Light Simulation with VRED

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Class Summary

Realistic light simulation is increasingly becoming more important to the design process, whether it is to support the design of a car’s head and tail lamp clusters, or assessing how lights can is distributed around the interior of a railway carriage to support brand identity or how a room in a building is lit.

This class will shed light (!) onto these topics describing how the various features of Autodesk VRED can be used to achieve different lighting effects. Attendees will learn amongst other topics how to differentiate between the various ray trace modes, how to use light simulation data and how the realistic modeling of materials is important to the overall scene visualization.

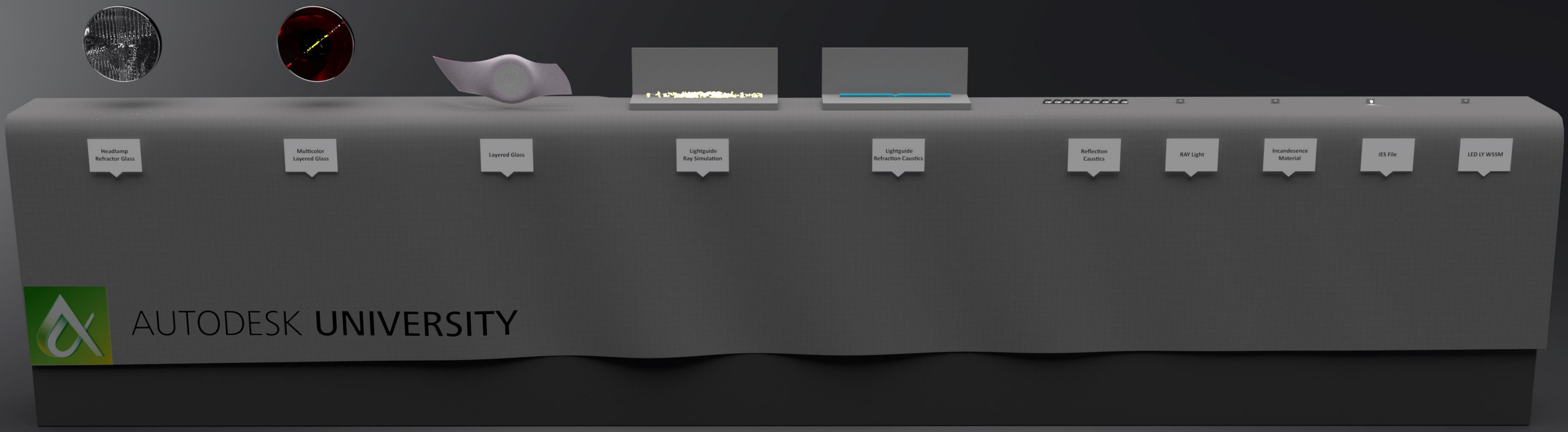
In this class we will work through simple examples with various significant design and engineering characteristic´s that you can easily adopt to your daily work visualization and models.

Key Learning Objectives

At the end of this class, you will be able to:

- Know what kind of data is necessary
- Work with IES files
- Know the values and impact of your *Render Settings*
- Work with *Incandescent Materials*
- Work with *RAY files*
- Know the values and impact of the *Glass Material*
- The difference between *Path Tracing & Photon Mapping*
- Work with *Layered Material* for multicomponent glass objects
- Understand the possibilities of the analytic *Camera Tone-Mapper*

Example Data



Organize as much Information you can

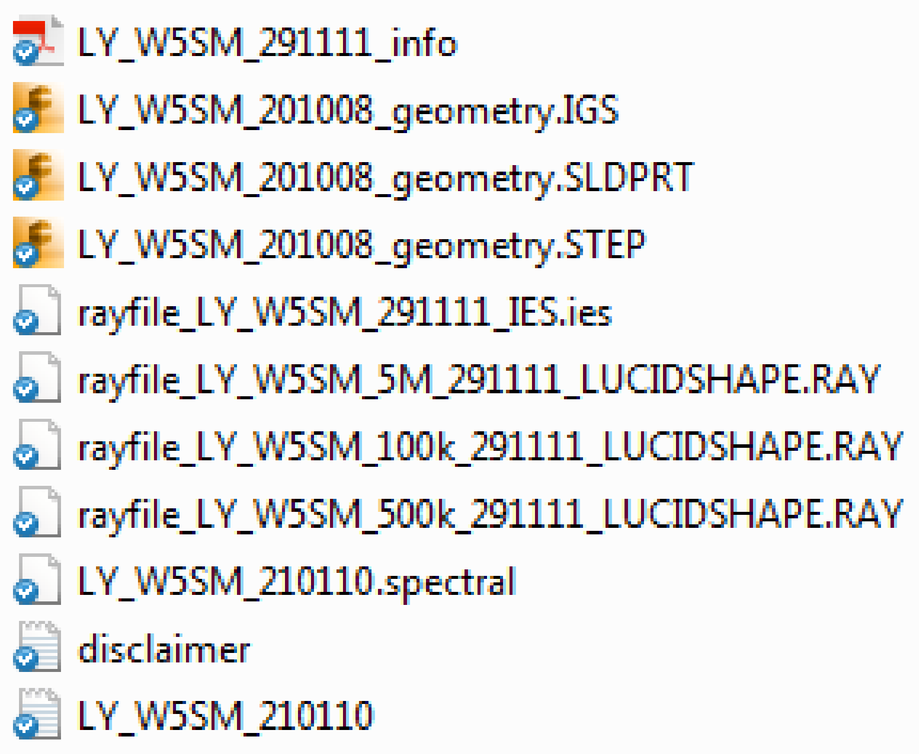
- **Full modeled 3D CAD data**
  - What makes the difference between engineering data and design data

- **Information about your light source**
  - Specification from supplier
  - IES data, RAY simulation data
  - Spectral color information

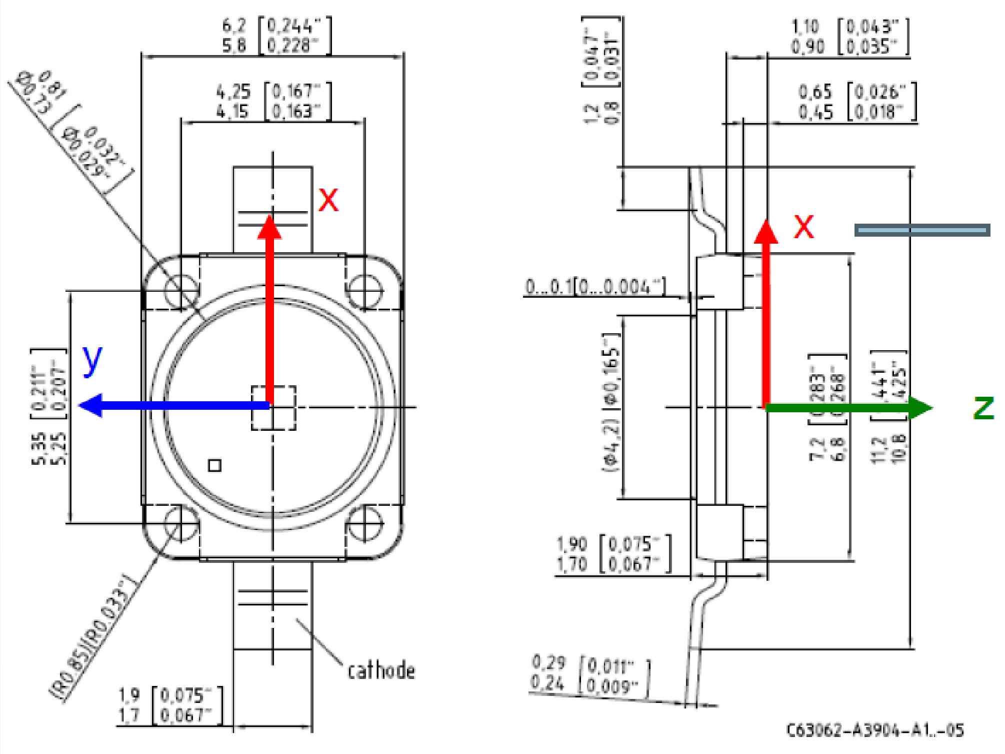
- **Information about your materials** (important for transparent plastic and glass materials)
  - Spectral color information (Example 8: multicomonent glass)
  - Correct refraction index (IOR) for transparent materials (glass, acryllic plastic etc.)

Example 1 – Osram, LY W5SM, GoldenDRAGON, yellow

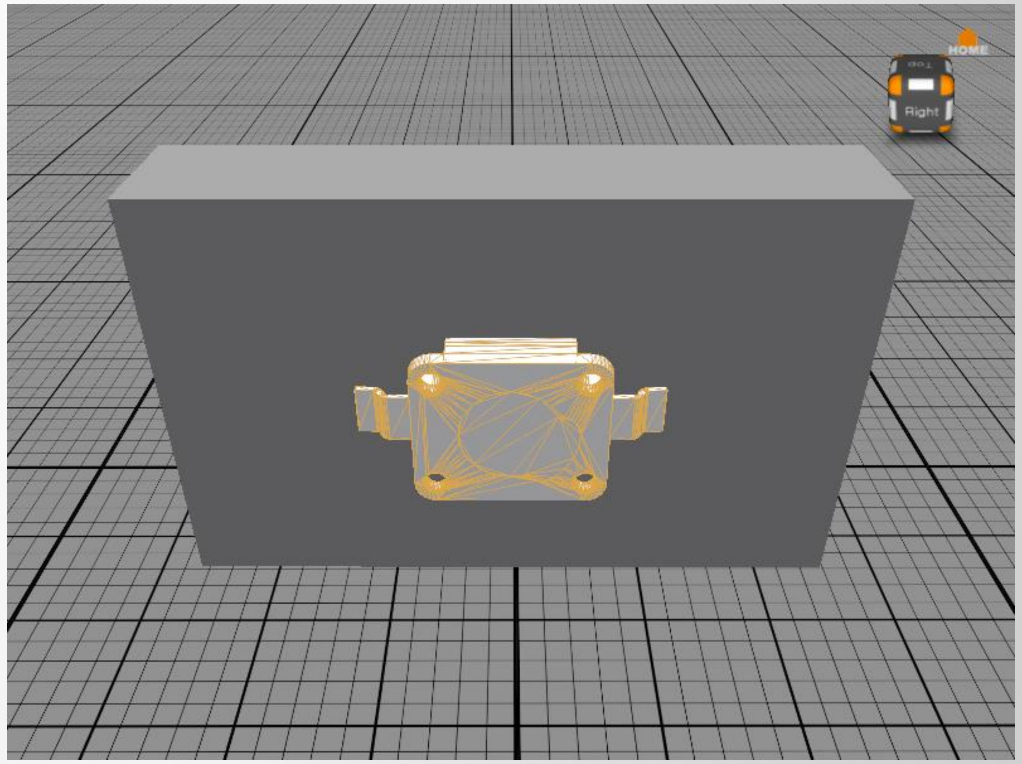
- CAD geometry (IGS, SLDPRT, STEP)
- LED specification (PDF)
- Spectral color information (Text file)
- IES file
- RAY file in different resolution (5M, 500K, 100K photons)



Files from supplier



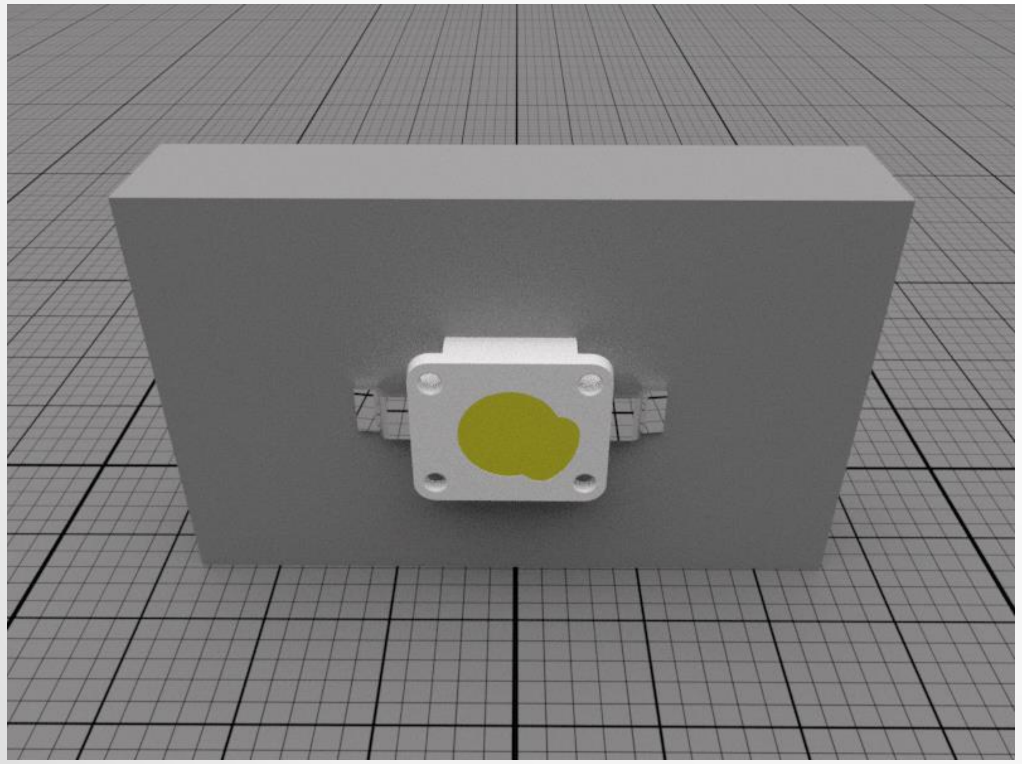
OsramSemiconductors.pdf



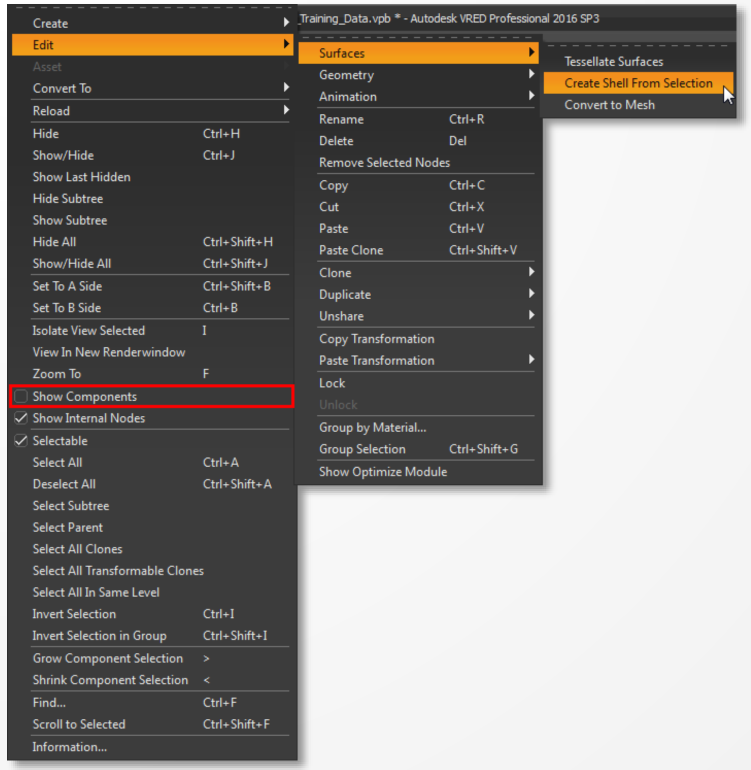
STEP file

Example 1 – Separate Geometry into different Materials

- ☑ Select **01_LEDLY_W5SM Group** in your scenetree and **+Add** the **LY_W5SM_201008_geometry.STEP** file
- ☑ This group node has already the correct transformation to place the LED on the table
- ☑ Import the STEP file with default settings when the **Import Dialog** appears
- ☑ Activate **Component Selection** mode and select the inner surface that emit the light later
- ☑ **Right Click > Edit Surfaces > Create Shell From Selection** to seperate this surface in a new **Shell** (necessary to assign new material)
- ☑ Create and assign a new **Plastic Material** from the **Material Editor**

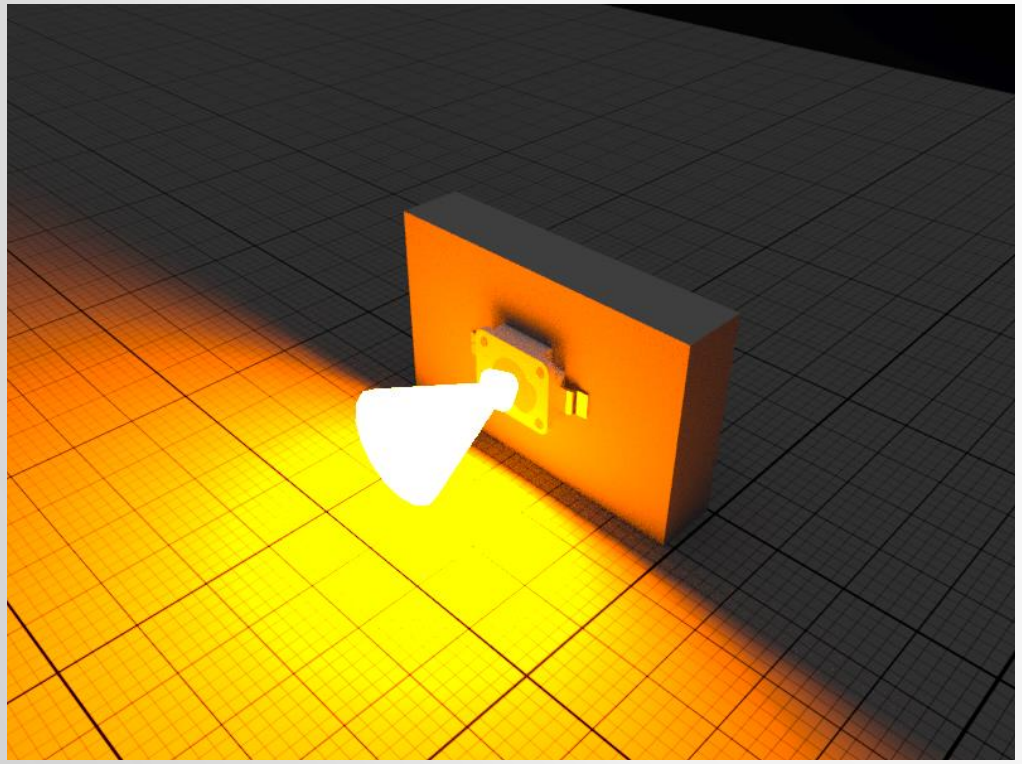


LED with seperated shells and materials

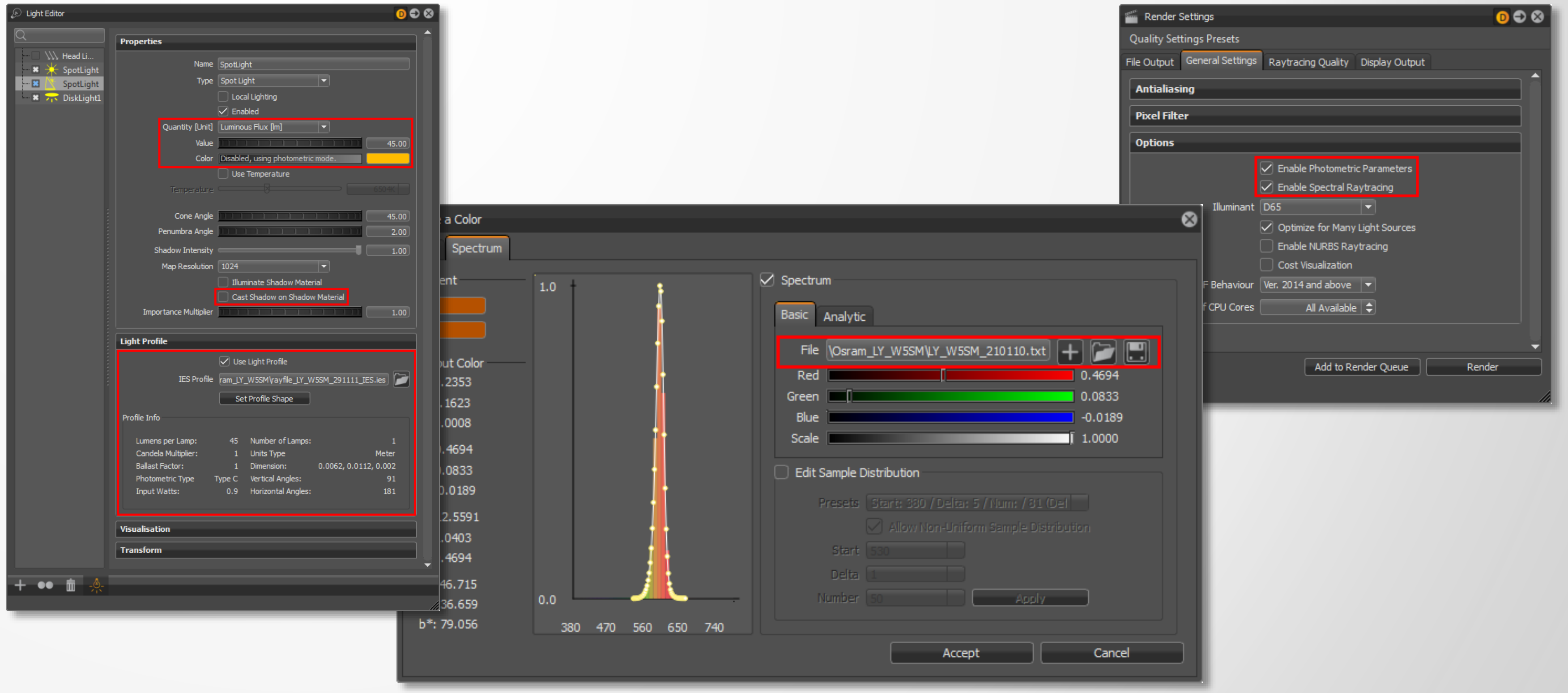


Example 2 – IES Files

- Enable **Photometric Parameters** & **Spectral Raytracing** in the **Render Settings**
- Place a **Spotlight** in front of the LED geometry (make sure it is not hidden inside the geometry)
- Load the **LY_W5S... .ies** file in the **Light Profile** tab for the created **Spotlight** in the **Light** Editor and enable **Use Light Profile** checkbox
- Disable **Cast Shadow on Shadow Material** to avoid shadow on the **Environment Dome** we are not interessted in
- Load the spectral color file **.txt** or **.spectral** to your **Spectrum** > **Color** tab in the **Light Editor**
- Hide the cone representation in the **Visualisation** tab of the **Light Editor** and enable **Raytracing** & **Antialiasing** in the menu bar

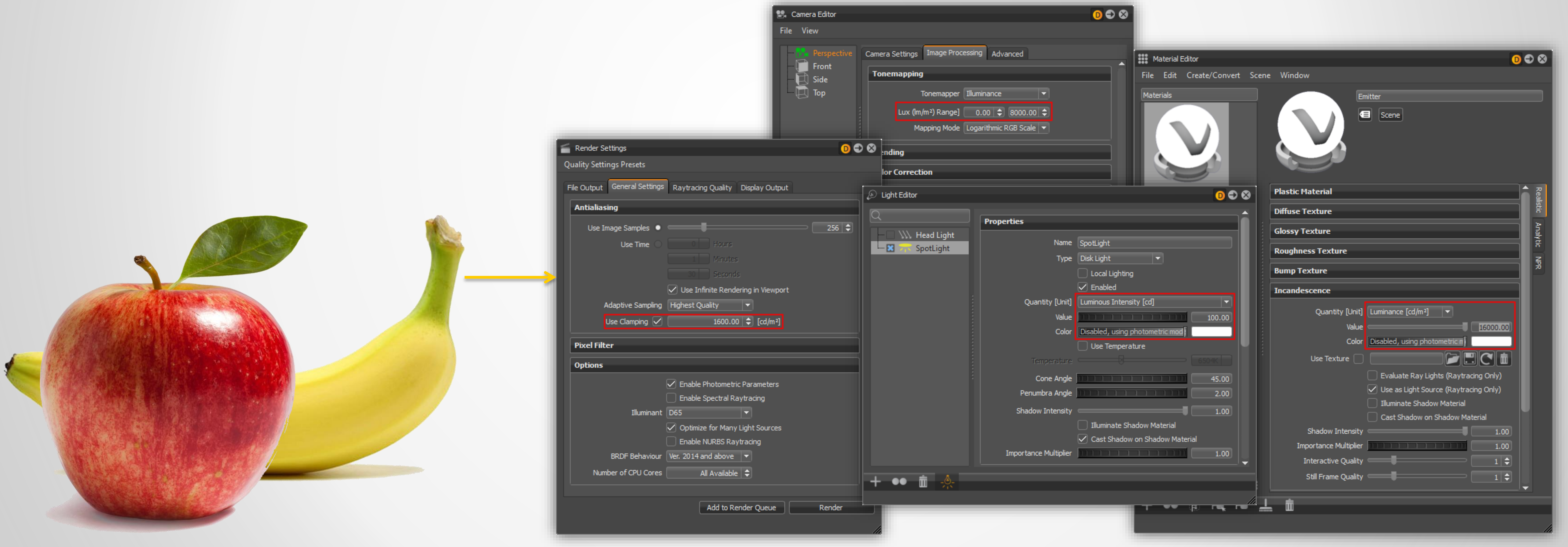


Spotlight with IES light profile



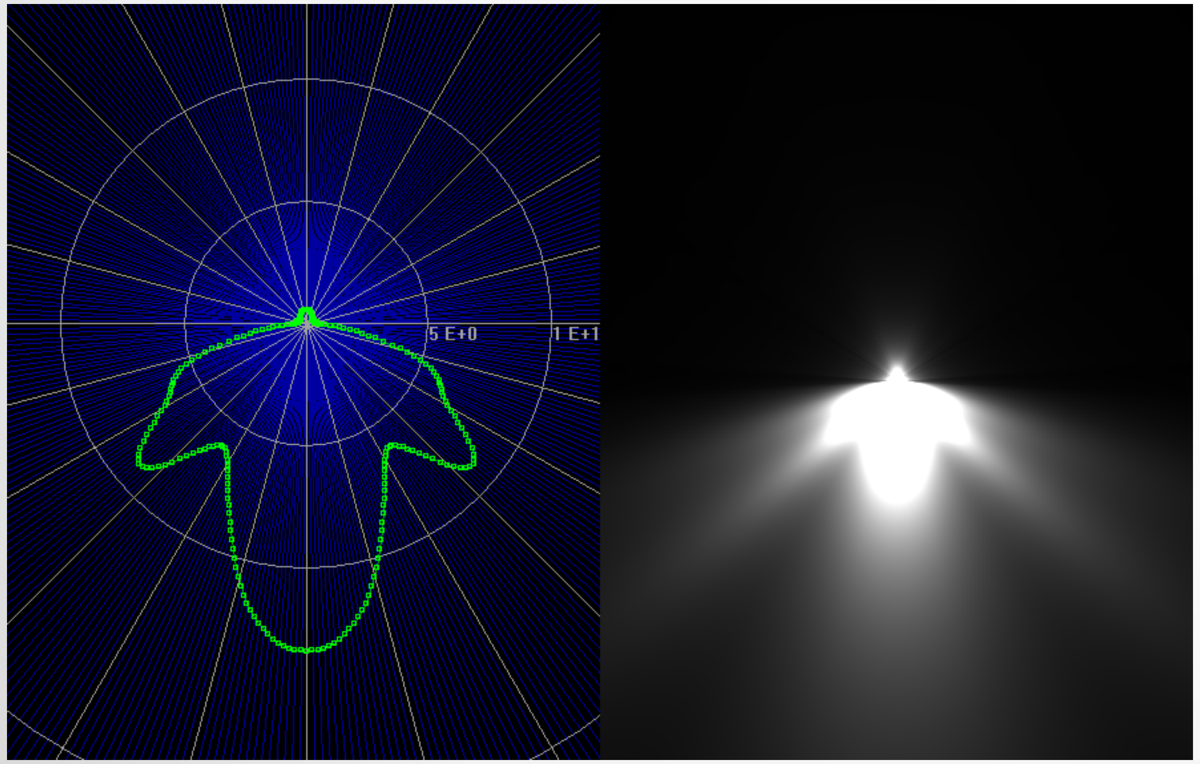
Deep Dive – Photometric Parameters

- Input values can be changed from intensity to light specific units in the user interface
- Photometric values can be found in Render Settings, Camera-, Light- & Material Editor

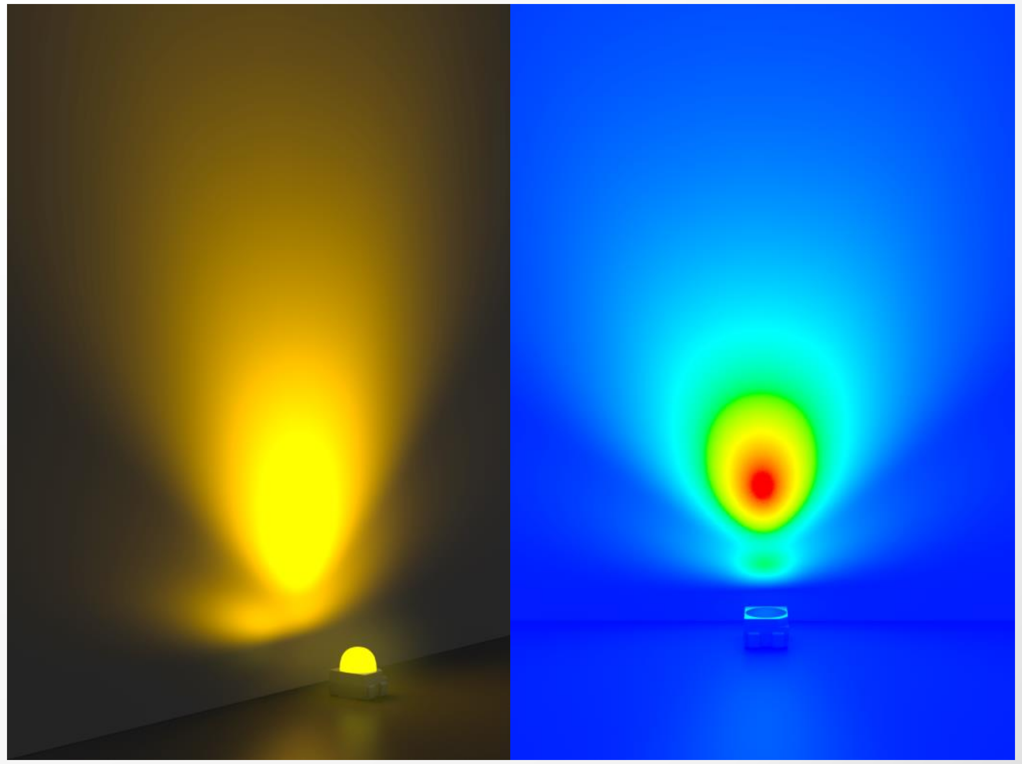


Deep Dive – IES Files

- IES is an angular based ASCII file format that stores the intensity and shape distribution behaviour of a light
- IES is only an approximation of the light distribution because it refers to one single point which does not exist in the reality
- A light source is always a object with a surface that emits light like a fillament or a bulb



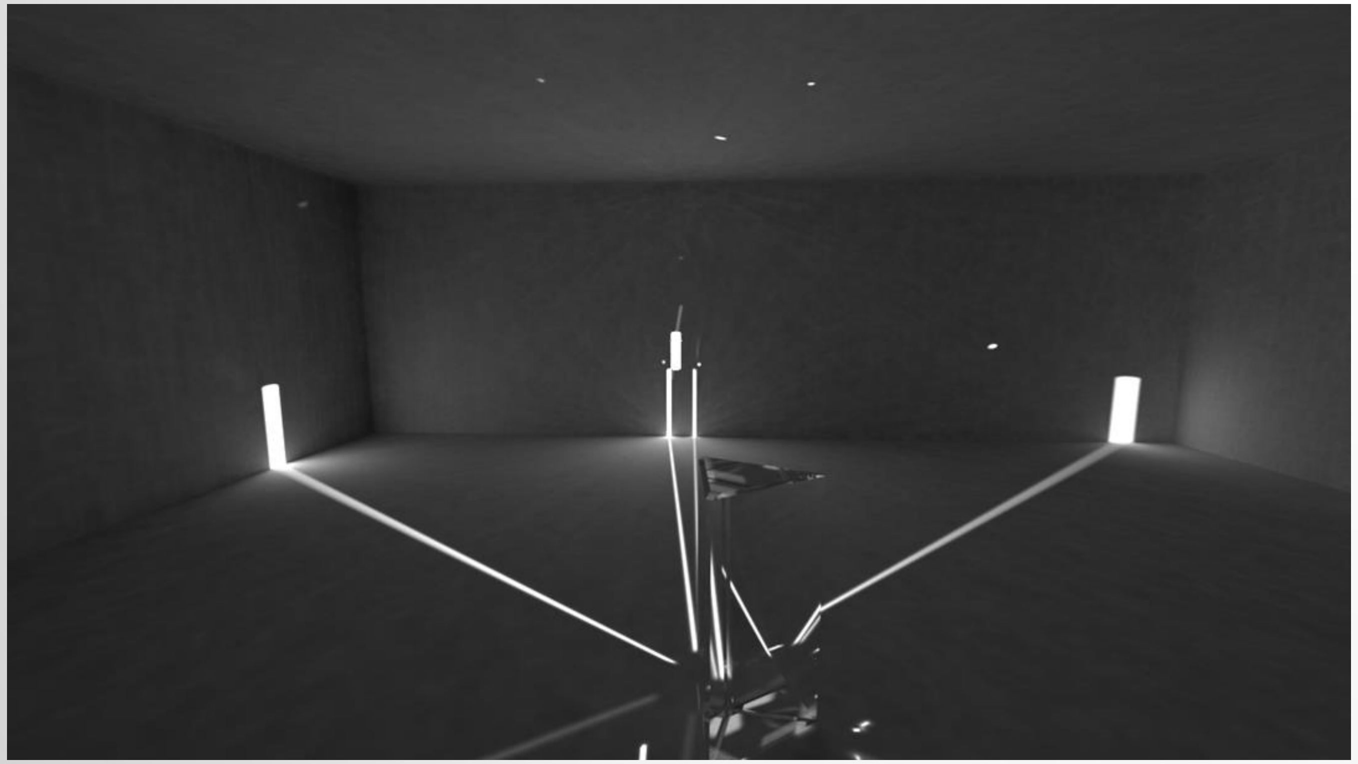
Rotation symetric IES file displayed in IESGen



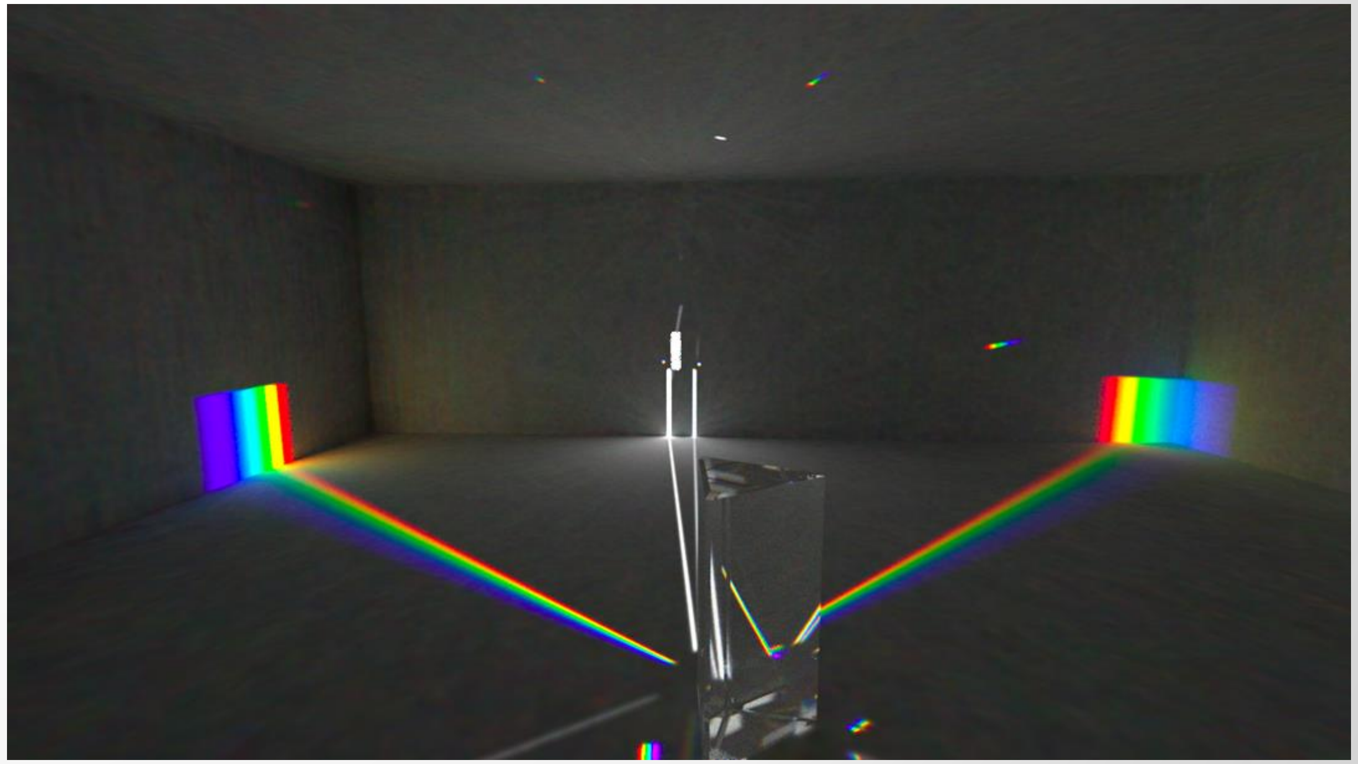
Luminance density of a IES file visualized in VRED

Deep Dive – Spectral Rendering

- Is where scene´s light transport is modeled with real wavelengths instead of RGB



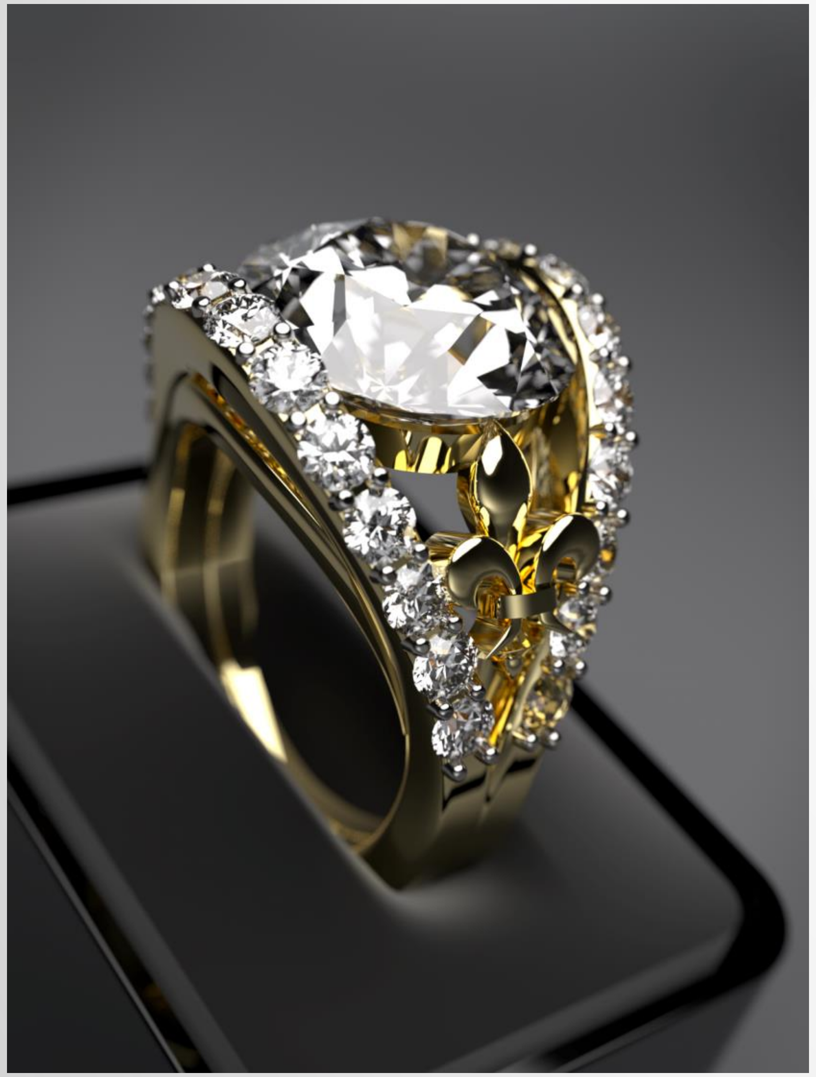
Light through glass prism rendered in RGB > white Light in = white Light out



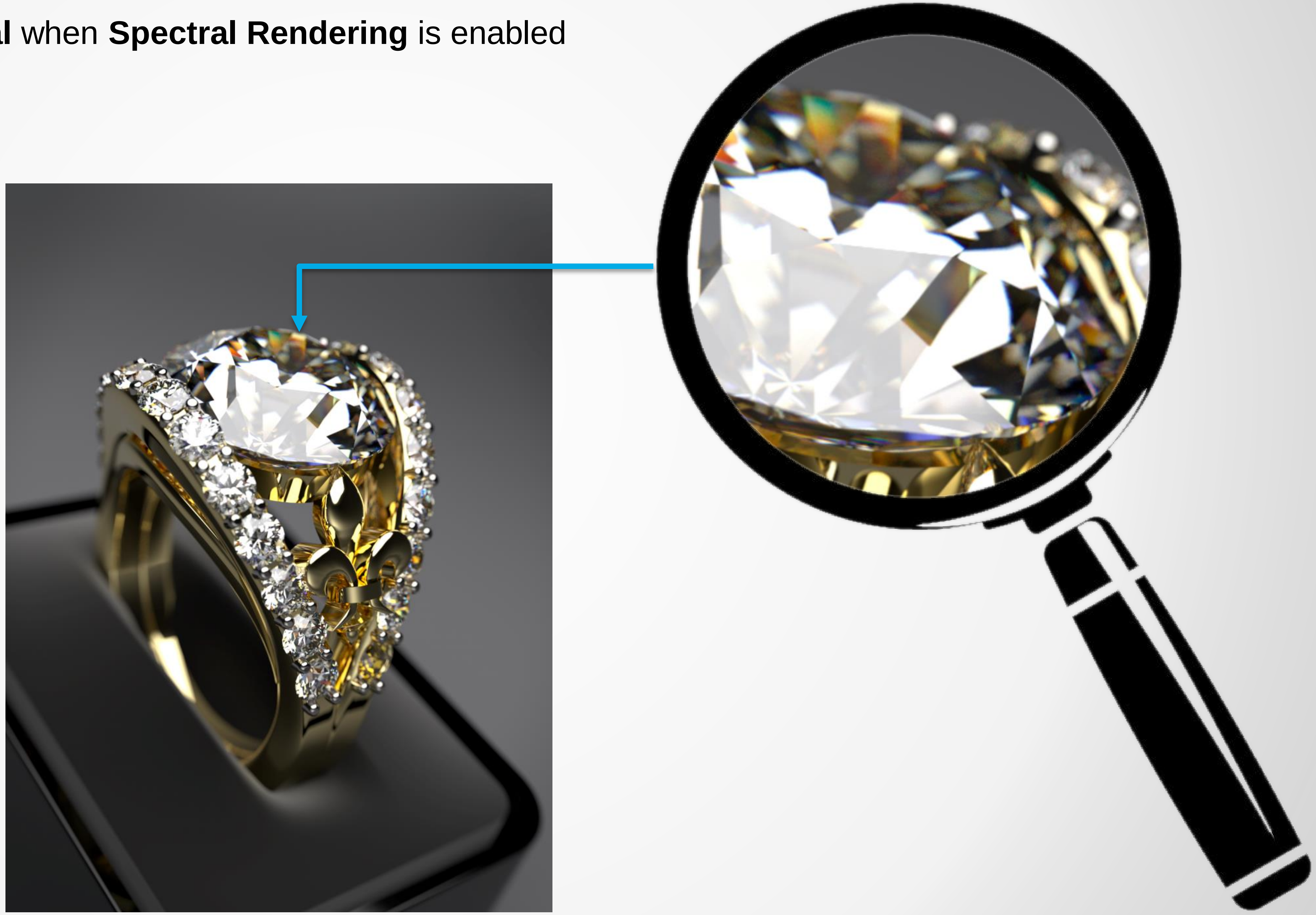
Light gets seperated into spectral color range

Deep Dive – Spectral Rendering

- VRED offers dispersion in **Glass Material** when **Spectral Rendering** is enabled



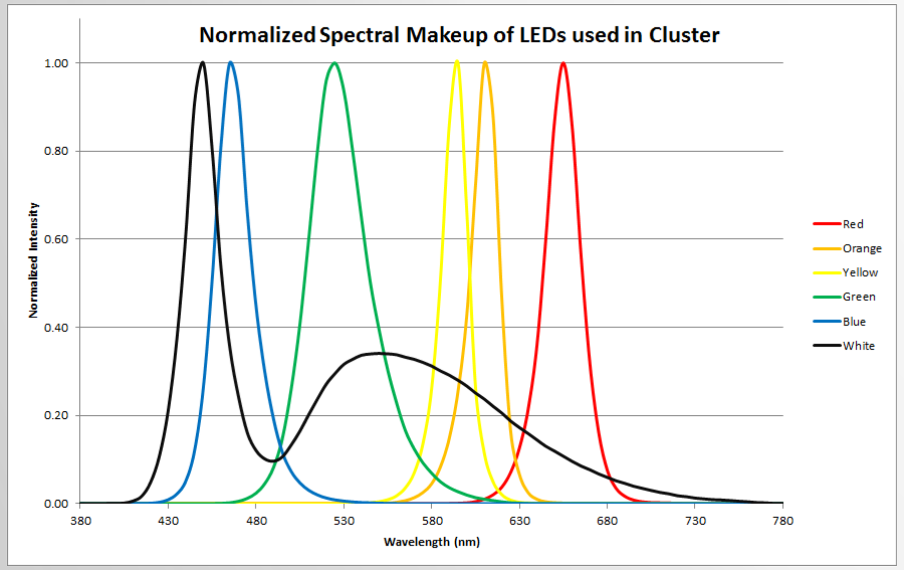
RGB rendering



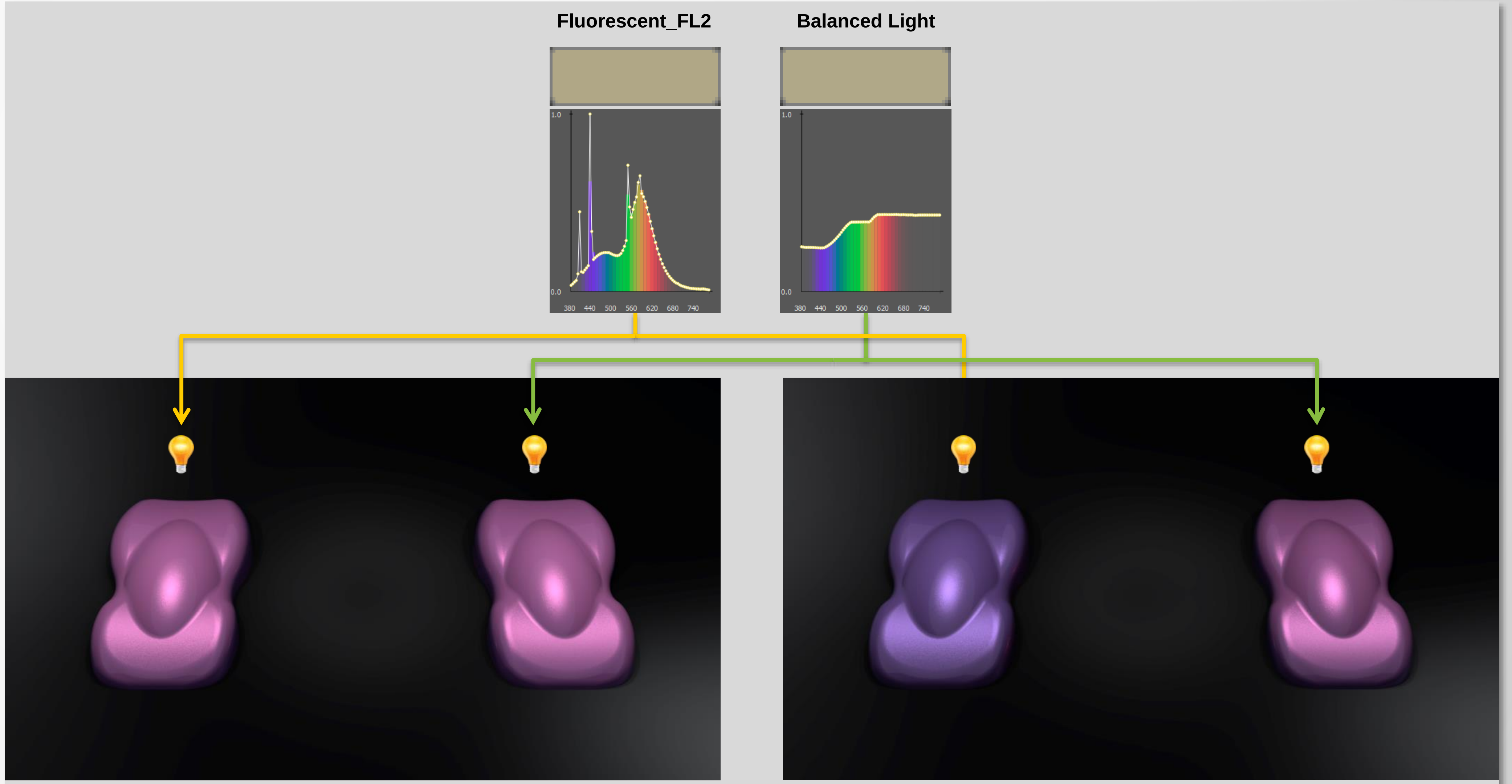
Spectral rendering with dispersion effect

Deep Dive – Spectral Rendering

- VRED offers the possibility to work with realistic color spectrum curves for materials and lights



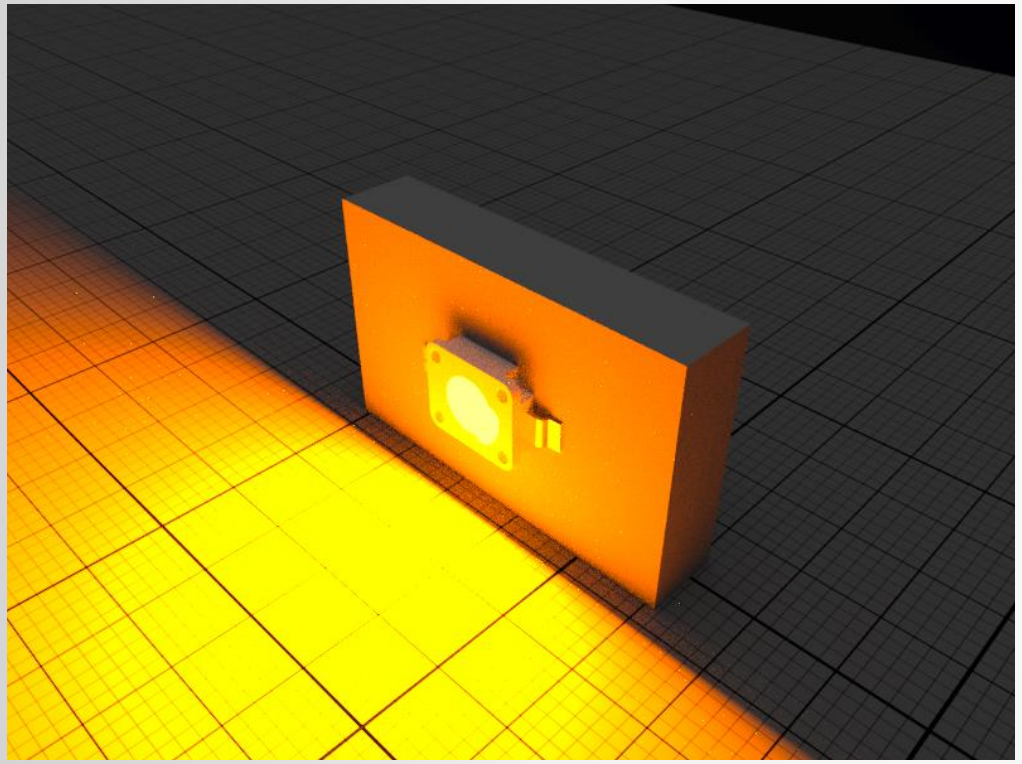
Spectral color curves



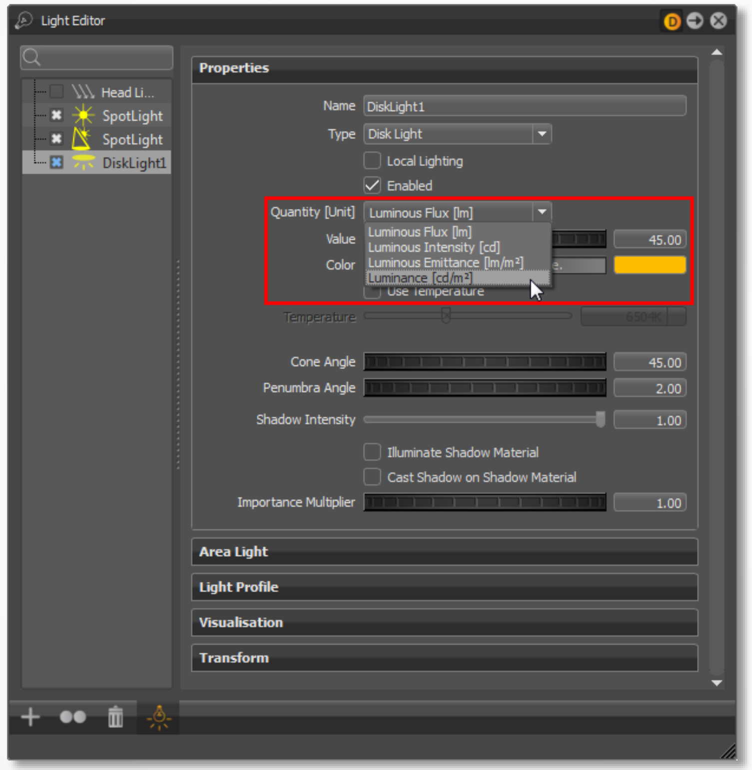
RGB rendering

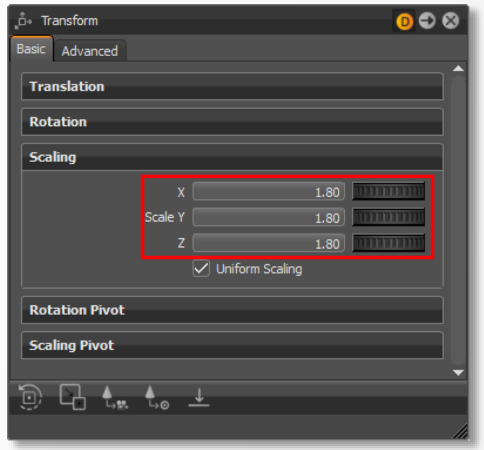
Spectral rendering

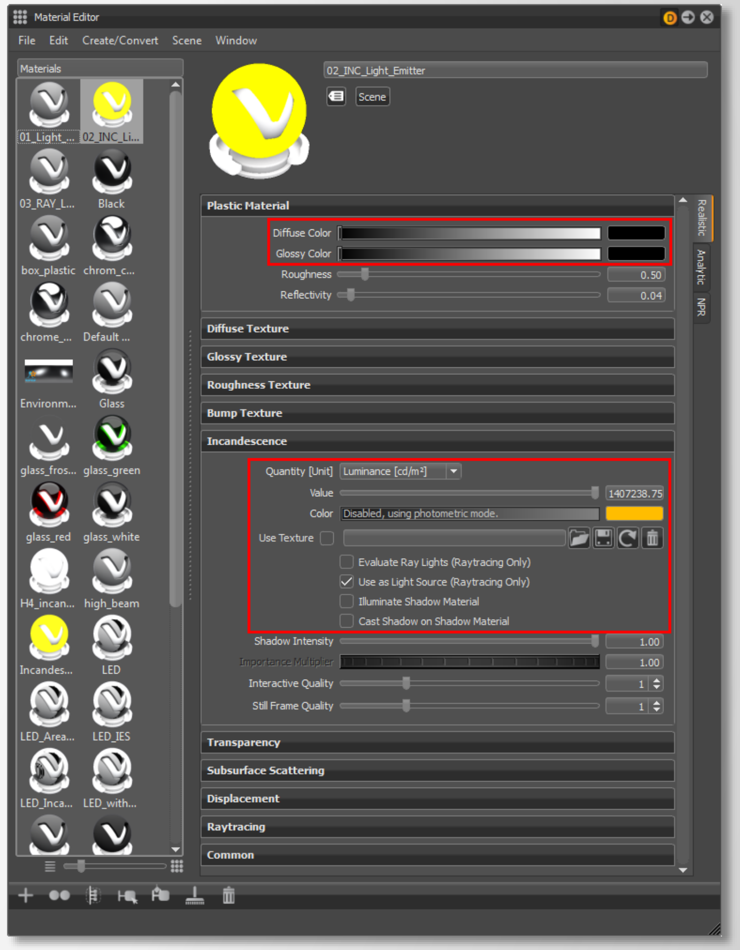
Example 3 – Incandescent Material



LED with incandescent material assigned





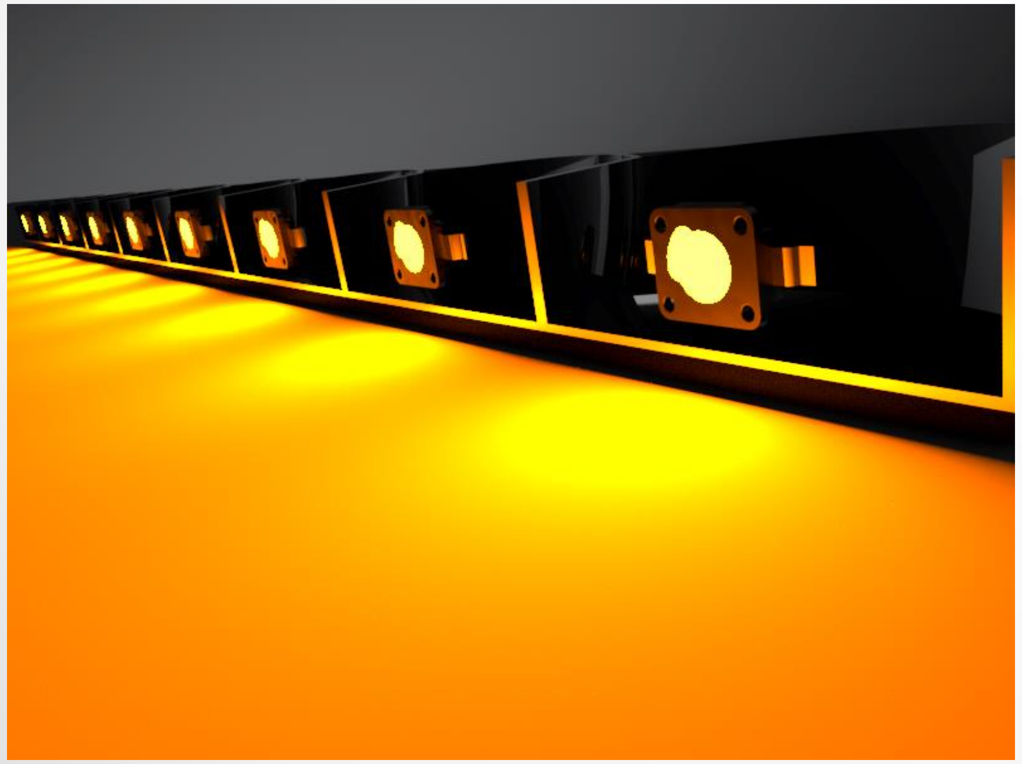


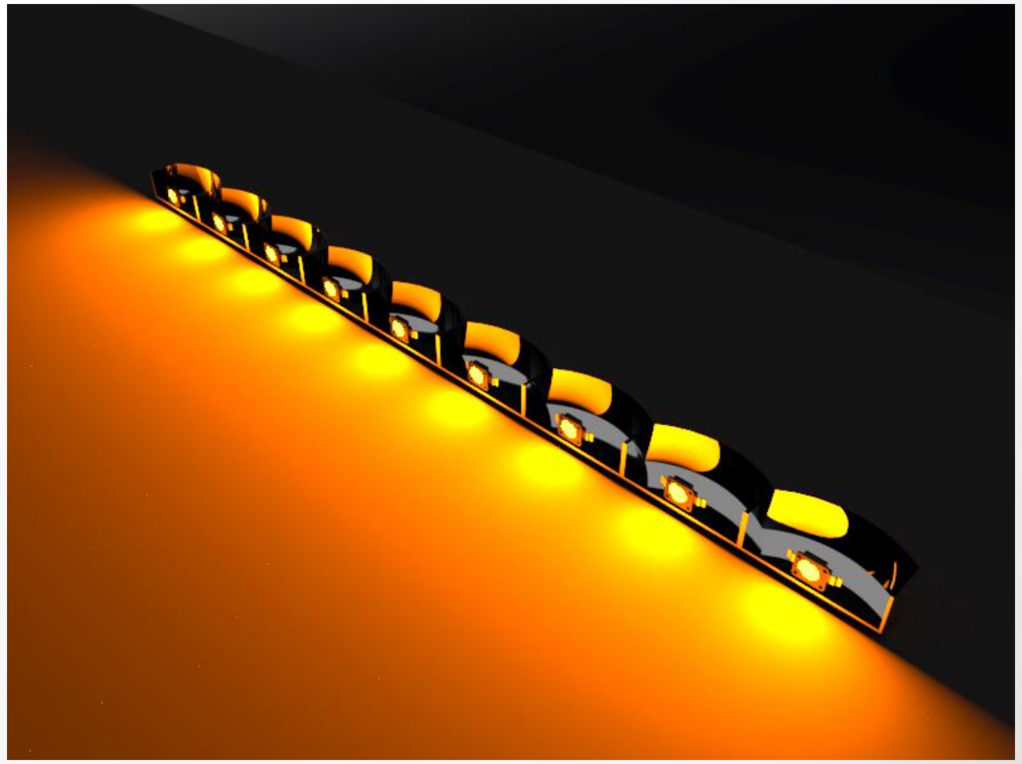
Example 3 – Incandescent Material

- If you don´t know the *(cd/m^2)* size of the light emitting surface, create a **Area Light** (DiscLight) in the **Light Editor**
- Scale the **DiscLight** to a Size that fits to the light emitting surface
- Type the **Luminous Flux *(lm)*** Value from you LED spezification into the **Quantity(Unit)** input field
- Use the **Quantity(Unit)** drop-down Box and change to **Luminance*(cd/m^2)***
- Copy the **Luminance *(cd/m^2)*** Value **VRED** calculates
- Create a new **Plastic Material** and copy this value in the **Quantity input** field in the **Incandesence** tab of your material
- Load the spectral color file in the **Incandesence** color input field
- Set the **Diffuse- & Glossy Color** of your material to black
- Activate **Use as Light Source** and disable the **Cast Shadow on Shadow Material**
- Rename the material to **Incandesence_Osram_LY_W5SM** and assign the created material to the inner surface that emits light
- Hide the **DiscLight** in the **Light Editor** and enable **Raytracing** & **Antialiasing** in the menu bar

Deep Dive – Pro & Con. of Incandescent Material

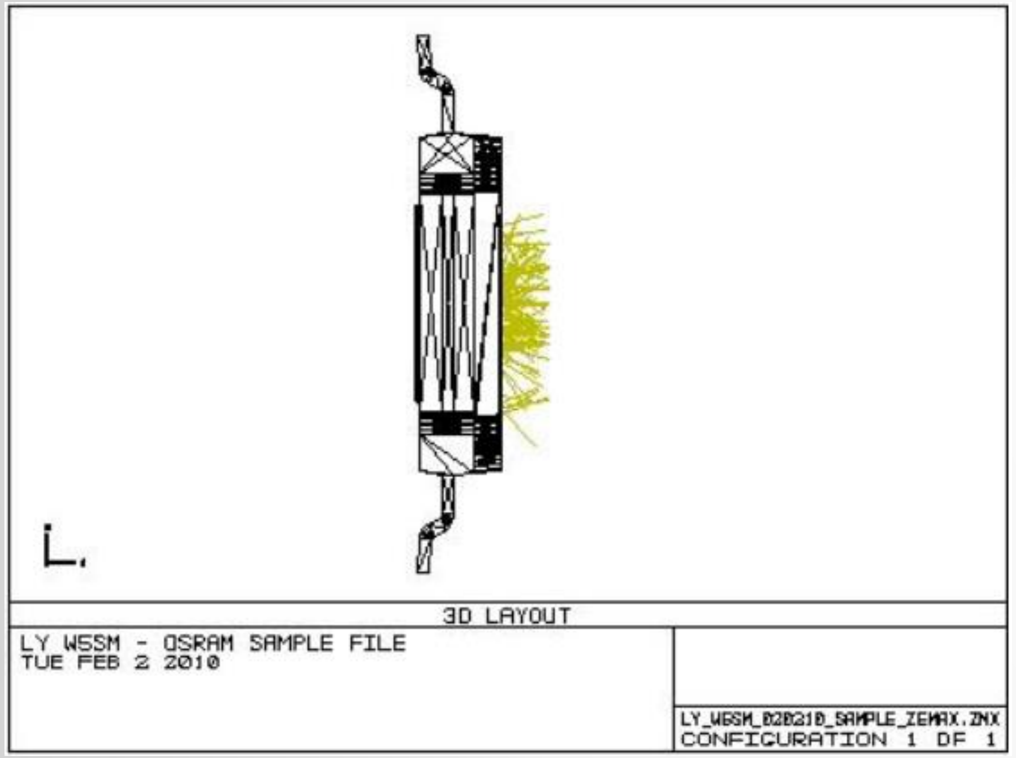
- 👎 No Shape Distribution on the Surface that is emitted directly by the IES Light
- ! Normaly you are not interesed in this because a Reflector- or Refractor Geometry is influencing the Distribution and you are more interested in the Result after the Light bounced and scattered through the Geometry
- 👍 You can copy an Incandesent Material to multiple Objects without placing many Light´s in your 3D Scene



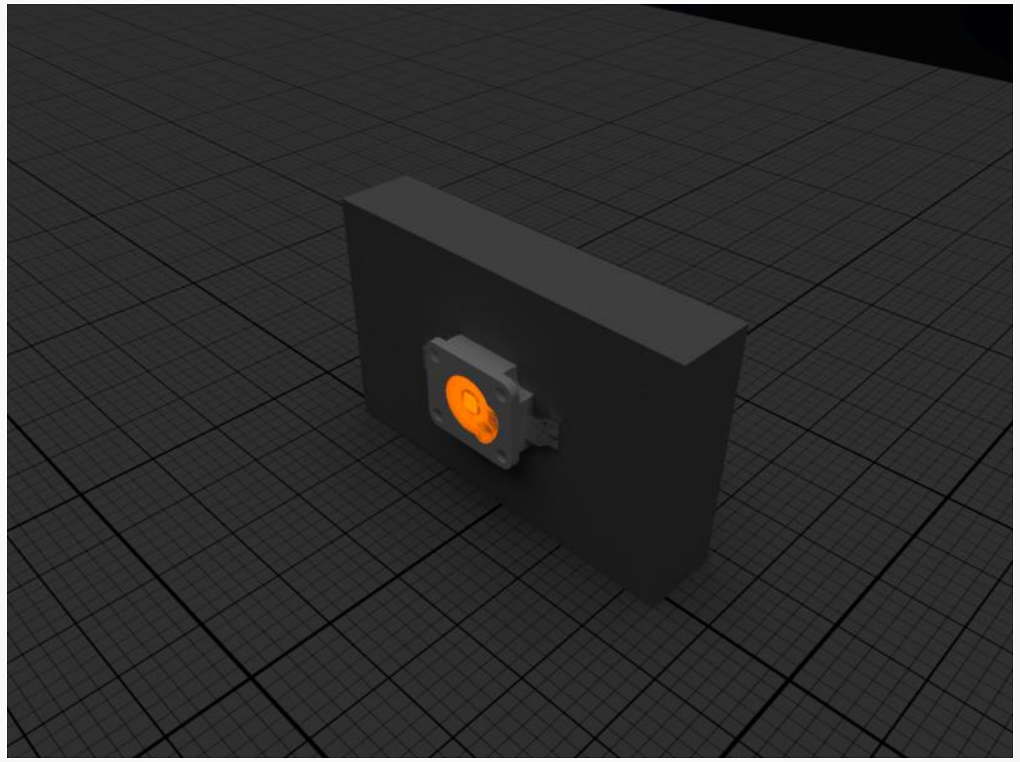


Multiple LED´s arranged in a Reflector

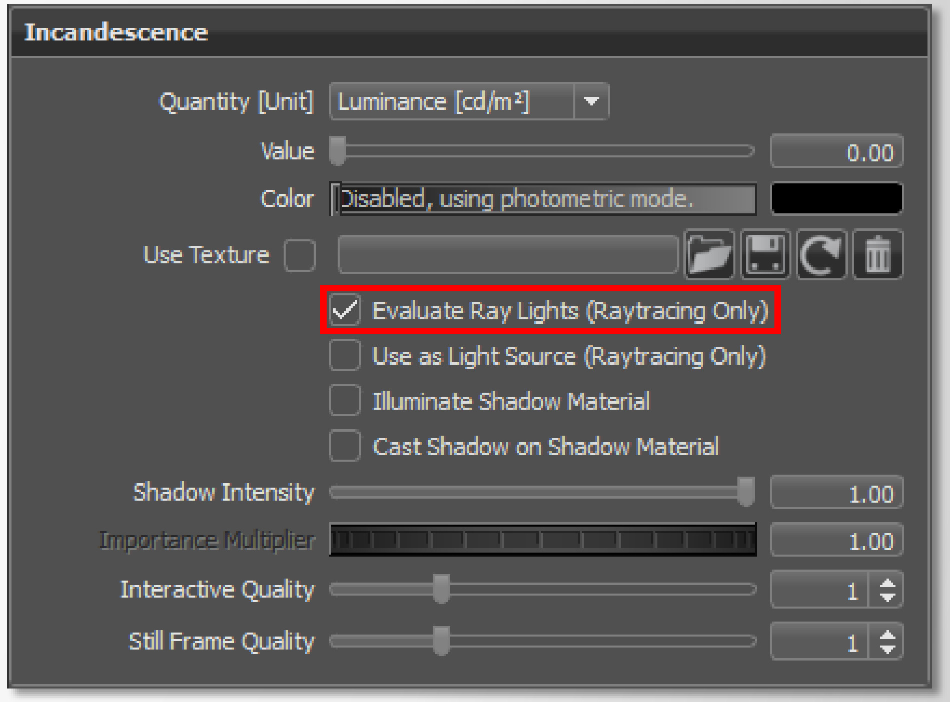
Example 4 – RAY File on Light Emitting Surface



RAY files shown in the OSRAM specification



RAY files on surface visualized in VRED

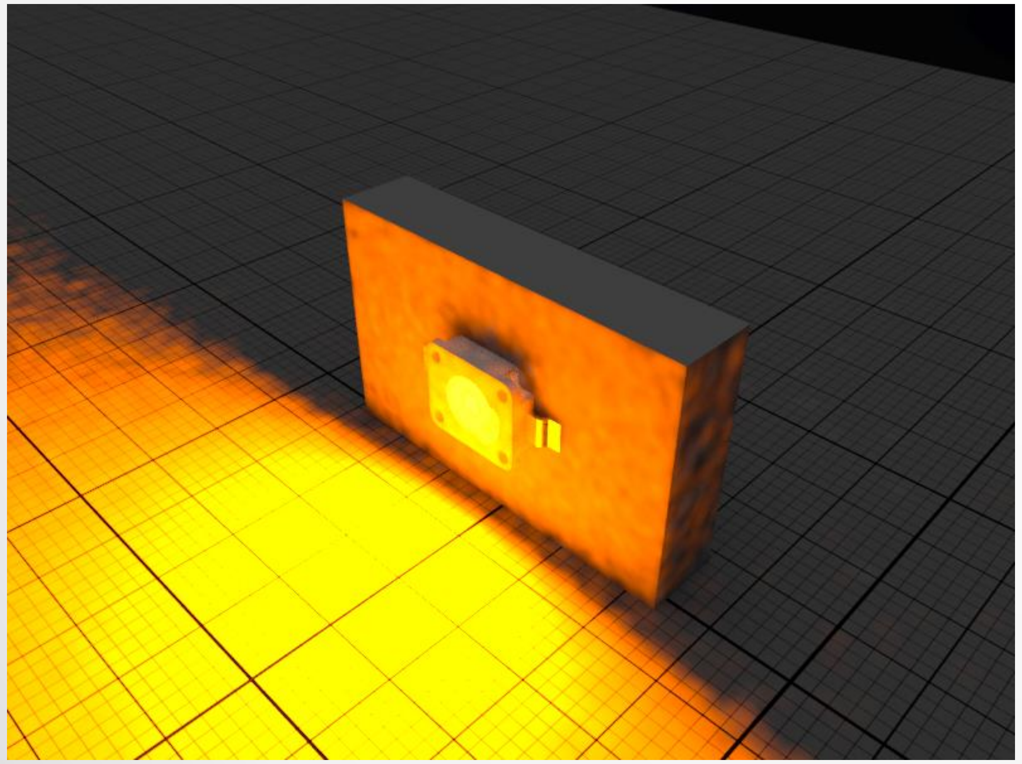


Example 4 – RAY File on Light Emitting Surface

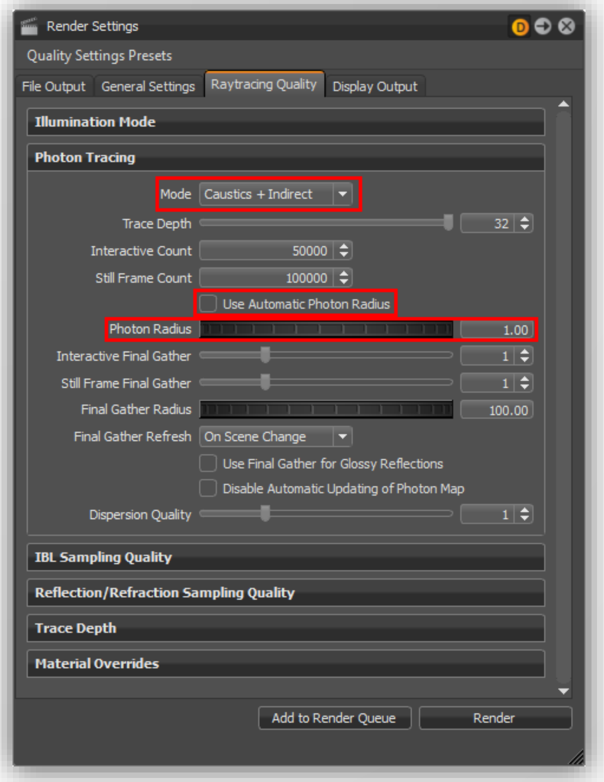
- Create a **RAY Light** in the **Light Editor** and place it in the position that is specified in the .pdf
- Load the RAY file in the **Light Editor** and disable the **Cast Shadow on Shadow Material** checkbox
- Change the **Luminous Flux *(lm)* Quantity Value** to 45 because this LED comes with a Luminous Power of 1
- Load the color spectrum file to your **RayLight** and set the **Visualization Raylength** to 0
- Create and assign a new **Plastic Material** to the inner surface and rename it to **LED_Ray_Surface**
- Open the **Incandesence Tab** of the new created material and activate **Evaluate Ray Lights**
- Also disable **Cast Shadow on Shadow Material** to avoid shadow we don´t need on the Environment Dome
- The LED is very bright. If you want to look at your simulation data on the surface set the **Intensity** Value of the Ray Light temporary to **0.01** in the **Light Editor**
- Note: Optional you can also change the **Camera Tone-Mapping** settings

Example 4 – Light Distribution from RAY File

- Change your **Quantity** intensity settings back to 45 for the **RAYLight** in the **Light Editor**
- Open the **Raytracing Quality** tab in your **Render Editor** and change the **Mode** to **Caustics + Indirect** in the **Photon Tracing** tab
- To get a better quality of the simulation data deactivate **Use Automatic Photon Radius** and set the **Photon Radius** to 1
- The quality is limited because the photons are stored in the RAY file. The **Ammount/Count** and the **Final Gather** settings don´t influence the quality of the end result
- To get a better result you need a RAY file with higher resolution (this will increase the necessary memory as well)

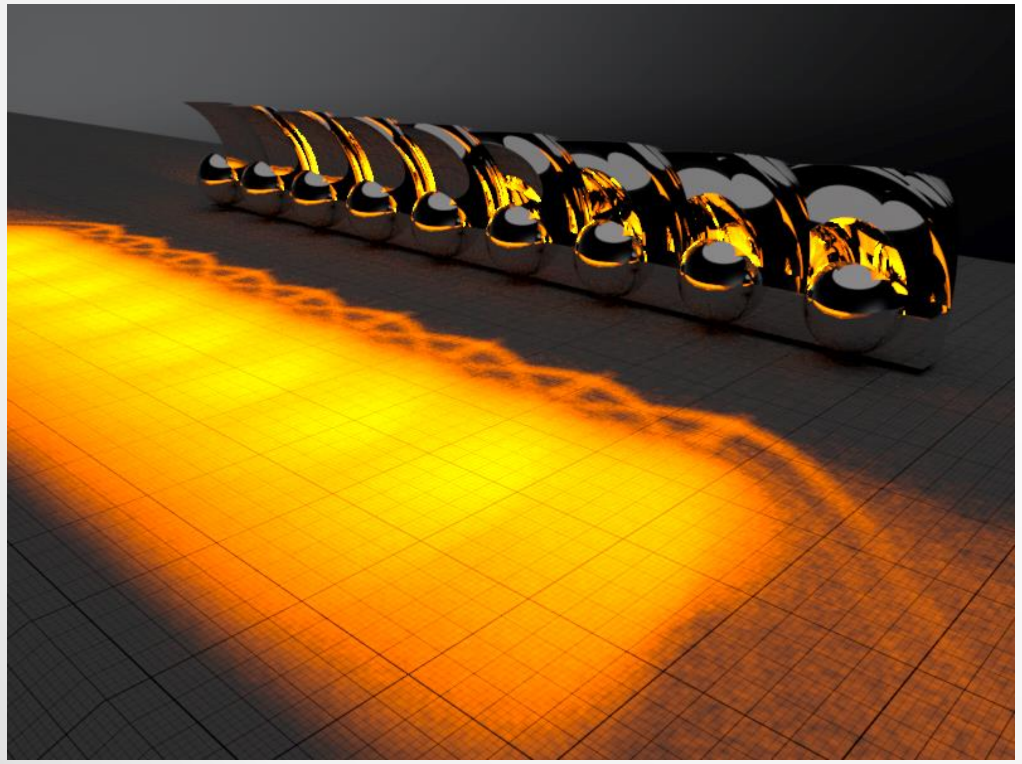


Light Distribution that is stored in the RAY File

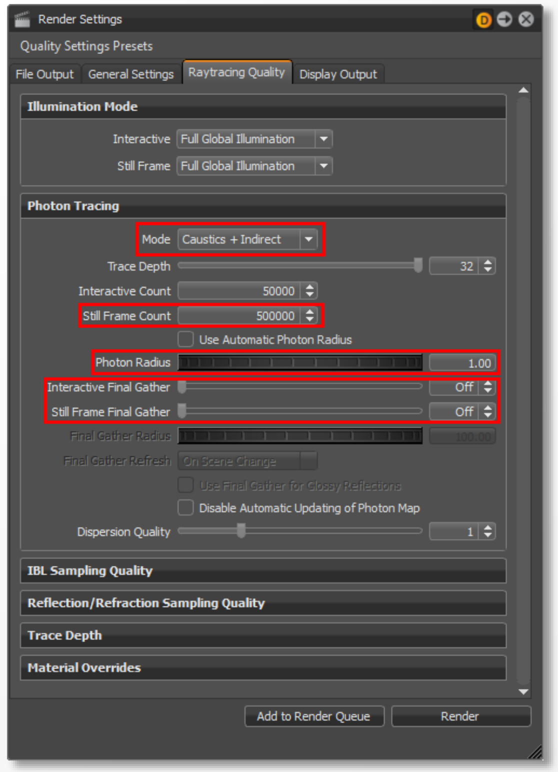


Example 5 – Photon-Mapping for Reflection Caustics

- ☑ Assign the Incandesent Material **Incandesence_Osram_LY_W5SM** that is created already to all LED light emitting surfaces
- ☑ **Show Visibility** of the Refractor Geometry in the **05_Multi_LED_Reflector** example
- ☑ Activate **Caustics + Indirect** mode in the **Photon Tracing** tab of your **Render Settings** module (done in the previous example)
- ☑ Set the **Still- & Frame Count** to 500000 and disable **Use Automatic Photon Radius**
- ☑ Change the **Photon Radius** to 1 and deactivate **Intercative & Still Frame Final Gather** (Off)

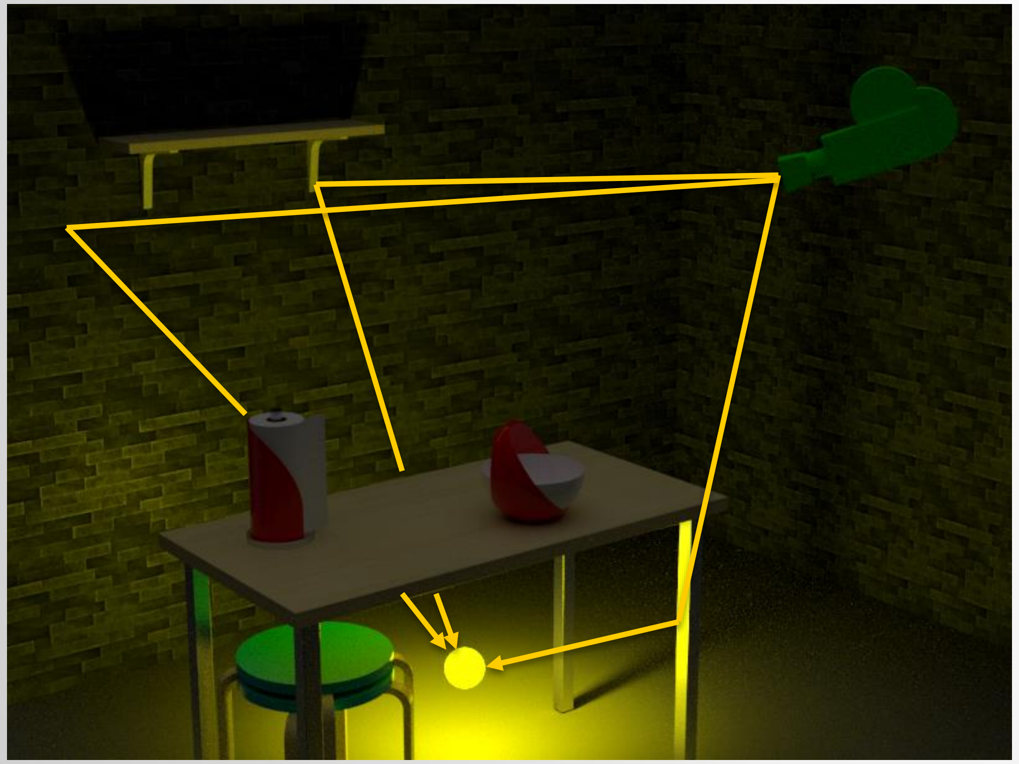


Reflector caustics on ground

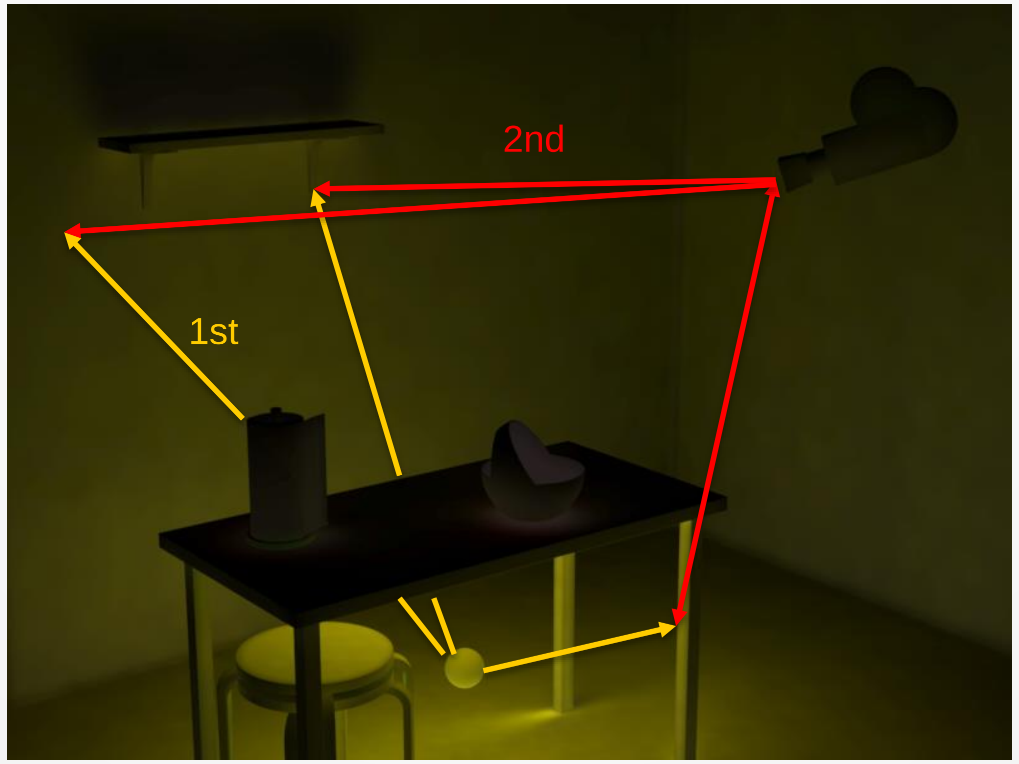


Deep Dive – Path-Tracing vs. Photon-Mapping

- In **Path Tracing** the camera ray is bouncing through the scene until the light source is found. Depending on the scene & indirections of the light it needs a lot of iterations until the image is noiseless
- In **Photon Mapping** the light distribution in the scene (starting from the source) is calculated first and stored in a map
- In the 2nd step the camera use the created map and not necessarly looking for the original light source in the scene



Path-Tracing



Photon-Mapping

Final image with Photon-Mapping

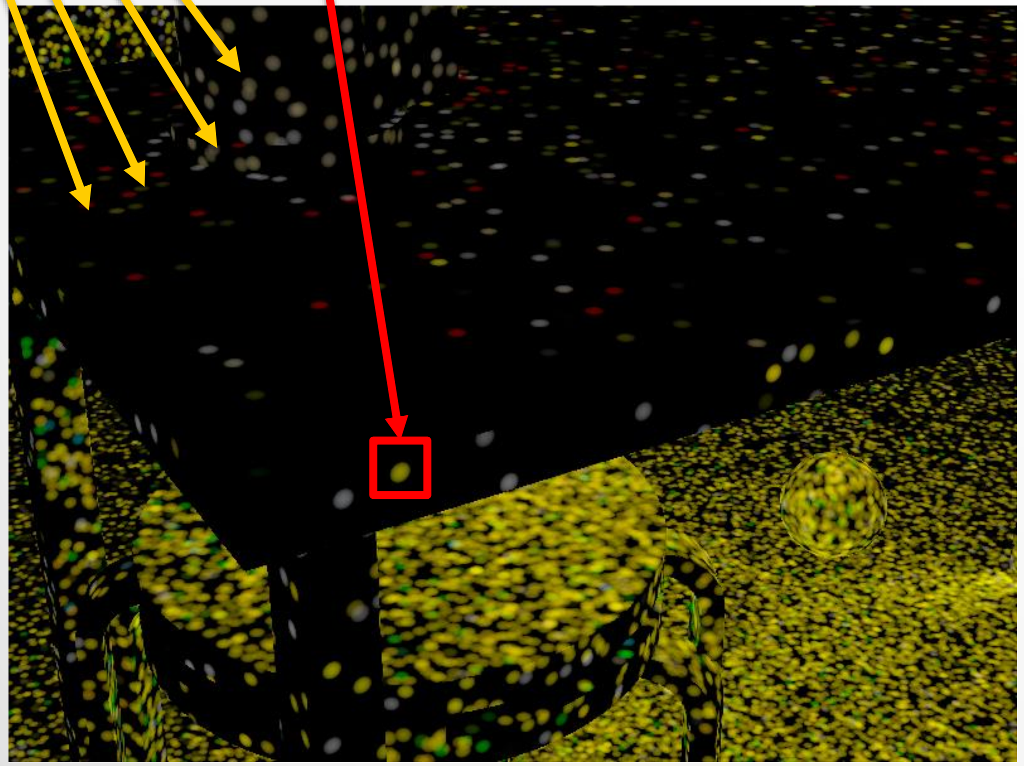
Deep Dive – Photon-Mapping Settings

Count = ammount of photons distributed in the scene

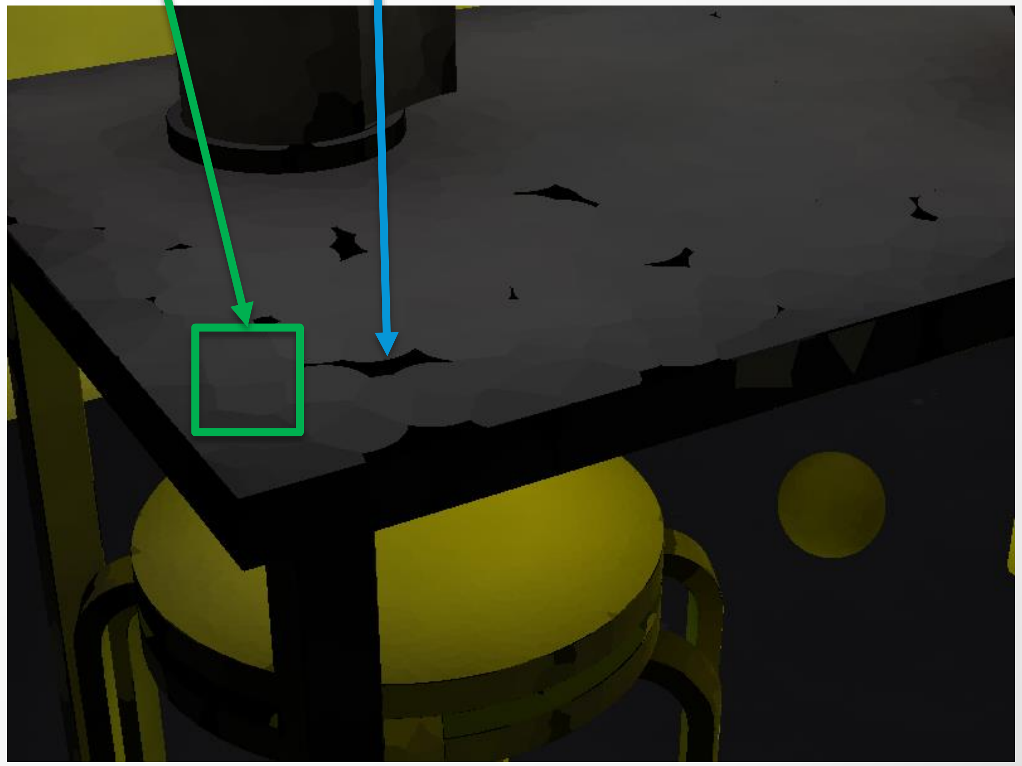
Final Gather Radius = bigger value merge more photons together

Photon Radius = diameter size

Final Gather = fills the gap in between the photons



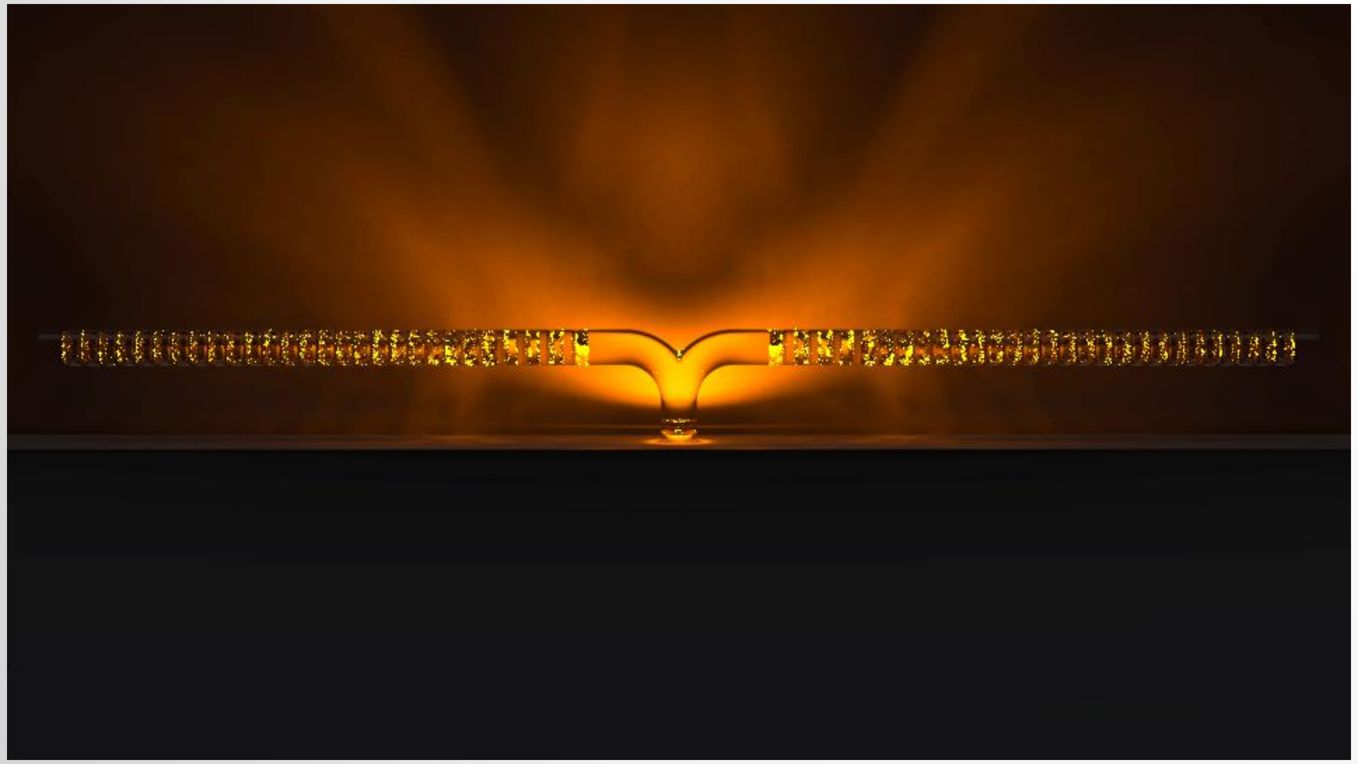
Photon-Map



…with Final Gather

Example 6 – Photon-Mapping for Glass Caustics

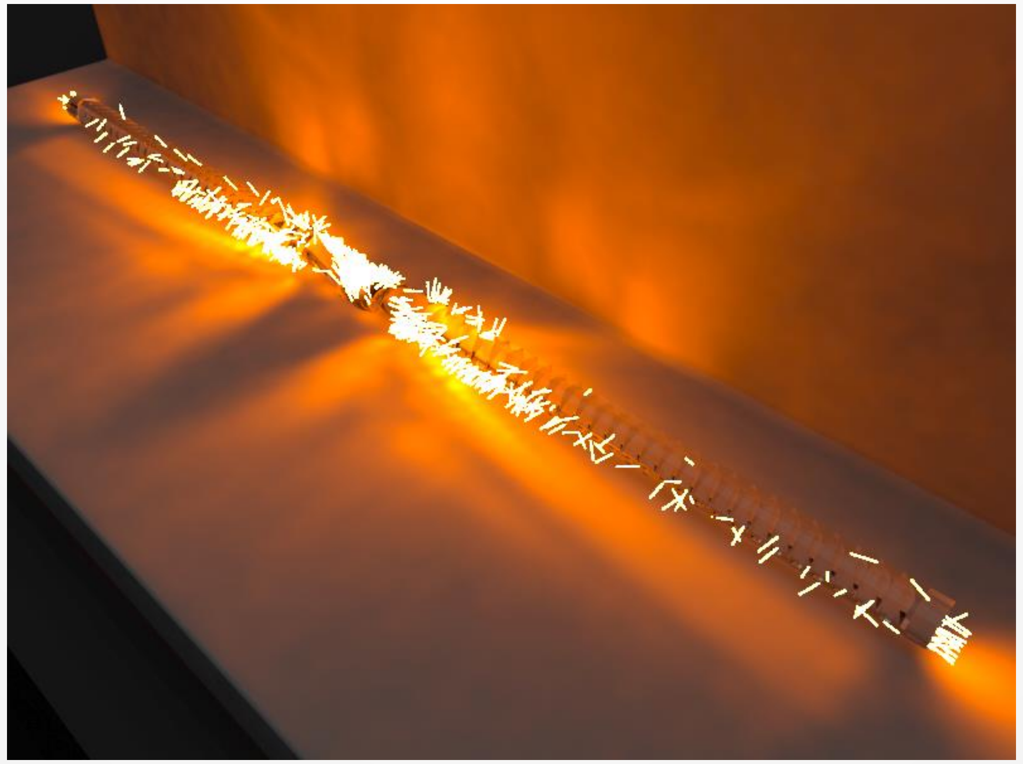
- ☑ Assign the already created **Incandesence_Osram_LY_W5SM** material to the light emitting surface of the LED
- ☑ Create a new **Glass** Material in the **Material Editor** and assign it to your Optical Light Guide **T-Element**
- ☑ Select the Medium **Acrylic glass (Polymet…)** with a proper IOR (1.4914) and enable **Solid Shadows** in the Glass Material settings
- ☑ Use the same **Photon-Mapping Render Rettings** from Example 5 to generate refraction caustics of the glass material
- ☑ Set the **Trace Depth** to 1024 for **Still Frame** to scatter enough Light inside the Light Guide
- ☑ **Show visibility of** the BOX in the **Scenetree** to see the caustics a little bit better



Refraction caustics on ground

Example 7 – RAY File on Surface

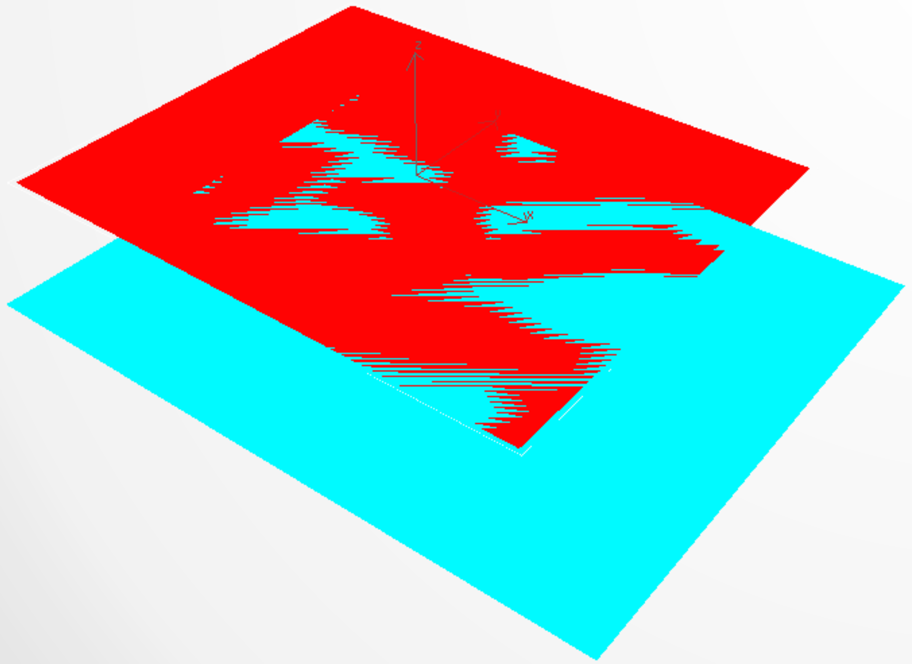
- The Ray file is limited in the amount of rays and normaly very big in size
- You are interested in the distribution of the **Light Guide Element** and not the LED
- Use a **IES** file or **Incandescent Material** + the color spectrum file + relistic material properties for the glass prism for a better result
- Use **RAY** simulation data for the object that catches light on surface (Light Guide) and generates caustics on ground

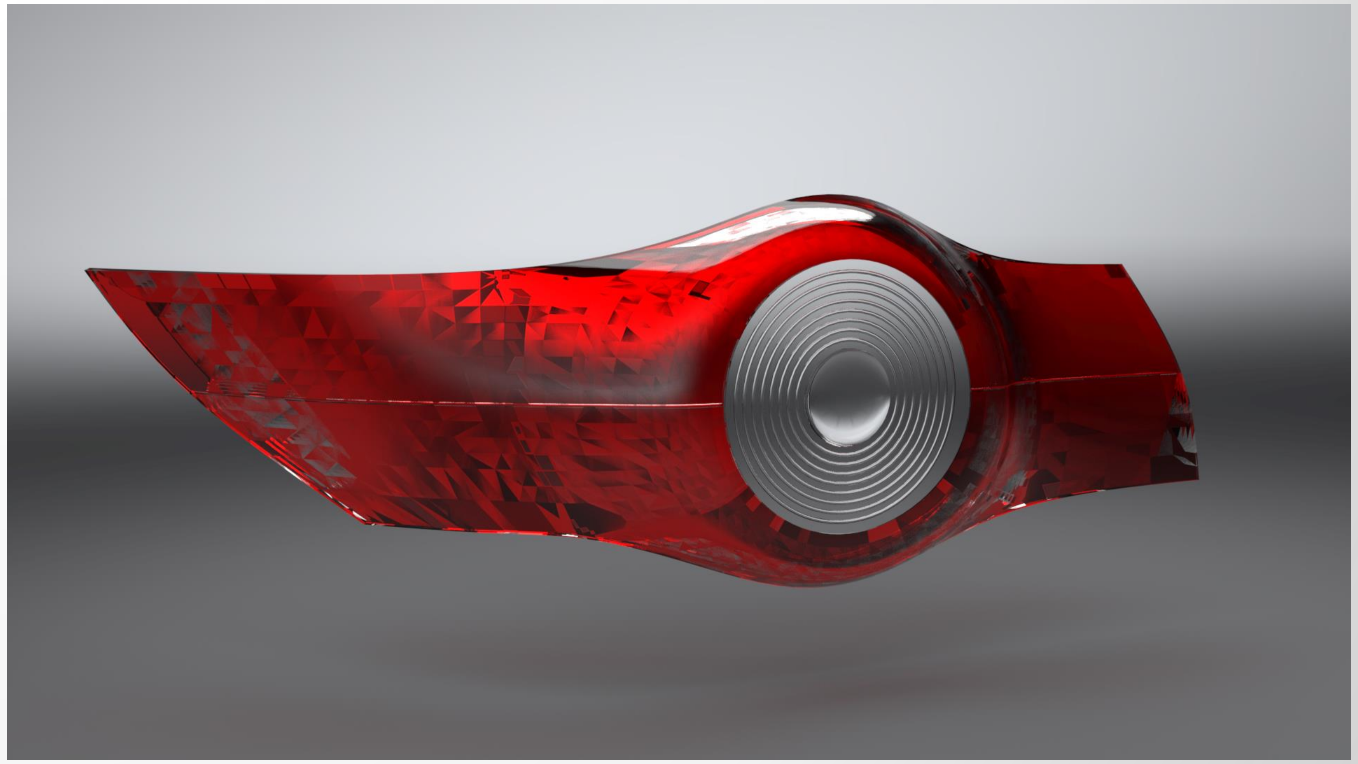


Ray File Simulation for the Light Guide „T-Element“

Example 8 – Layered Material for Multi-Component Glass

- The **Layered Material** is designed to solve **Z- Fighting** problems in multi-component materials such as taillight coverglas
- In reality two parts are merged/melted with each other but in CAD this **Contact Surface** is exists two times (outer surface of the inner glass + inner surface of the outer glass)
- Moving one part will generates a gap between the two objects and cause wrong refractions
- Deleting one or both inner contacte surfaces will generate wrong refractions as well

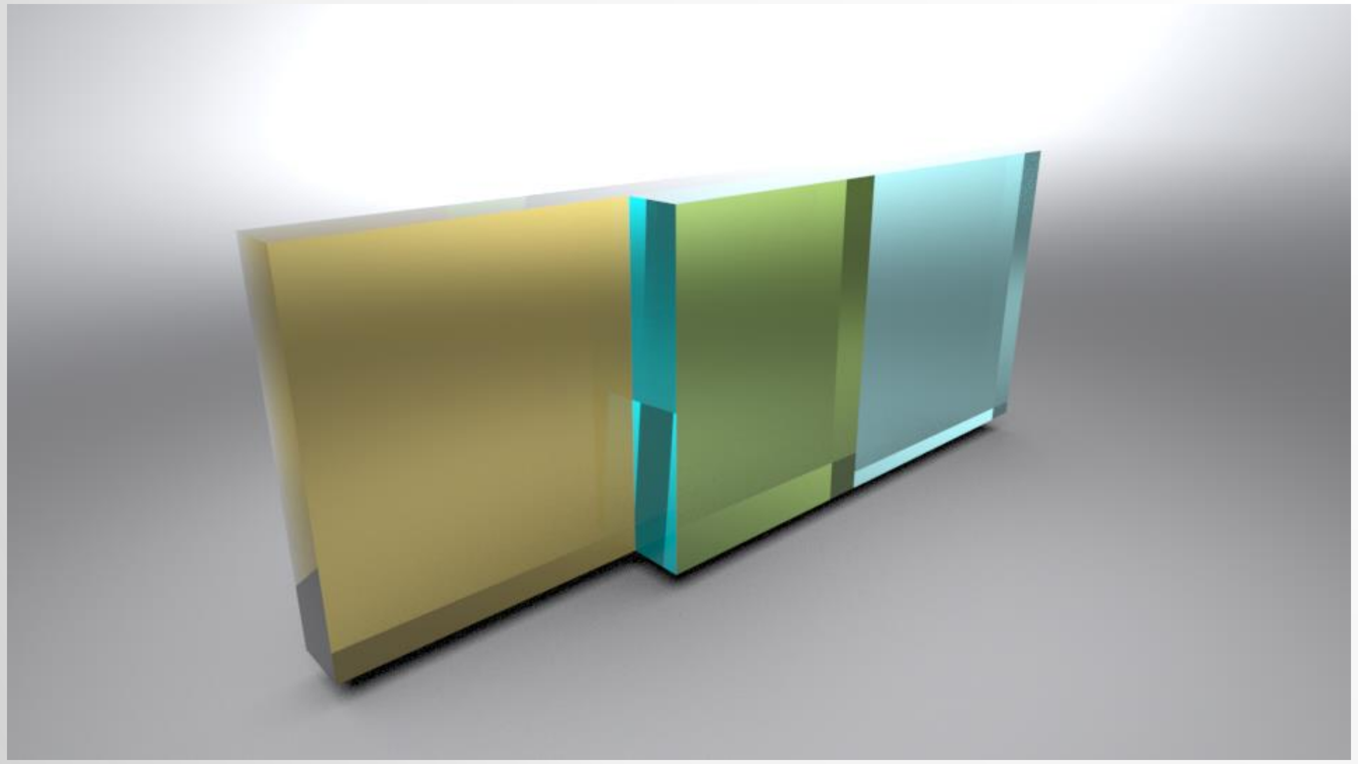


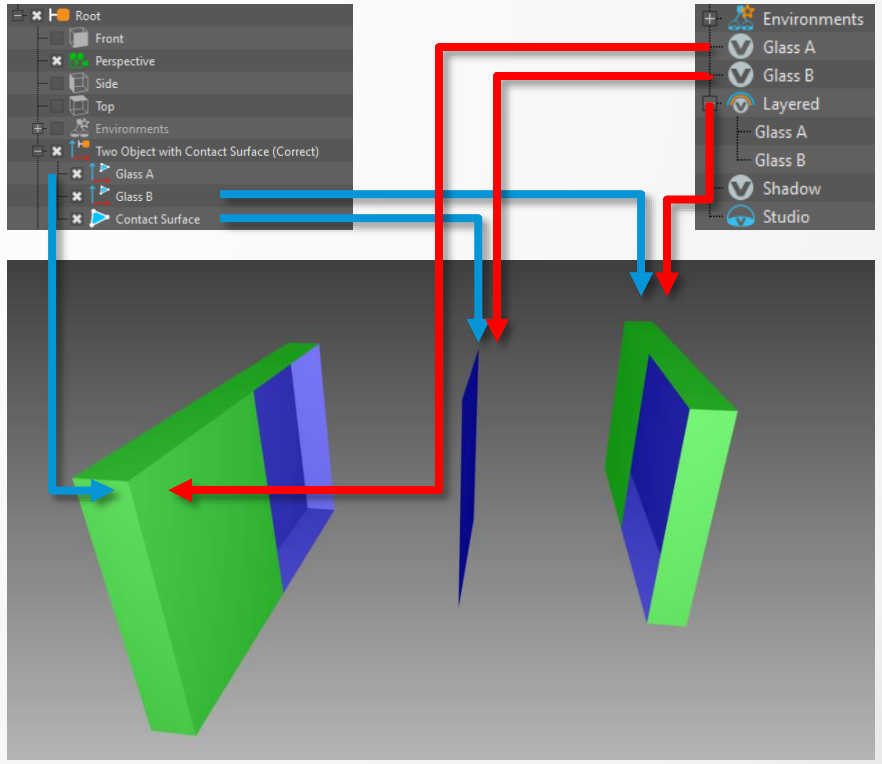


Z Fighting Problem between Red-, White- and Green Glass

Example 8 – Layered Material for Multi-Component Glass

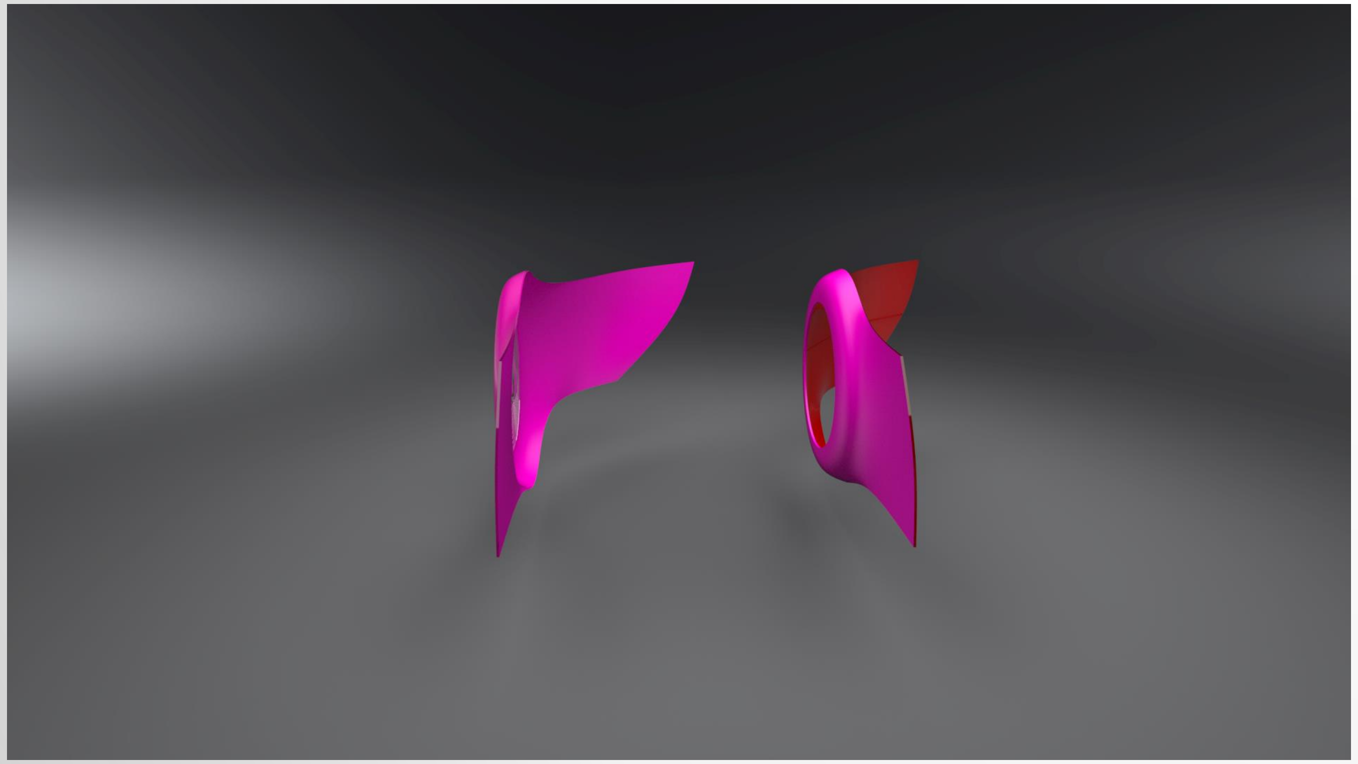
- **Layered Material** contains two **Glass Materials** that share a contact surface with each other
- This material container has to be assigned to the surface between outer- and inner glass (contact surface)

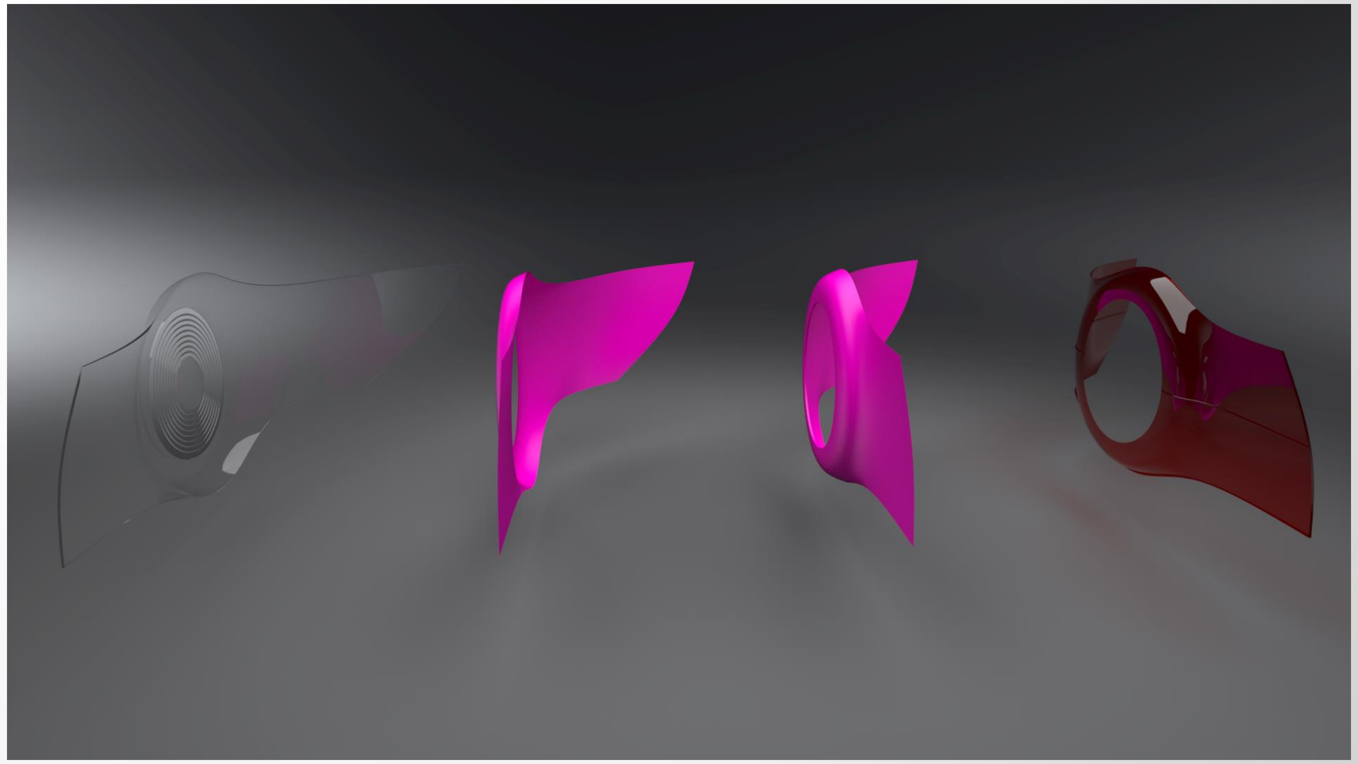




Example 8 – Layered Material for Multi-Component Glass

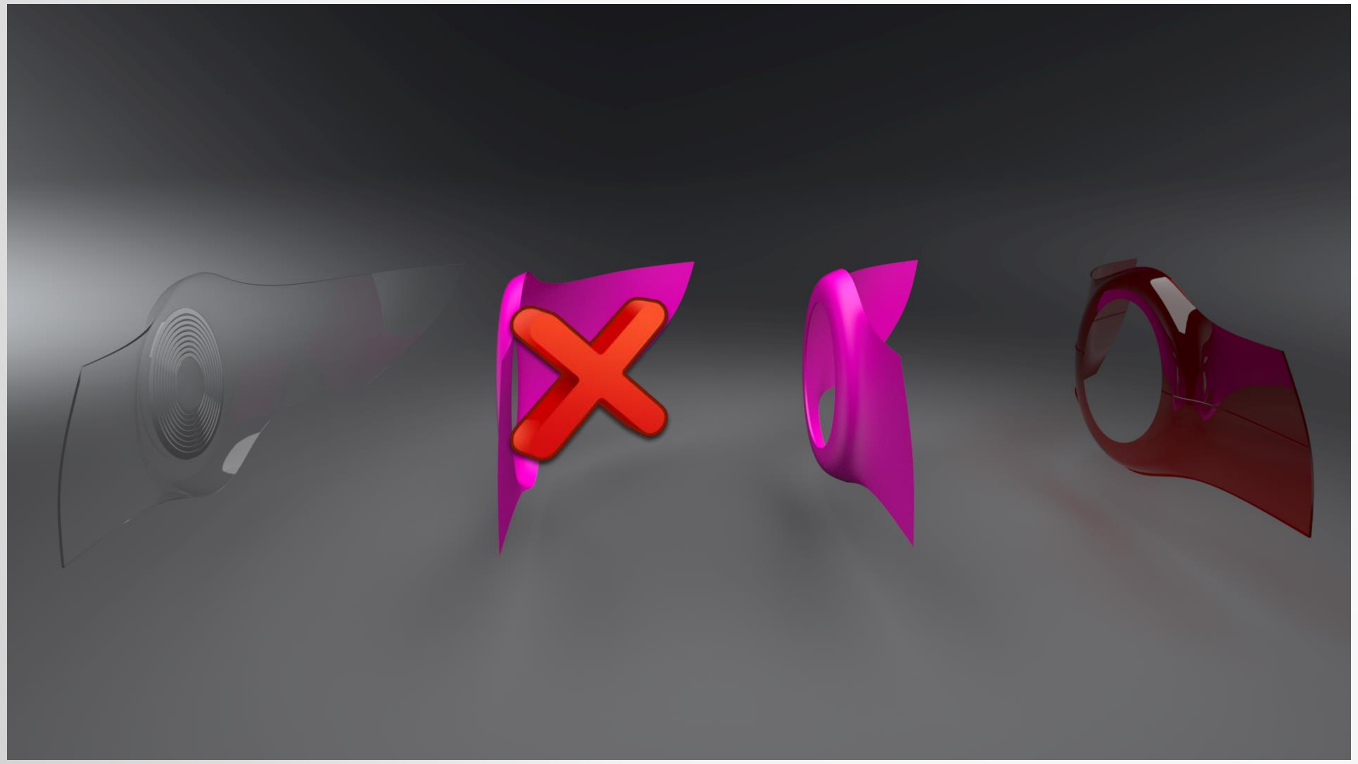
- Move the two glass objects (Glass_White_B & Glass_Red_A) apart from each other to identify the identical contact surfaces better
- Use **Selcet Components** to seperate the contact surfaces and move them into new Shell´s with a clear naming convention
- This is done already in the training data!

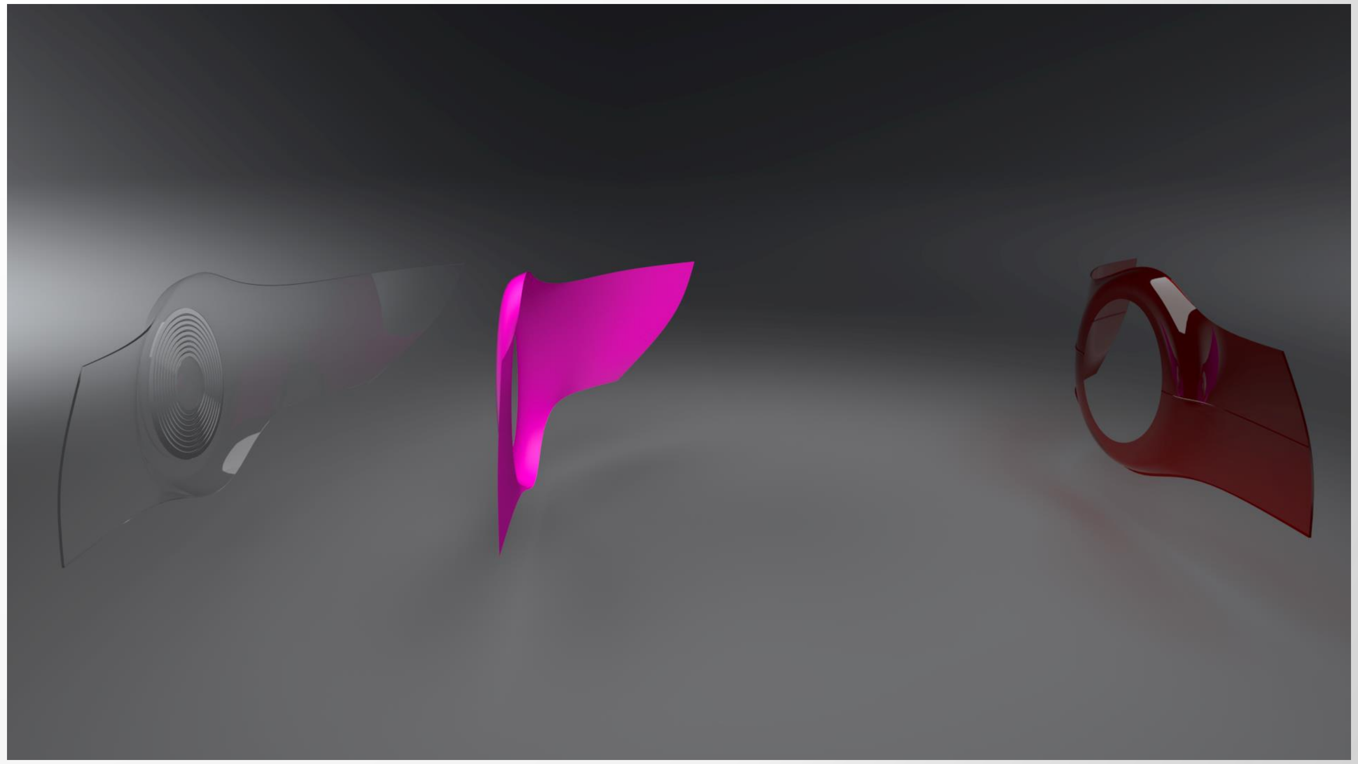




Example 8 – Layered Material for Multi-Component Glass

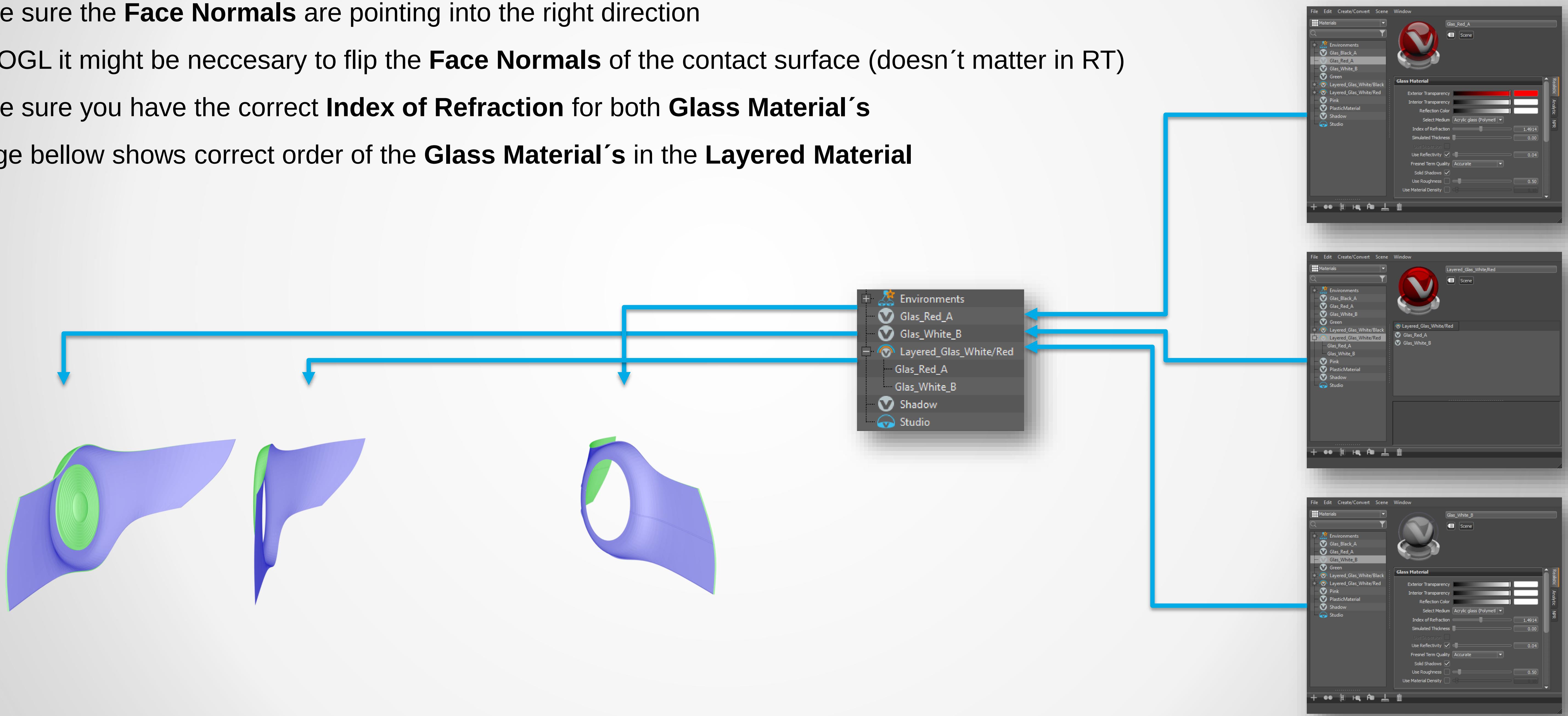
- ☑ Delete/hide the inner contact surface of the **White Glass** and keep only the **Red Contact Surface**
- ☑ This will be our new contact surface the **Layered Material** has to be assigned
- ☑ Create a **Red-** and **White Glass Material** with proper settings and assigne it to the outer glass objects
- ☑ Create a **Layered Material** and move both glasses into it
- ☑ Assign the **Layered Material** to the contact surface
- ☑ Move the glass objects back to their original position





Example 8 – Layered Material for Multi-Component Glass

- Make sure the **Face Normals** are pointing into the right direction
- For OGL it might be neccesary to flip the **Face Normals** of the contact surface (doesn´t matter in RT)
- Make sure you have the correct **Index of Refraction** for both **Glass Material´s**
- Image bellow shows correct order of the **Glass Material´s** in the **Layered Material**



Example 8 – Layered Material for Multi-Component Glass

- Correct result in **Raytracing** (Image 1) and **OGL** (Image 2)

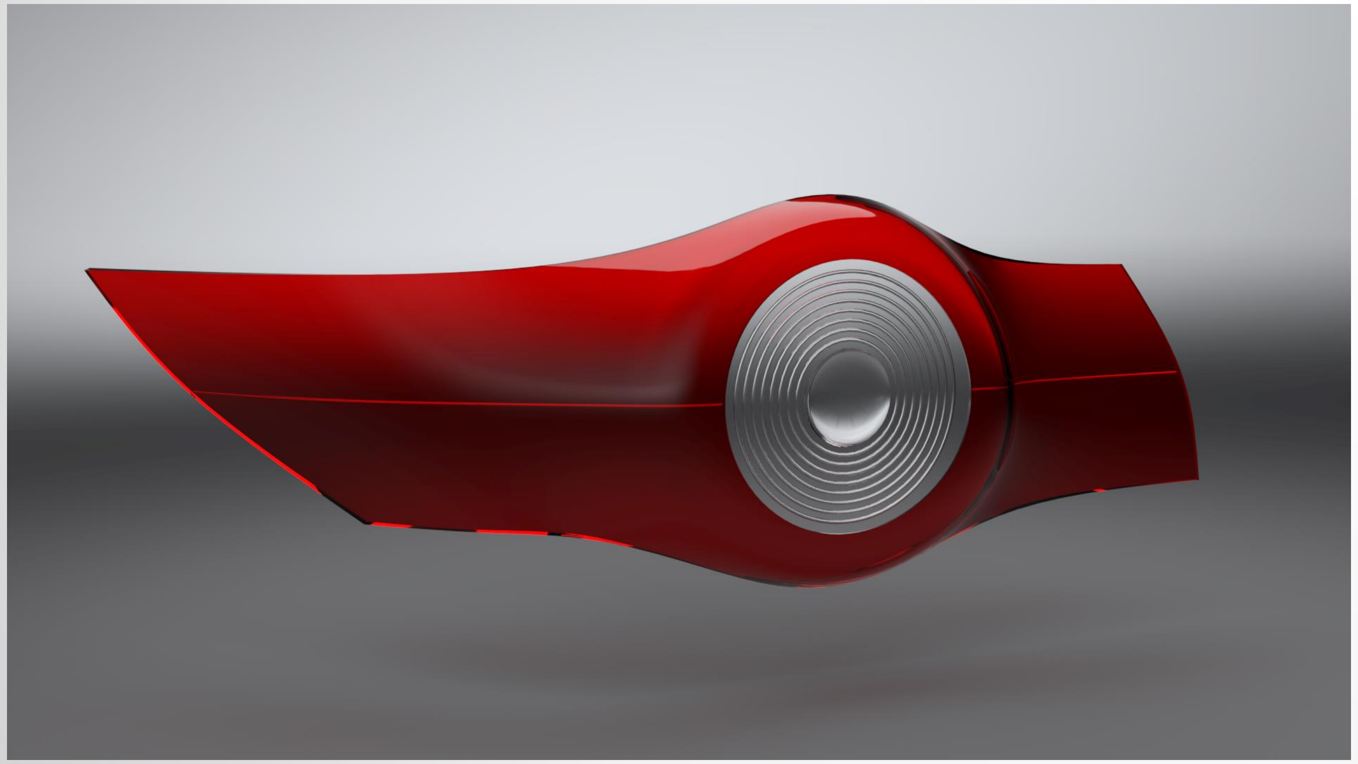


Image 1

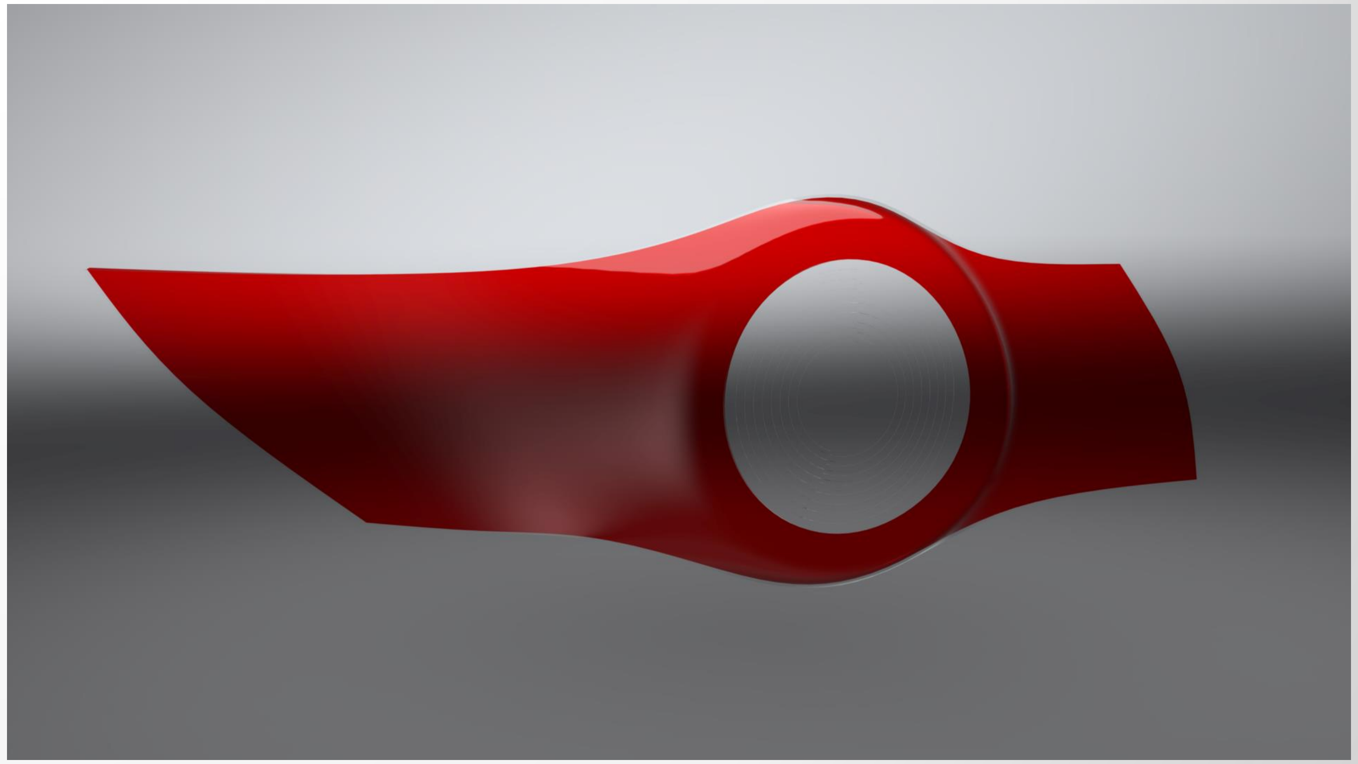
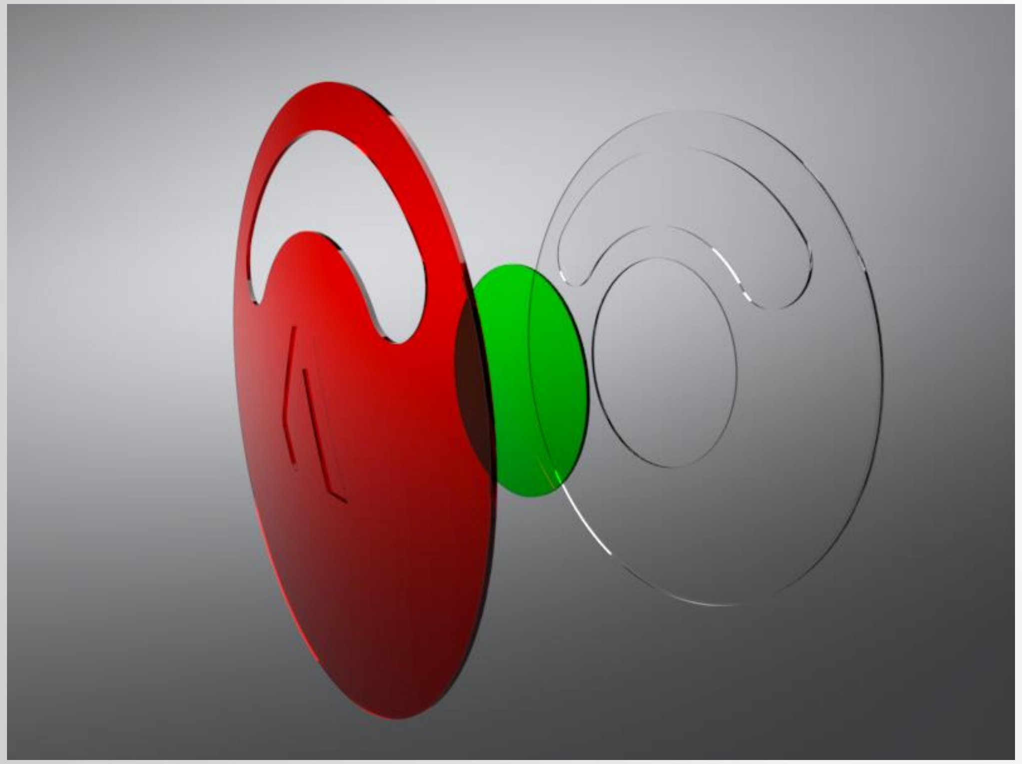
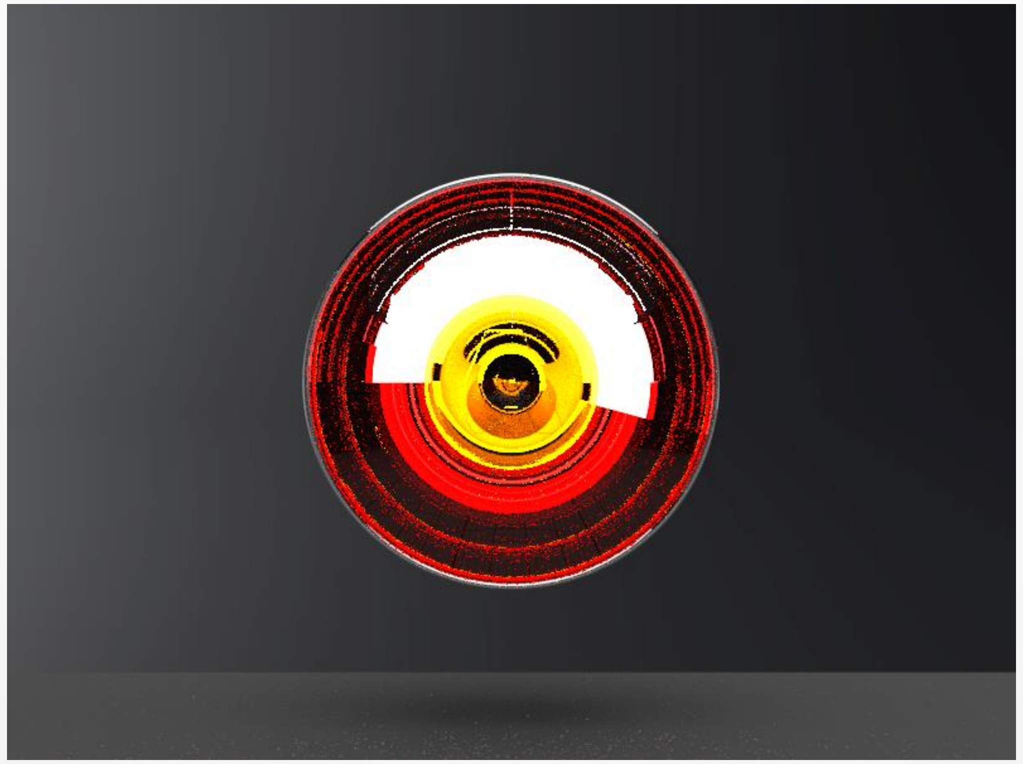


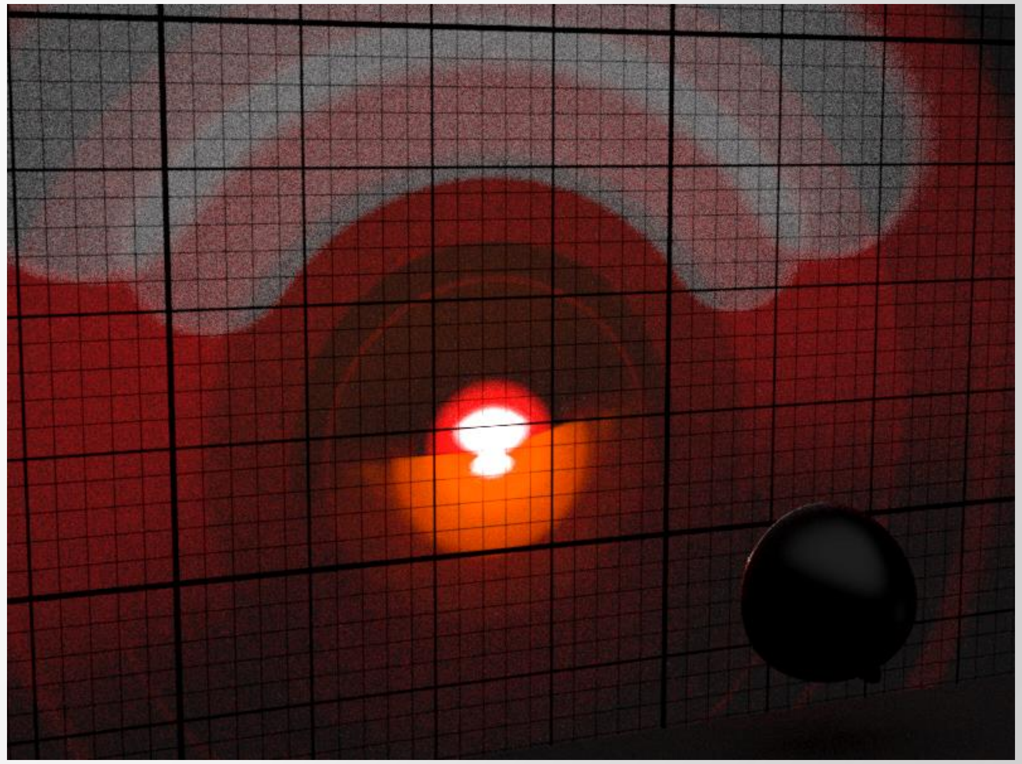
Image 2

Example 9 – Colored Multi-Component Glass

- The example shows a multicomponent tail lamp with an intigrated indicator light
- The 3 colored components (red glass + green glass + white glass) cause an orange light on the wall

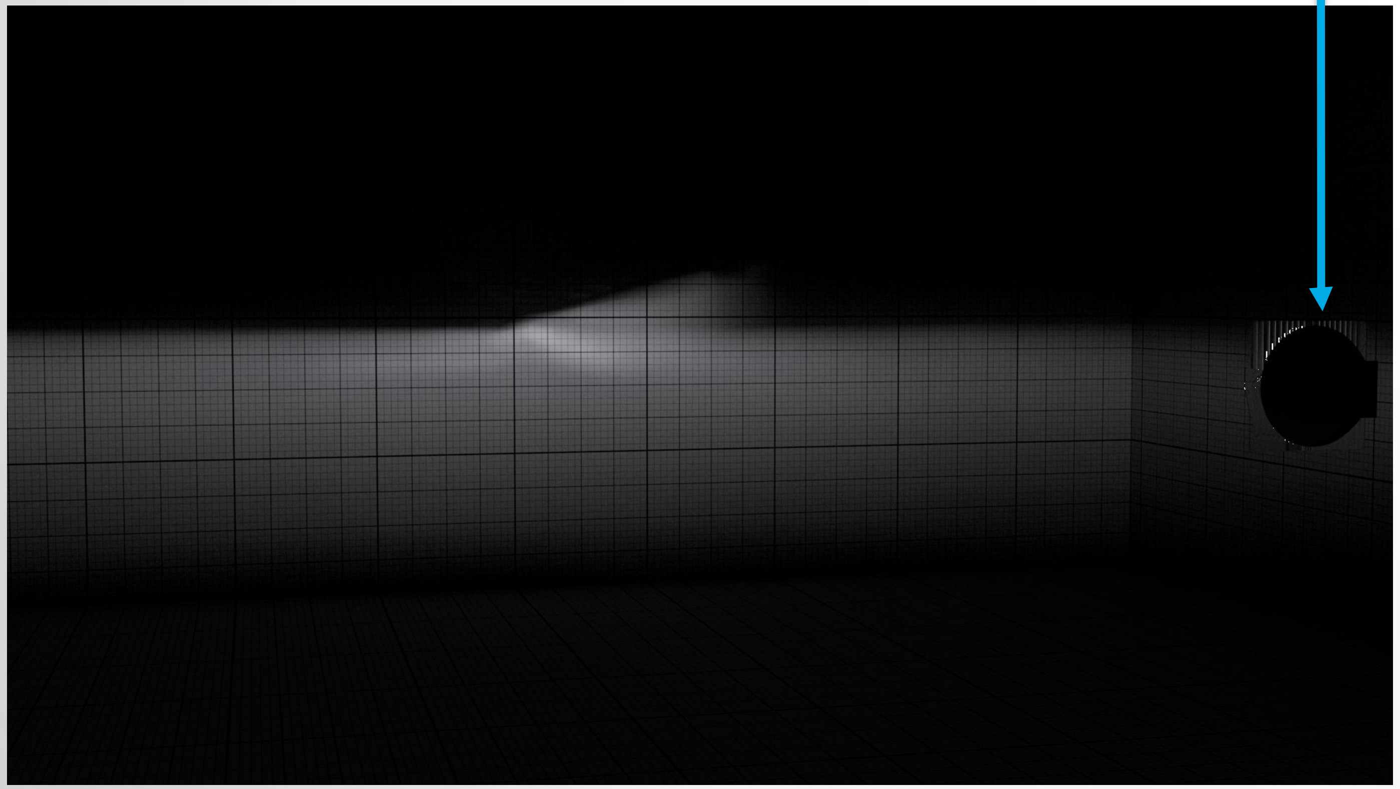


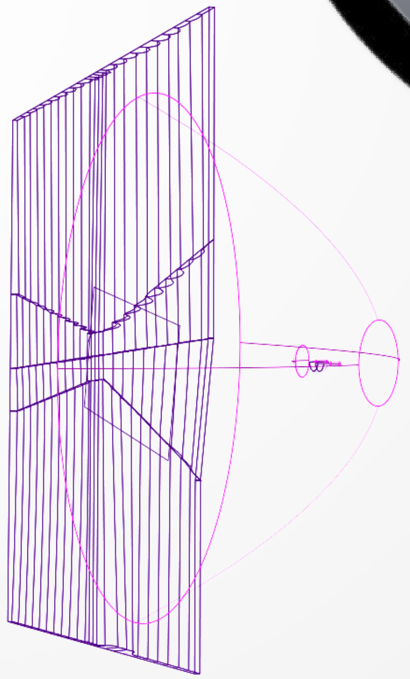


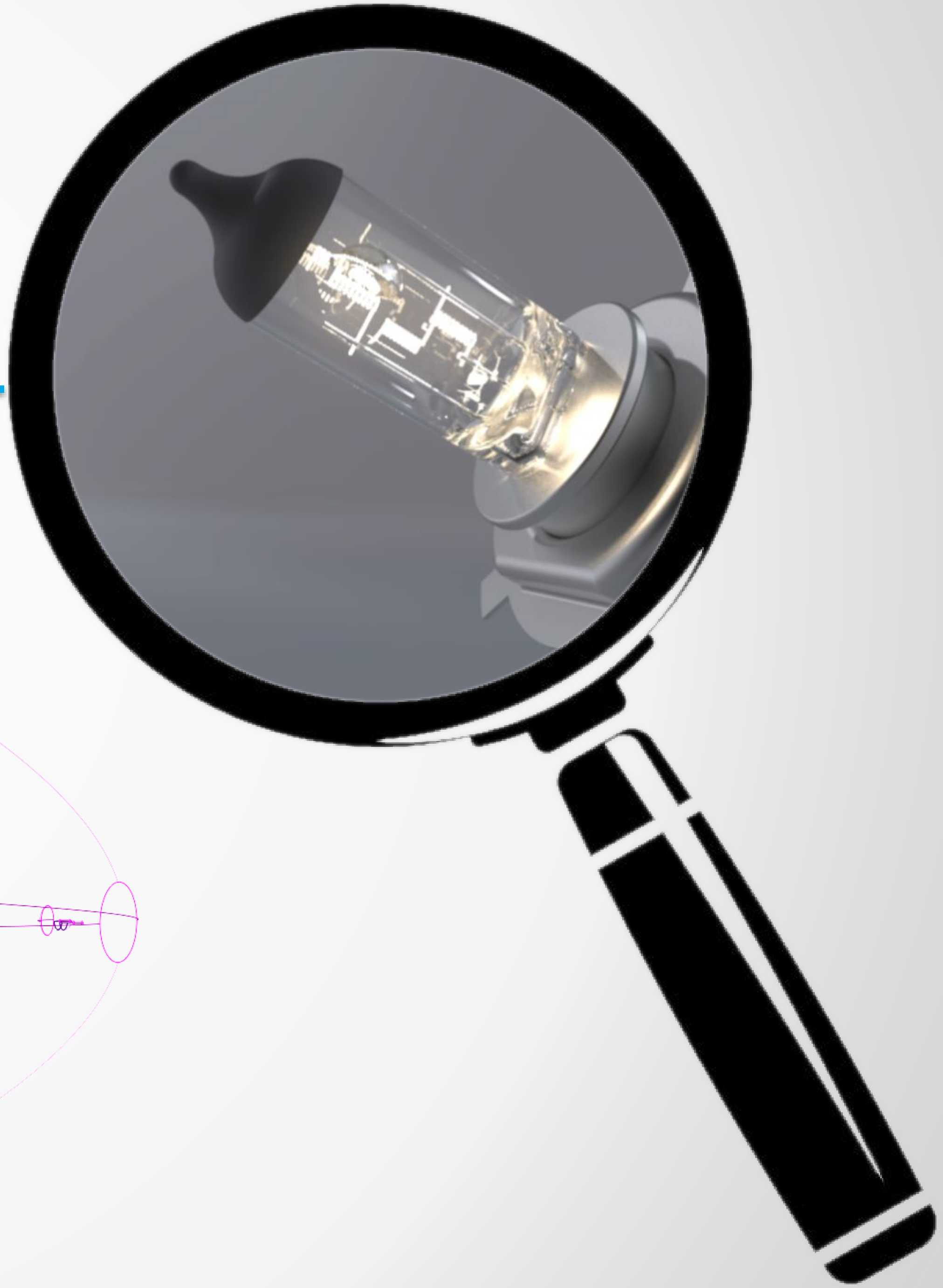


Example 10 – H7 Lamp behind Refractor Glass

- Example scene shows the light distribution calculated with Photon-Mapping from a filament behind a refractor geometry onto a wall







Example 9 – Comparison with Simulation Tool

- Characteristics of a real car lightbeam (Image 1)
- Optis Speos simulation software (Image 2)
- Autodesk VRED (Image 3)

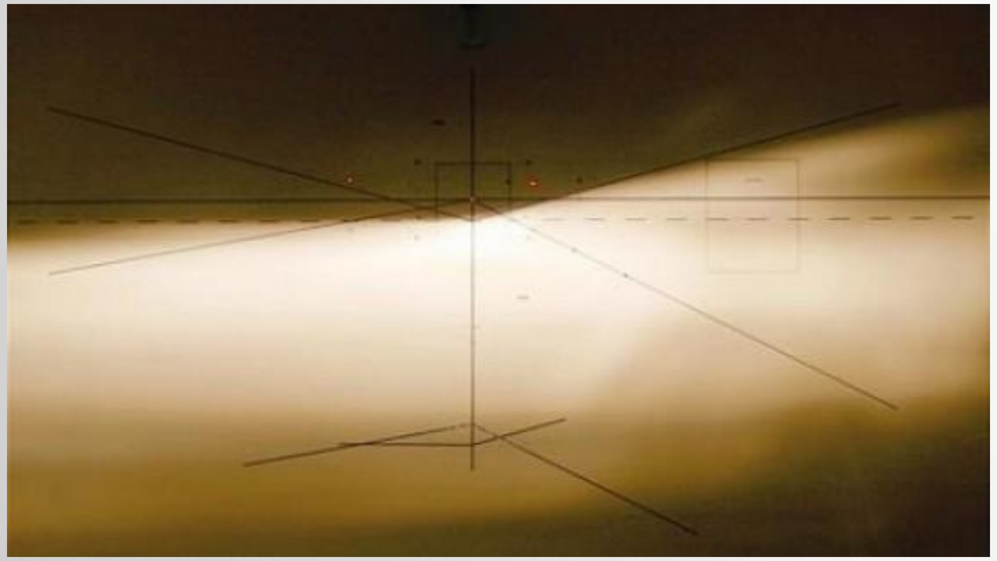


Image 1

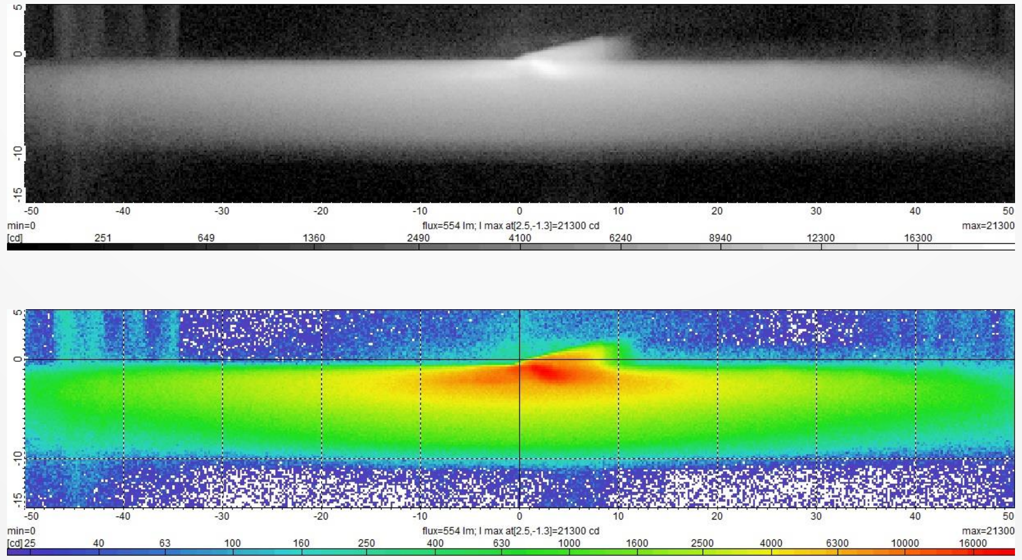


Image 2

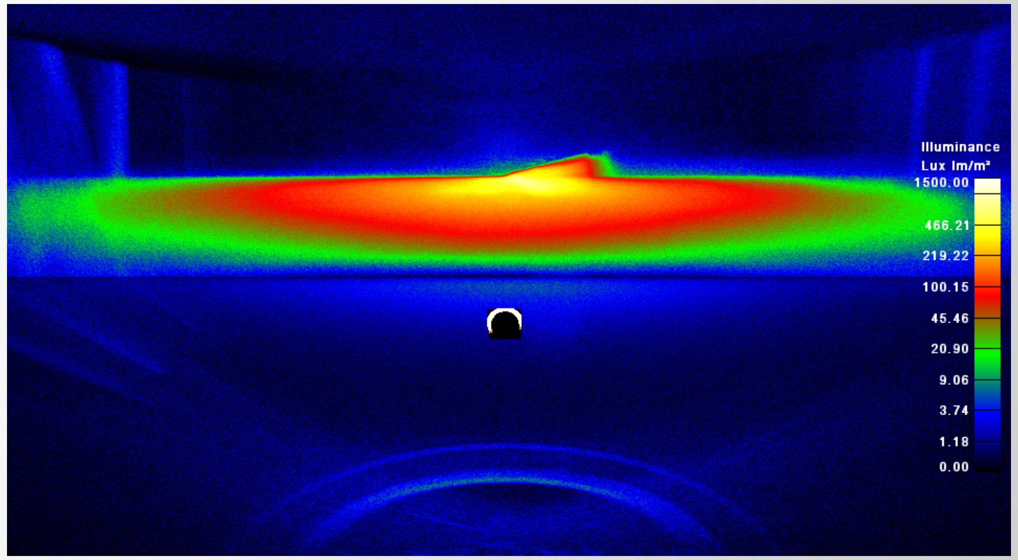
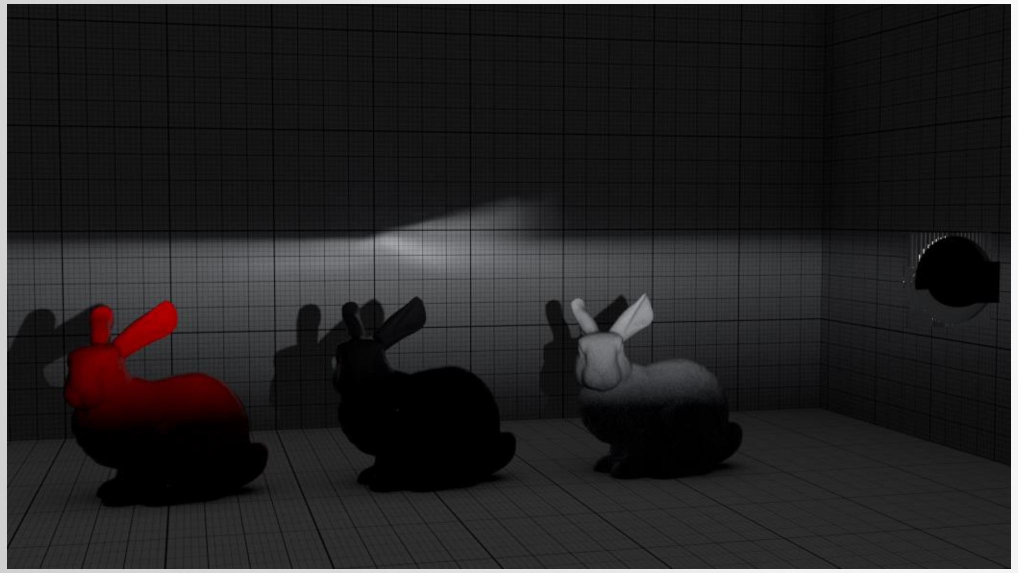


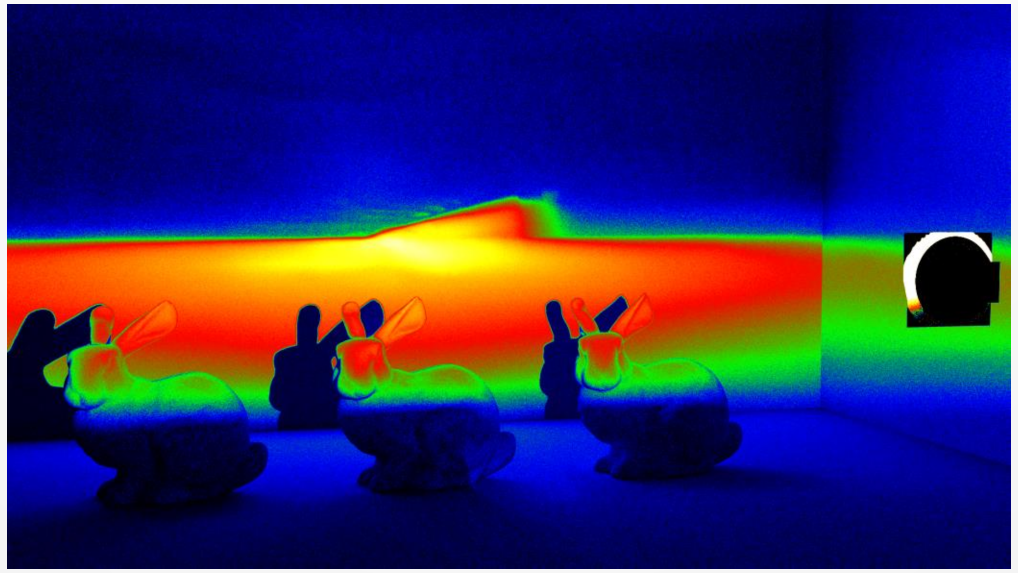
Image 3

Example 9 – Camera Tone-Mapping

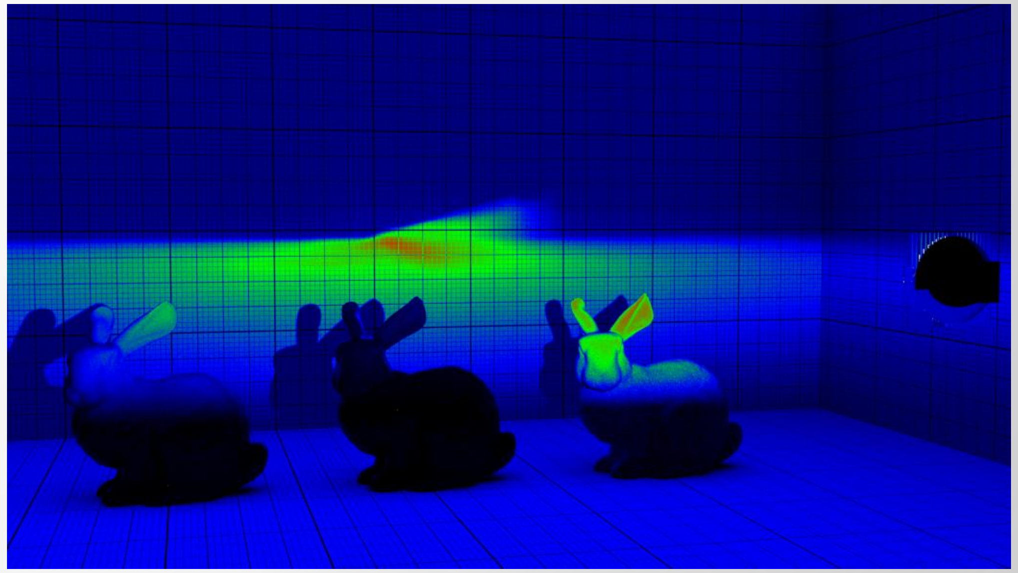
- Realistic light distribution in scene
- Illuminace **Tone-Mapping** shows the direct light received by the objects
- Luminance **Tone-Mapping** shows the light influenced by the material properties (color)



Realistic Rendering



Illuminance Tone-Mapping



Luminance Tone-Mapping

What you see compare to what you get

- **VRED** is able to render in HDR format
- Color- and intensity range of the pixels is much bigger than what can be displayed on a RGB screen
- Also the color- and intensity range of the human eye is different to what can be shown on a screen
- To allign the rendering to a result you would expect in reality VRED offers a camera Tone-Mapping

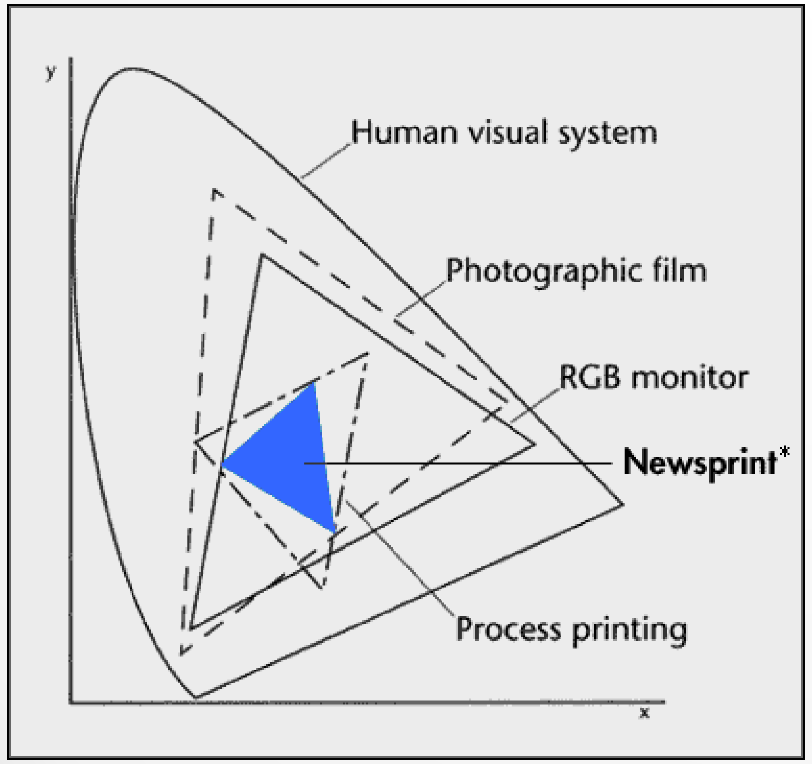
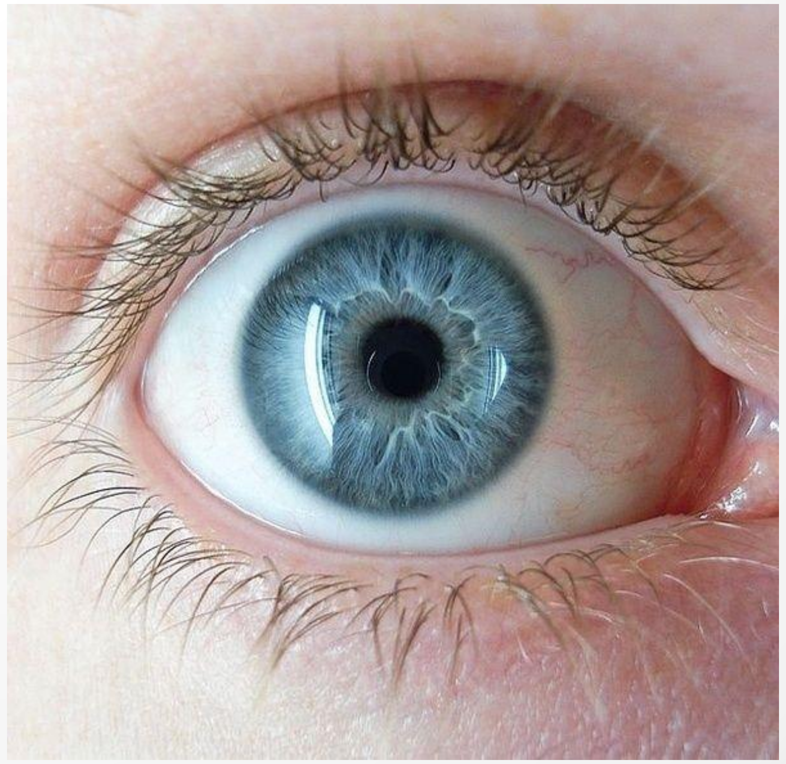


Image courtesy of Boston Globe Media



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