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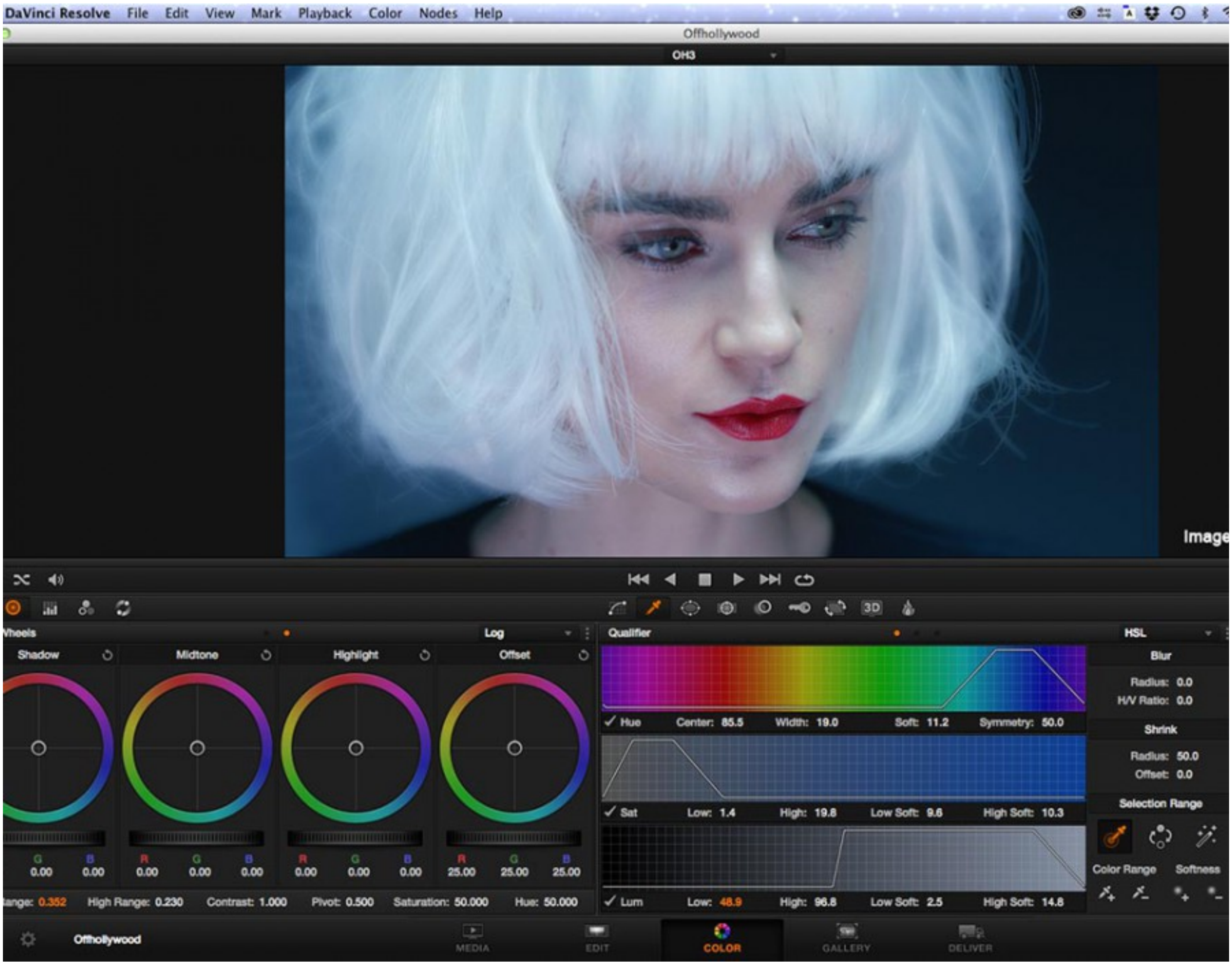
WHAT COLOUR IS THAT TEMPERATURE?



While most of us eventually absorb enough folk wisdom to deal with colour tempe are some aspects of it that simply aren't intuitive.

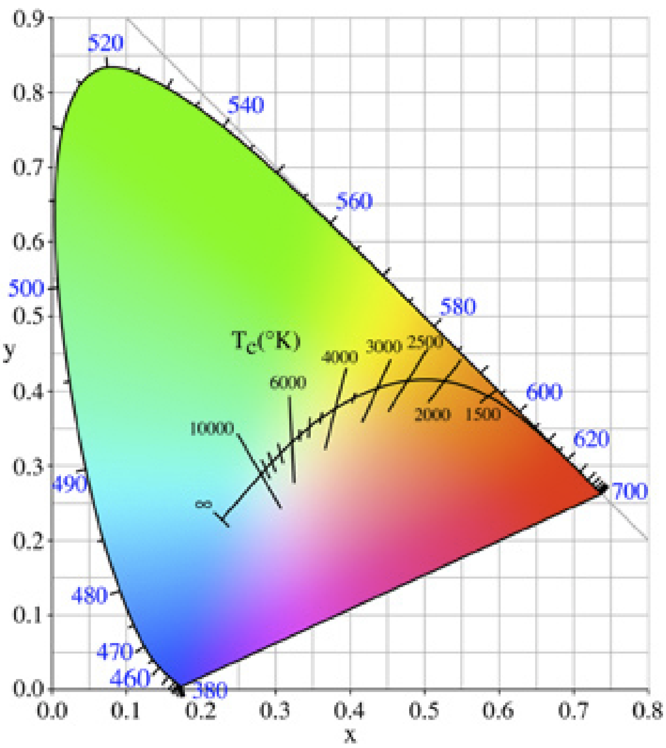
By Andy Ciddor

Why does the colour of light get cooler as the colour temperature increases? If Lee 201 Full converts 3200K tungsten light to 5700K daylight, why do two layers of 201 (or one layer of 200 Double CT Blue) convert the same 3200K light to 26,000K? Is it actually possible to pre outcome of combining correction filters?

Colour Temperature describes the colour (but not the brightness) of a light source by comp the colours of light emitted by a standard object at a known temperature. We are all familia happens as you heat up a piece of metal. Initially the metal gets too hot to touch, but not ho glow. Heat (infrared radiation) is being emitted, but as yet no visible light. Next, the metal st deep red colour as it is now emitting visible light at the low energy
end of the spectrum. As the temperature of the metal increases further, the energy of the e also increases; progressively adding the higher energy wavelengths of the spectrum and ch colour of the metal from orange, through yellow, to increasingly whiter light. However, in th objects, as things get hotter, sooner or later they melt, oxidize, vaporize or catch fire. This m hard to plot any simple curve relating a wide range of actual physical temperatures to light

To solve this problem, a theoretical object named the Black Body Radiator was devised. It is of the light emitting properties of a wide range of materials that can be heated until they glo is black, so that it has no reflective properties. Physicists have plotted the colours of light th emitted from this object at temperatures ranging from the theoretical Absolute Zero point molecular activity ceases) to infinity.

The temperature scale used for these measurements is Kelvin, which has absolute zero (-27 starting point, and like the familiar Celsius scale, uses centigrade degrees as its steps. On th water freezes at 273.15 degrees (0°C) and boils at 373.15 degrees (100°C). The unit for me colour temperature is not the degree however, it's simply the kelvin (K). For example, the cc temperature of the DXX lamp in a Readhead is 3200 kelvin. This doesn't mean the tungsten lamp is at a physical temperature of 3200°K. What it actually means, is that the colour of th from the Readhead's lamp matches what would be emitted by the Black Body Radiator heat temperature of 3200°K.



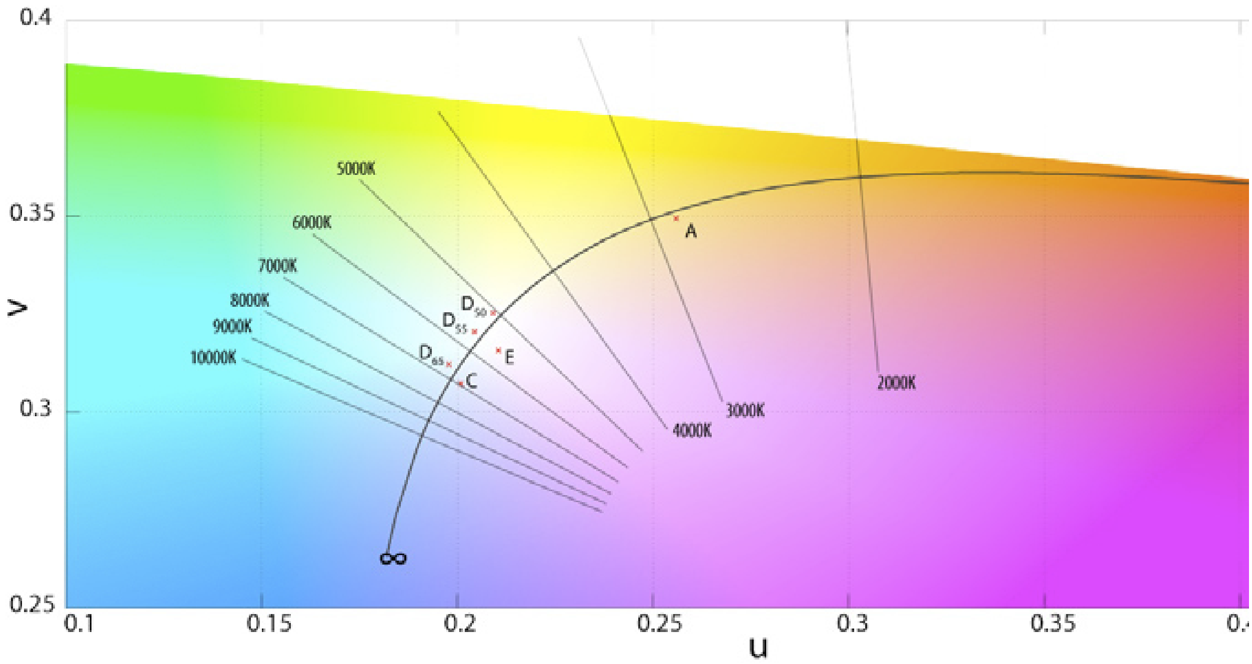
CIE Chromaticity Chart showing a plot of the colours of light emitted by the Black Body Radiator as it is heated to infinity °K. This path is known as the Black Body or Planckian locus.

BUT IS IT ART?

Colour temperature terminology has nothing whatsoever do with the way that colour is des world of art. Whether or not you have any recollection of art lessons, you were almost certa introduced to the notion of Newton's colour wheel and complimentary colours at some poi education. Frequently included with this view of colour comes the eighteenth century artist warm and cool colours. In this framework, the low energy colours — reds, yellows and orang considered Warm and Visually Active, while the higher energy blues and greens are classifi Visually Passive. Unfortunately, this view of colour is the total opposite of the relationship b

and physical
temperature in light sources.

As the temperature of an object rises during heating there are more high energy wavelengt greens, mauves and violets) in the light it emits, so the light looks whiter or 'cooler' in artistic terminology. In short: physically hotter equals artistically cooler. What could possibly be more straightforward?



A more detailed view of the Black Body locus showing some familiar colour temperatures and s illuminants. (Image source: Wikipedia)

THE KELVINATOR

Colour temperature corrections and conversions form an important part of the process of i production and image capture, in a wide range of AV applications. Here at V&F we consider so important that we will be covering it in depth in a future article. Once you venture outsid matching the light from a tungsten halogen lamp at 3200K, and nominal daylight at 5500K/ temperature correction starts getting a bit weird.

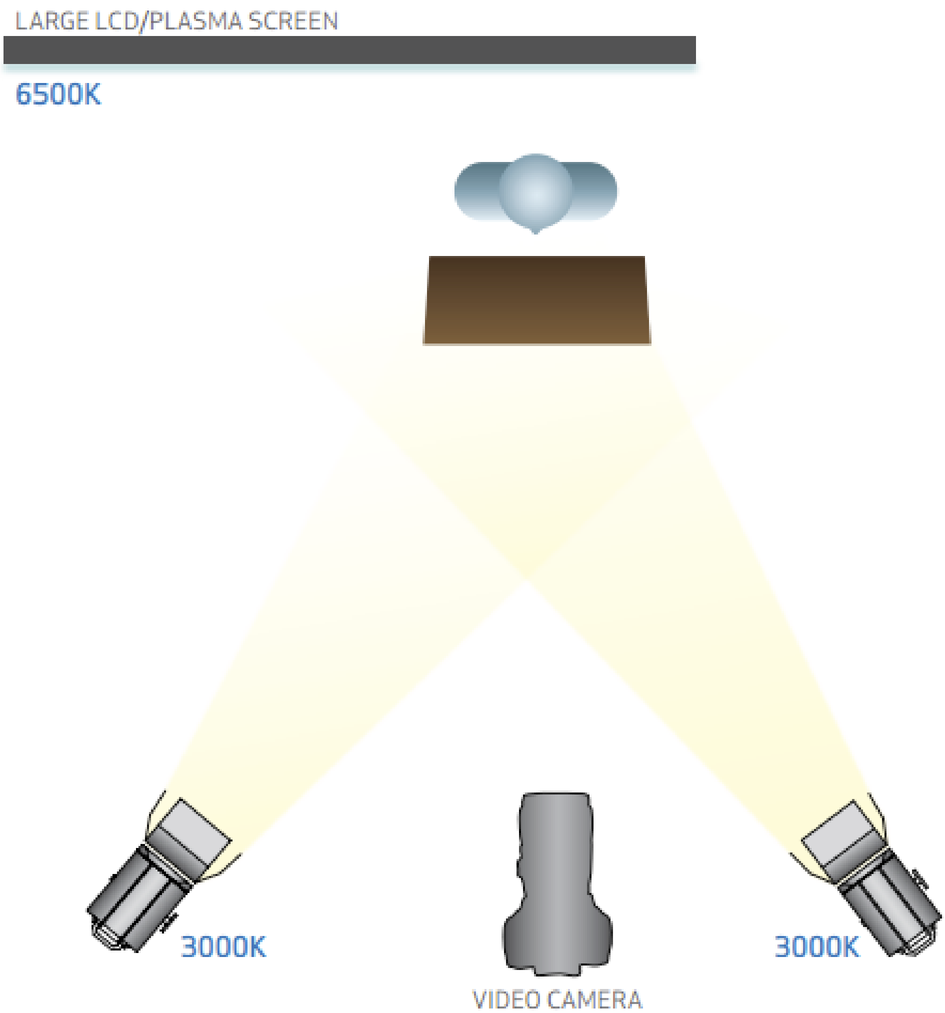
As you can see from the accompanying plot of the colour of light emitted by the Black Body during heating, the proportions of the colours emitted don't follow a simple straight line. Cc filter that removes specific colours for colour temperature matching, will have very differer depending on the colour temperature of the originating light source. This is why the same C Temperature Blue) filter that converts 3200K light to 5700K, will convert a 5700K source a to 26,000K, or a standard household lamp at 2000K up to only 2750K.

MIRED IN HISTORY

The worlds of photography and cinematography long ago hit on a useful, if not entirely strai technique for handling colour temperature corrections by working with mireds (see 'The M

Mired' below). Using this method, every colour temperature is converted to its mired value the correction factor of each filter is expressed as a mired shift with a positive or negative s the direction of the shift. The mired shift is listed in the manufacturers' swatch books and o websites. A negative shift value indicates that the filter increases colour temperature (it's a while a positive mired shift indicates that the filter lowers colour temperature (it's an orang

It's important to be aware that mired shifts differ between brands of what may appear to be correction filters. Rosco Cinegel CTB (#3202) has a mired shift of –131, while Lee 201 CTB 137. Cinegel Roscosun CTO (#3407) has a mired shift of +167, while Cinegel Roscosun 85 (also referred to as CTO) has a mired shift of +131. And just to be completely different, the C range (204) has a mired shift of +159. Equipped with a simple calculating device and a filter we can now take a starting colour temperature and a desired destination colour temperatu a little basic arithmetic, we can calculate which filters will give us the desired correction. Let's consider an everyday application of this process.

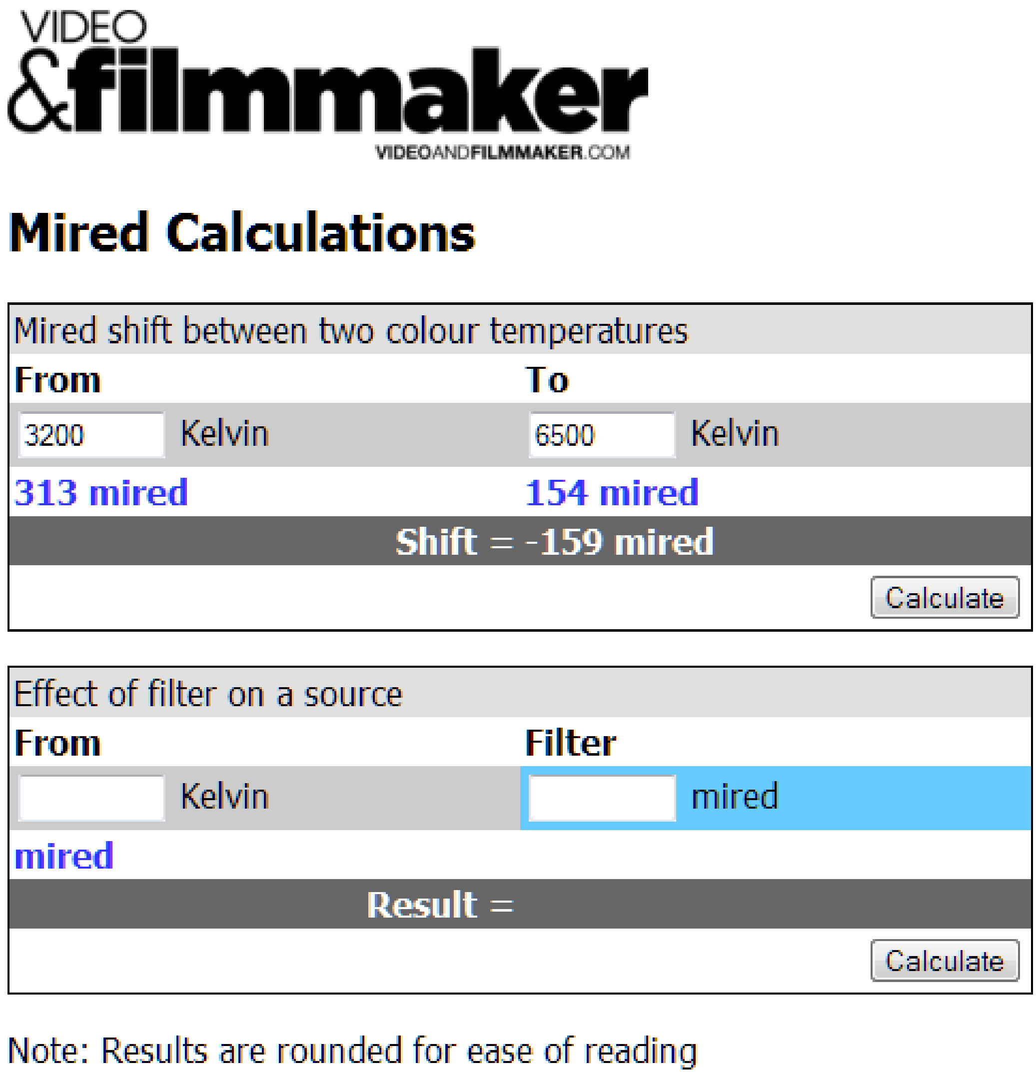


TEMPERATURE PRACTICALITIES

If we need to capture the image of a presenter at a lectern pointing to details on a nearby pl display screen, we not only need to match light levels between the presenter and the screen to match colour temperatures. This will avoid the common problem of the screen looking bl presenter looking orange. Then we can correctly expose and white balance the camera capt image. If there are a couple of profile spots (or theatrical fresnels) covering the lectern, they converted from their native 3000K up to the (approximately) 6500K of the plasma/LCD scr plasma/LCD screen will generally be colour adjustable somewhere in the range of about 65 SMPTE standard for television displays) to 9500K. The higher colour temperature settings because viewers seem to prefer cooler, bluer whites, even if they attain them at the expens colour representation.

To achieve our colour match we have a starting point of 3000K or 333 mired and a desired 6500K or 154 mired. To make this conversion we need to apply a correction of approximate (333 minus 154) in the blue or minus direction.

No single filter will do the job, but a combination of Lee 201 CTB (–137 mired) and Lee 203 mired) will be sufficiently close (–172 mired), with a resulting colour temperature of approximately 6200K. The camera will need to be configured for use in daylight, then white a reference card or alignment chart illuminated by the corrected 6200K light sources.



(http://www.videoandfilmmaker.com/scripts/mired_calcs.php)

Click image to open our Mired Calculator, its a good idea to bookmark this for later reference.

DIY - THE EASY WAY

To simplify the mired calculation process there is a mired calculator (link)(http://www.videoandfilmmaker.com/scripts/mired_calcs.php) that we've made available. It calculate temperatures and colour temperature differences in mireds. It also calculates the colour temperature resulting from placing correction filters over a given light source.

There is a calculator with similar capabilities on the Lee website, (link(http://www.leefilters.com shift-calculator.html)) that goes as far as suggesting which filters from the Lee range will give th correction. Be warned that some of the results it returns include the use of correction filter types of light sources which are totally unsuited to our application. Colour correction for lig don't match the curve of the Black Body Radiator, such as LEDs, fluorescents, arcs, and met halide discharge (including HMI, MSR, CID), is a can of worms that will be opened in a forthc for V&F. However, for the moment it remains a world of pain and confusion that we will avo

THE MAKING OF A MIRED

The relationship between the temperature of the Black Body Radiator and the proportions of light it emits, turns out to be a reciprocal function. Thus, by working with the reciprocals temperatures, we get a reasonably simple method for calculating the effects of colour corre light sources.

As revision for those who were traumatised for life by fractions at primary school: the recip number is one divided by that number or 1/n. The reciprocal of 2 is ½ or 0.5, and the reciproc 1/500 or 0.002. As the reciprocals of large numbers are small numbers, using the reciprocals colour temperatures produces fiddly results with several zeroes after the decimal point. Fo reciprocal of the 3200K from our tungsten halogen lamps is 0.0003125, hardly a number th to memorisation or a quick calculation on your mobile phone. Hence the choice to use mirec reciprocal degrees (one million divided by the colour temperature) for photographic applica

After rounding, tungsten light's 3200K is a manageable 313 mireds. Some physicists with no do than annoy a lot of already confused people, have suggested that we drop the name mire the SI standards-compliant term 'reciprocal megakelvins' (MK-1). Thus far the suggestion h ignored by the industry.

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