Vantablack Coatings for use in Automotive Applications

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Excerpt from Ansys September 2020 Webinar:

https://www.ansys.com/resource-library/webinar/ansys-2020-r2-materials-and-measurements

Headlamp Projector Module

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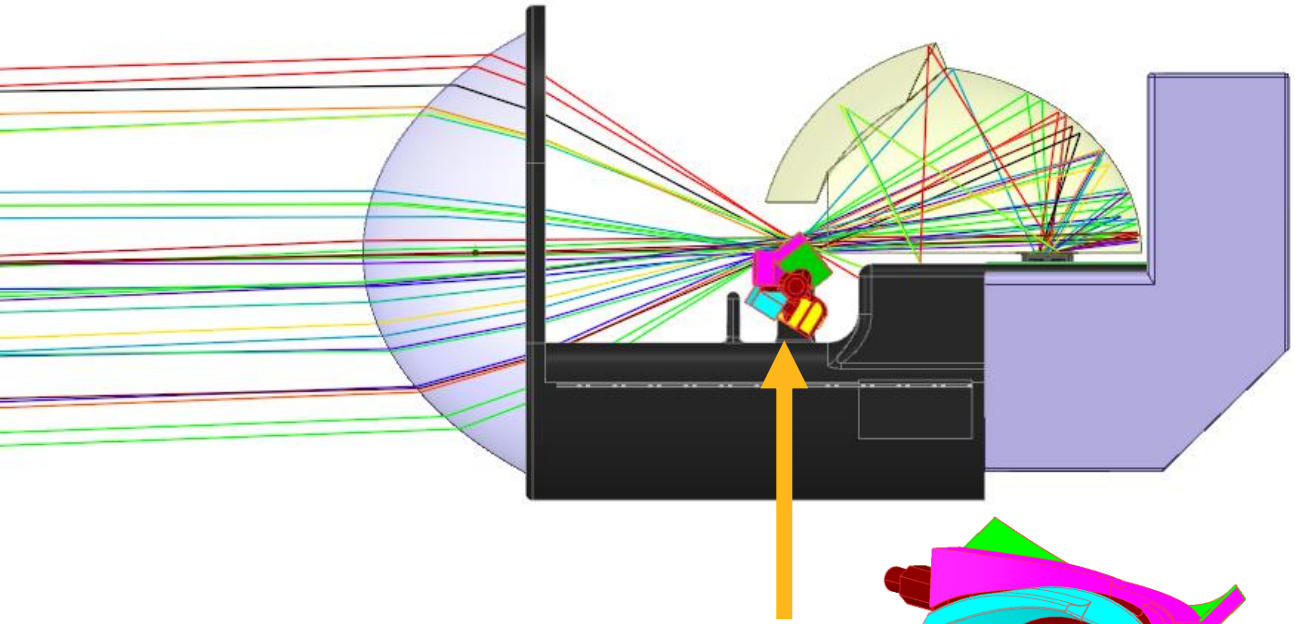
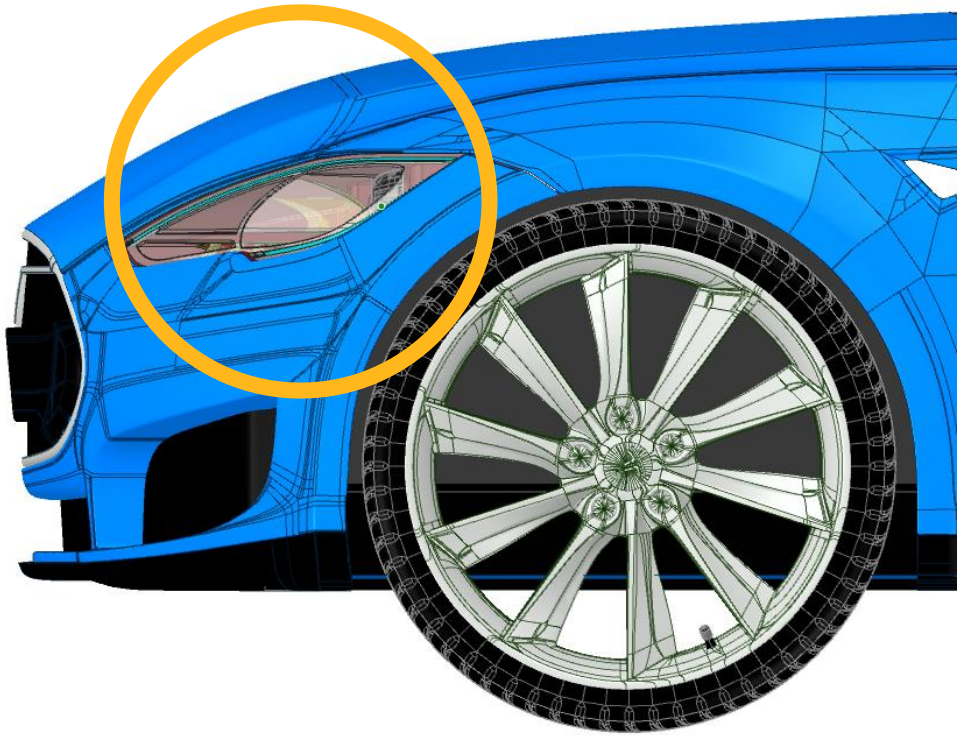
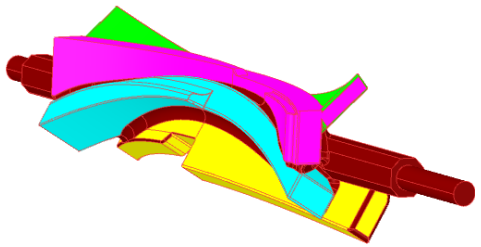
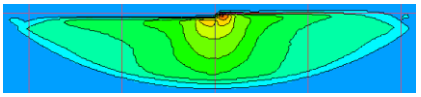
Headlamp Projector Module



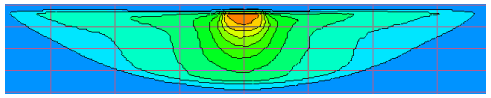


Shield

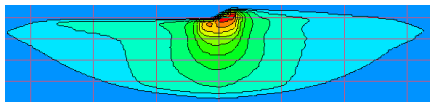




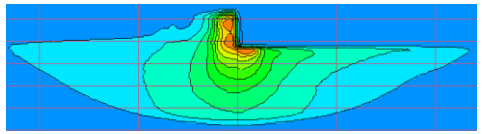
Shield : 0deg



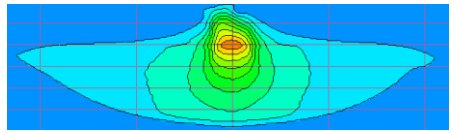
Shield : 50deg



Shield : 300deg



Shield : 150deg



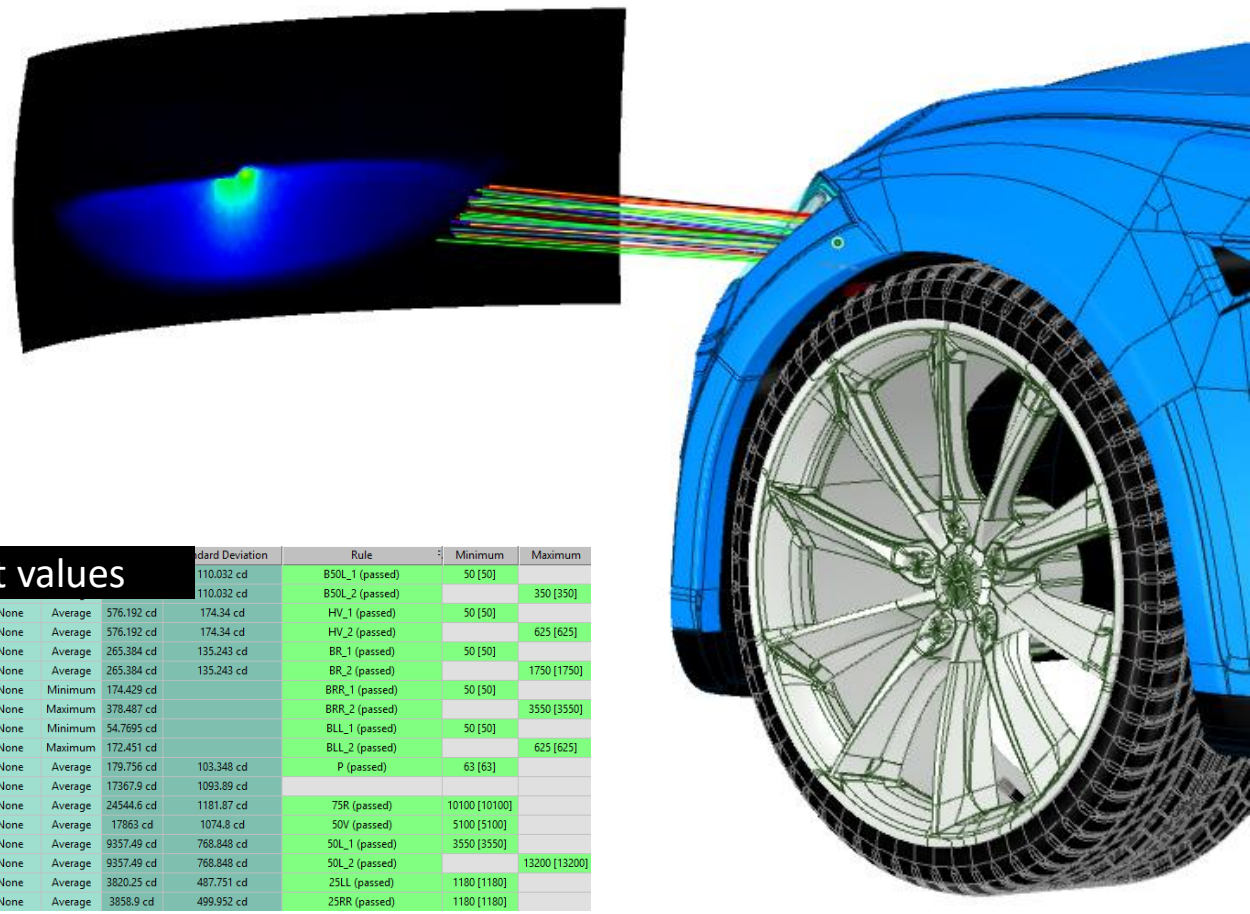
Shield : 210deg

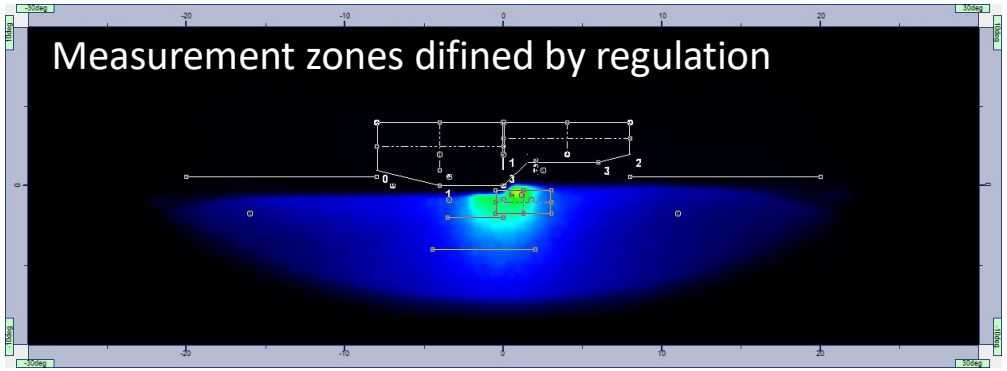
Intensity Sensor with Regulation Template

- Measurement point, line or zones defined in the template
- Each measure is tested against a regulation value

Green = pass

Red = fail



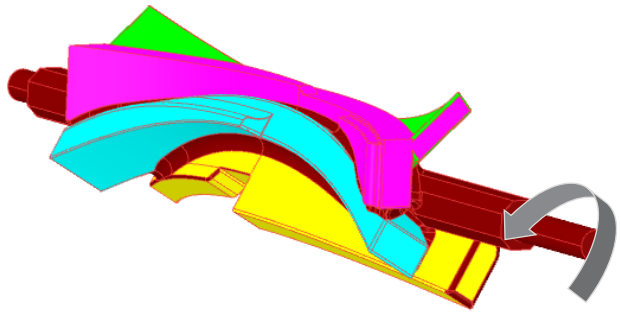


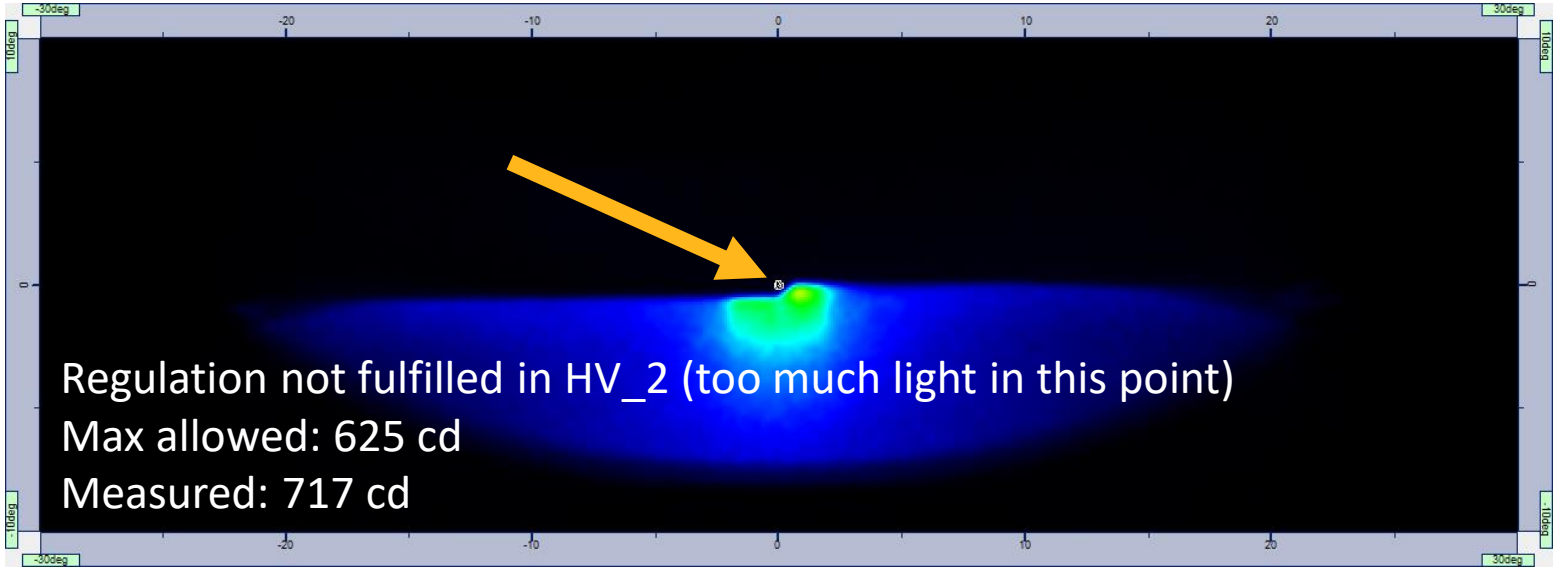
Measurement values

						dard Deviation	Rule	Minimum	Maximum
						110.032 cd	B50L_1 (passed)	50 [50]	
						110.032 cd	B50L_2 (passed)		350 [350]
HV	luminous_intensity	None	Average	576.192 cd	174.34 cd		HV_1 (passed)	50 [50]	
	luminous_intensity	None	Average	576.192 cd	174.34 cd		HV_2 (passed)		625 [625]
BR	luminous_intensity	None	Average	265.384 cd	135.243 cd		BR_1 (passed)	50 [50]	
	luminous_intensity	None	Average	265.384 cd	135.243 cd		BR_2 (passed)		1750 [1750]
BRR	luminous_intensity	None	Minimum	174.429 cd			BRR_1 (passed)	50 [50]	
	luminous_intensity	None	Maximum	378.487 cd			BRR_2 (passed)		3550 [3550]
BLL	luminous_intensity	None	Minimum	54.7695 cd			BLL_1 (passed)	50 [50]	
	luminous_intensity	None	Maximum	172.451 cd			BLL_2 (passed)		625 [625]
P	luminous_intensity	None	Average	179.756 cd	103.348 cd		P (passed)	63 [63]	
50R	luminous_intensity	None	Average	17367.9 cd	1093.89 cd				
75R	luminous_intensity	None	Average	24544.6 cd	1181.87 cd		75R (passed)	10100 [10100]	
50V	luminous_intensity	None	Average	17863 cd	1074.8 cd		50V (passed)	5100 [5100]	
50L	luminous_intensity	None	Average	9357.49 cd	768.848 cd		50L_1 (passed)	3550 [3550]	
	luminous_intensity	None	Average	9357.49 cd	768.848 cd		50L_2 (passed)		13200 [13200]
25LL	luminous_intensity	None	Average	3820.25 cd	487.751 cd		25LL (passed)	1180 [1180]	
25RR	luminous_intensity	None	Average	3858.9 cd	499.952 cd		25RR (passed)	1180 [1180]	

Regulation Fail

Tolerance rotation introduced in shield

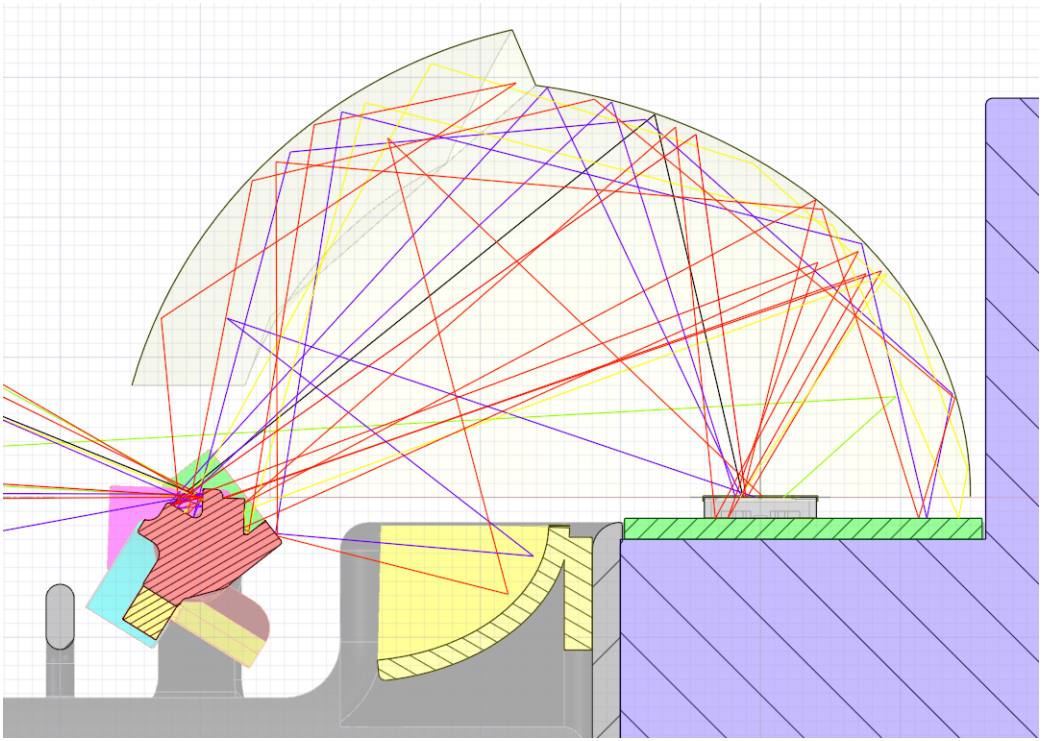


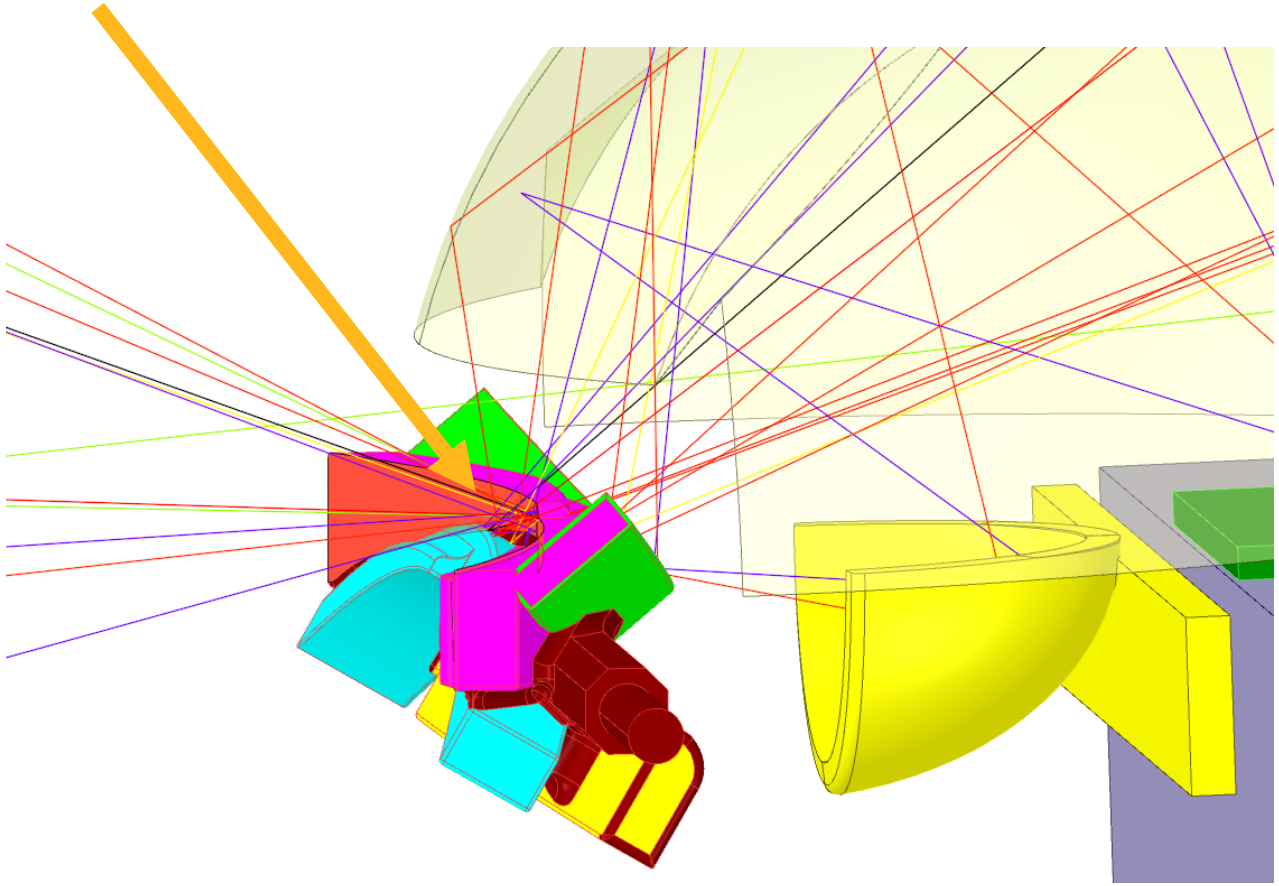


S	Area	Magnitude	Operator	Measure	Value	Standard Deviation	Rule	Minimum	Maximum
☐	B50L	luminous_intensity	None	Average	306.845 cd	150.988 cd	B50L_1 (passed)	50 [50]	
		luminous_intensity	None	Average	306.845 cd	150.988 cd	B50L_2 (passed)		350 [350]
☑	HV	luminous_intensity	None	Average	717.956 cd	156.015 cd	HV_1 (passed)	50 [50]	
		luminous_intensity	None	Average	717.956 cd	156.015 cd	HV_2 (failed)		625 [625]
☐	BR	luminous_intensity	None	Average	349.711 cd	166.426 cd	BR_1 (passed)	50 [50]	
		luminous_intensity	None	Average	349.711 cd	166.426 cd	BR_2 (passed)		1750 [1750]
☐	BRR	luminous_intensity	None	Minimum	169.888 cd		BRR_1 (passed)	50 [50]	
		luminous_intensity	None	Maximum	494.048 cd		BRR_2 (passed)		3550 [3550]
☐	BLL	luminous_intensity	None	Minimum	80.1223 cd		BLL_1 (passed)	50 [50]	
		luminous_intensity	None	Maximum	191.691 cd		BLL_2 (passed)		625 [625]
☐	P	luminous_intensity	None	Average	204.254 cd	101.357 cd	P (passed)	63 [63]	

Identification of the surface reflecting to much light

Shield surface highlighted in orange is reflecting light on the HV point (of the regulation)

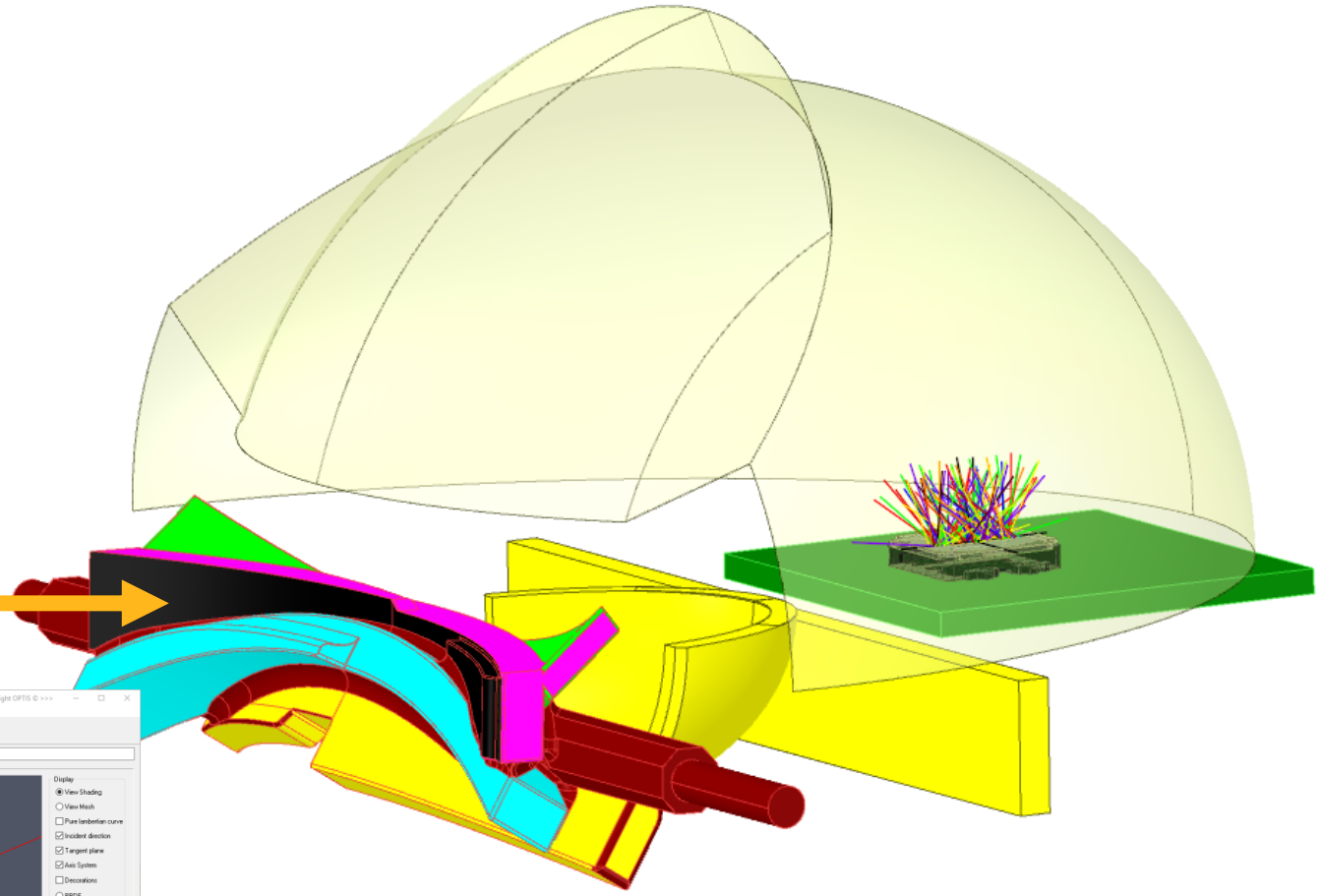




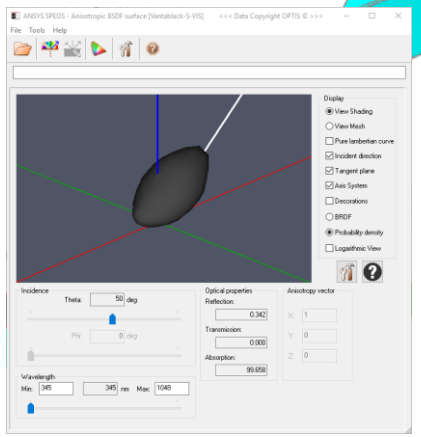
Apply Vantablack on the problematic surface

In this example, we are too late in the production process to do geometrical changes

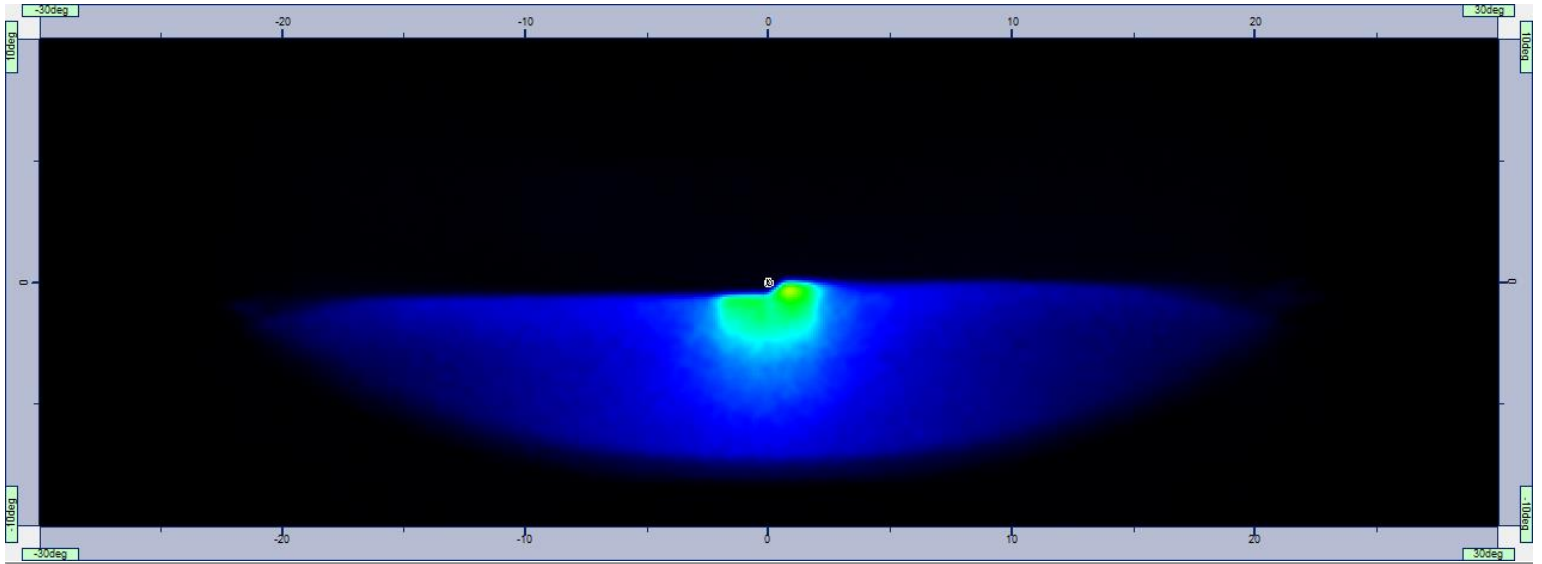
Vantablack material property applied on these faces



Vantablack material measured by Ansys: BRDF as simulation input



Simulation result with Vantablack: Regulation pass



S	Area	Magnitude	Operator	Measure	Value	Standard Deviation	Rule	Minimum	Maximum
☐	B50L	luminous_intensity	None	Average	240.342 cd	110.032 cd	B50L_1 (passed)	50 [50]	
		luminous_intensity	None	Average	240.342 cd	110.032 cd	B50L_2 (passed)		350 [350]
☑	HV	luminous_intensity	None	Average	576.192 cd	174.34 cd	HV_1 (passed)	50 [50]	
		luminous_intensity	None	Average	576.192 cd	174.34 cd	HV_2 (passed)		625 [625]
☐	BR	luminous_intensity	None	Average	265.384 cd	135.243 cd	BR_1 (passed)	50 [50]	
		luminous_intensity	None	Average	265.384 cd	135.243 cd	BR_2 (passed)		1750 [1750]
☐	BRR	luminous_intensity	None	Minimum	174.429 cd		BRR_1 (passed)	50 [50]	
		luminous_intensity	None	Maximum	378.487 cd		BRR_2 (passed)		3550 [3550]
☐	BLL	luminous_intensity	None	Minimum	54.7695 cd		BLL_1 (passed)	50 [50]	
		luminous_intensity	None	Maximum	172.451 cd		BLL_2 (passed)		625 [625]
☐	P	luminous_intensity	None	Average	179.756 cd	103.348 cd	P (passed)	63 [63]	
☐	50R	luminous_intensity	None	Average	17367.9 cd	1093.89 cd			
☐	75R	luminous_intensity	None	Average	24544.6 cd	1181.87 cd	75R (passed)	10100 [10100]	
☐	50V	luminous_intensity	None	Average	17863 cd	1074.8 cd	50V (passed)	5100 [5100]	
☐	50L	luminous_intensity	None	Average	9357.49 cd	768.848 cd	50L_1 (passed)	3550 [3550]	

Head-Up Display Housing

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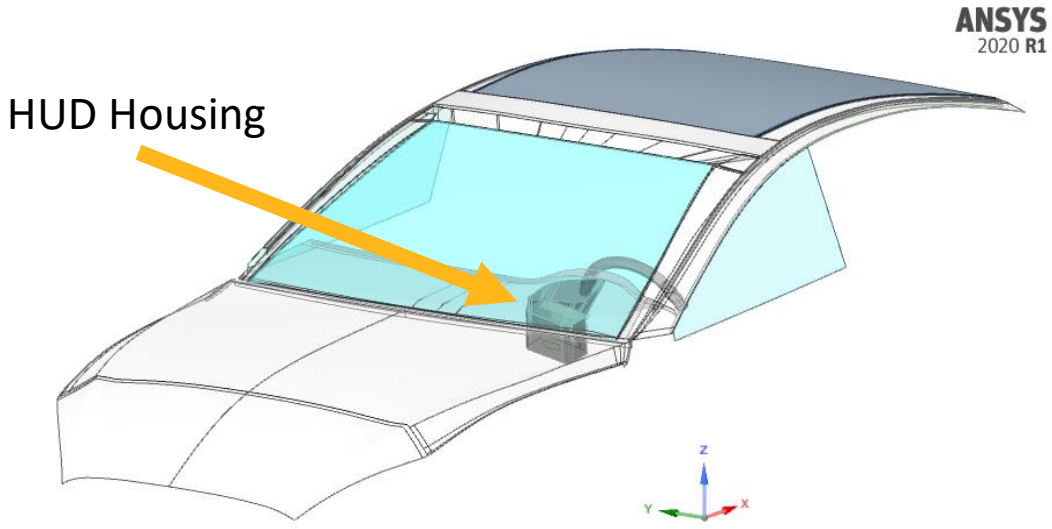
4 Materials Tested for HUD Housing

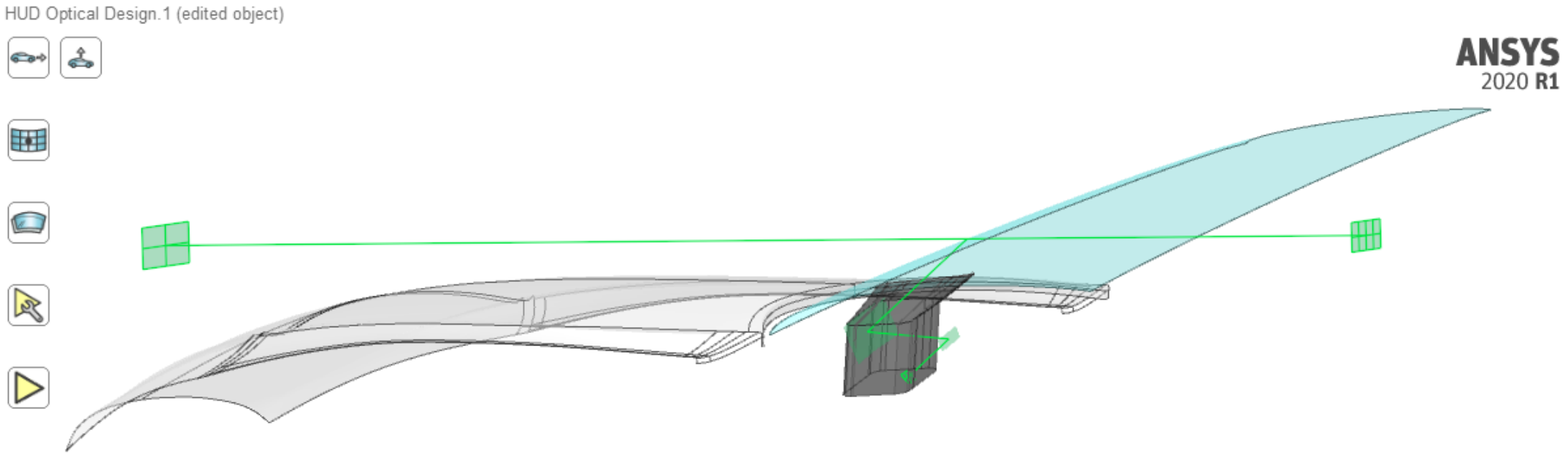
- Black Matt 1
  - (~17% Reflection @ Incidence 70° & 600nm)
- Black Soft
  - (~4.2% Reflection @ Incidence 70° & 600nm)
- Vantablack VBx2
  - (~1.2% Reflection @ Incidence 70° & 600nm)
- Vantablack S-VIS
  - (~0.6% Reflection @ Incidence 70° & 600nm)



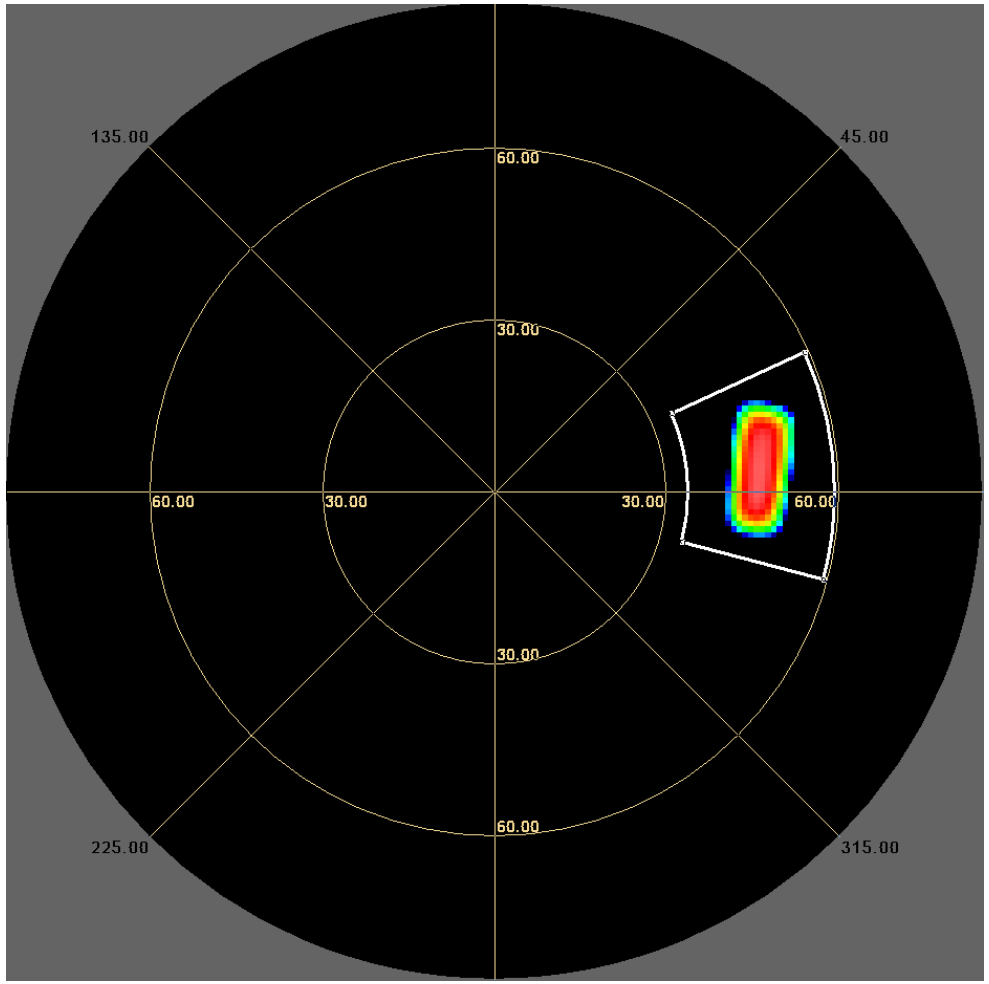
Head-Up Display Optical Design

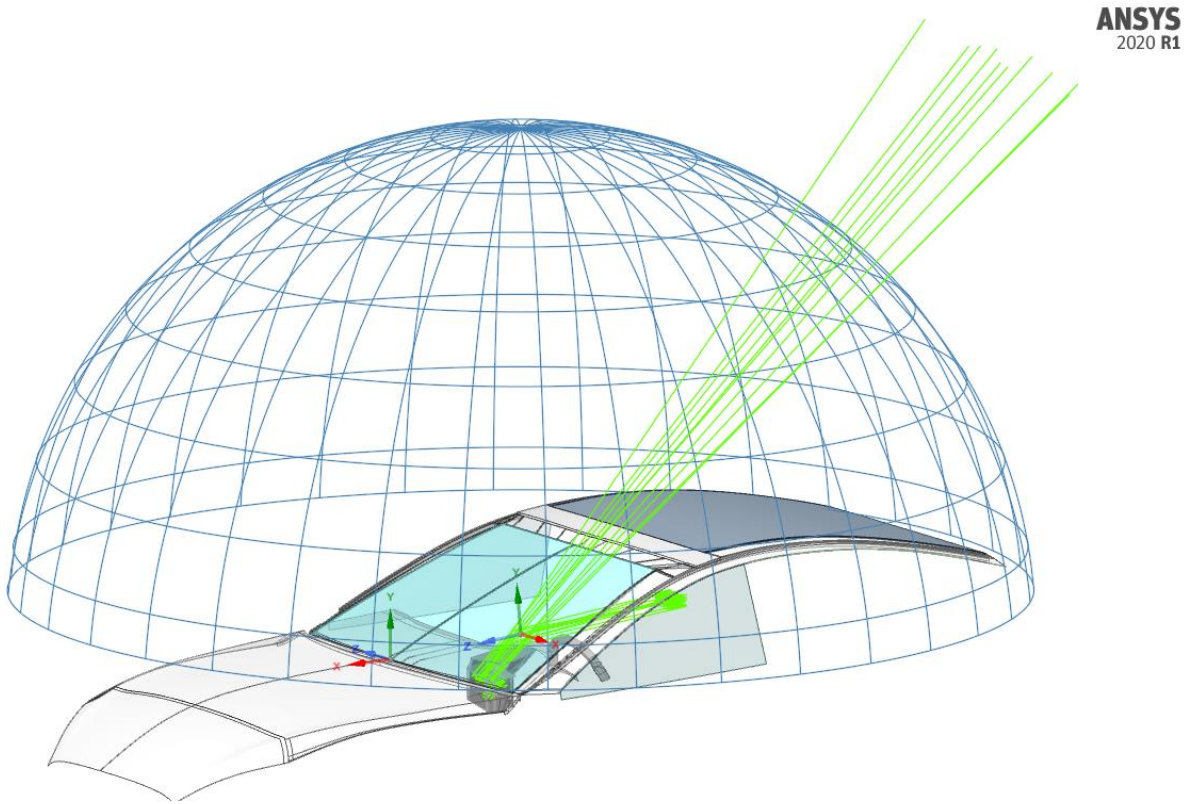
HUD Optical Design

HUD Optical Design helps generates mirrors and combiners to achieve the best virtual image quality



Critical Sun Position Identified with Light Expert





Black Matt 1 on HUD Housing

Black Soft on HUD Housing

Vantablack VBx2 on HUD Housing

Vantablack S-VIS on HUD Housing

Black Matt 1 on HUD Housing

Black Soft on HUD Housing

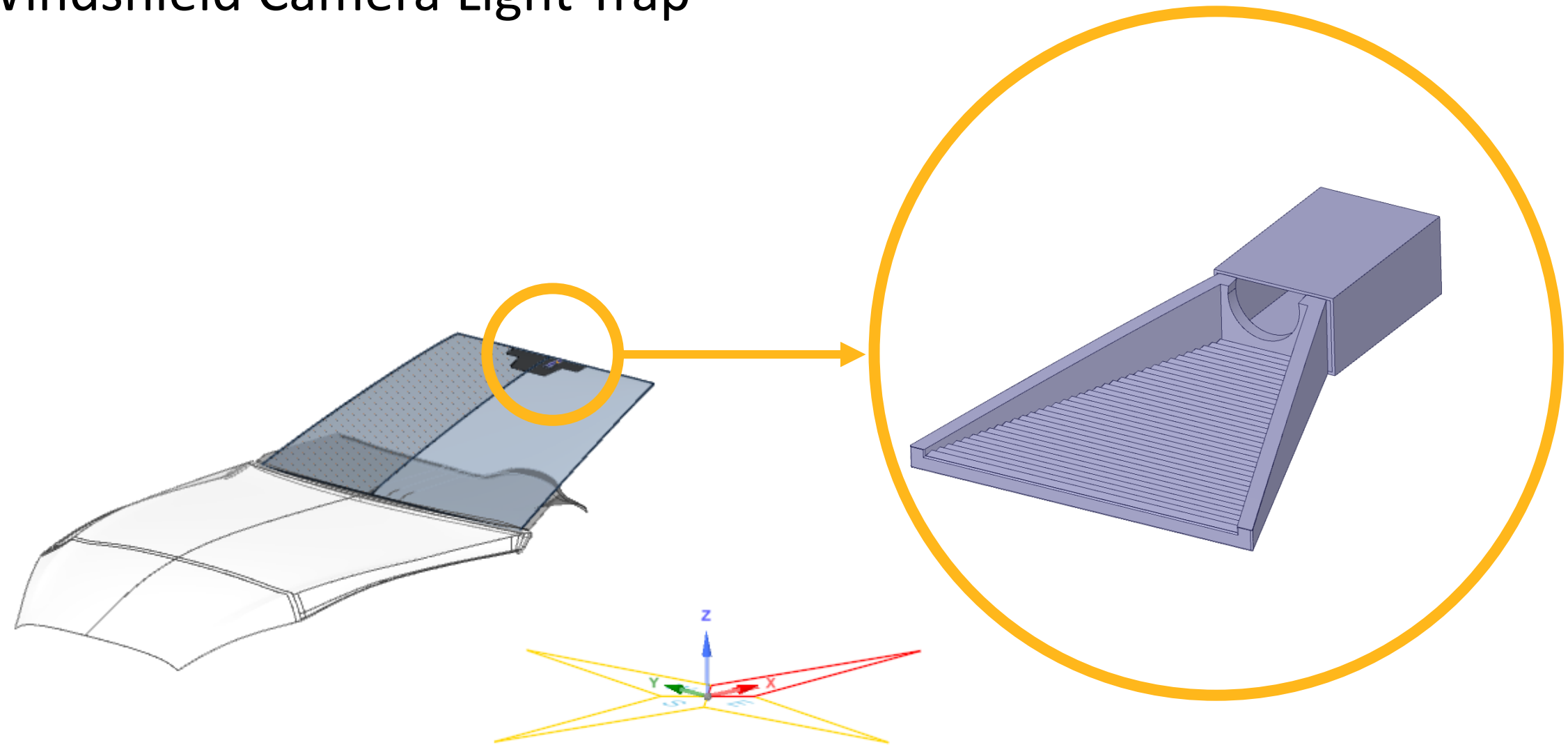
Vantablack VBx2 on HUD Housing

Vantablack S-VIS on HUD Housing

Windshield Camera Light Trap

Ansys

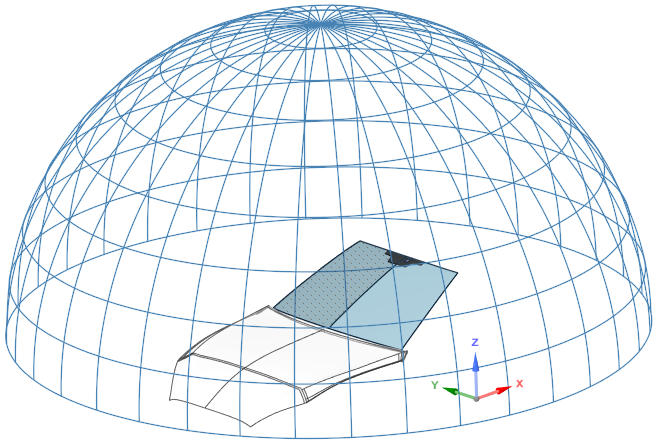
Windshield Camera Light Trap

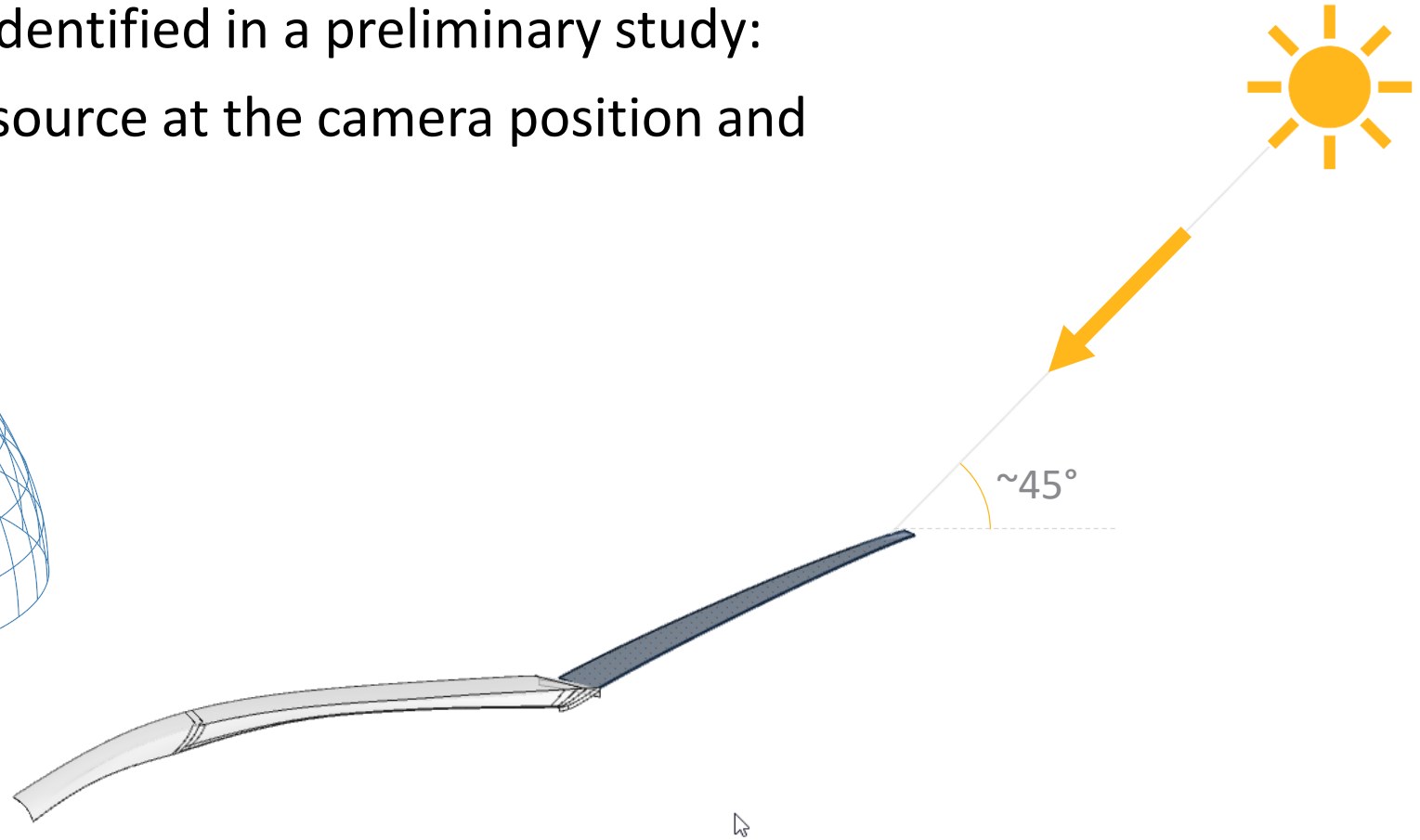


Sun in a Critical Position

Critical position of the sun identified in a preliminary study:

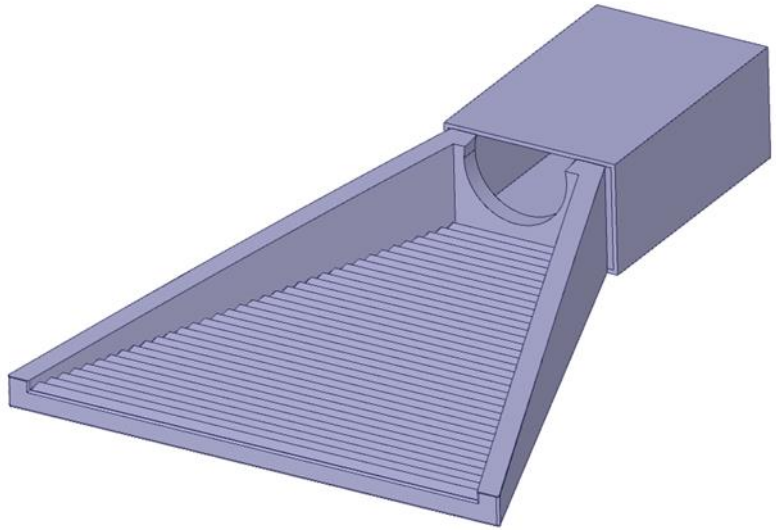
- (Reverse simulation with source at the camera position and intensity sensor on sky)



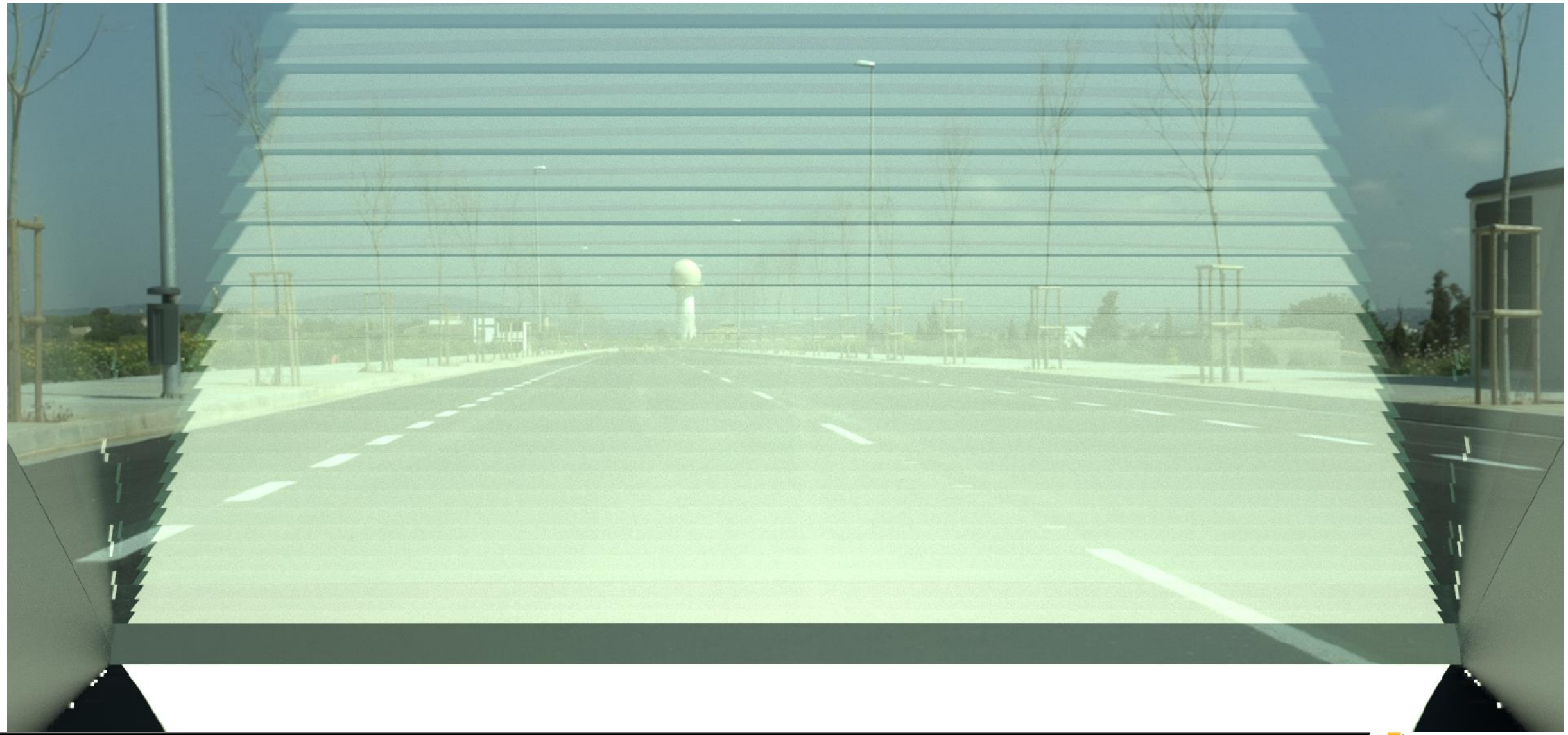


4 Materials Tested for the Light Trap

- Black Matt 1
  - (~17% Reflection @ Incidence 70° & 600nm)
- Black Matt 2
  - (~ 6.3% Reflection @ Incidence 70° & 600nm)
- Vantablack VBx2
  - (~1.2% Reflection @ Incidence 70° & 600nm)
- Vantablack S-VIS
  - (~0.6% Reflection @ Incidence 70° & 600nm)



Black Matt 1 on Windshield Camera Light Trap

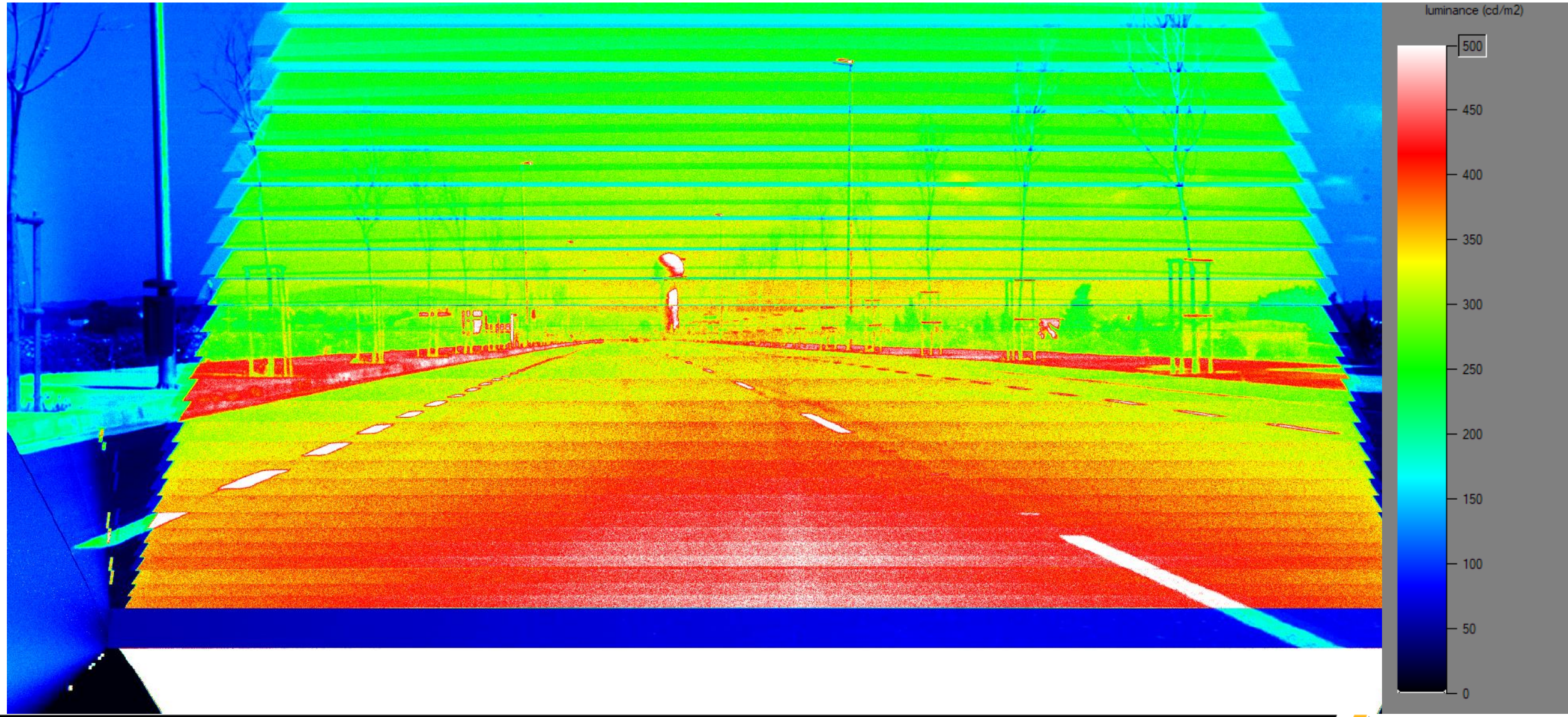


Black Matt 2 on Windshield Camera Light Trap

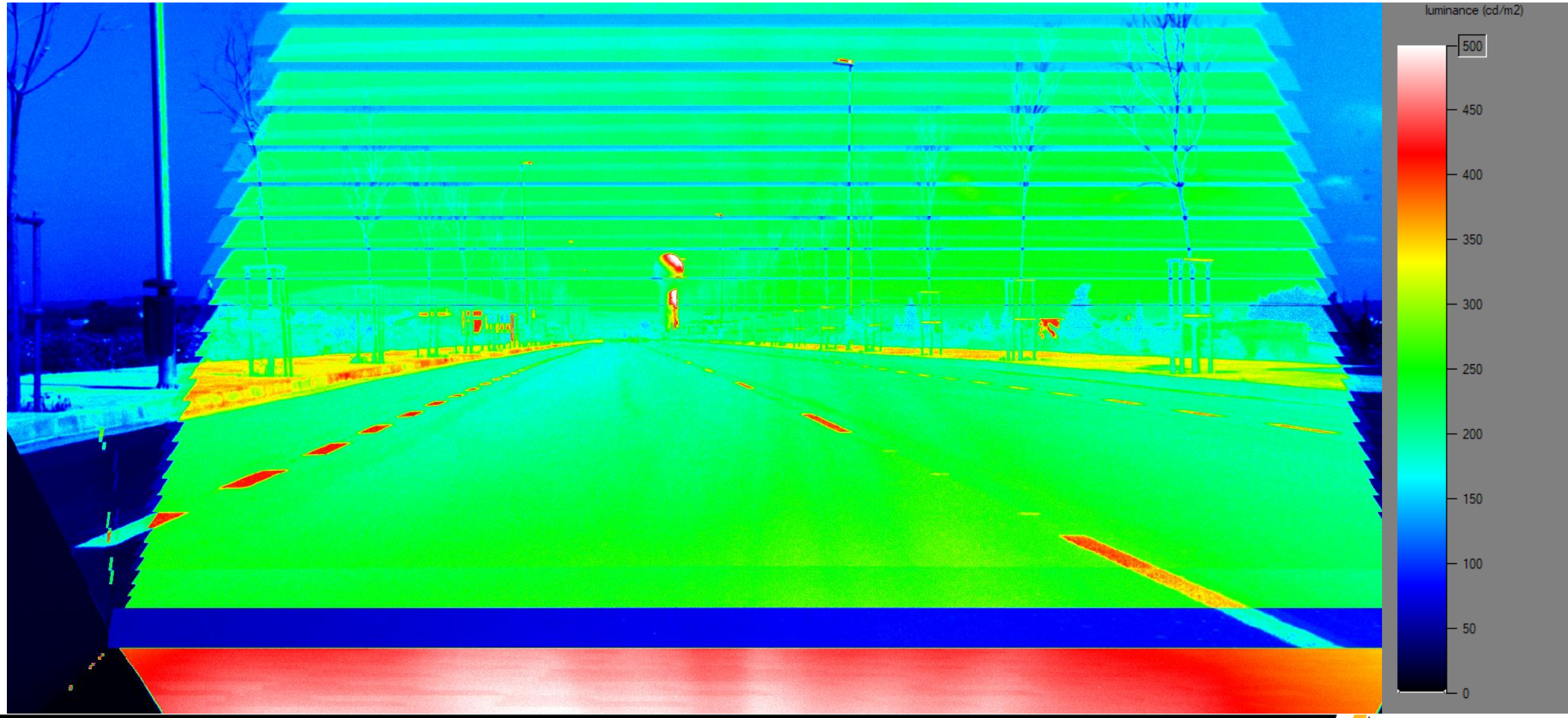
Vantablack VBx2 on Windshield Camera Light Trap

Vantablack S-VIS on Windshield Camera Light Trap

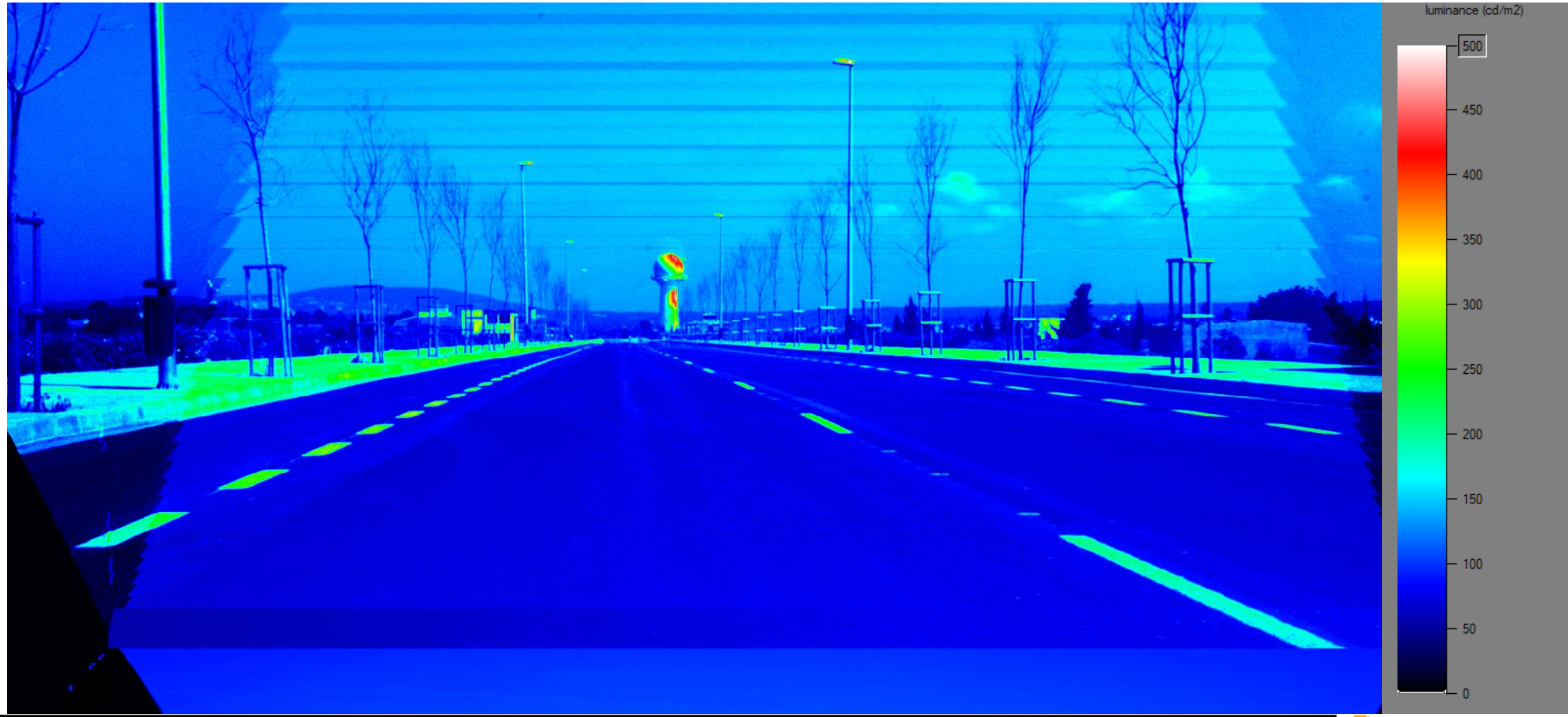
Black Matt 1 on Windshield Camera Light Trap



Black Matt 2 on Windshield Camera Light Trap



Vantablack VBx2 on Windshield Camera Light Trap



Vantablack S-VIS on Windshield Camera Light Trap

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