DVN Detroit Glare Forum Report

23 September 2025

DrivingVisionNews.com
Automotive lighting, driver assistance and smart interior
Published by
Driving Vision News, 116 rue Jules Guesde, 92300-Levallois-Perret France
Website: DrivingVisionNews.com

Glare Forum

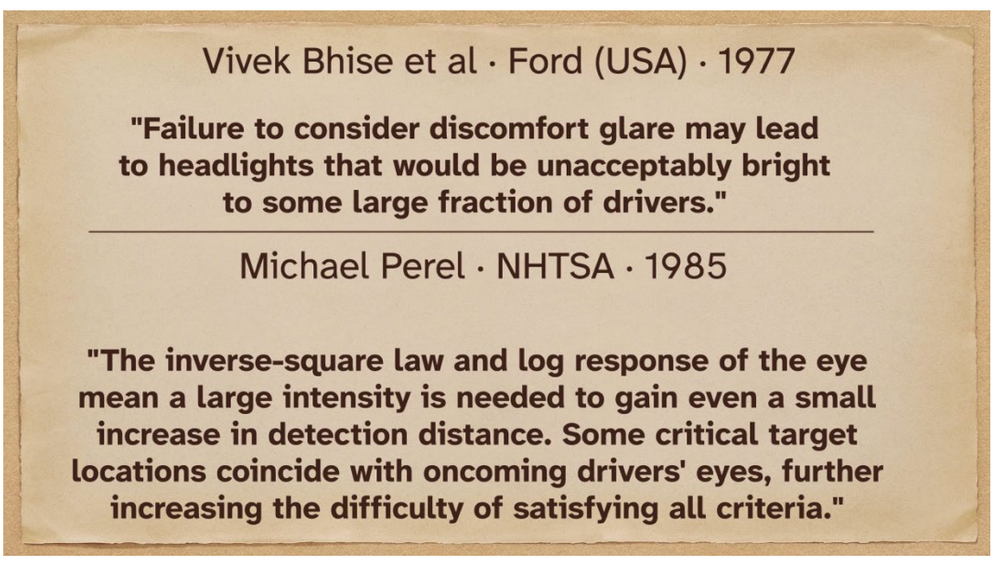
Introduction
Daniel Stern · DVN Chief Editor

The afternoon before the main workshop events got started, a special DVN Glare Forum was held, with lecture presentations and a panel discussion to address the hot-and-getting-hotter topic of traffic glare.

DVN Chief Editor Daniel Stern chaired the forum, which he opened by setting the issue in its geographical and historical context: American regulations and technical standards have long placed much less priority and emphasis on glare than those in Europe and, in fact, virtually the entire rest of the world outside the "American regulatory island" where UN Regulations are disregarded. He pointed out that this means findings and recommendations from elsewhere aren't necessarily applicable to the glare situation in the U.S. or vice-versa.

As an example, Stern cited U.S. findings that the blue content of the light from an LED headlamp means if it directs 1,000 candela toward oncoming eyes, it feels like 1,600 cd from a halogen lamp (without much blue in the output). At the same time, European researchers have found that LED low beams rich in blue light garner glare ratings only 0.5 step worse on the De Boer scale than halogen low beams. Both findings are true and correct; the very low intensity ECE low beams direct toward oncoming drivers renders the light colour substantially irrelevant to glare, while the high glare intensity of U.S. low beams means the light colour is relevant. Stern emphasized that these kinds of differences exist for most aspects of the glare equation: intensity, aim, luminance, etc.

U.S. scientists, Stern said, recognized decades ago that headlamp developments in the U.S. were on a trajectory to dramatically increase glare. Two examples Stern gave were 1977 comments by renowned Ford researcher Vivek Bhise, developer of the CHESS headlight beam evaluation tool, and 1985 comments by NHTSA scientist Michael Perel.



Stern homed in on a paper by Perel, in which a variety of low beam patterns were assessed with the CHESS tool: the then-current US and ECE beams, a couple of proposed modified US beams, and a beam with 40,000 candela below horizontal, a sharp cutoff, and little or no light above horizontal. This "40K" theoretical beam scored better than the actual beams in terms of detection, but its extreme glare meant it wound up with a similar figure of merit to the 1985-actual U.S. and ECE beams, even though The CHESS protocol weighs detection (e.g., of pedestrians) much more heavily than glare. Stern illustrated close parallels between the 40K theoretical beam and today's actual U.S. low beam patterns, the characteristics of which are largely driven by the IIHS ratings protocol.

With that, Stern yielded the floor to the next speaker.

Headlight Glare, Myriad Complaints – Are We Listening?

Naomi Miller, Pacific Northwest National Laboratory (emerita)

NaomI Miller mentioned the cocktail-party effect everyone professionally involved with vehicle lighting is familiar with: as soon as people learn of one's involvement in that field, the predictable question comes: "Can you fix that awful glare from those blue headlights?". She then pointed out a hard fact: the № 1 reason why headlight glare is bad is taht nobody buys a car based on how painful its headlamps are to other drivers!

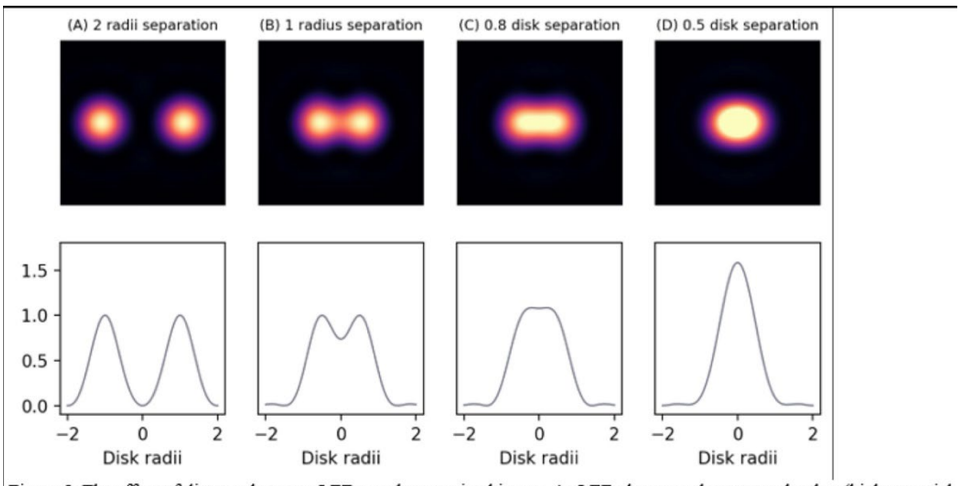


Figure 5: The effect of distance between LEDs on the perceived image. As LEDs become closer to each other (higher spatial frequency) the sources merge to form a larger source at an equal or higher brightness level.

Miller has a history of presenting intriguing, relevant information and uncommon perspectives in an engaging manner, and she did so again this time. LEDs are small and bright, she said, before explaining that when small light sources are viewed at a distance, the optics of the human eye overlaps the intensities, resulting in perceived intensity higher than measurable intensity. The implication of this finding for headlight glare is almost self-evident in context of current headlamp design trends – more and smaller optics.

Miller then described other factors contributing to intense headlight glare: high headlamp mount height and high intensity just below the cutoff means drivers of lower cars are in the maximum-intensity zone, either directly (versus oncoming drivers) or via mirrors (versus following drivers). She pointed out that unlike international practice, wherein low beam aim declination is geared to headlamp mounting height – mounted higher, aimed lower – U.S. aim philosophy disregards mount height. In Miller's terms, "the centre of required light distribution is relative to the headlight, not the height above the roadway".

After describing the feeling of greater glare provoked by blue-white light, Miller closed her presentation by wondering whether warmer-white light could be made into a selling point, and imploring the community to *listen* to the glare complaints rather than disregard or dismiss them.

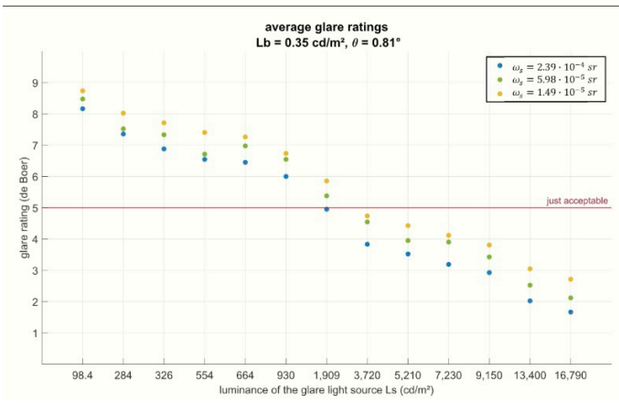
Impact of LED Light Source Size & Luminance on Discomfort Glare Perception in a Mesopic Environment

Elisabeth Kemmler, TU Darmstadt

Elisabeth Kemmler described the results of a laboratory experiment done at the behest of the German Federal Ministry for Digital and Transport, via the Federal Highway and Transport Research Institute.

Two parameters examined in the study were the luminance and the size (solid angle subtended) of an LED glare light source. Kemmler described in detail the research and experiment design and protocol – the laboratory configuration, the number and age of the participants, and the glare light characteristics.

Results – average glare ratings



de Boer rating	glare semantics
1	unbearable
2	-
3	disturbing
4	-
5	just acceptable
6	-
7	satisfactory
8	-
9	unnoticeable

Findings were an interesting mix: glare ratings (on the de Boer scale) worsened with increasing luminance, which is not surprising; it repeats and reinforces the findings of numerous other studies that brightness (here in terms of luminance) and discomfort glare are correlated.

But there was another finding to this research which is particularly interesting: larger solid angle of an LED glare light was found to cause more discomfort glare. On the surface, that seems like it contradicts years of other findings that discomfort glare is worse to some degree with a smaller light source than a larger one. However, deeper scrutiny resolves the apparent contradiction: this study varied luminances and sizes (solid angles) of the glare light sources. That's different to other studies which varied just the size, because a smaller-size light source producing a given intensity has higher luminance than a larger-size light producing that same intensity.

Kemmler closed her presentation by describing future experiments warranted by the present findings: dynamic field (driving) studies, and analysis of the effects of other relevant factors like background luminance and subject age.

Disomfort Glare in the IES Context
Larry Boxler, IES

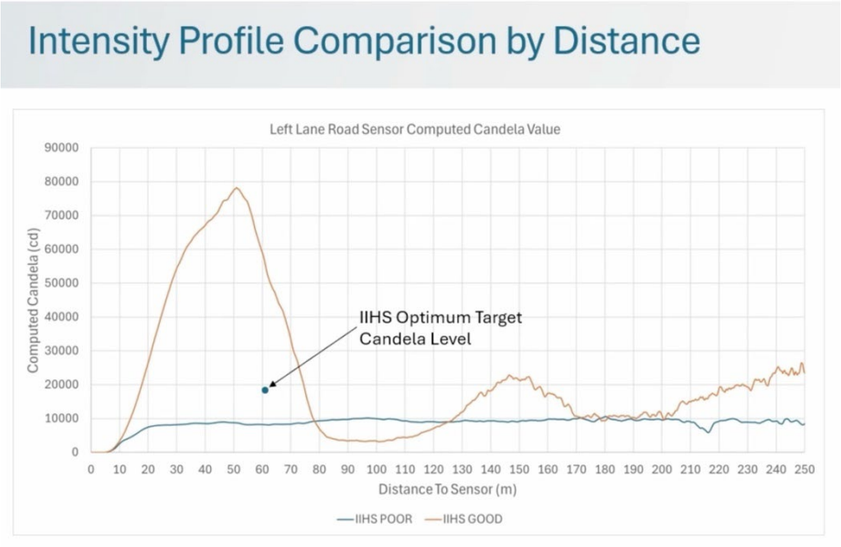
Larry Boxler is a veteran optical engineer with over 20 years' experience in vehicle lighting at Ford and Valeo, and over 10 years' experience in general and specialty lighting. His presentation was under the auspice of the Illuminating Engineering Society's Discomfort Glare in Outdoor Nighttime Environments (DGONE) technical committee.

Boxler started by introducing the committee (comprising lighting researchers, lighting designers, and lighting manufacturers) and their activities, notably defining a glare metric that can be used by lighting designers to determine the degree and distribution of "off site" discomfort glare. That term "off site" is particular to fixed lighting installations – street lights, lights in sports arenas, building lights, billboard lights, etc – but Boxler emphasized the large overlap between discomfort glare from lights with or without wheels under them.

Discomfort glare is complex; the actual visual/physiological mechanisms for discomfort glare are not well understood, measuring and characterizing discomfort glare is difficult, and there's a lack of reliable and accurate methods and equipment for assessing discomfort glare in the field.

Relevant points held in mind by the DGONE committee include the fact that people will look directly at glare sources (which makes "look away from the glare" impractical advice to motorists); the levels at which discomfort glare occurs vary with surrounding lighting, and intensity (in candela) is a useful metric for characterizing potential discomfort glare.

Boxler referenced CIE standard 150:2003 (intensity limits for glare, by zone). While this standard is for fixed lighting and not for car headlamps, it is interesting to see the nighttime glare-zone intensity limits: from 0 to 1,000 candela for three out of the four zone scenarios contemplated. That is right in the same neighbourhood as low beam headlamp intensity caps in their own nominal glare zones.



Then came an interesting line of connection: Boxler looked at details of the IIHS headlight evaluation protocol, and described how it drives high-glare beam patterns. The IIHS criterion of 5 lux is much higher than the 3-lux criterion generally considered appropriate, and this together with the IIHS left-curve requirements drive high-glare low-beam patterns. The degree of this effect was illustrated by a plot (shown here).

Boxler wound up his presentation by inviting engagement with the IES to combine knowledge and expertise to address the glare issue, saying there are questions that could best be answered collaboratively: is 5 lux appropriate? Should that criterion be lower? And can published standards from CIE and IES be used as evidence-based reasons for lowering the designed candela on the left side of the beam? Meanwwhile, he made some thoughtful suggestions for reducing glare in the short term: softer cutoffs, limiting intensity toward oncoming drivers by designing to meet IIHS "good" but not more than that, moving toward warmer-white light and larger lit areas, and improving automatic high beams and other sensor-based functions.

Other Voices

Daniel Stern, DVN

In this unusal presentation, DVN's Daniel Stern MC'd two video presentations solicited for this event. The first was by Mark Baker, whose "Soft Lights Foundation" advocates for glare control; Baker also started and runs a coarsely-named reddit forum against headlight glare.

Baker started out by describing his organization's online petition, entitled "Ban Blinding Headlights and Save Lives". He pointed out, correctly, that FMVSS 108 category LB2V, has little in the way of glare control. There is no anywhere-in-the-beam maximum, and there is no maximum at H-V. He also correctly stated that NHTSA has no regulation for headlight luminance. And he described news reports of individuals who experience non-epileptic seizures in response to LEDs.

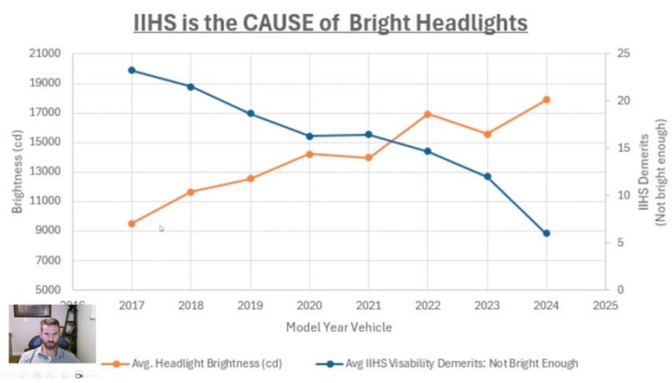
Baker showed the upward trajectory of U.S. nighttime pedestrian deaths, which he blames on headlight glare, and, after sharing some of the glare complaints he has fielded, he stated – incorrectly – that all vehicles with LEDs are categorically defective in terms of U.S. law, because no automaker has petitioned NHTSA for permission to install LED headlamps, and the U.S. Food and Drug Administration has not set safety standards for them.

In the end, Baker prescribed fixes for headlight glare: NHTSA should set limits on luminance, spectral power distribution (less blue) and pulsewidth modulation, and performance standards for headlamps must ensure photobiological, neurological, psychological, hormonal, and physical safety and comfort.

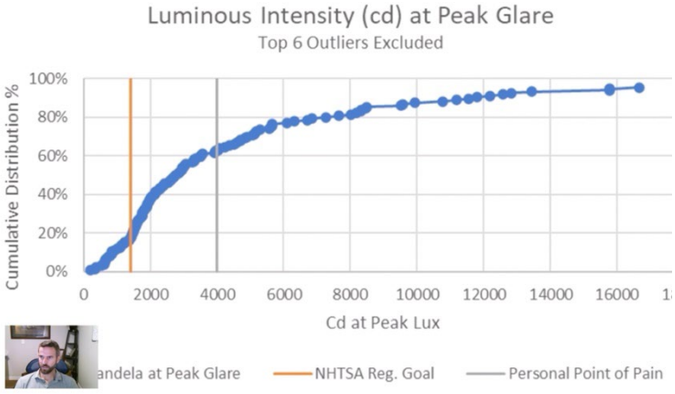
Next, Stern presented a video from citizen scientist and mechanical engineer Victor Morgan. Morgan described collecting data with a dashboard-mounted light meter, and comparing the findings to the requirements in FMVSS 108. He found that many headlamps exceed the nominal glare limits to a very large degree.

Morgan noted the difference between the older low beam standard LB1M (which had glare limits at H-V and other points) versus the current LB2V standard, wherein many of those glare limits do not exist. Then he made a point similar to that made by Larry Boxler: the IIHS protocol drives glaring headlights.

					Percent of NHTSA Brightness Limit				% Overpowered
Car Make	Car Model	Light Type	Stock?	Year	HV	DR	DL	UL	All Test Points
Tesla	3	LED	Yes	2019	308%	94%	1105%	84%	1191%
Alpha Romeo	Stelvio	LED	Yes	2020	368%	117%	1384%	151%	1621%
Toyota	Camry Hybrid	LED	Yes	2018	41%	115%	419%	100%	275%
Hyundai	Elantra	Filament	Yes	2015	17%	5%	42%	80%	N/A
Honda	Ridgeline	LED	Yes	2017	330%	57%	566%	2050%	2602%
Honda	Accord	LED	Yes	2019	133%	209%	212%	111%	265%
Acura	MDX	LED	Yes	2021	504%	3%	777%	2194%	3078%
VW	Atlas	LED	Yes	2021	20%	81%	233%	67%	N/A
Jeep	Wrangler	LED	Yes	2021	121%	85%	762%	144%	712%
Jeep	Wrangler	LED	Yes	2019	44%	87%	344%	74%	148%



Morgan presented a great deal of data, in contrast to Baker, who presented a great deal of personal opinion with shaky grounding in fact.



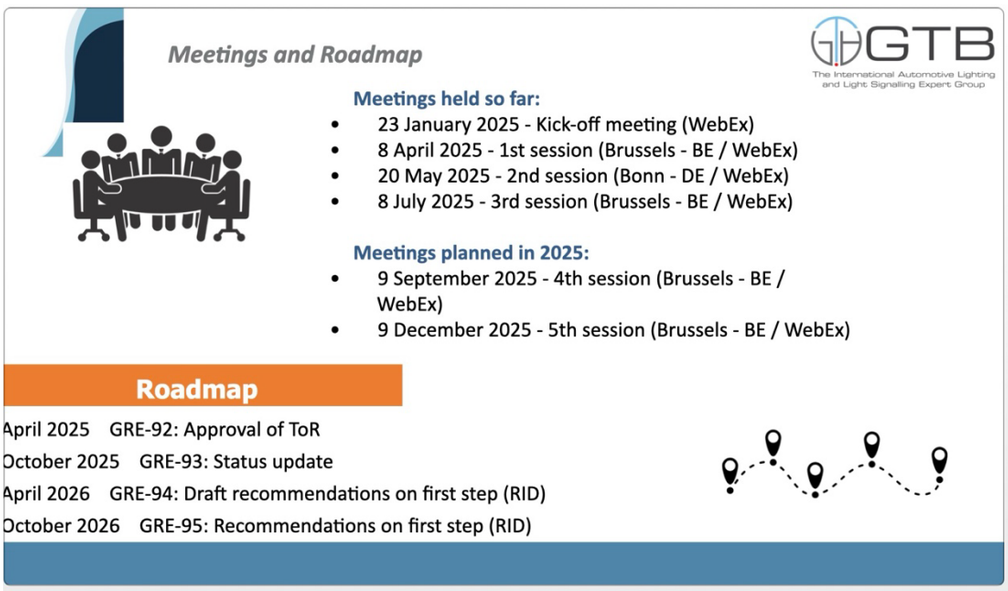
The third voice in this group was that of Dr. Nisa Khanh, author of a book entitled "Blinding LED Headlights: The Biggest Blunder of Modern Science". Her claims include: • Newton didn't understand calculus or the laws of motion, and Gauss didn't understand Gauss' Law' correcting their misunderstandings requires Bharatiya Ganita. • LEDs are a flat radiator, so the laws of optics and physics do not apply to the light they produce. • LED headlight luminance is higher than that of the sun, and the lambertian intensity distribution can't be altered by lenses. • All LED headlamps violate applicable regulations and standards, because

automakers and suppliers don't know how to properly perform photogoniometric measurements and don't understand the difference between luminance and luminous intensity.

GRE-TF on Glare Prevention
Bart Terburg, GTB

Renowned vehicle lighting regulatory expert Dr. Bart Terburg gave an update on the GRE task force on headlight glare prevention. He stated the reason for the task force's existence: various contracting parties (countries where the UN Regulations are used) have been increasingly concerned about glare, and so there is a pressing need for regulators and authorities to respond.

Terburg explained the evolution within GRE that led to the recent creation of the glare prevention task force, described its composition (over 60 members; 13 contracting parties and 9 NGOs) and laid out its objectives:



• Discern between avoidable and unavoidable glare occurrences, as well as short- and long-term solutions.

• Consider glare caused by road-illumination devices (headlamps, including ADB and AFS) and then consider glare caused by vehicle light-signalling devices.

• Improve the understanding of the different factors that influence glare, visibility, and conspicuity, and determine their respective weighted importance.

The task force has established a quartet of working groups called "homework teams": one to examine the existing literature, one to look at periodic technical inspections of vehicles, considering three stages of early vehicle service life: from type approval to the first periodic inspection (at end of production line, at point of sale, at first tech inspection), and what happens to the initial lamp aim between those stages. There's another homework team to look at ADB/AFS elements that could cause glare and identify improvements to be made. And a fourth team, not yet active, will coordinate the preparation of recommendations to GRE.

Has Headlight Glare Worsened in the New Millenium?
Dr. John D. Bullough, Light & Health Research Center

John Bullough, in another of his consistently excellent lectures, started out by examining google search-term and social- and regular-media instances over time for topics like "headlight glare" and "bright headlights", teasing out trends by comparing those terms with others like "loud muffler" (another car-related thing people complain about, other than lighting). Sure enough, there are more complaints now than before.

He made the important point that aside from disability glare and discomfort glare, which everyone is familiar with, there is also recovery glare – the glare light source is no longer in the visual field, but the driver is still effectively glared because their vision has not recovered its pre-glare acuity.

Bullough then looked at some causes: between 1996 and 2023, there's been a 9-per-cent increase in driver eye height, but a 21-per-cent increase in headlamp mounting height. Headlamps have also, in that time frame, gone from the warm white and large area/low luminance of halogens to the cold white and small area/high luminance of LEDs. A large headlamp (e.g., 8cm diameter) must be within 15 metres to be large enough for increased luminance to significantly increase discomfort glare, but a smaller lamp, with the resultant higher luminance, can create discomfort glare at greater distances.

He discussed oncoming versus mirror glare, and looked at low beam photometric distributions over time: the 2004 halogen sample had lower peak intensity and softer cutoffs than the 2019 LED sample.

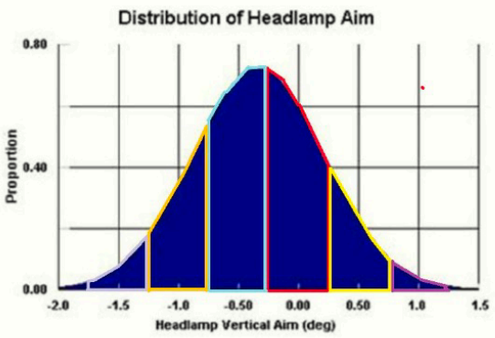
Headlight aim was next on Bullough's agenda; he noted that this is frequently cited in the literature as the most important factor in visibility and glare…and that headlight aim has been poor in the U.S. for years. He did note, however, that the IIHS tests have reduced aim variance in new vehicles.

Then, Bullough pivoted to looking at what might be done to reduce glare. He suggested a more stringent upper limit for headlamp mounting height, a limit on the blue content of headlamp light, and some way of controlling headlamp luminance – by minimum lit area size or some other method.

For a grand finalie, Bullough proposed an intriguing system of zonal intensity limits for low beams, below the horizontal cutoff, as well as an anywhere-in-the-beam intensity maximum.

What Could be Done? (cont'd.)

- Distribution / Aim: A Preliminary Proposal for Low-Beam Zonal Intensity Limits Below the Horizontal Cutoff



- Slices around -1.5°, -1°, -0.5°, 0°, 0.5° and 1° represent relative proportion of time headlights are aimed/misaimed by about that angular value
- A "typical" halogen headlight in 2019 produced an intensity of **5000 cd** straight ahead at 0° (Flannagan 2019)
- Accounting for **relative frequency** of angular mis/aim (**0°=100**), an "equivalent" amount of glare for upward misaim angles is:
  - **+0.5°**: relative frequency=**44**, intensity for equivalent glare=**11,000 cd** @ -0.5°
  - **+1°**: relative frequency=**9**, intensity for equivalent glare=**54,000 cd** @ -1°
- Framework could be applied to finer angular resolution and different assumptions about misaim and "typical" or "adequate" glare performance
- A blanket upper limit for low-beam intensity (e.g., **30,000 cd**) could also be incorporated to prevent values such as 54,000 cd

Panel Discussion
Chair: Daniel Stern, DVN

After all the presentations, the speakers assembled on stage to discuss the ideas presented, as well as questions submitted from attendees.

Audience participation was robust, with a vigorous discussion ensuing. There was apparently broad agreement by interested parties that the 5-lux criterion in the IIHS protocol drives glaring low beams, which would otherwise not be on the road — automakers feel compelled to do whatever is necessary to get an IIHS "Good" rating on the headlamps, otherwise they will be pilloried in the press. This is an excellent example of a non-governmental organization's activities doing more than the official regulations, and more quickly, to change vehicle lighting. Has it brought improved safety? IIHS thinks so; they say vehicles with "Good" headlamps are involved in fewer crashes, but there are questions as to whether this conclusion is truly supportable by the data, and even if it is, there is the possibility that those crashes are simply offloaded from an easily-discerned group (cars with "Good" headlamps) to more nebulous groups (cars driven by people glared by headlamps).

John Bullough (L), Daniel Stern (R)

All in all, this first DVN glare session was a rousing success. Perhaps it will turn out to have been first in a series!

L-R: Bart Terburg, Naomi Miller, Daniel Stern, John Bullough