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Advisories

Three types of advisories are used throughout this manual to provide helpful information or to alert you to the potential for hardware damage or personal injury. They are Notes, Cautions, and Warnings. The following is an example of each type of advisory. Use caution when servicing any electrical component.



NOTE An amplifying or explanatory comment related to procedural steps or text.



CAUTION

Used to indicate and prevent the following procedure or step from causing damage to the equipment.



WARNING

Used to indicate and prevent the following procedure or step from causing damage to the equipment.

Disclaimer: We have tried to identify all situations that may pose a warning or caution condition in this manual. However, PhiLumina, LLC does not claim to have covered all situations that might require the use of a Caution or Warning.



Safety Instruction

For your own safety and in order to guarantee safe operation of the system please read the following information prior to use.

- Never operate the system in areas where water or dust might penetrate the housing.
- Place the system on a stable base. Shocks, like dropping the system onto the floor, might cause serious damage to the device.
- Always unplug the system before cleaning it. Do not use cleaning liquids or sprays. Use only a dry, soft cloth on the case. Clean the optics with non-scratching lens tissue and lens cleaning fluid. Do not use strong solvents such as acetone.
- Make sure that the connecting cables are in good condition.
- Detach the system and contact the customer service in the following cases:
 - When a cable or plug is damaged or worn-out.
 - When water or other liquids have soaked into the device.
 - When the device is not working properly after following all instructions in the User's Manual.
 - If the system has been dropped or the housing has been damaged.



NOTE:

Before handling the PhiLumina Hyperspectral Imager, read the following instructions and safety guidelines to prevent damage to the product and to ensure your own personal safety.

Refer to the “Advisories” section for advisory conventions used in this manual, including the distinction between Warnings, Cautions, and Notes.

- Always use caution when handling/operating the instrument. Only qualified, experienced, authorized electronics personnel should access the interior of the instrument. The power supplies produce high voltages and energy hazards, which can cause bodily harm.
 - Use extreme caution when installing or removing components. Refer to the installation instructions in this manual for precautions and procedures. If you have any questions, please contact PhiLumina's Technical Support.
- Never modify or remove the radio frequency interference shielding from your instrument. To do so may cause your installation to produce emissions that could interfere with other electronic equipment in the area of your system.

In addition, take note of these safety guidelines when appropriate:

- When you disconnect a cable, pull on its connector or on its strain-relief loop, not on the cable itself. Some cables have a connector with locking tabs. If you are disconnecting this type of cable, press in on the locking tabs before disconnecting the cable. As you pull connectors apart, keep them evenly aligned to avoid bending any connector pins. Also, before connecting a cable, make sure both connectors are correctly oriented and aligned.

Warranty & Tech Support

Product Warranty

The PhiLumina Hyperspectral Imaging System carries a one-year warranty against defects in materials or workmanship from the date of shipment to the original purchaser. Any products found to be defective in material or workmanship will be repaired or replaced promptly.



NOTE

Products that have been modified will not be covered under this warranty.

Warranty & Repair

Please contact PhiLumina regarding warranty repair before returning the product.



NOTE

All returns to PhiLumina for Repair/Replacement/Credit must be shipped back to PhiLumina with shipping charges and duties paid.

Returns for Repair/Replacement/Credit

It is not required, though highly recommended, that you keep the packaging from the original shipment of your PhiLumina product. However, if you return a product to PhiLumina for warranty repair/replacement, you will need to package the product in a manner similar to



The manner in which it was received from our plant. PhiLumina cannot be responsible for any physical damage to the product or component pieces of the product that are damaged due to inadequate packing.

Physical damage sustained in such a situation will be repaired at the owner's expense in accordance with Out of Warranty Procedures. Please, protect your investment; a bit more padding in a good box will go a long way to ensuring the device is returned to us in the same condition you shipped it in.

Out of Warranty Repair

Repair for out of warranty PhiLumina manufactured products must be discussed with a technician before arrangements for the repair can be made.

Once the product is received at PhiLumina, an evaluation of the product/unit will be performed and a technician will contact you to discuss repairs and to obtain authorization for the repair work to be performed.

Contacting Technical Support

For a quick response, send an email to techsupport@philumina.com with a detailed description of your problem, or visit our web site at:

Our support department can also be reached by phone at (228) 363-4048.

Support is available Monday through Friday, 8:00 AM to 5:00 PM CT-USA. When contacting PhiLumina Technical Support, please be sure to include the following information:

- 1.Name
- 2.Company Name
- 3.Phone Number
- 4.Fax Number
- 5.E-mail Address
- 6.PhiLumina Product Name
- 7.PhiLumina Serial Number
- 8.Computer Make
- 9.Computer Model
- 10.Operating System and Version
- 11.Description of the Problem.



Returning Merchandise to PhiLumina

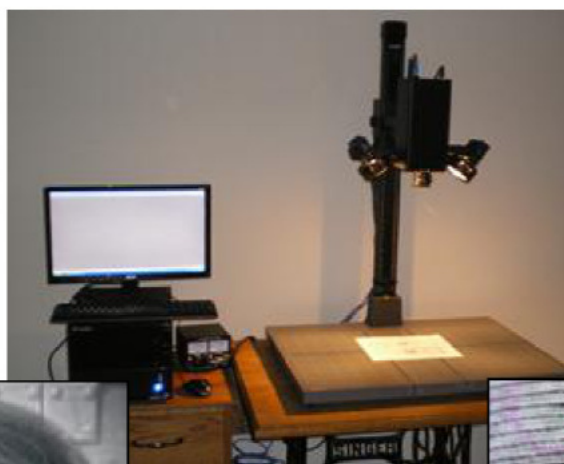
If service is required, and arrangements have been made with a PhiLumina's representative, please ship the well-packaged product to the address below:

PhiLumina, LLC 45 Hardy Court #355
Gulfport, MS 39507
USA

It is not required, though highly recommended, that you keep the packaging from the original shipment of your PhiLumina product. If you return a product to PhiLumina for warranty repair/replacement you will need to package the product in a manner similar to the manner in which it was received from our plant. PhiLumina cannot be responsible for any physical damage to the product or component pieces of the product (such as the host or expansion interfaces for PCI expansion systems) that are damaged due to inadequate packing. Physical damage sustained in such a situation will be repaired at the owner's expense in accordance with Out of Warranty Procedures. Please, protect your investment; a bit more padding in a good box will go a long way to ensuring the device is returned to use in the same condition you shipped it in.

HYPERSPECTRAL IMAGING SYSTEMS

1996-2014



VNIR 400H-USB

Setup and Operation

This manual is for use with PhiLumina, LLC Hyperspectral Imaging Systems product line. It gives an overall view and process of the hardware, software, and its use.

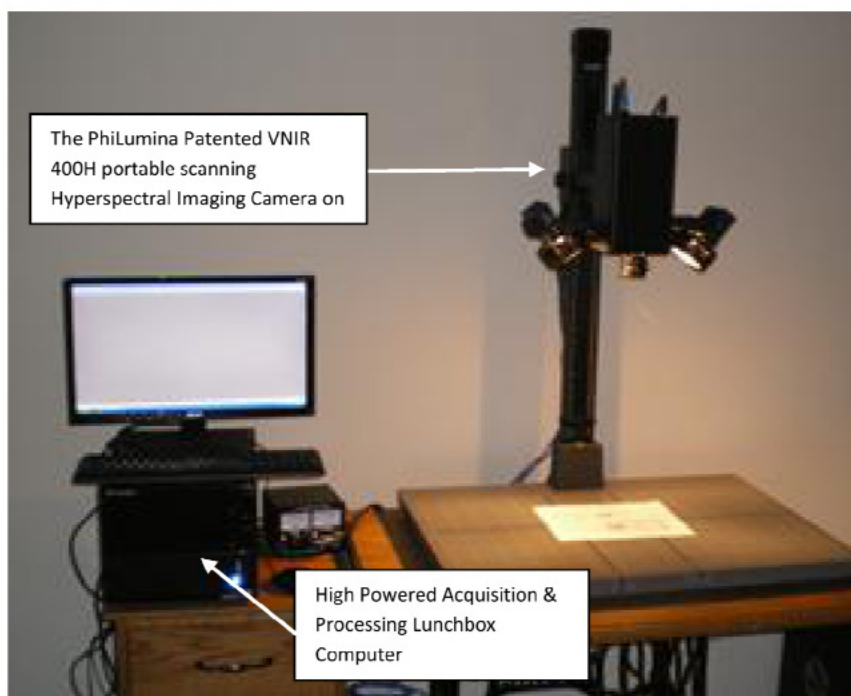
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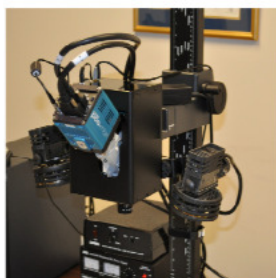
Introduction

The PhiLumina hyperspectral Imaging Systems hardware is designed to be easily setup and utilized via the PhiLumina 's HSI software, which allows the end user to easily acquire, save, and pre-process quality hyperspectral data (See the *PhiLumina's HSI Software Manual* for more details on the use of PhiLumina's HSI software).



The PhiLumina VNIR 400H Series Hyperspectral Imaging System (400-1000 nm)

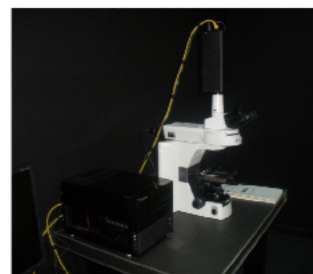
The imaging systems (*independent of the spectral range and spatial resolution that separates the current product line*) all function in the same manner using the same PhiLumina HSI software user friendly interface. The software has been designed to be user friendly without compromising the technical prowess of the internal functionality for standard and improved data processing. Each system comes in a convenient carrying case, documentation, warranty, and wavelength calibration files. The systems are calibrated at the PhiLumina's labs and delivered to you the end user with the software and calibration files installed on the system computer.



NUVNIR350



VNIR400 SERIES



VNIR400 MICROSCOPE

 Philumina FORWARDED TRAINING <i>Certified by the Space Foundation</i> 		PHILUMINA-VNIR/400H "VNIR" Series	
Sensor Type Pushbroom - Scanning Portable Turnkey Hyperspectral system (Addressable Hyperspectral Features)		Motor Control Motor Type Servo Thread Driven Control Computer Controlled Power Supply 24 Volt / Switchable Power	
Performance Spectral Range (Continuous Coverage) 400-1000nm # Spectra Channel Stands Up to 1000 # Spatial Pixels 1392 Field of view (Lens) 29 degrees F/# F/2.4 Spectral Width Sampling Flow ~.6 nm centered Spectral Resolution (FWHM) 2.8nm Pixel Size 6.45µm x 6.45µm Dynamic Range 14 bit Frame Rate 20Mhz Smileystone Distortion < .5nm Noise Level 7 e-rms@20MHZ Camera Type CCD/SONY ICX285AL Lens mount standard (other & custom mounts per request) c-mount Coding Thermal Compensated		Portability Mounting 2 (1/4 - 20) mounting Holes Upright Microscopes YES Tripods YES Copy stands YES Aircraft Mounts YES	
Data Transport USB-2 Accessories (Included) Sensor System Portable Computer Objective Lens (10" X 10") 99% Reference Panel (2" Round) 12.5% Reference Panel Acquisition Software Carrying Case		 Software and Data Processing Function Software Acquisition PHILUMINA 'imaging software Pre-processing PHILUMINA 'imaging software Operating System Microsoft XP/Win7 (Currently 32 & 64 bit operating systems)	
		Dimensions, Weight, and Power Item Dimensions (In/cm) Weight (lb/Kg) Sensor Footprint L(10") x W(4") x H(5") Sensor Weight L(25.4cm) x W(10.16cm) x H(12.7cm) 4.3lbs/1.95Kgs	
On-site Setup and Training upon request: ask for quote for these services. for ENVI training please contact . Exelis - ENVI developers and Specialists.		ALL PHILUMINA' sensors are calibrated to traceable standards Specifications subject to change	
http://www.philumina.com		Phone: 228-363-4048 Fax: 866-458-2404 Email: info@philumina.com	

 Philumina FORWARD THINKING		PHILUMINA-VNIR/400E "VNIR" Series Sensor Type Pushbroom - Scanning Portable Turnkey Hyperspectral system (Addressable Hyperspectral Features)	
Certified by the Space Foundation 		Performance Spectral Range (Continuous Coverage) 400-1000nm # Spectral Channels/Bands Up to 1000 # Spatial Pixels 1920 Field of view/Lens ~29 degrees F/# F/2.4 Spectral Width Sampling/Row ~6 nm centered Spectral Resolution (FWHM) 2.8nm Pixel Size 4.54µm x 4.54µm Data Output (Bit Range) 16 bit Frame Rate 26 Hz Smileycat/Distortion < .5nm Slit Size (W x L) 30 µm X 14.2 mm Camera Type CCD/SONY ICCX674 Lens mount standard (other & custom mounts per request) c-mount Cooling Uncooled	
Data Transport USB-3 Accessories (Included) Halogen Light Setup Portable Computer Objective Lens (10" X 10") White Reference (2" Round) Dark Reference Acquisition Software Carrying Case		Motor Control Motor Type Servo Thread Driven Control Computer Controlled Power Supply 24 Volt / Switchable Power Portability Mounting 2 (1/4 - 20) mounting Holes Upright Microscopes YES Tripods YES Copy stands YES Aircraft Mounts YES	
		 Software and Data Processing Function Acquisition Pre-processing Operating System (Currently 32 & 64 bit operating systems) Software PHILUMINA imaging software PHILUMINA imaging software PHILUMINA XP/Win7 (Currently 32 & 64 bit operating systems)	
Dimensions, Weight, and Power Item Dimensions (in/cm) Sensor Footprint L(10") x W(4") x H(5") L(25.4cm) x W(10.16cm) x H(12.7cm) Sensor Weight 4.3lbs/1.95kgs		On-site Setup and Training upon request; ask for quote for these services. for ENVI training please contact . exelis - ENVI developers and Specialists. Minimum Laptop Specs: i5 processor, 4G Ram, 1T HDD, 17" LCD monitor, Battery Life > 3 hours	
http://www.philumina.com		ALL PHILUMINA sensors are calibrated to traceable standards Specifications subject to change Phone: 228-363-4048 Fax: 866-458-2404 Email: info@philumina.com	

		PHILUMINA-NUVNIR-350 "VNIR" Series	
Certified by the Space Foundation 			
Sensor Type Pushbroom - Scanning Portable Turnkey Hyperspectral system Performance Spectral Range (Continuous Coverage) # Spectral Channels/Bands # Spatial Pixels Field of view Entrance Slit Size F/# Spectral Width Sampling/Row Spectral Resolution (Fw/Hw) Pixel Size Dynamic Range Frame Rate Smile/keystone Distortion Noise Level Camera Type Lens mount standard (other & custom mounts per request) Cooling		Motor Control Motor Type Control Power Supply Portability Mounting Upright Microscopes Tripods Copy stands Aircraft Mounts	
350-1000nm >910 <1000 2560 (usable ~80%) 30 degrees 30 µm x 30 mm F/2.4 approximately .7 centered 2.5 nm 6.5µm x 6.5µm 16 bit 95.3MHz < .5nm 1.4 e-rms@95.3MHZ sCMOS c-mount Peltier Cooled / with Fan		Servo Thread Driven Computer Controlled 24 Volt / Switchable Power 2 (1/4 - 20) mounting Holes YES YES YES YES	
Accessories (Included) Sensor System Portable Computer / Laptop with USB3 Objective Lens (10" X 10") 99% Reference Panel (2" Round) 12.5% Reference Panel Acquisition Software Carrying Case 			
Dimensions, Weight, and Power Item Sensor Footprint Sensor Weight		Software and Data Processing Function Acquisition Pre-processing Operating System (32 & 64 bit operating systems)	
Dimensions (ln/cm) L(10") x W(4") x H(5") L(25.4cm) x W(10.16cm) x H(12.7cm)		Weight (lb/Kg) 4.3lbs/1.95kgs	
On-site Setup and Training upon request: ask for quote for these services, for ENVI training please contact . Exelis - ENVI developers and Specialists.		Software PHILUMINA Imaging Software PHILUMINA Imaging Software Microsoft XP/Win7	
http://www.philumina.com		ALL PHILUMINA sensors are calibrated to traceable standards Specifications subject to change Phone: 228-363-4048 Fax: 866-458-2404 Email: info@philumina.com	

 Philumina FORWARD THINKING  Certified by the Space Foundation													
PHILUMINA-SWIR/900B "SWIR" Series Sensor Type Pushbroom - Scanning Portable Turnkey Hyperspectral system (Addressable Hyperspectral Features)		Performance Spectral Range (Continuous Coverage) 900-1700nm # Spectral Channels/bands Up to 230 # Spatial Pixels 320 Field of view 30 degrees F/# F/2 Spectral Width SamplingFlow ~2.5 nm centered Spectral Resolution (FWHM) 5nm Pixel Size 30µm x 30µm Dynamic Range 14 bit Frame Rate 60Hz Smile/keystone Distortion < .5nm Noise Level 60db Camera Type InGaAs Detector Lens mount standard (other & custom mounts per request) c-mount Cooling Forced Air Cooling											
Dimensions, Weight, and Power <table><thead><tr><th>Item</th><th>Dimensions (in/cm)</th><th>Weight (lb/Kg)</th></tr></thead><tbody><tr><td>Sensor Footprint</td><td>L(11") x W(4") x H(5")</td><td></td></tr><tr><td>Sensor Weight</td><td>L(27.94cm) x W(10.16cm) x H(12.7cm)</td><td>6lbs/2.72kgs</td></tr></tbody></table>		Item	Dimensions (in/cm)	Weight (lb/Kg)	Sensor Footprint	L(11") x W(4") x H(5")		Sensor Weight	L(27.94cm) x W(10.16cm) x H(12.7cm)	6lbs/2.72kgs	Motor Control Motor Type Servo Thread Driven Control Computer Controlled Power Supply 24 Volt / Switchable Power Portability Mounting 2 (1/4 - 20) mounting Holes Upright Microscopes YES Tripods YES Copy stands YES Aircraft Mounts YES		
Item	Dimensions (in/cm)	Weight (lb/Kg)											
Sensor Footprint	L(11") x W(4") x H(5")												
Sensor Weight	L(27.94cm) x W(10.16cm) x H(12.7cm)	6lbs/2.72kgs											
Software and Data Processing <table><thead><tr><th>Function</th><th>Software</th></tr></thead><tbody><tr><td>Acquisition</td><td>PHILUMINA' imaging software</td></tr><tr><td>Pre-processing</td><td>PHILUMINA' imaging software</td></tr><tr><td>Operating System</td><td>Microsoft XP/Win7</td></tr><tr><td colspan="2">(Currently 32 & 64 bit operating systems)</td></tr></tbody></table>		Function	Software	Acquisition	PHILUMINA' imaging software	Pre-processing	PHILUMINA' imaging software	Operating System	Microsoft XP/Win7	(Currently 32 & 64 bit operating systems)			
Function	Software												
Acquisition	PHILUMINA' imaging software												
Pre-processing	PHILUMINA' imaging software												
Operating System	Microsoft XP/Win7												
(Currently 32 & 64 bit operating systems)													
On-site Setup and Training upon request; ask for quote for these services. for ENVI training please contact . Exelis - ENVI developers and Specialists.		Data Transport USB 2.0 Accessories (Included) Sensor System Portable Computer Objective Lens (10" X 10") 99% Reference Panel (2" Square) 12.5% Reference Panel Acquisition Software Carrying Case											
http://www.philumina.com		ALL PHILUMINA' sensors are calibrated to traceable standards Specifications subject to change Phone: 228-363-4048 Fax: 866-458-2404 Email: info@philumina.com											

 <i>Certified by the Space Foundation</i>			
			
PHILUMINA-SWIR/2500 "SWIR" Series			
Sensor Type Pushbroom - Scanning Portable Turnkey Hyperspectral system (Addressable Hyperspectral Features)			
Performance		Motor Control	
Spectral Range (Continuous Coverage)		1000-2500nm	
# Spectral Channels/bands		Up to 220	
# Spatial Pixels		320	
Field of view		30 degrees	
F/#		F/2	
Spectral Width Sampling/Row		~2.5 nm centered	
Spectral Resolution (FWHM)		5nm	
Pixel Size		20µm x 20µm	
Dynamic Range		14 bit	
Frame Rate		60Hz	
Smile/keystone Distortion		< .5mm	
Noise Level		61db	
Camera Type		MCT Detector	
Lens mount standard (other & custom mounts per request)		c-mount	
Cooling		Peltier Cooled	
Dimensions, Weight, and Power			
Item	Dimensions (In/cm)	Weight (lb/Kg)	
Sensor Footprint	L(11") x W(4") x H(5") L(27.94cm) x W(10.16cm) x H(12.7cm)		
Sensor Weight		6lbs/2.72kgs	
On-site Setup and Training upon request: ask for quote for these services. for ENVI training please contact - Exelis - ENVI developers and Specialists.			
			
Data Transport USB 2.0		Portability	
Accessories (Included)		Mounting	
Sensor System		Upright Microscopes	
Portable Computer		Tripods	
Objective Lens		Copy stands	
(10" X 10") 99% Reference Panel		Aircraft Mounts	
(2" Square) 12.5% Reference Panel			
Acquisition Software			
Carrying Case			
</			

UNPACKING YOUR HSI SYSTEM



NOTE

Your new HSI system will come in a padded water proof carrying case. The main components and the main HSI Camera assembly will be in this case. Check your list of components and be sure that all of them are present (lights, tripod, power supplies, etc.).



CAUTION

Although your PhiLumina HSI product may be designed with international friendly switching power supplies; some items like light power supplies may need to be switched. Though they are checked at PhiLumina's facilities; there is the possibility that a switch may be missed.

SAFETY PROCEDURES



WARNING

It is important to turn on the camera on the system before turning on the lighting system. Some ARC based lamp systems can damage the cameras circuitry.



WARNING

Do not look into light sources and calibration lights, as they may have damaging UV and/or intensity properties that can be damaging to the eyes.

Software Installation



WINDOWS INSTALLATION:

1. Insert the CD into the CD-ROM drive of your computer. The CD should start automatically. If the menu does not start, go to the PhiLumina Install folder located on the CD and double click on Philumina.exe.
2. Follow the instructions on the dialogs that are displayed during the install process.
3. You will need to install the appropriate drivers for your camera. The drivers can be found under the drivers folder on the CD.
4. It is important now to refer to the PhiLumina HSI Software Users Manual that was supplied with your new PhiLumina HSI product.

PhiLumina's HSI software is the heart of their hyperspectral imaging product line. It runs on Win XP/Vista/7 Operating Systems. This section of this manual shows how to install this software. However, there is a separate software instruction manual that accompanies your new PhiLumina product. The PhiLumina HSI software will be pre-loaded and tested on your new system. However, there is also a CD with your system that will allow you to re-install, if needed.



PhiLumina, LLC : 45 Hardy Court #355, Gulfport, MS 39507

<http://www.philumina.com> Ph: 228-363-4048 info@philumina.com



The PhiLumina HSI system hardware is made up of the following components for the Basic Setup:

- The Hyperspectral Sensor Head & Scanning Assembly
- The camera & Filters
- The cables and interface
- The high powered computer
- The fore lens
- The white Reference Panel

The Hyperspectral Sensor head and Scanning Assembly:



The scanning assembly is comprised of the spectrograph, motor, patented focal plane scanner, and c-mount attachments for the fore lens and other mounting. The motor is found at the front of the assembly above the focal plane scanner and the motor control module is located at the top of the scanning assembly right above the optics assembly. This is all covered & protected by an assembly cover.

The camera mounts to the scanner assembly via a series of mounts as a connection between the camera and the optical mount. The two are bridged together by a rotating mounting bracket that is locked down during assembly and mounted inside the Motor Control



NOTE: M42-mount, C-mount, Custom mounts &/Or Other mount type connections may be used on your HSI system based on model and specification, for optimal performance.

**Order Blocking or Flattening Filter:**

The VNIR 400H comes with an Order Blocking Filter. These filters are used to remove any second order disturbance into longer wavelengths derived from the shorter wavelengths.

This filter is checked, installed, and tested by our expert lab technicians.

The Cables and Interfaces:

The VNIR 400H utilizes a standard USB cable to power the motor control assembly and as a separate camera interface/power supply.

USB

**Lunch box or Tower Computer:**

Your system will either come with a lunchbox computer or a tower computer with monitor, keyboard, and mouse. In this computer will be the Ethernet, USB 2.0, or frame grabber card/interface that will be needed to interface the camera system to the software system. This computer will come installed with PhiLumina' award winning software. ENVI analysis software is optional. If ENVI is ordered with the system, it will also be installed and tested on the system. All the appropriate files such as wavelength and pixel correction files will be loaded onto the system and tested as well by our expert technicians.



Lunch Box Computer



Tower Computer

Laptop Computer:

Some of our turnkey system products can now be used via a laptop, without an external interface. Our VNIR400H & E, our SWIR900 (T-FPS1700) series and our SWIR2500 (T-FPS2500) series can now be used via a laptop computer.



Laptop Computer

NOTE: See the documentation for the computer that comes with this system. All computer documentation from the manufacture can be found in the documentation packet that came with your system.

**White Reference Panel:**

Your new PhiLumina's system comes with one 99% NIST traceable white reference panel. This panel is use for purpose of percent reflectance calibration of the acquired sensor data. THEMIS' software utilizes two types of calibration function routines that use the data acquired with this reference.

NOTE: See the documentation for the reference panel that comes with this system. All reference documentation from the manufacture can be found in the documentation packet that came with your system.



NIST Traceable
Reference Panels

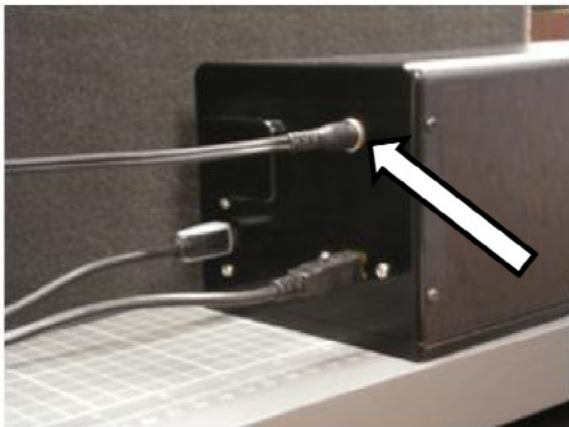
Objective/Fore Lens:

Your new PhiLumina' system comes with one fore- lens (*unless others were purchased with the system*). This lens will be a c-mount lens color balanced specifically for the spectral range for the product that was purchased. These lenses come in a series of different focal lengths. For example, the standard focal length that is typically packaged with the Philumina VNIR systems is a 23 mm c-mount lens color balanced for optimal performance between 400 and 1000 nanometers.

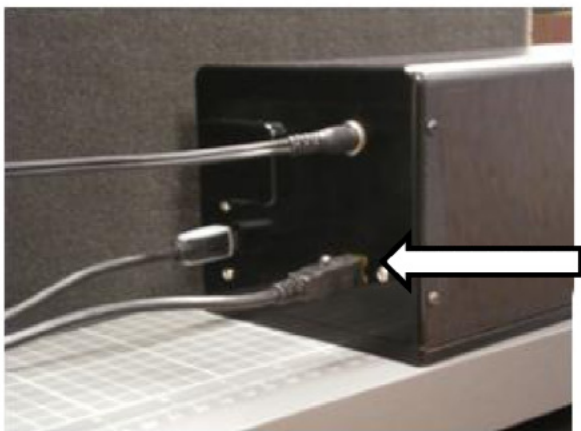
NOTE: See the documentation for the lens that comes with this system. All lens documentation from the manufacture can be found in the documentation packet that came with your system.



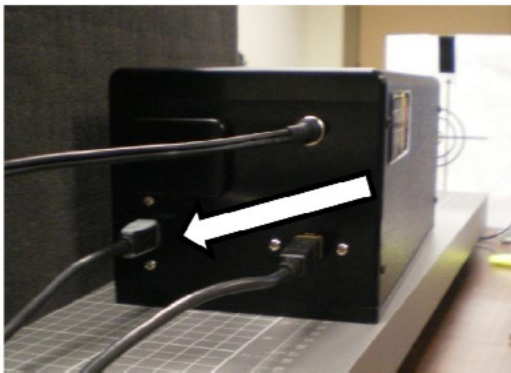
C-Mount Lenses

The Camera connections: VNIR 400H Series

The picture to the left shows the power cable being plugged into the VNIR 400 H Hyperspectral System. This cable must be plugged into a standard electrical power source. This cable powers the motor control, the cooling fan, and the digital camera. Listen for the fan motor to ensure the system is powered up – you should hear it running. If you don't, check your cable connections.



To the left is a picture of the USB motor control communications cable being plugged into the VNIR 400H Hyperspectral System. This cable controls the motor control system. This USB-2 cable can be plugged into any active USB-2/3 port.



To the left is a picture of the USB digital camera communications cable being plugged into the VNIR 400H Hyperspectral System. This cable controls the digital camera. This USB-2 cable can be plugged into any active USB-2/3 port on the computer.

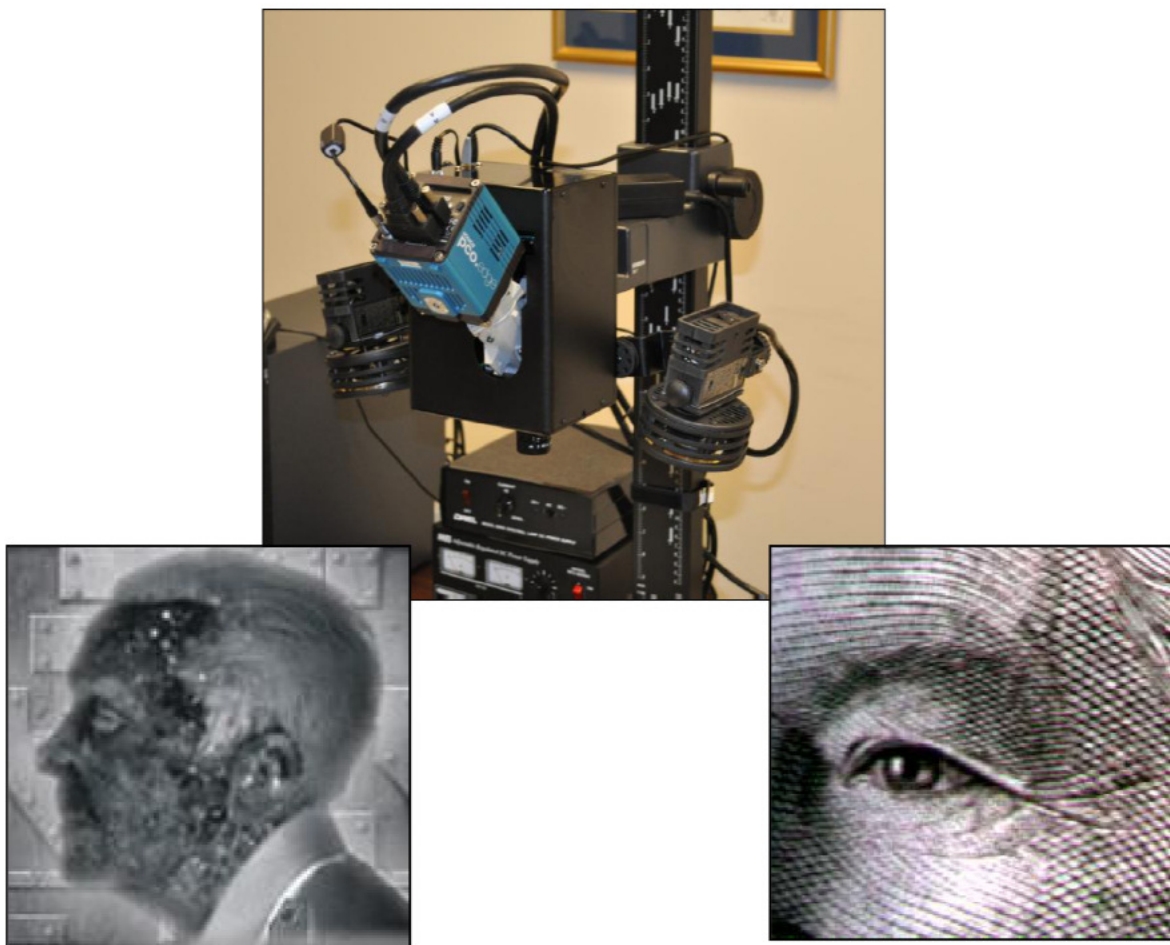
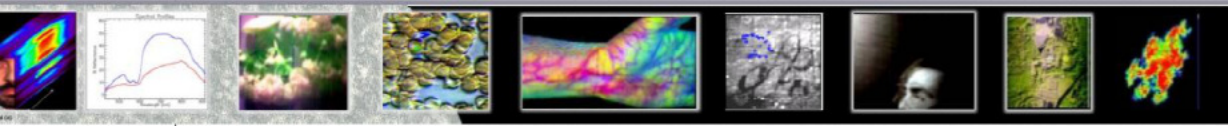


To the left is a picture of the Halogen Lights mounted on the backside of the motor control box. Insure that the lights are above the bottom of the lens and the path of their light crisscrosses across the target area. The lights must be plugged into a DC power converter.

To turn on the lights switch the MFJ Power Supply on, and then turn the "DC Adjust Knob" counter clockwise all the way to the left. Then turn on both Halogen lamps. Finally, turn the "DC Adjust Knob" clockwise to the right until the "Voltage Reading" dial is at 12 Volts on the MFJ Power Supply.

1996-2014

PhiLumina's HSI Manual



NUVNIR 350

Set Up and Operating Instruction

This manual is for use with PhiLumina, LLC's Hyperspectral Imaging Systems product line. It gives an overall view and process of the hardware, software, and its use.



The Themis' HSI system hardware is made up of the following components for the Basic Setup:

- The Hyperspectral Sensor Head & Scanning Assembly
- The camera & Filters
- The cables and interface
- The high powered computer
- The fore lens
- The white Reference Panel
- Halogen Lights with DC Converter

The Hyperspectral Sensor head and Scanning Assembly:



The scanning assembly is comprised of the spectrograph, motor, patented focal plane scanner, and c-mount attachments for the fore lens and other mounting. The motor is found at the front of the assembly above the focal plane scanner and the motor control module is located at the top of the scanning assembly right above the optics assembly. This is all covered & protected by an assembly cover.

The camera mounts to the scanner assembly via a c-mount connection between the camera and the optical mount. The two are bridged together by a rotating mounting bracket that is locked down during assembly and mounted inside the Motor Control box.





Order Blocking or Flattening Filter



The UVNIR350 comes with an Order Blocking Filter. These filters are used to remove any second order disturbance into longer wavelengths derived from the shorter wavelengths. This filter is checked, installed, and tested by our expert lab technicians.

The Cables and Interfaces:



USB Cable

The VNIR 400T utilizes two “Camera Link” cables (that plugs into the Frame Grabber Card on the computer) to transmit image data; a standard USB cable to power the Motor Control Assembly; and two standard Power Cables (on both the Motor Control Assembly and the Digital Camera).



Camera Link Cable

**White Reference Panel:**

Your new PhiLumina's system comes with one 99% and one 12.5% NIST traceable white reference panel. This panel is use for purpose of percent reflectance calibration of the acquired sensor data. THEMIS' software utilizes two types of calibration function routines that use the data acquired with this reference.



NOTE: See the documentation for the reference panel that comes with this system. All reference documentation from the manufacture can be found in the documentation packet that came with your system.

Your new PhiLumina's system comes with one objective/fore- lens (*unless others were purchased with the system*). This lens will be in most cases a c-mount (for our UVNIR350 and M42 mount) lens color balanced specifically for the spectral range for the product that was purchased. These lenses come in a series of different focal lengths. For example, the standard focal length that is typically packaged with the PhiLumina's VNIR systems is a 23 mm c-mount lens color balanced for optimal performance between 400 and 1000 nanometers (the UVNIR350 would be, etc).



C-Mount Lenses

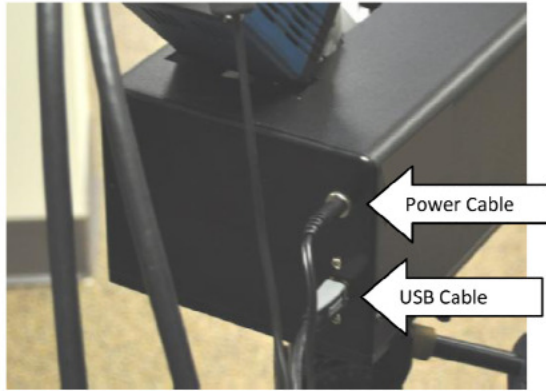


M42 -Mount Lenses

NOTE: See the documentation for the lens that comes with this system. All lens documentation from the manufacture can be found in the documentation packet that came with your system.

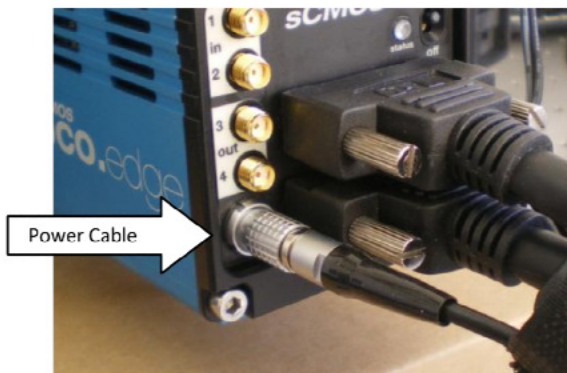


The Camera connections: THE UVNIR 350 Series

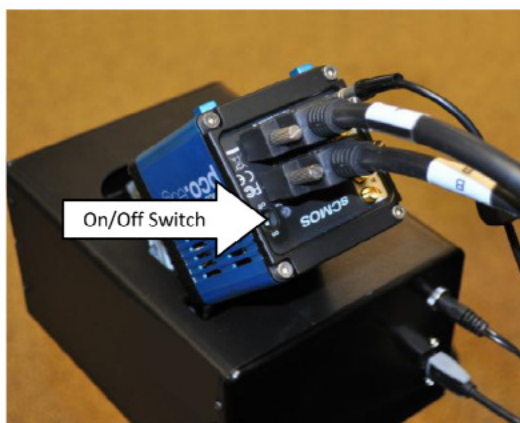


The top arrow to the left shows the **Power Cable** being plugged into the VNIR 400T Motor Control Assembly. This cable is plugged into a standard 110/220 voltage electrical power source.

The second arrow to the left shows the **USB Cable** being plugged into the Motor Control Assembly. This cable controls the movement of the slit and must be plugged into an active USB-2 or USB-3 port on the computer.



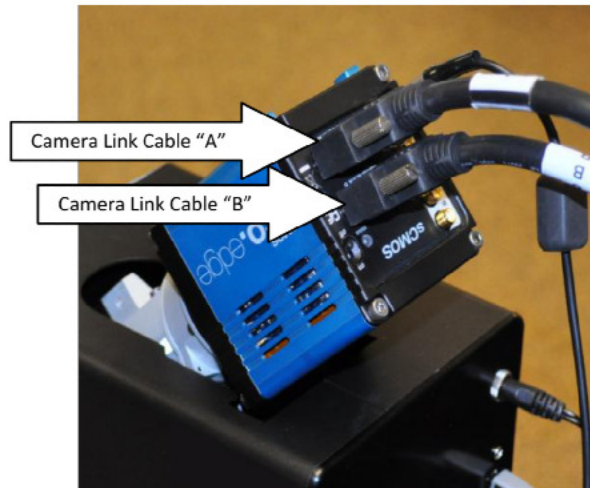
The second image to the left shows the "silver colored" pco.edge **Power Cable** that plugs into the top of the digital camera next to the two Camera Link Cables. This cable is plugged into a standard 110/220 voltage electrical power source.



The third image on the left shows the pco.edge **"On/Off" Switch** on top of the digital camera. This switch must be turned on before you initiate the HyperVisual Software program. If it is not, you must exit out of the program and restart the program for the software to recognize the camera. When not in use, we recommend you turn this switch off to maximize the life of this camera.

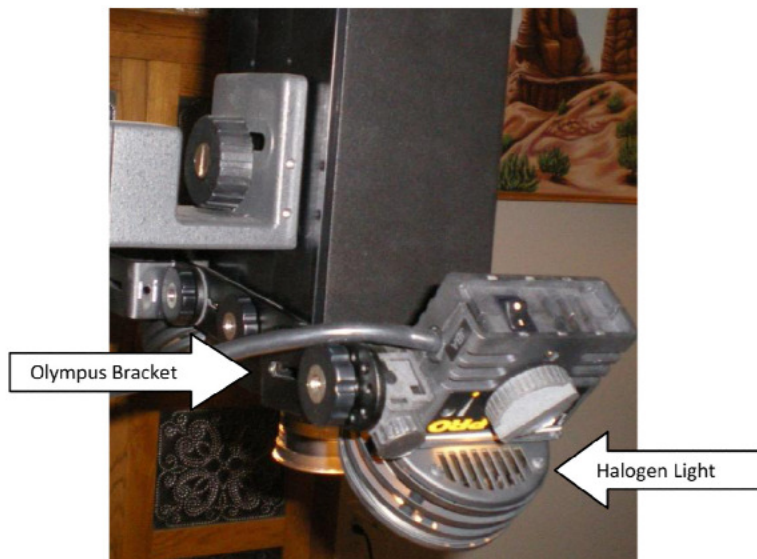


The Camera connections: THE NUVNIR 350 Series



The image to the left shows the two Camera Link Cables being plugged into the top of the pco.edge digital camera. These two cables transmit data to the computer from the digital camera and must be plugged into a Frame Grabber Card (Camera Link Card) on the computer.

It is important to note that the two cables are labeled either "A" or "B." Make sure you plug the "A" Cable into the "A" Slots on both the camera and the computer; and that you plug the "B" Cable into the "B" Slots on both the camera and the computer.



To the left is a picture of the Halogen Lights mounted on an Olympus Bracket on the backside of the Motor Control Assembly. Insure that the lights are above the bottom of the lens and the path of their light crisscrosses across the target area. The lights must be plugged into a DC power converter.

To turn on the lights switch the MFJ Power Supply on, and then turn the "DC Adjust Knob" counter clockwise all the way to the left. Then turn on both Halogen lamps. Finally, turn the "DC Adjust Knob" clockwise to the right until the "Voltage Reading" dial is at 12 Volts on the MFJ Power Supply.

HyperMicroscopy



PhiLumina's HSI systems are built to be multiplatform and adaptable to macro and micro systems. Attachments to microscope mounts via single and multiple standard ports and custom mounts, allow the end-user to use our award winning portable systems with the ability to move the system core from one research setting to another.

Technical Support

Philumina, LLC holds pride in their product, services, and support. If you are in need of support, have a question, or just want to give your input, contact one of the follow:

For software support: softwaresupport@philumina.com

For Sales Support: techexec@philumina.com

For General Support: info@philumina.com or 228-363-4048 or write to:

Philumina, LLC
45 Hardy Court #355 Gulf-
port, MS 39507 [http://](http://www.philumina.com)
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<http://www.philumina.com> Ph: 228-363-4048 info@philumina.com

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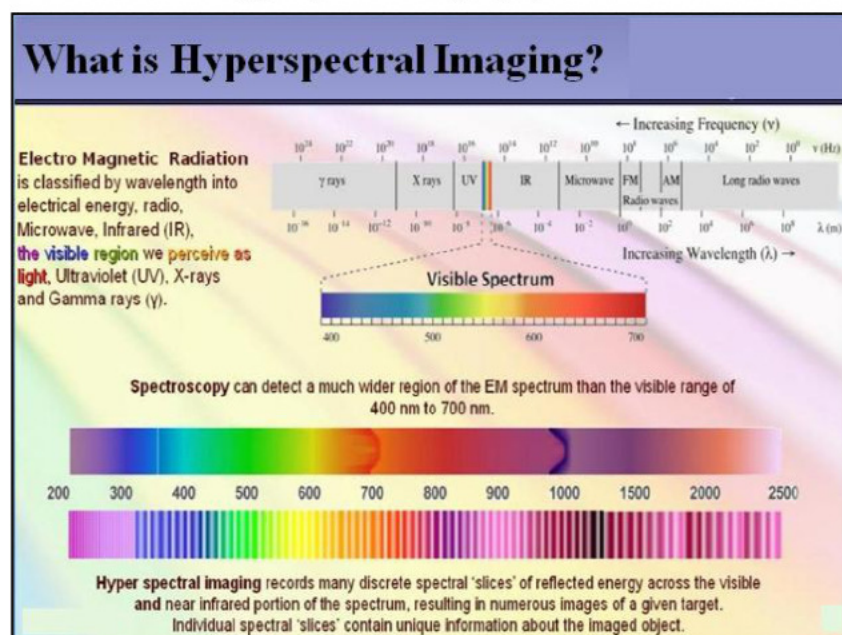
Chapter 1: Introduction

PHILUMINA® is a GUI-based software package that allows the end-user to communicate with and control hyperspectral imaging systems, scanning motors, cameras, and other PHILUMINA turnkey devices. The software is designed for Windows XP, and Windows 7 platforms (32 & 64 bit Operating Systems), it converts scanned images obtained from our hyperspectral systems into a single image data format that contains spatial and spectral information for every picture element in the image. It is a well tested stable platform that is designed with the end user in mind. It has a number of acquisition and pre-processing routines; as well as screen enhancements that can then be run on these hyperspectral images and finally ported into off-the-shelf image processing packages.

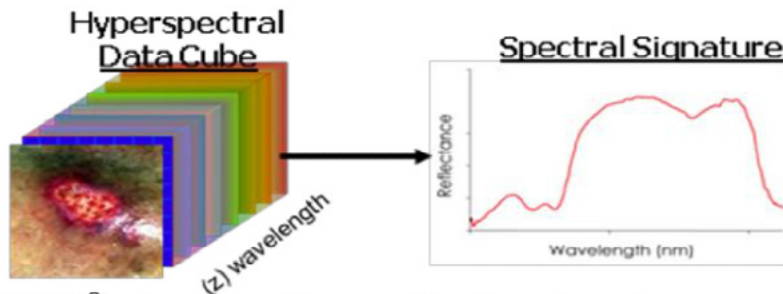
PHILUMINA® is the heart of the PHILUMINA'S core product line. It was originally derived from the NASA Commercial Space Program and was part of the technology inducted into the NASA Space Foundation's "Technology Hall of Fame". The software contains a user friendly approach while not losing the technological prowess of the functionality needed to acquire, process, normalize, save, catalog, and verify quality data. **PHILUMINA**® locates the hardware that has been programmed into its functionality, interacts with that hardware, acquires data sets, previews images, and saves data in formats such as Band Interleave by Line (BIL), Band Sequential (BSQ), LAN and several other industry formats. The image display can also be saved out to standard image formats such as Bitmap (bmp), JPEG (jpg), etc. **PHILUMINA**® offers powerful and traditional functionality such as normalization routines (including its pixel-by-pixel calibration methodology), noise removal functions, statistical output, ENVI headers, time stamp information, error logging, batch processing, project management, and many other features that is needed to capture and retain quality and accurate data from raw data set to data ready for analysis.

PHILUMINA® is easy to use and offers a very simple format for the end user. All functions can be found in tab and push button format and in traditional menus on the top menu bar.

PHILUMINA® is being used worldwide by a wide variety of researchers in use with their PHILUMINA'S hyperspectral imaging systems and for stand-alone image verification.



“Slicing” spectral information obtained from a target into hundreds of discrete images that contain reflective, absorptive and refractive properties unique to target as a function of wavelength. These properties are used to detect and identify unique signatures from the target. Such as a wound shown here:



The PHILUMINA[®] software provides user-friendly tools such as:

- **Live Preview** – this feature allows the end user to focus the system on the target and get a feel for where the target is in relation to the system.
- **Escape Function During Scan** – this feature allows the end user to cancel the scan or routine. The system then resets itself back to the original settings.
- **Geometry Control** – This is a built in feature that controls the system/scan to retain excellent geometry in reference to the target being scanned.
- **Camera Controls** – the software has a series of controls throughout that controls the specific camera that is being used and offers key features from offered with that camera.
- **Region of Interest Acquisition Controls** - for most of the newer cameras, PHILUMINA can be set to capture wavelength and spatial data via a region of interest that is chosen by the end user. There are several controls including a resolution wavelength width selection feature.
- **Real-Time View During Acquisition** – the software allows the end user to see what they are scanning. If it seems that the target is not in the right area, the end user can cancel the scan and reset for a new scan.
- **Image Display** – the image display allows the end user to see monochrome, RGB, wavelength specific, band specific, and curve data on an image display. The display features toolbars, functionality, and interactive tools.
- **Image Information Retrieval** - the software provides functions for statistics, curve retrieval, and header information.
- **Normalization/Calibration** – the software calibrates data via percent reflectance. Radiometric calibration routines will soon be added.
- **Noise Removal** – There are two types of noise removal that remove the noise in the spectral dimension. Traditional Mean Calibration and newer Linear Regression Models.
- **Image Statistics** – the software allows the end user to derive statistical information from the saved and acquired data.
- **Pixel Property Tool** – the pixel property tool can be used to analyze point curve data. A curve is generated for a particular point selected by the end user within the image display.
- **Batch Processing** – the software has a batch processing tool that can process acquired data and log errors without stopping the process.

header so that the work is done for you to port the saved data from the software directly into ENVI.

- **Project Management Tool** – this tool allows each end user to save their own settings for the system so that their projects stay intact for each specific user. There is also a note logging system in the header tool for each image.

Chapter 2: Installation

The installation process is rather simple for **PHILUMINA**® the software is loaded in a pre-selected folder that is created for you, unless you (the end-user) changes the path where you would like the software to be installed. Friendly pop-up messages will be displayed, if specific programs or additional features need to be shut down or pre-loaded. All of the pre-loaded features can be found on the **PHILUMINA**® installation CD.

To install **PHILUMINA**®:

1. Close all programs.
2. Insert the **PHILUMINA**® **Installation CD** into your CD-ROM drive. If AutoPlay is enabled on your system, the installation will begin automatically and you can skip steps 3 and 4.
3. From the **Start** menu, click on **Run**.
4. Type "**D:\setup**" (Substitute the appropriate drive letter of your CD-ROM for **D**).

Chapter 3: Getting Started

To start PHILUMINA®:

From your **Start** menu, select **Programs**, then select **PHILUMINA®** or double click the **PHILUMINA®** shortcut on your desktop.

PHILUMINA® will first scan through the sequence of hardware detection and then will load the main screen on the computer display.

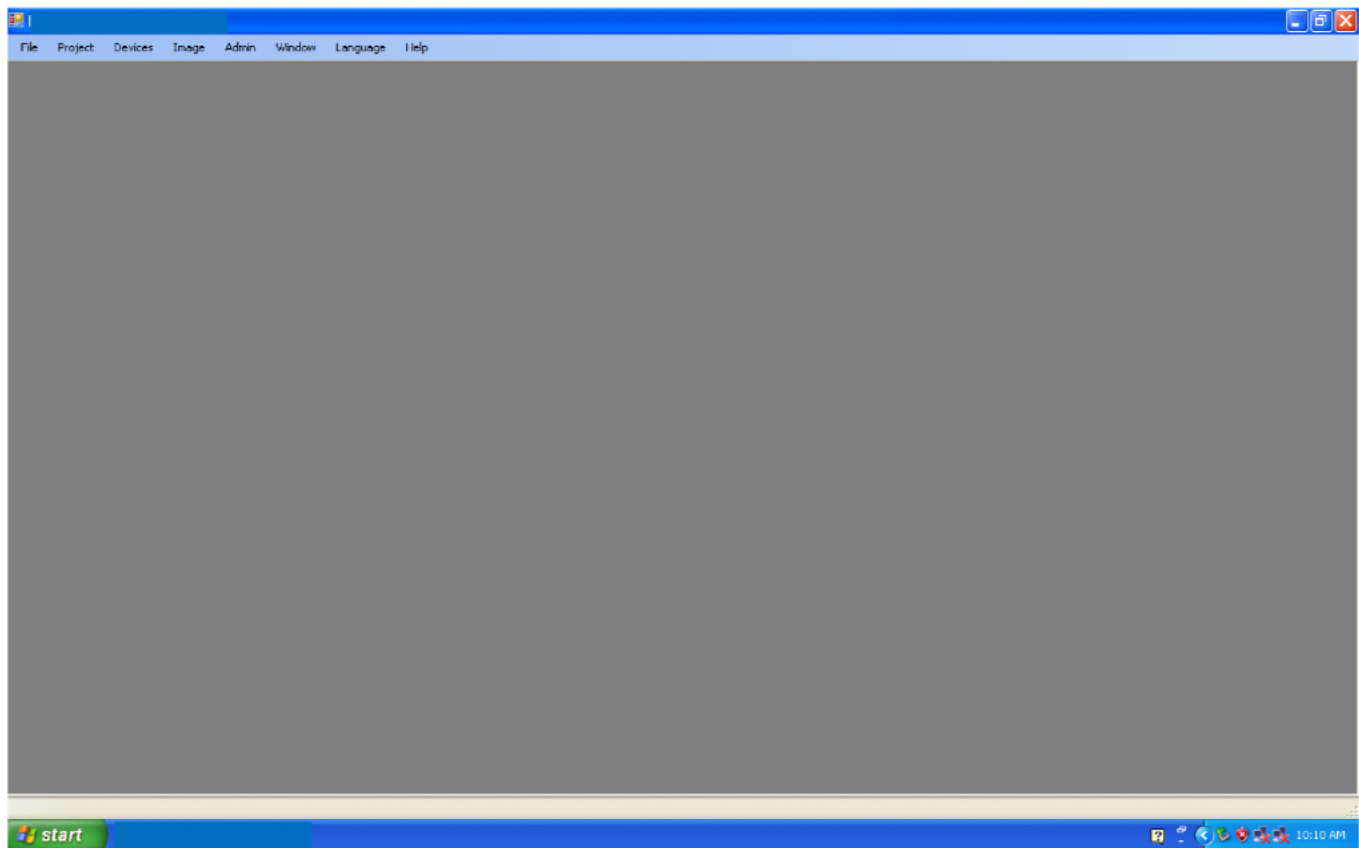


Figure 3.1: The main PHILUMINA® screen

Opening a File The file extension for PHILUMINA[®] is (*.hyp). However, the software also reads ENVI (*.img), (*.lan), and several other format files. A windows file selection (windows file explorer) dialog box will appear for you to select your *.hyp file to display in the image window for PHILUMINA[®].

To open an image file:

Select **File > Open** from the main menu and navigate to the file you want to open.
Then click **Open**.

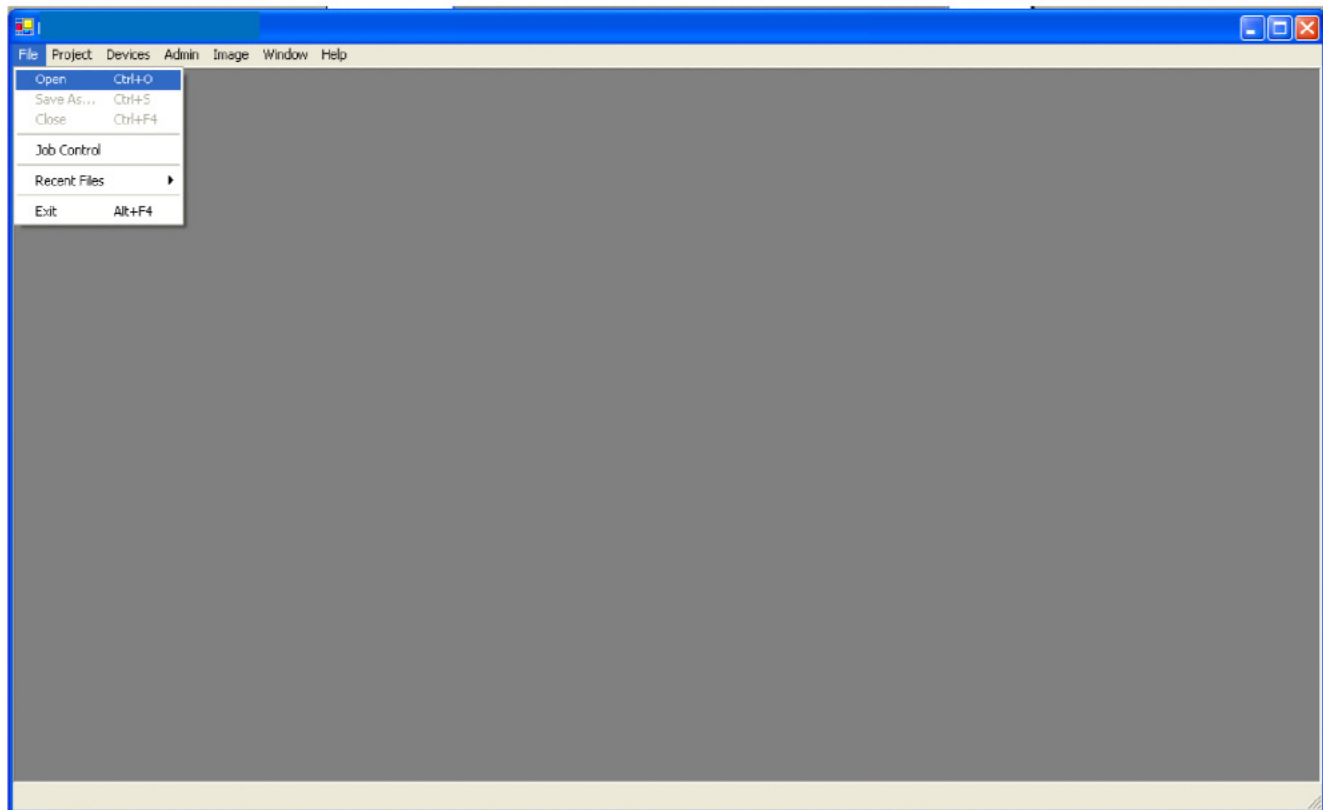


Figure 3.2: Opening an image file

PHILUMINA® remembers the last 5 files you opened, and makes it simple to reopen them by placing them in the **Recent Files** submenu.

To open a recent file:

Select **File > Recent Files** from the main menu and click on the file you want to open. The full path to the file is shown in the status bar at the bottom of the main window.

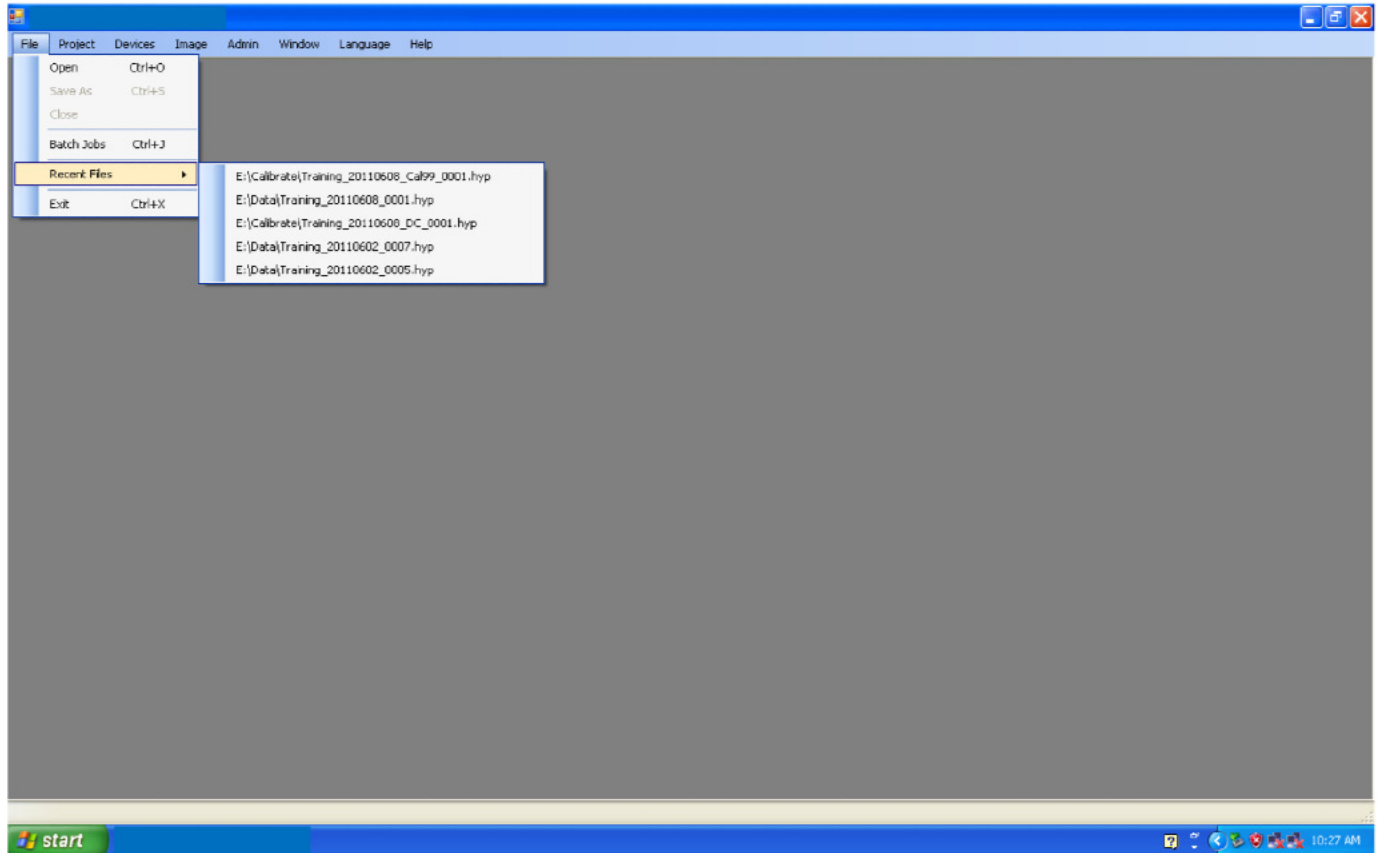


Figure 3.3: Opening a recent file

Saving a File

To save an open file:

Select **File > Save As** from the main menu. Navigate to where you want the file saved and type the name you want the file saved as. Then click **Save**.

Note: PHILUMINA[®] automatically saves files that have been modified. This feature is mostly used for renaming a file or for making a copy of it.

Closing a File

To close an open file:

Select **File > Close** from the main menu while the file you want closed has window focus.

Or

Click on the **Close** button in the upper right hand corner of the window to be closed. It appears as an **X** inside of a box.

Exiting PHILUMINA[®]

To exit PHILUMINA[®]:

Select **File > Exit** from the main menu.

Chapter 4: Setting Up Projects

PHILUMINA[®] incorporates the use of multiple projects for differing settings and hyperspectral camera systems to be run from the same system. Each project can be configured with default settings so that changing from one group of settings to another is as simple as changing the current project. Each project can also be set to operate a different hyperspectral camera system, making it possible to run multiple cameras from the same computer.

By utilizing the project manager feature, the end-user can save time in saving specific settings that they want to save and come back to later. This allows a large group to keep settings for each specific end-user and/or project. This project manager saves setting for the camera, motor control, displays, components, and user-specific settings (save ENVI header, Use Large Icons, etc.). The project manager also keeps track of specific and important files such as wavelength files, pixel correction files, etc.

Project Manager

The **Project Manager** can be accessed by opening the **Project** menu and selecting **Manage Projects**. The manager is broken into categories by tabs along the top of the window:

- **Project Settings:** Settings that apply globally to the project and that do not belong to any of the other categories.
- **Display Settings:** Settings that affect the way images are displayed. Contains settings for particular histogram stretches, which wavelengths to display by default, and the color of the application's background.
- **Camera Settings:** Settings that determine what camera system is associated with the project, as well as default settings for image acquisition.
- **Motor Settings:** Settings that determine what motor system is associated with the project, as well as default settings for image acquisition.
- **Stage Settings:** Settings that determine what fore-optics type is associated with the project.

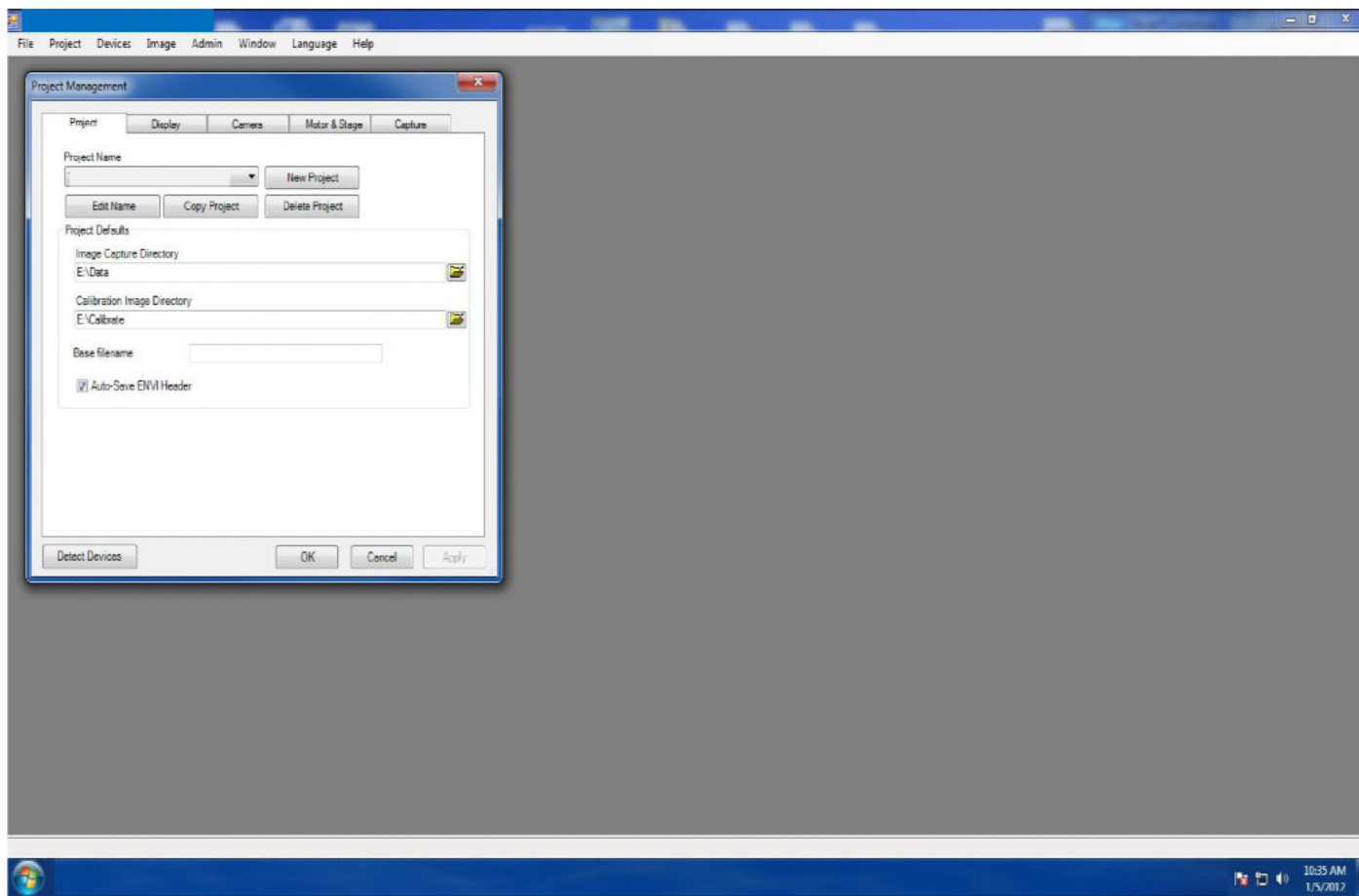


Figure 4.1: The Project Management window: Showing “Project Settings” Tab

Project Settings

This tab allows you to create new projects, edit the name of existing ones, or to delete a project completely. You can also set some general properties for the project as a whole.

- **Project Name:** Select the name of an existing project that you want to modify.
- **New Project:** Click this button to create a brand new project.
- **Copy Project:** Click this button to create an exact copy of the project that is currently selected.
- **Edit Name:** Allows you to change the name of the currently selected project.
- **Delete Project:** Completely deletes the project from the application’s database.
- **Default Capture Directory:** This sets the folder where captured images are to be saved by default. Images can be saved to other locations by manually entering the path while in the **Image Capture** window.
- **Directory for Calibration Files:** This sets the folder where calibration files (99% reflectance and Dark Current) are to be saved by default.
- **Auto-Save ENVI Header:** Checking this box results in a header file for the ENVI® image analysis program being created when an image is captured.

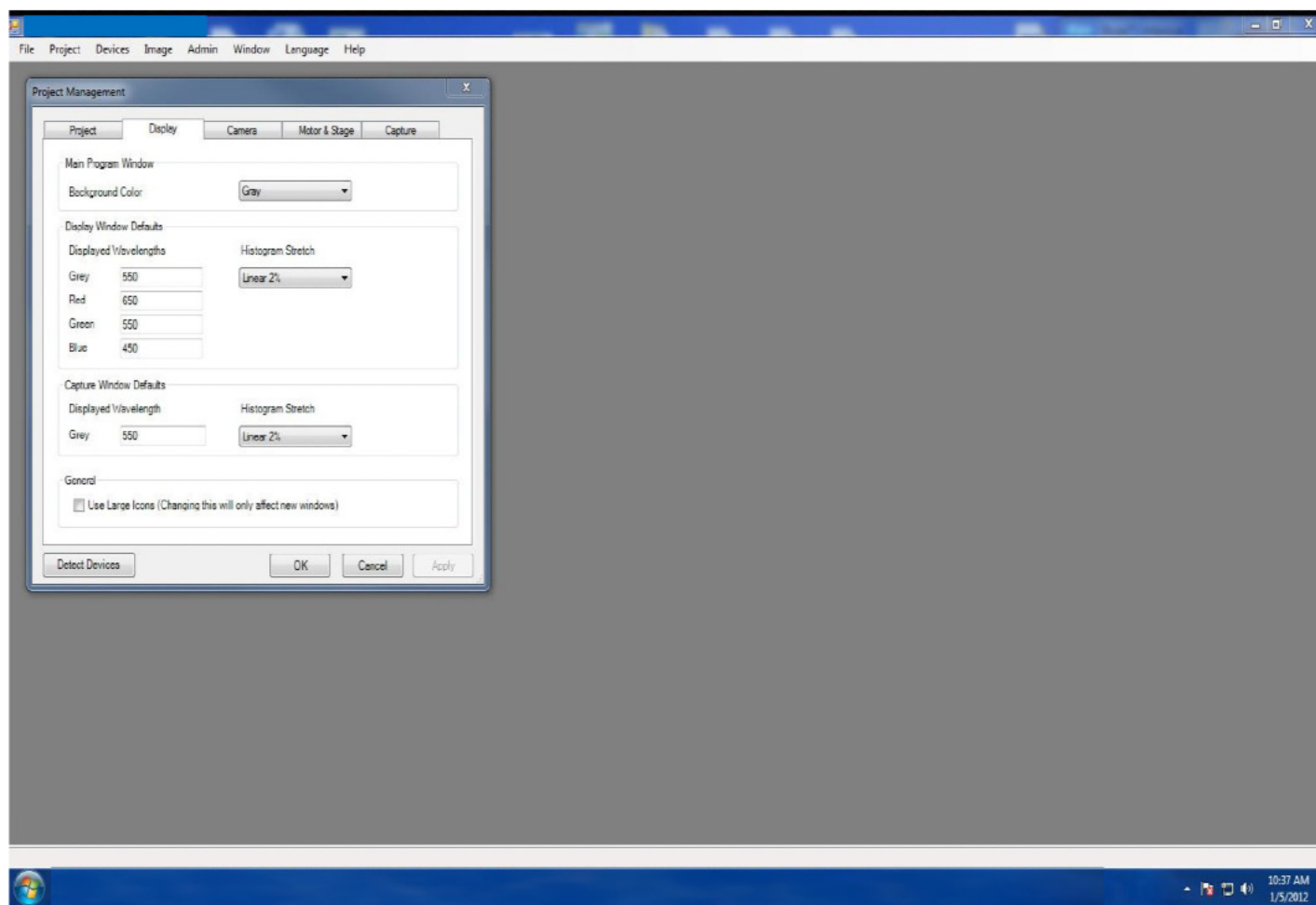


Figure 4.2: The Project Management window: Showing “Display Settings” Tab

Display Settings

This tab displays the settings that will affect the way images are displayed both during pre-view/capture and when they are loaded from a file. It also contains settings for the way the application itself is displayed.

- **Main Program Window:**
 - **Background Color:** This will allow you to change the background color of the application’s main window.
- **Display Window Defaults:**
 - **Displayed Wavelengths:** Each of these settings (Grey, Red, Blue, and Green) determines what wavelength of the image is to be displayed by default when an image is loaded from a file.
 - **Histogram Stretch:** This is the default type of stretch to be used when an image is loaded from a file.
- **Capture Window Defaults:**
 - **Displayed Wavelength:** This setting determines what wavelength will be displayed on the screen during a preview / capture.

- **Histogram Stretch:** This is the default type of stretch to be used for the image displayed on the screen during a preview / capture.
- **General:** The only current general function is for the allowance of larger

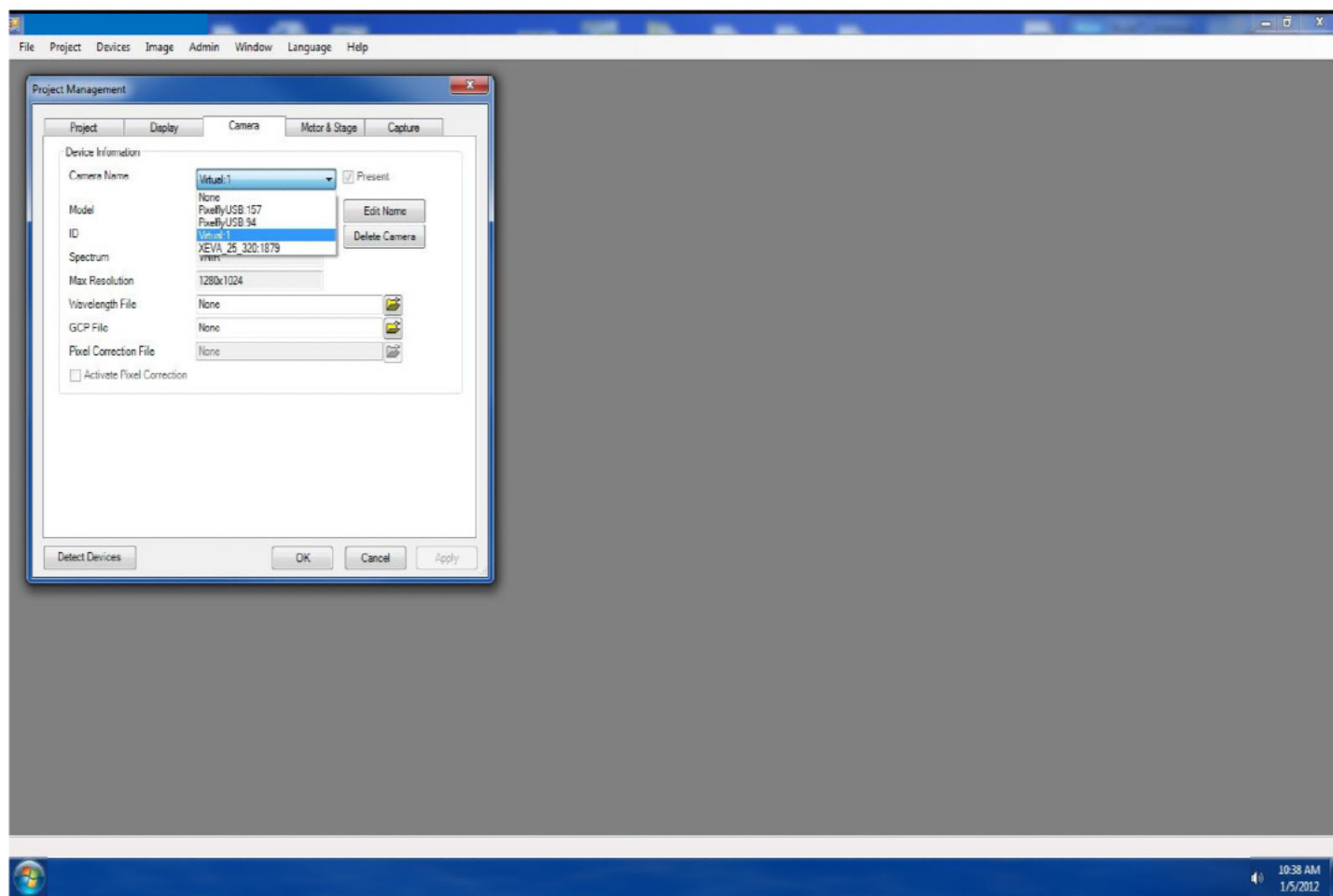


Figure 4.3: The Project Management window: Showing "Camera Settings" Tab

Camera Settings

This tab displays the settings for the camera that is attached to the project.

➤ Device Information:

- **Camera Name:** This contains a list of all the cameras that are currently stored in the database. The "Present" checkbox beside it will be checked if the currently selected camera is recognized by **PHILUMINA®**.
- **Model:** This displays the model of the currently selected camera.
- **ID:** This displays the ID of the currently selected camera.
- **Spectrum:** This displays what spectrum range the currently selected camera has.
- **Max Resolution:** This displays the maximum resolution of the currently selected camera.
- **Wavelength File:** This setting is for automatically attaching a wavelength file to an image as its being captured.

- **Activate Pixel Correction:** Checking this will cause the camera to perform pixel correction on any invalid pixels in its CCD, provided that the camera supports this feature.
- **GCP File:** This setting determines what file is to be used by default when performing GeoCorrection on an image taken by the currently selected camera.
- **Pixel Correction File:** This setting determines what file is to be used by default when performing Pixel Correction on an image taken by the currently selected camera
- **Edit Name:** Clicking this allows you to edit the name of the currently selected camera.
- **Delete Camera:** Clicking this removes the currently selected camera from the database.

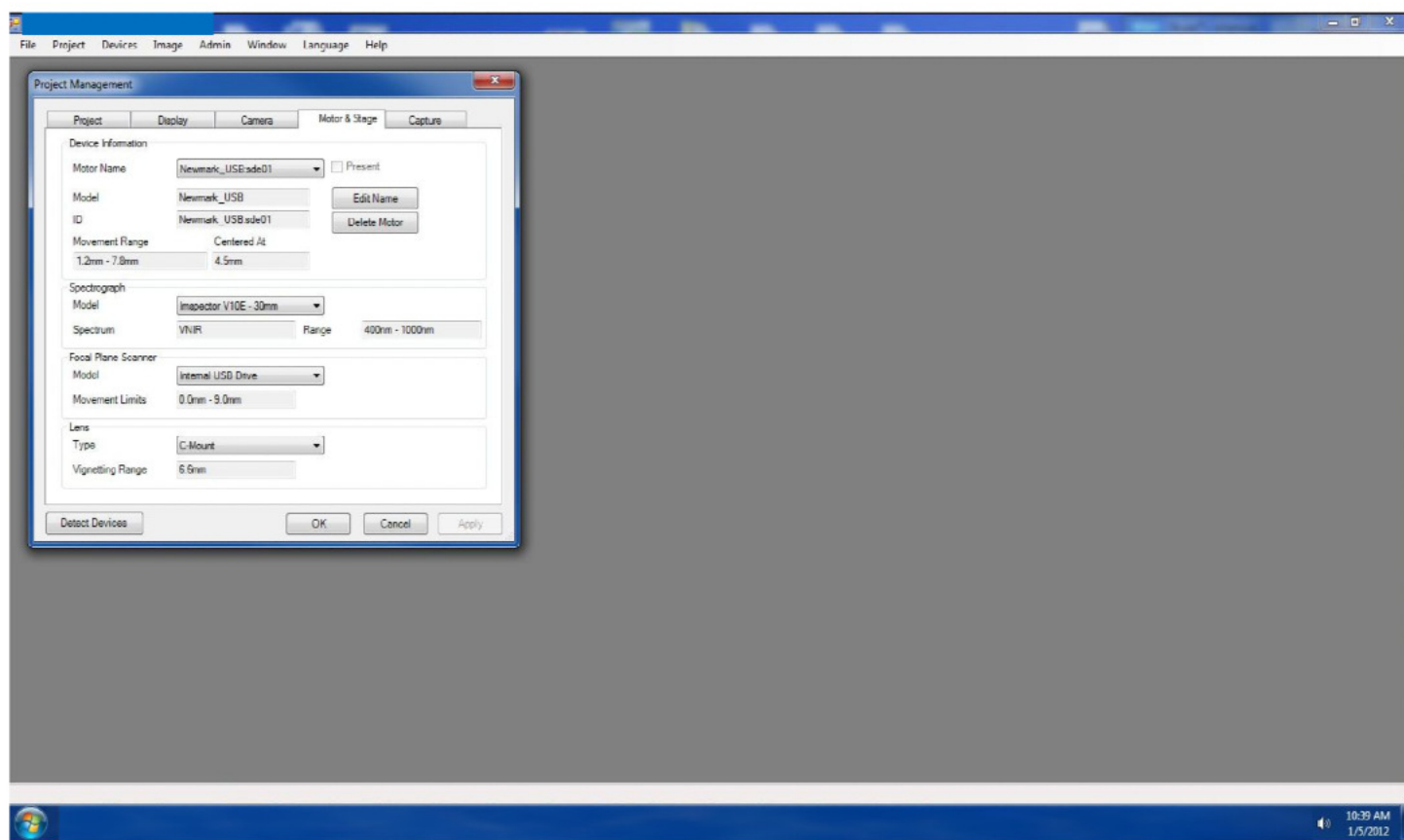


Figure 4.4: The Project Management window: Showing “Motor & Stage” Tab

Motor & Stage Settings

This tab displays settings for the motor that is attached to the project.

➤ Device Information:

- **Motor Name:** This contains a list of all the motors that are currently stored in the database. The “Present” checkbox beside it will be checked if the currently selected motor is recognized by **PHILUMINA®**.
- **Model:** This displays the model of the currently selected motor.
- **ID:** This displays the ID of the currently selected motor.

(The next two features are dependent on the “Stage Settings” tab information)

- **Centered At:** This displays where the center motor position is set for the given parameters.
- **Movement Range:** This displays the set range of movement for the currently selected settings in the “Stage Settings” tab.
- **Default Movement Settings:**
 - **Top to Bottom Movement:** This sets the motor to travel from its top position to its bottom position during a capture. This is mutually exclusive with **Bottom to Top Movement**.
 - **Bottom to Top Movement:** This sets the motor to travel from its bottom position to its top position during a capture. This is mutually exclusive with **Top to Bottom Movement**.
- **Spectrograph:**
 - **Model:** This list contains types of spectrographs. This feature is mainly for Header Information.
- **Focal Plane Scanner:**
 - **Model:** This contains a list of all the focal plane scanners that are currently stored in the database.
 - **Movement Limits:** This displays the physical range of movement for the currently selected focal plane scanner.
- **Lens**
- **Type:** This contains a list of lens mount types used
- **Vignetting Range:** This displays the physical range of movement allowed before distortion of the outer range of the lens plane affects the data input this is a function of

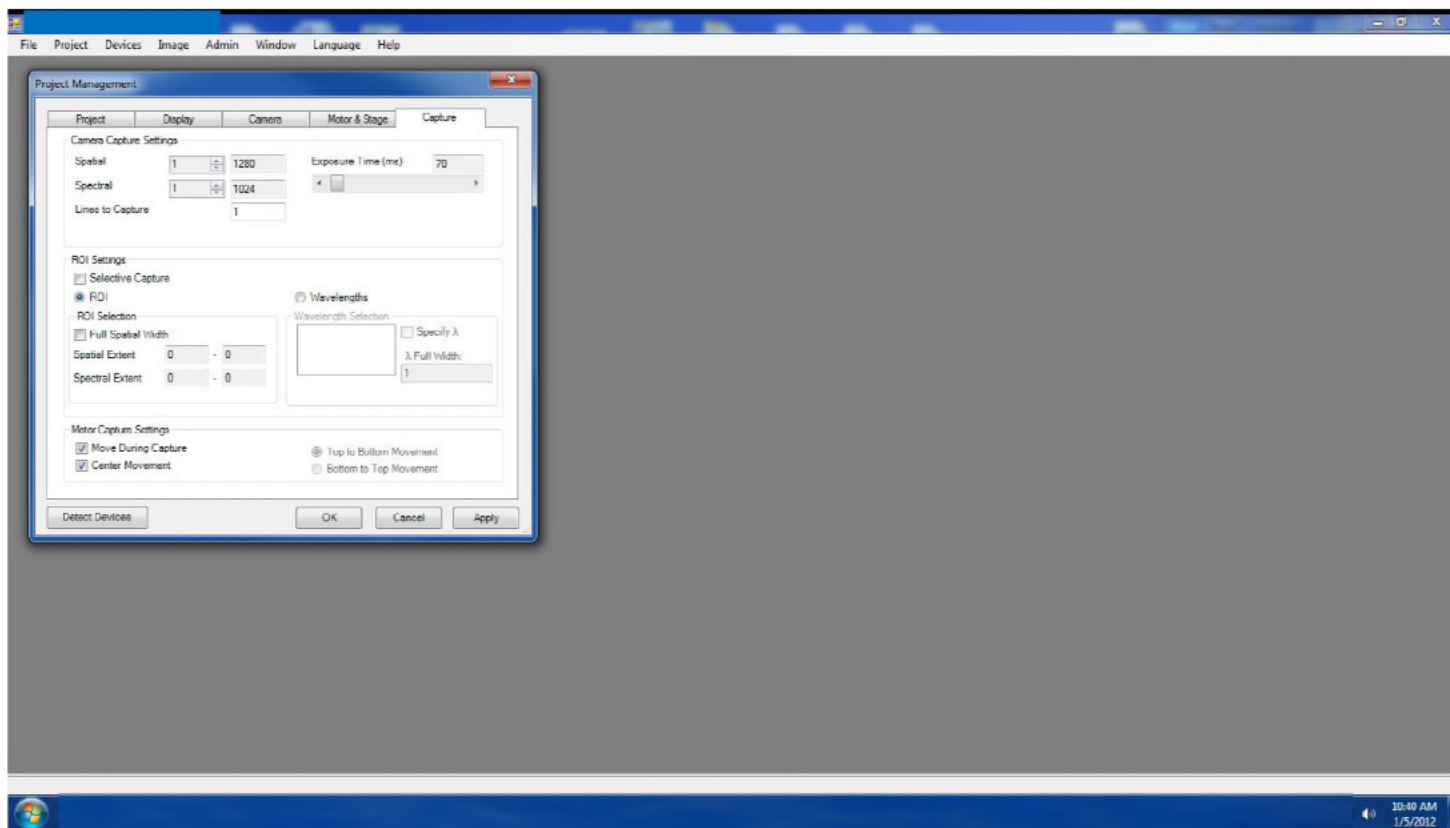


Figure 4.5: The Project Management window: Showing "Capture" Tab

Capture Settings

This tab displays settings for the fore-optics that are attached to the project.

- **Default Capture Settings:**
 - **Spatial Binning:** This allows you to set what spatial binning the camera will default to when the Image Capture window is opened.
 - **Spatial Resolution:** This displays the spatial resolution of the currently selected camera based on the spatial binning setting.
 - **Spectral Binning:** This allows you to set what spectral binning the camera will default to when the Image Capture window is opened.
 - **Spectral Resolution:** This displays the spectral resolution of the currently selected camera based on the spectral binning setting.
 - **Lines to Capture:** This is the default number of lines to capture per image acquired in the Image Capture window.
 - **Exposure Time:** This is the default exposure time to use when capturing an image in the Image Capture window.
 - **Activate Pixel Correction:** Checking this will cause the camera to perform pixel correction on any invalid pixels in its CCD, provided that the camera supports this feature.
- **ROI (Region of Interest) Capture Settings:** The display boxes in this area of the project manager are only details for what is set during ROI setup from the capture/Preview window that is then saved to the project. These settings cannot be changed from the

project manager; only from the user settings in the acquisition/capture/preview window.
NOTE: These ROI features are not available in all of PHILUMINA, LLC products as of yet.

- **Selective Capture:** This displays that the function has been set by the user in this project for selective capture.
- **ROI:** This button shows that the Draw ROI feature is set by the user for this particular project, as opposed to the Wavelength Selective List Feature.
- **ROI Selection:** This set of information shows what features in the ROI function has been set by the user.
- **Wavelengths:** This button shows that the Wavelength Selective List Feature is set by the user for this particular project, as opposed to the Draw ROI Feature.
- **Wavelength Selection:** This allows you to set what spectral binning the camera will default to when the Image Capture window is opened.
- **Full Spatial Width:** This check box shows that the end user has chosen to use the entire useful range of the X dimensional spatial data from the camera. If the Full Spatial Width is not used; then the spatial extent will show the new boundaries.
- **Specify Wavelength:** This feature shows what wavelengths were chosen from the Wavelength Selective List for this project.
- **Spectral Extent:** This shows the extent of the spectral ranges based on the user defined selection for the camera.

➤ **Motor Capture Settings:**

- **Movement is Centered:** Checking this will cause the motor to center the capture area inside its movement range during a capture.
- **Movement is Centered:** Checking this will allow the motor to move during capture.

Chapter 5: Image Display

Image files opened into **PHILUMINA**® are displayed in the **Image Display** window. This window contains numerous controls related to manipulating how the image is viewed, and also includes a toolbar that allows you to perform various manipulations of the image file itself.

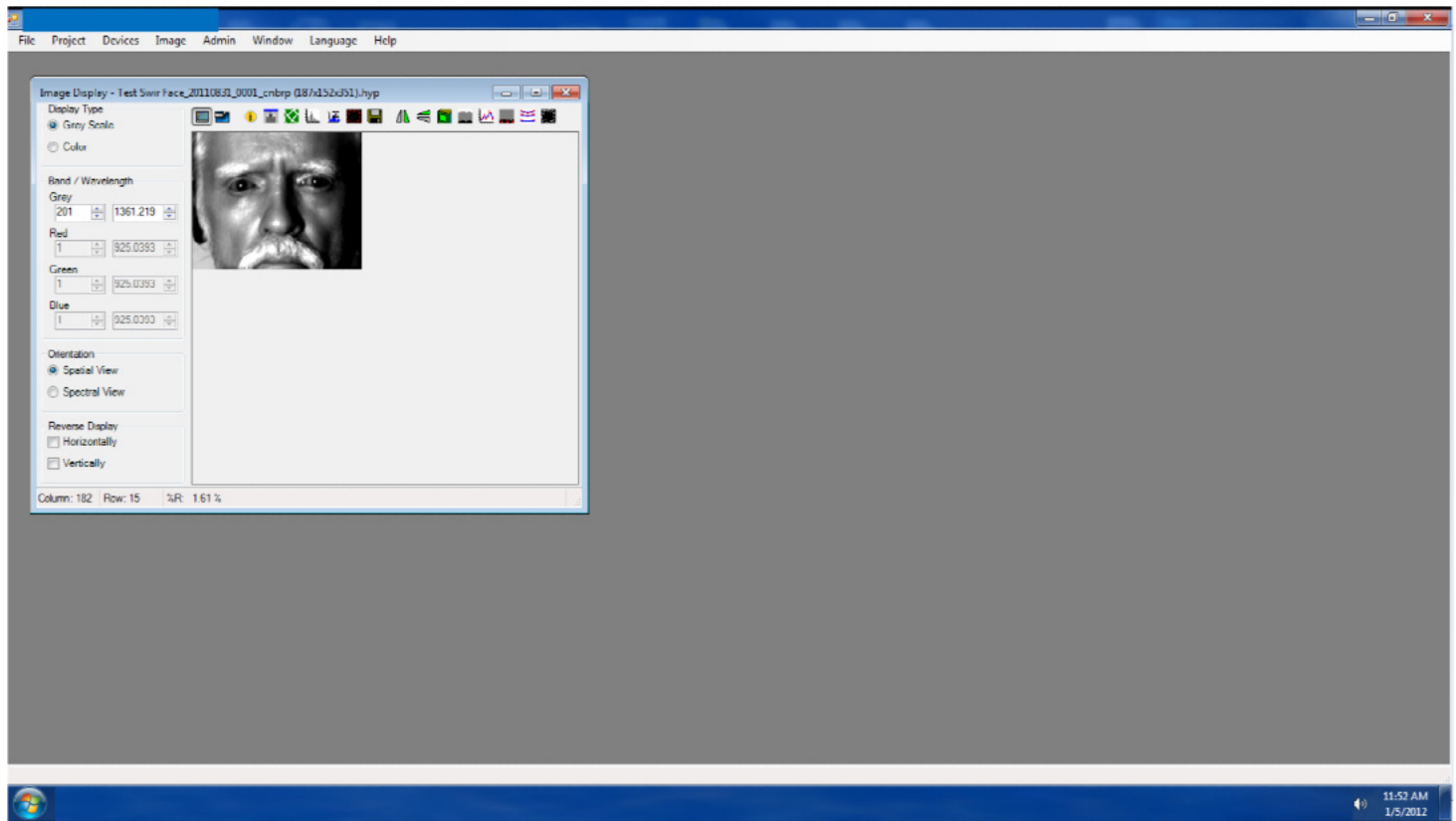


Figure 5.1: The Image Display window

Display Control Panel

The display control panel is located on the left side of the **Image Display** window. It contains the controls used to modify how the image is viewed. The various aspects of viewing the image that can be changed are:

- **Display Type:** The image can be displayed in either a Grey Scale output or in a RGB Color output.
- **Band/Wavelength:** The actual band/wavelength that is displayed can be changed to any of those within the range of the image.
- **Orientation:** The image can be displayed using either a spatial orientation or a spectral orientation.
- **Reverse Display:** The image can be reversed along both the horizontal and vertical axes. This only affects the current display, and not the actual image file.

Display Toolbar

The display toolbar is located at the top of the **Image Display** window. It contains the controls used to perform various manipulations of the image file, as well as several controls that display information about the image.



Figure 5.2: The Image Display Toolbar

The various operations that the toolbar can be used for are:

- **Show/Hide Control Panel:** Toggling this button of the toolbar changes the visibility of the control panel.
- **Close All Child Windows:** This button will close all windows that have been opened from the **Image Display** window at once.
- **Image Information:** This button will bring up the **Image Information** window, displaying information about the image file.
- **Import Wavelengths:** This button is used to add wavelengths to a file that doesn't have them, using a pre-built wavelength file.
- **Create ENVI® Header:** This button will create a header for the image file so that it can be used with the **ENVI®** image analysis program.
- **Histogram:** This button displays the **Histogram** window, allowing manipulations to be made to the histogram of the current image.
- **Calculate Statistics:** This button generates a statistics file for the image file, giving information such as the min/max values of the image and the standard deviations.
- **Bad Pixel Selection Function:** This button is used to help find saturated and dead pixels found on several types of cameras. The output is used with the Pixel Correction Function.
- **Export Image:** This button allows you to export the image currently displayed into either a *.bmp, *.jpg, *.png, or *.tif file formats.
- **Flip Horizontal:** This button causes the data in the image file to be flipped along its vertical axis, causing the left and right sides of the image to be swapped.
- **Flip Vertical:** This button causes the data in the image file to be flipped along its horizontal axis, causing the top and bottom sides of the image to be swapped.
- **Subset Image:** This button performs the process of sub-setting the data set in the spatial and/or spectral space.
- **Calibrate:** This button performs the process of calibrating the image from raw data values into percentage of reflection values.
- **Noise Removal:** This button is used to remove the various noise types from the image file using one of several methods.
- **Dark Current Noise Removal:** This button is used to remove the electronic noise from the

- **Geocorrection:** This button performs the process of geometrically correcting the data within an image file using a pre-built geocorrection file.
- **Pixel Correction Function:** This button is used to correct saturated and dead pixels found on several types of cameras.

Display Image

The **Display Image** fills up the remaining space on the **Image Display** window. It shows a visual representation of the data read in from the image file. Using the mouse in this image will enable several tasks to be performed:

- **Position Tracking:** By moving the mouse pointer over the image, the column, row, and value listings in the status bar are updated for the current position in the image.
- **Position Locking:** By left-clicking inside the image, a crosshair will be overlaid on the image, intersecting at the point clicked. This also locks the column, row, and value listings in the status bar at the values for that point in the image.
- **Spectral Curve:** By left-clicking inside the image and locking the position, a spectral curve can be performed at that point. Right-click inside the image to bring up the context menu, and choose **Spectral Curve**. Up to 6 different spectral curves can be performed on the image at a time.
- **Zoom:** By left-clicking and dragging a selection box in the image, the select area can be magnified. Right-click inside the image to bring up the context menu, and choose **Zoom**. Then choose the desired magnification.
- **Clear:** By right-clicking in the image and then selecting **Clear** in the context menu, a **Position Lock** can be unlocked, or any selection boxed will be removed.

Chapter 6: Image Capture

PHILUMINA® is capable of controlling several hyperspectral camera systems and can use these camera systems to record hyperspectral imagery of selected targets. This capacity of the application is handled in the **Capture Image** window.

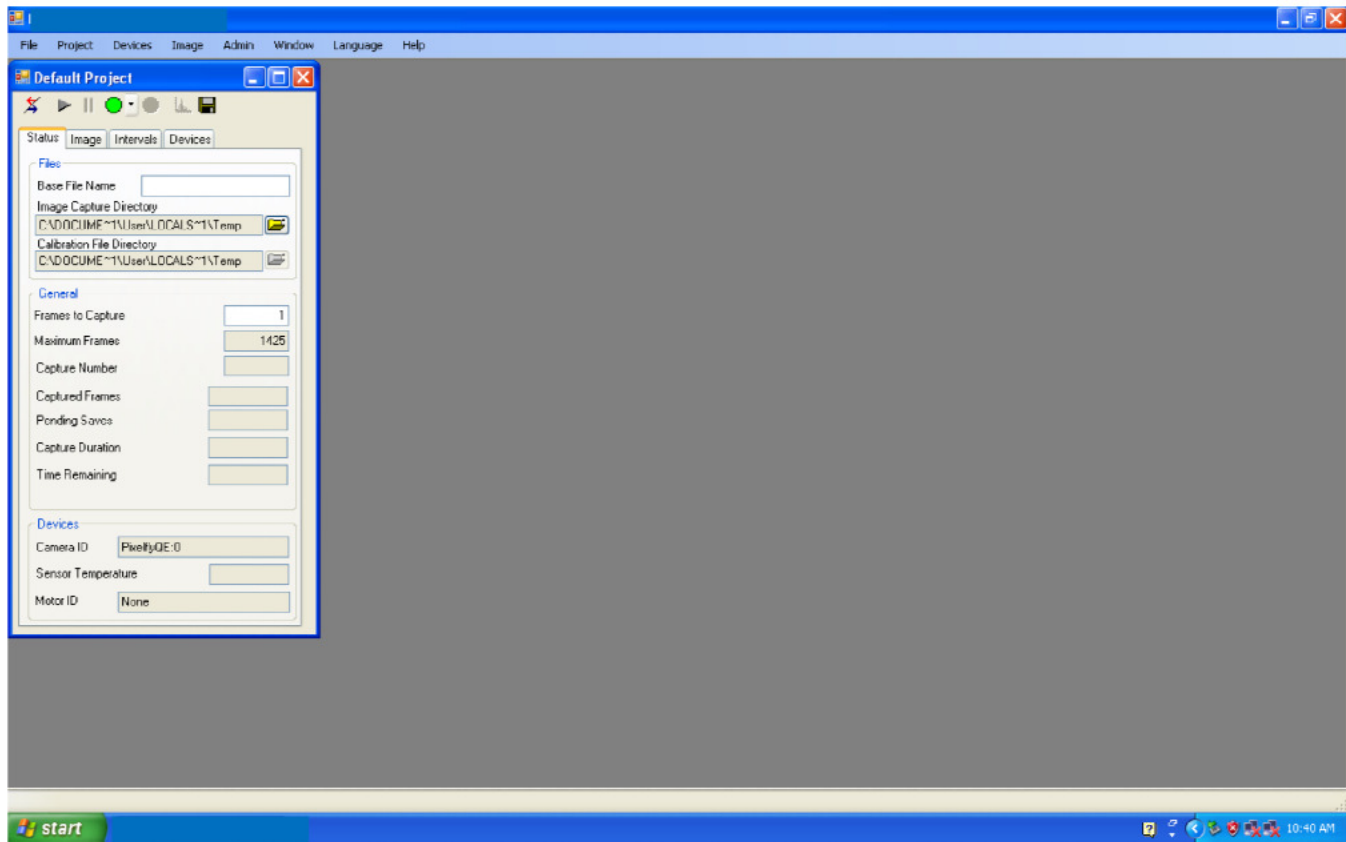


Figure 6.1: The Capture Image window: Showing the “Status” tab

The **Capture Image** window is divided into the following tabs: Status, Image, Intervals and Devices.

The Status Tab:

- **Files:** This group has several feature settings that defines where the output will be saved and what its naming convention will be.
 - Base File Name:** This is the name that you give for a given acquisition set. The name will remain the same until you change it. The software will automatically append a date and number sequence to each file saved under that naming convention.
 - Image Capture Directory:** This path line contains the directory for where the acquired data is saved. This is set in the Project Management Database. One can change the path by clicking on the button at the right of the directory space.
 - Calibration File Directory:** This path line contains the directory structure to where the calibration data sets will be saved.

- **General:** This group performs two functions.

Frames to Capture: This is where the end-user sets the lines that are to be captured within the maximum range.

Maximum Frames: This is a display of the maximum number of lines the camera system can capture in one image. This is determined from the range of the focal plane scanner of the camera if a motor is used, or from the amount of storage space on the hard drive if no motor is used.

This tab gives the status of the capture and save status and gives an estimation of the time left for each and for how long the capture should take. There is also a Sensor Temperature info box for monitoring purposes.

- **Devices:** This group pertains to the Camera specifications.

Camera ID: This identifies which camera will be used during the capture sequence.

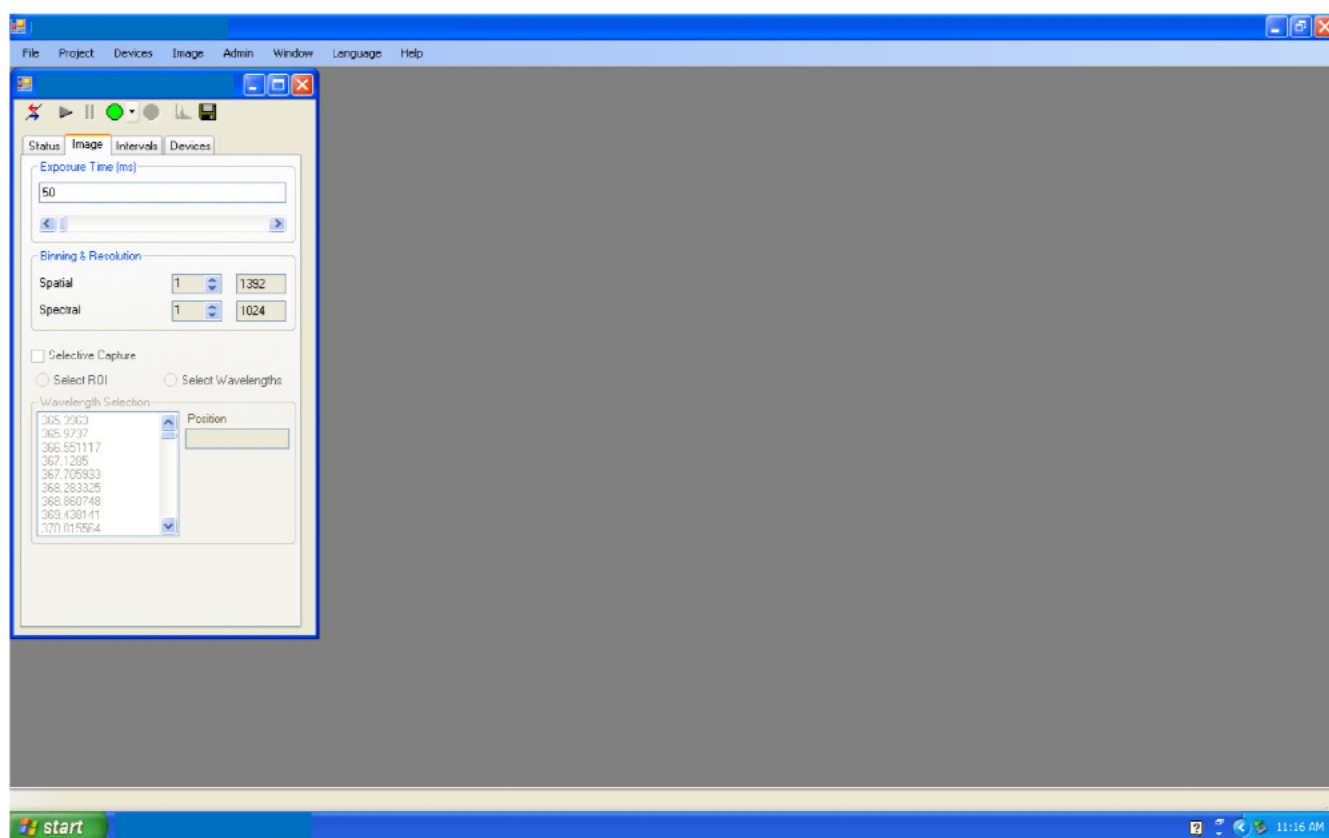


Figure 6.2: The Capture Image window: Showing the “Image” tab

The Image Tab:

- **Exposure Time:** This determines the length of time (measured in milliseconds) that the camera “ccd” will be exposed per line captured.
- **Binning and Resolution:** This group contains the information and settings for the binning of the camera and the resolution associated with the binning settings.

Spatial Binning: This is a list of the various levels of spatial binning the camera system supports.

Spatial Resolution: This displays what the spatial resolution of the image will be given the current spatial binning.

Spectral Binning: This is a list of the various levels of spectral binning the camera system supports.

Spectral Resolution: This displays what the spectral resolution of the image will be given the current spectral binning.

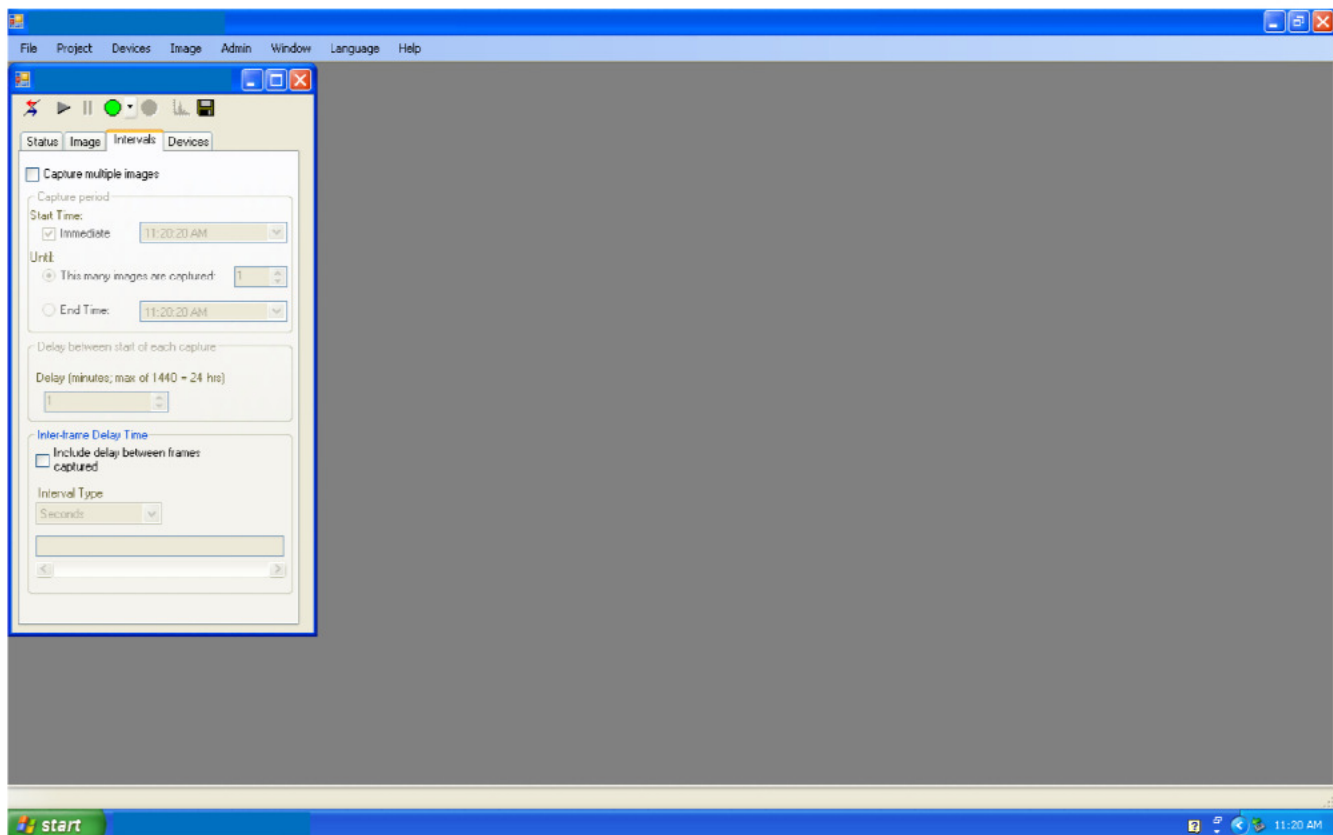


Figure 6.3: The Capture Image window: Showing the "Intervals" tab

- **Capture Multiple Images:** This feature is for use in the full frame mode for a camera when one wants to take images in a time sequence.
- **Delay between start of each Capture:** This is the time delay for the amount of time that the system waits between each of the image captures/scans.
- **Inter-frame Delay Time:** This adjusts the time between each actual frame captured. This is used in full frame mode not push broom. This means that a camera is being used without a spectrograph.
- **Include Delay between Frames Captured:** This is a check box that engages the Interframe delay time feature.

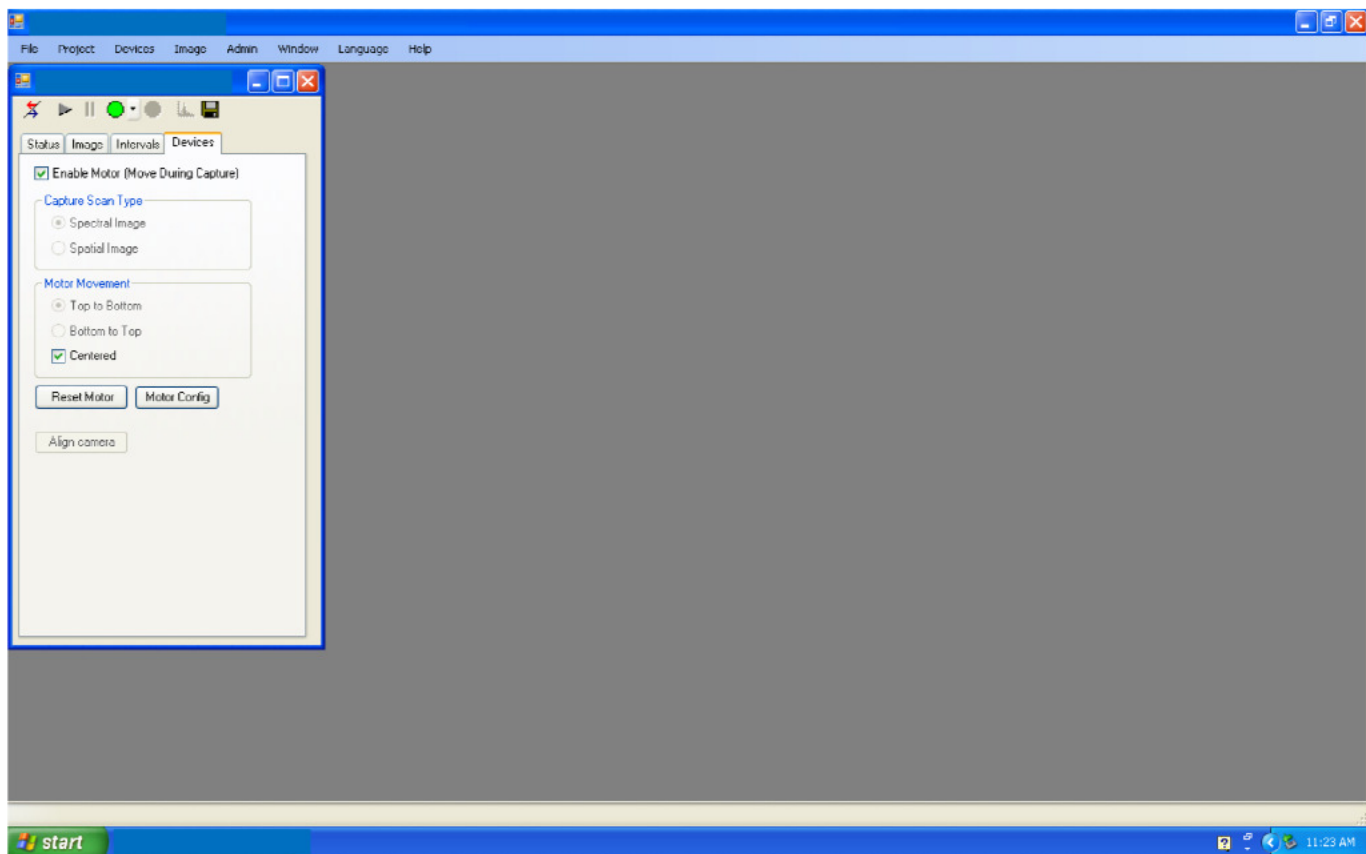


Figure 6.4: The Capture Image window: Showing the “Devices” tab

- **Enable Motor (Move during Capture):** This determines type of scan and how the motor will move during the capture. The different selections are:
 - **Spectral Image:** Means that you are in push broom mode using a spectrograph. This means that you are producing a spatial and spectral data cube.
 - **Spatial Image:** This means that you are using a full frame camera that does not have a spectrograph. There is no spectral feature to the data.
 - **Top to Bottom:** The motor will begin in its uppermost position and move towards its lowermost position during the capture.
 - **Bottom to Top:** The motor will begin in its lowermost position and move towards its uppermost position during the capture.
 - **Centered:** The motor will move to its center point, and will determine the range it needs to capture the image, then move according to whichever of the previous 2 selections are set.

Image Capture Toolbar

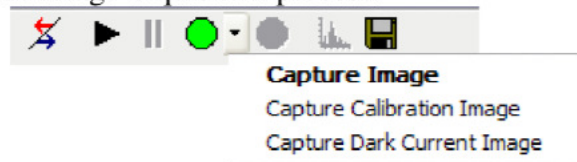
The toolbar is located at the bottom of the **Image Capture** window. It contains controls for setting and performing various actions with the camera system.



Figure 6.4: The Image Capture Toolbar

The various actions the toolbar can be used for are:

- **Show/Hide Sidebar:** Used to hide the sidebar data below.
- **Activate Preview Mode:** Used to see a real-time display of what the camera system “sees”.
- **Pause Preview Mode:** Used to pause the preview window. Clicking it again will restart the preview.
- **Begin Capture:** Begins the image acquisition process.



By pressing on the arrow next to the green capture button the end-user can choose what type of data he/she would like to acquire.

- **End Image Acquisition:** Stops an active preview or capture process and resets the system.
- **Show Histogram for Current Image:** Opens the **Histogram** window for adjusting the display of the image during capture or preview.
- **Save Project Defaults:** This button allows the end-user to change settings in the dialog and tabs to the current project settings.

Chapter 7: Image Processing

All image processing creates new image files, leaving the original image file unchanged.

Calibration

Calibration takes the raw data captured by the camera system, and using a linear interpolation algorithm, processes that data into a percentage of total reflection.

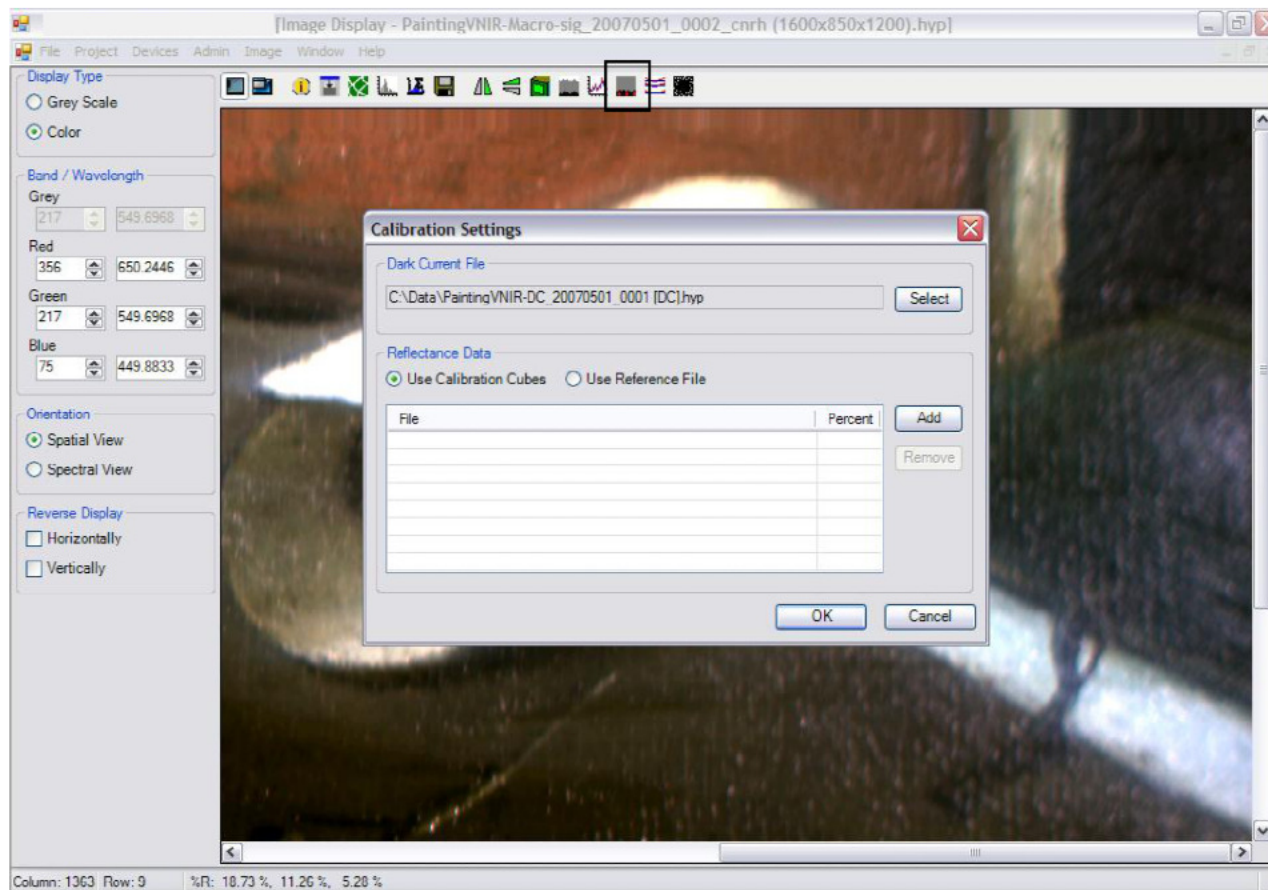


Figure 7.1: The Calibration settings window

- **Use Calibration Cubes:** This setting uses two different images to perform the calibration on the processed image. The **Dark Current Cube** is an image taken while the camera system is exposed to no light at all. This records only the electronic noise from the camera. The **99% Cube** is an image taken of a 99% reflection panel.
- **Use Reference File:** This setting is for when there is not a full reference image to cover the entire field of view. The full field of view would need to be covered in order to use the pixel-by-pixel calibration methodology in PHILUMINA.
- **Creating the Reference File:**
As seen in the Image example below, a file must be created containing the reference mean data needed to calibrate the image using prior art calibration standards, sometimes referred to as Mean/Average linear calibration to percent reflectance.

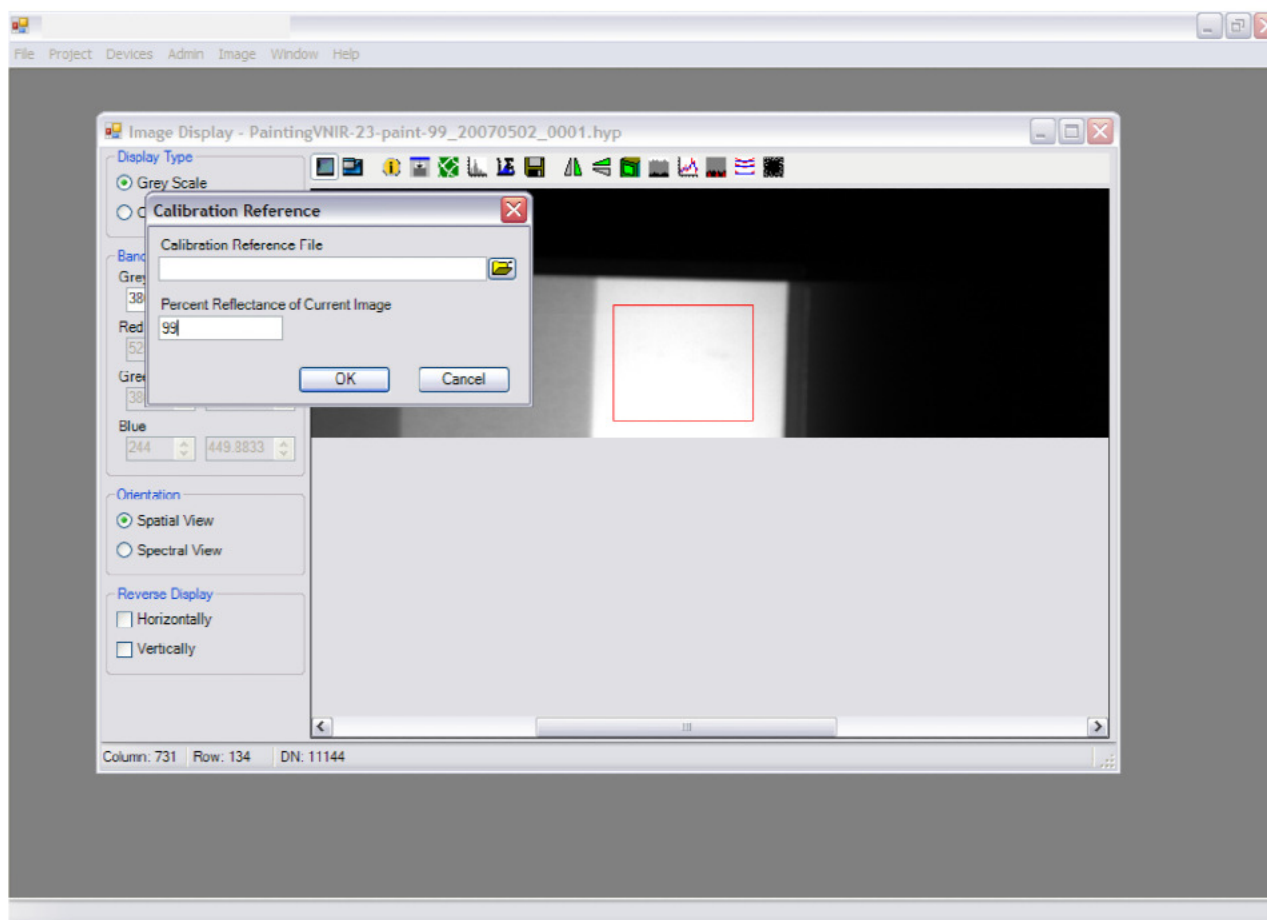


Figure 7.2: The Mean Calibration settings window

This window is generated by holding the left mouse button down and dragging it across the Region of Interest (ROI), let go of the left mouse button, pressing the right mouse button inside of the newly created ROI and selecting Create Reference File from the drop down menu.

The number typed in the Percent Reflectance of Current Image box should be that of the percentage of the given target reference. For Example: 0 would be for Dark Current and 99 would be for a 99% reference panel.

Save the calibration reference file by clicking on the button on the left hand side of the box labeled Calibration Reference File. This will open a standard Windows save box. Enter the name of your reference file and click OK.

Repeat this for your Dark Current File. Choose the same file for all reference material that belongs in that file to calibrate data associated with those reference values. When you go to save the Dark Current to the file that you already saved the 99% data too, it will ask you if you want to overwrite the file. Choose YES. The file will only append the data into the file.

2 CALIBRATION ROUTINES

Calibrate (Pixel By Pixel):

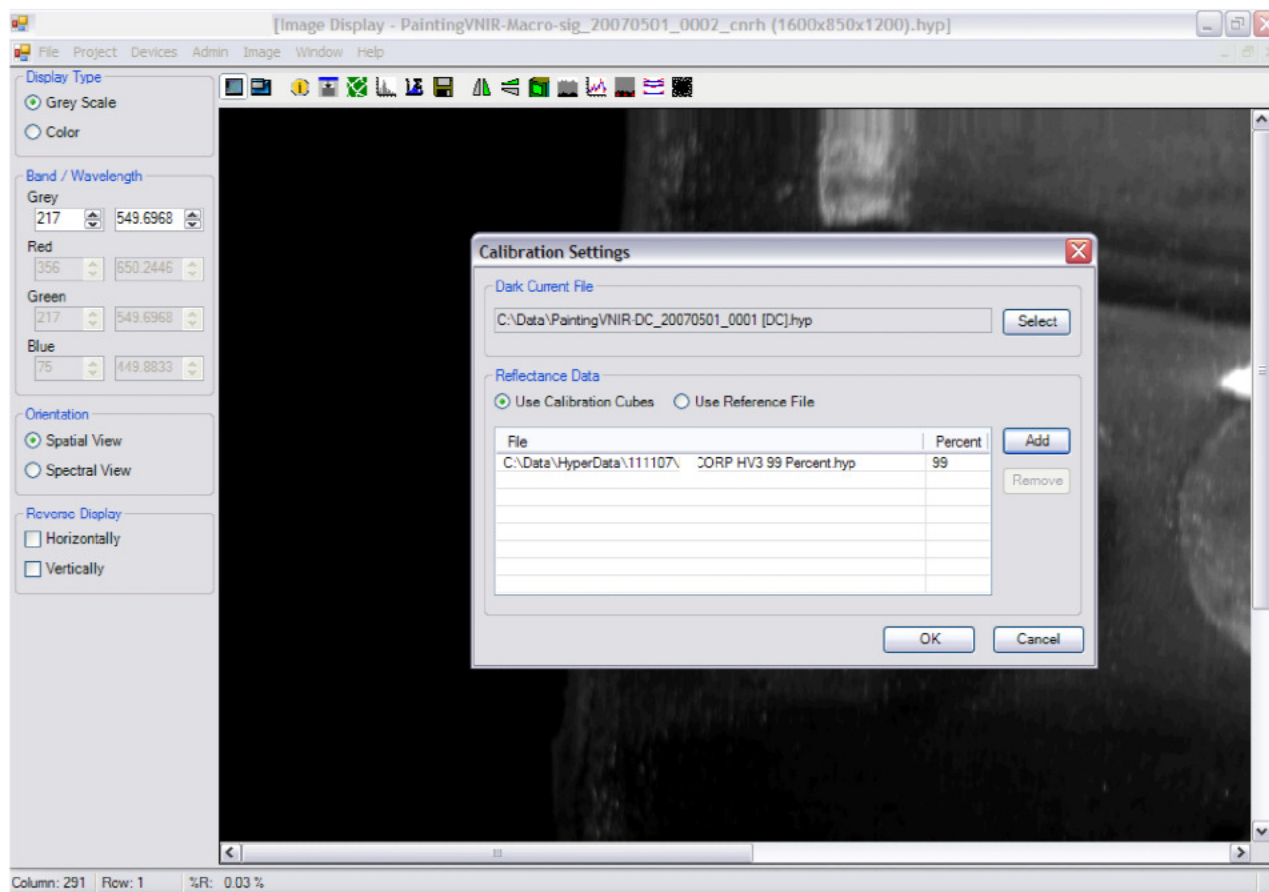


Figure 7.3: The Calibration settings window (Calibration Cubes Setting)

Pixel-by-Pixel calibration uses full images of the reference file and Dark Current to calibrate/normalize the data to percent reflectance.

Start by clicking the select button to choose a dark current file. The new PHILUMINA calibration file is a 2 band image that is a collection of dark current samples. If the dark current file that you have is from an earlier version of PHILUMINA software, you will need to open the dark current file in PHILUMINA first and then select convert to dark current from the Admin menu drop down list. This will then create a file with the [DC] extension on the end of the file. This can now be used in earlier versions of PHILUMINA software. Next you will choose whether you want to use calibration cubes or a reference file. If you want to use a reference file, move to the next section.

Click on Add to select the percent reflectance file. The standard is usually 99%. However, some users prefer linear regression using more than one % standard target. This percentage will be set in the file header when collecting a reference file during capture reference target procedure.

Once you have selected your files, press OK and the software will now calibrate your file to percent reflectance.

Calibrate via Mean/Average Reference:

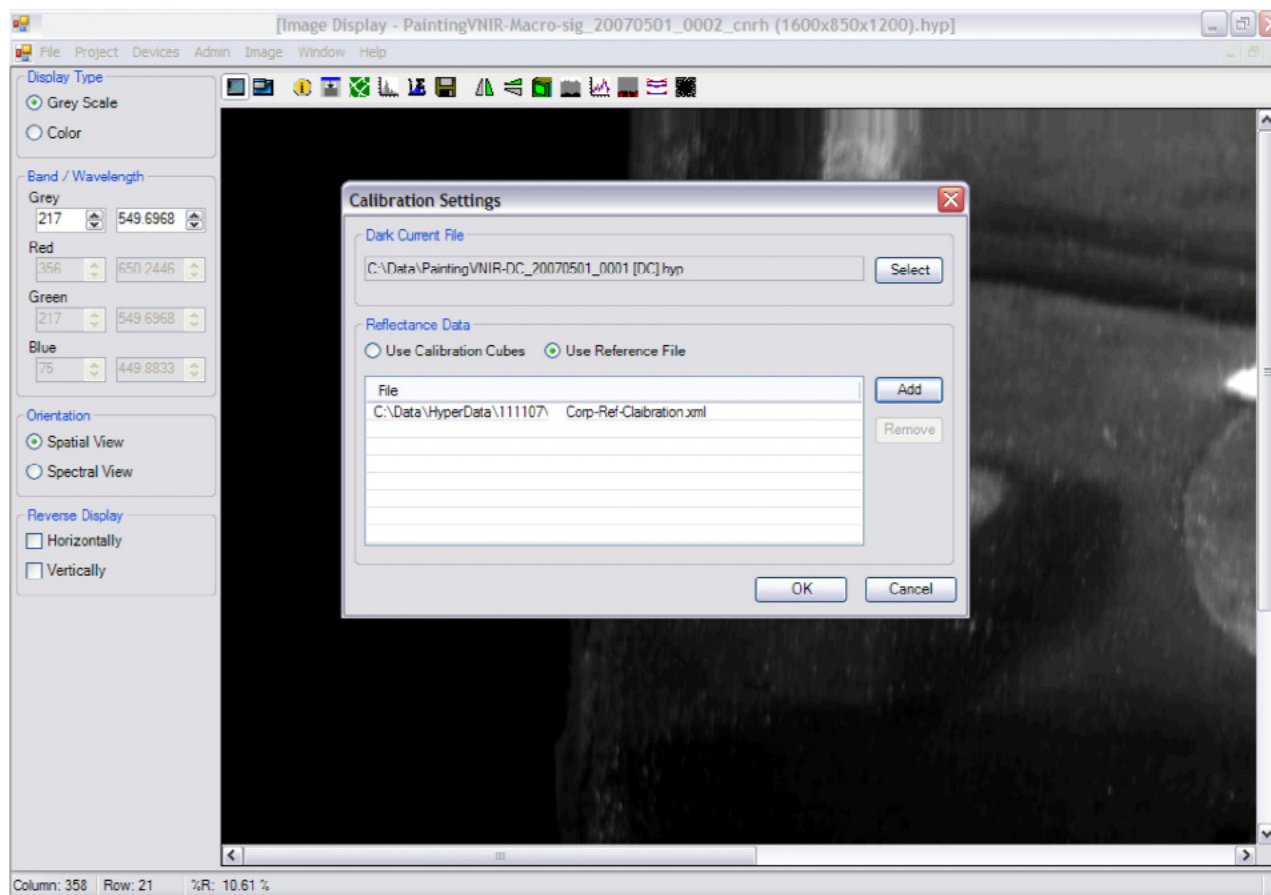


Figure 7.4: The Calibration settings window (Use Reference File Setting)

The Use Reference File routine allows the end user to use a calibration file (see creating reference file) when a full image reference file is not available.

Click the select button and choose a dark current file, this is file is not needed if you already have the dark current data in the reference file. Now click Add. A standard Windows box will open for you to select the calibration XML file to calibrate your data. Click OK.

Noise Removal

Noise removal uses certain algorithms to manipulate the data in and image in order to remove the digital noise from the image. The **Linear Regression** and **Savitsky-Golay** algorithms are supported by **PHILUMINA®**.

Subset Image

The subset image process allows the user to define a particular region of interest in an image and create an entirely new image file using that Region of Interest. Both the upper and lower bounds for bands, rows, and columns can be set, with the new image file created from the resultant inclusive selection.

Flatten Image

“Flattening” an image is the process of averaging all of the bands of the image together, creating a single spectral response for each pixel of the image.

Flip Horizontal

The horizontal flip process flips the image data along it’s vertical axis, creating a horizontally mirrored image.

Flip Vertical

The vertical flip process flips the image data along it’s horizontal axis, creating a vertically mirrored image.

Chapter 8: Batch Processing

PHILUMINA® is able to perform many image processing functions as a single batch process.

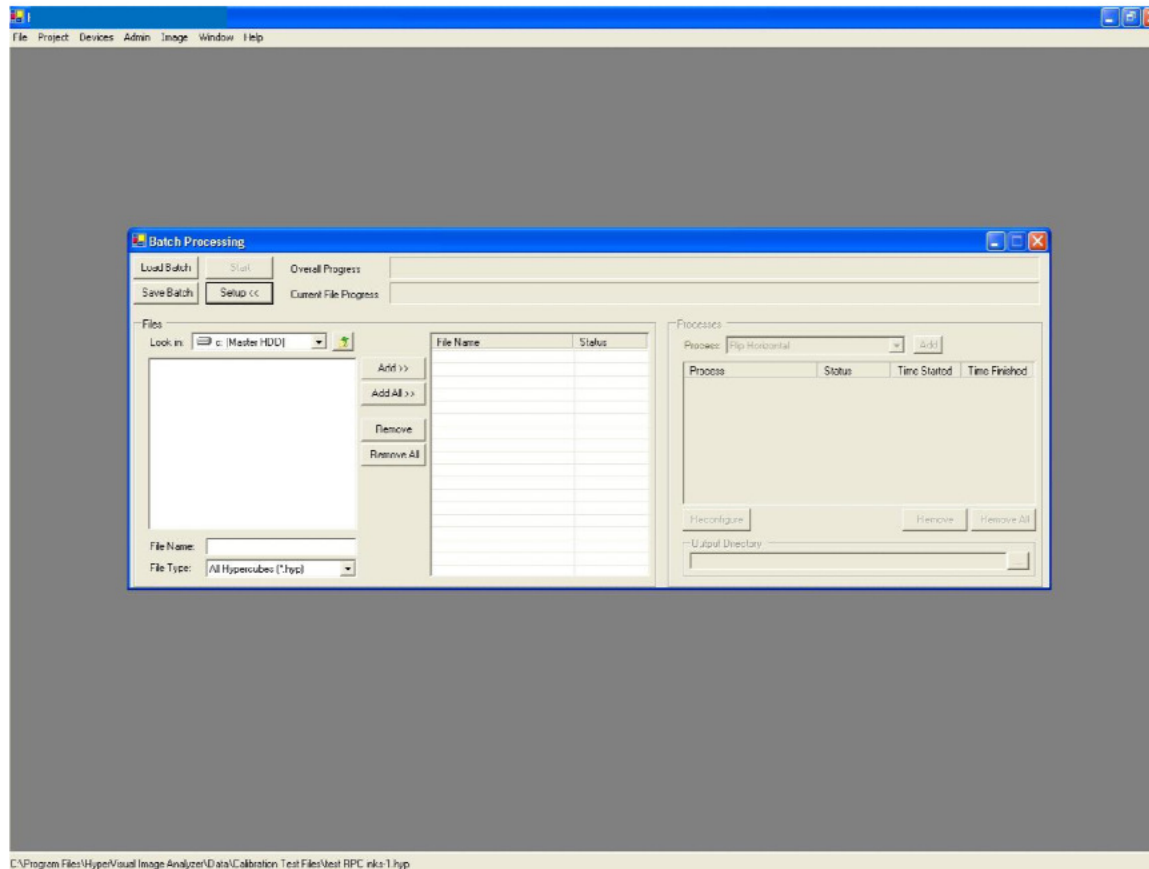


Figure 8.1: The Batch Processing window

The controls in the basic **Batch Processing** window are:

- **Load Batch:** Loads a batch setup that has been previously saved to a file.
- **Save Batch:** Saves the current setup to a file that can be reloaded at a later time.
- **Start:** Begins the current batch setup.
- **Setup:** Opens the Setup portion of the **Batch Processing** window.

Chapter 9: Trouble Shooting Guide

1. Halogen Lamps do not work:

- Ensure the White Wires from lights are connected to the Black (or negative) Terminal on the MFJ Power Supply.
- Ensure the Black Wires from lights are connected to the Red (or positive) Terminal on the MFJ Power Supply.
- Ensure both lights are switched off and the MFJ Power Supply is plugged in.
- Switch the MFJ Power Supply on; and then turn the “DC Adjust Knob” all the way to the left (counter-clockwise).
- Switch both Halogen Lamps on (switch is on top of each lamp).
- On the MFJ Power Supply – turn the “DC Adjust Knob” clockwise to the right until the “Voltage Reading” dial is 12 Volts. It is important for the consistency of the images that this dial is set on 12 Volts every time.
- Note: Failing to follow this sequence will cause the MFJ Power Supply to fail to function properly.

2. Computer does not recognize Camera:

- Ensure camera power adapter is plug in.
- Listen and see if the fan motor is running on the side of camera. If not, unplug and plug the power cable back into the top of the camera.
- Ensure the blue cable is properly connected. Ensure it is plugged into a card port on the back of the camera and not a standard port.
- Restart the computer.



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