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Systematic Comparison of Ultraviolet vs. White Light for Lightboard Illumination

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Systematic comparison of ultraviolet vs. white light for lightboard illumination

Craig W. Looney (Merrimack College)

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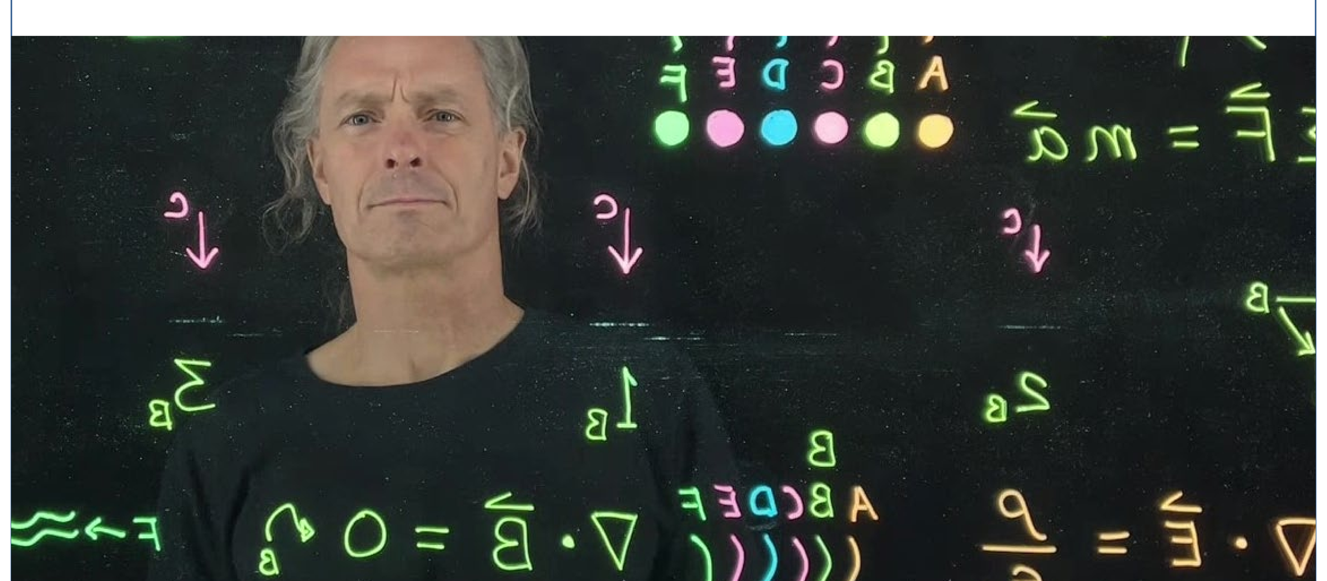
MOTIVATION

- Normally invisible **tempering defects** in high-clarity (low-iron) glass become **highly visible** when illuminated with edge-mounted white LEDs [1]. While such defects can be mitigated with careful attention to camera settings and presenter lighting [2, 3] they present an ongoing technical challenge.
- Obvious idea: use invisible **UV light** … this should cause fluorescent markers to visibly fluoresce, but should be invisible when scattered by defects.
- McCorkle and Whitener [4, 5] reported a qualitative appearance enhancement when using near-visible UV blacklight illumination, but no systematic investigations have been reported.

EXPERIMENT

A systematic comparative study of cool white LEDs vs. UV LEDs (peaked respectively at 396nm and 372nm, ±2nm [6]) for lightboard illumination was carried out on my self-constructed home lightboard [7], which has a number of features that make it well-suited for these experiments:

- An accessible glass-edge design allows easy removal/replacement of LED strands.
- Step-down DC converters (installed to eliminate banding effects caused by more commonly used PWM dimmers, see ref. [7]) provide precise, repeatable control of presenter and glass illumination levels.
- Minor but visible tempering-related defects, running left to right across the middle of the glass pane (underneath the arrows in the image below):

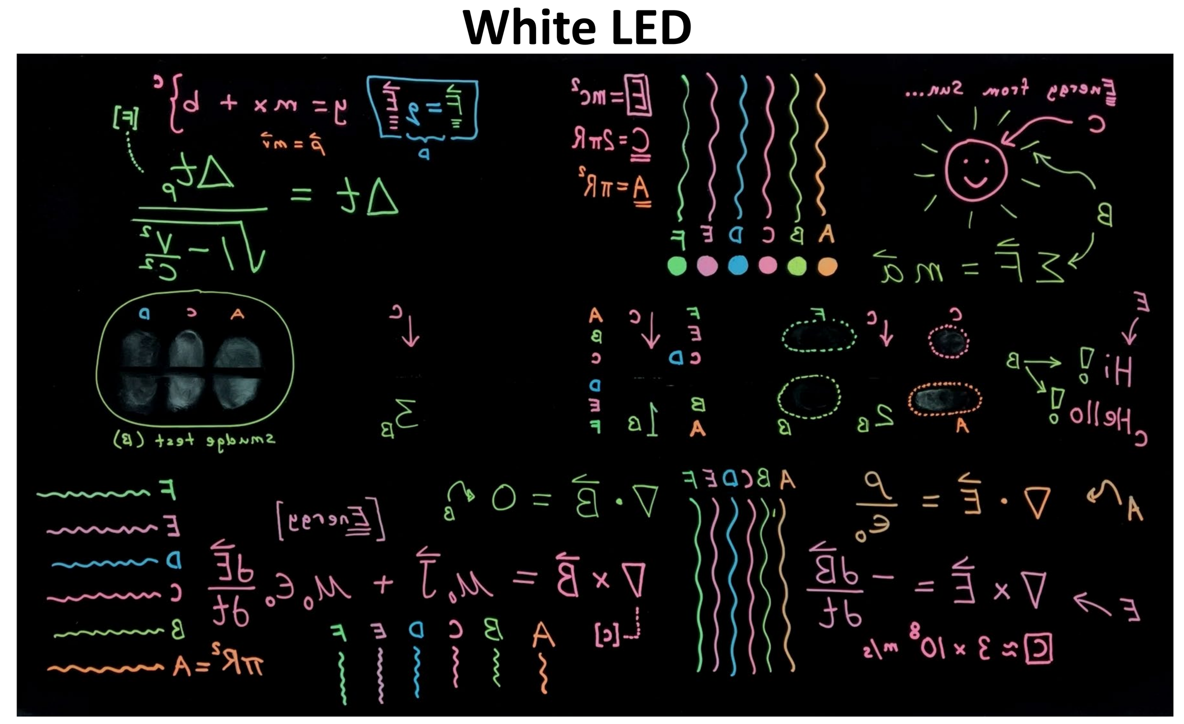


All video frames presented in this poster were extracted from iphone13 HD videos taken with the MoviePro app to manually and repeatably control camera settings (ISO, shutter speed, tint, temperature). With these factors as well as the presenter lighting levels held constant, the glass LED lighting levels were varied, with the goal of obtaining videos that could be compared head to head.

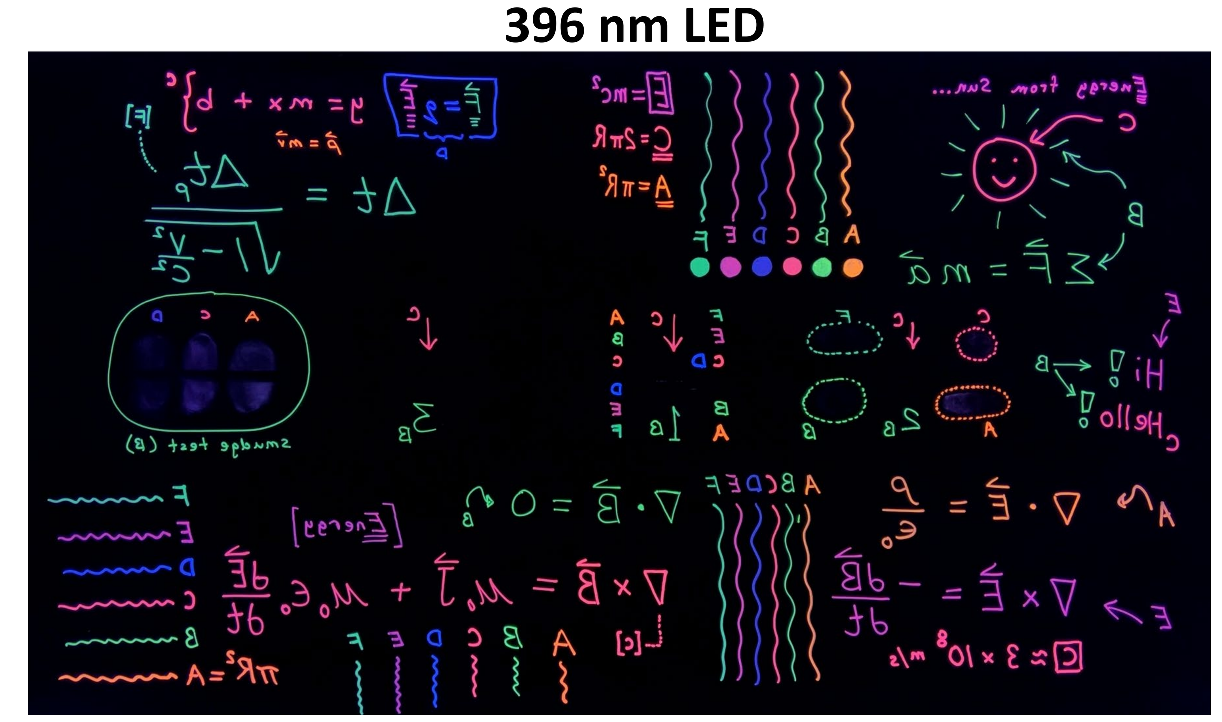
Selected RESULTS

White vs. 396 nm vs. 372 nm, presenter lights OFF (see figures below). With the presenter lights off, the glass is illuminated ONLY by the glass LEDs. With the camera settings and glass LED illumination levels shown, the tempering flaws are well-masked in all 3 video frames. However, we can clearly see that *the 396 nm LED provides better masking of the circled marker smudges* than the white LEDs while delivering equal-or-better writing brightness and superior color separation. Interestingly, the 372 nm light apparently causes the glass itself to fluoresce, reducing the overall visual quality. The smudge-masking result for the 396 nm light is a welcome result (but was not an "obvious" expectation, since the smudges consist of residue from *fluorescent* markers).

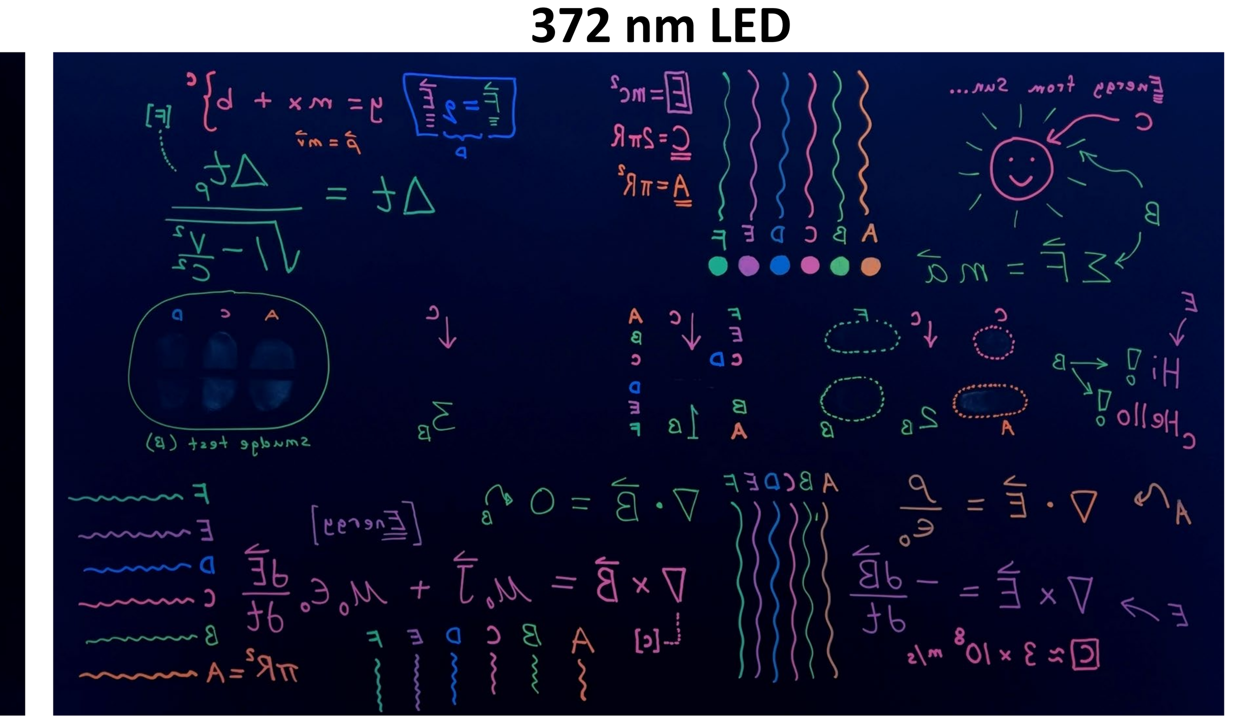
White LED



396 nm LED

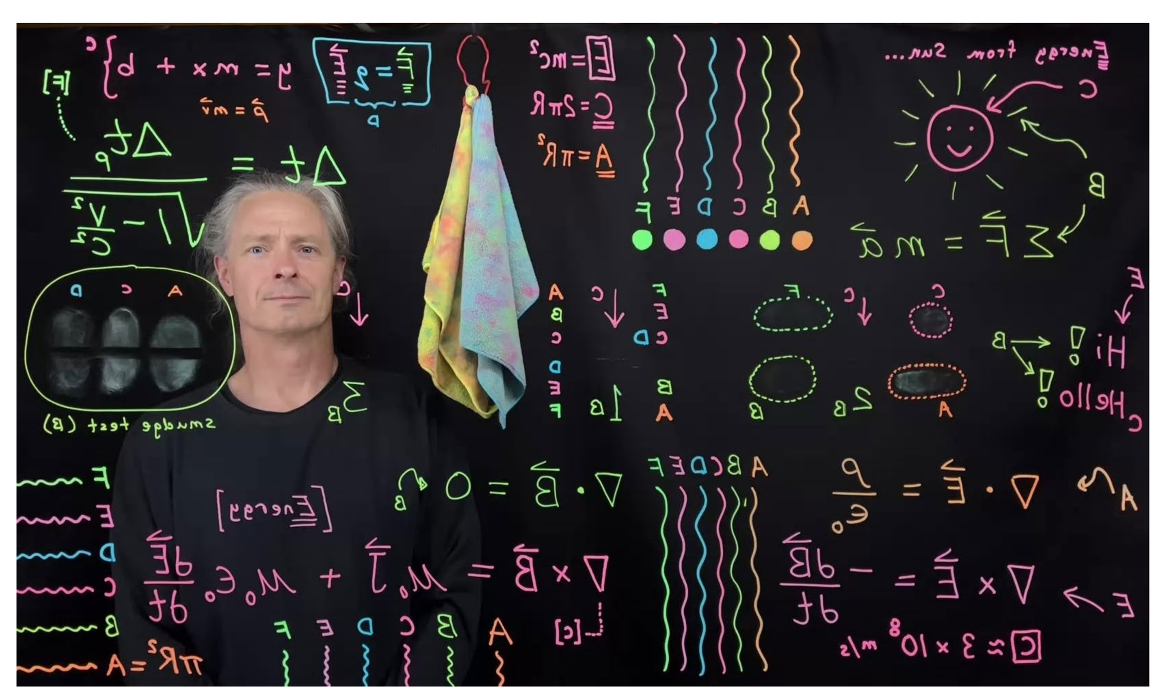


372 nm LED

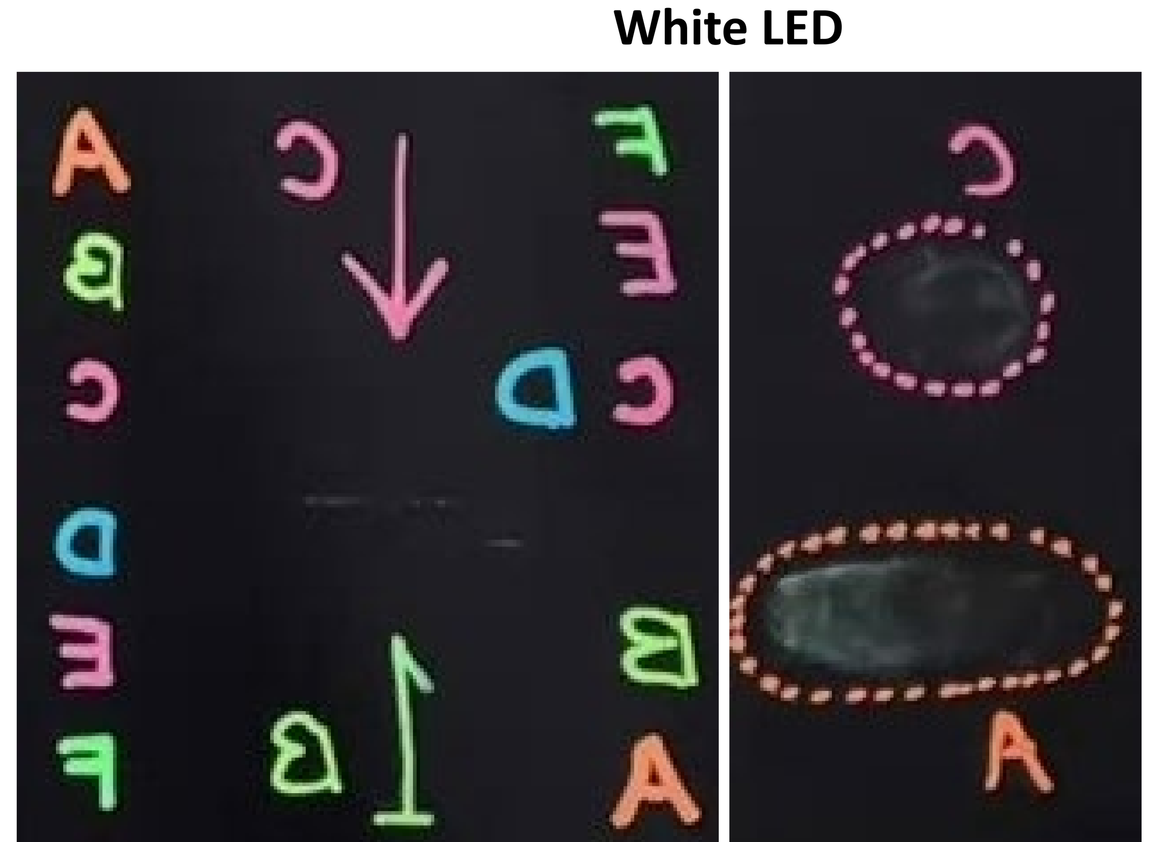


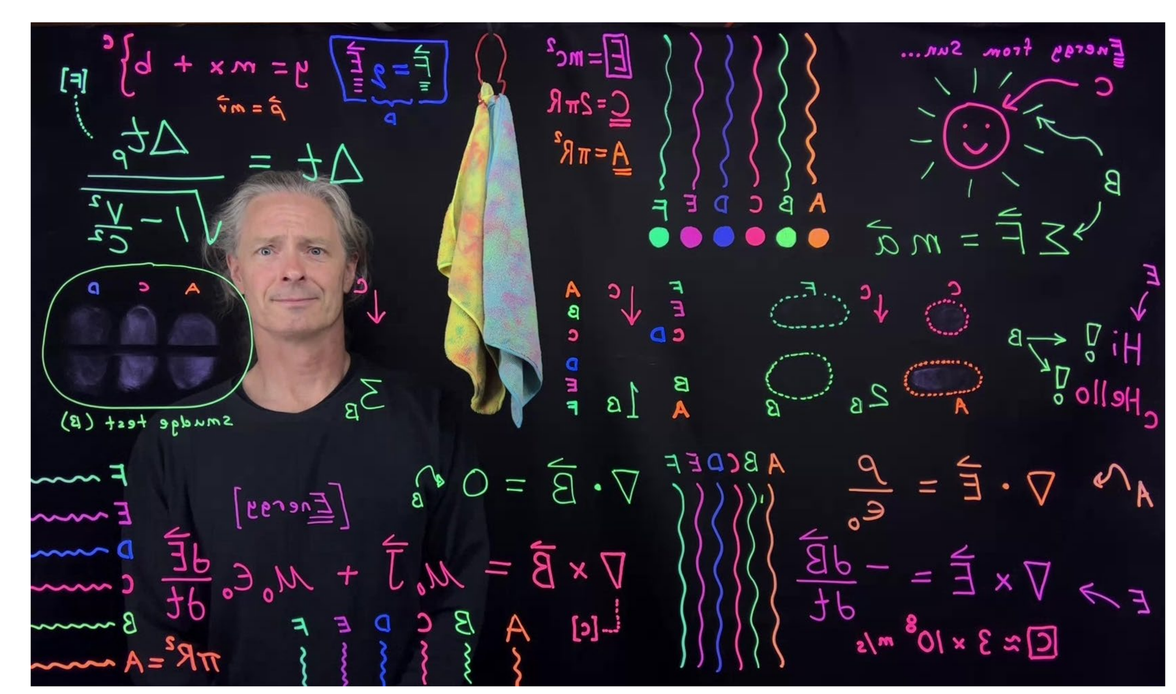
[Frames extracted from HD iPhone 13 video. Camera settings: ISO 500, shutter speed 1/60 sec., tint = 0, temp = 6000K. Presenter lights were OFF.]

White vs 396 nm, presenter lights ON (see figures below). In most lightboard setups, including mine, the glass receives some visible-light illumination from the "presenter lighting" and this works against the masking advantages of (mostly-invisible) 396 nm glass illumination. Nevertheless, in illuminated-presenter conditions, the masking advantages of 396 nm LEDs persist (while somewhat attenuated) … see figures below. *[Note: the advantage might or might not show up in the printed poster but it is visible in the PDF version of the poster and in the source videos.]*

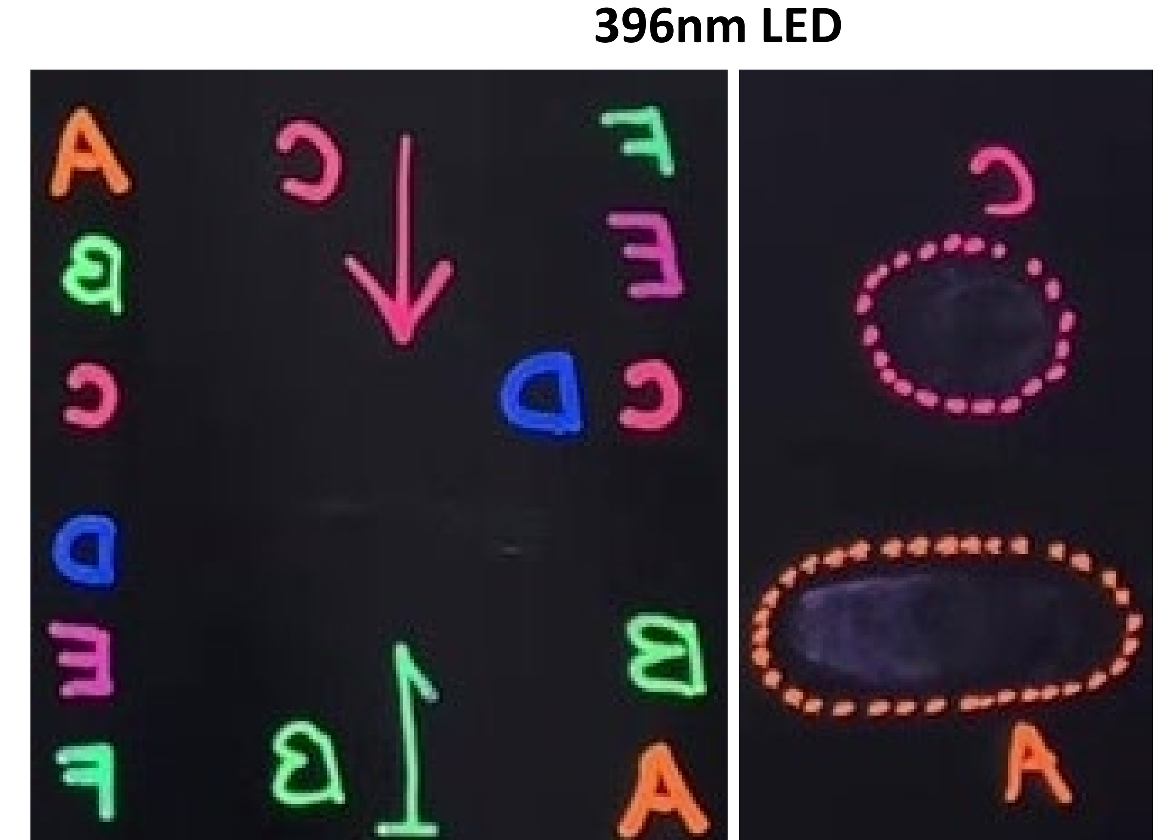


White LED





396nm LED



Identical presenter lighting and camera settings [iPhone 13: ISO 500, shutter speed 1/60 sec., tint = 0, temp = 6000K]

CONCLUSIONS (simplified!)

- 396 nm UV appears to be "better" than white light for lightboard illumination.
- However: careful attention to camera settings and illumination levels (for both glass and presenter) has *SUBSTANTIAL* masking capacity and this has been under appreciated.
- There is MUCH more detail and nuance to all of this … LET'S TALK!

References

[1] Michael Peshkin: https://www.lightboard.info/build-or-buy [accessed 6/20/2024}. Peshkin writes: "Getting unmarred glass can be a problem. Large sheets of glass must be tempered for safety, and often the rollers in a tempering furnace leave scuff marks on the glass, especially if the rollers haven't been cleaned and carry glass dust. This normally goes unnoticed; as one glass vendor told me, people look *through* glass, not *at* glass. In lightboards however the internal illumination makes any scuffs glow."

[2] Steve Griffiths: Lightboard, Camera, Action. (FLIP Learning blog post) https://flippedlearning.org/how_to/lightboard-camera-action/ [accessed 6/20/2024]

[3] Steve Griffiths: https://www.youtube.com/watch?v=i68rwDF8ipA.

[4] Sarah McCorkle and Paul Whitener. The Lightboard: A faculty introduction to the development of supplementary learning media. In *2017 Conference on Higher Education Proceedings*. Blacksburg, VA. Available at: https://www.researchgate.net/publication/368471692_The_Lightboard_A_faculty_introduction_to_the_development_of_supplemental_learning_media

[5] Sarah McCorkle & Paul Whitener. The Lightboard: Expectations and Experiences. *International Journal of Designs for Learning*. Volume 11, issue 1 (2020), pages 75-83. https://scholarworks.iu.edu/journals/index.php/ijdl/article/view/24642/33713

[6] Measured using Vernier VSP-EM spectrometer (±2nm per specifications).

[7] Craig W. Looney. Making High-Quality Videos on an Inexpensive DIY Lightboard (with Technical Tips Relevant to all Budgets). Spring 2023 Meeting of the New England Section of the American Physical Society, March 17-18, 2023, Amherst College, Amherst, MA. https://scholarworks.merrimack.edu/phy_facpub/20/