

**3M** Science.  
Applied to Life.™

# Visibility & Retroreflection for the

# Safety on the road

Hisarya, 22.4.2016

Bojan Kovac 3M (East) AG

# *Road Traffic Signs*

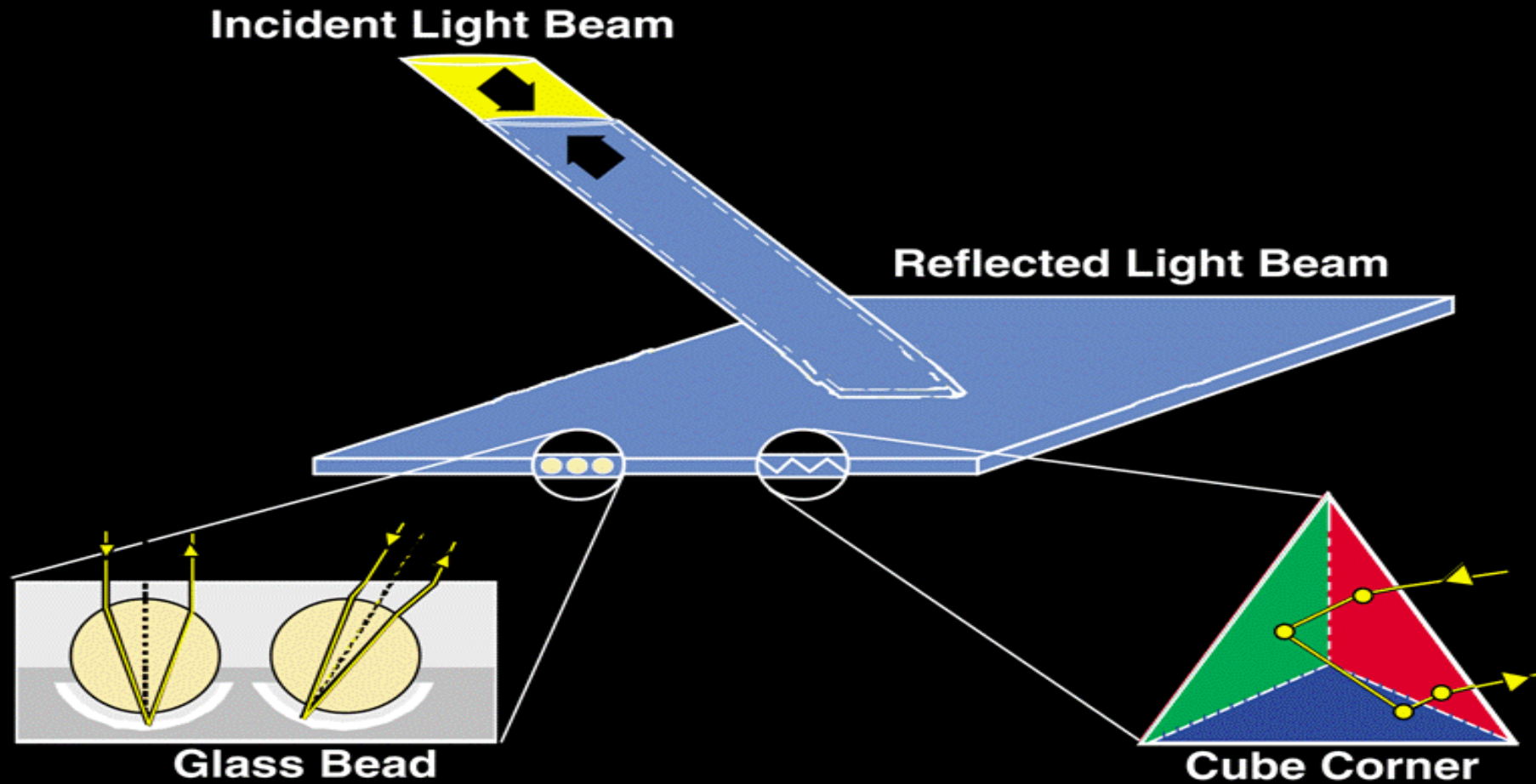
## *Overview*

1. Retroreflective Technology
2. Traffic Sign Requirements
3. Driver's Needs – Effectiveness – Traffic Safety

## *Legislation*

- International: UN Vienna convention 1968
- Local Legislation ( Traffic Law )
- Regulation
- Standards: BDS EN 12899 – 1 , CE Declaration of Conformity
- Technical specification : public tenders

# Retroreflection

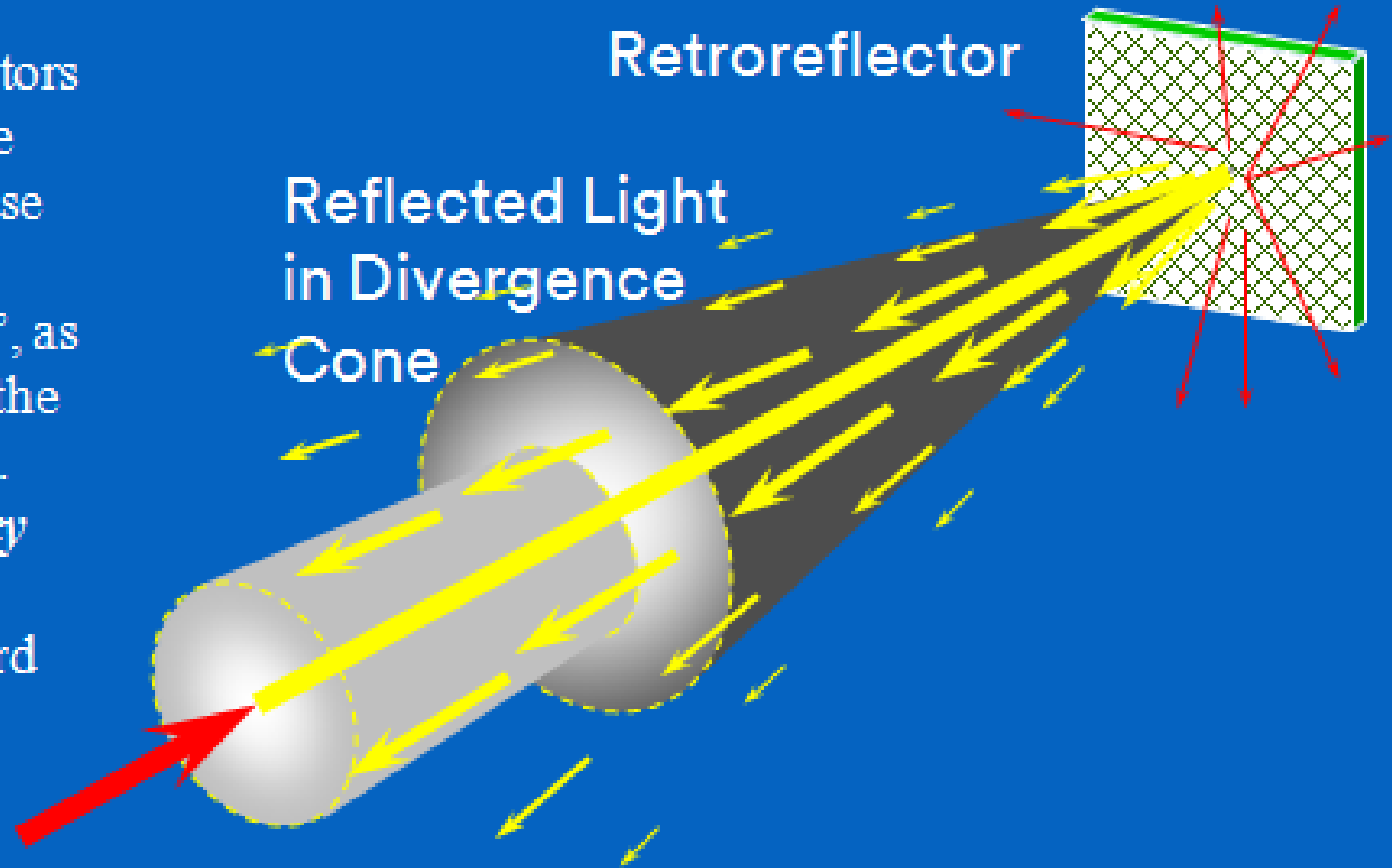


Two Systems of Retroreflection

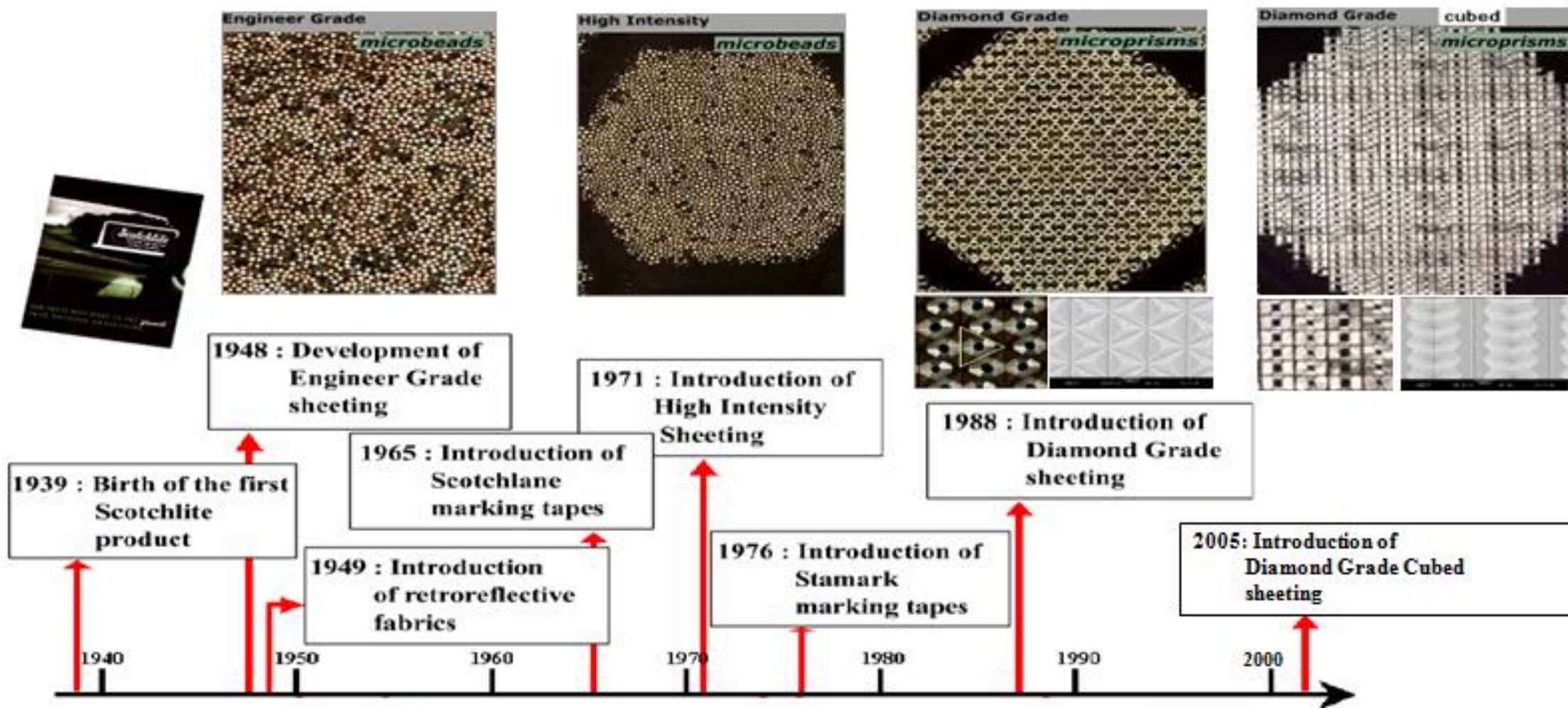
# Cone of Returned Light

Most retroreflectors also have diffuse reflection. Diffuse reflected light is simply “wasted”, as it does not help the nighttime driver. Higher *efficiency sheetings* divert more light toward the driver.

Light Source Direction

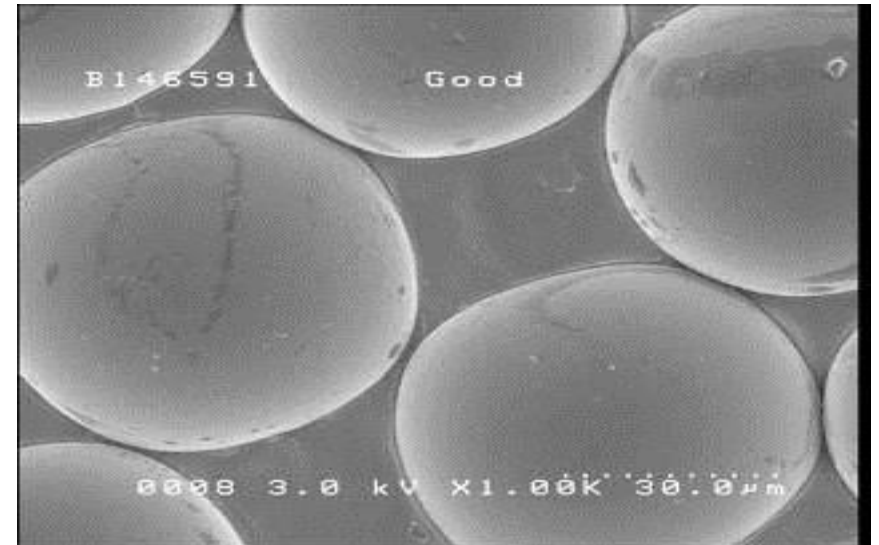
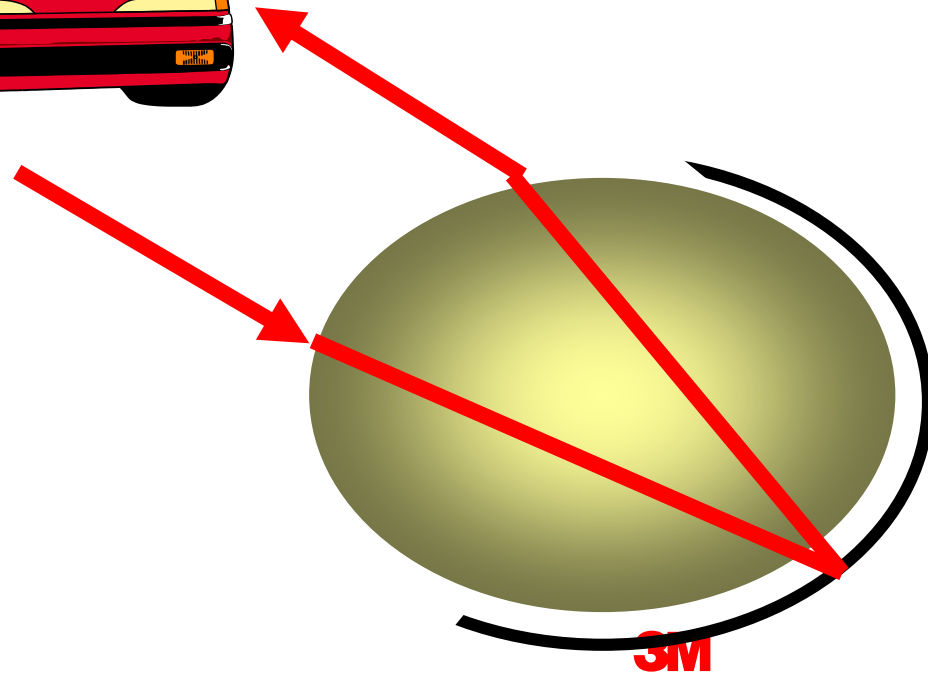
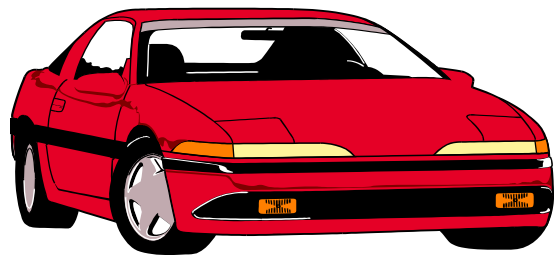


# Retroreflective Sign Sheeting History

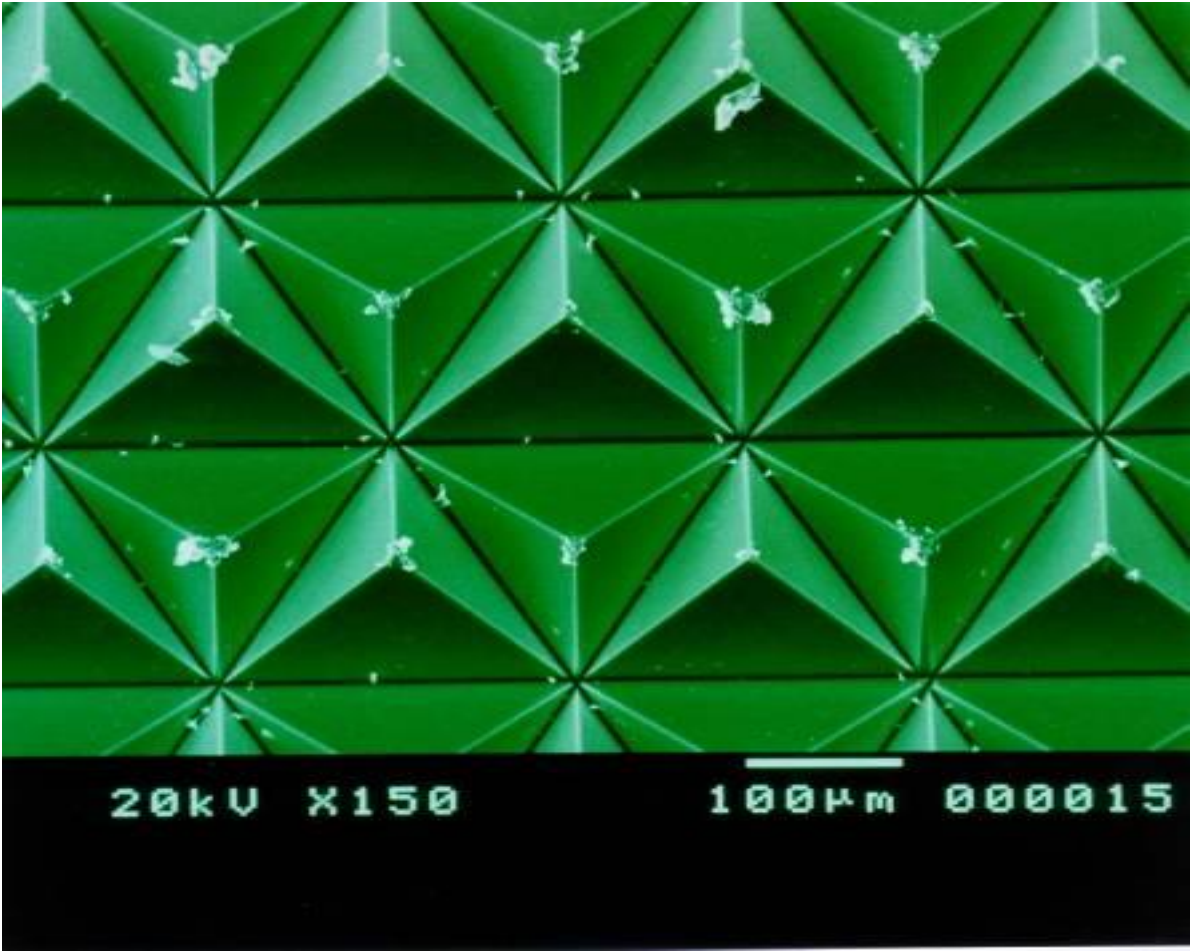
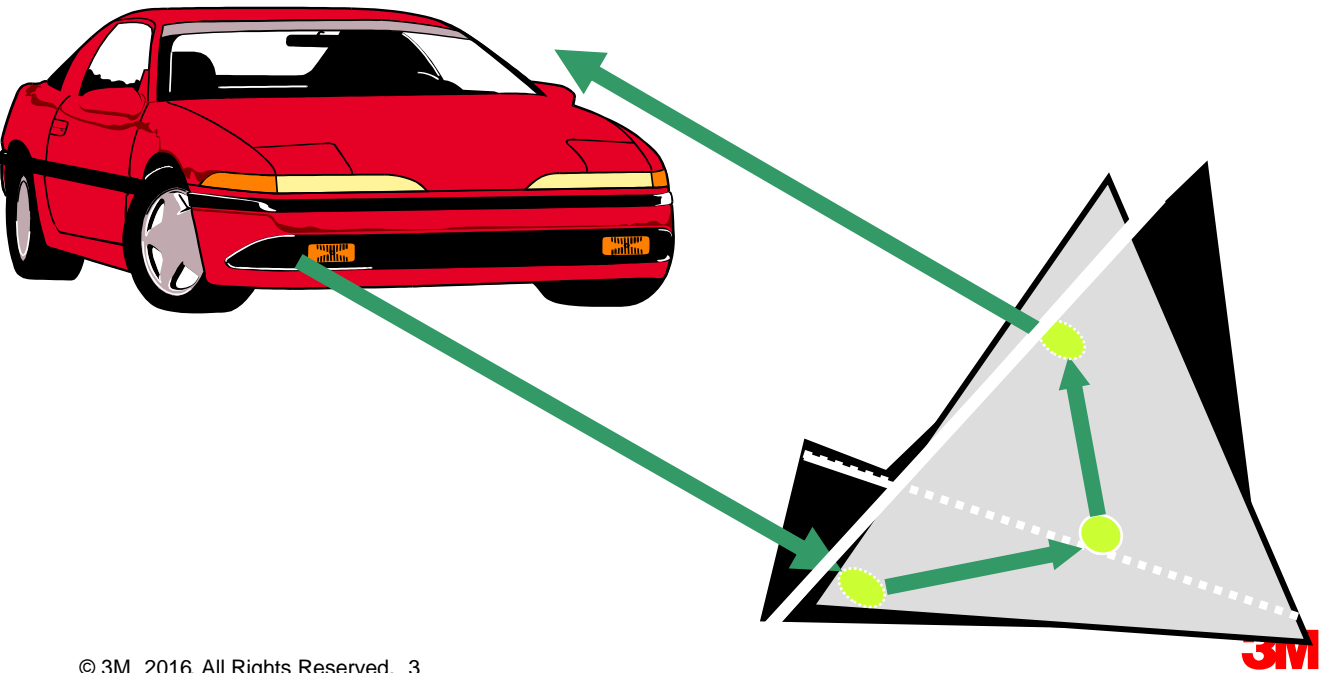


# *How the Technology Works*

## Glass Bead Technology

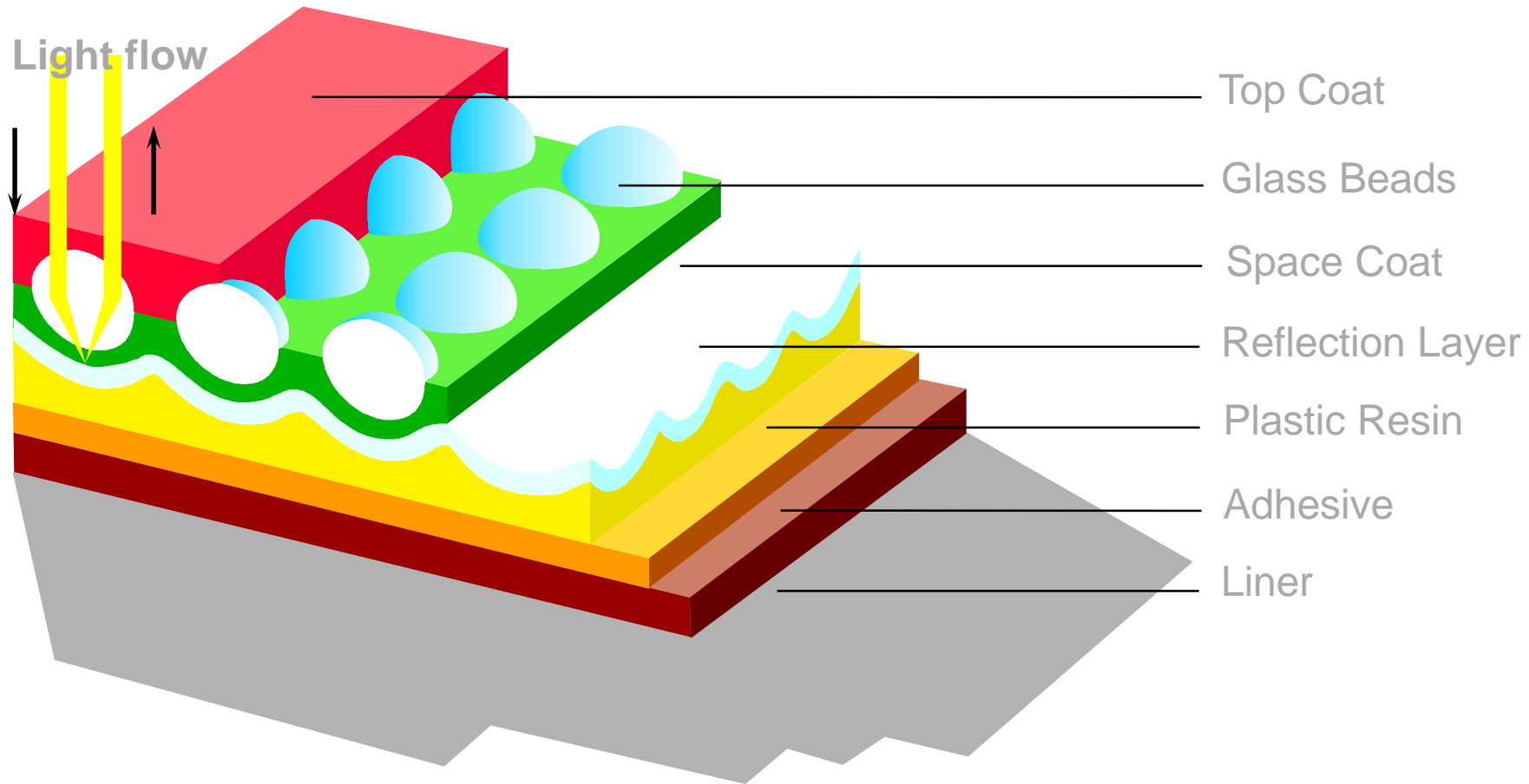


# How Prismatic Technology Works



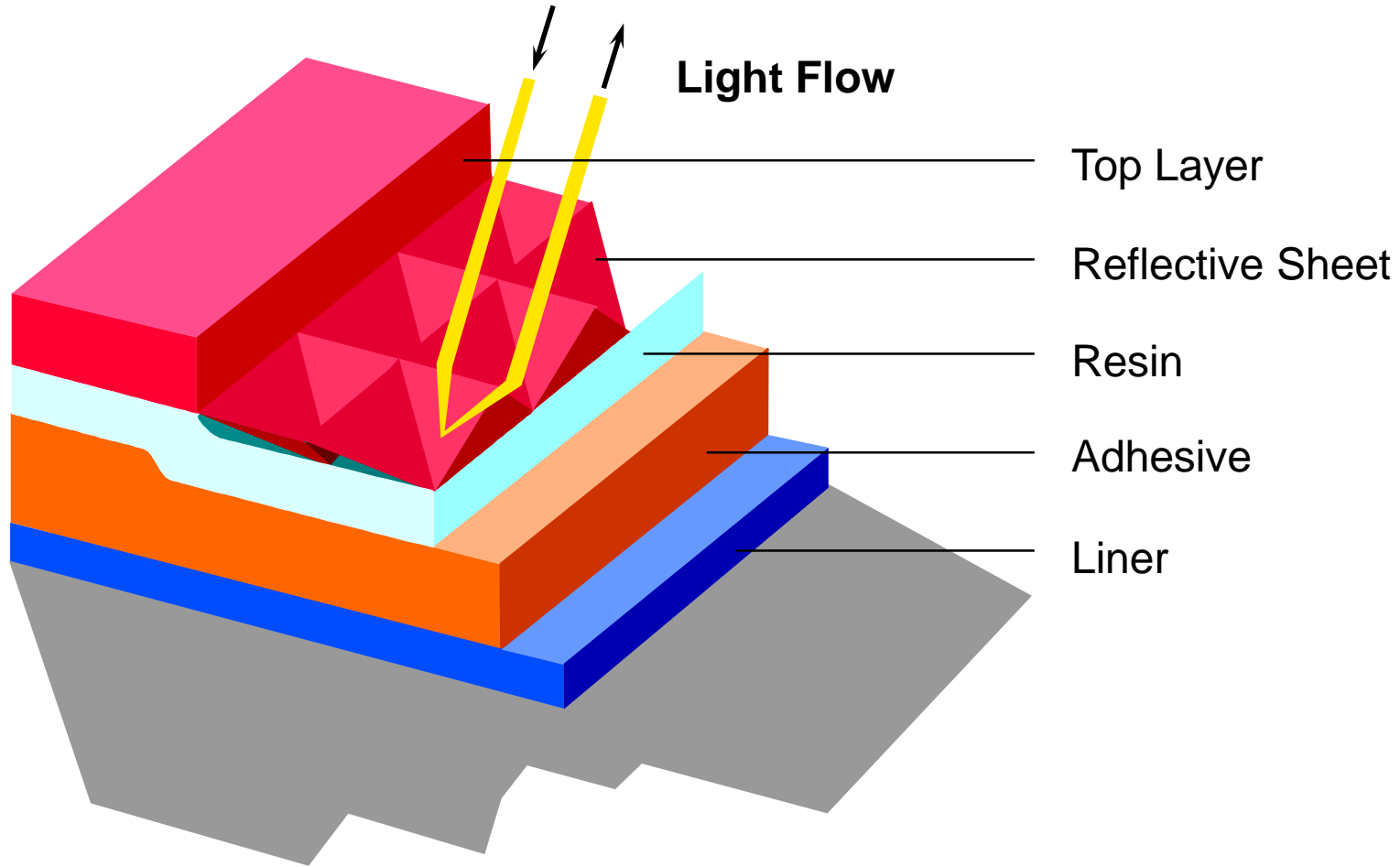


# *Class 1, RA1, RA2 beaded sheeting*



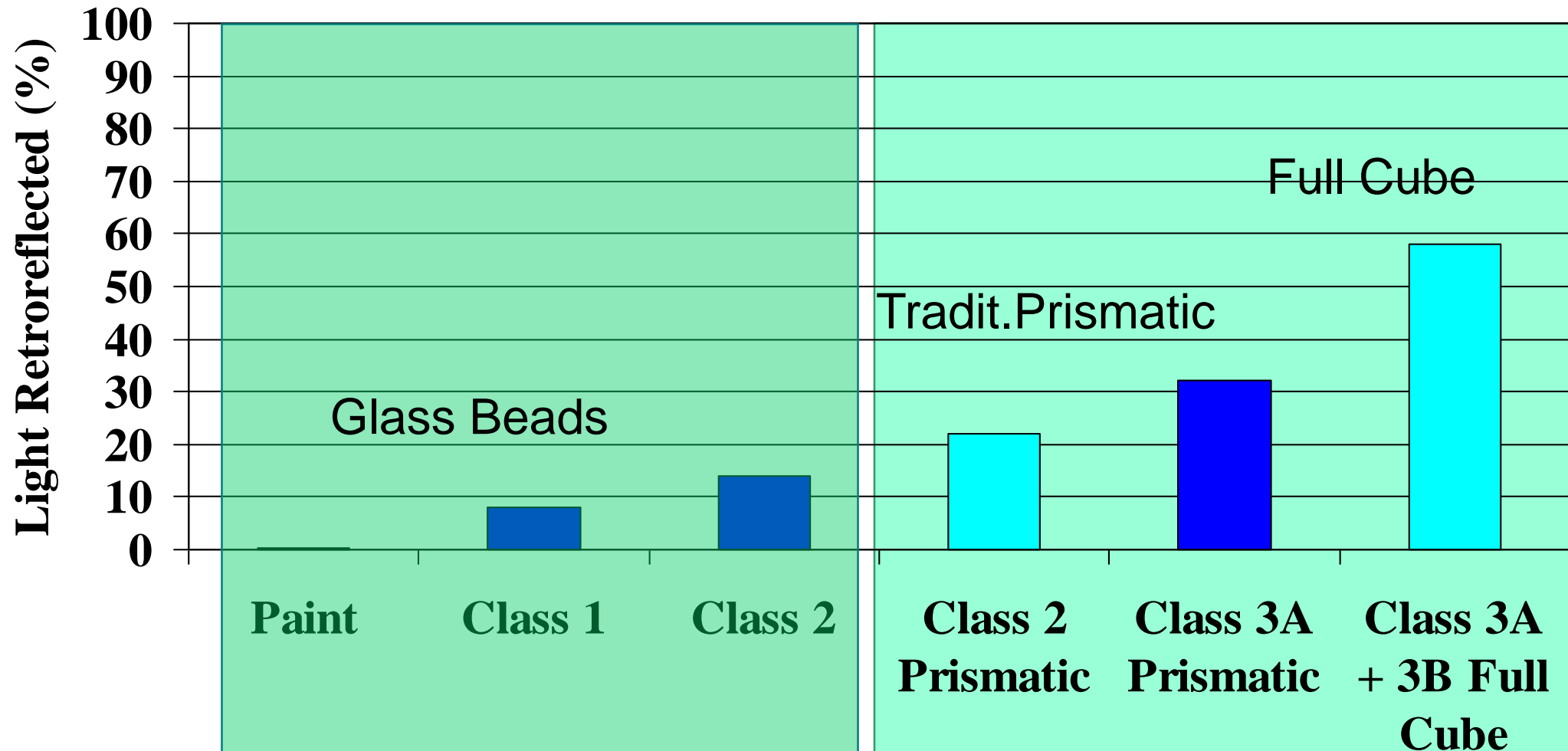
*Class 1, Class 2 and Class 3  
RA 3*

*RA 1, RA 2 and  
RA 3*



# *Retroreflective Technology*

## *Light Return Efficiency*

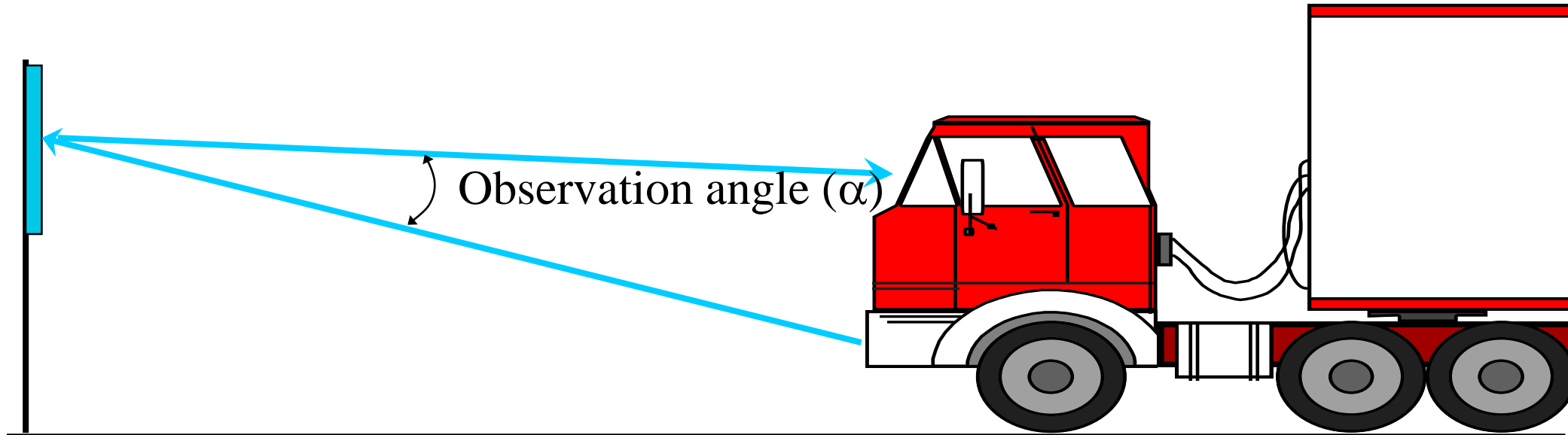


# Retroreflection requests BDS EN 1 2 899-1, Class 2; RA 2

Geometry of measurements		Color					
$\alpha$	$\beta_1$ ( $\beta_2=0$ )	White	Yellow	Red	Green	Blue	Orange
0,2°	+5°	250	170	45	45	20	100
	+30°	150	100	25	25	11	60
	+40°	110	70	15	12	8	29
0,33°	+5°	180	120	25	21	14	65
	+30°	100	70	14	12	8	40
	+40°	95	60	13	11	7	20
2°	+5°	5	3	1	0,5	0,2	1,5
	+30°	2,5	1,5	0,4	0,3	-	1
	+40°	1,5	1,0	0,3	0,2	-	-
“-“ Indicates "Value greater than zero but not significant or applicable"							

**Table A: Minimum Coefficient of Retroreflection [cd/(lx · m<sup>2</sup>)]**

# Observation Angle



# Observation Angle Scenarios

## Observation-

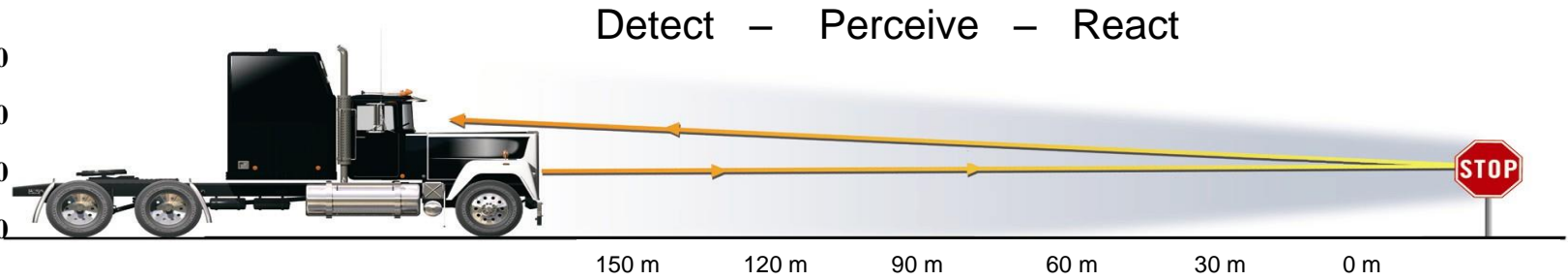
## Angle

150m = 0.70°

120m = 0.90°

90m = 1.20°

60m = 1.75°

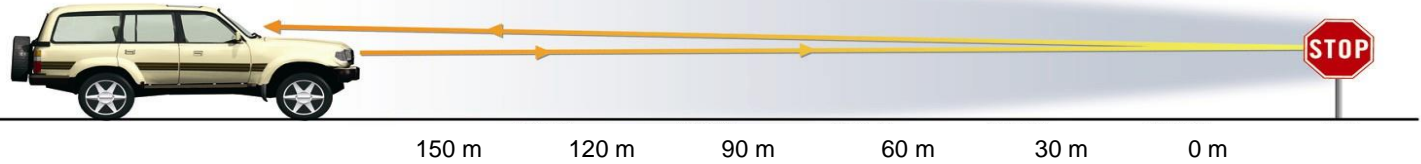


150m = 0.35°

120m = 0.45°

90m = 0.60°

60m = 0.90°

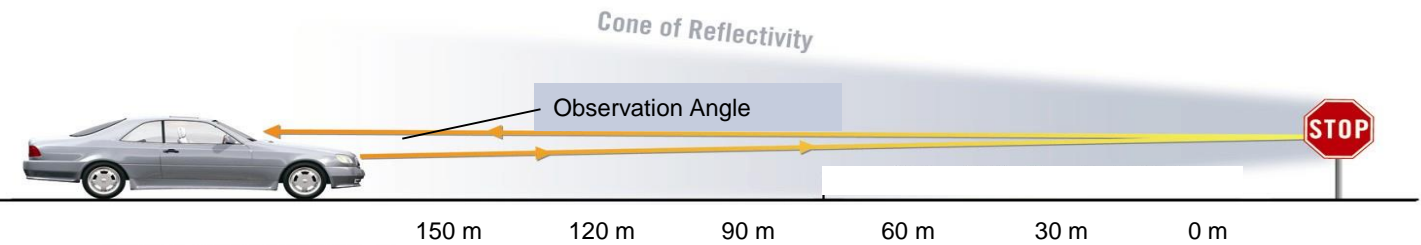


150m = 0.30°

120m = 0.40°

90m = 0.50°

60m = 0.75°



## *Conspicuity and Legibility*



*What you see during  
the day*

*Is not always what you  
get at night*



# *Colorimetry*



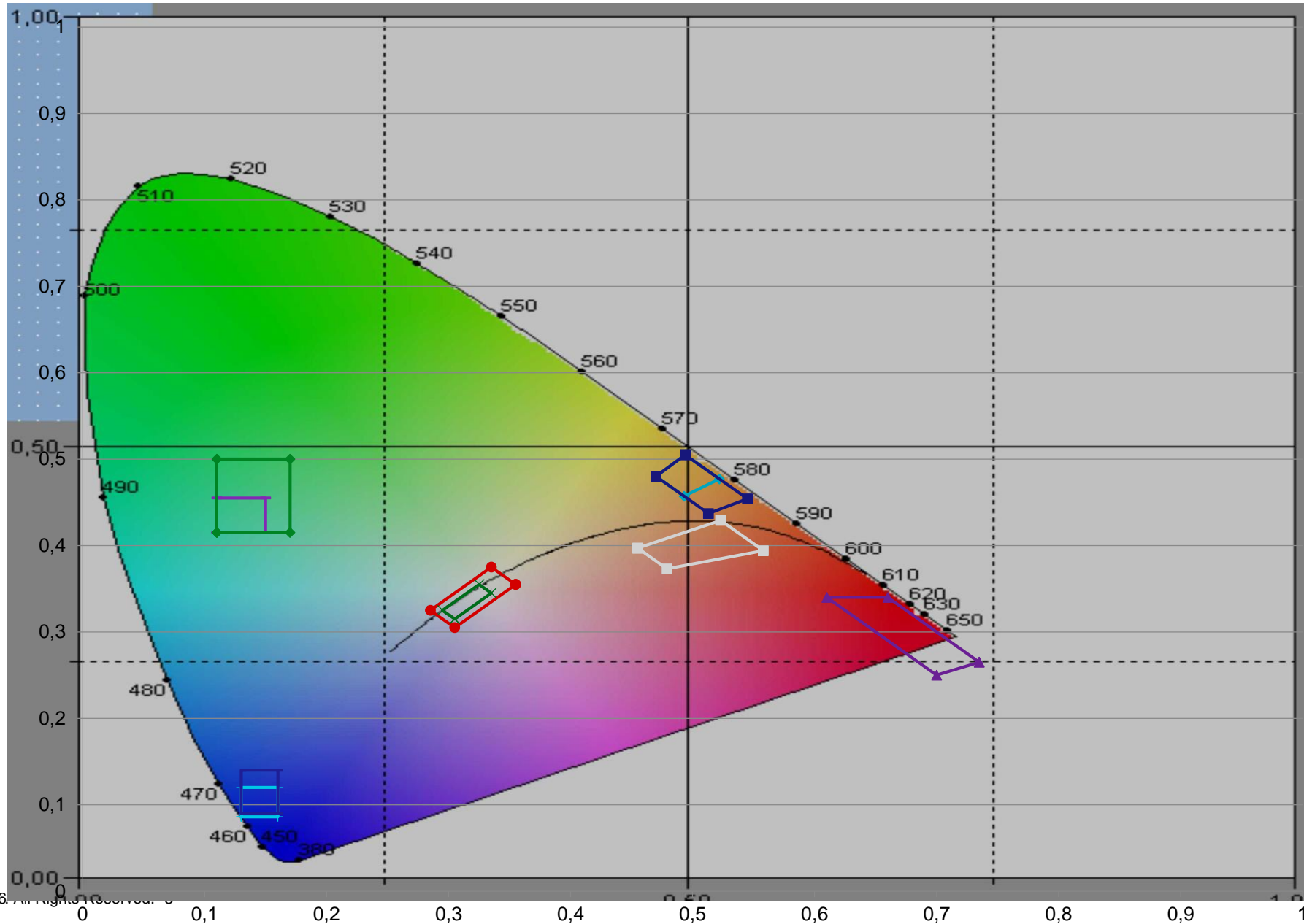
# CIE laboratory colorimetry

When tested in accordance with the relevant procedure specified in CIE 15, using CIE standard daylight illuminant D65 and the standard CIE 45/0 viewing conditions

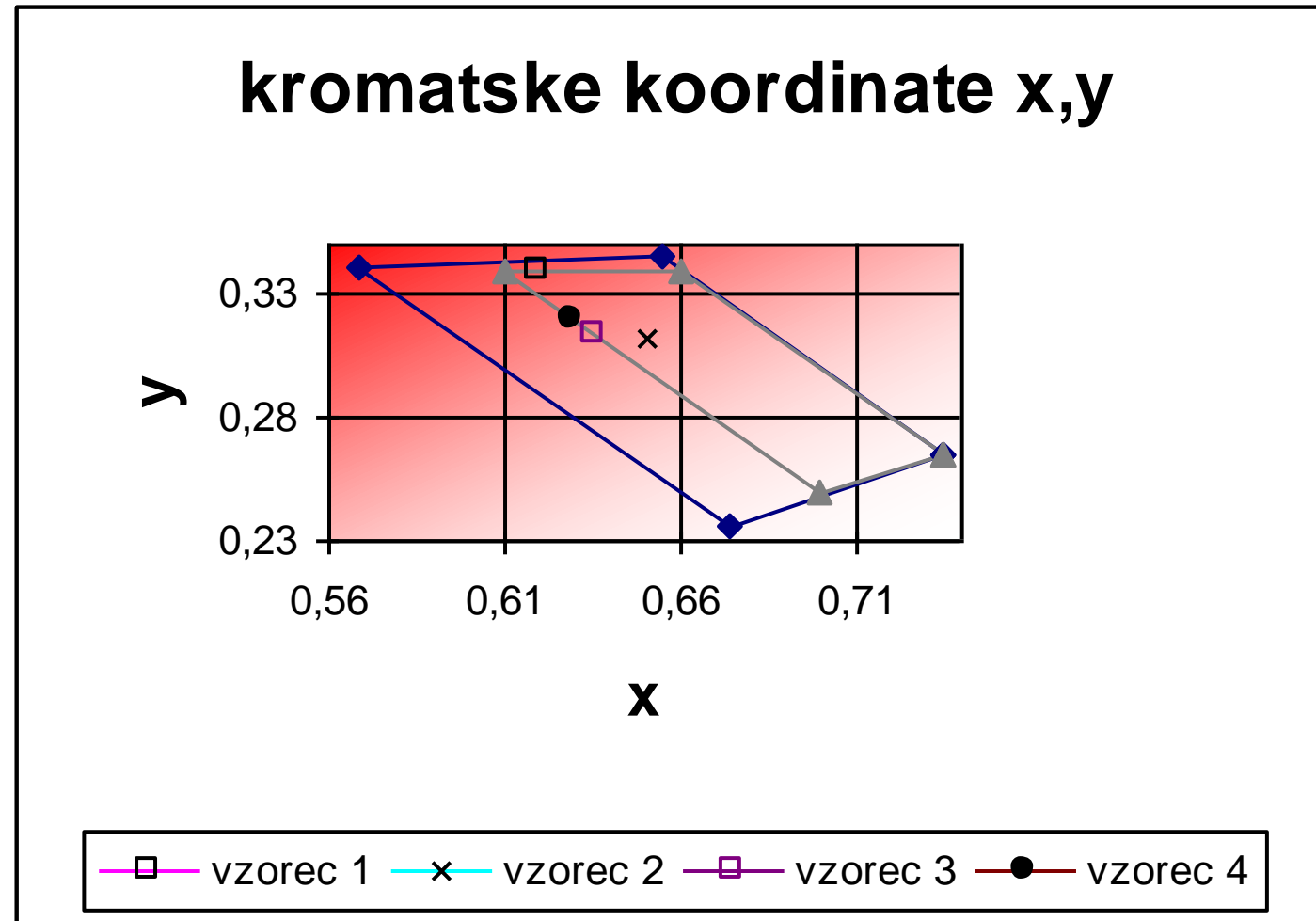
**Table 1 — Daylight chromaticity and luminance factors. Class CR1**

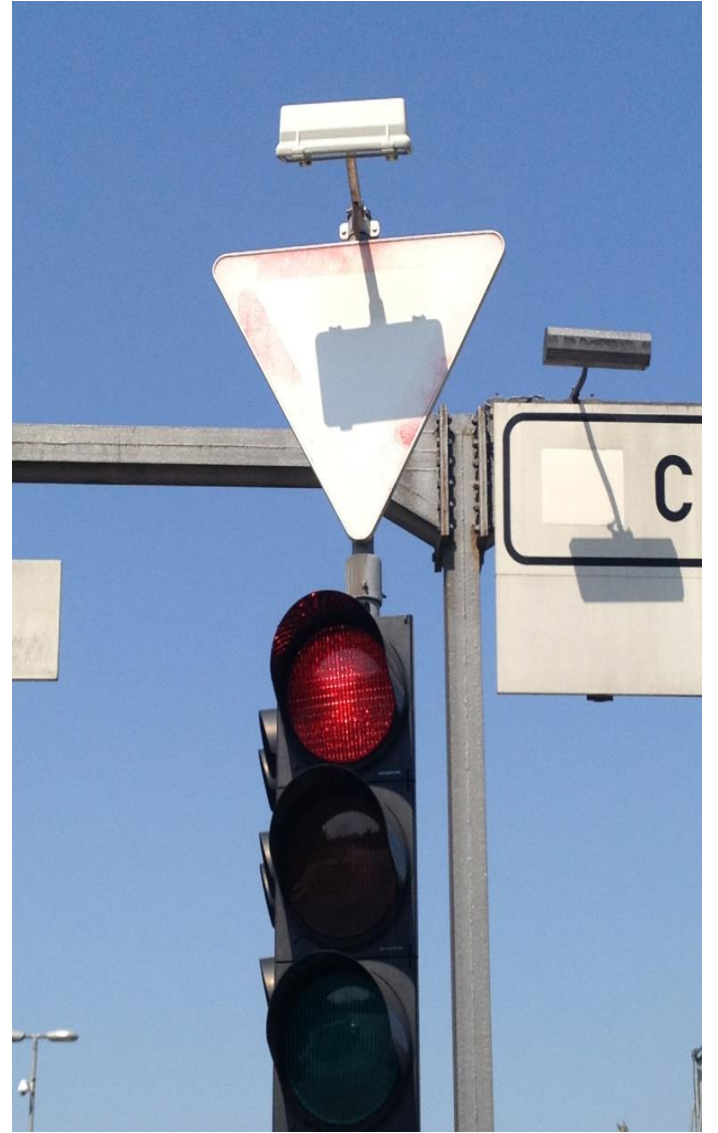
Colour	1		2		3		4		Luminance factor $\beta$	
	x	y	x	y	x	y	x	y	Table 3	Table 4
White	0,355	0,355	0,305	0,305	0,285	0,325	0,335	0,375	$\geq 0,35$	$\geq 0,27$
Yellow see Table 3	0,522	0,477	0,470	0,440	0,427	0,483	0,465	0,534	$\geq 0,27$	
Yellow see Table 4	0,545	0,454	0,487	0,423	0,427	0,483	0,465	0,534		$\geq 0,16$
Orange	0,610	0,390	0,535	0,375	0,506	0,404	0,570	0,429	$\geq 0,17$	$\geq 0,14$
Red	0,735	0,265	0,674	0,236	0,569	0,341	0,655	0,345	$\geq 0,05$	$\geq 0,03$
Blue	0,078	0,171	0,150	0,220	0,210	0,160	0,137	0,038	$\geq 0,01$	$\geq 0,01$
Green	0,007	0,703	0,248	0,409	0,177	0,362	0,026	0,399	$\geq 0,04$	$\geq 0,03$
Dark green	0,313	0,682	0,313	0,453	0,248	0,409	0,127	0,557	$0,01 \leq \beta \leq 0,07$	
Brown	0,455	0,397	0,523	0,429	0,479	0,373	0,558	0,394	$0,03 \leq \beta \leq 0,09$	
Grey	0,350	0,360	0,300	0,310	0,285	0,325	0,335	0,375	$0,12 \leq \beta \leq 0,18$	

# CIE laboratory colorimetry



# *Cromatic coordinates CR1, CR2*





# Retroreflection

## Material Definition

- EN 12899-1 defines Class RA1 and RA2 (EG and HI)
- EN 12899-1 point 4.2 Microprismatic according ETA
- National regulation (e.g. DIN, UNI, UNE)



## Positioning matrix

- national responsibility
- according to sign type
- according to surround
- according to road type

## II. PROMETNA SIGNALIZACIJA

### 1. Prometni znaki

#### 8. člen

(izvedba prometnih znakov)

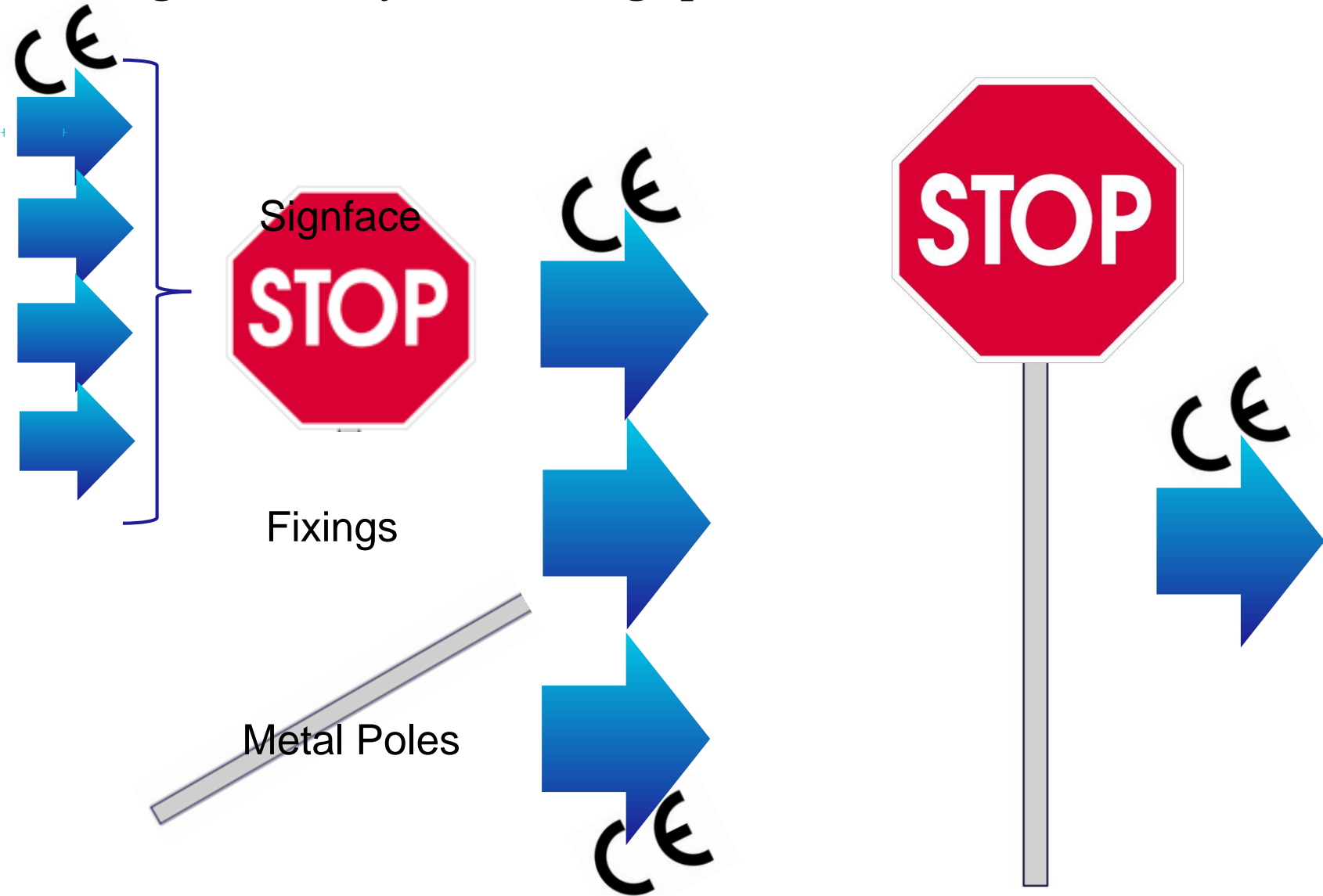
(1) Konstrukcija prometnega znaka mora skladno s standardom SIST EN 12899-1 glede mehanske odpornosti dosegati naslednje minimalne zahteve:

- faktor varnosti za obremenitve – razred PAF1,
- pritisk vetra – razred WL5,
- dinamični pritisk pri čiščenju snega – razred DSL1,
- najmanjša dopustna deformacija pri upogibanju – razred TDB4,
- prebadanje znaka – razred P3 in
- robovi plošče znaka – razred E2.


(2) Ne glede na prejšnji odstavek lahko upravljavec prometne površine zahteva drugačne zahteve glede učinkovitosti konstrukcije prometnega znaka, vendar le v mejah, ki jih dopušča SIST EN 12899-1.

# Impact of EN12899-1 on Sign manufacturing process

- Beaded Reflective Sheeting
- Prismatic Reflective Sheeting
- Auxiliaries : Inks, ECOF,...
- Support plate (metal)



# Declaration of Performance/ Leistungserklärung 3M High Intensity Prismatic 3930

<p><i>Construction Product Code / Bezeichnung des Bauproduktes</i></p> <p>Microprismatic Retroreflective Sheetting</p> <ol style="list-style-type: none"><li>1. 3M High Intensity Prismatic Series 3930</li><li>2. 3M High Intensity Prismatic Series 3930 + 3M Electrocut Film Series 1170</li><li>3. 3M High Intensity Prismatic Series 3930 printed with 3M Process Colour Series 880 I or N</li><li>4. 3M High Intensity Prismatic Series 3930 printed with 3M Process Colour Series 4700</li><li>5. 3M High Intensity Prismatic Series 3930 + 3M Piezo Inkjet Ink Series 8800UV + 3M Electrocut Film 1170</li><li>6. 3M High Intensity Prismatic Series 3930 + 3M Piezo Inkjet Ink Series 8800UV + 3M Dew Resistant Overlay Film 1180</li><li>7. 3M High Intensity Prismatic Series 3930 + 3M Premium Protective Overlay Film 1160</li><li>8. 3M High Intensity Prismatic Series 3930 + 3M Electrocut Film Series 1170 + 3M Premium Protective Overlay Film 1160</li><li>9. 3M High Intensity Prismatic 3930 + 3M Electrocut Film 1176 with or without 3M Protective Overlay Film</li><li>10. 3M High Intensity Prismatic Series 3930 printed with 3M Process Colour Series 4700 + 3M Premium Protective Overlay Film 1160</li><li>11. 3M High Intensity Prismatic Series 3930 + 3M Piezo Inkjet Ink Series 8800UV + 3M Premium Protective Overlay Film 1160</li><li>12. 3M High Intensity Prismatic Series 3930 + 3M Dew Resistant Overlay Film 1180</li><li>13. 3M High Intensity Prismatic Series 3930 + 3M Electrocut Film Series 1170 + 3M Dew Resistant Overlay Film 1180</li></ol>
<p><i>Intended Use / Verwendungszweck</i></p> <p>The construction product is used to manufacture sign faces for permanent traffic signs. The intended use includes, for example:</p> <ul style="list-style-type: none"><li>- Retro-reflective signs, retro-reflective and transilluminated signs (see also EN 12899-1)</li><li>- Variable message signs (see also EN 12966-1)</li></ul> <p>/</p> <p>Das Bauprodukt wird für die Herstellung von Signalbildern von ortsfesten, vertikalen Verkehrszeichen verwendet. Der Verwendungszweck schließt z.B. ein:</p> <ul style="list-style-type: none"><li>- Retroreflektierende Verkehrszeichen, retroreflektierende und innenbeleuchtete Verkehrszeichen (siehe EN 12899-1)</li><li>- Wechselverkehrszeichen (siehe EN 12966-1)</li></ul>
<p><i>Manufacturer / Hersteller</i></p> <p> 3M Deutschland GmbH Carl-Schurz-Str.1 D – 41453 Neuss</p>
<p><i>Assessment and Verification of Constancy of Performance / Bewertung und Überprüfung der Leistungsbeständigkeit</i></p> <p>System 1</p>
<p>StrAus-Zert, notified body 0913, Steinhausstr. 79, D-58099 Hagen performs the continuous surveillance, assessment and evaluation of the factory production control under system 1 and issued the certificate of conformity 0913-CPD-2012 / 02.</p> <p>/</p> <p>StrAus-Zert, notifizierte Stelle Nr. 0913, Steinhausstr. 79, D-58099 Hagen führt die laufende Überwachung, Beurteilung und Anerkennung der werkseigenen Produktionskontrolle nach System 1 durch und hat die Konformitätsbescheinigung 0913-CPD-2012 / 02 ausgestellt.</p>



# Impact of EN12899-1 : CE marking and info on final sign.



Customer ref: 0	
0120	Resistance to horizontal loads Wind action: WL5 Temporary deflection bending(sign plate): TDB4 Point loads: PL3 Partial action factor: PAF0 Dynamic snow load: DSL0 Fixings: Pass Permanent deflection: Pass
Morelock Signs Limited, Morelock House, Strawberry Lane, Willenhall, West Midlands, WV13 3RS Registered in England No. 3193048	Visibility characteristics Facing material HIP Daylight chromaticity & luminance factor-ETA class B1 & B2 Coefficient of retroreflection-ETA class R2
Certificate Number: GB09/78807 Year of manufacture: 2013 Dwg: 1200mm Circle IOF: 0	Durability Impact resistance of sign face material: Pass
BS EN12899-1:2007 Retroreflective sign plates for fixed vertical road traffic signs	Resistance to weathering 3 yr accelerated natural weathering test: Pass Resistance to corrosion - Aluminium: SP1

Customer ref: 0	
0120	Resistance to horizontal loads Wind action: WL5 Temporary deflection bending(sign plate): TDB4 Point loads: PL3 Partial action factor: PAF0 Dynamic snow load: DSL0 Fixings: Pass Permanent deflection: Pass
Morelock Signs Limited, Morelock House, Strawberry Lane, Willenhall, West Midlands, WV13 3RS Registered in England No. 3193048	Visibility characteristics Facing material HIP Daylight chromaticity & luminance factor-ETA class B1 & B2 Coefficient of retroreflection-ETA class R2
Certificate Number: GB09/78807 Year of manufacture: 2013 Dwg: 1200mm Circle IOF: 0	Durability Impact resistance of sign face material: Pass
BS EN12899-1:2007 Retroreflective sign plates for fixed vertical road traffic signs	Resistance to weathering 3 yr accelerated natural weathering test: Pass Resistance to corrosion - Aluminium: SP1

- Mandatory CE marking defined in Annex ZA :
- ZA 1 : Beaded - Microprismatic Reflective Sheeting
  - ZA 2/3/4 : Supports
  - ZA 5 : Signface
  - ZA 6 : Sign Assemblies

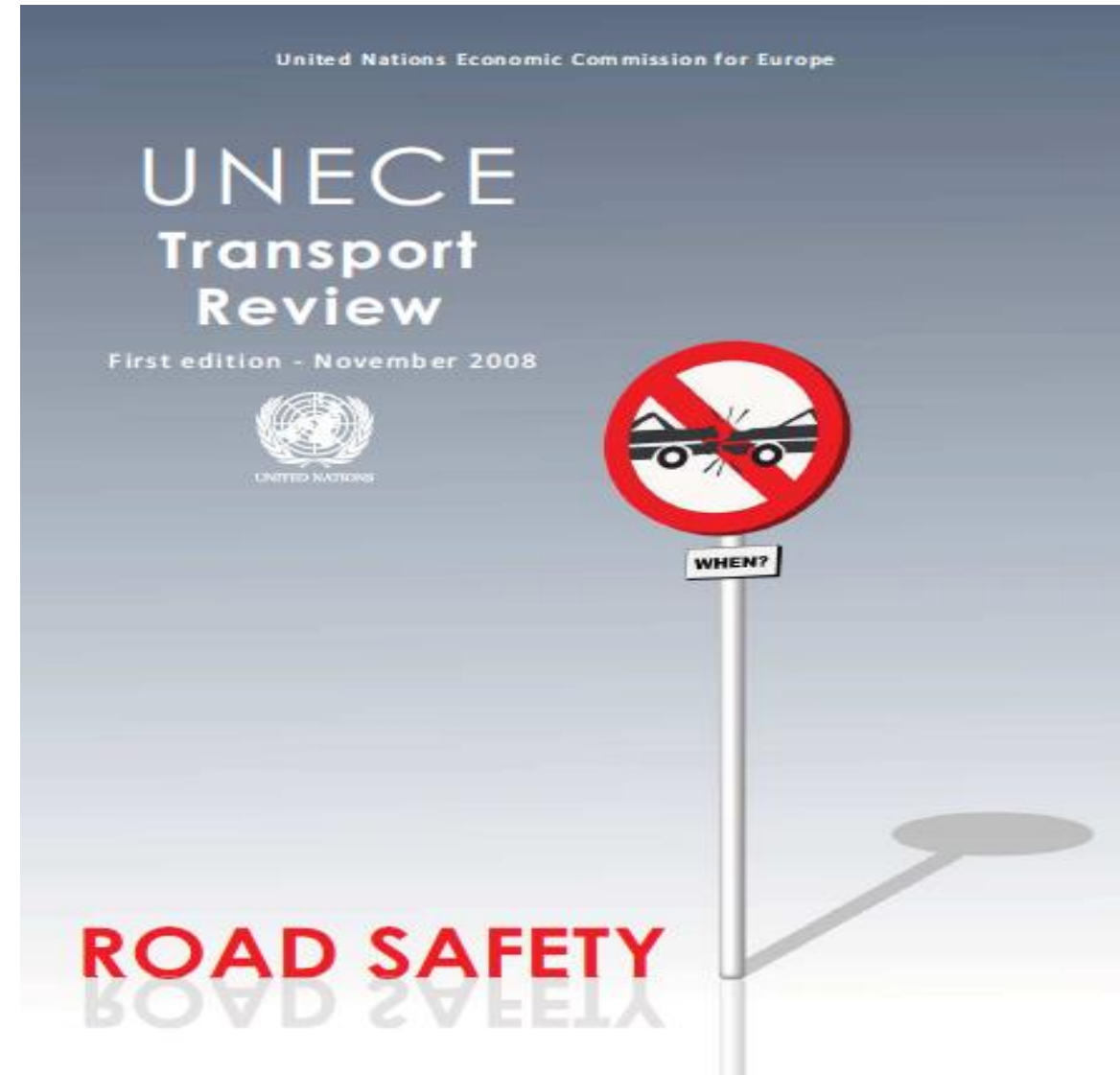


# *Driver's Needs*

## *- Effectiveness*

### *Review of latest research*

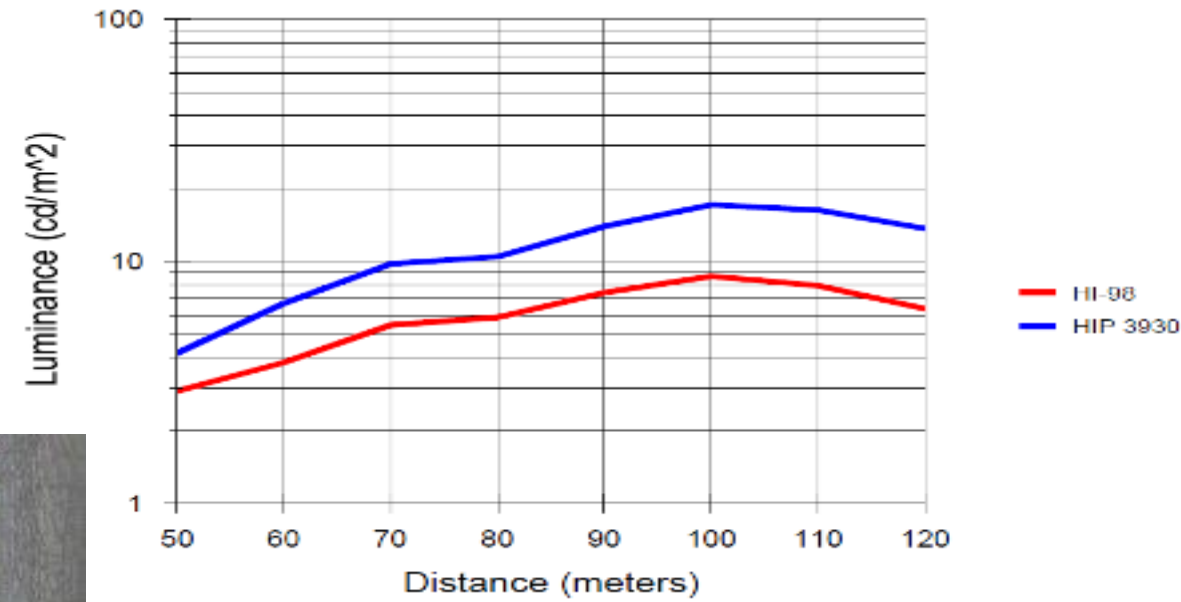
- 1. Subjective Rating*
- 2. eye tracking study*
- 3. % drivers served*



# *On-Road Test*

## *Glass Bead vs. Prismatic*

*Class RA 2 according EN 12 899-1*



*Perceived brightness often correlates with age*



20 Years



33 Years



46 Years

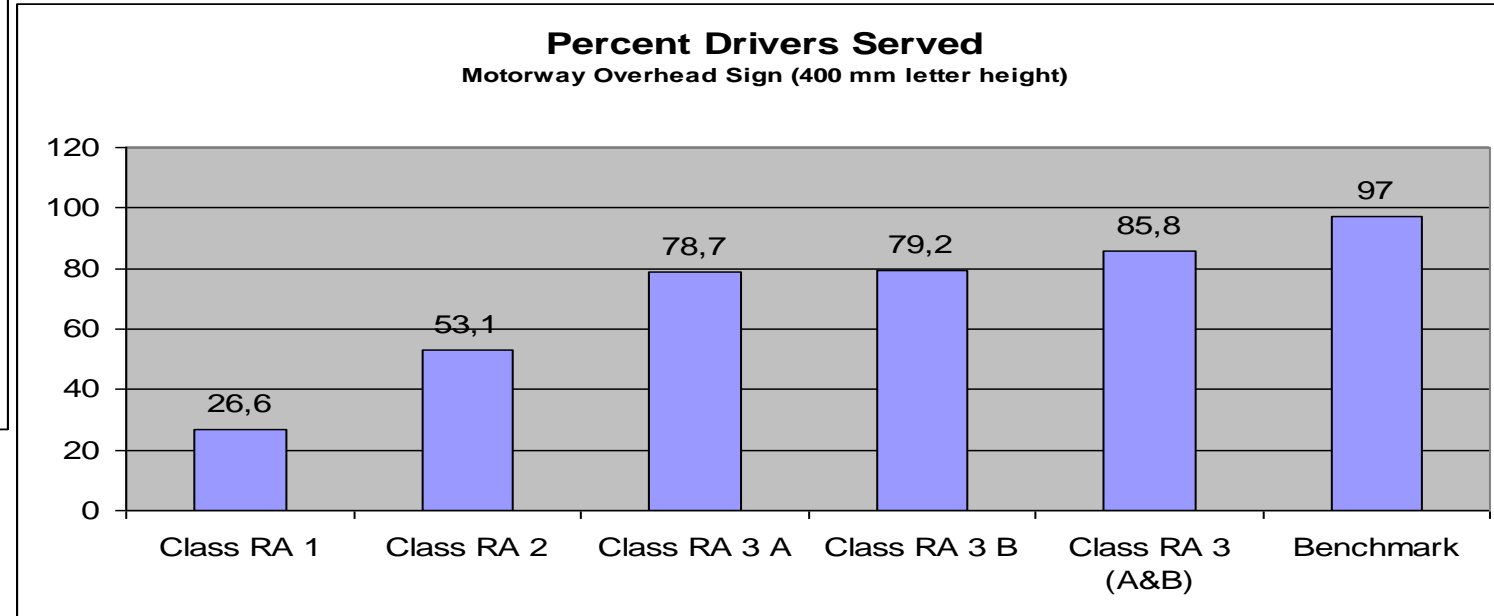
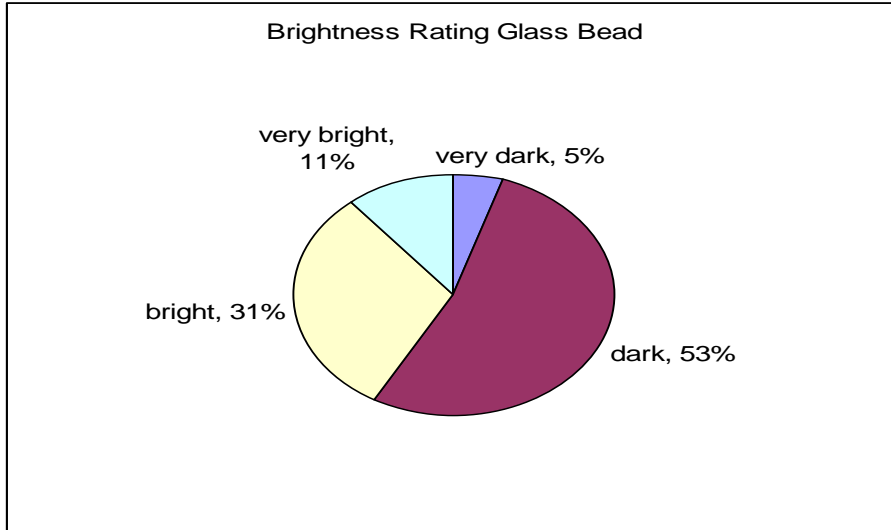


59 Years

Driver Age

# Summary

## Drivers Needs Studies



- Glass Bead Class 2 satisfies only  $\approx 50\%$  of drivers
- Microprismatic Class 3 can serve  $\approx 85\%$  of drivers



*Thank you*