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Part of the Teledyne Imaging Group

NIRvana® System Manual

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Revision History

Issue	Date	List of Changes
Issue 7	May 13, 2019	Issue 7 of this document incorporates the following changes: • Rebranded as Teledyne Princeton Instruments.
Issue 6	April 20, 2016	Issue 6 of this document incorporates the following changes: • Removed the Declaration of Conformity.
Issue 5	October 26, 2015	Issue 5 of this document incorporates the following changes: • Added Appendix D, C-Mount to Spec-Mount Procedure • Updated the Declaration of Conformity
Issue 4	August 7, 2014	Issue 4 of this document incorporates the following changes: • Added Appendix E, Calibration Charts; • Globally removed references to a tungsten source; • Reorganized the document.
Issue 3	November 1, 2013	Issue 3 of this document incorporates the following changes: • Updated the Declaration of Conformity; • Updated Acton Series to Acton SpectraPro Series.
Issue 2.A	December 10, 2012	Issue 2.A of this document incorporates the following changes: • Changed all PioNIR references to NIRvana. • Added CoolCUBE$_{II}$ hose and fitting vendor part numbers. • Updated First Light instructions. • Updated Chapter 10, Troubleshooting; • Updated warranty #7 with the "is a shutter which is a normal wear item…".
Issue 1.A	December 13, 2011	This is the initial version of this document

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Chapter 1:   About this Document

Thank you for purchasing a NIRvana® camera system from Teledyne Princeton Instruments. The system has been thoroughly tested to meet Teledyne Princeton Instruments' exacting standards and to meet the demanding requirements of many low light level imaging applications.

This manual provides users with information necessary to install a NIRvana camera and place it in operation. Topics include a detailed description of the NIRvana camera family as well as the installation, applications, cleaning, and specifications of the camera system.

1.1   Intended Audience

This user manual is intended to be used by scientists and other personnel responsible for the installation, setup, configuration, and acquisition of imaging data being collected using the NIRvana camera system.

This document provides all information necessary to safely install, configure, and operate the NIRvana camera system beginning with the system's initial installation.

Please read this manual carefully before attempting to operate the camera. Doing so will help minimize the learning curve and optimize the many features of this camera to suit all research needs.

1.2   Related Documentation

Table 1-1 provides a list of related documentation and user manuals that may be useful when working with the NIRvana camera system.

Table 1-1:   Related Documentation

Document Number	Document Title
4411-0125	LightField 4 User's Manual
4411-0048	WinSpec 2.6 Spectroscopy Software User Manual
4411-0046	WinView 2.6 Imaging Software User Manual

Current issues of Teledyne Princeton Instruments' manuals are available for downloaded from:

<ftp://ftp.piacton.com/Public/Manuals/Princeton_Instruments>

Current issues of Teledyne Acton Research manuals are available for downloaded from:

<ftp://ftp.piacton.com/Public/Manuals/Acton>

1.3   Document Organization

This manual includes the following chapters and appendices:

- **Chapter 1, About this Document**

  This chapter provides information about the organization of this document, as well as related documents, safety information, and conventions used throughout the manual.

- **Chapter 2, NIRvana Camera System**

  This chapter provides information about the NIRvana camera, interface card, cables, application software, and optional accessories.

- **Chapter 3, Installation**

  This chapter provides system setup actions cross-referenced with the relevant manuals and/or manual pages. It also contains system layout diagrams.

- **Chapter 4, System Setup**

  This chapter provides detailed directions for setting up the camera for imaging or spectroscopic applications and presents over-exposure protection considerations.

- **Chapter 5, Operation**

  Discusses a number of topics, including cooling and effects of high humidity and includes a step-by-step procedure for verifying system operation.

- **Chapter 6, LightField First Light Procedure**

  This chapter provides step-by-step instructions to verify initial system operation using LightField image acquisition software.

- **Chapter 7, WinX First Light Procedure**

  This chapter provides step-by-step instructions to verify initial system operation using WinX image acquisition software.

- **Chapter 8, Exposure and Signal**

  This chapter discusses factors that affect exposure, readout, and digitization of incoming signals

- **Chapter 9, Advanced Topics**

  Discusses the standard Trigger Response modes (Free Run {No Response}, External Sync {Readout Per Trigger}, and Continuous Cleans {Clean Until Trigger}), and Logic Output control.

- **Chapter 10, Troubleshooting**

  Provides courses of action to take if you should have problems with your system.

- **Appendix A, System Specifications**

  Provides camera and system specifications.

- **Appendix B, Outline Drawings**

  Includes an outline drawing of the C-mount NIRvana camera and the power supply.

- **Appendix C, Spectrograph Adapters**

  Provides information and procedures required to install a C-mount or spectroscopy-mount camera to Teledyne Acton Research SpectraPro Series spectrograph.

- Appendix D, C-Mount to Spec-Mount Procedure

   This appendix provides information necessary to replace the C-mount nose on a NIRvana camera with a spectroscopy-mount nose.

- Appendix E, Calibration Charts

   This appendix provides the following calibration charts for use with the NIRvana camera

- Appendix F, WinSpec/32/LightField Cross Reference

   Provides two alphabetically sorted tables (WinX to LightField and LightField to WinX) that cross reference terms used in the two applications.

- Warranty and Service

   Provides warranty and customer support contact information.

1.4   Conventions Used in this Manual

The following conventions are used throughout this manual:

- WinX is a generic term that collectively includes the following application software:
   — WinView/32;
   — WinSpec/32;
   — WinXTest.

- WinX and LightField® typically use different terms for the same functions or parameters. Unless a topic is specifically for WinX or LightField, the following conventions are used:
   — Curly brackets { } are used to denote a LightField term or location.
   — When information applies to both WinX and LightField, the WinX term will be listed first, followed by the LightField term surrounded by curly brackets.
      For example:
         Continuous Cleans {Clean Until Trigger}
   — When a location for setting a parameter is mentioned, the WinX location will be listed first, followed by the LightField location surrounded by curly brackets.
      For example:
         Exposure Time is configured on the Experiment Setup ► Main tab {Common Acquisition Settings expander}.

1.5   Safety Information

Before turning on the power supply, the ground prong of the power cord plug must be properly connected to the ground connector of the wall outlet. The wall outlet must have a third prong, or must be properly connected to an adapter that complies with these safety requirements.

⚠ **WARNINGS!** ————————————————

1. If the NIRvana camera system is used in a manner not specified by Teledyne Princeton Instruments, the protection provided by the equipment may be impaired.

2. If the wall outlet is damaged, the protective grounding could be disconnected. Do *not* use damaged equipment until its safety has been verified by authorized personnel. Disconnecting the protective earth terminal, inside or outside the apparatus, or any tampering with its operation is also prohibited.

Inspect the supplied power cord. If it is not compatible with the power socket, replace the cord with one that has suitable connectors on both ends.

⚠ **WARNING!** ————————————————

Replacement power cords or power plugs must have the same polarity and power rating as that of the original ones to avoid hazard due to electrical shock.

1.5.1   Safety Related Symbols Used in this Manual

⚠ **CAUTION!** ————————————————

The use of this symbol on equipment indicates that one or more nearby items should not be operated without first consulting the manual. The same symbol appears in the manual adjacent to the text that discusses the hardware item(s) in question.

⚠ **WARNING! RISK OF ELECTRIC SHOCK!** ————

The use of this symbol on equipment indicates that one or more nearby items pose an electric shock hazard and should be regarded as potentially dangerous. This same symbol appears in the manual adjacent to the text that discusses the hardware item(s) in question.

1.5.2   Precautions

To prevent permanently damaging the system, please observe the following precautions:

- If you are using high-voltage equipment (such as an arc lamp) with your camera system, be sure to turn the camera power ON LAST and turn the camera power OFF FIRST.
- When turning off and on the power supply, wait at least 10 seconds before switching it on. "TEC Fault" LED might come on if the power supply on/off state is switched too quickly.
- Use caution when triggering high-current switching devices (such as an arc lamp) near your system. The sensor can be permanently damaged by transient voltage spikes. If electrically noisy devices are present, an isolated, conditioned power line or dedicated isolation transformer is highly recommended.
- Do not block air vents on the camera. Preventing the free flow of air overheats the camera and may damage it.

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Chapter 2: NIRvana Camera System

This chapter provides an introduction to, and overview information about, Teledyne Princeton Instruments' NIRvana[1] camera system. Figure 2-1 shows those items that are typically included as part of a standard NIRvana Camera System.

Figure 2-1: NIRvana Camera System: Standard Items

Coolant Hoses   **MCX to BNC Cables (Lengths may vary)**   **Power Supply with Cable (100 V/240 V)**

Ethernet Card   **Cat 5e/6 Gigabit Cable (5 meters Standard)**

NIRvana Manual   **NIRvana Camera**   **Certificate of Performance**

Standard items include:

- NIRvana Camera;
- Power Supply and Cable;
- An Intel® PRO/1000 Gigabit Ethernet card for the host computer;
- Gigabit Ethernet cable;
- MCX-to-BNC Adapter Cables;
- Coolant Hoses;
- Certificate of Performance;
- NIRvana System Manual.

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1. Previously named PIoNIR.

In addition to the standard items, the following optional accessories are available for purchase from Teledyne Princeton Instruments:

- Application Software;
- External Cooling Circulator;
- Optical Adapters.

Refer to Section 2.6, Optional Accessories, on page 22 for information about accessories.

2.1 NIRvana Camera

The NIRvana camera, shown in Figure 2-2, is regulated by an internal controller which receives commands from the host computer/software and converts them to appropriate camera control signals, including synchronizing the operation of the NIRvana system with the rest of an experiment.

Figure 2-2: Typical NIRvana Camera

In addition, the internal controller converts analog optical data acquired by the CCD sensor into digital data which is then delivered to the host computer and data acquisition software being used. Read rate, binning information, and regions of interest for NIRvana cameras are some of the parameters that are configured using the data acquisition software on the host computer.

This section provides detailed information about the NIRvana camera.

2.1.1   CCD Sensor

The NIRvana camera incorporates a 640 x 512 CCD (20 x 20 μm pixels) InGaAs focal plane array (FPA) that is equipped with four-port differential readouts. The sensor's excellent response and outstanding sensitivity in the 0.9 μm -1.7 μm spectrum make it particularly well suited for Near-InfraRed (NIR) imaging applications.

Additional key features of the CCD sensor include:

- Readout rates of 2 MHz and 5 MHz capable of 22 and 55 frames per second, respectively;
- Deep cooling to -80?C which reduces the dark signal and enables long integration times.

2.1.2   Window

The NIRvana window is composed of AR-coated fused silica.

2.1.3   Cooling

Dark current is reduced in NIRvana camera systems by utilizing thermoelectric cooling of the sensors. Cooling by this method uses a Peltier cooler in combination with air-circulation (i.e., fan,) and/or circulating coolant.

To prevent condensation and contamination from occurring, cameras cooled in this manner are evacuated. Due to sensor size/packaging differences, the lowest achievable temperature varies by NIRvana model.

REFERENCES:

Refer to model-specific NIRvana data sheets for respective cooling specifications.

A feature of air-cooled NIRvana cameras is software control of the camera's internal fan. When fan vibration may affect results, the fan can be turned off and while coolant continues to be circulated through the camera, thus maintaining an adequate sensor cooling temperature.

NOTE:

A minimum of two (2) inches (50 mm) of clearance must be maintained around the camera's vented covers.

The operating environment of the camera can be from 0°C to 30°C, with a 0% to 80% relative humidity (non-condensing.) However, for best performance, the ambient temperature should be at or below 20ºC. Above this temperature, the sensor temperature can begin to degrade. If the camera is operating inside an enclosure, the enclosure must have unrestricted air flow to an open environment.

2.1.3.1   Internal Fan

The NIRvana is equipped with an internal, low-vibration fan that:

- Removes heat from the Peltier device that cools the sensor; and
- Cools the electronics.

An internal Peltier device directly cools the cold finger on which the sensor is mounted. Air drawn into the camera through the back of the camera removes the heat produced by the Peltier device and then vents out through the slots on the side panels. By default, the fan is always in operation, and air-cooling of both the Peltier and the internal electronics takes place continuously.

⚠️ **CAUTION!** —————————————————————

For the fan to function properly, free air circulation must be maintained between the sides of the camera and the laboratory atmosphere as described in Section 2.1.3, Cooling.

The low-vibration fan typically has no adverse affect on image quality. However, if the fan's vibration does reduce image quality and the NIRvana is also being cooled via an external coolant circulator, the fan may be turned off to reduce vibration.

2.1.3.2   External Coolant Circulator

Liquid-cooled cameras are equipped with internal hoses that connect to an external coolant circulator via bi-directional coolant ports located on the side of the camera.

Similar to air-cooled applications, circulating coolant removes heat that has been produced by the Peltier device. The primary advantage of circulating coolant is that it enables vibration-free data acquisition. For the circulating coolant to function properly, free air circulation must be maintained between the sides of the coolant circulator and the laboratory atmosphere.

🔍 **NOTE:** ——————————————————————

The coolant circulator can be Teledyne Princeton Instruments' CoolCUBE$_{II}$ or any commercially available circulator that is capable of continuously pumping a 50:50 mixture of room temperature (23ºC) water and ethylene glycol at a rate of 1 liter per minute. Hoses with fittings for the NIRvana ports are shipped with each camera.

When a CoolCUBE$_{II}$ is purchased with the NIRvana camera, the hoses will be equipped with CoolCUBE$_{II}$-compatible fittings.

2.1.4   Rear-Panel Connectors

Figure 2-3 illustrates the rear-panel connectors on a NIRvana camera.

Figure 2-3:   NIRvana Rear-Panel Connectors

Refer to Table 2-1 for information about each rear-panel connector.

Table 2-1:   NIRvana Rear-Panel Connectors

Label	Description
Shutter	LEMO® connector provides the shutter drive pulses for driving a Teledyne Princeton Instruments-supplied 25 mm external shutter. Camera power must be OFF before connecting to, or disconnecting from, this connector.
Power	24 V_{DC} (9.5 A max) input and TEC control from power supply.
EXT SYNC	0 to +3.3 V_{DC} programmable, TTL-compatible, logic output with a 10 kΩ pull-up resistor. Allows data acquisition and readout to be synchronized with external events. Through software, positive or negative (default) edge triggering can be selected.
LOGIC OUT	0 to +3.3 V_{DC} programmable, TTL-compatible, logic output. The output of this connector can be programmed, as well as inverted, via application software. For information about each signal, refer to Section 9.3, LOGIC OUT Control, on page 83.
Gig-E	Gigabit Ethernet connector. Used with the Cat 5e/6 Gigabit Ethernet cable (supplied) interconnecting the camera and the GigE interface card in the host computer. A high quality cable must be used to preserve data integrity during transmission. The cable can extend the distance between camera and the host computer by more than 50 m.

2.2   Standard Cables

Table 2-2 describes the cables included with a standard NIRvana Camera System.

Table 2-2:   Standard NIRvana Camera System Cables

Cable	Part Number	Description/Purpose	Length
Ethernet	6050-0621	Cat 5e/6 Ethernet cable. Connects the NIRvana camera to the host computer. The camera and the computer may be more than 50 meters apart. Contact the factory to order longer cables. 	5 m [16.4 ft]
MCX to BNC Adapter	6050-0540	Two MCX to BNC adapter cables are provided with the NIRvana system. These connect to the EXT SYNC and the LOGIC OUT connectors on the rear of the NIRvana. 	Varies
Power	6050-0596	Connects the NIRvana camera to the power supply. 	3 m [9.8 ft]

2.3 Coolant Hoses

Two external circulator coolant hoses are included with every NIRvana system. A quick-disconnect fitting that mates to the NIRvana coolant ports is installed on each of the hoses. When a Teledyne Princeton Instruments CoolCUBE$_{II}$ circulator is ordered with the NIRvana system, an appropriate fitting is also installed on the other end of each hose. If, however, a third-party circulator is used, customers must refer to the manufacturer's information and specifications to identify and obtain the necessary fittings that will need to be installed on the coolant hoses.

Table 2-3 provides manufacturer, part number, and dimension information for coolant hoses and fittings supplied by Teledyne Princeton Instruments.

Table 2-3: Coolant Hose and Fitting Information

Item	Part Number	Manufacturer	Dimensions
Coolant Hoses	MCM 5238K748	McMaster	Inner Diameter (ID): 10 mm [0.394 in] Length: 3 m [9.8 ft]
NIRvana Fittings	MCM 5478K811	McMaster	N/A
CoolCUBE$_{II}$ Fittings	CPC	NS6D17006	N/A

2.4 Certificate of Performance

Each NIRvana camera is shipped with a Certificate of Performance which states that the camera system has been assembled and tested according to approved Teledyne Princeton Instruments procedures. It documents the camera's performance data as measured during the testing of the NIRvana and lists the following camera- and customer-specific information:

- Sales Order Number;
- Purchase Order Number;
- Camera Serial Numbers

This information is useful when contacting Teledyne Princeton Instruments Customer Support.

2.5 NIRvana System User Manual

The NIRvana System User Manual describes how to install, configure, and use a NIRvana camera and its components.

2.6   Optional Accessories

Optional accessories include:

- Application Software:
    - LightField® (64-bit) and User Manual;
    - PICam Software (64-bit) and User Manual;
    - Scientific Imaging Toolkit (SITK);
    - WinView or WinSpec (32-bit) and User Manual;
    - PVCAM software (32-bit) and User Manual;
- CoolCUBE$_{II}$ Coolant Circulator;
- Optical Adapters
    - C to Spectroscopy-Mount Adapter;
    - Adjustable C to Spectroscopy-Mount Adapter.

Other optional items may be available. For complete information about available options for the NIRvana camera system, contact Teledyne Princeton Instruments.

2.6.1   Application Software

Teledyne Princeton Instruments offers a number of data acquisition software packages for use with NIRvana camera systems, including:

- LightField®

  LightField is Teledyne Princeton Instruments' 64-bit Windows Vista® and Windows® 7 data acquisition and processing software package. LightField combines complete control over Teledyne Princeton Instruments' cameras and spectrometers with easy-to-use tools for experimental setup, data acquisition and post-processing. LightField makes data integrity priority #1 via automatic saving to disk, time stamping, and retention of both raw and corrected data with full experimental details saved in each file.

  LightField works seamlessly in multi-user facilities, remembering each user's hardware and software configurations and tailoring options and features accordingly. The optional, patent-pending IntelliCal™ package is the highest-performance wavelength calibration software available, providing up to 10X greater accuracy across the entire focal plane than competing routines.

  Included with the software is a user manual which describes how to install and use the LightField application program (for 64-bit Windows Vista® and Windows® 7 operating systems). The manual is provided as a PDF on the installation CD. Additional information is available in the program's online help.

- PICam

  PICam is Teledyne Princeton Instruments' standard 64-bit software interface for cooled cameras. PICam is an ANSI C library of camera control and data acquisition functions. Currently, the interface supports Windows Vista and Windows 7.

- Scientific Imaging ToolKit™

  SITK™ is a collection of LabVIEW® VIs for scientific cameras and spectrographs. This third party software is available for purchase from Teledyne Princeton Instruments.

- WinView/32 and WinSpec/32

  WinView/32 and WinSpec/32 are Teledyne Princeton Instruments' 32-bit Windows$^®$ software packages designed specifically for high-end imaging and spectroscopy, respectively. The Teledyne Princeton Instruments' software provides comprehensive image/spectral capture and display functions. The package also facilitates snap-ins to permit advanced operation. Using the optional built-in macro record function, you can also create and edit your own macros to automate a variety of operations.

  WinView and WinSpec take full advantage of the versatility of the NIRvana camera and even enhance it by making integration of the detection system into larger experiments or instruments an easy, straightforward endeavor.

  Included with the software is a user manual which describes how to install and use the respective application program. A PDF version of the manual is provided on the installation CD. Additional information is available in the program's online help.

- PVCAM$^®$

  PVCAM is Teledyne Princeton Instruments' standard 32-bit software interface for cooled CCD cameras. It is a library of functions that can be used to control and acquire data from the camera when a custom application is being written.

  For example, in the case of Windows, PVCAM is a Dynamic Link Library (DLL.) It should also be understood that PVCAM is solely for camera control and image acquisition, not for image processing. PVCAM places acquired images into a buffer, where they can then be manipulated using either custom written code or by extensions to other commercially available image processing packages.

  NOTE:

  NIRvana may be compatible with third-party data acquisition software packages. Check with individual providers for compatibility and support information.

2.6.2   Coolant Circulator

An external coolant circulator can be connected to a NIRvana camera to cool the system by circulating coolant thus providing a low-vibration environment for accurate data acquisition. Each NIRvana camera is equipped with two coolant ports with quick-disconnect fittings for connection to an external circulator.

The external coolant circulator can be:

- Teledyne Princeton Instruments CoolCUBE$_{II}$ circulator;
- Any commercially available circulator that is capable of continuously pumping a 50:50 mixture of room temperature (23ºC) water and ethylene glycol at a rate of 1 liter per minute.

Two coolant hoses are included with every NIRvana camera system. Refer to Section 2.3, Coolant Hoses, on page 21 for complete information.

2.6.3 Optical Adapters

The following optical adapters are available for purchase and can be ordered separately:

- C-mount to Spectroscopy-Mount Adapter
- Adjustable C- to Spectroscopy-Mount Adapter

Figure 2-4 shows these two adapters.

Figure 2-4:   Optional Optical Adapters

**C-Mount to Spectroscopy
Mount Adapter**

**Adjustable C-Mount to
Spectroscopy Mount Adapter**

2.7 Care and Cleaning of a NIRvana System

From time to time, NIRvana cameras may require minor cleaning.

2.7.1 Detector Window

- Never remove the detector's front window. Ice will form immediately, destroying the sensor.
- Never operate the detector cooled without proper evacuation. This could *destroy* the sensor!
- This fused silica window maintains the vacuum in the detector.

2.7.2 Cleaning

⚠️ **WARNING!** ━━━━━━━━━━━━━━━

Turn off all power to the equipment and secure all covers before cleaning the units. Otherwise, damage to the equipment or injury to you could occur.

2.7.2.1 Camera

Although there is no periodic maintenance that *needs* to be performed on a NIRvana camera, users are advised to wipe it down with a clean damp cloth from time to time. This operation should only be done on the external surfaces and with all covers secured. In dampening the cloth, use clean water only. No soap, solvents or abrasives should be used. Not only are they not required, but they could damage the finish of the surfaces on which they are used.

2.7.2.2 Optical Surfaces

Optical surfaces may need to be cleaned due to the accumulation of atmospheric dust. We advise that the *drag-wipe* technique be used. This involves dipping a clean cellulose lens tissue into clean anhydrous methanol, and then dragging the dampened tissue over the optical surface to be cleaned. Do not allow any other material to touch the optical surfaces. Pay extra attention if the optical window is coated with AR (anti-reflection) materials as they can be susceptible to scratches. Please contact factory if you have any questions.

2.8   Repairs

Because the NIRvana camera system contains no user-serviceable parts, repairs must be performed by Teledyne Princeton Instruments. Should your system need repair, contact Teledyne Princeton Instruments customer support for instructions. For contact information, refer to Contact Information on page 124.

Save the original packing materials and use them whenever shipping the system or system components.

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Chapter 3:   Installation

Table 3-1 and Figure 3-1 through Figure 3-4 provide an overview of the sequence of actions required to install a NIRvana system and prepare to gather data. Refer to the indicated references for detailed information.

Table 3-1:   NIRvana System Installation Procedure (Sheet 1 of 2)

Action	For additional information, refer to...
1. If the system components have not already been unpacked, unpack them and inspect their carton(s) and the system components for in transit damage.	Section 4.1, Unpacking the System, on page 31.
2. Verify that all system components have been received.	Section 4.2, Checking the Equipment and Parts Inventory, on page 32.
3. If the components show no signs of damage, verify that the appropriate power cord has been supplied with the power supply.	Section 4.3.3, Power Requirements, on page 33.
4. If the Ethernet adapter card provided with the system is not already installed in the host computer, install it.	Refer to the manufacturer's instructions
5. If the application software is not already installed in the host computer, install it.	Section 4.4, Data Acquisition Software Installation, on page 36. Appropriate software manual.
6. Depending on application, attach lens to the camera or mount the camera to a spectrograph.	Section 4.5, Attaching a Lens to a C-Mount Adapter, on page 38. Appendix C, Spectrograph Adapters, on page 101.
7. With the power supply disconnected from the camera, connect the Ethernet cable to the GigE connector on the rear of the camera and to the Ethernet port on the installed Ethernet card.	
8. Air-Cooled System: Plug the power supply into the rear of the camera and plug the power supply into the power source. Liquid Cooling: Make the hose connections to the camera and plug the circulator into the power source. Add coolant if necessary. Turn on the circulator.	Section 4.7, Making the Camera-Circulator Connections for a CoolCUBEII, on page 40.
9. Turn ON the camera and spectrograph (if part of the experiment).	
10. Turn on the computer and begin running the application software.	Appropriate software manual.
11. Enter the hardware setup information or load the defaults from the camera. WinSpec requires that a spectrograph be defined.	Appropriate software manual.
12. Set the target sensor temperature.	Section 8.5, Sensor Temperature, on page 70.

Table 3-1:   NIRvana System Installation Procedure (Sheet 2 of 2)

Action	For additional information, refer to...
13. When the system reaches temperature lock, wait an additional 20 minutes and then begin acquiring data in focus mode.	Chapter 6, LightField First Light Procedure: • Section 6.1, Imaging Applications, on page 45; • Section 6.2, Spectroscopy Applications, on page 49; Chapter 7, WinX First Light Procedure: • Section 7.1, Imaging Applications, on page 57; • Section 7.2, Spectroscopy Applications, on page 61.
14. Adjust the rotational alignment focus for the best image or spectral lines. • LightField: Use the Align Spectrometer function; • WinSpec/32: Use the Focus Helper function for spectroscopy applications.	Chapter 6, LightField First Light Procedure: • Section 6.1, Imaging Applications, on page 45; • Section 6.2, Spectroscopy Applications, on page 49; Chapter 7, WinX First Light Procedure: • Section 7.1, Imaging Applications, on page 57; • Section 7.2, Spectroscopy Applications, on page 61.

Figure 3-1:   Typical Imaging Experiment Layout: Air-cooled Camera
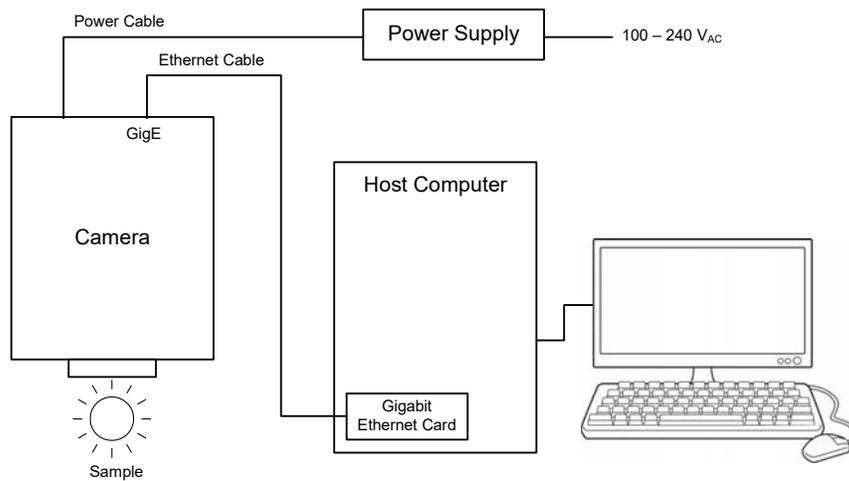
Figure 3-2:   Typical Spectroscopy Experiment Layout: Air-cooled Camera
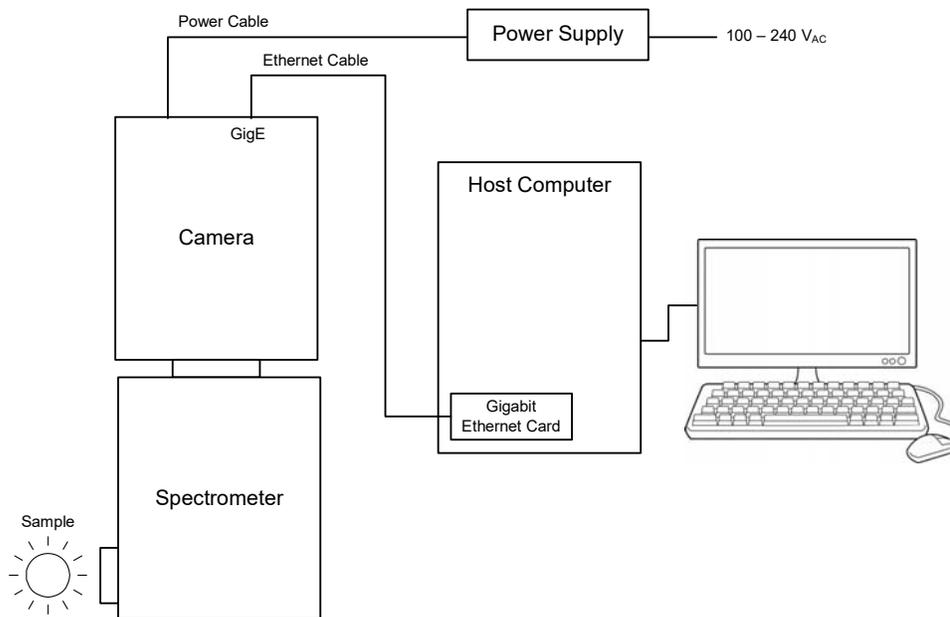
Figure 3-3:   Typical Imaging Experiment Layout: Air/Liquid-cooled Camera
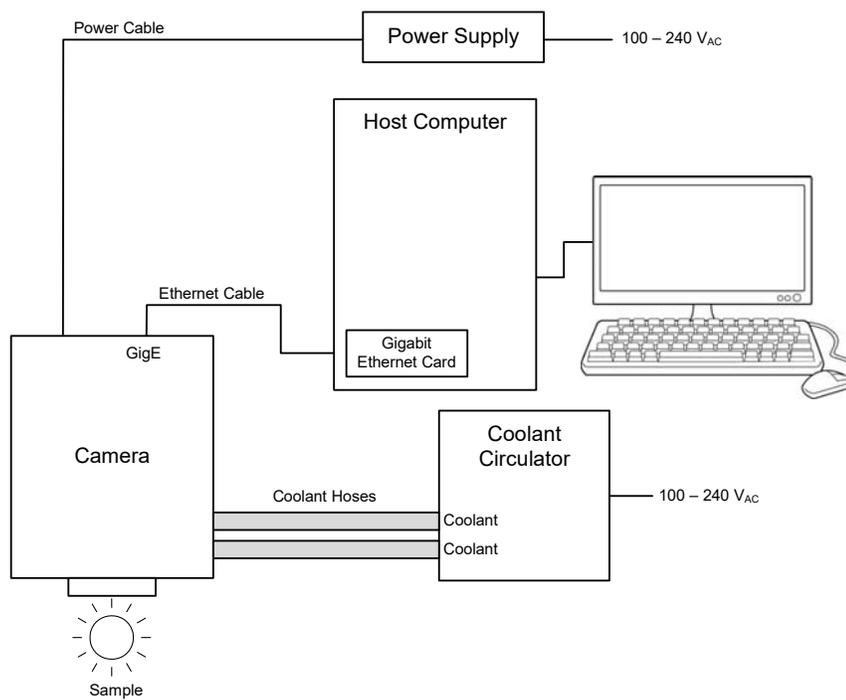
Figure 3-4:   Typical Spectroscopy Experiment Layout: Air/Liquid-cooled Camera
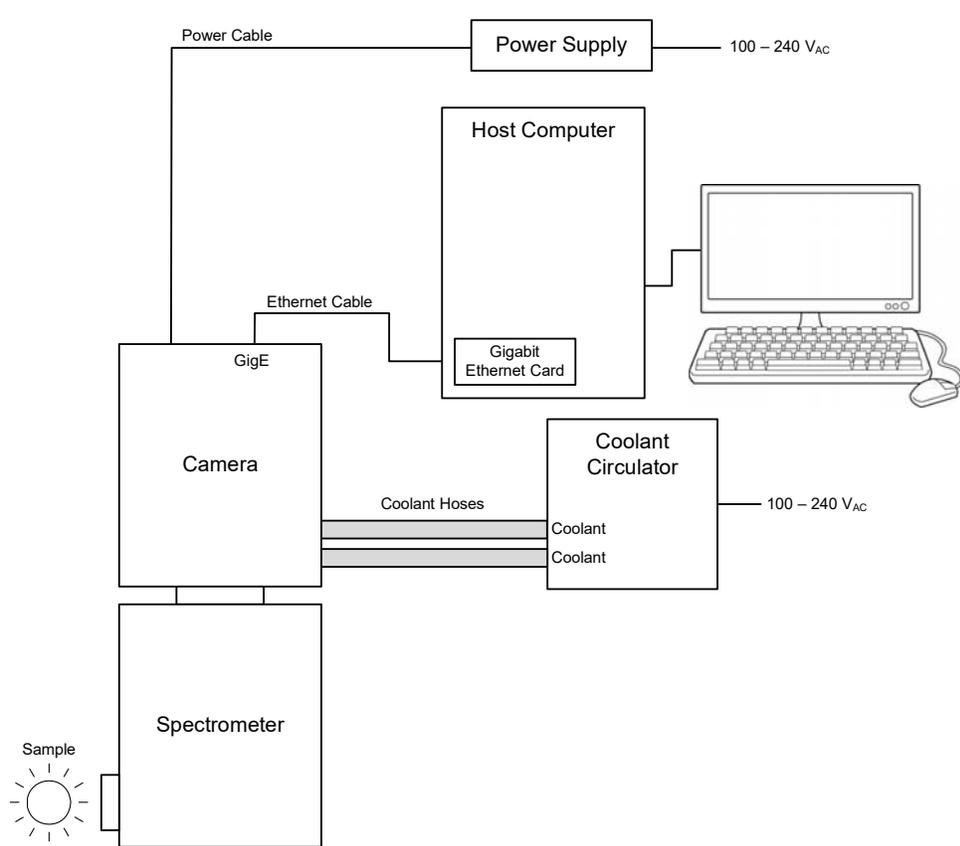
Chapter 4:   System Setup

> 🔍 **NOTE:**
>
> To minimize risk to users or to system equipment, turn the
> system OFF before any cables are connected or
> disconnected.

A NIRvana™ camera system consists of the following hardware components:

- Camera;
- Power supply;
- GigE adapter card;
- Cables
  — Ethernet;
  — Power;
  — MCX-to-BNC.

All of the components and cables required for your configuration should be included
with your shipment. Your NIRvana system has been specially configured and calibrated
to match the camera options specified at the time of purchase. The sensor window and
coatings you ordered have been installed in your camera head.

Keep all the original packing materials so you can safely ship the NIRvana for service if
necessary. If you have any difficulty with any step of the instructions, call Teledyne
Princeton Instruments Customer Support. For contact information, refer to Contact
Information on page 124.

Hardware installation consists of:

- Installing a dedicated GigE interface card;
- Attaching a lens to a C-mount on the camera, or to a C-to-F-mount adapter;
- Mounting the camera to a spectrograph (for spectroscopy applications only).

Software installation depends on the application software you will be using to run the
system. Refer to the manual supplied with the software for information about installing
and setting it up.

4.1   Unpacking the System

During unpacking, examine the system components for signs of shipping damage. If
there are any, notify Teledyne Princeton Instruments immediately and file a claim with
the carrier.

If damage is not apparent but camera or controller specifications cannot be achieved,
internal damage may have occurred in shipment. Save the original packing materials so
you can safely ship the camera system to another location or return it to Teledyne
Princeton Instruments for repairs if necessary.

4.2   Checking the Equipment and Parts Inventory

Verify that all required equipment and parts necessary to set up the NIRvana system have been received.

A complete system consists of:

- Standard Equipment:
  - Camera
  - Power Supply
  - Host Computer

    Can be purchased from Teledyne Princeton Instruments or provided by user. For enhanced performance, a fast hard drive (i.e., 10,000 rpm,) and 2 GB RAM is recommended.

    Depending on the application software being used, the host computer should be loaded with one of the following supported operating systems:

    - WinView/32 or WinSpec/32

      Windows® XP (32-bit, SP3 or later,) Vista® (32-bit,) or Windows® 7 (32-bit).

    - LightField

      Windows® Vista (64-bit) or Windows® 7 (64-bit)

    Refer to Section 4.3.4, Host Computer Specifications, on page 34 for additional host computer specifications.
  - Ethernet Cable

    15 ft (5 meter) cable (6050-0621) is standard.
  - GigE Interface Card (provided with the NIRvana system)
  - External Sync and Logic Out Cables

    MCX-to-BNC adapter cables.
  - Hoses

    Two coolant hoses with NIRvana-compatible quick-disconnects.
  - NIRvana System Manual
- Optional Equipment
  - Application Software
    - WinView/32 or WinSpec32 (version 2.5.25 or later) CD-ROM (optional)
    - LightField CD-ROM (optional)
  - Software User Manual (included with application software)
  - CoolCUBE$_{II}$ Coolant Circulator

4.3   System Requirements

This section summarizes NIRvana System requirements.

4.3.1   Environmental Requirements

- Storage temperature: ≤55°C
- Operating environment temperature: +5ºC to +30ºC; the environment temperature at which system specifications can be guaranteed is +20ºC
- Relative humidity ≤50%; non-condensing

> **NOTE:**
>
> For TE-cooled cameras, the cooling performance may degrade if the room temperature is above +20°C.

4.3.2   Camera Ventilation

Allow at least two (2) inches (50.8 mm) clearance around all vented covers.

The ambient air temperature must be less than 25ºC. When operating in ambient air temperatures greater than 25ºC, the sensor temperature can begin to degrade.

When the camera is operating inside an enclosure, the enclosure must have unrestricted flow to an open environment. The camera vents heat through vents near the nose, while its air intake is near the rear of the camera.

4.3.3   Power Requirements

Camera: The NIRvana camera receives its power from the supplied power supply, which in turn plugs into a source of AC power.

Power Supply: The receptacle on the power supply should be compatible with the line-voltage line cords in common use in the region to which the system is shipped. If the power supply receptacle is incompatible, a compatible adapter should be installed on the line cord, taking care to maintain the proper polarity to protect the equipment and assure user safety.

- Maximum Power Output: 112 W
- Nominal Input Specifications: 90-240 V_{AC}, 47-63 Hz, 140 W
- Output: 24 V_{DC} Maximum. The power supply also supplies required TEC power.

4.3.4   Host Computer Specifications

Host Computer specifications vary based on which data acquisition software is being used. This section provides minimum host computer specifications by software package.

> **NOTES:** ───────────────────────
> 1. Computers and operating systems undergo frequent revisions. The following information is intended to provide an approximate indication of the computer requirements. Contact the factory to confirm specific requirements.
> 2. The specifications listed are the MINIMUM required for a NIRvana camera. A faster computer with 2 GB (or more) RAM and a fast hard drive (e.g., 10,000 rpm,) will greatly improve system performance during live mode operation.

4.3.4.1   WinX Host Computer Requirements

When running WinX data acquisition software, the host computer must satisfy the following requirements:

- 32-bit Operating System:
  — Windows$^®$ XP (with SP3 or later,)
  — Vista$^®$ or
  — Windows$^®$ 7;
- 2 GHz Pentium$^®$ 4 (minimum);
- Native USB 2.0 support on the motherboard, or USB 2.0 Interface Card Recommended Interface Cards:
  — Desktop applications: Orange Micro 70USB90011 USB2.0 PCI;
  — Laptop applications: SIIG, Inc. USB 2.0 PC Card, Model US2246;
- 1 GB RAM minimum
- CD-ROM drive;
- 10,000 RPM (recommended) hard disk with a minimum of 1 GB available space. A complete WinX installation requires 17-50 MB of space. The remaining space is required for data storage, and is dependent on the number and size of images/spectra collected.

> **NOTE:** ───────────────────────
> Disk level compression programs are NOT recommended.

- Super VGA monitor and graphics card supporting at least 65,535 colors with at least 128 Mbyte of memory.

> **NOTE:** ───────────────────────
> Memory requirement is dependent on the desired display resolution.

- Mouse or other pointing device.

4.3.4.2 **LightField Host Computer Requirements**

When running LightField data acquisition software, the host computer must satisfy the following requirements:

a. 64-bit Operating System:

— Windows Vista$^{®}$, or

— Windows 7$^{®}$;

- 2 GHz Pentium$^{®}$ 4 (minimum);
- 1 GB RAM minimum
- CD-ROM drive;
- One unused PCI card slot (minimum) with the following minimum specifications:
  — PCI 2.3 compliant;
  — 32-bit;
  — 33/66 MHz bus;
- 10,000 RPM (recommended) hard disk with a minimum of 1 GB available space.

A complete LightField installation requires approximately 50 MB of space. The remaining space is required for data storage, and is dependent on the number and size of images/spectra collected.

NOTE:

Disk level compression programs are NOT recommended.

- Super VGA monitor and graphics card supporting at least 65,535 colors with at least 128 Mbyte of memory.

NOTE:

Memory requirement is dependent on the desired display resolution.

- Mouse or other pointing device.

4.4   Data Acquisition Software Installation

This section provides installation procedures for LightField and WinX data acquisition software.

4.4.1   Installing LightField

Perform the following procedure to install LightField on the host computer:

> **NOTE:**
>
> Install the GigE Adapter card BEFORE installing the LightField application software.

1. Verify that the operating system on the host computer is Windows Vista (64-bit) or Windows 7 (64-bit).
2. Confirm that the GigE adapter card has been installed.
3. Verify that the host computer is connected to the Internet. An internet connection may be required for product activation.
4. Insert the LightField installation CD into an appropriate drive on the host computer.
    The installation wizard will autostart, and the setup dialog will be displayed. See Figure 4-1.

Figure 4-1:   Typical LightField Installation Wizard Dialog
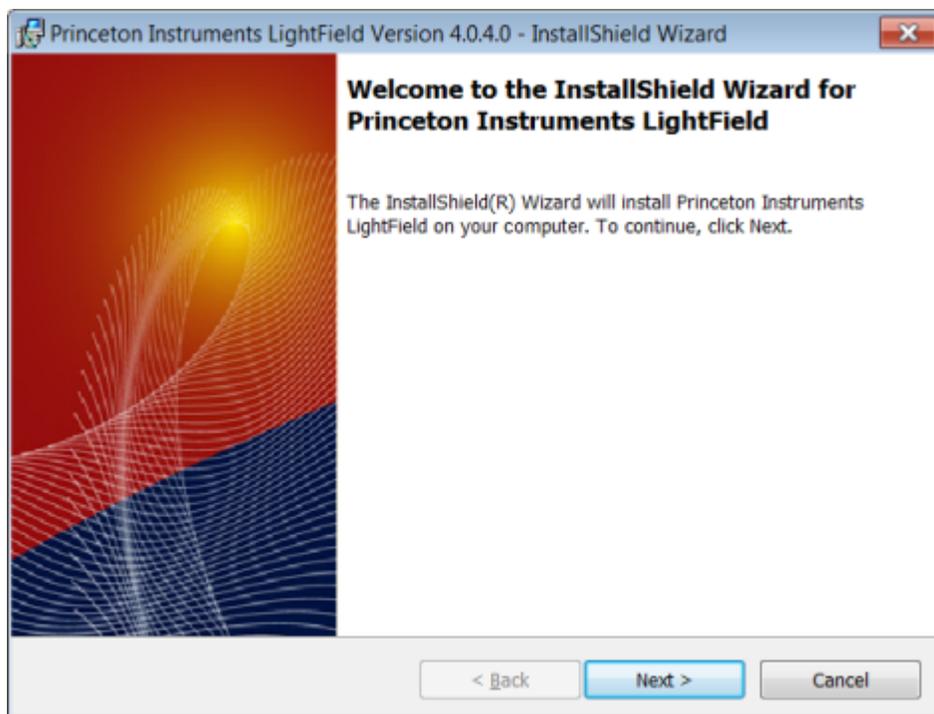
5. After the installation finishes, reboot the host computer.
6. Connect the NIRvana system components to the host computer and power them on.
7. Launch LightField and activate it according to on-screen instructions.
8. Begin experiment configuration.

4.4.2 Installing WinX

Perform the following procedure to install WinX on the host computer:

NOTES:

1. Install the GigE Adapter card BEFORE installing the WinView/32 or WinSpec/32 application software.
2. The interface cable between the camera and the host computer should remain disconnected until after WinView/32 or WinSpec/32 (version 2.5.25 or higher) has been completely installed.

1. Insert the WinView/32 or WinSpec/32 software installation CD into an appropriate drive on the host computer.

   The installation wizard will autostart, and the setup dialog will be displayed. See Figure 4-2.

Figure 4-2:   Typical WinView/32 Setup Dialog
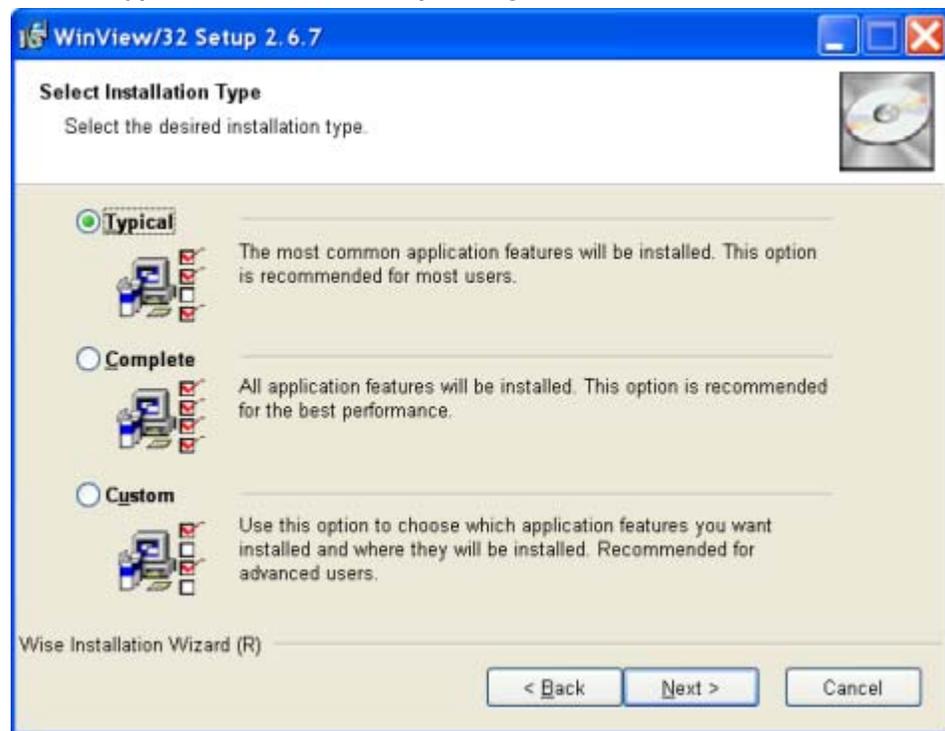
2. Select the radio button corresponding to the type of install to be performed:
   - Typical installs the most commonly installed program files;
   - Complete installs all application features;
   - Custom allows you to choose among the available program files.
3. Click Next > to begin the installation.
4. Once the installation is complete, connect the camera to the host computer.
5. Turn on the power supply for the camera.
6. Reboot the host computer.
7. During startup, Windows will detect the GigE card.

4.5 Attaching a Lens to a C-Mount Adapter

⚠ **CAUTION!** ———————————————

Overexposure Protection

Cameras that are exposed to room light or other continuous light sources will quickly become saturated. Set the lens to the smallest aperture (i.e., highest f-number,) and cover the lens with a lens cap to prevent overexposure. Saturation is not harmful to a non-intensified camera, but it should be avoided.

NIRvana cameras for imaging applications incorporate an integrated C-mount adapter. Other mounts may be available. Consult the factory for specific information relating to your needs. For information about contacting Teledyne Princeton Instruments Customer Support, refer to Contact Information on page 124.

4.5.1 Mounting the Lens

Each NIRvana camera is shipped with a protective dust cover screwed into the C-mount adapter opening. Simply unscrew the dust cover, store it, and then screw the desired lens in. Tighten the lens by hand only.

4.6   Adjusting a C-Mount Adapter

The NIRvana features an adjustable C-mount adapter that allows the focal depth to be changed.

Perform the following procedure to adjust the C-mount adapter:

1. Using the hex wrench supplied with the system (or a 0.050" hex wrench) loosen the setscrew securing the adapter. See Figure 4-3.

Figure 4-3:   Adjustable C-Mount Adapter
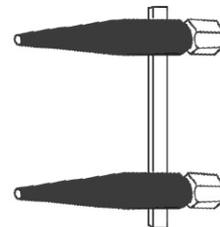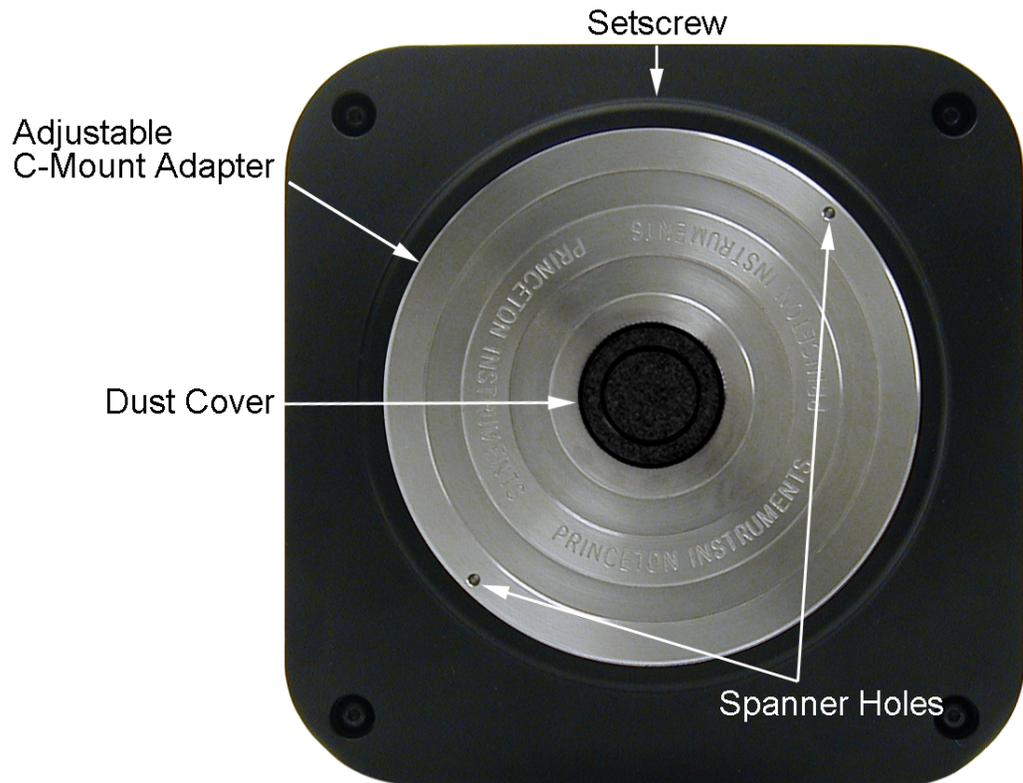
(2) Spanner Wrench Holes
.10" (2.5 mm) dia x .15" (3.8 mm) deep

2. Using a spanner wrench (or equivalent,) rotate the ring to the desired height.

NOTE:

The distance between the two adapter holes is 3.85"
[97.8 mm].

3. Use the hex wrench to tighten the setscrew to lock the adapter in place.

> � **NOTE:**
>
> To lock the setscrew, the face of the adapter should be no more than 0.1" (2.5 mm) out from the front surface of the camera nose.

> ⚠️ **CAUTION!**
>
> The C-mount lens thread-depth should be 0.21" (5.33 mm) or less. Otherwise, depending on the adapter in-out location, the lens could bottom out and damage the glass. If you are not certain of the thread depth, remove the adapter from the camera nose, thread the lens into the adapter until the lens threads are flush with the back surface of the adapter. Note the depth at the front surface, remove the lens, and then re-insert the adapter into the camera nose.

4.7 Making the Camera-Circulator Connections for a CoolCUBE$_{II}$

For liquid-cooled cameras, the CoolCUBE$_{II}$ circulator provides a vibration-free method of heat removal.

1. Verify that the camera and the circulator power switches are both turned off.
2. Verify that the circulator is positioned a minimum of 6 inches (150 mm) below the camera, but no more than 10 feet (3 m) below the camera.

   Typically, the camera is at table height and the circulator is nearby on the floor.
3. Make the coolant connections between the circulator and the camera. It does not matter which hose from the circulator is plugged into a coolant port on the camera.

   It is recommended that hoses be secured to the camera hose barbs using the clamp supplied.

Reservoir Cap

Coolant Ports

4411-0137_0010

> � **NOTES:**
>
> 1. Verify that there are no kinks in the hoses that would impede the coolant flow. Lack of sufficient flow can seriously harm the camera, and any resulting damage is not covered under warranty.
> 2. Damage caused by water leaking into the NIRvana voids the warranty.
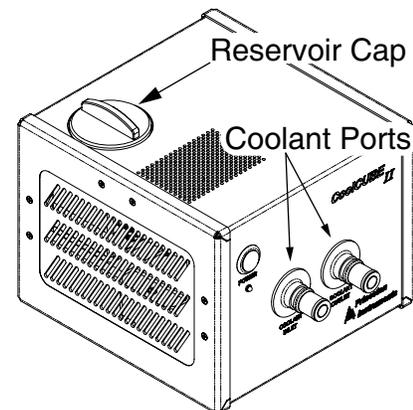
4. Unscrew the reservoir cap located on top of the CoolCUBE$_{II}$ and verify that the coolant reservoir contains coolant.

   If additional coolant is required, fill the tank with a 50:50 mixture of water and ethylene glycol.

5. Screw the reservoir cap back in.

6. Plug the circulator into a 100-240 V$_{AC}$, 50-60 Hz power source.

7. Turn the circulator on. Verify there are no leaks or air bubbles in the hoses. Note that small air bubbles (about the size of bubbles in soda) are common in the CoolCUBE$_{II}$ especially at start up and do not prevent proper operation.

   a. If there are no problems, proceed to step 8.

   b. If there are leaks or large air bubbles, turn the circulator off and correct the problem(s) by securing the hoses or adding more coolant to the reservoir.

   c. Turn the circulator back on. Recheck and if there are no problems, proceed to step 8.

8. Turn the camera on.

9. Launch the application software.

4.8   Configure Default LightField Camera Parameters

Perform the following procedure to configure default system parameters in LightField:

1. Verify that the NIRvana camera (and the associated spectrograph when configuring a spectroscopy system,) is connected to the host computer, and that associated power supplies for the camera and spectrograph (when applicable) are turned on.
2. Launch LightField.
3. While LightField is starting up, it will detect the available device(s) and load the appropriate icons into the Available Devices area in the Experiment workspace.
4. When an icon is dragged into the Experiment Devices area, the appropriate expanders are loaded into the Experiment Settings stack on the left-hand side of the window.

Figure 4-4:   Typical LightField Experiment Workspace
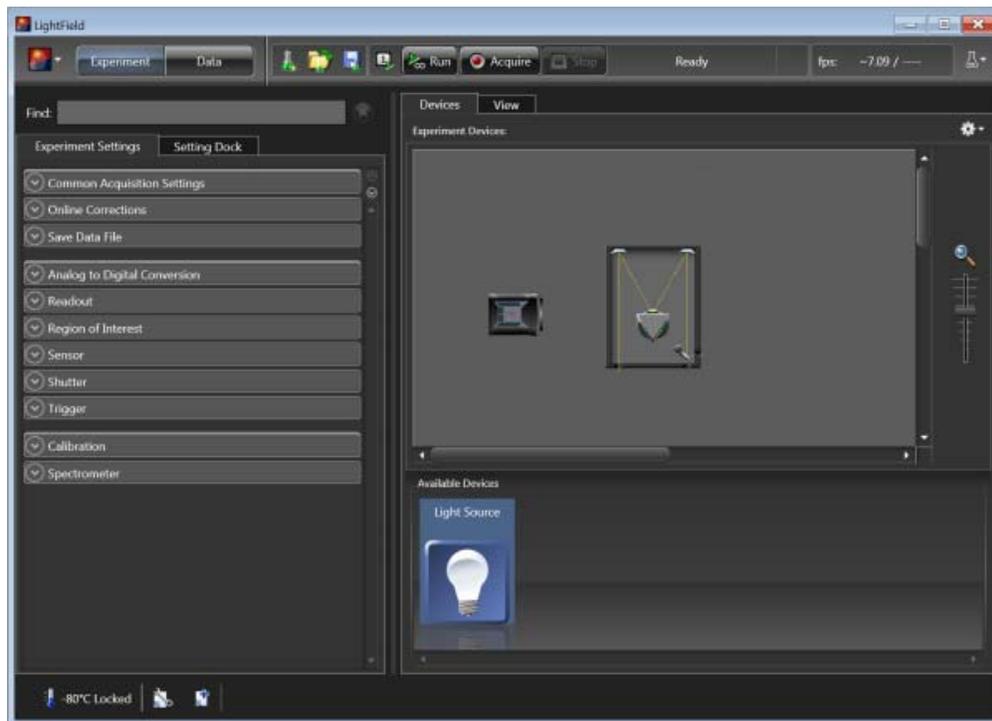
Because this is a new experiment, the default settings are automatically entered for the experiment device(s). These settings will allow you to begin previewing (Run button) or acquiring (Acquire button) data.

📖 **REFERENCES:**

For step-by-step procedures for basic system operation, refer to the following sections within Chapter 6, LightField First Light Procedure, on page 45:

- Section 6.1, Imaging Applications, on page 45, or
- Section 6.2, Spectroscopy Applications, on page 49.

Chapter 5:   Operation

Once the NIRvana camera has been installed as described in preceding chapters, operation of the camera is straightforward. For most applications, optimum performance is established using the Focus {Preview} mode, the camera's target temperature is set, and once the camera's temperature has stabilized actual data acquisition is performed in Acquire mode. Additional considerations regarding experiment setup and equipment configuration are addressed in the software manual.

During data acquisition, the sensor is exposed to a source for a specified length of time (i.e., Exposure Time,) and charge accumulates in the pixels.

> **NOTE:**
>
> Experiment setup parameters within the data acquisition software configure Exposure Time.

After the specified exposure time has elapsed, the accumulated signal is readout of the sensor, digitized, and then transferred to the host computer. Upon data transfer, the data are displayed and/or stored via the application software. This sequence is illustrated by the diagram shown in Figure 5-1.

Figure 5-1:   NIRvana Light Path Diagram
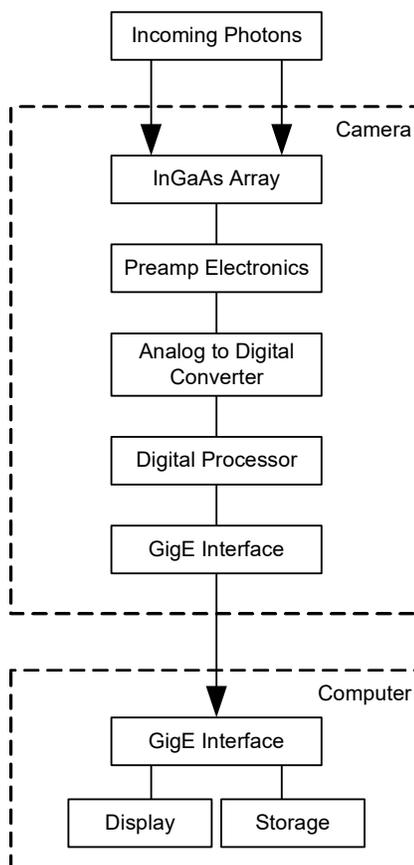
Whether or not the data are displayed and/or stored depends on the data collection operation that has been selected in the application software:

- Focus {Preview}

  This mode is typically used when setting up the system during First Light procedures.

  📖 **REFERENCES:** ─────────────────

  For additional information and procedures, refer to:
  - Chapter 6, LightField First Light Procedure, on page 45;
  - Chapter 7, WinX First Light Procedure on page 57.

  In Focus {Preview} mode, the number of frames is ignored. A single frame is acquired and displayed, another frame is acquired and overwrites the currently displayed data, and so on until Stop is selected. In WinX, the last frame acquired before Stop is selected can be stored. In LightField, this frame cannot be stored. Focus {Preview} mode is particularly convenient for familiarization and setting up. For ease in focusing, the screen refresh rate should be as rapid as possible, achieved by operating with axes and cross-sections off, and with Zoom 1:1 selected.

- Acquire

  This mode is typically used for the collection and storage of data. In Acquire mode, every frame of data collected can be automatically stored so the completed dataset may include multiple frames with one or more set of accumulations. This mode is typically selected during actual data collection.

  One limitation of Acquire mode operation is that if data acquisition continues at too fast a rate for it to be stored, data overflow may occur. In WinX, this can only occur in Fast Mode operation.

  📖 **REFERENCES:** ─────────────────

  For information about synchronizing data acquisition with external devices, refer to Chapter 9, Advanced Topics.

5.1   WinX On/Off Sequences

For both WinView/32 and WinSpec/32, the following on/off sequences must be followed to establish and maintain the communication link between the camera and the host computer:

1. The NIRvana camera must be powered ON before the WinX application is opened to ensure communication between the camera and the computer. If the WinX application is opened and the NIRvana is not powered ON, many of the functions will be disabled and you will only be able to retrieve and examine previously acquired and stored data. You must close the WinX application, power the camera ON, and reopen the application before you can set up experiments and acquire new data.

2. The WinX application must be closed before powering the camera OFF. If you power the camera OFF before closing the application, the communication link with the camera will be broken. You can operate the program in a playback mode (i.e., examine previously acquired data) but will be unable to acquire new data until you have closed the application, powered the camera ON, and then reopened the application.

Chapter 6:   LightField First Light Procedure

This chapter provides step-by-step instructions to verify initial system operation using LightField image acquisition software.

6.1   Imaging Applications

This section provides step-by-step instructions for acquiring an imaging measurement in LightField for the first time. The intent of this procedure is to help gain basic familiarity with the operation of the system and to show that it is functioning properly. Once basic familiarity has been established, then operation with other operating configurations, ones with more complex timing modes, can be performed.

This procedure assumes:

- The system has been set up in accordance with the instructions in previous chapters.
- Previous sections of this chapter have been read.
- Familiarity with the application software.
- The system is being operated in imaging mode.
- The target is a sharp image, text, or drawing that can be used to verify that the camera is "seeing" and for optimizing focus.

6.1.1   Configure LightField

Perform the following procedure to configure LightField for the first time:

> **NOTE:**
>
> This procedure is based on LightField. Basic familiarity with the LightField software is assumed. If this is not the case, review the software manual or have it available while performing this procedure.

1. Mount a test target in front of the camera.
2. Power ON the camera (the power switch is on the back of the power supply).
3. Turn on the computer power.
4. Launch the application software.

5. After LightField opens, you should see an icon representing your camera in the Available Devices area. In Figure 6-1, the camera shown is a NIRvana:640.

Figure 6-1:   Typical Available Devices Area
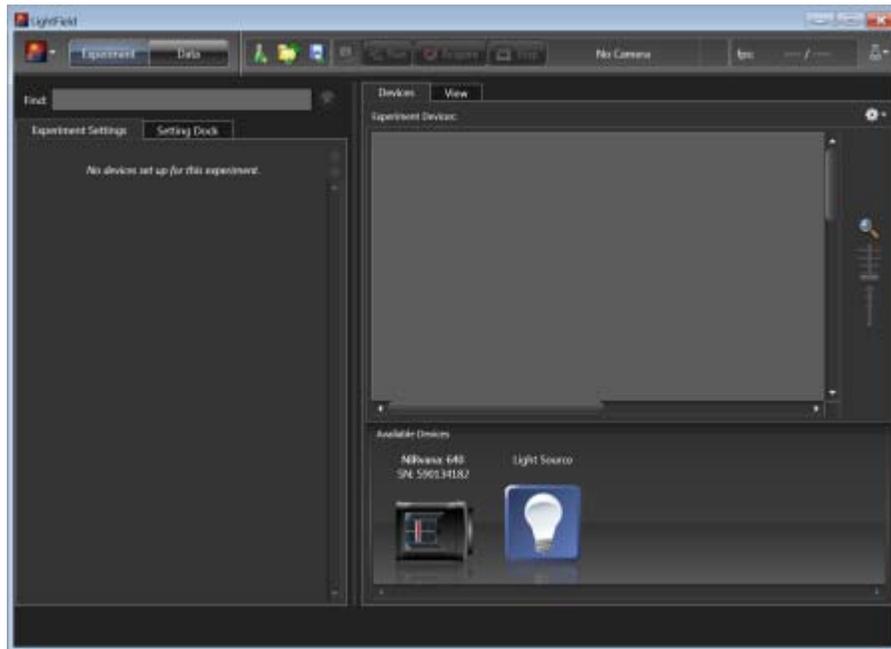
6. Drag the camera icon into the Experiment Devices area. See Figure 6-2.

Figure 6-2:   Typical Experiment Devices Area with NIRvana Camera
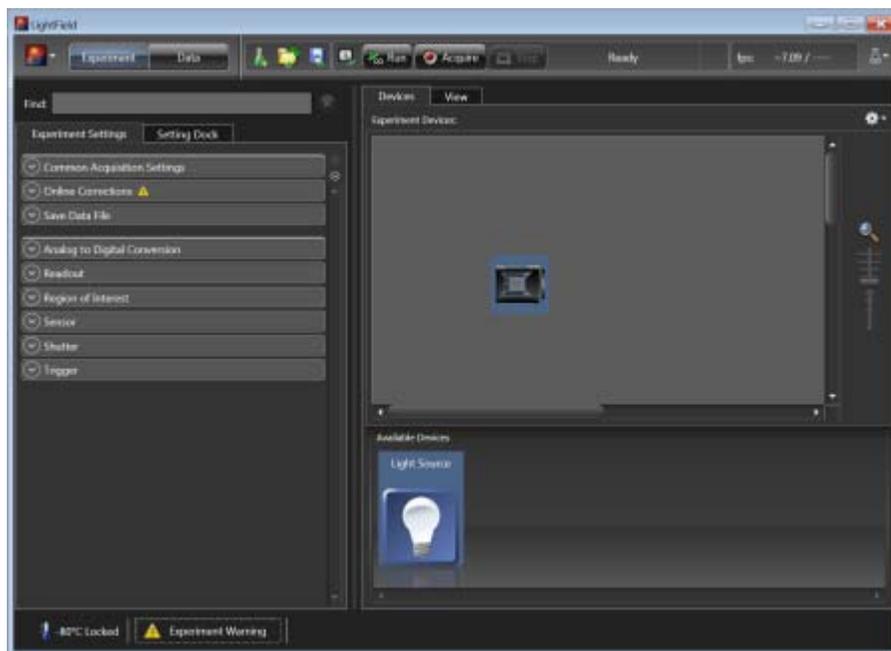
Note that the Experiment Settings stack on the left now displays several expanders. Since this is a new experiment, the default settings for the camera will be active. The Status bar at the bottom of the window displays an icon for temperature status. Temperature status reports the current temperature and if the set temperature has been reached. Clicking on the icon opens the Sensor expander where the set temperature can be changed.

6.1.2　　　Acquire Data

Perform the following procedure to acquire data:

1. Just above Experiment Devices, click on the View tab to change to the display area. See Figure 6-3.

Figure 6-3:　Typical View Area
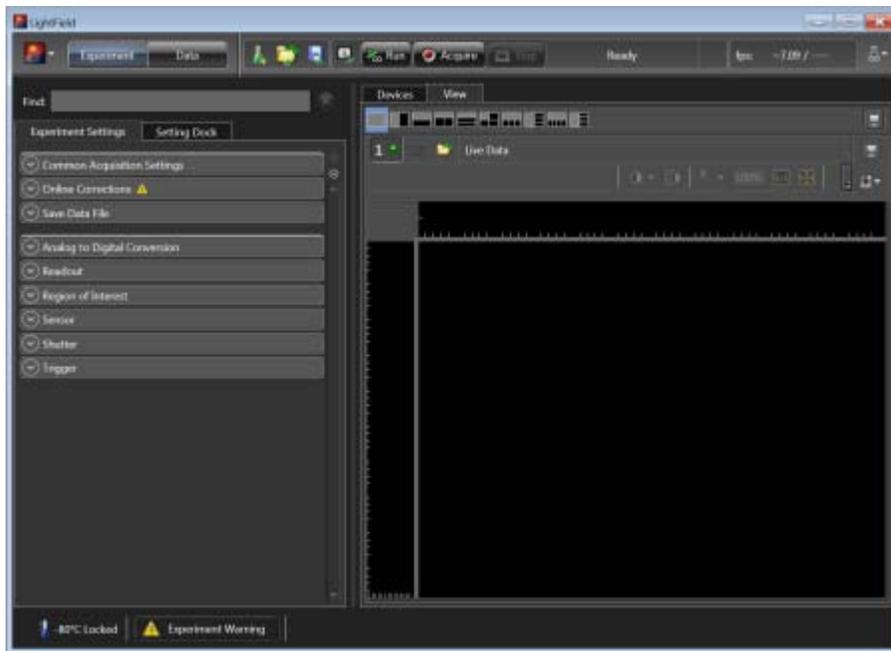
2. Click Run ▶ Run to start Preview mode. In this mode, images will be continuously acquired and displayed.

Figure 6-4:　Typical View Area Displaying an Image
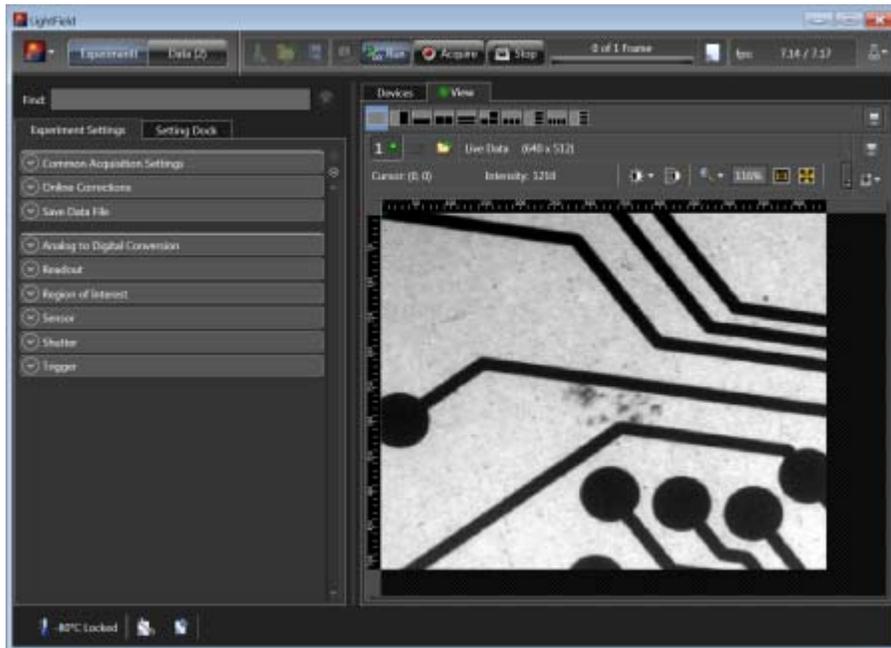
3. Adjust the lens aperture, intensity scaling, and focus for the best image as viewed on the computer monitor. Imaging tips include:
   - Begin with the lens blocked off and then set the lens to the smallest possible aperture (i.e., the greatest f-stop number.)
   - Verify there is a suitable target in front of the lens. An object with text or graphics works best.
   - Check the brightest regions of the image to determine if the A/D converter is at full-scale. A 16-bit A/D is at full scale when the brightest parts of the image reach an intensity of 65535. Adjust the aperture so that it is just slightly smaller (i.e., a greater f-stop,) than the setting where maximum brightness on any part of the image occurs.
   - Set the focus adjustment of the lens for maximum sharpness in the viewed image.
4. After the camera has been focused, stop Preview mode, continue Preview mode, begin Acquire mode, wait for the sensor to reach the operating temperature before going to Acquire mode, or shut down the system. Refer to Section 6.1.3, Shut Down Procedure, for the proper shut down procedure.

6.1.3   Shut Down Procedure

Perform the following procedure to safely shut down a LightField experiment:

1. Close LightField.
2. Turn off the camera power.

6.2   Spectroscopy Applications

This section provides step-by-step instructions for operating NIRvana in a LightField spectroscopy setup for the first time. The intent of this simple procedure is to help gain basic familiarity with the operation of the system and to show that it is functioning properly. Once basic familiarity has been established, then operation with other operating configurations, ones with more complex timing modes, can be performed. An underlying assumption for the procedure is that the camera is to be operated with a spectrograph (e.g., a Teledyne Acton Research Series 2300 spectrograph,) on which it has been properly installed.

> **REFERENCES:**
>
> Refer to Appendix C, Spectrograph Adapters, for information about mounting a spectrograph adapter to a NIRvana.

A suitable light source, such as a mercury pen-ray lamp, should be mounted in front of the entrance slit of the spectrograph. Any light source with line output can be used. Standard fluorescent overhead lamps have good calibration lines as well. If there are no "line" sources available, it is possible to use a broadband source for the alignment. If this is the case, use a wavelength setting of 0.0 nm for alignment purposes.

> ⚠ **CAUTION!**
>
> Overexposure Protection: Cameras that are exposed to room light or other continuous light sources will quickly become saturated. If the camera is mounted to a spectrograph, close the entrance slit of the spectrograph to reduce the incident light.

This procedure assumes:

- The system has been set up in accordance with the instructions in previous chapters.

  This includes mounting the spectrograph adapter to the camera as described in Appendix C, Spectrograph Adapters.

- Previous sections of this chapter have been read.
- Familiarity with the application software.
- The system is being operated in spectroscopy mode.
- The spectrograph has an entrance slit shutter that is being controlled by the NIRvana via the Shutter connector.

6.2.1   Configure LightField

Perform the following procedure to configure LightField for the first time:

1. Set the spectrograph entrance slit width to minimum (10 μm if possible).
2. Power ON the spectrograph.
3. Mount a light source such as a Teledyne Princeton Instruments Hg and Ne/Ar Dual Switchable light source in front of the entrance slit.

4. Connect the shutter cable between the entrance slit shutter and NIRvana's Shutter connector.

- External Slit Shutter: A shutter assembly mounted externally to the spectrograph has shutter cable that plugs into the Shutter connector.
- Internal Slit Shutter: A shutter mounted internally has an external shutter connector in the sidewall of the spectrograph. Connect a shutter cable from the NIRvana's Shutter connector to that connector.

5. Mount the camera to the spectrograph exit port.

6. Power ON the camera. The power switch is on the back of the power supply.

7. Turn on the computer power.

8. Launch the application software.

9. After LightField has launched, icons representing the camera and spectrograph should be displayed in the Available Devices area. In Figure 6-5, the camera is a NIRvana:640 and the spectrograph is an SP-2356.

Figure 6-5:   Available Devices Area
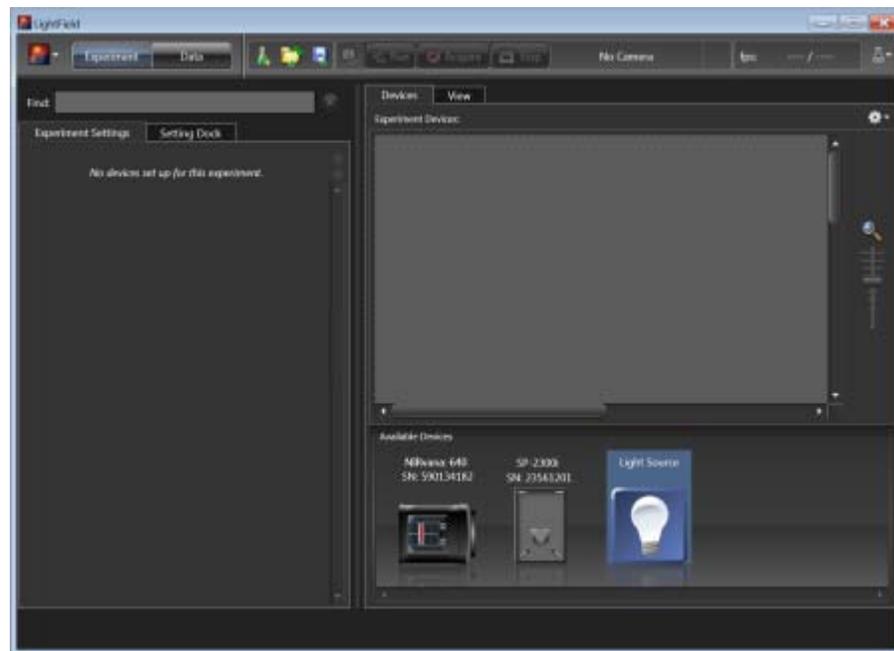
10. Drag each icon into the Experiment Devices area. See Figure 6-6.

Figure 6-6:   Experiment Devices Area
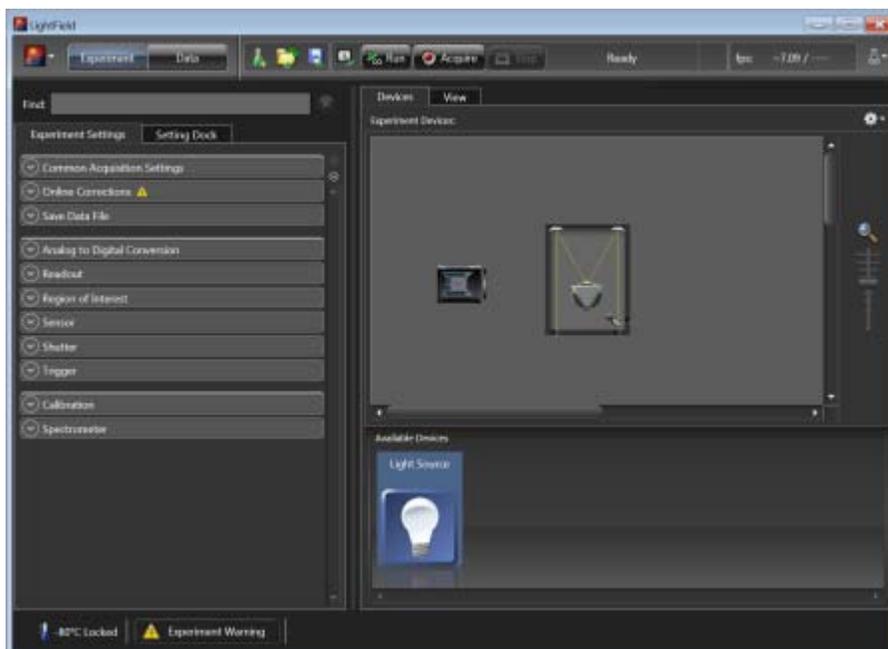
The Experiment Settings stack on the left now displays several expanders. Because this is a new experiment, the default settings for the camera will be active. The Status bar located at the bottom of the window displays an icon for temperature status. Temperature status reports the current temperature and whether the set temperature has been reached. Clicking on the icon opens the Sensor expander where the set temperature can be changed.

11. On the Shutter expander, select Shutter Mode: Normal.
12. Open the Spectrometer expander and select the appropriate grating. In this case, the 300g/mm (Blaze: 750) grating has been selected and the center wavelength has been set to 500 nm for a mercury lamp. When using a broadband source, select 0.0 nm.

6.2.2   Verify the Setup

Perform the following procedure to verify the configuration and setup:

1. Turn on the light source at the spectrograph's entrance slit.
2. Click Run to begin previewing data. Depending on the display settings, you should see either a spectral band (image) or a graph. Background noise will decrease as the camera cools to its default temperature.
3. Turn off the light source. The data display should change to a background noise pattern or low intensity graph. If this occurs you have confirmed that light entering the spectrograph is being seen by the camera. Skip step 4 and step 5, and proceed to Section 6.2.3, Rotational Alignment and Focus, on page 52.

4. If there is little or no difference between the data displayed when the light source is on or off:
   a. Verify that the light source has power and is turned on.
   b. Verify that the entrance slit is open a minimum of 10 μm.
   c. Check the Exposure Time (Common Acquisition Settings expander).
   d. Verify that Shutter Mode is set to Normal (Shutter expander).
   e. Check the shutter cable connections.
   f. Verify shutter operation. You should hear the shutter open and close while Run is active.

      If you hear a shutter operating and you have performed step a through step e, turn the light source on, wait a minute, and then turn the light off while you view the data display.

      - If the problem is fixed, stop acquisition or proceed to Section 6.2.3, Rotational Alignment and Focus, on page 52.
      - If you do not hear a shutter operating and you have performed step a through step e, stop data acquisition and proceed to step g.
   g. Verify that the spectrograph has an entrance slit shutter. An externally mounted shutter is easily confirmed. Verifying an internally mounted shutter requires access to the inside of the spectrograph. Refer to the spectrograph manual for information.
5. If additional assistance is required, contact Customer Support. Refer to Contact Information on page 124 for complete contact information.

6.2.3   Rotational Alignment and Focus

The camera mounting hardware provides two degrees of freedom:

- Rotation;

  Rotation relates to the physical rotation of the camera while watching a live display on the monitor so that spectral lines will be perpendicular to the rows on the array.

- Focus.

  In this context, focus means to physically move the camera back and forth through the focal plane of the spectrograph while watching a live display until the optimal focus is achieved.

> **NOTE:**
>
> When aligning accessories such as fibers, lenses, and optical fiber adapters, first align the spectrograph to the slit. Then align the accessory without disturbing the camera's position.

The following sections provide information and procedures necessary to rotationally align and focus a NIRvana system using LightField.

6.2.3.1   **Rotational Alignment**

Perform the following procedure to rotationally align the system:

📖 **NOTES:** ──────────────────────────

1. Although this procedure describes rotational alignment for a Teledyne Acton Research SP-2356i spectrograph, it is easily adapted to other spectrographs.

2. This procedure assumes that the camera and spectrograph have already been turned on and appropriate icons have been dragged into the Experiment Devices area as previously illustrated in Figure 6-6.

1. Click on the View tab located just above Experiment Devices to change to the display area. Figure 6-7 illustrates a typical View Area.

Figure 6-7:   Typical View Area
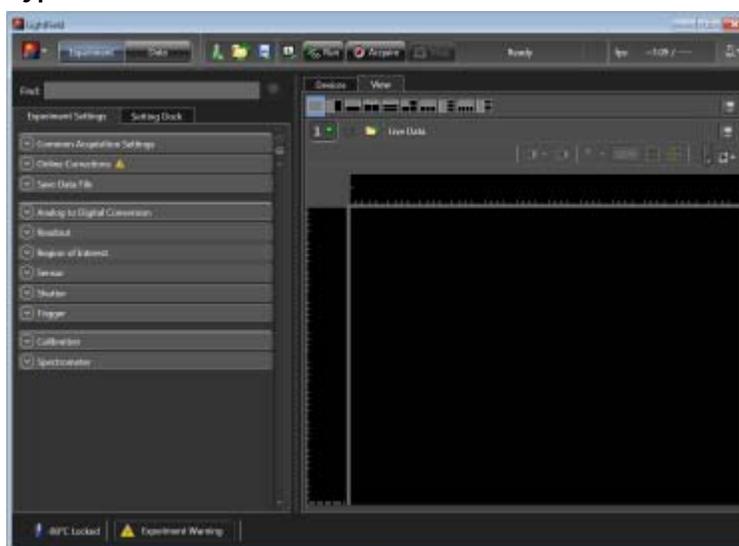
2. If you have not already done so, mount a light source such as a Teledyne Princeton Instruments IntelliCal light source at the front of the entrance slit. Any light source with line output can be used. Standard fluorescent overhead lamps have good calibration lines as well. If there are no line sources available, it is possible to use a broadband source for the alignment. If this is the case, use a wavelength setting of 0.0 nm for alignment purposes.

3. Open the Spectrometer expander, select the grating, and set the center wavelength to: 0.0 nm.

📖 **NOTE:** ──────────────────────────

Overhead fluorescent lights produce a mercury spectrum. Use a white card tilted at 45 degrees in front of the entrance slit to reflect overhead light into the spectrograph. Select 435.8 as the spectral line.

4. Set the slit to 10 µm. If necessary, adjust the Exposure Time to maintain optimum (i.e., near full-scale,) signal intensity.
5. Wait until the camera temperature locks at its default temperature.
6. Verify that the spectroscopy-mount adapter moves freely at the spectrograph.

> **NOTE:** ─────────────────────
>
> It may be necessary to loosen the two set screws that lock the sliding tube in place.

7. Select Align Spectrometer... from the Experiment Options menu.
8. Review the displayed information and click the Begin button.

    Typically, three 1-row high Regions of Interest (ROIs) are created:
    - One near the top of the sensor;
    - One in the middle of the sensor;
    - One near the bottom of the sensor.

    See Figure 6-8.

> **NOTE:** ─────────────────────
>
> Once data acquisition begins, it is continuously acquired and displayed, but NOT stored.

Figure 6-8:   Alignment Spectrometer: Pre-Rotational Alignment
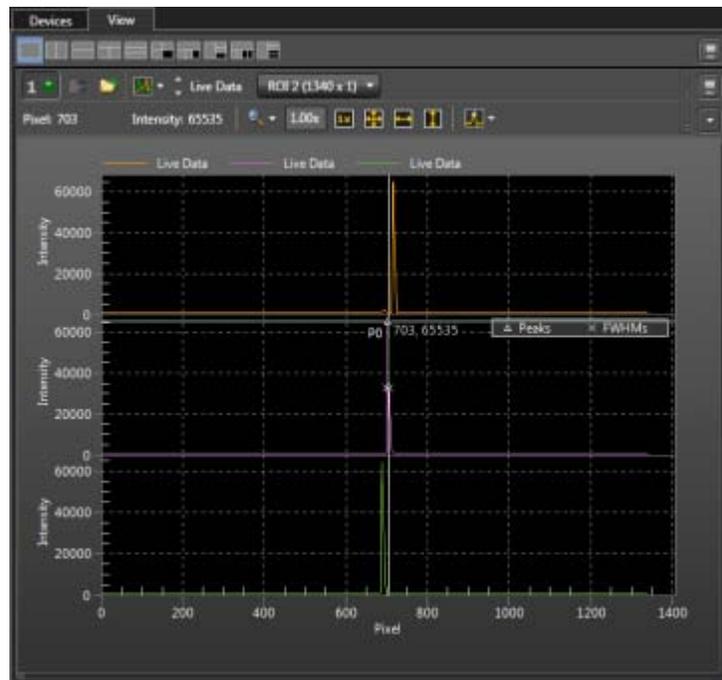
9. Adjust the rotational alignment by rotating the camera while watching a live display of the line. Click on a peak to monitor during the rotational alignment. This positions the large cursor to provide a vertical reference line across all of the ROIs. Rotate the camera until the selected peak is aligned horizontally in all of the ROIs. See Figure 6-9.

Figure 6-9: Alignment Spectrometer: Post Rotational Alignment
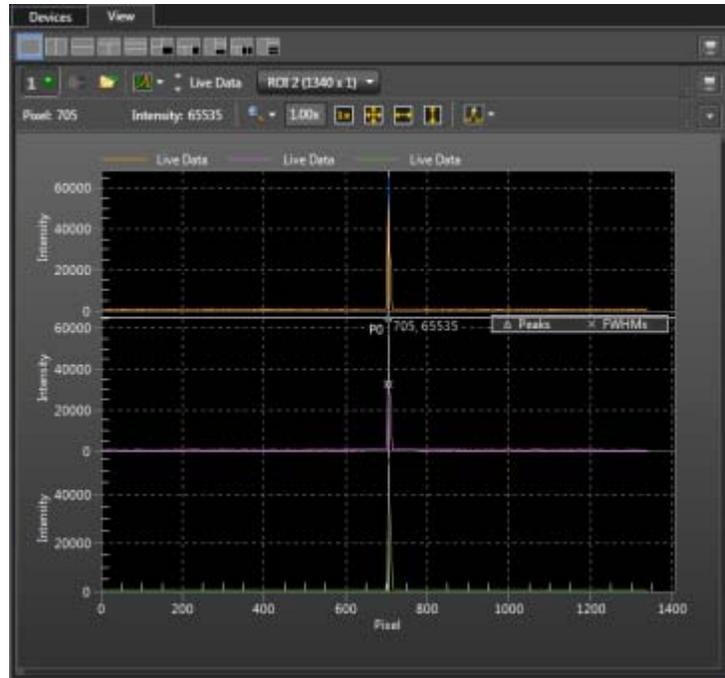
Alternatively, capture an image, display the horizontal and vertical cursor bars, and compare the vertical bar to the line shape on the screen. Rotate the camera until the line shape on the screen is parallel with the vertical bar.

6.2.3.2 Focus

Perform the following procedure to focus the system:

NOTES:

1. Although this procedure describes how to focus for a Teledyne Acton Research SP-2356i spectrograph, it is easily adapted to other spectrographs.
2. This procedure assumes that the camera and spectrograph have been turned on, appropriate icons have been dragged into the Experiment Devices area as previously illustrated in Figure 6-6, and the system has been rotationally aligned as described in Section 6.2.3.1, Rotational Alignment, on page 53.

1. Slowly move the camera in and out of focus. The spectral peak(s) should go from broad to narrow and back to broad. Maximize the intensity level and minimize the FWHM of the selected peak(s).

   NOTE:

   The Peak Finding function is active for the center graph so that FWHM information can be monitored to achieve the narrowest line width.

   Focusing is accomplished depending on the spectrograph being used as follows:

   - Long focal-length spectrographs (e.g., a Teledyne Acton Research SP-2300)
     The mounting adapter includes a tube that slides inside another tube to move the camera in or out as required to achieve optimum focus.
   - Short focal-length spectrographs
     There is generally a focusing mechanism on the spectrograph itself which, when adjusted, will move the optics as required to achieve proper focus.
   - No focusing adjustment
     If there is no focusing adjustment provided by either the spectrograph or by the mounting hardware the only option is to adjust the spectrograph's focusing mirror.

2. Tighten the two spectrograph set screws to secure the spectrograph sliding tube.
3. Halt data acquisition.

6.2.4   Acquire Data

After the system has been successfully aligned and focused, perform the following procedure to acquire data:

1. Stop running in Alignment mode.
2. Make any required changes to the experiment setup and/or software parameters.
   Changes might include adjusting exposure time, setting up an entrance slit shutter, changing the timing mode to External Sync, or lowering the temperature.
3. Begin running Acquire mode. Data will be acquired and displayed/stored based on the experiment's settings.
4. Once data collection has been completed, the camera may remain powered on so the array temperature will remain locked or the system may be shut down. Refer to Section 6.2.5, Shut Down Procedure, for the proper shut down procedure.

6.2.5   Shut Down Procedure

Perform the following procedure to safely shut down a LightField experiment:

1. Close LightField.
2. Turn off the light source and the spectrograph.
3. Turn off the camera power.

Chapter 7:   WinX First Light Procedure

This chapter provides configuration information and procedures for a NIRvana system to:

- Configure WinView/32 for imaging applications; and
- Configure WinSpec/32 for spectroscopic applications.

7.1   Imaging Applications

This section provides step-by-step instructions for acquiring an imaging measurement in WinView/32. The intent of this procedure is to help gain basic familiarity with the operation of the system and to demonstrate that it is functioning properly. Once basic familiarity has been established, then operation with other operating configurations, ones with more complex timing modes, can be performed.

This procedure assumes:

- The system has been set up in accordance with the instructions in previous chapters.
- Previous sections of this chapter have been read.
- Familiarity with the application software.
- The system is being operated in imaging mode.
- The target is a sharp image, text, or drawing that can be used to verify that the camera is "seeing" and for optimizing focus.

7.1.1   Configure WinView/32

Perform the following procedure to configure WinView/32 for the first time:

NOTE:

This procedure is based on WinView/32. If a different application is being used, then some modifications to the procedure may be required. Basic familiarity with the WinView/32 software is assumed. If this is not the case, review the software manual or have it available while performing this procedure.

1. Mount a test target in front of the camera.
2. Power ON the camera (the power switch is on the back of the power supply.)

NOTE:

The camera must be turned on before WinView/32 is launched.
WinView/32 must be closed before the camera is turned off.

3. Turn on the computer power.
4. Launch the application software.

5. Configure the software parameters as follows:

- Controller/Camera tab (Setup ► Hardware)

  These parameters should be automatically configured to the proper values for the system.

  — Controller type: This information is read from the camera.

  — Camera type: This information is read from the camera.

  — Shutter type: Custom (System dependent).

  — Readout mode: Available modes are read from the camera. Only Full Frame is available.

  See Figure 7-1.

Figure 7-1: **Typical Hardware Setup Dialog: Controller/Camera Tab**
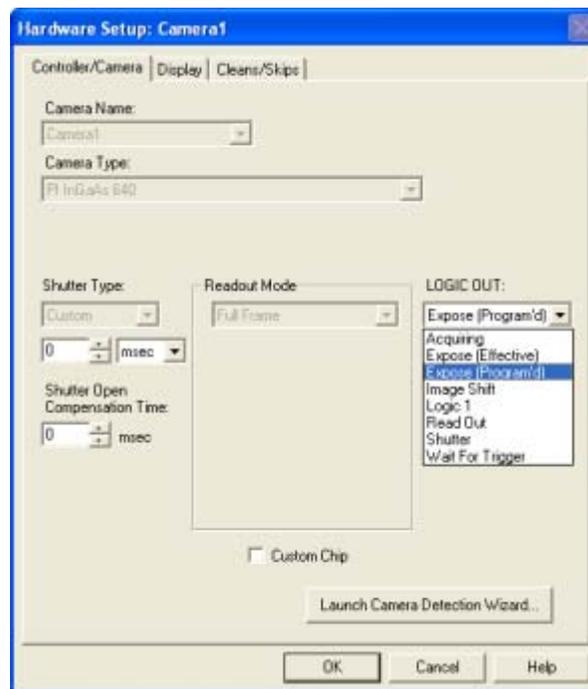
4411-0137_0013

- Detector Temperature (Setup ► Detector Temperature...)

  The default temperature setting is read from the camera. When the array temperature reaches the set temperature, the Detector Temperature dialog will report that the temperature is LOCKED. Figure 7-2 illustrates the default temperature for the NIRvana:640. Note that some overshoot may occur. This could cause temperature lock to be briefly lost and then quickly re-established. If you are reading the actual temperature reported by the application software, there may be a small difference between the set and reported temperature when lock is established. This is normal and does not indicate a system malfunction. Once lock is established, the temperature will be stable to within ±0.05°C.

Figure 7-2:   Typical Detector Temperature Dialog
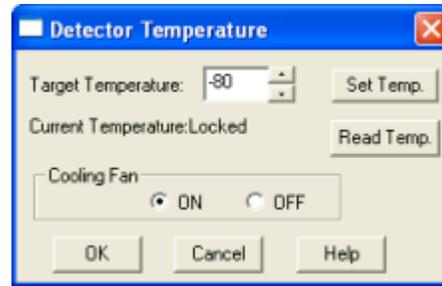
4411-0137_0014

> ⚲ **NOTE:** ─────────────────────────
>
> The Detector Temperature dialog will not display temperature information during data acquisition.

- Experiment Setup ► Main tab (Acquisition ► Experiment Setup...):
  — Exposure Time: 50 ms
  — Accumulations & Number of Images: 1
- Experiment Setup ► ROI tab (Acquisition ► Experiment Setup...): Use this function to define the region of interest (ROI).
  — Imaging Mode: Select this mode when running WinView/32.
  — Selecting Full loads the full size of the chip into the edit boxes.
- Experiment Setup ► Timing tab (Acquisition ► Experiment Setup...): see Figure 7-3.
  — Timing Mode: Free Run
  — Shutter Control: Normal
  — Safe Mode or Fast Mode: Fast Mode

Figure 7-3:   Typical Experiment Setup ► Timing Tab

SELECT FAST MODE
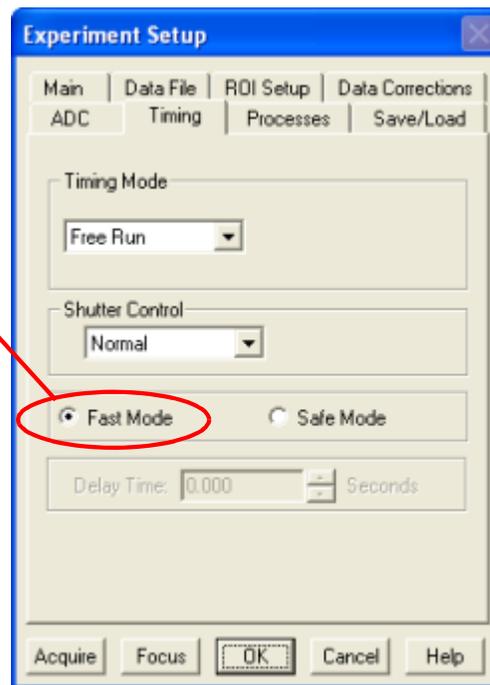
4411-0137_0015

7.1.2   Verify the Setup

Perform the following procedure to verify the configuration and setup:

1. When using WinView/32 and the computer monitor for focusing, select Focus from the Acquisition menu. Successive images will be sent to the monitor as quickly as they are acquired.

2. Adjust the lens aperture, intensity scaling, and focus for the best image as viewed on the computer monitor. Some imaging tips follow:

   - Begin with the lens blocked off and then set the lens at the smallest possible aperture (largest f-stop number).
   - Make sure there is a suitable target in front of the lens. An object with text or graphics works best.
   - Adjust the intensity scaling (by clicking the 5%-95% button at the bottom left corner of the data window) and adjust the lens aperture until a suitable setting is found. Once it has been determined that the image is present, select a lower setting for better contrast. Check the brightest regions of the image to determine if the A/D converter is at full-scale. A 16-bit A/D is at full scale when the brightest parts of the image reach an intensity of 65535. Adjust the aperture to where it is just slightly smaller (higher f-stop) than the setting where maximum brightness on any part of the image occurs.
   - Set the focus adjustment of the lens for maximum sharpness in the viewed image.

3. After you have focused the camera, you can stop Focus mode, continue Focus mode, begin Acquire mode, or wait for the CCD to reach the operating temperature before going to Acquire mode. Refer to Section 7.1.3, Shut Down Procedure, for the proper shut down procedure.

7.1.3   Shut Down Procedure

Perform the following procedure to safely shut down a WinView/32 experiment:

1. Close WinView/32.
2. Turn off the camera power.

7.2   Spectroscopy Applications

This section provides step-by-step instructions for operating a NIRvana in a WinSpec/32 spectroscopy setup for the first time. The intent of this simple procedure is to help gain basic familiarity with the operation of the system and to show that it is functioning properly. Once basic familiarity has been established, operation with other operating configurations, ones with more complex timing modes, can be performed. An underlying assumption for the procedure is that the camera is to be operated with a spectrograph (e.g., a Teledyne Acton Research SpectraPro Series 2300 spectrograph,) on which it has been properly installed.

> **REFERENCES:**
>
> Refer to Appendix C, Spectrograph Adapters, for information about mounting a spectrograph adapter to a NIRvana.

A suitable light source, such as a mercury pen-ray lamp, should be mounted in front of the entrance slit of the spectrograph. Any light source with line output can be used. Standard fluorescent overhead lamps have good calibration lines as well. If there are no "line" sources available, it is possible to use a broadband source for the alignment. If this is the case, use a wavelength setting of 0.0 nm for alignment purposes.

> **CAUTION!**
>
> Overexposure Protection: Cameras that are exposed to room light or other continuous light sources will quickly become saturated. If the camera is mounted to a spectrograph, close the entrance slit of the spectrograph to reduce the incident light.

This procedure assumes:

- The system has been set up in accordance with the instructions in previous chapters.

  This includes mounting the spectrograph adapter to the camera as described in Appendix C, Spectrograph Adapters.
- Previous sections of this chapter have been read.
- Familiarity with the application software.
- The system is being operated in spectroscopy mode.

7.2.1   Configure WinSpec/32

Perform the following procedure to configure WinSpec/32 for the first time:

> **NOTE:**
>
> This procedure is based on WinSpec/32. If a different application is being used, then some modifications to the procedure may be required. Basic familiarity with the WinSpec/32 software is assumed. If this is not the case, review the software manual or have it available while performing this procedure.

1. Set the spectrograph entrance slit width to minimum (10 μm if possible).
2. Mount the camera to the spectrograph exit port.

3. Mount a light source such as a Teledyne Princeton Instruments IntelliCal Hg/Ne-Ar Dual Switchable light source in front of the entrance slit.

4. Connect the shutter cable between the entrance slit shutter and the NIRvana's Shutter connector.

   a. External Slit Shutter: A shutter assembly mounted externally to the spectrograph has shutter cable that plugs into the Shutter connector.

   b. Internal Slit Shutter: A shutter mounted internally has an external shutter connector in the sidewall of the spectrograph. Connect a shutter cable from the NIRvana's Shutter connector to that connector.

5. Power ON the camera (the power switch is on the back of the power supply).

6. Turn on the computer power.

7. Launch the application software.

8. Configure the software parameters as follows:

   - Controller/Camera tab (Setup ► Hardware): These parameters should be set automatically to the proper values for your system.
     — Controller type: This information is read from the camera.
     — Camera type: This information is read from the camera.
     — Shutter type: Custom (System dependent).

Figure 7-4:   Typical Hardware Setup Dialog: Controller/Camera Tab
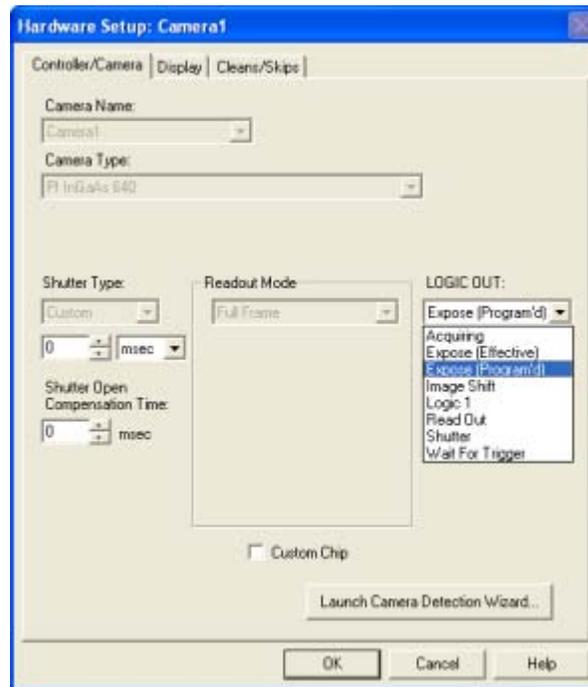

- Detector Temperature (Setup ► Detector Temperature...)

  The default temperature setting is read from the camera. When the array temperature reaches the set temperature, the Detector Temperature dialog will report that the temperature is LOCKED. Figure 7-5 illustrates the default temperature for the NIRvana:640. Note that some overshoot may occur. This could cause temperature lock to be briefly lost and then quickly re-established. If you are reading the actual temperature reported by the application software, there may be a small difference between the set and reported temperature when lock is established. This is normal and does not indicate a system malfunction. Once lock is established, the temperature will be stable to within ±0.05°C.

Figure 7-5: Typical Detector Temperature Dialog

4411-0137_0014

🔍📄 **NOTE:** ───────────────────────────

The Detector Temperature dialog will not display temperature information during data acquisition.

────────────────────────────────

- Experiment Setup ► Main tab (Acquisition ► Experiment Setup...):
  — Exposure Time: 50 ms
  — Accumulations & Number of Images: 1
- Experiment Setup ► ROI tab (Acquisition ► Experiment Setup...): Use this function to define the region of interest (ROI).
  — Spectroscopy Mode: Selected
  — Selecting Full loads the full size of the chip into the edit boxes.
- Experiment Setup ► Timing tab (Acquisition ► Experiment Setup...): see Figure 7-6.
  — Timing Mode: Free Run
  — Shutter Control: Normal
  — Safe Mode or Fast Mode: Fast Mode

Figure 7-6: Typical Experiment Setup ► Timing Tab

SELECT FAST MODE
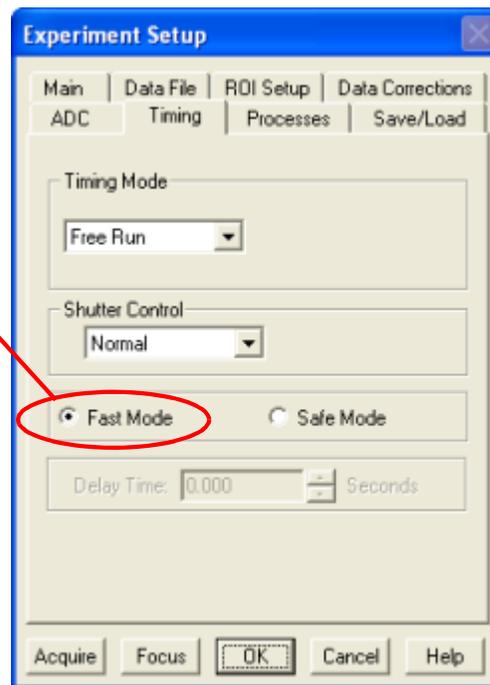
4411-0137_0015

7.2.2   Verify the Setup

Perform the following procedure to verify the configuration and setup:

1. Turn on the light source at the spectrograph entrance slit.

2. In WinSpec, select Focus (on the Acquisition menu or on the Experiment Setup dialog) to begin data accumulation. Depending on the display settings, you should see either a spectral band (image) or a graph. Background noise will decrease as the camera cools to its default temperature.

3. Turn off the light source. The data displayed should change to a background noise pattern or low intensity graph.

    If this occurs, you have confirmed that light entering the spectrograph is being seen by the camera. Skip step 4 and step 5, and proceed to Section 7.2.3, Rotational Alignment and Focus, on page 65.

4. If there is no difference between the data displayed when the light source is on or off:

    a. Verify that the light source has power and is turned on.

    b. Verify that the entrance slit is open at least 10 μm.

    c. Check the Exposure Time (Experiment Setup Timing tab).

    d. Confirm that Shutter Control is set to Normal (Experiment Setup Timing tab).

    e. Check the shutter cable connections.

    f. Verify shutter operation. You should hear the shutter open and close while running in Focus mode.

        If you hear a shutter operating and have performed step a through step e, turn the light source on, wait a minute and then turn the light off while you view the data display.

        •   If the problem is fixed, stop acquisition or proceed to Section 7.2.3, Rotational Alignment and Focus, on page 65.

        •   If you do not hear a shutter operating and have performed step a through step e, stop data acquisition and proceed to step g.

    g. Verify that the spectrograph has an entrance slit shutter. An externally mounted shutter is easily confirmed. Verifying an internally mounted shutter requires access to the inside of the spectrograph. Refer to the spectrograph manual for information.

5. If additional assistance is required, contact Customer Support. Refer to Contact Information on page 124 for complete contact information.

7.2.3   Rotational Alignment and Focus

The camera mounting hardware provides two degrees of freedom:

- Rotation;

  Rotation relates to the physical rotation of the camera while watching a live display on the monitor so that spectral lines will be perpendicular to the rows on the array.

- Focus.

  In this context, focus means to physically move the camera back and forth through the focal plane of the spectrograph while watching a live display until the optimal focus is achieved.

> **NOTE:**
>
> When aligning accessories such as fibers, lenses, and optical fiber adapters, first align the spectrograph to the slit. Then align the accessory without disturbing the camera's position.

The following sections provide information and procedures necessary to rotationally align and focus a NIRvana system using WinSpec/32.

7.2.3.1   Rotational Alignment

> **NOTES:**
>
> 1. Although this procedure describes rotational alignment for a Teledyne Acton Research SP-2356i spectrograph, it is easily adapted to other spectrographs.
> 2. This procedure assumes that the camera and spectrograph have already been turned on, WinSpec has been launched, and the camera and spectrograph has been identified. Additionally, it is assumed that the setup has been verified as described in Section 7.2.2, Verify the Setup, on page 64.
> 3. After the optics have been initially aligned, it is recommended that the rotational alignment procedure be repeated to fine tune the alignment.

Perform the following procedure to rotationally align the system:

1. If you have not already done so, mount a light source such as a Teledyne Princeton Instruments IntelliCal light source at the spectrograph's entrance slit. Any light source with a line output can be used. Standard fluorescent overhead lamps have good calibration lines as well. If there are no "line" sources available, it is possible to use a broadband source for the alignment. If this is the case, use a wavelength setting of 0.0 nm for alignment purposes.

2. Select the grating to move and set it to 0.0 nm when using a broadband source.

> **NOTE:**
>
> Overhead fluorescent lights produce a mercury spectrum. Use a white card tilted at 45 degrees in front of the entrance slit to reflect overhead light into the spectrograph. Select 435.833 as the spectral line.

3. Verify that the slit is set to a minimum of 10 μm. If necessary, adjust the Exposure Time to maintain optimum (i.e., near full-scale) signal intensity.

4. Wait until the camera temperature locks at its default temperature.

5. Verify that the spectroscopy-mount adapter moves freely at the spectrograph.

> **NOTE:**
>
> It may be necessary to loosen the two set screws that lock the sliding tube in place.

6. Within WinSpec/32, select Focus (on the Acquisition menu or on the Experiment Setup dialog) to begin data accumulation.

   Data will be continuously acquired and displayed but will not be stored until you stop acquisition and use the Save function on the File menu.

7. Adjust the rotational alignment using one of the following methods:

   - Rotate the camera while watching a live display of the line. Choose a peak to monitor during the rotational alignment. This peak will go from broad to narrow and back to broad. Leave the camera rotation set for the narrowest achievable peak.

   - Take an image, display the horizontal and vertical cursor bars, compare the vertical bar to the line shape on the screen, and rotate the camera until the line shape on the screen is parallel with the vertical bar.

   - Set up three ROIs (one at the top, one in the middle, and one at the bottom of the array) with 10 rows binned for each via the Experiment Setup ► ROIs tab.

     Next, change the data display via the Display Layout dialog, as follows:

     — 3d Graph is selected (General tab,)

     — The Z Axis Endpoints (3D Layout tab) are %X = 0 and % Y = 40,

     — The Save as Default check box is checked.

     After clicking on OK, you should see three stacked graphs. Align the large cursor with a prominent peak and rotate the detector until the peak aligns with the cursor within all three ROIs.

7.2.3.2　Focus

Perform the following procedure to focus the system:

> **NOTE:**
>
> Although this procedure describes rotational alignment for a Teledyne Acton Research SP-2356i spectrograph, it is easily adapted to other spectrographs.
>
> This procedure assumes that the camera and spectrograph have already been turned on, WinSpec has been launched, and the camera and spectrograph has been identified.
>
> Additionally, it is assumed that the setup has been verified as described in Section 7.2.2, Verify the Setup, on page 64, and the system has been rotationally aligned as described in Section 7.2.3.1, Rotational Alignment, on page 65.

Perform the following procedure to focus the system:

1. Slowly move the camera in and out of focus. The spectral peak(s) should go from broad to narrow and back to broad. Maximize the intensity level and minimize the FWHM of the selected peak(s).

   > **NOTE:**
   >
   > The Focus Helper function (Process ► Focus Helper...) may be used to determine the narrowest line width since it can automatically locate peaks and generate a report on peak characteristics during live data acquisition. Refer to the WinSpec/32 online help for more information.

   Focusing is accomplished depending on the spectrograph being used as follows:

   - Long focal-length spectrographs (e.g., a Teledyne Acton Research SP-2300)
     The mounting adapter includes a tube that slides inside another tube to move the camera in or out as required to achieve optimum focus.
   - Short focal-length spectrographs
     There is generally a focusing mechanism on the spectrograph itself which, when adjusted, will move the optics as required to achieve proper focus.
   - No focusing adjustment
     If there is no focusing adjustment provided by either the spectrograph or by the mounting hardware the only option is to adjust the spectrograph's focusing mirror.

2. Tighten the two spectrograph set screws to secure the spectrograph sliding tube.
3. Halt data acquisition.

7.2.4   Acquire Data

After the NIRvana has been properly aligned and focused, perform the following procedure to acquire data:

1. If running in Focus mode, halt data acquisition.
2. Make any required changes to the experiment setup and/or software parameters.
   Changes might include adjusting exposure time, setting up an entrance slit shutter, or lowering the temperature.
3. Begin running Acquire mode. Data will be acquired and displayed/stored based on the experiment's settings.
4. Once data collection has been completed, the camera may remain powered on so the array temperature will remain locked or the system may be shut down. Refer to Section 7.2.5, Shut Down Procedure, for the proper shut down procedure.

7.2.5   Shut Down Procedure

Perform the following procedure to safely shut down a WinSpec/32 experiment:

1. Close WinSpec/32.
2. Turn off the light source and the spectrograph.
3. Turn off the camera power.

Chapter 8:   Exposure and Signal

This chapter discusses factors that affect exposure, readout, and digitization of incoming signals. By understanding the exposure, readout, and digitization factors, and making adjustments to software settings, the signal-to-noise ratio can be maximized.

8.1   Sensor Architecture

A focal plane array (FPA) such as the one in NIRvana is a matrix of photodiodes bonded to a readout circuit on an IC chip. The photodiodes are sensitive to NIR wavelengths in which they absorb NIR radiation, convert it into electrons, and send a voltage signal in response to form an image. NIR imaging FPA photodiodes are composed of materials sensitive to NIR radiation.

Each cell on an FPA is connected to its own charge storage "well." These cells respond to the intensity of light or NIR radiation falling on their collection areas and store a proportional amount of charge in their associated "wells." Once charge accumulates for the specified exposure time (set in the software,) the charge in each well is read out serially through four video output ports.

8.2   Exposure Time

Exposure time, which is set on the Common Acquisition Settings expander, is the time between commands sent by the application software to start and stop signal accumulation on the sensor. In combination with triggers, these commands control when continuous cleaning of the sensor stops and when the accumulated signal will be read out. Cleaning prevents buildup of dark current and unwanted signal before the start of the exposure time. At the end of the exposure time, the sensor is readout and cleaning starts again.

8.3   Noise Sources

Primary noise sources include:

- Dark Signal

  NIR signal from the environment and leakage current.
- Input Signal

  Photon shot noise.
- Readout

  Noise generated when the multiplexers are read out.

An ideal detector contains no noise sources and is limited only by the photon shot noise. Unfortunately, there are always noise sources that will contribute noise of one kind or another to the total signal. The methods used to reduce the noise depend on the noise component being addressed. Infrared noise from the detector and the environment can be reduced by lowering the temperature of the detector and environment, respectively.

8.4 Built-In Gain Correction

The NIRvana camera is factory calibrated at -80°C for all speeds and gains to do a column-by-column gain correction. This, coupled with background subtraction, helps remove the vertical fixed pattern in the image due to column amplifier differences. If improved pixel-by-pixel correction is desired, refer to Section 8.7, Flat Field Correction, on page 71.

8.5 Sensor Temperature

As mentioned previously, lowering the temperature of the sensor generally enhances the quality of an acquired signal by lowering dark noise.

- When WinX is used, temperature control is achieved via the Detector Temperature dialog which is accessed from the Setup menu. See Figure 8-1.
- When LightField is used, temperature control is achieved on the Sensor expander. Initially, the default temperature appropriate for the specific model is used.

Figure 8-1: Typical Detector Temperature Dialog
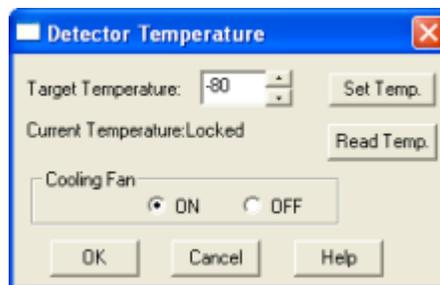
Once the temperature set point has been set, the software controls the camera's cooling circuits to reach set sensor temperature. Upon reaching that temperature, the control loop locks to that temperature for stable and reproducible performance. When temperature lock has been reached (i.e., the temperature is within 0.05°C of the set value,) the current temperature is Locked. The on-screen indication allows easy verification of temperature lock.

The time required to achieve lock can vary over a considerable range depending on such factors as the camera type, sensor type, ambient temperature, etc. Once lock occurs, it is okay to begin focusing. However, you should wait an additional twenty minutes before taking quantitative data so that the system has time to achieve optimum thermal stability.

When vibration may affect results, you can turn off the fan operation while making sure that the coolant is circulating through the camera to maintain the sensor cooling temperature. If the fan is turned off and there is no coolant circulating through the camera, the built-in thermo-protection switch may shut the camera down to prevent thermal damage. In the event that this occurs, wait approximately ten minutes, correct the situation that caused the shutdown, and re-power the camera.

The deepest operating temperature for a system depends on the sensor size and packaging. Refer to Table A-1 on page 93 for default cooling temperatures.

8.6 Background Subtraction

Background subtraction can be used to remove or reduce the impact of fixed pattern noise when acquiring data. The technique requires that a background image be acquired, stored, and selected as the background file to be used in background-subtracted data acquisition.

Since the NIRvana sensor has a strong fixed pattern in the image due to the differences in each pixel and in column amplifiers, background subtraction is particularly important. To greatly reduce the fixed pattern, take a 1 μs exposure and save it as a background file. You can then select that file to be used for background subtraction when running the actual experiment. The images illustrated in Figure 8-2 show the effect removing a persistent background can have on collected data.

Figure 8-2: Typical Background Subtraction Effects

| **Background** | **Raw Data** | **Background-Subtracted Data** |
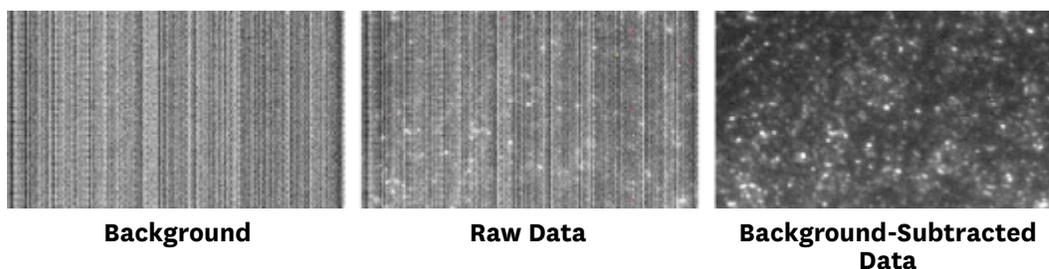
4411-0137_0025

8.7 Flat Field Correction

Non-uniformity of illumination sources and/or the non-uniformity of the InGaAs detector can be compensated for by applying Flat Field correction. This procedure is performed by first setting up the experiment parameters, waiting until the detector has reached operating temperature to ensure stability, and taking a Flat Field reference image of the illumination source (without the sample.) After the flat field has been acquired, select automatic Flat Field correction and specify the data file to be used. Then, set up the experiment with the sample in place and acquire data. The Flat Field data will automatically be applied to the raw data and the resulting data will be displayed and/or stored.

8.8   Dark Charge

Dark charge (also known as dark current) is the thermally induced buildup of charge in the sensor over time. The statistical noise associated with this charge is known as dark noise. Dark charge values vary widely from one sensor to another and are temperature dependent.

With the light into the camera completely blocked, the sensor pixels accumulate thermally generated electrons, dependent on the exposure time and camera temperature. The longer the exposure time and the warmer the camera, the less uniform this background will appear. Thus, to minimize dark-charge effects, the camera should be operated at its default sensor temperature.

> **NOTE:**
>
> Do not be concerned about the DC level of this background. This is not noise. It is a fully subtractable bias pattern. Simply acquire and save a dark charge "background image" under conditions identical to those used to acquire the "actual" image. Subtracting the background image from the actual image will significantly reduce dark-charge effects.

> ⚠ **CAUTION!**
>
> If a sudden change is observed in the baseline signal, there may be excessive humidity in the camera vacuum enclosure. Turn off the camera and contact Teledyne Princeton Instruments Customer Support. Refer to Contact Information on page 124 for complete contact information.

8.9   Saturation

When signal levels in a region of the image are very high, charge generated in one pixel may exceed the "well capacity" of the pixel, spilling over into adjacent pixels in a process called "blooming." In this case, a shorter exposure time is advisable, with signal averaging to enhance Signal-to-Noise (S/N) Ratio accomplished through the software.

For signal levels low enough to be read-noise limited, longer exposure times, and therefore longer signal integration on the sensor, will improve the S/N Ratio approximately linearly with the length of exposure time. There is, however, a maximum time limit for on-chip accumulation which is determined by either the saturation of the sensor by the signal or the loss of dynamic range due to the buildup of dark signal.

8.10   Cleaning

The basic cleaning function is implemented by clean cycles. These cycles start when the camera is turned on and a clean pattern is programmed into the camera. Their purpose is to remove charge that accumulates on the sensor while the camera not acquiring data (i.e., exposing and reading out the sensor.) Figure 8-3 illustrates the timing diagram for an experiment set up to acquire four (4) images in No Response timing mode. In this diagram clean cycles occur before the first exposure and after the last readout period.

Figure 8-3:   Typical Clean Cycle Timing Diagram

4411-0137_0026
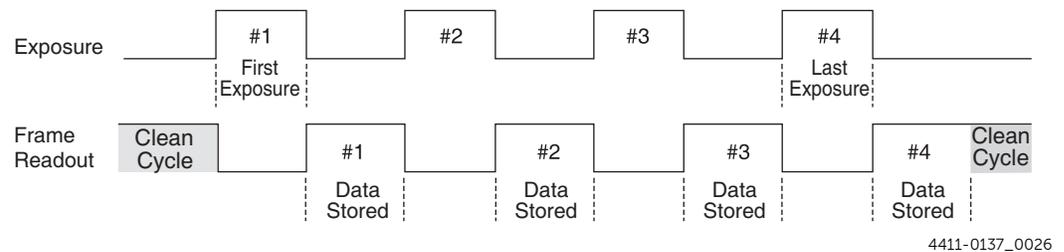
📖 **NOTE:** ─────────────────────────────────

The start of an exposure is signaled by `SCAN` going high but will not occur until the current clean cycle has been completed.

───

The configuration of clean cycles is performed on the Hardware Setup ► Cleans/Skips tab {via the Sensor Cleaning pane accessed on the Sensor expander.} When the camera configured for the first time, default values are automatically provided for the appropriate parameters. Although the default values provide the best performance for most applications, it is important to understand the effect each the following parameters has on cleaning operations:

- Number of Cleans {Number of Clean Cycles}

  This parameter is typically set to 1. These are additional clean cycles that may be required after a start exposure signal is received and the current clean cycle has finished. The maximum value for this parameter is camera-dependent.

- Number of Strips per Clean {Clean Cycle Height}

  Configures the number of rows that will be shifted and discarded per clean cycle. While a large number such as the number of rows in the sensor may result in the best cleaning of the sensor, the trade-off is that there may be a significant delay between the receipt of a start exposure signal and the beginning of the actual exposure. This delay occurs because the current clean cycle must be completed before a start exposure signal received during the cycle will be implemented. Typically, the default setting is much smaller, and in time critical experiments, this value should be 1 or 2.

- Continuous Cleans {Clean Until Trigger}

  This parameter is available only when the start of exposure is tied to an external trigger. Cleaning becomes active when Trigger Response is set to Readout Per Trigger or Shift Per Trigger. Figure 9-6 on page 81 illustrates a timing diagram that shows Clean Until Trigger operation.

8.11   Readout

Three factors to be considered with regard to sensor readout are:

- Region of Interest (ROI) Selection;

    Defining a Region of Interests allows a user-specified region on the sensor to be read out and the collected data saved. The remaining data is read out and discarded.

- Analog Gain Control (AGC);

    Analog Gain Control determines how many photons are required to generate an analog-to-digital unit. The gain selection should be based on the signal intensity.

- Software Binning.

    Software Binning occurs after a signal has been read out of the sensor and combines signals in adjacent pixels to create "super pixels."

8.11.1   Region of Interest (ROI)

NIRvana supports ROI (area) selection. However, there may not be any noticeable improvement in frame rate. While there will be no increase in readout speed, there will be a reduction in the size of the data set. When defining an ROI, make sure that the origin of the ROI is at a horizontal boundary of 4 pixels and that the ROI contains a multiple of 4 pixels in the horizontal. There are no restrictions on the vertical dimensions of an ROI.

The NIRvana sensor does not support vertical skips. All rows on the sensor are read out and converted before the non-ROI information is discarded. The default Vertical Skips settings of Minimum Block Size: 2 and Number of Blocks: 5, while appearing to work, will result in invalid data. Instead, these values must be change to 1 and 512, respectively, for the NIRvana sensor.

8.11.2   Controller Gain {Analog Gain}

Analog Gain Control is used to change the number of electrons required to generate an Analog-to-Digital Unit (ADU,) also known as a count.

- In WinX, the Controller Gain choices for NIRvana detectors are 1 and 2.
- In LightField, the Analog Gain choices are Low and High.

Users who measure high-level signals may wish to select 1 {Low} to allow the digitization of larger signals. Users who consistently measure low-level signals may wish to select 2 {High}, which requires fewer electrons to generate an ADU and reduces some sources of noise. This is a particularly important consideration in absorbance measurements.

Example

The following descriptions assume that the actual incoming light level is identical in both instances. The numbers used do not reflect the actual values for NIRvana and do not reflect actual detector performance.

- 1 {Low} requires 1750 electrons to generate one ADU.

  Strong signals can be acquired without flooding the sensor. If the gain is set to Low and the spectra or images appear weak, the gain setting should be changed to 2 {High}.

- 2 {High} requires 65 electrons to generate one ADU. Some noise sources are reduced.

  Because fewer electrons are needed to generate an ADU, weaker signals can be more readily detected. Lower noise further enhances the ability to acquire weak signals. If the sensor appears to be flooded with light, change the setting to 1{Low}.

This technique is also useful in high light level experiments where the detector is again photon shot-noise limited. Summing multiple pixels in software corresponds to collecting more photons, and results in a better S/N Ratio for the measurement.

NOTE:

In the WinX application software, gain selection is made on the Experiment Setup ► ADC tab.

In LightField, the choice is made on the Analog to Digital Conversion tab expander.

8.11.3   Software Binning

Software binning allows software averaging which can improve the S/N Ratio by as much as the square-root of the number of scans. Unfortunately, with a high number of scans, (i.e., greater than 100,) camera 1/f noise may reduce the actual S/N Ratio to slightly below this theoretical value. Also, if the light source used is photon-flicker limited rather than photon shot-noise limited, this theoretical signal improvement cannot be fully realized. Again, background subtraction from the raw data is necessary.

This technique is also useful in high light level experiments where the camera is again photon shot-noise limited. Summing multiple pixels in software corresponds to collecting more photons, and results in a better S/N Ratio for the measurement.

NOTE:

In WinX, software binning is set up via the Experiment Setup ► ROI Setup tab.

In LightField, it is configured via the Region of Interest expander and/or its related Edit Regions of Interest window.

8.12   Digitization

After gain has been applied to the signal, the Analog-to-Digital Converter (ADC) converts the analog information (continuous amplitudes) into digital data (quantified, discrete steps) that can be read, displayed, and stored by the application software. The number of bits per pixel is based on both the hardware and the settings programmed into the detector through the software. Refer to Section 8.11, Readout, on page 74 for additional information.

Factors associated with digitization include the digitization rate and baseline signal. Depending on the detector model, you may be able change the speed at which digitization occurs and/or offset the baseline. These factors are discussed in the following sections.

8.12.1 Digitization Rate {Speed}

After readout, an analog signal representing the charge of each pixel is digitized. The number of bits per pixel is based on both the hardware and the settings programmed into the detector through software. Dual digitizers (2 MHz/5 MHz) are standard for NIRvana imaging sensors.

The use of dual digitizers provides a choice of how quickly data will be digitized. Because readout noise of sensors increases with the readout rate, it is sometimes necessary to trade off readout speed for high dynamic range. The 5 MHz conversion speed is used for the fastest possible data collection while the 2 MHz conversion speed is used where noise performance is the paramount concern. Switching between conversion speeds is under software control for total experiment automation.

NOTE:

In WinX, the ADC rate is modified on the Experiment Setup ► ADC tab.

In LightField, the speed is changed on the Analog-Digital Conversion expander.

8.12.2 ADC Offset (Baseline Offset)

ADC offset (also known as baseline offset) provides another way of dealing with dark charge. Refer to Section 8.8, Dark Charge, on page 72 for additional information. By offsetting the baseline signal, much of the background is ignored during conversion.

During the exposure time, the sensor collects a charge pattern and an NIR signal in addition to the signal of interest. The longer the exposure time and the warmer the detector and the environment, the larger and less uniform this background will appear.

CAUTION!

If a sudden change in the baseline signal is observed, there may be excessive humidity in the detector vacuum enclosure. Turn off the camera and contact Teledyne Princeton Instruments Customer Support for instructions.

8.12.3 Readout Time

In WinX, the calculated readout time is reported on the Readout Time box (via the Acquisition menu.) In LightField, readout time is reported on the Sensor Readout expander and is calculated based on the current Analog-to-Digital rate setting. Since the entire sensor is read out before non-ROI information is discarded, ROIs have no effect on readout time.

Chapter 9:   Advanced Topics

Previous chapters discussed the configuration of hardware and software for basic operation. This chapter discusses the following topics associated with experiment synchronization:

- Shutter Control Modes;
- Timing {Trigger Response} Modes;
- LOGIC OUT Control.

Depending on the data acquisition software being used, experiment synchronization parameters are located as follows:

- When using WinX, parameters are found on the Experiment Setup ► Timing tab.
- When using LightField, parameters are found on the Shutter and Trigger expanders.

9.1   Shutter Control Modes

Shutter control mode is configured on the Experiment Setup ► Timing tab {Shutter expander}. Available modes for Full Frame operation are:

- Normal;
- Disabled Opened {Always Open};

    When selected, the shutter will not operate during the experiment and remains in the open position.
- Disabled Closed {Always Closed};

    When selected, the shutter will not operate during the experiment and remains in the closed position. This option is useful when making dark charge measurements.
- Pre Open {Open Before Trigger}.

    When selected, the shutter opens as soon as NIRvana is ready to receive an External Sync pulse. This is required if the time between the External Sync pulse and the event is less than a few milliseconds, the time it takes the shutter to open.

    This option is available with the following Timing {Trigger Response} Modes:

    — External Sync {Readout Per Trigger}
    — External Sync {Readout Per Trigger} with Continuous Cleans {Clean Until Trigger}.

    REFERENCES:

    Refer to Section 9.2, Timing {Trigger Response} Modes, on page 78 for additional information.

    NOTE:

    Shutter timing is included in the appropriate timing diagrams supplied in Section 9.2, Timing {Trigger Response} Modes.

9.2   Timing {Trigger Response} Modes

NIRvana's Timing {Trigger Response} modes for Full Frame operation are:

- Free Run {No Response};
- External Sync {Readout Per Trigger};
- Bulb Trigger {Expose During Trigger Pulse};
- Trigger Start {Start On Single Trigger}.

Timing mode, when combined with the Shutter Mode options, provide the widest variety of modes for precision experiment synchronization.

9.2.1   EXT SYNC Trigger Input

The selected Trigger Response determines how the camera will respond to an External Sync pulse supplied to the camera by the EXT SYNC connector on the rear of the camera. See Figure 9-1.

Figure 9-1:   NIRvana Camera: Rear Panel

Things to keep in mind when setting up the External Sync pulse input include:

- Pulse Height: 0 to +3.3 VDC logic levels (TTL-compatible.)
- Pulse Width (trigger edge frequency): The time between trigger edges.
- EXT SYNC Connector Impedance: High impedance.
- Trigger Polarity: Rising (+) or falling (-) must be indicated on the Trigger expander.

9.2.2 Free Run {No Response}

In this mode, the camera ignores any external triggers and all settings are obtained from the setup parameters, making the duration of each exposure time constant and the interval times between exposures constant.

NOTE:

In this timing mode, all shutter modes behave the same way.

See Figure 9-2 for the timing diagram for this mode.

Figure 9-2: Timing Diagram: Free Run {No Response} Mode
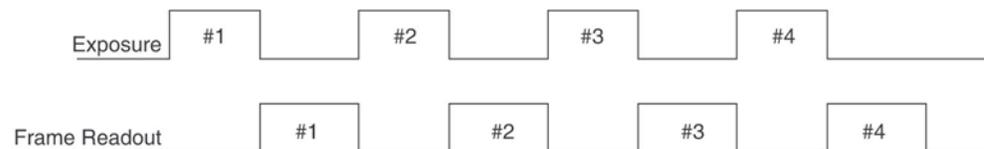
9.2.3 External Sync {Readout Per Trigger}

In this mode, each frame within a sequence requires a trigger. Each frame is exposed for the length of time specified within the software and is then read out. If a trigger arrives during the exposure-readout cycle for the previous frame, it is ignored.

NOTE:

For sequences comprised of a single frame, both Bulb Trigger {Expose During Trigger Pulse} and Trigger Start {Start on Single Trigger} modes are equivalent to External Sync {Readout Per Trigger} mode.

Figure 9-3 illustrates the timing diagram for this mode. Shaded areas ▮▮ indicate the idle time between exposures.

Figure 9-3: Timing Diagram: External Sync {Readout Per Trigger}
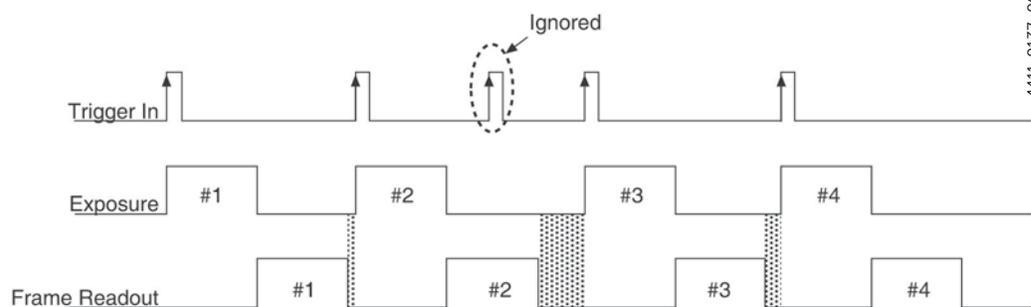
9.2.4   External Sync {Readout Per Trigger} with Continuous Cleans {Clean Until Trigger} Timing

Another timing mode supported by NIRvana is Continuous Cleans {Clean Until Trigger}. In addition to the standard cleaning of the sensor that occurs after the camera has been enabled, this mode removes any accumulated charge from the sensor up until the moment the External Sync pulse is received. Once the current cleaning cycle has been completed, data acquisition begins.

Figure 9-4 shows the timing diagram for this timing mode, while Figure 9-5 is a high-level flowchart of the overall process.

Figure 9-4:   Timing Diagram: External Sync with Continuous Cleans {Clean Until Trigger}
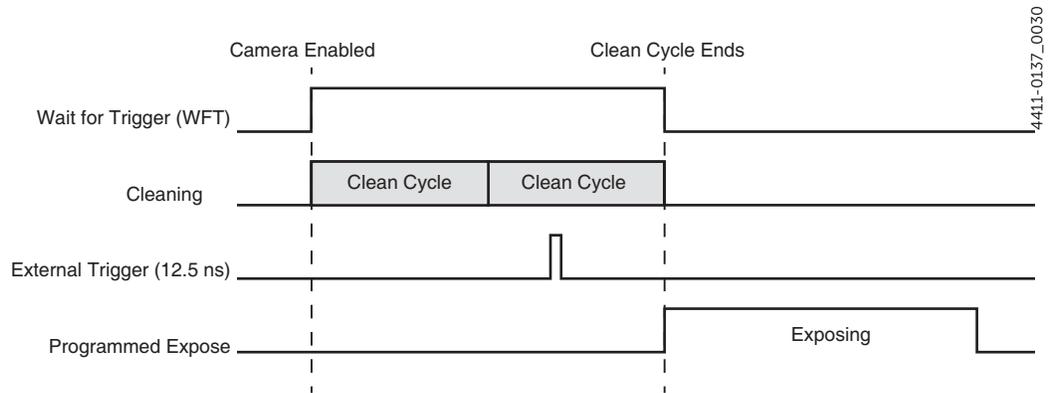
Figure 9-5:   Flowchart: Continuous Cleans {Clean Until Trigger}
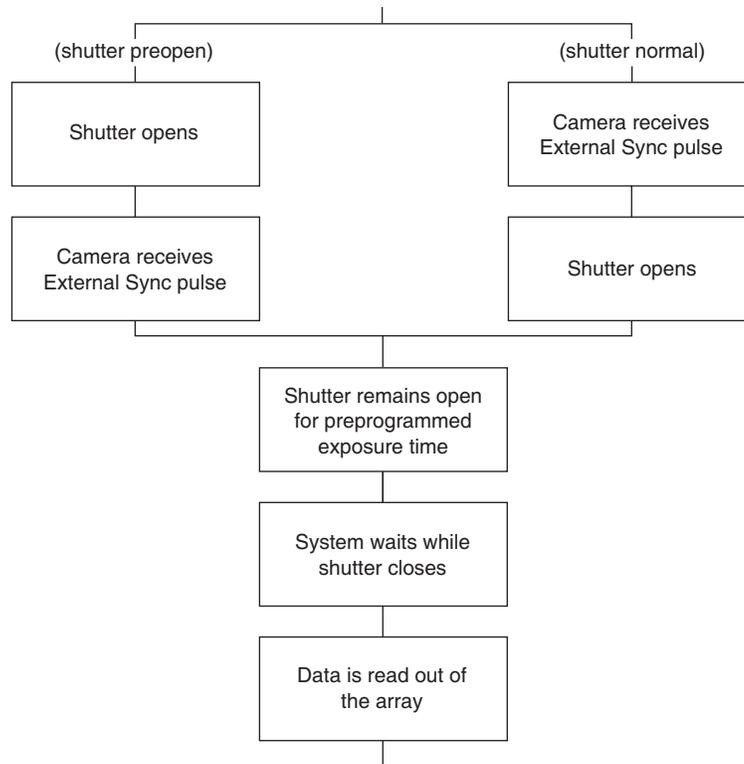
Once an External Sync {Readout Per Trigger} pulse has been received, cleaning of the sensor halts as soon as the current clean cycle has completed (a clean cycle reads out the entire sensor and then discards the data,) and frame data collection begins.

- When configured for Normal shutter operation, the shutter is opened for the specified exposure time.
- When configured for Pre Open {Open Before Trigger} shutter operation, the shutter is open throughout the Clean Until Trigger (CUT) operation, and once the External Sync pulse is received and the current clean cycle is completed, the shutter continues to remain open for the specified exposure time, and then closes.

Figure 9-6 illustrates the timing diagram for these two shutter configurations.

Figure 9-6:   Timing Diagram: Continuous Cleans {Clean Until Trigger (CUT)}
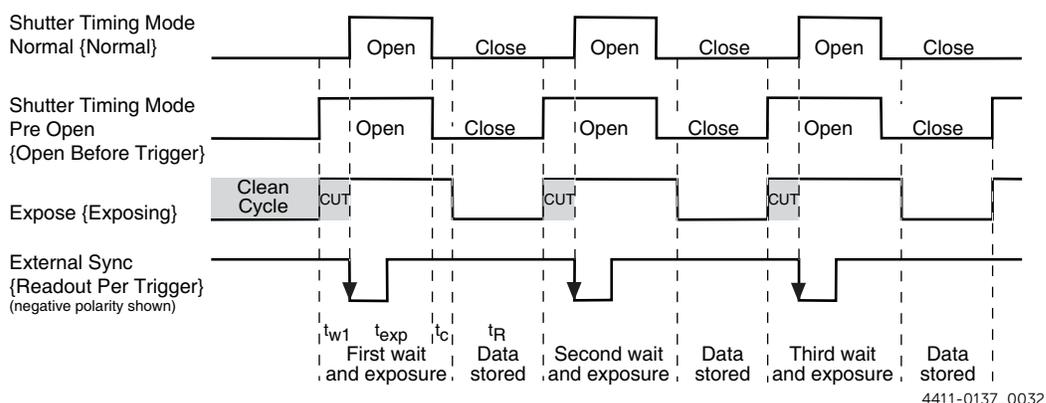
4411-0137_0032

9.2.5   Bulb Trigger {Expose During Trigger Pulse} Timing

When Bulb Trigger {Expose During Trigger Pulse} timing is selected, the camera exposure is determined by the EXT SYNC input on the camera (see Figure 9-1) which allows an external timing generator to control the exposure time for the camera.

In Full Frame mode, the transition from the inactive state to the active state of the input at the EXT SYNC connector starts the exposure, while the transition from the active state to the inactive state ends the exposure.

When the camera is ready to accept input through its EXT SYNC connector, the Waiting For Trigger (WFT) signal at the LOGIC OUT connector is high (if WFT is the selected output signal): WFT goes HIGH immediately after readout (or after preopen if it is active). It goes LOW when an active edge (+ or − edge depending on your setting) occurs and, if Continuous Cleans {Clean Until Trigger} is not enabled, the exposure begins. If continuous cleans is enabled, the camera will check for an active edge at the EXT SYNC connector before entering a continuous clean cycle. If none has occurred, a cycle will begin and complete. The EXT SYNC connector is checked again to see if an active edge has occurred and exposure will begin if it has.

> 🔍 **NOTE:**
>
> Continuous Clean is only performed on the first trigger in a sequence. Subsequent triggers will not initiate the Continuous Clean programmed pattern.

Figure 9-7 illustrates the timing diagram for Bulb Trigger {Expose During Trigger Pulse} mode with the following configuration settings:

- Three exposure sequence;
- No Pre Open {Open Before Trigger};
- No Continuous Cleans {Clean Until Trigger}.

Figure 9-7: Timing Diagram: Bulb Trigger {Expose During Trigger Pulse}
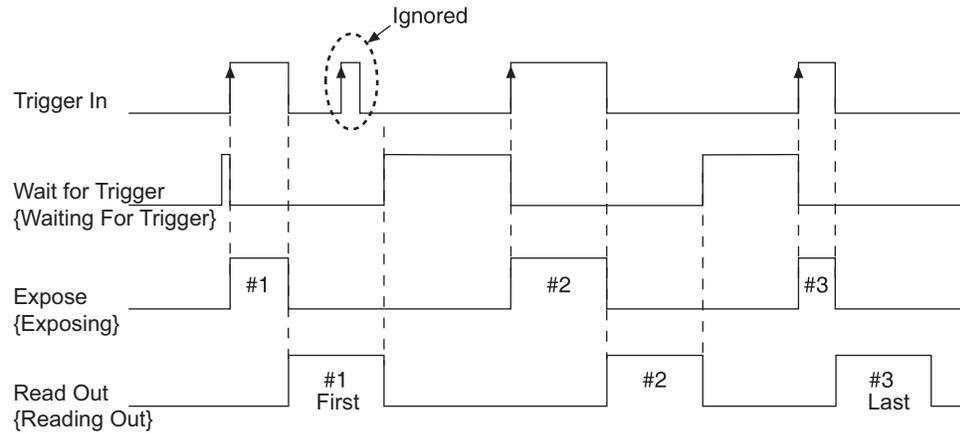
9.2.6   Trigger Start {Start On Single Trigger}

In this mode, the camera requires only one trigger to acquire a sequence of frames. Once the initial trigger has been received, the camera ignores any additional triggers until the entire exposure/readout sequence has been completed.

9.3   LOGIC OUT Control

This section provides information about the use of the Logic Out connector on the rear of the NIRvana. The signals at these connectors can be used to monitor camera operation or synchronize with external equipment.

The TTL-compatible logic level output (i.e., 0 to +3.3 V_{DC}) from the LOGIC OUT connector on the rear panel can be used to monitor camera status and control external devices. By default, the logic output level is high while the action is occurring.

The timing of the level changes depends on the output type selected on the Hardware Setup ► Controller/Camera tab {Trigger expander}.

The timing diagram shown in Figure 9-8 compares timing for the following three signals:

- Read Out {Reading Out}

  It is at a logic high when the sensor is being read; otherwise low.

- Shutter {Shutter Open}

  This level is at a logic high when the shutter is open. The output precisely brackets shutter-open time (exclusive of shutter open compensation, tc,) and can be used to control an external shutter or to inhibit a pulser or timing generator.

- Acquiring {Acquiring}

  After a start acquisition command, this output changes state on completion of the sensor cleaning cycles that precede the first exposure. Initially low, it goes high to mark the beginning of the first exposure. In free run operation it remains high until the system is halted. If a specific number of frames have been programmed, it remains high until all have been taken and then returns low. The timing diagram in Figure 9-8 assumes three frames have been programmed.

Figure 9-8:   Timing Diagram: LOGIC OUT Control
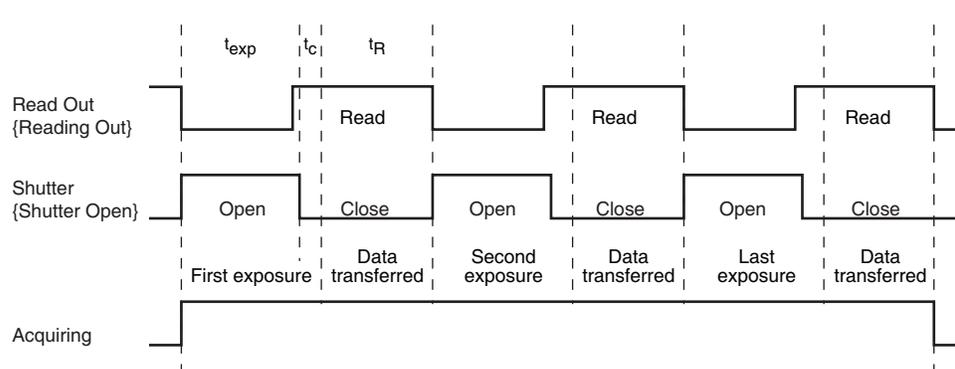
Additional related signals and configuration settings include:

- Expose (Effective) {Exposing}

  This level is at a logic high during the effective exposure time. This exposure time equals the read out time in frame transfer mode when the exposure time is less than the readout time. Otherwise, Expose (Effective) and Expose (Program'd) are identical.

- Expose Program'd {Exposing}

  This level is at a logic high during the programmed exposure time (i.e., the time configured in the software.)

- Logic 1 {Always High}

  The level at the connector is high.

- Wait for Trigger {Waiting For Trigger}

  This level is at a logic high when the camera is ready to acquire and is waiting for an external trigger (through the EXT SYNC connector) before exposing the sensor. The level goes low when a trigger is detected: exposure begins. The Wait for Trigger (WFT) signal goes high immediately after readout or after Open Before Trigger (if it is active). If continuous cleans is enabled, the camera will check for a trigger at the EXT SYNC connector before entering a continuous clean cycle. If none has occurred, a cleaning cycle is initiated and completed. Before the next cycle begins, the EXT SYNC connector is checked again, and exposure will start if a trigger has occurred.

NOTE:

When the Invert Logic {Invert Output Sign} check box is checked, the output is at a logic low when the action is occurring.

Chapter 10: Troubleshooting

⚠ **WARNING!** ─────────────────────────
Do not attach or remove any cables while the camera
system is powered on.
─────────────────────────────────────

Recommended troubleshooting guidelines are available for many issues that may occur
while working with a NIRvana system. Refer to Table 10-1 for additional information.

Table 10-1: Issues with Recommended Troubleshooting Guidelines

Issue	Refer to...
Acquisition Has Started but Data Display is Empty	page 86
Acquisition Started but Viewer Contents Do Not Update	page 87
Baseline Signal Suddenly Changes	page 87
Camera Stops Working	page 88
CoolCUBE$_{II}$: Low Coolant/Air in the Hoses	page 88
Temperature Lock Cannot be Achieved or Maintained	page 89
Gradual Deterioration of Cooling Capability	page 89
Device Is Not Found	page 90
Ethernet Network is Not Accessible	page 90
TEC Fault LED Comes On	page 92

10.1 Acquisition Has Started but Data Display is Empty

If you have started a data acquisition but no data are appearing in the data display, stop the acquisition. Look at the Data Display title bar and verify that the first number in the Region of Interest (ROI) is evenly divisible by 4. Figure 10-1 illustrates an ROI in which the number of horizontal pixels (i.e., the first number in the ROI dimensions, 30,) is not evenly divisible by 4.

Figure 10-1: Acquisition Display with Invalid ROI

4411-0137_0035
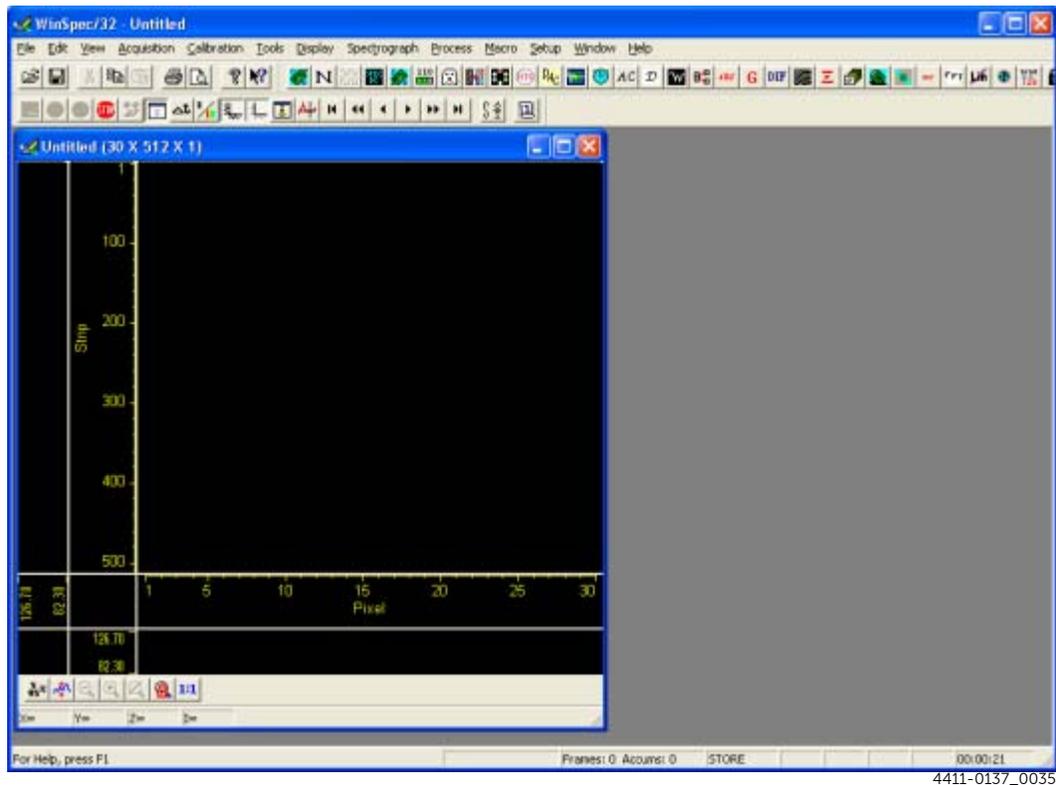
If the number of horizontal pixels is not divisible by 4, go to Experiment Setup. On the ROI Setup tab, change the Region of Interest (ROI) parameters for the experiment so that the resulting number of horizontal pixels or superpixels is divisible by 4. Then, re-run the acquisition.

10.2 Acquisition Started but Viewer Contents Do Not Update

In LightField, live data is normally displayed in the Experiment workspace viewer as it is being acquired (Preview or Acquire mode.) If the viewer is not being updated and acquisition is occurring, verify that there is a filename in the top row of the viewer. For example, in Figure 10-2 the filename `2010 May 11 13_13_49.raw` is displayed. If there is a filename, click on the camera icon. The file data will be cleared from the viewer and the live data will then be displayed.

Figure 10-2: Typical LightField Acquisition Display
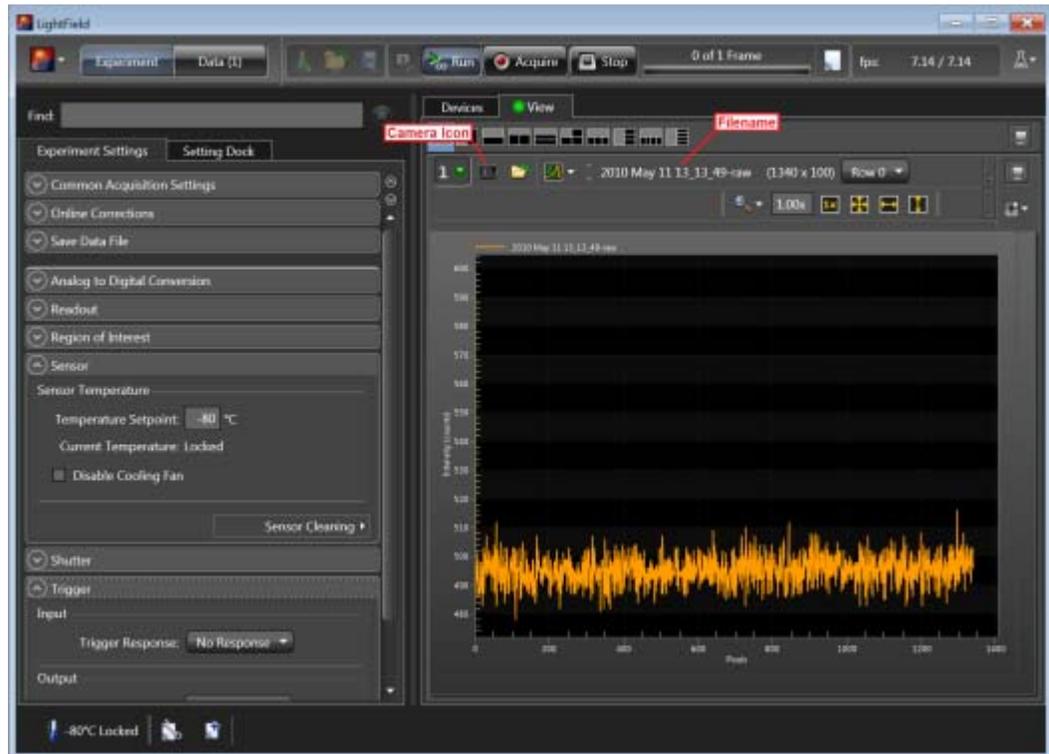
4411-0137_0036

10.3 Baseline Signal Suddenly Changes

A change in the baseline signal is normal if the temperature, gain, or speed setting has been changed. If this occurs when none of these settings have been changed, there may be excessive humidity in the camera vacuum enclosure. Turn the camera off and contact Teledyne Princeton Instruments Customer Support. Refer to Contact Information on page 124 for complete contact information.

10.4   Camera Stops Working

Problems with the host computer system or software may have side effects that appear to be hardware problems. If you are sure the problem is in the camera system hardware, begin with the following simple checks:

- Turn off all AC power.
- Verify that all cables are securely fastened.
- Turn the system on.

If the system still does not respond, contact Teledyne Princeton Instruments Customer Support.

10.5   CoolCUBE$_{II}$: Low Coolant/Air in the Hoses

⚠ WARNING!

If more than two inches (50.8 mm) of the coolant line is filled with air, the pump will stop working and may be damaged. If flow stops while the pump is on, turn off the CoolCUBE$_{II}$ and add coolant.

Perform the following procedure to troubleshoot a low coolant level for CoolCUBE$_{II}$ units:

1. Verify that the CoolCUBE$_{II}$ unit in question has been turned off, and its power cord removed from the AC wall receptacle.
2. Unscrew the reservoir cap on top of the CoolCUBE$_{II}$ and verify that the coolant reservoir contains coolant.

   If additional coolant is required, carefully add a 50:50 mixture of water and ethylene glycol until it is at the recommended level.
3. Screw the reservoir cap back in.
4. Verify the power switch is in the off position.
5. Plug the circulator into an appropriate 100-240 V$_{AC}$, 47-63 Hz power source.
6. Turn the circulator on.
7. Verify there are no leaks or air bubbles in the hoses.

📖 NOTE:

Small air bubbles that are approximately the size of bubbles in soda are common in the CoolCUBE$_{II}$, particularly at start up, and do not prevent proper operation.

- If there are no problems, proceed to step 8.
- If leaks or large air bubbles/pockets are observed, turn the circulator off and attempt correct the problem(s) by securing the hoses or adding more coolant to the reservoir. Turn the circulator back on.
  - If there are no problems, proceed to step 8.
  - If the problem persists, turn off the system, and contact Teledyne Princeton Instruments Customer Support. Refer to for complete contact information.
8. Turn the camera on.
9. Launch the application software.

10.6   Cooling Troubleshooting

This section provides recommended troubleshooting guidelines for cooling-related issues.

10.6.1   Temperature Lock Cannot be Achieved or Maintained

Possible causes for not being able to achieve or maintain lock include:

- Ambient temperature greater than +20°C. This condition affects TE-cooled cameras. If ambient is greater than +20°C, you will need to cool the camera environment or raise the set temperature.
- Airflow through the camera and/or circulator is obstructed. The camera needs to have approximately 2 inches (50 mm) clearance around the vented covers. If there is an enclosure involved, the enclosure needs to have unrestricted flow to an open environment. The camera vents its heat out the side vents near the nose. The air intake is at the rear of the camera.
- A hose may be kinked. Unkink the hose.
- Coolant level is low. Add coolant. Refer to Section 10.5, CoolCUBE$_{II}$: Low Coolant/Air in the Hoses, on page 88, for additional information.
- There may be air in the hoses. Add coolant. Refer to Section 10.5, CoolCUBE$_{II}$: Low Coolant/Air in the Hoses, on page 88, for additional information.
- The circulator pump may not be working. If you do not hear the pump running when the circulator is powered on, turn off the circulator and contact the manufacturer's Customer Support.
- The CoolCUBE$_{II}$ circulator is positioned higher than the camera.

  Reposition the circulator so that it is a minimum of 6 inches (15 cm) below, but no more than 10 feet (3 m) below, the camera. Typically, the camera is placed at table height and the circulator is on the floor.
- The target sensor temperature is not appropriate for the particular camera and sensor.
- The camera's internal temperature may be too high, such as might occur if the operating environment is particularly warm, if you are attempting to operate at a temperature colder than the specified limit, or if you have turned off the fan and are not circulating coolant through the camera. TE cameras are equipped with a thermal-protection switch that shuts the cooler circuits down if the internal temperature exceeds a preset limit. Typically, camera operation is restored automatically in about ten minutes. Although the thermo-protection switch will protect the camera, you are nevertheless advised to power down and correct the operating conditions that caused the thermal-overload to occur.

10.6.2   Gradual Deterioration of Cooling Capability

Although unlikely with the NIRvana camera[1], if a gradual deterioration of the cooling capability is observed, it might due to damaged camera vacuum. This can affect temperature performance such that it may be impossible to achieve temperature lock at the lowest temperatures. It is highly desirable to maintain the system's lowest temperature performance because lower temperatures result in lower thermal noise and better the signal-to-noise ratio. Contact the factory to make arrangements for returning the camera to the support facility.

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1. Teledyne Princeton Instruments guarantees a permanent vacuum for the life of a NIRvana camera.

10.7 Device Is Not Found

When LightField is launched, it looks for devices (e.g., cameras, spectrographs, and filters,) that are powered on and connected via a communications interface with the host computer. If it cannot find a device that had been used in the last experiment, it will continue to look for it.

Figure 10-3 illustrates a typical error dialog displayed when LightField is unable to locate a device (e.g., a spectrograph.)

Figure 10-3: Typical Load Experiment: Devices Missing Dialog

When trying to determine the cause for the hardware's not being found,

- Verify the device is connected and powered on.
  - If LightField cannot find a spectrograph that is connected and powered on, turn the spectrograph off and back on. LightField should now find it.
  - If LightField cannot find a GigE camera, you may need to open UDP ports 20200-20202. The ports may be closed as part of the local network's standard computer security (e.g., an anti-virus program or a firewall.) However, these ports must be open before LightField can detect a Teledyne Princeton Instruments GigE camera. Contact your local IT specialist for assistance if necessary.
- Cancel loading the experiment.

  Canceling a load means that the last used experiment will not be loaded automatically when LightField opens. However, you can load the experiment after all the devices are available, you can start a new experiment design, or you can load a different experiment that matches the devices you are using.

10.8 Ethernet Network is Not Accessible

When the Teledyne Princeton Instruments software is installed onto a host computer, all Intel Pro/1000 interface card drivers found are updated with the Intel Pro/1000 Grabber Adapter (Vision High-Performance IP Device) driver provided by Pleora Technologies, Inc. If the computer is connected to an Ethernet network via an Intel Pro/1000 card that does not use the Pleora driver, the network connection will be broken. The tool used to restore the network connection depends on whether WinX (32-bit) or LightField (64-bit) is being used.

10.8.1   WinX Applications

Perform the following procedure to restore an Ethernet network connection for WinX applications:

1. Navigate to the directory in which the EbDriverTool32.exe is stored.

   > **NOTE:** ───────────────────────────────
   >
   > The file may also be named EbDriverTool.exe.
   >
   > ───

   The file is typically stored on the host computer within the default Pleora directory (or one of the subdirectories):

   ```
   C:\Program Files\Common Files\Pleora
   ```

   If the file cannot be located on the host computer, it may be downloaded from the following location:

   ftp://ftp.princetoninstruments.com/public/Software/Official/WinX32/GigE/

2. Double click on the file to launch the application. Figure 10-4 illustrates the installation tool dialog that is displayed.

Figure 10-4: Typical 32-Bit eBUS Driver Installation Tool Dialog
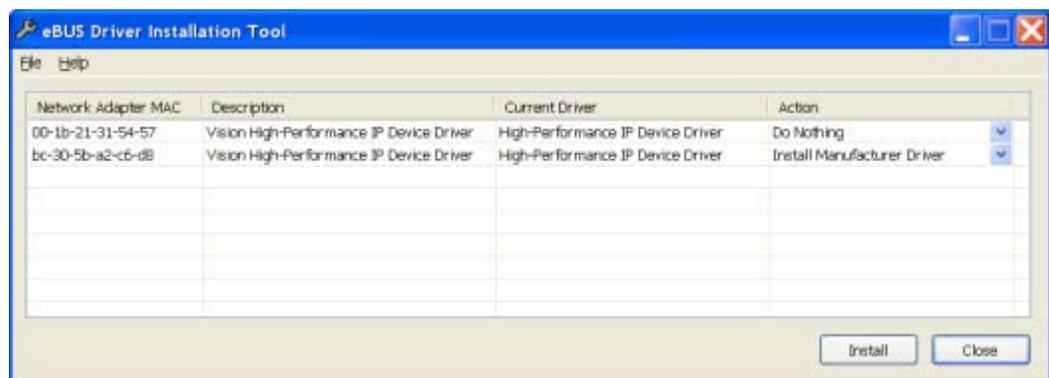
4411-0137_0038

3. Review the list of Ethernet cards displayed. Select the desired Ethernet card, and within the Action column, select Install Manufacturer Driver from the pull-down menu.

4. Click on the Install button to initiate the installation of the appropriate driver.

5. Once the driver installation has been completed, it may be necessary to reboot the computer.

   If prompted for a reboot, select:

   - Yes to reboot the host computer immediately, or
   - NO to delay rebooting the computer until a later time.

     When delaying the reboot, dismiss/close the eBUS Driver Installation Tool dialog.

6. Once the computer has been rebooted, verify that the network connection has been established.

10.8.2 LightField Applications

Perform the following procedure to restore an Ethernet network connection for LightField applications:

1. Navigate to the directory in which the EbDriverTool64.exe is stored.

   The file is typically stored on the host computer within the default Pleora directory (or one of the subdirectories):

   ```
   C:\Program Files\Common Files\Pleora
   ```

2. Double click on the file to launch the application. Figure 10-5 illustrates the installation tool dialog that is displayed.

Figure 10-5: Typical 64-Bit eBUS Driver Installation Tool Dialog

4411-0137_0039

3. Review the list of Ethernet cards displayed. Select the desired Ethernet card, and within the Action column, select Install Manufacturer Driver from the pull-down menu.

4. Click on the Install button to initiate the installation of the appropriate driver.

5. Once the driver installation has been completed, it may be necessary to reboot the computer.

   If prompted for a reboot, select:
   - Yes to reboot the host computer immediately, or
   - NO to delay rebooting the computer until a later time.

     When delaying the reboot, dismiss/close the eBUS Driver Installation Tool dialog.

6. Once the computer has been rebooted, verify that the network connection has been established.

10.9 TEC Fault LED Comes On

When cycling the power supply off and on, wait a minimum of 10 seconds before switching the supply back on. The TEC Fault LED may come on if the power supply's on/off state is switched too quickly.

> **NOTE:**
> The TEC Fault LED will also be illuminated if there is a problem with the cooling system.

Appendix A: System Specifications

This appendix provides general information and specifications for a NIRvana system. For additional information, refer to:

- Appendix B, Outline Drawings, on page 97;
- The device-specific data sheet.

> **NOTE:**
>
> All specifications are subject to change.

For up-to-date specifications and information, refer to device-specific data sheets which are available for download from Teledyne Princeton Instruments' website:

http://www.princetoninstruments.com

A.1   Sensor Specifications

Refer to Table A-1 for NIRvana:640 sensor specifications.

Table A-1:   NIRvana:640 Sensor Specifications

Quantity	Specification/Information
Default Operating Temperature: • 640 x 512 CCD	 -80?C
Sensor Format	Two-dimensional InGaAs focal plane array, 640 x 512 (20 x 20 ?m pixels) with 0.9-1.7 ?m spectral coverage
Sensor Window	Fused Silica (AR-coated)
Cooling Temperature	At 20?C ambient, cools to -80?C, -90?C with air and 15?C liquid circulation
Sensitivity	Response from 0.9 ?m to 1.7 ?m, peak QE >80%
Software-selectable Amplifiers	Select for high sensitivity or high dynamic range
Scan Rate	2 MHz and 5 MHz
Frame Rate	22 frames per second (fps) at 2 MHz 55 fps at 5 MHz digitization
Pixel Well Capacity (Typical)	Low Gain: 650 ke$^-$ High Gain: 40 ke$^-$
Integration Time	1 ?s to minutes
Dark Current (Typical)	Low Gain: 650 e$^-$/pixel/sec High Gain: 480 e$^-$/pixel/sec

A.1.1   Quantum Efficiency

Figure A-1 illustrates typical Quantum Efficiency (QE) data measured at +25?C. Longer cut-off wavelengths shift toward the blue by 8 nm per 10?C of cooling.

Figure A-1:   Typical NIRvana Quantum Efficiency (QE) Curve
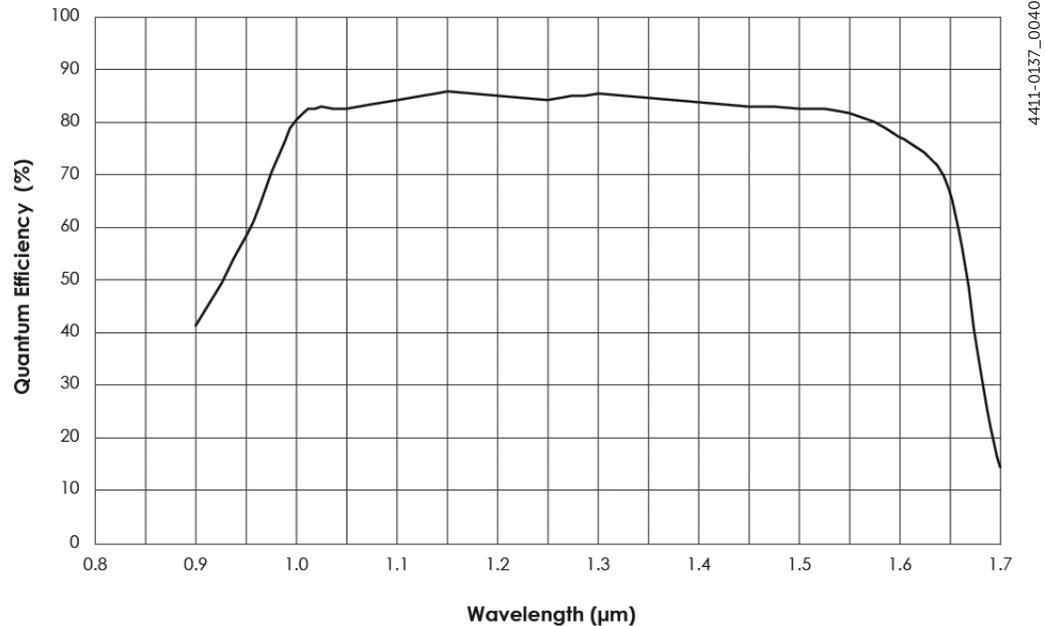
A.2   Camera Information

Focal Distance (Optical): C-mount, Front Surface to Focal Plane: 0.690" (17.53 mm)

Cooling Method(s): Thermoelectric; air.

Thermostatic Precision: ±0.05°C across entire temperature range.

Gain: Software-selectable:

- Low Gain (14 e⁻/count)
- High Gain (1 e⁻/count).

Dimensions: Refer to Appendix B, Outline Drawings, on page 97.

A.2.1   Connectors

The following, non-power connectors, are available on the rear of the NIRvana camera:

- Gig-E: Gigabit Ethernet connector.
- Shutter: LEMO® connector provides the shutter drive pulses for driving a Teledyne Princeton Instruments-supplied 25 mm external shutter. Camera power must be OFF before connecting to or disconnecting from this connector. Cable not supplied.

- Ext Sync: 0 to +3.3 VDC logic level input to allow data acquisition to be synchronized with external events. Trigger edge can be positive- or negative-edge as configured in software. An MCX-to-BNC adapter cable is included with system.

📖 **REFERENCES:** ———————————————

For additional information about Synchronization and Timing Modes, refer to:

- Section 9.1, Shutter Control Modes, on page 77;
- Section 9.2, Timing {Trigger Response} Modes, on page 78.

- Logic Out: 0 to +3.3 V_{DC}, TTL-compatible programmable logic level output. The output of this connector is programmable and can also be inverted via the application software.

📖 **REFERENCES:** ———————————————

For additional information about available output signals, refer to Section 9.3, LOGIC OUT Control, on page 83.

A.2.2   Power Specifications and Information

DC power to NIRvana and TE cooler is supplied by an external power supply via the custom power connector on the rear of the camera.

- Nominal Voltage Input: 90-240 V_{AC}, self-switching, 140 W.
- Power Consumption: 135 W

Figure A-2 illustrates the pinout of NIRvana's rear panel power connector.

Figure A-2:   Power Connector Pinout [NIRvana Rear Panel]
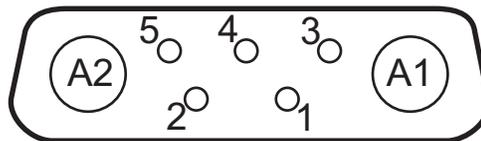
Table A-2 provides pin-specific signal information for NIRvana's rear-panel power connector.

Table A-2:   Power Connector Pinout [NIRvana Rear Panel]

Pin #	Description	Pin #	Description
A1	TEC Return	3	INT Out
A2	TEC Power	4	+24V In Return 1
1	INT Return	5	+24V In Return 2
2	+24V In		

A.2.3   Fan

24 CFM fan capacity at full power.

A.3   Available Mounts and Adapters

NIRvana supports the following imaging mounts and adapters:

- C-Mount: Standard threaded video mount;
- Spectroscopy-Mount: 3.60" and 3.88" bolt circle patterns;
- C- to Spectroscopy-Mount adapter [Optional];
- Adjustable C- to Spectroscopy-Mount adapter [Optional].

A.4   CoolCUBE$_{II}$ Circulator Specifications [Optional]

The CoolCUBE$_{II}$ Circulator is a closed loop system.

- Coolant: 50:50 ethylene glycol and water at 23°C
- Dimensions: Refer to Appendix B, Outline Drawings, on page 97
- Circulator Weight (Filled): 6.0 lbs (2.7 kg)
- Hose Weight (Filled): 3.0 lbs (1.4 kg) per hose
- Hoses: NIRvana- and CoolCUBEII-compatible 3/8" ID with quick disconnects at the camera ends and no-drip quick disconnects at the circulator ends. Refer to Table A-3 for associated manufacturer information and part numbers.

Table A-3:   CoolCUBE$_{II}$ Circulator Hose and Fitting Part Numbers

Item	Manufacturer	Part Number
Hose	McMaster	MCM 5238K748
NIRvana Fitting	McMaster	MCM 5478K811
CoolCUBE$_{II}$ Fitting	CPC	NS6D17006

A.5   Optional Equipment

Available options for a NIRvana system include:

- LightField application software and manual;
- WinView or WinSpec application software and manual;
- PICam software and manual (64-bit);
- PVCAM software and manual (32-bit);
- CoolCUBE$_{II}$ coolant circulator.

Contact Teledyne Princeton Instruments for information about options available for the NIRvana system.

Appendix B: Outline Drawings

📖 **NOTE:** ─────────────────────────────────

All dimensions are listed in inches [mm].

Figure B-1:   Outline Drawing: NIRvana:640 with C-Mount

Figure B-2:   Outline Drawing: NIRvana:640 with Spectroscopy-Mount
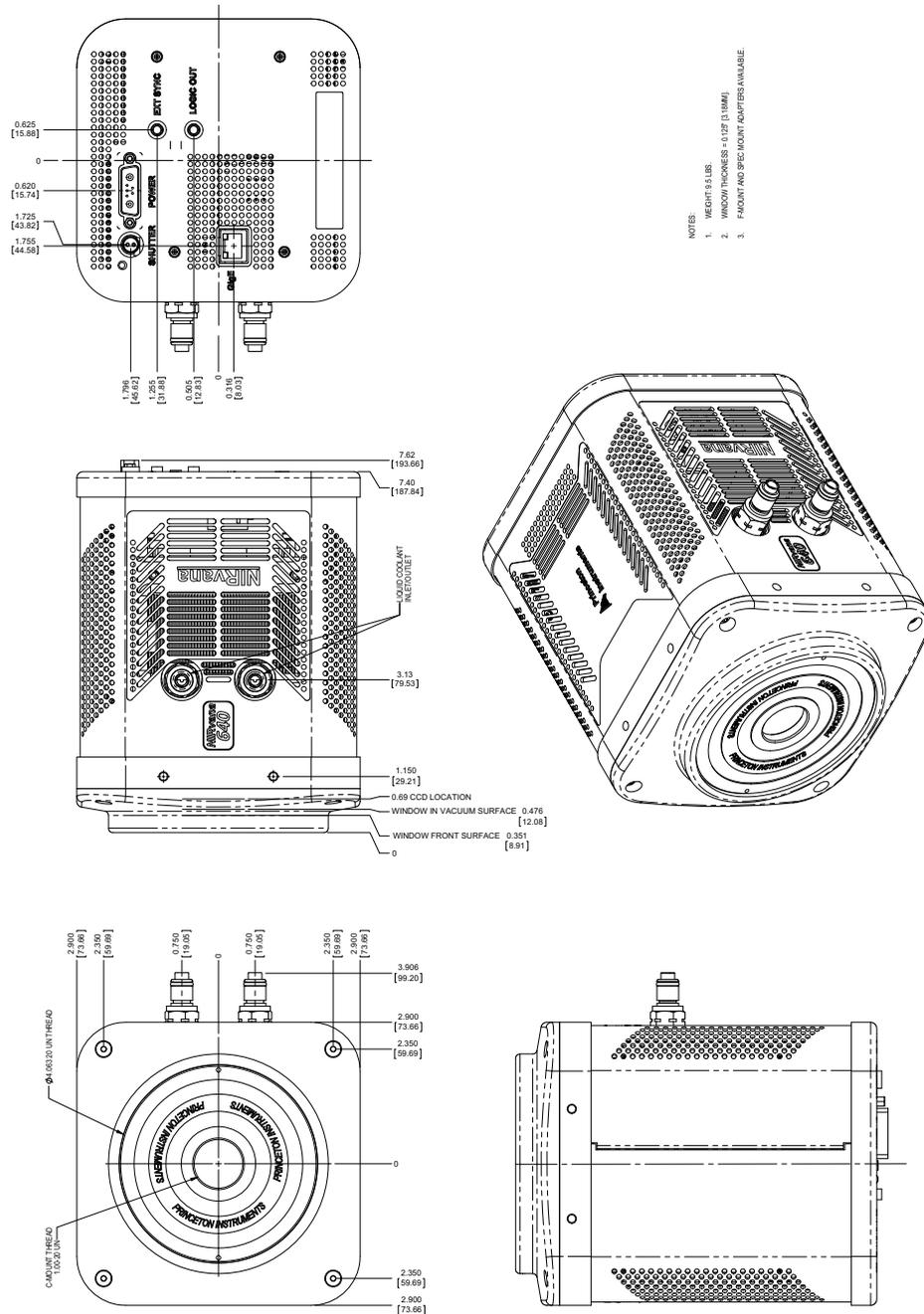
Figure B-3:   Outline Drawing: NIRvana Power Supply
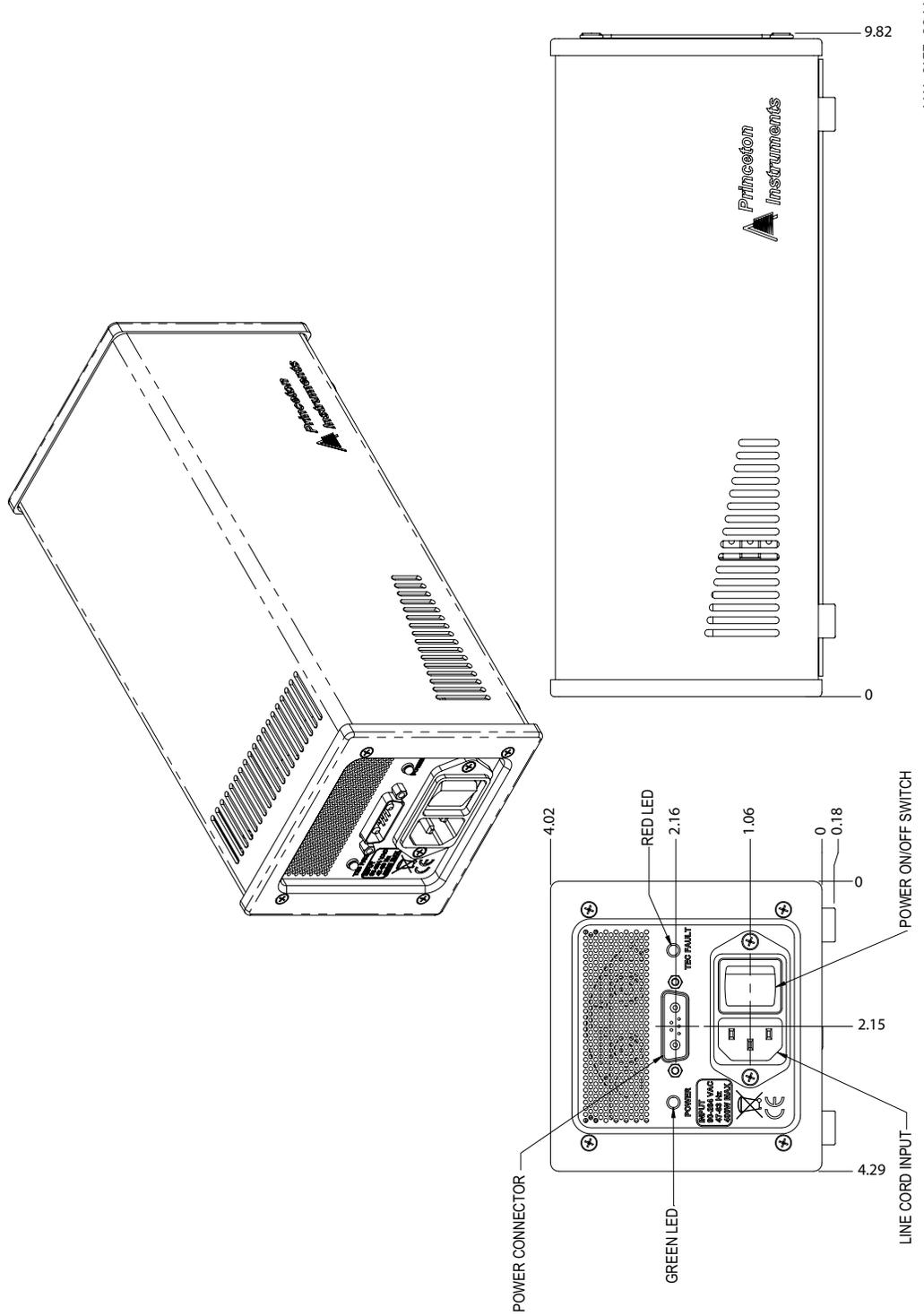
Figure B-4:   Outline Drawing: CoolCUBE$_{II}$
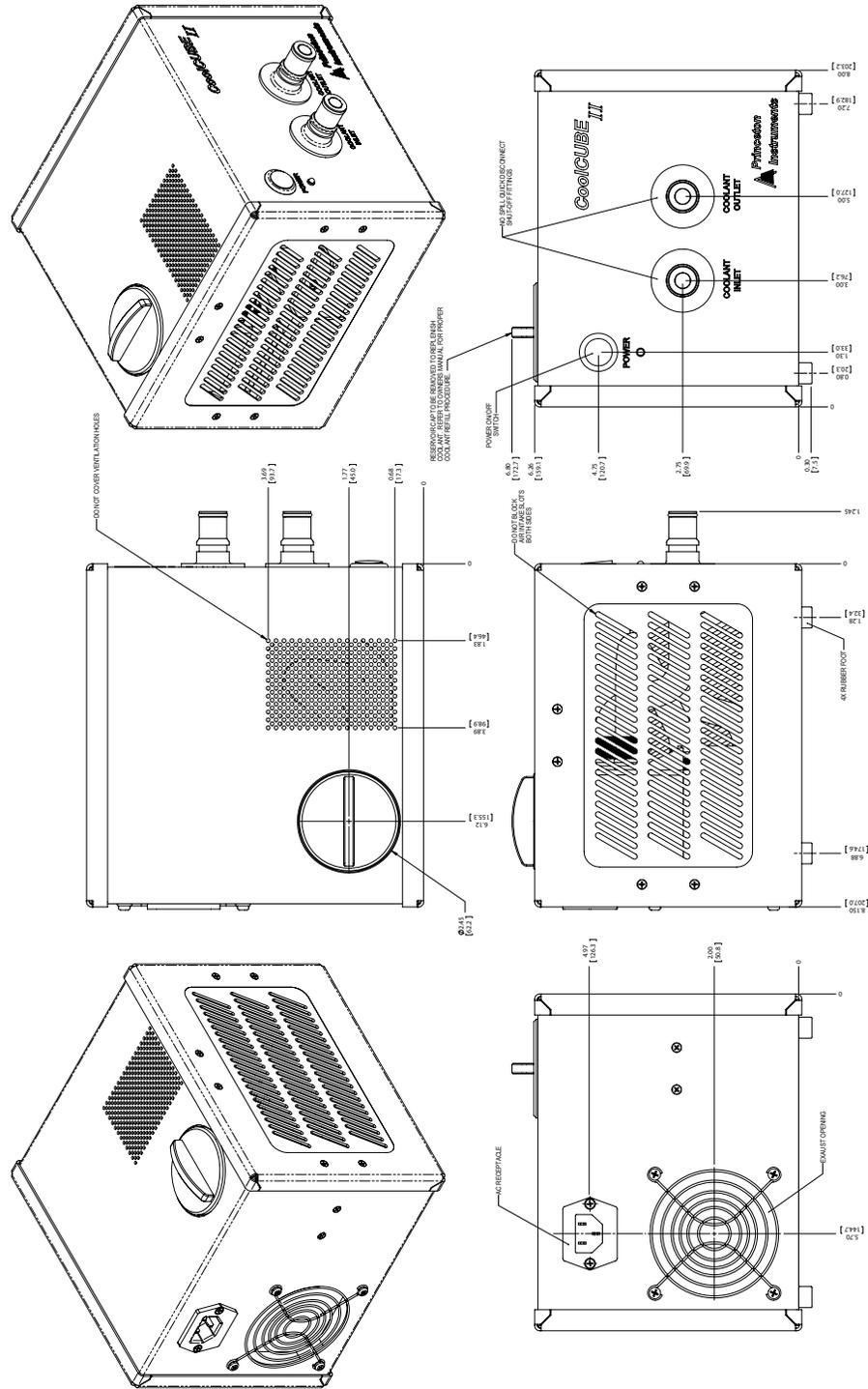
Appendix C: Spectrograph Adapters

NIRvana cameras for imaging are designed with a C-mount adapter to accommodate C-mount lenses. Cameras for spectroscopy applications are designed with two different bolt circle patterns to accommodate Teledyne Acton Research sliding tubes. Before mounting the camera to a Teledyne Acton Research Series spectrograph, you should follow the instructions in this appendix for attaching the appropriate spectrograph kit and sliding tube.

NOTE:

When mounted to a spectrograph, the text on the back of the NIRvana should be right side up.

Refer to Table C-1 for information about available spectrograph adapter kits.

Table C-1:   Spectrograph Adapter Information

Adapter Description	Adapter Kit Number	Information begins on...
Flange-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter	N/A	page 102
C-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter	N/A	page 103
Adjustable C- to Teledyne Acton Research SpectraPro Series Spectroscopy-Mount Adapter	7050-0104	page 105

C.1   Flange-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter

Figure C-1:   Flange Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter
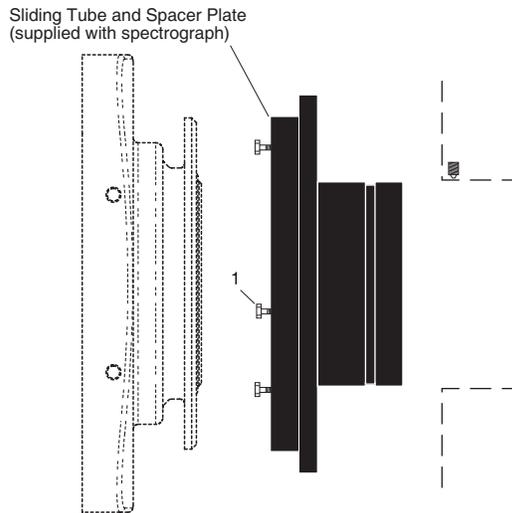
Table C-2:   Required Hardware: Flange-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount

Qty	Part Number	Description
3	2826-0120	Screw, 10-32 × 1/2, Hex Head, Stainless Steel

C.1.1   Installation Procedure

Perform the following procedure to install this adapter onto the NIRvana camera:

1. Verify the shipping cover has been removed from the spectrograph's detector port.
2. If the spacer plate has been removed, reinstall it on the sliding tube.
3. Leaving ¼" of thread exposed, mount the three (3) hex head screws to the sliding tube.
4. Mount the detector flange on the sliding tube assembly and rotate the detector so the screw heads are over the narrow end of the slots.
5. Tighten the screws.

> **NOTE:**
>
> Adapter parts are machined to provide a tight fit. If you need to remove the sliding tube from the spectrograph, first loosen the two setscrews that secure it, and then rotate the tube as you pull it out. If you have removed the sliding tube from the spectrograph, rotate the sliding tube as you re-insert it, and tighten the setscrews afterwards to secure it. Forcing the tube into the spectrograph could permanently damage the tube and the spectrograph opening.

C.2   C-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter

Figure C-2:   C-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount Adapter

Sliding Tube (supplied with spectrometer)
Spacer Plate (Removed)

4411-0137_0047
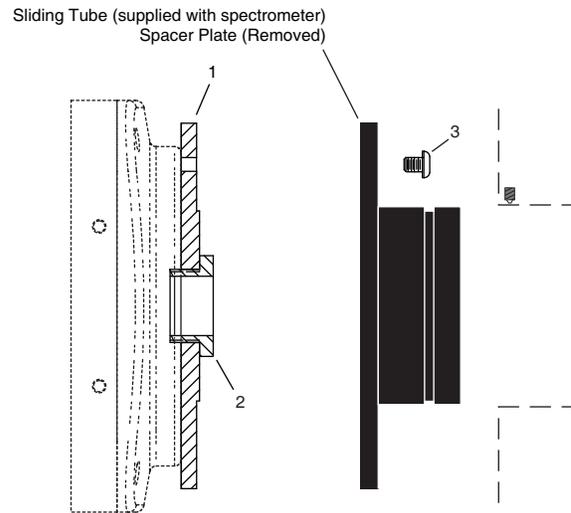
Table C-3:   Required Hardware: C-Mount to Teledyne Acton Research SpectraPro Spectroscopy-Mount

Qty	Part Number	Description
1	8401-071-01	Adapter Plate
1	8401-071-02	Threaded C-Mount Adapter
3	2826-0127	Screw, 10-32 × ¼, Button Head Allen Hex, Stainless Steel

C.2.1   Installation Procedure

Perform the following procedure to install this adapter onto a NIRvana camera:

1. Verify the shipping cover has been removed from the spectrograph's detector port
2. Loosen the set screws holding the sliding tube in the spectrograph and remove the tube. If there is a spacer plate installed on the sliding tube, remove it as well.
3. Place the flat side of the adapter plate against the face of the detector.
4. Insert the threaded C-mount adapter through the center hole in the plate and screw the adapter into the detector's C-mount.

5. Use three (3) 10-32 × ¼ screws to secure sliding tube to the adapter plate.

6. Gently insert the sliding tube into the spectrograph and fasten with the setscrews.

NOTE:

Adapter parts are machined to provide a tight fit. If you need to remove the sliding tube from the spectrograph, first loosen the two set screws that secure it, and then rotate the tube as you pull it out. If the sliding tube has been removed from the spectrograph, rotate the sliding tube as you re-insert it, and tighten the set screws afterwards to secure it. Forcing the tube into the spectrograph could permanently damage the tube and the spectrograph opening.

C.3   Adjustable C- to Teledyne Acton Research SpectraPro Series Spectroscopy-Mount Adapter

Figure C-3:   Adjustable C- to Teledyne Acton Research SpectraPro Series Spec-Mount Adapter
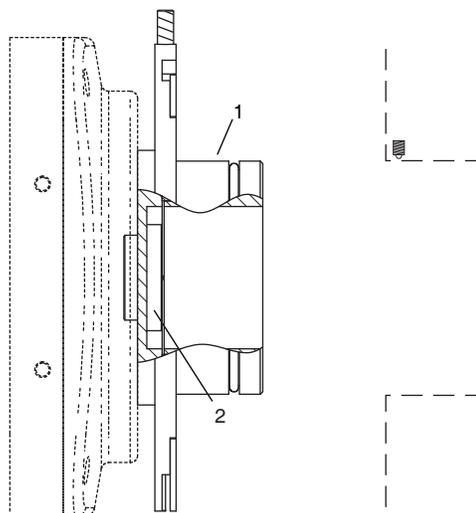
Table C-4:   Required Hardware: Adjustable C-Mount to Teledyne Acton Research Spectra Pro Spec-Mount

Qty	Part Number	Description
1		Adapter Plate
1	2518-1284	1.25"-32 Threaded Insert

C.3.1   Installation Procedure

Perform the following procedure to install this adapter on a NIRvana camera:

1. Verify the shipping cover has been removed from the spectrograph's detector port
2. Place the flat side of the adapter plate against the face of the detector.
3. Insert the threaded insert through the center hole in the plate and screw the adapter into the detector's C-mount.
4. Gently insert the sliding tube into the spectrograph and fasten with the setscrews.

> 🔍📋 **NOTE:** ────────────────────────
>
> Adapter parts are machined to provide a tight fit. If you need to remove the sliding tube from the spectrograph, first loosen the two setscrews that secure it, and then rotate the tube as you pull it out. If you have removed the sliding tube from the spectrograph, rotate the sliding tube as you re-insert it, and tighten the setscrews afterwards to secure it. Forcing the tube into the spectrograph could permanently damage the tube and the spectrograph opening.

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Appendix D: C-Mount to Spec-Mount Procedure

This appendix provides information necessary to replace the C-mount nose on a NIRvana camera with a spectroscopy-mount nose.

D.1   Required Parts and Tools

The following items are required:

- Tools:
  — 3/32 Hex Driver
  — 9/64 Hex Driver
- Spectroscopy-Mount Kit
  Refer to Table D-1 for a complete lits of items included in this kit.

Table D-1:   Spectroscopy-Mount Kit Contents

Item	Qty
O-ring, 3 ID x 0.070, Viton, Parker 2-041	1
Spectroscopy Nose	1
EMI strip, 21"	1
O-ring, 2-5/8 ID x 3/32 Viton, Parker 2-146	1
Dust cover, black, 4.25" x 11/32", Carlisle	1
Screw 8-32 x 5/8, Socket Head Hex, black oxide	4
Spectrometer mounting hardware kit	1

D.2   Exploded Parts Diagrams/Views

Figure D-1 illustrates an exploded view of the C-mount bezel and the spectroscopy mount. Refer to this diagram as necessary.

Figure D-1:   Exploded Views of C-Mount/Bezel (L) and Spectroscopy-Mount (R)
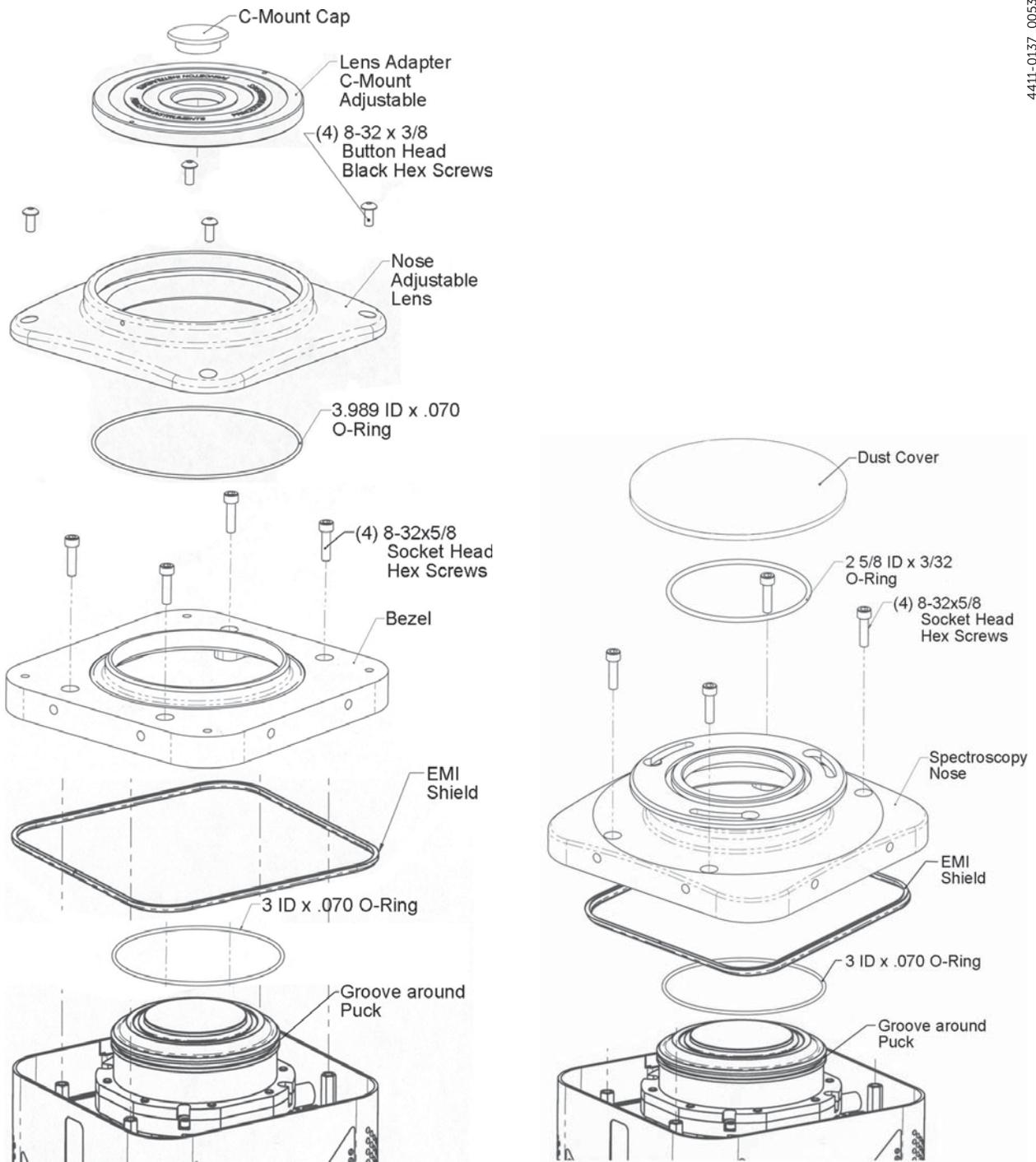
D.3   Replacement Procedure

Perform the following procedure to replace the C-mount with the spectroscopy-mount:

1. If the camera is connected to its power supply, verify the power supply is turned off. Disconnect it from the camera.
2. Disconnect all cables from the rear of the camera.
3. Position the camera with its nose up.
4. Use the 3/32 hex driver to remove four (4) 8-32 x 3/8 black button-head screws securing the front end to the camera. See Figure D-2.

Figure D-2:   Remove Screws Securing the Camera's Front End

5. Carefully lift the front end and screws up and off of the camera.
6. Use the 9/64 hex driver to remove the four (4) 8-32 x 5/8 socket head screws securing the bezel to the camera. See Figure D-3.

Figure D-3:   Remove Screws Securing the Bezel to the Camera
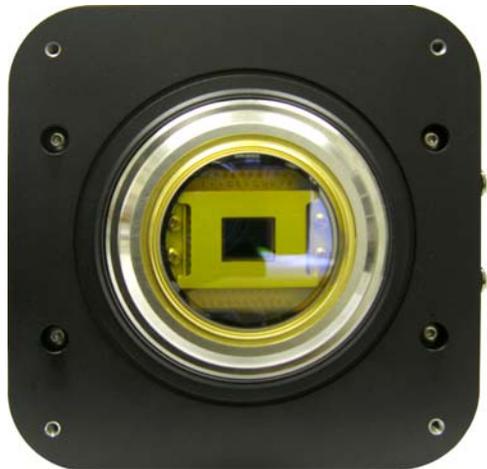
7. Carefully lift the bezel and screws up and off of the camera. See Figure D-4.

Figure D-4:   Camera with Bezel Removed
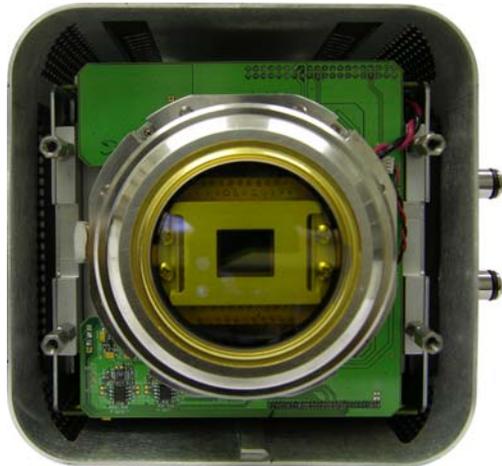
4411-0137_0056

8. Verify the 3 ID x 0.070 O-ring is in the groove around the puck. See Figure D-5.

Figure D-5:   Verify O-Ring Is In Place

4411-0137_0057

9. Examine the underside of the spectroscopy-mount to determine if the EMI strip is in the groove.
   - If bare metal is not visible at the bottom of the groove, the strip has been installed.
   - If bare metal is visible, install the 21" strip after removing the backing tape.

10. Position the spectroscopy-mount on the camera so that the holes are aligned with the standoffs. It may be necessary to move the side covers while pushing the mount down.

11. Use the 9/64 hex driver to secure the nose with the four (4) 8-32 x 5/8 socket head screws.

12. Place the 2-5/8 ID x 3/32 O-ring in the groove on the face the spectroscopy flange. See Figure D-6.

Figure D-6:   Installed Spectroscopy-Mount
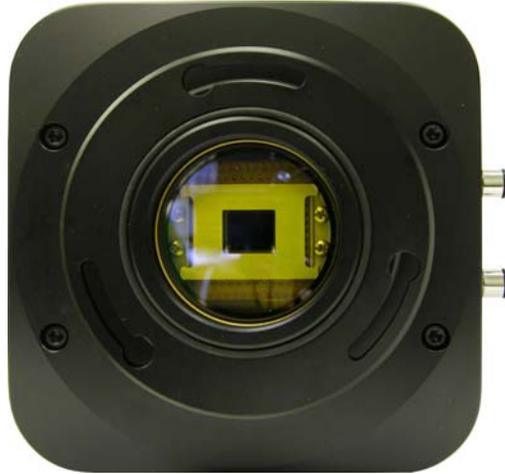
13. Place the dust cover over the flange to protect the window.
14. Place all C-mount parts that have been removed into a storage container and label it with the purpose of the enclosed parts. Store the container in a safe location.

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Appendix E: Calibration Charts

This appendix provides the following calibration charts for use with the NIRvana camera:

- HG Calibration Spectrum for NIRvana;
- Ne-Ar Calibration Spectrum for NIRvana.

Figure E-1: Hg Spectrum: NIRvana 1.7/SP-2500

4411-0137_0051
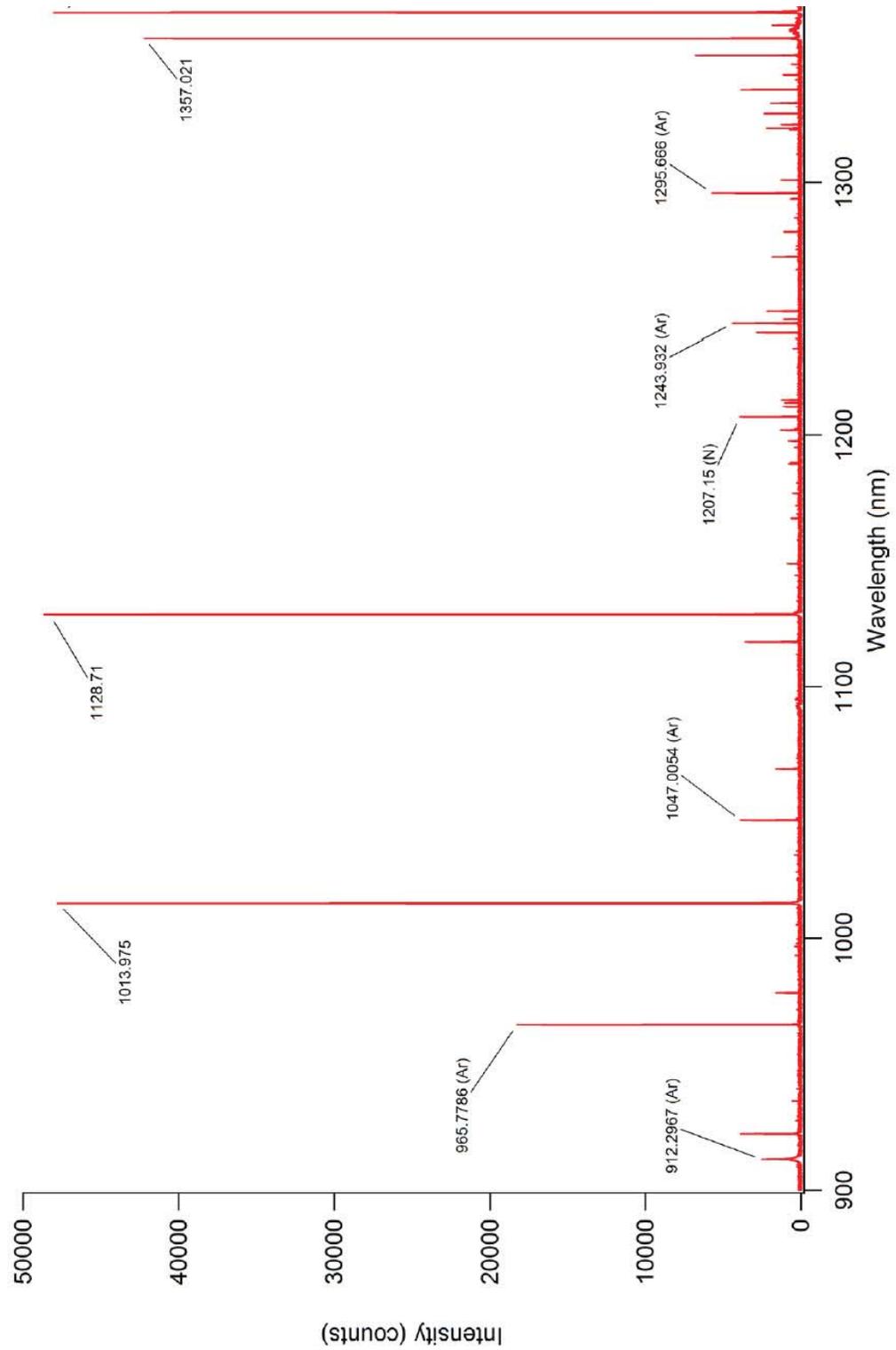
Figure E-2:   Ne/Ar Spectrum: NIRvana 1.7/SP-2500
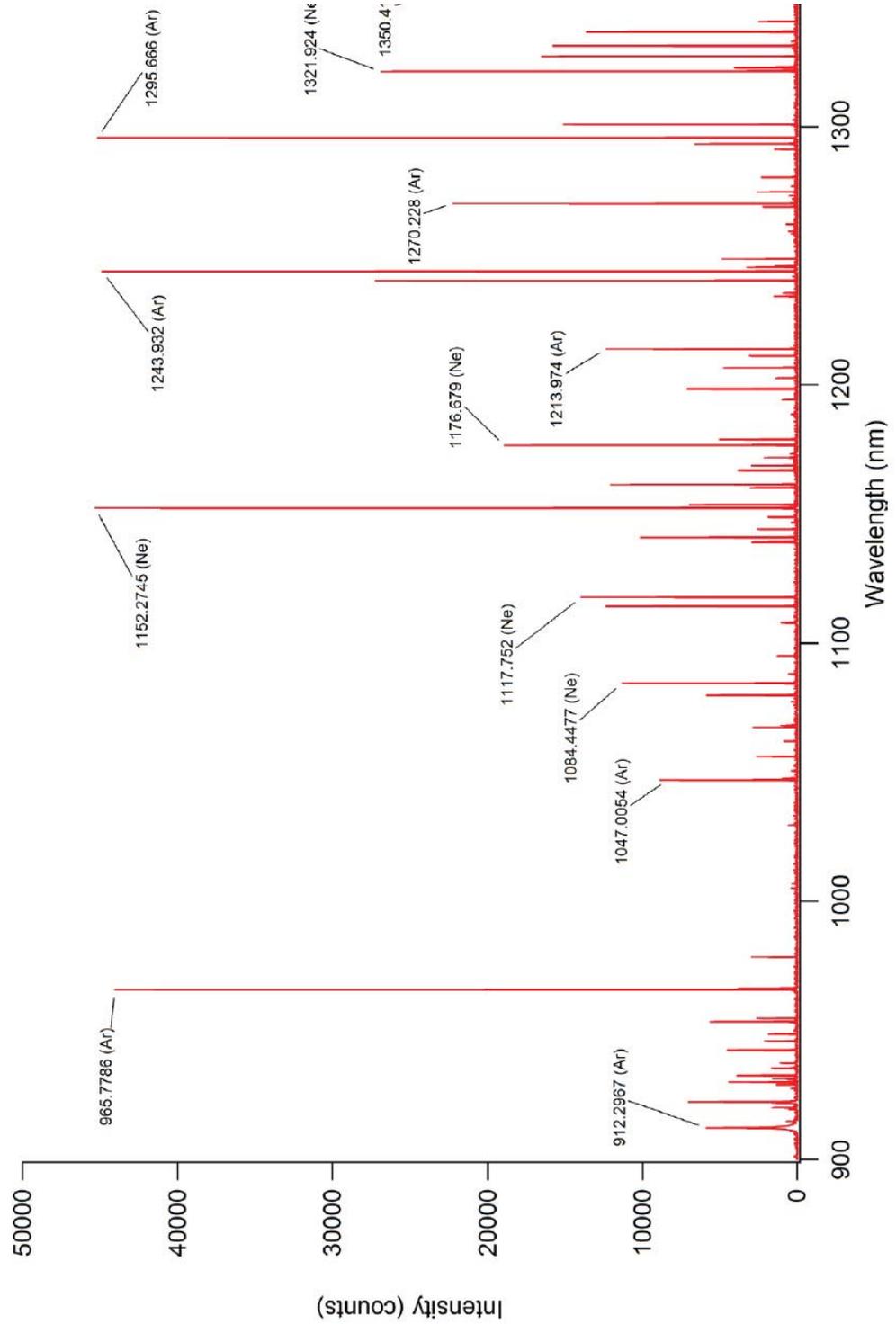
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Appendix F: WinSpec/32/LightField Cross Reference

This appendix provides cross reference information for terminology used within the WinSpec/32 and LightField application software packages.

F.1 WinSpec/32-to-LightField Terminology

Refer to Table F-1 for a list of WinSpec/32 terms and their corresponding LightField terms.

Table F-1: WinSpec/32-to-LightField Cross Reference (Sheet 1 of 2)

WinSpec/32 Term	LightField Term
Active Rows Parallel to Shift Register	Active Height
Active Shift Register Columns	Active Width
ADC Rate	Speed
ADC Resolution	Bit Depth
Continuous Cleans	Clean Until Trigger
Controller Gain	Analog Gain
Custom Chip	Custom Sensor
Custom Timing	Custom Timing
Disabled Closed (Shutter)	Always Closed (Shutter)
Disabled Open (Shutter)	Always Open (Shutter)
Dual Trigger Mode	Shift Per Trigger
Easy Bin	Sensor Readout Region expander functions
Edge Trigger	Trigger Determined By
External Sync	Readout Per Trigger
F.T. Dummies or Frame Transfer Dummies	Active Area: Top Margin
Focus	Preview or Run
Free Run	No Response
Logic Out	Output Signal
Logic Out: Logic 0	Output Signal: Always Low
Logic Out: Logic 1	Output Signal: Always High
Logic Out: Not Ready	Output Signal: Busy
Logic Out: Not Scan	Output Signal: Not Reading Out

Table F-1:   WinSpec/32-to-LightField Cross Reference (Sheet 2 of 2)

WinSpec/32 Term	LightField Term
Logic Out: Shutter	Output Signal: Shutter Open
Minimum Block Size	Final Section Height
Normal Shutter	Normal (Shutter)
Number of Blocks	Final Section Count
Number of Cleans	Number of Clean Cycles
Number of Strips per Clean	Clean Cycle Height
Post-Dummy Rows Parallel to Shift Register	Active Area: Bottom Margin
Post-Dummy Shift Register Columns	Active Area: Right Margin
Pre-Dummy Rows Parallel to Shift Register	Active Area: Top Margin
Pre-Dummy Shift Register Columns	Active Area: Left Margin
PreOpen (Shutter)	Open Before Trigger (Shutter)
Readout Port	Quality
Shutter Close Compensation Time	Closing Delay
Shutter Control	Shutter Mode
Shutter Open Compensation Time	Opening Delay
Single Trigger Mode (DIF)	Readout Per Trigger
Skip Serial Register Clean (deselected)	Clean Serial Register
Target Temperature	Temperature Setpoint
Timing Mode	Trigger Response

F.2   LightField to WinSpec/32

Refer to Table F-2 for a list of LightField terms and their corresponding WinSpec/32 terms.

Table F-2:   LightField-to-WinSpec/32 Cross Reference (Sheet 1 of 2)

LightField Term	WinSpec/32 Term
Active Area: Bottom Margin	Post-Dummy Rows Parallel to Shift Register
Active Area: Left Margin	Pre-Dummy Shift Register Columns
Active Area: Right Margin	Post-Dummy Shift Register Columns
Active Area: Top Margin	F.T. Dummies or Frame Transfer Dummies
Active Area: Top Margin	Pre-Dummy Rows Parallel to Shift Register
Active Height	Active Rows Parallel to Shift Register
Active Width	Active Shift Register Columns
Always Closed (Shutter)	Disabled Closed (Shutter)
Always Open (Shutter)	Disabled Open (Shutter)
Analog Gain	Controller Gain
Bit Depth	ADC Resolution
Clean Cycle Height	Number of Strips per Clean
Clean Serial Register	Skip Serial Register Clean (deselected)
Clean Until Trigger	Continuous Cleans
Closing Delay	Shutter Close Compensation Time
Custom Sensor	Custom Chip
Custom Timing	Custom Timing
Final Section Count	Number of Blocks
Final Section Height	Minimum Block Size
No Response	Free Run
Normal (Shutter)	Normal Shutter
Number of Clean Cycles	Number of Cleans
Open Before Trigger (Shutter)	PreOpen (Shutter)
Opening Delay	Shutter Open Compensation Time
Output Signal	Logic Out
Output Signal: Always High	Logic Out: Logic 1
Output Signal: Always Low	Logic Out: Logic 0
Output Signal: Busy	Logic Out: Not Ready
Output Signal: Not Reading Out	Logic Out: Not Scan
Output Signal: Shutter Open	Logic Out: Shutter

Table F-2:   LightField-to-WinSpec/32 Cross Reference (Sheet 2 of 2)

LightField Term	WinSpec/32 Term
Preview	Focus
Quality	Readout Port
Readout Per Trigger	External Sync
Readout Per Trigger (DIF)	Single Trigger (DIF)
Sensor Readout Region expander functions	Easy Bin
Shift Per Trigger (DIF)	Dual Trigger Mode (DIF)
Shutter Mode	Shutter Control
Speed	ADC Rate
Temperature Setpoint	Target Temperature
Trigger Determined By	Edge Trigger
Trigger Response	Timing Mode

Warranty and Service

Limited Warranty

Teledyne Princeton Instruments ("us," "we," "our,") makes the following limited warranties. These limited warranties extend to the original purchaser ("You," "you,") only and no other purchaser or transferee. We have complete control over all warranties and may alter or terminate any or all warranties at any time we deem necessary.

Basic Limited One (1) Year Warranty

Teledyne Princeton Instruments warrants this product against substantial defects in materials and/or workmanship for a period of up to one (1) year after shipment. During this period, Teledyne Princeton Instruments will repair the product or, at its sole option, repair or replace any defective part without charge to you. You must deliver the entire product to the Teledyne Princeton Instruments factory or, at our option, to a factory-authorized service center. You are responsible for the shipping costs to return the product. International customers should contact their local Teledyne Princeton Instruments authorized representative/distributor for repair information and assistance, or visit our technical support page at www.princetoninstruments.com.

Limited One (1) Year Warranty on Refurbished or Discontinued Products

Teledyne Princeton Instruments warrants, with the exception of the CCD imaging device (which carries NO WARRANTIES EXPRESS OR IMPLIED,) this product against defects in materials or workmanship for a period of up to one (1) year after shipment. During this period, Teledyne Princeton Instruments will repair or replace, at its sole option, any defective parts, without charge to you. You must deliver the entire product to the Teledyne Princeton Instruments factory or, at our option, a factory-authorized service center. You are responsible for the shipping costs to return the product to Teledyne Princeton Instruments. International customers should contact their local Teledyne Princeton Instruments representative/distributor for repair information and assistance or visit our technical support page at www.princetoninstruments.com.

XP Vacuum Chamber Limited Lifetime Warranty

Teledyne Princeton Instruments warrants that the cooling performance of the system will meet our specifications over the lifetime of an XP style detector (has all metal seals) or Teledyne Princeton Instruments will, at its sole option, repair or replace any vacuum chamber components necessary to restore the cooling performance back to the original specifications at no cost to the original purchaser. *Any failure to "cool to spec" beyond our Basic (1) year limited warranty from date of shipment, due to a non-vacuum-related component failure (e.g., any components that are electrical/electronic) is NOT covered and carries NO WARRANTIES EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Sealed Chamber Integrity Limited 12 Month Warranty

Teledyne Princeton Instruments warrants the sealed chamber integrity of all our products for a period of twelve (12) months after shipment. If, at anytime within twelve (12) months from the date of delivery, the detector should experience a sealed chamber failure, all parts and labor needed to restore the chamber seal will be covered by us. *Open chamber products carry NO WARRANTY TO THE CCD IMAGING DEVICE, EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Vacuum Integrity Limited 12 Month Warranty

Teledyne Princeton Instruments warrants the vacuum integrity of "Non-XP" style detectors (do not have all metal seals) for a period of up to twelve (12) months from the date of shipment. We warrant that the detector head will maintain the factory-set operating temperature without the requirement for customer pumping. Should the detector experience a Vacuum Integrity failure at anytime within twelve (12) months from the date of delivery all parts and labor needed to restore the vacuum integrity will be covered by us. Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Image Intensifier Detector Limited One Year Warranty

All image intensifier products are inherently susceptible to Phosphor and/or Photocathode burn (physical damage) when exposed to high intensity light. Teledyne Princeton Instruments warrants, with the exception of image intensifier products that are found to have Phosphor and/or Photocathode burn damage (which carry NO WARRANTIES EXPRESSED OR IMPLIED,) all image intensifier products for a period of one (1) year after shipment. *Refer to additional Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

X-Ray Detector Limited One Year Warranty

Teledyne Princeton Instruments warrants, with the exception of CCD imaging device and fiber optic assembly damage due to X-rays (which carry NO WARRANTIES EXPRESSED OR IMPLIED,) all X-ray products for one (1) year after shipment. *Refer to additional Basic Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Software Limited Warranty

Teledyne Princeton Instruments warrants all of our manufactured software discs to be free from substantial defects in materials and/or workmanship under normal use for a period of one (1) year from shipment. Teledyne Princeton Instruments does not warrant that the function of the software will meet your requirements or that operation will be uninterrupted or error free. You assume responsibility for selecting the software to achieve your intended results and for the use and results obtained from the software. In addition, during the one (1) year limited warranty. The original purchaser is entitled to receive free version upgrades. Version upgrades supplied free of charge will be in the form of a download from the Internet. Those customers who do not have access to the Internet may obtain the version upgrades on a CDROM from our factory for an incidental shipping and handling charge. *Refer to Item 12 in Your Responsibility of this warranty for more information.*

Owner's Manual and Troubleshooting

You should read the owner's manual thoroughly before operating this product. In the unlikely event that you should encounter difficulty operating this product, the owner's manual should be consulted before contacting the Teledyne Princeton Instruments technical support staff or authorized service representative for assistance. If you have consulted the owner's manual and the problem still persists, please contact the Teledyne Princeton Instruments technical support staff or our authorized service representative. *Refer to Item 12 in* Your Responsibility *of this warranty for more information.*

Your Responsibility

The above Limited Warranties are subject to the following terms and conditions:

1. You must retain your bill of sale (invoice) and present it upon request for service and repairs or provide other proof of purchase satisfactory to Teledyne Princeton Instruments.

2. You must notify the Teledyne Princeton Instruments factory service center within (30) days after you have taken delivery of a product or part that you believe to be defective. With the exception of customers who claim a "technical issue" with the operation of the product or part, all invoices must be paid in full in accordance with the terms of sale. Failure to pay invoices when due may result in the interruption and/or cancellation of your one (1) year limited warranty and/or any other warranty, expressed or implied.

3. All warranty service must be made by the Teledyne Princeton Instruments factory or, at our option, an authorized service center.

4. Before products or parts can be returned for service you must contact the Teledyne Princeton Instruments factory and receive a return authorization number (RMA.) Products or parts returned for service without a return authorization evidenced by an RMA will be sent back freight collect.

5. These warranties are effective only if purchased from the Teledyne Princeton Instruments factory or one of our authorized manufacturer's representatives or distributors.

6. Unless specified in the original purchase agreement, Teledyne Princeton Instruments is not responsible for installation, setup, or disassembly at the customer's location.

7. Warranties extend only to defects in materials or workmanship as limited above and do not extend to any product or part which:
   - has been lost or discarded by you;
   - has been damaged as a result of misuse, improper installation, faulty or inadequate maintenance, or failure to follow instructions furnished by us;
   - has had serial numbers removed, altered, defaced, or rendered illegible;
   - has been subjected to improper or unauthorized repair;
   - has been damaged due to fire, flood, radiation, or other "acts of God," or other contingencies beyond the control of Teledyne Princeton Instruments; or
   - is a shutter which is a normal wear item and as such carries a onetime only replacement due to a failure within the original 1 year Manufacturer warranty.

8. After the warranty period has expired, you may contact the Teledyne Princeton Instruments factory or a Teledyne Princeton Instruments-authorized representative for repair information and/or extended warranty plans.

9. Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.

10. All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall Teledyne Princeton Instruments' liability exceed the cost of the repair or replacement of the defective product or part.

11. This limited warranty gives you specific legal rights and you may also have other rights that may vary from state to state and from country to country. Some states and countries do not allow limitations on how long an implied warranty lasts, when an action may be brought, or the exclusion or limitation of incidental or consequential damages, so the above provisions may not apply to you.

12. When contacting us for technical support or service assistance, please refer to the Teledyne Princeton Instruments factory of purchase, contact your authorized Teledyne Princeton Instruments representative or reseller, or visit our technical support page at www.princetoninstruments.com.

Contact Information

Teledyne Princeton Instruments' manufacturing facility for this product is located at the following address:

Teledyne Princeton Instruments
3660 Quakerbridge Road
Trenton, NJ 08619 (USA)

Tel: 1-800-874-9789 / 1-609-587-9797
Fax: 1-609-587-1970

Customer Support E-mail: techsupport@princetoninstruments.com

Refer to http://www.princetoninstruments.com/support for complete support and contact information, including:

- Up-to-date addresses and telephone numbers;
- Software downloads;
- Product manuals;
- Support topics for Teledyne Princeton Instruments' product lines.

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www.princetoninstruments.com

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