Permanently installed projection equipment

Contents:

- Projection surfaces
- Projection types
- Dimensioning of a projection system

Permanently installed projection equipment

Contents:

- Projection surfaces
  - Projection screens
  - White board and white walls
  - Rear projection panels
  - Holographic rear-projection panels

Permanently installed projection equipment

Contents:

- Projection types
  - Front projection
  - Rear projection
  - Projection onto holographic panels

Permanently installed projection equipment

Contents:

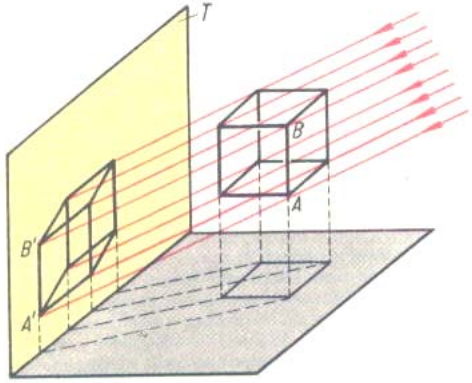
- Dimensioning of a projection system
  - Image size
  - Projection distance
  - Required light output
  - Technical equipment

Permanently installed projection equipment

Introduction: concept of projection

The term ‘projection’ comes from mathematics (geometry)

This is understood as being the reproduction of bodies and figures on a plane (image plane)



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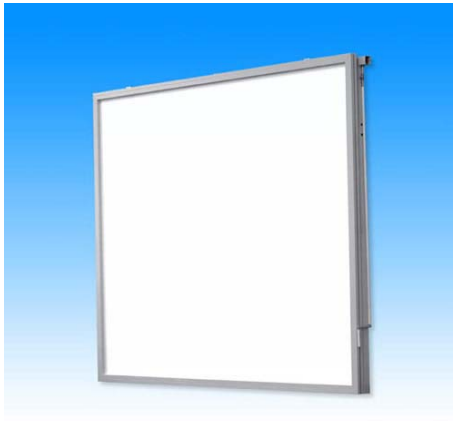
Projection screens / silver screens:

- Tripod projection screens
- Mobile and permanent fixed-frame screens
- Free-standing projection screens
- Ceiling mounted projection screens
- Wall / ceiling projection screens



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Projection screens: parameters

Light intensity factor (Gain)
is a measure for the efficiency of a projection screen and describes how many times brighter the respective projection screen is compared to a matt white surface (e.g. 1.7).

Scattering angle
is given in degrees and describes the angle at which the light intensity factor has sunk to half of the standard measured value (e.g. 30°).

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Projection screens: to DIN 19045

Type D: Diffuse reflection behaviour, the light is widely diffused.

Type P: Retro-reflective, the light is reflected back in the direction of the light source.

Type M: Angular reflective, the angle of reflection of the light is the same the angle of incidence.

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White board and white walls:

White boards are not suitable for projections

Disadvantage:

Suffer from hot spotting

Advantage:

Possible to make notes on image!

In many cases projecting onto a white wall provides a acceptable quality!

Special colour: magnolia, caparol

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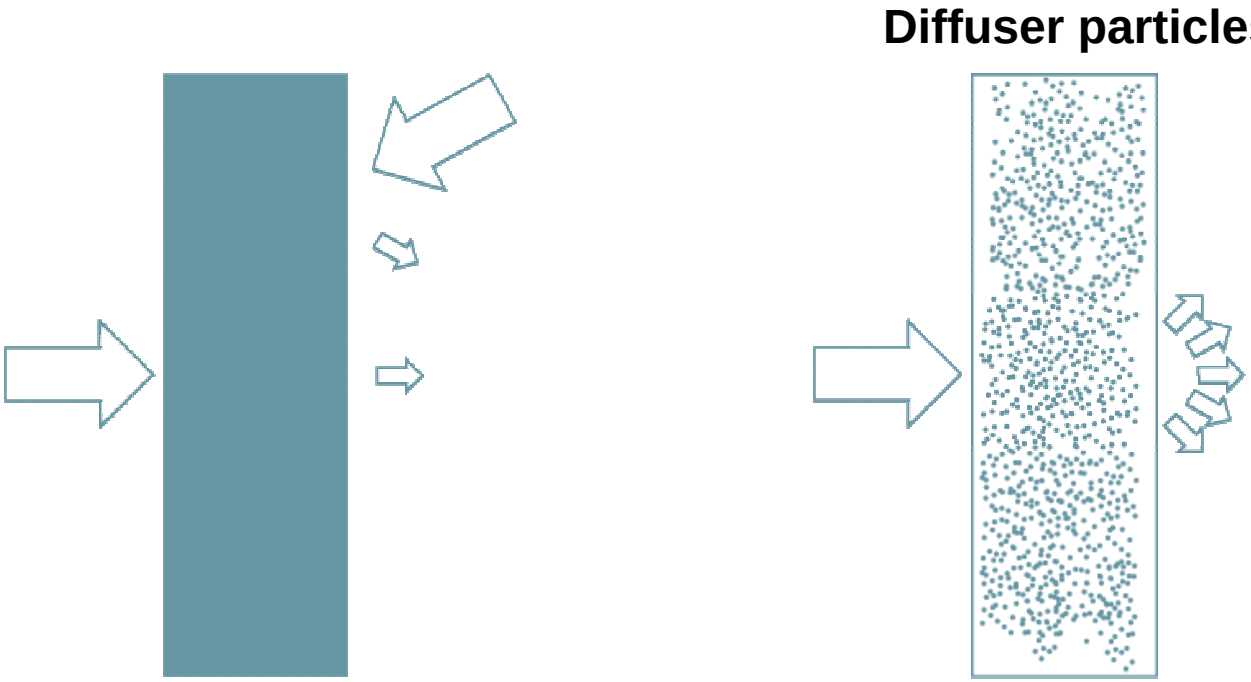
Rear projection panels

Plastic: contrast increased by pigmentation

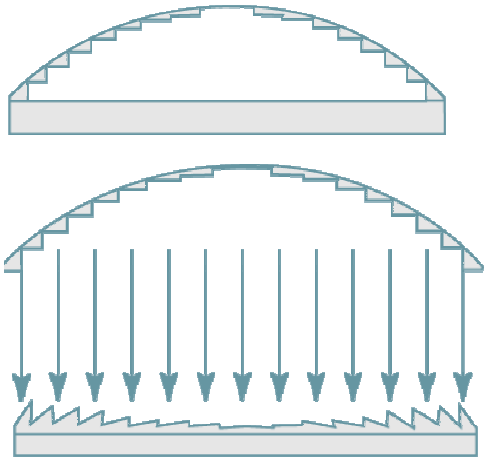
Pigmentation reduces light transmission



Permanently installed projection equipment

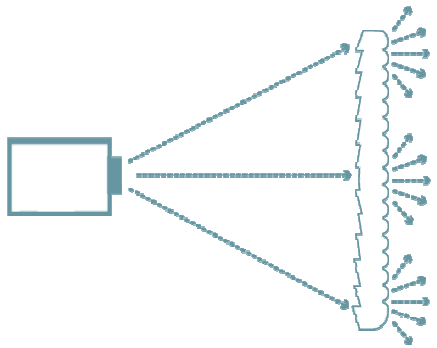
Rear projection panels

Only the curved edge of a lens is optically active. In the case of a fresnel lens the surface of the lens is ‘projected’ onto a plane. The optical resolution of the lens depends on the its fineness (screen pitch). Up to 10,000 different profiles are incorporated to make one projection panel!



Lenticular structure:

Profiled structure consisting of a large number of parallel, cylindrical grooves running vertically. They ensure a more focussed distribution of light in the horizontal plane.



Permanently installed projection equipment

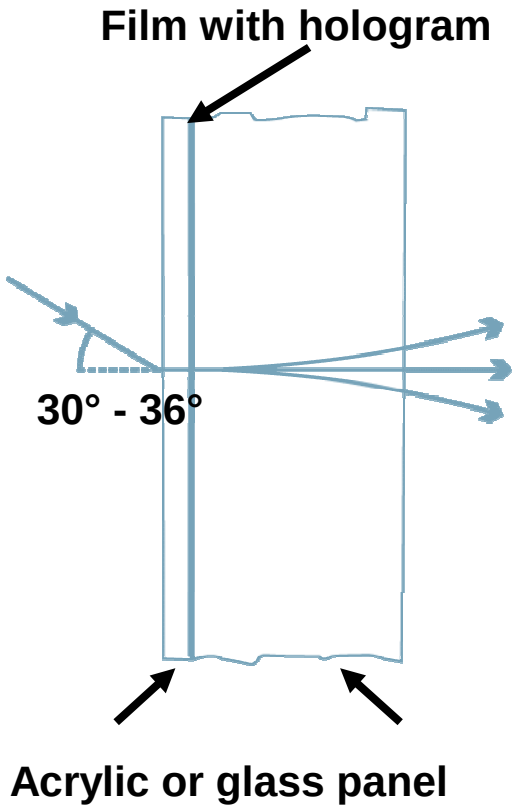
Holographic projection panels

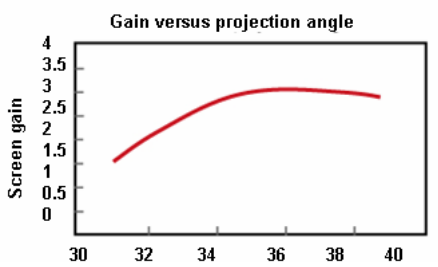
Application areas:

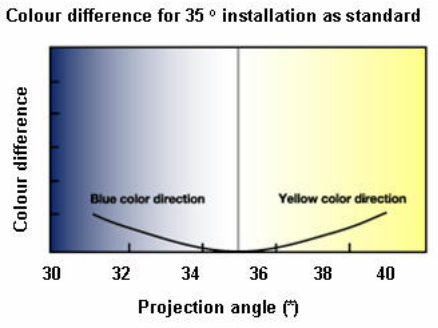
Shops
Supermarkets
Airports
Banks
High traffic areas
Etc.

Permanently installed projection equipment

Holographic projection panels







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Holographic projection panels

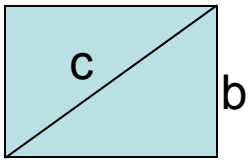
- Projection onto the panel at an angle of approx. 30 – 36 degrees. Varies between manufacturers.
- The projectors must be suitable for this projection angle; potentially the projection conditions may necessitate adjustment to the hardware or software.

Permanently installed projection equipment

Formats

The size of the projection surface is stated in inches (screen diagonals)! (1“ = 25.4mm)

4:3



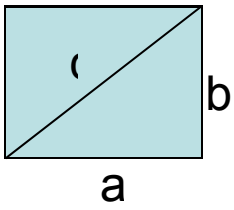
SVGA 800 x 600 pixels

XGA 1024 x 786 pixels

$a = \sqrt{c^2/1{,}56}$

b = 0.75 x a

5:4

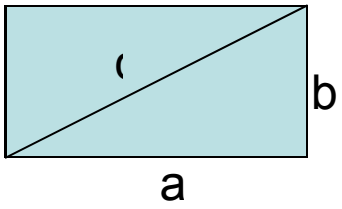


SXGA 1280 x 1024 pixels

$a = \sqrt{c^2/1{,}64}$

b = 0.8 x a

16:9



WXGA 1366 × 768 pixels

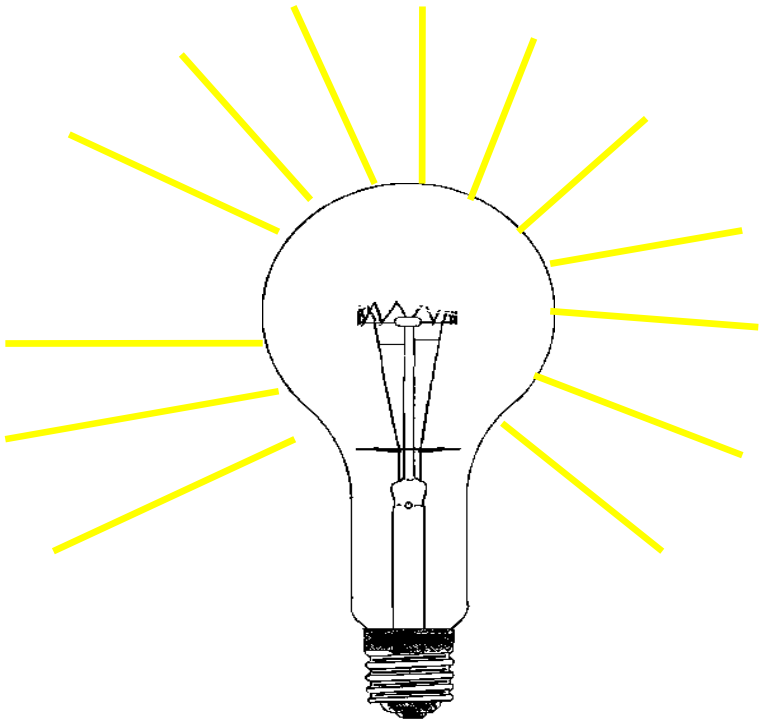
Other resolutions commercially available e.g. 950 x 534

$a = \sqrt{c^2/1{,}32}$

b = 9/16 x a

IFB con

Light technology – basic terms



Luminous flux Φ_v

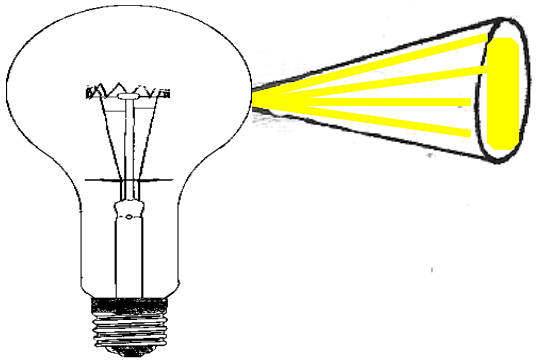
('light output')

Parameter derived from radiated power – evaluated by means of the spectral brightness sensitivity of the human eye – equals the amount of radiated light Q per unit of time t (Q/t)

Unit **LUMEN (lm)**

Permanently installed projection equipment

Light intensity and illumination

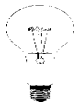


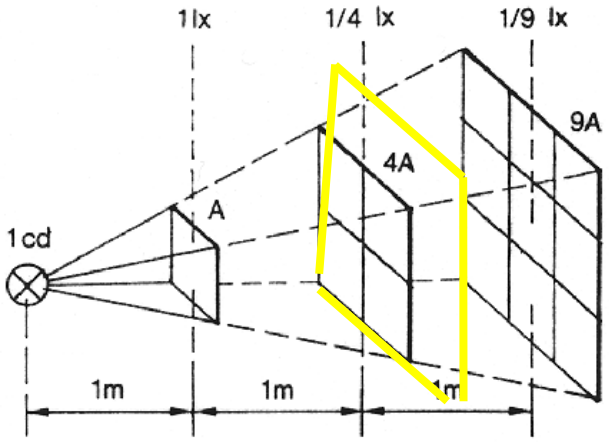
Light intensity I_v

(luminous flux per solid angle)

Light intensity is the radiation power per solid angle - parameter derived from weighting in accordance with the spectral brightness sensitivity of the human eye – equals the radiated light intensity Φ per solid angle ω

Unit **Candela (cd** = lm/ster**)**





Illumination E_v

(Luminous flux incident per unit area of surface)

Luminous flux incident Φ_v per unit area **A**

Unit **Lux (lx** = lm/m² **)**

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Table: Illumination

Fully darkened room	< 1 lx
Well darkened room	5 …. 20 lx
Partially darkened room	10 …. 100 lx
Room with uncontrolled incidence of daylight	50 …. 1,500 lx
Work station illumination	at least 300 lx
Outside under cloudy skies	5,000 …. 15,000 lx
Outside in sunshine	> 20,000 lx

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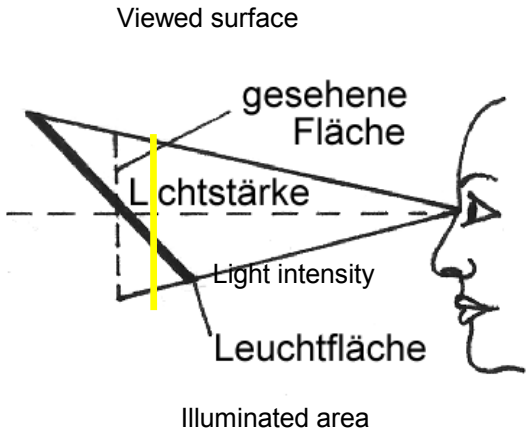

Luminance L_v

(Luminous density of a surface)

Luminance is the light density of a light emitting surface as seen by an observer.
$L_v = 1/\pi$ cd/m² is reflected by a perfectly white body when is illuminated by 1 lx.

Unit **cd/m²**

Typical luminance, (reference values)

Sun	up to 1.5 billion	cd/m²
Clear sky	2,000 ... 12,000	cd/m²
Cloud covered sky	1,000 ... 6,000	cd/m²
Moon	2,500	cd/m²
Candle flame	7,000	cd/m²
Clear light bulb	1 million ... 20 million	cd/m²
Matt light bulb	5,000 ... 50,000	cd/m²
Fluorescent lamps	3,000 ... 13,000	cd/m²
Sodium vapour lamp	75,000 ... 140,000	cd/m²
Mercury vapour lamp	1.9 million ... 6.2 million	cd/m²
Xenon high-pressure lamp	150 million ... 950 million	cd/m²
Mercury vapour high-pressure lamp	up to 1.7 billion	cd/m²
Television screen	250	cd/m²
Well lit streets	2	cd/m²
Lower limit of brightness perception	0.00001	cd/m²

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‘PIXELLING’

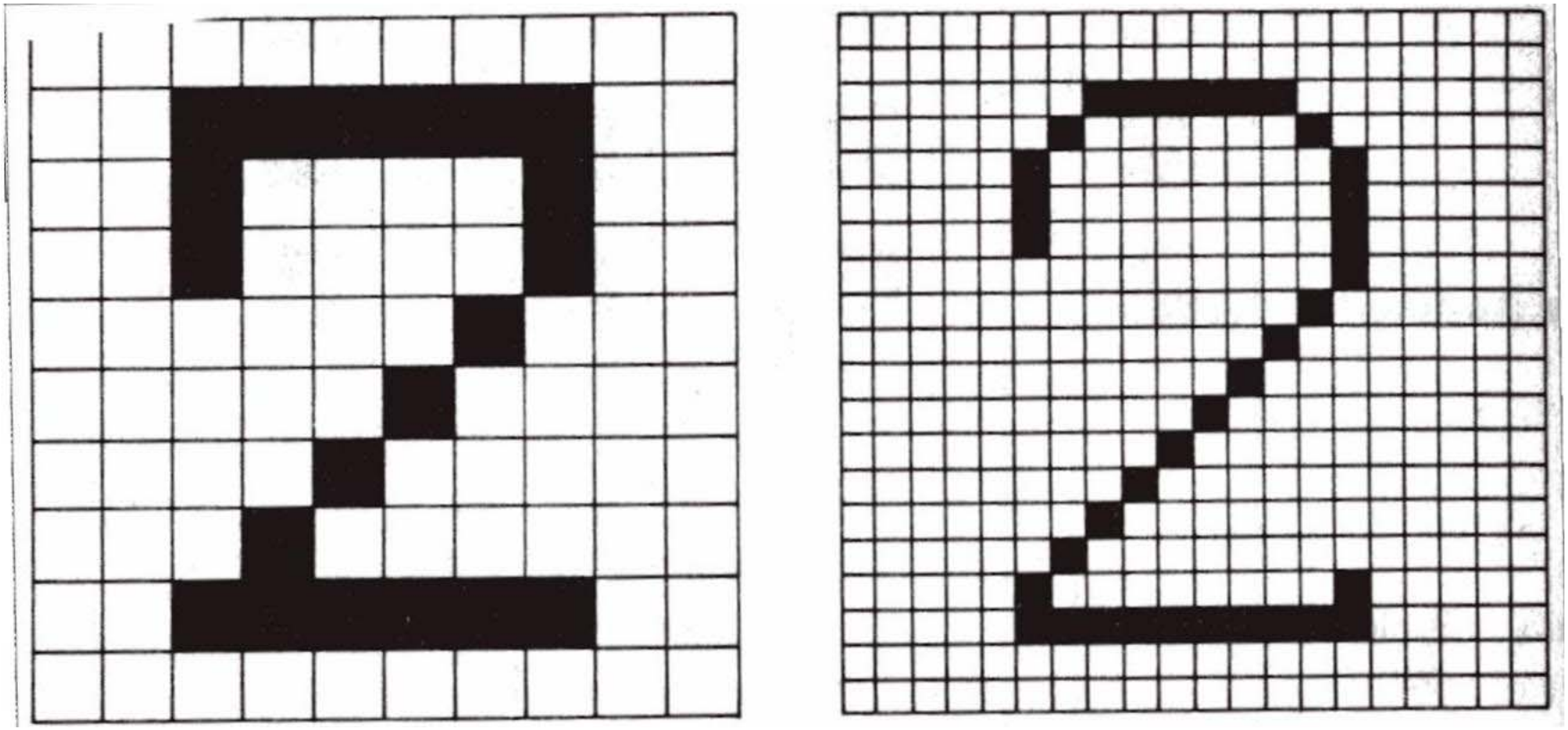

Image resolution at different pixel numbers

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Line number

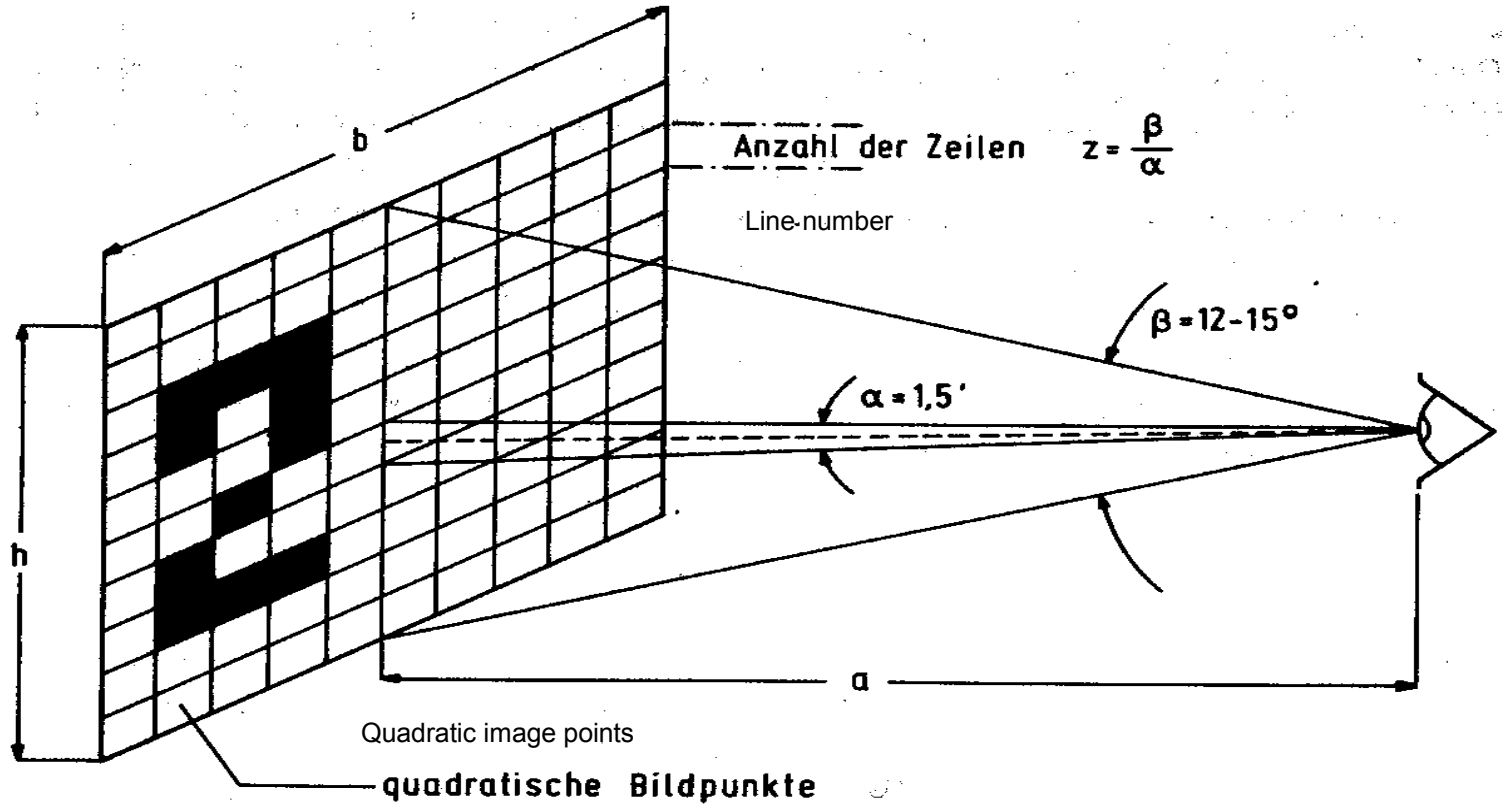

Abb. C3-9 Abhängigkeit des Betrachtungsabstandes von der Zeilenzahl

Fig. C3-9 Dependence of viewing distance on line number

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Different viewing distances at 1.5’ (angular minutes) result in the following optimal image heights:

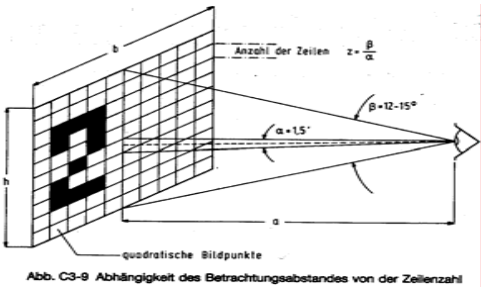

Abb. C3-9 Abhängigkeit des Betrachtungsabstandes von der Zeilenzahl

Viewing distance	Line height in mm	Picture height Hmax in mm for n lines (= line hight * n)					
r [m]	for beta 1.5'	480	575	600	768	1024	
1	0,4	0,2	0,3	0,3	0,3	0,4	
2	0,9	0,4	0,5	0,5	0,7	0,9	
4	1,7	0,8	1,0	1,0	1,3	1,8	
8	3,5	1,7	2,0	2,1	2,7	3,6	
16	7,0	3,4	4,0	4,2	5,4	7,1	
32	14,0	6,7	8,0	8,4	10,7	14,3	
beta=1.5' = 0.00043633							

Example:

Assumed typical viewing distance r = 4 m

➔1.7 mm max. line height no longer individually resolvable by eye

➔ 575 lines to project with a max. 1 m image height (as optimum)/(➔ 1.33 m width for 4:3)

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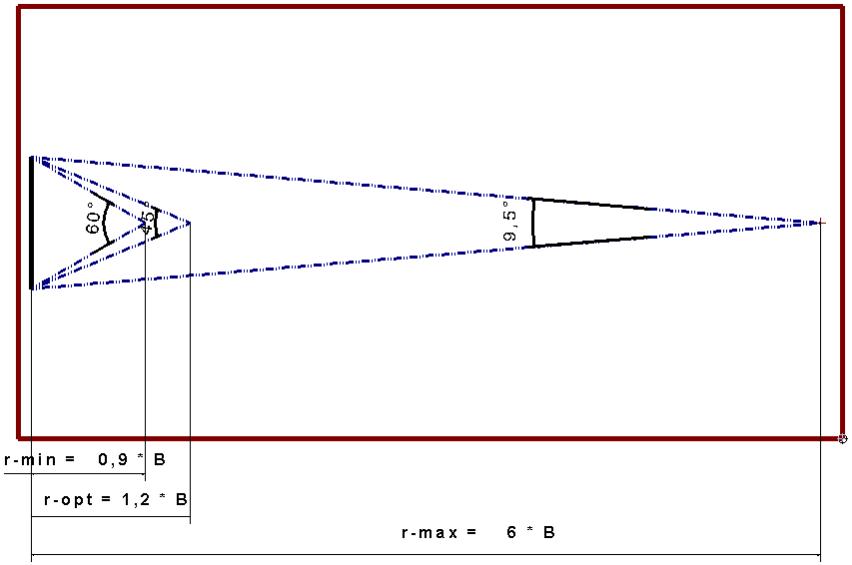
Viewing distance



Wide projection screen??

$B_{min} = r\text{-}_{max} / 6$

(viewing angle about 9.5 °)

better:

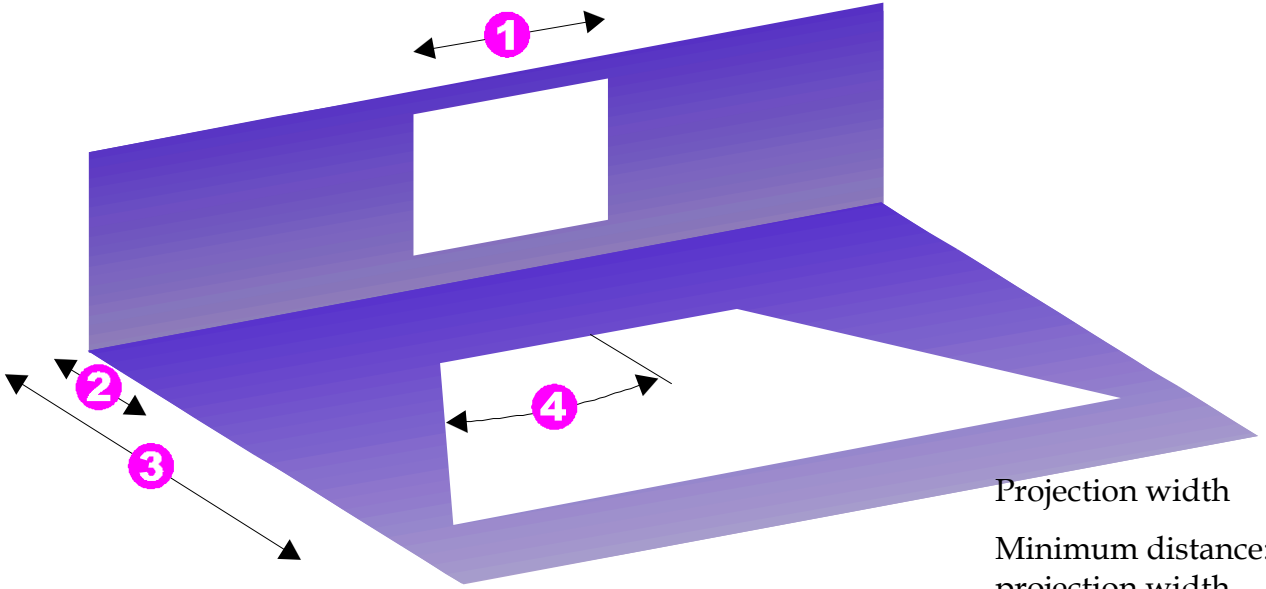
$B = r\text{-}_{max} / 5$

optimal viewing distance:
viewing angle 45°
according to
$r_{opt} = B * 1.2$

minimal viewing distance:
viewing angle 60°
according to
$r_{min} = B * 0.9$

Permanently installed projection equipment

Field of vision



Projection width

Minimum distance: 1.5 times projection width

Maximum distance: 6 times projection width

Maximum viewing angle: 40°

1. Projektionsbreite

2. Mindestabstand: 1,5-fache Projektionsbreite

3. Maximalabstand: 6-fache Projektionsbreite

4. Maximaler Betrachtungswinkel: 40°

Permanently installed projection equipment

r-max	B-minimal	H-min	r-opt	r-min	B-recommended	H-recommen	r-opt	r-min
8	1,3 x	1,0	1,6	1,2	1,6 x	1,2	1,9	1,4
10	1,7 x	1,3	2,0	1,5	2,0 x	1,5	2,4	1,8
12	2,0 x	1,5	2,4	1,8	2,4 x	1,8	2,9	2,2
16	2,7 x	2,0	3,2	2,4	3,2 x	2,4	3,8	2,9
20	3,3 x	2,5	4,0	3	4,0 x	3,0	4,8	3,6
24	4,0 x	3,0	4,8	3,6	4,8 x	3,6	5,8	4,3
28	4,7 x	3,5	5,6	4,2	5,6 x	4,2	6,7	5,0
32	5,3 x	4,0	6,4	4,8	6,4 x	4,8	7,7	5,8
36	6,0 x	4,5	7,2	5,4	7,2 x	5,4	8,6	6,5
40	6,7 x	5,0	8,0	6	8,0 x	6,0	9,6	7,2

Values are valid for image format 4:3

For 16:9 the width of the projection / silver screen should be increased, by a factor of 1.33

Projection screen width

$B_{min} = r_{max} / 6$

(viewing angle about 9.5 °)

better:

$B = r_{max} / 5$

Optimal viewing distance:

viewing angle 45° according to $r_{opt} = B * 1.2$

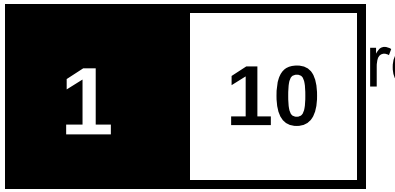
Minimum viewing distance:

viewing angle 60° according to $r_{min} = B * 0.9$

Permanently installed projection equipment

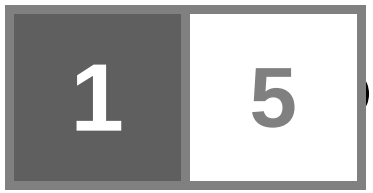
Scope of contrast = difference between the brightest light and black

Required for satisfactory presentation quality:



rox.

Sufficient if needs be (computer graphics):



rox.

For high quality cinema projection: several **hundred : 1** preferable

Dependent on: interference light and illuminance of projection

Permanently installed projection equipment

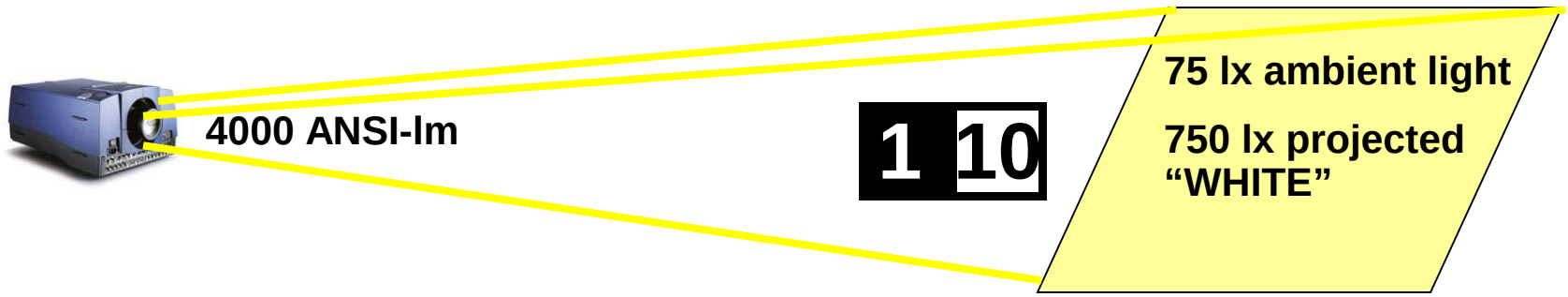
Example:

Unwanted light measure on screen: up to 75 lx

Required projection illuminance: 75 lx x 10 = 750 lx

Size of the projection screen: 2.66 m x 2 m = 5.33 m²

Required projector luminous flux = 750 lm/m² x 5.33 m² = 4,000 lm



Permanently installed projection equipment

Calculation of image size

L = 36 m B = 17 m H = 7 m

max. viewing distance r_{max} = 35 m

➔ favourable projection width $b_{p\text{-}opt}$ = 35 m / 5 = 7 m

➔ Projection height for 4:3 format $h_{p\text{-}opt} = b_{p\text{-}opt} * 3/4 = 7\ m * 3/4 = 5.25\ m$

➔ Projection surface $A_{p\text{-}opt} = b_{p\text{-}opt} * h_{p\text{-}opt} = 7\ m * 5.25\ m = ca.\ 37\ m^2$

Ultimate projection screen width dependent, however, on maximum image format (aspect ratio)

➔ min. viewing distance $r_{min} = b_{p\text{-}opt} * 0{,}9 = 7\ m * 0.9 = 6.3\ m$

Permanently installed projection equipment

Calculation: luminous flux of projector

given: projection surface $A_{p-} = b_p * h_p$ = 7 m * 5.25 m = approx. 37 m²

?? prevalent unwanted light (illuminance E in Lux) on the projection surface??

Measurement or pre-determined ➔ example: unwanted light = $E_{unwanted}$ = 30 Lux

Minimum contrast ➔ example: contrast = $E_{useful} / E_{unwanted}$ = 10 : 1

➔ Necessary useful light = E_{useful} = $E_{unwanted}$ * contrast = 30 Lux * 10 = 300 Lux

➔Luminous flux required = A_p * E_{useful}

= 37 m² * 300 Lux

= 11.100 Lumen

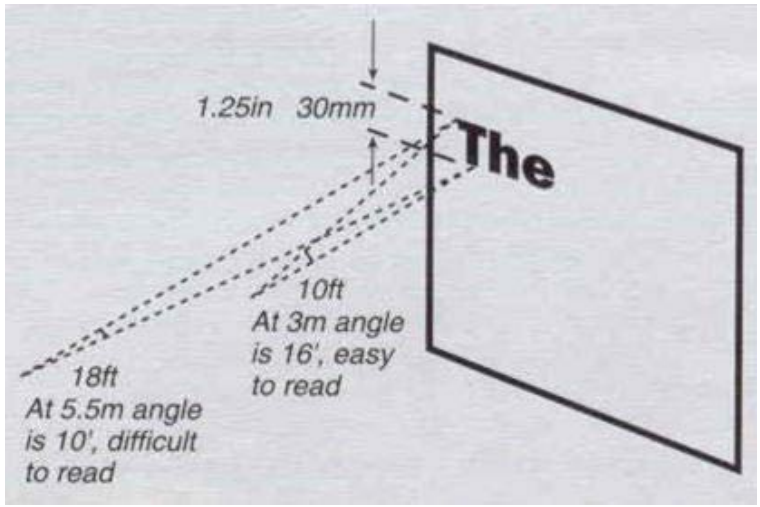
Permanently installed projection equipment

Calculation of the required letter height

Max. resolution of the human eye approx.1`- 1.5` (angular minutes)

To read written words min. 15`- 20` (angular minutes)

Writing on information displays min 30` (angular minutes)



Defined: projection surface $A_{p-} = b_p * h_p$ = 7 m * 5.25 m = approx. 37 m²

max. viewing distance r_{max} = 35 m

Min. character size: $h = r_{max} * \tan \alpha$ = 35000 mm * tan 0.25 = 153 mm

For XGA resolution: pixel height = 6.83 mm
No longer resolvable by human eye from around 16 m

Permanently installed projection equipment

Evaluate: distance between projector and projection surface

Manufacturers offer tools on their websites !!!

Permanently installed projection equipment

Calculation: image size or projector distance

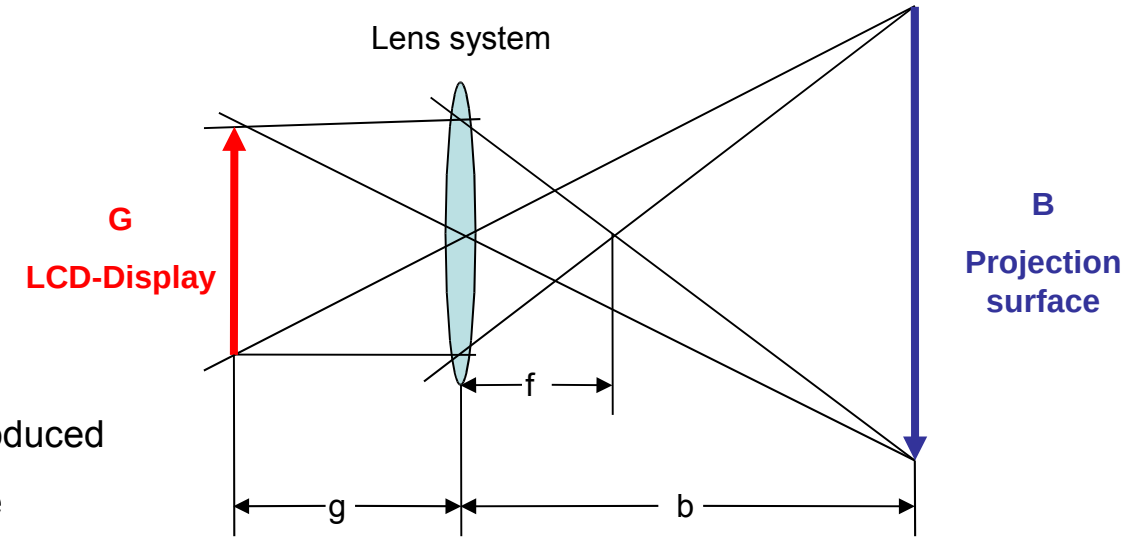
From the object size G [mm] and focal length f [mm]

G = LCD- or DMD-Display

$$b = f\,(B/G + 1)$$

or

$$B = G\,(b/f - 1)$$



G = height of the object to be reproduced

B = height of the projection surface

f = focal length of lens

b = distance between lens and projection surface

Permanently installed projection equipment

Calculation: image size or projector distance

From the projection ratio

Example:

Manufacturer's specification: projection ratio F = 1 : 1.6 – 2.9 zoom

Projection screen width:

Distance from projector to projection screen * 1.6 = B_{min} ,

Distance from projector to projection screen * 2.9 = B_{max} ,

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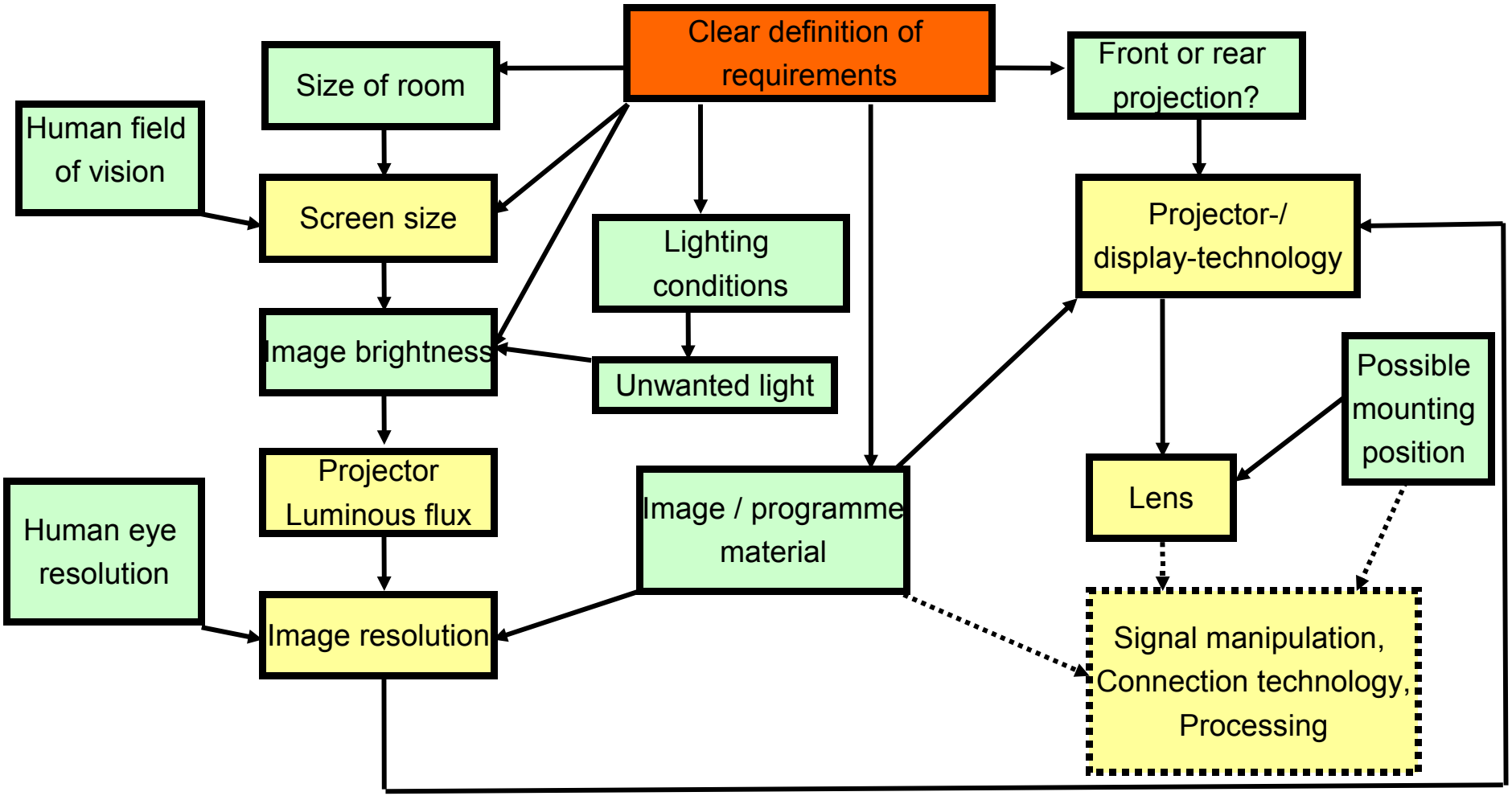
Dimensioning process



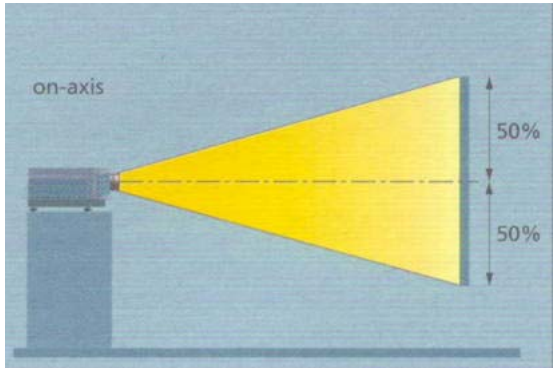
Permanently installed projection equipment

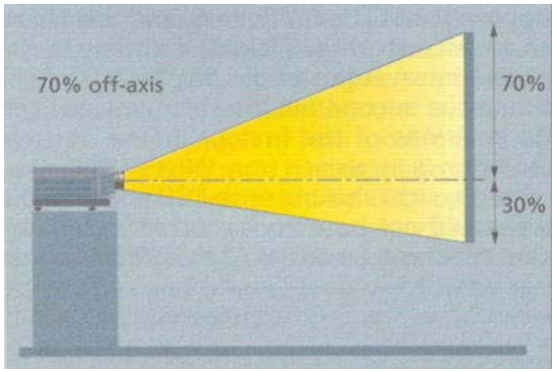
Comparison: front projection – rear projection

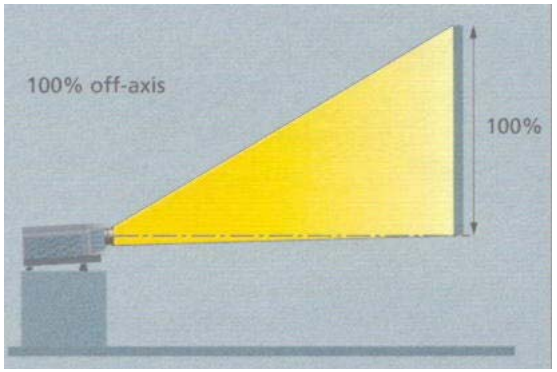
Front projection:	**Rear projection:**
Sensitive to unwanted light	Not sensitive to unwanted light
Noise level of projector	No noise from projector
Speaker in path of beam	Speaker not in path of beam
Low level investment	Additional space requirement (rear projection room)
	More complicated installation
	Higher level investment

Permanently installed projection equipment

Projection types:

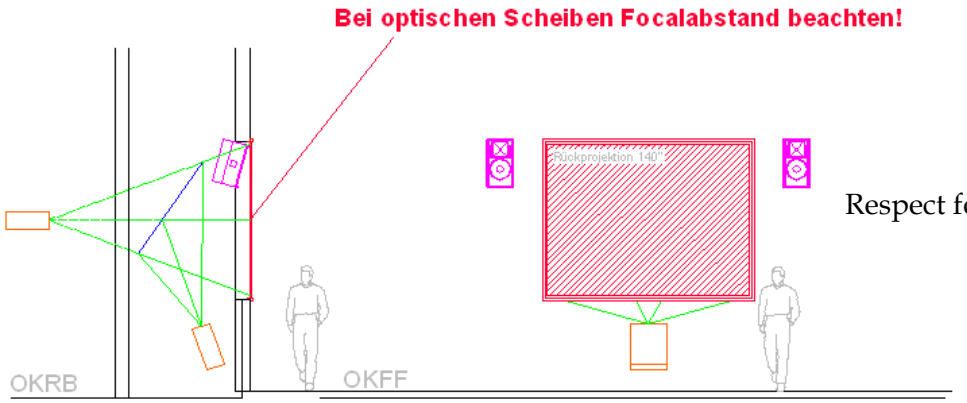




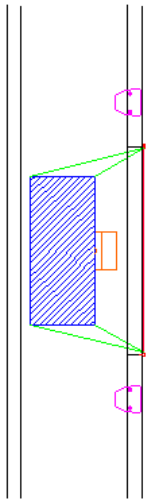


Permanently installed projection equipment

Rear projection facility



Respect focal distance in the case of optical panels



Rückprojektionsraum:
Klimatisierung beachten!!!!!!
Rückprojektionsraum innen matt schwarz Anlegen!!!!!!!
Zutritt nur für Techniker!!!

Rear-projection room:
Take care of climate control!!!
Fit out inside of rear-projection room with matt black lining!!!!
Access for technicians only!!!