



making360



Copyright © 2015

Published by ZO, LLC

press@making360.com

This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/4.0/deed.en_US.

First printing, October 2015

Contents

Introduction	4
I Problems of Shooting	6
The Elements	7
Set and Settings	9
II Problems of Stitching	17
Dailies Quickstitch	18
First Assembly	26
Patching Nadir	29

Introduction

What is this book?

2 sections, 57 chapters, loads of fun. problems of shooting and problems of stitching. solutions to those problems. all the techniques to slay all your demons. the book can be read in any random order or end to end cover to cover. however you like. the manual will be free. an open source version will be available for download in pdf format. there will also be a limited edition batch of hardcopy books for those who like to learn the analog way.

Who is this book for?

artists, pioneers, adventurers, astronauts, cowboys and cowgirls; basically anyone who wants to start experimenting on this new medium can join us. we have paved a path and laid stepping stones across this great divide for you to cross the river and join us in exploring a new land! we are sharing every tip and trick we have painfully learned ourselves so you can skip right to having fun. we only ask that you remember to come back and share your findings with everyone so we can build a community!

How to use this book?

How this book is organized?

Why is this book needed

we want to build a community by sharing everything we've learned about making professional 360 videos over the last 3 years. right now, there is very little docu-

mentation on the process, from start to finish, for creating narrative virtual reality films. by writing making360 our goal is to help those who are excited about exploring new storytelling techniques by aiding in skipping the initial hazing process. by sharing our experiences, we will be able to speed up your learning curve. creating 360 videos is very intense and detailed so we're here to walk you through it!

Problems of Shooting

The Elements

Problem:

You want to be the next first greatest VR storyteller of all time and space.

You want to create audiovisual immersive experiences. Expand cinema, compassion, consciousness. Explore change. You want to create new tools for self awareness. You want to help write a new cinematic language. You want to break open that window of limited views and dive right into pure experience. You want to bring the world one step closer to putting ourselves in each other's shoes. Hello, astronaut! That's great what are the first steps to take you closer? What materials do you need to shoot, learn, and grow right here right now today?

Solution:

Dive deep in. No fear. Take the first step. Then the one after that. Gather all the elements and start experimenting!

Here's a basic checklist for your journey

- cameras
- camera rig
- tripod
- audio slate/ring flash
- micro SD cards
- batteries
- usb hub charger
- hard drives
- extra accessories: batteries, micro SD cards, cameras
- courageous heart

- your charming smile

have fun!

千里之行，始於足下

Set and Settings

The nature of the experience depends almost entirely on set and setting. Set denotes the preparation of the individual, including his personality structure and his mood at the time. Setting is physical – the weather, the room's atmosphere; social – feelings of persons present towards one another; and cultural – prevailing views as to what is real. It is for this reason that manuals or guide-books are necessary. Their purpose is to enable a person to understand the new realities of the expanded consciousness, to serve as road maps for new interior territories which modern science has made accessible.

-Timothy Leary, The Psychedelic Experience: A Manual Based on the Tibetan Book of the Dead

Problem:

You have to set all the settings on the cameras.

You will have to manually set each camera by hand so decide the default settings you want to shoot before changing them. Every camera must have all the same settings, especially frame rate!

Solution:

Keep it RAW. Match all the cameras. Find the sweet spot between resolution and framerate.

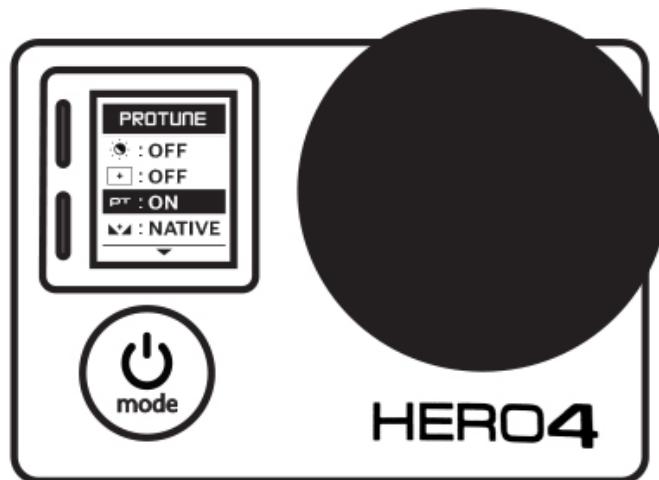
You want your settings matched identically across all the cameras. This will allow them to stitch better and have less color matching and balance to correct in post. Start by deciding the framerate and aspect ratio. This depends on the rig you selected. Certain rigs require a 4:3 aspect ratio instead of 16:9 so there is enough overlap between all the cameras to stitch.

If the cameras accidentally get knocked and the settings change it is ok as long

as the framerate and aspect ratio stayed the same. Even if one of the aspect ratios was different you might still be able to salvage the shot with some serious warping of that one camera.

Or if the exposure is drastically different in some of the cameras you can do some color correcting. However, if one of the camera's frame rate changes you will be out of luck! There needs to be the same number of frames for the stitching software to apply a calibration to.

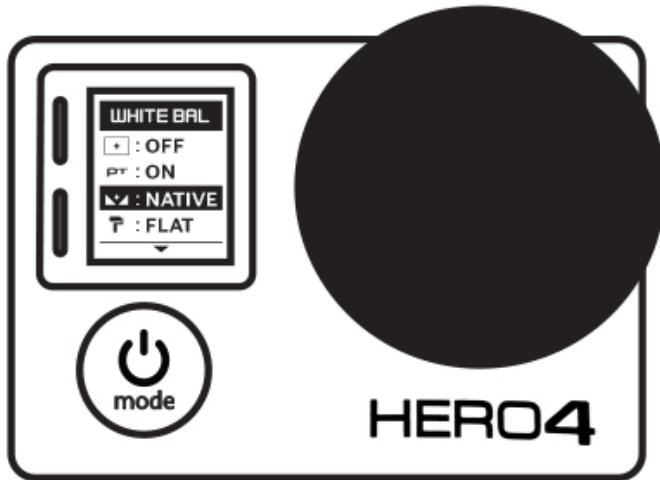
Protune - on



The protune setting should always be kept on. Protune will give you much higher dynamic image range and overall image quality with more detail in highlights and shadows. The image will shoot flatter for more freedom in color correction. Protune has higher data rate capture (up to 60 mbps) and less compression, giving you more information to work with. Having a neutral color profile across all the cameras will make them easier to color balance and correct for a nice stitch.

PROTIP: Turn protune ON first before you select all the other settings because all the settings for resolution and fps reset when protune is changed.

White Balance - cam raw



This keeps the color flat but you keep more information which you can color correct and grade during post production.

Resolution/FPS

Next decide your aspect ratio. Depending on which rig you are using, certain settings must be used for there to be enough overlap between the seams.

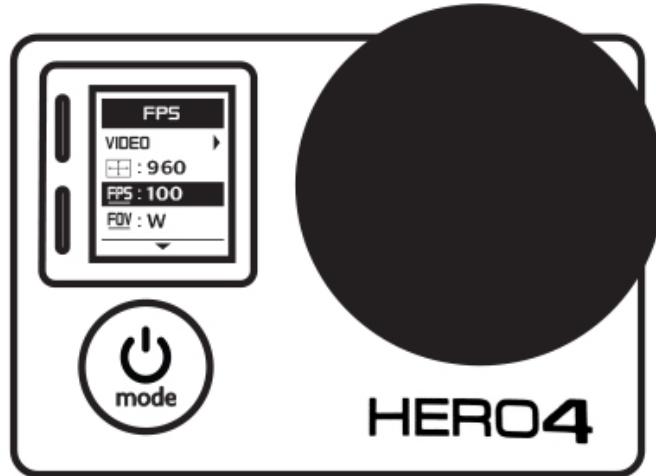
For a hemicube rig like Freedom360, 360 Heros Pro6, or 360Abyss the aspect ratio has to be 4:3 so there is enough overlap in the seams.

The most recent GoPro Hero 4s now offer:

2704x2028 at 30fps

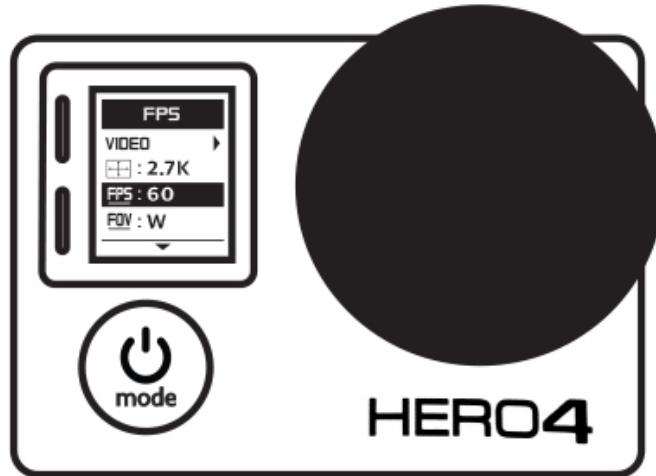
1440x1920 at 80fps

1280x960 at 100fps

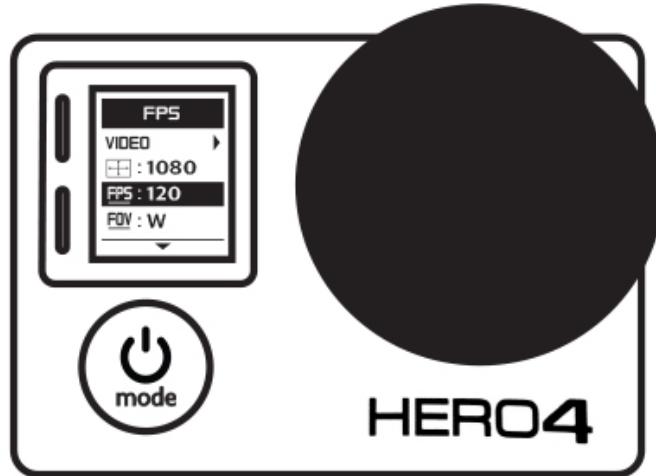


For more cylindrical rigs, the aspect ratio can be 16:9 because each camera will be closer to the adjacent left/right camera. The 16:9 aspect ratio will offer enough overlap. Then you can use the 2.7k settings and have a higher resolution output stitch like 8k.

2704x1520 at 60fps

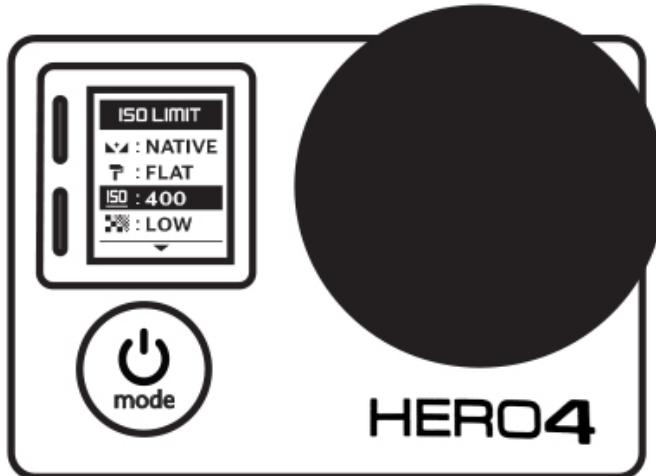


1920x1080 at 120fps



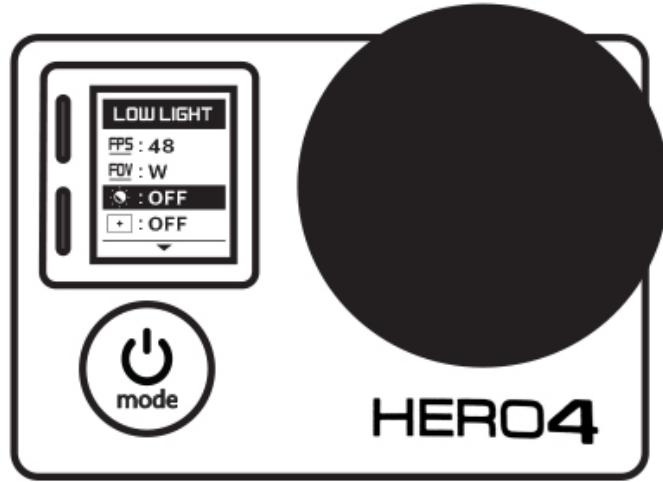
Choosing a higher frame rate will sacrifice resolution. Shoot at a higher fps for fast high action scenarios like drone shots or underwater. Higher frame rate gives more frames to sync the cameras.

ISO limit - 400



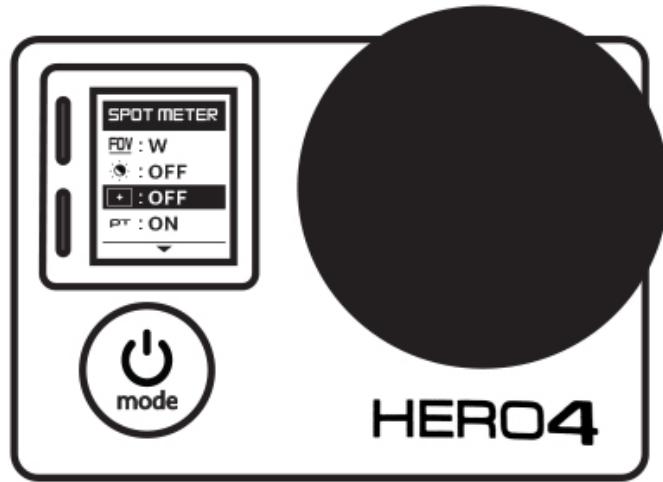
This adjusts the camera's sensitivity in low light conditions. Keep it at 400 which will give you darker videos but the least noise and gain.

Low Light - off

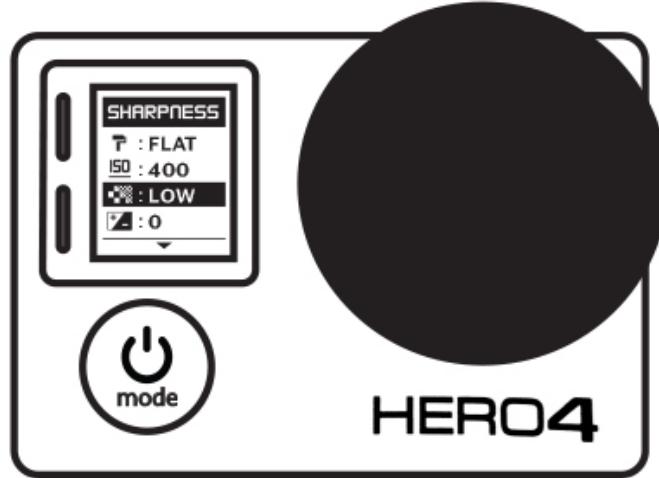


The camera will automatically adjust to changes in exposure when shooting in low light environments. Again, any setting where the cameras are automatically changing we want off so the cameras stay the closest settings to each other.

Spot Meter - off

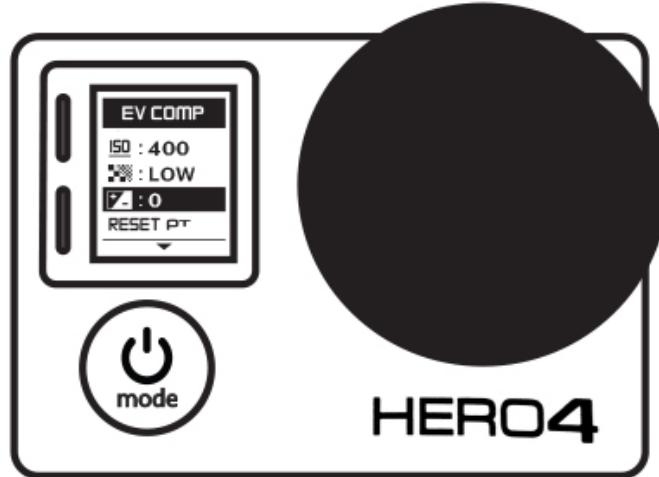


Sharpness - low



The videos will need to be sharpened during post production for more clarity and details in the headset. Use the low setting for less processing on the footage and more data in post.

Exposure compensation - 0.0



Range is -2 to +2, in 0.5 step increments. Leave the exposure on 0.0 and equal on all the cameras. If you have one or two cameras pointing at the sky, you can bump just those cameras up to +1.0 or +2.0. If you have realtime preview or field monitor

with you, try out and adjust the settings accordingly.

When using a new rig for a shoot, test the cameras and adjust settings the day before! Unload the footage and do a test stitch to double check and make sure the settings are correct and best for that rig. If you are torn between higher fps or resolution, do a test and check it out in the headset before. After you find the sweet spot, write down the settings and charge up the batteries for the shoot. Check again on the day of to make sure the settings did not accidentally get knocked in transit.

Problems of Stitching

Dailies Quickstitch

Problem:

You need to quickly stitch some source footage with burnt in timecode for a review session but don't know where to start.

You've just finished ingesting your source footage onto a hard disk after shooting multiple takes for many scenes. It's now time to sort and label your files into bins. As opposed to traditional post-production workflow, reviewing your dailies can't happen until your footage is stitched together. Stitching two or more videos together will first require you to organize your files properly.

Solution:

Organizing a project folder

Each sd card corresponds to a certain camera angle. When you ingest video files from one sd card, you are uploading all the takes into one folder (ex. Camera 1, Camera 2). You will need to move the video from each camera folder into a new take folder (ex. Take 1). Here's a snapshot of how it looks before and after.

Name
▼ after
▶ T001
▶ T002
▶ T003
▶ T004
▼ before
▶ cam1
▶ cam2
▶ cam3
▶ cam4

To quickly find which video files should be placed into a new take folder, open all your camera folders using the dropdown arrow. Start by highlighting the first mp4 in each camera folder, then look at the file size of each one. If it's the same or close in size for all highlighted files, the files are all from the same take. Drag them all into the new take folder. If you are unsure, you can always open the videos and view them.

Renaming source files later can be tricky so organize before stitching. Is your project is stereoscopic or monoscopic? If you shot in stereo, you will have two of each camera angle, corresponding to left/right eye. Make sure to include if the video is Left eye or Right eye in the filename.

The simple saying "for every minute spent organizing, an hour is earned" truly applies to 360 video editing. Remember you are editing the amount of take files times the number of cameras. Add a few prefixes to help you and your team down the line such as T01 for take number, HD or SD (4K/2K), C01 for camera number, LE or RE for Left Eye and Right Eye in a case of stereoscopic projects.

For example,

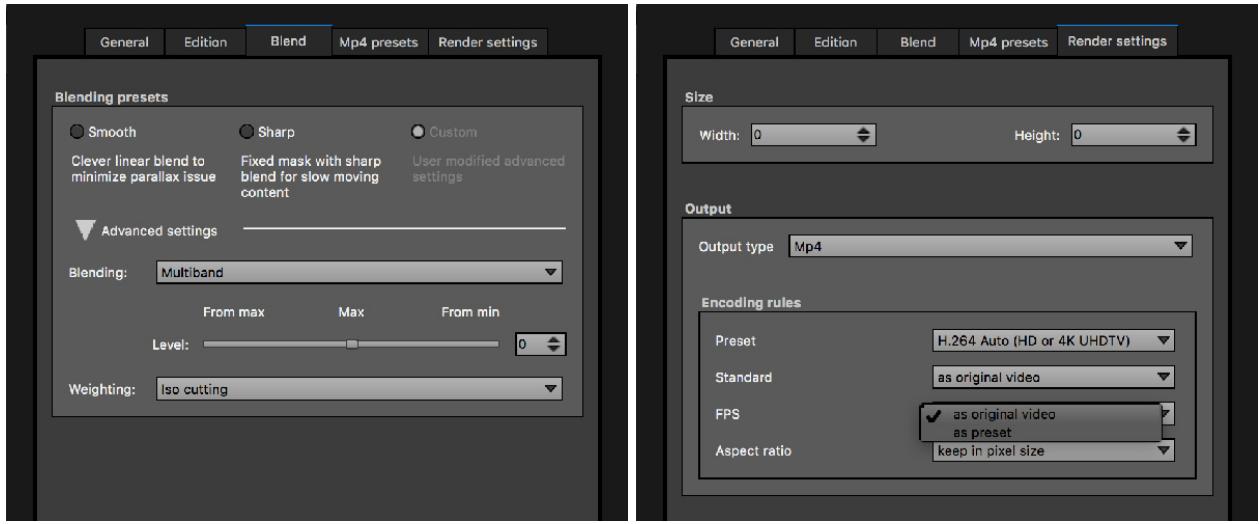
GOPR02355 would be T01_HD_C01_GOPR02355.mp4 for a monoscopic project.

GOPR01025 would be T07_4K_C03_LE_GOPR01025.mp4 for a stereoscopic project.

Quick stitching of takes

To combine the individual videos into a single high resolution seamless panoramic video, you will have to "stitch" them together. Most video camera manufacturers are developing built-in functionality to ease the stitching/playback of 360 dailies. If you don't have a real-time stitching solution, you will have to stitch the videos yourself before previewing dailies. Thanks to Autopano Video Pro (AVP) from Kolor, it's just a few clicks away.

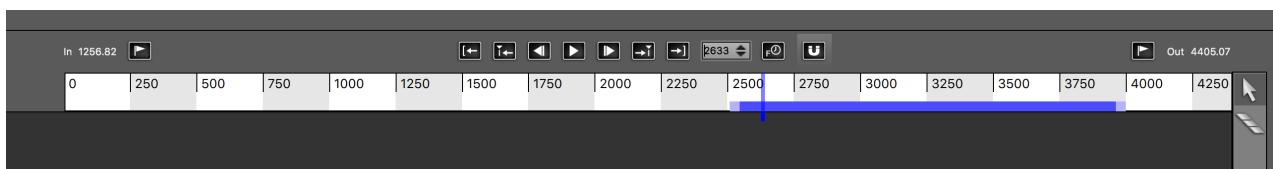
Open the "preferences" of AVP (or command + ,). Under Blend > set Blending Level to 0, Weighting to ISO Cutting, and Render settings FPS as original video.



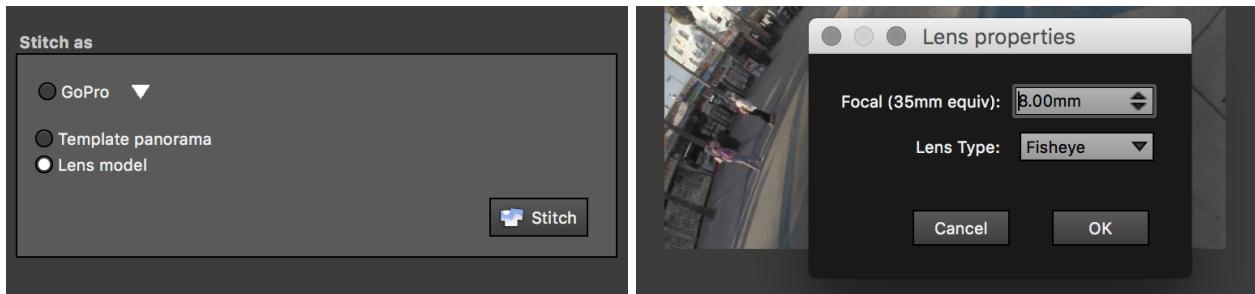
Drag your videos into AVP. All videos must have the same length, same format (mp4 or mov) and same frames per second (fps). The accuracy of the visual sync between cameras may vary depending on the equipment used, or your set and settings. Ensure all cameras are perfectly synchronized before stitching (e.g. Apply "Use Audio to Synchronize" under Synchronization menu).



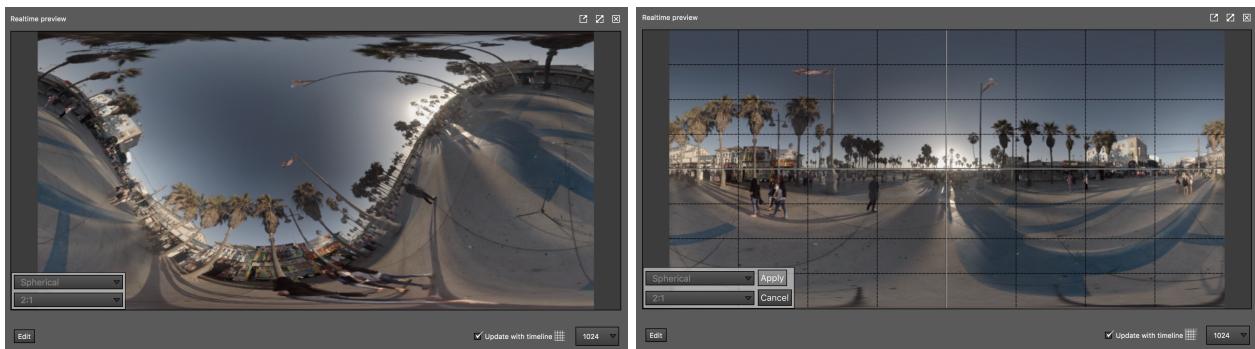
Before jumping onto the stitch tab (fourth icon in the AVP header bar), select a range of frames by trimming your timeline at beginning and end using the blue range selector. Then click on the exact frame you want for the calibration. Don't leave it on the beginning frames. You don't want to confuse AVP by trying to stitch the DP's fingers or face. Save that for later during the fine stitch.



Select a stitching preset using the dropdown. The default preset will auto stitch as GoPro. If you are using different camera lens, check "Lens model" and input the focal length and lens type. For example, enter in 8mm for your focal length and fisheye for type of lens. Press "OK" and then click "Stitch" and let AVP do the rest!



When stitched together, your panoramic video may need to be adjusted or rotated. Hold your cursor on the preview area and drag until the horizon is aligned. Don't forget to apply your changes.



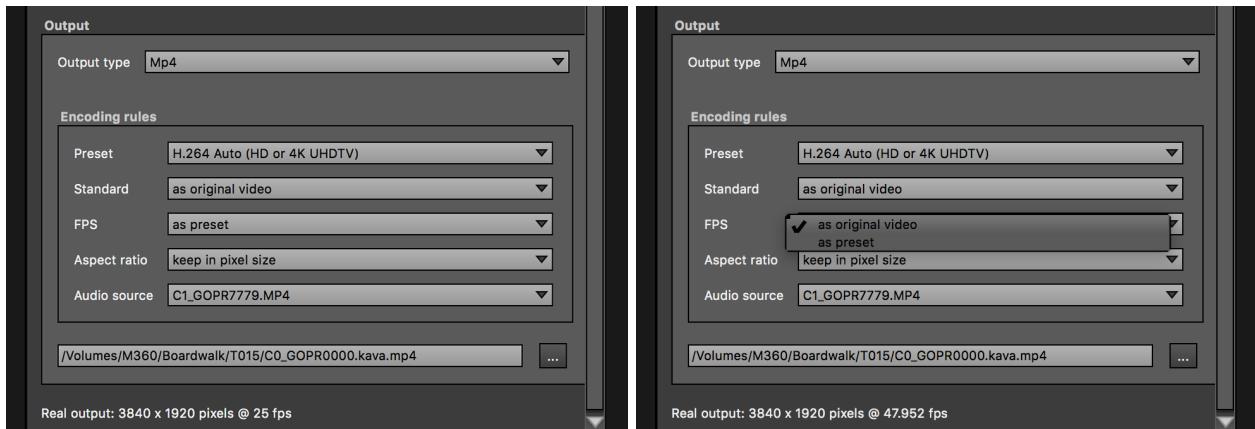
Bravo, you have just completed your first quick stitch, now you are ready to render your work!

Rendering your work

Rendering is the last step in any workflow. Every software you use to edit the picture or audio of a file will let you export the changes by creating a new video or audio file with the render settings you selected.

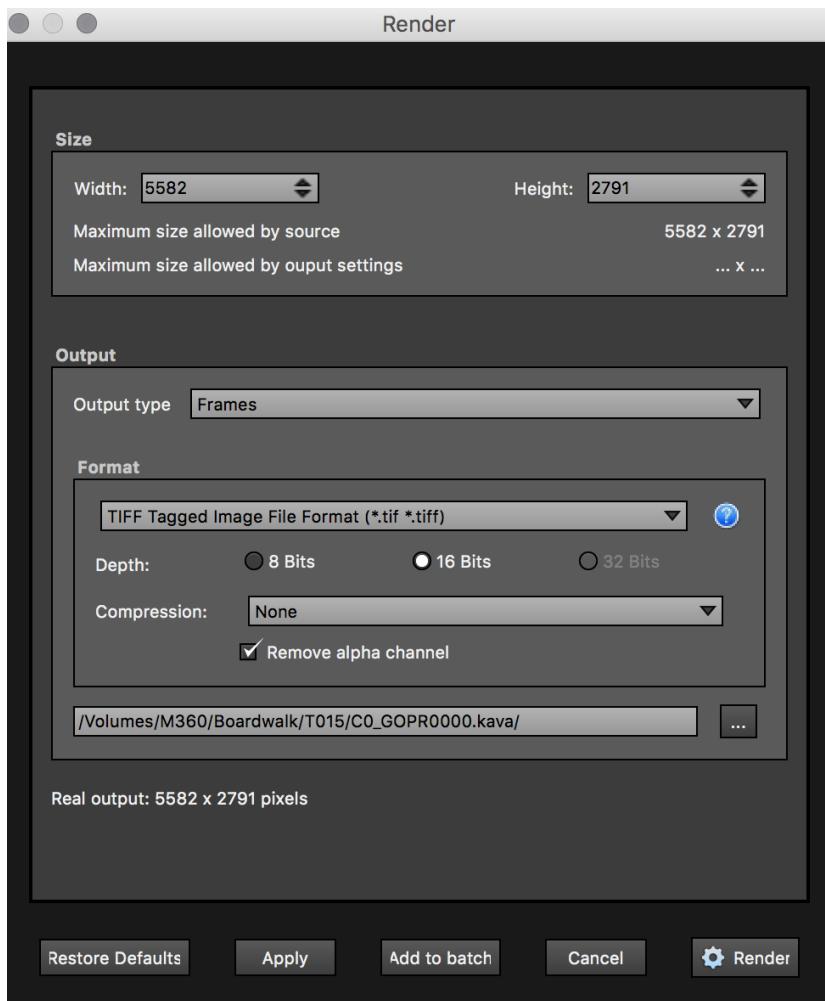
Before you start rendering, double check that all your default preferences are correct. Consider the right fps for the playback solution of your choosing. Even if you shot at 100fps or 60fps, you will want to output at an FPS that the headsets or video player can handle.

For example, if you want to upload your 360 video to youtube or facebook, the current allowed fps is 24, 25 or 30. For quick stitches, I generally like to set my FPS to be same "as original video" under the Render settings. Setting the default preferences will make it easier to batch render.



When you are ready to hit the "render" icon, AVP will bring a pop up some presets to choose from and show the maximum output size. The maximum output size is the resolution achieved from your 360 camera rig. Depending on the rig you chose, the final resolution after stitching can range from 4k to 8k. Presets are very valuable during stitching and you will want to get familiar with all the choices. When you want to render small files quickly to test and find seams to fix, you can output at a lower resolution such as 2k. Remember to change the settings back for your final render. You can always check at the bottom of the pop up window what resolution and frame rate the video will render as. For the GearVR, render your videos at 3840x1920 or 4096x2048 when shooting 4k (1920x960 is SD).

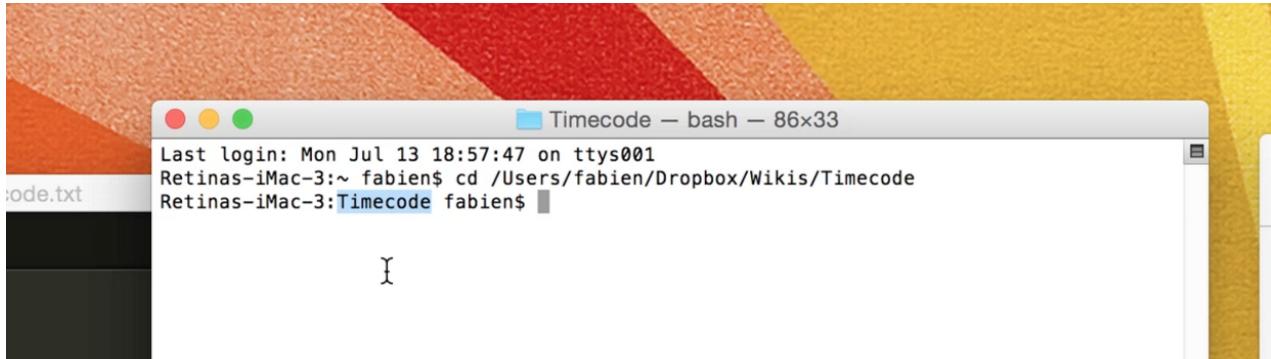
When rendering your fine stitch, it is highly recommended to render output type as frames, a sequence of uncompressed tiff images at 16 bit color depth. You will want to render frames to keep the highest resolution of your panorama and the maximum size allowed. There are limitations when you render videos. The bit depth will be between 8 to 10 bit, including the AVI uncompressed option, and there are size limits (for example: h264 mp4 maximum height at 2304px). Rendering tiff sequences will allow you to keep the maximum output resolution and quality. Your footage will be running through many processes down the pipeline. From stitching to vfx to editing to color grading, pixels will get distorted down the line. You will want to work and keep the files with at highest resolution and quality, starting with AVP Output TIFF Frames at 16 bit, and No compression in AVP.



PROTIP: Removing alpha channel when exporting tiffs will reduce the size of each tiff. Recommended for large sequences.

Every time you render, you are creating a new file. Stay organized so you know what version each render is. Add a prefix to every file. Use QS for Quickstitch, a version number _v001 for your tests, and FS for Fine Stitch. When rendering frames, select an output folder with the suffix _tiff in the name.

Encoding a burnt-in timecode



You can use After Effects, Premiere or any video editing software to encode a timecode or you can do it...the "hard" way aka not really, just geeky but in reality faster way! Hello FFmpeg! Don't let the terminal or command lines scare you!

For Mac users, the "drawtext" filter of FFmpeg is only working with this FFmpeg library. Unzip the 7zip file using Keka, then place the 30mb "ffmpeg" file in the directory where all the libraries live, usually /usr/local/bin/ffmpeg.

Show/Hide Hidden Folders and Files on Mac:

```
defaults write com.apple.finder AppleShowAllFiles YES
```

```
defaults write com.apple.finder AppleShowAllFiles NO
```

Open the Terminal app on Mac. Use the basic commands to access the directory where your stitched video is located.

PROTIP: If your Finder is opened with your video visible, drag the folder icon into the Terminal window AFTER typing "cd" (e.g. change directory).

Type the exact FFmpeg script for the action you want to perform on the video: embedding a timecode in center of video, at the same framerate as video.

```
ffmpeg -i video.mp4
```

Run FFmpeg by simply the typing "ffmpeg" in the terminal. FFmpeg takes a video in

and creates a new video out. Let's tell ffmpeg where and which video you want as input. Just type "-i" and the path/name of your file.

```
ffmpeg -i video.mp4 video_tc.mp4
```

Type the name for the output file. This FFmpeg script doesn't really perform any action besides renaming the output file. If you want to change the extension of the output filename to .mov, FFmpeg will operate a conversion of your video from MP4 to MOV.

To add any kind of text or timecode on your video, use the filter "drawtext" after calling it via -vf command before the output, such as:

```
ffmpeg -i video.mp4 -vf "drawtext=" video_tc.mp4
```

Select a monospaced font file from your machine:

```
fontfile ='/ Library/Fonts/Arial. ttf ':
```

Then add the format for the timecode including the framerate (matching same fps as video), font size, color, and position on the video:

```
timecode='00\:00\:00;00':r=29.97: fontsize=32: fontcolor=white: x=(w)/2:y=(h)/2
```

Note the colons are required between each argument. Put all of this together into one command line:

```
ffmpeg -i video.mp4 -vf "drawtext=fontfile='/Library/Fonts/Arial.ttf ': timecode='00\:00\:00;00':r=29.97:fontsize=32:fontcolor=white:x=(w)/2:y=(h)/2" video_tc.mp4
```

Press RETURN after pasting this line into your Terminal and FFmpeg will render the video again with the timecode on it. Good Job!

First Assembly

"23. Keep track of every day the date emblazoned in yr morning"

Jack Kerouac, Belief and Technique for Modern Prose

Problem:

You need to assemble a rough cut with multiple unstitched video streams.

You have just rendered the quickstitches with burnt in timecode and have to select the best parts for your edit. Should you edit with the source or the stitched footage? How should you log notes for the best 360 edit?

Solution:

Log notes from reviewing quickstitches.

Whether viewing the dailies with the crew after each day of production or during the director-editor viewing session in a headset, always log notes with the 360 space in mind. When auditioning for the best materials, consider which camera the viewer will be facing when putting the headset on. Have your log sheet ready with one row per camera.

The log sheet will evolve over the entire 360 editing workflow, so make it clean and beautiful! During ingestion, have the DIT tart this sheet by adding a column for each camera, a row for each take and some notes such as "bad cam", "false take", "dropped cam", etc. After organizing your camera files into take folders, update this log sheet and below each take, add as many rows as the number of cameras.

The goal of the log sheet is to track the INs and OUTs of all your selects, the cameras that need some exposure correction, the synchronization offsets, the location

of files and all notes from the team. The log sheet will be extremely helpful for the stitcher, editor, and director.

Put it together, stitched + unstitched.

As a rough draft, the first assembly usually will have the least amount of cuts. In 360, it's not optimal to have a lot of fast cuts and transitions. The viewer will need slow transitions to ease into the new environments. Your assembly will contain as many video/audio tracks as the number of cameras of your rig.

First, use the quickstitches to build an edit. This method is similar to the traditional rough cut edit. Bring all your quick stitches into Premiere, use the shortcut I for IN and O for OUT to reflect the log note's ins and outs selected by the director. All quickstitches should be synced and untrimmed to reflect the same timecode as the source footage you will be editing later.

When assembling all clips in your timeline, focus on the timing of the transitions. Give the viewer enough time to adjust to the new scene. Then edit all your best clips into the order you desire. When satisfied with the first assembly of the quickstitches, render a low resolution preview of it or start the next phase, assembling with the source footage.

Assembling with source footage will require one video track per camera and should match precisely the rough cut edit of the quickstitches. Make sure the quickstitches are properly named with the take and camera number. This will make it easy for you to locate the cameras that correspond to each clip in the timeline. Select all the cameras of each take, and sync them using the multi camera Synchronization through audio.

Bring the synced sequences of source footage to a new timeline with the settings matching the camera settings. Trim based on the INs and OUTs points of your log sheet and assemble them like the previous stitched first assembly. It's crucial to keep the same settings as the source video to avoid any compression.

If you shot plates or created titles and other vfx, you can easily add a video track over the source video track to create the final result you are trying to achieve even before stitching it.

The assembly using source footage is not for preview purpose, but for exporting the EDL or XML file. The EDL file or Edit Decision List is a file that many editing softwares read in order to recreate the same exact timeline after relocating the project folder and files.

Patching Nadir

Problem:

The tripod of the camera rig is visible and masking markers aren't removing it.

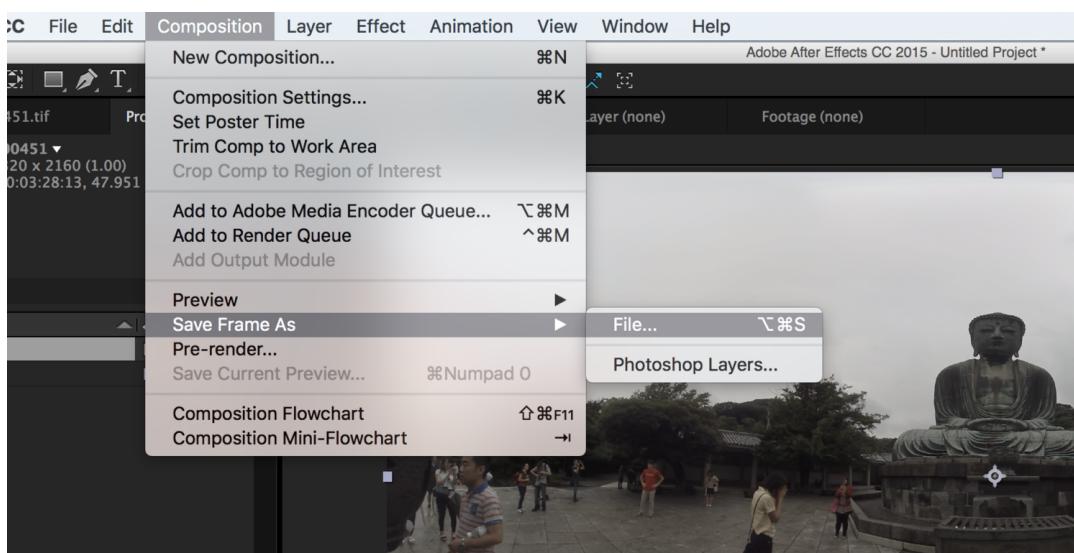
You have stitched your videos but the tripod still shows. You didn't shoot the moon to replace the camera rig and Autopano does not recreate missing pixels. When you try using the red masking markers to hide the rig, some weird blending or a black hole is generated in the panorama.

Solution:

Use Photoshop's clone stamp to recreate missing pixels.

Flip the panorama vertically to edit the desired area. Then convert your 2:1 Equirectangular panorama to 180° Fisheye / Domemaster format. After editing the nadir or zenith in Photoshop, convert back to 2:1 format and flip if needed to flatten the panorama.

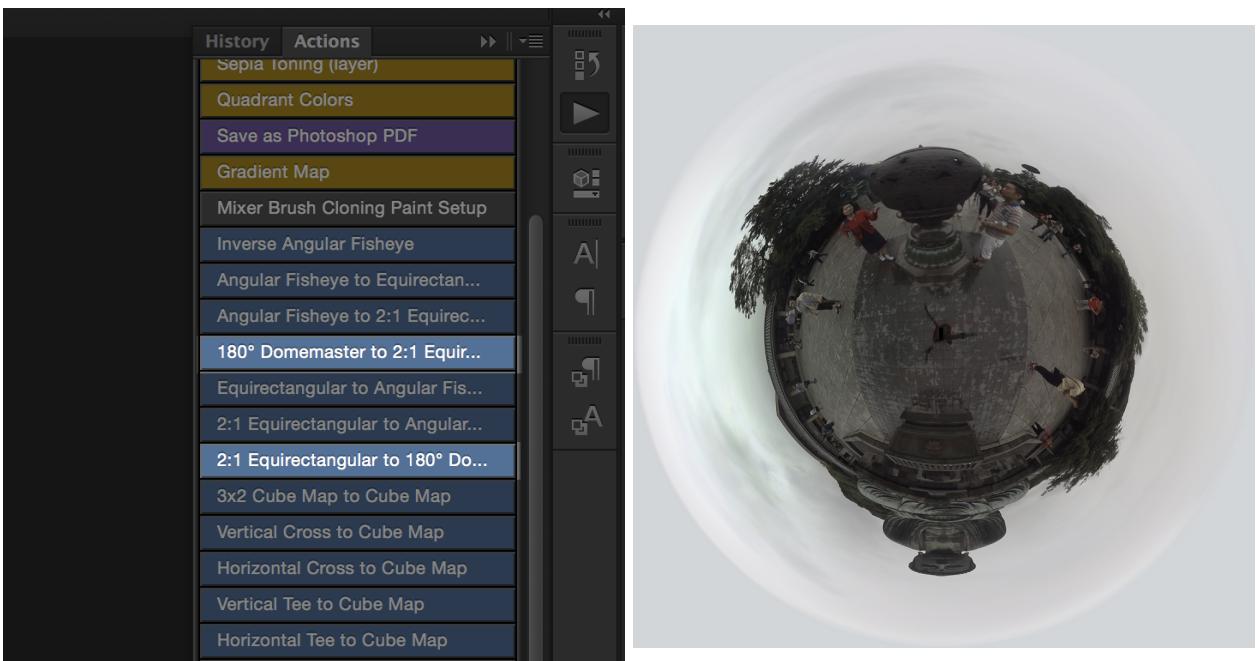
First, install Andrew Hazelden's Domemaster Actions for Photoshop.



After importing the image sequence into after effects, create a new composition with it and save the first frame as a photoshop layer. Render the file, and open it in Photoshop.



First rotate your image 180 degrees if you are editing the nadir or zenith. Flatten the layer before applying any Domemaster actions.



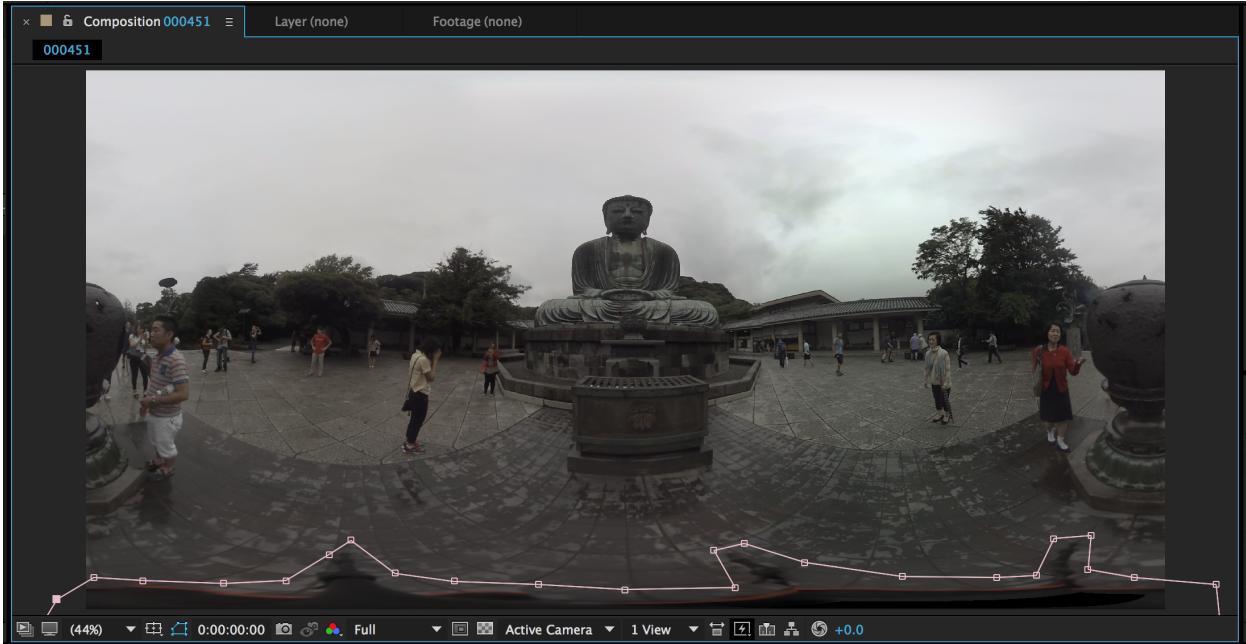
In the Actions list, select 2:1 equirectangular to angular fisheye or 180 domemaster. The panorama format is now converted to a planetarium view. Edit the tripod here using the stamp tool.

PROTIP: The stamp tool icon is located in the tool box. Press S on the keyboard to access it, then 'alt' to select area to clone. Click on the area with the tripod and apply the clone.



Afterwards, flatten your layers and apply the reverse domemaster actions, angular fisheye or 180 degree domemaster to 2:1 equirectangular. Then rotate the panorama 180 degrees if needed.

Back in After Effects, import the Photoshop layer and place the layer on top of your existing image sequence. The frame with the tripod removed will be used for the entire image sequence. Change the dimensions of the photoshop layer to 50% smaller if needed.



Using the pen tool, hide the layer and create a tight mask around the tripod from the original sequence. Show the hidden layer you created a mask with and adjust the feather to blend the edges of your mask with the original image.