

# High Dynamic Range: Where are we this week?

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# **Super-practical**

[https://github.com/  
stevenrobertson/hdr-talk](https://github.com/stevenrobertson/hdr-talk)

# **What is HDR?**

HDR for video  
which is not HDR for photos



Kevin McCoy

[https://en.wikipedia.org/wiki/High-dynamic-range\\_imaging#Example](https://en.wikipedia.org/wiki/High-dynamic-range_imaging#Example)

"Not just more pixels,  
better pixels"

Increased dynamic range

Higher brightness

Superb contrast

Wider color gamut

**Why care?**

Looks really quite good

Mobile-friendly

Compatible with existing  
and new experiences

**This is awkward...**

SMPTE ST 2084 sez:  
Codepoint 960 means  $10,000 \text{ cd/m}^2$

Content may be graded for  
4,000 nits today

"This display is only 500 nits,  
how can it be HDR?"

By Djembayz (Own work)

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via Wikimedia Commons



# Viewing conditions

A "good" display chain  
reproduces "creative intent"

1000 nits,  
in the color studio

Even if you could,  
you shouldn't

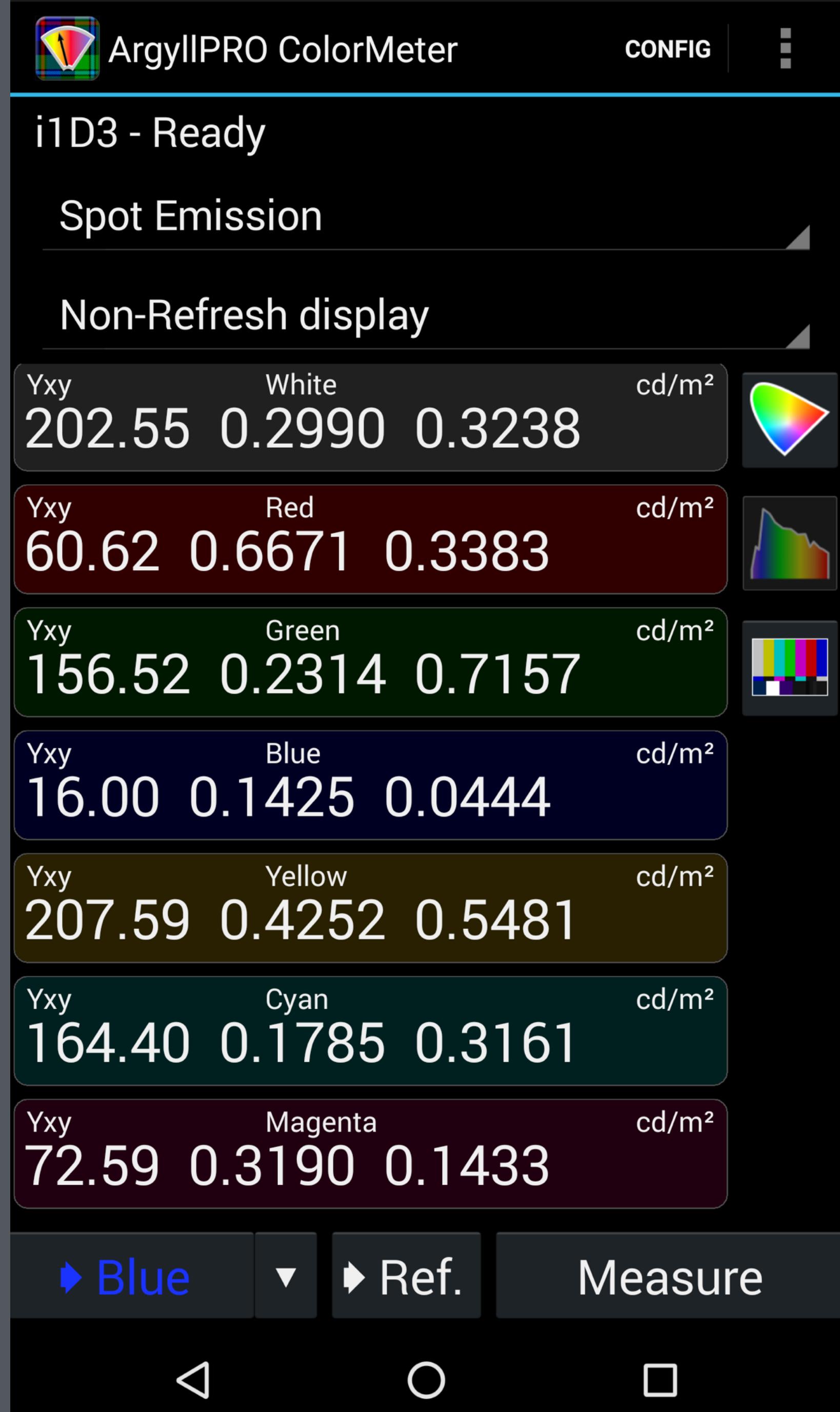
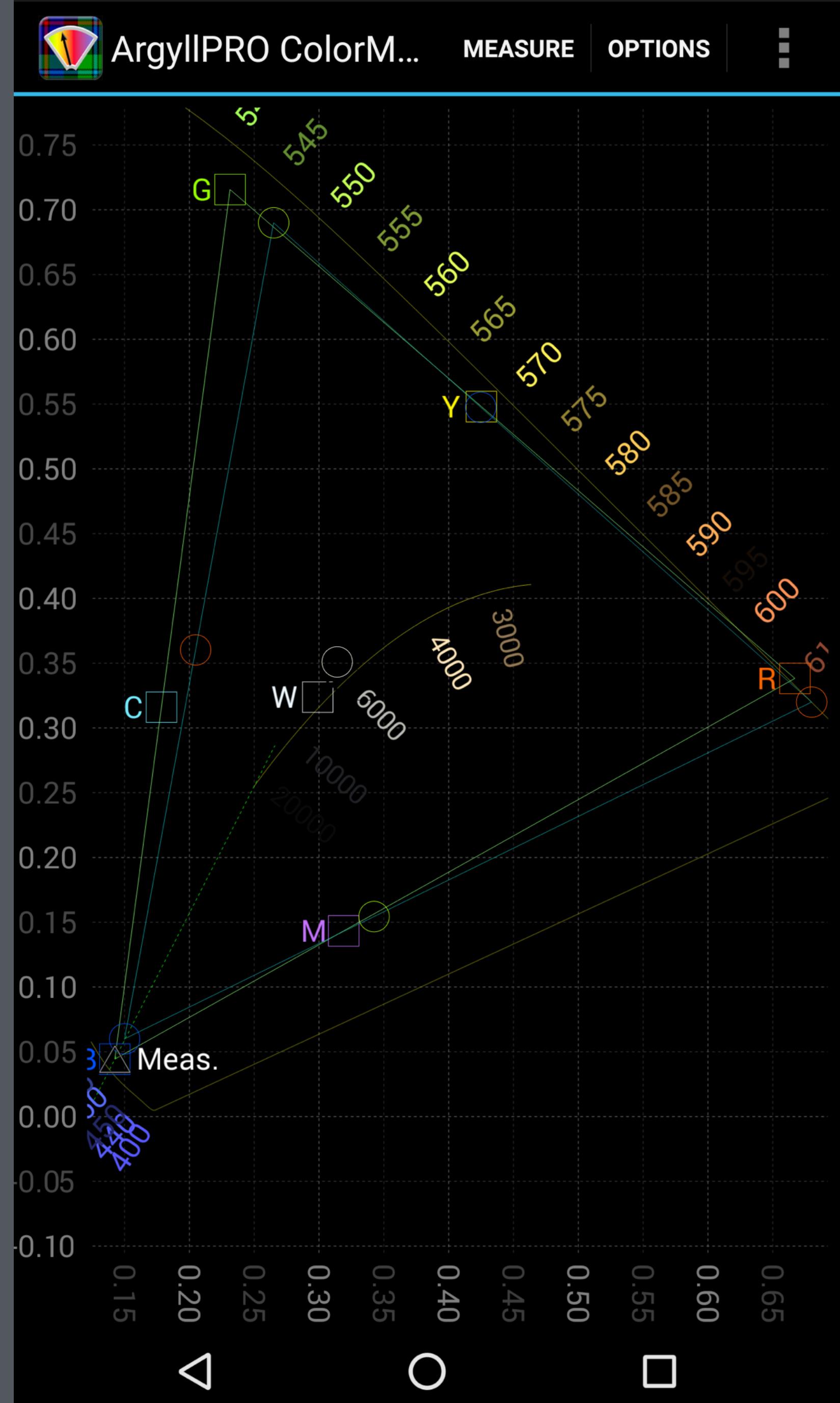
Photopic regime,  
practicalities

$500 > 1000$

**It's the future**

Proof-of-concept  
mobile demo

OLED is amazing



# Override brightness controls

"Hardware override"

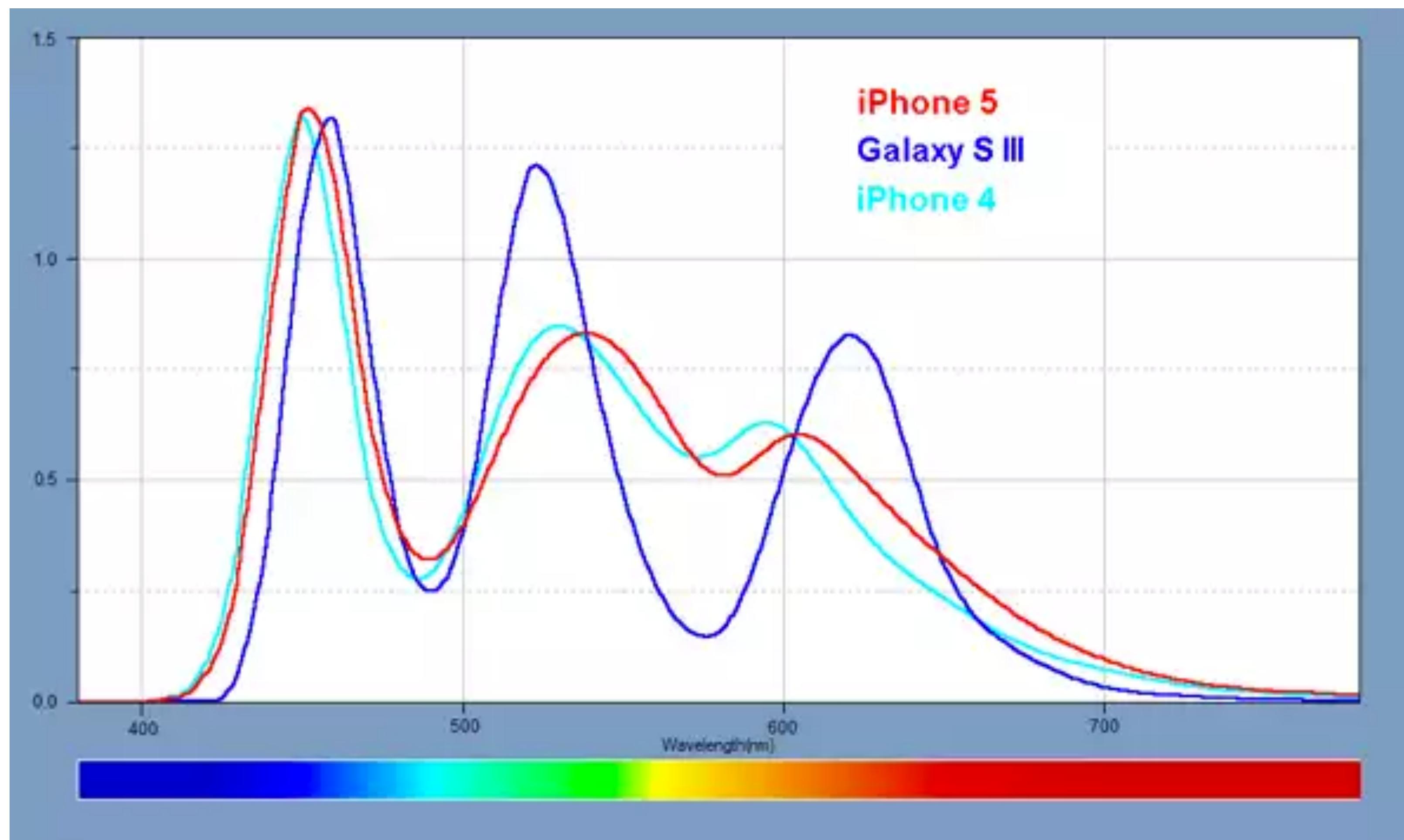
Dither like you mean it

Debanding is on its way

Characterize the mobile device

Get one with good  
spectral response

OLED and Q-Dot have  
sharp emission spectra



<http://tinyurl.com/a5qkaos>

(Yes, we are intending  
to publish this)

Manage a "power budget"  
for the viewer's adaptation

Here's the hard part

Get the user into  
a dark viewing environment

Android requires no permissions  
to access the light sensor

# **Producing content**

Shoot with a good camera

Record into a good format

Color grade on an  
HDR display

Render delivery formats  
with output metadata

**What's a good camera?**

We're not sure yet

You cannot use a GoPro.

The more precision,  
the better the results

Camera specs are annoyingly  
difficult to judge

More to say on this soon

**What's a good  
recording format?**

10-bit log,  
extended colour gamut

Better here makes your  
life easier later

CinemaDNG is particularly rad

AVC-Intra and the like  
are just fine

You do not need  
full Rec. 2020

# **Setting up a display**

Color-grading-compatible  
output card

BlackMagic  
Intensity Pro 4K

(I like BlackMagic)

**HDR TV**

# HDFury Integral

# InfoFrame

AVI InfoFrame  
sets up Rec. 2020

- RGB vs YCbCr
- Overscan
- Colorimetry
- Quantization range
- Active Aspect Ratio

HDR InfoFrame  
sets up transfer function and  
mastering metadata

- Transfer function
- Mastering display color primaries
- Mastering display brightness
- Content max brightness and max average brightness

Lie to it

InfoFrame calculators  
will hit the repo

Sony BVM-X300

The best display I've ever seen,  
period.

# **Sidebar: mastering metadata**

# MaxFALL and MaxCLL

Mastering display  
min/max brightness

Display RGB primaries  
and white point

Stringing this through media  
tools will be a *huge* pain

Everybody's mastering on one  
of three displays

"1,000 nit or 4,000 nit"

# **Footage**

We're filming a webseries!

Call around and ask  
for test footage

Rent a camera

Found footage  
[links in GitHub]

**Let's color grade?**

Load up Resolve

Configure pipeline to taste

Grade some content

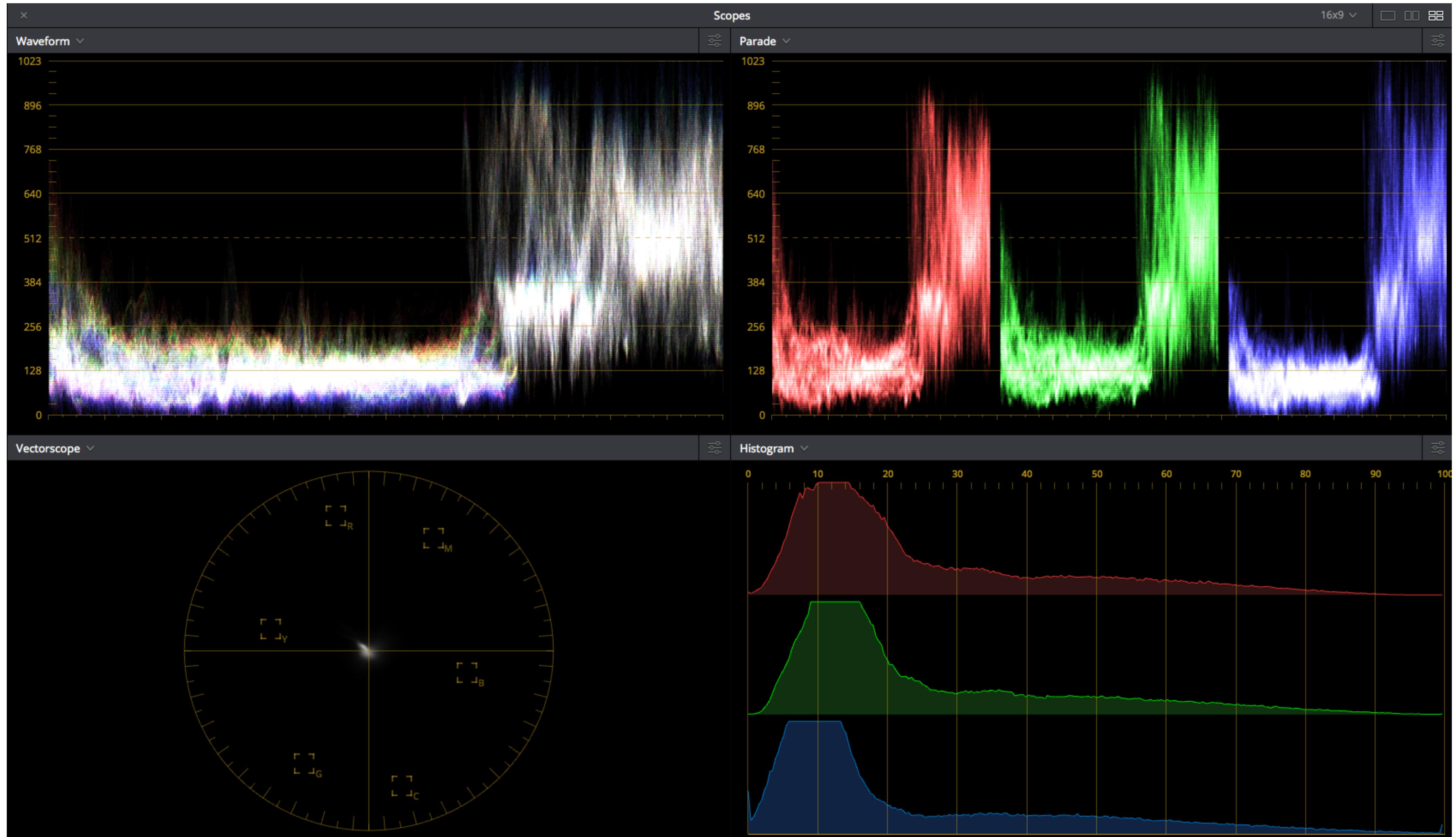
# Moral judgments

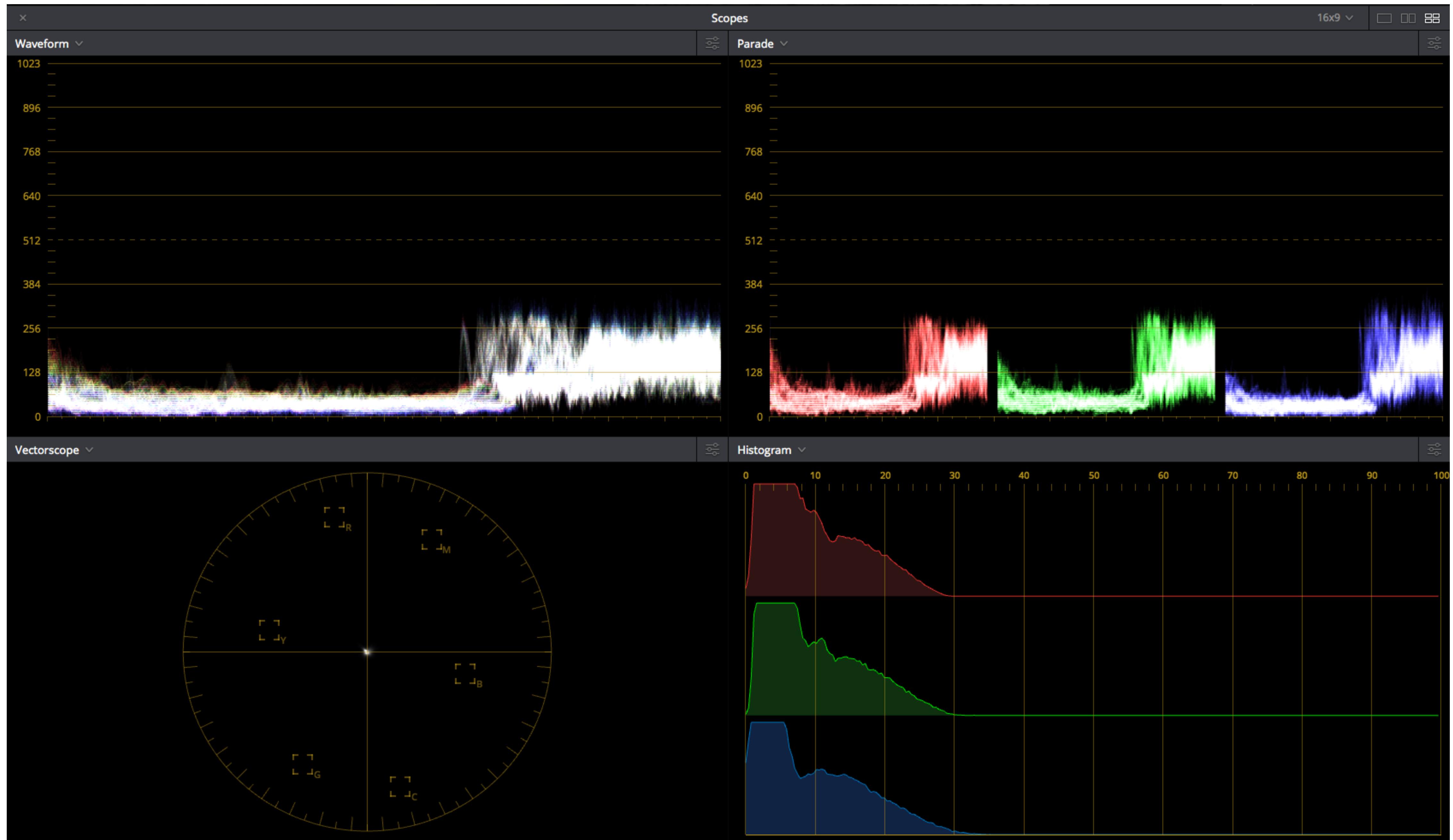
# ACES workflow

Resolve Color Managed

# Log vs Gamma

Where to put ungraded content





# **Metadata is important**

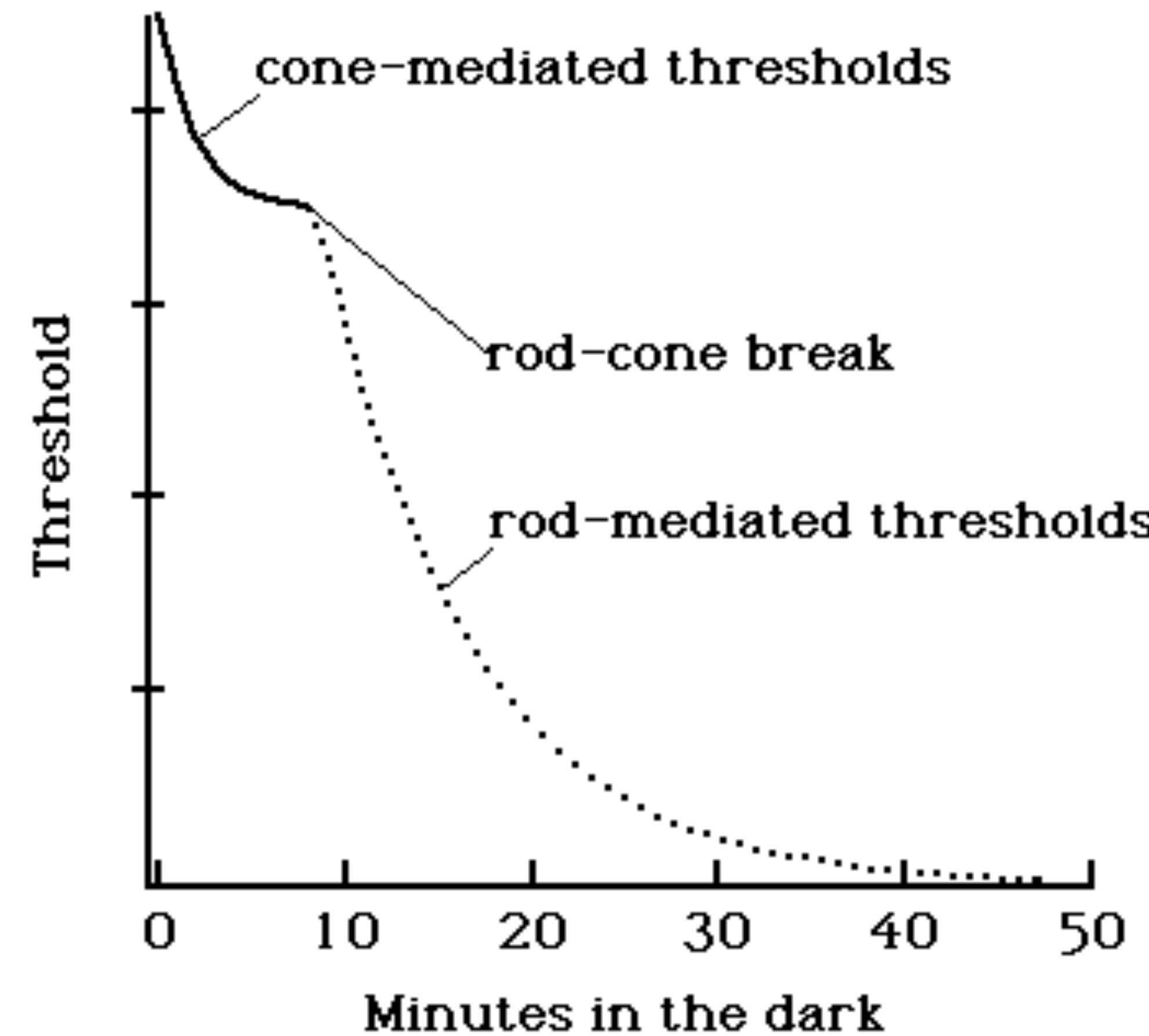
ID3 can't touch this

Test cards

Also appearing in the repo

**What looks good?**

Don't push it  
(the whole time)



# Biochemical factors



# **Export formats**

'nclx' atom

10 bits *at least*

ProRes XQ 4444

DNxHR HQX

CineForm

...raw YUV?

VP9 Profile 2

Hey, metadata!

It's not that slow

# **Delivery formats**

This stuff is fussy

We need new  
compression tunings

VP9 Profile 2

All of Samsung,  
many from LG, Hisense, others

# **Manipulating media**

NOTHING WORKS

# FFmpeg

```

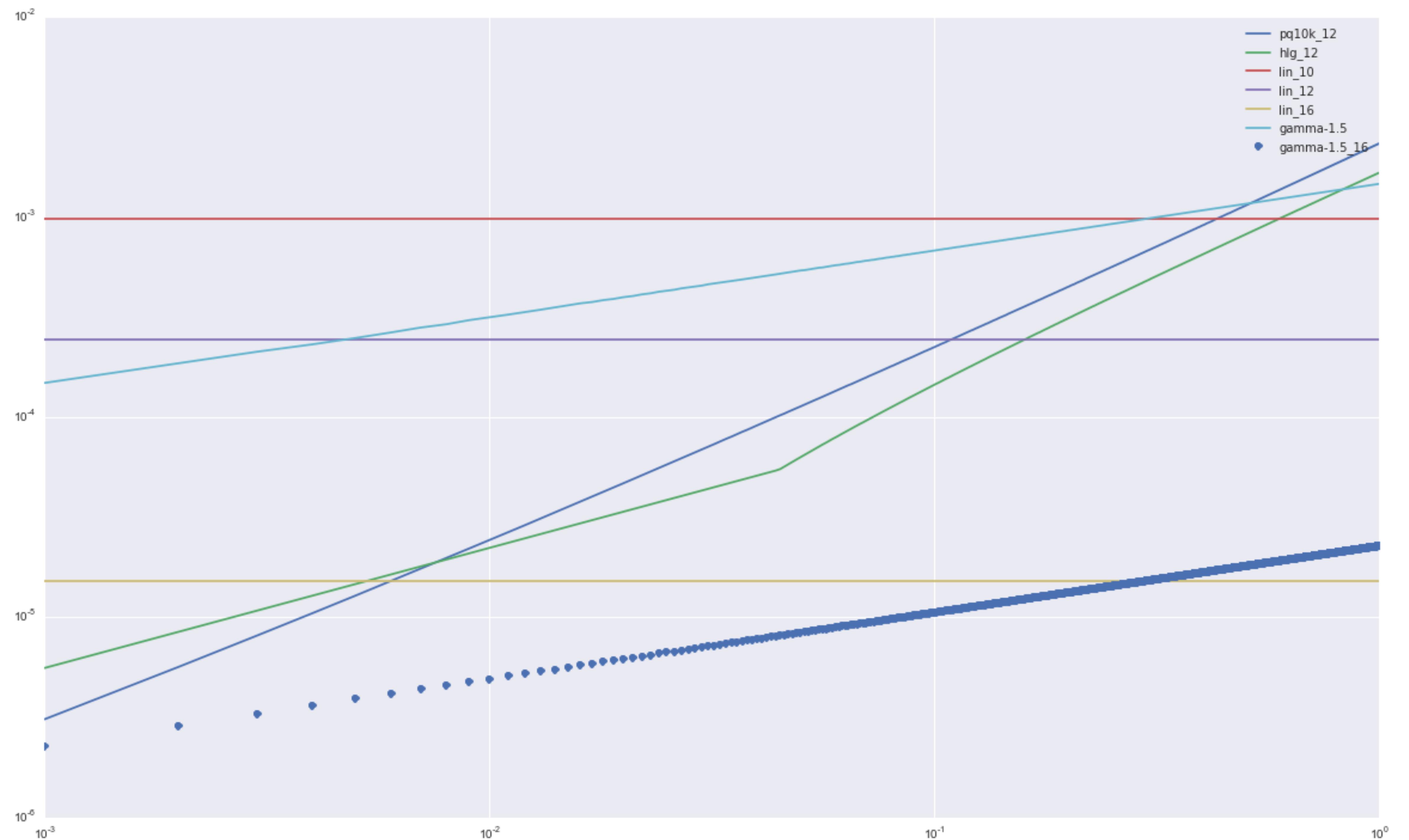
ffmpeg -ss 30 -t 10 -strict -2 -i NASA_render25_dnxhr.mov -c:v prores_ks -profile:v standard -vf
"format=rgb48le,lutrgb=(if(lte((pow(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/
(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",
(1/1.25))*12)\\"),1)\\",(0.5*pow(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/
(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",
(1/1.25))*12)\\"),0.5))\\",(0.17883277*log(((pow(((pow((max((pow((val/65535)\\",
(1/78.84375))-0.8359375)\\"),0)/(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))))\\",
(1/0.159301757812))*1000)/1000)\\",(1/1.25))*12)-0.28466892)))+0.55991073)*65535):
(if(lte((pow(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/(18.8515625-
(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",(1/1.25))*12)\\",
1)\\",(0.5*pow(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/(18.8515625-
(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",(1/1.25))*12)\\",
0.5))\\",(0.17883277*log(((pow(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/
(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",
(1/1.25))*12)-0.28466892)))+0.55991073)*65535):(if(lte((pow(((pow((max((pow((val/65535)\\",
(1/78.84375))-0.8359375)\\"),0)/(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))))\\",
(1/0.159301757812))*1000)/1000)\\",(1/1.25))*12)\\"),1)\\",(0.5*pow(((pow((max((pow((val/
65535)\\",(1/78.84375))-0.8359375)\\"),0)/(18.8515625-(18.6875*pow((val/65535)\\",(1/78.84375)))))))\\",
(1/0.159301757812))*1000)/1000)\\",(1/1.25))*12)\\"),0.5))\\",
((0.17883277*log(((pow((max((pow((val/65535)\\",(1/78.84375))-0.8359375)\\"),0)/(18.8515625-
(18.6875*pow((val/65535)\\",(1/78.84375)))))\\",(1/0.159301757812))*1000)/1000)\\",
(1/1.25))*12)-0.28466892)))+0.55991073)*65535),format=yuv422p10le" -y /Volumes/DiskHFS/
NASA_hlg_rt.mov

```

Nice little translator  
(also in repo)

# Linear light

Use Gamma 1.5,  
16-bit-per-channel RGB



# Color primaries



**COLOUR**  
colour science for python

If you know the primaries:

```
import colour, numpy as np

Samsung_RGB_to_XYZ_matrix = np.matrix(
    colour.models.normalised_primary_matrix(
        [0.6671, 0.3383, 0.2314, 0.7157, 0.1425, 0.0444],
        [0.299, 0.3238]))


Samsung_XYZ_to_RGB_matrix = np.linalg.inv(
    Samsung_RGB_to_XYZ_matrix)
```

LUT\_3D\_SIZE 64

0.0 0.0 0.0

0.0206128049935 0.0 0.000150818650564

0.0412256099869 0.0 0.000301637301129

0.0618384149804 0.0 0.000452455951693

0.0824512199739 0.0 0.000603274602257

0.103064024967 0.0 0.000754093252821

0.123676829961 0.0 0.000904911903386

0.144289634954 0.0 0.00105573055395

0.164902439948 0.0 0.00120654920451

0.185515244941 0.0 0.00135736785508

...

You'll lose metadata

You'll fight broken filters

Rec. 2020 doesn't work yet

I'd say just use Resolve, but...

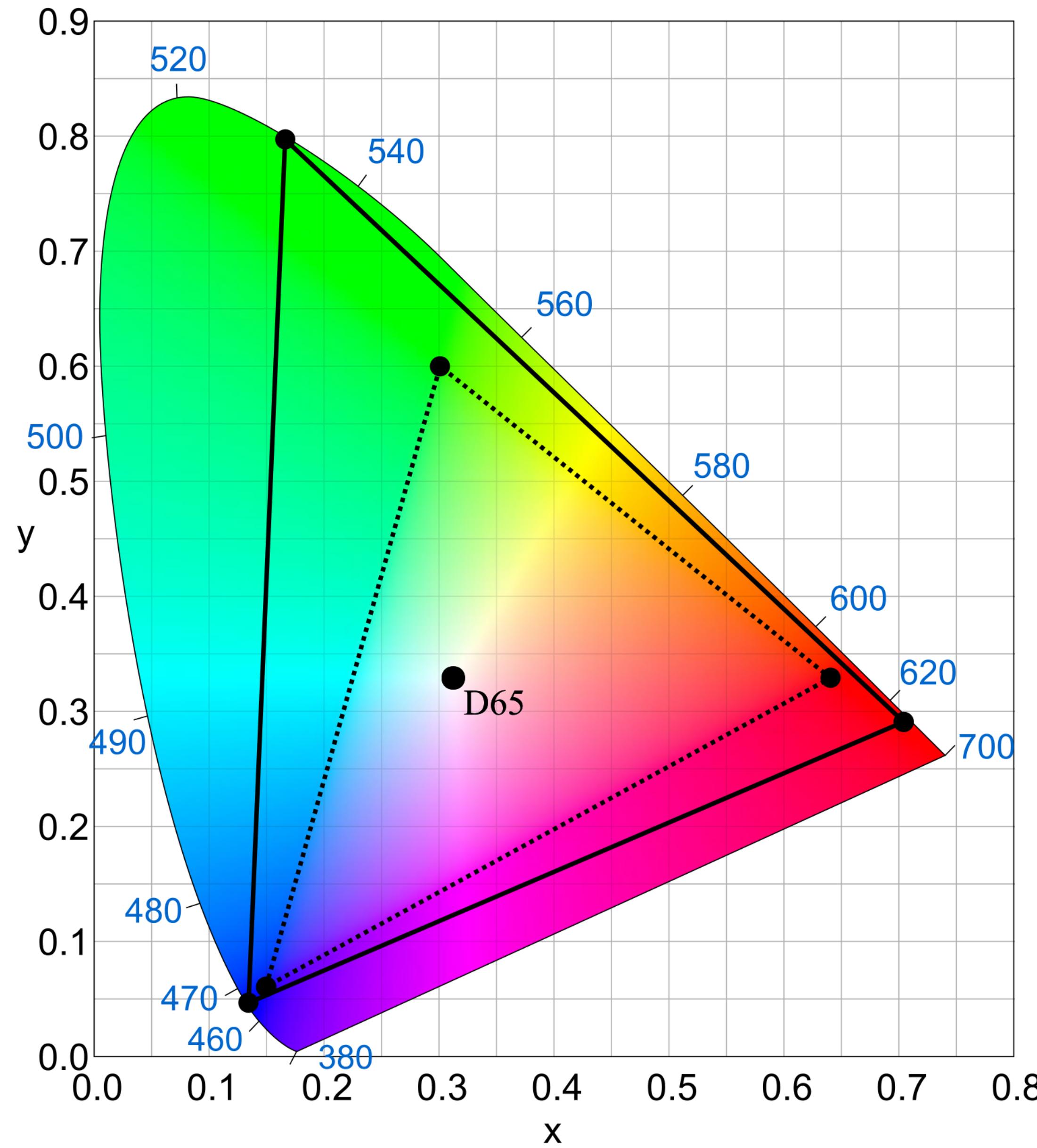
I'm writing an HDR filtergraph  
engine in PyCUDA

**Desktop eventually**

# Half-float output surfaces

Rec. 709, 100 nit nominal

# Going negative



Seems kooky,  
but really pragmatic

...except for that preposterous  
absolute-nits thing

# **YouTube's plans**

Few months away?

Fully launch TV  
Mobile in beta (maybe)

Android only, limited to  
devices we've characterized

Working extensively with  
YouTube Spaces

YouTube Originals

And, of course, me



strobe@google.com

<https://github.com/stevenrobertson/hdr-talk>