

Installing and Using Tachyon® VPL and Dark Energy® with Vantage

This App Note
applies to
Vantage
Version 6.3, 7.0,
7.0 UP1, UP2, UP3
& later

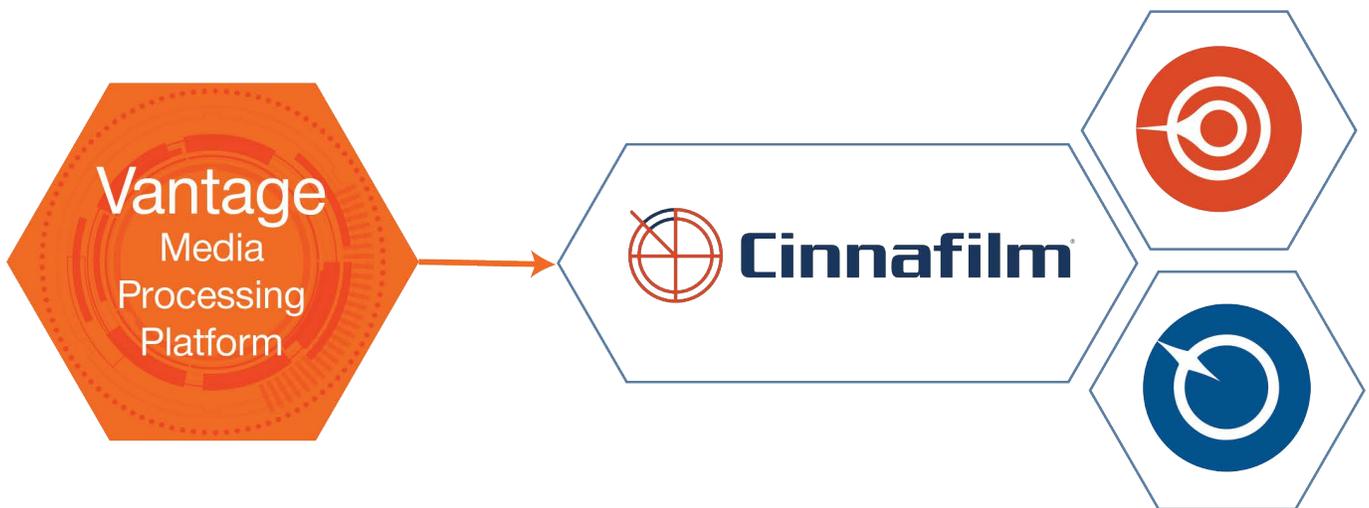


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Introduction to Tachyon

Tachyon® Video Processing Library (VPL) from Cinnafilm® is available as an optional add-on to Telestream Vantage Transcode and Transcode Pro. For professionals who deal in mixed standards and formats, the Tachyon option provides Vantage media workflows access to high-quality format and standards conversions tools.

The beauty of the integration in Vantage is that all the power of Tachyon's expansive VPL can be directly accessed within Vantage and included in Vantage workflows. In addition to providing extremely high quality, Tachyon saves users time, expense and labor by eliminating the need for baseband standards and format conversions.

Tachyon is highly optimized for GPU acceleration on Telestream Lightspeed servers with Vantage. (Lightspeed K20 and K80 servers can process two jobs simultaneously; K40 servers, one job.)

Important Note: Upgrading to Transcode version 2017.5 or later from an earlier version creates an incompatibility with Lightspeed Nvidia drivers that causes Tachyon jobs to fail. Contact Telestream Support to get the latest supported Nvidia driver installer (v354.56 or later) for your Lightspeed servers.

Features

Tachyon's feature set is built around a powerful phase correlation motion compensation engine called PixelStrings™. PixelStrings performs analysis on each frame, mapping the velocity and direction of each individual pixel. It then uses that motion information to predict (or synthesize) new frames at any point in time. The result is smooth motion playback at any framerate. With this level of analysis, Tachyon is able to provide advanced standards and format conversions.

- Tachyon Frame Rate Conversion Features:
 - Motion compensated cadence conversion
 - Automatic scene cut detection
 - Field-based conversion techniques
 - High quality de-interlacing
 - Conversions must be limited to/from these standard rates:
23.976p, 24p, 25p, 29.97p, 30p, 50p, 50i, 59.94i, 59.94p, 60i, 60p
 - Inputs: interlaced, progressive, pulldown, intermixed mode
- Tachyon Pulldown Detection and Removal Features:
 - Pulldown can be intermixed with non-pulldown footage
 - Standard pulldown/telecine patterns are removed (2:3, 2:2:2:4, etc.)
 - Auto detection of areas with damaged pulldown patterns and correct pulldown recovery
 - Algorithms for high noise and/or low signal to noise ratio
 - Algorithms for cartoon/anime
- Tachyon Resize Features: Tachyon implements various filters for the up/down scaling of images. Specific settings for individual filter parameters are hard-coded into the following user options:
 - Auto invokes specific levels of the various filters based on source resolution and target resolution

- Tachyon Motion Blur Features: Tachyon automatically implements shutter-angle specific motion blur for conversion from any higher frame rate to any lower frame rate.
 - Benchmarked against the Academy of Motion Pictures reference images
 - IMF compliant for down-sampling

Introduction to Dark Energy

Dark Energy® can be used for removing unwanted noise/film grain, and for creating image upscaling and downsampling. Downsamples are alias free and up-res'd images are scaled with heavy consideration to the image texture at the new raster size. Dark Energy can be used to:

- Create the best resolution scaled images
- Remove noise while maintaining details
- Virtually develop image texture that is realistic and is appropriately matched given the delivery raster

Grain/Noise Management Features

- Dark Energy Automatic Degrain/Denoise can be used to clean up film scans, restoration work, and electronic noise (digital cameras using a high ISO setting, low light, warm sensors, etc.).
- Dark Energy removes/lessens the impact of existing compression blocking, and it also removes macro/micro blocking from small format cameras (for example, GoPro).
- Dark Energy can be used as a pre-compression filter to improve compression results and allow better images at lower bitrates.
- Dark Energy Texture is a virtual texture development process that can simulate any film stock as well as provide layers of texture for optimal resolution modifications.
- Dark Energy Resize features: Dark Energy implements various filters for the up/down scaling of images. Filters include:
 - Denoise Amount
 - Sharpen Amount
 - Texture Size
 - Texture Amount
 - Texture Color
- Specific settings for individual filter parameters are hard-coded into the following user options:
 - Auto invokes specific levels of the various filters based on source resolution and target resolution.
 - Disable will turn the function off.
 - Extra Low/Low/Med/High/ExHigh will use settings predefined by Cinnafilm as appropriate for a graduated implementation of filters.

Benefits of Using Dark Energy

By addressing image texture while transcoding or performing resolution scaling, the benefits are wide and significant. Here are some of the benefits of using Dark Energy:

- Avoid expensive uplifts to 4K workflows. Maintain your HD/2K workflows and up-res via Dark Energy to UHD/4K deliverables once projects are fully completed.
- Retain details and prevent them from being lost under high compression
- Create higher quality images at lower bitrates (for example, when using Dark Energy, transcoders can compress a UHD image down to 20-megabit streams without losing significant details)
- Prevent compression banding at low bitrates
- Prevent dark colors from “crawling” on the screen
- Downsample to any resolution without fear of aliasing

Viewing Environment

Image texture cannot be effectively judged on a frame by frame, non-real time system. We highly recommend that the results of Dark Energy be viewed in the environment where they will be consumed. So if a project is intended for theatrical release, view the results in a proper theater. If it is for broadcast, view it through a set-top box or on a broadcast monitor. Viewing in the intended environment is the only way to ensure the images appear as expected.

Software/Hardware Requirements

- Lightspeed K20, K40, or K80 Server
 - Vantage Transcode or Vantage Transcode Pro
 - o Vantage version 6.3 with Media Transcoding & Analysis version 2015.9 or later
 - o Vantage license that includes a Tachyon/Dark Energy option(s) key (see Licensing below)
- Windows Server 2008 R2 or Windows Server 2012 R2

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Licensing

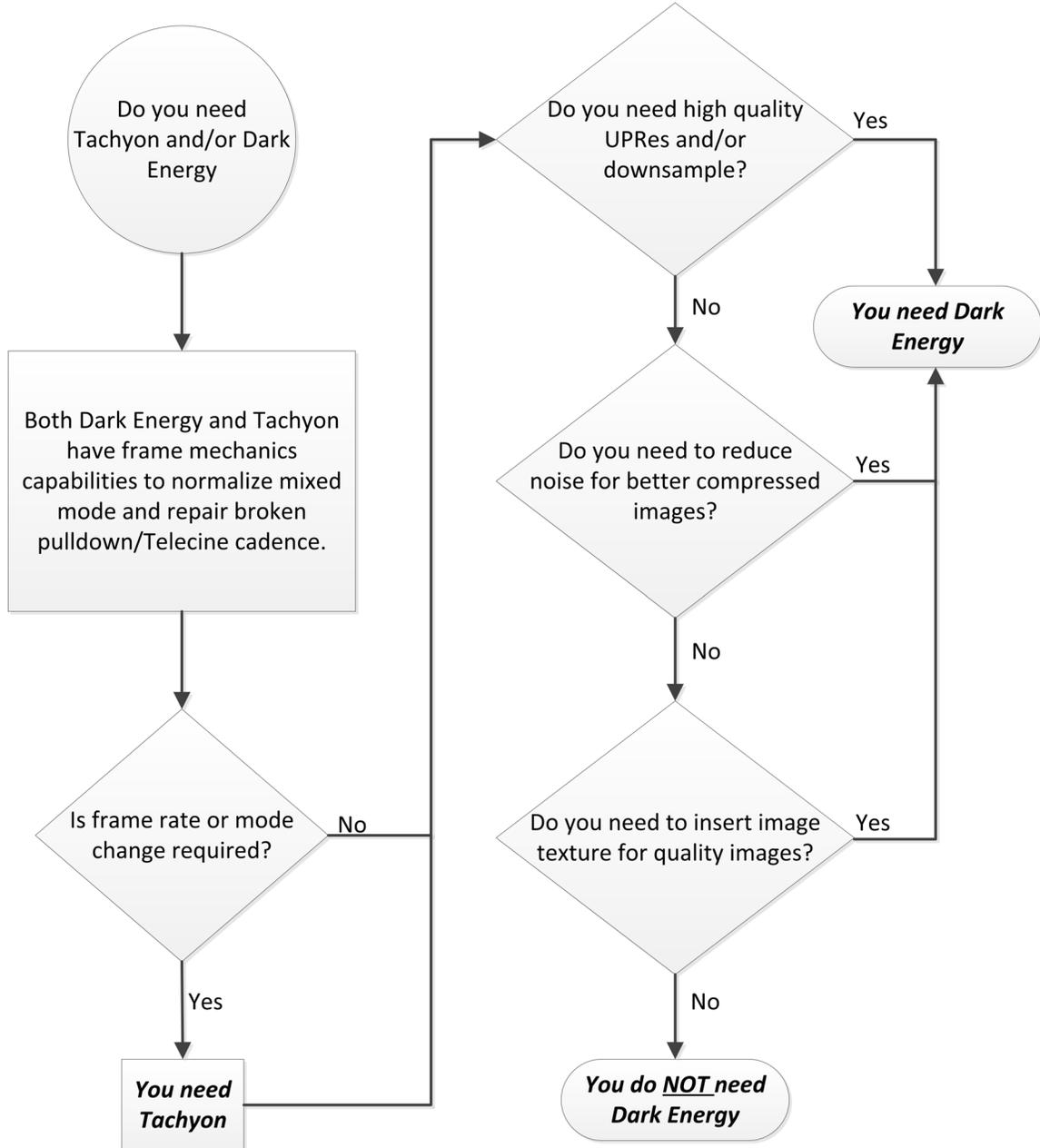
The Tachyon and Dark Energy options for Vantage are enabled using one of the following licensing options:

- V-TACHYON—Enables Tachyon inverse telecine processing and standards conversion for up to two (2) GPUs.
- V-DARKEN—Enables Dark Energy Texture processing and scaling for up to two (2) GPUs.
- V-TACH-DE—Enables Tachyon inverse telecine processing and standards conversion with Dark Energy Texture processing and scaling for up to two (2) GPUs.
- V-TACH-COMBINE—Upgrade an existing Vantage Tachyon License to a combined Vantage Tachyon and Dark Energy license.
- V-DARK-COMBINE—Upgrade an existing Dark Energy License to a combined Tachyon and Dark Energy license.

Tachyon and Dark Energy processing is GPU-based. Each GPU core, within a Lightspeed server running Vantage, can process a single Tachyon and Dark Energy operation. Tachyon and Dark Energy option licenses support 2 GPU each. In order to support more than 2 Tachyon/Dark Energy processes additional Tachyon and Dark Energy license options can be purchased.

Tachyon/Dark Energy—Choosing the right solution

Figure 1. Do you need Tachyon, or Dark Energy, or both?



Possible Outcomes:

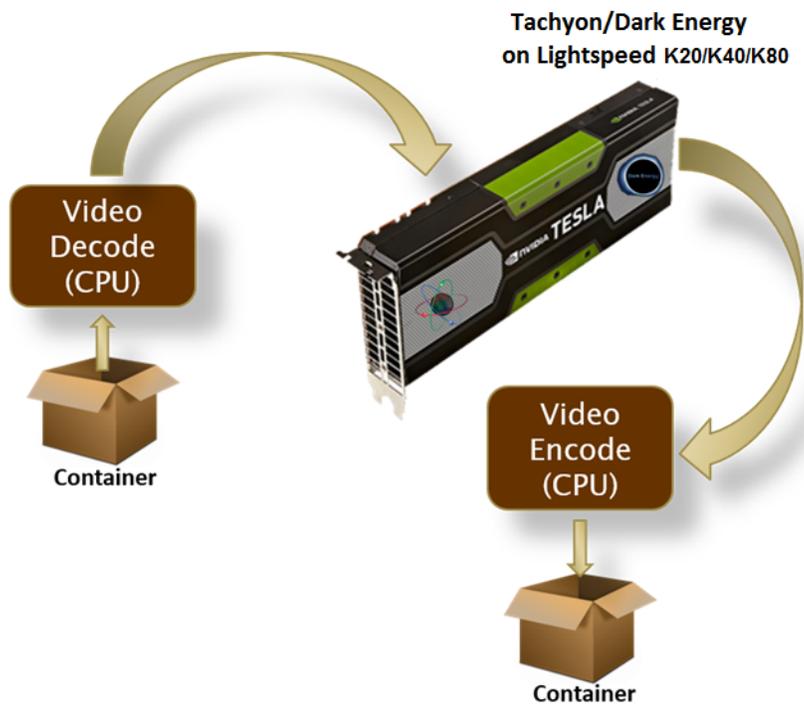
- Only Tachyon is needed (V-TACHYON)
- Only Dark Energy is needed (V-DARKEN)
- Both Tachyon and Dark Energy are needed (V-TACH-DE)

How Tachyon / Dark Energy Works

Understanding the inputs and outputs of Tachyon/ Dark Energy

In order to understand how Tachyon/Dark Energy works let's start with the process for moving images in and out:

Figure 2. Moving images in and out of Tachyon/Dark Energy



Tachyon/Dark Energy only processes uncompressed images. So to process images, the file is:

- Demuxed and decoded by Vantage using the CPU
- The file is handed off to Tachyon/Dark Energy
- On the Lightspeed's GPU, Tachyon/Dark Energy processes the file's images, performing all processes in a single render
- When completed, Tachyon/Dark Energy hands the file back to Vantage for encoding

Progressive Video Essence

Before performing any Denoise or image scaling, or doing any framerate conversion, rescaling, or interlacing changes, Tachyon/Dark Energy first converts all interlaced/telecined video to an intermediate progressive stream, whether film originated or video originated. This is called the Progressive Video Essence (PVE). This progressive stream of frames is then used by the Tachyon VPL to create the output video stream, which is created either by using the motion compensation engine or field-based conversion methods or by using Dark Energy to create the output video stream in the new raster and/or with texture management:

- Inverse Telecine will be performed to obtain the 23.976 essence on 29.97i Telecine/pull-down footage.
 - Broken cadence as well as advanced pulldown patterns (i.e. 2224 pattern) are also removed to generate the 23.976 PVE.
- De-interlacing will be performed to obtain a progressive essence which is double the source frame rate (i.e. 25i will become 50p).
- Progressive frames are passed through unchanged.
- Mixed mode is automatically recognized and dealt with accordingly on a scene-by-scene basis.

Film vs. Video Workflows

Understanding the source material is critical to achieving the highest quality StandardsTranscodes™ with the Tachyon VPL. Specific algorithms have been developed by Cinnafilm to optimize the conversion of source frame rates to whatever desired frame rates is required. Understanding how the Tachyon VPL processes various types of footage is very important to insure a quality result.

We begin with the premise that source material is either originated at a "film" rate or a "video" rate.

- **Typical Film Rates:** 23.976p, 24p, 25p, 29.97p, 30p
- **Typical Video Frame Rates:** 25i, 29.97i, 30i, 48p, 50p, 59.94p, 60p

As the Tachyon VPL performs analysis of the video file, it brings the *progressive video essence* of the images into memory for conversion to the desired target frame rate. *Progressive video essence* refers to images after they have been de-interlaced or after any pulldown pattern has been removed. The Tachyon VPL only converts PROGRESSIVE images, so high quality de-interlacing and pulldown removal is essential to the process.

Because of the varied types of frame rates and capture methods, there may be situations **where there is less motion information (lower frame rate) than what the frame rate actually indicates**. When this occurs, the optimal Tachyon setting for the targeted conversion may be different than expected. Those frame rates which will cause this situation to arise are:

- **29.97i created via Telecine/Pulldown**
 - 2:3 Pulldown: This takes a 23.976 progressive video and manipulates the progressive frames into fields, repeating fields in a 5:4 ratio, which will result in a playback frame rate of 29.97 interlaced FPS. Telecine material will have a signature pattern (when viewed on a progressive monitor) of 2 interlaced frames then 3 progressive frames, in a repeating

pattern. Although it is in a 29.97 FPS format, the motion equivalent frame rate is only 23.976.

- 2:2:2:4 Pulldown: This takes a 23.976 progressive video and simply duplicates every 4th frame. Although the images remain progressive, a broadcast monitor can display the file with ease.

- **29.97i created via PSF (Progressive Segmented Frames)**

- This takes 29.97p video, doubles each frame, and places each identical frame into the upper and lower segments of an interlaced frame. It allows for progressive 29.97 frame rates to be shown in equipment designed for 29.97 interlaced frames. The 29.97p format mimics the frame-by-frame image capture methods of 24p, but with less inter-frame judder, so it is in essence, a film rate. Source files in 29.97p are enigmatic as both film and video workflows can be used to create outputs.
- When viewed on a non-broadcast monitor, 29.97i PSF files will be seen without any interlacing combs and the metadata, if inspected, will show as interlaced. Tachyon has algorithms that automatically compensate for the discrepancy between the metadata and the actual video essence.

- **25i created via 2:2 pulldown**

- Analogous to 29.97i PSF, but for 50Hz systems. 25p originated frames are doubled, and each frame is fit into the upper and lower segment of a 25 FPS interlaced format. This allows film-captured content to not lose any cinematic characteristics. The video essence is 25p.

- **29.97i via mixed mode**

- Although not ideal, a common practice for North American editors is to mix file types into the same 29.97i editing timeline. The result is that any file which states a playback frame rate of 29.97i could have scenes that are:
 - o Purely progressive sections (PSF)
 - o True interlaced video 29.97i (aka 59.94i)
 - o Telecine (2:3 pulldown)

Tachyon has algorithms that automatically detect this situation, process each section in an optimal fashion, and load progressive essence video images into Tachyon buffers for conversion. The algorithms for detection are activated by using the *Allow Pulldown Removal* setting.

Determine your Tachyon Settings

Tachyon VPL has been preset to optimal settings for 90% of all video when in the AUTO mode.

Note: AUTO mode is critical for Mixed Mode (see above about Mixed Mode) situations because the Tachyon VPL will AUTOMATICALLY switch motion estimator settings on a scene by scene basis.

To determine the Tachyon settings best suited for your workflow visit the Tachyon Conversion Web application located at:

<http://www.cinnafilm.com/support/tachyon-settings-guide>

The screenshot displays the 'TACHYON CONVERSION WEB APP' interface. It is divided into two main sections: 'Input and Output' and 'Tachyon Settings'.

Input and Output: This section contains two dropdown menus. The 'Source Framerate' is set to '23.976p/24p' and the 'Output Framerate' is set to '29.971 (59.94 fields)'. A callout line points to these dropdowns with the text 'Enter source and output frame rate'.

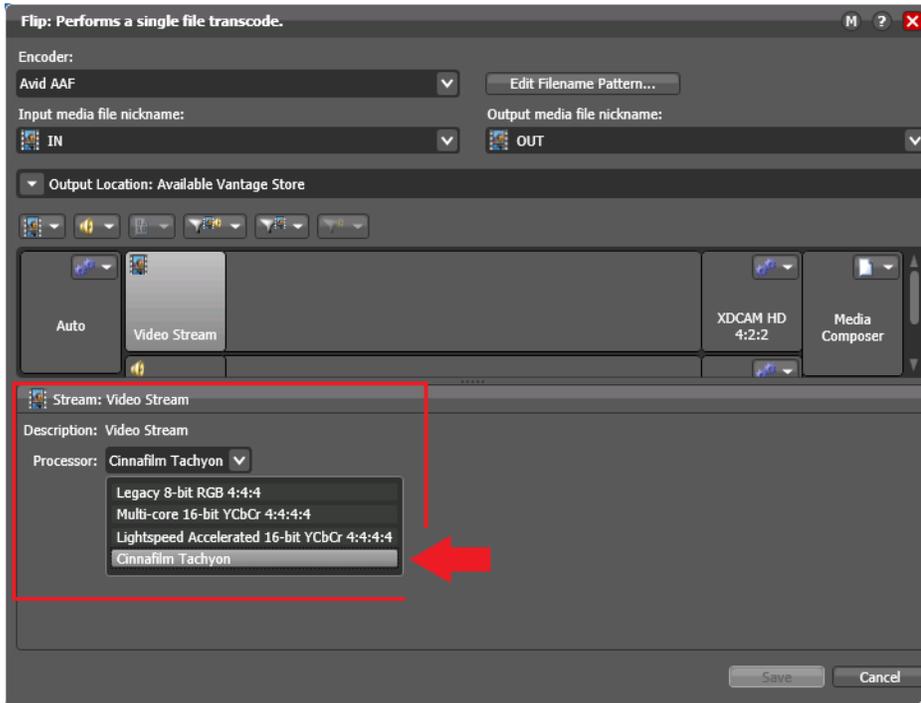
Tachyon Settings: This section is titled 'Tachyon Settings:' and contains two sub-sections: 'General' and 'Convert'.

- General:** Contains several checkboxes and dropdowns:
 - Adjust for Excessive Noise (checked)
 - Adjust for Cartoon/Anime (checked)
 - Allow Telecine/Pulldown Removal (checked)
 - Telecine/Pulldown Removal: Increased Detection Sensitivity (checked)
 - Telecine/Pulldown Removal: Residual Combing Removal (checked)
 - Resize Mode: Add black to fit (dropdown)
 - Input frame configuration: Detect from input file (dropdown)
 - Output frame configuration: Use Encoder Settings (dropdown)
- Convert:** Contains checkboxes and dropdowns:
 - Motion Compensation (checked)
 - Motion Compensation: Amount: Automatic (dropdown)
 - Motion Compensation: Block Size: Automatic (dropdown)
 - Motion Compensation: Fallback Blend Area: Automatic (dropdown)
 - Interlaced: Allow 2:2 Insertion (PSF) (checked)
 - Interlaced: Allow 2:3 Telecine Insertion (checked)
 - Interlaced: Allow Euro Insertion (checked)
 - Interlaced: Allow Adaptive Insertion (checked)
 - Progressive: Double Frames (checked)
 - Progressive: 4:5 Insertion (checked)

A callout line points to the 'Tachyon Settings' section with the text 'Tachyon settings'.

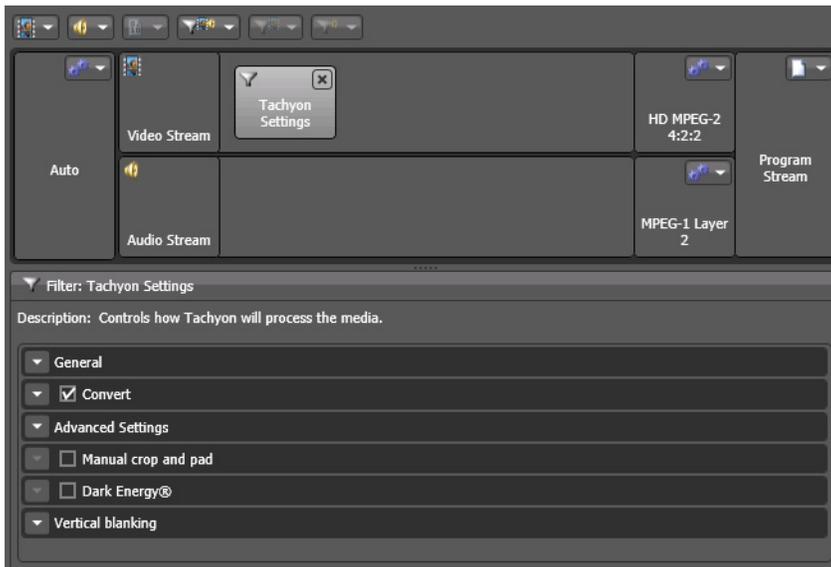
Accessing & Configuring the Tachyon VPL

The Cinnafilm Tachyon VPL, as implemented in Vantage, is a Video Stream VPL Processor option in the Flip action, as shown selected here, with the Flip inspector window open.



To select the Tachyon VPL, follow these steps:

1. Display the Flip action inspector in your workflow—click the **i** icon in the upper left corner.
2. Select the Video Stream element in the encoder.
3. In the editor panel below, select Cinnafilm Tachyon from the Processor drop down menu.
4. With Video Stream selected, click the Video Filter icon in the toolbar (2nd from right) and select Tachyon Settings to add the Tachyon filter to the video stream, as shown here:



The Tachyon Settings panel has six configuration sections for Tachyon VPL and Dark Energy:

- General—Configuring General Tachyon/Dark Energy Settings for transcoding
- Convert—Configuring Frame Rate conversion features
- Advanced Settings—Custom command line settings
- Manual Crop and Pad—Configure cropping/padding
- Dark Energy—Configuring Dark Energy settings
- Vertical Blanking—Configuring Vertical Blanking Settings.

Notes:

To better understand how to configure the Tachyon VPL for best use in your workflows, two terms should be noted: *Allow* and *Enable*.

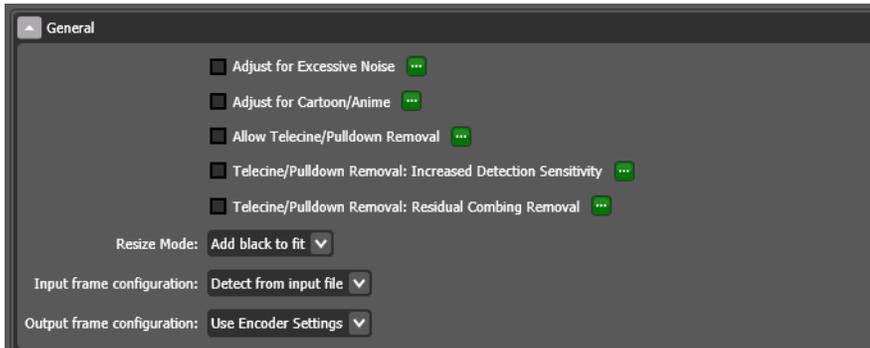
Checking an *Allow* option instructs the Tachyon VPL to—at its option—invoke a particular algorithm only when it is the best solution to achieve the frame rate conversion selected. For example, if *Allow 2:3 Insertion* is checked and the target is 29.97i and the source material is 23.976, Tachyon will insert a true 2:3 Telecine pattern in the output.

Because of the contingent nature of the *Allow* settings, they can be checked erroneously, and the Tachyon VPL will still produce good results.

Conversely, checking an *Enable* option instructs the Tachyon VPL to enable the feature/filter, regardless of whether it is the best solution for the problem or not.

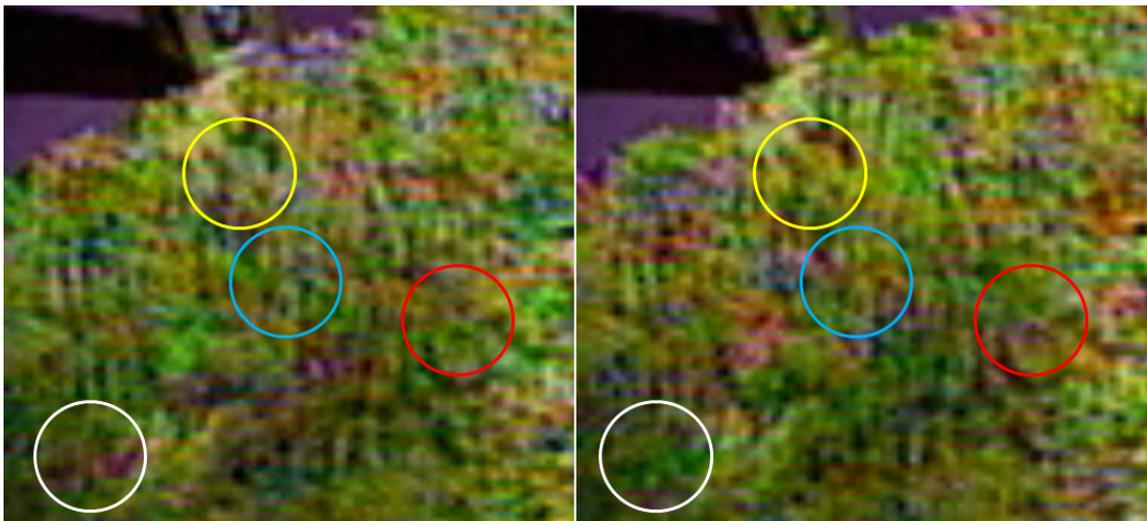
Configuring Tachyon/Dark Energy's General Settings

The General settings section contains controls to determine how the Tachyon VPL and Dark Energy process media for transcoding. These are the common settings which are used by Tachyon and Dark Energy for creating the Progressive Video Essence which all operations are performed on.



Adjust For Excessive Noise

When video is transferred to tape, there are many factors which could introduce chroma noise which is pattern in nature, and highly color transient. Chroma noise is not ideal for any Tachyon conversion, and it is recommended to use the *Adjust for Excessive Noise* setting during the transcode. Below are two successive frames which had high chroma noise present in them. Note how the shape of the noise remained constant, but the color shifted between each frame in each of the circled areas. This level of noise can be detrimental to both de-interlacing as well as inverse Telecine.



Tachyon has a setting which removes chroma noise during the analysis of the video in an effort to achieve higher accuracy during inverse Telecine or pulldown removal. To invoke this algorithm, simply check the Adjust for Excessive Noise to enable this setting.

Adjust for Cartoon/Anime

Animations have many repeated frames/fields, so when there is a broken cadence situation, there needs to be special care taken to ensure the video retains its original essence. This filter allows for retention of repeated frames/fields as appropriate. Check the *Adjust for Cartoon Anime* to enable this setting.

Note: This feature will not remove the chroma noise during the output. It is strictly an analysis tool.

Inverse Telecine

Tachyon's tracking of pixels and creation of motion vectors is quite robust and allows the incorporation of a very accurate scene cut detector. With each scene being accurately detected, Tachyon can apply different algorithms to each segment it encounters. Having segment by segment granularity enables an "intelligent inverse Telecine" where Tachyon can not only remove 2:3 patterns, it can normalize video with intermixed mode and correct cadence errors automatically.

- **Allow Telecine/Pulldown Removal** is a multi-function feature removing simple 3:2 pulldown patterns, automatically detects when Telecine patterns (cadence) is broken, and detects advanced cadence patterns such as the common 2224 pattern.

Note: The 2224 pattern refers to the rate at which fields are repeated. The images will all be progressive and will exhibit no combing, but rather, a duplicated frame every 4th frame. So for example, you are given 4 images, captured at 23.976:

0, 1, 2, 3

Since each frame has an upper and lower field, the images are duplicated into each field, following a 2 2 2 4 pattern. So the resultant 29.976 frames, based on the 4 above frames would be:

Upper Field	0	1	2	3	3
Lower Field	0	1	2	3	3
Repeat Rate	2	2	2	4	

Remember, because *ALLOW TELECINE REMOVAL* uses the *Allow* terminology, it only invokes the pulldown removal when Tachyon detects the presence of a pattern or broken pattern on scene-by-scene basis within a file.

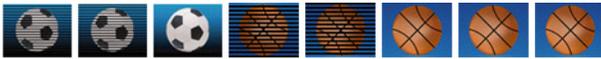
Broken 2:3 Cadence

Accurate Telecine material is easy for many conversion products to fix, but there is a very large amount of footage which contain broken 2:3 cadence. Broken cadence occurs when the Telecine pattern that started at frame 00:00:00:00 does not carry through the entire video.

The normal frame pattern is i1, i2, p1, p2, p3, and it should repeat through the entire project with scene cuts landing anywhere in the image sequence:



Broken 2:3 cadence occurs when editors piece clips together and end scenes based on image content only and disregard image cadence:



As you can see, the above sequence either should have had two more progressive football frames or started the basketball sequence with 2 progressive basketball frames.

When broken cadence is present, common problems seen at scene transitions with other inverse Telecine technologies are:

- Repeated frames
- Jump cuts
- Combing artifacts

With Tachyon's intelligent inverse Telecine analyzing each scene cut for correct 2:3 cadence, the software will automatically adjust the conversion algorithms and create the missing field from motion data when necessary.

Increase Detection Sensitivity

When pulldown is not achieved due to extremely broken cadence, or other factors such as highly mixed content or if chroma noise masks motion, the pulldown engine may fall back to de-interlacing rather than removing Telecine. For this reason a more sensitive pulldown pattern was created. This algorithm favors inverse Telecine, and with lower thresholds for triggering pulldown identification, the algorithm will maximize the number of progressive frames created.

To invoke this more sensitive pulldown removal algorithm, check the *Telecine/Pulldown: Increase Detection Sensitivity* box.

Residual Combing Removal

Unique to Tachyon is the ability to automatically remove composited cadence errors. The following is an example of a composited cadence error:

- Source Video 1 (V1) is 23.976 and video is Telecine'd to 29.97i
 - V1 has a green screen
 - The pattern for the first 5 frames is: P1, P2, P3, i1, i2
- Source Video 2 (V2) is 23.976 and video is Telecine'd to 29.97i
 - V2 is to be keyed into the green screen of V1
 - The pattern for the first 5 frames is: i2, P1, P2, P3, i1
- When keying, the editor did not match the Telecine pattern, so while V1 is interlaced, V2 is progressive. There will be 2 progressive frames in the 3:2 sequences which will match up in this case.

In this example, if a simple inverse Telecine were to be applied, the result would have combing artifacts that appear in the keyed areas of frames 1, 4, and 5.

Another example of where this filter is helpful is in progressive overlays onto Telecine content. A standard inverse Telecine will create combing artifacts in the progressive overlay anywhere there is motion. Tachyon automatically removes the combing artifacts from the progressive overlay once the inverse Telecine has been performed.

- **Residual Combing Removal**—If the images you are converting are composited 29.976, but the pulldown pattern was not adhered to when performing the composite, this setting is required to remove combing artifacts. It will also remove combing artifacts related to very poor 3:2 cadence.

This filter typically used when residual combing artifacts exist after pulldown has been removed. You may use both the *Allow Telecine/Pulldown Removal* and *Telecine/Pulldown: Residual Combing Removal* together.

Resize Mode

All resolution changes are interlaced video aware. If the input media is interlaced, a high quality de-interlacer first generates a progressive stream. The progressive stream is resized using a high quality Lanczos filter. Finally, the resized progressive frames are interlaced if the output is an interlaced format. This results in the highest quality resolution change of interlaced content. If you want to use Tachyon's high quality image scaling to produce a frame size and aspect ratio different than the source, set these parameters as appropriate.

Resizing Mode is the choice of either using a stretch, center extraction, or letterbox/pillar-box methods for resolution changes. If the Aspect Ratio is changing, then there will be black areas in the resolution changed image.

Intermixed Mode

For projects with intermixed mode, Tachyon will automatically “do the right thing.” For example, if a 29.97i project starts with interlaced content, then the scene changes to progressive segmented frames, then changes to a 2:3 scene, Tachyon will treat each section accordingly:

- Interlaced section is de-interlaced and 59.94p is loaded into the Tachyon buffers
- Progressive section is “passed through” as 29.97p is loaded into the Tachyon buffers
- Pulldown section is reduced to 23.976p and is loaded into the Tachyon buffers

Each section will then be converted by the output algorithm chosen. So if Motion Compensation is chosen and the desired output is 23.976, the example above would convert as follows:

- 59.94p is motion estimated to 23.976p
- 29.97p is motion estimated to 23.976p
- 23.976p is passed through to 23.976p

Input Frame Field Ordering Metadata Override

Field order metadata is essential to achieving high quality results from the Tachyon VPL. If your source media is interlaced and you are performing a motion-compensated conversion, your results should be very smooth. If you notice consistent stutter motion then chances are the field order metadata stored with the file is incorrect. Use the Input Frame Configuration options to override the stored metadata to fix these issues.

Input Frame Configuration

When source metadata pertaining to field dominance is known to be erroneous, select one of these options to override the metadata so Tachyon can process the file with the correct field order:

- Lower—overrides metadata and analyzes the video lower field first
- Upper—overrides metadata and analyzes the video upper field first
- Progressive—overrides metadata and analyzes the video as progressive

Output Frame Field Dominance Override

Certain interlaced format codecs by convention produce frames that are upper field first; others produce lower-field first frames. Use these settings to allow or override the conventions.

Output Frame Configuration

When generating output frames with an interlaced encoder, select an option to specify how frames should be configured if poor quality is observed:

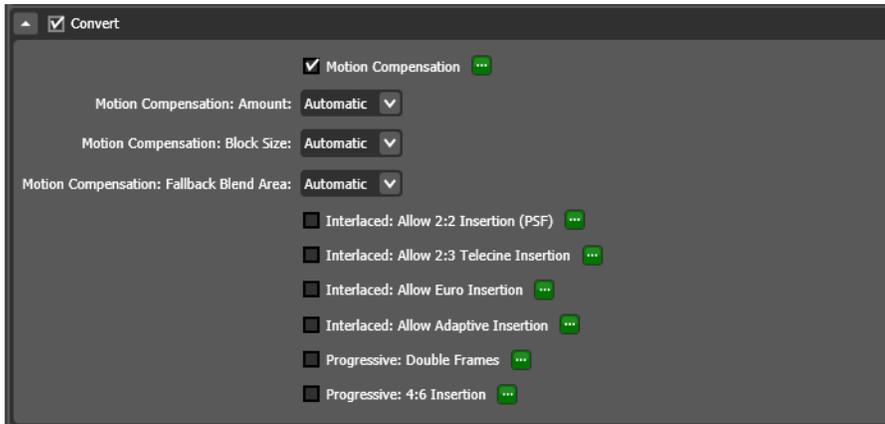
- Use Encoder Settings—(honors the standard implemented directly in the encoder)
- Interlaced Upper Field First—(when using an interlaced codec, produces interlaced upper field first frames, overriding the standard if different)
- Interlaced Lower Field First—(when using an interlaced codec, produces interlaced lower field first frames), overriding the standard if different
- Progressive—(produce progressive frames).

Advanced Settings

The Advanced Settings parameter can be used for custom command line instructions. Contact Telestream support.

Configuring Convert Settings

The Tachyon VPL's Frame Rate conversion features are exposed by checking the *Convert* check box in section just below the *General* Tachyon settings section.



Motion Compensation Conversion Settings

Motion Compensation—Turns on a phase correlation motion estimator to perform interpolated frame rate conversions. The diagram below demonstrates how the Pixel Strings™ engine identifies direction and velocity of objects and panning within a frame. Each color represents a different direction and the arrow size indicates velocity of the motion vector.



Zooming into this area of higher motion, it is easy to see where motion vectors collide and overlap. It is in the areas of intersection that Tachyon excels. Tachyon's patented conversions invoke different settings in the algorithms based on each scene's unique frame rate, as well as

special fallback algorithms to prevent artifacts which would normally occur with other motion-compensation based solutions.

In this picture, motion vectors are shown along with exaggerated, red “fallback” areas. The areas in red are where motion vectors intersect and become inconclusive. The red areas will not use motion data to create the new video frame. Instead, the red areas will “Fallback” to the closest, original, deinterlaced frame (Nearest Neighbor) by pasting in small portions of that nearest neighboring frame.



Tips for Motion Compensation

The amount of motion data present in the source file is critical to the outcome of motion compensation technologies.

- Starting with lower progressive frame essence rates will provide the least amount of motion data and will require higher amounts of fallback. The potential to create artifacts is highest when starting with low progressive frame rates (23.976, 24, 25, 29.97, 30).
- Starting with higher progressive frame essence rates will provide the cleanest conversions and will require less fallback. (25i, 29.97i, 50p, 59.94p are examples of higher frame rates which will create conversions with lower potential for artifacts.)
- When placed in *AUTO*, Tachyon will automatically adjust the motion compensation block size, fallback amount, motion amount, and block size on a scene by scene basis. However, manual override is possible by unchecking auto and selecting the settings desired.

Smart Resampler

We have previously gone over mixed mode video situations and described what happens during the analysis phase in Tachyon. To recap:

- Source Video: 29.97i via mixed mode
 - Scene 1 is true 29.97i
 - Scene 2 is PSF (progressive frames in an interlaced metadata container)
 - Scene 3 is Telecine (23.976 originated, Telecine was applied to get to 29.97i)
 - Scene 4 is true 29.97i
- Tachyon will ingest into its buffers the following frame rates after analysis
 - Scene 1 59.94p
 - Scene 2 29.97p
 - Scene 3 23.976p
 - Scene 4 59.94p

But by checking both the *Motion Compensation* checkbox and any of the *Interlaced: Allow Insertion* choices covered in the next section (such as the *Allow Adaptive Insertion*), the Tachyon VPL will automatically switch between the pixel-based and field-based output algorithms on a scene by scene basis to provide the cleanest possible render.

- Target for Video: 50i
 - Scene 1 converted to 50i via Motion Compensation
 - Scene 2 converted to 50i via Allow Adaptive
 - Scene 3 converted to 50i via Allow Adaptive
 - Scene 4 converted to 50i via Motion Compensation

This setting works for progressive outputs as well. Check *Progressive: Double Frames* and *Progressive: 4:6 Insertion* along with the *Motion Compensation* checkbox to achieve a smart resample output.

Motion Blur

Tachyon automatically calculates and invokes the proper amount of compliant motion blur, based on the reference images generated by the Academy of Motion Pictures.

Why this is important:

- High frame rates are captured with larger shutter angles. These images are combined with high speed playback, creating a perfect result.
- Dropping frames or motion estimating frames from a high frame rate source to a lower frame rate requires consideration of what the shutter angle would be at the lower frame rate.
- Tachyon automatically calculates and inserts the proper amount of motion blur based on the source frame rate and the target rate.
- Tachyon motion-blur for frame rate down samples will not have a strobe-effect and will adjust, scene-by-scene to accommodate any mixed mode situation.
- Tachyon motion-blur is automated and can only be turned off with the following Advanced Setting command string: `motion_blur=0.0`
- Tachyon motion-blur creation can also be overridden to any value desired. Simply set the value in the above command string to anything between 0.0 and 1.0

Field-Based Conversion Settings

These filters are for conversions which manipulate fields versus using motion compensation. When video sources contain low frame rates (Telecine material, 23.976, 24p, 25p) and a significantly higher frame is desired on output, a field based solution may provide stronger results than motion compensation. Keep in mind all of the concepts covered in the Video vs. Film Workflow section when deciding on when to use the field-based conversion settings. (For example, going from 24.0p to 25i should use the *Allow Euro Insertion* setting versus using motion compensation because the Euro filter will preserve the film-look of the 24.0p source).

Interlaced Insertion Settings

These filters are for interlaced outputs only. Leaving them accidentally checked on will not impact a progressive output, but can produce unexpected results when creating frame rates when the Target field rate is exactly double the Source field rate.

- **Interlaced: Allow 2:2 Insertion (PSF)** creates a new series of frames which are based on duplicating the field and interlacing it into top/bottom field. Maintains film-look.
- **Interlaced: Allow 2:3 Telecine Insertion** inserts a standard 2:3 Telecine pattern to 23.976p video stream to achieve a 29.97i frame rate
- **Interlaced: Allow Euro* Insertion** is for field based conversion rather than pixel-based. This method is valid for 24.0p to 50i conversions only.
- **Interlaced: Allow Adaptive* Insertion** is for field-based conversion rather than using pixel-based interpolation. This algorithm is designed for both integer and non-integer frame rate conversion targets – as long as one of them is a non-integer rate (23.976, 29.97, 59.94, etc.). This plug-in will create NTSC-PAL conversions clean of motion artifacts at the expense of possible slight stutter. Stutter is most noticeable with material that has smooth and uniform motion.

***NOTE:** These algorithms may cause a slight stutter based on the differential between the Source and Target frame rates when viewed on a progressive monitor. Please verify these outputs on a broadcast monitor. If these results prove to be unacceptable, perform the conversion using the Motion Estimator and uncheck Allow Adaptive Insertion.

Progressive Insertions

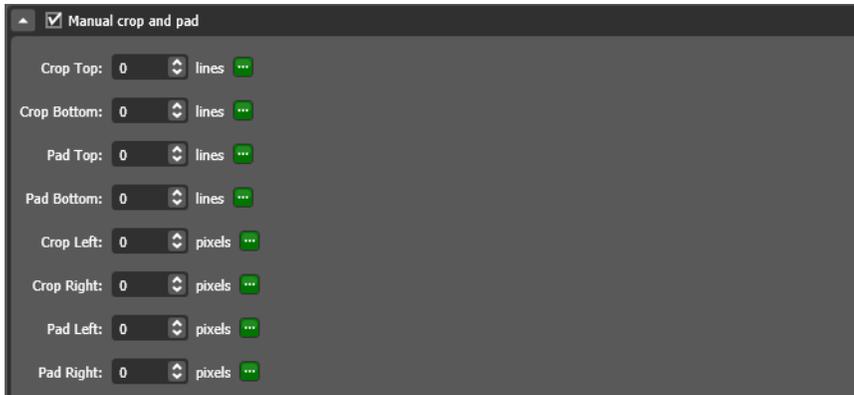
- **Progressive: Double Frames** repeats each progressive frame twice on output (motion rate is halved). This setting is used when you want to convert to high progressive frame rates (i.e. 50p/59.94p/60p) but want to preserve filmic qualities of the source (low motion rate, such as 24p).
- **Progressive: 4:6 Insertion** takes a 23.976 pattern and applies a repeated frame pattern in a 4:6 ratio to create 59.94p. This 4:6 59.94p will play smoothly on a broadcast monitor.

Enabling Manual Cropping and Padding

Enabling *Manual Crop and Pad* (masking) mode allows you to specify how many lines to add or delete from the top and bottom of video frames. These settings override any automatic crop and mask. That is, Vertical Blanking settings won't be used when Manual crop and pad is enabled.

When you enable manual cropping and padding, you will almost always want to change Resizing Mode (General Settings) from its default value (Add black to fit) to Stretch for best results.

Note: Crop values refer to the input source; Pad values refer to the Output.



Configuring Dark Energy Settings

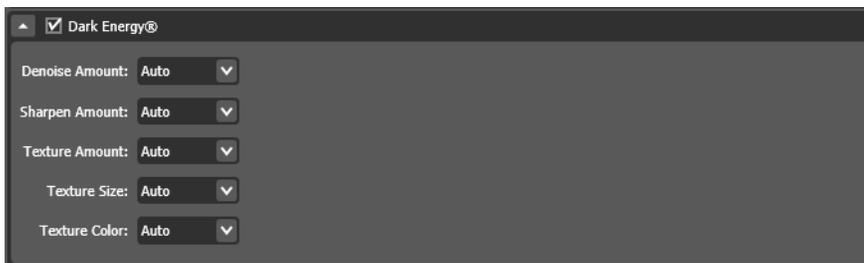
Vantage demuxes and decompresses the video file prior to handing the video to Dark Energy for processing. Dark Energy only works on video in the uncompressed state and does nothing to audio or closed caption data. Dark Energy will manipulate the images as appropriate, and return the uncompressed images to the transcoder for compression and muxing.

Note: While Dark Energy can correct cadence issues, it will not output a different frame rate than what the original file specified. For this functionality, you will need to license Tachyon.

Understanding Dark Energy Settings

Dark Energy is very powerful, but very simple to operate. The Dark Energy UI is comprised of 5 drop-down menu items, all of which can be placed into AUTO mode and obtain high quality results just by letting the intelligence in Dark Energy do its job. By *Enabling* Dark Energy and leaving all the drop-down boxes in the “Automatic” position, Dark Energy will automatically adjust the motion estimator and all other settings given the source and target raster sizes.

To *Enable* these settings check the Dark Energy box. When enabled, all video will route through a set of Dark Energy algorithms and will automatically be incorporated into any existing Tachyon VPL processes.



Drop Down Menu Choices

There are 7 selections in each drop-down menu, consisting of:

- *None*—disables this particular feature.
- *Auto*—automatically sets the level to Medium. Medium is a setting which will vary based on original raster and target raster. So while it is a general “catch all” for where to start from, it gives you two choices higher and two choices lower to tailor the processing to meet your needs.
- *Extra-Low*—this value is subtle and will be approximately 33% of the Auto setting.
- *Low*—this value is moderate and will be approximately 66% of the Auto setting.
- *Medium*—this is always recommended starting point, which is why it is the AUTO setting as well. This Medium setting was determined after years of processing images, so it is a very robust, very appropriate setting.
- *High*—this is 50% greater than Medium.
- *Extra High*—this is 2x the implementation of Medium.

Denoise Amount

Denoise Amount - This control specifies how much noise is removed from the video. Lower amounts of denoise will potentially leave items which could turn into compression blocking, too high of a denoise setting could result in compression banding. It is best to start with the AUTO setting and determine if more or less noise reduction is needed after running a short test clip.

Sharpen Amount

Sharpen Amount—Specifies how much sharpening happens during the denoise/image scaling process. If images are soft to begin with, the intelligence in Dark Energy will more than likely preserve the image, just at a different resolution. More sharpness may be needed in these cases.

If you increase the noise reduction amount, a correlating increase in the sharpness setting may be required. We advise running a couple of short test clips before running entire projects and libraries.

Texture Amount

Texture Amount—Will affect the amount of texture is “virtually developed” into the image at render. This texture is not an overlay or simple repeating texture pattern. The grain is constructed using chaotic math theorems which will result in texture/grain patterns that never repeat, and are always consistent.

Texture Amount is exactly that—how much image texture is desired on the output. For digitally acquired images (50i/60i) which are lacking warmth, an ideal workflow is to perform a frame rate conversion from 50i/60i to 24p using Tachyon (it will automatically generate the 180 degree shutter providing the appropriate amount of motion blur for the lower frame rate) and then add Image Texture with Dark Energy. The AUTO setting will set a broadcast specific amount of grain for the given target raster, so if you want a more pronounced texture look, increase this setting to High or Extra High.

Texture Size

Texture Size—This setting is analogous to film size. For HD images, Dark Energy will model a 35mm film grain size during the virtual render. For UHD images, Dark Energy leverages 70mm film grain size during the virtual render. Like other settings, the Auto will set the image texture size to the medium setting and then moving higher or lower will generate larger or smaller Image Texture structure.

Texture Color

Texture Size—If you are processing black/white video, set this value to Grayscale. Otherwise, for color images, select Color.

Benefits of Dark Energy

Higher Quality Images at Lower Bitrates

Compression blocking and compression banding are critical problems with creating low bit-rate files. Dark Energy enables clients to leverage the lower bitrate without having to sacrifice too much in quality.

Retention of Details

The following screen shots are excerpts from UHD 3840/2160 images:

- Uncompressed state, processed with Dark Energy
- Compressed Dark Energy result to 20 megabits/second using H.264
- Compressed, non-Dark Energy UHD result using same CODEC and bitrate (H.264, 20 Mb/s)

You'll notice the loss of detail on the chain-link fence around the observation deck on the non-Dark Energy, 20 Mb/S image. Also, the white building and the antenna lose image clarity and sharpness without the Dark Energy treatment.

Figure 3. Uncompressed Dark Energy HD-UHD Texture-Aware Up-Res



Figure 4. H.264 Compressed 20 Mb/s UHD (excerpt) Dark Energy Texture Aware Up-res

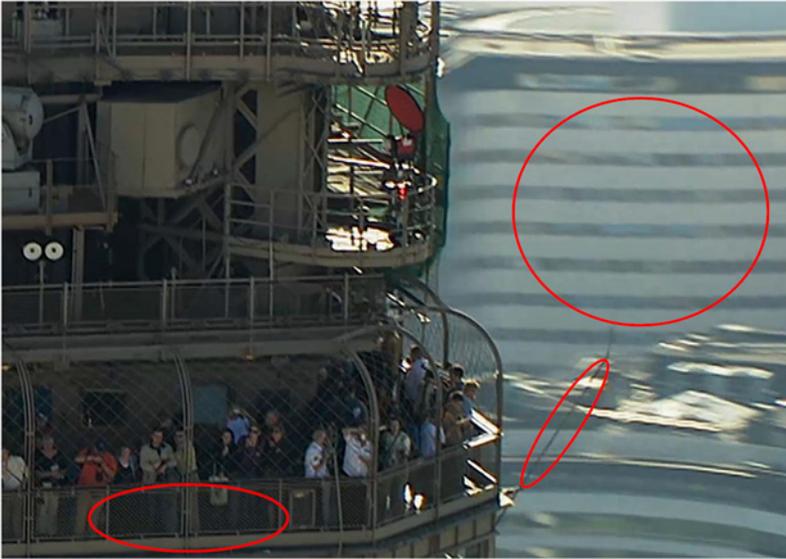
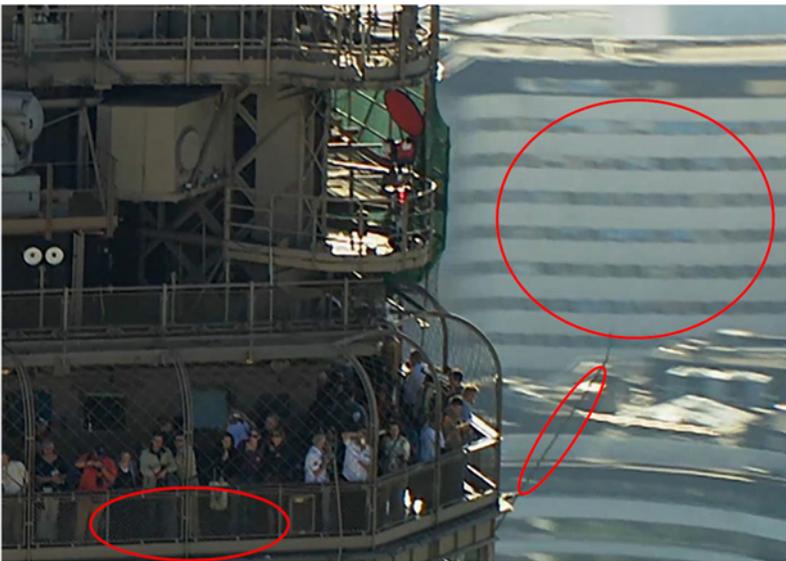


Figure 5. H.264 Compressed 20 Mb/S UHD Image (excerpt) Dark Energy Texture-Aware Upscale NOT used



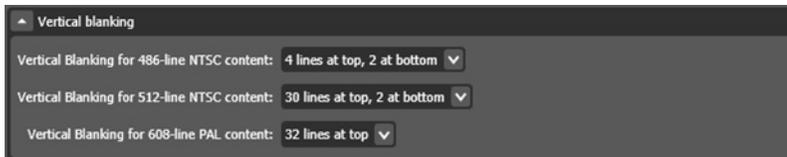
Configuring Vertical Blanking Settings

The options in the Vertical Blanking settings section enable you to specify (for input) and control (for output) how much vertical blanking is in the frame, and where it is located for 486- or 512-line NTSC or PAL (608-line) content. This setting instructs where and how much to crop or pad the video to either add or remove blanking during a transcode.

NTSC and 486-line content in particular may either have 2 lines of black at the bottom, or none, depending upon how it was encoded. This option also allows you to specify that the entire video is active (no vertical blanking), avoiding cropping of Web or desktop video with no blanking.

For each of these settings, select the appropriate VBI processing option from the popup menu:

- *Vertical Blanking for 486-line NTSC Content*
- *Vertical Blanking for 512-line NTSC Content*
- *Vertical Blanking for 608-line PAL Content*



Obtaining Support

Telestream support staff will be the first line for supporting the Vantage Tachyon VPL and Dark Energy options. If our support staff determines that the support needs are directly associated with Cinnafilm Tachyon or Dark Energy libraries, Telestream will connect the customer to Cinnafilm support directly.

Telestream support

<http://www.telestream.net/telestream-support/vantage/contact-support.htm>

Email: support@telestream.net

North American Phone Support:

- US Toll-free: 877-257-6245 (U.S.)
- International: +1.530-470-2036 (if calling outside the U.S.)
- Hours: 6AM to 6PM Pacific Time, Monday–Friday

EMEA and APAC Support:

- Contact your reseller for direct support.

See Telestream's Maintenance and Support Guide for more details:

<http://www.telestream.net/pdfs/datasheets/Telestream-Enterprise-M&S-Guide.pdf>

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