NED-LMD Near-Eye Display Measurement System

Gamma Scientific offers the world's first integrated Wide Field of View (FOV) spectroradiometric, image quality and auto collimating alignment analysis solutions for characterizing the Virtual Image and Qualified Viewing Space of near-eye displays. The NED-LMD (U.S. Patent No. 10,257,509) delivers high spatial resolution display quality measurements for Augmented Reality, Virtual Reality, Mixed Reality and Head Up Displays (AR, VR, MR, HUD). The system is uniquely designed to emulate the human eye, conforming to standards being developed by the ICDM committee of SID and the IEC.

GS-E10 Series R&D Reference Test Solution for AR/VR/MR/HUD Devices

Key Features

- Integrated camera offers 16H x 12V degree instantaneous FOV with 250 pixels/degree high resolution
- Robotic positioning for true eye motion representation and design eye point measurement
- Lightweight & compact telescope assures precision spatial positioning with robotic arms
- Patented SLR viewing system with integrated LED measurement spot projector with built-in autocollimator
- 1 or 2 degree field stop aperture selection for eye foveal region correlation measurement spot
- Exceptional color and spectral purity for high sensitivity, high dynamic range spectroradiometric measurements
- Large and small range goniometric options available, covering +/- 44 degrees vertical and +/- 22 degree vertical FOV of the device respectively

Measurement Parameters
✓ Luminance Uniformity
✓ Color Uniformity
✓ Image Contrast
✓ Field of View
✓ Image Virtual Distance
✓ Qualified Viewing Space Mapping
✓ Spectral Transmittance
✓ Ambient Contrast
✓ Auto Virtual Image Distance
✓ MTF and Resolution
✓ Left Eye Right Eye Parallax
✓ Distortion

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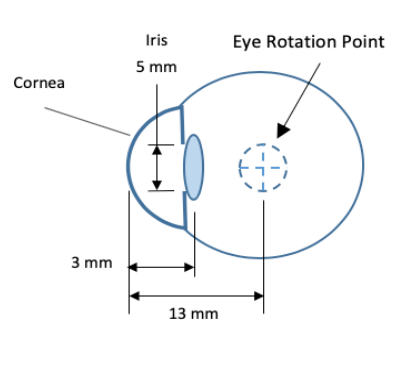
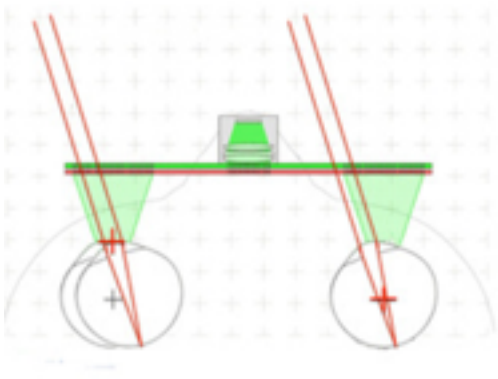
NED-LMD Near-Eye Display Measurement System



Small Entrance Pupil Requirement

Most display spectroradiometers have entrance pupils ranging from 20 to 40 mm. Proper characterization of near-eye displays requires an entrance pupil 5 mm or smaller diameter, matching that of the human iris. While this reduced entrance pupil greatly improves measurement accuracy, the light measurement system must have sufficient sensitivity and dynamic range to provide adequate signal to noise for both the small and large viewing areas associated with such displays.



Systems employing fixed pupil rotation deliver flawed information in terms of user experience.

Systems which match the Eye Rotation Point replicate real-world conditions.

True Eye Motion Representation

Luminance, color and uniformity versus angle of view are essential performance metrics in AR/VR/MR device characterization. Although some measurement systems attempt to replicate eye motion by rotating about the pupil's location, this can generate misrepresentative information in terms of the user experience. True representative information can only be attained by matching the rotation axis of the measurement system with that of the human eye.

Recent work has been done that defines a minimum essential set of measurement instrument characteristics to assure repeatable and reproducible photometric and colorimetric measurement results. These collective criteria are being used by the ISO, IEC TC110 and the ICDM committee of the Society for Information Display to establish regulations for the specification and safety of such systems.

Key Application Areas

We provide test & characterization solutions to ensure reliable, repeatable, and reproducible photometric and colorimetric measurement results for AR/VR/MR displays, head-up displays, helmet-mounted displays, avionic displays, medical and healthcare AR/MR devices and near-eye industrial, educational and training displays.

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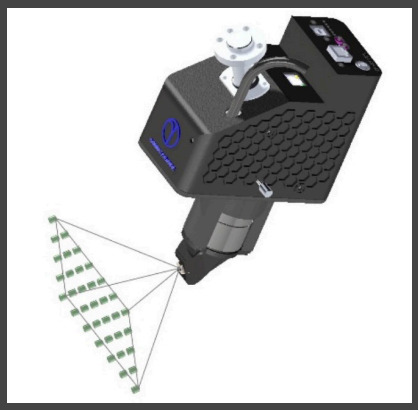
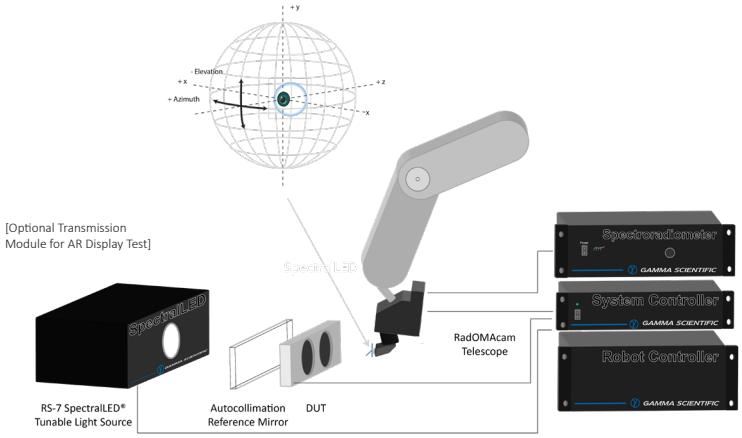
State-of-the-Art Camera System

The Radiometric Optical Multichannel Analyzer (RadOMA) camera/telescope integral optical head maps display uniformity at vantage point field of view, including luminance, CCT, CIE x,y, peak and dominant wavelength. An integrated programmable pattern generator displays any 2D / 3D test pattern and outputs in standard VDU formats such as Display Port and HDMI. With automatic scaling to any display resolution, the system supports from synchronous updates for motion artifact analysis.



NED-LMD GS-E10 R&D Reference Test System

The patented GS-E10 R&D Reference Test System consists of a System Controller, a high-accuracy Spectroradiometer with exceptional low-light measurement capability, a high resolution SpectralLED® tunable light source system and a high-resolution state-of-the-art RadOMA telescope with Motorized/Auto Focus functionality over +/-10Diopter range mounted to a precision 6-axis industrial robot.



The various elements of the system are fully integrated and configured by Gamma Scientific to ensure out-of-the-box, plug and play operation.

NED-LMD GS-E10 System Specifications

Telescope for Reference Test System	• 12 MP camera, 250 pixel/degree, 0.24'/pixel, 2-5 mm aperture (entrance pupil) • 16 x 12 degree horizontal / vertical measurement area • +/- 10 diopter adjustment (+/-0.1m to infinity) with motorized or auto focus • <1% polarization error between s- and p-
GS-1290-3 Spectroradiometer	• Luminance 0.05 to 10,000 nits • Chromaticity x=0.0008, y=0.0004
GS-940-7X Positioning Systems	• X,Y,Z positioning precision = +/-0.020 mm • ψ (psi) azimuth angle, α (alpha) elevation angle, resolution = 0.001, precision = 0.01 degrees • Qualified viewing space 50mm H x 250mm W x 30mm D for 170 x 44 degree field of view coverage

The above-listed specifications have been characterized for a collimated device under test (DUT). Specifications are subject to change without notice.

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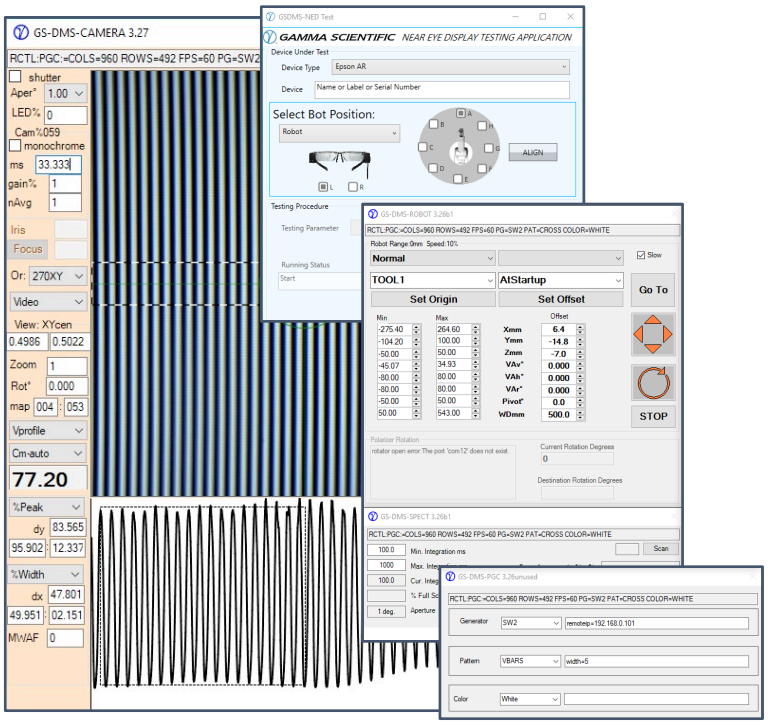


MTF and Position Screen Shots

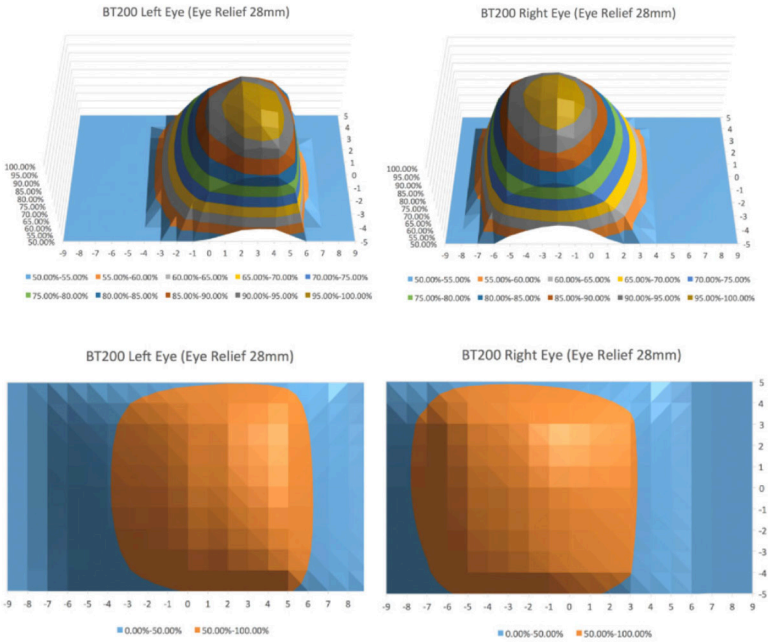
The GS-DMS software package is fully integrated and supplies all the tools necessary to align, and characterize luminance, color, luminance & color uniformity, field of view, contrast and resolution contrast and Modulation Transfer Function (MTF), in a programmable and automated process.

This is accomplished using a modular software structure that allows the flexibility to combine video pattern generation, goniometric, focusing and spatial positioning (for the reference test system), automatic data collection and test pattern generation and selection.

Custom test suites can be scripted to run multiple types of tests rapidly and consecutively.

Critical Enabling Design Features

- Compact size to allow positioning of entrance pupil at the design eye point
- High sensitivity / high dynamic range spectrometer with outstanding signal to noise for small and large areas
- Exceptional color measurement spectral purity
- Ability to cover over 160 degree FOV with high resolution measurements in the virtual image space
- Precision mechanical positioning to the design eye point (manual positioning options available)



Leveraging more than 40 years of expertise in field-deployed HUD measurement systems for US military aircraft including the F-16, F-18, F-117, B1B, C-17 and F-35 Gamma Scientific has unmatched depth of expertise in virtual image display measurement.

Rev 06.14.19

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