\ ACADEMY COLOR ENCODING SYSTEM \

ACES Architecture
Technical Advisory Council Meeting

Wednesday, February 16, 2021

\ ACESCentral.com \

Agenda

ACES 1.3 / 2.0 Progress Update (10 mins)

Working Group Progress Reviews

- Gamut Mapping (10 mins)
    - Final Report Discussion (20 mins)
- Output Transforms (10 mins)
    - Discussion of custom output transforms and impact on other system components (20 mins)

Standards Strategy (10 mins)

- Discussion (10 mins)

Expected outcomes

TAC is updated on progress of ACES 1.3 and 2.0 development

TAC provides feedback on topics including:

- Final report of Gamut Mapping Working Group
- Key points being discussed within the Output Transforms Working Group
- Drafting and timing of international standards documents

ACES 1.3 / 2.0 Progress Update

Progress Update

ACES 1.3 - Gamut mapping Algorithm

- Release candidate 1 - March 1, 2021 - On Target
- Release candidate 2 - April 1, 2021- On Target
- Final Release - April 30, 2021- On Target

Progress Update

ACES 2.0 - Late 2021 / Early 2022

- Key Working Groups
  - Output Transforms - Started and On Target
  - IDT Implementation - Started and On Target

Progress Update

Additional Documentation and Toolsets

- ACES 1.3 timeframe
  - AMF user guide and tools - On Target
  - CLF user guide and tools - On Target
  - IDT exposure guidelines and reference implementation - On Target
  - Gamut Mapping user guide - Starting soon

Progress Update

Additional Documentation and Toolsets

- ACES 2.0 timeframe
    - Output Transforms Documentation - In Progress
    - Compression best practices - Not Started

Discussion & Questions

Gamut Mapping Architecture Working Group

Technical Documentation

Co-Chairs : Carol Payne (Netflix) & Matthias Scharfenberg (ILM)

ACES

Tl;dr

We're done!

Background

Users of ACES are experiencing problems with clipping of colors and the resulting artifacts (loss of texture, intensification of color fringes). This clipping occurs at two stages in the pipeline.

- Conversion from camera raw RGB or from the manufacturer's encoding space into ACES AP0
- Conversion from ACES AP0 into the working color space ACES AP1

The current workaround is to utilize the "Blue Highlight LMT" - but this solution is incomplete and too specific to blue values. It also affects all pixels, as opposed to just offending out of gamut values.

History & Research

Users of ACES are experiencing problems with out of gamut colors and the resulting artifacts (loss of texture, intensification of color fringes).


Eggo
Eggo

Scope setting

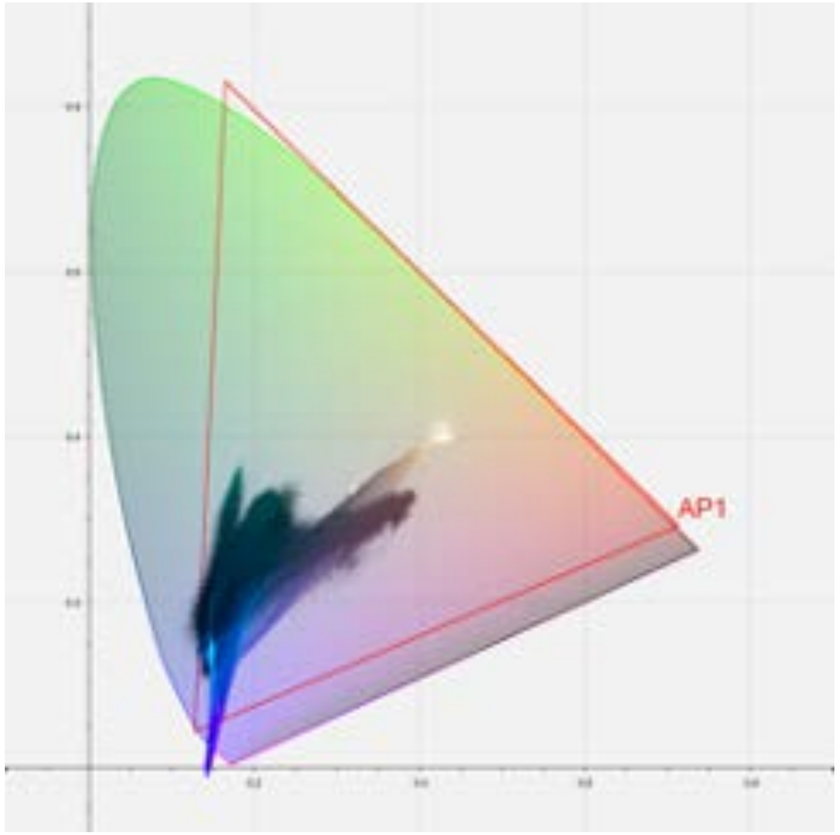
Ideals:

- Exposure invariance - f(a · RGB) = a · f(RGB)
- Source gamut agnosticism
- Monotonicity
- Simplicity - suited to a fast shader implementation
- Invertibility (we'll talk caveats later)
- Colors in a "zone of trust" will be left unaltered

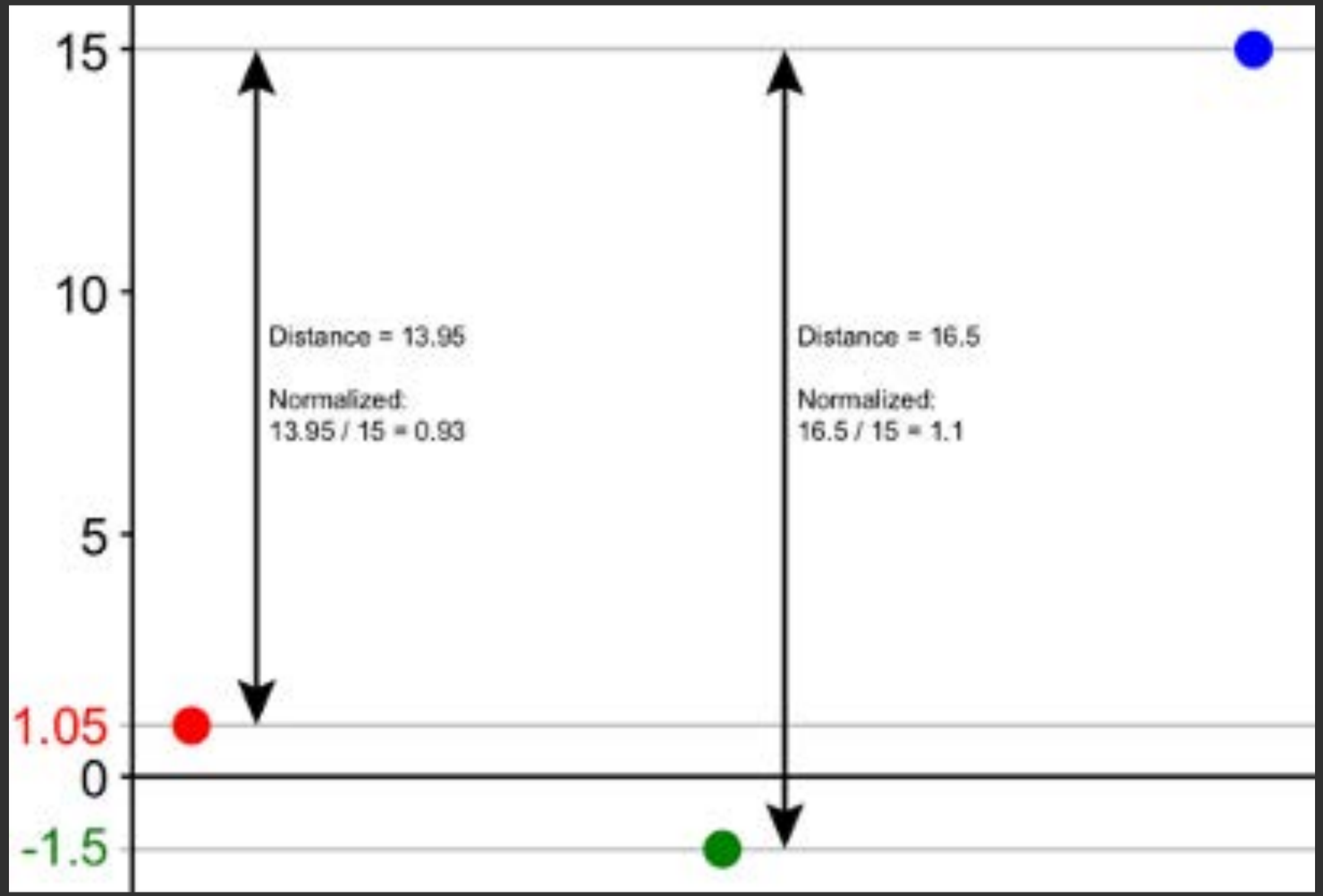
Out of Scope:

- Colorimetric accuracy or spectral plausibility of input device transforms (IDTs)
- Display gamut mapping. (Required modifications to the RRT/ODT will need to be addressed by a subsequent group.)
- Customizing for specific input/output gamuts
- Working in bounded or volume-based gamuts
- Actions which could limit creative choices further down the line (e.g. excessive desaturation)

Technical Specification



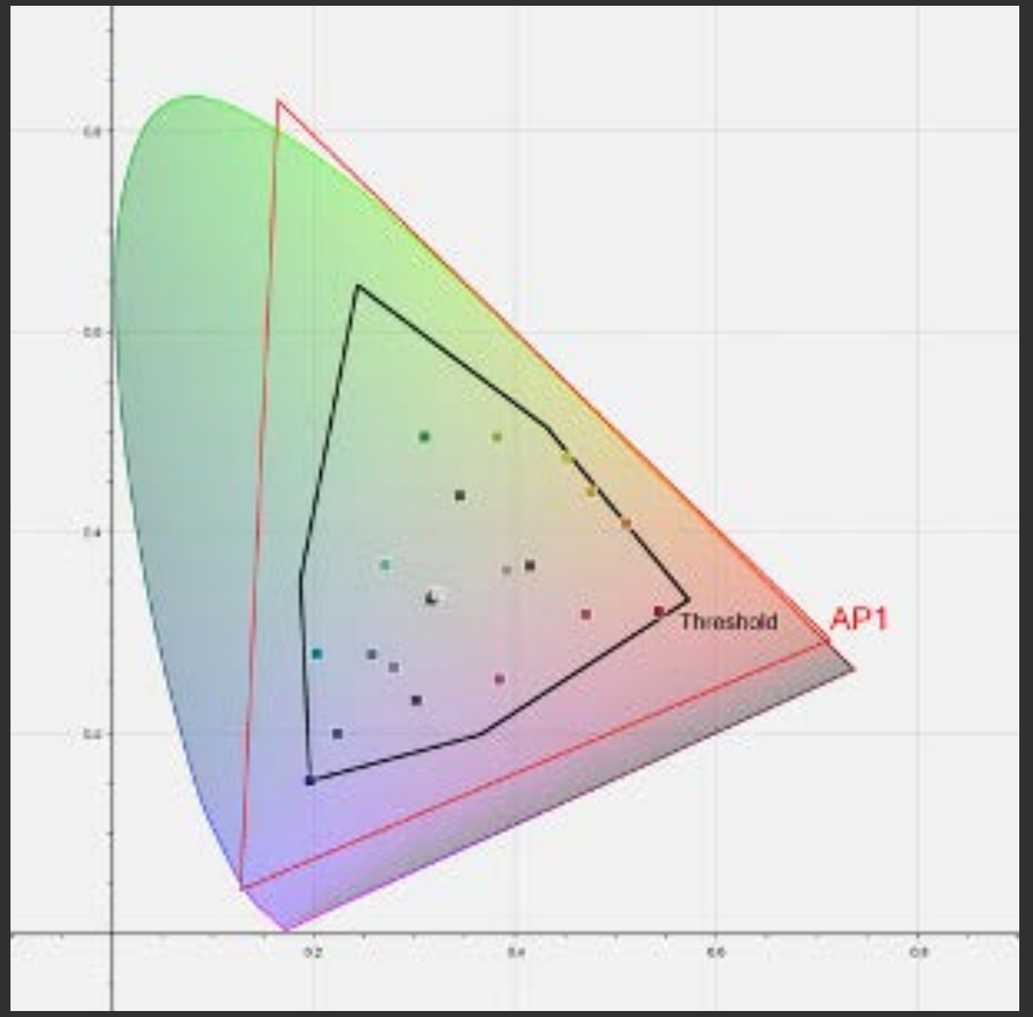
Technical Specification



Compressed distances

Compression Threshold

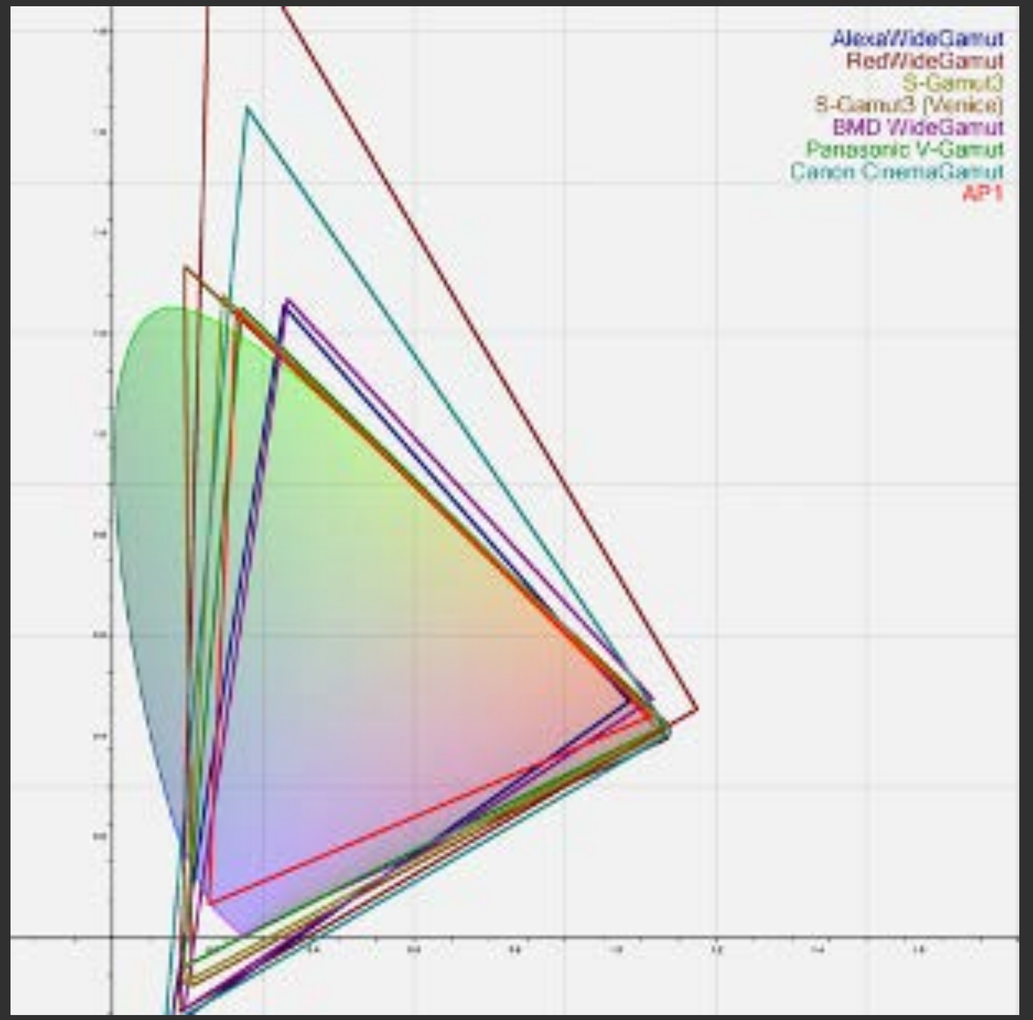
[0.815, 0.803, 0.88]



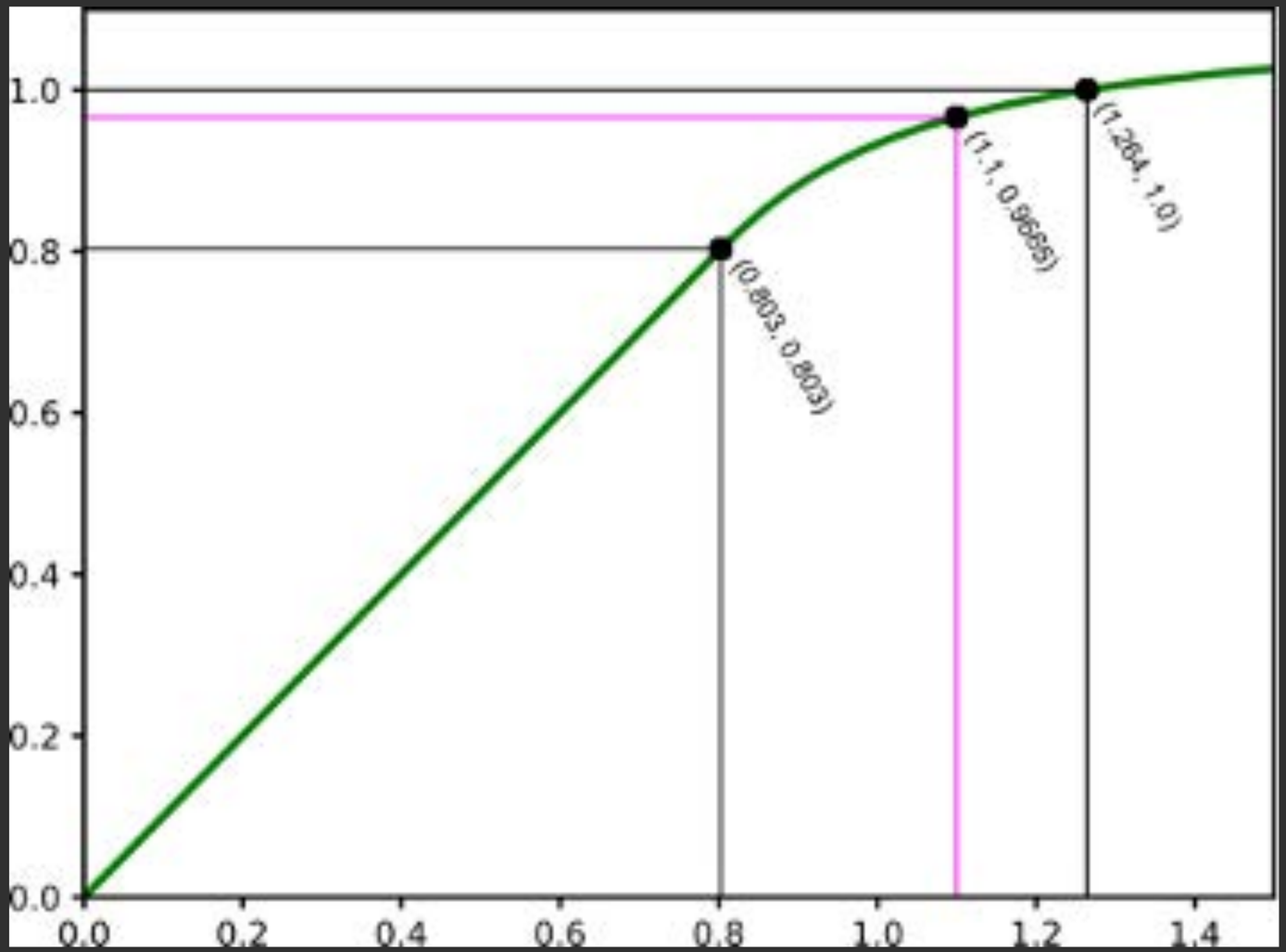
Parameters

Distance Limit

[1.147, 1.264, 1.312]



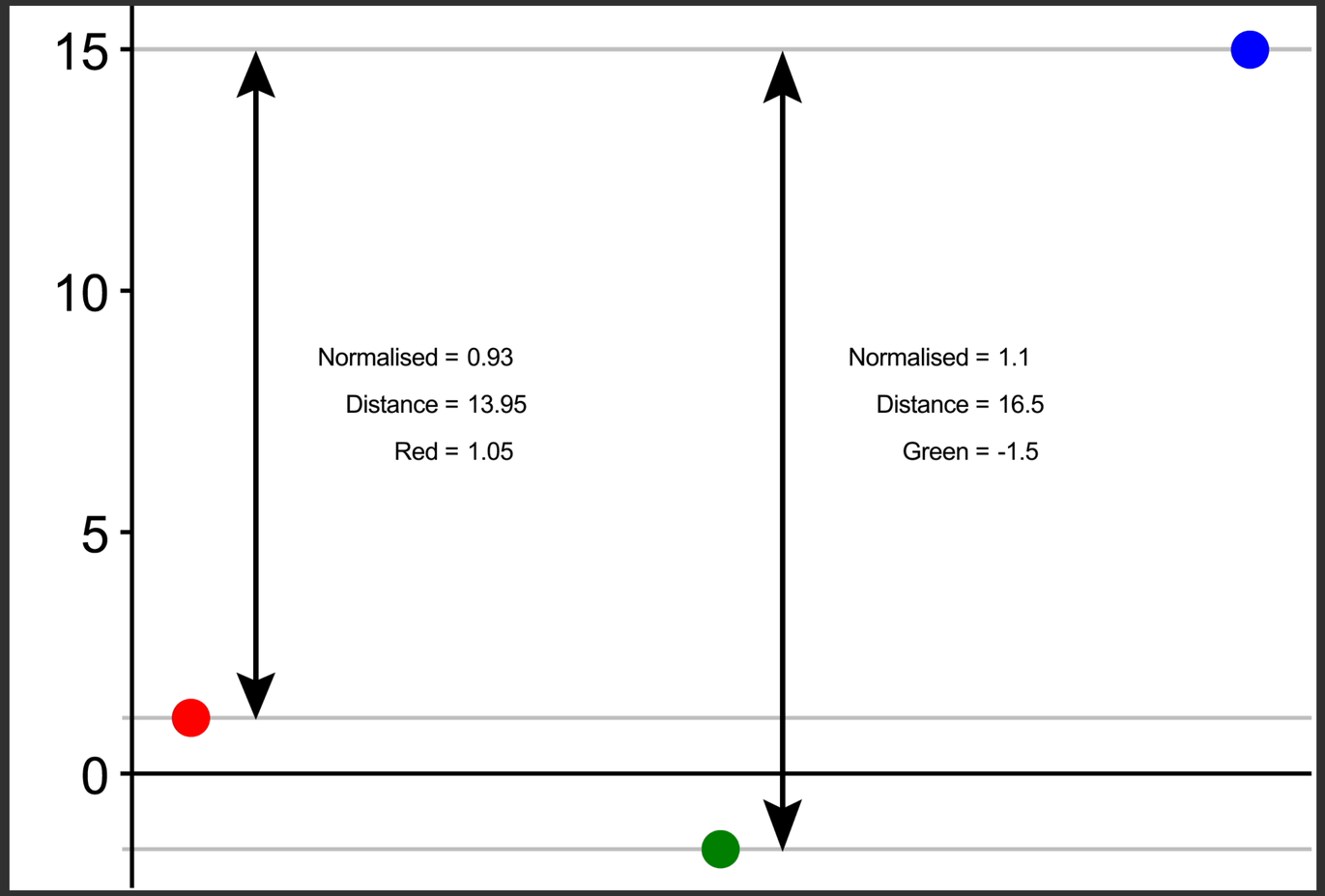
Parameters

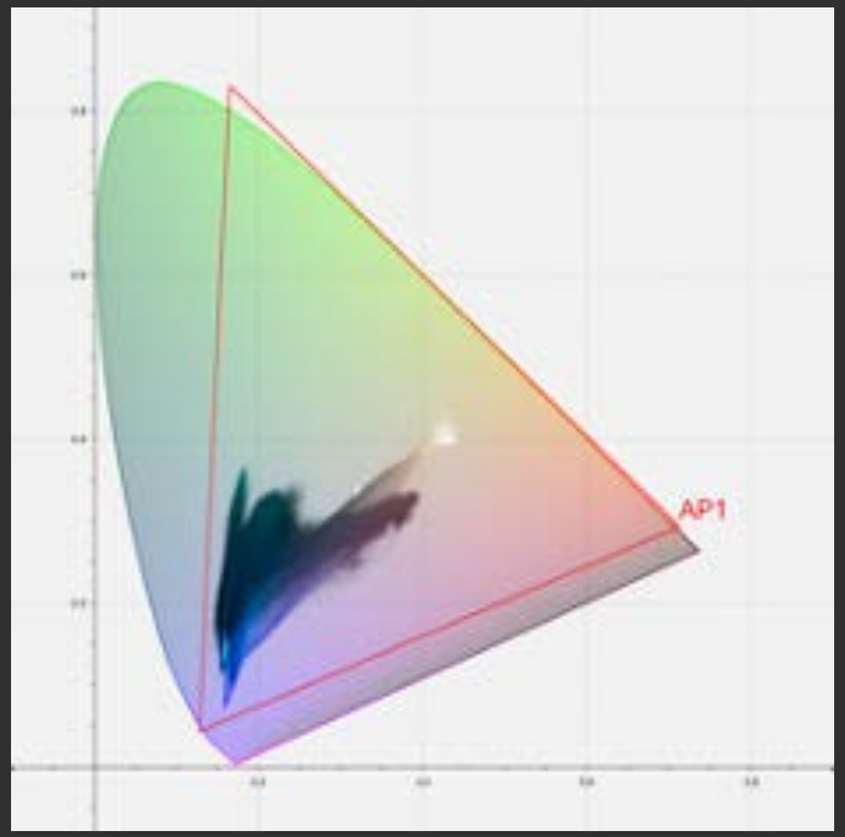


Power Curve Exponent

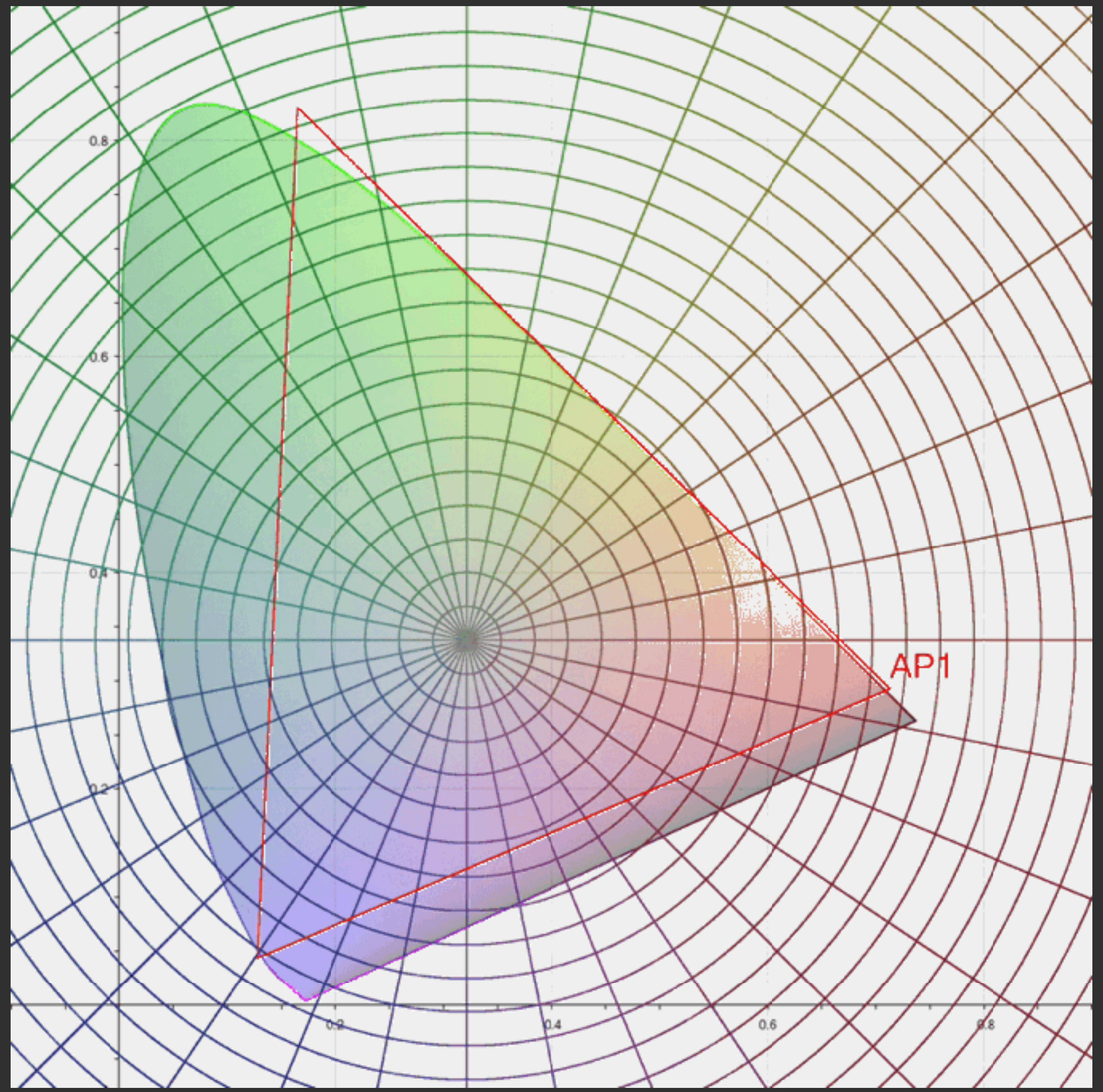
1.2

Compressed distances

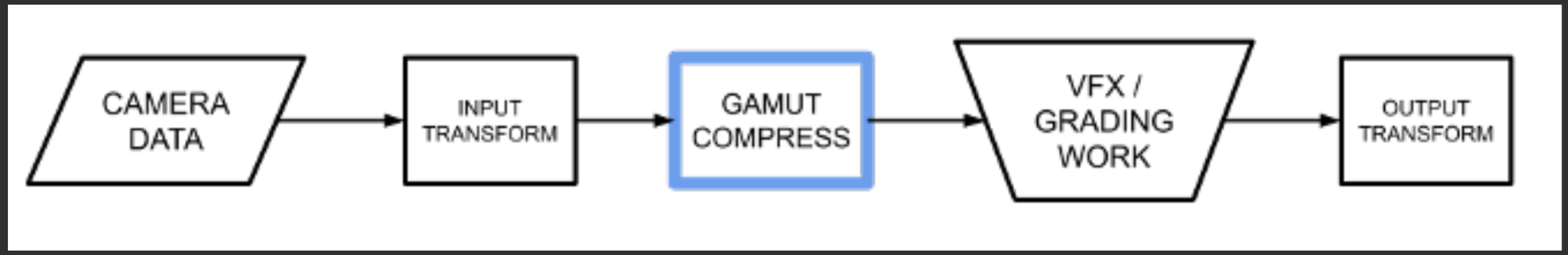



AP1

Results

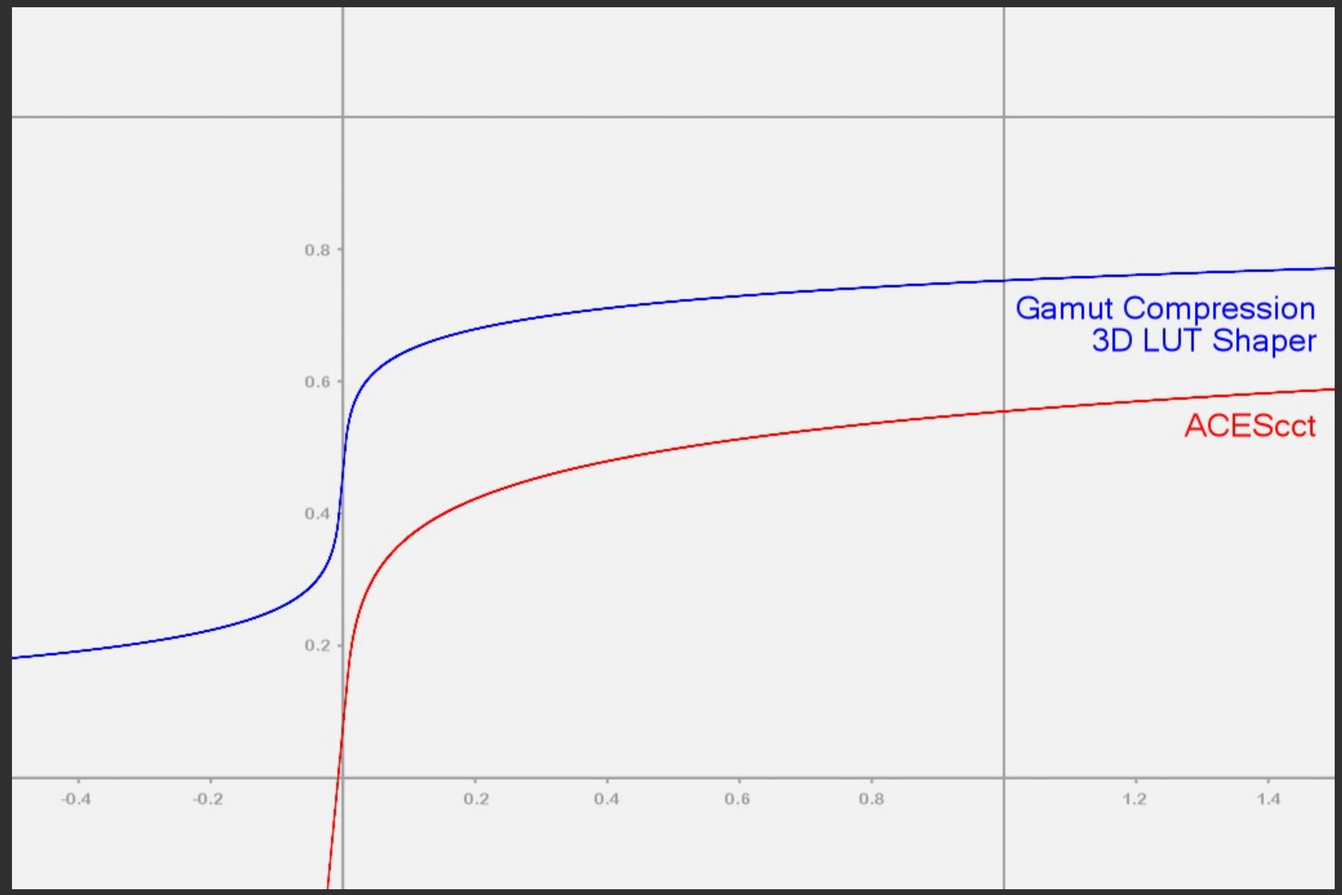


Workflow requirements



Implementation Considerations

- Invertibility
- Default Values
- 3D LUT Approximation
- Tracking



Discussion & Questions

Output Transforms Architecture Working Group

Co-Chairs : Alex Fry (ILM) & Kevin Wheatley (Framestore)

Summary of the "Top-Ten" Misconceptions

In order to avoid the pitfalls described in this section, it will be important for the Committee to keep the discussed myths and misconceptions in mind. For convenience, the main issues are summarized below:

1. Standard CIE colorimetry does not—and was not intended to—represent color appearance.
2. CIE XYZ values that have been converted to other recommended color spaces such as CIELAB still do not represent color appearance.
3. Use of the CIE 1931 Standard Colorimetric Observer should not be a concern for most imaging applications.
4. For proper color appearance, the colorimetry of a displayed image always must be altered (rendered) from that of an original live scene.
5. Original scenes routinely have areas of luminance greater than that of a perfect white in the principal subject area.
6. Two distinctly different luminance dynamic ranges must be considered for rendered images. One corresponds to range that can be displayed, the other corresponds to the range of original luminance information the display can represent.
7. Successful color encoding begins with a determination of an appropriate encoding method rather than with a color space or data metric.
8. There is no one "best" color space for digital images because different spaces are best suited for different purposes.
9. The design of a data metric must consider the resources of the particular system for which it is being designed.
10. Device-dependent color encoding methods can be designed such that they are unrestricted by the limitation of actual devices.

paper.dropbox.com/doc/ACES-Output-Transforms-Background-Information-pR0QOttCOXO8bpUE0lRlw

Dropbox Paper

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ACES Output Transforms - Background Information

Introduction

Key pre-release versions

[Clicking each version title will take you directly to the version tag on Github.]

DC22

Overview

- Derived from film work by M. Uchida and Fuji team
- Very filmic based - tone scale was more contrasty, especially in the toe
- Dependent on lots of LUTs
- No closed-form inverse

v0.1 (also known as UT33)

Overview

- Ratio-restoring tone scale in ODT only
- Problems:
  - lots of clipping steps which means:
    - gamut coverage in OCES is poor relative to the OCES encoding primaries
    - gamut coverage through the ODT is poor relative to the P3 encoding primaries
  - overly complex
  - non-invertible

Rendering Steps

RRT

1. Tone scale: applied to ACES RGB independently
2. Clip negatives
3. 3x3 adjustment matrix
4. Clip negatives
5. Per-hue contrast adjustments: several 11-point 1D LUTs with blending between 6 hue regions
6. Desaturation matrix: with equal 1/3 channel weighting, sat=0.86
7. Clip negatives

ODT

1. Ratio-restoring tone scale: applied to OCES RGB; norm = $(R^2 + G^2 + B^2) / (R + G + B)$
2. 3x3 matrix: OCES to XYZ
3. 3x3 matrix: XYZ to display primaries
4. Clip 0-1
5. Inverse EOTF

ACES


v0.1.1


v0.7.1


v1.2

Color Management for Digital Cinema

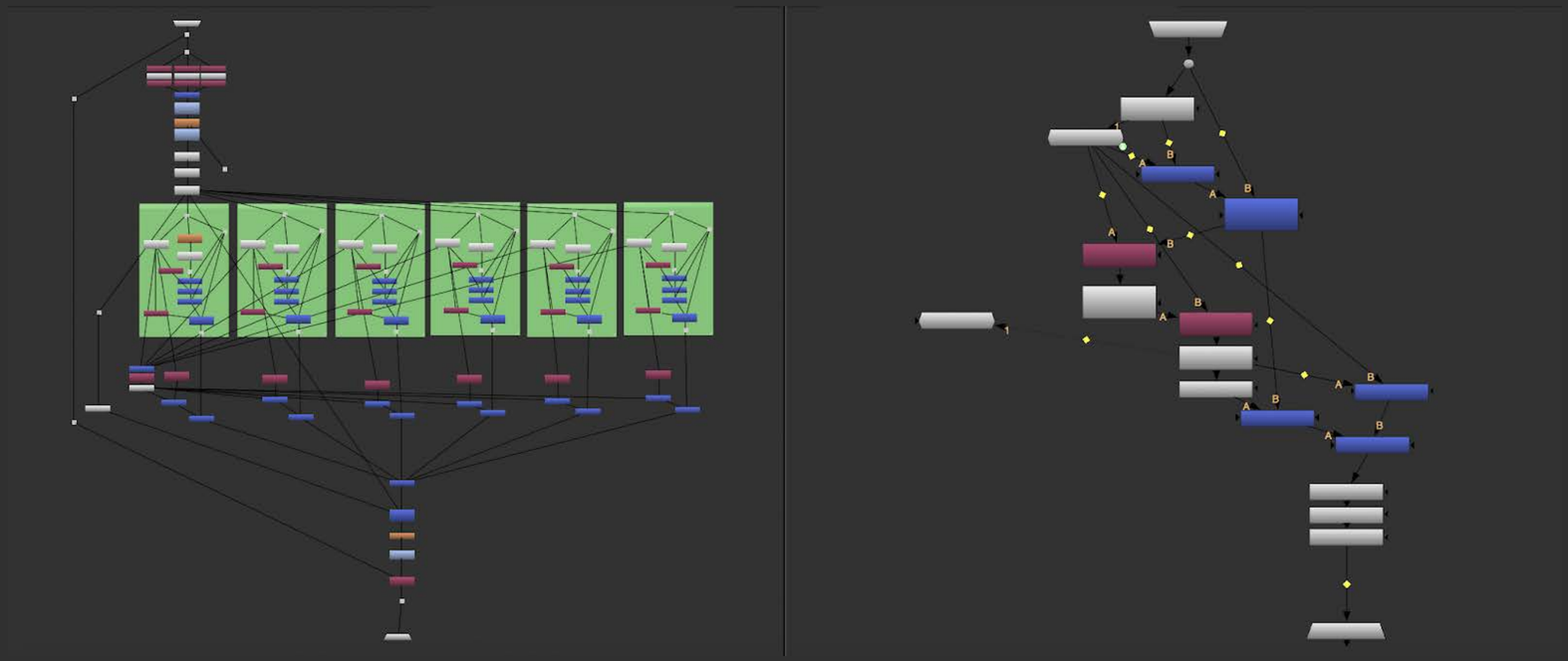
A Proposed Architecture and Methodology for Creating, Encoding, Storing and Displaying Color Images in Digital Cinema Systems

Edward J. Giorgianni
Submitted to the Science and Technology Council,
Academy of Motion Picture Arts and Sciences
November 25, 2005

ACES

Scene Colorimetry

Rendered Colorimetry



OCIOColorSpace1

OCIOColorSpace | Context | Node

channels: rgb | red | green | blue

in: scene_linear (ACES - ACEScg)

out: ACES - ACES2065-1

mask: none | inject | invert | fringe

(un)premult by: none | invert

mix: 1

ACES_011_RRT

User | Node

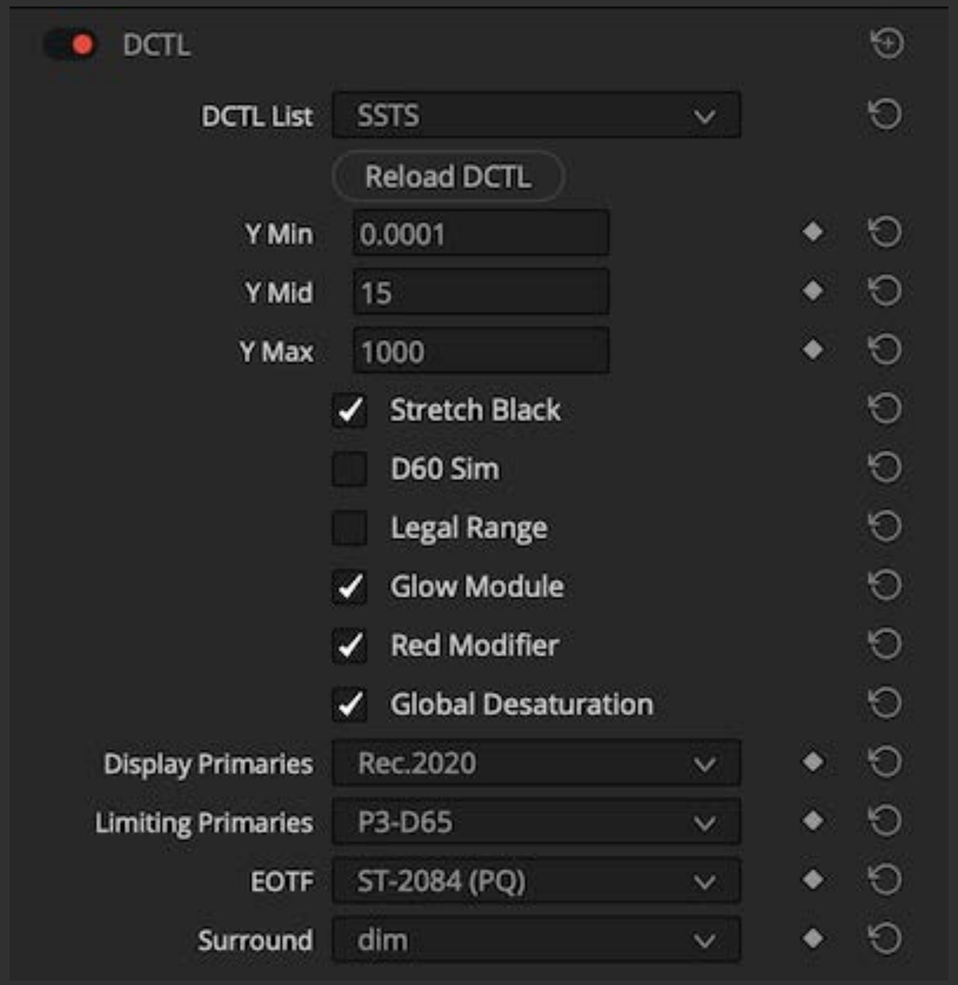
- rrt_shaper_fwd
- RRT_MTX
- R_MTX
- R_LUT
- Y_LUT
- G_LUT
- C_LUT
- B_LUT
- M_LUT
- SatMatrix

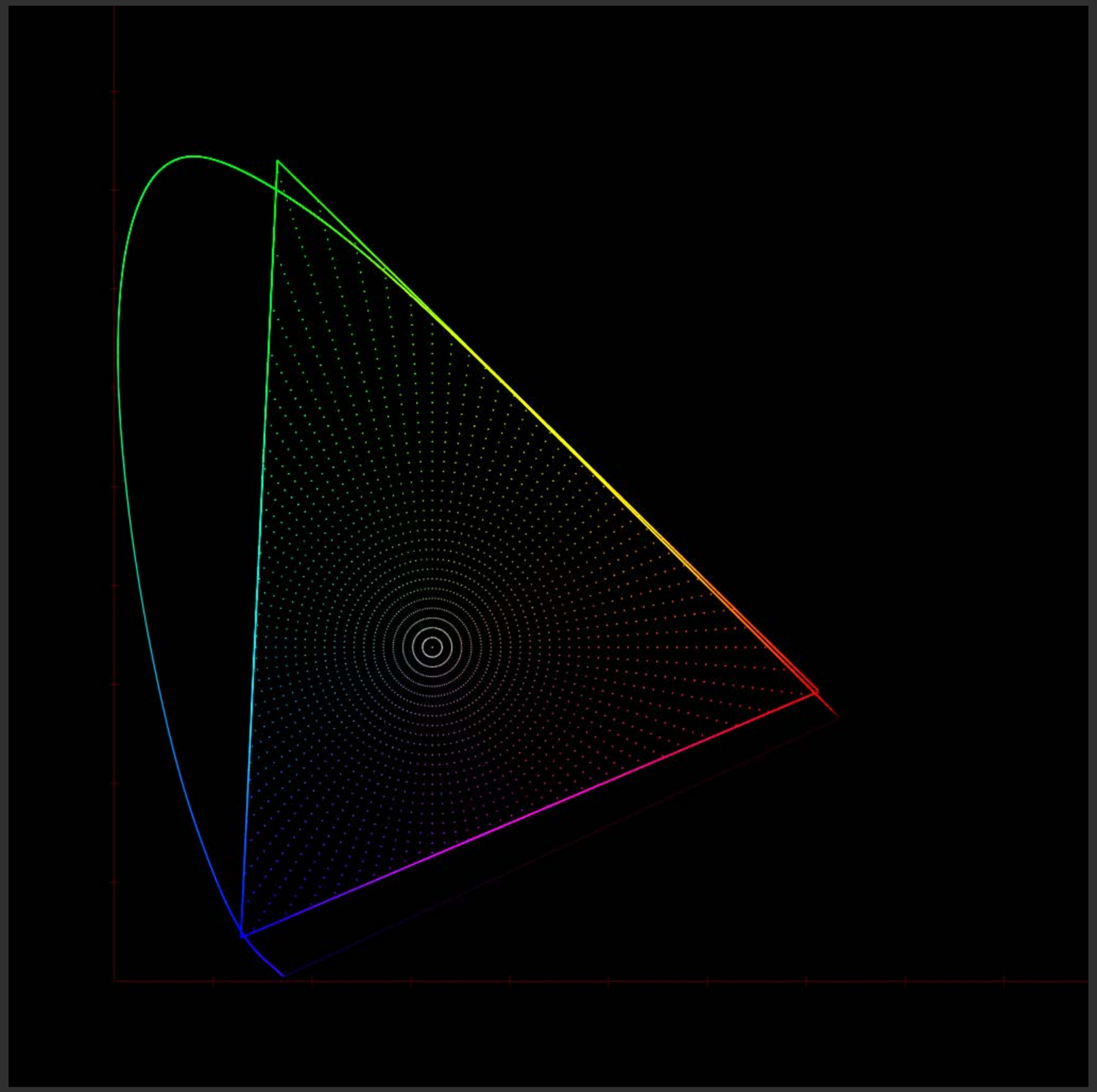
ACES_011_ODT

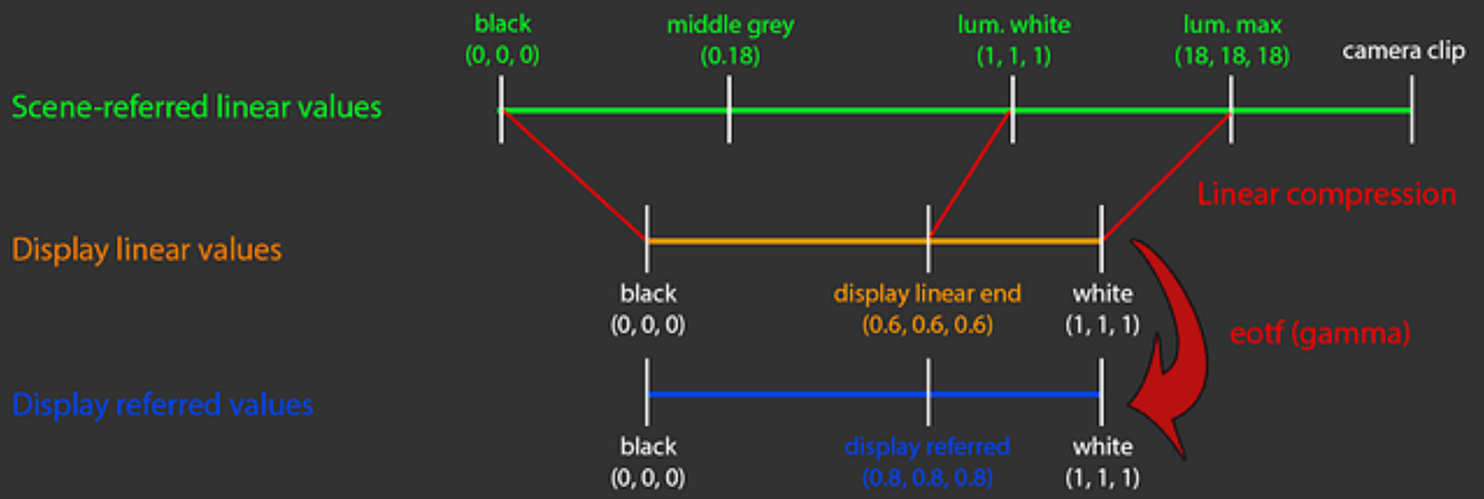
User | Node

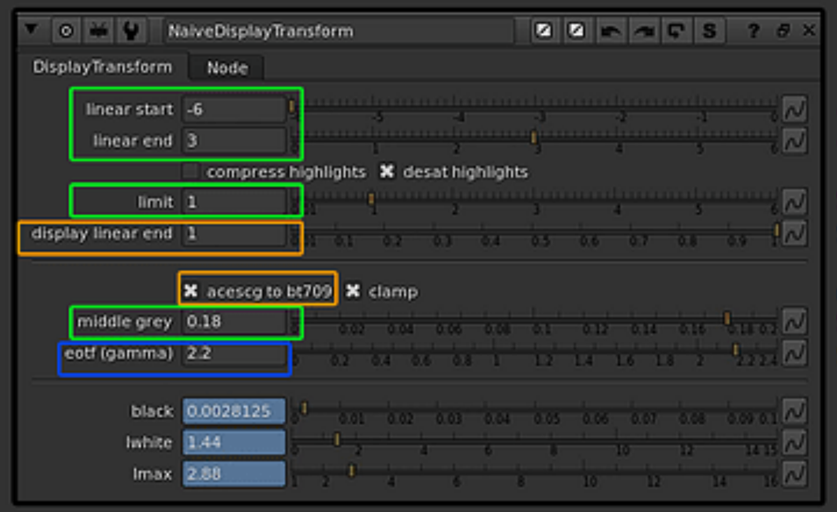
- rdt_shaper_fwd
- ratio-preserving tone-curve
- highlight_desat

out: sRGB (~2.20) | D65 | sRGB


DCTL
DCTL List
SSTS
Reload DCTL
Y Min
0.0001
Y Mid
15
Y Max
1000
Stretch Black
D60 Sim
Legal Range
Glow Module
Red Modifier
Global Desaturation
Display Primaries
Rec.2020
Limiting Primaries
P3-D65
EOTF
ST-2084 (PQ)
Surround
dim







Calculates scene linear black value (6 stops below middle grey)
Calculates scene linear lum. white value (3 stops above middle grey)

Sets scene linear lum.max value
Sets display linear end

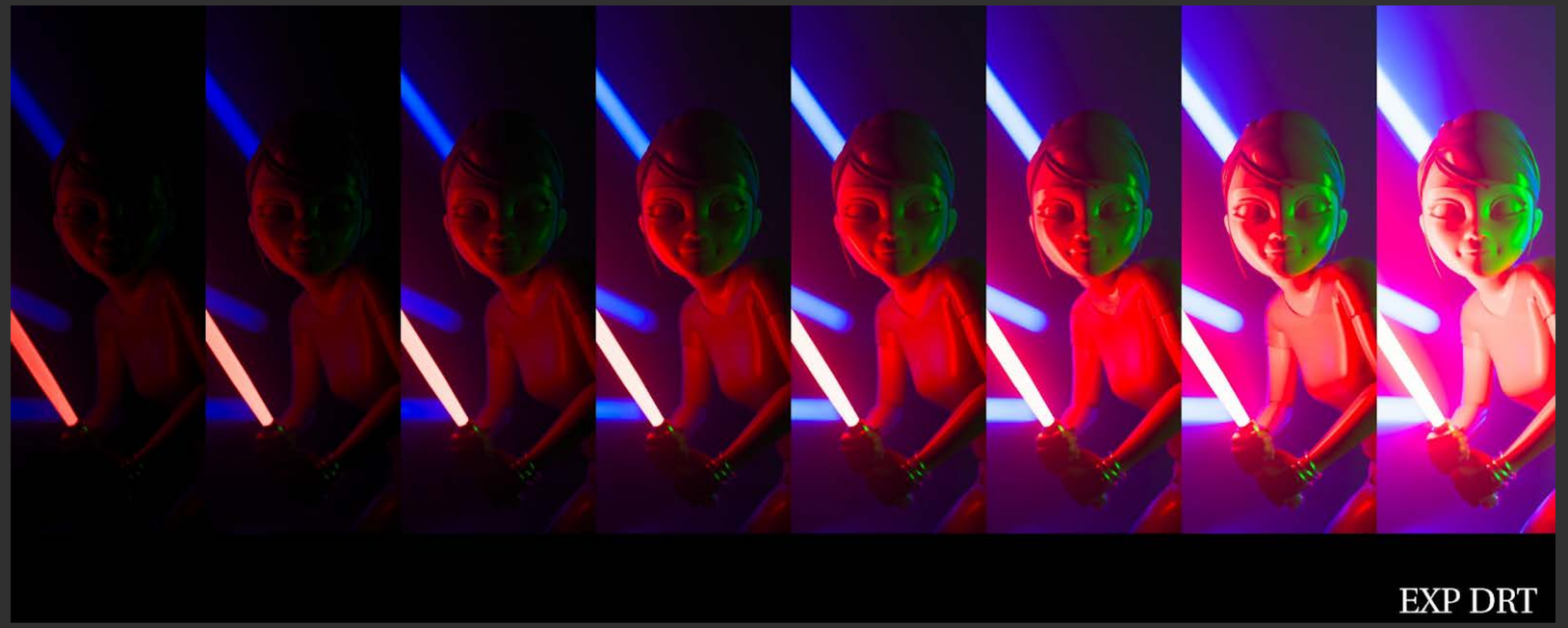
Converts primaries from scene to display
Sets scene linear middle grey
Sets eotf gamma display

Values and scales are not necessarily accurate.
They are just used as an example.

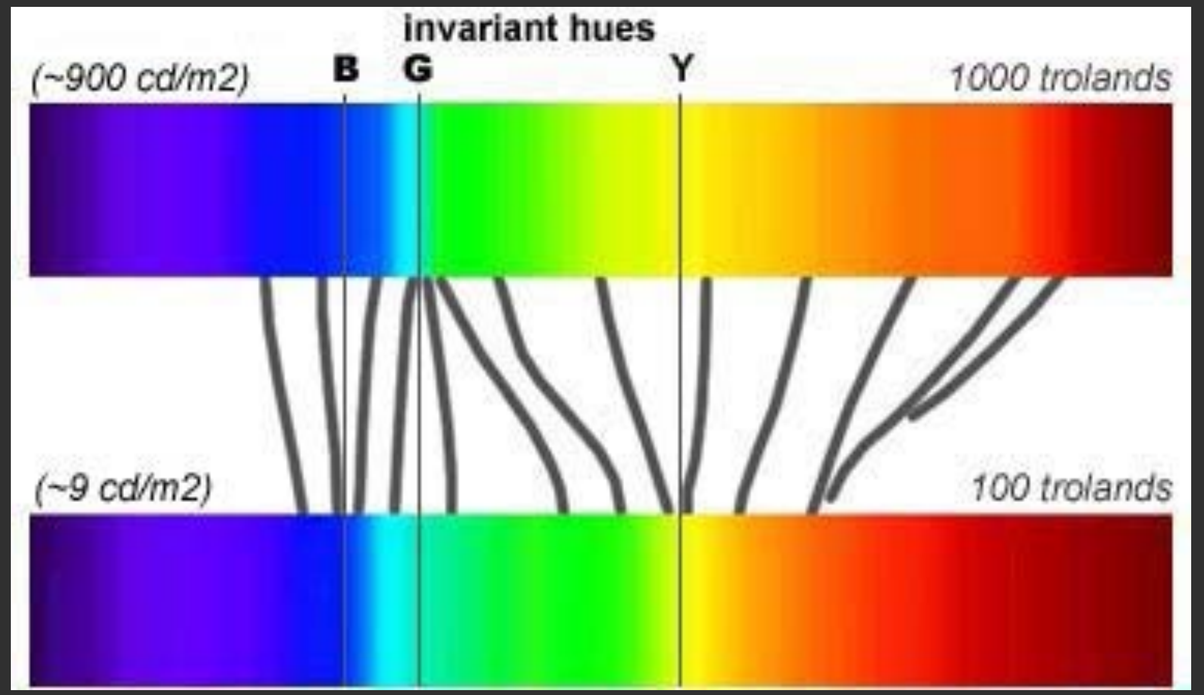

ACES 1.2


EXP DRT

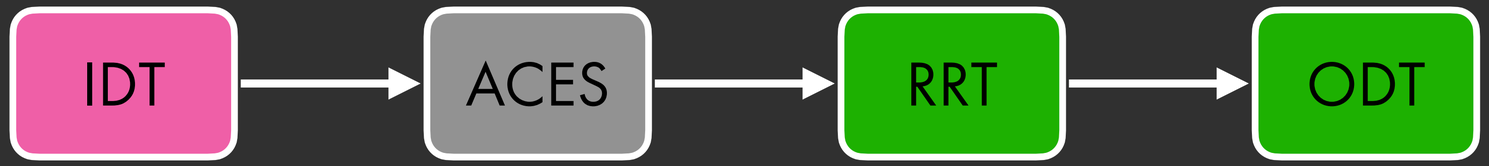

ACES 1.2

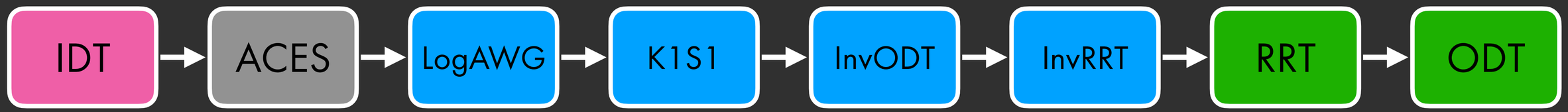

EXP DRT

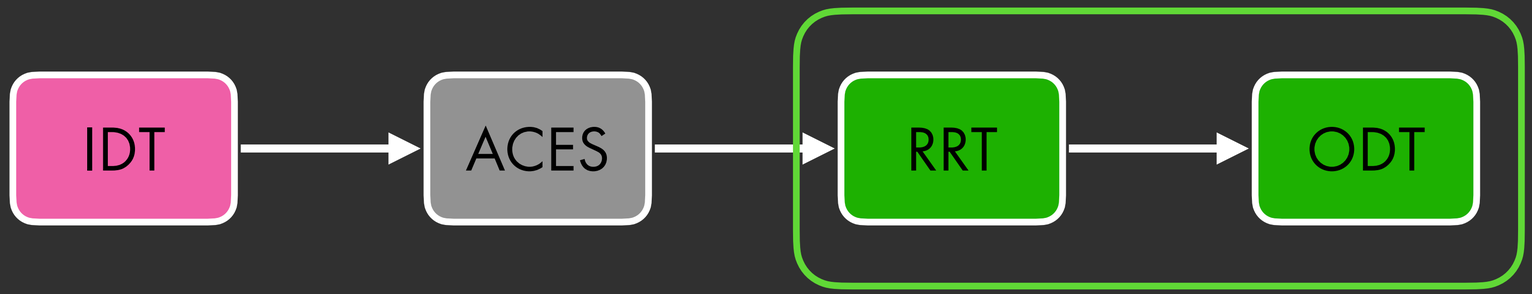

naive drt v2
-2.5 FSt
-2 Fst
-1 Fst
+1 Fst
+2 Fst
+2.5 Fst
ESSER TEST CHARTS
TE223 16:9

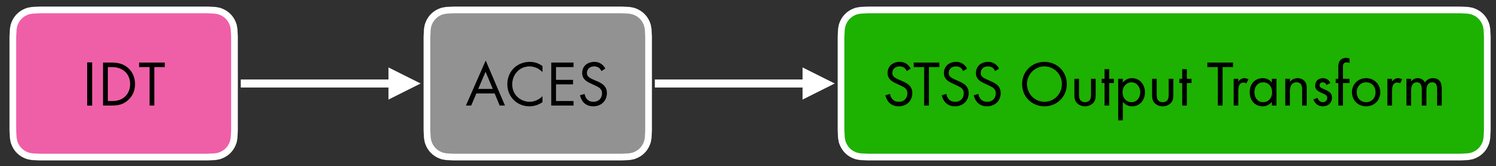


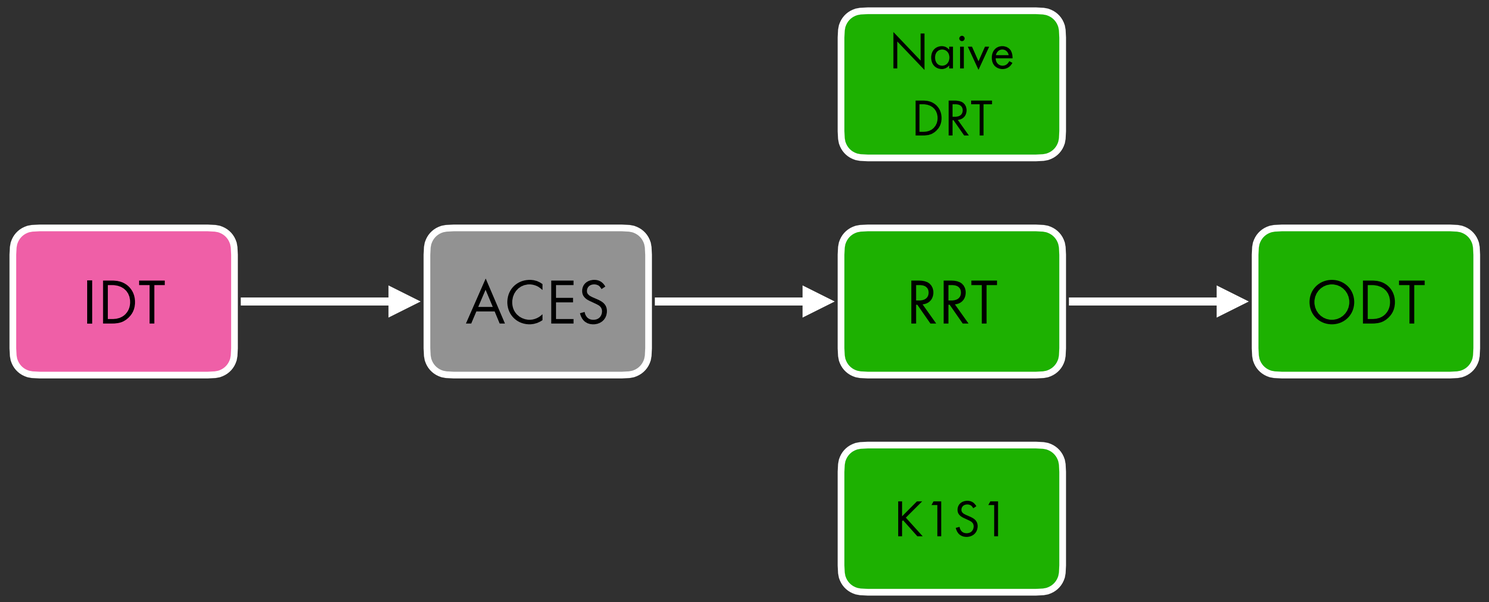
Bezold-Brücke Effect

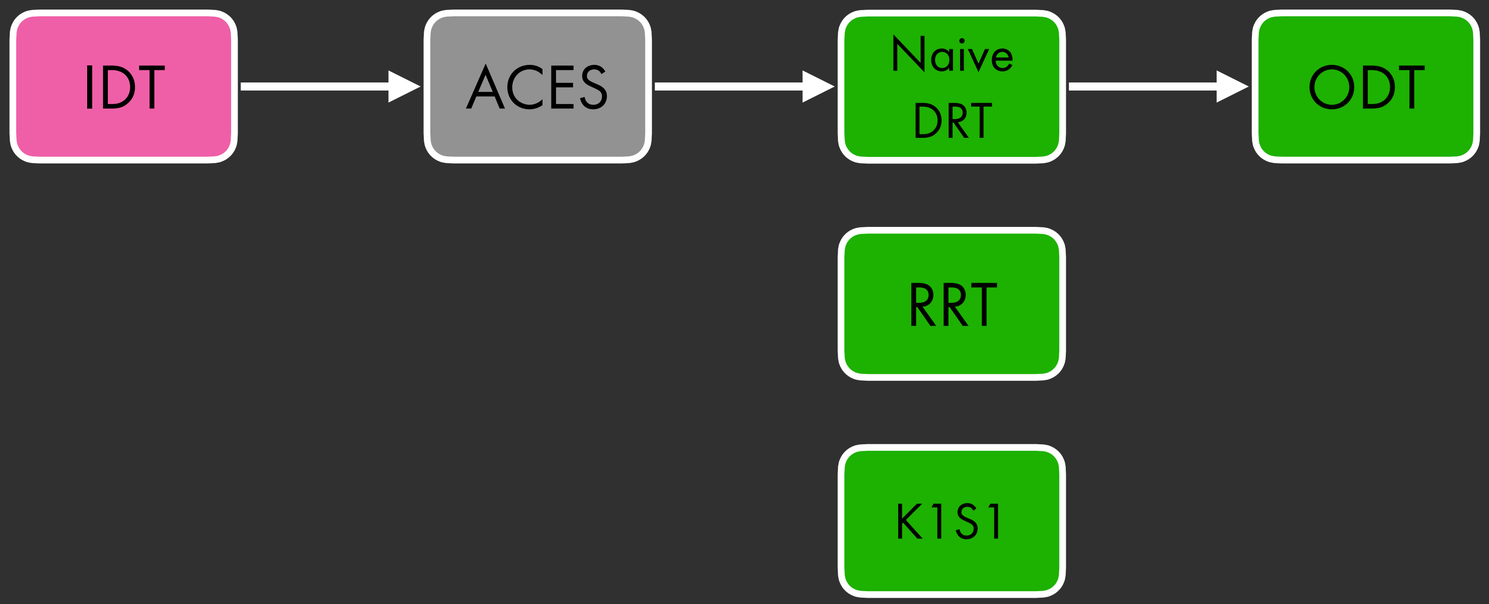

IDT
ACES
RRT
ODT

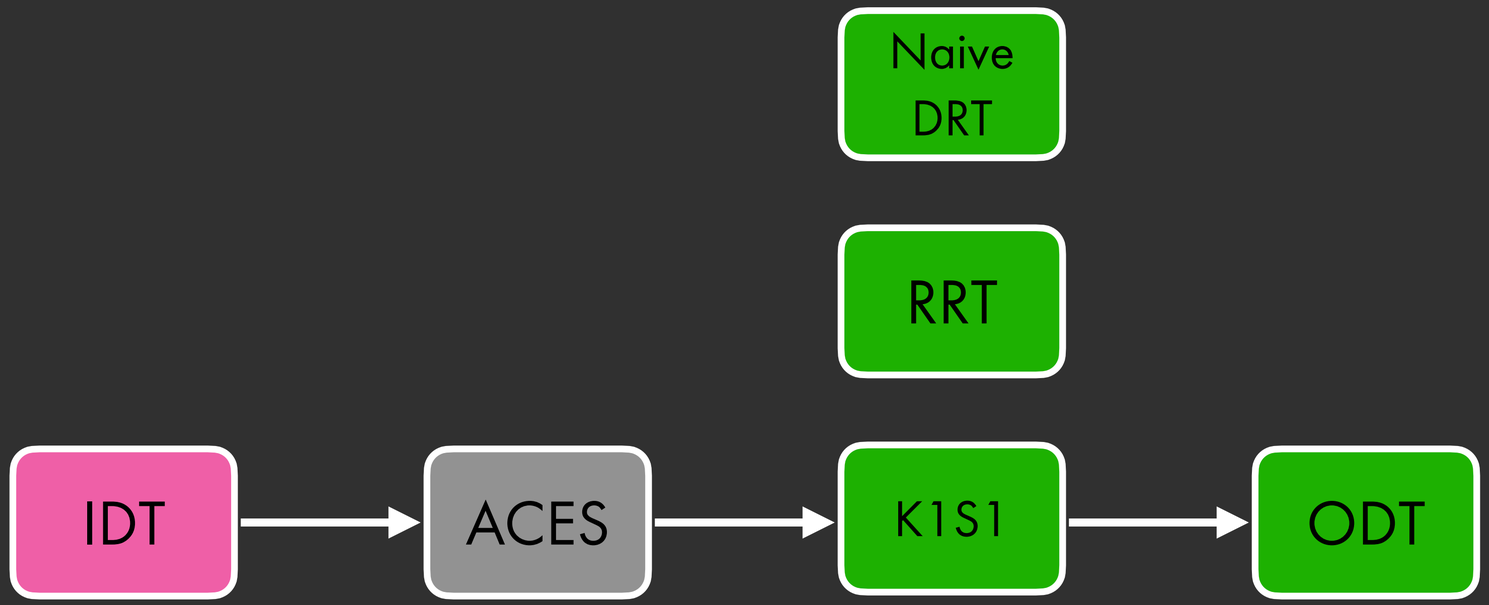

IDT
ACES
LogAWG
K1S1
InvODT
InvRRT
RRT
ODT

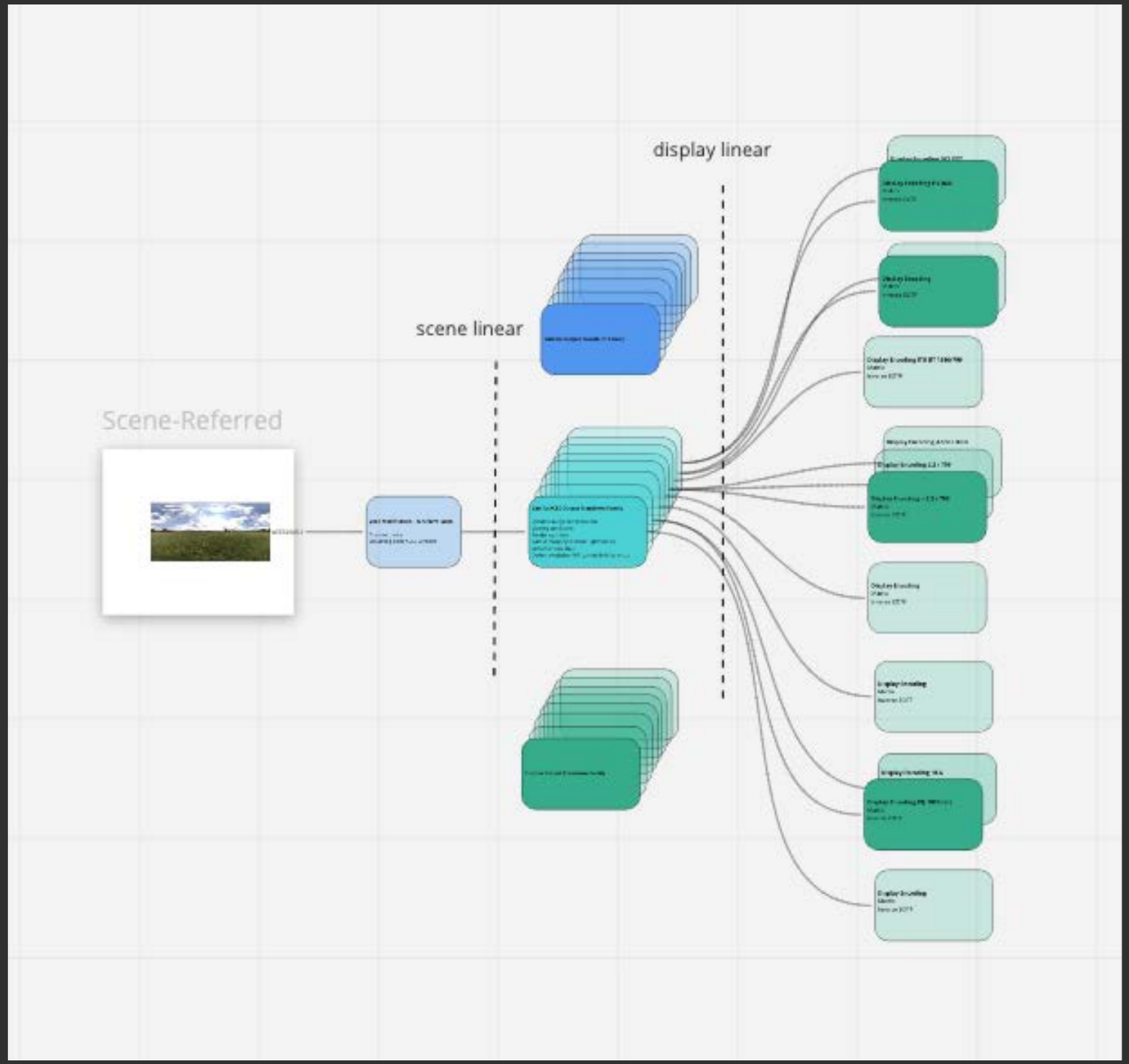

IDT
ACES
RRT
ODT

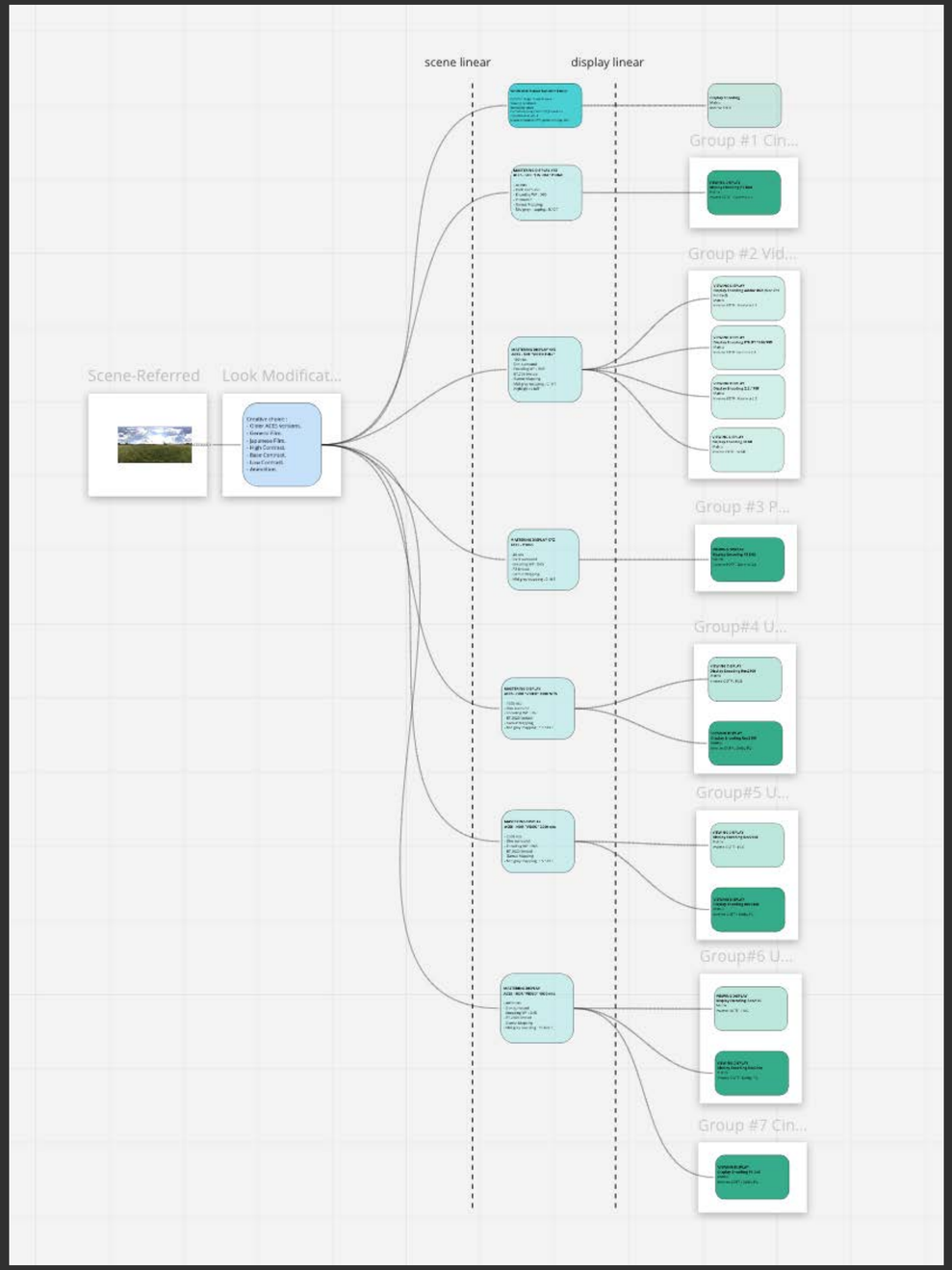

IDT
ACES
STSS Output Transform

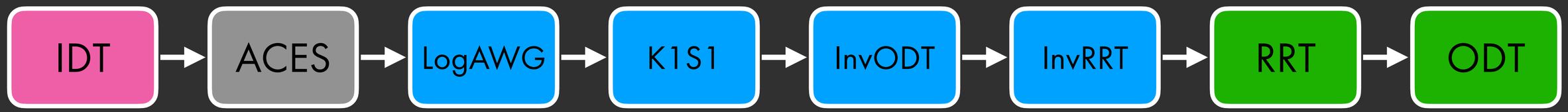

Naive
DRT
IDT
ACES
RRT
ODT
K1S1

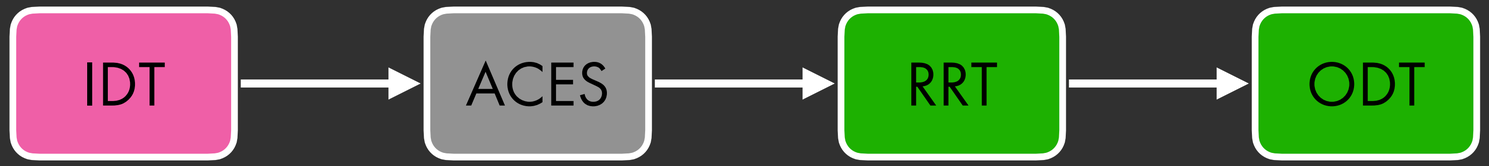

IDT
ACES
Naive
DRT
ODT
RRT
K1S1

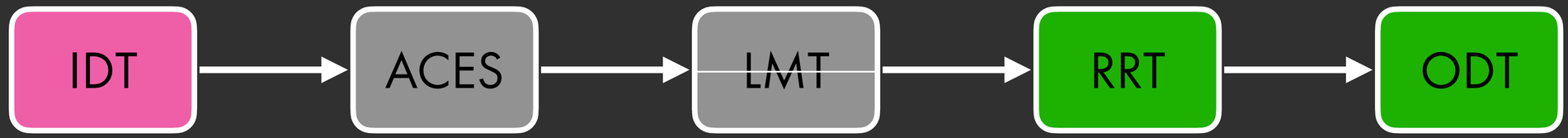

Naive
DRT
RRT
IDT
ACES
K1S1
ODT


display linear
scene linear
Scene-Referred


scene linear
display linear
Scene-Referred
Look Modificat...
Group #1 Cin...
Group #2 Vid...
Group #3 P...
Group#4 U...
Group#5 U...
Group#6 U...
Group #7 Cin...


IDT
ACES
LogAWG
K1S1
InvODT
InvRRT
RRT
ODT


IDT
ACES
RRT
ODT


IDT
ACES
LMT
RRT
ODT

Discussion & Questions

Standards Strategy

Standards Strategy

Successful approach

- Engineering though Academy hosted / community driven working groups
- Draft Academy documents with context and background not typically found in standards documents
- Allow time to germinate within the industry, collect feedback, modify as necessary
- Introduce to appropriate standards body

Standards Strategy

Existing Standards

- ACES Color Encoding – SMPTE ST 2065-1
- Academy Printing Density – SMPTE ST 2065-2
- Academy Density Exchange – SMPTE ST 2065-3
- ACES Container – SMPTE ST 2065-4
- MXF Wrapper for ACES – SMPTE ST 2065-5
- IMF App5 ACES – SMPTE ST 2067-50

Standards Strategy

Potential New Documents	Document Type	Priority	Level of Readiness
Common LUT Format	Standard	High	Medium-High
ACES Metadata File	Standard	High	Medium
ACEScg	Standard	Medium	Medium
ACEScc	Standard	Medium	Medium
ACEScct	Standard	Medium	Medium
ACES Output Transforms	Standard	High	Low
Digital Camera RGB to ACES	Recommended Practice	Medium	High
Film Scanner Setup	Recommended Practice	Medium	Low
ADX to ACES	Recommended Practice	Medium	Low
Digital Cinema Projector Setup	Recommended Practice	Low	High
ACES Whitepoint Derivation	Engineering Guideline	Low	High
Standardized Digital Motion Picture Model Description	Engineering Guideline	High	Low
ACES Vocabulary	Standard	High	Low
Output Referred Image conversion to ACES	Recommended Practice	Medium	Low
IDT Interchange Procedure	Recommended Practice	High	Low
LMT Interchange Procedure	Recommended Practice	High	Low
Lossless Compression for ACES Images	Standard	Medium	Low
CTL	Standard	Low	Medium
IES Standard Format for the Electronic Transfer of Spectral Data	Standard	Low	Medium