cinema TECHNOLOGY

www.cinema-technology.com

cinema technology & business publication › VOL.37 NO.3 › AUTUMN/WINTER 24

THE FLIGHT OF CINEMA

How flying 4D cinemas are bringing the thrill of theme parks to the big screen

Proudly a Carbon Neutral Publication › Supporting One Tree Planted.

Safeguarding IT Systems
> Cybersecurity in the modern cinema.

UK Cinemas Face Music Rights Battle
> Proposed new tariffs cause major concerns.

AI in the Cinema Ecosystem
> From production through to exhibition.

CTC

An official publication of IMIS INTERNATIONAL MOVING IMAGE SOCIETY powered by BKSTS

LASER ILLUMINATION IN CINEMA

PART 1

The use of electronic devices in cinema and the large screen projection world has been around for decades. In fact, Laser Projection has existed for over 30 years although in a different form to today. In this new series, we'll explore laser projection and the impact and challenges it presents across the entire cinema ecosystem.

Peter Wilson and Kommer Kleijn, IMIS Fellow Emeriti.

Formal digital cinema has existed since around the year 2000 when standardisation discussions started in earnest. The Hollywood Studios took a great interest in this and created the DCI (Digital Cinema Initiatives) to create a common requirements specification for their content to be shown. DCI (www.dcimovies.com) was launched in 2002 and still updates its website when technology advances enabling new features.

The Standards Authority chosen to generate Digital Cinema Standards is the SMPTE (Society of Motion Picture and Television Engineers) https://www.smpte.org/ of which I am a life Fellow. Kommer is also a Fellow. This is an American organisation run under ANSI Rules (American National Standards Institute) https://www.ansi.org/ . The Jurisdiction of SMPTE Standards is USA only even though they are voluntarily in common use worldwide. The finished SMPTE Standards are also passed through the International Standards Organisation (ISO) so in fact they have become International Standards. So, in a nutshell the committee work is carried out by SMPTE and the generated Standards Documents are then fast tracked through International Organisations. The result of this is that there is essentially one system in use worldwide for mainstream Digital Cinema of a consistently high standard.

Standards bodies do not necessarily reinvent the wheel and often use or refer to other authorities / bodies. For example, D-Cinema Standards use NIST (National Institute for Science and Technology) specifications for security systems and CIE1931 (Commission Internationale d'Eclairage / International Commission on Illumination) for colour reproduction. So why this series of articles? As we'll explore in more detail in future articles, there are rumours of colour discrepancies between what is seen by the Director in the Colour Grading Suite and what is showcased in mainstream cinema. This goes against the grain of the whole rationale of Digital Cinema and the process of standardisation. This issue seems to coincide with the introduction of Narrow Band Laser Illumination Technology in both cinemas and Colour Grading Suites. The rumours have steadily gathered pace so it is important to understand why this may be happening and what can be done to ameliorate the effect.

Why are Narrow Band lasers promoted for big screens?

Although initial investment can be higher, primarily there is a big advantage in power consumption and maintenance costs › with the additional benefit that the maximum light output for a single projector can be higher compared to lamp-based projectors. The downsides to Narrow Band Laser Illumination are Coherent Light Speckle and Metamerism (showcased in the June 2024 edition of Cinema Technology Magazine) where colours can appear different from more traditional projectors and also different between individual people. Both effects were known about for many years, although doubts existed about their extent.

What has gone wrong? Well, for one, when the reference Colour Space was noted in CIE1931, lasers did not exist so no measurements were made with Narrow Band Primary Laser light sources, essentially monochrome colours so their effect on metamerism in human vision and measurement techniques was not well understood back then (1931). Furthermore, as narrow band colour light was not part of nature during evolution, it may cause unexpected reactions in the human visual system.

For the technical description of the multiple issues embedded in this problem, we pass to Kommer Kleijn, an IMIS life member, SMPTE Fellow and Honorary member of IMAGO (International Federation of Cinematographers https://www.imago.org/). Kommer was Chair of the Imago Technical Committee for many years as well as a regular contributor to the EDCF Technical Module which I chaired for many years in the early days of digital cinema and its standardisation.

RGB laser light in cinema projection

On March 8 2024, an IMAGO ITC (Imago Technical Committee) meeting was held on the subject of issues cinematographers and colour graders had noticed with the use of RGB laser D-cinema projectors. I was asked to provide some explanations, as I have been following this subject for some time now as both an audio visual perception researcher and a cinematographer. Ahead of the meeting I attempted to prescribe the issues. CT

Issues

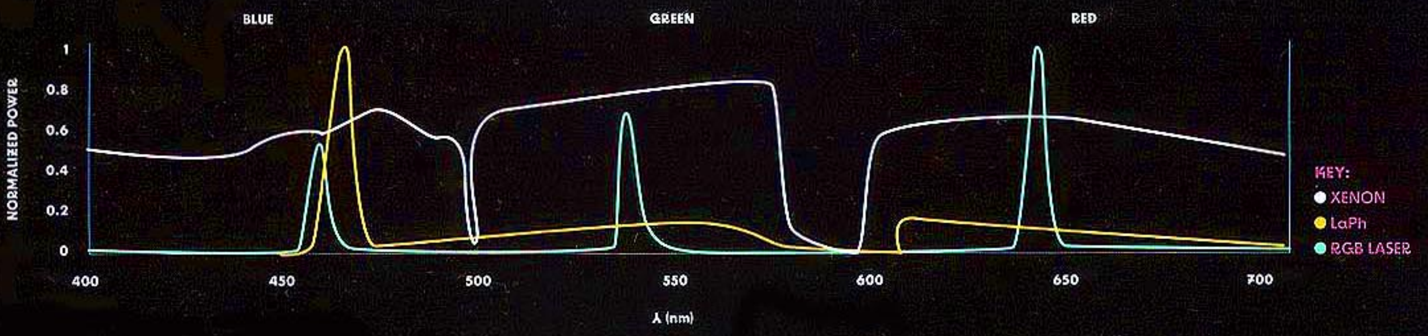
When the change from film projection to digital presentation first came about, much attention was given to guaranteeing continuity to filmmakers that their creative decisions about colour and contrast would remain unaltered in the commercial cinema theatre, as had been the case with analogue film projection.

With electronic projection, it was feared that, like with television, individual projectors would be each adjusted differently and that movies would look different on projectors using different imaging technologies, as there were at that time DLP (Texas Instruments Digital Light Processor), DILA (JVC Digital Image Light Amplifier) and SXRD (Sony Silicon Crystal Reflective Display) imagers with Xenon (xenon gas arc lamp) and UHP (Ultra High Pressure Mercury) light sources. Great care was taken to alleviate all the concerns and the filmmakers' community was assured that movies would look exactly the same on all current and future projectors and systems. To practically realise this, a series of technical measures were taken which were among others disabling access to the contrast, saturation and black level settings on the projectors and the design and adoption of a new DCP file format that defines "to be perceived colours" (XYZ coordinates in the CIE1931 diagram) rather than RGB values to steer the projector. This file format defines what must be seen, and not how the projector must be steered. Projector steering then is calculated on the fly by the projector itself, with the manufacturer taking responsibility for calculating the correct steering needed for the correct colours to be seen. Now colour rendering becomes independent from the physical projection technologies used.

All decisions are done in the grading room and should reproduce in every commercial cinema with precision. This given promise has been a condition for the filmmaking community allowing them to embrace digital projection, a promise that has been kept quite well for a number of years. I think this is worthy of serious congratulations to all involved in cinema presentation, equipment manufacturers, standardisation, and filmmaking.

Now, decades later, there seems to be some challenges emerging as film makers increasingly report not retrieving the colours chosen in the grading room, when seeing their movie in certain commercial theatres. Having a triple-monochrome spectrum in an RGB projector rather than a continuous spectrum seems to cause some practical differences. I have tried to separate these into groups. Three concern colour perception, one concerns an artefact, and one concerns image texture perception. A sixth is about a separate projector advancement and is not colour, but contrast related. These issues will be explored in detail in future articles in CT Magazine. The image below shows the spectrums of the discussed light sources overlaid to provide context for the next instalment in this series.

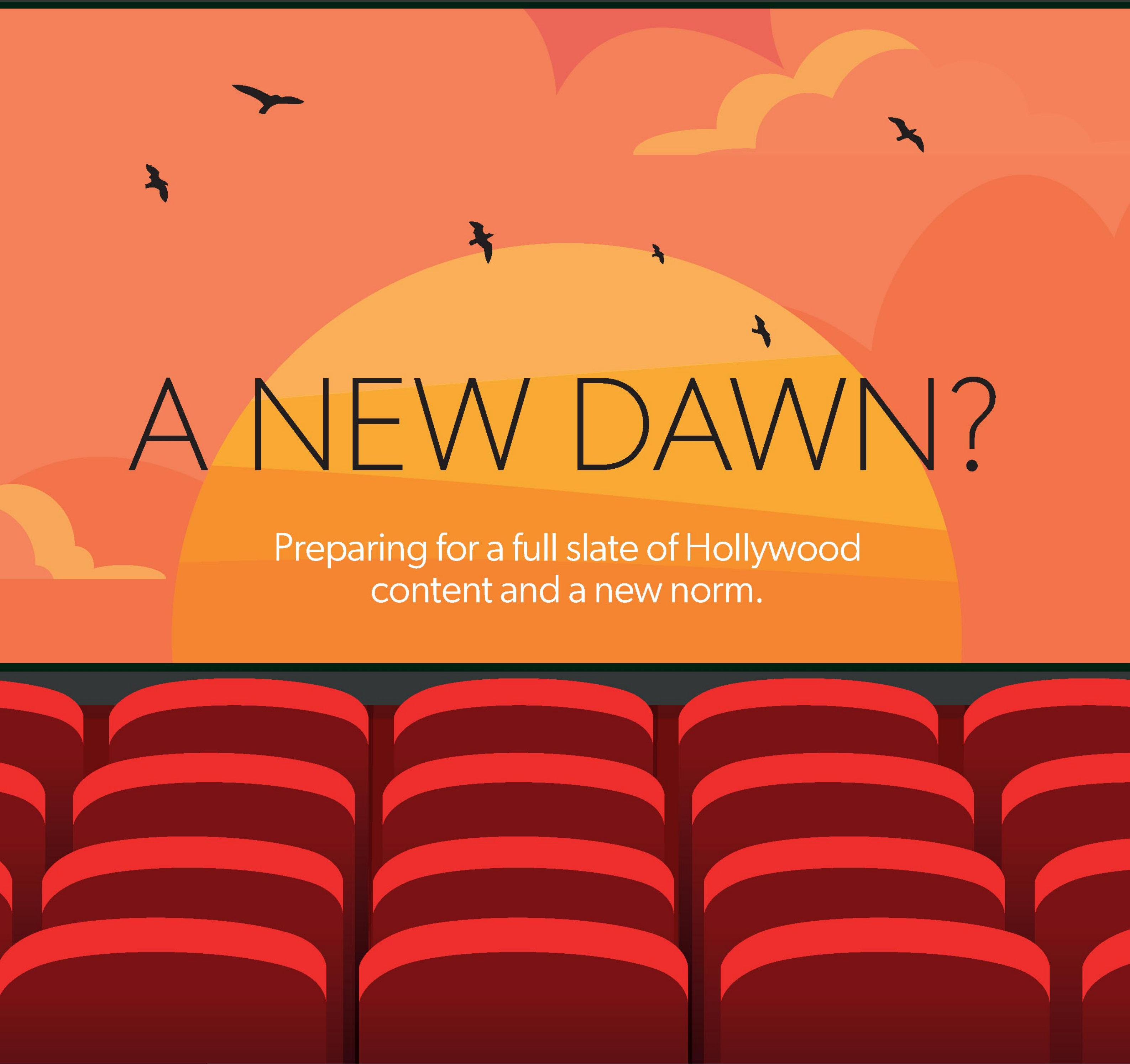
SPECTRUMS FOR XENON, PHOSPHOR-LASER AND RGB LASER LIGHT SOURCES FOR D-CINEMA



VOL.38 NO.1
SPRING 2025

CINEMA TECHNOLOGY

THE OFFICIAL PUBLICATION OF THE CINEMA TECHNOLOGY COMMUNITY



A NEW DAWN?

Preparing for a full slate of Hollywood content and a new norm.

PROUDLY CARBON NEUTRAL

ALSO IN THIS ISSUE

> A LOOK AT THE POST PRODUCTION PROCESS
> INTERVIEW WITH TIM WARNER (EX CEO - CINEMARK)
> THE CASE FOR SELF-POWERED LOUD SPEAKERS

CT MORE INFO

An official publication of CTC
IMIS INTERNATIONAL MOVING IMAGE SOCIETY powered by BKSTS

LASER ILLUMINATION IN CINEMAS PART 2

In part one, published in the Autumn / Winter issue of Cinema Technology Magazine, we identified that although the Digitisation of Cinema Exhibition was very carefully carried out with the best of intentions to preserve the very best quality, stability and fidelity to the original creation, technical changes in application can throw up unforeseen problems. In this second part we will outline some of the challenges arising.

WORDS: KOMMER KLEIJN AND PETER WILSON.

▲ Contemporary laser light source D-cinema DLP projector. Note the absence of a cooling exhaust hose.

WE WILL DEVELOP THE FOLLOWING KEY ISSUES:

- **A** "BROKEN" D-CINEMA COLOUR SCIENCE (ILLUMINANT METAMERIC FAILURE) +
- **B** METAMERIC VARIATIONS AMONG INDIVIDUALS (OBSERVER METAMERIC FAILURE) -
- **C** OBSERVER METAMERIC FAILURE DUE TO AGING OF THE HUMAN EYE LENS -
- **D** COLOUR FRINGING ARTEFACTS -
- **E** LASER SPECKLE ARTEFACTS +
- **F** CONTRAST PERFORMANCE OF LASER SOURCE PROJECTORS +
- **G** LASER CRISPINESS +

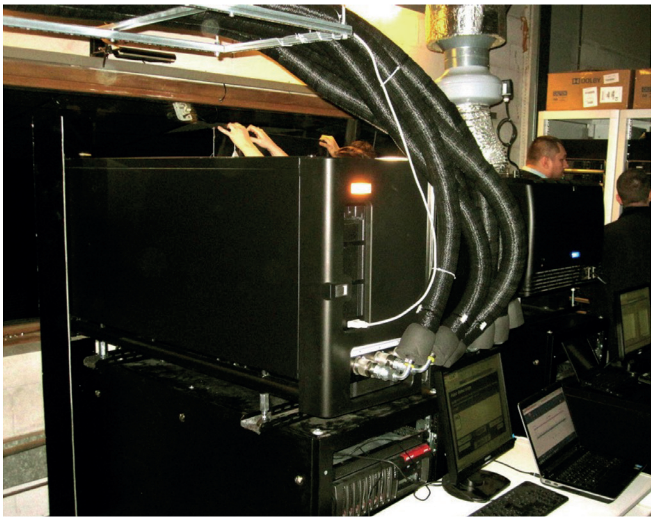
+ ISSUES FOR WHICH TECHNICAL SOLUTIONS HAVE BEEN IMAGINED OR ARE UNDER DEVELOPMENT, WHICH MAY SOLVE THE ISSUE EVENTUALLY IF SUCCESSFUL AND ECONOMICALLY VIABLE/ACCEPTABLE

- ISSUES FOR WHICH NO KNOWN SOLUTIONS HAVE YET BEEN IMAGINED, ARE KNOWN, PROJECTED OR UNDER DEVELOPMENT OTHER THAN TO ABANDON THE USE OF NARROW BANDWIDTH RGB LIGHT IN FAVOUR OF SPECTRAL LIGHT WHICH ARE FOR EXAMPLE AVAILABLE WITH RGB LASER-PHOSPHOR LIGHT SOURCES. NOTE THAT USING RGB PHOSPHOR LASER (A MODERN LIGHT SOURCE, ALSO BASED ON LASERS BUT FEATURING A BROAD SPECTRAL OUTPUT) WILL ALSO IMMEDIATELY RESOLVE ISSUES MARKED WITH (+), THUS RESOLVING ALL ISSUES AT ONCE.

NOTE: MOST, IF NOT ALL PROPOSED DIRECT VIEW LED CINEMA SCREENS ALSO EMIT NARROW BANDWIDTH RGB PRIMARIES AND AS SUCH ARE LIABLE TO PRESENT MOST OF THE SAME ISSUES THAT ARE OUTLINED FOR RGB LASER ABOVE, WITH THE EXCEPTIONS OF E) LASER SPECKLE AND POSSIBLY G) - LASER CRISPINESS.

IMAGES: KOMMER KLEIJN

Prototype RGB laser source by Christie Digital demonstrated at the IBC big screen theatre in Amsterdam 2012. Installed just outside of the projection booth, the thin white cables visible above the door are glass fibers carrying the laser light from this light source towards the DLP projectors in the booth.



Installation of the first commercial BARCO 6P RGB laser projection system (next to the Xenon projector on the right) in Kinepolis Brussels, November 2014. The hoses on the back go to an external chilling unit for heat evacuation.

A: "Broken" Colour Science (Illuminant metameric failure) (may be fixable)

Using a triple-monochrome RGB light source instead of a continuous spectrum light source apparently breaks the colour science that is in common use in the cinema industry. The colour science used in the cinema industry today is based on the CIE1931 standard observer and the subsequent mathematics. It seems, however, that this mathematics did not consider the possibility of triple-monochrome RGB light sources. I also note that in the year 1931, there probably were not that many laser light sources around! The practical problem that this causes is a perceptually different white point, even when the currently used colour science and measurement methods affirm that everything is set up correctly. The colour theory that is used to let us predict with certainty and precision what a human observer will see, does not seem to apply any more when a triple-monochrome light source is used. The currently used validation system or theory seems to be "broken". A projector using triple RGB monochrome light sources can measure O.K. towards the SMPTE reference projector standard, and satisfy the criteria for being "DCI compliant", while it is actually rendering colour in a way a human perceives it differently than intended. In fact, this was exactly what the XYZ DCP standard was designed to avoid. If the currently applied colour science, based on the CIE1931 observer, and the XYZ DCP standard that is based on it, turn out to be "broken" when used with narrow bandwidth primaries, then maybe we need a new colour theory to make it work again? Possibly new colour science can solve this problem. However, that would imply a rewrite of the SMPTE DCP standard (and the DCI specification). That could then allow for a stable white point and a colour rendering independent of the light source type, including Xenon, UHP, all flavours of phosphor-laser and all flavours of RGB laser. However, rewriting the standards would require a considerable amount of work. Someone would need to step up and propose to start it. Barco has recently announced a solution called "Metameric Offset Correction (MOC)" . By applying a 3x3 correction matrix to the calibration values of the RGB laser projector, the perceptual differences are reduced, without the need to change the actual DCP standard.

It must be applauded that Barco is actively researching and working on this issue. This solution is at this time proposed for projectors in grading rooms. Theatre projectors are not (yet) mentioned. That may raise the question how the graded work will show on theatre projectors, if not so equipped, and on projectors made by other brands. And if the MOC-modified projector will still measure as conformant to the actual standards, given the "broken standard" issue . If not, this might restrict this solution to the grading room, until an industry standard for this correction method would be created and licensed. That may not be trivial either, but could be much easier than rewriting the actual DCP standards. So, I think that the Barco "MOC" system may eventually be a promising development, although it would alleviate only this first issue, the ones that follow below are not affected by it. The same would be true for the alternative and more rigorous path of rewriting the SMPTE standards using a more recent colour science than CIE 1931. If successful that would resolve this first issue (the white point issue) as well, but again wouldn't solve the issues that follow.

[1] Flavours: Triple-monochrome RGB laser light source projectors may use different wavelengths for primary colours depending on brand or model. Some use different RGB wavelength for the left and right eye in 3D projection. [2] https://www.cinionic.com/white-paper/advancing-colour-accuracy-in-cinema-postproduction/
[3] https://cinionic.com/direct-downloads/partners/documents/whitepapers/Barco_Metamerism.pdf [4] We then might on one hand have RGB laser projectors (without MOC) that measure conformally to the actual standards but look different, and on the other hand have projectors that look more conformant (using MOC) but then do not measure conformity to the actual standards… It looks like if "broken colour science" has resulted in having "broken standards"?

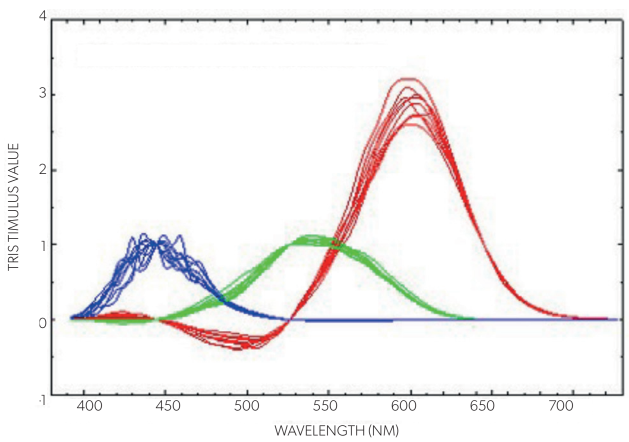
B: Individual metameric variations (Observer metameric failure) (no fix in view)

The spectral sensitivity curves of the receptor cells in the human retina vary from person to person. We are all different. The brain behind each individual pair of eyes is accustomed/trained to the specific spectral sensitivity of the individual eye retinas of that person and takes the above into account. However, this natural compensation mechanism has evolved with continuous spectrum light sources. When triple-monochrome light is used, the overlaps with the spectral sensitivity curves of the retina become cross-points rather than areas (See figure 3 below).

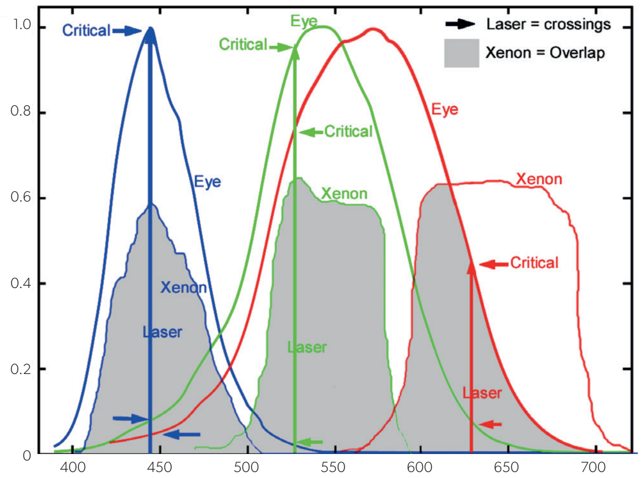
As a result, individual differences in spectral sensitivity curves may have a greater effect on the resulting trichromatic stimuli with RGB laser than with a continuous spectrum. And the brain is not trained for this and may not be able to compensate for the individual sensitivity differences in the same way. The perceived differences may then be bigger and this may become a concern. I found only a few studies about the severity of this effect. An interesting study by Yuta Asano et al , presented in November 2014, shows with practical images that the visual differences can be significant when working with a laser projector and an LCD display. This trigger's concerns that the effect might be far more severe than marginal, and triggers an interest towards further quantitative research. If it is confirmed that the perceptual differences between individuals can become significant in a cinema theatre setting, these differences could give trouble in grading sessions as the different players in the room (Director, Producer, Cinematographer, Colourist, ...) need to agree on colour decisions. If everyone sees something different on the same screen, then this could make obtaining a consensus more difficult. Subsequently it can diminish or possibly disturb the control that filmmakers have over what the final viewers see in the RGB laser equipped commercial cinema theatre. If individual patrons each see something different while watching the same screen, then it may also be different from the filmmakers' intentions.

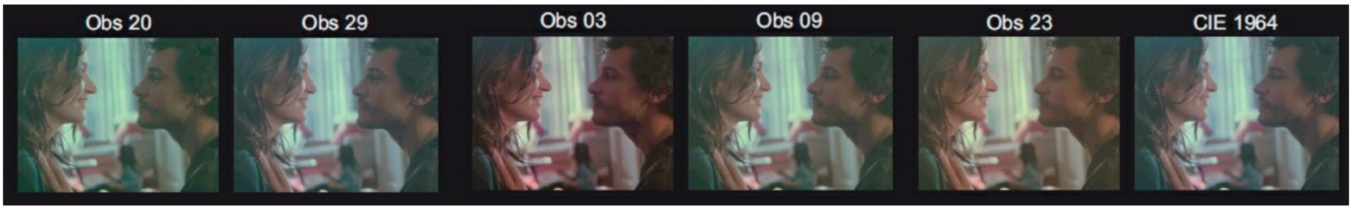
[5] Yuta Asano, Mark D. Fairchild, Laurent Blondé, Patrick Morvan, "Observer Variability in Colour Image Matching on a LCD monitor and a Laser Projector" in Proc. IS&T 22nd Color and Imaging Conf., 2014, pp 1 - 6, https://doi.org/10.2352/CIC.2014.22.1.art00001

INDIVIDUAL SPECTRAL SENSITIVITY CURVES AS MEASURED BY STILES AND BURCH



OVERLAPS BETWEEN SPECTRAL SENSITIVITY AND XENON, BECOME CROSSINGS WITH LASER



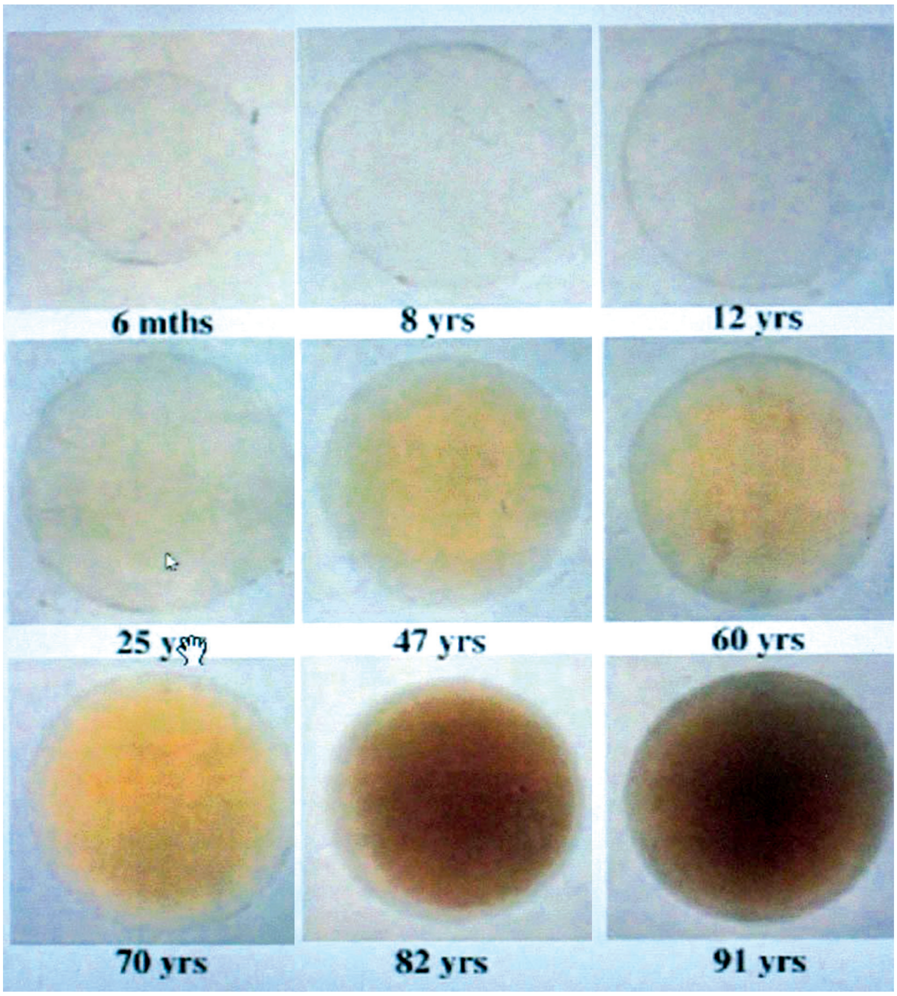


sRGB rendered test image 03 adjusted by extreme observers and the CIE 1964 observer

C: Aging of the human eye lens (no fix in view)

The biological lens in our eye's changes colour over the time of our life span. It evolves from transparent at birth to dark brown at high age. This goes largely unnoticed in normal life as the human brain will also evolve gradually with it and will learn to compensate for the physical colour change of the lens. But this natural neurological correction mechanism is disturbed again using narrow band monochromatic light. Without a continuous spectrum it becomes difficult for the brain to distinguish between real colours in front of our eyes and the colors coming from the coloured eye lens.

As a result, older cinema goers will experience more reddish skin tones when viewing a movie on an RGB laser lit screen. And the older they are, the redder they will perceive. On the other hand, if the film makers are aged, and grade their movie on an RGB laser lit system or another narrow band RGB display, then the younger movie goers in the cinema may experience too much green in the actor's skin tones, which can be very damaging to their appearance. This issue is quite bothersome as it concerns all of us and not only groups with certain genetic factors, secondly it affects the perceived red-green balance which is critical for images to be perceived natural and finally it seems to affect human skin tones which are considered very important in cinematography. Skin tones have significant emotional impact and can affect the "attractiveness" of the movie characters.



Source: Radiant Energy and the Eye (Functional ophthalmology), Sidney Lerman 1979 Macmillan/McGraw-Hill School Division ISBN 9780023699702

D: Colour Fringing (no fix in view)

Presentation systems using triple monochrome, or very narrow bandwidth primaries, can produce a colour fringing effect for the viewers. I found that this effect also is a result of incompatibility between the human visual system and narrow bandwidth primaries. It visually looks like registration errors between the colour channels, showing thin coloured (often red) lines where the image contains high contrast sharp borders. It is most visible on subtitles, logos, and credits but also on in-picture elements of high contrast, like specular highlights, window borders, horizons, and reflections on water. However, such coloured fringes are not actually physically there. Walking towards the screen allows us to confirm this: Close to the screen the effect disappears, walking away from the screen makes it larger, also with a well-aligned projector. The effect is proportional to the distance between the viewer and the screen. While with a mis-aligned projector this is exactly the other way around. The strength of the effect also varies from person to person and it is often stronger for persons wearing prescription glasses or contact lenses. Some people do not notice it at all. It also changes with contrast; it is more present with HDR. My view is that this effect occurs because of the workings of the human visual system: One must realise that, contrary to modern camera or projection optics, the human eye optical system is not equipped with compensation for chromatic aberrations. Nor are prescription glasses or contact lenses. High contrast sharp borders are projected on the retina with chromatic aberrations. In practice this means a slightly soft border with a soft rainbow pattern between the light and dark part. The unconscious image processing parts of our brain will recognise this specific border structure pattern as chromatic aberration and will correct for it. The unconscious brain will remove the rainbow pattern and the fuzziness and will reconstruct a sharp border, before passing the image on to the conscious part of the brain.

However, with a triple monochrome RGB light source, the rainbow pattern cannot form, nor will the fuzziness since there are only three narrow primaries, and all other wavelengths are absent in the light source. On the retina, three sharp borders will form instead of gradients, and the rainbow pattern will not be formed. The brain may not recognise this as a chromatic aberration and may not correct nor reconstruct it. It then passes the sharp coloured borders on to the conscious brain and these will be perceived.

An illustration for what the color fringing artefact can look like. Source: Christian Wieberg-Nielsen, Supervising Colorist, Storyline Studios, Oslo, Norway.

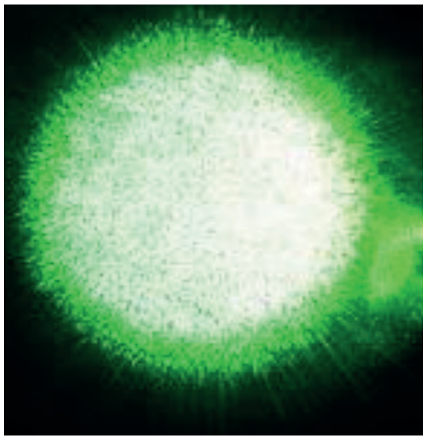
E: Speckle (Technical solutions have been developed but have costs)

Coherent monochrome light waves of laser light allow it to interfere with itself and create random dark and brighter spots in the image. This interference appears as a grainy and moving "speckle". This can be mitigated by applying diversity or mechanical vibration, each of which, however, comes with a cost in projector manufacturing or screen installation.

Speckle free projection has been achieved and shown, and at times it was believed to be a problem solved. However, in practice, complaints still occur. Speckle can not only cause viewing discomfort; it also can change the perceived texture (grain structure, noise structure) of the image and as such change the creative intent of the filmmakers. When several primaries work together, this already is some form of diversity, therefore speckle tends to show more on saturated reds or greens, when a single primary colour is active in a majority.

As some of the better remedies against speckle can be costly to implement, install and/or maintain, these remedies are not always applied for economic reasons.

This may explain the recent complaints received about it and the ongoing discussion within the industry as to what degree or quantity of speckle that remains can be considered as "acceptable".



Laser speckle. Source: en.wikipedia.org

[6] https://en.wikipedia.org/wiki/Speckle_(interference)#Mitigation

F: Contrast Changes (Not triple monochrome spectrum related, seems fixable)

Recent laser projectors are often capable of deeper blacks than lamp-based projectors are. This is a positive development but it also can raise issues if not managed carefully by us: It is possible that details in dark picture areas, not visible on Xenon projectors, unexpectedly become visible on a laser projector. If those details contain foreign elements (like cables running over the floor), then this can be bothersome for the cinema going experience. Secondly, deeper blacks, if unintended, can result in a different lighting atmosphere, and can potentially change the intentions of the Director of Photography, Colourist, Director, Producer, for the feeling of the scene.

Both effects can be explained when values lower (darker) than a xenon projector can render are (unintentionally?) put into a DCP and go unnoticed because of a Xenon projector in the grading room that was not able to render these. When the DCP is then presented on a laser projector, these values can be displayed. During grading we should probably best avoid putting values in the output file which the system in the grading room cannot display. Maybe grading software could help by issuing warnings in such cases? Or we could check on both display systems. Deeper black, like with HDR, is a valuable asset we can use, but for some time we will need to deal with the fact that not all theatres can display it.

Note also that this issue is not entirely new, as Sony SXRD projectors (now discontinued) were also capable of displaying some deeper blacks.

G: Laser Crispiness perception (may be fixable, research needed)

Cinematographers and colourists have reported that the look of the image on a "crispiness" level, or perceived grain / noise level, appear changed (augmented) on RGB laser viewings compared to what was carefully decided on a (Xenon-lit) grading. The images look crispier and / or grainier or noisier than when viewed on a Xenon projector. In one case this went as far as a director requesting a re-grade, creating a softer version of his movie, for RGB laser lit presentations, resulting in a dual inventory. The reasons for this happening have not been formally established yet, but are suspected to be the result of the presence of speckle, or the higher contrast, or a combination of both. CT

NON EXHAUSTIVE CONCLUSIONS

The replacement of Xenon and High-Pressure Mercury Lamps with Laser Illumination is proceeding at a fast pace, in fact some manufacturers have discontinued new projectors with Lamp based Light sources.

The issues mentioned above are real and cannot be swept under the mat.

Is a MOC (Metamerism Offset Correction-see part a) a sound approach? It only tries to address the white point issue which is only one of 6 issues outlined. Not All the issues will be solved by it. So, it is a question if MOC is worthwhile as the other important issues like individual differences and age differences will remain anyway.

If an MOC is required, is a 3x3 Matrix big enough? Will the MOC be Internationally standardised and will it be an open-source design so all manufacturers could adopt the same system? Will DCI want a Specification for a MOC? Where will it be deployed for maximum fidelity for the Movie-goers? Who will decide the parameters? Who will pay? Will grading suites need both Lamp Based and Laser Illumination to make special grades for Monochromatic Laser? Having had many discussions with studio executives I know Single distribution Inventory was a Holy Grail never achieved. Adding an extra layer to distribution inventory and an extra grade would not be optimum.

Using full phosphor laser (where all three colours are generated by phosphor laser) seems to be a more thorough approach as such full phosphor laser sources can be made with similar spectral characteristics to lamp based sources and thus not exhibiting any of the problems outlined here, while maintaining most of the advantages that laser sources have, like longevity and low maintenance. Phosphor laser sources may have slightly lower power efficiency than RGB laser sources, but their efficiency is still much better than that of lamp based light sources.

Similar techniques can be applied to direct view screens, and in that case the efficiency penalty is almost negligible.

So, it seems that there needs to be a meeting of the minds on where to go between, The DCI, CIE, SMPTE, ISO, Projector Manufacturers, Exhibitors and National Institutions.

WHO PAYS FOR THE WORK, WHO DOES THE WORK?

Is there still a thorough industry motivation to guarantee that the patrons will see a movie exactly as the film makers intended to? This was the case in the beginning of the millennium? Do we allow the medium to degrade to what happened in the television industry, where it is accepted that the television set manufacturers influence the displayed images?

Back in the days of digital cinema this was a hot discussion and a thorough commitment. Will we keep it up or will we let that go? Especially as current LED screens promise to present most of the exact same issues.

Answers on a Postcard Please.

3x3

BY APPLYING A 3X3 CORRECTION MATRIX TO THE CALIBRATION VALUES OF THE RGB LASER PROJECTOR, THE PERCEPTUAL DIFFERENCES ARE REDUCED, WITHOUT THE NEED TO CHANGE THE ACTUAL DCP STANDARD.

RGB

WITH A TRIPLE MONOCHROME RGB LIGHT SOURCE, THE RAINBOW PATTERN CANNOT FORM, NOR WILL THE FUZZINESS SINCE THERE ARE ONLY THREE NARROW PRIMARIES, AND ALL OTHER WAVELENGTHS ARE ABSENT IN THE LIGHT SOURCE.

2014

IN 2014, SHOWS WITH PRACTICAL IMAGES THAT THE VISUAL DIFFERENCES CAN BE SIGNIFICANT WHEN WORKING WITH A LASER PROJECTOR AND AN LCD DISPLAY.

Having had many discussions with studio executives I know Single distribution Inventory was a Holy Grail never achieved.

CT MORE INFO