



Köhler Illuminator Upgrade

User's Manual

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Manual prepared by **OptArc** – Designers and manufacturers of custom optical and optoelectronic systems using 3D printing rapid prototyping and based in the UK. See optarc.co.uk for details.

Safety Information

Identification of risk

Throughout this manual please take heed of **warnings given in bold text and highlighted yellow** to avoid possible damage to equipment and/or harm to people.

Risk to vulnerable groups

PUMA microscopes and associated systems are not toys. They contain small parts which may come loose such as tiny metal screws and washers and glass components that may splinter or break or otherwise present a choking or sharp object hazard or chemical hazard (e.g. for batteries). **Please do not let babies or young children play with or gain access to any aspect of a PUMA system without close appropriate adult supervision. Likewise keep PUMA systems away from pets.**

Risk of damage to eyesight

When choosing and using a light source for a PUMA microscope, care must be taken to avoid the use of or exposure to light that could damage eyesight.

In particular **never allow direct or specular reflections of the sun to enter the microscope** through the illuminating mirror.

Also, **never allow laser light to enter the microscope through the illuminating mirror if any viewing is to be done by eye** (as opposed to recordings by a camera only).

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You can download the latest version of this User's Manual as a PDF file from the Support section of the OptArc website via this link:

<https://www.optarc.co.uk/support/>



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Legal Information

Copyright

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Trade Marks

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Limitations of Use

The PUMA microscope and its associated systems do not have any certifications or regulatory approvals in any country for use in clinical diagnostics or treatment (human or veterinary).

The PUMA microscope and its associated systems are released to be used for research and educational purposes only.

Disclaimer

All PUMA project information including, without limitation, any CAD file or STL file and all documentation, advice and instruction (whether provided in video form, audible form, written form or otherwise) is provided 'as is' in good faith and is intended to be helpful but comes with no warranty whatsoever.

Anyone attempting to build or use a PUMA microscope or other PUMA-related material, accessory, module or derivative is hereby advised that there will be risk involved in 3D printing, post-print processing, assembly and usage of the resulting structures. This risk includes, without limitation, the risk of personal injury, damage and loss of resources.

Dr Paul J. Tadrous, TadPath and OptArc cannot accept any liability for any such injury, loss or other damages that may occur. All those who attempt to build or use any aspect of the PUMA project or derivatives thereof do so at their own risk.

Discrepancy in Appearance of Parts

The parts in your package may differ in exact appearance to the parts shown in this manual or in the associated videos or advertising materials because we always ship the latest versions of the scope and the manual and videos may have been prepared using earlier models. Functionality of the parts you receive will be the same or better than those illustrated in this manual and any associated video or advertising materials.

Abbreviations

Some common abbreviations used in this manual are listed below for convenience.

BFP Back Focal Plane

CAD Computer-aided design

IAD Illuminating aperture diaphragm (or the slot for this aperture)

IFD Illuminated field diaphragm (or the slot for this aperture)

PLA Poly-lactic acid

PUMA Portable Upgradeable Modular Affordable (3D printed microscopy system)

SLM Spatial Light Modulator

STL Stereolithography file format

Introduction

This manual pertains to the kit of parts supplied by OptArc that will enable you to upgrade the illumination system of a PUMA Foundation scope *that has previously been upgraded with the Abbe condenser upgrade kit* into a more advanced illumination system using Köhler illumination where *you will need to supply a suitable light source separately*.

This upgrade includes the upper collector assembly and 45 degree mirror block and illuminated field diaphragm (IFD) apparatus. No light source is included.

For more information about the parts used in this kit and, in particular if you would like to print any additional or replacement parts, please see the PUMA GitHub repository.

PUMA GitHub Page



<https://github.com/TadPath/PUMA>

Features of this Köhler upgrade kit

This kit will enable you to use Köhler transillumination with the full Abbe condenser for objective lenses in the range x2 to x100 oil.

This kit gives you access to the IFD slot and includes an IFD cross-hairs filter. It also provides you with an optional 30 mm spheroid lens which you can insert into the 'DI_M3_Adjustment_ring_Kohler' component as part of the formation of the latest design of lower collector for use with the PUMA LED light source but that light source is not included in this kit. The 'DI_Daylight_Kohler_adaptor' is included.

If you are not familiar with these 'DI_' model designations you can find them illustrated in the 'PUMA_3D_Printing_Guide.pdf' document in the PUMA GitHub repository.

What is not included in this upgrade kit

This upgrade kit is designed to make use of components already supplied as part of the Foundation scope and Abbe condenser upgrade kit as provided by OptArc. This means that this Köhler upgrade kit does *not* include those parts. Also, it does not include a light source (no LED or electric lamp or 23 mm lens lower collector or power supply). Likewise it does not include a mirror illuminator (it assumes you will be using the standard PUMA mirror that came with your Foundation scope) and does not include the long legs stand system because that comes with the Abbe condenser upgrade.

What's included in the kit

This Köhler illuminator upgrade kit includes the following items only (quantities in brackets) – see figures 1, 2, 3 and 4:

- 45 degree mirror block, extension, IFD slot assembly with thread lock and adjust ring, pre-assembled with all screws and nuts included (1)
- M3 thumbscrews (6)
- DI_Tool_44 (1)
- DI_Daylight_Kohler_adaptor (1)
- Upper collector assembly with 44 mm lens (smooth type) pre-fitted (1)
- Cross-hairs IFD filter (1)
- 30 mm lens, spheroid type (1)

No other parts are included. Please note that the lenses are of the moulded glass type which may contain small surface defects as is normal for such lenses. This does not constitute a defect in workmanship.

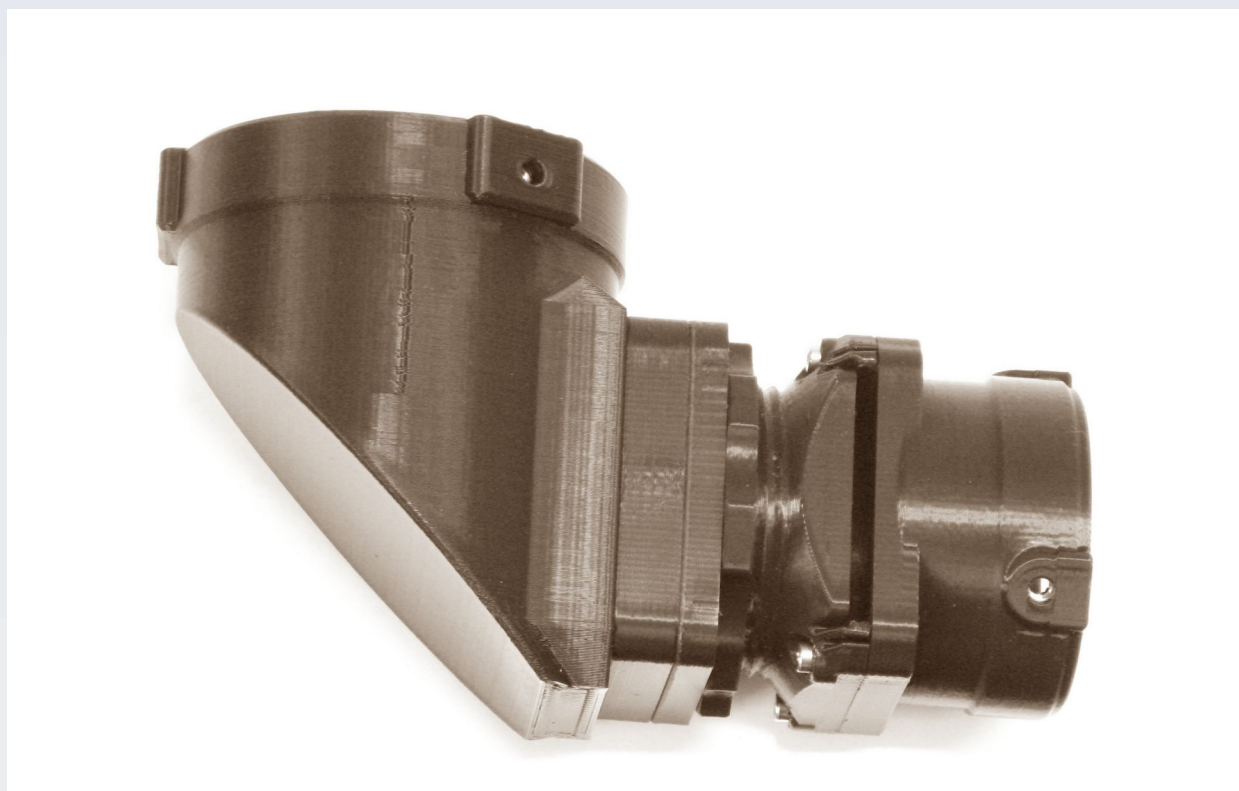


Figure 1. The 45 degree mirror block (DI_Collector_mirror_block) with spacer (DI_Mirror_block_spacer) and DI_Proximal_collector_attachment pre-fitted, including the DI_IFD_Tray, DI_IFD_Threadlock and DI_M3_Adjustment_ring_Kohler. This is pre-assembled with the correct screws and all 6 M3 nuts in place.



Figure 2. *Left:* DI_Daylight_Kohler_adaptor. *Right:* Upper collector assembly and 44 mm lens pre-assembled. This includes the 44 mm lens, DI_Cnd_to_UC, any DI_UC_Spacer models - as many as required to get the position of the lens correct (this is pre-done for you) and a DI_UC_Retention_Cap.



Figure 3. *Left:* Six M3 thumbscrews and one DI_Tool_44. *Right:* DI_IFD_Filter_crosshairs.

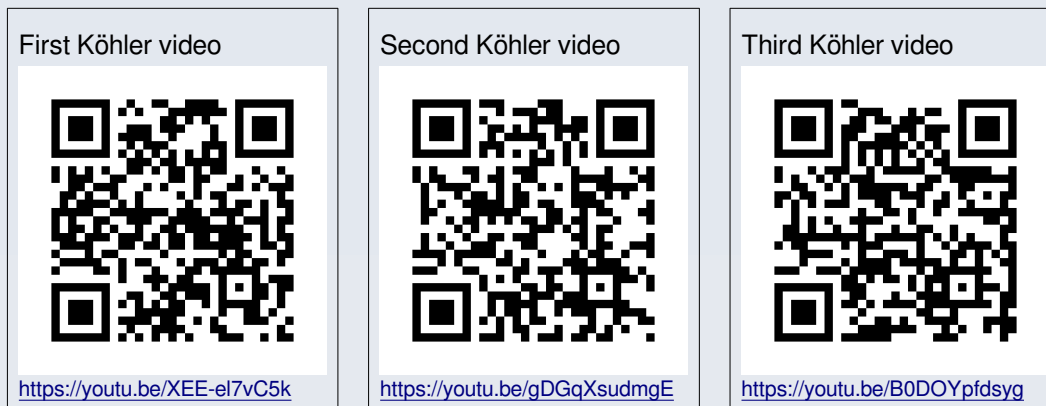
Figure 4: A 30 mm lens, spheroid type.



The upgrade procedure

Important: Please ensure you read the notes in this chapter in addition to (and before) following the upgrade video because the notes contain information that may modify the procedures described in the video due to the fact that the parts in this kit are partially pre-assembled for you.

Use and fitment of these parts are demonstrated in the three videos linked to below. Please see those first.



Note No alignment / collimating tools are provided with this kit apart from the single cross-hairs IFD filter. This should be sufficient to perform all required alignment with the daylight Köhler setup by looking down at the condenser from on top of the scope and by looking down the optical tube at the back-focal plane (BFP) of the objective.

Note: If you choose to apply the supplied 30 mm lens (as demonstrated in the third video) this will give approximately critical illumination (not Köhler) if used with an approximately collimated source. So this lens should not be fitted if you are using daylight from a distant source as your illumination or if you are providing some other kind of collimated external illumination.

Note: See figure 5. If the Abbe condenser is already in place and you screw the upper collector assembly into the thread at the base of the condenser, you can swivel the collector mirror block into position without removing this upper collector / condenser assembly from the stage provided you first loosen the condenser attachment plate thumbscrews to allow you to slide the whole condenser assembly as far forwards as possible. Once the collector mirror block is on, you can then re-centre the condenser (with the Köhler illuminator attached) and re-tighten the condenser attachment plate thumbscrews.

Do not to over-tighten any threads, especially 3D printed plastic threads, or damage to the models may result.



Figure 5. Procedure for connecting the collector mirror block to the upper collector and Abbe condenser without removing the latter structures from the stage. 1. First screw the upper collector assembly to the base of the Abbe condenser then loosen the thumbscrews under the stage that secure the condenser; 2. Slide the condenser / upper collector assembly forward as far as they will go; 3. Hook the collector mirror block onto the upper collector; 4. Secure the collector mirror block to the upper collector with its thumbscrews; 5. Re-centre the condenser and re-tighten its sub-stage thumbscrews. Reverse the process if you need to remove the collector mirror block.

Using the IFD filters

The cross-hairs filter supplied with this kit must be inserted with the cavity surface facing away from the mirror block. All other filter trays used in the PUMA system (those labelled as IAD filter trays) need to be inserted with the filter well cavity facing towards the collector mirror block. This is explained with illustrations in the 'Errata' video, link below. See specifically from time stamp 06:28.



Note that, due to the imperfect nature of the moulded glass lenses used in the Abbe condenser and Köhler illuminator that you will never get a fully flat focussed field for IFD filter patterns when viewed in the specimen plane and this lack of planarity increases with decreasing objective magnifications.

Likewise, for similar reasons, you will not get sharp or complete cut-off of light with an IFD filter pattern with this system and this effect will get worse with increasing magnification objectives.

Further information

The following videos on the PUMA Microscope YouTube channel give information that may be of interest when using your PUMA microscope with this upgrade kit:

Condenser Upgrade

<https://youtu.be/2wpsvA2cQgQ>

Köhler Illuminator

<https://youtu.be/XEE-el7vC5k>

Long Legs Stand System

<https://youtu.be/W5CvPGi-eL8>

Condenser 2

<https://youtu.be/80MFESelbnc>

Köhler 2

<https://youtu.be/gDGqXsudmgE>

Köhler Update

<https://youtu.be/B0DOYpfdsyg>

Stabiliser

<https://youtu.be/d8tMtWFhNY4>

See also the project GitHub repository for more information and details of any future upgrades or additions to the parts:

<https://github.com/TadPath/PUMA>

Maintenance

This chapter discusses routine user maintenance. For details about how to fully take-apart your condenser and re-assemble it see the PUMA Microscope YouTube channel videos.

Avoid excessive heat

The 3D printed parts are made of PLA plastic which has a glass transition temperature of about 60 °C (140 °F). This means it will start to soften and may deform if allowed to get near that temperature. It is advisable to avoid exposing the microscope to temperatures in excess of 40 °C (104 °F).

Under no circumstances should the scope be placed on or near a room heater or radiator (e.g. to dry off if it gets wet or for any other reason).

Avoid keeping the scope in a vehicle on a sunny day or in a transparent closed cabinet exposed to the sun.

Moisture and condensation

The 3D printed parts are made of PLA plastic which can withstand moisture by water and many solvents but it is not completely solid or waterproof meaning that if submerged or exposed to excessive wetness that liquid might find its way into the air cells inside microscope components and take a long time to evaporate. Furthermore PLA plastic is biodegradable so having aqueous solutions stagnating inside its components could hasten degradation (although noticeable effects may take several years).

For these reasons please protect your components from the rain and do not immerse the parts in liquid. The correct use of immersion oil is fine but the oil must be removed after use with absorbent tissue and do not use excessive oil.

Lens care

The lenses in the Köhler illuminator are strong moulded glass but if dropped on a hard surface they may crack or shatter so take care to avoid this.

The lenses are not coated with any special coatings and may become scratched if placed in contact with other glass lenses or other hard surfaces so take care when inserting and removing the lenses.

To clean the exposed surfaces of the lenses or other optical surfaces use an air duster or pneumatic soft lens brush to blow away any surface debris first. You may need to remove the collector mirror block and unscrew the upper collector assembly to get access to the flat surface of the upper collector lens for cleaning from time to time because plastic debris from the IAD filter insertions and removals may accumulate there over time.

Once surface dust is removed as described above, it should be possible to use ordinary soft absorbent household tissues to wipe away any oil or moisture.

Disposal and Recycling

The optics are made of glass.

The metal fixings are made of steel (mostly stainless steel but some elements may be galvanised steel).

The 3D printed plastic parts are made with poly-lactic acid (PLA) plastic. The following advice is current as of 2021. Consult your local authorities for the latest situation.

Recycling of PLA Plastic in the UK

Most councils in the UK do not accept PLA plastic in green or food waste.

PLA can be recycled but only by a very few specialist facilities. Most councils in the UK will not accept PLA plastic in their recycle bin waste.

PLA should therefore be disposed of in general household waste or sent to a specific facility that will accept it for recycling. Those with the ability to do so may also grind used PLA and reform it into usable 3D printer filament.

Recycling of PLA Plastic outside the UK

Please consult with your local authorities for recycling advice.

Electronics

The PUMA Köhler illumination upgrade kit has no electronic components.

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