



ADVANCED MATERIALS

AgeNT® Heaters for All Weather Lidar

29 November 2023

*Creating innovative product platforms for a **SAFER, MORE CONNECTED** and **SUSTAINABLE** world.*



Our mission is to develop and
manufacture advanced carbon nano materials
**to create a safer, more connected
and sustainable world.**

Through two CHASM **PRODUCT PLATFORMS**

NTeC[®]

Reinforcing Additives
for sustainable concrete



Conductive Additives
for better Li-ion batteries



AgeNT[®]

Transparent Heaters
for reliable ADAS sensors



Transparent Antennas
for 5G, IoT and beyond

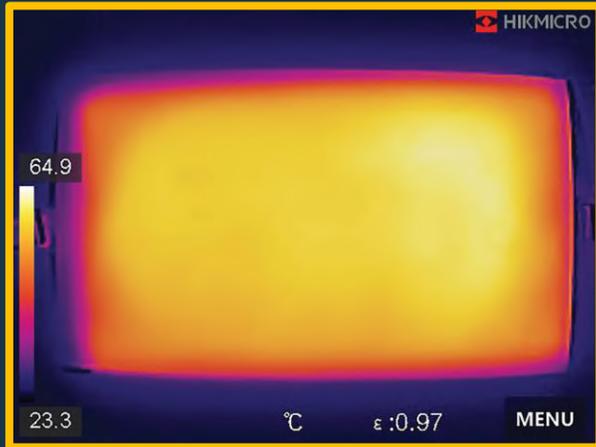


Why are Lidome Heaters needed?



- 1 21% of the six million vehicle accidents in the U.S. are weather-related
- 2 Lidar function is impaired by perception error caused by Moisture, Fog, and Ice
- 3 Perception error influence is moderate for SAE Level 3 and severe for Level 4

CHASM's Transparent Heater Solution

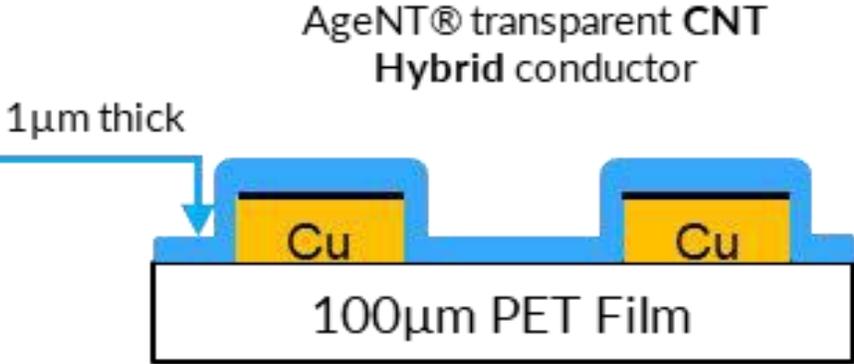
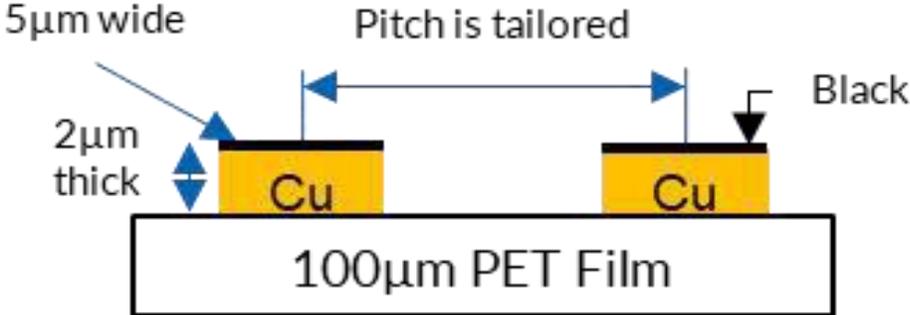
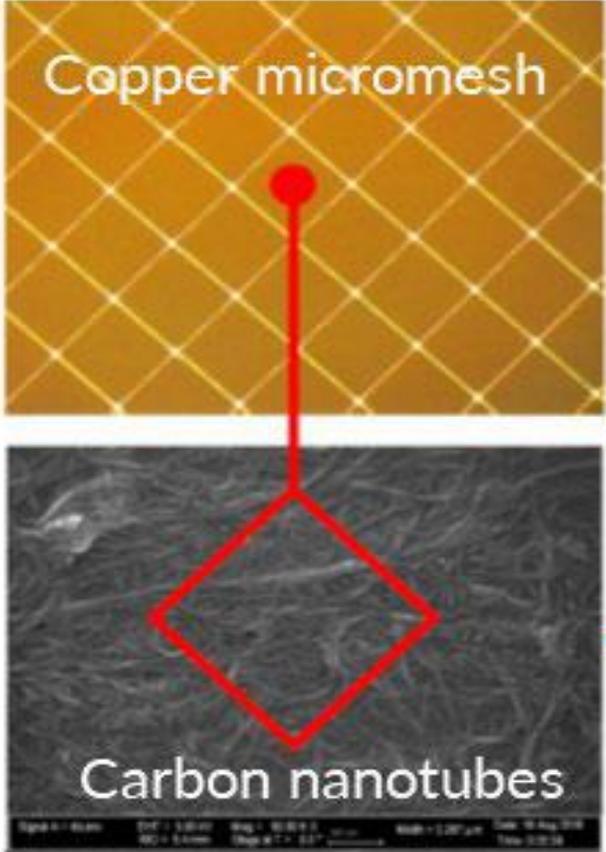


- ✓ Delivers rapid, uniform heating @ 12V
- ✓ Highest transmission and lowest beam deflection for lidar signal integrity
- ✓ Highly robust – flexible, environmentally stable, & can be mass-produced at low cost
- ✓ Only universal heater solution for lidar, radar & optical camera – ideal for cluster sensor solutions

CHASM's AgeNT[®] Technology



AgeNT[®] Transparent CNT Hybrid Conductors*



* Proven, Patented Technology

CHASM's AgeNT Heater Foil Specifications

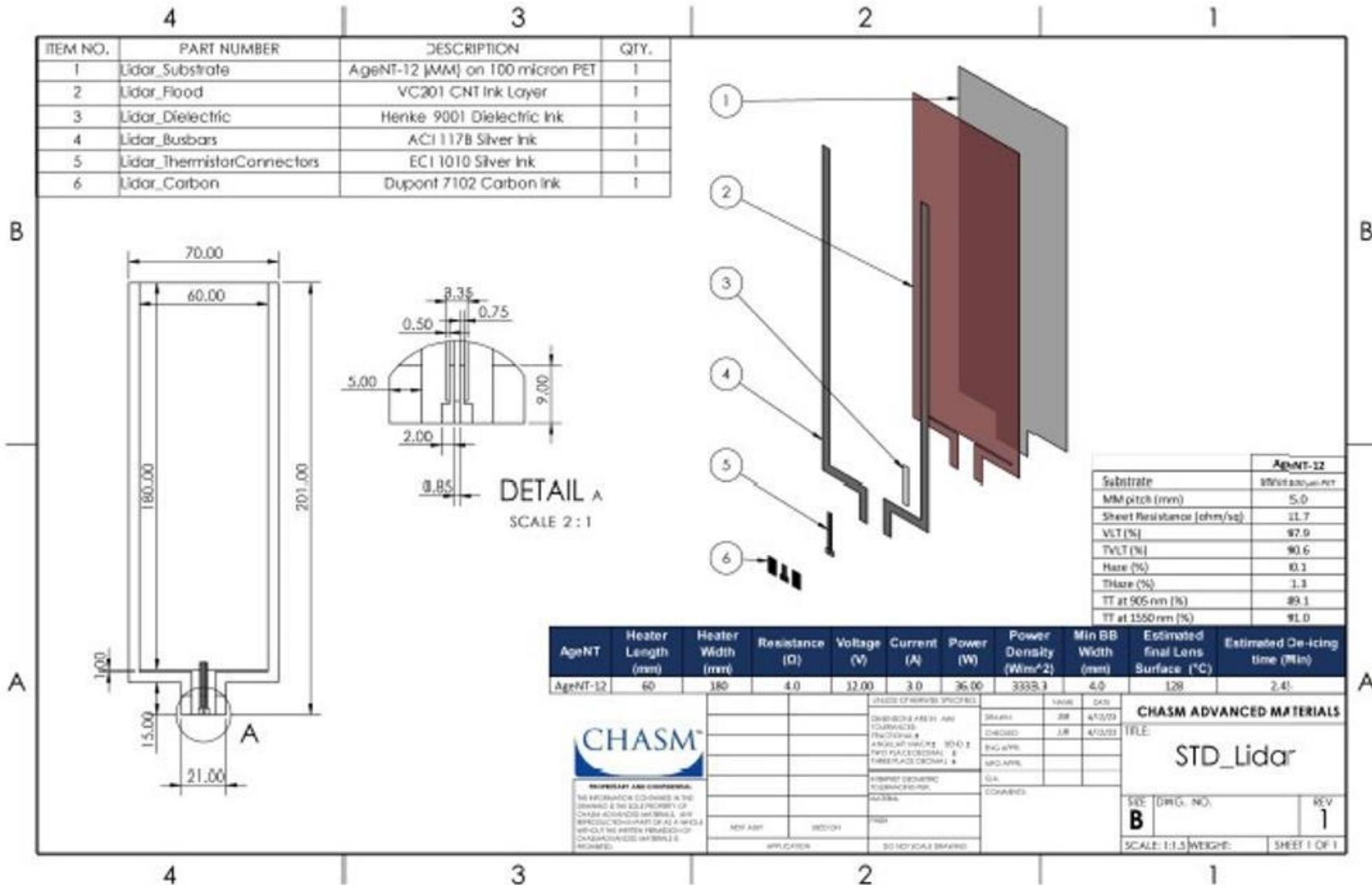


Two AgeNT heater options for Lidar applications:

- ✓ AgeNT-12: highest transmittance and lowest attenuation, with excellent de-icing
- ✓ AgeNT-3: even faster de-icing, with trade-off in transmittance and attenuation

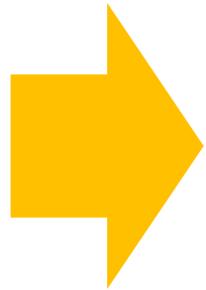
Heater Foil Solution		De-Icing Time	Total Transmittance (%)		Loss (dB)	
CNT Hybrid	R_s (Ω/\square)	5-10 min or less at 12V	Camera 550 nm	LiDAR 905 nm 1,550 nm		Radar 77 GHz
★ AgeNT-12	11.7	✓	90.6	89.1	91.0	0.1
AgeNT-3	2.6	✓	89.9	88.0	88.3	0.6

AgeNT® Heater Foil Stack up Drawing



CHASM's Business Model

CHASM is a Materials company delivering materials and heater designs to Tier One and Two Companies.

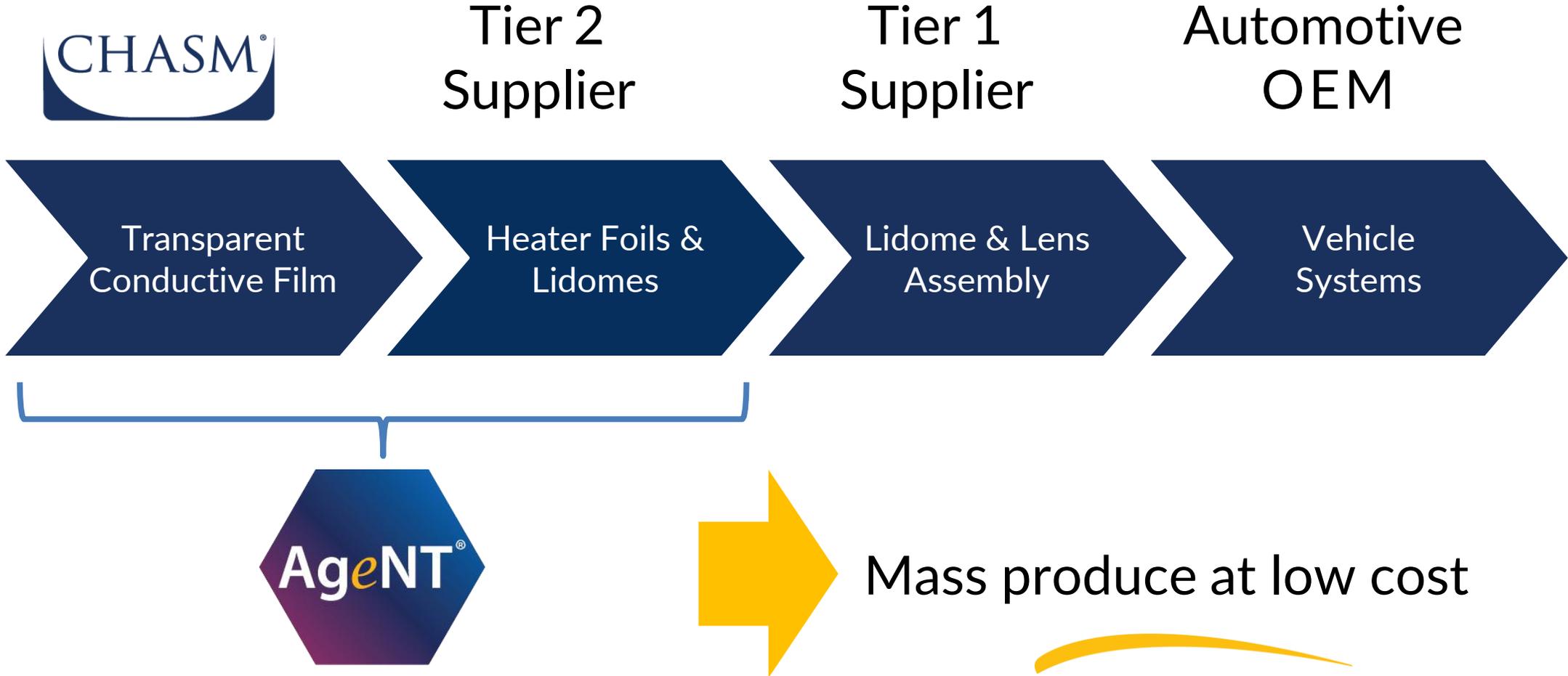


CHASM can **design, simulate, and produce** prototype heaters at our headquarters in Canton, MA, USA

- ✓ We have ISO 16949 certified partners in the Americas, APAC, and EMEA suppliers.



CHASM's Supply Chain Model





AgeNT[®] Transparent Heaters for Lidar

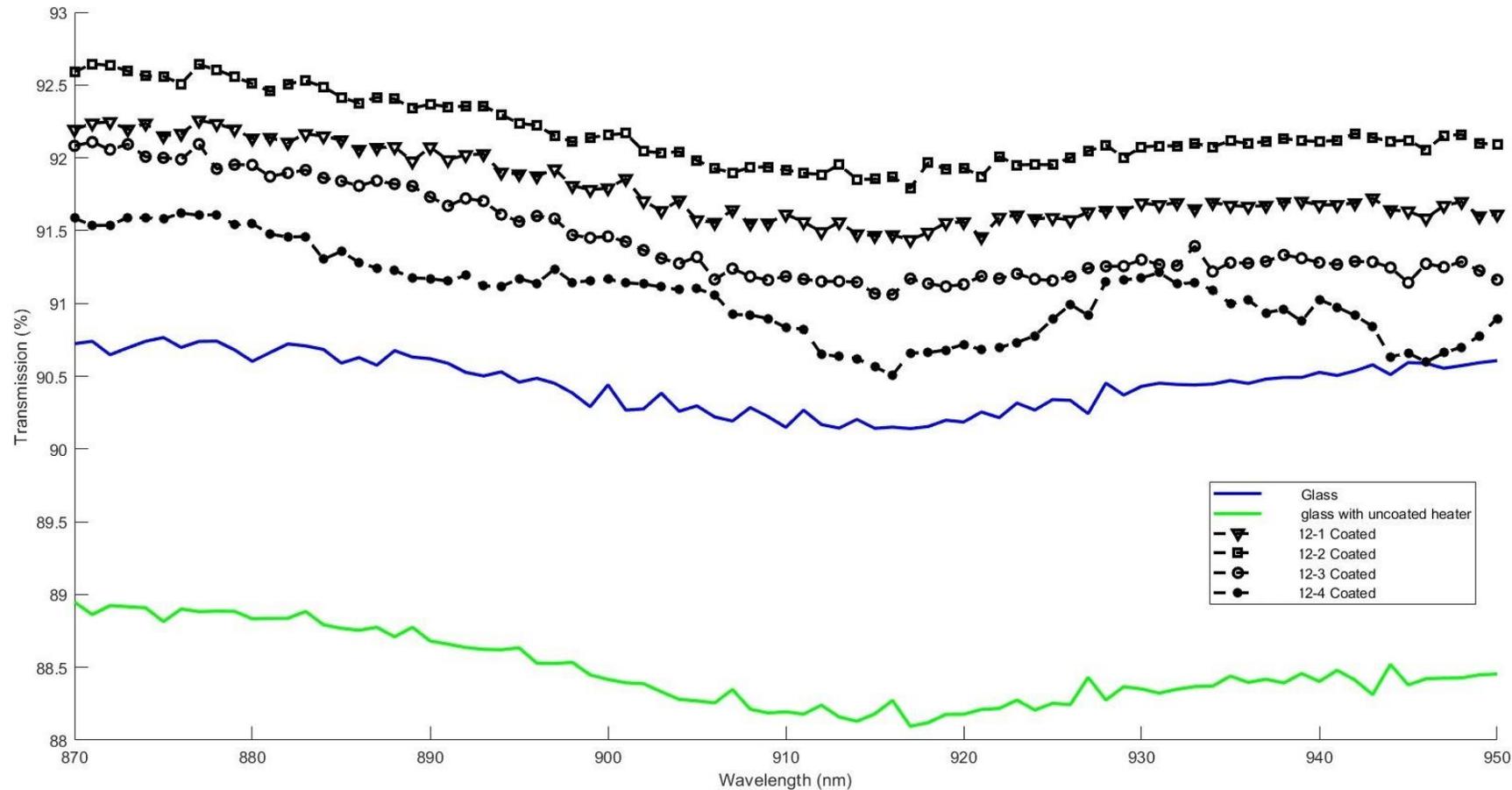
Validation Testing

Independent Lidar Test Lab Summary Results

- ✓ **Minimal scattering, reflection, point cloud loss**
- ✓ **Lidar performed the same with and without the CHASM Heater and with the Heater powered**

Transmission Results

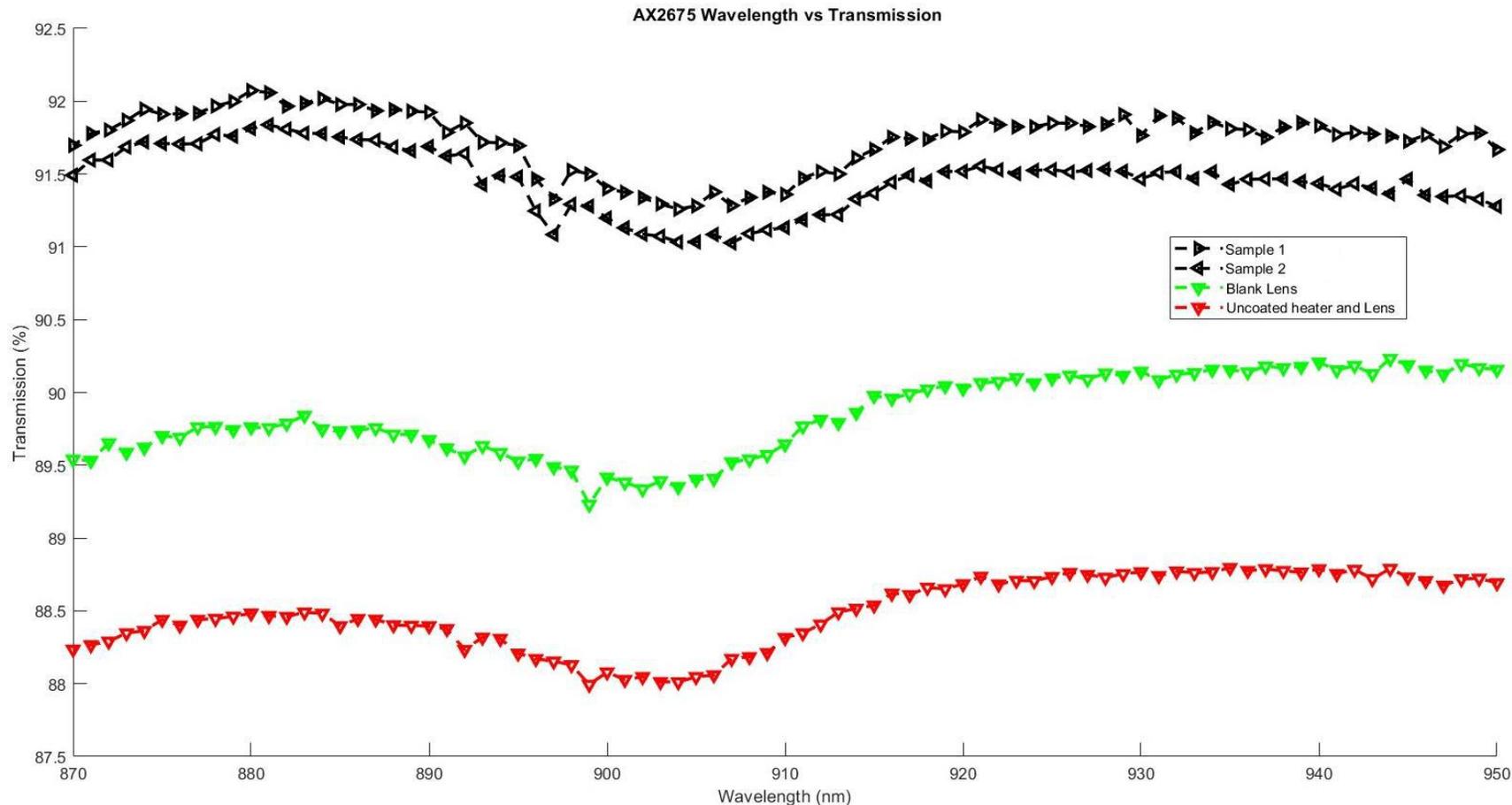
AgeNT-12 heater film laminated to IR transmitting cover glass



Up to 92%
transmission at
905nm with
Anti-Reflective
coating

Transmission Results

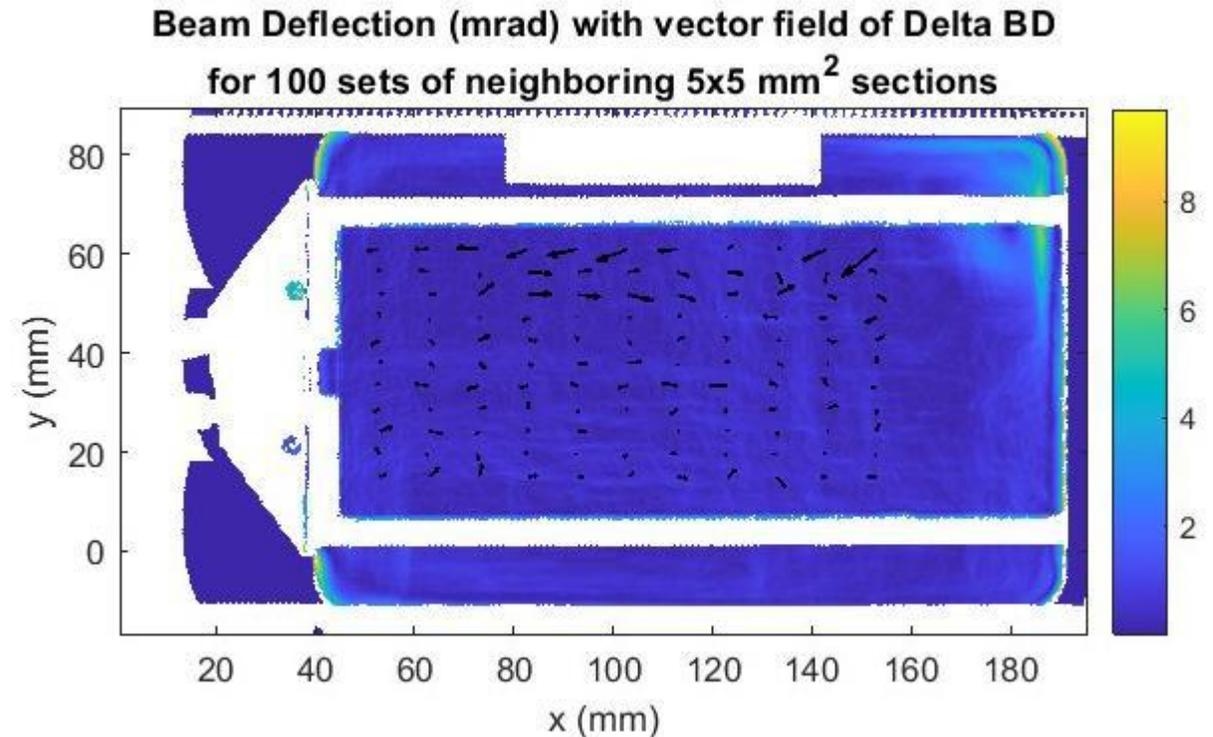
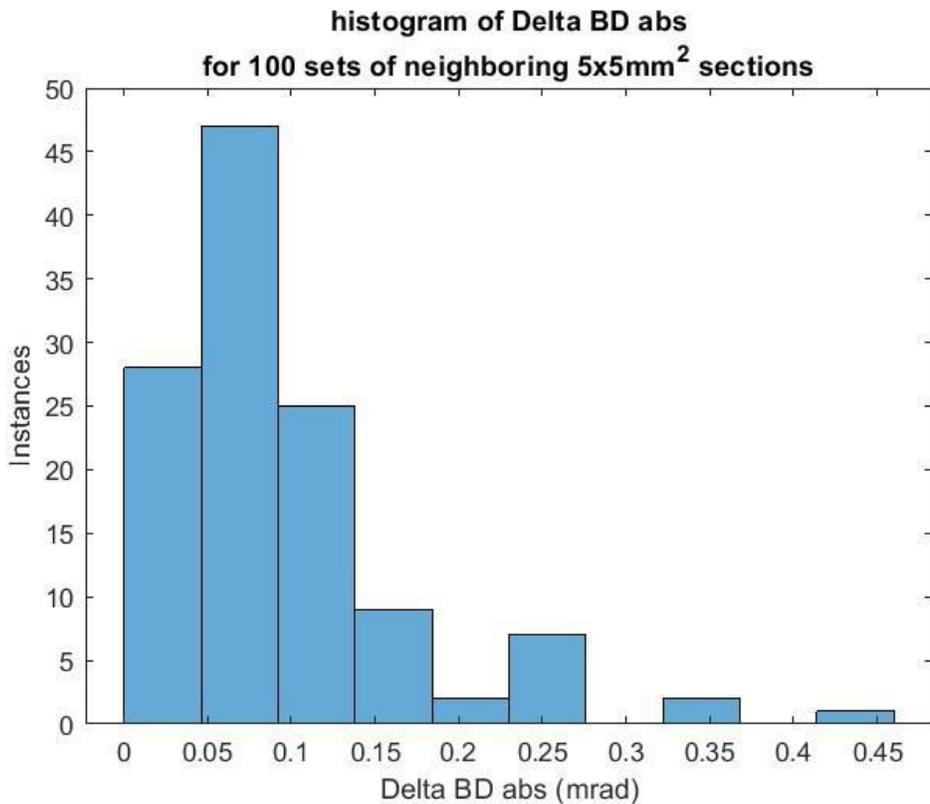
AgeNT-12 Heater Film laminated to IR transmitting PC lidome



Over 91%
transmission at
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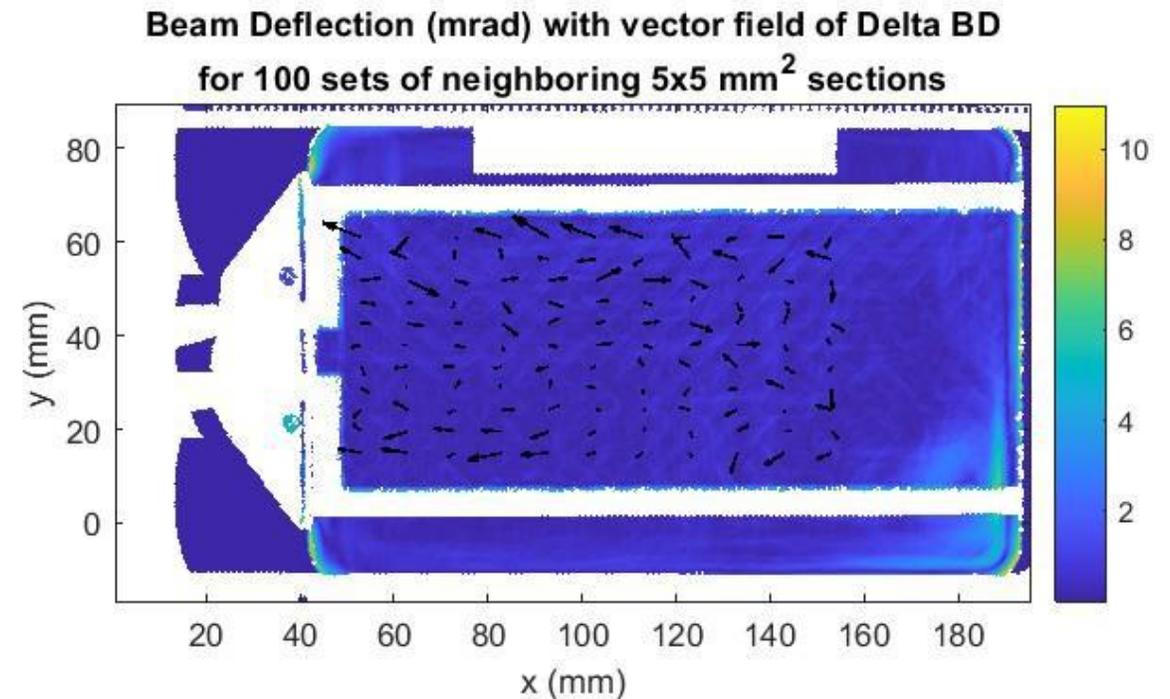
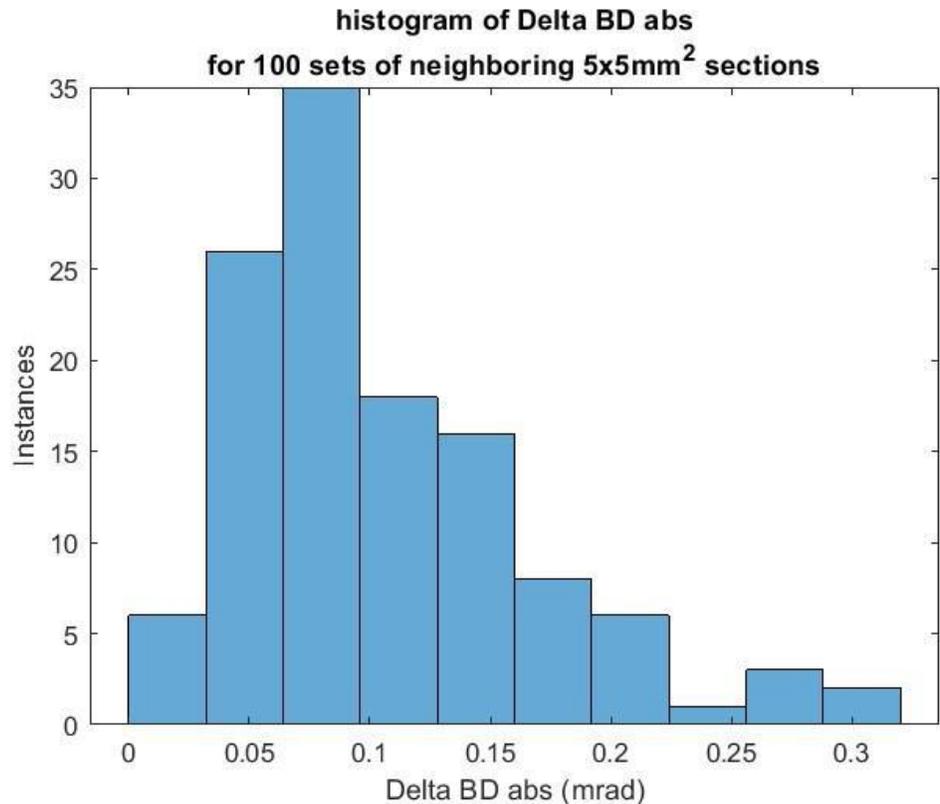
Beam Deflection Analysis – PC (unpowered heater)

mean Delta BD X (mrad)	mean Delta BD Y (mrad)	mean Delta BD abs (mrad)	Std Dev Delta BD abs	Max Delta BD abs (mrad)	Min Delta abs (mrad)
0.00047	-0.00623	0.09680	0.02565	0.45614	0.00398



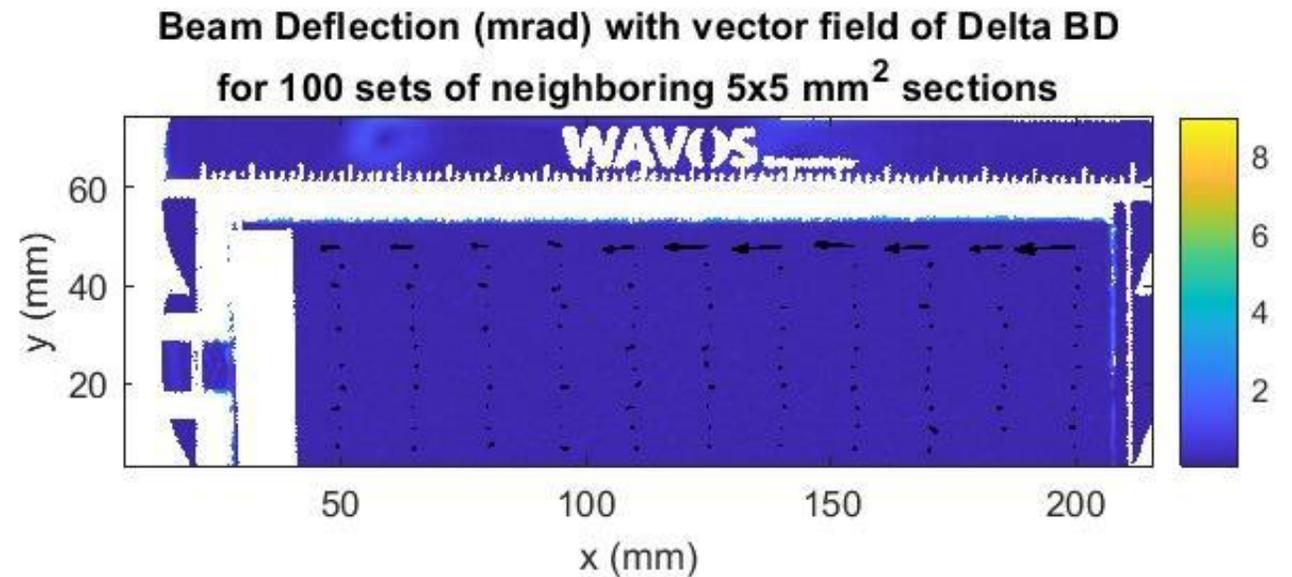
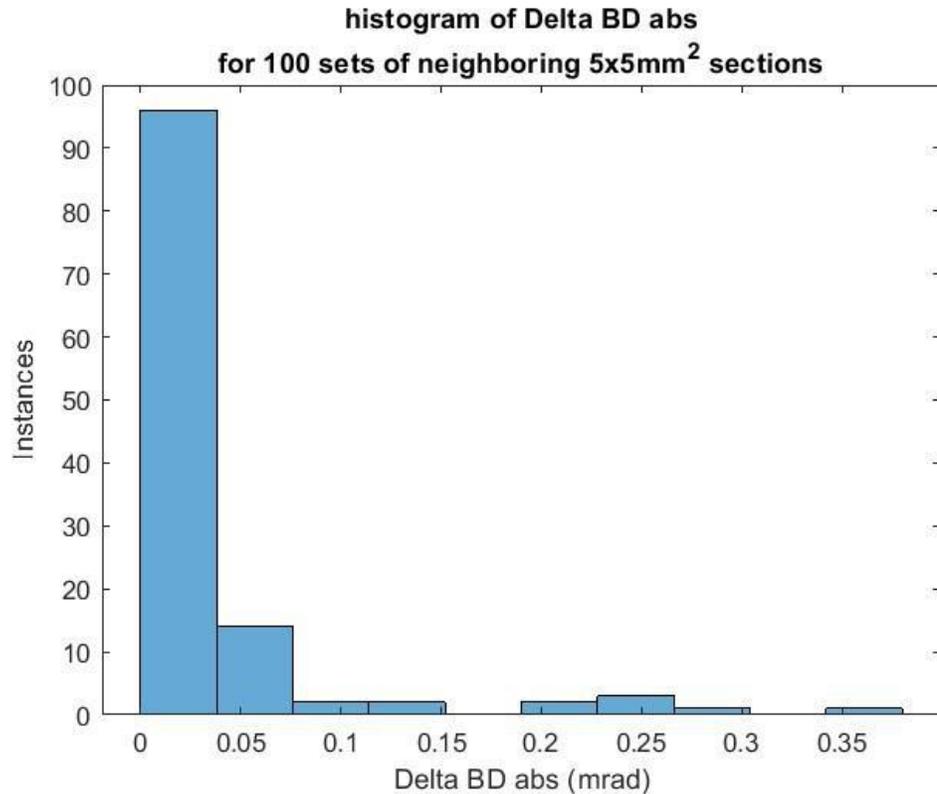
Beam Deflection Analysis – PC (powered heater)

mean Delta BD X (mrad)	mean Delta BD Y (mrad)	mean Delta BD abs (mrad)	Std Dev Delta BD abs	Max Delta BD abs (mrad)	Min Delta abs (mrad)
-0.01948	-0.00222	0.10655	0.01520	0.31055	0.01561



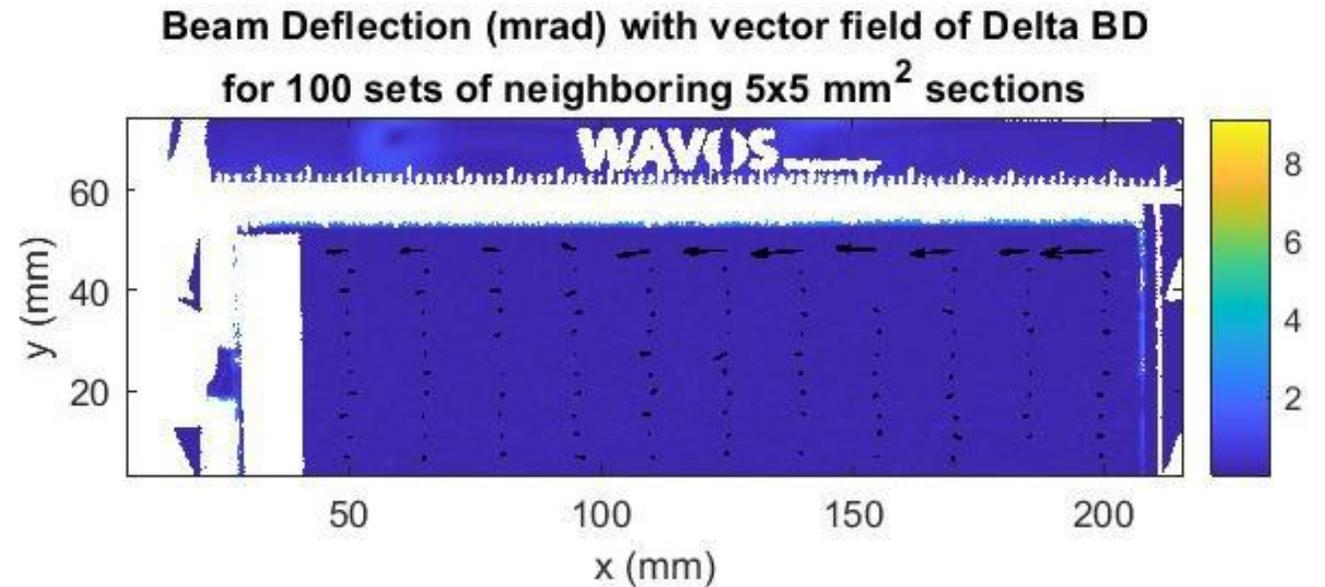
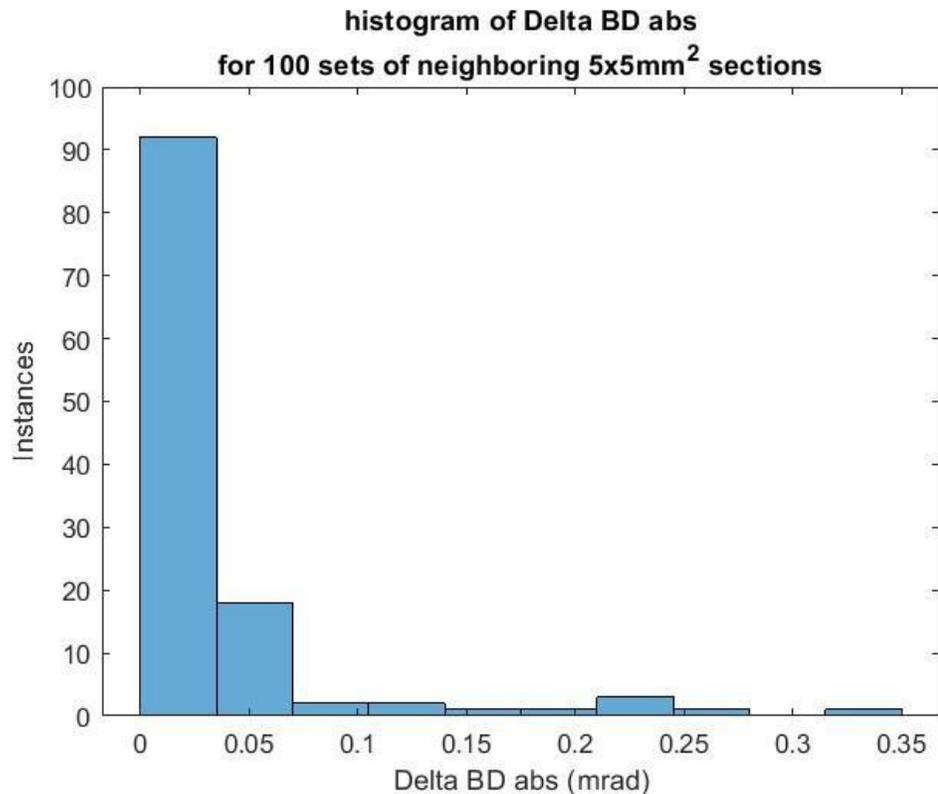
Beam Deflection Analysis – Glass (unpowered heater)

mean Delta BD X (mrad)	mean Delta BD Y (mrad)	mean Delta BD abs (mrad)	Std Dev Delta BD abs	Max Delta BD abs (mrad)	Min Delta abs (mrad)
-0.01932	-0.00244	0.04035	0.02578	0.37853	0.00231



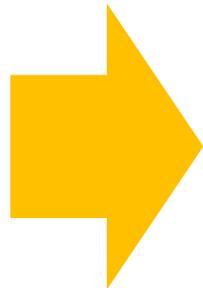
Beam Deflection Analysis – Glass (powered heater)

mean Delta BD X (mrad)	mean Delta BD Y (mrad)	mean Delta BD abs (mrad)	Std Dev Delta BD abs	Max Delta BD abs (mrad)	Min Delta abs (mrad)
-0.01782	-0.00265	0.03821	0.02329	0.34481	0.00048



Key Takeaways

- ✓ AgeNT® transparent heater foils have been validated for lidar by independent lab testing
- ✓ Volume manufacturing of heated lidomes at low cost can be realized with CHASM's supply chain design
- ✓ AgeNT-12 is the best transparent heater solution for lidar at 12V, with rapid, uniform heating and best compatibility with lidar, radar and optical camera sensors



Partner with us: evaluate our heater foils for your lidomes!



ADVANCED MATERIALS

Thank You

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