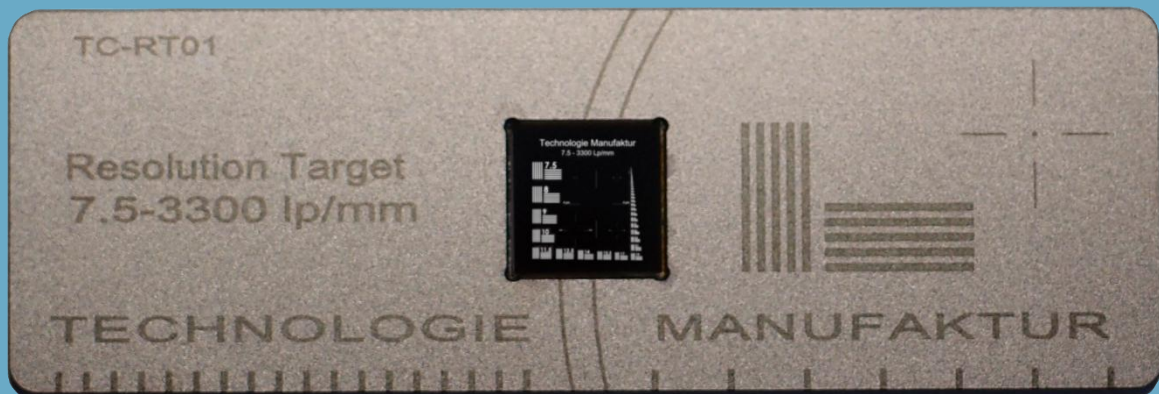


TECHNOLOGIE

MANUFAKTUR



# Resolution test targets for microscopy

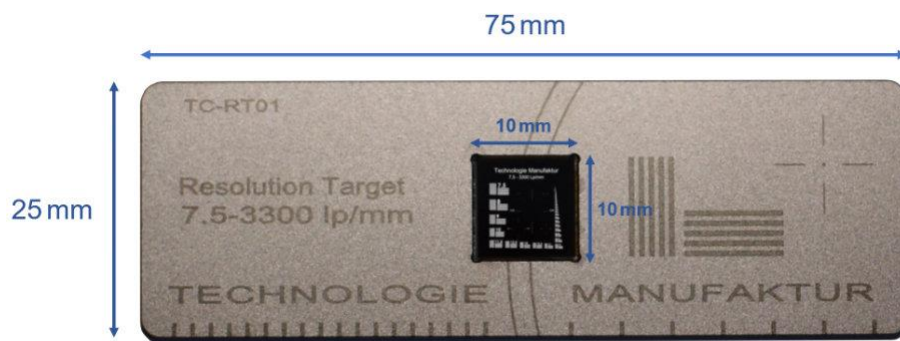


## Resolution test targets for high-end microscope lenses

All of our resolution test targets are made with high-precision e-beam lithography. The 10 x 10 mm<sup>2</sup> substrate consists of quartz, offering very broad spectral transmission (DUV-VIS-NIR). A chromium layer with high optical density is applied to the substrate.

The test structures are produced by ablation of the chromium layer, whereby structural sizes down to 100 nm are possible as a result of the e-beam process. At the same time, excellent dimensional tolerances and straightness of the structural edges are ensured. Through ablation of the chromium layer, the structures of the test slide are transparent, while the background is blocked by the remaining chromium layer.

The resolution test targets are embedded in a robust stainless-steel support with a standard size of 75x25 mm<sup>2</sup>. For use with a microscope objective a version is available with a 0.17 mm cover glass.

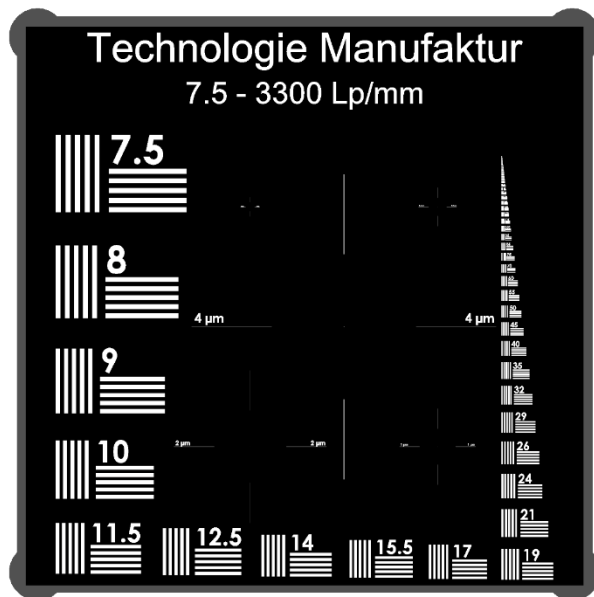


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## Resolution Target TC-RT01

Test target with 7.5 - 3300 line pairs per mm and Pinholes from 4  $\mu\text{m}$  to 0.25  $\mu\text{m}$

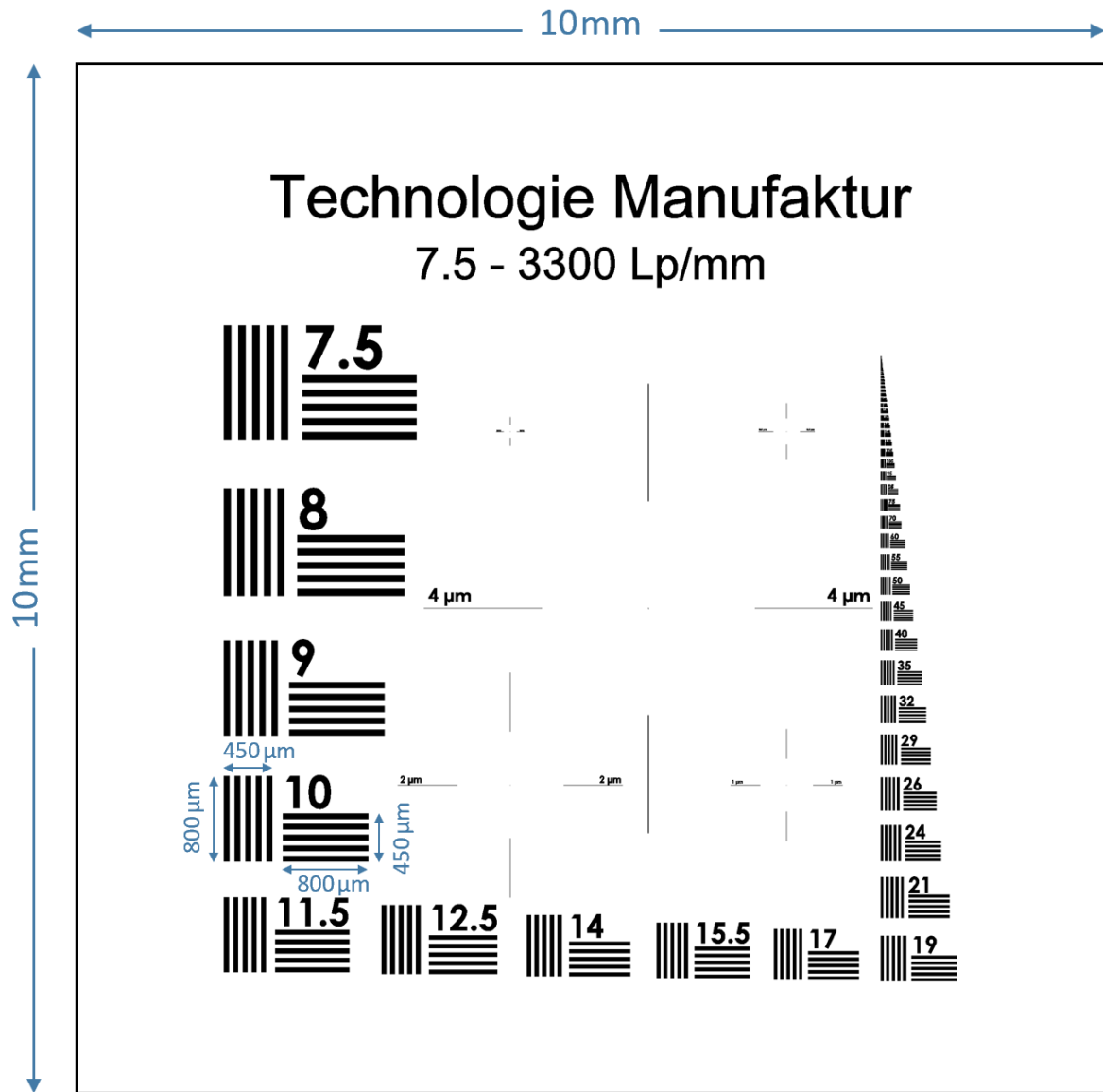


With this resolution test target, the resolution limit of an objective can be determined very easily and quickly in transmitted light. There are 58 line patterns with 7.5 to 3300 line pairs per mm in horizontal and vertical alignment. The simple arrangement of the structures and direct reading of the structure size on the test ensures intuitive handling. In addition, there are 5 pinholes with diameters between 4.0  $\mu\text{m}$  and 0.25  $\mu\text{m}$  to allow a more detailed characterization of micro-imaging optics. The structures are implemented as negative, i.e. only the structures are transparent, the background is blocked by a chrome layer.

### Specification:

Substrate	Quartz wafer (fused silica), 10 mm x 10 mm x 1 mm (layout see next page)
Substrate holder	Microscope slide format 75 mm x 25 mm x 1.5 mm, Stainless steel with laser engraving
Patterned layer	Chrome, optical density OD > 8@400 nm / 6@550 nm / 4.5@750 nm / 3.6@1 $\mu\text{m}$
Line patterns	58 groups, 7.5 – 3300 lp/mm (line widths 66.7 $\mu\text{m}$ – 0.152 $\mu\text{m}$ , see table on next page)
Pinholes (diameter)	4 $\mu\text{m}$ , 2 $\mu\text{m}$ , 1 $\mu\text{m}$ , 0.5 $\mu\text{m}$ , 0.25 $\mu\text{m}$
Dimensional tolerance (max. absolute error)	100 nm/cm = 10 <sup>-5</sup>
Spectral transmission range	200 nm – 2000 nm
Cover Glass (optional)	0.17 mm optical thickness

### Resolution test target layout



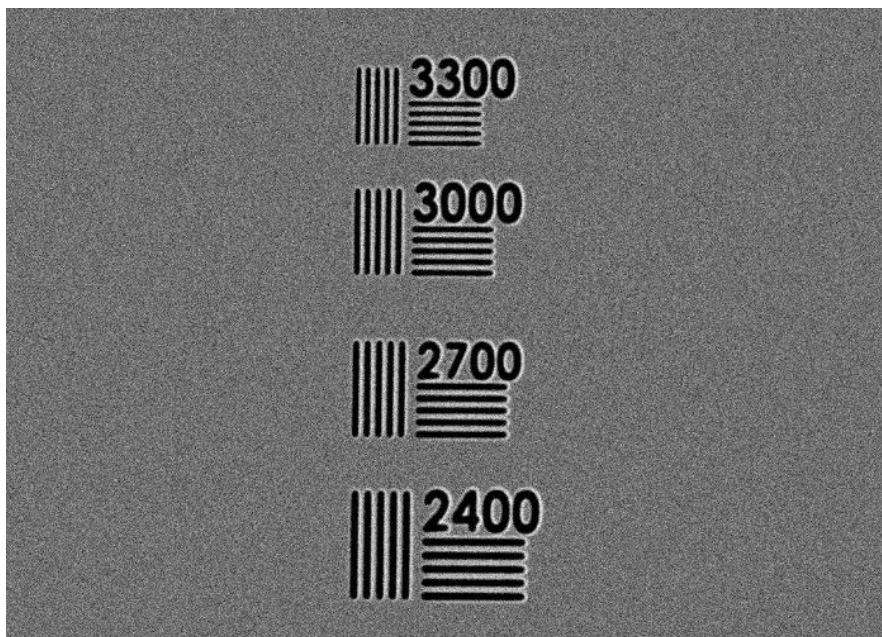
Line pattern groups (each of 5 lines horizontal & vertical) Line pairs/mm:

7.5	8	9	10	11.5	12.5	14	15.5	17	19	21	24	26	29	32
35	40	45	50	55	60	70	75	85	95	105	115	130	140	160
170	190	220	240	270	300	330	360	400	450	500	550	600	700	850
950	1050	1150	1300	1400	1600	1800	2000	2200	2400	2700	3000	3300		

## Dimensions of pinholes aiming lines

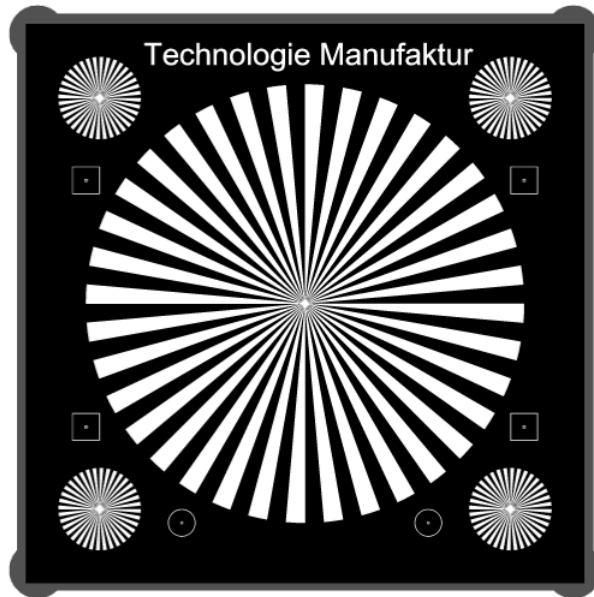
pinhole	line length	line width
4 $\mu\text{m}$	1100.00 $\mu\text{m}$	1.00 $\mu\text{m}$
2 $\mu\text{m}$	550.00 $\mu\text{m}$	0.50 $\mu\text{m}$
1 $\mu\text{m}$	275.00 $\mu\text{m}$	0.25 $\mu\text{m}$
0.5 $\mu\text{m}$	137.50 $\mu\text{m}$	0.25 $\mu\text{m}$
0.25 $\mu\text{m}$	68.75 $\mu\text{m}$	0.25 $\mu\text{m}$

## Electron microscopy micrograph of the finest resolution patterns



## Siemens Star TC-RT02

### Resolution test target with very high precision



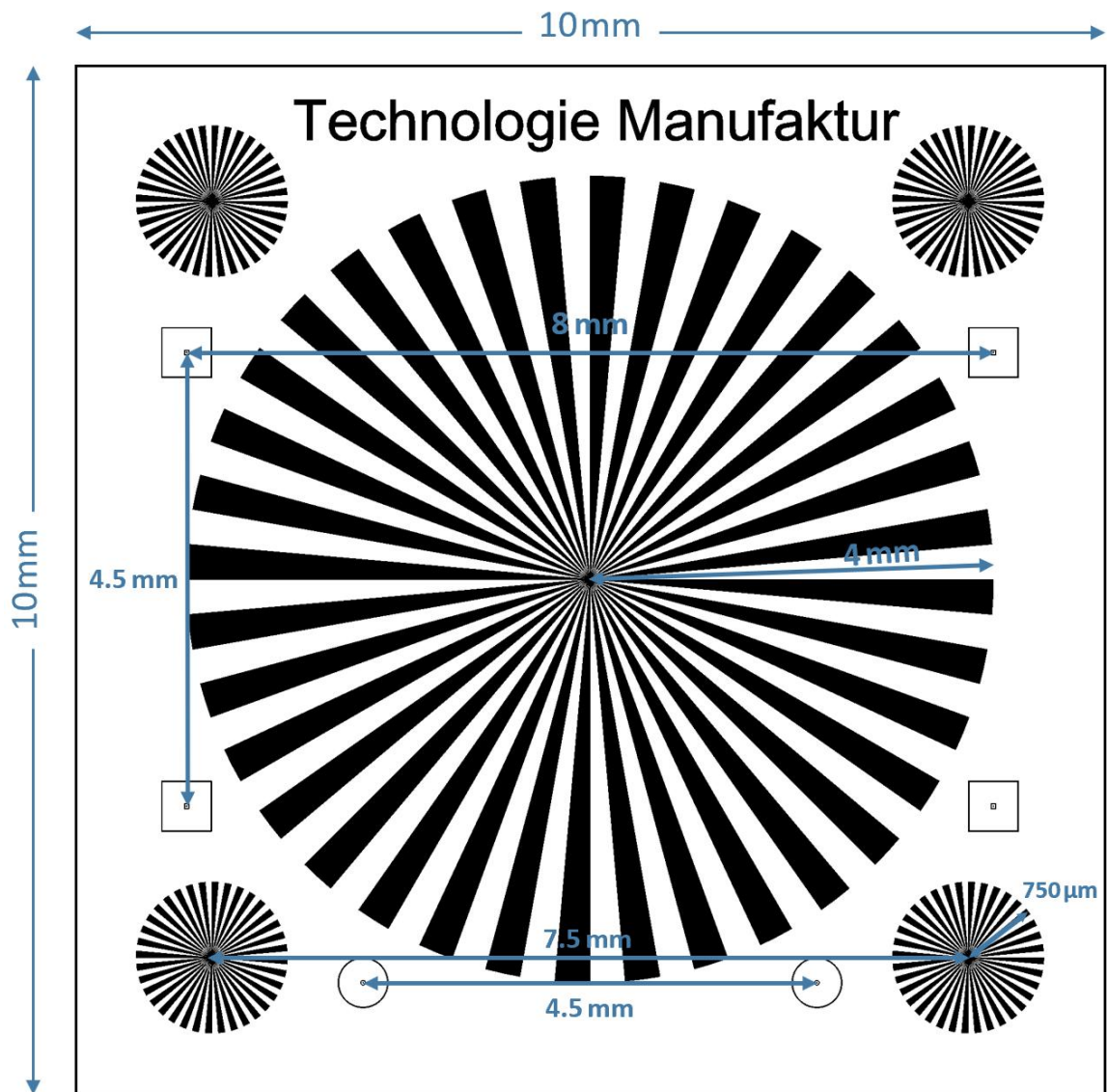
This resolution test consists of 5 Siemens stars and shows the peculiarity that the tapered segments in the center of the stars are precisely manufactured to a minimum width of 150 nm. Thus, this test target is also suitable for the determination of the resolution of microscope objectives of very high numerical aperture.

Additional measuring and positioning marks facilitate the adjustment. The pattern is "negative", i.e. the Siemens stars are transparent.

### Specification:

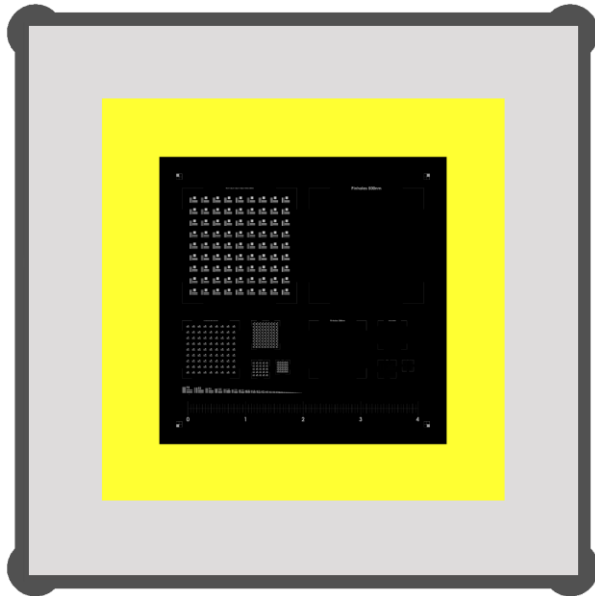
<b>Substrate</b>	Quartz wafer (fused silica), 10 mm x 10 mm x 1 mm (layout see next page)
<b>Substrate holder</b>	Microscope slide format 75 mm x 25 mm x 1.5 mm, Stainless steel with laser engraving
<b>Patterned layer</b>	Chrome, optical density OD > 8@400 nm / 6@550 nm / 4.5@750 nm / 3.6@1 μm
<b>Pattern</b>	1 central Siemens star with 36 segment pairs (diameter 8mm) 4 small Siemens stars with 36 segment pairs each (diameter 1.5mm) 6 measuring marks
<b>Dimensional tolerance (max. absolute error)</b>	100 nm/cm = 10 <sup>-5</sup>
<b>Spectral transmission range</b>	200 nm – 2000 nm
<b>Cover Glass (optional)</b>	0.17 mm optical thickness

## Siemens star test target layout



## Fluorescent Resolution Chart TC-RT03fl

Fluorescent resolution test target with up to 5000 lines per millimeter



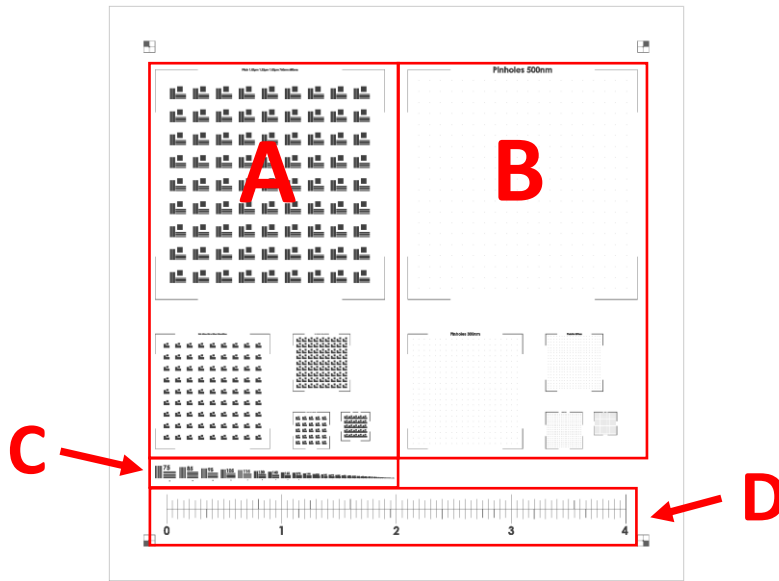
With this fluorescent ultra-high-resolution test chart the resolution limit and MTF of high-end microscope objective lenses can be determined over the full field of view. Line patterns with a pitch down to 200nm (5000 line pairs per mm) in horizontal and vertical alignment make it possible to access the resolution limit of the best available oil immersion objectives. Pinholes are arranged on grids covering the fields of 10x, 20x, 40x, 63x and 100x objective lenses. The structures of the test chart are produced on a high precision cover glass with thickness 0.17mm +/- 5µm cemented onto a transparent fluorescent substrate. Hence the test slide can be used in fluorescence and brightfield mode or with a laser scanning microscope. The structures are implemented as

negative, i.e. only the structures are transparent while the background is blocked by a chrome layer. There is also a version available for objective lenses that do not require a cover glass, TC-RT03 without "fl" for "fluorescent".

### Specification:

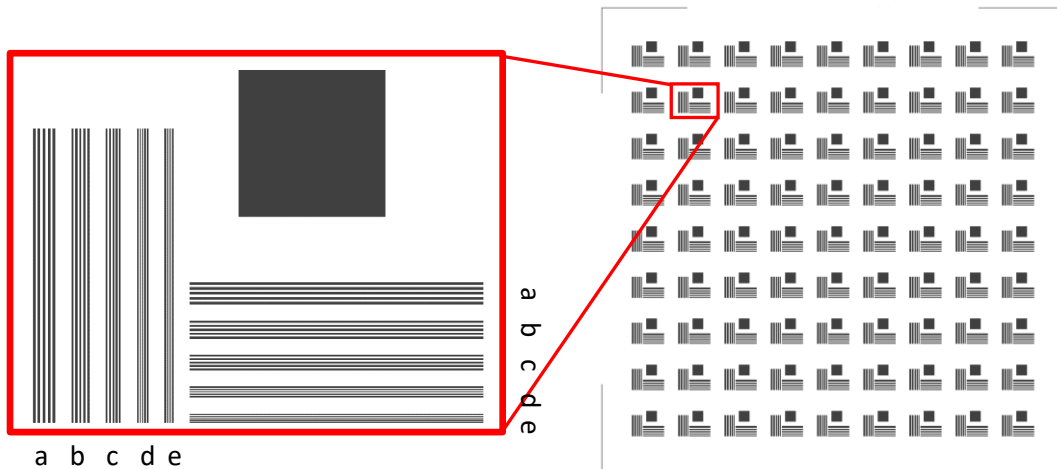
<b>Substrate</b>	Cover glass (D263 Schott), 5 mm x 5 mm x 0.17 mm on a fluorescent substrate 7 mm x 7 mm x 0.2 mm on a glass plate, 10 mm x 10 mm x 1 mm (layout see next page)
<b>Fluorescent substrate</b>	YAG:Ce crystal, no bleaching Excitation 420 – 520nm, Emission 500 – 700nm
<b>Substrate holder</b>	Microscope slide format 75 mm x 25 mm x 1.5 mm, Stainless steel with laser engraving
<b>Patterned layer</b>	Chrome, thickness 100 nm
<b>Line patterns</b>	41 groups, 75 – 5000 lp/mm
<b>Pinholes (diameter)</b>	500 nm, 400 nm, 320 nm
<b>Spectral transmission range</b>	310 nm – 2000 nm

Resolution test chart layout:



Area A:

Five areas with squares for slanted-edge MTF. Sizes of the areas match the field size of 10x, 20x, 40x, 63x and 100x microscope objective lenses. There are supplementary ultra-fine structures in some areas with pitches that are at or below the current limits of the manufacturing process. These structures may not be cleanly etched, incomplete, or covered with debris. We do not guarantee any specs for these structures.



	10x	20x	40x	63x	100x
Field size	2x2mm <sup>2</sup>	1x1mm <sup>2</sup>	0.5x0.5mm <sup>2</sup>	0.32x0.32mm <sup>2</sup>	0.25x0.25mm <sup>2</sup>
a Line Pitch*	1520nm	460nm	320nm	300nm	280nm
b Line Pitch*	1220nm	420nm	300nm	280nm	260nm
c Line Pitch*	1020nm	380nm	280nm	260nm	240nm
d Line Pitch*	760nm	340nm	260nm	240nm	220nm
e Line Pitch*	600nm	300nm	240nm	220nm	200nm

\*Specifications not guaranteed for these line structures

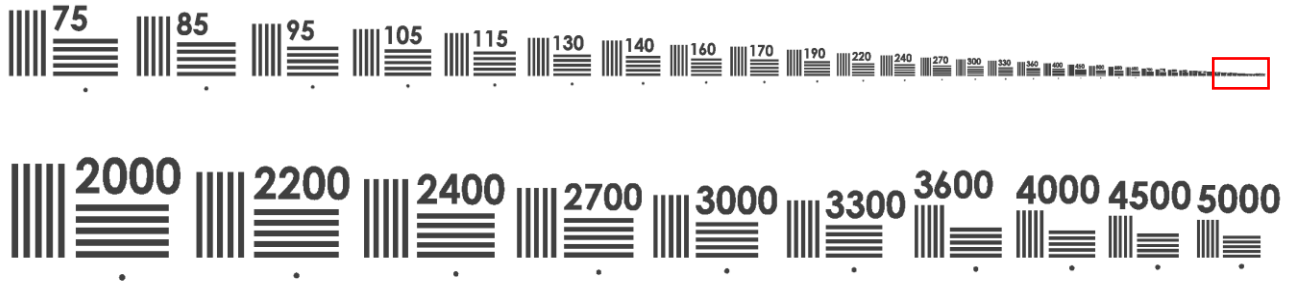
### Area B:

Five areas with 20x20 pinholes. Sizes of the areas again match the field size of 10x, 20x, 40x, 63x and 100x microscope objective lenses.

	10x	20x	40x	63x	100x
Field size	2x2mm <sup>2</sup>	1x1mm <sup>2</sup>	0.5x0.5mm <sup>2</sup>	0.32x0.32mm <sup>2</sup>	0.25x0.25mm <sup>2</sup>
Pinhole diameter	500nm	400nm	320nm	320nm	320nm

### Area C:

Line pattern groups (each of 5 lines horizontal & vertical) and a pinhole with a diameter matching the line width, but not smaller than 320nm.

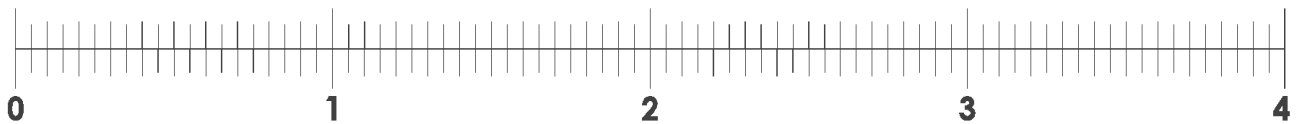


### Line pairs/mm:

75	85	95	105	115	130	140	160	170	190	220	240	270	300	330
360	400	450	500	550	600	700	770	850	950	1050	1150	1300	1400	1600
1800	2000	2200	2400	2700	3000	3300	3600	4000	4500	5000				

### Area D:

High precision scale of 4 mm length.

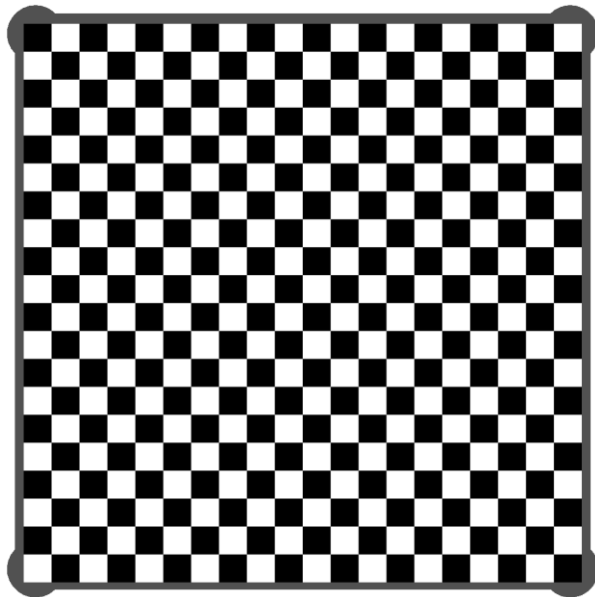


## Resolution Chart TC-RT03mat (no cover glass)

Specifications same as TC-RT03 but without cover glass and fluorescent substrate.

## Checkerboard pattern TC-CB50

Checkerboard of 50x50  $\mu\text{m}^2$  squares



A checkerboard with a total size of 9.0 x 9.0 mm<sup>2</sup> out of 50 x 50  $\mu\text{m}^2$  squares. It is particularly suitable for testing of image skew and curvature. The edges are extremely straight and sharp and therefore allow determination of local image quality as well.

(figure schematically)

### Specifications:

<b>Substrate</b>	Quartz wafer (fused silica), 10 mm x 10 mm x 1 mm
<b>Substrate holder</b>	Microscope slide format 75 mm x 25 mm x 1.5 mm, Stainless steel with laser engraving
<b>Patterned layer</b>	Chrome, optical density OD > 8@400 nm / 6@550 nm / 4.5@750 nm / 3.6@1 $\mu\text{m}$
<b>Pattern</b>	Checkerboard 9.0x9.0 mm <sup>2</sup> of 180x180 squares of 50x50 $\mu\text{m}^2$ size
<b>Dimensional tolerance (max. absolute error)</b>	100 nm/cm = 10 <sup>-5</sup>
<b>Spectral transmission range</b>	200 nm – 2000 nm
<b>Cover Glass (optional)</b>	0.17 mm optical thickness

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