



APOLLO

User Manual - Version 1.1

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Declaration of Conformity



This device complies with part 15 of the FCC rules. Operation is subject to the following conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation

Welcome to the Apollo Camera for Infrared Reflectography

Apollo is the latest advancement in infrared reflectography. Following in the footsteps of the world-renowned Osiris camera, Apollo uses an internal scanning mechanism to capture high resolution infrared reflectograms using a leading InGaAs area sensor.

By following this guide, you'll be ready to setup and use Apollo to capture your own high resolution infrared reflectograms in no time.

What's in the Box?



1. Apollo Camera Body
2. Allen Key for Securing Focus Rods
3. Lens Assembly
4. Focus Rods
5. Power Supply
6. USB Cable

Not Shown:

7. Software CD
8. User Manual
9. Light Plug and spares

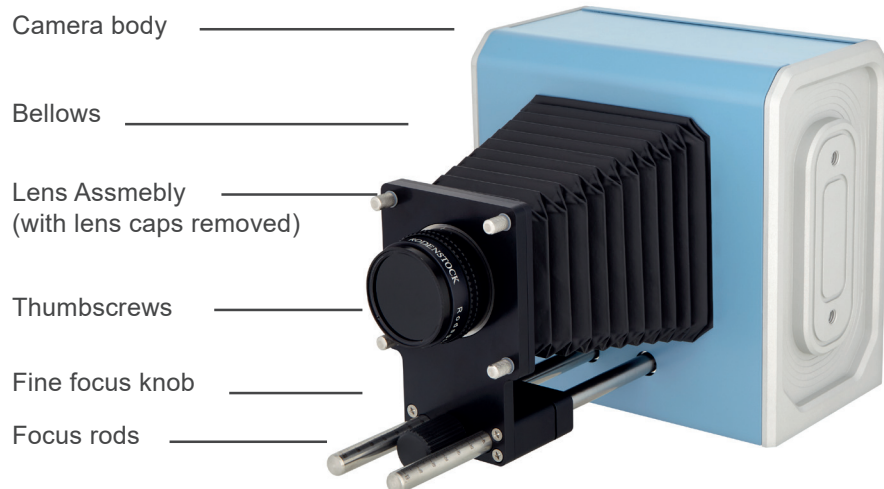
Assembling Apollo

The first thing you need to do is assemble Apollo.

The first time you assemble Apollo, remove the transit screw from the baseplate (see opposite) and replace with the supplied light plug.

After removing the transit screw, assembling Apollo can be done in six easy steps.

1. Remove your Apollo from its case and lie it on a flat surface.
2. Insert the focus rods into the holes on the front of the camera. Use the supplied allen key to secure the rods using the bolts on the underside of the camera.
3. Remove the lens cap from the camera body, and the back of the camera lens assembly.
4. Slide the lens assembly onto the focus rods.
5. Gently lift the bellows to meet the lens assembly and secure them in place using the four thumbscrews.
6. Slide the lens assembly slightly up the focus rods and gently secure using the screw on the side of the lens assembly.



Bolts to secure focus rods



Transit Screw - Remove before use

We recommend using Apollo on a tripod capable of supporting at least a 6kg payload. Apollo has both 1/4" and 3/8" tripod mount holes on the baseplate for compatibility with a large range of tripod mounts.

It's also possible to use Apollo on any flat surface, but be aware that the scanning process can cause vibrations and if Apollo moves or vibrates on the surface, you may see artefacts in your images.

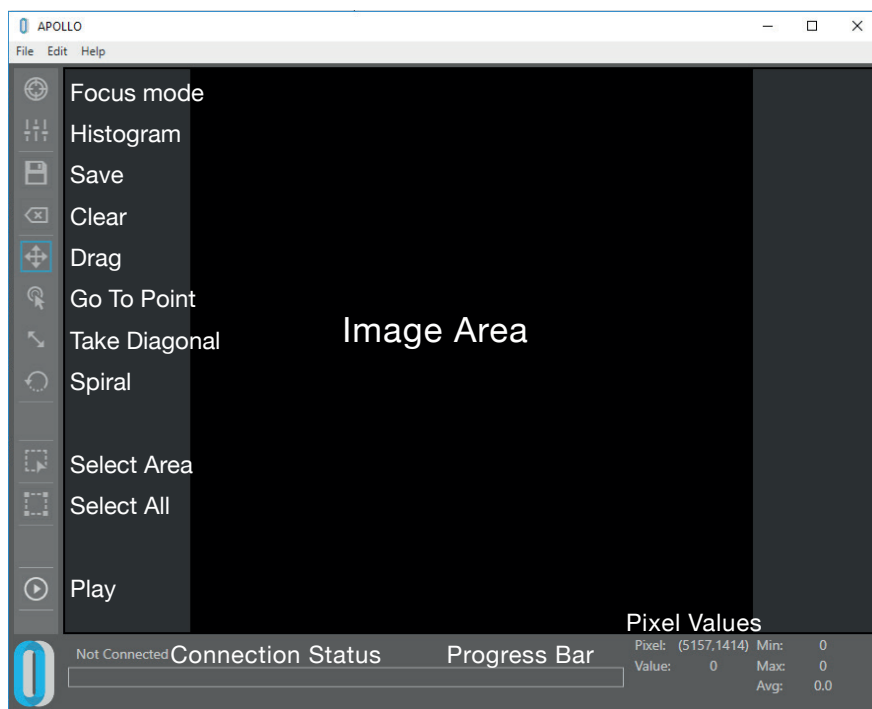
The Opus Apollo Software

Installation

The Opus Apollo software is supplied on CD ROM as standard. It is also possible to supply the software on USB stick or as a downloadable file when requested.

To install the software, insert the CD into your CD drive, run the ApolloSetup.exe file and follow the prompts.

The Home Screen



The Image Area

The black square represents Apollo's imaging area. Apollo captures a large number of small individual tiles and stitches them together to create an image over this entire area.

You can choose to select the entire image area, or select a subsection using the Select Area button.

Capturing additional subsections will continue to add them to the image area without erasing any current data. However, overlapping an existing subsection will overwrite it with the new selection.

Please note that overlapping sections which have been captured separately will not be blended at the edges. For high quality final images, we recommend always capturing your whole desired area as a single selection.

Clearing the Image Area

Select the Clear button to clear the image area. This will prompt a warning asking if you wish to clear the current image data, prior to clearing the image area.

The Home Position

When you switch on Apollo and open the Opus Apollo software, the camera will default to its Home Position. This corresponds to the top left hand corner of the image area.

Warm Up Time

The InGaAs sensor in Apollo is cooled to provide the best imaging performance. After switching on Apollo and connecting to the Opus Apollo software, it is good practice to wait for five minutes before taking a high quality capture to allow the temperature to stabilise. There is no problem with using this time to begin setting up, focussing and checking your lighting and positioning.

Setting up for your Session

Setting up carefully for an imaging session will help you capture the best quality images.

As a brief overview, the setting up process is generally:

- Assemble Apollo and place on tripod
- Position Apollo and evenly illuminate your subject
- Focus
- Check positioning and lighting in software
- Take dark frame
- Capture image

As you gain experience with Apollo, you'll likely develop your own processes and preferred ways of doing things, but the following pages should help you understand and master these main aspects of getting set up.

Positioning the Camera

First of all, you need to position Apollo at the optimum distance from your subject to capture the whole of your desired field of view. There are a couple of easy ways to work out this distance.

First, measure the longest edge of your subject, or the longest side of the area you would like to capture.

The table opposite shows a range of possible values for the longest edge and the minimum distance Apollo must be to capture the entire subject in a single image.

We recommend setting Apollo slightly further away than this to add a little flexibility in positioning the camera.

For example, for a painting with a longest edge of 80cm, Apollo must be at least 157cm away to capture the entire painting. We would advise setting Apollo around 165cm away to leave a margin of error.

Minimum distances for edge values within those in the table can be judged by the available values - for example if you have a painting with a longest edge of 96cm, we would set Apollo around 185 - 190cm away.

Longest Edge (cm)	Minimum Distance (cm)
50	113
60	128
70	142
80	157
90	172
100	186
120	216
140	245
160	275
180	304
200	333

Please note! All measurements should be taken from the front of Apollo's case.

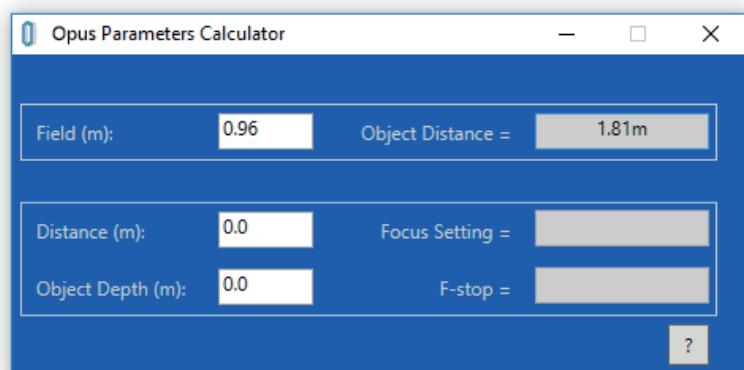
We also have [Parameters Calculator App](#) available on our website, to help calculate how far away from your imaging subject you should place Apollo.

Using the Calculator

Input the longest edge of your subject into the calculator as the 'Field'. The Object Distance will display the minimum distance required to fit your entire subject in the field of view.

You may wish to place Apollo a little further away than this to add flexibility when positioning the camera.

All measurements should be taken from the front of Apollo's case.



With Apollo positioned at your desired distance, check that the plane of the camera is parallel with your subject.

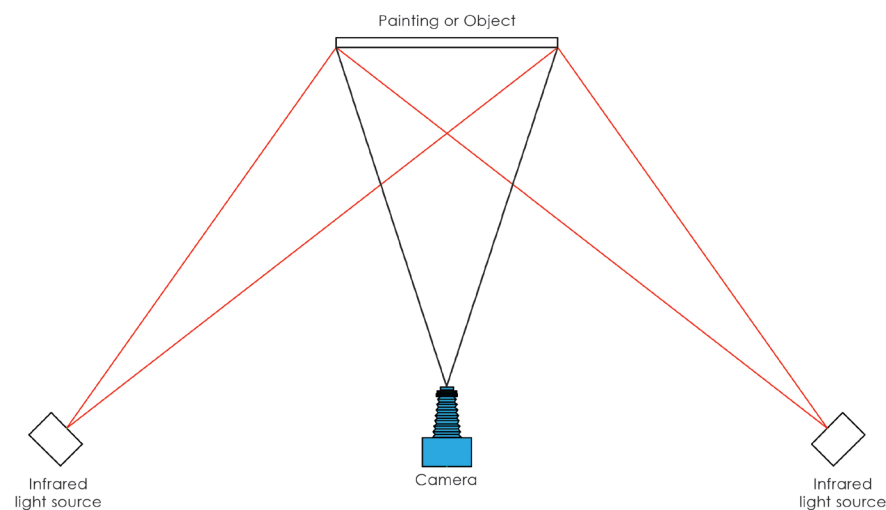
Lighting

Apollo is designed to use a tungsten halogen light source, though it is possible to use any light source that emits in Apollo's wavelength sensitivity (900 - 1700 nm).

For optimum image quality, it is important to illuminate your subject evenly. Two tungsten halogen light sources usually work well. However, if you encounter problems with the vertical uniformity of your lighting, you may want to consider using an array of lights on either side of Apollo.

It is best practice to have the illumination angled between 30 and 60 degrees. The diagram below shows a typical set up that should be suitable in most circumstances.

You can use the Apollo software to help check your lighting levels by monitoring the histogram and maximum and minimum pixel values. This is covered in more detail on page 22.



Lighting Stability

It is important to try and keep the lighting stable throughout an image capture. Variations in lighting during a capture can result in uneven illumination or artefacts in the finished image.

It is good practice to allow your lamps sufficient time to warm up and stabilise before taking your final image. A few minutes is usually fine for this. It is important to minimise other sources of variation, such as sunlight, opening and closing doors and moving around during image capture.

F/number

Your lens has an f/number that varies from 5.6 to 45 in steps. Changing the f/number has three effects:

1. Large f/numbers give greater depth of field. Subjects that aren't flat will require larger f/numbers to ensure that the whole of the object is in focus.
2. The larger the f/number, the less light will be collected by the camera, meaning large f/numbers may require an increase in illumination or exposure time.
3. The optical resolution of the camera is affected by both the f/number and the sensor. At low f/numbers, the resolution is limited by the sensor. For f/numbers large than f/16, the resolution is limited by the f/number.

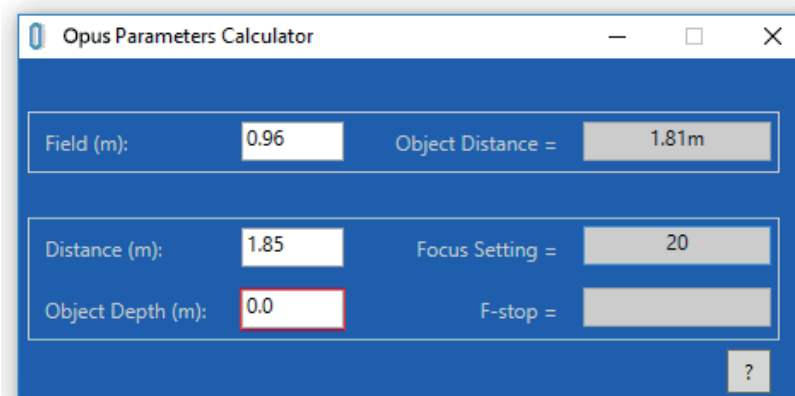
F/8 or F/11 are often suitable for many types of painting, or other relatively flat subjects. For non-flat subjects, you might like to use the Parameters Calculator App to help select a suitable f/number.

Focusing Apollo

Using the correct focus setting is key to capturing high quality, detailed images. As you become accustomed to using Apollo, you will find it easy to set the correct focus position of the lens assembly on the focus rods using the focus assist mode in the Opus Apollo software.

When starting out, you may find it helpful to use the Parameters Calculator App to provide an estimated focus setting.

To find your suggested initial focus setting using the Parameters Calculator App, enter the distance you have chosen to put Apollo from your subject into the Distance box. The calculator will provide a suggested initial Focus Setting. This is the recommended distance at which to slide the lens assembly on the focus rods. This position should be very close to the optimal focus position for your distance, but may need fine tuning depending on your imaging subject.



The screenshot shows the 'Opus Parameters Calculator' application window. It has a blue background and a white title bar with standard window controls. The interface is divided into two main sections. The top section contains two input fields: 'Field (m):' with the value '0.96' and 'Object Distance =' with the value '1.81m'. The bottom section contains three input fields: 'Distance (m):' with the value '1.85', 'Focus Setting =' with the value '20', and 'Object Depth (m):' with the value '0.0'. A small question mark icon is located in the bottom right corner of the application area.

Field (m):	0.96	Object Distance =	1.81m
Distance (m):	1.85	Focus Setting =	20
Object Depth (m):	0.0	F-stop =	

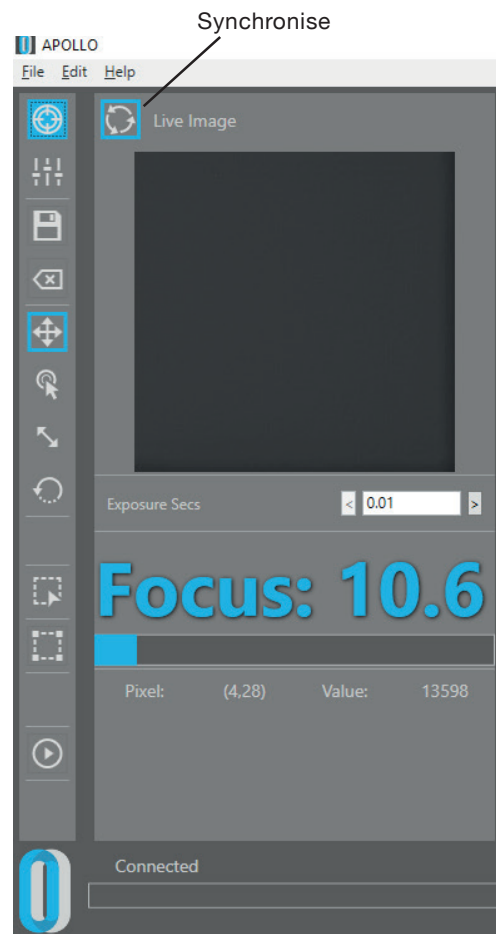
Focus Mode in Opus Apollo

The Apollo Software has a Focus Mode that will help you achieve the correct focus.

If you select the Focus Mode button, you will be shown a live preview from the sensor. The sensor is a 128 x 128 px area sensor, so you'll only be seeing a very small area, but it should be enough to help you achieve the optimum focus. The Synchronise button can be used to stop and restart the live preview.

Focus mode displays a focus measurement in the form of both a number and a focus bar. The number it uses is a compression calculation to measure the amount of detail in the image. The actual number displayed will vary greatly depending on the imaging subject, so there is no set number to be aiming for. Instead, what you are looking for is the highest value you can achieve on that particular tile.

As you gently slide the lens assembly on the focus rods, you will see the number increase or decrease, and will see a live update of the image tile. Gently adjust the lens assembly position until the number is at the



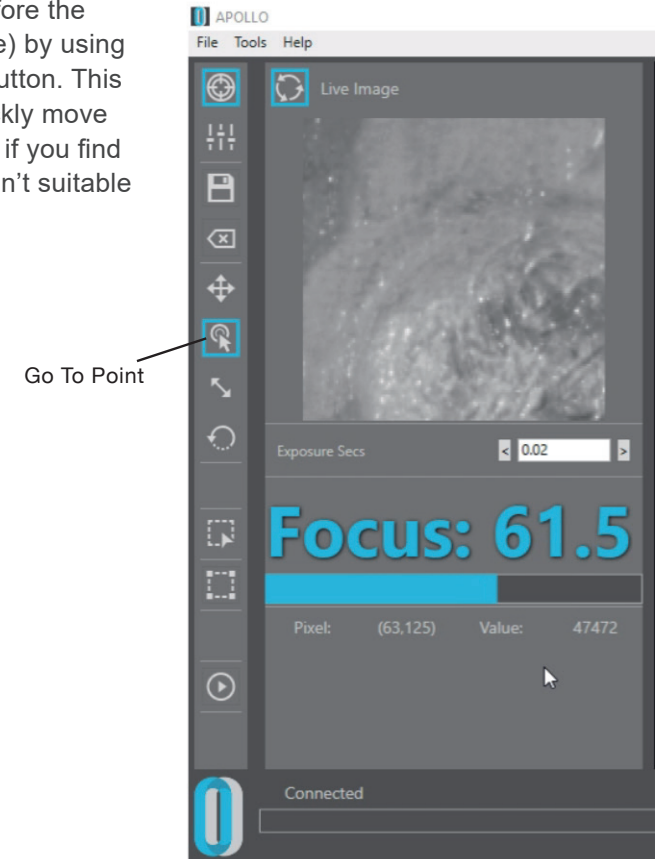
highest value you see for that tile and the image is visually sharp, and then secure the assembly on the focus rods.

Now adjust the fine focus knob on the front of the lens assembly to further fine tune the focus.

The focus number should be at its highest value for the given tile, and the image should be visually sharp.

It's best to use a tile with a recognisable feature. Things such as strong lines or cracks can provide good opportunities for focusing.

You can move the sensor in Apollo (and therefore the contents of the tile) by using the Go To Point button. This allows you to quickly move around the image if you find your current tile isn't suitable for focusing.

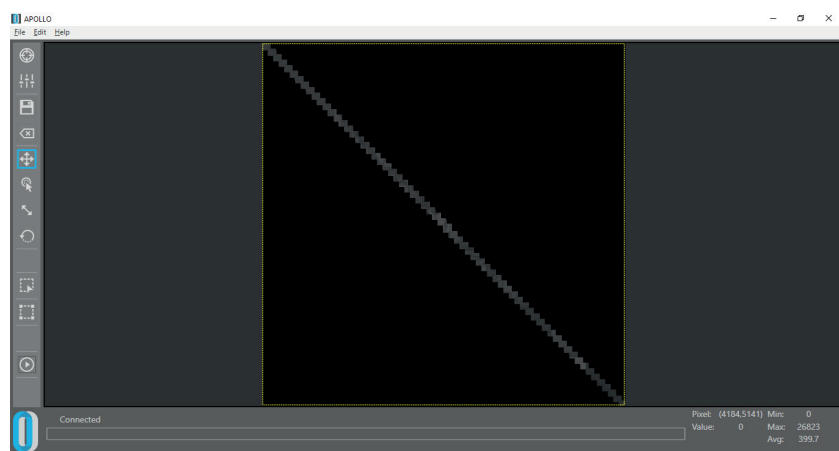


Checking Your Positioning

If you've set up using the Calculator App and positioned Apollo in the centre of your subject, you're nearly ready to go, but it's good practice to first check your positioning and lighting.

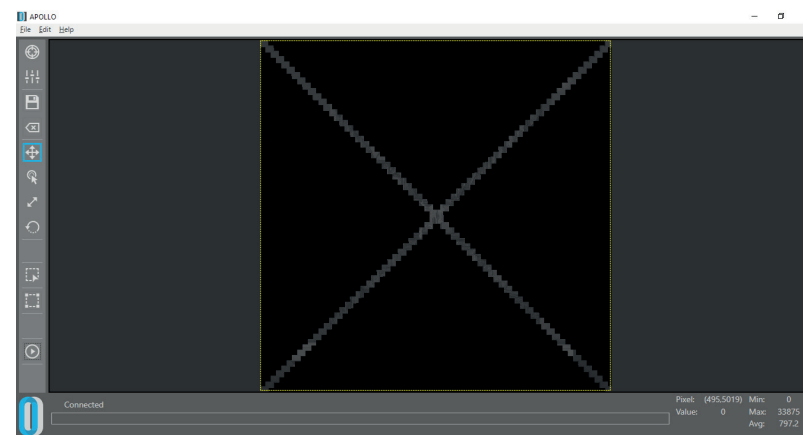
Using Diagonals

The Opus Apollo software includes a diagonal capture function that is useful for checking your field of view and the positioning of your subject. Selecting the Diagonal button will automatically select the whole imaging area. However, if you'd like to take a diagonal of a set area, you can drag to select it on the image area.



Clicking the Diagonal button twice changes the direction of the diagonal.

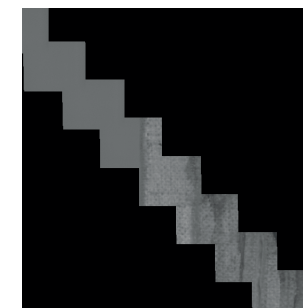
To capture your diagonal, press the Play button. To take an 'X', capture one angle of diagonal, click the diagonal button to change the direction, and press Play again to capture the new diagonal.



From this, you should be able to identify the top and bottom edges of your subject.

You might now want to check the side edges, or where you suspect the corners to be. You can do this by pressing the select area button, and dragging over your desired area. Press the Play button to capture your selected area.

At this point it's also worth zooming in to check that you are focused across your entire subject. You might wish to capture a couple of additional areas to check this.



Please note! You should always check your focus after adjusting the positioning of your camera or subject and fine tune if necessary.

Spiral Capture

There is also a spiral capture mode that alters the way the way the sensor is moved on the motors. It will start in the middle of your selected area and 'spiral' out until the entire selected area is captured.

To use it, select the spiral icon, select your area and then press Play.

Spiral mode can be useful if you are looking for a particular feature, but please note that it's intended as a preview mode and will not result in the highest quality results.

The Histogram

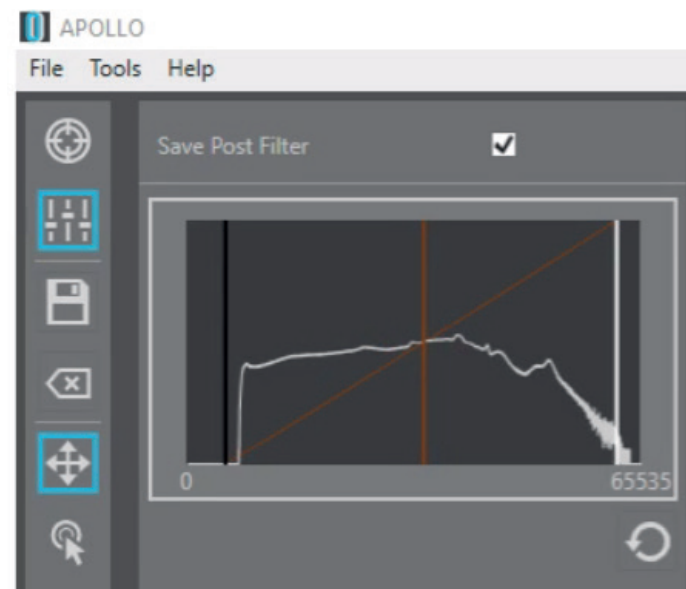
The Opus Apollo Software includes an adjustable histogram that helps you get the most out of the available dynamic range of Apollo.

You can adjust the black level, white level and grey level to alter how the image is displayed. To adjust the black level, click and drag the black slider. By default, this will be at the left side of the histogram.

To adjust the white level, click and drag the white level slider. By default, this will be at the right side of the histogram.

To adjust the grey level, click and slide the orange level slider. By default, this will be in the centre of the histogram.

The histogram will show whether you have values clipped at either end.



If your histogram is clipped at the black end (left) then you should try increasing your lighting. You can also try increasing the exposure time if increasing the lighting level isn't possible.

If your histogram is clipped at the white end (right) then you are oversaturating your image and data is being lost. Try decreasing your lighting. You may also want to decrease the exposure time if this is set higher than 0.01s.

Ideally, you are looking for a histogram with values spread across the entire range, without being clipped at either end.

The Save Post Filter button alters whether the image you save is with the current histogram values - ie as currently displayed on screen - or the full range of values - ie with no stretch applied.

Checking Your Lighting

In most circumstances, you can probably visually identify what are likely to be the brightest and darkest areas of your subject. Before taking a full capture, it's good practice to check that your brightest points won't saturate, and your getting adequate lighting on the darkest points of your image.

Using the Go To Point selector, you can quickly move around your image. Opening the Focus menu will provide you a preview of the current tile, along with the minimum and maximum values for that tile.

A value in the region of 60,000 may mean that pixel is saturating and you should decrease your lighting or exposure time.

Pixel:	(347,4332)	Min:	0
Value:	0	Max:	24838
		Avg:	370.5

Dark Frames

Like all imaging sensors, the sensor in Apollo accumulates dark current during an exposure. This appears in the form of noise that can decrease the quality of your final image.

Apollo uses a dark frame to adjust for dark current and remove it from the image.

We recommend taking a new dark frame before each 'final' image you capture. This makes our recommended process:

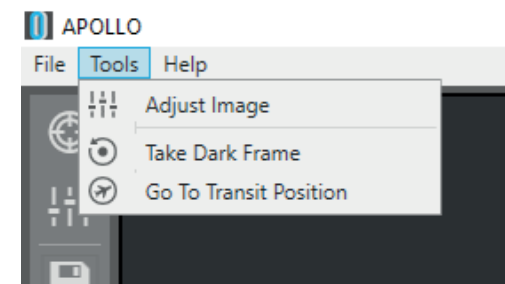
Set up Apollo > Adjust positioning, lighting and focus > Take dark frame > Take image

This ensures your dark frame is taken in the same environmental conditions and exposure time as your image.

In practice, if you consistently image in very similar conditions, the same dark frame should be sufficient over a number of sessions. However, any changes to things like temperature and exposure times will require a new dark frame for the best quality results.

You can take a dark frame by selecting the Dark Frame button in the tools menu - the rest of the process is automated.

If you haven't been updating your dark frame and find the quality of your images is decreasing, or you start seeing artefacts in your images, try taking a new dark frame to see if that solves the problem.



Taking a Picture

With Apollo positioned and focused, and your subject evenly illuminated, and our dark frame captured, you're ready to take your full image.

You can choose whether to capture the whole image area, or select the area around your subject.

Given the square field of view of the camera, it is unlikely your subject will fill the whole frame. This means we often find a selection to be preferable, as it will save a little time.

With your area selected, press the Play button to capture your image.

After 10% of the selected area has been captured, Apollo will provide a countdown showing the estimated time left to completion.

Updating Display

At the end of a capture, Opus Apollo will perform a high quality stitch of the captured image tiles. This can take a moment, and 'Updating Display' will be shown while this process is taking place.

On its completion, you will see the refreshed, high quality, stitched image of your subject.

Saving

You can save your image in a selection of file formats, depending what best suits your needs. The options are:

.tif
.png
.jpg
.fit

If the 'Save Post Filter' box is checked in the histogram menu, the image will be saved with the current stretch applied. Unchecking this option will save the full range of unstretched values.

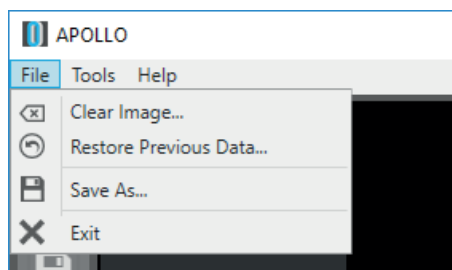
Saving an image saves the whole image area, so you may wish to crop your images in third party software.

Image Restore

The Opus Apollo software automatically keeps a backup of your current imaging session. This is kept even after you close the software,

so it's possible to restore your previous session and continue working with it.

To do this, select 'Restore Previous Data...' from the File menu. Any currently displayed unsaved image data will be removed.



Exposure Time

One great feature of the Apollo is that you can easily adjust the exposure time through the Focus menu.

Increasing the exposure time can be beneficial if you are in a situation where increasing the lighting level is not possible. It's also useful when using filters, as these pass less light.

Note that increasing the exposure time will also increase the amount of time it takes to capture an image.

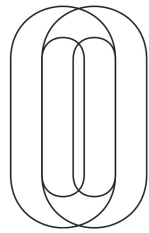
The Transit Screw

It is vital to remove the transit screw before using Apollo. Once the screw is removed, the hole can be filled by pushing in the supplied light plug.

It is possible to replace the transit screw if you're transporting Apollo a significant distance. This is a very sensitive process and we ask you to contact us using the contact form on our website www.opusinstruments.com or call us on +44 (0) 1603 740397 before replacing the transit screw so we can provide full instructions.

It is not necessary or recommended to replace the transit screw unless less transporting Apollo a significant distance in unmonitored conditions.





MACRO LENS AND
ILLUMINATION SYSTEM

Unpacking and assembly

Camera—Object Distance

Your lighting case holds the following parts;

- Instruction manual
- Lighting body
- Power supply
- Macro Lens

Assembly

1. Lay the camera on its back and remove the normal lens assembly consisting of the 150mm lens and the front plate.
2. Slide the lighting assembly onto the rods.
3. Unscrew the 150mm lens from the front plate — note the spacers behind the lens. These ensure that the F/stop display is visible when the lens is secured to the camera. Screw the Macro Lens into the front plate. The spacers may or may not be necessary to achieve the correct orientation of the F/stop display.
4. Slide the lens assembly onto the 2 rods and secure the lens plate to the bellows using the 4 thumbscrews.



The lighting control

Adjusting the lighting

Your lighting power supply has an on-off switch and a knob which allows adjustment of the lamp brightness. The necks of the lamps can be bent to allow optimum illumination of the object. The heads also swivel providing increased flexibility.

Heat Sensitive subjects

For subjects that are very sensitive to heat the lamp can be dimmed whilst setting the camera up. This will produce a dark image on the display. In order to achieve an image which will allow you to set the camera focus you may need to change the camera integration time.

Try changing the settings to 10msec HIGH GAIN to achieve an image bright enough to allow you to focus. NOTE—Your camera will not have been calibrated for 10msec HIGH GAIN and you will receive the message indicating this. The image will be slightly noisy and have horizontal stripes. When you are happy with the image focus and field then you may reset the camera to the 60Hz and adjust the lighting brightness in order to grab an image.

The lens F/number

Varying the lens F/number

The lens F/number is set by rotating the ring on the lens. Your lens has an F/number that can vary from 4.5 to 22 in steps. Varying the lens F/number has 3 effects.

1. The larger the F/number the greater the depth of field at the object. Objects which are not flat will require larger F/numbers to ensure that the whole of the object is in focus. The depth of field for different object distances and lens F/number is given in the appendices.
2. The larger the F/number the less light that the camera will collect. In order to maintain the amount of light on the detector either the exposure time must be increased or the illumination levels increased. An increase by one stop (e.g. F/11—F/16) will require a factor of 2 increase in illumination.
3. The resolution of the camera is a function of both the detector and the F/number. For low F/numbers the resolution is limited by the detector. For F/numbers greater than F/16 the resolution is limited by the F/number. Optimum imaging is between F/4.5 and F/11.

Initial set-up

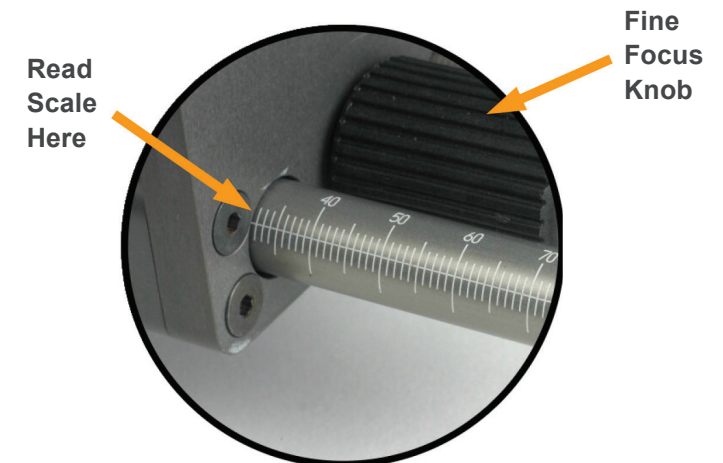
Camera—Object Distance

Using the graph in the appendix (BLUE LINE) select the camera object distance for the size of your object. Remember the camera has a square image format so take the largest object dimension.

**ALL MEASUREMENTS SHOULD BE TAKEN
FROM THE CENTRE OF THE OBJECT TO
THE FRONT OF THE CAMERA CASE**

Set the nominal focus

Use the graphs in the appendix (RED LINE) to select the focus setting and adjust the lens. The focus scale should be read at the front of the lens as per the diagram below. Which shows the lens set to 32.



Taking a picture

Set the F/number

Estimate how flat is your object. For flat objects set the camera to F/4.5. For non flat object use the graphs in the appendix to select the F/number.

Adjusting the fine focus

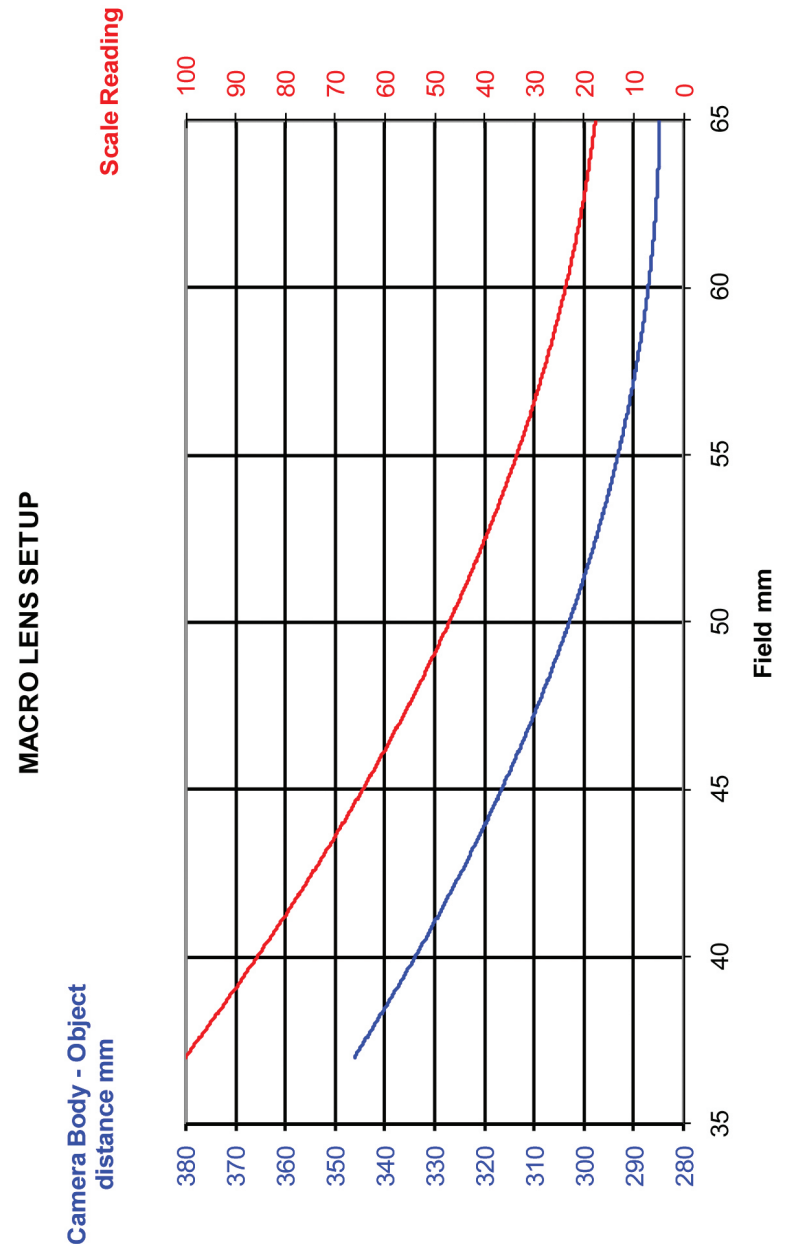
You will note that the camera—object distance does not vary greatly for different size objects. Adjusting the fine focus knob will vary the field size as well as the focus. It is therefore best to move the whole camera nearer or farther from the object to achieve an image that is close to focus before adjusting the fine focus.

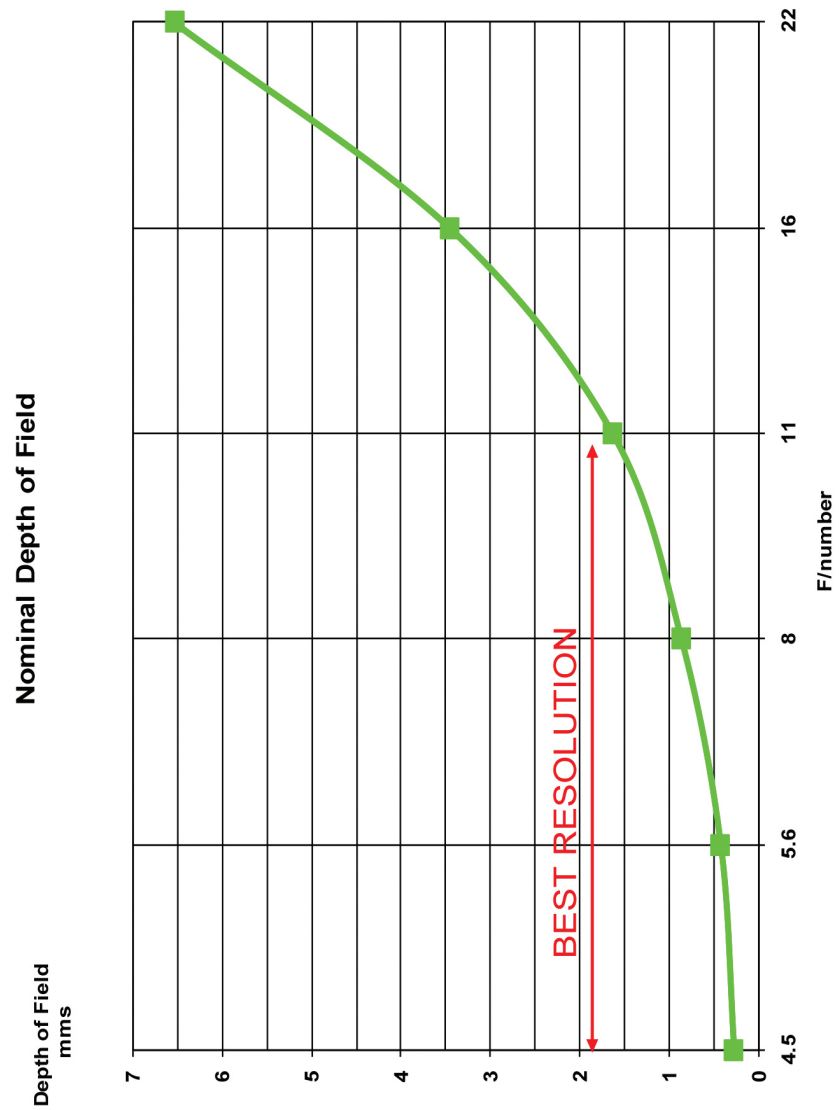
An Example

You have a 50mm object which is flat to 2.5mm. From the LENS SETUP graph and using the RED LINE we read off a value for the Scale reading of 47 for an object of 50mm.

Using the BLUE LINE on the graph we see that the camera—object distance should be 303mm.

The depth of field graph shows that we need to operate at either F/11 or F/16 to have all the object in focus.





Futher Information

If you would like any further help and advice on setting up or using your camera, please don't hesitate to get in touch with us.

Give us a call on [+44 \(0\) 1603 740397](tel:+4401603740397)

Or you can contact us using the contact form on our website www.opusinstruments.com where you can find more information about your camera, along with available accessories and case studies on infrared reflectography. If you have any research you'd like to share with us or on our site, we'd be delighted to hear from you.

We're always happy to help.



www.opusinstruments.com
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