



# MiTE Installation and User Guide

Version 1.0 — December 2013

# Setting Up MiTE

## Set-up Data Acquisition

MiTE is compatible with any National Instruments® device compatible with NI-DAQmx™. In this guide, a National Instruments USB-6008 is used as the data acquisition device.

### Step 1

#### Locate NI-DAQmx™ Software DVD

Before connecting anything to the computer, the National Instruments® NI-DAQmx™ software and drivers should be installed. A copy of this software should be included with the data acquisition hardware.

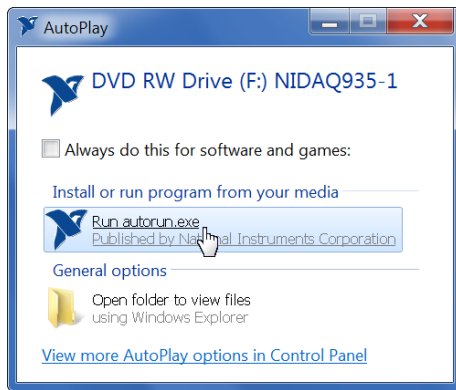


### Step 2

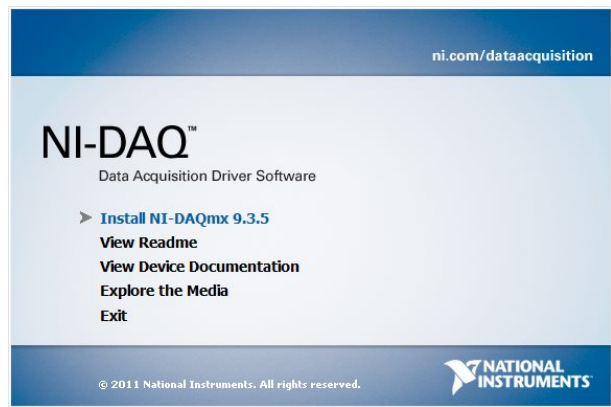
#### Install NI-DAQmx™ Software

- 2.1 Insert the DVD into the computer

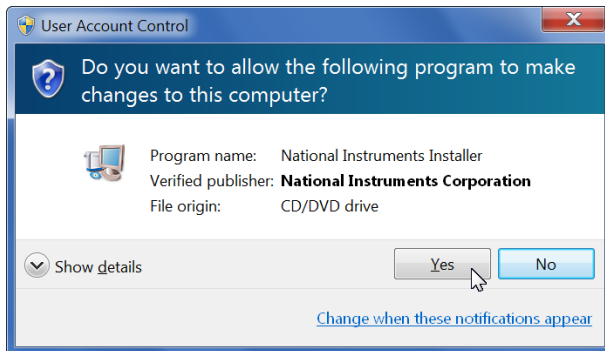




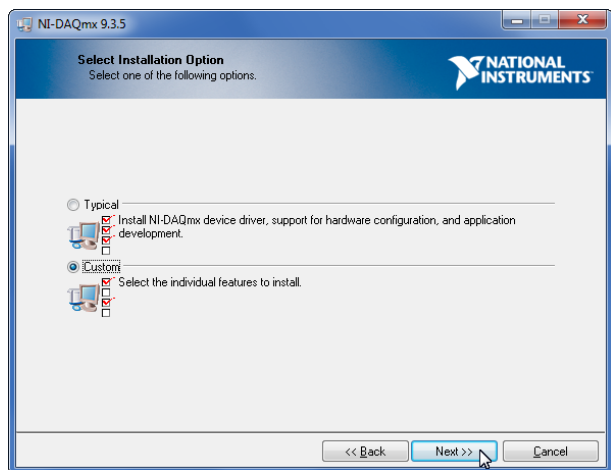
2.2 If an AutoPlay message is shown, select 'Run autorun.exe' (the highlighted option).



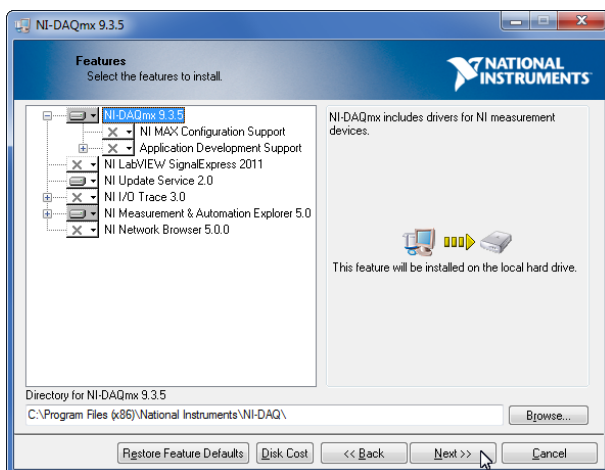
2.3 When the installer starts select the option to 'Install NI-DAQmx'



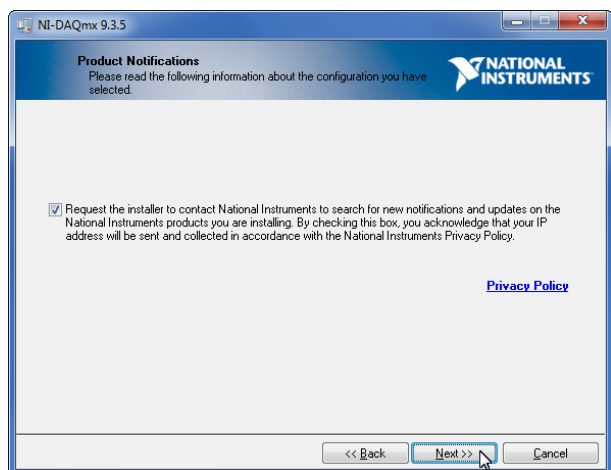
2.4 A user account control (UAC) message may be displayed. Press 'Yes' to continue the installation process.



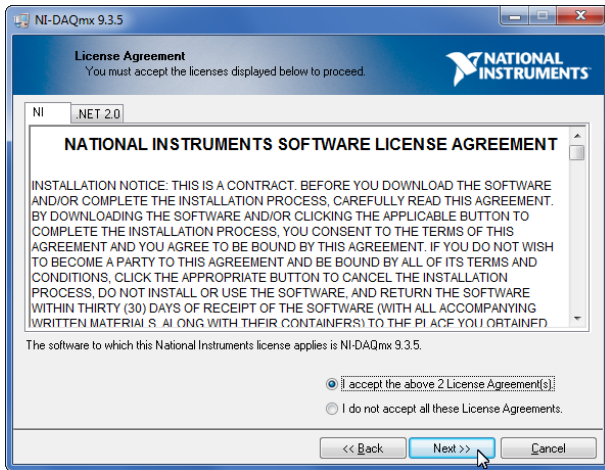
2.5 Select the 'Custom' installation option, then press the 'Next' button



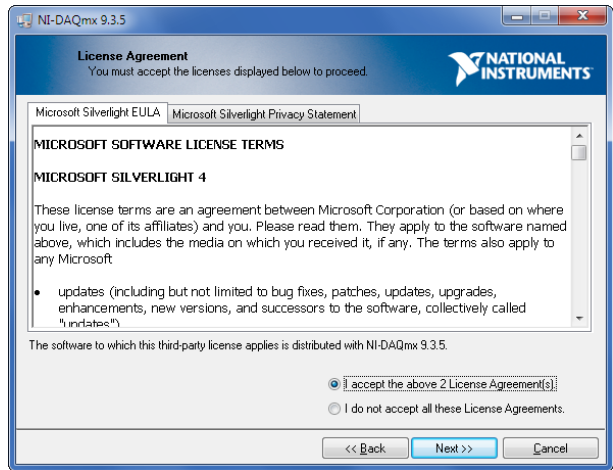
2.6 The features shown are the minimum required by MiTE. If required, additional features can be installed. Once the features are selected press the 'Next' button.



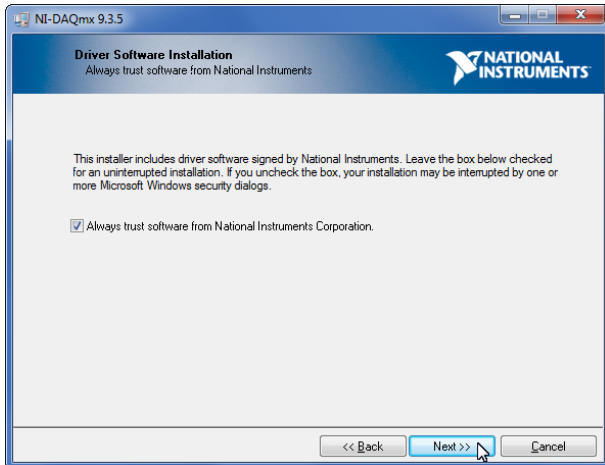
2.7 If desired the check-box on this screen may be selected to search for updates during the installation process. This will require a connection to the Internet. Press the 'Next' button.



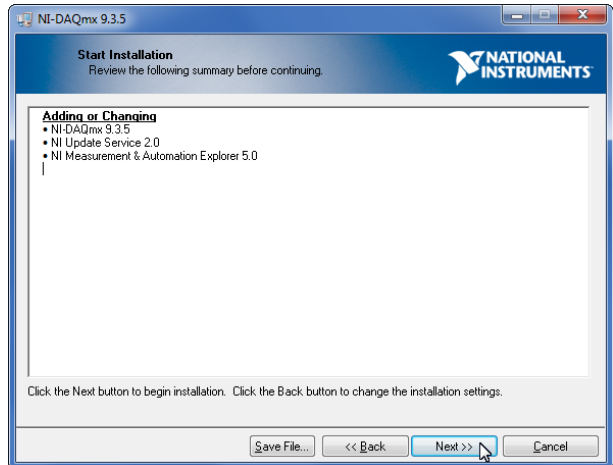
**2.8** A set of license agreements will be displayed. If accepted, press the 'Next' button.



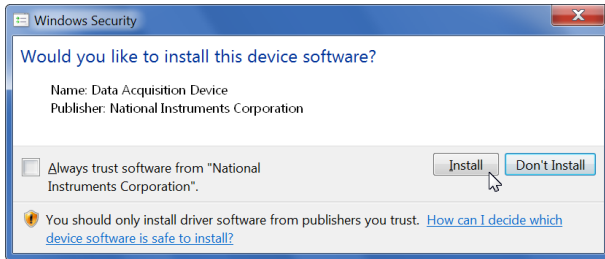
**2.9** Another set of license agreements may be displayed. If accepted, press the 'Next' button.



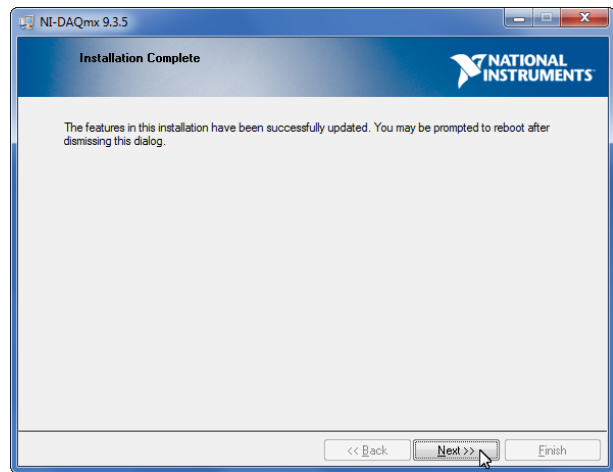
**2.10** An option is available to trust software from National Instruments®. Accepting this option will prevent confirmation dialogs appearing during installation. Press the 'Next' button.



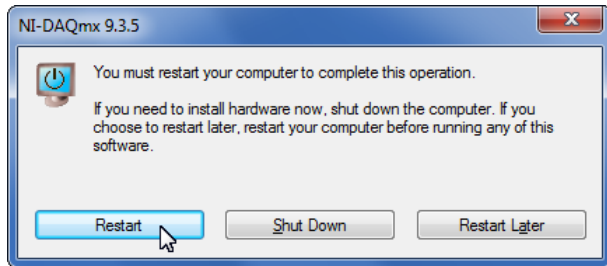
**2.11** The installation is now ready to start. A list of changes to be made is displayed. Press the 'Next' button to begin installation.



**2.12** If a message asking to install a driver published by National Instruments Corporation is displayed press 'Install' to continue the installation



**2.13** The installation is now complete. Press the 'Next' button.



**2.14** If prompted to restart, press the 'Restart' button.

### Step 3

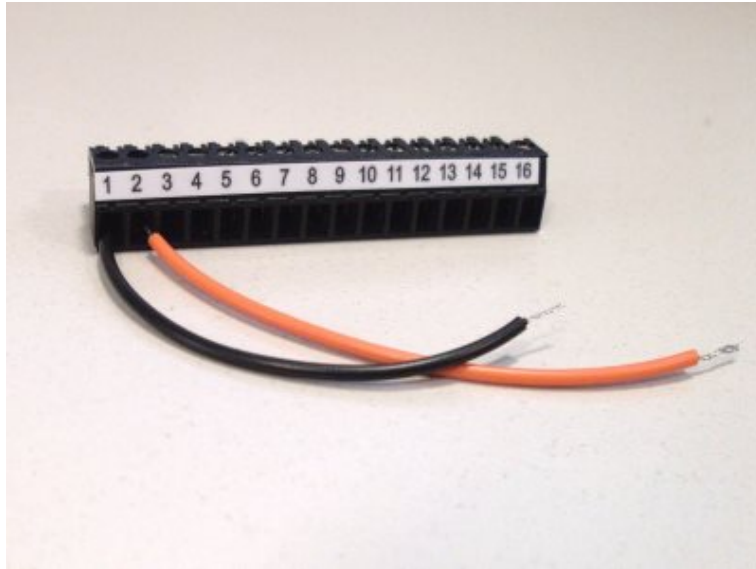
#### Connecting the signal to the Data Acquisition Device

*Note that these instructions apply to the National Instruments® USB-6008 device. If a different device is used the procedure may differ.*

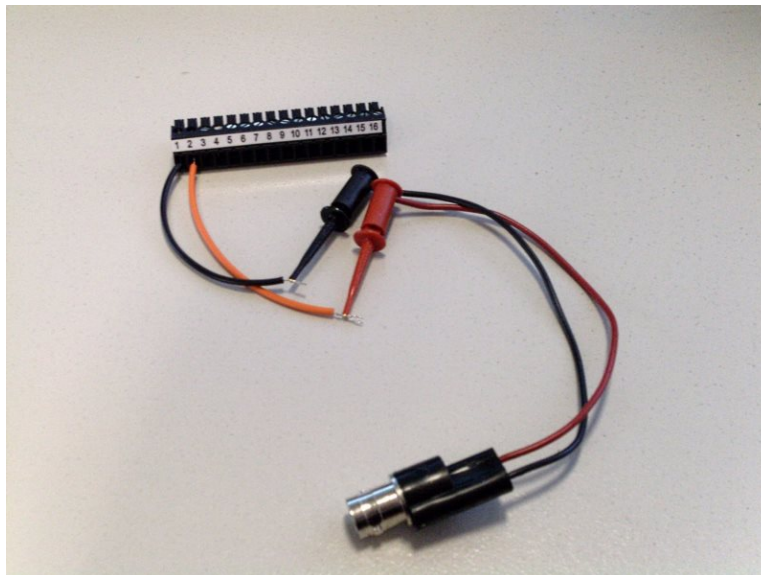
Take one of the connectors for the National Instruments® USB-6008 (There should be 2 in the box). If desired, a label can be placed on the connector to aid in connection (the numbered label is shown below).

In this guide, this input signal will be connected to the first analogue input, named AI0. Place the ground wire into the left-most connection, and the signal wire into the adjacent connection as shown below. If the analogue connector label is used, these connections are labelled GND and AI0 respectively.

Once inserted the wires can be secured in place by tightening the screws above the connection points.



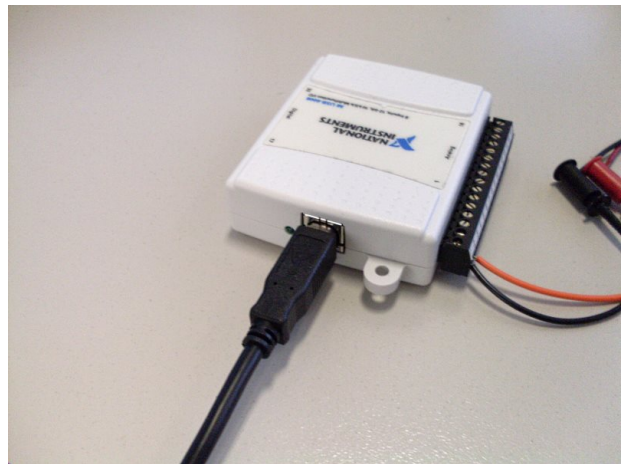
These wires can then be connected to the load signal. Here they will be connected using a BNC adapter.



The connector can now be inserted into the data acquisition device. Be sure to insert it on the side marked 'Analog'.



Once the connector is inserted and the NI-DAQmx™ software has been installed, the device can be connected to the computer through a USB port. First insert the square end of the USB cable into the device, then the rectangular end into the computer.



## Step 4

### Connecting the camera

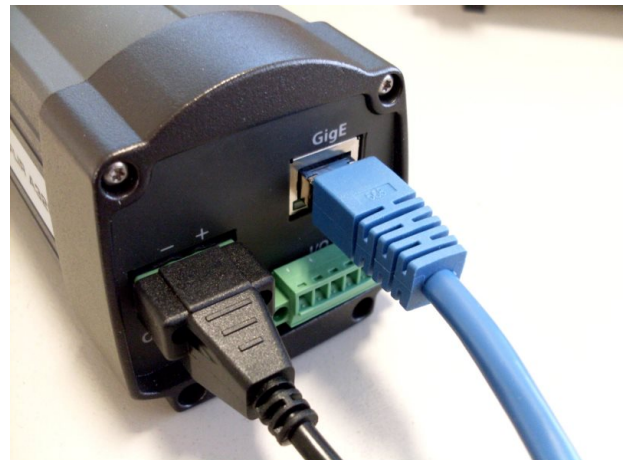
Depending on the type of camera used, the procedure to connect is different. For a FLIR 315, FLIR 325, or another externally powered camera, follow procedure 4A. For a FLIR A35, or another camera powered through the Ethernet cable, follow procedure 4B.

#### Step 4A: Connecting a FLIR A315/325 Camera

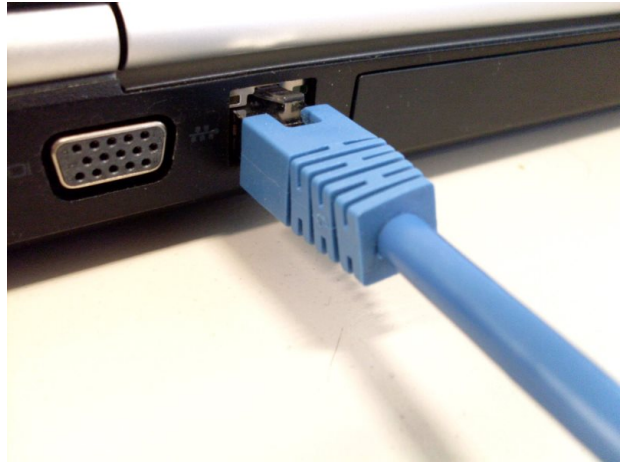


A FLIR A325 Camera. The FLIR A315 camera looks almost identical and is connected in the same manner.

To connect the camera, take one end of an Ethernet cable and insert it into the back of the camera. Then plug the power connector into the camera and then plug the power pack into a power socket. Then, take the other end of the Ethernet cable from the Ethernet Input port and insert it into an Ethernet port on the computer.







#### Step 4B: Connecting a FLIR A35 Camera



A FLIR A35 Camera.

A FLIR A35 requires a power over Ethernet (PoE) injector for power. There are a variety of PoE injectors available. However, all should have an Ethernet input, Ethernet output and power input ports. The Ethernet input may be named 'LAN In' or 'Data In' and the Ethernet output may be named 'LAN Out' or 'Data Out'.

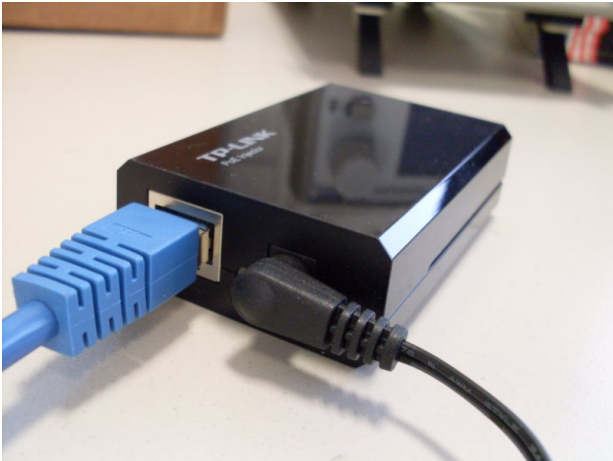
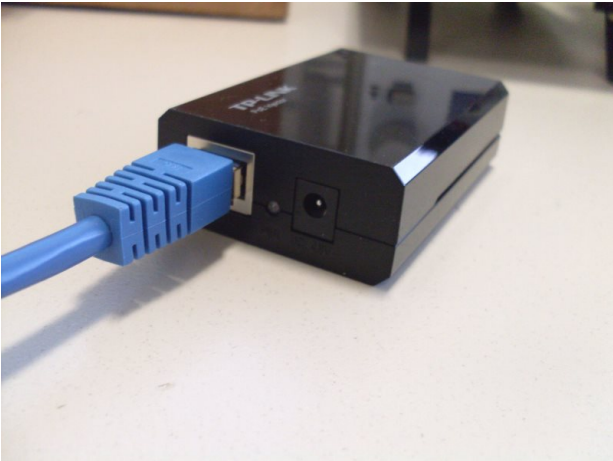


The Ethernet input and power input ports.

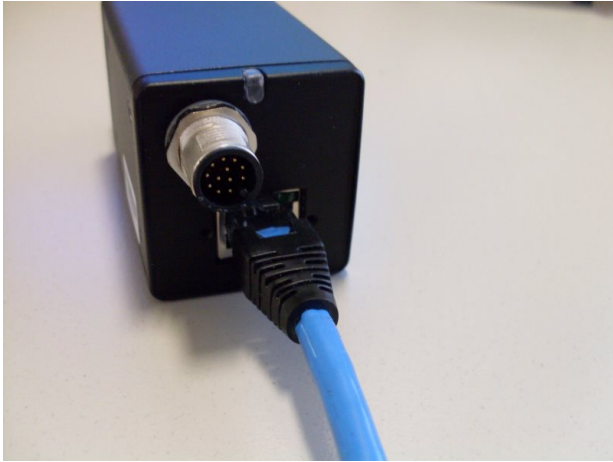


The Ethernet output port.

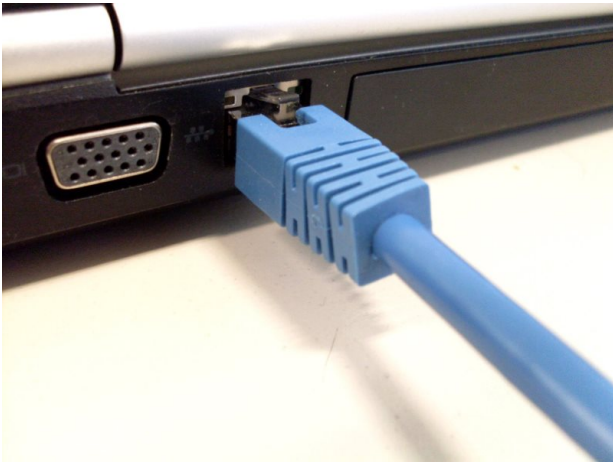
Insert one end of an Ethernet cable into the Ethernet Input of the PoE injector. Then insert the PoE power cable into the PoE injector, if required, and plug the cable into a power socket.



Next, plug a second Ethernet cable into the Ethernet Output port of the PoE injector.



Then connect the other end of the Ethernet cable from the Ethernet Output port into the camera. Then take the other end of the Ethernet cable from the Ethernet Input port and insert it into an Ethernet port on the computer.



## Step 5

### Ensure devices are powered and connected

When the power is switched on to the devices a visual indicator is displayed. There may be a delay of around 1 minute for a camera to start up. The visual indicators for the devices in this guide are listed below. Most Ethernet ports contain indicator lights which are illuminated when there is a connection.

*Note that the USB-6008 is powered over the USB connection and does not require any power source other than the computer its attached to.*

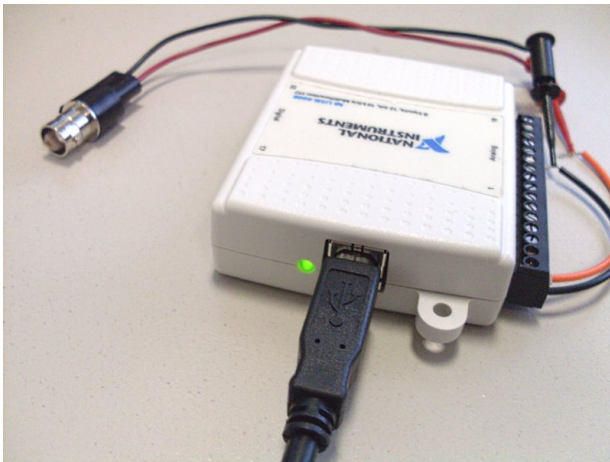
NI USB-6008	Flashing green light near USB connector.
FLIR A315/A325	Green light near power connector. Green activity lights on Ethernet port.
FLIR A35	Blue light on the top, at the rear of the camera. Green activity lights on Ethernet port.



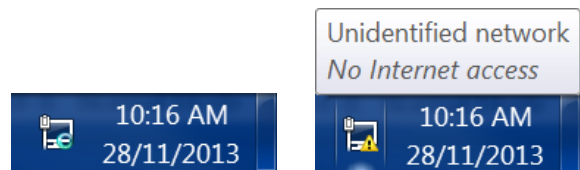
A FLIR A325 powered on and connected.



A FLIR A35 powered on and connected.



A USB-6008 powered on.



It is normal for the LAN notification icon to display a busy signal for quite some time. It is also normal for it to display a warning with 'No Network Access'

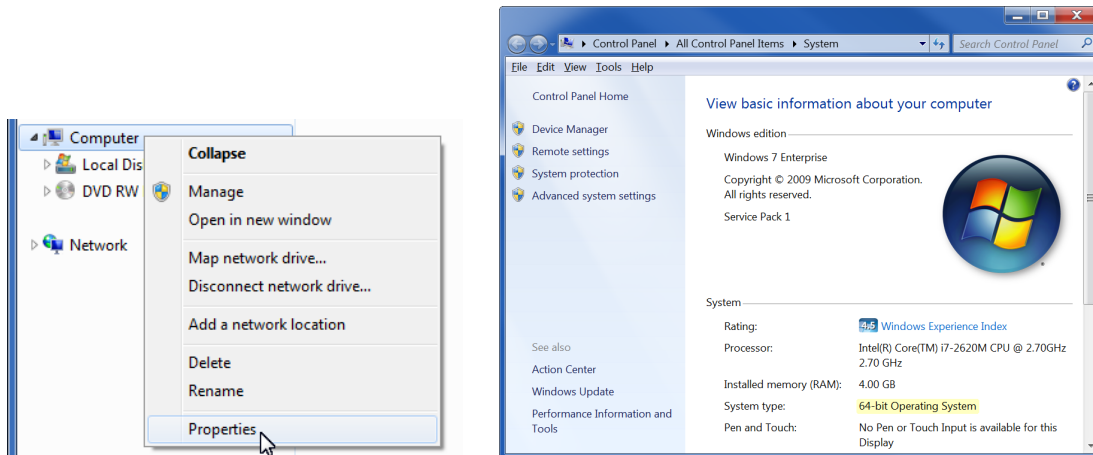
## Step 6

### Installing MiTE

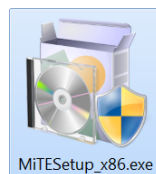
The correct version of MiTE must be installed, which depends on the type of Microsoft® Windows® installed on the computer. For 64-bit Windows MiTESetup\_x64.exe must be used, and for 32-bit Windows MiTESetup\_x86.exe must be used. An error message will be displayed if the incorrect installer is used.

### Determining which version to install

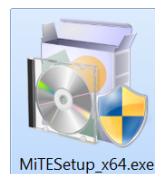
If you are unsure of which version needs to be installed, open Windows Explorer, right-click on 'Computer' or 'My Computer' on the area to the left of the window and then select the 'Properties' menu item. On Microsoft® Windows® Vista, and later versions, the 'System type' property will show if the system is a 32-bit or 64-bit system. On Microsoft® Windows® XP a 64-bit system will display this information in the 'System' group. A 32-bit version of Microsoft® Windows® XP will not display any information identifying it as a 32-bit system.



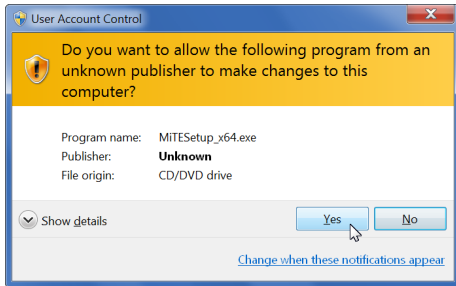
Begin the installation process by running the appropriate installer.



Installer for 32-bit Windows



Installer for 64-bit Windows



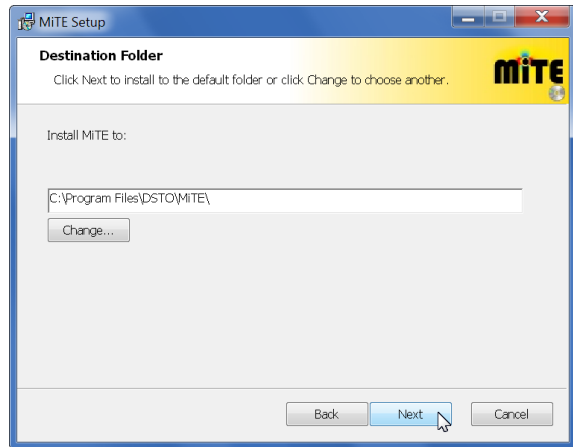
**6a** A user account control (UAC) warning may be displayed when you run the installer. Press 'Yes' to start the installer.



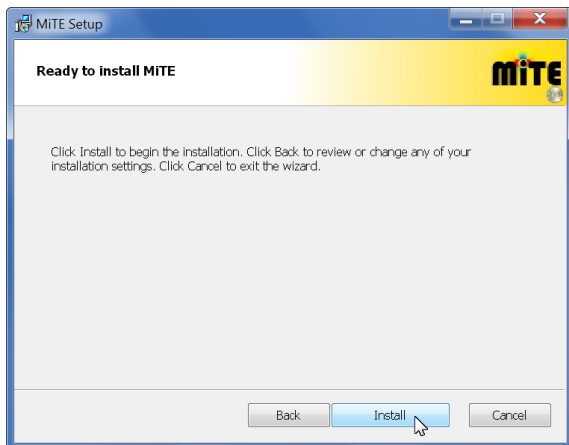
**6b** Some components required by MiTE may be installed before the Setup Wizard starts. If the computer is restarted while installing these components please re-run the installer. Once the welcome screen is displayed press 'Next' to start the setup procedure.



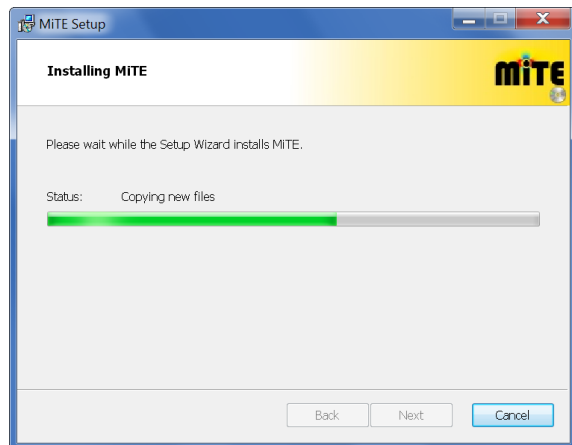
**6c** Read the license agreement and if it is acceptable click the check-box and press the 'Next' button.



**6d** The installation path of the application can be changed if needed. Press 'Next' when ready.



**6e** Click 'Install' to begin installing MiTE.



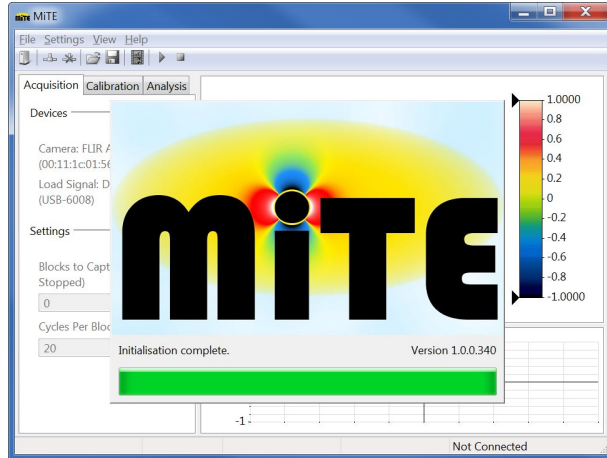
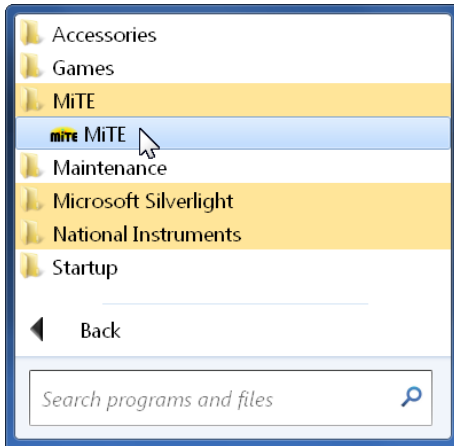
**6f** MiTE will now install. When the installation is complete press the 'Finish' button.

# Using MiTE

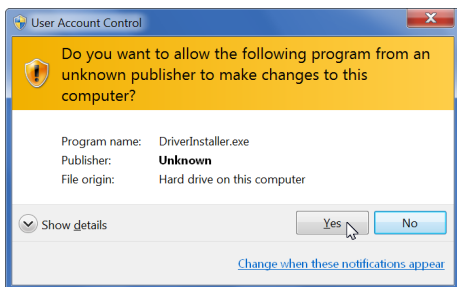
## Step 7

### Running MiTE

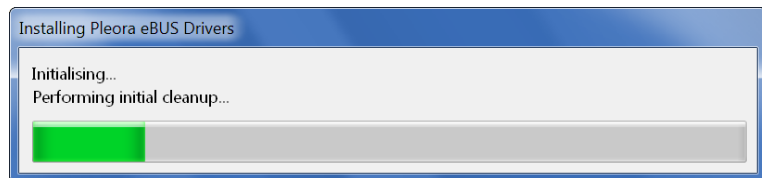
MiTE can be run from the start menu, under 'All Programs'. It can be found in the 'MiTE' folder as shown below. Once run, the MiTE start-up screen will displayed.



The first time MiTE is run it will install some drivers required to interface with the cameras. This may result in a user account control (UAC) window being displayed. If this happens press 'Yes' to continue. While installing the drivers, one or more messages asking 'Would you like to install this device software' may be displayed. Press 'Install' if this happens.

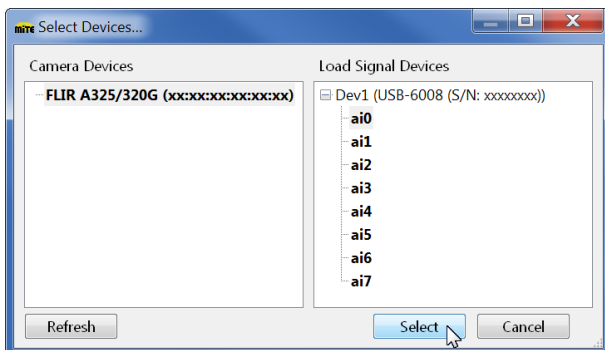


User account control window

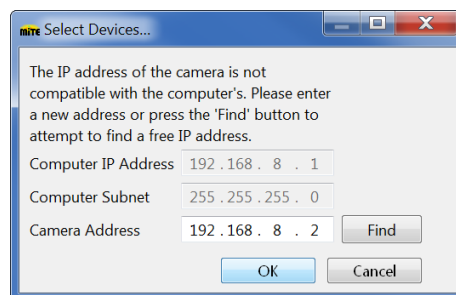


Driver installation utility

Once MiTE has started, the device selection window will be displayed, unless no devices are connected. This window can be accessed from the tool-bar if needed.



The select devices window with a camera and load signal acquisition device selected. If a device connected to the computer is missing press 'Refresh'. Press 'Select' once the devices are selected.



In some cases the IP address of the camera will need to be changed. MiTE will attempt to find an address for the camera or one can be entered manually. Press 'OK' to continue.

## Step 8

### Live-View

To enter live-view, press the button on the tool-bar shown below.



Live-view displays the image from the camera in real time as well as a 1 second window of the load signal.

### Focus Adjustment

The focus of an A325 or A315 camera can be adjusted in live-view. This is achieved by moving the focus adjustment slider below the live-view display. The further the slider is moved from the centre the faster the focus changes.

The slider can be moved using the mouse or keyboard. When using the mouse, the slider is dragged. When using the keyboard, the Left and Right arrow keys can be used for small adjustments or the Page Down and Page Up keys can be used for larger adjustments. When a mouse button or key is released the slider goes back to the centre and the focus adjustment stops.

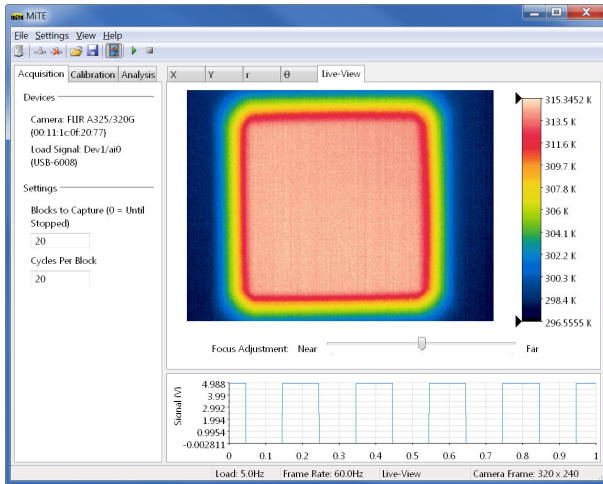
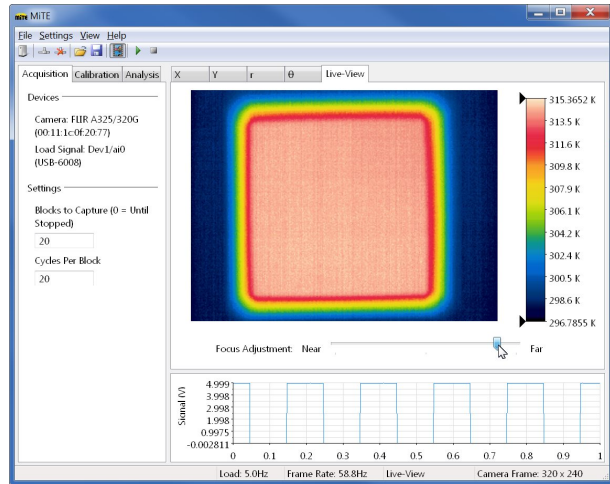


Image out of focus



Adjusting Focus

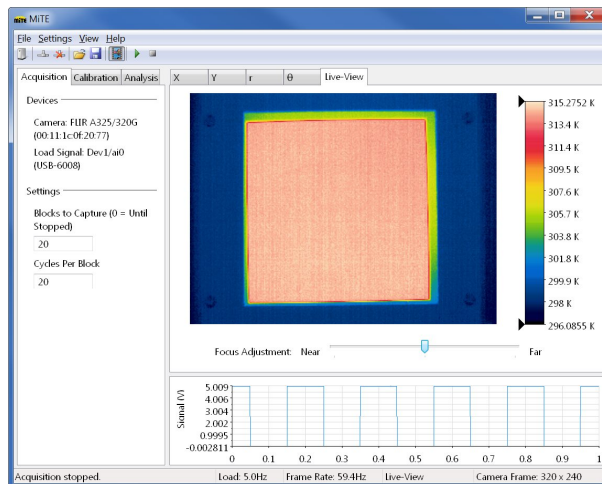


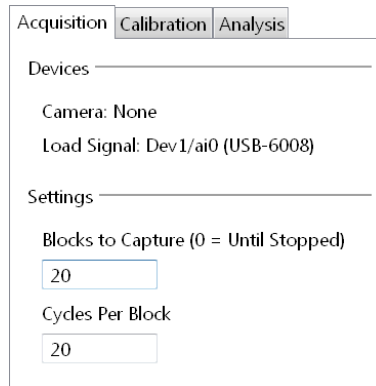
Image in focus

## Step 9

### Data Acquisition

There are two main settings which control the data acquisition process. The number of blocks to capture can be used to control the length of the acquisition process. It is possible to stop the process before capturing the number of blocks specified.

The number of cycles per block determines the number of load cycles in a block. The number of cycles has to balance between the accuracy of the frequency detection, which increases with more cycles, and the variation in frequency, which will also increase with more cycles. The value of 20 cycles per block generally gives a good compromise.



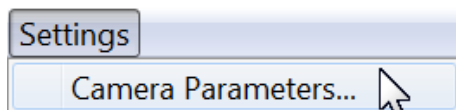
Acquisition configuration settings.

### Camera Calibration Parameters

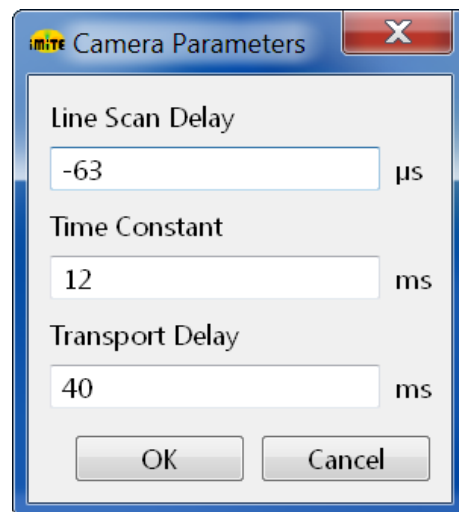
In order to make unbiased thermoelastic response measurements, a camera must be calibrated. The three calibration parameters required are the line scan delay, time constant and transport delay. The exact calibration parameters can be experimentally determined. For more details about camera calibration please see the appendix on page 20.

The line scan delay and time constant are fixed for each camera. The FLIR A325, A315 and A35 range of cameras do not appear to have a large variation in these parameters between cameras.

The transport delay is a function of many unknown factors. The transport delay is generally stable for a camera and computer pairing. A camera will likely have a different transport delay if used on a different computer.



The menu to access the camera parameters.

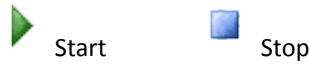


A set of typical camera parameters.



### Acquiring Data

Once the acquisition configuration is complete and the camera parameters are set then the acquisition is ready to begin. Press the tool-bar button to start the acquisition process. The acquisition process can be stopped at any time by pressing the stop button on the tool-bar.



Acquisition Toolbar Buttons.

During acquisition, the status bar at the bottom of the window will display information including the camera frame rate, the load signal frequency, the current block number and the image size.



The status bar.

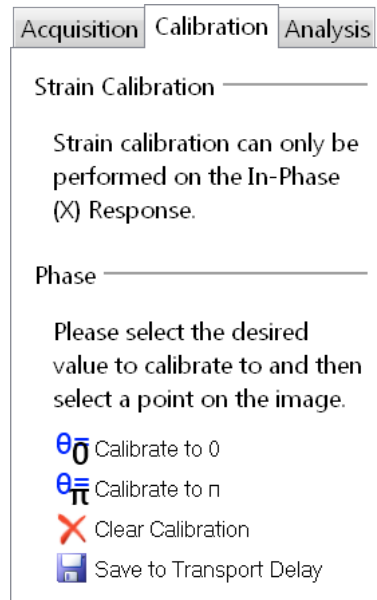
### Step 10

#### Phase Calibration

Phase calibration must be performed with the phase ( $\theta$ ) component of the response selected. This component can be selected by clicking the ' $\theta$ ' tab above the displayed response. Then select the 'Calibration' tab on the left side of the window.



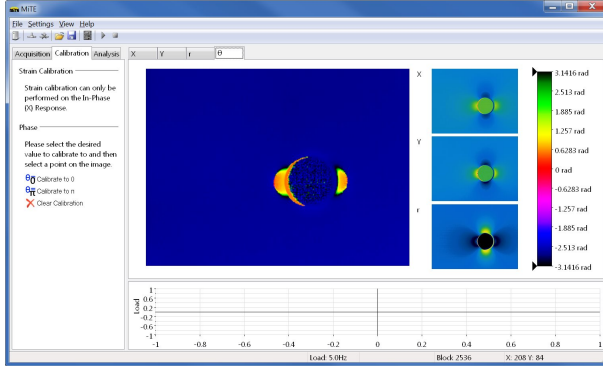
The phase component tab.



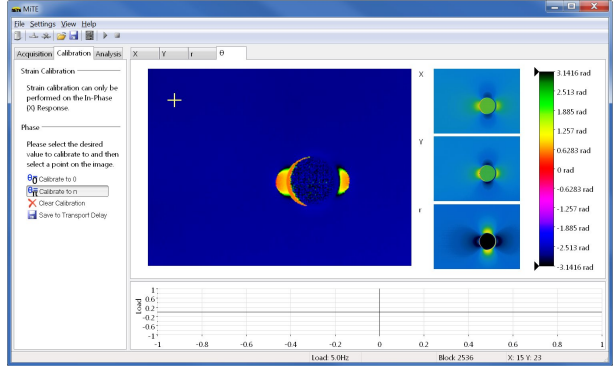
The phase calibration tab.

The phase can be calibrated where there is a section of the response which is known to be either 0 or  $\pm\pi$ . To calibrate click on either the 'Calibrate to 0' or 'Calibrate to  $\pi$ ' button (Figure 10.1). Then click on the part of the image which corresponds to the selected value of 0 or  $\pi$  (Figure 10.2). The phase will then be calibrated and the display updated (Figure 10.3). It is possible to undo any calibration made by pressing the 'Clear Calibration' button.

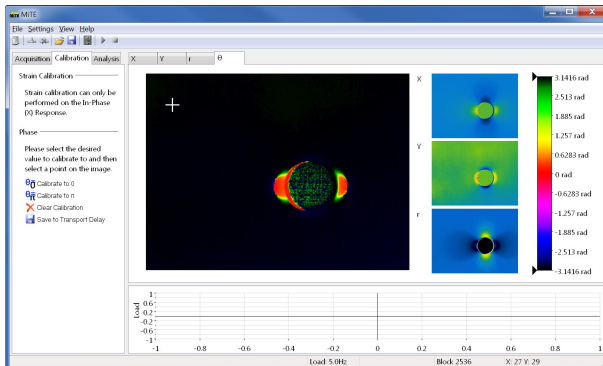
**Saving Calibration to Transport Delay** It is possible to save the calibration adjustment to the transport delay of the camera. See the appendix (page 20) for more information on calibrating the camera.



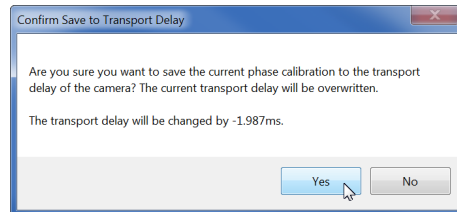
**10.1** The uncalibrated phase response. The area away from the hole should have a value of  $\pi$ .



**10.2** The response is calibrated by clicking the 'Calibrate to  $\pi$ ' button and then clicking part of the response away from the hole.



**10.3** The response has now been calibrated and the display updated.



**10.4** Confirmation message when saving the phase calibration to the camera's transport delay.

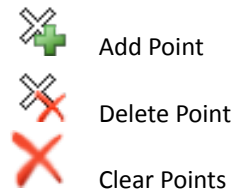
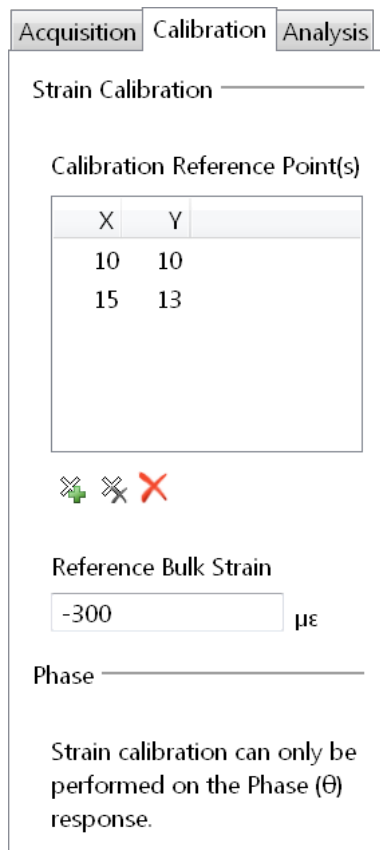
## Step 11

### Strain Calibration

A thermoelastic response can be calibrated to display bulk strain values for the in-phase (X) component. Calibrating for strain requires two steps. The first step is to select at least 1 point on the image by pressing the 'Add Point' button and clicking at the desired location. For example, the location corresponding to a strain gauge rosette. A placed point can be moved by dragging. The point should be placed on an area of image with a known bulk strain value. If more than 1 point is placed then an average of the points is used for calibration.

Once the point(s) are placed, a bulk strain measurement, which is known at the location of the points, should be entered in the 'Reference Bulk Strain' text box. Press Enter when this value is entered and the image should be calibrated to strain values.

A calibration point can be removed by selecting it in the points list and pressing the 'Remove Point' button. All points can be removed with the 'Clear Points' button.



The 'Add Point', 'Remove Point' and 'Clear Points' buttons.

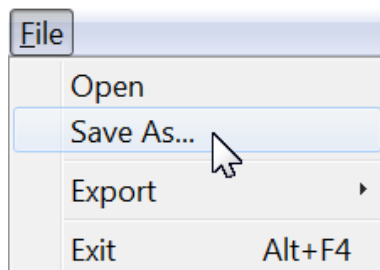
The calibration tab for the 'X' (in-phase) component.

## Step 12

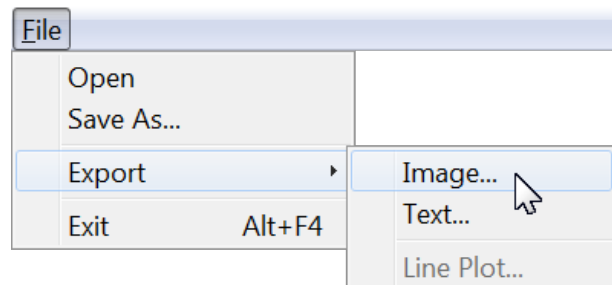
### Saving, Loading and Exporting Results

The thermoelastic response can be saved after acquisition. The saved file contains all the components of the response. This option can be found through the File menu. The saved response can then be loaded at a later time through the same menu.

The currently selected component can be exported as either an image or comma or tab separated text file. This option is also located under the File menu.



The File menu with the load and save options.



The Export menu with the exporting options.

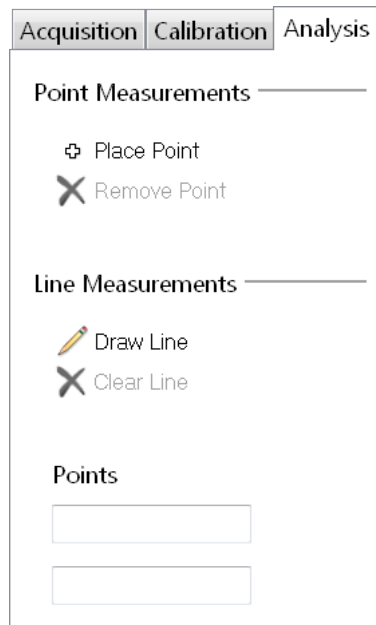
### Step 13

#### Analysis

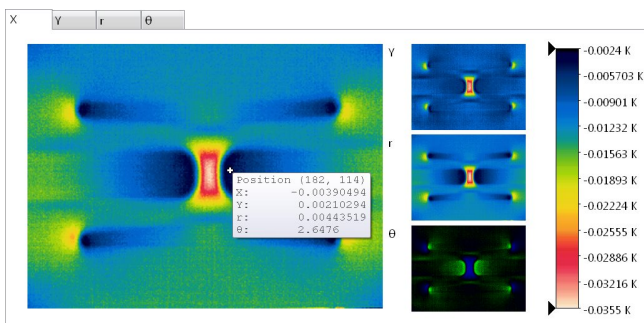
The analysis options can be found on the 'Analysis tab'. Both the line and point analysis options can be active at the same time.

A point analysis is made by clicking the 'Place Point' button and then clicking on a location on the image. The point can be move by dragging it. The point can be removed by clicking the 'Remove Point' button.

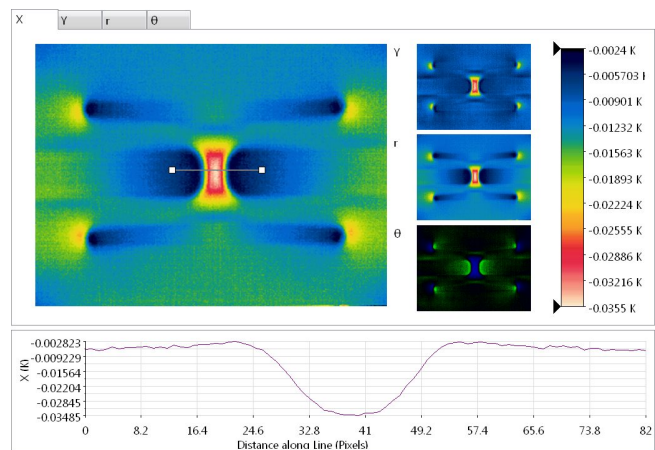
A line analysis is made by clicking the 'Draw Line' button and then pressing the mouse button in the start location and dragging the line to the desired location. Either point of the line can be moved at a later stage by dragging it. The line can be removed by clicking the 'Clear Line' button. The points of the line can be entered as pixel values in the 'Points' boxes. Each point is entered in the form of  $x, y$ . Press Enter after entering a point.



The analysis tab.



A point placed on the image.



A line placed on the image.

# Appendix

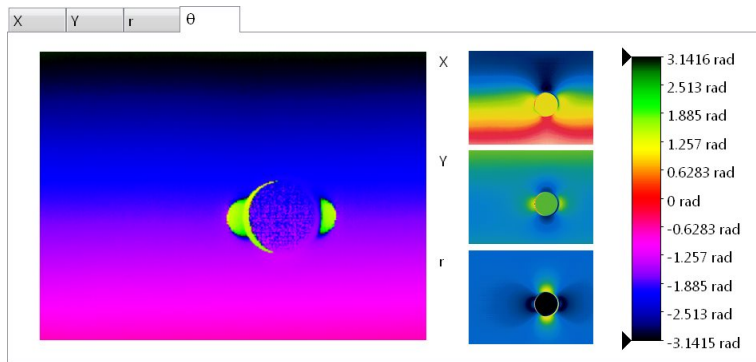
## Calibration

Three system time delays need to be correctly assigned for an unbiased thermoelastic response measurement. These are the (i) scan delay, (ii) time constant and (iii) transport delay. These parameters are entered through the camera parameters window which can be accessed through the Settings menu. This window is shown to the right.

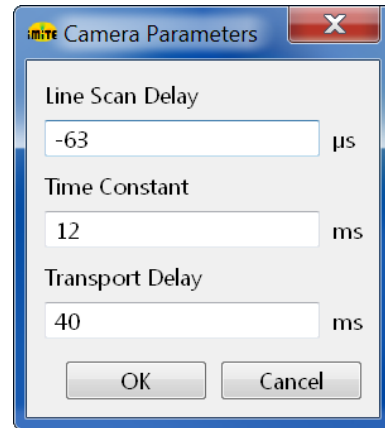
### Line Scan Delay

Refers to the delay in acquisition between successive horizontal lines in the FPA. For A315, A325 and A35 devices the value is approximately 63  $\mu\text{s}$ . A positive line scan delay corresponds to a top-down scanning procedure and a negative line scan delay corresponds to a bottom-up method.

If the line scan delay is not properly configured then a vertical gradient in the phase component will be visible.



A vertical phase gradient due to an incorrect line scan delay.



The camera parameters window.

### Time Constant

Refers to the thermal time constant of the detector. FLIR technical data sheets for the A315, A325 and A35 list a (typical) value of 12 ms, though precise values do vary. For instance, the following values were measured using an optical chopper and an area blackbody:

A315	12.1 ms
A325	10.0 ms
A35	12.3 ms

## Transport Delay

Refers to the delay in acquisition of the load reference and radiometric signals, which is a function of the notebook/camera/ADC configuration. It can be readily determined from thermoelastic testing of a geometrically uniform sample under cyclic loading. For pseudo-adiabatic conditions and in the absence of stress gradients the phase difference between the load reference and thermoelastic response should be  $\pm\pi$  (or 0 depending on the polarity of the load reference signal). Adjust the transport delay until such a value is obtained. The phase calibration function described in step 10 can make the necessary adjustment. Avoid excessively high or low loading frequencies. Paint coatings have a negligible effect on phase at low frequency but can have a significant influence at higher frequencies. Figure 1 shows the phase variation as a function of loading frequency for paint layers of three different thicknesses, assuming a paint thermal diffusivity of  $2 \times 10^{-7} \text{ m}^2/\text{sec}$  and a 3mm thick aluminium substrate. A loading frequency of 1 Hz should be suitable for coatings less than 40 microns thick.

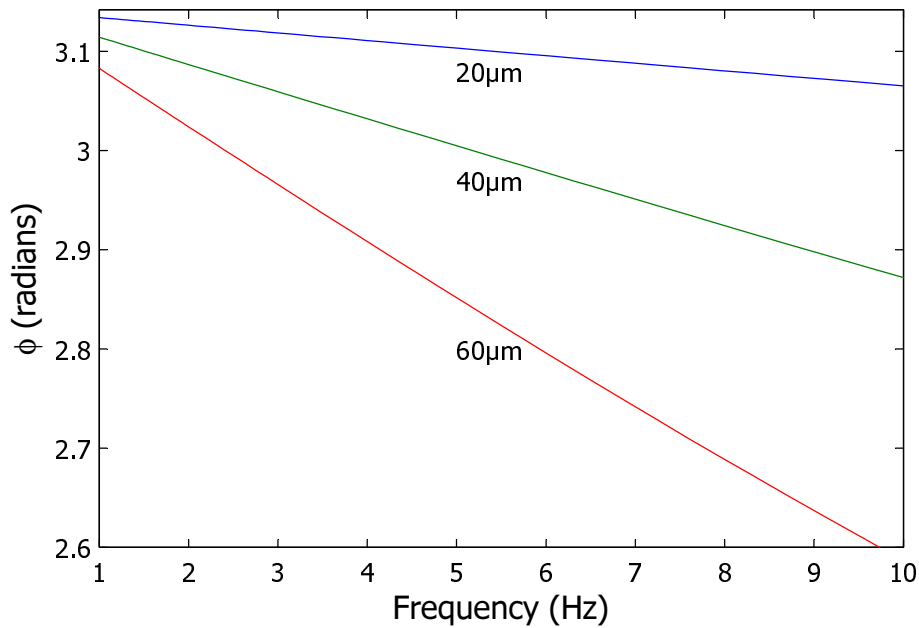


Figure 1: Phase variation as a function of loading frequency for paint layers of different thicknesses