Freeing Spring-Loaded Tips And Cover-Slip Correction Collars Of Olympus LB Objectives

REVISION 3

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2	Added NDA educational objectives, SPlan brightfield objectives, and A / DPlan darkfield objectives	11-16-2018
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Introduction

The higher-power objectives on most microscopes incorporate a spring-loaded design, such that the objective tip is free to move up into the outer barrel of the objective if the tip ever crashes into the cover slip of the slide under observation. This feature exists to prevent damage to the exposed lower optics of the objective and to prevent damage to the fragile cover slip. After a collision occurs and the focus has been raised to the point where the objective is no longer in contact with the cover slip, the spring in the objective pushes the tip back out to its original position, and the objective, none the worse for wear, is ready for use again. Additionally, many apochromatic objectives contain an integral correction collar to compensate for the adverse effects on optical performance introduced when observing specimens mounted under a cover glass of non-standard thickness, or when mounted with a significant layer of mounting medium between the specimen and the cover glass.

After many years of service, it is relatively common with Olympus BH-2, CH-2, and CH30/40 microscopes for the retractable spring tips in the higher power objectives, or for the cover-slip correction collars in the apochromatic objectives, to become sluggish and sticky, due to the ingress of immersion oil and other contaminants into the respective mechanisms.

When retractable spring tips are affected in this way, the condition can get bad enough that if the spring-loaded tip ever hits the coverslip and gets depressed, it could fail to return to its normal position after the objective has once again cleared the cover slip, which will impair the parfocality and optical performance of the affected objective. Even if the tip re-extends to its normal position following a collision with the cover slip, the presence of oil and contaminants within the spring mechanism can cause the force required to depress the tip to be high enough such that the retractable tip can no longer be counted on to safely protect the optics or the cover slip. Similarly, when cover-slip correction collars are affected, the rotation of the collar can get stiff enough that the objective loosens from the nosepiece turret when the collar is rotated or can even get stiff enough that the collar cannot be rotated at all.

Scope of this Document

This document describes the proper procedures to disassemble, clean, and reassemble the spring-loaded tip-retraction mechanism and cover-slip correction collars in many of the LB (long barrel) objectives used on the Olympus BH-2, CH-2, and CH30/40 microscopes. Specific instructions are included to repair the following types of spring-loaded objectives:

- EA achromatic objectives for the educational market
- NDA achromatic objectives for the educational market
- A / DPlan / SPlan brightfield objectives (without iris diaphragm)
- A and DPlan darkfield objectives (with iris diaphragm)
- DPlan apochromatic objectives (with correction collar)

Safety Warnings and Disclaimers

The content of this document is provided for informational purposes only, with no expressed or implied warranties whatsoever, including, but not limited to, function, suitability, safety, accuracy, and completeness of information.

Tools Needed

The following tools are needed to complete the disassembly, cleaning, and reassembly of the spring-loaded tip-retraction mechanism and cover-slip correction collars of the various objectives in the Olympus LB line:

- Screwdriver, #00 Phillips (item 1 of **Appendix 2**)
- Screwdriver, 1.5mm slotted (items 3 and 5 of **Appendix 2**)
- Screwdriver, 2.0mm slotted (item 4 of **Appendix 2**)
- Rubber, silicon (item 2 of **Appendix 2**)

Supplies Needed

The following supplies are needed to complete the disassembly, cleaning, and reassembly of the spring-loaded tip-retraction mechanism and cover-slip correction collars of the various objectives in the Olympus LB line:

- Cleaning solvent (see **Recommended Solvents** section below)
- Cotton swabs
- Len-cleaning wipes, pre-moistened (item 7 of **Appendix 2**).
- Silicone-free grease (item 8 of **Appendix 2**)
- LocTite® thread-locking adhesive (item 9 of **Appendix 2**)

Recommended Solvents

Some type of cleaning solvent will be needed to remove any oil or other contaminants found within the retractable-tip mechanism. Solvents that can be used are acetone (commonly sold as fingernail polish remover), diethyl ether, heptane, hexane, mineral spirits, turpentine, and xylene. Of the solvents listed, acetone fingernail polish remover is available in most grocery or department stores. Look for a fingernail polish remover that is labeled as 100% acetone.

Safety Considerations with Solvents

Regardless of whichever solvent is chosen, make sure that adequate ventilation is present during the cleaning process, and that any necessary personal protective equipment is utilized to minimize exposure. Consult the

MSDS sheet before using any unfamiliar solvents. Many of the solvents listed above are flammable, and their vapors may represent an explosion hazard if mishandled. Whichever solvents are chosen, be sure to follow all manufacturer's instructions and safety precautions.

Solvent Compatibility with Parts and Finishes

Be extremely careful with whatever solvent you choose to use. Since many solvents will remove the painted text from the outer barrel of the objectives, be sure to not allow the solvent to contact the painted surface of the objective. Additionally, many solvents will attack the black, knurled-rubber grip ring used on many DPlan and SPlan objectives.

How to Contact the Author

Please direct any questions or comments regarding this document (or Olympus BH-2 microscopes in general) to Carl Hunsinger (carlh6902@gmail.com).

Maintenance Procedures and Applicability

Table 1 provides a listing of the various maintenance procedures included in this document, and the specific Olympus LB objectives to which these procedures are known to be applicable.

Objective Type	Specific Objective(s)	Applicable Section of Document
EA Educational	EA 40X - Dry EA 100X – Oil Immersion	**EA Educational Achromatic Objectives**
NDA Educational	NDA 40X - Dry NDA 100X – Oil Immersion	**NDA Educational Achromatic Objectives**
A Brightfield	A 20X - Dry A 40X - Dry A 60X - Dry A 100X – Oil Immersion	**Achromatic Brightfield Objectives**
DPlan Brightfield	DPlan 20X - Dry DPlan 40X - Dry DPlan 100X – Oil Immersion	**Achromatic Brightfield Objectives**
SPlan Brightfield	SPlan 20X - Dry SPlan 40X - Dry SPlan 100X – Oil Immersion	**Achromatic Brightfield Objectives**
A Darkfield	A 100X – Oil Immersion, with Iris	**Achromatic Objectives with Iris Diaphragms**
DPlan Darkfield	DPlan 50X – Oil Immersion, with Iris	**Achromatic Objectives with Iris Diaphragms**
DPlan Apochromatic	DPlan Apo 40X – Dry, with Correction Collar DPlan Apo 60X - Dry, with Correction Collar	**Apochromatic Objectives with Correction Collars**

Table 1 – Maintenance procedures for specific objective types

EA Educational Achromatic Objectives

This section describes the procedure for disassembling, cleaning, and reassembling the spring-loaded tip-retraction mechanism of an Olympus EA educational objective, using the EA 100X oil-immersion objective (see **Figure 1**) as an example.

Figure 1 – Olympus EA 100X oil-immersion objective

Remove the Rear-Aperture Stop

The first step is to remove the rear-aperture stop (see **Figure 2**) from the top of the objective.

Figure 2 – The rear-aperture stop on top of the objective

The rear-aperture stop can sometimes be removed by simply grasping it and turning it counter-clockwise to unscrew it from the outer barrel of the objective. Frequently, however, it is not possible to loosen the rear-aperture stop in this way, since there is not much of it sticking up to get a grip on. In these cases, loosen the rear-aperture stop from the objective by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop onto the rubber sheet, while turning the objective counter-clockwise to loosen it (see **Figure 3**).

Figure 3 – Loosen the rear-aperture stop on a rubber sheet

When the rear-aperture stop comes loose, unscrew and remove the rear-aperture stop from the outer barrel of the objective by hand (see **Figure 4**), being careful that the compressed extension spring beneath the rear-aperture stop does not shoot out and get lost when the rear-aperture stop is removed.

Figure 4 – Remove rear-aperture stop from objective barrel

Remove the Extension Spring

Grasp the extension spring and remove it from the rear opening of the outer objective barrel (see **Figure 5**).

Figure 5 – Remove the extension spring

Remove the Inner-Optics Retaining Screw

Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to loosen and remove the inner-optics retaining screw in the outer barrel of the objective. This screw retains the retractable inner-optics barrel within the outer barrel of the objective (see **Figure 6**).

Figure 6 – Remove the inner-optics retaining screw

Remove the Inner-Optics Barrel

Being careful to not touch the exposed lens in the tip of the inner-optics barrel, carefully push the tip of the inner-optics barrel up into the bore of the outer barrel of the objective until the top end of the inner-optics barrel protrudes from the top of the outer barrel of the objective (see **Figure 7**).

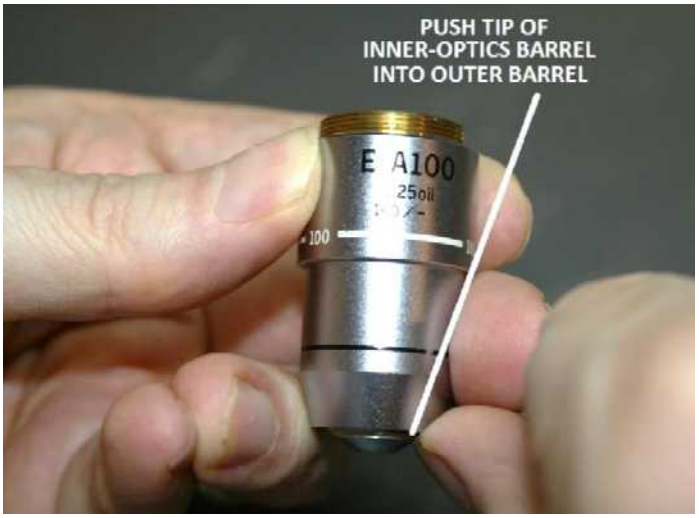

Figure 7 – Push objective tip up into the outer barrel

Grasp the protruding end of the inner-optics barrel at the top of the outer barrel of the objective and carefully withdraw the inner-optics barrel from the bore of the outer barrel (see **Figure 8**).

Figure 8 – Remove the inner-optics barrel

Clean the Inner Bore of the Outer Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the inner bore of the outer barrel of the objective (see **Figure 9**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the inner bore, leaving the inner bore scrupulously clean, otherwise the freedom of motion of the spring-loaded objective tip may be adversely affected.

Figure 9 – Clean the inner bore of the outer barrel

Clean the Outer Surface of the Inner-Optics Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the outer surface of the inner-optics barrel (see **Figure 10**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the outer surface, leaving the outer surface scrupulously clean, otherwise the freedom of motion of the spring-loaded tip may be adversely affected.

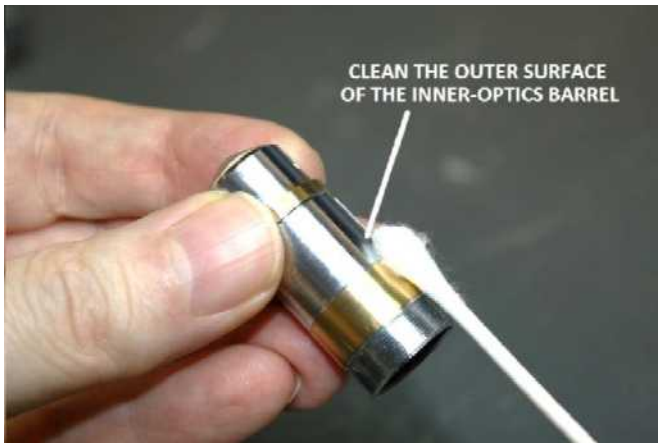

Figure 10 – Clean outer surface of the inner-optics barrel

Reinstall Inner-Optics Barrel into the Outer Barrel

Carefully insert the tip of the inner-optics barrel into the top of the outer barrel of the objective, and lower it into the outer barrel until the tip protrudes from the opposite end of the outer barrel (see **Figure 11**).

Figure 11 – Place inner-optics barrel into the outer barrel

Reinstall the Inner-Optics Retaining Screw

Look into the tapped hole in the side of the outer barrel of the objective (i.e., the hole for the inner-optics retaining screw) and carefully rotate the inner-optics barrel within the outer barrel until the slot on the inner-optics barrel aligns with the tapped hole in the outer barrel (see **Figure 12**).

Figure 12 – Align the inner slot with the tapped screw hole

Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to carefully reinstall the inner-optics retaining screw to secure the inner-optics barrel into the outer barrel of the objective (see **Figure 13**).

Figure 13 – Reinstall the inner-optics retaining screw

Test the Tip without the Extension Spring

Test the freedom of motion of the inner-optics barrel by holding the objective with the tip pointing downwards, and then press the tip up into the outer barrel of the objective (being careful to not touch the exposed lower lens while doing this) and release it. The tip should drop freely and without hesitation (see **Figure 14**). If the tip sticks or drops slowly, repeat the disassembly, cleaning, and reassembly procedure described above until the tip drops properly when tested in this manner.

Figure 14 – Press the tip up and allow it to drop

Reinstall the Extension Spring

Carefully place the extension spring into the rear opening of the outer barrel of the objective (see **Figure 15**).

Figure 15 – Reinstall the extension spring

Reinstall the Rear-Aperture Stop

Compress the extension spring with the rear-aperture stop and screw the rear-aperture stop into the inner threads in the top of the outer objective barrel (see **Figure 16**).

Figure 16 – Reinstall the rear-aperture stop

Tighten the rear-aperture stop by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop down onto the rubber sheet, while turning the objective clockwise (see **Figure 17**).

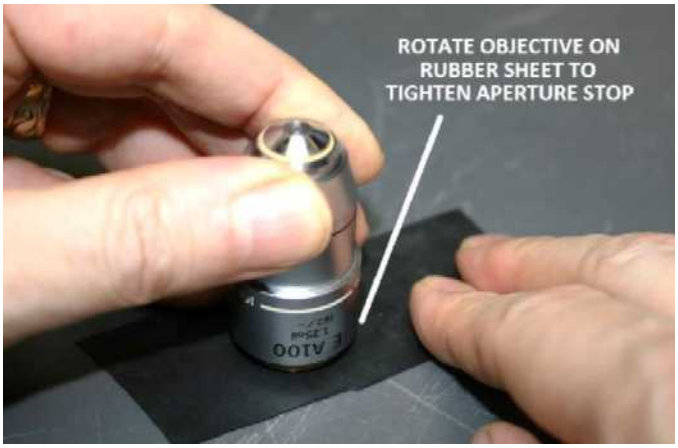

Figure 17 – Tighten rear-aperture stop on a rubber sheet

Test the Spring-Loaded Tip after Reassembly

Test the freedom of motion of the spring-loaded tip of the reassembled objective by pressing the tip into the bore of the outer barrel of the objective (be careful to not touch the lower lens while doing this). The tip should freely move into the outer barrel of the objective without any noticeable stickiness, binding or friction. Release the tip and verify that the tip re-extends to its original position without any hesitation (see **Figure 18**).

Figure 18 – Test the spring tip of the reassembled objective

Clean the Lower Objective Lens

Use a suitable pre-moistened lens wipe (item 7 of **Appendix 2**) to carefully clean the exposed lower lens in the retractable tip of the objective.

Return to Service

The EA 100X oil-immersion objective is now ready to provide many more years of trouble-free service (see **Figure 19**).

Figure 19 – EA 100X objective ready for service

Acknowledgements

Special thanks to Jerry Clement of J&H Microscope Services (Madison, WI) for his invaluable assistance with this section of this document.

NDA Educational Achromatic Objectives

This section describes the procedure for disassembling, cleaning, and reassembling the spring-loaded tip-retraction mechanism of an Olympus NDA educational objective, using the NDA 100X oil-immersion objective (see **Figure 20**) as an example.

Figure 20 – Olympus NDA 100X oil-immersion objective

Remove the Rear-Aperture Stop

The first step is to remove the rear-aperture stop (see **Figure 21**) from the top of the objective.

Figure 21 – The rear-aperture stop on top of the objective

The rear-aperture stop can sometimes be removed by simply grasping it and turning it counter-clockwise to unscrew it from the outer barrel of the objective. Frequently, however, it is not possible to loosen the rear-aperture stop in this way, since there is not much of it sticking up to get a grip on. In these cases, loosen the rear-aperture stop from the objective by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop onto the rubber sheet, while turning the objective counter-clockwise to loosen it (see **Figure 22**).

Figure 22 – Loosen the rear-aperture stop on a rubber sheet

When the rear-aperture stop comes loose, unscrew and remove the rear-aperture stop from the outer barrel of the objective by hand (see **Figure 23**), being careful that the compressed extension spring beneath the rear-aperture stop does not shoot out and get lost when the rear-aperture stop is removed.

Figure 23 – Remove rear-aperture stop from objective barrel

Remove the Extension Spring

Grasp the extension spring and remove it from the rear opening of the outer barrel of the objective (see **Figure 24**).

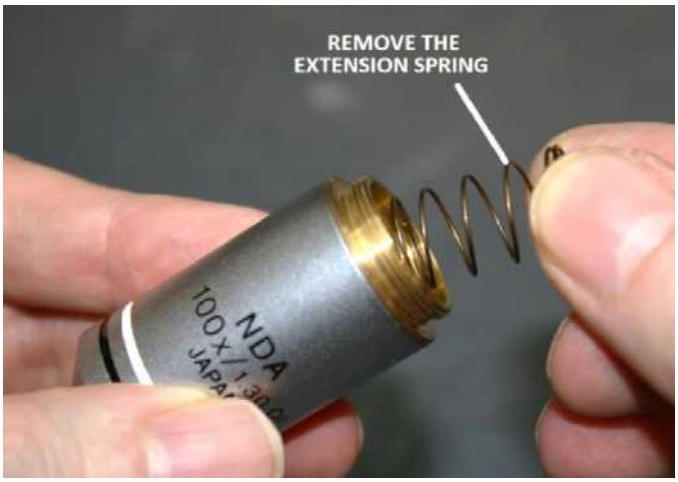

Figure 24 – Remove the extension spring

Remove the Inner-Optics Barrel

Being careful to not touch the exposed lens in the tip of the inner-optics barrel, carefully push the tip of the inner-optics barrel up into the bore of the outer barrel of the objective until the top end of the inner-optics barrel protrudes from the top of the outer barrel (see **Figure 25**).

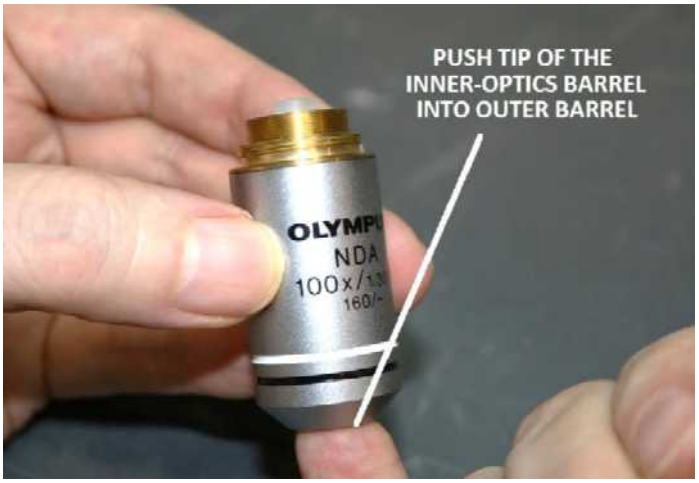

Figure 25 – Push objective tip up into the outer barrel

Grasp the protruding end of the inner-optics barrel at the top of the outer barrel of the objective and carefully withdraw the inner-optics barrel from the bore of the outer barrel (see **Figure 26**).

Figure 26 – Remove the inner-optics barrel

Clean the Inner Bore of the Outer Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the inner bore of the outer barrel of the objective (see **Figure 27**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the inner bore, leaving the inner bore scrupulously clean, otherwise the freedom of motion of the spring-loaded objective tip may be adversely affected.

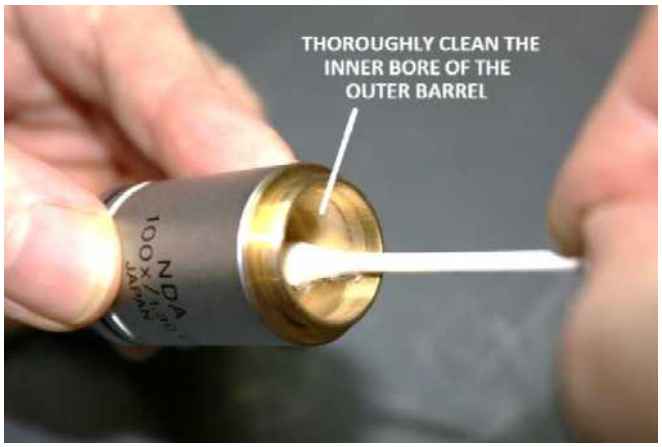

Figure 27 – Clean the inner bore of the outer barrel

Clean the Outer Surface of the Inner-Optics Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the outer surface of the inner-optics barrel (see **Figure 28**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the outer surface, leaving the outer surface scrupulously clean, otherwise the freedom of motion of the spring-loaded tip may be adversely affected.

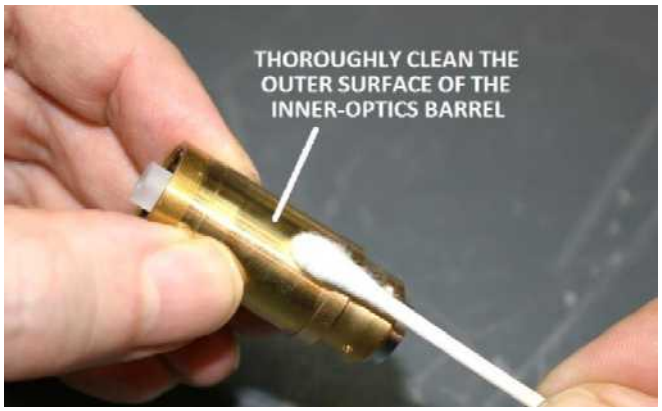

Figure 28 – Clean outer surface of the inner-optics barrel

Reinstall Inner-Optics Barrel into the Outer Barrel

Observe the inner bore of the outer barrel of the objective to identify the indexing stud (see **Figure 29**).

Figure 29 – Indexing stud on inner bore of the outer barrel

Carefully insert the tip of the inner-optics barrel into the top of the outer barrel of the objective, with the slot in the inner-optics barrel approximately aligned with the indexing stud on the inner bore of the outer barrel (see **Figure 30**).

Figure 30 – Insert tip with slot aligned with indexing stud

Lower the inner-optics barrel into the outer barrel of the objective as far as it will go. In the (unlikely) event that the tip of the inner-optics barrel protrudes from the bottom of the outer barrel, this means that the slot in the inner-optics barrel happened to be perfectly aligned with the indexing stud in the inner bore of the outer barrel, and the inner-optics barrel has fully seated in the outer barrel of the objective.

If the tip of the inner-optics barrel does not protrude from the outer barrel of the objective, gently grasp the protruding lens element at the top of the inner-optics barrel with a clean, dry optical tissue and rotate the inner-optics barrel a bit in both directions until the slot finds the indexing stud and the inner-optics barrel fully seats (see **Figure 31**).

Figure 31 – Seating the inner-optics barrel

Test the Tip without the Extension Spring

Test the freedom of motion of the inner-optics barrel by holding the objective with the tip pointing downwards, and then press the tip up into the outer barrel of the objective a bit, being careful to not touch the exposed lower lens. Do not press the tip too high into the outer barrel, otherwise the inner-optics barrel may lose indexing with the indexing stud in the inner bore of the outer barrel. If this happens, it will need to be re-aligned and re-seated per the previous step. Release the tip and verify that it drops freely and without hesitation (see **Figure 32**). If the tip sticks or drops slowly, repeat the disassembly, cleaning, and reassembly procedure described above until the tip drops properly when tested in this manner.

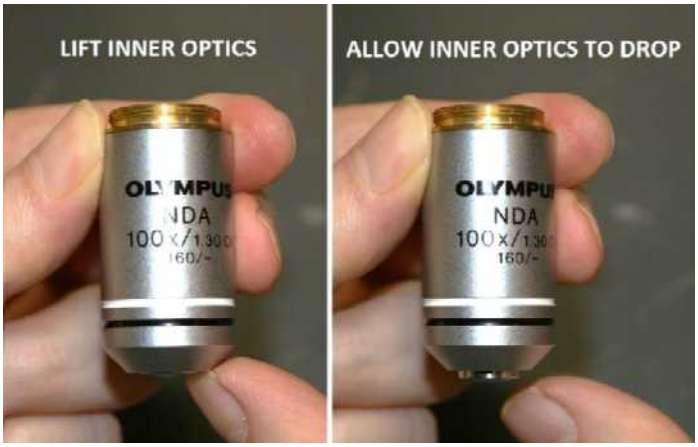

Figure 32 – Press the tip up and allow it to drop

Reinstall the Extension Spring

Carefully place the extension spring into the rear opening of the outer barrel of the objective (see **Figure 33**).

Figure 33 – Reinstall the extension spring

Reinstall the Rear-Aperture Stop

Compress the extension spring with the rear-aperture stop and screw the rear-aperture stop into the inner threads in the top of the outer barrel of the objective (see **Figure 34**).

Figure 34 – Reinstall the rear-aperture stop

Tighten the rear-aperture stop by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop down onto the rubber sheet, while turning the objective clockwise (see **Figure 35**).

Figure 35 – Tighten rear-aperture stop on a rubber sheet

Test the Spring-Loaded Tip after Reassembly

Test the freedom of motion of the spring-loaded tip of the reassembled objective by pressing the tip into the bore of the outer barrel of the objective (be careful to not touch the lower lens while doing this). The tip should freely move into the outer barrel of the objective without any noticeable stickiness, binding or friction. Release the tip and verify that the tip re-extends to its original position without any hesitation (see **Figure 36**).

Figure 36 – Test the spring tip of the reassembled objective

Clean the Lower Objective Lens

Use a suitable pre-moistened lens wipe (item 7 of **Appendix 2**) to carefully clean the exposed lower lens in the retractable tip of the objective.

Return to Service

The NDA 100X oil-immersion objective is now ready to provide many more years of trouble-free service (see **Figure 37**).

Figure 37 – NDA 100X objective ready for service

Achromatic Brightfield Objectives

This section describes the procedure for disassembling, cleaning, and reassembling the spring-loaded tip-retraction mechanism of an Olympus A, DPlan, or SPlan brightfield objective, using the DPlan 100X oil-immersion objective (see **Figure 38**) as an example.

Figure 38 – Olympus DPlan 100X oil-immersion objective

Remove the Knurled-Rubber Grip Ring

The black, knurled-rubber grip ring (which is present on the A, DPlan, and SPlan objective types without an iris diaphragm) must be removed from the outer barrel of the objective to gain access to the retaining screw that holds the spring-loaded inner-optics barrel in the outer barrel. Use a dental pick or similar tool (if necessary) to carefully lift the edge of the rubber grip ring and slide the rubber grip ring up and out of the groove into which it sits. Carefully remove the rubber grip ring by sliding it off the lower end of the objective (see **Figure 39**), being very careful to neither damage nor stretch the rubber grip ring in the process.

Figure 39 – Remove the knurled-rubber grip ring

Remove the Rear-Aperture Stop

The next step is to remove the rear-aperture stop (see **Figure 40**) from the top of the objective.

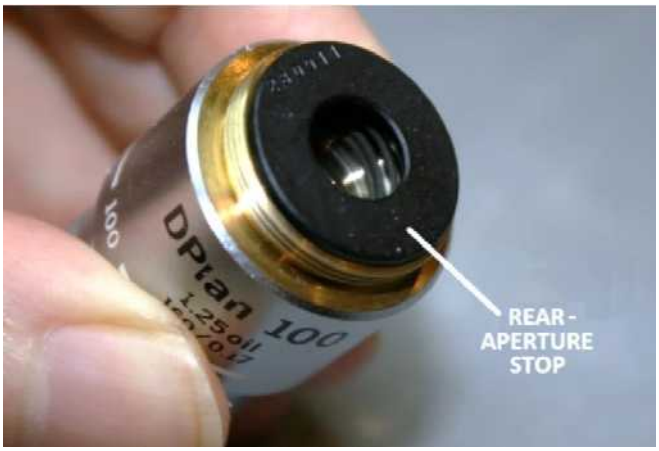

Figure 40 – The rear-aperture stop on top of the objective

The rear-aperture stop can sometimes be removed by simply grasping it and turning it counter-clockwise to unscrew it from the outer objective barrel. Frequently, however, it is not possible to loosen the rear-aperture stop in this way, since there is not much of it sticking up to get a grip on. In these cases, loosen the rear-aperture stop from the objective by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop onto the rubber sheet, while turning the objective counter-clockwise to loosen it (see **Figure 41**).

Figure 41 – Loosen the rear-aperture stop on a rubber sheet

When the rear-aperture stop comes loose, unscrew and remove the rear-aperture stop from the outer barrel of the objective by hand (see **Figure 42**), being careful that the compressed extension spring beneath the rear-aperture stop does not shoot out and get lost when the rear-aperture stop is removed.

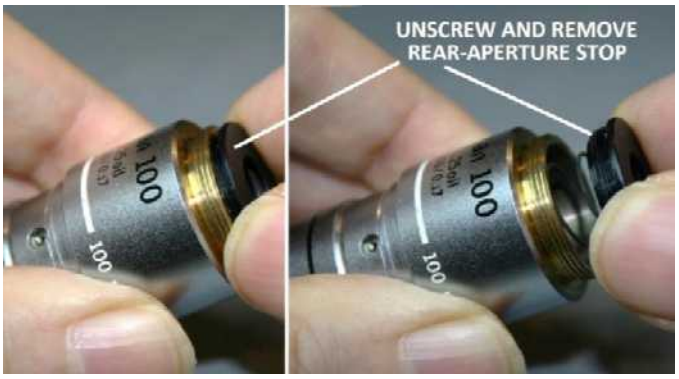

Figure 42 – Remove rear-aperture stop from objective barrel

Remove the Extension Spring

Grasp the extension spring and remove it from the rear opening of the outer barrel of the objective (see **Figure 43**).

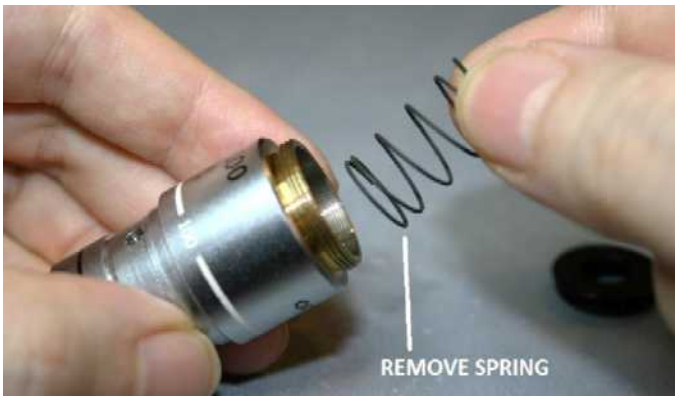

Figure 43 – Remove the extension spring

Remove the Inner-Optics Retaining Screw

Since the knurled-rubber grip ring has been removed, a small retaining screw will be visible in the groove in the outer barrel of the objective in which the rubber grip ring was positioned (see **Figure 44**). This small screw retains the spring-loaded, retractable inner-optics barrel within the outer objective barrel. Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to loosen and remove this retaining screw (see **Figure 45**).

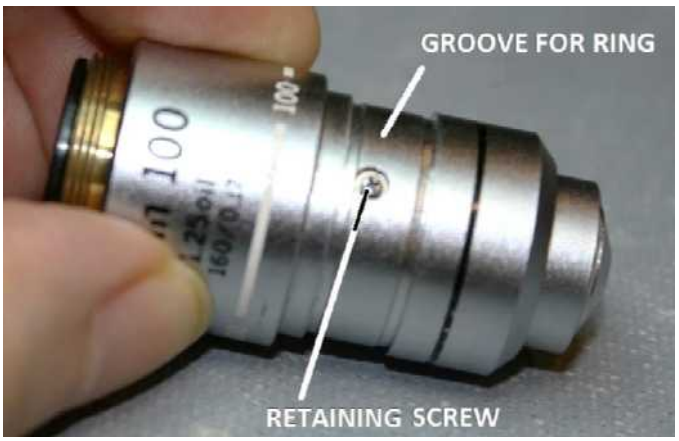

Figure 44 – A view of the inner-optics retaining screw

Figure 45 – Remove the inner-optics retaining screw

Remove the Inner-Optics Barrel

Being careful to not touch the exposed lens in the tip of the inner-optics barrel, carefully push the tip of the inner-optics barrel up into the bore of the outer barrel of the objective until the top end of the inner-optics barrel protrudes from the top of the outer barrel (see **Figure 46**).

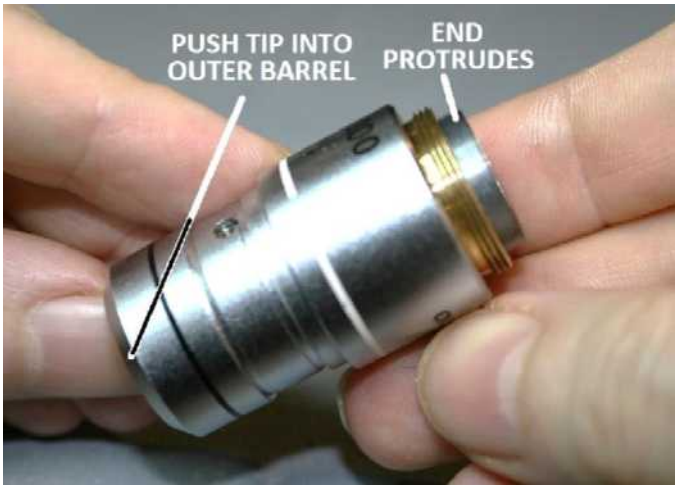

Figure 46 – Push objective tip up into the outer barrel

Grasp the protruding end of the inner-optics barrel at the top of the outer barrel of the objective and carefully withdraw the inner-optics barrel from the bore of the outer barrel (see **Figure 47** and **Figure 48**).

Figure 47 – Remove the inner-optics barrel

Figure 48 – Inner-optics barrel removed from outer barrel

Clean the Inner Bore of the Outer Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the inner bore of the outer barrel of the objective (see **Figure 49**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the inner bore, leaving the inner bore scrupulously clean, otherwise the freedom of motion of the spring-loaded objective tip may be adversely affected.

Figure 49 – Clean the inner bore of the outer barrel

Clean the Outer Surface of the Inner-Optics Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the outer surface of the inner-optics barrel (see **Figure 50**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the outer surface, leaving the outer surface scrupulously clean, otherwise the freedom of motion of the spring-loaded tip may be adversely affected.

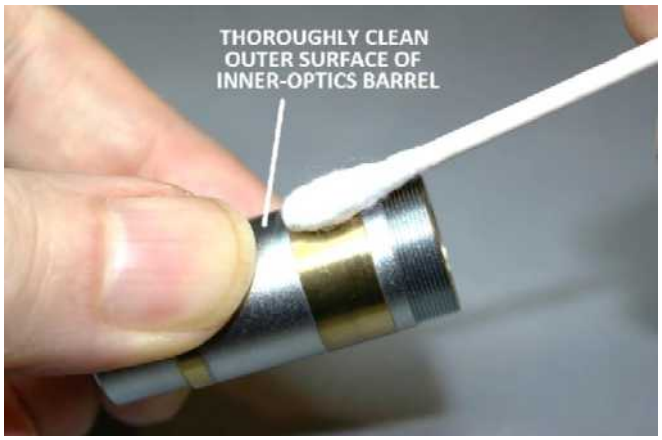

Figure 50 – Clean outer surface of the inner-optics barrel

Reinstall Inner-Optics Barrel into the Outer Barrel

Carefully insert the tip of the inner-optics barrel into the top of the outer barrel of the objective, and lower it into the outer barrel until the tip protrudes from the opposite end of the outer barrel (see **Figure 51**).

Figure 51 – Place inner-optics barrel into the outer barrel

Reinstall the Inner-Optics Retaining Screw

Look into the tapped hole in the side of the outer barrel of the objective (i.e., the hole for the inner-optics retaining screw) and carefully rotate the inner-optics barrel within the outer barrel until the slot in the inner-optics barrel aligns with the tapped hole in the outer barrel (see **Figure 52**).

Figure 52 – Align the inner slot with the tapped screw hole

Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to carefully reinstall the inner-optics retaining screw to secure the inner-optics barrel into the outer barrel of the objective (see **Figure 53**).

Figure 53 – Reinstall the inner-optics retaining screw

Test the Tip without the Extension Spring

Test the freedom of motion of the inner-optics barrel by holding the objective with the tip pointing downwards, and then press the tip up into the outer barrel of the objective (being careful to not touch the exposed lower lens while doing this) and release it. The tip should drop freely and without hesitation (see **Figure 54**). If the tip sticks or drops slowly, repeat the disassembly, cleaning, and reassembly procedure described above until the tip drops properly when tested in this manner.

Figure 54 – Lift the tip up and allow it to drop

Reinstall the Extension Spring

Carefully place the extension spring into the rear opening of the outer objective barrel (see **Figure 55**).

Figure 55 – Reinstall the extension spring

Reinstall the Rear-Aperture Stop

Compress the extension spring with the rear-aperture stop and screw the rear-aperture stop into the inner threads in the top of the outer barrel of the objective (see **Figure 56**).

Figure 56 – Reinstall the rear-aperture stop

Tighten the rear-aperture stop by placing a small sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop down onto the rubber sheet, while turning the objective clockwise (see **Figure 57**).

Figure 57 – Tighten rear-aperture stop on a rubber sheet

Test the Spring-Loaded Tip after Reassembly

Test the freedom of motion of the spring-loaded tip of the reassembled objective by pressing the tip into the bore of the outer barrel of the objective (be careful to not touch the lower lens while doing this). The tip should freely move into the outer barrel of the objective without any noticeable stickiness, binding or friction. Release the tip and verify that the tip re-extends to its original position without any hesitation (see **Figure 58**).

Figure 58 – Test the spring tip of the reassembled objective

Reinstall the Knurled-Rubber Grip Ring

Carefully reinstall the knurled-rubber grip ring into the groove on the outer barrel of the objective (see **Figure 59**), being careful to neither damage nor stretch the rubber grip ring in the process.

Figure 59 – Reinstall the knurled-rubber grip ring

Clean the Lower Objective Lens

Use a suitable pre-moistened lens wipe (item 7 of **Appendix 2**) to carefully clean the exposed lower lens in the retractable tip of the objective.

Return to Service

The DPlan 100X oil-immersion objective is now ready to provide many more years of trouble-free service (see **Figure 60**).

Figure 60 – DPlan 100X objective ready for service

Acknowledgements

Special thanks to Jerry Clement of J&H Microscope Services (Madison, WI) for his invaluable assistance with this section of this document.

Achromatic Objectives with Iris Diaphragms

This section describes the procedure for disassembling, cleaning, and reassembling the spring-loaded tip-retraction mechanism of an Olympus A or DPlan darkfield objective (i.e., those with an integral iris diaphragm), using the A 100X oil-immersion darkfield objective (see **Figure 61**) as an example.

Figure 61 – Olympus A 100X oil-immersion objective w/ iris

Remove the Knurled End-Ring

The knurled end-ring (see **Figure 62**) can sometimes be removed by grasping the outer barrel of the objective with one hand and rotating the knurled end-ring counter-clockwise with the other, to unscrew it from the outer barrel. If the knurled end-ring loosens in this way, hold the objective with the knurled end-ring facing upwards and carefully unscrew and remove the knurled end-ring (see **Figure 66**).

Figure 62 – The knurled end-ring and aperture ring

Frequently, however, it is not possible to loosen the knurled end-ring in this way. In these cases, place the objective into a suitable clamp (see **Appendix 1** of this document) to securely grasp the outer barrel of the objective. A clamp such as this allows the objective to be firmly held without marring the surface, damaging the marking text, or deforming the outer barrel of the objective (see **Figure 63**).

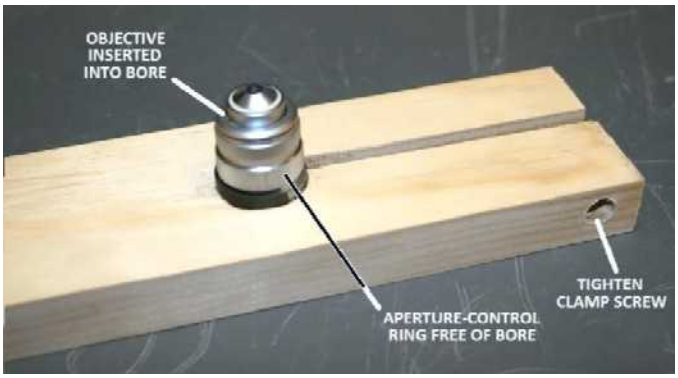

Figure 63 – Clamping the outer objective barrel

Using soft-jaw pliers, loosen, but do not fully remove, the knurled end-ring (see **Figure 64**). **CAUTION: Do not turn the aperture-control ring with the pliers!**

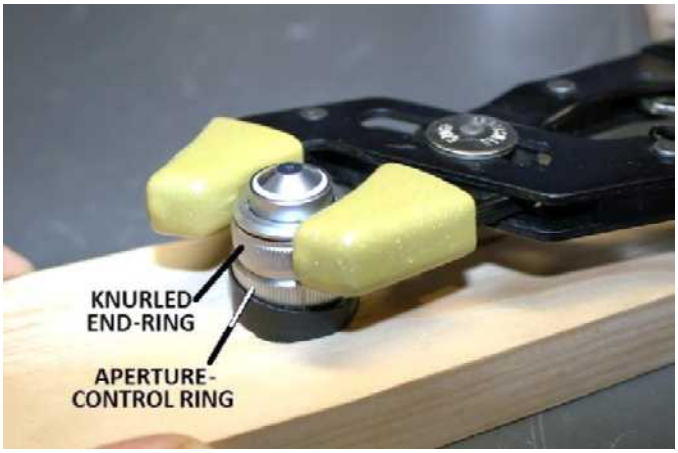

Figure 64 – Loosen the knurled end-ring

After breaking the knurled end-ring loose from the outer barrel of the objective, loosen the clamping screw and remove the objective from the objective clamp (see **Figure 65**).

Figure 65 – Remove the objective from the clamp

While holding the objective with the knurled end-ring facing upwards, carefully unscrew and remove the knurled end-ring (see Figure 66).

Figure 66 – Unscrew and remove the knurled end-ring

Remove the Aperture-Control Ring

Remove the aperture-control ring by lifting it straight up (without allowing it to rotate) until it is free of the outer barrel of the objective (see Figure 67).

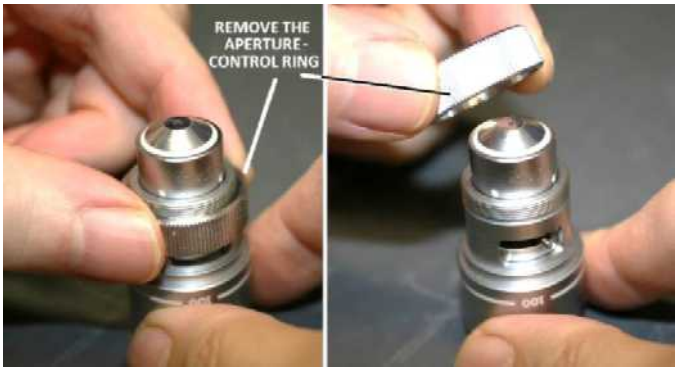

Figure 67 – Remove the aperture-control ring

Remove the Rear-Aperture Stop

The next step is to remove the rear-aperture stop (see Figure 68) from the top of the objective.

Figure 68 – The rear-aperture stop on top of the objective

The rear-aperture stop can sometimes be removed by simply grasping it and turning it counter-clockwise to unscrew it from the outer barrel of the objective. Frequently, however, it is not possible to loosen the rear-aperture stop in this way, since there is not much of it sticking up to get a grip on. In these cases, loosen the rear-aperture stop by placing a small sheet of silicone or similar "grippy" rubber (item 2 of Appendix 2) onto the work surface and firmly pressing the rear-aperture stop onto the rubber sheet, while turning the objective counter-clockwise to loosen it (see Figure 69).

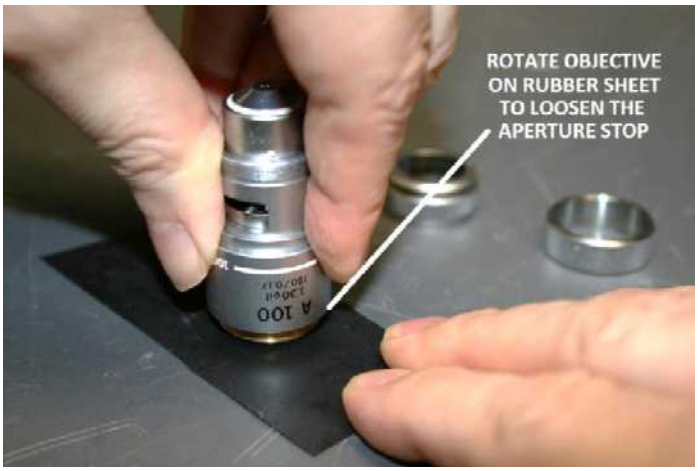

Figure 69 – Loosen the rear-aperture stop on a rubber sheet

When the rear-aperture stop comes loose, unscrew and remove the rear-aperture stop from the outer barrel of the objective by hand (see Figure 70), being careful that the compressed extension spring beneath the rear-aperture stop does not shoot out and get lost when the rear-aperture stop is removed.

Figure 70 – Remove rear-aperture stop from objective barrel

Remove the Extension Spring

Grasp the extension spring and remove it from the rear opening of the outer barrel of the objective (see Figure 71).

Figure 71 – Remove the extension spring

Remove the Aperture-Control Rod

Use a 1.5mm slotted screwdriver (item 3 of **Appendix 2**) to unscrew and remove the aperture-control rod, being very careful to not damage the delicate iris mechanism during the removal process (see **Figure 72**).

Figure 72 – Remove the aperture-control rod

Remove the Inner-Optics Retaining Screw

Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to loosen and remove the inner-optics retaining screw from the outer barrel of the objective (see **Figure 73**). This screw retains the retractable inner-optics barrel within the outer barrel.

Figure 73 – Remove the inner-optics retaining screw

Remove the Inner-Optics Barrel

Being careful to not touch the exposed lens in the tip of the inner-optics barrel, carefully push the tip of the inner-optics barrel up into the bore of the outer barrel of the objective until the top end of the inner-optics barrel protrudes from the top of the outer barrel (see **Figure 74**).

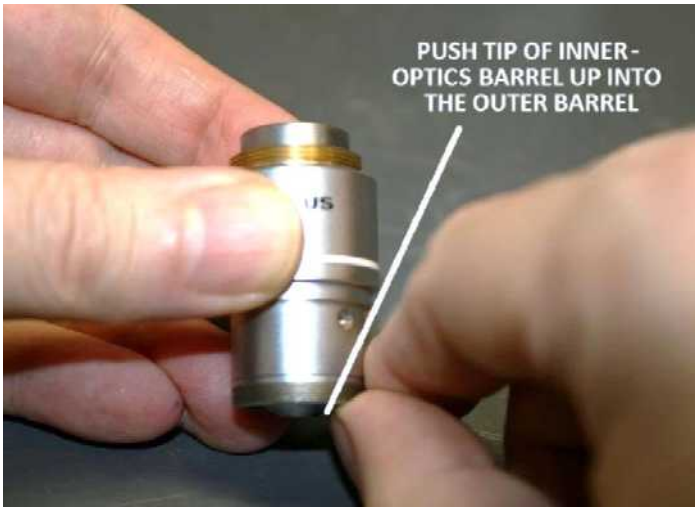

Figure 74 – Push objective tip up into the outer barrel

Grasp the protruding end of the inner-optics barrel at the top of the objective and carefully withdraw the inner-optics barrel from the bore of the outer barrel of the objective (see **Figure 75**).

Figure 75 – Remove the inner-optics barrel

Clean the Inner Bore of the Outer Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the inner bore of the outer barrel of the objective (see **Figure 76**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the inner bore, leaving the bore scrupulously clean, otherwise the freedom of motion of the spring-loaded objective tip may be adversely affected.

Figure 76 – Clean the inner bore of the outer barrel

Clean the Outer Surface of the Inner-Optics Barrel

Use a cotton swab and a suitable solvent (e.g., acetone) to thoroughly clean the outer surface of the inner-optics barrel (see **Figure 77**). It is critical that all traces of any oil or other contaminants be thoroughly removed from the outer surface, leaving the surface scrupulously clean, otherwise the freedom of motion of the spring-loaded tip may be adversely affected.

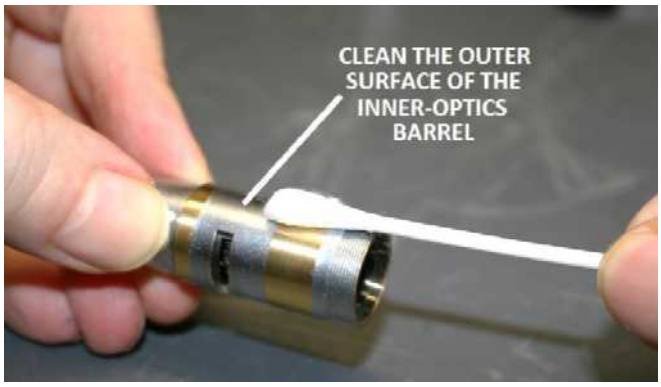

Figure 77 – Clean outer surface of the inner-optics barrel

Reinstall Inner-Optics Barrel into the Outer Barrel

Carefully insert the tip of the inner-optics barrel into the top of the outer barrel of the objective, and lower it into the outer barrel until the tip protrudes from the opposite end of the outer barrel (see **Figure 78**).

Figure 78 – Place inner-optics barrel into the outer barrel

Reinstall the Inner-Optics Retaining Screw

Look into the tapped hole in the side of the outer barrel of the objective (i.e., the hole for the inner-optics retaining screw) and carefully rotate the inner-optics barrel within the outer barrel until the slot in the inner-optics barrel aligns with the tapped hole in the outer barrel (see **Figure 79**).

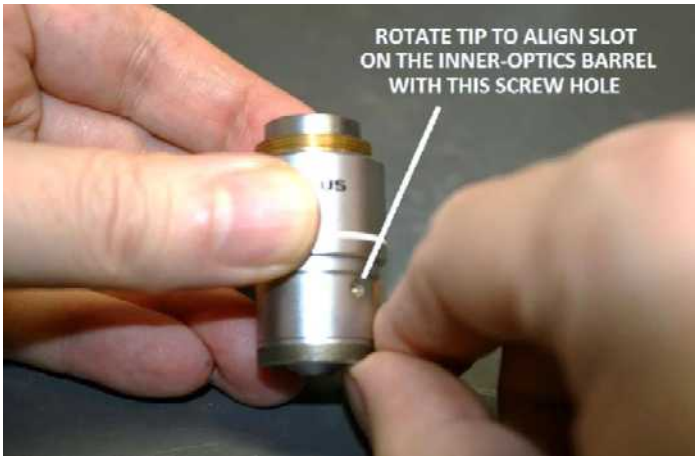

Figure 79 – Align the inner slot with the tapped screw hole

Use a #00 Phillips screwdriver (item 1 of **Appendix 2**) to carefully reinstall the inner-optics retaining screw to secure the inner-optics barrel into the outer barrel of the objective (see **Figure 80**).

Figure 80 – Reinstall the inner-optics retaining screw

Test the Tip without the Extension Spring

Test the freedom of motion of the inner-optics barrel by holding the objective with the tip pointing downwards, and then press the tip up into the outer barrel of the objective (being careful to not touch the exposed lower lens while doing this) and release it. The tip should drop freely and without hesitation (see **Figure 81**). If the tip sticks or drops slowly, repeat the disassembly, cleaning, and reassembly procedure described above until the tip drops properly when tested in this manner.

Figure 81 – Press the tip up and allow it to drop

Reinstall the Aperture Control Rod

Affix the aperture-control rod to a 1.5mm slotted screwdriver (item 3 of **Appendix 2**) using adhesive tape or a small section of suitably sized heat-shrink tubing (see **Figure 82** and **Figure 83**). Make sure the tip of the screwdriver is engaged with the slot in the aperture-control rod.

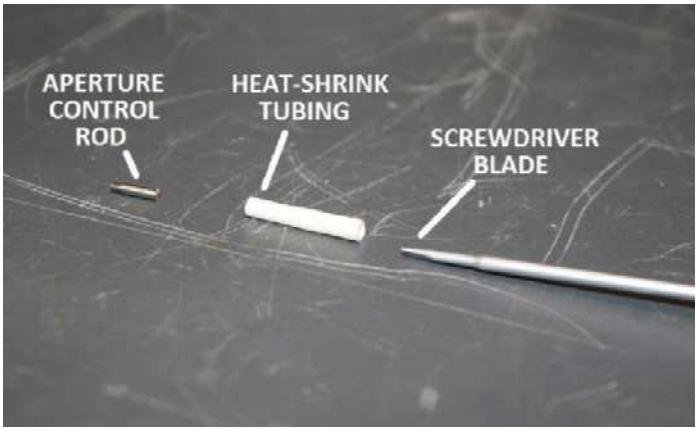

Figure 82 – Setup used to hold the aperture-control rod

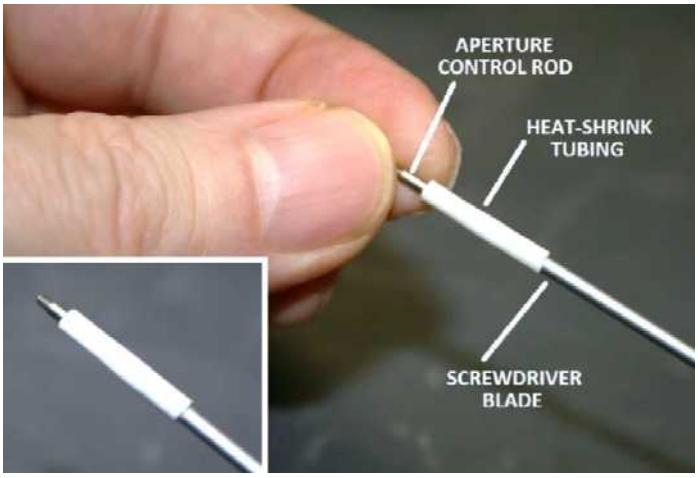

Figure 83 – Aperture-control rod affixed to screwdriver

Use a small screwdriver or other suitable tool to carefully rotate the iris mechanism within the outer barrel of the objective such that the tapped hole for the aperture-control rod is approximately centered in the slot in the outer barrel (see **Figure 84**).

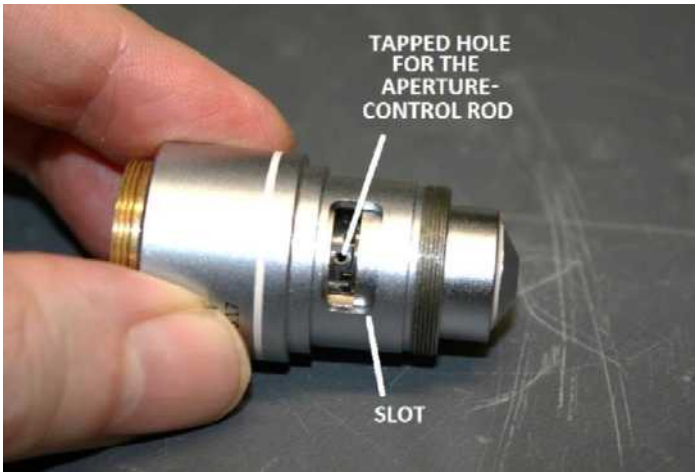

Figure 84 – Proper alignment of the iris mechanism

With the aperture-control rod attached to the tip of the screwdriver (see **Figure 83**), very carefully insert the aperture-control rod into the slot in the outer barrel of the objective and screw it into the tapped hole in the iris mechanism (see **Figure 85**), making sure that the aperture-control rod is properly oriented with respect to the tapped hole before engaging the threads to prevent cross-threading of the aperture-control rod. The iris mechanism is quite fragile, so take your time and do this step carefully to avoid any damage to the iris mechanism or to the threads of the rod.

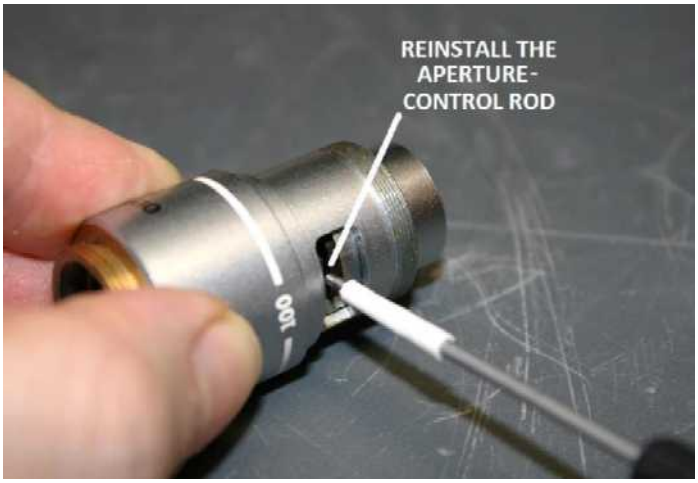

Figure 85 – Reinstall the aperture-control rod

Apply Grease to the Aperture-Control Ring

OPTIONAL: before reinstalling the aperture-control ring, carefully apply a spot of grease to the inner surface of the ring, directly across from the slot for the aperture-control rod (see **Figure 86**). This grease will provide a better feel for the aperture-control ring once

everything has been reassembled. CAUTION: Do not apply too much grease here, and do not apply the grease too close to the slot for the aperture-control rod, otherwise the grease may spread around during subsequent use of the objective and foul the iris-diaphragm mechanism. Do not use grease containing silicone here, to prevent silicone migration and subsequent fouling of the optical elements.

Figure 86 – Apply grease to the aperture-control ring

Reinstall the Aperture-Control Ring

Carefully place the aperture-control ring over the outer barrel of the objective, making sure that the circular groove in the end of the ring (see inset **Figure 87**) is facing the back end of the objective. Slide the aperture-control ring into place, making sure that the aperture-control rod slips into the slot in the inner bore of the aperture-control ring. Do not allow the grease (if present) to get anywhere on the objective barrel except for directly across from the slot for the aperture-diaphragm mechanism. After positioning the aperture-control ring, carefully remove any visible grease.

Figure 87 – Reinstall the aperture-control ring

Reinstall the Knurled End-Ring

While holding the objective with the tip pointing upwards so that the aperture-control ring stays in place, carefully reinstall the knurled end-ring onto the threaded end of the outer barrel of the objective and tighten it until it is tight enough that the objective may be removed from the nosepiece turret without loosening the knurled end-ring (see **Figure 88**).

Figure 88 – Reinstall the knurled end-ring

Reinstall the Extension Spring

Carefully place the extension spring into the rear opening of the outer objective barrel (see **Figure 89**).

Figure 89 – Reinstall the extension spring

Reinstall the Rear-Aperture Stop

Use the rear-aperture stop to compress the extension spring and screw the rear-aperture stop into the inner threads in the top of the outer barrel of the objective (see **Figure 90**).

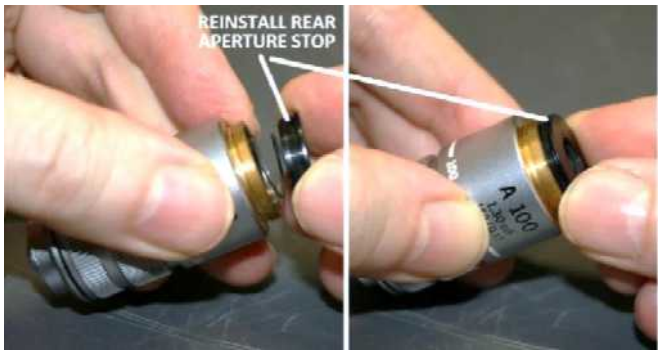

Figure 90 – Reinstall the rear-aperture stop

Tighten the rear-aperture stop by placing a small sheet of silicone or similar "grippy" rubber, (item 2 of **Appendix 2**) onto the work surface and firmly pressing the rear-aperture stop down onto the rubber sheet, while turning the objective clockwise (see **Figure 91**).

Figure 91 – Tighten the rear-aperture stop on a rubber sheet

Test the Spring-Loaded Tip after Reassembly

Test the freedom of motion of the spring-loaded tip of the reassembled objective by pressing the tip into the bore of the outer barrel of the objective (be careful to not touch the lower lens while doing this). The tip should freely move into the outer barrel of the objective without any noticeable stickiness, binding or friction. Release the tip and verify that the tip re-extends to its original position without any hesitation (see **Figure 92**).

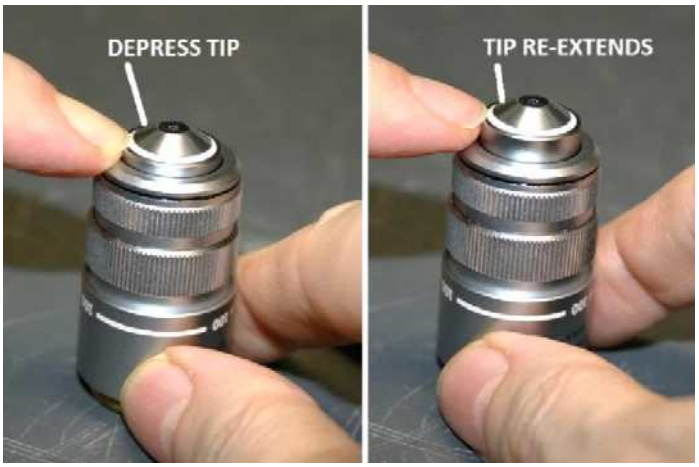

Figure 92 – Test the spring tip of the reassembled objective

Clean the Lower Objective Lens

Use a suitable pre-moistened lens wipe (item 7 of **Appendix 2**) to carefully clean the exposed lower lens in the retractable tip of the objective.

Return to Service

The A 100X oil-immersion darkfield objective is now ready to provide many more years of trouble-free service (see **Figure 93**).

Figure 93 – A 100X darkfield objective ready for service

Acknowledgements

Special thanks to Dr. Peter Lang, of Regensburg, Bavaria, for his invaluable assistance with this section of this document.

Apochromatic Objectives with Correction Collars

This section describes the procedure for disassembling, cleaning, and reassembling the spring-loaded tip-retraction mechanism and the cover-slip correction collar of an Olympus DPlan apochromatic objective, using the DPlan Apo 60X dry objective (see **Figure 94**) as an example.

Figure 94 – Olympus DPlan Apo 60X dry objective w/ collar

Place the Objective into a Non-Marring Clamp

Place the objective into a suitable non-marring clamp to securely grip the outer barrel of the objective (see **Appendix 1** of this document for the construction of such a clamp). The clamp described in **Appendix 1** allows the objective to be firmly held without marring the surface of the objective, damaging the marking text, or deforming the outer barrel of the objective (see **Figure 95**).

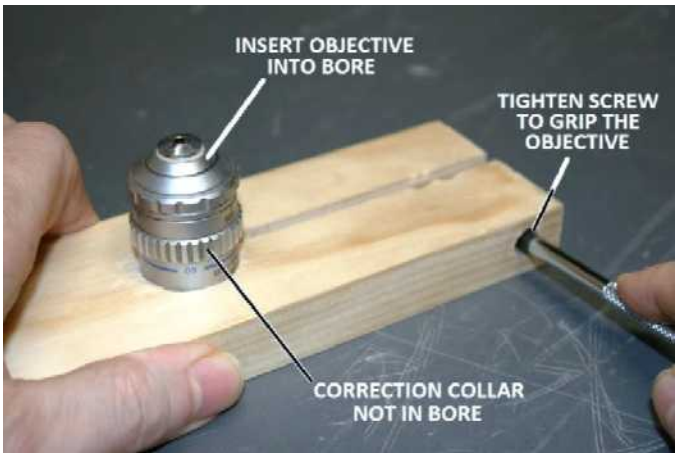

Figure 95 – Secure the objective in a non-marring clamp

Remove the Knurled End-Ring

The knurled end-ring (see **Figure 96**) can sometimes be removed simply by grasping the knurled end-ring by hand (with the objective in the clamp) and rotating it counter-clockwise to unscrew it from the outer barrel. If the knurled end-ring loosens in this way, carefully unscrew and remove the knurled end-ring (see **Figure 98).**

Figure 96 – The knurled end-ring and correction collar

Frequently, however, it is not possible to loosen the knurled end-ring by hand. If this is the case, use soft-jaw pliers to loosen the knurled end-ring (see **Figure 97**) and remove it by hand (see **Figure 98**). **CAUTION: Do not turn the cover-slip correction collar with the pliers!**

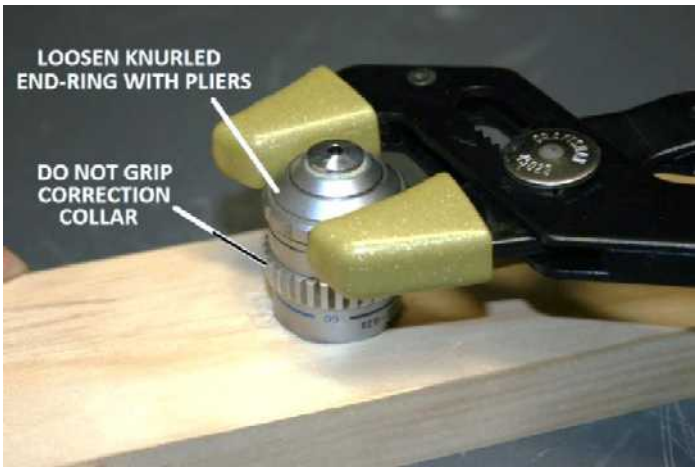

Figure 97 – Loosen the knurled end-ring with pliers

Figure 98 – Unscrew and remove the knurled end-ring

Loosen the Threaded Retaining Ring

There is a threaded retaining ring in the end of the objective which must be removed before the inner-optics barrel can be removed from the objective outer barrel (see **Figure 99**).

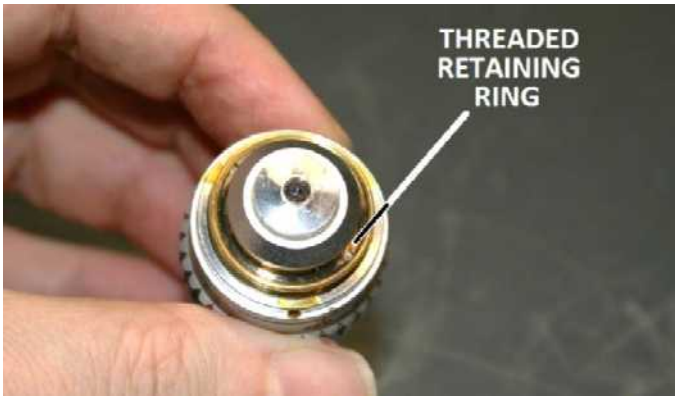

Figure 99 - The threaded retaining ring

With the objective secured in the non-marring clamp, carefully loosen, but do not remove, the threaded retaining ring (see **Figure 100**) using a lens spanner tool with pointed tips that are bent slightly inwards (item 6 of **Appendix 2**, see **Figure 101**).

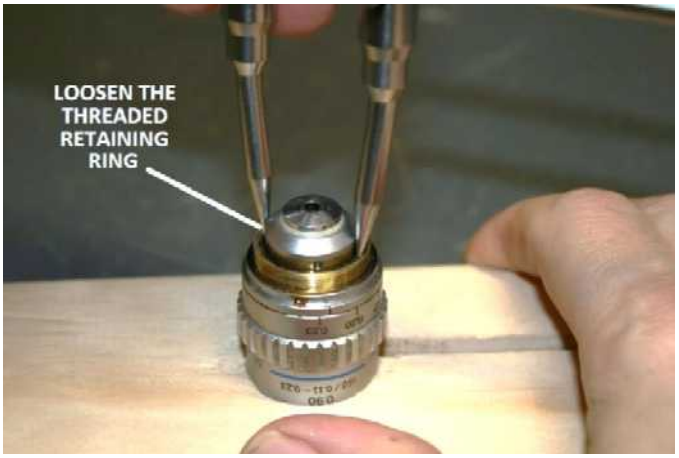

Figure 100 – Loosen the threaded retaining ring

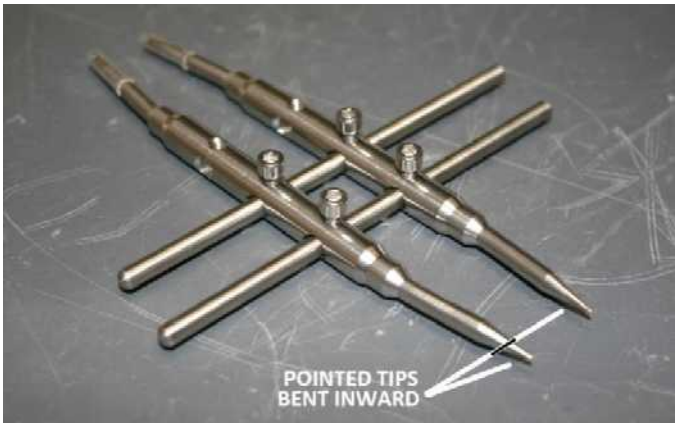

Figure 101 – Lens spanner tool with bent and pointed tips

After the threaded retaining ring has been broken free, loosen the clamping screw in the non-marring objective clamp and remove the objective from the clamp (see **Figure 102**).

Figure 102 – Remove the objective from the clamp

Remove the Correction-Collar Retaining Ring

The next step is to remove the retaining ring for the cover-slip correction collar (see **Figure 103**). This retaining ring is held in place by three very small slotted setscrews spaced equidistantly around the perimeter of the retaining ring (see **Figure 103**).

Figure 103 – The correction-collar retaining ring

Before attempting to remove the three setscrews from the correction-collar retaining ring, use a suitable solvent (e.g., mineral spirits) to remove any visible adhesive from the three slotted setscrew heads (see **Figure 104**). Observe the setscrews under a stereo microscope, if you have one available, and use a dental pick or other suitable sharp tool to thoroughly remove any remaining adhesive and debris from the slots in the three setscrew heads (see **Figure 105**).

Figure 104 – Clean adhesive from the setscrew heads

Figure 105 – Remove debris from the setscrew slots

Use a suitable slotted screwdriver (item 5 of **Appendix 2**) to carefully remove the three slotted setscrews holding the retaining ring for the cover-slip correction collar in place (see **Figure 106**).

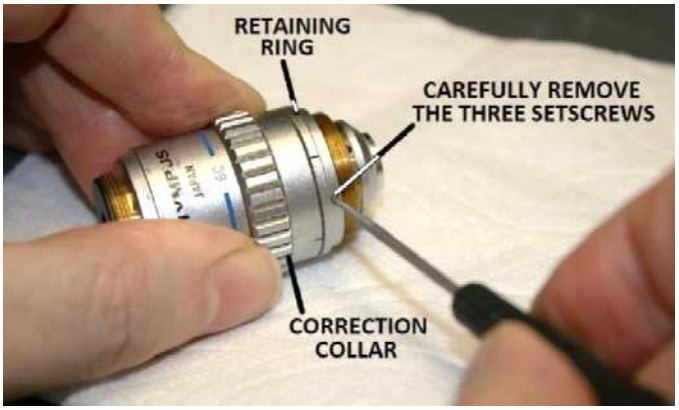

Figure 106 – Carefully remove the three tiny setscrews

Place the objective back into the non-marring objective clamp and use a suitable pair of pliers to grasp retaining ring for the correction collar (be sure to grasp the part of the ring that has the three tapped holes for the setscrews, since this part gets covered by the knurled end-ring, and any subsequent marring from the pliers will not be visible) and loosen (see **Figure 107**) and remove (see **Figure 108**) the retaining ring. Note that the retaining ring does not screw onto the objective outer barrel, but is likely stuck in place, nonetheless.

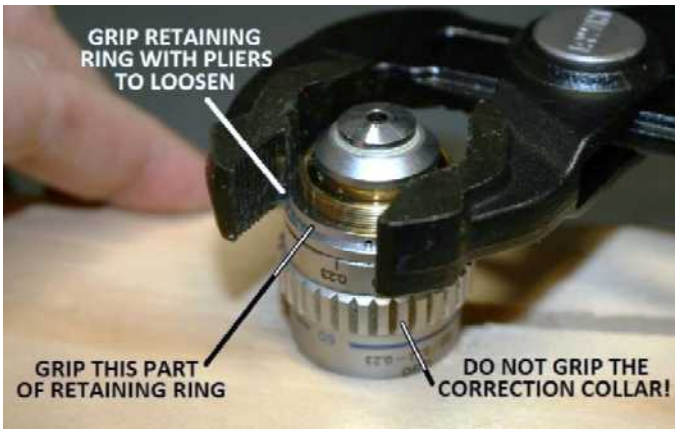

Figure 107 – Loosen the retaining ring from the outer barrel

Figure 108 – Remove the retaining ring from the outer barrel

Remove the Cover-Slip Correction Collar

Grasp the cover-slip correction collar and lift it straight up to remove it from the objective outer barrel (see **Figure 109**).

Figure 109 – Lift and remove the cover-slip correction collar

Remove the Inner-Optics Retaining Screw

Use a 2mm slotted screwdriver (item 4 of **Appendix 2**) to loosen and remove the side screw securing the inner-optics barrel into the objective outer barrel (see **Figure 110**).

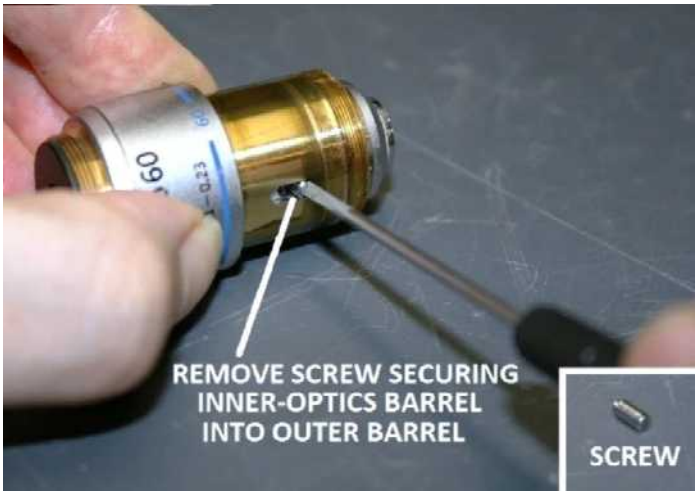

Figure 110 – Remove screw retaining the inner-optics barrel

Remove the Threaded Retaining Ring

Use a pointed tool of some sort to unscrew the (previously loosened) threaded retaining ring from the end of the objective. Unscrew it with the pointed tool far enough that it can be grasped and removed by hand (see **Figure 111**), but do not allow the threads to disengage from the threads in the outer barrel yet.

Figure 111 – Unscrew the threaded retaining ring

While pressing down on the tip of the objective to keep the inner-optics barrel from shooting out of the outer barrel when the threaded retaining ring disengages from the outer barrel, unscrew and remove the threaded retaining ring by hand (see **Figure 112**).

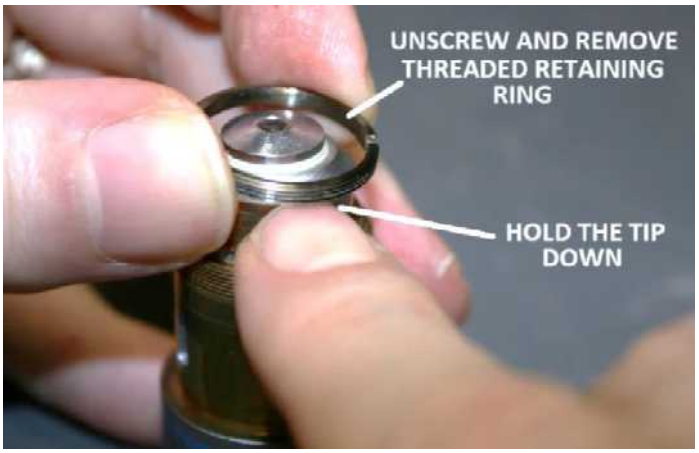

Figure 112 – Remove the threaded retaining ring

Remove Inner-Optics Barrel from the Outer Barrel

Carefully remove the inner-optics barrel from the objective outer barrel (see **Figure 113**).

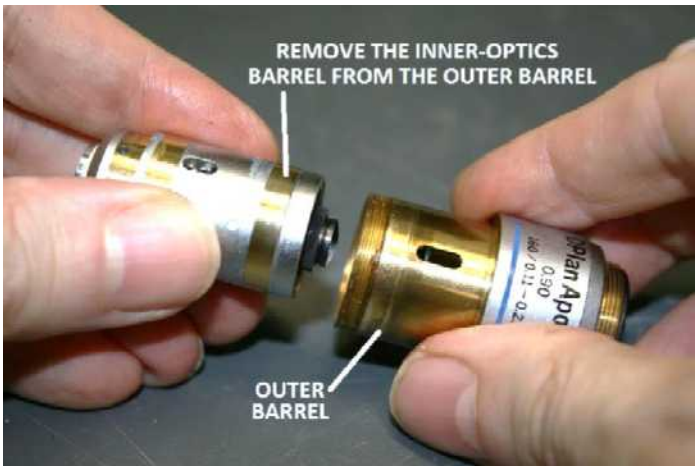

Figure 113 – Remove inner-optics barrel from outer barrel

Remove Extension Spring from the Outer Barrel

Remove the extension spring from the objective outer barrel (see **Figure 114**).

Figure 114 – Remove extension spring from the outer barrel

Clean the Outer Surface of the Outer Barrel

Use a suitable solvent (e.g., acetone) to thoroughly clean the exposed brass on the outer surface of the objective outer barrel (see **Figure 115**).

Figure 115 – Clean the exposed brass of the outer barrel

Clean the Inner Bore of the Outer Barrel

Use a suitable solvent (e.g., acetone) to thoroughly clean the inner bore of the objective outer barrel (see **Figure 116**).

Figure 116 – Clean the inner surface of the outer barrel

Clean the Outer Surface of the Inner-Optics Barrel

Use a suitable solvent (e.g., acetone) to thoroughly clean the outer surface of the inner-optics barrel (see **Figure 117**).

Figure 117 – Clean outer surface of the inner-optics barrel

Reinstall Extension Spring into the Outer Barrel

Reinstall the extension spring into the objective outer barrel (see **Figure 118**).

Figure 118 – Reinstall the extension spring into outer barrel

Reinstall Inner-Optics Barrel into the Outer Barrel

Carefully reinstall the inner-optics barrel into the objective outer barrel (see **Figure 119**).

Figure 119 – Reinstall inner-optics barrel into outer barrel

Reinstall the Inner-Optics Retaining Screw

Press the tip of the inner-optics barrel into the outer barrel to compress the extension spring, and rotate the inner-optics barrel until the screw hole in the inner-optics barrel aligns with the slot in the objective outer barrel (see **Figure 120**).

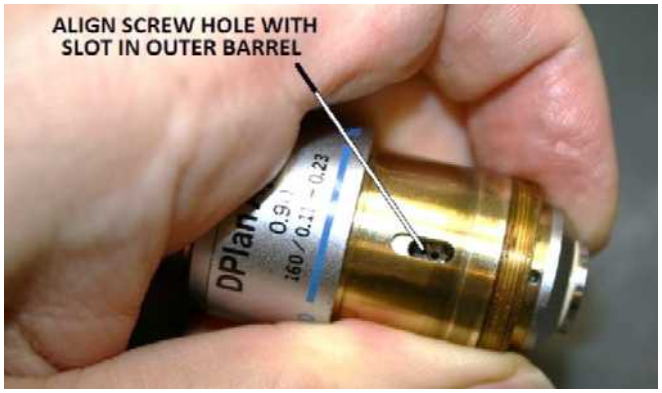

Figure 120 - Align screw hole with slot in the outer barrel

Use a 2mm slotted screwdriver (item 4 of **Appendix 2**) to carefully reinstall the inner-optics retaining screw to secure the inner-optics barrel into the outer barrel of the objective (see **Figure 121**).

Figure 121 – Reinstall the inner-optics retaining screw

Reinstall the Cover-Slip Correction Collar

Use a suitable solvent (e.g., acetone) to thoroughly clean the inner surface of the cover-slip correction collar (see **Figure 122**).

Figure 122 – Clean the inner surface of the correction collar

Apply a light coating of a silicone-free grease (item 8 of **Appendix 2**) to the large bearing area of the inner surface of the cover-slip correction collar (see **Figure 123**).

Figure 123 – Apply grease to the correction collar

Carefully place the greased cover-slip correction collar over the objective outer barrel, making sure the groove in the correction collar is properly aligned with the correction-collar stop screw (see **Figure 124** and **Figure 125**). Thoroughly remove any visible grease.

Figure 124 – Reinstall the cover-slip correction collar

Figure 125 – The correction collar in its proper position

Reinstall the Correction-Collar Retaining Ring

Use a suitable solvent (e.g., acetone) to thoroughly clean the inner surface of the correction-collar retaining ring (see **Figure 126**).

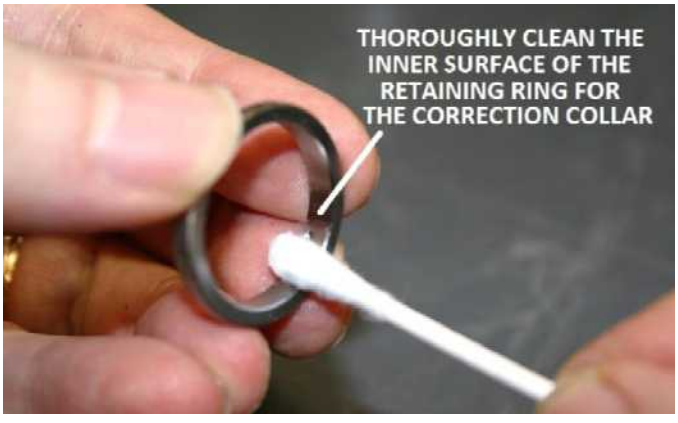

Figure 126 – Clean the inner surface of the retaining ring

Place the correction-collar retaining ring over the outer barrel of the objective and position it up against the cover-slip correction collar (see **Figure 127**).

Figure 127 – Place the retaining ring over the outer barrel

Carefully rotate the cover-slip correction collar to the fully counter-clockwise position, as viewed from above the objective. While holding the correction collar stationary, align the correction-collar retaining ring so that the index mark appears as shown in **Figure 128**.

Figure 128 – Set retaining ring index mark to just past "0.11"

While holding the correction-collar retaining ring stationary, carefully rotate the cover-slip correction collar to the fully clockwise position of it travel, as viewed from above the objective. The index mark on the retaining ring should appear approximately as shown in **Figure 129**. Position the retaining ring such that the index mark lands beyond the "0.11" and "0.23" markings by equal amounts at the two extremes of rotation of the cover-slip correction collar. The retaining ring is now positioned such that the index mark aligns with the "0.17" labeling in the center position of the correction collar. Do not allow the retaining ring to move from this position.

Figure 129 – Retaining ring index mark just past "0.23"

While not allowing the retaining ring to rotate, press the ring against the cover-slip correction collar and use a suitable slotted screwdriver (item 5 of **Appendix 2**) to carefully reinstall the three slotted setscrews that secure the retaining ring in position (see **Figure 130**).

Figure 130 – Reinstall setscrews to secure the retaining ring

Reinstall the Threaded Retaining Ring

While pressing the objective tip into the objective outer barrel to compress the extension spring, carefully engage the threaded retaining ring with the inner threads in the end of the outer barrel, but do not fully tighten it (see **Figure 131**).

Figure 131 – Engage threads of the threaded retaining ring

Use a suitable pointed tool to screw in the threaded retaining ring until it just begins to snug down, then loosen it approximately 1/8 turn (see **Figure 132**).

Figure 132 – Snug threaded retaining ring and loosen it a bit

Adjust Parfocality of the Objective

The threaded retaining ring must now be adjusted to make the objective parfocal with other objectives in the Olympus LB line. To do this, mount the objective on a microscope stand, along with a known-good objective of similar magnification (see **Figure 133**).

Figure 133 – Mount the objective onto a microscope stand

Using the known-good objective, observe a suitable test specimen mounted onto a slide directly against a 0.17mm cover slip, and sharply focus on an easily identifiable feature of the test slide. Next, rotate the nosepiece turret to switch to the objective under repair and set the cover-slip correction collar on this objective to the "0.17" position. Adjust the focus as necessary until the feature viewed previously is once-again sharp, noting which direction (either stage-up or stage-down) the focus was moved, as well as how much the focus was changed, to bring the feature into sharp focus.

Now rotate the nosepiece turret such that the objective under repair is situated so that the threaded retaining ring in the bottom of the objective can be accessed with a suitable pointed tool. If the stage was raised to obtain proper focus, loosen the retaining ring just a bit, and if the stage was lowered to obtain proper focus, tighten the retaining ring just a bit (see **Figure 134**).

Figure 134 – Adjust the threaded retaining ring

After adjusting the threaded retaining ring, press the spring-loaded tip up into the objective outer barrel and allow it to re-extend. Repeat the above process of focusing on the test feature with the known-good objective, switching to the objective under repair and re-focusing on the same test feature, and then adjusting the threaded retaining ring, until the objective is acceptably parfocal with the known-good objective.

Once the objective has been adjusted to be parfocal, remove the objective from the microscope stand and carefully apply a bit of LocTite® thread locker (item 9 of **Appendix 2**) to the threaded retaining ring (see **Figure 135**) to stake it in place and prevent it from moving during subsequent use of the objective.

Figure 135 – Stake the threaded retaining ring in place

Reinstall the Knurled End-Ring

Carefully reinstall the knurled end-ring onto the threaded end of the objective outer barrel and tighten it until it is sufficiently tight, such that the objective may be removed from the nosepiece turret via the knurled end-ring, without the knurled end-ring loosening (see **Figure 136**).

Figure 136 – Reinstall the knurled end-ring

Test the Spring-Loaded Tip after Reassembly

Test the freedom of motion of the spring-loaded tip of the reassembled objective by pressing the tip into the bore of the outer barrel of the objective (be careful to not touch the lower lens while doing this). The tip should freely move into the outer barrel of the objective without any noticeable stickiness, binding or friction. Release the tip and verify that the tip re-extends to its original position without any hesitation (see **Figure 137**).

Figure 137 – Test the spring tip of the reassembled objective

Clean the Lower Objective Lens

Use a suitable pre-moistened lens wipe (item 7 of **Appendix 2**) to carefully clean the exposed lower lens in the retractable tip of the objective.

Return to Service

The DPlan Apo 60X dry objective is now ready to provide many more years of trouble-free service (see **Figure 138**).

Figure 138 – DPlan Apo 60x dry objective ready for service

Appendix 1
A Non-Marring Clamp for Objectives

Construction of A Non-Marring Objective Clamp

A non-marring clamp for servicing objectives can be easily fabricated from a suitable piece of scrap wood and a wood screw (see **Figure 139**). Such a clamp allows the objective to be firmly held while the knurled end-ring is loosed, providing sufficient grip to prevent the barrel from turning, while at the same time spreading the clamping force over the circumference of the barrel, thereby preventing any flattening or distortion of the objective barrel. In the example shown here, a 12" x 3" X 3/4" piece of scrap wood and a 2-1/2" deck screw was used, but the actual dimensions are not critical.

Figure 139 – A non-marring objective clamp

Determine the Objective Barrel Size

Measure the diameter of the outer barrel of the objective that you wish to clamp. This measurement determines the size of the hole that must be bored into the piece of wood.

Bore and Slot the Wooden Piece

Use a Forstner bit or spade bit of suitable diameter to bore a hole in the piece of wood just slightly larger in diameter than that of the objective barrel. Use a bandsaw or handsaw to cut a 3/8" wide (approximate) slot in the piece of wood from one side of the hole to one of the ends of the board (see **Figure 140**).

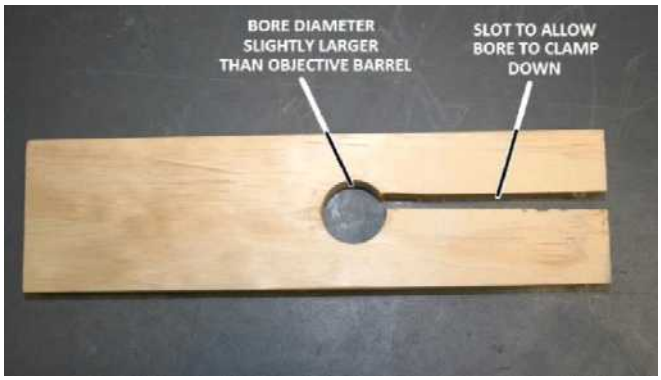

Figure 140 – Bore and slot in the wood piece

Drill Holes for the Clamping Screw

Obtain a wood screw which is approximately 1/2" or so shorter than the width of the piece of wood. Drill a hole in the piece of wood, using a drill bit whose diameter is slightly less than the diameter of the wood screw, starting from one side of the wood and drilling through the slot and into the opposite side. Do not drill all the way through the opposite side, but instead stop ¼" or so before that point. Next, use a drill bit whose diameter is slightly larger than that of the shaft of the screw to enlarge the hole on the side from which the drilling of the original hole was started. Do not drill past the slot and into the other side with this bit. Finally, use a drill bit whose diameter is slightly larger than the head of the screw to further enlarge the hole to create a counter-bore for the screw head. Drill the depth of this counter-bore such that the screw will bite deeply into the wood on the opposite side of the slot, but will not go completely through the opposite side (see **Figure 141**).

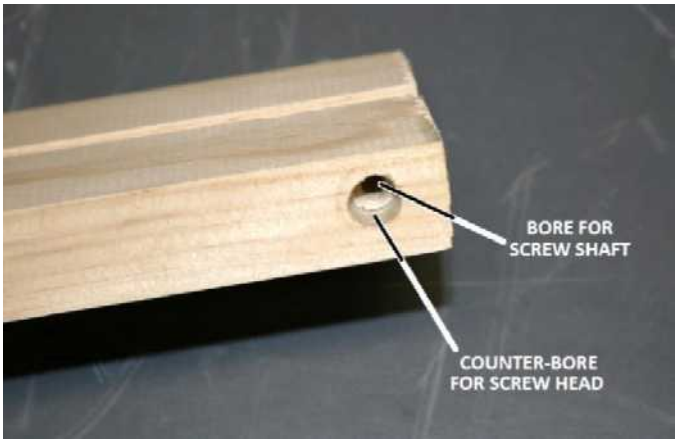

Figure 141 – Holes for the clamping screw

Install the Clamping Screw

Insert the screw into the counter-bore in the side of the piece of wood and drive the screw into the opposite side of the slot (see **Figure 142**).

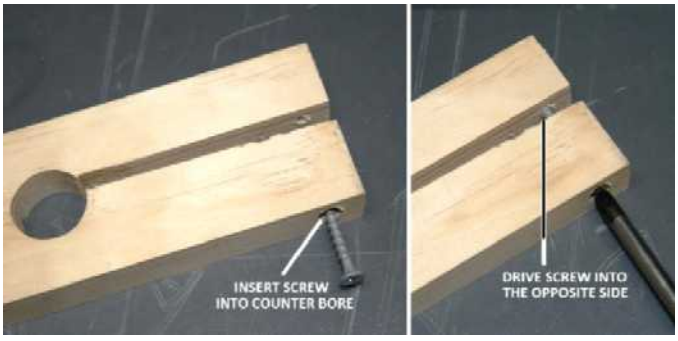

Figure 142 – Install the clamping screw

Using the Clamp

Place the wooden objective clamp onto the work surface (see **Figure 143**).

Figure 143 – Place the clamp onto the work surface

If desired, use a thin sheet of silicone or similar "grippy" rubber (item 2 of **Appendix 2**) to line the inner bore of the objective clamp (see **Figure 144**). The rubber sheet can provide additional grip and protection for the barrel of the objective but is not required.

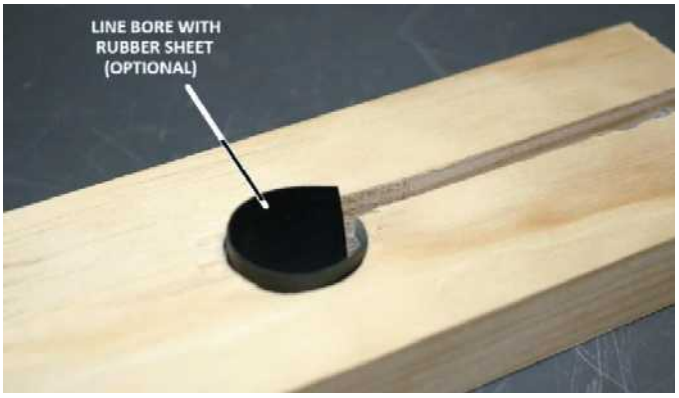

Figure 144 - Line the bore of the clamp bore with rubber

Place the objective into the rubber-lined bore of the objective clamp, with the tip pointing upwards. Make sure that the aperture-control ring or correction collar (if present) are free of the bore (see **Figure 145**).

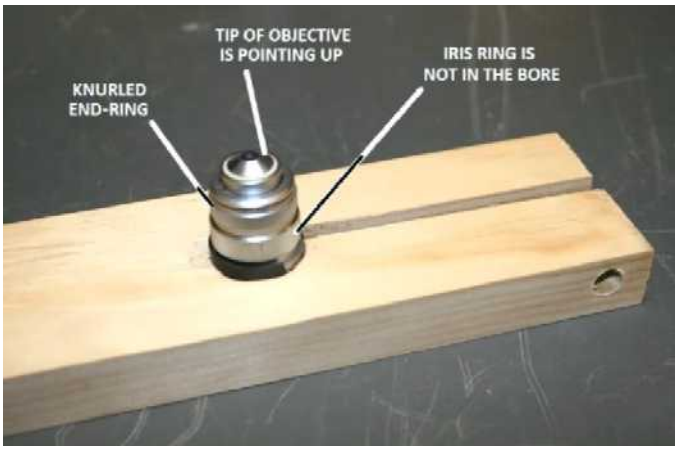

Figure 145 – Place the objective into the clamp bore

Tighten the side screw in the objective clamp until the clamp firmly bites down on the barrel of the objective (see **Figure 146**). The objective is now securely clamped in place and disassembly of the objective may now commence.

Figure 146 - Tighten screw to clamp the objective

Appendix 2

Tools and Supplies

Table 2 and Table 3 list specific information for the various tools and supplies discussed in this document. These tables list only the items that may be difficult to source locally. The pricing and availability listed below is accurate as-of November 2018 but is subject to change without notice.

Item	Description	Manufacturer	Manufacturer Model / #	Vendor	Vendor #	Price
1	Wiha screwdriver, 261 / PH00 x 40	Wiha	96100	Amazon	---	$8.77
2	Rubber, silicon, 12” X 12” X 1/16”	various	various	Amazon	---	$12.65
3	Slotted screwdriver, 260 / 1.5 x 40	Wiha	26015	Amazon	---	$5.18
4	Slotted screwdriver, 260 / 2.0 x 50	Wiha	26025	Amazon	---	$5.71
5	Slotted screwdriver, 260 / 1.5 x 40 (modified per note * below)	Wiha	26015	Amazon	---	$5.18
6	Lens spanner tool, bent/pointed tips	Neewer	---	Amazon	---	$12.99

Table 2 – Tools referenced in this document

* File or grind the tip of Wiha 260 1.5mm slotted screwdriver to approximately 1.35mm in width.

Item	Description	Manufacturer	Manufacturer Model / #	Vendor	Vendor #	Price
7	Lens wipes, pre-moistened, 100 count	Zeiss	---	Amazon	---	$7.39
8	Mobilgrease 28, Synthetic Aviation Grease, 13.7oz	Mobil	MIL-PRF-81322	Amazon	---	$22.87
9	LocTite® 222MS Low-Strength Thread Locker, Purple, 10cc	Henkel	22221	Amazon	---	$11.94

Table 3 – Supplies referenced in this document

Table 4 lists the contact information for the vendors referenced in Table 2 and Table 3.

Vendor	URL	Local Phone	Toll Free	Fax	email
Amazon	www.amazon.com	---	---	---	---

Table 4 – Vendor Listing