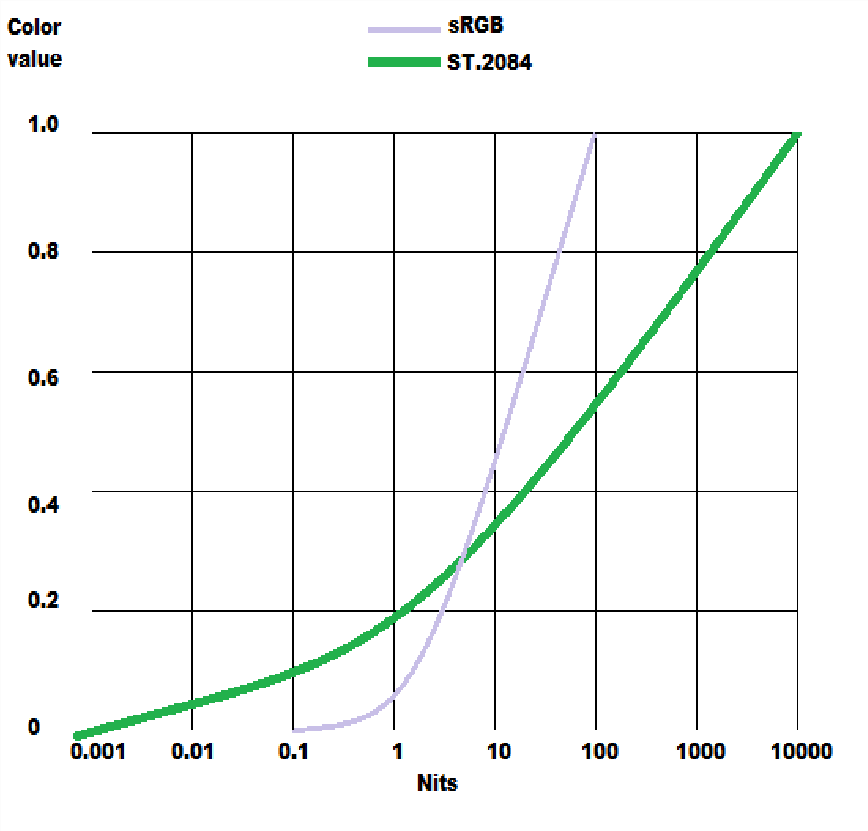
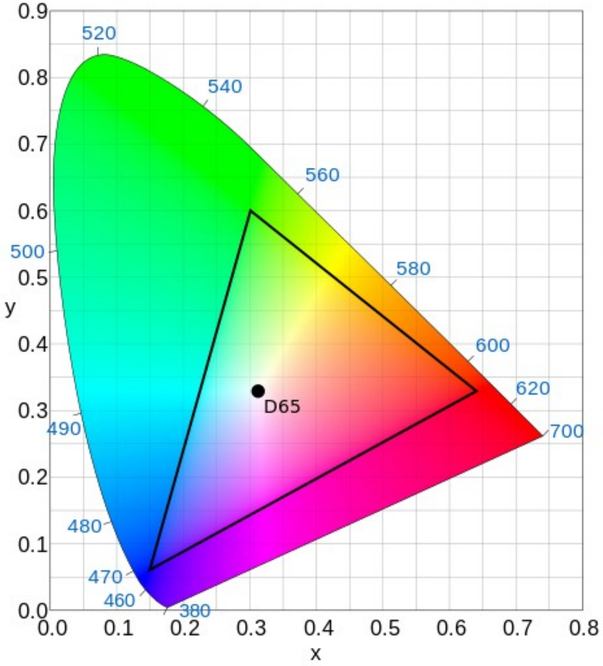
HDR Support In Krita

Boudewijn Rempt, boud@krita.org

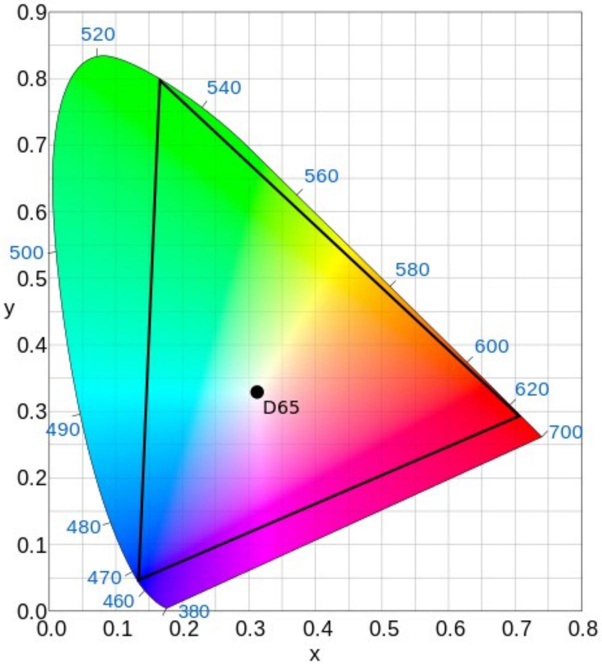
What is HDR: more nits



What is HDR: more colors

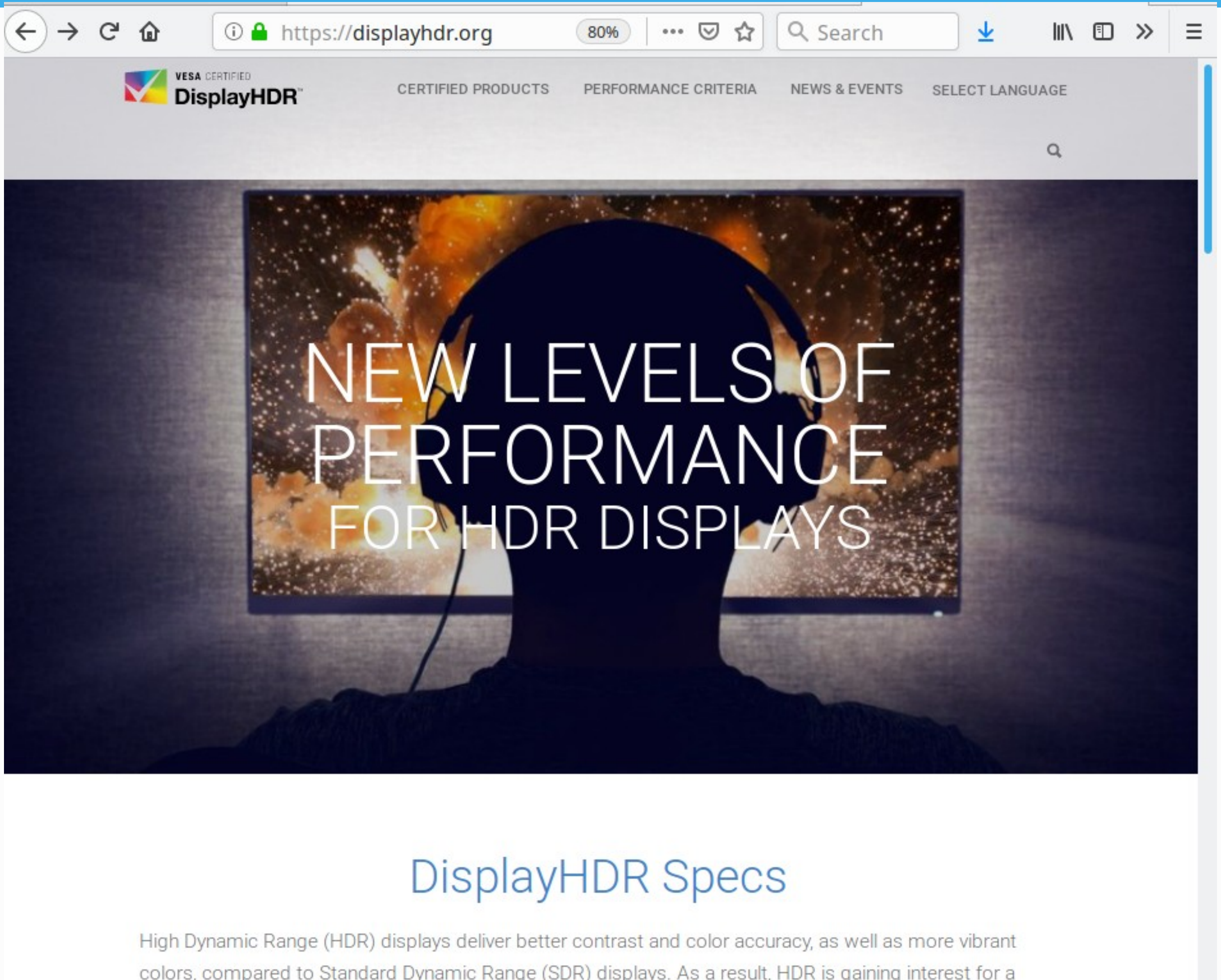


sRGB color space



Rec. 2020 color space
(spans much wider range of red and green colors)

OS Support, Devices, Standards and Specifications



NEW LEVELS OF PERFORMANCE FOR HDR DISPLAYS

DisplayHDR Specs

High Dynamic Range (HDR) displays deliver better contrast and color accuracy, as well as more vibrant colors, compared to Standard Dynamic Range (SDR) displays. As a result, HDR is gaining interest for a

What’s the deal for artists?

Let's watch an animation....

What do you need to get started

- HDR capable monitor
- a DisplayPort 1.4 or HDMI 2.0a or higher cable
- the latest version of Windows 10 with WDDM 2.4 drivers
- A PC with Intel Graphics and a 7th generation or later
- Intel® CoreTM processor.

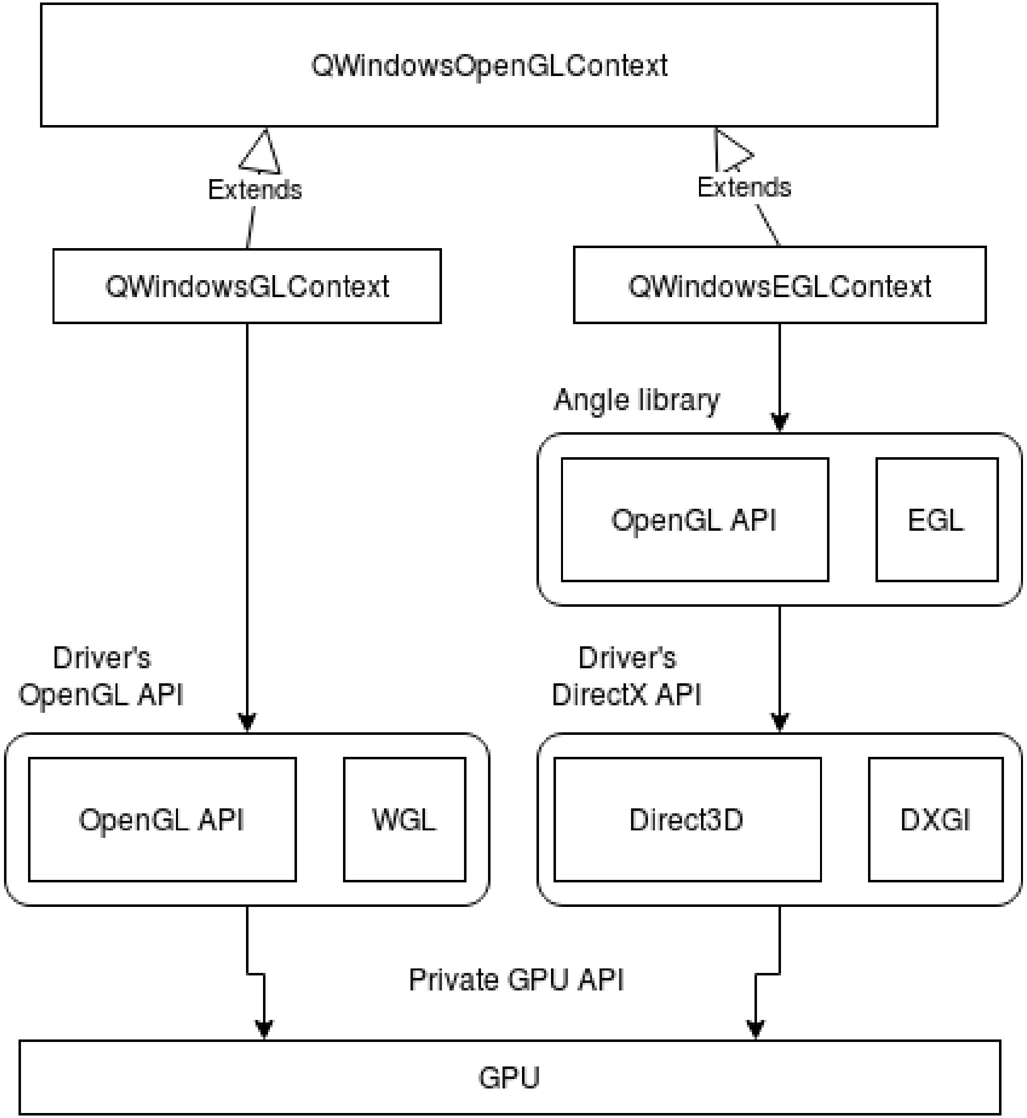
How to get started

- Switch the display to HDR mode manually, using the Windows settings utility.
- Select a default SDR brightness level to ensure that the screen display still looks normal.
- Configure Krita to support HDR. In the display settings panel, select the preferred surface (e.g. “Rec. 2020 PQ (10bit)”).
- In the Dockers menu, select the HDR-capable small colour selector.
- To create an HDR image, make a canvas using a profile with the Rec. 2020 gamut and a linear tone-response-curve. The appropriate profile for this is “Rec2020-elle-V4-g10.icc”.
- Do Art!

Saving, Exporting and Animating

- Save the work. Krita’s native .kra file format is a good way to save HDR images and can be used as the working format.
- For sharing with other image editors, use the OpenEXR format
- For sharing on the Web, use the expanded PNG format
- For exporting HDR animations, Krita supports saving HDR to the new codec for mp4 and mkv: H.265.

Hacking is such fun



Angle

We implemented 3 extensions to Angle:

- EGL_KHR_gl_colorspace — allows switching the surface into sRGB color space (also implements auto gamma correction of texture and framebuffer samplers)
- EGL_EXT_gl_colorspace_scrgb_linear — allows switching the surface into scRGB color space
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Patching Qt’s QTextureFormat

```
 // set main frame buffer color space to scRGB
QSurfaceFormat fmt;
// ... skipped ...
fmt.setColorSpace(QSurfaceFormat::scRGBColorSpace);
QSurfaceFormat::setDefaultFormat(fmt);

// create the app (also initializes OpenGL implementation
// if compiled dynamically)
QApplication app(argc, argv);
return app.exec();
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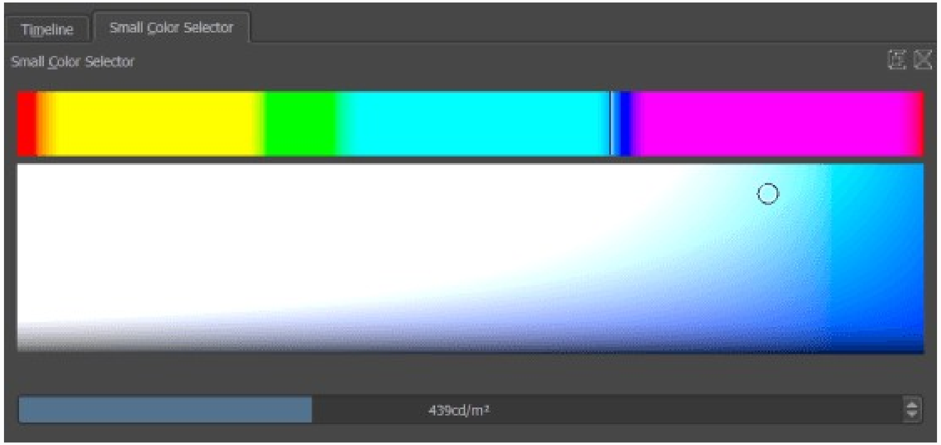
And of course...

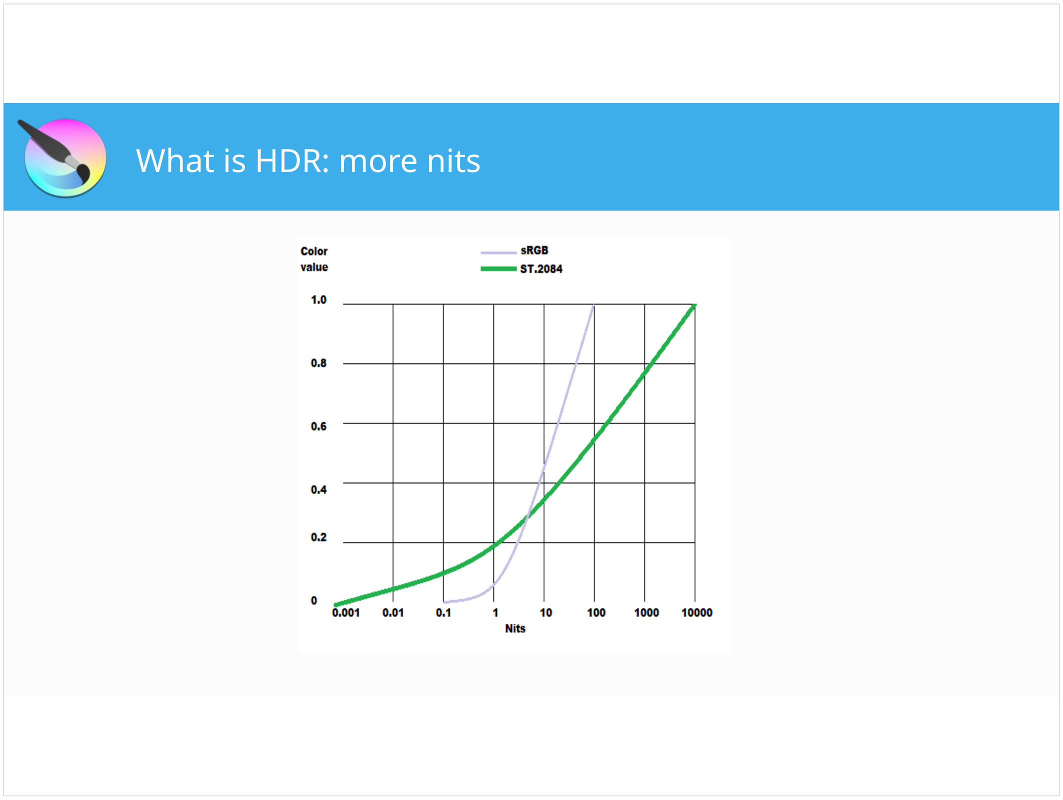
- You need a color selector



What the future brings

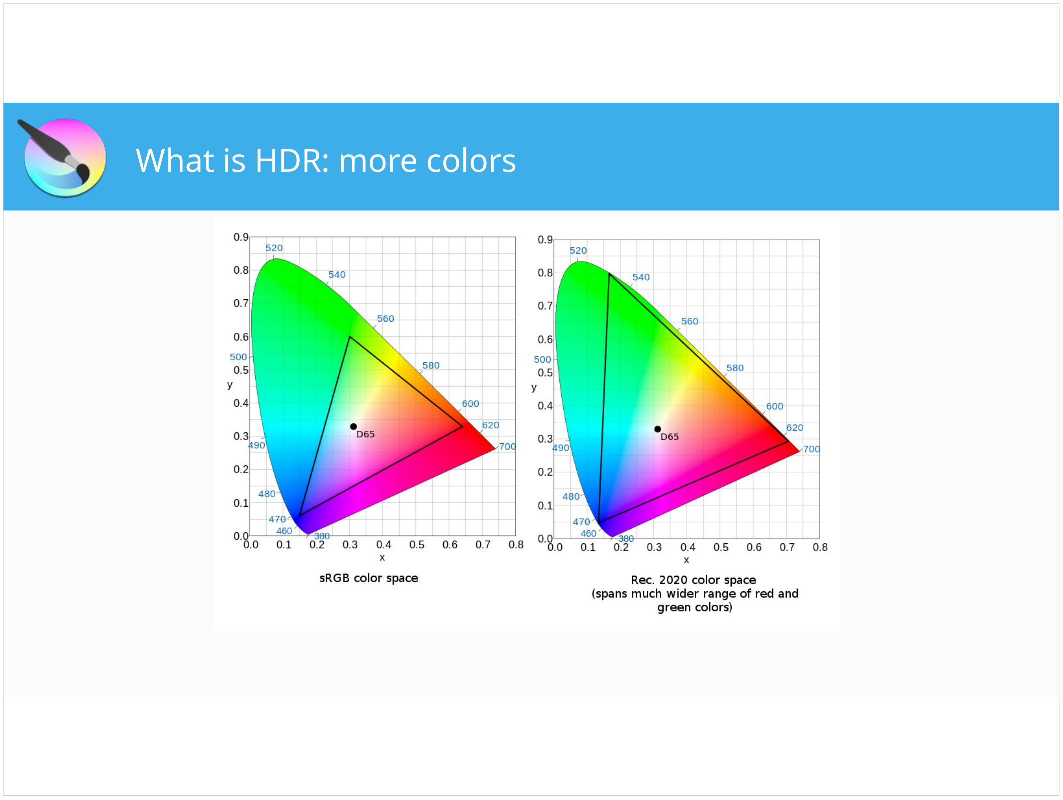
Questions?

- First off: HDR is **NOT** what you think: it’s **NOT** multiple exposures squashed into an ugly image. If you’re doing tonemapping you’re **NOT** doing HDR.
- When doing HDR, ICC-based color management becomes totally irrelevant, because…



What is HDR: more nits

- With real HDR, screens can realistically depict sources of light. For example, they can show the life-like effect of a sun beam piercing through a window instead of a ubdued, paper-style imitation. Whereas conventional screens are limited to a few hundred “nits” of brilliance, HDR screens can achieve 1,000 nits or more.



What is HDR: more colors

sRGB color space

Rec. 2020 color space
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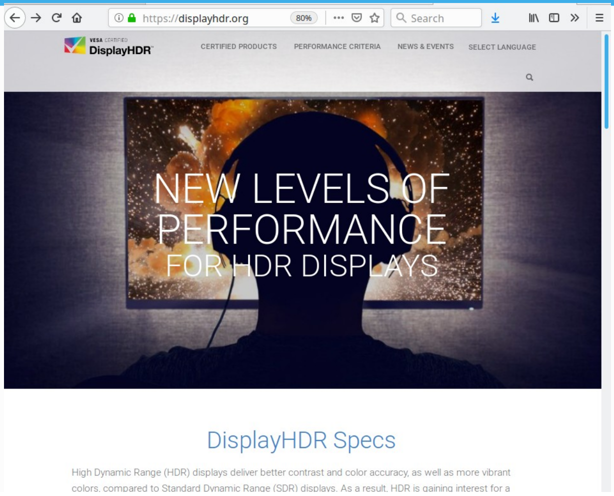
By comparison, HDR standards typically define 10 bits per pixel with some rising to 16. This extra capacity for storing information allows HDR displays to go beyond the basic sRGB colour space used previously and display the colours of Rec. 2020 (also known as BT.2020). This colour space offers a significantly richer gamut of colours, notably with many more variations of greens, blues and reds.

For artists, it’s like phtalo blue, cadmium red and viridian green got discovered again

OS Support, Devices, Standards and Specifications



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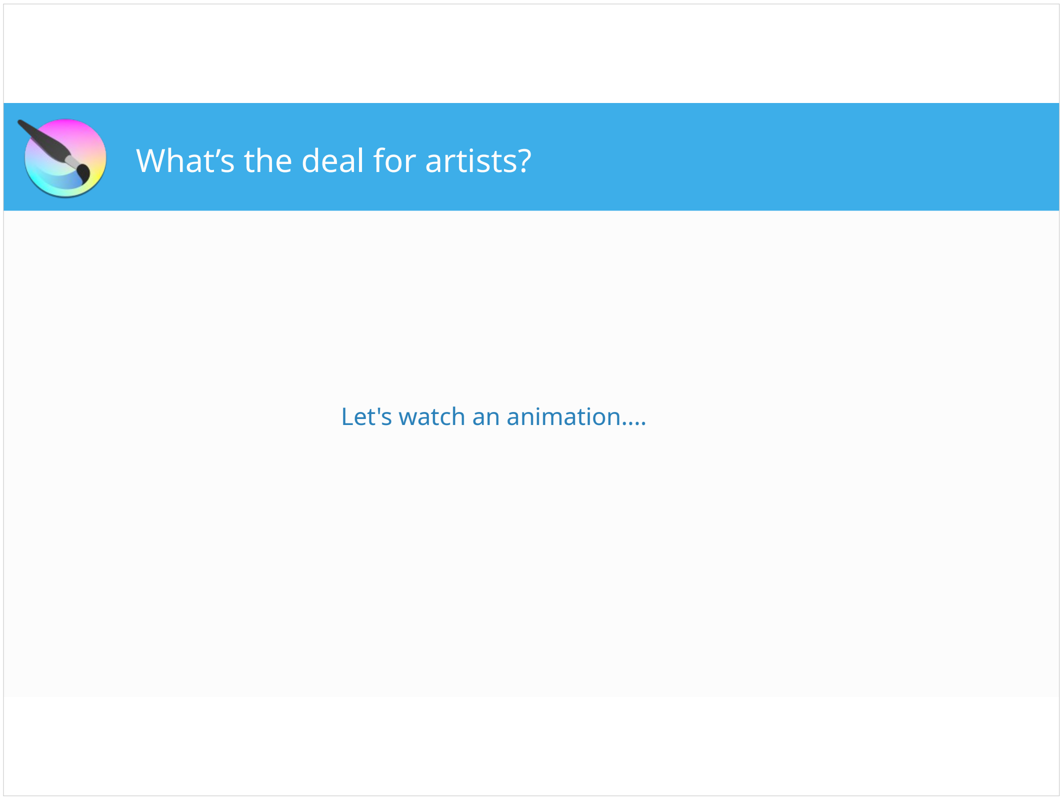
The number of certified monitors is increasing rapidly, and the first HDR 400 certified laptop (Dell XPS13) has been announced.

Currently, only Windows 10 has API for working with HDR monitors. Intel is working on Linux support as well.

There are some competing standards, like Dolby HDR, but only Vesa HDR is relevant for computers and content creation applications: so don’t get taken in by Lenovo with their Dolby HDR Thinkpad X1 laptops. Not the real deal!

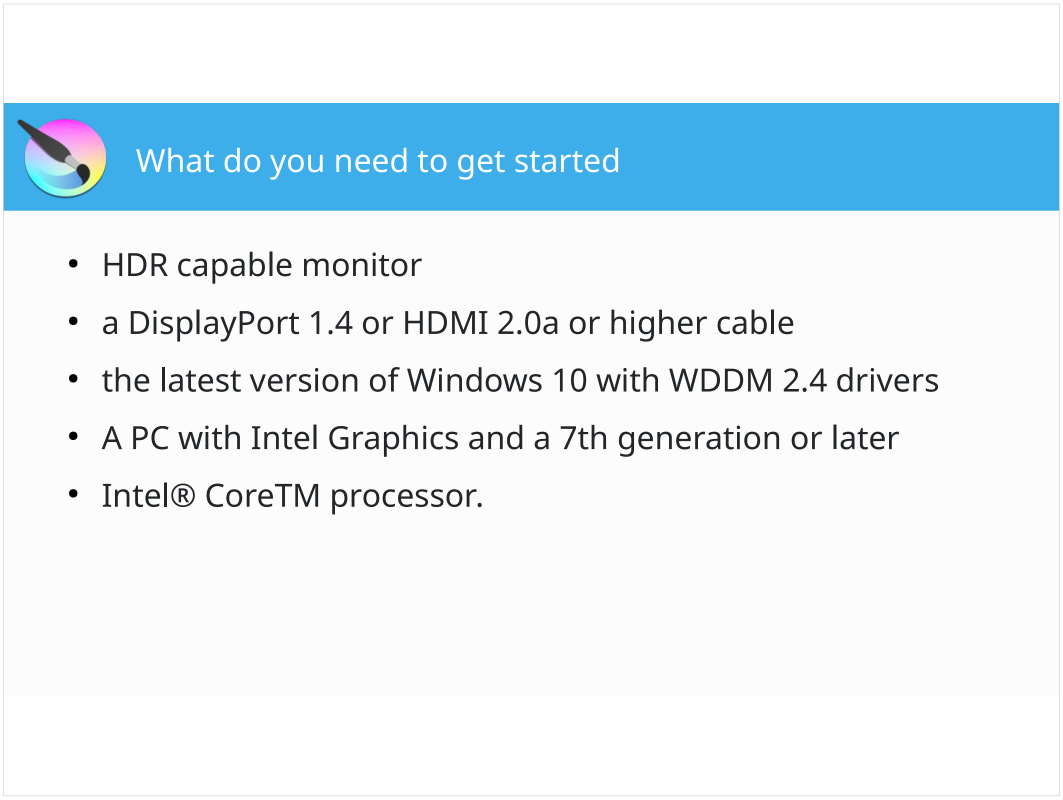


What’s the deal for artists?

Let's watch an animation....

For almost the last 30 years previously, artists could only expect that their monitors offered the display capabilities of normal paper. Displays were calibrated to look like a sheet of white paper illuminated by a source of light matching the D65 standard (the equivalent of average midday light in Western/Northern Europe).

Now, high dynamic range (HDR) technology has changed the situation significantly. HDR displays are not limited to emulating paper. They can display the brightness of real sources of light. For example, they can show the brilliance of a sun beam piercing a window, instead of just a paper-style replica of the sunbeam.



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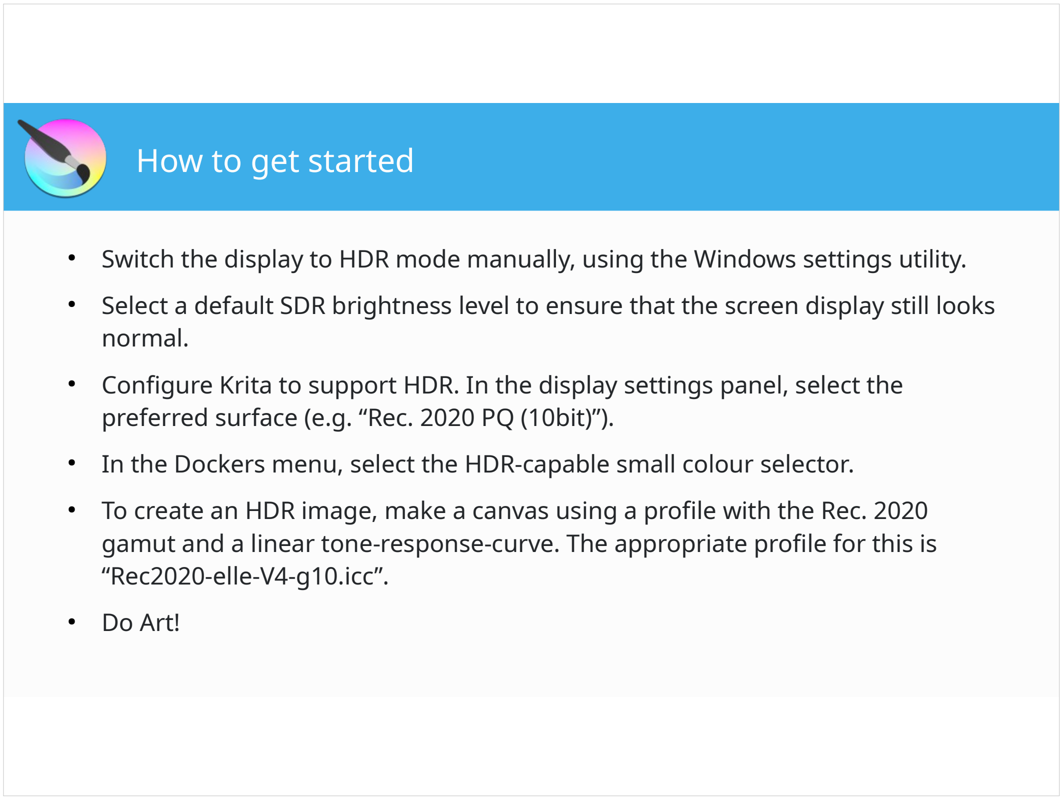
HDR capable monitor, a DisplayPort 1.4 or HDMI 2.0a or higher cable, the latest version of Windows 10 with WDDM 2.4 drivers and a PC with Intel Graphics and a 7th generation or later Intel® CoreTM processor.

Nvidia works, too, no idea about AMD. Be prepared for compatibility hassles; some Asus monitors don’t work with some Intel systems, it’s pretty immature still.



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- Do Art!

The act of painting in HDR is great fun, you can literally paint with light.

On a theoretical level, an HDR image could be constructed as display referred instead of scene referred, that is, you paint the light as it is in the scene, not to the extent of what the display allows.

There are always limits, though, the sun is, after all, quite a bit brighter than 1000 nits.

But you’re not painting the reflection of light anymore, but light.

Saving, Exporting and Animating

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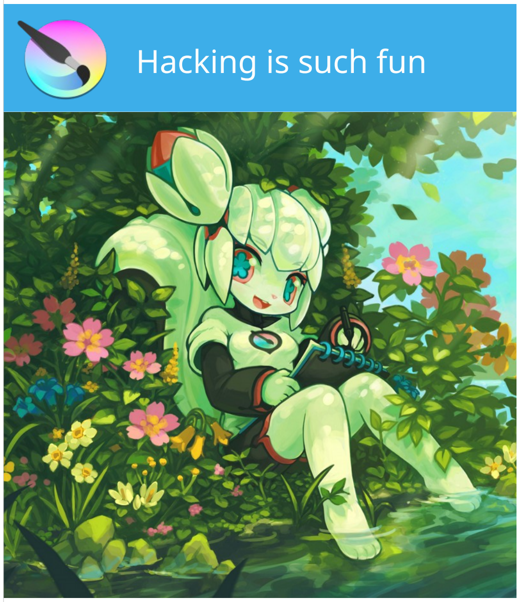
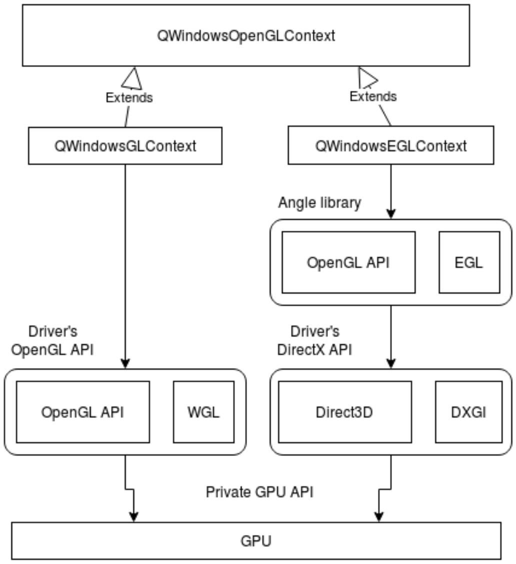
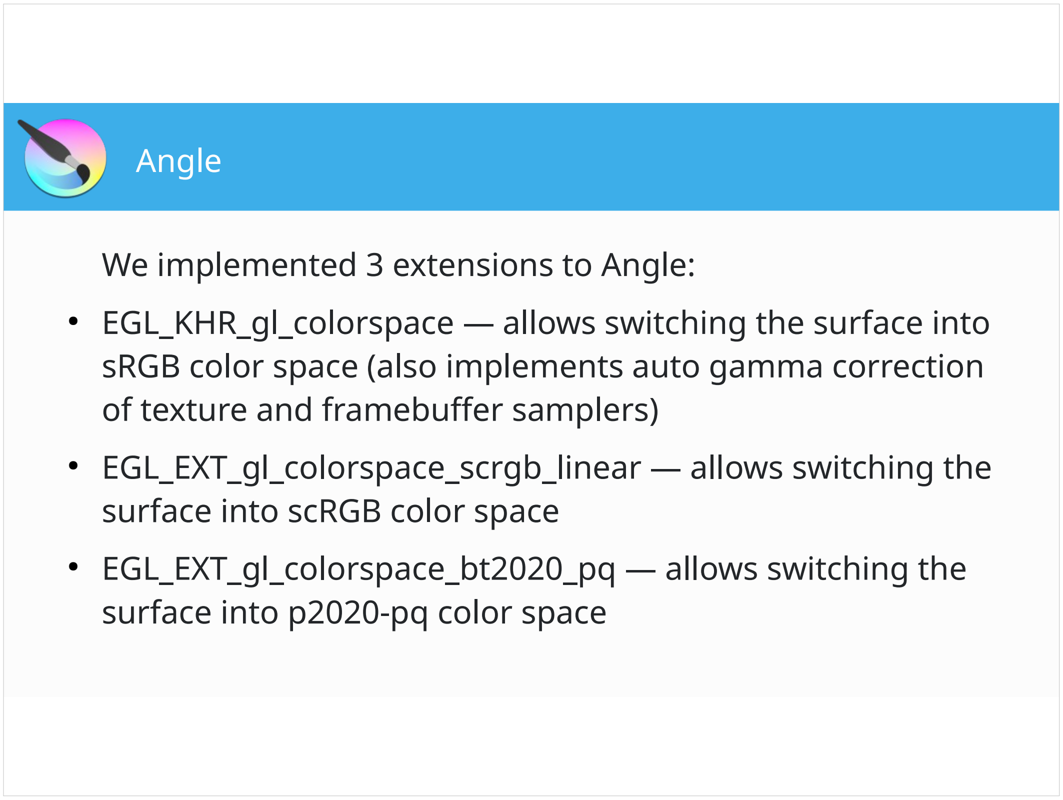




- Create a DXGI swap chain with 10-bit or 16-bit pixel format
- Set the color space of that swap chain to either p2020-pq (for 10-bit mode) or scRGB (for 16-bit mode).
- Make sure all the intermediate textures/surfaces are rendered in 10/16-bit mode (to avoid loss of precision)
- Since the GUI is usually rendered on the same swap chain, one should also ensure that the GUI is converted from sRGB into the destination color space (either p2020-pq or scRGB)



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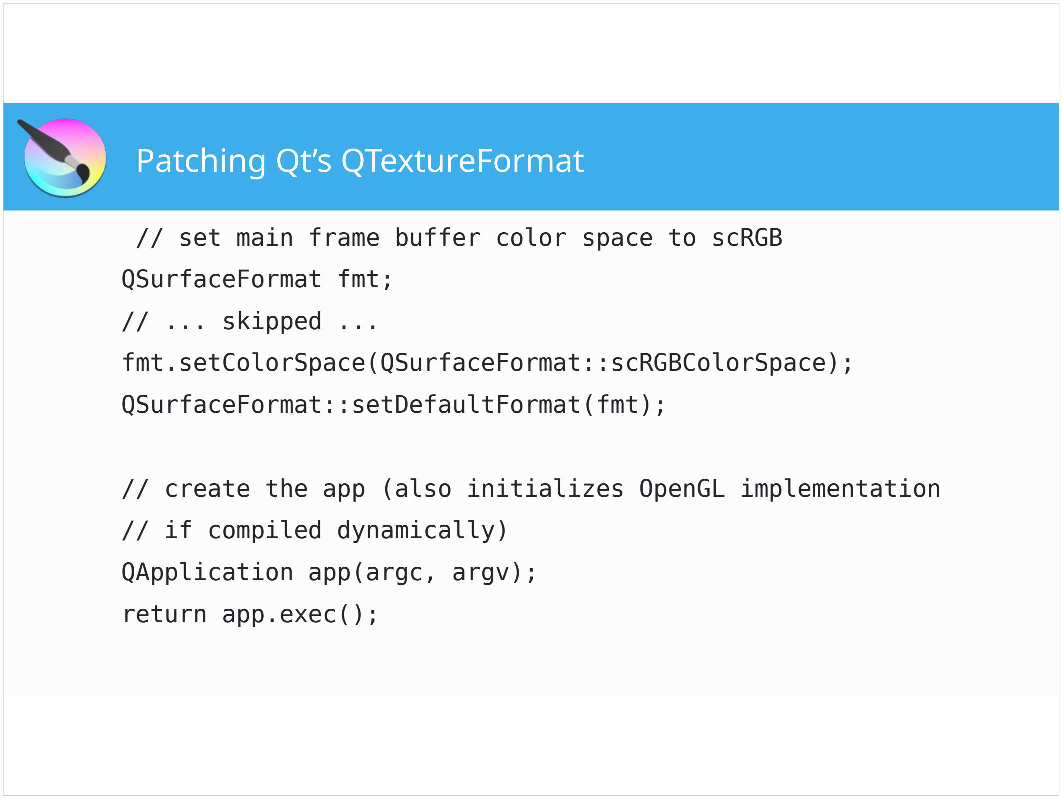
When displaying colours, HDR displays do not use traditional exponential gamma correction. Instead, they use a function called Perceptual Quantizer (PQ) which extends the dynamic range to both sun-bright and very dark values.

HDR images are standardised to use the Rec2020 gamut, and the PQ tone response curve (TRC).

However, a linear TRC makes it easier to edit images, so we decided to convert to PQ only when users were satisfied with their work.



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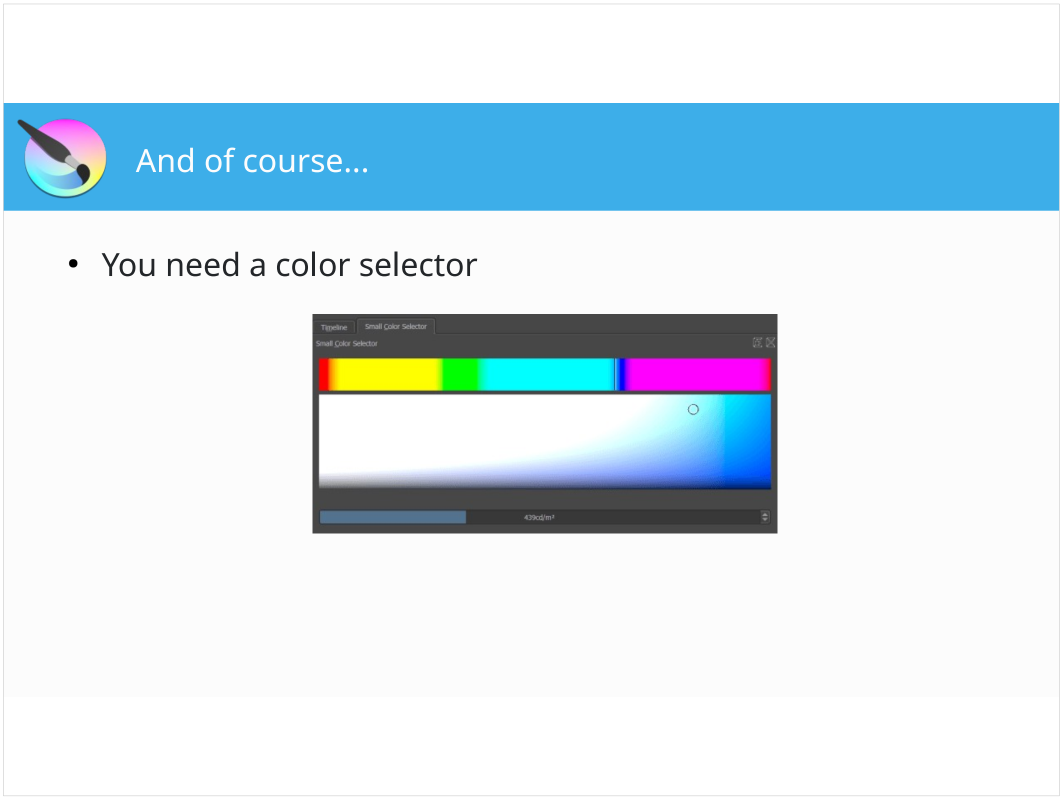
Basically, the first task was to modify the createWindowSurface() method to support colour space selection. In the user code the colour space now can be passed via the default surface format:

Then we had to make sure that everything rendered with QPainter – buttons and widgets and so on, were converted from sRGB to the display colorspace at the right brightness level.



And of course…

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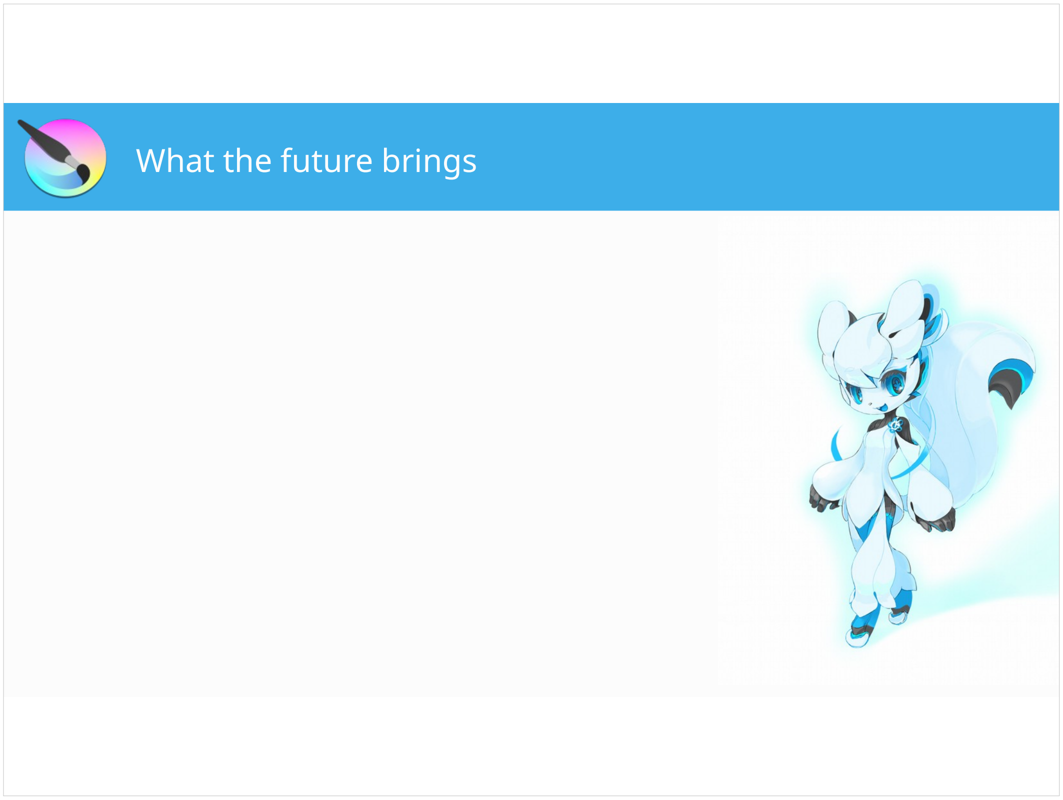
Another challenge was to fetch display information. Windows' API provides information about the connected display, its colour primaries, white point and HDR capabilities. But to fetch this info means knowing which HMONITOR handle is connected to which Qscreen object. To do this, the team implemented an extension to QWindowsNativeHandleInterface.



What the future brings

- Linux – macOS probably never
- More hardware, more mature OS support
- Getting our patches merged upstream
- Fixing bugs and adding features, like HDR gradients, making the filters work properly with HDR, fixing some blending more bugs and so on. After 4.3!