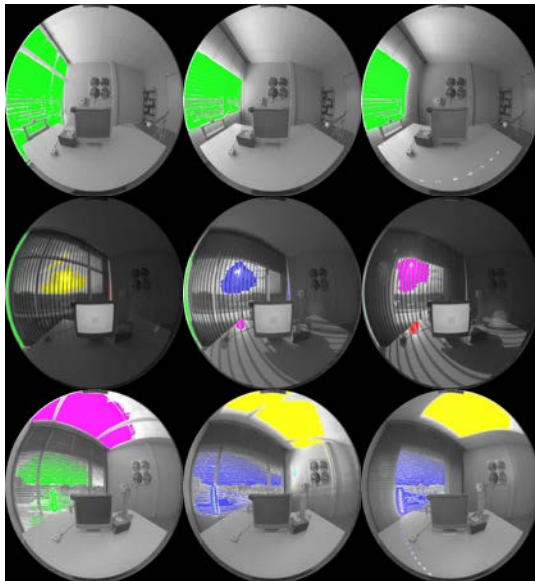

New features of evalglare

Evalglare – A Radiance based tool for glare evaluation



Jan Wienold,
Fraunhofer-Institut für
Solare Energiesysteme ISE

Content

- Introduction
- Known problems with 0.9x versions
- New features of the 1.08 version
 - View type handling
 - Supported view types
 - Low light correction
 - Age correction
 - Calculation of vertical illuminance only
 - Disability glare calculation
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 - Direction vector of glare sources
 - Tiny other changes

50% glazing



25% glazing



90% glazing



**First study 2006: User Assessments:
2 sites (D,DK), 3 window sizes, 3 shadings**



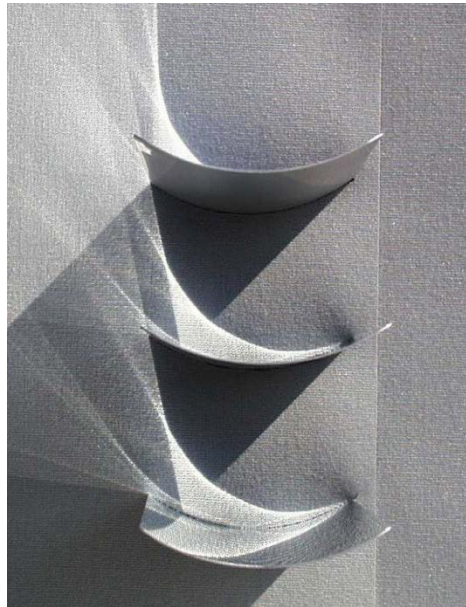
**74 subjects, more than 110h tests, about 50 days
349 different situations**

Tested three shading devices

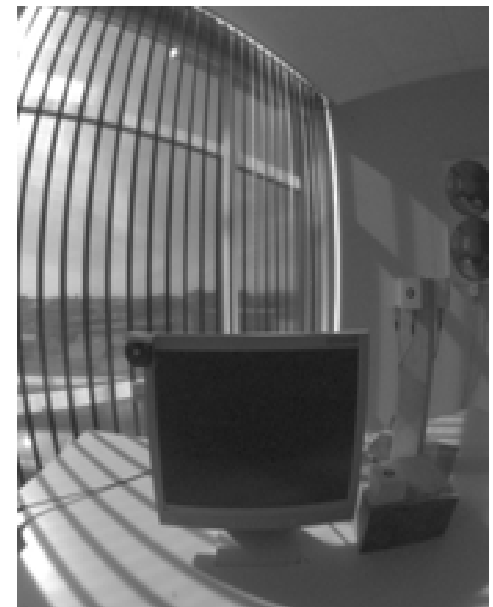
White Venetian blinds
80mm, convex, $r=.84$
D (sunny), DK (sunny)



Specular Venetian blinds
80mm, concave, $\rho=.95$
D (sunny), DK (cloudy)

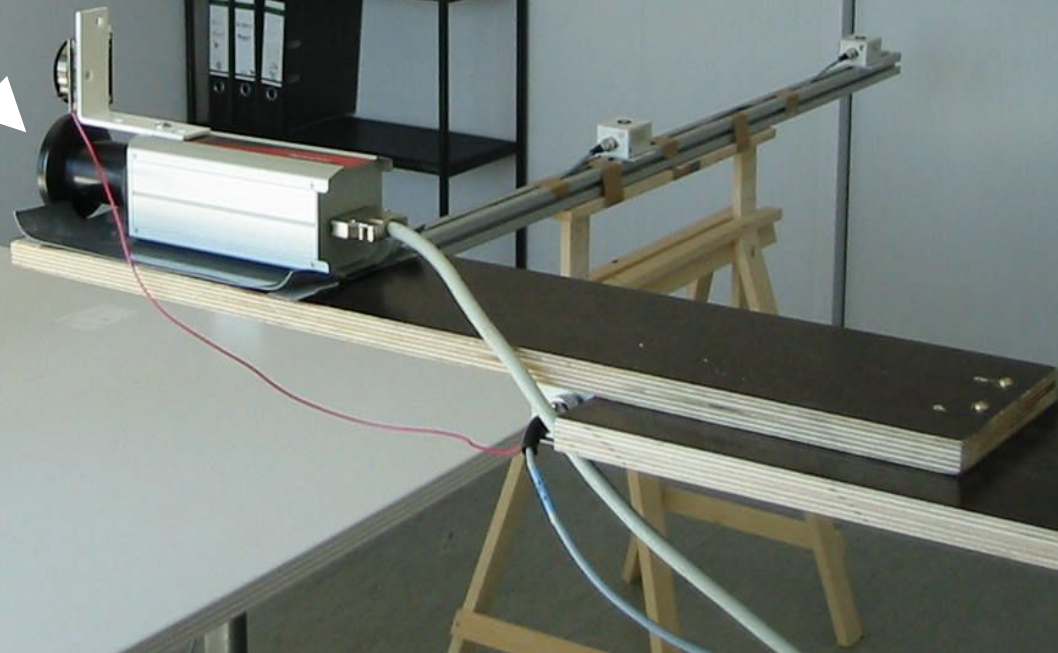


Vertical foil lamellas
 $\tau=0.02$
D (sunny)



Vertical illuminance
sensor at eye level

Luminance
camera
with fish eye lens



Daylight glare probability DGP

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

**Combination of the
vertical eye
illuminance with
modified glare index
formula**

E_v :	vertical Eye illuminance [lux]	$c_1 = 5.87 \cdot 10^{-5}$
L_s :	Luminance of source [cd/m ²]	$c_2 = 9.18 \cdot 10^{-2}$
ω_s :	solid angle of source [-]	$c_3 = 0.16$
P :	Position index [-]	$a_1 = 1.87$

Correlation between DGP and probability of persons disturbed

Strong correlation

Logistic regression:

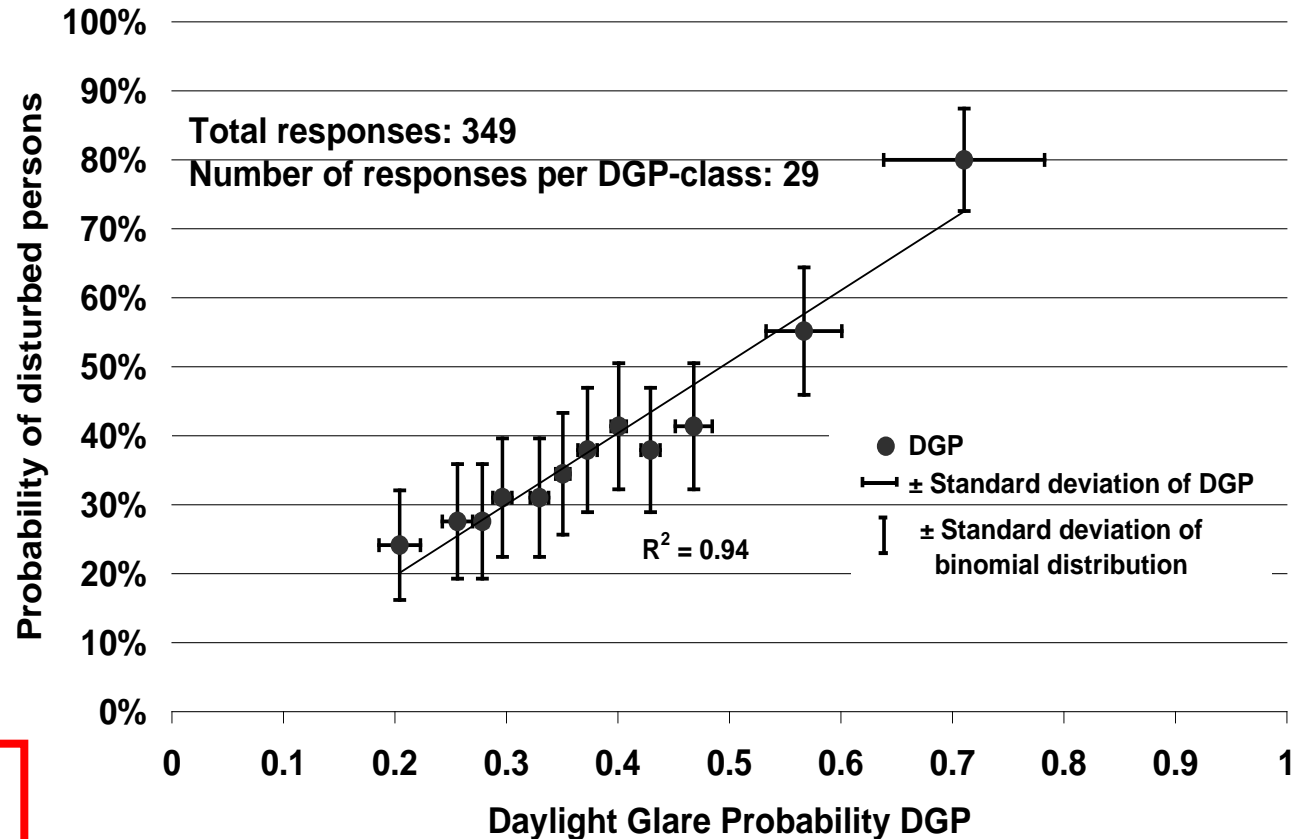
$$p = 3.44 \cdot 10^{-8}$$

⇒ Much stronger than for all other metrics

Valid for

$$\text{DGP} \geq 0.2$$

$$E_v \geq 380 \text{ lux}$$



What does evalglare?

- Detect glare sources
- Calculate solid angles from pixels/glare sources
- Calculate vertical illuminance from image
- Calculate various glare metrics (DGP, UGR, VCP, DGI, CGI...)
- Can be used also for calculating average luminance of surfaces (window..)

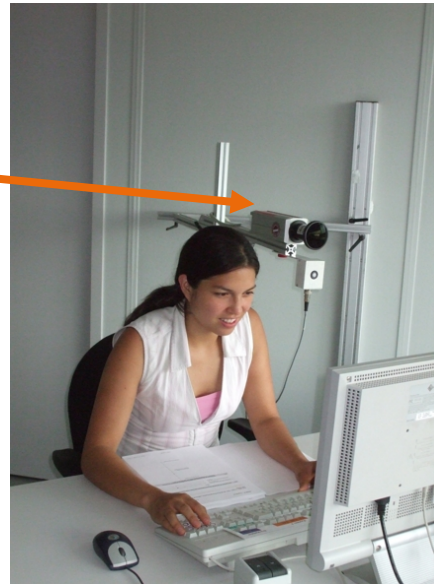
Open Questions

- Dark situations?
- Influence of age on glare perception?
- DGP also valid for fabrics?

Four year research project

- User assessments with different age groups
- User assessments with 2 fabric types
- User assessments with reduced transmission

**Luminance
camera with
fish eye lens**



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Known problems with 0.9x versions

- Only ONE problem...
 - > View type handling/**validity!**
 - What is an invalid view ????**

-> missing view information

-> Images treated by tools (like pcompos)

Then

RADIANCE routines treat view as invalid -> standard view is used <> fish eye!!

- Missing feature: other viewtype than vta

Example

Reality:

$E_v=6125$ lux, $DGP=0.52$

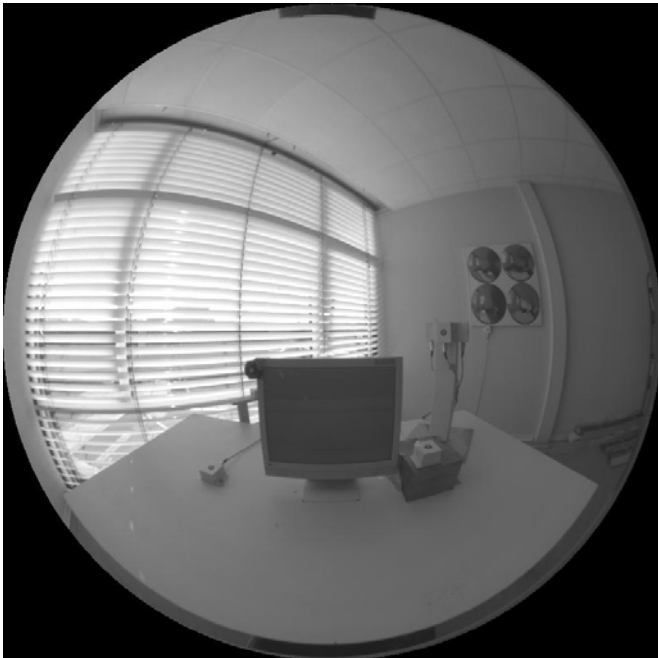
e.g. use

```
pcompos -s 1 testpic.pic 0 0
```

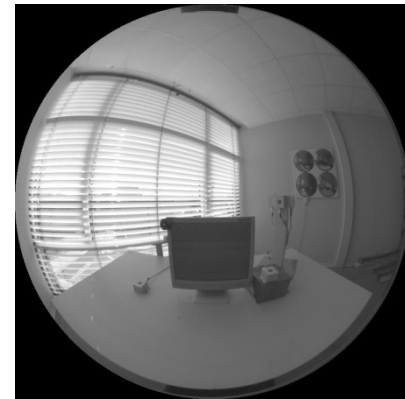
-> same image

-> tab added to the view option string in header

-> indicating invalid view



Example



original image

#?RADIANCE

CAPDATE= 2003:12:15 17:44:01

/scratch/wienold/ecco/WeisseJal/results/04.11.2003/2003-11-04-10-38-27-875.pf.pic:

VIEW= -vta -vv 182 -vh 182 -vp 0 0 0 -vd 0 0 1 -vu 0 1 0

pcompos -x 786 -y 786 /scratch/wienold/ecco/WeisseJal/results/04.11.2003/2003-11-04-10-38-27-875.pf.pic -313 -109

FORMAT=32-bit_rle_rgbe

changed image:

#?RADIANCE

CAPDATE= 2012:09:10 23:49:48

GMT= 2012:09:10 21:49:48

103_diagonal_morning_C_typing.pic:

CAPDATE= 2003:12:15 17:44:01

/scratch/wienold/ecco/WeisseJal/results/04.11.2003/2003-11-04-10-38-27-875.pf.pic:

VIEW= -vta -vv 182 -vh 182 -vp 0 0 0 -vd 0 0 1 -vu 0 1 0

pcompos -x 786 -y 786 /scratch/wienold/ecco/WeisseJal/results/04.11.2003/2003-11-04-10-38-27-875.pf.pic -313 -109

pcompos -s 1 103_diagonal_morning_C_typing.pic 0 0

FORMAT=32-bit_rle_rgbe

Example

Reality:

$E_v=6125 \text{ lux}$, $DGP=0.52$

e.g. use

```
pcompos -s 1 testpic.pic 0 0
```

-> same image

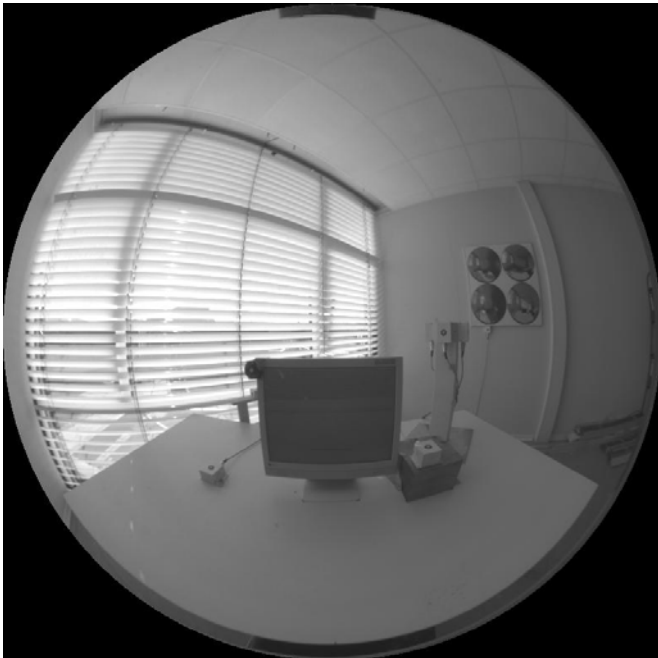
-> tab added to the view option string in header

-> indicating invalid view

Apply evalglare (e.g. v0.9f)

Wrong result:

$E_v=780 \text{ lux}$, $DGP = 0.23$!!!!!!!!!!!



Solution:

- Other handling of view type than before
- Implementing other viewtypes as well

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View type handling

- If invalid view, error message is displayed and program terminates:

error: no valid view specified

-> If such images should be used, the view options can be provided now per command line option:

-vtt	Set view type to <i>t</i> . (for fish-eye views, please use -vta or -vth preferably)
-vf <i>viewfile</i>	Get view parameters from <i>viewfile</i> .
-vv <i>val</i>	Set the view vertical size to <i>val</i> .
-vh <i>val</i>	Set the view horizontal size to <i>val</i> .

Supported view types

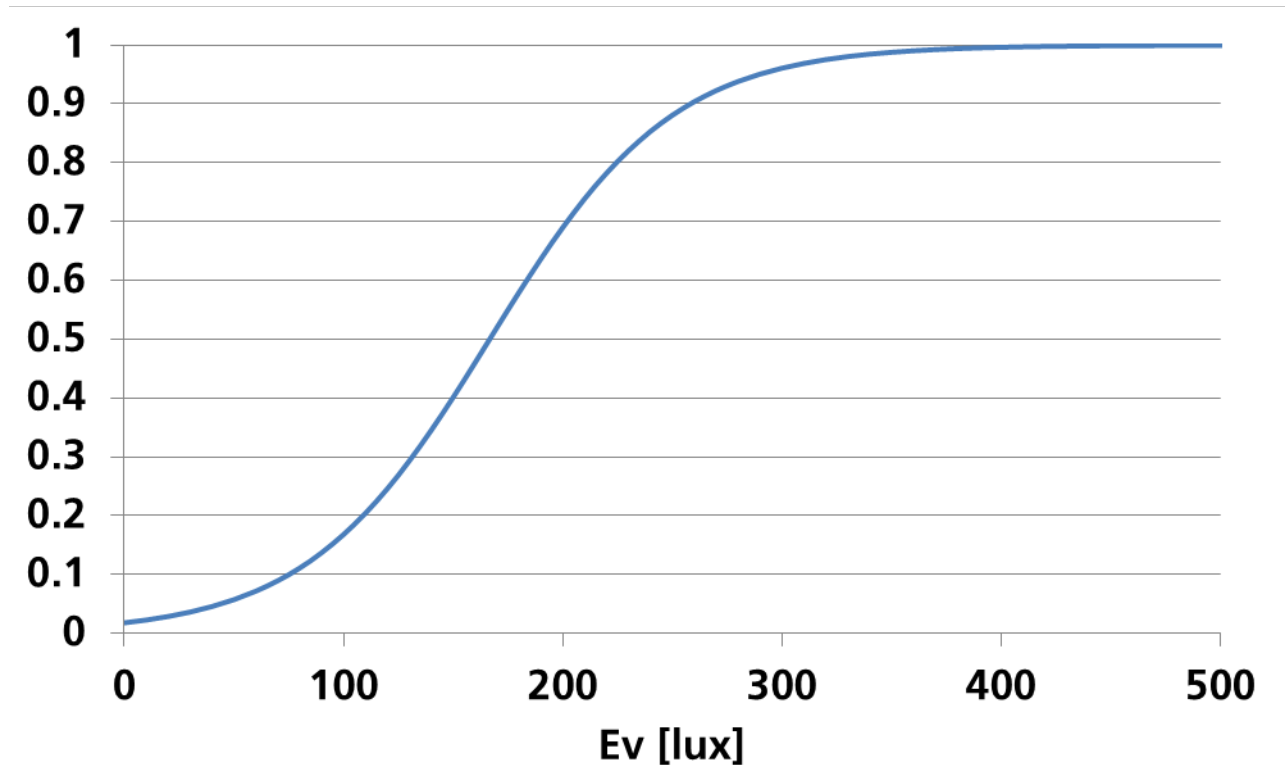
- **All view types are supported now!**
except parallel view
- -vta preferred (just because long term experience)
- Caution! If view does not cover 180° Ev cannot be calculated correctly -> should be provided then by -i option

Low light correction

- Problem: DGP is not defined for values smaller than 0.2 or $E_v < 320 \text{ lux!!}$
- correction factor for “low light” scenes
- advantage: existing DGP equation is not changed, but usability range extended
- based on user assessments
- s-Curve between 0-300 lux E_v

$$DGP_{\text{lowlight}} = DGP \frac{e^{0.024 * E_v - 4}}{1 + e^{0.024 * E_v - 4}}$$

Low light correction



$$DGP_{\text{lowlight}} = DGP \frac{e^{0.024 \cdot E_v - 4}}{1 + e^{0.024 \cdot E_v - 4}}$$

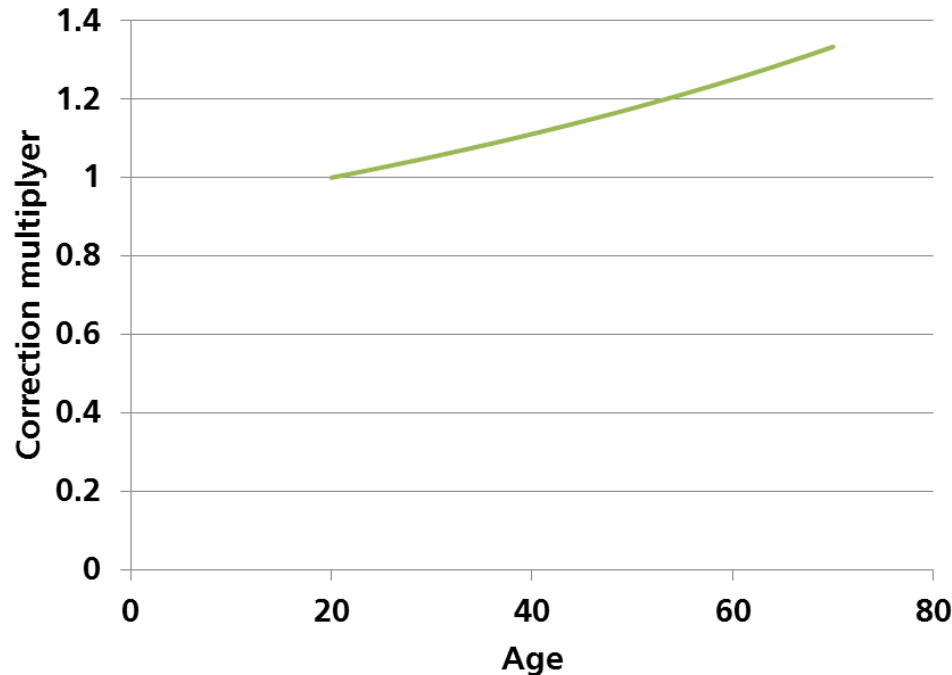
Age influence

- User assessments with 3 age groups
 - 15 test persons in age group 20-30
 - 15 test persons in age group 50-60
 - 15 test persons in age group 60-70
- parallel study in 9 office buildings à 15 offices each (done by University Karlsruhe)
- we found a (weak) improvement of the correlation between user perception and DGP when age is applied to equation
- This was confirmed by the office study (better improvement than in the lab study)



Age influence

- Following correction showed best correlation:



$$DGP_{age} = \frac{DGP}{(1.1 - 0.5 * \frac{age}{100})}$$

- evalglare implementation: New option: -a age
- default: age=20, factor =1

Calculation of vertical illuminance only

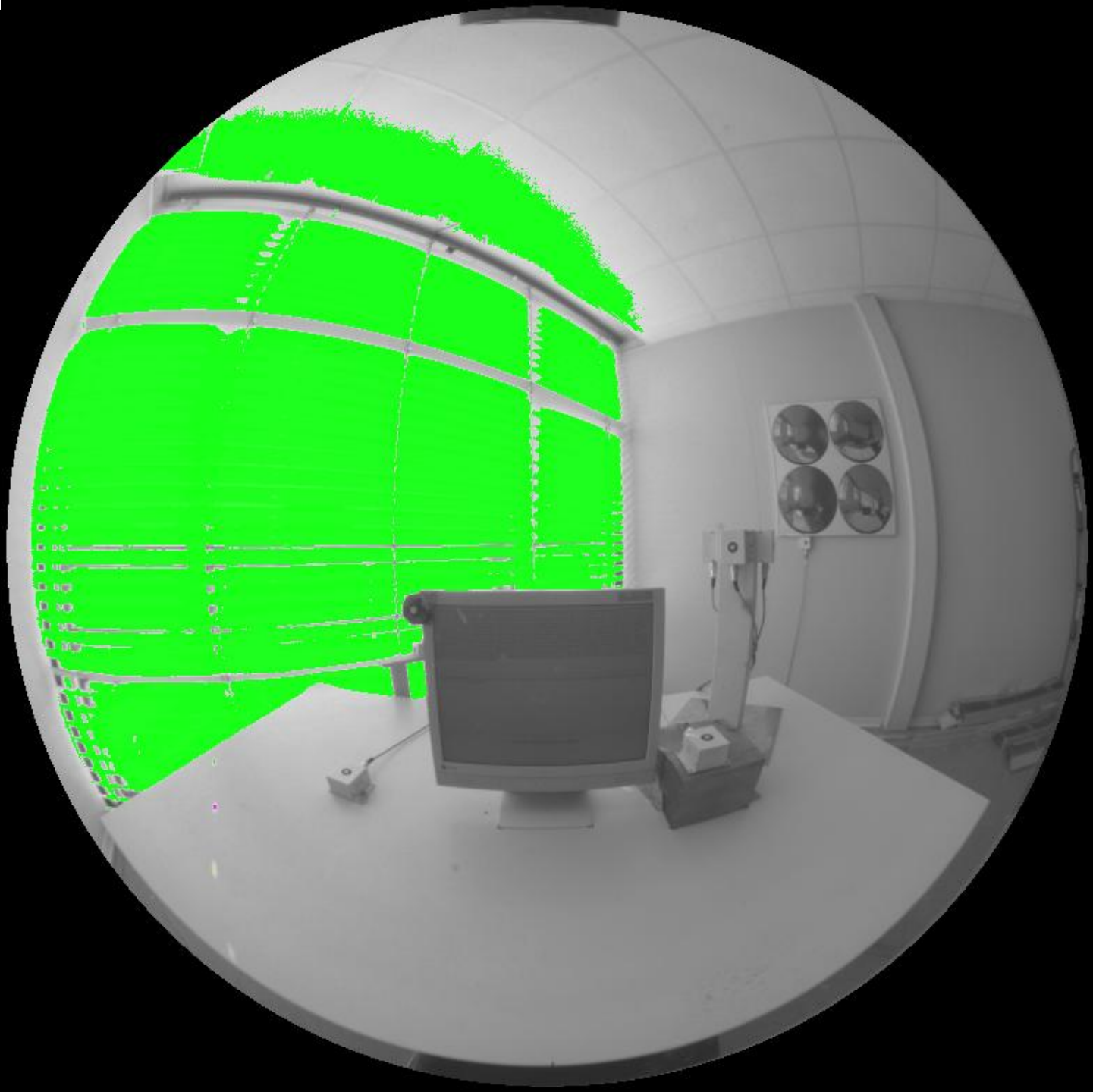
Disability glare calculation

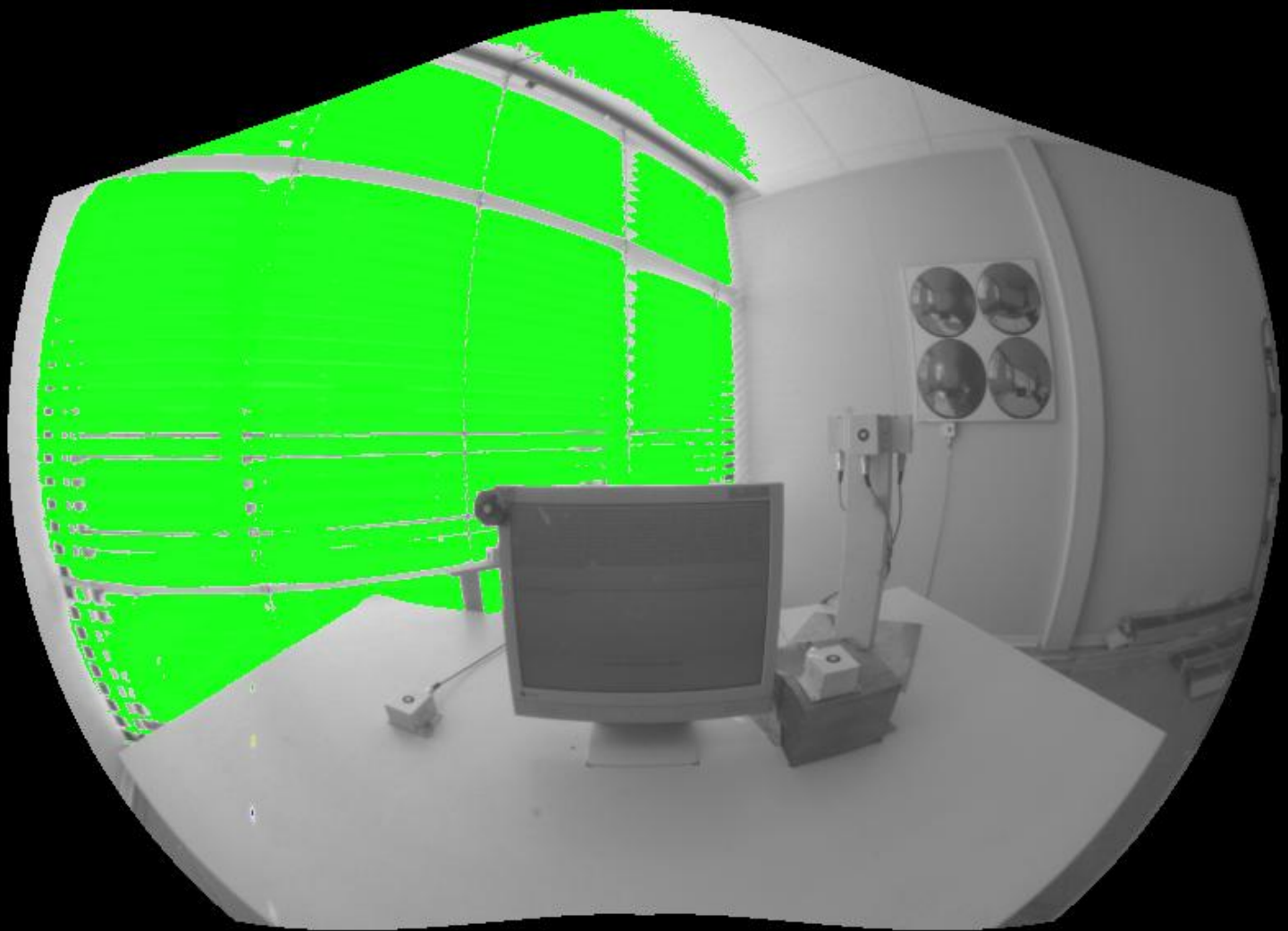
- New Option : -V
 - > Calculates just the vertical illuminance from image
- Calculation of disability glare (according to Poynter, age =20 years)
 - > CIE disability glare equations will be included in future
 - > output generated by detailed output (-d),
Disability Veiling Luminance L_{veil}

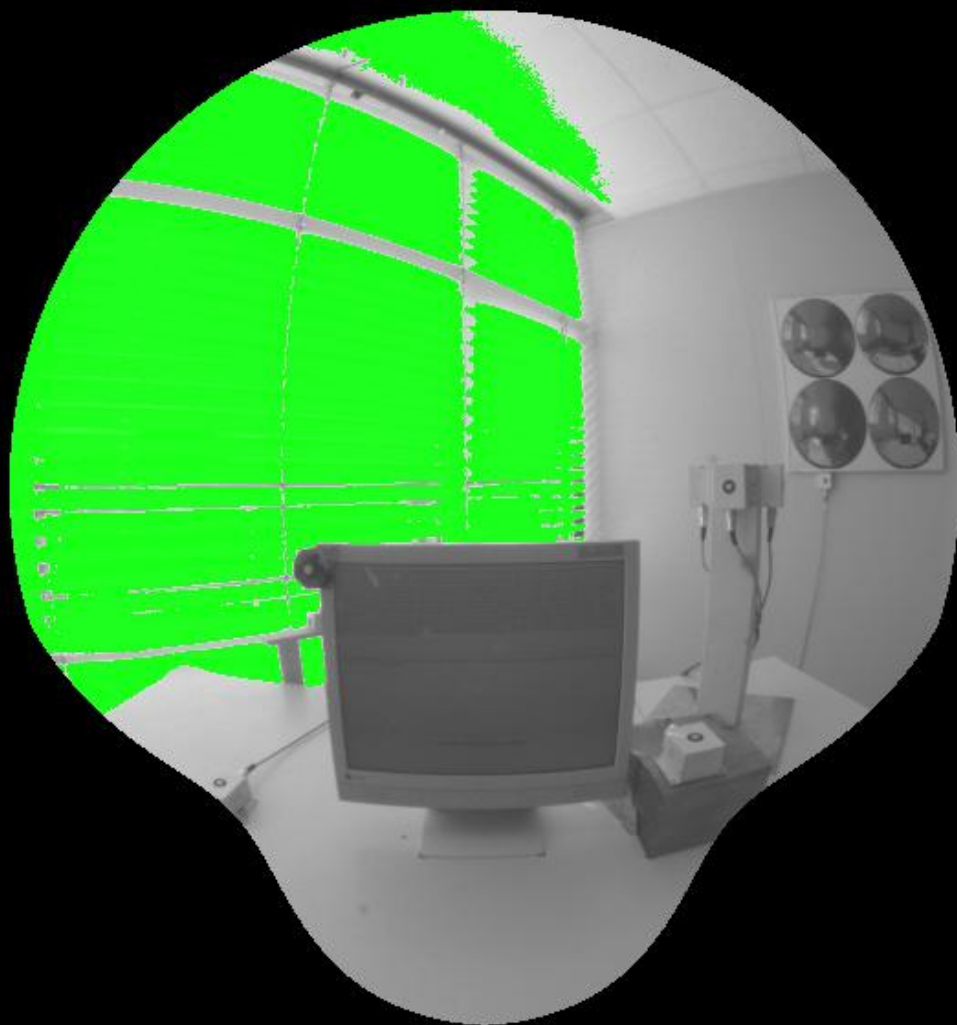
Cutting field of view based on Guth

- based on paper of Guth 1958:
Light and Comfort, Industrial Medicine and Surgery,
November 1958
- activated by option -G *type*,
type=1: total field of view,
type=2: field of view seen by both eyes





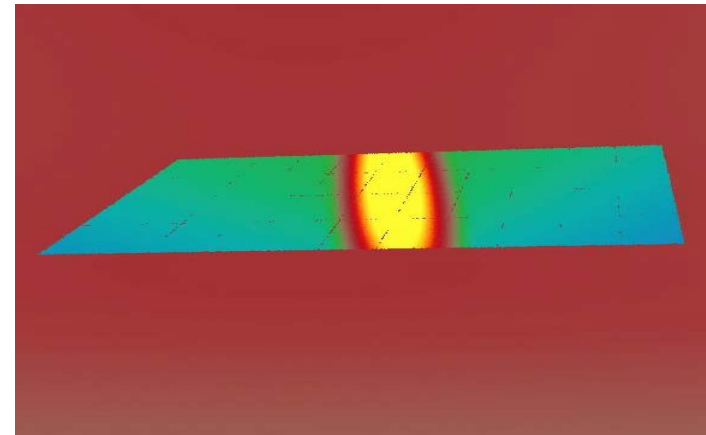
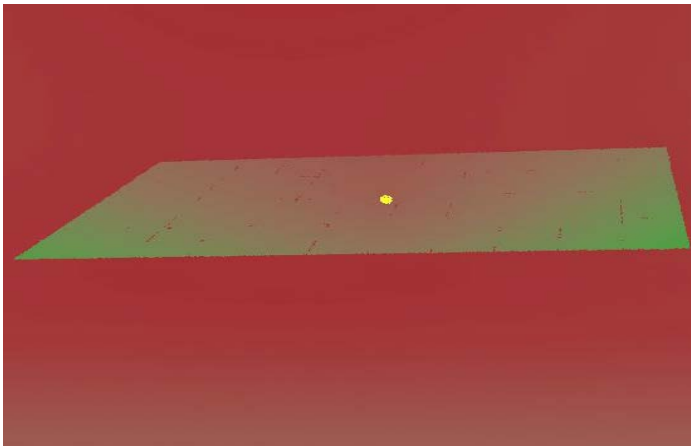
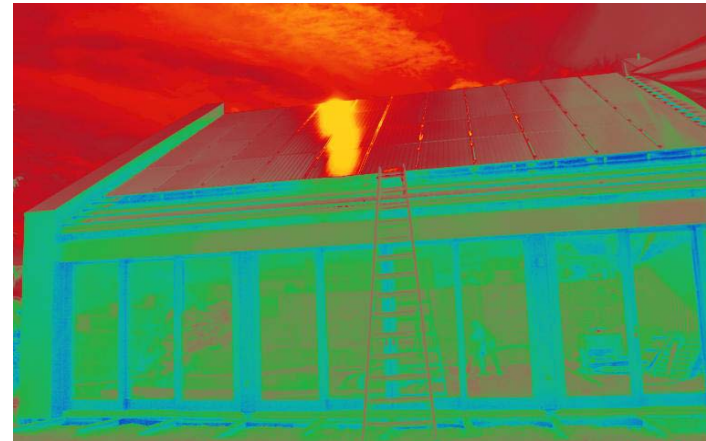




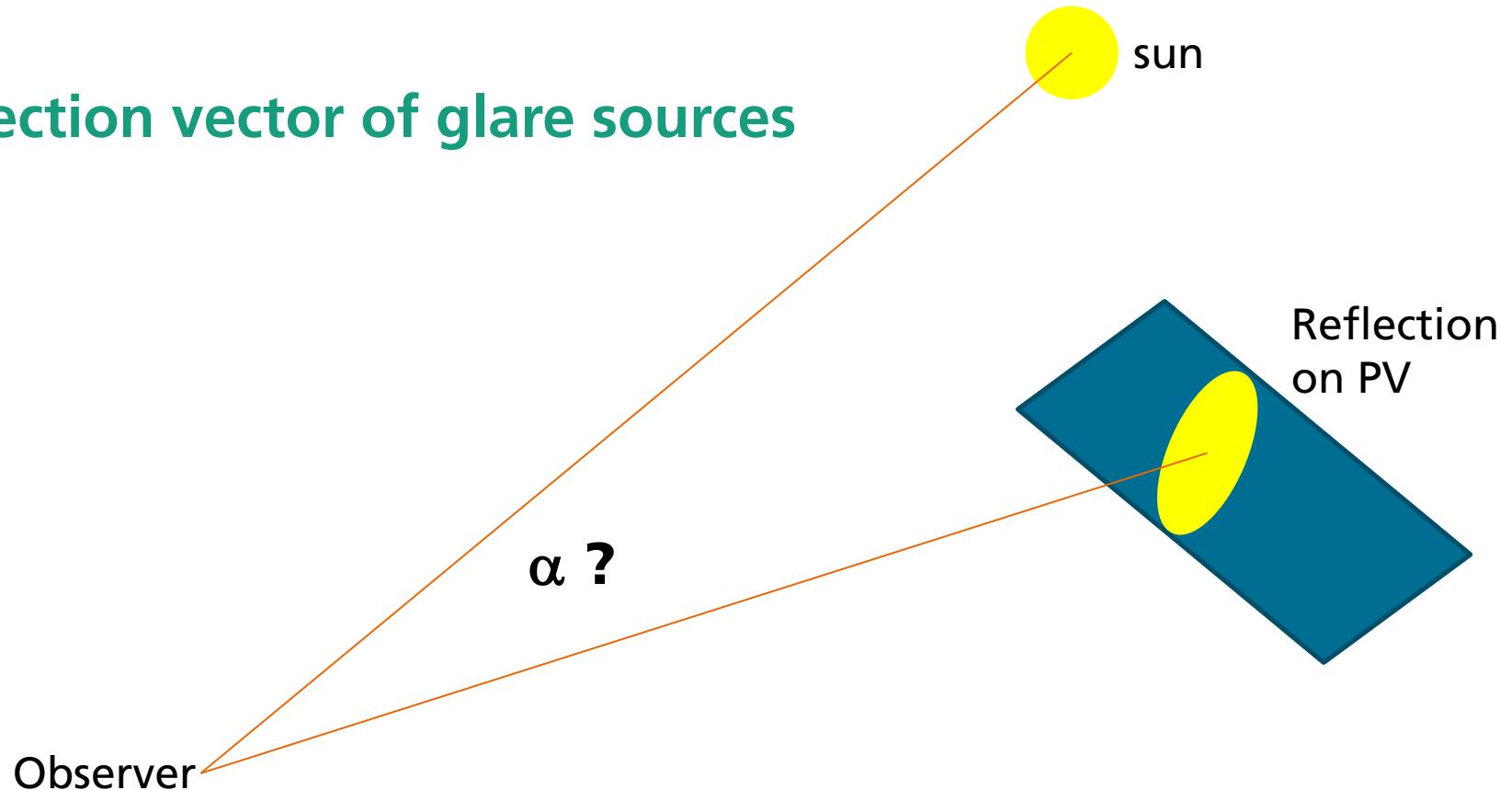
Direction vector of glare sources

Original Problem:

Determine the amount of min/day and h/year when glare occurs by reflections of a PV installation.



Direction vector of glare sources



Specific Problem:

What is the angle between sun and glare source?

Reason:

If angle $< 10^\circ$ the brain perceives only one glare source, even two glare sources could be seen

Direction vector of glare sources

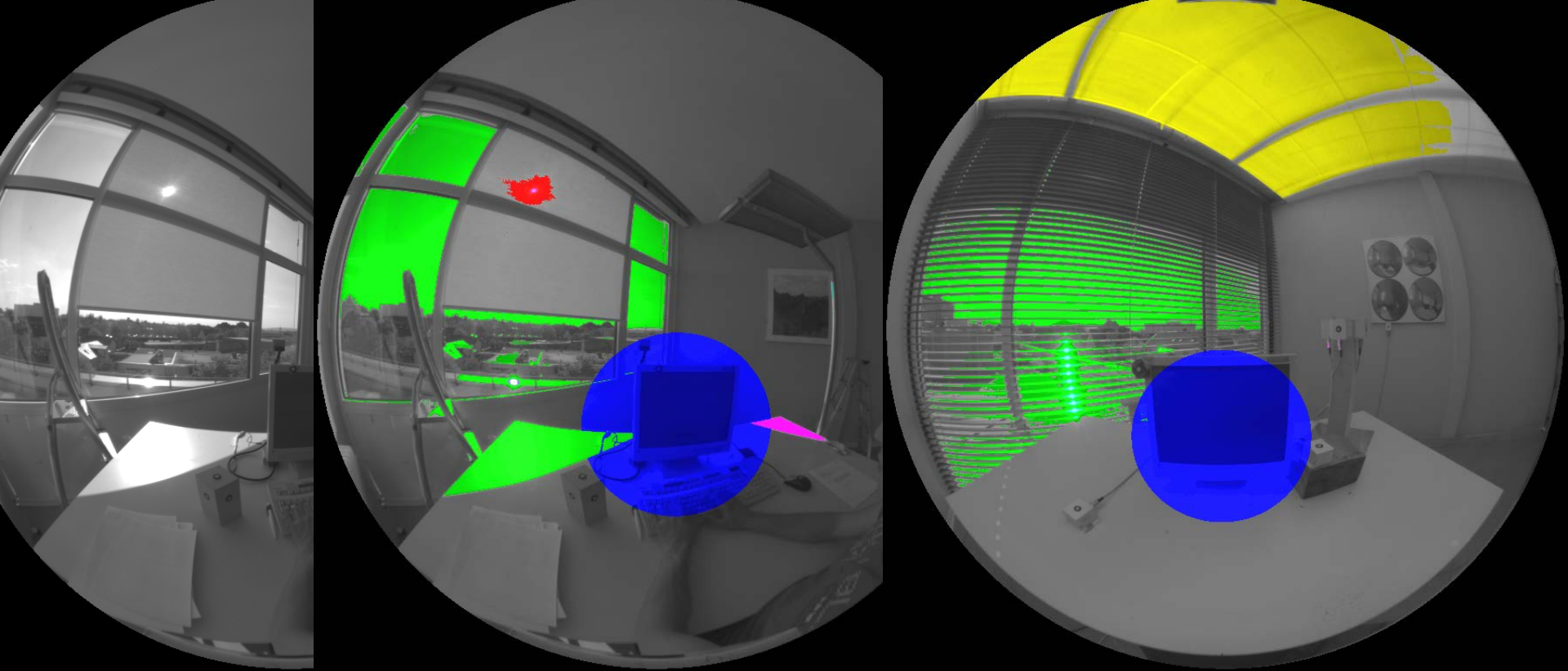
- Solution:
evalglare provides direction vector for each glare source
- scalar product gives then the cos of the angle

Using -d option, in the glare source section you get the X, Y, and Z direction of each glare source

```
2 No pixels x-pos y-pos L_s Omega_s Posindx L_b L_t E_vert Edir Max_Lum Sigma xdir ydir zdir
1 8.000000 363.125138 313.125297 746381308.068426 0.0000923477 2.948167 38.383377 11560.269531 61866.158167 61745.573231 746381312.000000 0.000000 -0.000111 -0.952052 0.3059
2 391.000000 442.571127 450.737313 753082.817802 0.0047627966 1.020995 38.383377 11560.269531 61866.158167 61745.573231 746381312.000000 0.000000 -0.271428 -0.947911 -0.1667
dgp,av_lum,E_v,lum_backg,E_v_dir,dgi,ugr,vcp,cgi,lum_sources,omega_sources,Lveil: 1.000000 11560.269418 61866.158167 38.383377 61745.573231 43.038952 84.689842 0.000000 83.017189
```


Tiny other changes

- version number is given by `-v` and written in the image header
- Piping of input pictures into evalglare possible.
- The threshold factor of absolute glare source detection (`-b`) is changed from 500 to 100.
- Peak extraction is default now (`-y`).
For deactivation use `-x`.



Version 1.08 is available in the next days.

Thanks for your attention!!