Light setup & Optimization

In this tutorial we will learn how to setup lights inside Thea Studio and how to create mesh lights and optimize them for faster rendering with less noise. Let us have a look at the different types of lights we got at our disposal with Thea and their characteristics.

Thea Omni Light

Thea Omni Light can be used like a light bulb as its light spreads out in all directions. By default the Omni light produces sharp shadows as it is a point light with no dimensions. To give shadows a softer look we can enable the “soft shadows” option and give the Onmi light a size (represented in meters). Increasing the radius value of the Omni light, increases accordingly the light source and therefore shadows become softer.

It is very important to make sure that the Omni light does not intersect with other geometry as this will lead to fireflies and more noise in your renders. When increasing the Omni light radius, check that the yellow ball that indicates the size is not intersecting with nearby geometry (shown in Image 01).

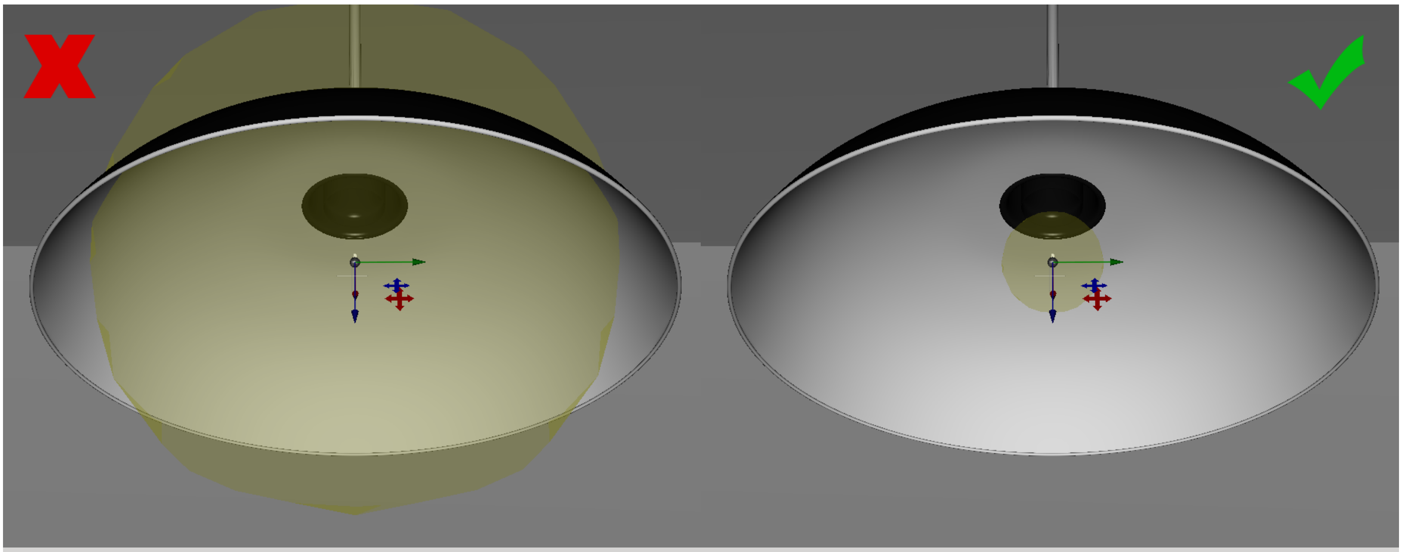

Image 01.
By enabling “soft shadows” we can give the light source radius a size and this way achieve a more natural look as we control the sharpness/softness of the shadows. Be careful to not set the radius too big that it intersects with nearby objects. A radius of 0,025 m is a good average size for a light bulb.

Thea Spot Light

Thea Spot Light displays two cones which represent light spread that we can modify to our needs through the fall off and hot spot settings. The fall off cone is displayed in blue while the hot spot cone has a yellow color. We also get two gizmos on our display that allow us to place and direct the light cone to the desired direction. Thea fall off and Hot spot setting define the spot light cone sharpness/softness (Image 02). We can also enable soft shadows and give the spot light a size. This will lead to more softer shadows.

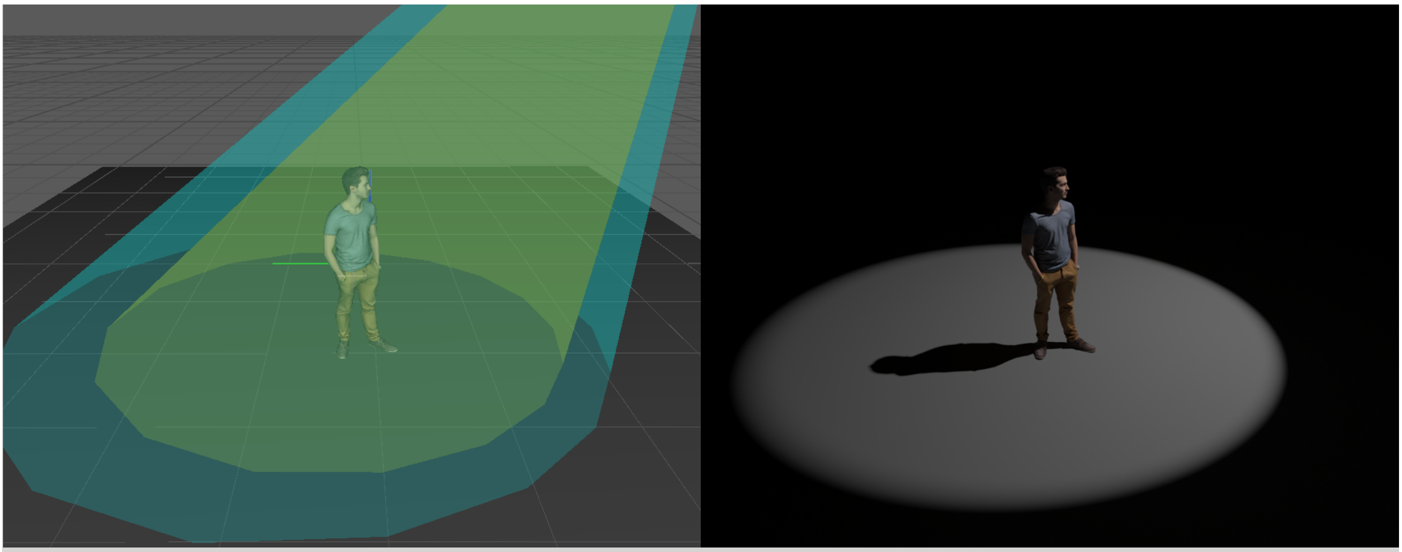

Image 02.
Through the Fall Off and Hot Spot settings we can define the sharpness/softness and size of the Spot light cone. We can also enable "soft shadows" and control this way the softness of the shadows.

Thea IES Light

An IES light looks like an Omni light but with the option to assign a IES profile to it. Its important to note that Thea IES light has a position which is important to place correctly (Image 03). IES files provide the light power data and so we don't have to change the light power settings. If we know the light source color temperature, we can give the correct color through Thea color lab using the black body color picker. IES data also contains how the light spreads to the reflectors inside the fixture and how the light source is built. Its important to note that we don't have to add reflective materials inside the fixture (reflectors) as the IES data already provides this and we also do not have to cover the light source with glass as the IES data has the light bending effect included. The optimal approach would be to use a simplified version of the light fixture geometry and place the IES light in its position.

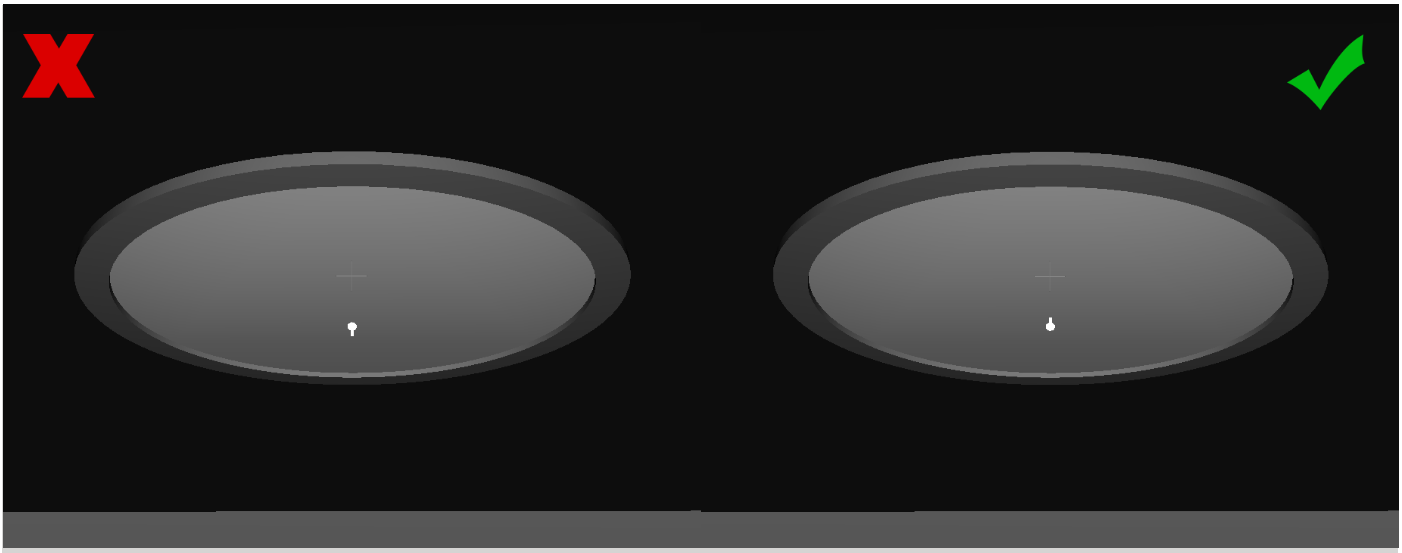

Image 03.
When placing an IES light under a light fixture, one needs to make sure to position the IES light correctly. The IES light bulb icon indicates in which direction the IES light is pointing.

Projector Light

Thea Projector light simulates a projector like those used for projecting images or films onto a projector screen. Its light cone is square and can be adjusted through the height and width settings. When using an image for the projector, we should use the same width and height proportions of the image for the projector with and height settings. As with the Spot light we are presented with two gizmos to direct the light cone and its position (Image 04).

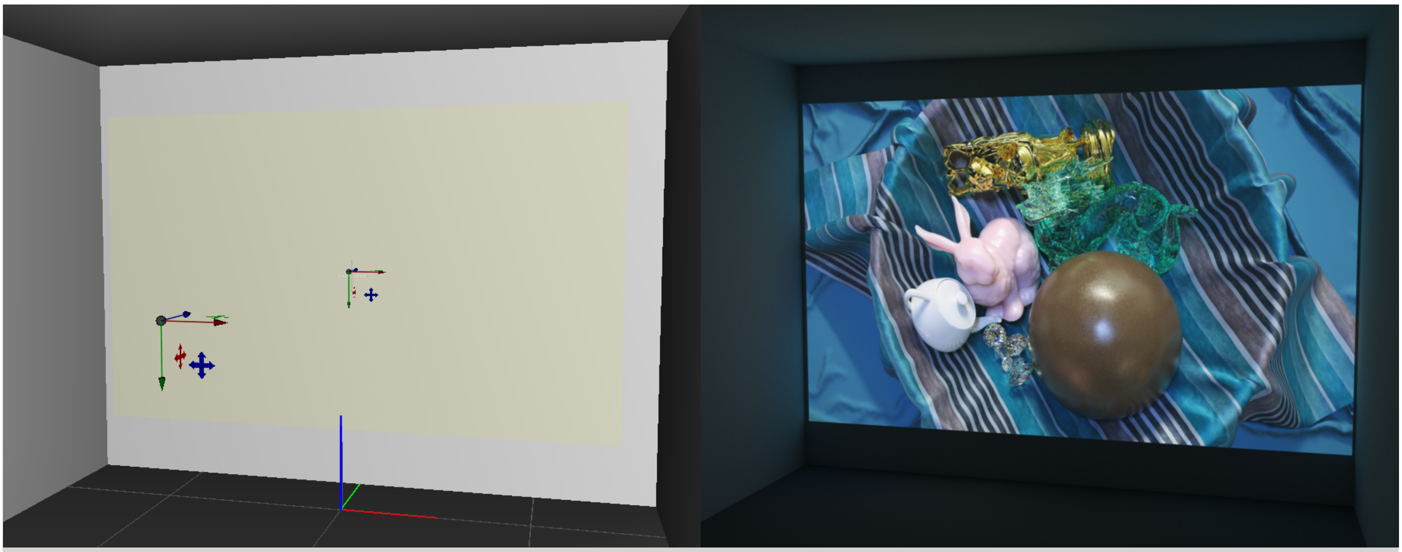

Image 04.
Thea Projector light can be used to project an image onto other geometry in the scene. We can place and direct the projector light cone through the two gizmos. Use the width and height proportion of the projected image for the projector width and height setting.

Mesh Light

Any mesh object in a scene can be converted to a light source by enabling the Emitter component in the Material Editor. Note that heavy geometry will add to longer render times, so keeping the polygon count of the emitter objects low will benefit in shorter render times.

With mesh emitters we have the advantage that we can simulate soft boxes (used by photographers), fluorescent tubes or neon signs which we can not simulate using Thea native lights. Another advantage is that the light source is also "visible" which in case of Thea native lights they are not.

When using mesh emitters we have to be careful how we assign our emitter material to our object before we export the scene to Thea as Thea separate/join objects through materials. It can easily happen that using the same material on different mesh emitters we end up in Thea with 1 emitter object. In this case when we assign a light power of 60 watts, we actually will get from the 6 emitters only 10 watts each as the light power is getting distributed over all 6 emitters. Make sure that your emitters get imported as separate object and then you can apply one and the same emitter material to all of them getting the correct light power for each emitter (Image 05).

When setting the light intensity, we should always make use of real world light power units such as Watts, Lumen or any of the available light units inside Thea. We can find realistic light power values at light bulb manufactures web pages or on the light bulb packaging. You can also read about correct light intensity setting at the Thea tutorial **"Accurate light intensity and camera exposure"**.

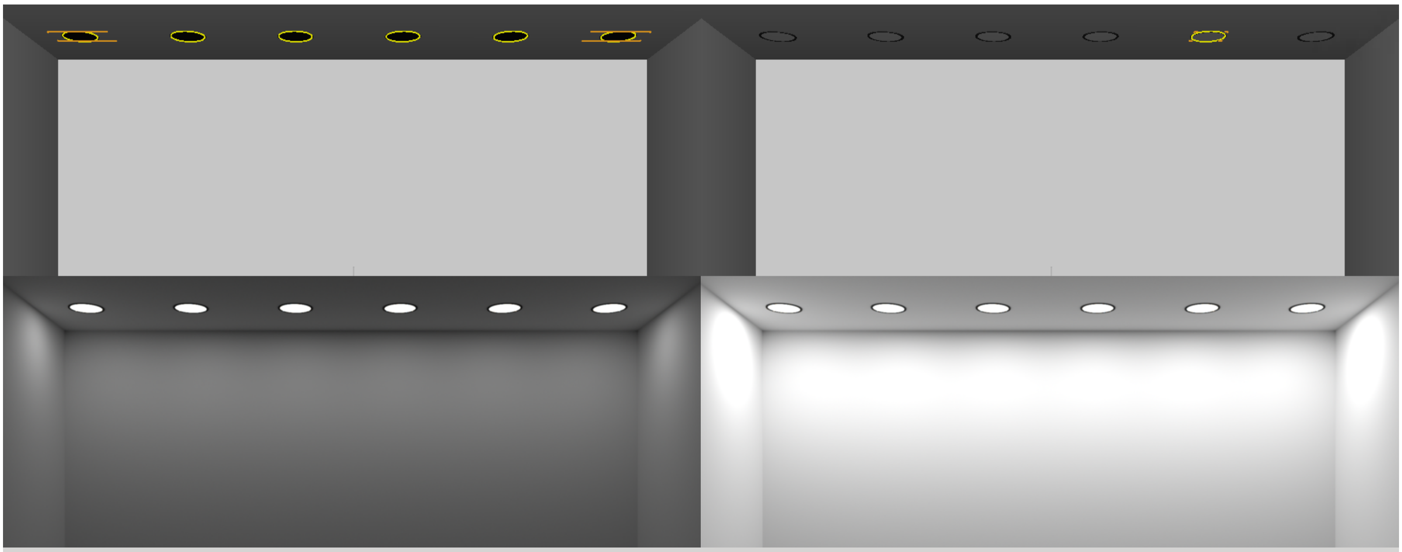

Image 05.
On the left image we assign 60 Watts to the emitter that got imported as one object. Each emitter will only emit 10 Watts as the light power get distributed over all 6 emitters. On the right we assign 60 Watts to each of the emitters as we can select them as single objects and each of them will emit 60 Watts.

Inserting Lights inside Thea Studio

We can insert Thea lights through the insert drop down menu under the insert icon on the top toolbar. Here we can also decide where to insert the light source, at viewer frame, global frame or cursor frame. The best way to insert a light source is to use "at cursor frame" as this will allow us to precisely insert our lights where we want. Before we insert a light, we can select the cursor frame through this icons and move the cursor frame to the location we want our light to get inserted. Note that the position and rotation of the cursor frame will also determinate the position and rotation of the inserted light (Image 06).

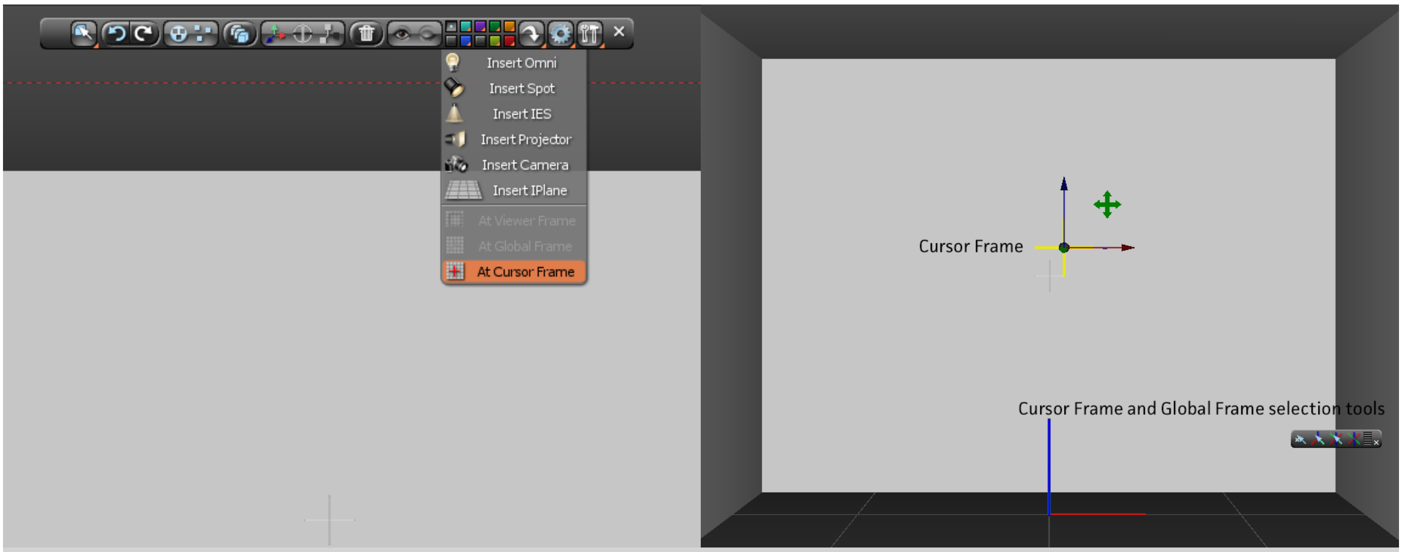

Image 06.
Using the insert drop down menu we can select between inserting our lights at viewer frame, global frame or cursor frame. We will have more control if we select "cursor frame" in combination with the selection tools.

Another way to place lights is to add “place holders” in your 3D modeling application like small cubes where the lights should get placed. Then inside Thea, we can select the place holder geometry and click on the “Align Cursor with Selection” icon. This will align the cursor to the selected geometry and when we insert now a Thea light, it will get placed exactly where the “place holder” geometry is located. After that we can delete the place holder geometry.

Making Thea lights visible

Thea lights are not visible as they are point lights, to make the light source visible, we have to create a low poly geometry that represents the light source and add a self luminance material to it.
This geometry can be as simple as a small plane or disc, or the inside of the light fixture. For the self luminance material we will make use of Thea “Passive Emitter” which visually acts like an emitter but actually does not emit any light to the scene.

We can make use of the same technique to optimize mesh emitters. For example we can create a disc (for a ceiling light) that is constructed like shown on image 10. We apply a passive emitter material to the disc and to the small triangle that is a bit above the disc (so it does not intersect with the disc), we add the real emitter material.

If we are going to add a IES profile to the mesh emitter, we will have to also assign a thin film material to it with a IOR = 1,00 to make it transparent. This is because some IES files can show black areas on the emitter and this way we prevent this to show up on our final render.

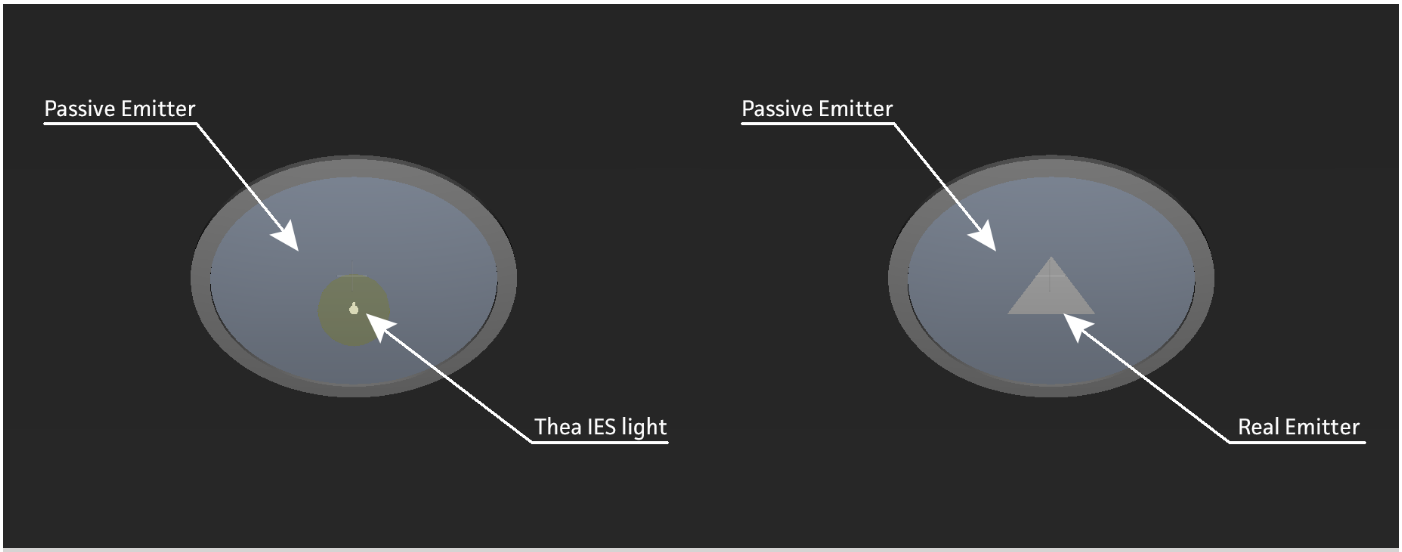

Image 07.
We can make Thea lights visible by applying a passive emitter to the fixture area and we can do the same when using a mesh emitter. Keeping the mesh emitter geometry as simple as possible will help shorten render times. A good size for a mesh emitter should be around 2 to 5 cm.

Optimization

Now that we have our lights setup correctly we could start rendering immediately but there are still some things we could do to get less noise and faster renderings. The following tips and techniques are by no means mandatory but if followed can save you valuable render time.

To better understand how we can further optimize our light setup, we need to know some basic concepts about how the render process works. For example the different light paths Thea has to calculate, mainly direct light (which is the fastest), indirect light (which is much slower to solve), caustics light (difficult to solve when light source is small).

Direct light is the light that hits the objects in the scene directly without any obstacle between the light and the objects. This type of light path is the fastest to solve.

Indirect light is light that has bounced of an object and “indirectly” illuminates other objects. This kind of light path is slower to solve as the light can bounce a long time through a scene until it looses all its energy. This is way we have more noise in our scene where we have shadow or penumbra areas where no direct light is illuminating the scene. This part of the scene gets only illuminated through indirect light. Many indirect light paths have to be calculated to fill those areas.

Caustics light is light that passes though transparent objects like glass or water or reflects from glossy objects like metals or even shiny plastics (any object that has a reflective component). It creates a light pattern like the caustics in a swimming pool or those reflected from mirror like objects.

This light paths are very compute intensive and depending on the size of the light source that produces caustics light, also very hard to calculate efficiently. Depending on the render engine and light source used, Caustics can be computed more efficient or not at all. This is the case of TR1/TR2 that can handle all light situations and light path efficient but with longer render times. Presto on the other hand can not produce caustics efficiently when using Thea lights or sunlight. One needs to make use of mesh lights that are big enough to be able to calculate the caustics path.

In some occasions caustics do not add that much to the overall visual result but in other situations it can make the difference.

Subsurface scattering fall in the same category like caustics light and are very difficult and time consuming to calculate (Thea uses the full unbiased method of physical correct medium calculation). When a light path enters a subsurface scattering material, it bounces inside the objects as it collides with tiny particles that are present inside the material (the particles present the material density). The more dens the material is, the more the light will bounce inside the material until it can exit. This can lead to long calculations and increases render time.

Comprehension of different light paths can help us optimize our scene and recognize situations that can produce more noise. Thinking about light as “energy” is also helpful as we will see with the following examples.

Image 8 shows a simple room with a Thea Omni light. This kind of light setup will render fast as most objects will receive direct light. The image next shows the same Omni light but with a light cover. Now the scene needs more time to get noise free then before and the reason is because of the light cover. Parts of the scene that got direct light are now getting indirect light only which increases render time. But there is something more going on with this light setup and it has to do with the light energy. All light sources have an inverse square light fall off, meaning that the light power at the light bulb has very high energy and everything close to it will also reflect high energy back. The light cover will act like a reflector even we don’t make use of reflective materials. If we give the inside of the light cover a bright diffuse color, we are producing “high energy” bounce light or indirect light that needs time to get noise free.

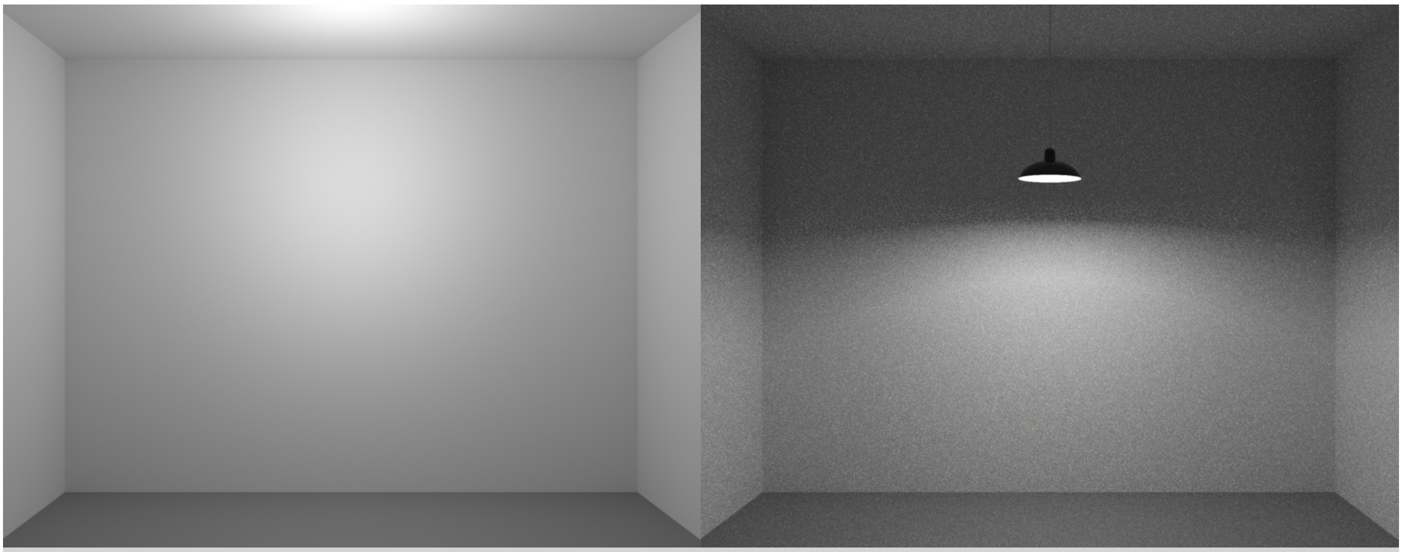

Image 08.

when using a light without a cover, we will get the fastest results as most light that arrives to the scene is direct light but as soon we add a cover to the light, a lot of light will become indirect light and we will have more noise in our scene that will take more time to clear up. Both images rendered for 30 seconds.

Giving the inside of the light cover a black diffuse color we will see how much faster our scene get noise free. Giving a black color to the inside of the light cover has lowered the energy of the reflected/indirect light and so reduced noise in our scene. We also add a passive emitter to the light cover so we keep the illusion of reflected light inside the light cover (image 9).

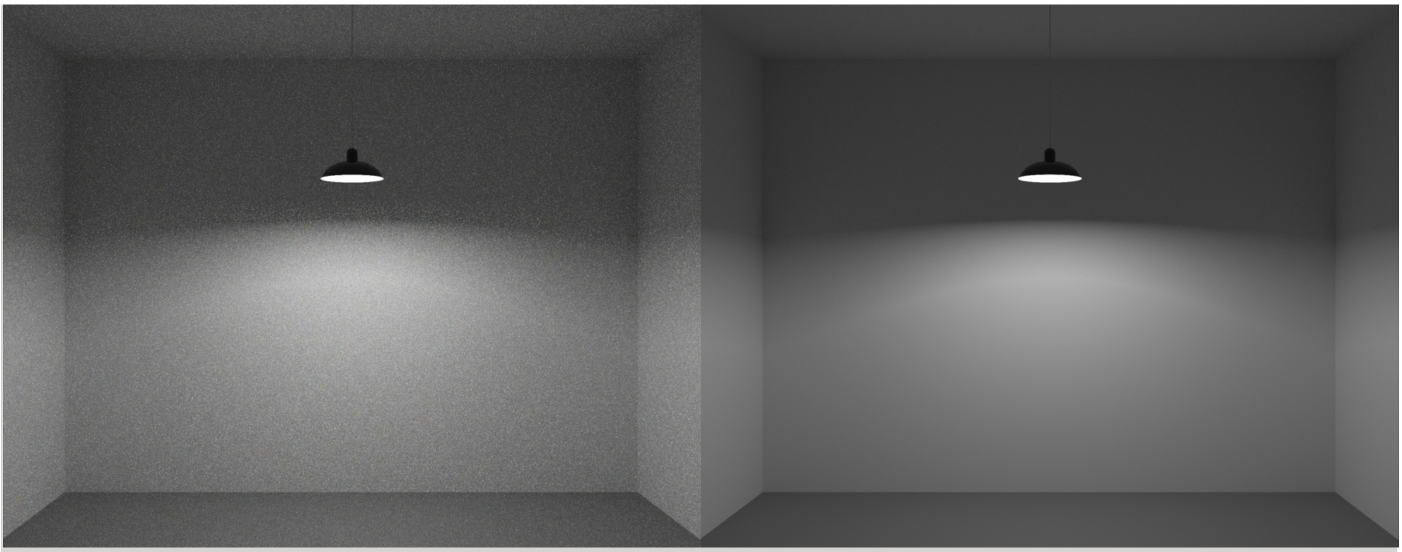

Image 09.

Here we can compare two renders, the original with normal light cover that has a bright color inside the light cover and the other image with the inside of the light cover using a black diffuse color and a passive emitter. Both images rendered for 30 seconds and we can clearly see how much faster the image with the light cover that uses black diffuse with passive emitter renders.

We can use this technique for the inside of all light covers that uses IES lights. Like mentioned in this tutorial, the IES light profile has the complete light with its fixture encoded so we should not add additional reflectors inside the light cover.

For normal light bulbs where we use Thea Omni light or a mesh emitter, this technique can work but if we have a closer look at Image 9 we can see that we actually lose the reflected light from the light cover and so we have less light in our scene. It is a very tiny bit we lose but this can change depending on the shape and size of the light cover. To compensate for this we have to use instead of a passive emitter inside the light cover, a real emitter material and use a very low light power. The light power needed will depend on the size and shape of the light cover but will always be lower then the light power of the light source (Image 10-11).

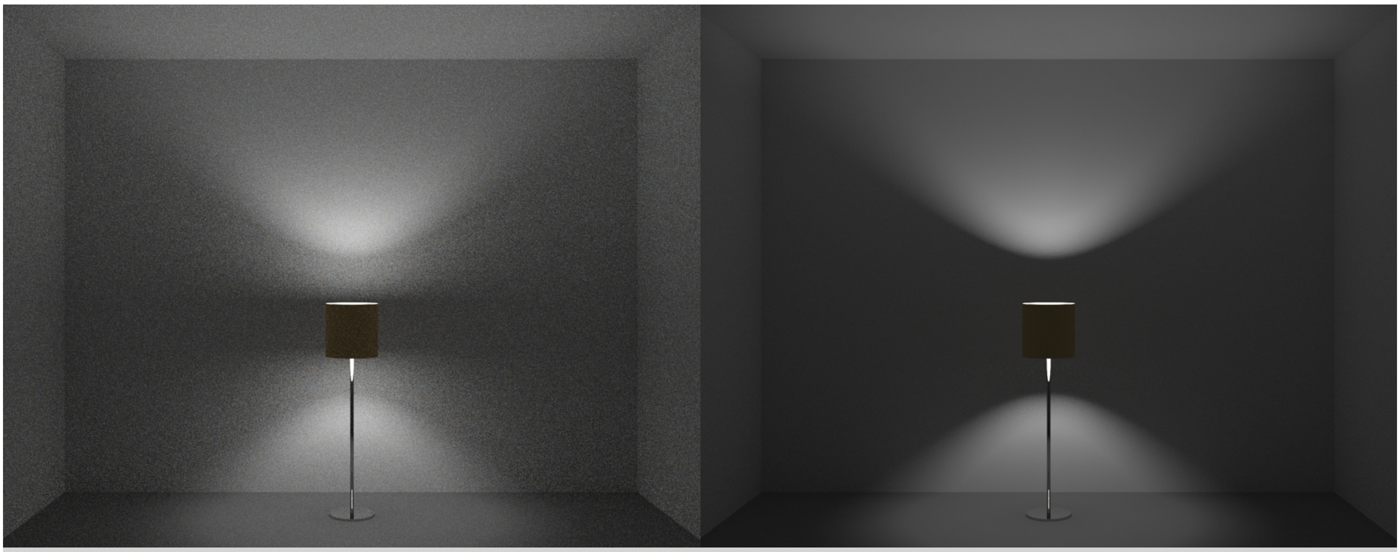

Image 10.
The first image show how the render looks with normal cover and the second with the light cover using passive emitter and black diffuse color (both images rendered for 1 minute). With this example we can clearly see how much light we can lose depending on the light cover shape using the passive emitter technique.

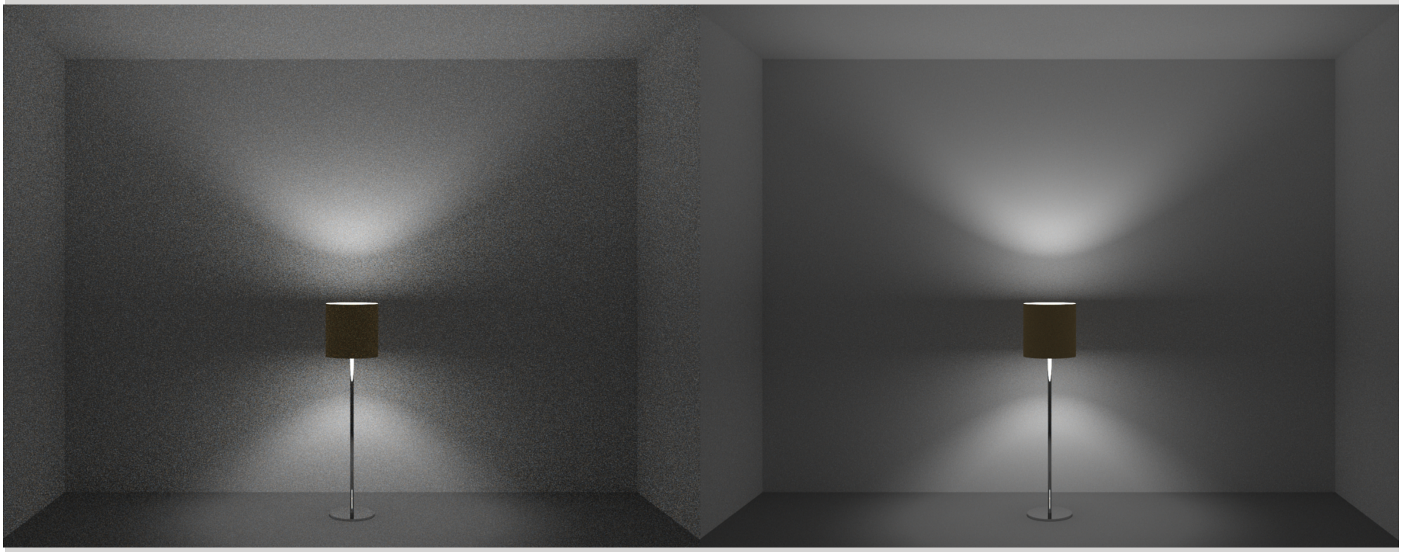

Image 11.
By changing the passive emitter of the cover for a real emitter material we get back the missing reflected light (both images rendered for 1 minute) and we still get a faster render even we are using more emitters. The reason for this is that we have "converted" indirect reflected light from the light cover in to direct light.

If the light cover is made out of translucent material, we can make use of the same technique by adding an emitter material also to the exterior of the light cover. Transmitted light through translucent materials will also produce noise and in this case we do not make use of the translucent material but simulate it with an emitter material. The interior part of the light cover has the same setup like the previous example with black diffuse color and emitter material at low power (image 12).

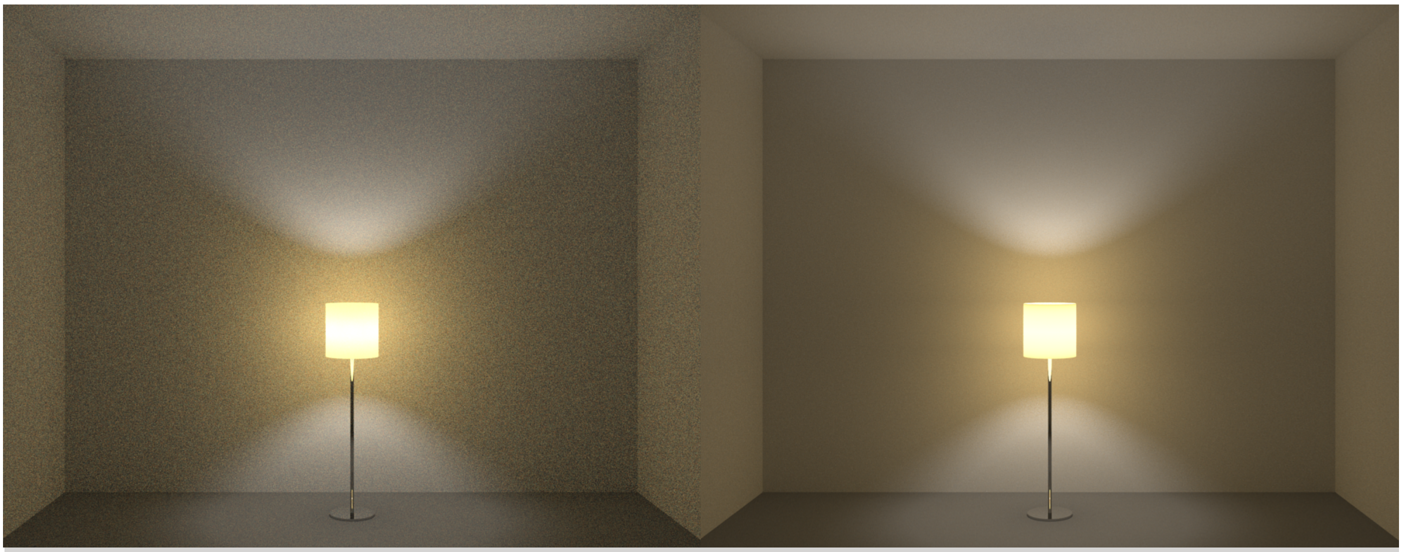

Image 12.
On the left image we can see how a normal translucent cover would render (geometry without thickness). On the right we see how it renders using the emitter also for the exterior of the cover. Note that in this case the emitter material for the interior of the cover needs to have the same color as the emitter material for the exterior of the cover (the color that was used for translucency). Both use black as diffuse color (both images rendered for 1 minute).

Caustics

Caustics are difficult to solve and will be a source of noise that will take longer to clear up. If we need to have accurate caustics, we can make use of Thea render engines TR1 or TR2 which will deliver 100% accurate results. Covering a light source with glossy glass will make the render times take longer as we are illuminating the whole scene only with caustic light and we can only use TR1/TR2, Adaptive AMC or the BSD render engines. Presto will not be able to solve this kind of situation efficiently in certain cases.

Good practice is to use thin film (thin glass) when ever possible instead of glossy glass. Use thin film on windows and any other object that represent thin glass. If you need to cover your light source with glass, then use thin film and Presto will be able to render the scene efficiently and all the other render engines that Thea offers will also benefit from this and render much faster.

But there are situations where we can not make use of thin film because the objects needs to make use of glossy glass like for example a crystal chandelier or water for a swimming pool in an outdoor scene. We could try thin film on those objects but we would loos to much realism. We can always make use of the other render engines Thea offer but what if we need the speed of Presto.

We can use a technique to “simulate” caustics. This will not produce real caustics but we will be able to render with Presto and gain render speed.

Thea does not offer out of the box “simulated” caustics but we can use a simple technique by duplicating our glass or water object and create a new material for the copy. Make the material of the copy unique so we can change it without affecting the material of the original object. Give the object copy a thin film material and in the properties panel disable “visible”. Select the original glass/water object and disable in the properties panel “cast shadow”.

Now we can render our scene more efficient with Presto and still get a good render (image 13).

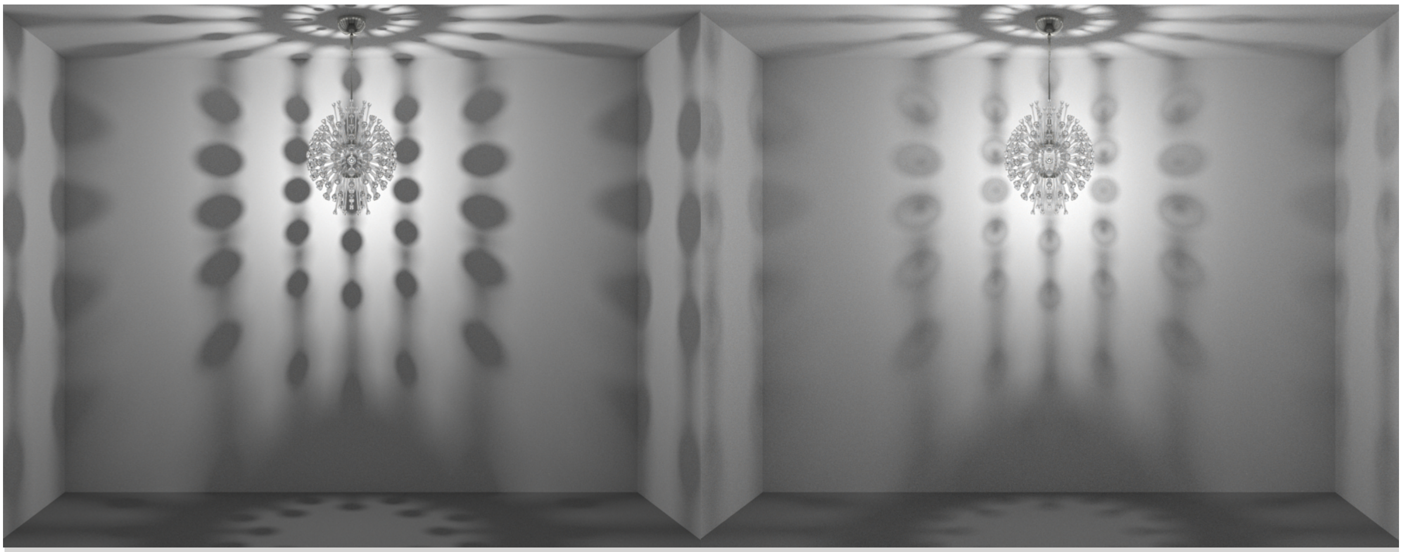

Image 13.
On the left image we can see that Presto can not render the caustics from the chandelier efficiently as the light source is too small. Using the technique of duplicating the glass object and assigning a thin film material, we can combine the shadows of the thin film chandelier with the light bending of the glossy glass chandelier making use of the "cast shadow" and the "visible" toggle in the properties panel.

We can use this technique to simulate caustics in a swimming pool like seen on image 14.
in this case we can add a "caustics" bitmap to the thin film reflectance color and clip map to simulate the caustics. One thing to note is that we can not make use of Absorption color or Medium for the glossy water material/object and thin film material/object as this technique will not work as expected. This restriction also holds for the example on Image 13.

Use this technique only with Presto or BSD (disabling caustics for BSD) and not with the other render engines like TR1/TR2 and Adaptive AMC as they will calculate caustics and the final result will not look as expected.

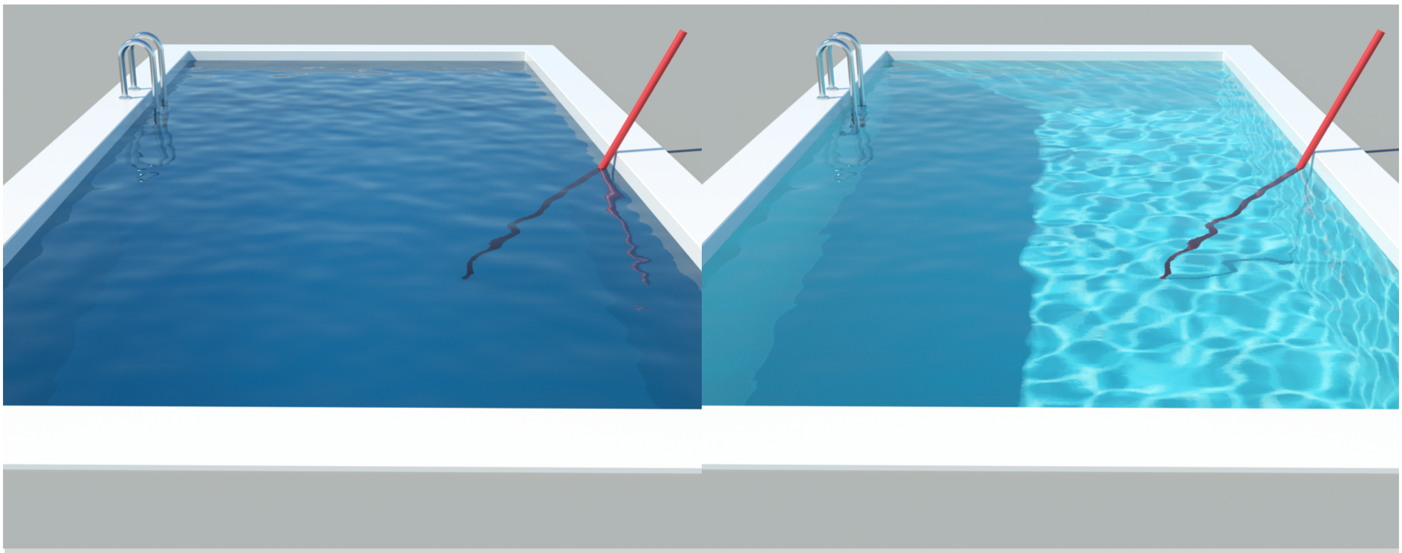

Image 14.
Presto can not render caustics from the sun light efficiently as the light source is to small and distant. Here we can make use of the technique of duplicating the water mesh object and applying a new separate thin film material to the copy. Additionally we add a "caustics" bitmap to the thin film reflectance and clip map to simulate the caustics. We disable "cast shadow" for the original water object and we disable "visible" for the duplicated water object with the thin film material.

As we can see, dedicating a little bit of time for the extra setup, we can reduce render times considerably without loosing final image quality. This will be specially evident when planing for an animation sequence.

Using mesh emitters whenever possible will also allow us to create light models with their fixtures/covers that we can reuse from our Thea model library so the invested time in setting up the lights is not lost. To finalize this tutorial there is a final tip on how we can use optimized mesh emitters but still have the appearance of high poly geometry.

In some occasions we can not hide the light source under fixtures or covers because they are visible as part of the light design or for any other reason. In this case we can make use of a similar technique we used with the glass objects explained earlier in this tutorial

We create our high poly light bulb or neon tube and also create a low poly version of the model (as low as possible without loosing the shape too much). The low poly version should only include the part of the light that will be emitting. We have to make sure that the low poly version is a bit smaller then the high poly version as we are going to place the low poly version inside the high poly version, so it needs to fit. Now we just have to set the high poly version to not "cast shadows" in the properties panel and give it a passive emitter material. We give the low poly version an emitter material with the correct watts or lumen power and we are ready (image 15).

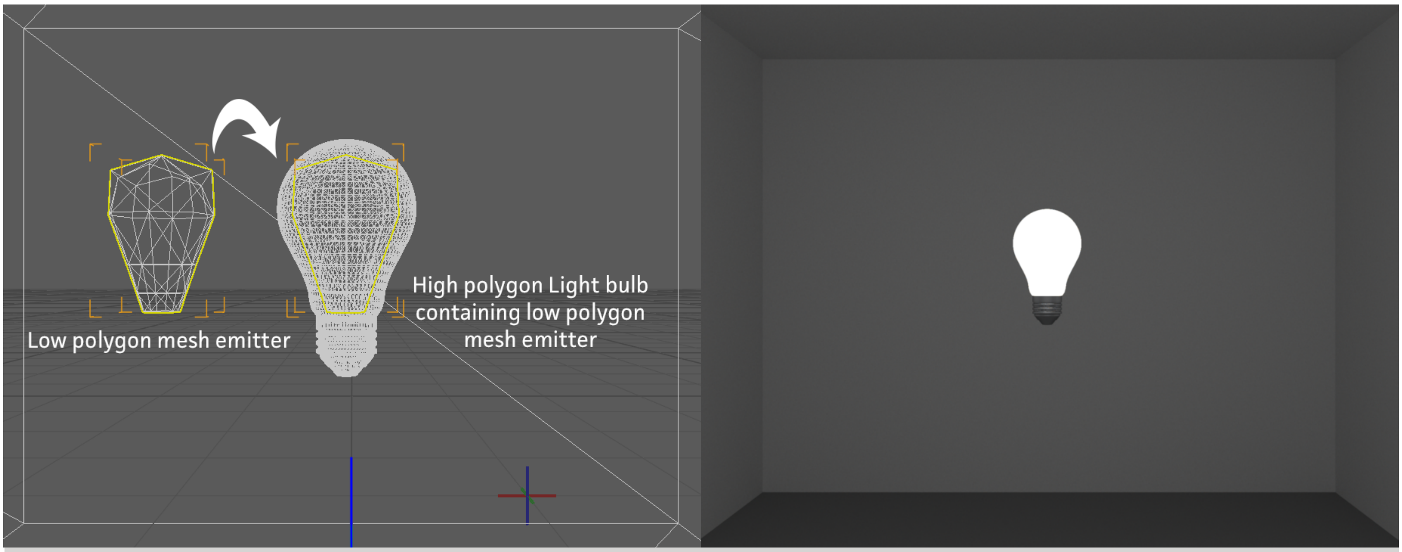

Image 15.
With this example we can see how we can use an optimized low poly mesh emitter with a high poly light bulb. We give the high poly light bulb a black diffuse color and a passive emitter and we set in the objects properties panel to not cast shadows. We can use this technique for all kind of light source shapes. Use this when the light source is visible and need to have a high polygon appearance.