



# HDR Application in Quality Assurance

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**Bartenbach**<sup>B</sup>

Funded by Interreg ERDF, in Project FACEcamp



# About us, HELLA

[www.hella.info](http://www.hella.info)

- HQ in Abfattersbach, Tirol, Austria
- 60 yrs anniversary 2019
- family owned
- Manufacturing sites in Austria, GER, POL, CZ, ITA;
- ~1300 FTEs
- Full line distributor:  
everything for daylight mgmt & its integration into facades
  - Roller shutters
  - Venetian Blinds
  - Roller Blinds
  - Box systems, Soffit systems, window attached boxes (top mounted)
  - awnings.
  - Outdoor living (Pergola)
- we deliver almost everywhere









Bishopsgate, London



[josef-gartner.permasteelisagroup.com](http://josef-gartner.permasteelisagroup.com)

100 Mount Street, Sydney



[https://www.permasteelisagroup.com/media/2756/2017\\_annualreport\\_en.pdf](https://www.permasteelisagroup.com/media/2756/2017_annualreport_en.pdf)

# What's a roller shutter?



# Roller Shutters











# Why QA HDR?



Night Shift

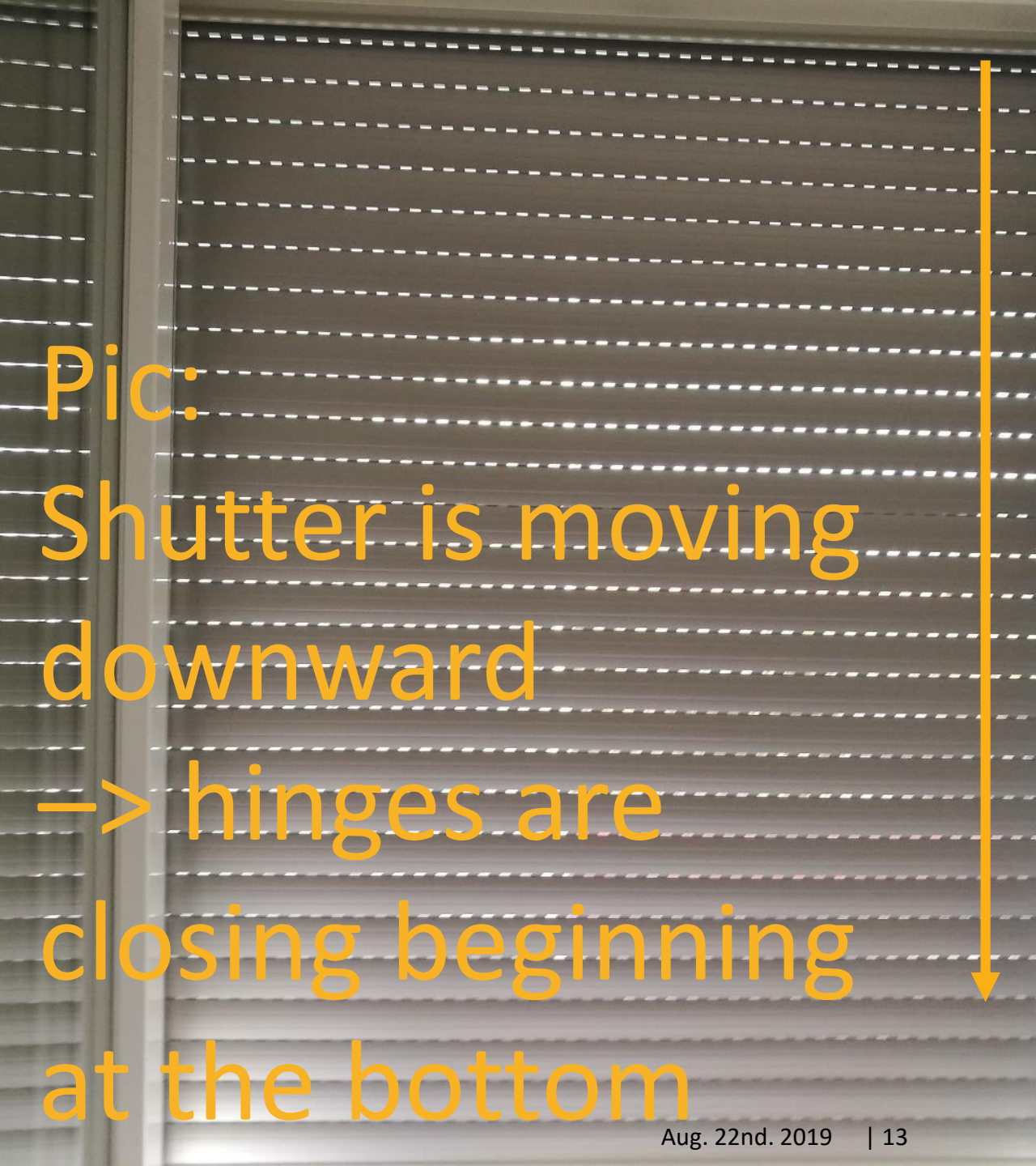
22:00 – 06:00

Sleeping anytime between

06:00 – 22:00

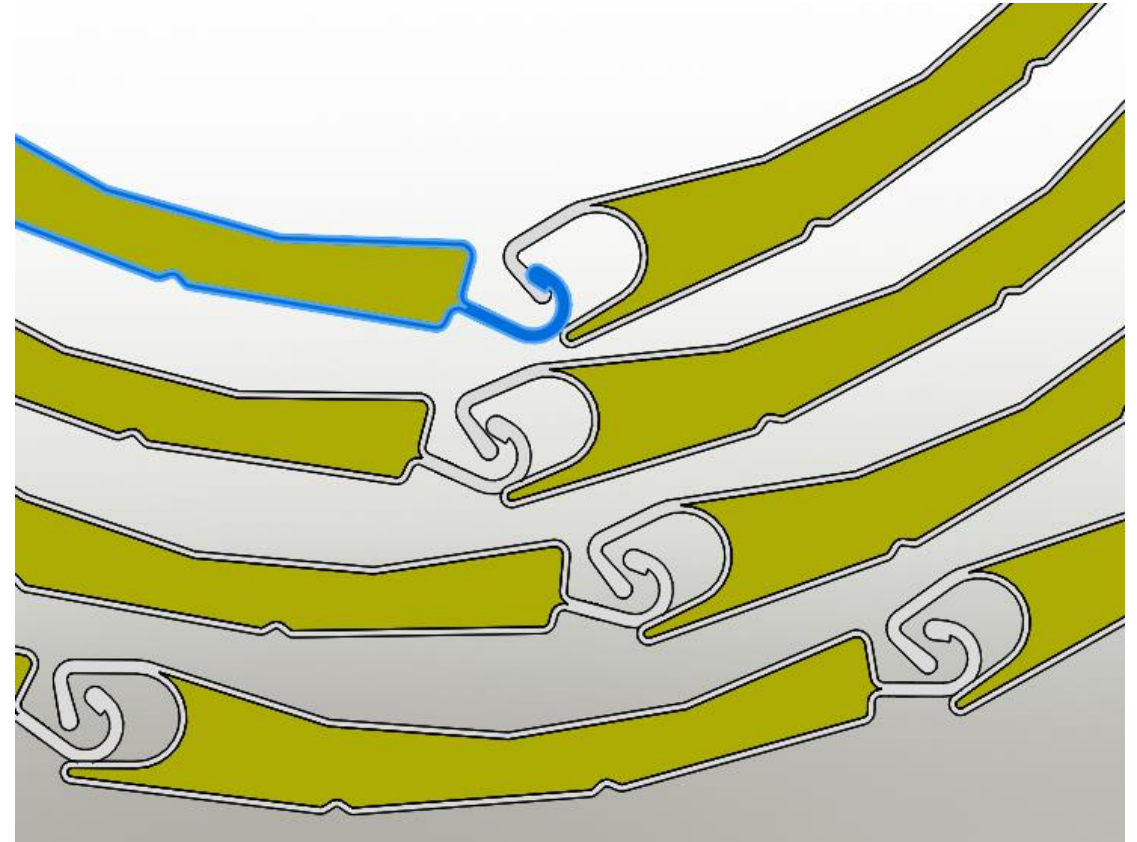
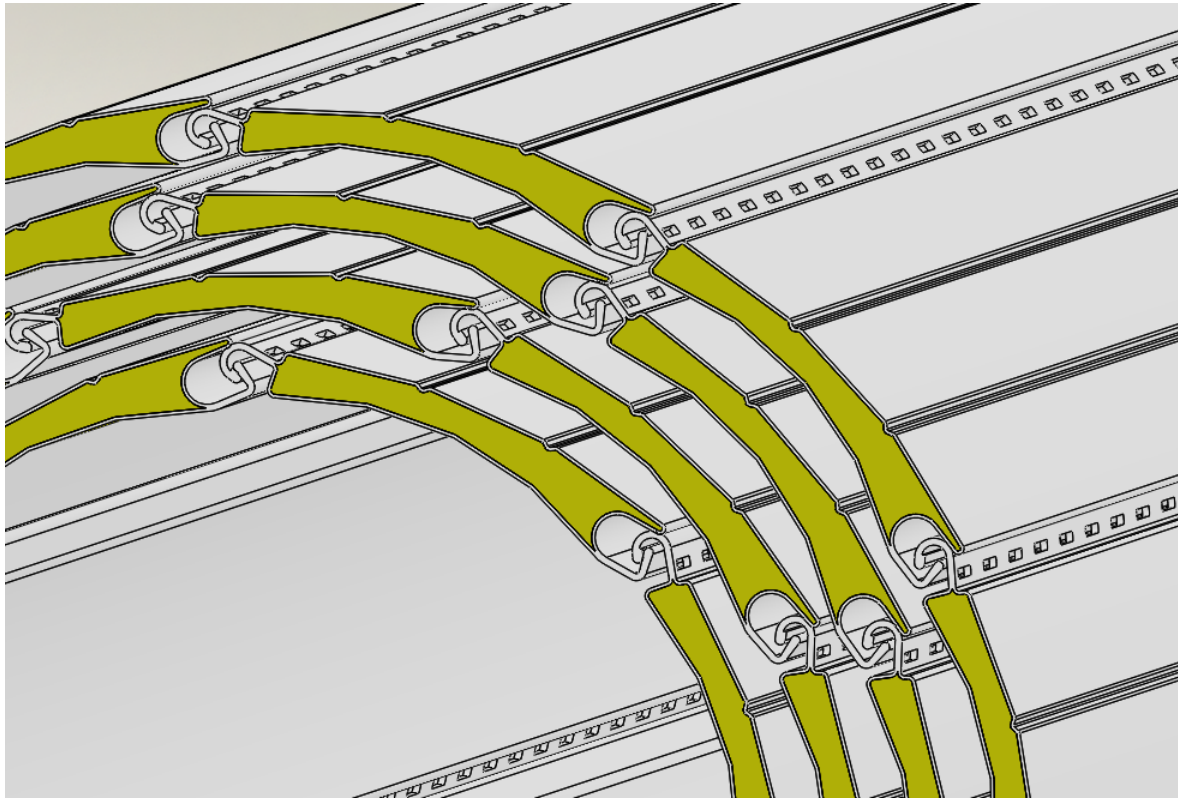
BUT:

A roller shutter is no obscuration device, by definition.



Pic:  
Shutter is moving  
downward  
→ hinges are  
closing beginning  
at the bottom

# Hinge System



# Roller Shutter: Hinge System

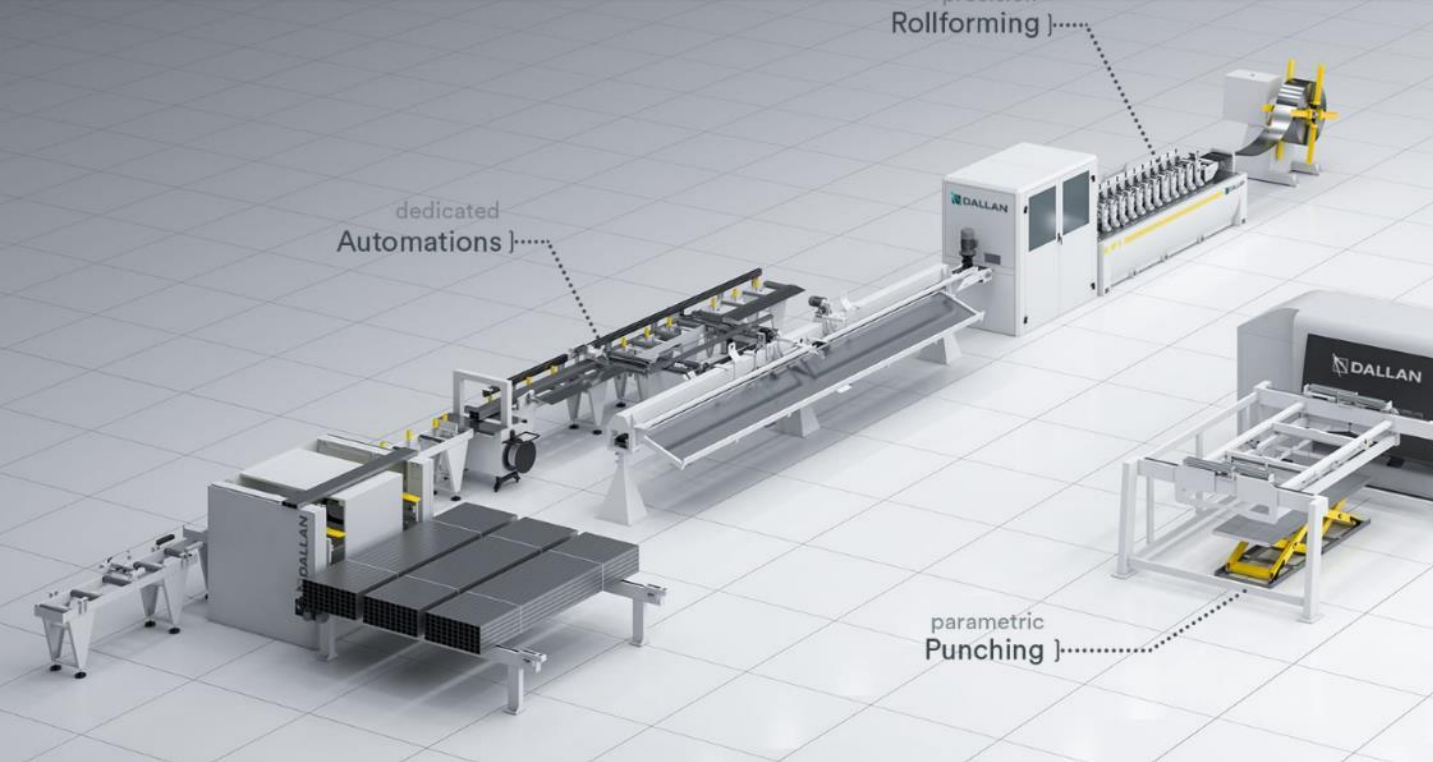
Full contact in closed position

Stretched whenever moving

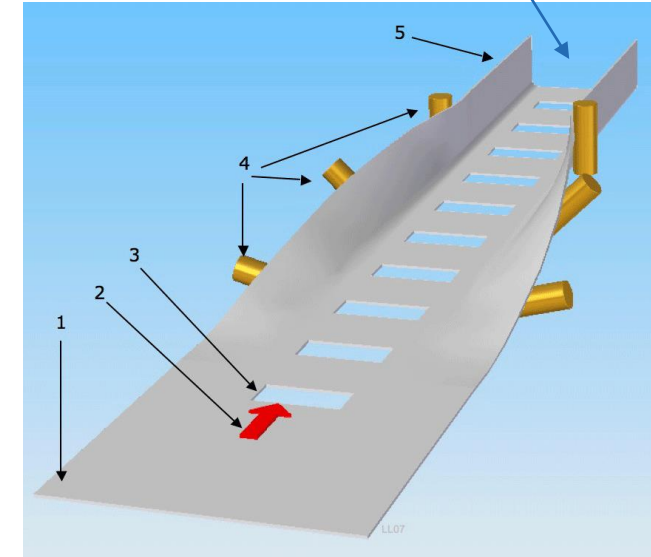


Aluminum slats





Filled with PUR Foam



Picture & data: dallan.com,  
wiki public domain

	Rollformer	Product	Max production speed	Machinable gauges	Machinable materials	COIL TO WINDOW	Compatibility
D63	T4	H15 - H55	37 m/min	0.2 - 0.6 mm	Al / Steel	yes	<a href="#">More</a>
D610	T4	H15 - H55	60 m/min	0.2 - 0.6 mm	Al / Steel	yes	<a href="#">More</a>
D6M	T4	H55 - H77	30 m/min	0.4 - 0.8 mm	Al / Steel	no	<a href="#">More</a>
D6100	T4	H77 - H100	25 m/min	0.6 - 0.9 mm	Al / Steel	no	<a href="#">More</a>
D6TL	T4	H15 - H55	37 m/min	0.2 - 0.6 mm	Al	yes	<a href="#">More</a>



# Plastic Slat

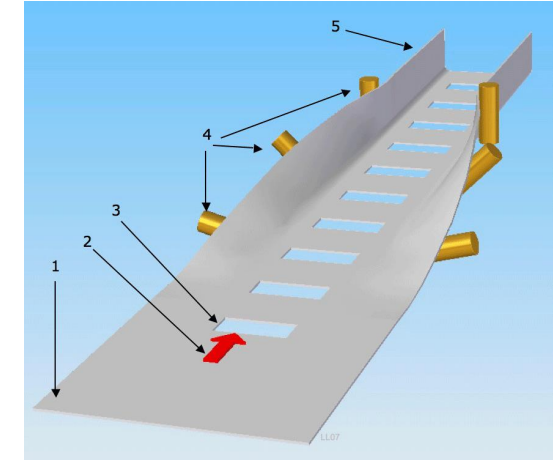
PVC Extrusion



# Process Quality – Manufacturing Tolerances

Starting point: Aluminum Coil incl. tolerances

- Lengthwise curvature (x & y)
- Lengthwise Torsion (z)
- Tolerances in Section x,y-plane
  - Roll dies
  - PUR hardening pressures
- Position of punches
- Burrs
  - Slat ends
  - punches
- Tolerances in Band surface (e.g. Gloss Units)



# The issue is

- a. Transmission through guiderails
- b. Transmission through hinges
- c. Transmission through slats (PVC)

This work focuses on (b) Transmission through hinges.



# Previous QA

Human subjective

Photos are sent per email ...





? Foto

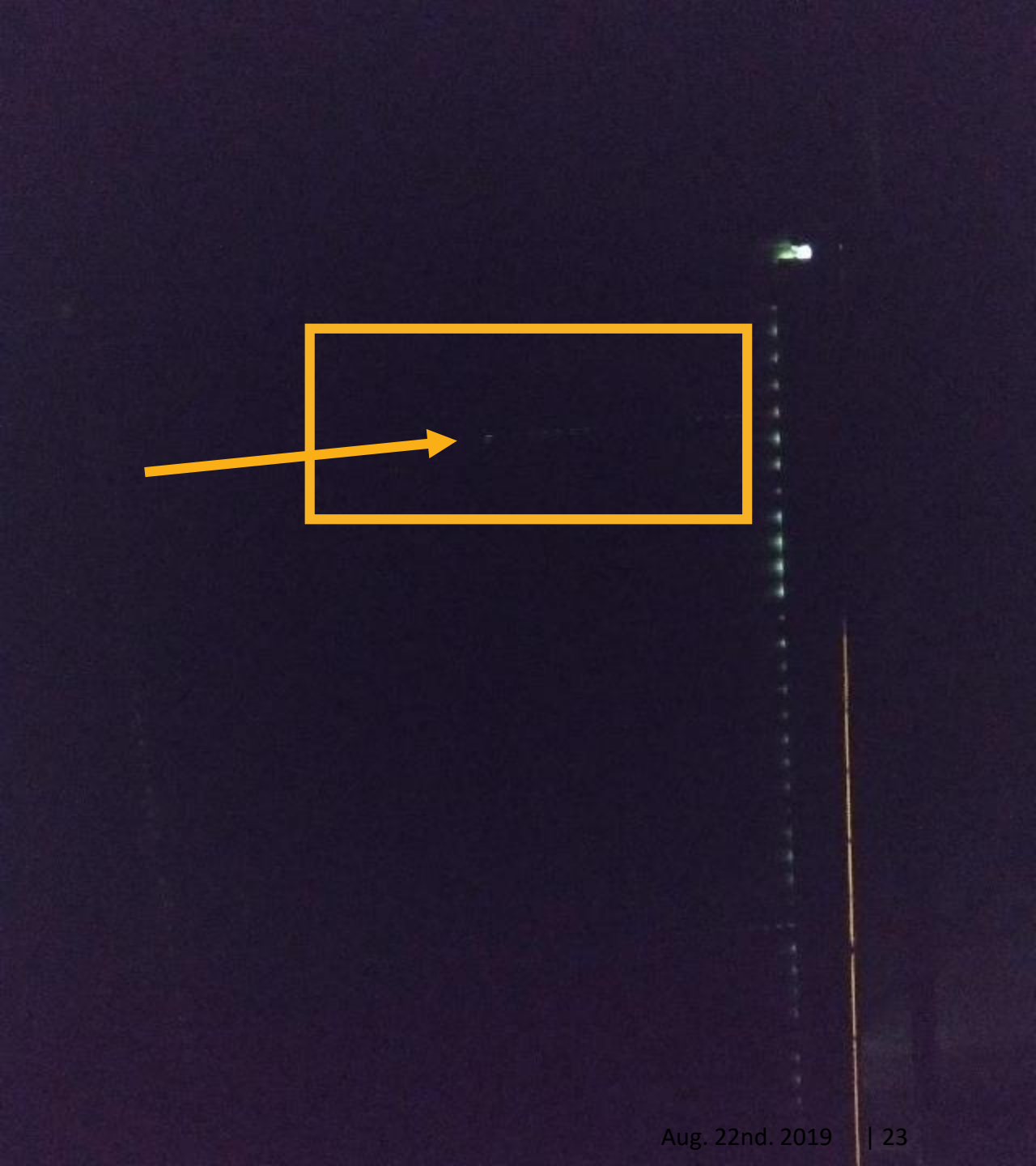


?



?

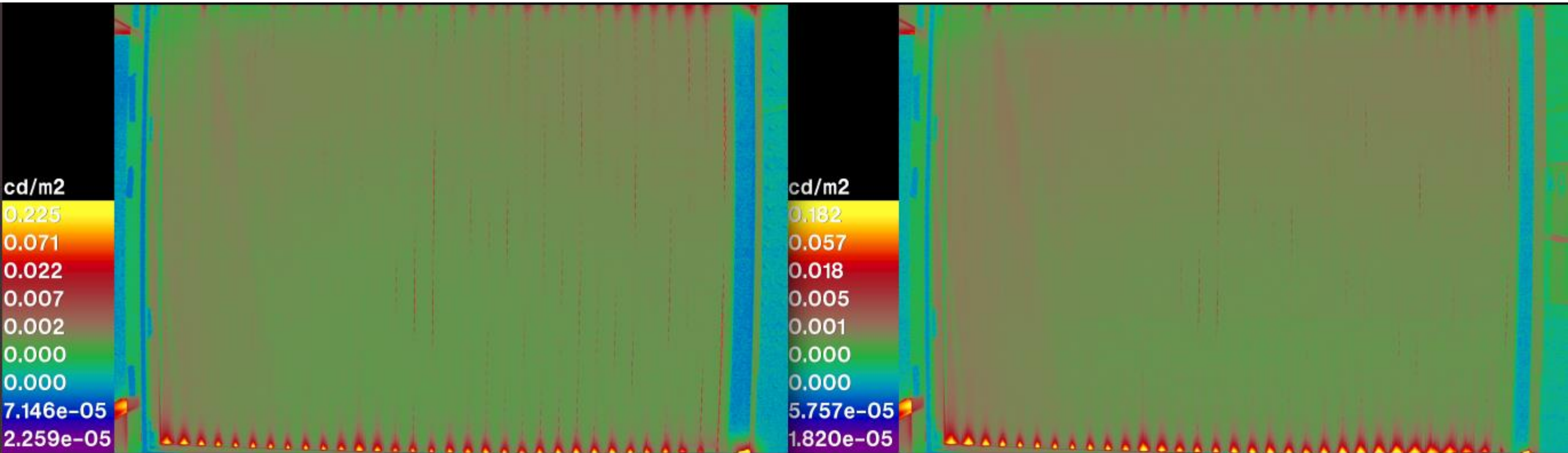




# Positions of slat – pressed down?

Left: just let fall the shutter from 150mm height

Right: press down the most top slat



scale!



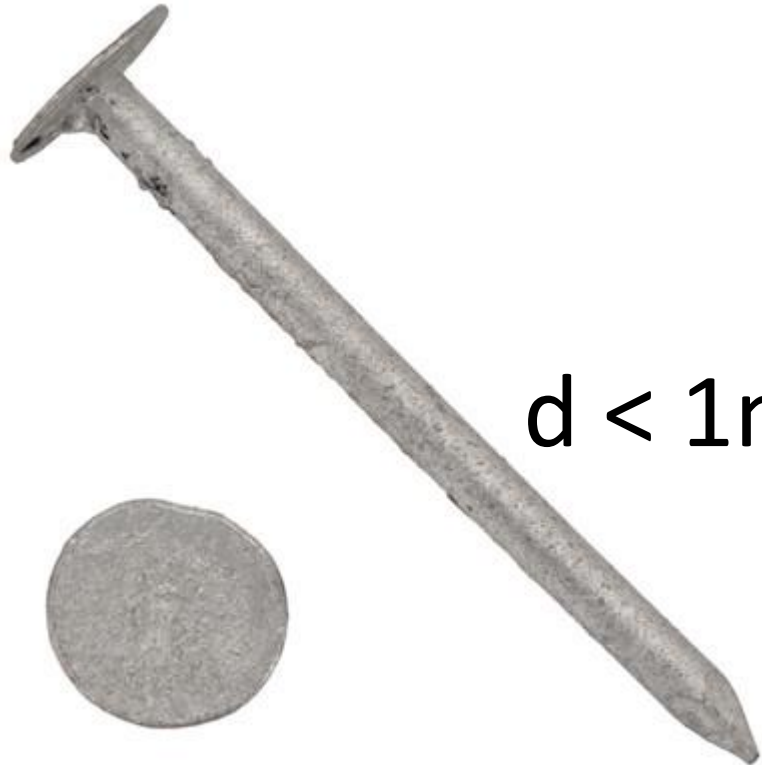
# Dispute on the definition of

,good' or ,bad'

,used to be better' or ,getting worse'

# The Industry's Association

Germany



$d < 1\text{mm}$

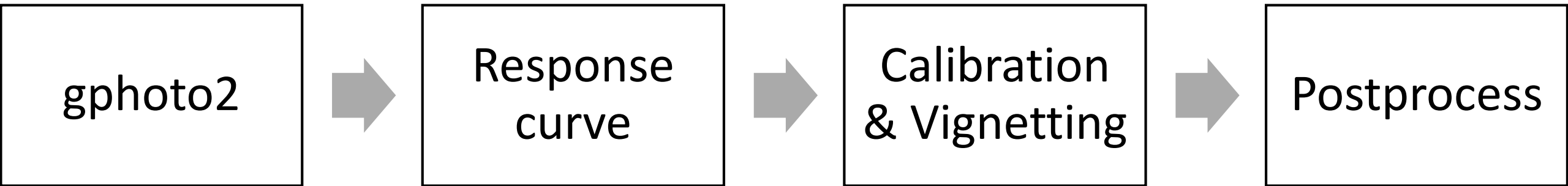
OK



# How to evaluate the techn. evolution of the product?

,better' or ,worse'

# Objective: Cancel out subjective evaluation





# Testbox



# Testbox

LED PWM dimmable, 6500K

$E = 16\text{-}23\text{klx}$  @ 100% (-> reasonable daylight scene)

$L = 4\text{-}5\text{kcd/m}^2$  @ 100%  $\neq E/\pi$

Diffusor is not completely lambert!

Dedicated, completely dark room is needed!

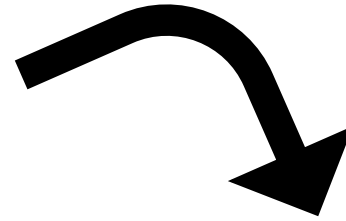
Fixed Position of Camera (in future)

$f/4.5$ , ISO 800 or 1600; A-Mode (Aperture fixed, Time adjusted);  
AF mechanically deactivated

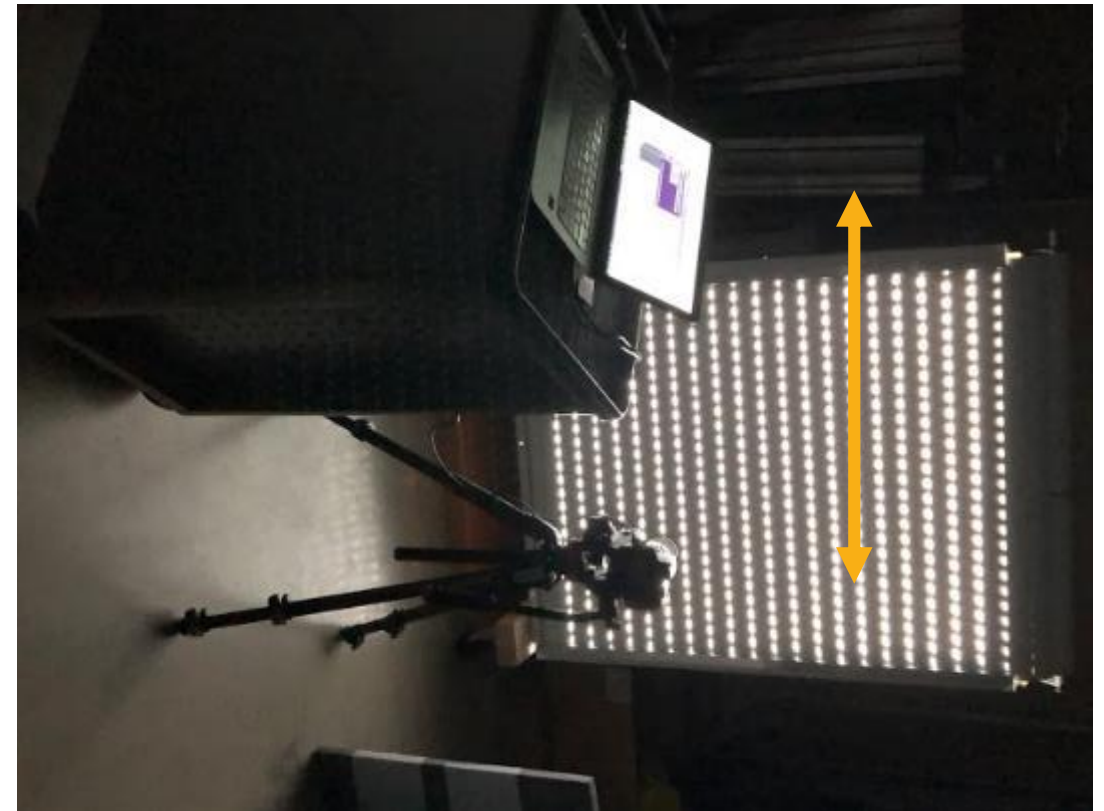


# Convention: x-axis pic = z in real

In Browser with autorotate



In file





# Gphoto2

Nikon D40 Version 1.10 – stick to this ancient device

Canon EOS 800D

-> well known and described all over the web

# Response Curve

```
hdrngen64bit -o hdr_out.hdr -a -x -k variance_out.hdr -r response_out.rsp DSC_in??.JPG
```

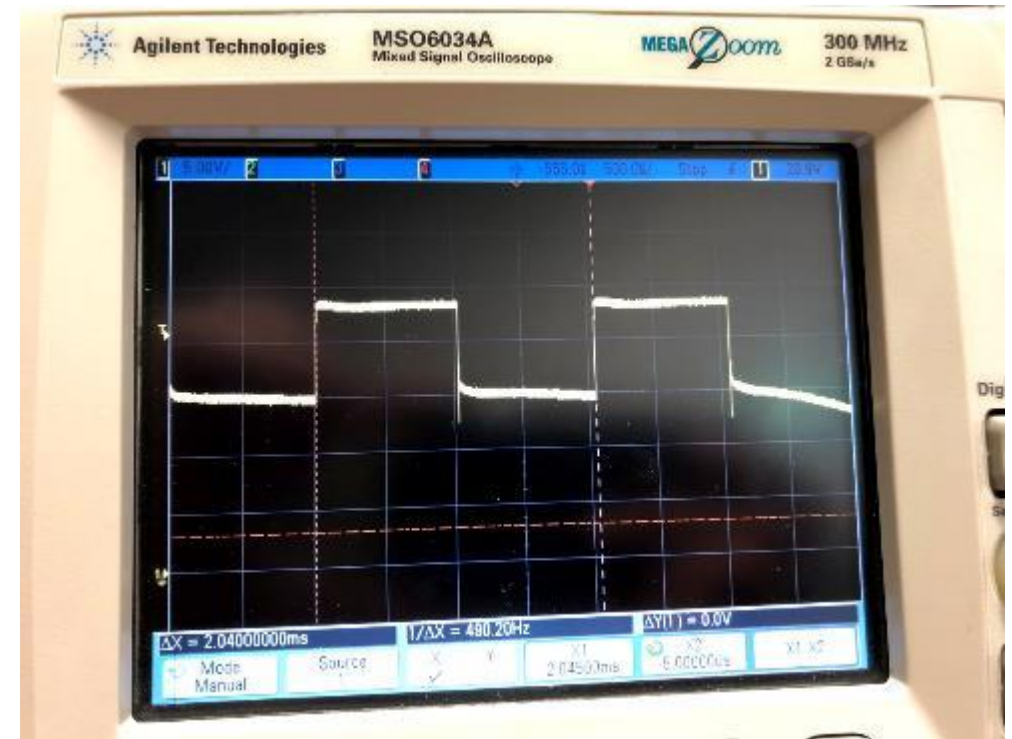
# PWM Dimming on LED Sources!

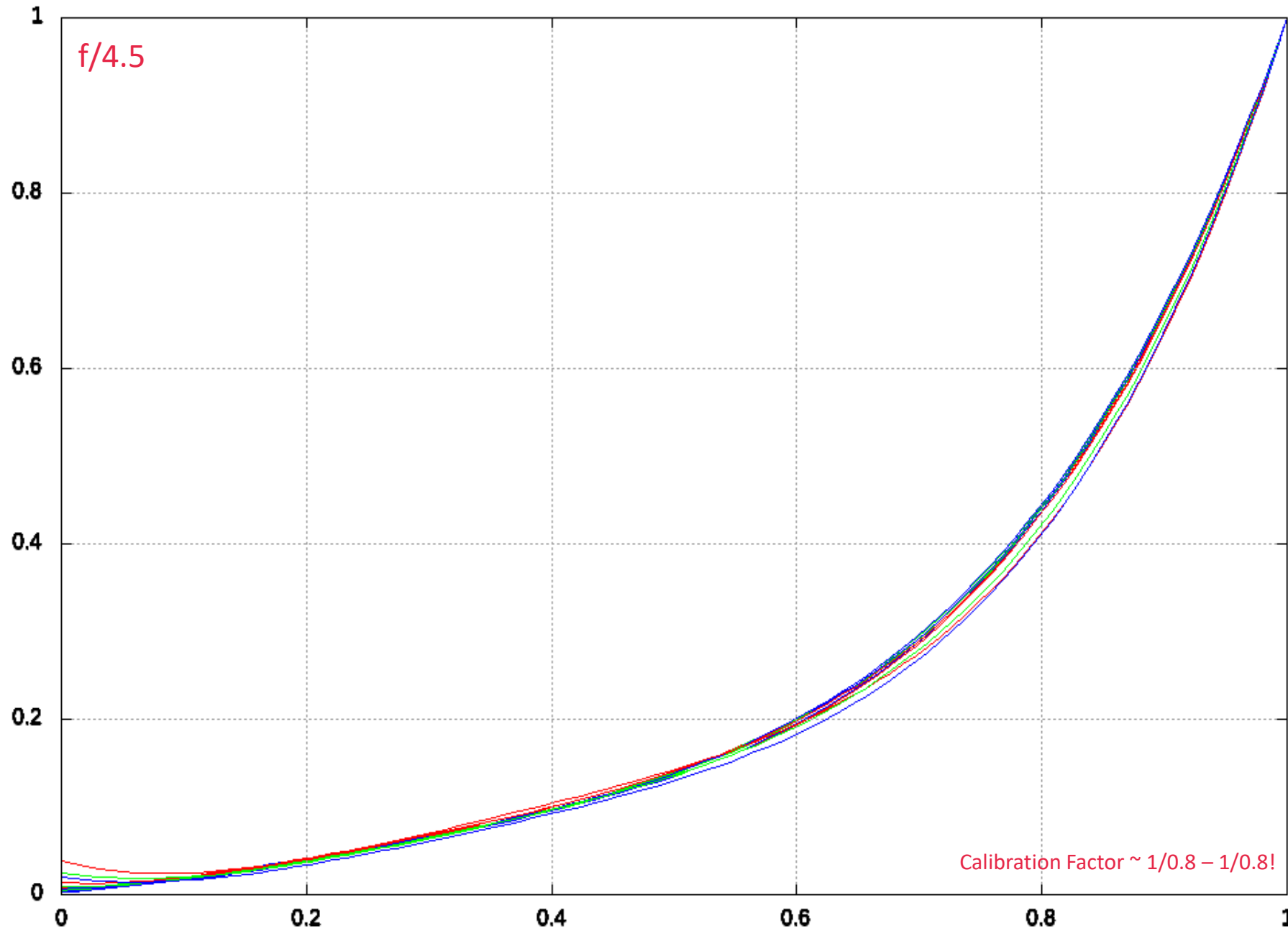
Finetuning due to the  $20 < \text{RGB value} < 200$  constraint .... no dimming allowed!

99%



50%







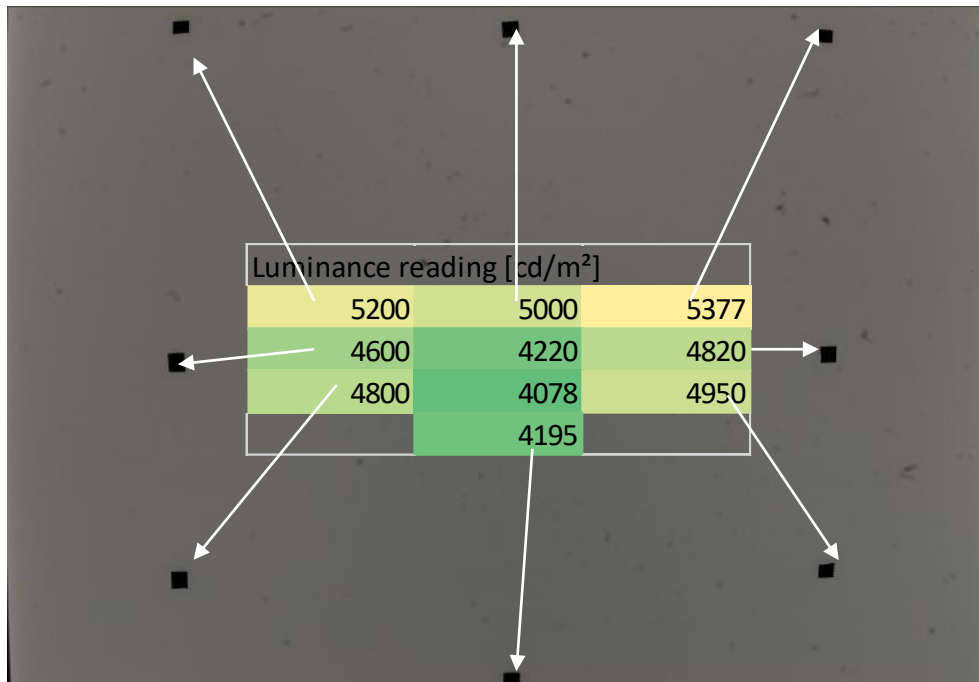
# Vignetting & Calibration Factor



# Vignetting testing

hdrngen64bit -o hdr\_out.hdr -a -x -k -r response\_in.rsp DSC\_00??.JPG

Different apertures



fototest45 f/9						
1746	1782	1803	0,33576923	0,3564	0,33531709	
1648		1698	0,35826087		0,35228216	
1668		1717	0,3475		0,34686869	
	1517			0,36162098		
fototest45 f/8						
1526	1531	1538	0,29346154	0,3062	0,2860331	
1639	1733	1525	0,35630435	0,41066351	0,31639004	
1615		1520	0,33645833		0,30707071	
	1778			0,4238379		
fototest45 f/5.6						
3297	3393	3370	0,63403846	0,6786	0,62674354	
3135	3040	3233	0,68152174	0,72037915	0,67074689	
3159		3221	0,658125		0,65070707	
	2894			0,68986889		
fototest45 f/4.5						
3721	3780	3819	0,71557692	0,756	0,71024735	
3562	3460	3636	0,77434783	0,81990521	0,75435685	
3612		3677	0,7525		0,74282828	
	3276			0,78092968		

# Vignetting + calibration

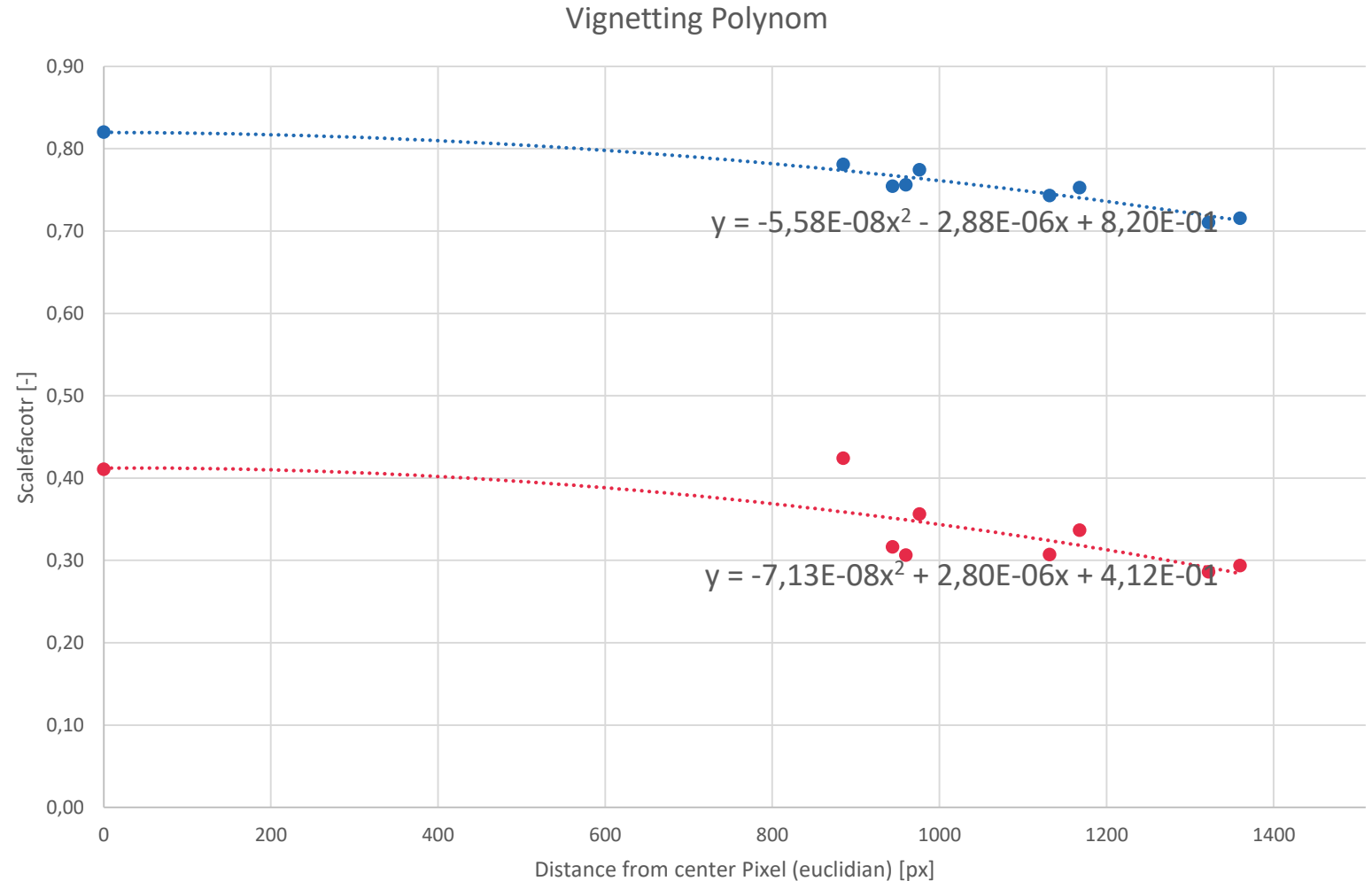
Depending on Aperture setting!

- f/4.5
- f/8

@18mm

Assumption:

Radially symmetric

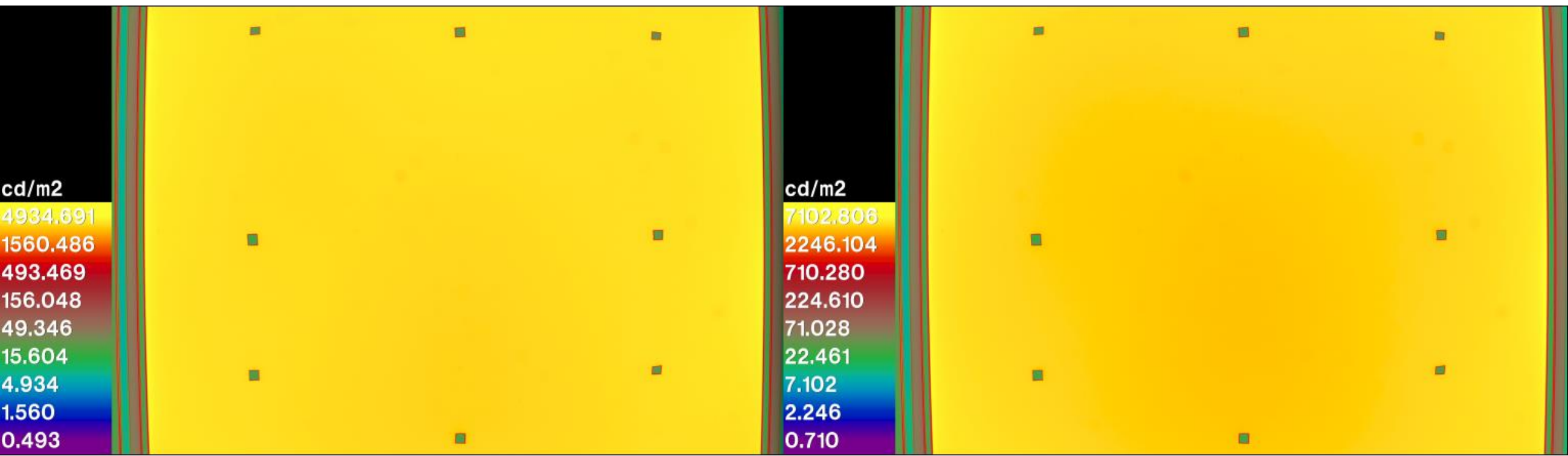


`pcomb -x 3008 -y 2000 -h -e "ro=ri(1)*f;go=gi(1)*f;bo=bi(1)*f;f=1/(-5.58*10^(-8)*d*d-2.88*10^(-6)*d+0.82);d=sqrt((x-1504)^2+(y-1000)^2)" -o hdr_in.hdr > hdr_out.hdximr`

Fototest44, 45

# Vignetting corrected

Still an error of approx. 3.5%



Luminance reading [cd/m²]		
5200	5000	5377
4600	4220	4820
4800	4078	4950
	4195	

fototest 45 f/4.5 antivignetted			ratio		
5059	4837	5259	0,97288462	0,9674	0,97805468
4543	4210	4720	0,9876087	0,99763033	0,97925311
4674		4835	0,97375		0,97676768
	4154			0,99022646	

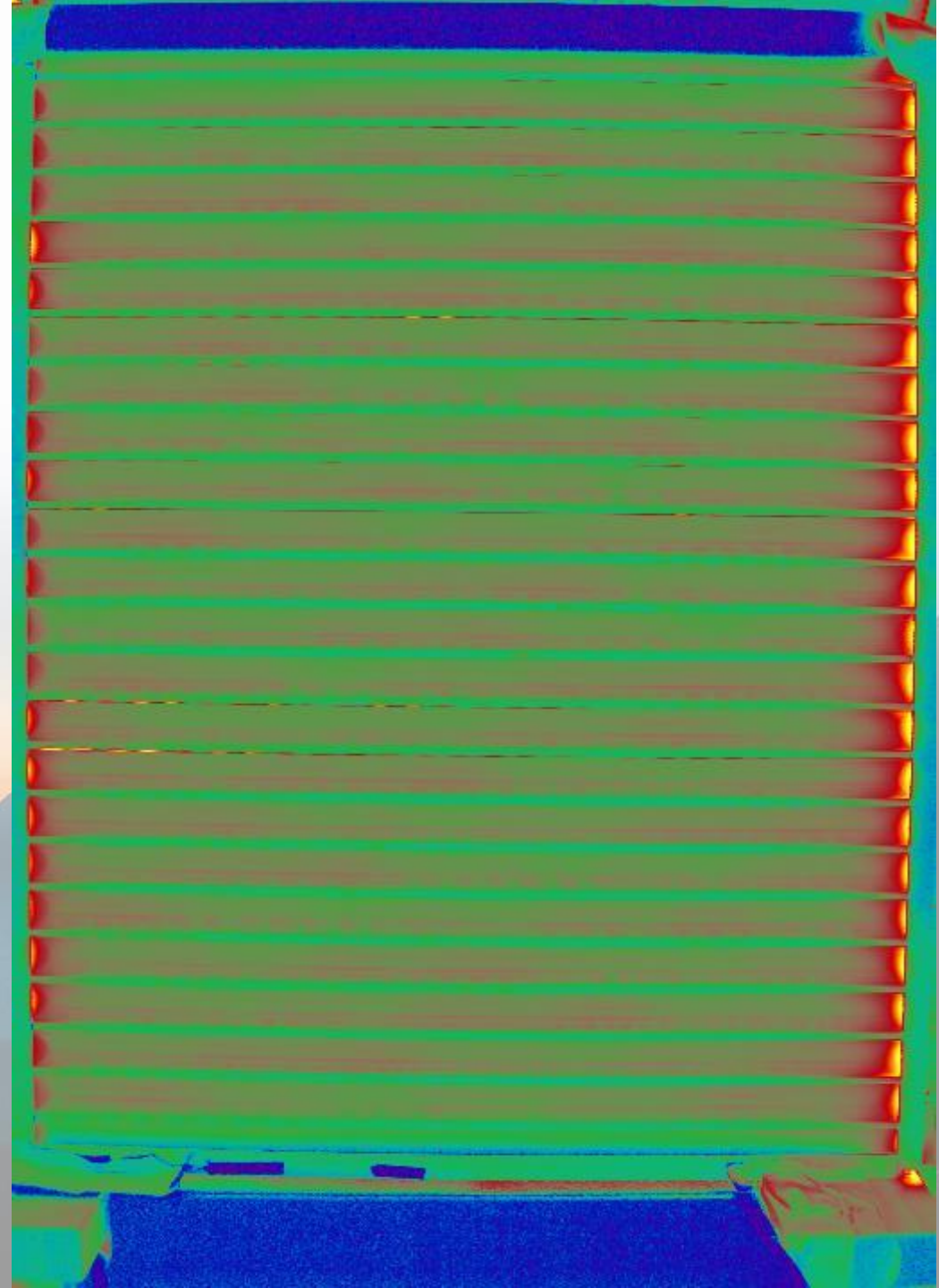


# Distortion

Up to now neglected but open issue

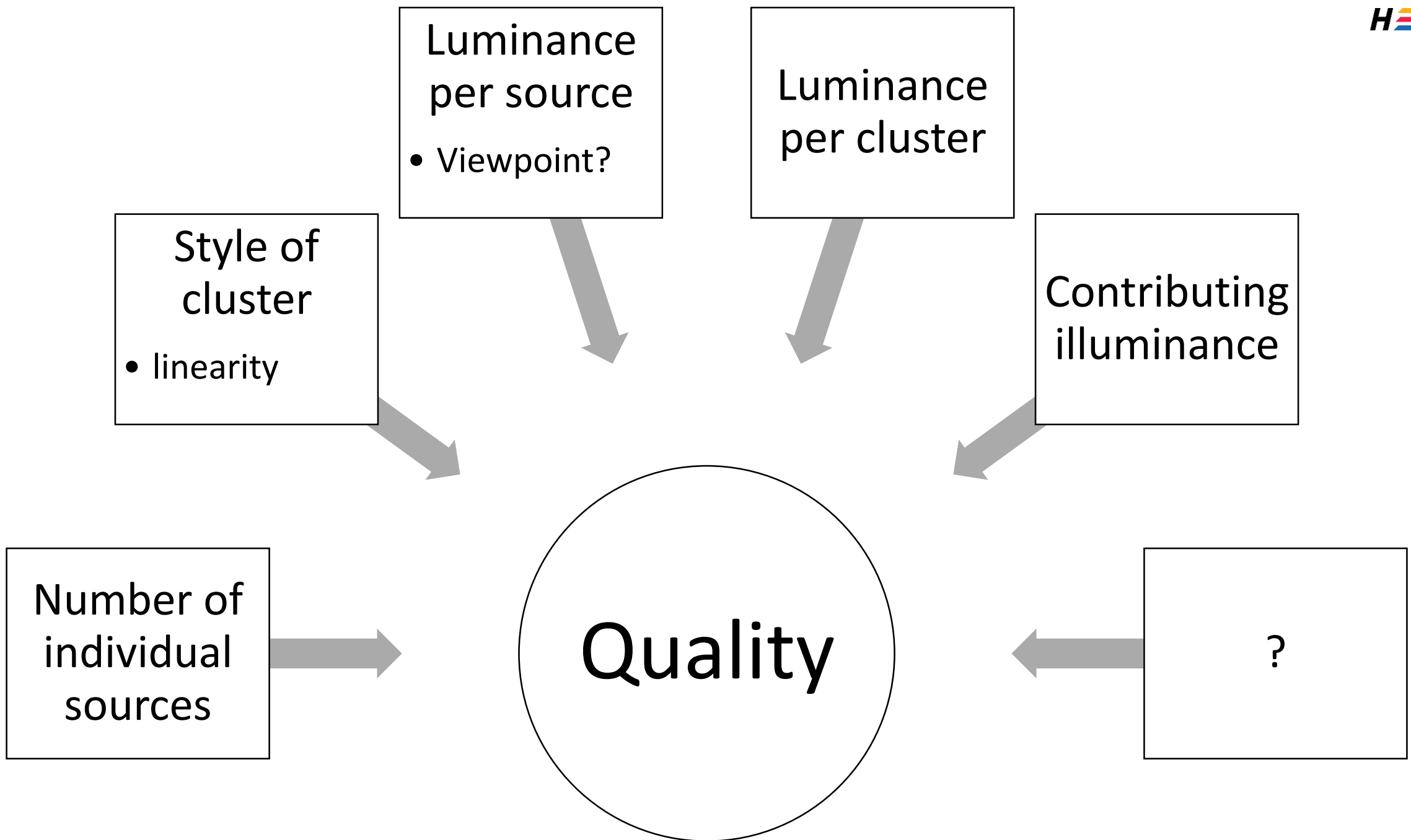
Do we need angular-corrected data out of evalglare?

-> All luminance data is obviously affected by it!



# Quality Indicators

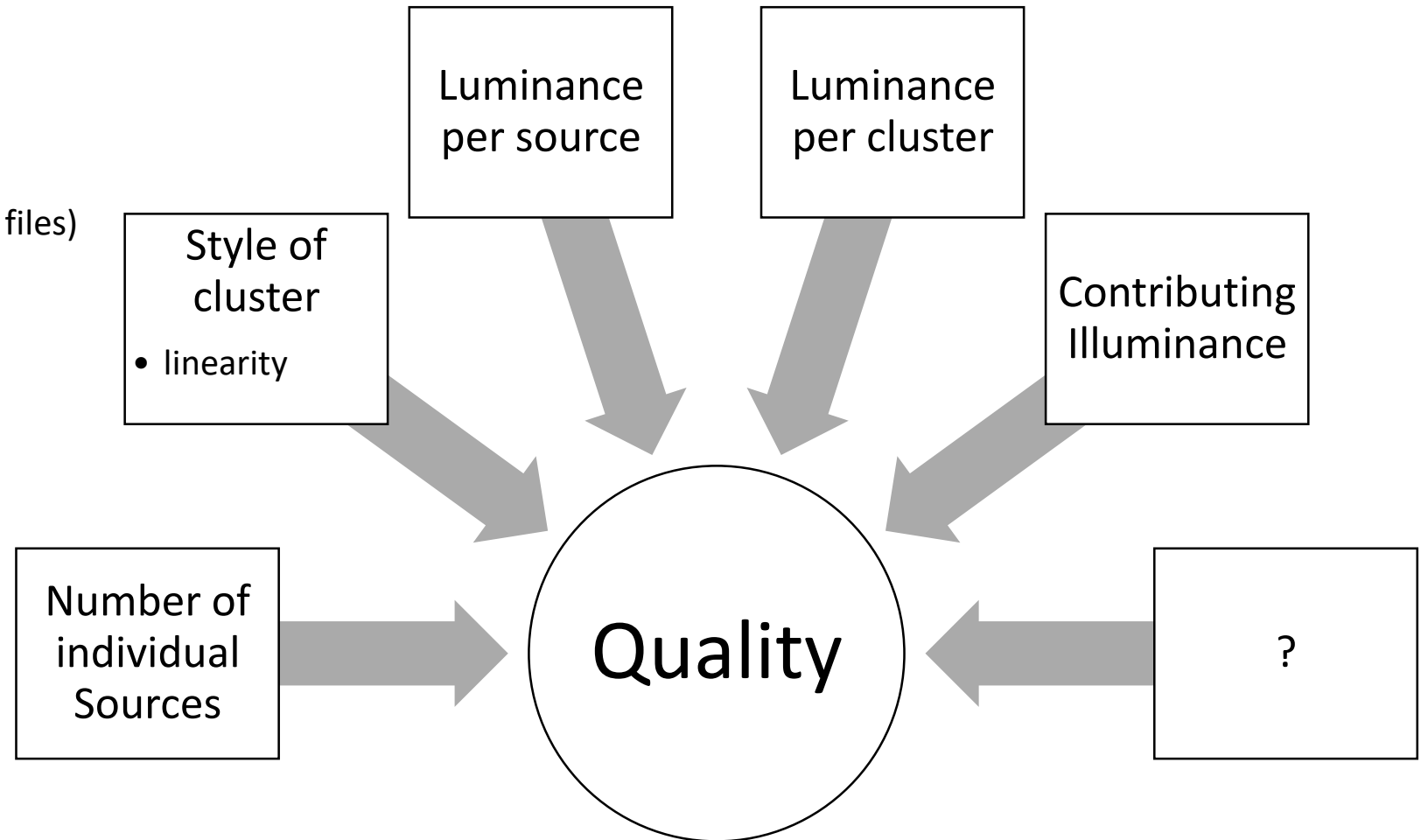






# Tools considered or tested

1. Matlab readhdr (missing in octave)
2. Pvalue -> \*.dat -> gnuplot (terrible files)
3. Findglare (not on hdr?)
4. evalglare

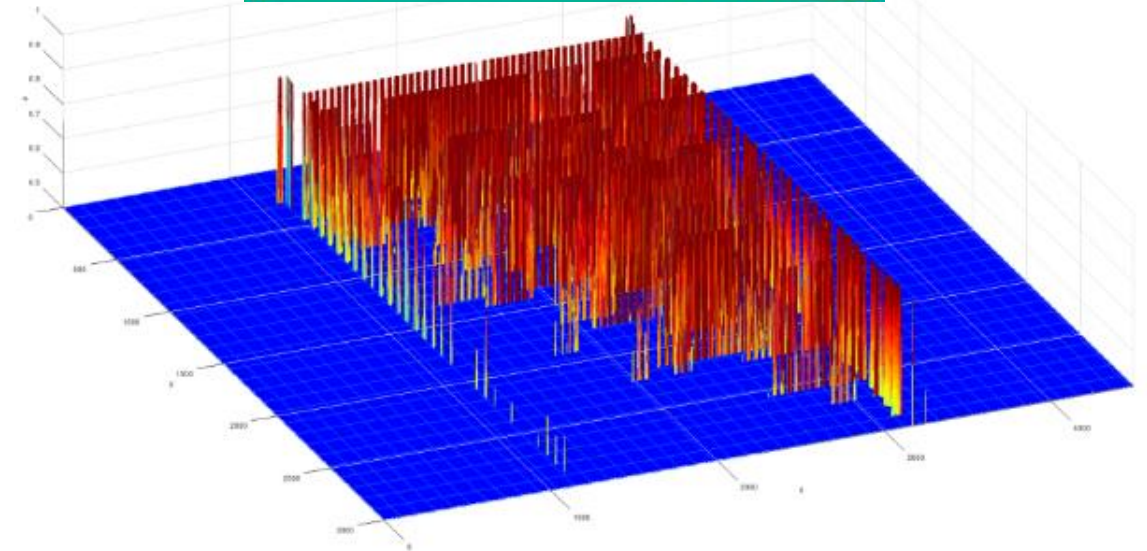
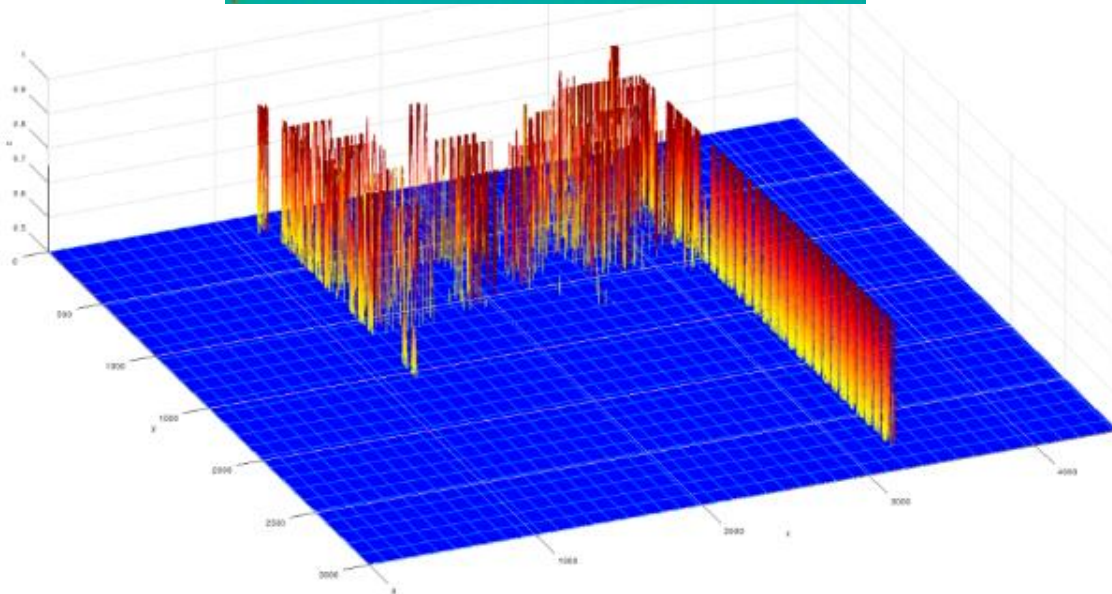
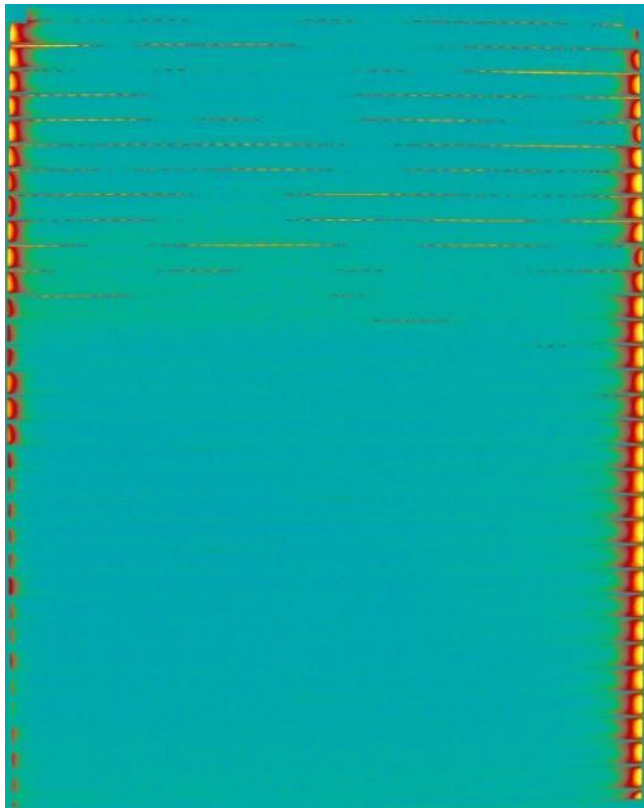


# Qualitative Criteria & Tools

				Matlab	pvalue->gnu	Evalglare
Number of sources	small		High	per pixel only	per pixel only	ok, clustered
Style of Cluster	linear		Random	unknown	missing	missing
Luminance of source	small		High	ok	ok	ok
Luminance of Cluster	small		High	missing	missing	ok
?						

# Matlab readhdr

Contribution from our intern Marco Bachmann



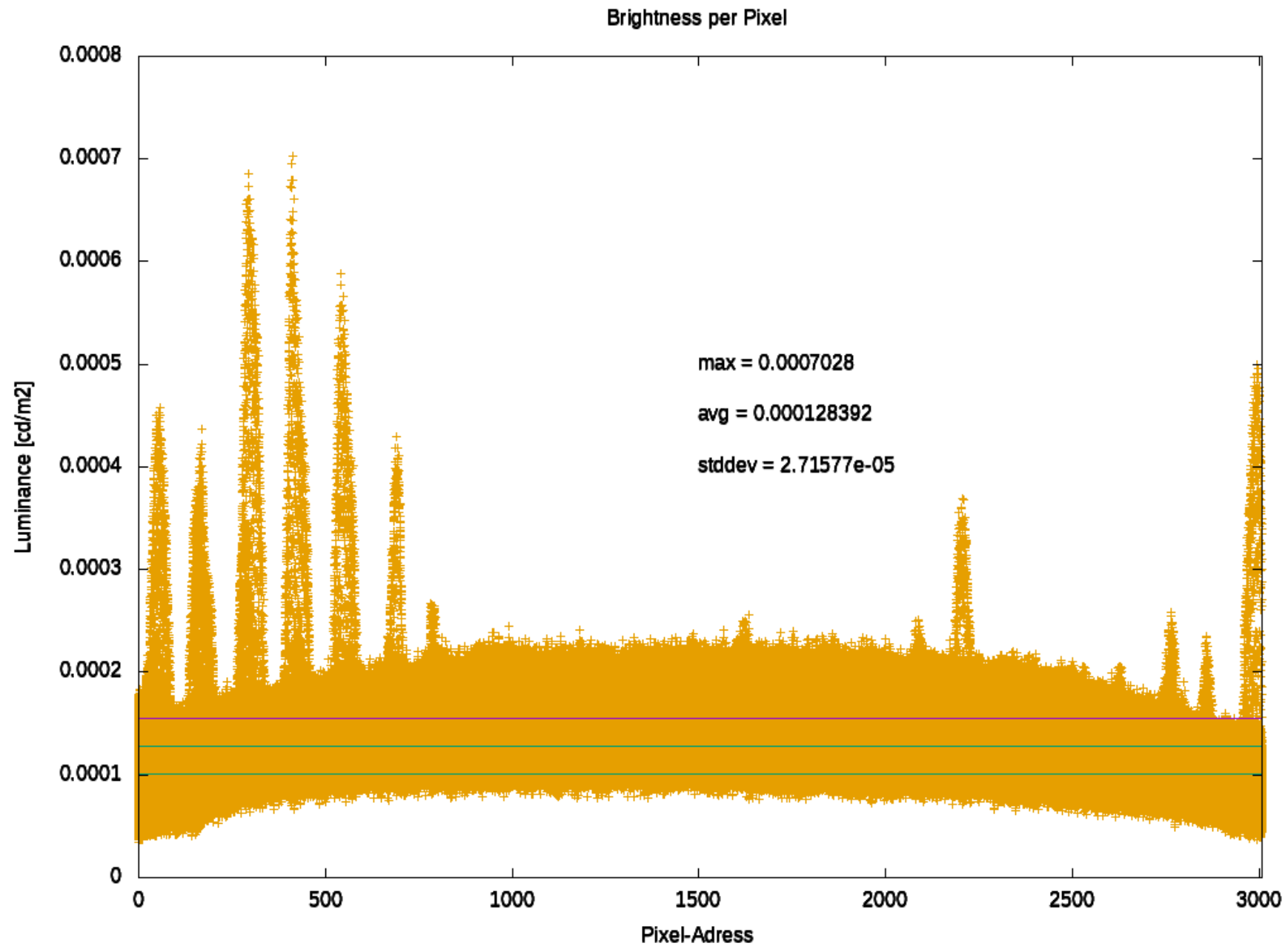


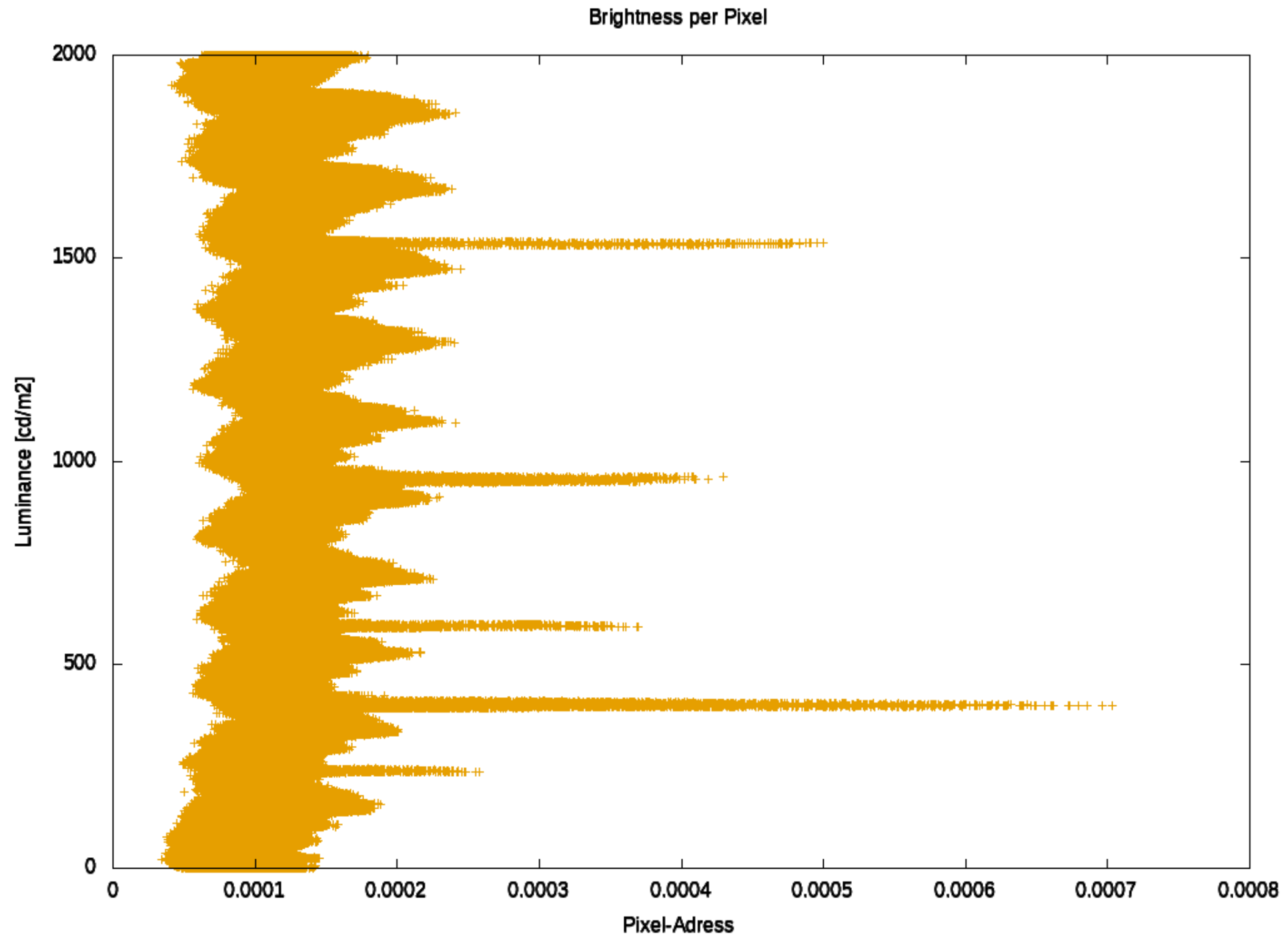
# Pvalue - gnuplot

# Using pvalue + gnuplot

```
pvalue -o -b -h -H hdr_in.hdr > data_out.txt
```

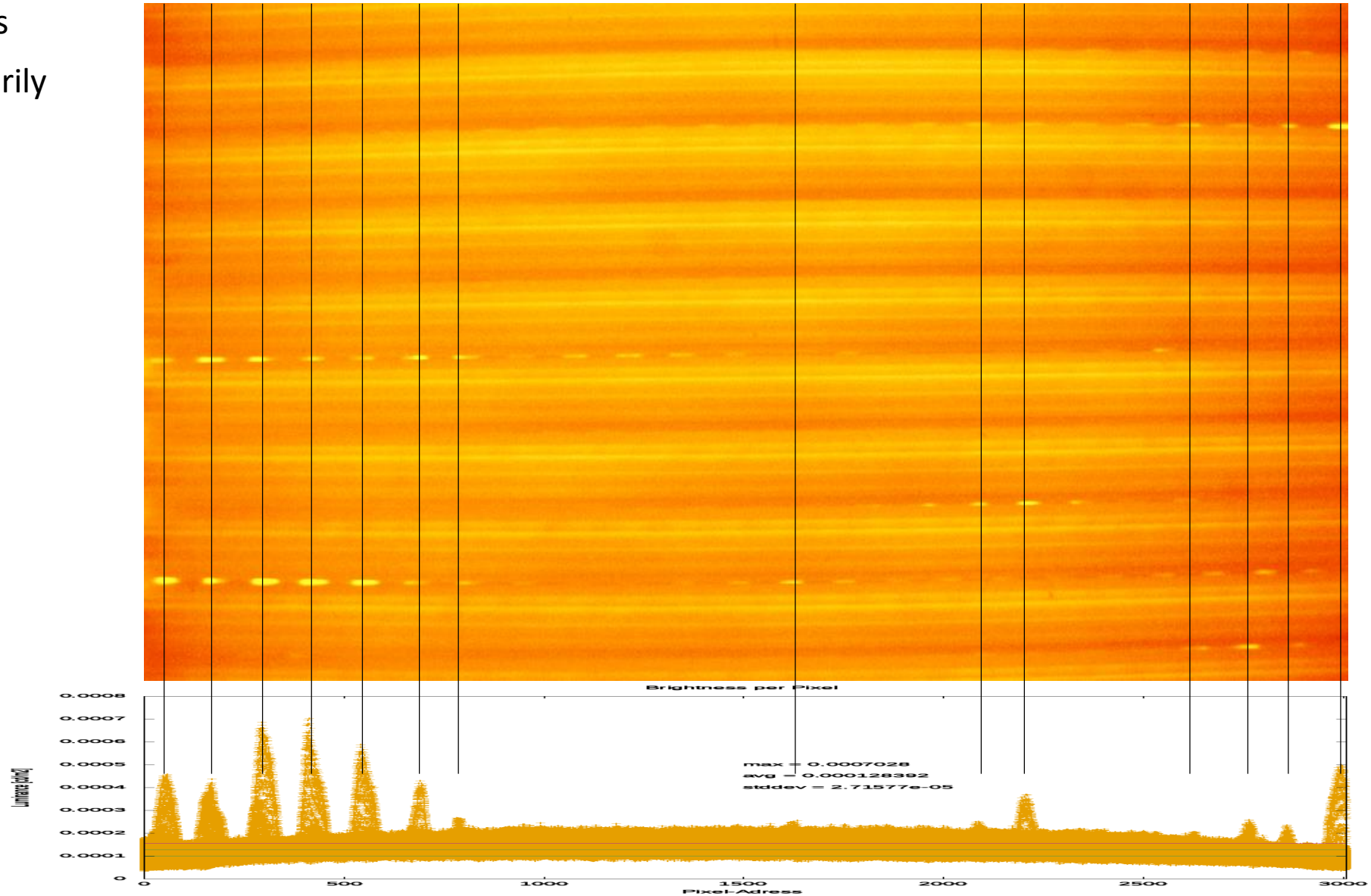
- Lars mailing list entry 2006

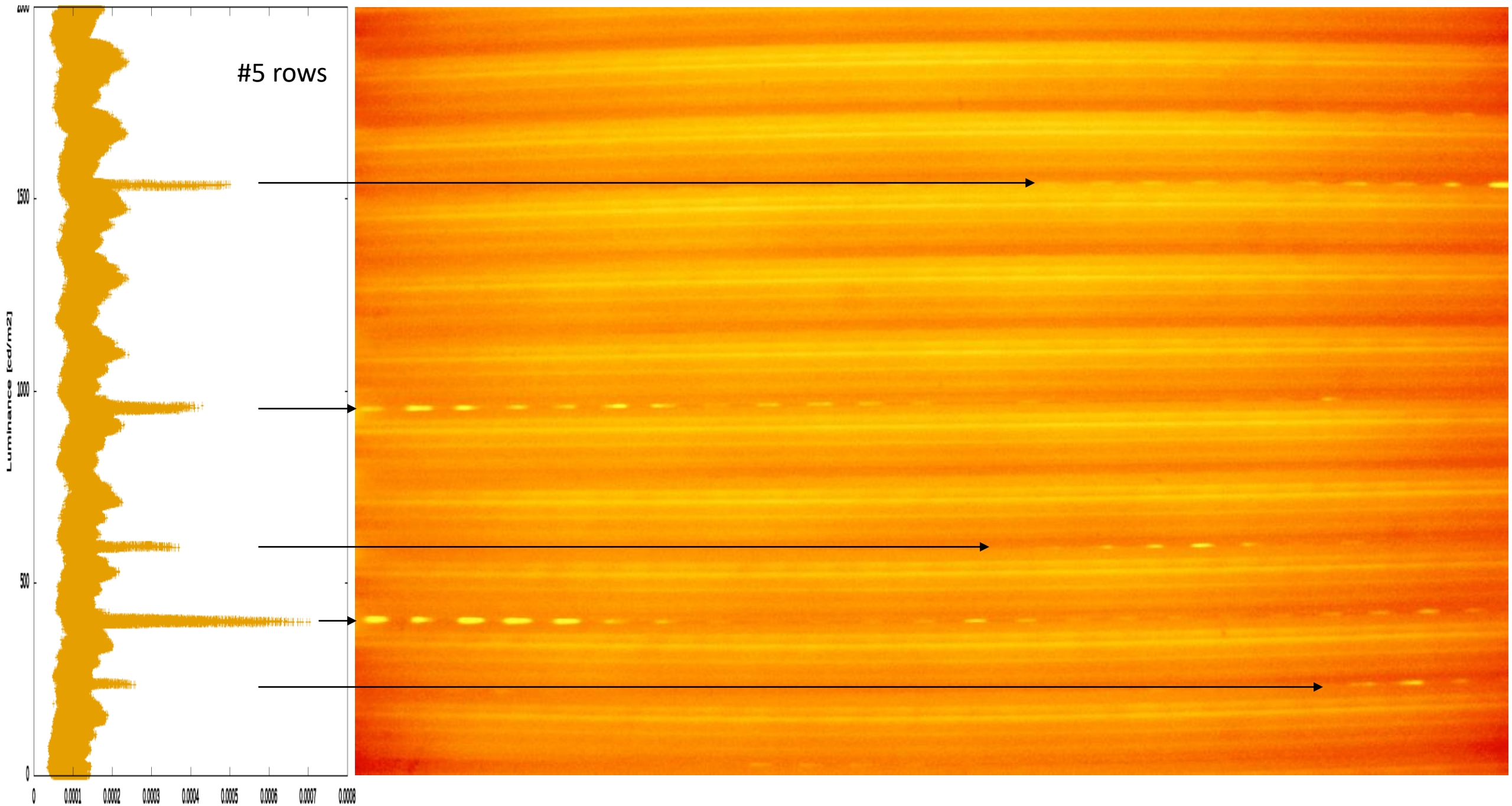


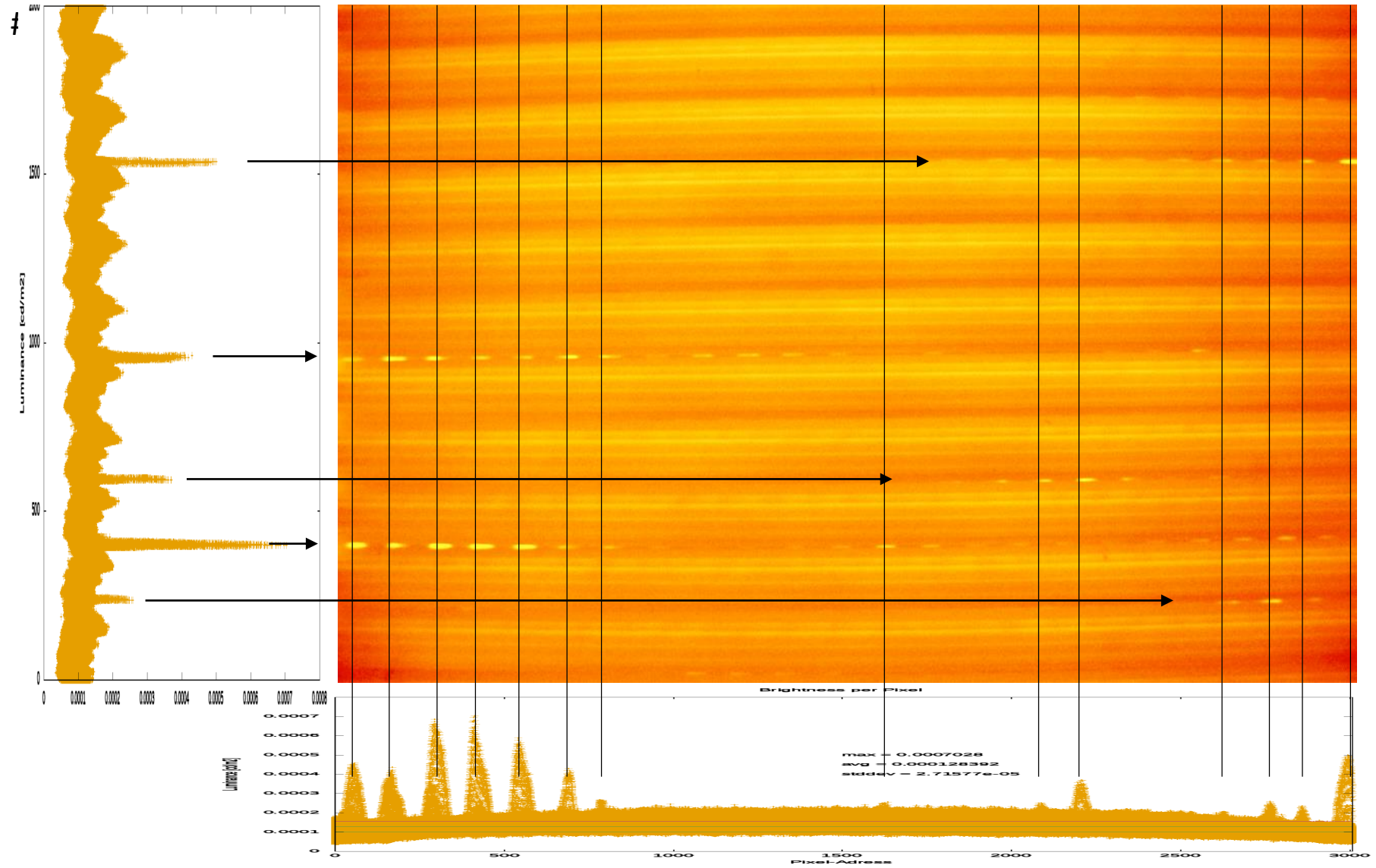




#14 columns  
 Not necessarily  
 aligned  
 vertically!









# Evalglare

```
evalglare -f -A mask.hdr -d -b $b -r $r -i $evlx -c checkfile.hdr in.hdr > detail_output.dat
```



# evalglare

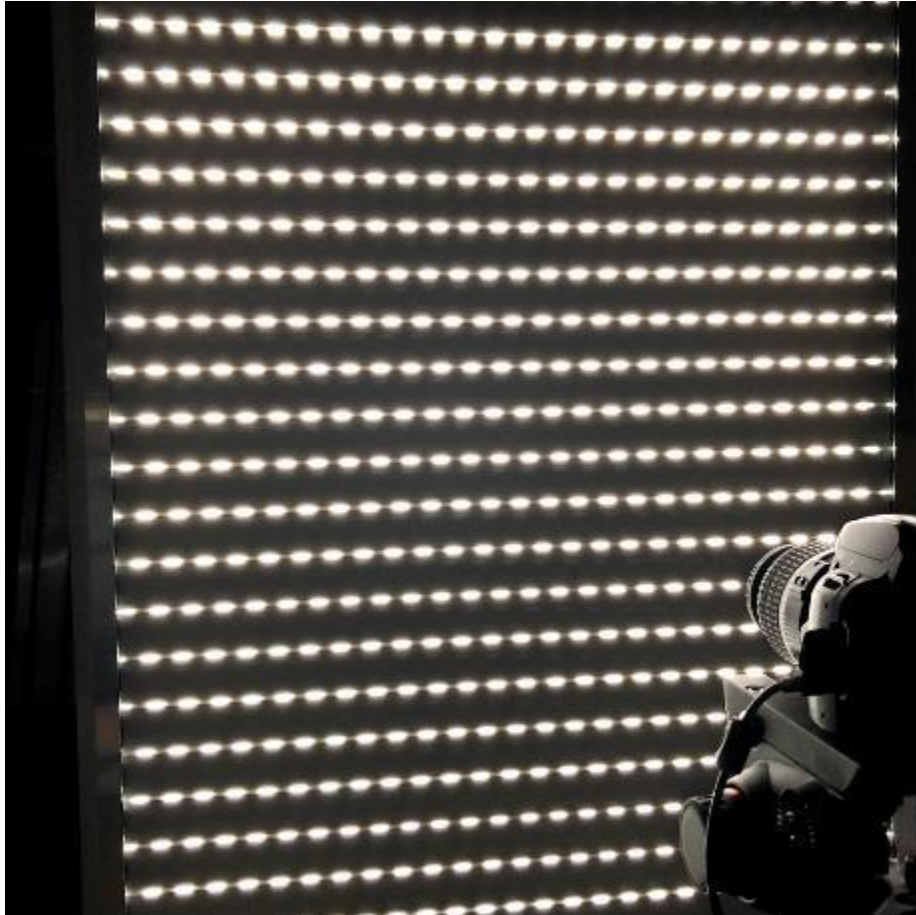
```
evalglare -f -A mask.hdr -d -b $b -r $r -i $evlx -c checkfile.hdr in.hdr > detail_output.dat
```

- f ... force to work on no-fisheye images and wrong headers
- A ... mask file (statistics on this area but no changes in source detection -> crop image for masking of source detection algorithm)
- d ... enables output of source description -> piped into a \*.dat file
- b ... multiplicator of source above mean luminance
- i ... measured vertical illuminance – in our application below measurement threshold 0.1
- c ... enables the generation of the \*.hdr showing the sources color shaded

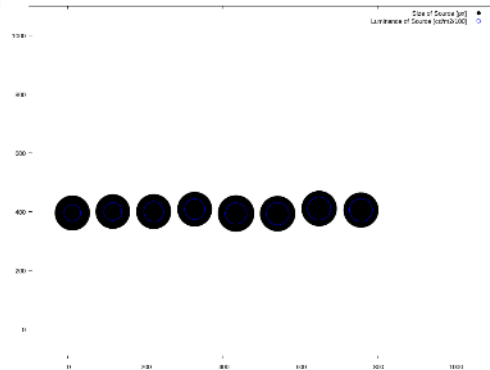
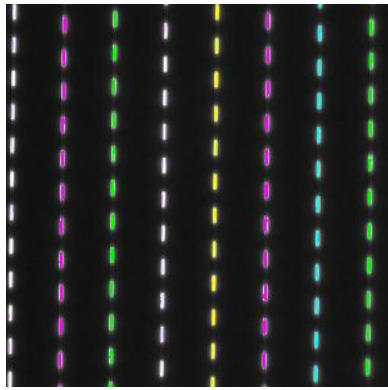
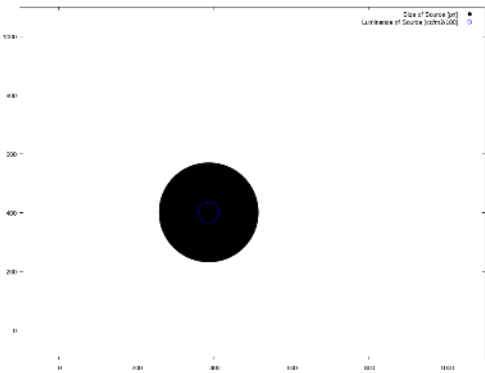
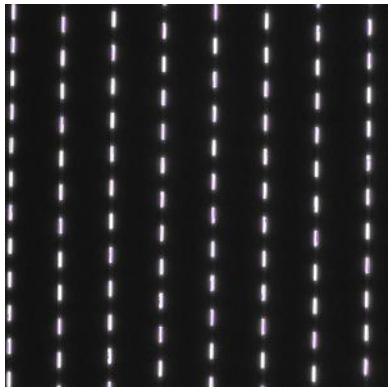
# Parameter setting b & r

Stretched shutter = visible punch holes

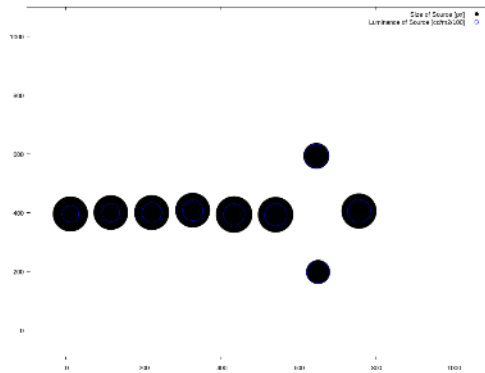
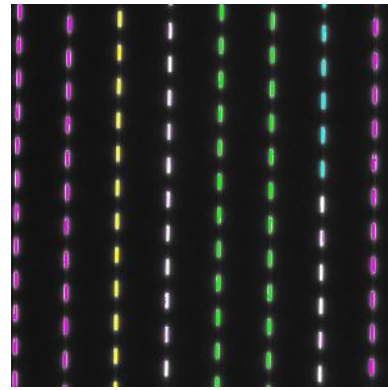
Two types of slats (52mm & 37mm)



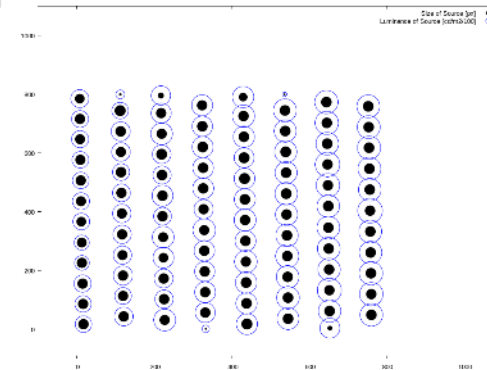
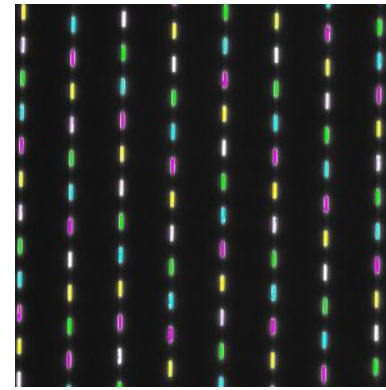
# K52 slat



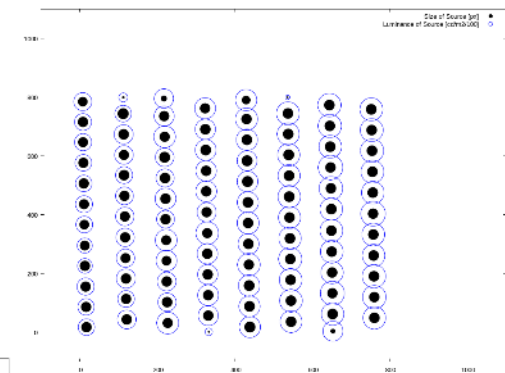
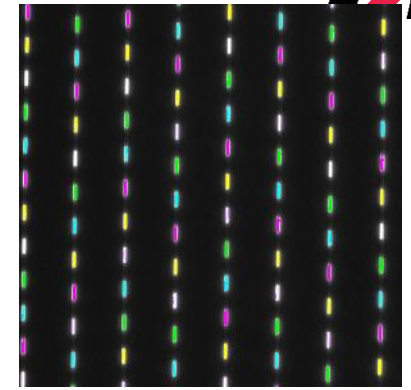
-b 2 -r 0.1



-b 2 -r 0.05



-b 2 -r 0.02



-b 2 -r 0.01

-b 2 -r 0.2



K52 closed with artefacts  
Peaks approx. 55pixel in x &  
9 pixel in y-direction

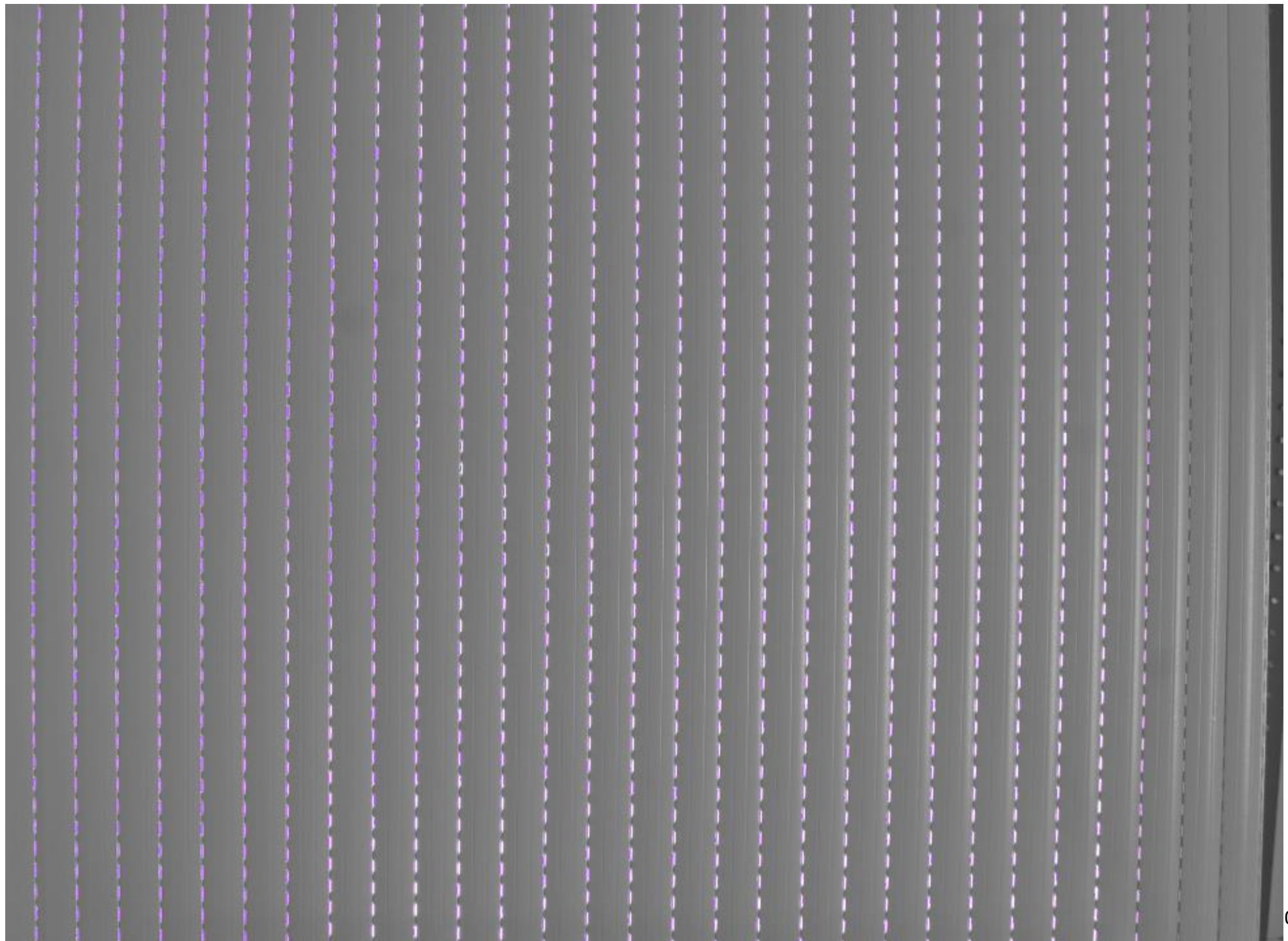
@3x2Megapixel Resolution



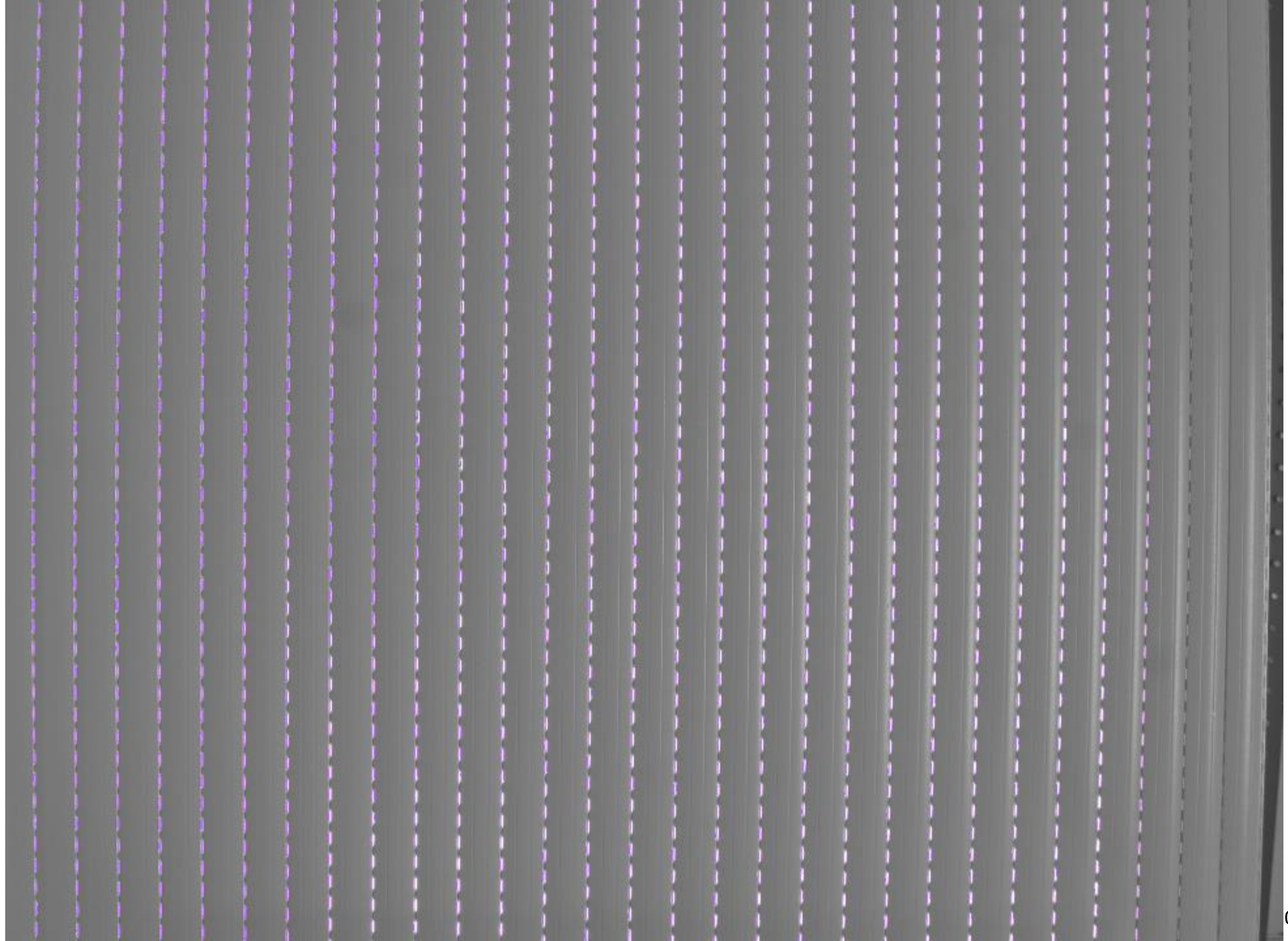
Indication:

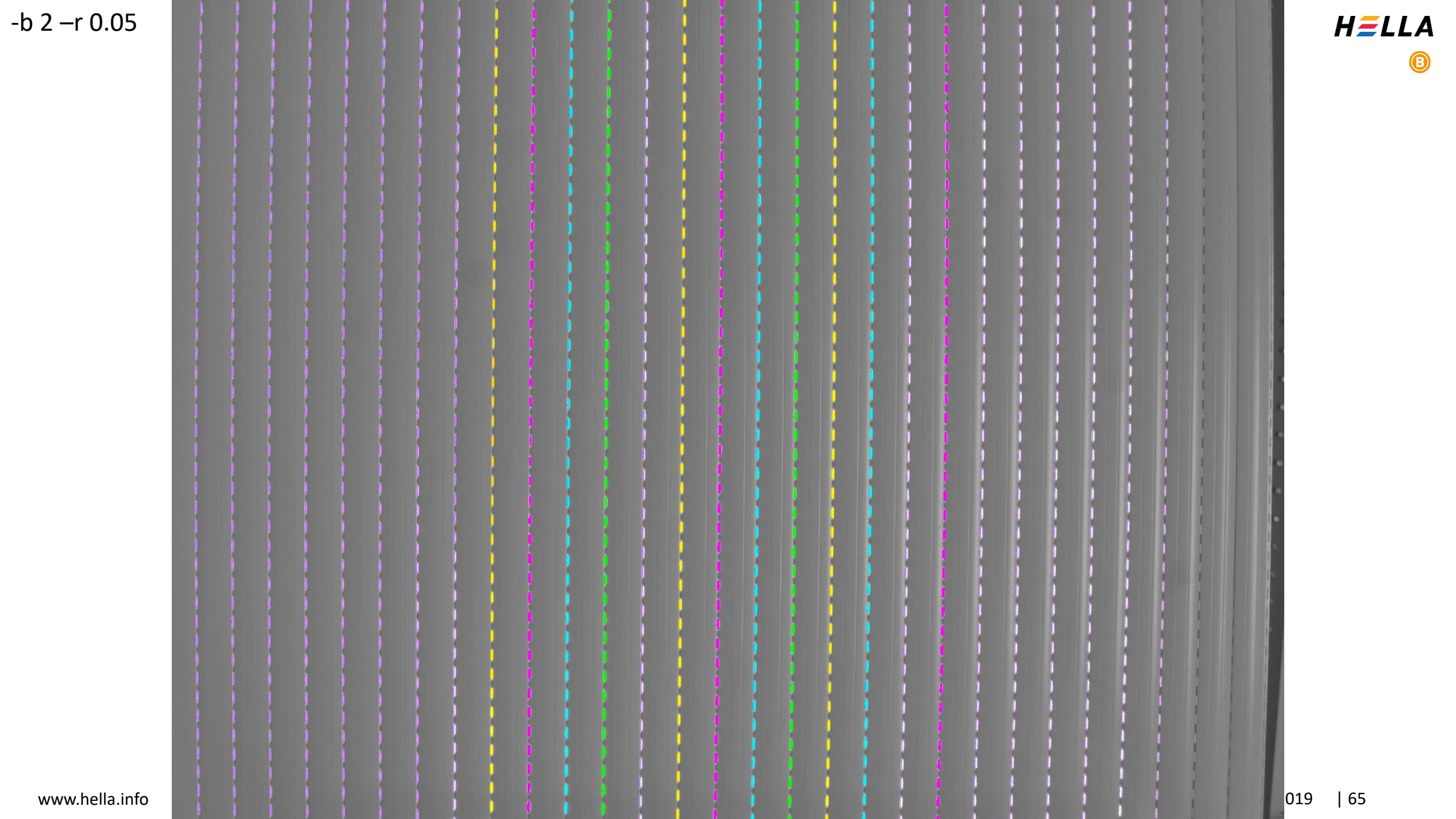
$55\text{pixel/peak} / 3000\text{pixel}/66^\circ = \sim 0.021\text{rad/peak}$  in x-direction  
 $9\text{pixel/peak} / 2000\text{pixel}/47^\circ = \sim 0.004\text{rad/peak}$  in y-direction

# A37 slat



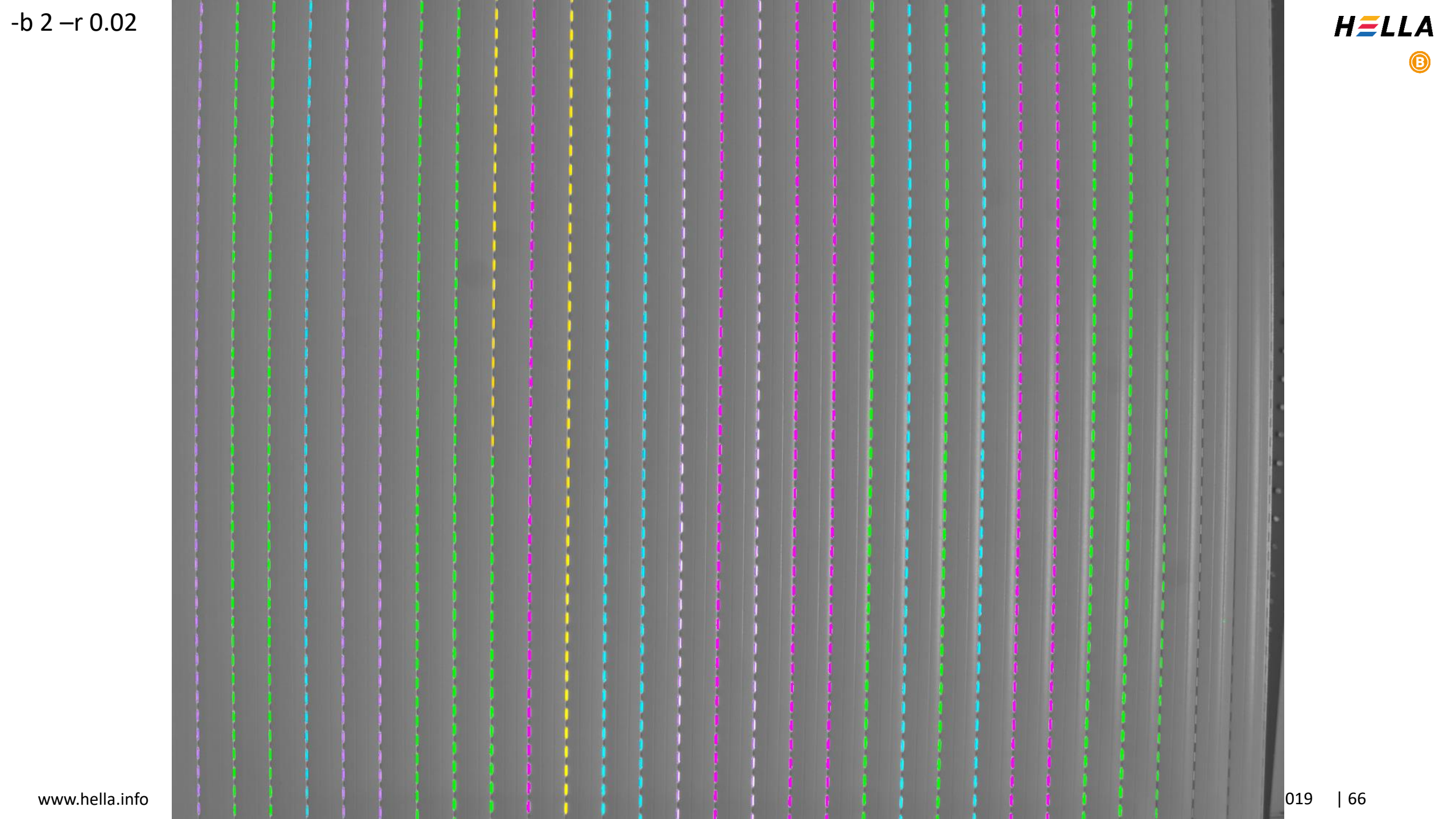




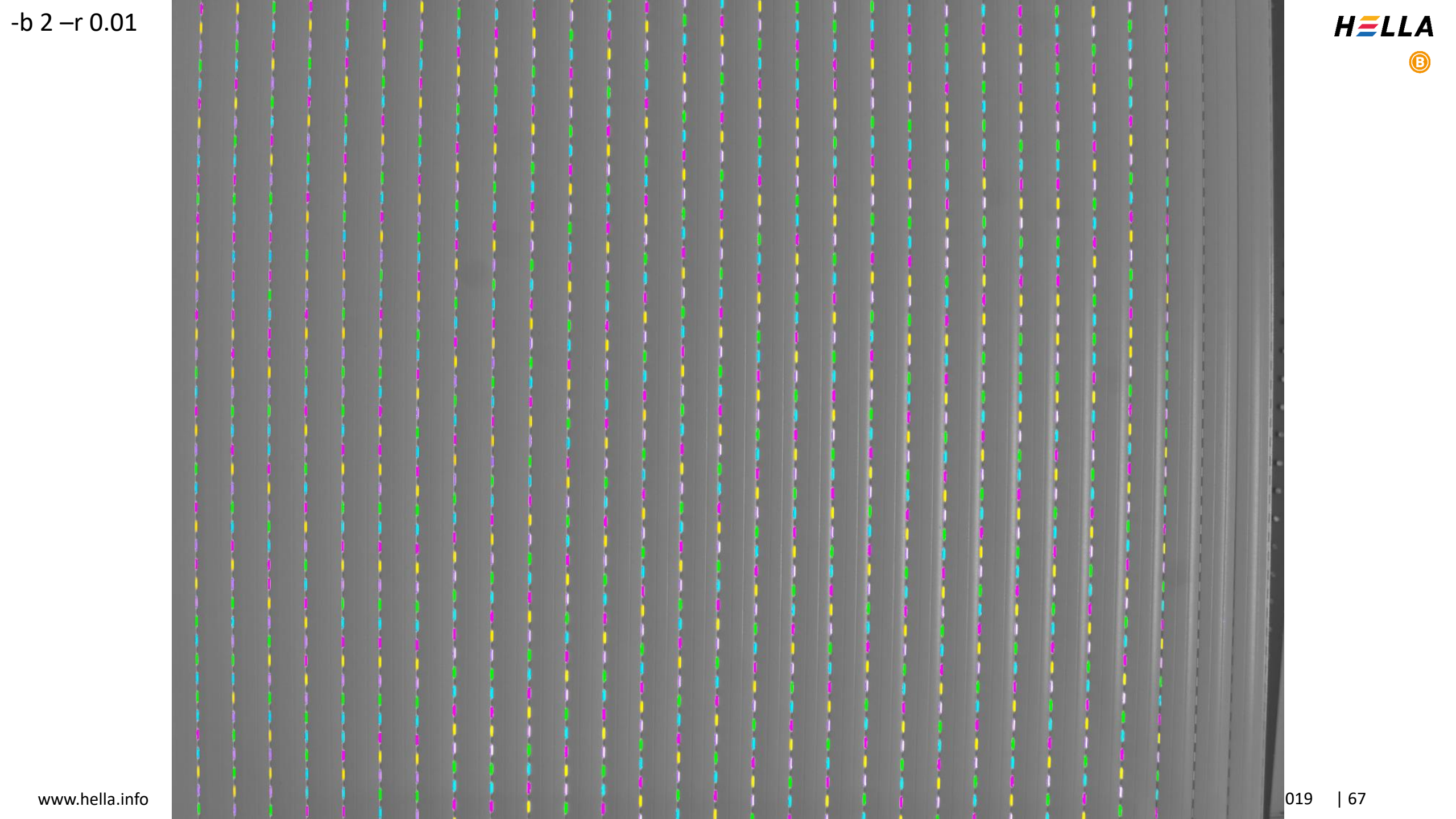


-b 2 -r 0.05

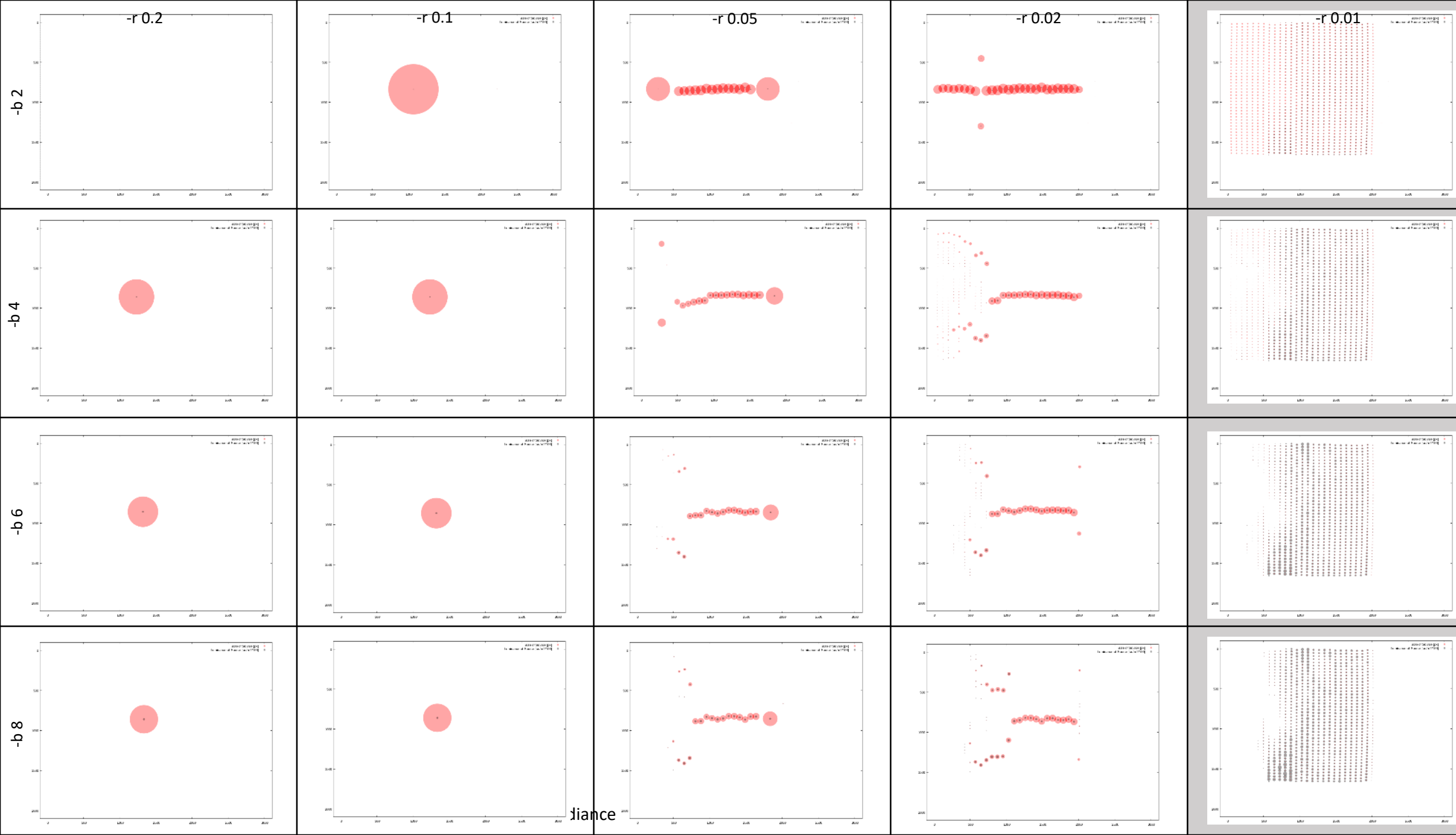




-b 2 -r 0.02



-b 2 -r 0.01



# ISO setting

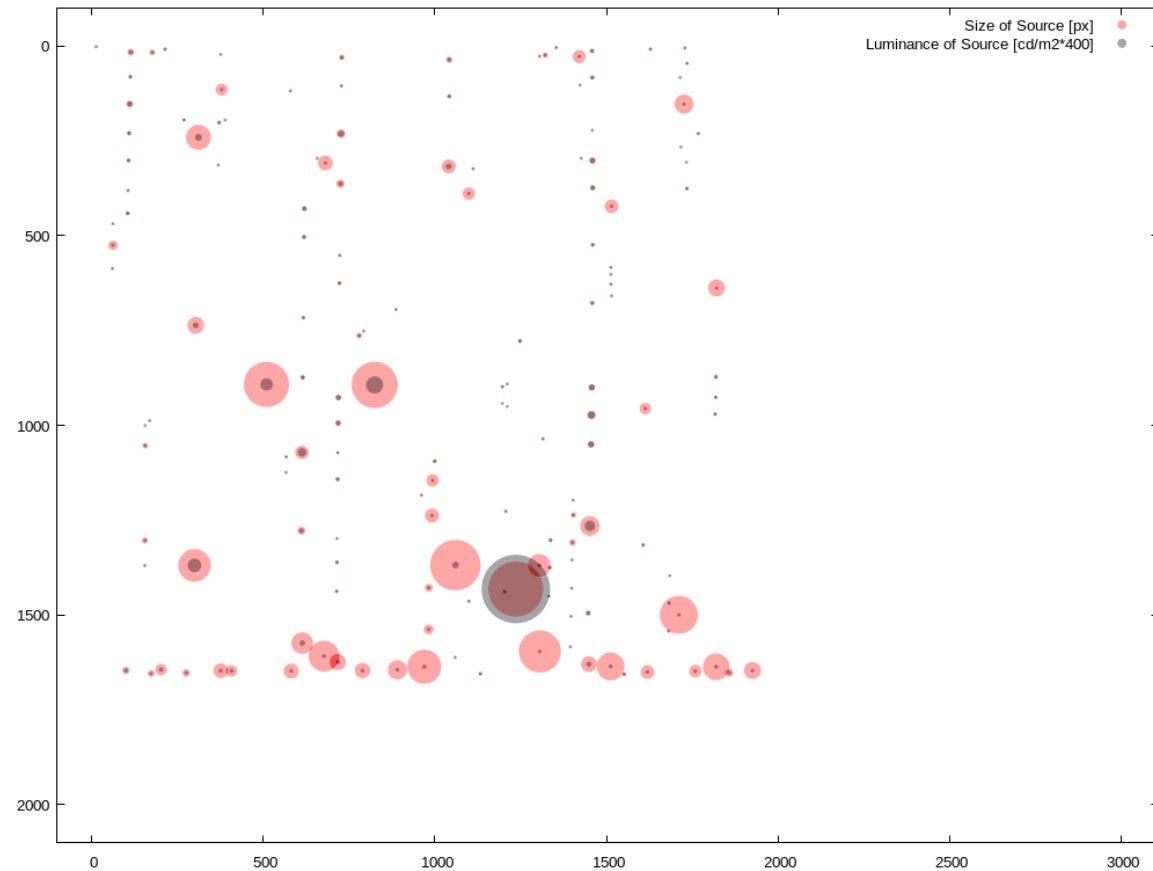


# ISO 800 or 1600

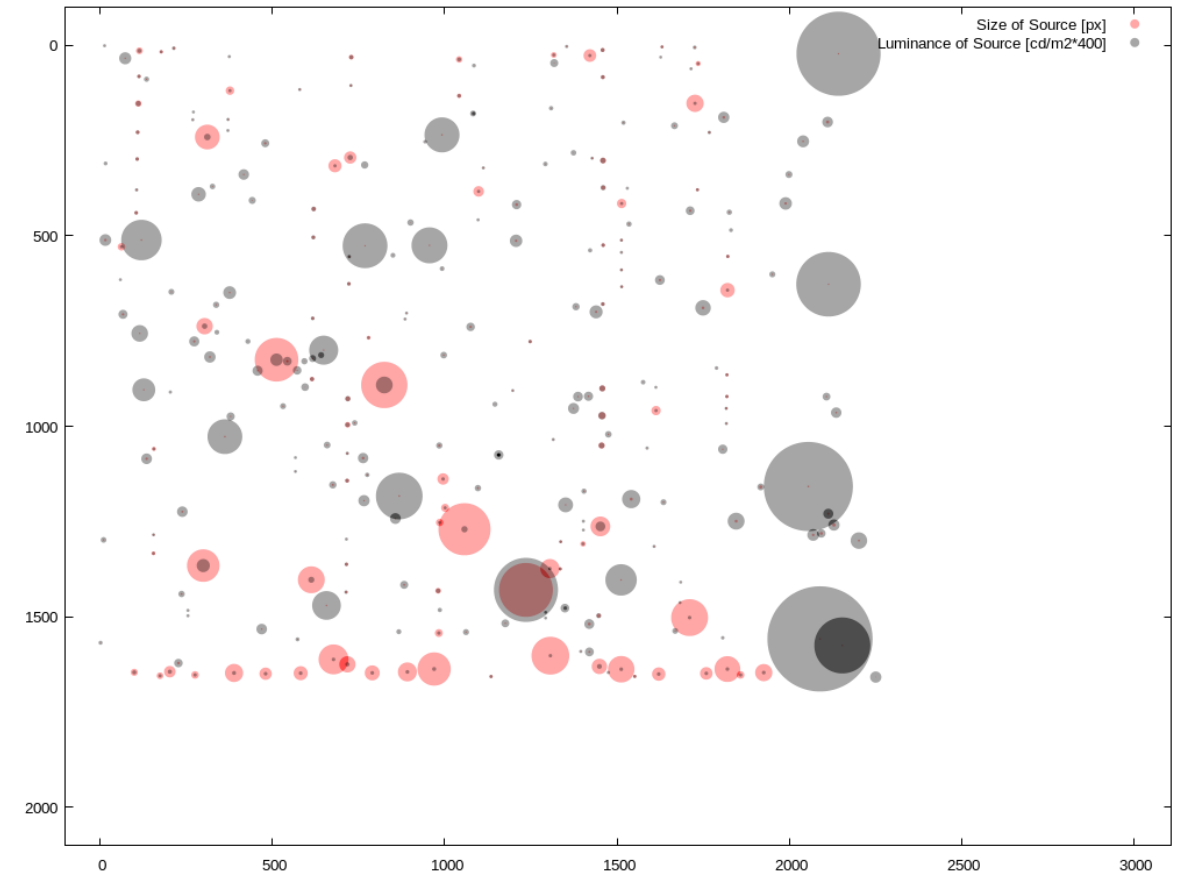
-b 2 -r 0.02

Session K52 7

## ISO 800



## ISO 1600





# Test series

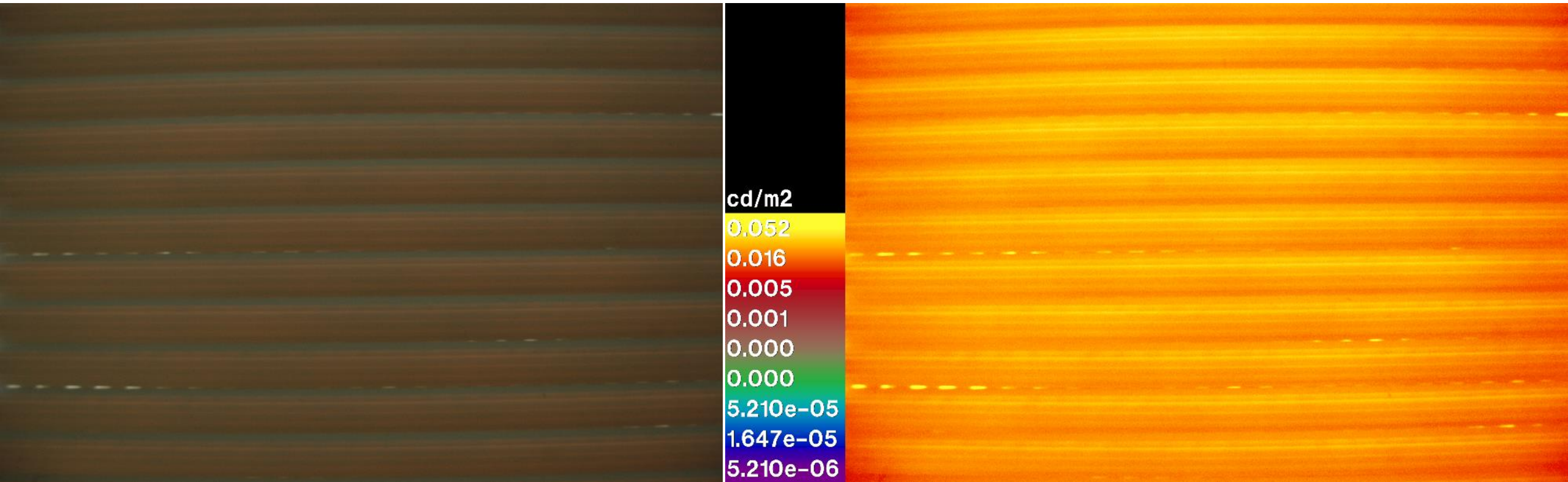


# get photos

hdrgen64bit -o hdr\_out.hdr -a -x -k -r response\_in.rsp DSC\_00??.JPG

EXPOSURE=4.837157e+02

VIEW= -vtv -vh 65.898430 -vv 46.627210

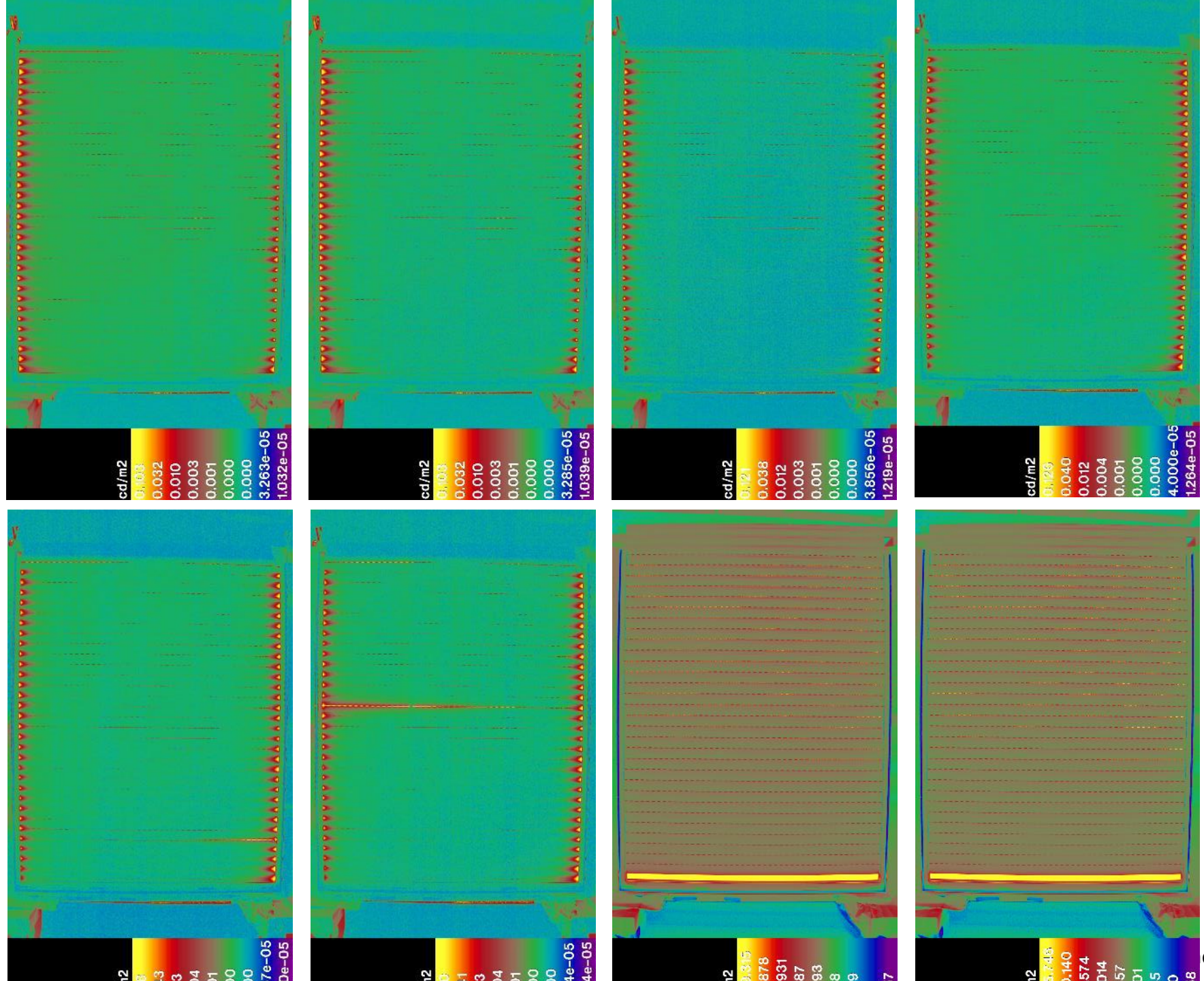


# A37

series of 8



A37 1 – 8  
800





# A37 – mask result

Output of evalglare mask algorithm

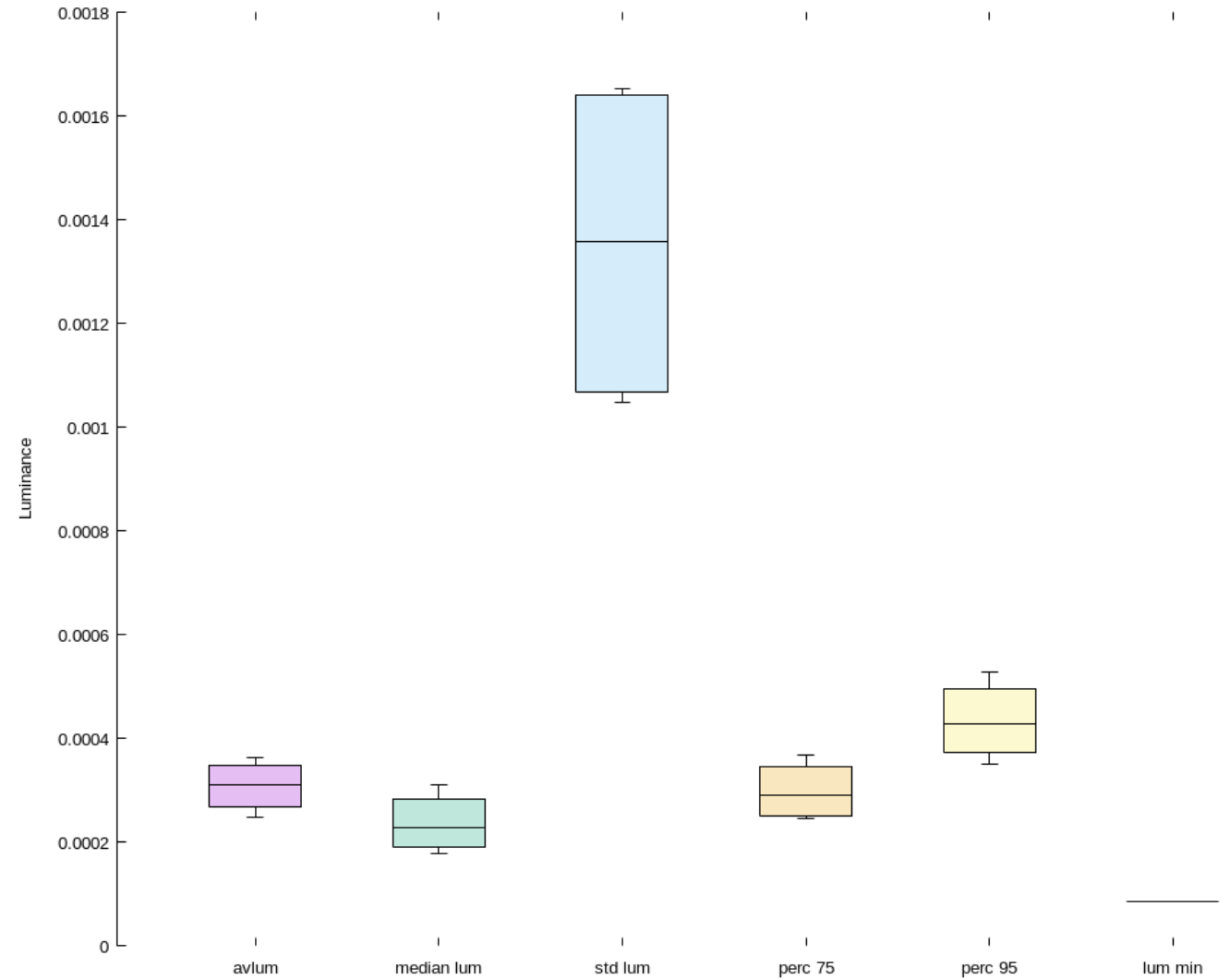
mask = full image, which was cropped beforehand

4 Series

Identical shutter

Moving between measurements

Too early too show real statistic

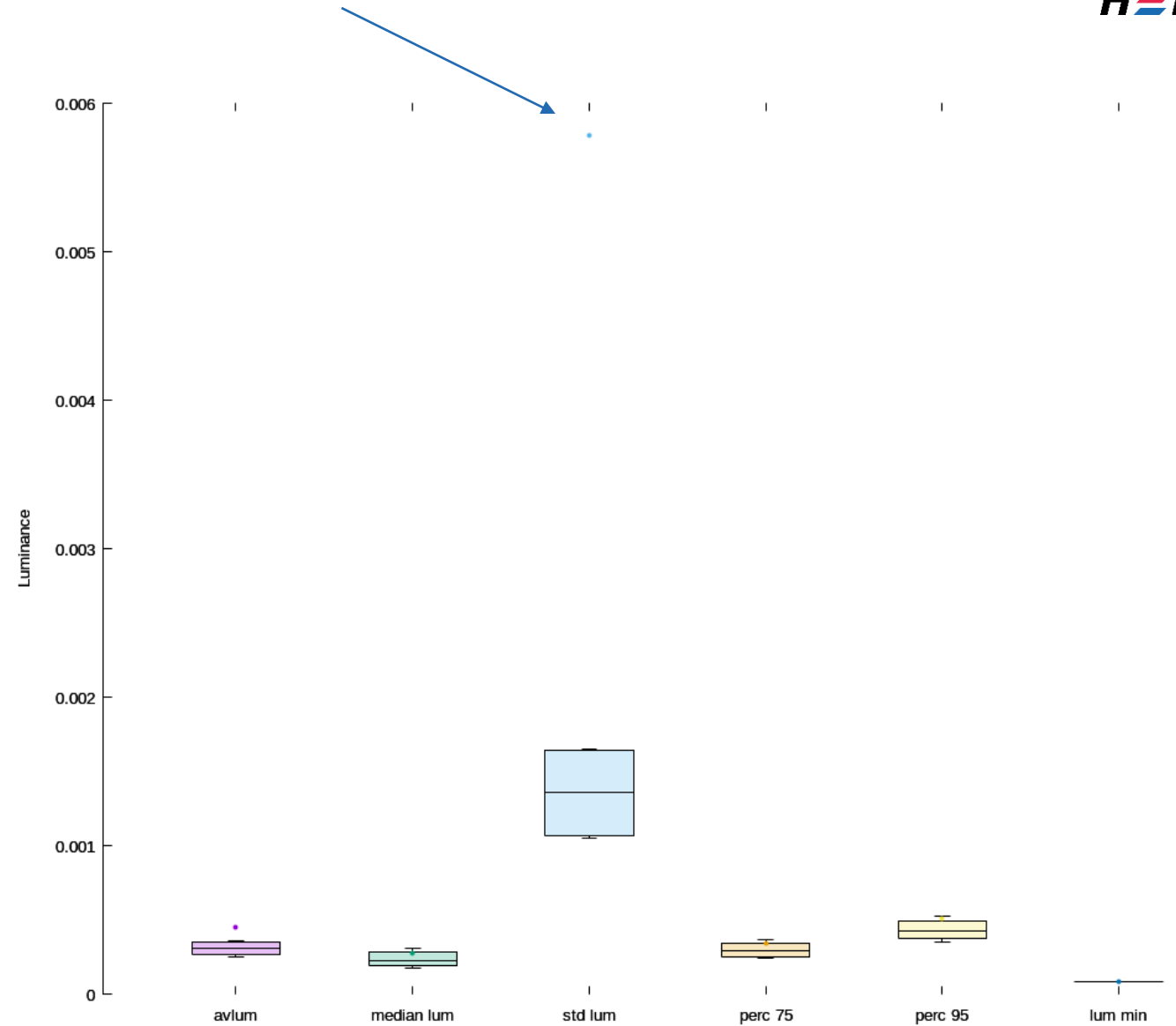


# A37 – manipulated

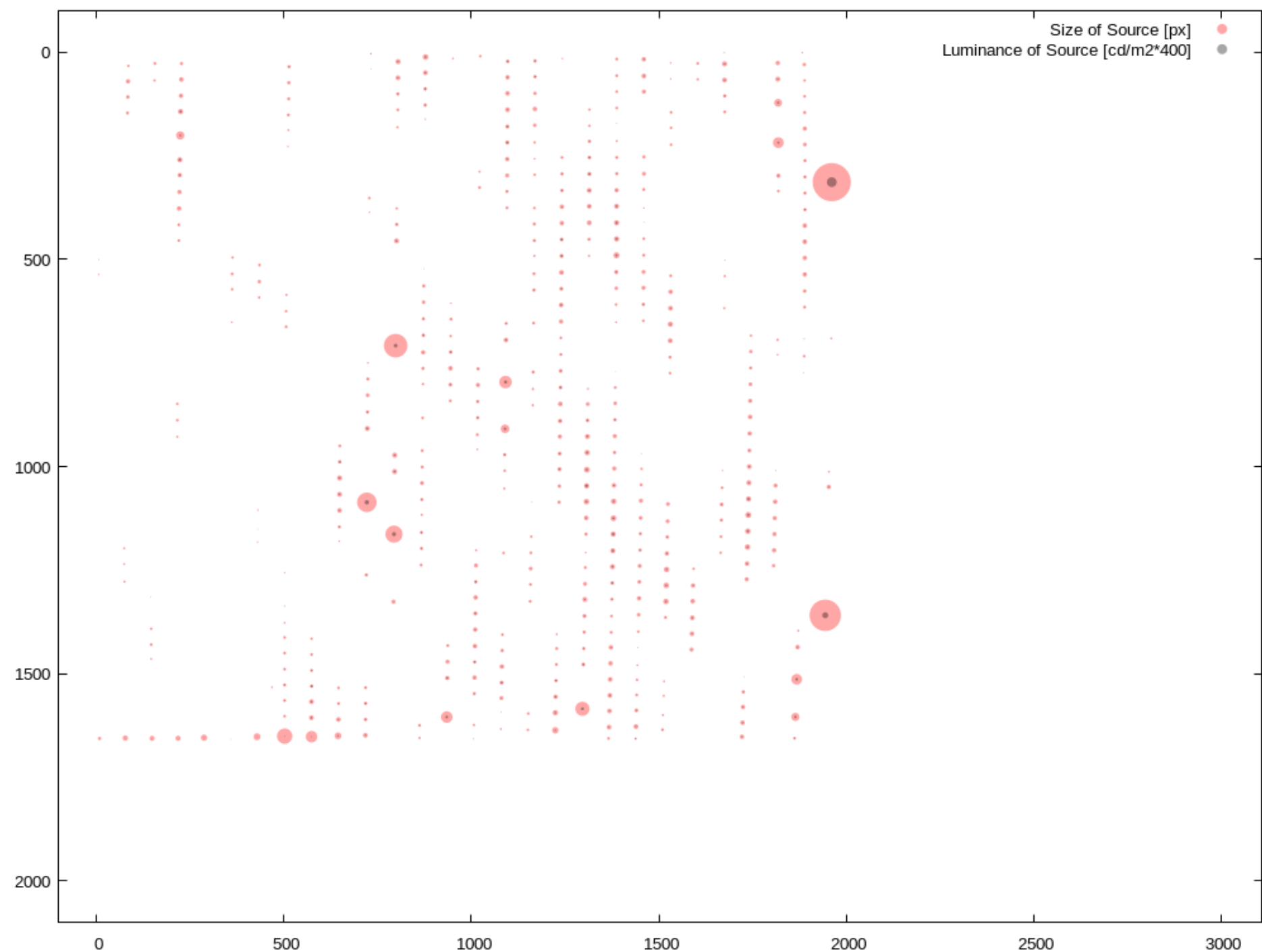
Output of evalglare mask algorithm

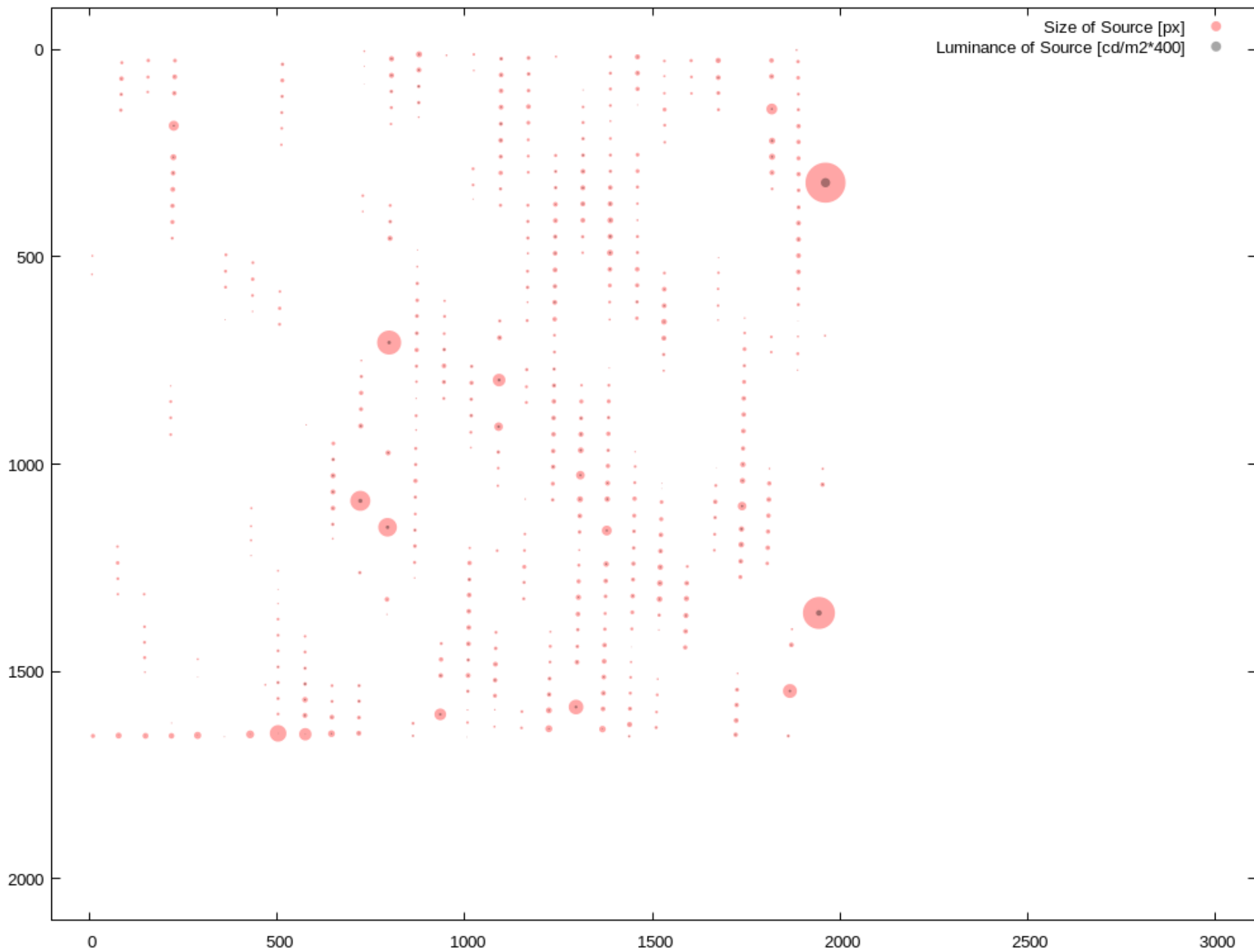
mask = full image, which was cropped beforehand

std\_lum changes most



A37 1  
- b 6 - r 0.01

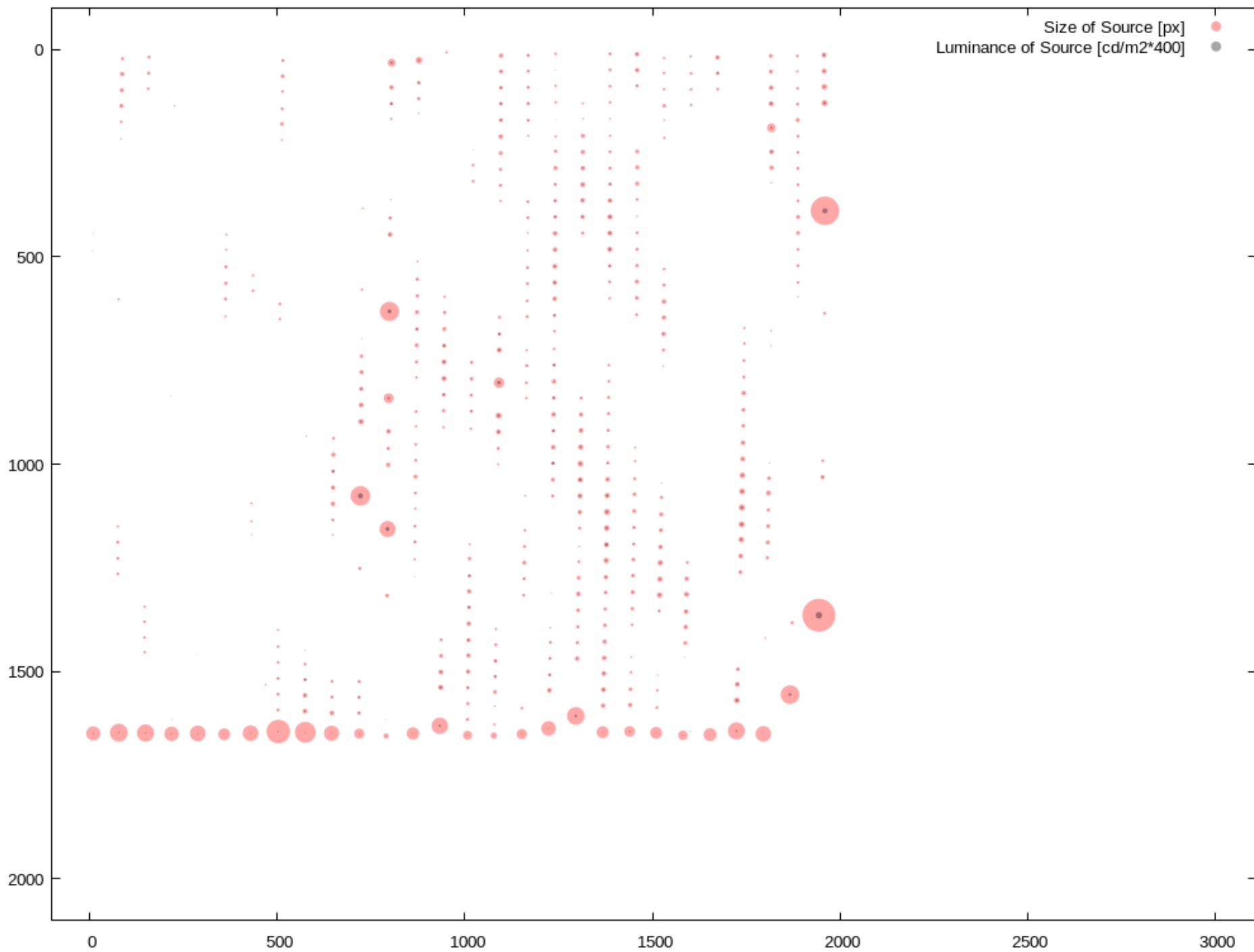




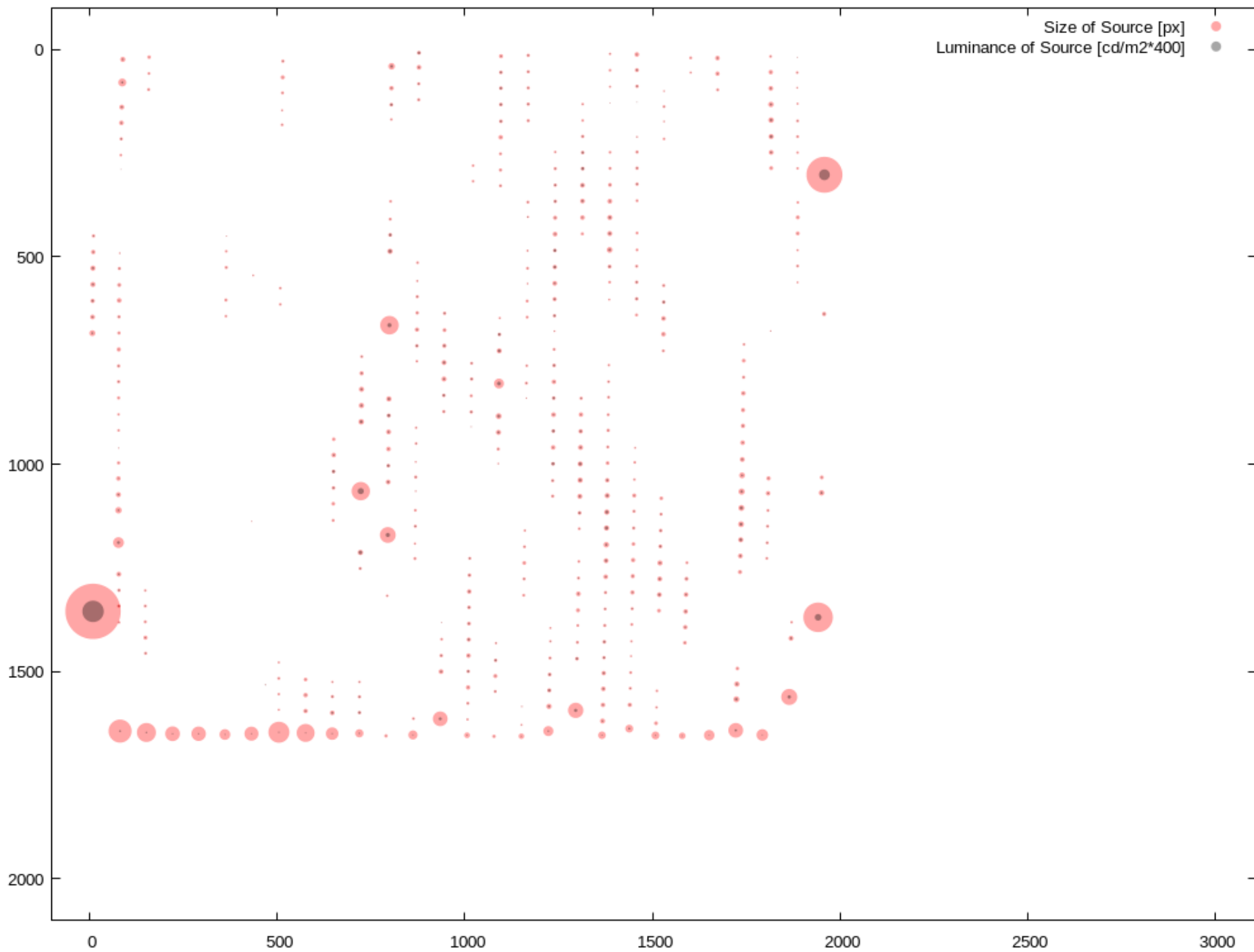




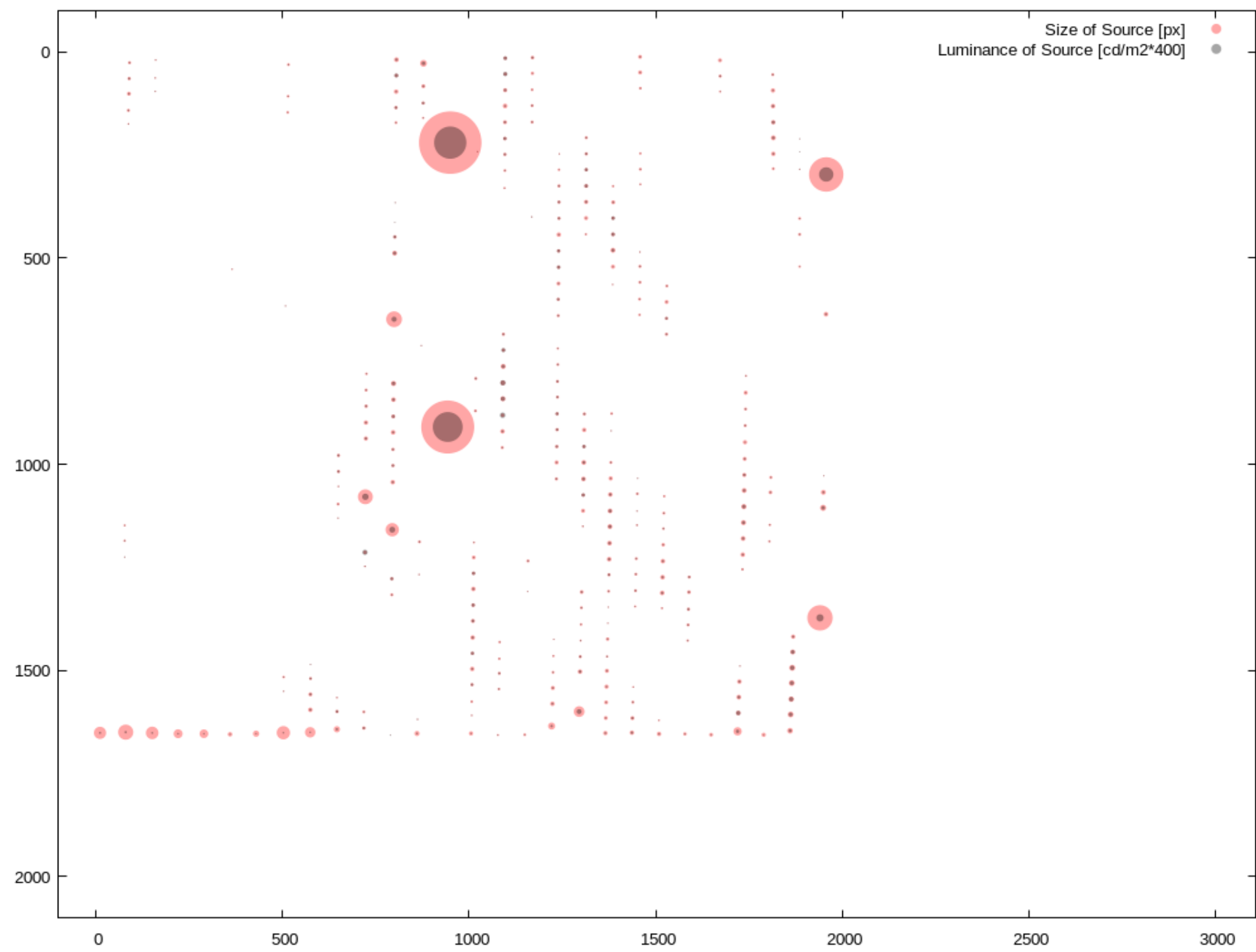
A37 4  
- b 6 -r 0.01

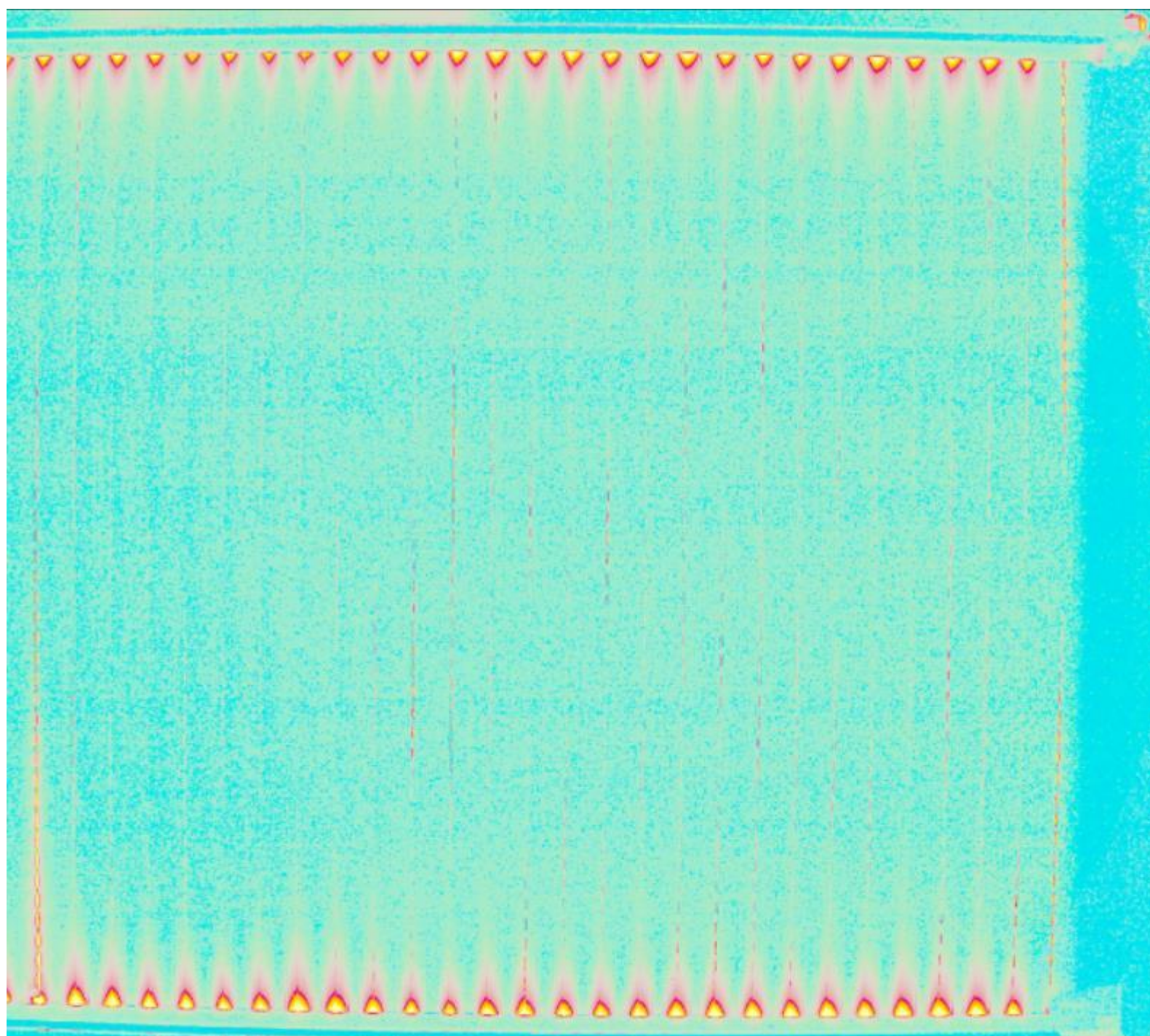


A37 5  
- b 6 - r 0.01

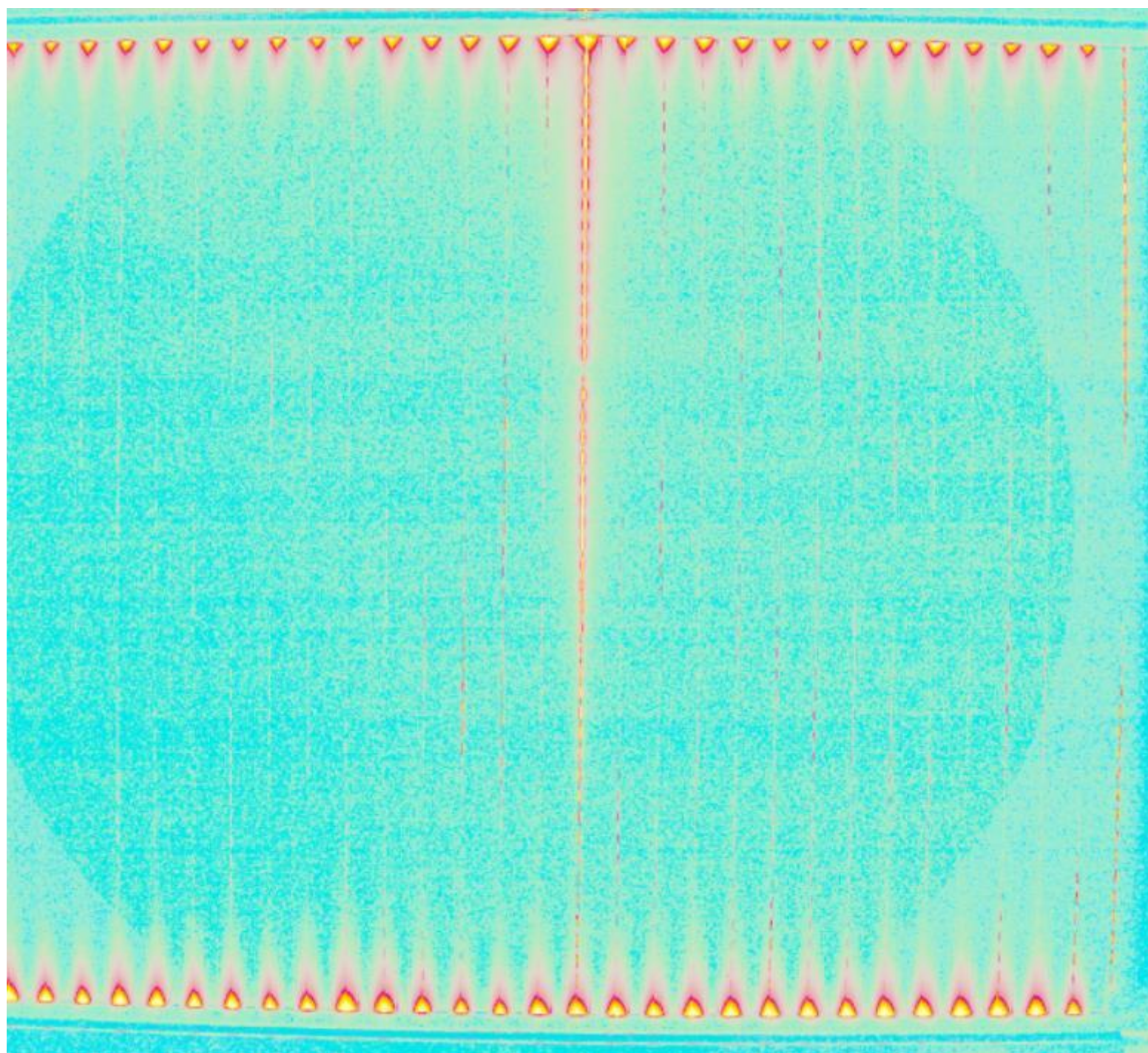


A37 6  
- b 6 -r 0.01



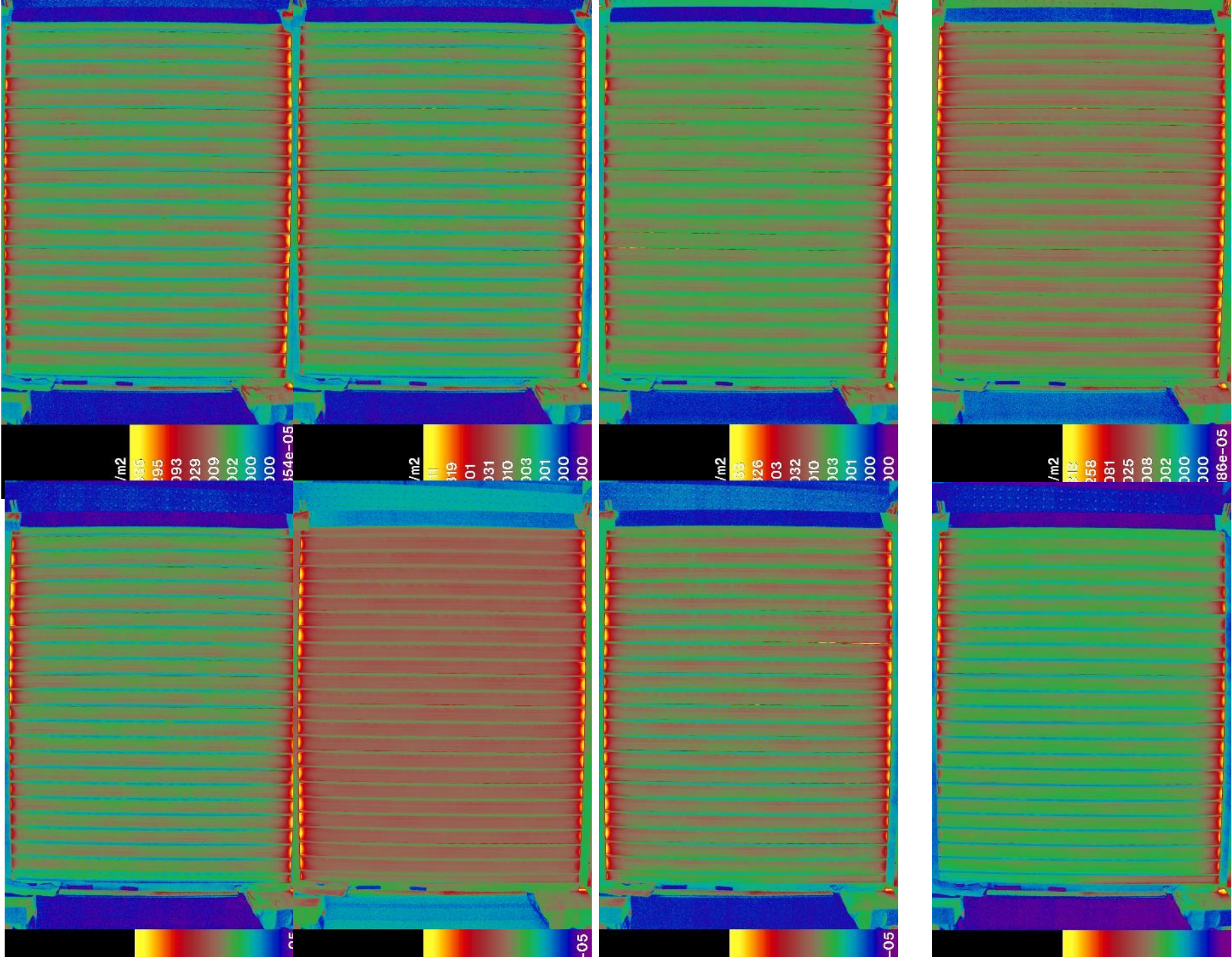




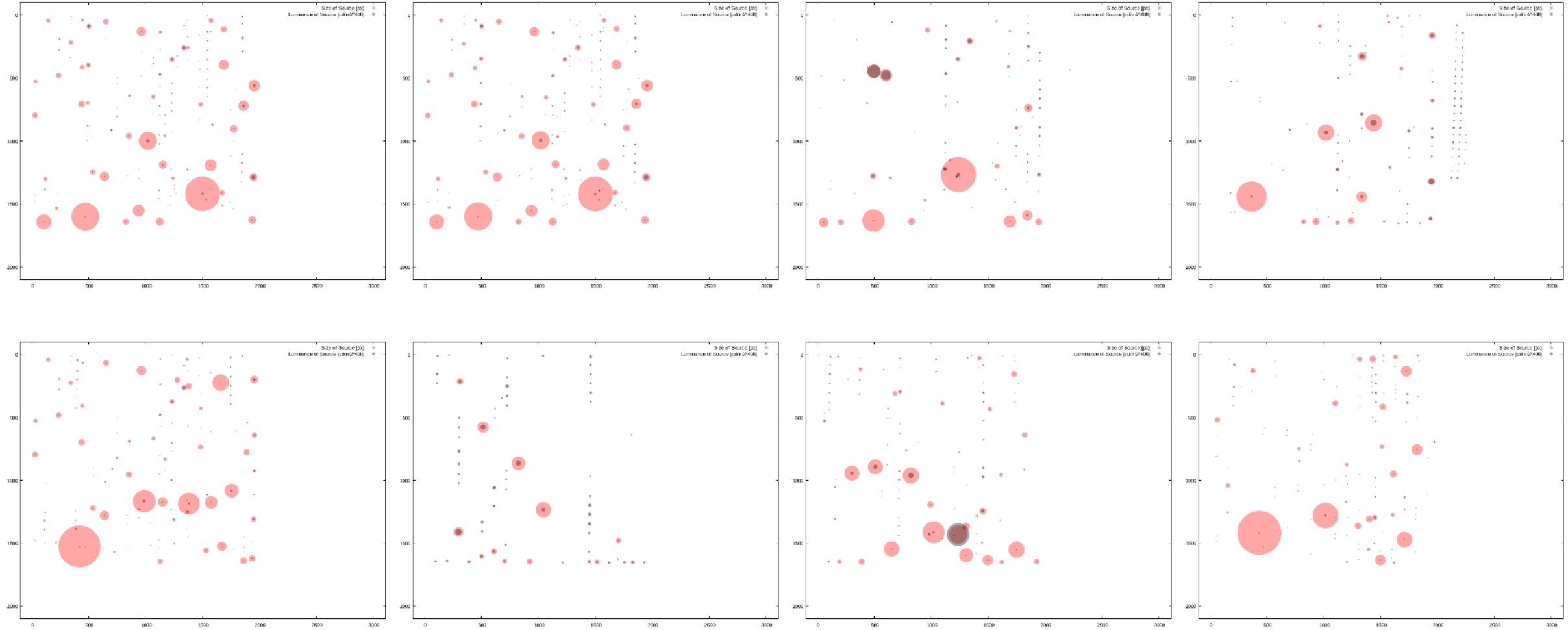


# K52

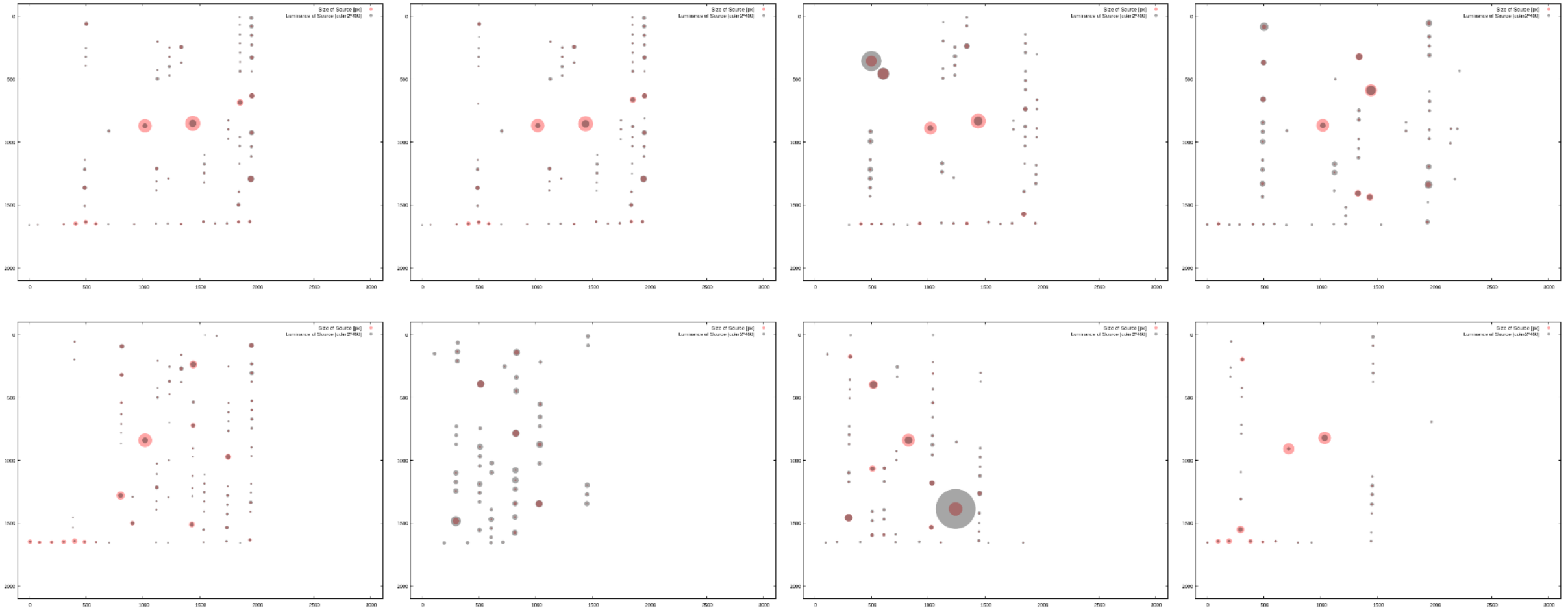




$-b \ 2 - r \ 0.02$



-b 4 - r 0.02





# Result

# Assessment Result

## A) Quantified: Evolving Statistic of evalglare maskdata

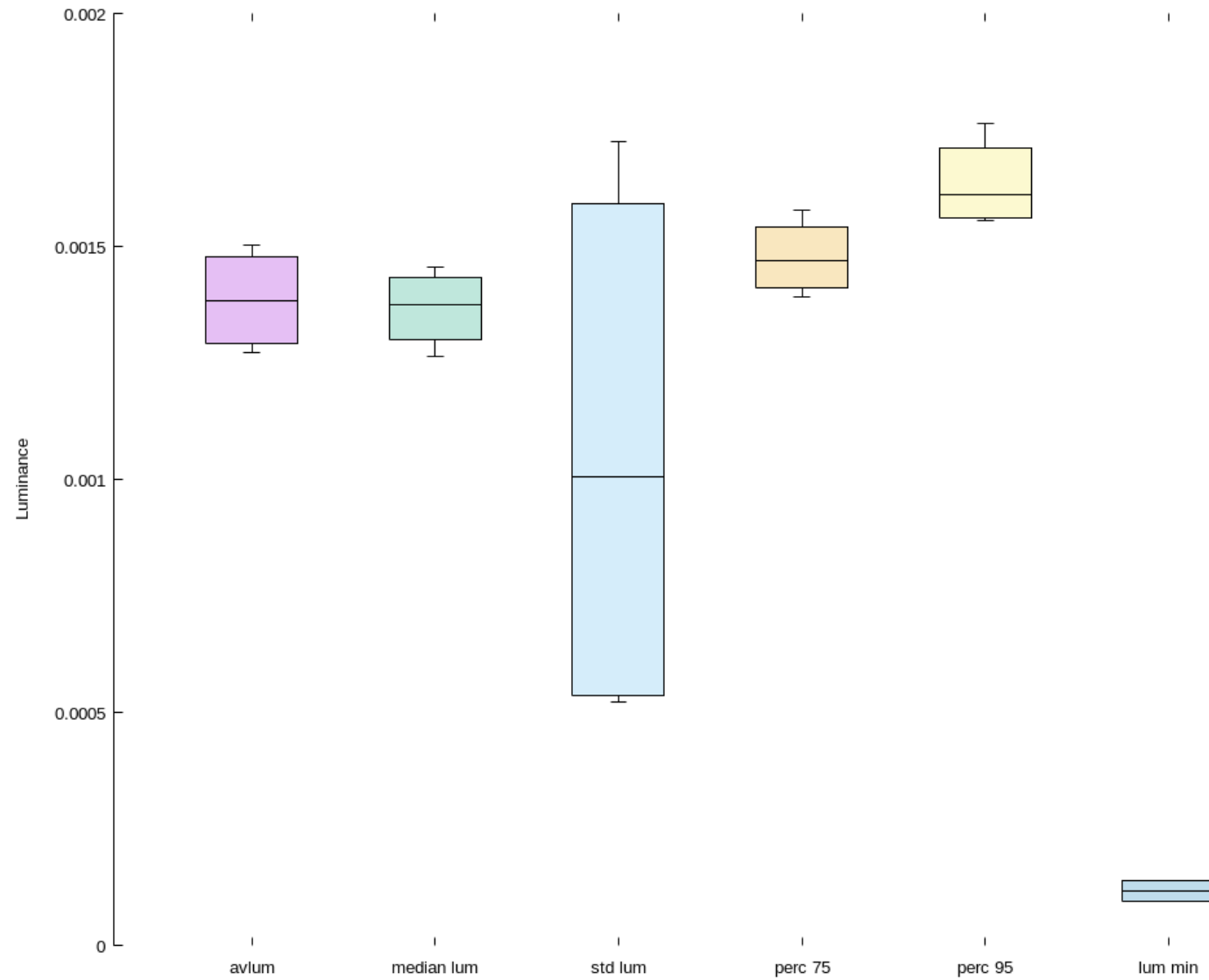
- no\_pixels
- Omega
- av\_lum
- median\_lum
- std\_lum
- perc\_75
- perc\_95
- lum\_min
- lum\_max

## B) Qualitative: Evolving x,y,circle plots

# A maskdata

Statistic

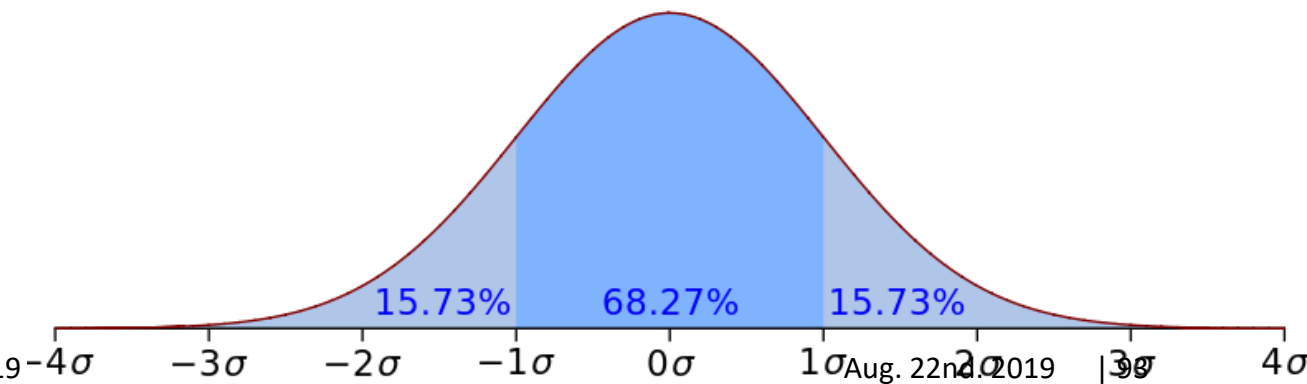
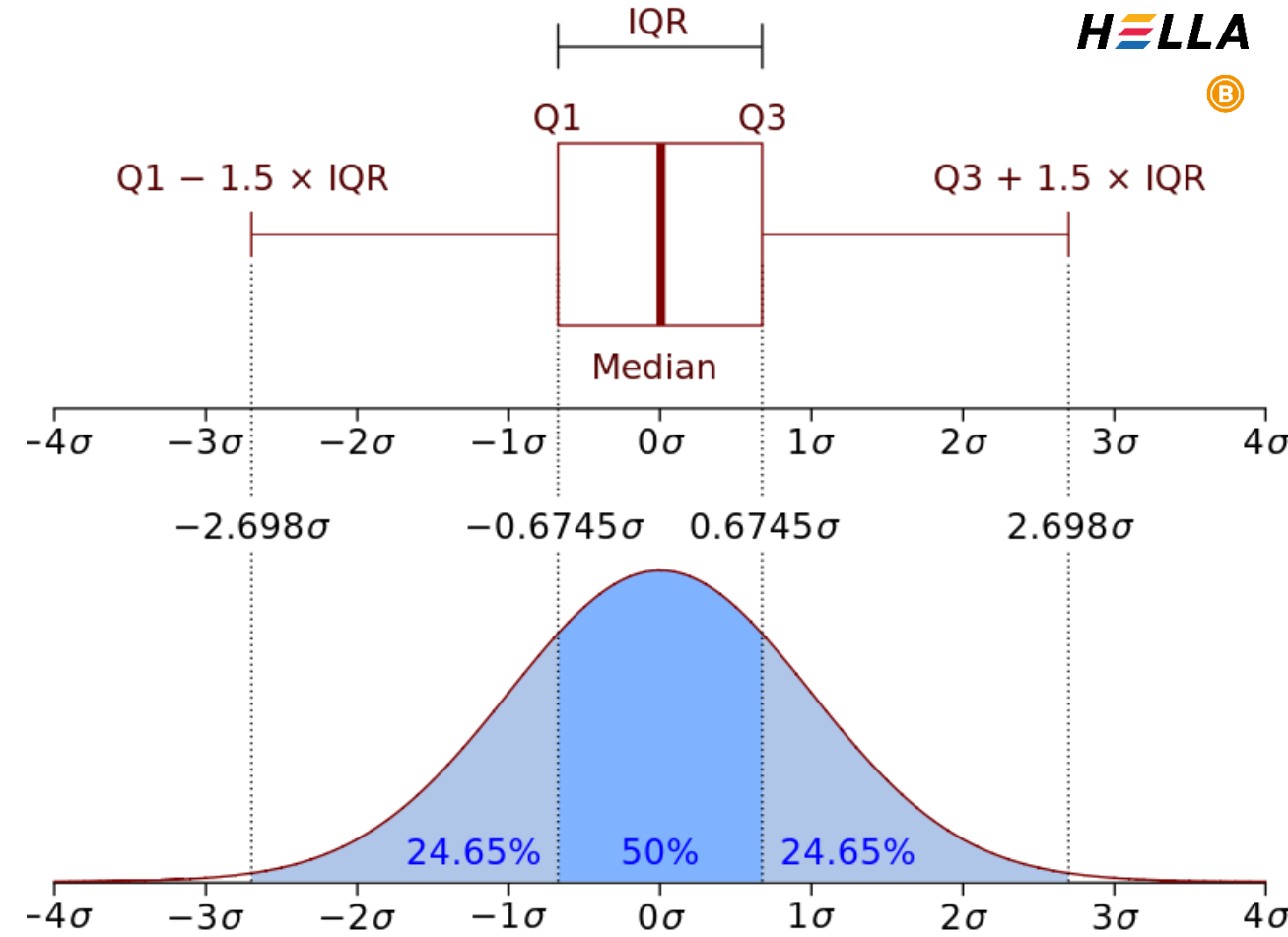
Whiskers (1.5 IQR)



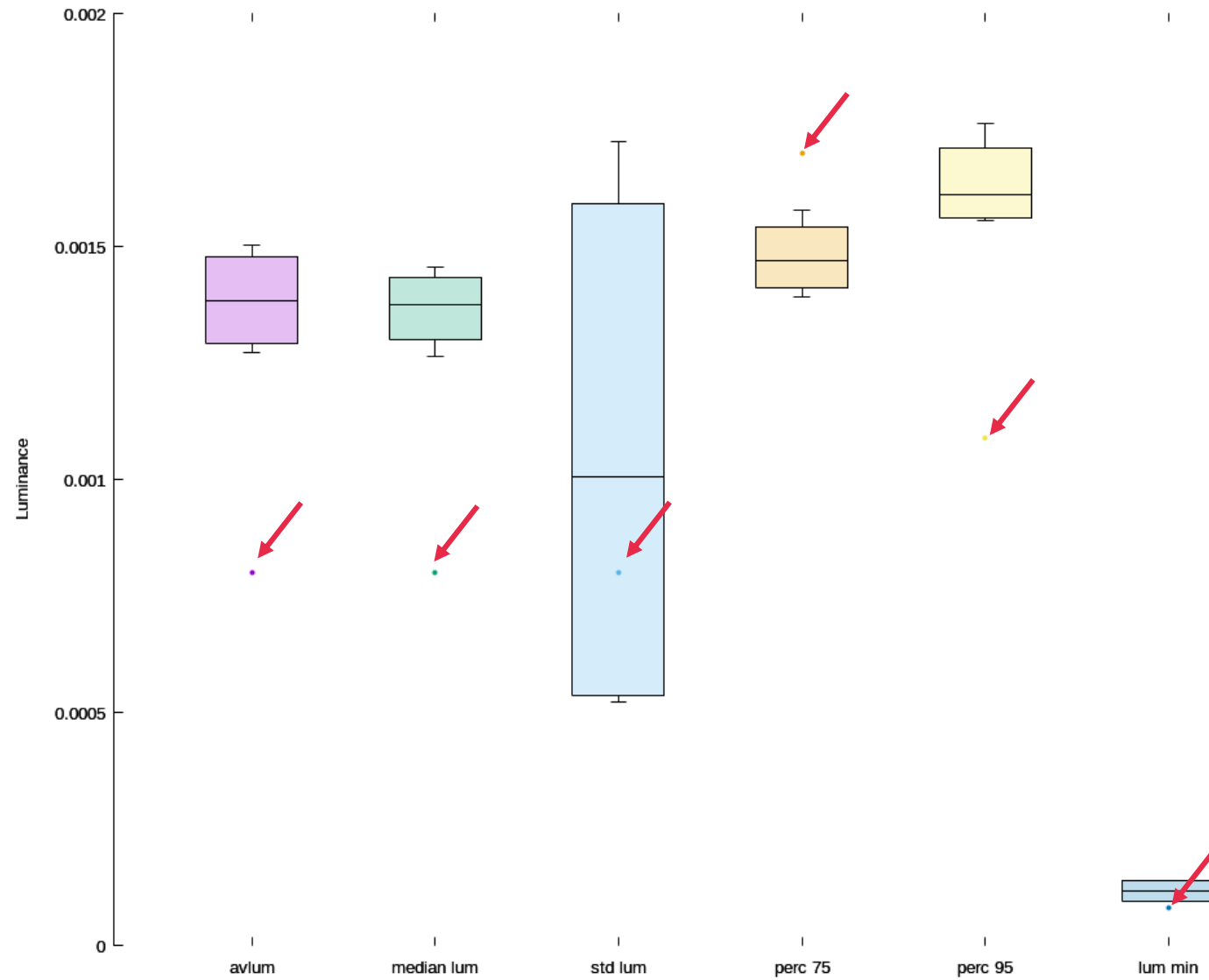
# Outliers IQR

Inter Quartile Range

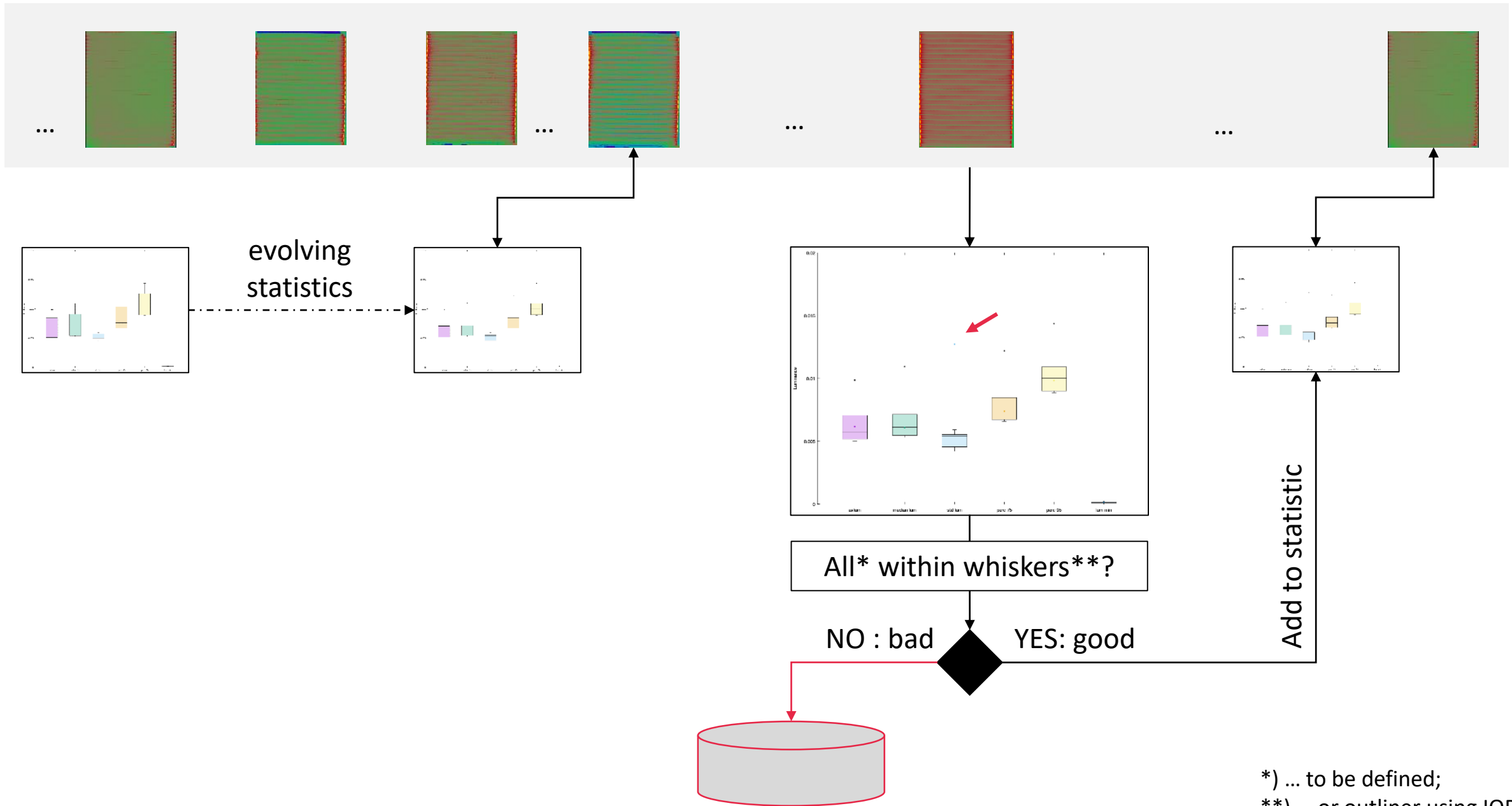
Soft or hard outlier



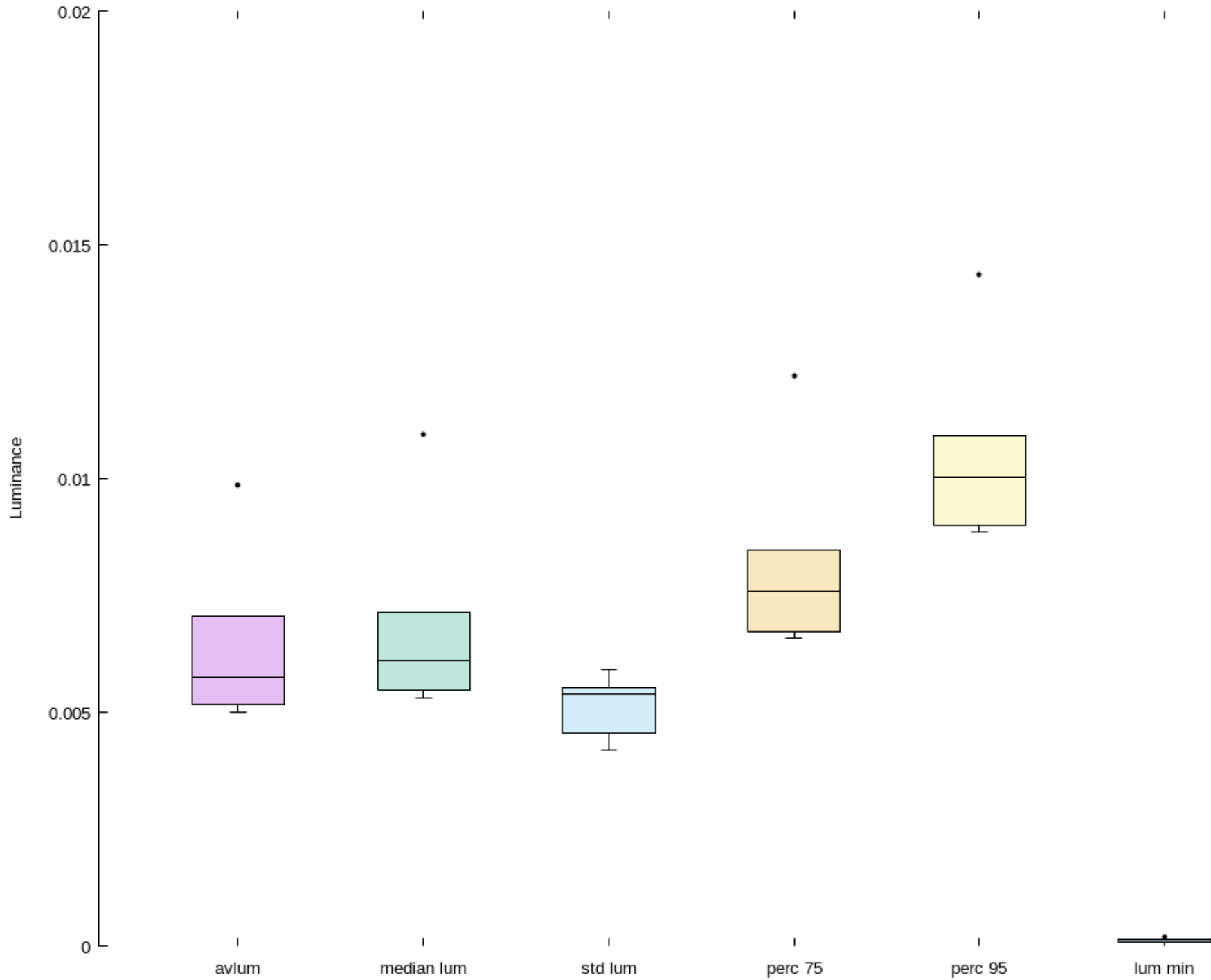
# Testresult

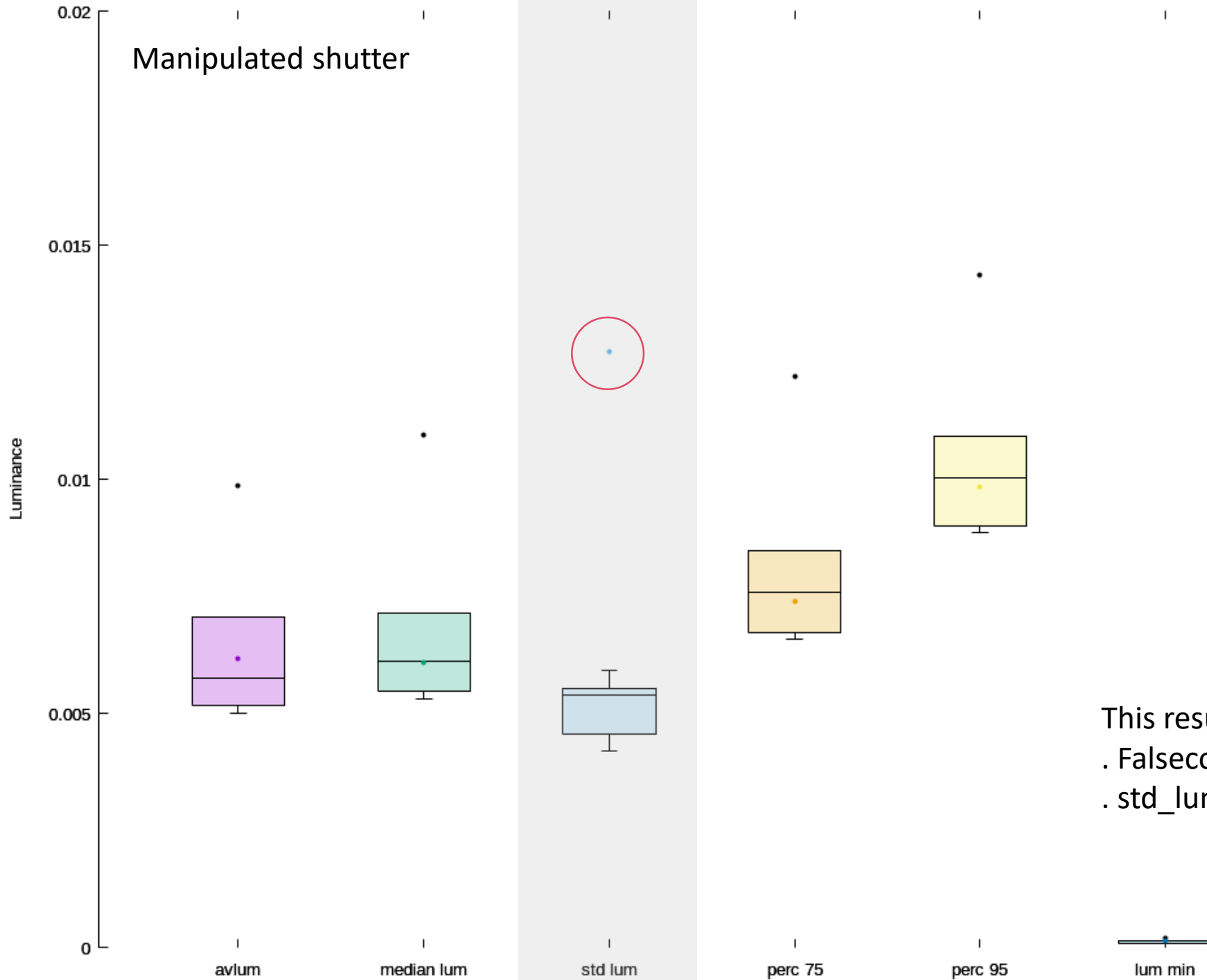




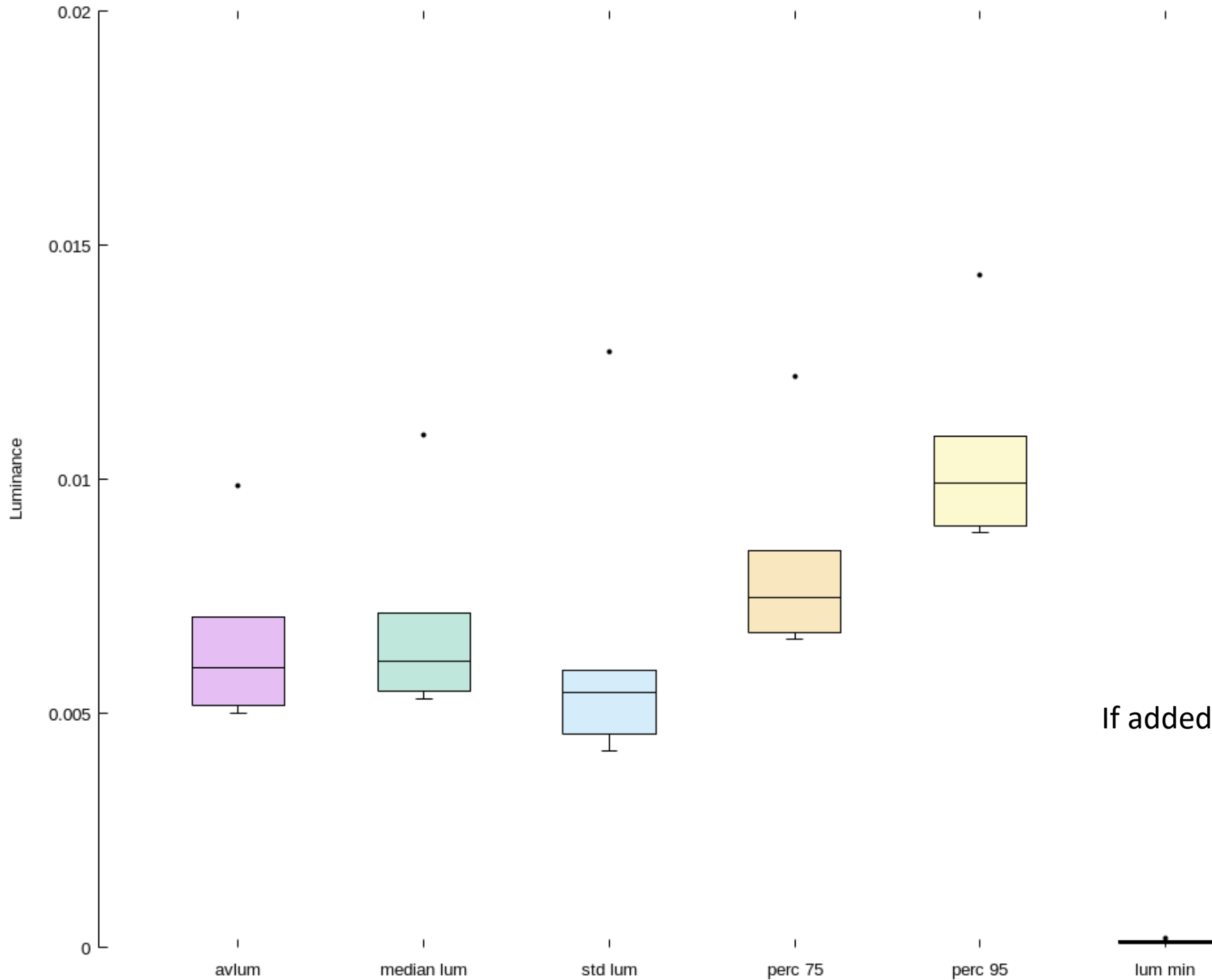


\*) ... to be defined;  
 \*\*) ... or outlier using IQR



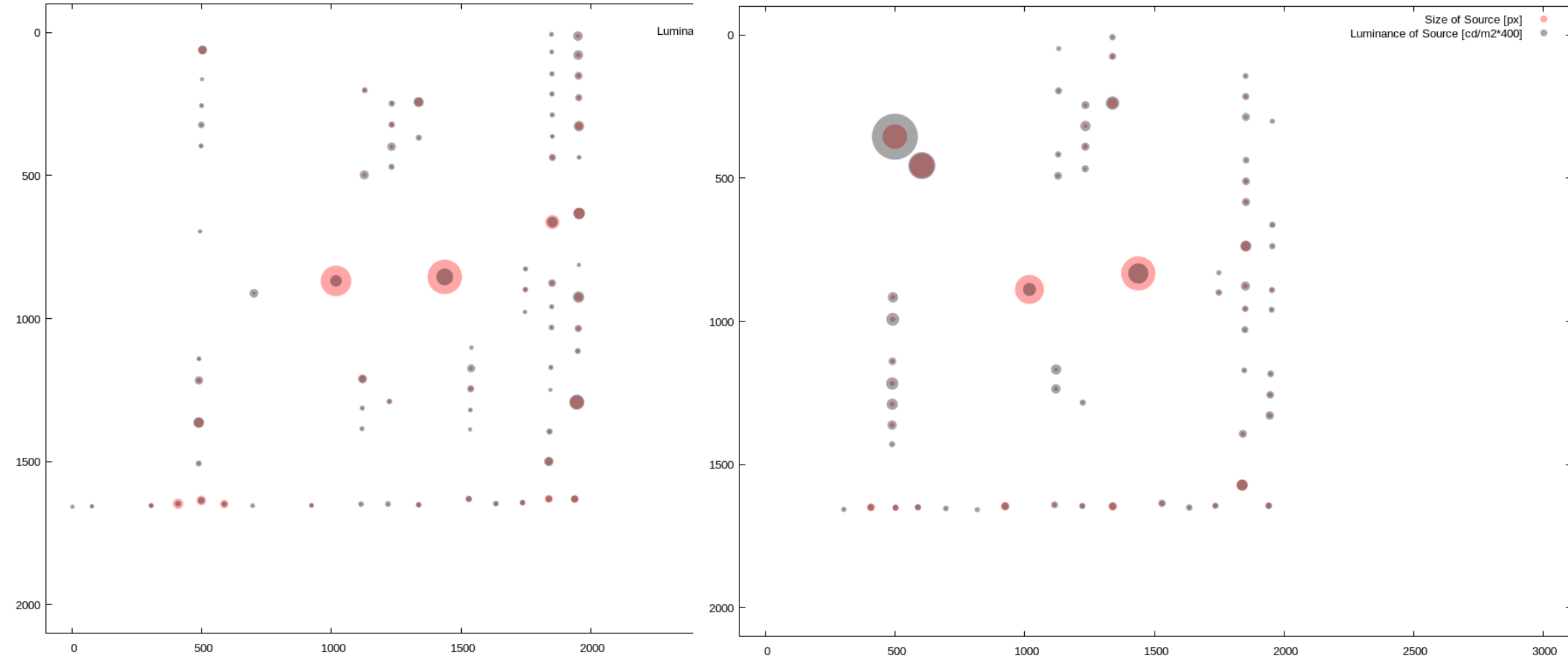


This result is detectable in:  
 . Falsecolour image  
 . std\_lum



If added – new outlier

## B) x,y,circle





# Outview

- compensation
- Industry cameras
- Human evaluators
- Color Dependencies
- Left – right rolling
- Color Dependencies
- Where is the brain?

# Acknowledgement



# References

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