

8. Beam splitters

The tasks of optical dividers are to combine or to distribute light beams of determined properties in some special way, depending of application. Such an effect is obtained due to the use of optically active materials or interference coatings. On the basis of application one can choose kind of divider, its shape and material.

Kinds of dividers depending on their function:

1. energetic (divides power of light beam)
 - metallic
 - dielectric
2. selective separators (filters)
 - edge filters:
 - short-pass filters
 - long-pass filters
 - narrow-band-pass filters
3. polarizing dividers (polarizers)
4. non-polarizing dividers

Kinds of dividers depending on their shape:

1. plate dividers
2. prismatic dividers
 - cubic
 - special

Energetic dividers are used for energetic separation of beam intensity in denominated ratio. They may serve to divide the beam of white light or another band of light spectrum as well as monochromatic light. The incident beam can be divided into transmitted and reflected beams with various ratios, e.g. R:T= 20:80, 30:70, 50:50, 70:30. The parameters of a light beam influence the choice of the kind of splitter.

Metallic coating beam divider is characterized by significant absorption lowering the intensity of reflected and transmitted beams after splitting, but has no influence on the state of light polarization and thus, may be used in wide range of band spectrum (has flat spectral characteristic).

Dielectric coating beam divider has no absorption qualities so it can be applied to high-power laser systems but as it has great influence on the state of outgoing beams polarization and can be used only in narrow spectrum band or line of monochromatic light.

Selective separators (filters) divide the beam with two wavelengths into two beams. (see "Filters").

Polarizing dividers separate the beam with mixed polarization states into two beams of one state of polarization. The reflected beam is "s" polarized and the transmitted beam is "p" polarized. (see "Polarizers").

Non-polarizing dividers are a special kind of interference dielectric coating dividers for energetic splitting of the beam without influencing the state of splitted beams polarization. It can be developed only for one wavelength of light. The splitting ratio can be 20:80 or 50:50 and differences between states of polarization are less than 5%.

8.1. Beam splitter plates

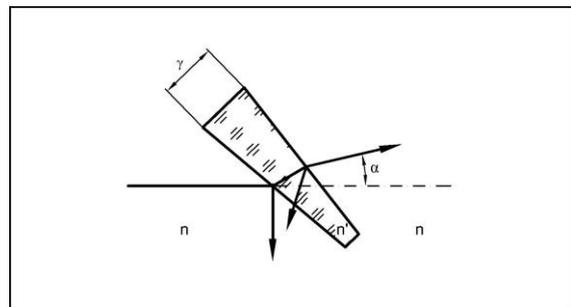
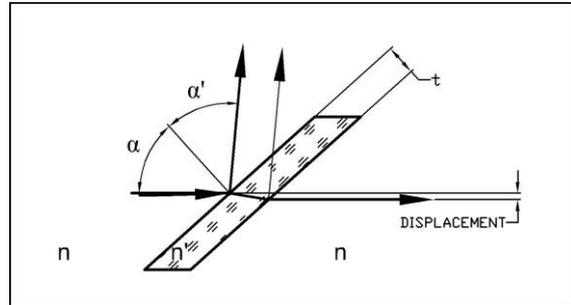
Plate dividers are thin plane-parallel or edge plates made of optical glass, quartz or single-axis crystals (e.g. CaF₂) coated with thin-film layers system. Depending on application it can be either metallic layer or dielectric coating. However one should remember that such an element introduces a shift or deviation into the light beam due to the thickness of optical element. In order to get the normal deviation between transmitted and reflected beams the working angle of incidence should mainly be 45°. The second surface of optical element is often coated with antireflection coating to avoid unwanted additional reflections. Such a divider can be applied in optical systems with high power of light beam.

Parallel displacement on a plane plate:

$$displacement = t \frac{\sin(\alpha - \alpha')}{\cos \alpha'}$$

Beam deflection with wedge angle γ at 45° angle of incidence:

$$\alpha = \gamma(n - 1)$$



Technical specification-beam splitter plates			
	Standard		
Substrate material	on request		
Size	5 mm ÷ 100 mm		
Size tolerance	-0,1 mm		
Clear aperture	90%		
Thickness tolerance	± 0,1 mm		
Flatness (633 nm)	1 λ per inch		
Surface finish (scratches - digs)	60 – 40		
Dividing ratio R:T (%)	metallic	10:90 up to 90:10	
	dielectric	30:70; 50:50; 70:30	BB
		10:90 up to 90:10	V-type
Dividing ratio tolerance	± 5% (for 50:50)%, ± 2% (for 90:10)%		
Wedge substrate	on request		
Spectral range	metallic	400 nm ÷ 6000 nm	
	dielectric	300 nm ÷ 10 600 nm	
AR Coatings	on request		
Mounting	on request		

According to customer specification, we can deliver non-standard beam splitters with significantly higher optical parameters: 20-40; λ/10 (633 nm).

8.2. Output laser mirrors

Output laser mirrors are a kind of plate dividers. They are used inside the laser generator. The shape of active area could be flat, concave or convex and coated with multi-layer dielectric system. High-quality quartz glass, N-BK7 ZnSe, etc. are used as a substrate material.



output mirror 532 nm



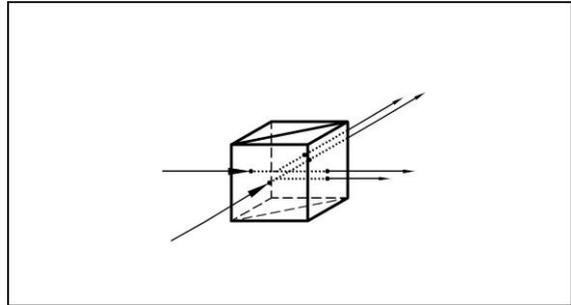
output mirror 1064 nm

Technical specification – output laser mirrors	
	Standard
Substrate material	on request
Size	5 mm ÷ 100 mm
Size tolerance	–0,1 mm
Clear aperture	90%
Thickness tolerance	± 0,1 mm
Surface accuracy (633 nm)	$\lambda/10$ per inch
Surface finish (scratches - digs)	10 – 5
Spectral range:	300 nm ÷ 6000 nm
AR Coatings	on request
Mounting	on request

According to customer specification, we can deliver non-output mirrors with higher optical parameters: $\lambda/20$ (633 nm), for example.

8.3. Beam splitter cubes

Prismatic or cube dividers are optical elements where the working splitting coating surface works at the angle of incidence 45° being glued inside the glass cube. In such an element there is no shift or deviation in the transmitted beam and the optical paths in transmission and reflection are equal. However, the layer of glue inside the cube decreases thermal durability of the element. Such elements work in medium and low light power optical systems.

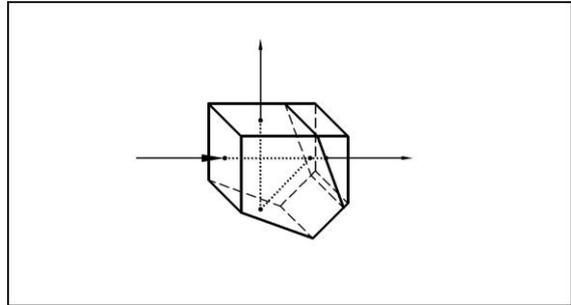


Technical specification – beam splitter cubes		
	Standard	
Material	on request	
Size	(5 x 5) mm (50 x 50) mm	
Size tolerance	+/- 0,1 mm	
Clear aperture	80%	
Angle tolerance	± 3 arcmin	
Flatness (633 nm)	1 λ per inch	
Surface finish (scratches - digs)	60 – 40	
Dividing ratio R:T (%)	metallic	10:90 up to 90:10
	dielectric	10:90 up to 90:10
Dividing ratio tolerance	± 5% (for 50:50)%, ± 2% (for 90:10)%	
Cut corners	on request	
Spectral range	metallic	350 nm ÷ 1500 nm
	dielectric	400 nm ÷ 1500 nm
AR Coatings	on request	
Mounting	on request	

According to customer specification, we can deliver non-standard beam splitter cubes with significantly higher optical parameters: 20-10; $\lambda/10$ (633 nm), for example.

8.4. Penta beam divider

Application of pentagonal prism divider is similar to that of cube divider, but in wide range of angles the image is not reverted and the deviation angle of reflected beam does not depend on the incidence angle. It may be applied in optical systems where precise positioning is either difficult or impossible. The prism is coated with metal reflection coatings and dielectric dividing coatings.



Technical specification – penta beam splitters		
	Standard	
Material	on request	
Size	(5 x 5) mm (30 x 30) mm	
Size tolerance	± 0,1 mm	
Clear aperture	90%	
90° degree tolerance	± 2 arcmin	
Beam deviation tolerance	1 arcmin	
Flatness (633 nm)	1 λ per inch	
Surface finish (scratches - digs)	60 – 40	
Spectral range	metallic	350 nm ÷ 1500 nm
	dielectric	400 nm ÷ 1500 nm
Dividing ratio R:T (%)	metallic	10:90 up to 90:10
	dielectric	10:90 up to 90:10
Dividing ratio tolerance	± 5% (for 50:50)%, ± 2% (for 90:10)%	
AR Coatings	on request	
Mounting	on request	

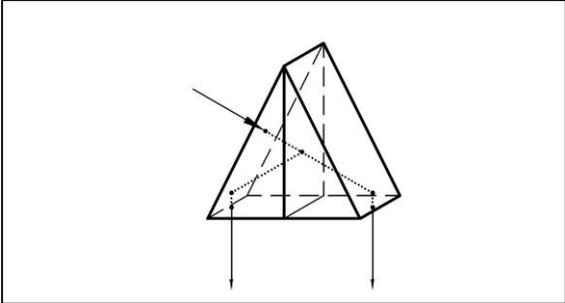
According to customer specification, we can deliver non-standard penta beam splitters with significantly higher optical parameters

Three groups of penta beam splitters with different deviation tolerance are offered:

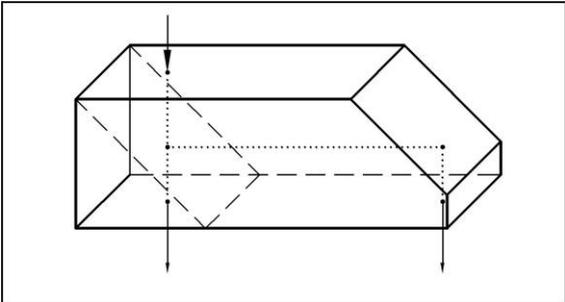
- up to 1 arcmin
- up to 30 arcsec
- up to 15 arcsec

8.5. Special prismatic beam splitters

KÖSTER prism made with two identical prisms ($90^\circ - 60^\circ - 30^\circ$). Longer short faces, with beam dividing coating on one of them, are cemented. With this prism, the light beam can be divided into two parallel beams. The distance between the two output beams can be adjusted by variation of the height of the incident beam“.



This **special beam divider** also enables splitting beam of light per two beams parallel each to the other, and parallel to the input beam with accuracy of tolerance.



Technical specification – prismatic beam dividers		
	Standard	
Material	on request	
Size	(5 x 5) mm (30 x 30) mm	
Size tolerance	± 0,1 mm	
Clear aperture	90%	
Thickness tolerance	± 0.1 mm	
Beam deviation tolerance	± 2 arcmin	
Flatness (633 nm)	1 λ per inch	
Surface finish (scratches - digs)	60 – 40	
Spectral range	metallic	350 nm ÷ 1500 nm
	dielectric	400 nm ÷ 1500 nm
Dividing ratio R:T (%)	metallic	10:90 up to 90:10
	dielectric	10:90 up to 90:10
Dividing ratio tolerance	± 5% (for 50:50)%, ± 2% (for 90:10)%	
AR Coatings	on request	
Mounting	on request	

According to customer specification, we can deliver prismatic dividers with significantly higher optical parameters: beam divergence – up to 30 arcsec, 40-20; $\lambda/10$ (633 nm).