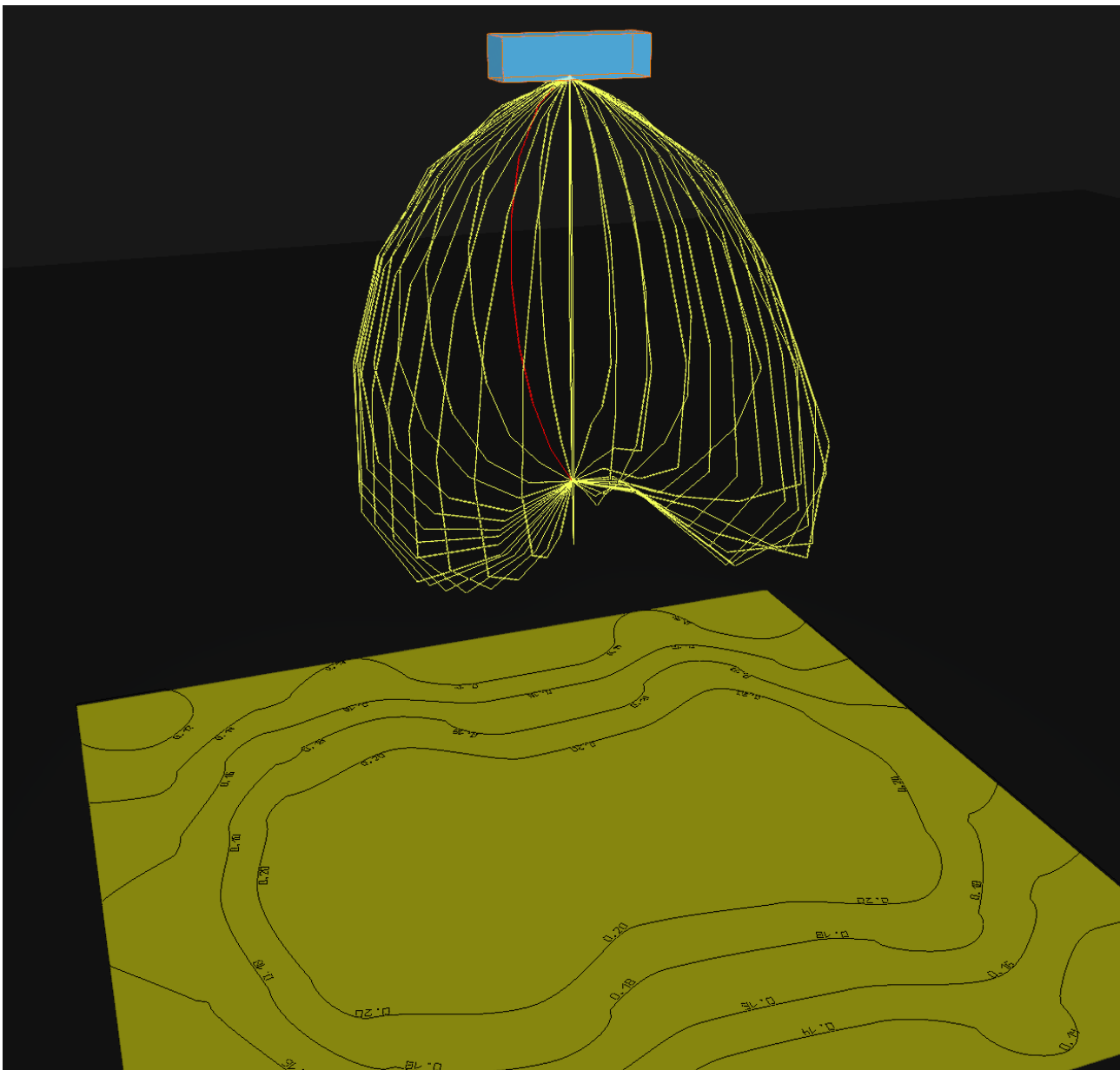


Guidelines

Working with UV radiation in DIALux

Revision: 23 February 2022



Contents

Important Information.....	3
Stepping the way through a new DIALux UV simulation.....	5
Working with doses and dose time.....	10
Standard dose time outputs in Viso Light Inspector	11

These guidelines contain descriptions and ideas on how to work creatively with Viso UV light distribution data in the free light planning software DIALux

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Important Information

These guidelines intend to give directions to experienced engineers on how to work creatively with Viso UV light distribution data in the free light planning software DIALux.

Viso System takes no responsibility for any planning result or actual germicidal exposure that is developed by means of the suggested methodology.

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Introduction

About this Document

These guidelines intend to give directions to experienced engineers on how to work creatively with Viso UV light distribution data in the free light planning software DIALux.

About DIALux

DIALux is a free-to-use light planning/lighting design software developed by DIAL. All examples in this document are made with DIALux Evo 9.2, but other versions are applicable too.

DIALux is not intended for working with UV lighting but can be used to sketch UV irradiation patterns with some precautions.

In DIALux, all numbers are in photometric units (lumen, lux, candela) and it does not handle radiometric units (W/sr, W/m² etc.) at all.

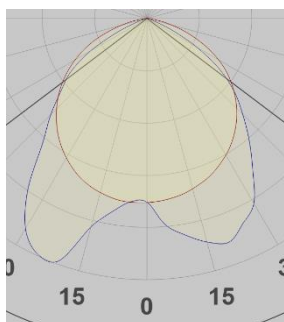
Viso UV light distribution files .IES/.LDT

Viso Light Inspector software can generate both .IES and .LDT files – luminaire light distribution files that can be used in DIALux lighting designs. However, using .IES/.LDT files for UV luminaires is irregular since they should just contain photometric values.

Nevertheless, if you generate Viso .IES/.LDT files for UV luminaires, the normal photometric values will be replaced by the corresponding radiometric numerical values:

Photometry			Radiometry		
Label	Symbol	Unit	Label	Symbol	Unit
Luminous flux	Φ_v	lumen (=lm)	Radiant power	Φ_e	W
Luminance	L_v	lm/m ² ·sr	Radiance	L_e	W/m ² ·sr
Luminous intensity	I_v	Cd	Radiant intensity	I_e	W/sr
Illuminance	E_v	Lux (=lumen/m ²)	Irradiance	E_e	W/m ²

In other words, the numbers are right but all units in DIALux simulations are wrong. Keeping this in mind, DIALux can still be used to calculate radiometric distributions.



Example:

These are the main outputs from a UV light measurement.

Output:	4315 mW
Peak:	1937 mW/sr
Power:	29,9 W
Power Fc:	0,99

The radiant power is 4315 mW equaling 4,315 W. In the .IES/.LDT file, this value (4,3) will occur as the “luminous flux = 4,315 lumen” although this is in fact the wrong unit.

The peak radiant intensity is 1937 mW/sr or 1,937 W/sr. In DIALux, this will be interpreted as 1,937 candela. This peak occurs on the left-hand side of the polar curve. Just under the luminaire, the value is approximately 70% of the peak value (interpreted from the diagram).

Stepping the way through a new DIALux UV simulation

STEP 1: Picking the active part of the spectrum

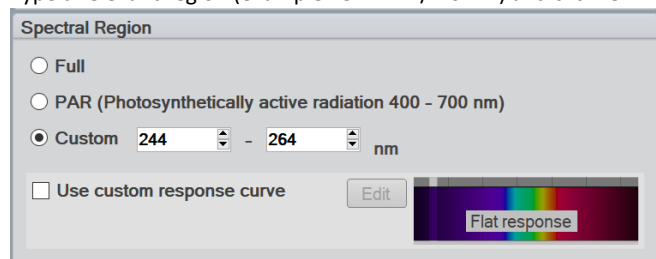
Viruses/bacteria have specific sensitivities toward different wavelengths. Thus, before exporting your results to .IES/.LDT format you must exclude radiation that does not contribute to inactivating your particular viruses/bacteria. Many UV light sources also radiate a little visual light. This should be removed.

In the Light Inspector software, you have the option of

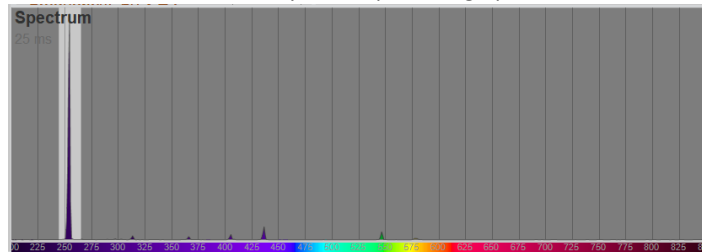
- 1) Working with a limited part of the spectrum, e.g. [244 nm;264 nm] – the Spectral region function, or
- 2) Working with the more sophisticated custom response curves.

Both will effectively sort out ineffective radiation. In this document we shall use option 1 as an example. Option 2 is described in more detail in the Light Inspector software manual.

- a. Pick your measurement.
- b. Click *Edit* → *Photometric* and choose tab “Measurement” – and go to Spectral Region
- c. Type a relevant region (example 254 nm +/-10 nm) and click ‘OK’



The result shows immediately in the spectrum graph:



Then, save you measurement to preserve changes.

Now, your light measurement data is ready for export.

STEP 2: Generating .IES/.LDT files

The Light Inspector allows you to export photometrical data in the two standard formats: IES¹ and LDT² (EULUMDAT). Both are text file formats that contain similar information but arranged differently. Both are primary outputs for software intended for light planning in spaces.

Hence, .IES/.LDT output files formats are standard light distribution files that are used in Dialux, Relux and other 3D light planning software. These formats just include photometric data and do not contain color information.

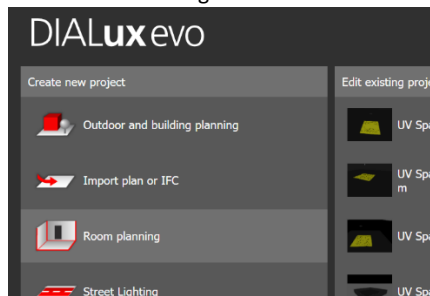
To export to IES simply select: *File* → *Export* → *IES* or *LDT* (both are valid for use in DIALux) and save to a suitable location.

STEP 3: Building a test space in DIALUX


In this section, we will build a very simple room with totally absorbing surfaces. More complex spaces with furniture etc. are also possible. In this case it is important to apply realistic UV reflectance value to all surfaces. UV is absorbed very differently from visual light, and absorption also depends on surface roughness.

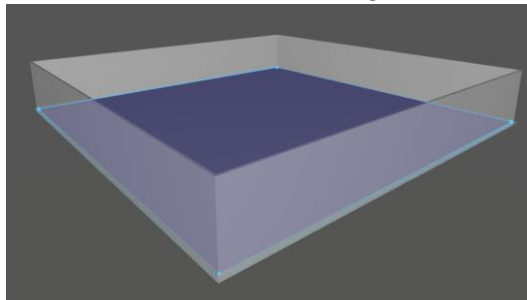
- a. Download (<https://www.dialux.com/en-GB/download>) and open DIALux Evo 9.2.
The following examples are all in metric units. However, DIALux can also be set work in imperial units.

- b. Pick "Room Planning"



Press 'OK' to standard settings, H=3,0 m and wall thickness 0,1 m

- c. Draw a new room with the mouse, e.g. 20x20 m, shift to 3D view 



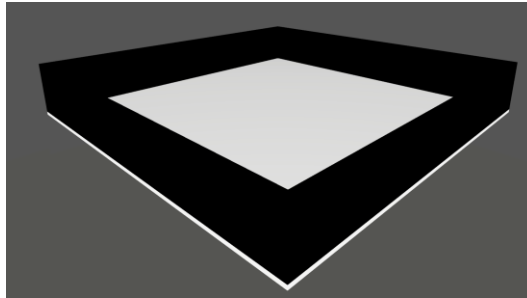
- d. Your surfaces need to be black to absorb all radiation, so none is reflected back to your calculation surface:




Press the materials button , press  Create colour material, and set red/green/blue sliders all to zero. Apply this 100% absorbing material to all

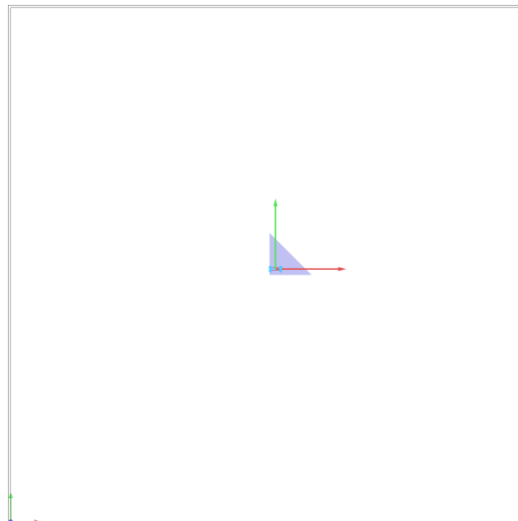
¹ Standardized in ANSI/IESNA LM-63-02. Widely used in the US

² Also called EULUMDAT. Not standardized, but proposed by Axel Stockmar (Light Consult Inc., Berlin) in 1990. Widely used in Europe

room surfaces by dragging the black ball to the surfaces (the floor can be excluded but remember the ceiling). Turn your view with the left mouse button pressed and pan with pressed-down mouse wheel.



- e. Press the  Light button
Press the floorplan view button  and centre the view with 
- f. Drag and drop your .LTD/.IES file onto the floor plan approximately in the middle:



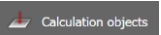
Adjust the position to the centre of your space (as space is 20x20, the middle is $x=10$, $y=10$).


Adjust the height to fit your analysis needs, e.g. 1 m over the floor


Positioning			
Position	10.295	9.840	3.000 m
Rotation	0.0	0.0	0.0 °

Adjust to:

Positioning			
Position	10.000	10.000	1.000 m
Rotation	0.0	0.0	0.0 °

- g. Press the  Calculation objects button

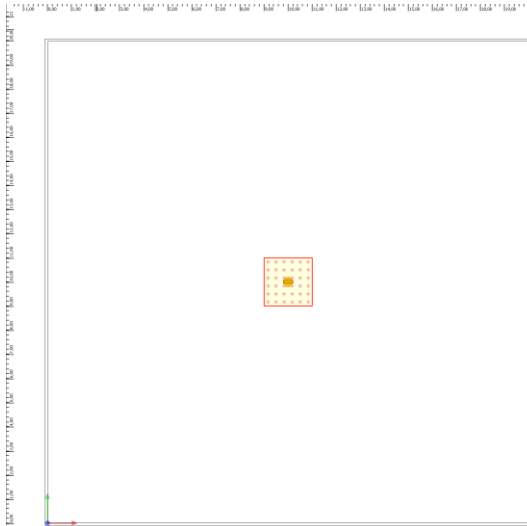
Press the 'horizontal illuminance button'  (un-press any other calculation parameter)

Press  Draw rectangular calculation object and draw a calculation surface on the floor plan with approximately the right size. Correct size and position by opening

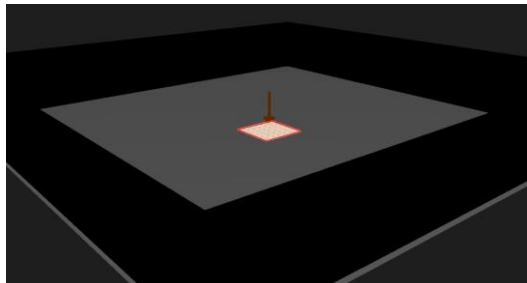
the 'positioning' area on the left-hand side and type your preferred size and location. In this example we use 2 m x 2m and location in the centre:


Positioning			
Position	10.000	10.000	0.000 m
Rotation	0.0	0.0	0.0 °
Size	2.000	2.000	m

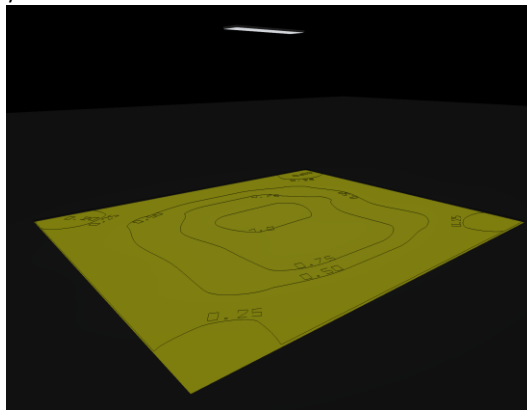
Your floor plan with the luminaire and the calculation surface should look like this now:





And in the 3D view:

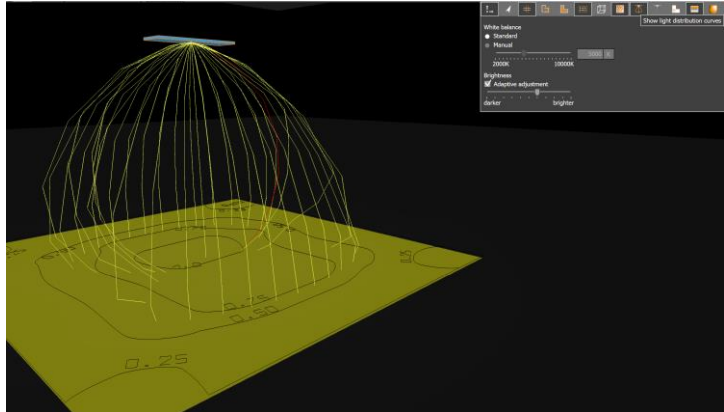


- h. Now calculate your irradiance pattern by pressing , and zoom in on your results with the mouse wheel:

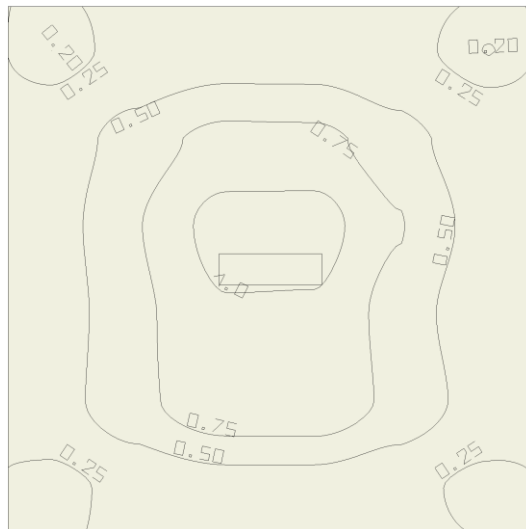


The iso-illuminance curves are in fact iso-irradiance curves, and the values should be interpreted as unit W/m^2 .

By clicking on the luminaire and clicking on  (In the upper right-hand corner) then  (show light distribution curve), you may even include the light distribution in the rendering:



From the top, your iso-irradiance (unit W/m^2) pattern looks like this (field 2x2 m, luminaire elevation is 1 m)



You can save this planning space and reuse many times.

Working with doses and exposure

The pattern above shows a planning result in W/m^2 .

However, in germicidal UV calculations, the *exposure time* to inactivate a certain virus/bacteria is more interesting.

Please note: Doses should always be picked from peer-reviewed scientific literature. Examples mentioned in this document are merely numerical examples and should not be used in practice.

Presuming that the dose needed to inactivate 99.9% e-coli bacteria on a surface is 5 mJ/cm^2 , how can we recalculate the iso-irradiance pattern to an iso-exposure time pattern?

Firstly, we need to recalculate the dose from mJ/cm^2 to $\text{J/m}^2 = \text{W}/(\text{s}\cdot\text{m}^2)$.

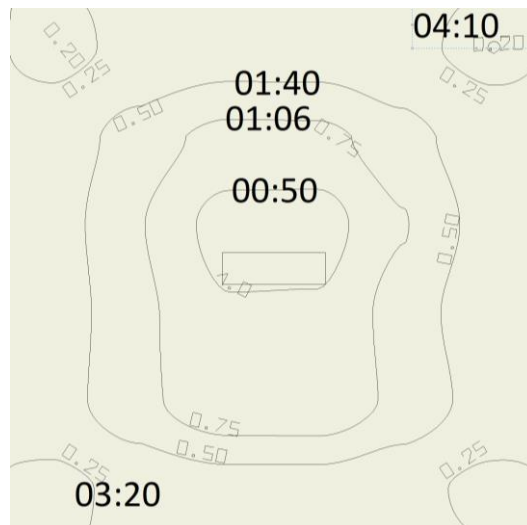
Multiply with 1000, divide by $100\cdot 100$:

$$5 \text{ mJ/cm}^2 = 50 \text{ J/m}^2$$

Then, recalculate the values from the irradiance diagram to exposure times (divide irradiance values $0,2\text{-}1,0 \text{ W/m}^2$ by 50 J/m^2):

W/m^2	s	=	hh	mm	ss
1	50,0	=	00	00	50
0,75	66,7	=	00	01	06
0,5	100,0	=	00	01	40
0,25	200,0	=	00	03	20
0,2	250,0	=	00	04	10

Plot your result in the diagram:

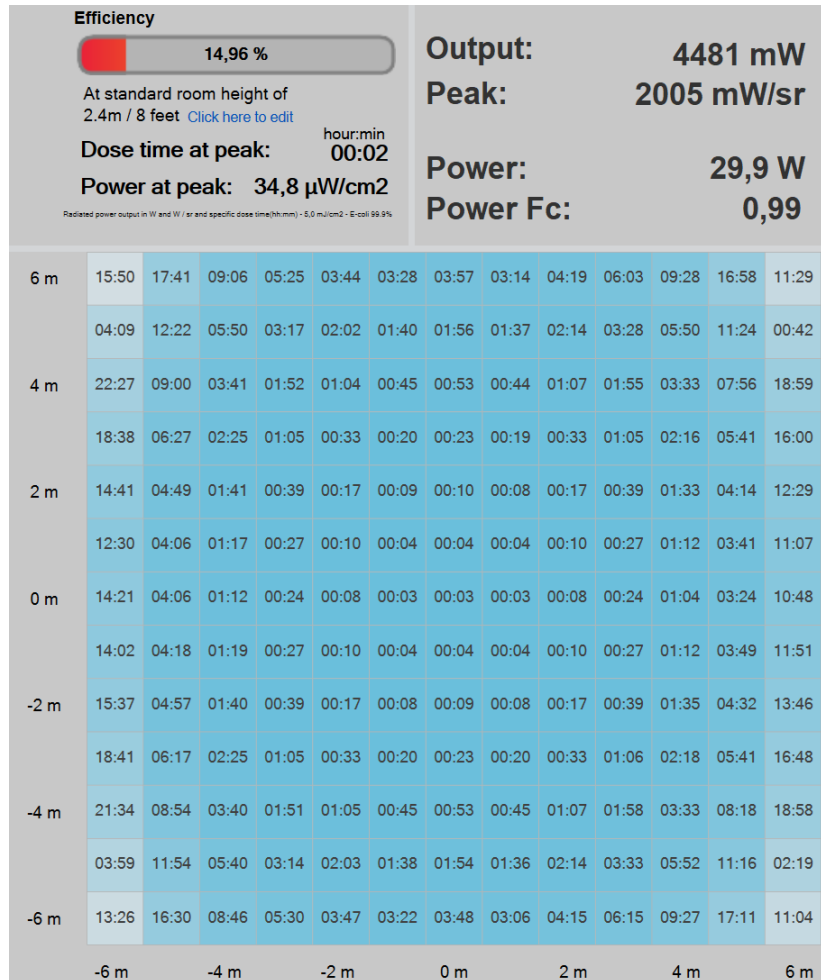


This iso-exposure pattern is valid for

- This specific luminaire
- Surface $2 \text{ m} \times 2 \text{ m}$
- Elevation 1 m
- 99,9% inactivation dose 5 mJ/cm^2

Standard exposure time outputs in Viso Light Inspector

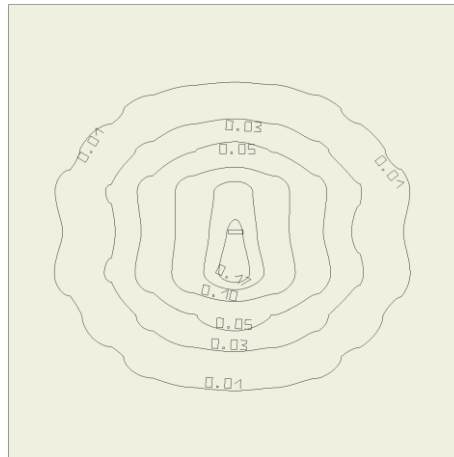
A standard output (photometrics set to "Dose units") could look a little like this:



Let us see how this output fits the DIALux calculation. The following change need to be made in DIALux:

- Change the luminaire elevation from 1 m to 2.4 m
- Change the size of the calculation area from 2 m x 2 m to 12 m x 12 m
- Recalculate the result

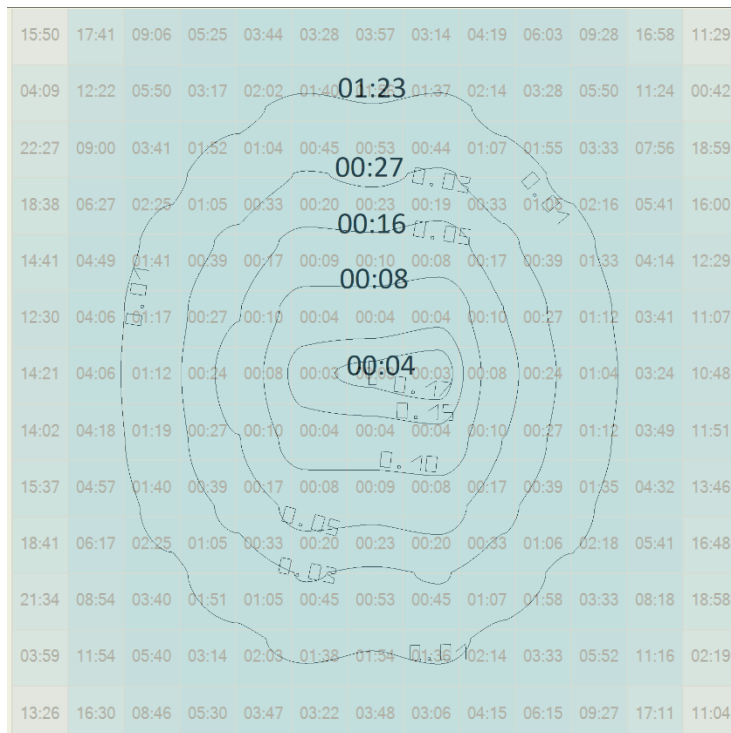
The iso-irradiance pattern now looks like this:



Recalculating the indicated irradiance values to iso-exposure:

Specific Dose	5 mJ/cm ²		
	Exposure time		
W/m ²	s		hh mm ss
0,17	294,1	=	00 04 54
0,1	500,0	=	00 08 20
0,05	1000,0	=	00 16 40
0,03	1666,7	=	00 27 46
0,01	5000,0	=	01 23 20

Rotating 90 degrees, and overlaying the result with the exposure time image from the software (does not show seconds):



Note: Some values in the edge of the diagrams may exceed 24 hours. Only the hh:mm portion of the figure is shown.



Light measurement made easy
