## Revision History

<table>
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<th>Issue</th>
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| Issue 5 | April 11, 2019     | Issue 5 of this document incorporates the following changes:  
- Rebranded as Teledyne Princeton Instruments.                                          |
| Issue 4 | April 20, 2016     | Issue 4 of this document incorporates the following changes:  
- Removed the Declaration of Conformity.                                              |
| Issue 3 | September 17, 2015 | Issue 3 of this document incorporates the following changes:  
- Updated the Declaration of Conformity;  
- Updated Figure B-2, and Figure B-3, with newly released outline drawings.          |
| Issue 2 | July 7, 2015       | Issue 2 of this document incorporates the following changes:  
- Expanded CAUTION on page 36 to include information about never powering down the NIRvana-LN until all components have reached ambient temperature.  
- Added CAUTION to Section 5.8, Shut Down Procedure, on page 47 about never powering down the NIRvana-LN until all components have reached ambient temperature.  
- Added CAUTION to Section 6.10, Shut Down Procedure, on page 59 about never powering down the NIRvana-LN until all components have reached ambient temperature. |
| Issue 1 | May 14, 2015       | This is the initial release of this document                                                                                                   |
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Chapter 1: About this Manual

Thank you for purchasing a NIRvana®-LN system from Teledyne Princeton Instruments. Since 1981 Teledyne Princeton Instruments has been the legendary name behind the most revolutionary spectroscopy and imaging products for cutting edge research. Please read the manual carefully before operating the camera. This will help you optimize the many features of this camera to suit your research needs. If you have any questions about the information contained in this manual, contact the Teledyne Princeton Instruments customer service department. Refer to Contact Information on page 118 for complete contact information.

1.1 Intended Audience

This manual is intended to be used by scientists and other personnel responsible for the installation, setup, configuration, and acquisition of imaging data collected using an NIRvana-LN system. This document provides all information necessary to safely install, configure, and operate the NIRvana-LN, beginning with the system’s initial installation.

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-LN camera system. To guarantee up-to-date information, always refer to the current release of each document listed.

Teledyne Princeton Instruments maintains updated documentation and user manuals on their FTP site. Visit the Teledyne Princeton Instruments FTP Site to verify that the most recent user manual is available and being referenced:

ftp://ftp.piacton.com/Public/Manuals/Princeton Instruments
ftp://ftp.piacton.com/Public/Manuals/Acton
1.3 Document Organization

This manual is organized as follows:

- **Chapter 1, About this Manual**
  Briefly describes the NIRvana-LN family of detectors; details the structure of this manual; and documents environmental, storage, and cleaning requirements.

- **Chapter 2, NIRvana-LN Camera System**
  Provides descriptions of each system component.

- **Chapter 3, Installation Overview**
  Cross-references system setup actions with the relevant manuals and/or manual pages. It also contains system layout diagrams.

- **Chapter 4, System Setup**
  Provides detailed directions for mounting the detector to a spectrometer and for interconnecting the system components.

- **Chapter 5, LightField First Light Procedure**
  This chapter provides a step-by-step procedure for placing a spectroscopy system in operation for the first time when using Teledyne Princeton Instruments’ LightField 64-bit data acquisition software.

- **Chapter 6, WinSpec/32 and WinView/32 First Light Procedure**
  This chapter provides a step-by-step procedure for placing a spectroscopy system in operation for the first time when using Teledyne Princeton Instruments’ WinSpec/32 data acquisition software.

- **Chapter 7, Exposure and Signal**
  This chapter discusses the various factors that affect the signal acquired on the array, including array architecture, exposure time, temperature, and saturation.

- **Chapter 8, Experiment Synchronization**
  Discusses standard timing modes (i.e., Free Run, External Sync, and Continuous Cleans,) Fast and Safe triggering modes, and TTL control.

- **Chapter 9, Non-Destructive Readout**
  This chapter provides information about Non-Destructive Readout, the ability to read collected data without initiating a clean operation making it possible to monitor an experiment’s progress without destroying/affecting currently collected data.

- **Chapter 10, Troubleshooting**
  Provides courses of action to take if you should have problems with your system.

- **Appendix A, Specifications**
  Includes computer, controller and detector specifications.

- **Appendix B, Outline Drawings**
  Includes outline drawings of the NIRvana-LN detector and its power supply.

- **Appendix C, IsoPlane 320 Mounting**
  Provides mounting instructions for the spectrograph adapters available for NIRvana-LN detectors.

- **Warranty and Service**
  Provides the Teledyne Princeton Instruments warranty and customer support contact information.
1.4 Conventions Used in this Manual

The following conventions are used throughout this manual:

- WinSpec/32 and LightField® typically use different terms for the same functions or parameters. Unless a topic is specifically for WinSpec/32 or LightField, the following conventions are used:
  - Curly brackets { } are used to denote a LightField term or location.
  - When information applies to both WinSpec/32 and LightField, the WinSpec/32 term will be listed first, followed by the LightField term surrounded by curly brackets.
    For example:
    
    Pre Open {Open Before Trigger}

- When a location for setting a parameter is mentioned, the WinSpec/32 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 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.
1.6 Grounding and Safety

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.

⚠️ WARNING! ⚠️
If the equipment 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 as that of the original ones to avoid hazard due to electrical shock.

1.7 Precautions

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

- The array is very sensitive to static electricity. Touching the array can destroy it. Operations requiring contact with the device can only be performed at the factory.
- When using high-voltage equipment (e.g., an arc lamp,) with the detector system, be sure to turn the detector power ON LAST, and turn the detector power OFF FIRST.
- When turning off and on the power supply, wait at least 10 seconds before switching it on. The SHUTTER FAULT LED will be lit until the application software initializes the detector. Ignore the LED status if there is no shutter.

⚠️ NOTE: ⚠️
The SHUTTER FAULT LED also lights when an external shutter is disabled closed.

- Use caution when triggering high-current switching devices (such as an arc lamp) near your system. The array 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 detector. Preventing the free flow of air overheats the detector and may damage it.
1.7.1 Detector

Observe the following precautions when working with the Detector:

- If the equipment 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. Never impede airflow through the equipment by obstructing the air vents. Allow at least one-inch air space around any vent.
- Prevent array saturation while data is not being acquired by completely closing the entrance slit to the spectrometer (especially when a shutter is not used).
- If LN-cooled detectors are operated under high humidity conditions, ice buildup could occur around the pressure relief vent valve ports and prevent them from operating properly.

1.7.2 Detector Window

⚠️ **WARNING!**

Never remove the detector’s front window. It is part of the vacuum chamber and removing it will damage the array. Operations requiring contact with the device can only be performed at the factory. Never operate the detector cooled without proper evacuation. This could **destroy** the array!

This window maintains the vacuum in the detector and, for LN-cooled detectors, it maintains the vacuum in the Dewar. The window is made of the highest quality quartz available.

1.7.3 External Shutter

Observe the following precautions when working with an external shutter.

- To prevent damage to the shutter or shutter drive circuitry, always turn the detector power supply off before connecting or disconnecting the shutter cable.
Chapter 2: NIRvana-LN Camera System

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

Figure 2-1: NIRvana-LN Camera System: Standard Items

Standard items include:

- NIRvana-LN Camera;
- Power Supply and Cable;
- Intel® PRO/1000 Gigabit Ethernet card for the host computer;
- Gigabit Ethernet cable;
- AUX I/O Cable;
- Certificate of Performance

Optional accessories available for purchase from Teledyne Princeton Instruments include:

- Application Software;
- Optical Adapters.

Refer to Section 2.6, Optional Accessories, on page 20 for additional information.
2.1 NIRvana-LN Camera

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

Analog optical data acquired by the InGaAs sensor is converted 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-LN 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-LN camera.

Figure 2-2: Typical NIRvana-LN Camera

NOTE: The standard mount for NIRvana-LN systems is an F-mount. An optional spectroscopy mount can be ordered.

2.1.1 InGaAs FPA Sensor

The NIRvana-LN camera incorporates a 640 x 512 (20 μm x 20 μm pixels) InGaAs focal plane array (FPA) that is equipped with a four-port readout. The sensor’s excellent response and outstanding sensitivity in the 0.8 μm -1.55 μm spectrum make it particularly well suited for Near Infrared II window/Short Wave Infrared (SWIR) region imaging applications.

Additional key features of the InGaAs sensor include:

- Readout rates of 256 kHz and 126 kHz capable of 28 and 1.77 frames per second, respectively;
- Deep cooling to -190°C which reduces the dark signal and enables long integration times.
2.1.2 Dewar
The standard upright Dewar holds 2.2 liters of liquid nitrogen (LN) which can maintain -190°C for more than 24 hours. All-directional and end-on Dewar inserts are available.

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

2.1.4 Rear-Panel Connectors
Figure 2-3 illustrates the rear-panel connectors on a NIRvana-LN camera.

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

Table 2-1: NIRvana-LN Rear-Panel Connectors (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutter</td>
<td>LEMO® connector for driving an external shutter. Stop data acquisition and turn off the power supply before connecting to or disconnecting from this connector.</td>
</tr>
<tr>
<td>Gig-E</td>
<td>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.</td>
</tr>
</tbody>
</table>
2.1.5 Dewar

The standard upright Dewar holds 2.2 liters of liquid nitrogen (LN). All-directional and end-on Dewar inserts are available.

2.2 Spectrometer Support

The NIRvana-LN easily mounts to the IsoPlane® SCT-320 spectrograph. Refer to Appendix C, IsoPlane 320 Mounting, on page 105 for information about mounting the NIRvana-LN to a spectrograph.

2.3 Power Supply

Figure 2-4 illustrates a typical NIRvana-LN power supply.

<table>
<thead>
<tr>
<th>Table 2-1: NIRvana-LN Rear-Panel Connectors (Sheet 2 of 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Label</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>AUX I/O</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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.

Refer to Section A.2, Power Specifications, on page 95 for power specifications.
2.4 Standard Cables

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

Table 2-2: Standard NIRvana-LN Camera System Cables

<table>
<thead>
<tr>
<th>Cable</th>
<th>Part Number</th>
<th>Description/Purpose</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet</td>
<td>6050-0621</td>
<td>Cat 5e/6 Ethernet cable. Connects the NIRvana-LN camera to the host computer.</td>
<td>5 m [16.4 ft]</td>
</tr>
<tr>
<td>AUX I/O</td>
<td>6050-0681</td>
<td>The AUX I/O cable provides TTL outputs and inputs for synchronization with external</td>
<td>Varies</td>
</tr>
<tr>
<td>Cable</td>
<td></td>
<td>devices. Inputs must be at least 2.4 $V_{DC}$ for a TTL high and less than 0.9 $V_{DC}$ for a low.</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>6050-0596</td>
<td>Connects the NIRvana-LN camera to the power supply.</td>
<td>3 m [9.8 ft]</td>
</tr>
</tbody>
</table>

2.5 Certificate of Performance

Each NIRvana-LN 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-LN 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.
2.6 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;
- Optical Adapter Plate

Other optional items may be available. For complete information about available options for the NIRvana-LN 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-LN camera systems, including:

- LightField
  LightField is Teledyne Princeton Instruments’ 64-bit Windows® 7/8 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. 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-LN 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-LN may be compatible with third-party data acquisition software packages. Check with individual providers for compatibility and support information.

2.6.2 Optical Adapters
Refer to Appendix C, IsoPlane 320 Mounting, on page 105 for information about the optional adapter for mounting the NIRvana-LN to a spectrograph.
2.7 Care and Cleaning of a NIRvana-LN System

From time to time, NIRvana-LN cameras may require minor 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.

2.7.1 Camera

Although there is no periodic maintenance that needs to be performed on a NIRvana-LN 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 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.

⚠️ WARNING! ⚠️
After cleaning optical surfaces using this method, verify that all surfaces and components have dried completely before applying power to the NIRvana-LN.

2.8 Repairs

The NIRvana-LN camera system contains no user-serviceable parts. Therefore, repairs must be performed by Teledyne Princeton Instruments. Should a system need repair, contact Teledyne Princeton Instruments customer support for instructions. For contact information, refer to Contact Information on page 118.

❗️ NOTE: ❗️
Save all original packing materials for future use when it is necessary to ship the system and/or system components.
Chapter 3: Installation Overview

Figure 3-1 illustrates a typical NIRvana-LN system diagram for imaging applications.

**Figure 3-1: System Diagram: NIRvana-LN Imaging Application**

Figure 3-2 illustrates a typical NIRvana-LN system diagram for spectrographic applications.

**Figure 3-2: System Diagram: NIRvana-LN Spectrographic Application**
Table 3-1 briefly describes the sequence of steps required to hookup a system and prepare to gather data. Refer to the indicated references for more additional information.

<table>
<thead>
<tr>
<th>Action</th>
<th>Refer to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>Section 4.1, Unpack the System, on page 27.</td>
</tr>
<tr>
<td>2. Verify that all system components have been received.</td>
<td>Section 4.2, Check the Equipment and Parts Inventory, on page 27.</td>
</tr>
<tr>
<td>3. If the components show no sign of damage, verify that the appropriate power cord has been supplied with the power supply.</td>
<td>—</td>
</tr>
<tr>
<td>4. LightField: If there is an unused Ethernet connector on the host computer, you can use it for communication and data transfer. If there is no available Ethernet connector, install the Ethernet card provided with the NIRvana-LN system. WinX/32: If the Ethernet adapter card provided with the system is not already installed in the host computer, install it.</td>
<td>Refer to the manufacturer supplied installation instructions.</td>
</tr>
<tr>
<td>5. If the application software has not already been installed on the host computer, install it.</td>
<td>LightField User Manual\textsuperscript{a} WinSpec/32 User Manual\textsuperscript{a}</td>
</tr>
<tr>
<td>6. Mount the detector to the spectrograph.</td>
<td>Section 4.6, Mount to a Spectrograph, on page 33.</td>
</tr>
<tr>
<td>7. With the power supply disconnected from the detector, connect one end of the Ethernet cable to the GigE connector on the rear of the NIRvana-LN and the other end to the Ethernet port on the host computer.</td>
<td></td>
</tr>
<tr>
<td>8. Connect the power supply to the NIRvana-LN.</td>
<td></td>
</tr>
<tr>
<td>9. Turn the NIRvana-LN power supply ON.</td>
<td></td>
</tr>
<tr>
<td>10. Turn on the computer and launch either LightField or WinX/32.</td>
<td>LightField User Manual\textsuperscript{a} WinView/32 User Manual\textsuperscript{a} WinSpec/32 User Manual\textsuperscript{a}</td>
</tr>
<tr>
<td>11. Enter the hardware and experiment setup information.</td>
<td>LightField User Manual\textsuperscript{a} WinSpec/32 User Manual\textsuperscript{a}</td>
</tr>
<tr>
<td>12. Set the target array temperature.</td>
<td>Section 7.4, Cooling the Array, on page 63.</td>
</tr>
</tbody>
</table>
Table 3-1: Installation Overview (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>Action</th>
<th>Refer to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. When the system reaches temperature lock, wait an additional 30 minutes before acquiring data in focus mode.</td>
<td></td>
</tr>
<tr>
<td>15. Adjust the rotational alignment for the best image or spectral lines.</td>
<td></td>
</tr>
<tr>
<td>- When using LightField, use the Align Spectrometer function.</td>
<td>Section 5.5, Rotational Alignment, on page 45</td>
</tr>
<tr>
<td>- When using WinSpec/32, use the Focus Helper function.</td>
<td>Section 6.7, Rotational Alignment, on page 57</td>
</tr>
<tr>
<td>16. Adjust the focus for the best image or spectral lines.</td>
<td></td>
</tr>
<tr>
<td>- When using LightField, use the Align Spectrometer function.</td>
<td>Section 5.6, Focus the System, on page 46</td>
</tr>
<tr>
<td>- When using WinSpec/32, use the Focus Helper function.</td>
<td>Section 6.8, Focus the System, on page 58</td>
</tr>
</tbody>
</table>

a. Refer to Table 1-1 on page 9 for document number information.
This page is intentionally blank.
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.

This chapter provides general information and procedures for setting up a NIRvana-LN system for operation in both imaging and spectroscopic applications.

4.1 Unpack the System
During the unpacking, check the system components for possible signs of shipping damage. If there are any, notify Teledyne Princeton Instruments and file a claim with the carrier. If damage is not apparent but detector or controller specifications cannot be achieved, internal damage may have occurred in shipment. Please save the original packing materials so you can safely ship the detector system to another location or return it to Teledyne Princeton Instruments for repairs if necessary.

4.2 Check the Equipment and Parts Inventory
Verify that all equipment and parts required to set up the NIRvana-LN system have been received.

A complete system consists of:
- Detector and 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.
- Operating System
  - LightField: Windows 7/8 (64-bit);
  Refer to Section 4.4, Host Computer Specifications, on page 29 for additional host computer specifications.
- Interface Card
  Intel® PRO/1000 card is supplied with the system.
- GigE cable:
  DB9 to DB9 cable (6050-0148-CE is standard)
- NIRvana-LN System User Manual

Optional items that may have been purchased and are included in the shipment include:
- Application Software:
  - LightField CD-ROM;
  - WinSpec32 (Version. 2.6.5 or later) CD-ROM;
- Software User Manual (included with application software).
4.3 System Requirements

This section provides general information about NIRvana-LN system requirements.

**REFERENCES:**

For detailed technical specification, refer to Appendix A, Specifications, on page 95.

4.3.1 Ventilation

A NIRvana-LN system requires the following ventilation conditions:

- **Detector**
  Allow at least one inch clearance for side and rear air vents.
  Where the detector is inside an enclosure, > 30 cfm air circulation and heat dissipation of 50W is required.

- **Power Supply**
  Allow at least one inch clearance for side and rear air vents.

4.3.2 Coolant

**WARNINGS!**

1. Even minimal contact with LN can cause severe injury to eyes and skin. Avoid contact with the splashing that will invariably accompany pouring LN into a room temperature Dewar.
2. Always be careful when removing the LN port cap if there is LN present in the Dewar. Pressure due to nitrogen gas can cause the cap to fly out when the retaining nut is loosened, possibly spraying you with liquid LN, which can cause severe injury.
3. An LN-cooled detector must never be tilted more than 30° from vertical, unless the all-directional Dewar option has been purchased. If mounting the Dewar to your system requires you to exceed the 30° limit, you may have the wrong type of Dewar. Contact the factory.

4.3.3 Detector Power

The NIRvana-LN detector receives its power from the power supply, which in turn plugs into a source of AC power.

**CAUTION!**

The plug on the line cord supplied with the system should be compatible with the line-voltage outlets in common use in the region to which the system is shipped. If the power cord plug is incompatible, a compatible plug should be installed, taking care to maintain the proper polarity to protect the equipment and assure user safety.
4.4 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-LN system. 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 operations.

### 4.4.1 LightField Host Computer Requirements

When running LightField data acquisition software, the host computer must meet, or exceed, the following specifications:

- 64-Bit Operating System
  - Windows 7;
  - Windows 8.
- 2 GHz Pentium® 4 (minimum);
- 2 GB RAM (minimum);
- CD-ROM drive
- At least one unused PCI card slot (PCI 2.3 compliant 32-bit 33/66 MHz bus)
- Super VGA monitor and graphics card
  Supporting at least 65535 colors with at least 128 Mbyte of memory.

**NOTE:**

Memory requirement is dependent on desired display resolution.

- 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.

- Mouse or other pointing device.
4.4.2 WinView/32 and WinSpec/32 Host Computer Requirements

When running WinView/32 or WinSpec/32 data acquisition software, the host computer must meet, or exceed, the following specifications:

- 32-Bit Operating System
  - Windows 7.
- 2 GHz Pentium 4 (minimum);
- 2 GB RAM (minimum);
- CD-ROM drive;
- At least one unused PCI card slot (32-bit) (PCI 2.3 compliant, 33/66 MHz bus)
- Super VGA monitor and graphics card
  Supporting at least 65535 colors with at least 128 Mbyte of memory.

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

- 10,000 RPM (recommended) hard disk with a minimum of 1 GB available space.
  A complete WinSpec/32 installation requires approximately 50 MB of space.
  The remaining 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.

- Mouse or other pointing device.
4.5 Data Acquisition Software Installation
This section provides the installation procedures for LightField and WinSpec/32 data acquisition software.

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

**NOTE:**
Install the GigE Adapter card BEFORE installing the WinSpec/32 application software.

1. The operating system on the desired host computer is either Windows Vista (64-bit) or Windows 7 (64-bit).
2. Verify the Pro 1000 interface 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 the CD drive on the host computer, and follow the on-screen prompts. Figure 4-1 illustrates a typical InstallShield Wizard dialog.

**Figure 4-1:** Typical LightField Installation Wizard Dialog

5. After the installation has been completed, reboot the host computer.
6. Connect the NIRvana-LN system components to the host computer and apply power.
7. Launch LightField and activate it according to on-screen instructions.

**REFERENCES:**
For additional information, refer to Chapter 5, LightField First Light Procedure, on page 39.

8. Begin experiment configuration.
4.5.2 Install WinSpec/32

Perform the following procedure to install WinSpec/32 on the host computer:

NOTES:

1. Install the GigE Adapter card BEFORE installing the WinSpec/32 application software.
2. Leave the interface cable disconnected from the detector until you have installed WinSpec/32.

1. Insert the WinSpec/32 software installation CD into the CD drive on the host computer. The installation program will automatically launch.
2. When the Select Installation Type dialog is displayed, select the desired type of installation:
   - Typical
     Installs all required drivers and commonly installed program files;
   - Complete
     Installs all available application drivers and features;
   - Custom
     Select specific features and drivers for installation, as well as to specify a custom installation directory. This is only recommended for use by advanced users.

Figure 4-2 illustrates a typical WinSpec/32 Installation Setup dialog.

Figure 4-2: WinSpec: Select Installation Type Dialog

3. Click Next > to continue with the installation, and follow on-screen prompts.
4. Once the installation has been completed, connect the detector to the host computer and turn on the detector’s power supply.
5. Reboot the host computer.

Windows will automatically detect the newly-installed GigE card.

REFERENCES:

For additional information, refer to Chapter 6, WinSpec/32 and WinView/32 First Light Procedure, on page 49.
4.6 Mount to a Spectrograph

The detector must be properly mounted to the spectrograph to take advantage of all the available grouping features. Depending on the spectrograph and detector type, special adapters may be required to mount the detector to the spectrograph. The appropriate adapters should have been included with your system if the spectrograph type was indicated when the system was ordered.

Refer to the adapter mounting instructions in Appendix C, IsoPlane 320 Mounting, on page 105, or the quick-start instructions that may have been shipped with the system.

**WARNING!**

An LN-cooled detector must never be tilted more than 30° from vertical, unless the “all-directional” Dewar option has been purchased. If mounting the Dewar to a system requires the 30° limit to be exceeded, you may have the wrong type of Dewar. Contact the factory for assistance.

4.6.1 Focal Plane Distance

The distance to the focal plane from the front of the mechanical assembly depends on the specific configuration as indicated in Table 4-1.

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Reference Point(s)</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN</td>
<td>Mounting Face (IsoPlane Nose) to Focal Plane</td>
<td>0.839” [31.3 mm]</td>
</tr>
</tbody>
</table>

**NOTE:**

The housing for a detector has a 7.60” [19.3 cm] bolt circle.

4.6.2 Optical Center of the Array

An LN-cooled detector shrinks when the Dewar is filled with liquid nitrogen, and the detector cools down to operating temperature. For side-on Dewars, the optical center of the array shifts downward by 0.022” [0.559 mm] and toward the mounting face by 0.010” [0.254 mm]. Because of this, an image area or a focus set at room temperature will change as a detector cools.

The NIRvana-LN is designed so the optical center of an array is offset at room temperature. Now, when a detector cools to operating temperature, the optical center of the array is at the center of the nose.

4.6.3 Array Orientation

All users with rectangular arrays must first determine the correct orientation of the detector. All detectors must be mounted in the correct orientation to take advantage of the many hardware and software features. The detector should be mounted so that the short axis of the array is parallel to the entrance slit. The long axis will therefore correspond to the wavelength axis of the spectrum, for maximum resolution.

The simplest way to determine the long and short axes of an array is to make a visual inspection of the faceplate. The faceplate cutout closely corresponds to the dimensions of the underlying array, which will itself be visible through the window.
4.7 Using an External Shutter

NIRvana-LN detectors do not contain internal shutters. However, a Teledyne Princeton Instruments 25 mm external shutter, which is typically placed over the entrance slit of a spectrograph, can be purchased.

Perform the following procedure to install a Teledyne Princeton Instruments-supplied 25 mm External Shutter onto a spectrometer:

1. Verify that the detector’s power supply is OFF.
2. Bolt the entrance slit shutter assembly to the entrance slit of the spectrograph. The entrance slit shutter mount used with Teledyne Acton Research SpectraPro series spectrographs requires no disassembly. See Figure 4-3.

Figure 4-3: Entrance Slit Shutter Mount

3. Connect the shutter cable to the Shutter connector on the back of the NIRvana-LN’s electronics box.
4. Turn on the detector’s power supply.
5. Launch the application software and configure the external shutter as follows:
   - Within LightField:
     - Within Experiment Settings locate the Shutter expander and open it.
   - Within WinSpec/32:
     - Open the Hardware Setup Controller/Camera tab.
     - Within the Shutter Type field, select Custom from the pull-down menu.
     - Click OK to save the configuration and dismiss the Hardware Setup dialog.

The time it takes the shutter to completely close is approximately 8 ms.

NOTE: Setting shutter compensation time will slow the readout rate.
4.8 Configure Default Parameters in LightField

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

1. Verify the NIRvana-LN (and spectrograph, if this is a spectroscopy system) is connected to the host computer and that the detector (and spectrograph) power supply is 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 and default values will automatically be loaded into the Experiment Settings stack on the left-hand side of the window.

REFERENCES:
Refer to Chapter 5, LightField First Light Procedure on page 39 for step-by-step procedures and complete information about basic system operation.

4.9 Configure Default Parameters for WinView/32 and WinSpec/32

Perform the following procedure to configure WinSpec/32 with default system parameters:

1. Verify the detector is connected to the host computer and that the detector’s power supply is turned on.
2. Open the WinSpec application software.
   The Camera Detection wizard will automatically run if this is the first time a Teledyne Princeton Instruments WinX application (e.g., WinSpec/32, WinView/32, or WinXTest/32,) has been installed with a supported detector.
   Otherwise, when installing a new detector type, click on the Launch Camera Detection Wizard… button on the Controller/CCD tab to start the wizard.
3. When the Camera Detection Wizard - Welcome dialog is displayed, the checkbox for manual configuration should remain unselected. See Figure 4-4.

Figure 4-4: Typical Camera Detection Wizard - Welcome Dialog
4. Click Next> to continue.
5. Follow on-screen prompts to complete the initial hardware setup. This Camera Detection wizard automatically enters default parameters on the Hardware Setup dialog tabs and provides an opportunity to acquire a test image to confirm system operation.

REFERENCES:
For complete information about basic system operation, refer to Chapter 6, WinSpec/32 and WinView/32 First Light Procedure on page 49.

4.10 Fill the Dewar

⚠️ CAUTION! ⚠️
Because of the low operating temperatures, cryogenically-cooled detectors must always remain powered ON when Liquid Nitrogen (LN) remains in the dewar.

If detector power is turned off with liquid nitrogen remaining in the Dewar the array temperature will drop below the array’s normal operating temperature of -190°C. The array will not work properly until the power is turned back on and the array has warmed back up to -190°C. Always keep the detector powered ON following the completion of all experiments until all LN has either been removed or allowed to evaporate from the dewar, and the detector has warmed up to ambient temperature.

⚠️ WARNINGS! ⚠️
1. Always wear protective equipment when working with Liquid Nitrogen. Even minimal contact with LN can cause severe injury to eyes and skin. Avoid contact with the splashing that will invariably accompany the pouring of LN into a room temperature Dewar.
2. Always be careful when removing the Dewar filler cap if there is LN present in the Dewar. Pressure due to nitrogen gas can cause the cap to fly out when the retaining nut is loosened, possibly spraying you with liquid LN, which can cause severe injury.

NIrvana-LN detectors use liquid nitrogen to reduce the temperature of the array. The liquid nitrogen is stored in a Dewar that is enclosed in a vacuum jacket for minimal external thermal losses. The chip temperature is regulated by a heating element driven by closed-loop proportional control circuitry. A thermal sensing diode attached to the cooling block of the detector monitors the array temperature. Although the array temperature can be thermostatically controlled from 25°C to -194°C, pixel gain and offset corrections will be optimal when the camera operates at its default temperature of -190°C.
4.10.1 Fill Procedure

Perform the following procedure to fill the Dewar on a NIRvana-LN detector:

1. Loosen the retaining nut a few turns, then remove the LN Dewar port cap by pulling it straight out. See Figure 4-5.

![Figure 4-5: Dewar Ports and Valve](image)

2. It is recommended that an LN transfer Dewar with a pouring spout be used to transfer LN from the storage tank to the detector. When using a funnel, place a thin vent tube into the Dewar through the funnel to reduce splashing due to boiling LN.

3. Pour approximately 100 ml of LN into the Dewar. Stop for 5-10 minutes until a “geyser-like” vapor burst from the Dewar opening has been observed. This burst is normal and is related to thermal equilibrium having been achieved between the LN and the Dewar container surfaces.

4. Fill up the Dewar (approximately 2.2 liters for the standard Dewar.) To test the LN level, briefly insert a straight piece of wire (i.e., a cryogenic “dip stick,”) into the Dewar and remove it. The LN level will be indicated by the condensation on the wire.

5. Once the Dewar has been filled, replace the filler cap and hand-tighten the retaining nut by giving it about 3/4 turn (or more) beyond the point where the nut feels snug.

---

**WARNING!**

Ice buildup may occur at the pressure relief valve ports if the detector is being operated under high humidity conditions. Ice buildup could prevent the valves from venting properly. Because the venting safety bell covers the valves, this condition would not be readily apparent.
6. Set the desired temperature via the Detector Temperature dialog in WinSpec. To see when the array temperature reaches and stabilizes at the target temperature, leave the Detector Temperature dialog open. When the target temperature is reached, the dialog will report that the Current Temperature has Locked. An LN-cooled array normally reaches -100°C in under 2 hours.

**NOTES:**

1. Temperature regulation does not reach its ultimate stability for at least 30 minutes after temperature lock has been achieved. After this period of time the desired temperature is maintained with great precision.

2. The Detector Temperature dialog will not display temperature information while you are acquiring data.

**CAUTION!**

The pressure relief valve under the protective covering (see Figure 4-5) will occasionally emit a plume of N₂ gas and mist. Continuous hissing indicates that the vacuum in the Dewar jacket is probably inadequate. In this case, first remove all LN from the Dewar and allow the Dewar to warm up to room temperature. Then contact Teledyne Princeton Instruments Customer Support for further instructions. Refer to Contact Information on page 118 for complete information.
Chapter 5: LightField First Light Procedure

This chapter provides a step-by-step procedure for placing an imaging or spectroscopy system in operation for the first time when using Teledyne Princeton Instruments’ LightField 64-bit data acquisition software. The intent of this procedure is to 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 chapter assumes that the detector is being operated with an IsoPlane SCT-320 spectrograph on which it has been properly installed.

REFERENCES:
Refer to Appendix C, IsoPlane 320 Mounting, on page 105 for mounting instructions.

In a typical spectrograph, light enters the entrance slit and is collected by a collimating mirror. Collimated light strikes the grating and is dispersed into individual wavelengths. Each wavelength leaves the grating at a different angle and is imaged by a focusing mirror onto the exit focal plane. Essentially, a spectrograph forms an image of the entrance slit in the exit focal plane with each position in the plane representing a different wavelength. Since each wavelength falls at a different horizontal position, the spectrum of the input light is spread across the array. Individual wavelengths focused at different horizontal positions along the exit port of the spectrograph are detected simultaneously. Rotating the diffraction grating scans wavelengths across the array, allowing the intensity at individual wavelengths to be readily measured.

A suitable light source should be mounted in front of the spectrograph’s entrance slit.

CAUTION!
Overexposure Protection: Detectors that are exposed to room light or other continuous light sources quickly become saturated. If the detector is mounted to a spectrograph, close the entrance slit of the spectrograph to reduce incident light.
5.1 Operation Overview

During data acquisition, the array is exposed to a source and charge accumulates in the pixels. After the defined exposure time, the accumulated signal is readout of the array, digitized, and 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 block diagram shown in Figure 5-1.

Figure 5-1: Light Path Block Diagram for NIRvana-LN Systems

Whether or not the data are displayed and/or stored depends on the data collection operation that has been selected within LightField:

- **Preview**
  This mode is typically used when setting up the system during the First Light procedure.
  In 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.

  **NOTE:** The last frame acquired before Stop is selected cannot be stored.

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
Acquire 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.

REFERENCES:
For information about synchronizing data acquisition with external devices, refer to Chapter 8, Experiment Synchronization, on page 71.

All procedures in this chapter assume:
• The system has been set up in accordance with the instructions in the previous chapters.
• LightField has been previously installed on the host computer.
• Familiarity with LightField.
  If this is not the case, review the LightField User’s Manual (refer to Table 1-1, Related Documentation, on page 9,) or have it available while performing this procedure.
• Section 4.10, Fill the Dewar, on page 36, has been read prior to filling the Dewar;
• The system is being operated in spectroscopy mode.
• The spectrograph has an entrance slit shutter that is being controlled by the NIRvana-LN via the Shutter connector.

5.2 System Setup and Configuration
Perform the following procedure to set up the system:
1. Set the spectrograph entrance slit width to 25 μm.
2. Mount a light source in front of the entrance slit.
3. Mount the detector to the spectrograph exit port.
4. Connect the detector shutter cable between the entrance slit shutter and the NIRvana-LN Shutter connector.
  • External Slit Shutter
    A shutter assembly mounted externally to the spectrograph has a shutter cable that plugs into the NIRvana-LN 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-LN Shutter connector to that connector.
5. Power ON the camera and fill the Dewar.
6. Power ON the spectrograph.
7. Turn on the host computer power.
8. Launch LightField.
5.3 Configure Parameters

Perform the following procedure to configure parameters:

1. Once LightField is running, icons representing the detector and the spectrograph are displayed in the Available Devices area. In Figure 5-2, the detector being used is a NIRvana-LN: 640 and the spectrograph is an IsoPlane.

Figure 5-2: Typical LightField Available Devices Area
2. Drag the icons into the Experiment Devices area. See Figure 5-3.

**Figure 5-3: Typical LightField Experiment Devices Area**

The Experiment Settings stack to the left now displays several expanders. Because this is a new experiment, the default settings for the detector are active. The Status bar at the bottom of the window displays an icon for temperature status which 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.

3. From the Shutter expander, select Shutter Mode: Normal.
5.4 Confirm System Setup

Perform the following procedure to confirm proper system setup and configuration:

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

2. Click Run to begin previewing data. Depending on the display settings, either a spectral band (i.e., image,) or a graph should be displayed. Background noise will decrease as the camera cools to its default temperature.

3. Turn off the light source.
   Does the displayed data change to a background noise pattern or low intensity graph?
   • YES
     Light entering the spectrograph is being seen by the camera. The system may now be aligned and focused. Proceed to Section 5.5, Rotational Alignment, on page 45.
   • NO
     There is no difference between data displayed when the light source is on or off. Proceed to step 4.

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

5. Verify that the entrance slit is open a minimum of 10 μm.

6. Verify the Exposure Time on the Common Acquisition Settings expander is as required.

7. Confirm that Shutter Mode is set to Normal on the Shutter expander. If it is not, change it to Normal.

8. Check the shutter cable connections.

9. Can the shutter be heard opening and closing while operating in Run mode?
   • YES
     Turn the light source on, wait a minute, and turn the light off while viewing the data display.
     Is the issue resolved?
     — YES
     Stop acquisition and proceed to Section 5.5, Rotational Alignment, on page 45.
     — NO
     Stop data acquisition and proceed to step 10.
   • NO
     Stop data acquisition and proceed to step 10.

10. Verify 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 instructions.

NOTE: To obtain assistance, contact Customer Support. Refer to Contact Information on page 118 for complete information.
5.5 Rotational Alignment

The detector mounting hardware provides two degrees of freedom:

- Rotation:
  Rotation is 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.
  Focus means to physically move the detector back and forth through the focal plane of the spectrograph while watching a live display. The approach taken is to slowly move the detector in and out of focus and adjust for optimum focus.

This section assumes:

- The detector and spectrograph have already been turned on and the appropriate icons have been dragged into the Experiment Devices area as shown in Figure 5-3.
- Familiarity with the locations of the mounting plate, Micrometer Compartment, and locking set screw on the IsoPlane. If unsure of these locations, refer to the IsoPlane manual supplied with the spectrograph.

Perform the following procedure to rotationally align and focus a NIRvana-LN camera:

1. Mount a light source such as a Teledyne Princeton Instruments Hg and Ne/Ar Dual Switchable light source in front of the entrance slit.
2. With the spectrograph properly connected to the computer, turn the power on, wait for the spectrograph to initialize.
3. With the NIRvana-LN mounted to the spectrograph and connected to the computer, turn on the power and wait for the camera to initialize. If the camera is LN-cooled, the Dewar should be filled while the camera is ON.
4. Launch LightField and drag the icons for the NIRvana-LN and the IsoPlane into the Experiment Devices area.
5. Open the Spectrometer expander. Select the appropriate grating and set the center wavelength to 763.51 nm if using an NeAr light source.
6. Set the slit to 25 \( \mu \text{m} \). If necessary, adjust the Exposure Time to maintain optimum (near full-scale) signal intensity.
7. Wait until the camera locks at its default temperature.

**NOTE:**

It may be advantageous to change the Shutter Control setting to Disable Opened for the following steps.

8. Verify that the spectroscopy-mount adapter moves freely at the spectrograph.
9. Review the displayed information and click the RUN button to begin data acquisition. Data will be continuously acquired and displayed but will not be stored.
10. Use a 9/64” hex wrench to loosen the four (4) screws at the corners of the camera mounting plate.
11. While watching a live display of the spectrum, select a peak to monitor.
12. Rotate the camera. Up to 4 degrees of rotation is possible. The observed peak will go from broad to narrow and back to broad. The camera is rotationally aligned when the observed peak is at its narrowest.

**NOTE:**

The system may also be rotationally aligned using the following alternative method:

1. Acquire an image.
2. Display the horizontal and vertical cursor bars.
3. Compare the vertical bar to the line shape on the screen.
4. Rotate the detector until the line shape on the screen is parallel with the vertical bar.

13. After completing the rotational alignment, tighten the four mounting plate screws.

### 5.6 Focus the System

This procedure requires familiarity with the location of:

- The mounting plate;
- The micrometer compartment; and
- The locking set screw.

**REFERENCES:**

Refer to the IsoPlane User Manual supplied with the spectrograph for complete information.

Perform the following procedure to focus the NIRvana-LN with an IsoPlane SCT-320 spectrograph:

1. Remove the cover from the Micrometer Compartment.
2. Use a 3/32” hex wrench to loosen the locking set screw.
3. While continuously acquiring data, adjust the micrometer until the intensity level of a selected peak or peaks is maximized.
4. Tighten the locking set screw.
5. Replace the Micrometer Cover onto the spectrograph. Replace and tighten all cover screws.
6. Halt data acquisition.
7. If the Shutter Control setting has been set to Disable Opened, change it back to Normal at this time.
5.7 Data Collection

Perform the following procedure to begin acquiring data:

1. After the system has been rotationally aligned and focused, stop running in Alignment or Run mode.
2. Make any required changes to the experiment’s setup and software parameters. Changes may include adjusting exposure time, setting up an entrance slit shutter, changing timing mode to External Sync, and/or lowering the target temperature.
3. Begin running Acquire mode. Data will be acquired and displayed/stored according to the experiment’s configuration settings.
4. When data acquisition is complete, the detector power should remain on so the array temperature will remain locked for subsequent data acquisition. If no further data is to be collected, proceed to Section 5.8, Shut Down Procedure.

5.8 Shut Down Procedure

Perform the following procedure to shut down the system:

1. For liquid nitrogen cooled systems: Carefully empty the Dewar and store the liquid nitrogen that has been removed.

⚠️ CAUTION! ⚠️

Because of the low operating temperatures, cryogenically-cooled detectors must always remain powered ON when Liquid Nitrogen (LN) remains in the dewar.

Always keep the detector powered ON following the completion of all experiments until all LN has either been removed or allowed to evaporate from the dewar, and the detector has warmed up to ambient temperature.

⚠️ WARNINGS! ⚠️

1. Always wear protective equipment when working with Liquid Nitrogen. Even minimal contact with LN can cause severe injury to eyes and skin. Avoid contact with the splashing that will invariably accompany the pouring of LN into a room temperature Dewar.
2. Always be careful when removing the Dewar filler cap if there is LN present in the Dewar. Pressure due to nitrogen gas can cause the cap to fly out when the retaining nut is loosened, possibly spraying you with liquid LN, which can cause severe injury.

2. Close LightField.
3. Turn off spectrometer power (when applicable.)
4. Turn off the detector power.
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Chapter 6: WinSpec/32 and WinView/32
First Light Procedure

This chapter provides a step-by-step procedure for placing a spectroscopy system in operation for the first time when using Teledyne Princeton Instruments' WinSpec/32 data acquisition software. The intent of this procedure is to 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 chapter assumes that the detector is being operated with an IsoPlane SCT-320 spectrograph on which it has been properly installed.

REFERENCES:
Refer to Appendix C, IsoPlane 320 Mounting, on page 105 for mounting instructions.

In a typical spectrograph, light enters the entrance slit and is collected by a collimating mirror. Collimated light strikes the grating and is dispersed into individual wavelengths (i.e., colors.) Each wavelength leaves the grating at a different angle and is imaged by a focusing mirror onto the exit focal plane. Essentially, a spectrograph forms an image of the entrance slit in the exit focal plane with each position in the plane representing a different wavelength. Since each wavelength falls at a different horizontal position, the spectrum of the input light is spread across the array. Individual wavelengths focused at different horizontal positions along the exit port of the spectrograph are detected simultaneously. Rotating the diffraction grating scans wavelengths across the array, allowing the intensity at individual wavelengths to be readily measured.

A suitable light source, such as an NeAr light source or an incandescent light bulb, should be mounted in front of the spectrograph’s entrance slit.

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


6.1 Operation Overview

During data acquisition, the array is exposed to a source and charge accumulates in the pixels. After the defined exposure time, the accumulated signal is readout of the array, digitized, and 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 block diagram shown in Figure 6-1.

Figure 6-1: Light Path Block Diagram for NIRvana-LN Systems

Whether or not the data are displayed and/or stored depends on the data collection operation that has been selected within WinSpec/32:

- **Focus**
  
  Focus is typically used when setting up the system during the First Light procedure.
  
  In Focus 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.

  **NOTE:**
  
  The last frame acquired before Stop is selected can be stored.

Focus 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**
  Acquire 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 when operating in Fast Mode is that if data acquisition continues at too fast a rate for it to be stored, data overflow may occur.

**REFERENCES:**
For information about synchronizing data acquisition with external devices, refer to Chapter 8, Experiment Synchronization, on page 71.

All procedures in this chapter assume:
- The NIRvana-LN system has been installed and setup in accordance with the instructions in previous chapters.
- WinX/32 has been previously installed on the host computer.
- Familiarity with WinX/32.
  If this is not the case, review the WinSpec/32 User’s Manual (refer to Table 1-1, Related Documentation, on page 9,) or have it available while performing this procedure.
- Section 4.10, Fill the Dewar, on page 36, has been read prior to filling the Dewar;
- The system is being operated in spectroscopy mode.
- The spectrograph has an entrance slit shutter that is being controlled by the NIRvana-LN via the Shutter connector.

### 6.2 Power On Sequencing
The NIRvana-LN camera must be powered on before WinX/32 is launched in order to establish and maintain communication between the NIRvana-LN camera and the host computer.

If WinX/32 is launched before the NIRvana-LN has been powered on, many of the functions will be disabled. Only previously saved data can be retrieved and/or examined.
6.3 System Setup and Configuration

Perform the following procedure to set up the system hardware:

1. Set the spectrograph entrance slit width to 25 μm.
2. Mount a light source in front of the entrance slit.
3. Mount the NIRvana-LN detector to the spectrograph exit port.
4. Connect the shutter cable between the entrance slit shutter and the NIRvana-LN 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-LN Shutter connector to that connector.
5. Turn on power to the detector and fill the Dewar.

**NOTE:**

The detector must be turned on before WinSpec/32 is launched.

6. Turn on power to the spectrograph.
7. Turn on power to the host computer.

6.4 Configure NIRvana-LN Parameters

Perform the following procedure to configure WinSpec/32 with appropriate NIRvana-LN configuration parameters:

1. From the WinSpec/32 menu bar, select Setup ► Environment to display the Environment dialog.
   Review the DMA Buffer size information and make any changes that are necessary.
   Large arrays (e.g., 2048 x 2048,) require a buffer size on the order of 32 MB. If the buffer size needs to be changed, the host computer must be rebooted in order for the new memory allocation to take effect.

**NOTE:**

After rebooting the host computer, WinSpec/32 must be launched again.
2. From the WinSpec/32 menu bar, select Setup ▶ Hardware to display the Hardware Setup dialog. Select the Controller/Camera tab. Verify and/or configure the parameters as indicated in Table 6-1.

Table 6-1:  WinSpec/32 Hardware Configuration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Type</td>
<td>—</td>
<td>This information is read from the camera.</td>
</tr>
<tr>
<td>Camera Type</td>
<td>—</td>
<td>This information is read from the camera.</td>
</tr>
<tr>
<td>Shutter Type</td>
<td>Custom</td>
<td>System dependent.</td>
</tr>
<tr>
<td>Readout Mode</td>
<td>Full Frame</td>
<td>Available modes are read from the camera.</td>
</tr>
</tbody>
</table>

3. From the WinSpec/32 menu bar, select Setup ▶ Detector Temperature. Configure the detector temperature parameters as indicated in Table 6-2.

Table 6-2:  WinSpec/32 Target Temperature Configuration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Temperature</td>
<td>-190°C</td>
<td>This information is read from the camera.</td>
</tr>
</tbody>
</table>

When the array temperature reaches the configured target temperature, the Detector Temperature dialog will indicate that the temperature is Locked. Once temperature lock has been established, the temperature will remain stable to within ±0.05°C.

**NOTES:**

1. Some overshoot may occur which may cause temperature lock to be lost briefly and then quickly re-established. When reading the actual temperature reported by the application software, there may be a small difference between the configured and reported temperature when lock is established. This is normal and does not indicate a system malfunction.

2. The Detector Temperature dialog does not display temperature information during data acquisition.
4. From the WinSpec/32 menu bar, select Acquisition ▶ Experiment Setup…. Verify and/or configure the parameters as indicated in Table 6-3.

Table 6-3: WinSpec/32 Experiment Setup Configuration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Tab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure Time</td>
<td>100 ms</td>
<td></td>
</tr>
<tr>
<td>Accumulations &amp; Number of Images</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ROI Tab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>These parameters define the region of interest (ROI).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spectroscopy Mode</td>
<td>This option is selected</td>
<td></td>
</tr>
<tr>
<td>Full</td>
<td>Loads the full size of the chip into the edit boxes.</td>
<td></td>
</tr>
<tr>
<td>Store</td>
<td>Stores the Pattern for future reuse.</td>
<td></td>
</tr>
<tr>
<td>Timing Tab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing Mode</td>
<td>Free Run</td>
<td></td>
</tr>
<tr>
<td>Shutter Control</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Fast Mode/Safe Mode</td>
<td>Safe Mode</td>
<td></td>
</tr>
</tbody>
</table>
6.5 Configure IsoPlane SCT-320 Parameters

Perform the following procedure to configure WinSpec/32 with appropriate IsoPlane SCT-320 configuration parameters:

1. From the WinSpec/32 menu bar, select Spectrograph ► Define. The Define Spectrograph dialog is displayed. See Figure 6-2.

Figure 6-2: Typical Define Spectrograph Dialog

2. Select Install/Remove Spectrograph.
3. Review the list of Supported Spectrographs and select Acton SCT320.
4. Click Install Selected Spectrograph.
5. From the WinSpec/32 menu bar, select Spectrograph ► Move.
6. Select the grating to be moved, and set it to an appropriate position. For example, when using a NeAr lamp, set the grating to 763.51 nm.

NOTE: The spectral range of a NIRvana-LN is 900 nm to 1600 nm at -190°C.

7. Turn on the light source at the spectrograph entrance slit.
6.6 Verify Shutter Operation

Perform the following procedure to verify the shutter is operating properly and light is being received at the NIRvana-LN camera:

1. From the WinSpec/32 menu bar, select Acquisition ▶ Focus to begin data acquisition.

   **NOTES:**
   1. Depending on the display settings, either a spectral band image or a graph will be displayed.
   2. Background noise will decrease as the camera cools to its default temperature.

2. Turn off the light source at the spectrograph’s entrance slit. Does the displayed image change to a background noise pattern or low intensity graph?
   - Yes
     Light entering the spectrograph is being seen by the camera and the system is operating properly.
     Proceed to Section 6.7, Rotational Alignment, on page 57.
   - No
     There is no observable difference in the displayed data. Click Stop to halt Focus mode, and proceed to step 3.

3. Verify the spectrograph has an entrance slit shutter installed.

   **NOTE:**
   When using a spectrograph with an internal shutter, refer to the manufacturer’s user manual for information about shutter access and operation.

4. Verify that the entrance slit is open a minimum of 10 μm.

   **NOTE:**
   When using a spectrograph with an internal shutter, refer to the manufacturer’s user manual for information about shutter access and operation.

5. Verify that the light source has power and is turned on.
6. From the WinSpec/32 menu bar, select Acquisition ▶ Experiment Setup.
7. Click on the Timing tab and verify the following configuration settings:
   - The system is configured for an appropriate Exposure Time. Verify that Shutter Control is set to Normal.
   - Make any necessary configuration changes, and click OK to save and apply the changes.
8. Verify all shutter cable connections are secure.
9. From the WinSpec/32 menu bar, select Acquisition ▶ Focus to resume data acquisition.
10. Determine if the shutter is operating properly. While running in Focus mode, it should be possible to hear the shutter opening and closing.
   - If the shutter can be heard opening and closing, and step 3 through step 8 have all been performed, turn on the light source and observe the data being displayed.
     After approximately one minute turn off the light source while viewing the data display. Does the displayed image change to a background noise pattern or low intensity graph?
     — Yes
       Proceed to Section 6.7, Rotational Alignment, on page 57.
     — No
       Stop data acquisition.
       Contact Customer Support for assistance. Refer to Contact Information on page 118 for complete contact information.

6.7 Rotational Alignment

Perform the following procedure to rotationally align a NiRvana-LN camera:

1. Mount a Teledyne Princeton Instruments light source such as the IntelliCal light source in front of the entrance slit of the spectrograph.

2. With the spectrograph properly connected to the computer, turn the power on, wait for the spectrograph to initialize.

3. With the NiRvana-LN mounted to the spectrograph and connected to the computer, turn on the power and wait for the camera to initialize. If the camera is LN-cooled, the Dewar should be filled while the camera is ON.

4. Verify that the spectrograph has been defined, choose the grating, and set the grating to 763.51 nm if using an NeAr light.

REFERENCES: Refer to Section 6.5, Configure IsoPlane SCT-320 Parameters, on page 55 for information about defining a spectrograph and moving the grating.

5. Set the slit to 25 \( \mu \)m. If necessary, adjust the Exposure Time to maintain optimum, near full-scale signal intensity.

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

NOTE: At this time, it may be advantageous to change the Shutter Control setting to Disable Opened.

7. Turn on Focus mode.

8. Use a 9/64" hex wrench to loosen the four (4) screws at the corners of the camera mounting plate.

9. While watching a live display of the spectrum, select a peak to monitor.
10. Rotate the camera. Up to 4 degrees of rotation is possible. The observed peak will go from broad to narrow and back to broad. The camera is rotationally aligned when the observed peak is at its narrowest.

**NOTE:**
The system may also be rotationally aligned using the following alternative method:
1. Acquire an image.
2. Display the horizontal and vertical cursor bars.
3. Compare the vertical bar to the line shape on the screen.
4. Rotate the detector until the line shape on the screen is parallel with the vertical bar.

11. After completing the rotational alignment, tighten the four mounting plate screws.

### 6.8 Focus the System

This procedure requires familiarity with the location of:
- The mounting plate;
- The micrometer compartment; and
- The locking set screw.

**REFERENCES:**
Refer to the IsoPlane User Manual supplied with the spectrograph for complete information.

Perform the following procedure to focus the NIRvana-LN with an IsoPlane SCT-320 spectrograph:
1. Remove the cover from the Micrometer Compartment.
2. Use a 3/32” hex wrench to loosen the locking set screw.
3. While continuously acquiring data, adjust the micrometer until the intensity level of a selected peak or peaks is maximized.
4. Tighten the locking set screw.
5. Replace the Micrometer Cover onto the spectrograph. Replace and tighten all cover screws.
6. Halt data acquisition.
7. If the Shutter Control setting has been set to Disable Opened, change it back to Normal at this time.
6.9 Acquire Data

Perform the following procedure to begin acquiring data:

1. After the system has been rotationally aligned and focused, stop running in Focus mode.
2. Make any required changes to the experiment’s setup and software parameters. Changes may include:
   - Adjusting exposure time;
   - Setting up an entrance slit shutter;
   - Changing timing mode to External Sync;
   - Lowering the target temperature.
3. Begin running Acquire mode.
   Data will be acquired and displayed/stored according to the experiment’s configuration settings.
4. When data acquisition is complete, the detector power should remain on so the array temperature will remain locked for subsequent data acquisition.

   If no further data is to be collected, proceed to Section 6.10, Shut Down Procedure.

6.10 Shut Down Procedure

Perform the following procedure to shut down the system:

1. For liquid nitrogen cooled systems: Carefully empty the Dewar and store the liquid nitrogen that has been removed.

   **CAUTION!**

   Because of the low operating temperatures, cryogenically-cooled detectors must always remain powered ON when Liquid Nitrogen (LN) remains in the dewar.

   Always keep the detector powered ON following the completion of all experiments until all LN has either been removed or allowed to evaporate from the dewar, and the detector has warmed up to ambient temperature.

   **WARNINGS!**

   1. Always wear protective equipment when working with Liquid Nitrogen. Even minimal contact with LN can cause severe injury to eyes and skin. Avoid contact with the splashing that will invariably accompany the pouring of LN into a room temperature Dewar.

   2. Always be careful when removing the Dewar filler cap if there is LN present in the Dewar. Pressure due to nitrogen gas can cause the cap to fly out when the retaining nut is loosened, possibly spraying you with liquid LN, which can cause severe injury.

2. Close WinSpec/32.
3. Turn off spectrometer power (when applicable.)
4. Turn off the detector power.
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Chapter 7: Exposure and Signal

This chapter discusses the various factors that affect the signal acquired on an array, including array architecture, exposure time, temperature, and saturation.

7.1 Array Architecture

A photodiode array (PDA) is a two-dimensional, rectangular array of photodiodes attached to an integrated circuit (IC) chip. For spectroscopy, a PDA is placed at the image plane of a spectrograph to allow a range of wavelengths to be detected simultaneously.

Each sensor on a PDA is connected to its own charge storage well. These sensors respond to the intensity of light or infrared (IR) 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 that has been configured within the software, the charge in each well is read out serially.

7.2 Exposure Time

Exposure, which is configured on the Experiment Setup ► Main tab (Common Acquisition Settings expander), is the time between start and stop acquisition commands sent by the application software to the detector. In combination with triggers, these commands control when continuous cleaning of the array stops and when the accumulated signal will be readout. The continuous cleaning prevents buildup of dark current and unwanted signal prior to the event of interest. At the end of the exposure time, the array is read out and cleaning starts again.

NOTE: The NIRvana-LN camera has a minimum exposure time of:
- 100 μs in 250 kHz mode;
- 200 μs in 100 kHz mode.
7.2.1 Exposure with External Shutter

When a camera does not have an internal shutter, either the light source must be controlled or an external shutter must be used to block light from the array during readout. If the light source can be electronically controlled using the SHUTTER MON output, the FPA can be read out in darkness.

Another way to prevent light from falling on the array during readout is to use a Teledyne Princeton Instruments supplied 25 mm external shutter which is typically used at a spectrograph entrance slit. This shutter can then be controlled by the camera and is synchronized with the exposure-readout cycle as shown in Figure 7-1. The shutter compensation time \( t_c \) is approximately 8 ms for the 25 mm shutter.

**NOTE:**

When acquisition time is on the order of \( \sim 130 \mu s \) at 2 MHz or \( \sim 510 \mu s \) at 500 kHz, the addition of the 8 ms shutter compensation time slows the readout time, thus reducing the number of frames per second. To minimize the impact of shutter compensation time, disable shutter open in software.

![Figure 7-1: Timing Diagram: Mechanical Shutter and SHUTTER MON](image)

In *Figure 7-1*:
- \( t_{\text{exp}} \) = Exposure Time;
- \( t_o \) = Shutter Open Compensation Time;
- \( t_c \) = Shutter Close Compensation Time;
- \( t_R \) = Readout Time;
- SHUTTER MON is the output of the SHUTTER MON connector on the Aux I/O cable, and the TTL OUT connector when Shutter is selected.

7.3 Noise Sources

Primary noise sources include:
- Dark signal - IR signal from the environment and leakage current;
- Input signal - photon shot noise;
- Readout - noise generated when the multiplexers are read out.

The 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.
7.4 Cooling the Array

The detector in the NIRvana-LN is cryogenically-cooled. Although the detector can be operated at temperatures in the range of -175°C to -194°C, pixel gain and offset corrections are optimal when the camera is at its default temperature of -190°C. Generally speaking, the lower the array temperature, the lower the dark current and, therefore, the greater the sensitivity.

Cryogenically-cooled detectors use liquid nitrogen to reduce the temperature of the array. The liquid nitrogen is stored in a Dewar that is enclosed in a vacuum jacket for minimal external thermal losses. The chip temperature is regulated by a heating element driven by closed-loop proportional control circuitry. A thermal sensing diode attached to the cooling block of the detector monitors the chip temperature.

7.4.1 Array Temperature Control

Lowering the temperature of an array generally enhances the quality of the acquired signal.

- When Light Field is being used, temperature control is done on the Sensor expander.
- When WinSpec/32 is the controlling software, temperature control is achieved using the Setup ► Detector Temperature dialog shown in Figure 7-2.

Figure 7-2: Typical WinSpec/32 Detector Temperature Dialog

Once the desired target array temperature has been configured, the software controls the detector’s cooling circuits to reach set array temperature. On reaching that temperature, the control loop locks to that temperature for stable and reproducible performance. When the Target Temperature (Temperature Setpoint) has been reached, the current temperature is Locked and an on-screen indication allows easy verification of temperature lock.

The deepest operating temperature for a system depends on the array size and packaging; and the time required to achieve lock can vary over a considerable range, depending on such factors as the detector type, array type, ambient temperature, etc. Once lock occurs, it is okay to begin focusing. However, you should wait an additional thirty minutes before taking quantitative data so that the system has time to achieve optimum thermal stability.

NOTE: The Detector Temperature dialog does not display temperature information during data acquisition.
7.5 Background Subtraction

Background subtraction removes a fixed noise pattern from the integrated signal. In the case of the InGaAs FPA, the fixed pattern noise is due to material variations that cause pixel input offset voltages to vary. The input offset voltage of a photodiode may be:

- Zero Bias;
  No dark current.
- Reverse Bias;
  Dark current with the same bias as the photo current.
- Forward Bias;
  Dark current opposite to the photocurrent.

The pixel-pixel variation is repeatable from one readout of the array to the next provided the array is maintained at the same temperature, the same experiment settings are being applied, and ambient conditions do not change. Because the pixel-to-pixel variation is not random electrical noise, it can be removed by background subtraction.

When acquiring a background to be subtracted, the identical experiment settings are used but the experiment's signal source remains OFF. After the background has been saved, background subtraction can be set up to occur automatically as part of the data acquisition process, or the background data can be subtracted from the experiment signal as a post-acquisition process. Subtracting the background removes the dark signal (ambient signal and dark current component) of the signal data.

Figure 7-3 illustrates the configuration of Automatic Background Subtraction in WinSpec/32.

Figure 7-3: Typical WinSpec/32 Automatic Background Subtraction Dialog
NOTES:

1. Although a pattern is repeatable, its profile will change from temperature setting to temperature setting. Therefore, both the background data and the experiment data MUST be acquired at the same locked temperature.

2. In situations where uncorrected/raw data is required, perform background subtraction as a post-acquisition process.

Figure 7-4 compares an unprocessed image with the same image after background subtraction has been applied.

Figure 7-4: Image Comparison: Unprocessed vs. Background Subtraction

7.6 Flatfield Correction

The application of Flatfield Correction compensates for any non-uniformity of illumination sources and/or non-uniformity of the InGaAs detector. Applying a flatfield correction is a three-step process:

- A reference flatfield image must be acquired and saved;
- The data acquisition software must be configured to automatically apply the acquired reference image;
- Experiment data are acquired and the flatfield data are applied.

Perform the following procedure to apply flatfield correction to acquired experiment data:

1. Configure experiment parameters within the data acquisition software.
2. Wait until the detector has reached its operating temperature to ensure stability.
3. Acquire a flatfield reference image of the illumination source without applying an input source/sample.
4. Save the acquired flatfield reference image on the host computer’s hard drive.
5. Configure the data acquisition software to automatically apply the specified flatfield file to newly acquired data.  
   Figure 7-5 illustrates how to enable automatic flatfield correction within WinSpec/32.

**REFERENCES:**  
Refer to the LightField User’s Manual listed in Table 1-1 on page 9 for information about enabling automatic flatfield corrections.

**Figure 7-5: WinSpec/32 Enabling Automatic Flatfield Correction**

6. Configure the experiment with the sample in place and acquire data.  
The flatfield data will be automatically applied to the raw data, and the resulting data will be displayed and/or stored.
Chapter 7 Exposure and Signal

7.7 Remove Sensor Blemishes

Blemish correction is used to correct for bad sensor pixels, rows, columns, and/or clusters either at the time of acquisition (Online Correction) or after acquisition (Post-Process Blemish Correction.)

When identifying defective rows or columns, the coordinates of the starting point must be defined, as well as the length of the defective row or column. (Column and row numbering start at zero.) Pixel defects are defined by the coordinates of the defective point. When identifying cluster defects, the defective rows, pixels, and columns in cluster must all have the same Cluster ID and must be identified as to Type, Column, Row, and Length (a pixel defect has a length of 1 when defined as part of a cluster). Note that all pixels in a cluster must be touching (even if only at a corner).

Hardware binning is performed before blemish correction, and binned pixels are corrected if they contain any pixels identified as defective.

REFERENCES:

For complete information about Blemish Correction, refer to the User Manual supplied with the image acquisition software being used.

7.8 Dark Signal

Dark signal is a buildup of charge on the array over time. Even with light into the detector completely blocked, the array will collect a dark signal that is dependent on the exposure time, detector temperature, and a variety of other factors. The longer the exposure time and the warmer the detector, the larger and less uniform this background will appear. Thus, to minimize dark signal effects, the detector temperature should be set for the lowest temperature within the recommended range for the detector. For NIRvana-LN, a default temperature of -190ºC provides the best performance.

Dark signal values vary widely from one array to another and are temperature dependent.

NOTE:

Dark signals are fully subtractable readout patterns. Refer to Section 7.5, Background Subtraction, on page 64 for complete information.

CAUTION!

If a sudden change in the baseline signal is observed, there may be excessive humidity in the vacuum enclosure of the detector. Immediately turn off the controller, and if using an LN-cooled camera, remove the liquid nitrogen.

Next, contact Teledyne Princeton Instruments Customer Support for further instructions. Refer to Contact Information on page 118 for complete contact information.
7.9 Saturation

When signal levels in some part of an 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 recommended with signal averaging to enhance S/N (Signal-to-Noise 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 array, 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, determined by either the saturation of the array by the signal or the loss of dynamic range due to the buildup of dark signal.

7.10 Readout

Two factors to be considered with respect to array readout are:

- Region of Interest (ROI);
  ROI selection allows a section of an array to be specified and its data read out and saved. All data not included in the specified ROI are read out and discarded.

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

7.10.1 Region of Interest (ROI)

NIRvana-LN supports Region of Interest (ROI) or area selection. While there will be no increase in readout speed, there will be a reduction in the size of the data set.

Restrictions on ROI selection are:

- An ROI must contain either:
  - 4 pixels, or
  - A multiple of 4 pixels.

- The starting pixel in an ROI must lie on a four-pixel boundary.
  For example:
  - Pixel 1, pixel 5, pixel 9, pixel 13, etc., are valid starting pixels.
  - Pixel 2, pixel 4, pixel 8, and pixel 15 are all invalid starting pixels.

7.10.2 Controller Gain (Analog Gain)

Analog gain is the number of electrons required to generate an Analog-to-Digital Unit (ADU) which is also known as a count.

The NIRvana-LN camera has fixed gain and is not configurable. The analog gain is typically $7e^-$/ADU.
7.11 Digitization

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

REFERENCES:

For additional information, refer to Section 7.10, Readout, on page 68.

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

7.11.1 Digitization Rate

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 the software.

7.11.2 ADC Offset (Baseline Offset)

ADC offset, also known as baseline offset, provides another way of dealing with dark signal. By offsetting the baseline signal, much of the background is ignored during conversion. For the NIRvana-LN, this offset is set at the factory and is not configurable.

REFERENCES:

For additional information, refer to Section 7.8, Dark Signal, on page 67.

During the exposure time, in addition to the signal of interest, the array collects a charge pattern and an IR signal. The longer the exposure time and the warmer the detector/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 vacuum enclosure of the detector. Immediately turn off the controller, and if using an LN-cooled camera, remove the liquid nitrogen. Contact Teledyne Princeton Instruments Customer Support for further instructions. Refer to Contact Information on page 118 for complete contact information.
All NIRvana-LN arrays have been tested for uniformity and do not exhibit any vignetting (i.e., reduction of response,) at the extreme ends of the array. If a reduction in response is measured across the array, it may be the result of one or more of the following conditions:

- Water condensation has occurred on the edges of the Dewar window. This will occur only when the previously described cooling/pumping instructions have not been followed or if the Dewar itself has sprung a leak. This is a very rare occurrence.
- The spectrograph is not illuminating the full photoactive area of the array. Most spectrographs provide a minimum 1-inch-wide focal plane that should span the entire array. If the exit port has been masked, the full focal plane may not be available.

### 7.12 Software Binning

Binning is the process of summing data from adjacent pixels to form a single pixel that is often called a Super Pixel. Because InGaAs arrays do not have a serial register or a summing node, binning is accomplished in software after data have been read out and digitized.

Software binning can be configured to occur automatically from the Acquisition ► Experiment Setup ► ROI Setup tab (Region of Interest expander).

The advantage of software binning is that it can improve the S/N ratio by as much as the square root of the number of scans. Unfortunately, with a large number of scans (i.e., greater than 100,) detector 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 achieved. Again, background subtraction from the data is necessary.
Chapter 8: Experiment Synchronization

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;
- Fast Mode;
- TTL OUT Control.

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

- WinView/32, WinSpec/32: Parameters are found on the Experiment Setup ► Timing tab.
- LightField: Parameters are found on the Shutter and Trigger expanders.

8.1 Shutter Control Modes

When an external entrance slit shutter is being controlled by NIRvana-LN, shutter operation can be coordinated with the experiment. Available shutter control modes for Full Frame operation are:

- Normal;
- Disable Opened (Always Open);
  When selected, the shutter will not operate during the experiment and remains in the open position.
- Disable 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 signal measurements of the background, or when no shutter is present in the system.

**NOTE:**

The red SHUTTER FAULT LED on the NIRvana-LN power supply illuminates when the shutter is in the Disable Closed (Always Open) state.

- Pre Open (Open Before Trigger).
  When selected, the shutter opens as soon as the detector’s internal controller is ready to receive trigger. This is required if the time between the trigger 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);
  - Trigger Start (Start On Single Trigger).

---

1. Only supported by WinView/32 and WinSpec/32.
8.2 Timing (Trigger Response) Modes

The selected Timing (Trigger Response) mode determines how the NIRvana-LN responds to a trigger received on the TRIGGER IN line on the AUX I/O port located on the rear of the camera. See Figure 8-1.

Figure 8-1: Rear Panel Connectors on NIRvana-LN Detector

When configuring the trigger input, consider the following criteria:

- **Pulse Height**
  0 to $+3.3 \, V_{DC}$ logic levels (TTL-compatible).

- **Pulse Width (trigger edge frequency)**
  The time between trigger edges.

- **Trigger In Connector Impedance**
  High impedance.

- **Edge Trigger (Trigger Determined By)**
  Rising (+) or Falling (-) Edge must be specified on the Experiment Setup ► Timing tab (Trigger expander).

The timing modes are combined with the Shutter Control (Shutter Mode) options, the widest variety of modes for precision experiment synchronization are provided. Supported Timing (Trigger Response) modes for Full Frame operation include:

- **Free Run (No Response);**
- **External Sync (Readout Per Trigger);**
- **Bulb Trigger (Exposure During Trigger Pulse);**
- **Trigger Start (Start On Single Trigger).**

**NOTE:**

Although it continues to be supported, Clean Until Trigger is no longer required due to improvements that have been made to the NIRvana-LN timing sequence.
8.2.1 Free Run (No Response)

In this mode, there is no external triggering or the camera ignores 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 8-2 for the timing diagram for this mode where:
- \( t_R \) = 4.051 mS.

Figure 8-2: Timing Diagram: Free Run (No Response)

8.2.2 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 a one-frame sequence, Bulb Trigger (Expose During Trigger Pulse) and Trigger Start (Start on Single Trigger) are equivalent to External Sync (Readout Per Trigger) mode.

Figure 8-3 illustrates a timing diagram for this mode where:
- Triggering is on Trigger In rising edge;
- \( t_{TRIG} \geq 20 \text{ nS} \);
- \( t_R = 4.051 \text{ mS} \);

Shaded areas indicate the idle time between exposures.
8.2.3 Bulb Trigger (Expose During Trigger Pulse)

When Bulb Trigger (Expose During Trigger Pulse) timing is selected, the camera exposure is determined by an external trigger received on the TRIGGER IN signal through the AUX I/O port (see Figure 8-1) which allows an external timing generator to control the exposure time of the camera.

In Full Frame mode, the transition from the inactive state to the active state of the external trigger starts the exposure, while the transition from the active state to the inactive state ends the exposure.

When the camera is ready to accept the external sync through the TRIGGER IN signal, the Wait for Trigger (Waiting For Trigger) (WFT) signal at the AUX I/O port’s TTL OUT signal is high (if WFT is the selected output signal):

- WFT goes HIGH immediately after readout (or after Pre Open when active.)
- WFT goes LOW when an active edge (+ or – edge depending on the setting) occurs and the exposure begins.

Figure 8-4 illustrates the timing diagram for Bulb Trigger (Expose During Trigger Pulse) mode with the following configuration settings:

- Non-Overlap Mode;
- Three Exposure Sequence;
- No Pre Open (Open Before Trigger).
8.2.4 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 further triggers until the entire exposure/readout sequence has been completed.

8.3 Fast Mode

When using WinView/32 or WinSpec/32 and are operating in Fast Mode, NIRvana-LN runs according to the timing of the experiment, with no interruptions from the computer. Fast operation is primarily intended for collecting real-time sequences of experimental data where timing is critical and events cannot be missed. Once the NIRvana-LN has sent the start command by the computer, all frames are collected without further intervention from the computer.

The advantage of this timing mode is that timing is controlled completely through hardware. A drawback to this mode is that the computer only displays frames when it is not performing other tasks. Image display has a lower priority, so the image on the screen may lag several images behind. A second drawback is that a data overrun may occur if the number of images collected exceeds the amount of allocated RAM, or if the computer cannot keep up with the data rate.

**NOTE:**

Only Fast Mode should be used when running a NIRvana-LN detector via WinSpec. Do not select Safe Mode if the choice is available. LightField always uses Fast Mode.

Figure 8-5 shows a flow chart for Fast Mode operation.
Figure 8-5: Fast Mode Operation Flowchart

1. **Start** (Fast Mode)
2. Computer programs camera with exposure and binning parameters.
3. Start Acquisition command sent from computer to camera.
4. Cleans Performed
5. 1 Frame collected as per timing mode.
6. Background or Flatfield on?
   - **Yes**: Background and/or Flatfield correction performed.
   - **No**: Frames Complete?
8. During next acquisition frames are displayed as time permits
9. Stop Acquisition command sent from computer to camera
10. Stop
8.4 TTL OUT Control

The TTL-compatible logic level output (0 to +3.3 VDC) from the TTL Out connector on the AUX I/O cable can be used to monitor camera status and control external devices.

**NOTE:**

By default, TTL OUT is active HIGH.

The timing of the level changes depends on the output type selected on the Hardware Setup Controller/Camera tab (Trigger expander):

- **Shutter (Shutter Open)**
  This level is at a logic high while the shutter is opening and during the programmed exposure time. The output precisely brackets shutter-open time (exclusive of the shutter close compensation time \( t_c \)) and can be used to control an external shutter.

- **Expose (Program’d) (Exposing)**
  This level is at a logic high during the programmed exposure time (i.e., the time configured in the software.) It can be used to synchronize a pulser or timing generator with exposure.

- **Read Out (Reading Out)**
  It is at a logic high when CCD is being read; otherwise low.

- **Acquiring (Acquiring)**
  After a start acquisition command, this output changes state on completion of the array 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 8-6 assumes three frames have been programmed.

**Figure 8-6: Timing Diagram: TTL OUT Control**
Additional related signals and configuration settings include:

- **Logic 1 (Always High)**
  
  TTL OUT is always pulled HIGH (1).

- **Wait for Trigger (Waiting For Trigger)**
  
  TTL OUT goes HIGH (1) when the camera is ready to acquire and is waiting for an external trigger from the TRIGGER IN signal before exposing the CCD. TTL OUT goes LOW (0) once a trigger has been detected and exposure has started.
  
  The Wait for Trigger (WFT) signal goes high immediately after readout or, if it is active, after Pre Open (Open Before Trigger).
  
  Before the next cycle begins, TRIGGER IN is checked again, and exposure will start if a trigger has occurred.

- **Invert LOGIC (Invert Output Signal)**
  
  When checked, TTL OUT is treated as an Active LOW signal.

- **Effectively Exposing**
  
  TTL OUT is HIGH (1) when the sensor is exposed as requested.
Chapter 9: Non-Destructive Readout

Typically, data readout operations are destructive in nature. That is, once the collected data are read, a cleaning operation is initiated, and the data are cleared from the FPA. In addition to standard readout operation, NIRvana-LN systems support Non-Destructive Readout (NDRO.) NDRO provides the ability to read data collected without initiating a clean operation making it possible to monitor an experiment’s progress without destroying/affecting currently collected data. This is particularly useful when performing experiments requiring extremely long exposure times, sometimes spanning hours.

**NOTE:**
NDRO is only supported within LightField 4.8 and later. WinX/32 does not support NDRO.

9.1 Configuration

NDRO is enabled and configured within the Readout expander in LightField. See Figure 9-1.

Figure 9-1: Typical LightField Readout Expander

When Enable NDRO is checked/enabled, two additional configuration settings are displayed:

- **NDRO Period;**
  This controls the rate of exposure progress via non-destructive readout.
  Valid values are 1 … 33521 seconds in 1-second increments.

- **Save NDRO Frames.**
  When checked, frames that have been read out in a non-destructive manner are saved in addition to those read out normally.
See Figure 9-2.

Figure 9-2: Typical LightField NDRO Configuration Parameters

![Configuration Parameters](image)

⚠️ **CAUTION!**

The configuration values for both Exposure Time and NDRO Period can be changed dynamically (i.e., while an experiment is in progress.) However, if Save NDRO Frames is enabled, and one (or both) of these values are changed while an Experiment is in progress, the experiment/application may crash if there is insufficient disk space.

### 9.1.1 Compatibility Restrictions

The following features are currently not supported when using NDRO:

- Exposures Per Frame (i.e., software accumulations,) is not supported during NDRO.
- Step and Glue is not currently supported with NDRO. Attempting to use these simultaneously results in an error condition.
9.2 Frame Tracking

Frame Tracking is the process by which LightField assigns an incrementing identification number to each frame as it is readout. Frame Tracking is enabled/disabled on the Common Acquisitions expander as shown in Figure 9-3.

Figure 9-3: Typical Common Acquisition Settings Expander: Frame Tracking

Frame Tracking must be enabled when using NDRO. By default, LightField automatically enables Frame Tracking when NDRO is enabled. However, if Frame Tracking is manually disabled, an Experiment Conflict is reported and displayed within LightField. See Figure 9-4.

Figure 9-4: Experiment Conflict: Frame Tracking Disabled During NDRO

During data acquisition, the Frame Tracking number is incremented only at the start of a Destructive Readout (DRO) cycle. When NDRO used:

- The tracking number starts at 0;
- Is not incremented for interim NDRO cycles;
- Increments on each DRO.
9.3 Monitoring Experiment Progress

An NDRO experiment’s progress is monitored and displayed using several criteria:

- Progress Circle
  Once an experiment has been started, the Progress Circle is displayed to the right of the three (3) Experiment Control buttons. See Figure 9-5.

Figure 9-5: Typical Experiment Progress Circle Display: 25% Complete

When performing standard experiments (i.e., DRO,) the Progress Circle indicates Exposure Per Frame progress. However, when an NDRO experiment is being performed, it represents the elapsed percentage of the Exposure Time for a single Destructive Readout cycle.

For example, consider an NDRO experiment with the following configuration settings:

- Exposure Time = 20 seconds;
  After 20 seconds, a Destructive Readout and cleaning is initiated.
- NDRO Period = 5 seconds.
  An NDRO is performed at 5 seconds, 10 seconds, and 15 seconds for each frame exposure.

Five seconds after the start of the experiment, 25% of the programmed Exposure Time has elapsed. Therefore, the indicator will have swept out 25% of the circle (represented by green shading,) similar to that shown in Figure 9-5.

At the end of the programmed exposure time, a Destructive Readout and cleaning is performed, the Progress Circle is reset to zero, and the progress indicator starts sweeping another circle.

**NOTE:**

When the programmed NDRO Period is longer than or equal to the programmed Exposure Time, no NDRO frames will be read/displayed, and the Progress Circle will not be active.

- Waiting for Data Progress Bar
  The Waiting for Data bar displays the progress/elapsed time between two consecutive data readout operations. Following each readout, the bar is reset to zero. The progress bar shown Figure 9-6 indicates that approximately 50% of the time has elapsed between two readout operations.

Figure 9-6: Typical Waiting for Data Progress Bar: 50% Elapsed
• Number of Frames Indicator
  Indicates how many frames have been completed with respect to the total
  number of Destructive Readout frames to be captured. Progress is indicated:
  — Numerically (e.g., 1 of 8 Frames, 2 of 30 Frames, etc.)
  — Graphically as a progress bar.
  See Figure 9-7.

Figure 9-7: Typical Number of Frames Progress Indicator

9.4 Other Derived Parameters

In addition to overall experiment progress information, the following rates are
 calculated using measured NDRO data:

• Estimated Frame Rate;
• Application Frame Rate;
• Data Transfer Rate.
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Chapter 10: Troubleshooting

**WARNING!**
Do not attach or remove any cables while the NIRvana-LN system is powered on.

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

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10.1 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 detector vacuum enclosure. Turn off the detector, carefully remove liquid nitrogen from the detector (if applicable,) and have the detector repumped before resuming normal operation. Contact Customer Support for further instructions. Refer to Contact Information on page 118 for additional information.

10.2 Camera1 (or Similarly Named Device) in Camera Name Field

When the Camera Detection Wizard installs a new camera, the camera is automatically named Camera#, where # = 1, 2, 3, ..., depending on the number of cameras detected. This name appears in the title bar on the Hardware Setup dialog, as well as the on the Hardware Setup ➤ Controller/Camera tab. See Figure 10-1.

Figure 10-1: Camera1 in Controller/Camera Tab, Camera Name Field

If desired, a more descriptive name can be provided by editing PVCAM.INI (located in the Windows directory) to rename the camera. The new name will then be used by the system until the Camera Detection Wizard is run again.

Perform the following procedure to change the default Camera Name:

1. Close the application program if it is running.
2. Using Notepad.exe, open PVCAM.INI from the Windows directory.
3. Edit the Name as illustrated in Figure 10-2.

Figure 10-2: Editing Camera Name using a Text Editor (e.g., NotePad)
4. Save the edited file.
5. The next time the image application software is launched, the new name will be displayed on the Hardware Setup dialog. See Figure 10-3

Figure 10-3: Updated Camera Name on Hardware Setup Dialog

![Hardware Setup: Camera1](image1.png)

![Hardware Setup: NIRvana-LN](image2.png)

**NOTE:**
If the Camera Detection Wizard is run at a later time, the camera's name will revert to the default value (i.e., Camera1.)
10.3 Cooling Troubleshooting

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

10.3.1 Temperature Lock cannot be Achieved or Maintained.

Possible causes could include:
- The vacuum has deteriorated and needs to be refreshed.
- The target array temperature is not appropriate for the particular detector and array.

10.3.2 Detector loses Temperature Lock

The internal temperature of the detector is too high. This might occur if the operating environment is particularly warm, if you are trying to operate at a temperature colder or warmer than the specified limit, or if there is not enough LN in the Dewar. Refill the Dewar and verify that temperature lock can now be achieved.

If the problem persists, contact Customer Support for further instructions. Refer to Contact Information on page 118 for additional information.

10.3.3 Gradual Deterioration of Cooling Capability

With time, there will be a gradual deterioration of the detector's vacuum. This, in turn, will eventually affect temperature performance and it may no longer be possible to achieve temperature lock at the lowest temperatures. In the kind of low-light applications for which cooled array detectors are so well suited, it is highly desirable to maintain the system's temperature performance because lower temperatures provide less thermal noise and better signal-to-noise ratio.

Vacuum deterioration occurs primarily as a result of outgassing of components in the vacuum chamber. Because outgassing normally diminishes with time, the rate of vacuum deterioration in new detectors will be faster than in old ones. When the detector no longer maintains an acceptable cold temperature, contact Customer Support to make arrangements to return the detector to have the vacuum restored. Refer to Contact Information on page 118 for additional information.

⚠️ WARNING! ⚠️

Do not open the vacuum valve under any circumstances. Opening the vacuum valve will void the warranty.
10.4 Data Overrun Due to Hardware Conflict Message Displayed

If this dialog appears when acquiring a test image, acquiring data, or running in focus mode, check the array size and then check the DMA buffer size. A large array (e.g., a 2048x2048 array) requires a larger DMA buffer larger setting than that for a smaller array (e.g., a 512x512 array.)

Figure 10-4: Data Overrun Due to Hardware Conflict Dialog

Perform the following procedure to change the DMA buffer size:

1. Note the array size listed on the Setup ▶ Hardware ▶ Controller/CCD tab or on the Acquisition ▶ Experiment Setup ▶ Main tab Full Chip dimensions.
2. Open the Setup ▶ Environment ▶ Environment dialog.
3. Increase the DMA buffer size to a minimum of 32 MB (64 MB if it is currently 32 MB or 128 MB if it is currently 64 MB), click on OK, and close WinSpec.
4. Reboot the computer.
5. Restart the application software, and begin acquiring data or focusing. If the problem persists, increase the DMA buffer size again.

10.5 Detector 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 detector system hardware, begin with these simple checks:

- Turn off all AC power.
- Verify that all cables are securely fastened and that all locking screws are in place. Correct any apparent problems and turn the system on.
- If the system still does not respond, contact Customer Support.
10.6 Ethernet Network is Not Accessible

When the Teledyne Princeton Instruments software is installed, all Intel Pro/1000 interface card drivers found on the host computer are updated with the Intel Pro/1000 Grabber Adapter (Vision High-Performance IP Device) driver provided by Pleora Technologies, Inc. If this 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 you are using WinX (32-bit) or LightField (64-bit).

10.6.1 WinSpec/32 Applications

Perform the following procedure to restore an Ethernet network connection for WinSpec/32 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:

   nx32/GigE/`

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 32-Bit eBus Driver Installation Tool Dialog**

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.

10.6.2 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 10-6 illustrates the installation tool dialog that is displayed.

   **Figure 10-6: Typical 64-Bit eBUS Driver Installation Tool Dialog**

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.
10.7 Program Error Message Displayed

Figure 10-7 illustrates the dialog that may be displayed when attempting to acquire a test image, acquire data, or run in focusing mode and the DMA buffer size is too small. A large array (e.g., a 2048x2048 array,) requires a larger setting than that for a smaller array (e.g., a 512x512 array.)

Figure 10-7: Typical Program Error Dialog

Perform the following procedure to correct the problem:

1. Click on OK.
2. Reboot WinSpec.
3. Note the array size on the Setup ► Hardware ► Controller/CCD tab or on the Acquisition ► Experiment Setup ► Main tab Full Chip dimensions). If the detector contains a large array (e.g., a 2048x2048 array,) and the DMA buffer size is too small, there will not be enough space in memory for the data set.
5. Increase the DMA buffer size to a minimum of 32 MB (64 MB if it is currently 32 MB, or 128 MB if it is currently 64 MB,) click on OK, and close WinSpec.
6. Reboot the computer.
7. Restart WinSpec and begin acquiring data or focusing. If the problem persists, increase the DMA buffer size again.
10.8 Serial Violations Have Occurred. Check Interface Cable.

Figure 10-8 illustrates the error message displayed when acquiring an image or focusing the detector and one (or both) of the following conditions exists:

- The detector system is not turned ON.
- There is no communication between the detector and the host computer.

Figure 10-8: Serial Violations Have Occurred Dialog

Perform the following procedure to correct the problem:

1. Turn OFF the detector system (if it is not already OFF).
2. Verify the computer interface cable is secured at both ends.
3. After verifying the cable is connected, turn the detector system power ON.
4. Click OK on the error message dialog and retry acquiring an image or running in focus mode.

NOTE: This error message will also be displayed if the detector system is turned OFF or a cable comes loose while the application software is running in Focus mode.

10.9 Vignetting

All arrays have been tested for uniformity and do not exhibit any vignetting (i.e., reduction of response,) at the extreme ends of the array. If such a reduction in response across the array is measured, it may be the result of one or more of the following conditions:

- Condensation of water on the edges of the array window has occurred. This should not happen unless the cooling/pumping instructions, previously mentioned, were not followed or if the Dewar has developed a vacuum leak (a rare situation).
- The arrays are held with a special mask that has been designed to minimize reflection and stray light. These masks have been designed to allow light rays to enter through the Dewar window even at very wide angles (e.g., ≥ f/1.5.) If vignetting is observed, it is possible that your experiment exceeds these angular constraints. Teledyne Princeton Instruments measures the array response with a collimated uniform light source to prevent such false bias results.
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Appendix A: Specifications

⚠️ CAUTION! ⚠️
The specifications supplied in this manual are subject to change without notification. For up-to-date information about NIRvana-LN detectors, refer to the data sheets available from Teledyne Princeton Instruments at www.princetoninstruments.com or contact a Teledyne Princeton Instruments Customer Representative. Refer to Contact Information on page 118 for additional information.

A.1 Mechanical Dimensions
Refer to Appendix B, Outline Drawings, on page 95 for hardware dimensions.
NIRvana-LN Weight:
- Empty: 15.2 lbs [6.9 kg];
- Filled with LN: 19.2 lbs [8.74 kg].
Power Supply Weight: 4 lb (1.8 kg)

A.2 Power Specifications
All DC voltages required by NIRvana-LN cameras are generated by an external power supply and then delivered to the camera using a custom power cable.
Refer to Table A-1 for input power specifications for the external NIRvana-LN Power Supply.

Table A-1: Input Power Specifications: External NIRvana-LN Power Supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Nominal</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>Input Frequency</td>
<td>47</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Input Power</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
A.3 Environmental Specifications

Refer to Table A-2 for environmental specifications for the NIRvana-LN system.

Table A-2: NIRvana-LN Environmental Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Temperature</td>
<td>-20°C — +55°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>5°C — +30°C</td>
</tr>
<tr>
<td>Operating Ambient Relative Humidity</td>
<td>&lt;50% (non-condensing)</td>
</tr>
<tr>
<td>Operating Ambient Temperaturea</td>
<td>0°C — +30°C</td>
</tr>
</tbody>
</table>

a. Although operation to -25°C is achievable, operation below 0°C is not guaranteed.

**CAUTION!**

High humidity climates may require the continuous flushing of the spectrograph’s exit port with nitrogen. If LN-cooled detectors are operated under high humidity conditions, ice buildup could occur around the pressure relief vent valve ports and prevent them from operating properly. Because the venting safety bell covers the valves, this condition would not be readily apparent. Damage from humid condensation may not be covered by the product warranty.

A.4 Focal Plane Array Specifications

Contact the factory for up-to-date information about available chips and chip performance specifications, or visit [www.princetoninstruments.com](http://www.princetoninstruments.com) for the current list of arrays supported by NIRvana-LN.
A.5 AUX I/O Interface

The AUX I/O interface provides access to the trigger function, DAC, and TTL signals via a rear panel connector and an AUX I/O cable that is supplied with each NIRvana-LN system. This section provides pinout information for both the rear panel AUX I/O connector as well as the AUX I/O Cable.

Table A-3 provides TTL signal specifications for the AUX I/O interface.

Table A-3: AUX I/O Interface TTL Signal Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Nominal</td>
</tr>
<tr>
<td>$V_{IN}$ (logic 1)</td>
<td>2.4</td>
<td>—</td>
</tr>
<tr>
<td>$V_{IN}$ (logic 0)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rise Time</td>
<td></td>
<td>≤ 40</td>
</tr>
<tr>
<td>Duration</td>
<td>≥ 100</td>
<td></td>
</tr>
</tbody>
</table>

The AUX I/O connector is located on the rear of the NIRvana-LN chassis. It is a female, DB26, high-density connector.

Figure A-1 illustrates the pinout of the AUX I/O connector, viewed from the rear panel of the NIRvana-LN chassis, with each contact/pin identified by its pin number.

Figure A-1: AUX I/O Connector Pinout

Table A-4 provides complete information about each AUX I/O pin and signal sorted by pin number.

Table A-4: AUX I/O Connector Pinout and Signal Descriptions (Sheet 1 of 3)

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal Name</th>
<th>Signal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRIGGER IN</td>
<td>0 to +3.3V logic level input (TTL-compatible) that has a 25 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.</td>
</tr>
<tr>
<td>2</td>
<td>TTL OUT</td>
<td>0 to +3.3V programmable logic level output (TTL compatible). The output of this connector can be selected and can also be inverted via the application software.</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
<tr>
<td>4</td>
<td>DAC1</td>
<td>10-bit programmable output (0 – 2.5 V). 100 ? source impedance.</td>
</tr>
</tbody>
</table>
Table A-4: AUX I/O Connector Pinout and Signal Descriptions (Sheet 2 of 3)

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal Name</th>
<th>Signal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>DAC2</td>
<td>10-bit programmable output (0 – 2.5 V). 100 ? source impedance.</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
<tr>
<td>7</td>
<td>READOUT MON</td>
<td>Active high. A high level on this output indicates that data is being read out of the array.</td>
</tr>
<tr>
<td>8</td>
<td>EXPOSE MON</td>
<td>Active high. A high level on this output indicates that the detector is exposing (integrating).</td>
</tr>
<tr>
<td>9</td>
<td>TTL I/O LATCH ENABLE</td>
<td>Logic 1, TTL I/O inputs are monitors. Logic 0, TTL I/O inputs are latched on the negative transition.</td>
</tr>
<tr>
<td>10</td>
<td>TTL I/O Data Bit 0</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>11</td>
<td>TTL I/O Data Bit 1</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>12</td>
<td>TTL I/O Data Bit 2</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>13</td>
<td>TTL I/O Data Bit 3</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>14</td>
<td>TTL I/O Data Bit 4</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>15</td>
<td>TTL I/O Data Bit 5</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>16</td>
<td>TTL I/O Data Bit 6</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
<tr>
<td>17</td>
<td>TTL I/O Data Bit 7</td>
<td>TTL level programmable input or output. 16-bit register, with 8 LSB for data and 8 MSB controlling I/O direction Logic 1: corresponding data bit is an output. Logic 0 the bit is an input).</td>
</tr>
</tbody>
</table>
### Table A-4: AUX I/O Connector Pinout and Signal Descriptions (Sheet 3 of 3)

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal Name</th>
<th>Signal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>GND</td>
<td>System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
<tr>
<td>19</td>
<td>Power Status</td>
<td>A high level on this output indicates that the detector power is switched on (+3.3 V = on, 0 V = off).</td>
</tr>
<tr>
<td>20</td>
<td>GND</td>
<td>System chassis ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
<tr>
<td>21</td>
<td>Reserved</td>
<td>Reserved for Future Use: DO NOT USE</td>
</tr>
<tr>
<td>22</td>
<td>Reserved</td>
<td>Reserved for Future Use: DO NOT USE</td>
</tr>
<tr>
<td>23</td>
<td>SHUTTER MON</td>
<td>The level at this output is high while the shutter is opening and during the programmed exposure time. The output precisely brackets shutter-open time (exclusive of the shutter close compensation time $t_c$) and can be used to control an external shutter.</td>
</tr>
<tr>
<td>24</td>
<td>HEATER ENABLE</td>
<td>Open or Logic 1 will enable the heater. Logic 0 will disable the heater.</td>
</tr>
<tr>
<td>25</td>
<td>GND</td>
<td>System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
<tr>
<td>26</td>
<td>GND</td>
<td>System digital ground. Any external circuitry intended to interface with the trigger control signals must reference this ground connection.</td>
</tr>
</tbody>
</table>
A.5.1 AUX I/O Cable

Each NIRvana-LN system includes an AUX I/O cable that provides convenient access to several system signals. The AUX I/O interface cable is comprised of a male DB26 connector on one end, and five female BNC cables on the other end, each of which provides access to a system signal.

Figure A-2 illustrates a typical cable.

Figure A-2: AUX I/O Cable (6050-0681)

Table A-5 provides the color code and pinout information for the AUX I/O interface cable.

Table A-5: AUX I/O Interface Cable Pinout and Signal Information

<table>
<thead>
<tr>
<th>Cable Color</th>
<th>BNC Conductor</th>
<th>Signal Name</th>
<th>DB26 Pin #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Center</td>
<td>TRIGGER IN</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Shield</td>
<td>Ground</td>
<td>3</td>
</tr>
<tr>
<td>Green</td>
<td>Center</td>
<td>TTL OUT</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Shield</td>
<td>Ground</td>
<td>6</td>
</tr>
<tr>
<td>Blue</td>
<td>Center</td>
<td>READOUT MON</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Shield</td>
<td>Ground</td>
<td>18</td>
</tr>
<tr>
<td>Gray</td>
<td>Center</td>
<td>EXPOSE MON</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Shield</td>
<td>Ground</td>
<td>20</td>
</tr>
<tr>
<td>Black</td>
<td>Center</td>
<td>SHUTTER MON</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Shield</td>
<td>Ground</td>
<td>25</td>
</tr>
</tbody>
</table>
Appendix B: Outline Drawings

NOTE:
Dimensions are in inches unless otherwise indicated.

B.1 Power Supply

Figure B-1: Outline Drawing: NIRvana-LN Power Supply
Figure B-2: Outline Drawing: NIRvana-LN with F-Mount

- MECHANICAL DISTANCE = 1.850
- WINDOW INSIDE SURFACE TO FOCAL PLANE = 1.028
- WINDOW THICKNESS = 0.059
- 64°
- VACUUM PORT
- LN FILL PORT
- NIKON "F" MOUNT
- POWER
- EXTERNAL SHUTTER
- AUX I/O
- MECHANICAL DISTANCE = 1.850
- WINDOW INSIDE SURFACE TO FOCAL PLANE = 1.028
- WINDOW THICKNESS = 0.059
- 64°
- VACUUM PORT
- LN FILL PORT
- NIKON "F" MOUNT
- POWER
- EXTERNAL SHUTTER
- AUX I/O

NOTES:
1. LN2 CAPACITY = 2.3 LITERS
2. UNIT WEIGHT (EMPTY) = 7.0KG    (FULL) = 8.8KG
Figure B-3: Outline Drawing: NIRvana-LN with Spec-Mount
Appendix C: IsoPlane 320 Mounting

Using the NIRvana-LN with an IsoPlane 320 requires the custom spectroscopy-mount illustrated in Figure C-1. This adapter is an optional accessory which can be purchased from Teledyne Princeton Instruments. Refer to Contact Information for complete contact information.

Figure C-1: IsoPlane SCT-320 Spectroscopy-Mount

C.1 Required Items

Refer to Table C-1 for the list of items required to prepare the NIRvana-LN to be used with an IsoPlane 320.

Table C-1: Required Items

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NIRvana-LN Spectroscopy Mount Kit</td>
<td>1</td>
</tr>
<tr>
<td>—</td>
<td>#2 Phillips-head screwdriver</td>
<td>1</td>
</tr>
<tr>
<td>—</td>
<td>9/64&quot; right-angle Allen wrench</td>
<td>1</td>
</tr>
<tr>
<td>—</td>
<td>O-ring Grease</td>
<td>1</td>
</tr>
</tbody>
</table>
C.2 Replace F-Mount Adapter

Before the NIRvana-LN can be attached to the IsoPlane 320, the spectroscopy-mount adapter must be installed on the camera, replacing the standard F-mount adapter.

Perform the following procedure to replace the standard F-mount adapter with the spectroscopy adapter on the NIRvana-LN:

1. Using the #2 screwdriver, remove and retain the seven (7) screws securing the F-Mount adapter to the nose of the NIRvana-LN. See Figure C-2.

Figure C-2: Removing F-Mount Adapter from NIRvana-LN Nose

2. Carefully slide the adapter away from the NIRvana-LN to remove the F-Mount Adapter from the camera.

3. Carefully position the spectroscopy adapter on the nose of the NIRvana-LN. Verify all mounting holes in the adapter align with those on the camera.

4. Replace and tighten the seven (7) screws removed in step 1.
C.3 Remove Camera Mounting Plate and Cover from IsoPlane 320

Because the NIRvana-LN includes an integrated mounting plate/flange, the camera mounting plate and shipping cover on the IsoPlane, illustrated in Figure C-3, must first be removed.

Figure C-3: IsoPlane Camera Mounting Plate and Cover

Use the 9/64” Allen wrench to remove the four (4) hex-head screws securing the camera mounting plate/shipping cover assembly to the IsoPlane.

**NOTE:**

The shipping cover and mounting plate can be removed as a single assembly/item.

Retain these four (4) screws for later use in Section C.4, Mount the NIRvana-LN on the IsoPlane 320, step 6, on page 108. See Figure C-4.
C.4 Mount the NIRvana-LN on the IsoPlane 320

Perform the following procedure to mount the NIRvana-LN onto the IsoPlane 320:

1. Carefully remove the o-ring from the spectroscopic adapter on the NIRvana-LN.
2. Apply a thin coating of o-ring grease on the entire o-ring.
3. Replace the o-ring on the adapter making sure it is fully seated within the groove on the adapter.
4. Align the NIRvana-LN spectroscopic adapter with the entrance to the IsoPlane 320 and carefully slide the camera into place.

5. Carefully rotate the NIRvana-LN until the four (4) mounting thru-holes are aligned with the four (4) threaded mounting inserts on the IsoPlane 320.
6. Place the four (4) hex-head screws removed in Section C.3, Remove Camera Mounting Plate and Cover from IsoPlane 320, on page 107 through the four (4) thru-holes on the NIRvana-LN and carefully hand-thread them into the IsoPlane 320 inserts.
7. Use a right-angle 9/64 Allen wrench to tighten the four (4) hex-head screws to secure the NIRvana-LN to the IsoPlane 320.

Figure C-6 illustrates a properly mounted and secured system.

Figure C-6: NIRvana-LN Mounted to an IsoPlane 320
This page is intentionally blank.
## Appendix D: WinX/LightField Cross Reference

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

### D.1 WinX-to-LightField Terminology

Refer to **Table D-1** for a list of WinX terms and their corresponding LightField terms.

**Table D-1: WinX-to-LightField Cross Reference (Sheet 1 of 2)**

<table>
<thead>
<tr>
<th>WinX Term</th>
<th>LightField Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Rows Parallel to Shift Register</td>
<td>Active Height</td>
</tr>
<tr>
<td>Active Shift Register Columns</td>
<td>Active Width</td>
</tr>
<tr>
<td>ADC Rate</td>
<td>Speed</td>
</tr>
<tr>
<td>ADC Resolution</td>
<td>Bit Depth</td>
</tr>
<tr>
<td>Continuous Cleans</td>
<td>Clean Until Trigger</td>
</tr>
<tr>
<td>Controller Gain</td>
<td>Analog Gain</td>
</tr>
<tr>
<td>Custom Chip</td>
<td>Custom Sensor</td>
</tr>
<tr>
<td>Custom Timing</td>
<td>Custom Timing</td>
</tr>
<tr>
<td>Disabled Closed (Shutter)</td>
<td>Always Closed (Shutter)</td>
</tr>
<tr>
<td>Disabled Open (Shutter)</td>
<td>Always Open (Shutter)</td>
</tr>
<tr>
<td>Dual Trigger Mode</td>
<td>Shift Per Trigger</td>
</tr>
<tr>
<td>Easy Bin</td>
<td>Sensor Readout Region expander functions</td>
</tr>
<tr>
<td>Edge Trigger</td>
<td>Trigger Determined By</td>
</tr>
<tr>
<td>External Sync</td>
<td>Readout Per Trigger</td>
</tr>
<tr>
<td>F.T. Dummies or Frame Transfer Dummies</td>
<td>Active Area: Top Margin</td>
</tr>
<tr>
<td>Focus</td>
<td>Preview or Run</td>
</tr>
<tr>
<td>Free Run</td>
<td>No Response</td>
</tr>
<tr>
<td>Logic Out</td>
<td>Output Signal</td>
</tr>
<tr>
<td>Logic Out: Logic 0</td>
<td>Output Signal: Always Low</td>
</tr>
<tr>
<td>Logic Out: Logic 1</td>
<td>Output Signal: Always High</td>
</tr>
<tr>
<td>Logic Out: Not Ready</td>
<td>Output Signal: Busy</td>
</tr>
<tr>
<td>Logic Out: Not Scan</td>
<td>Output Signal: Not Reading Out</td>
</tr>
<tr>
<td>WinX Term</td>
<td>LightField Term</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Logic Out: Shutter</td>
<td>Output Signal: Shutter Open</td>
</tr>
<tr>
<td>Minimum Block Size</td>
<td>Final Section Height</td>
</tr>
<tr>
<td>Normal Shutter</td>
<td>Normal (Shutter)</td>
</tr>
<tr>
<td>Number of Blocks</td>
<td>Final Section Count</td>
</tr>
<tr>
<td>Number of Cleans</td>
<td>Number of Clean Cycles</td>
</tr>
<tr>
<td>Number of Strips per Clean</td>
<td>Clean Cycle Height</td>
</tr>
<tr>
<td>Post-Dummy Rows Parallel to Shift Register</td>
<td>Active Area: Bottom Margin</td>
</tr>
<tr>
<td>Post-Dummy Shift Register Columns</td>
<td>Active Area: Right Margin</td>
</tr>
<tr>
<td>Pre-Dummy Rows Parallel to Shift Register</td>
<td>Active Area: Top Margin</td>
</tr>
<tr>
<td>Pre-Dummy Shift Register Columns</td>
<td>Active Area: Left Margin</td>
</tr>
<tr>
<td>PreOpen (Shutter)</td>
<td>Open Before Trigger (Shutter)</td>
</tr>
<tr>
<td>Readout Port</td>
<td>Quality</td>
</tr>
<tr>
<td>Shutter Close Compensation Time</td>
<td>Closing Delay</td>
</tr>
<tr>
<td>Shutter Control</td>
<td>Shutter Mode</td>
</tr>
<tr>
<td>Shutter Open Compensation Time</td>
<td>Opening Delay</td>
</tr>
<tr>
<td>Single Trigger Mode (DIF)</td>
<td>Readout Per Trigger</td>
</tr>
<tr>
<td>Skip Serial Register Clean (deselected)</td>
<td>Clean Serial Register</td>
</tr>
<tr>
<td>Target Temperature</td>
<td>Temperature Setpoint</td>
</tr>
<tr>
<td>Timing Mode</td>
<td>Trigger Response</td>
</tr>
</tbody>
</table>
### D.2 LightField to WinX

Refer to Table D-2 for a list of LightField terms and their corresponding WinX terms.

**Table D-2: LightField-to-WinX Cross Reference (Sheet 1 of 2)**

<table>
<thead>
<tr>
<th>LightField Term</th>
<th>WinX Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Area: Bottom Margin</td>
<td>Post-Dummy Rows Parallel to Shift Register</td>
</tr>
<tr>
<td>Active Area: Left Margin</td>
<td>Pre-Dummy Shift Register Columns</td>
</tr>
<tr>
<td>Active Area: Right Margin</td>
<td>Post-Dummy Shift Register Columns</td>
</tr>
<tr>
<td>Active Area: Top Margin</td>
<td>F.T. Dummies or Frame Transfer Dummies</td>
</tr>
<tr>
<td>Active Area: Top Margin</td>
<td>Pre-Dummy Rows Parallel to Shift Register</td>
</tr>
<tr>
<td>Active Height</td>
<td>Active Rows Parallel to Shift Register</td>
</tr>
<tr>
<td>Active Width</td>
<td>Active Shift Register Columns</td>
</tr>
<tr>
<td>Always Closed (Shutter)</td>
<td>Disabled Closed (Shutter)</td>
</tr>
<tr>
<td>Always Open (Shutter)</td>
<td>Disabled Open (Shutter)</td>
</tr>
<tr>
<td>Analog Gain</td>
<td>Controller Gain</td>
</tr>
<tr>
<td>Bit Depth</td>
<td>ADC Resolution</td>
</tr>
<tr>
<td>Clean Cycle Height</td>
<td>Number of Strips per Clean</td>
</tr>
<tr>
<td>Clean Serial Register</td>
<td>Skip Serial Register Clean (deselected)</td>
</tr>
<tr>
<td>Clean Until Trigger</td>
<td>Continuous Cleans</td>
</tr>
<tr>
<td>Closing Delay</td>
<td>Shutter Close Compensation Time</td>
</tr>
<tr>
<td>Custom Sensor</td>
<td>Custom Chip</td>
</tr>
<tr>
<td>Custom Timing</td>
<td>Custom Timing</td>
</tr>
<tr>
<td>Final Section Count</td>
<td>Number of Blocks</td>
</tr>
<tr>
<td>Final Section Height</td>
<td>Minimum Block Size</td>
</tr>
<tr>
<td>No Response</td>
<td>Free Run</td>
</tr>
<tr>
<td>Normal (Shutter)</td>
<td>Normal Shutter</td>
</tr>
<tr>
<td>Number of Clean Cycles</td>
<td>Number of Cleans</td>
</tr>
<tr>
<td>Open Before Trigger (Shutter)</td>
<td>PreOpen (Shutter)</td>
</tr>
<tr>
<td>Opening Delay</td>
<td>Shutter Open Compensation Time</td>
</tr>
<tr>
<td>Output Signal</td>
<td>Logic Out</td>
</tr>
<tr>
<td>Output Signal: Always High</td>
<td>Logic Out: Logic 1</td>
</tr>
<tr>
<td>Output Signal: Always Low</td>
<td>Logic Out: Logic 0</td>
</tr>
<tr>
<td>Output Signal: Busy</td>
<td>Logic Out: Not Ready</td>
</tr>
<tr>
<td>Output Signal: Not Reading Out</td>
<td>Logic Out: Not Scan</td>
</tr>
<tr>
<td>Output Signal: Shutter Open</td>
<td>Logic Out: Shutter</td>
</tr>
</tbody>
</table>
# Table D-2: LightField-to-WinX Cross Reference (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>LightField Term</th>
<th>WinX Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preview</td>
<td>Focus</td>
</tr>
<tr>
<td>Quality</td>
<td>Readout Port</td>
</tr>
<tr>
<td>Readout Per Trigger</td>
<td>External Sync</td>
</tr>
<tr>
<td>Readout Per Trigger (DIF)</td>
<td>Single Trigger (DIF)</td>
</tr>
<tr>
<td>Sensor Readout Region expander functions</td>
<td>Easy Bin</td>
</tr>
<tr>
<td>Shift Per Trigger (DIF)</td>
<td>Dual Trigger Mode (DIF)</td>
</tr>
<tr>
<td>Shutter Mode</td>
<td>Shutter Control</td>
</tr>
<tr>
<td>Speed</td>
<td>ADC Rate</td>
</tr>
<tr>
<td>Temperature Setpoint</td>
<td>Target Temperature</td>
</tr>
<tr>
<td>Trigger Determined By</td>
<td>Edge Trigger</td>
</tr>
<tr>
<td>Trigger Response</td>
<td>Timing Mode</td>
</tr>
</tbody>
</table>
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](http://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](http://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;
   - 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 foregoing 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](http://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](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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