



# OTKBFM

## Back Focal Plane Detection Module for OTKB(/M)

### User Guide



















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## Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

## Chapter 2 Safety

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.



### WARNING



**This unit must not be operated in explosive environments.**



### CAUTION



**Make sure the fuse setting at the back of the laser diode driver and temperature controller are appropriate for your region. Failure to do this will result in damage to the controllers. Set TEC and max LD current parameters according to the specifications of the trapping laser diode before operating the Optical Trapping Kit. Failure to do so may result in damage of trapping laser diode. Also refer to the manual for the white light source current driver. Failure to do this may result in damage to the LED.**



### WARNING



**Latex gloves should be worn to prevent oil from fingers from reaching all optical surfaces. Make sure you use appropriate laser safety glasses during operation.**



### WARNING



**Avoid Exposure – ASE and laser radiation emitted from apertures.  
Never look directly in to beam.**

## Chapter 3 Introduction

The Back Focal Plane Detection module is an add-on for Thorlabs' modular tweezer system, OTKB(/M). It basically adds a quadrant detector module to the setup and includes the required optic to image the backaperture of the condenser onto the detector. Two strain gauge controllers and the detector read out controller are included as well.

This module is designed for users who wish to use their own data acquisition hardware and develop their own software code.



**Figure 1** OTKBFM Back Focal Plane Detection Module. The three controller cubes include are two strain gauge controllers and one detector controller.

Data Acquisition hardware and Software Analysis is not included in this package. Thorlabs' OTKBFM-CAL Module can be combined with this module to add those two elements. Please refer to the Thorlabs web page for additional details.

If you have any custom integration setup questions, please contact our technical support department ([techsupport@thorlabs.com](mailto:techsupport@thorlabs.com)).

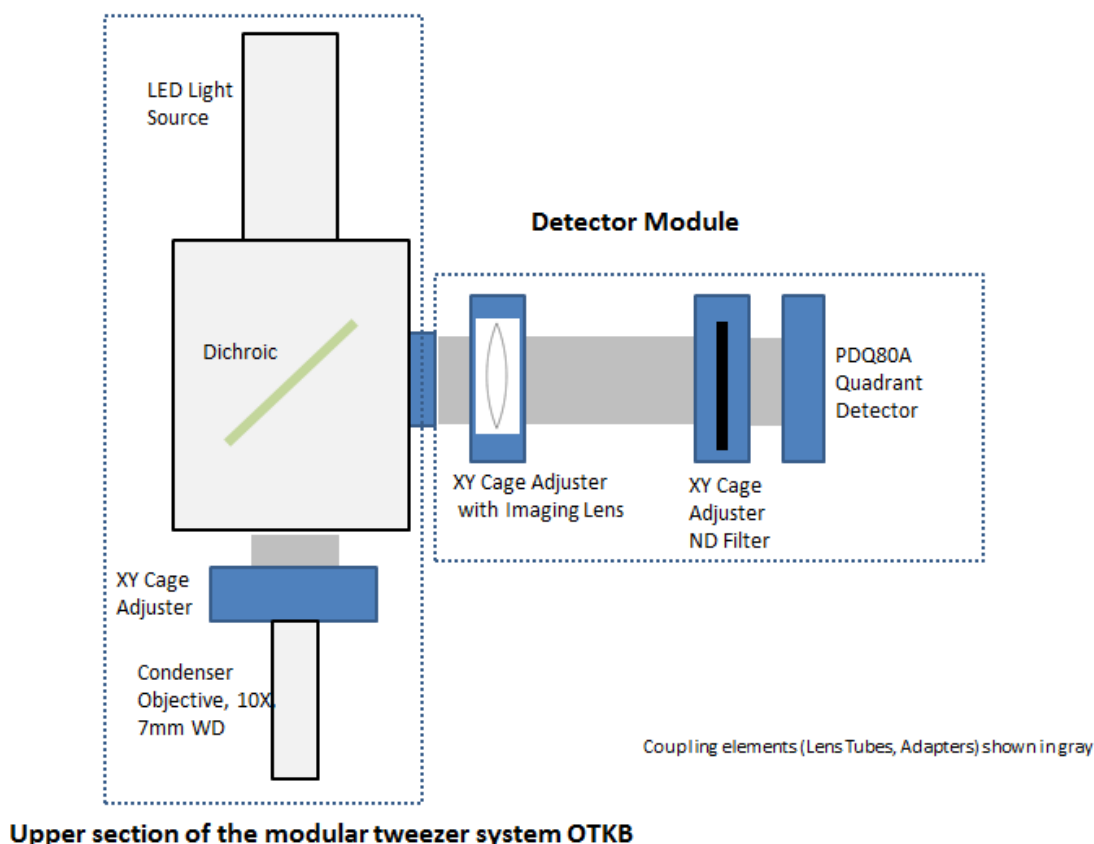
## Chapter 4 Optical Force Measurement Module

The OTKBFM module contains the components that can be used to add a quadrant detector to the modular tweezer system OTKB(/M).

By placing the Position Sensing Detector (PSD) in a plane conjugate to the back focal plane of the condenser, the signal generated by the QPD is sensitive to the relative displacement of the trapped particle from the laser focus spot position. As a result the output of the detector can be used to determine the stiffness, and force of the optical trap. The detector module is connected to the cage cube above the condenser. A KPA101 Kinesis® Auto Aligner and two KSG101 Kinesis Strain Gauge Readers are the main components included in this module. For high bandwidth measurements the QPD signal can be read out from the controller cube directly via a DAQ card (not included).

Figure 2 shows a schematic of the detector module. The lens which is used to image the backfocal plane of the condenser onto the detector has a focal length 40 mm, Thorlabs item # LB1027-B. It is mounted in one of the two cage XY adjusters as shown in figure 2. Its relative position with respect to the detector can be therefore be adjusted in order to center the laser spot on the detector.

In addition an ND filter is mounted in the second cage XY adapter. This filter, Thorlabs part number NE06B, has an optical density of 0.6 and is used to make sure that the detector will not saturate.



**Figure 2** Schematic showing the OTKBFM detector module connected to the left side, vertical segment of modular tweezer setup OTKB.

## Chapter 5 Setup and Alignment

This section assumes that the user has purchased a modular tweezers system OTKB(/M) to which the backfocal plane detection module will be attached.

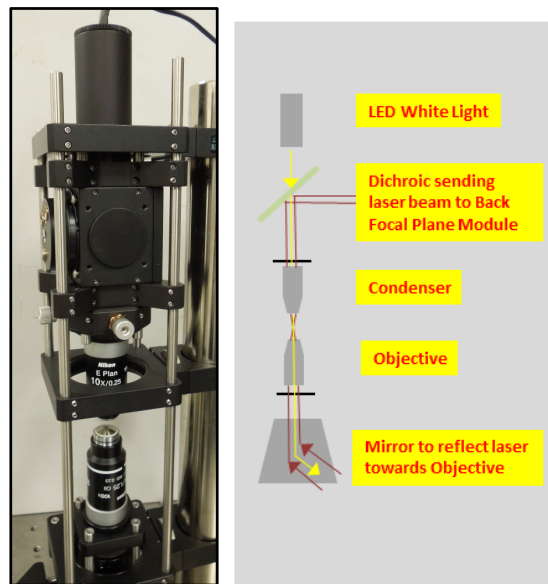


### CAUTION



**Please observe proper laser safety procedures. IR laser beams are particularly dangerous because they cannot be seen. Always wear the appropriate type of laser glasses (not included) when working with laser beams.**

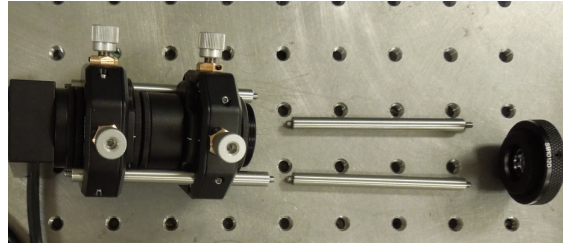
The OTKBFM detection module monitors the laser beam after it is collimated by the condenser lens. As shown in Figure 3 the laser beam will be focused by the objective, create the optical trap in the sample plane, and afterwards it will be collimated by the condenser. A dichroic optic is positioned above the condenser lens (part included with modular tweezer setup OTKB), which reflects the beam towards the side and out of the vertical path. In the first step the beam is aligned such that it is centered relative to the detector cage system segment.



**Figure 3** *Left Side, vertical segment of modular tweezer setup OTKB; Right side, schematic of vertical segment showing position of LED, Dichroic, Condenser and Objective*

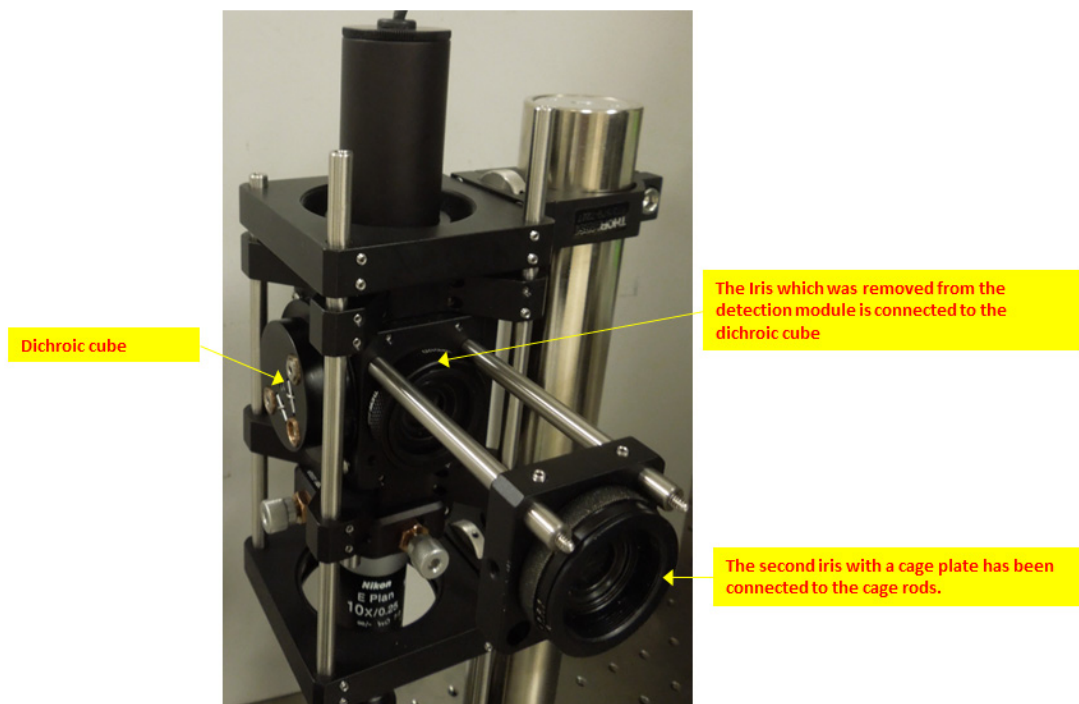
- 1) If the objective and condenser are not already aligned with respect to each other, use the visible LED light source to align them. For this connect the LED to its power supply and monitor the camera image on the screen. Loosen the cage plate which holds the objective and move the assembly up and down until you see a maximum brightness on the camera image. No sample needs to be present during this step. When the position is found, tighten the screws which clamp the cage plate with the objective in place. Use the XY adjuster to which the condenser is attached to further maximize the brightness on the camera image. The light spot on the surface of the objective lense should be centered now.
- 2) Remove the dichroic and white light LED temporarily and use an IR viewing card to check if the laser beam is collimated. Check the beam at the exist where the LED source usually is mounted and move the card vertically upwards. The beam should have a diameter of 3 mm to 5 mm over several centimeter of vertical travel. If this is not the case, adjust the objective to condenser distance. Only small adjustments are needed at this point. When done, put the dichroic and LED back in place. The correct dichroic orientation will be set at step 5.

- 3) Disconnect the iris and two of the four cage rods from the detector module as shown in Figure 2.



**Figure 4** The iris and two cage rods have been removed from the detector module.

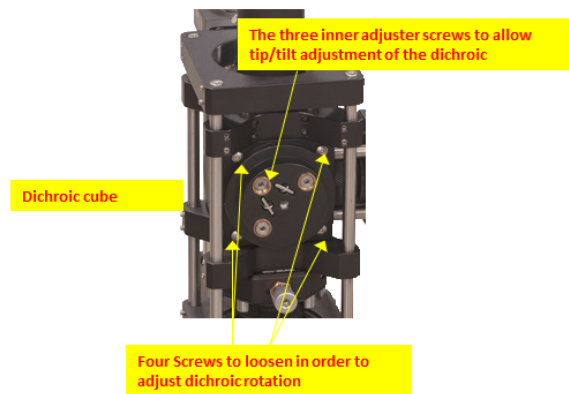
- 4) On the cage system cube which holds the dichroic remove the cap where the detector module will be attached and connect the iris and two cage rods as shown in Figure 3.



**Figure 5** The iris and two cage rods have been removed from the detector module and connected to the dichroic cage mount. In addition a second cage plate with Iris (included in OTKBFM module) as been connected to the cage rods.

- 5) Loosen the four screws which hold the dichroic optic in place and rotate the platform on which the dichroic sits. While doing this hold an IR viewing card in front of the first iris in the cage segment which was attached in the previous step. At this position the viewing card is located between the two iris and the iris connected to the dichroic should be about half way open. Slowly rotate the dichroic a full 360° while looking at the viewing card and determine at which orientation the brightest spot is found.





**Figure 6 Adjustments on the dichroic cube.**

- 6) Switch the viewing card to a position after the second iris. With the second iris about half way open keep adjusting the dichroic orientation until the beam goes through both irises while step by step closing down the second opening aperture of the second iris.
- 7) Remove the cage plate with the iris which is just used during alignment. Remove the iris connected to the cage cube and connect it again to the detector module. Loosen the clamping screws on the two XY cage adjusters which clamp the cage rods to the XY adjusters. These are the two cage rods which are still connected to the detector module. That way when you slide the module onto the rods which are already connected to the cage cube you can rotate the detector module rods and thread them into the cage cube.
- 8) Connect the detector module by sliding it over the two cage rods which are already connected to the dichroic cube. Rotate the other two cage rods so that they thread into the dichroic cube as well and tighten the clamping screws which clamp the XY adjusters to the cage rods.

For optimum results, it is advisable to keep the power on the quadrant detector between 250  $\mu\text{W}$  and 1 mW. For reference, when we use the standard OTKB laser the following power levels are typically measured in front the ND filter in the detector module:

100 mA gives 553  $\mu\text{W}$ ,  
 150 mA gives 1.6 mW,  
 200 mA gives 2.7 mW,  
 250 mA gives 3.8 mW,  
 300 mA gives 4.9 mW.

After connecting the detector cable to the KPA101 Kinesis PSD Controller you can start reading out the laser spot position via the APT User software. The software is included with using the included software medium or by downloading the package from the Thorlabs webpage, [www.thorlabs.com](http://www.thorlabs.com). It can be found in the section 'Services' – 'Downloads' – 'Motion Controllers' – 'Servo, Stepper, and Closed-Loop Piezo Controllers'.

The XY cage adjusters in the detector module can be used to adjust the laser in the center of the detector module. For fast position read-out it is recommended to read the position signal directly via the SMA connectors on the KPA101 controller cube by connecting them to the analog input of a data acquisition card. An SMA-BNC cable (not included) can be useful for this, e.g. Thorlabs item # CA2812.

Alternatively the force calibration module, OTKBFM-CAL, can be added which adds data acquisition and analysis hardware as well as software capabilities.



**Figure 7** Backside of the KPA101 Quadrant Detector Cube showing the SMA connections and the connector for the detector.

## Chapter 6 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



**Wheelie Bin Logo**

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

### 6.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### 6.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

## Chapter 7 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at [www.thorlabs.com/contact](http://www.thorlabs.com/contact) for our most up-to-date contact information.



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