



Improving Performance, Proxies, and the Render Cache

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DaVinci Resolve is a high-performance piece of software designed to enable real time effects on a variety of workstations. This section describes the various ways you can monitor your performance to make sure you're maintaining real time playback, along with different methods of optimizing real time performance, including using on-the-fly proxies and the background Render Cache.

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Understanding the GPU Status Display

Every viewer in Resolve exposes a GPU status indicator and a frame-per-second (FPS) meter, which appears in the Viewer's title bar, which shows you your workstation's performance whenever playback is initiated. Since DaVinci Resolve uses one or more GPUs (graphics processing units) to handle all image processing and effects, the GPU status display shows you how much processing power is being used by whichever clip is playing.



Frame rate and GPU indication, green is good

A green status indicator shows there is plenty of GPU processing headroom available. As the GPU resources is increasingly taxed, this green graph eventually turns red to show that the available GPU power is insufficient for consistent real time playback.



Red indicates that playback is at slower than real time

Eventually, as you add more and more effects and corrections, you'll reach the limits of available performance, forcing DaVinci Resolve to either drop frames, or play video at a slower speed in order to maintain high image quality, shown by the red FPS indicator.

When real time performance falls short, DaVinci Resolve provides a variety of controls and options that let you enhance real time playback and effects. Each is useful for different situations, and all can work together so you can choose the best trade-off between image quality and performance while you work. All of these methods can be set up to have no effect on your delivered output.

Prioritizing Audio or Video Playback in the Edit Page

When available processing power is insufficient to play the clip or clips at the position of the playhead due to the grade, transforms, or effects that are applied at that moment in the Timeline, you have the ability to choose exactly how performance in Resolve degrades, by turning the "Show All Video Frames" on or off in the Option menu of the Edit page Viewers.

- **Show All Video Frames off:** The default setting, ideal for video editing. Prioritizes audio playback at the expense of dropping video frames when processing power is tight, resulting in a more conventional playback experience.
- **Show All Video Frames on:** An alternate setting that's ideal when you're doing effects work, for which you need to see every single frame play back, sequentially. Audio quality is compromised while every frame of video plays in slower-than-real-time, if necessary, to maintain playback.

Keep in mind that this setting only affects playback when GPU performance is lacking. In areas of the Timeline where performance is adequate, playback remains uncompromised.

Using Proxies to Improve Performance

If you don't want to either drop frames or play at slower than real time speed whenever the GPU Status indicator is in the red, an immediate way of improving performance is to turn on the Use Proxies option in the View menu. Using Proxies reduces processing demands by taking advantage of the resolution independence of Resolve to lower the resolution of your clips on-the-fly, thereby increasing real time playback performance without the need to spend time caching part or all of the timeline, or create optimized media (both discussed later).

To turn Use Proxies on and off, do one of the following:

Choose Playback > Proxy Mode > Half Resolution, Quarter Resolution, or None.

Press PROXY ON/OFF on the T-bar panel of the DaVinci control panel. (Defaults to the last proxy resolution you selected from the menu. Half is the default if you haven't selected a resolution yet.)

Turning on one of the proxy resolutions reduces the working resolution by either half or a quarter of whatever the current Timeline resolution is for your project. Working at a temporarily reduced resolution increases your workstation's real time performance, while the resolution independence of Resolve guarantees that every window you draw and sizing operation you make scales correctly to the actual resolution of your project.

Proxy Resolution	Width	Height
Full-HD/Half-UHD	1920	1080
Half-HD/Quarter-UHD	960	540
Quarter-HD/Eighth-UHD	480	270
Eighth-HD/Sixteenth-UHD	240	135

Reducing Decode Quality to Improve Raw Performance

The Use Proxy command will improve performance when grades and effects are responsible for your project's slower than real time playback, but Use Proxy won't help when real time performance is being used up by the need to debayer raw media. The only way to improve playback performance for debayered clips without taking the time to either generate optimized media or render to the Source Cache by enabling the Smart Cache is to open the Camera Raw panel of the Project Settings, and reduce the Decode Quality and/or Play Quality of the raw media formats you're using:

- **Decode Quality:** Camera raw formats such as R3D and F65 can be debayered at different levels of quality. For higher real time performance, you can choose a lower quality setting while you work, and then switch to a higher quality when rendering the final output. A "Force debayer res to highest quality" checkbox in the Render Settings list of the Deliver page makes it easy to follow this workflow.
- **Play Quality:** This option provides the additional ability to set a lower resolution for debayering during playback than for when the playhead is stopped. By default playback uses the same setting as the Decode Quality pop-up menu.

Options for reducing resolution vary by format, but at the very least include full, half, and quarter resolution (R3D and Sony Raw have options for full, half, quarter, eighth, and sixteenth). The one exception is the Phantom Cine format, which doesn't have Decode Quality options at all.

If you reduce the Decode Quality of raw media formats in your project to improve performance, you can use the “Force debayer res to highest quality” checkbox in the Render Settings list of the Deliver page to ensure that Resolve renders all raw formats at the highest quality available, so you don't have to worry about forgetting to change the decode quality back when it's time to render.

Using Optimized Media to Improve Overall Performance

If you're editing or grading processor-intensive media such as camera raw or H.264 sourced media, you can create pre-rendered, optimized media in one of a variety of finishing formats that lets you work more efficiently, by seamlessly turning slow-to-decode media formats into a more processor-efficient format and resolution, and giving you the ability to easily switch your project back and forth between these optimized “proxy” files and the original source media.

The advantage of using optimized media to help you work faster is that it's pre-generated, meaning you can render it once and then use the files for the duration of your work in that project (unless you change the debayering settings of the raw media). Also, optimized media improves the playback performance of clips throughout Resolve, including in the Media page and in the Media Pool and Source Viewer of the Edit page, whereas the similar but different Source Cache component of the Smart Cache only improves the performance of clips that are already in the Timeline by caching them at the Timeline resolution. This makes optimized media ideal for editing workflows of all kinds.

Choose the Right Optimized Media Format for Your Project

You have the option of choosing the Resolution and Format of the optimized media you create, using controls in the General panel of the Project Settings. Be aware that the format you choose will determine whether out-of-bounds image data is preserved when the signal is optimized. If you find that image data (typically bright highlights) are clipped after optimizing, you should switch to 16-bit float, ProRes 4444, or ProRes 4444 XQ; in particular, any of these three codecs are appropriate for HDR grading.

Creating Optimized Media

Creating optimized media to work with is easy. Resolve automatically manages the relationship between source clips and the optimized media you create, so all you need to do is choose which clips to make optimized media for. You can manually choose which clips to optimize, or you can use a Smart Bin to collect all of the media corresponding to one or more formats you need to optimize to gather it procedurally. In either case, this gives you the option of only optimizing clips in formats that require optimization, saving you time.

For example, if you're editing a project that consists half of camera raw media, and half of DNxHD media, you probably only need to optimize the camera raw media, so you can create a Smart Bin that gathers all of it, based on Resolution, Codec, File Name, or whatever other metadata is appropriate. Once gathered, it's an easy thing to select all of these clips in preparation for the next step.

To create optimized media for one or more selected clips:

Right-click one of the selected clips, and choose Generate Optimized Media from the contextual menu.

All optimized media is written to the same directory as the Cache files are written, which defaults to the first scratch disk listed in the Preference dialog's Media Storage panel. The location of Cache and Optimized files is also selectable via the "Cache files location" setting in the General Options panel of the Project Settings.

Seeing Which Clips Have Been Optimized

If you want to check to see which clips have been optimized, an Optimized Media column in the list view of the Media Pool will be populated with the resolution of whatever optimized media you've created (Original, Half, Quarter, etcetera). Clips that have not been optimized appear with "None."

Optimized Media for Raw Source Clips

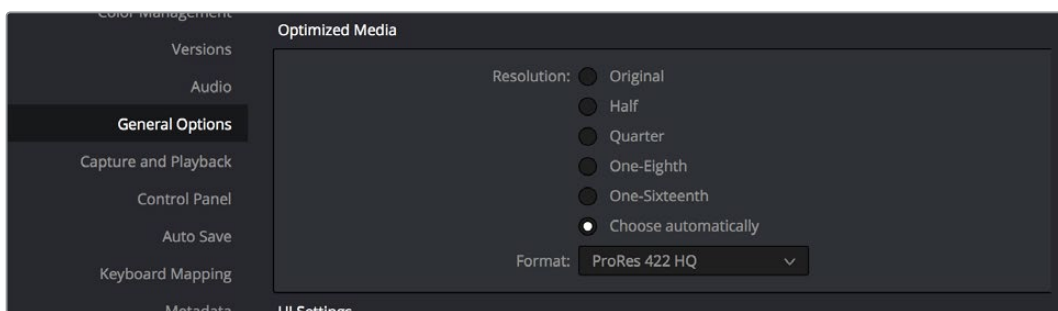
In general, once you create optimized media, Resolve keeps track of it and continues using it regardless of whatever changes you make to your project, including changing the Timeline resolution. However, camera raw clips pose one exception to this, since changing the raw settings, either in the Project Settings or in the Color page, has a profound effect on the resulting debayered output.

The rules for optimization of camera raw media are as follows:

- If the "Save with Version" checkbox in the Camera Raw palette of the Color page is disabled, camera raw clips can be optimized, but any change to the camera raw settings of these clips will automatically discard the optimized media for those clips, requiring you to re-generate optimized media for them.
- However, if "Save with Version" is turned on, which allows different versions of a grade to have different debayer settings, then you cannot optimize those clips, since there can be only one optimized file per clip in the timeline.

Customizing the Type of Optimized Media You Create

The General panel of the Project Settings has a set of controls that govern what kind of media files are created when you create optimized media.



Options available for creating Optimized media in the General Options panel of the Project Settings

There are two settings:

- **Resolution:** Lets you choose whether to create optimized media at the same size as your original media files (by choosing Original), or to reduce the bandwidth of your optimized media further by reducing its resolution by a Half, Quarter, Eighth, or Sixteenth. The “Choose automatically” option tries to balance visual quality with efficiency by only reducing the resolution of media files that are larger than the currently selected Timeline resolution, using whatever reduction ratio best matches the Timeline resolution.
- **Format:** Lets you choose the format and codec with which to generate optimized media. Options include Uncompressed 10-bit and Uncompressed 16-bit float for maximum quality, which stores image data in the optimized and proprietary .dvcc image format. Other options include ProRes Proxy through 4444 XQ, and DNxHR LB through 444. Be aware that the format you choose will determine whether out-of-bounds image data is preserved when the signal is optimized. If you find that image data (typically super-white levels) are clipped after optimization, you should switch to 16-bit float, ProRes 4444, or ProRes 4444 XQ; in particular, any of these three codecs are appropriate optimized formats for HDR grading.

The “Choose automatically” option of the Resolution setting bears a bit more explanation. When selected, only source media with a higher resolution than the selected Timeline resolution will generate downsized optimized media. How much each clip will be downsized depends on how much larger each clip is than the Timeline resolution. For example, if you’re working within a 1080 resolution project, then 8K clips will generate quarter-resolution optimized media, and 4K clips will generate half-resolution optimized media, such that all optimized media is somewhere around 1080 resolution. All clips that are 1080 and smaller generate optimized media at the same resolution as the source clips.

In the example of a 4K project, 8K clips will generate half-resolution optimized media, and all other clips that are 4K and smaller will generate optimized media at the same resolution as the source clips.

Switching Between Optimized and Original Media

Choosing whether or not you’re using optimized media is easy. Simply choose Playback > Use Optimized Media if Available to switch your entire project between using optimized media (if it’s been generated), or the original media. Furthermore, a checkbox in the Render Settings of the Deliver page lets you choose whether you want to use optimized media to speed up rendering, or render using the original media only.

NOTE: Optimized media is not included in Media Management operations, nor is it included as part of Archive operations in the Project Manager.

Deleting Optimized Media

The optimized media you generate within a project is persistent; it’s saved for future use even when the project is closed and later reopened. If you need to delete optimized media to free up space on your scratch volume, you can do so with a single command.

To clear optimized media:

Open the project, and choose Playback > Delete Optimized Media.

Using Optimized Media for Delivery

An option in the More options section of the Render Settings in the the Deliver page, “Use Optimized Media,” lets you output using Optimized Media, rather than the original media, in order to save rendering time. If you’re planning on using this option, it’s advisable to set the Optimized media format to a suitably high-quality format to guarantee the best results.

Using the Smart Cache to Improve Effects Performance

Another option for achieving real time performance when the GPU Status indicator is in the red due either to Timeline effects, Color page grading, or processor-intensive media in the Timeline, is to use the Smart cache or User cache modes of the Render Cache. The Resolve Smart Cache automatically renders and caches processor-intensive grades, or clips that you manually flag for caching when right-clicking any clip in the Color page or Edit page timeline and enabling the Render Cache Clip Output option. When Smart cache is enabled, frames of each automatically or manually flagged clip are cached as they play, or automatically cached whenever you pause work. Once you’ve cached part of the Timeline, using either mode, these clips play back in real time until they’re modified, which triggers the need to re-cache.

The advantage of the Smart and User Caches is that you only cache media within a timeline, so you only cache media that you actually need to finish a program. However, the Smart and User caches aren’t useful for speeding up work done with source media in the Media Pool; that’s what optimized media is for (as described in the previous section).

To use clip caching, do one of the following:

- Choose Playback > Render Cache > Smart to set Resolve to automatically cache computationally intensive effects.
- Choose Playback > Render Cache > User to set Resolve to only cache clips that you manually flag by right-clicking a clip in the timeline and turning on its Render Cache Clip Output checkbox.
- In the Color page, press Option-R to cycle among Off, Smart, and User.
- Press CACHE MODE on the T-bar panel of the DaVinci control panel to toggle among the available options.

Choose the Right Cache Media Format for Your Project

You have the option of choosing the Resolution and Format of the cached media you create, using controls in the General panel of the Project Settings. Be aware that the format you choose will determine whether out-of-bounds image data is preserved when the signal is cached. If you find that image data (typically bright highlights) are clipped after optimizing, you should switch to 16-bit float, ProRes 4444, or ProRes 4444 XQ; in particular, any of these three codecs are appropriate for HDR grading.

Understanding the Render Cache

On all pages, you can use the options in the Playback > Render Cache submenu, selecting None, Smart, or User to either disable or initiate caching. In Smart mode, Resolve renders clips in the Timeline that will exceed your computer's real time capabilities to the "Cache files location" specified in the General Options panel of the Project Settings, to enable real time playback of these clips even on underpowered workstations. Alternately, in User mode, Resolve only caches clips that you manually flag.

The Source, Node, and Sequence Caches are Separate

The cache mechanism in Resolve actually comprises three independently managed media caches that interact with one another. This is done to keep you working quickly by ensuring that changes you make to your timeline don't require a grade to be re-cached, and that changes you make to a grade don't require the timeline to be re-cached. The three levels of caching are:

- **Source:** Caches the portion of each source media file that appears in the timeline in its pre-graded state at the Timeline resolution. By caching media formats that Resolve considers to be processor-intensive to decode, such as H.264 and various raw camera formats, you'll experience vastly improved editing and grading performance. At any time, you have the option to turn the source cache on or off for individual clips, or for multiple selected clips all at once. This lets you switch between using the native source format of each clip, or the cache format you've chosen.
- **Node cache:** Acts to cache processor-intensive operations within a clip's grade in the Color page. Ordinarily, only processor-intensive nodes (along with all nodes appearing upstream) are cached, meaning that, for example, if Nodes 1 and 2 are cached, you can continue adjusting Nodes 3, 4, and 5 to your heart's content without needing to re-render your grade to the cache. However, there's one other way the Node cache can be used, and that's by turning on the "Render Cache Clip Output" option in the timeline of either the Edit or Color pages. This forces a clip's entire grade to be cached all the way through the Node tree's output, which results in higher real time performance in the Edit page, at the expense of needing to completely re-cache a clip whenever you adjust any part of its grade.
- **Sequence cache:** Caches timeline-specific effects such as transitions, opacity adjustments, and composite mode superimpositions.

Choosing a Cache Format and Location

The cache format is user selectable by opening the General Options panel of the Project Settings, and using the "Cache frames in" pop-up menu to choose one of the ProRes, DNxHR, or uncompressed 10- or 16-bit float uncompressed .dvcc formats. Selecting a higher quality cache format guarantees high quality image playback, but makes more demands on the throughput and size of your available disk storage. On the other hand, choosing a more highly compressed cache format makes real time playback possible on less capable computers with slower and smaller storage, at the expense of slightly compromised image quality. Ideally, you should choose the highest quality cache format that your workstation's storage can accommodate.

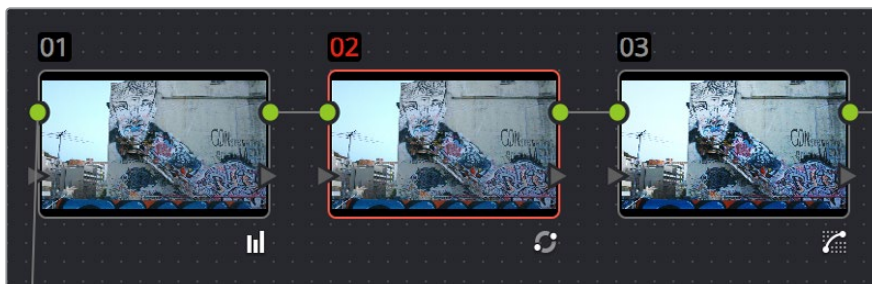
The format you choose will also determine whether out-of-bounds image data is preserved when the signal is cached. If you find that image data (typically super-white levels) are clipped after caching, you should switch to 16-bit float, ProRes 4444, or ProRes 4444 XQ; in particular, any of these three codecs are appropriate cache formats for HDR grading.

The Cache files location defaults to the first volume you add to the Scratch Disks list of the Media Storage panel of the Resolve Preferences. If no scratch disk is specified, your System disk will be used, which may pose problems with capacity and/or performance depending on the size and type of System disk you're using, and on the media format you choose to cache to. For this reason, it's nearly always advisable to set your first scratch disk to the largest, fastest storage volume available to your workstation.

Enabling Smart Cache

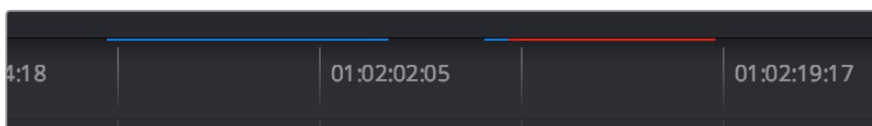
The Smart Cache option of the Render Cache submenu provides the best user experience when you want to “set it and forget it.” Choosing Smart triggers a variety of automatic caching behaviors designed to optimize playback in DaVinci Resolve by rendering clip formats, grading operations, and timeline effects that are known to be performance-intensive. The rules for Smart mode caching are:

- **Source caching:** Caches source media in its pre-graded state. By caching media that is processor-intensive to decode, you’ll experience improved editing and grading performance. In Smart mode, H.264, DCP, JPEG2K or camera raw clips that have been edited into a timeline are automatically cached at their source, and are resized to the current Timeline resolution regardless of the media’s original resolution. Camera raw clips are cached using the currently selected project or clip debayer settings. Source caching can also be manually controlled, as explained later in this chapter.
- **Node caching:** Caches specific nodes in the Color page, along with all upstream nodes. By caching processor-intensive nodes, you free up real time capability for the remaining downstream nodes in a grade. In Smart mode, Resolve automatically caches any nodes that use Motion Blur, Noise Reduction, or OFX plug-ins. You can also manually flag a node for caching in Smart or User modes by right-clicking it and choosing Node Cache > On.



Node Cache indicator seen as a red colored node number on node two of the Node Editor of the Color page

- **Clip caching:** An alternate way of forcing node caching in either Smart or User modes is to right-click any clip in the Timeline of the Edit page, or right-clicking a thumbnail in the Color page, and turn on “Render Cache Clip.” This caches the output of the Color page node graph, effectively caching every single node in the tree. Caching a clip’s entire grade is most useful when you want to improve trimming and playback performance in the Edit page. Flagging a clip for caching also causes EVERY VERSION associated with that clip to be cached as well.
- **Sequence caching:** Caches clips with effects applied to them in the Timeline, improving trimming and playback performance for clips using processor-intensive Edit page effects. In Smart mode, Resolve automatically caches all superimposed clips that use composite modes other than “Normal,” and any clips with opacity or speed effects. Clips cannot be manually flagged for Sequence caching.



Source, Clip, and Sequence Cache bars seen in the Timeline of the Edit page, red bars show areas of the timeline that need caching, blue shows areas that have been cached

Enabling User Cache

The User cache option of the Render Cache submenu provides a strictly user-controlled caching experience. In User mode, only clips and nodes that you manually flag will be cached. For example, if you don't want to cache at the Node or Sequence level, but you do want to cache each clip at the source, you can set the cache mode to User, then select all the clips you want to cache, right-click them, and set "Render Cache Clip Source" to On.

Here's how each of the caches work in User mode:

- **Source caching:** The "Render Cache Clip Source" setting for clips in the Timeline defaults to Auto, but you can manually set one or more selected clips to Render Cache Clip Source > On to force those clips to be cached in User mode.
- **Node caching:** You can right-click any node in the Color page node tree and choose Node Cache > On to force that node to cache in User mode, along with all upstream nodes to the left of it.
- **Clip caching:** An alternate way of forcing node caching in either Smart or User modes is to right-click any clip in the Timeline of the Edit page, or right-clicking a thumbnail in the Color page, and turn on "Render Cache Clip." This caches the output of the Color page node graph, effectively caching every single node in the tree. Caching a clip's entire grade is most useful when you want to improve trimming and playback performance in the Edit page. Flagging a clip for caching also causes EVERY VERSION associated with that clip to be cached as well.
- **Sequence caching:** Sequence caching cannot be done manually; it only happens in Smart mode.

When Caching Happens

When either Smart or User caching is enabled, caching happens whenever you play clips that are to be cached. Cache indicators on the Edit and Color page timelines show the status of the cache. Red means "to be cached," while blue means "has been cached."

If background caching is enabled in the Project settings, and there are no UI or control panel adjustments made for a user-definable number of seconds (this is adjustable in the General Options panel of the Project Settings), caching will automatically begin during periods of user inactivity.

Controlling Source Caching

You can manually control which clips in the Timeline are cached, and which are not. You can select one or more clips in the Timeline of the Edit page, or in the Thumbnail Timeline of the Color page, right-click one of the selected clips or thumbnails, and choose an option from the Render Cache Clip Source submenu. There are three options:

- **Auto:** The clip will only be cached in Smart mode, and only if it's a format designated for caching.
- **On:** The clip will be cached in either Smart or User mode, no matter what format.
- **Off:** The clip will not be cached, in either Smart or User modes.

Controlling Node Caching

You can manually control which nodes in a grade are cached, and which are not. Right-click any node in a node tree, and choose an option from the Node Cache submenu.

There are three options:

- **Auto:** The flagged node and all upstream nodes will only be cached in Smart mode if it contains an operation that's designated for caching.
- **On:** The node will always be cached in either Smart or User mode, no matter what operations it performs.
- **Off:** The node will not be cached, in either Smart or User modes. This lets you exclude nodes from caching in smart mode if they're capable of real time operation on your system.

Clearing Cached Media

Each project's cache is persistent; the cache is saved for future use even when the project is closed and later reopened. If you need to delete a project's cache to free up space on a storage volume, there are three options in the Delete Render Cache submenu:

- **All:** You can delete all media in the cache to reset every single cached clip.
- **Unused:** You can choose to delete only Unused cache clips that no longer correspond to clips or effects in the Timeline.
- **Selected clips:** You can make a manual selection of clips in the Timeline, and delete the cache corresponding to just those clips.

To clear a project's cache:

Open the project, and choose Playback > Delete Render Cache > All, Unused, or Selected Clips.

Using the Cache for Delivery

An option in the More options section of the Render Settings in the Deliver page, "Use Render Cached Images," lets you export media from the cache, rather than re-rendering from scratch, in order to save time. If you're planning on using this option, it's advisable to set the cache format to a suitably high-quality format to guarantee the best results.

Using Proxies, Optimized Media, and Caching Together

How you use DaVinci Resolve's various performance-enhancing features together is entirely up to you, but you should know that they're not an either/or proposition. For example, you can create optimized media from the camera raw original clips in your project, then enable Proxy playback to enhance the performance of your 4K timeline, and turn on Smart Cache to speed up your work in the Color page as you add noise reduction and Open FX to every clip. All three of these optimization methods work happily and seamlessly together to improve your performance while keeping the image quality of your project as high as the Optimized and Cache formats you've selected in the General Options panel of the Project Settings.

Other Project Settings for Improving Performance

In addition to working with proxies, using reduced raw decoding quality, generating optimized media, and enabling the Smart and User caches, there are five additional options in the Project Settings window you can use to further improve real time performance if you're working on an underpowered computer, at the expense of lower image quality while you work. These settings can then be changed back to higher quality modes prior to rendering.

- **Set timeline resolution to:** (Master Project Settings, Timeline Format) DaVinci Resolve is resolution independent, so you can change the resolution at any time and all windows, tracks, sizing changes, and keyframe data will be automatically recalculated to fit the new size. Lowering the Timeline resolution while you're grading will improve real time performance by reducing the amount of data being processed, but you'll want to increase Timeline resolution to the desired size prior to rendering. This is effectively the same as using the Proxy command, but you get to choose exactly what resolution you want to work at.
- **Enable video field processing:** (Master Project Settings, Timeline Format) You can leave this option turned off even if you're working on interlaced material to improve real time performance. When you're finished, you can turn this setting back on prior to rendering. However, whether or not it's necessary to turn field processing on depends on what kinds of corrections you're making. If you're applying any filtering or sizing operations such as blur, sharpen, pan, tilt, zoom, or rotate, then field processing should be on for rendering. If you're only applying adjustments to color and contrast, field processing is not necessary.
- **Video bit depth:** (Master Project Settings, Video Monitoring) Monitoring at 8-bit improves real time performance, at the expense of possibly introducing banding to the monitored image.
- **Use optimized display mode during playback:** (Master Project Settings, Video Monitoring) Enabling this setting improves real time performance by hiding on-screen controls that appear in the Viewer, such as the cursor, Power Window outlines, and split-screen views during playback. When playback is stopped, onscreen controls reappear.
- **Uses Bilinear filter:** (Image Scaling) A lower quality image transform setting that is less processor intensive. A "Force sizing highest quality" checkbox in the Render Settings list of the Deliver page helps make sure you don't accidentally render your final media at this lower quality setting.
- **Match Timeline Settings checkbox:** (Image Scaling, Output Scaling Preset) If the Output resolution doesn't match the Video format resolution in the Master Project Settings, there is performance overhead since images need to be resized before they're output to SDI. For the best performance while you're grading, it's recommended to set the Output resolution to match the Video format resolution while you're working. However, once you're ready to output via the Deliver page, you should make sure this setting isn't using a smaller resolution than you intend to render out with. If necessary, you can turn Match Timeline Settings back on if the Timeline is set to the actual resolution you need to output, or you can manually change this to the correct resolution.