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CARL ZEISS
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ZEISS LUMINAR Objectives
Special systems for photomacrography

"Mikro" Bulletin No. 3

General

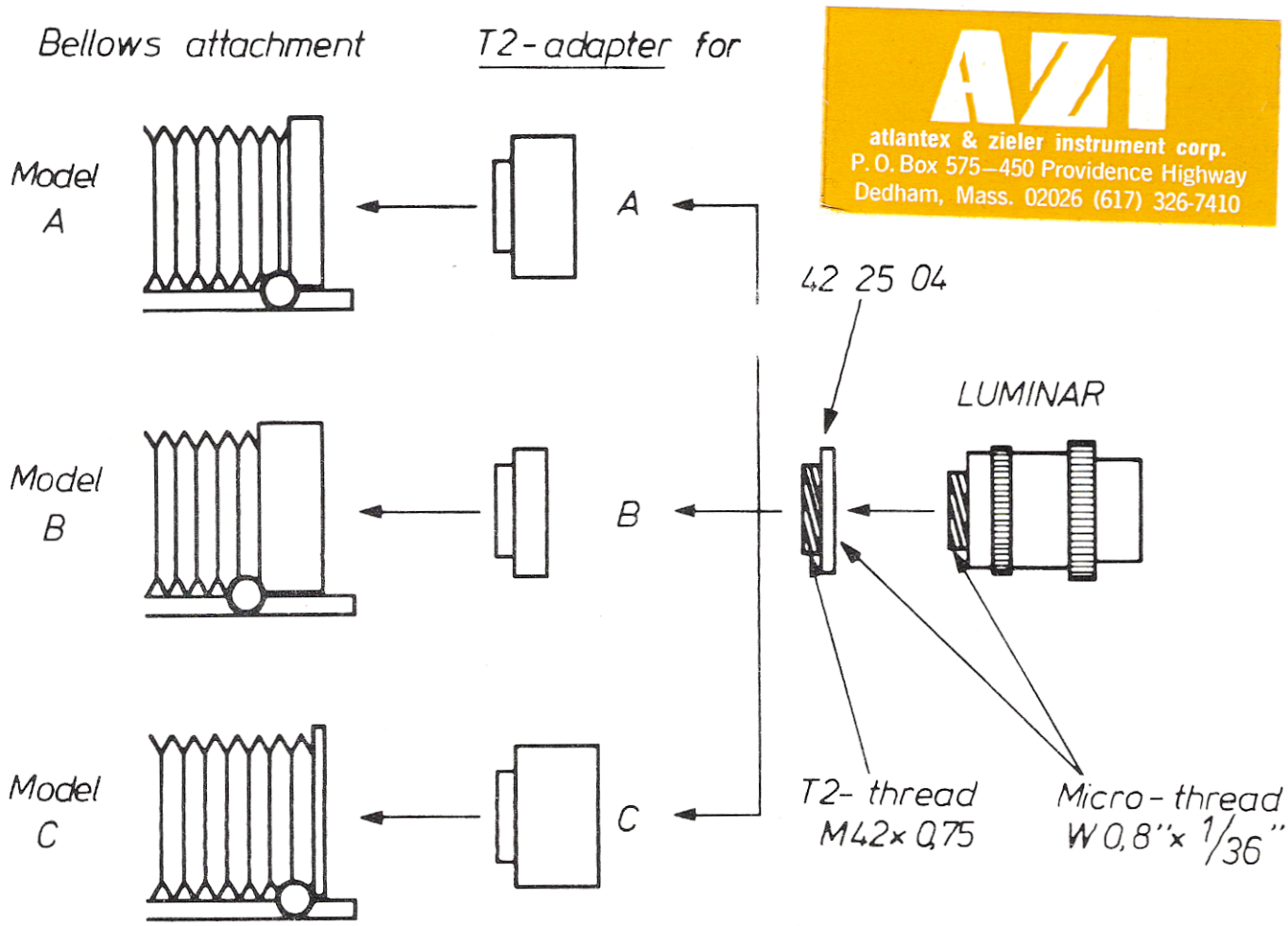
LUMINAR objectives are special photographic systems for those cases where the image distance (distance between objective — film) is larger than the object distance (distance between objective — object).

Depending on the requirements, 3 to 5 lenses are used to achieve maximum imaging quality. High numerical apertures (these correspond to the f-number of normal photo lenses) offer maximum resolving power. Coupling this with the precision applied in manufacturing microscope objectives we have developed top-flight products that are unsurpassed.

LUMINAR objectives are supplied with the focal lengths of 16 mm, 25 mm, 40 mm and 63 mm, have an iris diaphragm with engraved exposure factors and the international microscope standard thread W 0.8" x 1/36".

Camera adapters:

All well-known producers of prefessional view cameras supply LUMINAR adapters and some of them even have the objectives in their delivery programme.



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To be able to use LUMINAR objectives with the bellows units of various 35 mm reflex cameras, the LUMINAR thread/T2 thread ring (Zeiss Cat.No. 42 25 04) together with the T2 adapters marketed by specialist dealers is required; T2 adapters are available for almost all makes on the international market.

Technical data:

	Focal length	N.A.[1]	Max. relative aperture[2]	Angle of view for ∞ approx.	Reproduction ratio obtainable with a bellows unit of a 35 mm reflex camera[3]	Cat. No.
LUMINAR 16	16.1 mm	0.2	1:2.5	18°	7.8 to 14:1	46 25 11
LUMINAR 25	26.0 mm	0.14	1:3.5	22°	3.8 to 7.8:1	46 25 13
LUMINAR 40	39.9 mm	0.13	1:4	27°	1.75 to 4.2:1	46 25 15
LUMINAR 63	63.4 mm	0.11	1:4.5	27°	9.9 to 2.5:1	46 25 17

Hints on procedure:

Before starting with the work,it is recommended to draw up a table containing the **object fields** covered by the various LUMINAR focal lengths at the camera used. For this, focus camera on a millimeter scale and find the size of the object field filling the viewfinder at minimum and maximum extension. (The **scale** can then be determined by dividing the long format side by the real length in the object. – Example: 25 mm of the object fill the 35 mm width of the viewfinder of a reflex camera; the scale is then 35 mm : 25 mm = 1.4 : 1).

After these preparations the LUMINAR required for any object size to be photographed can be selected.

Nowadays **exposure measurement** is performed through the lens and offers no problems. As many exposure meters work far more exactly in bright light, make measurement with full aperture. Stop down afterwards and increase exposure time by the factor indicated on the LUMINAR diaphragm.

[1] For image distance ∞

[2] For object distance ∞

[3] Applicable to a standard bellows unit with approx. 45 mm minimum and 130 mm maximum extension.

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For close-up flash photography there are various formulas, two of which have been tested by us with so-called compact flashes:

$$1.\ \text{Distance reflector - object} = \frac{\text{guide number of the flash unit} \times 0.7}{\text{effective f-stop}}$$

$$2.\ \text{Distance reflector - object} = \left(\frac{\text{guide number}}{\text{effective f-stop}}\right)^2$$

(For the effective f-stop the nominal f-stop x (scale + 1) can also be substituted but we prefer to calculate with the effective f-stop.

In our opinion the simplest way of **determining the effective f-stop** is to divide the image distance (Bw) by the diameter of the exit pupil the former depending on the extension and representing the space between the diaphragm ring of the LUMINAR objective and the film plane. The values of the exit pupil diameters are given below:

Rel. aperture given as exposure factor	LUMINAR 16	LUMINAR 25	LUMINAR 40	LUMINAR 63
1	6.5 mm	7.00 mm	10 mm	14.5 mm
2	4.6 mm	5.00 mm	7 mm	10 mm
4	3.2 mm	3.5 mm	5 mm	7.2 mm
8	2.3 mm	2.5 mm	3.5 mm	5.1 mm
15	1.6 mm	1.7 mm	2.5 mm	3.6 mm
30	1.15 mm	1.25 mm	1.75 mm	2.55 mm

(Note: the value for 1 can be noted on the objective; for the next but one exposure factor this value must be divided by 1/2, the next by $\sqrt{2}$).

Example:

We assume a flash unit with the guide number 22 (for the film speed used). The entire format of a 6 mm long object is to be reproduced by a 35 mm camera. 35 mm : 6 mm = 5.8 : 1 is the scale M. Table 1 suggests LUMINAR 25 for this. Adjust bellows so that 6 mm are covered. Measurement of the distance diaphragm ring – film plane (the latter often marked with ⊖ on the camera body) yields 155 mm. To gain in depth of field stop down to 4. Effective f-stop (Table 2) is then 155 :3.5 = 44. Formula 2 results in 22 : 44 =0.5; 0.5^2 = 0.25. 25 cm is the correct distance between reflector and object. Formula 1 gives us 22 x 0.7 = 0.35 m.

Formulas and parameters in photomacrography:

$$\text{Scale } M = \frac{\text{image size}}{\text{object size}}$$

$$M = \frac{\text{image distance Bw} - \text{focal length f}}{\text{f}}$$

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$$\text{Nominal relative aperture} = \frac{\text{exit pupil dia. AP}}{f}$$

$$\text{Nominal f-stop} = \frac{f}{AP}$$

$$\text{Effective relative aperture} = \frac{AP}{Bw}$$

$$\text{Effective f-stop} = \frac{Bw}{AP}$$

$$\text{Effective f-stop} = \text{nominal f-stop} \times (M + 1)$$

$$\text{Numerical aperture (towards object for image distance } \infty) = \frac{\text{entrance pupil dia. EP}}{2f}$$

To give a formula for the depth of field is very problematic because in the macrorange aspects of diffraction and physiology have to be taken into account in addition to those of geometrical optics.

For the sake of completeness a formula after SOLF (1973) is given:

$$\text{Depth of field} = 2 u K (M + 1) / M^2$$

(K = nominal f-stop; u = permissible diameter of the circle of confusion in the image). This formula does not allow for diffraction phenomena.

(For normal photographs on 24x36 mm format the diameter of the circle of confusion is 0.03 mm, for 6x6 cm format 0.06 mm and for 9x12 cm format 0.1 mm. These values are often quite unrealistic for photomacrography because the unsharpness due to diffraction inevitably caused when stopping down is frequently larger than the values given.)

Note:

As the LUMINAR objectives are derived from the "Mikro" field - as are the microobjectives – some of them are not marked with the relative aperture ("speed") but with the numerical aperture.

The former is to be found in table 1. With the aid of numerical aperture A the resolving power is calculated according to the equation

$$d = \frac{\lambda}{2A}$$

(d = least resolvable distance between two details in the object,
λ = wavelength of the light (for daylight approx. 0.0005 mm)).

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