Zeiss Microscope Optics

The essence of superb optical performance

ZEISS

West Germany

Optics is not only an exact science, it is also a highly challenging art. So is the manufacturing of optical systems and microscopes. And so is, for that matter, microscopy itself, as any dedicated and successful microscopist will confirm.

This brochure is intended to acquaint users of Zeiss microscopes with the vast choice and options available to them to equip their instruments so as to obtain maximum performance tailored to their specific tasks. It is also to assist future users, who are looking for quality, versatility, and durability that come with Zeiss, in their choice of just the right optical systems for them.

Our nationwide sales and service organization of engineers stands ready to analyze your needs and make knowledgeable recommendations. We suggest that you avail yourself of this service. It is free and may help you improve the results you can achieve and save you valuable time. It's like buying a Steinway. You are sure that you get all the know-how and quality available in piano building, but even the most talented pianist needs coaching and practice to bring out the full richness and shading of sound the instrument is capable of producing, the infinite nuances that make the difference.

When Dr. Ernst Abbe, the founder of the Carl Zeiss Foundation, applied for the first time, in 1872, his newly established scientific formulae to the already then quite accomplished art of microscope making at Zeiss, he virtually launched the optical industry. Ever since, Zeiss has continued researching the rather esoteric science of optics, and our engineers have always pushed the perfection of optical systems to the limits of the laws of physics. With advancing technology and the introduction of new materials there has been an ongoing interaction at Zeiss between scientific know-how, utmost mechanical precision, and the development of the art and skills of craftsmanship. As a result, the latest findings have again and again been translated into optical systems and microscopes that have set the standard for the entire industry and, importantly, have kept Zeiss instruments always up to the state of the art.

At Zeiss it was also recognized very early on that, with the expanding use of microscopy and the increasing sophistication in many applications, optical systems and microscopes would have to meet vastly differing requirements. The logical consequence was the modular-design approach for the entire line of microscopes, permitting the exchange and interchange of components without compromising performance or sacrificing quality and, again important for the user, eliminate obsolescence. Of course, the ready and easy interchangeability of parts by the user is possible only through highly refined mechanics and precision engineering. Components snap right into place, they move with unequaled smoothness, without friction, and resist wear and tear during heavy use year-in year-out. Exchanged optical parts, for example, are automatically parfocal and precentered in all the widely used instrument configurations.

And there is another payoff in the modular design, a benefit no other microscope manufacturer can claim: For more than three decades Zeiss objectives, eyepieces, and condensers have remained fully exchangeable. In other words, it is possible to take, let's say, a 1951 model microscope and do IR microscopy, micro-photometry, image analysis, and everything else in-between by attaching or connecting the latest accessories. This unique capability defies the notion that Zeiss is expensive. In fact, in the long run it is highly economical, because we guarantee

Quality
Versatility
Durability.

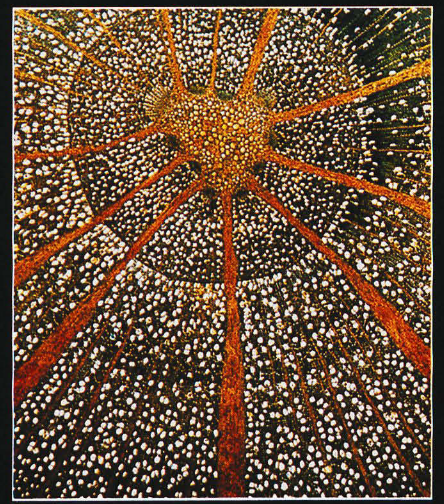
Another important advantage which deserves to be borne in mind is that from the very beginning Zeiss has had access to the best optical glass in the world. It is supplied by the sister company, the Schott Glassworks, which also belongs to the Carl Zeiss Foundation. Zeiss optical systems maintain their quality and clarity, even under adverse climatic conditions (the off-the-shelf lenses which took the photographs in the hard vacuum of the moon and in outer space attest to that), and our design engineers have never shied away from using glass types containing the most intractable substances if it meant superior optical results and durability.

Zeiss systems give you the assurance of consistency of quality in every product. A consistency that results from a long tradition which has produced innumerable breakthroughs and innovations for the benefit of users and, for that matter, for the entire optical industry.

Steel
hardened in highly overheated state.
Nomarski Differential Interference Contrast.
Instrument: Zeiss AXIOMAT (upright version)
Objective: Epiplanachromat 100x/1.30 Oil HD Pol
Magnification on film: 1000x • Agfachrome 50 L 4x5"
Specimen preparation and photography: G. Wilpert, Carl Zeiss, Oberkochen

Bull sperm

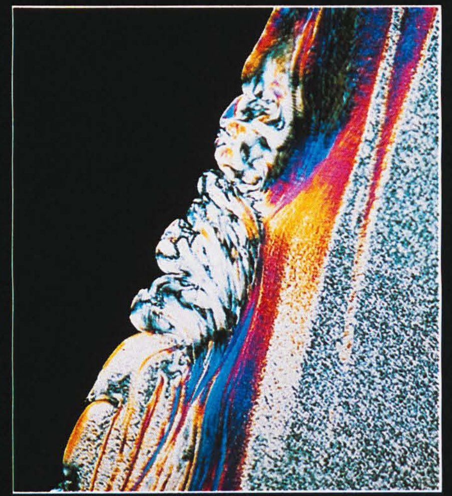
Instrument: Zeiss Standard Microscope 14 with MC 63 Attachment Camera
Objective: Planapochromat 100x
Magnification on film: 400x
Specimen: J.A. Kraan, Carl Zeiss, Zurich



Fagus (Beech), several years growth, cross section

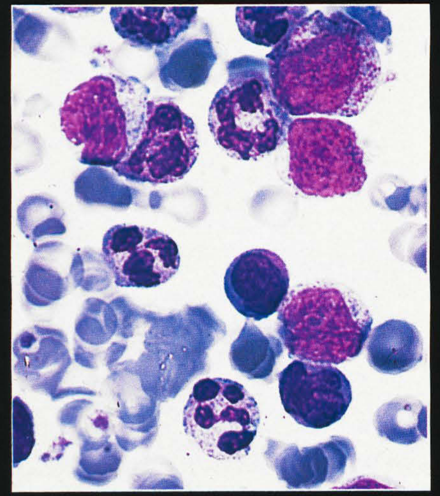
Instrument: Zeiss Standard Microscope 14 with Attachment Camera MC 63
Objective: Planapochromat 6.3x • Magnification 24x
Specimen: JA Kraan, Carl Zeiss, Zurich

Stem of nyphea alba, cross section
Instrument: Zeiss Universal Microscope with Attachment Camera MC 63, Polarized light
Objective: Planapochromat 10/0.32
Magnification on film: 32x • Agfachrome 50 L 10x12
Preparation: Neureuther, Grossmehring
Photography: Carl Zeiss, Oberkochen



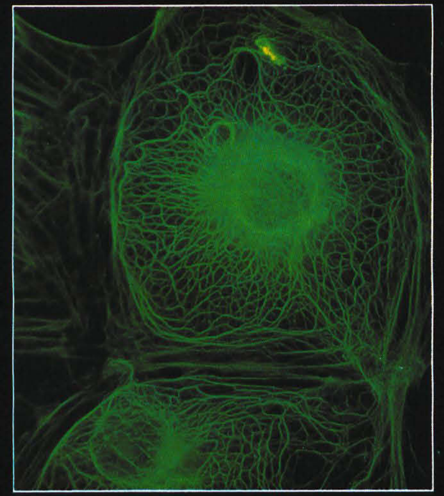
Plastic material

Instrument: Zeiss Standard Microscope with Attachment Camera MC 63
Objective: Planapochromat 10/0.32; polarized light
Magnification on film: 25x • Kodak S° AFFTY film 4x5"
Preparation: Technical University Aalen
Photography: J. Tuente, Carl Zeiss, Oberkochen



Human blood, myological leukemia

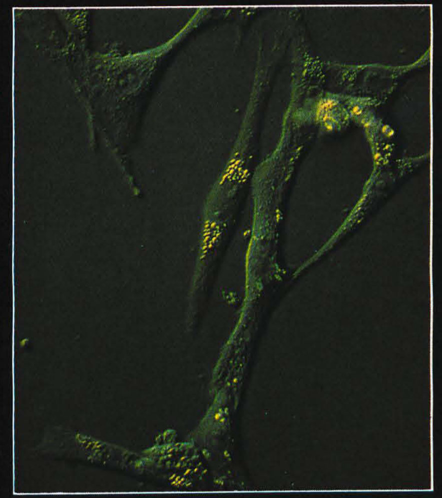
Instrument: Zeiss Standard Microscope 14 with MC 63 Attachment Camera
Objective: Planapochromat 100x
Magnification on film: 400x
Specimen : J.A. Kraan, Carl Zeiss, Zurich



Indirect Immunofluorescence with FITC

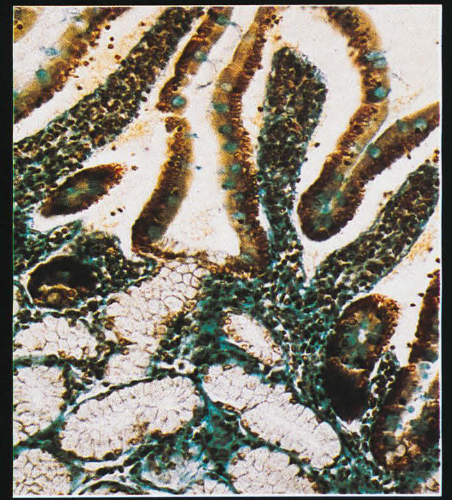
Indirect immunofluorescence with FITC which makes visible the complex cytoplasmatic structure of the tonofilament-like fibres (prekeratin) in epithelial cells of a kangaroo rat (potorus tridactylis) in culture (Pt K_2).

Instrument: Photomicroscope III equipped with incident-light fluorescence condenser III RS
Objective: Planapochromat 63/1.4 oil
Magnification on film 250x • High-speed Kodak Ektachrome
Preparation: Dr. K. Weber, Professor for biophysical chemistry, Max Plank Institute, Goettingen



Cultured myocardial cells of embryonic chicken hearts

Instrument: Zeiss AXIOMAT (Inverted-transmitted-light version)
Nomarski differential interference contrast
Objective: Planapochromat 25/0.65
Magnification on film: 125x
Preparation: Professor H. Tritthart MD, Dr. B. Koidl, Institute for medical physics and biophysics, University, Graz
Photography: Dr. Gundlach, Carl Zeiss, Oberkochen



Human Pylorus, Hopa stain

Instrument: Zeiss Axiomat
Objective: Planapochromat 25/0.65
Pancratic condenser 0.8
Magnification on film: 200x • Agfachrome 50 L
Specimen: Professor Hermann, MD, Dept. of Anatomy, University Ulm
Photography: Dr. H. Gundlach, Carl Zeiss, Oberkochen

Martensite in Austenite 150 Cr6

Hardened in highly overheated state. Nomarski Differential Interference Contrast.
Instrument: Zeiss AXIOMAT (upright version)
Objective: Epiplanachromat 50x/0.95 HD Pol
Magnification on film: 500x • Agfachrome 50 L 10x12
Preparation and photography: G. Wilpert, Carl Zeiss, Inc.

Zeiss firsts

The following list of Zeiss firsts may convey an idea of the scope of Zeiss' pioneering contribution:

1872 For the first time microscope systems are built on a scientific basis using Professor Ernst Abbe's mathematical formulae and producing pre-calculated results of consistently good image quality.
This major breakthrough put an end to the trial-and-error method for all times.
The Abbe condenser is introduced.

1878 The first homogeneous oil immersion objectives.

1886 The first APOCHROMAT objectives which eliminate spherical and chromatic aberration to an extent unknown before. Their design principle is valid to this day, and the name APOCHROMAT, coined by Ernst Abbe, has become a generic term accepted throughout the optical industry.

1893 Koehler illumination is introduced by Professor August Koehler, a staff scientist at Zeiss. It is still the standard in the industry for optimal utilization of the microscope's performance capability.

1897 The first microscope for 3-D viewing offered by Zeiss – the very first stereomicroscope (Greenough system).

1911 Zeiss parfocal and parcentered objectives. Parfocality and parcentration are achieved to such close tolerances that, even at highest magnifications, objectives can be exchanged without losing focus and object field.

1925 Zeiss introduces binocular observation tubes with constant tube length (after Siedentopf).

1936 Phase contrast optics first introduced by Zeiss. Still indispensable today for the study of live specimens.

1942 The first antireflexion coatings of all lens-to-air surfaces within a lens system were invented at Zeiss. This innovation resulted in a substantial increase in light transmission in optical systems and greater contrast in the image.

1946 Zeiss introduces a second stereomicroscope design (the telescope-type). These stereomicroscopes accept attachments for photomicrography, drawing, dual observation, and others.

1952 The first stereoscopic surgical microscope introduced by Zeiss. First used for microsurgical interventions on the inner ear, it gave rise to the development of new surgical techniques by surgeons the world over and in many other disciplines. There is no major hospital anywhere today without one or several operation microscopes.

1955 Zeiss introduces the first microscopes with built-in automatic camera systems (Photomicroscope for 35mm and Ultraphot for large-format and 35mm photography).

1958 The first fully automatic attachment camera offered as an accessory to the entire line of Zeiss microscopes opens the field of photomicrography to all microscope users. With it, documentation becomes a whole new aspect in routine and research microscopy in the life and material sciences.

1959 Introduction of PLAN-APOCHROMAT objectives for large, flat-field images of unsurpassed resolution and contrast.

1973 The AXIOMAT with two built-in and fully automatic camera systems is introduced. It represents a totally new concept in microscope design, incorporating both upright and inverted microscope modes in one instrument, along with the first truly lateral-chromatic-aberration-free objective systems offering an unprecedented wide field of view.

1977 A new concept in the design of inverted microscopes is introduced with the IM and ICM Photo-Invertoscopes with fully integrated, fully automatic 35mm and 4x5" camera systems.

1978 The first multi-immersion systems developed by Zeiss (water, glycerine, oil) which greatly enhance fluorescence microscopy.

Unequalled optical performance through today's advanced technology

Zeiss diffraction-limited microscope optics render superb images and reveal minute specimen detail. These limits of performance are dictated by the laws of physics. The numerical aperture (N.A.) indicated on each lens clearly defines the detail we can expect to resolve

$$d = \frac{\lambda}{2\,N.A.}$$

Optical design, computer ray tracing and performance evaluation for on and off-axis picture points assure you of performance well within the lens parameters of a given system.

Computer graphics display the intensity distribution in each picture point and monitor the correction of all aberrations.

Exceptionally close tolerances and meticulous craftsmanship, along with the latest techniques of laser alignment, guarantee superb image quality with every lens.

Parfocality and parcentration

Zeiss was first to standardize the parfocal distance of 45mm. As a result, Zeiss lenses have been fully interchangeable for over thirty years.

Strictest tolerances

Take the tolerances for the magnification of an objective. For lenses of most manufacturers they can range anywhere from ±2 to ±5%. At Zeiss they are ±1%. This makes calibration for most routine measurements superfluous.

Antireflexion coatings

Single and multiple-layer coatings of lens-to-air surfaces reduce internal reflections to a minimum, substantially enhance the contrast in the image and increase the transmission for a maximum of image information.

Long lasting performance

An objective's ability to maintain its original crisp image formation capability over long periods of time depends on the characteristics of the glass types used. Therefore, Zeiss engineers cannot develop their designs around glass types which are either hygroscopic or acid-sensitive even though they are much easier to handle, because these characteristics would eventually lead to foggy images. Zeiss designers can use only stable glasses which guarantee continued high performance, withstand even adverse environmental conditions, such as humidity, and maintain consistently high light transmission. These glass types are sometimes more expensive or may require more sophisticated design, but they mean a long life and excellent results.

Sealing of front lenses

Zeiss pioneered the development of cement types that completely seal and protect the front lens from oil or water seepage.

Specimen protection by spring mount

The resilient mount not only protects the specimen but, more importantly, protects the front lens of the objective.

Some 150 OBJECTIVES to choose from for magnifications from 1x to 100x

This is the widest range offered by a single manufacturer for more techniques and applications, whether for research or routine work, in transmitted or reflected light.

There is a choice of objectives to cover all microscope techniques:

- Brightfield
- Darkfield
- Phase Contrast
- Polarization
- Differential Interference Contrast
- Fluorescence
- Reflectance Contrast
- Long working distance objectives to observe through special windows
- Antiflex systems
- Strain-free polarization objectives
- UV-transmitting Ultrafluars.

Magnification / Numerical Aperture	TYPE OF OBJECTIVE										TECHNIQUES							
	Achromat	F-Achromat	Planachromat	Neofluar	Plan-Neofluar	Planapochromat	Ultrafluar	Transmitted Light	Reflected Light	Working Distance mm	Brightfield	Darkfield	Phase Contrast	Interference Contrast	Fluorescence	Polarized Light	Reflection Contrast	UV
1.0/0.04			X					X		4.4	X					X		
1.25/0.04			X					X		4.0	X							
2/0.4			X						X		X							
2.5/0.08		X	X					X		8.9	X					X	X	
2.5/0.08									X	5.0	X	X				X		
3.2/0.07	X							X		22.3	X							
4/0.14						X		X		9.35	X							
4/0.10 HD			X						X	2.0	X	X				X		
4/0.10			X						X	9.0	X			X		X	X	
5/0.1			X						X		X							
6.3/0.12 UD	X							X		13.5	X							
6.3/0.16			X					X		4.9	X		X	X				
6.3/0.20				X				X		10.8	X							
8/0.20 HD			X						X	2.0	X	X				X		
8/0.20			X						X	7.1	X			X		X	X	
10/0.22	X							X		5.0	X	X	X			X		
10/0.25		X						X		6.8	X	X	X					
10/0.22			X					X		4.8	X	X						
10/0.30				X				X		4.0	X	X						
10/0.32						X		X		0.35	X	X						
10/0.20							X	X		7.4	X					X		X
10/(0.2) 0.15			X						X		X							
16/0.12 UD	X							X		10.0	X							
16/0.35			X					X		2.8	X	X	X					
16/0.40				X				X		1.0	X		X					
16/0.5					X			X		0.15	X		X	X	X			
16/0.35			X						X	2.8	X					X	X	
16/0.30 LD			X						X	4.1	X					X		
16/0.35 HD			X						X	2.0	X	X				X		
16/0.50					X			X		0.32	X					X		
20/(0.3) 0.2			X						X		X							
20/0.57 UD	X							X		6.3	X							
20/0.25 LD		X						X		2.15	X	X	X					
25/0.45	X							X		0.9	X	X						
25/0.45			X					X		1.4	X		X					
25/0.60								X		0.54	X		X			X		
25/0.8					X			X		0.13	X		X	X	X			
25/0.8					X				X	0.32	X					X		
25/0.65						X		X		0.17	X		X					
32/0.40							X	X		0.46	X							X
40/0.60			X					X		1.5	X		X	X				
40/0.60 LD			X						X	5.4	X					X		
40/0.60 HD			X						X	2.2	X	X				X		
40/0.65	X	X						X		0.45	X	X	X					
40/0.65			X					X		0.7	X	X	X	X				
40/0.65 UD	X							X		6.8	X							
40/0.75 W	X							X		1.6	X		X	X				
40/0.75				X				X		0.33	X		X					
40/0.85	X							X		0.36	X		X			X		
40/0.85	X								X	0.5	X					X		
40/0.85			X						X	0.23	X			X		X		
40/0.85 HD			X						X	0.25	X	X				X		
40/0.9					X			X		0.13	X		X		X			
40/0.9					X				X		X					X		
40/0.95						X		X		0.09	X		X		X			
40/1.00						X		X		0.38	X		X		X			
63/0.80	X							X		0.14	X		X		X			
63/0.90				X				X		0.09	X		X		X			
63/1.2					X			X		0.12	X		X		X			
63/1.2					X			X		0.12	X							
63/1.25			X					X		0.5	X		X	X				
63/1.25				X					X		X							
63/1.40								X		0.09	X		X	X				
80/0.95			X						X	0.09	X					X		
80/0.95 HD			X						X	0.09	X	X				X		
100/1.1				X				X		0.5	X		X		X			
100/1.25	X							X		0.09	X		X			X		
100/1.25		X						X		0.25	X	X	X		X			
100/1.25			X					X		0.09	X		X	X	X			
100/1.25							X	X		0.07	X					X		X
100/1.25			X						X	0.25	X			X		X		
100/1.25 HD			X						X	0.25	X	X				X		
100/1.30				X				X		0.24	X		X		X			
100/1.30						X		X		0.09	X		X		X			

Designed for either the standardized 160mm tube length or infinity-corrected as for the Axiomat, the full line of objectives covers all types of corrections:

Achromat – Simplest and most economical lens design for all types of routine microscopes

Planachromat – An economical flatfield lens system ideal for photomicrography, widefield microscopy, especially the study of thin sections

Neofluar – Excellent color correction for superior image contrast and brightness

Plan Neofluar – A flatfield, highly color-corrected system for exceptional image contrast over a large field and high light transmission in the near UV range

Planapochromat – A fully color-corrected flatfield objective for the ultimate in image resolution

Epiplan – Specifically designed for reflected-light microscopy with excellent color and flatfield correction

Epiplanapochromat – The reflected-light flatfield objective of unequalled image quality

Ultrafluar – Special UV-transmitting objective chromatically corrected from 230-700 nm

Only Zeiss offers Plan Neofluars and Planapochromats for phase-contrast and differential interference contrast for the ultimate resolution and contrast in these very important microscope techniques.

Why so many different types of objectives?

The many different types evolved from the realization that the vastly varying applications require many different characteristics and performance capabilities of the optics if the user is to obtain optimum results.

All imaging systems have inherent aberrations. The effort and care involved in correcting these aberrations is reflected in the cost of the objectives of the various types. While the names Planachromat and Planapochromat have become generic terms used throughout the industry, the standards of performance within each type are each manufacturer's very own. Of course, from the earliest beginnings, the standards set by Zeiss have been the highest.

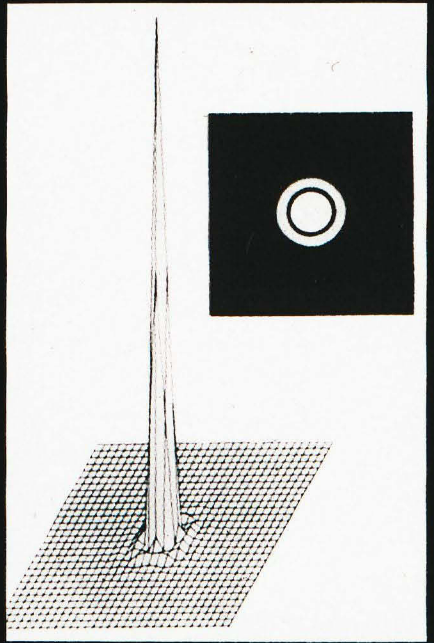
What are the major aberrations?

Spherical aberration

Lenses with spherical surfaces focus axial rays differently from peripheral rays. By combining positive and negative lens elements made of glass of different refractive indices, both the axial and peripheral rays are focused to the same point. This correction is optimized for one or two wavelengths in the visible spectrum.

Chromatic aberration

Rays of different spectral colors are focused in different planes producing severe color fringing around image structures. Positive and negative lens elements of different refractive indices and dispersions, are combined so that rays of two or three colors form one sharp point.

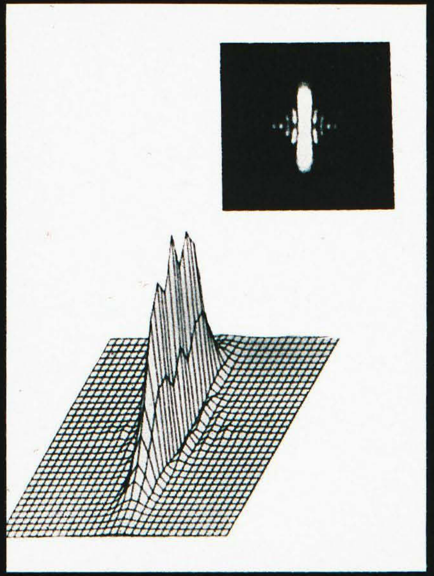


Upper Corner: Airy disc created by F-Achromat 100 at 0.8 NA at best focus.

Lower Corner: 3-dimensional intensity distribution of the same Airy disc pattern.

Flatness aberration

With an uncorrected lens system a flat specimen does not appear in sharp focus over the entire field. Either the periphery or the center of the field of view (depending on focus) is out of focus. A flatfield lens eliminates this aberration and renders images sharp from the center to the edge of the field.



Upper Corner: airy disc pattern created by astigmatic aberration in lens.

Lower Corner: 3-dimensional intensity distribution of astigmatic airy disc.

Astigmatism

Off-axis image points are either tangentially or radially distorted, resulting in loss of peripheral sharpness. The larger the field diameter, the more difficult it is to correct for this aberration.

Coma

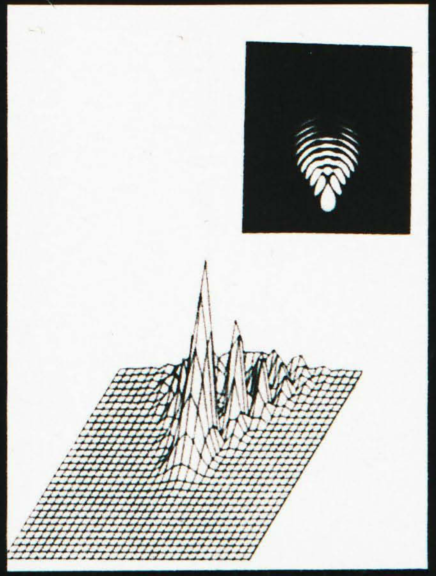
Asymmetrical aberration for peripheral image points, resulting from the failure of a lens to focus rays from peripheral object points which pass through the center of the lens and its periphery to the same image point.

Distortion

Distortion is an aberration resulting from a change in magnification between axial image points and peripheral image points. Straight geometric lines, which do not intersect the optical axis, are either curved in or out resulting in pincushion or barrel distortion.

Lateral chromatic aberration or chromatic magnification difference

After correction of the axial chromatic aberration peripheral specimen features will still display color fringes as a result of differences in the magnification for different colors.



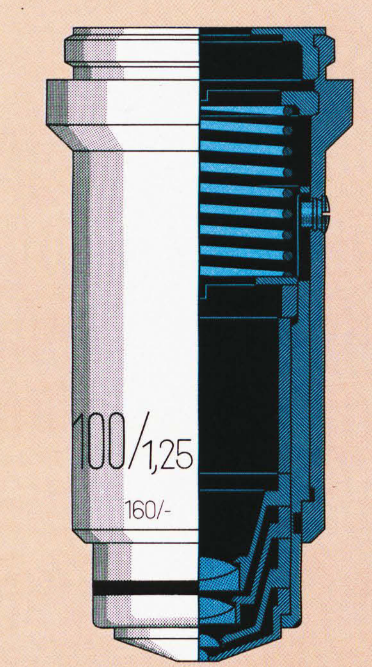
Upper Corner: airy disc pattern created by coma in objective lens.

Lower Corner: 3-dimensional intensity distribution of coma effected airy disc.

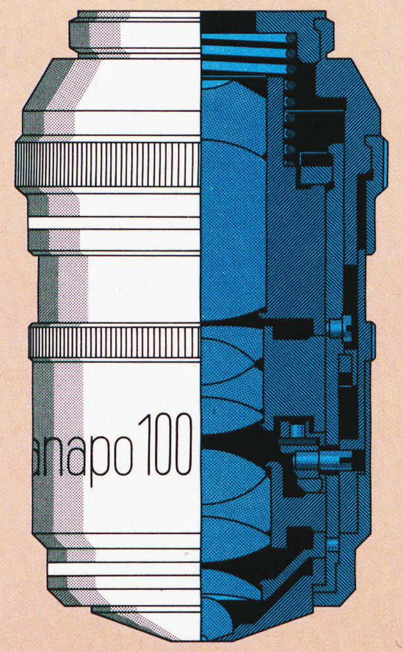
How do the various objectives perform for the three major aberrations?

Types	Spherical	Chromatic	Flatness
Achromats	2λ	2λ	no
F-Achromats	2λ	2λ	improved
Neofluars	3λ	<3λ	no
Plan-Neofluars	3λ	<3λ	yes
Planapochromats	4λ	>4λ	yes

1λ = corrected for green (middle range of visible spectrum)
2λ = corrected for blue & red (broad range of visible spectrum)
3λ = corrected for blue, green & red (full range of visible spectrum)
4λ = corrected for dark blue, blue, green and red



Achromat 100/1.25 Oil



Planapochromat 100/1.3 Oil w/Iris

Difference in Sophistication and Number of Production Steps

Number of steps in:		
Mechanical production	35	
Optical production	172	207
Mechanical quality control	23	
Optical quality control	35	58
Total number of steps		265

Number of steps in:		
Mechanical production	66	
Optical production	302	368
Mechanical quality control	45	
Optical quality control	68	113
		481

How are objectives marked and designated?

Here are some examples:

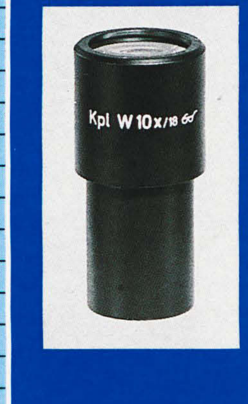
Neofluar	40/0.75 160/0.17	40 = Objective magnification 0.75 = Numerical aperture 160 = Tube length in mm 0.17 = Coverglass thickness for which objective is corrected
Plan-Neofluar	25/0.8 corr 160/W/Glyc/Oil	corr = "corr" stands for correction collar for adjustment of the lens to three different immersion liquids: water, glycerin, oil
Epiplanapo	25/0.65 HD Pol ∞/–	Epiplan Apochromat objective for reflected-light microscopy 0.65 HD Pol HD = brightfield/darkfield pol = strain-free for polarizing microscopy ∞ = infinity-corrected – = corrected for use without coverglass
Epiplan LD	40/0.60 160/1.5	LD = long working distance 1.5 mm = coverglass thickness. A lens cap is available to accommodate for differing coverglass thicknesses and uncovered objects.

The higher degree of correction for spherical, chromatic and flatness aberrations entails also higher correction for all other aberrations.
Correction for lateral chromatic aberrations is most successfully and most consistently accomplished not by the objective alone, as with so-called CF (chrome-free) lenses, but by the objective in combination with a compensating eyepiece, or a separate corrector or tube lens.
With all objectives given the same residual lateral chromatic aberration (l.c.d.), and all compensating eyepieces the same compensating effect (same l.c.d. with opp. sign), not only full interchangeability is assured, but a final image is produced which is free from color fringes around peripheral specimen structures and crisp and sharp to the very edges of the field.
Whether the field of view diaphragm appears with an orange fringe (a property of some compensating eyepieces) a blue fringe or none at all depends on where the eyepiece compensates, with eyelens or field lens.

Full range of eyepieces
for tubes with 23 mm internal diameter

Magnification	Field of View No.	Angle of View °	Focusing Type	Micro-Projection
2x	20			x
2.5x	20			x
3.2x	20			x
4x	20			x
C 5x	20	23		
C 6.3x	18	26		
*Kpl 6.3x	18	26		
C 8x	18	30		
C 8x	18	30	x	
Kpl 8x	18	33		
Kpl 8x	18	33	x	
*Kpl 8x	18	32		
*Kpl 8x	20	37		
*Kpl 8x	20	37	x	
*Cpl 10x	18	42		
*Cpl 10x	18	42	x	
*Kpl 10x	18	41		
*Kpl 10x	18	41	x	
*Kpl 10x	20	45		
*Kpl 10x	20	45	x	
*S-Kpl 10x	20	45		
*Cpl 12.5x	12.5	48		
*Kpl 12.5x	12.5	36	x	
*Kpl 12.5x	18	48		
*Kpl 12.5x	18	48	x	
*Kpl 12.5x	20	53	x	
*Kpl 16x	12	36		
*Kpl 16x	12	36	x	
*Kpl 16x	16	55		
Kpl 20x	8	36		
Kpl 20x	8	36	x	
Kpl 25x	6.3	36		

*High eyepoint for spectacle wearers
C = Standard compensating type
Kpl = Compensating flat-field type with minimal distortion
Cpl = Compensating flat field
S-Kpl = Compensating flat-field type, highly corrected, ideal demanding photomicrography



Eyepieces
for tubes with 30 mm internal diameter

Magnification	Field of View No.	Angle of View °	Focusing Type
4x	30	27	
10x	20	43	
*10x	25	55	
*10x	25	55	x
*16x	16	55	
25x	10	55	
25x	10	55	x

Compensating eyepieces range in magnification from 2x (projection eyepiece f = 125 mm) to 25x. Their degree of correction for image flatness and color aberrations classifies them as C, Cpl, Kpl and S-Kpl eyepieces.

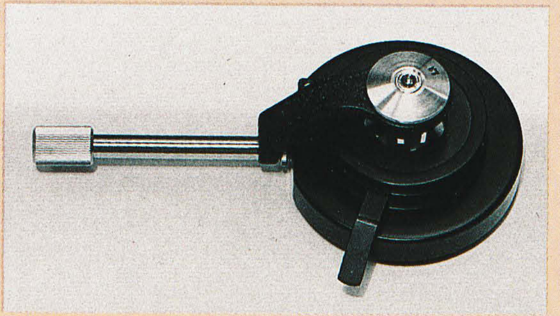
Focusing eyepieces accept reticules for photomicrography, for measuring, counting etc. Their adjustable eyelens furthermore compensates for differences between the observer's eyes.

Microscope condensers for transmitted light

Description	Front Lens	N.A.	Focal Length mm	Working Distance mm	B.F.	D.F.	Phase	Pol	DIC
Condenser 0.9Z	swing-out	0.9	13.1	2.0-2.2	x				
Condenser 1.3Z	swing-out	1.3	8.4	1.6-1.8	x				
Condenser 0.9 Z Pol	swing-out	0.9	13.1	2.0-2.2	x			x	
Condenser 1.3 Z Pol	swing-out	1.3	8.4	1.6-1.8	x			x	
Condenser 0.32-1.4 Pol*	removable	0.32-1.4			x			x	x
Phase Condenser 11Z	swing-out	0.9	13.1	2.0-2.2	x		x		
Phase Condenser 11 Z Pol	swing-out	0.9	13.1	2.0-2.2	x		x	x	
Phase Condenser IV Z/7*	fixed	0.63	15.3	11	x		x		
Condenser V Z*	removable	1.4	6.8	1.3-1.5	x	x	x		
DIC Condenser IV Z/7*	fixed	0.63	15.3		x		x	x	x
DIC Condenser V Z*	fixed	1.4	6.8		x		x	x	x
Ultracondenser 1.2-1.4	fixed	1.2-1.4	5.9	1.1-1.3		x			
Darkfield Condenser 0.8-0.95	fixed	0.8-0.95	8.2	6		x			
Darkfield Condenser 0.7-0.85	fixed	0.7-0.85	8.5	6.5		x			

*achromatic, aplanatic condensers (corrected for chromatic spherical aberration) and sine condition

In the transmitted-light microscope the condenser is an essential component which contributes greatly to the maximum performance of the objective. ZEISS condensers cover not only the full range of microscope techniques, as indicated in this table, but include special systems for exceptionally long working distances. Whether upright or inverted microscopy, there are Zeiss condensers custom-tailored to a multitude of specific applications.



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