [g/cm^3]	0.141	0.144	0.143
Appearance	Slight damages	Good	Good
File name of transmittance data [.txt]	tsa114-3_ 2023.12	tsa120-1	tsa120-2

Tile	TU Measured
TSA88-1	Yes
TSA120-1	Yes
TSA120-2	No
TSA114-3	No

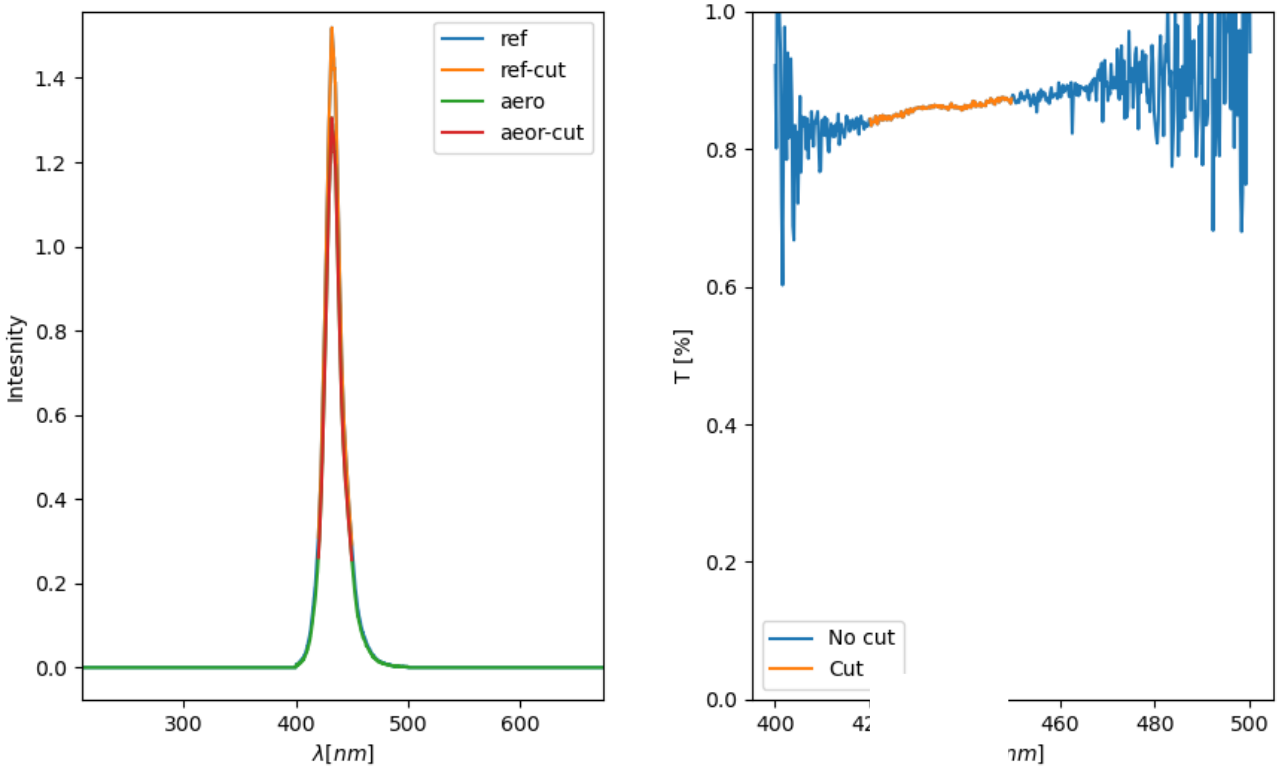
Transmittance Setup



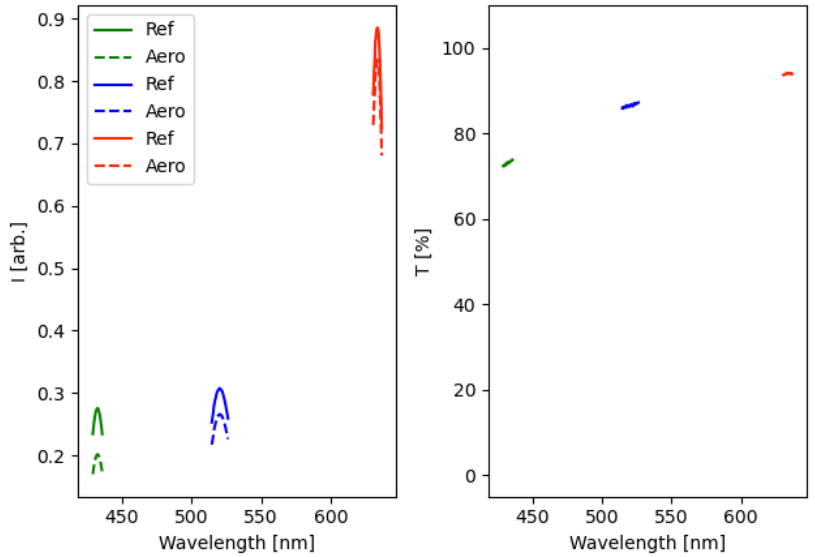
Transmittance Measurement Procedure

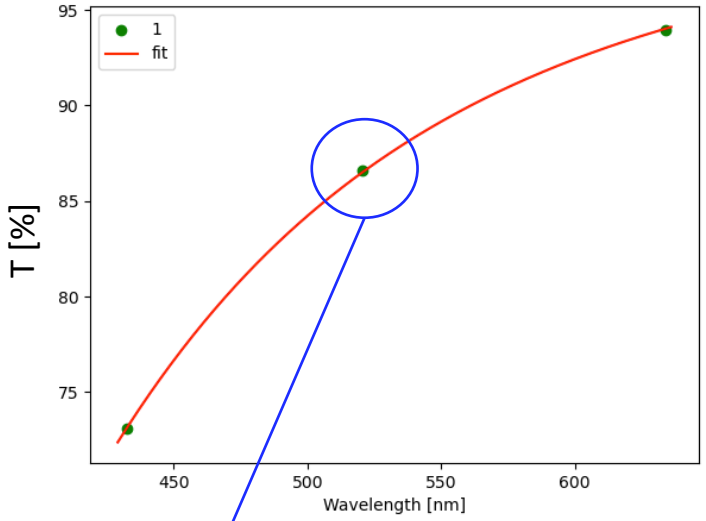
- Currently using 3 fixed wavelength LEDs are used to measure the transmittance $(430nm, 530nm, 625nm)$
- LED Measurement point
  - Cut window to remove tails where intensity is too low
  - Window sensitivity less than ~0.2%

Example



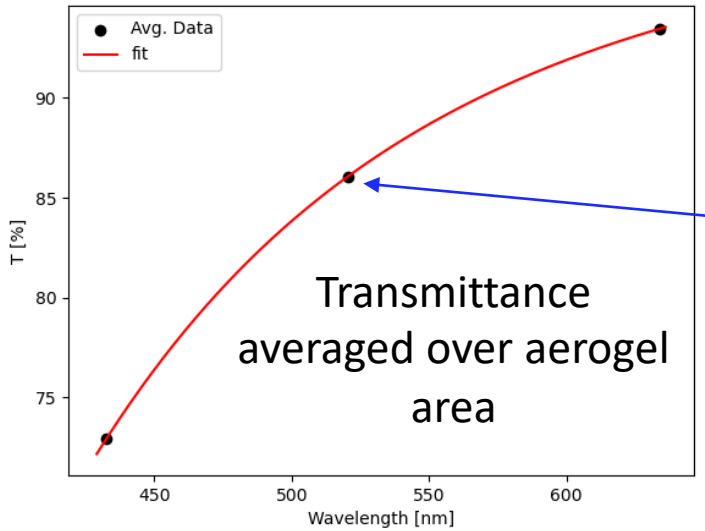
Transmittance Measurement Systematic Study



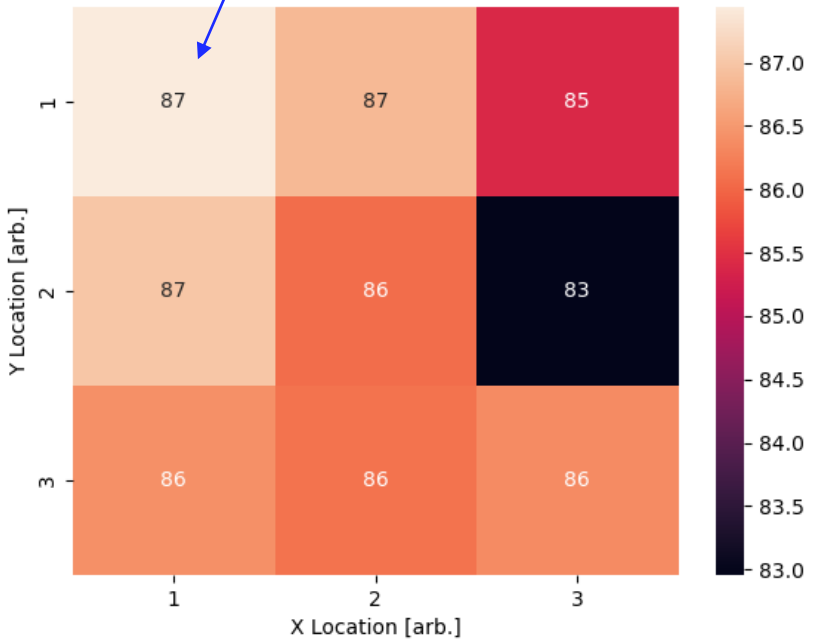


Transmittance for single aerogel location

$< \lambda > = 520\ nm$



Transmittance averaged over aerogel area

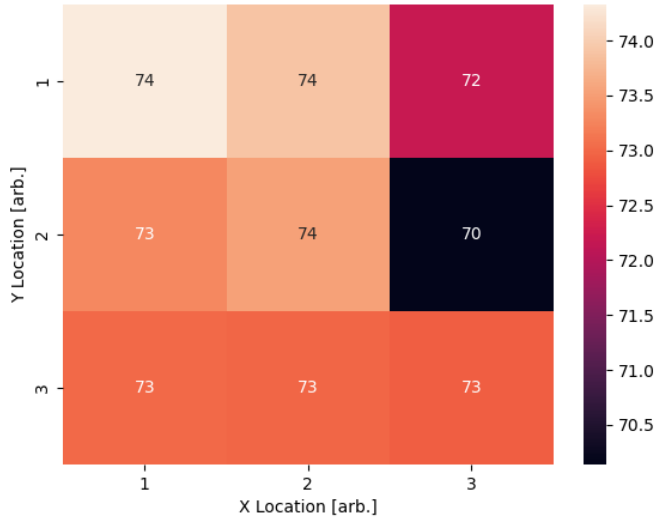


Each LED wavelength has its own aerogel area map

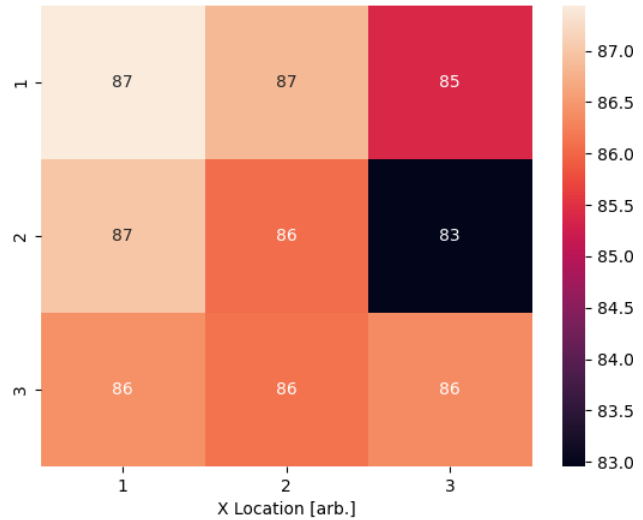
TU Transmittance Results

- TSA88-1

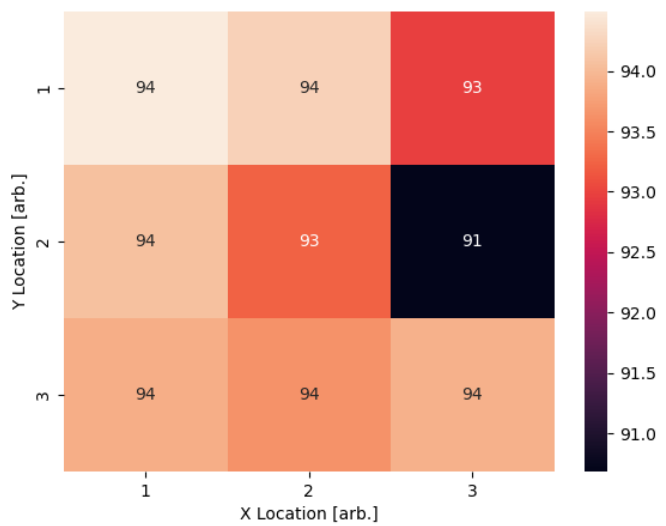
$< \lambda > = 432\ nm$



$< \lambda > = 520\ nm$

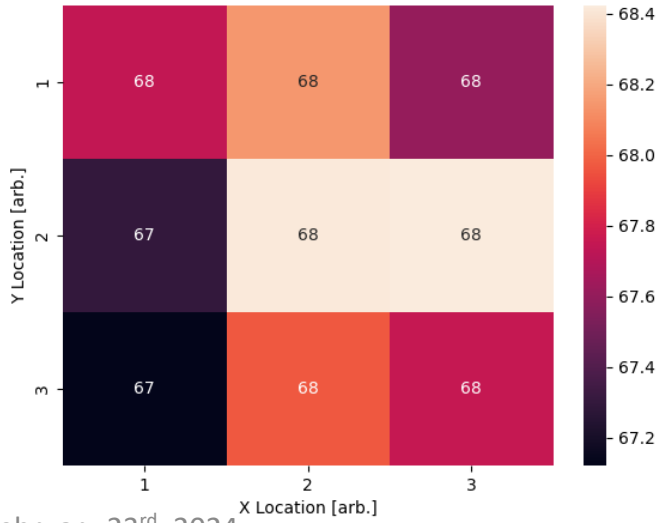


$< \lambda > = 634\ nm$

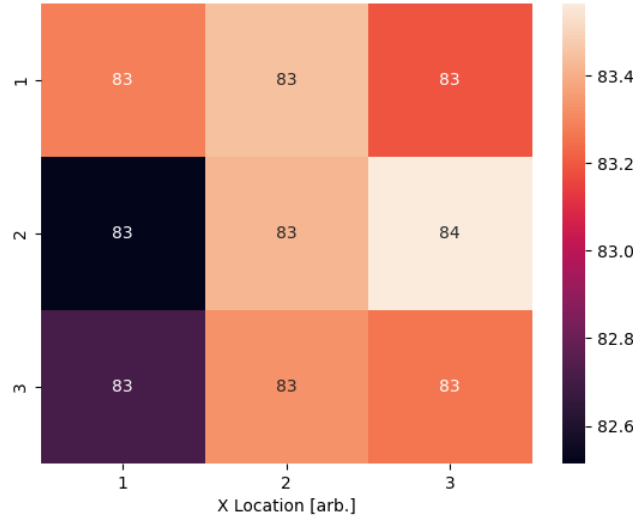


- TSA120-1

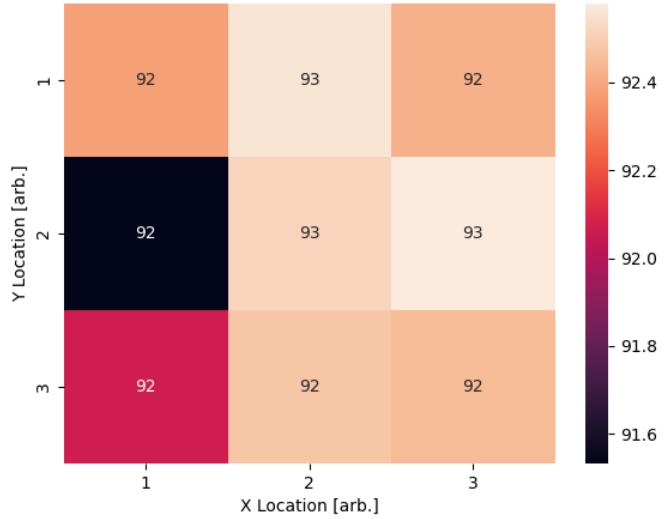
$< \lambda > = 432\ nm$



$< \lambda > = 520\ nm$

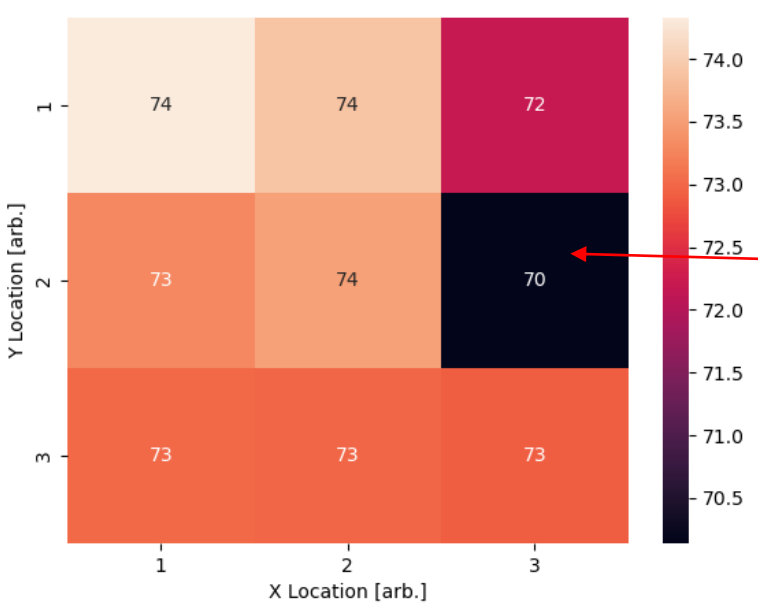


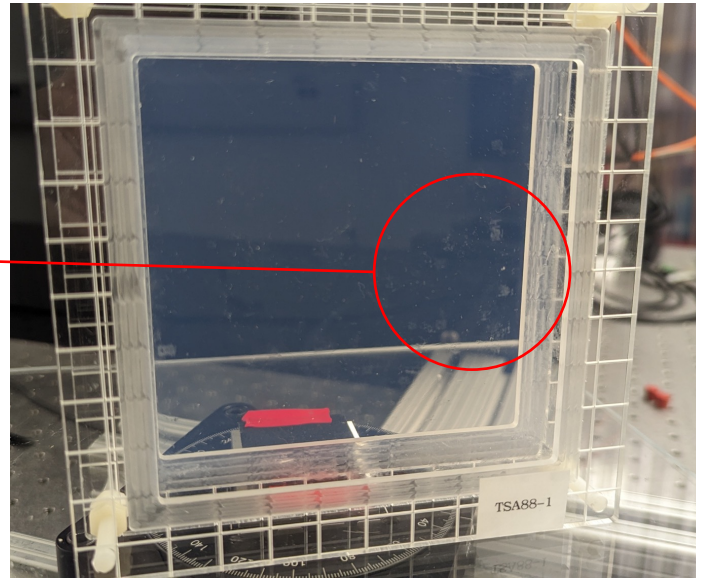
$< \lambda > = 634\ nm$



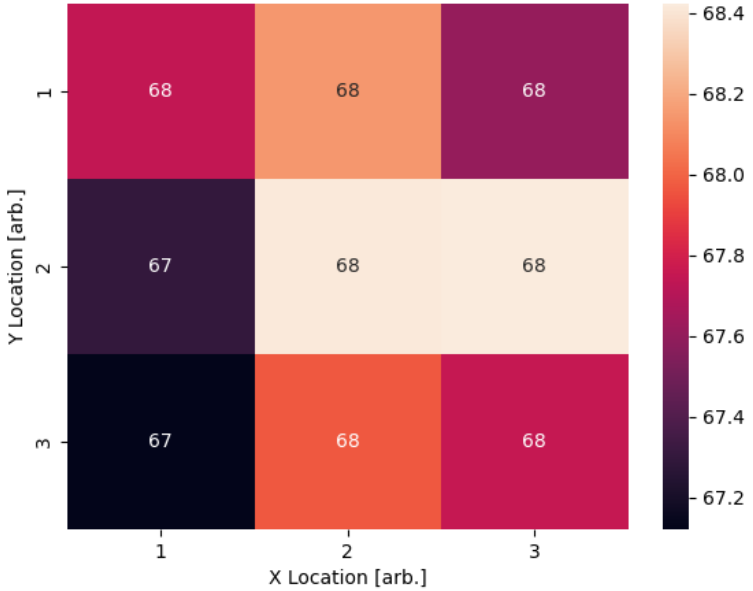
TU Transmittance Results

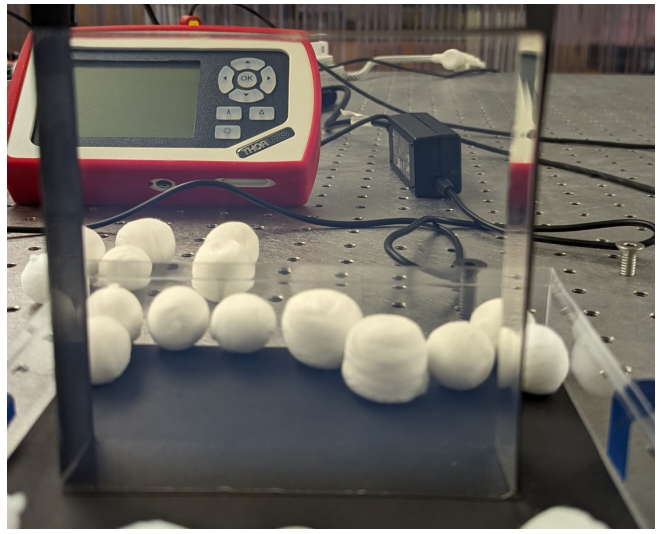
- TSA88-1 outlier due to poor TU aerogel handling



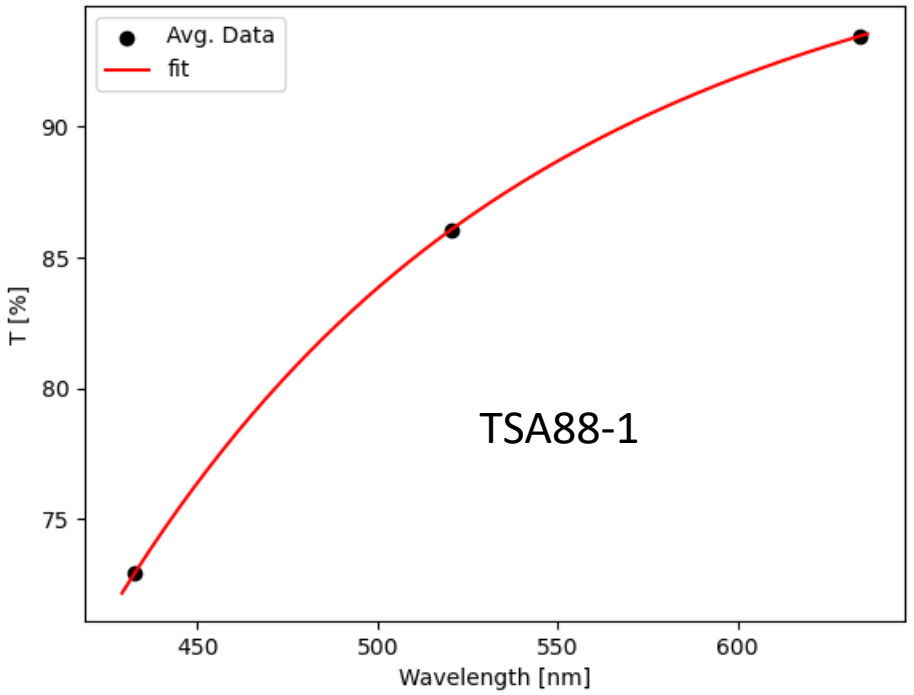


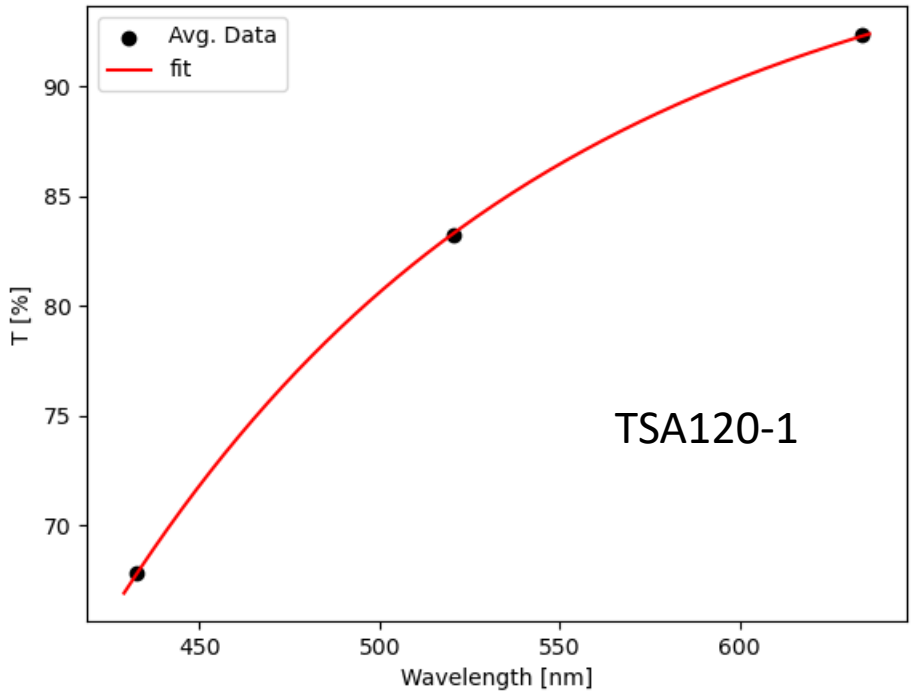
- TSA120-1 more uniform transmittance across aerogel (note color scales)





TU Transmittance Results





TU Transmittance Comparisons: TSA88-1

- Two identical measurements agreed within ~0.55%
- BNL measurements are for one local location
- Local locations could be different then TU single location measurements
- Not sure about the AF measurement location(s)
- AF transmittance expected to be larger for TSA88-1 due to TU handling

TSA88-1: Transmittance comparison using TU **central** measurement

$\lambda\ [nm]$	(TU – BNL)/BNL [%]	(TU – AF)/AF [%]	(BNL –AF)/AF [%]
432.5	1.55	-3.99	-5.46
520.5	1.03	-2.78	-3.78
633.7	-1.02	-1.64	-0.63

TSA88-1: Transmittance comparison using TU **average** tile measurement

$\lambda\ [nm]$	(TU – BNL)/BNL [%]	(TU – AF)/AF [%]	(BNL –AF)/AF [%]
432.5	2.10	-3.47	-5.46
520.5	2.09	-1.76	-3.78
633.7	0.04	-0.59	-0.63

TU Transmittance Comparisons: TSA120-1

TSA120-1: Transmittance comparison using TU **central** measurement

$\lambda\ [nm]$	(TU – BNL)/BNL [%]	(TU – AF)/AF [%]	(BNL –AF)/AF [%]
432.5	--	-2.13	--
520.5	--	-1.72	--
633.7	--	-0.32	--

TSA120-1: Transmittance comparison using TU **average** tile measurement

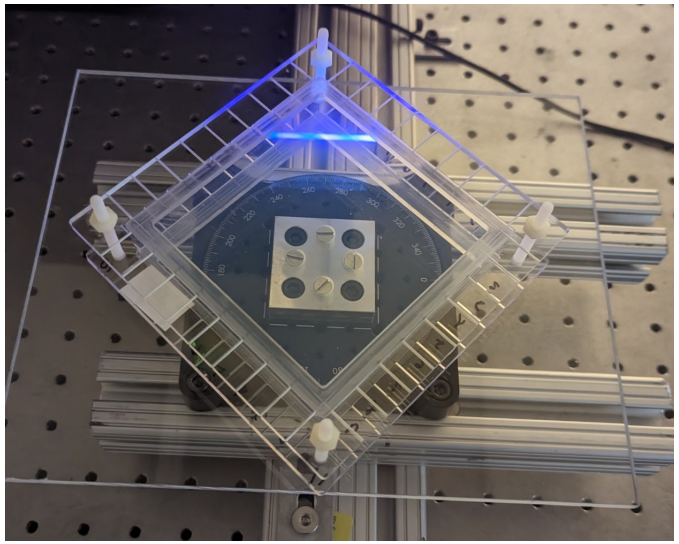
$\lambda\ [nm]$	(TU – BNL)/BNL [%]	(TU – AF)/AF [%]	(BNL –AF)/AF [%]
432.5	--	-2.98	--
520.5	--	-1.99	--
633.7	--	-0.52	--

Transmittance: Next Steps

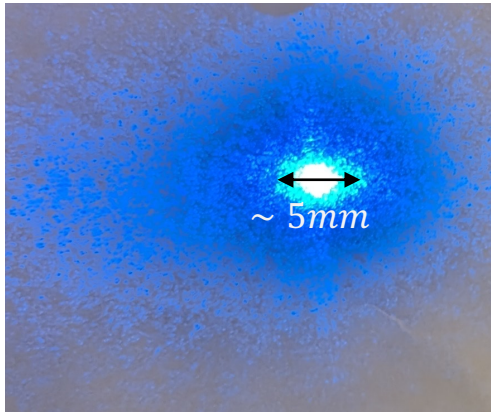
- ❑ Measure remaining aerogel tiles at TU (TSA114-3, TSA120-2)
- ❑ Measure Transmittance over area of aerogel tiles at BNL
  - Will provide a more direct comparison for final validation
- ❑ Determine how many LEDs are needed for proper fit characterization of transmittance curve
  - Preliminary study shows TU will need at least one more LED deeper into the UV (~300 nm) for better fit
- ❑ Improve measurement systematic uncertainty estimate by increasing number of identical measurements
- ❑ Additional Purchases
  - 1-3 additional LEDs, depending on curve fit study outcome: $470 -- $1,410
  - 2-5 LED Drivers (1 per LED): $1,080 -- $2,700
  - Can PED money be allocated to these purchases?

Index of Refraction

- Prism method is used
  - $4.5\ mW$ laser with spectra peak at $403\ nm$
  - Beam spot deflection is projected to a screen down stream of aerogel (~2m)
  - Deflected beam spot largest source of uncertainty
  - Minimum beam spot deflection is measured. This is typically ~15cm - 20cm at ~ 2m



Deflected beam spot on screen



Comparison of TU (average of four corners) and AF index of refraction measurements

Tile	TU ($\lambda = 403\ nm$)	AF ($\lambda = 405\ nm$)	(TU-AF)/AF [%]
TSA88-1	1.0398 +/- 0.0007	1.0390	0.077
TSA120-1	1.0413 +/- 0.0011	1.0404	0.087

Index of Refraction: Next Steps

- Implement CCD camera:
  1. Direct beam spot into CCD camera → deflection is too large relative to CCD sensor
  2. Image beam spot on screen with CCD camera, calibrate to get pixel/mm, measure deflection distance

- How was this implemented for other aerogel QAs?