IQ Linear

Cutting-Edge Flat Optics

Technical Guide

Version 2024-08-27

NANOPTIQS

NANOPTIQS

Welcome to IQS NANOPTIQS

As part of the IQS Group, we specialize in micro and nanostructured optics, revolutionizing LED lighting, sensors, and automotive lights. Our expertise? Creating high-efficiency, innovative optical elements.

Innovative Optical Solutions

Our products, including the IQ Linear series, offer superior performance through miniaturization and precision in light management. For custom needs, the IQ System delivers tailored solutions, enhancing both material and energy efficiency.

Expertise That Leads

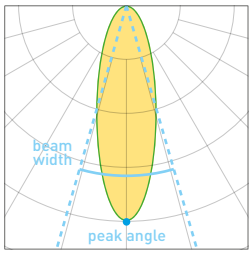
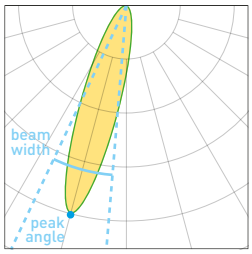
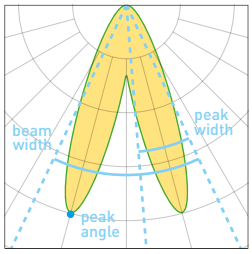
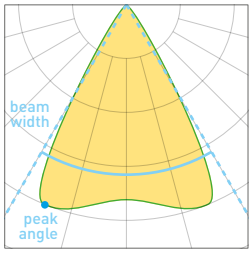
Our R&D team, with 25+ years in the field, drives our success, utilizing advanced technologies to design, develop and produce cutting-edge optics in our state-of-the-art facilities in the heart of the Czech Republic.

3D model showing a typical microstructured surface. The microstructured depth is exaggerated in order to clearly show the facets.

Pioneering optics innovation with micro and nanostructures

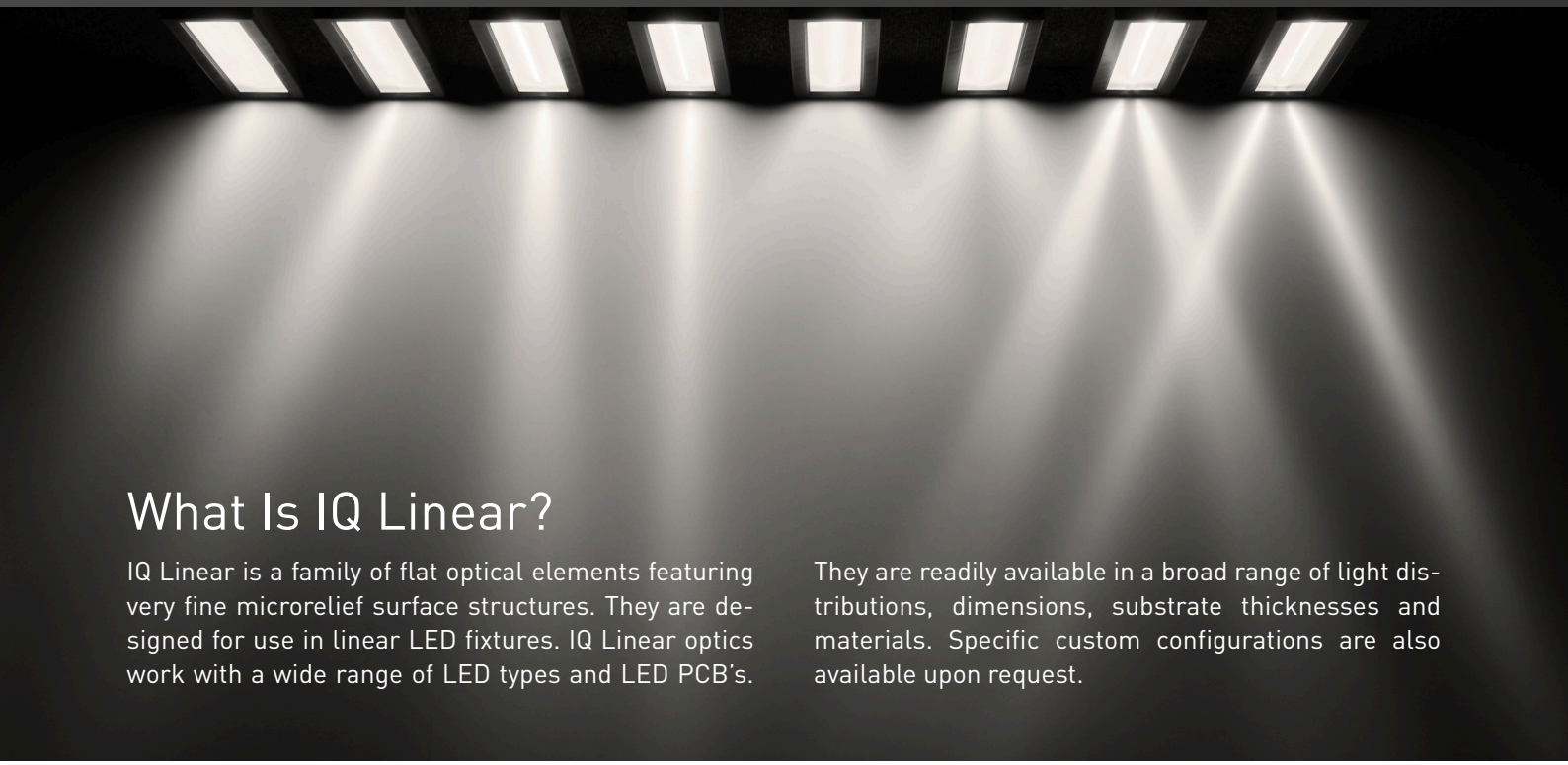
Contents

IQ Linear Brief Overview

Light Distribution Type		Name	Nominal Distance to LED	Max. Optics Width	Nominal Beam/Peak Width	Nominal Peak Angle	Nominal Peak Intensity	Page
Deep		NILO 1	10 mm	40 mm	14°	0°	1.0 cd/lm	**6**
		NILO 2	10 mm	40 mm	20°	0°	0.8 cd/lm	**8**
		NILO 1W	20 mm	65 mm	14°	0°	0.9 cd/lm	**22**
		NILO 4W	20 mm	65 mm	45°	0°	0.5 cd/lm	**24**
Single Asymmetric		DARLO 1	10 mm	40 mm	21°	26°	0.7 cd/lm	**10**
		DARLO 2	10 mm	40 mm	49°	21°	0.5 cd/lm	**12**
		DARLO 3W	20 mm	65 mm	75°	22°	0.4 cd/lm	**26**
Double Asymmetric		ELBO 1	10 mm	40 mm	61°/13°	−25°/+25°	0.8 cd/lm	**14**
		ELBO 2	10 mm	40 mm	55°/17°	−19°/+19°	0.7 cd/lm	**16**
		ELBO 3	10 mm	40 mm	80°/40°	−23°/+23°	0.4 cd/lm	**18**
		ELBO 3W	20 mm	65 mm	85°/43°	−24°/+24°	0.4 cd/lm	**28**
Medium Wide / Batwing		NUBO 1	10 mm	40 mm	86°	−28°/+28°	0.3 cd/lm	**20**
		NUBO 1W	20 mm	65 mm	87°	−26°/+26°	0.3 cd/lm	**30**

IQ Linear

A Quick Introduction



What Is IQ Linear?

IQ Linear is a family of flat optical elements featuring very fine microrelief surface structures. They are designed for use in linear LED fixtures. IQ Linear optics work with a wide range of LED types and LED PCB's.

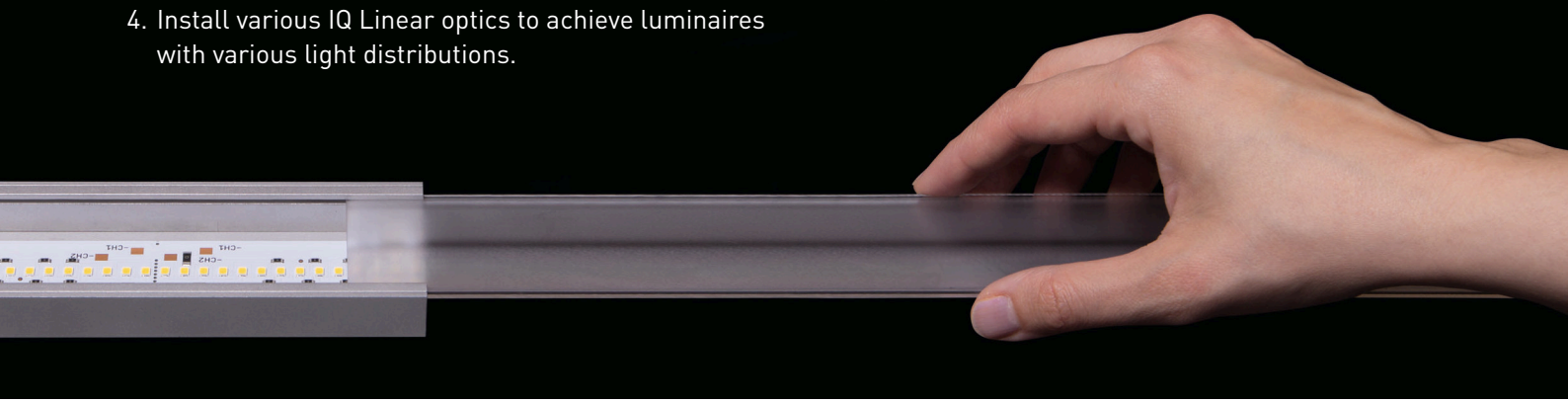
They are readily available in a broad range of light distributions, dimensions, substrate thicknesses and materials. Specific custom configurations are also available upon request.

How Does IQ Linear Compare to Other Optics?

A typical linear luminaire manufacturer can use about three types of optics: conventional diffusers, microprismatic sheets and linear lenses. Conventional diffusers often lead to poor efficiency and no light control. Microprismatic sheets offer single type of light control and may be bulky and expensive. Linear lenses offer various types of light control, but are the bulkiest, the most expensive and limited to a particular width. IQ Linear optics offers various types of light control and superb efficiency like linear lenses, while keeping flexibility and simplicity.

How to Build an IQ Linear Based Luminaire?

1. Select suitable luminaire body such as an aluminium profile.
2. Select and install favourite single row LED PCB.
3. Select width and thickness of IQ Linear optics that fits the design needs.
4. Install various IQ Linear optics to achieve luminaires with various light distributions.



IQ Linear
A Quick Introduction

What Are the Benefits of IQ Linear?

Slim and innovative optics offering new luminaire design options.

Significant savings on luminaires and energy consumption.

Designed for use with a wide range of LEDs and PCBs.

Available in various widths, lengths and thicknesses.

Precise and variable light management.

Carbon footprint reduction due to energy and material-efficient production.

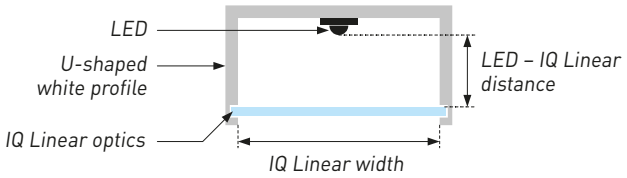
Miniaturization of luminaire design.

The efficiency of the optics up to 95 % compared to clear plastic luminaire covers.

How to Read IQ Linear Datasheets?

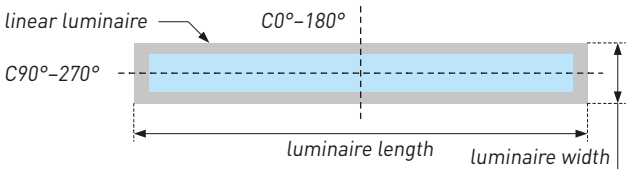
Datasheets of IQ Linear optics describe properties of typical linear luminaires containing IQ Linear. It is important to realize that IQ Linear optics is just one component of the whole luminaire, and that properties of the luminaire depend on all components and their assembly. Thus, luminaires with atypical construction will most likely show different properties.

First of all, the datasheet of a particular IQ Linear optics describes properties of a "nominal luminaire". It is comprised of a U-shaped white profile, with a single row of LEDs in its centre, and with IQ Linear optics at "the nominal distance" from the LED. The nominal distance is specified for each IQ Linear optics, it is either 10 or 20 mm. Width of the optics is the maximum possible width also specified for each optics, either 40 or 65 mm.



Such luminaire construction is used to measure the nominal parameters, e.g., beam width (FWHM), peak luminous intensity, etc. One parameter deserves special attention: the specific efficiency. As efficiency of the luminaire depends a lot on, e.g., particular white material of the fixture, a real efficiency (flux of luminaire / flux of LED) would be misleading. Thus, the specific efficiency defined as "flux of a luminaire with IQ Linear optics / flux of a luminaire with a clear PMMA cover" is given. Specific efficiency is not as sensitive to luminaire details as the real efficiency; moreover, such number is an interesting quantity for those who wish to replace a clear cover by IQ Linear.

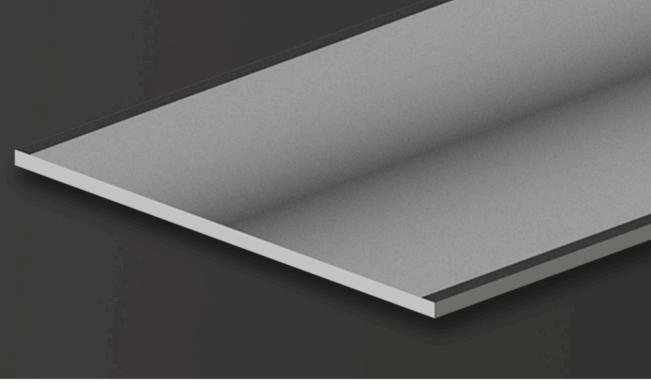
Light distribution curves are shown for the planes C0°–180° and C90°–270° according to the following convention:



Light distribution can be also assessed by looking at simulations of a floor or a wall illumination.

To indicate how a particular IQ Linear optics behaves in other than the nominal configuration, variety of other measurements are given. They show, e.g., what happens when changing the optics width, LED–optics distance or when IQ Linear is used off-axis (structure optical centre is not directly below LEDs). For each measurement, the datasheet shows the light distribution curve and their key parameters including real efficiency. The intent of these parameters is their mutual comparison; for instance, one can judge how efficiency drops when a parameter is changed. This change will be likely similar regardless of the real efficiencies of particular luminaires.

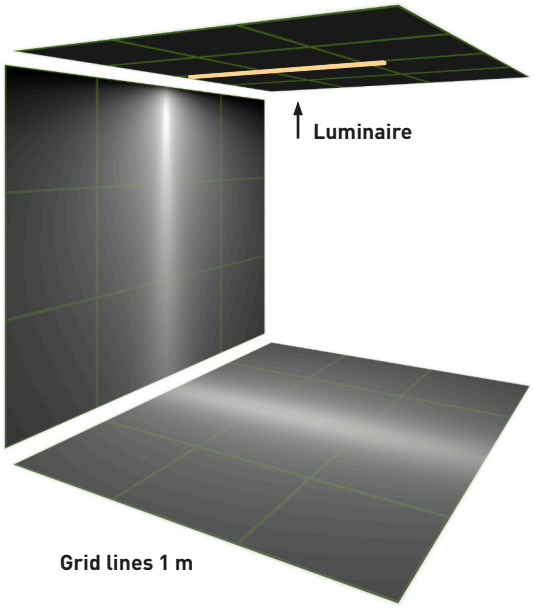
NILO 1



Nominal Light Distribution Parameters

Code	NILO 1
Beam Type	Deep
Nominal Distance to LED	10 mm
Nominal Beam Width	14°
Nominal Peak Angle	0°
Nominal Peak Intensity	1.0 cd/lm
Specific Efficiency	93 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

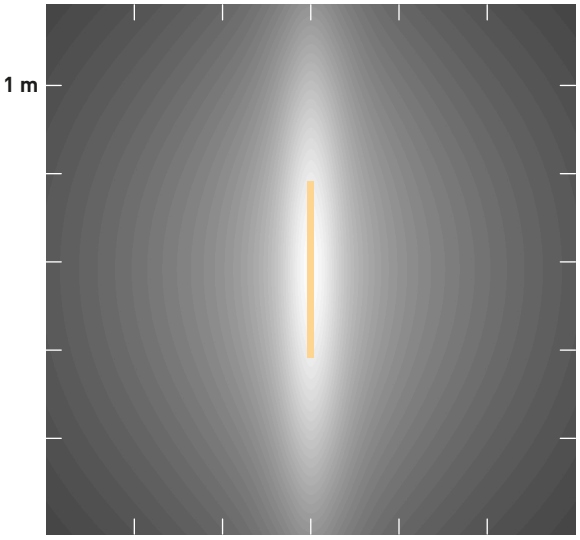


Dimensions and Material

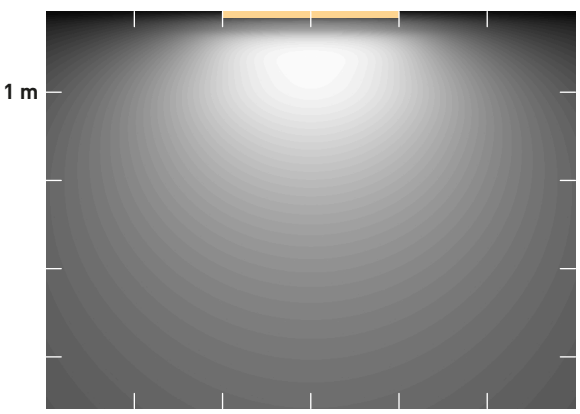
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

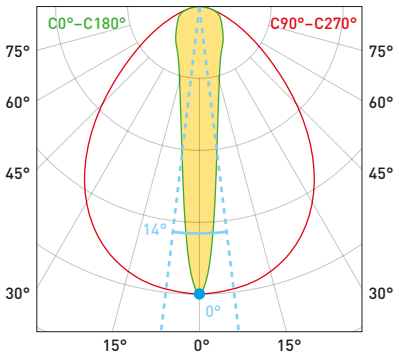
- Extremely narrow symmetric distribution, suitable for illumination from greater heights or accent lighting.
- Can be used for illumination of conference and lecture halls, industrial buildings, warehouses, and airports.
- In combination with a tilted luminaire it can be used for grazing incidence applications.
- Can be used to make single asymmetric light distributions when used off-axis. Such light distributions can be used, e.g., for display accent lighting.

Symmetric Distribution with an Extreme Narrow Peak

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the decentering offset changes the peak angle. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.
NILO 1 optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

LED – IQL DISTANCE 10 mm
IQ LINEAR WIDTH 20 mm

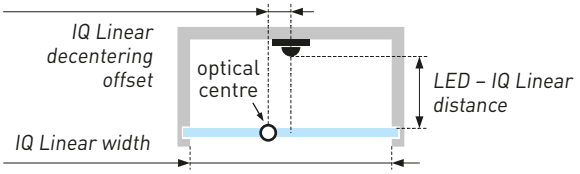
6 mm	4 mm	2 mm	0 mm
FWHM 24°, peak 30°, 0.6 cd/lm, eff 76%	FWHM 17°, peak 21°, 0.8 cd/lm, eff 76%	FWHM 14°, peak 12°, 0.9 cd/lm, eff 76%	FWHM 13°, peak 0°, 0.9 cd/lm, eff 76%

IQ LINEAR WIDTH

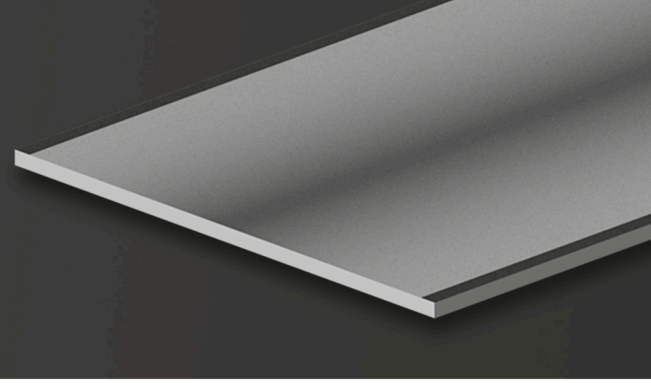
LED – IQ LINEAR DISTANCE

	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 42°, peak 0°, 0.5 cd/lm, eff 84%	FWHM 49°, peak 0°, 0.5 cd/lm, eff 90%	FWHM 46°, peak 0°, 0.5 cd/lm, eff 84%	FWHM 52°, peak 1°, 0.5 cd/lm, eff 85%
6 mm	FWHM 19°, peak 0°, 0.7 cd/lm, eff 72%	FWHM 23°, peak 0°, 0.7 cd/lm, eff 83%	FWHM 24°, peak 0°, 0.7 cd/lm, eff 81%	FWHM 27°, peak 0°, 0.7 cd/lm, eff 83%
nominal distance 10 mm	FWHM 12°, peak 0°, 0.9 cd/lm, eff 75%	FWHM 13°, peak 0°, 0.9 cd/lm, eff 76%	FWHM 14°, peak 0°, 1.0 cd/lm, eff 81%	
15 mm	FWHM 12°, peak 0°, 0.8 cd/lm, eff 66%	FWHM 12°, peak 0°, 0.8 cd/lm, eff 71%	FWHM 12°, peak 0°, 0.9 cd/lm, eff 77%	
20 mm	FWHM 16°, peak 0°, 0.6 cd/lm, eff 66%	FWHM 17°, peak 0°, 0.7 cd/lm, eff 74%		

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



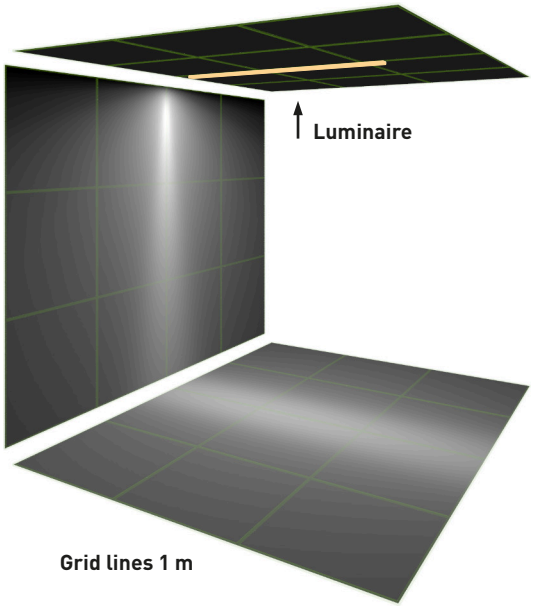
NILO 2



Nominal Light Distribution Parameters

Code	NILO 2
Beam Type	Deep
Nominal Distance to LED	10 mm
Nominal Beam Width	20°
Nominal Peak Angle	0°
Nominal Peak Intensity	0.8 cd/lm
Specific Efficiency	93 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

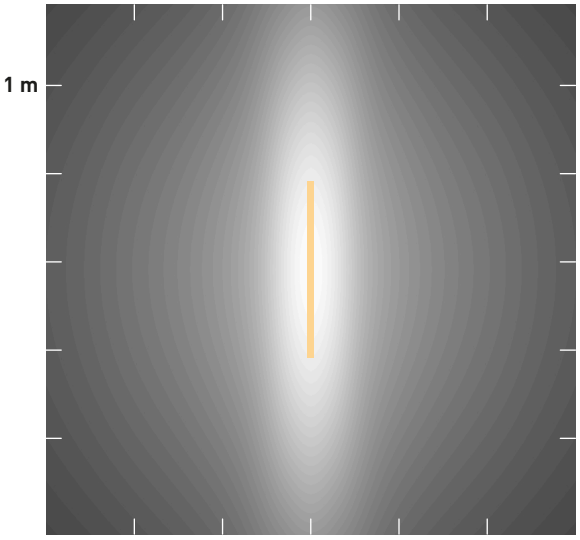


Dimensions and Material

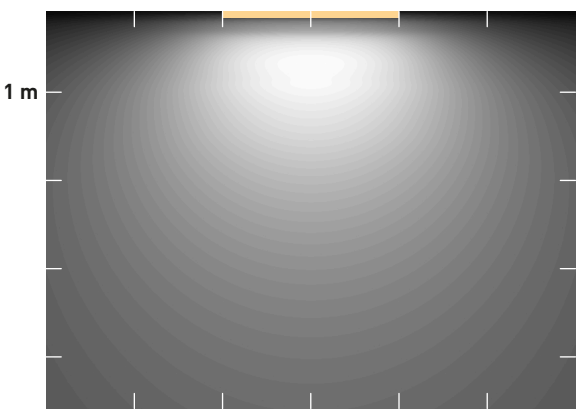
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

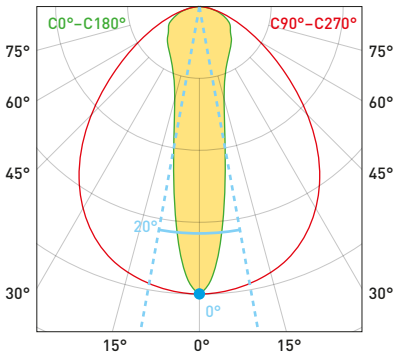
- Narrow symmetric distribution, suitable for illumination from moderate to greater heights.
- Can be used for illumination of conference and lecture halls, workspaces, office or industrial buildings, warehouses, and airports.
- In combination with a tilted luminaire it can be used for wall washing applications.
- Can be used to make single asymmetric light distributions when used off-axis. Such light distributions can be used, e.g., for display accent lighting or wall washing.

Symmetric Distribution with a Narrow Peak

Light Distribution Adjustment

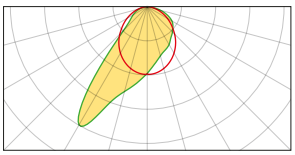
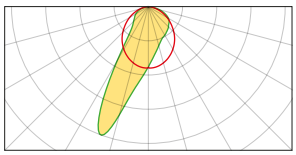
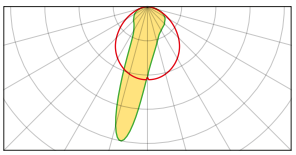
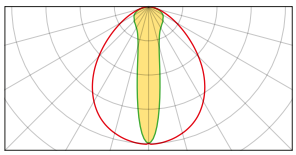
Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the decentering offset changes the peak angle. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.
NILO 2 optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

Nominal light distribution curve



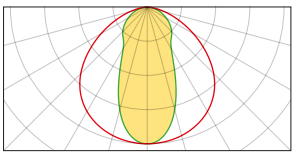
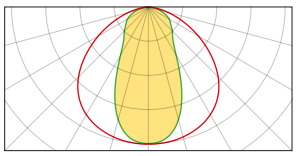
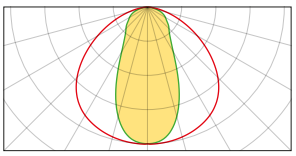
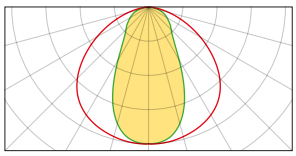
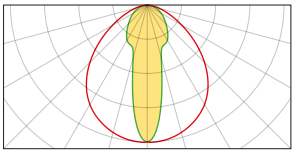
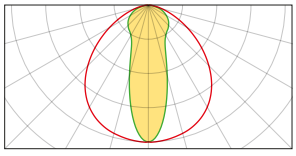
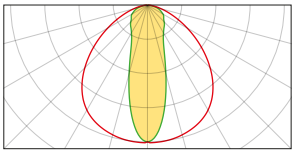
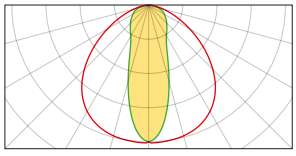
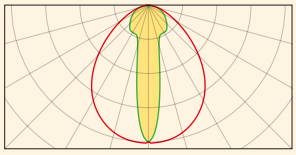
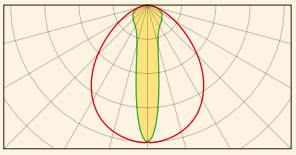
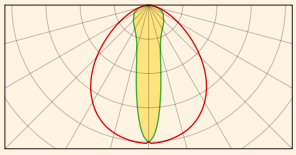
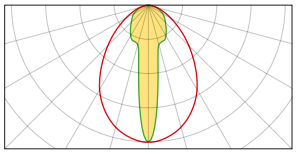
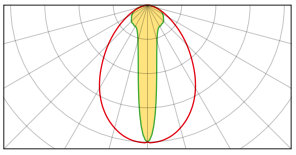
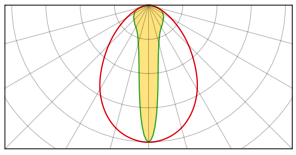
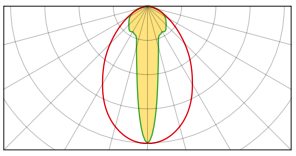
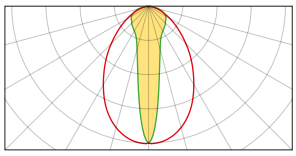
IQ LINEAR DECENTERING OFFSET

LED – IQL DISTANCE 10 mm
IQ LINEAR WIDTH 20 mm

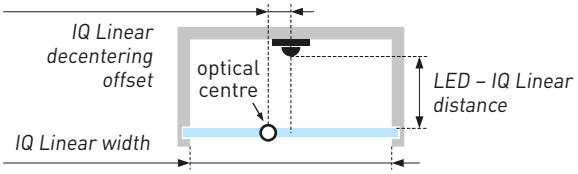
6 mm	4 mm	2 mm	0 mm
			
FWHM 38°, peak 29°, 0.5 cd/lm, eff 77%	FWHM 25°, peak 20°, 0.6 cd/lm, eff 76%	FWHM 21°, peak 11°, 0.7 cd/lm, eff 76%	FWHM 19°, peak 0°, 0.8 cd/lm, eff 75%

IQ LINEAR WIDTH

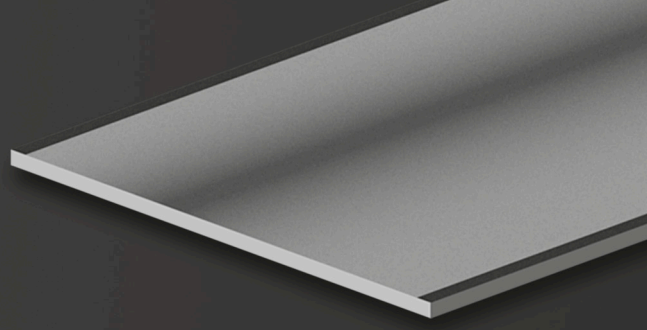
LED – IQ LINEAR DISTANCE

	5 mm	10 mm	20 mm	40 mm
3 mm	 FWHM 47°, peak 0°, 0.5 cd/lm, eff 83%	 FWHM 53°, peak 0°, 0.5 cd/lm, eff 90%	 FWHM 51°, peak 0°, 0.5 cd/lm, eff 83%	 FWHM 56°, peak 1°, 0.5 cd/lm, eff 84%
6 mm	 FWHM 25°, peak 0°, 0.6 cd/lm, eff 71%	 FWHM 32°, peak 0°, 0.6 cd/lm, eff 83%	 FWHM 31°, peak 0°, 0.6 cd/lm, eff 81%	 FWHM 34°, peak 0°, 0.6 cd/lm, eff 83%
nominal distance 10 mm	 FWHM 19°, peak 0°, 0.7 cd/lm, eff 74%	 FWHM 19°, peak 0°, 0.8 cd/lm, eff 75%	 FWHM 20°, peak 0°, 0.8 cd/lm, eff 81%	
15 mm	 FWHM 16°, peak 0°, 0.6 cd/lm, eff 66%	 FWHM 15°, peak 0°, 0.7 cd/lm, eff 70%	 FWHM 16°, peak 0°, 0.8 cd/lm, eff 77%	
20 mm		 FWHM 18°, peak 0°, 0.6 cd/lm, eff 66%	 FWHM 18°, peak 0°, 0.7 cd/lm, eff 74%	

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



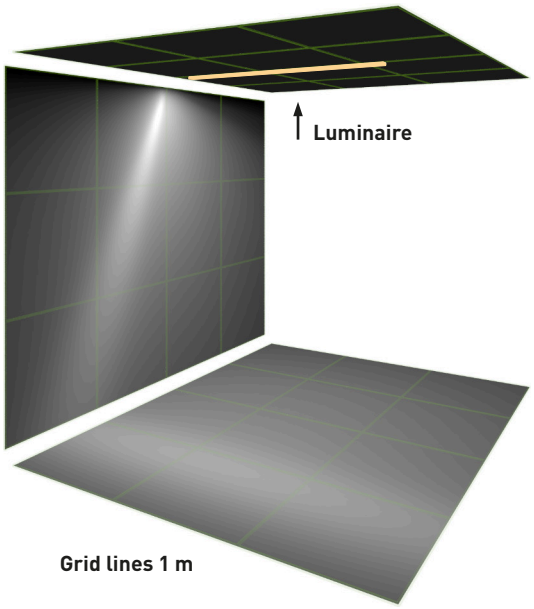
DARLO 1



Nominal Light Distribution Parameters

Code	DARLO 1
Beam Type	Asymmetric
Nominal Distance to LED	10 mm
Nominal Beam Width	21°
Nominal Peak Angle	26°
Nominal Peak Intensity	0.7 cd/lm
Specific Efficiency	91 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

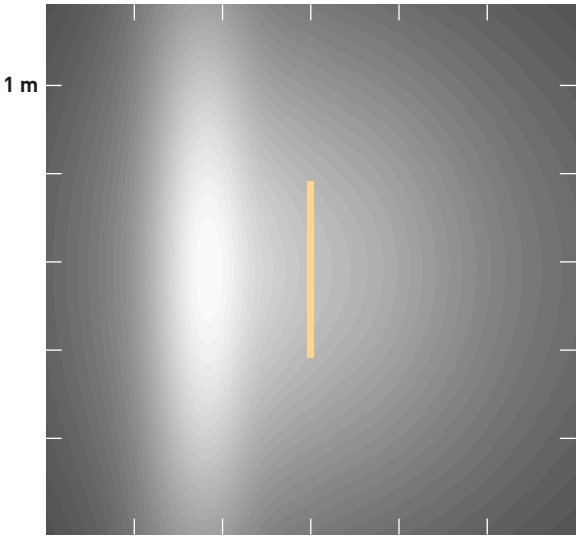


Dimensions and Material

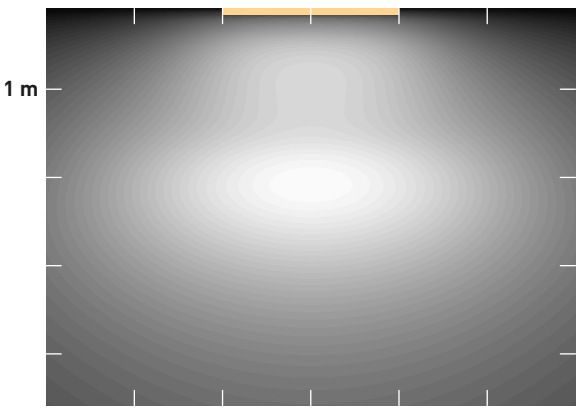
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

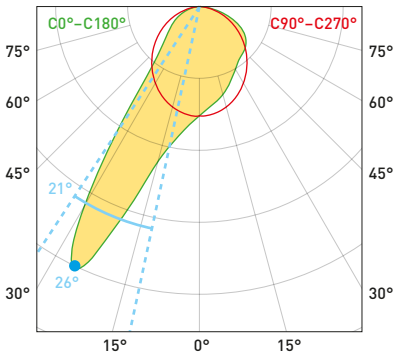
- Single asymmetric distribution with narrow peak, suitable for asymmetric floodlighting, wall washing or accenting.
- Can be effectively used in galleries, houses, classrooms, in shops for single shelf illumination or integrated in railings for walkway and staircase illumination.
- Also suitable for in-ground mounted luminaires for wall washing and grazing applications.
- Peak angle can be adjusted when used off-axis, i.e., by changing the decentering offset, or by changing LED – IQ Linear distance.

Single Asymmetric Distribution with a Narrow Peak

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Peak angle can be adjusted by changing the decentering offset or LED – IQ Linear distance, which also affects the beam width (FWHM). Note that changing the IQ Linear width usually does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls. DARLO 1 optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

LED – IQL DISTANCE 10 mm
IQ LINEAR WIDTH 20 mm

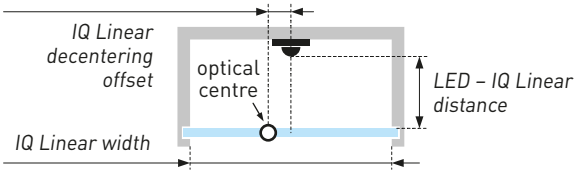
–4 mm	–2 mm	0 mm	+2 mm
FWHM 83°, peak 44°, 0.4 cd/lm, eff 75%	FWHM 33°, peak 36°, 0.5 cd/lm, eff 76%	FWHM 20°, peak 24°, 0.7 cd/lm, eff 75%	FWHM 22°, peak 14°, 0.7 cd/lm, eff 75%

IQ LINEAR WIDTH

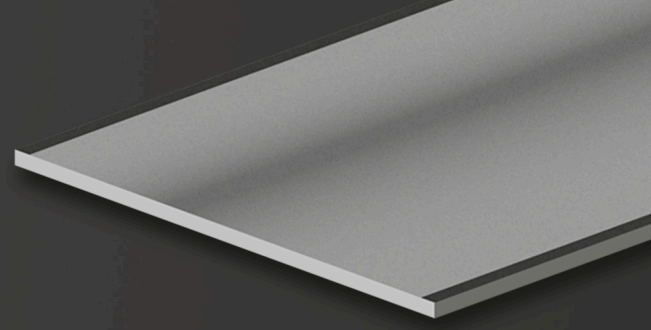
LED – IQ LINEAR DISTANCE

	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 88°, peak 20°, 0.3 cd/lm, eff 81%	FWHM 110°, peak 16°, 0.3 cd/lm, eff 86%	FWHM 94°, peak 43°, 0.3 cd/lm, eff 82%	FWHM 114°, peak 15°, 0.3 cd/lm, eff 82%
6 mm	FWHM 65°, peak 21°, 0.4 cd/lm, eff 70%	FWHM 69°, peak 34°, 0.4 cd/lm, eff 81%	FWHM 56°, peak 37°, 0.5 cd/lm, eff 81%	FWHM 50°, peak 35°, 0.5 cd/lm, eff 81%
nominal distance 10 mm	FWHM 25°, peak 22°, 0.5 cd/lm, eff 73%	FWHM 20°, peak 24°, 0.7 cd/lm, eff 75%	FWHM 21°, peak 26°, 0.7 cd/lm, eff 80%	
15 mm	FWHM 22°, peak 18°, 0.5 cd/lm, eff 65%	FWHM 14°, peak 18°, 0.7 cd/lm, eff 70%	FWHM 15°, peak 19°, 0.8 cd/lm, eff 76%	
20 mm		FWHM 13°, peak 15°, 0.7 cd/lm, eff 65%	FWHM 14°, peak 15°, 0.8 cd/lm, eff 73%	

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



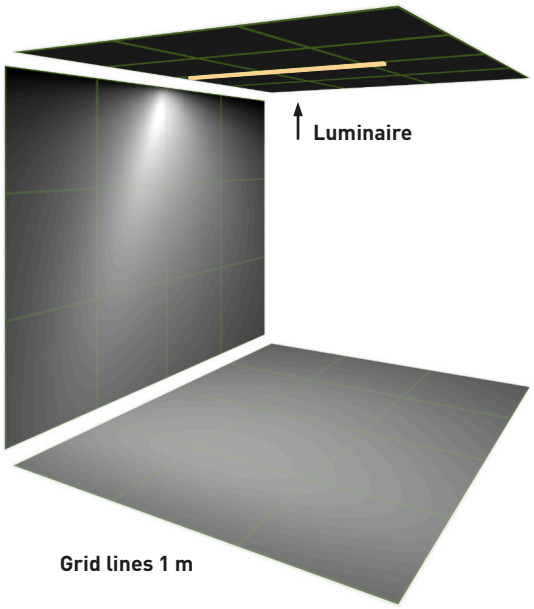
DARLO 2



Nominal Light Distribution Parameters

Code	DARLO 2
Beam Type	Asymmetric
Nominal Distance to LED	10 mm
Nominal Beam Width	49°
Nominal Peak Angle	21°
Nominal Peak Intensity	0.5 cd/lm
Specific Efficiency	93 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

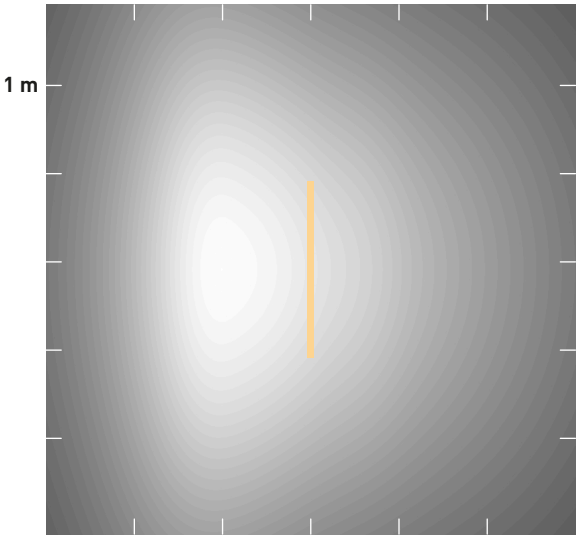


Dimensions and Material

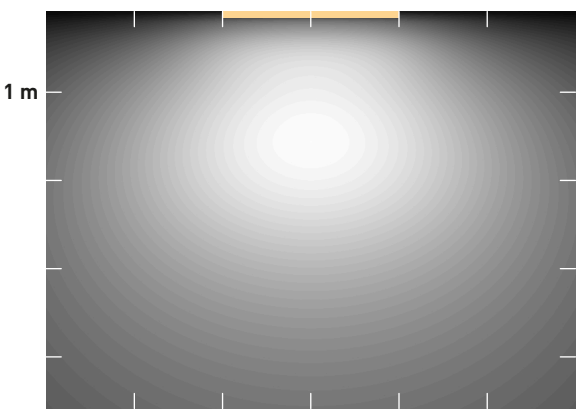
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

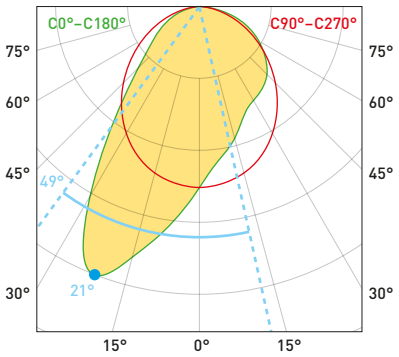
- Single asymmetric distribution with broad peak, suitable for wall and floor illumination and indirect lighting illumination of walls.
- Can be used for illumination of large rooms or corridors, workspaces, receptions, galleries, and halls.
- Can be also effectively used in multipurpose luminaires for small shops or even houses to reduce the number of light fixtures.
- Peak angle can be adjusted when used off-axis, i.e., by changing the decentering offset, or by changing LED – IQ Linear distance.

Single Asymmetric Distribution with a Broad Peak

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Peak angle can be adjusted by changing the decentering offset or LED – IQ Linear distance, which also affects the beam width (FWHM). Note that changing the IQ Linear width usually does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

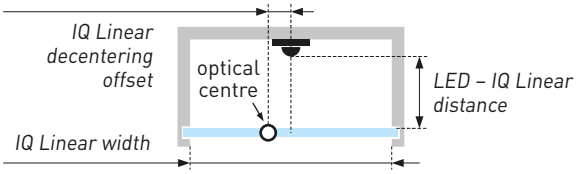
IQ LINEAR WIDTH

LED – IQL DISTANCE 10 mm
IQ LINEAR WIDTH 20 mm

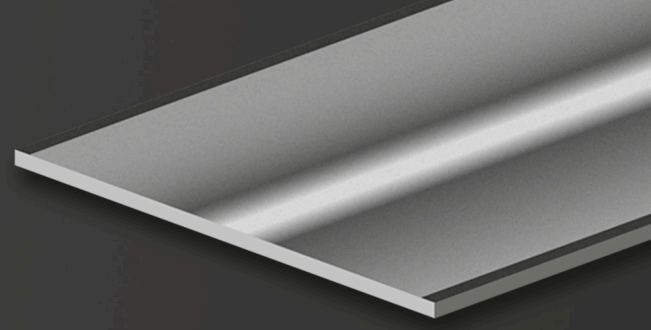
LED – IQ LINEAR DISTANCE

LED – IQ Linear distance	–4 mm	–2 mm	0 mm	+2 mm
3 mm	FWHM 92°, peak 36°, 0.3 cd/lm, eff 77%	FWHM 77°, peak 31°, 0.4 cd/lm, eff 77%	FWHM 47°, peak 21°, 0.5 cd/lm, eff 76%	FWHM 38°, peak 11°, 0.5 cd/lm, eff 76%
6 mm	FWHM 81°, peak 14°, 0.4 cd/lm, eff 82%	FWHM 99°, peak 15°, 0.3 cd/lm, eff 89%	FWHM 95°, peak 20°, 0.3 cd/lm, eff 82%	FWHM 100°, peak 16°, 0.3 cd/lm, eff 83%
10 mm (nominal distance)	FWHM 60°, peak 13°, 0.4 cd/lm, eff 70%	FWHM 73°, peak 25°, 0.4 cd/lm, eff 82%	FWHM 77°, peak 29°, 0.4 cd/lm, eff 81%	FWHM 70°, peak 27°, 0.4 cd/lm, eff 82%
15 mm	FWHM 51°, peak 20°, 0.4 cd/lm, eff 74%	FWHM 47°, peak 21°, 0.5 cd/lm, eff 76%	FWHM 49°, peak 21°, 0.5 cd/lm, eff 81%	
20 mm	FWHM 43°, peak 16°, 0.4 cd/lm, eff 65%	FWHM 34°, peak 15°, 0.5 cd/lm, eff 71%	FWHM 34°, peak 16°, 0.5 cd/lm, eff 79%	
	FWHM 29°, peak 12°, 0.5 cd/lm, eff 66%	FWHM 29°, peak 13°, 0.6 cd/lm, eff 75%		

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



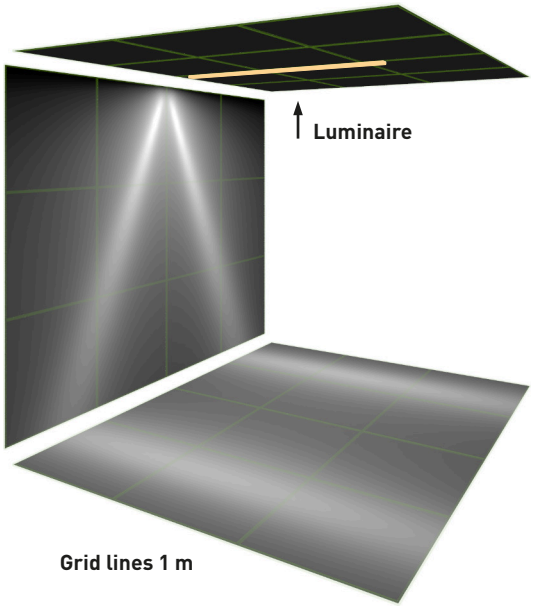
ELBO 1



Nominal Light Distribution Parameters

Code	ELBO 1
Beam Type	Double-asymmetric
Nominal Distance to LED	10 mm
Nominal Beam/Peak Width	61°/13°
Nominal Peak Angle	–25°/+25°
Nominal Peak Intensity	0.8 cd/lm
Specific Efficiency	94 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

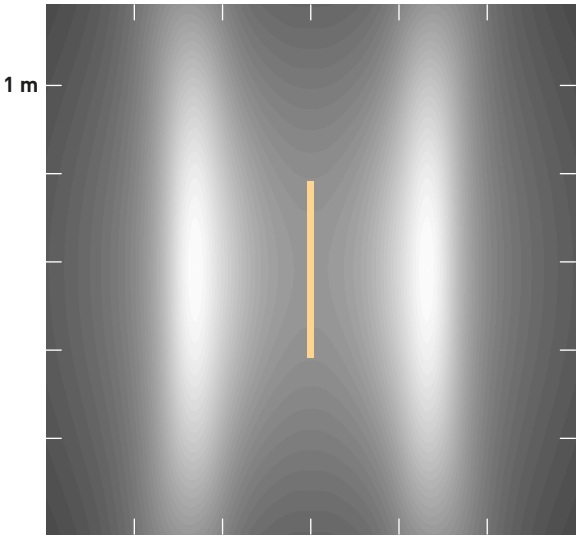


Dimensions and Material

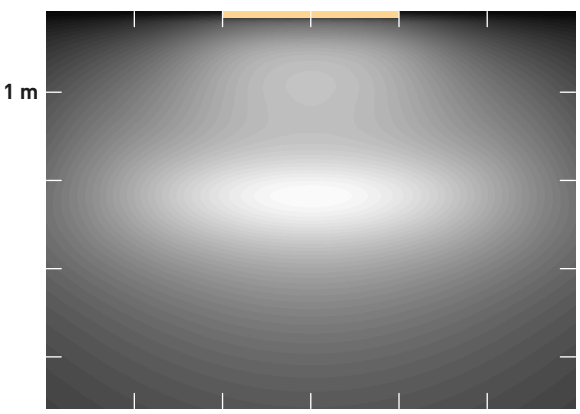
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

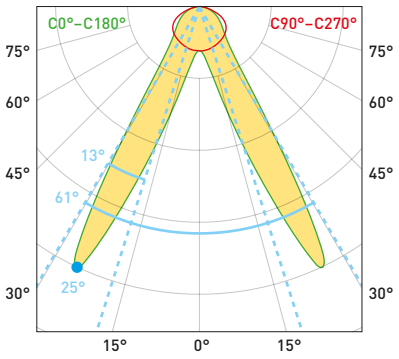
- Double asymmetric distribution with extreme narrow peaks, suitable for high contrast targeted illumination, reduces the number of fixtures.
- Can be used for dual shelf illumination in shops, supermarkets, libraries, archives, galleries, or warehouses. Especially suitable for accenting purposes.
- Symmetric adjustment of the peak angles can be achieved by changing LED – IQ Linear distance.
- When implemented with small LED – IQ Linear distance it can be used for wide beam applications such as illuminating parking area or indirect ceiling illumination.

Double Asymmetric Distribution with Extreme Narrow Peaks

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that changing the IQ Linear width usually does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls. ELBO 1 optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

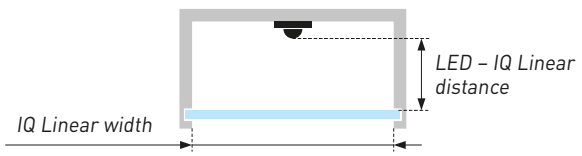
Nominal light distribution curve



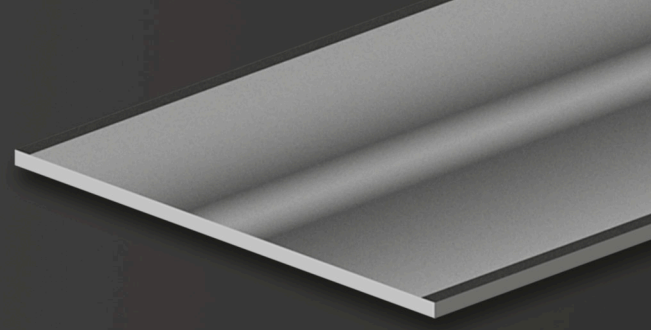
IQ LINEAR WIDTH

LED – IQ LINEAR DISTANCE	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 105°, peak 32°, 0.3 cd/lm, eff 78%	FWHM 121°, peak 53°, 0.3 cd/lm, eff 86%	FWHM 125°, peak 53°, 0.3 cd/lm, eff 87%	FWHM 132°, peak 55°, 0.3 cd/lm, eff 86%
6 mm	FWHM 71°, peak 23°, 0.4 cd/lm, eff 71%	FWHM 86°/32°, peak 34°, 0.5 cd/lm, eff 84%	FWHM 90°/30°, peak 33°, 0.5 cd/lm, eff 84%	FWHM 89°/27°, peak 39°, 0.6 cd/lm, eff 87%
10 mm (nominal distance)	FWHM 62°/18°, peak 22°, 0.6 cd/lm, eff 75%	FWHM 59°/11°, peak 25°, 0.8 cd/lm, eff 77%	FWHM 61°/13°, peak 25°, 0.8 cd/lm, eff 82%	
15 mm	FWHM 44°/10°, peak 17°, 0.6 cd/lm, eff 66%	FWHM 44°/9°, peak 17°, 0.9 cd/lm, eff 71%	FWHM 47°/10°, peak 18°, 0.9 cd/lm, eff 79%	
20 mm		FWHM 37°/9°, peak 14°, 0.8 cd/lm, eff 67%	FWHM 37°/9°, peak 14°, 0.8 cd/lm, eff 74%	

Values below the graphs:
beam width/peak width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



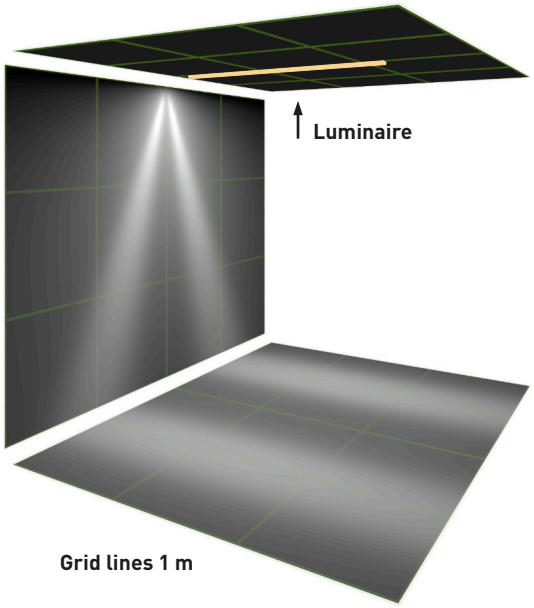
ELBO 2



Nominal Light Distribution Parameters

Code	ELBO 2
Beam Type	Double-asymmetric
Nominal Distance to LED	10 mm
Nominal Beam/Peak Width	55°/17°
Nominal Peak Angle	–19°/+19°
Nominal Peak Intensity	0.7 cd/lm
Specific Efficiency	95 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

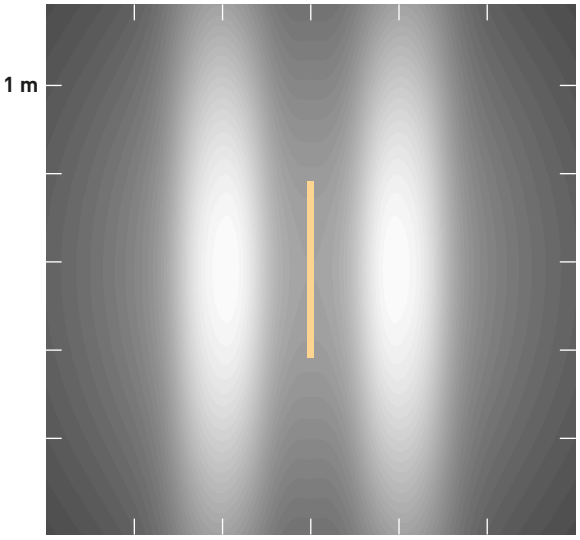


Dimensions and Material

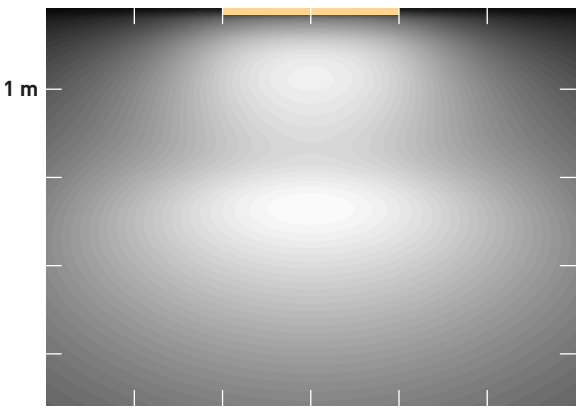
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

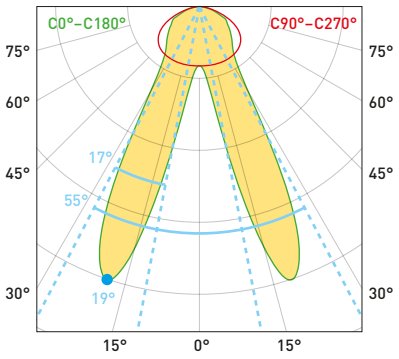
- Double asymmetric distribution with narrow peaks, suitable for vertical illumination with minimal downward / vertical illumination, reduces number of fixtures.
- Can be used for dual shelf illumination in shops, supermarkets, libraries, archives, galleries, or warehouses.
- Also applicable for narrow corridor wall illumination.
- Symmetric adjustment of the peak angles can be achieved by changing LED – IQ Linear distance.

Double Asymmetric Distribution with Narrow Peaks

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls. ELBO 2 optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

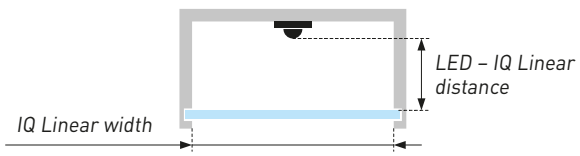
Nominal light distribution curve



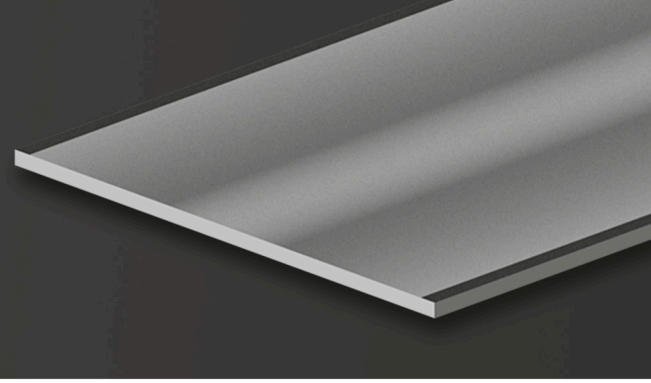
IQ LINEAR WIDTH

LED – IQ LINEAR DISTANCE	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 87°/37°, peak 29°, 0.4 cd/lm, eff 83%	FWHM 106°/43°, peak 36°, 0.4 cd/lm, eff 90%	FWHM 96°/36°, peak 32°, 0.4 cd/lm, eff 87%	FWHM 102°/39°, peak 33°, 0.4 cd/lm, eff 87%
6 mm	FWHM 56°/21°, peak 19°, 0.4 cd/lm, eff 71%	FWHM 74°/25°, peak 24°, 0.5 cd/lm, eff 84%	FWHM 78°/27°, peak 25°, 0.5 cd/lm, eff 84%	FWHM 76°/26°, peak 26°, 0.5 cd/lm, eff 86%
nominal distance 10 mm	FWHM 52°/17°, peak 18°, 0.6 cd/lm, eff 75%	FWHM 56°/17°, peak 18°, 0.6 cd/lm, eff 78%	FWHM 55°/17°, peak 19°, 0.7 cd/lm, eff 83%	
15 mm	FWHM 37°/11°, peak 14°, 0.6 cd/lm, eff 67%	FWHM 38°/11°, peak 14°, 0.7 cd/lm, eff 72%	FWHM 40°/11°, peak 15°, 0.8 cd/lm, eff 79%	
20 mm		FWHM 31°/9°, peak 11°, 0.7 cd/lm, eff 67%	FWHM 31°/9°, peak 11°, 0.8 cd/lm, eff 75%	

Values below the graphs:
beam width/peak width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



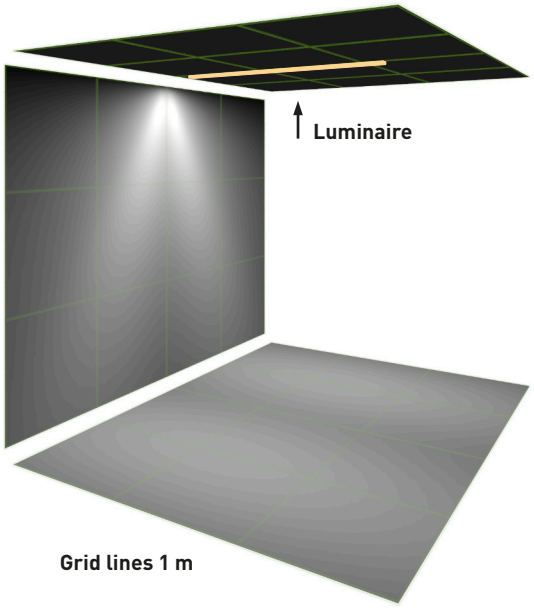
ELBO 3



Nominal Light Distribution Parameters

Code	ELBO 3
Beam Type	Double-asymmetric
Nominal Distance to LED	10 mm
Nominal Beam/Peak Width	80°/40°
Nominal Peak Angle	–23°/+23°
Nominal Peak Intensity	0.4 cd/lm
Specific Efficiency	94 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

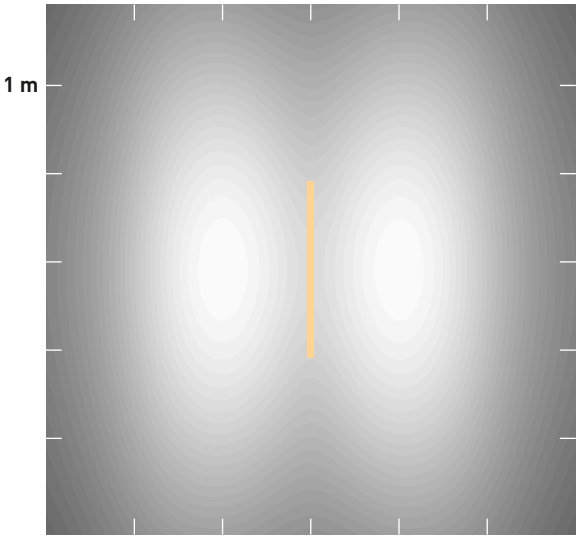


Dimensions and Material

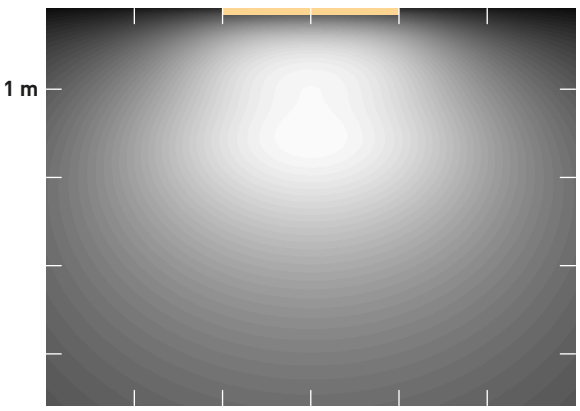
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



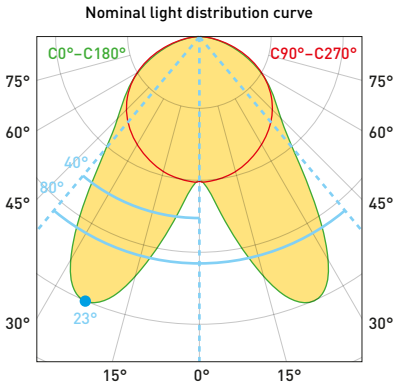
Application Suggestions

- Double asymmetric distribution with broad peaks and accented downward illumination.
- Can be used for illumination of shelves and corridors in supermarkets, libraries, archives, galleries, or warehouses.
- Symmetric adjustment of the peak angles can be achieved by changing LED – IQ Linear distance.
- Suitable for corridor wall, floor illumination and indirect lighting, especially when implemented with shorter LED – IQ Linear distances.

Double Asymmetric Distribution with Broad Peaks and Accented Downward Illumination

Light Distribution Adjustment

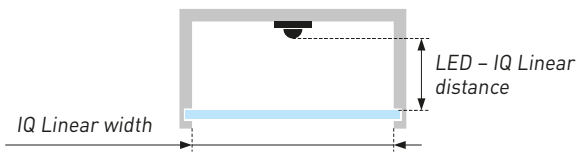
Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.



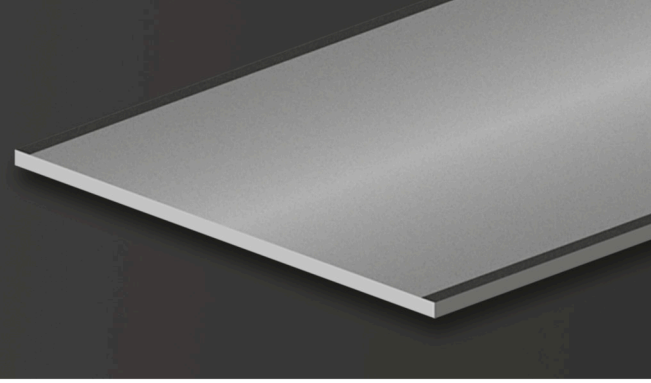
IQ LINEAR WIDTH

LED – IQ LINEAR DISTANCE	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 101°, peak 0°, 0.3 cd/lm, eff 82%	FWHM 119°, peak 29°, 0.3 cd/lm, eff 89%	FWHM 120°, peak 32°, 0.3 cd/lm, eff 83%	FWHM 117°, peak 32°, 0.3 cd/lm, eff 84%
6 mm	FWHM 78°, peak 16°, 0.3 cd/lm, eff 70%	FWHM 91°, peak 25°, 0.3 cd/lm, eff 82%	FWHM 99°, peak 29°, 0.3 cd/lm, eff 82%	FWHM 102°, peak 30°, 0.3 cd/lm, eff 84%
nominal distance 10 mm	FWHM 70°, peak 18°, 0.4 cd/lm, eff 74%	FWHM 77°/39°, peak 23°, 0.4 cd/lm, eff 77%	FWHM 80°/40°, peak 23°, 0.4 cd/lm, eff 82%	
15 mm	FWHM 59°, peak 14°, 0.3 cd/lm, eff 66%	FWHM 59°/29°, peak 17°, 0.4 cd/lm, eff 72%	FWHM 68°/32°, peak 19°, 0.4 cd/lm, eff 80%	
20 mm		FWHM 50°, peak 14°, 0.4 cd/lm, eff 66%	FWHM 61°, peak 15°, 0.4 cd/lm, eff 76%	

Values below the graphs:
beam width/peak width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



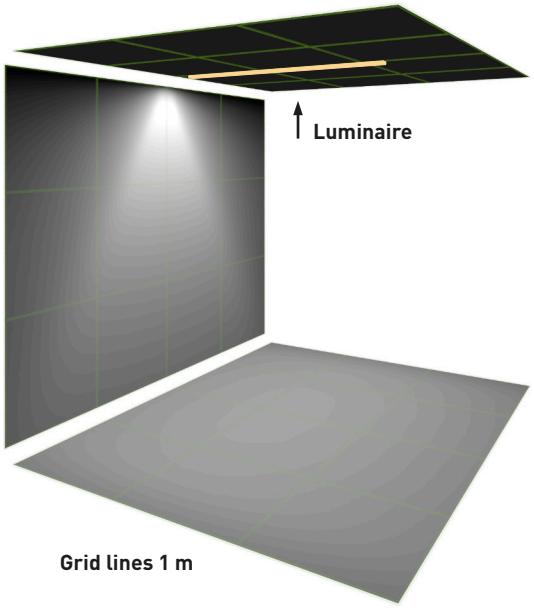
NUBO 1



Nominal Light Distribution Parameters

Code	NUBO 1
Beam Type	Medium wide
Nominal Distance to LED	10 mm
Nominal Beam Width	86°
Nominal Peak Angle	–28°/+28°
Nominal Peak Intensity	0.3 cd/lm
Specific Efficiency	94 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 10 mm, width 40 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

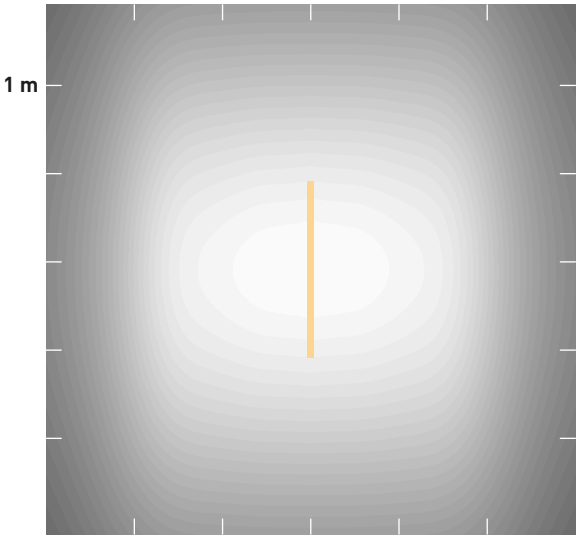


Dimensions and Material

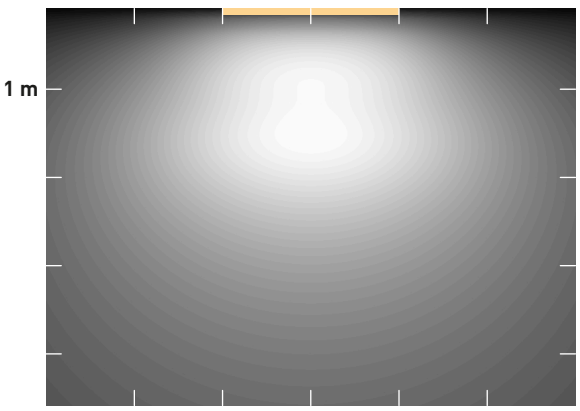
Width*	up to 40 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

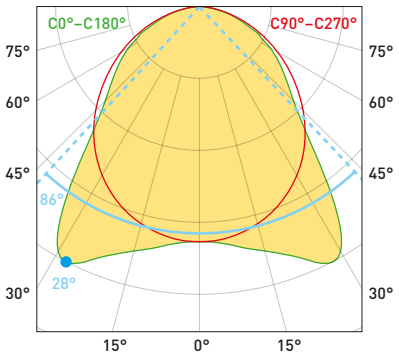
- Standard batwing distribution, suitable for uniform illumination of various surfaces.
- Can be used for illumination in residential houses, offices, and industrial workspaces, meeting, or conference rooms, receptions, and classrooms.
- Also suitable for ceiling illumination to achieve indirect lighting.

Standard Batwing Distribution

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that making IQ Linear width too narrow or using other than nominal LED – IQ Linear distance breaks the batwing look of the light distribution. For making very narrow or slim batwing luminaires you might consider, e.g., ELBO 3 or ELBO 3W optics. Also note that narrow luminaires lead to lower total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

Nominal light distribution curve

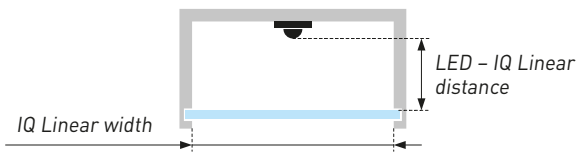


IQ LINEAR WIDTH

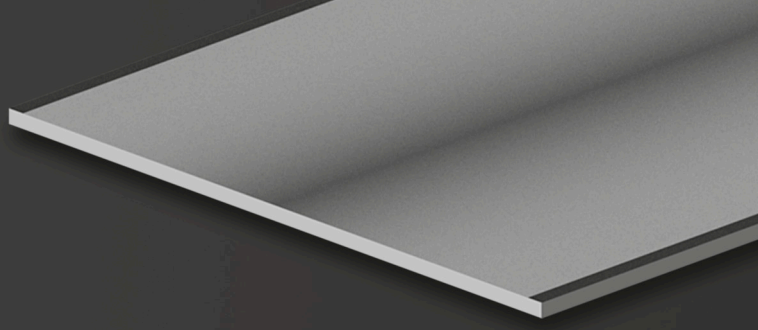
LED – IQ LINEAR DISTANCE

	5 mm	10 mm	20 mm	40 mm
3 mm	FWHM 95°, peak 0°, 0.3 cd/lm, eff 82%	FWHM 115°, peak 0°, 0.3 cd/lm, eff 89%	FWHM 118°, peak 0°, 0.3 cd/lm, eff 83%	FWHM 118°, peak 0°, 0.3 cd/lm, eff 83%
6 mm	FWHM 76°, peak 0°, 0.3 cd/lm, eff 71%	FWHM 93°, peak 10°, 0.3 cd/lm, eff 82%	FWHM 105°, peak 18°, 0.3 cd/lm, eff 82%	FWHM 108°, peak 19°, 0.3 cd/lm, eff 83%
nominal distance 10 mm	FWHM 76°, peak 0°, 0.3 cd/lm, eff 74%	FWHM 82°, peak 26°, 0.3 cd/lm, eff 77%	FWHM 86°, peak 28°, 0.3 cd/lm, eff 82%	
15 mm	FWHM 65°, peak 0°, 0.3 cd/lm, eff 65%	FWHM 63°, peak 20°, 0.4 cd/lm, eff 72%	FWHM 72°, peak 21°, 0.4 cd/lm, eff 79%	
20 mm		FWHM 54°, peak 16°, 0.4 cd/lm, eff 66%	FWHM 64°, peak 17°, 0.4 cd/lm, eff 76%	

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



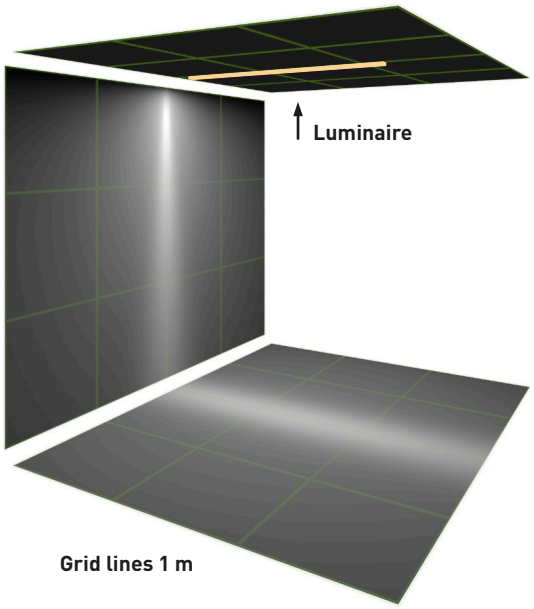
NILO 1W



Nominal Light Distribution Parameters

Code	NILO 1W
Beam Type	Deep
Nominal Distance to LED	20 mm
Nominal Beam/Peak Width	14°
Nominal Peak Angle	0°
Nominal Peak Intensity	0.9 cd/lm
Specific Efficiency	90 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 20 mm, width 65 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

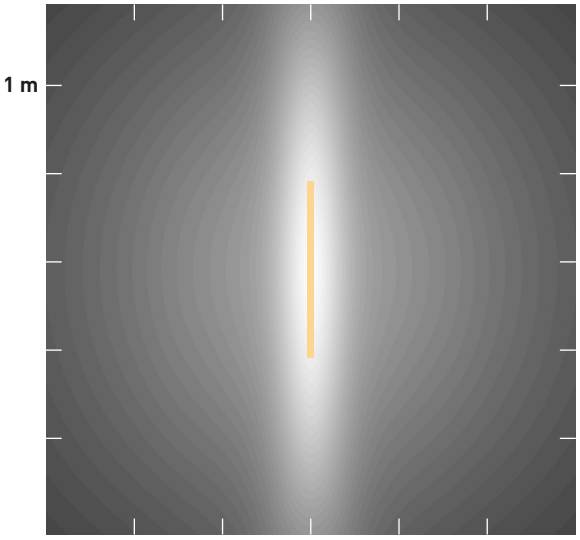


Dimensions and Material

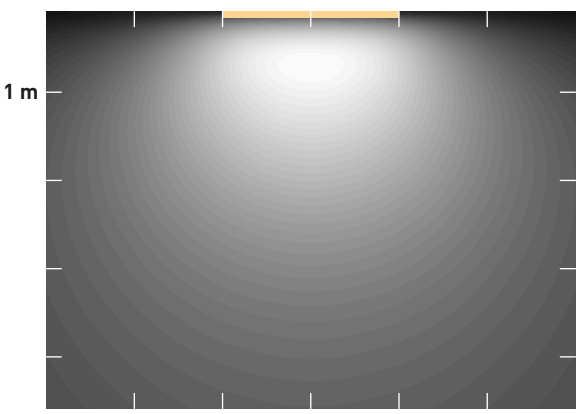
Width*	up to 65 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

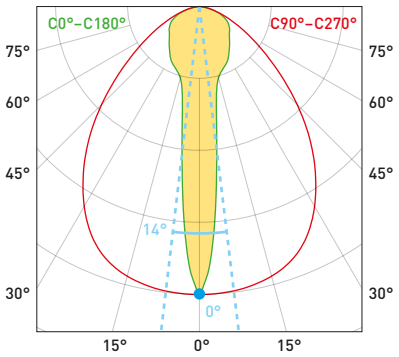
- Extremely narrow symmetric distribution, suitable for illumination from greater heights or accent lighting.
- Can be used for illumination of conference and lecture halls, industrial buildings, warehouses, and airports.
- In combination with a tilted luminaire it can be used for grazing incidence applications.
- Can be used to make single asymmetric light distributions when used off-axis. Such light distributions can be used, e.g., for display accent lighting.

Symmetric Distribution with Extreme Narrow Peak

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the decentering offset changes the peak angle. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.
NILO 1W optics in the nominal distance leads to strong light focusing, which when used with narrower dimensions could show deficiencies of LEDs (such as colour over source) in the light output. If this happens, it is recommended to use other than the nominal distance to fix the colour behaviour.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

LED – IQL DISTANCE 20 mm
IQ LINEAR WIDTH 40 mm

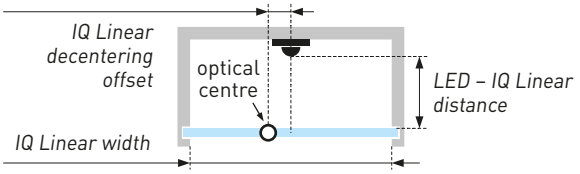
12 mm	8 mm	4 mm	0 mm
FWHM 17°, peak 29°, 0.6 cd/lm, eff 73%	FWHM 14°, peak 20°, 0.8 cd/lm, eff 77%	FWHM 13°, peak 10°, 0.8 cd/lm, eff 77%	FWHM 13°, peak 0°, 0.9 cd/lm, eff 77%

IQ LINEAR WIDTH

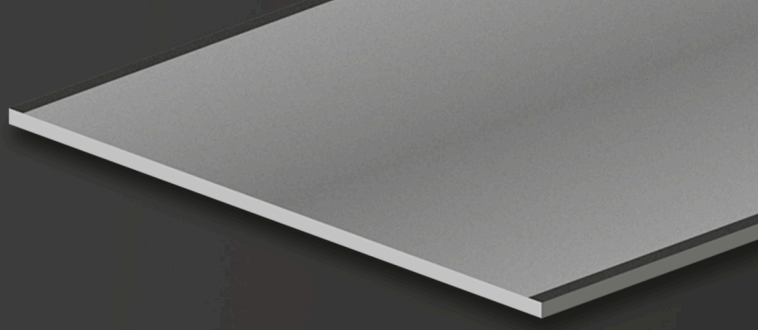
LED – IQ LINEAR DISTANCE

	10 mm	20 mm	40 mm	65 mm
5 mm	FWHM 59°, peak 0°, 0.4 cd/lm, eff 85%	FWHM 59°, peak 0°, 0.4 cd/lm, eff 84%	FWHM 68°, peak 0°, 0.4 cd/lm, eff 84%	FWHM 64°, peak 0°, 0.4 cd/lm, eff 84%
10 mm	FWHM 29°, peak 0°, 0.6 cd/lm, eff 75%	FWHM 33°, peak 0°, 0.6 cd/lm, eff 78%	FWHM 37°, peak 0°, 0.5 cd/lm, eff 81%	FWHM 39°, peak 0°, 0.5 cd/lm, eff 81%
nominal distance				
20 mm	FWHM 12°, peak 0°, 0.9 cd/lm, eff 69%	FWHM 13°, peak 0°, 0.9 cd/lm, eff 77%	FWHM 14°, peak 0°, 0.8 cd/lm, eff 76%	
30 mm	FWHM 9°, peak 0°, 0.8 cd/lm, eff 59%	FWHM 10°, peak 0°, 0.9 cd/lm, eff 70%	FWHM 11°, peak 0°, 0.8 cd/lm, eff 74%	
40 mm		FWHM 16°, peak 0°, 0.6 cd/lm, eff 64%	FWHM 17°, peak 0°, 0.7 cd/lm, eff 70%	

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



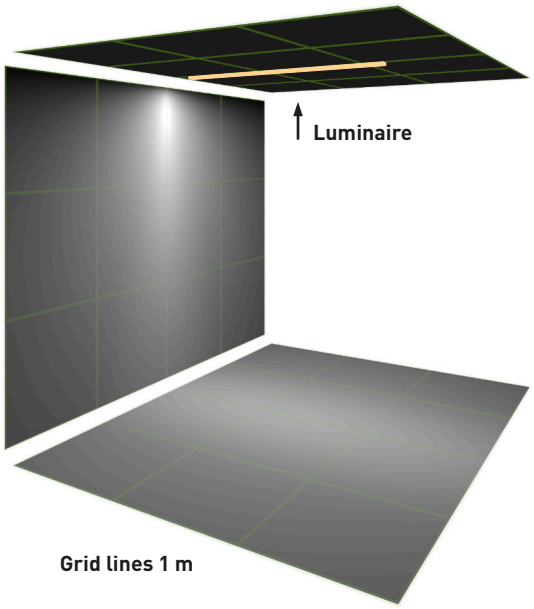
NILO 4W



Nominal Light Distribution Parameters

Code	NILO 4W
Beam Type	Deep
Nominal Distance to LED	20 mm
Nominal Beam/Peak Width	45°
Nominal Peak Angle	0°
Nominal Peak Intensity	0.5 cd/lm
Specific Efficiency	92 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 20 mm, width 65 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

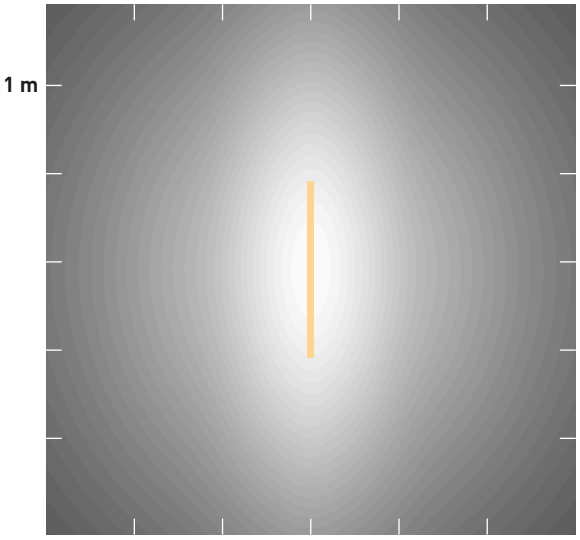


Dimensions and Material

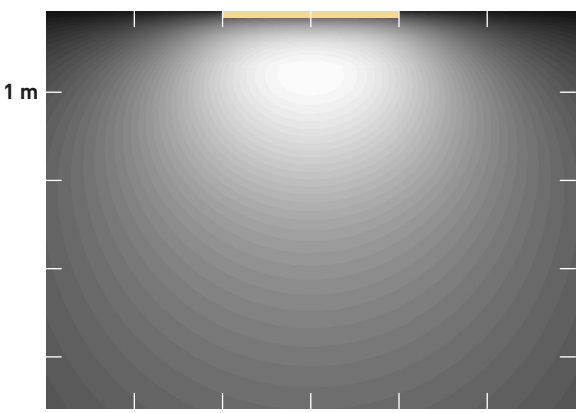
Width*	up to 65 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

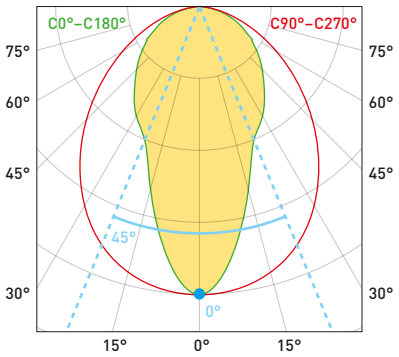
- Medium narrow symmetric distribution, suitable for illumination from greater heights.
- Can be used for illumination of desks, corridors, aisles, conference and lecture halls, industrial buildings, warehouses, and airports.
- In combination with a tilted luminaire it can be used for wall washing applications.
- Can be used to make single asymmetric light distributions when used off-axis. Such light distributions can be used, e.g., for wall washing.

Symmetric Distribution with Medium Narrow Peak

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the decentering offset changes the peak angle. Changing the distance from the LED to the IQ Linear changes the beam angle (FWHM). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

LED – IQL DISTANCE 20 mm
IQ LINEAR WIDTH 40 mm

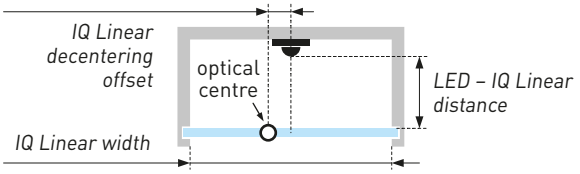
12 mm	8 mm	4 mm	0 mm
FWHM 76°, peak 23°, 0.4 cd/lm, eff 75%	FWHM 62°, peak 17°, 0.4 cd/lm, eff 75%	FWHM 50°, peak 9°, 0.5 cd/lm, eff 75%	FWHM 42°, peak 0°, 0.5 cd/lm, eff 76%

IQ LINEAR WIDTH

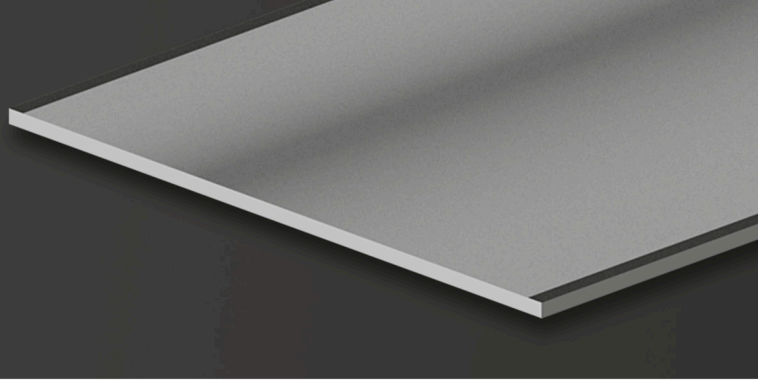
LED – IQ LINEAR DISTANCE

	10 mm	20 mm	40 mm	65 mm
5 mm	FWHM 76°, peak 0°, 0.4 cd/lm, eff 82%	FWHM 80°, peak 0°, 0.4 cd/lm, eff 81%	FWHM 81°, peak 1°, 0.4 cd/lm, eff 82%	FWHM 80°, peak 0°, 0.4 cd/lm, eff 83%
10 mm	FWHM 51°, peak 0°, 0.4 cd/lm, eff 73%	FWHM 59°, peak 0°, 0.4 cd/lm, eff 76%	FWHM 63°, peak 1°, 0.4 cd/lm, eff 81%	FWHM 64°, peak 0°, 0.4 cd/lm, eff 84%
nominal distance 20 mm	FWHM 34°, peak 0°, 0.5 cd/lm, eff 66%	FWHM 42°, peak 0°, 0.5 cd/lm, eff 76%	FWHM 45°, peak 0°, 0.5 cd/lm, eff 82%	
30 mm	FWHM 23°, peak 0°, 0.5 cd/lm, eff 57%	FWHM 38°, peak 0°, 0.5 cd/lm, eff 69%	FWHM 43°, peak 0°, 0.5 cd/lm, eff 78%	
40 mm	FWHM 30°, peak 0°, 0.5 cd/lm, eff 63%	FWHM 42°, peak 0°, 0.5 cd/lm, eff 74%		

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



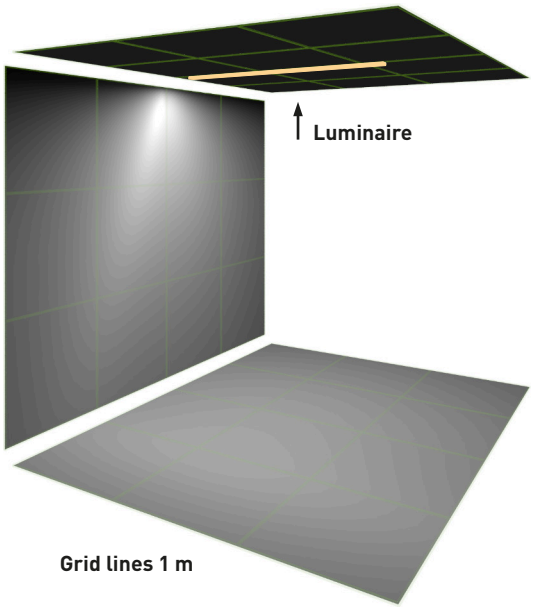
DARLO 3W



Nominal Light Distribution Parameters

Code	DARLO 3W
Beam Type	Asymmetric
Nominal Distance to LED	20 mm
Nominal Beam/Peak Width	75°
Nominal Peak Angle	22°
Nominal Peak Intensity	0.4 cd/lm
Specific Efficiency	94 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 20 mm, width 65 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

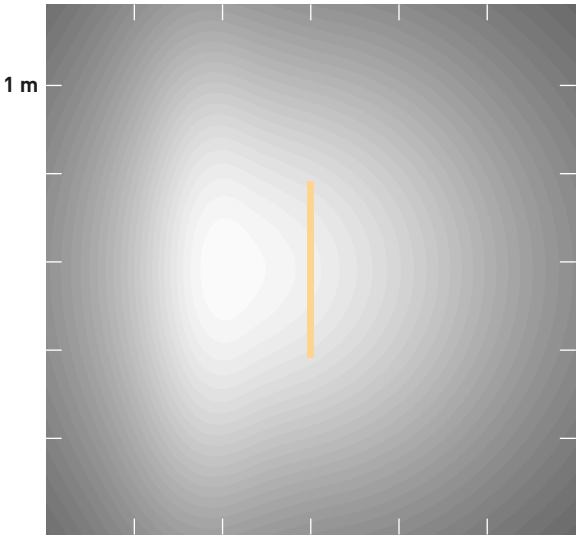


Dimensions and Material

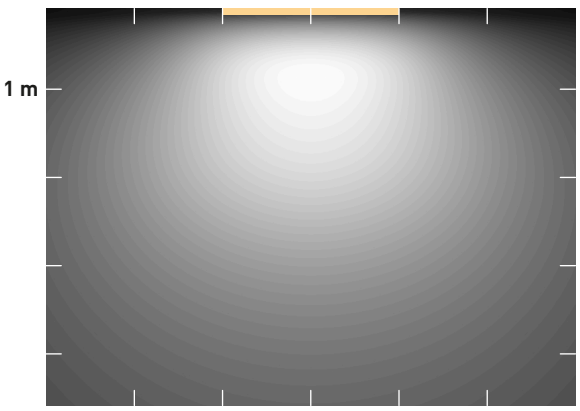
Width*	up to 65 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

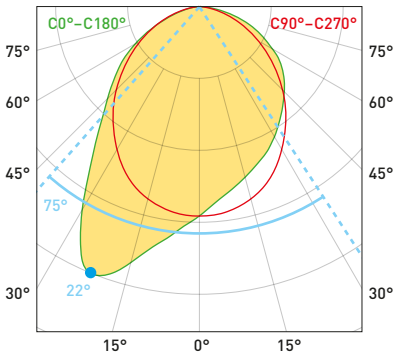
- Single asymmetric distribution with a broad peak and enhanced side illumination for smooth wallwashing, suitable for wall and floor illumination or indirect lighting.
- Can be used for illumination of large rooms or corridors, workspaces, receptions, galleries, and halls.
- Can also be effectively used in multipurpose luminaires for small shops or even houses to reduce the number of light fixtures.
- Peak angle can be adjusted when used off-axis, i.e., by changing the decentering offset, or by changing LED – IQ Linear distance.

Single Asymmetric Distribution with a Broad Peak and Enhanced Side Illumination

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Peak angle can be adjusted by changing the decentering offset or LED – IQ Linear distance, which also affects the beam width (FWHM). Note that changing the IQ Linear width usually does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

Nominal light distribution curve



IQ LINEAR DECENTERING OFFSET

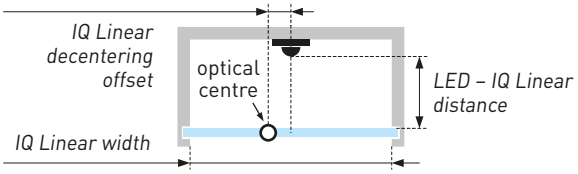
–8 mm	–4 mm	0 mm	+4 mm
FWHM 94°, peak 38°, 0.3 cd/lm, eff 76%	FWHM 80°, peak 30°, 0.4 cd/lm, eff 76%	FWHM 69°, peak 21°, 0.4 cd/lm, eff 76%	FWHM 63°, peak 12°, 0.4 cd/lm, eff 76%

LED – IQL DISTANCE 20 mm
IQ LINEAR WIDTH 40 mm

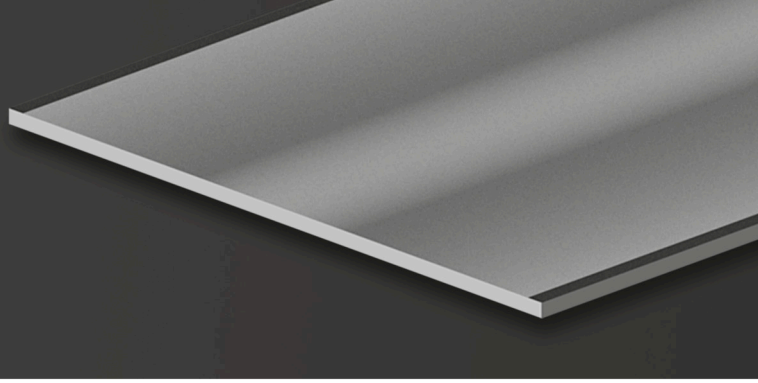
IQ LINEAR WIDTH

10 mm	20 mm	40 mm	65 mm	LED – IQ LINEAR DISTANCE
FWHM 99°, peak 8°, 0.3 cd/lm, eff 83%	FWHM 108°, peak 7°, 0.3 cd/lm, eff 81%	FWHM 110°, peak 5°, 0.3 cd/lm, eff 82%	FWHM 109°, peak 6°, 0.3 cd/lm, eff 83%	5 mm
FWHM 72°, peak 15°, 0.4 cd/lm, eff 73%	FWHM 94°, peak 25°, 0.3 cd/lm, eff 76%	FWHM 103°, peak 15°, 0.3 cd/lm, eff 82%	FWHM 102°, peak 12°, 0.3 cd/lm, eff 85%	10 mm
nominal distance	FWHM 57°, peak 18°, 0.4 cd/lm, eff 66%	FWHM 69°, peak 21°, 0.4 cd/lm, eff 76%	FWHM 75°, peak 22°, 0.4 cd/lm, eff 83%	20 mm
	FWHM 40°, peak 13°, 0.4 cd/lm, eff 58%	FWHM 48°, peak 14°, 0.5 cd/lm, eff 70%	FWHM 56°, peak 15°, 0.5 cd/lm, eff 79%	30 mm
	FWHM 38°, peak 13°, 0.5 cd/lm, eff 65%		FWHM 48°, peak 12°, 0.5 cd/lm, eff 75%	40 mm

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



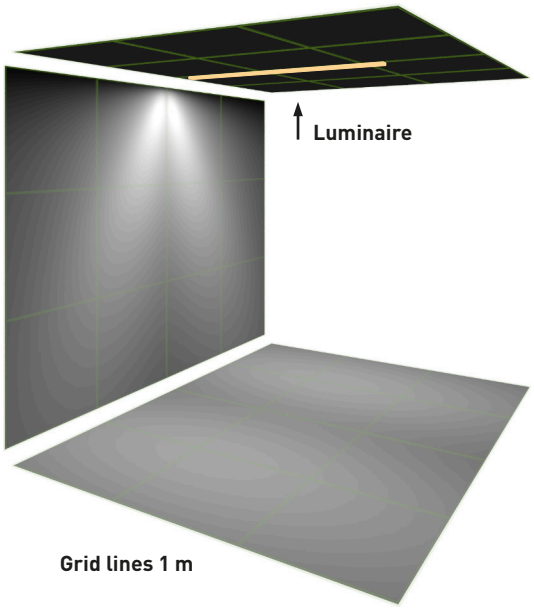
ELBO 3W



Nominal Light Distribution Parameters

Code	ELBO 3W
Beam Type	Double-asymmetric
Nominal Distance to LED	20 mm
Nominal Beam/Peak Width	85°/43°
Nominal Peak Angle	–24°/+24°
Nominal Peak Intensity	0.4 cd/lm
Specific Efficiency	94 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 20 mm, width 65 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

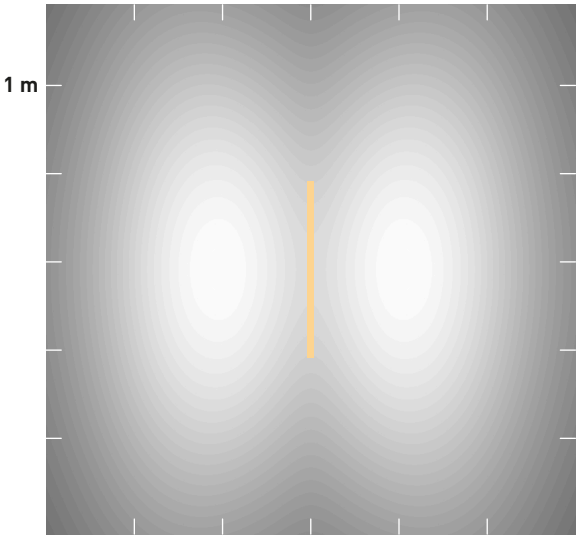


Dimensions and Material

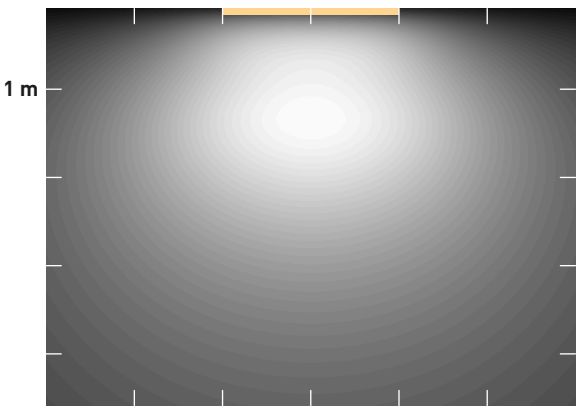
Width*	up to 65 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

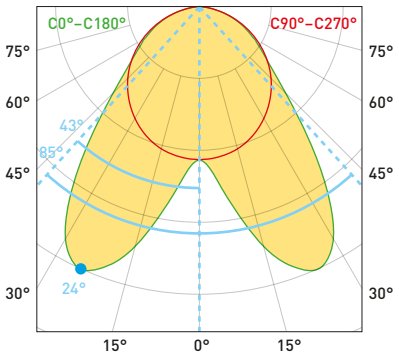
- Double asymmetric distribution with broad peaks and accented downward illumination.
- Can be used for illumination of shelves and corridors in supermarkets, libraries, archives, galleries, or warehouses.
- Symmetric adjustment of the peak angles can be achieved by changing LED – IQ Linear distance.
- Suitable for corridor wall, floor illumination and indirect lighting, especially when implemented with shorter LED – IQ Linear distances.

Double Asymmetric Distribution with Broad Peaks and Accented Downward Illumination

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that changing the IQ Linear width does not significantly affect light distribution, but changes total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

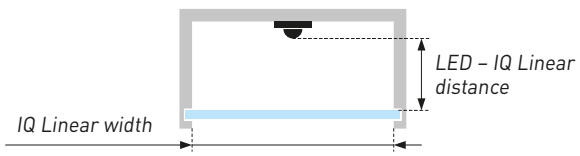
Nominal light distribution curve



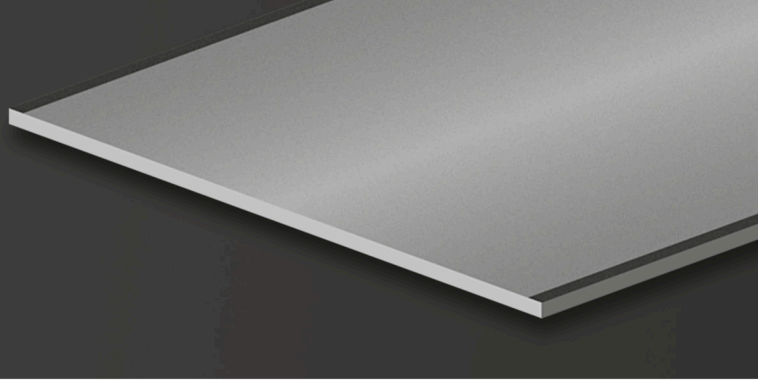
IQ LINEAR WIDTH

LED – IQ LINEAR DISTANCE	10 mm	20 mm	40 mm	65 mm
5 mm	FWHM 112°, peak 13°, 0.3 cd/lm, eff 83%	FWHM 126°, peak 25°, 0.3 cd/lm, eff 81%	FWHM 127°, peak 0°, 0.3 cd/lm, eff 82%	FWHM 128°, peak 0°, 0.3 cd/lm, eff 84%
10 mm	FWHM 82°, peak 19°, 0.3 cd/lm, eff 72%	FWHM 103°, peak 28°, 0.3 cd/lm, eff 77%	FWHM 113°, peak 30°, 0.3 cd/lm, eff 83%	FWHM 117°, peak 32°, 0.3 cd/lm, eff 85%
20 mm (**nominal distance**)	FWHM 69°, peak 19°, 0.3 cd/lm, eff 67%	FWHM 81°/40°, peak 24°, 0.4 cd/lm, eff 77%	FWHM 85°/43°, peak 24°, 0.4 cd/lm, eff 84%	
30 mm	FWHM 56°, peak 15°, 0.3 cd/lm, eff 58%	FWHM 62°/29°, peak 18°, 0.4 cd/lm, eff 70%	FWHM 68°/34°, peak 19°, 0.4 cd/lm, eff 79%	
40 mm		FWHM 51°, peak 14°, 0.4 cd/lm, eff 64%	FWHM 58°, peak 15°, 0.4 cd/lm, eff 75%	

Values below the graphs:
beam width/peak width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs



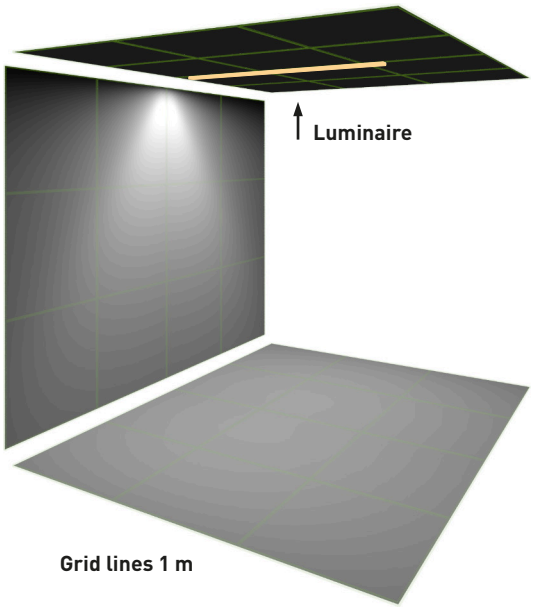
NUBO 1W



Nominal Light Distribution Parameters

Code	NUBO 1W
Beam Type	Medium wide
Nominal Distance to LED	20 mm
Nominal Beam Width	87°
Nominal Peak Angle	–26/+26°
Nominal Peak Intensity	0.3 cd/lm
Specific Efficiency	95 %

Parameter values are shown for standard configuration, which is LED – IQ LINEAR distance 20 mm, width 65 mm, LED below IQ Linear optical centre (decentering offset = 0 mm), white fixture.
Nominal peak intensity is given with respect to flux of LEDs.
Specific efficiency is given as a ratio: flux w. IQ LINEAR / flux w. clear PMMA.

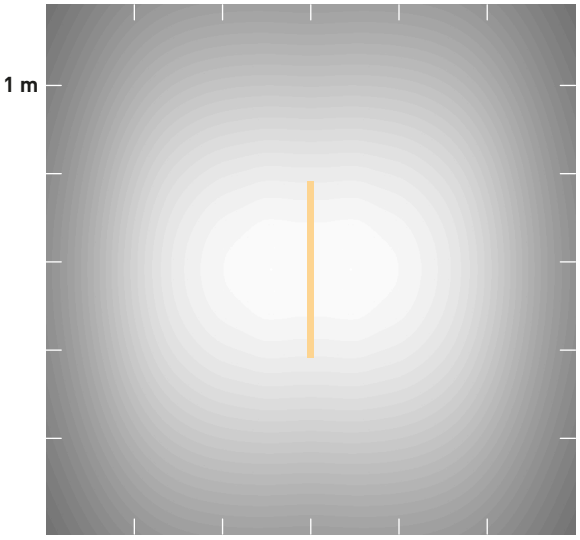


Dimensions and Material

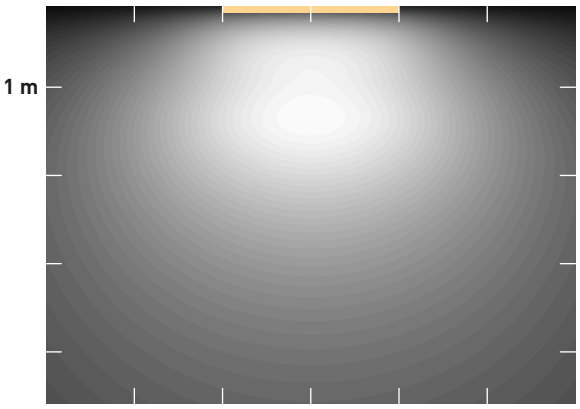
Width*	up to 65 mm
Thickness*	PMMA (1.5–2 mm), PC film (0.125–0.500 mm)
Length*	up to 2000 mm (PMMA sheet) or up to 1400 mm (PC film)
Material	PMMA sheet, PC film

* Customizable dimensions available to meet your individual needs.

Floor illumination
luminaire mounting height 3 m



Wall illumination
luminaire – wall distance 1 m



Application Suggestions

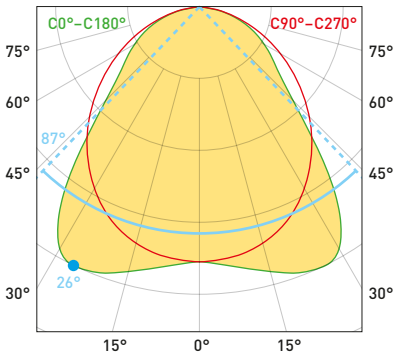
- Standard batwing distribution, suitable for uniform illumination of various surfaces.
- Can be used for illumination in residential houses, offices, and industrial workspaces, meeting, or conference rooms, receptions, and classrooms.
- Also suitable for ceiling illumination to achieve indirect lighting.

Standard Batwing Distribution

Light Distribution Adjustment

Variety of light distributions is possible by using IQ Linear in other than the nominal position. Changing the distance from the LED to the IQ Linear changes the beam width (FWHM), peak angle and luminous intensity at gamma = 0° (nadir). Note that making IQ Linear width too narrow or using other than nominal LED – IQ Linear distance breaks the batwing look of the light distribution. For making very narrow or slim batwing luminaires you might consider, e.g., ELBO 3 or ELBO 3W optics. Also note that narrow luminaires lead to lower total luminaire efficiency (flux of the luminaire / flux of LEDs) as a lot of light hits the luminaire walls.

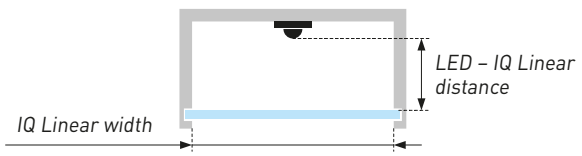
Nominal light distribution curve



IQ LINEAR WIDTH

LED – IQ LINEAR DISTANCE	10 mm	20 mm	40 mm	65 mm
5 mm	FWHM 101°, peak 8°, 0.3 cd/lm, eff 83%	FWHM 113°, peak 0°, 0.3 cd/lm, eff 82%	FWHM 115°, peak 0°, 0.3 cd/lm, eff 83%	FWHM 115°, peak 0°, 0.3 cd/lm, eff 84%
10 mm	FWHM 76°, peak 0°, 0.3 cd/lm, eff 73%	FWHM 101°, peak 11°, 0.3 cd/lm, eff 77%	FWHM 113°, peak 10°, 0.3 cd/lm, eff 83%	FWHM 114°, peak 0°, 0.3 cd/lm, eff 86%
nominal distance 20 mm	FWHM 70°, peak 10°, 0.3 cd/lm, eff 67%	FWHM 85°, peak 23°, 0.3 cd/lm, eff 77%	FWHM 87°, peak 26°, 0.3 cd/lm, eff 84%	
30 mm	FWHM 58°, peak 8°, 0.3 cd/lm, eff 58%	FWHM 63°, peak 19°, 0.4 cd/lm, eff 70%	FWHM 69°, peak 20°, 0.4 cd/lm, eff 79%	
40 mm		FWHM 52°, peak 14°, 0.4 cd/lm, eff 65%	FWHM 58°, peak 16°, 0.4 cd/lm, eff 75%	

Values below the graphs:
beam width
angle of the peak intensity
peak intensity in cd/lm
efficiency given as the ratio flux of luminaire / flux of LEDs

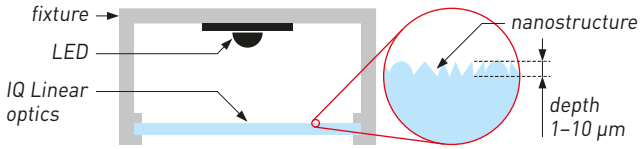


IQ Linear Optical Function

Composition of IQ Linear

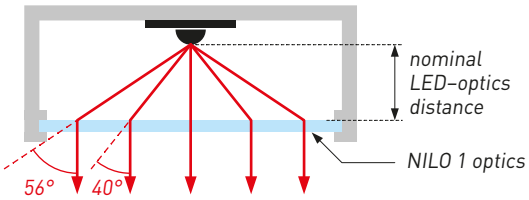
In order to use the full potential of IQ Linear, it is worth understanding its optical function.

IQ Linear sheets or films are transmissive optical elements. Their surface is covered by a nanostructure, which can be thought of as a vast amount of very small lenses, prisms or similar structures that bend light passing through. Those features are just a few micrometers deep so that the optics can be considered flat for practical purposes. This means, besides others, that IQ Linear optics can be formatted like any other flat material, or that the optical features can be applied on a substrate of arbitrary thickness.



Basic principle

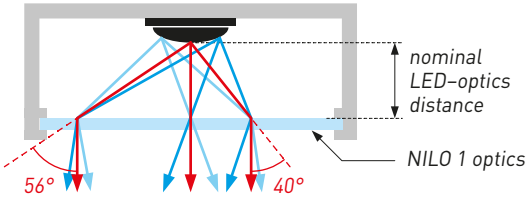
It is assumed that the optics is illuminated from a row of tiny LEDs at a nominal distance (e.g. 10 mm). The surface features are crafted in such a way that at each point, a light ray is bent by an exact amount, creating the nominal light distribution. The easiest optics to understand is NILO 1 which turns rays from LEDs into a bunch of parallel rays.

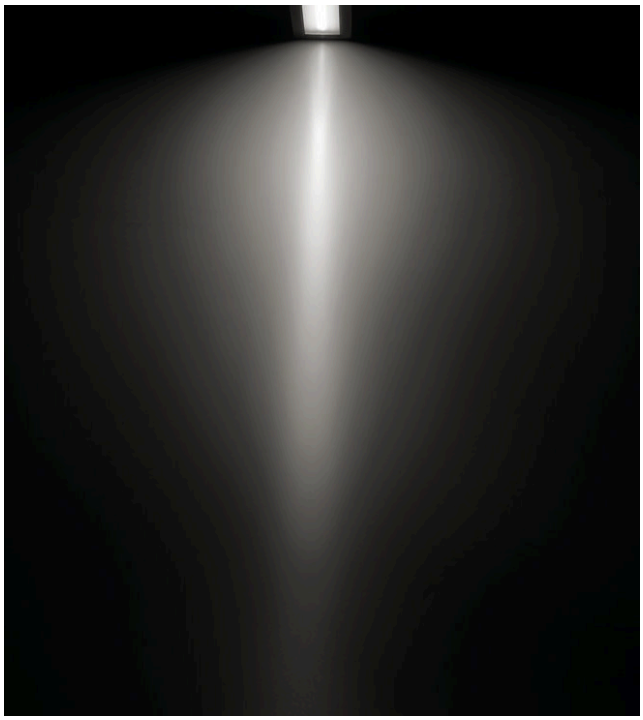


It is important to realize that it is essentialy the light bending power that is fixed (in the figure, it is "bent by 40°" or "bent by 56°"). Thus, when the incoming light is changed, the outgoing light changes as well.

Influence of a larger LED

For instance, if we use much larger LEDs, each point of optics is illuminated by a bunch of rays. Each of those rays are bent by the same angle, i.e., the whole bunch of rays are bent by a specific angle. This leads to a wider light distribution.

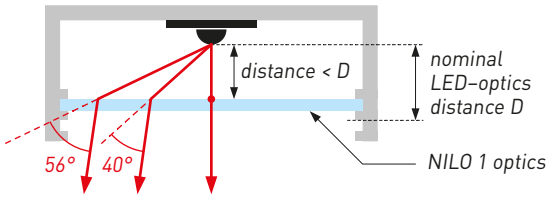




Test luminaire with NILO 1 optics

Changing LED–optics distance

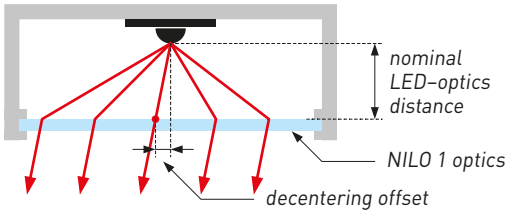
Essentially the same happens when IQ Linear is placed closer to LEDs. As "the light bending power" is fixed at each point, the outgoing rays are no longer parallel, which leads to a wider light distribution. To see how LED–optics distance actually changes NILO 1 light distribution curves, check the datasheet on page 6.



Using IQ Linear off-axis

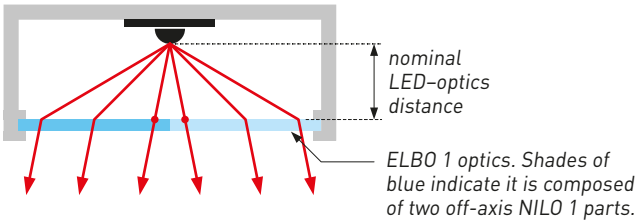
Note that there is a point at the NILO 1 optics that does not bend light at all (denoted by a red circle at the previous figure). Yet another thing happens when such a point is not directly above the LEDs, i.e., the decentering offset is not 0 mm. When the optics is placed at a

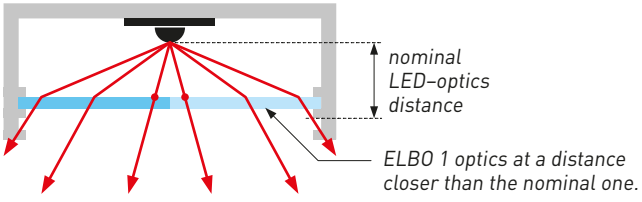
nominal distance, the outgoing rays are substantially parallel again, but angularly shifted, making a narrow single asymmetric light distribution. To see light distribution curves of NILO 1 placed off-axis, check the datasheet on page 6.



Other IQ Linear optics

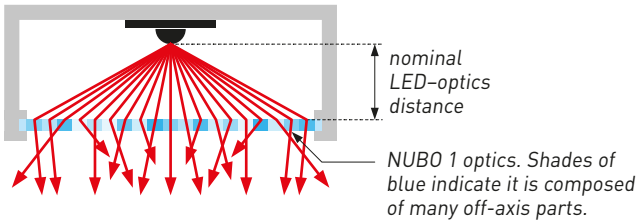
In order to explain other IQ Linear optics, let us first take a closer look at the narrowest double asymmetric optics, ELBO 1, see the photo on the right. We can say that it is comprised of two off-axis NILO 1 optics stitched together. Thus, the left part makes a bunch of parallel rays pointing leftwards, and vice versa. Clearly, placing ELBO 1 to other than the nominal distance would change the angle between the peaks and the divergence of the rays in the left and the right parts, i.e., width of both beams. To see how LED–optics distance actually changes ELBO 1 light distribution curves, check the datasheet on page 14.



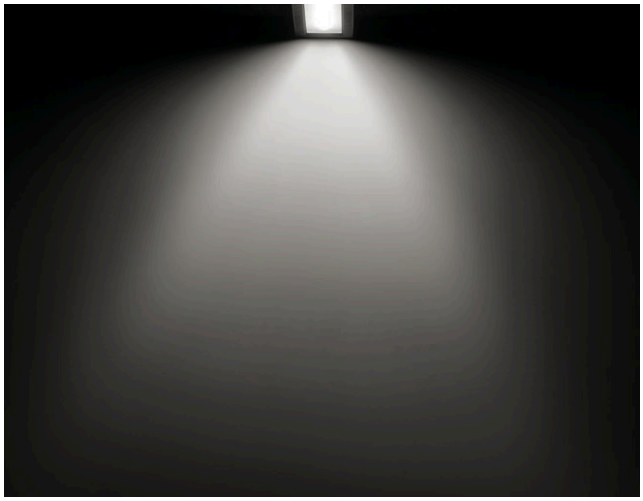


To explain all other IQ Linear types, it is worth reminding that the light bending features are very small. This allows to split the area of the optics not just to two parts like in ELBO 1, but to many more tiny parts, tens or hundreds of them. For instance, the NUBO 1 optics making a batwing light distribution is split to hundreds of tiny parts, each behaving like off-axis NILO 1, each redirecting light to a specific direction. The directions and corresponding amount of light are precisely balanced so that the net effect is the desired batwing distribution. All other IQ Linear optics act like that.

Test luminaire with ELBO 1 optics



Moreover, those tiny parts are mixed in a way that each small area of IQ Linear tries to create the same light distribution. This enhances homogeneity of the light emitting surface and allows one to adjust IQ Linear width without significantly affecting the optical function.

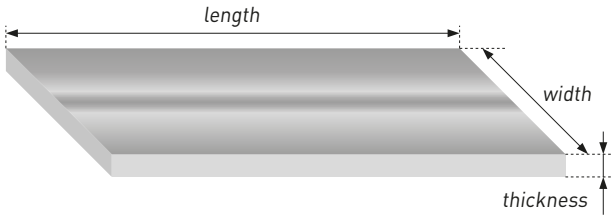


Test luminaire with NUBO 1 optics

Building Luminaires with IQ Linear

Recommendation
Before delving into details of luminaire construction, a reader is encouraged to read the explanation of the IQ Linear optics on pages 32–33. Many subtleties of the design become obvious.

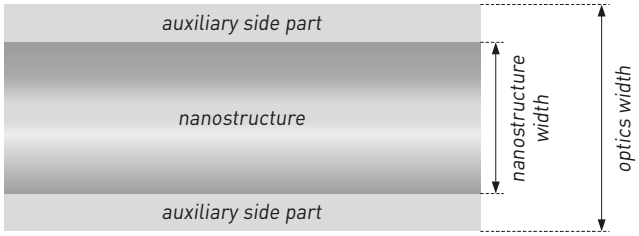
Dimensions of IQ Linear optics
IQ Linear optics is a rectangular piece of a flat substrate. A nanostructure is applied on one surface in a process similar to printing. The optics can be thus easily manufactured and delivered with various thickness, length and width.



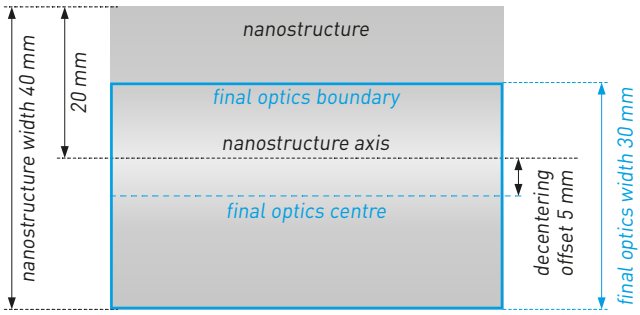
Thickness
As the nanostructure is just a few micrometers deep, thickness of the optics is essentially given just by thickness of the substrate. The substrate can be either a rigid sheet or a flexible film. Standard rigid sheets are 1.5 or 2 mm thick, but there is no problem in using other thickness. Thickness of standard flexible films is in range between 125 and 500 µm. Indeed, thinner substrates are more economical while thicker substrates are more stiff. Substrate should be thus as thin as possible with respect to the luminaire requirements and assembly method.

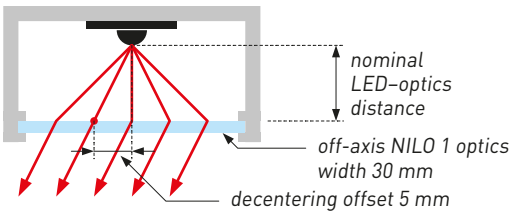
Length
Maximum length of the optics depends on the manufacturing technology. The technology used for rigid sheets can reach lengths up to about 2000 mm, optics are delivered in individual pieces. The roll-to-roll technology used for flexible films can reach lengths up to 1400 mm, optics can be delivered either in a roll or slit and cut to individual pieces of arbitrary width and length.

Width
Maximum width of the optics depends on IQ Linear type. Optics with the nominal LED – IQ Linear distance 10 mm can be up to 40 mm wide, optics with the nominal distance 20 mm can be up to 65 mm wide. Names of the latter type of optics always end with W (such as NILO 1W) for easy identification.
On the other hand, minimum width of the optics is essentially not limited.
It is worth mentioning that some part of the optics must be used for assembly purposes. To maximise the useful area of the optics, the nanostructured area can be surrounded by auxiliary side parts.

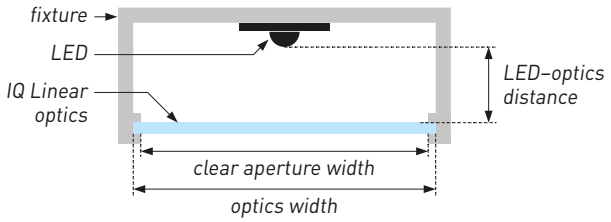


Width may be also affected when using optics in off--axis position. For instance, if one wants to use a fixture with centrally positioned LEDs and NILO 1 optics with decentering offset 5 mm, the maximum width of optics is just 30 mm.



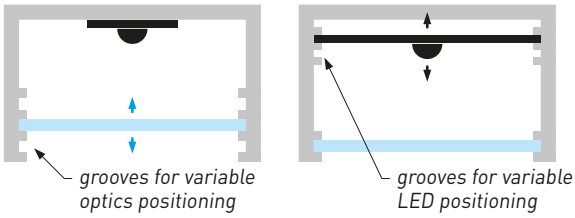


Basic geometry of the luminaire body
The most common use of IQ Linear is a linear luminaire, and the most common linear luminaire body is an aluminium profile. It is thus worth starting with this case. Other types will be briefly discussed in section "Other luminaire types" on page 37.
There are three key decisions to be made: how to attach IQ Linear optics to the fixture, what will be the distance between LED and the optics, and what will be the width of the optics and the luminaire.



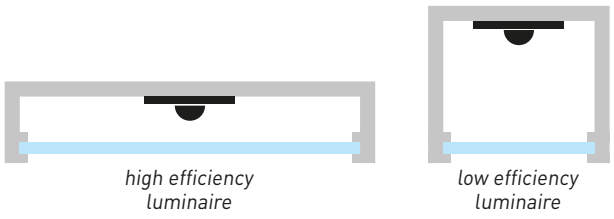
Methods of attaching the optics to the fixture will be discussed in the section "IQ Linear thickness and assembly of a luminaire" on page 37.

The distance between the LED and the optics substantially affects light distribution. For instance, NILO 1 optics (see page 6) mounted 3 mm from LEDs creates a medium wide beam with FWHM 52°, while at the nominal distance 10 mm it gives an extreme narrow beam with FWHM 14°. It is thus worth carefully looking through datasheets of individual optics and pick the distance for a luminaire (or a family of luminaires) that matches the intent. For more versatility, it is possible to design a profile allowing variable LED–optics distance.

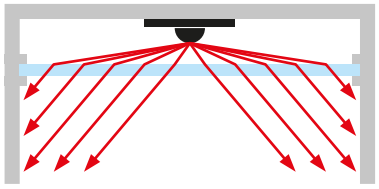


Width of the optics, or more precisely clear aperture width, does not usually affect light distribution significantly. For instance, NILO 1 optics (see page 6) mounted 3 mm from LEDs creates a medium wide beam with FWHM from 49° to 52° for the optics width from 10 to 40 mm. Indeed, wider optics generally lead to more efficient luminaires as more light directly hits the optics.

It is important to realize that the ratio of LED–optics distance and optics width significantly affects luminaire efficiency. In general, wide and low luminaires are more efficient than narrow and tall luminaires. This is the reason why extremely narrow and tall luminaires (such as 5 mm wide and 20 mm high) are not covered in the datasheets as efficiency would be impractically low.



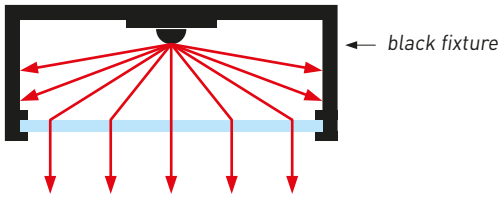
Efficiency and light distribution are also affected by any material outside the optics. For instance, when a double asymmetric optics such as ELBO 1 (see page 14) is recessed in a deep profile, hardly any light is able to leave the luminaire. The most efficient luminaires should thus contain no parts shielding light. For intentional shielding aiming glare reduction, see section "Glare reduction" on page 38.



Details of the luminaire interior

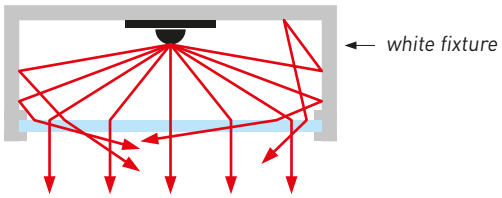
This section covers both shape and material of the luminaire interior and their effect on luminaire efficiency and light distribution.

The easiest to understand case is a luminaire with a perfectly black interior. Clearly, any light that hits the fixture surface is lost, leading to low efficiency. The only important parameters are LED–optics distance and optics width; actual shape of the interior does not affect anything if it does not directly block light. Output of such a luminaire will be affected by IQ Linear optics only. It will become clear in a while that light distribution will be narrower as stray light will be reduced.

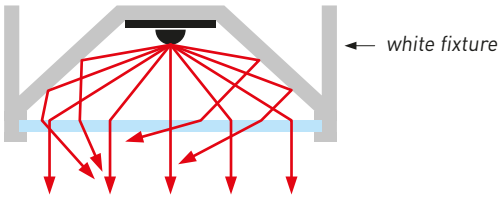


A luminaire with diffused white surface behaves differently. Light that hits the fixture surface is now diffusely reflected. Some light is reflected towards the optics and leaves the luminaire. However, such reflected light hits the optics at a random angle and subsequently leaves the luminaire at a random angle too. Light distribution is thus combined with basically omnidirectional light, leading to wider light distributions or more stray light. On the other hand, efficiency of such lu-

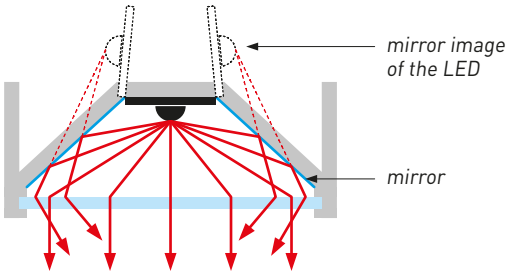
minaire is significantly higher than of a black luminaire.



Clearly, light reflected off the white surface may hit the white surface a second time and then hit the optics. If the reflectance of the white surface was 100%, it would not cause any difference. But as reflectance of the white surface is usually 80% to 90%, light reflected multiple times off the white surface gradually fades, i.e., light gets lost. To avoid multiple reflections, it is necessary to make the internal surface area as small as possible. For instance, a natural way how to reduce surface of a rectangular aluminium profile is to slant the internal walls.



Another way to reduce multiple reflections is to use a glossy or even mirror-like surface. A well designed luminaire interior reflects light just towards the optics, i.e., multiple reflections are avoided. However, a new phenomenon appears: a mirror-like slanted wall creates a mirror image of the LED, i.e., it seems that the optics is illuminated by multiple LEDs at once.



Such a behaviour may be acceptable when creating wide light distributions. Stray light will be reduced compared to white surfaces as light is not randomly scattered. On the other hand, a mirror surface will likely cause problems when creating extremely narrow beams – instead of single narrow beam, several surrounding narrow beams may appear. The best way to think about performance of such a luminaire is to imagine a standard light distribution curve shown in a datasheet summed with off-axis light distribution curves for each mirror image of the LED.

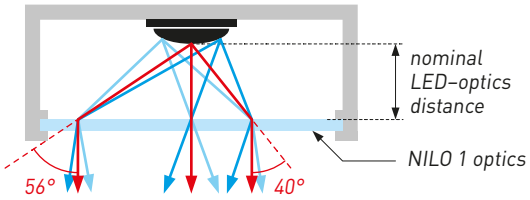
A summary of this section is that dark luminaire interior leads to lower efficiency and sharper light distribution, while light luminaire interior leads to higher efficiency and wider light distribution. Slanted walls may further increase efficiency. A table gives an impression how such details affect efficiency:

Efficiency of ELBO 3, width 40 mm, LED–optics 10 mm

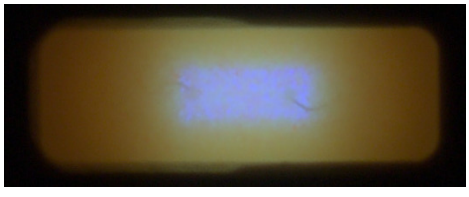
black interior, rectangular profile	70%
white interior, rectangular profile	88%
white interior, slanted walls	93%
mirror interior, slanted walls	90%

Selection of LED and PCB

It was already explained in section "Influence of a larger LED" on page 32 that small LEDs generally lead to a sharper light distribution and narrower beams, while big LEDs lead to opposite results. The reason is simple. One can imagine that a big LED is composed of many small light sources next to each other, and the resulting light distribution is a sum of many angularly shifted light distributions. The effect is negligible for wide light distributions, but significant for narrow ones.



Creating narrow beams also requires careful selection of LEDs in terms of colour homogeneity. For instance, a closeup of an LED may reveal it is far from uniform:



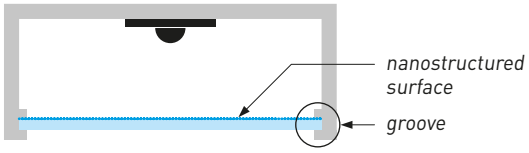
Closeup of a 4014 LED chip

If we imagine this LED composed of many small light sources, bluish in the centre and yellow near the edges, it is obvious that a narrow beam optics such as

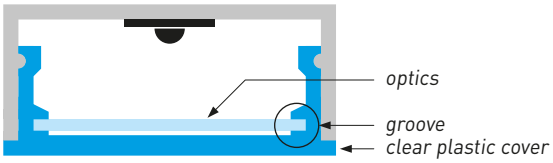
NILO 1 must create a bluish narrow beam surrounded by a yellowish rim.
A similar reasoning can be used when selecting a PCB. IQ Linear is designed for use with PCBs with single row of LEDs. If one uses e.g. a dual row PCB, the resulting light distribution will be a sum of two angularly shifted light distributions. This will likely cause probems when creating narrow light distributions, but may be well acceptable for a wider one.
A final note on LED and PCB selection deals with LED pitch. IQ Linear optics is not sensitive to LED pitch in terms of light distribution curve. LED pitch is, however, relevant when talking about look of the luminaire. IQ Linear is not designed to completely hide LED chips. Thus, LEDs spaced far apart will create isolated bright spots on the optics. Closely packed LEDs are thus preferred for more homogeneous look.

IQ Linear thickness and assembly of a luminaire
IQ Linear optics can be produced using a rigid substrate or a flexible film. Thickness of the optical nanostructure is a few micrometers, which means that thickness of optics is given just by thickness of the substrate in most pratical situations. NANOPTIQS normally uses films of thickness between 125 µm and 500 µm, and rigid sheets of thickness 1.5 mm or 2.0 mm. A substrate of custom thickness is also possible.
Quality of the optical function is not affected by a selection of the substrate. Mechanical properties are, however, very different. Optics price is also affected by the substrate. In general, a thinner substrate is more economical as it requires less material. On the other hand, a very thin substrate may be difficult to handle during assembly, especially when dealing with long optics. Selection of the substrate must be thus a compromise between all aspects.
There are several standard ways for attaching IQ Linear optics to the fixture. Regardless of the method, **the nanostructured surface must face LEDs**.

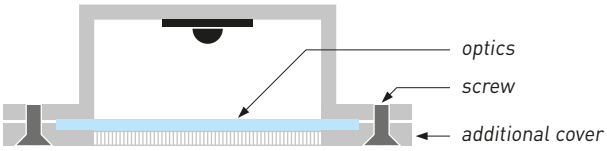
- Slide optics into grooves in an aluminium profile. Grooves have to be deep enough with respect to optics stiffness and profile width. Thinner substrate may require deeper grooves.



- Slide optics into grooves in a clear plastic cover. This approach is compatible with using diffusing plastic covers for luminaires without any optical function. Disadvantage of this approach is slightly lower efficiency.

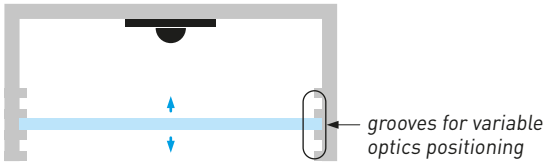


- Clamp optics to the fixture by an additional cover. The cover may be attached using screws, click-in features or other means.

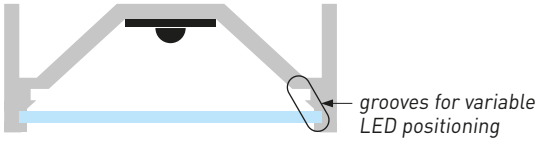


Other luminaire types
Besides the simplest luminaire type, a linear luminaire comprised of a simple aluminium profile and optics, IQ Linear can be used to build more complex luminaires.

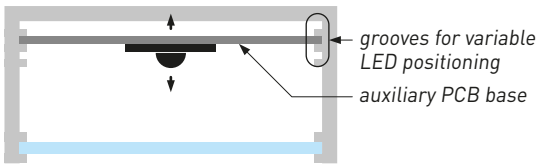
- A linear luminaire with adjustable optical function can be built in three ways. All of them utilize the fact that the light distribution depends on LED–optics distance.
  The simplest approach uses a rectangular profile with more slide-in grooves for IQ Linear optics. A disadvantage is that some grooves are deep in the fixture, which leads to light blocking and reduced efficiency.



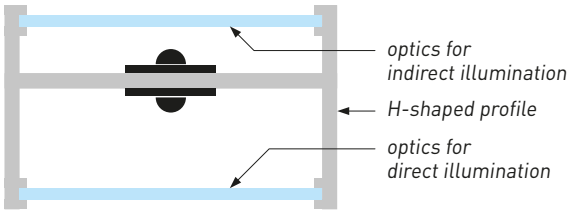
  An alternative approach uses a profile with slanted walls, which helps to keep the luminaire efficient. Moreover, the slanted walls may be designed to



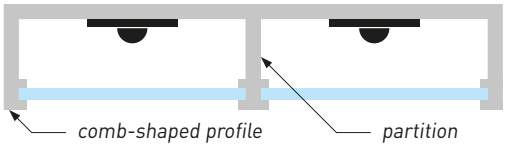
shield the light, thus reducing glare. However, such an approach requires optics of various widths for each LED–optics distance.
Yet another approach uses a rectangular profile with slide-in grooves for a PCB or a platform holding it.



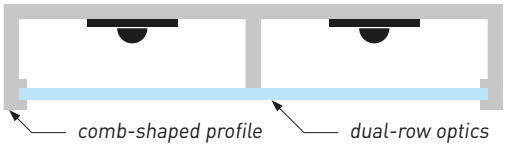
- A direct–indirect linear luminaire can be easily built using a H-shaped profile. In the indirect part, it is advantageous to use double asymmetric ELBO optics with small LED–optics distance.



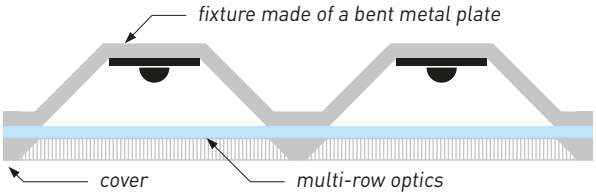
- A multi-row linear luminaire can be easily built using a comb-shaped profile.



It might be especially advantageous to ask for a custom IQ Linear with several optics next to each other on a single substrate. In that case, partitions between individual rows might not be necessary if crosstalk between rows is negligible. However, partitions may still be useful for supporting the optics.

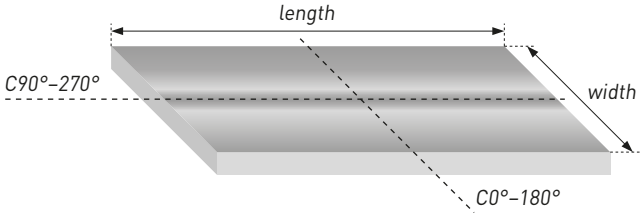


- A recessed panel luminaire is in fact a short multi-row luminaire, e.g., 8 rows 500 mm long next to each other. Body of such a luminaire can be made of, e.g., a bent metal plate. It is especially advantageous to use custom IQ Linear with several optics next to each other to simplify the assembly. It is also advantageous to clamp the optics to the fixture using a cover with external glare reducing features (see the following section). In this way, it is possible to build luminaires fulfilling requirements for, e.g., the most demanding office illumination.



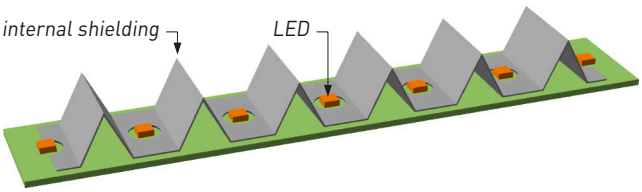
Glare reduction

IQ Linear optics is designed to shape light of a linear luminaire perpedicular to the luminaire length (plane C0°–180°). Due to various principal and technological reasons, ability to bend light from LED is not perfect – some part of LED light is scattered in space in unwanted directions. Such light contributes to glare.

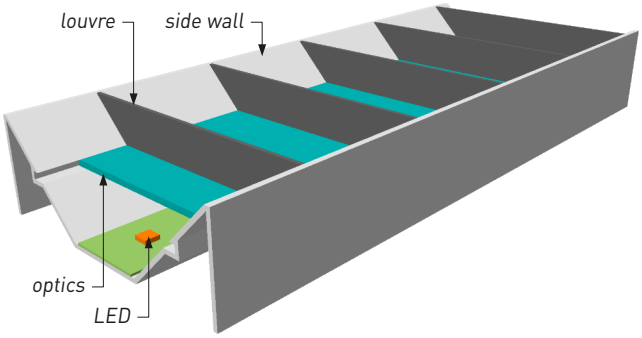


In the direction parallel to the luminaire length (C90°–270°), IQ Linear optics does not affect light significantly. To put it in another way, light distribution in C90°–270° is about the same like light distribution of the LED, i.e., usually FWHM 120°. Such a wide light distribution contributes to glare.
There are several ways how to reduce glare. First of all, the glare sensation depends on luminous area. Luminous flux spread over larger area decreases glare. Thus, it is better to use IQ Linear optics as wide as possible. If it is possible to divide requested luminous flux between several rows of a multi-row luminaire (see section "Other luminaire types" on page 37), it is even better. Note that doubling luminous area decreases unified glare rating (UGR) by 2.4.
Other way to reduce glare is light shielding. Light shielding is also necessary in some applications (e.g., office lighting), where luminance at high gamma angles must be lower than a certain value.
There are two types of shielding: internal (between the LEDs and the optics) and external (after the optics).
Internal shielding is used to limit light leaving the LED strip in the C90°–270° plane. As IQ Linear optics barely affects light in this direction, any FWHM narrowing improves glare rating.

The best internal shielding system is comprised of mirror (e.g., polished aluminium) wedge partitions between LEDs. Such partitions should redirect light directly towards optics. Such internal shielding system can be made of thin bent aluminium sheet with holes for LEDs. Such a shielding system decreases UGR in the C90°–270° direction by about 5, while efficiency drops just by about 8% (depending on geometry).



External shielding system is basically the same as louvre system used in conventional linear luminaires. Side walls shield light in the C0°–180° plane, while louvres shield light in the C90°–270° plane. Material used for the external shielding system provides a compromise between efficiency and glare rating. Anodized aluminium or a grey diffuse material provide a good compromise.

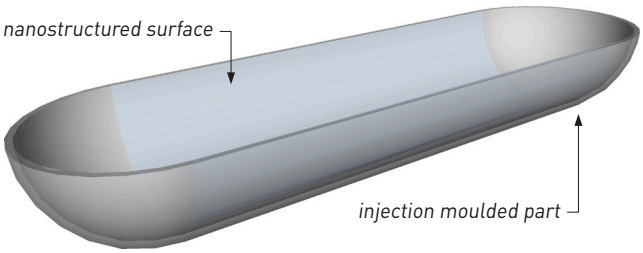


Customized IQ Linear

The technlogy behind IQ Linear, both on the design and manufacturing sides, is very flexible. It is possible not only to customize optics width, length, thickness or substrate material; more freedom is available.

First of all, it is possible to design a new IQ Linear optics for a custom nominal LED–optics distance, with a custom light distribution, optimized for a particular width, etc.

Second, it is possible to employ technology that applies IQ Linear nanostructure onto injection moulded rigid parts, for example on luminaire covers. This option is especially interesting when IQ Linear optics is designed for a curved substrate. Advantage of this technology is that one can use a single injection mould creating the overall shape of the cover, and to change the optical function just by changing the nanostructure. Contact us for details.



Troubleshooting

When designing a prototype luminaire with IQ Linear optics for the first time, it may happen that the optics do not work as expected. Please check the list of the most common pitfalls before concluding that the optics are not suitable.

- Samples may arrive equipped with a protective film. Ensure it was removed.
- Check that the optics is installed with the nanostructured surface facing LEDs. It is not difficult to recognize which side of optics is nanostructured, but it requires a bit of practice. If you can see a mirror reflection of a window or a light source in the optics, you are looking at the flat side. If you cannot see any mirror reflections, you are looking at the nanostructured side.
- Avoid touching the nanostructured side. Grease, oil, water, glue, etc., easily fill the small dips in the nanostructure, making the nanostructure non-functional. If this happens, the affected part of the nanostructure becomes significantly more transparent than the unaffected part.
- Check whether LED–optics distance matches the intended light distribution; double check the LED–optics overview in the datasheet. Also check whether LEDs are positioned below the optics centre (in case you are not aiming for off-axis use).
- Sometimes, colour dispersion may appear, especially when creating narrow beams. If it is rainbow-like (you can see faint red, green, blue tints), double check that the nanostructure is facing LEDs. Also try to slightly change the LED–optics distance. If the light beam is bluish in the centre and is surrounded by a yellow crown, it is most likely caused by LEDs with strong colour inhomogeneity.

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CHANGES

2024-08-27:	Updated specific efficiency values (from new measurements)
	Added NILO 4W
	Minor changes in drawings, text corrections
2024-03-01:	Initial version