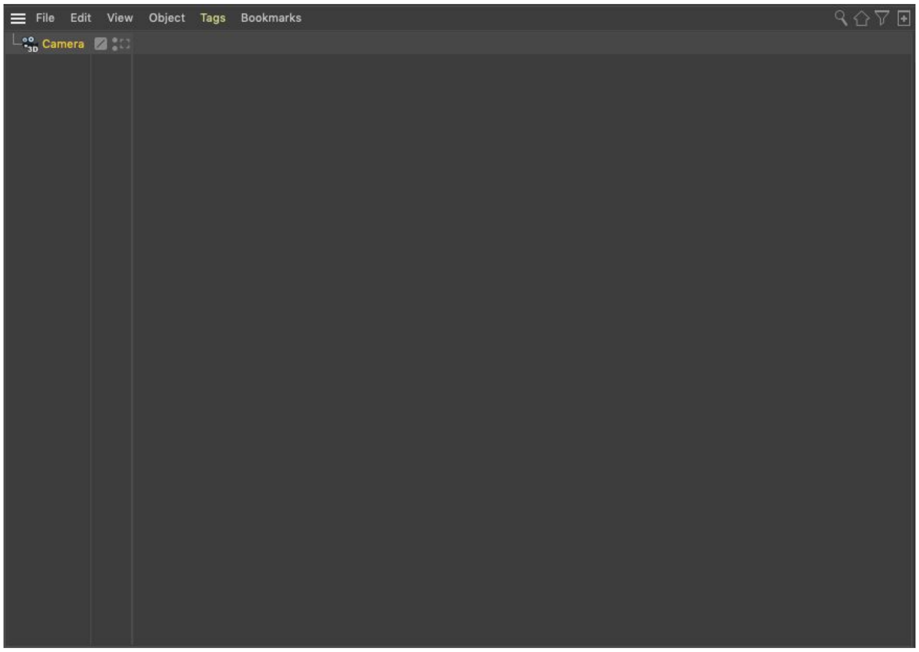
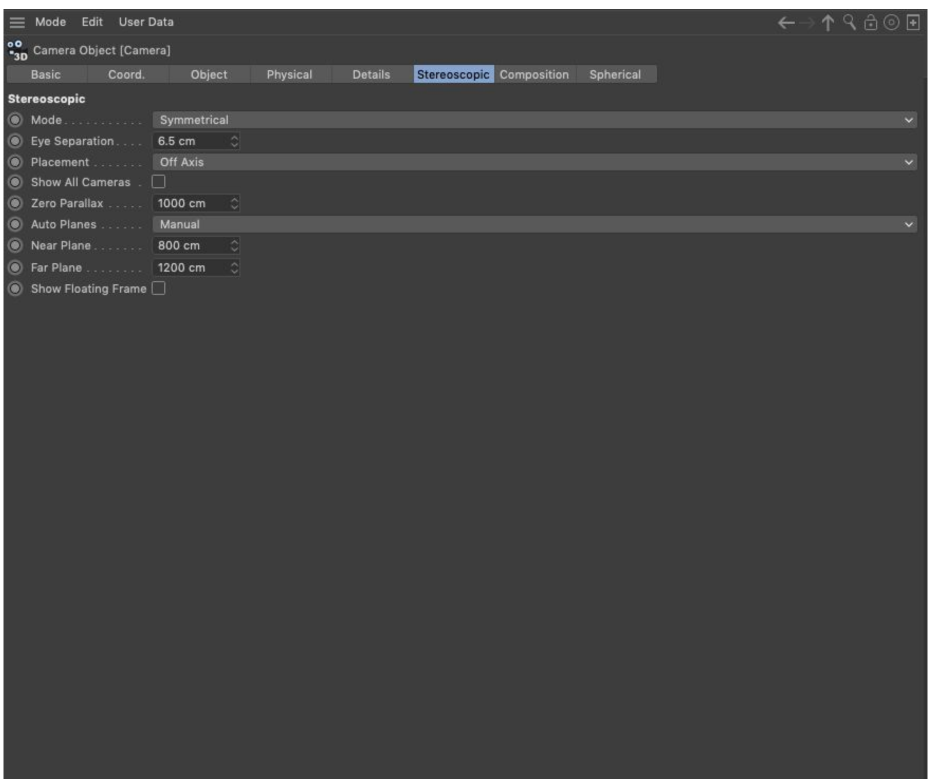
Cinema 4D
2 Step Rendering Setup

PART I:

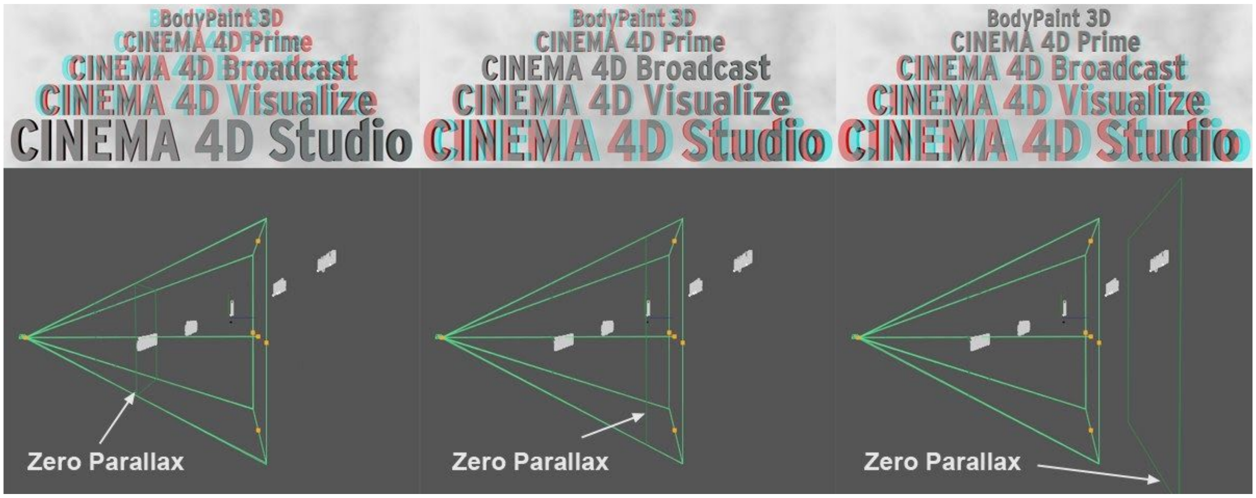
In order to add a camera to the scene go up to the camera menu or camera icon and create a camera.



Click on Stereoscopic:
Make sure mode is Symmetrical and placement is set to off-axis



Zero Paralax:



The zero parallax is a virtual plane that lies vertically to the camera's angle of view and defines where the projection plane lies, i.e., the plane that represents the monitor screen at its depth. Objects that lie in front of this plane in the direction of the camera protrude spatially out of the monitor in the direction of the viewer; objects that lie behind this plane lie "within" the monitor.

In the Viewport, the zero parallax is displayed as the dark green camera plane at the center.

If you link the **Zero Parallax** to the **Focus Distance** via XPresso you can adjust the zero parallax interactively in the Viewport using handles.

Auto Planes

Near Plane[0..+∞m]

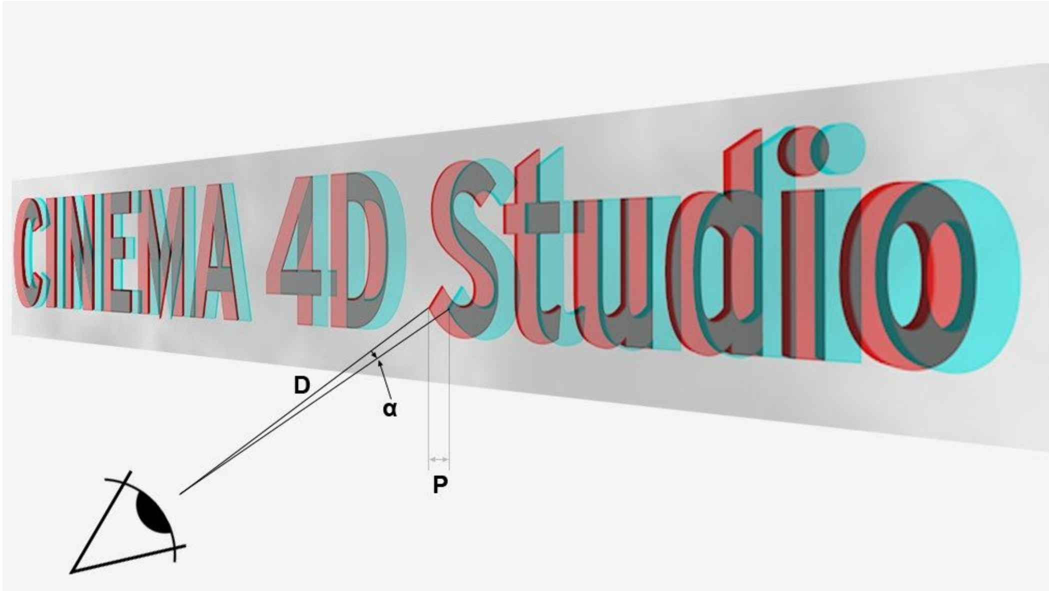
Far Plane[0..+∞m]

If you want to play it safe, select *90* and place all visible objects in the direction of the camera and behind this plane.

The **Auto Planes** do not affect rendering! They only serve as visual references that you can adjust manually. If you determine via test renderings that the optimal spatial impression within a given distance from the camera has been achieved (objects that, for example, lie too close to the camera – while the zero parallax is positioned far away – can only be seen with great effort by the human eye), then you can define these planes accordingly and can place objects in the Viewport correctly within the resultingly restricted space.

The options *70* and *90* represent a parallax of 70 and 90 arc seconds, respectively, for the near plane. These values are described in technical literature as values at which the human eye can perceive spatially with normal effort. Therefore, objects should lie behind this near plane.

A formula even exists that defines the maximum parallax (distance between red and cyan (anaglyph)):



P = tan a * D

Whereby P = Parallax, D = Distance of the viewer from the projection plane (e.g., the monitor), a = Angle between 2 points that the eye can comfortably perceive (this should be max. 1.5° or somewhat less).

For a monitor and an average distance between eyes and monitor of 50 cm, an average reference value of 13 mm results.

Additional Reading:

The stereoscopic camera settings let you define all properties having to do with the creation of two or more images whose perspectives are slightly offset. Detailed information regarding stereoscopy can be found here.

Detailed information about **Spherical Camera** in VR Stereoscopy can be found here.

Mode

Mono

This is the normal camera mode without stereoscopy.

Symmetrical

Use this mode if you want to render normal stereoscopic images. A double camera will be assumed and each camera will be assigned half of the defined **Eye Separation** value, left and right, respectively.

Left

Right

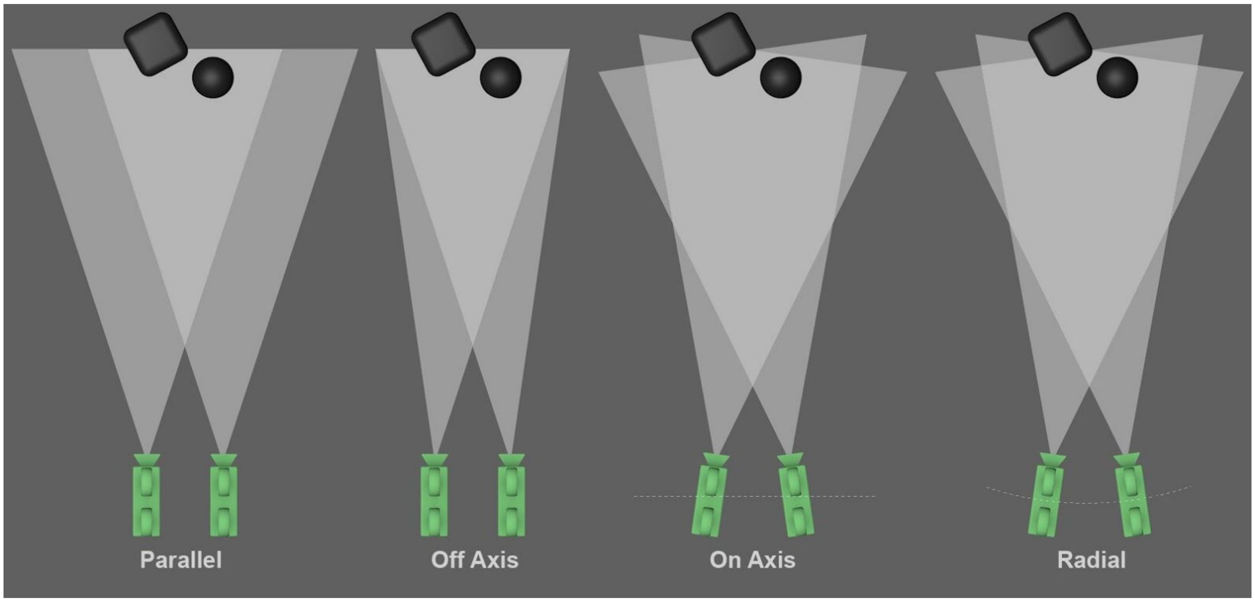
Depending on the parameters defined, both cameras will be positioned as follows on the Camera object's X axis:

- Left: left camera is set to *0*, right camera is set to **+distance between eyes**
- Right: left camera is set to **-distance between eyes**, right camera is set to *0*

Eye Separation[0..+∞m]

This value defines the distance between the left and right eye. The default value of *6.5cm* reflects the average distance between a human's eyes. Normally, this value should be as small as possible. Greater values will produce a correspondingly larger spatial view but it will also become more strenuous for the viewer to view the scene. Exception: a scene, e.g., a landscape, is depicted that lies far away from the camera.

Placement



Depending on placement, both (or several) cameras will be oriented differently.

Even though several options are available, most of them are only there for compatibility reasons. For stereoscopic double images you should always (with the exception of special circumstances) set **Placement** to *Off Axis*. Each example in the image above uses a double camera only. In the **Render Setting**’s stereoscopic settings, images can be set to render in channels, i.e., a scene can be rendered from any number of camera perspectives. Their arrangement will also be as shown above.

Parallel

This is the most simple stereoscopic camera arrangement. Both cameras are positioned parallel to each other (the image axes are also parallel). Stereoscopic images with this type of arrangement only depict objects that lie in front of the projection plane. Hence, the null plane CANNOT be moved by modifying the **Zero Parallax** value (see also **Zero Parallax**). This is in contrast to the following three modes.

Off Axis

Basically the same camera arrangement as *Parallel* but with an offset (similar to **Film Offset X**), which means that the image axes are no longer parallel but intersect. The zero parallax lies at this point of intersection (see next setting, **Zero Parallax**). Objects can be depicted to lie spatially either in front of or behind the projection plane (i.e. in or in front of the monitor).

Tip:

This mode is recommended for stereoscopic double images because it delivers the best results for the widest range of applications.

On Axis

When this mode is selected, both cameras are rotated so their Z axes intersect with the zero parallax. This reflects approximately how the human eye works but is not recommended for the creation of stereoscopic images because a vertical parallax can result. This mode is also referred to as "toe-in".

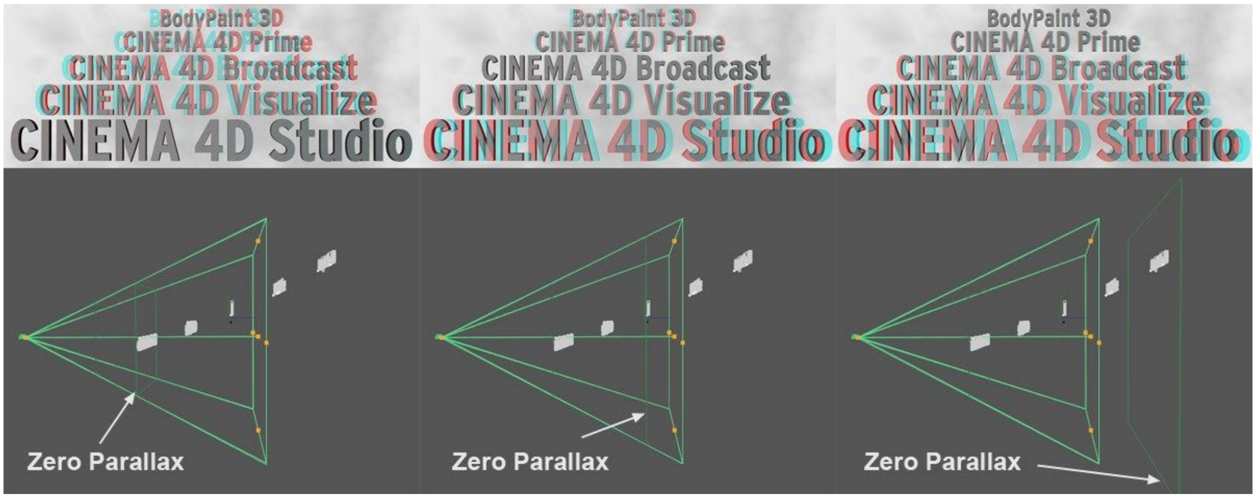
Radial

This mode is similar to *On Axis* except that both cameras don’t lie on the Z axis but on an arc (whose center point lies on the point of intersection of both cameras’ zero parallaxes).

Show All Cameras

Enable this option if both left and right cameras (instead of only a single camera) should be displayed in the Viewport.

Zero Parallax[0..+∞m]



The zero parallax is a virtual plane that lies vertically to the camera's angle of view and defines where the projection plane lies, i.e., the plane that represents the monitor screen at its depth. Objects that lie in front of this plane in the direction of the camera protrude spatially out of the monitor in the direction of the viewer; objects that lie behind this plane lie "within" the monitor.

In the Viewport, the zero parallax is displayed as the dark green camera plane at the center.

If you link the **Zero Parallax** to the **Focus Distance** via XPresso you can adjust the zero parallax interactively in the Viewport using handles.

Auto Planes

Near Plane[0..+∞m]

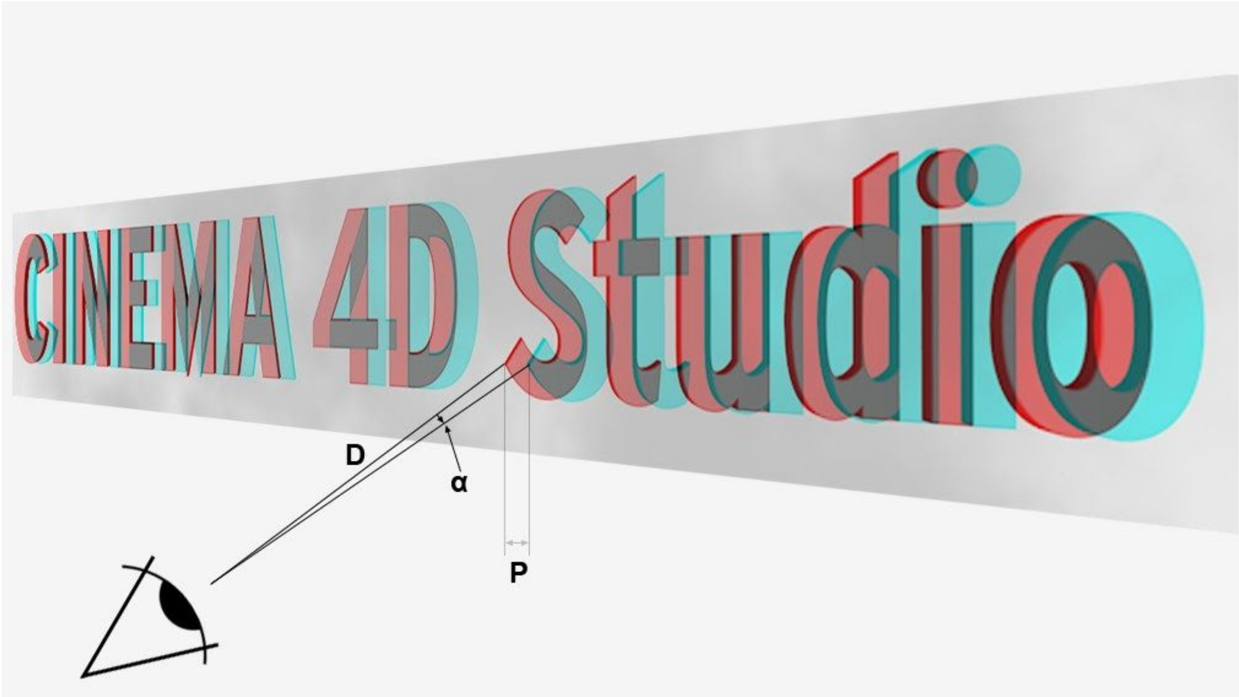
Far Plane[0..+∞m]

If you want to play it safe, select *90* and place all visible objects in the direction of the camera and behind this plane.

The **Auto Planes** do not affect rendering! They only serve as visual references that you can adjust manually. If you determine via test renderings that the optimal spatial impression within a given distance from the camera has been achieved (objects that, for example, lie too close to the camera – while the zero parallax is positioned far away – can only be seen with great effort by the human eye), then you can define these planes accordingly and can place objects in the Viewport correctly within the resultingly restricted space.

The options *70* and *90* represent a parallax of 70 and 90 arc seconds, respectively, for the near plane. These values are described in technical literature as values at which the human eye can perceive spatially with normal effort. Therefore, objects should lie behind this near plane.

A formula even exists that defines the maximum parallax (distance between red and cyan (anaglyph)):

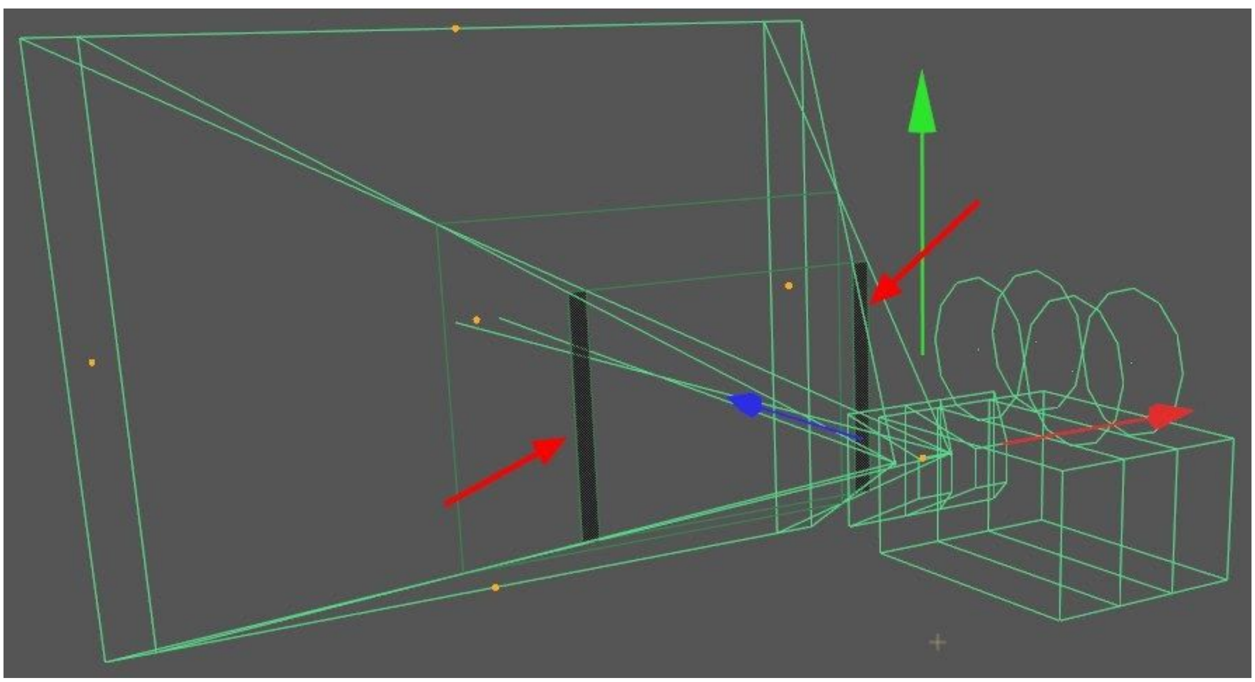


P = tan a * D

Whereby P = Parallax, D = Distance of the viewer from the projection plane (e.g., the monitor), a = Angle between 2 points that the eye can comfortably perceive (this should be max. 1.5° or somewhat less).

For a monitor and an average distance between eyes and monitor of 50 cm, an average reference value of 13 mm results.

Show Floating Frame



Enables or disables the display of critical regions (that can be seen by each camera). The **Show All Cameras** option must also be enabled.

Stereoscopic rendering with a Spherical Camera

Special settings are available if you want to make the 360° view of a Spherical Camera stereoscopic. The left and right eye views will be combined to a single image (left = top; right = bottom).

Stereo Mode

*The various **Stereo** modes with the camera axes (the cameras are rotated internally for rendering panoramas).*

The following options are available:

- **Mono**: no stereoscopic images will be rendered.
- **Parallel**: both cameras will be arranged with parallel axes of view.
- **Toe-in**: both cameras' axes of view will cross. The point of intersection can be defined using the **Focal Distance**.

The primary difference between both stereo modes lies in the definition of the null paralllaxe, i.e., the distance from the camera at which no parallaxe is generated. This spatial depth can be seen in the Viewport. If *Toe-In* is selected, the null parallaxe will be defined using the **Focal Distance** setting and cannot be subsequently modified. If *Parallel* is selected, the null parallaxe is infinite and can be subsequently modified (by moving the left and right perspectives).

Stereo Layout

Here you can define how both stereo images should be arranged or which one should be rendered alone.

Eye Separation[0..+∞m]

This value defines the distance between both cameras/eyes. The default distance of 6.5 cm represents the average distance between human eyes.

Eye to Neck Distance[0..+∞m]

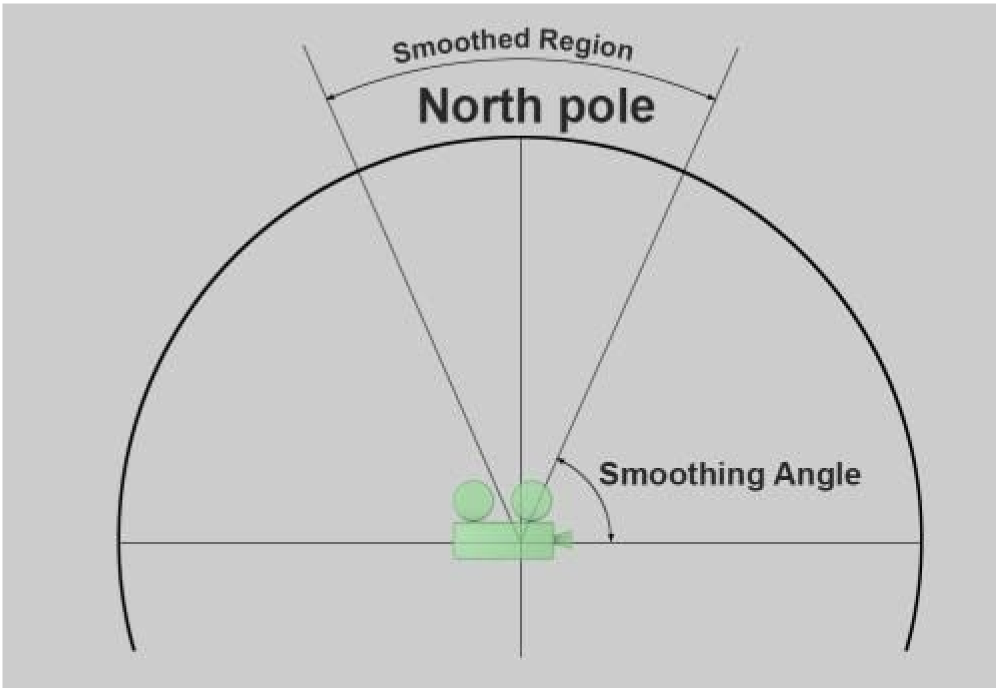
Depending on which target model is rendered (this system works according to the Oculus Rift targeting system), you can define the horizontal distance from the neck "Atlas" (or **C1**) to the eyes (see image above). The Atlas is the rotational joint around which the head rotates, including the (forward-lying) eyes. The camera's rotational point will therefore no longer lie at the center of both cameras if the **Eye to Neck Distance** is set to *0*.

Focal Distance[0.01..+∞m]

If **Stereo Mode** is set to *Toe-In*, you can use this setting to define where the null parallaxe should lie. Objects that lie in front of this point and face in the camera's direction of view will protrude out of the monitor towards the viewer; objects that lie behind this point will more-or-less "sink" into the monitor.

Top Pole Smoothing

Bottom Pole Smoothing



For technical reasons, stereoscopy cannot be rendered correctly around the poles. To prevent unwanted artefacting, the stereo effect can be gradually faded in these regions. In most cases, this can be done with no problem because the visually important elements mostly occur horizontally around the camera's location (and not vertically above or below it).

The smoothing can be defined separately for top and bottom poles. In the region in which the smoothing takes place the views will be equalized with the left and right cameras until they are identical with the maximum possible smoothing. The smoothing types are described below.

Top Smoothing Angle[-90..0°]

Top Pole Exp[0..10]

Bottom Smoothing Angle[0..90°]

Bottom Pole Exp[0..10]

How smoothing will be done from the start to the pole is determined by the using the *Linear* option (with linearly increasing strength, i.e., abrupt deployment) or the *Exponential* (with exponentially increasing strength, i.e., gradual deployment) using the defined defined **Smoothing Angle**. The **Top/Bottom Polx Exp** settings can be used to affect the *Exponential* option.

PART II:

Rendering Stereospic:
This part of the tutorial is to achieve the desired output that works best for Leia's devices.
In your Render Settings, make sure to check on Stereoscopic on the right tab. A new window is going to be accessible. In this window make sure that the following options are selected:

Under Stereoscopic

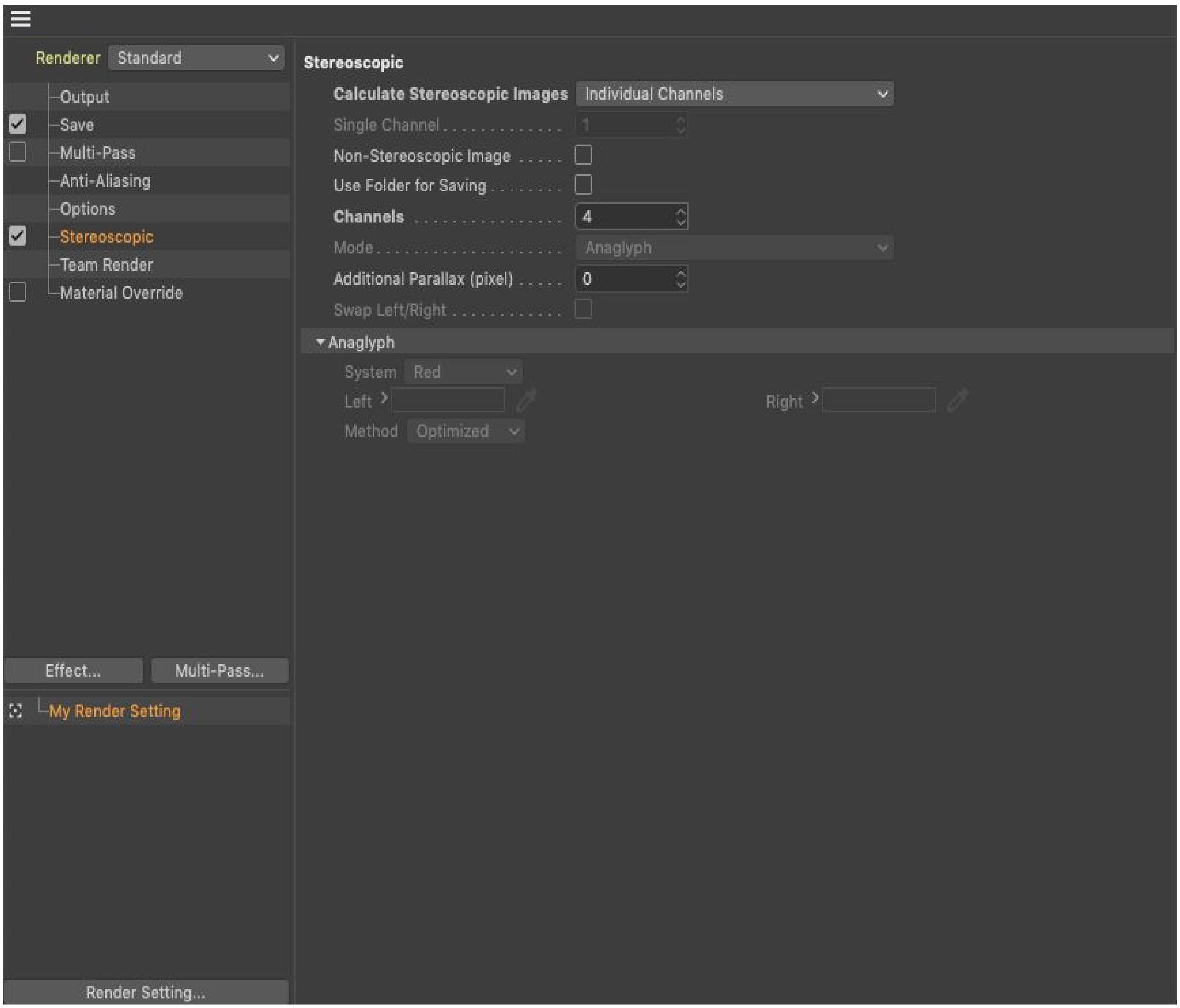
⇩

<u>Calculate Stereoscopic Images = Individual Channels</u>

⇩

<u>Channels = 4</u>

Please use the following image as an example:

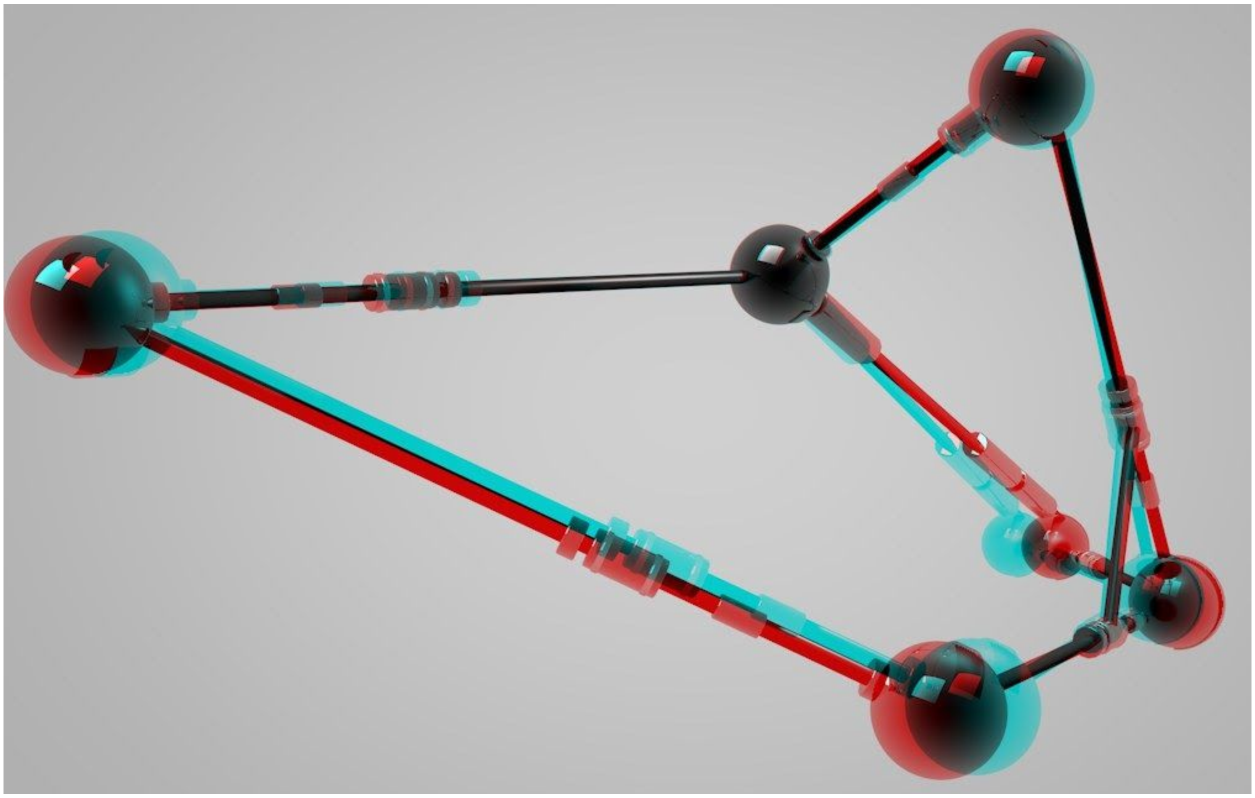


Channels[1..2147483647]

Here you can define any number of channels (=intermediate views). How these cameras are arranged is described under **<u>Placement</u>**.

Additional Information:

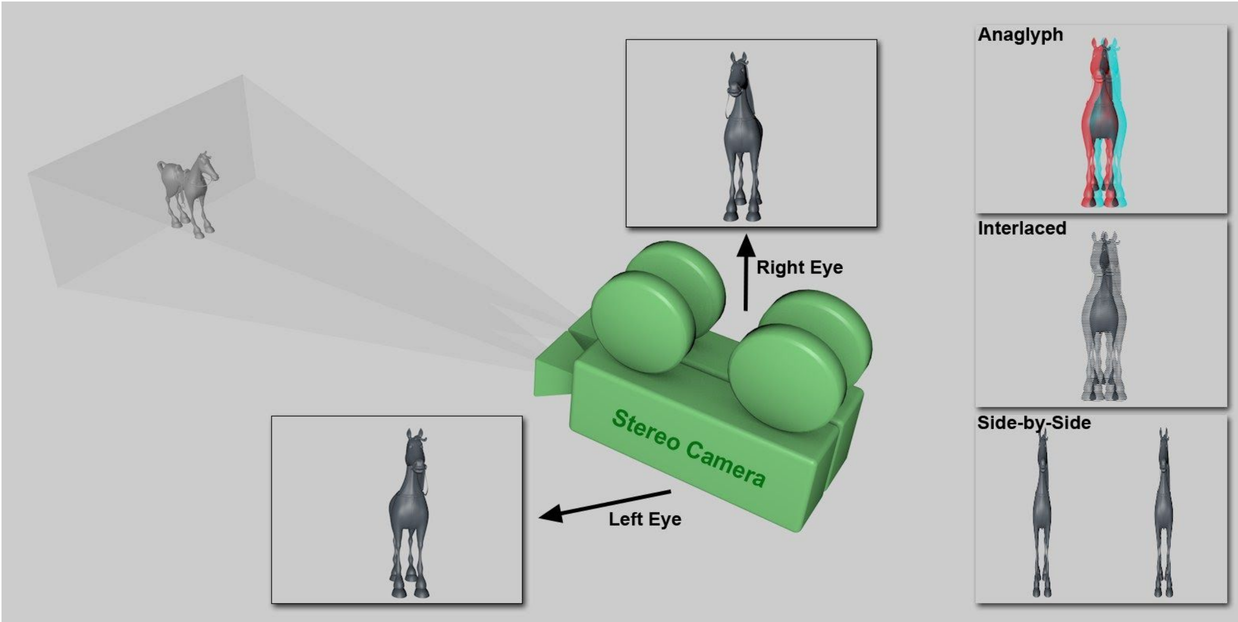
Stereoscopic



This image practically reaches out to you if viewed through 3D anaglyph glasses (red-cyan).

Over the years, several attempts have been made at displaying images, movies and videos in three dimensions. More recently – mainly as a result of the numerous 3D movies – a new 3D boom has taken place. Among the reasons for this are most likely the advance in technology that makes it possible to display 3D images and movies true to color and free of fatigue for the human eye. What most techniques have in common is that they basically record two images of the same scene from slightly offset perspective views (namely that of the left and right "eyes", respectively). These two images must then be displayed to the viewer in a way that the left eye only perceives the left image and the right eye the right image (which is done using specially designed glasses). The rest is done more-or-less automatically: the brain combines these two images into a single image.

Of course this is a task that Cinema 4D has also mastered. We've made it easy to place any number of cameras in a scene in order to render it from all possible angles.



Two images with different perspectives are combined to create a stereoscopic image.

Cinema 4D uses the following techniques:

Anaglyph (rendering and Viewport): This is the most well known method, which has been used in movie theaters since the 50s. An image's color information is separated using 2-color glasses (previously red-green, today most commonly red-cyan). Advantage: simple, affordable glasses. Disadvantage: color range is in part very limited.

Shutter (Viewport only): The most high quality method is the use of special glasses that are synchronized with a monitor, which makes it possible for images to be displayed alternately to the left and right eye. Advantage: best quality, true color reproduction. Disadvantage: expensive (special hardware, monitor must offer 120 Hz).

Interlaced (rendering and Viewport): This method requires a monitor with a polarization filter and glasses with polarized glass. Since both images are coded into a single image (e.g., left eye all even, right eye all uneven lines), the resolution is halved. Advantage: affordable glasses, good color reproduction. Disadvantage: special monitor required, reduced resolution.

Side-by-Side (rendering and Viewport): Left and right images are switched and squeezed into a normal image size. Some televisions use this technique for HD 3D because the transmission band width is the same as the HD band width. The terminal device must be able to decode these double images and display them sequentially (most commonly in combination with shutter glasses). Disadvantage: reduced resolution, expensive technology (special hardware required).

auto-stereoscopic: For additional auto-stereoscopic techniques any number of views that lie within the range of the defined **Eye Separation** value can be rendered for the left and right eye (the auto-stereoscopic **Channels** setting can be found in the **Render Settings**'s **Stereoscopic** menu).

In Cinema 4D, a scene can be displayed stereoscopically in the Viewport (for which 3D anaglyph glasses and special hardware, incl. shutter glasses are required) or rendered in stereoscopic format.

Stereoscopy is created in Cinema 4D as follows:

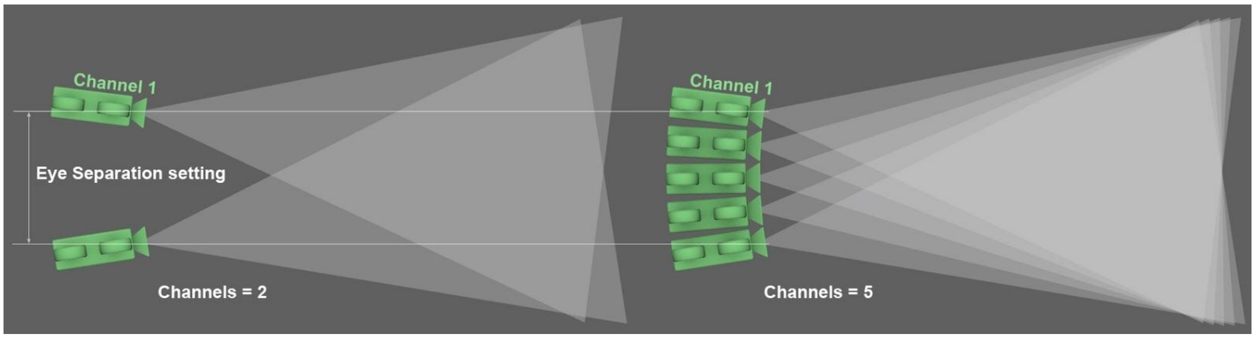
1. The parameters required to render a scene stereoscopically can be found in the **Stereo Camera**'s Stereoscopic tab. Naturally this camera must be selected for the given view.
2. If you want to display the scene stereoscopically, **Stereoscopic** must be enabled for a given Viewport (**Options** menu). Additional settings can be found in the Viewport's **Configure...** settings' **Stereoscopic** tab.

3. If you want to render stereoscopically, numerous settings are available in the Render Settings' Stereoscopic menu with regard to how double images can be coded and rendered.
4. In the Picture Viewer's Stereo tab you will find a selection menu that lets you define exactly what will be displayed in the Picture Viewer (e.g., the stereoscopic image or only the image for the left eye). Here you can also interactively adjust both camera views to a single stereoscopic image.
5. A spherical camera (360° view) has been integrated into Cinema 4D R19. This camera has special stereoscopic settings (its perspective cannot be displayed in the Viewport).

It is not possible to render stereoscopic images in the Viewport.

Calculate Stereoscopic Images

Here you can define how the stereoscopic images should be rendered (and displayed in the Picture Viewer) and saved (this is defined in the Render Settings' **Save** menu).



At left a stereoscopic setup with 2 channels, at right a stereoscopic setup with 5 channels.

In contrast to stereoscopic techniques that use 2 channels, multi-channel techniques let you render multiple camera views, which can then be edited as channels (or streams) using external applications. auto-stereoscopic playback devices can then be used to view these images with two matching channels (that can change depending on the angle of view).

Individual Channels

Several camera views can be rendered, depending on the number of channels defined. Channel 1 will always be the left eye perspective and channel X will always be the right eye perspective. If **Channels** is set to greater than *2* additional views will be rendered between these views. Select this mode if you want to subsequently create a stereoscopic image, either in the Picture Viewer or using an external application.

Merged Stereoscopic Image

A stereoscopic image will be rendered using the left and right eye views only and no other channels. This is the mode with which you will normally render.

Individual Channels and Merged Image

In addition to the left and right eye views (or any number of additional intermediate camera views), a combined, stereoscopic image will be created out of a combination of these views.

Single Channel

Only the channel defined by the **Single Channel** value will be calculated. This mode is recommended if you – for whatever reason – only want to render a single camera view.

Single Channel[1..2147483647]

If this option is selected you can define which channel should be rendered. *1* will always render the left eye view and the value defined for **Channels** will be the right eye view. in-between values will represent the intermediate camera views, as described in **Placement**.

Non-Stereoscopic Image

Enable this option if the normal camera view (i.e. the camera view as defined in the camera's **Coord.** tab) should be calculated in addition to the stereoscopic (or auto-stereoscopic) views.

Use Folder for Saving

If enabled, individual channels ("channel left", "channel right", etc. or sequentially numbered if more than 2) and the stereo image ("channel combined") will each be placed in their own folder at the location defined in the Render Settings' **Save** tab. The path name will be added to the file names.

Mono images on the other hand will not be saved to an extra folder.

Channels[1..2147483647]

Here you can define any number of channels (=intermediate views). How these cameras are arranged is described under **Placement**.

Mode

Anaglyph

This is the most well known method, which has been used in movie theaters since the 50s. An image's color information is separated using 2-color glasses (previously red-green, today most commonly red-cyan). Advantage: simple, affordable glasses. Disadvantage: color range is in part very limited.

Side-by-Side

Left and right images are switched and squeezed into a normal image size. Some televisions use this technique for HD 3D because the transmission band width is the same as the HD band width. The terminal device must be able to decode these double images and display them sequentially (most commonly in combination with shutter glasses). Disadvantage: reduced resolution, expensive technology (special hardware required).

Interlaced

This method requires a monitor with a polarization filter and glasses with polarized glass. Since both images are coded into a single image (e.g., left eye all even, right eye all uneven lines), the resolution is halved. Advantage: affordable glasses, good color reproduction. Disadvantage: special monitor required, reduced resolution.

Additional Parallax (pixel)[0..2147483647]

Moves the image halves by the defined value in pixels. This can be used to increase the stereoscopic effect.

Swap Left/Right

If enabled, the left and right image halves will be swapped.

▾ Anaglyph

System

The color of the stereoscopic color coding can be defined here when using the *Anaglyph* mode. Both colors should be the same as the lenses of the 3D anaglyph glasses you will be using. If your client does not supply you with color information, use *Red-Cyan*. This is the most commonly used color combination and can display numerous colors compared to the primary color combinations of red-green or red-blue.

You can use the *Custom* option to create your own color combination (however, it will then be difficult to find a matching pair of glasses…).

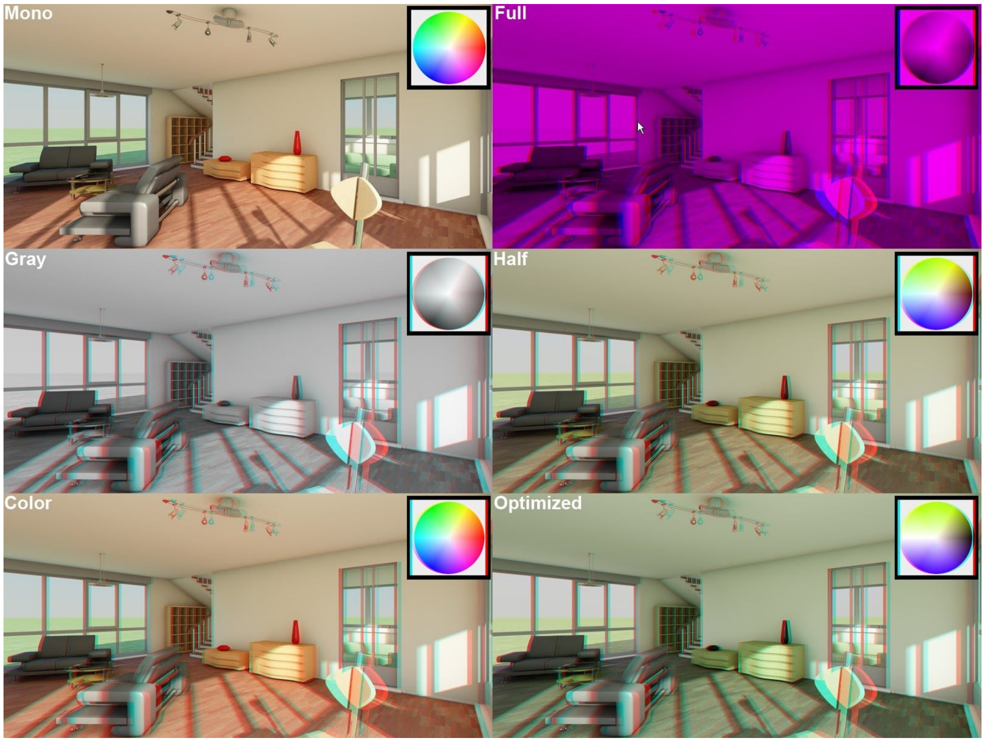
If **Method** is set to anything else but *Full* you will only be able to define the left eye color. The right eye color will automatically be set to the left eye's complimentary color.

Left

Right

Here you can define the individual colors for the stereoscopic color coding (**System** must be set to *Custom*). The left color must be the same as the color of the left lens of the glasses.

Method



The different available methods (Full with anaglyph colors red-blue). Models by DOSCH Design.

Using this setting's options you can affect the color of the stereoscopic image. A problem with the anaglyph technique is the color deviation of the original scene. Some colors cannot be displayed without straining the viewer's eyes (red when using red-cyan coding). It is suggested that *Optimized* be used because it offers the least strenuous "viewing experience".

Red-Blue or *Red-Green* should be used when **Method** is set to *Full*...

The following list is closely arranged according to the quality that can be expected from anaglyph images. The list is arranged from worst to best:

Full

The oldest (and lowest quality) method of anaglyph display due to the fact that the display is dark and monotone. This mode is designed for use with the *Red-Blue* or *Red-Green* anaglyph techniques.

Gray

The anaglyph image will appear as a gray-scale image through the glasses (not designed for use with red-blue or red-green). For brighter images use *Full*.

Half Color

Color

These modes allow only a limited color reproduction compared to the previously described options. Blue, green and yellow tones can be reproduced very well when the common red-cyan code is applied. If *Color* is selected, "retinal rivalry" can occur, i.e., red surfaces (red-cyan) will cause the left eye to pass on maximum color intensity to the brain and the right eye will only see "black". This is irritating and strenuous for the eyes (can be observed on the red vase in the image above). This effect can be minimized by selecting *Half Color*. However, red will then be darkened to such a degree that it can no longer be recognized as such.

Optimized

This mode is similar to the *Half Color* mode but it offers better color reproduction and minimizes the retinal rivalry effect (see above).

▾ Side-by-Side

Alignment

This mode defines whether or not both image parts should be arranged next to each other (horizontally or vertically).

Left Mirror X

Left Mirror Y

Right Mirror X

Right Mirror Y

If **Mode** is set to *Side-by-Side* you are given the option of mirroring the image halves along the **X** or **Y** axes.

▾ Interlaced

Type

If **Mode** is set to *Interlaced*, you can also define whether the coding should take place via offset lines (*Horizontal*) or columns (*Vertical*). Furthermore, there is an additional combination of both modes called *Checkerboard*.

A few guidelines for achieving good stereoscopic images

There are several rules that should be followed when creating stereoscopic images. This is necessary so they can be easily viewed without any unnatural effects or fatigue for the viewer's eyes. Hence, the following guidelines should be followed.

- Depth of Field: It is generally suggested that a larger depth of field (i.e. little blur) be used. A common 2D technique is to take the background out of focus using a slight depth of field. A blurred wall behind a sharp object makes this surface look flat. Such techniques are in contrast to stereoscopic techniques.
- Distance from object(s): The 3D effect depends a lot on how far the viewer is from the projection plane (monitor, screen, paper, etc.). The farther away the viewer is from the projection plane, the stronger the 3D effect will be (the perceived impression of depth between an object that is near and one that is far away)! This should be taken into consideration when creating a stereoscopic zone.
- Ghosting is when one eye perceives the image information of the other eye (leads to irritation). This is especially noticeable in images with high contrast (anaglyph images in particular are prone to this). Therefore, you should avoid such contrasts in your images if at all possible. Very small parallax values can also reduce ghosting.
- It is often irritating for the eye when objects are cut off at the edge of an image (if they do not lie on the projection plane). However, because there are always objects that lie on the edge of an image, it shouldn't necessarily be the most important object in the image, the one that is currently the center of attention, that is being cut off.
- For videos it is important to give the eye time to adjust to strong parallax changes (between different settings). Short, fast cuts should then be avoided.
- Avoid exaggeration: Chain saws constantly flying towards the viewer or similar scenes can be fatiguing for the eye. Such visual gimmicks should be used sparingly or be well thought out.
- Read the CameraViewport and stereoscopy descriptions. Here you will find additional guidelines that should be followed.

As you can see, the creation of (good) stereoscopic images can be challenging and many things have to be taken into consideration. But isn't this true for all areas of expertise…?

Limitations for Stereoscopy

Note that a Stereo camera's Child objects cannot be rendered in stereo.

Stitching for Leia Displays

Once the views are generated using the techniques as explained above, we need to make them compatible for playback on Leia displays. We are sharing one of the ways of doing this and we will be using ffmpeg to:

stack the views 1 and 2 horizontally
ffmpeg -i view1.png -i view2.png -filter_complex hstack topStack.png

stack the views 3 and 4 horizontally
ffmpeg -i view3.png -i view4.png -filter_complex hstack bottomStack.png

stack the top and bottom stacks vertically and append the name with a "2x2"
ffmpeg -i topStack.png -i bottomStack.png -filter_complex vstack final_2x2.png

Links:

Camera Object: Stereoscopic:

https://help.maxon.net/r23/en-us/#html/OCAMERA-ID_GROUP_STEREO.html%3FTocPath%3DCreate%2520Menu%7CCamera%2520Object%7C_____6

Edit Render Settings: Stereoscopic

https://help.maxon.net/r23/en-us/#html/DRENDERSETTINGS-RDATA_GROUP_STEREO.html%3FTocPath%3DRender%2520Menu%7CEdit%2520Render%2520Settings%7C_____9