



# Leica DM L

Instructions

*Leica*

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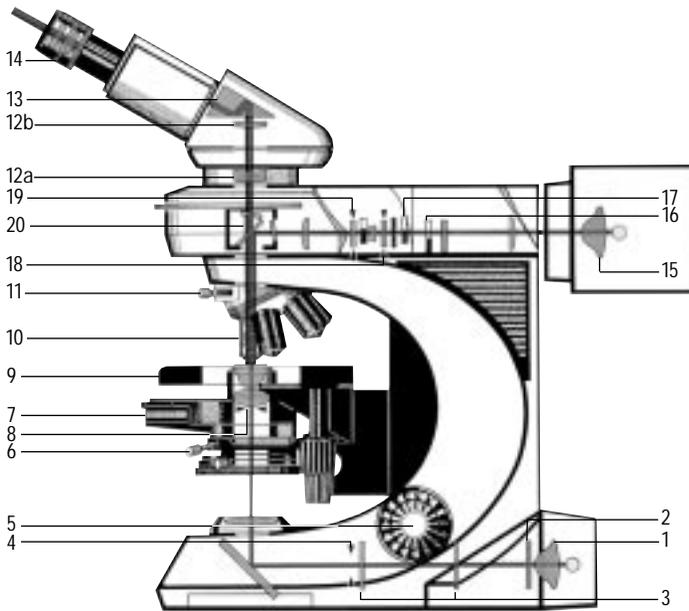
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# General specifications

## General specifications

The Leica DML microscope family consists of a number of variants such as:

Leica DMLB	(30 W lamp/with transformer supply/30 T) 020-519.500 to 020-519.503
Leica DMLB	(30 W lamp/with switched mode power supply/30 S) 020-519.504 to 020-519.507
Leica DMLB	(100 W lamp/with switched mode power supply/100 S) 020-519.507 to 020-519.511
Leica DMLP and DMLM	(100 W lamp/with switched mode power supply/100 S) 020-520.701 to 020-520.718
Distribution voltage (mains) (→ p. 9):	30 T 230/115/100 V ~ ± 10 % 30 S 90 – 250 V~ 100 S 90 – 250 V~
Frequency:	50 – 60 Hz
Power consumption (→ p. 9):	30 T max. 45 VA 30 S max. 45 VA 100 S max. 160 W
Fuses:	see page 63
Ambient temperature:	10 – 36 °C
Relative humidity:	0 – 80 % up to 30 °C
For inside use only	
Overvoltage category:	II
Pollution degree:	2



Cross section diagram of DAS Mikroskop LEICA DM LB

### Transmitted light path

- 1 Transmitted light source (30 or 100 W)
- 2 Filter, permanently built-in
- 3 3 switchable filters\*
- 4 Field diaphragm
- 5 Focusing
- 6 Polarizer\*
- 7 Condenser, with disc\*
- 8 Aperture diaphragm
- 9 Stage with specimen
- 10 Objectives
- 11 Tube slot (IC prisms\*, compensator\*)
- 12 Tube lens system in the tube
- 13 Tube prisms
- 14 Eyepiece (intermediate image, field diaphragm)

### Incident light path\*

- 16–20: Vertical illuminator\*
- 15 Light source\* (halogen, Hg or Xe)
- 16 Filter (BG 38)
- 17 Light stop
- 18 Aperture diaphragm
- 19 Field diaphragm
- 20 Filter system or incident light reflector

\* not part of all configurations

# Important notes on this manual

The Leica DML microscope series consists of several basic stands and a range of modular components allowing an almost unlimited variety of individual outfits. Therefore this manual has been given a modular layout as well to show you other possible configurations besides your own. It applies to the microscope Leica DMLB (mainly for biological and medical applications) and, together with a supplementary manual, to the microscopes DMLP (polarized light) and DMLM (material examinations). The manual is divided into three main chapters:

## Assembly, Performance parameters, Operation

The manual is multilingual. Due to the spiral binding you can turn the language you want to the front. A foldable pocket-sized set of **brief instructions** is also available in various languages for the different basic stands, please consult your supplier. A list of key data on objectives, eyepieces, graticules and fluorescence filter cubes is also supplied with this microscope. It is constantly being updated. **Special manuals** are delivered with some additional equipment such as microscope cameras, heating stages, and also in case of modifications. We also print extensive brochures on microscopy, which can be ordered, as can extra copies of this manual, from our agencies for a cover charge.



**Attention:**

**This manual is an integral part of the product and must be read carefully before switching on and using the microscope!**

## Text symbols and their meanings:

(1.2) Numbers in brackets, e.g. (1.2), refer to illustrations, in this example Fig. 1, pos. 2.

→ p. 20 Numbers with an arrow, e.g. → p. 20, refer to a specific page in this manual.



Special safety information is printed on a grey background and marked with the symbol on the left.



Warning of hot surface.



n.b. Incorrect operation can damage the microscope or accessories.



Explanatory note.



Component is not part of every configuration.

# Installation and safety

## Unpacking, documents

Please compare the delivery carefully with the packing note, delivery note or invoice. We strongly recommend that you keep a copy of these documents with the manual, so that you have information on the time and scope of delivery later when ordering more equipment or when the microscope is serviced. Make sure that no small parts are left in the packing material. Some of our packing material has symbols indicating environment-friendly recycling.



### Attention:

When taking the microscope out of its packing and putting it onto the desk, take care not to damage the sensitive vibration-damping feet on the bottom of the microscope.



### Attention:

On no account should you connect the microscope and peripherals to the mains yet → p. 9 (mains voltage) and p. 52 (incident light only).

## Installation site



### Attention:

Make sure that the workplace is free from oil and chemical fumes. Vibrations, direct sunlight and major temperature fluctuations have a negative effect on measurements and photomicrography. A stable desk of optimum height (70 – 80 cm) is important. This and an

ergonomically designed chair which can be adjusted in several positions are the external prerequisites for fatigue-free microscopy.

## Safety



### Attention:

To guarantee that the microscope and accessories are in a perfectly safe condition, please note the following advice and warnings: The mains plug must only be inserted into a grounded outlet. If an extension cord is used, it must be grounded as well. Using the ground connection (1.7), any accessories connected to the microscope which have their own and/or a different power supply can be given the same ground conductor potential. Please consult our servicing personnel if you intend to connect units without a ground conductor.



### Attention:

The instruments and accessories described in this manual have been safety-tested and checked for possible hazards. Before modifying the instrument in any way or combining it with non-Leica products not dealt with in this manual, it is essential to consult the Leica agency for your area or the main factory in Wetzlar!

# Power supply



## Attention:

### Transit protection

To avoid damage caused by vibration, take the following precautions before transporting the microscope: disassemble the objectives and condenser (14.7). Remove the stage after loosening the clamp screw (28.13). Block the vertical movement of the stage bracket by fitting hard foam rubber between the microscope base, stage bracket and objective nosepiece.

### Built-in power supply

The DML microscope series can be supplied with 3 different built-in power supplies for 12 V halogen lamps, depending on its intended application.

### Data, Setting the mains voltage

Some of the following data may vary according to the model:

#### Built-in supply Type L 30 T (Fig. 1a)

Non-stabilized (major fluctuations in the mains voltage may lead to visible falloff of image brightness and colour shifts in photography). Max. output 30 W ( $\leq 12$  V). Power consumption 45 VA.

Switchable voltage setting 230 V or 115 V (+10/–20 %) on the back of the microscope (1 and 2).



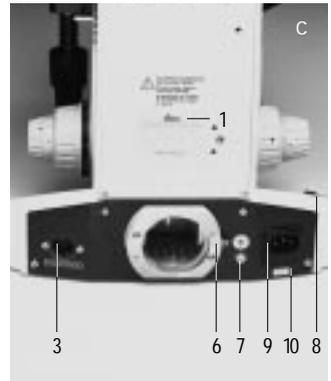
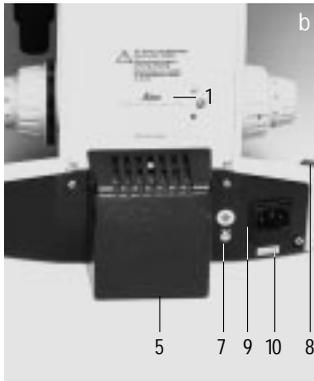
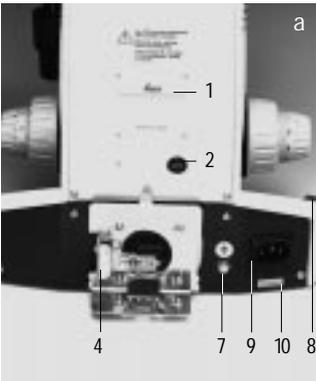
## Attention:

For users where the local mains voltage is **100 – 120 V**: the microscope has been set at 230 V at the factory! Make sure to disconnect from the mains before switching the voltage (230 or 115 V)!

Fig. 1a – c Backs of DM L microscopes

a Type L 30 T, b Type L 30 S, c Type L 100 S

1 Type plate, 2 115/230 V switch (type L 30 T only), 3 Connection for 12 V 100 W lamp, type L 100 S only; some configurations also have 2 100 W ports with switch, e.g. for alternate operation (transmitted/incident light), 4 12 V 30 W halogen lamp, 5 Cover, only for 30 W (removed in Fig. 3a), 6 Adapter ring with clamp screw for 100 W lamphousing, 7 Ground connection, 8 Mains switch with pilot lamp, 9 Mains cable connection, 10 Fuse module with 2 fuses (type indicated on adhesive label)



## Built-in power supply Type L 30 S and

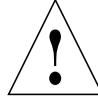
### Type L 100 S (Figs. 1b and 1c)

Electronic stabilisation of output voltage  $\leq 12$  V.  
Automatic adaptation to the local mains voltage of 90 – 250 V, continuous. Max. output 30 or 100 W. Power consumption 45 or 160 W.

## Fuses

All versions of the stand are equipped with safety fuses on both phases. The fuse module (1.10) can be removed with a sharp object. Safety data → back of microscope (1.10); code no. → p. 63.

The fuse ratings apply for all mains voltages.



## Attention:

On no account should you use fuses of different ratings.

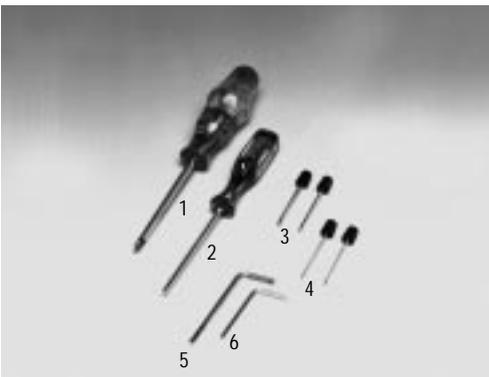
## External power units

Assembly of lamphousings, lamp change → p. 21; 23.

Gas discharge lamps (Hg, Xe → p. 24) are always fed by external power units. For incident light, the 100 W halogen lamp can alternatively also be run on an external power unit, e.g. for simultaneous transmitted and incident light illumination. A separate instruction manual is supplied for external power units.

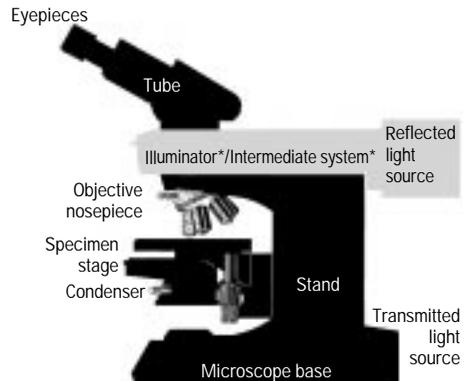
**Fig. 2** Assembly tools

1 Crosstip screwdriver\*, 2 3 mm hexagonal screwdriver, 3 2 mm centering keys\*, condenser UCL/UCLP, 4 1.5 mm centering keys\*, 5 3 mm Allen key\*, 6 2.5 mm Allen key\* (short version)



**Fig. 3** The main microscope components

\* not part of all configurations



# Filter holders for transmitted light

## Assembly tools

You only need a few ordinary screwdrivers to assemble your microscope. These are supplied with the delivery. Replacements for lost tools can be obtained from us or from a tool shop (Fig. 2, spare parts list, → p. 63).

## Filter magazine\* Transmitted light

Turn the microscope stand **upside down** (tube and intermediate systems are not assembled!) loosen the 3 screws (4.1) and lift off the base plate.

Insert the filters ( $\varnothing$  40 mm) into the semicircular mounts (4.2). This does not have to be done in any particular order. The name of the filter can

be seen on its edge, e.g. N 16. Stick corresponding adhesive labels close to the operating levers (4.5). Cf → 33.7, put filter magazine back in position (4.1; 33.7).

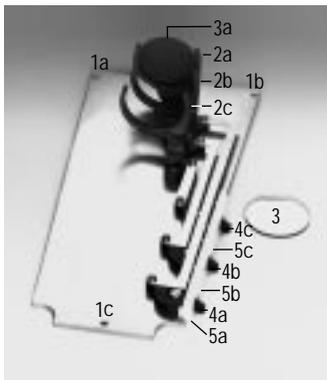
## Filter holder\*

Attachment: 2 filters or Pol components with 32 mm diameter (32.5) can be inserted in the filter holder (5.3; 32.1). The slit above the ICT/P polarizer (6.3) is only for  $\lambda$ - or  $\lambda/4$  compensator (32.5).

Push the guide hole (5.3) into the guide pin at the bottom (right) of the condenser holder and attach holder with knurled screw (left) (5.1; 5.2).

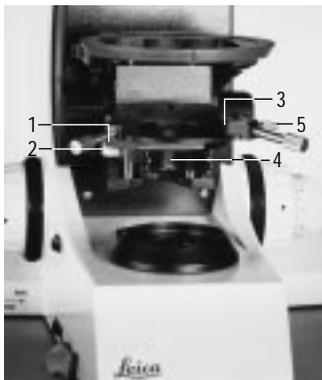
**Fig. 4** Fitting the filter magazine (transmitted light)

1a, b, c Openings for fastening screws, 2 Mounts for  $\varnothing$  40 mm filters, 3 Filter, 4 Switch lever, 5 Adhesive label



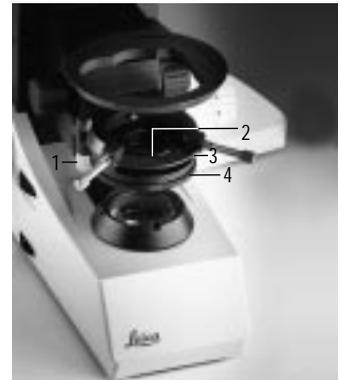
**Fig. 5** Filter holder (mounting diameter 32 mm, → Fig. 32 and 33)

1 Hole for attachment, 2 Fastening screw (above it; condenser centration illustrated), 3 Hole for guide pin, 4 Filter holder\* with 2 filter mounts, 5 Condenser clamp screw



**Fig. 6** Polarizer L ICT/P for transmitted light

1 Fastening screw, 2 Polarizer, 3 Mount for  $\lambda$ - or  $\lambda/4$  compensator, 4 Polarizer mount, rotatable



# Assembly of condensers

## ICT/P polarizer

Attached with the knurled screw on the left (6.1), the pin at the right on the underside of the condenser holder serves as a stop when the polarizer is swung in and out. Slot (6.3) is only for  $\lambda$ - or  $\lambda/4$  compensator (32.5), not filters!

## Intermediate piece with filter mounts

Only in combination with lamphousing (series 105/106/107): The intermediate piece\* with filter mounts (Fig. 21) taking 2 filters with  $\varnothing$  50 mm can be additionally assembled between the stand and the lamphousing.

7 different condenser types are available for this microscope series (Figs. 7 – 13). Further information → p. 32.

## Condensers CL/PH and CLP/PH and UCL/UCLP

For polarization the strain-free Pol versions CLP/PH 0.85 or UCLP 0.85 (similar to 7.1 and 7.4) or the UCA/P condenser (Fig. 10) are necessary.

The full name of the condenser has the suffix S1. This signifies that the condenser is intended for use with specimen slides of ca. 1 mm thickness. To be more precise (as per DIN/ISO) 1.0 to 1.2 mm → table on p. 32.

If the condenser is not yet complete, the following components\* may have to be fitted before the condenser is adapted to the microscope (Fig. 14), see p. 16 for fitting details.



## Auxiliary condenser lens LS

The auxiliary lens LS (8.1, for DM LS microscope only) must not be inserted at the bottom of the condenser, or it will not be possible to obtain exact Koehler illumination, → p. 37.

## Condenser disc UCL\*

Condenser discs\* (9; 11) can be inserted into condensers UCL 0.90/1.25 OIL (7.1), UCLP 0.85 and UCA/P (10.5) for certain illumination techniques (darkfield = DF, phase contrast = PH, polarization = whole- and quarter-wave compensator) and the lens for objective 2.5x. Condenser disc UCA/P → p. 14.

To remove and assemble the disc, screw out the screw (7.2; 9.4; 11.9) completely. Turn back the centering screws (9.3) with the centering keys (7.5) until the light rings, whole- and quarter-wave compensator\* and lens\* 2.5x (Fig. 9) can be inserted.



## Light rings\*

The largest hole is for brightfield observation (= BF), the smaller ones for light rings or whole-/quarter-wave compensators. If you use a smaller hole for brightfield, the maximum illumination aperture cannot be used.

The lettering (e.g. DF, PH 1...,  $\lambda$ ) must point **upwards**, the whole- and quarter-wave compensators (9.6) must be inserted with the correct orientation: the notch must point towards the centre of the disc! The lettering of

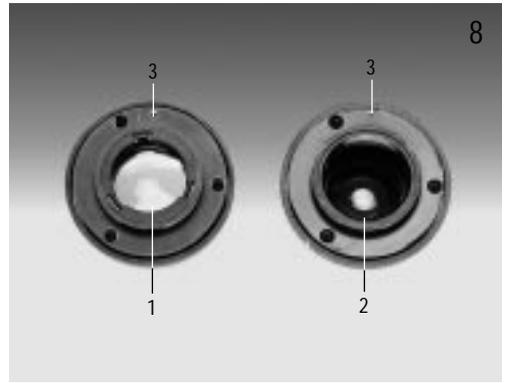
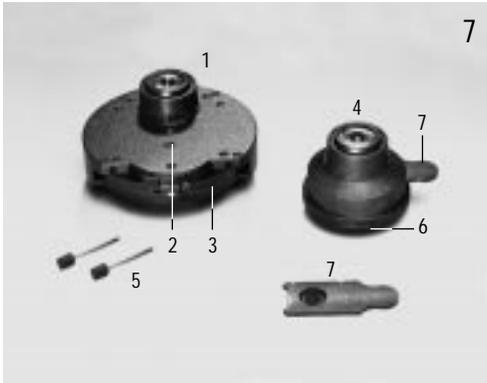
the components should tally with the marking at the opposite position (outer edge of the disc). Tighten the centering screws (9.3; 9.5) until the components are roughly in the center of the holes.

**Fig. 7** Condensers UCL 0.90/1.25 OIL (1) and CL/PH 0.90/1.25 OIL (4)

The CLP/PH 0.85 and UCLP 0.85 condensers required for polarization look nearly the same as the CL/PH and UCL condensers from the outside, but are not intended for oil immersion (engraving **P 0.85**)

1 UCL 0.90/1.25 OIL, 2 Fixing screw (plate axis), 3 Condenser disc, 4 CL/PH 0.90/1.25 OIL, 5 Centering keys, 6 Aperture diaphragm, 7 Slide with light ring\*

**Fig. 8** Underneath of condenser (CL/PH in this example) with (1) and without (2) auxiliary lens LS (2), 3 Orientation pin

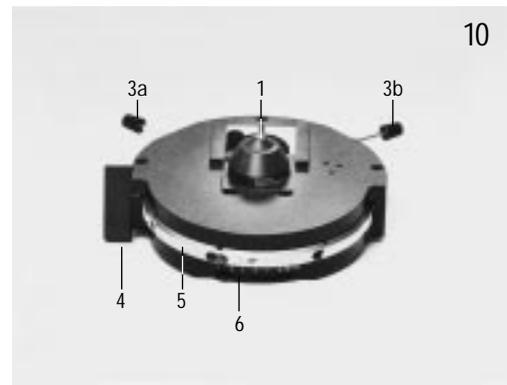
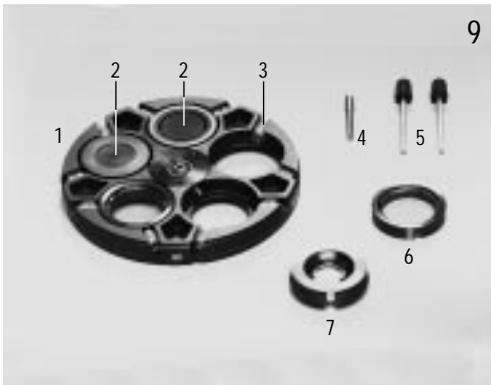


**Fig. 9** Fitting the UCL condenser disc

1 Condenser disc, 2 Light ring for darkfield or phase contrast (or whole-/quarter-wave compensator), 3 Centering screws, 4 Axis, 5 Centering keys, 6  $\lambda$ - or  $\lambda/4$  compensator, 7 Auxiliary lens 2.5x... 20x

**Fig. 10** UCA/P condenser

1 Condenser top, → Fig. 12, 2 Centering key holder, can be disassembled, 3a, b Centering keys, 4 Switch lever for condenser top, 5 UCA disc, → Fig. 11, 6 Aperture diaphragm lever



## Lens for 2.5x objective\*

For observation with the 2.5x objective, a special adaptation lens (9.7) must be inserted into one of the holes in the UCL disc. This lens is not available for condensers CL/PH, CLP/PH andachr. apl. 0.9 (P) → p. 40. However, for the 2.5x objective, a slide with diffusing screen can be slotted in, but **not** for polarized light.

## Light ring slide\*

Slides with light rings DF, PH 1 to PH 3 can be slotted into the CL/PH, CLP/PH andachr. apl. 0.9 (P) condensers from the right (7.7)\*, → p. 42.

## Condenser Achr. apl. 0.9 (P)

With swing-out condenser top for brightfield and Pol contrast from 1.6x upwards (not illustrated).

## UCA/P condenser

### UCA/P condenser disc

The UCA/P hinged condenser (Fig. 10) can be fitted with various screw-on condenser tops (Fig. 12) (the standard version has the 0.90 S1 top, → p. 32 and p. 40) and is available with a 6-position disc (10.5 and Fig. 11). The largest position should be used for brightfield and therefore left empty if possible.

To disassemble the disc: Unscrew the fastening screw of the disc (11.9), which at the same time is the axis of rotation. This is to be found on the underneath of the condenser and must be fully screwed out.

Assembly of light rings,  $\lambda$ - and  $\lambda/4$  compensator → p. 12 (UCL condenser disc). The components of the UCA/P condenser discs (Fig. 11) and UCL/UCLP condenser discs (Fig. 9) are **not** intercompatible. Smallest possible objective magnification with UCA/P: 1.6x; an auxiliary lens is not necessary.

Fig. 11 UCA/P condenser disc

1 Light ring "small, PH", 2 Light ring "large" for large holes, 3a, b ICT condenser prism, 4 Marking for assembly of the ICT condenser prisms, 5 Marking K on the prism mount, 6 Guide groove for prism, 7 Adhesive label, 8 Centering screws, 9 Axis of rotation, 10  $\lambda$ - or  $\lambda/4$  compensator

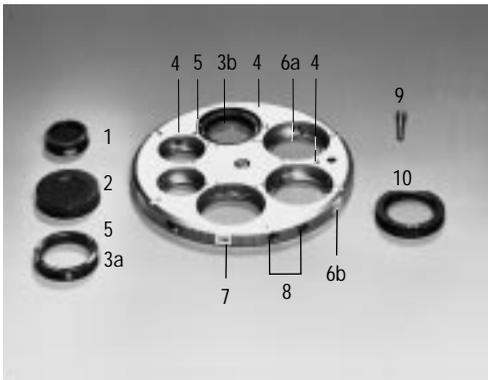


Fig. 12 Range of condenser tops for UCA/P condenser



## ICT condenser prisms

Insert the ICT condenser prisms  $K_2$ ,  $K_3$  etc. (11.3a) into the large holes (11.3b) as follows:



- Turn back the centering screws slightly (11.8) with the 2 mm key (2.3 or 2.6).
- Prism labelling upwards, the name  $K_2$ ... (11.5) must be near the marker dot (11.4) on the edge of the hole (ICT [transmitted light interference contrast] will not be possible if the prism is inserted rotated by  $180^\circ$ !).
- The 2 catches on the underneath of the prism must click **exactly** into the guide slit (11.6).
- Screw in the centering keys slightly (11.8), checking that all prisms can be moved properly in ↗ direction and are close to the lower edge of the hole.

## Labelling

Remove self-adhesive labels, e.g. BF, DF, etc. from the backing film with the aid of a small knife or a needle and stick on to the smooth areas on the outer edge of the disc as follows:

- On the opposite side (i.e. on the other side of the axis of rotation) from the light ring or prism.
- So that the lettering is not upside down when read.
- For IC prisms: as the same prism may be used for one or several objectives, find out from the optics objective data sheet for which objectives the particular prism can be used, e.g. only for 10x objective (in the case of PL FLUOTAR®) or for 10x **and** 20x (for N PLAN).



Before fitting the disc into the condenser, make sure that neither of the centering screws (11.8) is sticking out at the side.

**Fig. 13** Special darkfield condensers

1 Upper part (dry), 2 Lower part, 3 Orientation pin, 4 Upper part (oil immersion)



## Assembly of the condenser disc

Fasten the condenser disc with the axis screw (11.9), check that the disc rotates properly through 360°; it may be blocked if the centering screws (11.8) are not screwed in far enough.



### Attention:

The disc must not be mistaken for the similar looking disc of the DM IRB inverted microscope.

### Condenser top\*

Screw condenser top (Fig. 12) onto the UCA/P condenser (10.1).

## Special darkfield condensers

Screw upper (13.1; 13.4) and lower (13.2) parts together, further information → p. 45.

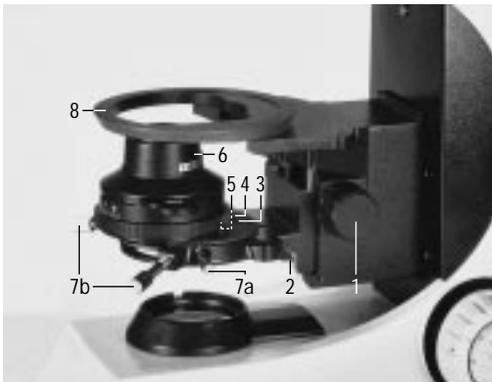
### Fixing the condenser

Raise the specimen stage as far as the stop (28.7). Lower the condenser carrier using the drive knob (14.1, can be operated on both sides). Slightly loosen the clamp screw (14.7a) until the condenser can be inserted horizontally from the front. Make sure the guide pin (8.3) clicks into the groove (14.5)!

Tighten the clamp screw (14.7a) **slightly**, so that the condenser cannot be removed.

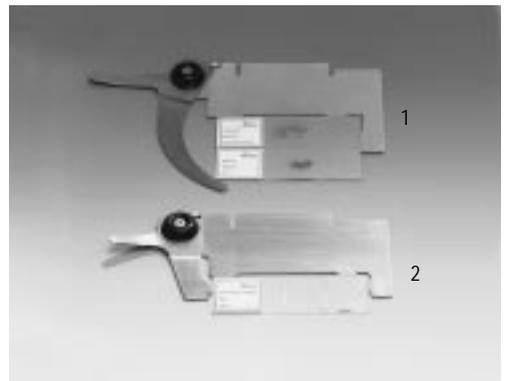
**Fig. 14** Assembly of condenser

**1** Condenser height adjustment, **2** Condenser height stop, **3** Guide groove (→ Figs. 5 and 6), **4** Fastening hole for polarizer or filter holder (Figs. 5 and 6), **5** Orientation pin and corresponding groove, **6** Condenser (CL in this example), **7a** Condenser clamp screw, **7b** Condenser centration, **8** Mount for rotatable mechanical stage



**Fig. 15** Interchangeable object holders\*

**1** for 2 specimens of 26 mm x 76 mm, **2** One-hand object holder for 1 specimen



# Assembly of stage, object guide, tube system

## Stages

Mechanical stage on DMLB and DMLM microscope: slightly turn out clamp screw (28.13) and insert stage, holding slightly at an angle, into the circular mount (14.8). Then align horizontally, slightly tighten the clamp screw (28.13) and check that the stage can be rotated.

DMLP and DMLM microscopes only (see supplementary LP/LM manual).

Additional vertical height adjustment\* (dovetail guide, not illustrated): Lower coarse focus as far as the stop (28.7) by turning the control. The objectives must be removed.

Loosen the stage clamp lever on the right of the stage bracket (not illustrated) and slide stage bracket onto the dovetail guide from above. Slide stage downwards until the dovetail rail at the top of the stage bracket protrudes by 0 – 1 mm at least. Make sure the clamp lever (not illustrated) is screwed tightly enough to prevent the stage slipping downwards or moving out of a horizontal position. Affix the stage to the stage bracket (see above). The clamp lever can be set at any position by pulling it out in an axial direction.

## Object guide\*

Assemble with two clamp screws (28.2). Your delivery will either contain the guide for 2 specimen slides (15.1) or the one-hand object holder for 1 specimen slide, size 26 mm x 76 mm (15.2).

A special Pol object guide and specimen clips are available for the Pol rotary stage\* (see LP/LM manual).

## Tube and intermediate systems

The tube is adapted to the stand direct or via intermediate systems (Fig. 27, 39, 48). Tubes and intermediate systems are secured with the lateral clamp screws (39.1a, b):

Loosen clamp screw (39.1a, b) slightly if necessary with hexagonal screwdriver (2.2). Insert the tube or intermediate system into the circular mount (dovetail) and align by rotating (viewing port to the front). Pol components may have a clickstop device (pin). Make sure that components do not jam each other. Retighten clamp screw (39.1).



### Attention:

Additional photo adapter tubes are required for some photo tubes (Figs. 43 – 45).

When combined with other intermediate systems, illuminators (Fig. 17; 39) are always assembled underneath (i.e. **directly onto the microscope stand**). The number and type of useable intermediate systems is limited, → p. 30 – 31.

Besides tubes from the DML range (Fig. 44), it is also possible to adapt tubes from DMR research microscopes (Fig. 46) using the R/L adapter (45.2).

The Ergo module (45.3) is used for raising the viewing port by 30 mm (or 60 mm if two are used).

### Incident light reflectors\*/ Fluorescence filter systems\*

Remove cover on the right-hand side of the illuminator (39.3) (Recess for finger on the underneath of the cover, 17.7).

Insert the filter system (combination of excitation filter, dichroic mirror and suppression filter) or incident light reflector (Fig. 16), with the bevelled end of the dovetail guide to the front, as far as the stop.

Up to 4 positions can be used by turning the turret plate.

**Fig. 16\*** Incident light reflectors and filter systems, see also Fig. 49 of supplementary manual LP/LM

1 45° BF reflector with neutral density filter N\*, 2 DF darkfield reflector, 3 Adjusting reflector (DMR series only), 4 Fluorescence filter system, 5 Bertrand lens module, 6 ICR module, 7 POL system, 8 Smith reflector



**Fig. 17\*** Incident light turret plate, after opening the window on the side of the illuminator (39.3)

1 Turret plate, 2 Labelling of assembly position, 3a, b Dovetail mount, 4 Name of the filter system or reflector, 5 Order code no. of the system, 6 Filter system or reflector with position data, 7 Recess in housing (for removing the cover), 8 Clamp screw for fixing in position





The Smith reflector and the DF reflector (16.3 and 16.5) can only be put in opposite positions.

The 4 positions of the turret plate are each marked on the **left** of the dovetail guide with the figures 1 – 4 (17.2).

In addition, the position currently in the light path is indicated on the outer edge of the turret plate (17.1).

Self-adhesive labels are supplied with the filter systems and reflectors to indicate the positions 1 2 3 4 and the short names of the filter cubes and reflectors (e.g. M2).

Stick the label 

1	2	3	4
---	---	---	---

 in the rectangular recess at the front of the illuminator, and then stick the labels with the short names in the corresponding areas underneath, according to the marking on the systems (17.4) and the number at the **left** on the filter wheel (17.2). The Smith reflector (with 2 reflecting areas and lenses, Fig. 16.3) and the DF reflector (with annular mirror, Fig. 16.5) are not labelled. The arrow label can be used for transmitted light ↑ (vacant position) or for incident light ↓ brightfield, POL and ICR.

Push the cover (35.3) hard until it clicks in place again.



#### Attention:

Never look directly into the incident light path!

There is **danger of glare** when switching on the brightfield reflector (BF) or Smith reflector (6.4; 6.5)!

#### Light stop\*

Insert the black plate (30.5) between the two stage plates (39.4), after lowering the condenser (not with Pol rotary stage).

#### Photomicrography\*

In general, a trinocular tube (Fig. 44.4, 44.5 and 46.2 – 3; 46.10), an HC photo eyepiece adapter tube (45.4) and HC photo eyepieces with a fitting diameter of 27 mm are necessary for the adaption of photomicrographic devices. Unless the photomicrographic equipment is fitted with a special viewing port with format outlines, HC PLAN **M** eyepieces, i.e. with focusable eyelens (18.4) and inserted photogracule have to be used in the binocular port. See the manual supplied with the photographic equipment for further details.

#### TV adaption\*

→ p. 60

## Eyepieces



For direct visual observation: If you **are wearing** glasses, pull off or push back the glare protection (18.7), as it may prevent you seeing the whole field of view.

Only use Leica **HC PLAN** eyepieces.

Exceptions: 16x/14 B and 25x/9.5 B widefield eyepieces from the range of Leica AG Heerbrugg/CH, for which a special adapter ring is required, which is pushed onto the eyepiece (19.2).

Always make sure the pair of eyepieces have identical magnifications and field of view numbers, e.g. 10x/20!

Further important information → p. 29 – 32, 35.

**Fig. 18** Eyepieces

1 – 4 Eyepieces ready for use by viewers without eyeglasses (anti-glare protection 10 mounted or pulled up), 5 PHOTO eyepiece, 6 10x/25 M eyepiece disassembled, 6 Upper part, 7 Lower part, screwed off (applies also for 10x/22 M, 12.5x/16 M, but not for 10x/20 and 10x/20M), 8a, b Retainer ring for eyepiece graticules, can be screwed out, 9 Eyepiece graticule\*, 10 Anti-glare protection, removed for viewers wearing eyeglasses (it can be pushed back with eyepieces 10x/20 and 10x/22, insertable and remove pos. 8a or 8b). The 12.5x/16 M model is basically the same as the 10x/25 M eyepiece.



## Assembly of graticules\*

Only possible for eyepieces with adjustable eyelens = **M** type (18.4). The second eyepiece should also be an M type.



### Attention:

Be extremely careful to avoid dust and fingermarks, as these will be visible in the field of view. The graticule diameter is always **26 mm** for HC PLAN eyepieces.

10x/20 M and 12.5x/16 M eyepiece only: Screw the retainer ring out of the underneath of the eyepiece (18.6).

10x/22 M and 10x/25 M eyepiece only: Screw out the bottom part of the eyepiece (18.8) and screw out the retainer ring with a blunt blade. Insert the graticule with the coated side downwards (in the direction of the objective), so that any lettering is seen the right way round when later observed in the viewing direction.

Screw the retainer ring back in.

**Fig. 19** Widefield eyepiece 16x/14 B  (Leica AG, Heerbrugg/CH)

1 Clamp screw, 2 Spacer ring for Leica microscopes (must be pushed upwards as far as the stop)



## Photoeyepieces\*

The observation eyepieces **HC PLAN** (fitting diameter 30 mm) are designed for direct visual observation only. Special eyepieces with fitting diameter of **27 mm** and the engraving **HC...PHOTO** are used for the adaption of photomicrographic equipment with a fixed magnification factor, e.g. DMLD and MPS systems and for special TV adaption systems (adapter Fig. 44 – 46!).

## Objectives

Always only use Leica objectives of tube length  $\infty$  (infinity)! The standard thread is M25, or for incident light darkfield objectives BD M32 (Fig. 27). Adapters for objectives with smaller threads → Fig. 26. It is customary, though not essential, to arrange the objectives so that the magnification increases when the objective nosepiece is rotated counterclockwise. Lower the specimen stage as far as possible before assembling the objectives.



### Attention:

Close vacant threads in the nosepiece with dust protection caps (code no. → p. 63).  
Further information → p. 27 – 28.

## Lamps, assembly

The lamphousings are secured to the back of the microscope (1c.6) or to the illuminator (Fig. 39) with a clamp screw (37.5) and 3 mm hexagonal screwdriver (2.2). If required, the intermediate piece\* with filter slots (21.6) can be used, which accommodates filters of 50 mm diameter.



For 100 W transmitted light, **only** the LH 107 can be used!

Before assembling to the microscope, you should check that the lamphousings have been properly fitted with 12 V 30 W or 100 W halogen lamp or gas discharge lamp (Hg, Xe), → following pages.

Order code nos. of replacement lamps → p. 63.



### Attention:

**Fire hazard!** Keep lamphousings (hot surfaces!) at least 10 cm (4") away from inflammable objects such as curtains, wallpaper or books!

**Danger of glare!** Never look into the direct light path!

## Lamp change, Transmitted light



**Attention:**

12 V 30 W  
12 V 100 W

Unplug the connecting cable from the back of the instrument (1.9) or external power unit.

Open the lamphousing:

**30 W** version only: Pull off the cover (1b.5) upwards.

**100 W** version only: (Lamphousing 105/2 or 107, not illustrated, like LH 106): Using a coin, open the cover on the right side of the lamphousing (37.1) and lift off cover.



**Caution:**

**The lamp may still be hot!**  
Pull out lamp.



**Attention:**

**Without removing** its protective **covering**, put the new lamp into the base as far as the stop (1a.4; 20.1), making sure it is not at an angle. Remove protective covering. If there are any finger marks on the lamp or illumination lens, wipe them off immediately with a clean cloth!

The lamp does not need readjusting.

Inhomogeneous illumination is possible if the lamp has been inserted at an angle or if cheap lamps are used.

## Light sources, Incident light

The Leica DM L microscope is fitted for incident light BF, DF, POL and ICR with a 12 V 100 W halogen lamp. For incident light fluorescence, mercury and xenon gas discharge lamps are preferable due to the brighter image (Fig. 20 – 24) obtained.

### Lamphousing 106\*, 105/2\*, 107/2 and 107

Only for 12 V 100 W halogen lamp (centerable in x and y direction), focusable, aspherical collector. Without reflector, with grooved diffusing screen, heat-absorbing filter (Fig. 20 and 37).

Lamphousing 105/2: like LH 106, but without lamp and collector adjustment.

### Lamphousing 106 z

Like lamphousing 106, but with centerable and focusable reflector and 4- or 6-lens collector (Fig. 22). Quartz collector on request.

The following lamps, each with their own special holder (Figs. 23 and 24) are possible:

12 V 100 W halogen lamp, alternating current

50 W Hg ultra high pressure lamp, alternating current

100 W Hg ultra high pressure lamp, direct current, non-stabilized

100 W Hg ultra high pressure lamp, direct current, stabilized

75 W high pressure xenon lamp, direct current, stabilized

### Power units\*

Different power units are required for the various types of lamp. Some of these vary from country to country, see separate instructions. Check hour counter!



### Attention:

Do not connect until the lamps have been assembled, → p. 21. Check the mains voltage setting and correct if necessary or use a series transformer, e.g. 110/230 V.

### Lamphousing 106\*, 105/2, 107/2 and 107 Halogen lamp

Disconnect from power supply (mains plug, microscope or external power unit).

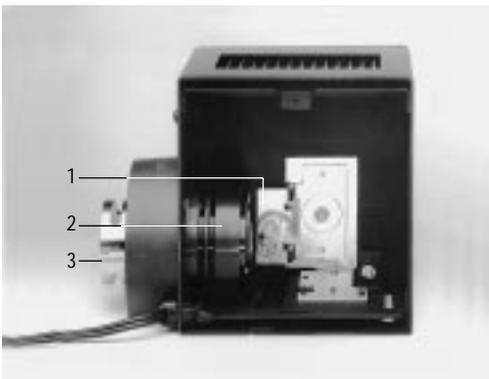
Unscrew screw on cover (21.1) and remove cover.

Move the collector to the front (21.4; 20.2, does not apply for LH 105/2 and 107).

Remove the defect lamp and put a new 12 V 100 W halogen lamp into the lamp holder without tilting (20.1).

**Fig. 20** Lamphousing 106\*, opened. Lamphousings 105/2 and 107 have a similar design.

1 Holder with 12 V 100 W halogen lamp, 2 Collector, 3 Diffusing screen



### Attention:

**Leave the protective covering on the lamp until it is in its holder!**

Avoid making fingerprints or wipe off immediately.

Close the lamphousing (21.1).

### Lamphousing 106 z\* Halogen lamp

Disconnect from power supply (plug).

Loosen screws (22.4 and 22.9) with crosstip screwdriver, pull cutout plug slightly out of the socket (22.11) and flip up lid (22.1). Loosen the screws (22.10) on the lamp holder and pull out the lamp holder (Fig. 23). Remove the defect lamp and insert a new 12 V 100 W halogen lamp.



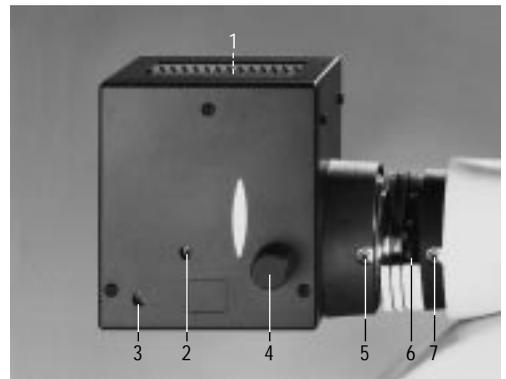
### Attention:

**Leave the protective covering on the lamp until it is in its holder!**

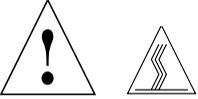
Avoid making fingerprints or wipe off immediately!

**Fig. 21** Lamphousing 106\* and intermediate piece for filters (Ø 50 mm)

1 Screw for opening the lamphousing, 2, 3 x and y centration of the lamp\*, 4 Collector focusing, 5, 7 Fixing screws, 6 Filter holder (intermediate piece) for filters Ø 50 mm



## Lamphousing 106 z\* Hg and Xe lamps



**Danger:**

The following information is extremely important and should be adhered to under all circumstances:

Always unplug the power unit from the mains before assembly work is carried out.

Wait for the lamphousing to cool down before opening (at least 15 min.). Danger of explosion!

Never touch glass parts of the burner with your hands. Remove any finger marks or dust carefully (perhaps using alcohol).

Adjust lamps immediately after ignition (→ p. 54 – 57).

Never look directly into the light path, danger of glare.

Avoid frequent switching on and off, as this can impair the stability of the illumination and shorten the lamp's life. Hot Hg lamps cannot be reignited until they have cooled down.



**Attention:**

We recommend that you let new burners burn in for several hours without interruption if possible. It is a good idea to keep a record of the hours the lamp is in use and to compare with the manufacturer's specifications. Replace discoloured, spent lamps and dispose of ecologically.

We cannot accept any liability for damage resulting from a lamp explosion.

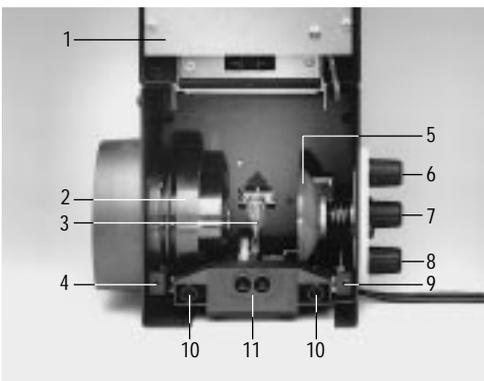


**Attention:**

Always wear safety clothing (gloves and face mask) when assembling Xe burners (danger of explosion).

**Fig. 22** Lamphousing 106 z\*

1 Lid, flipped up, 2 Collector, 3 12 V 100 W halogen lamp with holder or gas discharge lamp (see Fig. 24), 4, 9 Lid screws, 5 Reflector, 6, 8 Screws for x/y centering of condenser, 7 Reflector focusing, 10 Screws for lamp socket, 11 Socket for cut-out plug



**Fig. 23** 12 V 100 W lamp holder (LH 106 z only)





**Attention:**

Protect movable interior parts with foam rubber or similar in case of shipment. Disassemble the burner.

To open lamphousing 105 z: undo screws (22.4), pull the cut-out plug slightly out of the socket (22.11) and flip up the lid of the lamphousing.

Undo the screws (22.10) and remove the lamp holder (Fig. 24). Remove the spent burner by loosening the clamp screws (24.1 and 24.3).

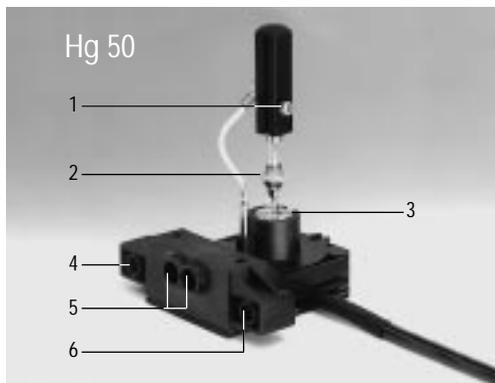


**Attention:**

Insert burner as follows, adhering strictly to the above safety information:  
Do not remove the protective covering yet (24.7).

**Fig. 24** Lamp holders for gas discharge lamps\*

1 Upper clamp, 2 Seal point of the burner, 3 Lower clamp, 4, 6 Drill holes for fixing the holder, 5 Sockets for cut-out plug, 7 Protective cover



## Lamphousing 106 z\* Hg and Xe lamps

Always insert the burner so that



### Attention:

1. the lettering on the metal base is upright after insertion (different diameters of the metal base for the Hg 100 and Xe 75 burners ensure that these are always inserted the right way up). If one of the bases is labelled "UP" it must therefore be assembled at the top.

2. if the lamp bulb has a seal point (24.2), turn the burner so that this point will be at the **side**, not in the light path.

Apart from the halogen lamp the following gas discharge lamps can be used, all requiring different lamp holders (Fig. 24) and power units:

Type	Average life
Hg ultra high pressure lamp 50 W (alternating current)	100 h
Xe high pressure lamp 75 W (direct current, stab.)	400 h
Hg ultra high press. lamp 100 W (direct current, stabilized/non-stabilized)	200 h
Hg ultra high pressure lamp 100 W (dir. curr., stabil./non-stabil., type 103 W/2)	300 h

Put the upper pin of the burner between the clamps of the flexible power supply and clamp with screw (24.1).

Unscrew the stud (24.3) in the holder slightly, insert the lower end of the metal base and retighten the stud.

Exchanging the collector on lamphousing 106 z:

Move the collector to the rearmost position with the focusing knob (21.4; 20.2). Pull the focusing knob of the collector outwards. The collector can now be removed.



### Attention:

Make sure that the lamp base and the power unit have the same number. If the lamp base is marked L 1, for example, L 1 must also be set on the power unit to make full use of the lamp and not to shorten its life.

Move the collector to the front position with the focusing knob (21.4; 20.2).



### Attention:

Remove the protective covering from the burner (24.7).

Put the lamp holder with burner inserted into the lamphousing and secure with the screws (22.10). Try moving the collector (21.4): it must not touch the power lead.



### Attention:

When closing the lamphousing make sure that the pins of the cut-out plug engage in the sockets (22.11). Retighten the screws of the lid. Push the cut-out plug in as far as it will go.

Attach the lamphousing to the microscope (21.5) and connect to the power unit (compare mains voltage!).



### Attention:

Adjust burner **immediately** after ignition.  
→ p. 53 – 55

# Performance parameters of objectives

Due to basic physical principles and the physiology of the human eye, all imaging techniques, not only the microscope, are subject to limitations in performance. For proper use of the microscope you should therefore know and observe the following information.

## Objectives

The DML microscope series is based on tube length  $\infty$  (infinity) and a focal length of the tube lens of  $f = 200$  mm. Therefore, only objectives with the engraving  $\infty$  (Fig. 25) and M25 or M32 thread may be used.

## Objective labelling

Examples (see also Fig. 25) and meaning of the symbols:

$\infty/-$	$\infty/0.17$	$\infty/0/D$
C PLAN 10x/0.22	C PLAN 40x/0.65	N PLAN 50x/0.75

**Fig. 25** Objectives, examples

**1** Brightfield objective, **2, 3** POL objectives, **4** Phase contrast immersion objective, **5** Immersion objective with iris diaphragm, **6** CORR objective for inverted microscopes, **7** BD objective for incident light brightfield and darkfield (M25 thread)

Some immersion objectives **with** a knurled ring have a front part which can be pushed up and "locked" with a small rotational movement. This device must be unlocked for observation! The sleeve of PL FLUOTAR and PL APO objectives can be rotated so that the engraving can be read more easily.



$\infty$

Objective for infinite tube length ( $\infty$ ).

-

The objective can be used **with and without** a coverglass.

**0.17**

The objective may **only** be used **with** a coverglass of the standard 0.17 mm thickness. Use without a coverglass or with a coverglass of a very different thickness will result in a distinct drop in performance, especially for objectives with high apertures,  $\rightarrow$  p. 41.

**0**

Use **without** a coverglass, e.g. for cell smear specimens, incident light.

## D (or A, B, C)

Pupil position of the objective (important for ICT interference contrast and ICR → p. 48).

## Objective type (performance class):

### C PLAN

Achromat

### N PLAN

Planachromat

### PL FLUOTAR®, HC PL FLUOTAR, HCX PL FLUOTAR

Semi-Planapochromat

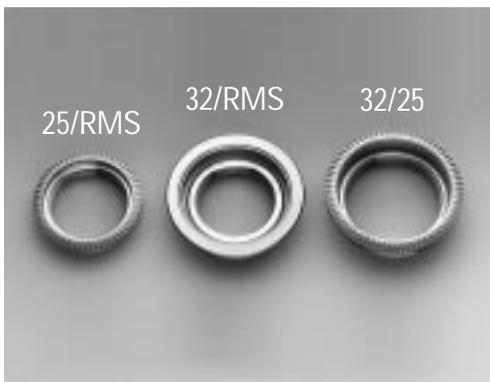
### PL APO

Planapochromat

### 10x/0.22

Magnification and aperture. The aperture (pick-up angle) influences resolution, field depth, contrast and brightness. Objectives with a built-in iris diaphragm are engraved with their maximum and minimum aperture, e.g. 0.85-0.55 (Fig. 25.4).

**Fig. 26** Objective spacer rings for adapting objectives with smaller thread



## Attention:

Objectives with built-in iris diaphragm!  
The knurled ring may only be used to adjust the diaphragm, **not** for screwing in and out.  
Risk of damage!

## OIL, W, IMM

Immersion objectives for: oil, water, universal (oil, water, glycerine, etc.) → p. 33.

## PH

PH = phase contrast objective, the corresponding light ring in the condenser is also indicated, e.g. PH 2.

## BD

BD = Brightfield/Darkfield; objectives for incident light microscopy with M32 thread.

## P, POL

Strain-free objective for quantitative polarized light microscopy.

## Eyepieces

Our product range comprises the following eyepieces:

Leica eyepiece type	Magnification/ field of view no.	Eyepiece port <sup>1)</sup>
---------------------	----------------------------------	-----------------------------

### Eyepieces for observation

HC PLAN	10x/25	 M
HC PLAN	10x/20	 M
HC PLAN	10x/20	
HC PLAN	12.5x/16	 M
Widefield <sup>++)</sup>	16x/14 B	 M
Widefield <sup>++)</sup>	25x/9.5 B	 M

Necessary for widefield eyepieces 16x and 25x: spacer ring (19.2)

+)  
 = with removable or turn-back glare protection: for use with or without glasses

M = adjustable eyelens (dioptre compensation) and mount for graticules of 26 mm diameter → p. 20 and optics data sheet.

++) from the range of Leica AG Heerbrugg/CH (formerly WILD)

Eyepiece tube diameter: 30 mm.



The eyepiece type LEITZ PERIPLAN® may not be used! Eyepieces of the earlier-type L PLAN may only be used with earlier-type tubes (before about 1998) **without** the HC engraving!

### Photo eyepieces and eyepiece adapter tubes

Not for visual observation, only for adaptation of DMLD and MPS photomicro systems, mounting diameter 27 mm, together with special eyepiece adapter tube (46.4).

HC eyepiece 18x/20 PHOTO  
 HC eyepiece 10x/16 PHOTO  
 HC eyepiece 12.5x/13 PHOTO

Eyepiece adapter tube for HC eyepiece 10x/16 (MPS) PHOTO

Eyepiece adapter tube for HC eyepiece 12.5x/13 (MPS) PHOTO

Eyepiece adapter tube for DMLD (10x and 12.5x) PHOTO

### Eyepiece field of view number

For a certain microscope configuration a certain eyepiece field of view number must not be exceeded (see below), e.g. 20. If the maximum field of view is exceeded, there may be a disturbing loss of definition or vignetting at the edge of the image, see following pages!

The eyepiece field of view number (fov) stands for the diameter of the intermediate image in the eyepiece in mm, i.e. the diameter of the circular diaphragm which limits the image format and which lies within the eyepiece.

This fov is indicated on the eyepiece after the magnification, e.g. 10x/20.



The maximum admissible eyepiece field of view number of a certain configuration is derived from the following instrument data:

<b>Field performance of objectives</b>	<b>see below</b>
<b>Field performance of intermediate module(s)</b>	<b>see below</b>
<b>Field performance of tube</b>	→ <b>S. 31</b>
<b>Illumination of condenser</b>	→ <b>S. 32</b>

The decisive value is always the **smallest**. If, for example, the intermediate modules (see below) only allow the field of view number 20, although the objectives and tube allow 25, the maximum field of view number for the eyepieces is 20. Eyepieces with the field of view number 25 can lead to vignetting here. In detail, the following applies:

### Field performance of objectives

The engraving on the objectives does not include their field performance. It can vary slightly within a class of objective, e.g. the lower objective magnifications may well have slightly higher values than the approximate values given below:

Objective series	max. recommended eyepiece fov			
	15	20	22	25
Achromats	████████████████████			
C PLAN achromats	████████████████████			
N PLAN Plan achromats	████████████████████			
PL FLUOTAR® Semiapochr.*	████████████████████			
PL APO Planapochromats*	████████████████████			

Further objective data → p. 27.

\* incl. HC PL and HCX PL models

### Field performance of the intermediate modules

The maximum admissible field performance of the intermediate modules is derived from the type designation listed in the following table and also on your invoice. Each type designation consists of 2 values separated by a slash, e.g. Ergomodule L 2/25.

The first value (2 in our example) is a relative measure (height index) of the overall height of the module. If the height index is multiplied by the factor 15, the distance by which the viewing port or the overall height of the microscope is raised is increased in **mm**, i.e.  $2 \times 15 = 30$  mm (ca.) in our example. The second value (25 in our example) is the maximum field of view number possible with this module.

- Ergomodule L 2/25
- Magnification changer L 3/25
- Pol module A/BL L 4/20
- Tracing device L 3/20
- Dual viewing attachment L 3/20 (2 viewers)
- Multi viewing attachment L 3/20 (in preparation)
- Illuminator LRF 4/22 for fluorescence
- Universal illuminator LU 4/25 und LU P 4/25

### Field of view no. Tubes

The type designation of DM L tubes (Figs. 44, 46) also contains a combination of numbers which indicate the maximum admissible eyepiece fov number, e.g. Binocular tube HC LB 0/3/4.

The numbers have the following meanings (→ table below): the numbers **0/3/4** indicate the maximum permissible height index of the intermediate modules (see section on field performance at the top of p. 30) for the eyepiece field of view numbers **25, 22 and 20** → p. 30).

That is to say, in the above example:

1st number (**0**): Fov 25 is only possible if the tube is directly attached to the microscope, i.e. **without** an intermediate system.

2nd number (**3**): Fov 22 can only be obtained up to height index **3**, e.g. magnification changer L 3/25 can be used.

3rd number (**4**): Fov 20 is possible up to a maximum height index of **4**, e.g. 2 Ergomodules L 2/25.

If there is a dash instead of a number, e.g. *-/-/7*, it means that the tube cannot be used for the corresponding field of view at all, i.e. in the example not for fov 25 and 22, while fov 20 is possible up to index 7.

Overstepping the admissible values can cause vignetting (shading at the edges of the image) with some objectives.

**HC** engraving: Only eyepieces of the type **HC PLAN** and widefield 16x and 25x (→ p. 29) can be used.

Further examples:

**0/4/4** Field of view 25 is only possible with direct tube adaption to microscope stand (height index of intermediate modules therefore 0), providing suitable objectives are used. Fov 20 and 22 can be used up to height index **4**, e.g. with the fluorescence device. The addition of a further module would not be admissible; a solution to the problem would be a tube with the following parameters:

**4/5/7**

Fov 25 is possible up to height index 4 (e.g. 2 Ergomodules L 2/25 or magnification changer L 3/25). Fov 22 is possible up to height index 5, fov 20 is possible up to height index 7, e.g. illuminator L LRF 4/20 plus magnification changer L 3/25.

*-/-/7*

The tube allows fields of view up to **20** mm only. If intermediate modules are used, the sum of their height values must not be higher than 7.

Tubes from the DMR range (Fig. 46): Always fov 25, the fov is limited by the tube adapter HC L/R 4/25 here (45.2, → p. 65).

### Table of tubes

**Binocular tube HC LB 0/3/4 and HC LBP 0/3/4**

**Trinocular tube HC L1T 4/5/7 and HC L1TP 4/5/7**

**Trinocular tube with 3 switching positions**

**HC L3TP 4/5/7**

**Trinocular tube with image erection and 2 switching positions HCL 2TU 4/5/7**

**Ergotube, binocular HC LVB 0/4/4**

**Ergophototube, trinocular HC L1VT 0/4/4**

**DMR tubes incl. adapter HC R/L 4/5/7**

Further details → p. 64.

## Condenser characteristics

Condensers and their correct setting are an important aspect of microscopy. A range of different models is available for the Leica DML microscope series.

Distinguishing criteria are:

**Illumination technique** (BF = brightfield, DF = darkfield, OI = oblique illumination, PH = phase contrast, ICT = differential interference contrast, (P) = polarization contrast, P = quantitative polarization.

**Smallest possible objective magnification** BF, (P), P for 20 and 25 mm field of view. DF, OI, PH and ICT only possible from 10x objective upwards, with the exception of DF with condenser top 0.50/S15: from 5x objective.

**Intercept distance**, i.e. distance between specimen plane at Koehler illumination and the highest point of the condenser (lens or mount).

**Aperture** (dry and/or immersion).

**Ease of use.**

Type designation and aperture	Illumination techniques	Lowest objective magnification <sup>1)</sup>	Intercept distance (ca.)
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### Condensers with non-movable front lens (Fig. 7):

<b>CL/PH 0.90/1.25 OIL<sup>2)</sup></b>	BF, DF, PH, OI	4x/2.5x <sup>1)</sup>	1.5 mm
---	----------------	-----------------------	--------

<b>CLP/PH 0.85</b>	BF, DF, PH, OI, POL	4x/2.5x <sup>1)</sup>	1.7 mm
--------------------	---------------------	-----------------------	--------

for DF, PH, OI: light ring slide

<b>UCL 0.90/1.25 OIL<sup>2)</sup></b>	BF, DF, PH, OI	4x/2.5x <sup>3)</sup>	1.5 mm
---------------------------------------	----------------	-----------------------	--------

<b>UCLP 0.85</b>	BF, DF, PH, OI, POL	4x/2.5x <sup>3)</sup>	1.7 mm
------------------	---------------------	-----------------------	--------

Light rings for DF/PH and  $\lambda$ - and  $\lambda/4$  compensators for Pol and the 2.5x auxiliary lens can be inserted into the rotatable condenser disc (Fig. 9) with 5 positions (centerable).

### Condenser achr. apl. 0.9 (P) with swing-out condenser top

0.9	BF (P)	1.6x <sup>1)</sup>	1.6 mm
-----	--------	--------------------	--------

### Condenser UCA/P with hinged, interchangeable condenser tops (Fig. 10)

(from 1.6x objective with condenser top swung out):

<b>0.90 S1</b>	BF, DF, PH (P) ICT	1.6x	1.35 mm
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<b>P 0.90 S1</b>	BF, DF, PH P ICT	1.6x	1.35 mm
------------------	------------------	------	---------

<b>P 1.40 OIL S1</b>	BF P ICT	1.6x	1.30 mm
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<b>0.50/S15<sup>4)</sup></b>	BF, DF (P)	1.6x	15 mm
------------------------------	------------	------	-------

Light rings for DF and PH, ICT prisms and  $\lambda$ - and  $\lambda/4$  compensators for Pol can be inserted into the rotatable condenser disc (11) with 6 positions (centerable).

### Special darkfield condensers (Fig. 23):

<b>D 0.80 – 0.95</b>	DF (dry) <sup>5)</sup>	10x	1.5 mm
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<b>D 1.22 – 1.44 OIL</b>	DF (Oil) <sup>6)</sup>	10x	1.5 mm
--------------------------	------------------------	-----	--------

<sup>1)</sup> With slot-in diffusing screen, but not for polarized light. Lowest objective magnification for DF, PH, ICT: 10x

After removing the condenser CL/PH, CLP/PH; UCL; UCLP objective magnifications 1.6x and 2.5x (BF and POL) are possible

<sup>2)</sup> Dry, with glycerine and immersion oil (immersion in BF only)

<sup>3)</sup> With 2.5x auxiliary lens

<sup>4)</sup> For 2 mm glass; for every extra mm glass the intercept distance is enlarged by about 0.3 mm, e.g. for 6 mm glass = ca. 16.2 mm

<sup>5)</sup> Max. objective aperture 0.75

<sup>6)</sup> Max. objective aperture 1.10 (iris diaphragm!)

## Total magnification

**Total magnification = objective magnification x eyepiece magnification.**

If using the magnification changer (→ p. 65, Fig. 45.1), multiply the set magnification factor, e.g. 1.5x, as well.

### Examples:

Objective	Eyepiece	Magnification changer	Total magnification	Upper limit of useful magnification	Comment
10x/0.22	10x/20	–	100x	220x	not exceeded
10x/0.22	10x/20	2x	200x	220x	not exceeded
40x/0.60	10x/20	–	400x	600x	not exceeded
40x/0.60	10x/20	1.5x	600x	600x	not exceeded
40x/0.60	10x/20	2x	800x	600x	exceeded

In the last example, therefore, the Useful Magnification has been exceeded, which may result in blurred images.

## Object field diameter

If you divide the eyepiece field of view number by the objective magnification, you obtain the true diameter of the observed object field. The eyepiece magnification is not taken into account in the calculation. With the 10x/25 eyepiece and a 50x objective, for example, an object field of  $25 : 50 = 0.5$  mm can be surveyed.

If the tube factor (TF) is other than 1x, the result must be divided by the tube factor as well.

In the above example, the object field would be  $0.5 : 1.5 = 0.33$  mm with TF = 1.5\*.

## Simple survey magnification

Use a 4x, 5x or 10x objective. For condenser UCA/P, swing in the condenser top. Hold a specimen over the **light exit** in the microscope base instead of putting it on the stage.

## Useful magnification

The total magnification of a light microscope is subject to physical limits known as the useful magnification. This is roughly a **thousand times** the aperture of the objective, → p. 28.



### Caution:

Do not cause any scratches!

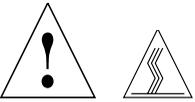
Focus by adjusting the height of the stage (28.7) or the condenser (28.4).

Although this method does not claim to produce a good image, it offers the advantage of great field depth, e.g. for fast scanning of series of specimens in a similar way to a magnifying glass. If the photomicrographic equipment does not comprise a data reflection facility, a labelled piece of foil or paper can be copied onto the beginning of the film, for example, to enable identification in the photo lab.

# Transmitted light, basic setting

## Switching on

Mains connection and fuse → p. 9 – 10.  
Operate mains switch (28.9) so that the integrated coloured pilot lamp lights up. Some versions of the microscope (not illustrated) have a further switch on the right side for switching between the transmitted and incident light halogen lamp.



### Caution:

Keep lamphousings at least **10 cm (4")** away from inflammable objects such as curtains, wallpaper or books! **Fire hazard!**

## Brightness

Adjust the brightness with the dial (28.11). The numbers on the dial are not absolute values, but are intended to enable reproducible settings. The maximum value is about 12 V, the marking point of a colour temperature of approx. 3200 K.

## Brightfield, basic setting

Switch the condenser disc\* (28.15), if present, to the **BF** (= brightfield) position or pull out the light ring slide (7.7).

Move condenser (28.4) as far as the upper stop.

Open the field diaphragm (28.10).

If present:

Pull out the light trap\* (30.5; 39.4).

Set magnification changer\* (45.1) at pos. 1.

If you want to use transmitted light, switch fluorescence illuminator\* into empty position or filter system A (39.2).

## Adjustment specimen

For initial adjustment of the microscope it is advisable to have a specimen that contains areas of high and low contrast. Survey observation → p. 33.

For incident light fluorescence of transparent specimens, adjust in transmitted light first.



### Attention:

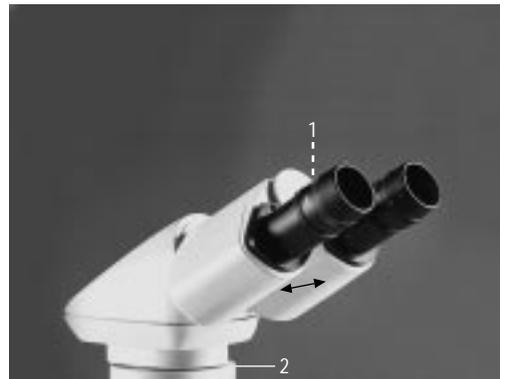
Secure the specimen with object holder (Fig. 15) or specimen clips (not illustrated). The coverglass must point **upwards**.

**Fig. 27** Tube adjustment

↔ Individual interpupillary distance setting

1 Scale (mm), 2 Intermediate module\*, in illustration:

Ergomodule (→ 45.3)



## Focusing

The coaxial controls on each side of the microscope have a total of 5 functions (→ Fig. 28, p. 38):

**Outer knob** (28.8), both sides

Fine focusing, 1 scale unit corresponds to 1  $\mu\text{m}$  vertical travel → p. 59. On some versions of the microscope, the fine focusing has two steps of 1  $\mu\text{m}$  or 4  $\mu\text{m}$  vertical travel per scale unit. To switch over: press focusing knob to the left or right.

**Middle knob** (28.7), both sides

Coarse focusing, total travel ca. 22 mm. On some versions of the microscope, the vertical adjustment range of the stage can be extended by the clamp on the stage bracket (Allen screw, right). Microscopes DM LP and LM only: additional stage height adjustment → special manual.

## Upper stage stop Torque adjustment

**Inner, black knurled wheels** (28.6 and 28.17)

**left:** individually adjustable torque of focusing

**right:** individually adjustable height stop of focusing.

A stop is set at the current stage position by Adjustment  $\uparrow$ .

Cancelling the stop: turn the knurled wheel in the opposite direction  $\downarrow$ .

To adjust torque of the x/y stage movement: Consult Technical Service!

## Setting the tube and eyepieces

For trinocular tube\* with switchable beamsplitter only: Set beamsplitter at visual observation by adjusting the rod (46.4). A key to the switching positions is given in symbols on the side of the tube.

For eyepieces **with inserted graticule\*** only: Bring the object greatly out of focus or remove from the light path and sharply focus the graticule with a relaxed eye by adjusting the eyelens (Fig. 18.4). (The easiest way to relax your eye is to look at a distant object outside the room for a moment.) Focus the object through the eyepiece **with** graticule only. Now close your eye and focus the object only by adjusting the second eyepiece.

Only when **no** graticule is inserted in either eyepiece:

When adjusting the eyelens you will see a light-coloured line (18.5) encompassing the basic part of the eyepiece. This shows the correct position of the eyelens for people with normal eyesight and for spectacle wearers looking through the microscope with corrective glasses.



Glasses with bifocal or progressive lenses must be removed before looking through the microscope.

Only when **one** eyepiece is **without** an adjustable eyelens:

Focus the object exactly through this eyepiece first (close your other eye), then focus the image again by adjusting the eyelens of the second eyepiece.

If wearing glasses you should remove (18.10, for 10x/25) or push back (18.10, for 10x/20 and 10x/22) the glare protection, but make sure to put it on if you are not wearing glasses (18.7).

Set your interpupillary distance by pulling the eyepiece tubes apart or pushing them closer together (Fig. 27) until you see one superimposed image, not a double image, when you look with both eyes. Make a note of your personal interpupillary distance, e.g. 65. In addition for Ergotubes (44.3, 44.5, 46.10): set the viewing angle (0 – 35°) by tilting the binocular viewing port. To avoid fatigue symptoms, vary the viewing angle from time to time.

Close any tube exits you will not be using (44.4; 46.5), as stray light may otherwise disturb viewing.

### Analyser\*

If the microscope has an integrated analyser (28.1, 32.6), fit or remove as required (only necessary for polarized light, → p. 46 and interference contrast → p. 48).

### Filters

Light filters (→ Figs. 4 – 6; 21.6, 32.1; 33.7, "optics" data sheet). Here are the functions of the most important filters:

Filter	Application
<b>Grey filter N/Neutral density filter</b>	Grey filters (neutral density filters) are used to attenuate light without influencing the colour temperature. The engraved value, e.g. N16, indicates the attenuation value. N16, therefore, means reduction to $f^{1/16} = 100/16 = 6.25\%$ transmission.
<b>Green filter, GR</b> panchromatic	Contrast enhancement for black-and-white photography.
<b>DLF</b>	Conversion filter (blue daylight filter, similar to CB12) for colour photography with daylight film, integrated in filter magazine.
<b>BG 38</b> (blue filter)	Suppression of red in fluorescence (is integrated in fluorescence illuminator [39.8]).
<b>ALF</b>	Artificial light filter for colour photography with artificial light film, to enhance colour contrast.
<b>BG 20</b>	Highlights red in Polaroid exposures.
<b>VG 9</b> (green filter)	Contrast enhancement in chromosome photography.

CB1.5, CB3

Blue conversion filters. Raise the colour temperature for special lamps.

CR1.5

Red conversion filter. Lowers the colour temperature, e.g. from 6000 K (colour temperature of an Xe lamp) to 5500 K (colour temperature of daylight film).

BG 23

To enhance the contrast of the complementary colours blue and red for black-and-white film.

### Filter systems for fluorescence

→ Data sheet for optics

### Brightfield, Koehler illumination\*

Turn a 10x objective into the light path and focus the specimen (28.7; 28.8). Condenser UCA/P\* only: **engage** the condenser top (10.1 and 10.4). The condenser top is **swung out** for objective magnifications < 10x.

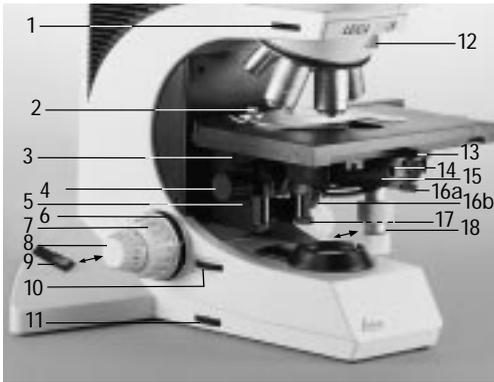
### Condensers Field diaphragm\*

Close the field diaphragm (28.10). Narrow the aperture diaphragm (28.14) if necessary. Rotate the condenser stop screw (28.5) clockwise and move the condenser to the highest position with the height adjustment (28.4, bilateral). Click the condenser disc\* (28.15) into the "**BF**" = brightfield position or pull out the light ring slide\* (7.7) as appropriate.

By rotating the condenser stop screw (28.5) or the condenser height adjustment (28.4), lower the condenser until the edge of the field diaphragm appears sharply focused (29b). In addition, centre the image of the field diaphragm with both centering screws (28.16a/b), i.e. until it is in the centre of the field of view (29c).

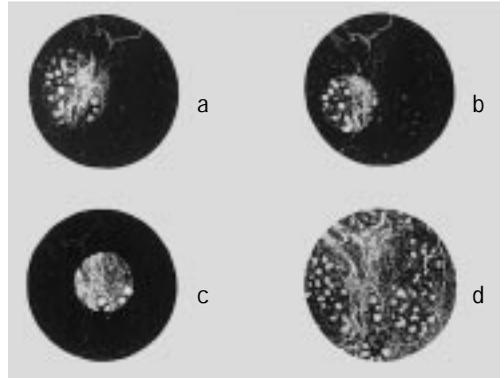
**Fig. 28** Transmitted light controls (in this example: UCL condenser)

1 Analyser slot, 2 Fastening of object holder, → Fig. 15, 3 Hole for centering key\* (UCL condenser, → Fig. 9.3), 4 Condenser height adjustment (bilateral control), 5 Adjustable condenser height stop, 6 Torque adjustment, focusing, 7 Coarse focusing, 8 Fine focusing, (two-step\* ↔), 9 Mains switch and pilot lamp, 10 Field diaphragm\*, 11 Brightness control, 12 Mount for IC prisms and compensators (tube slit), 13 Clamp screw for stage rotation, 14 Aperture diaphragm, 15 Condenser disc\*, → Fig. 9, 16a, b Condenser centration, 17 Stage height stop, 18 x, y stage movement



**Fig. 29** Koehler illumination

**a** Field diaphragm not focused, not centered, **b** Field diaphragm focused, but not centered, **c** Field diaphragm focused and centered, but diameter too small, **d** Field diameter = field of view diameter (Koehler illumination)



Open the field diaphragm (28.10) until it just disappears from the field of view (24d). When changing an objective the condenser centration may have to be slightly adjusted.

The field diaphragm (28.10; 29c/d) protects the specimen from unnecessary warming and keeps all light not required for image formation away from the object to enable greater contrast. It is therefore only opened just wide enough to illuminate the viewed or photographed object field. A change in magnification therefore always necessitates matching of the field diaphragm. Light path → p. 6.

### Aperture diaphragm

The aperture diaphragm (28.14, 7.6, 10.6) determines the resolution, depth of field and contrast of the microscope image. The best resolution is obtained when the apertures of the objective and the condenser are roughly the same.

When the aperture diaphragm is stopped down to be smaller than the objective aperture, resolving power is reduced, but the contrast is enhanced. A noticeable reduction in the resolving power is observed when the aperture diaphragm is stopped down to less than 0.6x of the objective aperture and should be avoided where possible.

The aperture diaphragm is set according to the viewer's subjective impression of the image, the scale on the dial is just to allow reproducible settings and does not represent absolute aperture values. In principle you can do a calibration yourself by comparison with the apertures of various objectives. Visual comparison of the apertures of the objective and the condenser can be made as follows: Remove the eyepiece from the eyepiece tube or use an auxiliary telescope (Fig. 30.1) (→ p. 43) and focus. Close or open the aperture diaphragm until its image is just visible in the objective pupil (brighter circle). This is considered the standard setting, i.e. condenser aperture = objective aperture. Replace the eyepiece.

For objects with low contrast the aperture diaphragm can be stopped down further to highlight faint specimen details. In polarized light microscopy, narrowing the aperture diaphragm usually results in brighter colours.



#### n.b.:

The aperture diaphragm in the **illumination light** path is **not** for setting the image brightness. Only the rotary brightness adjustment knob or the neutral density filters should be used for this.

# Operation of transmitted light

An aperture diaphragm in the **objective** (Fig. 25.4) is normally fully opened. The reduction in image brightness caused by stopping down results in:

- Greater depth of field
- Less coverglass sensitivity (p. 27)
- Suitability for darkfield (p. 44)
- Change in contrast

## Objective magnifications 1.6x and 2.5x\*

Lowest magnification, see also p. 32.

Condensers CL/PH or CLP/PH and UCL or UCLP: (→ p. 13): objective **4x**. With slot-in diffusing screen in slide 2.5x, but not for polarized light.

Condensers UCL/UCLP with auxiliary lens 2.5x (9.7): **2.5x** objective.

First **disengage** the lens for the 2.5x objective (9.7) (switch to PH or BF position), set Koehler illumination → p. 37 (Fig. 29) with 4x or 10x objective.

Engage lens for 2.5x objective with condenser disc (28.15) (not possible with CL/PH or CLP/PH condenser).

Open the aperture diaphragm (28.14) as far as the stop.

Narrow the field diaphragm (28.10). In case of arc-shaped vignetting, **center the lens**: insert both centering keys (9.5) into the UCL or UCLP condenser (9.3; 28.3) at an angle from the back and adjust until the **asymmetrical** vignetting disappears. Remove the centering keys and open the field diaphragm.

The lens can only be used up to an objective magnification of max. 20x. Exact Koehler illumination (→ p. 37) can no longer be obtained!

Magnifications of **1.6x** and **2.5x** are also possible with the CL/PH or CLP/PH and UCL or UCLP condensers (→ p. 13) if the condenser is removed completely. The field diaphragm then takes over the function of the aperture diaphragm.

## Condenser tops\*

UCA/P condenser (Fig. 10) andachr. apl. 0.9 (P): from **1.6x** objective (the slot-in diffusing screen (see p. 14) must be used on the condenserachr. apl. 0.9 (P), max. eyepiece fov 22).

The condenser top (10.1; 12) is disengaged for objective magnifications 1.6x and 5x, and engaged from 10x upwards. The functions of the aperture and field diaphragms are then cyclically exchanged.

The oil immersion condenser top can be used to enhance resolution with objectives of 1.0 aperture or higher, condenser top **S15** for long free working distances, e.g. for heating stages. When thick glass windows are used, the total working distance (distance between the condenser top and the specimen plane) increases by approx. 1/3 of the glass thickness. Condenser tops with the engraving **P** are required for quantitative polarization microscopy as they are especially low in strain.

# Operation of objectives

## Immersion objectives\*

**OIL:** only use optical immersion oil (30.4) of DIN/ISO standard. Cleaning → p. 62. Lettering → p. 27 – 28 and p. 41.

**W:** Water immersion, used distilled water if possible.

**IMM:** Universal objective for water, glycerine or oil.

To immerse: Lower the stage or turn the objective slightly out of the light path, apply 1 – 2 drops of immersion oil to the specimen, taking care to avoid bubbles.



### Attention:

Focus carefully, as the working distance of immersion objectives is usually extremely short. Be careful with objectives with front locking device!

## Locking of objectives

Some immersion objectives (identified by a knurled grip, Fig. 25) can be shortened by pushing in the front part by about 2 mm and rotating slightly. This stops any remaining drops of immersion liquid from wetting objects and other objectives when the nosepiece is turned.



### Attention:

This locking device must be released before the immersion objective is used again, as otherwise the spring mechanism protecting the specimen and the objective is inactive and the other objectives are not parfocal with the immersion objective.

## CORR objectives

Special objectives which can be adjusted to different coverglass thicknesses: set the correction mount (not illustrated) roughly to an average or estimated value by turning the knurl. Focus the specimen (→ Fig. 25).

Adjust the correction mount until you obtain optimum contrast, possibly refocusing with the fine drive. This setting may be extremely difficult with low-contrast or featureless specimen areas.

## Colour coding of objectives

As per DIN/ISO standards, the magnification of each objective is indicated by a colour ring:

100x 125x 150x 160x	63x	40x 50x	25x 32x	16x 20x	10x	6.3x	4x 5x	2.5x	1.6x
white	dark blue	light blue	dark green	light green	yellow green	orange	red	brown	grey

Immersion objectives have a second coloured ring (Fig. 25) further down:

**black** Oil or Imm (= universal objective for oil, water, glycerine)

**white** water

**orange** glycerine

# Operation of phase contrast

## Immersion condensers

The condensers CL/PH 0.90/1.25 **OIL** and UCL 0.90/1.25 **OIL** (Fig. 7) are usually used **dry**. The maximum illumination aperture is then 0.90. Both condensers can also be used with immersion oil (30.4). 1 – 3 drops of immersion oil are applied to the front lens, the specimen is put on the stage, avoiding air bubbles, and Koehler illumination is set as usual, → p. 37. The optical coupling medium then allows apertures of up to max. 1.25, i.e. an improvement of the resolving power of high-aperture oil objectives (e.g. 100x/1.25 **OIL**), although only for brightfield. See p. 62 on how to remove the oil.



You can also use glycerine instead of oil. The Pol condensers CL P/PH 0.85 and UCL P 0.85 can only be used dry.

The condenser top P 1.40 OIL S1 (Fig. 12) can also be used on the UCA/P condenser (Fig. 10) for enhancing resolution for objectives with apertures from about 1.0.

## Brightfield

Illumination techniques which display the empty areas of the specimen as the brightest parts of the image are called brightfield. Light-absorbing object structures are required for this type of imaging, i.e. it usually makes sense to stain the specimen first. Optical contrasting techniques offer an alternative (PH, DF, POL etc.).

## Possible errors

Wrong coverglass thickness (→ p. 27) or wrong objective. Specimen has been placed on stage with coverglass downwards instead of upwards. Aperture diaphragm (28.14) opened too wide or closed. Condenser at wrong height or wrongly centered. Light ring engaged by mistake (28.15; 7.2; 7.7).



Lamp not inserted straight (→ p. 21). Dirty optics.

2.5x lens not centered.

## Phase contrast

Similar to transmitted light darkfield (→ p. 44), phase contrast is used to form high contrast images of unstained specimens.

Turn the phase contrast objective (engraving PH, Fig. 25) with the lowest magnification (usually 10x) into the light path and focus the specimen. If you have difficulty in finding the object plane: Temporarily narrow the aperture diaphragm (28.14) or use a stained specimen. Set the condenser disc in the **BF** position (28.15) or pull out the light ring slide (7.7).

Set Koehler illumination (→ p. 37): Focus the field diaphragm together with the object by x, y and z adjustment of the condenser.

Set the light ring corresponding to the objective engraving (e.g. PH 1) on the condenser disc (28.15) or use the light ring slide (7.7).

The double engraving  $\lambda$  and  $\lambda/4$  on the UCL condenser disc is without significance here (the disc can be optionally equipped with light rings, whole- and quarter-wave compensators for polarization (9.6) or with the 2.5x lens (9.7)). Individual labels can be stuck onto the UCA disc (10 and 11).



Make sure to open the aperture diaphragm (28.14) (= pos. **PH**).

## Auxiliary telescope

Insert an auxiliary telescope\* (30.1) into the observation tube in place of an eyepiece. Slightly loosen the clamp ring (30.3) and focus the annular structures by adjusting the eyelens (30.2). Retighten the clamp ring. This does not apply for CL/PH and CLP/PH condensers (7.4).

## Centering the light rings

Condensers UCL/UCLP and UCA/P (Figs. 7 and 10):

Insert both centering keys (7.5; 8.3) at the back of the condenser (9.5; 9.3; 11.3a/b) and adjust until the dark ring (PH = phase ring in objective) coincides with the slightly narrower bright ring (LR = light ring in condenser) → Fig. 31a – c.

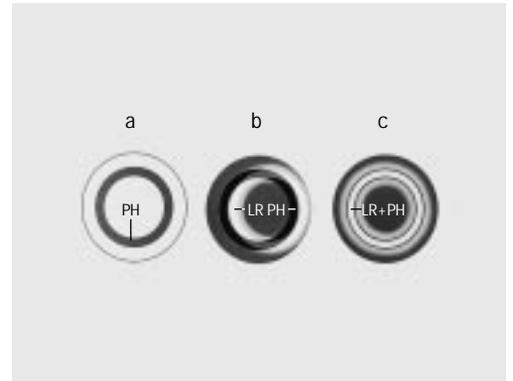
**Fig. 30**

1 Auxiliary telescope, 2 Adjustable eyelens, 3 Clamp ring for fixing the focus position, 4 Immersion oil, 5 Light trap for fluorescence (interruption of transmitted light, → 39.4)



**Fig. 31** Centration process for phase contrast, observed with an auxiliary telescope

**a** Condenser in brightfield position (BF), PH = light ring in objective, **b** Condenser in PH position, light ring LR not centered, **c** Light ring and phase ring centered



# Operation of transmitted light darkfield

Watch the quality of the phase contrast image. If using the auxiliary telescope, watch the image with one eye through the eyepiece. Then repeat the centration process for the other objective light ring combinations.

CL/PH condenser (7.4; 7.7): Centration of the light ring is not necessary.

## Possible errors

Specimen: too thick, too thin, too brightly stained; refractive index of mounting medium and specimen identical so that there is no phase jump.

Specimen slide too thick, so Koehler illumination not possible.



Wedge-shaped coverglass position, so centration of light and phase ring is no longer effective.

Wrong light ring, or light ring has been inserted upside down (see assembly → p. 12). Aperture diaphragm not open. Light ring not centered. Wrong condenser top (UCA/P: 0.90 S1 only!).

## Transmitted light darkfield with CL/PH and CLP/PH, UCA/P condensers

Darkfield is possible with most objectives from 10x magnification; the image background may be inhomogeneously illuminated at lower magnifications.



## Attention:

The highest possible objective aperture is **0.75**, although objectives with higher apertures can be used if it is possible to reduce the aperture with a built-in iris diaphragm. These objectives can be identified by the fact that the maximum and minimum apertures are given in the objective engraving and in our lists, e.g. 1.30 – 0.60 (Fig. 25.4).

Rotate the condenser disc (28.15) to position **BF** or pull out **DF** light ring slide (7.7) as far as the stop. Focus the specimen (10x objective). If you have trouble finding the specimen plane, temporarily close the aperture diaphragm (28.14).

Set Koehler illumination (p. 37) (sharply focus the centered field diaphragm together with the specimen, Fig. 29).

Open the aperture diaphragm as far as the stop (= **PH** pos.) and turn the disc to Pos. **D** (= darkfield ring) or insert slide with DF light ring into condenser CL/PH or CLP/PH (Fig. 7). If the DF image is inhomogeneous with a homogeneous specimen, centre the DF light ring as follows (does not apply for CL/PH and CLP/PH condenser, Fig. 7.4): Use an objective with a high magnification (40x – 100x), observe without an eyepiece or insert auxiliary telescope (30.1) and focus. Put the two centering keys into the condenser (28.3) from the back at an angle and adjust until the brighter circle (objective pupil) is no longer asymmetrically illuminated. Optimize image homogeneity by slightly adjusting the height of the condenser.

## Transmitted light darkfield with special darkfield condenser

The application potential of the DF condensers (Fig. 13) depends on the aperture of the objective in use. For objectives with built-in iris diaphragm (25.4), the aperture can be adapted.

DF condenser:	max. objective aperture:
D 0.80 – 0.95	0.75
D 1.20 – 1.44 OIL	1.10

Phase contrast objectives do not produce as good a darkfield image for critical specimens as brightfield objectives.

After turning the screw (28.5) clockwise, move the condenser height stop to the top position (28.4).



Carefully clean both sides of the specimen. Traces of dust and oil film on the glass surfaces and air bubbles in the mounting medium considerably reduce the quality of the darkfield image!

Put the specimen on the stage.

Focus the specimen with the 10x objective, open the field diaphragm (28.10).

Adjust the condenser in x, y and z direction (28.16a/b) until the field is as homogeneously illuminated as possible, narrowing the field diaphragm again (28.10; 29c). You can now

switch to objectives of higher magnifications. Only the observed object field should be framed with the field diaphragm.

## Immersion darkfield

See above for assembling the immersion condenser. Apply a drop of oil to the front part before putting the specimen on the stage. Take care to avoid air bubbles. The setting is equivalent to “Transmitted light darkfield with CL/PH and CLP/PH, UCA/P condensers” → p. 44.

## Possible errors

Darkfield illumination shows up the slightest inhomogeneities in the specimen. However, as dust particles and finger marks on either side of the specimen and on the front lenses of the objective and condenser cause light scattering and diffraction, great care must be taken to keep the specimen surfaces and adjacent lenses absolutely clean!



If the objective aperture is greater than the above limit of 0.75 or 1.10, or if the condenser is greatly decentered, the image will resemble that obtained in brightfield.

# Operation of oblique illumination, polarization

## Oblique illumination\*

To obtain a relief-like contrast; push DF slide (CL/PH and CLP/PH condenser; 7.7) in part way or rotate condenser disc (18.15) slightly out of the DF position (open aperture diaphragm).

## Assembly of polarizers\*

Push the **analyser** (32.6) into the microscope stand (33.1). The engraving  $\lambda$  must be on the underneath. When incident light illumination is switched on, the analyser must be pushed into the slot of the illuminator (on the left side). The rotatable analyser\* (not illustrated) is turned to the zero position.

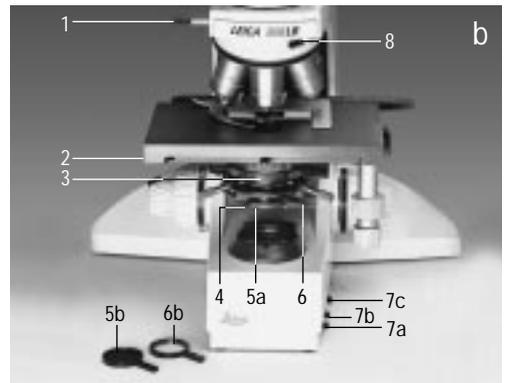
There is also an optional intermediate tube Pol\* (Pol module A/BL) with switchable analyser and Bertrand lens (not illustrated).

**Fig. 32** Accessories for contrast techniques\*

1 Filter holder, → Fig. 5b and 33.4, 2 Transmitted light polarizer IC/P, → (34.9 and 6.2), 3 Polarizer, Ø 32 mm, → (33.5a/b), 4 Compensator Ø 32 mm, in the example  $\lambda$  compensator, for mounting in filter holder (33.6a) or in polarizer IC/P (34.4), 5 Light filter Ø 32 mm, for filter holder (33.1), and for incident light universal illuminator, 6 Analyser, → (33.1), 7 Compensator for tube slit → (33.8), in the example  $\lambda$  compensator, 8 IC prism, for tube slit (33.8, 34.6), in the example for objectives with pupil position D, → p. 50 and 28, 9 Light ring slide for CL/PH and CLP/PH condensers, → p. 42 – 44

**Fig. 33** Polarization contrast\*, transmitted light

1 Analyser, → (32.6), 2 Clamp screw for stage rotation, 3 Aperture diaphragm, 4 Filter holder, → Fig. 32.1, 5a, b Polarizer, Ø 32 mm, 6a, b  $\lambda$ - or  $\lambda/4$  compensator, Ø 32 mm, 7a, b, c Switch lever for transmitted light filter magazine, → Fig. 4, 8 Mount for IC prisms and compensators (with dust protection flap)



**Polarizer:** Attach filter holder (32.1) to the condenser holder (33.4; 5.2), → p. 11. Push the polarizer (33.5a/b) into the **lower** opening.



**Attention:**

Always use the polarizer with the labelled side **upwards**, as otherwise the integrated heat protection filter is ineffective and the special polarizer will become useless (discolouring!). Alternatively, use polarizer ICT/P\* (32.2; 34.9).



**Condenser:** The standard condensers CL/PH and UCL 0.90/1.25 OIL S1 are **not** suitable for polarization, as there may be major lens strain. The Pol condenser CLP/PH 0.85 S1 or UCLP 0.85 S1 is required. Apart from the engraving **0.85**, they look just like the standard condensers (Fig. 7) or the UCA/P condenser (Figs. 10, 11, 12) from the outside.

**Crossing the polarizers**

Remove the object or find an empty area of the specimen. Push the analyser into the stand as far as the 2nd clickstop (33.6 and 34.1), or switch on the module (not illustrated). Turn the hinged analyser outfit (not illustrated) into the marked centre position. Remove compensators (33.4; 33.7; 33.8; 9.6; 11.10) from the light path. Rotate the polarizer (33.5a or 34.8 and 34.9) until you reach the maximum extinction position in the eyepiece.

**$\lambda$ - and  $\lambda/4$  compensator**

To activate the compensator ( $\lambda$  = 1st order red = gypsum plate = wave plate = sensitive tint or  $\lambda/4$  = mica plate): push in the analyser (32.6) upside down. Alternatives:

Insert the  $\lambda$  or  $\lambda/4$  compensators (33.6b) above the polarizer (33.6a) and rotate to the left, roughly as far as the stop. The disc (9.6; 11.10) can also be equipped with a whole- and quarter-wave compensator, or 4 x 20 mm compensators (32.7) can be pushed into the tube slit (33.8) or  $\lambda$  compensator in slide for condenser CLP/PH.

**Possible errors**

Polarizers damaged (discoloured) by powerful light sources or dirty.  
Objectives or condenser strained through mechanical damage or wrong condenser (CL/PH and UCL cannot be used!)  
Beamsplitter or filter or diffusing screen between the polarizers.  
Mounting medium or specimen slide or coverglass birefringent.  
Further sources of error → p. 42.

# Operation of transmitted light interference contrast

## Condenser for interference contrast

**n.b.:** Only use the condenser tops 0.90 S1 or P 0.90S1 and P 1.40 OIL. The condenser top with long working distance 0.50 S15 (p. 14) is not designed for ICT work, → optics data sheet. Assembly → p. 11, 46.

## Crossing the polarizers



**To obtain a good quality ICT image, the analyser must be set exactly at 0 (rotatable version, not illustrated) and the polarizer must be exactly crossed (extinction position)!**

Push the analyser (32.6) into the microscope as far as the second clickstop (34.1). Alternatively, the Pol intermediate tube, (Pol module A/BL, not illustrated) can be used. When incident light illumination is switched on, the analyser must be pushed into the slit on the left of the illuminator (not illustrated).

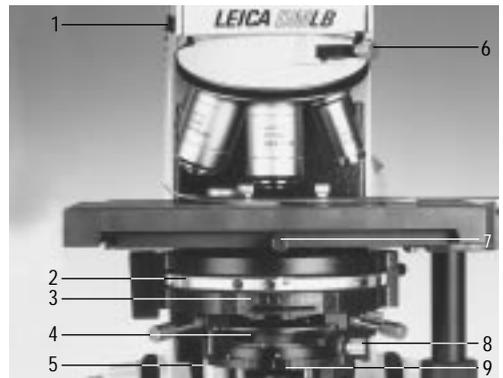
**Rotatable analyser only:** Loosen analyser clamp (not illustrated) and set so that the two line markings are exactly opposite each other.

Turn the disc in the UCA/P condenser (34.2) to the brightfield position (HF or BF), the condenser prisms are then disengaged. Switch off the incident light reflector\* (39.2).

Pull the objective prism slide (32.8) fully or partly out of the tube slit (34.6).

**Fig. 34** Transmitted light interference contrast ICT and transmitted light polarization

1 Analyser → (32.6), 2 Condenser disc\*, with ICT condenser prisms, 3 Aperture diaphragm, 4 Slit for compensators  $\lambda$  and  $\lambda/4$  with  $\varnothing$  32 mm, → (32.4), 5 Polarizer fixing screw, → Fig. 5 and 6, p. 11, 6 Tube slit for IC prisms or 6 x 20 mm compensator, → (32.7 and 32.8), 7 Clamp screw for stage rotation, 8 Clamp screw for polarizer rotation, 9 Polarizer, rotatable ↔



Focus the specimen. It may be easier to focus a stained specimen first or the edge of the coverglass. Set Koehler illumination exactly (→ p. 37), then find an empty area of the specimen or remove the specimen.

Engage the polarizer (34.9 or 33.5a) and turn it round the zero position until the optimum extinction position is observed through the eyepiece. This setting can be found particularly accurately with a high magnification objective (40x or 63x) as follows:

Open the aperture diaphragm (34.3) as far as the stop, swing in the condenser top (10.1; 10.4). Using the auxiliary telescope in place of an eyepiece, focus by moving the front piece (30.2) fix with (30.3) or just remove an eyepiece and observe without an eyepiece. The polarizers are exactly crossed when the two branches of the hyperbola are as near to each other as possible (35b) or form a blurred cross (35a).

Fix this crossed position with the clamp screw (34.8).

## Adjustment of the condenser prisms

If the equipment was delivered together, the condenser prisms will already have been adjusted at the factory, but it is advisable to check the adjustment from time to time, especially after transport:

Pull out the objective-side prism slide (34.6; 32.8) fully or partway.

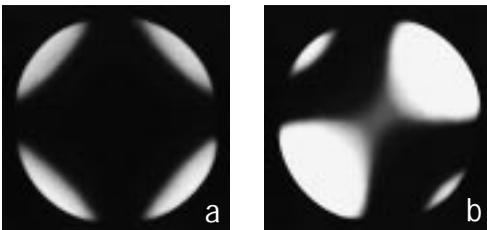
Swing in the condenser top (10.4 or 10.1). Use the auxiliary telescope (30.1) in place of an eyepiece.

Engage the condenser-side prisms (34.2; 11.5) one after the other and focus (30.2 and 30.3) the auxiliary telescope on the dark diagonal compensation stripe (Fig. 36). The compensator must be inactive, i.e. the engraving  $\lambda$  must be on the lower side of the analyser (34.1) or the  $\lambda$  and  $\lambda/4$  plate (32.4) must be removed.

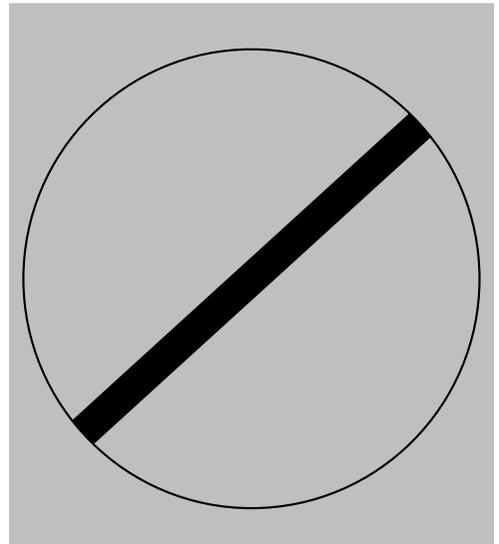
**Fig. 35a, b** Crossing the polarizers when observing through an auxiliary telescope or Bertrand lens, high-aperture Pol objective

**a** exactly crossed, **b** not exactly crossed

Pos. **a** cannot be set if there is strain in the condenser or objective, Pos. **b** is adequate for ICT and polarization contrast



**Fig. 36** Objective pupil with correctly centered compensation stripe



The dark stripe should be in the centre of the brighter circular area (Fig. 36). If not, proceed as follows: push in the left-hand centering key (10.3b) on the back of the condenser until it clicks into position and rotate it until the stripe is in the centre of the circle. The right-hand key is not required. However, make sure that the left-hand centering screw for light rings is not turned too far inwards or it may obstruct the movement of the prism with the left-hand key.

### Objectives for ICT

Transmitted light interference contrast is possible with objectives that have the letter indicating the pupil position, e.g. D, in the first line of engraving (p. 27), and which are listed as suitable for ICT on the optics data sheet.

A condenser prism, e.g. K<sub>2</sub>, must also be available for the objective.

### Choice of prisms

Insert the objective prism slide (32.8) into the tube slit (34.6). The code letter, e.g. D, must coincide with the code letter in the objective engraving (→ p. 27).

Select the condenser-side prism (34.2) that corresponds to the magnification of the objective used, e.g. pos. 20/40 for 20x and 40x objectives, → note on p. 15.

Swing in the condenser top 0.90 S1 (or 1.40 OIL). Set Koehler illumination exactly (→ p. 37). This is made easier by temporarily focusing a stained specimen or the edge of the coverglass.

### Setting ICT contrast

Carefully adjust the objective prism slide with the adjustment screw (34.6) to obtain an optimum image. Also adjust the contrast with the aperture diaphragm (34.3). Particularly sensitive setting is possible with the  $\lambda/4$  compensator (32.4), which is inserted into the holder under the condenser (34.4) and rotated (objective prism roughly at the centre position). Optimum contrast for specimens with parallel structures can be obtained by rotating the stage (34.7).

### $\lambda$ compensator

Colour contrast: Insert the  $\lambda$  compensator (32.2) above the polarizer (34.4 or 33.6a) and rotate.

### Preparation

ICT gives best results for unstained, relatively thin, **non**-birefringent specimens. Interpretation of birefringent specimens can be extremely difficult, if not impossible. It may be helpful to rotate the specimen to an optimum azimuth position.



### Attention:

Specimen slides, coverglasses and embedding resins of birefringent material may not be used.

## Preparation errors

### Possible sources of error if ICT image quality is unsatisfactory:

Embedding medium, specimen slide (petri dish) or object (e.g. crystals, fibres) are of birefringent material. The phase shifts caused by birefringence disturb the interference contrast image. This can sometimes be remedied by rotating the specimen.

The specimen is too thick or too thin.

The specimen slide or coverglass is too thick.

The difference in the refractive indices of the specimen and the embedding medium is too small (this often happens when uncovered specimens are observed with an immersion objective).

Inhomogeneous mounting medium.

Objects with parallel structure: object is at a wrong azimuthal orientation (remedy: rotate object with stage (34.7)).

### Errors in instrumentation

Polarizers not engaged, or rotated too far out of the crossed position, or, though crossed, turned out of the zero position.

Polarizer has been damaged by powerful light sources. Check this by holding the polarizer against a window or light source. Damaged light sources then show distinctly uneven colouring.

The IC prisms in the condenser are in the wrong position or upside down (→ p. 15) or decentered (Fig. 36). This is checked by combining an IC prism with all available objectives and seeing if the interference contrast image is optimal at corresponding magnifications of the objective and the condenser.

The condenser top is not engaged or the wrong condenser top is being used (only 0.90 S1, 0.90 S1 or P 1.40 OIL, see optics data sheet).

Koehler illumination not set (image of field diaphragm in the specimen plane).

Aperture diaphragm too wide or too narrow.

Dirty optics or polarizer.

### Dust protection

Turn the condenser prism out of the light path if it is not being used for a long time, keep objective prisms in a dust-free place. Clean condenser front lens frequently.

# Incident light techniques

## Switching on the incident light source

The following incident light techniques are described in the special supplementary manual for DMLP (polarized light) and the DMLM (material testing):

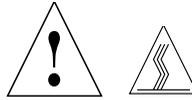
Brightfield BF, darkfield DF, polarized light Pol, ICR interference contrast.

Switch on the lamp at the microscope (28.9) or the external power unit. Hg lamps take a few minutes to achieve their full intensity, and do not ignite when hot!



### Attention:

For microscopes with transmitted/incident light switchover on the right side of the microscope base (not illustrated): switch to incident light. Move the filter system or reflector (Fig. 16, p. 18) into the light path (39.2). Open the light trap (39.9). Remove any diffusing screens\* from the light path.



### Caution:

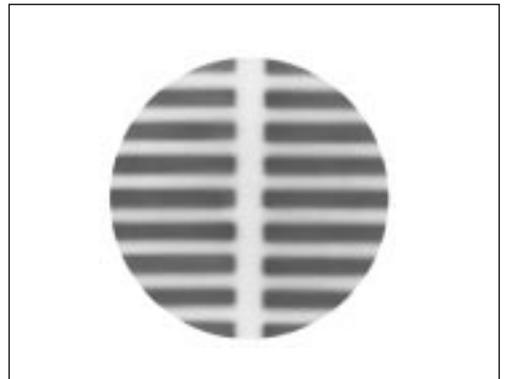
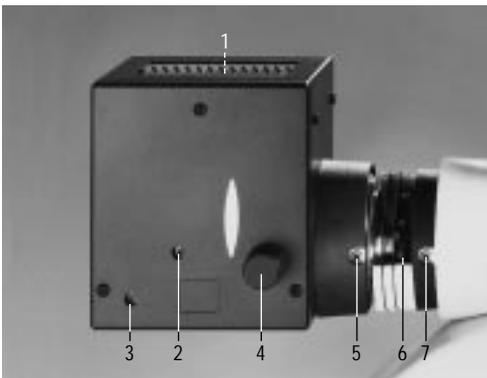
Make sure to adjust the light source immediately, then form an image by one of the following methods (Fig. 38 and 41), does not apply for Lamphousing 105/2 and 107 (without centration).

**Fig. 37** Lamphousing 106 (with 12 V 100 W halogen lamp)

1 Screw for opening the lamphousing, 2, 3 x/y lamp centration (holes for Allen centering keys or 3 mm screwdriver, 4 Collector focusing, 5, 7 Clamp screw, 6 Filter holder (intermediate piece)\* for Ø 50 mm filters, pos. 3 and 4 do not apply for Lamphousing 105/2 and 107 (not illustrated)

**Fig. 38** Lamphousing 106

Reflection of the lamp filament, greatly schematized: in reality the reflection is extremely low in contrast, the bright overlap area is wider and less defined. With Lamphousing 106 z the reflection is rotated by 90°, → Fig. 41c



## Imaging the light sources to check adjustment

### Projection without objective (method 1)

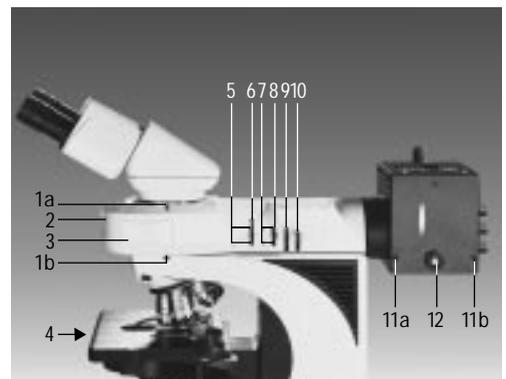
Put a piece of paper or similar on the specimen stage and roughly focus the surface with a dry objective of low to medium magnification. Set the field and aperture diaphragms (39.6 and 39.8) roughly at the centre position. With a felt or ballpoint pen, make a dot or cross at any position on the paper and slide it into the small illuminated field. Maybe fix the paper in position. Turn a vacant nosepiece position into the light path or remove the objective: The light source (38, 41) will then be imaged on the paper via the beamsplitter/filter cube. Cont. → p. 54.

### Projection on the microscope base (method 2)

Pull the light stop\* (30.5) out of the stage (39.4). Center the condenser at least roughly → p. 37. Remove the specimen. Turn a 4x, 5x or 10x objective into the light path. Switch the condenser disc\* to the BF position (7.3) or pull out the light ring slide (7.7). Open the aperture diaphragm in the condenser (28.14). Put a piece of paper on the microscope base. Adjust the height of the stage (28.7) or condenser (28.4) until the bright circle (= image of the objective pupil) is quite sharply defined. Set the field and aperture diaphragms in the illuminator (39.6 and 39.8) roughly at the centre position. Mark the middle of the bright area.

**Fig. 39** Incident light fluorescence illuminator LRF 4/22

**1a, b** Fixing screws, **2** 4-position filter wheel, **3** Cover, with indentation grip x in housing, **4** Light trap\* (light stop for transmitted light), insertable in mechanical stages, concealed in the illustration, → (30.5), **5** Holes for centering keys (field diaphragm), **6** Field diaphragm adjustment, **7** Holes for centering keys (aperture diaphragm), **8** Aperture diaphragm adjustment, **9** Light stop (dark flap), **10** BG 38 filter, **11a, b** Fixing screws for flip-up lid of lamphousing 105 z, **12** Cut-out plug, → Fig. 22.11



## Halogen lamps: LH 106

Adjust the collector (37.4) until you see the lamp filament (Fig. 38). If using the fluorescence illuminator, you will only be able to see a few coils of the filament.

Using a hexagonal screwdriver (2.2) adjust the horizontal position (37.3) of the lamp holder until the slightly brighter stripe in the reflection of the lamp filament is in the centre of the brighter area (Fig. 38), as marked by the dot you made. Then move the reflection of the lamp filament with the vertical adjustment (37.2) to the centre of the range of movement.

No adjustment is needed for lamphousing 105/2 (not illustrated). It is very important that the lamp sits straight in the holder.

## Halogen, Xe and Hg lamps: LH 106 z

### Lamphousing 106 z: Halogen, Xe, Hg lamp (Fig. 40 and 41).

The image of the light source is focused with the collector (40.6), if using the fluorescence illuminator you will only be able to see a few coils of the lamp filament.

The adjustment principle is similar for all light sources:



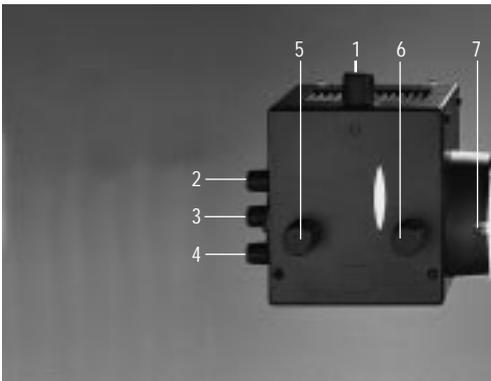
Move the **reflection** of the lamp filament or discharge arc to side (41a) by turning the adjustment screws on the back of the lamphousing (40.2 and 40.4).

Focus the **direct image** of the filament or discharge arc (40.6) and adjust as follows (41b, 40.1/40.5 and 40.6):

**Halogen lamps:** just above or below the center marking you made (Fig. 41b), or, especially for higher objective magnifications, as for the Xe lamp (Fig. 41c), i.e. in the centre = superimposing.

Fig. 40 Lamphousing 106 z

1 Vertical lamp adjustment, 2, 4 Vertical and horizontal adjustment of the reflection, 3 Mirror focusing, 5 Horizontal lamp adjustment, 6 Collector (focusing of lamp filament), 7 Fixing screw



Move the **reflection** into the brighter circular area (40.2 and 40.4), focus (40.3) and align symmetrically to the direct image (41c). Alternatively, the images can be made to coincide, as with Hg and Xe lamps.

### Mercury (Hg) and Xenon lamps (Xe)

Move the **direct** image (41b) to the **centre** of the brighter circle with the horizontal and vertical (40.5 and 40.1) adjustment of the holder. Move the reflection into the brighter circular area (40.2 and 40.4), focus (40.3) and adjust the mirror until the reflection **coincides** with the direct image (41c).



**Attention:**

#### Caution with He and Xe lamps:

Be careful not to project the reflection on the electrodes for long, as there is a **risk of explosion** if they overheat. The two electrodes can just be seen in the extension of the symmetry plane of the discharge arc. Replace spent burners in good time and dispose of in an environment-friendly way. Do not open the lamphousing until the lamp has cooled down and you have disconnected it from the mains. Wear protective clothing (gloves and mask) when using Xe lamps. Hg lamps take a few minutes to reach their full intensity; they do not ignite when hot.



**Attention:**

Never look directly into the light path!  
There is **danger of glare** when switching on the brightfield reflector (BF) or Smith reflector (6.4; 6.5)!

### Reflector, filter systems

Turn an objective into the light path and focus the specimen in transmitted light first. Select a reflector to suit the illumination technique (BF/DF, ICR, POL) or a filter system (16 and 39.2) to suit the excitation and emission spectrum of the object (→ optics DM L/DM R data sheet) and switch it into the light path, assembly → p. 18.

### Objective, tube factor

Use high-aperture objectives (immersion) to obtain optimum fluorescence image intensity; open the iris diaphragm in the objective if applicable (Fig. 25.4). Trinocular tube\* with switchable beamsplitter: switch to highest possible intensity for visual observation (46.4). For fluorescence: Switch magnification changer\* (45.1), if present, to factor 1x. Protect the immersion oil from impurities to avoid disturbing fluorescence. Use low-fluorescence mounting media, coverglasses and specimen slides!

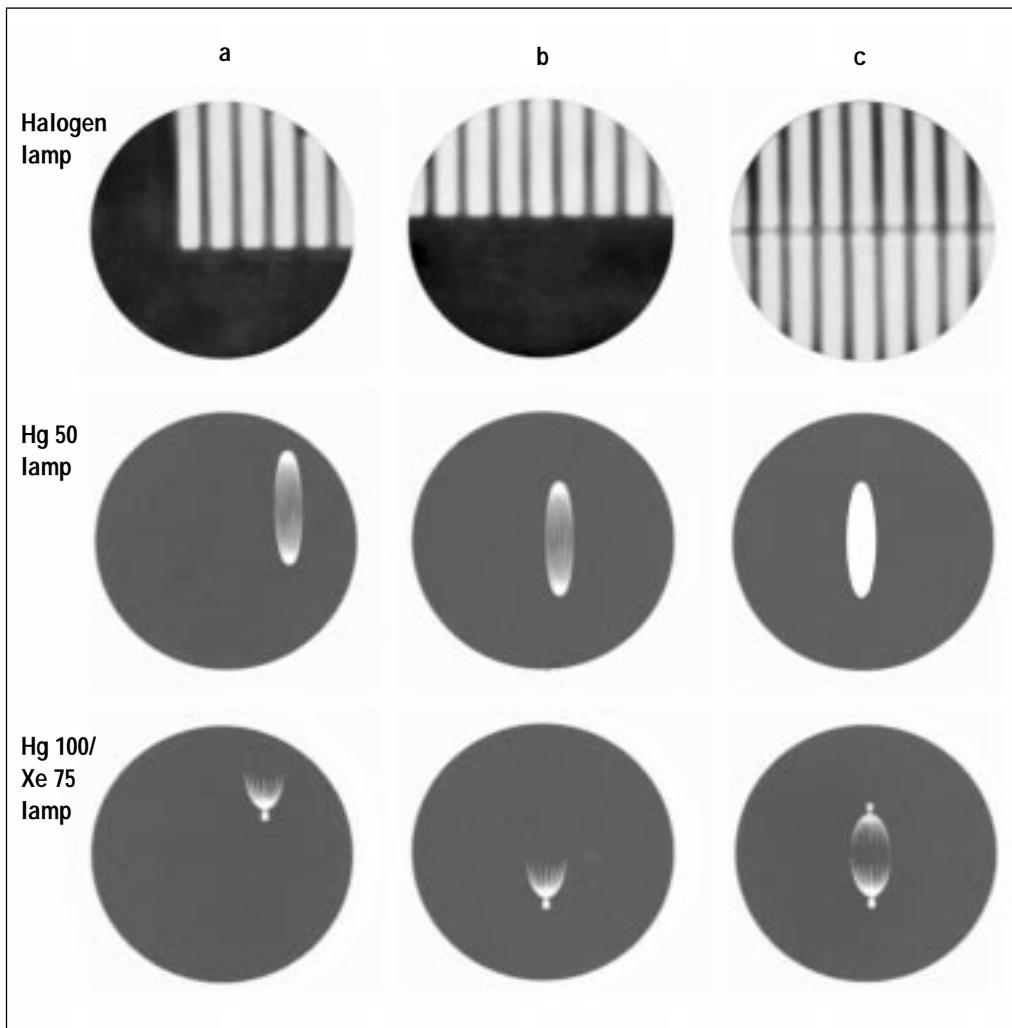
Unblock the incident light path (39.9), switch off transmitted light or cover with slide (39.4; 30.5) (push into the stage from the front), focus the specimen. Disengage the BG 38 filter (39.9) if there is no disturbing red background. Always engage the filter for photography, however.

## Collector setting

### Halogen, Hg and Xe lamps:

Adjust the collector (40.6; 37.4) until the object field is homogeneously illuminated, optimize adjustment if possible; does not apply for LH 105/2 and 107.

**Fig. 41** Schematic diagram of lamp adjustment for lamphousing 106 z (in reality the lamp images are less well defined)  
a direct lamp image, focused, but decentered  
b direct lamp image in the correct position  
c reflected and direct lamp image in correct position



## Diaphragm settings

Open the **field diaphragm** (39.6) until the field of view is just illuminated. Stopping down may improve the contrast and be gentler to sensitive fluorescence specimens. Centration: Put the two centering keys (2.4) into the two holes (39.5) and turn until the diaphragm is in the centre position. Max. field of view: with fluorescence illuminator LRF 4/22 = 22, with additional optics: 25.

With universal illuminator LU or LUP: 25.

**Aperture diaphragm** (39.8): For fluorescence open fully, for incident light brightfield, polarization and interference contrast ICR stop down to the desired contrast. To centre (does not apply for fluorescence): Use a flat, well-reflecting specimen, if necessary a glass plate (specimen slide). Use the BF or POL reflector and focus. Pull out the eyepiece so that the aperture diaphragm (39.8) can be seen in the eyepiece tube. Alternatively, use the auxiliary telescope (30.1) or a Bertrand lens. Push in the two centering keys (2.4, 39.7) and turn until the aperture diaphragm is in the centre position.

## Mirror housing for 2 lamp-housings

For alternate use of two lamps, the manually switchable mirror housing 106 can be interposed between the incident light illuminator and the two lamphousings.

## Protective filter\*

When using gas discharge lamps for polarized light, it is advisable to slot a protective filter (not illustrated) into the front of lamphousing 106 z to avoid damaging the incident light polarizer (POL filter system).

## Possible errors



### Weak fluorescence, weak image intensity due to:

Incorrectly stored, too old or faded specimens, fast specimen fading (e.g. for FITC); inspecific filter combination, numerical aperture of objectives too low, eyepiece magnification too high, spent lamp, room too bright. Trinocular tube: wrong beamsplitter setting (45.4), secondary light due to reflection at the condenser.

### Low contrast image due to:

Excitation bandwidth too great, inspecific staining, fluorescing mounting medium, auto-fluorescence of the objective or immersion oil. Dirty glass surfaces.

# Linear measurements

## Linear measurements

The following are required for linear measurements:

- Graticule with scale division in eyepiece (Fig. 42) or HC FSA 25 PE tube with diapositive overlay device → p. 68 or a digital linear measuring eyepiece.
- Stage micrometer for calibration.

## Micrometer value

The micrometer value of the objective-eyepiece combination used must be known before the measurement, i.e. the distance in the specimen that corresponds to the length of a division on the graticule used.

Calibration:

Align the stage micrometer and the graticule parallel to each other by rotating the eyepiece and adjust the zero marks of both scales to exactly the same height (Fig. 42).

Read how many scale divisions of the stage micrometer correspond to how many on the microscope scale (graticule) and divide the two values to obtain the micrometer value for the total magnification in use.

Example:

If 1.220 mm of the stage micrometer corresponds to 50 divisions of the measurement scale, the micrometer value is  $1.220 : 50 = 0.0244 \text{ mm} = 24.4 \text{ }\mu\text{m}$ . For extremely low objective magnifications it may be that only part of the measurement scale can be used for calibration.

Important: If using the magnification changer (46.1):

Remember to take the additional magnification value into consideration! We strongly recommend you calibrate each objective and each factor of the magnification changer separately instead of extrapolating the micrometer values of the other objectives or magnification steps from the calibration of one objective. Measurement errors may occur if the eyepiece is not pushed into the tube as far as the stop.

Particularly large object structures can also be measured on the stage with the verniers (0.1 mm); the distance to be measured could be calculated from a combined x and y measurement.

# Thickness measurements

## Thickness measurements

In principle, thickness measurements can be carried out if both the upper and the lower surface of the object can be clearly focused. The difference in stage height setting (mechanical dual knob focusing; distance between two divisions ca.  $1\ \mu\text{m}$ ) gives a value for transmitted light objects that is falsified by the refractive index of the object (which has been "transfocused") and perhaps immersion oil. The true thickness of the object detail measured in transmitted light is given by the vertical stage movement (focusing difference)  $d'$  and the refractive indices  $n_o$  of the object and  $n_i$  of the medium between the coverglass and the objective (air = 1).

$$d = d' \frac{n_o}{n_i}$$

### Example

The upper and lower surface of a thin polished specimen have been focused with a dry objective ( $n_i = 1.0$ ), scale readings of mechanical fine drive (division spacing =  $1\ \mu\text{m}$ ):

9.0 and 27.0.

Therefore  $d' = 18 \times 1 = 18\ \mu\text{m}$ .

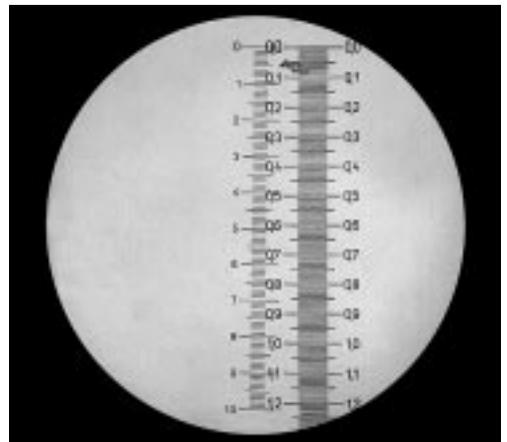
The refractive index of the object detail was taken to be  $n_o = 1.5$ .

Thickness  $d = 18 \times 1 \times 1.5 = 27\ \mu\text{m}$ .

## Object marker

The object marker is screwed in place of an objective (not illustrated). When rotated, a diamond is lowered onto the coverglass or object surface, where circles of variable radii can be scribed to mark objects.

Fig. 42 Scale of the graticule in the eyepiece (left) and image of stage micrometer (right)



# TV microscopy

## Adaption

Various adapters are available for the connection of TV cameras with c-mount and B-mount thread (Fig. 43).

The c-mount adapters listed in the following table can be used on all trinocular phototubes. Some tubes (Figs. 43–45) require a photo adapter tube as well. The picture area on the monitor depends on the adapter used and on the chip size of the camera.

### Calculation of the magnification on the monitor

The magnification on the monitor  $M_{TV}$  can be calculated with the following formula or measured with a stage micrometer and a cm scale:

$$M_{TV} = \frac{\text{objective magnification} \times \text{factor of magnification changer} \times \text{TV adapter magnification} \times \text{monitor diameter}}{\text{chip diameter of camera}}$$

	Recorded picture diagonal with			
	1 inch camera	2/3 inch camera	1/2 inch camera	1/3 inch camera

#### without zoom magnification

c-mount adapter 1x HC	16	11	8	6
c-mount adapter 0.63x HC	–	17.5	12.7	9.5
c-mount adapter 0.5x HC	–	–	16	12
c-mount adapter 0.35x HC	–	–	–	17.1
c-mount adapter 4x HC	4	2.8	2	1.5

#### without zoom magnification

c-mount adapter 1x	–	–	16	12
B-mount adapter 1x	–	–	16	12
B-mount adapter 1.25x	–	17.5	–	–
F-mount adapter 1x	–	–	16	–
F-mount adapter 1.25x	–	17.5	–	–

Plus (essential requirement): TV optics – 0.5 x HC (screw connection)

#### with zoom magnification (Vario TV adapter)

c-mount, 0.32 – 1.6x HC	–	–	19 <sup>1)</sup> –5	18–3.8
B-mount, 0.5 – 2.4x HC	–	–	16 <sup>1)</sup> –3.3	–
B-mount, 0.5 – 2.4x HC	–	–	–	12–2.5

<sup>1)</sup> from zoom factor 0.42x only!

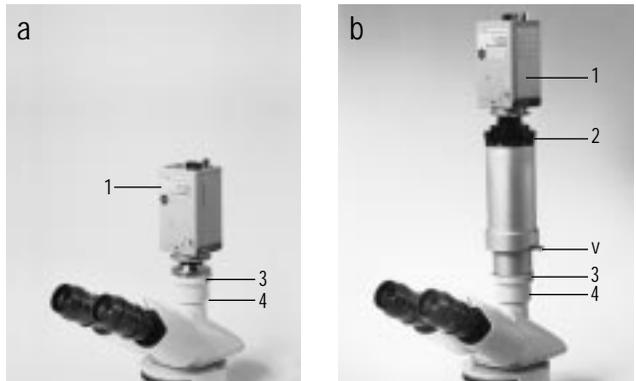


Fig. 43a, b

a: c-mount adapter on trinocular tube

1 TV camera

2 Adapter with c-mount thread (or B-mount bayonet)

3 Clamp screw

4 Photo adapter tube of zoom system

b: Vario TV adapter

## Possible errors

Picture too dim (noisy TV picture, poor contrast).

Remedy: Increase lamp intensity, swing filter out of light path, switch over beamsplitter in tube system, switch TV camera to higher sensitivity.

Picture too bright (TV picture glare).

Remedy: Switch neutral density filter, switch over beamsplitter in tube system, reduce camera sensitivity.

Picture area too small.

Remedy: Use a TV adapter with a smaller factor.

Incorrect colour rendering.

Remedy: Vary illumination intensity, carry out white balance for TV camera according to manufacturer's instructions, use a conversion filter, e.g. DLF.

Disturbed picture frame.

Remedy: Earth the microscope, Variotube and camera. Avoid parallel laying of mains and signal cables; connect camera and microscope to the same mains phase (socket).

Picture spoilt by inhomogeneous glare and/or spots. Lamps or windows are reflected in through the eyepieces.

Remedy: Switch over the beamsplitter or cover eyepieces or remove the disturbing light source. Dirt particles in the light path, lamphousing not centered (TV systems are generally more sensitive to inhomogeneous illumination).

# Care and maintenance



## Attention:

Disconnect from the mains before cleaning or servicing!

## Dust protection

Protect the microscope and peripherals from dust by putting on the flexible dust cover after each work session. Dust and loose particles of dirt can be removed with a soft brush or lint-free cotton cloth.

## Solvents

Obstinate dirt can be removed with a clean cotton cloth moistened with any ordinary hydrous solution, benzine or alcohol. Do not use acetone, xylol or nitro dilutions.

Cleaning agents of unknown composition should be tested on an inconspicuous part of the microscope. Painted or plastic surfaces must not be tarnished or etched.



## Attention:

## Acids, alkaline solutions

Particular care should be taken when working with acids or other aggressive chemicals. Always avoid direct contact between such chemicals and the optics or stands. Thorough cleaning after use is strongly recommended. Keep the microscope optics absolutely clean.

## Dust/optics

Remove any dust from glass surfaces with a fine, dry, grease-free artists' hair brush, or by blowing with a bellows ball or by vacuum suction. Any remaining dirt can be removed with a clean cloth moistened with distilled water. Failing this, use pure alcohol, chloroform or benzene.

## Oil

First wipe off immersion oil with a clean cotton cloth, then wipe over several times with ethyl alcohol.



## Attention:

Fibre and dust residue can cause disturbing background fluorescence in fluorescence microscopy.

Objectives must not be opened for cleaning. Only the front lens can be cleaned in the ways described above and the upper lens by blowing dust off with a bellows ball.

All Leica instruments are manufactured and tested with extreme care. If you do have cause for complaint, however, please do not try to repair the instruments and their accessories yourself. Contact your national agency or our central servicing department, the Technical Service in Wetzlar direct. Postal address:

Leica Microsystems Wetzlar GmbH  
Abt. Technischer Service Tel. +49(0)6441-292849  
Postfach 2040 Fax +49(0)6441-292266  
D-35530 Wetzlar Telex 4 83 849 leiz d

Please direct any questions on application to our Produktmanagement Mikroskopie → p. 2.

# Main wearing and spare parts, tools

Code no. Part no.	Component	Used for	
<u>Spare lamps</u>			
500 317	Halogen lamp 12 V 30 W	Integrated illumination, transmitted light	
500 974	Halogen lamp 12 V 100 W	Lamphousing 105/105 z	
500 137	Ultra high pressure Hg lamp 50 W	Lamphousing 106 z	
500 138	Ultra high pressure Hg lamp 100 W	Lamphousing 106 z	
in prep.	Ultra high pressure Hg lamp 100 W (103 W/2)	Lamphousing 106 z	
500 139	High pressure xenon lamp 75 W Lamphousing 106 z		
<u>Tools/adjustment keys</u>			
016-500.020-001	Hexagonal screwdriver	Assembly and adjustment of light rings, UCL condenser	
023-123.030-027	2 mm Allen key	Assembly of heating stage and illuminating mirror	
020-434.045	2.5 mm Allen key, angled, shortened		
<u>Spare axis (screw) for condensers</u>			
023-123.030-015		UCL/UCLP condenser	
023-132.034-030		UCA/P condenser	
<u>Screw covers for vacant nosepiece positions</u>			
020-422.570-000	Screw cover M25	Objective nosepiece	
016-016.005-200	Screw cover M32	Objective nosepiece BD	
<u>Spare eyecups (anti-glare protection) for HC PLAN eyepiece</u>			
021-500.017-005	Eyecup HC PLAN	10x/25 eyepiece	
021-264.520-018	Eyecup HC PLAN	10x/22 eyepiece	
021-264.520-018	Eyecup HC PLAN	10x/20 eyepiece	
<u>Light trap fluorescence</u>			
090-938.001-017	Light trap	Incident light fluorescence	
<u>Immersion oil DIN/ISO standard, fluorescence-free</u>			
513 787	10 ml	OIL and IMM objectives and oil condenser tops	
513 522	100 ml		
513 788	500 ml		
<u>Spare fuses, according to IEC 127-2 and/or UL 198 G and/or company type</u>			
824-767.000-000	T 630 mA	IEC 127-2	DM LB micr. power supply (for 12 V <b>30 W</b> halogen) unstabilized
825-347.000-000	T 2 A	Wickmann 19 195/ Schurter FST/ UL 198 G	DM LB micr. power supply (for 12 V <b>30 W</b> halogen) stabilized
845-410.000-000	T 4 A	Wickmann 19 195/ Schurter FST/ UL 198 G	DM LB, LP, LM microscope power supply (for 12 V <b>100 W</b> halogen) stabilized
823-493.000-000	T 2.5 A	IEC 127-2	Power unit Xe 75 Hg 100 stabilized (500 311)
827-902.000-000	T 1.25 A	IEC 127-2	Power unit Xe 75 Hg 100 stabilized (500 311)
824-716.000-000	for 90 – 140 V		
824-716.000-000	T 160 mA	IEC 127-2	Power unit Xe 75 Hg 100 stabilized (500 311)
826-095.000-000	for 90 – 140 V		
826-095.000-000	T 80 mA	IEC 127-2	Power unit Xe 75 Hg 100 stabilized (500 311)
825-347.000-000	for 187 – 164 V		
825-347.000-000	T 2 A	IEC 127-2	Power unit Hg 100 non-stabilized (500 299)
Without fuses: Power unit Hg 50 (500 277)			
302-053.023-001 Ignition capacitor for power unit Hg 50			

# Supplements

## Tube series

2 tube series are available for DML microscopes. Note that the field of view number might be limited → p. 27 – 32:

### Tubes from the DM L range (Fig. 44).

Tubes for polarized light microscopy are identified by the extra letter P, e.g. Binocular tube HC LBP, Trinocular tube HC L3TP (similar to Fig. 46.2). The Pol tube is exactly aligned for polarized light microscopes by an orientation pin and special Pol eyepieces with ready aligned cross line (right-hand eyepiece only); it can also be used without restriction on ordinary DML microscopes.

### Tubes from the DMR research microscope range (Fig. 46).

In combination with the tube adapter HCR/L (45.2), these can also be used on all microscopes in the DML range. Special tubes enable, for example, graticule or slide overlay, etc. → p. 68.



### Attention:

### Intermediate modules\*

When using intermediate modules, remember that the eyepiece field of view number may be affected → p. 30.

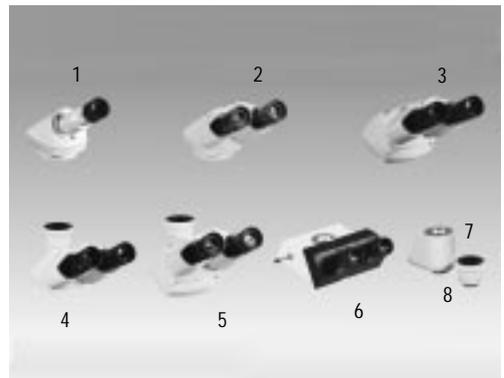
### Ergomodule\*

By integrating one or several Ergomodules L 2/ 25 (45.3), the viewing port of the microscope can be raised by 30 mm for each one.

Fig. 44 Tube range L

1 Monocular tube\* LMP -/-/7, 2 Binocular observation tube HC LB 0/3/4, 3 Ergonomy tube, binocular, viewing angle 0 – 35° HC LVB 0/4/4, 4 Trinocular tube H L1T 4/5/7, with fixed beamsplitter (50 % to the vertical exit, 50 % to the binocular port), 5 like 4, but with adjustable viewing angle of 0 – 35° (HC L1VT 0/4/4), 6 Trinocular tube with 3 switching positions HC L3TP 4/5/7, 7 Photo adapter tube for tube 6, 8 Photo adapter tube for tube 6 with 2 exits (50 %/50 %) Trinocular tube with image erection HC L2TU 4/5/7 not illustrated

\* no longer produced



## Magnification changer\*

For stepwise additional increase of the total magnification by the factors 1.5x and 2x. → Fig. 45.1.

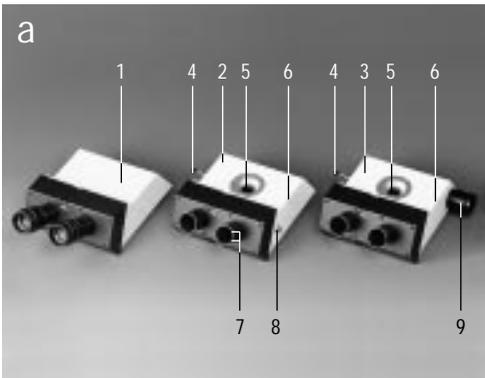
**Fig. 45** Additions to the tube range

1 Magnification changer (1x, 1.5x, 2x), 2 Adapter HC R/L for DMR tubes (Fig. 45) 3 Ergomodule L2/25 for raising the viewing port by 30 mm, 4 Eyepiece adapter tube HC PHOTO



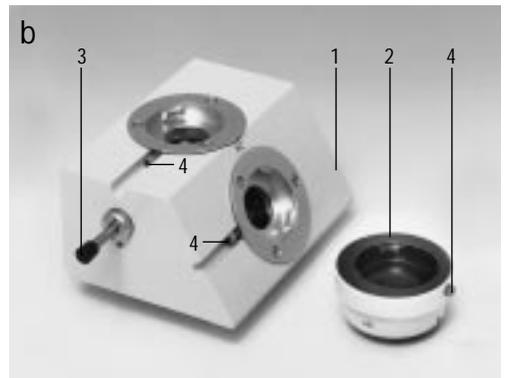
**Fig. 46a** Microscope tubes from the DMR range (only with adapter 36.2)

1 BSA 25: Binocular tube with focus compensation, 2 HC FSA 25 PR and HC FSA 25 P: Binocular phototubes with (PR) or without (P) back reflection, 3 HC FSA 25 PE: Binocular phototube with lateral reflection, 4 Switch rod for beamsplitter, 5 Mount for photo adapter tube, 6 Clamp ring for HC photo adapter tube, 7 Clickstop device for Pol eyepieces, 8 Socket for dark flap control cable (PR tube only), 9 Connection for lateral reflection, 10 FSA photo adapter tube, 11 FSA photo adapter tube with 2 exits (3 switching positions)



**Fig. 46b** Photo adapter tubes

1 Photo adapter tube, switchable, 2 Photo adapter tube (standard, vertical), 3 Switch rod (100% ↑/100% →), 4 Clamp screw



## Battery connection

In case of battery connection please contact the technical service of Leica.

## Heating stages\*

Heating stage with temperature range up to approx. 45 °C (Fig. 47):

Assembly: Detach the ordinary specimen stage (only rectangular stages are suitable) from the stage bracket by undoing the screw (28.13 → p. 38) at the front of the stage and replace with the heating stage (2 fixing screws). No special objectives or condensers are required, preferably use the UCA/P condenser with condenser top S15, → p. 13. The heating stage has its own instruction manual. Heating stage 350 (up to 350 °C), not illustrated, always requires the condenser outfit UCA/P-S15 and objectives with working distances > 7 mm, → optics DM L/DM R data sheet.

## Viewing attachments\*

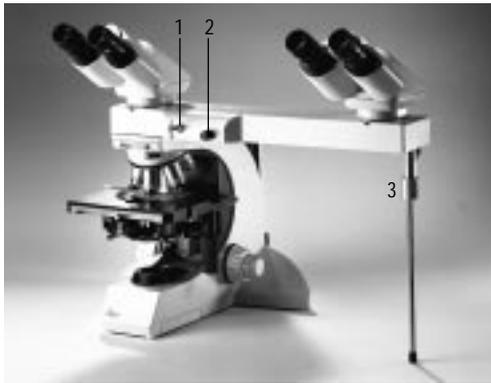
Dual viewing attachment L3/20 for 2 viewers (Fig. 48). The two viewers may either sit next to each other (the image in the 2nd port is laterally reversed) or opposite (image positions identical). The telescopic support (48.3) should always be set exactly, making sure that the tracing device is not at a tilt to the microscope and that the microscope stand is not deformed. The fade-in arrow (48a, 1 – 2) can be moved in x and y direction: Move the lever (48a, 1 – 2) vertically or pull out/push in. If this lever is rotated, the colour of the arrow can be changed (red/yellow).

Fig. 47 Heating stage up to 45°



Fig. 48a Dual viewing attachment

1 Movement of light pointer in x and y direction, change from red/yellow by rotating, switchover of colour filter, 2 Brightness control, 3 Adjustment of arm support  
The external power supply (illuminated arrow) is not illustrated (socket underneath, next to the support)



Multi viewing attachment L MD 3/20 (Fig. 48b) → separate manual. There may be limitations for specimen images in dim light (darkfield, polarization, fluorescence).

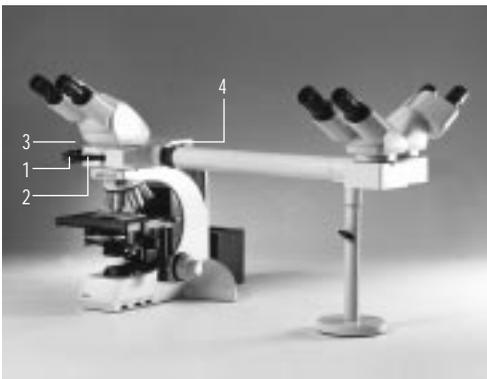
### Tracing device\*

The tracing device L 3/20 allows an optical overlay of large objects (next to the microscope) on the microscope image. This makes it easy to draw specimens by tracing their outlines or superimpose scales → also lateral overlay, p. 68.

By interrupting the microscope light path it is also possible, particularly for TV microscopy, to display larger objects or whole pages of books. An additional lamp, e.g. reading lamp, is necessary for this.

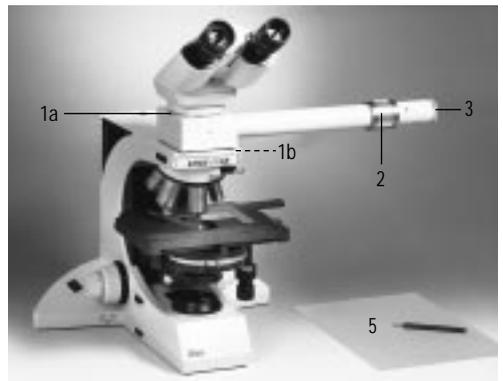
**Fig. 48b** Multi viewing attachment

1 Filter slide, 2 Movement of light pointer, 3 Mains switch, 4 Fuse and voltage selector



**Fig. 48c** Tracing device

1a, b Clamp screws, 2 Focusing, 3 Shutter, 5 Drawing planes



## Lateral overlay\*

The devices for diapositive overlay and macroscopy can only be adapted to the HC FSA 25 PE tube (46.9) (Fig. 49 and 51).

These tubes have a side flange (46.9) to allow attachment of the reflection optics (Fig. 49.3 and 51.3).

The reflection optics are used for the mechanical and optical adaption of the diapositive overlay device and the macro dual zoom system.



### Attention:

If reflection optics are not adapted to the microscope (49.3 and 51.3), an image cannot be obtained.

## Diapositive overlay device\*

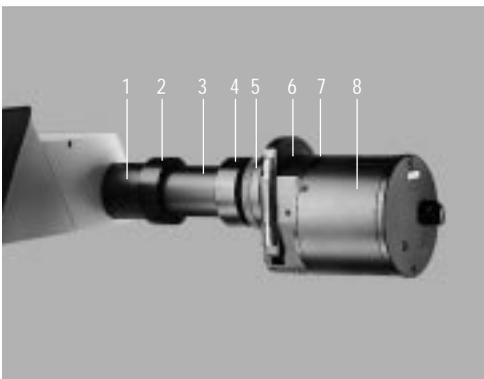
The diapositive overlay device consists of the reflection optics, the illumination unit with 6 V/ 4 W halogen lamp (49.8), the standard 5 x 5 cm slide frame (49.6) and the control for focusing the transparencies. The halogen lamp is fed by a separate transformer (Fig. 50).

### Assembly of the diapositive overlay device

Align the reflection optics to the tube flange (49.1) with the coupling ring (49.2) and screw down. The guide pin must latch into the groove of the mount. Screw the diapositive overlay device onto the reflection optics with the coupling ring (49.4) in the same way. Again, make sure the guide pin latches into position.

**Fig. 49** Diapositive overlay device on the HC FSA 25 PE tube

1 Tube flange, 2 Coupling ring for reflection optics, 3 Reflection optics, 4 Coupling ring for diapositive overlay device, 5 Knurled ring for focusing, 6 5 x 5 cm slide frame, 7 Filter slot, 8 Illumination tube of lamphousings



**Fig. 50** Transformer



## Changing the halogen lamp in the illumination unit



### Attention!

Disconnect from power supply.

Screw out the Allen screw at the back and remove the lamp unit from the lamphousing. Take the lamp out of the socket and replace, making sure that the contact paths of the lamp (6 V 4 W) lie on the contacts in the socket. Do not touch the lamp bulb with your fingers due to the danger of perspiration burning in.

After the lamp unit has been replaced in the lamphousing, the lamp holder can be adjusted vertically by about 2 mm with the Allen screw from beneath.

Looking through the microscope eyepiece, adjust the lamp to the height where the greatest image brightness is achieved.

### Operation of diapositive overlay

The diapositive overlay device (Fig. 49) is used to reflect measurement and comparison masks,  $\mu\text{m}$  marks, marker arrow, company logo, charge and quality data, etc. into the microscope image so that they can be recorded together with the image.

The following diapositives are available:

Marker arrow

10 mm measurement scale with 100 divisions

$\mu\text{m}$  marks for 2.5x – 100x objectives

10 x 10 mm grid division in 100 fields

Test circle and measured length for grain size measurements

Picture series for ASTM-E 112 grain size measurements.

Individual masks with any measurement and comparison patterns, quality data, company logos etc. can be made by the user.

To do this, the original must be photographically reproduced on a 35 mm negative, i.e. bright lines on a dark background and framed in a standard 50 x 50 mm slide frame. The best film to use is fine-grain "document film".

The diapositive is imaged in the intermediate image plane of the microscope at a scale of 2 : 1. A distance of e.g. 5 mm in the diapositive overlay is magnified to 10 mm in the intermediate image plane of the microscope.

The overlay device only works when the beamsplitter in the tube (46.4) is set at 50/50 (switch rod in middle position).

The framed diapositive is inserted in the integrated holder (49.6) (white side of diapositive with lettering facing microscope).

The holder is adjustable on all sides, so the overlay can be moved to different areas of the microscope image. Remember that when you move the diapositive, the overlay will move in the opposite direction. This takes a bit of getting used to.

You can give the bright lines a coloured background by putting 32 mm colour filters in the filter slot (49.7).

### Macroscopy device\*

This consists of the reflection optics (51.3), the macro adapter (51.5) and the macrodual zoom.

### Assembly of the macro device

Screw the reflection optics (51.3) onto the tube flange (51.1) with the coupling ring (51.2).

Align the macro adapter (51.5) against the macrodual zoom and secure with the threaded ring (51.6).

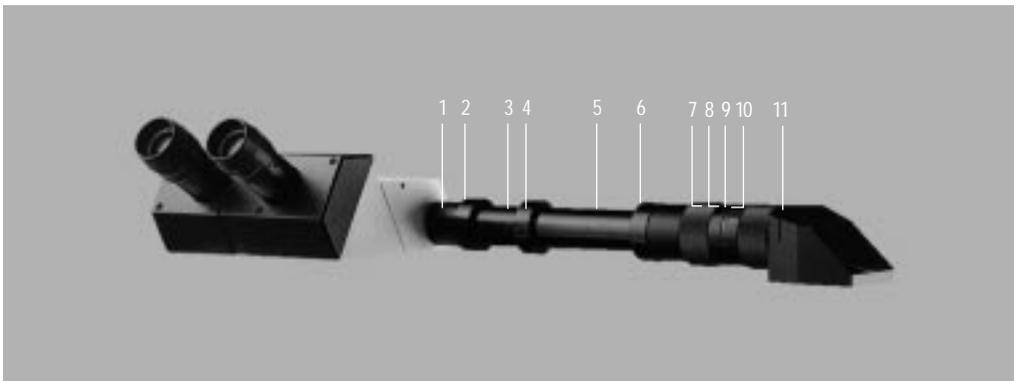
Fasten the macro adapter and the macrodual zoom to the reflection optics with the coupling ring (51.4). Watch the guide pin.

### Operation of the macro device

Like the diapositive overlay device, the macro overlay (Fig. 51) only works in the 50/50 beamsplitter position (switch rod at middle position) of the HC FSA 25 PE tube.

Fig. 51 Macro device on the HC FSA 25 PE tube

1 Tube flange, 2 Coupling ring, 3 Reflection optics, 4 Coupling ring, 5 Macro adapter, 6 Threaded ring, 7 Zoom setting ring 1 : 4, 8 Zoom factor scale, 9 Scale for magnification factor of the working distance, 10 Scale for distance of object from the lower edge of the mirror housing, 11 Mirror housing



## Operation of macro device

The microscope illumination is left switched off to avoid disturbing image brightening.

The object is placed on the stage under the mirror housing of the macrodual zoom (51.11) and illuminated.

Stand lamps, cold-light illuminators and fibre-optic lamps, etc. are suitable light sources for macroscopy.

The image is observed in the microscope tube and focused by turning the knurled ring.

The magnification can be changed continuously in a range of 1 : 4 by adjusting the knurled ring (51.7).

When changing the magnification with the zoom control the object may change position slightly and go out of focus. It must then be refocused and moved back into position.

The zoom magnification factors can be read on the scale (51.8). The magnification also changes when the distance between the object and the macro attachment is varied.

The total magnification in the microscope, the reproduction ratio on the photograph or TV image can be quickly and easily measured with a scale and calculated.



**Important:** For normal viewing without the macro mirror housing or macrodual zoom, put on the cover to avoid disturbing overlay effects.

The mirror housing (51.11) can be rotated through 360°, for example to alter the angle at which the photograph is taken. This is done by loosening the Allen screw.

The intermediate image magnification  $M_1$  of the macro object can be worked out from the eyepiece field of view (see page 29) and the diameter of the object field (measured with a graduated ruler) as follows:

### Magnification

$$M_1 = \frac{\text{field of view } \emptyset}{\text{object field } \emptyset} \text{ e.g. } \frac{10\text{x}/25 \text{ eyepiece}}{\text{object field} = 200 \text{ mm}} \quad M = 0.125$$

Viewed with a 10x eyepiece, this intermediate image of 0.125x gives a total magnification of 1.25x in the microscope eyepiece (0.125 x 10x = 1.25).

The total magnification in the film plane of a camera is derived from multiplying the intermediate image magnification  $M_1$  by the magnifications of the photo eyepiece and camera attachment, e.g.:

intermediate image magnification 0.125x

photo projection lens 2.5x

large-format attachment 4x

$0.125 \times 2.5 \times 4 = 1.25x$

The total magnification at the 4 x 5" large-format camera of the photo TV module would therefore be 1.25x.

The total magnification can be roughly worked out using the scale divisions on the macrodual zoom:

The following factors are multiplied:

- magnification factor of the working distance (scale 51.9, e.g. 0.11x)
  - zoom factor (scale 51.8, e.g. 1x)
  - correction factor of the reflection optics (without engraving 1.17x)
  - eyepiece magnification (e.g. 10x)
- e.g.  $0.11 \times 1 \times 1.17 \times 10 = 1.29$

The total magnification in the eyepiece would therefore be 1.29x.

## Drawing

### Using the macrodual zoom as a drawing device

Drawing microstructures under the microscope has the advantages over photomicrography that significant details can be highlighted and that structures can be depicted in three dimensions. Apart from this, drawing with the superimposed image method is a valuable didactic exercise.

It is done by superimposing the drawing area (the area of the stage under the mirror housing of the macrodual zoom) onto the microscope image. The drawing area or sheet of paper is homogeneously illuminated with a stand lamp or table lamp.

The microscope illumination and illumination of the drawing area are matched providing the lamps are adjustable; otherwise the brightness of the drawing area can be varied by altering the proximity of the lamp.

# Linear measurements

The exact magnification of the object in the drawing is most easily determined by means of a stage micrometer, by transferring the length measured by the stage micrometer onto the drawing. The magnification can also be calculated as follows:

$$M_{Ze} = \frac{M_{Obj}}{F_{Zoom} \times F_D \times F_E} \text{ e.g. } \frac{5 \times}{4 \times 0.11 \times 1.176} = M_{Ze} 9.6 \times$$

$M_{Ze}$  = magnification in the drawing plane

$M_{Obj}$  = objective magnification

$F_{Zoom}$  = magnification factor of the zoom optics, scale...

$F_D$  = magnification factor of the object distance, scale...

$F_E$  = correction factor of the reflection optics, (1.176x)

The magnification can be altered by changing the zoom setting (scale...) or the level of the drawing plane.

At the smallest zoom setting the drawing area has a diameter of approx. 190 mm, at the highest zoom setting approx. 48 mm with an eyepiece field of view of 25 mm. For different fov numbers the correction value is fov/25.

## Auxiliary lens 2x

An auxiliary lens 2x can be screwed in under the mirror (51.11) to magnify the field that is to be imaged. This must be taken into account for the above formula. This auxiliary lens 2x is recommended for microscopic tracing as object structures are shown twice as large.

## Overlay of data and code numbers with the VARICODE system

The VARICODE system can be supplied together with the macrodual zoom.

It allows code numbers, micron measurement bars, ASTM grain size pictures and 35 mm negatives to be overlaid on the microscope image.

Further details on how to use this system can be found in the manual of the manufacturer, Leica AG, Vienna. Not illustrated.

## VARIMET digital measurement system

The VARIMET measurement system can be connected to the reflection optics for the measurement of microstructures. An adapter is available on request. See manufacturer's manual (Leica AG, Vienna) for further details.

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# EU Conformity declaration

We hereby declare that the product specified below conforms in its design and construction as well as the model we have put on the market to the relevant safety and health regulations laid down by the European Union.

This declaration will cease to be valid if the instrument is modified without our consent.

**Product:** DM LB, DM LP and DM LM

Model: Microscope

Identification Nos.: 020-519.010-000  
020-519.011-000  
020-520.701 to 020-520.718

EU directives: Low voltage: 73/23/EWG  
EMC: 89/336/EWG

Harmonized standard applied: EN 50081-1  
EN 50082-1  
EN 61010-1

National and international standards applied: VBG 1  
VBG 4

Wetzlar, September 15, 1995

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The Leica logo is written in a red, cursive script font. The letters are connected and have a slight shadow effect, giving it a three-dimensional appearance. The 'L' is particularly large and stylized.