Operating Manual
Axioskop 2 FS *plus* / FS MOT
Research Microscope

Knowledge of this manual is required for the operation of the instrument. Would you therefore please make yourself familiar with the contents of this manual and pay special attention to hints concerning the safe operation of the instrument.

The specifications are subject to change; the manual is not covered by an update service.

Issued by:

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Microscopy in a few steps using the example of "Setting of transmitted-light brightfield according to KÖHLER"

☞ Before starting to use the Axioskop 2 FS *plus* and/or Axioskop 2 FS MOT microscopes, make sure to read the notes on instrument safety and the Description (Chapter 1) and Start-up (Chapter 2) chapters.

(1) As described in chapter 2, the microscope is ready for operation and switched on according to section 3.3.

(2) Place a high-contrast specimen on the mechanical stage (cover slip pointing upwards).

(3) Swing in 10x objective in the objective slider and focus on the specimen; if possible, always move the specimen away from the objective!

(4) Move condenser – e.g. universal condenser 0.9 – (in brightfield position, front lens switched in) to the upper stop position via the condenser drive. The height adjustment must be set in such a way that the specimen is not touched by the condenser.

(5) Close luminous-field diaphragm until it is visible in the field of view, even if not in focus (Fig. 0-1/**A**).

(6) Lower universal condenser 0.9 until the edge of the luminous-field diaphragm appears in focus (Fig. 0-1/**B**).

(7) Center luminous-field diaphragm using centering screws on the condenser carrier (Fig. 0-1/**C**) and open it until its edge just disappears behind the field of view (Fig. 0-1/**D**).

(8) To set the aperture diaphragm (contrast), remove one eyepiece from the binocular tube and set the aperture diaphragm to approx. 2/3 of the diameter of the objective exit pupil (Fig. 0-1/**E**). Optimum contrast setting is dependent on the respective specimen.

(9) Insert eyepiece again and, if required, refocus on the specimen via fine drive.

(10) Since the field size and the objective aperture change after each objective change, steps (5) to (9) must be repeated.

(11) For objective magnifications between 1.25x and 5x, the front lens 0.9 of the universal condenser must be swung out and the aperture diaphragm opened entirely.

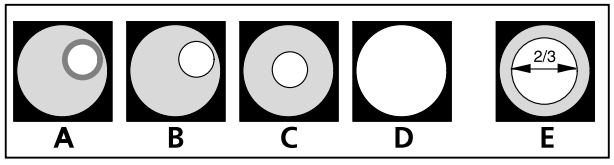


Fig. 0-1 Diaphragm settings in transmitted-light brightfield according to KÖHLER

Notes on instrument safety

The Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes were designed, produced and tested in compliance with DIN 61010-1 (IEC 1010-1), Safety requirements for electrical measuring, control and laboratory instruments, and meet the requirements of appendix I of directive 73/23/EC and the relevant CSA and UL directives. The instruments meet the requirements of the EC directive 89/336/EC and the EMC legislation of November 9th, 1992. This operation manual includes information and warnings which must be observed by the user.

The following warning and information symbols are used in this manual:

NOTE
This symbol is a warning which you must observe under all circumstances.

CAUTION
This symbol is a warning which indicates a hazard to the instrument or instrument system.

CAUTION
This symbol is a warning which indicates a hazard to the user of the instrument.

CAUTION
Hot surface!

CAUTION
UV radiation is emitted!

CAUTION
Disconnect the instrument from the line before opening it!

The Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes, including original accessories, may only be used for the microscope techniques described in this manual.

Particular attention must be paid to the following warning notes:

The manufacturer cannot assume any liability for any other applications, possibly also involving individual modules or single parts. This also applies to all service or repair work which is not carried out by authorized service personnel. Furthermore, this forfeits all the claims against warranty.

The Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes are provided with a special transport lock at the front of the stand. The microscopes must not be transported or moved without this transport lock. It is particularly important to avoid holding the instrument on the objective slider even if it is moved only a small distance away from its position; otherwise, the instrument will be damaged.

The power plug must be inserted in a socket featuring a grounding (earth) contact. The grounding effect must not be made ineffective by an extension cable which does not have a protective ground wire.

If it is established that the protection measures are no longer effective, the instrument must be switched off and safeguarded against inadvertent operation. Contact a Zeiss service agency or Carl Zeiss microscopy service for the repair of the instrument.

The separate 12 V DC 100 W power unit for the HAL 100 permits the use of line voltages in the range between 100 and 240 V ±10 %, 50 - 60 Hz. Voltage change is not required.
The power supply for the HBO 103 (ebq 100 dc) or XBO 75 (ebx 75 isolated) permits a voltage range of 90 to 250 V AC, 50 to 60 Hz. The instruments will automatically adjust to the existing voltage. Voltage change is not required.

Before switching on the instrument, check whether it is suitable for the line voltage present.
Always disconnect the instrument from the line before opening the instrument and before changing the fuses.

Make sure to use only fuses of the rated power required. The use of makeshift fuses and the short-circuiting of the fuse holders are not permitted.

The Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes are not equipped with any special devices for protection from substances which are corrosive, toxic, radioactive or otherwise hazardous to health. All the legal regulations for accident prevention, particularly those in the respective countries, must be observed when handling such substances.

Gas discharge lamps, e.g. HBO 103, emit ultraviolet radiation which can cause burns on the eyes and skin. Therefore, never look directly into the light of these lamps and avoid direct, unprotected incidence of their light on your skin. When using the microscope, always use the protective devices belonging to the instrument (e.g. special attenuation filters). When hot, gas discharge lamps are under high internal pressure and may therefore only be changed when they have cooled down, and protective gloves and goggles must be used (for detailed information please see Operating Manual B 40-065 e).

When fluorescence filters are used, the filter protecting from heat emitted by the microscope illuminator must not be removed, since fluorescence filters are sensitive to heat and their performance might therefore be impaired.

Avoid touching the hot lamp housing. Always disconnect the relevant power unit from the line before changing the lamps and allow the instrument to cool down for approx. 15 mins.

Dust and dirt can impair the performance of the instrument. Therefore, the instrument must be protected against these influences as far as possible, and covered with the dust cover if it is not used for longer periods of time. Always check whether the illuminators are switched off before you cover the instrument.

Placing objects against or covering ventilation slats can lead to a build-up of heat which will damage the instrument and, in extreme cases, cause a fire. Always keep the ventilation slats clear and make sure that no objects enter the instrument through the ventilation slats.

The instruments must be operated by trained personnel only who must be aware of the possible danger involved with microscopy and the relevant application. The Axioskop 2 FS *plus* / Axioskop 2 FS MOT is an optical precision instrument which can be impaired in its performance or damaged when handled improperly.

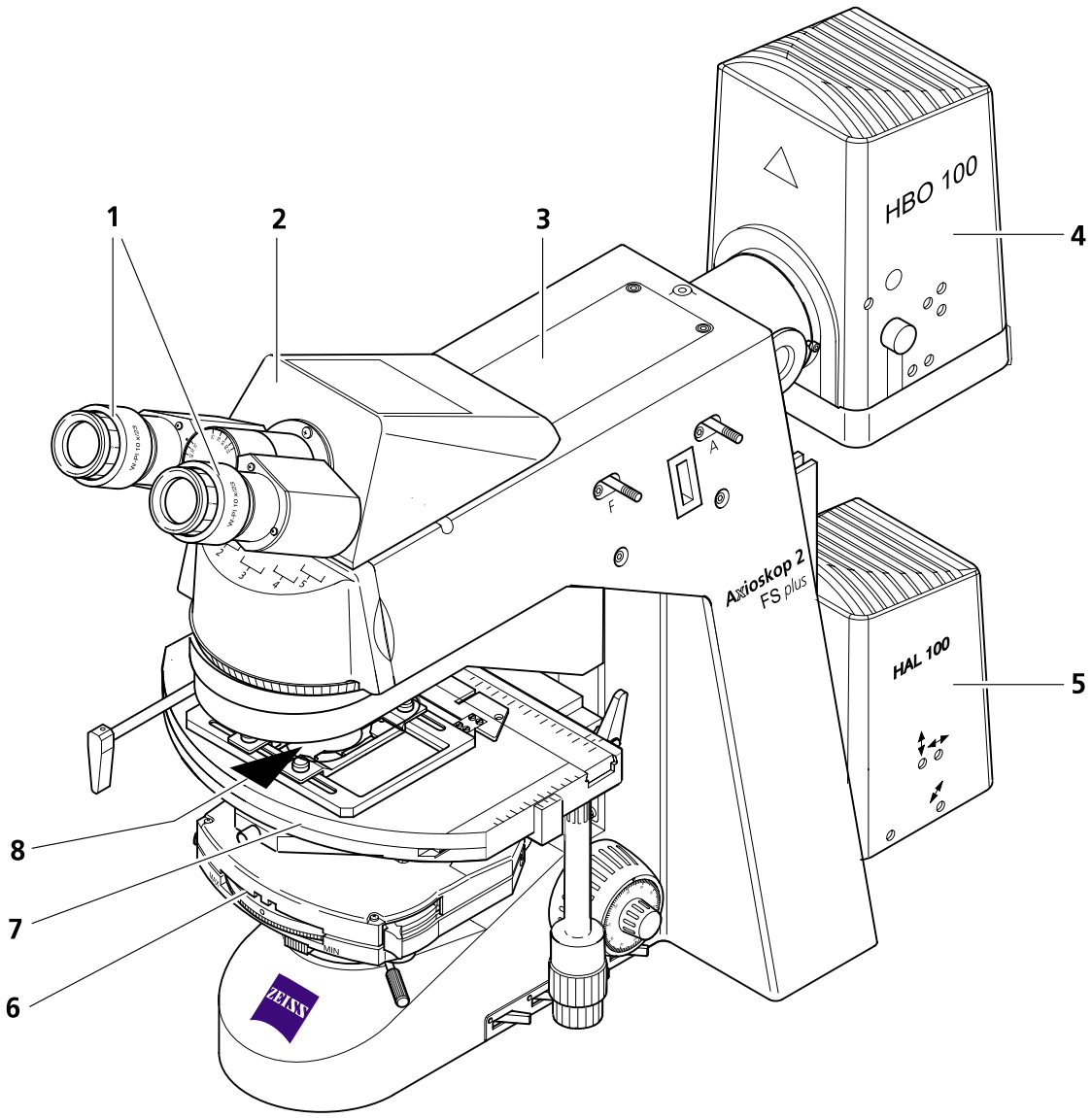
Notes on warranty

The manufacturer guarantees that the instrument has no material and production defects when delivered. You must inform us of any defects immediately and we must do anything to minimize the damage. If the manufacturer is informed of such a defect, he is obliged to remove it; it is his decision whether he does this by repairing the instrument or by delivering an instrument free of any defect. No guarantee is provided for defects caused by natural wear (wearing parts in particular) and improper use.

The instrument manufacturer is not liable for damage caused by faulty operation, negligence or any other meddling with the instrument, particularly the removal or replacement of instrument components, or the use of accessories from other manufacturers. This forfeits all the claims against warranty.

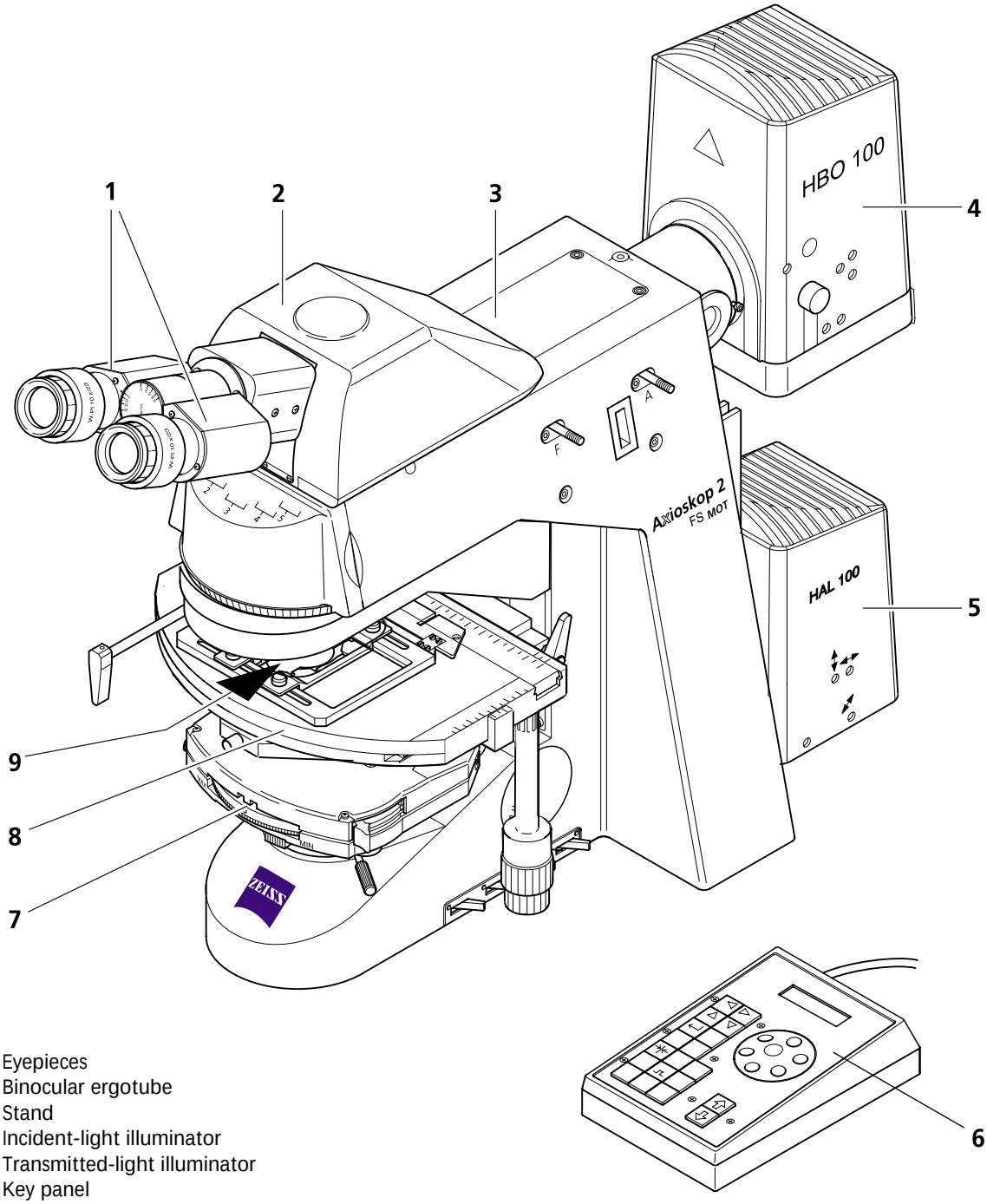
With the exception of the work specified in this manual, no maintenance or repair of the Axioskop 2 FS *plus* / Axioskop 2 FS MOT may be performed. Repairs may only be performed by Zeiss service staff or specially authorized personnel. Should any defect occur with the instrument, please get in touch with your local Zeiss agency.

Overall view of the Axioskop 2 FS *plus*



1 Eyepieces
2 Binocular tube
3 Stand
4 Incident-light illuminator
5 Transmitted-light illuminator
6 Condenser
7 Mechanical stage
8 Objectives

Overall view of the Axioskop 2 FS MOT



1 Eyepieces
2 Binocular ergotube
3 Stand
4 Incident-light illuminator
5 Transmitted-light illuminator
6 Key panel
7 Condenser
8 Mechanical stage
9 Objectives

INSTRUMENT DESCRIPTION

Contents

List of illustrations

1 INSTRUMENT DESCRIPTION

1.1 Name and intended application

Manufacturer's name: Axioskop 2 FS *plus* microscope
Axioskop 2 FS MOT microscope

The Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes have been particularly designed for electrophysiological applications. They can be used as transmitted-light microscopes or, with epi-fluorescence equipment, as combined transmitted-light / incident-light microscopes.

1.2 Instrument description and main features

With the advanced pyramid and modular design, the Axioskop 2 FS *plus* incorporates time-tested principles in microscope construction, thus ideally combining modern demands on design, operating convenience and function with technical performance. Thanks to the modular design, existing microscope modules of the Axioplan 2, such as tubes, intermediate tubes and condensers, are easy to attach.

The Axioskop 2 FS *plus* is offered as a manual and a motorized version. The basic stand is equipped with either manual (Axioskop 2 FS *plus*) or motorized operation and function controls (Axioskop 2 FS MOT), but is otherwise identical for both versions.

Depending on the instrument configuration, the following microscopy and contrasting techniques are possible:

Transmitted-light:

- brightfield
- darkfield
- phase contrast
- differential interference contrast (DIC)

Incident-light:

- fluorescence contrast

If ordered, the optional epi-fluorescence equipment including the adjusting aid is integrated in the microscope stand on delivery. For technical reasons, retrofitting of existing instruments with the epi-fluorescence equipment should be performed by Zeiss service staff.

The binocular tubes and the suitable adapters allow one microscope camera, one SLR camera or one video camera to be attached for documentation purposes.

Major instrument features of the **Axioskop 2 FS *plus* (manual)**:

- Stable and sturdy diecast stand with T-shaped base in the pyramid design
- Object focusing via ball-type planetary gear and coaxial drive
- Fixed and rotary mechanical stage with ceramic-coated surface and extended drive for higher operating convenience
- High-performance HAL 12 V 100 W illuminators for transmitted light and HBO 103 for incident light
- Achromatic-aplanatic universal condenser 0.9 with swing-in front lens for applications in brightfield, darkfield, phase contrast and differential interference contrast
- 2-position objective slider with W 0.8“ thread
- ICS Achroplan objectives
- Binocular tubes and phototubes with fixed and variable viewing angle
- 10x focusing eyepieces with field number 23, suitable for spectacle wearers
- High-performance epi-fluorescence equipment
- Wide variety of attachment possibilities for photography and videomicroscopy

In addition to the above instrument features, the **Axioskop 2 FS MOT** has the following features which differ from the manual version:

- High-precision step motor drive for objective focusing
- Control unit and keypad for motorized focusing
- Microscope interface for the connection of the control unit for motorized focusing

1.3 Axioskop 2 FS *plus* (manual) microscope configurations and modules

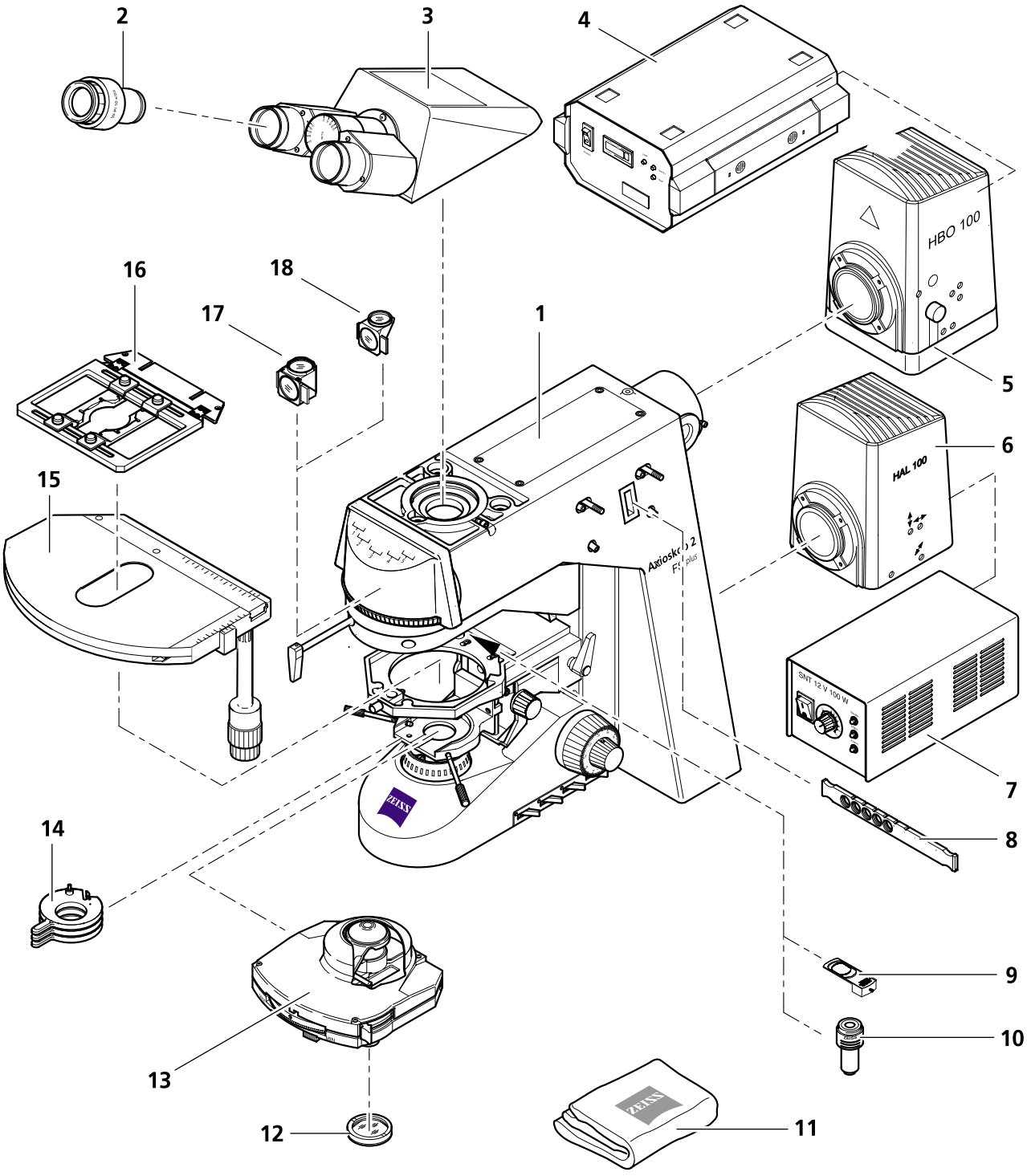


Fig. 1-1 Axioskop 2 FS *plus* (manual) microscope configurations

Key to Fig. 1-1:

1 Stand
2 Eyepiece
3 Binocular tube 30°/23
4 HBO 100 W transformer
5 HBO 103 illuminator
6 HAL 12 V 100 W halogen lamp
7 Separate 12 V DC 100 W power unit
8 FL filter slider
9 DIC slider
10 Objective
11 Dust cover
12 DIC prism
13 Achromatic-aplanatic universal condenser 0.9 H D DIC
14 Filter mount
15 Mechanical stage 75x50/240° R
16 Universal mounting frame
17 Reflector module FL P&C
18 Analyzer module D

Axioskop 2 FS *plus* (manual) microscope configurations)	**Cat. No.**
Configurations	
The "Axioskop 2 FS *plus*" research microscope is offered in the following configurations:	
for transmitted-light brightfield, phase contrast, interference contrast and epi-fluorescence	
Modules	
The "Axioskop 2 FS *plus*" research microscope consists of the following modules:	
"Axioskop 2 FS *plus*" microscope stand with 5x reflector turret, drive for objective focusing, 2-position objective slider H DIC W 0.8" FS, transmitted-light and incident-light equipment	452310-0000-000
Eyepieces:	
W-PL 10x/23 Br. foc.	000000-1016-758
PL 10x/23 Br. foc.	000000-1026-548
Eyecup	444801-0000-000
Auxiliary microscope	000000-1006-362
Tubes:	
Binocular tube 30°/23	452340-0000-000
Binocular phototube 30°/23 (30/70)	452344-0000-000
Binocular ergotube 6-25°/23	452341-0000-000
Binocular ergo-phototube 6-25°/23 (100/0 or 0/100)	452342-0000-000
Illuminators:	
HAL 12 V 100 W halogen illuminator	447219-0000-000
HBO 103 illuminator	487211-9804
Separate 12 V DC 100 W power unit, stabilized	458417-0000-000
HBO 100 W transformer for HBO 100 W/2 and HBO 103 W/2	458451-9901
Objectives, see section 1.5	
DIC sliders:	
DIC slider 10x/0.30 W II	444438-0000-000
DIC slider 40x/0.8 W III	444451-9901-000
DIC prisms without polarizer:	
DIC prism II / 0.9 for SENARMONT	000000-1004-902
DIC prism III / 0.9 for SENARMONT	000000-1004-903
Condensers:	
Achromatic-aplanatic universal condenser 0.9 H	445435-0000-000
Achromatic-aplanatic universal condenser 0.9 H D Ph	444336-0000-000
Achromatic-aplanatic universal condenser 0.9 H D Ph DIC	445439-0000-000
Achromatic condenser 0.8 H D Ph DIC	445445-9901-000
Polarizers:	
SENARMONT DIC polarizer	453622-0000-000
Filters:	
6-position FL filter slider, for filter diameters d = 18 mm	446377-0000-000
3-position filter mount, for filter diameters d = 32 mm	452159-0000-000
Conversion filter 3200 ... 5500 K	467850-9901-000
Stage and condenser carriers:	
"Axioskop 2 FS *plus*" stage carrier with condenser carrier for the attachment of Zeiss stages	452327-0000-000
Special "Axioskop 2 FS *plus*" condenser carrier for the attachment of non-Zeiss stages	000000-1022-999

Axioskop 2 FS *plus* (manual) microscope configurations	**Cat. No.**
Modules	
Mechanical stages from Zeiss:	
Mechanical stage 75x50 R with ceramic coating and adjustable coaxial drive 130 mm	453505-9901-000
Mechanical stage 75x50/240° R with ceramic coating and adjustable coaxial drive 130 mm	453502-9905-000
Mechanical stage 75x50 R with ceramic coating and fixed coaxial drive 130 mm	453523-0000-000
Universal mounting frame for Petri dishes and microscope slides	453545-0000-000
Technique modules:	
FL reflector module	452888-0000-000
e.g. with filter sets for epi-fluorescence	
filter set 01 UV excitation H 365	488001-0000-000
filter set 09 blue excitation 450 - 490	488009-0000-000
filter set 15 green excitation H 546	488015-0000-000
Analyzer module D	452187-0000-000
Optovar module 1.25x	452188-0000-000
Optovar module 1.6x	452194-0000-000
Optovar module 2.5x	452164-0000-000
Dust cover M (medium)	459311-0000-000
Dust cover G (large)	459312-0000-000
Additional accessories	
The "Axioskop 2 FS *plus*" research microscope can be equipped with the following additional accessories:	
Intermediate tube with height adjustment for binocular ergotube / phototube 452341 / 452342	452376-0000-000
Adapter for Axioskop 2FS *plus* to allow the use of tubes / intermediate tubes from the Axioplan 2 line	452969-0000-000
MC 80 DX microscope camera for 24 mm x 36 mm	496065-9804-000
MC 200 CHIP microscope camera for 24 mm x 36 mm	496059-9804-000
MC 200 CHIP microscope camera for large-format photography	496060-9804-000

1.4 Axioskop 2 FS MOT microscope configurations and modules

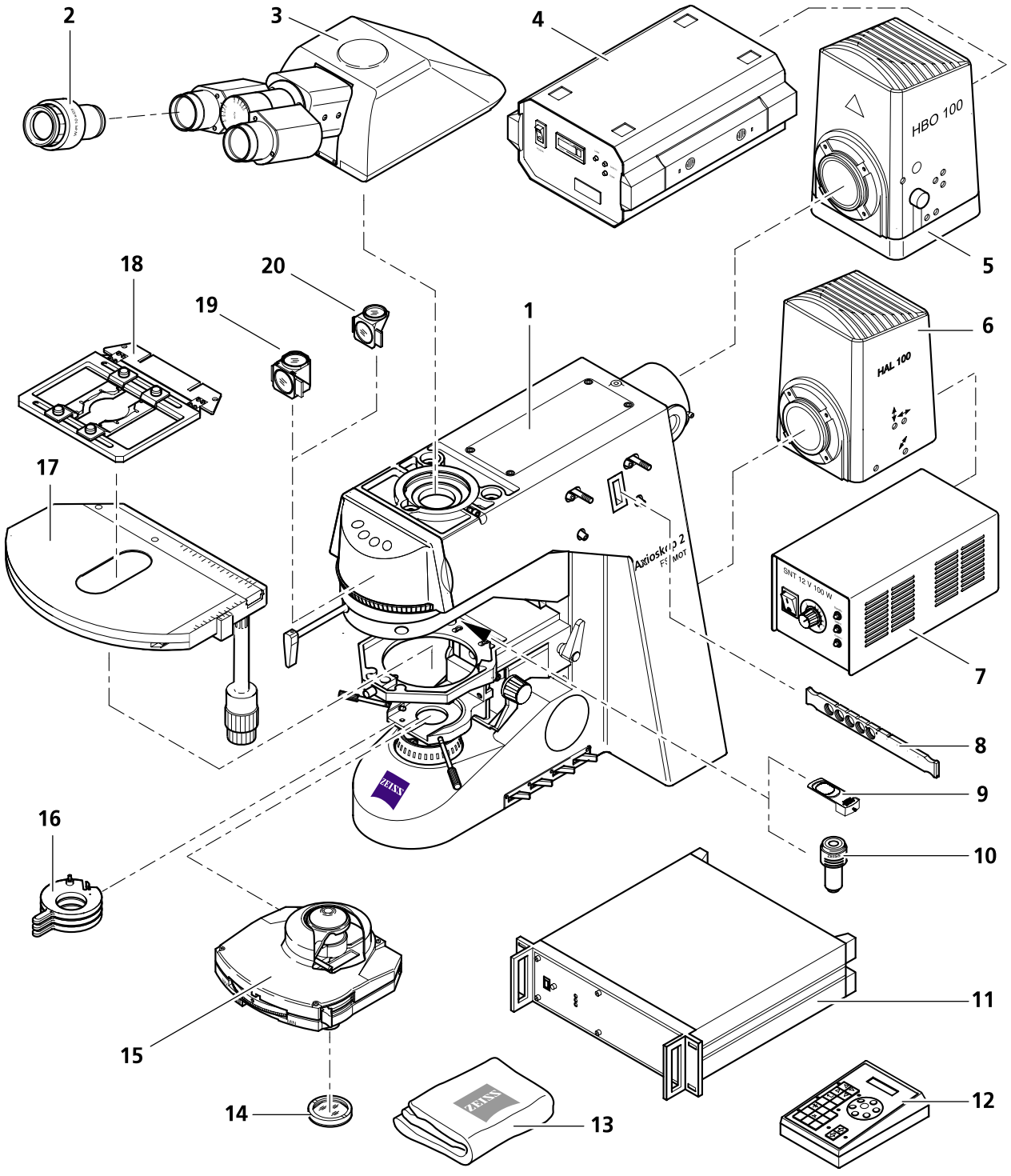


Fig. 1-2 Axioskop 2 FS MOT microscope configurations

Key to Fig. 1-2:

1 Stand
2 Eyepiece
3 Binocular ergotube 6-25°/23
4 HBO 100 W transformer
5 HBO 103 illuminator
6 HAL 12 V 100 W halogen illuminator
7 Separate 12 V DC 100 W power unit
8 FL filter slider
9 DIC slider
10 Objective
11 Control unit
12 Keypad
13 Dust cover
14 DIC prism
15 Achromatic-aplanatic universal condenser 0.9 H D DIC
16 Filter mount
17 Mechanical stage 75x50/240° R
18 Universal mounting frame
19 Reflector module FL P&C
20 Analyzer module D

Axioskop 2 FS MOT microscope configurations	**Cat. No.**
Configurations	
The "Axioskop 2 FS MOT" research microscope is offered for the following techniques:	
transmitted-light brightfield, phase contrast, interference contrast and epi-fluorescence	
Modules	
The "Axioskop 2 FS MOT" research microscope consists of the following modules:	
"Axioskop 2 FS MOT" microscope stand with 5-position reflector turret, motorized drive for objective focusing, 2-position objective slider H DIC W 0.8" FS, transmitted-light and incident-light equipment	452311-0000-000
Eyepieces:	
W-PL 10x/23 Br. foc.	000000-1016-758
PL 10x/23 Br. foc.	000000-1026-548
Eyecup	444801-0000-000
Auxiliary microscope	000000-1006-362
Tubes:	
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Binocular phototube 30°/23 (30/70)	452344-0000-000
Binocular ergotube 6-25°/23	452341-0000-000
Binocular ergo-phototube 6-25°/23 (100/0 or 0/100)	452342-0000-000
Illuminators:	
HAL 12 V 100 W halogen illuminator	447219-0000-000
HBO 103 illuminator	487211-9804-000
Separate 12 V DC 100 W power unit, stabilized	458417-0000-000
HBO 100 W transformer for HBO 100 W/2 and HBO 103 W/2	458451-9901-000
Objectives, see section 1.5	
DIC slider:	
DIC slider 10x/0.30 W II	444438-0000-000
DIC slider 40x/0.8 W III	444451-9901-000
DIC prisms without polarizer:	
DIC prism II / 0.9 for SENARMONT	000000-1004-902
DIC prism III / 0.9 for SENARMONT	000000-1004-903
DIC prism III / 0.8	000000-1087-445
Condensers:	
Achromatic-aplanatic universal condenser 0.9 H	445435-0000-000
Achromatic-aplanatic universal condenser 0.9 H D Ph	444336-0000-000
Achromatic-aplanatic universal condenser 0.9 H D Ph DIC	445439-0000-000
Achromatic condenser 0.8 H D Ph DIC	445445-9901-000
Achromatic condenser 0.8 H DIC	000000-1087-444
Polarizers:	
SENARMONT DIC polarizer	453622-0000-000
Filters:	
6-position FL filter slider, for filter diameters d = 18 mm	446377-0000-000
3-position filter mount, for filter diameters d = 32 mm	452159-0000-000
Conversion filter 3200 ... 5500 K	467850-9901-000
Stage and condenser carriers:	
"Axioskop 2 FS *plus*" stage carrier with condenser carrier for the attachment of Zeiss stages	452327-0000-000
Special "Axioskop 2 FS *plus*" condenser carrier for the attachment of non-Zeiss stages	000000-1022-999

Axioskop 2 FS MOT microscope configurations	**Cat. No.**
Modules	
Mechanical stages from Zeiss:	
Mechanical stage 75x50 R with ceramic coating and adjustable coaxial drive 130 mm	453505-9901-000
Mechanical stage 75x50/240° R with ceramic coating and adjustable coaxial drive 130 mm	453502-9905-000
Mechanical stage 75x50 R with ceramic coating and fixed coaxial drive 130 mm	453523-0000-000
Universal mounting frame for Petri dishes and microscope slides	453545-0000-000
Technique modules:	
FL reflector module	452888-0000-000
e.g. with filter sets for epi-fluorescence	
filter set 01 UV excitation H 365	488001-0000-000
filter set 09 blue excitation 450 - 490	488009-0000-000
filter set 15 green excitation H 546	488015-0000-000
Analyzer module D	452187-0000-000
Optovar module 1.25x	452188-0000-000
Optovar module 1.6x	452194-0000-000
Optovar module 2.5x	452164-0000-000
Installation kit for motorized control unit and keypad	
Dust cover M (medium)	459311-0000-000
Dust cover G (large)	459312-0000-000
Additional accessories	
The "Axioskop 2 FS MOT" research microscope can be equipped with the following additional accessories:	
Intermediate tube with height adjustment for binocular ergotube / phototube 452341 / 452342	452376-0000-000
Adapter for Axioskop 2 FS *plus* to allow the use of tubes / intermediate tubes from the Axioplan 2 line	452969-0000-000
MC 80 DX microscope camera for 24 mm x 36 mm	496065-9804-000
MC 200 CHIP microscope camera for 24 mm x 36 mm	496059-9804-000
MC 200 CHIP microscope camera for large-format photography	496060-9804-000

Fig. 1-3 Objective

1.5 Objectives

The objectives are the optical centerpiece of the microscope. The following is an example of how objectives can be labelled:

Achroplan 10x/0,3W Ph1 ∞/–

where

10x : objective magnification, with a defined color ring on the objective being allocated to each magnification step (Zeiss color code)

0.3 : numerical aperture

∞ : infinite image distance; these objectives can only be used with ICS microscopes from Carl Zeiss

– : can be used with cover slip thickness D = 0 or 0.17 mm

or

0.17 : can only be used with cover slip thickness D = 0.17 mm

Other labels:

Oil : oil immersion objective

Ph1 : phase contrast objective with a green color ring and phase stop Ph1

W : objectives for water immersion

Color ring code for objective magnification

Color ring on objective	black	brown	red	orange	yellow	green	light blue	dark blue	white
Magnification factor	1.25x	2.5x	4x; 5x	6.3x	10x	16x; 20x; 25x; 32x	40x; 50x	63x	100x; 150x

The objective magnification multiplied with the eyepiece magnification (minimum 10x) results in the visual overall magnification: e.g. 10 x 10 = 100x.

The overall magnification should not exceed or fall below the useful magnification range. The useful magnification range was defined by Ernst ABBE as 500 to 1000 times the numerical aperture of the objective used. No further details are resolved above that limit. For an objective with a numerical aperture of 0.25, the range of useful magnification is between 125 and 250x.

The exact observance of the cover slip thickness of 0.17 mm is all the more necessary the higher the numeric aperture of the objective. Therefore, certain objectives can be set for different cover slip thickness (due to correction mount). For this, a specimen area is searched, and the position of the correction ring where optimum focus and image contrast are obtained is determined (refocusing is always required).

When immersion objectives are used, the air between the cover slip and the objective is replaced with a liquid, which is immersion oil in most cases. The plastic oiler containing 20 ml of 581 N immersion oil (n_D = 1.515) is particularly suitable for this purpose.

To prevent oil contamination of the specimen when the nosepiece is turned, the resilient mounts of the immersion objectives can be locked in their lifted position by turning them to the right (do not forget to unlock them again!).

The following objectives are ideal for the Axioskop 2 FS *plus* and Axioskop 2 FS MOT microscopes:

Microscopy technique	**Objective**	**Magnification / Num. Aperture**	**Free working distance in mm**	**Cover slip thickness D in mm**	**Cat. No.**
Transmitted-light	Achroplan	10x/0.30 W Ph 1			440039-0000-000
-brightfield	Achroplan	40x/0.80 W	3.6		440090-9901-000
-darkfield	IR-Achroplan	40x/0.80 W	3.6		440095-0000-000
-phase contrast	Achroplan	63x/0.90 W	1.4		440067-0000-000
-interference contrast	Achroplan	100x/1.0 W	0.97		440087-0000-000
Incident-light					
-fluorescence					

1.6 Eyepieces

The following eyepieces are offered for the Axioskop 2 FS *plus* und Axioskop 2 FS MOT:

Eyepiece	Image angle	Application	Cat. No.
Eyepiece W-PL 10x/23 Br. foc. (2x)	49.4°	with all tubes, see pp. 1-6, 1-10	455043-0000-000, aspheric
Eyepiece W-PL 10x/23 Br. foc. (2x)	49.4°	with all tubes, see pp. 1-6, 1-10	000000-1016-758
Eyepiece PL 10x/23 Br. foc. (2x)	49.4°	with all tubes, see pp. 1-6, 1-10	000000-1026-548

W-PL and PL in the eyepiece name refers to the excellent image flatness up to the edge of the field of view. PL 10x/23 Br. foc. eyepieces ensure excellent optical correction, particularly in combination with the ergotubes. If required, eyecups for the eyepieces can be ordered under Cat. No. 444801.

1.7 Stage micrometers and eyepiece reticles

Measuring and counting using the microscope requires stage micrometers and eyepiece reticles, a selection of which is listed below:

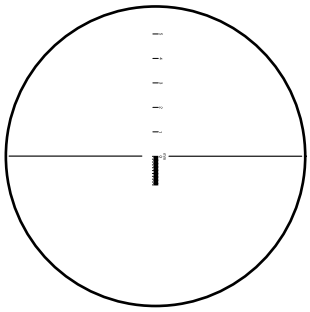
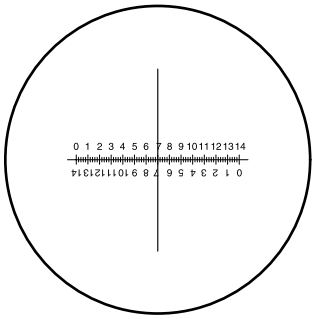
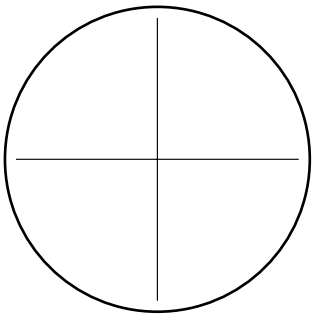
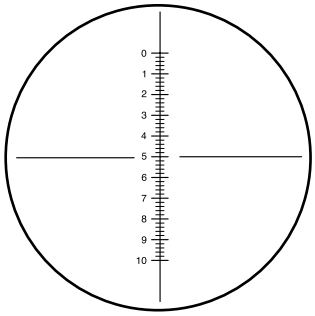
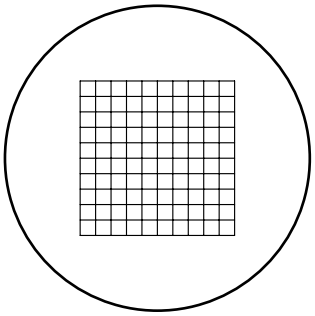
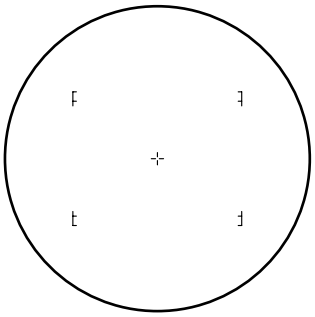
Illustration	Description, Technical Data	Cat. No.
	**Stage micrometer, positive 5 + 100/100 y** D = 0.17 mm gradation on the +y-axis: 5 mm in 5 intervals gradation on the -y-axis: 1 mm in 100 intervals with 2 opposing scales = 10 µm, accuracy ±1µm	474026-0000-000
	**Crossline micrometer 14:140, d = 26 mm** gradation length = 14 mm increments = 0.1mm gradation tolerance ≤ 0.001 mm	454060-0000-000

Illustration	Description, Technical Data	Cat. No.
	**Eyepiece reticle / d = 26 mm**	474064-0000-000
	**Crossline micrometer 10:100, d = 26 mm** gradation length = 10 mm increments = 0.1 mm gradation tolerance ≤ 0.001 mm	474066-9901-000
	**Net micrometer 12.5x12.5/5;10 / d = 26mm** area 12.5x12.5 mm, divided in fields of 10x10	474068-0000-000
	**Photo reticle MC 2.5x / d = 26 mm** for 35 mm photography with an additional magnification of 2.5x or for large-format photography with a 10x additional magnification.	454075-0000-000

☞ If an eyepiece reticle is used, the binocular tube or the phototube must be equipped with two foc. eyepieces containing an adjustable eyelens, into one of which the eyepiece reticle is mounted.

1.8 Technical Data

Dimensions (width x depth x height)

Axioskop 2 FS *plus* / FS MOT with phototube and HAL 100.....approx. 280 mm x 600 mm x 475 mm
Axioskop 2 FS *plus* / FS MOT with phototube and HBO 103.....approx. 280 mm x 733 mm x 475 mm
Axioskop 2 FS *plus* / FS MOT with ergo-phototube and HAL 100.....approx. 280 mm x 670 mm x 500 mm
Axioskop 2 FS *plus* / FS MOT with ergo-phototube and HBO 103.....approx. 280 mm x 800 mm x 500 mm

Weight

Axioskop 2 FS *plus* .....approx. 18 kg
Axioskop 2 FS MOT .....approx. 18 kg

Ambient conditions

Storage and transport (in packaging)

Permissible ambient temperature.....-10 to +60 °C
Permissible relative humidity.....20 % to 85 % at +35 °C
Atmospheric pressure.....800 hPa to 1060 hPa

Operation

Permissible ambient temperature.....+10 to +45 °C
Permissible relative humidity.....20 % to 85 % at +35 °C
Altitude .....max. 2000 m
Atmospheric pressure.....800 hPa to 1060 hPa
Pollution degree.....2

Operating data

Operation .....closed rooms
Protection class I
Enclosure protection..... IP 20
Electrical safety .....in compliance with DIN EN 61010 (IEC 1010-1) including CSA and UL directives
Overvoltage category II
Radio interference suppression .....in accordance with EN 55011, Class B
Insensitivity to noise .....in accordance with EN 50082-2
Line frequency .....50 to 60 Hz

Separate 12 V DC 100 W power unit, stabilized

Operation ..... closed rooms
Protection class I
Enclosure protection ..... IP 20
Line voltage ..... 100 to 240 V ±10 %
Change of line voltage is not required!
Line frequency ..... 50 to 60 Hz
Power consumption when HAL 100 is used ..... 100 VA

HBO 100 W transformer (HBO 100 W/2 and HBO 103 W/2)

Operation ..... closed rooms
Protection class I
Enclosure protection ..... IP 20
Line voltage can be changed between ..... 115 VAC and 230 VAC
Line frequency ..... 50 to 60 Hz
Power consumption when HBO 103 is used ..... 265 VA

Fuses in accordance with IEC 127

Separate 12 V DC 100 W power unit ..... T 4 A/H, 5x20 mm
HBO 100 W transformer ..... T 3.15 A/H, 5x20 mm

Light sources

Halogen illuminator ..... HAL 12 V / 100 W
Adjustment of the light source ..... continuous, 3 to 12 V
Mercury pressure short-arc lamp ..... HBO 103 W/2
Power consumption for HBO 103 W/2 ..... 103 W

Opto-mechanical data

Stand with manual objective focusing

coarse drive .....6 mm / rotation

fine drive ..... 0.1 mm / rotation; 1 µm increments

lifting range ..... max. 11 mm

Achromatic-aplanatic universal condenser 0.9 with

swing-in front lens 0.9

for objective magnifications $M_{obj.} < 10x$ .....swing out condenser front lens 0.9

for objective magnifications $M_{obj.} \geq 10x$ ..... swing in condenser front lens 0.9

brightfield insert with turret disk with 5 or 7 positions;

.....for brightfield, darkfield

..... for phase contrast 1, 2, 3

.....for DIC I, II, III (changeable)

Objective change .....manually via 2-position slider H DIC, W 0.8" FS

Change of technique modules.....manually via 5-position reflector turret

Axioskop 2 FS MOT

Stand with objective focusing ..... motorized

lifting range .....11 mm

focusing..... via motor control and keypad

focusing speed.....variable

end switch for working area.....can be set electronically

activation of stored focus positions.....up to 4 positions can be stored

defined deactivation and activation of the latest work position .....via Home function

focusing in defined steps.....increments available from 0.1 to 499 µm

START-UP

Contents

List of illustrations

2 START-UP

The Axioskop 2 FS *plus* / Axioskop 2 FS MOT can be installed, converted and started up by the customer himself. However, it is also possible to have the microscope installed or converted by Zeiss service staff against an extra charge.

☞ Before installation and start-up of the microscope, make sure to carefully read the **Notes on instrument safety**.

2.1 Initial start-up

2.1.1 Unpacking and installation of the microscope

The basic instrument is supplied in two polyethylene cases in cardboard packaging.

One case contains the stand and the major modules (such as objectives, eyepieces, tubes, condensers, etc.). The second case contains the HAL 100 and HBO 103 illuminators with their relevant power supply units, a tools bag and the control unit and the keypad (for the motorized version).

The following modules are factory-attached to the microscope stand: stage carrier with mechanical stage, universal mounting frame, filter mount and SENARMONT polarizer, technique modules and the epi-fluorescence equipment with adjusting aid.

If the equipment was ordered for applications in differential interference contrast, the DIC sliders are already inserted in the objective slider and centered.

- Use the carrying handle (2-1/**2**) to remove the stand with polyethylene components from the cardboard packaging. Remove the polyethylene components from the stand. Remove all the other instrument components from the packaging.
- Use delivery note to check the consignment for completeness.
- Place instrument (2-1/**4**) on a vibration-free, flat worktable on the microscope mat (2-1/**5**). The size of the microscope mat is 500 mm x 400 mm (width x length).
- Orderly dispose of original packaging or keep it for storage or return of the instrument to the manufacturer.

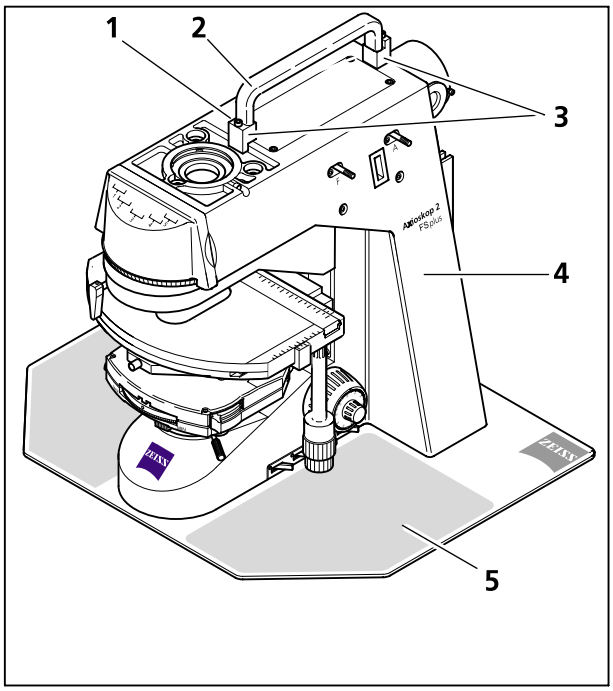


Fig. 2-1 Setting up the microscope

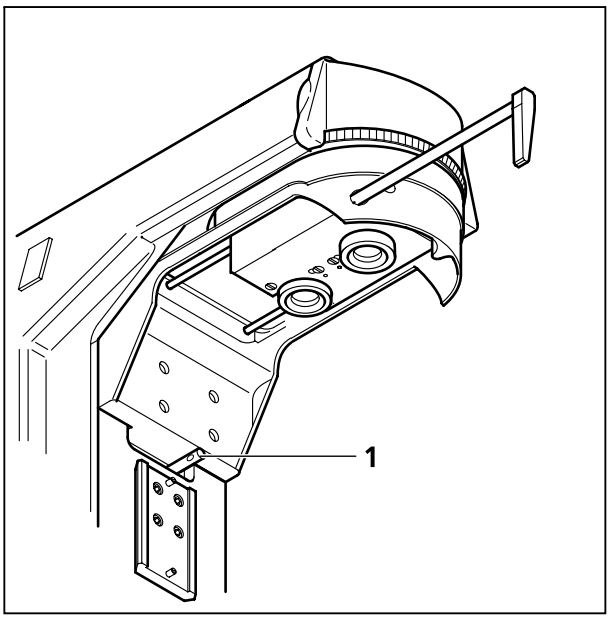


Fig. 2-2 Remove transport locking device

2.1.2 Remove transport lock and carrying handle

To exclude damage to the precision objective focusing drive during transport, the Axioskop 2 FS *plus* / FS MOT microscopes are equipped with two safety screws and a carrying handle. When the microscope has been set up, these items must be removed.

- Remove both safety screws (2-2/**1**) using a SW 3 ball-headed screwdriver.
- Remove all adhesive tapes, including those at the drive knobs.
- Use SW 3 ball-headed screwdriver to loosen both fixation screws (2-1/**1**) of the carrying handle bases (2-1/**3**) and remove the carrying handle (2-1/**2**) with bases from the stand.

After removal of the safety screw, the microscope must not be held at the objective slider to lift it for a change of position, since this will damage the mechanical components of the focusing drive.

For the Axioskop 2 FS *plus* MOT, please observe the note at the rear of the stand concerning the removal of a further transport lock.

2.1.3 Attachment of binocular tube or phototube

All the binocular tubes included in the microscope configurations listed in section 1.3 or 1.4 can be attached to the Axioskop 2 FS *plus* / Axioskop 2 FS MOT as described below.

- Loosen hexagonal screw (2-3/**3**) using the SW3 ball-headed screwdriver. Remove dust covers (2-3/**2**) from the tube underside and the dovetail mount on the stand.
- Hold the binocular tube (2-3/**1**) or the binocular phototube in a slightly inclined position and attach it to the stand mount (2-3/**4**). Turn the binocular tube in the required observation position and tighten the hexagonal screw using the ball-headed screwdriver.

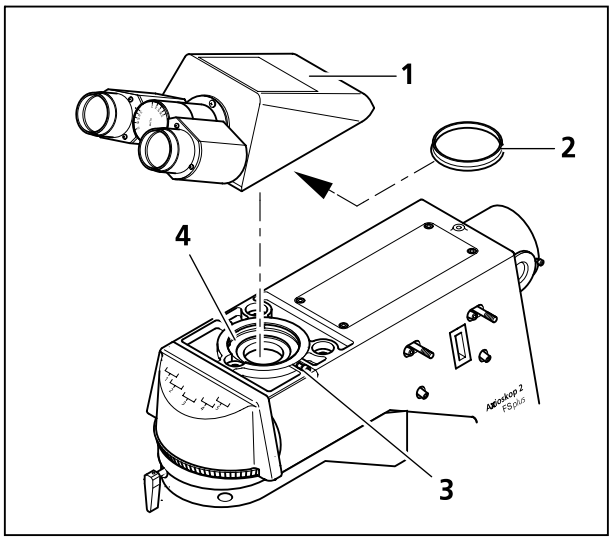


Fig. 2-3 Attachment of binocular tube

2.1.4 Remove the stage carrier

To screw in the objectives and insert the condenser and, if required, the DIC slider, it is recommended to remove the stage carrier. It is not necessary to remove the modules which have already been mounted, such as mechanical stage, filter mount or SENARMONT polarizer, from the stage carrier.

Proceed as follows:

- Hold stage carrier (2-4/**1**) with your left hand.
- Use your right hand to loosen the clamping screw (2-4/**3**) by 5 turns.
- Swing the stage carrier to the left in its horizontal position until it glides out of the dovetail mount (2-4/**2**) on the right.
- Then remove the stage carrier from the stand by pulling it to the front and place it on the table in such a way that toppling is avoided.

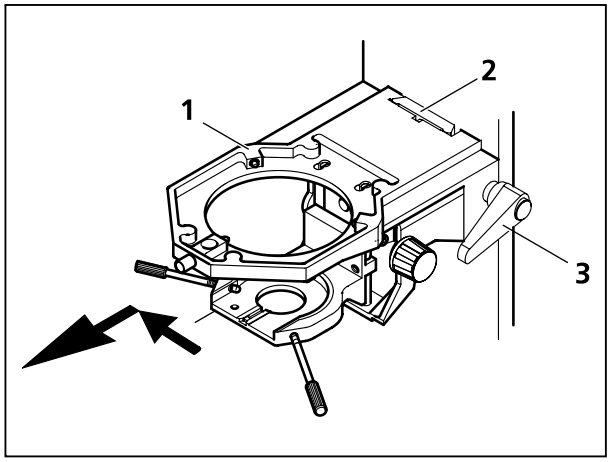


Fig. 2-4 Remove the stage carrier

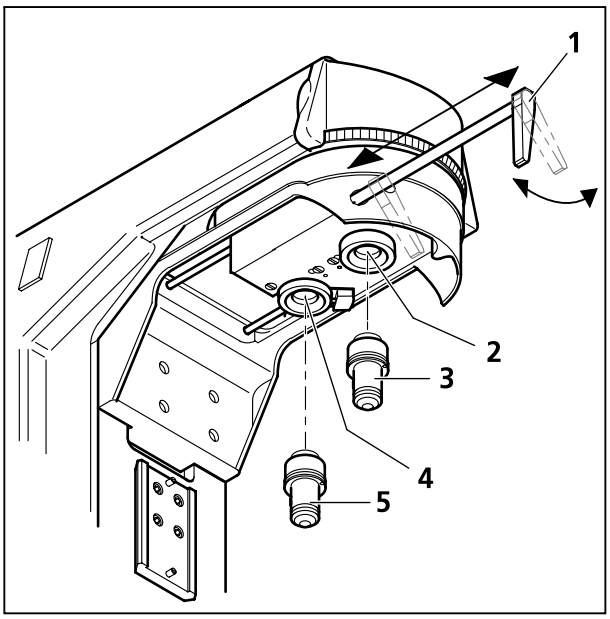


Fig. 2-5 Screwing in of objectives

2.1.5 Screw in objectives

- Remove the stage carrier (see 2.1.4) and place it on the table in such a way that toppling is prevented.
- Move front objective mount (2-5/**2**) into the work position via the pushrod (2-5/**1**) (also see page 3-8).
- Remove objective (2-5/**3**) with the required magnification factor from the case and screw it in the front mount of the objective slider until stop.
- Move rear objective mount (2-5/**4**) into the work position via pushrod (2-5/**1**). Remove the second objective (2-5/**5**) from the case and screw it into the rear mount until stop.

☞ Attach stage carrier again only after inserting the DIC slider (if required) and the condenser.

2.1.6 Attachment of the condenser

It is recommended to remove the stage carrier before you insert the condenser.

- Remove the stage carrier (if not yet done - see 2.1.4) and safely place it on the table.
- Use lever (2-6/**8**) to fold out the front lens on the condenser. Unscrew both centering screws (2-6/**3**) until their ends are no longer visible.
- Move condenser carrier (2-6/**2**) to the lowest position via drive for height adjustment (2-6/**5**).
- Insert condenser (2-6/**1**) between condenser carrier (2-6/**2**) and stage carrier (2-6/**4**). Orient the locking screw on the underside of the condenser in the direction of the groove (2-6/**7**).
- Press dovetail of condenser against the spring mount (2-6/**6**) of the condenser carrier until the condenser can be placed on the condenser carrier horizontally.
- Let condenser go smoothly; the screw will lock in position in the groove (2-6/**7**) at the front.
- Screw in centering screws until they engage in the dovetail of the condenser.

Proceed in the same way when attaching the achromatic condenser 0.8 H D Ph DIC (2-7/**1**). The item numbers **2** to **7** in Fig. 2-7 are identical to those in Fig. 2-6.

☞ Attach stage carrier again only after insertion of the DIC slider.

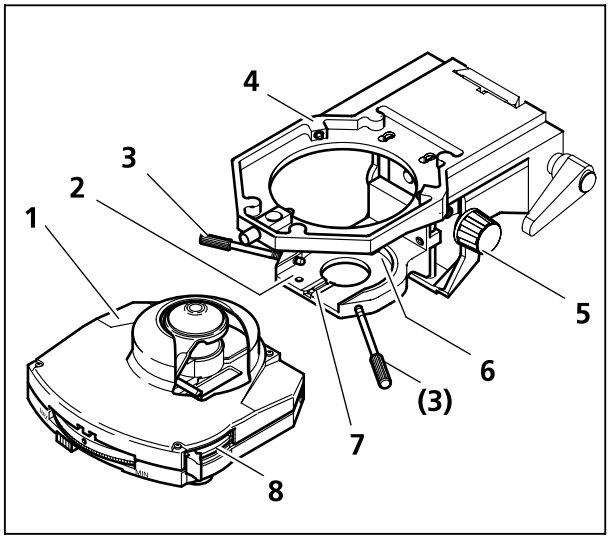


Fig. 2-6 Attachment of universal condenser

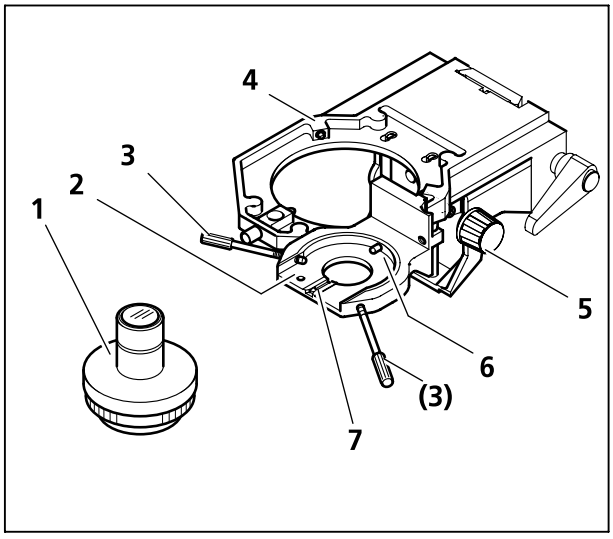


Fig. 2-7 Attachment of achromatic condenser 0.8 H D Ph DIC

2.1.7 Insertion of DIC slider

If the microscope equipment was ordered for applications in differential interference contrast, the DIC sliders are already inserted in the objective sliders and centered.

For retrofitting, or to change the DIC slider, proceed as follows:

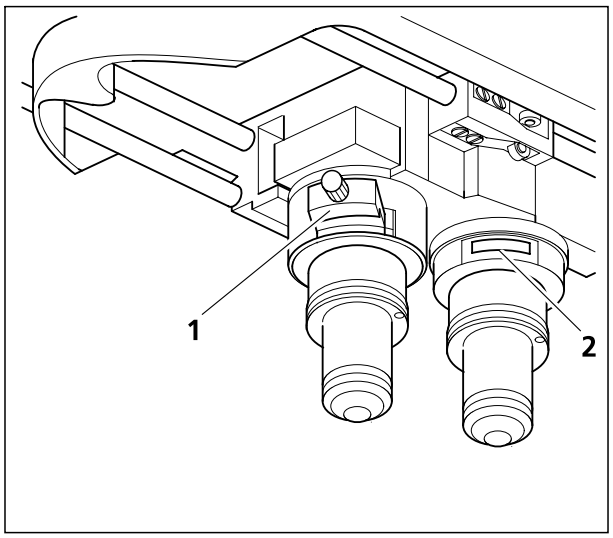


Fig. 2-8 Insertion of DIC slider

- Remove the stage carrier (if not yet done - see 2.1.4) and safely place it on the table.
- Bring front objective mount in the work position (see page 3-8).
- Push suitable DIC slider (2-8/**1**, see labels) in the provided opening (2-8/**2**) of the objective slider above the objective.
- Make sure that the DIC slider precisely locks into position.
- Bring rear objective mount in the work position (see page 3-8) and proceed in the same way as described above.

☞ After being inserted in the objective slider, the DIC sliders must be moved into center position. However, this requires the microscope to be put in operation completely and the KÖHLER illumination to be set (see chapter 3, section 3.3.1). Setting of the DIC sliders to the center position is described in section 3.3.4 (3) of chapter 3.

- When the objectives, the DIC slider and the condenser have been inserted, the stage carrier must be attached to the microscope again (see section 2.1.8).

2.1.8 Attach stage carrier and align its height

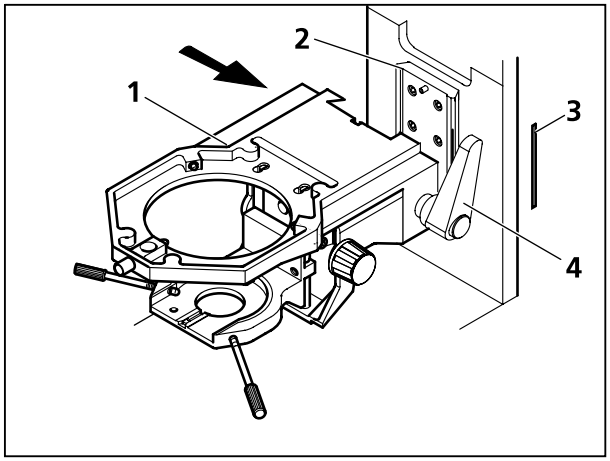


Fig. 2-9 Attachment of stage carrier

Please proceed as follows to attach the stage carrier to the stand:

- Hold the stage carrier (2-9/**1**) with your left hand and insert it in the dovetail guide (2-9/**2**) on the left of the stand in a slightly inclined position.
- Hold the stage carrier as horizontally as possible and press it against the guiding surfaces on the left side. Turn the stage carrier to the right to enable also the right side to engage in the dovetail mount of the stand.
- Slightly tighten the clamping lever (2-9/**4**) with your right hand.
- Depending on the thickness of the cover slips used, align the stage carrier with the top (low cover slips) of the marking scale (2-9/**3**) or the bottom (high cover slips) and tighten clamping lever (2-9/**4**) without exerting too much pressure.

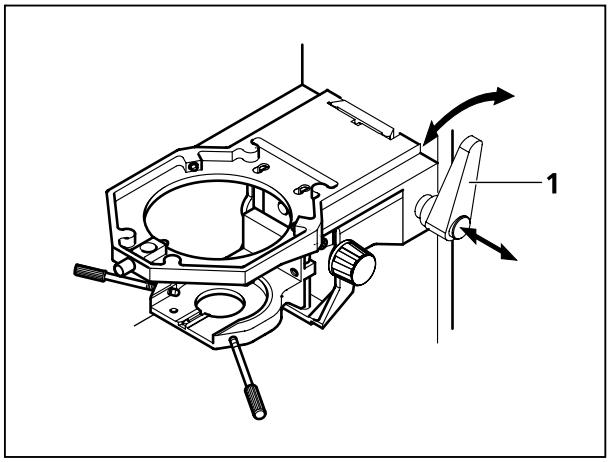


Fig. 2-10 Change the orientation of the clamping lever

The orientation of the clamping lever of the stage carrier can be selected as required:

- Press clamping lever (2-10/**1**) against the spring until stop (in the direction of the stage carrier).
- Turn the clamping lever in the required angular position.
- Release clamping lever until it clickstops in position again.

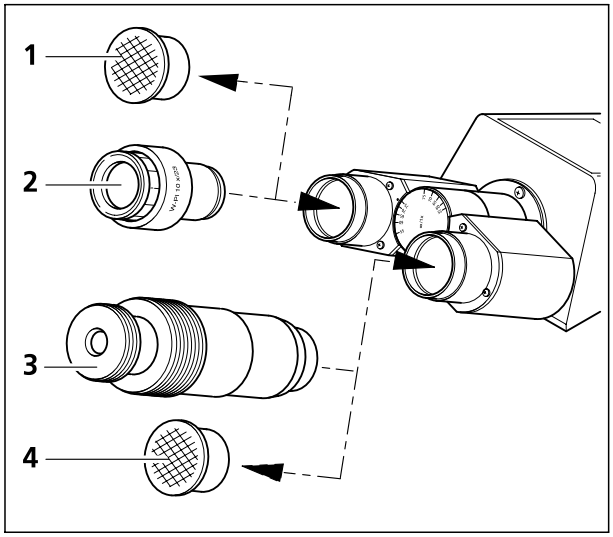


Fig. 2-11 Inserting the eyepieces

2.1.9 Insertion of eyepieces and centering telescope

- Remove both dust covers (2-11/**1** and **4**) from the binocular tube.
- Remove both eyepieces (2-11/**2**) from the cases and insert them in the binocular tube until stop.
- The centering telescope (2-11/**3**), which is used to view the aperture/phase/darkfield stops and to center phase and darkfield stops, can be inserted in one of the tubes instead of an eyepiece. The adjustable eyelens permits focusing on these stops and the setting to be fixed using a clamping screw.

☞ The eyepieces W-PL 10x/23 Br. foc. and PL 10x/23 Br. foc. can be used with all tubes (see pp. 1-6, 1-10).

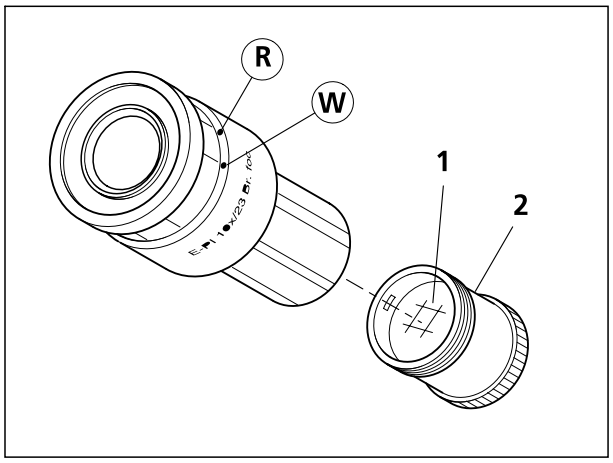


Fig. 2-12 Inserting the eyepiece reticle

Inserting the eyepiece reticle

The eyepieces PL 10x/23 Br. foc. are intended for use with eyepiece reticles.

The slight image shift caused by the additional path through the glass is taken into account on the diopter scale by the fact that the zero point position is indicated not by the white dot (2-12/**W**), but by the red dot (2-12/**R**).

The eyepiece reticles (2-12/**1**) have been adhered to screw-in mounts (2-12/**2**) by the manufacturer to allow easy replacement.

To replace an eyepiece reticle, only remove screw-in mount (2-12/**2**) with eyepiece reticle (2-12/**1**) and replace it with a screw-in mount containing the required eyepiece reticle.

☞ If eyepiece reticles are inserted into the unscrewed mount by the customer, attention must be paid to the labelling being visible the right way up after insertion.

Compensation of ametropia when eyepiece reticles are used

The correct use of an eyepiece reticle requires two focusing eyepieces, e.g. E-PL 10x/23 Br. foc., to allow the user to compensate for differences in the visual performance of his two eyes.

- Use the focusing eyepiece to focus on the line figure of the eyepiece reticle; focus on the edge of the field of view if no eyepiece reticle is used.
- Use the focusing drive to focus on the microscope image of a specimen through the eyepiece set as described above.
- Then use the second focusing eyepiece to focus the microscope image for the second eye. The position of the focusing drive on the microscope stand must not be changed.

2.1.10 Setting of the interpupillary distance of the binocular tube

The eyepiece distance is matched to the user's individual interpupillary distance by swinging the eyepiece tubes symmetrically towards one another (2-13/**A** and 2-13/**B**).

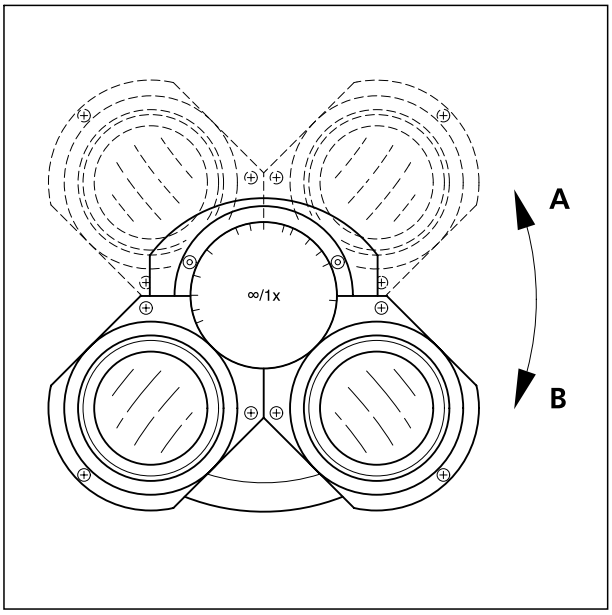


Fig. 2-13 Setting the interpupillary distance of the binocular tube

2.1.11 Setting of viewing height

The viewing height can be set continuously in the range from 6 to 25° by changing the viewing angle of the two ergotubes. Furthermore, the binocular component of the ergotubes can be swivelled by 180°.

2.1.12 Connect the instrument to the line and switch the illumination on/off

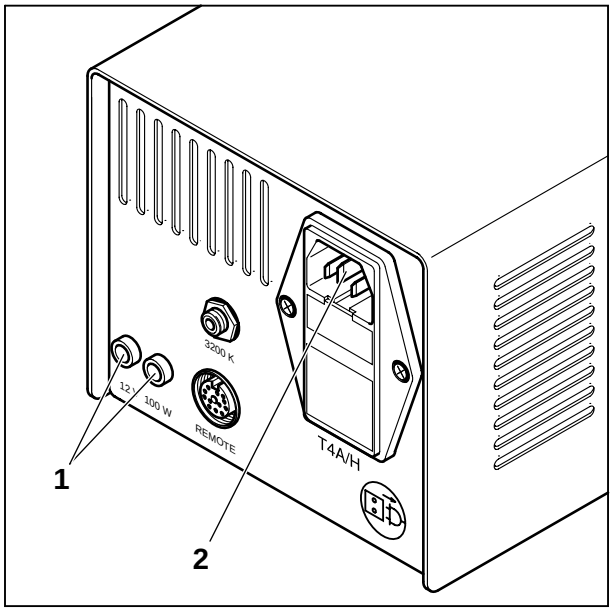


Fig. 2-14 Connection of halogen illuminator

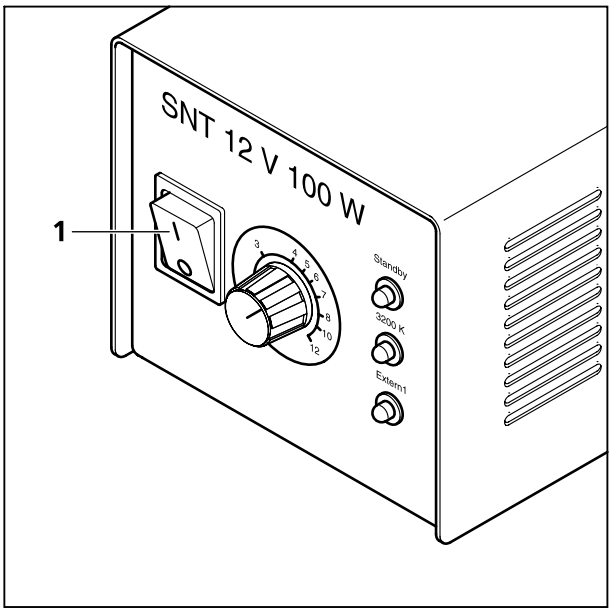


Fig. 2-15 Switch halogen illuminator on/off via separate power unit

The Axioskop 2 FS *plus* / FS MOT microscopes do not have their own line connection in order to avoid voltage potentials in the microscope which might affect electrophysiological examinations. Accordingly, each of the HAL 100 and HBO 103 microscope illuminators are supplied by a separate voltage supply unit.

Switch the HAL 100 halogen illuminator on or off

The HAL 100 halogen illuminator is supplied via the separate 12 V DC 100 W power unit and directly switched on/off from there.

- Connect plug of halogen illuminator to 12 V 100 W socket (2-14/**1**) of the separate power unit (also see 2.1.13).

Should the halogen illuminator be equipped with a 3-pin plug (cable shielding), the third pin of the plug can be removed without any risk of the microscope being affected.

- Connect the power unit to the line via connector (2-14/**2**) and cable.

The separate power unit can be connected to line voltage between 100 and 240 VAC, 50 - 60 Hz. The power unit sets itself **automatically** to the available line voltage within this range.

- Switch HAL 100 halogen illuminator on/off via line switch (2-15/**1**).

Connect HBO 103 illuminator and switch it on/off

The HBO 103 illuminator (for epi-fluorescence) is supplied via a separate transformer and switched on/off via the power unit of this transformer.

- Insert multi-pin plug of the HBO 103 illuminator into the instrument socket (2-16/**2**) of the HBO 100 W transformer and secure it with captive coupling ring (also see 2.1.14).
- The HBO 100 W transformer must be connected to the line via its line socket (2-16/**3**).
- Switch the HBO 100 W transformer on/off using line switch (2-16/**1)**.

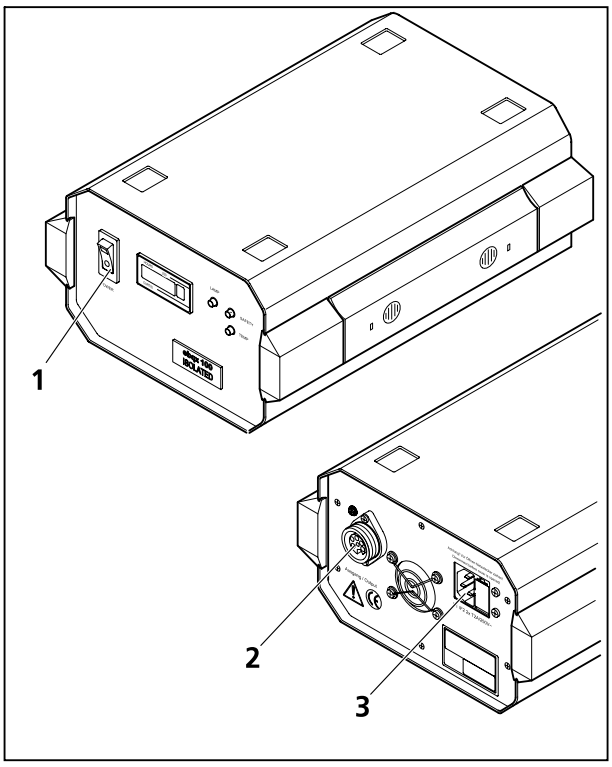


Fig. 2-16 HBO 100 W transformer (front and rear)

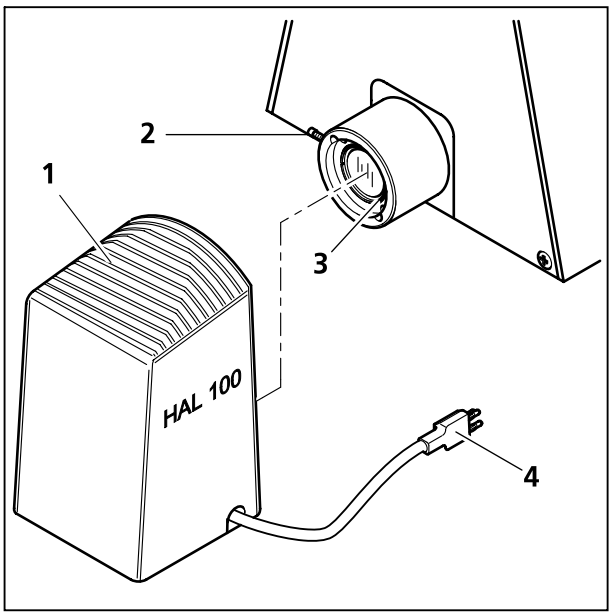


Fig. 2-17 Attachment of HAL 100 halogen illuminator

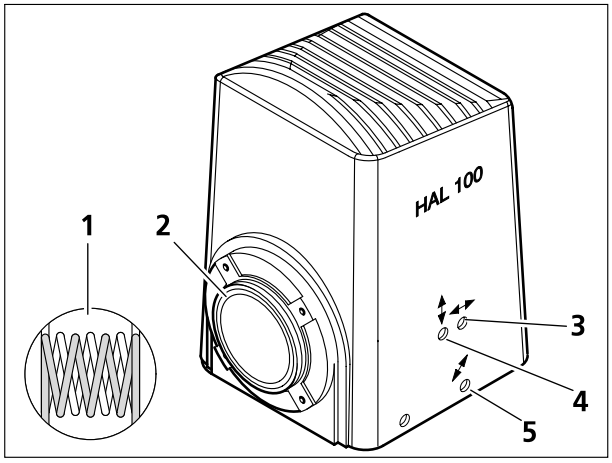


Fig. 2-18 Adjustment of HAL 100 halogen illuminator

2.1.13 HAL 100 halogen illuminator

(1) Attachment of HAL 100 halogen illuminator

- Remove cover from transmitted-light tube (2-17/**3**).
- Insert dovetail (2-18/**2**) of lamp housing (2-17/**1**) in transmitted-light tube (2-17/**3**) on the instrument rear and use the SW 3 ball-headed screwdriver to tighten clamping screw (2-17/**2**).
- Connect 3-pin illuminator plug (2-17/**4**) to 3-pin 12 V/100 W socket (2-14/**1**) of the separate 12 V DC 100 W power unit (also see 2.1.12).

(2) Adjustment of HAL 100 halogen illuminator

a) Coarse adjustment

- Loosen clamping screw (2-17/**2**) and remove the halogen illuminator from the microscope stand.
- Switch on separate 12 V DC 100 W power unit as described under 2.1.12.
- Direct the light beam against a projection area (wall) approx. 3 m away.

Do not look into the light exit opening of the illuminator.

- Set adjusting screw (2-18/**3**) using SW 3 ball-headed screwdriver in such a way that both images of the lamp coil are as sharply focused as possible on the projection screen.
- Then set adjusting screws (2-18/**4** and **5**) in such a way that the lamp coil of one image exactly fills the gaps in the reflector image (2-18/**1**).

b) Fine adjustment

- Attach illuminator to the stand again and tighten clamping screw (2-17/**2**).
- Remove diffusion disk (3-1/**12**) and filters (3-1/**15**), if switched in, from the beam path.
- Focus on the specimen using objective ≤ 40x and search for a free object area.
- Remove eyepiece and center lamp coil and its reflector image in the pupil image using adjusting screws (2-18/**4** and **5**).
- Use adjusting screws (2-18/**3**) to optimize the homogeneous illumination of the pupil image.
- Switch in diffusion disk and required filters.

2.1.14 HBO 103 illuminator

(1) Attach HBO 103 W/2 mercury vapor short-arc lamp

The HBO 103 illuminator and the HBO 103 W/2 mercury vapor short-arc lamp are supplied in separate packages for safety reasons.

Therefore, insertion of the HBO 103 W/2 lamp into the lamp housing is the first step to the start-up of this illuminator.

Insertion of a new HBO 103 W/2 lamp is described in detail on page 2-27, section 2.2.8 entitled "Changing the HBO 103 W/2 mercury vapor short-arc lamp".

(2) Attachment of HBO 103 illuminator

- Remove cover from the incident-light tube (2-19/**1**).
- Insert dovetail of lamp housing in incident-light tube (2-19/**1**) on the instrument rear and use SW 3 ball-headed screwdriver to tighten clamping screw (2-19/**2**).

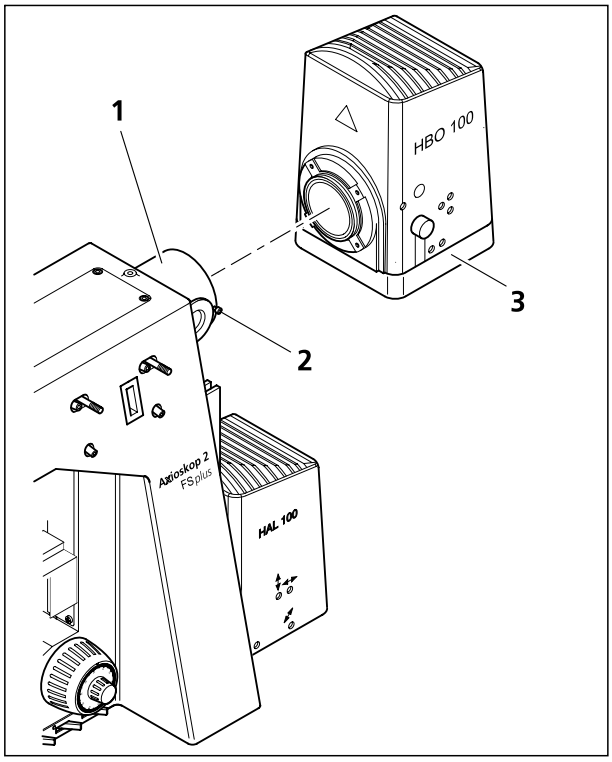


Fig. 2-19 Attachment of HBO 103 illuminator

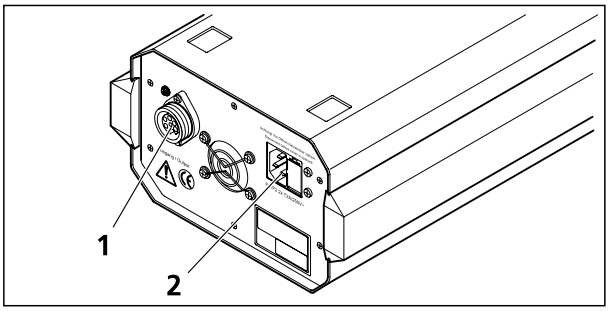


Fig. 2-20 HBO 100 W transformer

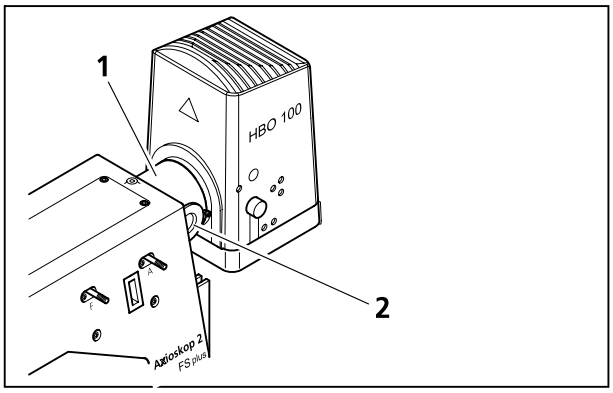


Fig. 2-21 Adjusting aid

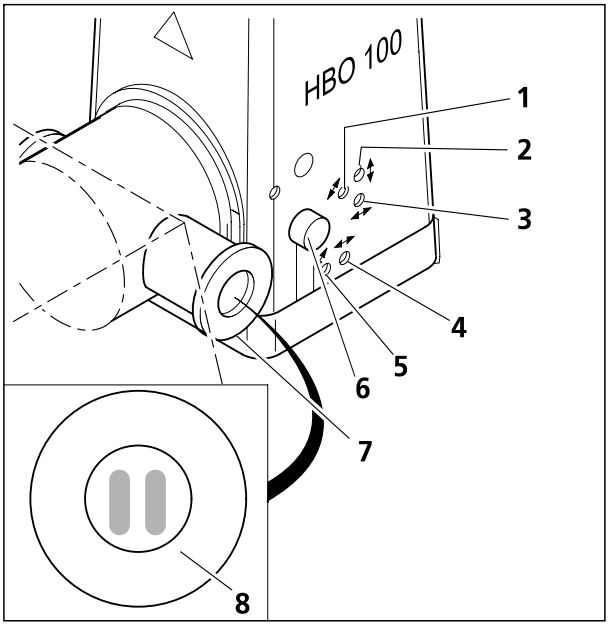


Fig. 2-22 Adjustment of mercury vapor short-arc lamp

- Insert multi-pin plug of the HBO 103 illuminator (2-19/**3**) into socket (2-20/**1**) of the HBO 100 W transformer and secure it with captive coupling ring (also see 2.1.12).
- Connect line cable to socket (2-20/**2**) of the HBO 100 W transformer first, then connect it to the line.

(3) Adjustment of HBO 103

Adjustment of the HBO 103 illuminator described below is performed in two steps: coarse adjustment and subsequent fine adjustment. The latter can be performed with or without adjusting aid (2-21/**2**) on the incident-light tube (2-21/**1**).

Coarse adjustment:

- Remove HBO 103 illuminator from the microscope stand by loosening clamping screw (2-19/**2**).
- Switch on HBO 103 on HBO 100 W transformer (2-16/**1**) and allow it to heat to operating temperature. Make sure not to look into the light exit opening of the illuminator.
- Direct light beam against a projection area (wall) approx. 3 m away.
- Use knurled knob (2-22/**6**) to focus on the brighter focal spot via collector adjustment.
- Use adjusting screw (2-22/**4**) and SW 3 ball-headed screwdriver to locate and focus on the slightly darker, reflected focal spot.
- Use adjusting screws (2-22/**1** and **3**) and SW 3 ball-headed screwdriver to set the height and side of the brighter focal spot in the same way as the focal spot image (2-24).

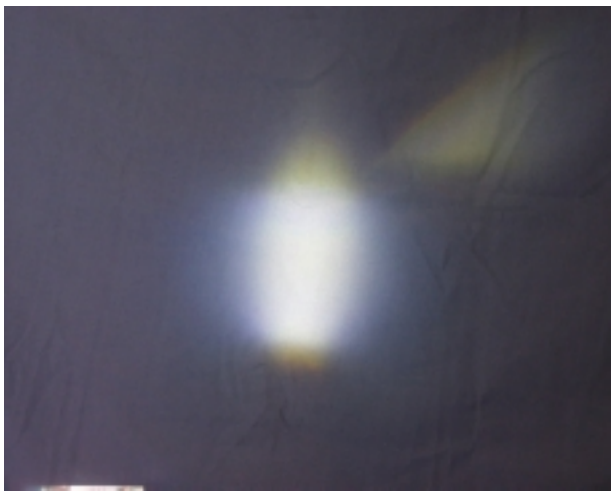


Fig. 2-23 Focal spots of HBO 103 before coarse adjustment

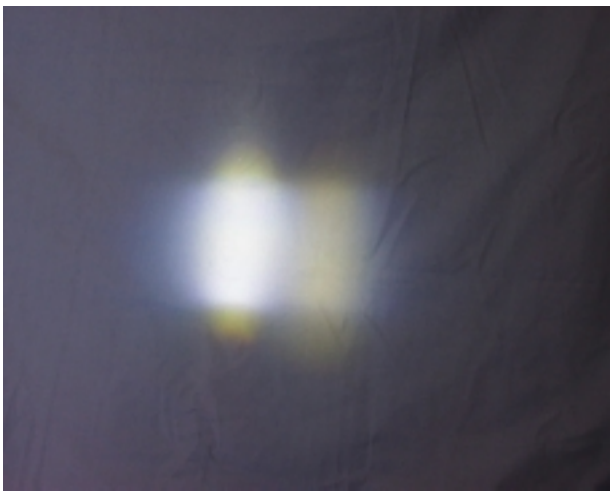


Fig. 2-24 Focal spots of HBO 103 after coarse adjustment

☞ During coarse adjustment of the focal spots, adjusting screws (2-22/**2** and **5**) must not be changed, since they influence the reflector setting in the HBO 103 illuminator.

If required, the above settings for coarse adjustment of the HBO 103 illuminator can be performed repeatedly.

Fine adjustment using adjusting aid

- Attach HBO 103 illuminator to microscope stand as described in section 2.1.14 (2).
- Pull adjusting aid (2-21/**2**) out of the incident-light tube (2-21/**1**). The brighter focal spot of the HBO 103 W/2 lamp and its slightly darker reflector image become visible in the black glass window of the adjusting aid.
- Use knurled knob (2-22/**6** or 2-25) to focus on the brighter focal spot via collector adjustment.
- Apply SW 3 ball-headed screwdriver on adjusting screw (2-22/**4**) to focus on the slightly darker, reflected focal spot of the lamp.

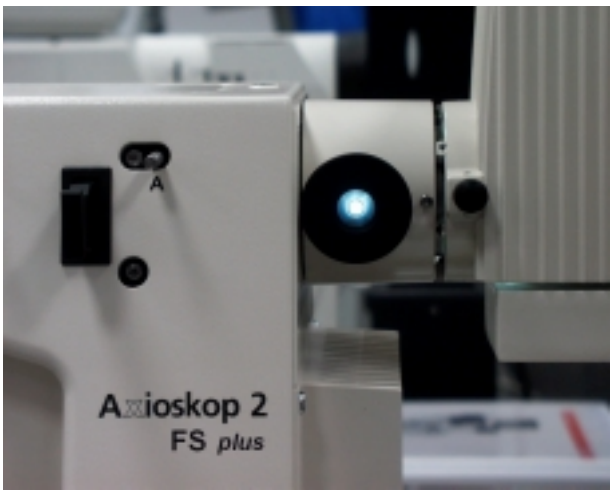


Fig. 2-25 Focal spot imaging via adjusting aid and knurled knob for focusing

- If required, set knurled knob (2-22/**6**) and adjusting screw (2-22/**4**) alternately until both focal spots have the same dimension (see Fig. 2-24).
- Use adjusting screws (2-22/**1** and **3**) to adjust the brighter focal spot in the adjusting circle, e.g. on the left side, in the same way as the focal spot image (2-25).
- Use adjusting screws (2-22/**2** and **5**) to adjust the dark focal spot in the adjusting circle, e.g. on the right side, in the same way as the focal spot image (2-22/**7** and 2-24).
- Push in adjusting aid again.

☞ The two focal spots of the HBO 103 W/2 lamp must **not** superimpose in the adjusting circle of the adjusting aid!

If required, the above settings for fine adjustment of the HBO 103 illuminator can be performed repeatedly.

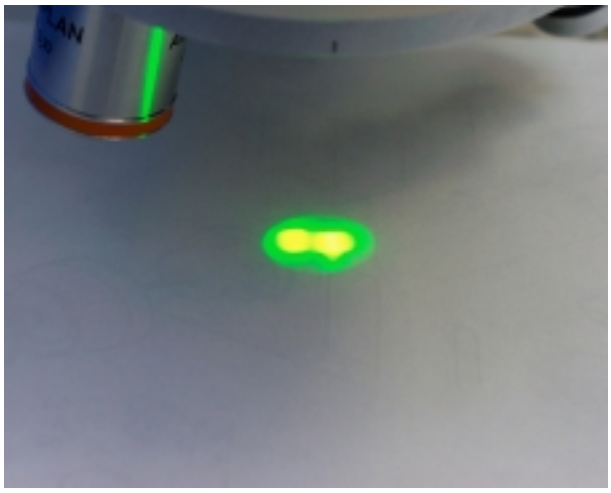


Fig. 2-26 **Focal spot imaging without adjusting aid on the mechanical stage**

Fine adjustment without adjusting aid

- Attach HBO 103 illuminator to microscope stand as described in section 2.1.14 (2).
- Remove one objective from the nosepiece and switch empty opening in function position.
- Place a white sheet of paper on the mechanical stage.
- Fully open the precentered luminous-field and aperture diaphragms in the incident-light illumination beam path.
- The pupil image with the two focal spot images is now visible on the white sheet of paper. If required, reduce light intensity using attenuation filters in the 3-position or 6-position filter slider.
- Use knurled knob (2-22/**6**) to focus on the brighter focal spot via collector adjustment.
- Apply SW 3 ball-headed screwdriver on adjusting screw (2-22/**4**) to focus on the slightly darker, reflected focal spot of the lamp.
- If required, set knurled knob (2-22/**6**) and adjusting screw (2-22/**4**) repeatedly until both focal spots have the same dimension.
- Use adjusting screws (2-22/**1** and **3**) to set the brighter focal spot in accordance with Fig. 2-26.
- Use adjusting screws (2-22/**2** and **5**) to set the darker focal spot in accordance with Fig. 2-26.

2.1.15 Connect control unit and keypad to the Axioskop 2 FS MOT

Focusing of the Axioskop 2 FS MOT is performed exclusively using the motorized z-adjustment of the objective slider. The high-precision step motor used for z-adjustment is accommodated in the stand and operated via a separate control unit with connected keypad.

Proceed as follows to connect the control unit and the keypad to the Axioskop 2 FS MOT:

- Connect keypad plug to the **Keypad** socket (2-27/**2**) at the rear of the control unit.
- Plug one end of the connecting cable to the **Motor Microscope** socket (2-27/**1**) of the control unit and the other end to the Axioskop 2 FS MOT interface (2-28/**1**).

Make sure not to mix up the plugs when you connect the microscope and the keypad to the control unit.

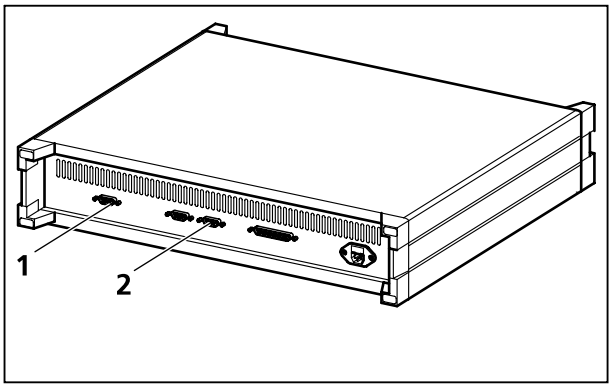


Fig. 2-27 Control unit (rear)

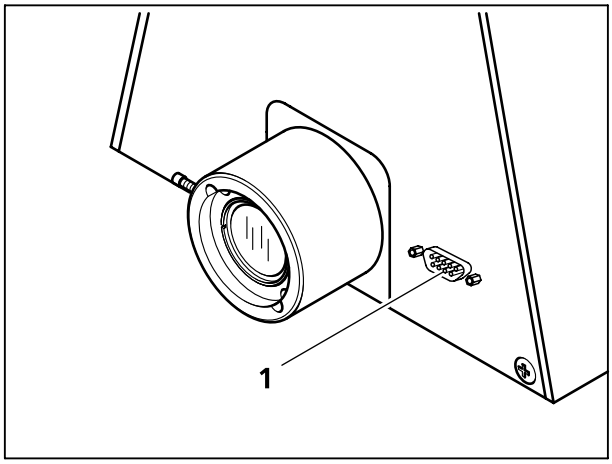


Fig. 2-28 Axioskop 2 FS MOT (rear)

2.1.16 Switch on/off the control unit of the Axioskop 2 FS MOT

- Switch the control unit and keypad on/off via the line switch (2-29/**1**).

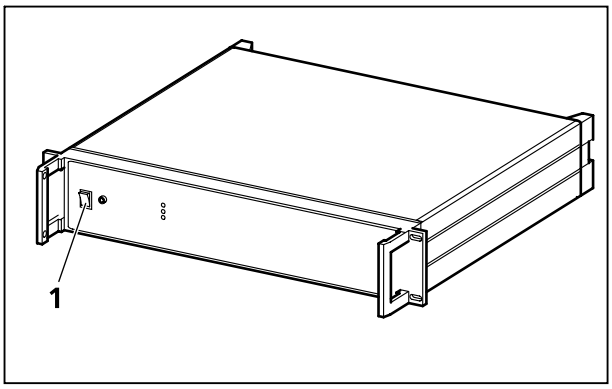


Fig. 2-29 Switch on/off the control unit of the Axioskop 2 FS MOT

2.1.17 Attachment of round cable holder

The round cable holder supplied with the mechanical stages can be used to attach electrical cables, e.g. from dictating machines. For this purpose, the round cable holder should be adhered to a suitable position on the microscope.

The round cable holder also can be used to hold and store the SW 2 screwdriver on the microscope stand, e.g. behind the objective slider or at any other freely accessible position of the stand.

2.2 Attachments and conversions

☞ The steps required for attachments to and conversions of the microscope are explained in the following. After this, the respective modules must be reset in a functioning status again.

2.2.1 Changing the condenser

It is recommended to remove the stage carrier if you want to change the condenser.

- Remove the stage carrier (see 2.1.4) and safely place it on the table.
- Use lever (2-30/**8**) to fold out the front lens on the available condenser.
- Move condenser carrier (2-30/**2**) to the lowest position via drive for height adjustment (2-30/**5**).
- Unscrew both centering screws (2-30/**3**) until condenser can be easily taken out of its mount.
- Lift available condenser from the orientation groove by slightly tilting it upwards and pull it out to the front.

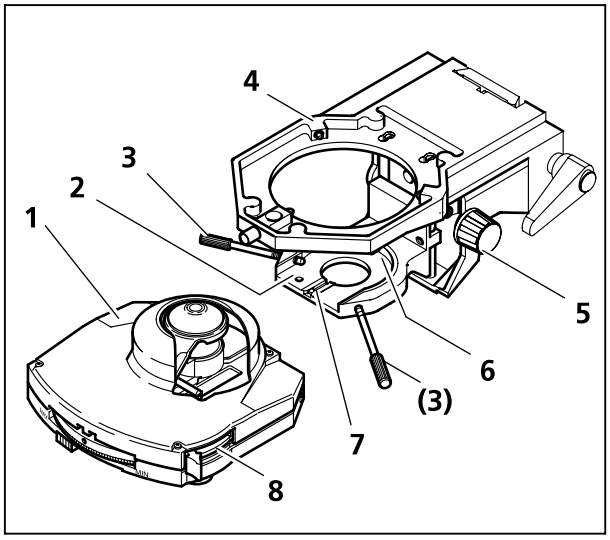


Fig. 2-30 Changing the condenser

- Use lever (2-30/**8**) to fold out the front lens on the condenser to be inserted.
- Insert condenser (2-30/**1**) between condenser carrier (2-30/**2**) and stage carrier (2-30/**4**). Orient the locking screw on the underside of the condenser in the direction of the groove (2-30/**7**).
- Press dovetail of condenser against the spring mount (2-30/**6**) of the condenser carrier until the condenser can be placed on the condenser carrier horizontally.
- Let condenser go smoothly; the screw will lock in position in the groove (2-30/**7**) at the front.
- Screw in centering screws until they engage in the dovetail.
- Attach stage carrier to the microscope stand again (see section 2.1.8).

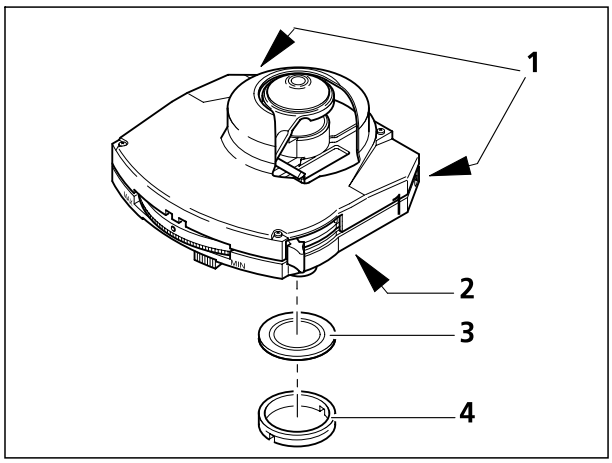


Fig. 2-31 Changing the phase stop

2.2.2 Changing the phase stop for phase contrast or darkfield in the universal condenser (if required)

- Tighten both centering screws (2-31/**1**) until stop using SW 1.5 Allen screwdriver.
- To loosen the cover on the condenser underside (2-31/**2**), loosen both grub screws and remove the cover. Position turret disk with phase stop to be changed in the exchange opening and hold it on the knurled ring, since no click-stop is effective in this position.
- Use mounting device contained in tool set to unscrew retainer ring (2-31/**4**) from the condenser underside (2-31/**2**) and allow phase stop (2-31/**3**) to slide out.
- To insert the new phase stop, turn condenser round, insert the new phase stop, tighten retainer ring, loosen both centering screws and recenter phase stop using the centering telescope. Make sure that the correct label is visible on the knurled ring of the turret when the unit is swung into the beam path.

2.2.3 Changing the DIC prism in the universal condenser

- To loosen the cover on the condenser underside (2-32/**1**), loosen both grub screws using the SW 2 screwdriver and remove the cover. Position the turret disk containing the DIC prism to be exchanged in the exchange opening and hold it on the knurled ring.
- Unscrew retainer ring using the so-called double-function tool (2-32/**4**).
- Now screw the tool in the prism mount (2-32/**3**) with the threaded side (2-32/**4**) and pull out DIC prism (2-32/**2**).
- Remove DIC prism (2-32/**2**) from the tool and screw on the new, required DIC prism.
- Installation of the DIC prism is made in reverse order. Make sure that the DIC prism is oriented correctly (groove 2-32/**5** must engage in the pinion of the mount). Make sure that the knurled ring of the turret disk is labelled correctly.

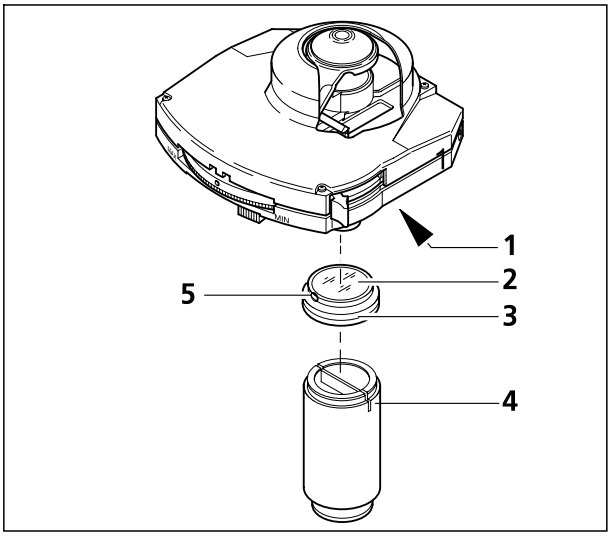


Fig. 2-32 Changing the DIC prism

2.2.4 Attachment of filter mount

- Hold filter mount (2-33/**5**) parallel to the underside of the condenser carrier (2-33/**3**) and screw holding pin (2-33/**4**) of the filter mount (2-33/**5**) into the front threaded hole on the left below the condenser carrier (2-33/**3**) until stop using the SW 2 angled Allen key (2-33/**6**).
- Use adjusting lever (2-33/**1**) to screw stop bolt (2-33/**2**) into the rear threaded hole of the condenser carrier until stop.

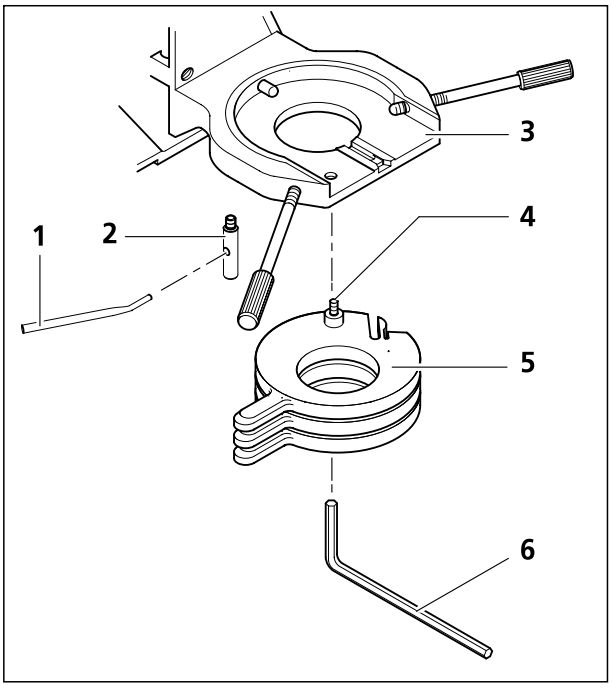


Fig. 2-33 Attachment of filter mount

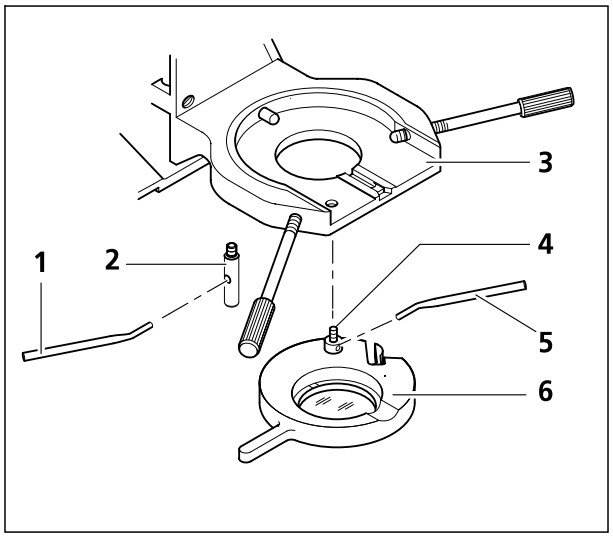


Fig. 2-34 Attachment of Polarizer D

2.2.5 Attachment of Polarizer D

- Hold polarizer (2-34/**6**) parallel to the underside of the condenser carrier (2-34/**3**) and screw stop bolt (2-34/**4**) of the polarizer (2-34/**6**) into the threaded hole on the left below the condenser carrier (2-34/**3**) until stop using the angled adjusting lever (2-34/**5**).
- Use adjusting lever (2-34/**1**) to screw stop bolt (2-34/**2**) into the rear threaded hole of the condenser carrier (2-34/**3**) until stop.

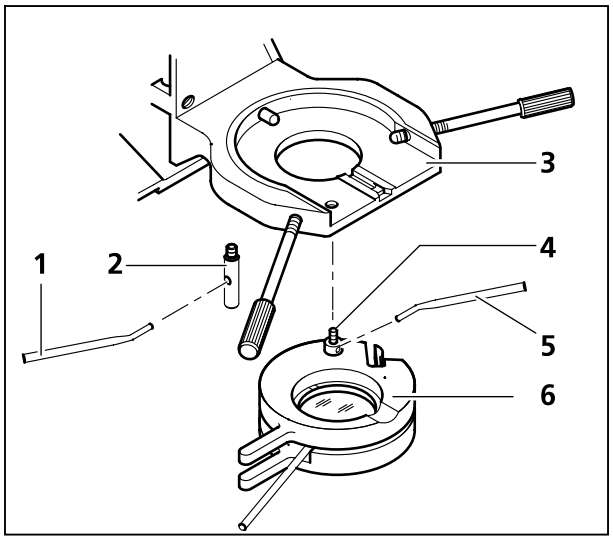


Fig. 2-35 Attachment of SENARMONT DIC polarizer

2.2.6 Attachment of SENARMONT DIC polarizer

- Hold polarizer (2-35/**6**) parallel to the underside of the condenser carrier (2-35/**3**) and screw stop bolt (2-35/**4**) of the polarizer (2-35/**6**) into the threaded hole on the left below the condenser carrier (2-35/**3**) until stop using the angled adjusting lever (2-35/**5**).
- Use adjusting lever (2-35/**1**) to screw stop bolt (2-35/**2**) into the rear threaded hole of the condenser carrier (2-35/**3**) until stop.

2.2.7 Changing the HAL 100 halogen lamp

- Switch off the separate power unit of the halogen lamp as described in section 2.1.12, remove illuminator plug from the 12 V / 100 W socket of the power unit and allow the unit to cool down for approx. 15 minutes.
- Loosen screw (2-36/**5**) until the lamp housing can be removed in an upward direction.
- Press both spring levers (2-36/**3**) downwards and pull out the old halogen lamp (2-36/**2**) in an upward direction.
- Press both spring levers downwards, insert new lamp, with protection cap (2-36/**1**) being attached in lamp base (2-36/**4**), let go the spring lever and pull the protection cap off.
- Press spring lever briefly downwards again to center the lamp.
- Attach lamp housing again and tighten clamping screw (2-36/**5**).

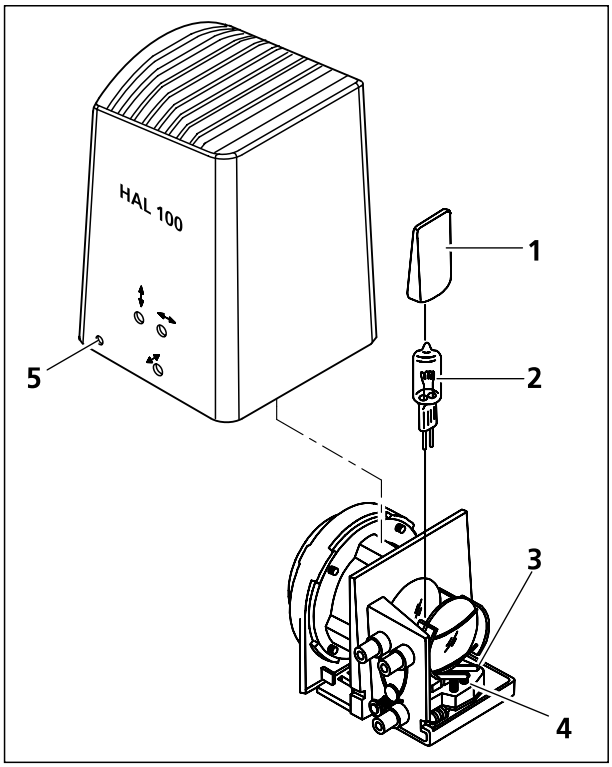


Fig. 2-36 Changing the halogen lamp

2.2.8 Changing the HBO 103 W/2 mercury pressure short-arc lamp

Before opening the lamp housing, make sure that no connection to the electrical line is available.

The HBO 203 W/2 lamps may only be changed after they have cooled down. Allow the HBO 103 microscope illuminator to cool down for approx. 15 mins to avoid the risk of burns.

The HBO 103 W/2 lamp may only be removed from the packaging and inserted in the HBO 103 illuminator if a protective mask and safety gloves are worn.

All electrical clamping connections must be made carefully. Pronounced heat during operation may result in loose contacts.

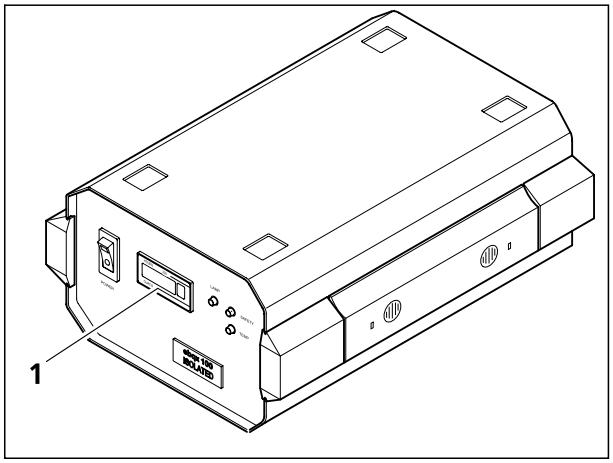


Fig. 2-37 HBO 100 W transformer

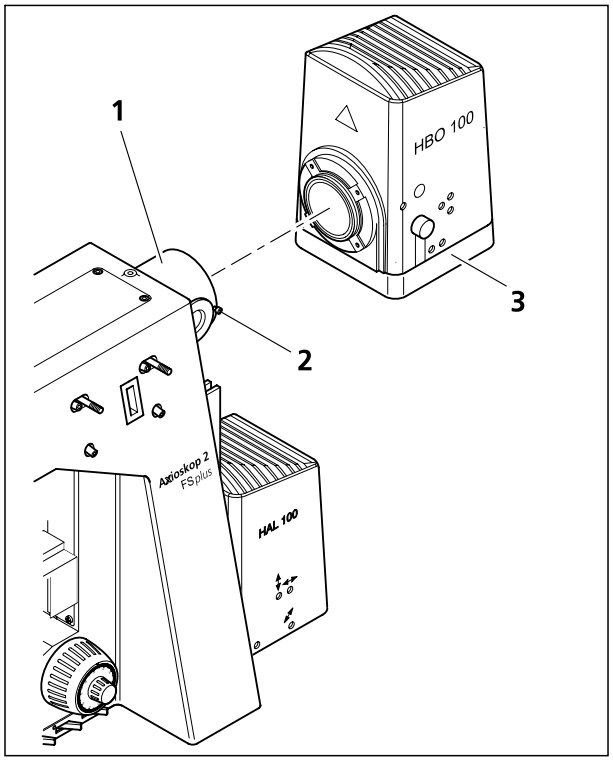


Fig. 2-38 Removing the HBO 103 illuminator

After expiry of the average operation time of 300 h, the HBO 103 W/2 mercury vapor short-arc lamp must be exchanged.

The operating time of the lamp can be checked on the counter (2-37/**1**) of the HBO 100 W transformer.

Follow the following steps when changing the HBO 103 W/2 lamp:

- Remove or unscrew the line plug and the HBO 103 plug from the HBO 100 W transformer.
- Wear protective mask and safety gloves.
- Use SW 3 ball-headed screwdriver to loosen clamping screw (2-38/**2**) and remove HBO 103 illuminator (2-38/**3**) from the incident-light tube (2-38/**1**) of the microscope stand.
- Use focusing knob (2-39/**3**) to bring collector to the position at the very front (in the direction of the light).
- Use ball-headed screwdriver to loosen clamping screw for lamp housing (2-39/**2**) and carefully remove lamp housing (2-39/**1**) from the lamp mount (2-40/**3**) in an upward direction.
- Press spring handle (2-40/**4**) down and remove defective lamp (or transport securing pin) with the heat sink from the lamp socket 2-40/**2**). You do not need to remove the cable connection.

- Loosen the fixing screw (2-40/**5**) on the heat sink (2-40/**6**) and remove heat sink. If you cannot remove (or replace) the heat sink, take out the screw completely, screw it into the neighboring threaded hole and use it to press out the heat sink.
- Dispose of defective lamp according to regulations.
- Place new lamp with the smaller diameter into the heat sink until it touches.

When inserting, make sure to use the hole with the correct diameter and do not put any pressure on the lamp.
Correct placement in the heat sink is indicated with **H** (for HBO) or **X** (for XBO).

- Clamp fixing screw onto heat sink.
- Place new lamp (2-40/**1**) with heat sink into the appropriate position in the lamp socket (2-40/**2**) while pressing down on the spring handle (2-40/**4**). Make sure that the feed line to the heat sink is free on the side. Release spring handle. Do not put any pressure on the lamp.
- Place lamp housing (2-39/**1**) on the lamp mount (2-40/**3**) and tighten with clamping screw (2-39/**2**).
- Connect HBO 103 plug and line plug to the HBO 100 W transformer.
- Adjust HBO 103 illuminator as described in section 2.1.14 (3).

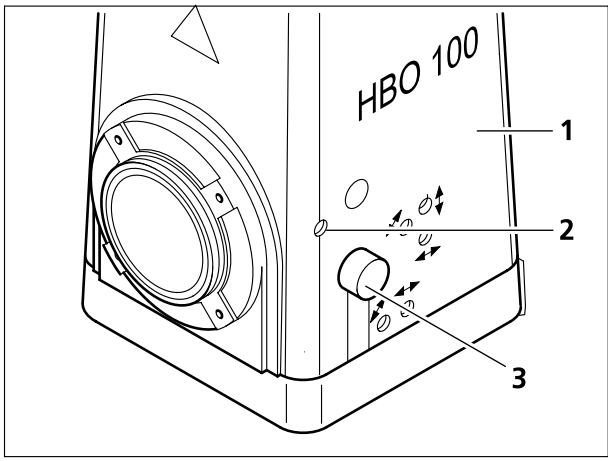


Fig. 2-39 Removing HBO 103 lamp housing

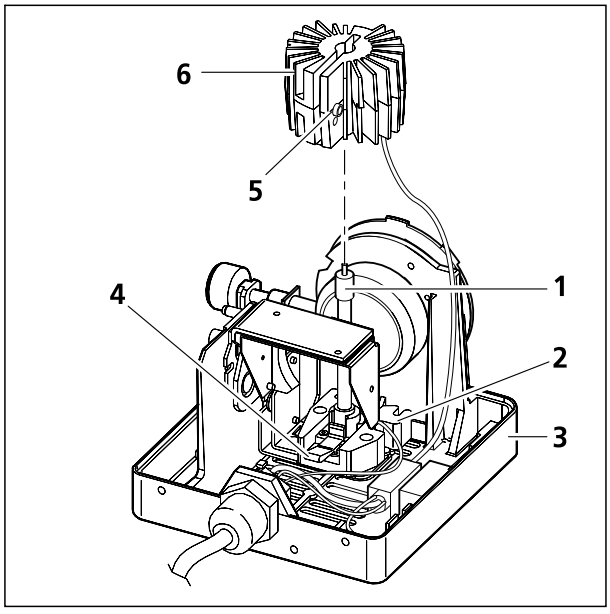


Fig. 2-40 Changing the HBO 103 W/2 mercury pressure short-arc lamp

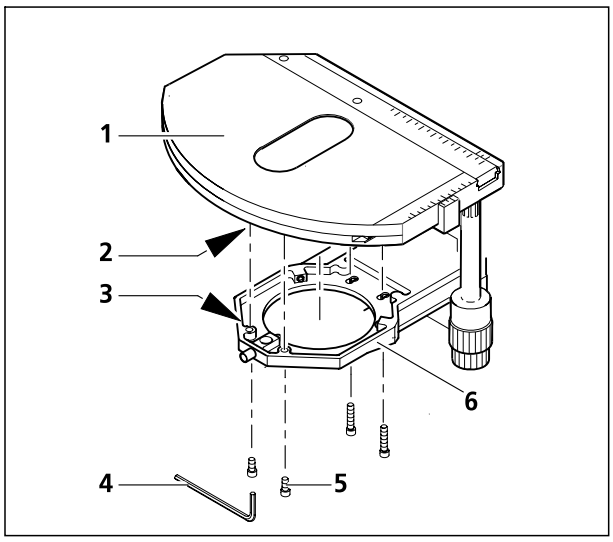


Fig. 2-41 Changing the fixed mechanical stage

2.2.9 Changing the mechanical stage

Depending on type, mechanical stages can be fixed or they can be rotated or centered. The movement range is 75 mm in x-direction and 50 mm in y-direction. The drive is either on the right or left for fixed stages. The drive is on the right on stages that rotate.

(1) Fixed mechanical stage 75x50 R

a) Removing the stage

- Unscrew 4 fixation screws (2-41/**5**) on the stage carrier (2-41/**6**) using angled SW 3 Allen key (2-41/**4**)
- Remove stage (2-41/**1**) from the stage carrier in upward direction.

b) Attaching the stage

- Attach stage (2-41/**1**) to stage carrier (2-41/**6**) in such a way that the threaded holes (2-41/**2**) on the underside of the stage are positioned above the openings of the stage carrier (2-41/**3**).
- Insert four fixation screws (2-41/**5**) through the stage carrier from below and screw them in the stage underside; use the shorter screws on the front.
- Orient stage in x-y direction and tighten the fixation screws.

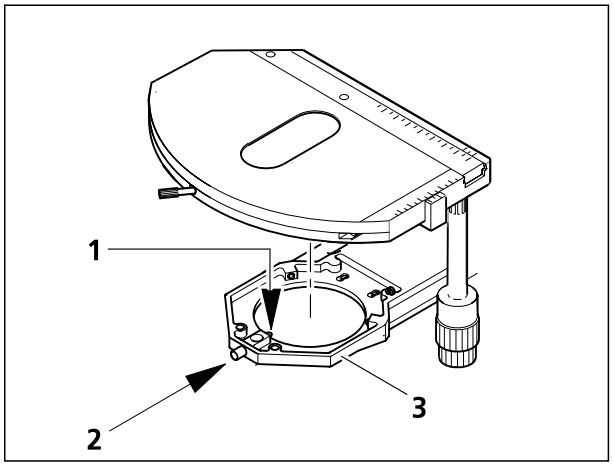


Fig. 2-42 Changing the rotary mechanical stage

(2) Rotary mechanical stage 75x50/240° R

a) Removing the stage

- Loosen screwing cap (2-42/**2**) of spring housing with approx. 3 rotations.
- Press stage to the front against spring pin (2-42/**1**), lift it off the stage carrier (2-42/**3**) at the back and remove it in upward direction.
- Tighten screwing cap (2-42/**2**).

b) Attaching the stage

- Loosen screwing cap (2-42/**2**) of spring housing with approx. 3 rotations.
- Attach stage to the spring pin (2-42/**1**) via dovetail groove.

- Press stage to the front against spring pin and lower its back in the stage carrier (2-42/**3**), then let go.
- Tighten screwing cap (2-42/**2**).

c) Centering the stage

When objectives with a high magnification are used, centering can be exact for one selected objective only. All stages are factory-precentered, i.e. a set specimen detail remains in the image center even when the stage is rotated. If the image detail moves from the image center (2-43/**5**) after stage rotation, recentering should be performed as follows:

- Loosen stage clamping screw (2-43/**4**) and screwing cap of the stage carrier (2-43/**1**)
- Rotate the stage to determine the maximum specimen deflection (2-43/**5**, tip of the arrow) in the direction of the eyepiece reticle.
- Reset the two centering screws on the stage carrier (2-43/**2**) using one SW 1.5 Allen screwdriver (2-43/**3**) each to move the specimen detail by half the arrow length in the direction of the crossline center. Check whether specimen detail moves when the stage is rotated again; repeat the procedure, if required.
- When centering is finished, tighten screwing cap (2-43/**1**) again.

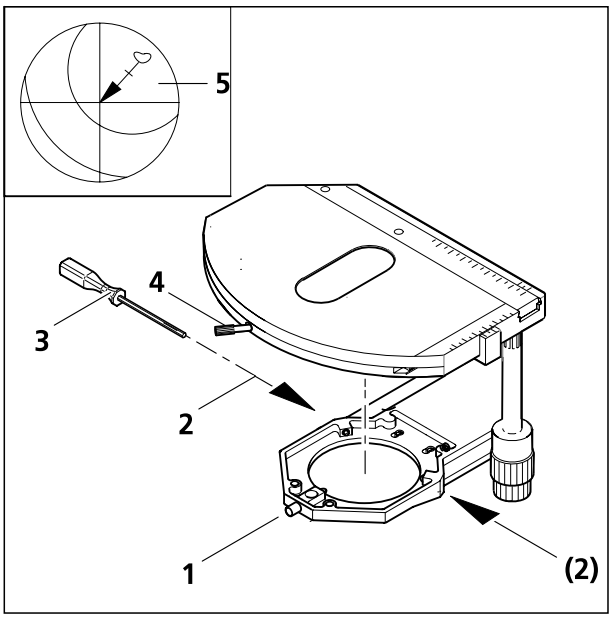


Fig. 2-43 Centering the rotary mechanical stage

The stage can be rotated by 240° to a range of y ≤ 27 mm. No rotation is possible above this range.

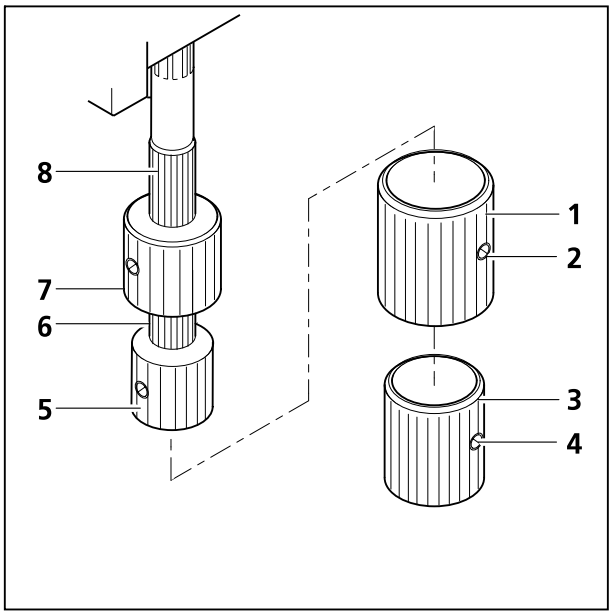


Fig. 2-44 Setting the torque of the coaxial stage drive

(3) Adjusting the travel on ergo-drive

On the mechanical stages with ergo-drive, the travel range of the **X** and **Y** adjustment can be extended by a **max. 15 mm** by axial movement of the drive buttons.

(4) Removing and mounting additional sleeves

Both drive buttons are fitted with additional sleeves. These serve to provide an even finer setting of the object position. They can be removed if faster object movement is more important.

- First loosen the two clamping screws (2-44/**4**) of the bottom additional sleeve (2-44/**3**) and remove it downwards, then loosen both clamping screws (2-44/**2**) of the top additional sleeve (2-44/**1**) and pull this down and off as well.
- Mount the additional sleeves back on the drive knobs in reverse order and tighten both the clamping screws.

(5) Setting the smoothness (torque) of the two drive knobs of the ergo-drive

The ergo-drive is set to a medium smoothness value at the factory. This setting can be changed as follows.

a) Adjusting the X direction

- Remove the additional sleeves (2-44/**1** and **3**) from the drive knobs if necessary. Loosen the clamping screws to do so.
- Push the X drive knob (2-44/**5**) down and the Y drive knob (2-44/**7**) up.
- Hold the X drive knob (2-44/**5**) and turn the bright knurled ring (2-44/**6**) above it to the right (easy action) or left (sluggish action) until the desired smoothness is achieved.

b) Adjusting the Y direction

- Hold the Y drive knob (2-44/**7**) and turn the bright knurled sleeve (2-44/**8**) above it to the right (sluggish action) or left (easy action) until the desired smoothness is achieved.
- Replace the additional sleeves if necessary and tighten the clamping screws.

☞ To ensure long life of the stage, the scuff from the specimen holders should be removed at regular intervals. Make sure that the scuff does not get into the guiding components for the x-movement.

(6) Changing the universal mounting frame

- Loosen two countersunk screws (2-45/**1**) using SW 2 Allen key (2-45/**3**).
- Remove universal mounting frame (2-45/**2**) from the mechanical stage (2-45/**4**) in upward direction.
- Attach required mounting frame or specimen holder (2-45/**5**) to the mechanical stage and tighten the two countersunk screws.

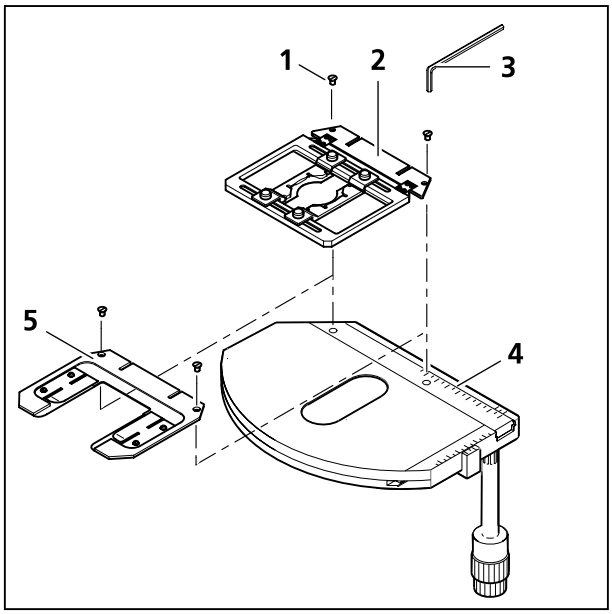


Fig. 2-45 Attaching the universal mounting frame

2.2.10 Changing the binocular tube

- Use SW 3 ball-headed screwdriver to loosen clamping screw (2-46/**3**) and remove available tube in an upward direction.
- Place dust cap (2-46/**2**) for tube lens protection above the dovetail of the binocular tube.
- Remove dust cap from the required tube.
- Insert dovetail of tube (2-46/**1**) in the stand opening (2-46/**4**) and align the tube.
- Tighten clamping screw (2-46/**3**).

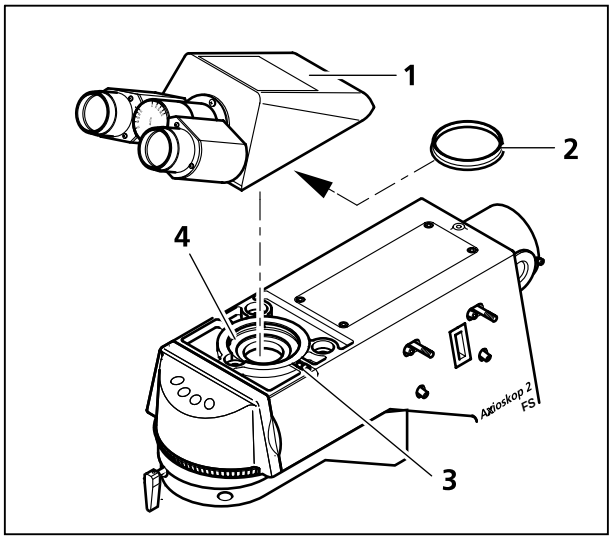


Fig. 2-46 Changing the binocular tube

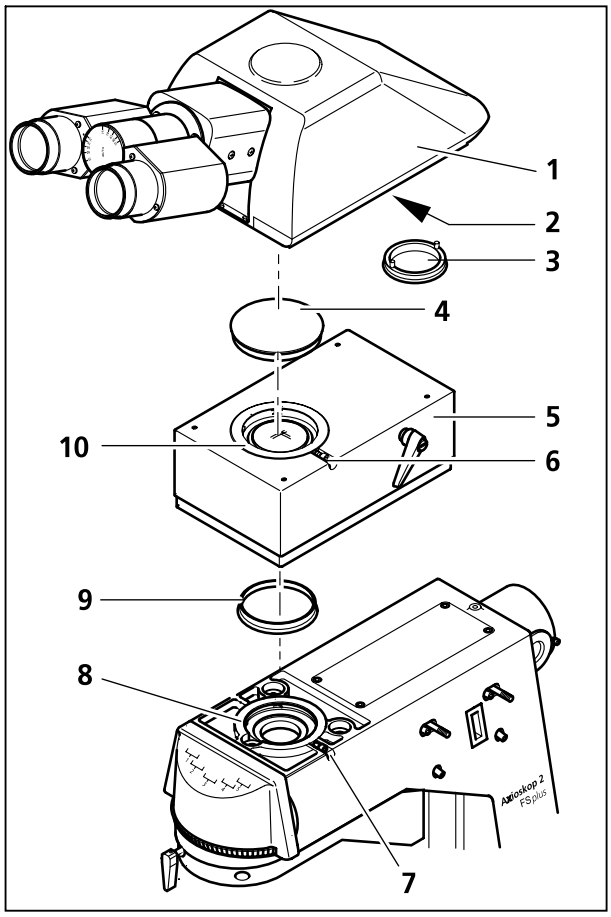


Fig. 2-47 **Attachment of intermediate tube with height adjustment**

2.2.11 Attachment of intermediate tube with height adjustment

The intermediate tube with height adjustment may only be used in combination with a binocular ergotube.

When removing the intermediate tube and attaching the binocular ergotube, make absolutely sure to screw the tube lens into the binocular ergotube again. Otherwise, correct imaging of the specimen is not possible.

- Use SW 3 ball-headed screwdriver to loosen clamping screw (2-47/**7**) and remove attached binocular tube in an upward direction.
- Remove dust cap (2-47/**9**) from the dovetail of the intermediate tube with height adjustment (2-47/**5**).
- Insert dovetail of intermediate tube in the stand opening (2-47/**8**) and tighten clamping screw (2-47/**7**) only slightly.
- Align intermediate tube with the outer edges of the stand, then tighten clamping screw (2-47/**7**).
- Unscrew tube lens (2-47/**2**) from the binocular ergotube (2-47/**1**). The tool from the storage case (2-47/**3**) must be used to remove the tube lens. Insert pins in the drilled holes of the tube lens mount and remove tube lens by turning. The tube lens should then be stored in the case.
- Remove upper dust cap (2-47/**4**) from the intermediate tube with height adjustment.
- Insert dovetail of binocular ergotube in the upper opening (2-47/**10**) of the intermediate tube, align the tube and tighten clamping screw (2-47/**6**).

2.2.12 Attachment of adapter for the Axioskop 2 FS *plus*

The adapter for the Axioskop 2 FS *plus* is used to attach intermediate tubes and/or tubes of the Axioplan 2 to the Axioskop 2 FS *plus* / Axioskop 2 FS MOT.

- Use SW 3 ball-headed screwdriver to loosen clamping screw (2-48/**5**) and remove available tube of the Axioskop 2 FS *plus* in an upward direction.
- Insert dovetail of the adapter for the Axioskop 2 FS *plus* (2-48/**3**) in the stand opening (2-48/**6**) on the underside and slightly tighten clamping screw (2-48/**5**).
- Insert fixation screw (2-48/**2**) in countersunk hole of the adapter (2-48/**3**) and screw it into the drilled hole (2-48/**4**) on the stand.
- Tighten clamping screw (2-48/**5**) and fixation screw (2-48/**2**).
- Attach required intermediate tube and/or tube (2-48/**1**) of the Axioplan 2 to the adapter and clamp it using screw (2-48/**7**) (also see the Axioplan 2 manual).
- Insert eyepieces with field number 23 into the Axioplan 2 tube (2-48/**1**).

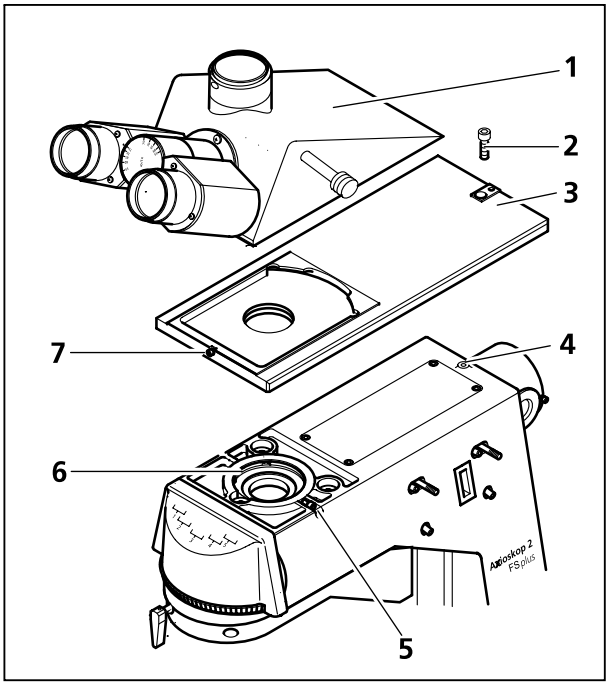


Fig. 2-48 **Attachment of adapter for Axioskop 2 FS *plus***

2.2.13 Installing and Removing "Push&Click" Modules

FL P&C reflector module # 000000-1046-281
Optovar module 1,25x (for transmitted-light only) # 000000-1046-284
Optovar module 1,6x (for transmitted-light only) # 000000-1046-283
Optovar module 2,5x (for transmitted-light only) # 000000-1046-282
Analyzer module D # 000000-1050-958

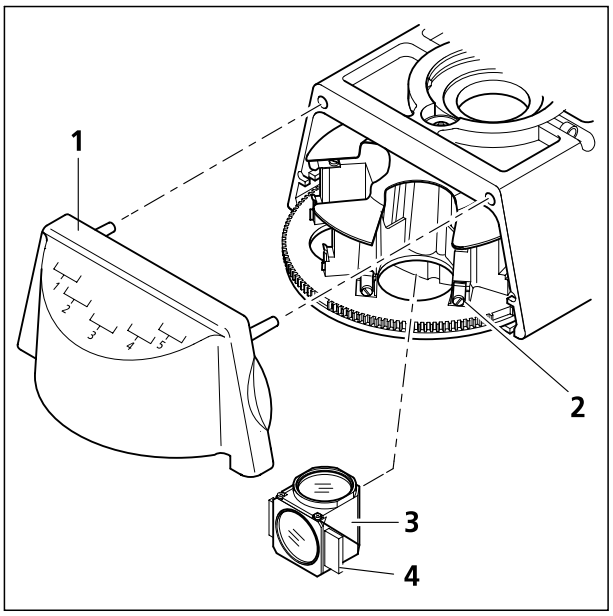


Fig. 2-49 Changing the technique module

Installing a module:

- Pull the cover cap (2-49/**1**) off from the front of the reflector turret.
- Insert the module (2-49/**3**) with the retaining elements (2-49/**4**) attached to the right and left of the module from above at an angle into the spring clamps (2-49/**2**) on the reflector turret.
- Then press the module at the top until it also snaps securely into the top spring clamps of the reflector turret.

Aligning the respective module when installing it in the reflector turret:

FL P&C reflector module
: the excitation filter is facing forwards; the emission filter is facing upwards

Optovar module
: the lens is facing upwards; the empty module opening is facing forwards

Analyzer module
: the analyzer is facing upwards, the empty module opening is facing forwards

Removing a module:

- Tip the module slightly and pull it first out of the top spring elements and then out of the After removing or installing the reflector modules, insert the cover cap with the top two pins in the stand housing and press until the bottom retaining elements snap in.
- By switching the reflector turret three positions clockwise, the mounted module swings into the beam.

2.2.14 Changing the filter set in the FL P&C reflector module

The filter sets for the FL P&C reflector module can be combined and assembled individually by the customer. Appropriate filter sets or fully assembled FL P&C reflector modules can be ordered from Carl Zeiss.

- Remove FL P&C reflector module (2-50/**3**) from the reflector turret (also see 2.2.13).
- Use mounting device from the tool set to unscrew retainer ring (2-50/**1**).
- Turn the reflector module around and allow the filter (2-50/**2** or **4**) to drop on a soft surface.
- The barrier filter is inserted at (2-50/**2**), the excitation filter at (2-50/**4**), and both are secured using retainer ring (2-50/**1**).

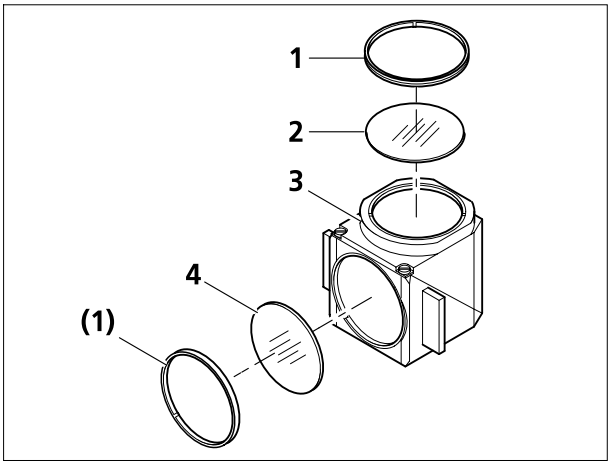


Fig. 2-50 Changing the filter set in the P&C FL reflector module

2.2.15 Changing the beam splitter in the FL P&C reflector module

Attachment of filters and of the beam splitter requires utmost care to prevent damage and contamination of the optical components.

We would recommend you to order completely equipped FL P&C reflector modules, since changing the beam splitter requires much skill.

Otherwise, proceed as follows:

- Remove FL P&C reflector module from the reflector turret (also see 2.2.13).
- Loosen the two slotted screws (2-51/**1**) with a screwdriver.
- Hold both halves of the reflector module together turn opposite to the installation position and place down.

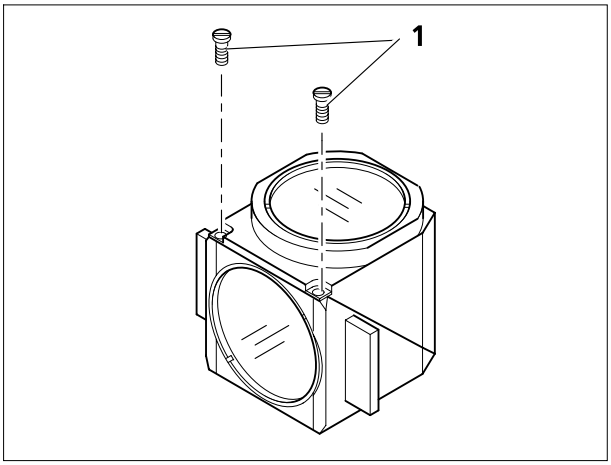


Fig. 2-51 Changing the beam splitter

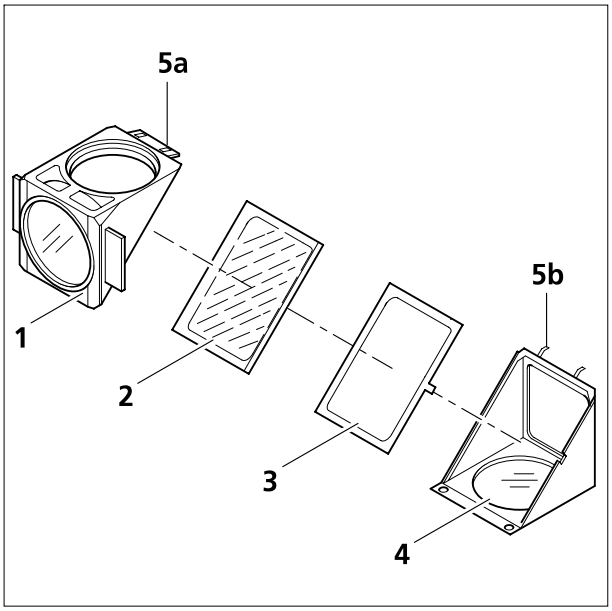


Fig. 2-52 Changing the beam splitter

- Now tip up the module half on top (2-52/**1**) and remove from the retaining elements (2-52/**5b**) of the bottom module half.
- Remove the beam splitter (2-52/**2**) and spring frame (2-52/**3**) from the bottom module half.
- Remove the old beam splitter and carefully place the new one with the reflective side facing downwards on the spring frame (2-52/**4**) and place both parts together in the bottom module half. Make sure that the side latch of the spring frame is in the appropriate recess in the bottom module half.

The reflective side of the beam splitter is recognizable by carefully placing a wooden splint on the surface of the beam splitter. There is no spacing between the splint and its mirror image

- Place the top module half (2-52/**1**) on the bottom module half (2-52/**4**) (the retaining elements 2-52/**5b** grip the eyes 2-52/**5a**). Hold both halves together and turn back to the installation position
- Re-insert the slotted screws and tighten them.
- Finally, attach the adhesive label with the name of the filter combination to the side of the module.

OPERATION

Contents

List of illustrations

3 OPERATION

3.1 Overview of operation and function controls

The Axioskop 2 FS *plus* research microscopes are offered in a manual version and in a version with a motorized focusing drive.

The major difference between the two versions is that objective focusing of the Axioskop 2 FS MOT is only possible by motor via control unit and keypad. Manual focusing directly on the microscope is not possible.

All the other functions of the manual and the motorized versions are completely identical.

In the chapter entitled "Operation", the manual operation functions are explained first, and the function possibilities provided by the control unit and keypad for motorized objective focusing (single-hand operation) are explained separately afterwards.

The explanations on illumination and contrasting techniques always refer to the manual microscope version.

Special information on the motorized microscope version is only provided in cases where the procedure is different to that with the manual Axioskop 2 FS *plus*.

3.1.1 Operation and function controls of the Axioskop 2 FS *plus*, manual

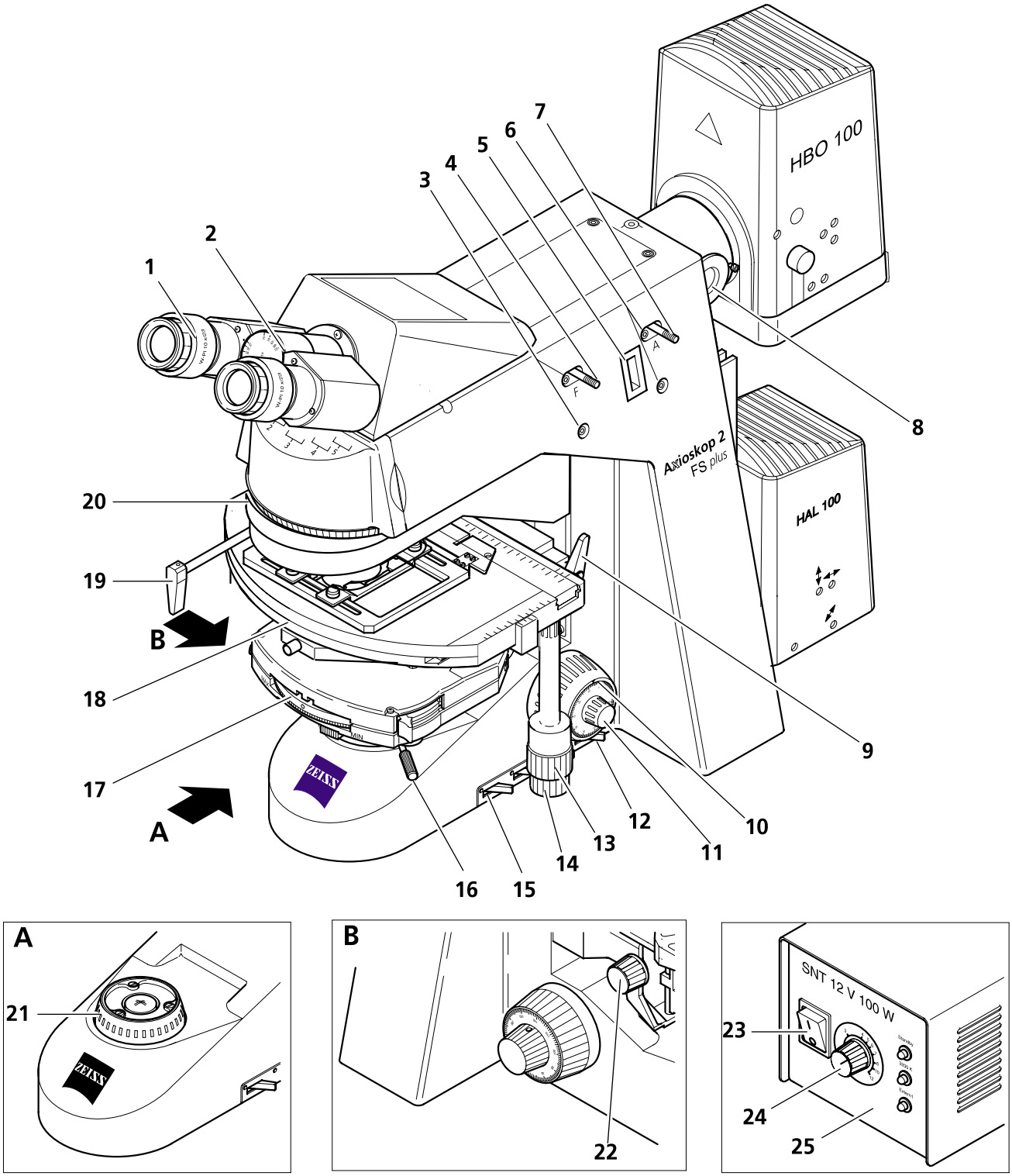


Fig. 3-1 Operation and function controls of the Axioskop 2 FS *plus*, manual

Key to Fig. 3-1:

1 Eyepieces
2 Binocular tube
3 Centering screws for luminous-field diaphragm (incident light)
4 Pushrod for luminous-field diaphragm (incident light)
5 Compartment for filter slider
6 Centering screws for aperture diaphragm (incident light)
7 Pushrod for aperture diaphragm (incident light)
8 HBO / XBO adjusting aid
9 Clamping lever for stage carrier
10 Focusing drive - coarse adjustment (on both sides)
11 Focusing drive - fine adjustment (on both sides)
12 Lever to swing in / out the diffusion disk
13 Drive for movement of the mechanical stage in the y-direction
14 Drive for movement of the mechanical stage in the x-direction
15 3 levers to swing in / out the filters in the transmitted-light filter magazine
16 Centering screw for universal condenser (on both sides)
17 Universal condenser
18 Mechanical stage with universal mounting frame
19 Pushrod for objective change
20 Reflector turret
21 Luminous-field diaphragm (transmitted light)
22 Drive for condenser height adjustment
23 On / Off switch for transmitted-light illumination
24 Control for light intensity
25 Separate 12 V DC 100 W power unit

Eyepieces

– Both eyepiece versions, PL 10x/23 Br. foc. and W-PL 10x/23 Br. foc., enable compensation of ametropia of the user's eyes (see section 2.1.3) and also accept eyepiece reticles (see section 1.7).

Binocular tubes

– The four binocular tubes offered permit the individual setting of the interpupillary distance and the viewing height within set limits. Furthermore, the two ergotubes permit the viewing angle to be set individually within a range from 6 to 25°.

Centering screws for luminous-field diaphragm (incident light)

– Centering of the luminous-field diaphragm using the SW 3 screwdriver (see section 3.3.5).

Pushrod for luminous-field diaphragm (incident light)

– Continuous setting of the luminous-field diaphragm diameter (see section 3.3.5).
– Pushrod pushed in: fully open
– Pushrod pulled out: closed

Compartment for filter slider

– For 3-position or 6-position FL filter slider with 18 mm filter diameter.

Centering screws for aperture diaphragm (incident light)

– Centering of aperture diaphragm using SW 3 screwdriver (see section 3.3.5).

Pushrod for aperture diaphragm (incident light)

– Continuous setting of the aperture diaphragm diameter (see section 3.3.5).
– Pushrod pushed in: fully open
– Pushrod pulled out: closed

Adjusting aid for lamp adjustment

– The adjusting aid is used to adjust and center the HAL 100 halogen illuminator and the HBO 103 mercury vapor short-arc lamp.

Clamping lever for stage carrier

– This lever is used to clamp the removable and height-adjustable stage carrier to the stand.
– Height adjustment range: approx. 15 mm

Focusing drive - coarse adjustment (coarse drive)

– Focusing drive for coarse adjustment available on both sides of the instrument:
1 rotation coarse = 6 mm
– Overall lift: 25 mm

Focusing drive - fine adjustment (fine drive)

– Focusing drive for fine adjustment available on both sides of the instrument:
1 fine rotation = 0.1 mm

Lever to swing in / out the diffusion disk

The integrated diffusion disk (3-1/**12**)) is used to achieve homogeneous illumination, though at a slight loss of light.

- Lever in front position: diffusion disk swung out
- Lever in rear position: diffusion disk swung in

Drive for movement of the mechanical stage in Y

- Movement of the mechanical stage in Y, maximum travel range: 50 mm
- Adjustable torque (smoothness)

Drive for movement of the mechanical stage in X

- Movement of the mechanical stage in X, maximum travel range: 75 mm
- Adjustable torque (smoothness)

3 levers to swing in / out the filters in the transmitted-light filter magazine

- 3 switchable neutral-density filters to match the image brightness in the field of view, maximum attenuation factor: 1:4400;
  Lever correspond to (on the stand from front to back): 1.5 %, 6 % and 25 % transmission
- lever in front position: filter swung out
- lever in rear position: filter swung in

Centering screw for condenser

- Centering screws for condenser centering attached to both sides of the condenser carrier.

Universal condenser

Depending on the version, the achromatic-aplanatic universal condenser (3-2/**1**) is equipped with:

- Fold-out front lens
- Turret disk for:
  brightfield - without or with DIC **I**, **II**, **III**
  darkfield - **D**
  phase contrast - Ph **1**, Ph **2**, Ph **3**
  interference contrast - DIC **I**, **II**, **III**
- Aperture diaphragm (iris stop)

The front lens is folded in / out using lever (3-2/**2**). Turning the turret wheel (3-2/**4**) swings the brightfield insert and the contrast stops in the beam path. The abbreviation of the set turret position (e.g. **D**) is displayed in one of the windows (3-2/**5**). Slider (3-2/**3**) opens and closes the aperture diaphragm.

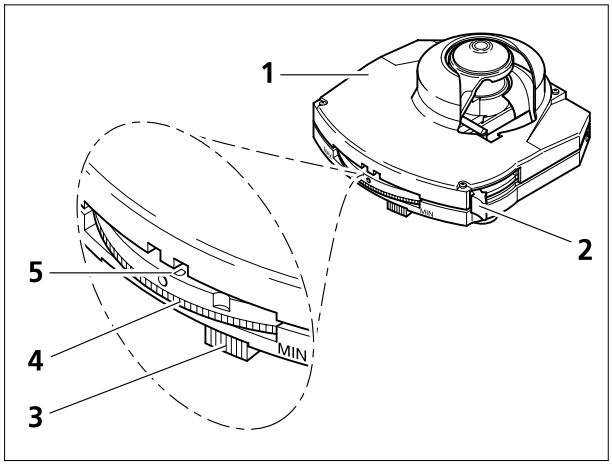


Fig. 3-2 Universal condenser

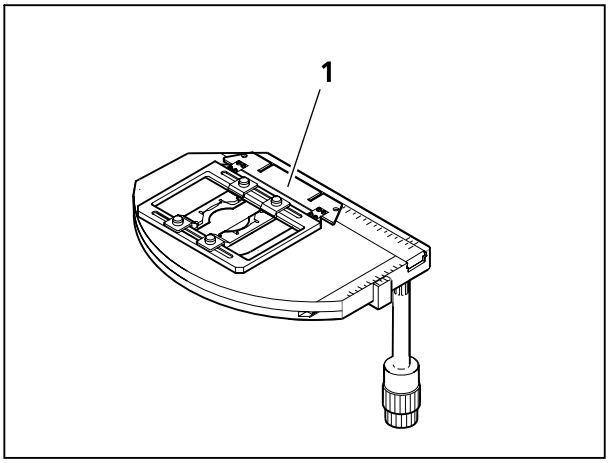


Fig. 3-3 Mechanical stage with universal mounting frame

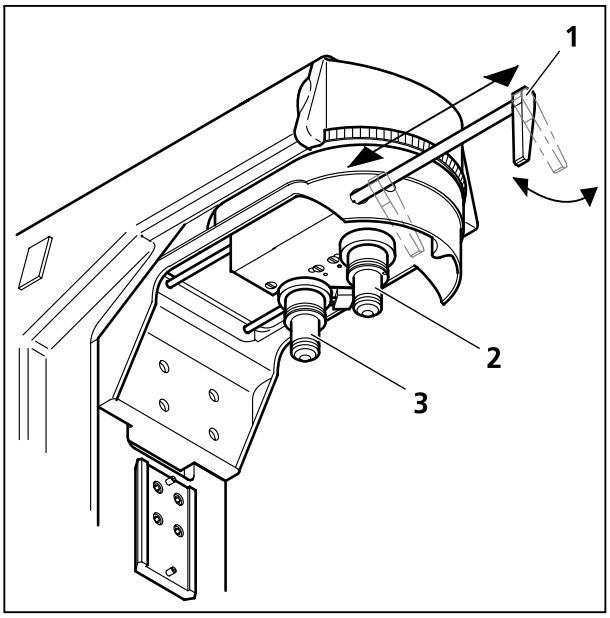


Fig. 3-4 Objective slider

Mechanical stage with universal mounting frame

– Mounting, positioning and fixation of the specimens on the universal mounting frame (3-3/**1**).

Pushrod for objective change

– Sliding and lowering function for objective change via pushrod (3-4/**1**) in single-hand operation.
– Lifting range for objective change: 9 mm above work position.

- Turn the pushrod to the right and remove front (3-4/**2**) or rear (3-4/**3**) objective from the work position.
- Pull or push the pushrod (3-4/**1**) and bring front or rear objective into the beam path.
- Turn the pushrod to the left to lower the objective into the work position.

Reflector turret

– Accepts a maximum of five technique modules, such as the FL P&C reflector module and the shutter plate for incident light, and the Optovar module and analyzer module for transmitted light.
– Fast change of technique modules by turning the knurled ring of the reflector turret.

Luminous-field diaphragm

– Wheel (3-5/**2**) for the continuous setting of the luminous-field diaphragm (transmitted light).
– Additional mount (3-5/**1**) for filters with diameter d = 32 mm.

Drive for condenser height adjustment

– Height adjustment of the condenser to set KÖHLER illumination.

On / Off switch

– Position 0 = power unit switched off
– Position I = power unit switched on

Control for light intensity

– Controls the DC supply of the halogen illuminator in the 3 ... 12 V range. Display of the existing operating voltage at the scale of the halogen illuminator.

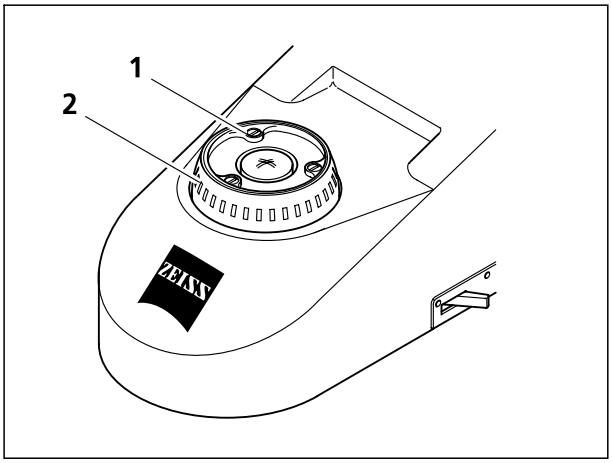


Fig. 3-5 Luminous-field diaphragm

Binocular ergotube 6-25°/23

The binocular ergotube 6-25°/23 allows the viewing angle to be changed continuously in the range between 6° and 25° by swivelling the binocular component.

– To set the most convenient viewing angle, swivel the binocular component (3-6/**1**) upwards or downwards.
– The viewing height can be changed by turning the entire binocular component around 360° (3-8).
– The interpupillary distance can be changed by separate adjustment of the two eyepiece tubes.

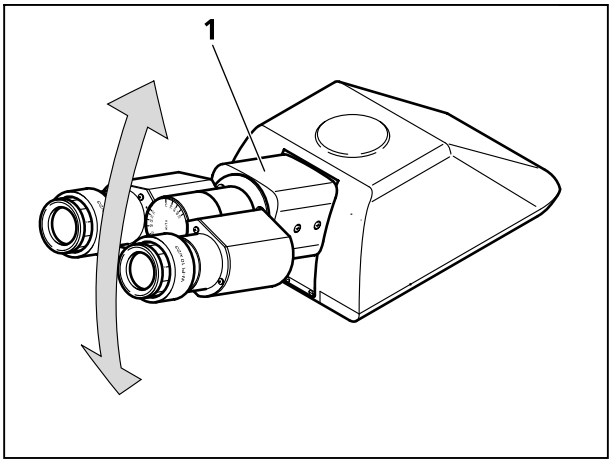


Fig. 3-6 Binocular ergotube

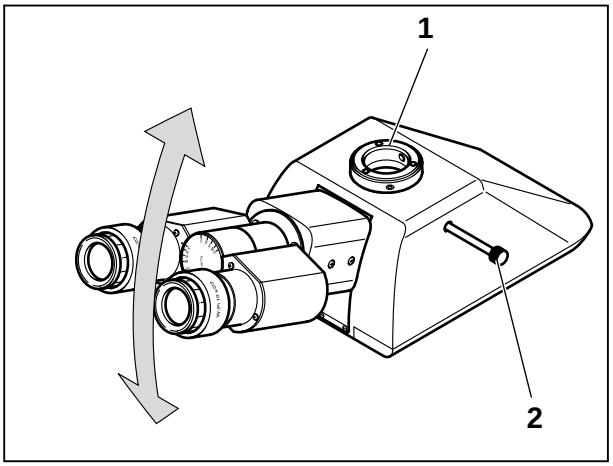


Fig. 3-7 Binocular ergo-phototube

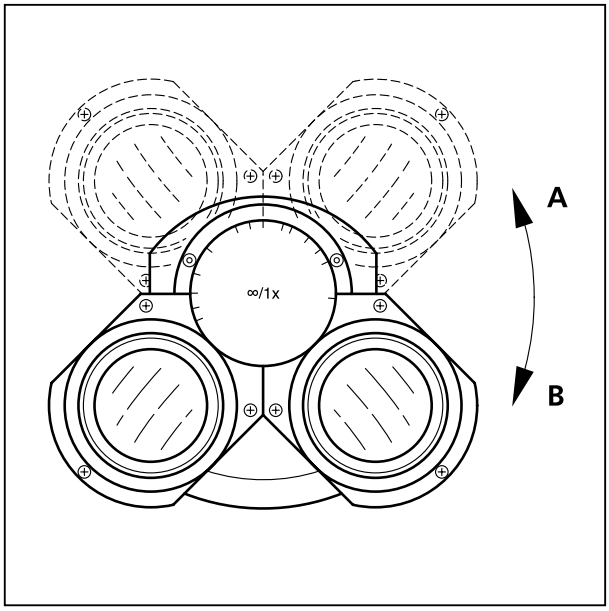


Fig. 3-8 Setting the interpupillary distance of the ergotube

Binocular ergo-phototube 6-25°/23 (100/100)

The camera port (3-7/**1**) of the binocular ergo-phototube allows the attachment of SLR-cameras, microscope cameras and video cameras via the relevant adapters. The light can be directed either to the eyepieces or to the attached camera via a pushrod.

- Pushrod (3-7/**2**) pushed in:
  100 % of the light for the eyepieces
- Pushrod (3-7/**2**) pulled out:
  100 % of the light for the camera.
- To set the most convenient viewing angle, swivel the binocular component (see 3-6/**1**) upwards or downwards.
- The viewing height can be changed by turning the entire binocular component around 360° (3-8).
- The interpupillary distance can be changed by separate adjustment of the two eyepiece tubes.

Filter mount

The filter mount allows three additional dia. 32mm color filters to be swung in the beam path together or separately.

- Insert filter in one of the three filter plates (3-9/**1**).
- Swing filter plate into the beam path using grip (3-9/**2**) until it engages in locking pin (3-9/**3**).

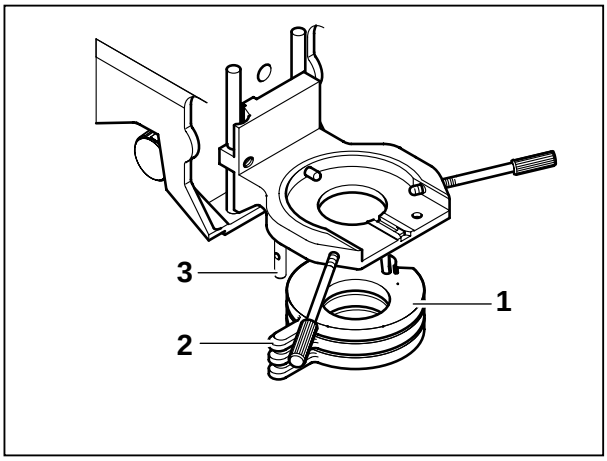


Fig. 3-9 Filter mount

Transmitted-light filter magazine

The transmitted-light filter magazine (3-1/**15**) contains 3 swing-in neutral-density filters or the VIS/IR filter set for attenuation of the image brightness in the field of view. Each of these 3 neutral-density filters features graded transmission values of 1.5 %, 6 % and 25 % (viewed on the stand from front to back), thus permitting the maximum attenuation factor of 1:4400 when used individually or in combination.

When several filters are combined, the transmission value is calculated as the product of the individual transmission values in percent.

Filter slider

The 3-position or 6-position FL filter slider (1-1/**8**) permits dia. 18 mm filters (e.g. PINKEL-type filters) to be inserted in the incident-light beam path. The position of the various filters in the beam path is locked via relevant notches in the filter slider.

The filter sliders can be equipped individually. For this purpose, only the rubber retaining ring must be removed.

Since the 6-position FL filter slider projects on the other side of the stand when pushed through, or can be inserted from both sides, the cover attached to the left of the stand as a standard must be exchanged for a special guiding piece, which is supplied together with the 6-position FL filter slider. The cover and the guiding piece are just inserted in the stand opening, i.e. they are easy to mount.

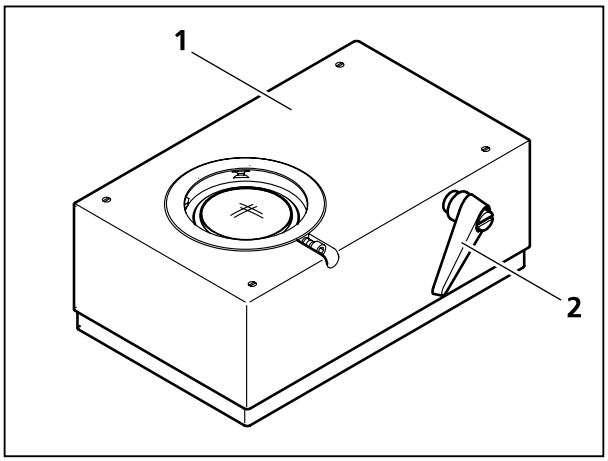


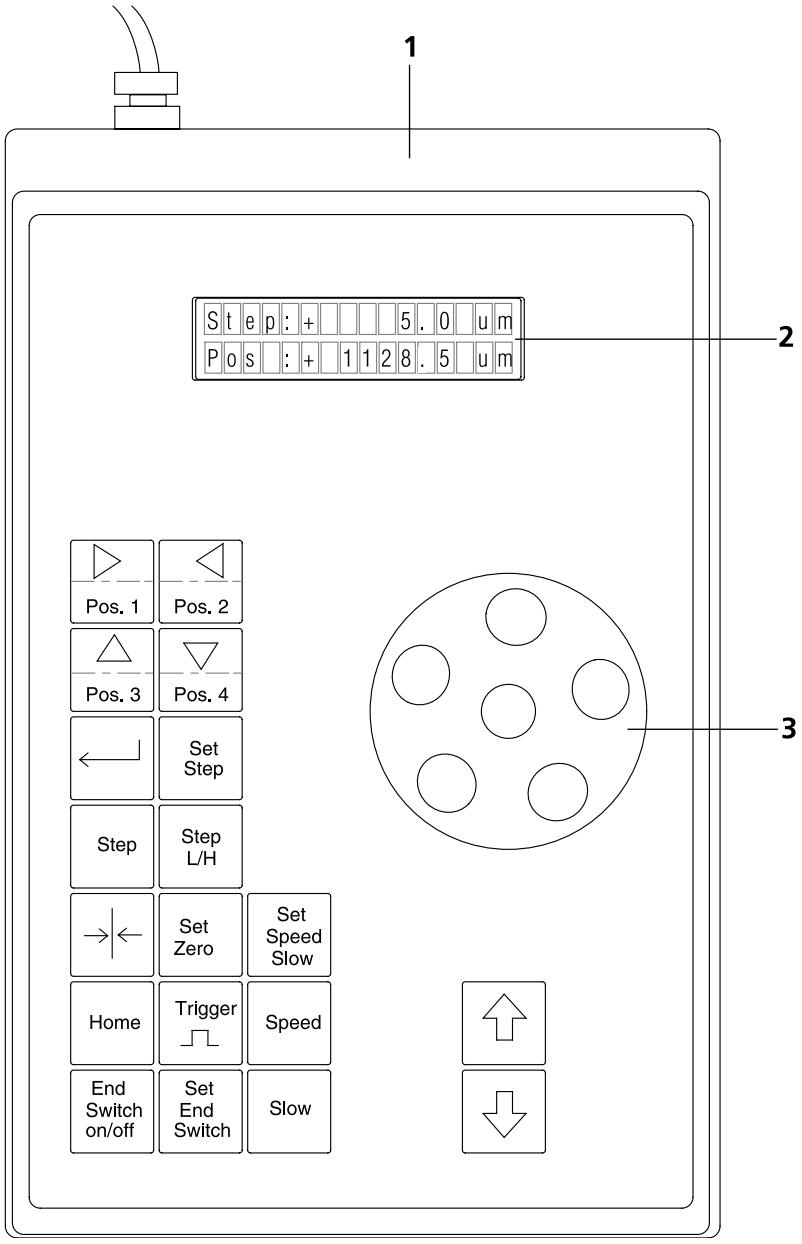
Fig. 3-10 **Intermediate tube with height adjustment**

Intermediate tube with height adjustment

Attachment of the intermediate tube with height adjustment allows the viewing height of the Axioskop 2 FS *plus* to be increased continuously from 60 to 110 mm. This intermediate tube can only be used in combination with the binocular ergotube 6-25°/23 or the binocular ergo-phototube 6-25°/23 (100/100).

- Loosen clamping lever (3-10/**2**) of the tube. A system of springs presses the upper part (3-10/**1**) of the tube upwards.
- Press down upper part (3-10/**1**) or let go through the force of the spring until the required height is achieved.
- Tighten clamping lever (3-10/**2**).

3.1.2 Keypad for objective focusing of the Axioskop 2 FS MOT (single-hand control)



1 Keypad
2 Display
3 Handwheel for fine adjustment of the focusing drive

Fig. 3-11 Keypad of the Axioskop 2 FS MOT

Function keys of the keypad

Key	Function
	Key for upward motion of focusing drive (positive direction, away from the specimen)
	Key for downward motion of focusing drive (negative direction, towards the specimen)
	Set Slow-Speed values (in combination with the Pos. 3 and 4 position keys)
	Select 'fast' focusing speed
	Select 'slow' focusing speed
	Activate stored focus position 1
	Activate stored focus position 2
	Activate stored focus position 3
	Activate stored focus position 4
	Input key for confirmation / acceptance of settings
	Determine the step width
	Execute step
	Set step speed to maximum (High)
	Approach zero point
	Set zero point
	Leave defined focus position (work range) or approach it again (Home function)
	Release steps via external trigger signal
	Set end switch of work range (in combination with direction keys)
	Activate / deactivate end switch (in combination with direction keys)

Display

The set step width or the positive or negative position deviation with reference to the zero point is shown in the display field of the keypad. When setting functions are performed, the display is used to show the changeable setting values.

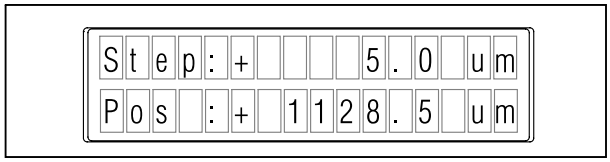


Fig. 3-12 Display

Handwheel for fine adjustment

The handwheel permits the very sensitive adjustment of the focusing drive (minimum: 0.1 µm) for very precise focus settings at high objective magnifications in particular. Turning the handwheel moves the objective slider upwards or downwards via the focusing drive.

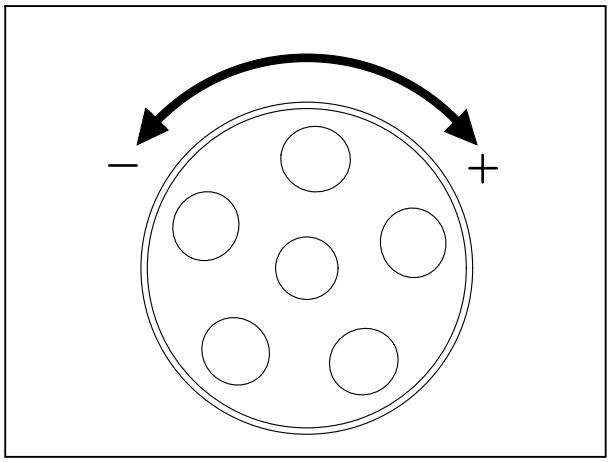


Fig. 3-13 Handwheel for fine adjustment

Upwards / downwards direction keys

The **upwards / downwards** direction keys control the upward and downward movement of the focusing drive. When one of the direction keys is pressed, the setting of the focusing drive is changed at the preset speed until the key is released again.

The speed of the focusing drive can be roughly set to the **slow** and **fast** speed ranges via the **Slow** and **Speed** keys. The relevant speed range LED integrated in the left upper corner of the key lights up.

It is also possible to set the speed of the focusing drive for the **Slow** and **Speed** ranges independently of each other in 16 steps. This allows the single-hand control to be easily matched to individual requirements.

The steps for the Slow and Speed ranges are set as follows:

- Press the key of the speed range to be changed (e.g. Slow; the LED of the Slow key lights up).
- Press the **Set Speed Slow** key. The current speed step is shown in the display of the keypad.

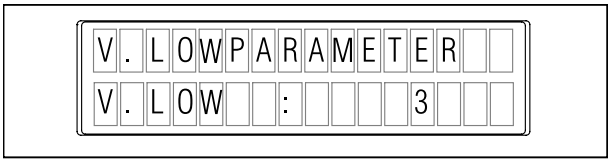


Fig. 3-14 Display-appearing when speed is set in the Slow range

- Then set the required speed step in the range from 0 to 15 via the **Pos. 3** and **Pos. 4** keys The display value 0 corresponds to the slowest and 15 to the fastest speed step which can be set. The Pos. 3 key is used to increase the speed step and the Pos. 4 key to reduce it. Each press of the key changes the setting by one step.
- Press the ↵ key to confirm the performed setting.

The setting is retained even when the control unit is switched off.

Store and approach the focus position

Up to 4 positions can be stored and approached separately. The positions always refer to the currently stored zero point. If the zero point is shifted, the stored positions are automatically shifted by the same amount.

The positions can be set without regard to sequence at any required point.

If a position is stored for the first time, the current position value of this key is simply overwritten.

a) Store the focus position, e.g. Pos. 2

- Set the required focus position via the direction keys (or the handwheel).
- First press the ↵ key and hold it, then press the required position key, e.g. Pos. 2.
- Release both keys. The set position is now stored on the relevant position key (e.g. Pos. 2).

b) Approach the focus position, e.g. Pos. 2

- Press the relevant position key, e.g. Pos. 2. The stored position is then approached automatically.

Set zero point and approach it

Any required position within the travel range of the objective slider can be defined as zero point. The display is set to zero to allow the measurement of distances. If the zero point is shifted, all the previously stored positions (Pos. 1 to Pos. 4) are shifted by the same amount.

a) Set the zero point

- Use the direction key (or the handwheel) to set the required position for the new zero point.
- Press the **Set Zero** key to set the current position as the new zero point. The former zero point is deleted.

b) Approach the zero point

- Press the →|← key to activate the currently stored zero point.

Defined leaving and relocation of the current focus position (Home function)

The Home function permits the defined leaving and activation of the work range. This enables a work position left via the Home function to be reproducibly relocated with an accuracy in the µm range.

a) Defined leaving of the focus position

- Press the **Home** key to move the objective slider out of the current work position in the defined direction. The LED in the **Home** key lights up.

b) Defined relocation of the focus position

- Press the **Home** key again to return the objective slider in the last defined work position. The LED in the **Home** key lights up.

☞ If the end switches for the work range are activated, the Home function is not available. To be able to use the Home function, the end switches must be deactivated (see page 3-18).

If the objective slider is in the Home position, the other keys of the keypad are not active.

Set step width and perform steps

The Step function allows the focusing drive to be reproducibly shifted by a certain amount (step width) as often as required. The step width can be selected as required in the range from 0.1 to 499 µm.

The steps can be performed slowly or at maximum speed.

If an external trigger signal is connected to the control unit, steps can be triggered up to 7 times every 2 seconds. The step width is then limited to max. 10 µm.

a) Set step width

- Press the **Set Step** key.

The display shows the current step width under **S. old** and the changed value under **S. new**. The sign (+/-) indicates the direction in which the objective slider is moved in the step mode.

- Use the **Pos. 1** and **Pos. 2** keys to move the cursor over the digits of the display and the **Pos. 3** and **Pos. 4** keys to change the required value.

☞ If the zero is passed in the relevant digit field when pressing the **Pos. 3** and **Pos. 4** keys, the sign is reversed and the step is then performed in the opposite direction.

- Confirm the setting by pressing the ↵ key.

b) Perform steps

- Each press of the **Step** key moves the objective slider one step further in the set direction.
- Press the **Step L/H** key to set the speed in the Step mode to slow (L = low) or to maximum (H = high). When maximum speed has been selected, the LED of the **Step L/H** key lights up.

End switches of the work range

The software integrated in the control unit permits a work range for objective focusing to be defined via electronic end switches. When these end switches are reached, the focusing drive is switched off automatically.

The work range can be defined as required in the entire travel range of the objective slider, and activated or deactivated any time.

☞ If the end switches for the work range are activated, the Home function is not available.

a) Set end switches

- Use the ⇩ direction key (or the handwheel) to approach the lowest position of the work range to be defined.
- Press the **Set End Switch** and the ⇩ direction key simultaneously to set the lower end switch.
- Use the ⇧ direction key (or the handwheel) to approach the uppermost position of the work range to be defined.
- Press the **Set End Switch** and the ⇧ direction key simultaneously to set the upper end switch.

b) Activate / deactivate end switches

- Press the **End Switch on/off** key and the ⇧ direction key simultaneously to activate the end switches. The LED of the **End Switch on/off** key lights up.
- Press the **End Switch on/off** key and the ⇩ direction key simultaneously to deactivate the end switches. You can now go beyond the limits of the defined work range within the mechanical travel range.

3.2 Switching on and basic settings

3.2.1 Axioskop 2 FS *plus*, manual

The Axioskop 2 FS *plus* microscope does not have any on/off switches for the illumination equipment on the stand itself. The illumination systems need only be switched on/off as required via the power supply unit.

Normally, the separate power unit for the transmitted-light illumination is switched on first, and the HBO 100 W transformer for the incident-light illumination is additionally switched on only if the epi-fluorescence technique is actually applied.(see page 3-30).

- Switch on the separate 12 V DC 100 W power unit for transmitted-light illumination via the on/off switch (3-1/**23**) on the instrument front.
- Use the light intensity control (3-1/**24**) to set the required brightness. The scale on the control (3-1/**24**) indicates the existing lamp voltage of the transmitted-light halogen illuminator.

3.2.2 Axioskop 2 FS MOT

In addition to the voltage supply instruments for the illumination systems, the Axioskop 2 FS MOT also requires the control unit for the motorized focusing drive to be switched on.

- Switch on the control unit via the on/off switch (3-15/**1**) on the instrument front.

When the control unit has been switched on, an internal system check is performed. Various data and test procedures are shown on the display.

The control unit is ready for operation after approx. 15 seconds. The display shows the set step width and the position value of the objective slider with reference to the set zero position.

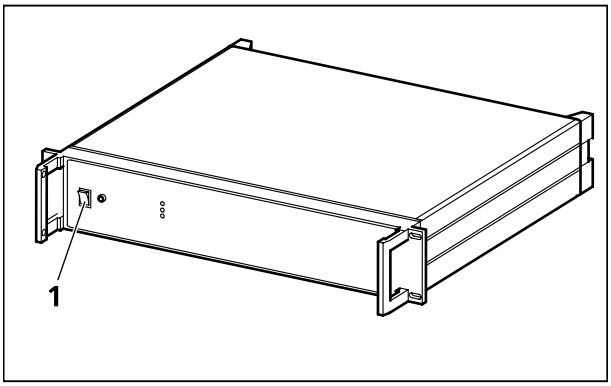


Fig. 3-15 Switch on control unit for focusing drive

3.3 Illumination and contrasting techniques

3.3.1 Setting of transmitted-light brightfield according to KÖHLER

(1) General principle

Transmitted-light brightfield microscopy is the most usual of all the optical techniques, since it allows the easy and fast viewing of high-contrast or stained specimens (e.g. blood smears).

For as true-to-object imaging as possible, indirect ray bundles, i.e. ray bundles diffracted and scattered on the specimen details, are of major importance in addition to the so-called direct ray bundles. The higher the portion of indirect rays (aperture), the more realistic the microscope image will be, according to ABBE's rule.

To utilize the entire optical performance of the microscope, especially of the objective, the condenser, the luminous-field diaphragm and the aperture diaphragm should be set in accordance with the rules for KÖHLER illumination. These basic rules of microscope setting are described in detail in section 3.3.1 (3) "Transmitted-light brightfield settings according to KÖHLER on the manual Axioskop 2 FS *plus*" .

(2) Transmitted-light brightfield equipment of the manual Axioskop 2 FS *plus*

Each manual Axioskop 2 FS *plus* configuration permits performance of the transmitted-light brightfield technique.

(3) Transmitted-light brightfield settings according to KÖHLER on the manual Axioskop 2 FS *plus*

– The manual Axioskop 2 FS *plus* has been set up as described in chapter 2.
– Switch on the transmitted-light illumination via the separate power unit.

- Set the image brightness via the light intensity control (3-1/**24**) of the separate power unit.
- Place a high-contrast specimen in the universal mounting frame of the mechanical stage.
- Swing in front lens of the universal condenser (3-16/**2**) (for objectives ≥ 10x) and use drive for height adjustment (3-17/**2**) to move the condenser to the upper stop. The stop must be set in such a way that the specimen is not touched by the condenser (for setting of the condenser stop see section 3.3.1 (4)).
- Switch turret disk of condenser (if available) to position H for brightfield via the knurled ring. If no separate brightfield position is available, the turret position (I, II, or III) can be chosen which does not contain a DIC prism. If all three positions are equipped with DIC prisms, switch off the analyzer in the reflector turret.

☞ One turret position of the universal condenser should remain empty for highest demands in transmitted-light brightfield.

- Swing in 10x objective (yellow ring, see p. 1-12) in the objective slider (3-16/**5**) and focus on the specimen via focusing drive (3-16/**1**).
- Close luminous-field diaphragm (3-16/**3**) until it becomes visible (even if not in focus) in the field of view (3-16/**A**).
- Use drive for height adjustment (3-17/**2**) to lower condenser until the edge of the luminous-field diaphragm appears in focus (3-16/**B**).
- Use both centering screws (3-17/**3**) of the universal condenser to center the luminous-field diaphragm (3-16/**C**) and then open the diaphragm until its edge just disappears from the field of view (3-16/**D**).
- For aperture diaphragm setting (contrast), remove one eyepiece from the tube and look into the tube with your naked eye. Use sliding knob (3-16/**4**) to set the aperture diaphragm to approx. 2/3 ... 4/5 of the diameter of the objective exit pupils (3-16/**E**). In most applications, this aperture diaphragm setting provides optimum contrast at almost ideal resolution, and is therefore the best compromise for the human eye.
- Insert eyepiece in the tube again.

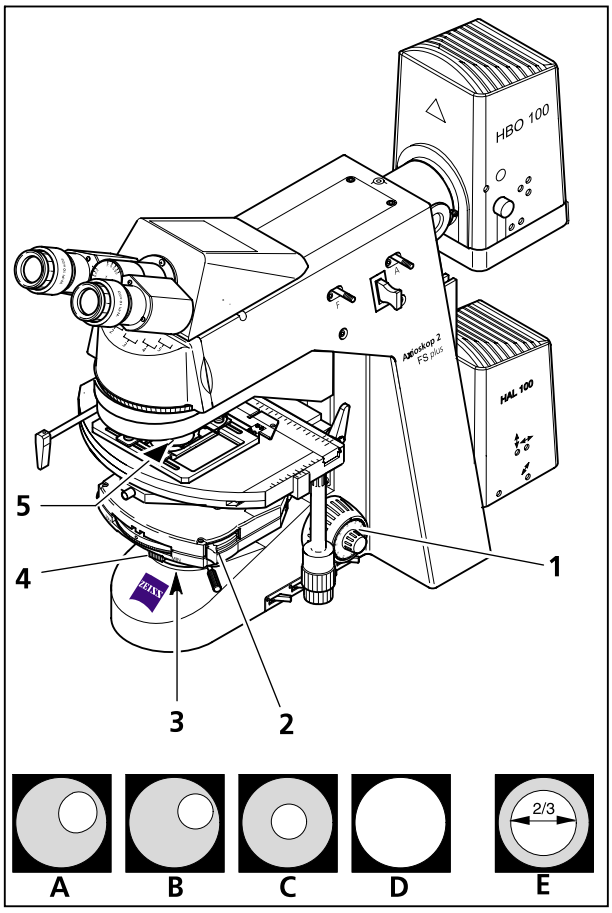


Fig. 3-16 **Microscope settings on the Axioskop 2 FS *plus* in transmitted-light brightfield**

☞ Since field size and objective aperture change after every objective change, the setting of the luminous-field diaphragm and the aperture diaphragm must be repeated to obtain optimum results.

For < 10x objectives, the front lens of the condenser must be folded out and the aperture diaphragm fully opened. In the case of such large fields, the luminous-field diaphragm can also be used for better contrasting by reducing its opening until it becomes visible in the field of view.

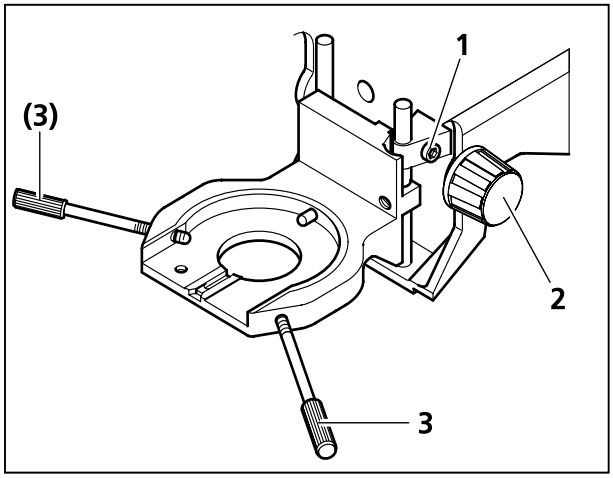


Fig. 3-17 Setting the height stop on the condenser carrier

(4) Setting the height stop on the condenser carrier

- Loosen fixation screw of height stop (3-17/**1**) using SW 3 ball-headed screwdriver.
- Use focusing drive to focus on the specimen.
- Close luminous-field diaphragm and image it in focus via the height adjustment control (3-17/**2**) of the universal condenser.
- Carefully lift the condenser slightly without touching the specimen.
- Tighten fixation screw (3-17/**1**) of the height adjustment.

(5) Transmitted-light brightfield configuration of the Axioskop 2 FS MOT

Each Axioskop 2 FS MOT configuration permits the performance of the transmitted-light brightfield technique.

(6) Setting the Axioskop 2 FS MOT for transmitted-light brightfield according to KÖHLER

– The Axioskop 2 FS MOT has been set up as described in chapter 2.
– Switch on the transmitted-light illumination via the separate power unit.
– Switch on the control unit for motorized objective focusing.

- Set KÖHLER illumination as described in section 3.3.1 (3) for the manual Axioskop 2 FS *plus*.
- Unlike the Axioskop 2 FS *plus*, focusing is made via the keypad of the control unit.

☞ For < 10x objectives, the front lens of the universal condenser must be folded out and the aperture diaphragm fully opened.

3.3.2 Setting of transmitted-light darkfield

(1) General principle

On account of their light transmission, unstained biological specimens, such as bacteria or living cell cultures, are often barely or not at all visible in transmitted-light brightfield. This changes markedly if such specimens are viewed in transmitted-light darkfield, where the specimen is always illuminated using an aperture which is larger than that of the objective used.

In darkfield, only the diffracted and scattered light components, which are important for image formation, reach the objective, while the direct unchanged light bundles are directed past the objective. This is one of the reasons why even fine structures can be resolved, although they are below the resolving power of the light microscope and appear very bright on a dark background.

(2) Transmitted-light darkfield configuration for the manual Axioskop 2 FS *plus* and the Axioskop 2 FS MOT

– Universal condenser with darkfield stop in position D and 0.76 ... 0.90 aperture on the illumination side.
– Use of ICS objectives up to the maximum aperture of 0.75. Objectives with a higher aperture can only be used together with the above universal condenser if they feature an integrated aperture iris stop.

(3) Transmitted-light darkfield settings on the manual Axioskop 2 FS *plus* and Axioskop 2 FS MOT

- Setting of KÖHLER illumination is identical to transmitted-light brightfield, except that the highest aperture objective must be used instead of the 10x objective.
- Turn turret disk of the universal condenser to position D and swing in condenser front lens.
- Remove eyepiece from the tube (replace it with the centering telescope) and check the centering of the darkfield stop in the objective exit pupil. If the central darkfield stop D in the universal condenser is outside or out of the center of the objective exit pupil, and if the exit pupil is not homogeneously dark, the darkfield stop must be recentered.
- To center the darkfield stop, use the two SW 1.5 (3-18/**1** and **4**) Allen screwdrivers and set the two centering screws (3-18/**2** and **3**) until the objective exit pupil is homogeneously dark. After centering, remove both SW 2 screwdrivers from the condenser.

☞ Since the apertures of objectives with an integrated aperture iris stop are too high for transmitted-light darkfield, the aperture iris stop must be closed to the limit aperture of 0.75.

As dark a field background as possible is always the performance criterion for the darkfield technique.

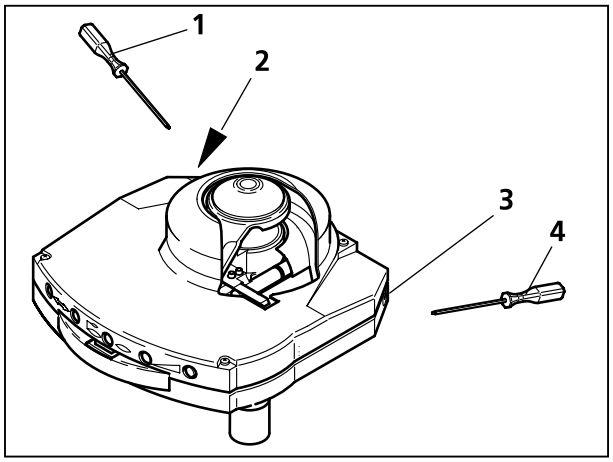


Fig. 3-18 Centering of darkfield stop on the universal condenser

- Insert eyepiece in the tube again.
- If the height of the dark field condenser has been set correctly and sensibly enough, any visible brightening in the field of view can be reduced, and the luminous-field diaphragm image will be almost perfectly in focus.
- Finally, match the diameter of the luminous-field diaphragm to the size of the field of view.

☞ Darkfield microscopy requires specimens to be considerably cleaner than in other techniques. Finger prints, dirt or dust particles in particular have negative effects, since they brighten the background of the field of view and decrease the contrast of the object image.

3.3.3 Setting of transmitted-light phase contrast

(1) General principle

The phase contrast technique is ideal for examinations of thin, unstained specimens, e.g. culture cells. The human eye is unable to see phase differences (differences in refractive index and thickness) between the different cell components.

The phase contrast technique uses the optical modulators "phase stop and phase ring“ and the interference procedures during the formation of the intermediate image to change the small phase differences in intensity and color differences which are visible to the eye.

The high-intensity, direct light components are attenuated using the annular channel optically defined as "phase stop and phase ring", and a constant phase shift is applied. The indirect light components diffracted at different cell components, however, by-pass this optical channel and are influenced by the in-phase refractive index and the thickness differences in the specimen.

In the intermediate image plane, the differently influenced partial beams interfere and are enhanced or attenuated - depending on the phase position. This interference results in image contents displaying intensity and color differences which can be recognized by the human eye.

(2) Configurations of the manual Axioskop 2 FS *plus* and the Axioskop 2 FS MOT

- Phase contrast objectives with phase rings Ph 1, Ph 2 or Ph 3 for different average numeric apertures which can also be used in brightfield without any restriction.
- Universal condenser with turret disk containing centering phase stops Ph 1, Ph 2 and Ph 3 for different average numeric apertures.
- The inserted phase stop on the universal condenser must match the appropriate label on the objective, e.g. Ph 1.

(3) Transmitted-light phase contrast settings on manual Axioskop 2 FS *plus* and Axioskop 2 FS MOT

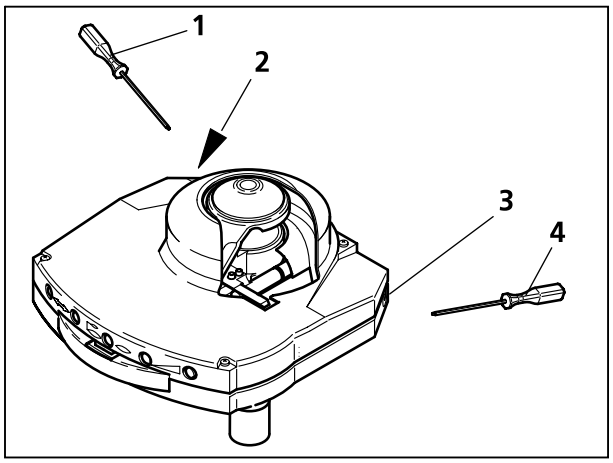


Fig. 3-19 Centering of phase stop on universal condenser

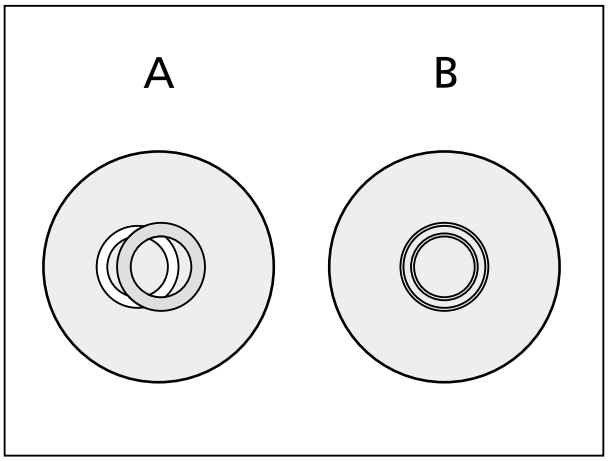


Fig. 3-20 Centering of phase stop (bright in condenser) to phase ring (dark in objective)

- Swing phase contrast objective, e.g. Ph 1, in the beam path.
- Insert phase stop labelled like the phase contrast objective, e.g. Ph 1, using the turret disk of the universal condenser.
- To check centering and congruence of the bright phase stop (in condenser) with the dark phase ring (in objective), remove one eyepiece from the tube and replace it with the centering telescope. Use the correction device of the centering telescope to focus on the phase stop and the phase ring in the objective exit pupil.
- If congruence is not perfect (3-20/**A**), the two SW 1.5 screwdrivers (3-19/**1** and **4**) must be used on the two centering screws (3-19/**2** and **3**) to recenter the bright phase stop until complete congruence with the dark phase ring is achieved (3-20/**B**).
- Insert eyepiece in the tube again.

Normally, however, centering is not required, since the phase stops are factory-centered and the centering is retained even if the universal condenser is removed from the condenser carrier and attached again.

To enhance the image contrast, an interference wide-band filter, green 32 x 4, can be placed on the luminous-field diaphragm or inserted in the filter mount (if available).

Complete phase contrast is only achieved if the bright phase stop (in condenser) and the dark phase ring in objective) are exactly congruent in the illumination beam path (3-20/**B**).

3.3.4 Setting of transmitted-light differential interference contrast (DIC)

(1) General principle

The transmitted-light DIC technique is an alternative contrasting technique for polarization applications, permitting high-contrast 3D images of transparent specimen details.

Light which has been linearly polarized by a polarizer is split into two partial beams in a birefringent prism. These partial beams pass two close-lying specimen areas with different refractive indices and specimen thickness. This causes path differences in both beams. The beams are then united in a second birefringent prism and feature the same vibration direction after passing the analyzer. Therefore, both beams can interfere in the intermediate image, with the path differences being transformed into different gray values (intensities). A λ-compensator (lambda plate) subsequently changes the gray values to colors.

(2) Axioskop 2 FS *plus* and Axioskop 2 FS MOT configuration

– Objectives offered with DIC equipment
– DIC sliders, suitable for the objectives used, are integrated in the objective slider and centered.
– Condenser with turret disk with DIC prisms (DIC I, DIC II, DIC III)
– Polarizer, e.g. SENARMONT polarizer

☞ In the case of the achromatic-aplanatic universal condensers 0.9 H D Ph DIC, 445439-0000-000, the DIC prisms in the turret disk are already combined with a polarizer. When other condensers are used, a separate polarizer is therefore required, e.g. the SENARMONT polarizer.

– DIC analyzer module in reflector turret
– Rotary mechanical stage should be preferred

☞ If the Axioskop 2 FS *plus* / FS MOT microscopes have not been ordered with DIC equipment, DIC sliders must be inserted in the objective slider and centered to enable the performance of examinations in differential interference contrast. Insertion of the DIC sliders is described in section 2.1.7 of chapter 2. Setting to the center position is described below under **(3)**.

(3) Centering of DIC sliders

– The DIC sliders have been correctly inserted in the objective slider as described in chapter 2.
– The microscope has been set for KÖHLER-type brightfield illumination.
– 10x objective (or low-power objective used) is in work position of objective slider.
– Brightfield position or empty position of condenser turret is in the beam path.

- Swing in SENARMONT polarizer (3-22/**4**), consisting of carrier with λ/4 plate (above) and rotary polarizer (below).

- Move rod of the rotary polarizer (3-22/**5**) on the SENARMONT polarizer in the 45° click-stop position.
- Swing in analyzer module D on the reflector turret (3-22/**1**).
- Remove one eyepiece from the tube and replace it with a centering telescope.

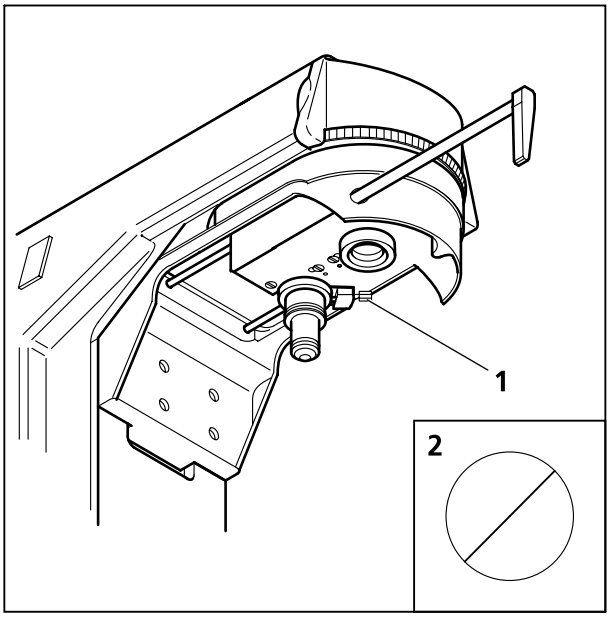


Fig. 3-21 Centering of DIC slider

- A diagonal black line (3-21/**2**) of the DIC slider becomes visible in observation of the field of view using the centering telescope.
- Adjust the knurled screw of the DIC slider (3-21/**1**) to move the diagonal black line into the center of the field of view.
- Remove centering telescope and insert eyepiece again.

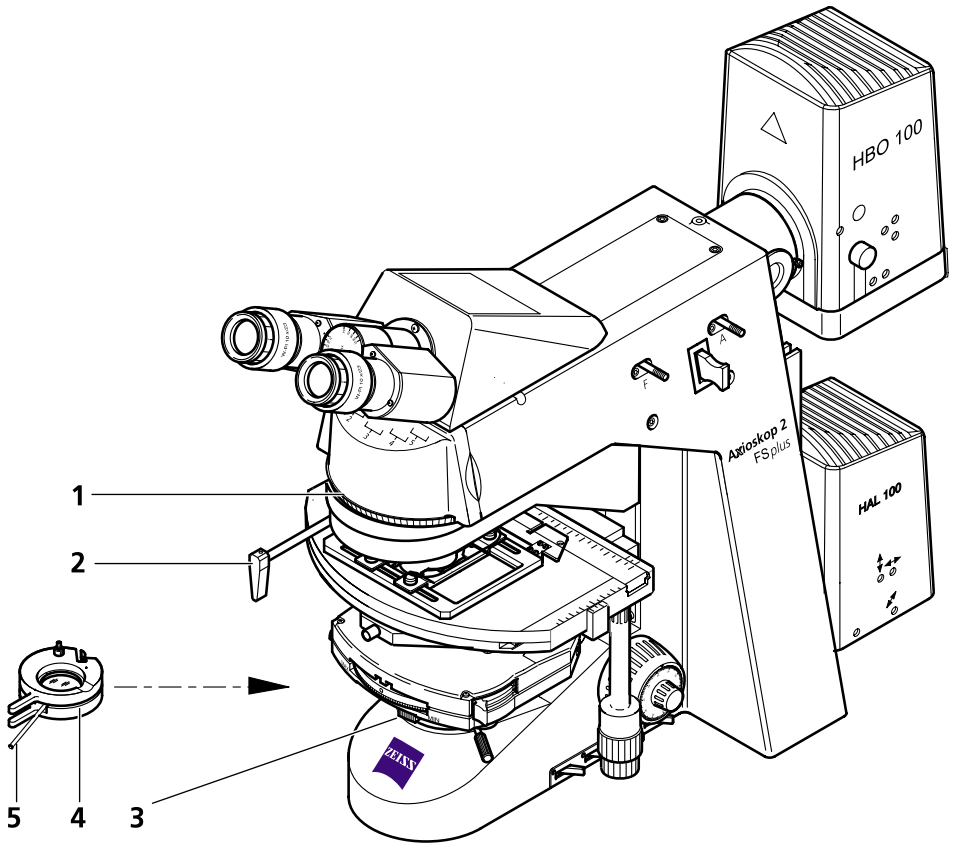
(4) Setting of transmitted-light DIC on Axioskop 2 FS *plus*) and Axioskop 2 FS MOT

- Move the DIC-suitable objective in the objective slider in the work position via the pushrod (3-22/**2**).
- Swing in the DIC analyzer module on the reflector turret (3-22/**1**).
- Swing in the suitable DIC prism I, II or III (digit on condenser turret disk).

☞ The universal condenser must not be equipped with DIC prisms which are integrated together with polarization filters.

- Move SENARMONT polarizer (3-22/**4**) (polarizer and λ/4 plate) into click-stop position.
- Set luminous-field diaphragm and aperture diaphragm (3-22/**3**) in accordance with the KÖHLER rules.
- In SENARMONT-DIC, optimum contrast is set by turning the polarizer via pushrod (3-22/**5**) in the lower part of the SENARMONT polarizer. The λ/4-plate positioned above must always be swung in if SENARMONT contrasting is to be successful. If the DIC slider is correctly positioned in the center, darkness is created in the click-stop position of the SENARMONT polarizer, i.e. the path difference is 0 nm in this position.

☞ Because of its use of polarized light, the DIC technique is impaired if birefringent components, e.g. foils sometimes used with histological sections, are positioned between polarizer and analyzer. The same applies to Plexiglas culture chambers if the chamber is made of plastic. In such cases, it is recommended to use chambers with glass bottoms to avoid the loss of optical performance.



1 Reflector turret
2 Pushrod of objective slider
3 Sliding knob for aperture diaphragm
4 SENARMONT polarizer
5 Pushrod of the rotating polarizer

Fig. 3-22 Components for the transmitted-light DIC technique on the Axioskop 2 FS *plus*

3.3.5 Setting of epi-fluorescence

(1) General principle

The epi-fluorescence technique permits high contrast images of fluorescent substances in typical fluorescence colors. In the epi-fluorescence microscope, light generated by a high-performance illuminator reaches the excitation filter (band-pass) via a heat protection filter. The filtered, short-wave excitation emission is reflected by a dichroic beam splitter and focused on the specimen via the objective. The specimen absorbs the short-wave emission and then emits the long-wave fluorescence (Stoke's law), which is now gathered by the objective and transmitted by the dichroic beam splitter. Finally, the rays pass a barrier filter (long-pass/band-pass), which only allows the long-wave emission from the specimen to be transmitted.

Excitation and barrier filters, which are both positioned in the FL P&C reflector module together with the relevant dichroic beam splitter, must be perfectly matched.

(2) Axioskop 2 FS *plus* and Axioskop 2 FS MOT configuration

- FL P&C reflector module and shutter plate in reflector turret
- HBO 103 or HBO 50 mercury vapor short-arc lamp for incident-light illumination
- HAL 100 halogen illuminator for transmitted-light illumination

☞ Before the epi-fluorescence technique is applied, it is absolutely necessary to adjust the mercury vapor short-arc lamp in accordance with section 2.1.14 by using the adjusting aid. If required, re-adjustment must be performed depending on the operation time.

(3) Setting of epi-fluorescence on the Axioskop 2 FS *plus* and Axioskop 2 FS MOT

Initial epi-fluorescence setting is made much easier if a strongly fluorescent specimen is used first. Demonstration specimens can also be used first.

- Switch on the HAL100 halogen illuminator.
- Swing in the objective.
- Move condenser turret to position H, transmitted-light brightfield (or also phase contrast), and then move to the specimen area to be examined.
- Keep light path in the incident-light illuminator blocked at first using the shutter plate on the reflector turret (3-23/**1**) or the barrier position of the incident-light filter slider (3-23/**5**).

- Switch on the HBO 103 or HBO 50 mercury vapor short-arc lamp (3-23/**2**) (see section 2.1.12, page 2-14) and allow it to heat up to its operation temperature for approx. 15 mins.
- Select the FL P&C reflector module in reflector turret (3-23/**1**) containing the required fluorescence filter combination (depending on the excitation) and switch it on.
- When using the incident-light filter slider (3-23/**4**), unblock the light path in the incident-light illuminator.
- Remove one eyepiece from the tube and set the aperture diaphragm (3-23/**3**) by opening it until the entire objective exit pupil is unblocked.
- Insert eyepiece in tube again and close luminous-field diaphragm (3-23/**5**) until it is visible in the field of view.
- Use the two centering screws (3-23/**6**) to center the luminous-field diaphragm in relation to the edge of the field of view.
- Either open the luminous-field diaphragm until it just disappears behind the edge of the field of view or, if there is a risk of specimen bleaching, reduce it until it is visible in the field of view.

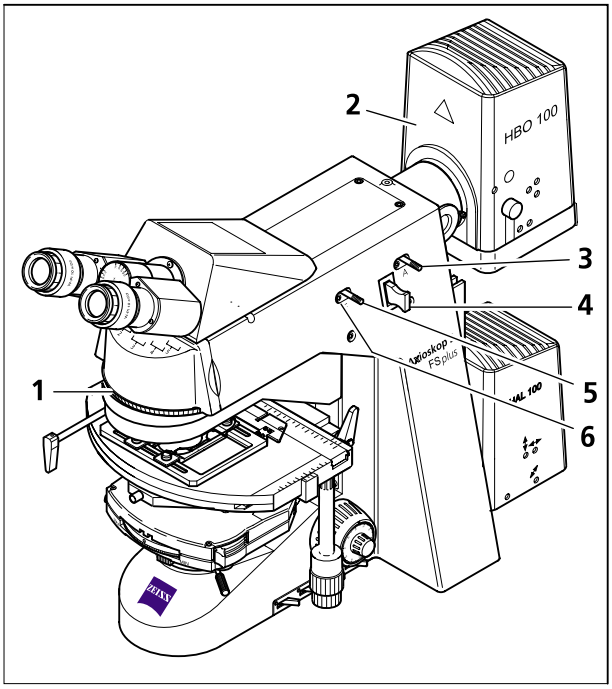


Fig. 3-23 Components for epi-fluorescence on the Axioskop 2 FS *plus*

- Finally, refocus on the specimen and optimize the HBO 103 collector position as described in section 2.1.14. Set the collector in such a way that homogeneous illumination is obtained with the short-wave excitation reflector module. When modules with long-wave excitation are used, correction of the collector position is not required.

3.4 Documentation

3.4.1 Attachment of photomicrography equipment

The Axioskop 2 FS *plus* / Axioskop 2 FS MOT equipped with a binocular phototube (3-24/**5**) can be switched from observation to photomicrography (pushrod pulled out) using the pushrod (3-24/**7**). The special T2 adapter 2.5x and other T2 adapters permit commercially available 35 mm SLR cameras (SLR - Single Lens Reflex) and special microscope cameras (e.g. MC 80 DX or MC 200 CHIP from Carl Zeiss) to be attached to the 60 mm interface camera port of the binocular phototube. For use of photomicrography equipment please see the relevant operating instructions.

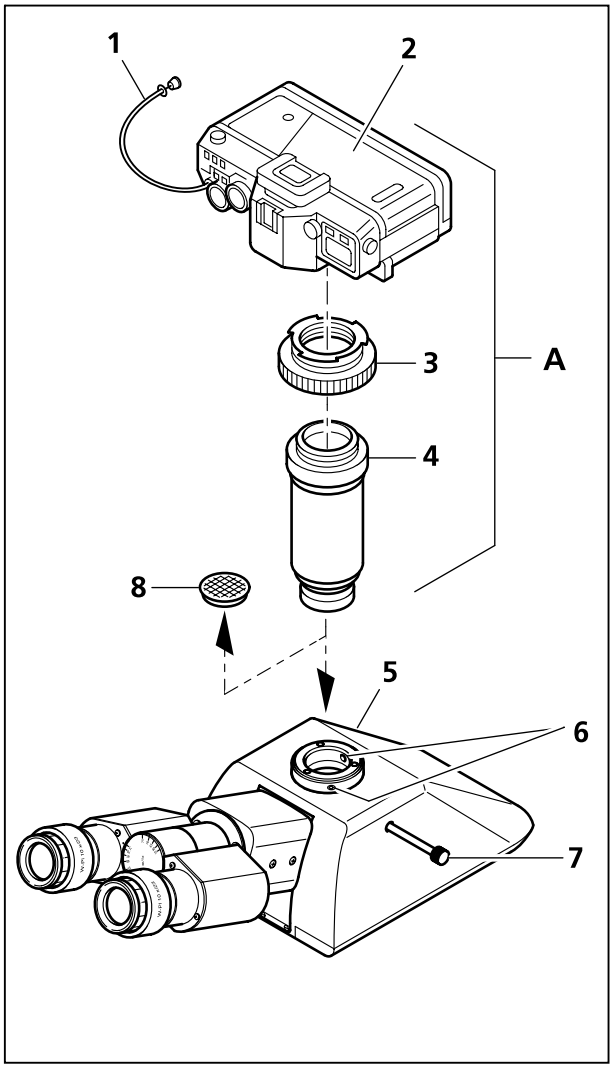


Fig. 3-24 Attachment of SLR camera (e.g. Contax 167 MT)

(1) Attachment of a SLR camera, e.g. CONTAX 167 MT

- Screw T2 adapter (416010-0000-000, 3-24/**3**) suitable for the used camera on the 2.5x connector for T2 (456005-0000-000, 3-24/**4**).
- Attach camera (416181-0000-000, 3-24/**2**) and, if required, cable release (416167-0000-000, 3-24/**1**).
- Remove dust cap (3-24/**8**) from the phototube (3-24/**5**) and insert premounted unit **A** in the phototube.
- Align unit in the required position and tighten 3 Allen screws (3-24/**6**).

☞ If focusing is not to be performed through the viewfinder of the camera, a focusing eyepiece with photo reticle MC 2.5x / d = 26 mm (454075-0000-000, see p. 1-15) must be used.

☞ For detailed information on SLR cameras please see manual G 42-406 ll, "35 mm SLR cameras for microscopes and stereomicroscopes".

(2) Attachment of a microscope camera, e.g. MC 80 DX or MC 200 CHIP from Carl Zeiss

The Axioskop 2 FS *plus* / Axioskop 2 FS MOT microscope allows not only attachment of SLR cameras, but also of microscope cameras, e.g. MC 80 DX or MC 200 CHIP from Carl Zeiss. You can order the MC 80 DX and MC 200 CHIP microscope cameras under the catalog numbers given in section 1.3, "microscope configurations". You will also need all the other components for which catalog numbers are given.

- Insert 60 mm interface adapter (456006-0000-000, 3-25/**5**) in phototube (3-25/**6**) and tighten three hexagonal screws (3-25/**7**).
- Insert P 2.5x projection lens (456021-0000-000, 3-25/**4**) in the microscope camera adapter (3-25/**5**).
- Attach MC 80 DX basic body (3-25/**2**) to the microscope camera adapter until stop, align it and tighten clamping ring (3-25/**3**) anti-clockwise.
- Attach 35 mm Mot DX film cassette (3-25/**1**) to the basic body in such a way that the contact pins tightly engage in the relevant sockets.
- Use focusing eyepiece with MC 2.5x / d = 26 mm photo reticle (454075-0000-000, see 1-15).

The installed microscope camera must be operated independently of the microscope directly via control panel (MC 80 DX) or via a PC / Notebook separately connected to the microscope camera.

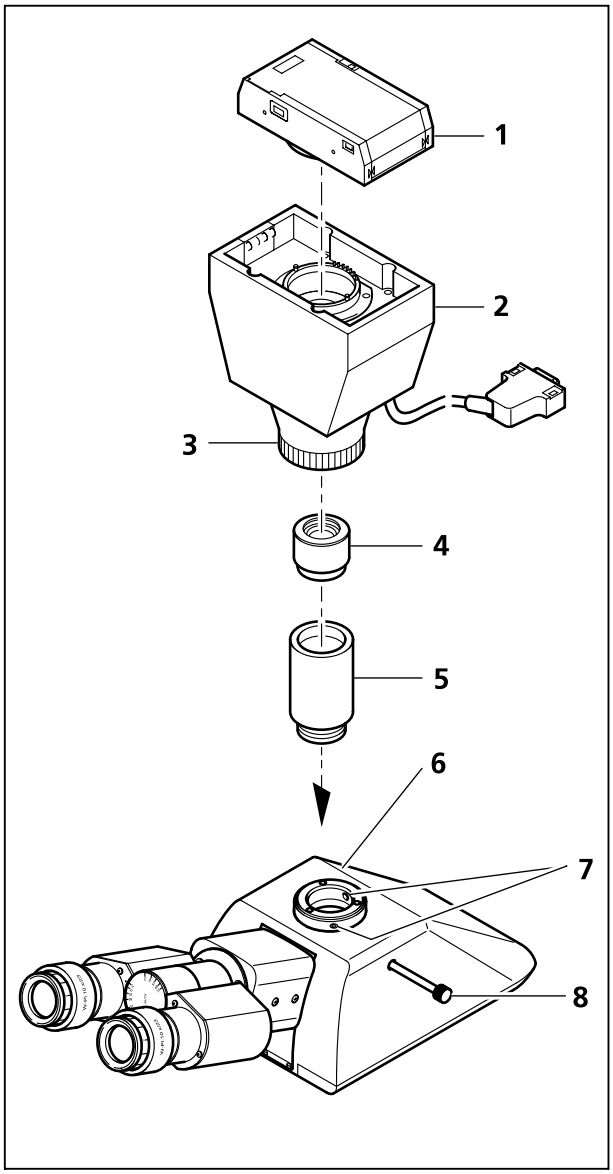


Fig. 3-25 Attachment of microscope camera (e.g. MC 80 DX)

The following T2 adapters are available for SLR cameras:

T2 Adapter for SLR cameras	**Cat. No.**
T2 Adapter for CONTAX (CONTAX-bayonet)	416010-0000-000
T2 Adapter for OLYMPUS OM (OM-bayonet)	416002-0000-000
T2 Adapter for MINOLTA (SR-bayonet)	416003-0000-000
T2 Adapter for CANON (FD-bayonet)	416004-0000-000
T2 Adapter for NIKON (F-bayonet)	416009-0000-000
T2 Adapter for PENTAX (KA-bayonet)	416011-0000-000

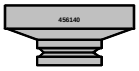
3.4.2 Attachment of videomicroscopy equipment

Due to ICS optics from Carl Zeiss, the completely corrected intermediate image falls directly on the target of the video camera. This permits optimum quality of the image transfer, even if high-resolution video cameras are used.

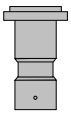
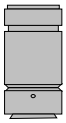
The following video adapters with 60 mm interface permit the connection of 1-chip b/w and color CCD cameras and 3-chip color / high-resolution CCD cameras to the phototube of the Axioskop 2 FS *plus* / Axioskop 2 FS MOT.

Tube	Adapters	Cameras
AXIOSKOP 2 FS PLUS PHOTO-TUBE WITH 60 MM INTERFACE	**456105-0000-000** 60 C 2/3“ 1,0×	CAMERAS WITH C-MOUNT
	000000-1069-414 60 C 2/3“ 0,63×	
	456106-0000-000 60 C 1/2“ 0,5×	
	456108-0000-000 60 C 1/3“ 0,4×	
	452989-0000-000 Zoom 44 C 1/3“ (3 CCD) 0,35x ... 1,6x To be used with attachable component 60-44: **456140-0000-000**	
	456115-0000-000 60 ENG 2/3“ 1,0×	3-CHIP-CAMERAS WITH 2/3“ BAYONET
	452984-0000-000 Zoom 44 ENG 1/2“ 0,5× ... 2,4× To be used with attachable component 60-44: **456140-0000-000**	3-CHIP-CAMERAS WITH 1/2“ BAYONET
	452992-0000-000 44 ENG 1/2“ 0,63× To be used with attachable component 60-44: **456140-0000-000**	

The 60 - 44 adapter also allows video adapters with 44 mm interface to be used with the phototube of the Axioskop 2 FS *plus* / Axioskop 2 FS MOT with 60 mm interface.

Video adapter (Cat. No.)	Suitable for:	Comments
 **456140-0000-000** Adapter 60 - 44	Microscopes with 60 mm interface and all video adapters for 44 mm interface.	Connects video adapters for 44 mm interface to microscopes with 60 mm interface.

3.4.3 Attachment of adapter for digital compact cameras

Tube	Adapters	Cameras
AXIOSKOP 2 FS PLUS PHOTO-TUBE WITH INTERFACE 60 MM	 **000000-1096-522** D40 M52x0,75 To be used with: **456006-0000-000**  **000000-1108-984** 44 M52x0,75 To be used with: **456140-0000-000**	**COMPACT-DIGITAL-CAMERAS / CAMCORDERS WITH FILTER-THREAD 37/52 MM**

3.5 Quantitative microscopy

3.5.1 Measurement of lengths

The measurement of lengths using the Axioskop 2 FS *plus* / Axioskop 2 FS MOT requires the following, for example:

- stage micrometer, positive 5 + 100/100 y, D = 0.17 mm as the object
- eyepiece crossline micrometer 10:100, d = 26 mm in the eyepiece

An overview of available stage micrometers and eyepiece reticles is given in section 1.7.

Before length measurement using the microscope can be performed, the micrometer or scale value of the objective / eyepiece reticle combination must be determined. This scale value is exactly that distance in the specimen which complies to one interval of the used crossline micrometer.

For calibration, align the scales of the stage micrometer and the crossline micrometer parallel to each other by turning the eyepiece, and make the zero line of both scales exactly congruent. If, for example, 99 increments (of 10 µm each) of the stage micrometer correspond to exactly 100 increments of the crossline micrometer, as in Fig. 3-26, the resulting scale value k' for the used objective / eyepiece reticle combination (A-Plan 10x/0.25 and crossline micrometer 10:100) is

$$k' = \frac{99}{100} \times 10\ \mu m = 9.9\ \mu m$$

☞ The distance to be measured should be ≥ 5 mm in the eyepiece field to keep the influence of random measuring deviations as low as possible. Other measuring errors can occur if the eyepiece has not been inserted into the tube until stop.

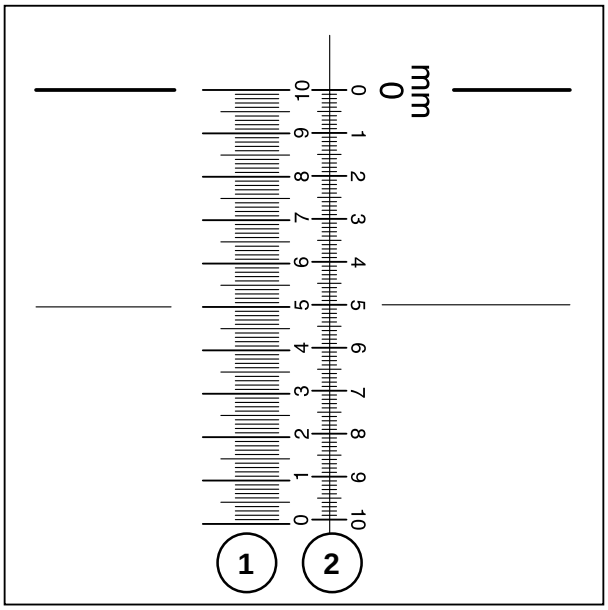


Fig. 3-26 **Length measurement using scale 1 on the stage micrometer (object) and scale 2 on the crossline micrometer (eyepiece)**

After exchange of the stage micrometer for the specimen to be measured, the measuring distance of interest results from the number of increments of the crossline micrometer (tenth estimated), multiplied by the scale value k'. Example:

$$L = 35.5 \times 9.9\ \mu m = 351.5\ \mu m$$

Particularly large object structures can also be determined by using the vernier scale gradations (0.1 mm) on the mechanical stage. Here, it might be necessary to determine the distance to be measured through calculation from a combined x and y measurement (Pythagoras).

3.5.2 Height measurement

Height measurements using the microscope are always possible to be performed if both the lower and upper side of the specimen can be focused. This should preferably be performed using a precision focusing drive and a high-aperture objective with a low depth of focus.

The difference in the height of the objective slider results in a height value for transmitted-light specimens which is falsified by the refractive index of the specimen (through which focusing was made) and perhaps by the immersion oil. The correct height value d of the specimen measured in transmitted light results from the difference of height adjustments (focus difference) d' and the refractive indices n_P of the specimen and n_M of the medium between cover slip and specimen:

$$d = d' \times \frac{n_P}{n_M}$$

Example:

The upper (3-27/**1**) and lower side (3-27/**2**) of a specimen were focused using a dry objective (n_M = 1,0).

The indicated intervals of the mechanical fine drive are 15.0 and 24.5, which means that d' = 9.5 µm with an interval of 1 µm.

☞ To make things easier, the Axioskop 2 FS MOT permits one focus position to be set to zero and the difference d' of the height adjustment of the objective slider to be read directly from the display of the keypad

The refractive index of the specimen area n_P has been assumed as n_P = 1.5. Therefore, the thin section height is:

$$d = d' \times \frac{n_P}{n_M} = 9.5\ \mu m \times \frac{1.5}{1} = 14.25\ \mu m$$

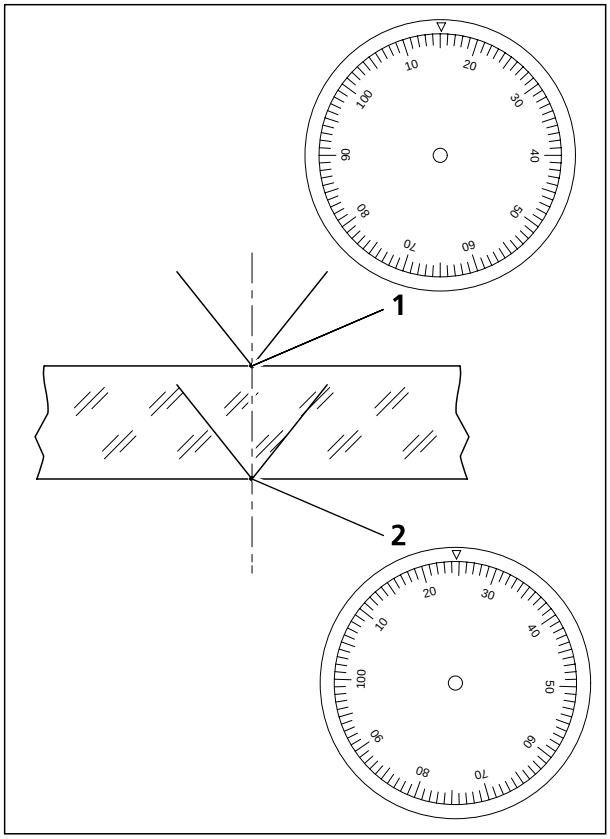


Fig. 3-27 Height measurement

CARE, MAINTENANCE, TROUBLESHOOTING AND SERVICE

Contents

List of illustrations

4 CARE, MAINTENANCE, TROUBLESHOOTING AND SERVICE

4.1 Instrument care

Care of the Axioskop 2 FS *plus* / Axioskop 2 FS MOT is limited to the following operations:

- Switch off the instrument after every use and place instrument cover on it to protect it from dust and humidity.
- Never expose the instrument to inadmissible climatic conditions (high humidity and temperature).

The best way to remove stubborn dirt on glass surfaces, e.g. finger prints or traces of grease and immersion oil, is the use of a piece of cotton wrapped around a wooden stick and a small amount of distilled water or a non-aggressive solution.

- distilled water: clean glass surface using a slightly moistened wad of cotton by moving in circles starting in the middle.
- Optics cleaning solution, consisting of 15 % isopropanol and 85 % medical alcohol (benzoline): clean glass surface using a slightly moistened wad of cotton by moving in circles starting in the middle.
- Remove dust from optical surfaces using a natural hair brush or an air blower.

When using the microscope in humid climatic zones, proceed as follows:

- Store instrument in bright, dry and well-ventilated rooms with a humidity of less than 65 %: optical components and accessories which are particularly susceptible to the growth of fungus, e.g. objectives and eyepieces, should be stored in a dry closet.
- When the equipment is stored in closed cases for a longer period of time, the growth of fungus can be avoided by including cloths soaked in fungicide in the cases.

The risk of growth of fungus on opto-mechanical instruments always exists in the following conditions:

– Relative humidity of more than 75 % and temperatures between +15 °C and +35 °C for more than three days.

– Installation in dark rooms without air ventilation.

– Dust deposits and fingerprints on optical surfaces.

4.2 Instrument maintenance

4.2.1 Performing checks

- Make sure that the instrument(s) comply with the required line voltage (e.g. the HBO 100 transformer).
- Check line cable and plug for defects.
- If any damage is visible, switch off the instrument. Have instrument repaired only by an expert.
- Make sure that the maximum operation time of the halogen and mercury vapor short-arc lamps is not exceeded.

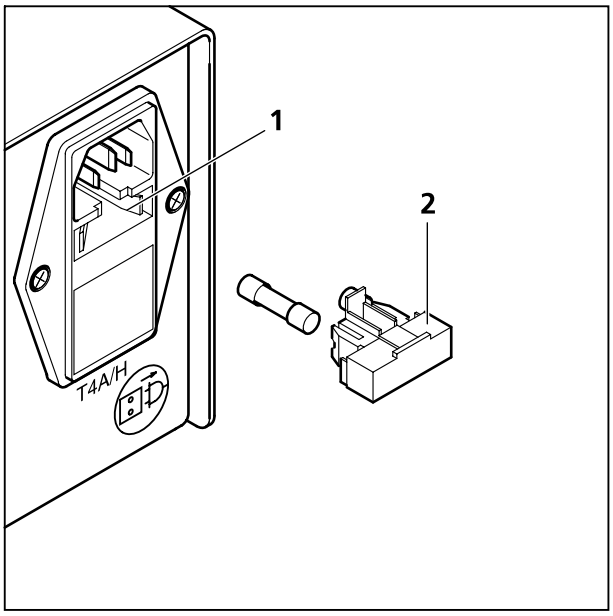


Fig. 4-1 Changing the fuses, e.g. of the separate 12 V DC 100 W power unit

4.2.2 Changing the fuses

Always pull the power plug before changing the fuses.

The fuse compartment is positioned at the rear of the relevant power supply unit. It is combined with the instrument socket and contains two **T 4 A/H 250 V** (separate 12 V DC 100 W power unit) or **T 3.15 A** fuses (HBO 100 transformer).

- Disconnect the instrument from the line.
- Pull out fuse holder (4-1/**2**) in forward direction and remove it from the fuse compartment (4-1/**1**).
- Remove defective fuses from the fuse holder and insert new fuses. Make sure that the correct fuses are used (label).
- Insert fuse holder in the fuse compartment again and press it in until stop.
- Connect the instrument to the line.

4.3 Troubleshooting

Problem	Cause	Remedy
Shadows or inhomogeneous image brightness in the field of view; the field is not entirely visible.	The vis/phot pushrod on the camera tube is not in the correct (intermediate) position.	Move the vis/phot pushrod on the phototube in the correct position (end position), see page 3-10.
	Objective in objective slider not lowered to work position.	Lower objective in objective slider to work position.
	Condenser not set correctly.	Set condenser correctly (adjustment, centering), see p. 3-20 ff.
	Aperture diaphragm not set correctly.	Set aperture diaphragm correctly (centering, opening), see p. 3-20 ff.
	Luminous-field diaphragm not set correctly.	Set luminous-field diaphragm correctly (centering, opening), see p. 3-20 ff.
	Filter not inserted correctly in filter mount.	Insert filter correctly in filter mount.

Problem	**Cause**	**Remedy**
Low resolving power and poor image contrast.	Aperture diaphragm opening not set correctly.	Set aperture diaphragm opening in accordance with the 2/3 rule or depending on the specimen features, see p. 3-20 ff.
	Condenser not focused correctly and condenser lens 0.9 not switched correctly.	Focus condenser and switch condenser lens 0.9 on or off correctly, see p. 3-20 ff.
	Wrong cover slip thickness for transmitted-light objectives with cover slip thickness 0.17 mm.	Use standardized cover slips with thickness 0.17 mm.
	Use of no or unspecified immersion oil with immersion objectives.	Use immersion oil 518 N from Carl Zeiss, see p. 4-9.
	Air bubbles in the immersion oil.	Apply new oil to remove the bubbles.
	Immersion oil at the front lens of a dry objective.	Clean the front lens of the dry objective, see p. 4-3.
	Corr. ring is not set to the correct cover slip thickness.	Set the corr. ring to the correct thickness, see p. 1-12.
	Dirt or dust on the optical surfaces of objectives, eyepieces, condensers or filters.	Clean the appropriate optical components, see p. 4-3.
Asymmetrically blurred images, e.g. one side in focus, one side not in focus.	Condenser not set correctly.	Set condenser correctly, see p. 3-20 ff.
	Nosepiece not in click-stop position.	Correctly click-stop nosepiece.
	Specimen is not clamped in position on the mechanical stage.	Correctly insert specimen in specimen holder and clamp it.

Problem	**Cause**	**Remedy**
Great focus differences after objective change.	Focusing eyepieces are not set correctly.	Set focusing eyepieces to the appropriate ametropia, s. p. 2-13.
	Objective not screwed in until stop.	Screw in objective until stop.
	Tube lens either not integrated or integrated superfluously.	Integrate tube lens or remove superfluous tube lens.
Left and right fields of view cannot be combined into an image.	Interpupillary distance of the binocular tube is not set correctly.	Set interpupillary distance correctly, see p. 2-13.
	Focusing eyepieces are not set correctly.	Set focusing eyepieces to the appropriate ametropia, s. p. 2-13.
Eye-fatiguing microscopy.	Interpupillary distance of the binocular tube is not set correctly.	Set interpupillary distance correctly, see p. 2-13.
	Focusing eyepieces are not set correctly.	Set focusing eyepieces to the appropriate ametropia, s. p. 2-13.
	Image brightness not acceptable.	Adjust lamp voltage or insert conversion filter.
	Binocular tube optically / mechanically out of alignment.	Check / repair by microscopy service.
Dirt or dust in the field of view.	Condenser not focused correctly and condenser lens 0.9 not switched correctly.	Focus condenser and switch condenser lens 0.9 on or off correctly, see p. 3-20 ff.
	Aperture diaphragm opening too small.	Set aperture diaphragm opening in accordance with the 2/3 rule or depending on the specimen features, see p. 3-20 ff.
	Dirt or dust on the optical surfaces of objectives, eyepieces, condensers, filters or specimens.	Clean the optical surfaces of the appropriate components, see p. 4-3.

Problem	**Cause**	**Remedy**
The 12 V 100 W halogen lamp does not function although the on / off switch is in "on" position.	Line cable not connected to the line.	Connect line cable to the line and make sure to check the instrument and line voltage.
	12 V 100 W halogen lamp not installed.	Attach 12 V 100 W halogen lamp, see p. 2-27.
	12 V 100 W halogen lamp defective.	Replace 12 V 100 W halogen lamp, see p. 2-27.
	The specified 12 V 100 W halogen lamp is not used.	Use the specified 6 V 12 W halogen lamp, see p. 1-6.
	Fuses are defective.	Exchange fuses, see page 4-4.
The 12 V 100 W halogen lamp flickers, unstable brightness.	End of average life of 12 V 100 W halogen lamp.	Replace 12 V 100 W halogen lamp, see p. 2-27.
	Incorrectly installed or broken line cable.	Connect line cable correctly or replace it.
	The pins of the 12 V 100 W halogen lamp are not correctly inserted into the receptacle.	Correctly insert pins of 12 V 100 W halogen lamp in receptacle, see p. 2-27.

4.4 Spares, consumables and tools

Description	Cat. No.	Application
12 V 100 W halogen lamp	380079-9540-000	for HAL 100 illuminator
HBO 103 W/2 mercury pressure short-arc lamp	380301-9350-000	for HBO 103 illuminator
SW 3 ball-headed screwdriver	000000-0069-551	to change tubes and illuminators
SW 2.5 ball-headed screwdriver		to change FL reflector modules
Eyepiece eyecup	444801-0000-000	recommended for low-brightness techniques to suppress reflected light
Dust cover for eyepiece tube	000000-0168-373	to close instrument openings which are not used
518 N immersion oil 20 ml oiler 100 ml bottle 250 ml bottle 500 ml bottle	 444950-0000-000 444952-0000-000 444953-0000-000 444954-0000-000	for oil immersion applications n_D = 1.515
Cleaning paper, 300 sheets	462975-0000-000	to clean optical surfaces
G-fuse inserts (5x20 mm) T 4 A/H 250 V 2x T 3.15 A 2x		protects the integrated power unit from excessive load
Dust cover M Dust cover G (only in combination with binocular phototube)	459311-0000-000 459312-0000-000	to cover the instrument after use

4.5 Requesting service

All repairs of mechanical and optical components inside the microscope, of the power units and of the electronic control of the focusing drive may only be performed by Carl Zeiss service staff or specially **authorized** personnel.

To ensure the optimum setting and trouble-free function of your microscope even for a longer period of time, we would recommend you to conclude a service/maintenance contract with Carl Zeiss.

In the case of subsequent orders or when service is required, please get in touch with your local Zeiss agency.

Further information is available in the Internet under:

micro@zeiss.de

http://www.zeiss.de

ANNEX

List of abbreviations

AC	Alternating Current
A-Plan	Achromatic objectives featuring improved image flatness (ICS line)
Br.	Suitable for eyeglass wearers
CCD	Charge Couple Device
CSA	Canadian Standards Association
D	Cover slip thickness
D	Darkfield
d	Diameter (e.g. of filters)
d	Height value (height measurement)
d'	Difference of stage height setting (focus difference in height measurement)
DC	Direct Current
DIC	Differential Interference Contrast
DIN	Deutsches Institut für Normung (German standards association)
DL	Transmitted light
DX	Coding system for the storage of electronically legible information (e.g. film speed)
EG	European Community
EN	European standards
EMV	Electromagnetic compatibility
ENG	Electronics News Gatering
EWG	European Economic Community
FAA	Free working distance
FL	Fluorescence
foc.	Focusing
fot	Photography
H	Brightfield
HAL	Halogen lamp
HBO	Mercury vapor short-arc lamp for fluorescence
ICS	Infinity Color-Corrected System
IEC	International Electrotechnical Commission

IP	International Protection (protection class)
ISO	International Organization for Standardization
L	Measuring distance (length measurement)
LED	Light Emitting Diode
MC	Microscope Camera
MOT / mot.	Motorized
n_M	Refractive index of the medium
n_D	Refractive index of D-line (sodium)
n_P	Refractive index of the specimen
Ph	Phase contrast
PL	Flatfield
R	Right (drive on the right of the mechanical stage)
SLR	Single Lens Reflex
SW	Wrench opening
T	Slow-blow (fuse type)
TV	Television
T2 Adapter	Standardized connector for 35 mm cameras
UL	Underwriter Laboratories
UV	Ultraviolet
VDE	Verband Deutscher Elektrotechniker (association of German electrotechnicians)
vis	Visual
V_{obj}	Magnification of the objective
W 0,8"	Whitworth-type thread 0.8"
W-PL	Wide-angle eyepiece
XBO	Xenon short-arc lamp

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