Reflecting Objectives
User Guide X15 NA0.28, X15 NA0.50

Introduction

Reflecting objectives from Beck Optronic Solutions build on C. R. Burch's 1947 demonstration that a precisely designed two-mirror system can eliminate spherical aberration, coma, and astigmatism. The theory also shows that adjusting the mirror separation allows the objective to maintain optimal performance across different tube lengths and cover-glass thicknesses. These two models are factory-set only and are normally configured for a 160 mm tube length and a 0.17 mm cover slip, unless alternative values were specified at purchase.

On receiving your objective…

When you receive the objective, remove it from its box and inspect it carefully for any signs of transit damage. Confirm that the adjustment keys and the silverpoint slide are included (5001, X15 NA 0.28 model only).

Mounting the Objective

Beck Optronic Solutions reflecting objectives use a standard Royal Microscopical Society thread (0.8" x 36TPI Whitworth). Screw the objective firmly into the microscope or mounting plate.

The large scalloped mounting ring contains six small set screws (A). Loosening these slightly allows you to rotate the objective body to achieve the desired orientation—for example, positioning the spiders or, on the X15 NA 0.28 model, bringing the centering adjustment screws (B) into a more convenient location. Re-tighten the screws once the orientation is set.

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Mirror Centering Adjustment

In this type of mirror system, image quality is highly sensitive to small centering errors of the secondary mirror.

The X15 NA 0.28 model allows user adjustment to remove residual centering error if point images show asymmetry. A silverpoint slide is provided for this purpose: a metallised slide containing numerous pinholes between 0.5 and 5 µm. When the objective is correctly adjusted and focused, these pinholes should appear as perfect Airy discs with two or three diffraction rings.

Mount the slide, illuminate it in transmission, focus, and locate an area with small pinholes. Use the two Allen keys to adjust the secondary mirror. A second pair of adjustment holes, positioned at right angles to the first, allows correction in both x and y directions. Ensure all screws are tightened after adjustment.

The goal is to eliminate coma—an asymmetric, comet-like distortion—so that each point image is perfectly circular, with continuous diffraction rings and identical appearance on either side of best focus. A detailed procedure with example images is available in *Aligning a Beck Optronic Solutions Reflecting Objective* on our website: www.reflectingobjectives.com.

Centering the Optics

The X15 NA 0.5 reflecting objective is supplied fully adjusted—tube length, cover-slip thickness, and centering are all set and locked to prevent the need for user realignment. In rare cases, such as after a significant impact, re-adjustment may be required. The objective can be returned to Beck Optronic Solutions for recalibration, but the main body shell is now left without Loctite so that users may access the adjustment screws if necessary. Unscrewing the body shell reveals the centering screws arranged as shown in the sketch, along with four additional lock screws on the lower face. These lock screws must be loosened slightly before making adjustments and tightened again before replacing the body shell.

A key advantage of the reflecting objective is its complete absence of chromatic aberration. This allows you to perform accurate alignment in the visible region even if you cannot observe the image at other wavelengths, ensuring correct setup before integrating the objective into your system.

Specifications

	5001 x 15 NA0.28	5002 x 15 NA0.50
Focal Length	13.35 mm	13.41 mm
Magnification	X15	X15
Field of view at the object	1.2 mm diameter	1.2 mm diameter
Numerical aperture	0.28	0.50
% of central area obstructed	25%	21.5%
Working distance (approximate)	24.5 mm	23.2 mm
Mounting thread	RMS, 0.8” 36 T.P.I, BSW	

References

The first paper to show that a high NA, high magnification microscope objective could be made from 2 spherical mirrors is that of CR Burch – Proceedings of the Physical Society, 1947, Vol 59(1), 41-46-2.

There is an excellent paper by Seymour Rosin entitled “Inverse Cassegrainian Systems” Applied Optics Vol. 7, Issue 8, pp. 1483-1497 (1968). This paper develops the aberration theory and shows many variants of the 2-mirror system.