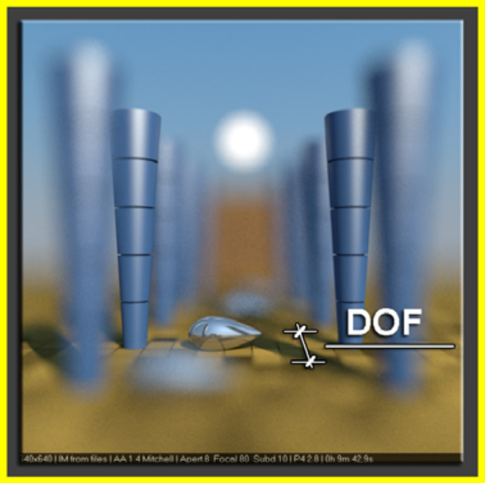
Depth of field (DOF)

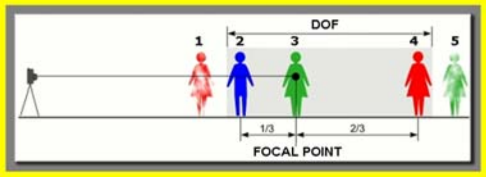
In photography ***Depth of Field*** (abbreviated as ***DOF***) is the distance in front of and behind the main subject which appears as sharp and focused.

■ **Figure 4.224**
Very low Depth of Field.


DOF
:40x640 | IM from files | AA 1 4 Mitchell | Apert.8 Focal 80 Subd.10 | P4 2.8 | 0h 9m 42.9s

For each setting of the lens there is only one distance where objects appear to be completely focused. The sharpness decreases gradually moving towards and away from the photographer. The depth of field is the distance behind and in front of the subject where blurring is not noticeable or tolerable; the ***DOF*** is defined as greater if this interval is larger and smaller when it is in fact smaller. In the previous example the ***DOF*** is extremely limited. These concepts, from the purely photographical point of view, are explained amply in the section of the book regarding the new ***VRayPhysicalCamera***. For now it is sufficient to understand that by ***DOF*** we mean the zone which is still sharp before and after the plane where the object is focused.

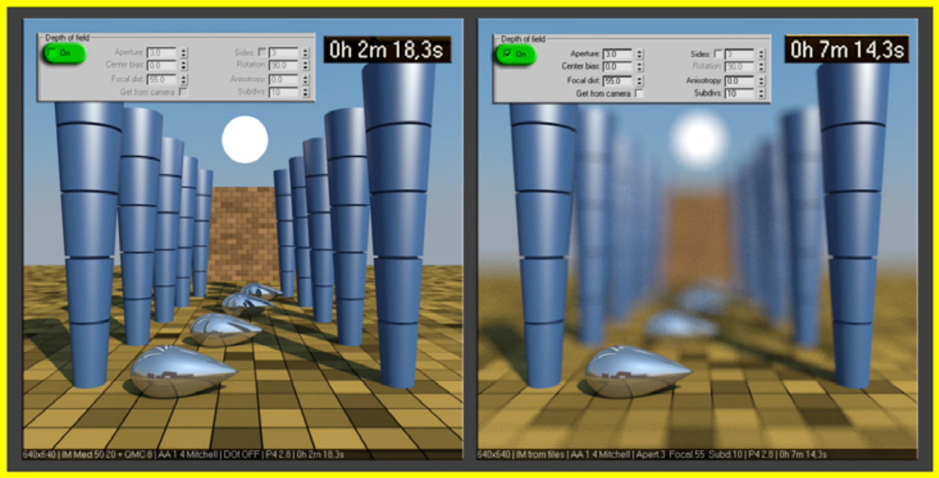
■ **Figure 4.225**
Functioning scheme of the *DOF*.



VRay allows two methods to be used for ***DOF*** generation. One of them is independent from the camera and its parameters. The user sets it manually with values he or she prefers. The other method, introduced in ***VRay 1.5***, relies on optical physical modelling for an accurate and realistic ***DOF***. For this last method one must use a special camera which ***VRay 1.5*** provides. Here the first method is described, the one which exists since the creation of ***VRay***. The options for ***DOF*** configuration are many and here we analyze them one by one.

On - this parameter activates the ***DOF*** in ***VRay***.

■ **Figure 4.226**
Activation and deactivation of the
DOF effect.



Depth of field
□ On
Aperture: 3.0
Center bias: 0.0
Focal dist: 55.0
Get from camera □
Sides: □ 3
Rotation: 30.0
Anisotropy: 0.0
Subdivs: 10

0h 2m 18,3s

640x640 | IM Med 50 20 + QMC 8 | AA 1 4 Mitchell | DOf OFF | P4 2.8 | 0h 2m 18,3s

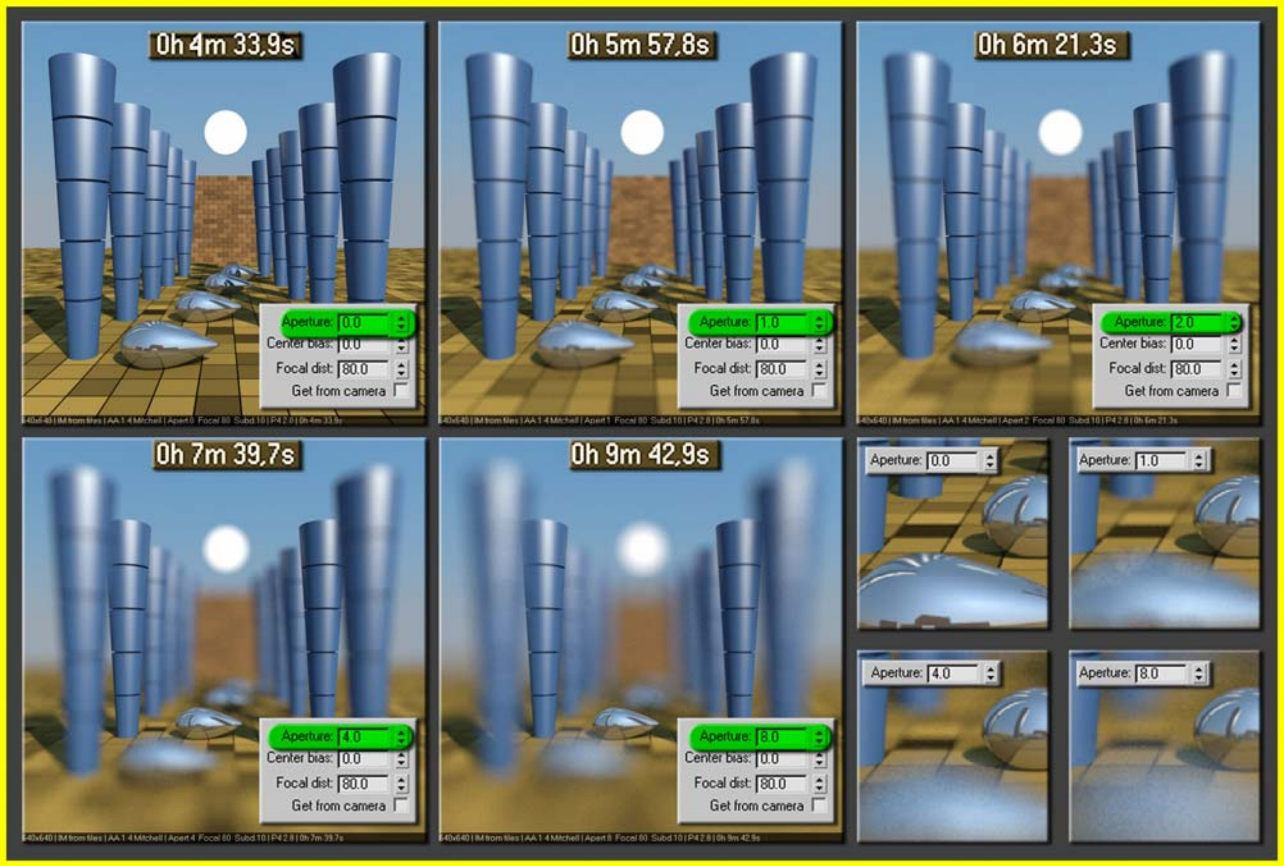
Depth of field
☑ On
Aperture: 3.0
Center bias: 0.0
Focal dist: 55.0
Get from camera □
Sides: □ 3
Rotation: 30.0
Anisotropy: 0.0
Subdivs: 10

0h 7m 14,3s

640x640 | IM from files | AA 1 4 Mitchell | Apert.3 Focal.55 Subd.10 | P4 2.8 | 0h 7m 14,3s

One can see how rendering times are almost threefold and how the scene has become much more realistic. Unfortunately with ***DOF***, rendering times are increased and this is more apparent, the smaller the ***DOF*** is. Soon we will witness how the time for rendering depends on two factors: the opening of the camera and ***Subdivision***.

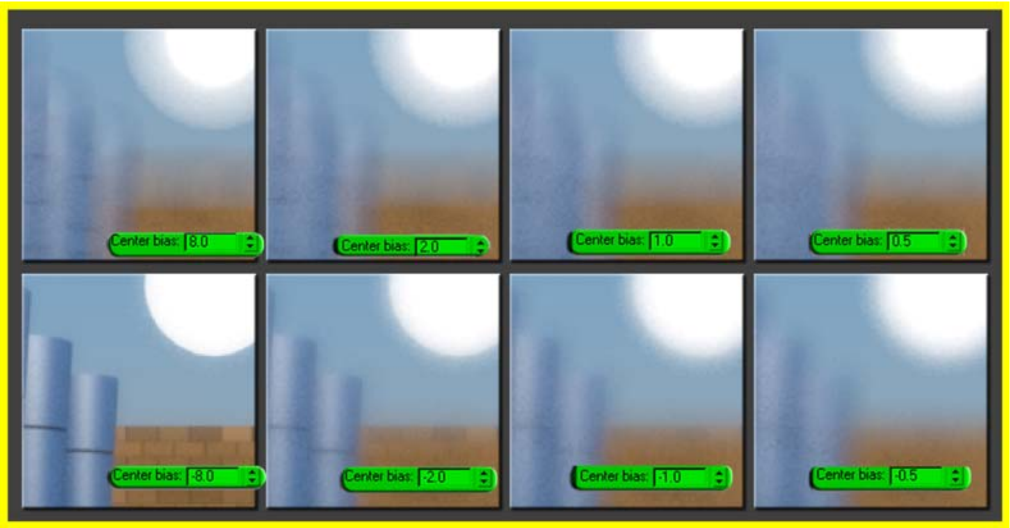
Aperture - this parameter represents the opening of the virtual camera, measured in ***World*** units. Small values increase the ***DOF***, large values lower it.



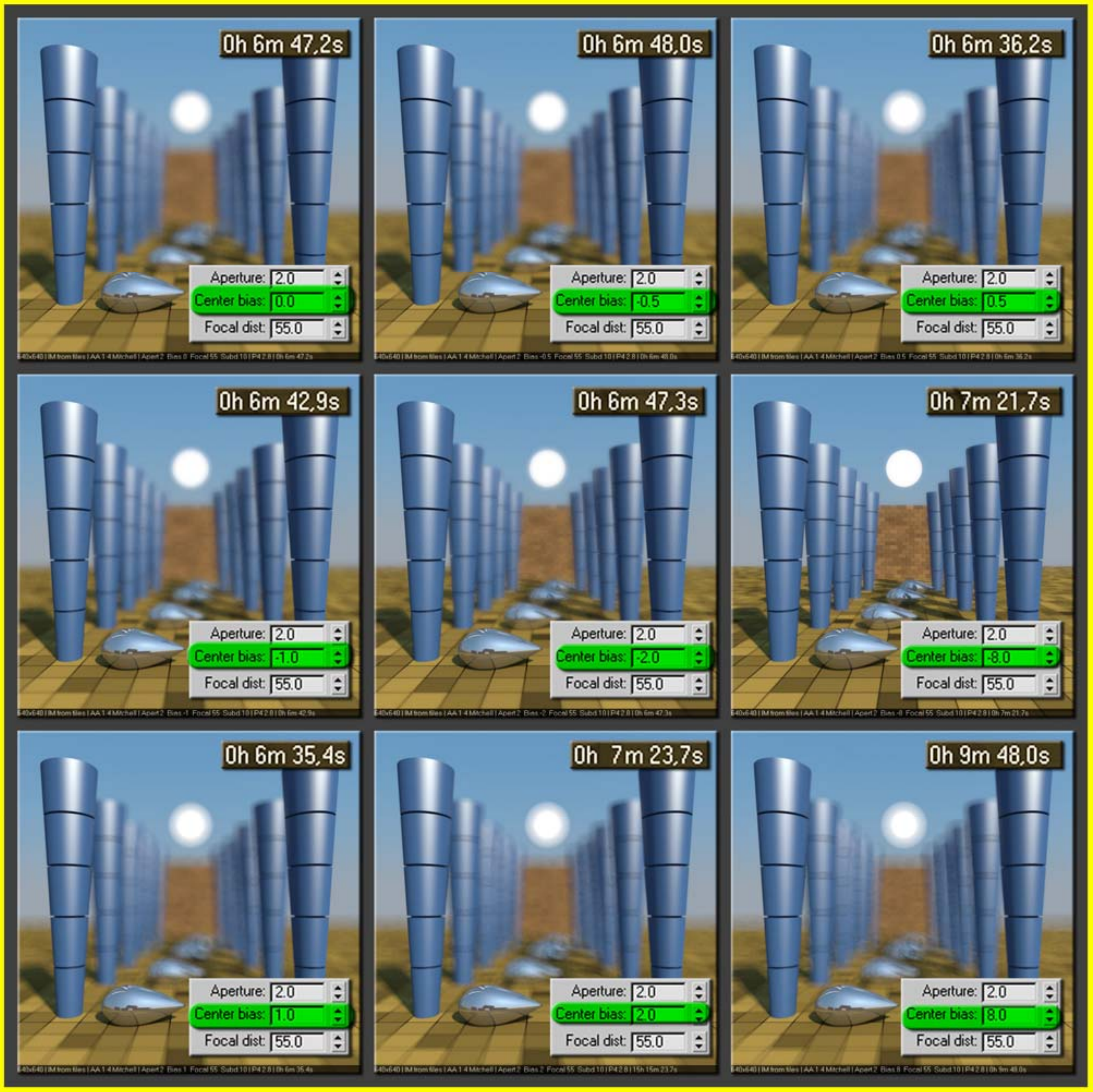
■ **Figure 4.227**
Rendering carried out with different *Aperture* values.

If one uses ever higher ***Aperture*** parameter values, the ***DOF*** tends to decrease more and more. Rendering time also increases.

Center bias - this value determines ***DOF*** uniformity. Negative values "block" the ***DOF***.



■ **Figure 4.228**
Level of Rendering detail altered with different parameters of *Center bias*.


0h 6m 47,2s
Aperture: 2.0
Center bias: 0.0
Focal dist: 55.0

0h 6m 48,0s
Aperture: 2.0
Center bias: -0.5
Focal dist: 55.0

0h 6m 36,2s
Aperture: 2.0
Center bias: 0.5
Focal dist: 55.0

0h 6m 42,9s
Aperture: 2.0
Center bias: -1.0
Focal dist: 55.0

0h 6m 47,3s
Aperture: 2.0
Center bias: -2.0
Focal dist: 55.0

0h 7m 21,7s
Aperture: 2.0
Center bias: -8.0
Focal dist: 55.0

0h 6m 35,4s
Aperture: 2.0
Center bias: 1.0
Focal dist: 55.0

0h 7m 23,7s
Aperture: 2.0
Center bias: 2.0
Focal dist: 55.0

0h 9m 48,0s
Aperture: 2.0
Center bias: 8.0
Focal dist: 55.0

■ **Figure 4.229**
Rendered images with different *Center bias* settings.

Compared to ***Center bias*** = 0, negative values tend to decrease the effect of ***DOF*** and positive values tend to emphasize it, creating a type of distortion. It is easy visible at the tops of columns furthest away from the camera where the render creates a sort of doubling when values are high, as if they were vibrating. Rendering time is more or less the same for the values considered, except for a peak which takes place with ***Center bias*** = 8.

Focal distance - this defines the distance of the maximum possible focus. Objects which are further or nearer than this distance are not focused. Before passing on to examples, observe the scene and dimensions.

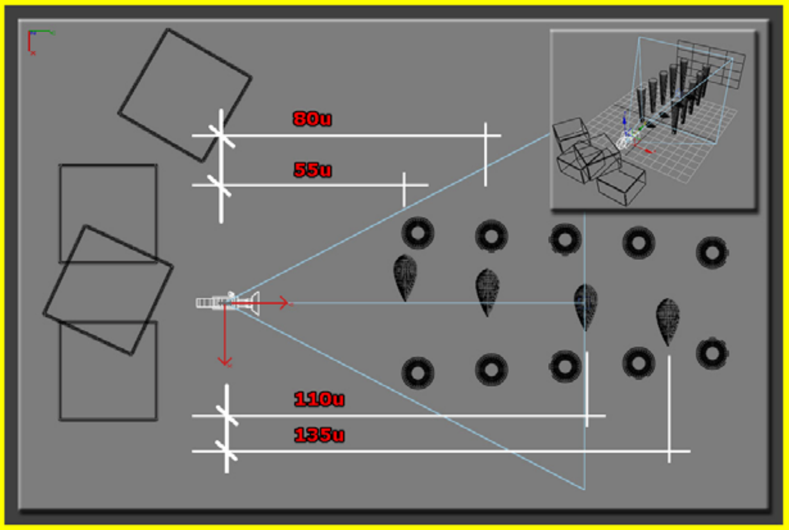


Figure 4.230
Dimensioned plot of the scene.

In *VRay* there are two methods to determine the exact point of focus. The first consists of analytically specifying the distance one wants the maximum focus to correspond; And this is what the ***Focal Distance*** parameter does. The user must manually input the distance of focus for objects. The other method, instead, consists of using the ***target*** of the camera as a marker for the position for focus.

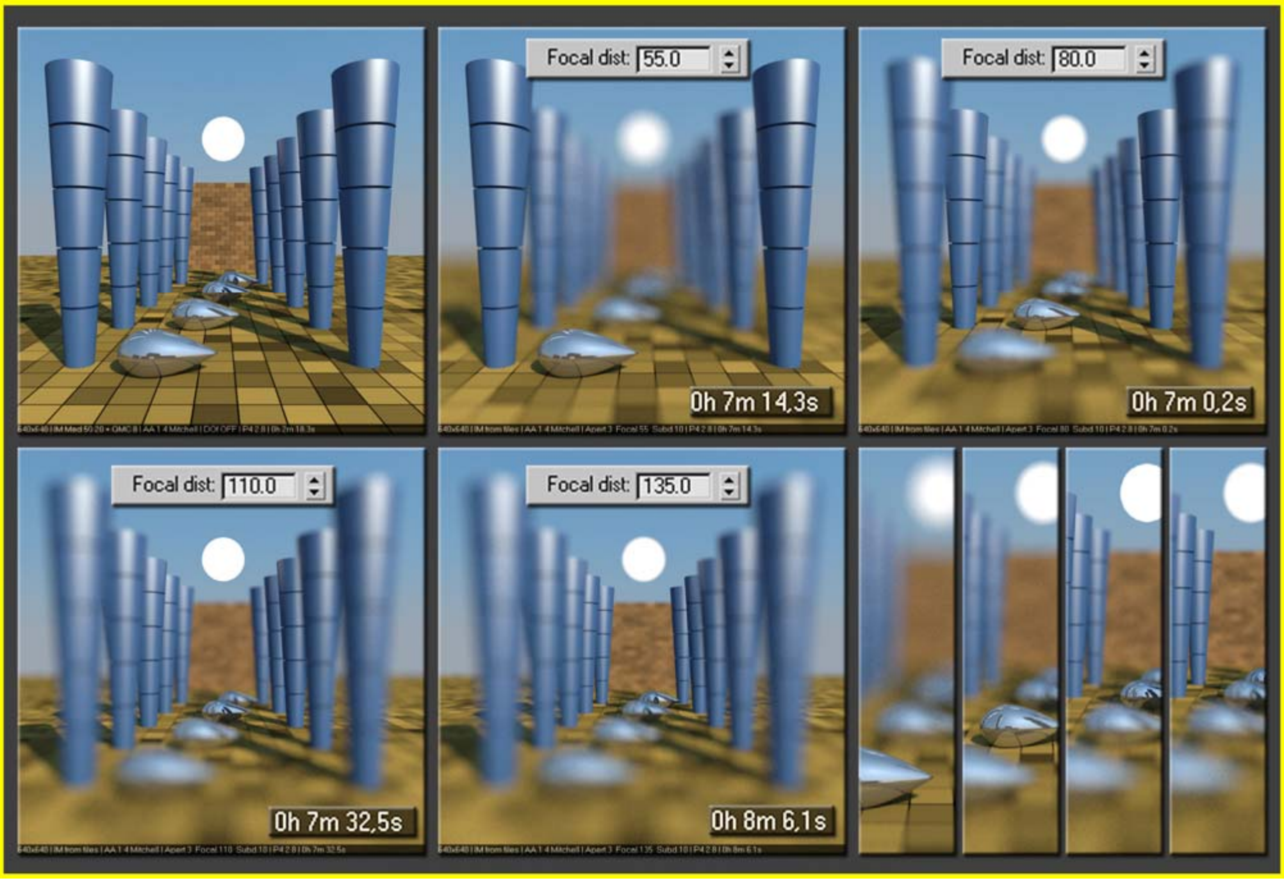
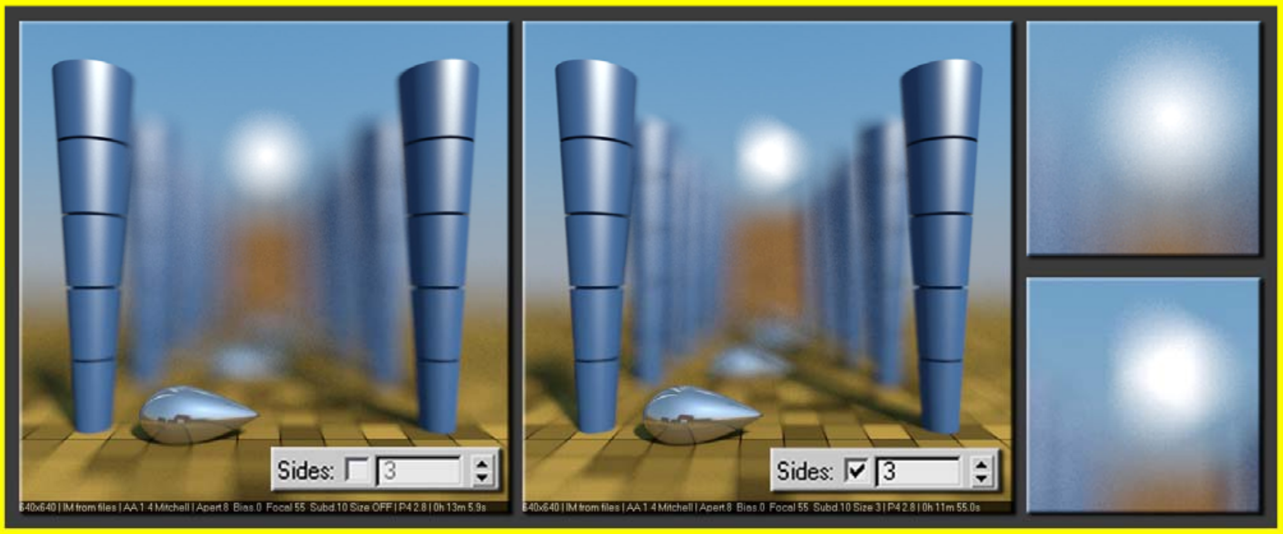


Figure 4.231
Rendering carried out with different Focal Dist, manually set.

Focal Dist is a precise method for defining the point of focus. Rendering time in this case is around 7 min. for almost all examples. Only in the last case does it last 8 min. This is because the portion of the image where the ***DOF*** is present is smaller and the out-of-focus spots are more intense.

Get from camera - this is the second method for defining the position of top focus. If it is activated this distance is set by the position of the camera's ***target***. It does not work if the render is carried out by a User or perspective view. If this is the case, the values entered into ***Focal Distance*** manually do not influence the ***DOF*** at all, because it is managed by the position of the camera's target.

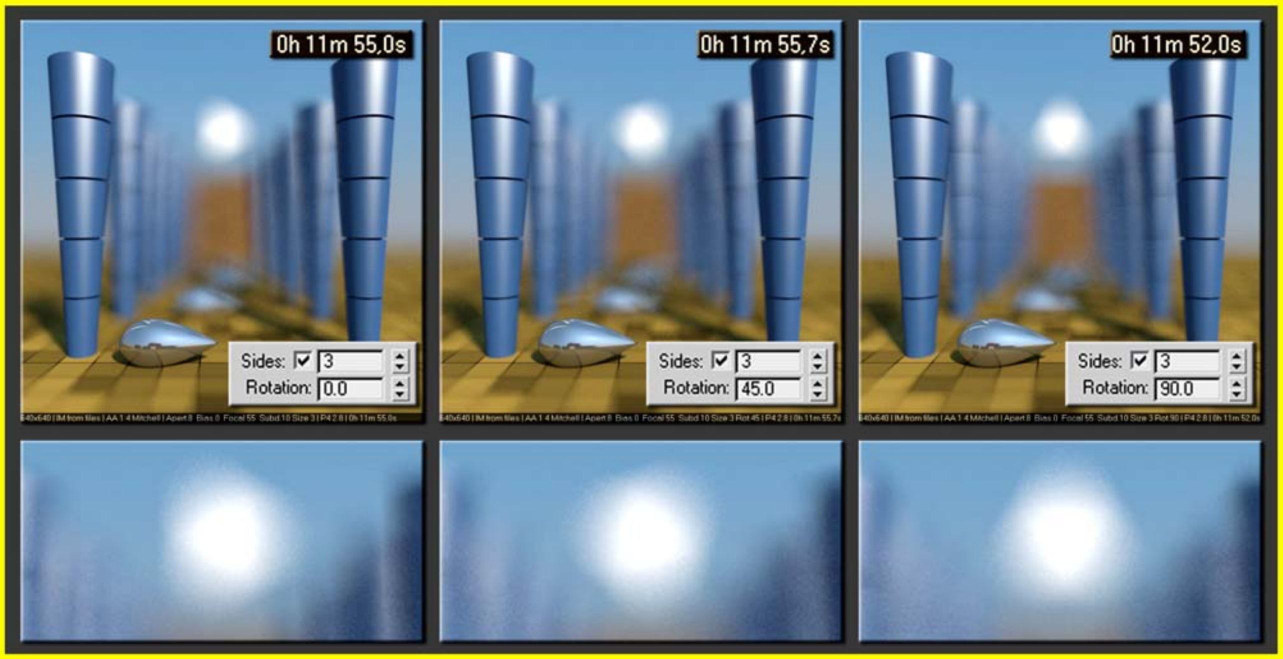
Sides - this parameter allows one to simulate the polygonal shape of the diaphragm of a photographic camera. If it is deactivated, the shape is circular.


Sides: □ 3
640x640 | IM from files | AA 1 4 Mitchell | Apert 8 Bias 0 Focal 55 Subd 10 Size OFF | P4 2 8 | 0h 13m 5.9s
Sides: ☑ 3
640x640 | IM from files | AA 1 4 Mitchell | Apert 8 Bias 0 Focal 55 Subd 10 Size 3 | P4 2 8 | 0h 11m 55.0s

■ **Figure 4.232**
Polygonal effect of the *DOF* caused by the activation of the parameter called *Sides*.

It is easy to observe the effect of activating the ***Sides*** parameter. The luminous sphere, which initially has a completely circular shape, changes its outline when ***Sides*** is activated and tends to take on a triangular shape. This is because the value of ***Sides*** = 3. Values under 3 cannot be entered. In fact no geometrical shape can be made up of two sides. The whole scene undergoes changes and by using ***Sides*** = 3 the ***DOF*** is more defined.

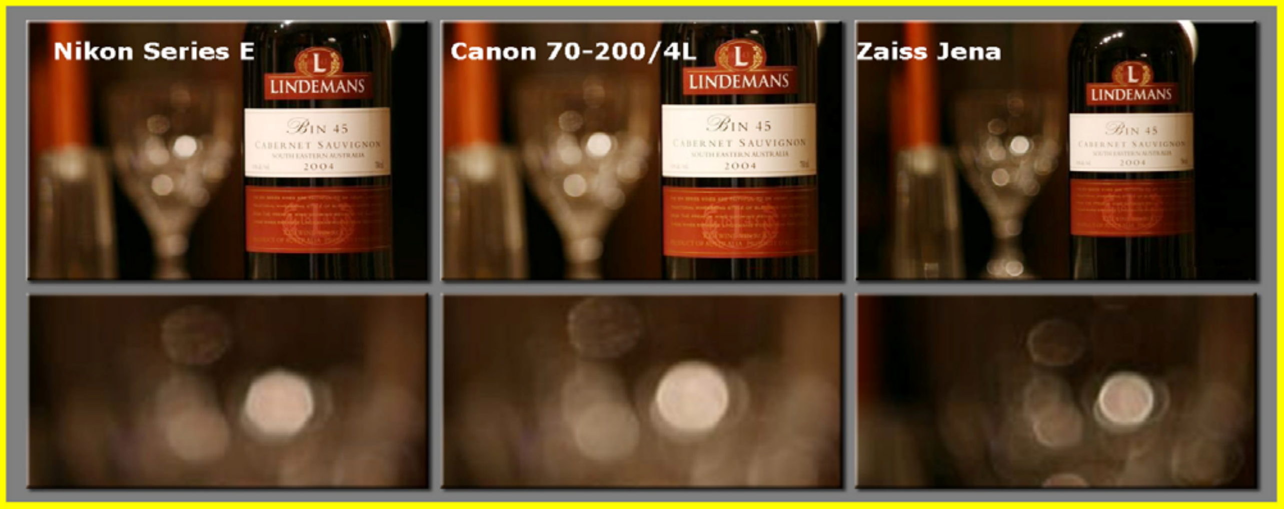
Rotation - this specifies the angle of rotation of the polygonal shape generated by the ***Sides*** parameter.


0h 11m 55,0s
Sides: ☑ 3
Rotation: 0.0
640x640 | IM from files | AA 1 4 Mitchell | Apert 8 Bias 0 Focal 55 Subd 10 Size 3 | P4 2 8 | 0h 11m 55.0s
0h 11m 55,7s
Sides: ☑ 3
Rotation: 45.0
640x640 | IM from files | AA 1 4 Mitchell | Apert 8 Bias 0 Focal 55 Subd 10 Size 3 Rot 45 | P4 2 8 | 0h 11m 55.7s
0h 11m 52,0s
Sides: ☑ 3
Rotation: 90.0
640x640 | IM from files | AA 1 4 Mitchell | Apert 8 Bias 0 Focal 55 Subd 10 Size 3 Rot 90 | P4 2 8 | 0h 11m 52.0s

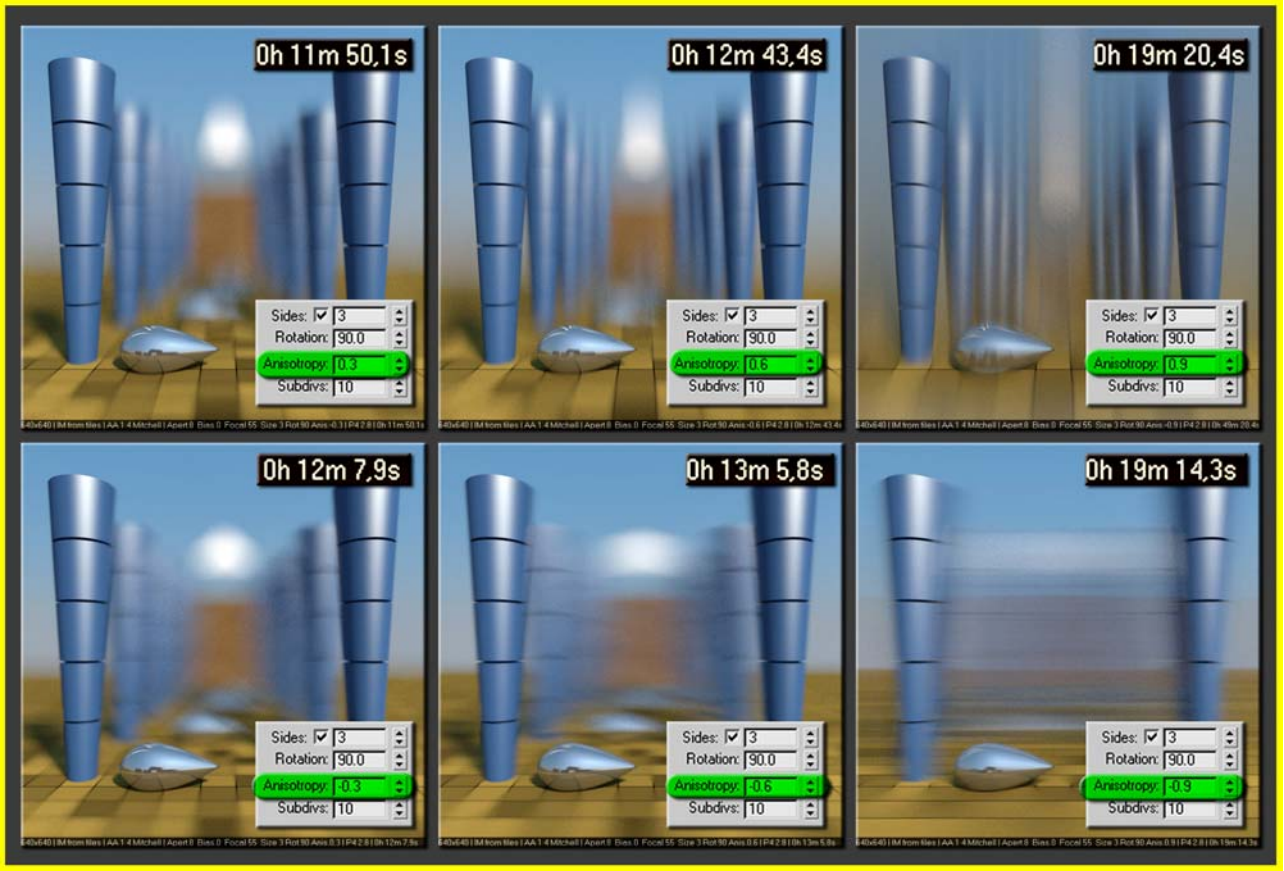
■ **Figure 4.233**
DOF rotation.

The effect caused by changing the ***Rotation*** parameter is easily recognizable when one analyzes the luminous sphere. The rotation by 45° and 90° makes the triangular shape of the ***DOF*** change inclination.

Anisotropy - this option allows one to extend the ***bokeh*** effect horizontally and vertically. Positive values tend to "iron out" the shape vertically. Negative values do the same horizontally. ***Bokeh*** is approximately the sound of a Japanese word. There is no equivalent word in English and it refers to the quality of an image, in the out-of-focus, blurred areas.



■ **Figure 4.234**
Some *bokehs* obtained with different lens setups.



Sides: ☑ 3
Rotation: 90.0
Anisotropy: 0.3
Subdivs: 10

Sides: ☑ 3
Rotation: 90.0
Anisotropy: 0.6
Subdivs: 10

Sides: ☑ 3
Rotation: 90.0
Anisotropy: 0.9
Subdivs: 10

Sides: ☑ 3
Rotation: 90.0
Anisotropy: -0.3
Subdivs: 10

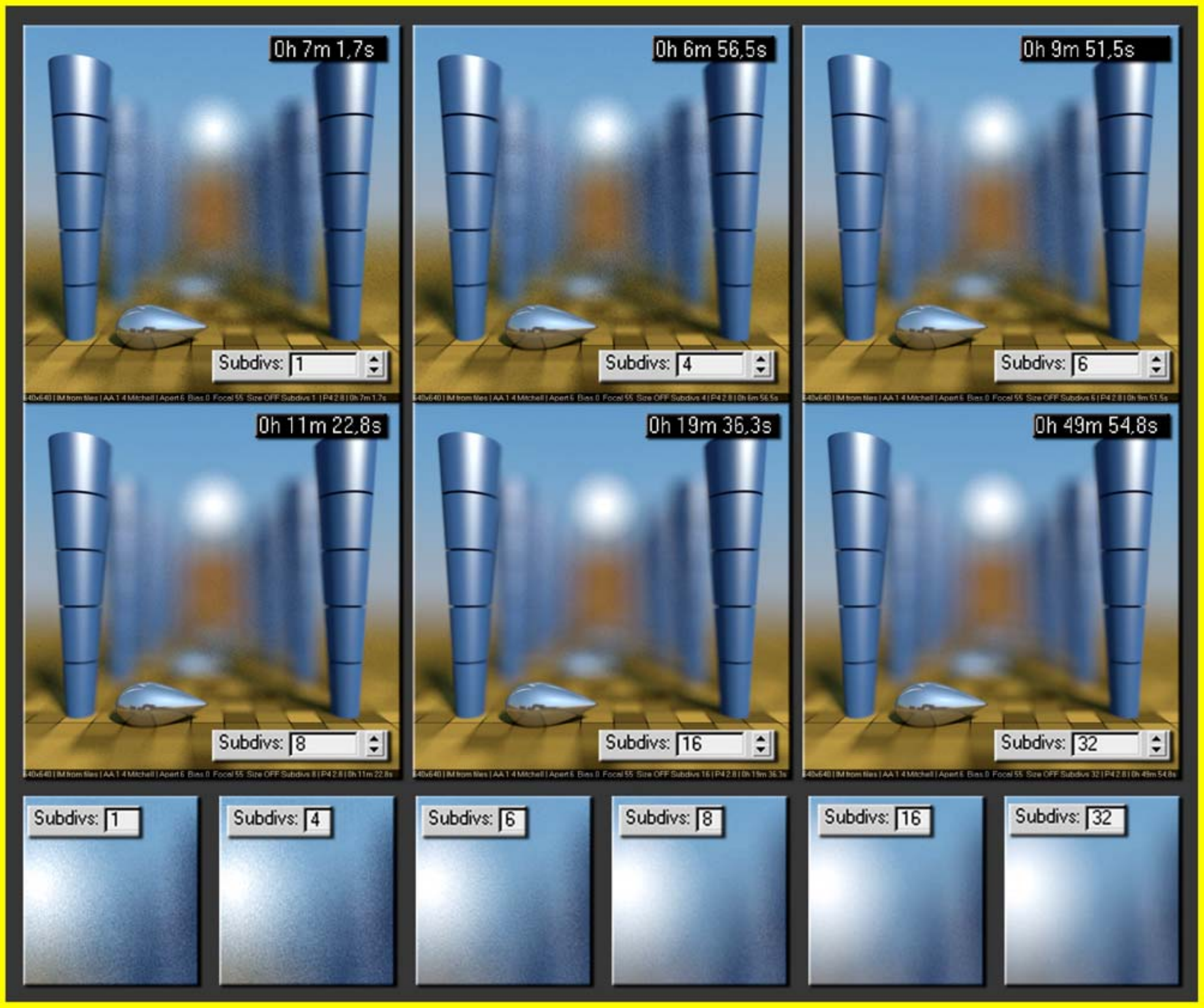
Sides: ☑ 3
Rotation: 90.0
Anisotropy: -0.6
Subdivs: 10

Sides: ☑ 3
Rotation: 90.0
Anisotropy: -0.9
Subdivs: 10

■ **Figure 4.235**
Different images with various *Anisotropy* settings.

The effects of changing the ***Anisotropy*** are evident, as is the increase in rendering time. What happens is a sort of stretching of the ***DOF***.

Subdivs - this controls the quality of the ***DOF***. Low values allow a faster calculation, but the ***DOF*** becomes grainy and disturbed. With high ***DOF*** values the quality improved, but rendering time suffers. It is intuitable how ***Subdivs*** depend on the parameters in the ***VRay: rQMC samples***, as in all the effects where the ***Subdivision*** parameter is involved.

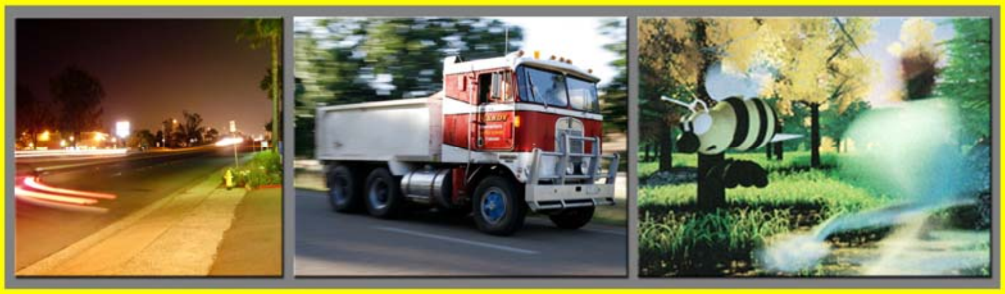


■ **Figure 4.236**
Decrease in granularity caused by increase of *Subdivs*.
- - - DVD - - -

The increase in rendering time is obvious, as is the lessening of noise within images, due to the greater number of subdivisions.

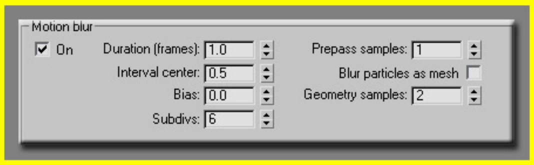
Motion blur (MB)

Motion blur is an optical phenomenon which is created when objects or cameras move fast during an animation. What actually happens is that the image is stretched in the areas of maximum speed.



■ **Figure 4.237**
Photographic examples of *Motion blur*. The car headlights create a long trail caused by the long exposure of the camera. In the second example a truck runs on the road, perfectly focused with a environment in *Motion blur* in the background. In the last example we can see a *Motion blur* effect in one of the first 3D short films in history.

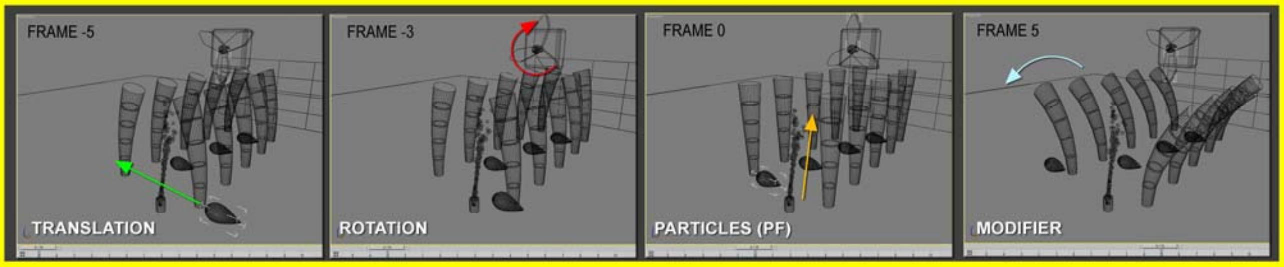
Motion blur gives animations a lot of realism, but this is also the effect it has in a static image. For this reason, when making animations, or when one wishes to give an object a sense of movement, it is definitely a must to apply **Motion blur**.



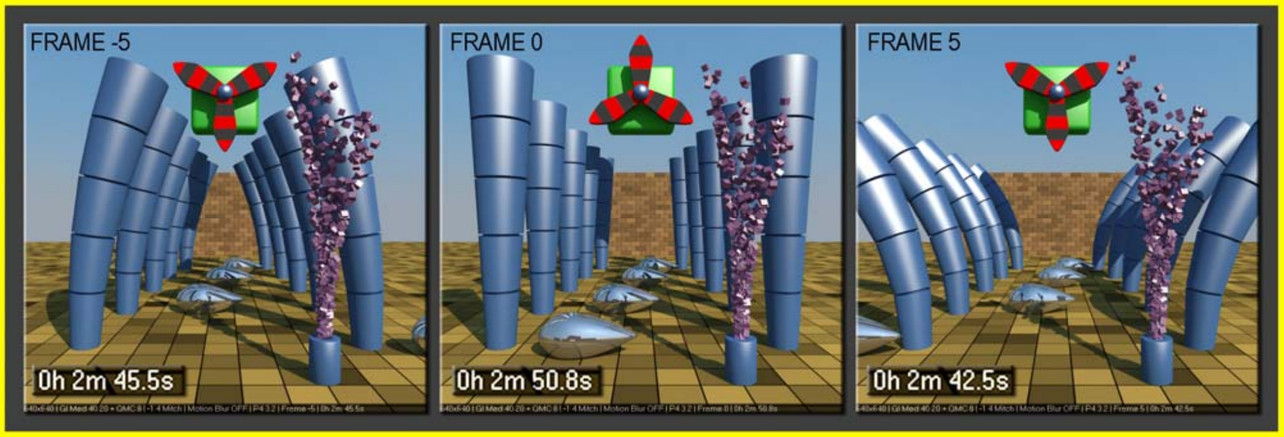
Motion blur
☑ On
Duration (frames): 1.0
Interval center: 0.5
Bias: 0.0
Subdivs: 6
Prepass samples: 1
Blur particles as mesh □
Geometry samples: 2

■ **Figure 4.238**
Parameters from the *Motion blur* section in VRay.

First of all, we will illustrate the animation being examined. It lasts 10 frames, with an interval which varies from -5 to +5. It is very simple and parts of it move thanks to simple rotations or thanks to the fact of having applied modifiers. Also, a particle system called ***Particle Flow*** has been added which emits moving objects. For a few tests frame number 0 has been used, which is the frame where objects are still. The columns and teardrop-shaped objects are in the same position as in the ***DOF*** test, whereas the fan and the particle system are new objects.

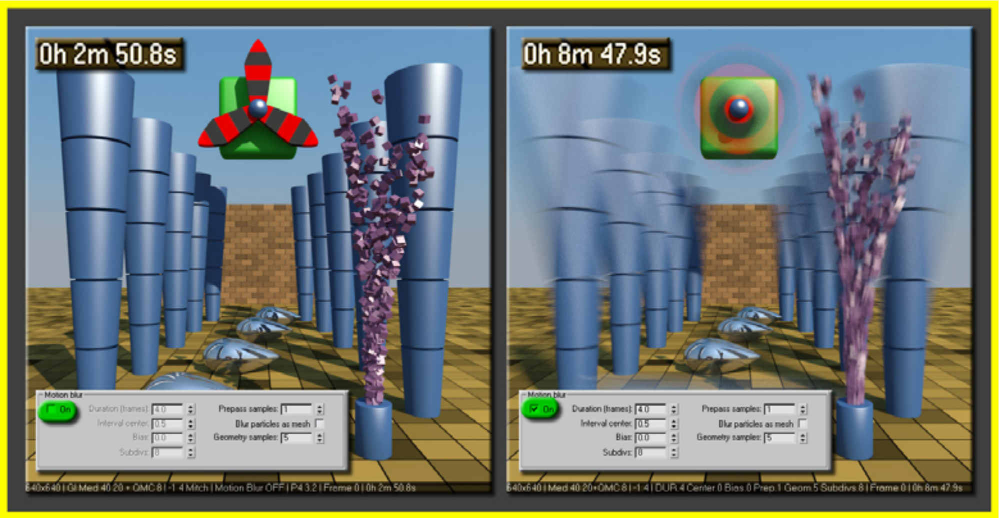


■ **Figure 4.239**
The animation only lasts a few frames, but this is enough to analyze the main parameters which have been made available by VRay.



■ **Figure 4.240**
Rendering of a few frames without *Motion blur* activated.

On - this activates ***Motion blur***. All commands and controls are activated or deactivated regarding ***Motion blur***.



0h 2m 50.8s

Motion blur

□ On Duration (frames): 4.0 Interval center: 0.5 Bias: 0.0 Subdivs: 8

Prepass samples: 1 Blur particles as mesh □ Geometry samples: 5

640x640 | GI Med 40 20 + QMC 8 | -1 4 Mitch | Motion Blur OFF | P4 3.2 | Frame 0 | 0h 2m 50.8s

0h 8m 47.9s

Motion blur

☑ On Duration (frames): 4.0 Interval center: 0.5 Bias: 0.0 Subdivs: 8

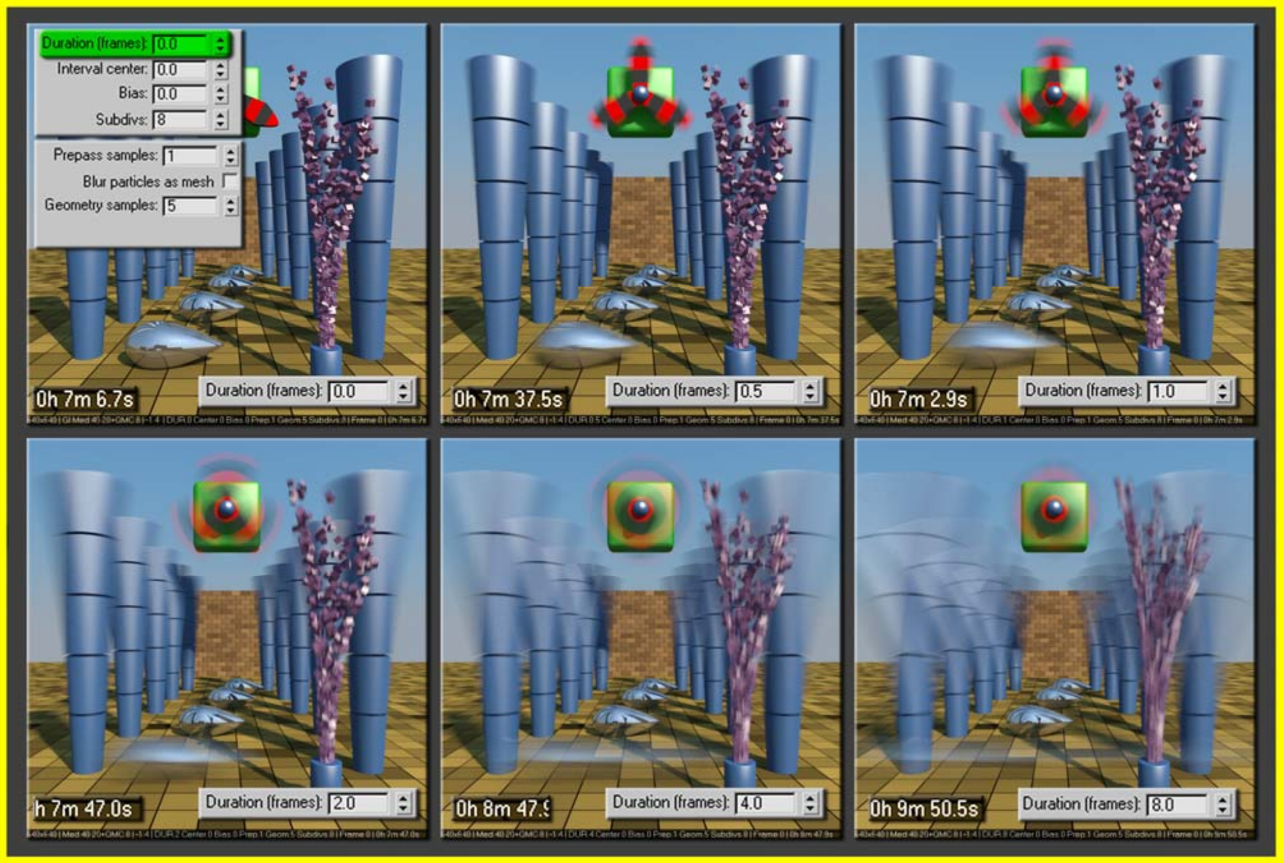
Prepass samples: 1 Blur particles as mesh □ Geometry samples: 5

640x640 | Med 40 20+QMC 8 | -1 4 | DUR 4 Center 0 Bias 0 Prep 1 Geom 5 Subdivs 8 | Frame 0 | 0h 8m 47.9s

■ **Figure 4.241**
Activation of parameters which concern *Motion blur* in VRay.

One can see how the use of ***Motion blur*** increases rendering time greatly. Quality and calculation time can be modified according to the user's needs.

Duration - this specifies the opening of the ***shutter*** of the camera, measured in frames.



Duration (frames): 0.0 Interval center: 0.0 Bias: 0.0 Subdivs: 8

Prepass samples: 1 Blur particles as mesh □ Geometry samples: 5

0h 7m 6.7s Duration (frames): 0.0

0h 7m 37.5s Duration (frames): 0.5

0h 7m 2.9s Duration (frames): 1.0

h 7m 47.0s Duration (frames): 2.0

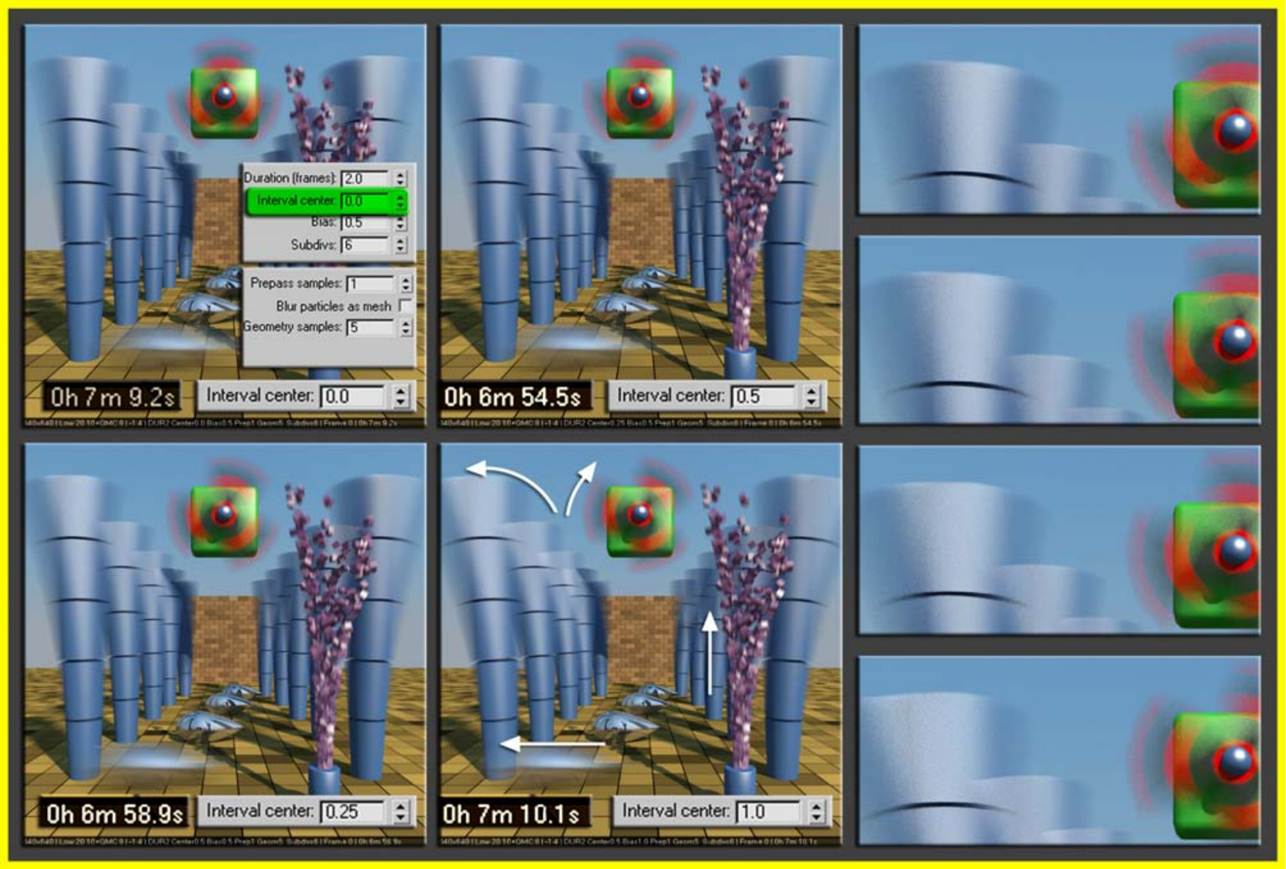
0h 8m 47.! Duration (frames): 4.0

0h 9m 50.5s Duration (frames): 8.0

■ **Figure 4.242**
Variation of the duration of *Motion blur*.

The effects caused by this parameter are the increased ***Motion blur*** effect and rendering time, although the latter suffers a little from increasing the ***Duration*** parameter.

Interval center - this specifies the central position of ***Motion blur*** compared to the 3ds Max frame. Value 0.5 means that the centre of the interval of ***Motion blur*** is between one frame and the next. Value 0.0 means that the centre of the interval of ***Motion blur*** is exactly on the current frame. Default value is 0.5.


Duration (frames): 2.0
Interval center: 0.0
Bias: 0.5
Subdivs: 6
Prepass samples: 1
Blur particles as mesh □
Geometry samples: 5

0h 7m 9.2s Interval center: 0.0

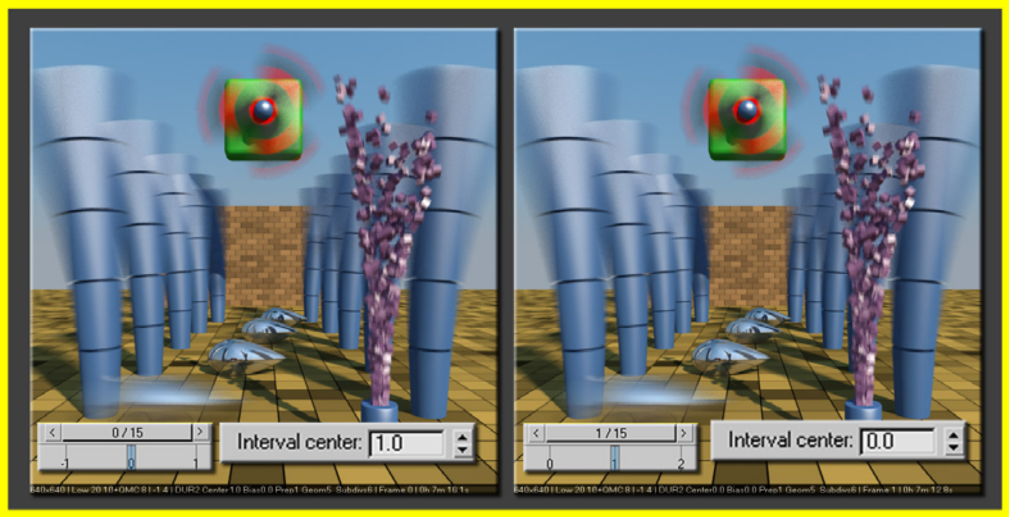
0h 6m 54.5s Interval center: 0.5

0h 6m 58.9s Interval center: 0.25

0h 7m 10.1s Interval center: 1.0

■ **Figure 4.243**
Rendering with different values of *Interval centre*.

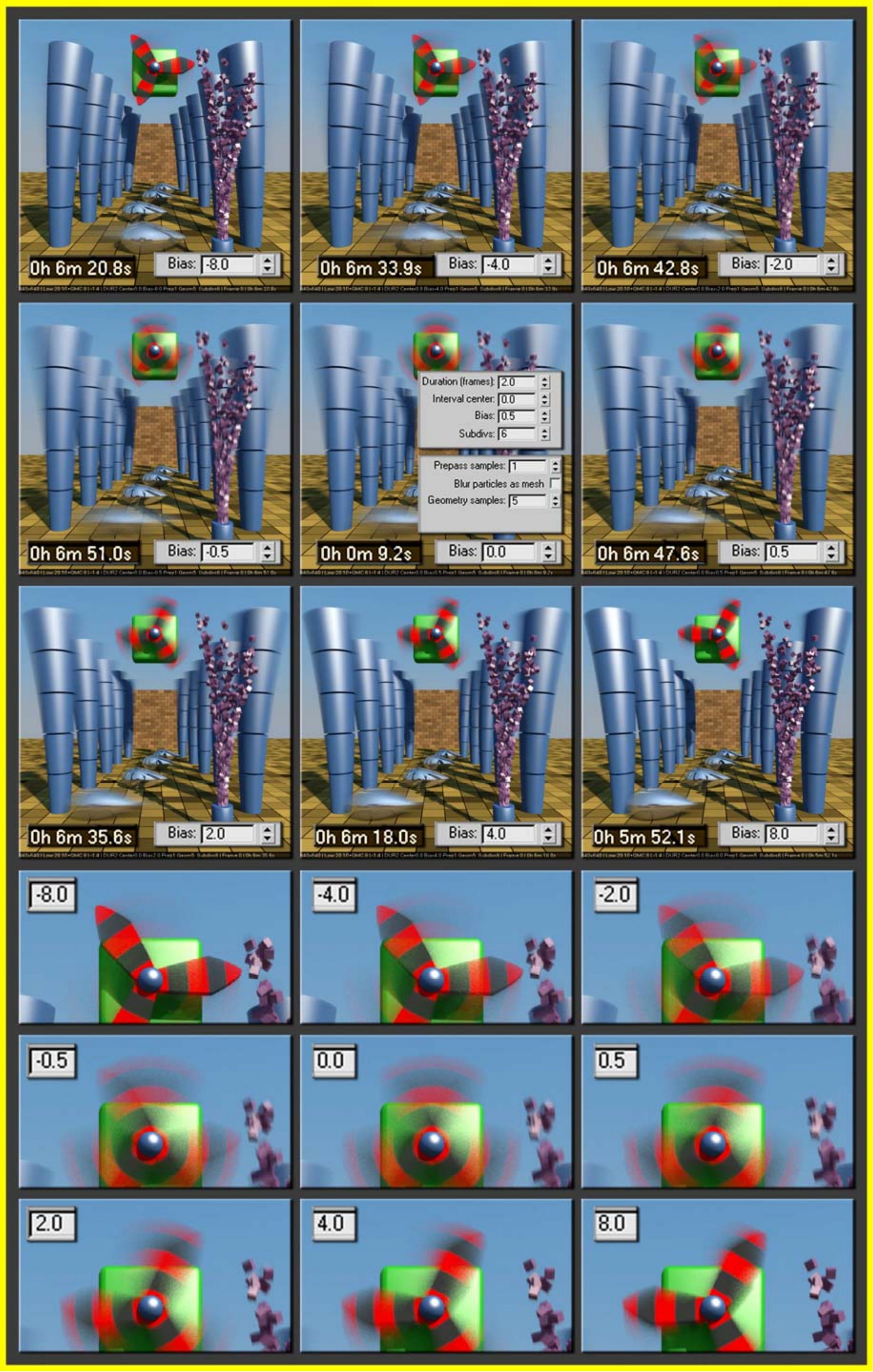
This parameter, which has a range from 0 to 1, allows one to move the centre of ***Motion blur*** within the frame of reference, and therefore modify its result. In this case, frame number 0 has been used. With ***Interval center*** = 1 one has the same result that one would get by setting frame number 1 to ***Interval center*** = 0.


0 / 15 Interval center: 1.0

1 / 15 Interval center: 0.0

■ **Figure 4.244**
With the *Interval center* parameter applied on different frames it is possible to obtain the same *Motion blur* result.

Bias - this parameter controls the bias of ***Motion blur***. Value 0,0 means that light crosses the camera in a uniform way during the hole interval of ***Motion blur***. With positive values the light is concentrated towards the end of the interval. Negative values concentrate it towards the beginning.



Duration (frames): 2.0
Interval center: 0.0
Bias: 0.5
Subdivs: 6

Prepass samples: 1
Blur particles as mesh □
Geometry samples: 5

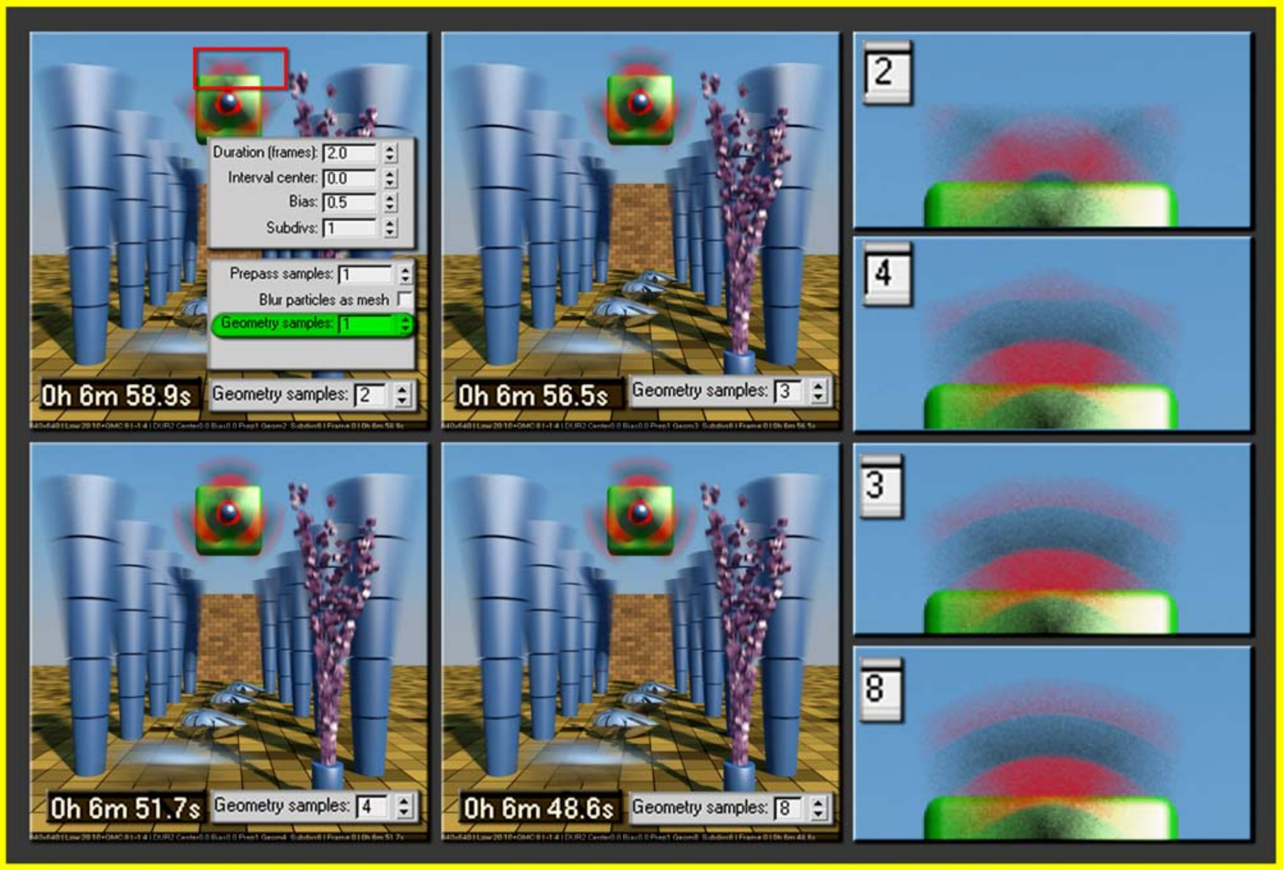
■ **Figure 4.245**
Trail effect caused by changes made to the *Bias* settings.

Changing this parameter a trail appears which, in case of negative values, anticipates the movement of the object. It is easy to see how when ***Bias*** = 0, ***Motion blur*** is perfectly symmetrical, whereas with positive values the propeller, behind itself, produces a typical trail of a moving object. If values are too high though, this effect tends to be cancelled. It is therefore necessary to find the correct compromise between ***Bias*** and "trail length". In our case, a value between 2.0 and 4.0 seems to be the best solution.

Prepass samples - this parameter controls the number of samples of the ***Motion blur*** calculated during the calculation of the ***Irradiance Map***.

Blur particles as mesh - this parameter controls the ***Motion blur*** of every single unit in a particle system. When this parameter is activated, particles are considered as single meshes and ***Motion blur*** is applied normally. If the system has its own particular characteristics causing such that the number of particles changes between a frame and the next, this parameter should be deactivated. In this case the calculation of ***Motion blur*** should be calculated during post-production with use of the ***VRayVelocity*** element.

Geometry samples - this parameter controls the number of geometrical segments used for approximating ***Motion blur***. If objects move in a non-linear way one must increase this value, in order to avoid possible flaws. Notice that the more ***Geometry samples*** are used, the more memory is consumed because more copies of the same mesh are necessary to apply ***Motion blur*** to.



Duration (frames): 2.0
Interval center: 0.0
Bias: 0.5
Subdivs: 1

Prepass samples: 1
Blur particles as mesh ☐
Geometry samples: 1

0h 6m 58.9s Geometry samples: 2

0h 6m 56.5s Geometry samples: 3

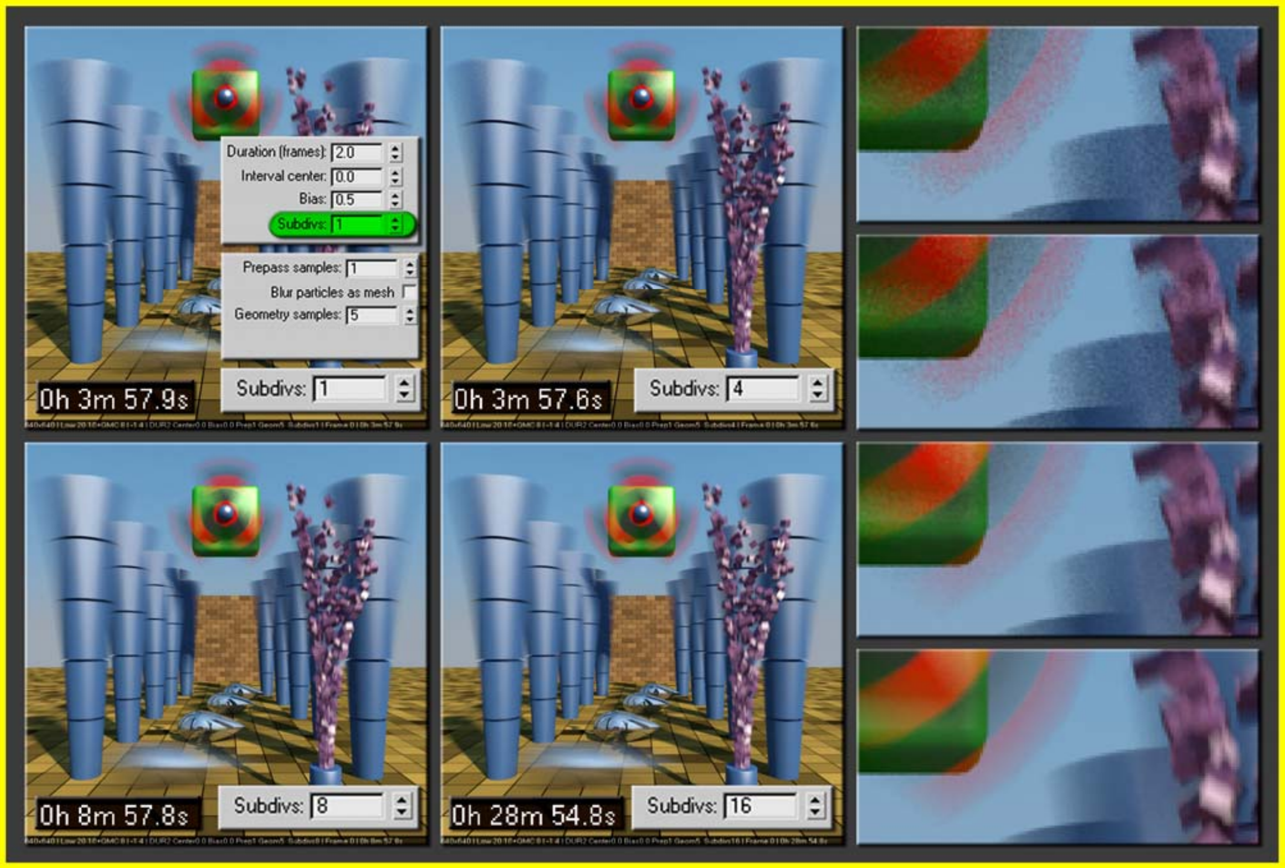
0h 6m 51.7s Geometry samples: 4

0h 6m 48.6s Geometry samples: 8

■ **Figure 4.246**
Variation of the *Geometry samples* value within VRay's *Motion blur*.

The effect of this parameter is quite evident, especially on the propeller. As it maintains a rotatory movement, the ***Motion blur*** greatly benefits from an increased number of samples. If it uses only two samples, ***VRay*** only has two instances of the object for calculating ***Motion blur***, at the start and at the end. Interpolation can only be straight. The greater the number of samples, the better the approximation of ***Motion blur*** becomes. If ***Motion blur*** is applied to an object which moves in a straight line, for example the tear-drop object on the floor, the variation of the ***Geometry samples*** parameter does not provide any evident changes.

Subdivs - this controls the quality of noise within ***Motion blur***. Low values permit a faster calculation, but the effect is more coarse and disturbed. With high values, ***Motion blur*** is of a higher quality, but at the cost of rendering time. As all ***Subdivs***, also these depend on the parameters in the ***VRay: rQMC samples***.



Duration (frames): 2.0
Interval center: 0.0
Bias: 0.5
Subdivs: 1

Prepass samples: 1
Blur particles as mesh □
Geometry samples: 5

Subdivs: 1
Subdivs: 4
Subdivs: 8
Subdivs: 16

■ **Figure 4.247**
Variation in the number of subdivisions in *Motion blur*.
- - - DVD - - -

As the number of ***Subdivisions*** increases, the quality improves noticeably, but so does rendering time. The range goes from 4 min. for a low quality ***Motion blur*** to 30 min. for high quality. If ***DOF*** and ***Motion blur*** are being used simultaneously, VRay considers the highest ***Subdivs***.
Often it is useful to fulfil ***Motion blur*** in post-production, rather than directly within 3D software. This allows a greater flexibility and faster renders, but the result obtained in post-production does not always equal the quality one reaches when working in 3D. It all depends on time, the hardware and the quality one wishes to obtain.