



# **Rio 4K/8K**

High performance online editing,  
color and finishing

## **Application Note**

### **ACES Color Workflow**

June, 2020

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## Overview

ACES (Academy Color Encoding System) is a color management system defined by Academy of Motion Picture Arts and Sciences. The ACES allows for a fully encompassing color accurate workflow, with seamless interchange of high quality motion picture images regardless of source. From V4.5.8, Rio supports ACES color management scheme defined by ACES 1.0.

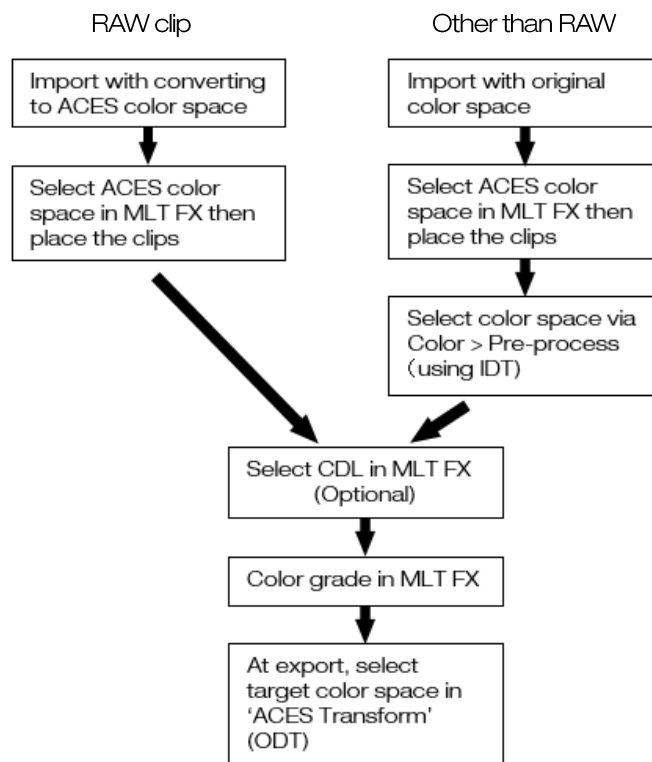
## ACES Color Space

The ACES color space is based on RGB color additive model. There are various standard for the correspondence between the values of video components like RGB and the color and brightness of light. In Rio, this matrix is consisting from ACES2065-1 Color space and Scene-linear Transfer curve settings.

Even if the RGB signal values are the same, the corresponding colors and brightness will differ if the color space standards are different. You may get different image in a display. Because, RGB signal values corresponding to the same color and brightness is vary depending on color space. If source signal's color space is different to the color space supported by the display, you may get different image in the display.

For example, generally, computer display works on sRGB color space. If you try to display a footage that has different color space like camera's log, displayed image will have no sharpness in brightness and the colors will look dull. This caused by different color space. If both would work on same color space, you can get correct image. Matching color space is very important to get the correct image.

## Summary of ACES workflow



## Supported File Formats

Rio V4.5.8 supports below type of files in ACES color workflow

File type	Supported format	Note
Camera RAW files	RED R3D ARRI RAW (HDE not supported) Sony RAW Canon Cinema RAW (Cinema RAW Light not supported)	
Other formats	See 'Load IDT' chapter	IDT required
EXR	EXR files in ACES color space	

## Loading IDT

In ACES Workflow, clips other than ARRI RAW, RED R3D, Sony RAW will require a step to load IDT before importing. Rio converts the color space to ACES by using IDT (Input Device Transform). If you import Canon Cinema RAW (.rmf) or other type of clip (except ACES EXR), you need to load IDT (.clf)

### Steps to load IDT

- 1) Create C:\RioAcesIDT folder
- 2) Unzip downloaded IDT zip file.
- 3) Copy unzipped .clf files into the folder created step#1
- 4) Open Rio f.1 menu.
- 5) At Active Cube Folder, choose C:\RioAcesIDT folder
- 6) Close the menu then restart Rio software

### IDT matrix

IDT file type	Affected Formats
ARRI Log C ALEXA Wide Gamut.clf	ARRI Log C ALEXA Wide Gamut
Canon EOS C100 TypeA (D55).clf	Canon EOS C100
Canon EOS C100 TypeA (Tungsten).clf	For D55 & Tungsten illuminants
Canon EOS C100 Mark II TypeA (D55).clf	Canon EOS C100 Mark II
Canon EOS C100 Mark II TypeA (Tungsten).clf	For D55 & Tungsten illuminants
Canon EOS C300 TypeA (D55).clf	Canon EOS C300
Canon EOS C300 TypeA (Tungsten).clf	For D55 & Tungsten illuminants
Canon EOS C300 Mark II Canon Log BT2020 TypeD (D55).clf	Canon EOS C300 Mark II Type A (Canon Log2 Cinema Gamut)
Canon EOS C300 Mark II Canon Log BT2020 TypeD (Tungsten).clf	Type B (Canon Log2 Rec.2020 Gamut) Type C (Canon Log Cinema Gamut) Type D (Canon Log Rec.2020 Gamut)

Canon EOS C300 Mark II Canon Log Cinema Gamut TypeC (D55).clf	Type E (Canon Log3 Cinema Gamut)
Canon EOS C300 Mark II Canon Log Cinema Gamut TypeC (Tungsten).clf	Type F (Canon Log3 Rec.2020 Gamut)
Canon EOS C300 Mark II Canon Log2 BT2020 TypeB (D55).clf	For D55 & Tungsten illuminants
Canon EOS C300 Mark II Canon Log2 BT2020 TypeB (Tungsten).clf	
Canon EOS C300 Mark II Canon Log2 Cinema Gamut TypeA (D55).clf	
Canon EOS C300 Mark II Canon Log2 Cinema Gamut TypeA (Tungsten).clf	
Canon EOS C300 Mark II Canon Log3 BT2020 TypeF (D55).clf	
Canon EOS C300 Mark II Canon Log3 BT2020 TypeF (Tungsten).clf	
Canon EOS C300 Mark II Canon Log3 Cinema Gamut TypeE (D55).clf	
Canon EOS C300 Mark II Canon Log3 Cinema Gamut TypeE (Tungsten).clf	
Canon EOS C500 TypeA (D55).clf	Canon EOS C500
Canon EOS C500 TypeA (Tungsten).clf	Type A (3G-SDI 1 / 2, Cinema RAW file, Mon.1 / 2)
Canon EOS C500 TypeB (D55).clf	Type B (MXF file, HDMI / HD-SDI)
Canon EOS C500 TypeB (Tungsten).clf	For D55 & Tungsten illuminants
Panasonic V-Log V-Gamut.clf	Panasonic V-Log V-Gamut
Sony S-Log S-Gamut.clf	Sony S-Log1 S-Gamut
Sony S-Log2 S-Gamut (Daylight).clf	Sony S-Log2 S-Gamut Daylight (5500K)
Sony S-Log2 S-Gamut (Tungsten).clf	Sony S-Log2 S-Gamut Tungsten (3200K or 4300K)
Sony S-Log3 S-Gamut3.clf	Sony S-Log3 S-Gamut3
Sony S-Log3 S-Gamut3.Cine.clf	Sony S-Log3 S-Gamut3.Cine
DCDM.clf	DCDM (Digital Cinema Distribution Master)
DCDM (P3-D65 Limited).clf	DCDM (P3D65 limited) or equivalent file
P3-D60.clf	P3-D60
P3-D65.clf	P3-D65
P3-D65 (D60 Simulation).clf	P3-D65 (D60 simulation) or equivalent
P3-DCI (D60 Simulation).clf	P3-DCI (D60 simulation) or equivalent
P3-DCI (D65 Simulation).clf	P3-DCI (D65 simulation) or equivalent
Rec2020.clf	Rec.2020
Rec709.clf	Rec.709
Rec709 (D60 Simulation).clf	Rec.709 (D60 White Point)
sRGB.clf	sRGB
sRGB (D60 Simulation).clf	sRGB (D60 White Point)

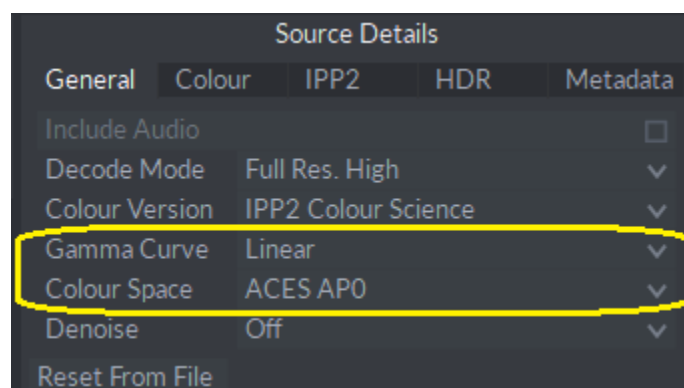
P3-D65 ST2084 (mid=7.2nits, max=108nits).clf	P3-D65 ST2084 (108nits) or equivalent
Rec2020 HLG (mid=15nits, max=1000nits).clf	Rec.2020 HLG clip that 18% Gray corresponds to 15nits
Rec2020 HLG (mid=26nits, max=1000nits).clf	Rec.2020 HLG clip that 18% Gray corresponds to 26nits
Rec2020 ST2084 (mid=15nits, max=1000nits).clf	Rec.2020 PQ clip with max 1000 nits and 18% Gray corresponds to 15nits
Rec2020 ST2084 (mid=15nits, max=2000nits).clf	Rec.2020 PQ clip with max 2000 nits and 18% Gray corresponds to 15nits
Rec2020 ST2084 (mid=15nits, max=4000nits).clf	Rec.2020 PQ clip with max 4000 nits and 18% Gray corresponds to 15nits
Rec2020 ST2084 (mid=26nits, max=1000nits).clf	Rec.2020 PQ clip with max 1000 nits and 18% Gray corresponds to 26nits
Rec2020 ST2084 (mid=26nits, max=2000nits).clf	Rec.2020 PQ clip with max 2000 nits and 18% Gray corresponds to 26nits
Rec2020 ST2084 (mid=26nits, max=4000nits).clf	Rec.2020 PQ clip with max 4000 nits and 18% Gray corresponds to 26nits

## Import clip

Below are importing options for ARRI RAW, RED R3D, Sony RAW and CANON Cinema RAW clips.

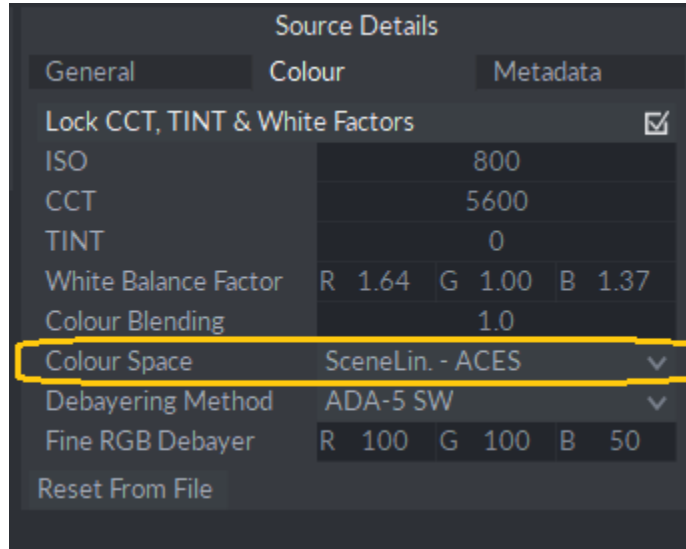
### RED clip (.r3d)

Option location		Source Details > General
Parameter	Gamma Curve	Linear
	Color Space	ACES AP0



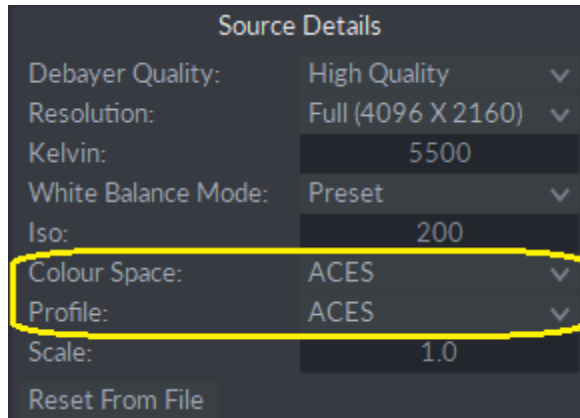
### ARRI RAW

Option location		Source Details > General
Parameter	ColorSpace	SceneLin. - ACES



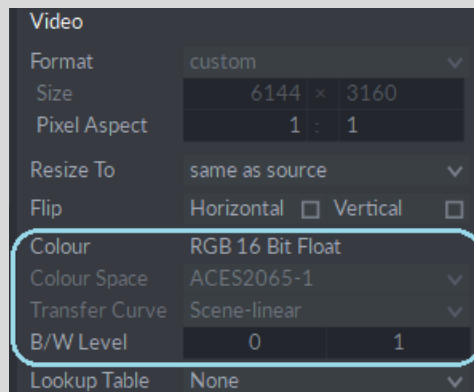
### Sony RAW and X-OCN

Option location		Source Details
Parameter	ColorSpace	ACES
	Profile	ACES



**NOTE**

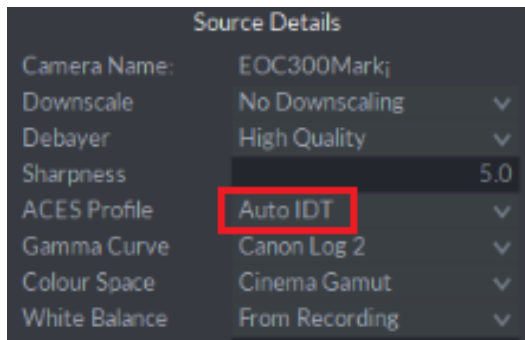
To import RAW clips of the above three types, make sure if Color and B/W Level have below values



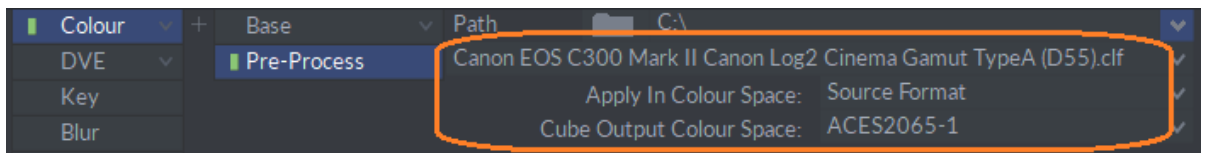
## Canon Cinema RAW

In this case, you cannot select ACES color space. Import the clip by using another color space temporarily. Once imported, convert to ACES color space by using IDT. Follow below steps:

- 1) Make sure that IDT\* that corresponds to Gamma Curve and Color Space has been loaded  
*\* In this steps, either Canon EOS C300 Mark II Canon Log2 Cinema Gamut TypeA (D55).clf or Canon EOS C300 Mark II Canon Log2 Cinema Gamut TypeA (Tungsten).clf should be selected*
- 2) Register a clip to import list.
- 3) Select 'Auto IDT' profile



- 4) Import the clip.
- 5) Place imported clip onto the timeline.
- 6) Select Color > Pre-Process
- 7) Change Color space and Transfer curve by selecting below values



## For clips other than RAW

To import a clip other than Camera RAW, import it in the unique color space to the clip. And then use IDT to convert to ACES color space and place it onto the timeline.

The color space of the clip is determined by camera settings at the time of shooting. IDT according to the clip should be used for correct conversion to ACES color space. Note selected color space when shooting a footage. Because, valid color space might be detected automatically when importing a clip. But if not, you may be required to set the value manually by referring noted color space information. Below is steps to import and place the type of clips into MLT FX:

- 1) Drag and drop source clip into import list
- 2) At Video, make sure that displayed Color Space and Transfer Curve are same as when shooting a footage.
- 3) Select B/W Level determined by selected Transfer Curve.
- 4) Configure MLT FX color space.
- 5) Place imported clip.
- 6) Select Color > Pre-Process then select IDT.



### B/W Level

B/W Level is determined by selected Transfer Curve. Transfer Curve is categorized to two type of ranges (either full-range or video range)

Below type of transfer curve is full-range. Other transfer curves are video range

- ARRI Log C
- Canon Log / Log 2 / Log 3
- Panasonic V-Log
- Sony S-Log3

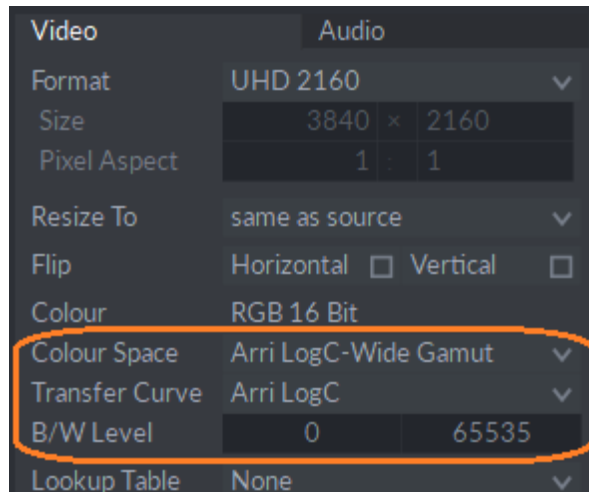
B/W level value should be set is vary depending on the range and video bit depth

Video depth	B/W Level	
	Full-range	Video range
8 bit	0 255	16 235
10 bit	0 1023	64 940
12 bit	0 4095	256 3760
14 bit	0 16383	1024 15040
16 bit	0 65535	4096 60160
Float	0 1	0 1

### Sample import steps

Import ARRI ALEXA Mini LF ProRes4444 MXF file

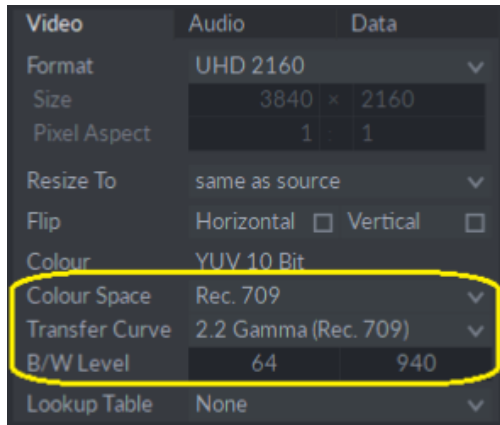
Once the file is registered to import list, Color Space, Transfer Curve and B/W Level are correctly detected automatically. In this case, you can import the file without changing these settings for ACES workflow



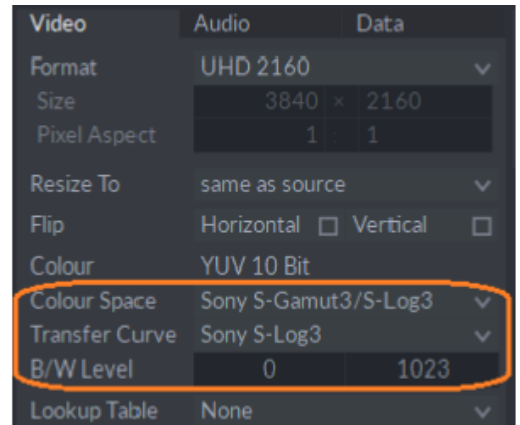
Import Sony XAVC MXF file with S-Gamut3 / S-Log3 color space

Once the file is registered to import list, mismatched color space and transfer curve appear. In this case, adjust each value as below:

- Color Space: Sony S-Gamut3 / S-Log3
- Transfer Curve: Sony S-Log3
- B/W Level: 0 1023



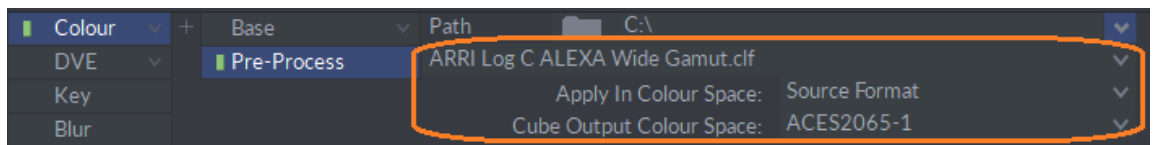
Values originally detected



Modified values

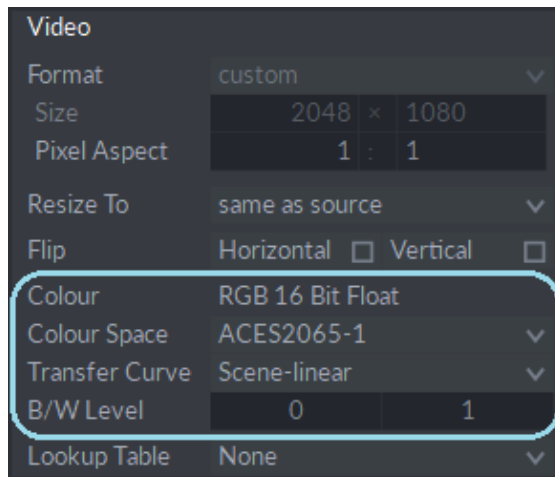
### Select IDT

After placing imported clip onto the timeline, at Color / Pre-process, select IDT according to the camera model, color temperature at the time of shooting, Color Space and Transfer Curve. Also, select 'Source Format' at Apply In Color Space and 'ACES2065-1' at Cube Output Color Space



### EXR clip with ACES color space

If EXR clip has ACES color space, confirm if below values appear in Video dialog.



\* At Color, RGB 32 Bit Float may appear instead of 16 bit (it depends on selected clip type).

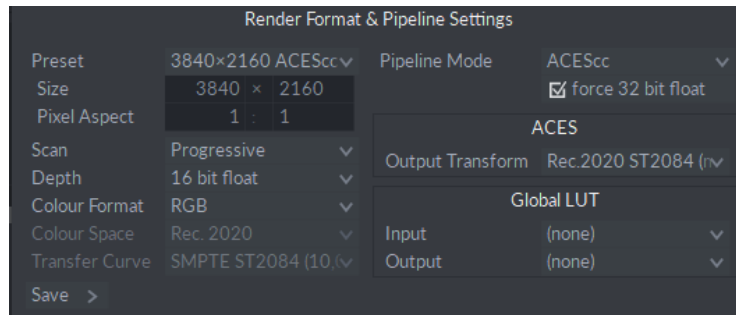
### Affected clip types

- ACES EXR clip exported by Rio (worked in ACES workflow)
- ACES EXR clip converted from:
  - RED R3D by REDCINE-X Pro
  - ARRI RAW (incl. HDE) by ARRIRAW converter
  - Sony RAW (incl. XOCN) by Sony RAW Viewer

- Canon Cinema RAW / Cinema RAW Light by Cinema RAW Development
- Black Magic RAW by DaVinci Resolve
- Other clip by other conversion application

## MLT FX color space settings

ACES Pipeline settings options are available from v4.5.8



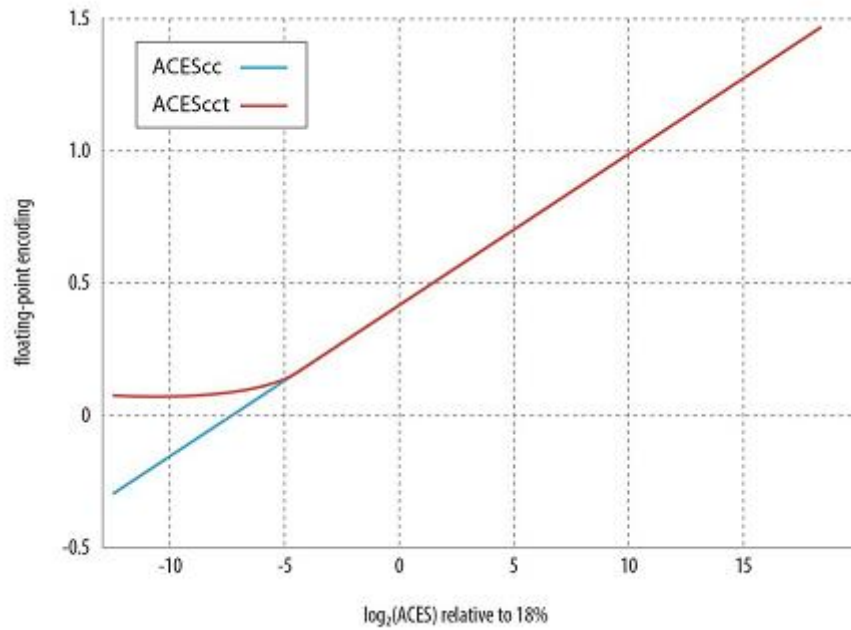
### Pipeline Mode

Several options have been changed or added from V4.5.8. See below comparison.

V4.5.8	V4.5.7 or earlier	Notes
Source	Source color processing	-
Managed	Float 16/32 processing	V4.5.8 automatically selects float 16 or 32 bit depends on video depth - Video 8 or 10bit: Float 16bit - Other depth: Float 32bit
ACEScc ACEScct	-	Refer to below for details.
Force 32 bit float	-	Pipeline process mode is force switched to float 32 bit

### Difference between ACEScc and ACEScct

They differ in the signal level corresponding to the black level (perfect black with zero brightness). For ACEScc it is in the negative position and for ACEScct it is just above zero (see below fig). Depending on which one is used, the effect of color control in the dark areas of the shadow will differ.



### ACES Output Transform

ODT (Output Device Transform) is a guideline defined by ACES for rendering the large gamut and wide dynamic range of the RRT to a physically realized output device with limited gamut and dynamic range. At this pane, select ODT for correct preview

Transform type (ODT type) should be selected depends on below situation:

Color space is equal between exported format and connected monitor: Select color space of exported clip

Color space is different between of them: Select color space supported by connected monitor

ACES Output Transform	Color space
ACES2065-1	ACES
ACEScc	ACEScc
ACEScct	ACEScct
ACEScg	ACEScg
ACESproxy	ACESproxy
P3-D65	P3-D65
P3-D65 (D60 simulation)	P3-D65 with D60 White point
P3-D65 (Rec.709 limited)	P3-D65 with limited output to the Rec.709 gamut
P3-D65 ST2084 (108nits)	P3-D65 with 108 cd / M <sup>2</sup> luminance, and ST.2084 (PQ)
P3-D65 ST2084 (1000 nits)	P3-D65 with 1000 cd / M <sup>2</sup> luminance, and ST.2084 (PQ)
P3-D65 ST2084 (2000 nits)	P3-D65 with 2000 cd / M <sup>2</sup> luminance, and ST.2084 (PQ)
P3-D65 ST2084 (4000 nits)	P3-D65 with 4000 cd / M <sup>2</sup> luminance, and ST.2084 (PQ)
P3-D60	P3-D60

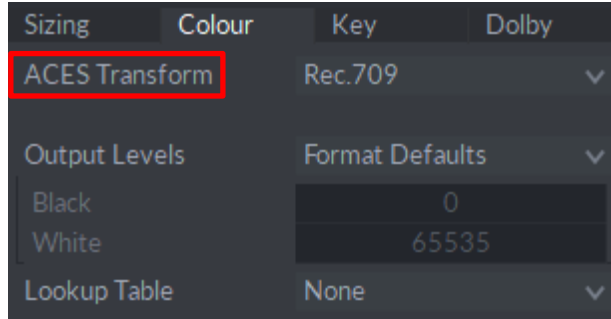
P3-DCI (D60 simulation)	P3-DCI with D60 white point
P3-DCI (D65 simulation)	P3-DCI with D65 white point
DCDM	DCDM
DCDM (P3D60 limited)	DCDM with limited output to P3-D60
DCDM (P3D65 limited)	DCDM with limited output to P3-D65
Rec.709	Rec.709
Rec.709 (D60 simulation)	Rec.709 with D60 white point
Rec.2020	Rec.2020
Rec.2020 (Rec.709 limited)	Rec.2020 with limited output to the Rec.709 gamut
Rec.2020 (P3D65 limited)	Rec.2020 with limited output to P3-D65
Rec.2020 HLG (mid=15 nits, max=1000 nits)	Rec.2020 HLG with 1000 (max) and 15 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=15 nits, max=1000 nits)	Rec.2020 ST2084 (PQ) with 1000 (max) and 15 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=15 nits, max=2000 nits)	Rec.2020 ST2084 (PQ) with 2000 (max) and 15 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=15 nits, max=4000 nits)	Rec.2020 ST2084 (PQ) with 4000 (max) and 15 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 HLG (mid=26 nits, max=1000 nits)	Rec.2020 HLG with 1000 (max) and 26 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=26 nits, max=1000 nits)	Rec.2020 ST2084 (PQ) with 1000 (max) and 26 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=26 nits, max=2000 nits)	Rec.2020 ST2084 (PQ) with 2000 (max) and 26 (18 % gray) cd / M <sup>2</sup> luminance
Rec.2020 ST2084 (mid=26 nits, max=4000 nits)	Rec.2020 ST2084 (PQ) with 4000 (max) and 26 (18 % gray) cd / M <sup>2</sup> luminance
sRGB	sRGB
sRGB (D60 simulation)	sRGB with D60 white point

## Global LUT

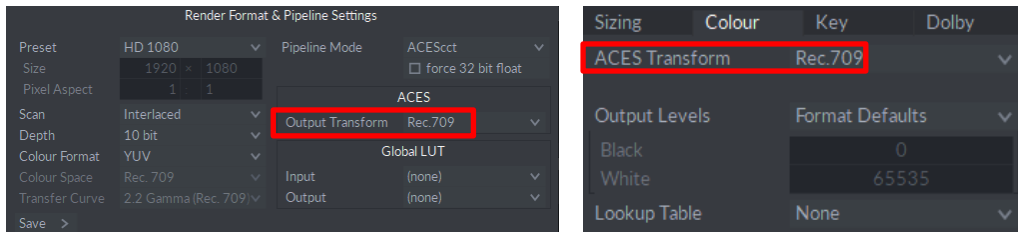
LUT that applies to each input and output stage of MLT FX pipeline processing. Selected LUT will be applied to all segments in the timeline.

## Clip export

When you select a content created in ACES workflow, at Color tab, ACES Transform will appear instead of Color Space.



In default, same type of transform as you selected at Output Transform (in Render Format & Pipeline settings) will appear



If you would like to export with different type, at ACES Transform, select the transform type you would like to use. In this case, render result will expire. Re-render will automatically run.

## Color control in ACES workflow

### How color control works

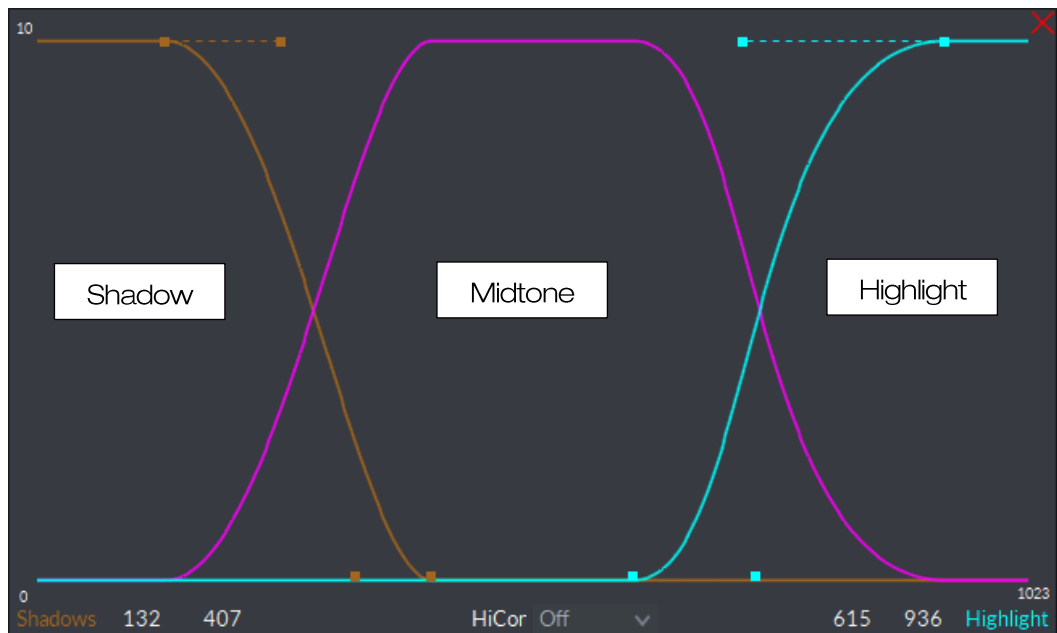
In V4.5.7 or earlier, MLT FX Color processing always worked with Rec.709 Color space and 2.2 Gamma (Rec.709) Transfer curve. This design only considers to control the range of colors and brightness that can be represented by SDR.

From V4.5.8, the MLT FX Color processing supports ACES pipeline processing mode. It considers handling a wider range of colors and brightness (high dynamic range and wide color gamut).

As the result, you may get much different image even though taking same manipulation as before. You will be required a manipulation that differ to you did in earlier version

Especially, when you operate the color control while switching between "Shadow", "Midtone", and "Highlight", the range of each effect becomes significant.

The action range of "Shadow", "Midtone", and "Highlight" can be adjusted in the range graph. Below figure is example of adjustment.



Horizontal axis is video signal value (this is 10 bit as example) with 0 at the left end and 1023 at the right end. If is a float, 0.0 is on the left and 1.0 is on the right.

Vertical axis shows the extent of action, and the bottom means that there is no action. For example, when you operate the color control in "Shadow", you can see that the low signal value works, but the higher signal does not, as the brown line shows. Similarly, "Midtone" (magenta line) works only near the center, excluding low and high areas. The "Highlight" (cyan line) only affects high signals.

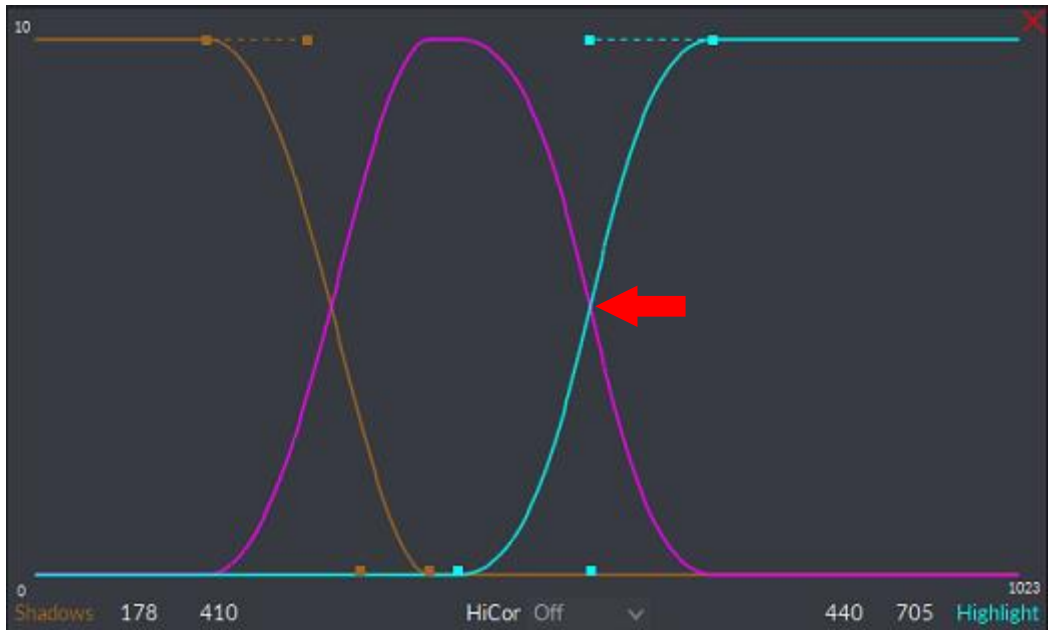
In the above, the Shadow, Midtone, and Highlight ranges are adjusted to be about one third of the total. It seems that this level of setting may be easier for color control. In the following, we will assume that this setting was used for conventional SDR footage.

In Rec.709 color space, the right end of the horizontal axis is the maximum value of the Rec.709 called 'White'.

On the other, in ACES workflow, the right end of the horizontal axis is the maximum value of either ACEScc or ACEScct that corresponds to extremely bright highlights that cannot be displayed in existing display models. In the workflow, signal equivalent to Rec.709 is roughly at center (not right end). The right half of the graph is a very bright image part that cannot be covered by Rec.709. This area is for displaying very bright video areas such as the shimmering reflections of metal or glass, lights or the sun.

If you use above graph in ACES workflow, you can only use Highlight to control the very bright highlights. You won't be able to control the level around legacy white.

If you want to adjust around white point by using highlight, you need to move cross point of magenta and cyan (the point is where the highlight start to work) as showed in below picture

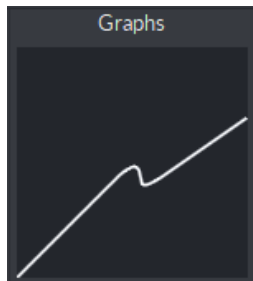


Once the range is adjusted like this, you will be able to adjust brightness that is equivalent to Rec.709 white.

### Adjust Shadow, Midtone and Highlight

There may be a case that you need to adjust each of Shadow, Midtone and Highlight by combination using of lift, gamma and gain.

For example, if you want to down Highlight by only adjusting Gain, unnatural curve like below picture may appear in Graphics.



As a result, changing near boundary between the Midtone and Highlight may become unnatural. To avoid it, also raise Lift value. Graphics will have natural curve.



Checking Graphics curve shape will be helpful to avoid unnatural change near boundary between of them.



## ASC CDL workflow

From V4.5.8, Rio considers ASC CDL that is a format for the exchange of basic primary color grading information between equipment and software from different manufacturers. The format defines the math for three functions (Slope, Offset and Power). Each function uses a number for the red, green, and blue color signal.

Once you place a clip onto MTL FX timeline, select Colour > CDL then select a color space that matches to the equipment that will hand over the CDL to Rio.

Key		Offset	Power	Slope	Saturation
Blur	Red	0.000000	1.000000	1.000000	1.000000
Graphics	Green	0.000000	1.000000	1.000000	
Text	Blue	0.000000	1.000000	1.000000	
Plug-ins					
OFX					
CDL					

Apply In Colour Space:	ACEScc	▼
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Rio has below color type for the CDL:

- ACES2065-1
- ACEScc
- ACEScct