DE BEERS GROUP

SynthDetect™

Operating Manual



PLEASE READ THIS IMPORTANT INFORMATION PRIOR TO USE

DISCLAIMER

The intended use of this SYNTHdetect instrument is expressly limited to that set out in Terms and Conditions for the Supply of SYNTHdetect instruments, Software and Warranty support services (the "Conditions") and this Operating Manual. Changes to this Operating Manual will be effective once they are published on https://www.iidgr.com. Continued use of the SYNTHdetect instrument signifies acceptance of these changes.

DISCLAIMER

This is an EMC Class B product. These products may be used in residential/domestic environments and commercial/business/industrial environments.

IMPORTANT NOTICE

THERE ARE NO USER SERVICEABLE PARTS WITHIN THE INNER SYNTHdetect INSTRUMENT COVERS.

INTELLECTUAL PROPERTY RIGHTS

The SYNTHdetect instrument is protected by intellectual property rights including the following patent: WO2017001835

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1 LIMITATIONS OF USE

The SYNTHdetect Instrument

- Is a screening device intended for use in all locations where loose diamond and diamond containing jewellery pieces are handled and which meet the environmental conditions specified in section 2.4.
- Is designed to accept loose diamond and a range of jewellery pieces to discriminate natural from synthetic diamond and commonly used diamond simulants.
- Requires a level of operator interpretation.
- Is only intended for use with colourless or near-colourless diamonds.
- Will have increased referral rate if used for fancy coloured diamonds.
- Is not intended for use in the classification of other precious gems or diamond simulants, nor to detect the treatment of natural diamonds, e.g. fracture filling, irradiation or high pressure high temperature treatments.
- Does not screen for diamond type.
- Contains software to aid in the interpretation of results. Users should treat this as a guide and always compare images with those contained in the Image Library.

The diamonds used in the SYNTHdetect Instrument

- Must be placed in the field of view of the camera.
- Must be in direct line of sight of the excitation source.
- Must be completely uncovered i.e. not in bags or located under watch glasses.

The jewellery used in the SYNTHdetect Instrument

- Must be placed in the field of view of the camera.
- Must be in direct line of sight of the excitation source.
- Must be completely uncovered i.e. not in bags.
- May need to be manipulated to visualise all set stones.

Stones which are indicated as potential non-natural diamond by the SYNTHdetect instrument should not be classified as synthetic diamond or diamond simulant without additional testing as a very small percentage of natural diamond may show similar characteristics.

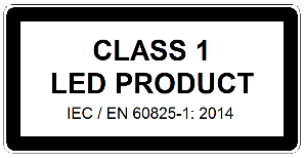
2 SAFETY INFORMATION

2.1 SAFETY LABELS USED ON THE SYNTHDETECT INSTRUMENT

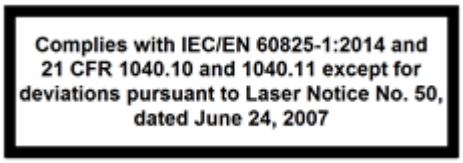
The SYNTHdetect instrument operates from a 24 V D.C. power limited supply unit which is connected to the mains supply using a standard IEC flex supplied by the manufacturer.

⎓

The SYNTHdetect instrument contains a high power pulsed xenon source. Safety interlocks are fitted to prevent exposure of the operator to the source output.









2.2 POSITION OF LABELS

2.2.1 External Labels

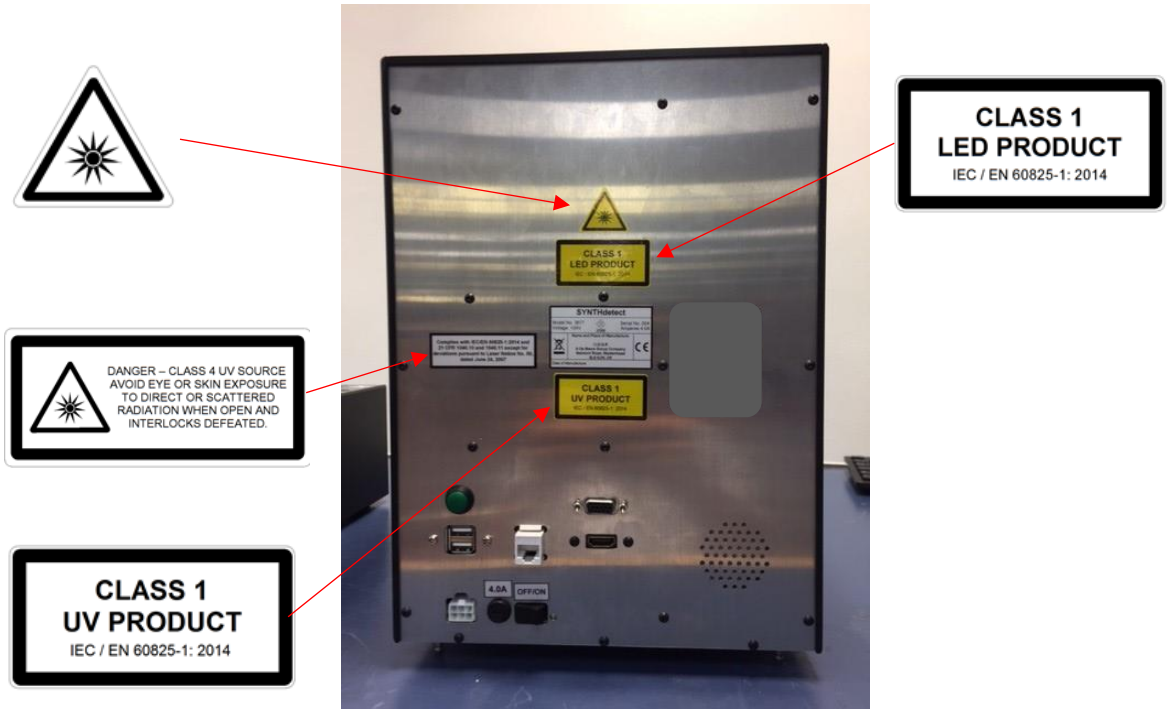


Figure 1– External labels on rear view of the SYNTHdetect.

2.3 ENVIRONMENTAL

The SYNTHdetect instrument is designed for indoor use only.

It operates from a supply voltage of 24 V D.C. and fused at a maximum current of 4.0 A.

Warning

The SYNTHdetect instrument must only be used with the power supply provided.

The SYNTHdetect instrument is designed for use in a non-industrial electromagnetic environment. Under certain electromagnetic conditions it is possible that the SYNTHdetect instrument will require to be restarted in order to continue to operate.



This equipment is marked in compliance with EU directives 2012/19/EU and EN50419.

It is marked with the recycling symbol as shown. It means that at the end of the life of the equipment it must not be placed in the normal domestic unsorted waste stream. Please return it to the manufacturer at the address below for appropriate recycling and disposal:

De Beers Technologies UK
Belmont Road
Maidenhead
Berkshire SL6 6JW
United Kingdom

The SYNTHdetect instrument should only be used in accordance with the instructions given in this Operating Manual. Failure to follow these instructions could impair the safety protection that is provided.

The SYNTHdetect instrument contains a short wave ultraviolet source. The safety aspects of this potential hazard are also discussed in section 2.6.

Caution

Use of controls or adjustments or performance of procedures other than those specified herein may result in exposure to hazardous ultraviolet radiation.

2.4 GENERAL SAFETY

The SYNTHdetect unit should only be used in accordance with the instructions given in this Operating Manual. **Failure to follow these instructions could impair the safety protection that is provided.**

The SYNTHdetect unit is a Class 1 Ultraviolet (UV) product. The safety aspects of these potential hazards are discussed in section 2.6.

Warning



Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous exposure ultraviolet radiation.

2.5 UV SAFETY

The SYNTHdetect has been designed to protect the user from exposure to UV radiation. Internally the UV light path is entirely enclosed and the bottom jewellery chamber forms part of an interlock system.

Prior to using the SYNTHdetect the condition of the front cover should be inspected. **In the event that the cover becomes cracked the user should immediately isolate the SYNTHdetect unit from the mains and return it to the supplier for servicing.**

2.6 SERVICE WARNING

SYNTHdetect will warn the user periodically that a calibration is required. It is strongly advised that this is conducted. Refer to section 5.2 Calibration.

Warning



There are no user serviceable parts within the inner SYNTHdetect unit enclosures.

3 INTRODUCTION

3.1 GENERAL

This manual describes the installation and operation of the SYNTHdetect.

This instrument is designed to generate surface luminescence in diamond samples.

The vast majority (>99.9%) of colourless/near colourless natural diamond exhibits a characteristic pale blue phosphorescence that exists for tens of milliseconds after UV excitation pulse. This phenomenon is used as a specific marker to positively identify a natural diamond as this feature is not observed in high pressure high temperature (HPHT) or chemical vapour deposition (CVD) synthetic diamond. The marker can be observed in both Type Ia and Type IIa diamonds and as such is a type independent screening instrument.

The SYNTHdetect instrument may be used with a wide variety of polished or rough colourless/near colourless diamond either loose or in set jewellery.

The apparatus consists of a xenon flash lamp producing microsecond pulses and special ultraviolet filter with optics to produce an area of ultraviolet illumination at the sample. The flash lamp illumination is controlled by accurate timing electronics. The sample can be viewed with the camera exposure and UV excitation synchronised to produce a fluorescence image, or with a variable offset (or exposure delay) applied to produce a phosphorescence image. The sample may be viewed under white light conditions, to aid with focussing and stone identification in jewellery. The sample may also be viewed live under white light, fluorescence and phosphorescence simultaneously.

3.2 OPERATING PRINCIPLE

Ultraviolet light of wavelength less than about 225 nm is substantially absorbed within a few microns of the diamond surface to produce what is effectively a surface luminescence image. The decay characteristics of the luminescence can be imaged with microsecond timing accuracy.

3.3 KEY FEATURES

3.3.1 SYNTHdetect Hardware and Software

The SYNTHdetect user interface provides control of the instrument in the different sample excitation and imaging modes and allows users to view, manage and export sample snapshots captured with the Instrument.

3.3.2 Image library

The SYNTHdetect is supplied with example images of polished natural diamonds, HPHT (high-pressure, high-temperature) synthetics grown in a belt-type press, HPHT synthetics grown in a BARS-type press and CVD (Chemical Vapour Deposition) grown synthetics. These images also show the luminescence characteristics of each type under varying camera conditions, i.e. exposure times and exposure delays.

It is recommended that new users of SYNTHdetect take time to review these images with the supporting notes accompanying each image. These images can be useful in comparing with captured images.

3.3.3 SYNTHdetect Front View

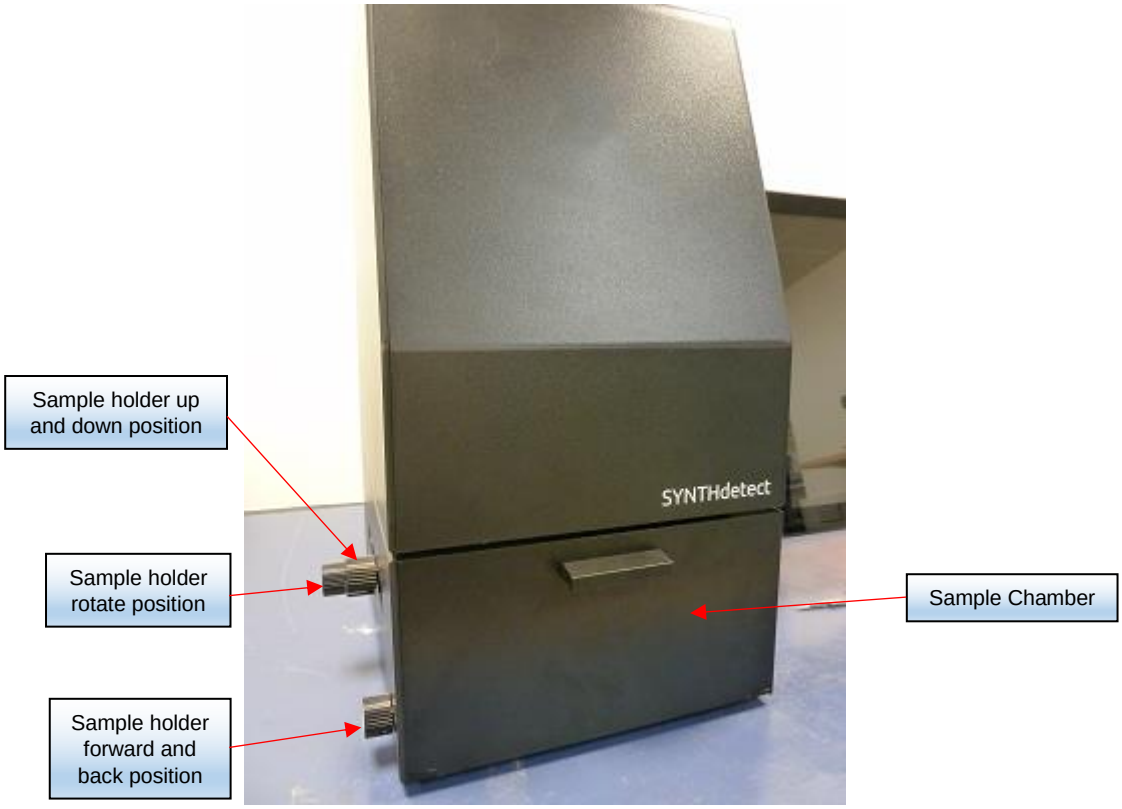


Figure 2 - External controls and sample chamber.

3.3.4 SYNTHdetect Rear View

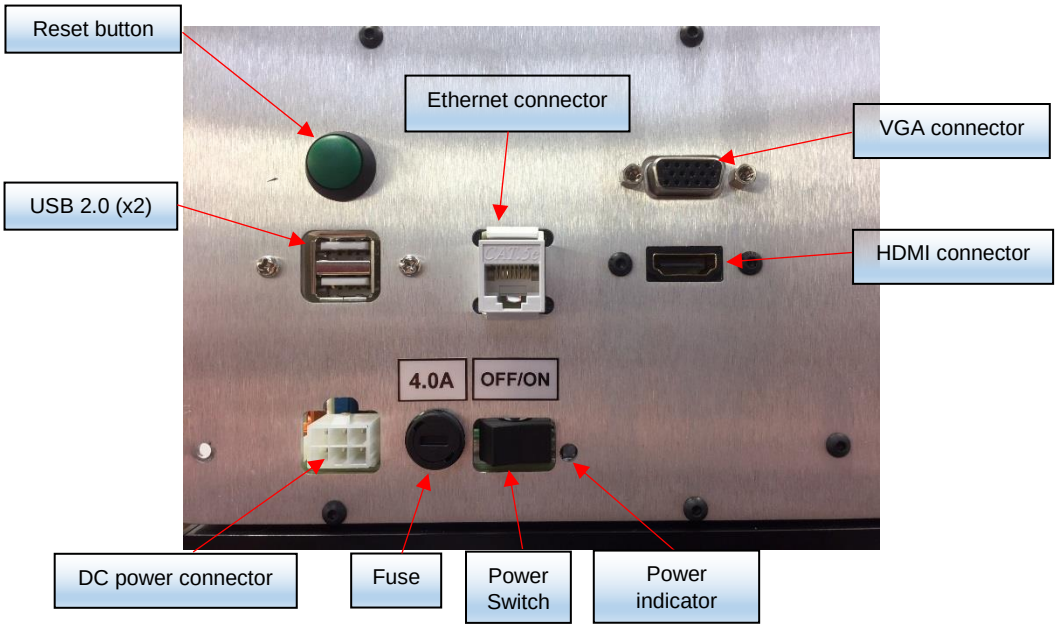


Figure 3 – Rear view of the SYNTHdetect unit.

	Description
VGA connector	The VGA connector allows connectivity to the monitors VGA port. VGA by default.
HDMI connector	The HDMI connector allows connectivity to the monitors HDMI port. HDMI may not automatically connect to some monitors. VGA is recommended.
USB 2.0 connector	This USB connector is used for connecting the monitor touch screen to the embedded PC. It can also be used for keyboard or mouse connectivity (not supplied).
Red LED Indicator	When this LED is lit it indicates that the SYNTHdetect instrument is powered on.
Power Switch	The power switch is a toggle switch that switches power to the SYNTHdetect instrument.
DC Power Input	The power input takes 24V from the mains power adaptor supplied with the instrument.
Ethernet	The Ethernet allows connectivity to the user's network for transfer of images, or connectivity to the internet for software updates.
Reset	The Reset Button allows for soft power down in the event of system crash.

3.3.5 Jewellery Piece and Melee Control

The SYNTHdetect has external control knobs to allow the manipulation of the jewellery piece or melee tray. These control knobs allow the following range of movement

1. Forward – backward
    a. This control will move the melee tray/jewellery holder backwards and forwards (top to bottom of screen image)
2. 360 degree rotation
    a. This control will rotate a jewellery piece holder 360 degrees. **Note:** This is not used for the melee tray.
3. Up – down (focus)
    a. This control is used to move the melee tray/ jewellery holder closer or further away from the camera lens.

Note: The 2/3 control knob can also be used to move the jewellery piece backwards and forwards.

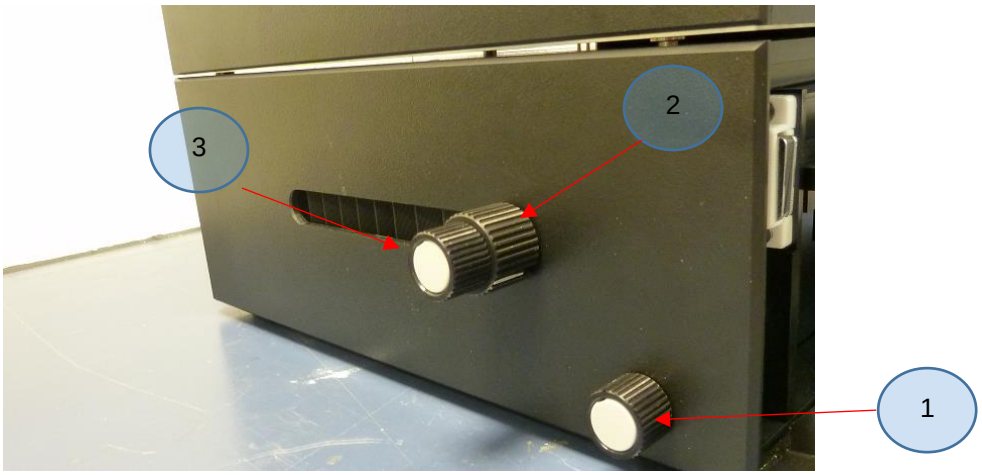


Figure 4 – External control knobs.

To open the SYNTHdetect pull the black handle as shown below. The door has a slow opening feature so it is not required to be supported whilst opening.

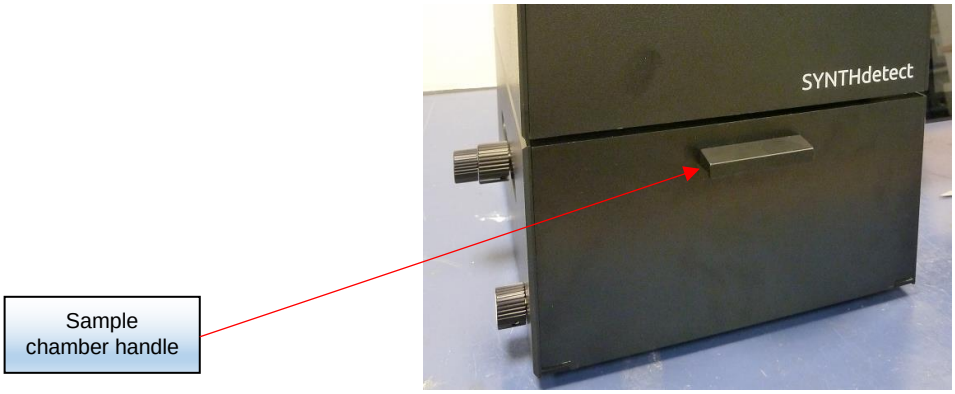


Figure 5 – Sample chamber handle.

3.3.6 Jewellery Piece / Melee Holder

The SYNTHdetect chamber has been designed to allow the inspection of various jewellery pieces and melee diamonds using a variety of jewellery holders.

To add the required holder follow the instructions below:-

1. Open the sample chamber (see 3.1) and pull the forward – backward control knob towards the front on the machine to expose the back plate (see image below).

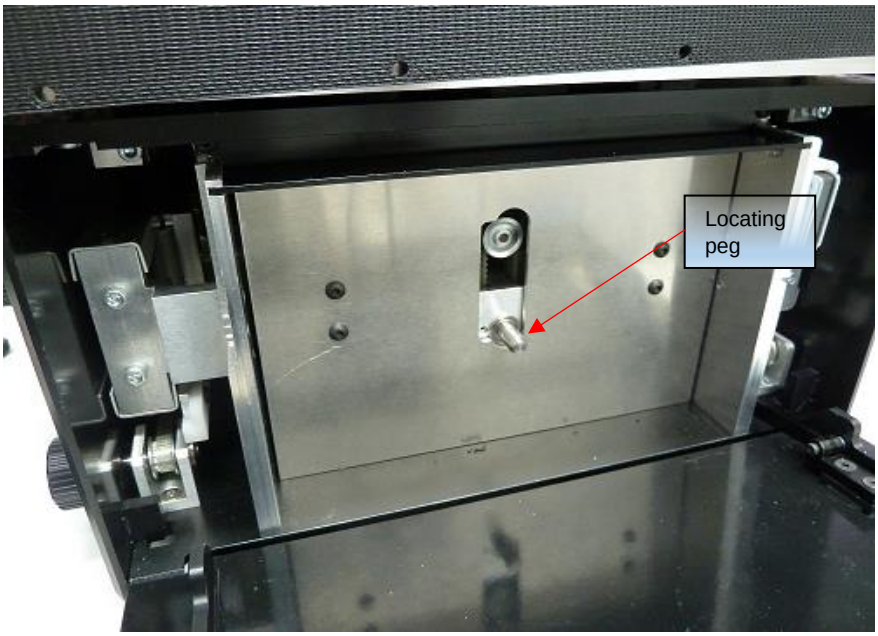


Figure 6 – Internal view of jewellery chamber.

1 On the back plate (shown above) a metal peg is located in the centre. This peg will fit into the rear hole of the jewellery piece holder. Push the jewellery holder firmly into position.

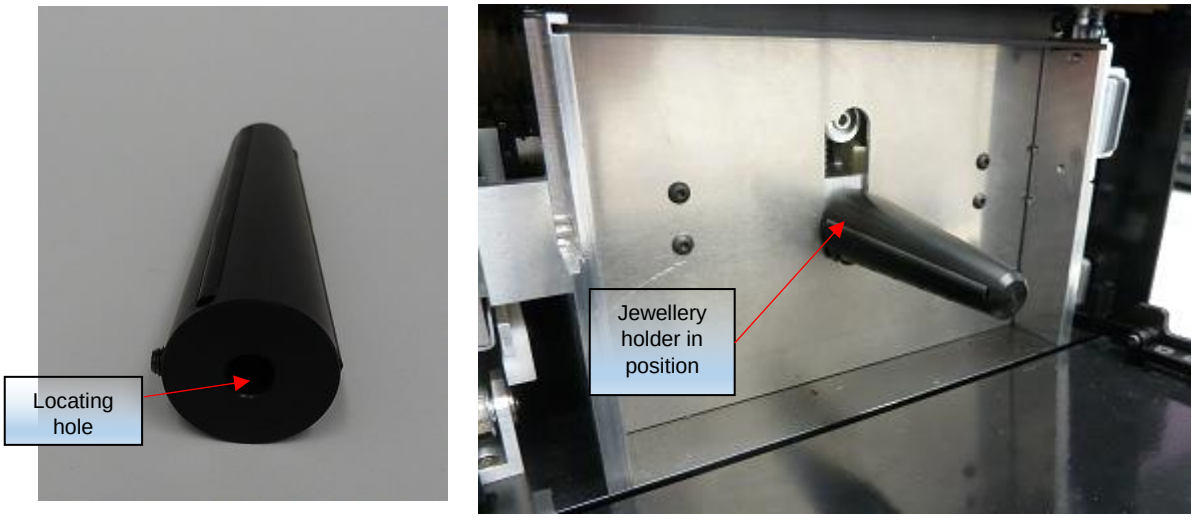


Figure 7 – Ring holder and ring holder in position

4 EXTERNAL CONNECTIONS

4.1 CONNECTING THE SYNTHDETECT

The following image is a rear view of the SYNTHdetect showing the external connectors. See relevant section for further details on each of the external connections.

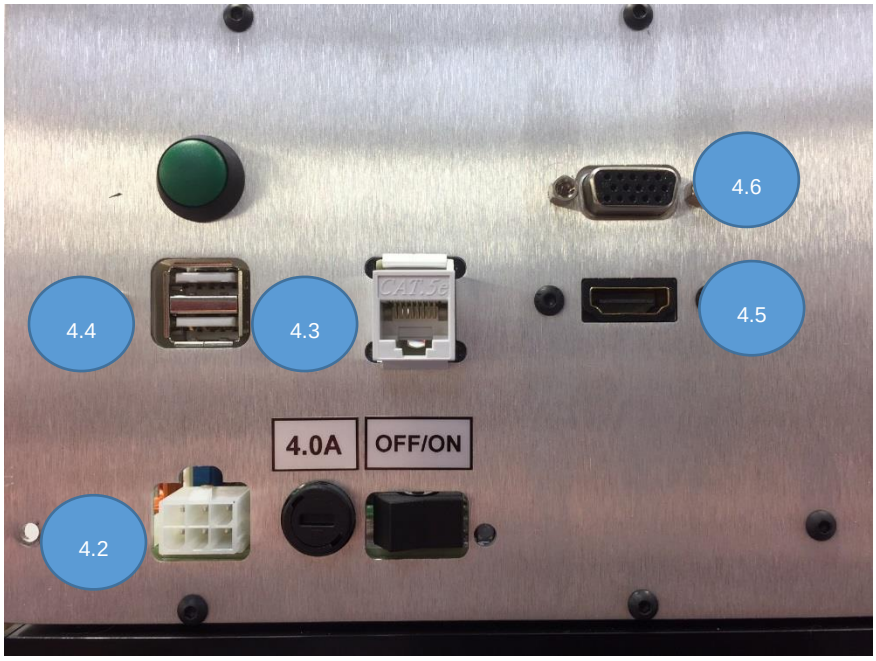


Figure 8 – SYNTHdetect connectors (rear panel).

4.2 POWER SUPPLY

The SYNTHdetect unit is powered from the mains supply. An external power supply is used to convert the mains supply voltage to that required by SYNTHdetect unit.

The mains supply wall socket must be easily accessible.

The external power supply provided with the SYNTHdetect unit is designed for use throughout the world and does not require adjustment for use in different countries. It is connected to the mains supply by a standard IEC flex terminated with a plug suitable for use in the country of operation. The power supply is connected to the SYNTHdetect unit device by means of a power socket located at the rear of the SYNTHdetect unit (see Figure 8 above).

If the mains power supply shows signs of damage or malfunction the user should immediately stop using the machine, disconnect the power supply from the mains supply and contact the supplier.

Warning



The SYNTHdetect unit must be used only with the power supply provided by the manufacturer of the SYNTHdetect unit.

The SYNTHdetect unit has a power switch at the rear. When not in use the SYNTHdetect unit should first be shut down via power icon on the main user interface and then once this is complete turned off using this switch. The power supply should then be disconnected from the mains supply.

When power is applied to the SYNTHdetect unit power lights are illuminated on the rear panel (red) to indicate this.

4.3 ETHERNET PORT (OPTIONAL)

This allows the SYNTHdetect unit to be connected to a computer network for the purposes of connecting to the internet to allow software upgrades to be automatically downloaded, allow remote support to be provided when required and save images that have been captured.

4.4 USB PORT

The USB port allows the connection of the touchscreen and user supplied peripheral devices such as a keyboard, mouse and USB thumb drive.

Tip / Information

The USB port of the SYNTHdetect unit can supply only limited power to a connected device. External USB hard disks and similar higher power peripherals may not operate correctly and could cause the embedded PC within the SYNTHdetect unit to behave erratically.

If higher power or multiple devices are to be used it is strongly advised that a user supplied externally powered USB hub be employed.

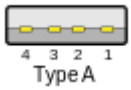
1. Connect the B type end of the USB cable



Into the correct socket on the underneath of the monitor.



Connect the A type socket into one of the two one of the two USB type sockets on the rear of the SYNTHdetect (Connector 4.4. As shown in Figure 8)



1. Connect either end of the VGA to the correct socket underneath the monitor and the other end into the rear of the SYNTHdetect.
2. Connect the DC power connector into the rear of the SYNTHdetect.
3. Toggle the power switch and confirm the power LED indicator lights up.
4. Connect Ethernet cable if required.

   The SYNTHdetect unit will now boot up the operating system and main application.

4.5 VGA

It is recommended to use the SYNTHdetect with a VGA connection to the monitor.

4.5.1 Connecting VGA

1. Power down the SYNTHdetect and the monitor.
2. Remove HDMI if connected.
3. Insert the VGA cable into the rear of the SYNTHdetect (see Figure 8 for VGA connector location)
4. Insert the other end of the VGA
5. Power up the monitor and the SYNTHdetect

Tip / Information

If the VGA does not display at first, use the monitors menu to select VGA as a source.

4.6 HDMI

Tip / Information



Please note, The SYNTHDetect may not work with all HDMI monitor configurations. VGA connection is recommended.

Tip / Information



On rare occasions the monitor may not display the HDMI video. If this is the case, switch the monitor off and back on again using the button on the side of the display.

5 INSTALLATION AND COMMISSIONING

5.1 SELECTION OF LOCATION FOR INSTALLATION

SYNTHdetect is designed for use on a desk, work bench or work top. The desk on which the machine is to be located should be capable of supporting the weight of the machine (>20 kg). The desk should be at least 30cm deeper than SYNTHdetect to allow space for the cables at the rear. If a user supplied mouse and/or user supplied keyboard are to be used there should be sufficient space for them to be used comfortably. (A user-supplied USB hub will be required if more than one USB device is to be connected).

Care should be taken in choosing a location to ensure that the operator does not adopt a posture which could give rise to discomfort.

It is advisable to position the unit such that bright lights or sunlight cannot affect the visibility of the screen.

SYNTHdetect should be positioned away from the edge of the desk to ensure that it cannot fall.

The installation location should be chosen for its suitability for handling small diamonds; the floor should be tiled rather than carpeted and both floor and the desk on which the SYNTHdetect is sited should be free from crevices or similar stone traps. The desk should be free from clutter.

The environmental conditions of the chosen location should fall within the limits set out in Section 2.4.

Two mains outlets are required for SYNTHdetect and should be located close to the desk on which the instrument is sited such that the mains lead to the power supply and the power lead from the power supply to the SYNTHdetect do not create a trip or similar hazard and are not subject to potential damage. It should be possible for the operator to easily isolate the power supply of the SYNTHdetect from the mains supply.

1. Follow the steps detailed in Section 9 which describes how to unpack and lift SYNTHdetect.
2. Position the machine in the centre of the desk ensuring there is clear desk in front of the machine. Ensure the SYNTHdetect is placed in an acceptable position as once the installation is complete the instrument should not be moved.

Warning



Once installation of SYNTHdetect is complete it should not be moved.

3. Ensure the power switch on SYNTHdetect is in the off position.
4. Ensure the switch on the mains supply is in the off position.
5. Perform a visual check of the SYNTHdetect power supply, its lead and the supplied IEC mains lead to ensure they have not been damaged in transit.
6. Plug the SYNTHdetect power supply into the ‘power in’ socket on the rear of the machine.
7. Connect the IEC mains lead first to SYNTHdetect power supply and then to the mains supply.
8. Turn on the mains supply.
9. Turn on SYNTHdetect using the switch on the rear panel.
10. The instrument will boot up.

It is advised that following installation a calibration is performed (See Section 5.2).

5.2 CALIBRATION

SYNTHdetect requires periodic user calibration to ensure continued high performance. The SYNTHdetect will monitor its calibration and inform the user when calibration is due.

Tip / Information

If the current calibration has expired it is advisable to recalibrate prior to screening.

Each SYNTHdetect is supplied with a calibration sample which is inscribed with the serial number of the instrument with which it is associated. The calibration sample must be kept securely and must be kept clean.

Warning

The calibration sample supplied with each SYNTHdetect is designed for use only with that instrument. Particular care should be taken if more than one SYNTHdetect is used in a given location. If an incorrect calibration sample is used in an instrument the calibration procedure will fail and the performance of that SYNTHdetect will be impaired.



Figure 9 - SYNTHdetect calibration sample

1. Locate the calibration sample and ensure the serial number inscribed on the tool matches the serial number of the machine being calibrated. The serial number of the machine is displayed on the machine rating plate at the rear of the machine.
2. Insert the main tray in to the instrument and place the calibration plate on the main tray using the location pins, and close the drawer.
3. Select Multi Capture mode
4. Click Show Grid
5. Maneuver the plate and ensure the two diamond samples are visible inside the grid (Figure 10), and adjust focus if required.
6. Adjust gain settings for each window if required.
7. Stop Capture
8. Click Calibrate Colours
9. Should the calibration fail, check gain and/or focus.

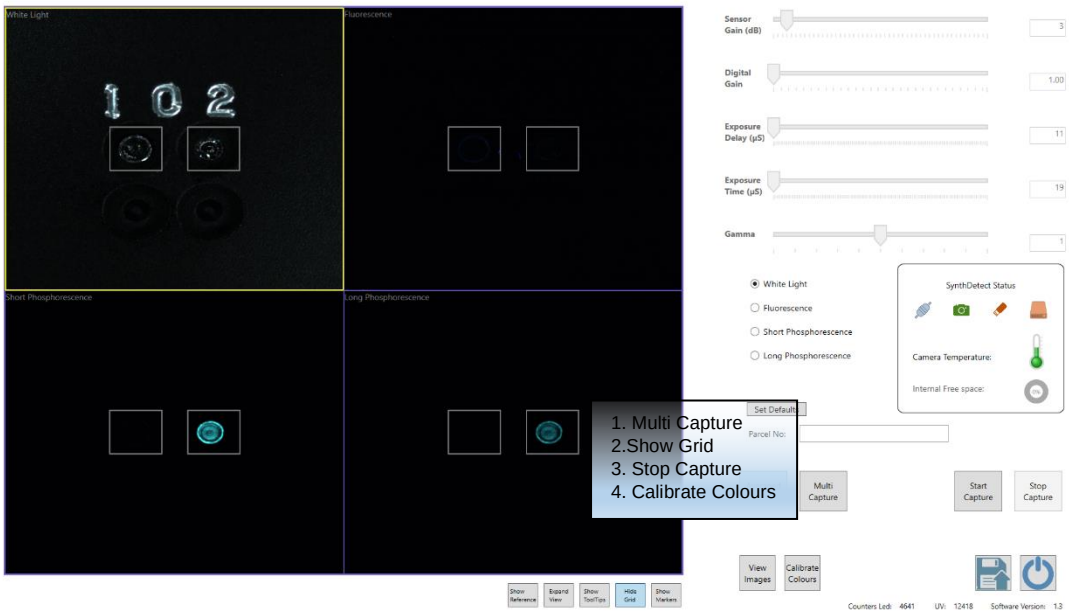


Figure 10 – Calibration Procedure

6 SOFTWARE USER INTERFACE

Once the instrument has been set-up, it is possible to run the SYNTHdetect application and operate the instrument.

Tip / Information

Upon powering up the SYNTHdetect unit the main application will be displayed automatically. However if the application fails to start it can be run by the following methods

The first by double clicking the icon on the Windows desktop and the second by clicking on the 'SYNTHdetect' shortcut in the Programs list in the Windows start menu.

Trouble Shooting
A few errors can occur which will result in the following error.

Incorrect camera serial number or **Camera disconnected**
This error will result in a message box being displayed with the text 'Camera Missing' written in it.
Contact the service centre for this to be investigated.

6.1 APPLICATION WINDOW

The SYNTHdetect application consists of a number of differing controls and elements:

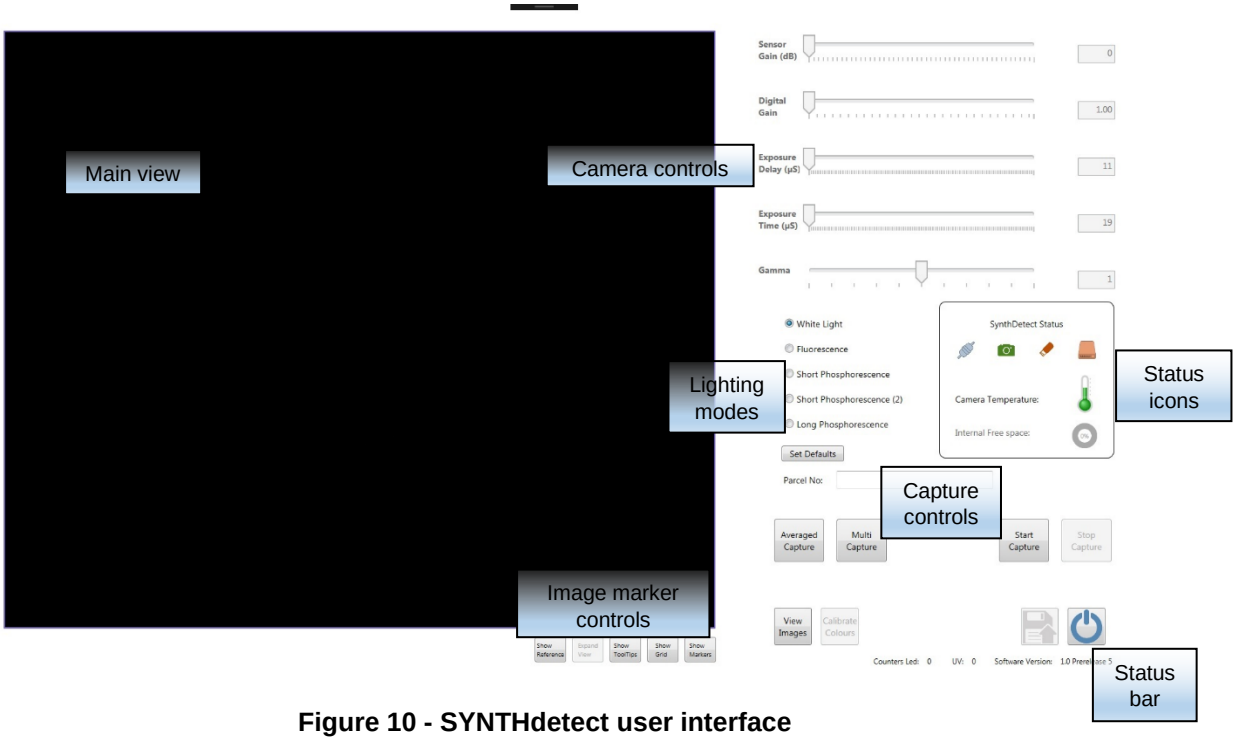


Figure 10 - SYNTHdetect user interface

	Description
Main view	The main view has two modes of operation: • Single image – showing a single lighting mode real-time capture from the instrument. • Multiple capture – showing four simultaneous lighting modes in real-time from the instrument. This view will also be used to display captured images.
Capture controls	Starts and stops captures and image calibration.
Status bar	Shows the software version and LED/UV counts.
Status icons	The status icons group shows the active state of various SYNTHdetect features
Camera control	The camera controls section provides various setting to allow fine tuning of the capture sequence.

6.2 COMPONENTS OF THE APPLICATION WINDOW

6.2.1 Camera Controls (Single Capture)

Single capture provides a single video output of white light illumination, fluorescence or phosphorescence.

The following camera parameters can be adjusted under the 'Single Capture' mode. These parameters can be altered by using the appropriate sliders or entering a value in the text box.

	Description
Sensor Gain (dB)	Increase/decrease the sensor gain. Sensor gain is applied first by an analogue amplifier (+24 dB) and then continues automatically via a digital amplifier
Digital Gain	Increase/decrease the post sensor digital amplifier. This is independent of sensor gain and applies a linear multiplier from 1 to 4 in 0.1 increments.
Exposure Delay (µs)	Increase/decrease the exposure delay (i.e. camera offset).
Exposure Time (µs)	Increase/decrease the camera exposure time.
Gamma Correction	Applies gamma compression (<1) or expansion (>1). Recommended for when snapshots have a large range of contrast.
Set Defaults	This will set the above controls back to the pre-set values.

Note: If the value entered into the text box is outside of the range for that control, the text box will highlight in red. The tooltip for this control will then show the acceptable range.

Important: Digital noise increases linearly and quickly with higher gain values. Users should evaluate image quality with added gain.

6.2.2 Camera Controls (Multiple Capture)

When using multi capture mode, the camera captures white light, fluorescence, phosphorescence with a short delay and phosphorescence with a long delay in a cyclic sequence. It is a requirement for exposures and delays to be fixed to maintain the sequence. As such, only one parameter can be adjusted for each viewing window under the 'Multiple Capture' mode.

	Description
Sensor Gain (dB)	Increase/decrease the sensor gain. Sensor gain is applied first by an analogue amplifier (+24 dB) and then continues automatically via a digital amplifier increasing the cameras actual sensor gain.

Note: If the value entered into the text box is outside of the range for that control, the text box will highlight in red. The tooltip for this control will then show the acceptable range.

Important: Digital noise increases linearly and quickly with higher gain values. Users should evaluate image quality with added gain.

When operating in multi capture mode, the frame rate is reduced and Digital Gain is not available.

6.2.3 Lighting Modes

The SYNTHdetect can operate with a number of different light settings. The user is able to select one type of lighting mode by clicking the radio button to the left of the text.

Note: In multiple capture mode clicking on one of the four images will also change to the corresponding lighting mode.

	Description
White light	Show the sample with visible light and no UV light.
Fluorescence	Show the sample whilst being excited with UV light.
Short Phosphorescence	Show the sample Phosphorescence by charging it with UV light and showing the result.
Short Phosphorescence (2)	As above but at an extended delay after the UV excitation. This is used as a secondary setting for detection of natural diamond.
Long Phosphorescence	As above but at a much longer time after the UV excitation. This is used as a secondary setting to aid in screening for synthetics with long lived phosphorescence.

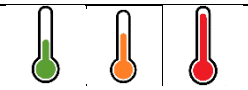
6.2.4 Capture Controls

The following set of controls allow the user to operate the SYNTHdetect.

	Description
Averaged Capture	Captures a sequence of twenty images and then takes an average of all twenty to produce a single averaged image.
Multi Capture	Starts the multiple capture mode.
Start Capture	Starts the single capture mode.
Stop Capture	Stops capture.
View Images	Allows the viewing of captured images.
	Saving images available **Note:** only present when the capture has stopped.
	Powers the SYNTHdetect unit down.
Parcel No.	Enter the parcel number currently being examined. This identifier will be used for image metadata and file naming.

6.2.5 Status Icons

The SYNTHdetect uses a series of icons to show the status of various features detailed bellow.

	Description
	Network connected
	Network disconnected
	Camera disconnected
	Camera connected
	SSD (Solid State Disk) disconnected
	SSD (Solid State Disk) connected
	USB drive not connected
	USB drive connected
	Camera temperature status
	Percentage of free space available on the SSD. **Note:** This icon is only used when the SSD is in use)

6.2.6 **Main View**

As previously mentioned, the SYNTHdetect has two different display modes:

6.2.6.1 Single Capture

The default main view can be seen in Figure 12 (showing natural and synthetic diamond samples). Zooming can be applied by hovering the mouse over the image and scrolling the mouse wheel or pinch and zoom if using the touch screen.

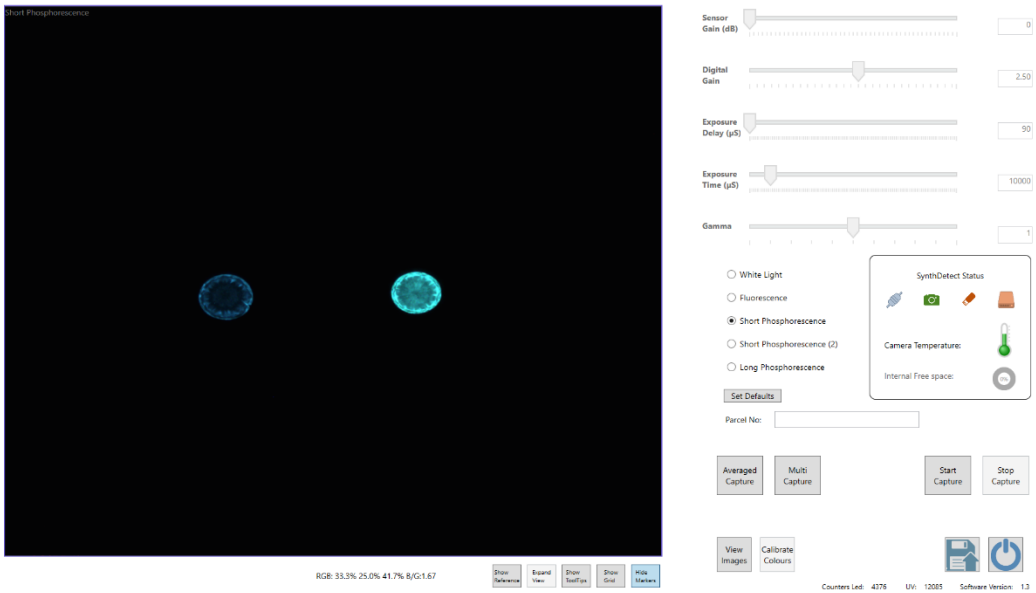


Figure 11 - Main application single capture mode.

6.2.6.2 Multiple Capture

In multiple capture mode (Figure 13) the user is restricted to four lighting modes. Each of these lighting modes has its own quarter of the capture screen in which the currently accessed view is surrounded by a yellow square.

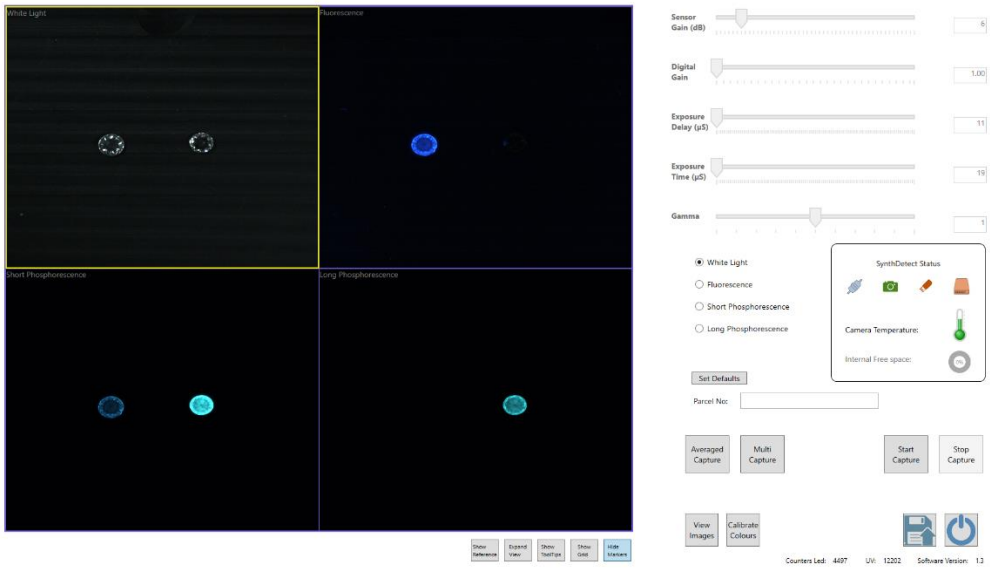


Figure 12 - Main application multiple capture mode.

6.3 IMAGE MARKER CONTROLS

The SYNTHdetect has five controls that will interact with the main image display.

6.3.1 Show – Hide Reference

Displays a swatch of natural and synthetic diamond colours for comparison with recorded images.

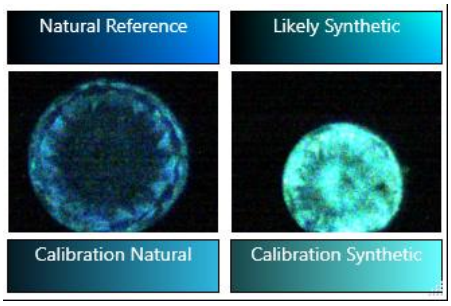


Figure 14 – Show – Hide Reference Swatch

6.3.2 Expand – Collapse View

Use this to switch between four images or a zoomed in single image.

Note: The zoomed in image will be the selected one with a yellow border/ selected radio button.

6.3.3 Show – Hide Tooltips

Shows or hides the mouse over tool tips for image metadata.

6.3.4 Show-Hide Grid

Shows or hides the grid for calibration stone alignment

6.3.5 Show-Hide markers

Shows or hides markers place for image movement or diamond referrals.

6.4 VIEWING CAPTURED IMAGES

To view the captured images left mouse click or press the View Images button to display the following set of controls.

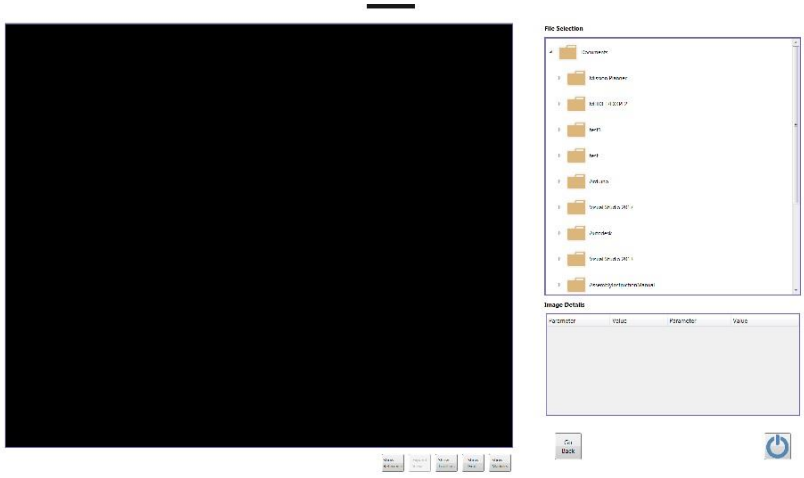


Figure 13 – View images.

In the right hand side of the screen is a control called ‘File Selection’. The images will be saved under the computer name, in this case ‘MHDLT7LXKPF2’

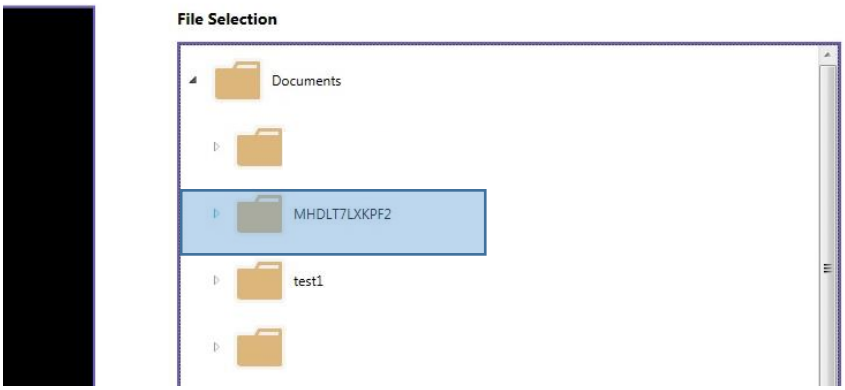


Figure 14 – Root image folder.

Left click or press the arrow to the left of the folder icon to expand the folder and show any sub-folders (See Figure 17).



Figure 15 – Folder/Sub-folder structure

6.5 IMAGE LIBRARY

The SYNTHdetect is supplied with example images of polished natural diamonds, HPHT (high-pressure, high-temperature) synthetics grown in a belt-type press, HPHT synthetics grown in a BARS-type press and CVD (Chemical Vapour Deposition) grown synthetics. These images also show the luminescence characteristics of each type under varying camera conditions, i.e. exposure times and exposure delays.

To access the Image library select the View images button and navigate to Reference Image Library.

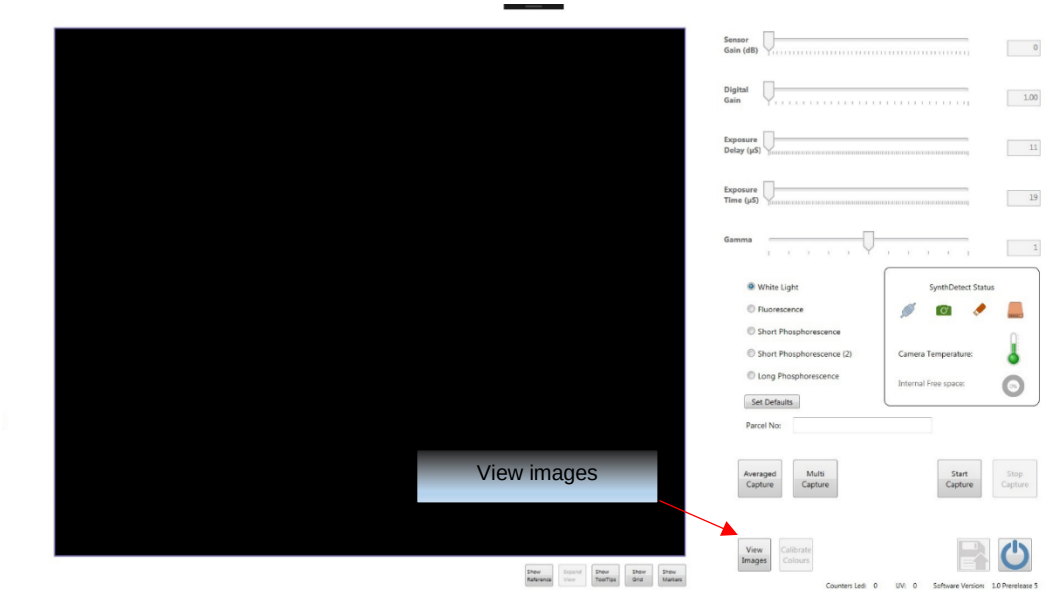


Figure 16 - View images

Then select the file of interest. The image of the stone is shown along with full details of the settings under which the image was taken.

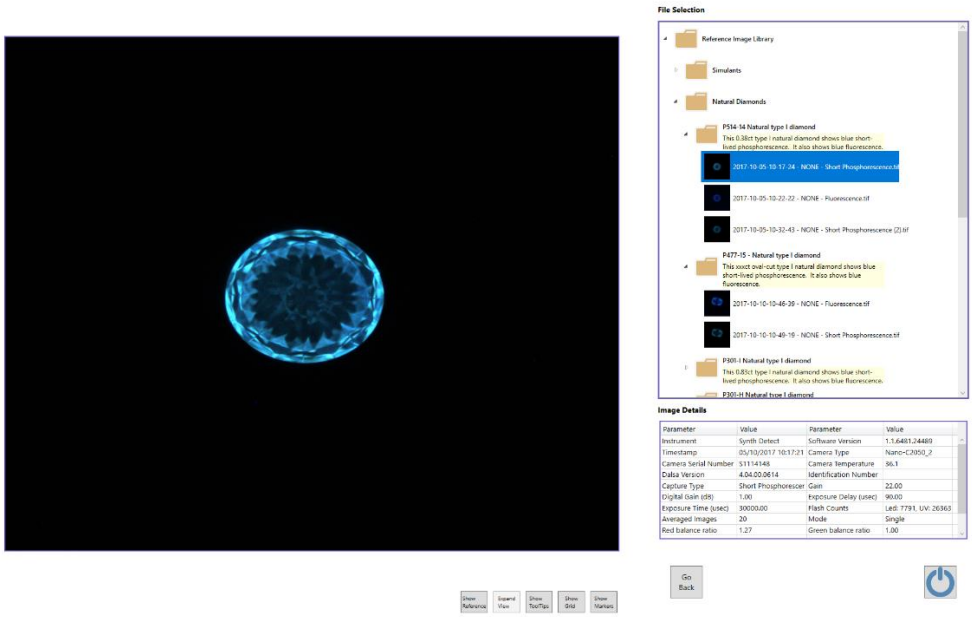


Figure 17 - Image library

These images can be referred to at any time to assist the operator in the decision making process.

7 OPERATING SYNTHDETECT

7.1 WHITE LIGHT MODE

White light shows the sample illuminated by the white (visible) light from the LED source inside the unit. This mode is used to position and focus samples prior to excitation with UV.

1. Switch the unit on and wait for the SYNTHdetect main application to be displayed.
2. Open the jewellery chamber and insert the relevant sample holder (see section 9.3.1).
3. Mount the sample on to the holder and push the Forward / backward control knob so that the holder doesn't obstruct the chamber door and then close the door.

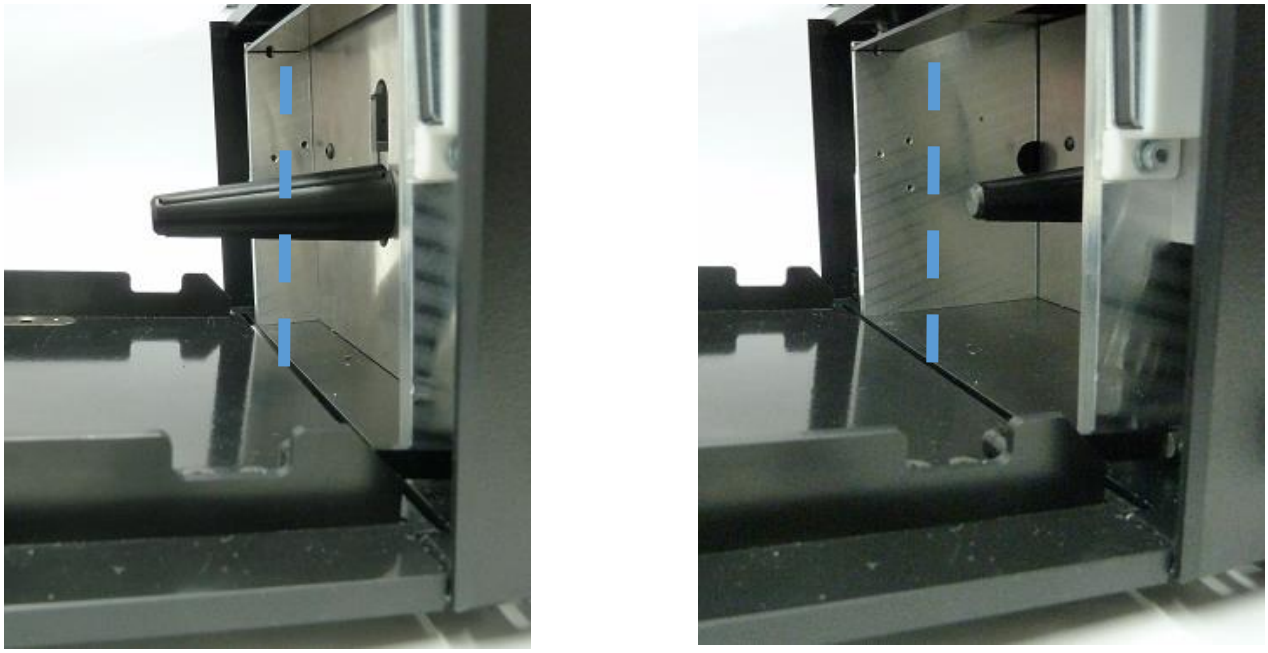


Figure 20 – Jewellery chamber obstruction.

4. On the SYNTHdetect main application ensure the ‘White Light’ radio button is checked.

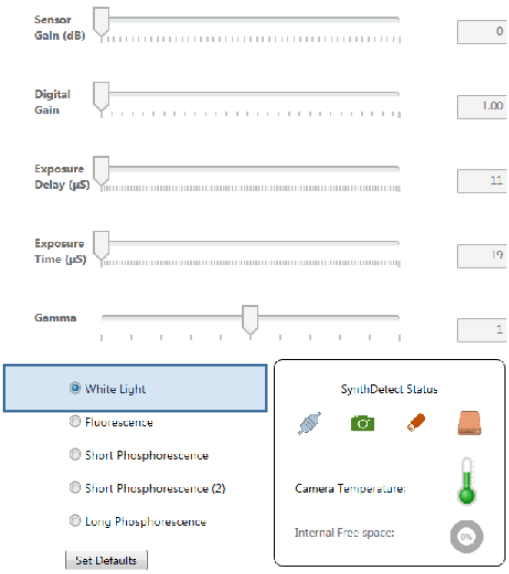


Figure 21 – White light radio button

5. Press the [Start Capture] button and observe the image in the main display.

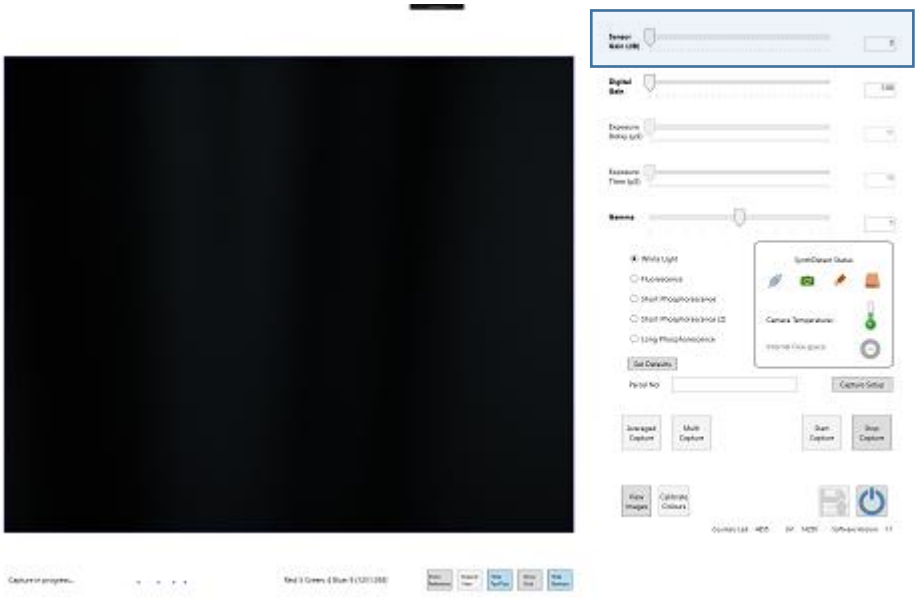


Figure 18 – Sensor gain slider

Note: The image maybe too dark to see. If this is the case use the **Sensor Gain** slider to increase the gain (See above).

6. The image maybe out of focus. To correct this use the Up – Down control knob (No 3, section 3.2) to raise and lower the platform to get the image in focus.

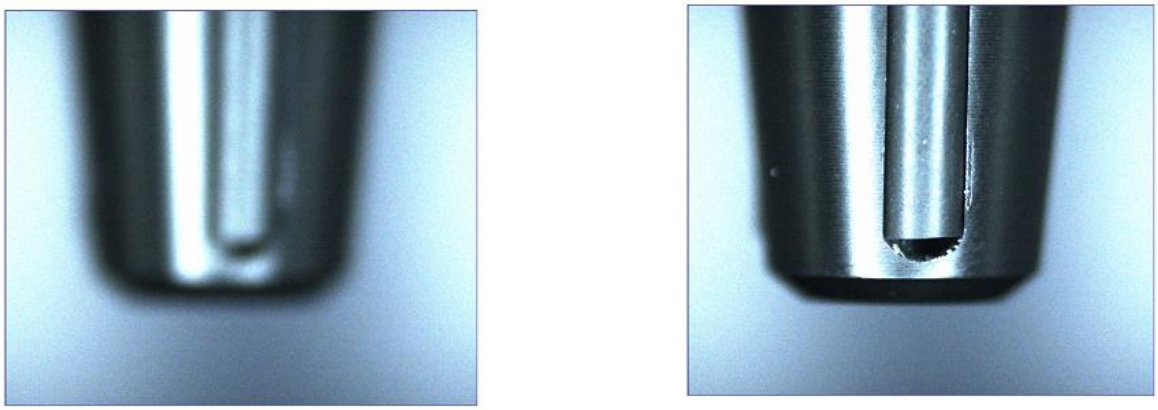


Figure 19 – Focus control

7.2 EXAMINING MELEE STONES

The following section will walk through examination of melee stones.

1. If the SYNTHdetect application hasn't been started, double-click the desktop icon to start the application and wait for the following user interface to be displayed.

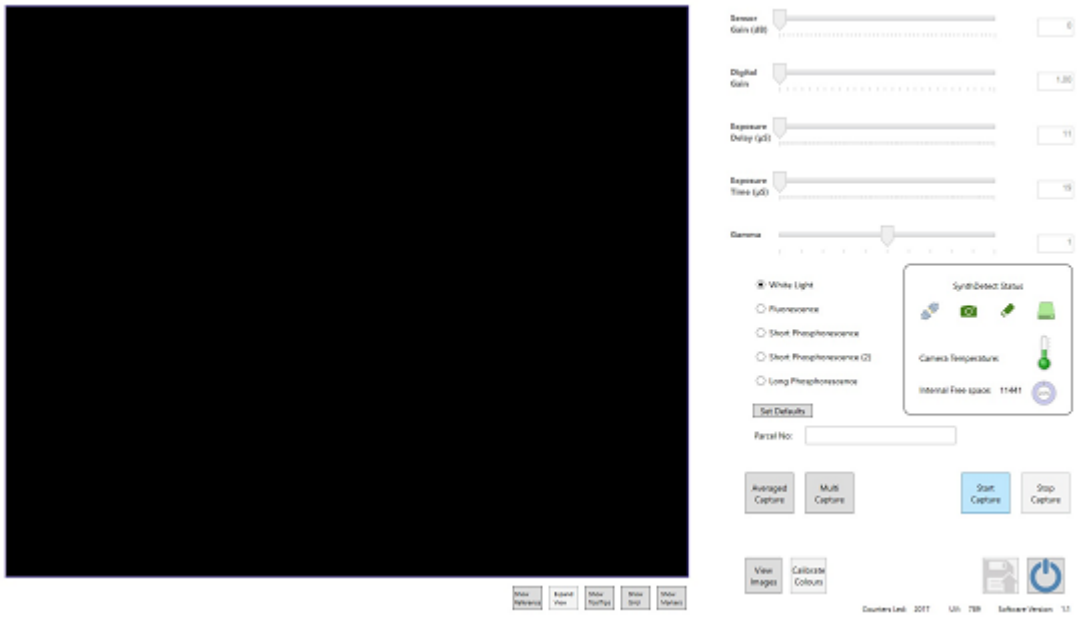


Figure 20 – User interface

2. Place the melee stones or jewellery piece into the lower module and close the door fully.

3. The default light setting is White-light when the application is loaded but if this is not the case select it by clicking on the radio button next to the White Light text

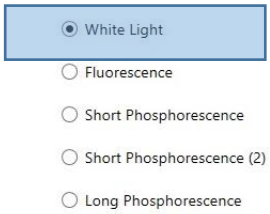


Figure 21 - White light radio button

4. Click on the Start Capture button and observe an image in the main window and using the external knobs, move the item to be observed into view.



Figure 22 – Image out of focus

5. Again, using the external knobs move the item into focus.



Figure 23 – Image in focus

7.3 FIELD STOP

SYNTHdetect is fitted with an adjustable field stop. The field stop is adjusted using the control knob illustrated below:



Figure 24 – Field stop control

Rotating the field stop control knob opens and closes an iris in the excitation beam. The control is fitted with a ‘clutch’ feature which ensures that the iris cannot be damaged by the user.

Using the field stop the user is able to adjust the field of view down to approximately 1 mm. Depending on the diamonds size this allows isolation of a single stone.

This feature is typically required to increase the level of contrast in areas where luminescence is weak. This is achieved by reducing the amount of stray light originating from areas of the sample other than the region of interest. Light from brightly luminescing regions often back-illuminates the region of interest, reducing the ability to see weakly luminescing features. The field stop provides the facility to confine the UV illumination area to the region of interest – thus minimising the level of back-illumination and increasing image contrast.

7.4 AUTO DETECTION ALGORITHM

SYNTHdetect uses an auto detection algorithm to assist the operator.

The software enables the operator to simply click on an image and the algorithm result is displayed on screen.

The result will simply be presented as a '**Natural**', '**Refer**', '**Background**', '**Too Saturated**' or '**Not Detected**'.

The auto detection algorithm is only available once the stop capture button has been activated and only when the image has been taken within the following range of camera delay and exposure times:

Delay: 90 – 10,000 μs

Exposure: 10,000 – 40,000 μs

The following rule is also applied to the auto detection algorithm:

Delay + Exposure ≤ 40,000 μs

Stone selection is either conducted via 'right clicking on the stone' or using the touchscreen. If auto detection is attempted with the settings out with those stated above, the result 'SettingsOutOfRange' will be returned.

Auto Detection Algorithm is available in both single and multi-capture viewing modes.

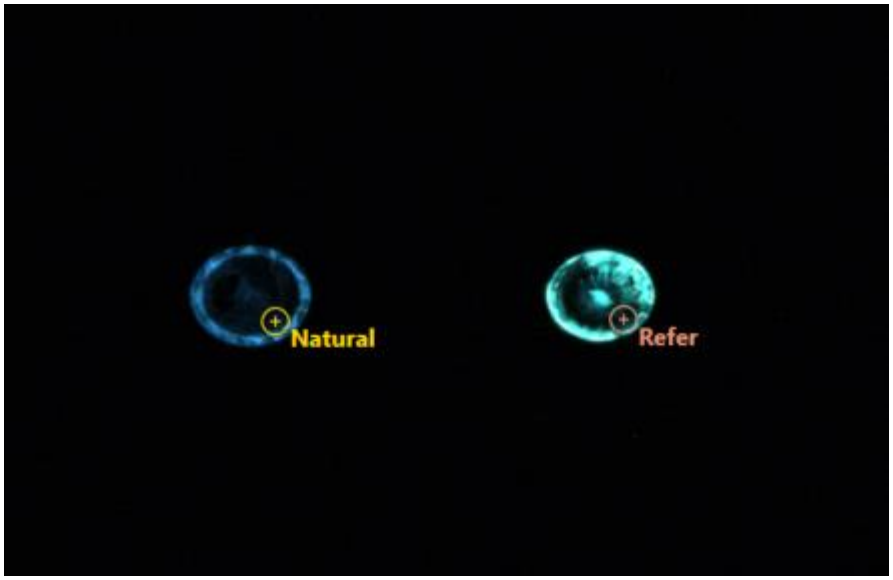


Figure 25 - Auto detection algorithm

7.5 BASIC USE OF CONTROLS AND INTERPRETATION OF RESULTS

1. Ensure that the stones requiring screening are colourless or near-colourless.
2. Load the sample to be tested using the most suitable attachment.
3. Start capture to begin live video and stop capture to stop.
4. Under white light focus on the sample.
5. Switch the lighting mode to Short Phosphorescence (1).
6. Adjust Sensor and/or Digital gain to achieve a clear image.

With the lighting conditions in Short Phosphorescence (1), the following results are possible:-

- **Natural**
- **Refer**
- **Background**
- **Too Saturated**
- **Not Detected**

Note: a 'Refer' result does not necessarily indicate that the stone is synthetic since the stone may be a member of a rare group of natural diamonds which will also be referred by SYNTHdetect. Diamond simulants will also be classified in this way.

7.5.1 Natural

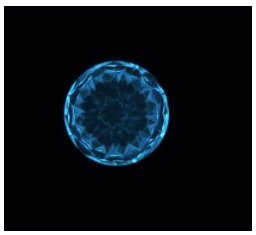


Figure 30 – Natural diamond

A natural diamond has been detected – no further testing required. Only natural diamond can exhibit this colour of phosphorescence.

7.5.2 Refer

The following images relate to a 'Refer' result based on turquoise phosphorescence within the time range given above. Typically less than 0.1% of natural diamond will be classified in this category.

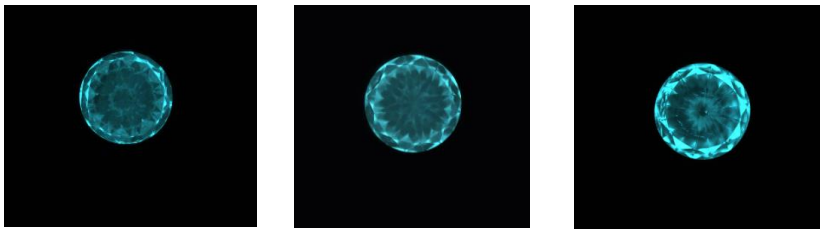


Figure 31 – Refer Results

A refer result is not an indication that the stone is synthetic, rather it will require further analysis. SYNTHdetect can identify an HPHT synthetic from other diamonds that also exhibit long lived turquoise phosphorescence. This can be achieved by selecting the Fluorescence lighting setting. The fluorescence results from the stones shown in Figure 31 are shown alongside the phosphorescence images, in Figure 32.

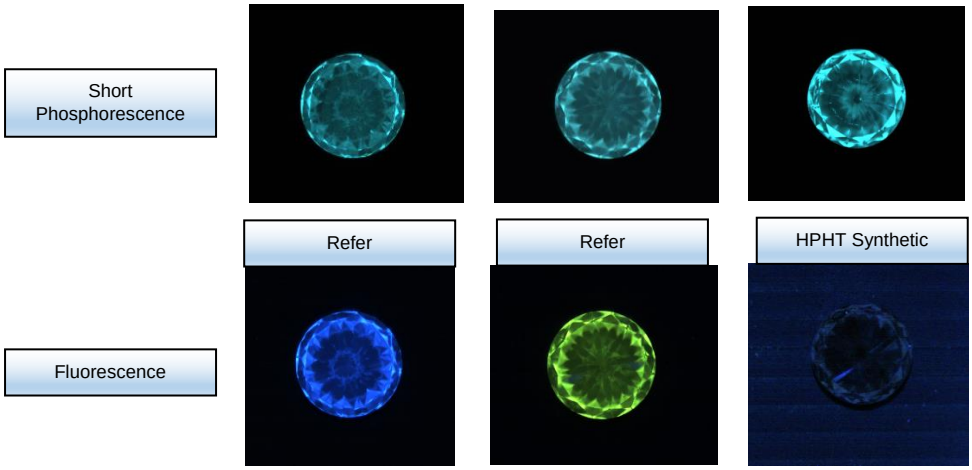


Figure 32 – Refer Results under Fluorescence conditions

Under these conditions, the HPHT synthetic (right image) exhibits no appreciable or extremely weak fluorescence. This is combination of weak or inert fluorescence and long lived turquoise phosphorescence is a characteristic feature of colourless HPHT synthetic diamond.

The stones shown in the left and middle images remains a ‘Refer’ as these characteristics can overlap with Type IIb natural diamond and certain CVD synthetics. Further tests are required to confirm the origin of these stones.

Note: The Auto Detection Algorithm is not available under fluorescence conditions.

Other phosphorescence colours will also give a ‘Refer’ result. A stone’s origin cannot be determined from this result and further testing is required. Examples of potential ‘Refer’ cases are shown below.

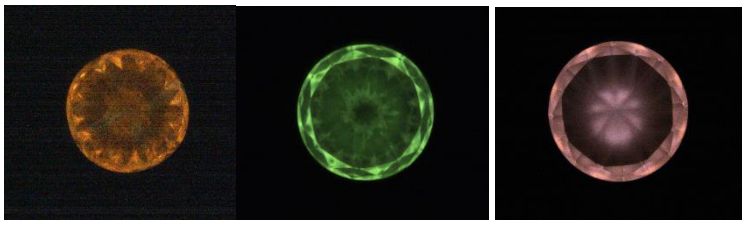


Figure 33 – Other Possible Refer Results

Note: Refer results are not limited to the colours shown in Figure 33.

7.5.3 Background

If the Auto Detection Algorithm is used on a weak image, the algorithm may not be able to distinguish the stone boundary from the background. If this situation occurs the result 'Background' will be returned. Increase the camera gain and re-attempt the analysis.

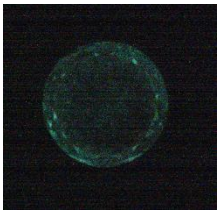


Figure 34 – Example of Weak Signal

7.5.4 Too Saturated

SYNTHdetect does not automatically adjust camera gain to compensate for the wide variety of phosphorescence intensity that can be exhibited by diamond samples. An operator must adjust camera gain manually for each sample. If the Auto Detection Algorithm returns the result 'Too Saturated', the Sensor and/or Digital gain is set too high (Figure 35).

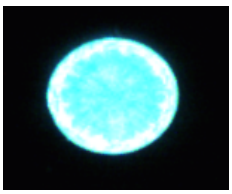


Figure 35 – Example of Saturated Image

7.5.5 Not Detected

This result will be returned if image analysis is attempted in a region where there is no image of a stone. It is also possible for no phosphorescence to be exhibited, for example in high purity CVD synthetics and some diamond simulants. Care should be taken not to overlook these stones as they also require further testing beyond SYNTHdetect. If Auto Detection Algorithm is used on a non-phosphorescing stone, the result 'Not Detected' will be returned.

7.6 ADVANCED USE OF CONTROLS

7.6.1 Short Phosphorescence (2)

There are a small percentage (<<0.1%) of natural diamond that exhibit the characteristic blue phosphorescence along with other phosphorescence components, such as green, when viewed under the Short Phosphorescence (1) conditions.



Figure 36 – Stone exhibiting blue and green phosphorescence using Short Phosphorescence (1) setting.

If Auto Detection Algorithm is used here, a ‘Refer’ result will be returned. In these rare occasions, it may be necessary to use the Short Phosphorescence (2) setting. This applies a longer delay before camera exposure to allow the faster decaying green component to extinguish, and isolate the blue component required for detection.



Figure 37 – Blue phosphorescence isolated using Short Phosphorescence (2) setting.

If the Auto Detection Algorithm is used now, a ‘Natural’ result will be returned. If a ‘Refer’ result is returned in Short Phosphorescence (1) and a ‘Natural’ result returned in Short Phosphorescence (2), the ‘Natural’ result takes precedence.

7.6.2 Long Phosphorescence

This setting is useful for aiding in identifying stones which exhibit phosphorescence on timescales longer than that of the blue phosphorescence shown in natural diamond, such as HPHT synthetics. This is particularly useful for jewellery to help isolate stones in clusters that show long lived turquoise phosphorescence.

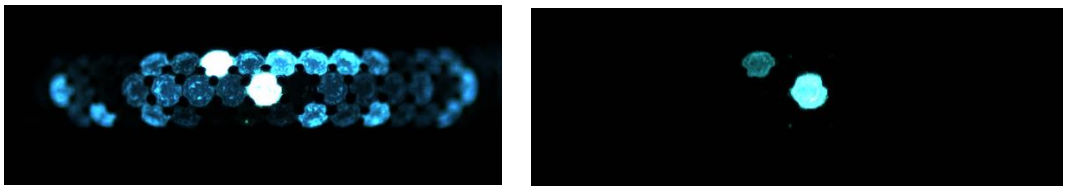


Figure 38 – Jewellery piece under Short Phosphorescence (1) [LEFT] and Long Phosphorescence [RIGHT].

7.6.3 Manual Control of Camera Delay and Exposure Times

There are very few cases where the luminescence decay characteristics of natural diamond are more complicated, with multiple components of differing colours co-existing. In these cases, it may be the case that using the auto detection algorithm on Short Phosphorescence (1) or Short Phosphorescence (2) settings is not sufficient to isolate any blue phosphorescence and a 'Refer' result is returned. It can be advantageous to study these samples in more detail, particularly in jewellery to avoid the unnecessary expense of unsetting stones for further testing or disposal.

This is also useful for basic study of the luminescence characteristics of any diamond.

Here, an operator can take full control of the camera's delay and exposure settings (Figure 39) in order to isolate any blue component that may exist. The auto detection algorithm will remain available providing the criteria described in Section 7.4 is maintained.

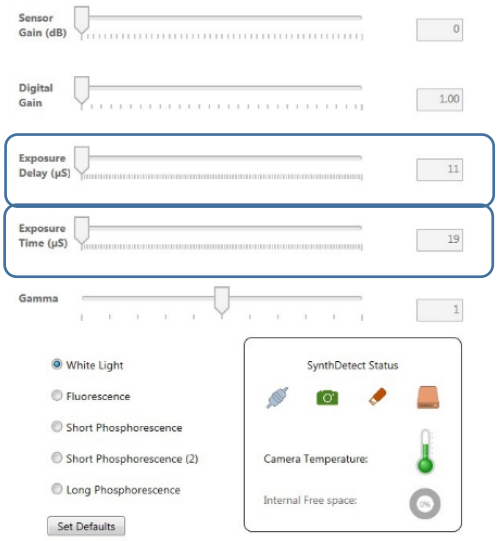


Figure 39 – Manual controls.

The blue phosphorescence in natural diamond exhibits exponential decay characteristics. To help in visualising and/or enhancing any blue component of the phosphorescence, increasing the camera delay time will extinguish faster decaying components and decreasing the exposure time will discriminate against longer decaying components. Generally, increasing the delay to around 5,000 μs and then gradually decreasing the exposure time can result in observation of the blue phosphorescence. Camera gain will need to be adjusted to accommodate the reduction in intensity.

If changing the delay and exposure settings does not return a 'Natural' result from the auto detection algorithm, the stone must be referred for further testing.

Tip / Information

When using manual controls, users should refer to the Image Library for guidance.

Note: Should the sum of delay time and exposure time increase beyond ~90,000 μs, the frame rate will drop automatically from 10 frames per second to 5 frames per second.

7.6.4 Set Defaults

When an operator takes manual control of the camera delay and exposure settings, these are retained in whatever setting was selected previously (except white light). Press Set Defaults to return the fluorescence and phosphorescence settings to default. Settings will return to default when the SYNTHdetect is power cycled.

7.6.5 Gamma Correction

The camera is programmed with a lookup table (LUT) as a component of its embedded processing features. The LUT is used for gamma correction. Gamma correction is most useful in studying images that have a large range of contrast. Gamma compression (<1, makes dark regions lighter) or expansion (>1, makes dark regions darker) can be applied.

Note: Auto Detection Algorithm will not operate unless Gamma = 1.

8 TROUBLESHOOTING & MAINTENANCE

8.1 NO VIDEO DISPLAY

On rare occasions the monitor may not display the HDMI video. If this is the case, switch the monitor off and back on again using the button on the side of the display.

9 UNPACKING AND PACKING SYNTHDETECT

9.1 UNPACKING THE SYNTHDETECT

Warning



Appropriate manual handling procedures should always be followed whilst moving the SYNTHdetect.

1. Ensure the box is the correct way up before removing the external packing tape. Open the box.
2. Remove the monitor box.
3. The ancillary items will now be accessible. Carefully remove all the items from the box.
4. Remove the top layer of packing foam from the box.
5. The SYNTHdetect can now be removed from the packaging.
6. Ensure the desk surface where the machine is to be placed is clear and the path between the machine and the desk is unobstructed.
7. Lift the machine clear of the box and gently place it on the desk.
8. The packaging should be retained in case it is necessary to return the SYNTHdetect to the supplier for servicing or repair work.

9.2 PACKING THE SYNTHDETECT

Warning



Appropriate manual handling procedures should always be followed whilst moving the SYNTHdetect.

If the SYNTHdetect is not returned to the supplier in the correct transit case then damage in transit is highly likely. Remedial work to correct such damage will be at the expense of the customer.

1. Position the SYNTHdetect transit box suitably close to the SYNTHdetect to avoid having to carry the device too far.
2. Disconnect the SYNTHdetect from its power supply and cables. If these are to be returned they may be placed in the recess in the top section of the transit case.
3. Ensure the control knobs are in the most forward position
4. Lift the machine and lower it into the transit box base.
5. Fit the top section of the SYNTHdetect packing foam (note that this will fit only one way).
6. Insert any ancillary items that are also being return with the machine.
7. Pack the monitor into its packaging box.
8. Place the monitor into the SYNTHdetect packaging box and tape shut.

9.3 PACKING LIST

In addition to this manual, be certain that you have the following items:

- SYNTHdetect instrument
- Mains power supply
- Mains power adapter cable (with country specific plug)
- USB cable **A-B**
- VGA cable
- Melee tray
- Bangle holder
- Ring holder
- Main tray
- Numbered calibration plate

If any item is missing or damaged please contact your supplier for assistance.

9.3.1 Accessories

The following jewellery holder accessories will come packaged with the SYNTHdetect.

Main tray – Used for mounting the melee tray and calibration plate. Can also be used for loose stones, brooches etc.

Foam conical holder – suitable for bangles and watches

Small cone – Ring holder also drilled holes permit some earring testing.

Melee tray - The holder is capable of holding approximately 650 stones (the hole diameters are 0.5mm, therefore stones of this diameter or smaller should be mounted on the solid tray).



Figure 40 – SYNTHdetect jewellery holder accessories.

9.3.2 Optional accessories

The following accessories are available for use on SYNTHdetect:

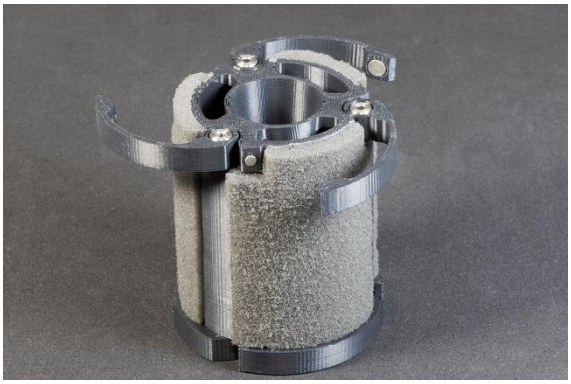


Figure 41 - Loose bracelet/necklace holder (can also hold watches)



Figure 42 - Earring holder



Figure 43 - Multiple ring holder

10 SPECIFICATION

Model Number:	3677
Instrument:	SYNTHdetect

Power requirements:	+24 V DC @ 4.0 A Max
Maximum voltage fluctuation:	+/-2%
Supplied mains adaptor:	
Power requirements:	80 – 264 V AC @ 9.0 A
Maximum voltage fluctuation:	+/-10%
Filter requirements:	None
Environment:	Indoor use
Maximum altitude:	2000 m
Temperature range:	15°C - 30°C
Humidity:	80% up to 31° decreasing linearly to 50% at 40°
Rated pollution degree:	II
Ventilation requirements:	Do not obstruct ventilation holes.
Video:	
Resolution:	1296 x 1296
Field of view:	17 mm x 17 mm (55 mm x 17 mm with scanning)
Screen Size:	21.5” (54.6 cm)
Weight:	30 kg
Dimensions:	310 mm (w) x 340 mm (d) x 458 mm (h)
Regulatory standards:	EN 61010-1:2010 (Safety) EN 61326-1:2013 (EMC) EN 60825-1:2014 (Optical)
Manufacturer:	De Beers Ignite™ Belmont Road Maidenhead SL6 6JW United Kingdom

11 LEGISLATIVE COMPLIANCE TESTING

11.1 LEGISLATIVE COMPLIANCE DIRECTIVES

The SYNTHdetect Device is compliant with the following directives:

Low Voltage Directive	(LVD)	2014/35/EU
Electromagnetic Compatibility Directive	(EMC)	2014/30/EU
Restriction of use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive	(RoHS)	2011/65/EU
Waste of Electronic and Electrical Equipment Directive	(WEEE)	2012/19/EU

11.2 STANDARDS TO WHICH CONFORMITY IS DECLARED

The SYNTHdetect Device has been successfully tested to the following standards:

EN 61326-1:2013

Electrical equipment for measurement, control and laboratory use. EMC requirements.

EN 61010-1:2010

Safety requirements for electrical equipment for measurement, control, and laboratory use

EN 60825-1:2014

Safety of laser products. Equipment classification and requirements

11.3 CE DECLARATION OF CONFORMITY

Declaration of Conformity

Directives to which conformity is declared:

Low Voltage Directive	(LVD)	2014/35/EU
Electromagnetic Compatibility Directive	(EMC)	2014/30/EU
Restriction of use of certain Hazardous Substances in electrical and electronic equipment Directive	(RoHS)	2011/65/EU
Waste of Electronic and Electrical Equipment Directive	(WEEE)	2012/19/EU

Standards to which conformity is declared:

EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control and laboratory use.
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use – EMC requirements. Equipment classified as Class B for emissions.
EN 60825-1:2014	Power requirements for a Class 1 UV product.

Manufacturers Name:	De Beers UK Limited
Manufacturers Address:	De Beers Group Ignite, Belmont Road, Maidenhead, Berkshire, SL6 6JW UK
Type of Equipment:	SYNTHdetect SYNTHdetect XL
Model Number:	3677

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive and standards.

Place: Maidenhead, Berkshire

Date: 30 SEPT 2021

Signature: 

Full Name: TREVOR POULTER

Position: PRODUCT GROUP MANAGER

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