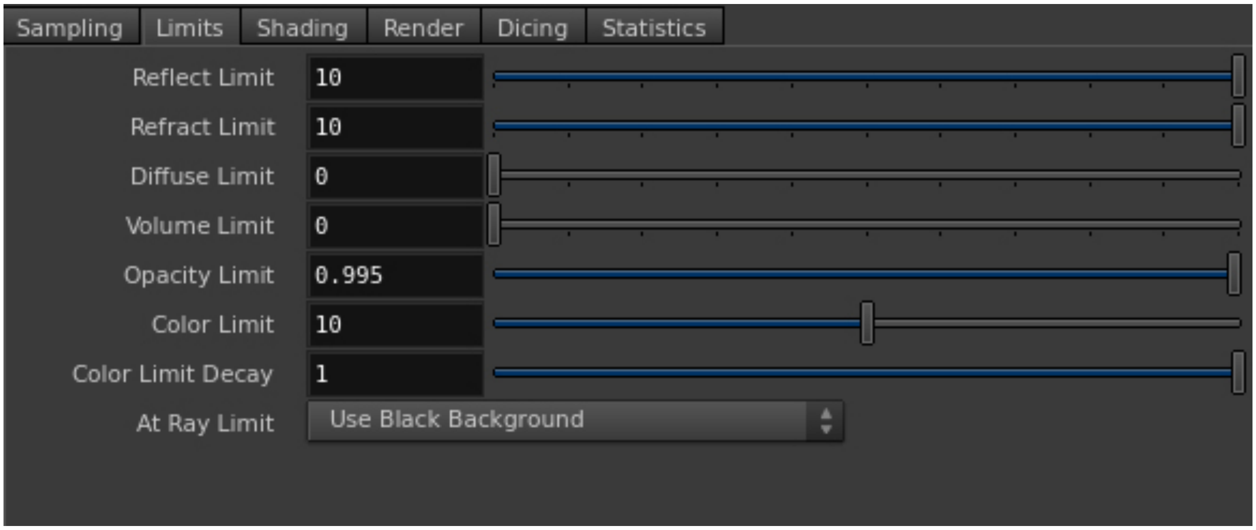
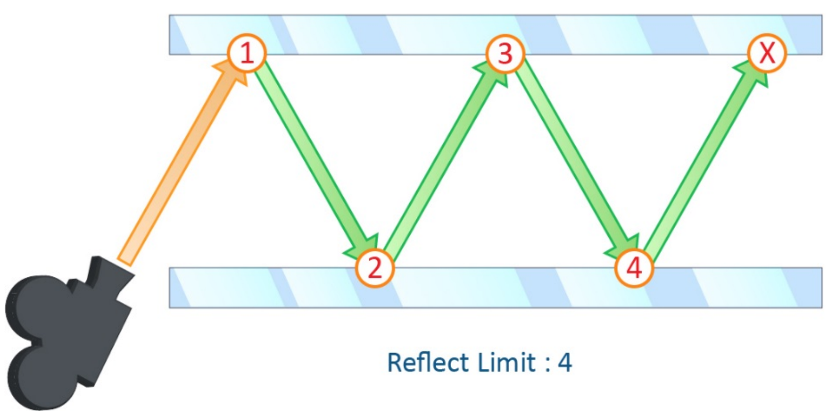
The Limits Tab

The **Limits Tab** can be found under the **Rendering** Tab on the **Mantra** Node.

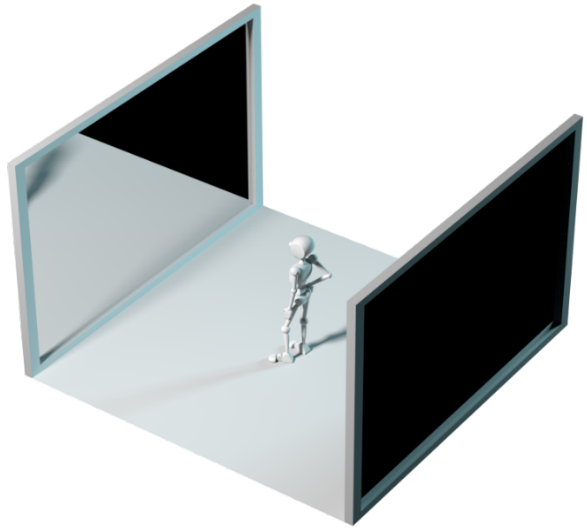


The parameters found on this tab control the amount of times a ray associated with a specific component is allowed to propagate through a scene. Setting these limits has influence over the final look of your scene as well as the amount of time it will take the render your image without noise.

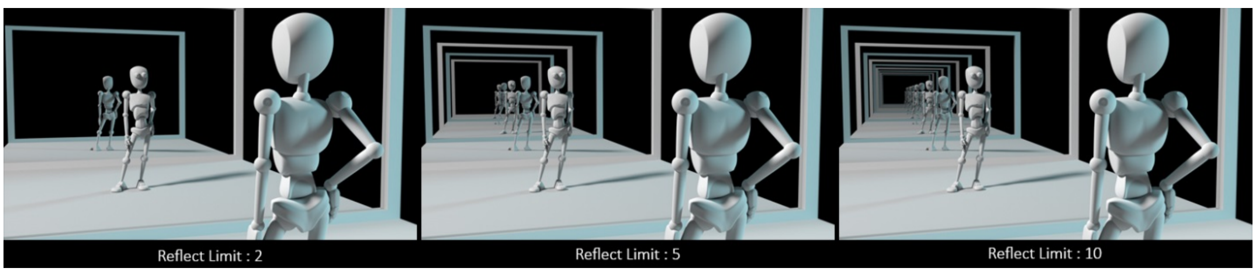
Reflect Limit



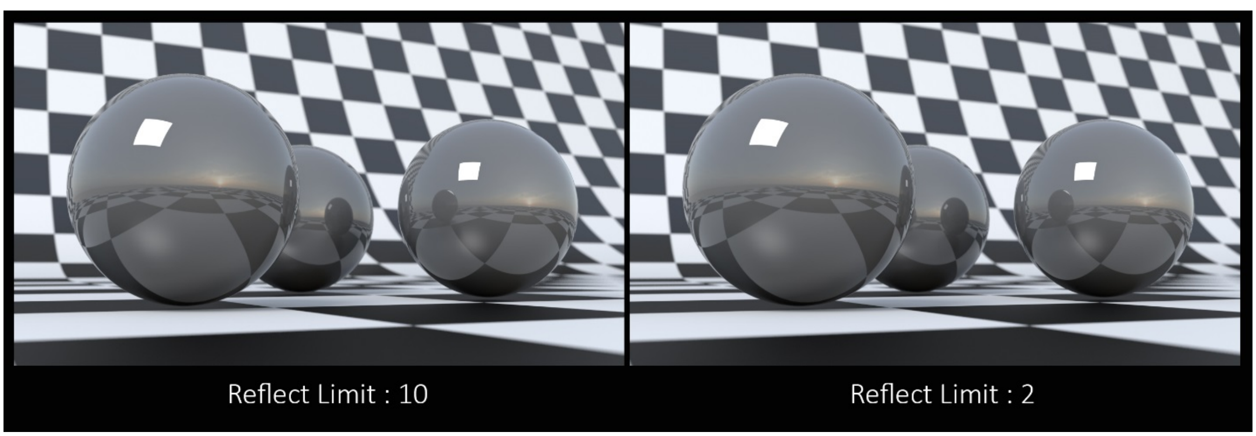
This parameter controls the number of times a ray can be reflected in your scene.



The above example shows a classic “Hall of Mirrors” scenario with the subject placed between two mirrors. This effectively creates an infinite series of reflections.



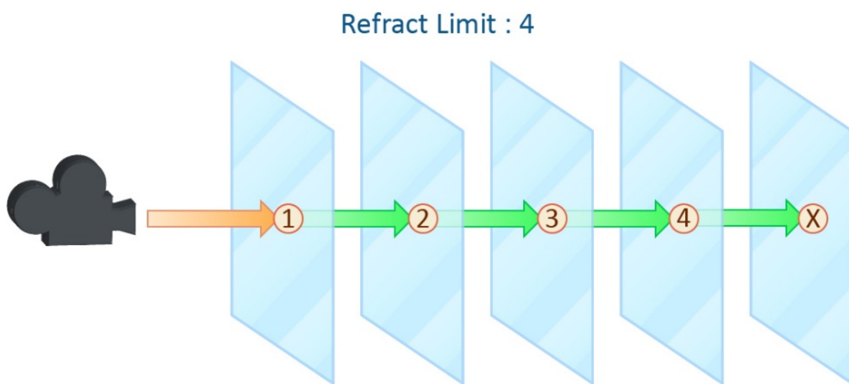
From this camera angle the reflection limits are obvious and have a large impact on the accuracy of the final image. However, in most cases the reflection limit will be subtler, allowing you to reduce the number of reflections in your scene and optimize the time it takes to render them.



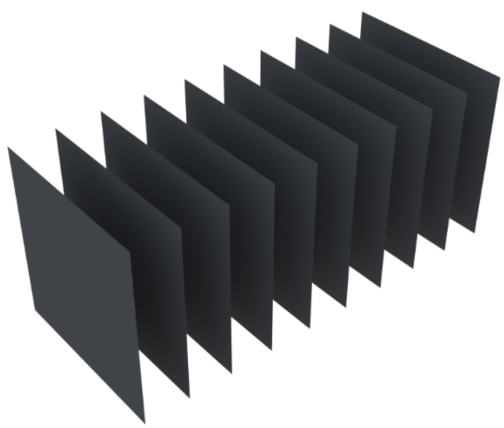
Remember that the first time a light source is reflected in an object, it is considered a direct reflection. Therefore, even with Reflect Limit set to 0, you will still see specular reflections of light sources.

To control what happens when the maximum number of reflections is exceeded, see the **At Ray Limit** parameter on the **Limits** tab.

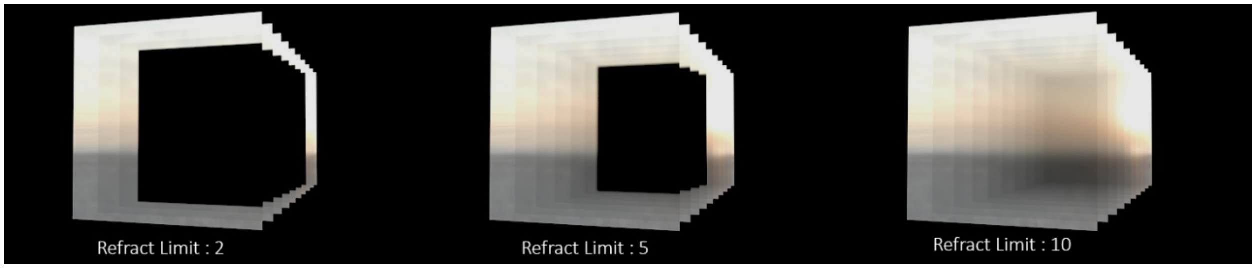
Refract Limit



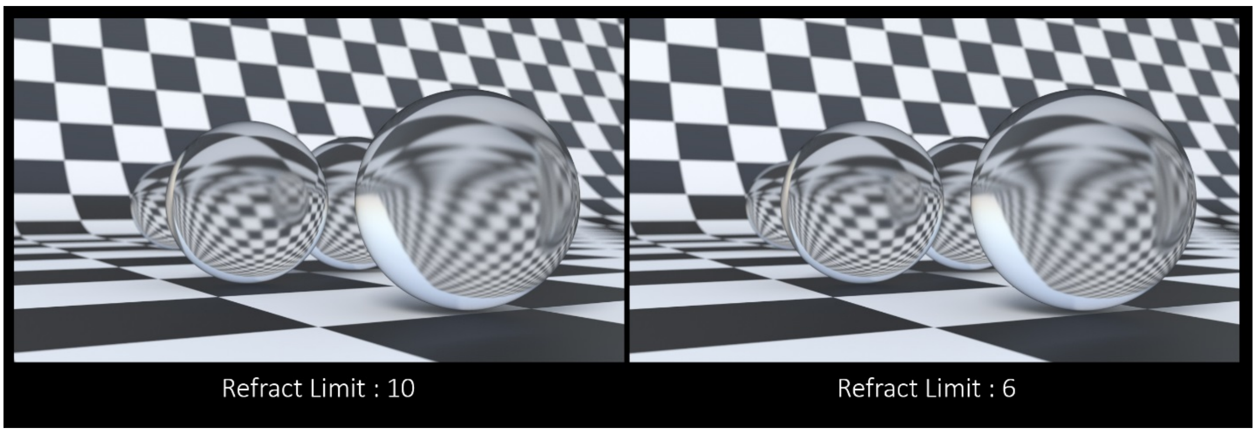
This parameter control the number of times a ray be refracted in your scene.



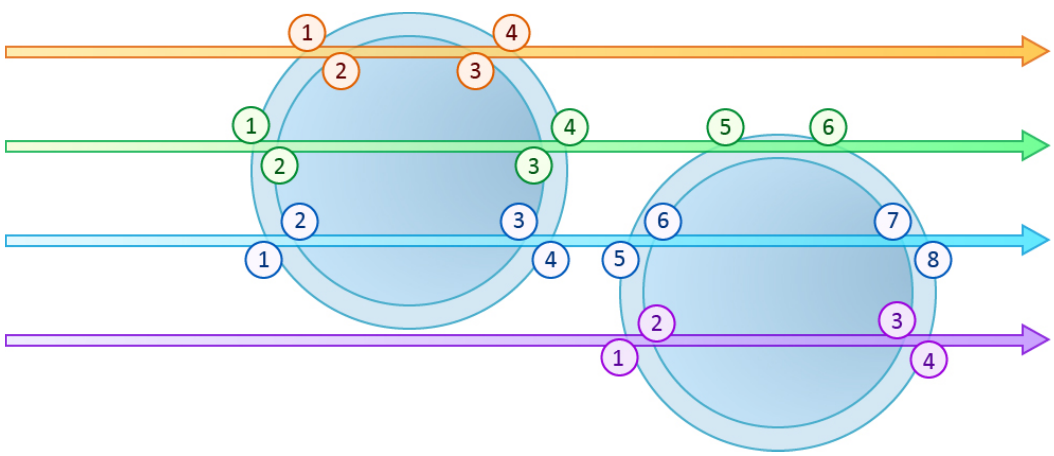
The above example shows a simple scene with ten grids all in a row. By applying a refractive shader, we will be able see through the grids to an image of a sunset in the background.



From this camera angle, for the image to be accurate, the refraction limit must match the number of grids that that are in the scene. However, most scenes will not have this number of refractive objects all in a row and so it is possible to reduce the refract limit without affecting the final image while also reducing the time it takes to render them.



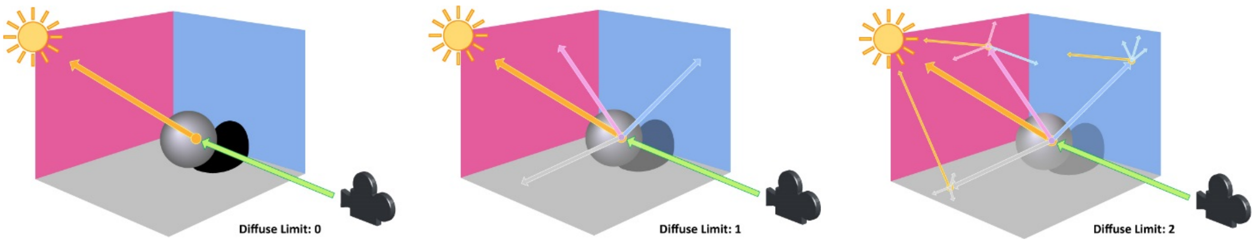
Keep in mind that this Refract Limit refers to the number of surfaces that the ray must travel through, not the number of objects.



Remember that the first time a light source is refracted through a surface, it is considered a direct refraction. Therefore, even with Refract Limit set to 0, you will see refractions of Light Sources. However, since most objects in your scene will have at least two surfaces between it and the light source, direct refractions are often not evident in your final render.

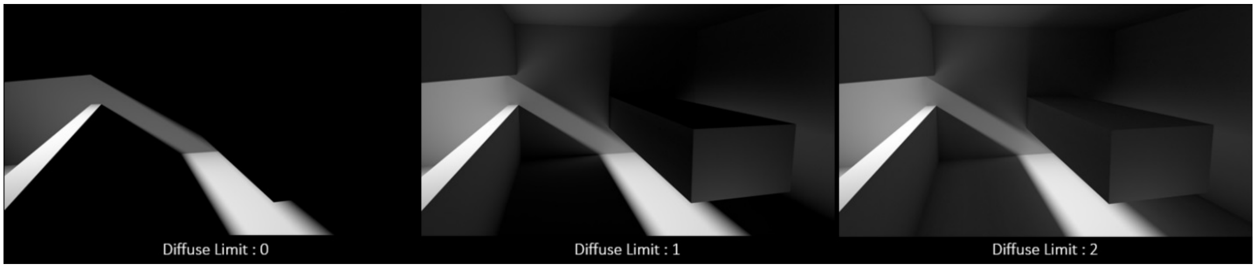
To control what happens when the maximum number of refraction is exceeded, see the **At Ray Limit** parameters on the **Limits** tab.

Diffuse Limit

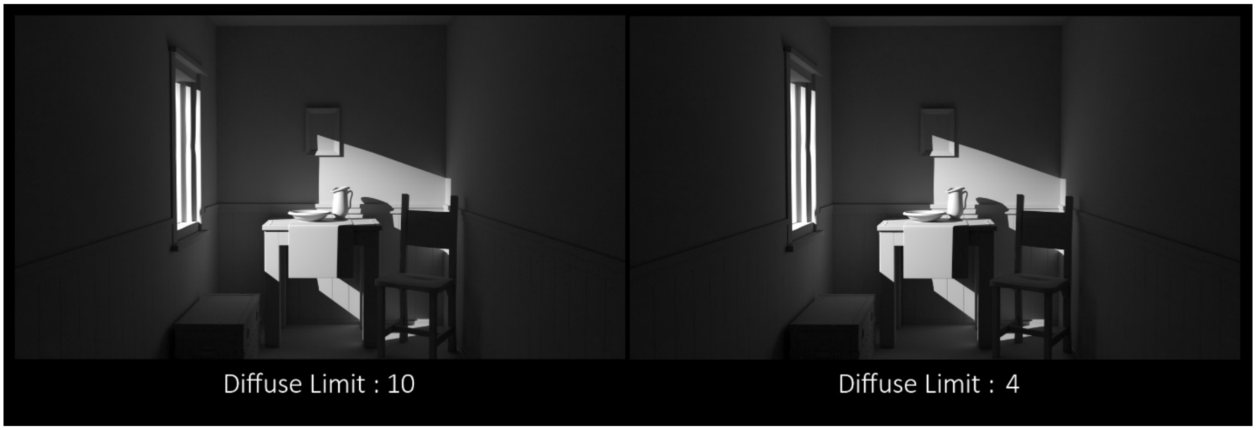


This parameter controls the number of times diffuse rays can propagate through your scene.

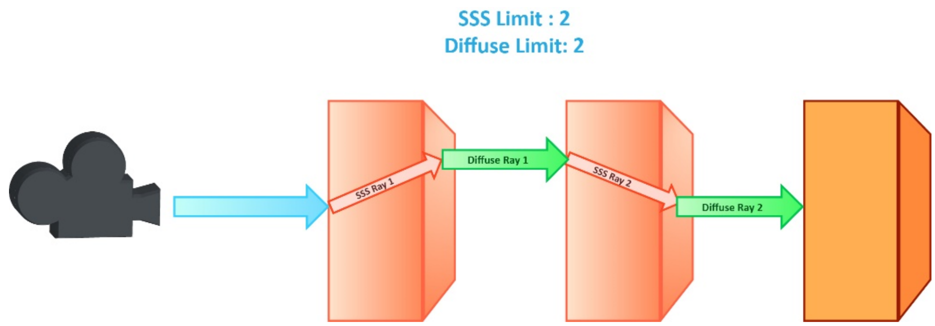
Unlike the **Reflect** and **Refract Limits**, this parameter will increase the overall amount of light in your scene and contribute to most global illumination. With this parameter set above zero diffuse surfaces will accumulate light from other objects in addition to direct light sources.



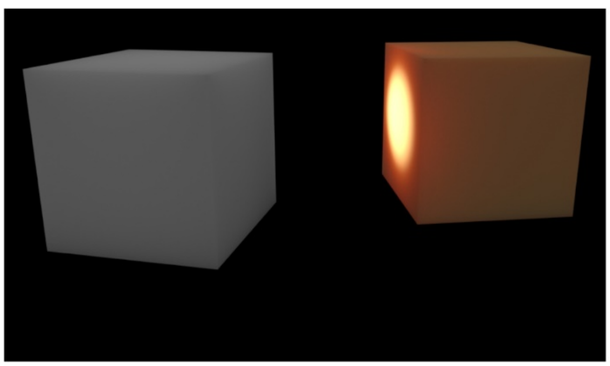
In this example, increasing the **Diffuse Limit** has a dramatic effect on the appearance of the final image. To replicate realistic lighting conditions, it is often necessary to increase the **Diffuse Limit**. However, since the amount of light contribution usually decreases with each diffuse bounce, increasing the **Diffuse Limit** beyond 4 does little to improve the visual fidelity of a scene. Additionally, increasing the Diffuse Limit can dramatically increase noise levels and render times.



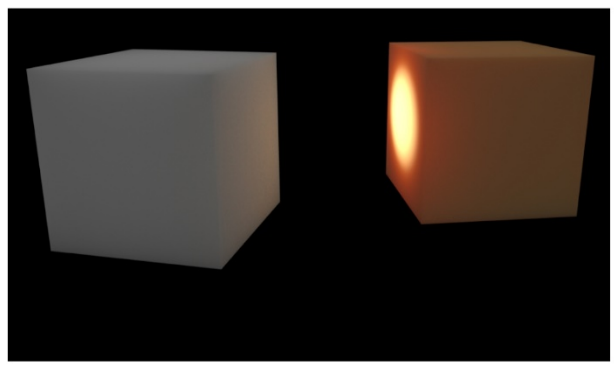
SSS Limit



This parameter controls the number of times light generated from materials with Sub-Surface Scattering will be included in the evaluation of indirect light. It is intrinsically linked to the Diffuse Limit, since the propagation of indirect diffuse rays is what allows the evaluation of new SSS samples.



SSS Limit: 1
Diffuse Limit: 1

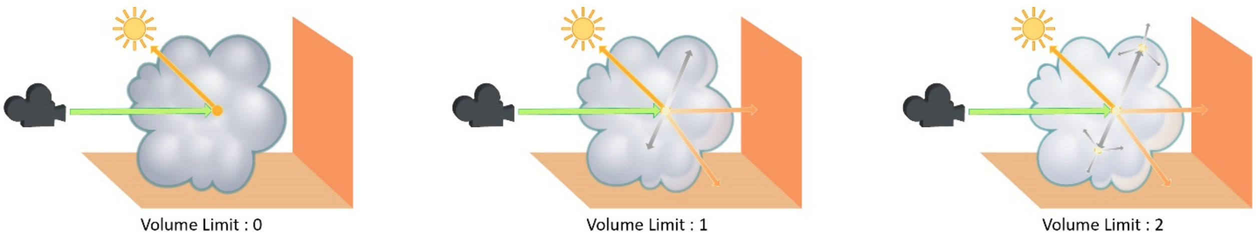


SSS Limit: 2
Diffuse Limit: 1

In this example, increasing the SSS limit allows the grey SSS material to receive indirect illumination from the orange SSS material. You may also notice a relationship between Diffuse Limit and SSS Limit – essentially, to match the contribution of indirect light, you will usually need one extra SSS Sample.

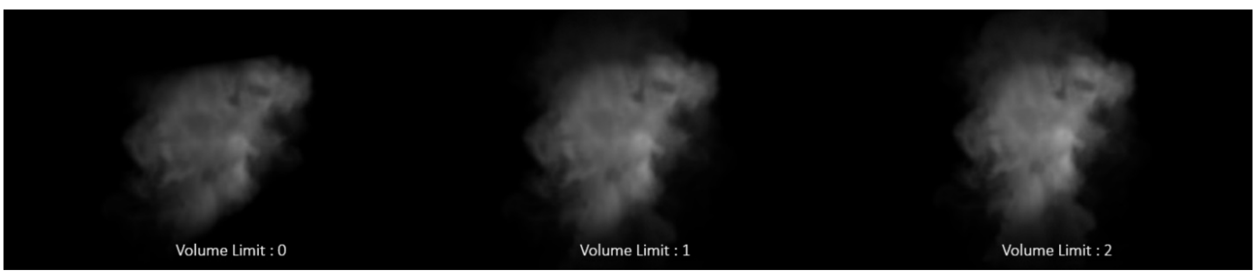
Keep in mind that materials with SSS enabled absorb and scatter light, so the light contribution to other SSS objects will often be quite small. Increasing SSS limits beyond 2 will do little to improve the realism of a final render but may require dramatically more SSS samples. In fact, in many cases even an SSS Limit of 1 (essentially limiting the contribution to the object itself) will be sufficient to create highly realistic renders.

Volume Limit



This parameter controls the number of times a volumetric ray can propagate through a scene. It functions in a similar fashion to the **Diffuse Limit** parameter.

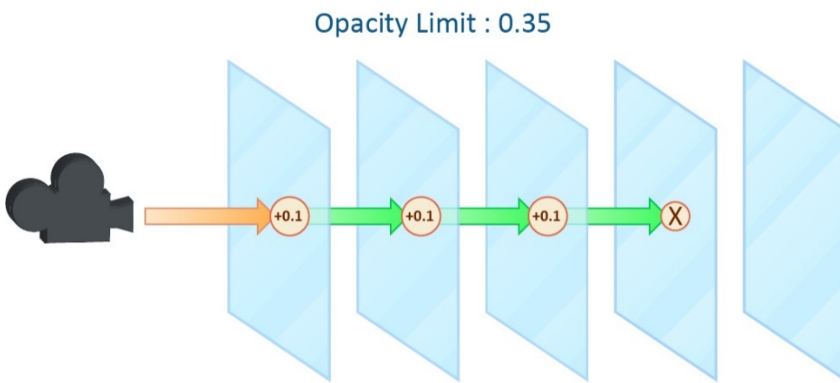
Increasing the **Volume Limit** parameter will result in much more realistic volumetric effects. This is especially noticeable in situations where only part of a volume is receiving direct lighting. Also, in order for a volumetric object to receive indirect light from other objects, the Volume Limit parameter must be set above 0.



With the **Volume Limit** set to values above zero, the fog volume takes on the characteristic light scattering you would expect from light travelling through a volume. However, as with **the Diffuse Limit**, the light contribution generally decreases with each bounced ray and therefore using values above 4 does not necessarily result in a noticeably more realistic image.

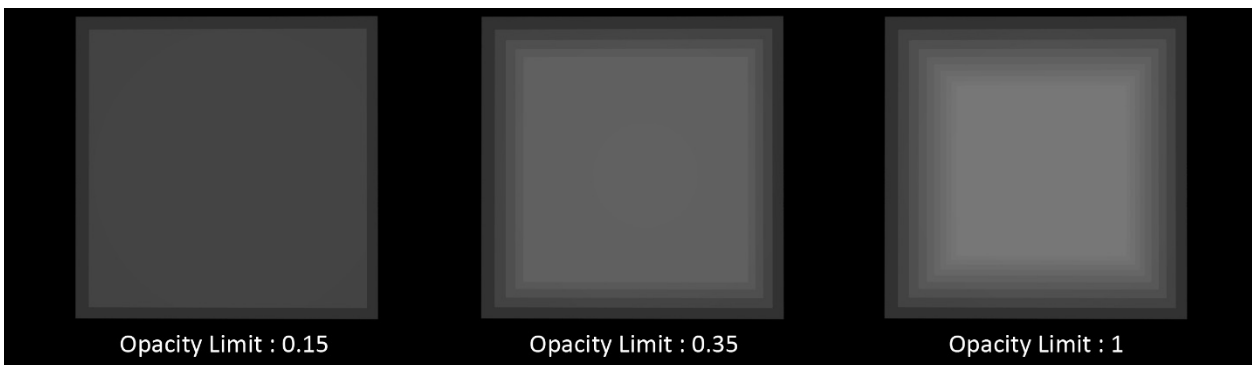
Also, increasing the value of this parameter can dramatically increase the amount of time spent rendering volumetric images.

Opacity Limit

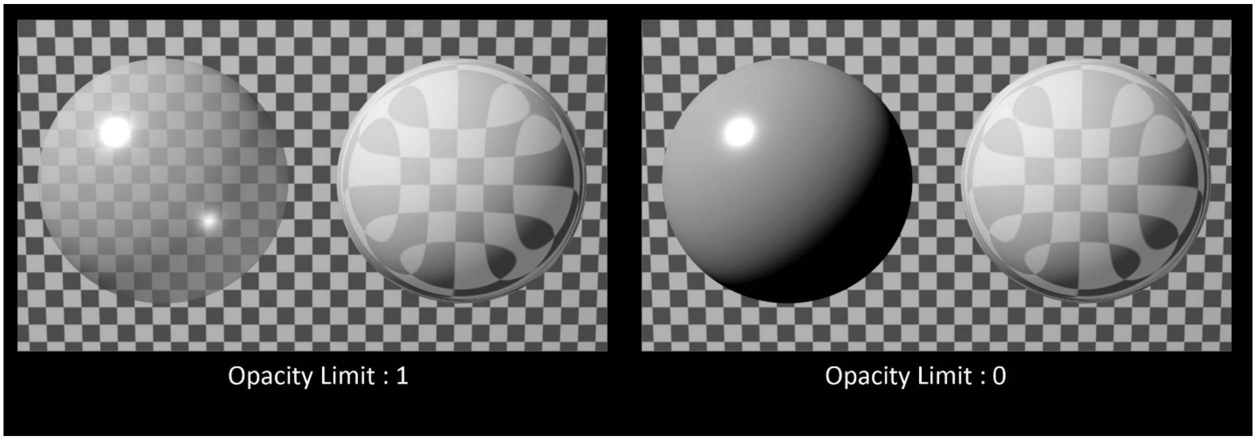


As a ray travels through many transparent surfaces, or through a volume, it will calculate the **cumulative** amount of Opacity. When this value exceeds the **Opacity Limit** mantra will assume all surfaces beyond this point are opaque.

This parameter behaves in a similar fashion to both the **Reflect** and **Refract Limit** but operates on accumulated values rather than simply the number of surfaces the ray has passed through.

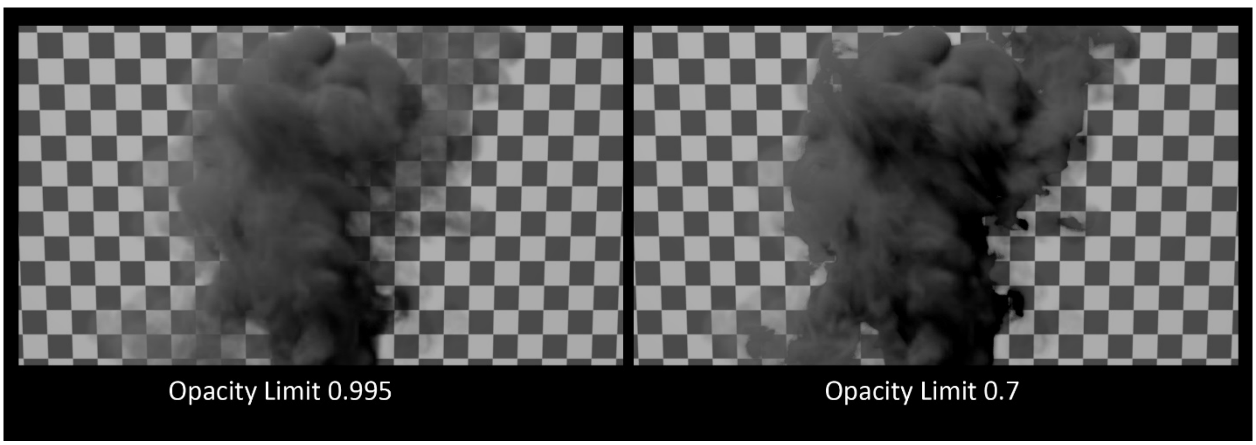


In the above example, each grid has a shader attached with an opacity value of 0.1. It is important to remember that in this case “transparent” refers to objects whose opacity is less than 100% and does not include refractive objects which can appear transparent.



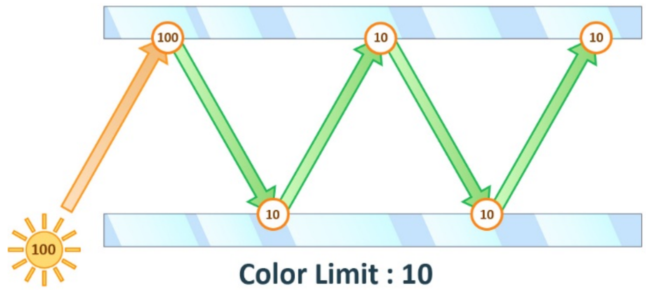
In the above example, the sphere of the left has an opacity of 0.5, with no refraction. The sphere on the right has an Opacity of 1 with refraction enabled. You can see that the **Opacity Limit** has no effect on the amount of refraction, only affecting objects whose opacity value is less than 1.

While reducing the **Opacity Limit** may save a small amount of render time (1 – 5%) using low values may result in banding and other artifacts when your camera is moving or an animation is evolving. This can be especially noticeable in smoke simulations where opacity values are constantly changing.



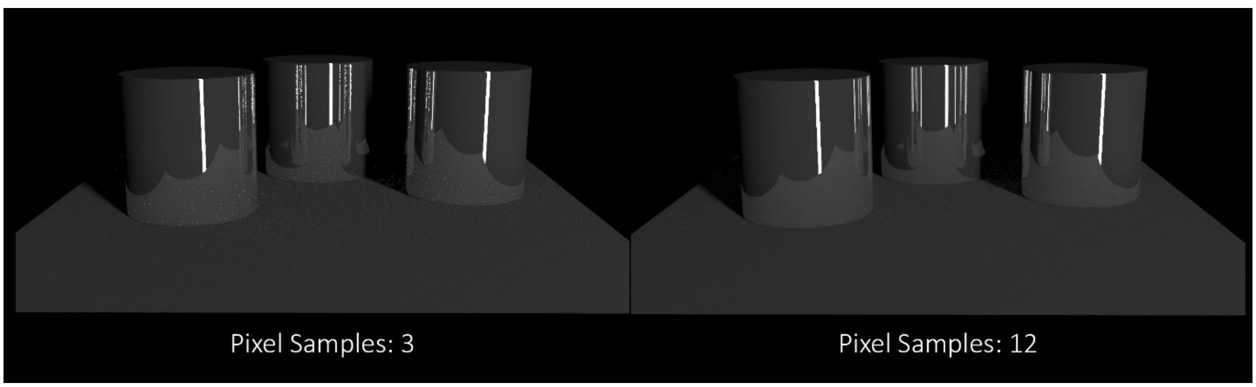
The default value for **Opacity Limit** is quite aggressive, changing this value should be done carefully and the results inspected across a range of frames in an animated sequence.

Color Limit



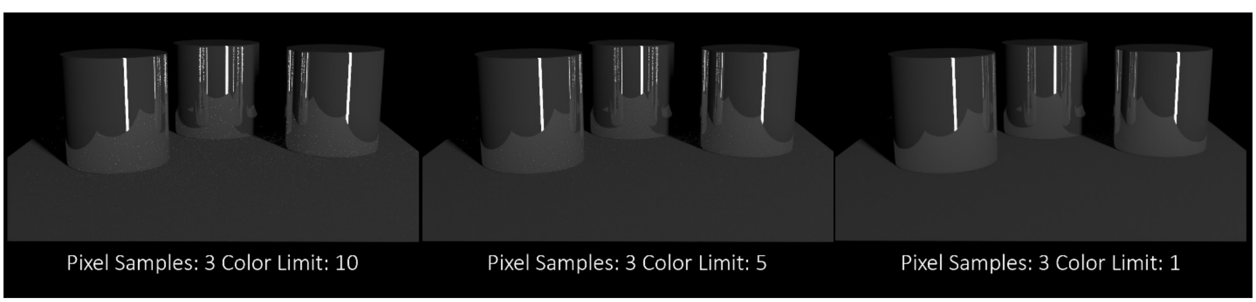
This parameter controls the maximum value a shading sample is allowed to return from indirect sources.

Physically Based Rendering can cause “spikes” in color values when extremely bright indirect light sources are under sampled. This results in “fireflies” in the final rendered image which can be very difficult to remove without very high sampling rates.

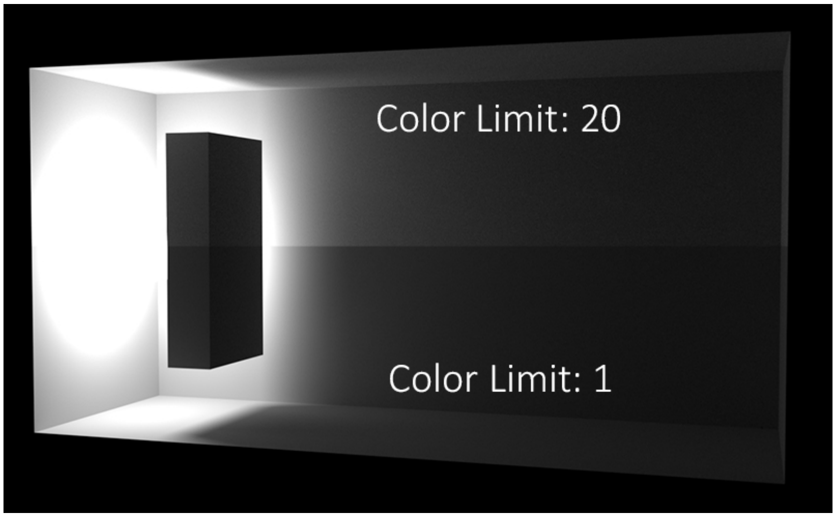


You can see in the example above, that even at 12x12 pixel samples, the “fireflies” still remain. Adjusting Min and Max indirect rays sample settings could remove this noise, but at the cost of longer render times.

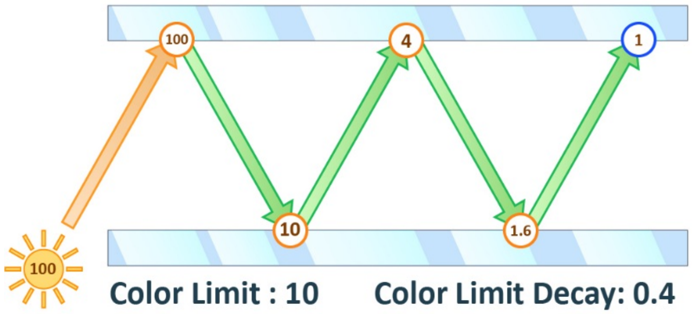
Decreasing the **Color Limit** parameter clamps the color values in these indirect samples and can help to avoid these “spikes”.



Reducing the **color Limit** can be an effective way of removing “fireflies” without increasing sampling rates. However, clamping the values in indirect lighting can result in an overall reduction in the amount of light in your scene. This is especially evident in scenes which are mostly illuminated by indirect light.

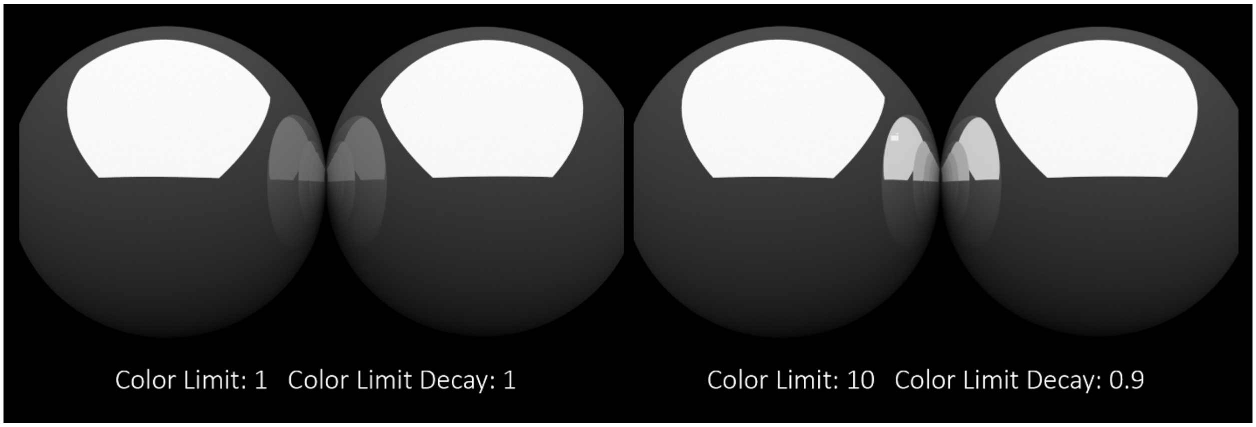


Color Limit Decay



This parameter causes the **Color Limit** to decay as rays propagate through the scene.

Since the **Color Limit** parameter acts as clamp on the indirect values in your scene, it can occasionally cause indirect reflections to appear too dim. To disguise this effect, the **Color Limit Decay** can decrease the color limit after each bounce. This way the decrease in light only becomes apparent after several bounces where the effect is less noticeable.

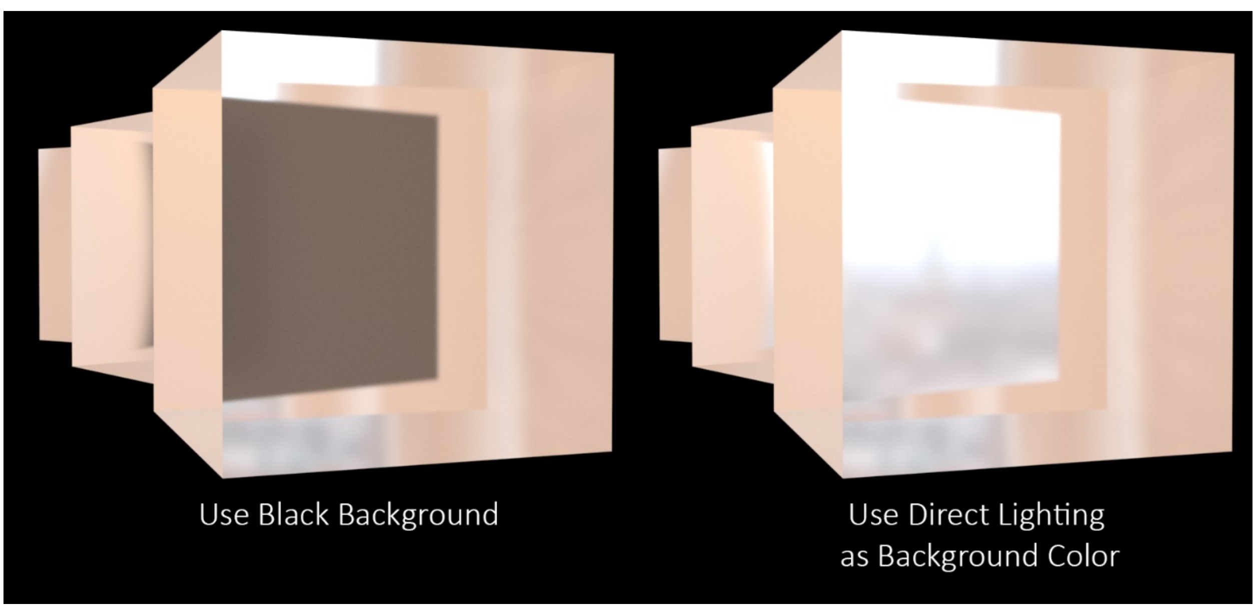


In the above example (color corrected with a brightness value of 0.1) you can see that by reducing the Color Limit value, all secondary values are clamped to the same amount. However, by setting the color limit decay without adjusting the color limit, the brightness of each reflection is reduced after each bounce producing a more subtle reduction in intensity.

Setting the **Color Limit Decay** value to 0.9 will cause the color limit to be 90% of its original value after one bounce, 81% after two bounces, etc. **The Color Limit will never decay below a value of 1**, so this setting will not affect colors in the 0-1 range.

At Ray Limit

This parameter allows you to control how Mantra deals with rays that reach the ray tracing limit (For example the **Reflect Limit** or **Refract Limit**).



In the above example, the refract Limit has been set to 2.

Setting the “At Ray Limit” parameter to “Use Black Background” will simply render black once the limits are reached. This is the default setting and will work in most scenes since the Reflect or Refract Limit is unlikely to be reached. However, in scenes where the limit is noticeable in the rendered image, the black color can be quite noticeable and stand out against the colors in the scene.

In this case, it is advisable to increase the limit until the effect is avoided or use the second option for this parameter “Use Direct Lighting as Background Color”. This will replace the black color with whichever color or image is used in your direct lighting, for instance an Environment Light.

For More Information about how the settings on an Environment Light affect this parameter see the Lighting section.