

PROBLEM

In on-set virtual production (OSVP), LED volumes are used on film sets to display dynamically rendered real-time scene backgrounds. The wall content is typically generated from the camera pose and viewing angle using Unreal Engine. The camera is freely movable and captures only a portion of the LED wall [1]. This region, referred to as the inner frustum, is therefore rendered at increased fidelity. Angular color shift [2] here is particularly evident at certain camera viewing angles relative to the LED wall. This poster proposes an approach for dynamically compensating the angular color shift in real time directly within the rendering engine using a simplified far-field simulation model derived from goniometric measurements.

RELATED WORK

Color Management and LED Challenges [3] highlight the need to align creative intent with camera capture, emphasizing the difficulty of managing LEDs' narrow-band spectral output.

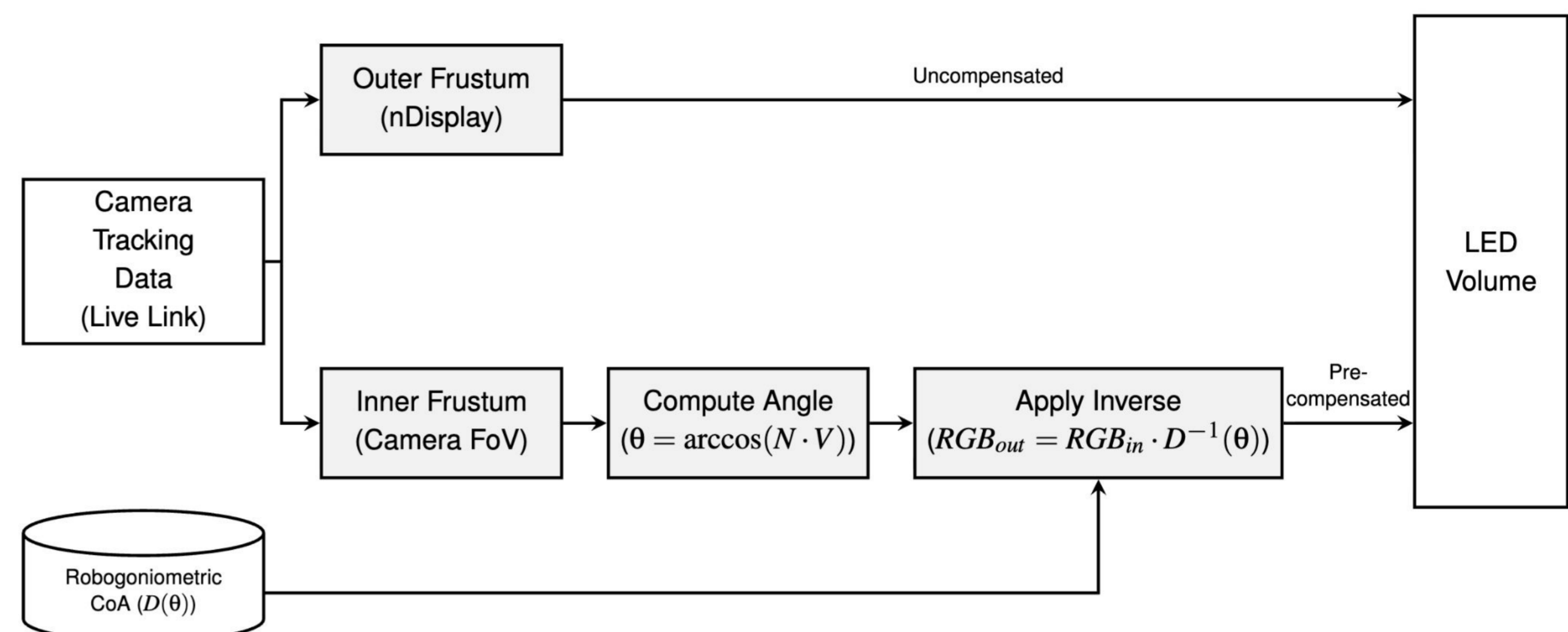
Static Calibration Frameworks OpenVPCal [4] aligns LED panels to cameras using static CCMs/LUTs, but ignores angular errors.

Angular Color Shift Analysis [5] use Fourier optics for full color volume analysis, but methods are data-intensive. [6] propose near-field goniophotometry for spectral ray files, noting far-field approximations for extended sources.

Real-Time Application Our work adopts [7] far-field approximation to reduce computational complexity for real-time use.

Panel-Specific Considerations [8,9] address metameric failures in multi primary lighting scenarios, which are relevant for accurate color rendition.

METHODOLOGY



Robogoniometric Data Capturing

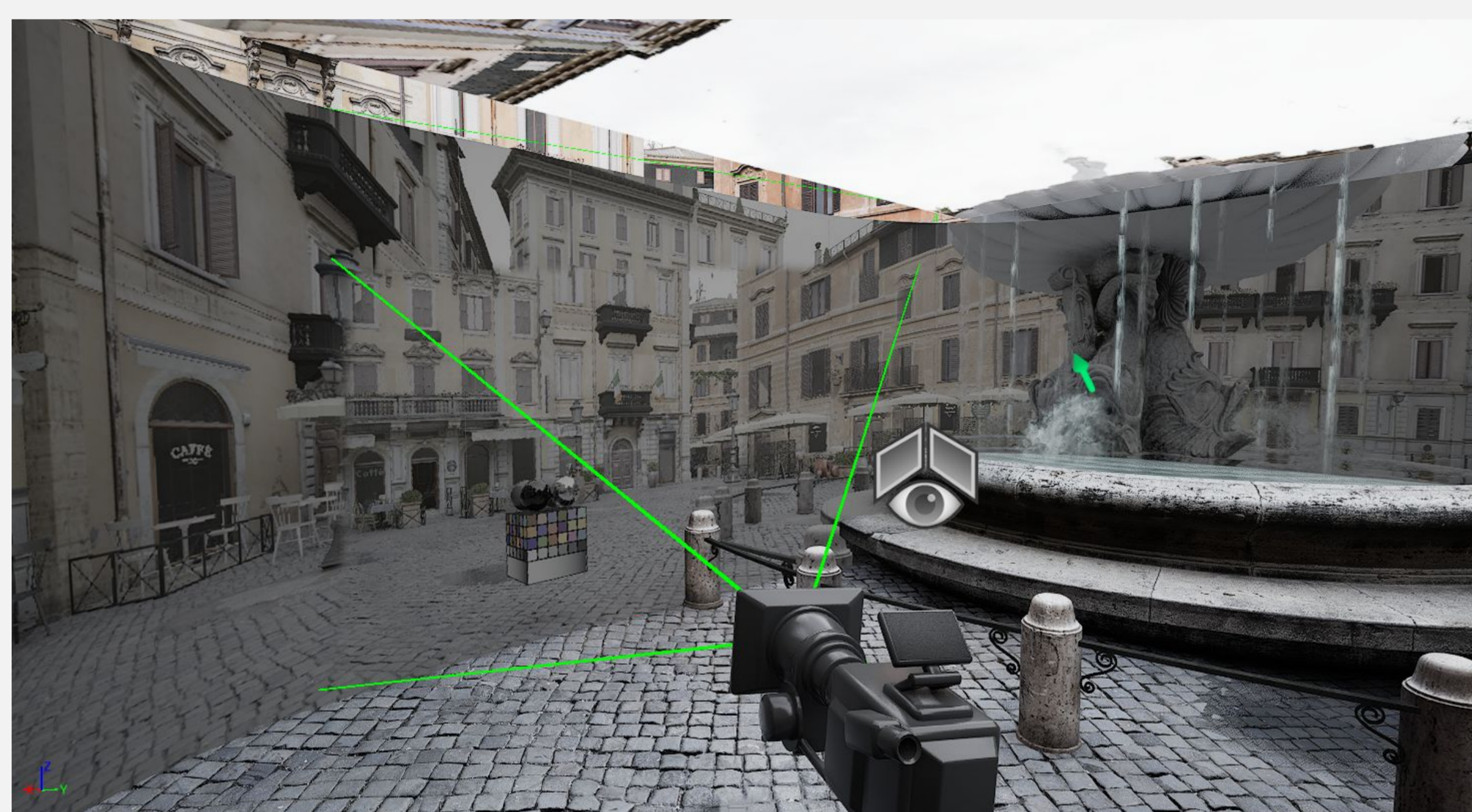
Our approach utilizes a robogoniometer to capture correlated color temperature and spectralradial information for the LED panel at 8m distance. This data can be used to derive an .ies profile plus SPD per angle.

Live Link Data with Camera FoV for Angular Color Compensation

As OSVP utilizes a tracked camera, the angle between the LED panels normal and the camera can be computed and the angular color shift can be compensated for the inner frustum.

RESULTS

- Color over Angle Measurements for a VP typical LED-Panel (50 x 50 cm – 1500 nits – 1.56 pixel pitch)
- Proof of concept derived 3x3 LUT configuration per 15° /45° data points
- Our approach is addressing the worst temperature dependant color drift due to 20 minutes (ICDM) warm-up time with full-white Test pattern



Inner Frustum applied to the nDisplay Cluster, with Live-Link and Color Calibration Cube for Reference

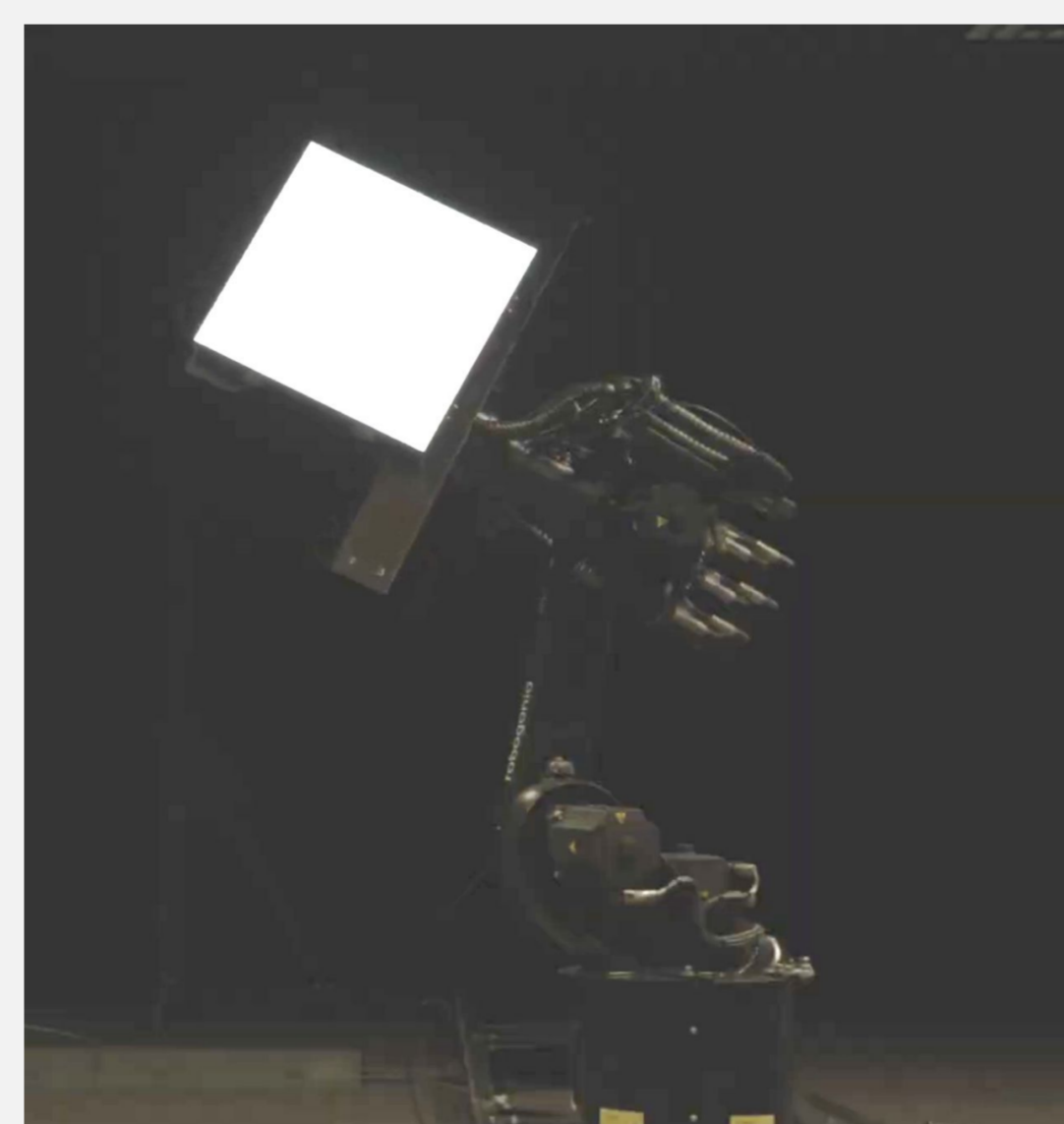
Theta (°)	Elevation (°)	CCT (K)	ΔE2000 (to 6500K)	Theta (°)	Elevation (°)	CCT (K)	ΔE2000 (to 6500K)
0	0	6504	0.032	45	20	6546	0.362
0	20	6667	1.283	45	40	6975	3.409
0	40	7103	4.201	45	60	7819	7.798
0	60	7871	8.014	135	20	6362	1.125
180	20	6411	0.719	135	40	6525	0.198
180	40	6552	0.409	135	60	7146	4.456
180	60	7112	4.255	225	20	6463	0.296
90	20	6449	0.409	225	40	6643	1.104
90	40	6710	1.599	225	60	7185	4.682
90	60	7453	6.119	315	20	6629	0.999
270	20	6563	0.494	315	40	6968	3.365
270	40	6739	1.809	315	60	7583	6.749
270	60	7229	4.931				

ΔE2000 values are derived from CCT via the Kang et al. (2002) approximation

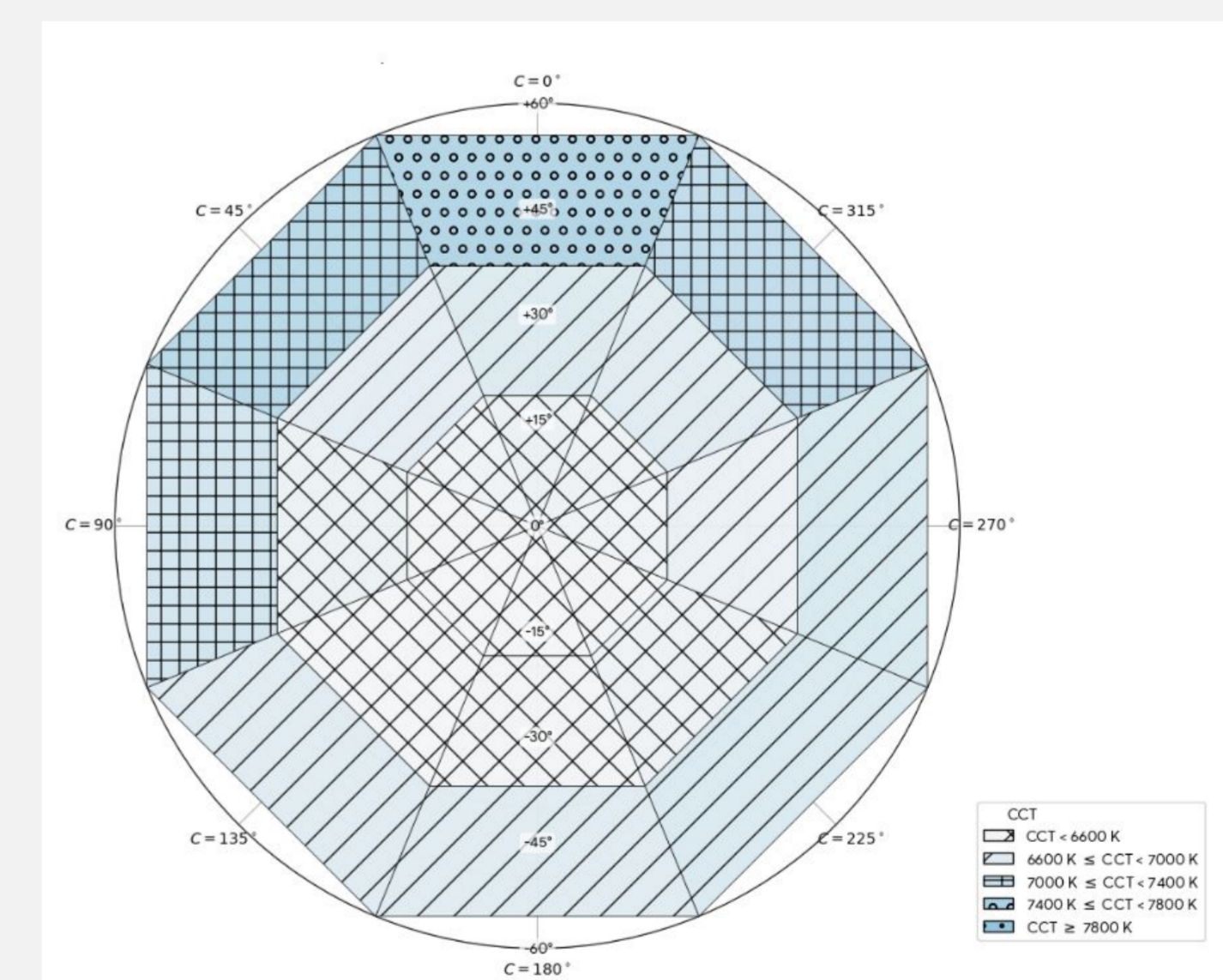
OVERVIEW

OSVP uses LED volumes to display real-time rendered backgrounds driven by camera pose and viewing direction. The camera-visible region, known as the inner frustum, is rendered at higher fidelity but is particularly affected by **angular color shift** at oblique viewing angles.

Current calibration frameworks focus only on static angle-independent compensation of errors in color rendition. In our approach, we use a robogoniometric setup to measure the far-field colorimetric behavior of LED panels and derive a lightweight, angle-dependent color profile for the LED wall that can be directly used for real-time angular color shift correction. A detailed comparison of color differences relative to an uncompensated inner frustum is planned for the future and is not yet complete at the time of publication.



Robogonio during measurement filmed (ARRI Alexa 35)



Color over Angle Data shown as CCT

AFFILIATIONS



HOCHSCHULE
HAMM-LIPPSTADT



FILMUNIVERSITÄT
BABELSBERG
KONRAD WOLF



LAVALabs



Grant Number: **EFRE-20801830**

We would like to thank Frank Tappe and Jörg Meyer from Hamm-Lippstadt University of Applied-Sciences supporting the measurements using the robogonio in the light measurement lab.

REFERENCES

- [1] Fink, N., and Sawicki, M. (eds.). 2023. The VES Handbook of Virtual Production. Routledge, New York, NY, USA.
- [2] Ng, K. E. 2025. Investigation of Color-Over-Angle in Multi-Chip Array LEDs. doi:10.26180/30745235.v1.
- [3] Long, D., Bogart, R., Stephens, S., Meininger, C., Goldstone, J., Kang, T., Brillhart, K., and Geduldick, J. 2025. Color Management Principles for LED Panels in On-Set Virtual Production. doi:10.5594/JMI.2025/XEJK1138.
- [4] Payne, C., and Giardiello, F. L. 2022. "OpenVPCal": An Open Source In-Camera Visual Effects Calibration Framework. doi:10.1145/3532836.3532625.
- [5] Boher, P., Leroux, T., Bignon, T., and Collomb-Patton, V. 2016. 72-3: Optical Characterization of a Transparent LCD Using a Fourier-Optics Multispectral Viewing-Angle System. doi:10.1002/sdtp.10891.
- [6] Jacobs, V. A., Audenaert, J., Bleumers, J., Durinck, G., Rombaets, P., and Hanselaer, P. 2015. Rayfiles including spectral and colorimetric information. doi:10.1364/OE.23.00A361.
- [7] Yu, X., George, D., Millward, J., and Debevec, P. 2025. Real-Time Multispectral Lighting Reproduction. doi:10.1145/3721250.3743035.
- [8] Gudemann, L., Fröhlich, J., and Brendel, H. 2022. Color Reproduction in LED Wall Virtual Production Stages. doi:10.2352/CIC.2022.30.1.21.
- [9] LeGendre, C., Yu, X., Liu, D., Busch, J., Jones, A., Pattanaik, S., and Debevec, P. 2016. Practical multispectral lighting reproduction. doi:10.1145/2897824.2925934.