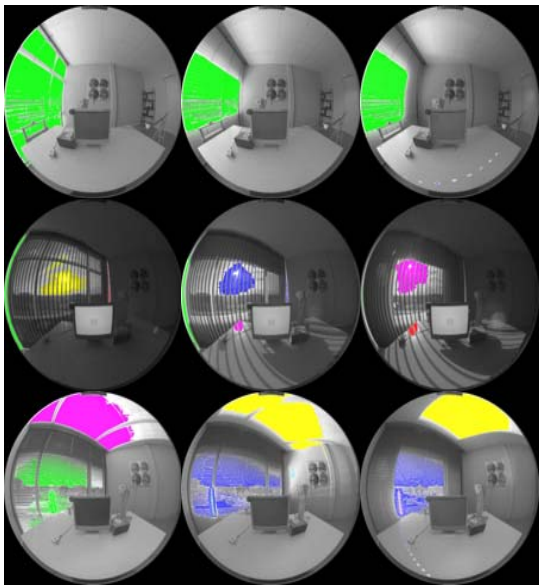
Evalglare
A Radiance based tool for glare evaluation

Introduction



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Solare Energiesysteme ISE

Fraunhofer ISE

Content

- General remarks
- Installation issues
- Internals: Details about
  - Detection algorithms, use of the task area feature
  - Position index
  - Peak extraction
  - Smoothing
  - Search radius
  - Checking picture
- Outputs
- Limitations
  - Validity range of DGP
  - Picture size, calculation speed

General remarks

- Command line based tool to evaluate glare within a given image, mainly daylit scenes.

Usage (independent on operating system):

evalglare [options] picfile

- Software needs only the executable file
- Output to “standard output” -> flexible

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Installation issues

Where to get ?

- Radiance page of ISE: http://www.ise.fraunhofer.de/radiance

Windows

- Executable (evalglare.exe) is provided as zipfile

Linux, cygwin and Mac

- Software must be compiled first:

1. Extract files with tar –zxf evalglare_vxx.tar.gz
2. cd evalglare
3. make

Copying

- Executable must be copied into standard Radiance folder

First steps to go

Evaluate your picture or demo picture

- first step: make sure, that picture has reasonable size (max 800x800)

- If not, use pfilt to downsize by
  pfilt -1 –x 800 –y 800 i*nput.pic >output.pic*

- simple evaluation:

evalglare picfile

- second step visualize glare sources

evalglare –c output.pic picfile

Open output.pic with viewer

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Detection of glare sources

What is a glare source? (In the view of a program)

⇒ reliable algorithm to detect a “glare source” in a scene

⇒ should be valid for any kind of visual environment

I) Average luminance of the whole scene:
Every pixel larger than x-times of the av. luminance is treated as glare source (RADIANCE default=7)

Main disadvantages:

⇒ In bright scenes, only few zones are detected

⇒ Does not take into account, that the overall amount of light at the eye (=vertical illuminance) is a main glare parameter

Detection of glare sources

II) Fixed value threshold (e.g. 2000cd/m²) :

Disadvantages:

⇒ Does not take into account adaptation level

⇒ Works only in limited scenes properly

III) Calculate “task luminance” and treat all pixels higher than x-times of the task luminance as glare source
Depending on the “size” of the task, the adaptation level is taken into account
Disadvantage: Knowledge of task location needed

All three methods are implemented into evalglare

Detection of glare sources

Which parameter must be set for the detection modes?

-b *value*

Value > 100 : Fixed luminance value detection mode is enabled

e.g. –b 2000 : Every pixel showing a luminance larger than 2000 cd/m² is treated as a glare source pixel

-> Try out with your image (use b=500, b=2000, b=5000) and visualize!

Detection of glare sources

Which parameter must be set for the detection modes?

-b *value*

Value $\leq$ 100 *and neither* –t *nor* –T are used :

Average luminance detection mode is enabled

e.g. –b 5 : Every pixel showing a luminance larger than 5 times of the average luminance of the full image is treated as a glare source pixel

-> Try out with b=0, b=2 and b=10 with your image and visualize!

Detection of glare sources

Which parameter must be set for the detection modes?

-b *value*

Value $\leq$ 100 *and either* –t *or* –T are used :

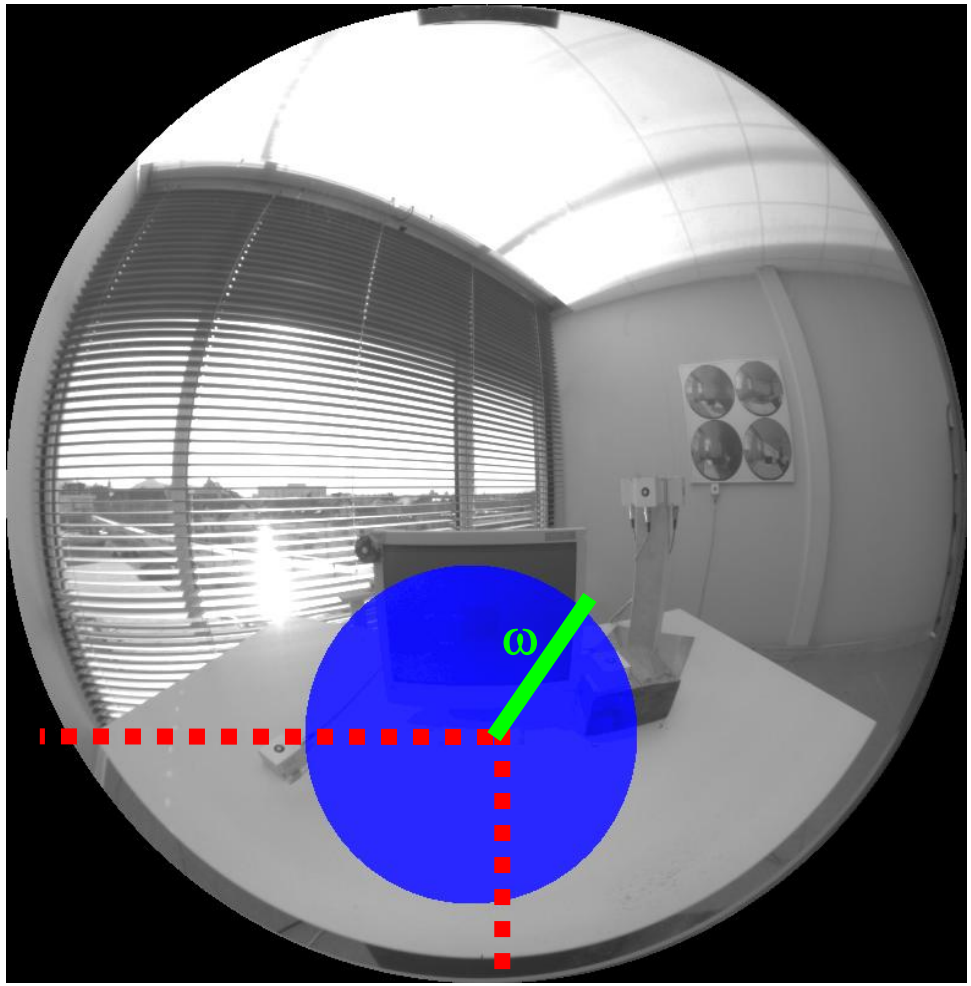
Task luminance detection mode is enabled

e.g. –b 5 –T 300 300 0.5

: Every pixel showing a luminance larger than 5 times of the average luminance of the task area is treated as a glare source pixel

-> Try out two different task positions and sizes with your image and visualize!

Detection of glare sources
Define task luminance
as threshold for glare source



Two parameters have to be provided:

1. *x y* position of picture (centre of task)
2. opening angle ω of task

-t *x y* ω : task mode without colouring

-T *x y* ω : task mode with colouring

Detection of glare sources

But important to know:

Using task area mode does not change viewing direction!!!

No influence on position index!! (not yet, need?)

Position index is used in most glare metrics

Principal structure of glare metrics:

$$G = f\left(\frac{L_s^{a_1} \cdot \omega_s^{a_2}}{L_b^{a_3} \cdot P^{a_4}}\right)$$

L_s: Luminance of source
ω_s: Solid angle of source
L_b: Background luminance ⇒ adaptation
P: Position index

Position index is used in most glare metrics

$$DGP = c_1 \cdot E_v + c_2 \cdot \log\left(1 + \sum_i \frac{L_{s,i}^2 \cdot \omega_{s,i}}{E_v^{a_1} \cdot P_i^2}\right) + c_3$$

$$DGI = \frac{2}{3}(GI + 14) \qquad GI = 10 \log_{10} 0.48 \sum_{i=1}^{n} \frac{L_s^{1.6} \cdot \Omega_s^{0.8}}{L_b + 0.07\,\omega_s^{0.5}\,L_s}$$

$$CGI = 8 \log_{10} 2 \cdot \frac{\left[1 + \frac{E_d}{500}\right]}{E_d + E_i} \cdot \sum_{i=1}^{n} \frac{L_s^2\,\omega_s}{P^2}$$

$$UGR = 8 \log_{10} \frac{0.25}{L_b} \cdot \sum_{i=1}^{n} \frac{L_s^2\,\omega_s}{P^2}$$

L_s : source luminance

L_b : background luminance

Ω_s: Modified solid angle

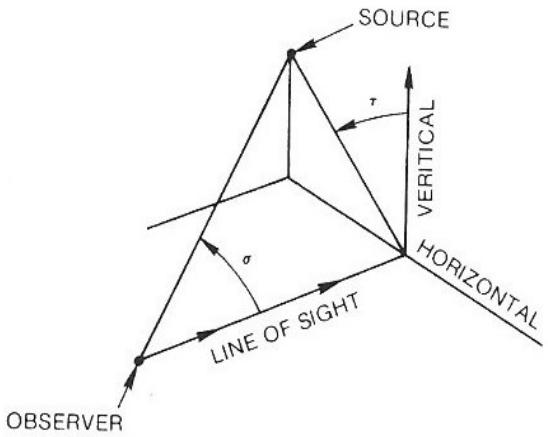
ω_s: solid angle of source

P: Guth position index

E_d: direct vertical illuminance

E_i: indirect vertical illuminance

Calculation of existing glare formulas
IES position index



$$\ln P = [35.2 - 0.31889\,\tau - 1.22e^{-2\tau/9}]10^{-3}\sigma + [21 + 0.26667\,\tau - 0.002963\,\tau^2]10^{-5}\sigma^2$$

τ : angle from vertical plane containing sourceand line of sight

σ : angle between line of sight and line from observer to source

Only defined above view direction!

Position index below line of sight: Model from Toshie Iwata 1997 Expressed by Prof. Einhorn

$$P = 1 + 0.8 * R / D \qquad \{R < 0.6D\}$$
$$P = 1 + 1.2 * R / D \qquad \{R >= 0.6D\}$$

$$R = \sqrt{H^2 + Y^2}$$

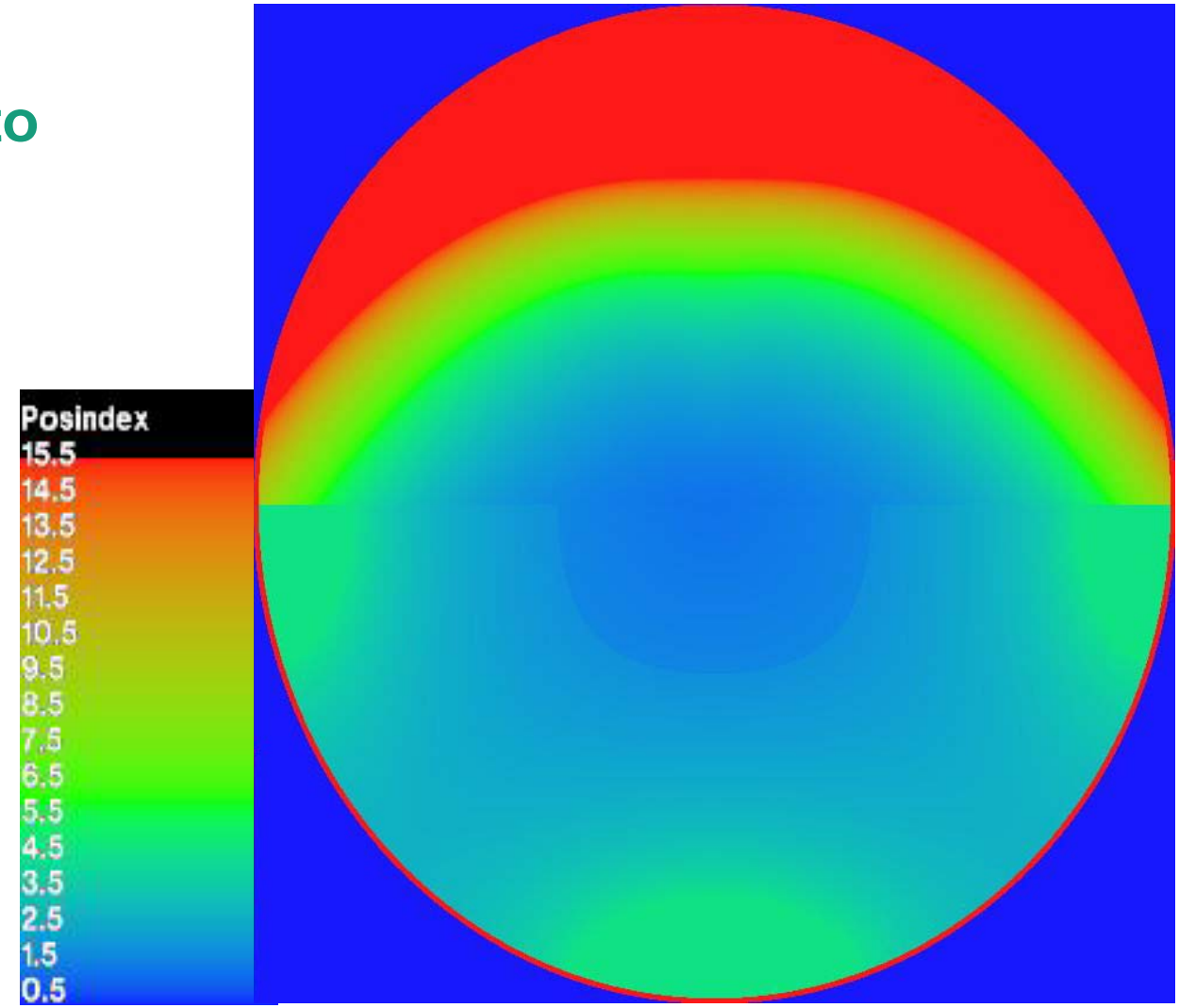
D : distance eye - to plane of source in view direction

H : Vertical distance between source and view direction

Y : Horizontal distance between source and view direction

Position index implementation into evalglare

View direction is always in centre of picture!!



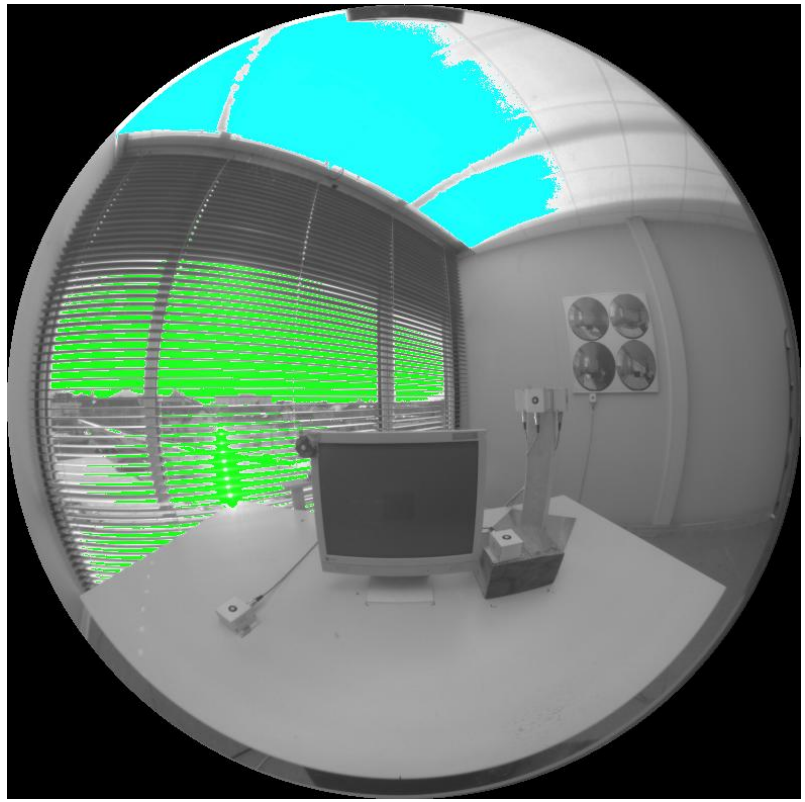
New Position index

A new position index is proposed by a Korean research group

Will be implemented as alternative in upcoming version.

Glare source detection algorithm: Merging of pixels to a glare source (gs)

Which pixels should be counted to which glare source?



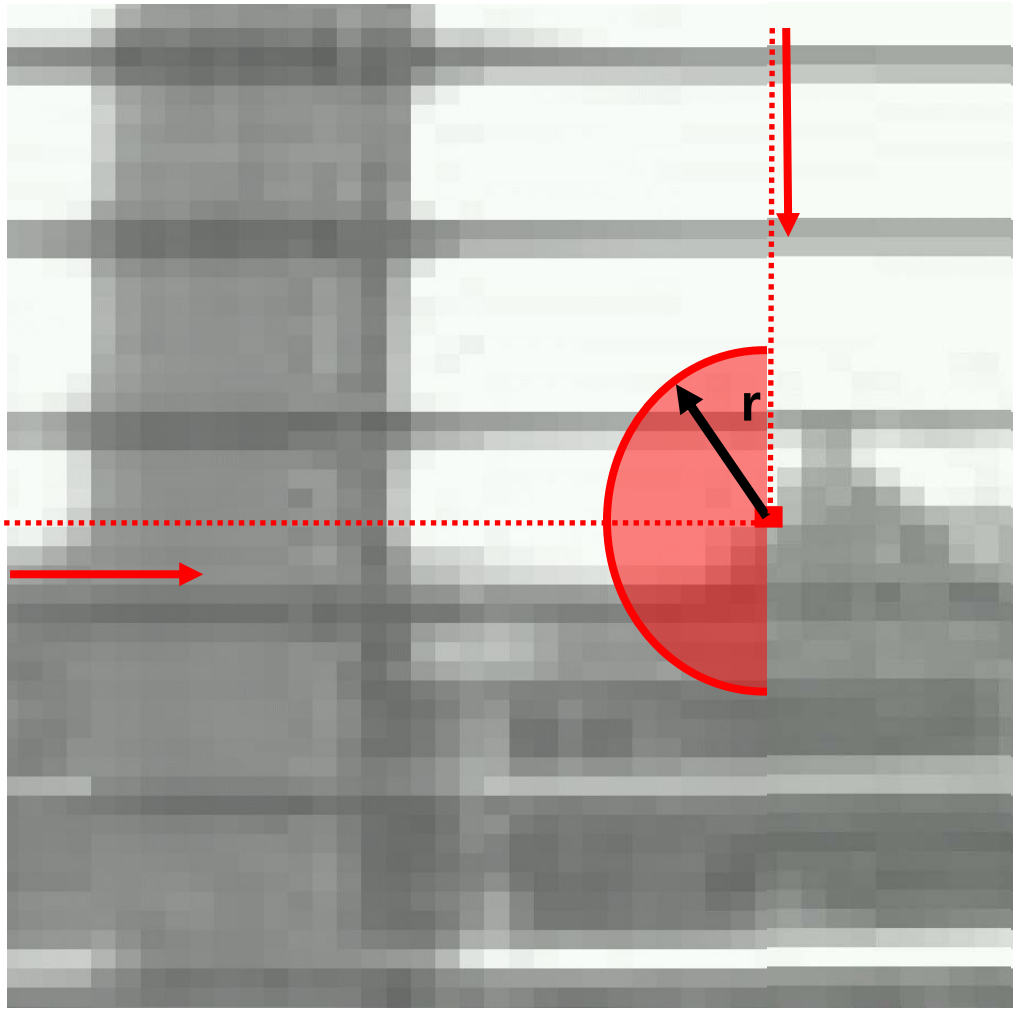
Detection of gs algorithm

First scan of picture pixel by pixel

If L_{pixel} > threshold (task luminance) then

Search for other pixels in the nearby (r provides as ω as parameter)

Add pixel to gs (luminance, position)

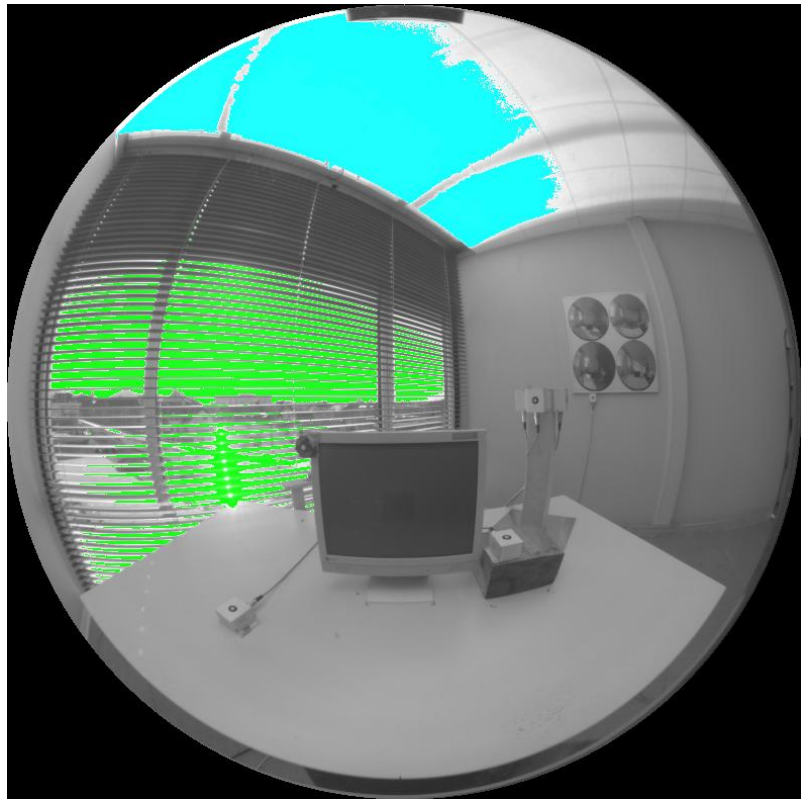


Influence of the –r parameter

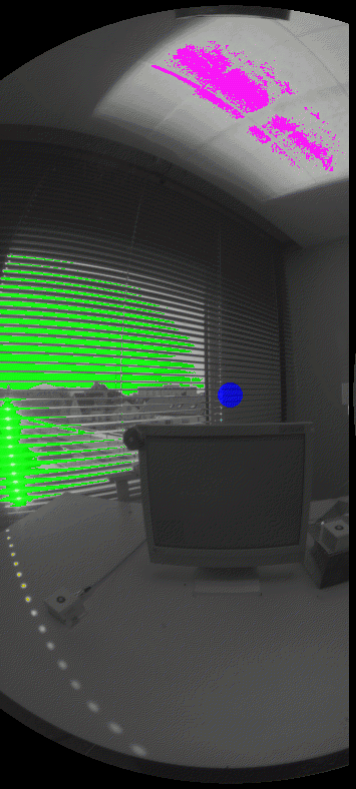
Merging of “glare areas” to a glare source – How large should be a glare source?

Influence of the –r parameter

-r is a search diameter, not a radius

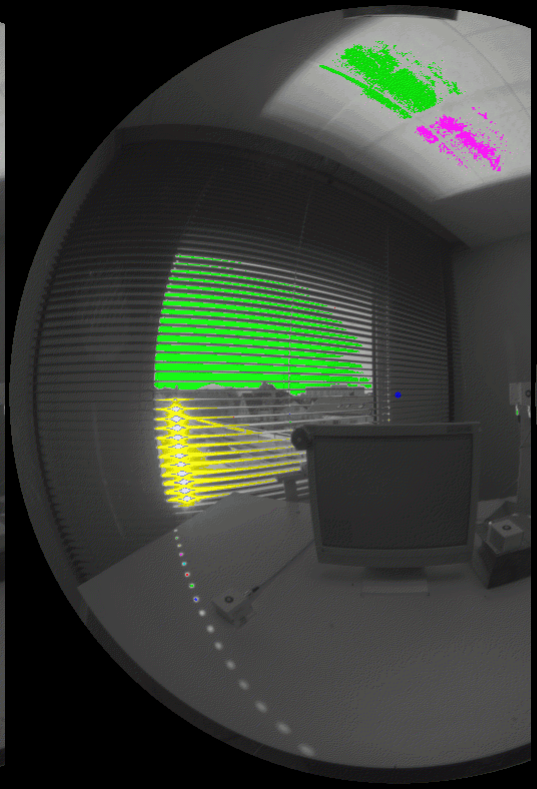


R=0.2 (default)



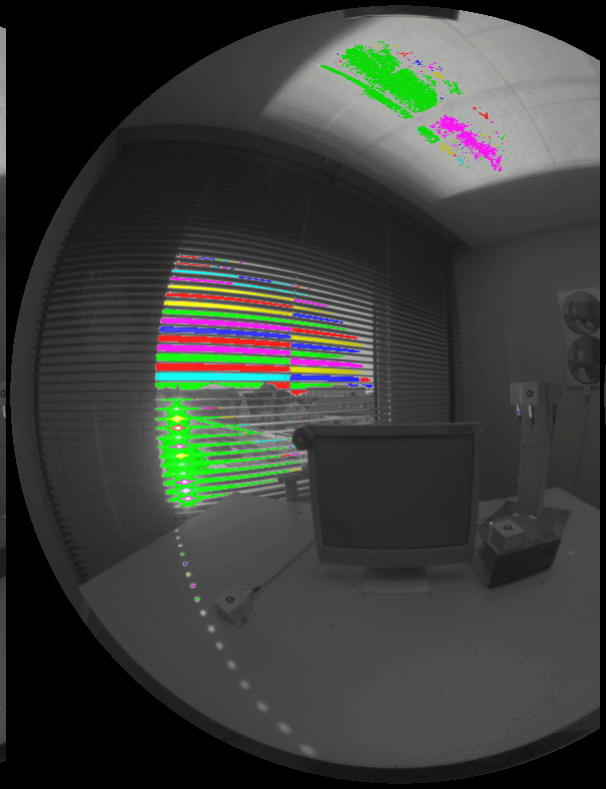
DGP 0.6277

R=0.05



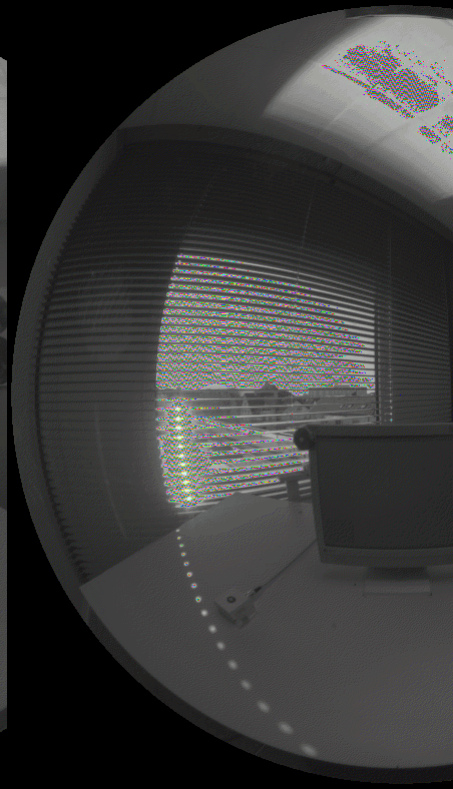
0.6274

R=0.015



0.6286

R=0.001



0.67

-> Try out different search radius with your image and visualize!

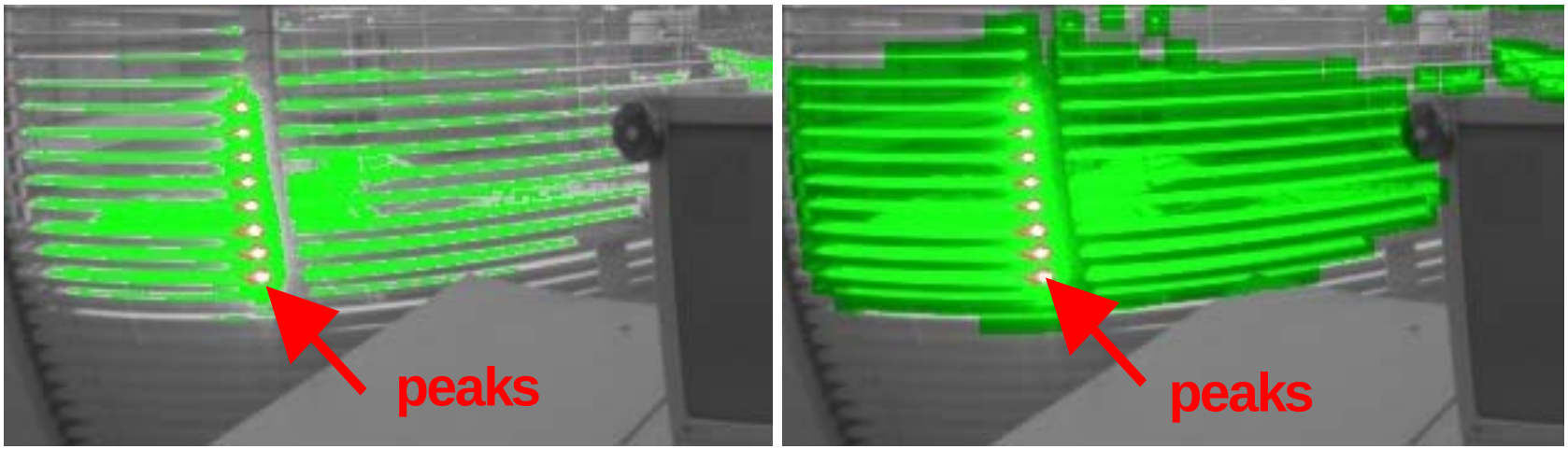
Glare source treatment within evalglare

Smoothing (–s):

If there are darker zones „within“ a detected glare source, they could be enclosed to the glare source

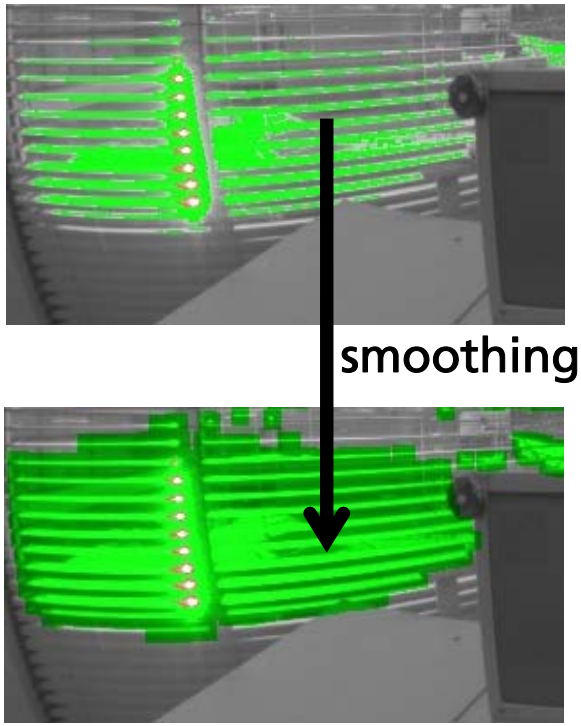
Spot extration (–y)

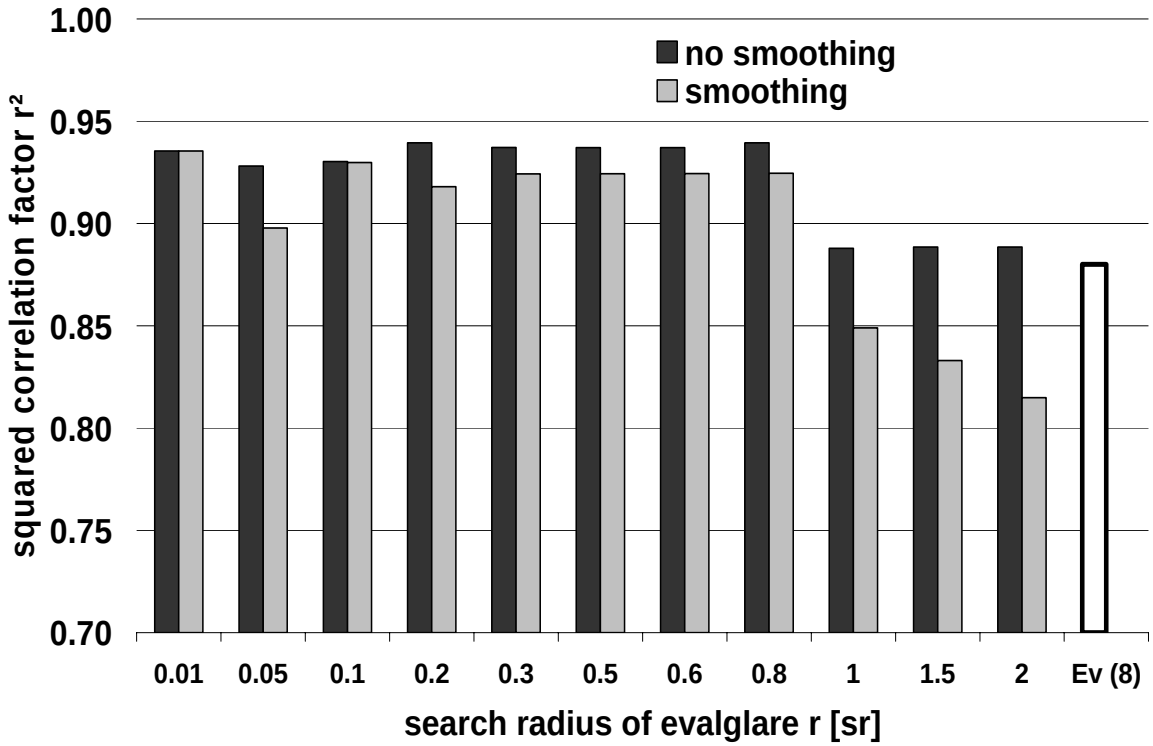
“Peaks” of very high luminances can be extracted to an extra glare source – this is now default. Switching off spot extraction by –x.



-> Try out smoothing option with your image and visualize!

Influence of detection parameters: Smoothing and search radius





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The evalglare checking picture (–c *picfile*)

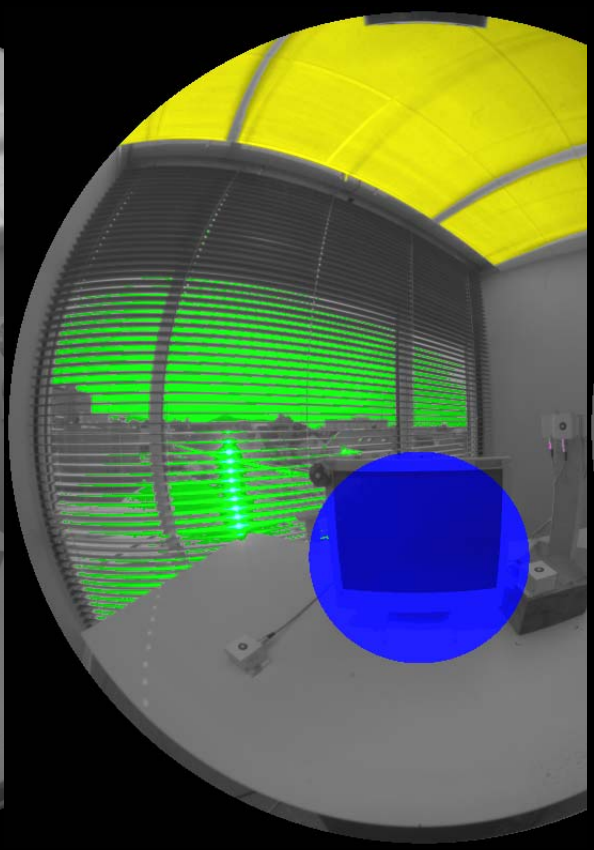
the most overestimated feature ….

Up to now:

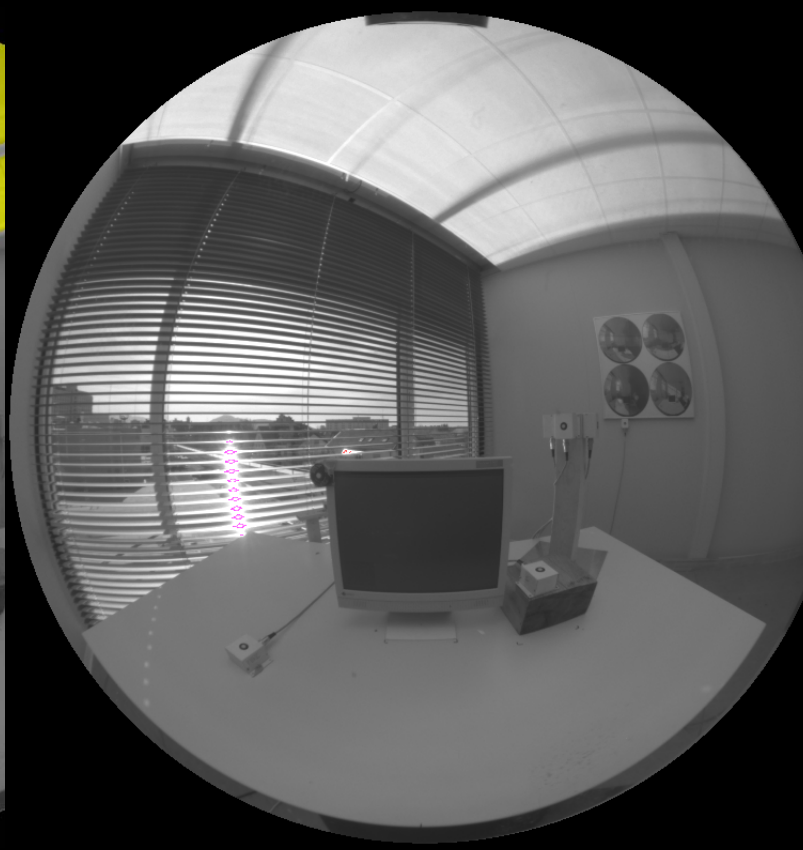
- Each found glare source gets a certain color.
- In total 6 colors, the 7th glare source gets the first color again.
- Just a visualization of the glare sources – no information about importance

- The color might lead the user think of a significance, which is not present!

DGP=0.744

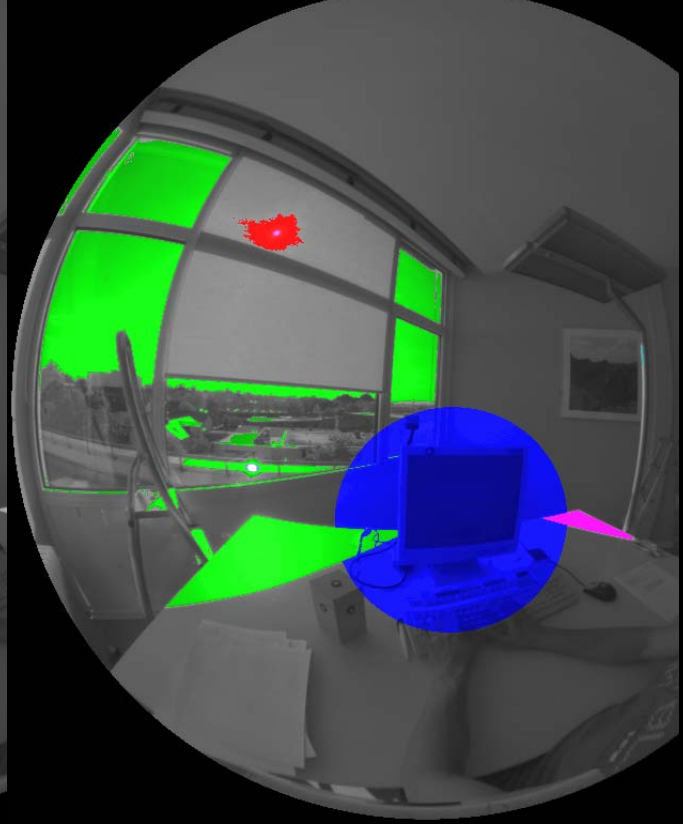


DGP=830



DGP=843

DGP=0.549



DGP=0.616

DGP=0.616

Why not just take into consideration the really high peaks?

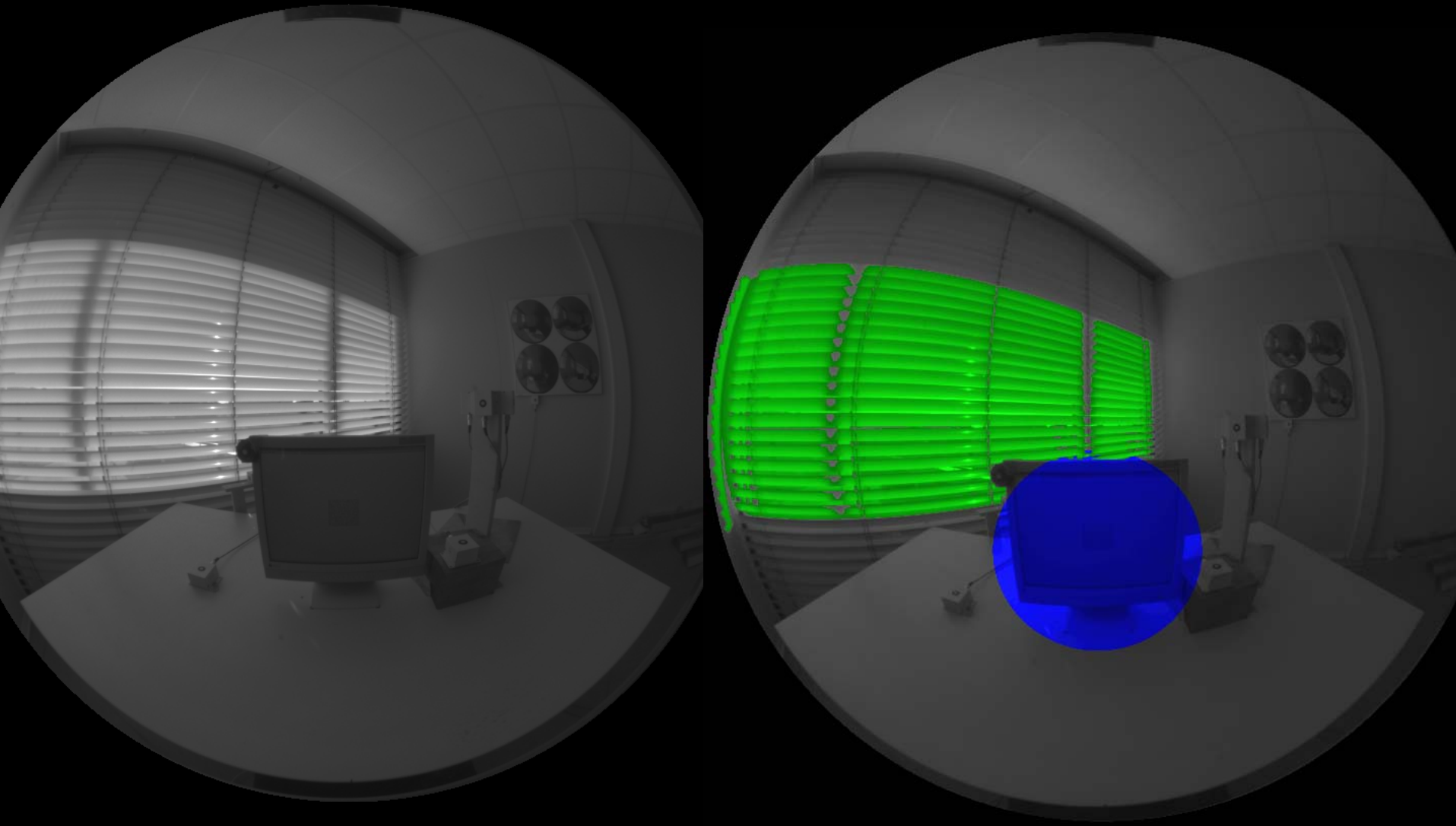
Advantages

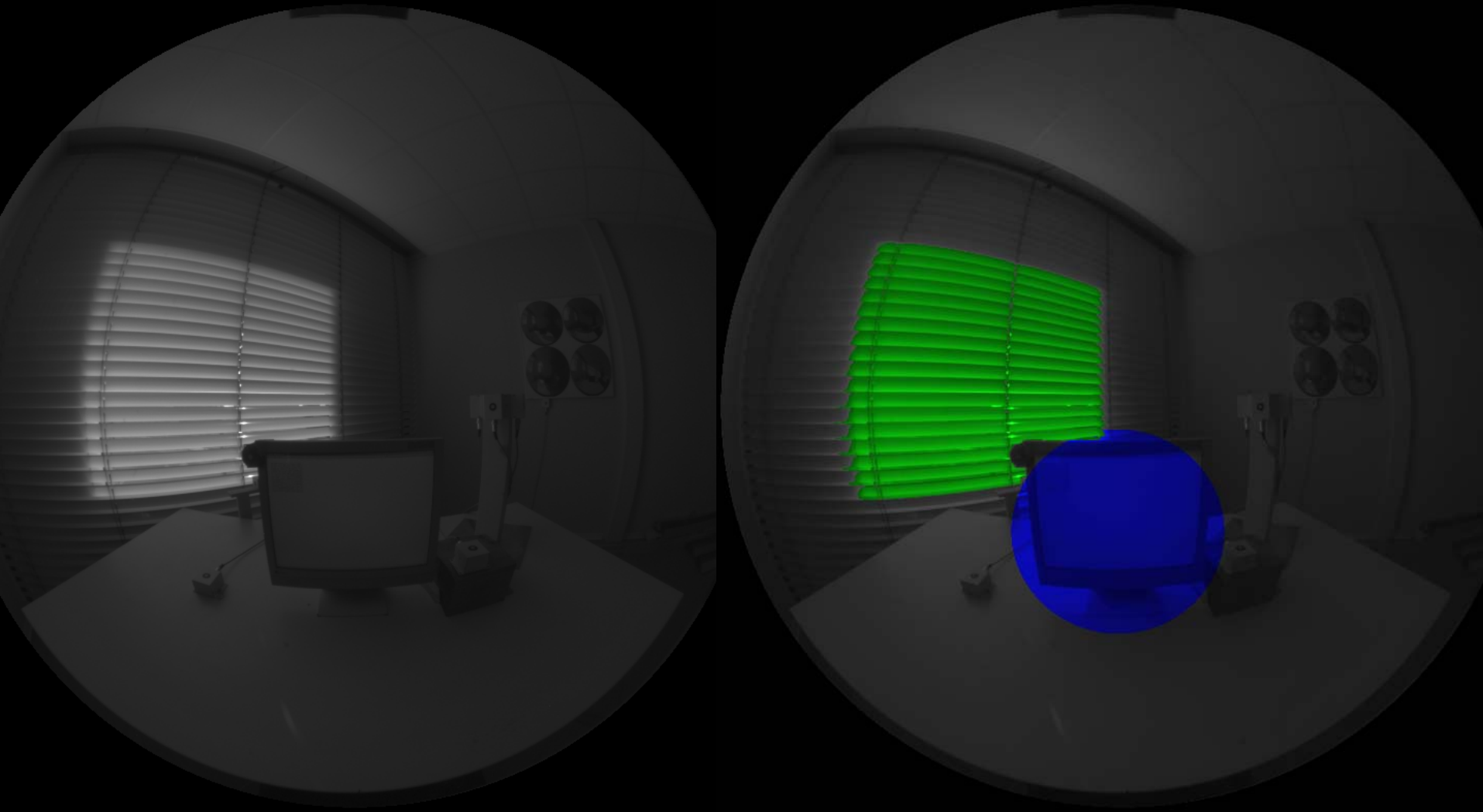
- Easy approach
- faster to calculate

But

- Can we really catch all possible scenes?
- The answer is unclear…

two other examples:


+5%
DGP=0.378
DGP=0.395


+9%
DGP=0.250
DGP=0.273

Glare source detection algorithm – some conclusions

- Fast and easy approach is to use only the peak glare sources
- Parameters allow I high flexibility in catching glare sources
- DGP is robust against “wrong” parameter settings
- Using only the peaks may lead to an underestimation

Future

- Scale color into importance classes, suggestion:
  light green: influence less than 10% on DGP
  yellow: Influence between 10-20% on DGP
  red: Influence more than 20% on DGP

What to do if you don‘t have a fish-eye image?

- measure the vertical eye illuminance separately to be accurate
- try to catch the main light sources in the image
- use:

evalglare –i Ev *picfile*

The –i option enables to provide external illuminance values

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Evalglare output

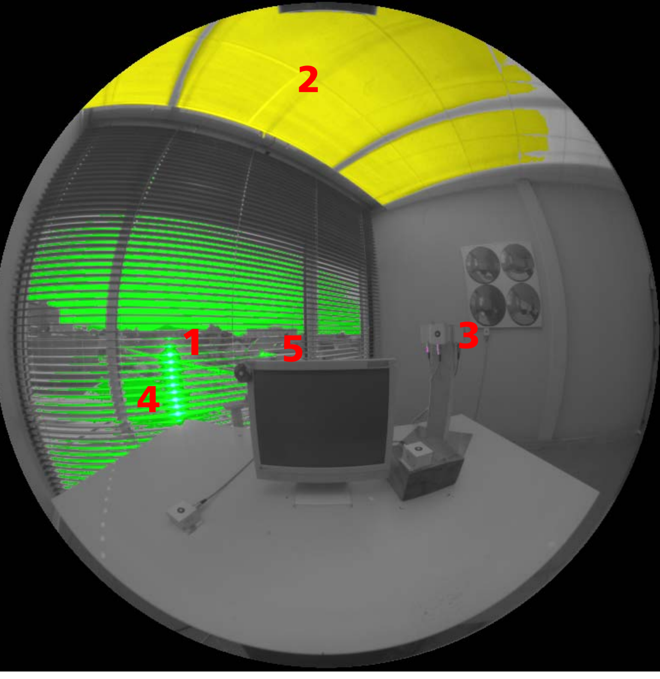
Default (without any extra output option):

dgp,dgi,ugr,vcp,cgi: 0.273524 17.810987 22.451195 4.903594 26.712412

DGP DGI UGR VCP CGI

DGI,UGR,VCP,CGI only of glare sources are found!!!

Evalglare output



Detailed output by using -d

5 No pixels x-pos y-pos L_s Omega_s Posindx L_b L_t E_vert Edir Max_Lum

1 30712.0 219.157 383.54 8567.619 0.4434009 1.924 1080.37 781.16 9977.0 6582.9 1712672.0

2 67682.0 420.27 114.27 7190.05 0.83404703 16.00 1080.37 781.16 9977.0 6582.9 1712672.0

3 8.0 516.34 410.37 4581.05 0.0001251574 1.4390 1080.37 781.16 9977.0 6582.9 1712672.0

4 497.0 214.28 452.17 351968.3 0.0073479117 2.071 1080.37 781.16 9977.0 6582.9 1712672.0

5 18.0 319.27 416.22 134618.3 0.0002892997 1.255 1080.37 781.16 9977.0 6582.9 1712672.0

dgp,av_lum,E_v,lum_backg,E_v_dir,dgi,ugr,vcp,cgi,lum_sources,omega_sources:
0.82999 3089.41 9977.022 1080.37 6582.9 29.4 37.72 0.000000 46.435944 9664.94 1.285210

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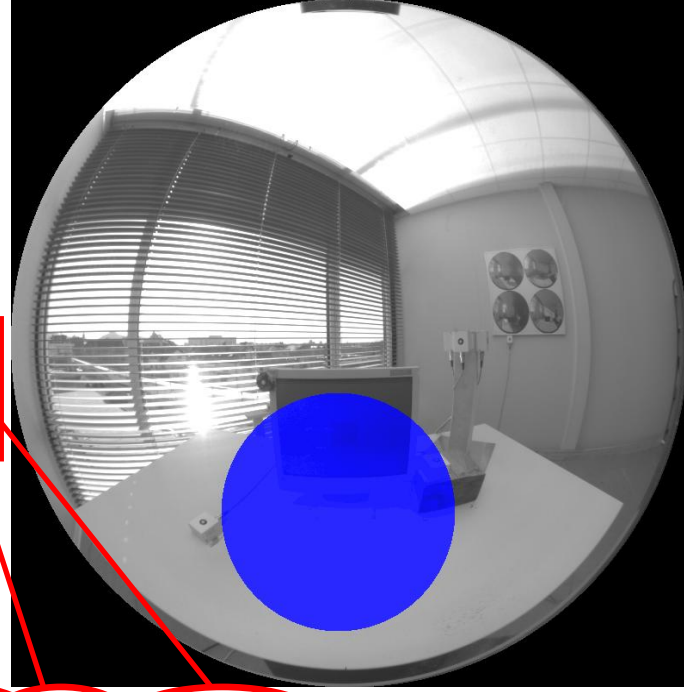
Evalglare output



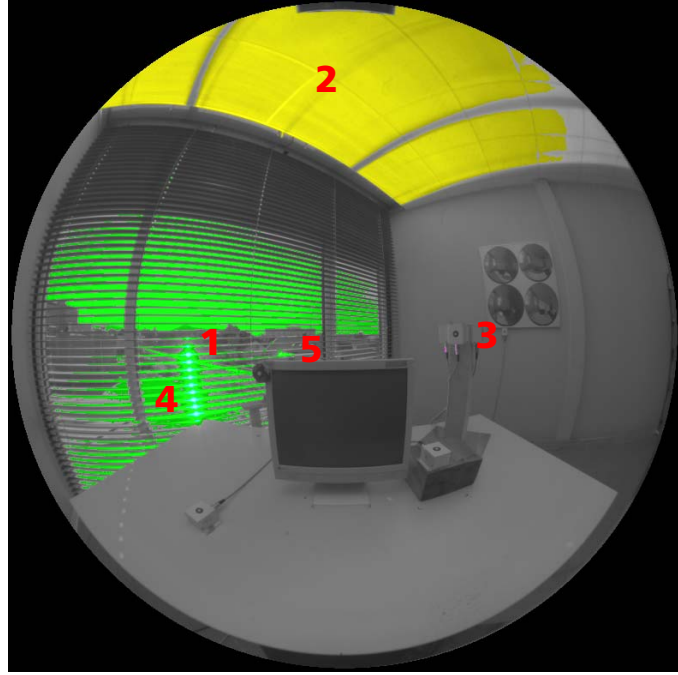
Direct eye illuminance
=contribution to Ev from glare sources

Max. luminance

Detailed output by using -d

5 No pixels x-pos y-pos L_s Omega_s Posindx L_b L_t E_vert Edir Max_Lum
1 30712.0 219.157 383.54 8567.619 0.4434009 1.924 1080.37 781.16 9977.0 6582.9 1712672.0
2 67682.0 420.27 114.27 7190.05 0.83404703 16.00 1080.37 781.16 9977.0 6582.9 1712672.0
3 8.0 516.34 410.37 4581.05 0.0001251574 1.4390 1080.37 781.16 9977.0 6582.9 1712672.0
4 497.0 214.28 452.17 351968.3 0.0073479117 2.071 1080.37 781.16 9977.0 6582.9 1712672.0
5 18.0 319.27 416.22 134618.3 0.0002892997 1.255 1080.37 781.16 9977.0 6582.9 1712672.0
dgp,av_lum,E_v,lum_backg,E_v_dir,dgi,ugr,vcp,cgi,lum_sources,omega_sources:
0.82999 3089.41 9977.022 1080.37 6582.9 29.4 37.72 0.000000 46.435944 9664.94 1.285210

Evalglare output



Average luminance in image

Solid angle of glare sources

Detailed output by using -d

5 No pixels x-pos y-pos L_s Omega_s Posindx L_b L_t E_vert Edir Max_Lum
1 30712.0 219.157 383.54 8567.619 0.4434009 1.924 1080.37 781.16 9977.0 6582.9 1712672.0
2 67682.0 420.27 114.27 7190.05 0.83404703 16.00 1080.37 781.16 9977.0 6582.9 1712672.0
3 8.0 516.34 410.37 4581.05 0.0001251574 1.4390 1080.37 781.16 9977.0 6582.9 1712672.0
4 497.0 214.28 452.17 351968.3 0.0073479117 2.071 1080.37 781.16 9977.0 6582.9 1712672.0
5 18.0 319.27 416.22 134618.3 0.0002892997 1.255 1080.37 781.16 9977.0 6582.9 1712672.0
dgp,av_lum,E_v,lum_backg,E_v_dir,dgi,ugr,vcp,cgi,lum_sources,omega_sources:

0.82999 3089.41 9977.022 1080.37 6582.9 29.4 37.72 0.000000 46.435944 9664.94 1.285210

Evalglare output

- Detailed information about the glare sources and the image
- Other evaluations also possible

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Evalglare limitations

- Validity range of DGP:

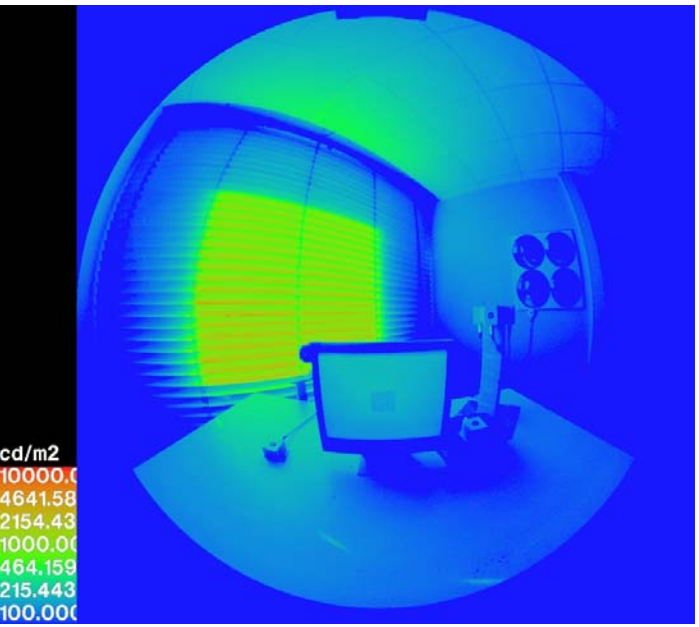
DGP > 0.2 and Ev > 380 lux

- Extension to low-brightness scenes is foreseen in next months (available until March 2010)

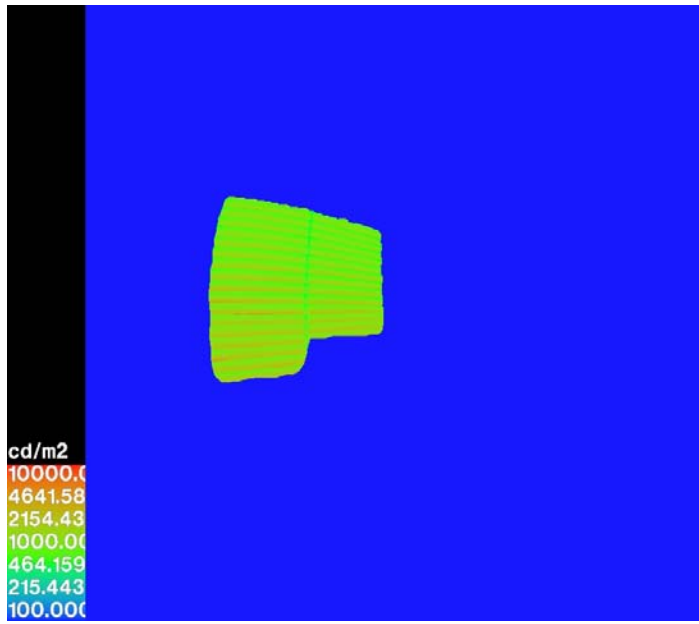
- DGP-results valid only for persons below 40 years, extension for other ages is also foreseen in next months (available until March 2010)
- Calculation time increases with image size, preferred size 800x800 Minimum should be 400x400.

Evalglare: non-glare evaluations

- Luminance and solid angle determination of any part of image by using masking

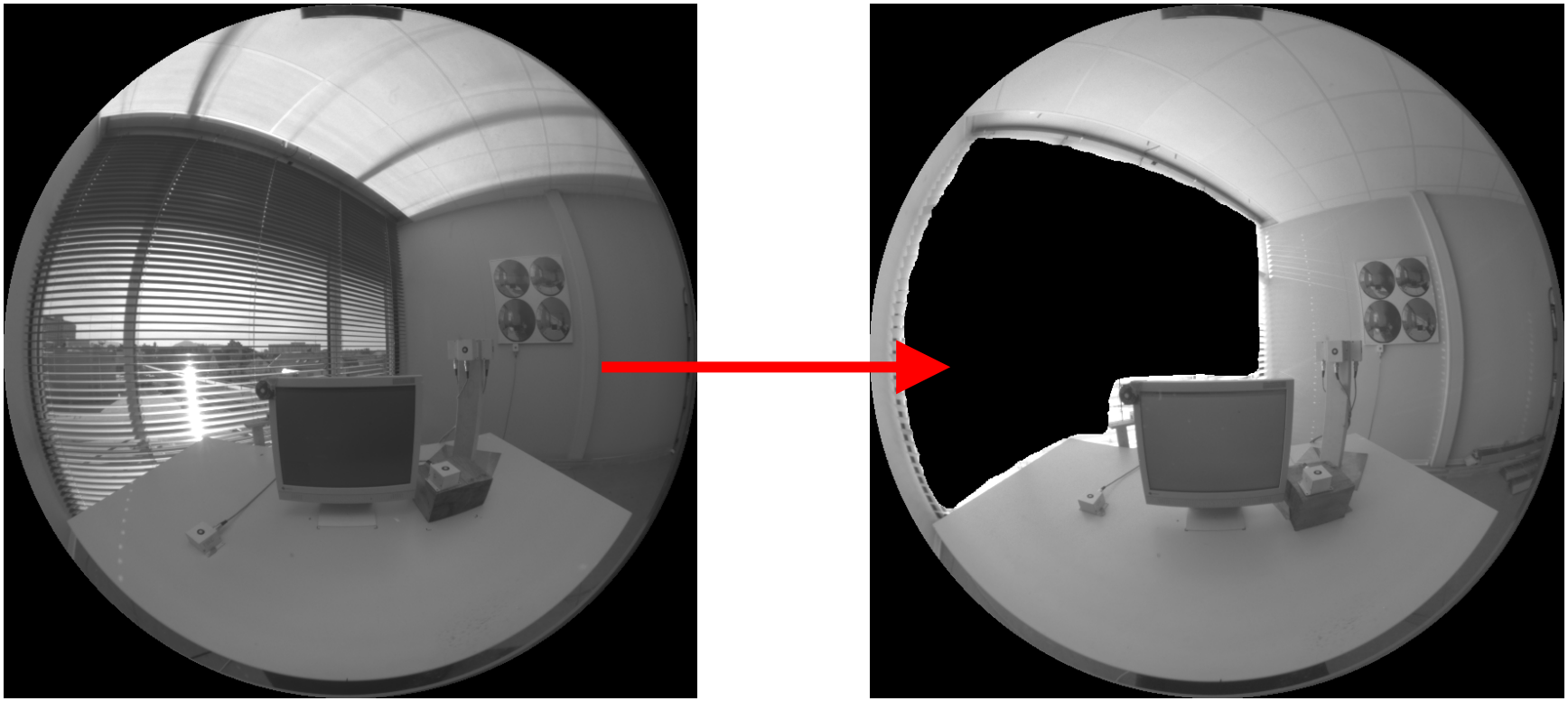


Using a mask



Example: Getting the window luminance and solid angle

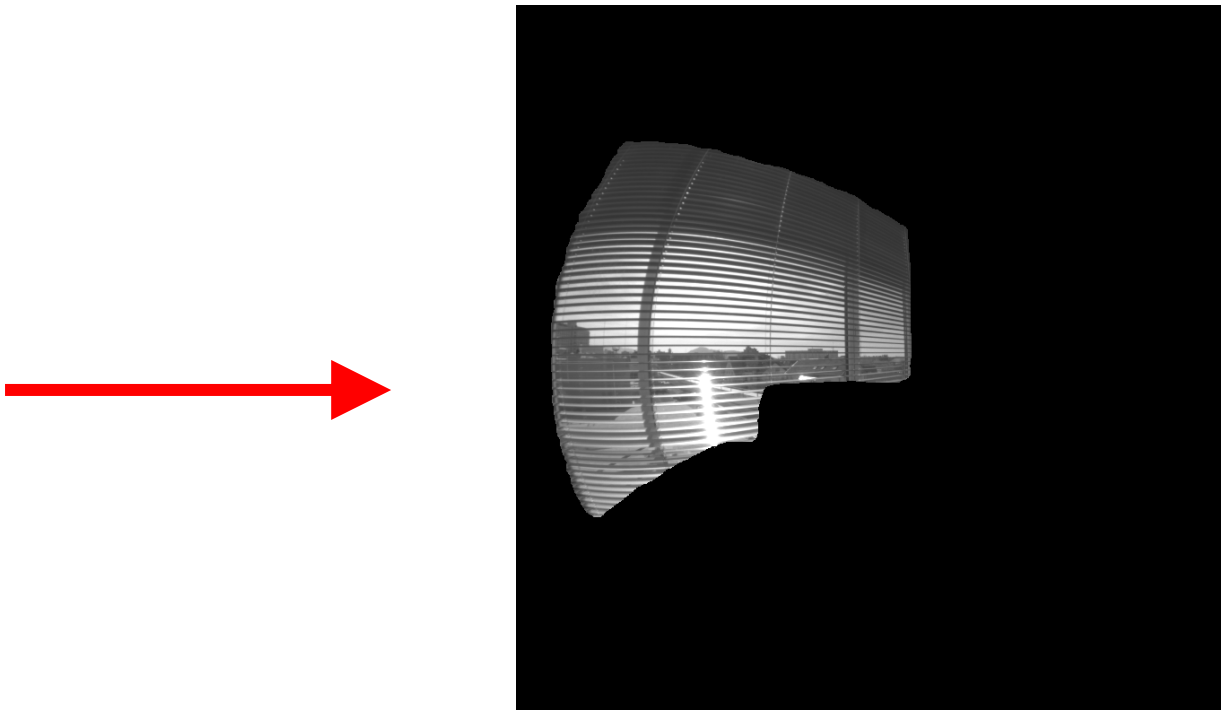
1. Make window area black with photoshop



Example: Getting the window luminance

2. Use pcomb command to cut out window area of image of interest:

   pcomb *input.pic*–s -1000 *mask.pic* > *window.pic*



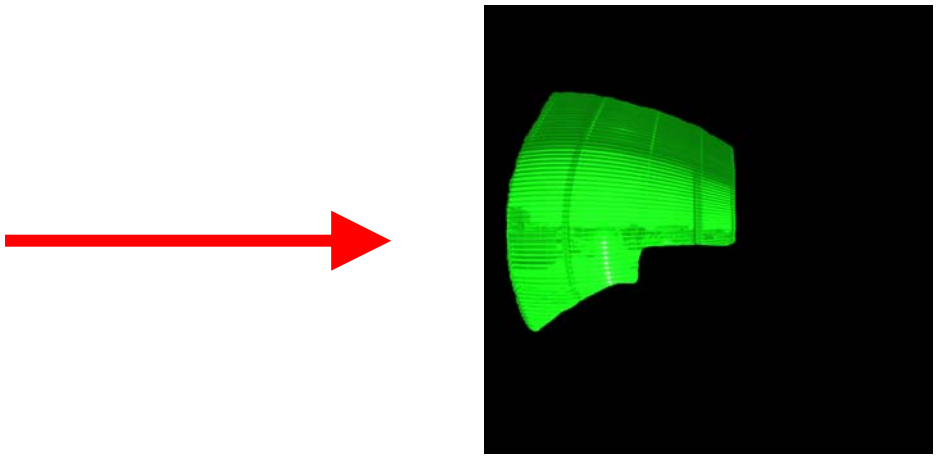
Example: Getting the window luminance and solid angle

3. Run evalglare in a way, that all the window is detected as glare source:

evalglare –x –t 10 10 0.01 –c check.pic –d window.pic :

dgp,av_lum,E_v,lum_backg,E_v_dir,dgi,ugr,vcp,cgi,lum_sources,omega_sources: 0.494902 1237.729260 5376.439188 -0.000002 5376.439195 24.842464 nan 0.000000 35.501968 **4837.941070 1.607504**

av. Lum solid angle



Thanks for your attention!!