

DARKER SKY

Norddeich: Light measurements & lighting challenges in ports

Interreg
North Sea



Co-funded by
the European Union

DARKER SKY



NiedersachsenPorts (NPorts)

Foundation: 01.01.2005

Locations:

- 5 large seaports
- 7 island supply ports
- 3 regional ports
- 1 central Oldenburg



Niedersachsen

Ports 2



Norden Branch

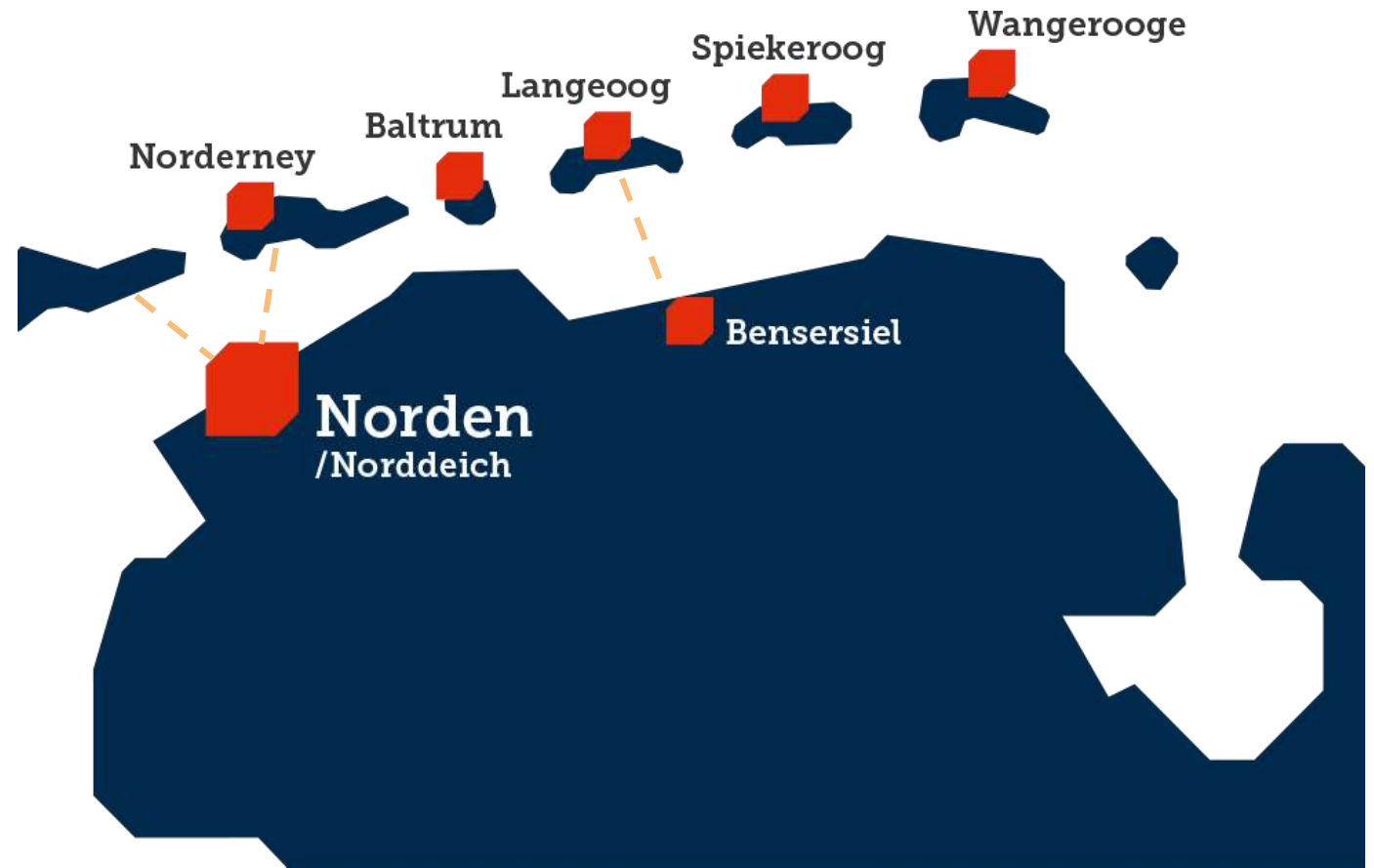
Island supply ports:

- Norddeich (ferry lines to Norderney & Juist)
- Bengersiel (ferry line to Langeoog)

Island ports:

- Norderney, Baltrum, Langeoog, Spiekeroog & Wangerooge

The Norden branch manages these seven island and coastal ports.



Norddeich



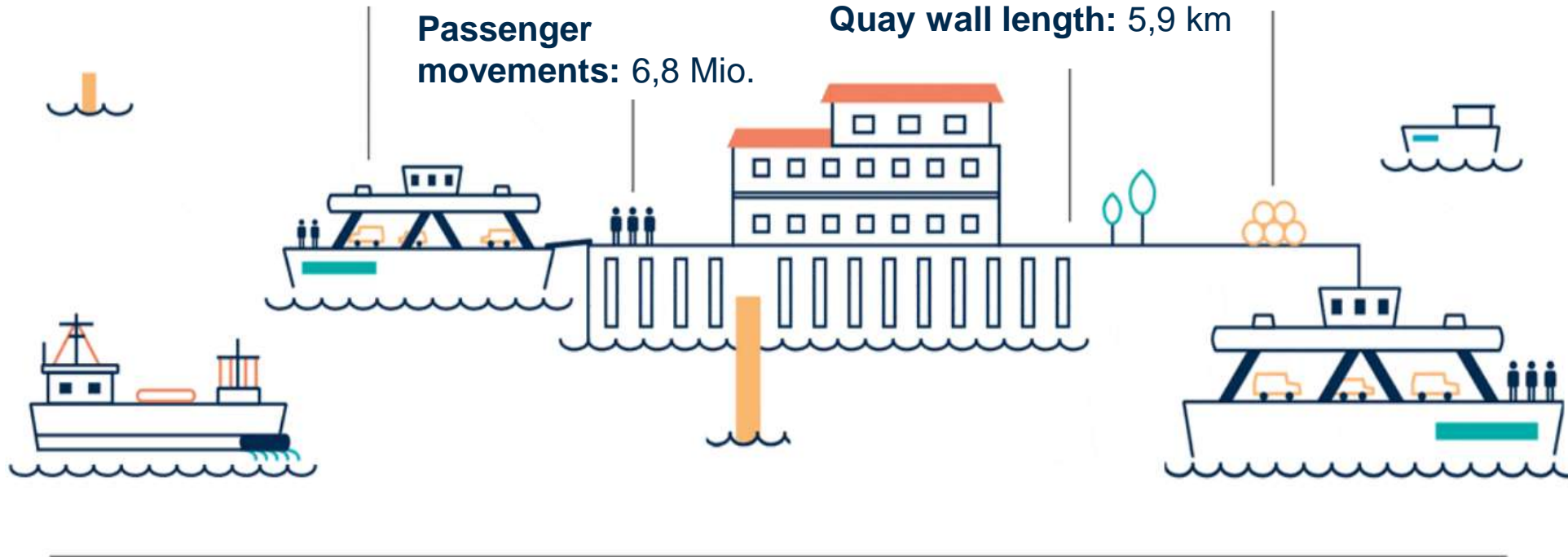
The Norden branch in figures

Ship calls: 28.962

Cargo handling: 1,2 Mio. t

**Passenger
movements: 6,8 Mio.**

Quay wall length: 5,9 km



Port area (land + water): 256 ha

Expansion area: 4 ha

Status 2023

Niedersachsen

Ports 5



Initial situation of the lighting in Norddeich

Case light



Panel radiators



Many different lamp types:

- Low-pressure sodium vapor lamps
- High-pressure sodium vapor lamps
- Older LED luminaires

→ No uniform lighting



NPorts corporate guideline for environmentally friendly lighting

1 Light control



- Shielded luminaires
- Low mounting height
- Avoidance of illumination of water surfaces

2 Lighting system



- Use a software-based lighting management system
- Demand-based lighting control

3 Light color



- Areas close to water without video surveillance 1800-2200 K
- Areas far from water/areas with video surveillance 3000 K

4 Visual inspections



- Regular inspections to monitor the lighting requirements



Challenge: Combining nature conservation & occupational safety

Good lighting must combine legal and environmental requirements, but..

- the legal situation is complex and sometimes unclear
- standard-compliant lighting can mean that it gets brighter (30 Lux LED \neq 30 Lux NAV)
- the change in standards holds great potential for saving energy and light emissions

Thanks to the adaptive control system, we are ready to act to reduce light pollution!





Conversion concept for Norddeich east port

8 measures:

- 1 LED technology
- 2 Light color
- 3 Light control
- 4 Shielding
- 5 Lighting system
- 6 Light intensity
- 7 Motion sensors
- 8 Making light colors tangible

on the "Walk of Light"

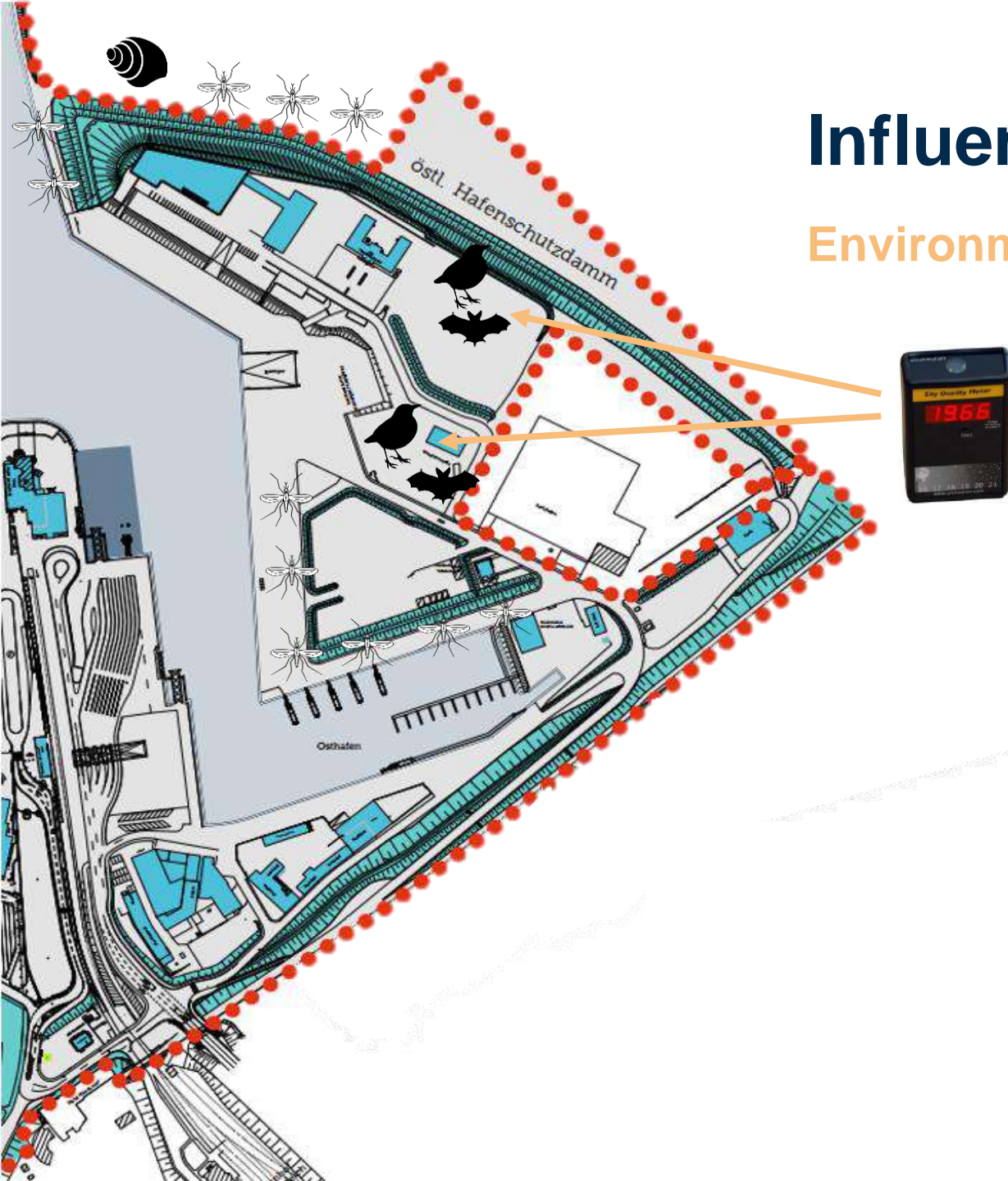


scan for
press
release



Influence of lighting in the Osthafen

Environmental monitoring







Light measurements:

- Measurements of sky brightness with SQMs (Sky Quality Meters)
- Measurements of photometric parameters (illuminance, luminance and color temperature)



Biodiversity monitoring:

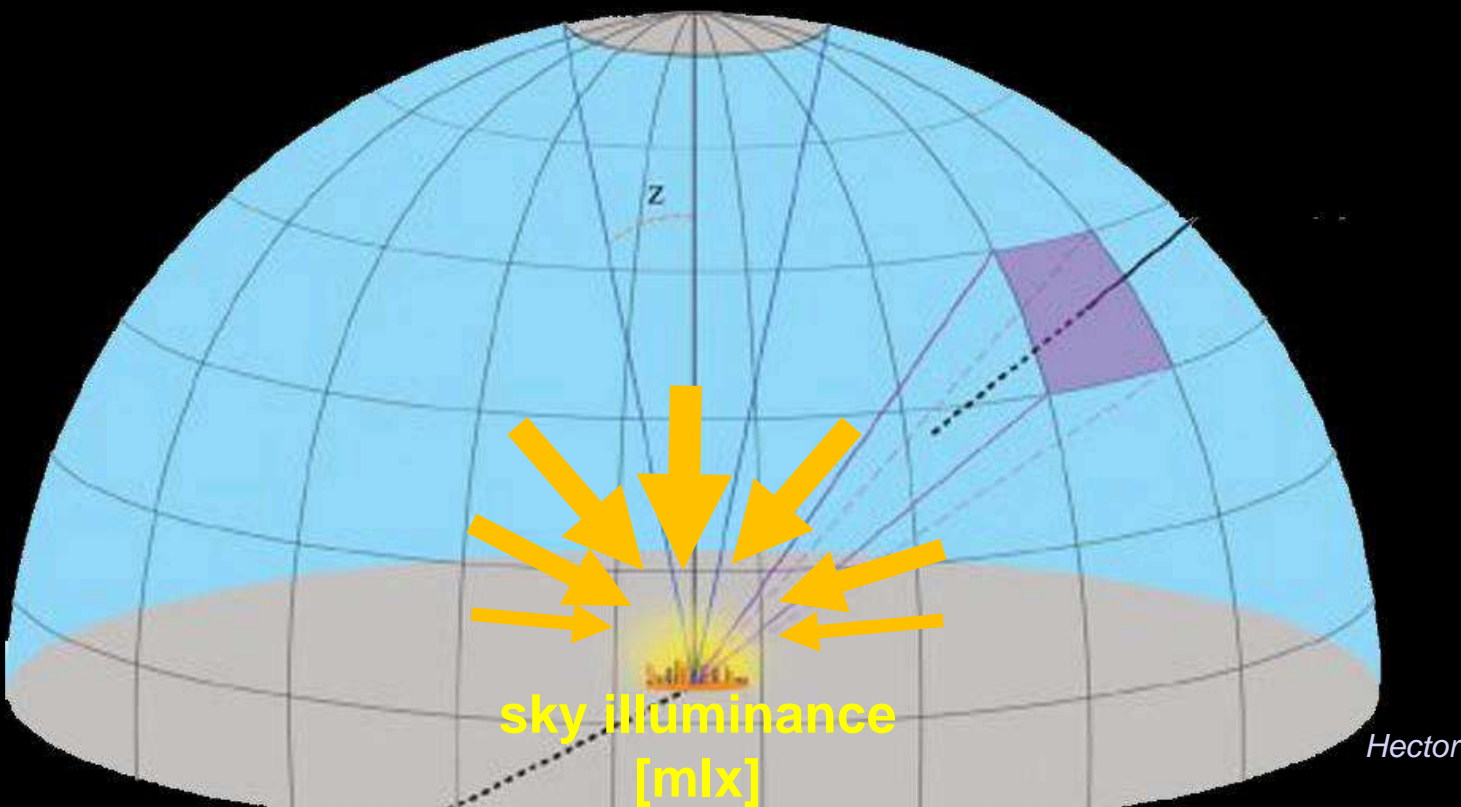
Model	M	A	M	J	J	A	S	O
	12 nights							
	All period							
			3x2days					
	1 day of sampling							



Measurements of light

sky: astronomical units

sky brightness/sky luminance
[mag/arcsec², mcd/m²]

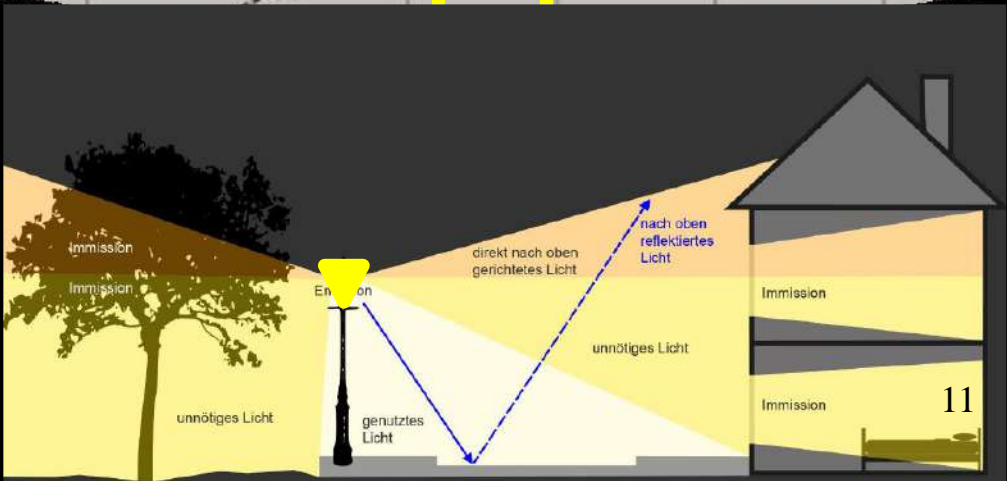


ground: photometric units

problems:

- sensitivity
- spectral response

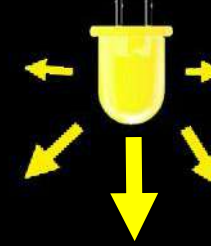
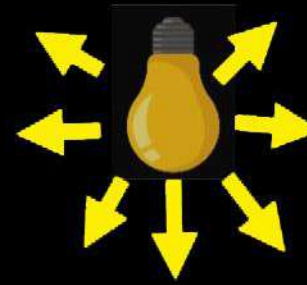
light emission
[cd, cd/m²]



light immission
[lx]

Light emission

light source “lamp”: luminous flux [lm]



Luminous surface (billboard, sign):

luminance cd/m^2 : luminance meter, digicam

sky: $0.000\ 2\ \text{cd/m}^2$

night vision: $0.01\ \text{cd/m}^2$

roads: $1\ \text{cd/m}^2$

glare (SSK): $730\ \text{cd/m}^2$

sun: $1\ 600\ 000\ 000\ \text{cd/m}^2$

adaption / glare



$120\ \text{cd/m}^2$

illuminance $20\ \text{lx}$

luminance $< 1\ \text{cd/m}^2$



Light immission illuminance [lux]

Need of illumination?

road lighting: EU industrial norms (orientation<>law)

different categories (lighting class):

- main roads: M1 – M6 / C0 – C5 : **>7.5 lx**
- pedestrian, residential: P1 – P7 : **>2 lx**

characteristics: minimum values:

- mean luminance / illuminance (std. reflection)
- uniformity
- energy consumption

maximum:

- next lighting class, **<15 lx needed** (Khanh)
- nature?

Intrusion: light immission

max. illuminance on window 1 lx



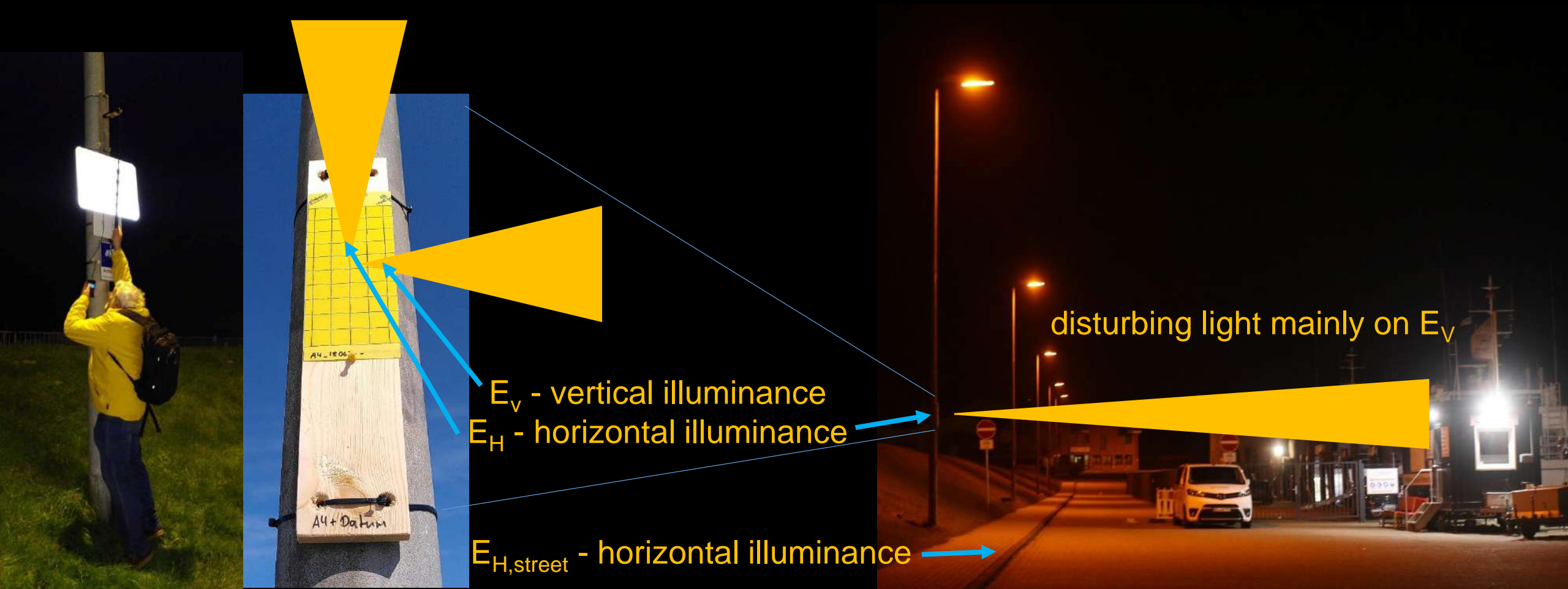
Light measurements Norddeich 23.10.2024

measurements of insect catches – at sticky traps

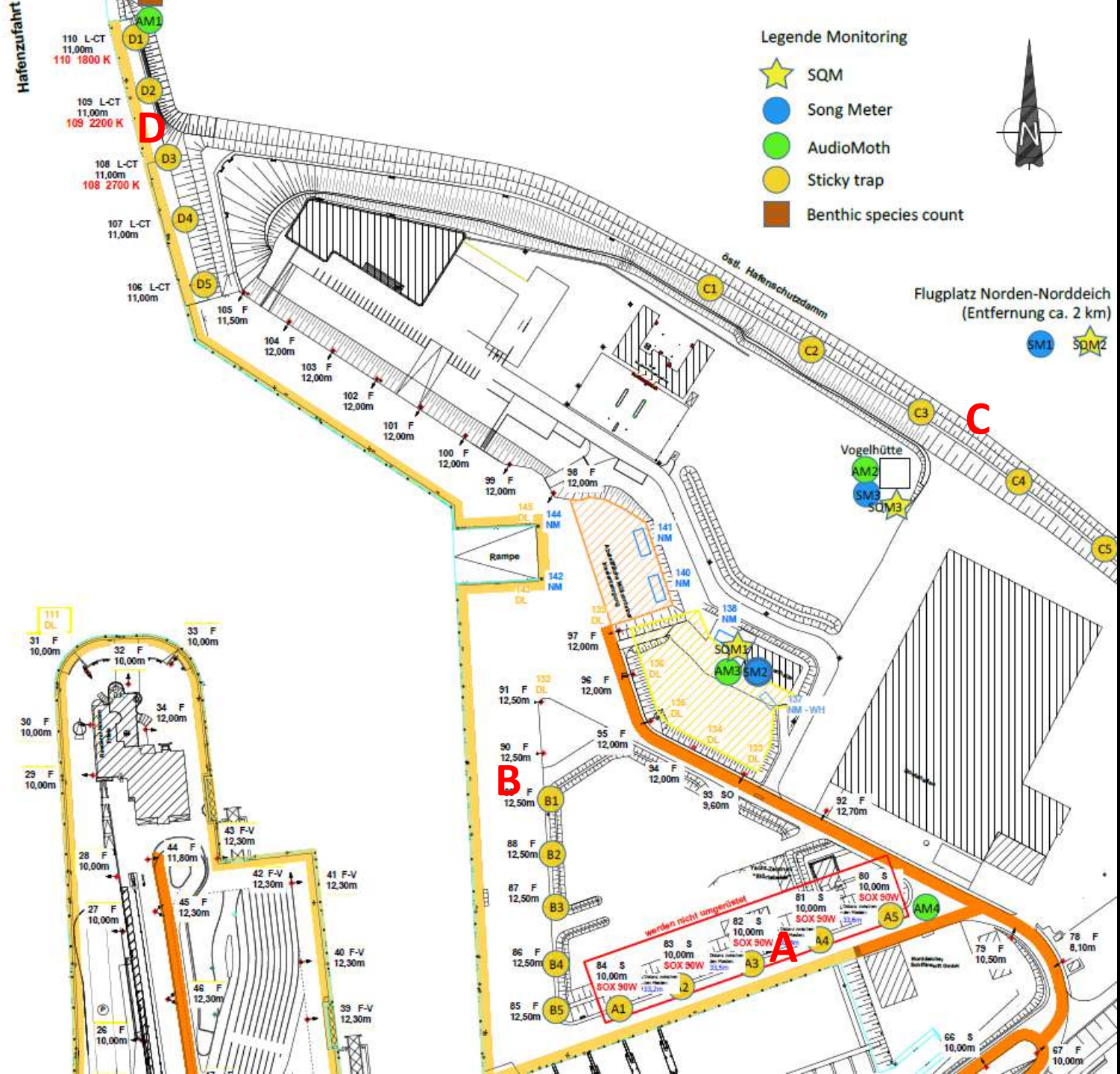
illuminance meter Mavomaster with

separate measurement head Mavoprobe LUX5032B

mounted on a selfie stick



plan



Interreg
North Sea

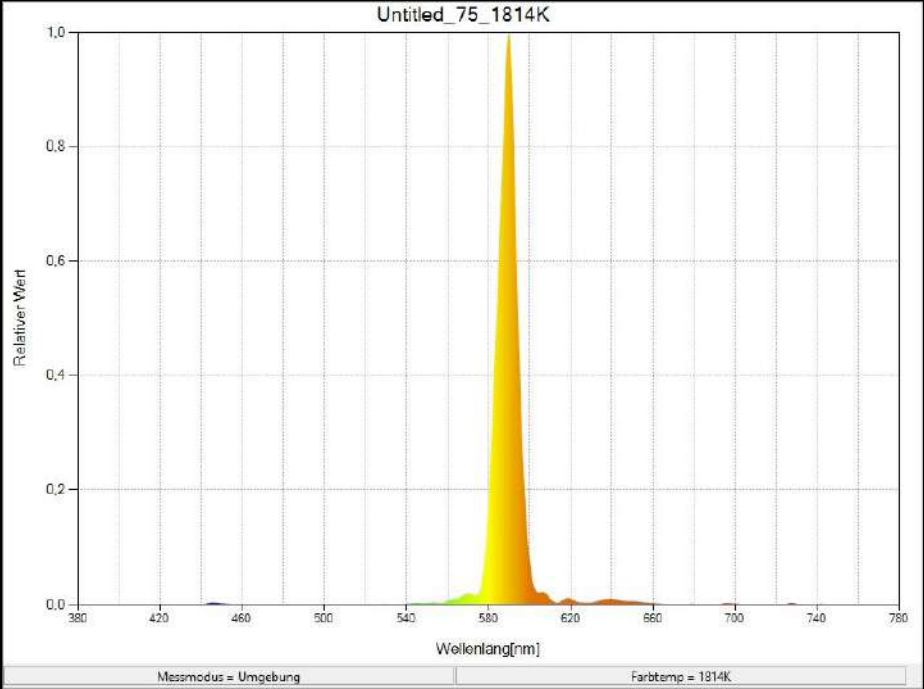


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Light measurements Norddeich 23.10.2024

A1 – A5: sodium low pressure

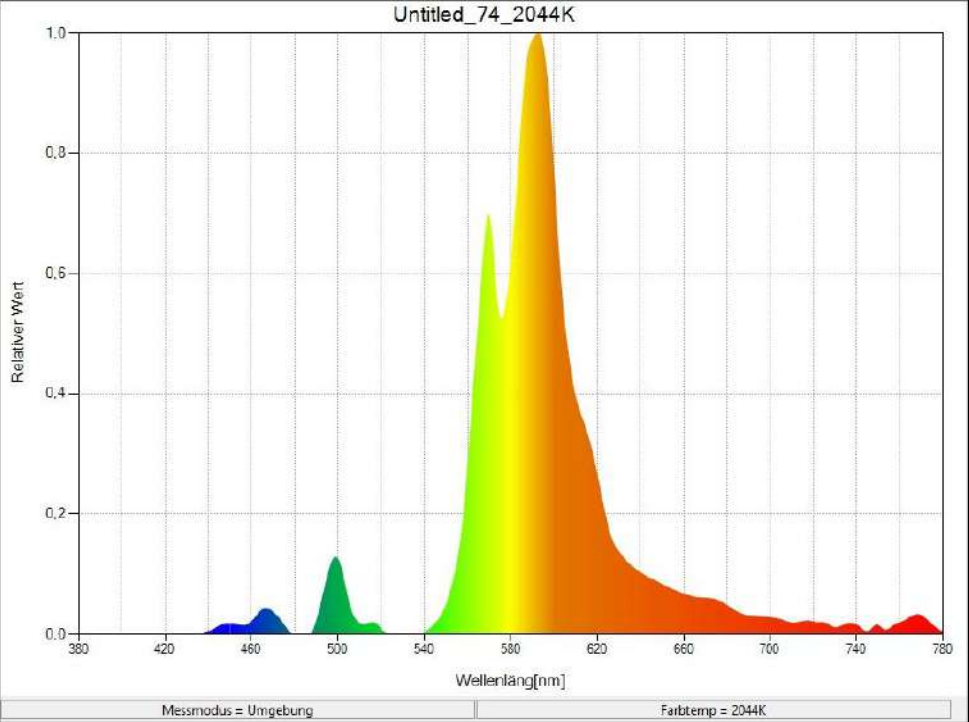


	A1	A2	A3	A4	A5	mean
E_H	47	43	54	43	45	46.4
E_V	13	5	7.6	6	7	7.7
$E_{H, street}$	27.5	24	27.5	24	25	25.6
	3 flood lights		flood boat	flood light weak		



Light measurements Norddeich 23.10.2024

B1 – B5: sodium high pressure

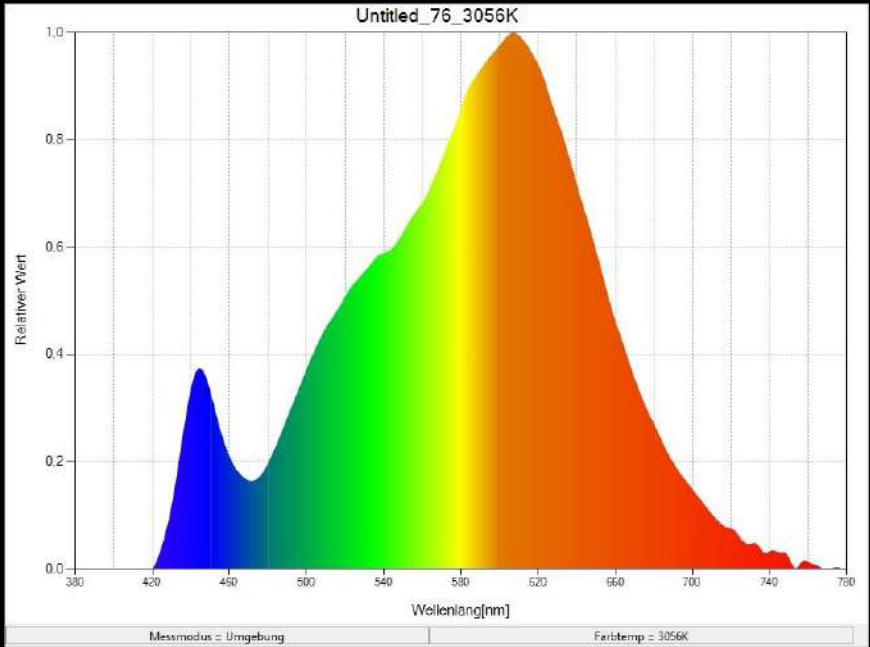


	B1	B2	B3	B4	B5	Mean
E_H	88	130	90	150	85	108.6
E_V	8	16	7	9	9	9.8
$E_{H, street}$	57	75	54	88	50	64.8
			flood lights ship			



Light measurements Norddeich 23.10.2024

D1 – D5: 3000 K LED

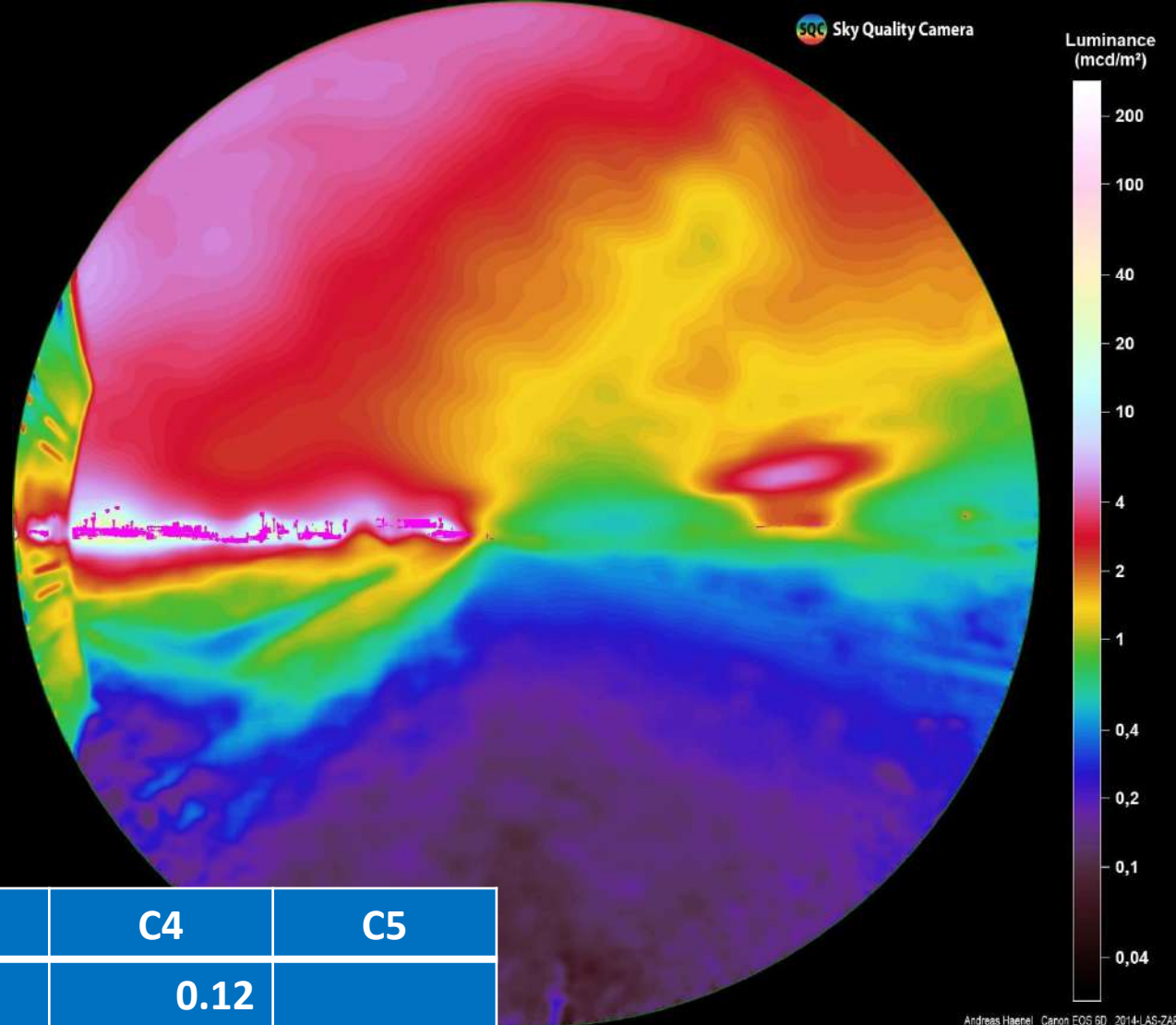


	D1	D2	D3	D4	D5	Mean
E_H	42	38	39	45	40	40.8
E_V	4	5.2	5	5	7	5.2
$E_{H, street}$	27.6	25	27	30	28	27.5
					lights ferry	



Light measurements Norddeich 23.10.2024

C1 – C5: dark



	C1	C2	C3	C4	C5
E_H	0.45			0.12	
E_V	1.1			0.15	
$E_{H, \text{street}}$	0.12			0.06	
	lighting firm				



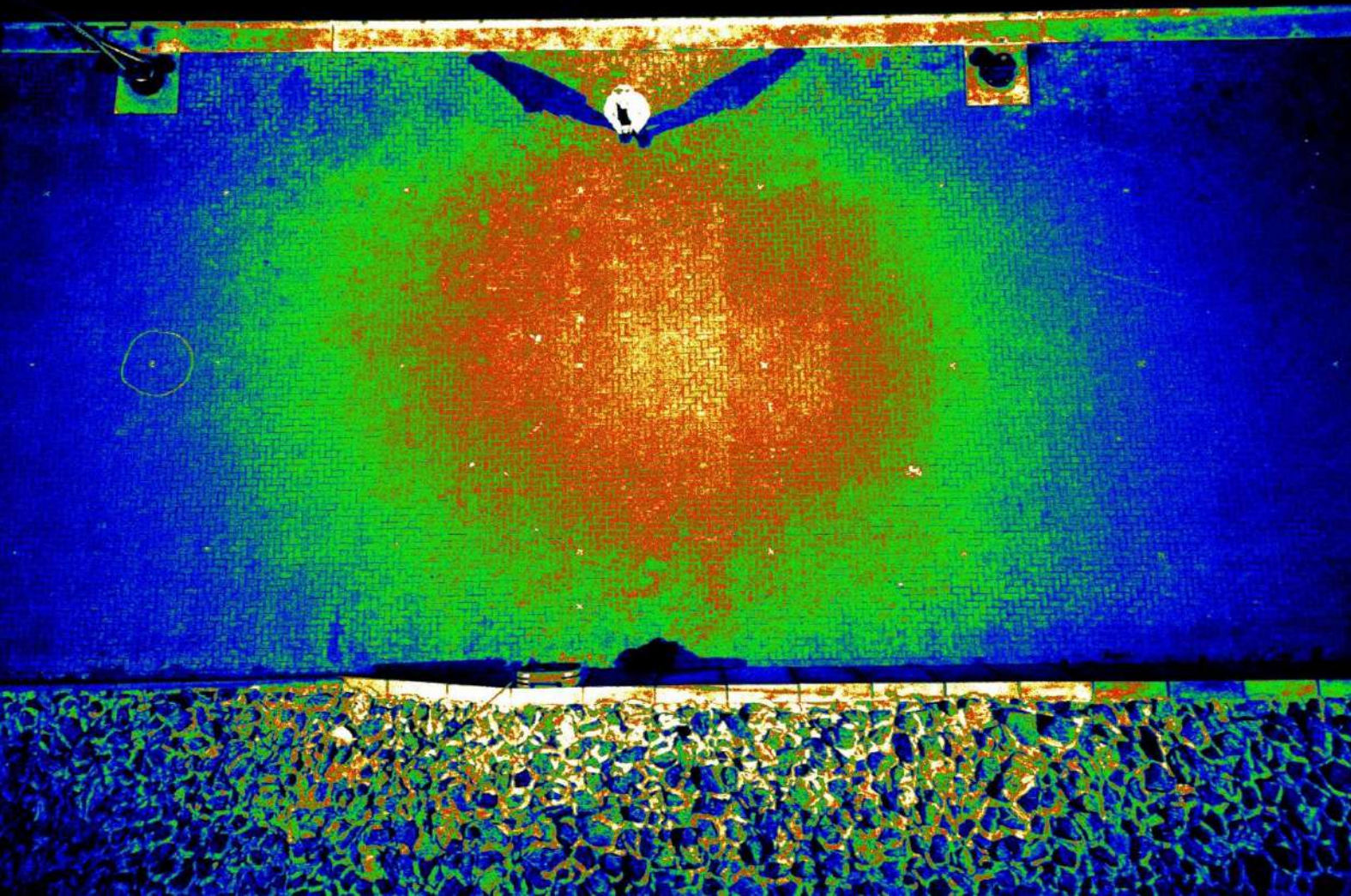
Light measurements Norddeich 23.10.2024

Illuminance Benthos monitoring

6.5 -> 4.7 lx towards open sea



Light measurements Norddeich 23.10.2024
first test drone/UAV
uncorrected (distortion, vignetting) G image



Light measurements Norddeich 23.10.2024

first test drone/UAV

test merge with Photoshop (*Björn*)



Light measurements Norddeich 23.10.2024

measurement points:

“norm” grid 3m x 3m

reduced grid (3 x 3)



Light measurements Norddeich 23.10.2024

measurement grid measured with Mavolux 5032 B

using the norm grid (3 m):

Mitte											Kaikante	EN 12464-2	
16.9	16.5	19	20.9	21.3	19.6	20.8	18.8	14.4	19.1	17			
21.5	23.1	23.3	24.2	25.4	25.4	23.6	24.6	21.4	21.3	21.5			
26.2	25.9	25.8	26.3	25.7	25.3	24.6	24.4	23.9	24.3	24.8			
27	27.1	25.7	24.8	23.5	22.4	22.5	23	23.5	21.9	23.9			
											E _m	22.78	10
											U ₀	0.63	0.25

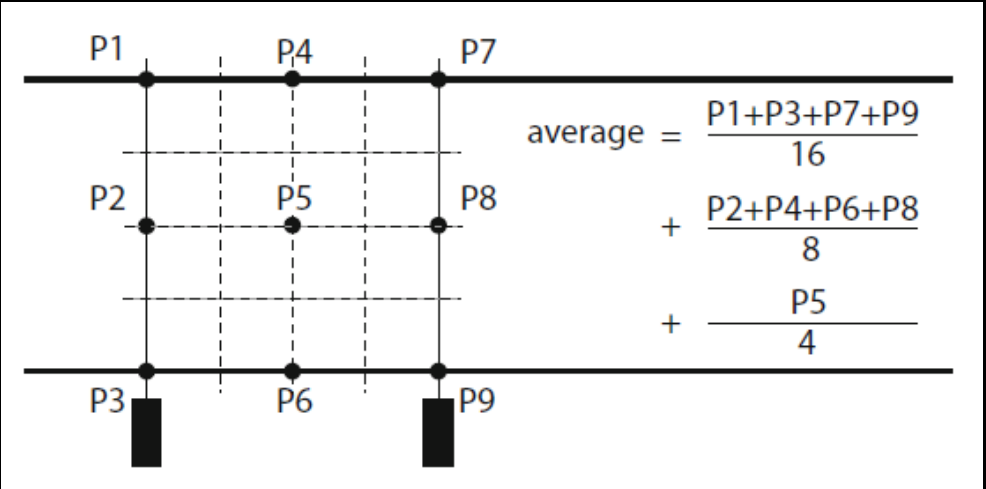
using the reduced grid (3 x 3 points):

16.9	19.6	17	Kaikante	EN 12464-2		
24.9	25.8	23.5		E _m	22.14	10 lx
26.7	21.5	23.4		U ₀	0.76	0.25

very simple max-min-method:

$$E_m = (26.7 + 17)/2 = 22.8 \text{ lx}$$

$$U_0 = E_{\min}/E_{\min} = 17/22.8 = 0.74$$

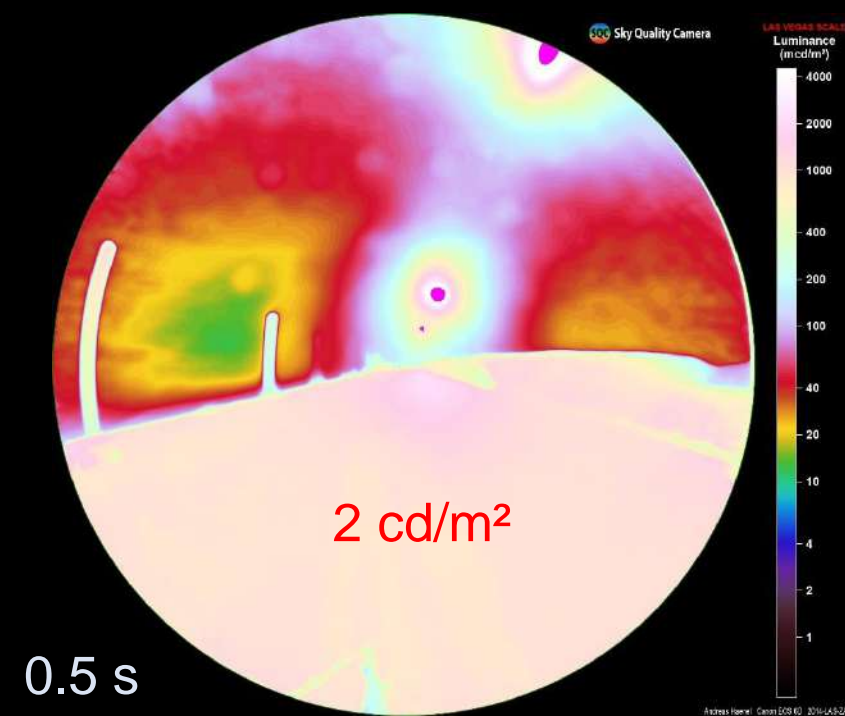
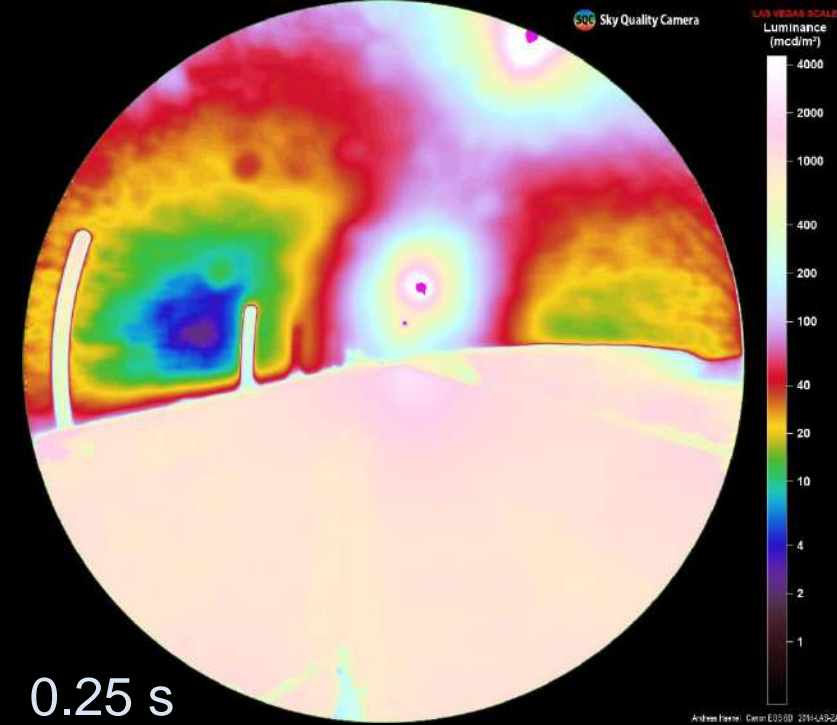


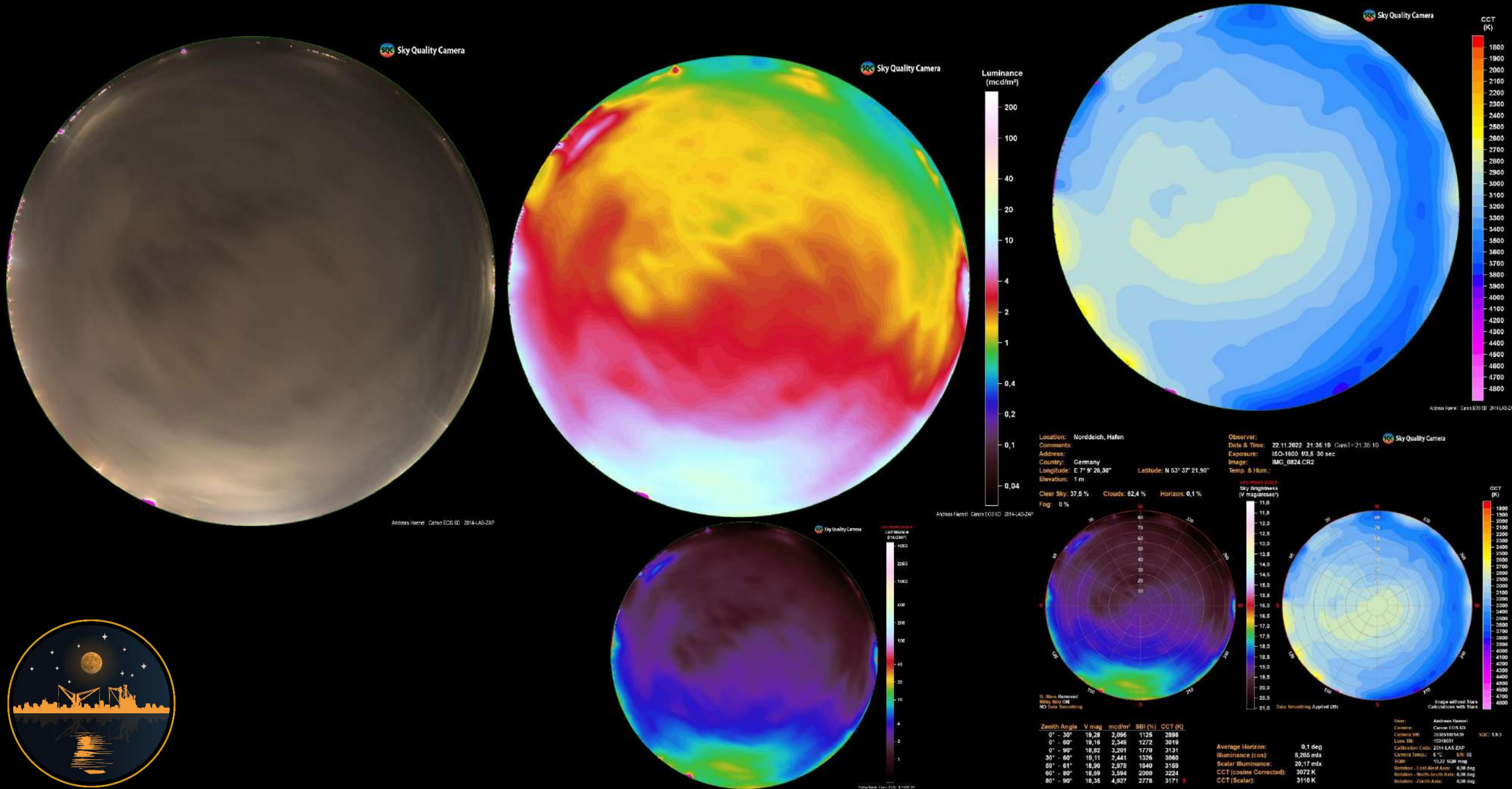
according to *van Bommel*: **E_m = 24.1 lx**



luminance measurements with Canon 6D (ISO 400)

Walk of Light





informal: Measurements Norddeich West port (change 2022)

11.10.2021

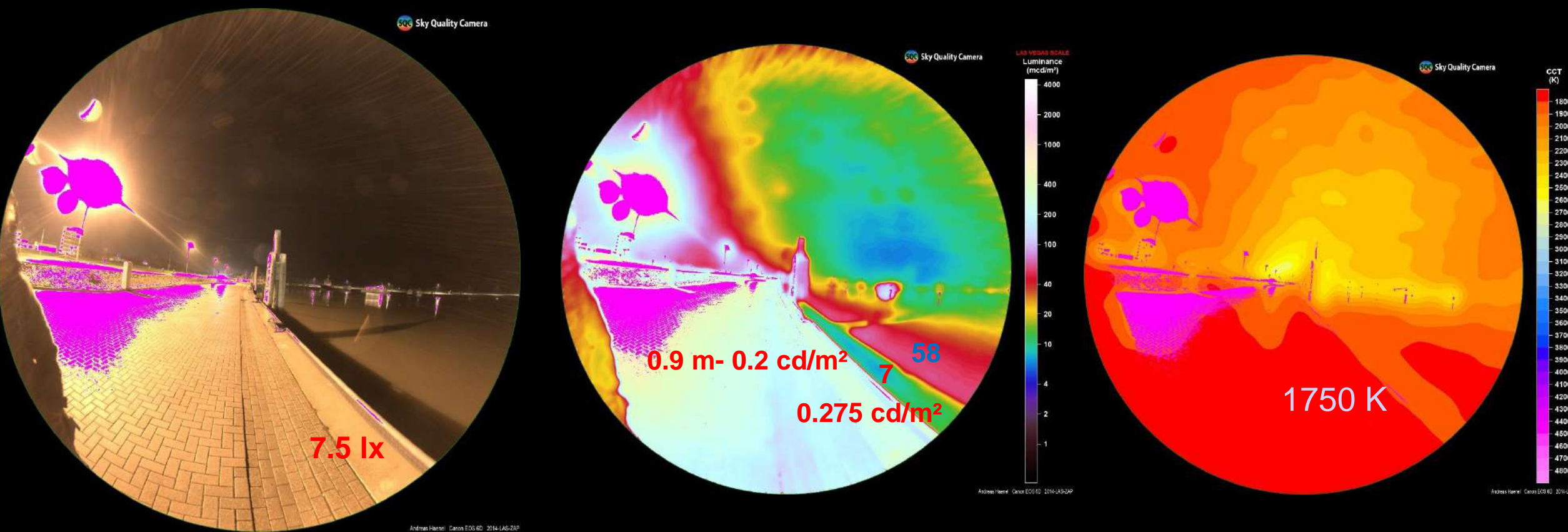


23.10.2024



Norddeich port West, quay edge, 22.11.2022

Illuminance quay edge 7.5 lx, luminosity 0.275 cd/m²



luminosity on water in mcd/m²!

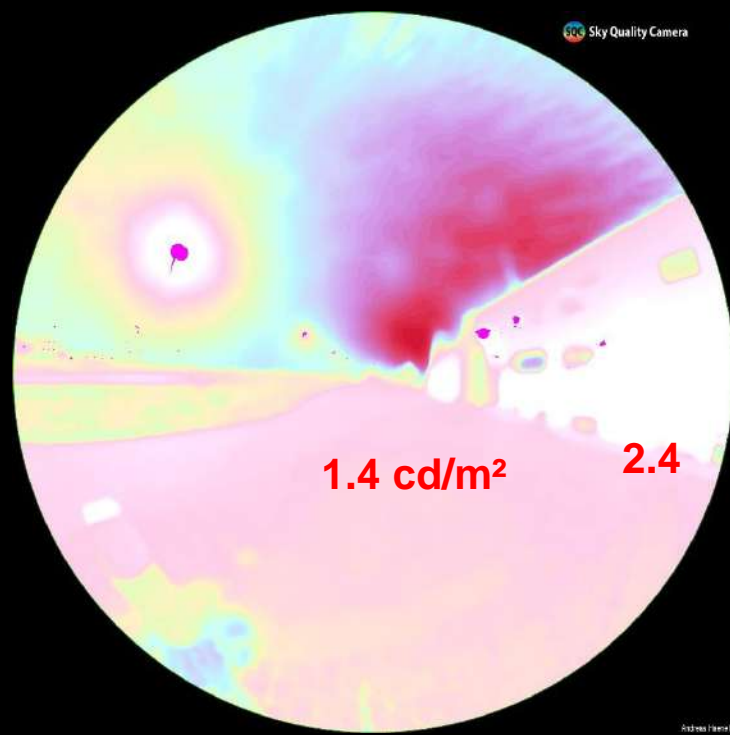
Norddeich port West, quay edge, 5.11.2024

same direction, influenced by ferry

Illuminance quay edge 22 lx, luminance 2.4 cd/m²

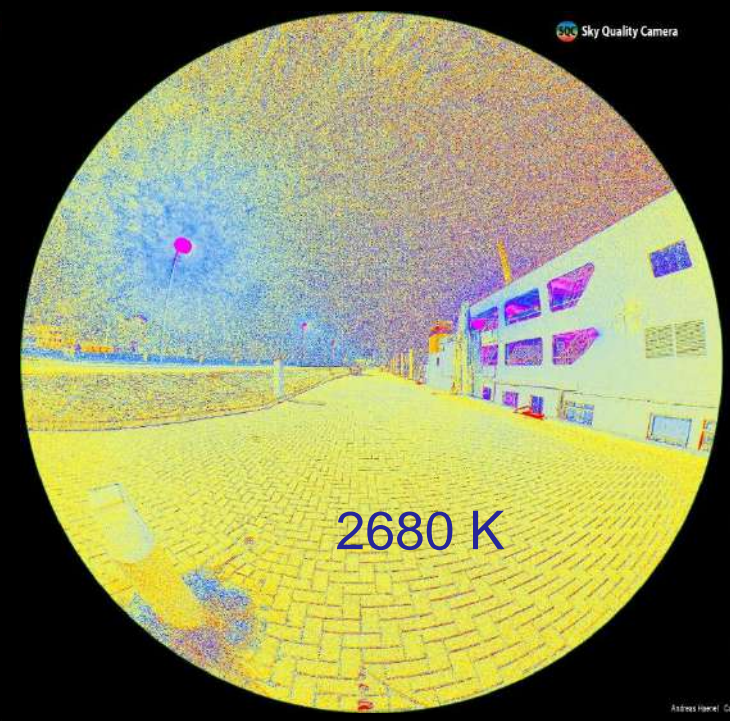
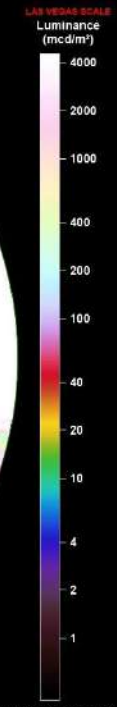


22 lx



1.4 cd/m²

2.4

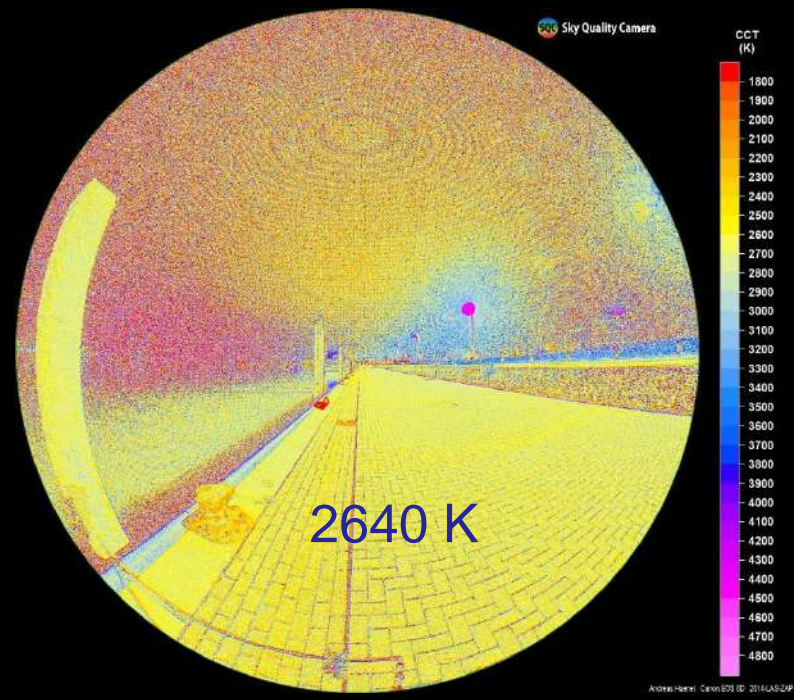
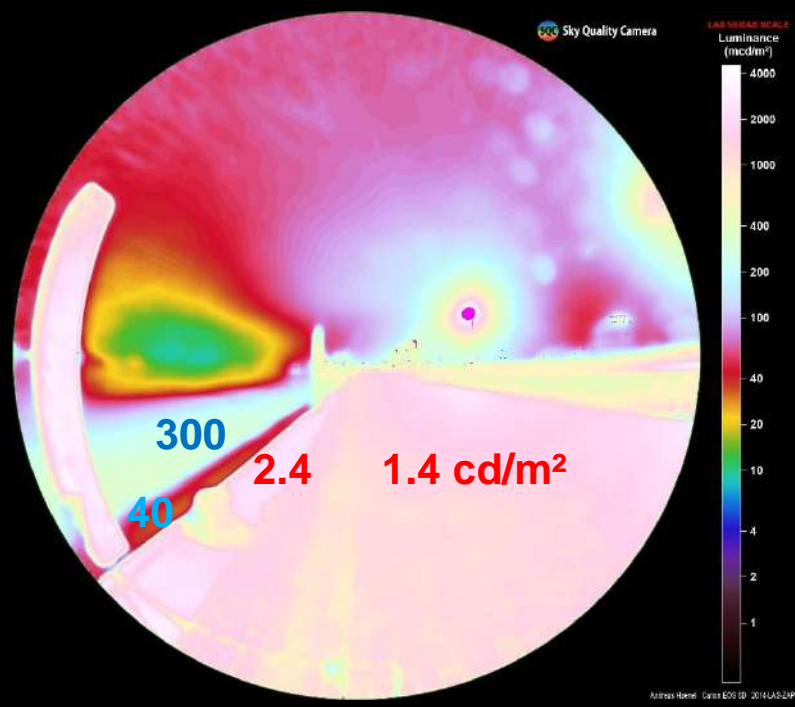
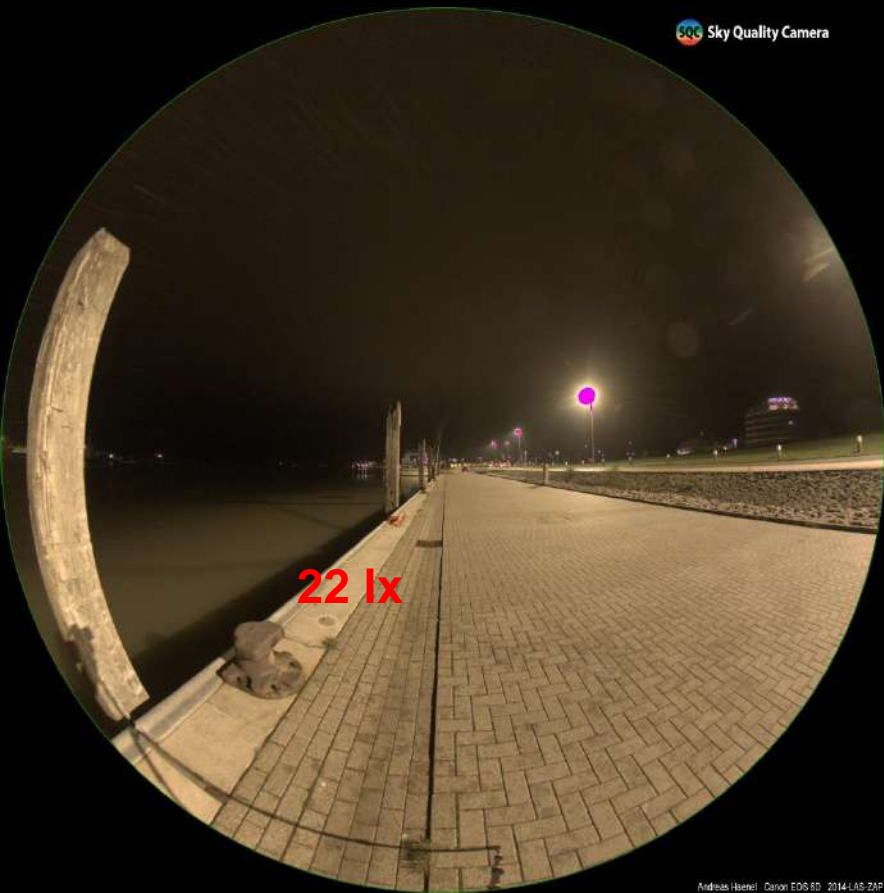


2680 K



Norddeich port West, quay edge, 5.11.2024

Illuminance quay edge 22 lx, Luminance 2.4 cd/m²



Luminance on water in mcd/m²!

Measurements Norddeich West port

Changes 2022/2024

	2022	2024	Increase
quay edge [lx]	7.5	22	2.9
quay edge [cd/m²]	0.275	2.4	8.7
street [cd/m²]	0.9-0.2	1.4	1.5-7
water shadow [mcd/m²]	7	40	5.7
water illuminated [mcd/m²]	58	300	5.2
cct [K]	1750	2660	