

Standards booklet for Glass Optics Procurement

We are looking for supplier partnerships for glass optics components. Reach out if you meet one or more of the specified qualifications: GlassOpticalComponents@tno.nl

1. Scope of the Document

Optical components are essential to a wide range of advanced applications, including scientific research, astronomy, lithography, and space exploration - domains in which TNO has established itself as a leading center of expertise in the High Tech Industry.

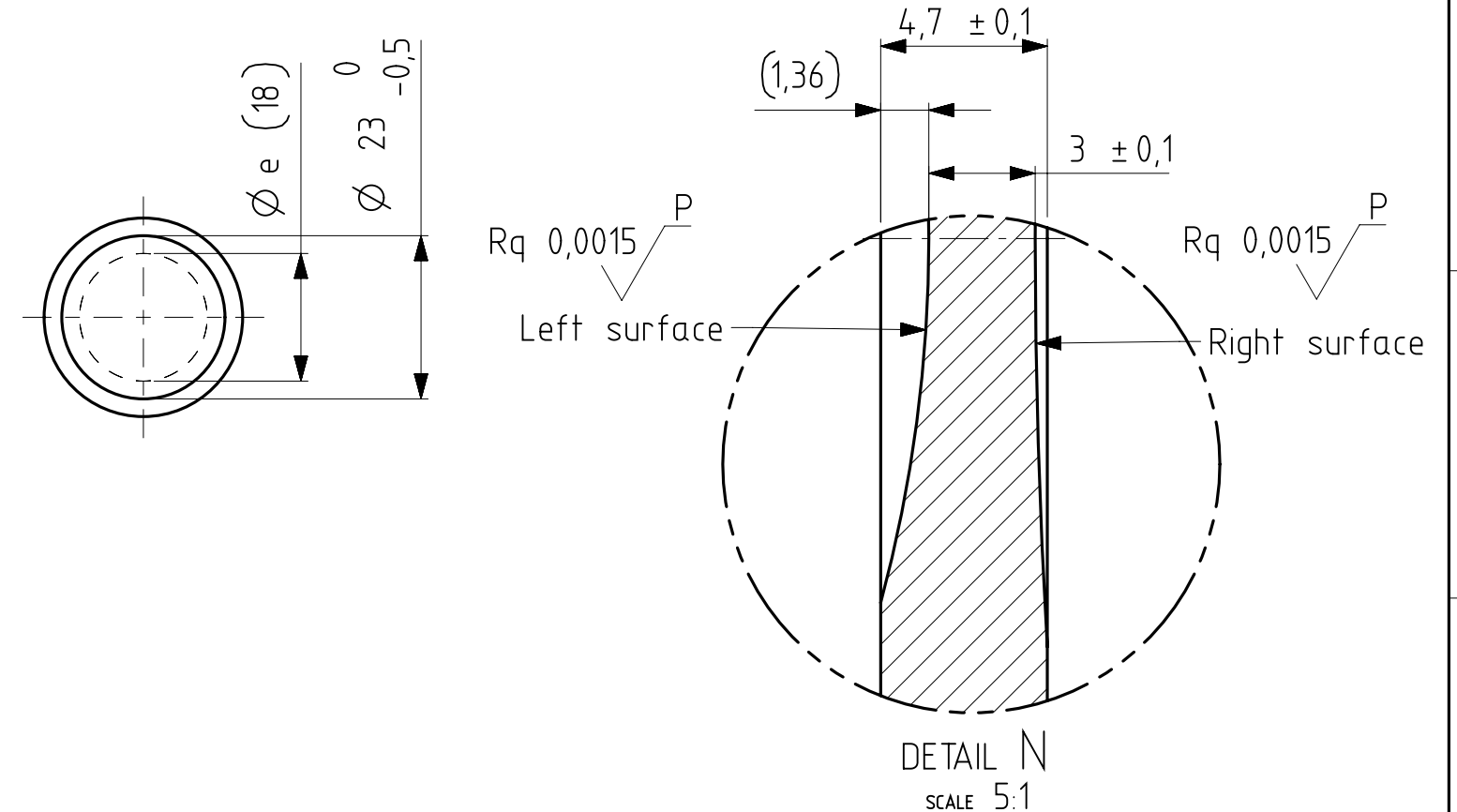
Within the Glass Optics Procurement group, we act as the interface between internal project teams and the supplier chain. Our goal is to foster partnerships that support our project needs, while also sourcing specialized optics for small-volume or one-off optics.

This booklet serves as a reference tool, showcasing examples of optical components used in past projects. It illustrates the level of complexity and quality standards we require. Please refer to the drawings below for further detail.

2. Outlook work

At TNO, we're always exploring new technologies and applications. For future projects, we're seeking supplier partnerships in areas like thermal IR-optical components, for which there is a need for high refractive index, low absorption optical components that can be produced cost-effectively. And new materials, for example:

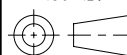
- Germanium (N=4, expensive, long lead time, significant absorption at 10.3 μ m)
- ZnSe (N=2.4, low absorption, not nice for manufacturing)
- Chalcogenide glasses. These are designed to be easy for a manufacturing, partly as alternatives to Ge and ZnSe.


$$\text{SAG HEIGHT} = \frac{(1/R) y^2}{1 + \sqrt{1 - (1+K) (1/R)^2 y^2}}$$

y	Sag
0 mm	0,000000 mm
3 mm	-0,113878 mm
6 mm	-0,456339 mm
9 mm	-1,029887 mm



- Custom lens with concave aspheric surface
- Typical lens material -> Fused Silica
- Example of a "standard" custom request

LEFT SURFACE		MATERIAL SPECIFICATION		RIGHT SURFACE			
R -39,53957 (Aspheric CC) conic constant K = -0,58276 ϕe 18 mm Protective chamfer: 0,3mm ± 0,1mm ⊙ λ AR @λ=589nm 3/ 2; RMSi <15nm 4/ 0,3mrad 5/ 1x0,063; L1x0,01 6/ 100 W/cm @ λ=589nm		Fused Silica n _d 1,45843 v _d 67,87 0/ 5 1/ 1x0,1 2/ 2 ; 5		R 193,74104 (Spheric CC) ϕe 18 mm Protective chamfer: 0,2mm ± 0,05mm ⊙ λ AR @λ=589nm 3/ 2; RMSi <10nm 4/ - 5/ 1x0,063; L1x0,01 6/ 100 W/cm @ λ=589nm			
Indications in accordance with ISO 10110							
		General Geometric Tol	Metric Screw Thread	General Tolerances	Roundings ISO-13715	Roughness ISO-4287	Projection ISO 128
ISO 2768- K		ISO 965 6H/6g	ISO 1101				
Material				Release Status			
				Released			
Treatment				Project			
Units mm	Part name			Part Number		Assembly Number	
Scale 1 : 1	EXAMPLE: Fused Silica Asphere Lens						
Sheet 01 of 01						Rev.	Date
Sheet type 110							
Format A3							
				Cust.ID			

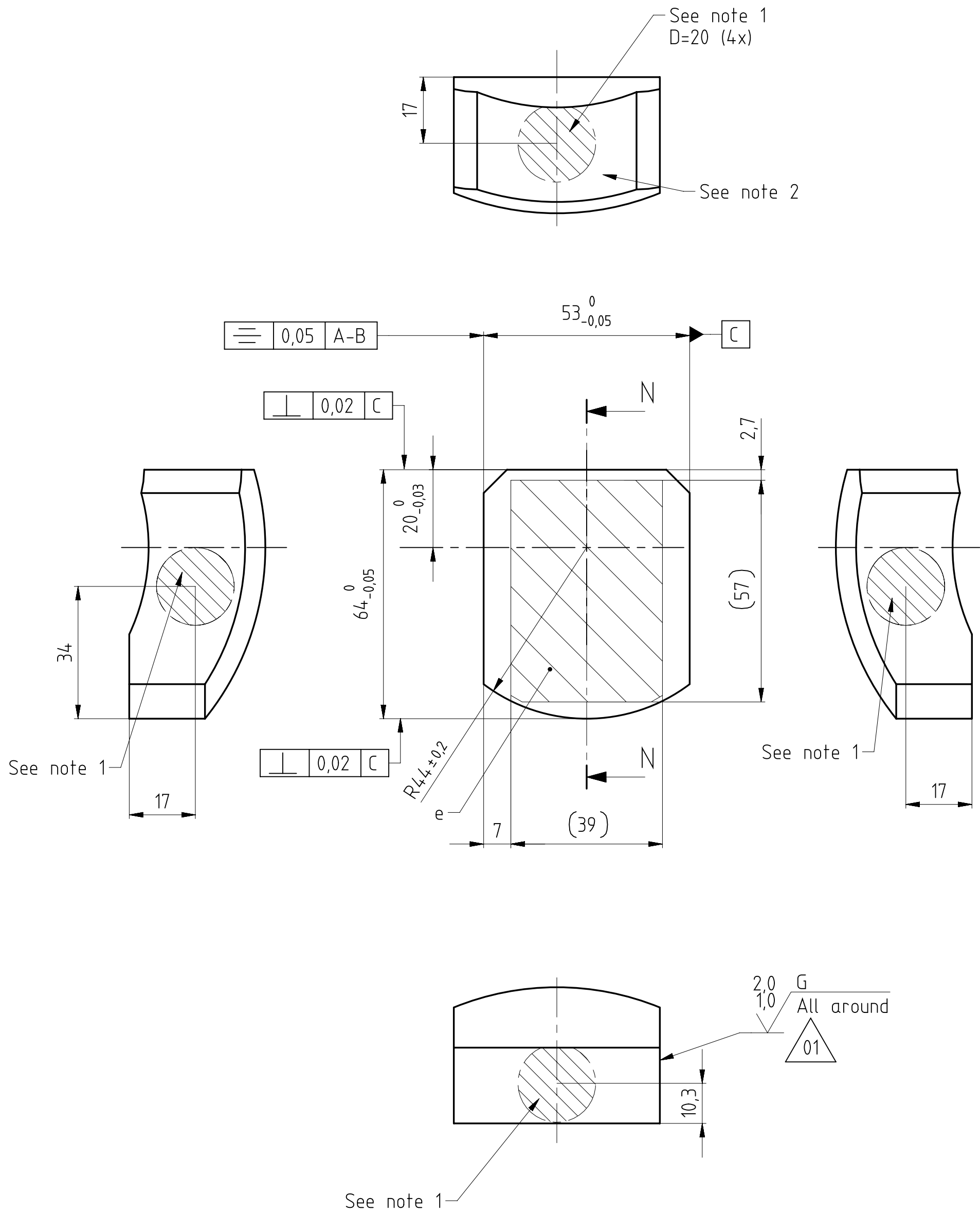
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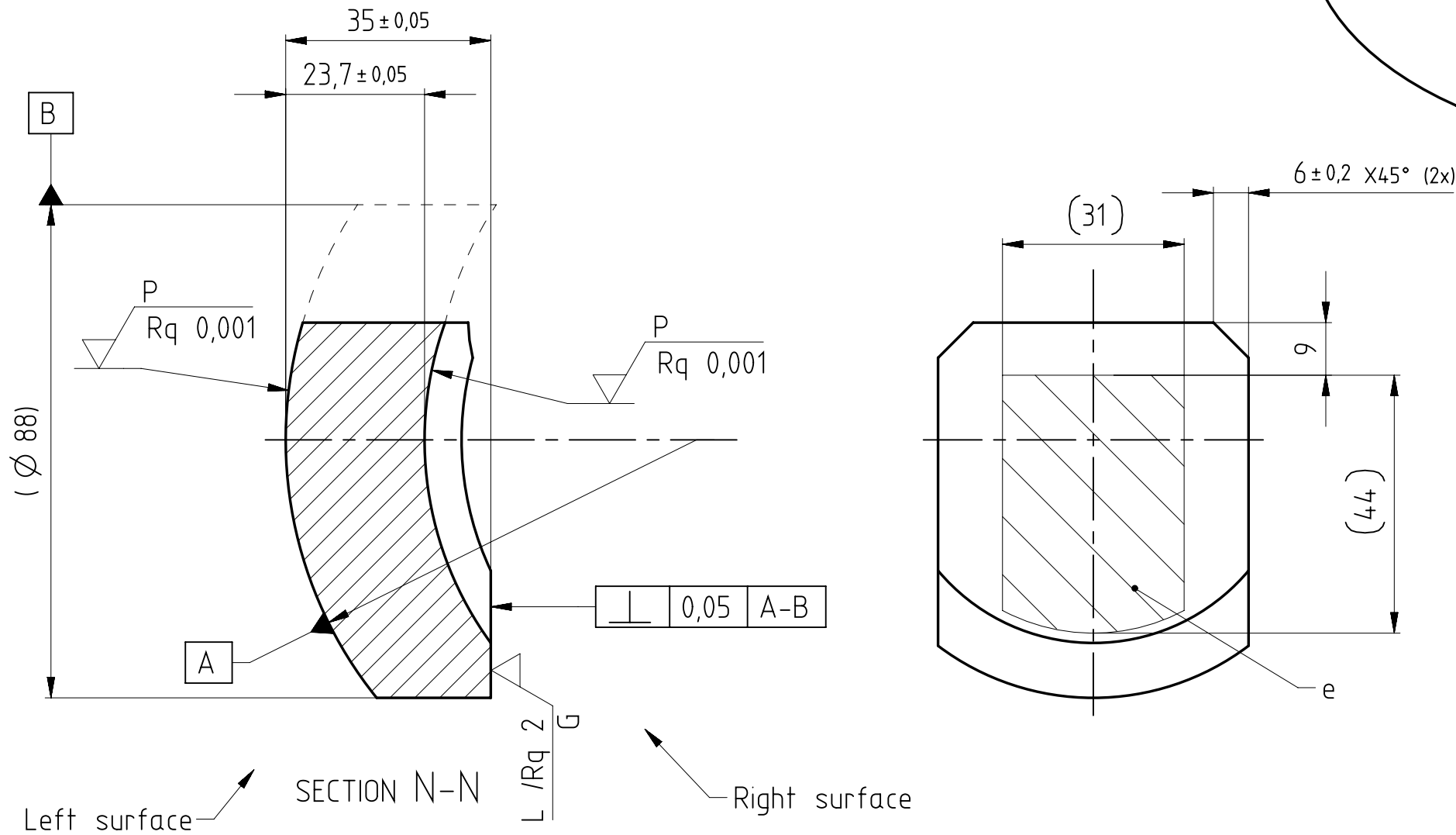
Design key features

- Particular shape: Off centered cut lens

- Low roughness



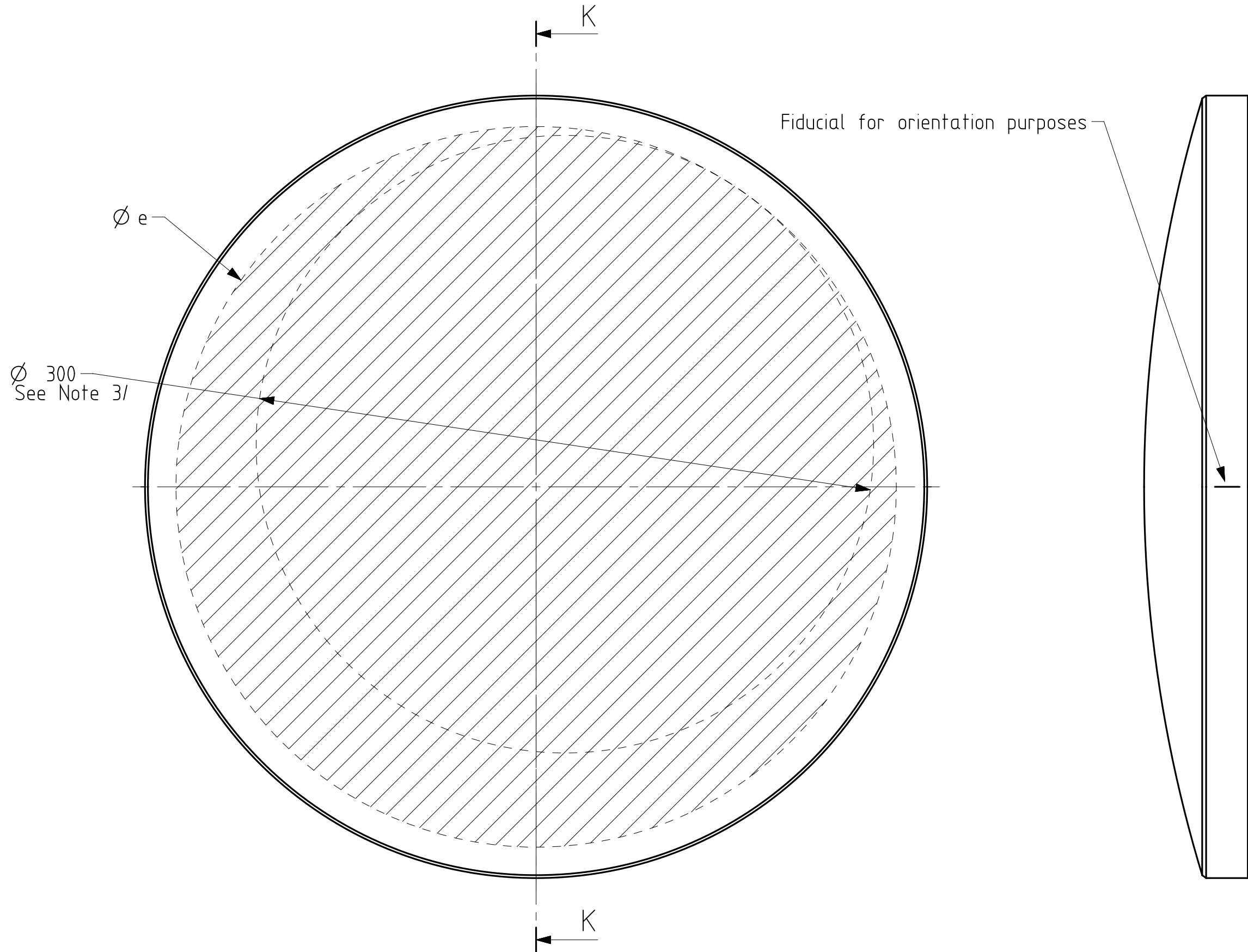
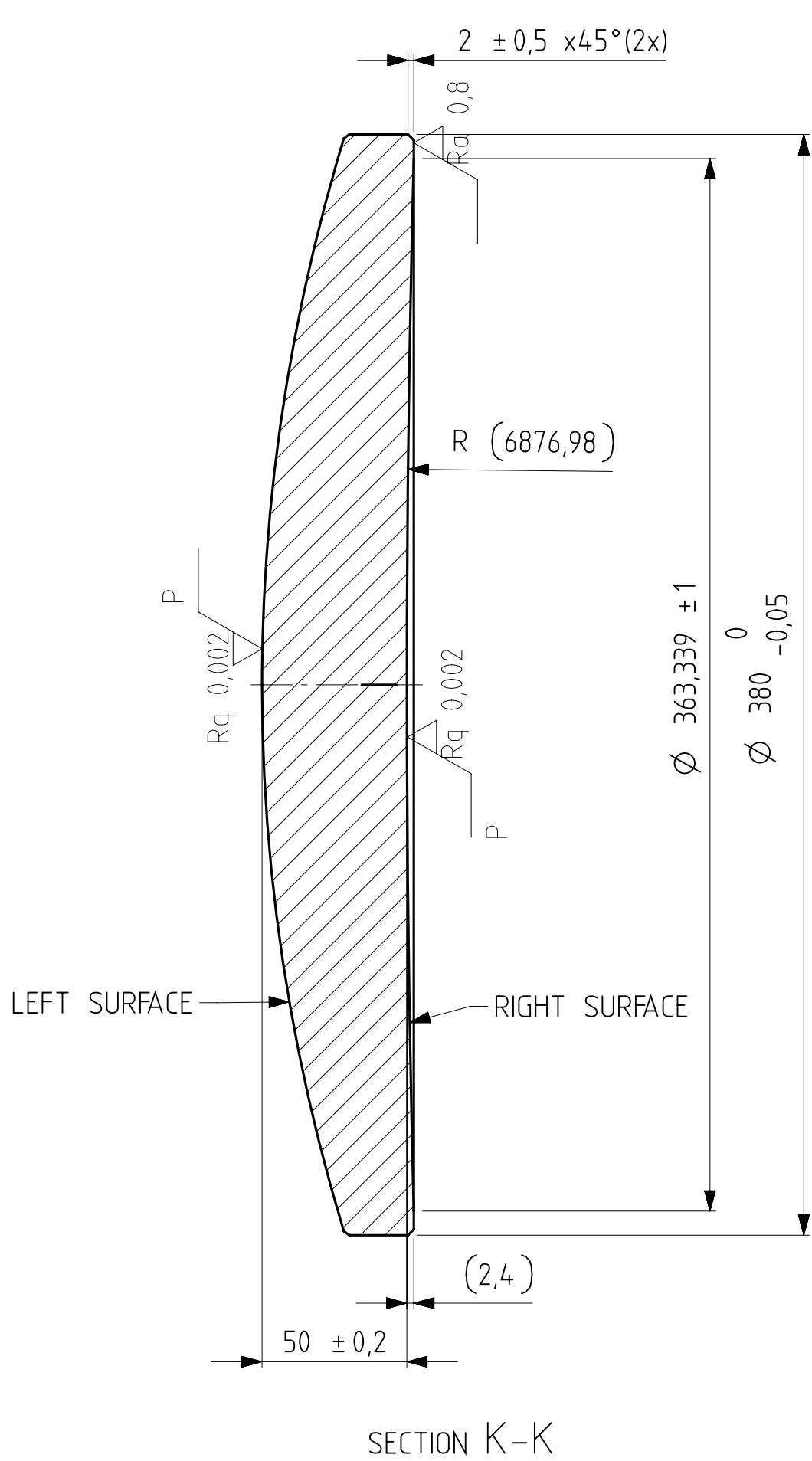
NOTE 1: Glueing area: No number marking allowed
NOTE 2: Mark component with serial number



01		changed roughness changed scratches	
LEFT SURFACE		MATERIAL SPECIFICATION	RIGHT SURFACE
R 70,12292 CX		Fused Silica (SiO ₂)	R 58,73796 CC
e 57 x 39 Protective chamfer: 0,3±0,1		n 1,47012±0,0005 (λ=400nm) v 67,8±0,8%	e 44 x 31 Protective chamfer: 0,3±0,1
λ 3/ 3(1) 4/ - 5/ 3x0.063		0/ 1/ 1x0,08 2/ -,5	λ 3/ 3(1) 4/ 1' A-B 5/ 3x0.063
Indications in accordance with ISO 10110			
TNO innovation for life		General Geometric Tol ISO 2768- K	General Geometric Tol ISO 2768- K
Metric Screw Thread ISO 965 6H/6g		General Tolerances ISO 1101	General Tolerances ISO 1101
Roundings ISO-13715 -0,2 +0,5		Roundings ISO-13715 -0,2 +0,5	Roundings ISO-13715 -0,2 +0,5
Roughness ISO-4287 1,6		Roughness ISO-4287 1,6	Roughness ISO-4287 1,6
Projection ISO 128		Projection ISO 128	Projection ISO 128
Material		Release Status	
SEE TABLE		RELEASED	
Treatment		Project	
Units mm		Part Number	
Scale 1 : 1		Assembly Number	
Sheet 01 of 01		Rev Date	
Sheet type 110		Cust ID	
Format A2			

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ASPHERIC CONSTANTS

$$\text{SAG HEIGHT} = \frac{(1/R) \cdot y^2}{1 + \sqrt{1 - (1+k) \cdot (1/R)^2 \cdot y^2}}$$

y	Sag
0 mm	0 mm
20 mm	0,313822 mm
40 mm	1,255774 mm
60 mm	2,827312 mm
80 mm	5,030881 mm
100 mm	7,869927 mm
120 mm	11,348928 mm
140 mm	15,473427 mm
160 mm	20,250083 mm
175 mm	24,265213 mm

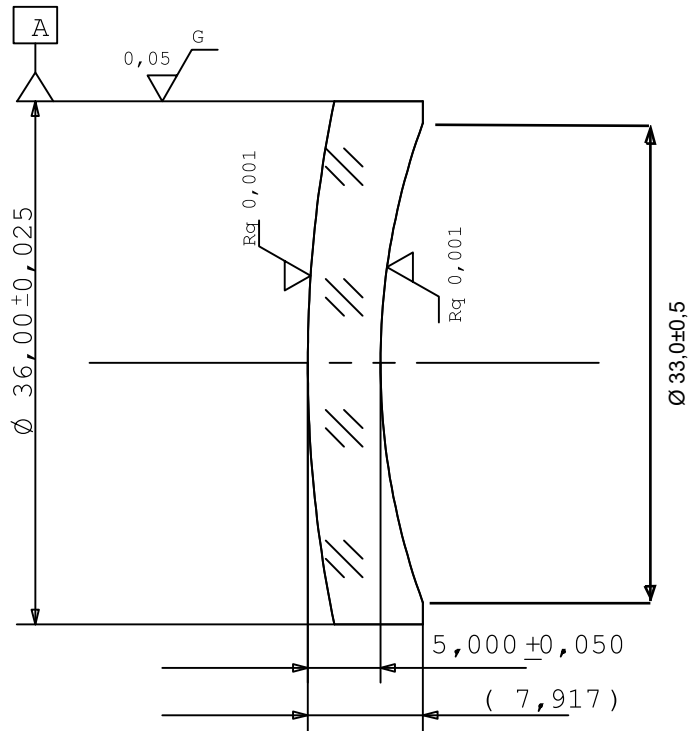
LEFT SURFACE	MATERIAL SPECIFICATION	RIGHT SURFACE
R 637,3855 (Aspheric CX) conic constant k = -0,4776 ϕ_e 350mm λ Uncoated 3/ 8(-) RMSi <40nm; λ = 546,1nm (all ϕ 300mm within ϕ_e) 4/ 1,2 arcmin 5/ 5x0,20; L10x0,04 6/ -	Schott N-BK7 n_d 1,51680 v_d 64,17 0/ 10 1/ 5x0,6 2/ 4 ; 0	R 6876,98 (Spheric CC) ϕ_e 350mm λ Uncoated 3/ 8(-) RMSi <25nm; λ = 546,1nm (all ϕ 300mm within ϕ_e) 4/ - 5/ 5x0,20; L10x0,04 6/ -
Indications in accordance with ISO 10110		

Manufacturing challenges

- Large optic with clear aperture of $\phi 350$ mm
- Fastidious surface inspection

TNO innovation for life		General Geometric Tol	Metric Screw Thread	General Tolerances	Roundings ISO-13715	Roughness ISO-4287	Projection ISO 128
		ISO 2768- K	ISO 965 6H/6g	ISO 1101	-0.2 +0.5	-0.2 +0.5	1,6
Originator: B. Dekker	Material				Release Status		
					Released		
	Treatment				Project		
	Units mm	Part name			Part Number		Assembly Number
	Scale 1 : 1	EXAMPLE: Large Aspheric (Ø380mm)					Rev
Sheet 01 of 01							
Sheet type 110							
Format A2							
				Cust ID			

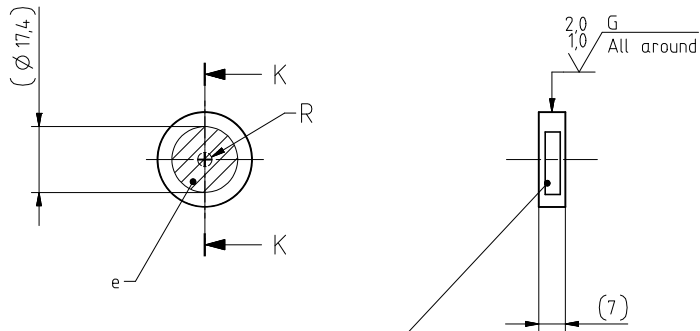
Coating durability
Abrasion: ISO9211-3-1-01
Adhesion: ISO9211-3-2-01
Solvent sol: ISO9211-12-3-01
Damp heat: ISO9211-3-5-07
Temp cycling: ISO9211-3-8-07
Cold: ISO9211-3-6-09
Test matrix to be agreed



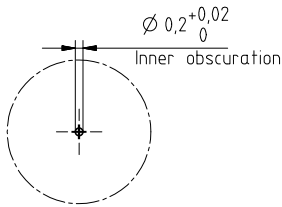
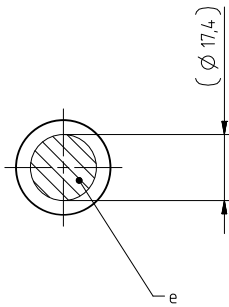
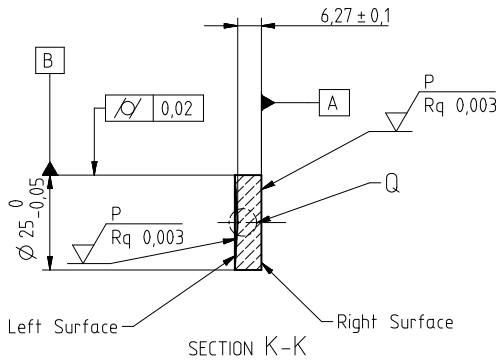
- Lens with spherical convex and concave surfaces
- Coating performance requested for a wide temperature range
- Example of a "standard" custom request

Left surface:		Material specification:		Right surface:	
R 89,6896 (cx) Øe 31,00 3/5(-)RMSi<25nm 4/3,5' 5/2x0,1; L2x0,01 6/- coating: R(532-850nm)<1% bevel: 0,5		GLASS TYPE: NSF57 Ne 1,8550 ±0,005 Ve 23,59±0,5% 0/10 1/2x0,04 2/-;-		R 48,1339 (cc) Øe 31,00 3/5(-)RMSi<25nm 4/- 5/2x0,1; L2x0,01; E0,25 6/- coating: R(532-850nm)<1% bevel: 0,3	
Rev level	Dr.	Date	TNO		
Next assy	Chk	Project:			
Revisions	Eng	Size A		Part: EXAMPLE: Custom Lens + coating	
Ltr descr dt	OA	Scale 2:1	Units=mm		Ind. acc. ISO 10110

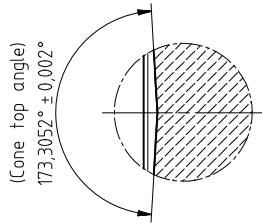
Item	Rev	Name	Revision Description



Add serial no.:
Part's 5 last digits no. - 01xxx-#
is serial no, e.g.: 01, 02, 03, ...



DETAIL R
SCALE 10:1



DETAIL Q
SCALE 5:1

SAG table should be use for control purposes only

r [mm]	Sag [mm]
0	0
2,5	-0,146189
5	-0,292412
7,5	-0,438636
10	-0,584859
12,5	-0,731082



Trimetric View
SCALE 1:1

Manufacturing challenges

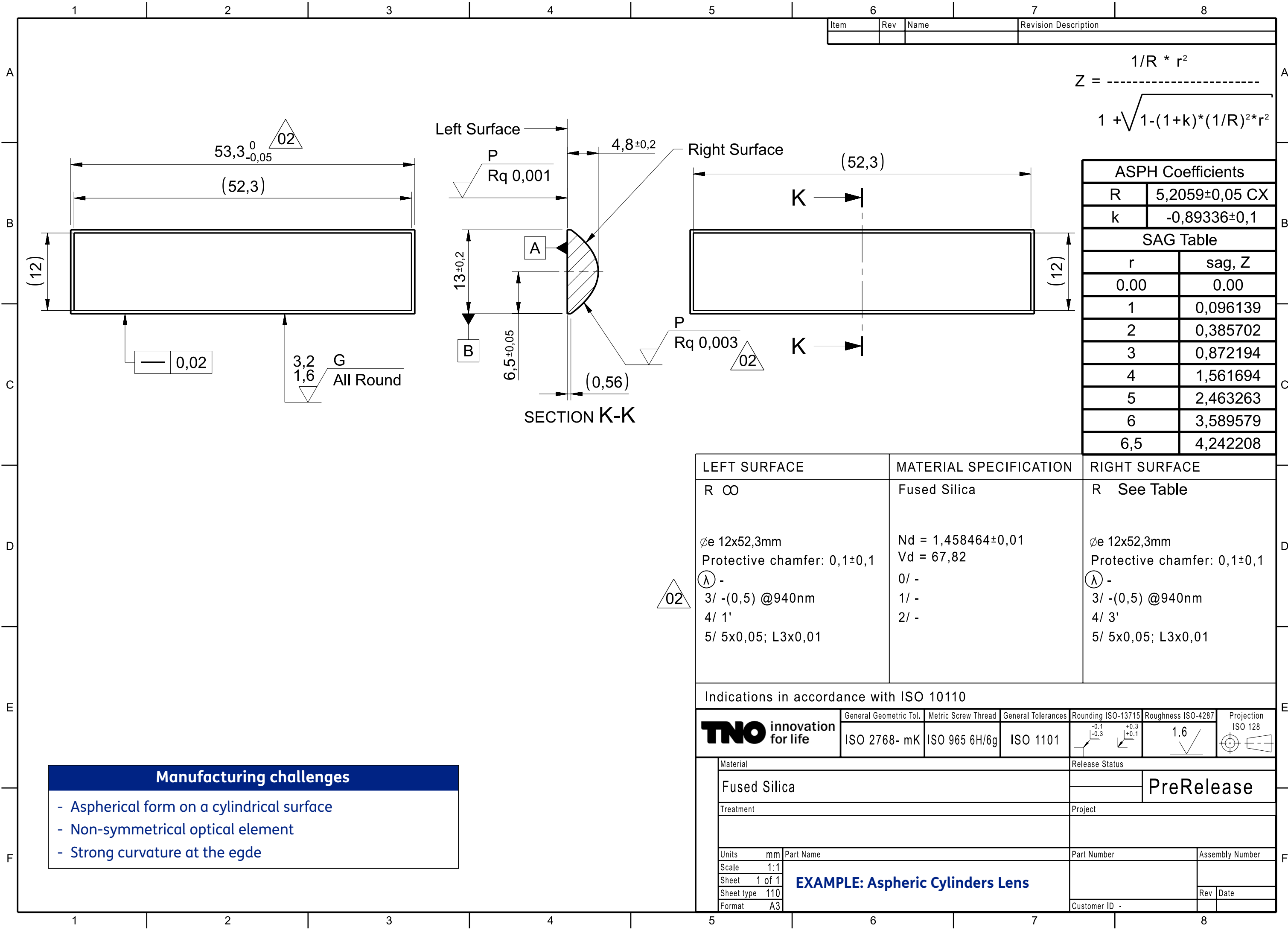
- Cone angle tolerance is strict
- Tolerance on location of tip w.r.t outer diameter is strict
- Transmitted WFE requirement is (very) low
- CaF2 substrate with high purity requirement

LEFT SURFACE	MATERIAL SPECIFICATION	RIGHT SURFACE
Concave cone Inner obscuration=0,2mm Øe 17,4mm Protective chamfer: 0,2±0,1 AR T: > 80% for 633nm AoI: 0-5° 3/ RMSt < 28nm 4/ 0.5mrad (0.05mm) 5/ 3x0.025 / L1x0.001 6/ NA	CaF2 IR-Grade Crystal orientation TBD 0/ 17 1/ 1 x 0,10 2/ 3 ; 4	R ∞ Øe 17,4mm Protective chamfer: 0,2±0,1 AR T: > 80% for 633nm AoI: 0-5° 3/ RMSt < 28nm 4/ 0.5mrad (0.05mm) 5/ 3x0.025 / L1x0.001 6/ NA
Indications in accordance with ISO 10110		
TNO innovation for life		
General Geometric Tol.	Metric Screw Thread	General Tolerances
ISO 2768- fK	ISO 965 6H/6g	ISO 1101
Rounding ISO-13715		
Roughness ISO-4287		
Projection ISO 128		
Release Status		
Project		
Part Number		
Assembly Number		
Rev		
Date		
Customer ID		

EXAMPLE: Concave Axicon

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$$Z = \frac{1/R * r^2}{1 + \sqrt{1 - (1+k) * (1/R)^2 * r^2}}$$

ASPH Coefficients	
R	5,2059±0,05 CX
k	-0,89336±0,1
SAG Table	
r	sag, Z
0.00	0.00
1	0,096139
2	0,385702
3	0,872194
4	1,561694
5	2,463263
6	3,589579
6,5	4,242208

LEFT SURFACE	MATERIAL SPECIFICATION	RIGHT SURFACE
R ∞	Fused Silica	R See Table
∅e 12x52,3mm Protective chamfer: 0,1±0,1	Nd = 1,458464±0,01 Vd = 67,82	∅e 12x52,3mm Protective chamfer: 0,1±0,1
⊙ - 3/ -(0,5) @940nm 4/ 1' 5/ 5x0,05; L3x0,01	0/ - 1/ - 2/ -	⊙ - 3/ -(0,5) @940nm 4/ 3' 5/ 5x0,05; L3x0,01

Indications in accordance with ISO 10110

TNO innovation for life	General Geometric Tol.	Metric Screw Thread	General Tolerances	Rounding ISO-13715	Roughness ISO-4287	Projection ISO 128		
	ISO 2768- mK	ISO 965 6H/6g	ISO 1101					
Material	Fused Silica			Release Status				
						PreRelease		
	Treatment			Project				
	Units	mm	Part Name		Part Number		Assembly Number	
	Scale	1:1						
	Sheet	1 of 1						
	Sheet type	110						
Format	A3							
EXAMPLE: Aspheric Cylinders Lens				Customer ID -		Rev	Date	

Manufacturing challenges

- Aspherical form on a cylindrical surface
- Non-symmetrical optical element
- Strong curvature at the egde