

K2 IND

CONFOCAL SCANNING OPTICAL MICROSCOPE ATTACHMENT

USER'S GUIDE
MANUAL NUMBER 600-00002-01



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K2 Industrial Optics Module Guide

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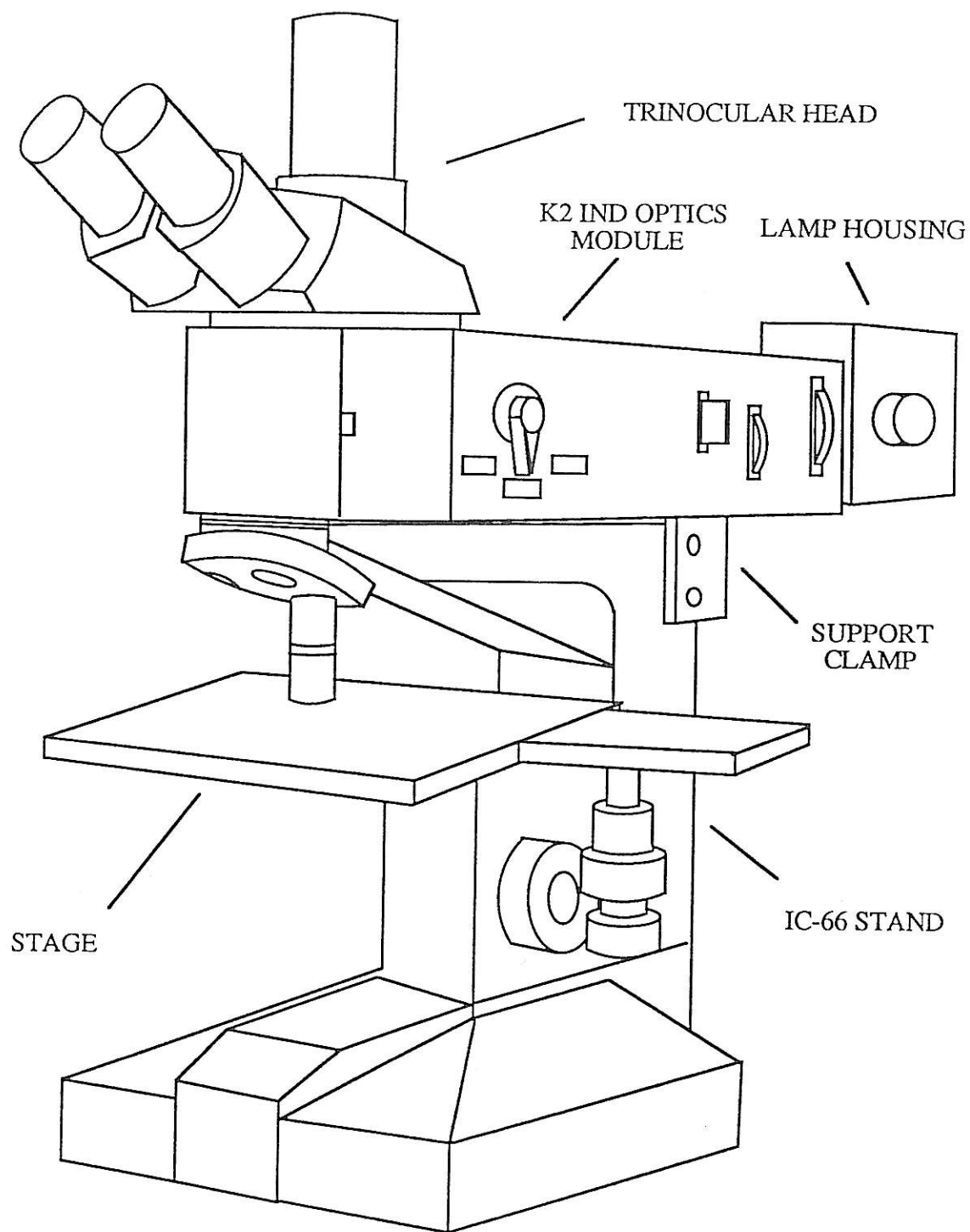


Figure 1 - K2 IND as mounted on IC-66

K2 Industrial Optical Module

User's Guide

1.0 GENERAL DESCRIPTION

The K2 Industrial (K2 IND) is an attachment module for the standard industrial microscope, which converts the standard microscope to a real-time confocal scanning microscope. It allows imaging of extremely thin layers of structure within an object, thus producing images with outstanding clarity and contrast. The K2 IND operates with a conventional white light source, producing images in full color; it can also use monochromatic illumination by manually switching in an optical narrow band filter built in the module. All the advantages of the K2 IND can be obtained with virtually the same simplicity in operation as a standard microscope.

The K2 IND can be either operated as a stand-alone system with the images viewed through eyepieces as shown in Figure 1, or interfaced with a video camera and a computer system for image processing and measurement. An optional Focus Finder unit can be connected to the module and the microscope stand to offer the user a convenient method for locating the focal plane automatically while in the confocal mode. The user may also adjust the fine focus position remotely, using a Trackball positioning device.

This manual contains the specifications, configuration, installation and operation of the K2 IND optics module.

2.0 SPECIFICATIONS

Imaging Modes:	Brightfield
	Confocal, 25 μ m (read Appendix)
	Confocal, 45 μ m (read Appendix)
Magnification (module):	2X for Nikon IC-66
	1.4 X for Leitz Ergolux
Field of View:	20 mm at the eyepiece
Objective Lens Correction:	210 mm for Nikon IC-66
	Infinity for Leitz Ergolux
Light Source:	100W mercury arc lamp
	75W' xenon arc lamp (optional)
	100W tungsten halogen lamp (optional)

Illumination Spectrum:	White light (400 - 730 nm) Green light (center wavelength 546 nm, width 10 nm) Blue light (center wavelength 436 nm, width 10 nm)
Illumination Control:	Five-position filter wheel Aperture selector Field diaphragm
Dimension:	Width 6" Height 4" Length 16"
Weight:	20 lbs
Electrical:	12 V AC, 400 mA

3.0 CONFIGURATION

1. K2IND (Ergolux version) P/N 012-00010-AA consisting of:
 - A. Optics module, including microscope modifications and the positioning plate.
 - B. Accessory kit, including the manual, 12V AC transformer, tube lens assembly, shipping materials.
 - C. Options: Focus Finder, including microscope conversion kit, electronics controller, keypad and cables.
2. K2IND (IC-66 version) P/N 012-00010-AB consisting of:
 - A. Optics module including the rear support clamp.
 - B. Accessory kit, including the manual, 12V AC transformer and shipping materials.
 - C. Options: Focus Finder, including microscope conversion kit, electronics controller, keypad and cables.

4.0 DESCRIPTION OF OPERATING CONTROLS

There are five controls on the K2IND module as shown in Figure 2

- 1) Imaging Mode Selector
- 2) Aperture Selector
- 3) Filter Wheel
- 4) Field Diaphragm
- 5) Transfer Lens Adjustment Screw (not shown)

These controls have the following functions :

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These controls have the following functions :

Imaging Mode Selector: This lever has three positions: BF, CF1 and CF2

Position "BF" : Brightfield mode

Position "CF1" : Confocal mode, 45 micron pinhole

Position "CF2" : Confocal mode, 25 micron pinhole

Aperture Selector: There are five precision apertures mounted on the slider. The aperture diameter for each slider position is:

Position "1" : 1.0 mm

Position "2" : 1.5 mm

Position "3" : 2.5 mm

Position "4" : 4.0 mm

Position "5" : Open

Filter Wheel: The filter wheel has five filter positions:

Position "1" : Open

Position "2" : 25% neutral-density filter

Position "3" : 10% neutral-density filter

Position "4" : Green narrow band filter at 546 nm

Position "5" : Blue narrow band filter at 436 nm

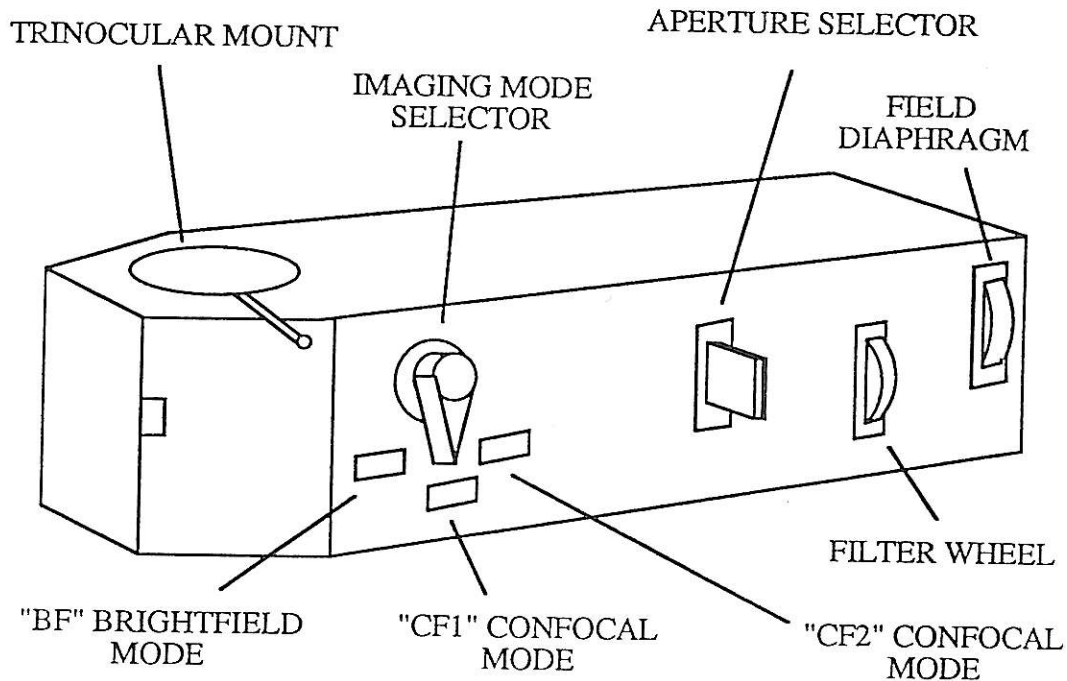


Figure 2 - K2 IND optics module

Field Diaphragm: This diaphragm controls the illumination area in the field of view.

Transfer Lens Adjustment: This screw is located on the left side cover and covered by a plastic plug. It focuses the intermediate image plane (disk) to the eyepieces. A proper focus plane should be checked after transportation of the module.

5.0 INSTALLATION AND ALIGNMENT

- 1) Install the positioning plate (for Leitz Ergolux) or rear support clamp (for Nikon IC-66) to the microscope stand as shown in Figure 1.
- 2) For the Leitz Ergolux only: install the tube lens assembly into the microscope stand.

- 3) Put the K2 IND optics module on the microscope stand.

Important : Make sure the K2 IND sits flat on the bino-mount of the microscope stand. Improper setup will cause image flickering, vibration and degradation !!!

- 4) Attach the microscope binocular (or trinocular) head on the K2 IND module.

5.1 ILLUMINATOR ALIGNMENT

The procedure is slightly different for the Leitz and the Nikon lamp housings. Please find out what kind of lamp housing you are using and read the corresponding instruction manual.

A. For Leitz 103Z Lamp Housing

- 1) Fasten the lamp housing to the K2 IND module, then turn on the power. Wait a few minutes for the bulb to warm up if you are using an arc lamp.
- 2) Position the centering aid of the lamp housing in the light path. Adjust the collector lens control, the lamp height control and horizontal control to focus and center the direct image of the source (filament or arc) to the cross lines on the centering aid. Remove the centering aid out of the light path.
- 3) Set the imaging mode selector to position "BF", the aperture selector and filter wheel to position "1", and the field diaphragm to the open position. Focus the microscope to a flat object such as mirrors and silicon wafers.
- 4) Adjust the lamp height control and horizontal control to center the illumination spot in the field of view. Then adjust the collector controls to obtain the best image.
- 5) Use the centering aid to overlap the mirror image of the source with the direct image by adjusting only the back reflector controls to maximize the image intensity.

- 6) Close the field diaphragm to the minimum opening without causing interference in the image.

B. For Nikon Lamp Housing

- 1) Remove the lamp housing from the module and turn on the power. Wait a few minutes for the bulb to warm up if you are using an arc lamp.
Warning: Do not direct the light to the human eyes !
- 2) Direct the light to a dark surface and roughly collimate and center the light. Then fasten the lamp to the module.
- 3) Set the imaging mode selector to position "BF", the aperture selector and filter wheel to position "1", and the field diaphragm to the open position. Focus the microscope to a flat object such as a mirror or a blank silicon wafer.
- 4) Adjust the lamp height control and horizontal control to center the illumination spot in the field of view. Then adjust the collector controls to obtain the best image.
- 5) Remove the lamp from the module. Direct the light to a dark object and adjust the back reflector controls to overlap the light reflected from the mirror with the direct light. Then through the eyepieces, fine adjust the back reflector controls to maximize the image intensity.
- 6) Close the field diaphragm to the minimum opening without causing interference in the image.

5.2 TRANSFER LENS ADJUSTMENT:

- 1) Align the illuminator following the illuminator alignment procedure.
- 2) Set the imaging mode selector to position "CF1". Stop the disk by turning off the power to the module.
- 3) Insert a 10X eyepiece with a reticle into the tube.
- 4) Adjust the focus knob on the microscope to maximize the image intensity from a reflective sample in the eyepieces.
- 5) Use a screwdriver to turn the Transfer lens adjustment screw until the pinholes in the stationary disk are clearly in focus simultaneously with the reticle in the eyepiece.

6.0 K2 INDUSTRIAL ELECTRONICS

6.1 OVERVIEW

All electronics components are contained in the K2 IND optics module except for the wall-mounted power transformer.

Provision for an optional Video Camera is included. When the camera is used, the rotating disk is synchronized with the TV vertical frame rate; otherwise, the disk is synchronized to the AC line frequency.

The additional electronics required to support the optional Focus Finder controller is included in the standard optics module.

6.2 INSTALLATION

Figure 3 is a block diagram of the configuration when in use.

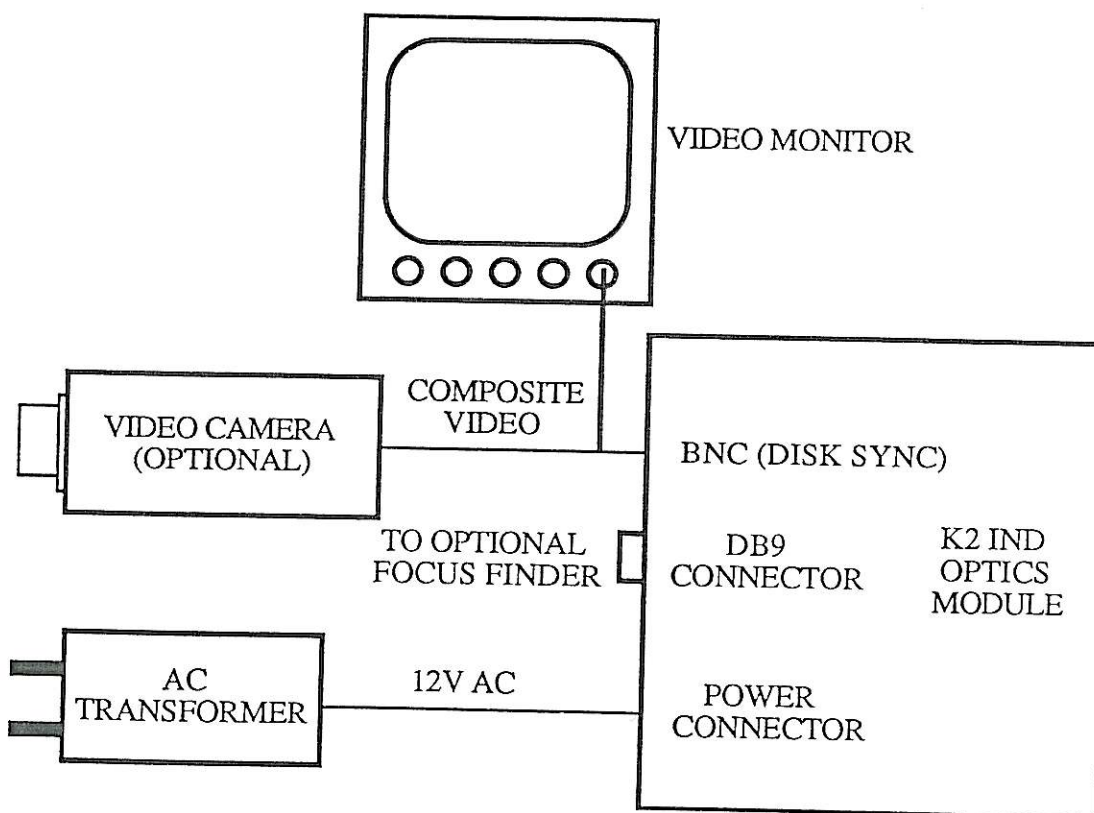


Figure 3 - K2 IND electronics interface

To complete the electronics installation, plug the wall transformer output lead into the power connector at the rear of the optics module (see Figure 4 for backplate connections). Plug the transformer into any 115V 60 Hz outlet. The unit will be powered immediately; no power switch is provided.

If a video camera is used, use a BNC TEE connector and coax cable to connect the composite video from the camera to the BNC connector at the rear of the module. When the camera is ON and attached to the unit, the disk will synchronized to the TV vertical frame rate.

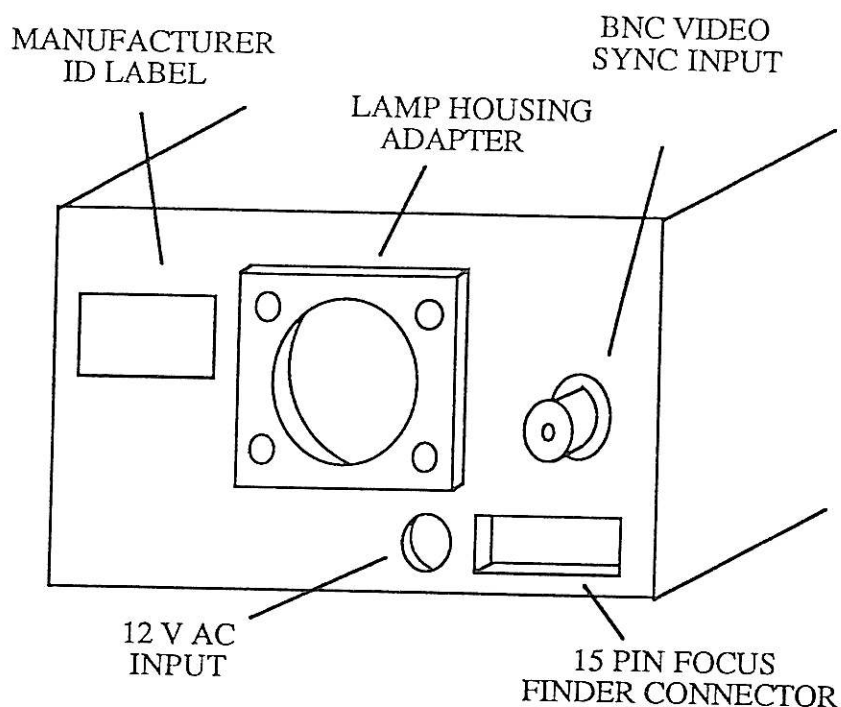


Figure 4 - K2 IND backplate connections

6.3 DISK SYNCHRONIZATION

The confocal disk rotation rate is synchronized with either the line frequency or the video vertical sync signal. This feature works automatically; if a composite video signal is present at the BNC at the rear of the attachment, the disk will automatically sync to this signal. Otherwise, the line frequency is used.

6.4 FOCUS FINDER

The electronics required to support the Focus Finder Option is included in the standard optics module. This includes the photo sensor board and the logic to support the Focus Finder function.

6.5 SERVICE AND ADJUSTMENTS

The location of the internal circuit boards are shown in Figure 5. However no user serviceable elements are included and there are no user adjustments required.

6.6 ALTERNATE POWER SOURCES

The attachment operates from 12V AC, 50/60 Hz. If other line voltages are present, use an appropriate wall transformer for the local conditions.

The transformer must be rated for 12V AC, and provide at least 400 mA.

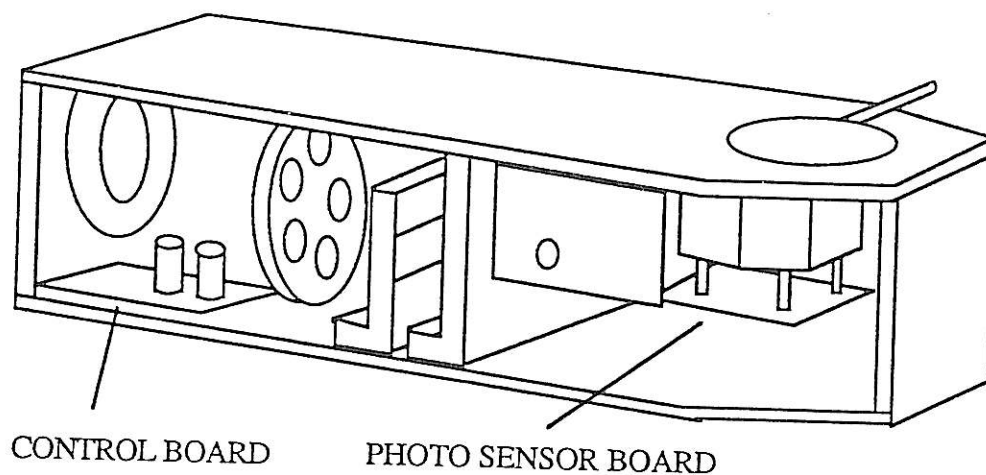


Figure 5 - Circuit board locations

APPENDIX: OPERATION PRICIPLES

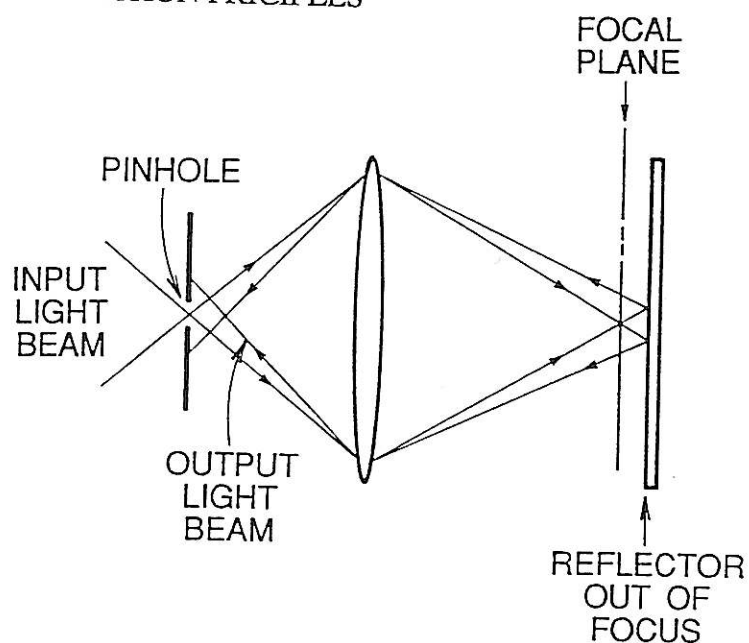


Figure 6 - Schematic illustration of imaging in a confocal microscope

The principle of the confocal scanning optical microscope is schematically shown in Figure 6. Light passing through a pinhole, acting as a point source, is focused by an objective lens to a point on the object. If the object is in the focal plane, the light reflected from the object is refocused at the pinhole and passes through it with maximum intensity. Otherwise, the reflected light is partially defocused at the pinhole and most of it will be blocked. The amount of light passing through the pinhole is strongly dependent on the axial position of the object. Only the light reflected from a structure near the focal plane can pass through the pinhole to produce an image. Therefore, the confocal microscope has excellent depth resolution, which can be approximately expressed as $\Delta z(3\text{dB}) = 0.45\lambda/n(1 - \cos\theta_0)$ where λ is the optical wavelength, n is the refractive index of the objective working media, and $n \sin\theta_0$ is the numerical aperture of the lens. For a typical 0.9 N.A. dry objective, the theoretical depth of focus is $0.45 \mu\text{m}$ at 546 nm . Figure 7 compares the theoretical depth response curve with a measured curve using a Leitz 125X0.8 objective at 546 nm . Since in a confocal microscope, the light passes through the objective lens twice, its point spread function is the square of that of a standard microscope. The transverse resolution of the confocal microscope is slightly higher (by about 30%) than that of the standard microscope using the same objective lens.

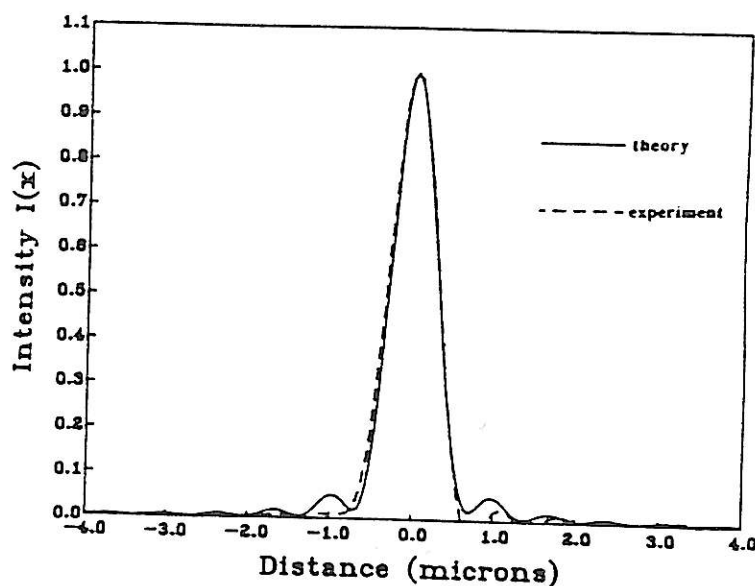


Figure 7 - Plots of theoretically calculated and experimentally measured depth response curves for 125X0.8N.A. Leitz objective lens at $\lambda = 546 \text{ nm}$ with $25 \mu\text{m}$ pinholes.

To generate a real-time confocal image of the sample, the K2 IND uses a rotating pinhole disk (called Nipkow disk) to scan multiple spots over the sample (shown in Figure 8). The disk is made from chromium coated fused-silica plate and contains a number of pinholes arranged in multiple spiral patterns. The pinholes are separated so their interaction is negligible. Rotating the disk causes the spiral patterns to scan the entire object forming a

complete image. The disk has two sets of pinholes arranged in two circular bands on the disk. The inner band is patterned with pinholes of 25 microns in diameter and has a transmission of 1%, while the outer band has larger pinholes, 45 microns in diameter with a slightly higher transmission of 2%.

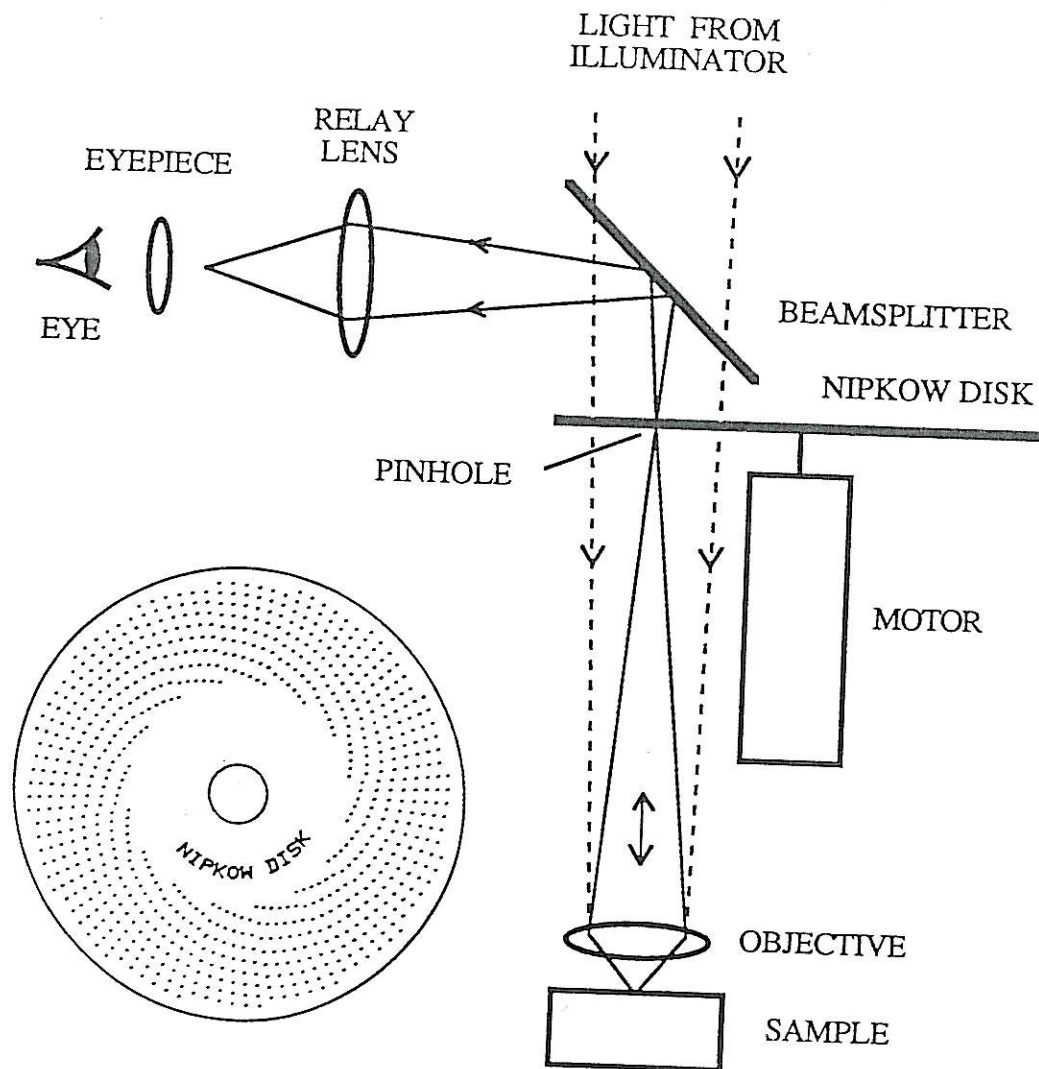


Figure 8 - Optical schematic of K2 IND and the Nipkow disk

The disk has two positions. In the position 1, the disk is out of the optical path. In this position the microscope functions like a standard microscope. In the second and third positions, the outer and inner bands are in the optical path respectively. Both positions provide confocal imaging capability. The outer zone produces brighter images with some what reduced depth discrimination. The inner zone produces images with maximum depth discrimination but weaker image intensity.