



# Virtual Reality Photography

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Scott Highton

[www.vrphotography.com](http://www.vrphotography.com)

[www.highton.com](http://www.highton.com)



MacWorld 2011  
User Conference **US983**

January 29, 2011



# Visual Impact of the Panorama

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# Visual Impact of the Panorama

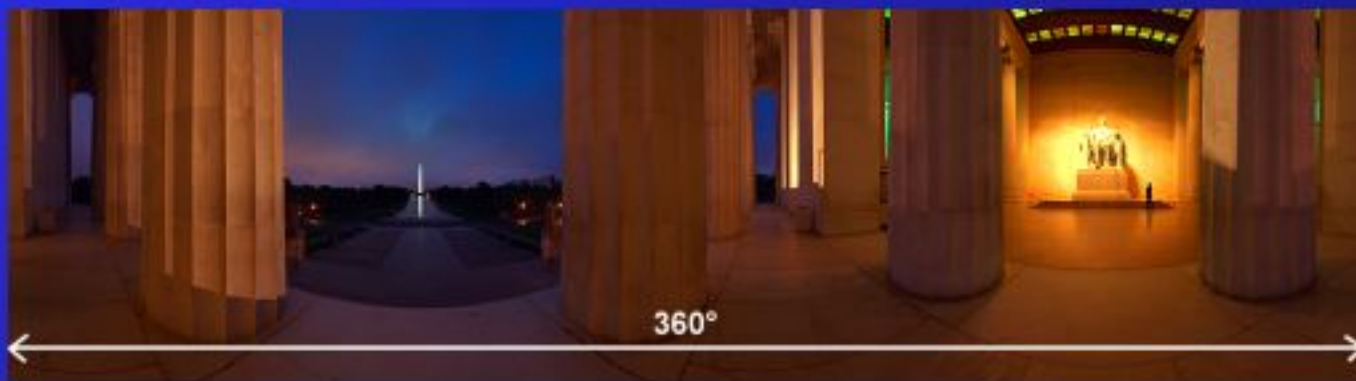
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# Horizontal Views

- ◆ “Partial” panorama:  
 $< 360^\circ$  fov(x)
- ◆ “Full” panorama:  
 $\geq 360^\circ$  fov(x)



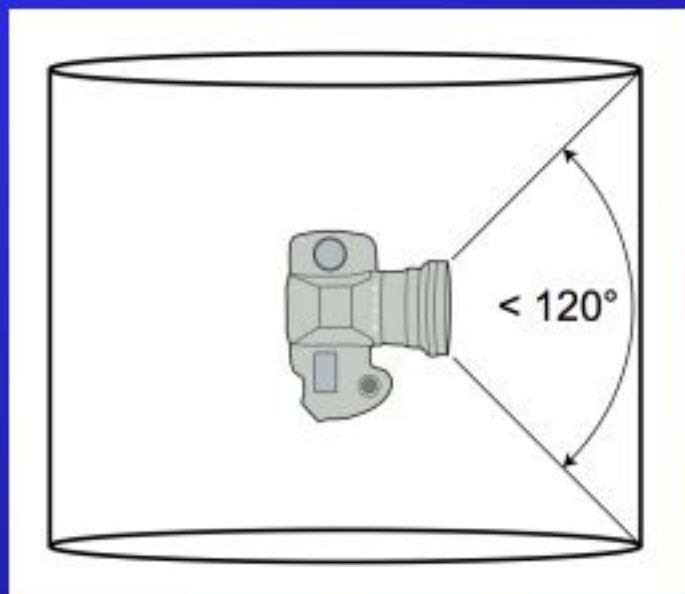


# Cylindrical Format – fov(y)

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- ◆ *Vertical views*

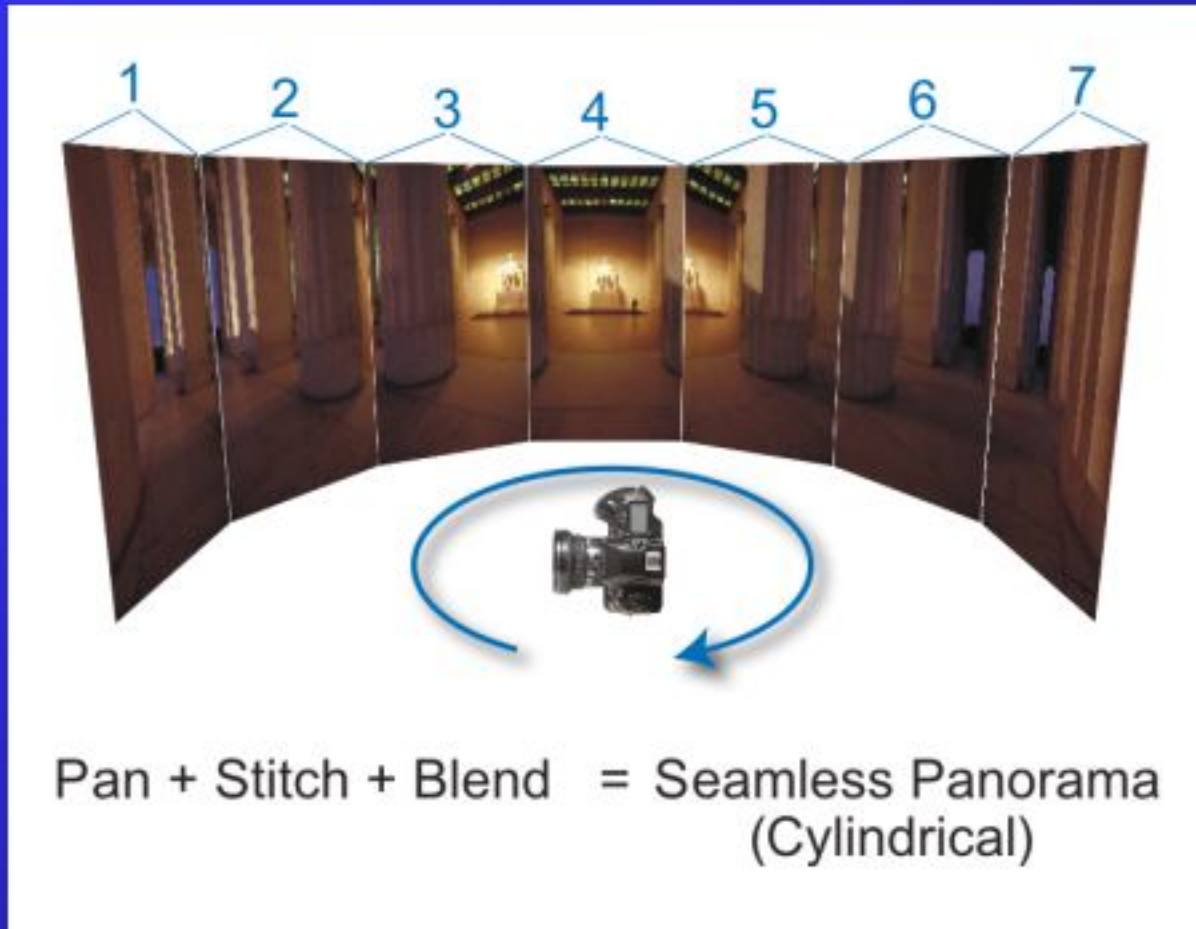
Cylindrical – restricted fov(y)







# Cylindrical Stitching





# Shooting & Stitching Basics

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- ◆ Images should overlap by **1/3** to **1/2**
- ◆ Pan left to right
- ◆ Exposure, WB, focus, focal length match
- ◆ Tripod use **highly** recommended
- ◆ Entrance pupil alignment

## ◆ **Stitching software:**

PTGui

Autodesk Stitcher

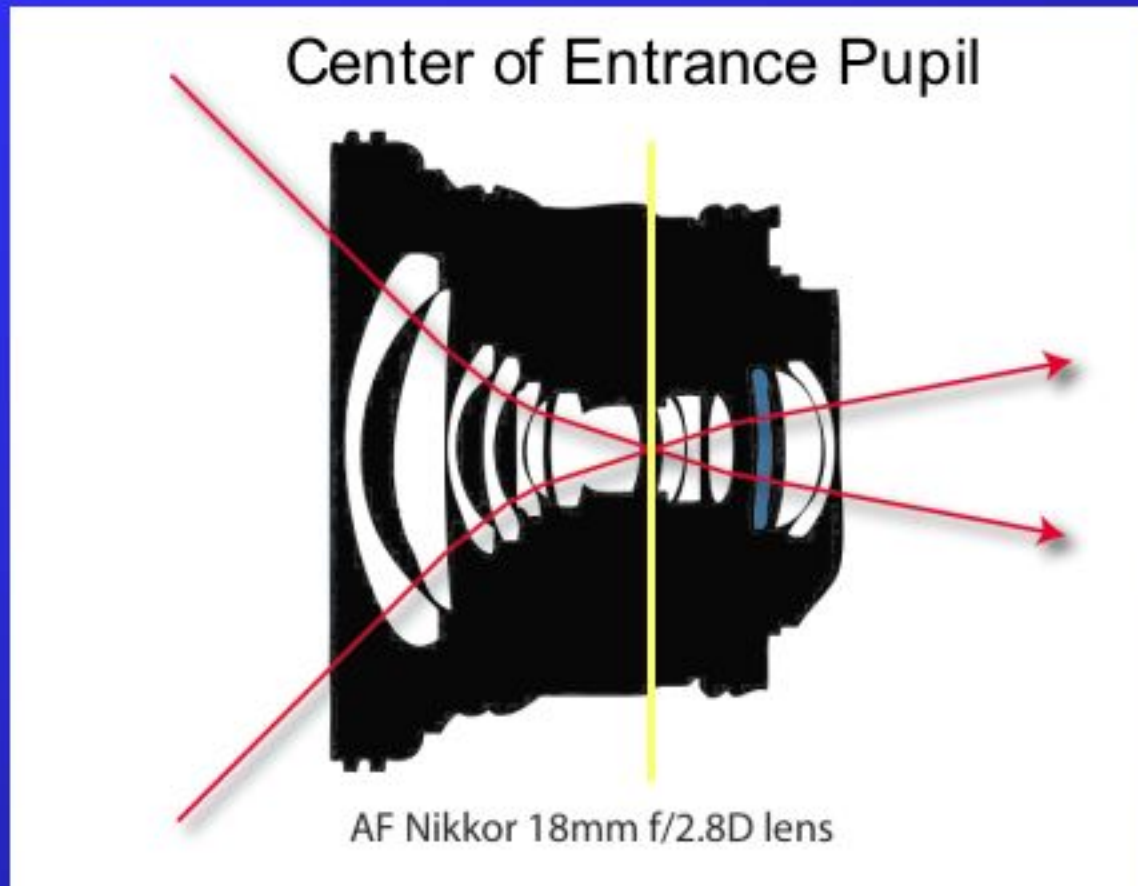
VRWorx

Panoweaver



# Entrance Pupil Alignment

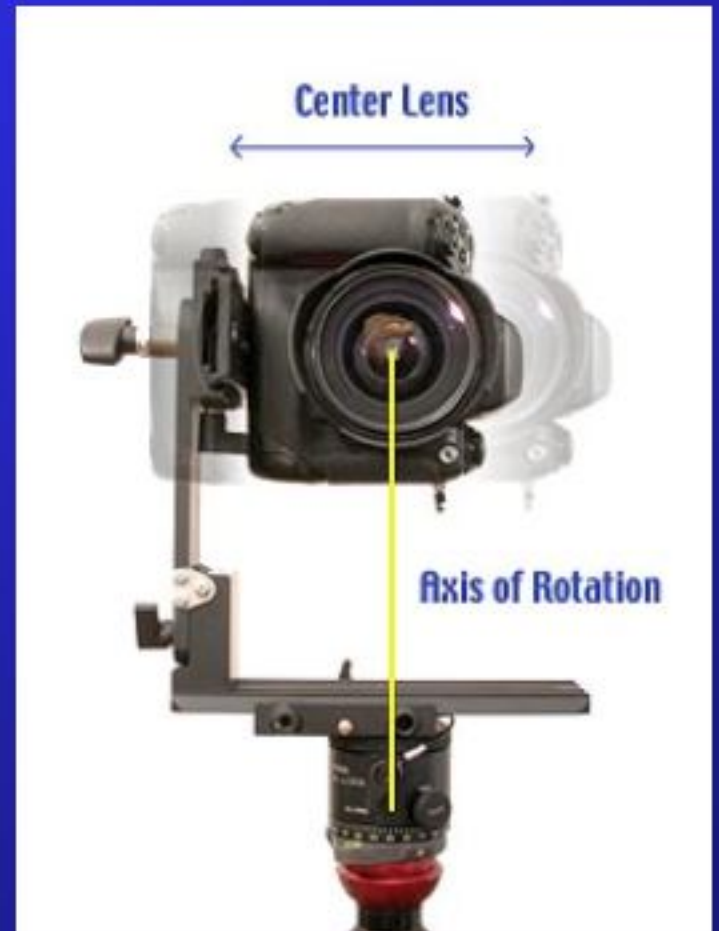
---







# Entrance Pupil Alignment





# Entrance Pupil Alignment

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(Misaligned)



# Entrance Pupil Alignment



(Aligned)





# Commercial Pan Heads

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**Manfrotto**

**Peace River Studios**

**Nodal Ninja**

**360Precision**

**Panosaurus**

**Really Right Stuff**

**Agnos**

Entrance pupil alignment process:

**[www.vrphotography.com](http://www.vrphotography.com)**



# Camera Orientation

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Horizontal  
(Normal)

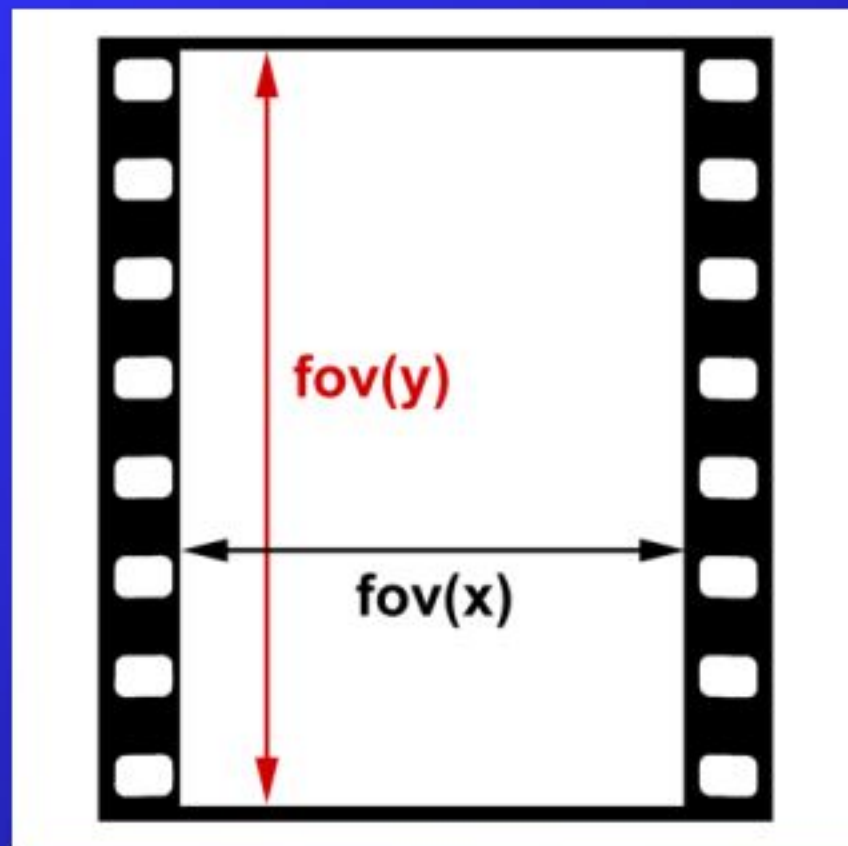
Vertical  
(Portrait)





# Fields of View – fov

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# Camera Orientation – fov(y)

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Vertical



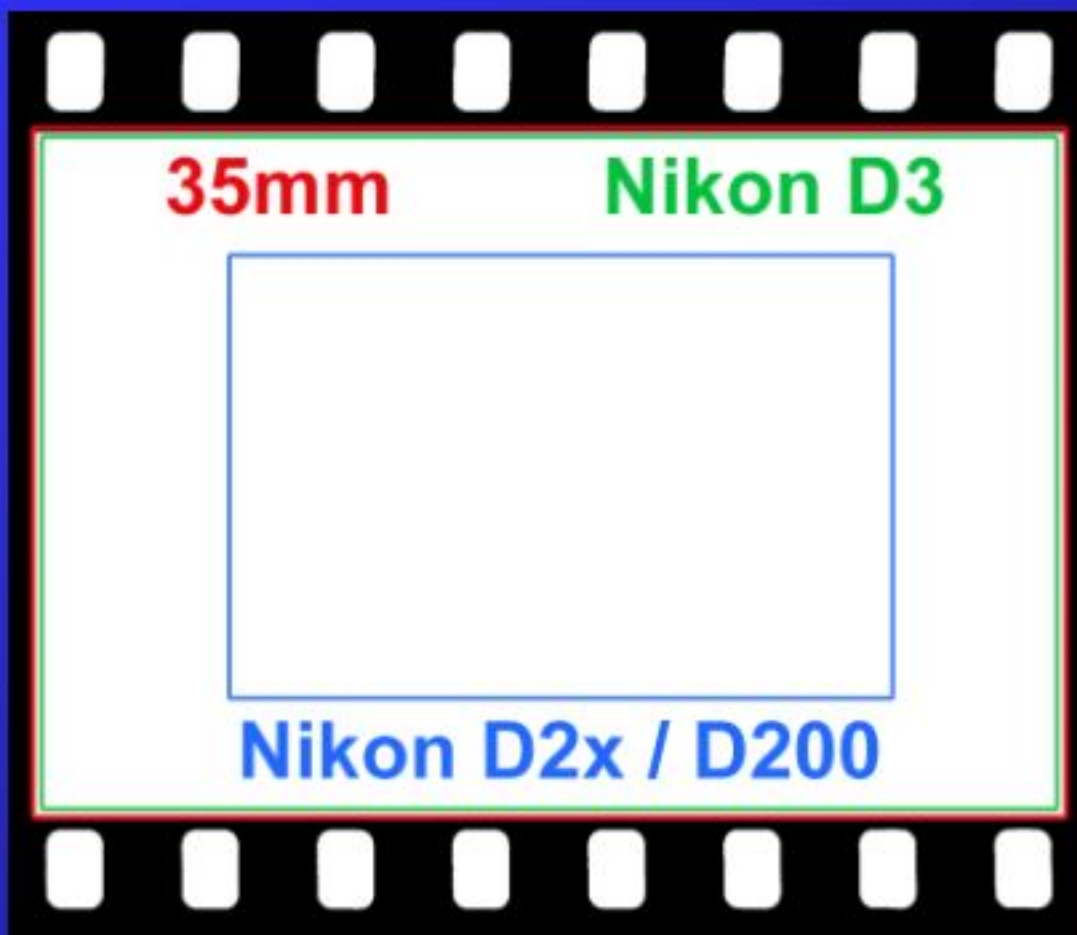
Horizontal





# Cropping – Digital Sensors

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# VR Photo Slate Book

### Fields of View (Fov): 35mm camera & lenses

Focal length	FovH	FovV	Shots/360°
28mm	84°	54°	8
35mm	63°	42°	8
50mm	47°	31°	8
75mm	32°	21°	8
100mm	25°	16°	8
150mm	17°	11°	8
200mm	13°	8°	8
300mm	9°	6°	8
400mm	7°	5°	8
500mm	6°	4°	8
600mm	5°	3°	8
800mm	4°	2°	8
1000mm	3°	2°	8

### Slate Book Instructions

The Slate Book is designed to allow photographers to be confident of their work when preparing a scene.

When shooting the Slate Book, it is important to use the correct lens and camera settings. The Slate Book is designed to be used with a 35mm camera and lens. The Slate Book is designed to be used with a 35mm camera and lens. The Slate Book is designed to be used with a 35mm camera and lens.

### Hyperfocal Distances

	35mm	45	55.6	66	81.1	95	110
10mm	11	13	16	19	23	27	31
15mm	17	20	25	30	37	44	51
20mm	23	28	35	42	51	61	71
25mm	29	35	44	53	64	76	88
30mm	35	43	53	64	77	91	105
35mm	41	50	62	75	90	106	123
40mm	47	58	72	87	104	122	141
45mm	53	65	81	98	117	137	158
50mm	60	73	91	110	131	153	177
55mm	67	81	100	121	144	168	194
60mm	75	90	111	134	159	185	213
65mm	83	100	123	148	175	203	233
70mm	92	111	137	164	193	223	256
75mm	101	122	151	182	214	246	282
80mm	111	133	165	200	234	268	307
85mm	121	145	180	219	255	291	333
90mm	132	158	198	241	280	318	363
95mm	143	172	211	257	300	340	389
100mm	155	187	228	277	321	363	416

www.vrphotography.com





# Cylindrical Panorama Capture

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- ◆ Traditional camera + pan head + stitching





# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping







# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping



Produces flattened  
torus image

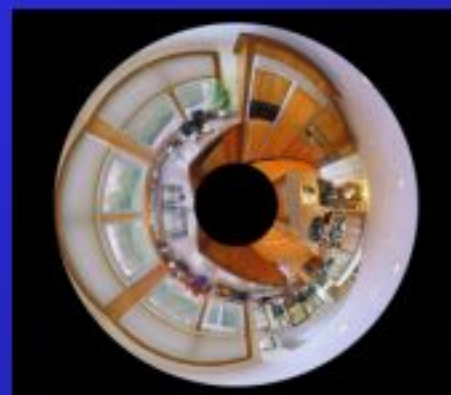






# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping



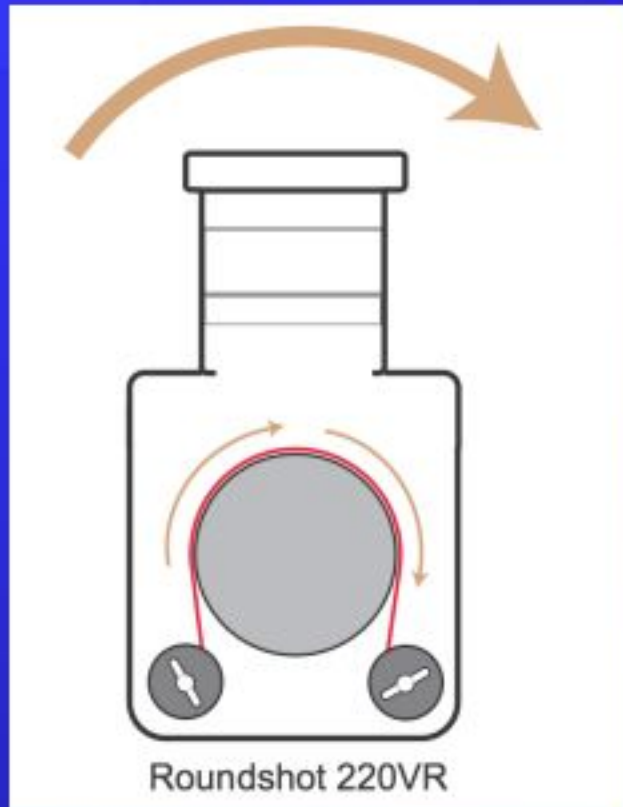
PhotoWarp  
software





# Cylindrical Panorama Capture

- ◆ Slit-scan full rotation camera





# Fov(y) - Cylindrical vs. Cubic

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Cylindrical

Cubic





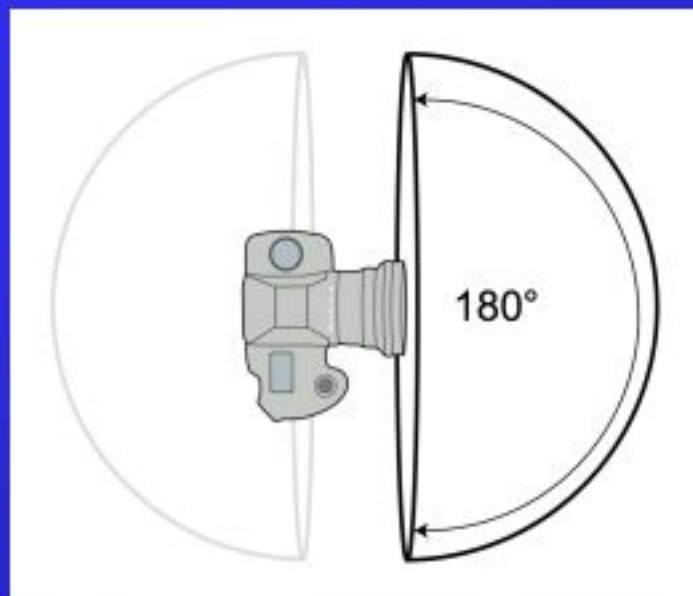


# Panoramic Formats

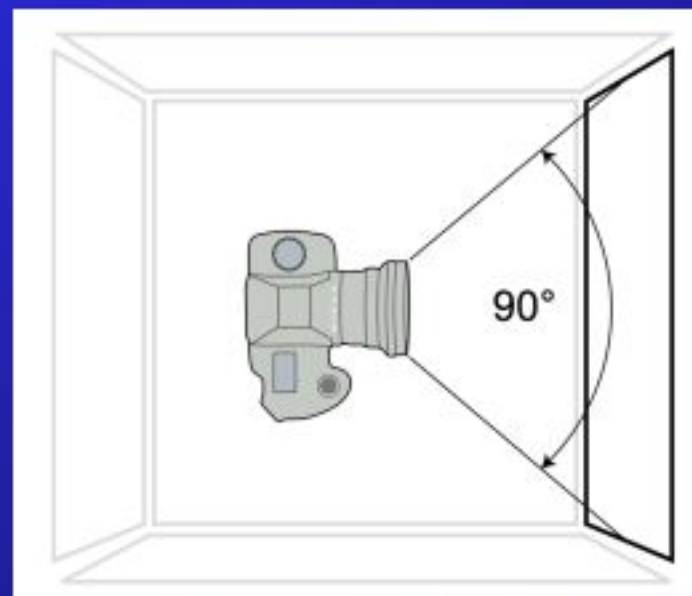
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- ◆ *Vertical* views – unlimited fov(y)

Spherical



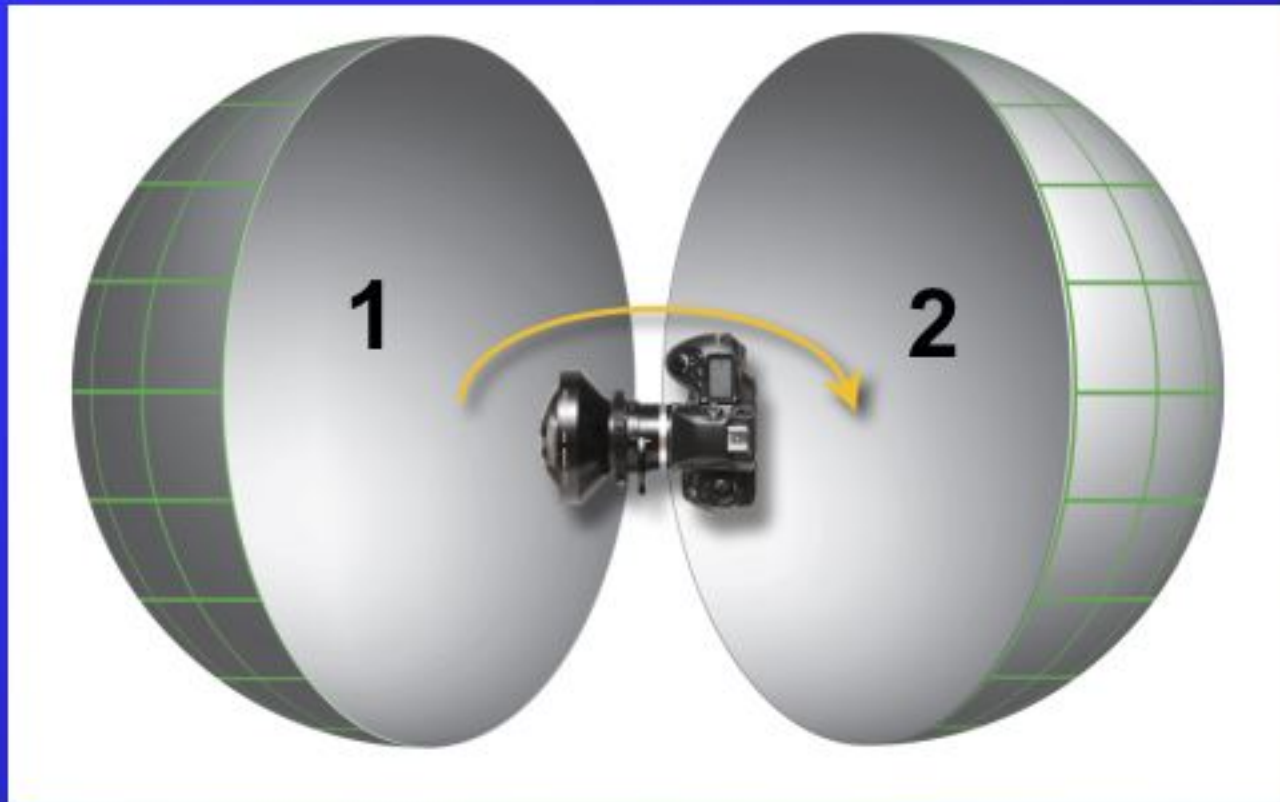
Cubic





# Spherical Panoramas

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Two or More (True) Fisheye Images - IPIX



# Scanning Digital Cameras

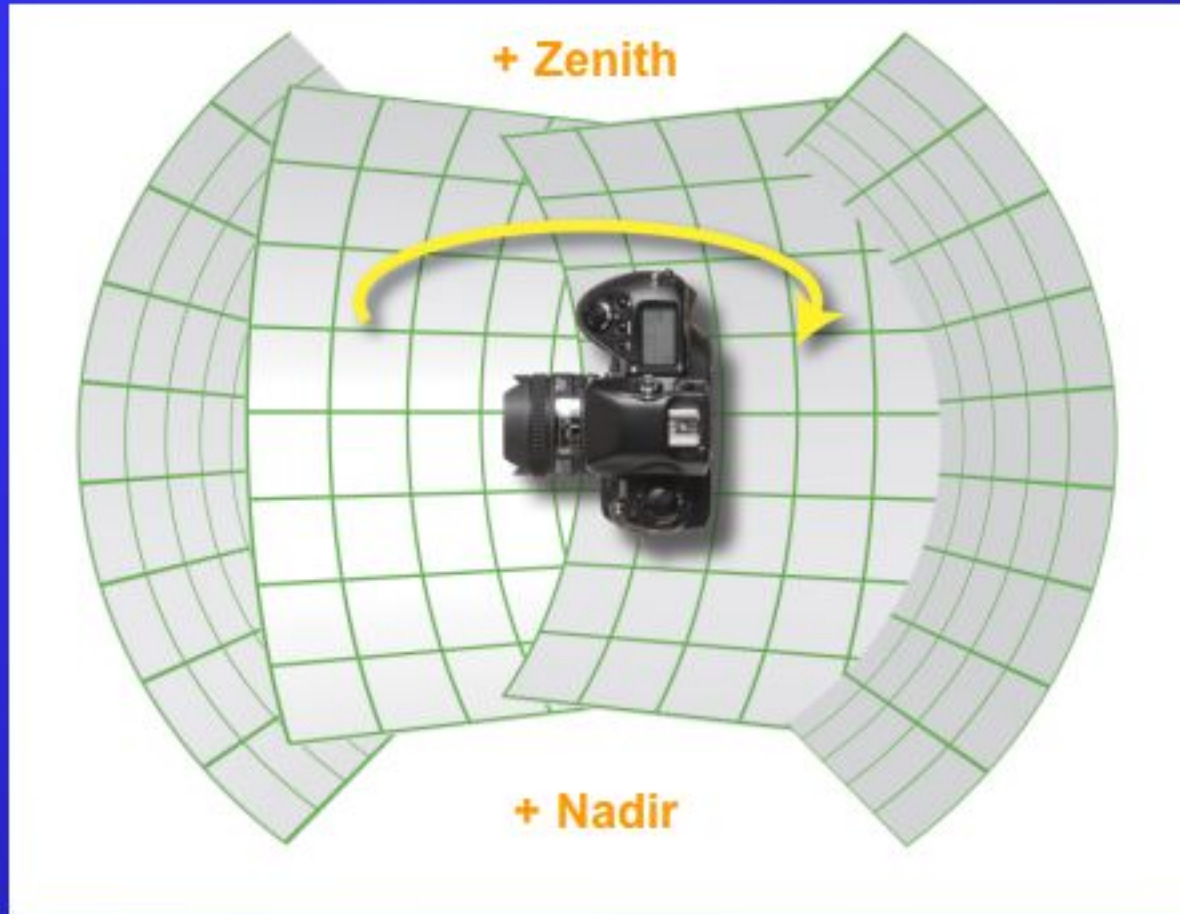
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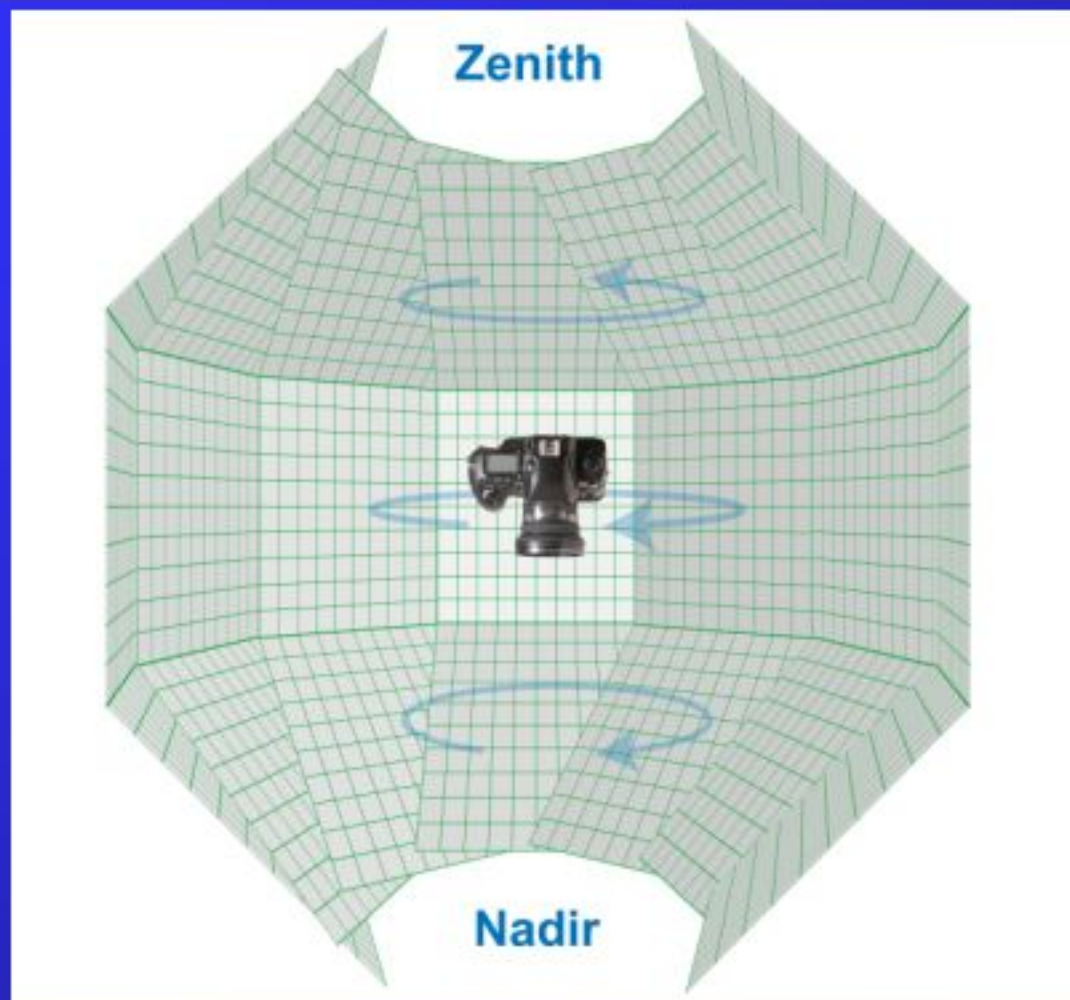
# Spherical / Cubic Panoramas



Stitched Full Frame Fisheye Images



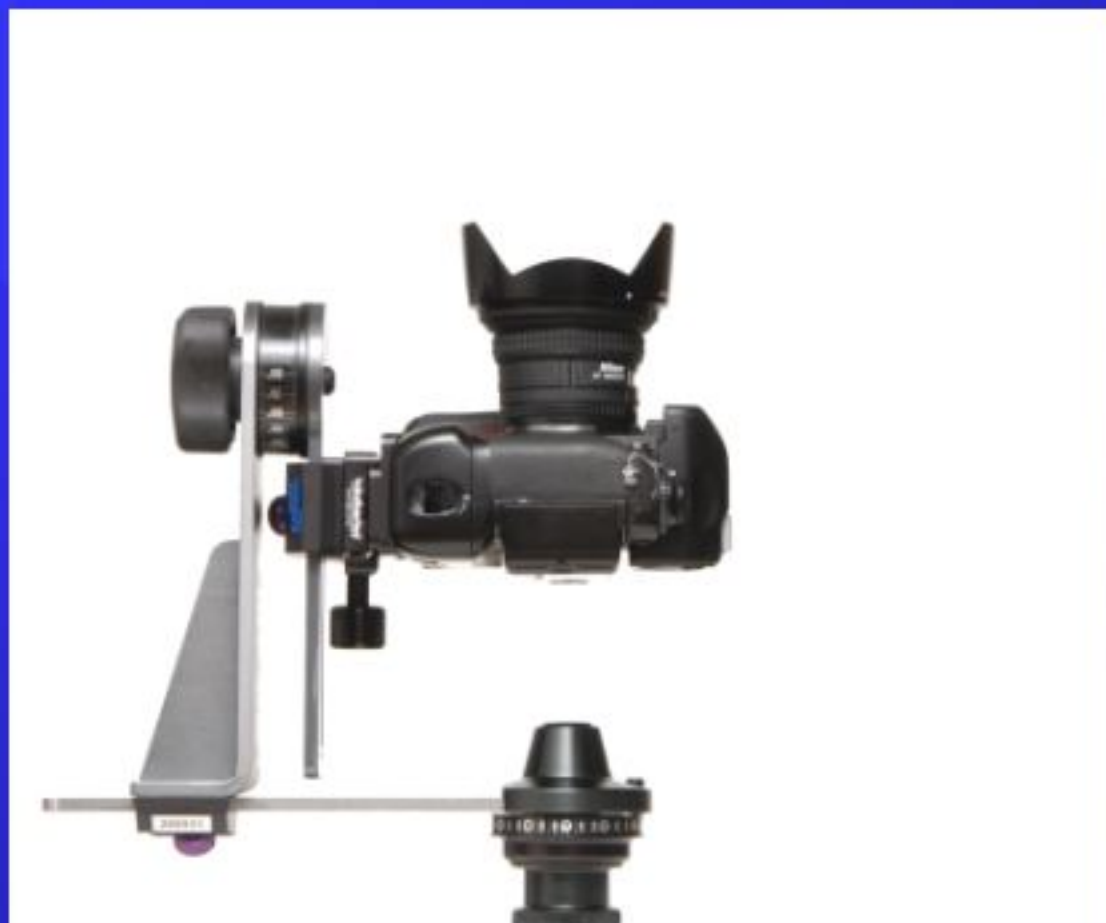
# Multi-Row Panoramas





# Multi-Row Image Capture

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Kaidan QuickPan Pro





# Multi-Row Image Capture



**Lens:** Nikkor 18mm

**Exp:** 1/125 sec @ f/11

**Pan:** 3 rows - 12 exp. ea.

**Date:** 8/20/04



# Multi-Row Image Capture

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# Multi-Row Stitching

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# Multi-Row Stitching

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# Create VR Panoramic Movie

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# Stitching Applications

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- ◆ PTGui  
[www.ptgui.com](http://www.ptgui.com)
- ◆ Autodesk Stitcher  
[www.realviz.com](http://www.realviz.com)
- ◆ Photoshop CS5 Extended (3D) & PhotoMerge  
[www.russellbrown.com](http://www.russellbrown.com)
- ◆ Flash movie preparation: Pano2VR  
[gardengnomesoftware.com](http://gardengnomesoftware.com)





# Stitching Application Demo

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- ◆ PTGui – <http://www.ptgui.com>

Demo version (Mac or Windows): Free

Full version: ~ \$106

Pro Version: ~ \$199



# Choosing Your Tools

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- ◆ Choose stitching/assembly software first!
- ◆ Do you need full 360°x180° vs. cylindrical?
- ◆ Then, choose photo tools:
  - ◆ Camera & lens
  - ◆ Digital vs. film
  - ◆ Grip, camera support, pan head
  - ◆ Other post production needs (retouching, etc.)
- ◆ Other limitations
  - ◆ Lighting needs
  - ◆ Location requirements



# Panorama Effectiveness

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“f/8 and be there!”







# Effective Photography

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“f/8 and be there!”





# Effective Photography

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# Effective Photography

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# Effective Photography

---





# Effective Photography

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# Effective Photography

---







# Effective Panoramas

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# Effective Panoramas

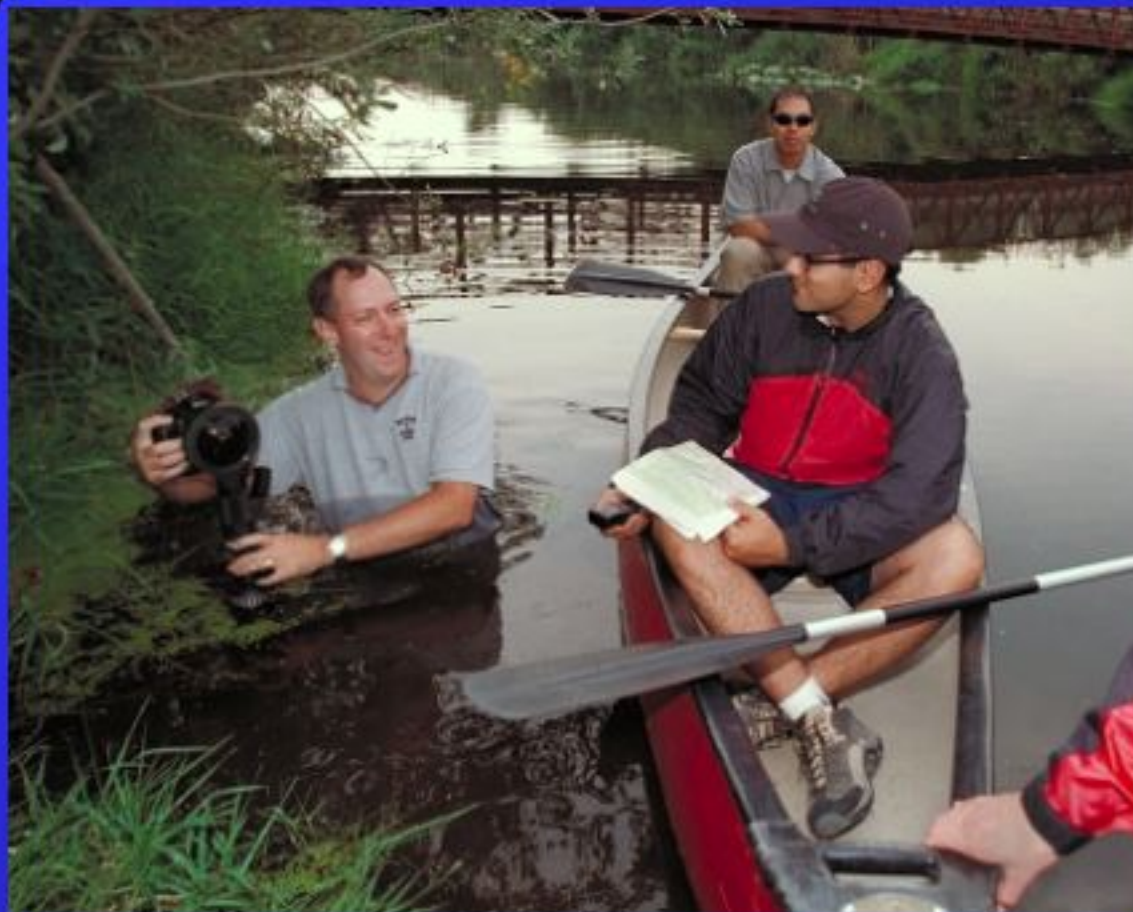
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- ◆ Involve your viewers
- ◆ Immerse them in the story
- ◆ It's your story to tell – don't make your audience have find it for themselves

**Practice this!**



# Location Photography







# Location Lighting

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6:06 am



# Subject Interest

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# Other Useful Panorama Software Applications

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- ◆ Pano2VR

[gardengnomesoftware.com](http://gardengnomesoftware.com)

- ◆ Cubic Converter

[www.clickheredesign.com.au/software/](http://www.clickheredesign.com.au/software/)

- ◆ SpinControlVR

[panosalado.com](http://panosalado.com)





# Object Movies

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# Object Movies

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# Object Movies

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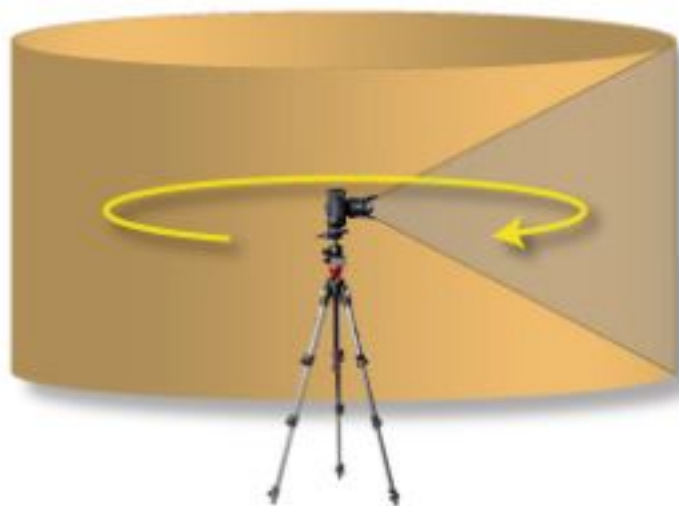




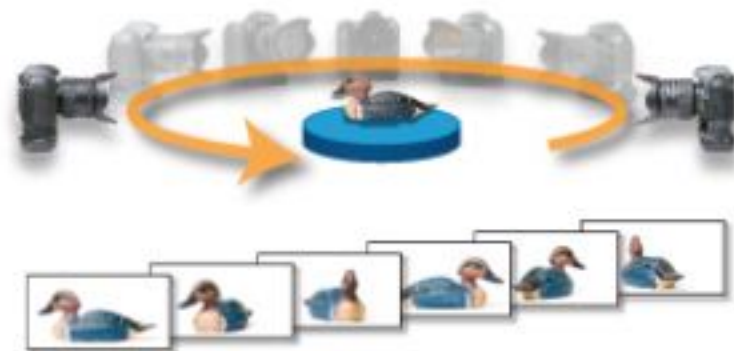


# Panoramas vs. Objects

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Panoramas  
(Camera faces outward)



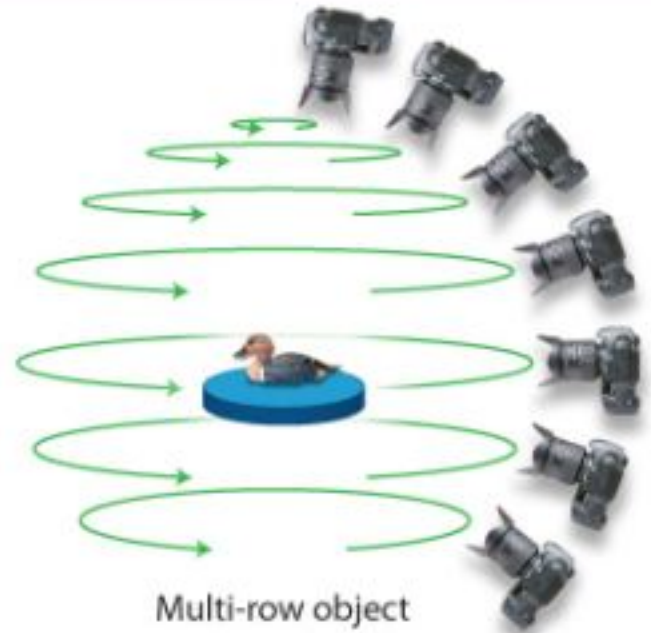
Object movies  
(Camera faces inward)



# Single vs. Multi-row Objects



Single row object



Multi-row object



# Multi-row Object Movie

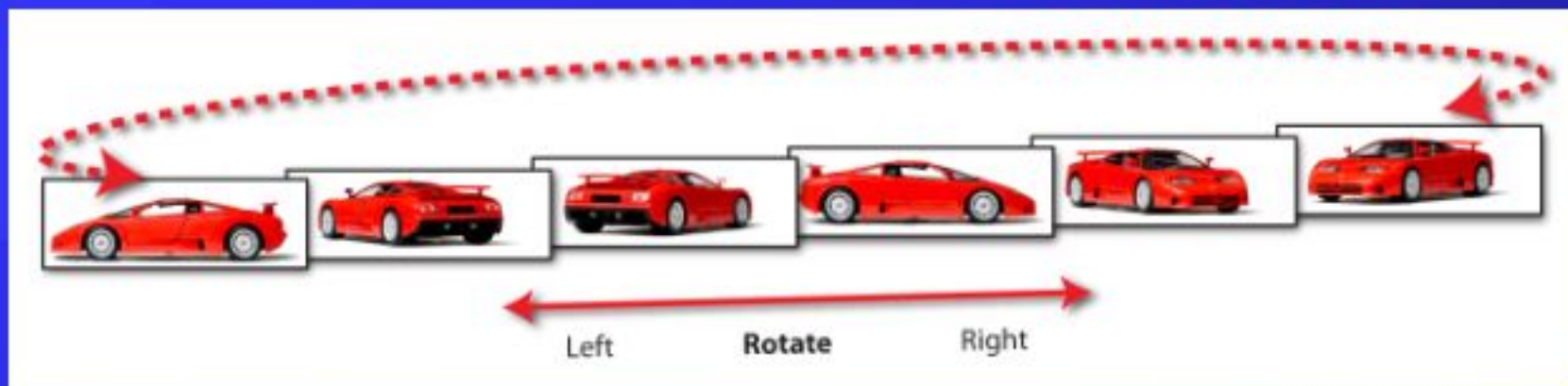
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# Multi-row Object Movies





# Object Photography Technique

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## ◆ Consistency and Repeatability

Camera: lock focus, WB, exposure, position

Object: controlled motion increments

Lighting: consistent throughout rotation

## ◆ Tools Needed

Digital camera

Tripod or stable camera/object rig

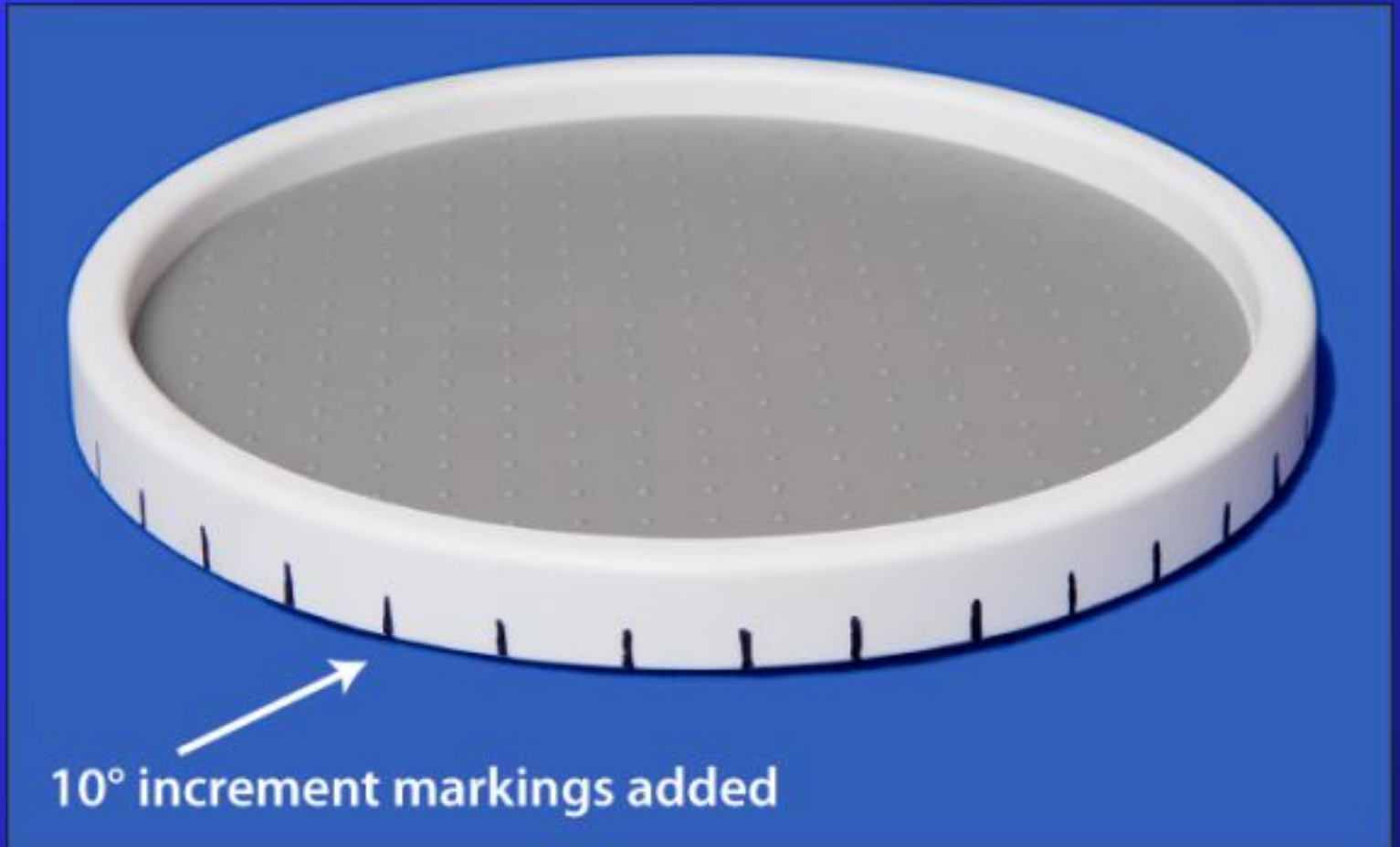
Turntable for object

Object authoring software



# Object Turntables

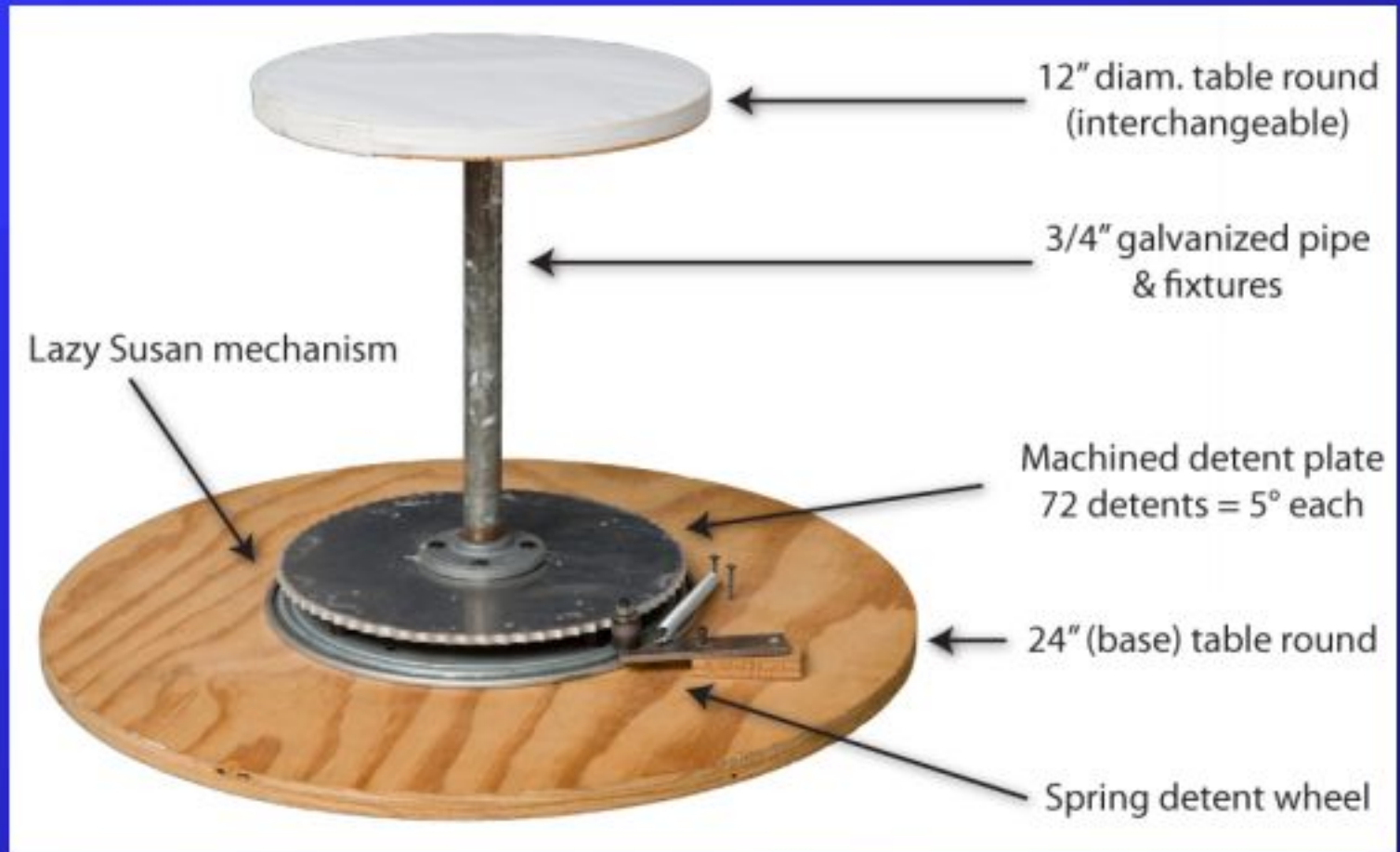
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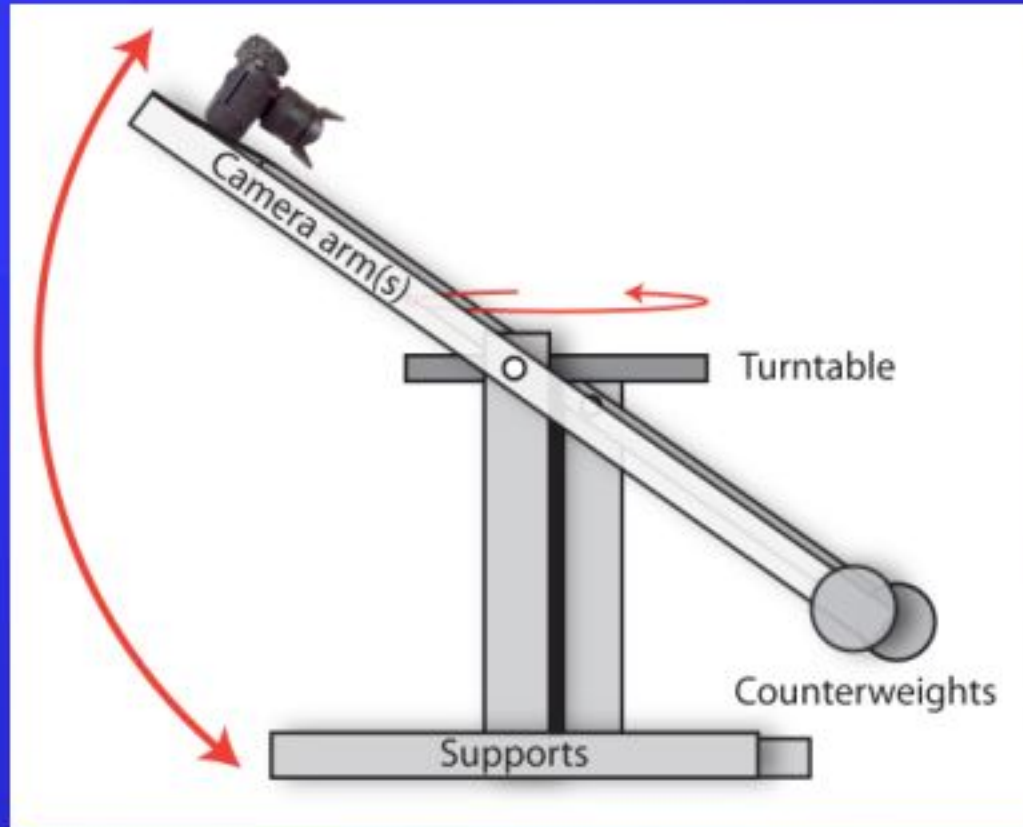


# Object Turntables

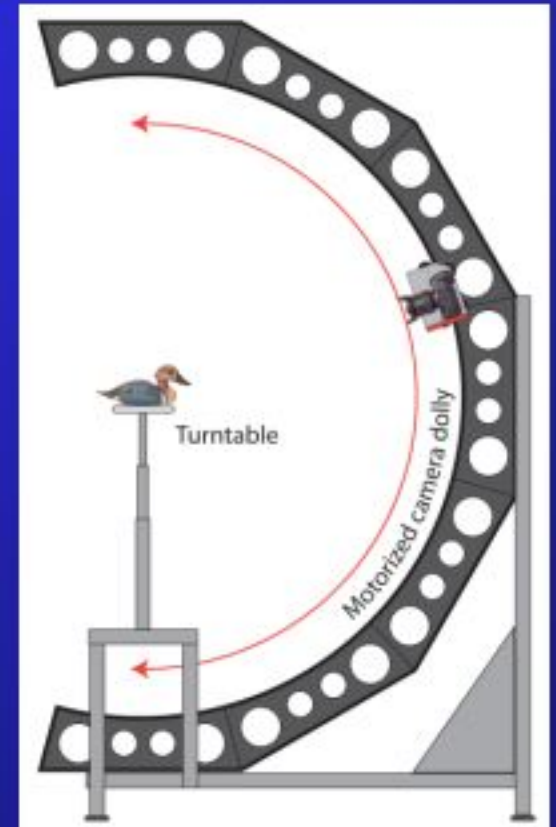




# Object Rigs (Multi-Row)



Rotating Arm



C-Frame



# Object Rigs (Multi-Row)

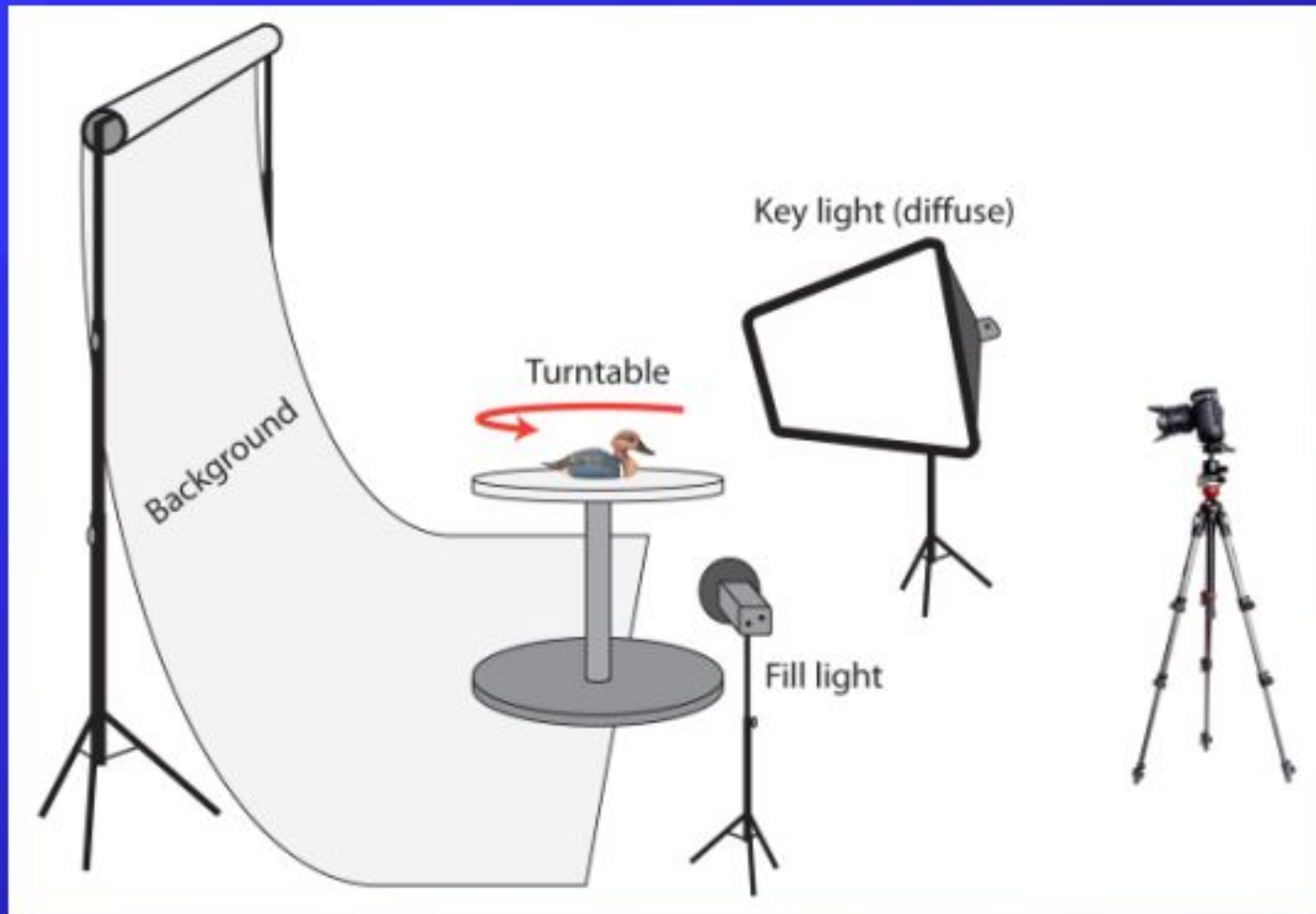


Articulating Arm





# Object Lighting



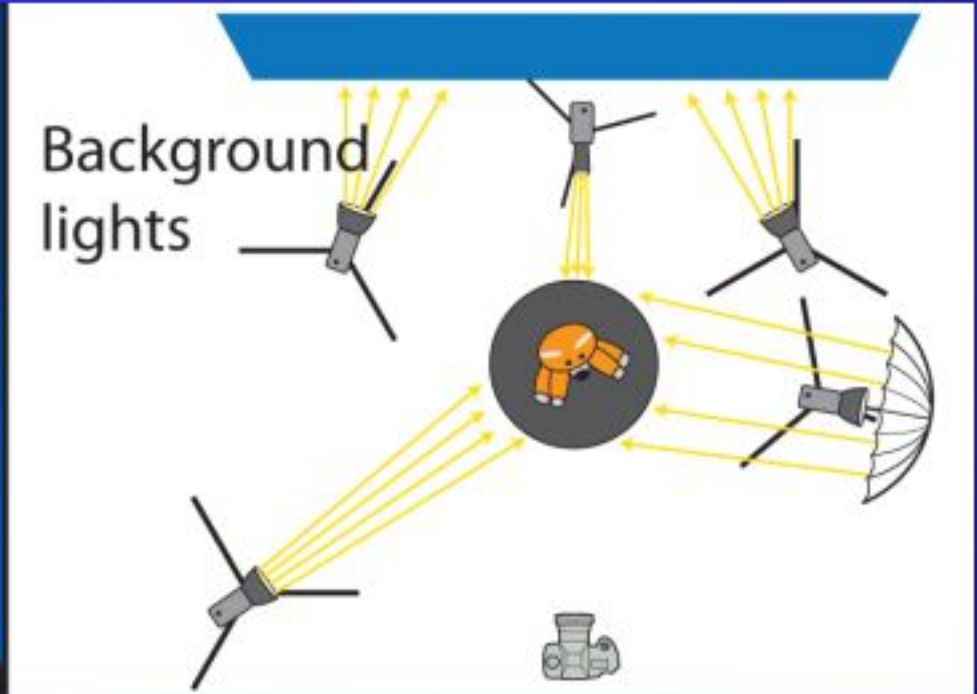


# Object Lighting - Single Light





# Object Lighting - Multiple Lights

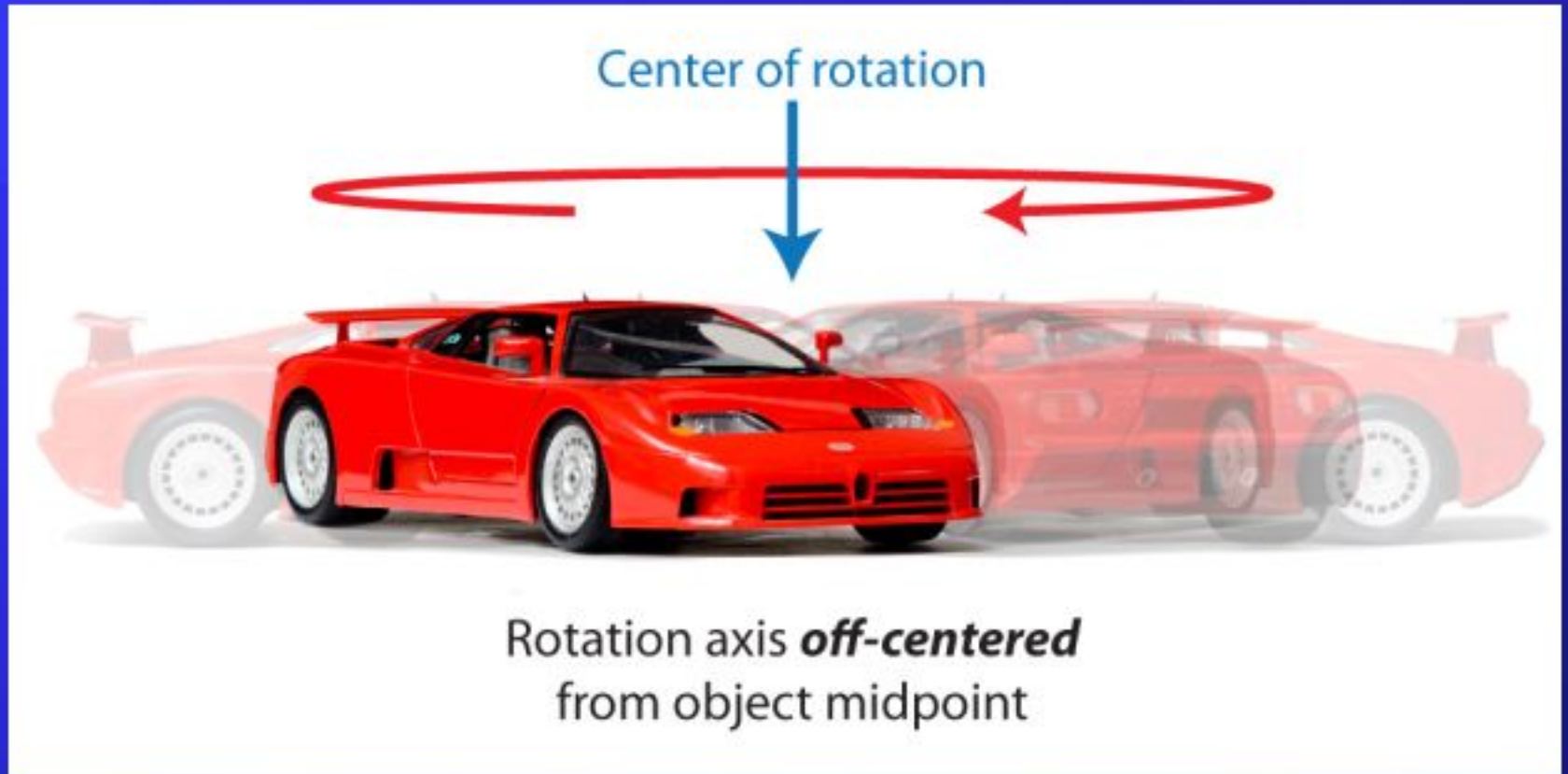






# Axis of Rotation

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# Perspective and Lens Choice

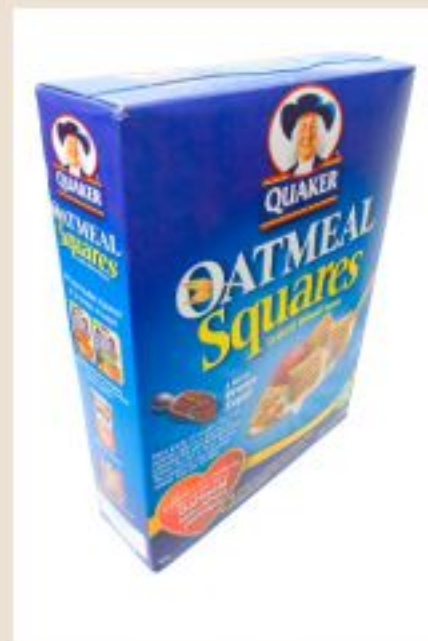
## Wide angle lens (18mm)



Low view



Mid-level



High view  
elevated



# Perspective and Lens Choice

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Telephoto views (180mm)



Wide angle (18mm)





# Making the Object Movie

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VR Worx – [www.vrtoolbox.com](http://www.vrtoolbox.com)  
(Mac or Windows) \$299.99

Object2VR (including Flash authoring)  
(Mac or Windows) ~ \$67.00  
[www.gardengnomesoftware.com](http://www.gardengnomesoftware.com)



# Object Movie Details

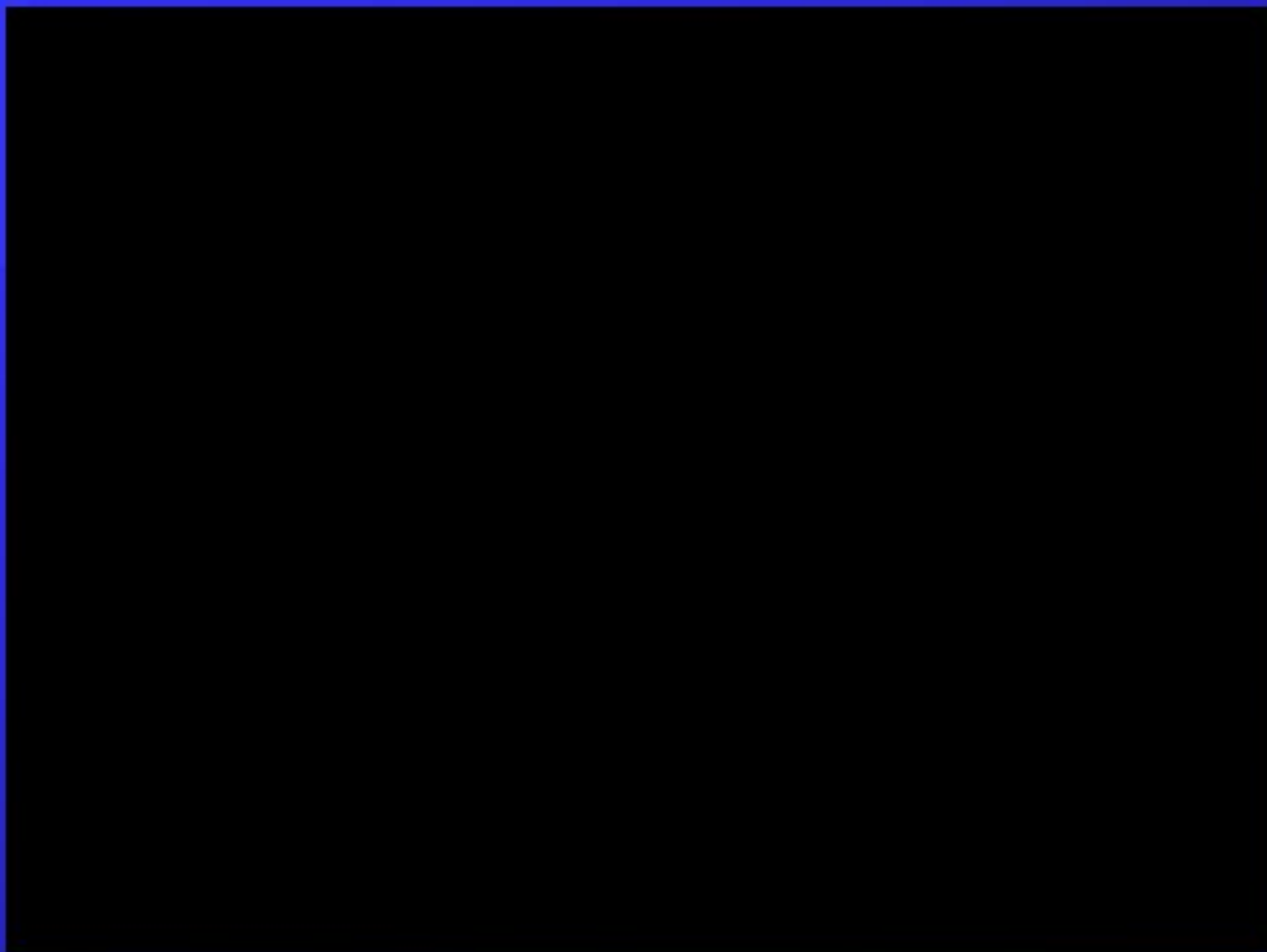
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# Yosemite - Half Dome

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# Virtual Reality Photography

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Author, Virtual Reality Photography

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# Virtual Reality Photography

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# Visual Impact of the Panorama

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# Visual Impact of the Panorama

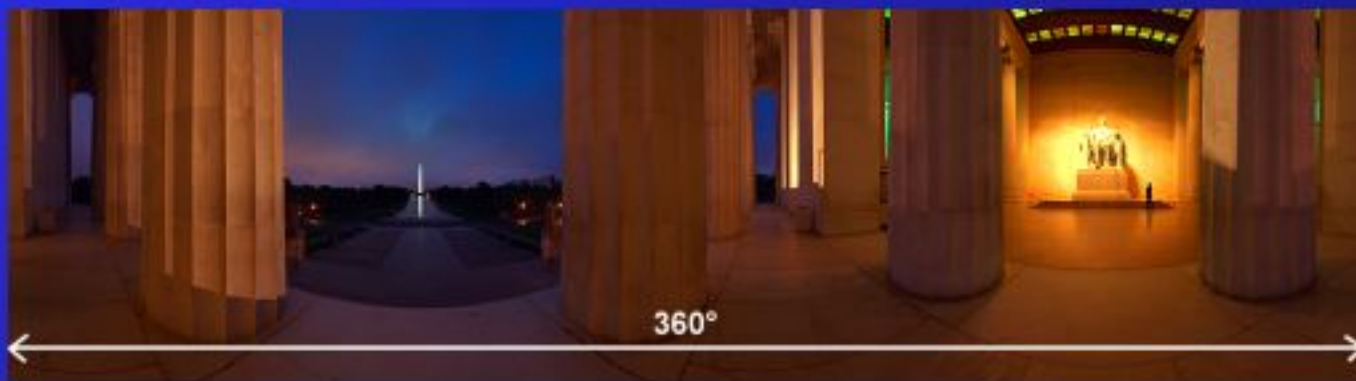
---





# Horizontal Views

- ◆ “Partial” panorama:  
 $< 360^\circ$  fov(x)
- ◆ “Full” panorama:  
 $\geq 360^\circ$  fov(x)



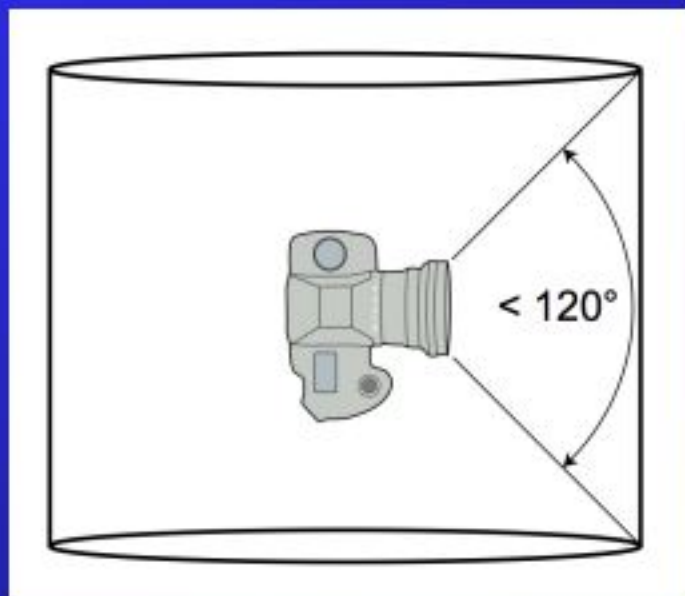


# Cylindrical Format – fov(y)

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- ◆ *Vertical views*

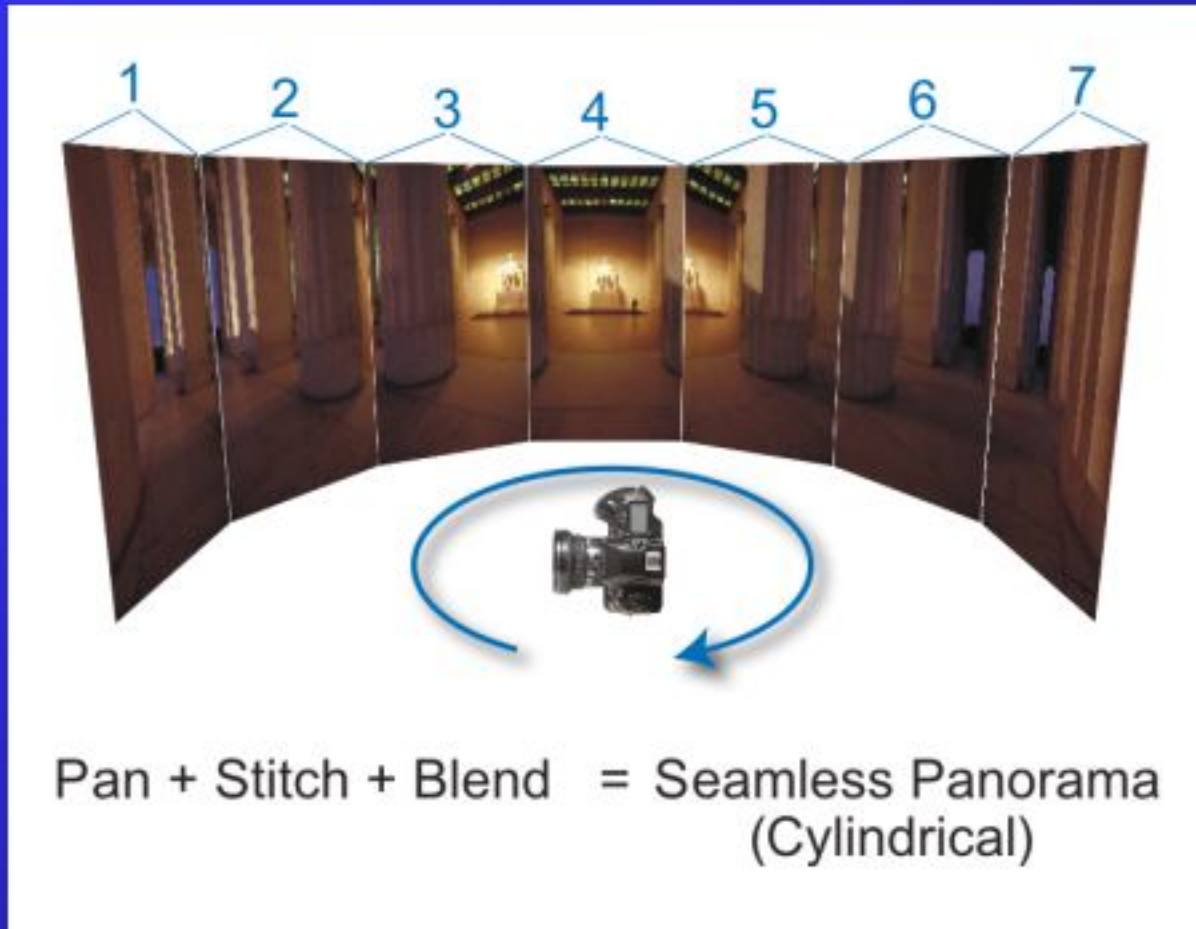
Cylindrical – restricted fov(y)







# Cylindrical Stitching





# Shooting & Stitching Basics

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- ◆ Images should overlap by **1/3** to **1/2**
- ◆ Pan left to right
- ◆ Exposure, WB, focus, focal length match
- ◆ Tripod use highly recommended
- ◆ Entrance pupil alignment

## ◆ **Stitching software:**

PTGui

Autodesk Stitcher

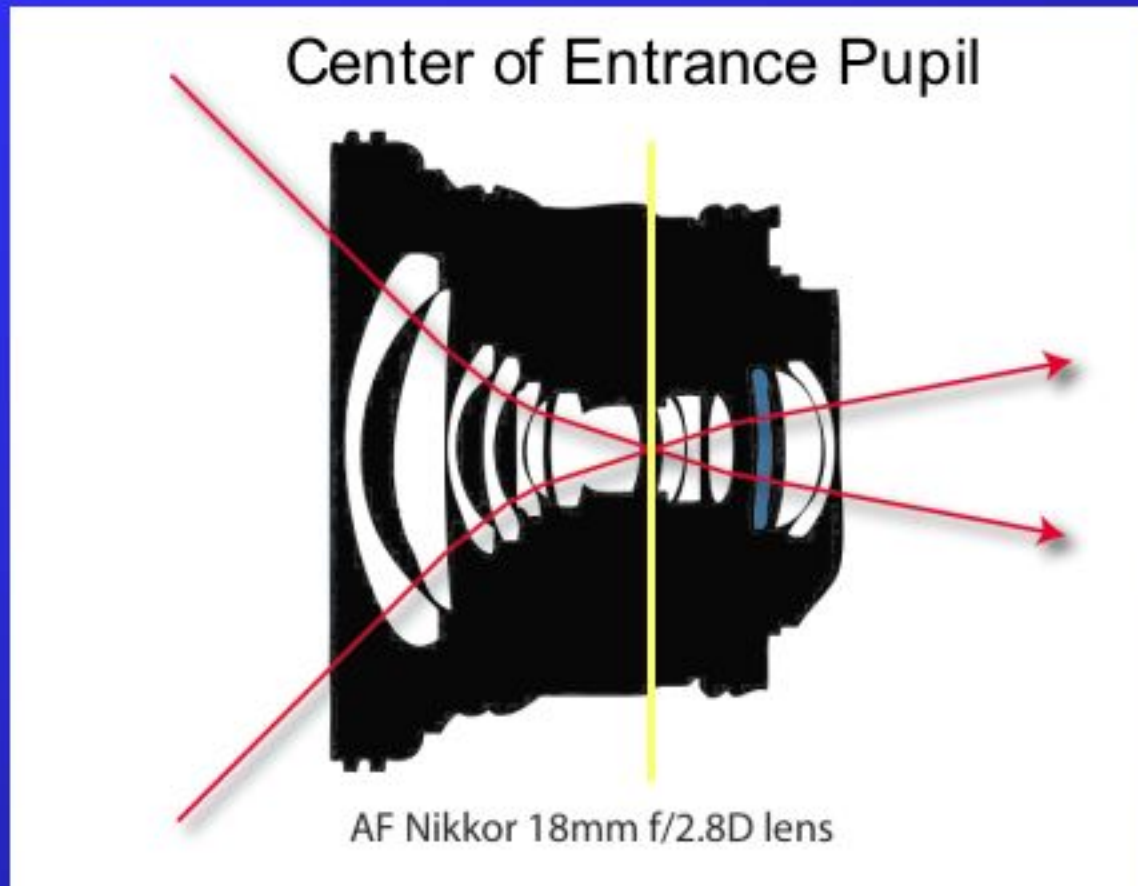
VRWorx

Panoweaver



# Entrance Pupil Alignment

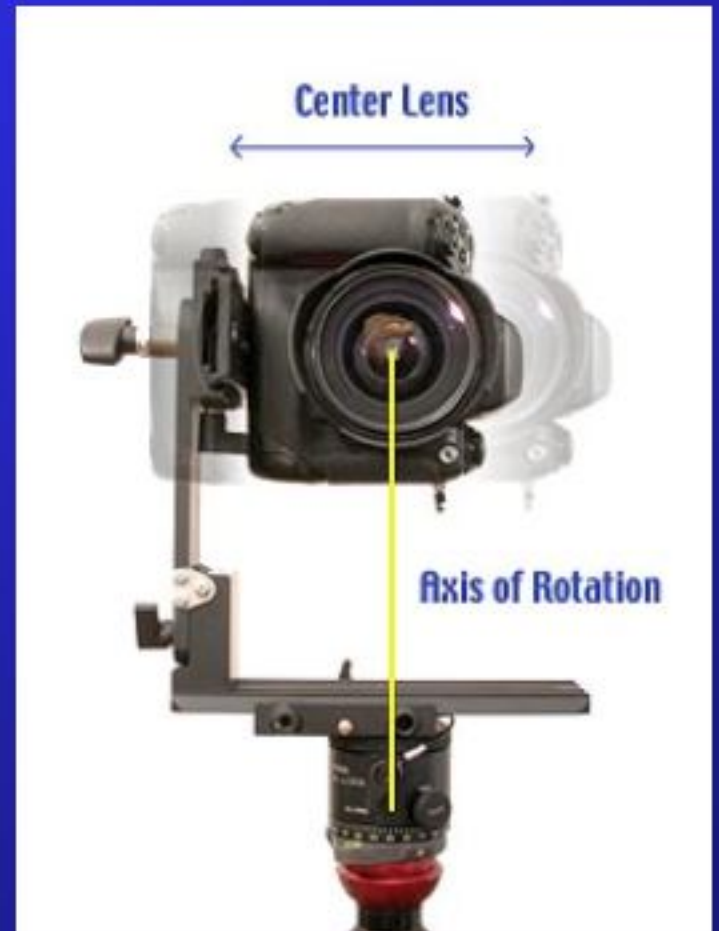
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# Entrance Pupil Alignment





# Entrance Pupil Alignment

---



(Misaligned)



# Entrance Pupil Alignment



(Aligned)





# Commercial Pan Heads

---

**Manfrotto**

**Peace River Studios**

**Nodal Ninja**

**360Precision**

**Panosaurus**

**Really Right Stuff**

**Agnos**

Entrance pupil alignment process:

**[www.vrphotography.com](http://www.vrphotography.com)**



# Camera Orientation

---

Horizontal  
(Normal)

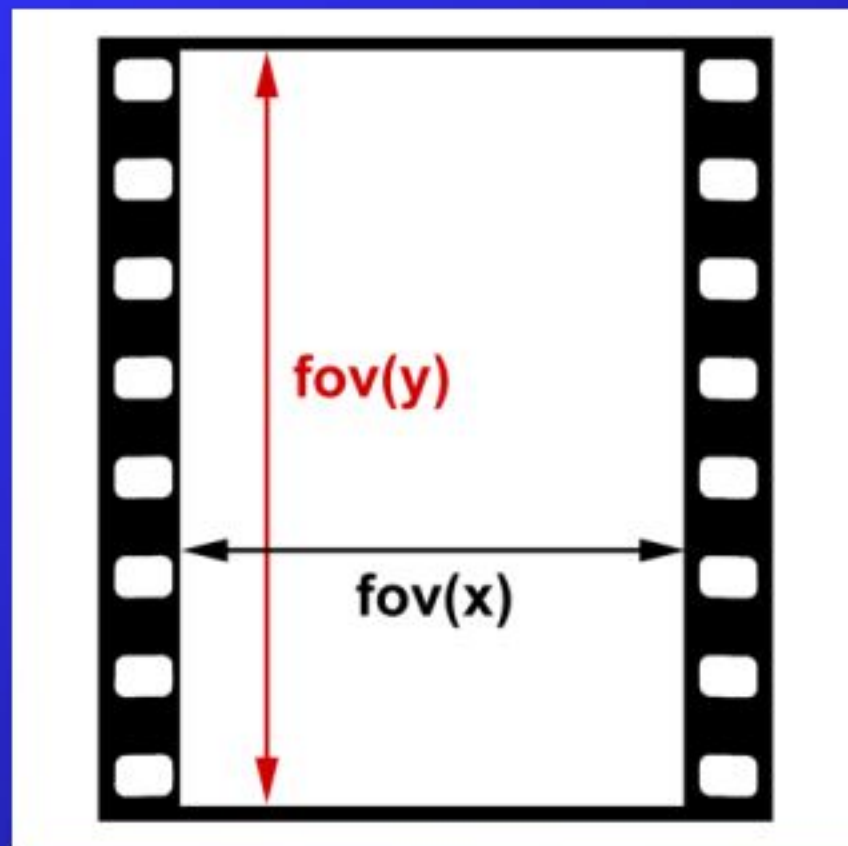
Vertical  
(Portrait)





# Fields of View – fov

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# Camera Orientation – $\text{fov}(y)$

---

Vertical



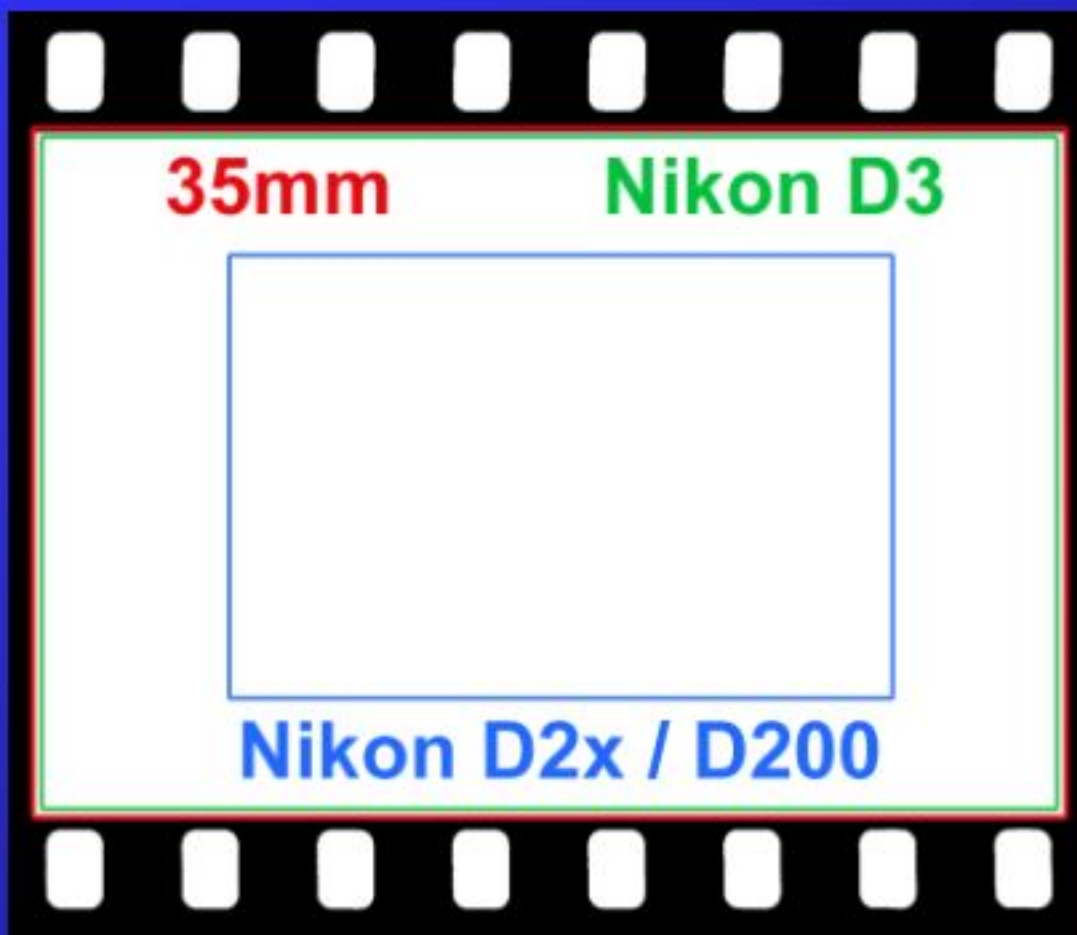
Horizontal





# Cropping – Digital Sensors

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# VR Photo Slate Book

© All rights reserved

**VR Photo Slate** [www.vrphotography.com](http://www.vrphotography.com)

Lens / Camera: \_\_\_\_\_ Date: \_\_\_\_\_

Exposure: \_\_\_\_\_ Location / Subject(s): \_\_\_\_\_

Shots per 360°: \_\_\_\_\_  Panorama  Object

(Rows / shots)  Object Node: \_\_\_\_\_ Roll or Disk: \_\_\_\_\_

### Fields of View (Fov): 35mm camera & lenses

Focal length	FovH	FovV	Shot/360°
28mm	84°	51°	8
35mm	63°	39°	8
50mm	47°	29°	8
75mm	31°	20°	8
100mm	24°	15°	13
150mm	16°	10°	13
200mm	12°	8°	13
300mm	8°	5°	20
400mm	6°	4°	20
500mm	5°	3°	27
600mm	4°	3°	34
800mm	3°	2°	45
1000mm	2°	1°	55

### Slate Book Instructions

The Slate Book is designed to be used as a reference for the production of VR content in photography systems.

When using the Slate Book, it is important to note that the information on the cover and the back of the book is for reference only. The information on the back of the book is for reference only. The information on the back of the book is for reference only. The information on the back of the book is for reference only.

### Hyperfocal Distances

	35mm	45	55.6	66	81.5	95	110
11mm	11	1.5	2.4	3.8	5.2	7.8	11.4
15mm	15	2.1	3.2	4.8	6.2	8.8	12.4
20mm	20	2.7	4.0	5.6	7.0	9.6	13.0
25mm	25	3.4	4.8	6.4	7.8	10.4	13.6
30mm	30	4.0	5.6	7.2	8.6	11.2	14.2
35mm	35	4.7	6.2	7.8	9.2	11.8	14.8
40mm	40	5.3	6.8	8.4	9.8	12.4	15.4
45mm	45	6.0	7.5	9.0	10.4	13.0	16.0
50mm	50	6.7	8.1	9.6	11.0	13.6	16.6
55.6mm	55.6	7.4	8.8	10.2	11.6	14.2	17.2
60mm	60	8.0	9.4	10.8	12.2	14.8	17.8
66mm	66	8.7	10.0	11.4	12.8	15.4	18.4
75mm	75	9.7	10.9	12.3	13.7	16.3	19.3
81.5mm	81.5	10.3	11.5	12.9	14.3	16.9	19.9
90mm	90	11.1	12.2	13.6	15.0	17.6	20.6
100mm	100	12.0	13.0	14.4	15.8	18.4	21.4

↑ Depth of field increases

→ Field of view increases

[www.vrphotography.com](http://www.vrphotography.com)





# Cylindrical Panorama Capture

---

- ◆ Traditional camera + pan head + stitching





# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping







# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping



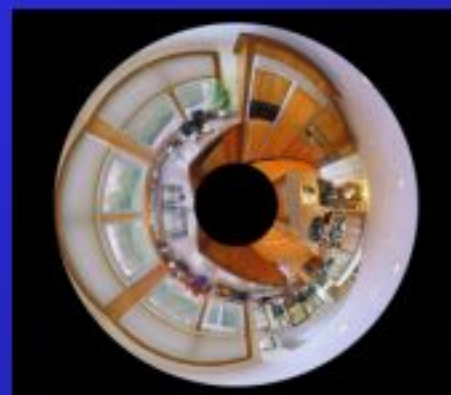
Produces flattened  
torus image





# Cylindrical Panorama Capture

- ◆ Parabolic mirror (single shot) + Dewarping



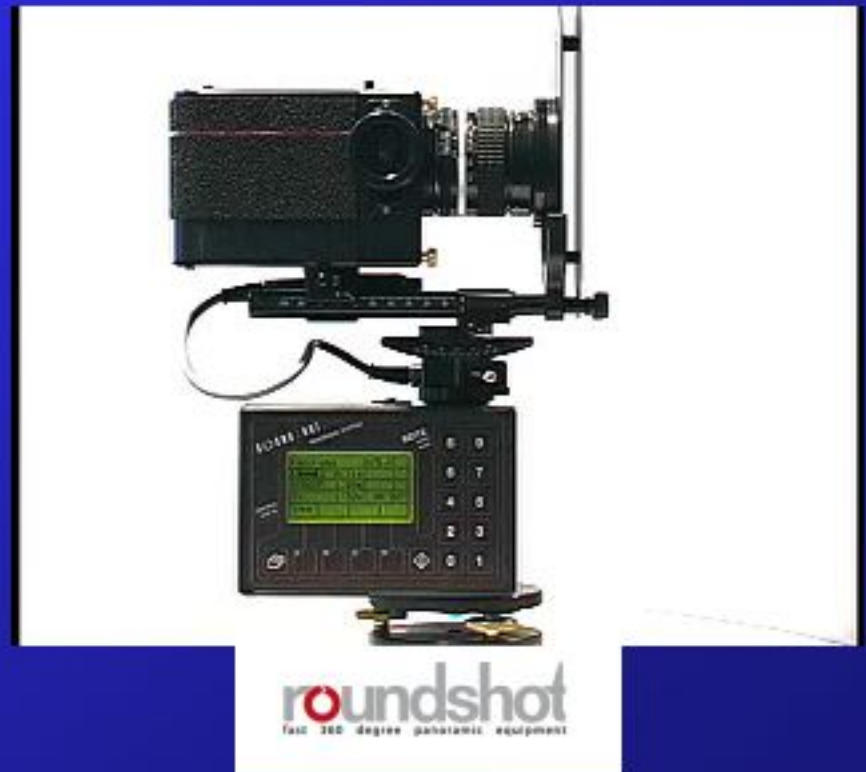
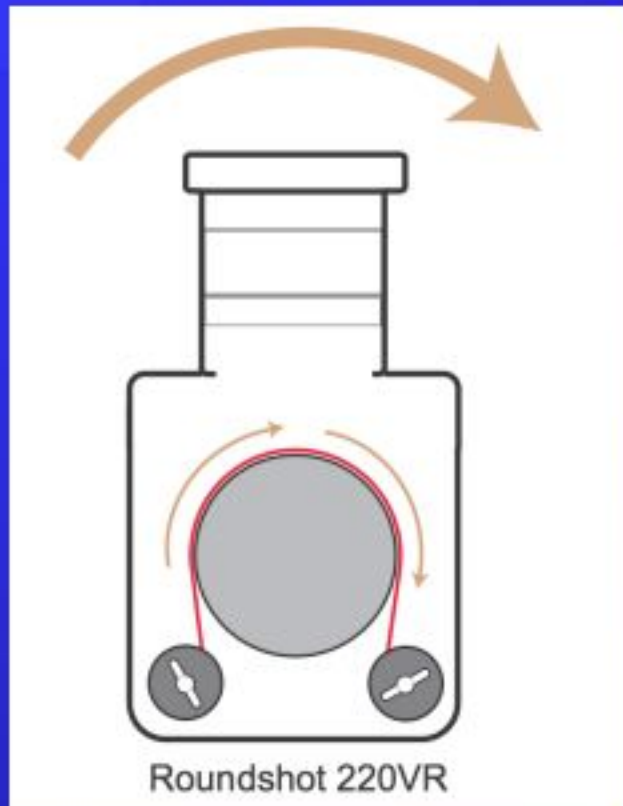
**PhotoWarp  
software**





# Cylindrical Panorama Capture

- ◆ Slit-scan full rotation camera





# Fov(y) - Cylindrical vs. Cubic

---

Cylindrical

Cubic



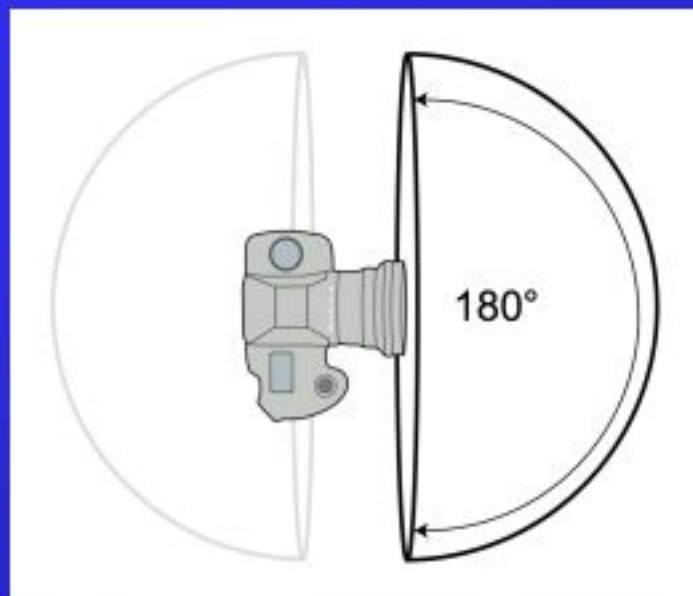




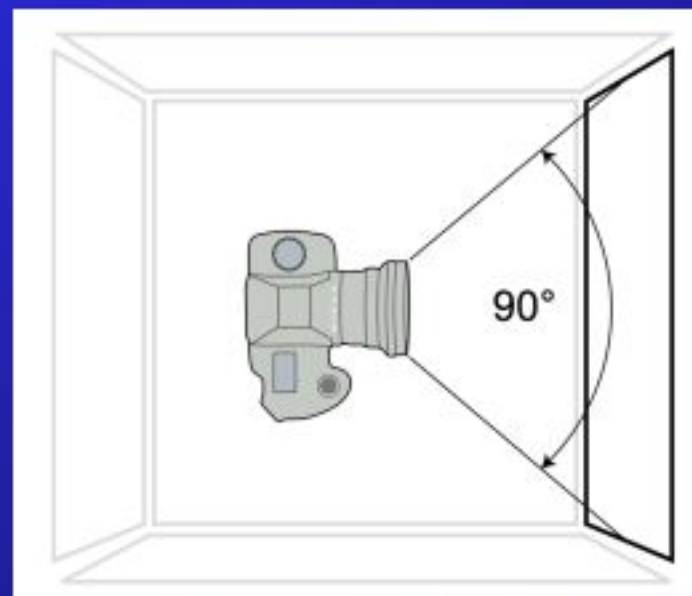
# Panoramic Formats

- ◆ *Vertical* views – unlimited fov(y)

Spherical



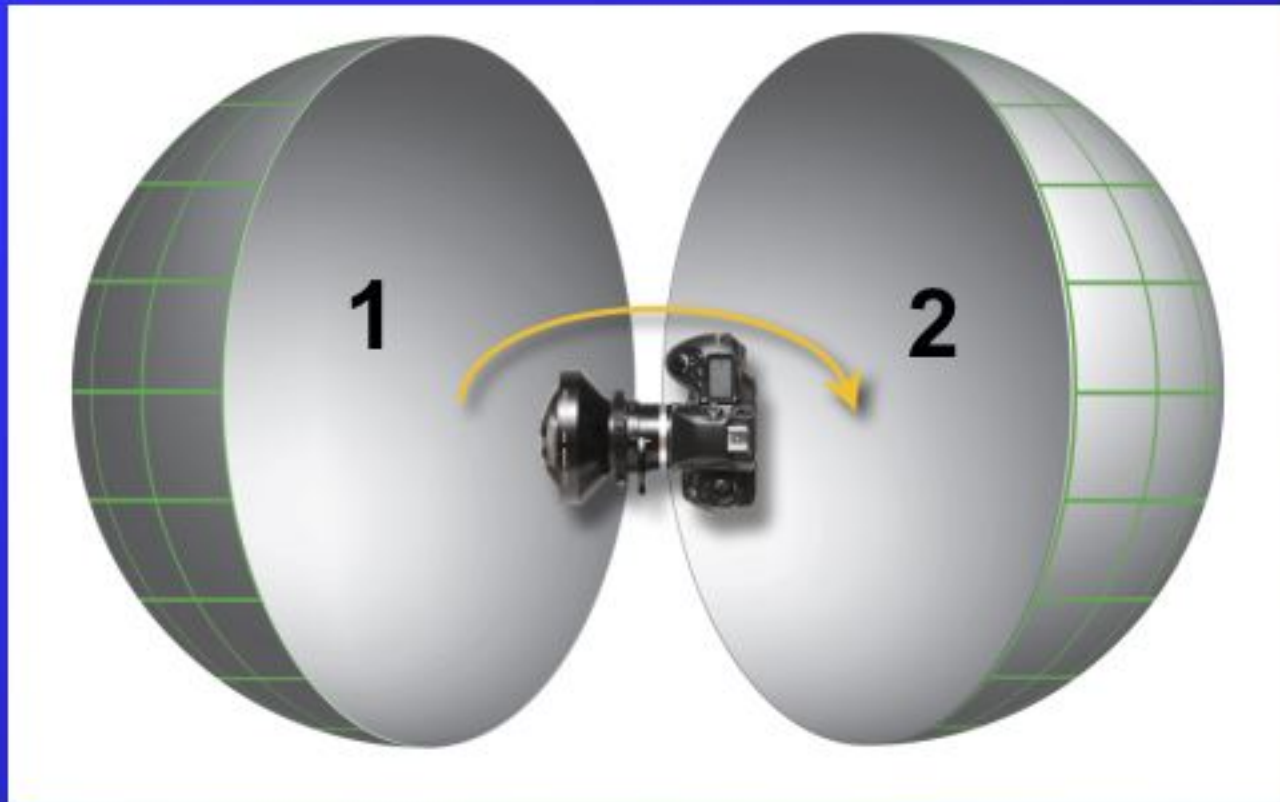
Cubic





# Spherical Panoramas

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Two or More (True) Fisheye Images - IPIX



# Scanning Digital Cameras

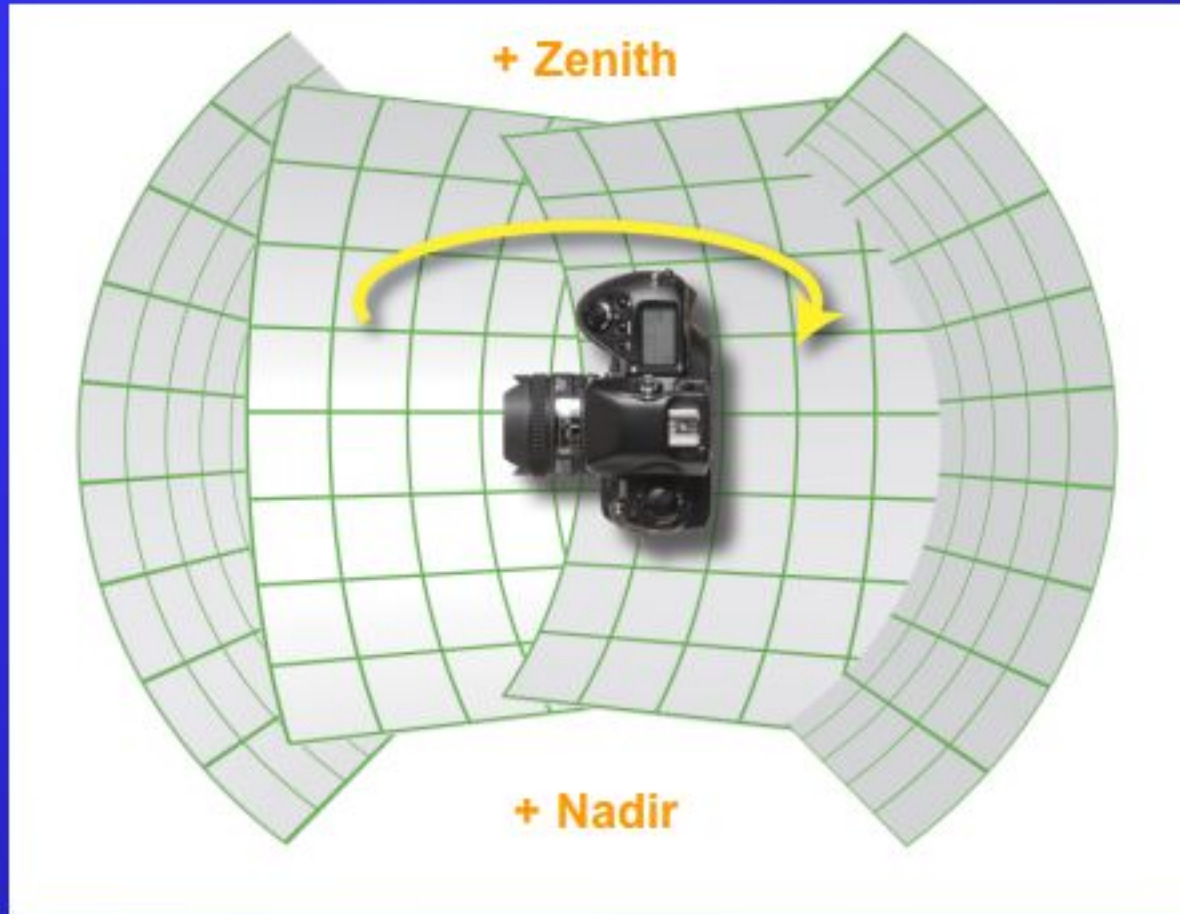
---







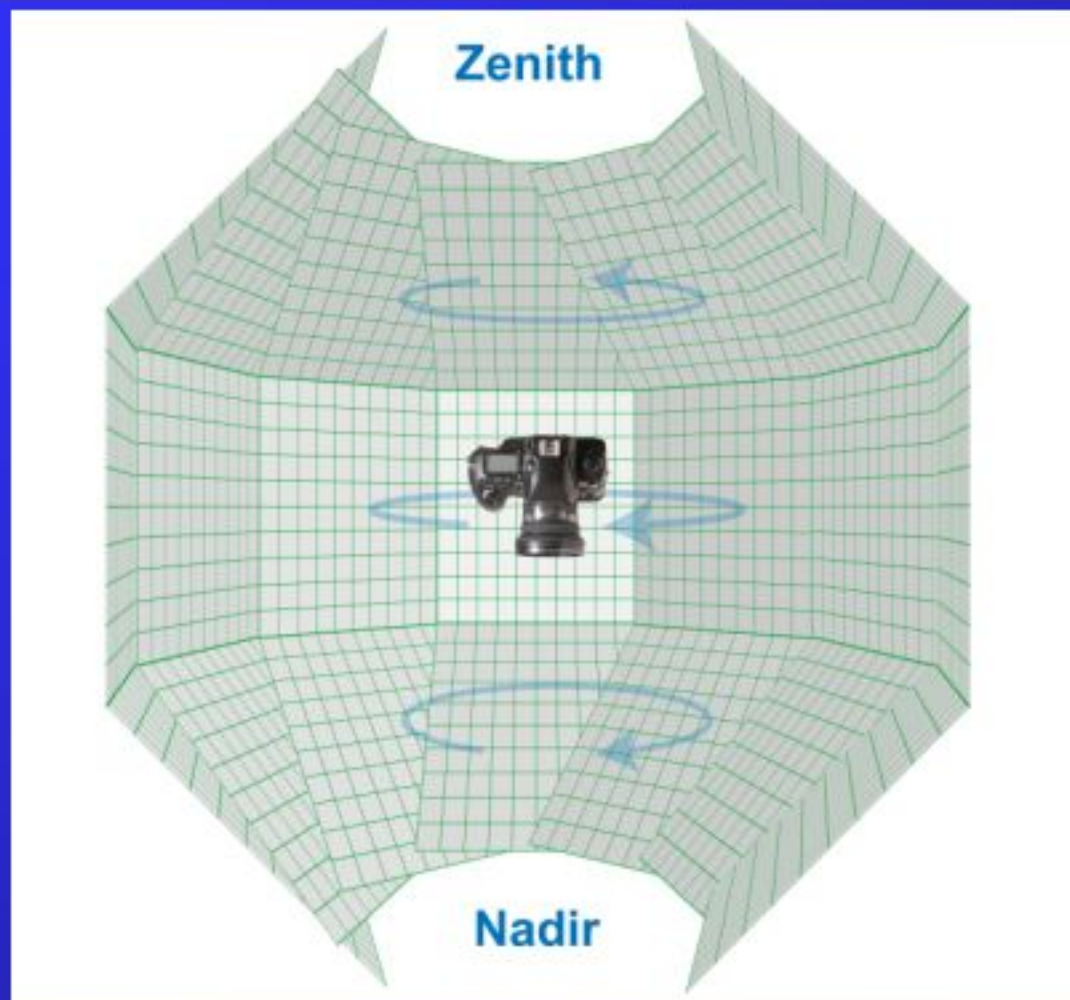
# Spherical / Cubic Panoramas



Stitched Full Frame Fisheye Images



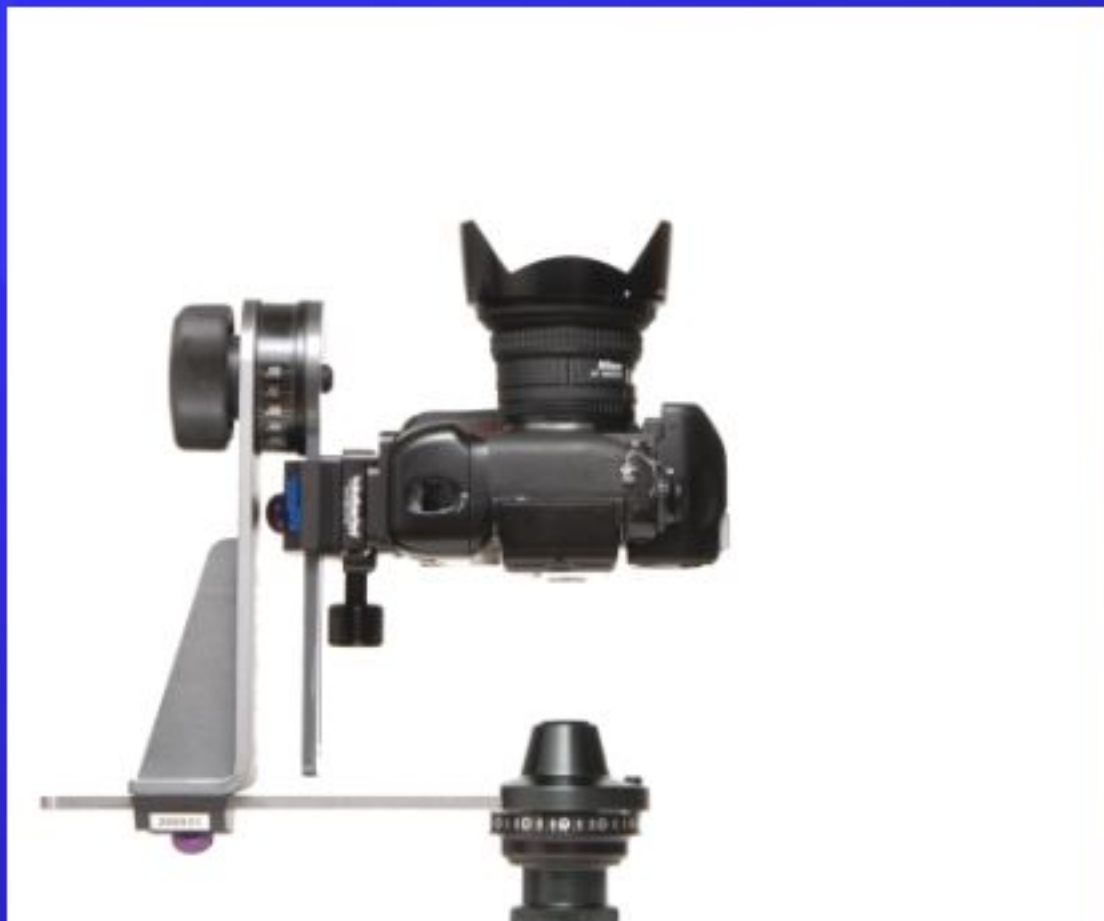
# Multi-Row Panoramas





# Multi-Row Image Capture

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Kaidan QuickPan Pro





# Multi-Row Image Capture



**Lens:** Nikkor 18mm

**Exp:** 1/125 sec @ f/11

**Pan:** 3 rows - 12 exp. ea.

**Date:** 8/20/04



# Multi-Row Image Capture

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# Multi-Row Stitching

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# Multi-Row Stitching

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# Create VR Panoramic Movie

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# Stitching Applications

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- ◆ PTGui  
[www.ptgui.com](http://www.ptgui.com)
- ◆ Autodesk Stitcher  
[www.realviz.com](http://www.realviz.com)
- ◆ Photoshop CS5 Extended (3D) & PhotoMerge  
[www.russellbrown.com](http://www.russellbrown.com)
- ◆ Flash movie preparation: Pano2VR  
[gardengnomesoftware.com](http://gardengnomesoftware.com)





# Stitching Application Demo

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- ◆ PTGui – <http://www.ptgui.com>

Demo version (Mac or Windows): Free

Full version: ~ \$106

Pro Version: ~ \$199



# Choosing Your Tools

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- ◆ Choose stitching/assembly software first!
- ◆ Do you need full 360°x180° vs. cylindrical?
- ◆ Then, choose photo tools:
  - ◆ Camera & lens
  - ◆ Digital vs. film
  - ◆ Grip, camera support, pan head
  - ◆ Other post production needs (retouching, etc.)
- ◆ Other limitations
  - ◆ Lighting needs
  - ◆ Location requirements



# Panorama Effectiveness

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“f/8 and be there!”







# Effective Photography

---

“f/8 and be there!”





# Effective Photography

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# Effective Photography

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# Effective Photography

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# Effective Photography

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# Effective Photography

---







# Effective Panoramas

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# Effective Panoramas

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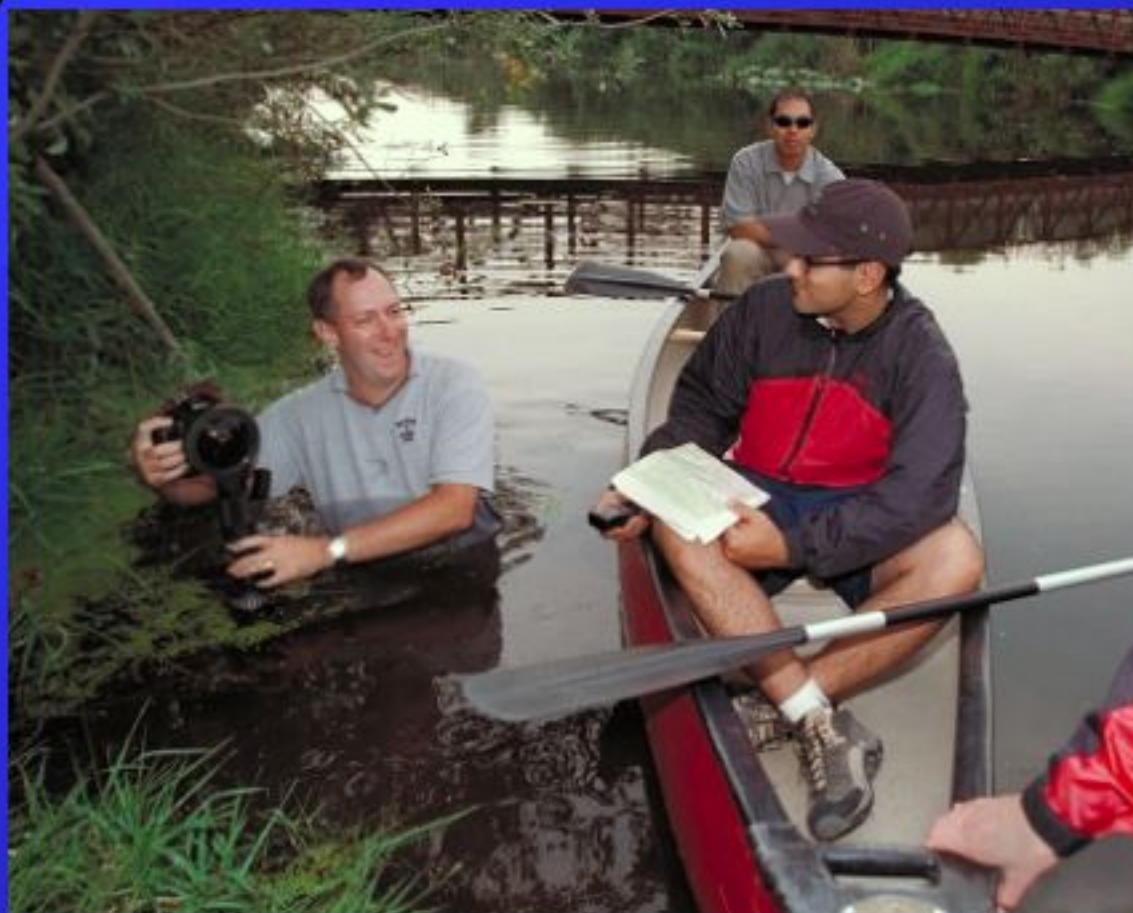
- ◆ Involve your viewers
- ◆ Immerse them in the story
- ◆ It's your story to tell – don't make your audience have find it for themselves

**Practice this!**



# Location Photography

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# Location Lighting

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6:06 am



# Subject Interest

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# Other Useful Panorama Software Applications

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- ◆ Pano2VR

[gardengnomesoftware.com](http://gardengnomesoftware.com)

- ◆ Cubic Converter

[www.clickheredesign.com.au/software/](http://www.clickheredesign.com.au/software/)

- ◆ SpinControlVR

[panosalado.com](http://panosalado.com)





# Object Movies

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# Object Movies

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# Object Movies

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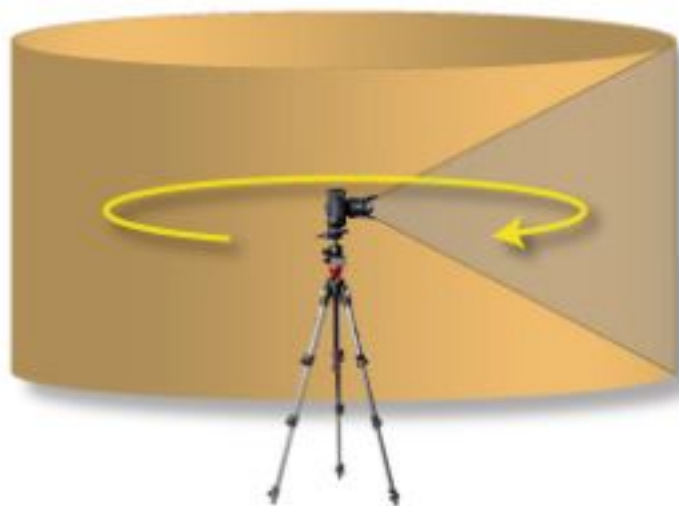






# Panoramas vs. Objects

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Panoramas  
(Camera faces outward)



Object movies  
(Camera faces inward)

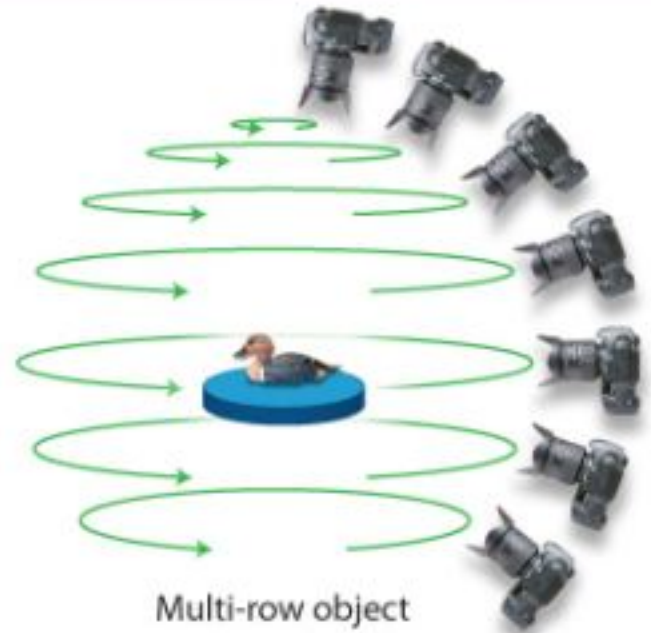


# Single vs. Multi-row Objects

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Single row object



Multi-row object



# Multi-row Object Movie

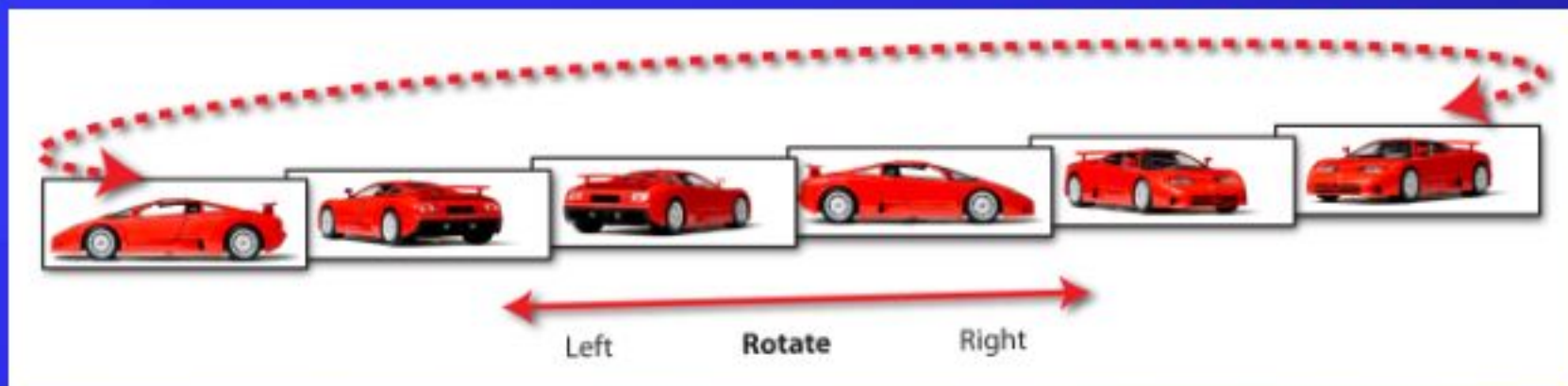
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# Multi-row Object Movies





# Object Photography Technique

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## ◆ Consistency and Repeatability

Camera: lock focus, WB, exposure, position

Object: controlled motion increments

Lighting: consistent throughout rotation

## ◆ Tools Needed

Digital camera

Tripod or stable camera/object rig

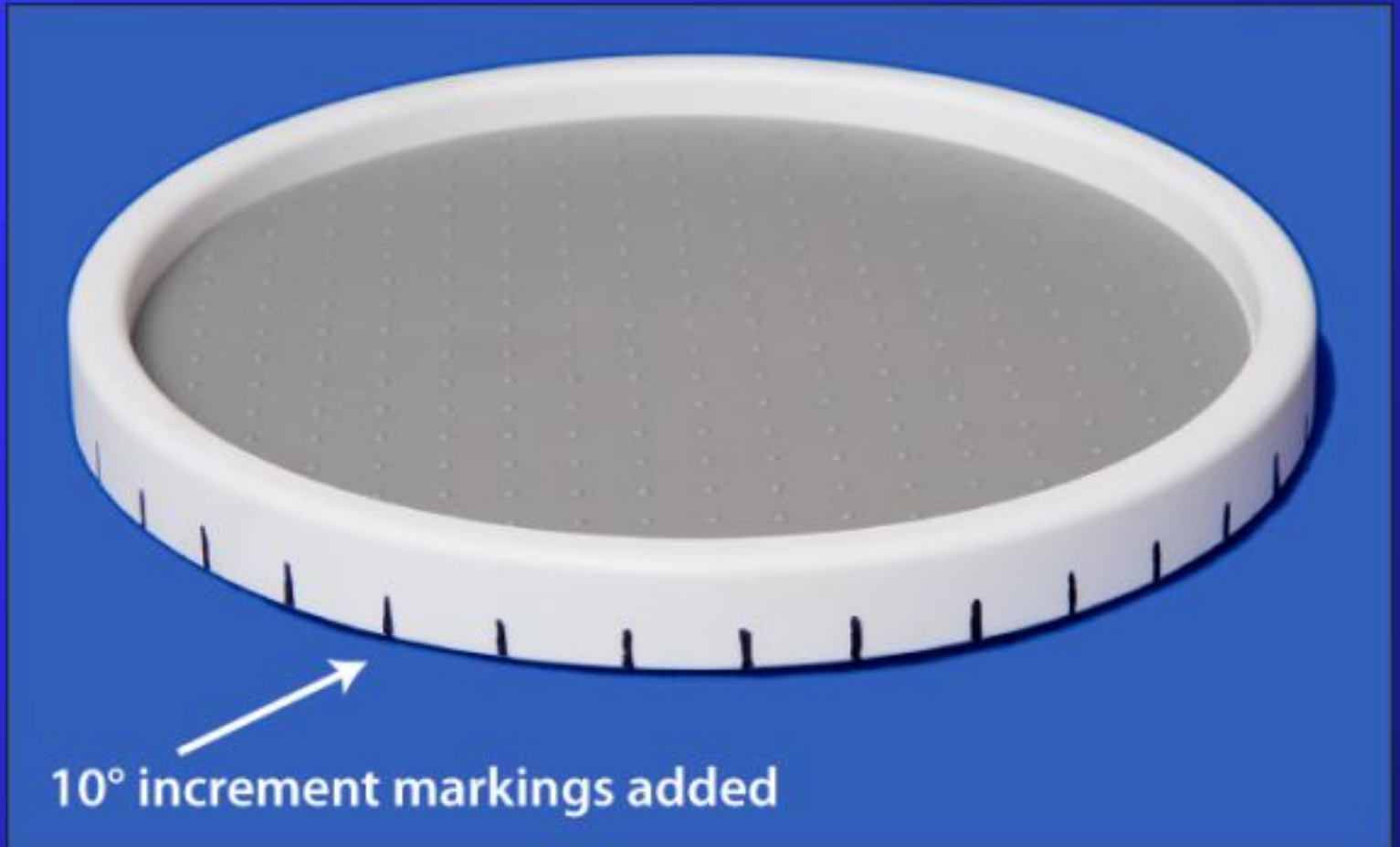
Turntable for object

Object authoring software



# Object Turntables

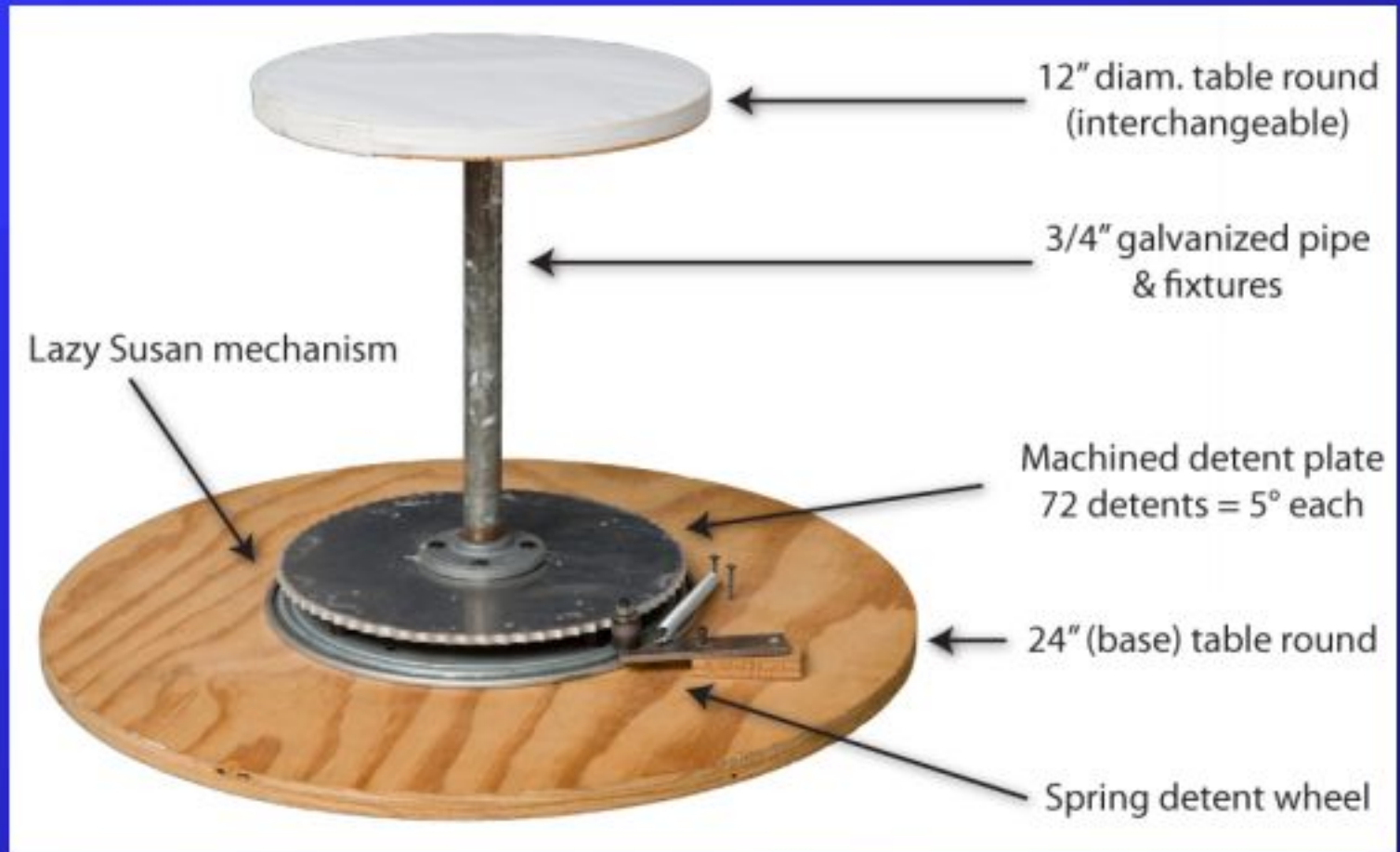
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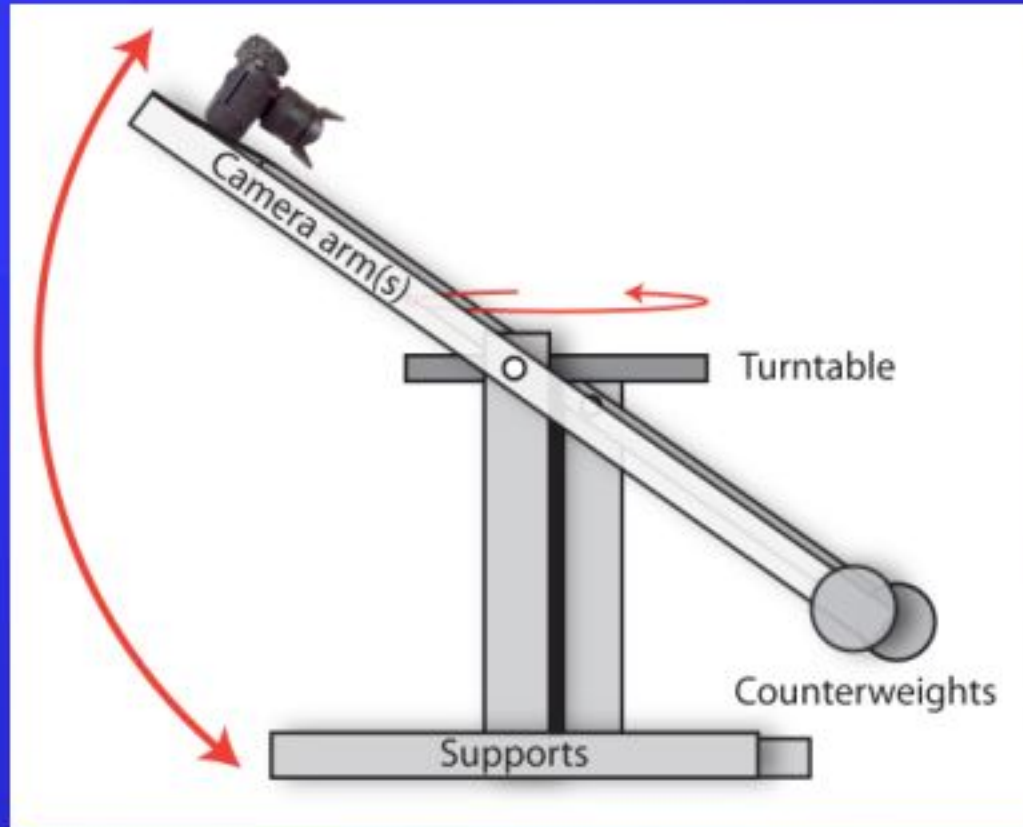


# Object Turntables

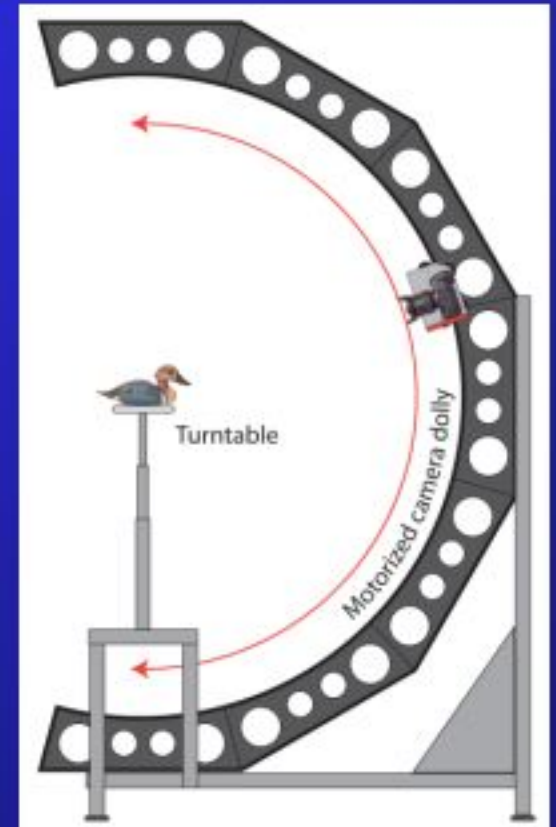




# Object Rigs (Multi-Row)



Rotating Arm



C-Frame



# Object Rigs (Multi-Row)

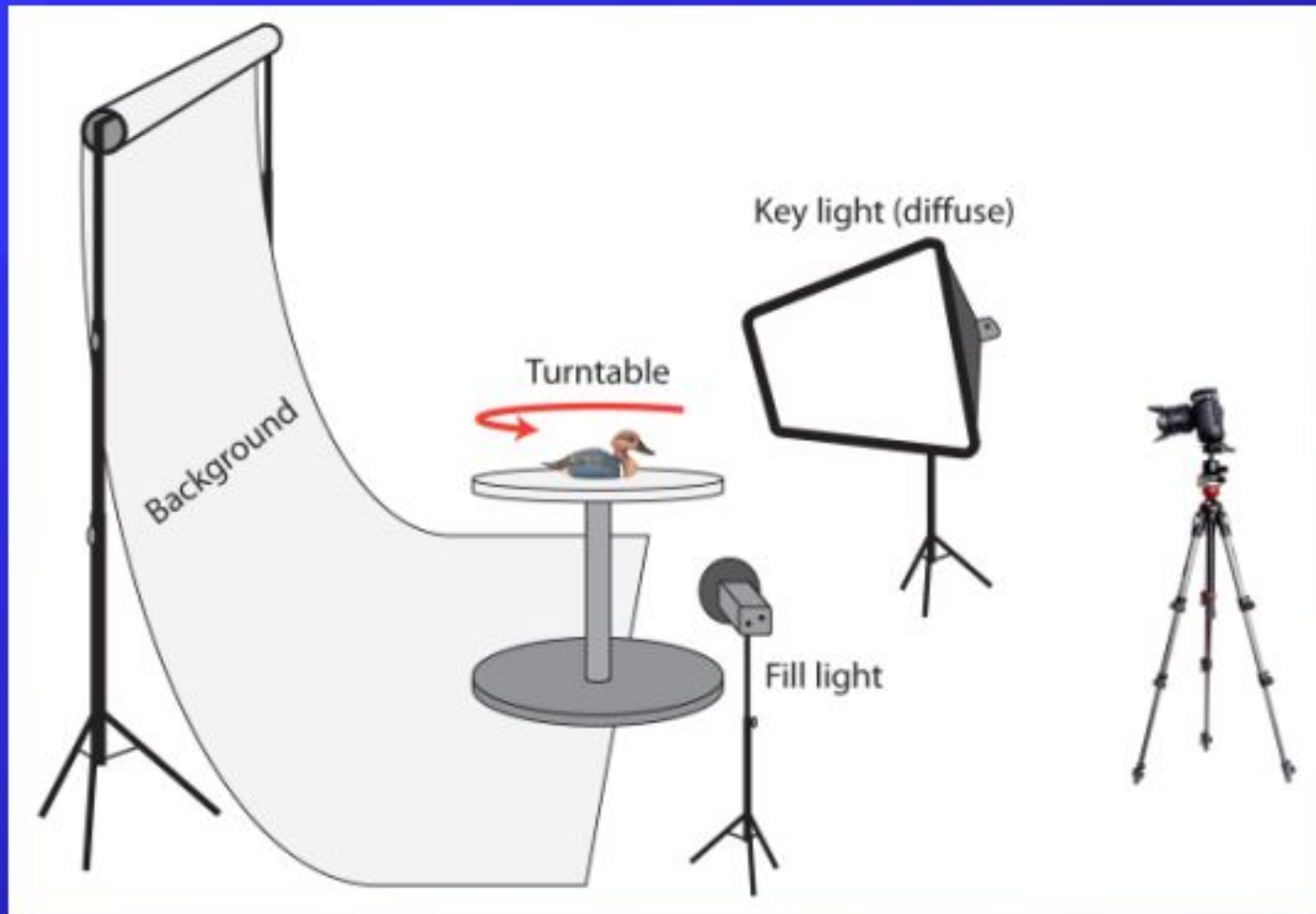


Articulating Arm





# Object Lighting



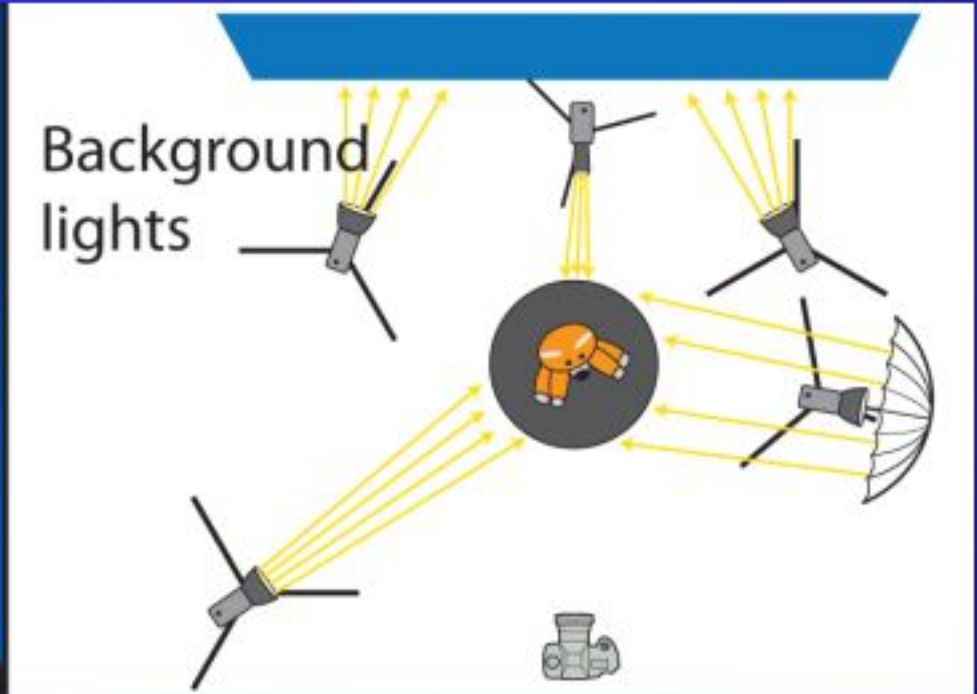


# Object Lighting - Single Light





# Object Lighting - Multiple Lights

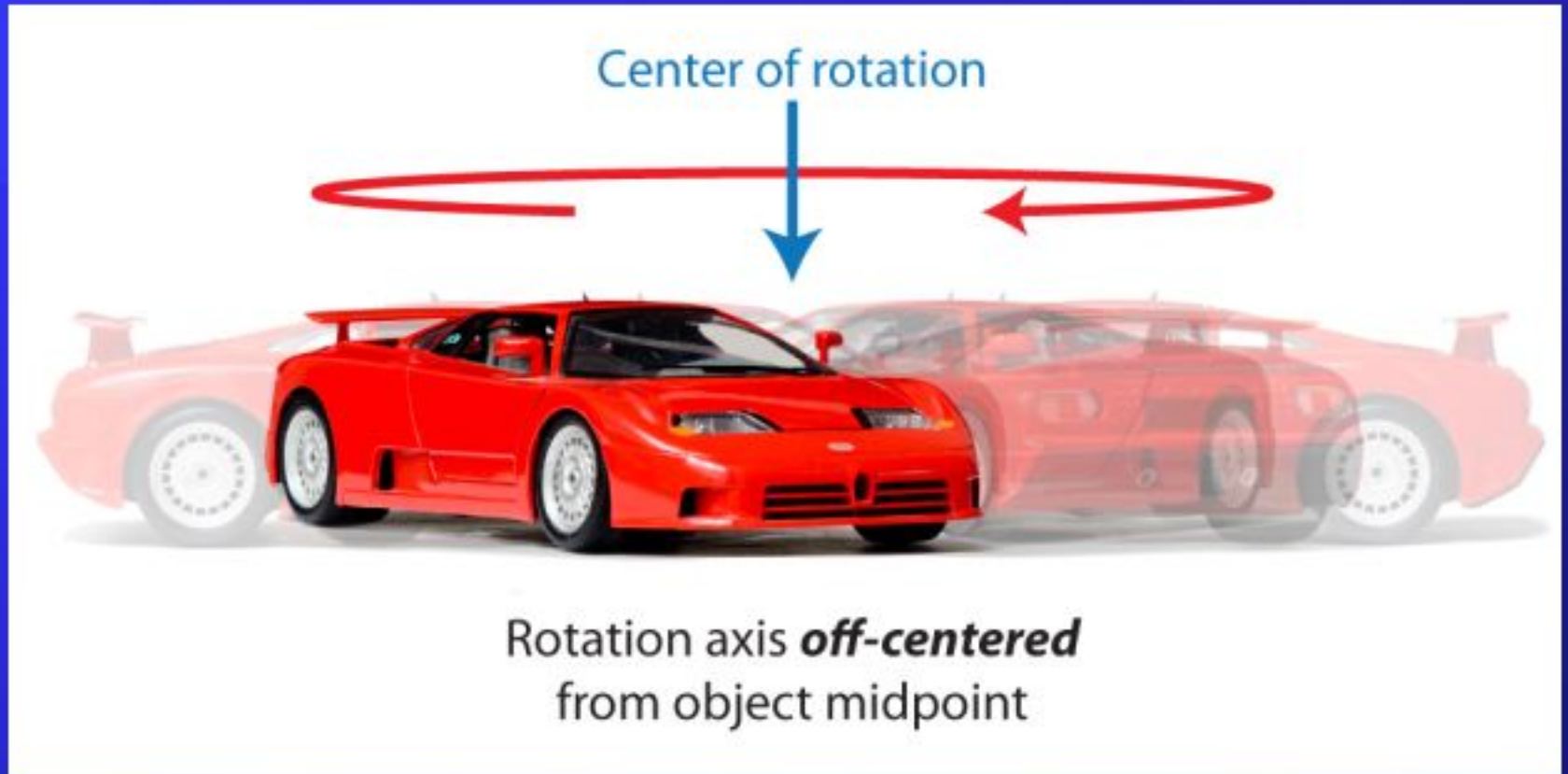






# Axis of Rotation

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# Perspective and Lens Choice

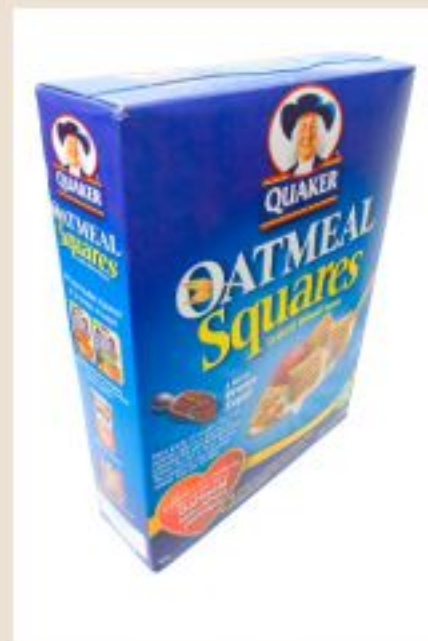
## Wide angle lens (18mm)



Low view



Mid-level



High view  
elevated



# Perspective and Lens Choice

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Telephoto views (180mm)



Wide angle (18mm)





# Making the Object Movie

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VR Worx – [www.vrtoolbox.com](http://www.vrtoolbox.com)  
(Mac or Windows) \$299.99

Object2VR (including Flash authoring)  
(Mac or Windows) ~ \$67.00  
[www.gardengnomesoftware.com](http://www.gardengnomesoftware.com)



# Object Movie Details

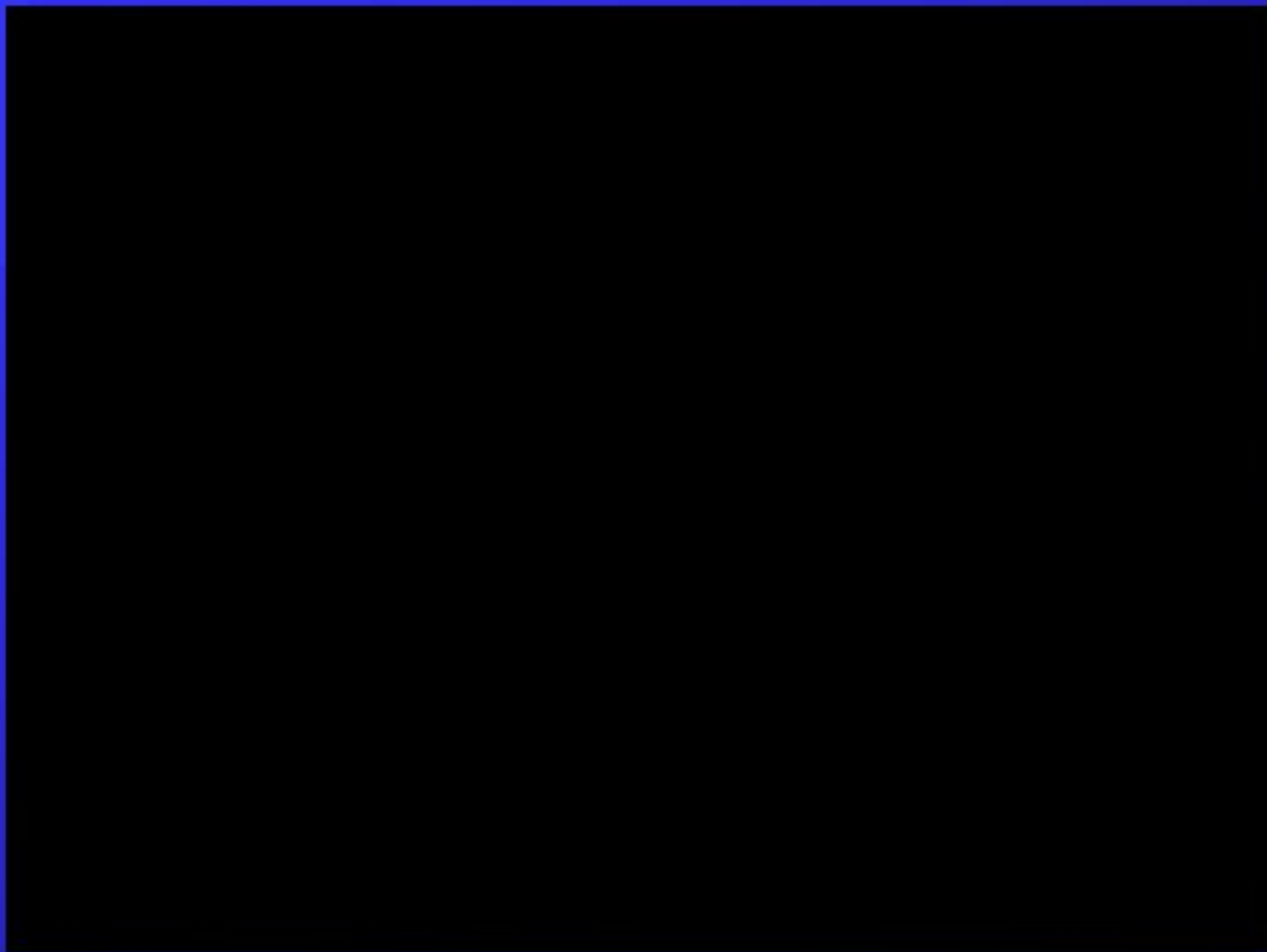
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# Yosemite - Half Dome

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# Virtual Reality Photography

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Scott Highton  
Author, Virtual Reality Photography

[www.vrphotography.com](http://www.vrphotography.com)

MacWorld User Conference **US983**