

SAE HEADLIGHT RATING STANDARDIZATION

STATIC EVALUATION RESULTS AND INITIAL THOUGHTS FOR A DYNAMIC EVALUATION

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HEADLIGHT PERFORMANCE ASSESSMENT NEEDS

1. Measure the important aspects of the vehicle's beam pattern,
 - a) Safety Light
 - b) Maneuvering / Foreground Light (driver perceived safety)
 - c) Glare (intensity & gradient transitions)
2. contain appropriately balanced targets for each of these aspects in terms of Safety, Maneuvering / Foreground Light, and Glare
3. correlate with other Headlight assessments
4. be repeatable, and
5. be predictable.

US HEADLIGHT PERFORMANCE ASSESSMENT SYSTEMS

CR Consumer Reports™
 ** Not to Scale

Publishing Ratings since 2004
 Lamps aimed prior to testing (CCD)
 Subjective Low & High Beam Evaluation
 Mainly Static Evaluation (target visibility)
 Covers many aspects of a beam pattern
 No Dynamic Feature Evaluation
 Requires calibrated set of eyes

IHS HLDI Insurance Institute for Highway Safety
 Highway Loss Data Institute

Low beams
 Optimal low-beam illumination
 High beams
 Optimal high-beam illumination
 Rating includes credit for high-beam assist

Press Releasing Ratings since 2016
 Lamp aim only checked (eye)
 Objective Low & High Beam Evaluation
 Dynamic Driving Evaluation (>5 lux)
 ONLY focused on Down Road light
 Pushes legal limits of a beam pattern
 Includes AHB and AFS, not ADB
 Complex & Expensive Rating Method

SAE INTERNATIONAL

Static Proposal

- G - Glare Photodetector @ 60m**
 4m to left @ 1.7 meter high
 -6 points when > 0.634 lux
- V_c - Visibility Photodetector @ 95m**
 straight @ 0.2m high
 ≥ 3 Lux = 5 points (= 3+ lux @ 95m)
 ≥ 2.40 Lux = 4 points (= 3+ lux @ 85m)
 ≥ 1.87 Lux = 3 points (= 3+ lux @ 75m)
 ≥ 1.40 Lux = 2 points (= 3+ lux @ 65m)
 ≥ 1.00 Lux = 1 point (= 3+ lux @ 55m)
- V_l - Visibility Photodetector @ 65m**
 4m to left @ 0.2 meter high
 ≥ 3 Lux = 5 points (= 3+ lux @ 65m)
 ≥ 2.56 Lux = 4 points (= 3+ lux @ 60m)
 ≥ 2.15 Lux = 3 points (= 3+ lux @ 55m)
 ≥ 1.78 Lux = 2 points (= 3+ lux @ 50m)
 ≥ 1.44 Lux = 1 point (= 3+ lux @ 45m)
- V_r - Visibility Photodetector @ 115m**
 4m to right of vehicle @ 0.2m high
 ≥ 3 Lux = 5 points (= 3+ lux @ 115m)
 ≥ 2.50 Lux = 4 points (= 3+ lux @ 105m)
 ≥ 2.05 Lux = 3 points (= 3+ lux @ 95m)
 ≥ 1.64 Lux = 2 points (= 3+ lux @ 85m)
 ≥ 1.28 Lux = 1 point (= 3+ lux @ 75m)

New SAE Rating Developed in 2016
 Lamps aimed prior to testing (eye)
 Objective Low Beam Evaluation
 Static Evaluation (>3 lux)
 ONLY focused on Down Road light
 Balance Glare, Gradient, and Seeing
 No Dynamic Feature Evaluation
 Simple Inexpensive Rating Method

POOR CORRELATION IMPACTS



IIHS 07DEC16: "Among 2017 models, only seven are available with good-rated headlights. They are the Chevrolet Volt small car, Honda Ridgeline pickup, Hyundai Elantra small car, Hyundai Santa Fe midsize SUV, Subaru Legacy midsize car, Toyota Prius v midsize car and Volvo XC60 midsize luxury SUV."

LT Hybrids/EV FWD 1.5-liter 4-cyl. electric, 1-speed Direct	RTL Pickup truck AWD 3.5-liter V6, 6-speed Automatic ✔ Recommended	SE Small car FWD 2-liter 4-cyl., 6-speed Automatic ✔ Recommended	GLS SUV AWD 3.3-liter V6, 6-speed Automatic ✔ Recommended	2.5i Premium Sedan AWD 2.5-liter 4-cyl., CVT ✔ Recommended	Three Wagon FWD 1.8-liter 4-cyl. hybrid, CVT ✔ Recommended	T6 SUV AWD 2-liter 4-cyl. turbo, 8-speed Automatic ✔ Recommended	Latitude SUV 4WD 2.4-liter 4-cyl., CVT

Headlight Rating



Vastly different headlight performance scores undermines the credibility of the ratings

STANDARDIZED ASSESSMENT METHOD

- Headlight Ratings are welcome, but the current US assessments:
 - do not include all the important aspects of a beam pattern
 - push requirements too far
 - have variability in the ratings
 - do not correlate with each other
- SAE would like to help by recommending a more comprehensive headlight rating system

SAE HEADLAMP ASSESSMENT

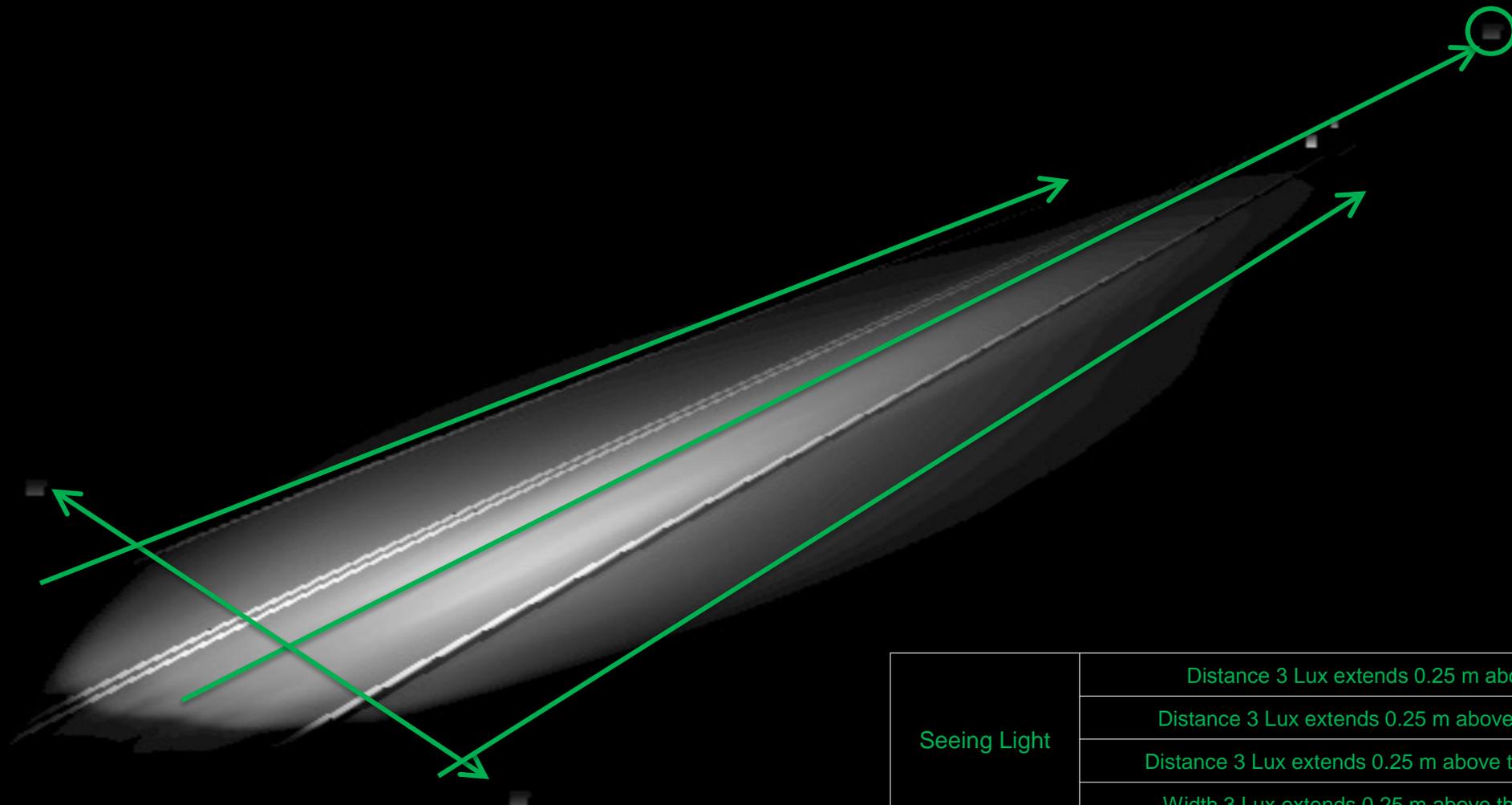
- SAE Task Force formed to develop a comprehensive headlight assessment
- Initial Direction, **2019 Status**:
 - Vehicle based evaluation on a test track – **Found this to be difficult for Uniformity, other Characteristics can be measured on a test track ... and simulated**
 - Defined, objective, and measurable criteria – **Criteria define, refining Targets**
 - Comprehends all aspects of a beam pattern's performance and targets an appropriate balance between seeing, glare, and comfort
 - **Important Characteristics are Comprehended**
 - **The Tradeoffs between opposing Characteristics may not be defined (eg: Glare & Seeing)**
 - Consistent Aim requirements following an accurate procedure – **Working**
 - Includes Dynamic aspects (ADB, AFS, etc.) – **In Concept Phase**

	Attribute	Measurement	Reference
Object Detection	Distance 3 Lux extends down the road in the driver's lane. (UMTRI)	3 Lux Distance on a Target 0.25m above road – Center of Lane	IIHS: RE = 100m, LE = 60m @ 5 lux Conversion: RE = 129m, LE = 77m @ 3 lux
	Distance 3 Lux extends down the left edge of the lane to the left of the driver's lane (UMTRI)	3 Lux on a Target 0.25 m above road – Left edge to the Left	IIHS: RE/LE(250m Rad) = 70m @ 5 lux Conversion: RE/LE = 90m @ 3 lux
	Distance 3 Lux extends down the right edge of the lane to the right of the driver's lane (UMTRI)	3 Lux on a Target 0.25 m above road – Right edge Lane to the Right	IIHS: RE/LE(250m Rad) = 70m @ 5 lux Conversion: RE/LE = 90m @ 3 lux
	Object Detection Width at 25 meters in front of vehicle	3 Lux Width Distance on a Target 0.25 m above road	IIHS: RE/LE(150m Rad) = 60m @ 5 lux Conversion: RE/LE = 77m @ 3 lux
	Object Detection Width at 5 meters in front of vehicle	3 Lux Width Distance on a Target 0.25 m above road	IIHS: RE/LE(150m Rad) = 60m @ 5 lux Conversion: RE/LE = 77m @ 3 lux
	Sign Light	Sign Light not lighting signs	Any information??
Foreground Light	Lit Road Width 5 meters in front of vehicle	Lit Road Width on the Road (cosine corrected)	
	Lit Road Distance Down Road	Lit Road Distance on the Road (cosine corrected)	
	Area / Shape of Lit Road	??	Ford Customer Pleasing Beam
	Uniformity		1999-01-0700 Software Controlled Homogeneity Analysis of Headlamp Light Distribution
Gradient	Sharpness	FMVSS procedure	Gradient sharpness along entire gradient
	Sharpness at locations along		
	Shape		ECE, VOR, VOL, Country Light, Flat, IIHS
Glare	Opposing Glare	Opposing Eye Lux	
	Mirror Glare	Mirror Glare	

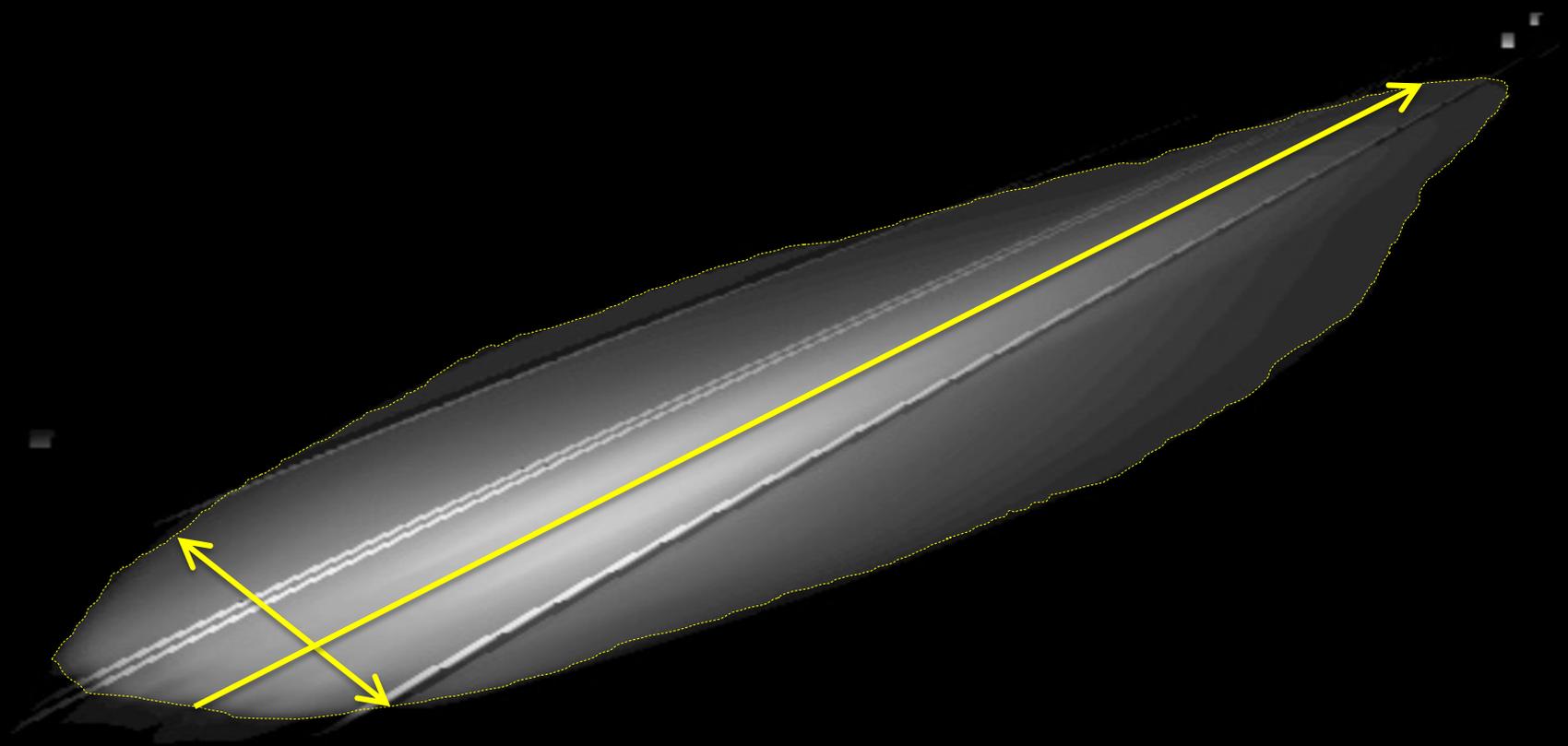
Original from 2017 – Low Beam

CURRENT SAE SUMMARY FOR LOW BEAM

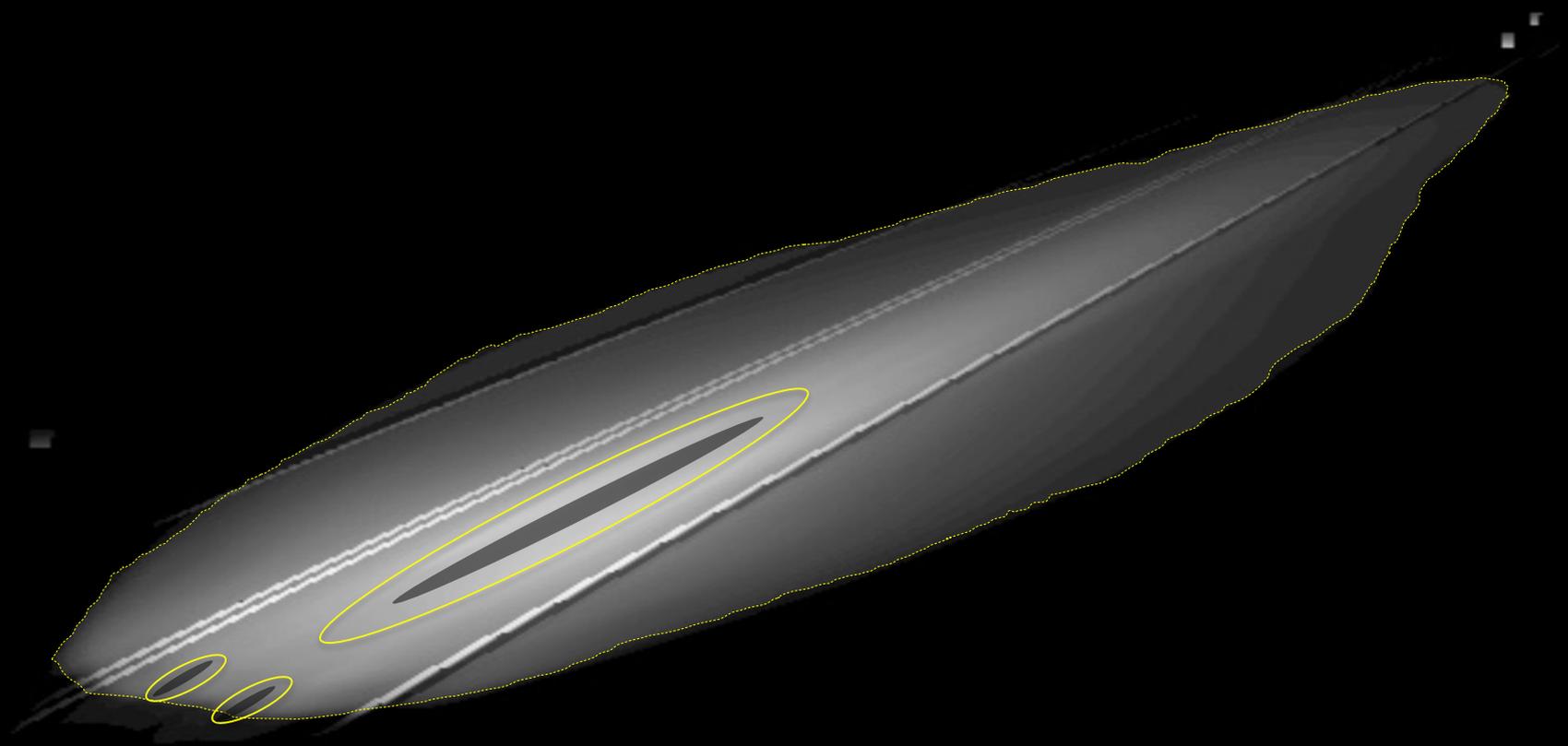
Category	Characteristic	Vehicle Test or Simulation
Seeing Light	Distance 3 Lux extends 0.25 m above the road in the driver's lane	Vehicle
	Distance 3 Lux extends 0.25 m above the left edge of a lane to the left	Vehicle
	Distance 3 Lux extends 0.25 m above the right edge of a lane to the right	Vehicle
	Width 3 Lux extends 0.25 m above the road 5 meters in front of vehicle	Vehicle
Foreground / Maneuvering	Width that 1 Lux Cosine Corrected extends 5 meters in front of vehicle	Vehicle
	Distance 1 Lux Cosine Corrected extends down the road in the driver's lane	Vehicle
	Uniformity – Number of Detectable Streaks	Simulation
Gradient	Gradient Sharpness – Less Sharp is Better	Vehicle
Glare	Opposing Eye Lux and/or [Ratio of Opposing Eye Lux when Aimed up 0.5 deg and Opposing Eye Lux]	Vehicle



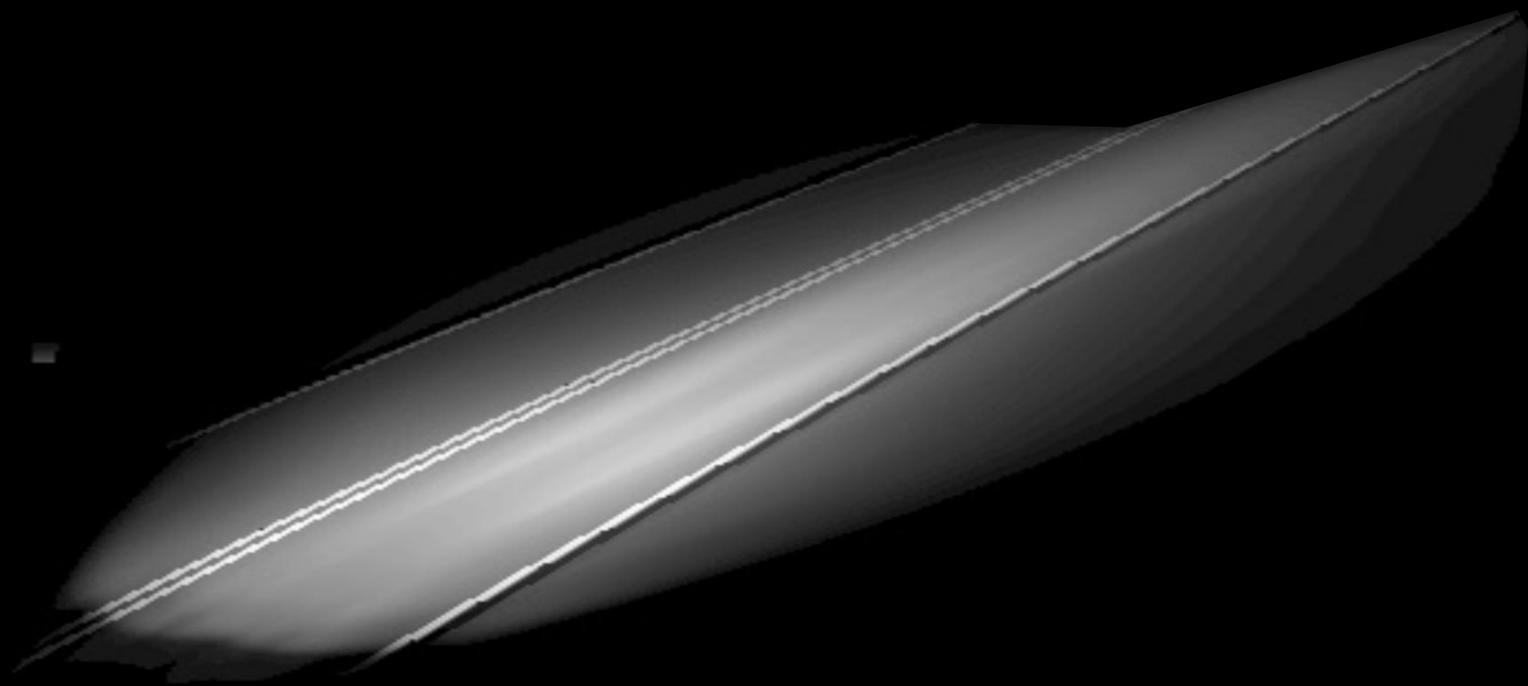
Seeing Light	Distance 3 Lux extends 0.25 m above the road in the driver's lane
	Distance 3 Lux extends 0.25 m above the left edge of the lane to the left
	Distance 3 Lux extends 0.25 m above the right edge of the lane to the right
	Width 3 Lux extends 0.25 m above the road 5 meters in front of vehicle



Foreground / Maneuvering	Width that 1 Lux Cosine Corrected extends 5 meters in front of vehicle
	Distance that 1 Lux Cosine Corrected extends down the road in the driver's lane

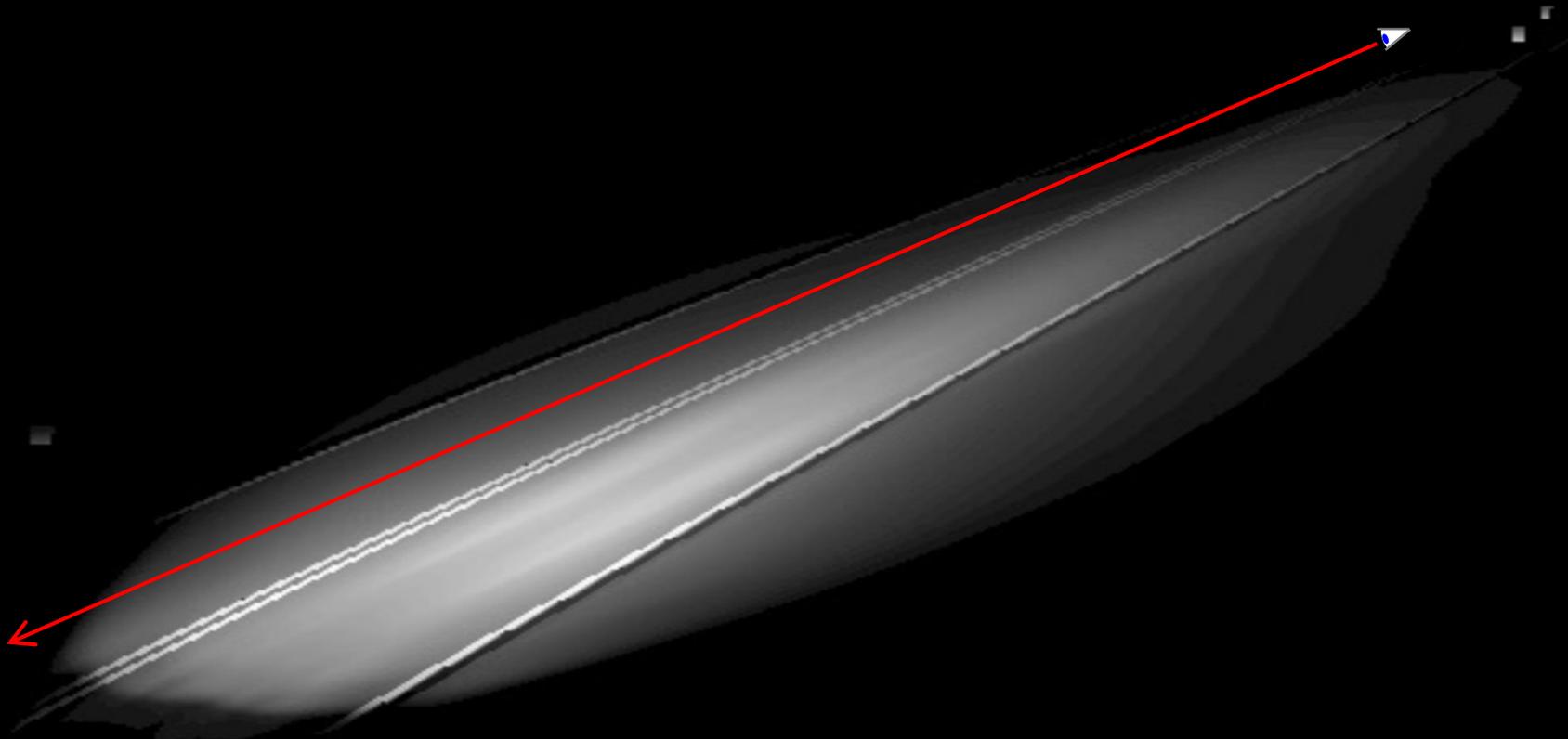


Foreground / Maneuvering	
	Uniformity – Number of Detectable Streaks (Simulation)

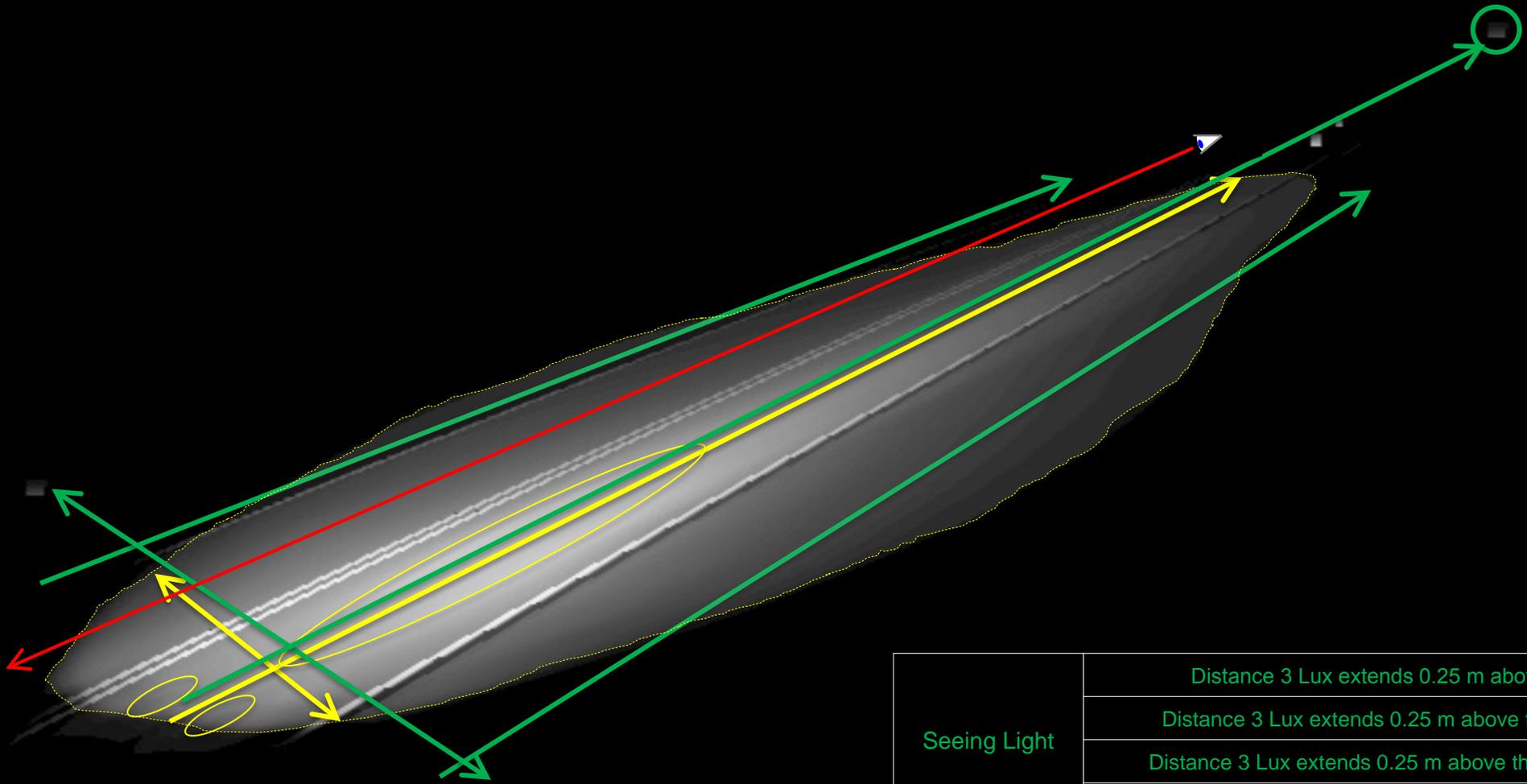


Gradient

Gradient Sharpness – Less Sharp is Better



Glare	Opposing Eye Lux and/or Ratio of Opposing Eye Lux when Aimed up 0.5 deg and Opposing Eye Lux
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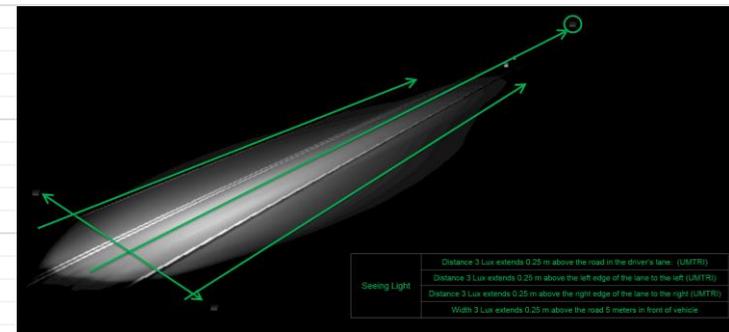
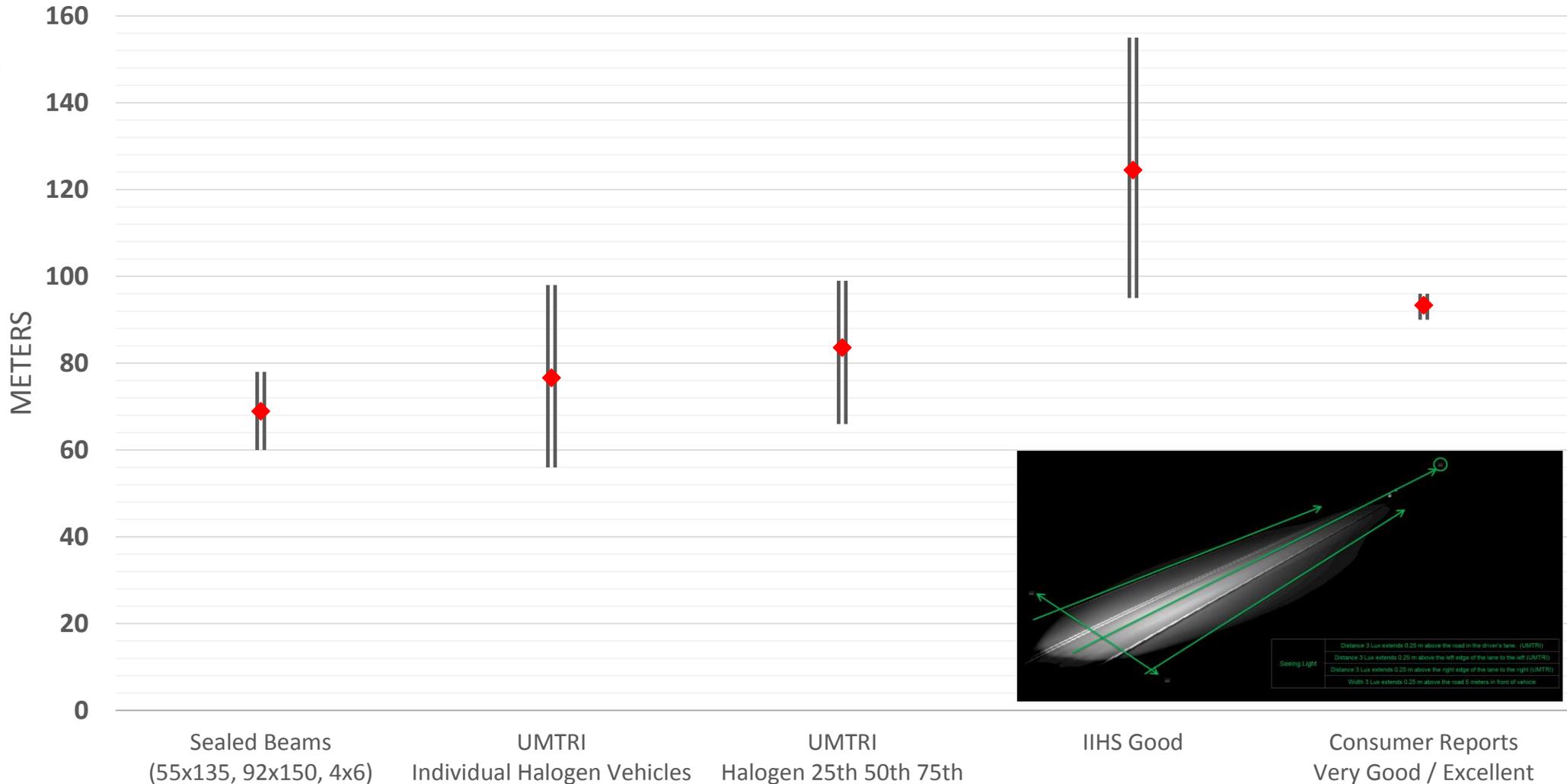


Seeing Light	Distance 3 Lux extends 0.25 m above the road in the driver's lane
	Distance 3 Lux extends 0.25 m above the left edge of the lane to the left
	Distance 3 Lux extends 0.25 m above the right edge of the lane to the right
	Width 3 Lux extends 0.25 m above the road 5 meters in front of vehicle
Foreground / Maneuvering	Width that 1 Lux Cosine Corrected extends 5 meters in front of vehicle
	Distance that 1 Lux Cosine Corrected extends down the road in the driver's lane
	Uniformity – Number of Detectable Streaks (Simulation)
Gradient	Gradient Sharpness – Less Sharp is Better
Glare	Opposing Eye Lux and/or Ratio of Opposing Eye Lux when Aimed up 0.5 deg and Opposing Eye Lux

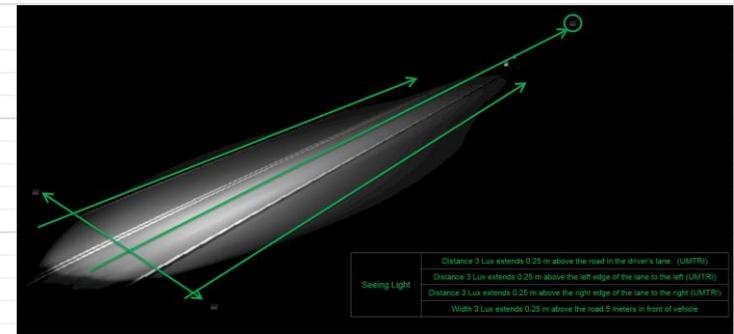
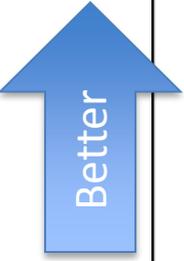
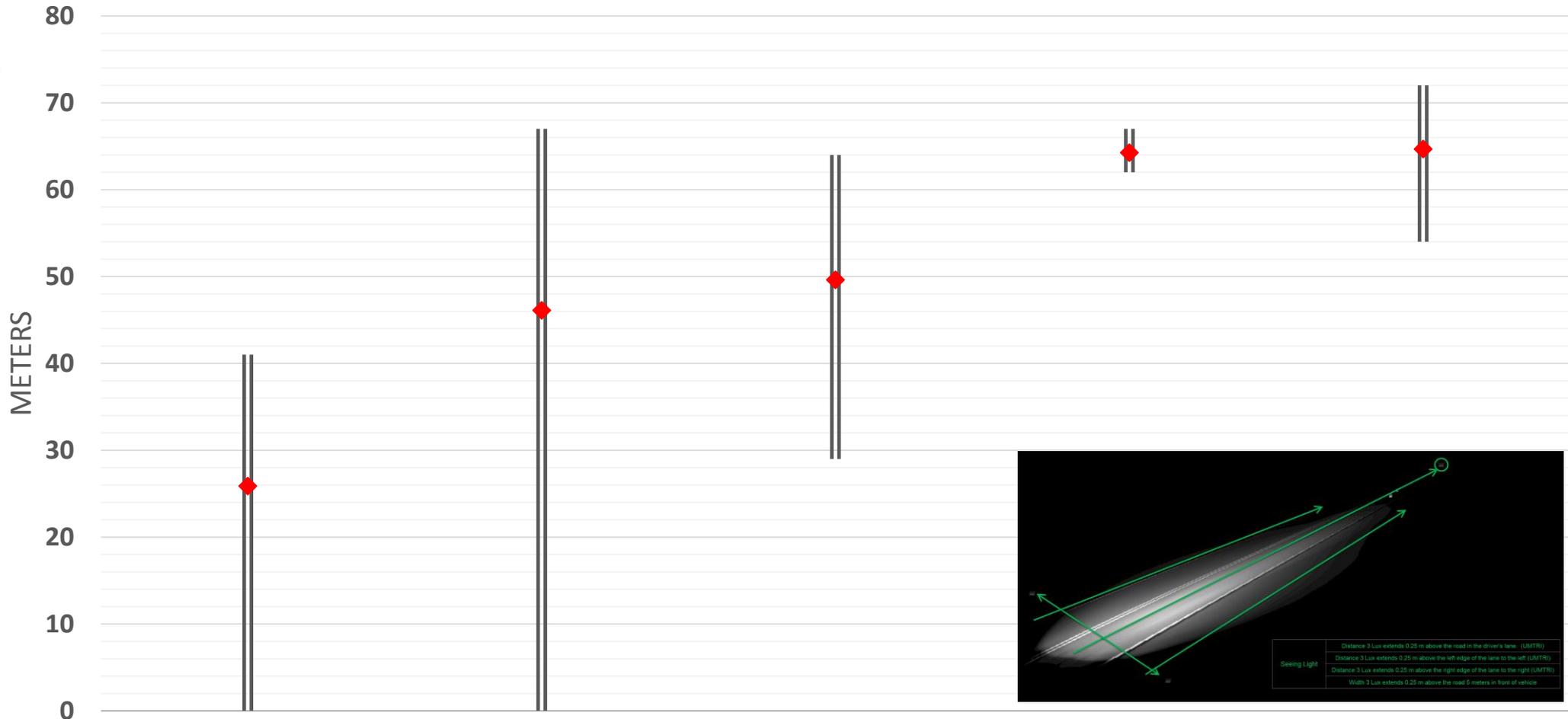
RESULTS

- Simulated a number of Low Beam headlamps against these Characteristics
 - ✓ UMTRI
 - Individual Halogen Vehicles
 - 25th, 50th, and 75th Percentile Patterns at multiple mounting heights
 - ✓ IIHS – Good Rated Headlamps
 - ✓ CR – Very Good & Excellent Headlamps
 - ✓ Sealed Beams

3 Lux Distance Down the Road in the Driver's Lane



3 Lux Distance Down the Road Left Edge of Lane to Left



Sealed Beams
(55x135, 92x150, 4x6)

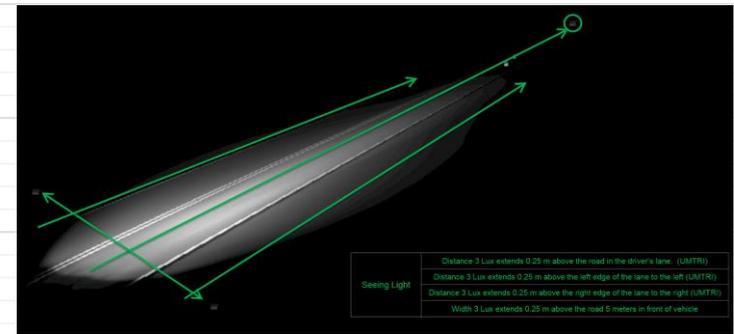
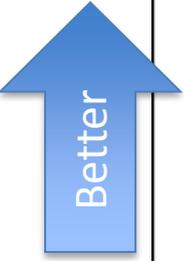
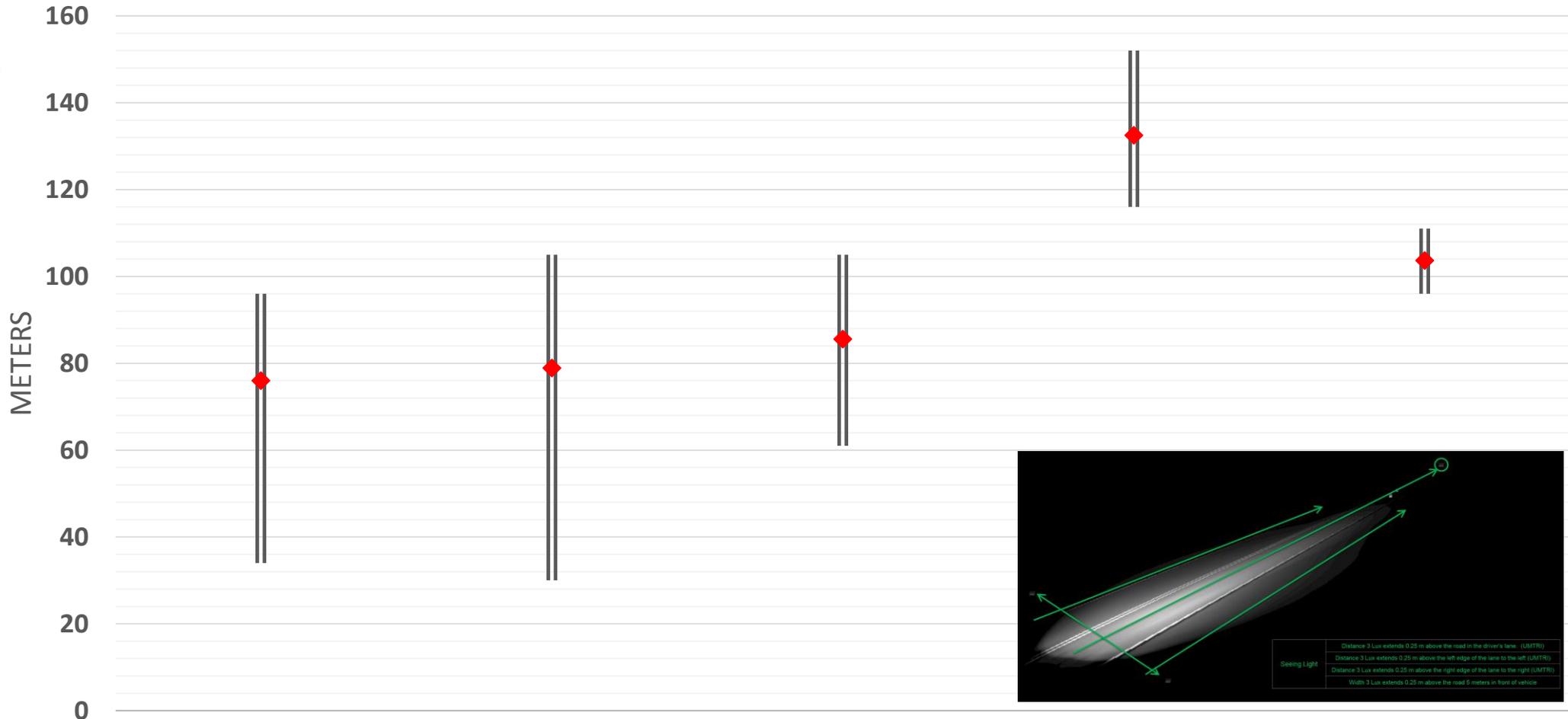
UMTRI
Individual Halogen Vehicles

UMTRI
Halogen 25th 50th 75th

IIHS Good

Consumer Reports
Very Good / Excellent

3 Lux Distance Down the Road Right Edge of Lane to Right



Sealed Beams
(55x135, 92x150, 4x6)

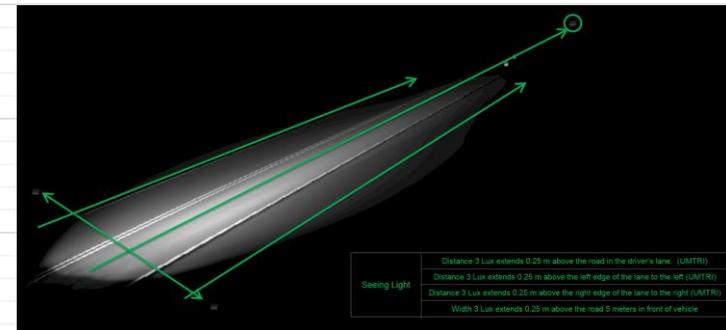
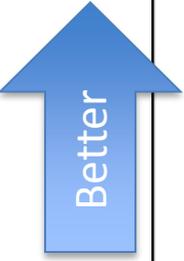
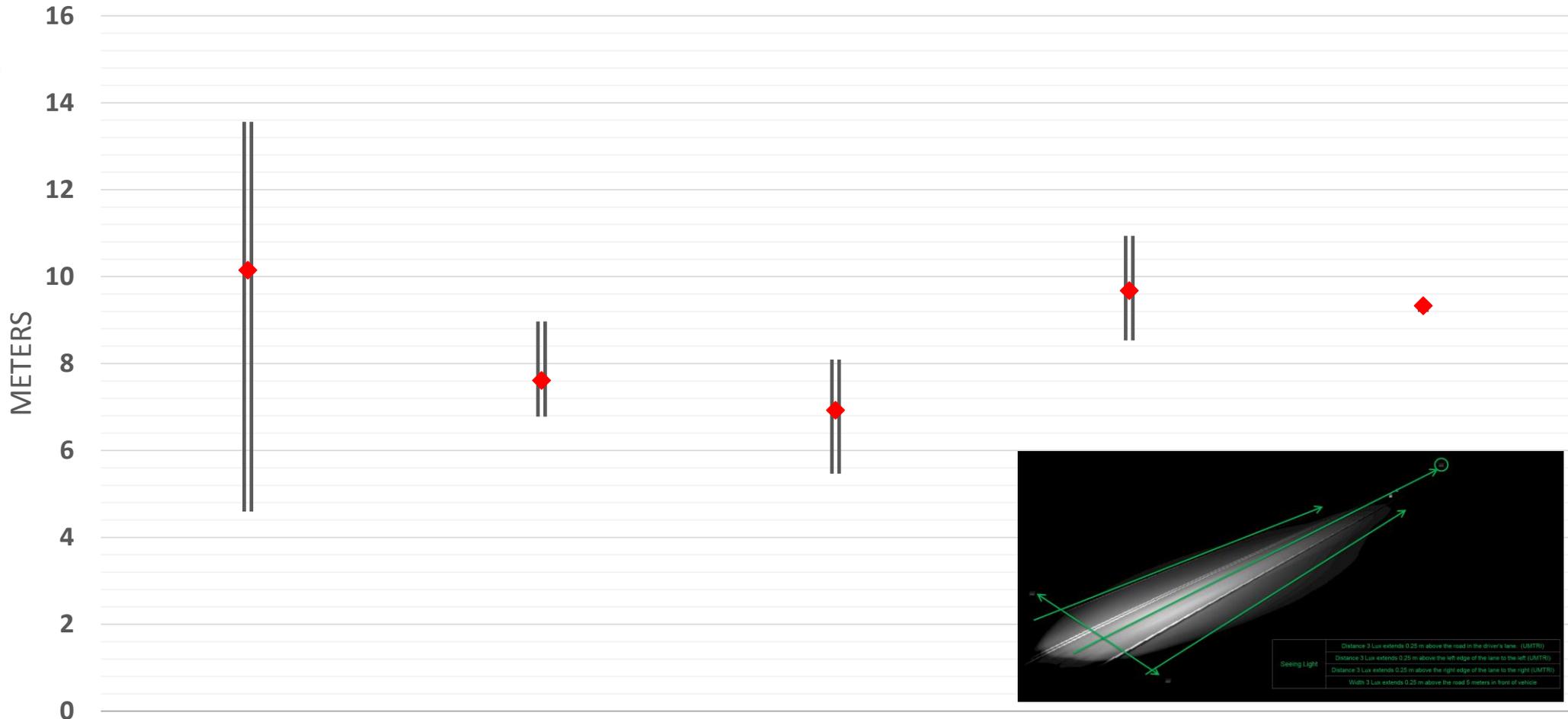
UMTRI
Individual Halogen Vehicles

UMTRI
Halogen 25th 50th 75th

IIHS Good

Consumer Reports
Very Good / Excellent

3 Lux Width at 5 meters in Front of Vehicle



Sealed Beams
(55x135, 92x150, 4x6)

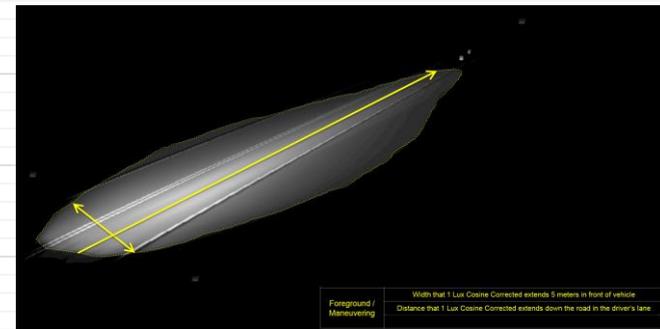
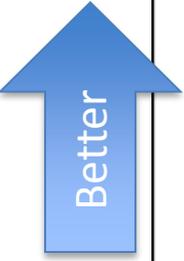
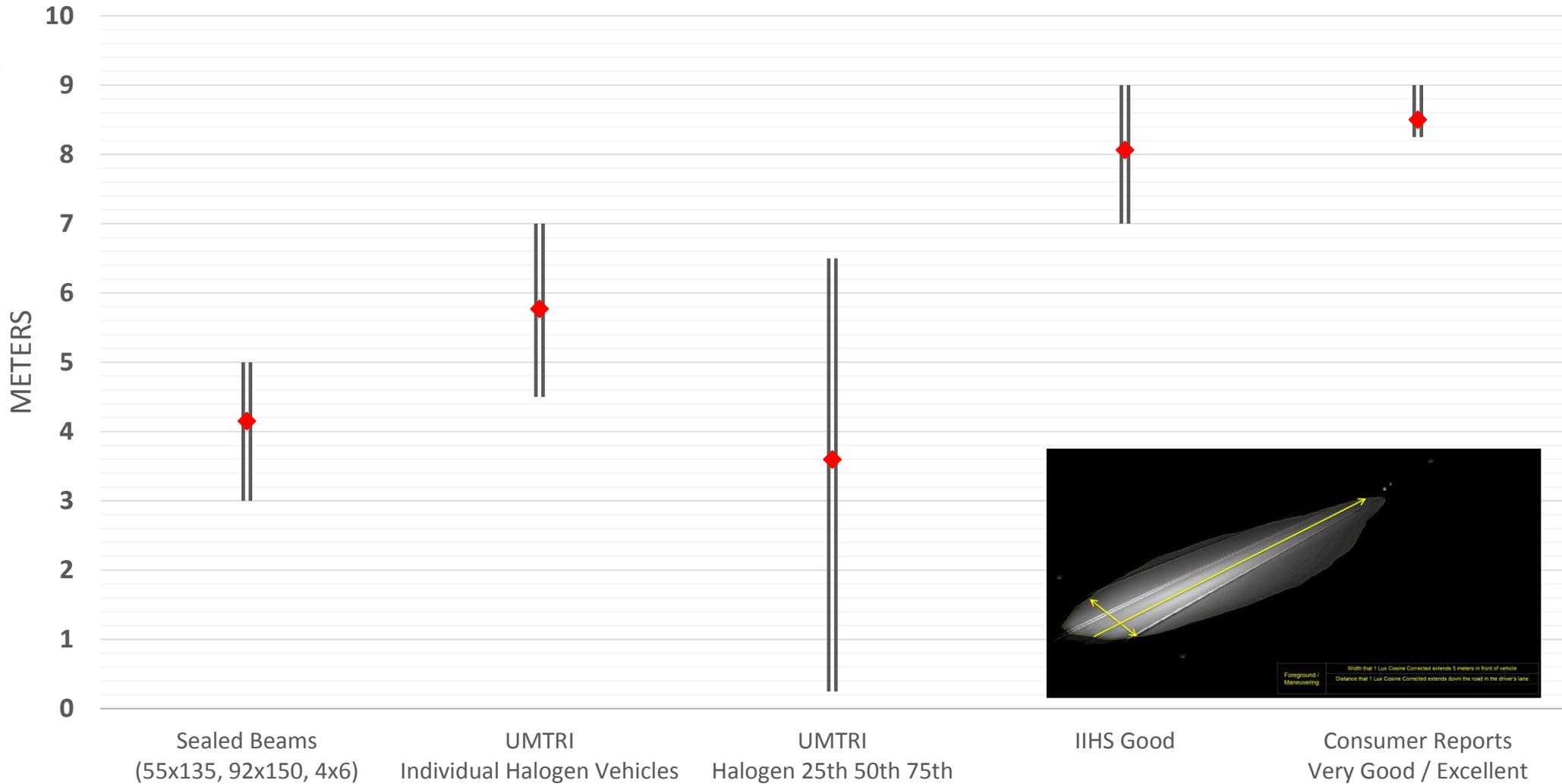
UMTRI
Individual Halogen Vehicles

UMTRI
Halogen 25th 50th 75th

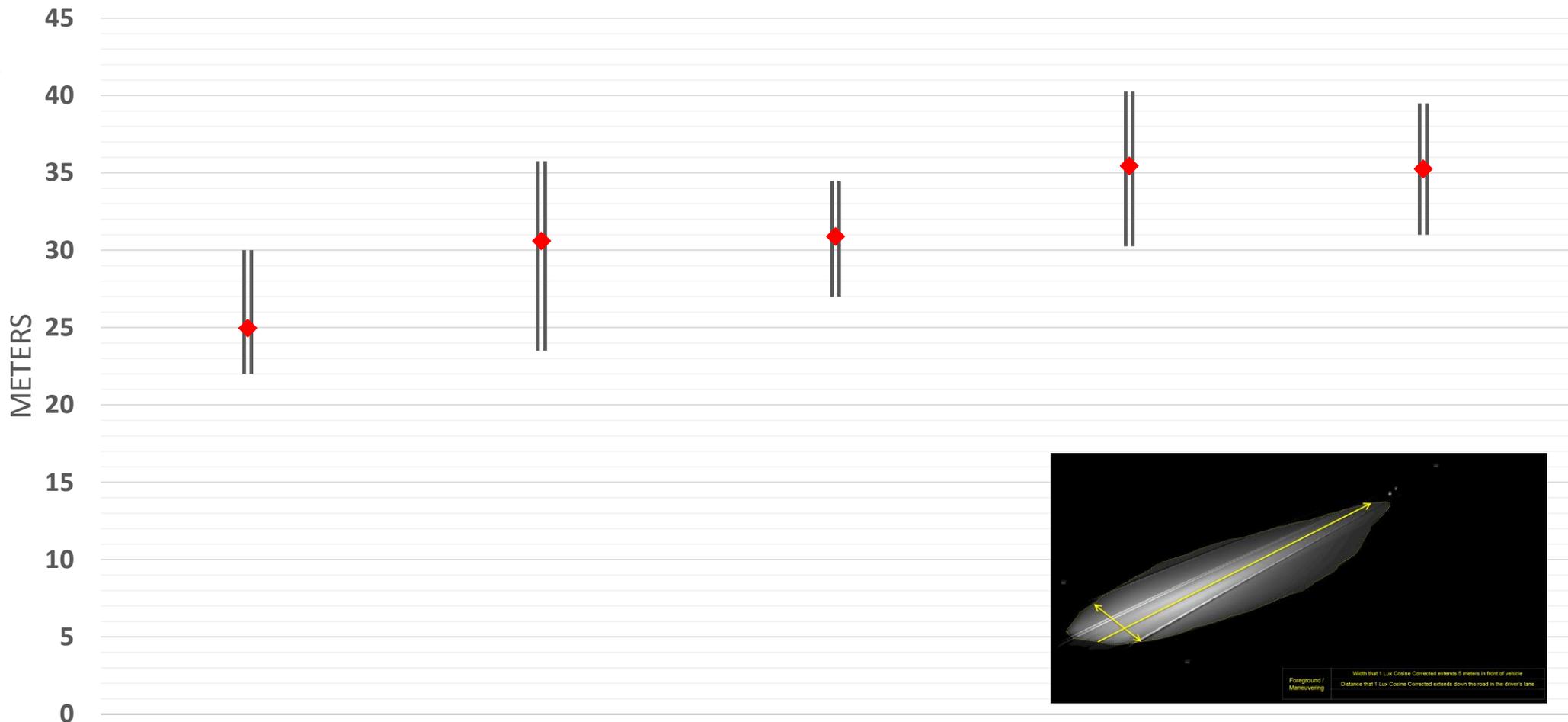
IIHS Good

Consumer Reports
Very Good / Excellent

Lit Road Width 5 meters in Front of Vehicle



Lit Road Range Down Road



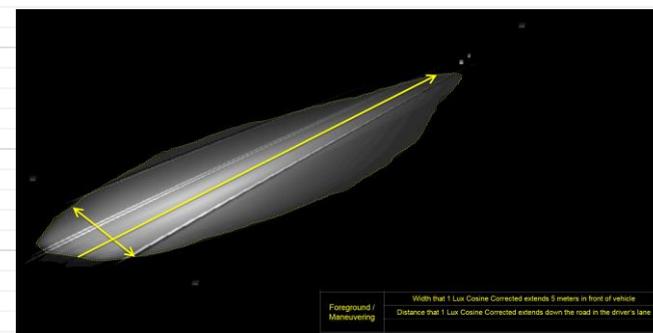
Sealed Beams
(55x135, 92x150, 4x6)

UMTRI
Individual Halogen Vehicles

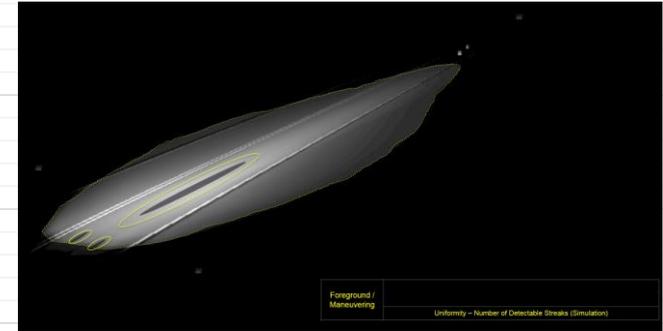
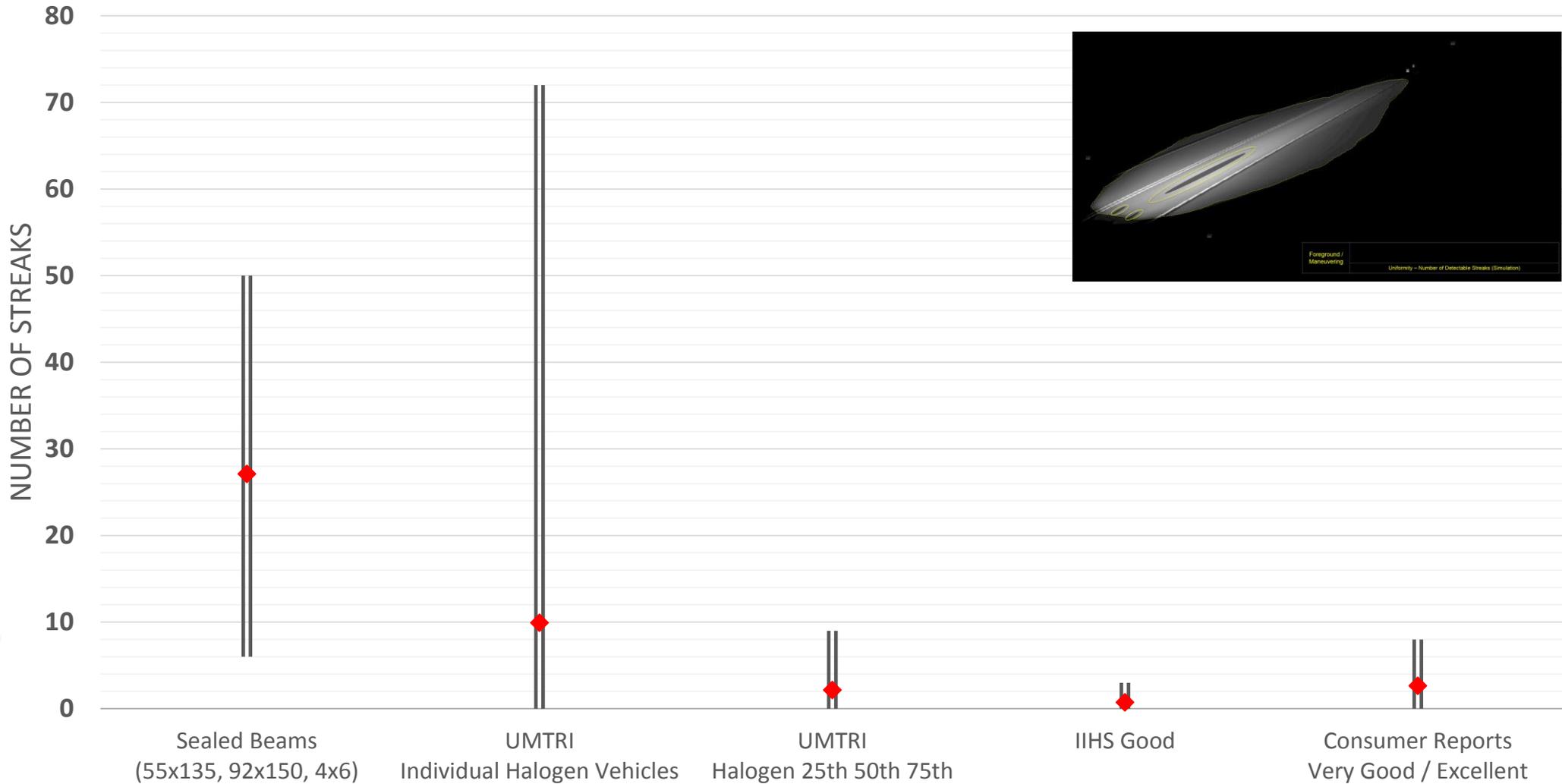
UMTRI
Halogen 25th 50th 75th

IIHS Good

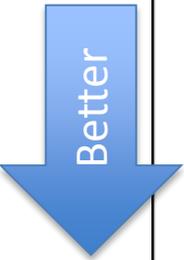
Consumer Reports
Very Good / Excellent



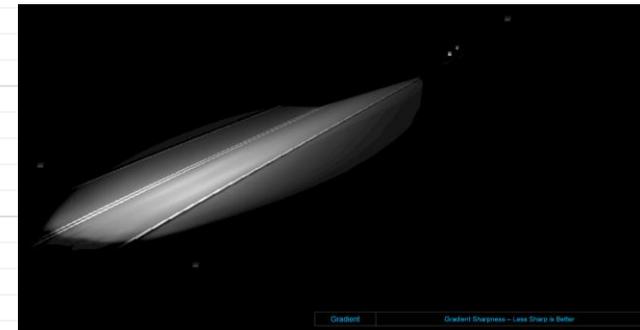
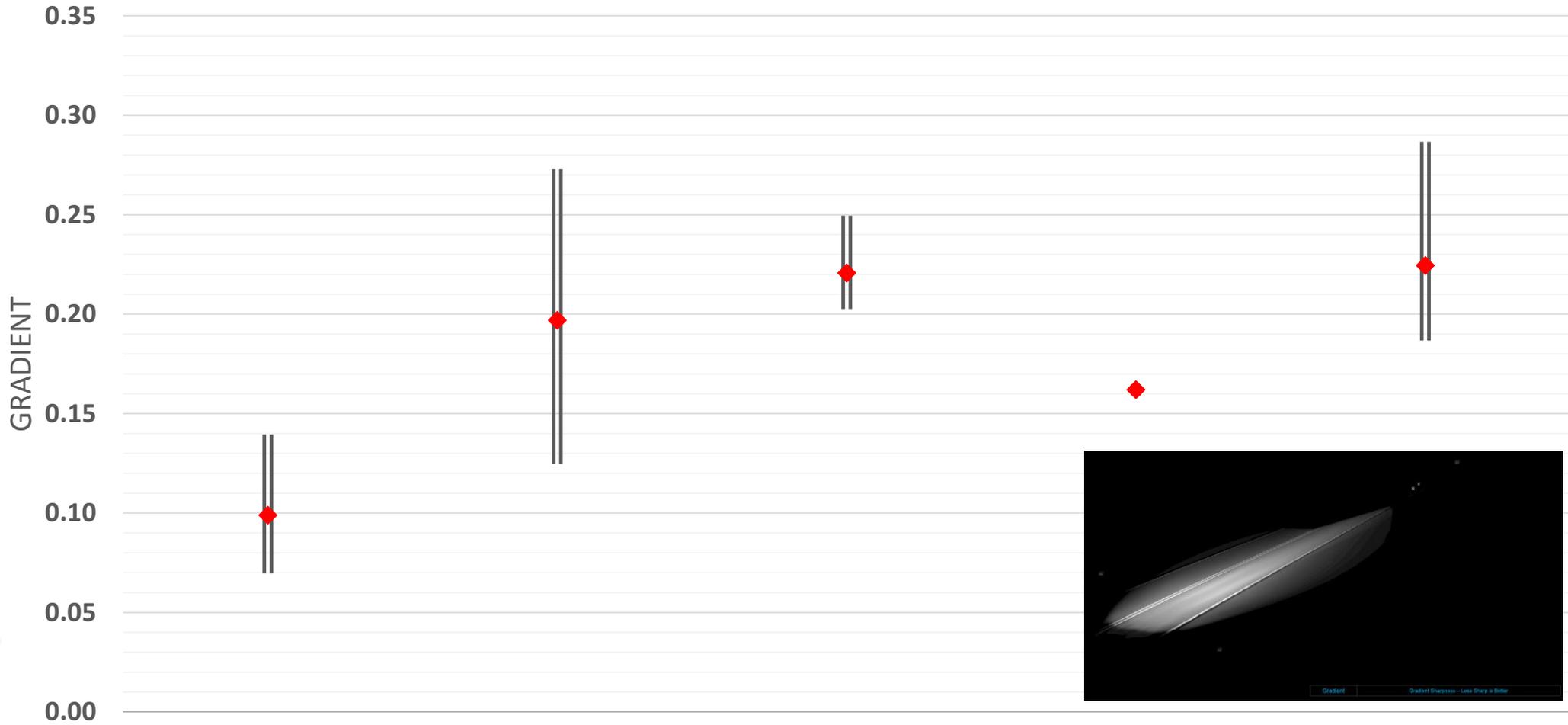
Uniformity



Better



Gradient Sharpness



Better

Sealed Beams
(55x135, 92x150, 4x6)

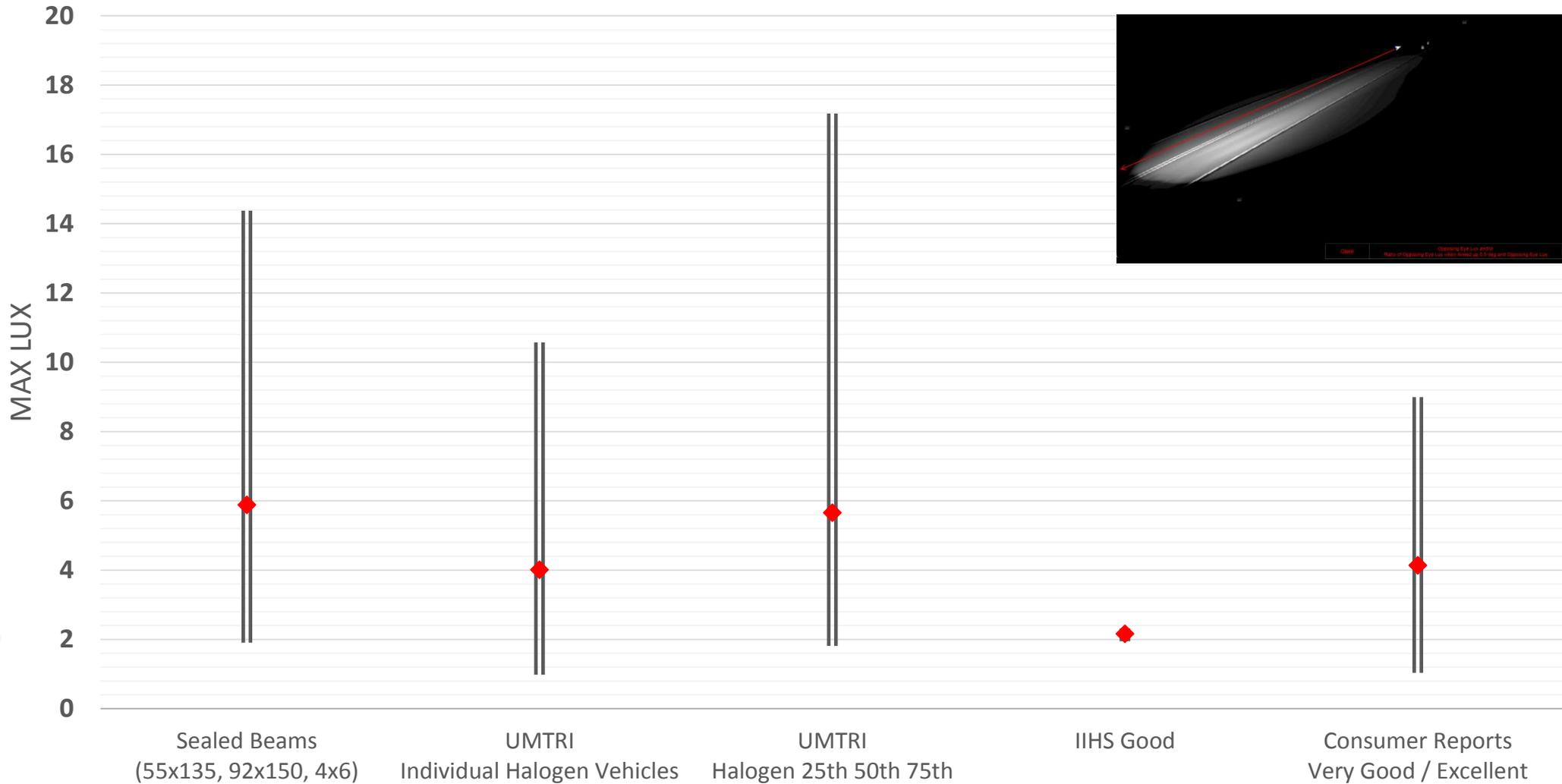
UMTRI
Individual Halogen Vehicles

UMTRI
Halogen 25th 50th 75th

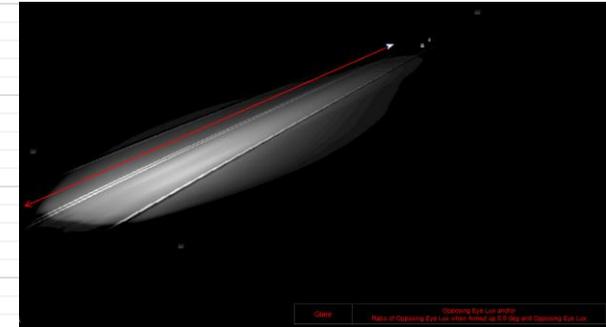
IIHS Good

Consumer Reports
Very Good / Excellent

Opposing Glare



Better



Opposing Glare Ratio

Proposal - Ratio of Opposing Eye Lux Aimed up 0.5° versus Opposing Eye Lux

GLARE @ 0.5° UP / PROPER AIM GLARE



Better

0

Sealed Beams
(55x135, 92x150, 4x6)

UMTRI
Individual Halogen Vehicles

UMTRI
Halogen 25th 50th 75th

IIHS Good

Consumer Reports
Very Good / Excellent

1600

1400

1200

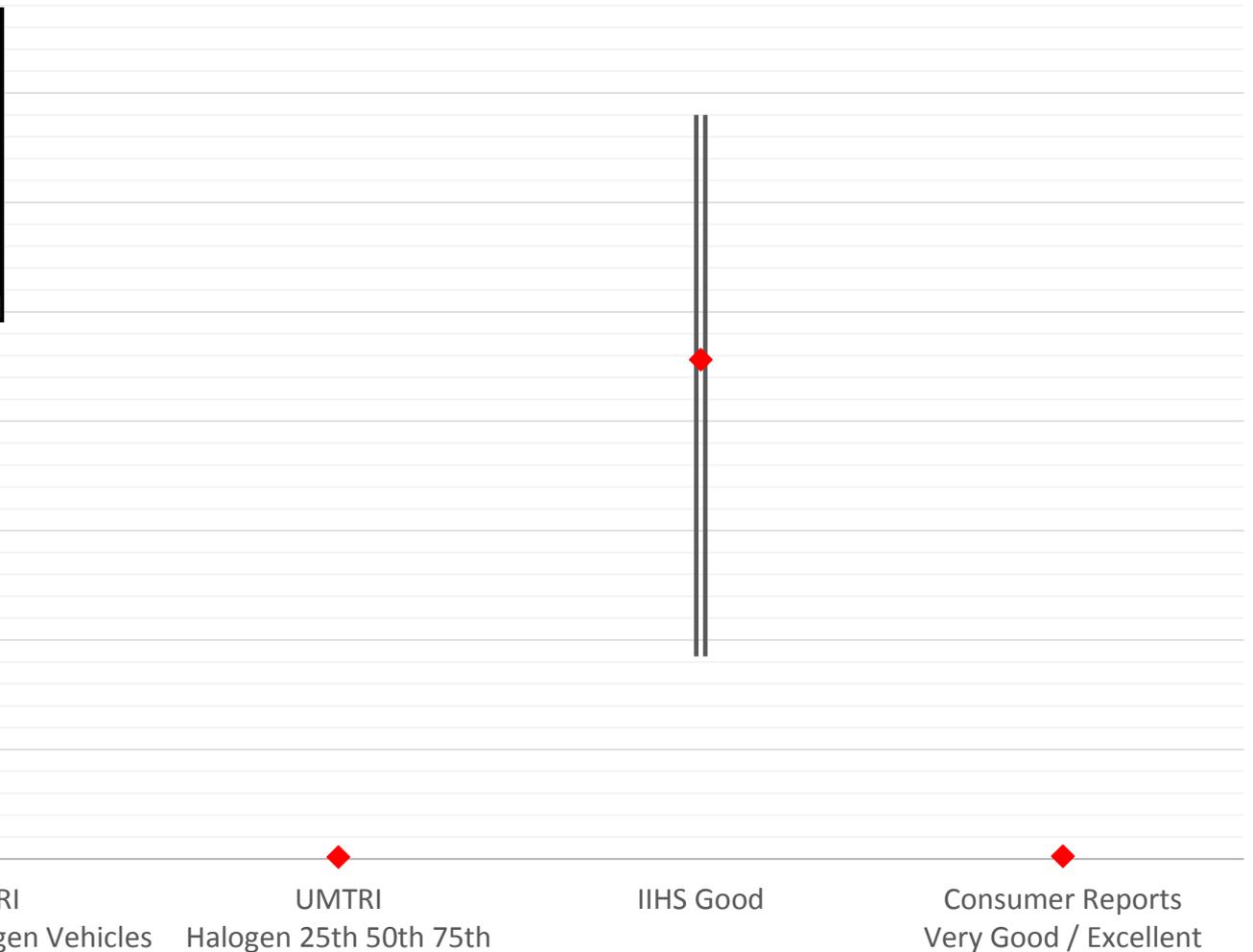
1000

800

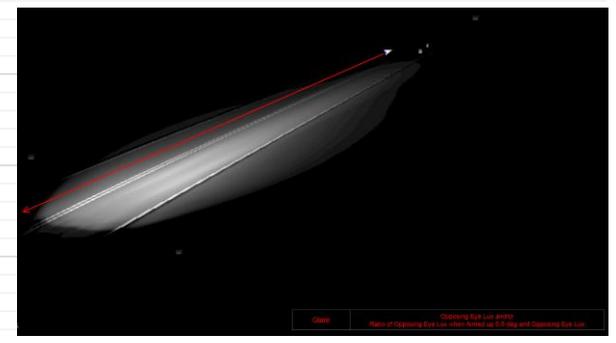
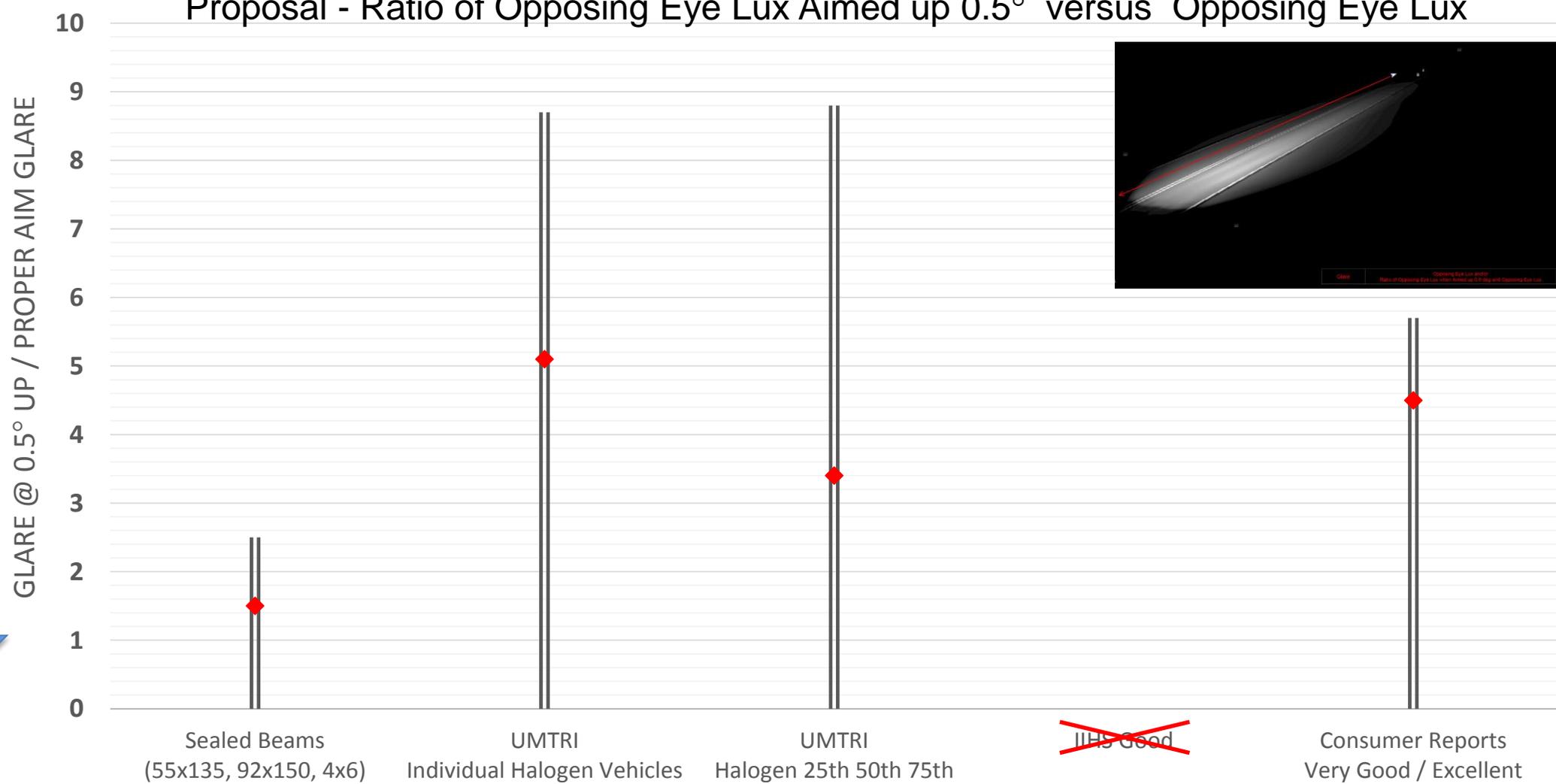
600

400

200

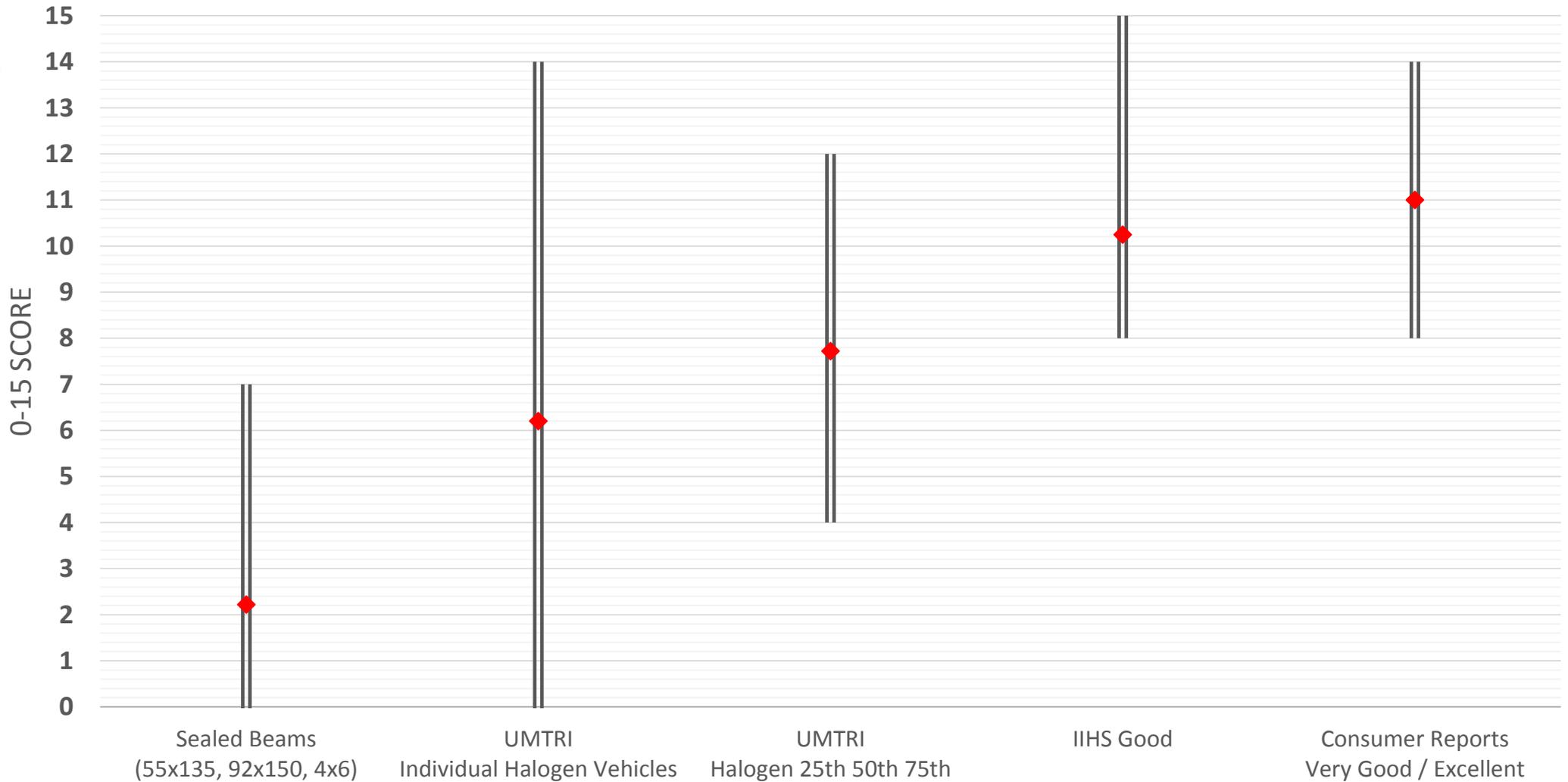
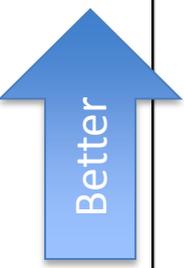


Opposing Glare Ratio Proposal - Ratio of Opposing Eye Lux Aimed up 0.5° versus Opposing Eye Lux

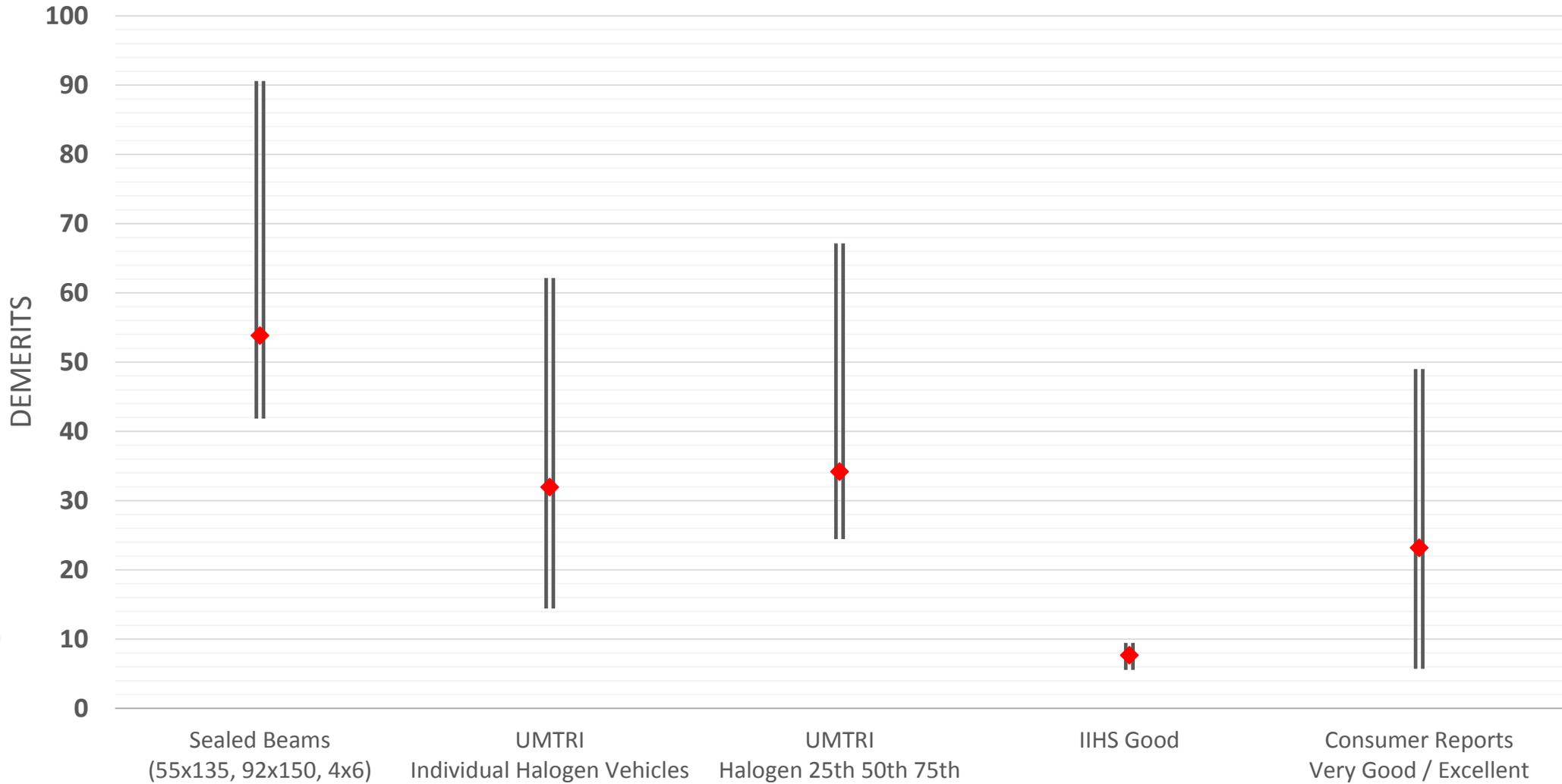


OTHER INTERESTING INFORMATION

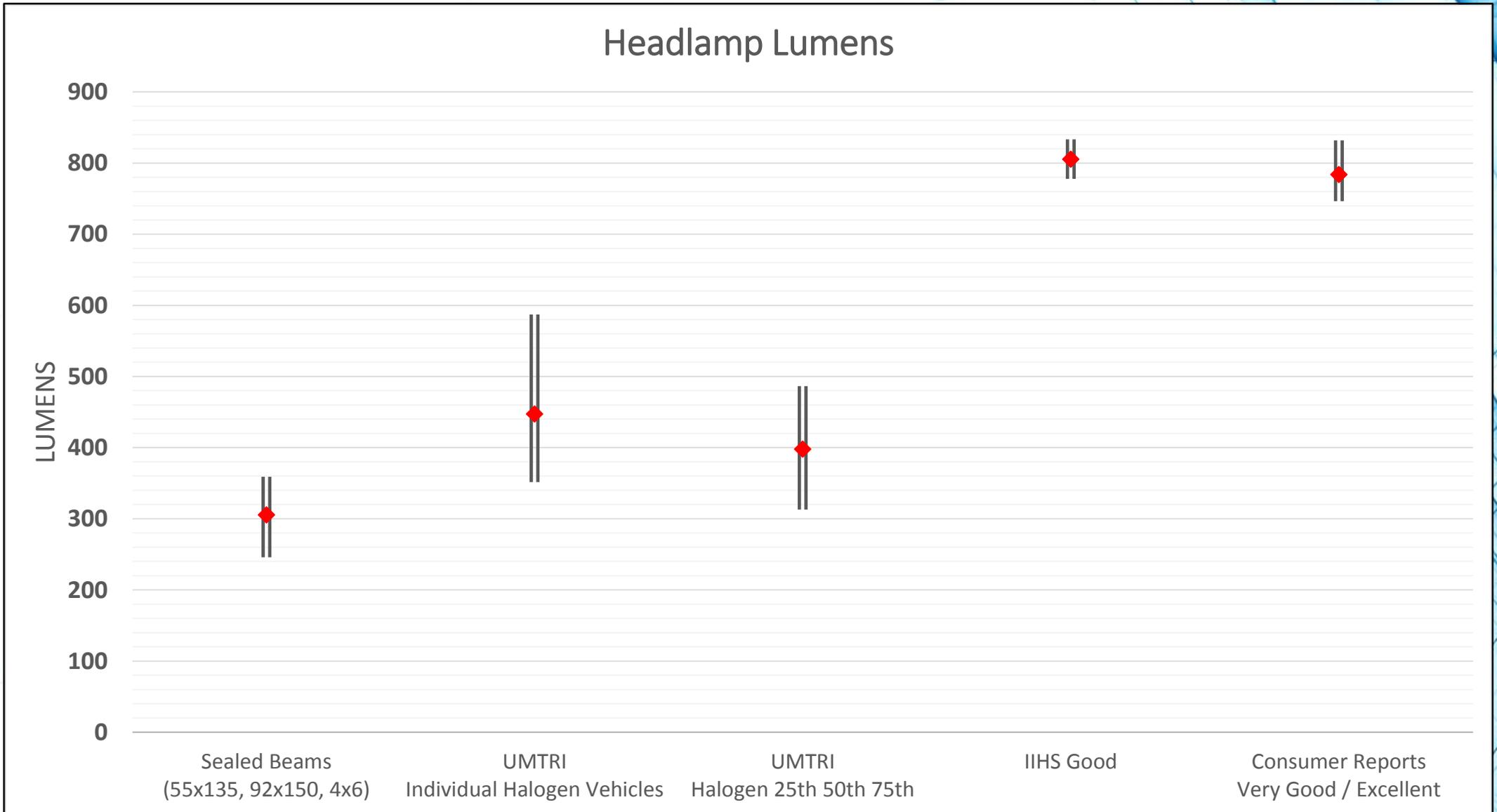
SAE NCAP Low Beam



IIHS Demerits - Low Beam Only



Better



DYNAMIC EVALUATION - INITIAL THOUGHTS

- A dynamic evaluation would mainly focus on ADB, Bending Light, Motorway, etc. i.e. dynamically activated features
- IIHS already evaluates Low Beam dynamically
 - Perhaps start with a similar method ...
 - Adding opposing headlights to the test
 - Remove the measurement complexity
- The SAE Task Force would be interested in any suggestions

SUMMARY - STATIC LOW BEAM EVALUATION

- SAE has developed a test track low beam static evaluation method low beam
 - But, an objective test track beam pattern uniformity method not been developed
 - Performance thresholds are being established
- Any contribution of lamps or photometric data to the SAE Task Force of “Good” performing Low Beams would be appreciated
 - An ies or Excel matrix of data ... or a lamp
 - Contact michael.larsen@gm.com

Seeing Light	Distance 3 Lux extends 0.25 m above the road in the driver's lane
	Distance 3 Lux extends 0.25 m above the left edge of the lane to the left
	Distance 3 Lux extends 0.25 m above the right edge of the lane to the right
Foreground / Maneuvering	Width 3 Lux extends 0.25 m above the road 5 meters in front of vehicle
	Width that 1 Lux Cosine Corrected extends 5 meters in front of vehicle
	Distance that 1 Lux Cosine Corrected extends down the road in the driver's lane
Gradient	Uniformity – Number of Detectable Streaks (Simulation)
Glare	Gradient Sharpness – Less Sharp is Better
	Opposing Eye Lux and/or Ratio of Opposing Eye Lux when Aimed up 0.5 deg and Opposing Eye Lux

SAE HEADLIGHT RATING STANDARDIZATION

STATIC EVALUATION RESULTS AND INITIAL THOUGHTS FOR A DYNAMIC EVALUATION

Michael Larsen, Exterior Lighting Technical Fellow

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Thank You